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PROJECT: FR-1A French Satellite

PRESS KIT

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TO BE LAUNCHED NO EARLIER THAN DECEMBER 6

NEWS NASA
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NASA TO LAUNCH SCIENTIFIC SATELLITE FOR FRANCE

The National Aeronautics and Space Administration in cooperation with the French National Center for Space Studies (Centre National d'Etudes Spatiales, CNES) will attempt to launch no earlier than Dec. 6, a 135-pound scientific satellite called FR-1A.

Purpose of the FR-1A is to study very low frequency (VLF) radio wave propagation in various regions of the ionosphere and the Earth's magnetosphere and to measure electron densities. The satellite will be launched into a circular, nearly polar orbit at an altitude of about 490 miles with an inclination of 76 degrees to the Equator. The orbital period will be about one hour and 40 minutes. Planned lifetime of FR-1A is three months.

The launching will be at the Western Test Range, Calif., using a NASA four-stage Scout. In addition to providing the launch vehicle and launch services, NASA is to track the satellite and acquire data.

FR-1A was designed, built and tested by CNES. The French National Center of Telecommunications (Centre National d'Etudes des Telecommunications, CNET) designed the satellite's scientific experiments and will be responsible for data interpretation and publication of results to the world scientific community.

In accordance with a Memorandum of Understanding concluded between CNES and NASA in February, 1963, a two-phase program was developed for the FR-1 project.

Phase I included launching of four sounding rockets from the NASA Wallops Station, Va., to investigate VLF propagation in the lower ionosphere and to demonstrate the technical feasibility of the FR-1 concept. The launchings, all involving NASA Aerobee 150A sounding rockets and French-built payloads, were conducted Oct. 17 and 31, 1963, and Sept. 17 and 25, 1965. Phase II began shortly after the October 1963 launchings and will culminate in the orbital launching of the FR-1A satellite.

The operating principle of FR-1A involves sending VLF signals to the spacecraft from special transmitting stations at Ste. Assise, France, and Balboa, Panama Canal Zone. The signals, which will be transmitted at various wavelengths

and under varying conditions, are then retransmitted by special antennas on board the satellite to the NASA Space Tracking and Data Acquisition Network (STADAN) ground stations. CNES has supplied special French VLF receivers for four of these stations. By study of the signals a clearer insight into how VLF waves are affected by the ionosphere will be obtained.

An electron density probe experiment, provided by the University of Birmingham, England, consists of an on-board sensor designed to measure electron densities in the vicinity of the satellite's orbit. This data will help in interpreting VLF data obtained through the primary FR-1A experiment.

NASA participation in the French FR-1A program is directed by the Office of Space Science and Applications, NASA Headquarters, in cooperation with Office of International Affairs. NASA's Goddard Space Flight Center, Greenbelt, Md., is responsible for project supervision and data acquisition. NASA's Kennedy Space Center, Western Test Range, Lompoc, Calif., will provide pre-launch and launch support and it's Langley Research Center, Hampton, Va., is responsible for the four-stage Scout launch rocket. The Scout rocket is produced by Ling-Temco-Vought, Inc. Dallas.

(BACKGROUND INFORMATION FOLLOWS)

BACKGROUND INFORMATION

Scientific Objectives

The scientific objectives of the FR-1A satellite are to (1) carry out studies of very low frequency (VLF) radio wave propagation phenomena and (2) measure electron densities in the vicinity of the orbit.

The VLF Experiment

The VLF experiment, designed by Dr. L. R. O. Storey of CNET, has as its objective the investigation of how VLF radio waves propagate in various regions of the ionosphere and the Earth's magnetosphere. In this respect, the scientific mission of FR-1A will continue ionosphere studies conducted by the Canadian-built Alouette spacecraft and others.

A better understanding of how VLF radio waves react in the ionosphere and in theEarth's magnetosphere is of great importance in long-range radio propagation. The propagation of radio waves has been under study for the past 40 years but many of the mechanisms involved are not yet fully understood.

The reflection of radio waves from the ionosphere--thus making possible radio communications--depends on two factors: (1) the frequency of the waves transmitted and (2) the density of electrons.

Essentially the mechanism for radio propagation at most wavelengths works as follows: The electric field of a radio wave causes vibrations of free electrons in the ionosphere. These electrons "reflect" the radio waves at the same frequency as the transmitted waves--depending on the type of radio waves and the electron density of a particular region of the ionosphere.

VLF radio waves (up to a few kilocycles) are unusual in that they apparently are not entirely reflected by the lower portions of the ionosphere.

Instead, investigation pioneered by Dr. Storey and others, shows that VLF waves break into three components when they enter the ionosphere. The first is absorbed by the ionosphere, the second is reflected back to Earth, while the third component travels through the ionosphere into the magnetosphere. In this

last region, under the influence of the Earth's magnetic field, the direction of propagation of the signal tends to follow the lines of magnetic force. This is known as signal ducting. Irregularities in the ionosphere appear to increase this tendency.

Therefore, the third component of outgoing VLF transmissions moves toward the equator, crosses it, and returns to the Earth in the opposite hemisphere to a location described as magnetically conjugate, that is, where the magnetic field line returns to Earth in the opposite hemisphere.

Thus, a strong VLF field exists in the two zones. One is near the transmitter--and the other is in the area magnetically conjugate to the transmitter zone in the opposite hemisphere.

The two primary scientific objectives of the VLF experiment are to:

(1) Study the propagation of VLF waves from the ground to the magnetosphere.

(2) Study irregularities in the distribution of the ionosphere.

To achieve this objective, FR-1A will measure the electric and magnetic components of the VLF field in an effort to determine what field is generated at the spacecraft with respect to time, season, and range from the VLF transmitting stations located in France and in the Panama Canal Zone.

The satellite will receive transmissions from these stations on two different VLF frequencies. It will then measure the components of the VLF radio waves using antennas which generate voltages proportional to the received field. The outputs are then fed to transmitters and transmitted to ground stations.

The location of the two VLF ground stations was an important consideration in development of the VLF experiment. The Ste. Assise, France, station with the call sign FUB, made available to CNET by the French Bureau of Postes et Telecommunications, is at a high geomagnetic latitude. This will give scientists an opportunity to study VLF signals from the higher latitudes, because signals in this region penetrate deeper into the magnetosphere on long lines of magnetic force.

Thus, the magnetic conjugate of Ste. Assise is in the vicinity of Johannesburg, Republic of South Africa, where a NASA-STADAN station is located to receive the returned signal.

This station will be augmented by a special French-operated station located at Pretoria.

The second station, at Balboa, Panama Canal Zone, is operated by the U.S. Navy with the call sign NBA. It is well situated because of its low geomagnetic latitude. Its magnetic conjugate is near Quito, Ecuador, the location of a STADAN station, although it will be augmented by STADAN stations in Lima, Peru, and Santiago, Chile.

In addition to the STADAN network to receive telemetered FR-1A VLF data, five stations operated by the French Government at Bretigny, France; Hammaguir, Algeria; Ouagadougou, Republic of Upper Volta; Brazzaville, Republic of the Congo; and Pretoria, Republic of South Africa, will be used.

In addition to the primary objectives of the VLF experiment, secondary objectives are:

(1) A study of the transmission coefficient of the lower ionosphere.

(2) Study of the propagation of VLF radio waves along the lines of magnetic force from one hemisphere to another (signal ducting).

(3) Study of the impedance of the four electric antennas carried by the satellite.

The Electron Density Probe Experiment

This device, developed by Professor J. Sayers of the University of Birmingham, England, will measure electron density in the vicinity of the satellite. Mounted on the bottom of the satellite on a telescoping 19-inch tube, it consists of a parallel-plate capacitor sensor with wire mesh plates to allow free passage of electrons between the plates.

The capacitor actually is one arm of a radio-frequency bridge circuit operating at 39 megacycles (Mc). The dielectric constant of the ionospheric plasma--electron population--is determined by measuring the capacitance with the plasma between the plates and comparing this with the capacitance measurement made in vacuum conditions which is obtained by biasing the plasma electrons away from the vicinity of the plates. The electron density is determined from the plasma dielectric constant factor. Results from this experiment will be used primarily in conjunction with findings from the VLF observations.

CHARACTERISTICS OF THE FR-1A SATELLITE

The French-built FR-1A satellite consists of two eight-sided prisms attached to an eight-sided main body about 27 inches in diameter and 52 inches long (including the magnetic antenna support boom). After orbit is achieved, four six and one-half foot long dipole antennas are deployed by centrifugal force. These antennas are used to sense the electric field. Extending 19 inches from the bottom of the spacecraft is the electron-density probe device which is mounted on a telescoping boom.

The prominent physical feature of the satellite is the magnetic field antenna which protrudes from the top of the main base and is used to measure magnetic field lines. In addition, four telemetry antennas are mounted at 90-degree intervals from the top of the main body of the spacecraft. Attitude control is achieved by spin-stabilization techniques.

The power system consists of solar cells mounted on panels covering 85 per cent of the main body. They will provide power from the Sun for two nine-cell silver-cadmium batteries. FR-1A power loads are about 4.5 watts with experiments turned

off and, with experiments on, about 15.5 watts. Portions of the remaining surfaces of the main body, and the electron density probe, are covered with a thin layer of gold to enhance the conductivity of the satellite.

The metal frame of FR-1A consists of an alloy of magnesium, aluminum and titanium because of weight considerations. A passive system of thermal control is obtained by using various white coatings which are designed to help provide a thermal environment ranging from 17 to 32 degrees Centigrade for the electronic instrumentation and circuitry.

THE SCOUT ROCKET

Scout is a multi-stage launch rocket using four solid propellant rocket motors capable of carrying payloads of varying sizes on orbital, space probe or reentry missions. Scout is 72 feet long and weighs 20 tons at liftoff.

The four motors are interlocked with transition sections which contain guidance, control, ignition, instrumentation systems, separation mechanisms, and spin motors required to stabilize the fourth stage. Guidance is provided by a strapped-down gyro system and control is achieved by a combination of

aerodynamic surfaces, jet vanes and hydrogen-peroxide jets.

Scout is capable of placing a 320-pound payload into a 300-nautical mile orbit or of carrying a 100-pound scientific probe 18,000 miles from Earth.

Scout stages include the following motors:

First Stage: Algol IIB - 100,944 pounds thrust, burning time 80 seconds.

Second Stage: Castor I - 63,109 pounds thrust, burning time 46 seconds.

Third Stage: Antares II (ABL X-259) - 22,606 pounds thrust, burning time 34.9 seconds.

Fourth Stage: Altair II (ABL X-258) - 6,414 pounds thrust, burning time 22.2 seconds.

FR-1A Project Officials

The following key officials are responsible for the FR-1A satellite program:

Republic of France

Professor Jean Coulomb, President CNES

General R. Aubiniere, Director General, CNES

Professor Jacques Blamont, Scientific and Technical Director, CNES

Dr. Jean-Pierre Causse, Program Director, CNES

Xavier Namy, Project Manager, CNES

Pierre Chiquet, Tracking and Data Acquisition Director, CNES

Christian Fayard, Technical Director, CNET

Dr. L. R. O. Storey, Scientific Director, CNET

NASA Headquarters

Dr. Homer E. Newell, Associate Administrator for Space Science and Applications

Arnold W. Frutkin, Assistant Administrator for International Affairs

Dr. John E. Naugle, Acting Director for Sciences, Office of Space Science and Applications

John R. Holtz, FR-1A Program Manager

Dr. Erwin R. Schmerling, FR-1A Program Scientist

Warren A. Guild, Scout Program Manager

Goddard Space Flight Center

Dr. John F. Clark, Acting Director

Dr. John W. Townsend, Jr., Deputy Director

Samuel R. Stevens, FR-1A Project Manager

Dr. Robert W. Rochelle, FR-1A Project Scientist

Joseph H. Conn, FR-1A Project Coordinator

Kennedy Space Center

Robert H. Gray, Assistant Director for Unmanned Launch Operations

Joseph B. Schwartz, Acting Director, KSC Western Test Range Operations Division

C. R. Fuentes, Spacecraft Coordinator

Langley Research Center

E. D. Schult, Scout System Manager

R. A. Schmitz, Scout Payload Coordinator

FR-1A SATELLITE

FACT SHEET

Weight	About 135 pounds (plus about 23 pounds for separation).
Configuration	Main structure 27 inches across corners and 52 inches long in launch configuration with two truncated octagonal prisms, joined at bases by octagonal central section.
Appendages	In orbit, four six-foot four-inch dipole antennas for electric field measurements will be deployed normal to vehicle spin axis. An electron-density measurement probe on a telescope boom will be extended 19 inches below base of the spacecraft.

Launch rocket:	Four-stage NASA Scout
Launch Site:	Western Test Range, California
Orbit:	Circular, near-polar inclined 76 degrees from the Equator at 490 statute miles, with orbital period of one hour, 40 minutes.
Lifetime:	Three months (15-day minimum).

Power System:

Power Supply:	Solar cells mounted on spacecraft exterior to charge two silver-cadmium battery packs.
Voltage:	12 volts unregulated
Power Requirements:	9 watts nominal power

Communications and Data-Handling System:

PAM/FM/PM telemetry:	Telemetry 1 (TM1) transmitter 136.800 MC, 350 mw, continuous
FM/PM telemetry:	Telemetry 2 (TM2) transmitter 136.350 MC, 1000 mw, on command
Tracking:	Telemetry 1 carrier
VLF Experiment:	5 VLF receiver output transmitted by TM2

TELEMETRY STATIONS

Tracking Stations:	Goddard Space Flight Center's Space Tracking and Data Acquisition Network (STADAN).

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French/CNES interferometer tracking: DIANE
Hammaguir, Algeria
Pretoria, Rep. of S. Africa

Experiment VLF Stations:

(a) Transmitting station operated by French government: Ste. Assise, France (FUB).

(b) STADAN stations operated by GSFC that will receive VLF signal from Ste. Assise. (FUB). Winkfield, England; Johannesburg, Republic of S. Africa.

(c) Transmitting station operated by U. S. Navy at Balboa, Panama Canal Zone.

(d) STADAN stations receiving VLF signal are Lima, Peru; Quito, Ecuador.

Command Stations:

U. S. Government: STADAN stations.

French government:

Bretigny (CNES) near Paris, France
Hammaguir, Algeria
Pretoria, Republic of South Africa

Data Acquisition:

(a) STADAN, operating on 136-Mc spacecraft transmissions Telemetry 1, PAM/FM/PM; Telemetry 2, FM/PM

(b) French stations (IRIS) operating as in (a)

Bretigny (S&O) France
Hammaguir, Algeria
Ouagadougou, Upper Volta
Brazzaville, Republic of the Congo
Pretoria, Republic of South Africa

NASA INTERNATIONAL PROGRAM

The FR-1A project is one of many in a NASA international program which has among its objectives:

(1) To provide opportunities for scientists of other nations to participate in programs designed to contribute to man's understanding and use of his spatial environment;

(2) To support the operating requirements of the NASA program; and

(3) To demonstrate the open character and peaceful purposes of the U. S. space program.

A cooperative international satellite project such as FR-1A is the subject of mutual agreement between NASA and the central civilian space agency of the participating government. Each participating country accepts full financial responsibility for its own contributions to joint projects and agrees to general publication of the scientific results.

NASA has agreements for the launching of cooperative satellites with the United Kingdom, Canada, Italy, the Federal Republic of Germany, France and the 10-nation European Space Research Organization.

FR-1A is the sixth satellite scheduled to be launched under these programs. Previous satellite launches were the United Kingdom's Ariels I & II on April 26, 1962 and March 27, 1964; Italy's San Marco, Dec. 15, 1964; and Canada's Alouette I on Sept. 29, 1962. Alouette II was scheduled for a November 1965 launching as this press kit went to print.

MEMORANDUM OF UNDERSTANDING BETWEEN THE FRENCH CENTRE NATIONAL D'ETUDES SPATIALES AND THE UNITED STATES NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

The Centre National d'Etudes Spatiales (CNES) and the National Aeronautics and Space Administration (NASA) affirm a mutual interest in conducting, on a timely basis, a program of experiments to investigate the propagation of Very Low Frequency (VLF) electromagnetic waves. It is hoped that these experiments will culminate in the launching of a VLF satellite into an earth orbit. The experimental program is planned to consist of two phases, the second conditioned upon mutual agreement that scientific and technical feasibility has been demonstrated in the first:

Phase I - Appropriate sounding rockets will be launched to investigate characteristics of the region between 75 and 100 kilometers.

Phase II - A scientific satellite to investigate VLF characteristics above 100 kilometers will be placed into an earth orbit by means of a Scout launching vehicle.

CNES shall, in general, assume responsibility for the following:

(1) Design, fabrication, and testing of all payloads, including satellite engineering.

(2) Scientific data reduction and analysis in all phases of the program.

(3) Support of French personnel for any training required in the above areas.

NASA shall, in general, assume responsibility for the following:

(1) Provision of two Aerobee 150A sounding rockets (including nose cones) with backup for Phase I.

(2) Provision of a Scout booster with backup for Phase II.

(3) Launching of the sounding rockets in Phase I and the satellite in Phase II.

(4) Such training of French personnel in CNES areas of responsibility as may be feasible and as may be accommodated within the limitations of NASA operational requirements.

(5) Provision of technical consultation and technical data as appropriate.

(6) Provision of technical assistance in spacecraft testing (including final acceptance testing) and backup facilities, as required.

(7) Tracking and data acquisition, as mutually agreed, in Phases I and II of the program using existing NASA sounding rocket and scientific satellite tracking and data acquisition facilities.

No exchange of funds is contemplated between the two cooperating agencies.

Each agency agrees to designate a single project manager to be responsible for coordinating the agreed functions and responsibilities of each agency with the other. Together they will establish a joint working group with the appropriate membership. Details for implementation shall be resolved on a mutual basis within this working group.

The scheduling of the two phases of the program shall be as mutually agreed.

Results of the planned experiments will be made freely available to the world scientific community.

It is hoped that implementation of the planned experiments will provide the groundwork for continuing contacts between CNES and NASA, and that opportunities for further space science projects of mutual interest may be considered as they arise.

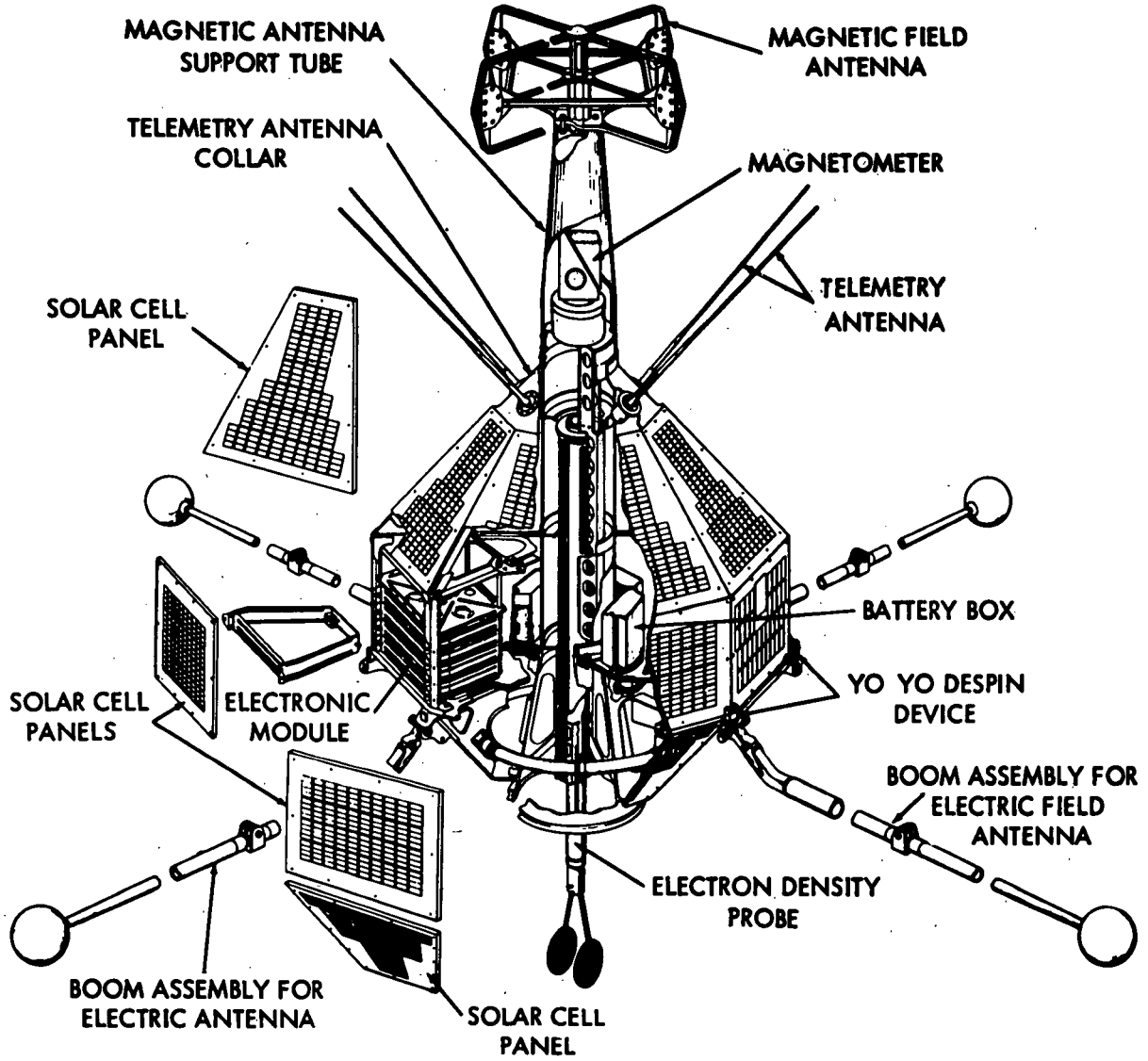
J. Coulomb
For the French Centre National d'Etudes Spatiales

Hugh L. Dryden
For the National Aeronautics and Space Administration

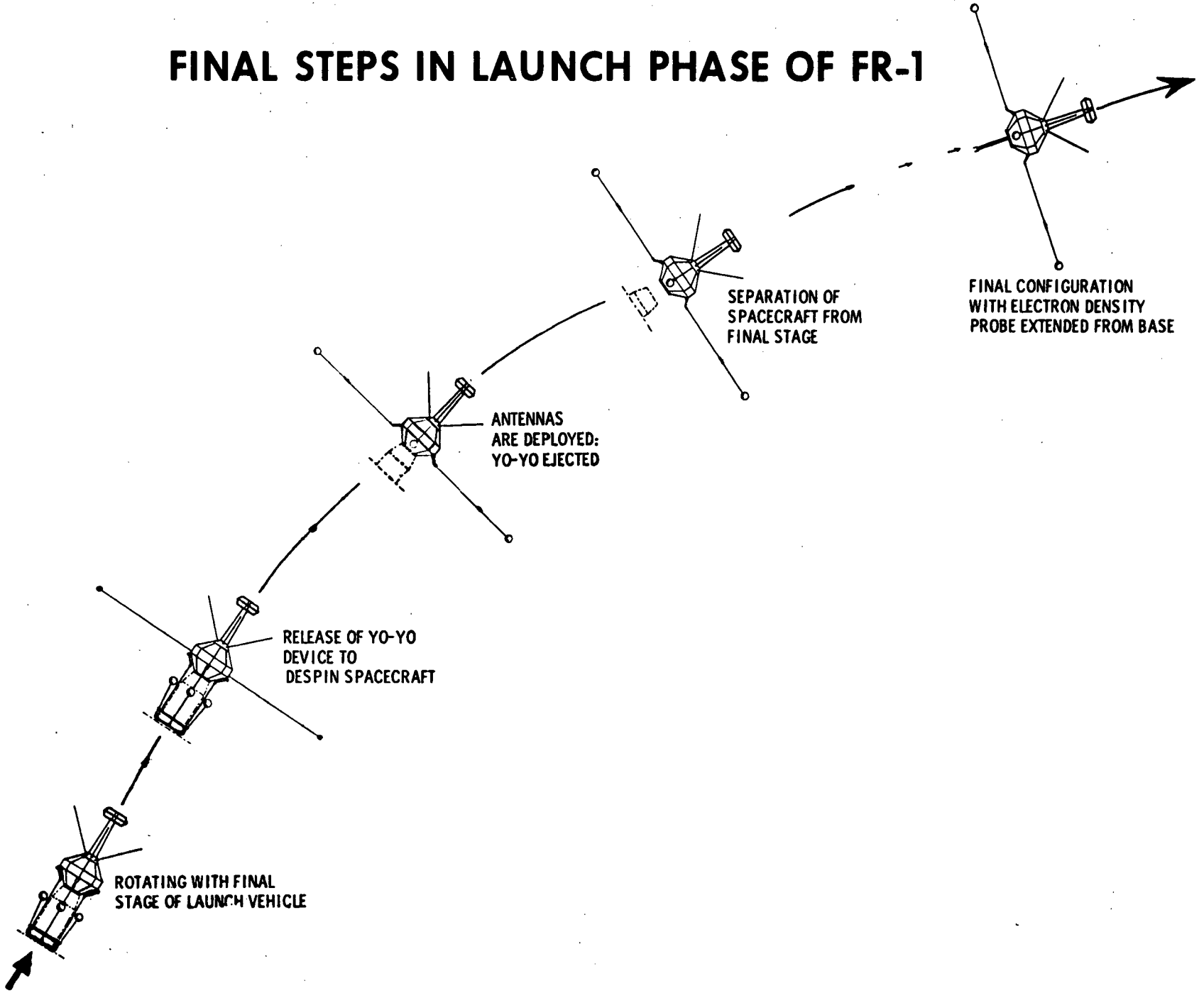
February 18, 1963
Date

- end -

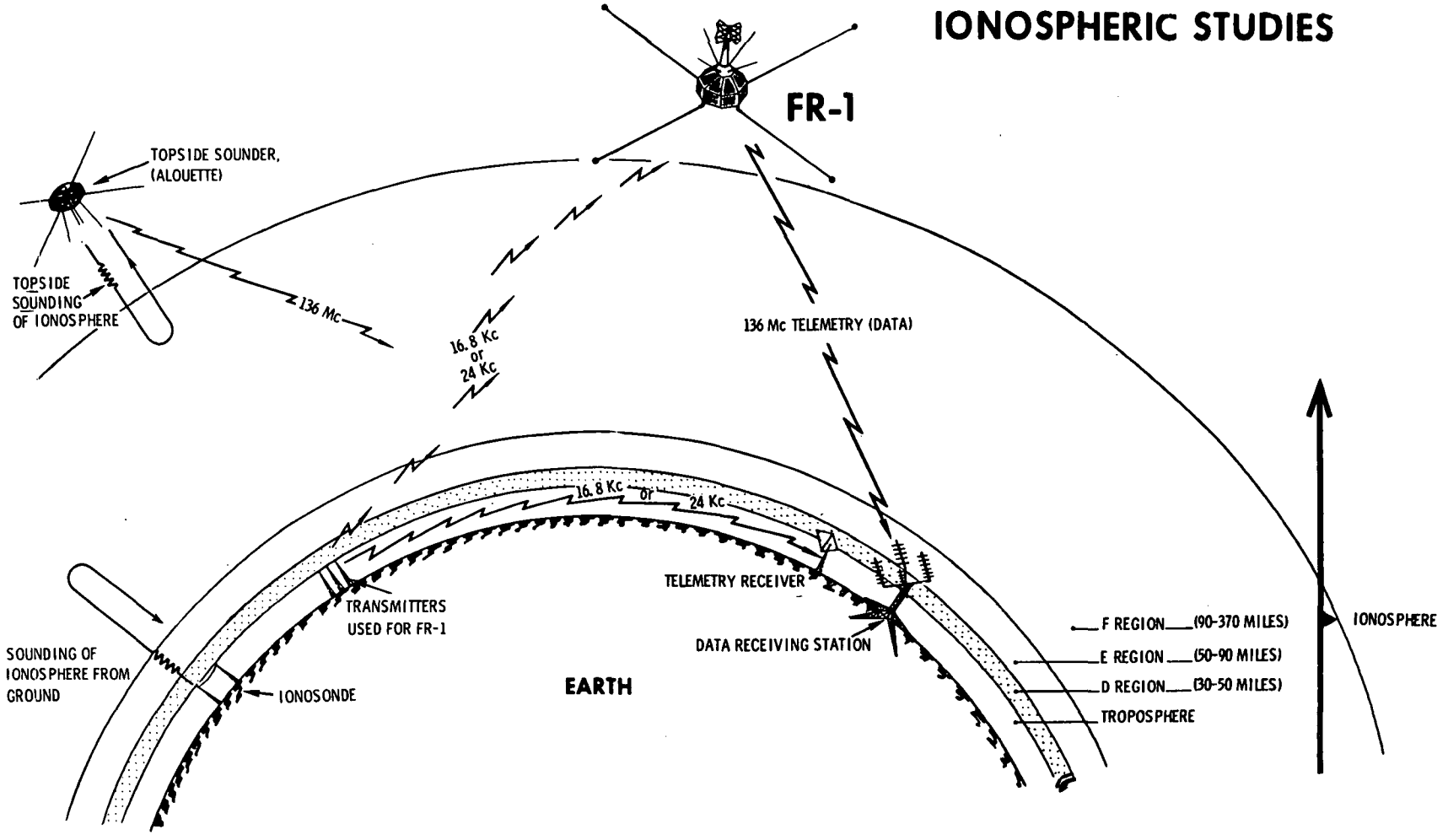
FRENCH SATELLITE (FR-1)



FINAL STEPS IN LAUNCH PHASE OF FR-1



FR-1 AND COMPLEMENTARY IONOSPHERIC STUDIES



FR-1 STUDY OF VLF SIGNAL DUCTING