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NASA

National Aeronautics and Space Administration

A Review of NASA

International Programs

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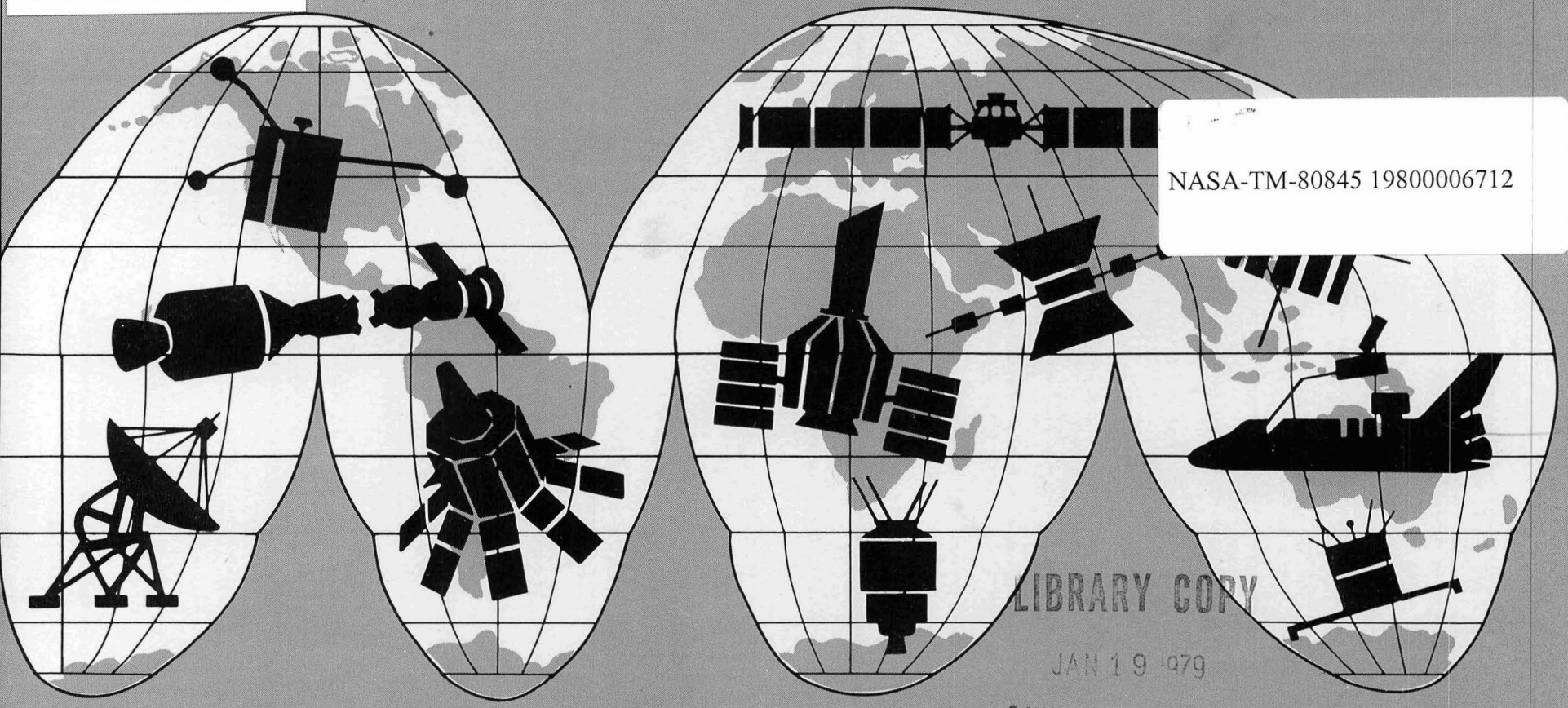

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AS OF JANUARY 1, 1979

A review of
NASA INTERNATIONAL PROGRAMS

Prepared by
The Staff of the International Affairs Division
NASA Headquarters
Washington. D. C.

IN80-14971 #

FOREWORD

During the twenty years of its existence, NASA has developed an extensive program of international cooperation involving more than 100 countries, developing as well as industrialized, in a variety of scientific and technical activities. International cooperation is an important, constructive dimension of the United States (US) space program and has helped NASA to meet the challenges of space exploration and to harness the benefits of space for mankind. The relationships established to carry out the activities described in this booklet provide a basis for continuing and expanding international cooperation in the 1980's and beyond.

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INTRODUCTION

Pursuant to the National Aeronautics and Space Act of 1958, NASA has developed an extensive program of international cooperation which has opened the entire range of its space activities to foreign participation. Cooperative programs and activities involving nations and groups of nations are established by (1) agency to agency memoranda of understanding (MOU's), (2) agency to agency letter agreements, or (3) more formal intergovernmental agreements. The relative complexity, cost, and duration of the program or project dictate in part the type of arrangement used to establish the cooperative effort. NASA's international activities demonstrate the many peaceful purposes and applications of space science and technology and provide opportunities for contribution by scientists and agencies of other countries to the tasks of increasing human understanding and use of the spatial environment. Cooperation also supports operating requirements for the launching and observation of spacecraft.

Cooperation by the United States (US) with other nations contributes to the US aeronautical and space research program and to broader national objectives by

- Stimulating scientific and technical contributions from abroad
- Enlarging the potential for the development of the state of the art
- Providing access to foreign areas of geographic significance for measurements of space flights
- Enhancing satellite experiments by foreign ground-support programs
- Developing cost-sharing and complementary space programs
- Extending ties among scientific and national communities
- Supporting US foreign relations and foreign policy

NASA's international activities follow guidelines which recognize the interests of the US and foreign scientists, establish a basis for sound programs of mutual value, and contribute substantively to the objectives of international cooperation. These guidelines provide for

- Designation by each participating government of a central civilian agency for the negotiation and supervision of joint efforts
- Conduct of projects and activities of scientific validity and mutual interest
- Agreement upon specific projects rather than generalized programs
- Acceptance of financial responsibility by each participating agency for its own contributions to joint projects
- Provision for the widest and most practicable dissemination of the results of cooperative activities

Cooperative activities have ranged from flight of foreign built spacecraft to ground-based study and analysis of data. Activities include, for example, contributions of experiments or payloads to be flown in space by NASA, joint projects to develop flight hardware, use of data or lunar samples provided by NASA for ground-based studies in other countries, operation of Earth stations by foreign entities to receive data from NASA satellites, training, visits, and joint publication of scientific results. In addition, NASA provides on a reimbursable basis certain services, including launching satellites and data and tracking services.

This booklet provides a synoptic overview of the main activities to date and identifies the cooperating countries and institutions which have been involved in NASA's international activities. It was prepared by the staff of the International Affairs Division, NASA Headquarters. To aid the reader and to increase the usefulness of this publication, measurement values are given in both SI and U.S. Customary Units and a list of commonly used acronyms and abbreviations is included as an appendix. Comments and suggestions for improvement, as well as requests for additional copies, should be directed to:

International Affairs Division
Code LI-15
NASA Headquarters
Washington, DC 20546

Cumulative Statistical Summary Through January 1, 1979

	Number Countries1 International Organizations	Number Projects/ Investigations/Actions Completed or in Progress As of January 1, 1979
COOPERATIVE ARRANGEMENTS		
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US Experiments with Foreign Co-Investigators or Team Members	11	60
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Meteorological Satellite	45 (116)**	
Geodynamics	41	
Space Plasma	38	
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Support of Manned Space Flights	21	
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Balloon Flights	7	6
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	Number Countries1 International Organizations	Number Projects1 Investigations/Actions Completed or in Progress As of January 1, 1979
REIMBURSABLE LAUNCHINGS		
Launchings of Non-US Spacecraft	10	66
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TRACKING AND DATA ACQUISITION		
NASA Overseas Tracking Stations/ Facilities	19	43
NASA Funded SAO Optical and Laser Tracking Facilities	15	20
Reimbursable Tracking Arrangements		
Support Received by NASA	4	11
Support Provided by NASA	3	31
PERSONNEL EXCHANGES		
Resident Research Associateships	45	951
International Fellowships	21	358
Technical Training	21	904
Foreign Visitors	126	68,000

*AIDSAT Demonstrations
**APT Stations

Cooperative Spacecraft Projects

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
	CANADA				
○	Alouette-I Western Test Range (WTR) Sep. 29, 1962	Thor-Agena B 1000 km Circular Near Polar	DRTE	Defense Research Telecommunications Establishment (DRTE)	Sound ionosphere from above (topside sounder) to measure its hour-to-hour electron densities.
					Determine electron density at height of satellite.
					Monitor very low frequency (VLF) noise in range of 1 to 10 kilocycles/sec.
				National Research Council of Canada (NRCC)	Measure primary cosmic ray particles outside the Earth's atmosphere.
○	Alouette-II WTR Nov. 29, 1965	Thor-Agena B 500-3000 km Near Polar	DRTE	DRTE/NRCC	Same Canadian experiments as Alouette-I.
				Goddard Space Flight Center (GSFC)	Determine electron temperature in vicinity of orbiting spacecraft.
○	International Satellite for Ionospheric Studies (ISIS-I) WTR Jan. 30, 1969	Improved Delta 500-3500 km Polar	DRTE	DRTE	Swept- and fixed-frequency topside sounders supplemented by eight additional experiments, four Canadian and four United States (US).

○ Completed Project
● Current

Cooperative Spacecraft Projects

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
	CANADA (Continued)				
○	ISIS-II WTR Mar. 31, 1971	Improved Delta 1400 km Circular Near Polar	CRC (formerly DRTE)	DOC Communications Research Center (CRC)	Swept- and fixed-frequency topside sounders supplemented by ten additional experiments, six Canadian and four US.
●	Communications Technology Satellite (CTS) Eastern Test Range (ETR) Jan. 13, 1976	Delta Equatorial Synchronous	CRC	CRC/NASA Lewis Research Center (LeRC)	Communication and broadcasting satellite transmitting in 12 GHz band at high power levels to small terminals. Design, development and operation provided by CRC; 20 W traveling wave tube (TWT) provided by ESA; 200 W TWT and launch provided by NASA. Satellite time shared by US and Canada for broadcast experiments in education, health care, community and special services, and communications technology.
	EUROPEAN SPACE AGENCY (ESA); FORMERLY ESRO*				
○	International Radiation Investigation Satellite (IRIS) (ESRO-II) WTR May 17,1968	Scout 320-870 km Near Polar	ESRO – France – Netherlands – United Kingdom (UK)	Center for Nuclear Studies, CNRS Utrecht Observatory University of Leeds University of Leicester University College, London	Integrated study of solar radiation and cosmic rays.
○	Aurorae (ESRO-I) WTR Oct. 3, 1968	Scout 260-1490 km Near Polar	ESRO – Denmark – Norway – Sweden – UK UK	Royal Technical University University of Oslo Kiruna Geophysical Observatory Queen's University, Belfast Radio and Space Research Station, Slough	Integrated study of high latitude energetic particles and their effects on the ionosphere.

*European Space Research Organization – hereinafter shown as ESA.

Cooperative Spacecraft Projects

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
	EUROPEAN SPACE AGENCY (Continued)				
	Aurorae (Continued)		UK	University College, London (2 experiments)	
●	International Sun-Earth Explorer-2 (ISEE-2) ETR Oct. 22, 1977	Delta 280-138,000 km Low Inclination	ESA – France – Italy	Paris Observatory University of Rome (ISEE-2 only)	ESA is providing daughter (ISEE-2) spacecraft to the project consisting of three coordinated spacecraft to study magnetosphere, interplanetary space, and their interaction.
●	International Ultraviolet Explorer Satellite (IUE) ETR Jan. 26, 1978	Delta Low Inclination Geosynchronous	GSFC/European Space Technology Center (ESTEC) Culham Laboratory, UK		US/ESA/UK tripartite agreement: ESA provides essential hardware and ground support for the spacecraft and telescope, which will study ultraviolet (UV) spectroscopy of stellar objects, gas clouds, planets, and comets.
●	Spacelab-I Kennedy Space Center (KSC) 1981	Space Shuttle Low Earth Orbit	ESA	NASA Marshall Space Flight Center (MSFC)	Multidisciplinary mission involving over 70 experiments and 200 investigators from 16 countries. Experiments will be conducted in stratospheric and upper atmospheric research, materials processing, plasma physics, biology, botany, medicine, astronomy, solar physics, and in technology areas such as thermodynamics and lubrication.
●	Space Telescope (ST) ETR 1983	Space Shuttle 500 km Circular	MSFC	(1) ESTEC (2) European Faint Object Camera Team Leiden Observatory, Netherlands European Southern Observatory, Chile University of Cambridge, UK	ESA is contributing to the NASA ST project: (1) the ST Solar Array; (2) one of four focal plane instruments, the Faint Object Camera, with photon event counter detector to operate in the wavelength range 120-800 nm; and (3) scientific and engineering ground operations support. ESA-sponsored astronomers will receive roughly 15% of the ST observing time.

Cooperative Spacecraft Projects

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
	EUROPEAN SPACE AGENCY (Continued)				
	Space Telescope (Continued)			Laboratory for Space Research, Netherlands University College, London, UK Laboratory for Space Astronomy, CNRS, France Royal Greenwich Observatory, UK University Observatory, Vienna, Austria University of Liege, Belgium University of Padua, Italy University of California at Berkeley, US	
o	International Solar Polar Mission ((ISPM), NASA/ESA Dual Spacecraft Mission) ETR 1983	Shuttle/Inertial Upper Stage (IUS) Planetary Out-of-Ecliptic	ESA	Jet Propulsion Laboratory (JPL)	ESA is providing one of the two ISPM spacecraft to journey out of the ecliptic plane of the solar system to conduct coordinated observations of the interplanetary medium and the Sun simultaneously, or stereoscopically, in the northern and southern hemispheres of the inner solar system.
	FRANCE				
○	FR-1 WTR Dec. 6, 1965	Scout 750 km Circular Near Polar	National Center for Space Studies (CNES)	National Center for Telecommunications Studies (CNET)	Simultaneously measure the electric and magnetic components of VLF radio emissions and measure electron densities.

Cooperative Spacecraft Projects

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
	FRANCE (Continued)				
○	Eole Wallops Island Aug. 16, 1971	Scout 680-900 km Mid Inclination	CNES	Aeronomy Service CNRS/National Meteorological Service/CNES	Determine feasibility of a satellite/balloon system to gather meteorological data on a global scale. Tests included satellite location and interrogation of instrumented balloons drifting at a constant level in the Southern Hemisphere.
	GERMANY*				
○	AZUR-I WTR Nov. 7,1969	Scout 390-3150 km High Inclination	Federal Ministry for Scientific Research (BMwF)	Max Planck Institute (MPI), Munich	Measure proton energy spectrum and omnidirectional flux.
				University of Kiel	Measure midrange energy spectrum of protons.
				MPI, Lindau	Measure electrons above 40 KeV energy threshold and higher energy spectrum of protons.
				Technical University of Braunschweig	Monitor satellite's axis with respect to geomagnetic field.
				Institute for Physics of the Atmosphere, Oberpfaffenhofen	Photometric observation of aurorae emissions at selected wavelengths.
○	Barium Ion Cloud Probe Wallops Island Sep. 20, 1971	Scout Apogee 32,000 km	BMwF	MPI, Munich/NASA Langley Research Center (LaRC)	Study the broad features of electric and magnetic fields in the magnetosphere: test the validity of barium release technique as a means of simulation of the interaction of the solar wind with an ionized comet trail, and study the behavior of an ion cloud in a collisionless plasma.

*As used in this report, Germany refers to the Federal Republic of Germany unless otherwise indicated.

Cooperative Spacecraft Projects

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
	GERMANY (Continued)				
○	AEROS WTR Dec. 16, 1972	Scout 220-860 km High Inclination	BMwF	MPI, Heidelberg	Measure number, density, and composition of neutral and ionized components; correlate data with solar extreme ultraviolet (EUV) measurements.
				Fraunhofer Institute, Freiburg	Measure energy distribution of electrons and ions, total and local ion densities.
				Ionospheric Institute, Breisach	Measure solar EUV radiation and its variations.
				GSFC	Measure total neutral density.
○○	Helios ETR (Two Flights) Dec. 10, 1974 Jan. 15, 1976	Titan-III/Centaur Heliocentric Perihelion Approx. 0.30 AU	BMwF	MPI, Munich/NASA Ames Research Center (ARC)	Measure low energy particle fluxes.
				Technical University of Braunschweig	Measure vector components of the magnetic field and magnetic fluctuations.
				University of Rome/ GSFC	Measure vector components of the magnetic fields extending range of Braunschweig experiment.
				GSFC/University of Iowa/University of Minnesota	Observe electrostatic and electromagnetic wave phenomena.
				University of Kiel	Measure protons and alpha particles.

Cooperative Spacecraft Projects

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
	GERMANY (Continued)				
	Helios (Continued)			University of Adelaide/GSFC	Measure protons and electrons. Monitor X-ray emission of Sun.
				MPI, Lindau	Detect and count electrons.
				Heidelberg State Observatory	Observe zodiacal light in white light and measure polarization.
				MPI, Heidelberg	Measure micrometeoroid flux.
				University of Hamburg/JPL	To test general relativity theory and study solar mass and orbital characteristics of the inner planets.
●	Project Galileo (formerly Jupiter Orbiter Probe (JOP)) KSC 1983	Space Shuttle and Twin IUS Planetary Trajectory	JPL	University of Bonn MPI, Heidelberg	Federal Ministry for Research and Technology (BMFT) is contributing to the NASA Project Galileo: (1) the Retro-Propulsion Module (RPM), bipropellant engines for mission maneuvers and insertion of the JOP spacecraft into Jovian orbit; and (2) sponsorship of the participation of 14 German scientists in the payload.

cooperative Spacecraft Projects

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
ITALY				
o Project "San Marco" (Phase I) Wallops Island Apr./Aug. 1963	Shotput Sub-Orbital Launches (Tests)			
o San Marco-I (Phase II) Wallops Island Dec. 15, 1964	Scout 200-820 km Low Inclination Eccentric	Italian Space Commission	School of Aerospace Engineering, University of Rome	Determine local density of upper atmosphere (Phase II) and local density of equatorial upper atmosphere (Phase III) by measuring the instantaneous aerodynamic drag on the respective satellites.
o San Marco-II (Phase III) San Marco Range* Apr. 26,1967	Scout 220-800 km Near Equatorial Eccentric		University of Florence	Ionospheric propagation studies (Faraday rotation technique) using beacon (Phase II and Phase III).
o San Marco-III San Marco Range Apr. 24,1971	Scout 200-700 km Near Equatorial	Center for Aero-space Research (CRA), University of Rome	CRA	Continue use of drag force balance to measure the local density of equatorial upper atmosphere by measuring the instantaneous aerodynamic drag on the satellite.
			GSFC	By means of mass spectrometry: (1) To measure directly the densities of molecular nitrogen, molecular oxygen, atomic oxygen, argon, and helium. (2) To measure directly the source density of molecular nitrogen.

*Towable platform in Indian Ocean equatorial waters. University of Rome also responsible for launching Scout vehicle.

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
	ITALY (Continued]				
○	San Marco-III-2 San Marco Range Feb. 18,1974	Scout 200-850 km Near Equatorial	CRA	CRA	Continue use of drag force balance to provide measurements of the diurnal variations of the equatorial neutral thermosphere density for correlation with simultaneous data on composition and temperature from NASA's Explorer-51 (Atmospheric Explorer-3).
				GSFC	Two mass spectrometers to measure directly the composition and temperature of the equatorial neutral thermosphere for correlation with data taken simultaneously on identical instrument on Explorer-51.
●●	San Marco-D (Two Spacecraft) San Marco Range 1981	Scout One at High Inclination Low Orbit; One at Near Synchronous, Highly Elliptical Orbit	CRA	CRA	On low altitude spacecraft, continue use of drag force balance to measure equatorial neutral thermosphere density. On high altitude "multistationary" spacecraft, use spinning infrared radiometer to obtain five-band measurement of ozone distribution.
				GSFC	On low altitude spacecraft, use neutral mass spectrometer to measure neutral composition, temperature and solar winds; with electric field probe, study equatorial ionospheric phenomena near equatorial electrojet.
				Fraunhofer Institute, Freiburg	Airglow spectrometer to measure day and night airglow from low altitude spacecraft.

Cooperative Spacecraft Projects

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
	NETHERLANDS				
○	Astronomical Netherlands Satellite (ANS) WTR Aug. 30,1974	Scout 500 km Near Polar	Netherlands Astronomy Satellite Program Authority	Kapteyn Astronomical Observatory	UV photometry.
				Space Research Laboratory (SRL), Leige University, Utrecht	Measure soft X-ray emissions.
				American Science and Engineering/ Massachusetts Institute of Technology (MIT)	Measure hard X-ray emissions.
•	Infrared Astronomical Satellite (IRAS) WTR 1981	Delta 900 km Circular High Inclination	Netherlands Agency for Aerospace Programs (NIVR)	(1) Universities of Groningen, Amsterdam, and Leiden, Netherlands (2) University College, London, Queen Mary College, Royal Observatory Greenwich, and Science Research Council (SRC), UK (3) Jet Propulsion Laboratory (JPL); NASA Ames Research Center (ARC); GSFC; California Institute of Technology (CalTech); and Association of Universities in Astronomy, US	A satellite to be built in the Netherlands with a cryogenically coupled infrared (IR) telescope (provided by NASA) with appropriate focal plane detectors for IR measurements in 4 bands from 8-120 μm. The objective is to produce an IR all-sky survey of discrete sources and publish results as a sky and source catalogue. UK SRC is providing the ground control and operating facility.

Cooperative Spacecraft Projects

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
	SPAIN				
○	INTASAT WTR Nov. 15, 1974	Delta (Piggyback) 500 km Circular Mid Inclination	National Institute for Aerospace Technology (INTA)	INTA	Ionospheric beacon for synoptic study of the ionosphere by ground-base observations of radio signals transmitted from the satellite.
	UNITED KINGDOM				
○	Ariel-I ETR Apr. 26, 1962	Delta 360-770 km High Inclination	GSFC	Imperial College, London	Measure spectrum of primary cosmic ray energies and its variations, with Cerenkov detector.
				University of Birmingham	Measure local electron density with radio frequency impedance probe.
				University College, London	Measure electron temperature and density with Langmuir probe.
					Measure ion mass composition and temperature with mass spectrometer.
					Measure energy spectrum of solar hard X-rays.
					Measure solar UV emissions (Lyman-Alpha).
○	Ariel-II Wallops Island Mar. 27, 1964	Scout 480-590 km High Inclination	GSFC	Meteorological Office, UK Air Ministry	Measure atmospheric ozone with filtered photocells and spectrometer.

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
	UNITED KINGDOM (Continued)				
	Ariel-II (Continued)			Mullard Radio Astronomy Observatory, University of Cambridge	Measure galactic radio noise.
				Nuffield Radio Astronomy Laboratories, Jodrell Bank	Measure micrometeoroid flux by optical detection of holes formed in a thin metallic film.
○	Ariel-III WTR May 5,1967	Scout 440-500 km High Inclination	Royal Aircraft Establishment, Farnborough	Meteorological Office, UK Air Ministry	Measure vertical distribution of molecular oxygen in Earth's atmosphere.
				University of Manchester	Measure large-scale noise sources in galaxy.
				University of Sheffield	Measure intensity of VLF radiation.
				Radio and Space Research Station, Slough	Measure intensity and geographical distribution of sources of natural terrestrial noise.
				University of Birmingham	Measure electron density and temperature.
○	Ariel-IV WTR Dec. 11, 1971	Scout 480-490 km High Inclination	SRC	University of Birmingham	Measure electron temperature.
				University of Sheffield/Radio and Space Research Station, Slough	Measure VLF radiation and lightning discharge noise.

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
	UNITED KINDOM (Continued)				
				Nuffield Radio Astronomy Laboratories, Jodrell Bank	Measure ionospheric and cosmic radio noise.
	Ariel-IV (Continued)			University of Iowa	Measure low energy proton and electron intensities.
○	Ariel-V San Marco Range Oct. 15, 1974	Scout 500 km Circular Low Inclination	SRC	Mullard Space Science Laboratory/University College, London/GSFC	Measurement of X-ray source positions and sky survey.
				University of Leicester	Conduct sky survey and examine distribution of isotropic X-ray background.
				Mullard Space Science Laboratory/University College, London/GSFC	Study of the spectra of individual stellar X-ray sources utilizing proportional counter.
				University of Leicester	Examination of the radiation of X-ray sources by means of a scattering polarimeter.
				Imperial College, London	Study of high energy X-ray sources and identification of regular periodic pulsations in the X-ray flux with the periods of known pulsars.
●	International Ultraviolet Explorer Satellite (IUE) ETR Jan. 26, 1978	Delta 48,875 km Low Inclination Geosynchronous	GSFC/ESTEC/ Culham Laboratory, UK	GSFC/Culham Laboratory, UK	US/UK/ESA tripartite agreement: UK provides essential hardware and gound support for the spacecraft and telescope, which will study UV spectroscopy of stellar objects, gas clouds, planets, and comets.

Experiments on NASA Spacecraft

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
	EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:				
	AUSTRALIA				
●	Spacelab-3 Kennedy Space Center (KSC) 1982	Space Shuttle Low Inclination Circular	NASA Marshall Space Flight Center (MSFC)	University of Sydney	To observe the aggregation of human red blood cells under conditions approaching zero gravity. Result will contribute to improved hematological diagnostics.
	BELGIUM				
○	Skylab Eastern Test Range (ETR) May 14, 1973	Saturn 430 km Circular High Inclination	MSFC	Catholic University, Louvain	Space manufacturing experiment in multipurpose furnace to study pore size and shape of melted and solidified silver grids in weightless environments.
	CANADA				
●	Long Duration Exposure Facility (LDEF) KSC 1981-1982	Space Shuttle Low Inclination Circular	NASA Langley Research Center (LaRC)	University of Toronto	Determine effects of exposure to the space environment on the mechanical properties of selected polymer matrix composite materials.

○ Completed Project
● Current

Experiments on NASA Spacecraft

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS: DENMARK				
• High Energy Astronomical Observatory-C (HEAO-C) ETR 1979	Atlas/Centaur 600 km Circular Low Inclination	MSFC	Danish Space Research Institute (DSRI) (Co-Principal Investigator with National Center for Scientific Research (CNRS), France)	Investigation of isotopic composition and atomic number of galactic incident cosmic nuclei on the periodic table between beryllium and tin.
• LDEF KSC 1981-1982	Space Shuttle Low Inclination Circular	LaRC	Royal Technical University of Denmark/Rockwell International Science Center	Crystal growth studies under prolonged zero gravity.
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS: EUROPEAN SPACE AGENCY (ESA)				
• LDEF KSC 1981 • 1982	Space Shuttle Low Inclination Circular	LaRC	European Space Technology Center (ESTEC)	US/ESA/Ireland tripartite project: investigation of the charge spectrum of cosmic ray nuclei from Z = 30 to uranium and beyond.

Experiments on NASA Spacecraft

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
	FRANCE				
	Sixteen Experiments:				
OO	Orbiting Geophysical Observatories WTR (OGO-2, OGO-4) Oct. 14, 1965 Jul. 28, 1967	Thrust-augmented Thor-Agena 400-1000 km Low Inclination	NASA Goddard Space Flight Center (GSFC)	Aeronomy Service, CNRS (Co-Experimenter with GSFC)	Measure airglow at 6300 Å, 5577 Å, 3914 Å, and in the near ultraviolet (UV) region with photometer.
O	OGO-5 ETR Mar. 4, 1968	Atlas-Agen 280-148,000 km Low Inclination	GSFC	University of Paris	Determine density and temperature of hydrogen in geocorona with hydrogen cell.
O	Orbiting Solar Observatory (OSO-5) ETR Jan. 22, 1969	Delta 550 km Circular Low Inclination	GSFC	CNRS	Measure self-reversal of the solar Lyman-Alpha spectrographic line.
O	OGO-6 WTR Jun. 5, 1969	Thorad-Agena 400-1070 km High Inclination	GSFC	University of Paris	Measure altitude distribution and width of atomic oxygen line in airglow and aurora, and derive temperature and excitation processes in the atmosphere.
OO	Apollo-16, -17 ETR Apr. 16, 1972 Dec. 6, 1972	Saturn V Lunar Trajectory	Manned Spacecraft Center (MSC); now NASA Johnson Space Center (JSC)	Center for space Studies of Radiation (collaborative with University of Frankfurt- see Germany)	Measurement of effects on selected biosystems of bombardment by heavy nuclei of primary cosmic radiation during manned flight operations. (BIOSTACK experiment)

Experiments on NASA Spacecraft

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:					
	FRANCE (Continued)				
○	Skylab ETR May 14, 1973	Saturn 430 krn Circular High Inclination	MSFC	Laboratory for Space Astronomy, CNRS	Provide general sky survey, improve classification of hot young stars up to tenth magnitude, obtain a luminosity distribution of nearby galaxies and investigate distribution of ionized hydrogen.
○	OSO-8 ETR Jun. 21, 1975	Delta 550 km Circular Low Inclination	GSFC	University of Paris/ Laboratory of Stellar and Planetary Physics, CNRS	Study the chromosphere fine structure by means of simultaneous high resolution observations of the profile of Lyman-Alpha and Beta, Magnesium II and Calcium H and K lines.
○	Apollo-Soyuz Test Project (ASTP) ETR Jul. 15, 1975	Saturn IB 230 km Circular High Inclination	JSC	Paul Sabatier University (Co-Investigator with University of Frankfurt, Germany)	Measurement of effects on selected biosystems of bombardment by heavy nuclei of primary cosmic radiation during manned flight operations. (BIOSTACK experiment)
●	International Sun-Earth Explorer (ISEE-1 and ISEE-2) NASA/ESA ETR Oct. 22, 1977	Delta 280-138,000 krn Low Inclination	GSFC	Paris Observatory	Measure the integrated electron density between ISEE-1 and ISEE-2 spacecraft with very high time resolution using a radio pulsar on ISEE-1 and a receiver on ISEE-2.

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:				
FRANCE (Continued)				
● NASA Heliocentric Mission (ISEE-3) ETR Aug. 12, 1978	Delta Halo Orbit Heliocentric	GSFC	Meudon Observatory	Study three dimensional mapping of the solar wind magnetic field.
● Pioneer Venus-2 ETR Aug. 8,1978	Atlas/Centaur Planetary Trajectory	ARC	Aeronomy Service, CNRS (Co-Principal Investigator with ARC)	Study the vertical extent, structure, and distribution of the clouds of Venus using a nephelometer.
● TIROS-N WTR Oct. 13, 1978	Atlas F Near Polar Circular	GSFC	National Center for Space Studies, CNES	Demonstrate French Satellite Data Collection System (ARGOS) on TIROS-N for use in polar orbiting meteorological satellites. Provide systems for NOAA operational satellites in the TIROS-N series.
● High Energy Astronomical Observatory-C (HEAO-C) ETR 1979	Atlas/Centaur 600 km Circular Low Inclination	MSFC	Center for Nuclear Studies, CNRS (Co-Principal Investigator with DSRI)	Investigation of isotopic composition and atomic number of galactic incident cosmic nuclei on the periodic table between beryllium and tin.
● LDEF KSC 1981-1982	Space Shuttle Low Inclination Circular	LaRC	CNRS	Investigation of long term space exposure on thin metal film and evaporated cathodes, optical coatings, holographic gratings, thermal coatings, structural materials, and optical fibers.

Experiments on NASA Spacecraft

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
	EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:				
	GERMANY				
	Fourteen Experiments:				
∞	Apollo-16, -17 ETR Apr. 16, 1972 Dec. 6, 1972	Saturn V Lunar Trajectory	JSC	Frankfurt University1 Center for Space Studies of Radiation	Measurement of effects on selected biosystems of bombardment by heavy nuclei of primary cosmic radiation during manned flight operations. (BIOSTACKS I & II)
∞	ASTP ETR Jul. 15, 1975	Saturn IB 230 km Circular High Inclination	JSC	Frankfurt University Max Plack Institute (MPI), Martinsried	BIOSTACK III - Measurements similar to BIOSTACKS I & II. Study of electrophoretic separation of blood fractions under zero gravity.
●	ISEE-1 and ISEE-2 (NASA/ESA Dual Spacecraft Mission) ETR Oct. 22, 1977	Delta 280-138,000 km Low Inclination	GSFC	MPI, Munich	Investigation of nuclear and ionic charge distribution as a function of energy range (5 KeV-20 MeV).
●	NASA Heliocentric Mission (ISEE-3) ETR Aug. 12,1978	Delta Halo Orbit Heliocentric	GSFC	MPI, Munich	Investigation of nuclear and ionic charge distribution as a function of energy range (5 KeV-20 MeV).

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:				
GERMANY (Continued)				
o Pioneer Venus-2 ETR Aug. 8, 1978	Atlas/Centaur Planetary Trajectory	ARC	University of Bonn	Neutral mass spectrometer measurements of the number densities of various atmospheric constituents and their altitude dependence in the upper atmosphere of Venus.
oo LDEF KSC 1981-1982	Space Shuttle Low Inclination Circular	LaRC	Messerschmitt-Boelkow-Blohm, Munich	Investigation of the combined effect of radiation and contamination on different thermal coatings and of solar cells.
			University of Frankfurt	Investigation of the biological effectiveness of the structured components of cosmic radiation during space flight.
oo Project Galileo (formerly Jupiter Orbiter Probe (JOP)) KSC 1982	Space Shuttle and Twin Inertial Upper Stage (IUS) Planetary Trajectory	JPL	University of Bonn	Precise determination of the helium abundance in the atmosphere of Jupiter at the levels 3-10 bars through use of an optical interferometer for refractive index measurements on atmospheric samples.
			MPI, Heidelberg	Determination of the physical and dynamic properties of small dust particles in the environs of Jupiter with emphasis on interaction of dust with the magnetosphere and satellite surfaces.
oo International o Solar Polar Mission (ISPM) KSC 1983	Space Shuttle IUS Planetary Trajectory Out-of-the-Ecliptic	JPL	Ruhr University, Eochurn	Zodiacal light experiment.
			MPI, Lindau	Mass separating solar wind experiment. Interstellar gas measurement.

Experiments on NASA Spacecraft

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:					
	INDIA				
●	Spacelab-I KSC 1981	Space Shuttle Low Inclination	MSFC/ESTEC	Tata Institute of Fundamental Research (TIFR)	Studies on the ionization states of solar and galactic cosmic ray heavy nuclei.
	IRELAND				
●	LDEF KSC 1981-1982	Space Shuttle Low Inclination Circular	LaRC	Dublin Institute for Advanced Studies	US/Ireland/ESA tripartite project: investigation of the charge spectrum of cosmic ray nuclei from Z = 30 to uranium and beyond.
	ITALY				
○	OSO-6 ETR Aug. 9, 1969	Delta 550 km Circular Low Inclination	GSFC	University of Bologna	Solar X-ray monitoring and gamma ray astronomy in the energy range 20-200 KeV.
	JAPAN				
○	Skylab ETR May 14,1973	Saturn 430 km Circular High Inclination	MSFC	Japanese National Research Institute for Metals	Space manufacturing experiment to study in multipurpose furnace in weightless environments the production of silicon carbide whisker-reinforced composite metals.

Experiments on NASA Spacecraft

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:					
	JAPAN (Continued)				
●	Spacelab-I KSC 1981	Space Shuttle High Inclination Circular	MSFC	University of Tokyo	Space Experiment with Particle Accelerators (SEPAC)- major space plasma physics facility for active and interactive experiments in the ionosphere and magnetosphere.
	NETHERLANDS				
	Three Experiments:				
○	OGO-5 ETR Mar. 4, 1968	Atlas-Agena 280-148,000 km Low Inclination	GSFC	Delft Technical Institute	Six-counter telescope to measure absolute flux and energy spectrum of cosmic ray electrons.
●	NASA Heliocentric Mission ISEE-3 ETR Aug. 12,1978	Delta Halo Orbit Heliocentric	GSFC	Space Research Laboratory (SRL), University of Utrecht	Measurement of energetic electrons and protons at E > 20 KeV.
●	Solar Maximum Mission (SMM) 1979	Delta Low Inclination Circular	GSFC	SRL, University of Utrecht (Co-Experimenter with the University of Birmingham)	US/Netherlands/United Kingdom (UK) tripartite project: hard X-ray imaging spectrometer.

Experiments on NASA Spacecraft

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
	EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:				
	ROMANIA				
●	Drop Dynamics Module Spacelab-3 KSC 1982	Space Shuttle Low Earth Orbit High Inclination	MSFC	Babes-Bolyai University	Space processing experiment to investigate the surface flow of liquids in the absence of gravity.
	SWITZERLAND				
	Eight Experiments:				
○○ ○○○	Apollo-11, -12, -14, -15, -16 ETR Jul. 16, 1969 Nov. 14, 1969 Jan. 31, 1971 Jul. 26, 1972 Apr. 16, 1972	Saturn V Lunar Trajectory	MSC	University of Bern	Experiment to measure composition of solar wind by trapping solar wind ions on sheet of aluminum foil deployed by astronaut and returing foil to Earth for analysis.
○	Skylab ETR May 14, 1973	Saturn 430 km Circular High Inclination	MSFC	University of Bern	Spectroscopic analysis of solar wind composition.

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:				
SWITZERLAND (Continued)				
● LDEF KSC 1981-1982	Space Shuttle Low Inclination Circular	LaRC	University of Bern	Collection and mass spectroscopic analysis of interstellar noble gas atoms.
● ISPM KSC 1983	Space Shuttle IUS Jupiter Swing-by Trajectory	JPL	University of Bern	Solar wind ion composition spectrometer.
UNITED KINGDOM				
Twenty-one Experiments:				
○ Explorer-20 WTR Aug. 25, 1964	Scout 870-1020 km Near Polar	GSFC	University College, London	Measure ion mass composition and temperature with ion mass spectrometer. (Similar experiment on Ariel-I.)
○○ Explorer-31 (Direct Measurement Explorer) WTR Nov. 29,1965	Thor-Agena B 500-3000 km High Inclination (Piggyback with Alouette-II)	GSFC	University College, London	Measure ion mass composition and temperature with spherical ion mass spectrometer. (Similar experiment on Ariel-I.) Measure electron temperature with planar electron temperature probe.

Experiments on NASA Spacecraft

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:					
	UNITED KINGDOM (Continued)				
∞	OSO-4 ETR Oct. 18, 1967	Delta 550 km Circular Low Inclination	GSFC	University of Leicester/ University College, London	Measure distribution of total solar X-ray emission over a wide band.
				University College, London	Study solar He I and He II resonance emission (304 Å)
∞	OGO-5 ETR Mar. 4, 1968	Atlas-Agena 280-138,000 km Low Inclination	GSFC	University College, London	Spherical probe to measure electron density and temperature.
				University of Southampton	Spark chamber to measure direction of incidence of uncharged primary cosmic rays.
○	OSO-5 ETR Jan. 22, 1969	Delta 550 km Circular Low Inclination	GSFC	University of Leicester/ University College, London	Measure solar X-ray flux with spectroheliograph.
○	OSO-6 ETR Aug. 9, 1969	Delta 550 km Circular Low Inclination	GSFC	University College, London	Study of Solar He I and He II resonance radiation by means of a twin-line monochromator.
○	Nimbus-4 ETR Apr. 8, 1970	Thor-Agena 1100 km Circular High Inclination	GSFC	Reading University1 Oxford University	Selective chopper radiometric temperature probe.

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:					
	UNITED KINGDOM (Continued)				
○	Orbiting Astronomical Observatory (OAO-3) ETR Aug. 21, 1972	Atlas-Centaur 740 km Circular Mid Inclination	GSFC	University College, London/University of Leicester	Study the X-ray emission of stars and nebulae and obtain information on the interstellar absorption of He and the heavier elements.
○	Nimbus-5 ETR Dec. 11,1972	Delta 1100 km Circular High Inclination	GSFC	Heriot Watt University Oxford University	Selective chopper radiometer for water vapor, cloud, and atmospheric temperature sounding.
○	Nimbus-6 WTR Jun. 12,1975	Delta 1100 km Circular High Inclination	GSFC	Oxford University	Pressure modulated carbon dioxide radiometer for upper atmosphere temperature sounding.
●	TIROS-N WTR Oct. 13, 1978	Atlas F 830 km Circular Near Polar	GSFC	Meteorological Office, UK Air Ministry	Provide a stratospheric sounding radiometer system to demonstrate this technology for use in future operational meteorological satellite systems. Provide future systems to NOAA for future operational satellites in the TIROS-N series.
●	Nimbus-7 WTR Oct. 24, 1978	Delta 955 km Circular Near Polar	GSFC	Oxford University	Radiometer for stratospheric and mesospheric sounding.

	Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
	EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:				
	UNITED KINGDOM (Continued)				
●	SMM 1979	Delta Circular Low Inclination	GSFC	University of Birmingham (Co-Experimenter with SRL, University of Utrecht)	US/UK/Netherlands tripartite project: hard imaging X-ray spectrometer.
●●	LDEF KSC 1981-1982	Space Shuttle Circular Low Inclination	LaRC	University of Reading	Investigation of effects of exposure to the space environment of high performance infrared multilayer filters.
				Kent University	Investigation of erosion effects by exposure of multiple foil arrays.
●●	Spacelab-2 KSC 1982	Space Shuttle High Inclination	MSFC	University of Birmingham	Hard X-ray imaging of clusters of galaxies and other extended X-ray sources.
				Appleton Laboratory and University College, London	Determination with high accuracy of the absolute abundance of helium in the solar corona.
●	Atmospheric Cloud Physics Laboratory KSC 1982	Space Shuttle Orbit To Be Determined	MSFC	University of Manchester	Water droplet freezing in conditions approaching zero gravity.

Experiments on NASA Spacecraft

	Project and Date	Country	Co-Experimenter's1 Team Member's Affiliation	Experiment
	US EXPERIMENTS WITH FOREIGN CO-INVESTIGATORS OR TEAM MEMBERS:			
OO OO	Pioneers 6-9 Dec. 16, 1965 Aug. 17,1966 Dec. 13, 1967 Nov. 8, 1968	India	Physical Research Laboratory (PRL), Ahmedabad	GSFC: Cosmic ray anisotropy.
O	Gemini-9 Jun. 3, 1966	Israel	Tel Aviv University	Dudley Observatory: Micrometeorite collection.
O	Gemini-10 Jul. 18, 1966	Germany	MPI, Heidelberg	Dudley Observatory: Micrometeorite collection.
OO	Gemini-12 Nov. 11, 1966	United Kingdom	Birkbeck College University of London	Dudley Observatory: Micrometeorite collection.
		Israel	Tel Aviv University	Dudley Observatory: UV imaging of dust in upper atmosphere.
O	Pioneer-8 Dec. 13, 1967	Italy	University of Rome University of Aquila	GSFC: Flux gate magnetometer.
O	OGO-6 Jun. 5,1969	France	University of Paris	University of Pittsburgh: Sodium airglow.
O	Apollo-11 Jul. 16, 1969	Australia	University of Sydney	MSC: Data analysis of lunar dust.

Experiments on NASA Spacecraft

	Project and Date	Country	Co-Experimenter's/ Team Member's Affiliation	Experiment
	US EXPERIMENTS **WITH** FOREIGN CO-INVESTIGATORS OR TEAM MEMBERS:			
○	Apollo-12 Nov. 14, 1969	Australia	University of Sydney	MSC: Detector experiments on early Apollo Surface Experiments Package (EASEP) on Apollo-11 and Apollo Lunar Surface Experiments Package (ALSEP) on Apollo-12.
○	Apollo-16 Apr. 16, 1972	Germany	University of Frankfurt	JSC: Microbial ecology evaluation device.
o	Meteoroid Technology Satellite Aug. 13, 1972	Germany	MPI, Heidelberg	ARC: Cosmic dust detectors.
○○	Pioneer-10, -11 Mar. 3, 1972 Apr. 16, 1973	Germany Australia	MPI, Munich University of Adelaide	ARC: Plasma detector. GSFC: Cosmic rays.
○○	Interplanetary Monitoring Platform (IMP) IMP-H Sep. 22, 1972 IMP-J Oct. 25, 1973	Germany	MPI, Munich	University of Maryland: Very low energy cosmic ray composition.
○	Skylab May 14,1973	Switzerland	University of Bern	JSC: Magnetospheric particle composition.
○	Mariner-10 Nov. 3,1973	France United Kingdom	Paris Observatory University of London	JPL: Television science team. JPL: Television science team.

Experiments on NASA Spacecraft

	Project and Date	Country	Co-Experimenter's/ Team Member's Affiliation	Experiment
	US EXPERIMENTS WITH FOREIGN CO-INVESTIGATORS OR TEAM MEMBERS:			
○○ ○	Atmospheric Explorer-C, -D, & -E Dec. 16, 1973 Oct. 6, 1975 Nov. 19, 1975	United Kingdom	York University	University of Michigan: Airglow photometer.
○○	Helios Dec. 10, 1974 Jan. 15, 1976	Australia Italy	University of Adelaide University of Rome	GSFC: Cosmic rays. GSFC: Flux gate magnetometer.
○	OSO-8 Jun. 21, 1975	United Kingdom	University College, London	Lockheed Palo Alto Research Laboratory: Mapping X-ray heliometer.
○○	ASTP Jul. 15, 1975	Germany	University of Mainz University of Frankfurt	JSC: Killifish hatching and orientation. Lawrence Radiation Laboratory: Light flash and charged particle correlations.
○○	Viking -1 and -2 Aug. 20, 1975 Sep. 9, 1975	United Kingdom	Nuffield Radio Astronomical Laboratories, Jodrell Bank	LaRC: Radio Science Team.
●● ●	Voyager-I and Voyager-2 (Formerly Mariner Jupiter/Saturn) Aug. 20,1977 Sep. 5, 1977	Germany France United Kingdom	Technical University of Braunschweig University of Paris Meteorological Office, UK Air Ministry	GSFC: Magnetometer. University of Colorado: Planetary radio astronomy team. New Mexico State University: Imaging science team.

Experiments on NASA Spacecraft

Project and Date	Country	Co-Experimenter's1 Team Member's Affiliation	Experiment
US EXPERIMENTS WITH FOREIGN CO-INVESTIGATORS OR TEAM MEMBERS:			
ISEE-1 (NASA/ESA Dual Spacecraft Mission) Oct. 22, 1977	France	Paul Sabatier University	University of California at Berkeley: Energetic particles.
	Sweden	Royal Institute of Technology	University of California at Berkeley: Quasi-static electric field.
	Germany	MPI, Munich	Lockheed Palo Alto Research Laboratory: Plasma composition.
	Switzerland	University of Bern	Lockheed Palo Alto Research Laboratory: Plasma composition.
Pioneer Venus-1 (Orbiter) May 20,1978	United Kingdom	Oxford University	JPL: Radiometric temperature sounding.
	Germany	Institute for Space Physics-Freiburg	Lockheed Palo Alto Research Laboratory: Retarding potential analyzer.
	ESA	ESTEC	GSFC: Langmuir probe.
Pioneer Venus-2 (Multiprobe) Aug. 8,1978	France	University of Lille	University of Wisconsin: Solar flux and atmospheric absorption.
ISEE-3 Aug. 12,1978	Switzerland	University of Bern	GSFC: Solar wind composition.
Nimbus-7 Oct. 24, 1978	United Kingdom	National Physical Laboratory,	LaRC: Limb Infrared (IR) Monitor of the Stratosphere (LIMS).
	Germany	British Aerospace	GSFC: Scanning multichannel microwave radiometer.
		University of Munich	LaRC: Limb IR Monitor of the Stratosphere.
SMM 1979	United Kingdom	University College, London	Lockheed Palo Alto Research Laboratory: X-ray polychromator for solar flare studies.
	Germany	MPI, Munich	University of New Hampshire: Solar gamma ray observations.
Spacelab-1 1981	Canada	Defense and Civil Institute of Environmental Medicine and McGill University	Massachusetts Institute of Technology (MIT): Vestibular experiments in Spacelab.
	France	Laboratory for Space Astronomy (LAS), CNRS	University of California at Berkeley: Far UV observations using the FAUST (Far UV Space Telescope) instrument on the Spacelab-1 mission.

Experiments on NASA Spacecraft

Project and Date	Country	Co-Experimenter's/ Team Member's Affiliation	Experiment
US EXPERIMENTS WITH FOREIGN CO-INVESTIGATORS OR TEAM MEMBERS:			
Project Galileo 1982	Germany	Technical University of Braunschweig	Bell Labs/University of Florida: Lightning and 1 Hz to 100 KHz radio waves.
		MPI, Lindau	
		MPI, Lindau	University of Iowa: Jovian plasma investigation.
		MPI, Garching	NOAA: Jovian orbital magnetospheric particles instrument.
		University of Munich	JPL: Imaging team.
	France	CNES	ARC: Cloud nephelometer.
		CNES	University of Iowa: Jovian plasma investigation.
		Meudon Observatory	JPL: Near IR mapping spectrometer.
	Canada	University of Calgary	JPL: Imaging team.
Space Telescope 1983	Canada	Dominion Astrophysical Observatory	GSFC: High resolution spectrometer.
	United Kingdom	Cambridge University	Interdisciplinary scientists.
ISPM 1983	France	Paris Observatory	High Altitude Observatory: X-ray and white-light coronagraph.
	Germany	MPI, Garching	CalTech: Comprehensive particle analysis system.

Experiments on NASA Spacecraft

Project and Date	Country	Co-Experimenter's/ Team Member's Affiliation	Experiment
US EXPERIMENTS WITH FOREIGN CO-INVESTIGATORS OR TEAM MEMBERS:			
ISPM (Continued)	France	Paris Observatory Center for Research on the Physics of the Environment Laboratory for External Geophysics	GSFC: Unified radio and plasma wave experiment.
	Germany	Technical University of Braunschweig MPI, Lindau University of Bonn	GSFC: Magnetic field experiment.
	Italy	National Research Council (CNR)	GSFC: Magnetic field experiment.

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
ARGENTINA			
National Commission for Space Research (CNIE)	2 Nike-Cajun above 90 km	Chamical, Argentina Dec. 1964	National University of Tucuman: Measure D and E region electron density and temperature, ion density and ultraviolet (UV) radiation.
	12 Arcas 60 km	Tartagal, Argentina Nov. 1966	Atmospheric Sciences Laboratory/CNIE: Observe changes in wind, temperature, and ozone in the upper atmosphere associated with the total solar eclipse of November 12, 1966.
	3 Orion 85 km	Wallops Island Nov. 1966	CNIE: Obtain data on vehicle flight performance characteristics for Argentine-built sounding rockets.
	2 Nike-Apache 90-140 km	Chamical Sep. 1967	National University of Tucuman: Investigate physical processes producing sporadic E.
	38 Boosted Dart and Arcas 48 Boosted Dart and Arcas 17 Boosted Dart 24 Boosted Dart 10 Boosted Dart 9 Boosted Dart 27 Boosted Dart 50 Boosted Dart 27 Boosted Dart* up to 65 km	Chamical Apr. 1966-Apr. 1968 Mar Chiquita, Argentina May 1968-Dec. 31, 1971 1972 1973 1974 1975 1976 1977 1978	CNIE: Project constitutes one element of Experimental Inter-American Meteorological Sounding Rocket Network (EXAMETNET). In May 1968, CNIE moved EXAMETNET operations from Chamical to the Argentine Atlantic range near Mar Chiquita.

*As of November 1978

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
AUSTRALIA			
Department of Supply	4 Skylark 200 km	Woomera, Australia Sep. - Nov. 1961	NASA Goddard Space Flight Center (GSFC): Measure stellar and nebular UV radiation in southern skies. Compare with northern hemisphere data.
Commonwealth Scientific and Industrial Research Organization (CSIRO)	2 Aerobee 150 A 2 Aerobee 150 A above 120 km	Wallops Island Nov. - Dec. 1962 Apr. - May 1963	CSIRO: Measure very low frequency (VLF) radio noise in the ionosphere.
Department of Supply	3 Aerobee 150 205 km	Woomera May - Jun. 1970	Manned Spacecraft Center (MSC), now NASA Johnson Space Center (JSC)/University of Wisconsin/University of Adelaide/ University of Tasmania: Measure X-ray and UV radiation from selected stars in southern skies.
Department of Supply	7 Aerobee 170 175 km	Woomera Nov. 1973	Massachusetts Institute of Technology (MIT)/CalTech/University of Wisconsin/Naval Research Laboratory: X-ray studies of sources unique to the southern skies.
University of Adelaide/Australian Department of Defense (ADOD)	7 Aerobee 175 km	Woomera Feb. 1977	University of Adelaide/Johns Hopkins University/Columbia University/Naval Research Laboratory: X-ray and UV studies of sources unique to the southern skies.
BRAZIL			
National Commission for Space Research (CNAE)	1 Nike-Apache 80 km 2 Nike-Apache 80 km	Wallops Island Aug. 1965 Natal, Brazil Dec. 1965	CNAE/GSFC: Evaluate cosmic ray effects on the lower D region of the ionosphere.

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
BRAZIL (Continued)			
CNAE (Continued)	64 Boosted Dart and Arcas 12 Boosted Dart	Natal Jan. 1, 1966-Dec. 31, 1971 1972	CNAE: Project constitutes one element of EXAMETNET, an experimental research network to obtain high altitude data.
	9 Nike-Cajun 13 Nike-Cajun 3 Nike-Cajun 40-100 km	Natal May - Dec. 1966 Jun. - Dec. 1967 Mar. 1968	CNAE/GSFC: Measure wind, temperature, pressure, and density using grenade technique.
	1 Black Brant IV 2 Black Brant IV approx. 800 km	Natal Jun. 1968 Sep. 1970	GSFC/MSC: Measure dynamics of inner radiation belts in South Atlantic Anomaly region.
	1 Black Brant IV 1 Black Brant IV approx. 800 km	Natal Jun. 1969 Sep. 1969	Cambridge Research Laboratory/MSC: Investigate reflection, absorption, and transmission of radio waves in the ionosphere, near the Geomagnetic Equator.
	1 Nike-Apache 1 Nike-Tomahawk 17 Nike-Hydac 1 Nike-Javelin 180-700 km	Cassino, Brazil Nov. 1966	CNAE/GSFC: Various United States (US) and Brazilian experimenters: Study the effects of the solar eclipse of November 12, 1966 on the Earth's atmosphere. Investigate solar X-ray source functions.
	1 Aerobee 150 205 km	Natal Dec. 1966	Catholic University: Identify new X-ray sources in the Southern Hemisphere.
	1 Nike-Tomahawk approx. 350 km	Natal Mar. 1967	University of New Hampshire: Measure intensity of cosmic particles, flux, Lyman-Alpha radiation, and ionospheric electron density.

Country and Cooperation Agency	Number, Type of Rocket, and Altitude	Launch.Site and Date	Experimenter and Project Description
BRAZIL (Continued)			
CNAE (Continued)	2 Javelin approx. 1000 km	Natal Jun. 1967	US/Brazil/Germany tripartite agreement: MPI, Lindau/University of Kiel/MPI, Munich/Technical University of Braunschweig. Flight test instrumentation for the German research satellite AZUR and investigate proton and electron energy spectra, proton flux, and solar and galactic alpha particles.
	1 Aerobee 150 205 km	Natal Nov. 1967	Cambridge Research Laboratory: Measure day airglow emissions in equatorial regions.
	2 Nike-Iroquois 70-160 km	Natal Nov. 1967	Cambridge Research Laboratory: Engineering tests of payloads to measure meteoriod flux in upper atmosphere.
	4 Nike-Iroquois 70-160 km	Natal Aug. 1968	Cambridge Research Laboratory: Measure meteoroid flux in the upper atmosphere with recoverable payloads.
	2 Aerobee 150 205 km	Natal Jun. 1969	CNAE: Examine celestial X-ray emission sources in Southern Hemisphere.
	1 Javelin approx. 1000 km	Natal Jun. 1969	Southwest Center for Advanced Studies: Determine the ion composition of the F region of the ionosphere.
	1 Aerobee 150 205 km	Natal Mar. 1969	Cambridge Research Laboratory: Determine infrared (IR) profile of Earth's horizon in equatorial region.
	1 Black Brant IV approx. 800 km	Natal Sep. 1969	MSC/Lawrence Radiation Laboratory: Determine measurements of the charge particles environment in the South Atlantic Anomaly region.
	4 Black Brant V-C	Natal Jan.-Feb. 1973	CNAE: Atmospheric soundings in support of AEROS Satellite.

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
BRAZIL (Continued)			
Institute of Space Research (INPE), Formerly CNAE	24 Boosted Dart	Natal 1973	INPE: Continuation of EXAMETNET.
	14 Boosted Dart	1973	
	22 Boosted Dart	1974	
	6 Boosted Dart	1975	
	19 Boosted Dart	1976	
	34 Boosted Dart	1977	
	7 Boosted Dart*	1978	
	11 Boosted Dart up to 65 km	Marambaia, Brazil 1976	
National Council on Scientific and and Technological Development (CNPq)	2 Javelin approx. 1000 km	Natal Nov. 1973	US/Brazil/Germany tripartite agreement: MPI, Munich1 University of California at Berkeley/INPE. To continue barium cloud studies under spread-F conditions.
Commission for Space Activities (COBAE)	Up to 30 meteorological and up to 30 ozone rockets per year	Natal Nov. 1978-1980	Nimbus-7 and Stratospheric Aerosol and Gas Experiment (SAGE) atmospheric research calibration and verification of satellite sensor measurements.
CANADA			
National Research Council of Canada (NRCC)	6 Black Brant III 100 km	Wallops Island Jun./Dec. 1962	NRCC: Determine vehicle flight performance characteristics and obtain engineering data on effectiveness of instrumentation. Cosmic ray sensor and magnetometer included. (Churchill Research Range Facilities inoperative during this period due to fire damage.)

*As of November 1978

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
CANADA (Continued)			
NRCC (Continued)	176 NASA-Sponsored Launchings	Churchill Research Range, Canada Jan. 1966-Dec. 1976	NRCC/GSFC: Various Canadian and US experimenters use the range for launching sounding rockets in auroral zone to study atmospheric and ionospheric phenomena.
	Approx. 5 per year	1977	
	2 Boosted Arcas	Resolute Bay, Canada Oct. 1967	NRCC/GSFC: Study polar cap absorption events and D region ionosphere and measure height profile of high energy protons.
	2 Boosted Arcas	Aug. 1968	
	1 Boosted Arcas 100 km	Oct. 1969	
	1 Black Brant IV approx. 800 km	Wallops Island May 1968	Defense Research Telecommunications Establishment (DRTE): Flight test instrument designed for International Satellite for Ionospheric Studies (ISIS-A) to investigate VLF noise in one to ten kilocycle range.
	3 Nike-Tomahawk approx. 350 km	Cape Parry, Northwest Territory Mar. 1969	GSFC: Study ionospheric currents, upper atmosphere wind variations, and electric fields by the barium release technique.
	1 Black Brant V-C approx. 300 km	Churchill Research Range Feb. 1978	NRCC/National Oceanic and Atmospheric Administration (NOAA)/Max Planck Institute (MPI), Lindau: Investigation to explore electric fields directed parallel to the geomagnetic field at high latitudes.
DENMARK			
Danish Research Administration (DRA)	2 Nike-Tomahawk approx. 250 km	Sdndre Strdmfjord, Greenland Jul. 1974	Danish Meteorological Institute/University of Texas: Electric and magnetic fields and energetic particle measurements in the polar cusp region of the ionosphere.

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
DENMARK (Continued)			
Danish Space Research Institute (DSRI)	2 Nike-Tomahawk approx. 250 km	Søndre Strdmfjord Aug. 1976	DSRI/University of California at Berkeley: Continue investigations of the polar cusp region of the ionosphere with electric field, low-energy particle electron density and temperature and magnetic field measurements.
DRA	2 Nike-Tomahawk approx. 250 km	Fairbanks, Alaska Feb. 1978	Danish Meteorological Institute/Cornell University: Study of coupling between ionized and neutral components of the thermosphere using chemical release techniques.
EUROPEAN SPACE AGENCY (ESA)	1 Aerobee 200 approx. 300 km	White Sands, New Mexico Oct. 1974	European Space Technology Center (ESTEC)/GSFC: Demonstrate and study start-up behavior and thermal performance of various heat pipe designs under zero gravity.
FRANCE			
National Center for Space Studies (CNES)	2 Aerobee 150 2 Aerobee 150 above 280 km	Wallops Island Oct. 1963 Sep. 1965	National Center for Telecommunications Studies (CNET): Study irregularities in the ionosphere through simultaneous measurements of VLF field strength and local electron density.
	2 French Dragon approx. 400 km 2 French Centaure approx. 190 km	Hammaguir, Algeria Apr. 1964	CNES/GSFC: Simultaneously measure charged particle and neutral gas temperatures in the ionosphere.
	1 Aerobee 150 1 Aerobee 150 1 Aerobee 150 approx. 280 km	White Sands, New Mexico Nov. 1964 Nov. 1965 Jun. 1967	National Center for Scientific Research (CNRS): One of experimenters providing special sampling surfaces to collect and analyze extraterrestrial dust particles as part of Project Luster.

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
FRANCE (Continued)			
CNES (Continued)	4 Nike-Cajun 12 Nike-Cajun approx. 75 km 3 French Centaure approx. 120 km	Kourou, French Guiana Mar. 1971 Sep. 1971 Sep. 1971	CNES/GSFC: Measurement of thermodynamic structure and circulation of equatorial atmosphere between 30 and 95 km and the flow of atmospheric tides.
	3 Arcas approx. 60 km	Kerguelen Islands Feb. 1972	CNES/University of Houston: Measurement of X-ray flux due to precipitating electrons during periods of intense VLF chorus activity.
National Meteorology Agency (MN)	8 Super-Arcas approx 150 km 10 Loki-Dart approx. 60 km	Wallops Island Mar. 1972	MN/Wallops Station: World Meteorological Organization (WMO) sponsored sounding rocket intercomparison tests among France, Japan, and NASA to improve the correlation of data returned by independent future launchings of various rocket systems.
CNES	1 Nike-Apache 1 Indian Centaure approx. 120-150 km	Thumba, India Oct. 1972 Sep. 1973	CNES/GSFC/Department of Space (DOS): Describe steady-state electrojet and study plasma instabilities by means of simultaneous launchings of magnetometers, Langmuir and resonance probes, and electric fields payloads.
	14 Super-Arcas approx. 150 km 21 Super-Loki approx. 75 km	Kourou Sep. 1973	MN/Wallops Station: WMO sponsored intercomparison tests among France, United Kingdom (UK), Union of Soviet Socialist Republics (USSR), and NASA to improve the correlation of data returned by independent future launchings of various rocket systems.
	1 Black Brant V-C approx. 800 km 1 Black Brant V-C approx. 800 km	White Sands Feb. 1974 Jan. 1975	Laboratory of Stellar and Planetary Physics (LPSP), CNRS/ University of Colorado: High resolution spectroscopy of the solar helium line in connection with Pioneer-10 program.

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
FRANCE (Continued)			
CNES (Continued)	1 Veronique approx. 212 km	Kourou Apr. 1975	Laboratory of Space Astronomy/University of California at Berkeley: Study of the UV spectrum of Quasar 3C 273 as part of the CNES Rocket Astronomy Program "FAUST." Rocket data to be used to derive the density of the intergalactic medium.
	13 Super-Arcas approx. 150 km 18 Super-Arcas 12 Super-Arcas 15 Super-Arcas 15 Super-Arcas 20 Super-Arcas*	Kourou 1973 1974 1975 1976 1977 1978	CNES participation in EXAMETNET.
	approx. 150 km 1 Black Brant 1 Black Brant approx. 800 km	White Sands Aug. 1975 Feb. 1976	LPSP/CNRS/University of Colorado: Project "Kalos" to calibrate instruments developed for flight in Orbiting Solar Observatory-8 (OSO-8) spacecraft.
GERMANY			
Federal Ministry for Education and Science (BMBW)	1 Aerobee 150 1 Aerobee 150 1 Aerobee 150 2 Aerobee 150 approx. 280 km	White Sands, New Mexico Nov. 1964 Nov. 1965 Oct. 1966 Jun/Aug. 1967	MPI, Heidelberg: One of several experimentersproviding special sampling surfaces to collect and analyze extraterrestrial dust particles as part of Project Luster.
BMwF	1 Nike-Apache approx. 195 km	Wallops Island Jul. 1966	Ionospheric Institute of Breisach: Variable frequency impedance probe to measure electron density.

*As of November 1978

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
GERMANY (Continued)			
BMwF (Continued)	**1** Javelin approx. **950** km **1** Nike-Tomahawk approx. **300** km	Wallops Island Sep. **1966** Wallops Island Sep. **1966**	MPI, Munich: Observations of artificial ion clouds to investigate the physics of comets, the interplanetary medium, and the Earth's magnetosphere.
	1 Nike-Apache approx. ***250*** **km**	Churchill Research Range, Canada Nov. **1966**	MPI, Lindau/Ionospheric Institute of Breisach/German Aerospace Research and Test Establishment (DFVLR): To flight test instrumentation for the German research satellite AZUR and investigate UV emission intensities and proton and electron flux during an auroral event.
BMBW	**5** Nike-Apache **2** Nike-Apache approx. **250** km	Kiruna, Sweden Apr./Dec. **1967** Jun. **1968**	MPI, Munich: To investigate electric fields in the upper atmosphere, particularly during an auroral event by observations of ionized clouds.
	2 Javelin approx. **1000** km	Natal, Brazil Jun. **1967**	US/Germany/Brazil tripartite agreement: MPI, Lindau/University of Kiel/MPI, Munich/Technical University of Braunschweig. Flight test instrumentation for the German research satellite AZUR and investigate proton and electron energy spectra, proton flux, and solar and galactic alpha particles.
	4 Nike-Apache approx. **250** km	Thumba, India Mar. **1968**	US/Germany/India tripartite agreement: Physical Research Laboratory (PRL), Ahmedabad/MPI, Munich: Investigate electric fields in the equatorial electrojet by means of artificial barium-ion clouds.
	2 Nike-Apache approx. **250** km	Kiruna Jun. **1968**	MPI, Heidelberg: Register micrometeorites and cosmic dust.

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
GERMANY (Continued]			
BMBW (Continued)	1 Javelin approx. 1000 km	Wallops Island Oct. 1970	MPI, Munich: Continue barium cloud studies and test prototype for Scout-launched barium payload.
	1 Aerobee 170 1 Aerobee 150 1 Aerobee 200 1 Aerobee 200 approx. 210 km	White Sands Apr. 1971 Apr. 1972 Aug. 1973 Dec. 1973	Working Group for Space Physics, Freiburg: Measure solar coronal extreme ultraviolet (EUV) radiation. The 1973 flights were in support of operations of the Apollo telescope mount on Skylab.
	4 Black Brant V-C 285-350 km	Natal Jan. - Feb. 1973	MPI, Heidelberg/University of Bonn/Working Group for Space Physics, Freiburg/MPI, Lindau/DFVLR Extraterrestrial Sensor Technology Group: Conduct aeronomic investigations timed with the overflight of the AEROS Satellite to achieve intercalibration and completion of vertical profile measurements at subsatellite altitudes.
	1 Black Brant V-C approx. 160 km	Wallops Island Jun. 1974	University of Bonn: Measurement of (1) atomic oxygen densities in the lower thermosphere, (2) altitude profiles of minor constituents such as argon, carbon dioxide, ozone, etc., and (3) the fine structure of the turbopause. Conducted as part of the ALADDIN Campaign to obtain a complete description of the neutral and ionized atmosphere in a 24-hr period.
BMFT	2 Javelin	Natal	
BMFT	2 Javelin approx. 1000 km	Natal Nov. 1973	US/Germany/Brazil tripartite agreement: MPI, Munich1 University of California at Berkeley/INPE. To continue barium cloud studies under spread-F conditions.

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
GERMANY (Continued)			
BMFT (Continued)	1 Aerobee 200 approx. 300 km	White Sands Oct. 1974	German Space Research Corporation (GfW)/GSFC: Demonstrate and study start-up behavior and thermal performance of various heat pipe designs under zero gravity.
	2 Black Brant V approx. 300 km	White Sands Jan. 1976	NASA Marshall Space Flight Center (MSFC)/University of Hamburg/University of Clausthal: Metallurgical experiments in zero gravity as part of the NASA space processing basic research program.
	4 Aries approx. 500 km	Kiruna Mar. 1976 ,Mar. 1977 1979	MPI, Munich/University of California at Berkeley: Project Porcupine sounding rocket program to support the International Magnetospheric Study by a complex of in situ particles and field measurements, barium cloud releases, and ground observations under auroral activity conditions. Project Porcupine included experimenters from ESA, Germany, France, and Austria.
	1 Black Brant V-C approx. 300 km	Churchill Research Range Feb. 1978	NRCC/NOAA/MPI, Lindau: Investigation to explore electric fields directed parallel to the geomagnetic field at high latitudes.
	2 Nike-Black Brant approx. 500 km	White Sands Sep. 1978 1979	Lockheed Palo Alto Research Laboratory/Institute for Space Physics Research (IPW), Freiburg: Acquisition of solor corona spherical data at X-ray and EUV wavelength and full solar disc imagery in the line of C III.
GREECE			
Greek National Committee for Space Research	7 Boosted Arcas approx. 95 km	NASA Ship Off Koroni, Greece May 1966	GSFC: Investigate relationship between the variation in ionization below 90 km and changes in solar UV and X-ray flux during total solar eclipse.

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
INDIA			
Indian Space Research Organization (ISRO) of the Department of Atomic Energy (DAE)	1 Nike-Apache	Thumba, India Nov. 1963	PRL:
	5 Nike-Apache	Jan./Nov. 1964	(1) Measure upper atmosphere winds by ground photography of illuminated sodium vapor released from rocket.
	2 Nike-Apache	Mar. 1966	(2) Measure upper atmosphere winds by ground photography of illuminated chemicals released from rocket.
	5 Nike-Apache 150 km	Mar. 1967	(3) Investigate relationship between wind shears and sporadic E by combining measurements under (2) above, with electron density measurement.
	4 Nike-Apache 150 km	Thumba Jan. 1964	University of New Hampshire: Investigate the equatorial electrojet at the Geomagnetic Equator by means of magnetometer instrumentation
	30 Boosted Dart approx. 100 km	Thumba 1964-1966	Indian National Committee for Space Research (INCOSPAR): Meteorological rocket sounding payload supplementing the Indian Ocean expedition.
	1 Nike-Apache	Thumba Jul. 1966	PRL: Investigate the equatorial electrojet at the Geomagnetic Equator by means of magnetometer/Langmuir probe instrumentation.
	3 Nike-Apache 150 km	Aug. 1968	
	1 Nike-Apache 170 km	Thumba Feb. 1968	PRL: Measure neutral atmospheric winds above 85 km and measure electron densities in the upper atmosphere up to 160 km by means of trimethyl aluminum (TMA) and Langmuir probe payloads.
	4 Nike-Apache approx. 250 km	Thumba Mar. 1968	ISRO/GSFC: Investigate electric fields in the equatorial electrojet by means of artificial barium-ion clouds.

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
INDIA (Continued)			
ISRO, DAE (Continued)	2 Boosted Arcas 85 and 95 km	Thumba Mar. 1968	ISRO/GSFC: Investigate equatorial electron density distribution in ionosphere D region by means of radio propagation experiments.
	2 Nike-Apache 150 km	Thumba Apr. 1968	US/India/Japan tripartite agreement: PRL/Institute of Space and Aeronautical Science (ISAS), Tokyo University. Measure absolute flux and energy spectrum and time variation of discrete X-ray sources (Crab Nebula, Scorpio, etc.). Also make a comprehensive survey of the southern sky.
	1 Nike-Apache 150 km	Thumba Nov. 1968	PRL: Investigate sources of X-ray emissions in the southern sky.
	2 Nike-Apache 150 km	Thumba Apr. 1969	US/India/Japan tripartite agreement: PRL/ISAS, Tokyo University. Obtain data on changes in X-ray emission from the celestial X-ray source, SCO X-1, and compare it with corresponding changes in visual observations made from the ground.
	1 Nike-Apache 150 km	Thumba Mar. 1970	National Physical Laboratory (NPL), New Delhi: Measure electron and ion densities and Lyman-Alpha and X-ray flux by means of a riometer payload.
	4 Nike-Apache approx. 125-170 km 3 Nike-Tomahawk 280-320 km 4 Boosted Arcas 90 km	Thumba Jan./Mar. 1970 Mar. 1970 Mar. 1970	ISRO/GSFC: Study interrelation between ion composition, airglow emissions, and vertical drift velocities in the F region of the ionosphere.

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
INDIA (Continued)			
ISRO, DAE (Continued)	2 Nike-Apache 150 km	Thumba Jan. 1971	ISRO: Study of plasma instabilities of the D and E regions by Langmuir probes, and proton precession magnetometers.
	4 Nike-Apache 150-200 km	Thumba Apr. 1971	ISRO/University of Tokyo: Study of various ionospheric phenomena in the equatorial electrojet and electron densities by means of sodium vapor payloads, proton magnetometers, and high frequency capacitor probes.
	1 Nike-Apache 160 km	Thumba Apr. 1972	ISRO: Study of D and E region plasma instabilities by means of tip sensors on Langmuir probes.
DOS	1 Nike-Apache 1 Indian Centaure approx. 120-150 km	Thumba Oct. 1972 Sep. 1973	DOS/GSFC/CNES: Describe steady-state electrojet and study plasma instabilities by means of simultaneous launchings of magnetometers, Langmuir and resonance probes, and electric field payloads.
ISRAEL			
National Committee for Space Research	1 Aerobee 150	White Sands, New Mexico Nov. 1965	University of Tel Aviv: One of several experimenters providing special sampling surfaces to collect and analyze extraterrestrial dust particles as part of Project Luster.
	1 Aerobee 150 2 Aerobee 150 approx. 280 km	Oct. 1965 Jun./Aug. 1967	
ITALY			
Italian Space Commission (ISC)	8 Nike-Cajun and Nike-Asp 80-200 km	Sardinia Jan./Apr./Sep. 1961 Dec. 1962	ISC: Measure upper atmosphere winds by ground photography of illuminated sodium vapor released from rocket.

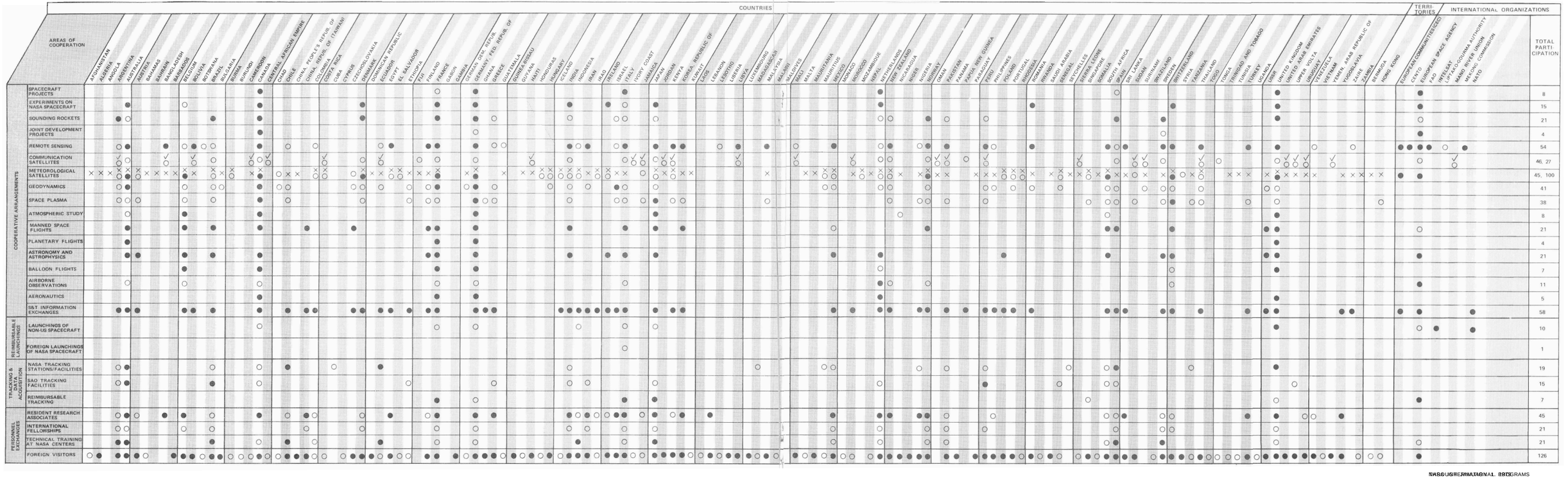
Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
ITALY (Continued)			
ISC (Continued)	1 Nike-Tomahawk 280-320 km	San Marco Range, off Coast of Kenya Nov. 1971	GSFC: Measure nitrogen and electron temperatures and densities in conjunction with a passage of the San Marco III satellite to provide calibration verification of its instruments.
JAPAN			
Radio Research Laboratory (RRL)	3 Nike-Cajun 100-130 km 2 Aerobee 150 above 130 km 1 Javelin above 200 km	Wallops Island Apr./May 1962 Wallops Island Sep. 1963 Oct. 1964	RRL/GSFC: Combine Japanese swept frequency resonance probe with GSFC Langmuir probe for electron density and temperature determination.
Japanese Science and Technology Agency/ Japanese Meteorological Agency	10 MT-135 10 Boosted Arcas approx. 20-60 km	Wallops Island Apr. 1967	Japanese Science and Technology Agency/Japanese Meteorological Agency/Wallops Station: Obtain comparison data on operational characteristics of the rockets; gain additional information on diurnal wind and temperature cycles.
ISAS	2 Nike-Apache 150 km	Thumba, India Apr. 1968	US/Japan/India tripartite agreement: PRL/ISAS, Tokyo University. Measure absolute flux and energy spectrum and time variation of discrete X-ray sources (Crab Nebula, Scorpio, etc.). Also make a comprehensive survey of the southern sky.
	2 Nike-Apache 150 km	Thumba Apr. 1969	US/Japan/India tripartite agreement: PRL/ISAS, Tokyo University. Obtain data on changes in X-ray emission from the celestial X-ray source, SCO X-1, and compare it with corresponding changes in visual observations made from the ground.

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
JAPAN (Continued)			
Japanese Meteorological Agency	10 MT-135 approx. 60 km	Wallops Island Mar. 1972	Japanese Meteorological Agency/Wallops Station: WMO sponsored sounding rocket intercomparison test among France, Japan, and NASA to improve the correlation of data returned by independent future launchings of various rocket systems.
NETHERLANDS			
Netherlands Organization for Advancement of Pure Research	4 Nike-Apache up to 120 km	Coronie, Suriname Sep. 1965	Astronomical Observatory, University of Utrecht: Investigation of upper atmosphere equatorial winds by ground-based photography of illuminated sodium vapor released from payloads with simultaneous measurements of ionospheric drift (Mitra method).
Laboratory for Space Research (LRO)	1 Aerobee 150 approx. 200 km	White Sands, New Mexico Oct. 1967	LRO: Observation of the spatial distribution of solar X-ray sources by means of zone plate telescopes and a fine attitude control system.
NEW ZEALAND			
National Space Research Committee (NSRC)	1 Arcas 2 Arcas 95 km	Birdling's Flat, New Zealand May 1963 Sep./Dec. 1964	University of Canterbury, New Zealand: Measure wind drift and turbulent diffusion in the D region of the ionosphere by rocket borne radio propagation measurements and by ground-based photography of illuminated aerosol released from rocket.
	1 Boosted Arcas approx. 95 km	Karikari Peninsula, New Zealand May 1965	Range and experiment validation.

NASA International Activities Summary



● CURRENT

○ COMPLETED PROJECT OR DISCONTINUED ACTIVITY

✓ AIDSAT DEMONSTRATIONS

× APT STATIONS

Cooperative Sounding Rocket Projects

Country and Cooperating Agency.	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
NEW ZEALAND (Continued]			
National Space Research Committee (NSRC) (Continued)	6 Boosted Arcas appox. 95 km	Karikari Peninsula May 1965	(1) University of Canterbury: Differential absorption with ground-based sounders. (2) GSFC: Electron density by Faraday rotation technique.
NORWAY			
Norwegian Committee for Space Research (NCSR) Jointly With Royal Technical University of Denmark	1 Nike-Cajun	Wallops Island Dec. 1961	Norwegian Defense Research Establishment (NDRE)/Royal Technical University of Denmark (Andoya launchings), GSFCINDRE (Wallops launchings): Measure D and E region electron and ion density and electron collision frequency by radio absorption experiment, Faraday rotation experiment, and RF impedance and conductivity probes. Lyman-Alpha monitor (Wallops) and energetic particles experiment (Andoya) also included.
	1 Nike-Apache	Jun. 1962	
	2 Nike-Cajun above 90 km	Mar./Apr. 1963	
	2 Nike-Cajun	Andoya, Norway Aug./Dec. 1962	
	1 Nike-Cajun	Sep. 1963	
	1 Nike-Apache	Sep. 1963	
	3 Nike-Apache above 100 km	Mar. 1964	
	4 Nike-Apache	Andoya Mar./Nov. 1965	
	1 Nike-Apache	Jun. 1966	
	2 Nike-Apache above 120 km	Mar. 1967	
NCSR	4 Boosted Arcas up to 90 km	Andoya Mar./Dec. 1965	NDREIGSFC: Support for ground-based cross-modulation studies of the ionosphere using Faraday rotation technique.
	2 Boosted Arcas approx. 95 km	Andoya Mar. 1965	US/Norway/Sweden tripartite agreement: Uppsala Ionospheric Observatory/NDRE. Measure ion and electron densities in D Region of ionosphere. Measure winds and sodium emissions in aurorae. Measure auroral phenomena by observing the effects of artificial shock wave created by a high-energy explosive charge.
	1 Nike-Apache up to 120 km	Andoya Mar. 1965	
	1 Nike-Apache up to 120 km	Andoya Mar. 1965	

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
NORWAY (Continued)			
NCSR (Continued)	2 Boosted Arcas up to 80 km 1 Sidewinder-Arcas approx. 85 km	Andoya Aug./Oct. 1967 Nov. 1968	NDREIGSFC: Launch experiments into Polar Cap Absorption (PCA) event to study relationships between sudden increase in radio wave absorption and flux of low energy incoming particles or, in absence of PCA event, modify experiments to obtain auroral absorption data.
Norwegian Council for Scientific and Industrial Research (NTNF)	1 Nike-Apache 133 krn	Andoya Mar. 1966	NDREIGSFC: Study the ionic composition of the D region with an ion-spectrometer payload.
	6 Nike-Tomahawk *approx. 320 km **approx. 230 km	Andoya Aug./Sep. 1967	NTNF/GSFC: Three pairs of barium ion cloud and instrumented payloads launched to compare the relatively new barium technique of measuring electric fields with proven methods of direct field measurement.
	5 Nike-Tomahawk *approx. 320 km **approx. 230 krn	Andoya Sep./Oct. 1968	NTNF/GSFC: Each instrumented payload (two NTNF) was launched within minutes of a barium payload (three NASA) to study dynamics of the auroral ionosphere by observing the electric and magnetic fields and the charged particle environment during auroral activity.
	2 Nike-Tomahawk up to 280 krn	Andoya Feb./Mar. 1970	University of Bergen/Norwegian Institute for Cosmic Physics1 NDREIGSFC: Integrated auroral studies including neutral particle and ion composition, electric fields, photometry at selected wavelengths, and high and low energy particle density and *fluxes.*
	1 Nike-Tomahawk approx. 213 km 1 Nike-Tomahawk approx. 250 krn	Andoya Nov. 1970 Andoya Jan. 1971	NDRE/GSFC: Integrated transauroral studies including low energy particles, electron densities, and auroral emissions at selected wavelengths.
	1 Nike-Tomahawk approx. 250 km 1 Nike-Tomahawk approx. 250 km	Andoya Jan. 1972 Andoya Jan. 1973	NDREIGSFC: Study of plasma resonances in the auroral and transauroral ionospheric F layer and of variations in low energy particle fluxes in pulsating aurorae.

*Barium ion cloud payload
**Instrumented payload

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
NORWAY (Continued)			
NTNF (Continued)	**1** Nike-Tomahawk	Andoya Jan. **1972**	Norwegian Institute for Cosmic Physics: Study of sources and effects in upper atmosphere during strong line emission in auroral zone.
	1 Nike-Tomahawk approx. **250** km	Andoya Jan. **1973**	
	1 Nike-Apache approx. 120 km	Andoya Jan. **1972**	NDRE/NOAA: Study relationship between particle streams, and electric fields.
	1 Nike-Tomahawk approx. **250** km	Andoya Jan. **1973**	
	1 Nike-Cajun approx. **100** km	Andoya May **1972**	NDRE/University of Maryland: Study relativistic electron precipitation events.
	1 Nike-Apache approx. **120** km	Andoya May **1972**	
	2 Nike-Tomahawk approx. **250** km	Andoya Jan. **1974** Dec. **1974**	NDRE/University of Maryland/GSFC: Continue studies of electron precipitation and DC electric fields oriented along the geomagnetic field vector inside the ionospheric polar cap F layer.
	2 Nike-Tomahawk approx. **200** km	Andoya Nov. **1976**	Norwegian Institute of Cosmic Physics/University of Bergen/ GSFC: Observe electric field reversal associated with the Harang discontinuity, in particular the spatial variation of the electric field, optical auroral emissions, and particles are to be determined and related to auroral substorm parameters.
	2 Terrier-Malenute approx. **500** km	Nov. **1976**	
	1 Nike-Tomahawk approx. **250** km	Andoya Feb. **1976**	NDRE/GSFC: To develop an electron sonde for studies of reflected electrons and study the geophysical effects of the electron pulse.

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
NORWAY (Continued)			
NTNF (continued)	1 Nike-Tomahawk approx. 250 km	Andoya Feb. 1977	NDRE/GSFC: To investigate possible abnormalities in F region chemistry associated with auroral displays using ion and plasma diagnostic instruments.
	2 Nike-Tomahawk approx. 250 km	Andoya Jan. 1977 Feb. 1977	University of Minnesota/Danish Meteorological Institute1 NTNF: To investigate the basic mechanisms which produce an aurora using advanced design analyzers, particle counters, photometers, and magnetometers.
	2 Nike-Tomahawk approx. 250 km	Andoya Jul. 1978	NDRE/Norwegian Institute for Cosmic Physics/University of Bergen/University of Sussex, UK/NOAA/GSFC: Study of variety of effects produced in the magnetosphere by an electron beam.
PAKISTAN			
Space and Upper Atmosphere Research Committee (SUPARCO)	2 Nike-Cajun 1 Nike-Cajun 8-125 km 3 Nike-Apache 2 Nike-Apache 125-200 km	Sonmiani Beach, Pakistan Jun. 1962 Mav 1963 Apr./Nov./Dec. 1964, Feb. 1966	SUPARCO: Measure upper atmosphere winds by ground-based photography of illuminated sodium vapor released from payload.
	32 Boosted Dart up to 65 km	Sonmiani Beach 1964-1967	SUPARCO: Meteorological rocket soundings supplementing the International Indian Ocean Expedition.
SUPARCO jointly with SRC	2 Nike-Cajun 80-125 km 1 Nike-Cajun 2 Nike-Apache 1 Nike-Apache 2 Nike-Cajun 80-125 km	Sonmiani Beach Apr. 1965 Mar. 1966 Mar./Apr. 1966 Nov. 1967 Mar. 1970	US/Pakistan/UK tripartite agreement: GSFC/SUPARCO/ University College, London. Measure wind, temperature, pressure, and density using grenade technique, between 50 and 150 km.

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
PERU			
Geophysical Institute of Peru (IGP)	4 Nike-Tomahawk approx. 500 km 8 Nike-Apache approx. 200 km 7 Super-Arcas approx. 150 km 10 Super-Loki approx. 80 km	Chilca Range, Peru May/Jun. 1975	Dudley Observatory/University of Pittsburgh/University of Illinois/Pennsylvania State University/University of Denver1 Geophysics Corporation of America: Ionospheric and magnetospheric studies at a site on the Geomagnetic Equator. In addition, twelve balloons were flown as a part of this Project "Antarqui."
SPAIN			
National Space Research Commission (CONIE)	10 Boosted Dart 6 Boosted Dart 13 Boosted Dart 14 Boosted Dart 29 Boosted Dart 23 Boosted Dart 26 Boosted Dart 24 Boosted Dart 7 Boosted Dart 1 Boosted Dart 2 Boosted Dart 48 Boosted Dart 14 Boosted Dart* 20-60 km	Huelva, Spain Oct./Dec. 1966 Jan./Feb. 1968 Jan./Dec. 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978	CONIE: Measure wind and temperature using payload or instrumented sondes. Beginning in 1971, launchings conducted in conjunction with EXAMETNET.
	4 Nike-Cajun 80-125 km	Huelva Mar./May 1969	National Institute for Aerospace Technology (INTA): Measure wind, temperature, pressure, and density using grenade technique.

*As of November 1978

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
SPAIN (Continued)			
CONIE (Continued)	4 Nike-Cajun 80-125 km	Huelva Apr./May 1971	CONIE: Temperature, pressure, density, and wind measurement in the stratosphere and mesosphere.
	1 Nike-Cajun 85 km 1 Nike-Apache 122 km	Huelva Jul. 1972	CONIE: Ion composition studies of the ionospheric D and E regions.
	2 Nike-Apache 120 km 2 Nike-Cajun 85 km	Huelva 1979	CONIE: Particles, fields and neutral atmosphere studies in connection with the Perseids meteor shower.
SWEDEN			
Swedish Space Research Committee (SSRC)	1 Arcas 80 km 4 Nike-Cajun up to 100 km	Jokkmokk, Sweden Aug. 1961 Kronogard, Sweden Aug. 1962	University of Stockholm: (1) Measure winds during occurrence of noctilucent clouds by optical tracking of smoke trail created by release of aerosol powder from rocket. (2) Measure upper atmosphere temperature, wind, pressure, and density during occurrence of noctilucent clouds by means of rockets instrumented with explosive charges and associated electronics.
	4 Nike-Cajun up to 100 km 4 Nike-Apache up to 120 km	Kronogard Aug. 1963 Aug. 1964	University of Stockholm/Cambridge Research Laboratory: (1) Direct sampling of noctilucent clouds with recoverable container. Also energetic particles experiment (Kiruna Geophysical Observatory).

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
SWEDEN (Continued)			
SSRC (Continued)	4 Nike-Cajun up to 120 km	Aug. 1964	(2) Measure upper atmosphere temperature, wind, pressure, and density during occurrence of noctilucent clouds by means of rockets instrumented with explosive charges and associated electronics.
	2 Nike-Apache approx. 100 km	Kiruna, Sweden Aug. 1970	(3) Particle collection and scattered light photometry in noctilucent clouds.
	1 Aerobee 150 approx. 180 km	White Sands, New Mexico Nov. 1965	Uppsala Ionospheric Observatory: One of several experimenters providing special sampling surfaces to collect and analyze extra-terrestrial dust particles as part of Project Luster.
	3 Boosted Arcas approx. 95 km	White Sands Oct./Dec. 1963	Uppsala Ionospheric Observatory: To measure ion and electron concentrations between 40-80 km.
	1 Boosted Arcas approx. 95 km	Wallops Island Mar. 1964	Uppsala Ionospheric Observatory: Measure upper atmosphere winds by ground-based photography of sodium-lithium releases from payload.
	2 Boosted Arcas approx. 95 km 1 Nike-Apache up to 120 km 1 Nike-Apache up to 120 km	Andoya, Norway Mar. 1965 Andoya Mar. 1965 Andoya Mar. 1965	US/Sweden/Norway tripartite agreement: Uppsala Ionospheric Observatory/NDRE. Measure ion and electron densities in D region of ionosphere. Measure winds and sodium emissions in aurorae. Measure auroral phenomena by observing the effects of artificial shock wave created by a high-energy explosive charge.
	1 Boosted Arcas II approx. 145 km 2 Boosted Arcas II approx. 145 km	Kiruna Oct. 1968 Andoya Jan. 1969	Uppsala Ionospheric Observatory: Measure ion and electron densities in D and lower E regions of ionosphere under varying auroral conditions.

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
SWEDEN (Continued)			
SSRC (Continued)	4 Nike-Cajun up to 100 km	Kiruna Jan. 1969	US/Sweden/UK tripartite agreement: GSFC/University of Stockholm/University College, London. Measure wind, temperature, pressure, and density using grenade technique.
	2 Nike-Apache approx. 100 km	Kiruna Aug. 1970	Dudley Observatory/GSFC: Particle collection, scattered light photometry, and electric field measurements in noctilucent clouds.
	1 Petrel approx. 100 km	Kiruna Aug. 1970	Uppsala Ionospheric Observatory: Ion and electron fluxes and electron energy spectra measurements in noctilucent clouds.
Swedish Board for Space Activities (SBSA)	1 Nike-Tomahawk	Kiruna Feb. 1972	Royal Institute of Technology/Kiruna Geophysical Observatory/ Uppsala Ionospheric Observatory/Lund Observatory/University of California at Berkeley: Electric field and current measurements, electron and proton spectra, photometry, and micrometeoroid detection during auroral events.
	1 Nike-Tomahawk approx. 200 km	Jan. 1973	
	3 Nike-Apache approx. 100 km	Kiruna Oct. 1972	Dudley Observatory/GSFC: Particle collection, scattered light photometry, and plasma detection in connection with the Giacobini-Zinner meteor shower.
	2 Nike-Apache approx. 100 km 1 Nike-Cajun approx. 80 km	Kiruna Aug. 1973	Dudley Observatory/GSFC/University of Stockholm: Direct sampling, photometry, and mass spectrometer studies in noctilucent clouds.
	2 Nike-Apache approx. 100 km	Kiruna Mar. 1975	University of Stockholm/GSFC: Atomic oxygen measurements, nightglow components, ozone, nitrous oxide (NO), and water vapor.

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
SWEDEN (Continued)			
SBSA (Continued)	1 Nike-Tomahawk approx. 200 km	Kiruna Feb. 1977	Uppsala Ionospheric Observatory/GSFC: Magnetosphere1 ionosphere interactions and mechanisms for energetic particle participation.
	2 Super-Arcas approx. 80 km	Kiruna Feb. 1977	University of Houston: Measure the flux of bremsstrahlung X-rays following explosive detonation in the ionosphere, in conjunction with Nike-Tomahawk campaign.
	1 Nike-Orion 190 km	Kiruna Apr. 1978	Institute of Meteorology, University of Stockholm: Observe UV emission from NO in the aurora, investigate excitation mechanisms and the changes in NO concentration associated with auroral processes.
UNITED KINGDOM			
British National Committee for Space Research	2 Nike-Apache up to 120 km	Wallops Island Jul./Nov. 1964	University of Birmingham/University of Illinois/Geophysics Corporation of America: Combine British radio frequency capacitance probe with Langmuir probe, radio propagation experiment, and energetic particle sensors to check reliability of ionospheric measurement techniques.
SRC	1 Aerobee 150	White Sands, New Mexico Nov. 1964	Birkbeck College: One of several experimenters providing special samplings surfaces to collect and analyze extraterrestrial dust particles as part of Project Luster.
	1 Aerobee 150	Nov. 1965	
	1 Aerobee 150 approx. 280 km	Oct. 1966	
	2 Nike-Cajun	Sonmiani Beach, Pakistan Apr. 1965	US/UK/Pakistan tripartite agreement: GSFC/University College, London/SUPARCO. Measure wind, temperature, pressure, and density using grenade technique, between 50 and 150 km.
	3 Nike-Apache	Mar./Apr. 1966	
	1 Nike-Apache	Nov. 1967	
	2 Nike-Cajun 80-200 km	Mar. 1970	

Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
UNITED KINGDOM (Continued)			
SRC (Continued)	4 Nike-Cajun up to 100 km	Kiruna, Sweden Jan. 1969	US/UK/Sweden tripartite agreement: GSFC/University College, London/University of Stockholm. Measure wind, temperature, pressure, and density using grenade technique.
	3 Skylark 200 km	Woomera, Australia Jun. 1973 Aug. 1973 Dec. 1973	University of Leicester: Conduct of up to three stabilized Skylark sounding rockets to study X-ray emissions from the solar corona using very high resolution spectroscopy. These observations were coordinated with Apollo telescope operations on Skylab.
	2 Paiute-Tomahawk 70-160 km	Wallops Island Jun. 1974	University College, London/GSFC: To conduct electric field measurements as part of the ALADDIN campaign to obtain a complete description of the neutral and ionized atmosphere in a 24-hr period.
	1 Skylark 200 km	Woomera Oct. 1974	Mullard Space Science Laboratory/GSFC: Soft X-ray studies of galactic sources with a grazing incidence telescope.
	2 Skylark 200 km	Andoya, Norway 1977	Mullard Space Science Laboratory/GSFC: Measurements of field aligned currents in the high latitude magnetosphere synoptically with measurements from the ESA Geostationary Scientific Satellite (GEOS).
	1 Skylark 200 km	Woomera Apr. 1977	Mullard Space Science Laboratory/GSFC: Continuation of soft X-ray studies of galactic sources with a grazing incidence telescope.
	1 Aries approx. 500 km	White Sands 1979	Mullard Space Science Laboratory/Lockheed Palo Alto Research Laboratory: Determination of the spectra and angular structure of extended sources of X-ray emission using an imaging X-ray telescope and bent crystal spectrometer under development for Spacelab application.

Joint Development Projects

	Country or Organization	Delivery Date	Program Description
	CANADA		
●	Space-Shuttle Attached Remote Manipulator System (RMS)	1979	National Research Council of Canada (NRCC) undertook in June 1975 to design, develop, and manufacture the RMS at Canadian expense. The RMS will deploy payloads from the shuttle payload bay, retrieve them, and perform certain payload servicing operations in space.
	EUROPEAN SPACE AGENCY (ESA)		
○	Heat Pipe	1973	European Space Technology Center (ESTEC) designed, fabricated, and delivered to NASA an experimental bendable miniature heat pipe for integration into a Black Brant sounding rocket payload launched in 1974.
●	Spacelab	1979	Nine member countries of ESA - Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, Switzerland, and the United Kingdom - entered into an agreement in September 1973 with the United States (US) to undertake, as an ESA special project funded entirely in Europe (possibly in excess of $500 million), to design, develop, manufacture, and deliver to NASA, a Space Laboratory (Spacelab) for use with the Space Shuttle. Austria, an ESA observer, is also contributing to the Spacelab development. The Spacelab will consist of a pressurized laboratory module, permitting experimenters to work in normal shirt-sleeve environment, and a platform or pallet to support telescopes and other instruments requiring direct space exposure. The module and pallet, separately or together, will be carried to orbit and remain in the Space Shuttle Orbiter's payload bay for missions lasting 7 to 30 days. ESA will deliver the first Spacelab flight unit about one year before the first operational flight of the Shuttle, currently planned for 1981. NASA will purchase any similar additional required Spacelabs from Europe on agreed terms. Experimental objectives of the first Spacelab mission in 1981 are jointly planned by NASA/ESA. Selection of the experiment complement was made in February 1977.

○ Completed Project
● Current

Joint Development Projects

	Country or Organization	Delivery Date	Program Description
	GERMANY		
○	Heat Pipes	1973	German Space Research Corporation (GfW) designed, fabricated, and delivered to NASA an experimental flat plate vapor chamber heat pipe for integration into a Black Brant sounding rocket payload in 1974.
○	Sounding Rocket Recovery System	1973	German Aerospace Research and Test Establishment (DFVLR)/NASA Goddard Space Flight Center (GSFC)/Sandia Laboratories: Joint development to upgrade sounding rocket recovery systems to 453.6-kg (1000-lb) capacity by rocket flight testing in early 1973.
○	Aries	1975	DFVLR/GSFC: Joint development of the Aries heavy sounding rocket system using US surplus vehicles. Vehicles with shared technology tasks and instrumentation. Test flight August 1975.
	SWEDEN		
○	Boost Control System	1976	Swedish Space Corporation (SSC)/GSFC: Joint development of a Boost Control System (BCS) designed to reduce sounding rocket dispersion. BCS provided by SSC; Black Brant V-C sounding rocket furnished by NASA. Launched January 1976.

Cooperative Ground—Based Projects

Project	Number of Countries	Description
REMOTE SENSING		
○ Preliminary Cooperative Projects 1968–1971	2	In 1968, NASA initiated cooperative remote sensing research projects with the Institute of Space Research (INPE) and the National Commission on Outer Space (CONEE). These projects emphasized the development of airborne remote sensing techniques and systems in anticipation of the 1972 launching of NASA's Earth Resources Technology Satellite (ERTS), Landsat-1 (formerly ERTS-1).
● Investigations Programs 1972–1978	46*	Researchers from 46 countries and 4 international organizations successfully participated in the Landsat-1, Landsat-2, Skylab Earth Resources Experiment Package (EREP) investigations programs, and bilateral research projects analyzing Earth resources data and provided NASA with periodic reports on their work. The reports, covering a variety of disciplines, have been published in proceedings of symposiums sponsored by NASA.
Foreign Landsat Ground Stations Landsat-1 1972** Landsat-2 1975 Landsat-3 1978 Landsat-D 1981 (planned)	8	Because of the growing benefits resulting from the Landsat investigations program and in order to obtain more complete and current Landsat data, the following agencies have concluded agreements with NASA under which they establish Landsat receiving, processing, and data distribution facilities. In exchange for direct access to Landsat-type satellites, these cooperating agencies have agreed to (a) pay NASA a nominal access fee, (b) make data available to NASA under certain circumstances, and (c) make the Landsat data they acquire publicly available at reasonable charges.

	Agreement Signed	Station Location and Operation Date
Canada		
○ Department of Energy, Mines, and Resources (DEMR) (Canada Centre for Remote Sensing – CCRS)	1971 Renewed 1976	Prince Albert, Saskatchewan, 1972 St. John's, Newfoundland, 1977

*See Appendix B for list of countries.
**Ceased collecting data in 1977.

○ Completed Project
● Current

Cooperative Ground—Based Projects

Project	Number of Countries	Description
REMOTE SENSING (Continued)		
Foreign Landsat Ground Stations (Continued)		
		Agreement Signed / Station tion and Operational Date
Brazil		
○ Brazilian Commission for Space Activities, now Institute of Space Research (INPE)		1973 Renewed 1976 Renewed 1978 / Cuiaba, 1974
Italy		
● Telespazio (Superseded by agreement with European Space Agency (ESA))		1974 / Fucino (Rome), 1976
Iran		
○ Planning and Budget Organization		1974 / Shahdasht (Tehran), 1979*
Zaire		
○ ERTS — Zaire		1975 / Kinshasa*"
Chile		
○ University of Chile		1975 / Santiago**
Argentina		
○ National Commission for Space Research (CNIE)		1976 / Mar Chiquita, 1980'

"Projected.
**Funding not yet available.

Cooperative Ground—Based Projects

Project	Number of Countries	Description
REMOTE SENSING (Continued]		
Foreign Landsat Ground Stations (Continued)		Agreement Signed / Station Location and Operational Date
ESA (Supersedes agreement with Italy)		1978 — Fucino (Rome), 1976; Kiruna, Sweden, 1978
India		
○ National Remote Sensing Agency		1978 — Hyderabad, 1980
@Exchangeof Computer Programs for Remote Sensing Image Analysis	1	NASA and the Canadian DEMR agreed in 1978 to exchange certain image analysis computer programs for use in analyzing Landsat and other remotely sensed data.
@ApplicationsExplorer Mission-A (Heat Capacity Mapping Mission – HCMM) 1978	9	Data-use investigations were undertaken with France, Italy, Spain, Switzerland, Australia, Canada, Germany, the Commission of European Communities (CEC), and the United Kingdom in 1978. These investigations will study Earth surface and subsurface phenomena through thermal inertia measurements operating over the same area during day and night times. To support European data-use investigations, ESA has established a direct reception facility at Lannion, France, to receive and process HCMM data of Europe under an agreement concluded with NASA in 1978.
●Seasat Data Use and Direct Reception 1978	2	ESA and the Canadian DEMR both proposed Seasat data-use investigations which required the real-time reception of Seasat sensor data in various regions. These proposals were accepted and ground stations established at Oakhanger, UK, and Shoe Cove, Newfoundland, in 1978. Both stations received Seasat data beginning shortly after its launch in July 1978 and until its failure in October 1978. Data analysis and research are continuing.

Cooperative Ground—Based Projects

Project	Number of Countries	Description
COMMUNICATION SATELLITE PROJECTS		
○ Relay, Telstar and Synchronous Communications Satellite (Syncom) 1962–1964	12	Projects Relay, Telstar, and Syncom demonstrated the feasibility of transoceanic communications via active repeater satellites by picking up and amplifying signals received from ground stations and retransmitting them to Earth. The following countries provided ground stations for cooperative programs in the testing of United States (US) experimental communications satellites: Brazil, France, Italy, and UK (1962); Germany and Japan (1963); Denmark, Norway, and Sweden operating a joint receiving facility, Spain (1964); and Canada (1966). Nearly all stations conducted experiments involving transmission of telephone, telegraph, and high speed data as well as intercontinental television experiments. This cooperation extended and continued under the Applications Technology Satellites (ATS). President Kennedy spoke with the Prime Minister of Nigeria, which hosted the USS Kingsport as the African terminal for Syncom 2 in Lagos Harbor. In October 1964, Syncom 3 carried live television coverage of the Olympic Games from Japan.
ATS		
● ATS–1 Dec. 1966	7	Australia, through Qantas, participated in a very high frequency (VHF) aeronautical communications experiment using a VHF transponder and conducted super high frequency (SHF) and VHF tests in 1967–1968. Japan received spin scan cloud cover pictures during severe storm periods in 1971–1973. ATS-1 is also being used in experimental programs beginning in 1971 for transmission of educational materials by the University of Hawaii to universities in New Zealand, Fiji, Papua New Guinea, and Tonga. The University of the South Pacific is making similar transmissions to its five campuses in the South Pacific. Canada, in cooperation with NASA Goddard Space Flight Center (GSFC), conducted an experiment in 1972 to observe the effects of signals at high latitudes and low elevation angles. Japan's Radio Research Laboratory (RRL) in coordination with GSFC controlled the NASA ATS-1 spacecraft on an experimental basis from Japan during 1974–1976.

Cooperative Ground—Based Projects

Project	Number of Countries	Description
COMMUNICATION SATELLITE PROJECTS (Continued)		
ATS (Continued)		
○ ATS-3 Nov. 1967	5	ATS-3 was used by Germany and the Netherlands to conduct maritime communications and navigation experiments by the UK in VHF aircraft and for surface communications experiments and to evaluate the use of chirp modulation to combat multipath effects and doppler shifts on radio link transmissions, and by Norway in an experiment to determine the effectiveness of collecting oceanographic and meteorological data from sensors on instrumented buoys. Brazil and Stantord University used ATS-3 in an experiment involving voice and data transmissions of educational programs.
○ ATS-5 Aug. 1969		ATS-5 was used by Canada in 1970 to correlate data obtained from ground magnetic measurements at the conjugate point in Canada and to obtain millimeter wave propagation data.
ATS-6 May 1974		
○ Position Location and Aircraft Communication Experiment (PLACE) 1974—1975	2	Department of Communications (DOC) and ESA participated in experiments to obtain engineering data and practical experience for determining the operational feasibility of air traffic control and maritime satellite systems operating in the aeronautical L-Band.
○ Satellite Instructional Television Experiment (SITE) 1975—1976	1	NASA provided 4 hr per day of satellite time between August 1, 1975 and July 31, 1976, for use by the Indian Space Research Organization (ISRO) for broadcast of Indian-produced TV programs on family planning, health, and agricultural production directly to small, inexpensive, Indian-made ground receivers in some 2400 Indian villages.
○ S-Band Experiment 1975—1976	1	As an extension of NASA/ISRO SITE cooperation, ISRO demonstrated the feasibility of S-Band for satellite community television transmission with receiver hardware similar to that being used in the SITE project and also improved understanding of propagation phenomena.
○ Propagation Experiment at 13/18 GHz 1975—1976	2	ISRO and ESA experimenters operated NASA-supplied small ground transmit terminals at diverse sites with varied climatological conditions at 13 and 18 GHz to ATS-6 for relay back to an ESA-provided ground station at 4 GHz.

Cooperative Ground–Based Projects

Project	Number of Countries	Description
COMMUNICATION SATELLITE PROJECTS (Continued)		
ATS (Continued)		
ATS-6 May 1974 (Continued)		
○ Millimeter Wave Propagation Experiment 1975–1976	1	ESA experimenters participated in the ATS-6 experiment to evaluate the propagation characteristics of space-to-Earth links centered at 20 GHz and 30 GHz under measured meteorological conditions.
○ Radio Beacon Experiment 1975–1976	1	The Indian Physical Research Laboratory (PRL) participated in the ATS-6 Radio Beacon Experiment with investigations of scintillation phenomena and measurements of total electron content by Faraday rotation technique and group delay method.
○ SITE Solar Array Demonstration 1976	1	As an extension of SITE cooperation, ISRO conducted a test of the technical and economic feasibility of using solar cell arrays as power sources to operate standard SITE receiver terminals. NASA supplied the solar cell arrays.
○ Advanced Satellite for Interdisciplinary Communications, Brazil (SACI) 1975	1	NASA provided 30 minutes a day, 5 days a week of satellite time between February and May 1975 for use by INPE for the instruction of primary school students in the Brazilian state of Rio Grande de Norte.
○ AID-sponsored International Applications Demonstration (AIDSAT) 1976	27	Agency for International Development (AID) and NASA used the ATS-6 experimental communications satellite to broadcast films and live discussions on remote sensing, communications, and disaster relief technologies and their applications for development to 27 developing countries from August through October 1976 as ATS-6 moved from geostationary position over Africa to the Western Hemisphere. The following countries participated in the demonstrations: Argentina, Bangladesh, Bolivia, Cameroon, Central Afrjcan Empire, Costa Rica, Ecuador, Haiti, Ivory Coast, Jamaica, Jordan, Kenya, Libya, Mali, Mano River Union (Sierra Leone and Liberia), Morocco, Oman, Pakistan, Peru, Sudan, Suriname, Thailand, United Arab Emirates, Upper Volta, Uruguay, and Arab Republic of Yemen.

Cooperative Ground—Based Projects

Project	Number of Countries	Description
COMMUNICATION SATELLITE PROJECTS (Continued)		
ATS (Continued)		
ATS-6 May 1974 (Continued)		
● University of the South Pacific 1978–1979	1	The University of the South Pacific is developing an experiment involving ATS-6 video and ATS-1 audio transmissions to its campuses in the South Pacific region. These transmissions will provide the University an opportunity to test the use of satellite communications for expanded educational services.
○ Test of Portable Ground Terminals 1975–1978	1	Field test by GSFC of portable, low-cost experimental 12 GHz ground terminals supplied by the Japanese RRL with the CTS experimental communications spacecraft.
○ Data Collection Platform Test 1977	2	In 1977, the Argentine National Space Commission and Bolivian Geological Service utilized the experimental Data Collection System (DCS) onboard Landsat-2 to determine the usefulness of communications satellites to relay data on river water levels, rainfall, and other phenomena occurring in remote locations to a central collection point. The cooperating agencies utilized portable transmitters in remote locations to send signals to a central monitoring station several times a day as Landsat-2 passed within view.

Cooperative Ground—Based Projects

Project	Number of Countries	Description
METEOROLOGICAL SATELLITE PROJECTS		
○TIROS 1961–1965	42	NASA/National Oceanic and Atmospheric Administration (NOAA) and **42** national weather services compared simultaneously acquired TIROS satellite photography and ground observations. These weather services were located in Argentina, Australia, Austria, Belgium, Brazil, Burma, Canada, Chad, Colombia, Costa Rica, Czechoslovakia, Denmark, El Salvador, France, Germany, Hong Kong, Hungary, Iceland, India, Indonesia, Iraq, Ireland, Jamaica, Japan, Kenya, Mauritius, Mozambique, the Netherlands, New Zealand, Norway, Poland, Portugal, Rhodesia, Senegal, Singapore, South Africa, Sudan, Switzerland, Thailand, United Arab Emirates, and UK.
*Automatic Picture Transmission (APT) 1963–present	**116"**	Nationally owned and operated APT direct receiving stations permit repeated readout of local cloud cover images from NOAA satellites.
○National Commission on Outer Space (CONEE) **1968**	1	Joint project combining satellite meteorological data acquired with NASA-loaned APT set with meteorological data from conventional sources to make effective communications network for disseminating data to users. Project led to **1972** "Joint United Nations (UN)/World Meteorological Organization (WMO) panel and training seminar on the use of meteorological satellite data" held in Mexico City.
○Nimbus-4, Interrogation Recording and Location System (IRLS) **1971**	**1**	UK Institute of Aviation Medicine used Nimbus4 IRLS for navigation and data relay purposes in round-the-world light aircraft flight in May **1971.**
○French Eole Follow-On **1972**	**1**	After completion of the initial cooperative Eole satellite/balloon experiment, some of the remaining Eole electronic packages were installed on buoys for oceanographic experiments including a cooperative French/NASA/NOAA experiment to investigate the structure and relation of currents in the Western Atlantic and the Gulf Stream and others were placed on icebergs to study the continental current near Antarctica.

*See Appendix C for locations of APT stations.

Cooperative Ground—Based Projects

Project	Number of Countries	Description
METEOROLOGICAL SATELLITE PROJECTS (Continued)		
Nimbus-6, RAMS 1974-present	7	Investigators in Australia, Canada, Denmark, France, Norway, South Africa, and the UK are using or have used the Random Access Measurement System (RAMS) in meteorological and oceanographic experiments.
● Nimbus-7 1977-present	9	Scientists from the CEC, UK, Denmark, Switzerland, Canada, South Africa, Germany, France, and Belgium were selected by NASA in 1977 to participate in NASA-sponsored experiment teams which will validate and conduct initialdata-use investigations with data from the eight Nimbus-7 instruments.
● Nimbus-7 Direct Reception 1978-present	1	In support of European members of the Nimbus-7 Experiment Teams, ESA is receiving Nimbus-7 Coastal Zone Color Scanner and Scanning Multifrequency Microwave Radiometer data directly at a ground station in Lannion, France.
GEODYNAMICS		
○ GEOS-1, Nov. 1965 ○ PAGEOS, Jan. 1966 ○ GEOS-2, Jan. 1968	13	GEOS-1 (Explorer-29) and GEOS-2 (Explorer-36), active satellites containing instruments for optical and electronic observations, and PAGEOS, a passive reflector satellite for large-scale optical observations, were designed for a world-wide geodetic program to determine more accurately the Earth's size and shape. Twenty-seven non-US stations in Australia, Brazil, Chad, Chile, Ethiopia, Italy, Japan, Mauritius, Mexico, Netherlands, New Zealand, Norway, and UK have observed these satellites photographically to improve geodetic datum accuracies. France participated with NASA in the analysis of data obtained by the laser tracking of French and US geodetic satellites.
○ National Geodetic Satellite Program (NGSP) 1966—1970	23	Argentina, Australia, Brazil, Chad, Chile, Denmark, Ecuador, Ethiopia, Germany, Iran, Italy, Japan, Mauritius, Mexico, New Zealand, Norway, Philippines, Portugal, Senegal, South Africa, Suriname, Thailand, and UK accommodated BC-4 camera teams at 34 locations for US observations of PAGEOS.

Cooperative Ground–Based Projects

Project	Number of Countries	Description
GEODYNAMICS (Continued)		
○ International Satellite Geodesy Experiment (ISAGEX) 1964–1972 French Satellites: Diademe–C, Diademe–D, PEOLE US Satellites: BE–B (Explorer–22), BE–C (Explorer–27), GEOS–1, GEOS–2	24	NASA cooperated in this Committee on Space Research (COSPAR)-initiated program for laser and optical observation of three French and four US satellites. These observations were completed in mid-1971 and involved Australia, Belgium, Brazil, Bulgaria, Czechoslovakia, Ethiopia, Finland, France, Germany-FRG, Germany-GDR, Greece, Hungary, India, Japan, the Netherlands, New Zealand, Peru, Romania, South Africa, Sweden, Switzerland, Spain, UK, and Union of Soviet Socialist Republics (USSR).
● GEOS–3, Apr. 1975–present	5	Twelve investigators from Australia, Canada, France, Germany, and Israel are conducting experiments in Earth physics, sea state, and ocean physics utilizing GEOS–3 doppler, laser, and C-Band tracking and altimetry data.
○ Lunar Laser Ranging Experiment (LURE) 1974–1976	2	Australian and French scientists ranged the laser retro reflectors left on the Moon's Mare Tranquilitatis, Fra Mauro, and Hadley Rim during the Apollo missions. The laser ranging yielded information on the motions of the Earth and the Moon.
● French Satellite STARLETTE Nov. 1977–present	1	NASA and the French National Center for Space Studies (CNES) have agreed to exchange laser ranging observations of STARLETTE acquired by US and French laser stations.
○ International Clock Synchronization Demonstration, 1978	6	Experimenters from Australia, Canada, Germany, France, Japan, and the UK participated with 4 US agencies in a clock synchronization demonstration using a NASA-developed receiver with the US Navigation Technology Satellites to compare worldwide clocks to an accuracy of approximately one msec. The Canadian and French experimenters used receivers on loan from NASA.
SPACE PLASMA PROJECTS ○ Alouette–1, Sep. 1962 ○ Explorer–20, Aug. 1964 ○ Alouette–2, Nov. 1965 ○ ISIS–1, Jan. 1969 ○ ISIS–2, Mar. 1971	8	The Alouette/ISIS series of satellites used a swept frequency sounder system and Explorer–20 used a fixed frequency system to measure the ionospheric electron density. US and foreign stations take coordinated ground soundings and satellite top-side soundings which permit comparison of top and bottom-side ionospheric profiles. Australia, Canada, France, India, Japan, New Zealand, Norway, and the UK have operated stations for acquisition of top-side sounder data.

Cooperative Ground—Based Projects

Project	Number of Countries	Description
SPACE PLASMA PROJECTS (Continued)		
○ Explorer—22, Oct. 1964 ○ Explorer—27, Apr. 1965 (Beacon Satellites)	37	At 102 ground stations in Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, Denmark, Ethiopia, Finland, France, Germany, Ghana, Greece, India, Israel, Italy, Jamaica, Japan, Kenya, Korea, Malaysia, New Zealand, Nigeria, Norway, Pakistan, Peru, Singapore, South Africa, Spain, Sudan, Sweden, Switzerland, Tanzania, Thailand, Turkey, and UK, plus Antarctica and Hong Kong, Faraday rotation, scintillation, and doppler differential experiments have been conducted in order to measure integrated electron density in a vertical plane between a satellite and the ground and variations in electron density as a function of latitude, season, and diurnal time.
○ Orbiting Geophysical Observatory OGO—6, Jan. 1969	1	Very low frequency (VLF) experiment reactivated in October 1971 to permit a 6-month Japanese study of VLF whistlers and emissions.
● Origin of Plasma in the Earth's Neighborhood (OPEN), 1978—1979	4	Scientists from Max Planck Institute (MPI), Garching, Germany; University of Bern, Switzerland; National Research Council of Canada (NRCC), Canada; and the University of Tokyo, Japan, are participating in a NASA study group to develop and recommend future flight programs in space plasma physics.
ATMOSPHERIC STUDY PROJECTS		
○ Upper Atmosphere Particle Studies 1967	1	The Swedish Space Research Committee (SSRC) and NASA arranged in 1967 for a mobile pulsed laser radar, located in Sweden, to be used to determine height, distribution, and scattering properties of cosmic dust and aerosol particles during the presence and absence of noctilucent clouds.
○ Global Climatology of the Stratosphere, 1976	1	NASA, GSFC, NOAA, and the Free University of Berlin jointly studied global climatology of the stratosphere using ozone data from Nimbus-4 backscattered ultraviolet (UV) experiment incorporating German analysis of stratospheric height and temperature fields.
● Atmospheric Explorer (AE) Program 1977—1978	2	Appleton Laboratory, UK: Use of AE data in correlation with ground data from Arecibo Observatory in Puerto Rico for study of ion-drift and ion-drag phenomena.
● 1979		University of Bonn, Germany: Use of AE data to construct a statistical model of the ionosphere in the 60-4000 km region.

Cooperative Ground—Based Projects

Project	Number of Countries	Description
ATMOSPHERIC STUDY PROJECTS (Continued)		
○ Correlative ground-based measurements to support Global Air Sampling Program (GASP) around-the-world flight, 1977	4	NASA GASP instrument package to analyze ambient air by in situ sampling was carried by aircraft special flight around the world over the poles in Oct.—Nov. 1977. Scientists in Australia, New Zealand, South Africa, and the UK provided ground-based data for correlation with the airborne GASP data.
● Ground Truth Support of Applications Explorer Mission B/Stratospheric Aerosol and Gas Experiment (SAGE) to be launched in 1979	3	One UK scientist is a member of the SAGE Experiment Team, assisting NASA in instrument development, prelaunch planning, and postlaunch sensor performance evaluation for the SAGE mission. In addition, scientists from Belgium, Japan, UK, and the Joint Research Center (JRC) of the CEC are participating in ground truth science activities for SAGE and serving as members of the SAGE Ad Hoc Ground Truth Working Group.
● Ground Ozone Instrument Intercomparison 1979	2	Ground ozone measurement instruments provided by Canada and New Zealand will be compared with the Dobson spectrophotometcrat NASA Wallops Flight Center.
SUPPORT OF MANNED SPACE FLIGHTS		
● Lunar Sample Studies (Apollo Missions) 1969–present	21	More than 90 foreign Principal Investigators (PI's) and more than 280 foreign Co-Investigators (Co-I's), from Australia, Belgium, Brazil, Canada, Czechoslovakia, ESA, Finland, France, Germany, India, Italy, Japan, Korea, Mexico, Norway, Republic of China (Taiwan), South Africa, Spain, Switzerland, USSR, and UK, are, or have been, conducting a full range of experiments on samples of lunar rocks and fine materials returned by the Apollo Lunar Landing Missions. Studies involve mineralogy and petrology, chemical and isotopic analyses, physical properties, and bioscience and organic analyses.
○ Biomedical Experiments Team Skylab 1973–1975	2	German Air Force and UK Royal Air Force physicians and life scientists were assigned for two years to NASA Johnson Space Center (JSC) as part of the Skylab biomedical team studying effects of long duration space flight on crew.

Cooperative Ground—Based Projects

Project	Number of Countries	Description
SUPPORT OF PLANETARY FLIGHTS		
● Planetary Surface Feature Studies 1973–present	1	MPI, Heidelberg/University of Tuebingen/University of Munich. Digital and photographic, image processing. Production of planetary lineament maps using data provided by NASA.
○ Measurement of Radio Emissions from Jupiter, 1976	1	Meudon Observatory operated NASA-provided electronic equipment and antennas at the Nancay Radioastronomy Station as part of the NASA network monitoring decameter wavelength radio emissions from Jupiter.
○ Planetary Geology Program 1976	1	The Laboratory of Dynamic Internal Geology of the University of Paris-Sud conducted structural study of scarps visible on surface of Mercury and compared the structures on Mercury with structures on the Moon and Earth.
● Planetary Geology Program 1977–1978	1	University of Munich Institute for General and Applied Geology is carrying out monoscopic and stereoscopic measurements of planetary images and preparing topographic and lineation maps.
● Viking Guest Investigator Program 1976–1979	4	Scientists from the University of Munich, Germany/Rene Bernas Laboratory, France/ University of Melbourne, Australia/SRC, UK/and CNES, France, are participating in studies using data from the NASA Viking Mars Mission.
ASTRONOMY AND ASTROPHYSICS		
● Machine Readable Star Catalogues 1978–1979	1	The Center for Stellar Data (CDS) of Strasbourg, France, and NASA are coordinating their activities in the area of machine readable star catalogues. (Seven European institutes participate in CDS.)
● Monograph Series on Stellar Astrophysics 1978–1979	1	The French CNRS and NASA are jointly sponsoring a series of monographs on the subject of stellar astrophysics.

Cooperative Ground—Based Projects

Project	Number of Countries	Description
ASTRONOMY AND ASTROPHYSICS (Continued)		
• Small Astronomy Satellite (SAS-3) Guest Investigator Program 1978—1979	3	Scientists from the Tata Institute of Fundamental Research, India; University of Tasmania, Australia; and the Dominion Astrophysics Laboratory, Canada are carrying out studies using SAS-3 data.
• Advanced X-Ray Astrophysics Facility (AXAF) 1978—1979	2	University of Leicester, UK and the MPI, Garching, Germany are participating in the NASA AXAF feasibility study.
• High Energy Astronomical Observatory (HEAO-1) Guest Investigator Program 1979	1	Scientists from National Center for Scientific Research (CNRS) and the CNES are conducting studies using data from HEAO-1.
• Orbiting Astronomical Observatory (OAO) Guest Investigator Program 1979	13	Forty-four astronomers from the following institutes have carried out observing programs on OAO: Italy: Observatory of Trieste, University of Padua Netherlands: Kapteyn Astronomical Observatory, The University of Utrecht, University of Groningen, and University of Amsterdam Canada: The University of Western Ontario, University of Alberta, University of Montreal, and David Dunlap Observatory France: CNRS and Paris Observatory ESA: Headquarters UK: Culham Laboratory, Queen's University Belfast, and Anglo-Australian Observatory USSR: Crimean Astrophysical Observatory and Byurakan Observatory (Armenian SSR) Poland: University of Wroclaw Austria: University of Vienna Germany: University of Bonn and MPI, Garching Belgium: Institute of Astrophysics, University of Liege South Africa: South African Astronomical Observatory Finland: University of Helsinki

Cooperative Ground—Based Projects

Project	Number of Countries	Description
ASTRONOMY AND ASTROPHYSICS (Continued)		
• Solar Maximum Mission (SMM) Guest Investigator Program 1979	10	Astronomers from 19 institutes in France, Switzerland, the UK, Italy, Japan, Brazil, Ireland, Germany, Belgium, and Sweden are scheduled to act as Guest Investigators using data from SMM.
• International Ultraviolet Explorer (IUE) Guest Investigator Program 1979	5	Twelve astronomers from the following institutes are carrying out observing programs using IUE: Canada: Dominion Astrophysical Observatory Japan: Tokyo Astronomical Observatory Mexico: National University of Mexico UK: University of Manchester USSR: Struve Astrophysical Observatory

Cooperative Balloon and Airborne Projects

Project and Date	Number of Countries	Description
BALLOON FLIGHTS:		
○ Spectrotelescope Studies 1966–1973	1	The Institute for Space Physics Research (IPW) of Freiburg, Germany and NASA conducted three high altitude balloon soundings using a high resolution solar spectrotelescope designed to gain new knowledge of fine structure elements of solar atmosphere. NASA provided balloons that carried the instruments to an altitude of about 24,386 m (80,000 ft). Flights were conducted in Nov. 1966 and Nov. 1968 and in 1973. The United States (US) National Center for Atmospheric Research (NCAR) provided launching services from the Balloon Flight Station, Palestine, Texas.
○ Study of Stellar Near Ultraviolet Light 1968	1	Under an agreement between the Swiss Committee for Space Research (SCSR) and NASA, a balloon flight was made in Sep. 1968 from the NCAR facility at Palestine, Texas. The balloon payload, developed by the Observatory of Geneva, was designed to study stellar near ultraviolet (UV) radiation. The balloon lifted the 170-kg (375-lb) payload to an altitude of about 41,450 m (136,000 ft).
○ Study of Solar and Atmospheric Neutrons 1969–1972	1	Max Planck Institute (MPI), Munich and NASA conducted a series of high altitude balloon soundings to measure the flux of neutrons of solar origin. NASA provided balloons carrying large (over 590-kg (1300-lb)) German payloads to altitudes of over 30,480 m (100,000 ft). Instrumentation consists of large spark chambers in which scattering events can be recorded. Flights were conducted in Sep. 1969 and Oct. 1972.
○ Stratospheric Studies, 1977	1	Under an agreement between the Atmospheric Environment Service (AES) and NASA, a joint balloon flight project was conducted in Nov. 1977 from the National Scientific Balloon Facility, Palestine, Texas, for (1) an intercomparison of different techniques for measurements of stratospheric gases and (2) gathering a comprehensive set of measurements of stratospheric gases. Two US balloons were launched, one carrying US instrumentation and the other Canadian.

○ Completed Project
● Current

Cooperative Balloon and Airborne Projects

	Project and Date	Number of Countries	Description
BALLOON FLIGHTS: (Continued)			
○	Stellar Ultraviolet (UV) Astronomy Studies 1976 1979	2	The Space Research Laboratory (SRL) at Utrecht, the Netherlands, Liege University, Belgium, and NASA are carrying out a series of launchings of the Balloon Borne Ultraviolet Spectrophotometer (BUSS) instrument from the NCAR facility at Palestine, Texas. The scientific objective is to carry out high resolution UV spectrometry of main sequence stars. The 726-kg (1600-lb) BUSS instrument is floated at an altitude of about 38,100 m (125,000 ft) for up to 12 hr, enabling detailed spectrographic studies.
●	Stratospheric Research Nimbus-7 Limb Infrared Monitor of the Stratosphere (LIMS) Data Validation 1978 1979	5	Experimenters from Belgium, Canada, Germany, France, and the United Kingdom (UK) provided instruments for joint balloon flights as part of the LIMS data validation effort. In addition, a UK experimenter is performing ozone measurements from the Argentine Islands in the Antarctic using NASA-supplied ozonesondes and balloons.
AIRBORNE OBSERVATIONS:			
○	Solar Eclipse Observation Flights South Pacific, May 1965 Brazil, Nov. 1966	4	Experimenters from Belgium, Italy, the Netherlands, and Switzerland joined US scientists in May 1965, and experimenters from Italy joined in November 1966, in studying the structure and composition of the solar atmosphere, searching for faint comets in the vicinity of the Sun, and conducting temperature distribution studies.
○	Astronomical Mirror Loan Dec. 1971–May 1972	1	On loan to CNES/Paris Observatory is a NASA CV-990 gyro-stabilized mirror system for infrared (IR) astronomy observations onboard a French Mystere aircraft.
○	Auroral Expeditions Convair 990 Polar Region Flights Feb.–Mar. 1968 Nov.–Dec. 1969	4	Two groups of experimenters from Canada, one from France, and observers from Norway and Sweden joined US experimenters on a series of flights from Churchill Research Range, Canada, principally to look for aurorae at midday in a region where the Sun remains below the horizon throughout the day.
○	Infrared (IR) Astronomy, 1974	1	Two experiments proposed by the Meudon Observatory were conducted on the NASA Airborne Infrared Observatory (AIRO): One to obtain spectral measurements of the far IR spectrum of Jupiter and the other to study the emission lines from interstellar matter.

Cooperative Balloon and Airborne Projects

Project and Date	Number of Countries	Description
AIRBORNE OBSERVATIONS: (Continued)		
○ Comet Kohoutek Observation on Airborne Science Spacelab Experiments System Simulation (ASSESS I) Flight, 1974	3	Experimenters from France, Germany and Italy joined US scientists in infrared and ultraviolet observations of Comet Kohoutek during the first ASSESS mission.
○ Meteors-Observation of Quarantid Meteor Shower Near Ottawa, Canada, 1976	1	Experimenters from Canada conducted complementary observations using high and low power meteor radars in the Ottawa area and batteries of ground spectrographs at two stations.
○ Cloud Motion Wind Estimates NASA P-3 Aircraft, Flights in Bermuda Area, Jan.–Feb. 1976	1	A French experimenter participated in Phase IV "Wind Estimate from Cloud Motion" Aircraft Experiment to verify geostationary satellitederived cloud motion wind estimates. Data on cloud height and cloud motion acquired from the aircraft were compared with cloud motion wind estimates derived from Synchronous Meteorological Satellite (SMS)/GEOS-1 satellite cloud height and cloud motion data acquired over the same area in the same time period. This verification project supported preparation for First GARP (Global Atmospheric Research Program) Global Experiment (FGGE).
○ Stratospheric Latitude Survey Convair 990 Flights from Alaska to New Zealand, Nov. 1976	3	French infrared absorption grille spectrometer included as part of aircraft instrument complement to investigate composition of upper atmosphere, particularly type and density of trace constituents, and to determine whether concentration of trace constituents differs between Northern and Southern Hemispheres. Experimenters in Australia and New Zealand conducted coordinated complementary ground-based measurements including radiosonde vertical temperature profiles and ozonesonde and Dobson spectrophotometer measurements of ozone.
○ ASSESS I Convair 990 Flights from Moffett Field, California, May 1975	1	Candidate Spacelab science and applications instruments sponsored by the European Space Agency (ESA) and NASA were flown on the NASA CV-990 Airborne Laboratory to simulate a Spacelab mission.

Cooperative Balloon and Airborne Projects

Project and Date	Number of Countries	Description
AIRBORNE OBSERVATIONS: (Continued)		
○ Cloud Motion Wind Estimates Convair 990 Flights from Moffett Field, California, Feb.–May 1977	1	French high resolution multispectral scanning radiometer "Aries" included among instruments on board aircraft for Phase V of "Wind Estimate from Cloud Motion" program. French radiometer experiment will simulate response of proposed satellite sensors to middle and high-level clouds over a mid-latitude oceanic region, with a view to measurement of cloud height using a visible channel and various infrared channels.
○● Infrared Stellar Observations ● 1976 1978 1979	3	Stockholm Observatory in Sweden is furnishing flight and test hardware for NASA Lear Jet observation flights to study the infrared spectra of K and M stars. The Meudon Observatory is furnishing interferometric and associated equipment to study ionic abundances, eiectron density, and ionization and velocity structure of selected stellar objects. This work is done on the NASA Kuiper Airborne Observatory (C-141). ESA and the Astronomical Institute, University of Utrecht, the Netherlands, are furnishing a super heterodyne submillimeter-wavelength spectrometer to investigate the transitions which occur in the formation of collapsing interstellar clouds. This work is done on the NASA Kuiper Airborne Observatory (C-141).
○ ASSESS II (Flown in US and Europe) May 1977	1	European scientific instruments sponsored by ESA and NASA applications experiments were flown on the NASA CV-990 research aircraft in this the second simulation of a nine-day Spacelab mission.
○ Stratospheric Studies 1977	1	Under an agreement between AES and NASA, US and Canadian experimenters participated in coordinated flights of the NASA U-2 aircraft and a Canadian balloon from Cold Lake, Alberta to investigate the observed decrease of nitrogen dioxide (NO_2) north of 45° N latitude.

Cooperative Aeronautical Projects

Country, Project, and Date	Description
CANADA	
● Augmentor-Wing Development and Test 1970-present	The Canadian Department of Industry, Trade, and Commerce and NASA are jointly funding a multiyear flight test project to develop a STOL (short take-off and landing) research aircraft incorporating the "Augmentor-Wing" concept. This is being supported by a Canadian Defense Research Board (DRB) and NASA augmentor-wing and tunnel research effort.
FRANCE	
○ Tilt Rotor Vertical/Short Take-Off and Landing (V/STOL) Tests 1969-1972	National Office for Aerospace Studies and Research (ONERA) and NASA conducted a cooperative wind tunnel research program to test tilt rotors for V/STOL aircraft. Wind tunnels in the United States (US) and France were used in carrying out the project.
○ Transonic Wind Tunnel Flutter Tests 1972-1973	ONERA and NASA began a research project on transonic flutter to improve confidence in transonic wind tunnel flutter results and flutter techniques used in NASA and ONERA wind tunnels.
○ Wake Vortex Studies 1974	In cooperation with ONERA, a study was conducted to compare wake vortex turbulence behind typical subsonic and supersonic transports.
● Propagation of Acoustic Disturbances 1976-present	A study was initiated with ONERA on propagation of acoustic disturbances through a shear layer for fixed and moving sources.
● Jet Noise 1976-present	ONERA in cooperation with NASA will study the effect of forward speed on jet noise by using wind tunnel measurements on the J-85 engine.
GERMANY	
○ Dornier 31 V/STOL Flight Simulation and Flight Tests, 1969-1970	Federal Ministry for Education and Science, Germany (BMBW) and NASA conducted two cooperative projects based on the advanced jet V/STOL transport Dornier 31 (DO-31). In the first, NASA conducted flight simulation programs to study stability, control, and handling qualities during landing, transition, and descent phases of flight. In the second, NASA pilots flew the DO-31 for approximately 12 hr to test performance limitations under various V/STOL descent and ascent conditions.

○ Completed Project
● Current

Cooperative Aeronautical Projects

Country, Project, and Date	Description
GERMANY (Continued)	
● Helicopter Blade Tip Loading 1977-present	This cooperative study of aerodynamic loads on the helicopter blade tips of varying designs is in collaboration with the German Aerospace Research and Test Establishment (DFVLR) Institute for Aeroelastics in Goettingen, Germany.
NETHERLANDS	
● Transonic Airfoil Study 1976-present	A study of transonic unsteady aerodynamics of two dimensional airfoils has been initiated in cooperation with the National Aerospace Laboratory (NLR).
● Aircraft Fuel Saving Study 1978-1980	A study has been initiated in cooperation with the Netherlands Department of Civil Aviation to evaluate aircraft fuel savings by using real-time global meteorological data in flight planning.
UNITED KINGDOM	
○ Wind Tunnel and Flight Test Correlations 1967-1970	A study was conducted with the Ministry of Technology to correlate a boundary layer control flap system installed on a Hunting-126 aircraft using wind tunnel and flight test results.
○ Runway Traction Study 1968-1969	A study was conducted in cooperation with the Ministry of Technology to test the effects of runway grooving on aircraft and ground vehicle performance and handling.
● Thrust Vectoring in Forward Flight 1972-1979	This cooperative effort involved the Ministry of Defense (Procurement Executive) in a study to determine the effects of thrust vectoring on aircraft performance and handling. Simulator and flight tests were conducted in both the US and United Kingdom (UK).
● Scale and Wind Tunnel Effects Study 1974-1979	NASA and the Ministry of Defense (Procurement Executive) agreed to conduct tests on a UK-furnished model to assess scale effects and wind tunnel effects at transonic speeds.
● Atmospheric Turbulence Simulation 1975-1979	NASA conducted, in cooperation with the Ministry of Defense (Procurement Executive), an evaluation of a Royal Aircraft Establishment turbulence model on a NASA flight simulator.

Cooperative Aeronautical Projects

Country, Project, and Date	Description
UNITED KINGDOM (Continued)	
• Airfoil Tests in Cryogenic Wind Tunnels 1975-present	NASA and the Ministry of Defense (Procurement Executive) are involved in a program to determine the effects of Reynolds number and condensation on the pressure differential of a "Peakey" airfoil in a cryogenic wind tunnel. Theoretical work is complete and wind tunnel tests are scheduled for mid-1979.
• Jet and Fan Noise Test Technique 1977-present	In cooperation with the Ministry of Defense (Procurement Executive), the results of UK-tested engine nozzles were compared with the results of UK engine nozzles tested in NASA wind tunnels.

US/USSR Coordinated Space Projects

Project and Date	Description
1962 Agreement:	
○ Joint Soviet Academy/NASA Projects in Meteorology 1962-1971	Established a communications link for exchange of meteorological data; contemplated coordinated launchings of meteorological data is now handled by the State Committee of the Union of Soviet Socialist Republics (USSR) on Hydrometeorology and Control of the Natural Environment and the National Oceanic and Atmospheric Administration (NOAA).
○ Telecommunication, 1962-1964	Experiments using the United States (US) passive communications satellite Echo-2, antennas at the USSR Zemenki facilities.
○ Geomagnetic Mapping, 1962-1973	Data were exchanged from ground-based observatories on Cosmos 49, Cosmos 321, Orbiting Geophysical Observatory (OGO)-2, and OGO-6.
○ Joint Review of Space Biology and Medicine 1965–1976	NASA SP-374: Foundations of Space Biology and Medicine completed in 1976 in both English and Russian. Three volumes of joint and independent papers on experience in space flight research in fields of biology and medicine.
○ Apollo-Soyuz Test Project (ASTP), 1970-1975 October 1970 Agreement - Study Phase April 1972 Agreement - Developmental Phase May 1972 - Summit Agreement	Under the initial US/USSR agreement on compatible rendezvous and docking systems, both countries examined technical and feasibility aspects. In April 1972, the Soviet Academy and NASA decided to commence development and plan for a test flight in 1975. The May 1972 Summit Agreement confirmed that and other bilateral undertakings in US/USSR space cooperation. In July 1975 the Apollo and Sovuz crafts docked successfully, and each crew visited the other's spacecraft and conducted five joint experiments.
● 1971 Agreement on Space Sciences and Applications - Renewed in 1974 and 1977	Building on earlier experience, this agreement provides for: Exchange of lunar samples; exchange of information regarding results of space research; exchange of findings of interest from planetary probes; coordination of meridional meteorological sounding rocket networks; coordinated studies of ocean and vegetation surveys in agreed areas by space and conventional means; exchange of biomedical results in manned space flights; flight of US life sciences experiments of Soviet biosatellites; and flight of USSR life sciences experiments on Spacelab.

US/USSR Coordinated Space Projects

Project and Date	Description
• Experimental Satellite System for Search & Rescue of Vessels and Aircraft in Destress 1977 Agreement	US and USSR satellites equipped with transponders are to receive distress signals and relay them to ground stations for independent search and rescue operations during a demonstration test of the system beginning in 1982. This agreement would support a US/Canada/France project currently under negotiation.
• Manned Space Flight, 1977-present May 1, 1977 Agreement - Study Phase May 18, 1977 Agreement - Extended May 14, 1972 Summit Agreement	The May 1 agreement provides for a study of the objectives, feasibility, and means of a possible joint mission using the US shuttle and the USSR Salyut spacecraft. The Summit Agreement confirmed this effort and other bilateral undertakings in US/USSR space cooperation.
• Support of Other Agencies' Cooperative Agreements with the USSR in Science and Technology	NASA has provided technical support to the DOE, FAA, and NOAA.

Scientific and Technical Information Exchanges

Project and Date	Description
● NASA/European Space Agency (ESA) Technical Documentation, Microfiche, and Computer Search 1969-present	ESA Document Service and NASA RECON System are reciprocally available and ESA provides identification and precis of new European documentation to NASA RECON system. System compatibility makes possible computer tape and microfiche exchange.
● Bilateral Technical Document Exchange Program 1962-present	NASA maintains separate technical document exchange programs with **214** organizations in 58 countries and another 299 organizations receive additional services, primarily copies of the STAR.
○ Korean Institute of Science and Technology (KIST) 1971-1972	Agency for International Development (AID) initiated an experimental project to test the feasibility of transferring aerospace technology documented in NASA scientific and technical information collection to meet specific Korean economic development needs. This pilot project resulted in a number of transfers in the electronics area. An AID-sponsored international workshop to discuss the results of the project was conducted by KIST in Korea in 1972 and in Latin America in 1973.

Launchings of Non-US Spacecraft

Country, Name, Purpose*	Vehicle, Launch Site**, Date
CANADA	
○ Telesat-A (Anik-I) (DC)	Delta/Nov. 9, 1972
○ Telesat-B (Anik-II) (DC)	Delta/Apr. 20, 1973
○ Telesat-C (Anik-III) (DC)	Delta/May 7, 1975
○ Telesat-D (Anik-B) (DC)	Delta/Dec. 15, 1978
EUROPEAN SPACE AGENCY (ESA)	
○ HEOS-1 (S)	Delta/WTR/Dec. 5, 1968
○ BOREAS/ESRO 1B (S)	Scout/WTR/Oct. 1,1969
○ HEOA A-2 (S)	Delta/WTR/Jan. 31, 1972
○ TD-1 (S)	Delta/WTR/Mar. 12, 1972
○ ESRO IV (S)	Scout/WTR/Nov. 20, 1972
○ COS-B (S)	Delta/Aug. 8, 1975
○ GEOS-A (S)	Delta/Apr. 20, 1977
○ OTSA (EC)	Delta/Sep. 13, 1977
○ METEOSAT (A)	Delta/Nov. 22, 1977
○ OTSB (EC)	Delta/May 11, 1978
○ GEOS-B (S)	Delta/Jul. 14, 1978
FRANCE/GERMANY	
○ Symphonie-A (EC)	Delta/Dec. 18, 1974
○ Symphonie-A (EC)	Delta/Aug. 26, 1975
GERMANY	
○ AEROS-B (S)	Scout/WTR/Jul. 16, 1974
INDONESIA	
○ Palapa-A (DC)	Delta/Jul. 8, 1976
○ Palapa-B (DC)	Delta/Mar. 10, 1977
ITALY	
○ SIRIO (EC)	Delta/Aug. 25, 1977
JAPAN	
○ GMS (A)	Delta/Jul. 17, 1977
○ CS (EC)	Delta/Dec. 14, 1977
○ BS (EC)	Delta/Apr. 7, 1978
NATO (via DOD)	
○ NATO A (C)	Delta/Mar. 20, 1970
○ NATO B (C)	Delta/Feb. 2, 1971
○ NATO III-A (C)	Delta/Apr. 22, 1976
○ NATO III-B (C)	Delta/Jan. 27, 1977
○ NATO III-C (C)	Delta/Nov. 18, 1978
UNITED KINGDOM	
○ Skynet-I (via DOD) (C)	Delta/Nov. 22, 1969
○ Skynet-2 (via DOD) (C)	Delta/Aug. 26, 1975
○ Skynet-2A (via DOD) (C)	Delta/Jan. 18, 1974
○ UK-4 (S)	Scout/WTR/Mar. 8,1974
○ Skynet-2B (via DOD) (C)	Delta/Nov. 22. 1974
● UK-6 (S)	Scout/Wallops/May 1979

*Purpose Code:
- A - Applications
- C - Communications
- D - Domestic
- E - Experimental
- I - International
- S - Scientific

**All launches from Eastern Test Range (ETR) except where otherwise indicated.

○ Completed Project
● Current

Launchings of Non-US Spacecraft

Country, Name, Purpose*		Vehicle, Launch Site**, Date
INTELSAT		
○ Intelsat I	F-1 (IC)	Delta/Apr. 6, 1965
○ Intelsat II	F-1 (IC)	Delta/Oct. 26, 1966
○ Intelsat II	F-2 (IC)	Delta/Jan. 11, 1967
○ Intelsat II	F-3 (IC)	Delta/Mar. 23, 1967
○ Intelsat II	F-4 (IC)	Delta/Sep. 28, 1967
○ Intelsat III	F-1 (IC)	Delta/Sep. 19, 1968
○ Intelsat III	F-2 (IC)	Delta/Dec. 19, 1968
○ Intelsat III	F-3 (IC)	Delta/Feb. 6, 1969
○ Intelsat III	F-4 (IC)	Delta/May 22, 1969
○ Instelsat III	F-5 (IC)	Delta/Jul. 26, 1969
○ Intelsat III	F-6 (IC)	Delta/Jan. 15, 1970
○ Intelsat III	F-7 (IC)	Delta/Apr. 23, 1970
○ Intelsat III	F-8 (IC)	Delta/Jul. 23, 1970
○ Intelsat IV	F-2 (IC)	Atlas C/Jan. 25, 1971
○ Intelsat IV	F-3 (IC)	Atlas C/Dec. 19, 1971
○ Intelsat IV	F-4 (IC)	Atlas C/Jan. 22. 1972
○ Intelsat IV	F-5 (IC)	Atlas C/Jun. 13, 1972
○ Intelsat IV	F-7 (IC)	Atlas C/Aug. 23, 1973
○ Intelsat IV	F-8 (IC)	Atlas C/Nov. 21, 1974
○ Intelsat IV	F-6 (IC)	Atlas C/Feb. 20, 1975
○ Intelsat IV	F-1 (IC)	Atlas C/May 22, 1975
○ Intelsat IV-A	F-1 (IC)	Atlas C/Sep. 25, 1975
○ Intelsat IV-A	F-2 (IC)	Atlas C/Jan. 29, 1976
○ Intelsat IV-A	F-3 (IC)	Atlas C/Jan. 6, 1978
○ Intelsat IV-A	F-4 (IC)	Atlas C/May 26,1977
○ Intelsat IV-A	F-5 (IC)	Atlas C/Sep. 29, 1977
○ Intelsat IV-A	F-6 (IC)	Atlas C/Mar. 31, 1978
● Intelsat V	F-1 (IC)	Atlas C/Aug. 1979
● Intelsat V	F-2 (IC)	Atlas C/Nov. 1979
● Intelsat V	F-3 (IC)	Atlas C/Mar. 1980
● Intelsat V	F-4 (IC)	Atlas C/Jul. 1980

Foreign Launchings of NASA Spacecraft

Country, Name, Purpose*	Vehicle, Launch Site**, Date
ITALY	
○ SAS-A (Explorer-42) uhuru (S)	Scout, San Marco, Dec. 12, 1970
○ SSS-A (Explorer-45) (S)	Scout, San Marco, Nov. 15, 1971
○ SAS-B (Explorer-48) (S)	Scout, San Marco, Nov. 16,1972
○ SAS-C (Explorer-53) (S)	Scout, San Marco, May 7, 1975

*Purpose Code: A - Applications
C - Communications
D - Domestic
E - Experimental
I - International
S - Scientific

**All launches from Eastern Test Range (ETR) except where otherwise indicated.

○ Completed Project
● Current

NASA Overseas Tracking Stations/Facilities

Country/Site	Date of Agreement1 or Operational Date	Date Deactivated
ARGENTINA		
○ Mar del Plata (tracking ship Vanguard)	1973	1974
AUSTRALIA		
○ Carnarvon	Feb. 11,1963	Dec. 1974
○ Darwin (OGO)	Feb. 26,1960	1968
● Deakin-NASCOM Switching Center	Feb. 11,1963	Still active
● Honeysuckle Creek	Feb. 11,1963	Still active
○ Muchea	Feb. 26,1960	Mar. 1964
● Orroral Valley	Oct. 22, 1963	Still active
● Tidbinbilla	Oct. 22, 1963	Still active
○ Toowoomba (ATS)	Dec. 7, 1965	Jun. 1970
○ Woomera (MSFN)	1960	1963
○ Woomera (DSN)	Feb. 26,1960	Dec. 1972
○ Woomera (Minitrack)	Aug. 1957	1966
● Yarragadee (Mobile Laser)	Jun. 27,1978	Still active
BRAZIL		
○ Brasilia	1962	1963
CANADA		
○ St. John's, Newfoundland	Aug. 24,1960	Aug. 1970
	Dec. 20,1971	Aug. 1973
	Feb. 23,1972	Nov. 1975
CHILE		
○ Antofagasta	Nov. 15, 1956	Jul. 1963
● Santiago	Feb. 19, 1959	Still active
CUBA		
○ Havana	Acquired when NASA formed	Jan. 1959
ECUADOR		
● Quito	Feb. 24,1960	Still active
INDIA		
○ Ahmedabad	1962	1962
MADAGASCAR		
○ Antananarivo	Oct. 7, 1963	Jul. 1975
○ Majunga	1963	1964
MAURITIUS		
○ Plaisance Airfield Used for ARIA Staging	Sep. 3,1968	1975
MEXICO		
○ Guaymas	Apr. 12, 1960	Nov. 1970

○ Completed Project
● Current

NASA Overseas Tracking Stations/Facilities

Country/Site	Date of Agreement1 or Operational Date	Date Deactivated
NIGERIA		
○ Kano	Oct. 19, 1960	Dec. 1967
PAKISTAN		
○ Rawalpindi (Portable Landsat Receiver)	Aug. 1975	Sep. 1977
PERU		
○ Lima	Mar. 6, 1959 (Became operational Aug. 1956)	Nov. 1966
SEYCHELLES		
○ Mahe	Dec. 30, 1966	1977
SPAIN		
○ Canary Islands	Mar. 1960	Feb. 1975
● Madrid	Apr. 14,1966	Still active
○ Madrid (ATS-6)		Sep. 1976
SOUTH AFRICA		
○ Johannesburg	Sep. 13, 1960	(DSN) Jun. 1974 (STDN) Oct. 1975
TANZANIA		
○ Zanzibar Island.	Oct. 14, 1960	Jul. 1964
UNITED KINGDOM		
○ Antigua	Jan. 23, 1967	Aug. 1970
○ Antigua (Minitrack)	Installed Oct. 1956	1961
● Ascension Island	Jun. 26,1956	Still active
● Bermuda	Mar. 15, 1961	Still active
○ Canton Island	Apr. 6, 1961	Dec. 1967
○ Grand Bahama	May 3, 1968	Oct. 1969
○ Grand Turk	Acquired when NASA formed	Jul. 1961
○ Grand Turk (Mobile Laser)	1975	1976
● Grand Turk (Mobile Laser)	1978	Still active
● Winkfield	Jan. 1, 1967	Still active

NASA Funded SAO Optical and Laser Tracking Facilities

Country/Site	Operational Date	Deactivation Date
ARGENTINA		
○ Villa Dolores	Jul. 1958	Oct. 1966
○ Cornodoro Rivadavia	Nov. 1966	Jan. 1970
AUSTRALIA		
○ Woomera	Mar. 1958	Jun. 1964
○ Island Lagoon	Jul. 1964	Apr. 1973
● Orroral Valley	1976	Laser–Still Active
BRAZIL		
● Natal	Sep. 1966	Laser–Still Active
○ San Paulo	Unknown	1977
CANADA		
○ St. Margaret's, New Brunswick	Aug. 1976	Jun. 1978"
ETHIOPIA		
○ Addis Ababa	Aug. 1966	Aug. 1976
GREECE		
○ Dionysos	Dec. 1967	Jun. 1978"
INDIA		
○ Naini Tal	Aug. 1958	Jun. 1978"
IRAN		
○ Shiraz	May 1958	Jul. 1966
JAPAN		
○ Tokyo	Apr. 1958	May 1968
○ Dodaira	May 1968	Jun. 1978"
NETHERLANDS ANTILLES		
○ Curacao	Jun. 1958	Jul. 1966
PERU		
● Arequipa	Jul. 1958	Laser–Still Active
SENEGAL		
○ Dakar	Dec. 1970	Sep. 1971
SOUTH AFRICA		
○ Olifantsfontein	Mar. 1958	Sep. 1975
SPAIN		
○ San Fernando	Mar. 1958	Jun. 1978"
UPPER VOLTA		
○ Ouagadougou	May 1972	Nov. 1975

"Terminated NASA funding. Continues as local operation.

○ Completed Project
● Current

Reimbursable Tracking Arrangements

Country/Spacecraft	Date
SUPPORT RECEIVED BY NASA	
FRANCE	
○ Explorer–42 (SAS–1)	1970–74
○ Syncom 3	1971
○ San Marco 3	1971
○ Explorer–48 (SAS–2)	1972–74
○ Explorer–53 (SAS–3)	1975–76
ITALY	
○ Explorer–42 (SAS–1)	1970
○ Explorer–53 (SAS–3)	1975
○ TIROS–N	1978
● NOAA-A	1978
UNITED KINGDOM (Includes Singapore and Falkland Islands)	
○ UK 1,2	1963–70
○ Alouette	1963–71
○ Explorer42 (SAS–1)	1970

Country/Spacecraft	Date
SUPPORT PROVIDED BY NASA	
EUROPEAN SPACE AGENCY (ESA)	
● Ariane	1979–80
FRANCE	
○ A–1	1965
○ D–1A	1966
○ DIADEME–1	1967
○ DIADEME–2	1967
○ PEOLE	1970–73
○ D2–A (Tournesol)	1971–74
○ SRET–1	1972
○ D5–A (POLLUX)	1973–75
● D5–B (CASTOR)	1973–79
○ STARLETTE	1975–78
○ SRET–2	1975–78
○ D2–B	1975–77
○ SIGNE III	1977–78
FRANCE/GERMANY	
○ DIAL–WIKA	1970

Country/Spacecraft	Date
SUPPORT PROVIDED BY NASA (Continued)	
JAPAN	
○ Ohsumi	1970
○ MS–T1 (Tansei–1)	1971
○ MS–F2 (Shinsei)	1971
○ REXS (Denpa)	1972
○ MS–T2 (Tansei–2)	1974
○ SRATS (Taiyo)	1975
○ ETS–1 (KiKu–1)	1975
○ CORSA–A	1976
○ ISS–1 (UME)	1976
○ MS–T3 (Tansei–3)	1977
○ ETS–2 (KiKu–2)	1977
○ EXOS–A (Kyokko)	1978
○ ISS–2 (UME–2)	1978
○ EXOS–B	1978
● CORSA–B	1979
● ECS–B	1979

○ Completed Project
● Current

Personnel Exchanges

Program	Purpose	Participation	Current	Cumulative
Resident Research Associateships	Postdoctoral and senior postdoctoral grants are provided for senior foreign scientists. The program, administered for NASA by the National Academy of Sciences, provides for participation in research at NASA centers and the Jet Propulsion Laboratory (JPL) for one year.	Foreign Nationals from Countries	121 25	951 45
International Fellowships	Theoretical and experimental training in the space sciences is provided on a cost sharing basis to foreign graduate students at United States (US) universities for one year with the possibility of renewal for a second year. This program, which was terminated in 1976, was administered for NASA by the National Academy of Sciences and designed to contribute to the capabilities of cooperating countries.	Fellows from Countries/ Universities		358 21 36
Technical Training at NASA Centers	Technical training can be arranged for foreign scientific and technical personnel at NASA centers in support of agreed cooperative programs and ground facility operations. The length of training may vary from several months to one year.	Foreign Nationals from Countries or Organizations	37 9	904 21*
Foreign Visitors	Officials and scientists from foreign countries/organizations visit NASA facilities in programs demonstrating the open, peaceful character of the US civilian space effort and the opportunities it provides for participation by other countries.	Visitors from Countries or Organizations	4,000 78	68,000 126**

*Includes European Space Agency (ESA).
**See following page for additional information.

Personnel Exchanges

Foreign Visitors to NASA Facilities*

Afghanistan
''Algeria
''Argentina
''Australia
''Austria
Bahamas
''Barbados
''Belgium
Benin
''Bolivia
Botswana
''Brazil
''Bulgaria
Burma
Burundi
Cameroon
*Canada
Central African Empire
Chad
''Chile
''China, People's Republic of
''China, Republic of (Taiwan)
Colombia
Costa Rica
Cyprus
*Czechoslovakia
''Denmark
''Dominican Republic
Ecuador
*Egypt
El Salvador
Ethiopia
''European Space Agency
''Finland
''France
Gabon
''Gambia
German Democratic Republic
''Germany, Federal Republic of
''Ghana
''Greece
Guatemala
''Guinea
Guyana
''Haiti
Honduras
''Hungary
Iceland
*India
•Indonesia
''Iran
Iraq
''Ireland
*Israel
•Italy
Ivory Coast
Jamaica
''Japan
''Jordan
''Kenya
''Korea, Republic of
Kuwait
Laos
''Lebanon
Lesotho
*Liberia
''Libya
''Luxembourg
Madagascar
Malawi
''Malaysia
''Mali
Malta
''Mauritania
Mauritius
''Mexico
Monaco
Morocco
Nepal
''Netherlands
''New Zealand
''Nicaragua
''Niger
''Nigeria
''Norway
''Pakistan
''Panama
''Paraguay
''Peru
''Philippines
''Poland
''Portugal
Rhodesia
*Romania
Rwanda
''Saudi Arabia
Senegal
Sierra Leone
''Singapore
Somalia
''South Africa
''Spain
*Sri Lanka
''Sudan
Swaziland
''Sweden
''Switzerland
''Syria
Tanzania
''Thailand
Togo
Trinidad and Tobago
Tunisia
''Turkey
Uganda
''Union of Soviet
Socialist Republics
Latvia
Lithuania
''United Arab Emirates
''United Kingdom
Bermuda
Hong Kong
''Upper Volta
*Uruguay
''Venezuela
Vietnam, Republic of
*Yemen
''Yugoslavia
Zaire
Zambia

'Indicates visits during calendar year 1978

APPENDIX A: ABBREVIATIONS AND ACRONYMS

A

AAP	Apollo Applications Program
ADOD	Australian Department of Defense
ADOS	Australian Department of Science
AE	Atmospheric Explorer
AES	Atmospheric Environment Service, Canada
AID	Agency for International Development, US
AIDSAT	AID Sponsored International Applications Demonstration
AIRO	NASA Airborne Infrared Observatory
ALADDIN	Atmospheric Layering and Density Distribution of Ions and Neutrals
ALSEP	Apollo Lunar Surface Experiments Package
ANS	Astronomical Netherlands Satellite
APT	Automatic Picture Transmission
ARC	NASA Ames Research Center
ARGOS	French Satellite Data Collection System on TIROS-N
ARIA	Advanced Range Instrumented Aircraft
ASSESS	Airborne Science Spacelab Experiments System Simulation
ASTP	Apollo-Soyuz Test Project
ATS	Applications Technology Satellite
AU	Astronomical Unit
AXAF	Advanced X-Ray Astrophysics Facility

B

BCS	Boost Control System
BIOSTACK	Biological Effects of Cosmic Radiation (Heavy Nuclei) Experiment
BMBW	Federal Ministry for Education and Science, Germany
BMFT	Federal Ministry for Research and Technology, Germany
BMwF	Federal Ministry for Scientific Research, Germany
BNCSR	British National Committee for Space Research
BSE	Broadcast Satellite Experiment, Japan

BUSS	Balloon Borne Ultraviolet Spectrophotometer

C

CalTech	California Institute of Technology
CCRS	Canada Centre for Remote Sensing
CDS	Center for Stellar Data, France
CEC	Commission of European Communities
CENS	Center for Nuclear Studies, France
CENTO	Central Treaty Organization
CESR	Center for Space Studies of Radiation, France
CNAE	National Commission for Space Research, Brazil; now INPE
CNES	National Center for Space Studies, France
CNET	National Center for Telecommunications Studies, France
CNIE	National Commission for Space Research, Argentina
CNPq	National Council on Scientific and Technological Development, Brazil
CNR	National Research Council, Italy
CNRS	National Center for Scientific Research, France
COBAE	Commission for Space Activities, Brazil
Co-I	Co-Investigator
CONEE	National Commission of Outer Space, Mexico
CONIE	National Space Research Commission, Spain
Co-PI	Co-Principal Investigator
COSPAR	Committee on Space Research, ICSU
CRA	Center for Aerospace Research, Univ. of Rome, Italy
CRC	DOC Communications Research Centre, Canada; formerly DRTE
CSIR	Council for Scientific and Industrial Research, South Africa
CSIRO	Commonwealth Scientific and Industrial Research Organization, Australia
CS	Communications Satellite, Japan
CTS	Communications Technology Satellite
CZCS	Coastal Zone Color Scanner

D

DAE	Department of Atomic Energy, India
DCIEM	Defense and Civil Institute of Environmental Medicine, Canada
DEMR	Department of Energy, Mines, and Resources, Canada

DFRC	NASA Dryden Flight Research Center
DFVLR	German Aerospace Research and Test Establishment
DITC	Department of Industry, Trade, and Commerce, Canada
DOC	Department of Communications, Canada
DOD	Department of Defense, US
DOE	Department of Energy, US
DOS	Department of Space, India
DRA	Danish Research Administration
DRB	Defense Research Board, Canada
DRTE	Defense Research Telecommunications Establishment, Canada; now CRC
DSC	Data Collection System
DSN	Deep Space Network, NASA
DSRI	Danish Space Research Institute

E

EASEP	Early Apollo Surface Experiments Package
Eole	US/French Meteorological Satellite/Balloon Project
EPA	Environmental Protection Agency, US
EREP	Earth Resources Experiment Package, Skylab
ERTS	Earth Resources Technology Satellite; now Landsat
ESA	European Space Agency; formerly ESRO
ESDAC	European Space Data Center, Germany; now ESOC
ESOC	European Space Operations Center, Germany
ESRIN	European Space Research Institute, Italy
ESRO	European Space Research Organization; now ESA
ESTEC	European Space Technology Center, Netherlands
ETR	Eastern Test Range; includes both Patrick Air Force Base and Cape Canaveral, Florida
EUV	Extreme Ultraviolet
EXAMETNET	Experimental Inter-American Meteorological Rocket Network

F

FAA	Federal Aviation Administration, US Dept. of Transportation
FAO	Food and Agriculture Organization, UN
FAUST	Far UV Space Telescope

FGGE	First GARP Global Experiment
FRG	Federal Republic of Germany

G

GARP	Global Atmospheric Research Program
GASP	Global Air Sampling Program
GATE	GARP Atlantic Tropical Experiment
GDR	German Democratic Republic
GEOS	ESA Geostationary Scientific Satellite
GfW	German Space Research Corporation
GISS	Goddard Institute for Space Studies
GSFC	NASA Goddard Space Flight Center
GWE	Global Weather Experiment

H

HCMM	Heat Capacity Mapping Mission
HEAO	High Energy Astronomical Observatory
Helios	US/Germany Solar Probe
HEO	High Energy Observatory
HEOS	European Highly Eccentric Orbit Satellite

I

IAF	International Astronautical Federation
ICSU	International Council of Scientific Unions
IES	Ionospheric Explorer Satellite
IGP	Geophysical Institute of Peru
IGY	International Geophysical Year
IMP	Interplanetary Monitoring Platform
INCOSPAR	Indian National Committee for Space Research
INPE	Institute of Space Research, Brazil; formerly CNAE
INTA	National Institute for Aerospace Technology, Spain
INTELSAT	International Telecommunications Satellite Organization
IPW	Institute for Space Physics Research, Germany
IR	Infrared
IRAS	US/Netherlands Cooperative Infrared Astronomical Satellite
IRIS	International Radiation Investigation Satellite
IRLS	Interrogation Recording and Location System
ISAGEX	International Satellite Geodesy Experiment

ISAS	Institute of Space and Aeronautical Science, University of Tokyo, Japan
ISC	Italian Space Commission
ISEE	US/ESA Cooperative International Sun-Earth Explorer
ISIS	US/Canadian International Satellite for Ionospheric Studies
ISPM	International Solar Polar Mission
ISRO	Indian Space Research Organization; formerly part of DAE; now part of DOS
ITU	International Telecommunications Union
IUE	International Ultraviolet Explorer Satellite
IUS	Inertial Upper Stage

J

JOP	Jupiter Orbiter Probe; now Project Galileo
JPL	Jet Propulsion Laboratory, CalTech
JRC	Joint Research Center, CEC
JSC	NASA Johnson Space Center, formerly Manned Spacecraft Center

K

KeV	Kilo-Electron Volt
KIST	Korean Institute of Science and Technology
KSC	NASA Kennedy Space Center

L

LACIE	Large Area Crop Inventory Experiment
LAGEOS	Laser Geodynamic Satellite
Landsat	Land Satellite for Remote Sensing; formerly ERTS
LaRC	NASA Langley Research Center
LAS	Laboratory for Space Astronomy, CNRS, France
LDEF	Long Duration Exposure Facility
LeRC	NASA Lewis Research Center
LIMS	Nimbus-7 Limb Infrared Monitor of the Stratosphere
LPSP	Laboratory of Stellar and Planetary Physics, CNRS, France
LRO	Laboratory for Space Research, Netherlands
LURE	Lunar Laser Ranging Experiment
Luster	Lunar and Extraterrestrial Dust Analysis Project

M

MAROTS	Maritime Orbital Test Satellite, ESA
MIT	Massachusetts Institute of Technology
MMS	Multimission Modular Spacecraft

MN	National Meteorology Agency, France
MPI	Max Planck Institute, Germany
MSC	Manned Spacecraft Center; now NASA Johnson Space Center
MSFC	NASA Marshall Space Flight Center
MSFN	Manned Space Flight Network
MOU	Memoranda of Understanding

N

NACA	National Advisory Committee for Aeronautics; predecessor of NASA
NAS	National Academy of Sciences, US
NASCOM	NASA Communications
NASDA	National Space Development Agency, Japan
NATO	North Atlantic Treaty Organization
NCAR	National Center for Atmospheric Research, NOAA, US
NCSR	Norwegian Committee for Space Research
NDRE	Norwegian Defense Research Establishment
NGSP	National Geodetic Satellite Program, US
Nimbus	US Series of Experimental Meteorological Satellites
NIVR	Netherlands Agency for Aerospace Programs
NLR	National Aerospace Laboratory, Netherlands
NOAA	National Oceanic and Atmospheric Administration, US Dept. of Commerce
NPL	National Physical Laboratory, India
NRCC	National Research Council of Canada
NSF	National Science Foundation, US
NSRC	National Space Research Committee, New Zealand
NSSDC	National Space Science Data Center, US
NTNF	Norwegian Council for Scientific and Industrial Research

O

OAO	Orbiting Astronomical Observatory
OGO	Orbiting Geophysical Observatory
ONERA	National Office for Aerospace Studies and Research, France
OPEN	Origin of Plasma in the Earth's Neighborhood
OSO	Orbiting Solar Observatory

P

PAGEOS	Passive Geodetic Earth Orbiting Satellite

Palapa	Indonesian Domestic Communications Satellites
PCA	Polar Cap Absorption
PI	Principal Investigator
PLACE	Position Location and Aircraft Communication Experiment
PRL	Physical Research Laboratory, India

R

RAE	Radio Astronomy Explorer Satellite
RAMS	Nimbus-7 Random Access Measurement System
RECON	Remote Console, NASA Scientific and Technical Information System
RF	Radio Frequency
RFI	Radio Frequency Interference
RMS	Space Shuttle - Attached Remote Manipulator System
RPM	Retro-Propulsion Module, Project Galileo
RRL	Radio Research Laboratory, Japan

S

SACI	Advanced Satellite for Interdisciplinary Communications, Brazil
SAGE	Stratospheric Aerosol and Gas Experiment
"San Marco"	A Cooperative US-Italian Satellite Program for Atmospheric Density Measurement
SAO	Smithsonian Astrophysical Observatory
SARSAT	Satellite-Aided Search and Rescue Demonstration Project
SAS	Small Astronomy Satellite
SBSA	Swedish Board for Space Activities
SCSR	Swiss Committee for Space Research
Seasat	NASA Experimental Ocean Monitoring Satellite
SEOS	Synchronous Earth Observatory Satellite
SEPAC	Space Experiments With Particle Accelerators
SHF	Super High Frequency
SITE	US/Indian Satellite Instructional Television Experiment
SMM	Solar Maximum Mission
SMS	Synchronous Meteorological Satellite
Soviet Academy	Academy of Sciences, USSR
SP	Special Publication, NASA
SRC	Science Research Council, UK
SRL	Space Research Laboratory, University of Utrecht, the Netherlands

SS	Space Shuttle
SSC	Swedish Space Corporation
SSRC	Swedish Space Research Committee
SSS	Small Scientific Satellite
SSUS	Spinning Solid Upper Stage
ST	Space Telescope
STAR	Scientific and Technical Aerospace Reports, NASA
STARLETTE	French Geodetic Satellite
STDN	Space Tracking and Data Network, NASA; formerly STADAN
STOL	Short Take-Off and Landing
STS	Space Transportation System
SUPARCO	Space and Upper Atmosphere Research Committee, Pakistan
Syncom	Synchronous Communications Satellite

T

TDRSS	Tracking and Data Relay Satellite System
TIFR	Tata Institute of Fundamental Research, India
TIROS	US Polar Orbiting Meteorological Satellite
TMA	Trimethyl Aluminum
TWT	Traveling Wave Tube

U

UHF	Ultra High Frequency
uhuru	Explorer-42; also christened "uhuru," which is Swahili for "freedom"
UK	United Kingdom
UN	United Nations
US	United States
USSR	Union of Soviet Socialist Republics
UV	Ultraviolet

V

VAFB	Vandenberg Air Force Base, California
VHF	Very High Frequency
VLF	Very Low Frequency
V/STOL	Vertical/Short Take-Off and Landing

W

WMO	World Meteorological Organization
WTR	Western Test Range, VAFB, California

X

XTM	Extraterrestrial Materials

APPENDIX B: INTERNATIONAL PARTICIPATION IN NASA'S EARTH RESOURCES INVESTIGATIONS PROGRAMS

Argentina (1), (3)
Australia (1), (2), (3)
Bangladesh (1), (2)
Belgium (1)
Bolivia (1), (2), (3)
Botswana (1)
Brazil (1), (2), (3)
Canada (1), (2), (3)
Central Treaty Organization (CENTO)* (2)
Chile (1), (3)
Colombia (1)
Commission of European Communities (CEC)* (2)
Ecuador (1)
Egypt (2)
Finland (1), (2)
Food & Agriculture Organization (FAO), UN* (1), (2), (3)
France (1), (2), (3)
Germany, Federal Republic of (1), (2), (3)
Greece (1)
Guatemala (1)
India (1)
Indonesia (1)
Iran (1), (2), (3)
Israel (1), (3)
Italy (1), (2), (3)
Japan (1), (2), (3)
Kenya (1), (2)
Korea (1), (2)
Lesotho (1)
Libya (2)
Malaysia (1), (2)
Mali (1), (3)
Mekong Commission* (1), (2)
Mexico (1), (2), (3)
Netherlands (1), (3)
New Zealand (2)
Norway (1), (2)
Pakistan (2)
Peru (1), (2)
Philippines (1)
Romania (2)
South Africa (1), (2)
Spain (1), (2)
Sri Lanka (2)
Sweden (1), (2)
Switzerland (1), (2), (3)
Thailand (1), (2), (3)
Turkey (2)
United Kingdom (1), (2), (3)
Venezuela (1), (3)

(1) Landsat 1 1972-1975
(2) Landsat 2 1975-1978
(3) Skylab Earth Resources Experiment Package (EREP) Investigations 1973-1976

*Indicates International Organization

APPENDIX C: LOCATIONS OF APT STATIONS

Automatic Picture Transmission (APT) capabilities are built into all operational meteorological satellites that are developed by NASA for the National Oceanic and Atmospheric Administration (NOAA). These satellites are launched by NASA but once in orbit became the operational responsibility of NOAA. Receiving station technology, developed at the NASA Goddard Space Flight Center (GSFC), is made available to anyone wishing to make a modest investment to obtain real-time local cloud cover images. APT stations may be purchased commercially and range in price from $20K - $50K. However, many countries have made substantially higher investments in APT. The locations of APT stations are given below:

Afghanistan
Algeria
Angola (status unknown)
Antarctica (US Naval Research)
Argentina
Australia
Austria
Azores
Bahamas
Bahrain
Bangladesh
Barbados
Belgium
Bermuda
Bolivia
Brazil
Bulgaria
Burma
Cambodia (status unknown)
Cameroon
Canada
China, People's Republic of
China, Republic of (Taiwan)
Curacao
Gran Canaria
Chile
Colombia
Costa Rica
Denmark
Dominican Republic
Ecuador
Egypt
El Salvador
Ethiopia
Fiji
Finland
France
German Democratic Republic
Germany, Federal Republic of
Ghana
Guatemala
Guyana
Haiti
Honduras
Hong Kong
Hungary
Iceland
India
Indonesia
Iran
Iraq
Ireland
Israel
Italy
Japan
Jordan
Kenya
Korea
Kuwait
Malagasy Republic
Malaysia
Malta
Martinique, French West Indies
Mauritania
Mauritius
Mexico
Morocco
Mozambique
Nepal
Netherland Antilles
Netherlands
New Guinea
New Zealand
Nicaragua
Nigeria
Norway
Nova Scotia
Oman
Pakistan
Paraguay
Peru
Philippines
Poland
Portugal
Rhodesia
Romania
Saudi Arabia
Scotland
Senegal
Seychelles
Sierra Leone
Singapore
Somali
South Africa
South Yemen
Spain
Sri Lanka
Suriname
Sweden
Switzerland
Tahiti
Tanzania
Thailand
Trinidad
Tunisia
Turkey
Union of Soviet Socialist Republics (USSR)
United Arab Emirates
United Kingdom
United States
Upper Volta
Uruguay
Venezuela
Yugoslavia
Zaire
Zambia

NASA-Langley, 1979

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