COORDINATION OF ADVANCED SOLAR OBSERVATORY (ASO)
SCIENCE WORKING GROUP (SWG) FOR THE
STUDY OF INSTRUMENT ACCOMMODATION AND
OPERATIONAL REQUIREMENTS ON SPACE STATION

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Final Report

by

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for

National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

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(NASA-CR-185371) COORDINATION OF ADVANCED SOLAR OBSERVATORY (ASO) SCIENCE WORKING GROUP (SWG) FOR THE STUDY OF INSTRUMENT ACCOMMODATION AND OPERATIONAL REQUIREMENTS ON SPACE STATION Final Report, 1 Aug. 1987 - G3/12

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1. ABSTRACT

In this project, the objectives are to coordinate the activities of the Science Working Group (SWG) of the Advanced Solar Observatory (ASO) for the study of instruments accomodation and operation requirements on board space station. In order to facilitate the progress of our objective we have organized two conference, together with two small group discussions.

2. SYNOPOSIS

To meet the challenge of space activities in the 21st century, it is necessary for us to prepare our potential experiments to be ready on board space station. Thus, it is necessary for the solar physics community to prepare their experiments to be compatible with those accomodation and operation requirements for space station. In order to carry out such a task, the Advance Solar Observatory (ASO) Science Working Group (SWG) was formed by the Office of Sapce Science and Application, NASA-HQ and is managed by the Marshall Space Flight Center. The ASO SWG is chaired by Dr. A. B. C. Walker, Jr. of Stanford University.

The first activity was to participate in the Second International Meeting on the Use of Space Station for research in solar-terrestrial physics which was held at the European Space Agency (ESA) Head Office in Paris, France on September 21-23, 1987. The purpose of participating in this meeting was to understand the ESA concept of the utilization of the space station for solar-terrestrial research which may make the cooperation efficient. A report of this meeting is included in Appendix 3.1.

In March, 1988, Teledyne Brown Engineering was awarded a contract to conduct a study for ASO accomodations requirements on space station. In order to maximum the benefits of this study, Prof. A. B. C. Walker, Jr., together with Professor S. T. Wu, (P. I. of this grant) organized a one day workshop to discuss some key issues concerning ASO's cluster experiments on board space station. The workshop's agenda is included in Appendix 3.2.

It is a concern of the NASA planning office that solar activity could have serious consequences on the space stations design as well as space activities such as the launch of the space telescope because of the rising cycle (Cycle 22) of solar activity. One simple reason to cause our caution is that when the solar activities increase, the atmosphere density will increase accordingly. Then, the drag forces will increase, such that the life time of the space station and space telescope (or other satellites) will decrease significantly. Therefore, we have assembled, with the concurrence of the COR, a group of solar physicsts, solar forecasters and NASA personnel to discuss the issues. It was an effective meeting. It has been concluded that further investigation is needed in order to meet the challenge. This meeting was coordinated by J. B. Smith, Jr., a member of CSPAR. The details of this meeting is included in the Proceedings which is included in Appendix 3.3.

In summary, we are pleased to report that this grant has been carried out successfully with its original objectives.

APPENDIX

3.1. Report on the Second International Meeting on the Use of the Space Station for Research

Minutes of the Second International Meeting on the Use of the Space Station for Research in Solar-Terrestrial Physics

21-23 September 1987
held at ESA Head Office
8-10 rue Mario-Nikis
Paris 15, France

Prepared by: S. T. Wu
Center for Space Plasma and Aeronomic Research
The University of Alabama in Huntsville
Huntsville, AL 35899 U. S. A.

September 21 - 23, 1987, the second international meeting on the use of the space station for research in solar-terrestrial physics was held at the European Space Agency (ESA) headquarters office in Paris, France. This meeting was arranged by Dr. George Haskell of the ESA and co-chaired by W. W. Roberts of the National Aeronautics and Space Administration/George C. Marshall Space Flight Center (NASA/MSFC). Thirty people from America, Canada and Europe attended this meeting. Among them nine were scientists and engineers from industry, university and government agencies from the United States. A list of the participants and a program are included in Appendix I. Some of the highlights and future plans of the three days of discussions are briefly summarized in the following:

I. Highlights

1. Mr. A. Frandsen of the Space Physics Division/OSSA/NASA Headquarters gave a presentation concerning the OSSA/NASA point of view about STO planning priorities and strategies for the use of space station which can be stated as follows:

(i) Core station strategies

(ii) U. S. polar platform strategies

(iii) Attached payload investigation selection issues

(iv) Plasma interactions and effects working group

(v) SSPIE working group approach

Details of these subjects are included in Appendix II.

2. Professor A. B. C. Walker of Stanford University gave a presentation concerning planning of the ASO. The important issues are:

(i) The configuration of the Advanced Solar Observatory

(ii) Scientific objectives which could be accomplished by ASO

(iii) Current status of ASO

(iv) Further development of ASO studies

A set of viewgraphs about some of the details of these subjects are included in Appendix III.

3. Dr. Jack Kropp of TRW made a presentation on the study status of STO. Important subjects discussed were:

(i) Identify a set of typical solar terrestrial instruments

(ii) Derive specific accomendation requirements which these instruments will impose on space station.

(iii) Assess major operating parameters

(iv) Prepare approach to include international instruments.

(v) Develop concept for STO implementation on space station.

(vi) Estimate costs

Details of these subjects are published in a contract report entitled "Study Status" by TRW S & T Group, S/N 46652.000 submitted to MSFC in September 1987.

4. Mr. William T. Roberts of NASA/MSFC summarized the current status of STO/ASO. Because of the recent cancellation of some planned projects such as the Plasma Lab and SOT which resulted in severe impact on the planning of STO/ASO he pointed out the following in his presentation.

(i) Concerning STO

- o Meet all the P.I.s of the plasma group to reconstruct the program.
- o In early 1988, instrument implementation studies with P.I.s will be carried out.
- o Reform the science working group.

(ii) Concerning ASO

- o ASO space station accommendation requirements study will be initiated.
- o Proposed definition studies on co-observing instruments will be started.

5. Professor S. T. Wu made a presentation concerning the international programs and some scientific objectives during 1987-1990 and 1990-1995 period sponsored by SCOSTEP (Scientific Committee on Solar-Terrestrial Physics). Dr. Wu is a bureau member of the SCOSTEP. A set of viewgraphs describing some of the details of these subjects is included in Appendix IV.

6. Dr. David J. W. Kendall of the Space Division, National Research Council of Canada gave a presentation of the Canadian position on the use of the space station for research in solar terrestrial physics. A set of viewgraphs describing the details of his presentation is included in Appendix V.

7. Mr. Alan C. Holt of the Utilization and Operation Group/Space Station Program Office/NASA Headquarters gave a presentation about the activities and goals of the newly formed space station user integration division at NASA Headquarters. A set of viewgraphs describing the details is included in Appendix VI.

8. Mr. B. Schmitz of CUPG/DFVLR, West Germany gave a presentation on the Columbus Phase B2 utilization study. A set of viewgraphs for his presentation is included in Appendix VII.

9. Dr. George Haskell of the ESA head office, discussed the space station science attached payload program stucture within the ESA. A chart describing the organization is shown in Figure 1. He stressed that the coordination between ESA and NASA needs to be enhanced in all aspects of the space station scientific utilization program.

10. Dr. C. Reading of ESA made a presentation on the ESA's program on Earth observation which has been considered as candidate for attached payloads on board space station. A set of his viewgraphs is included in Appendix VIII.

11. Dr. Gerd Thomaschek of ESA/ESTEC presented ESA's CSTP operations status. In his presentation, he reported the present status of instruments, specific items, UOC concept and future activities. A set of his viewgraphs is included in Appendix IX.

II. Future Action Items

During the three days discussion, we have concluded the following:

1. Coordination effects between ESA and NASA need to be enhanced. In particular, the joint A/O needs to be coordinated further.

2. Space Station user management structure needs to be determined.

3. Specific scientific objectives for space station need to be addressed. It is desirable to organize an international science working group to coordinate scientific instrument development.

4. An agenda for the 1988 science workshop will be organized by Dr. David Kendall Space Division/NCR of Canada.

5. A documentation concening STO on space station needs to be developed.

APPENDIX I

Participants List and Program

SECOND INTERNATIONAL MEETING ON THE USE OF THE SPACE STATION FOR RESEARCH IN SOLAR-TERRESTRIAL PHYSICS

21-23 September 1987

EXPECTED ATTENDANCE

EUROPE

CSTP Science Team

P. Bauer	Service d'Aéronomie, Verrières
C. Chaloner	Rutherford Appleton Laboratory
C. Hanuise	Université de Toulon
P. Maltby	University of Oslo
D. Ramsden	University of Southampton
D. Rees	University College London
P. Simon	Institut d'Aéronomie Spatiale de Belgique, Bruxelles
J. Stadsnes	University of Bergen

Invited Expert

K. Grossmann	Bergische Universität Wuppertal

ESA

D/SCI	:	H. Olthof, M. Coradini, G. Tomaschek, J.-P. Lebreton, S. Volonté, B. Andersen, M. Huber, S. Babayan (Administrative Assistant)
D/SSP	:	G. Haskell, G. Peters, J.-J. Dordain, R. Jönsson, S. Adamy-Guérin (Administrative Assistant)
D/ECM	:	C. Readings, I. Duvaux-Béchon
D/ESTEC	:	D. Kassing
D/TEL	:	G. Berretta, K. Galligan

CUPG

B. Schmitz
R. Henderson

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CANADA

D. Kendall	NRC, Ottawa

USA

A. Frandsen	OSSA/NASA HQ
J. McGuire / AL. Holt SSU	Space Station/NASA HQ
A. Walker	Stanford University
S. Mende	Lockheed
G. Carignan	University of Michigan
J. Kropp	TRW
W. Taylor	TRW
S. Wu	University of Alabama
W. Roberts	NASA/MSFC

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87-09-18

SECOND INTERNATIONAL MEETING ON THE USE OF THE SPACE STATION FOR RESEARCH IN SOLAR-TERRESTRIAL PHYSICS

21-23 September 1987

ESA Head Office, 8-10, rue Mario-Nikis,
Paris 15

Room 123 (Cinema)

DRAFT AGENDA

Monday, 21 September

09h30	WELCOME AND INTRODUCTION	H. Olthof
	SESSION I : ATTACHED PAYLOADS	(Chairman : H. Olthof)
10h00	Current Planning for STO	A. Frandsen
10h30	Current Planning for ASO	A. Walker
11h00	Break	
11h15	STO Study Status	W. Taylor/J. Kropp
12h15	Next Steps for STO/ASO	W. Roberts
12h30	Discussion	
13h00	Buffet lunch	
14h00	Columbus Phase B-2 Utilisation Study: Work Package 4000 (Attached Payloads)	B. Schmitz
14h30	Plans for Phase B-2 Extension	G. Haskell
14h45	Survey of Candidate Attached Payloads from Other Disciplines	C. Readings S. Volonté D. Kassing G. Berretta I. Duvaux-Béchon
15h15	Break	
15h45	Survey (continued)	USA Canada (D. Kendall)
16h15	Status of Small Attached Payloads Working Group	A. Frandsen
16h30	Discussion; Future Actions	
17h30	End of Session	
17h30	Cocktails (Floor 2B)	

Tuesday, 22 September

	SESSION II : PLATFORMS	(Chairman: W. Roberts)
09h30	Model Payloads related to STP on Polar Platforms	J.-P. Lebreton/W. Roberts
10h00	Discussion on complementarity	
10h30	Announcements of Opportunity	M. Coradini/A. Frandsen
11h00	Break	
11h15	Technical issues	
	- emc	C. Chaloner
	- on-line data processing	P. Bauer
	- contamination	D. Rees
12h30	Future Actions	
12h45	Use of EURECA-B	H. Olthof
13h00	Buffet lunch	
	SESSION III : PAYLOAD OPERATIONS REQUIREMENTS	(Chairman: M. Coradini)
14h00	CSTP Sub-Group Report	P. Maltby
14h30	Requirements Synthesis	G. Tomaschek
15h00	Break	
15h15	NASA View on STP Requirements	W. Roberts
15h45	Discussion; Future Actions	
17h00	End of Session	

Wednesday, 23 September

SESSION IV : SCIENCE THRUSTS (Chairman: M. Huber)
Kremhail

09h30 Discussion: In the light of expected developments (STSP, theoretical advances, etc.) are we still on the right track with our plans for use of Space Station for STP ?

Introduced by:

S. Wu
P. Bauer
D. Rees
S. Mende

11h00 Break

11h15 Discussion (continued)

SESSION V : CONCLUSIONS AND FUTURE ACTIONS (Co-Chairmen: M. Coradini/A. Frandsen)

12h00 Agenda to be set up in response to discussion, but including:

- Space Station user management structure
  International Forum on the ~~st~~ scientific ~~uses~~ utilization of Space Stat[illegible]
- input to IFSUSS (November, La Jolla)
- drafting of summary report
- future actions

13h00 Buffet lunch

14h00 SESSION V (continued)

15h00 Break

17h00 End of Meeting.

APPENDIX II

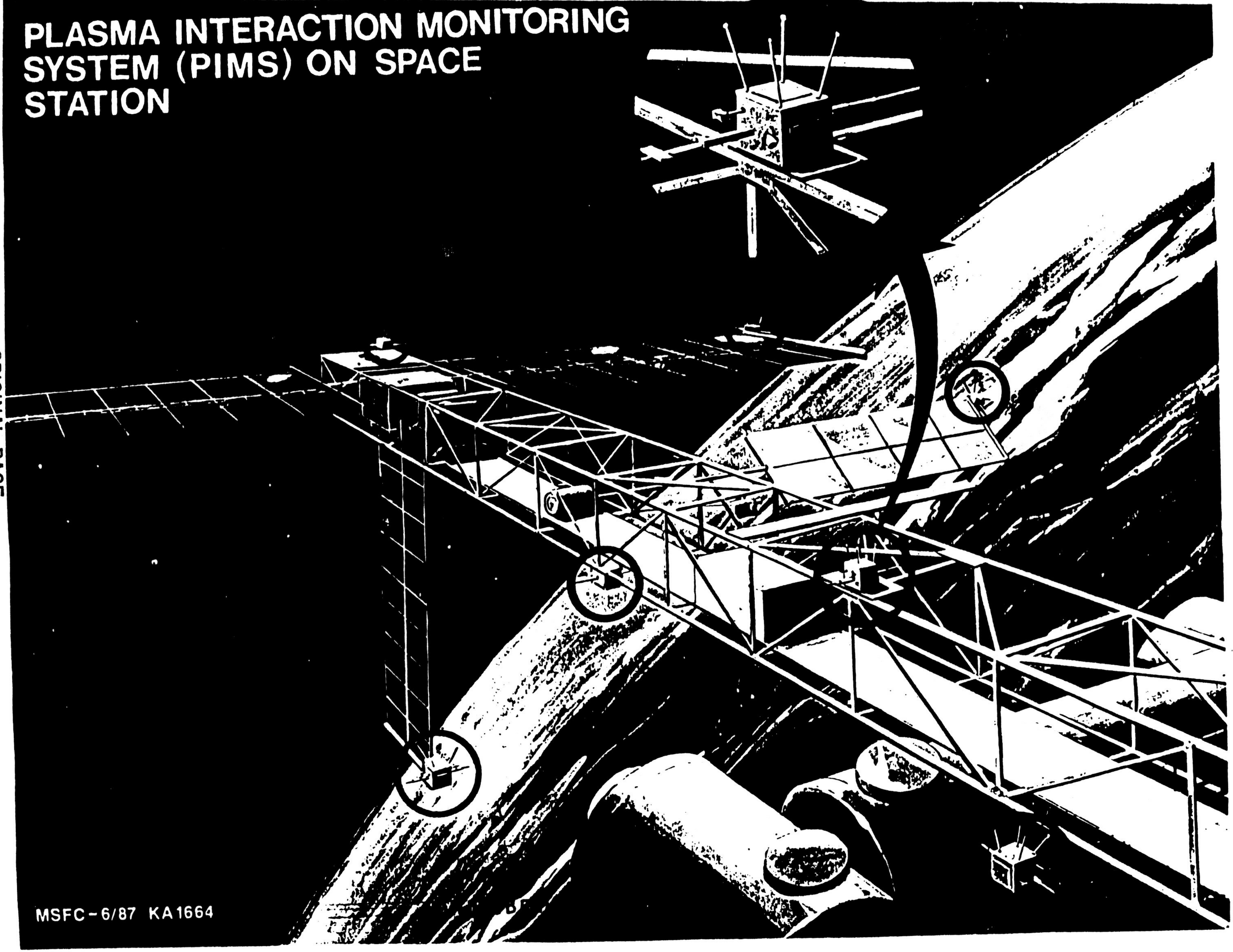
Viewgraphs of the STO Planning Strategies

Presented by

A. Frandsen
Space Physics Division, OSSA/NASA

STO PLANNING
PRIORITIES

- WITHIN THE NASA OFFICE OF SPACE SCIENCE AND APPLICATIONS (OSSA), DR. FISK'S PRIORITIES FOR USE OF THE BLOCK I SPACE STATION ARE:
  - LIFE SCIENCES AND MICROGRAVITY MATERIALS PROCESSING DISCIPLINES TO USE THE PRESSURIZED MODULES
  - EARTH OBSERVATION SYSTEM ON POLAR PLATFORM
  - RELATIVELY SIMPLE ATTACHED PAYLOADS
    - NO FINE POINTING REQUIREMENT
    - CONDUCIVE TO RESOURCE SHARING
    - TOLERANT OF NON-OPTIMAL CONDITIONS (I.E. CONTAMINATION)
    - NOT DEMANDING OF CREW ATTENTION


PLASMA INTERACTION MONITORING SYSTEM (PIMS) ON SPACE STATION
MSFC-6/87 KA1664

STO PLANNING
CORE STATION STRATEGIES

- NEW STO CONCEPTS NEEDED WHICH REFLECT THE NEW REALITY FOR THE BLOCK I STATION

- STRATEGIES INCLUDE:

  - MAKE CREATIVE USE OF PIMS SENSORS, AND PIMS ACCOMMODATION SYSTEM

  - MAKE USE OF EXISTING SPACELAB INSTRUMENTS THAT ARE 'SIMPLE'

  - SHARE INTERNATIONAL RESOURCES TO FORM INTERNATIONAL SOLAR-TERRESTRIAL INVESTIGATIONS

STO PLANNING

U.S. POLAR PLATFORM STRATEGIES

- EARTH OBSERVATION SYSTEM (EOS) IS GIVEN TOP PRIORITY FOR USE OF U.S. PLATFORM(S)
- PLAN STO OBJECTIVES WITHIN CONSTRAINTS OF THE PRESENT, DRAFT EOS A.O.
    - 25% OF PAYLOAD CAPABILITY IS SET ASIDE FOR OPERATIONAL USE
    - 75% OF PAYLOAD CAPABILITY AVAILABLE FOR 'NON-OPERATIONAL' SCIENCE
    - PI INSTRUMENTS TO BE INCLUDED WHICH SUPPORT OR COMPLEMENT THE EOS MEASUREMENTS
    - THE NEED FOR POLAR ORBIT MUST BE DEFENDED FOR NON-EOS SCIENCE
- PRESENT A SOLID CASE FOR GREATER RESOURCE AND SPACE ALLOCATIONS TO STO
- WORK FOR ADDITIONAL, LOWER ALTITUDE, DISCIPLINE-ORIENTED PLATFORMS THAT COVER ALL LOCAL TIMES

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STO PLANNING

ATTACHED PAYLOAD INVESTIGATION SELECTION ISSUES

- COORDINATED ANNOUNCEMENTS OF OPPORTUNITIES (AO'S) PREFERRED, (E.G. EOS AO), BUT JOINT AO (E.G. SOHO/CLUSTER) POSSIBLE
- FOR THE SMALLER INVESTIGATIONS, PI EXPERIMENTS ARE THE MAIN OPPORTUNITIES FOR PARTICIPATION
- AT SOME TIME, AN OPPORTUNITY WILL EXIST TO UPGRADE THE NOAA SPACE ENVIRONMENT MONITOR (SEM) FACILITIES, IF SIGNIFICANT ENOUGH INSTRUMENTATION ADVANCES BECOME AVAILABLE
- THE INVOLVEMENT AND LEGACY OF EXISTING SPACELAB INVESTIGATOR TEAMS
- RELATIONSHIP OF THE SPACE STATION ATTACHED PAYLOAD AND POLAR PLATFORM NEW STARTS TO FREE-FLYER NEW STARTS WITHIN AN AGENCY

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STO PLANNING

PLASMA INTERACTIONS AND EFFECTS WORKING GROUP

- THE SPACE STATION PLASMA INTERACTIONS AND EFFECTS (SSPIE) WORKING GROUP IS ONE OF TWO NASA-OSSA-SPONSORED WORKING GROUPS INVESTIGATING SPACE STATION OPERATING ENVIRONMENT ISSUES
  - SSPIE WORKING GROUP, DR. CAROLYN PURVIS, NASA LeRC, CHAIRMAN
  - SPACE STATION NEUTRAL CONTAMINATION WORKING GROUP, DR. MARSHA TORR, NASA MSFC, CHAIRMAN
- SSPIE WORKING GROUP IS CHARTERED BY NASA OSSA TO STUDY POSSIBLE INTERACTIONS OF SPACE STATION WITH THE AMBIENT PLASMA ENVIRONMENT, AS WELL AS THE EFFECT ON PAYLOADS OF THE INDUCED PLASMA ENVIRONMENT, AND TO SORT OUT WHICH PHENOMENA ARE IMPORTANT
  - CORE STATION, BLOCK I AND BLOCK II
  - POLAR PLATFORM(S)
- SSPIE WORKING GROUP MEMBERSHIP CONSISTS OF ABOUT THIRTY EXPERTS
- WORKING GROUP BROKEN DOWN INTO SUBCOMMITTEES:
  - STATIC EFFECTS (FURTHER BROKEN DOWN INTO 'ISSUES')
  - DYNAMIC EFFECTS (ALSO BROKEN DOWN INTO 'ISSUES')
  - PIMS EXPERIMENT DEFINITION

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STO PLANNING

SSPIE WORKING GROUP APPROACH

- THE SPACE STATION PLASMA INTERACTIONS AND EFFECTS (SSPIE) WORKING GROUP IS APPROACHING ITS TASKS AS FOLLOWS:
  - IDENTIFY CONCEIVABLE STATION-PLASMA INTERACTIONS OR EFFECTS
  - DETERMINE EXISTING DATA AND/OR MODELS WHICH CAN BE USED TO TEST HYPOTHESES
  - ASSIGN ACTIONS FOR MEMBERS TO ANALYZE DATA/MODELS, AND REPORT BACK AT NEXT MEETING, (SEPTEMBER 29-30, 1987)
  - DISCUSS RELATIVE IMPORTANCE OF POSSIBLE INTERACTIONS AND EFFECTS
  - DISCUSS METHODS OF CONTROL, AND APPROPRIATE SYSTEM SPECIFICATIONS
  - DEFINE AN APPROPRIATE MONITORING SYSTEM, (I.E. PIMS)
  - PREPARE REPORT OF INITIAL FINDINGS, (ABOUT END OF CY 1987)
  - RECOMMEND WHAT MUST BE DONE NEXT

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9/21/87

APPENDIX III

Current Planning of ASO

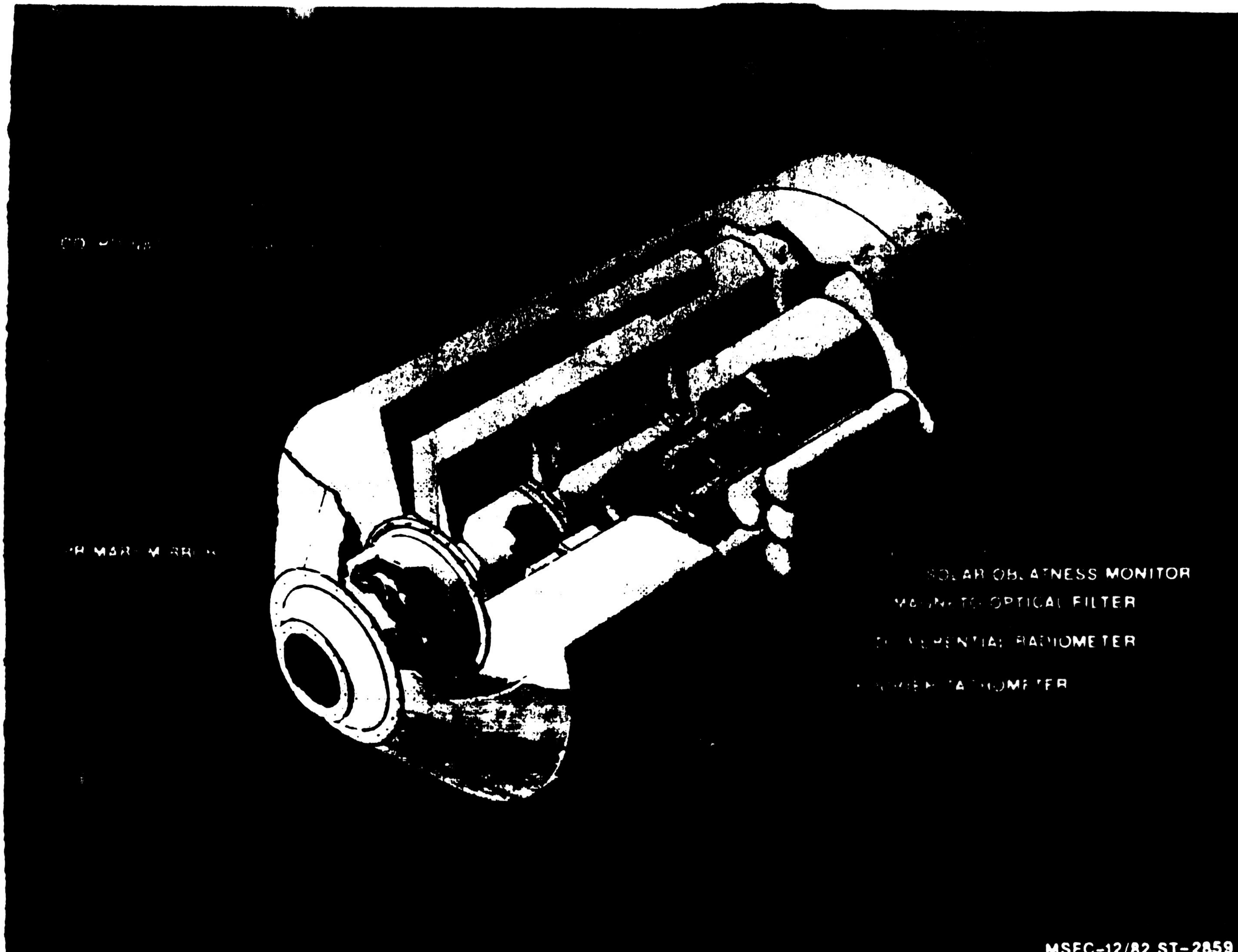
Presented by

Prof. A. B. C. Walker, Jr.
Stanford University

WHAT IS THE CONFIGURATION OF THE ADVANCED SOLAR OBSERVATORY?

The ASO consists of two main ensembles:

* High Resolution Telescope Cluster
  - "Solar Optical Telescope"
  - Extreme Ultraviolet Telescope
  - Soft X-Ray Telescope and XUV Spectrometer
  - Solar Gamma Ray & Neutron Spectrometer
  - Helioseismemeter
* Pinhole/Occulter Facility
  - White Light & Ultraviolet Coronal Telescopes
  - Coded Aperture Hard X-Ray Imaging Systems
* Anticipated Growth Capabilities Include ?
  - An Expanded Cluster of Instruments Sensitive to High Energy Radiations
  - A Low Frequency Radio Interferometer and Spectrograph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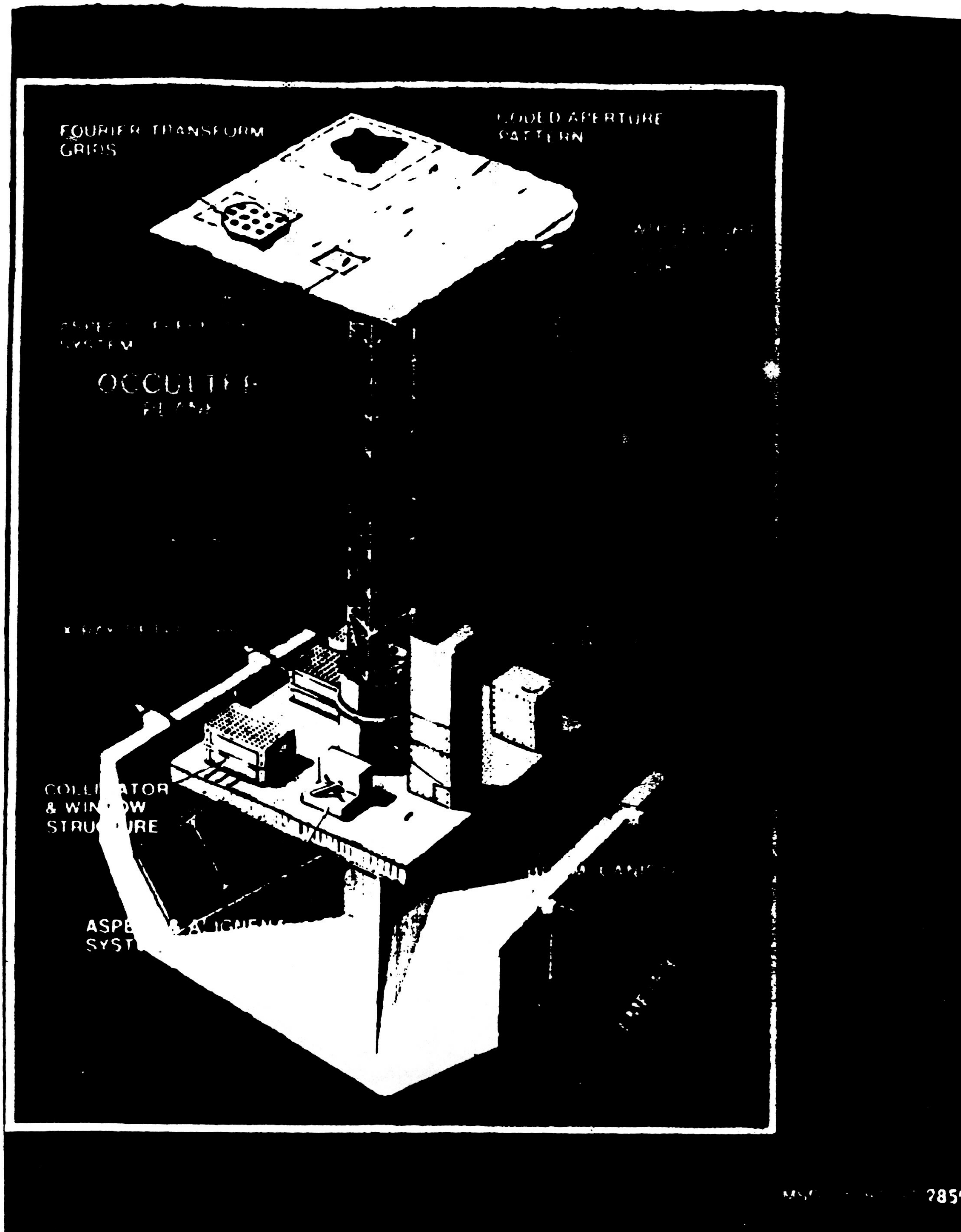

FOURIER TRANSFORM
GRIDS
PATTERN

WHAT WILL THE ADVANCED SOLAR OBSERVATORY ACCOMPLISH?

* It will provide, for the first time, instruments capable of observing in detail the underlying processes that control many astrophysical phenomena.

* It will allow the sun to be studied simultaneously over the entire electromagnetic spectrum, from high energy gamma radiation to low frequency radio waves, corresponding to phenomena occuring over the temperature range from 8000 F. to 100,000,000 F.

* It will give solar physicists the diagnostic capability to determine the detailed physical conditions within the solar plasma on spatial and temporal scales that will allow direct comparison of theory with the observed behavior of a typical astrophysical plasma.

* It will answer questions about:
  - The solar interior
  - Solar magnetism and the solar activity cycle
  - The solar atmosphere
  - The heliosphere

Current Status of ASO

1. The status of HRSO is now uncertain
   a. A study of a HRSO free flyer will be conducted
   b. depending on the direction of the HRSO program, HRSO may or may not become part of the ASO instrumentation

2. Phase A studies on aspects of the P/OF are currently being carried out at MSFC

3. Instrument definition studies on ASO science instruments are urgently needed

4. A Space Station Accomodation study at Brown/Teledyne will shortly begin

Proposed ASO Studies

1. A Symposium on ASO Development Strategies has been proposed to NASA. Issues to be addressed are:

   a. How should ASO be deployed. Possibilities include
      - i The Space Station
      - ii a platform co orbiting with Space Station
      - iii a polar platform
      - iv One or more free flyers

   b. The relationship between "HRSO" and ASO

   c. The relationship of ASO and STO

   d. The size and configuration of the ASO component Instruments will be reviewed and revised as appropiate

   e. The ASO Instrument Development Strategy will be reviewed and revised as appropiate

   f. The impact of SOHO on ASO planning will be discussed

2. Major 2 year studies are proposed for the highest priority ASO instruments. The first year would emphasize the concepts for the science instruments themselves, including

   a. new technologies for optics and detectors
   b. configuration of facility optics
   c. options for focal plane instruments

The second year will address the accomodation of the scientific instruments on ASO

The individual studies to be undertaken include

d. i. P/OF
   ii Soft X-Ray / XUV
   iii High Energy (γ-Ray)
   iv EUV
   v. Visible / IR / UV, including oscillations

APPENDIX IV

International Programs on Solar Terrestrial Physics
During the periods 1987-1990 and 1990-1995

Presented by

S. T. Wu
The University of Alabama in Huntsville

SCOSTEP PROGRAMS

1987 - 1990

(PAD) Polar and Auroral Dynamics:

Dr. H. Oya, Chairman

(MAP) Middle Atmosphere Program

DR Sydney Bowhill

(SIV) Solar Interplanetary Variability:

Dr. E. J. Smith, Chairman

(STEP) Solar-Terrestrial Energy Program:

Dr. G. Rostoker and Dr. V. A. TRoitskay,
Co-Chairman

(STP-M) STP Meterology:

Dr. W. L. Godson, Chairman
Prof. Dr. E. R. Mustell, Vice Chairman

(WITS) World Ionospher/Thermospher Study:

Prof K. D. Cole and Prof. C. H. Liu,
Co-Chairman

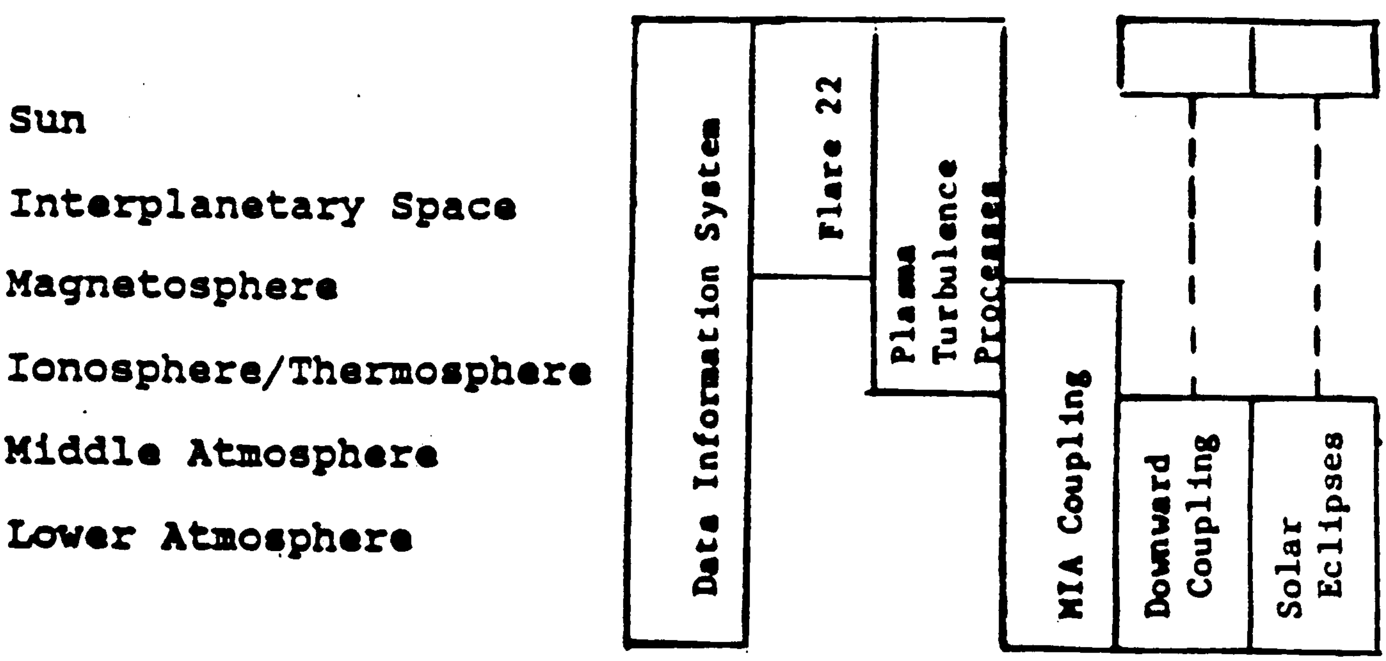
SCOSTEP PROGRAMS

1990 - 1995

THE SOLAR TERRESTRIAL ENERGY PROGRAM (STEP)

Co-Chaired by: Prof. Gordon Rostoker and
Prof. V. A. Troitskaya

An International collaburative Study of Problems in Solar Terrestrial Relationships



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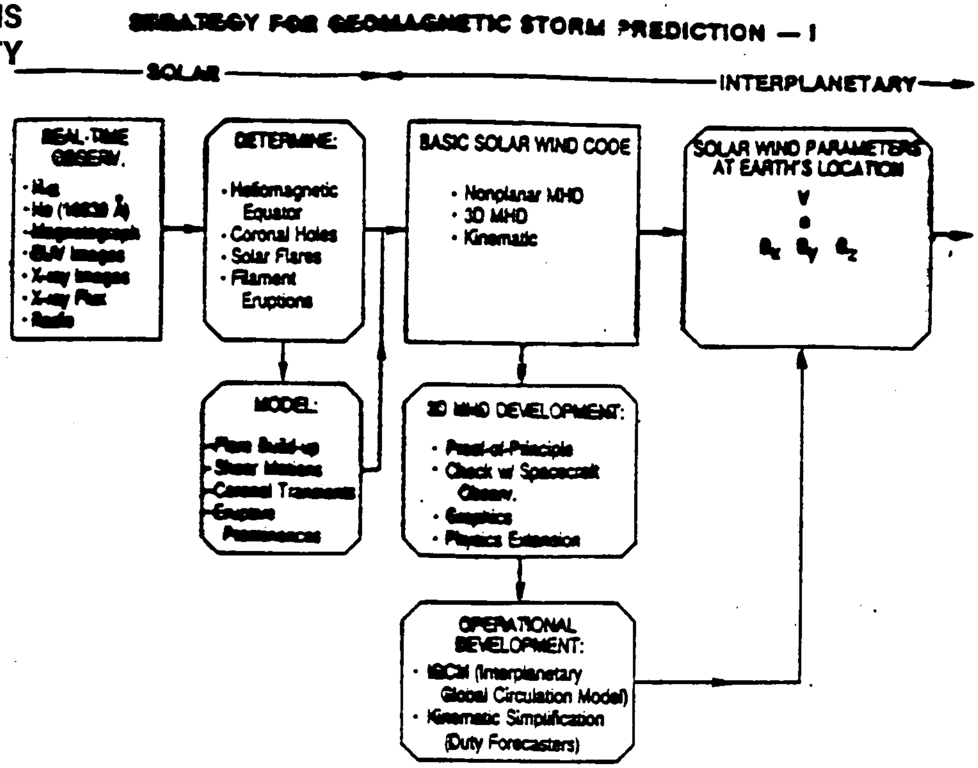


Figure 10. First half of STEM/2000 strategy for geomagnetic storm prediction: the solar-interplanetary connection. Flow chart, read from left to right, starts with real-time observations for both quiet and disturbed periods.

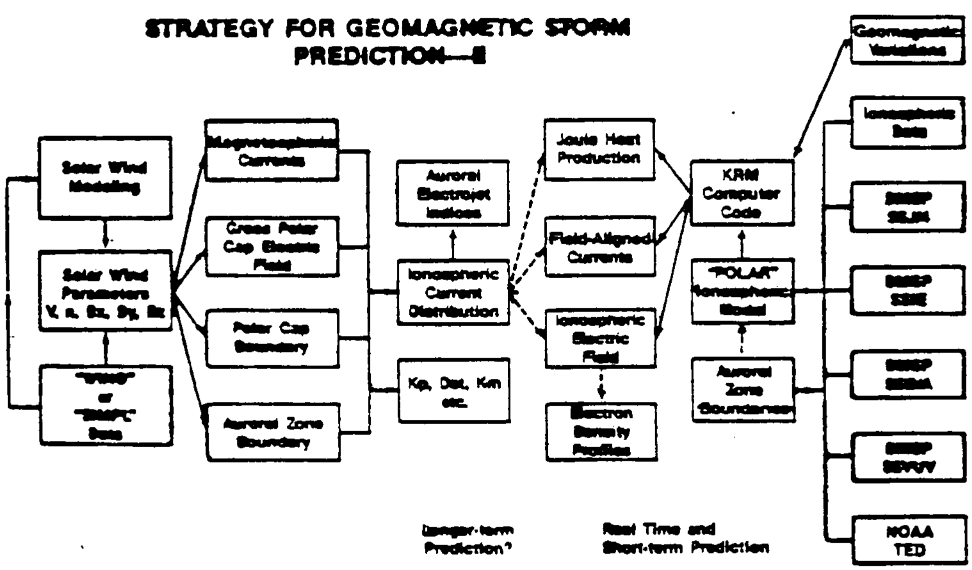
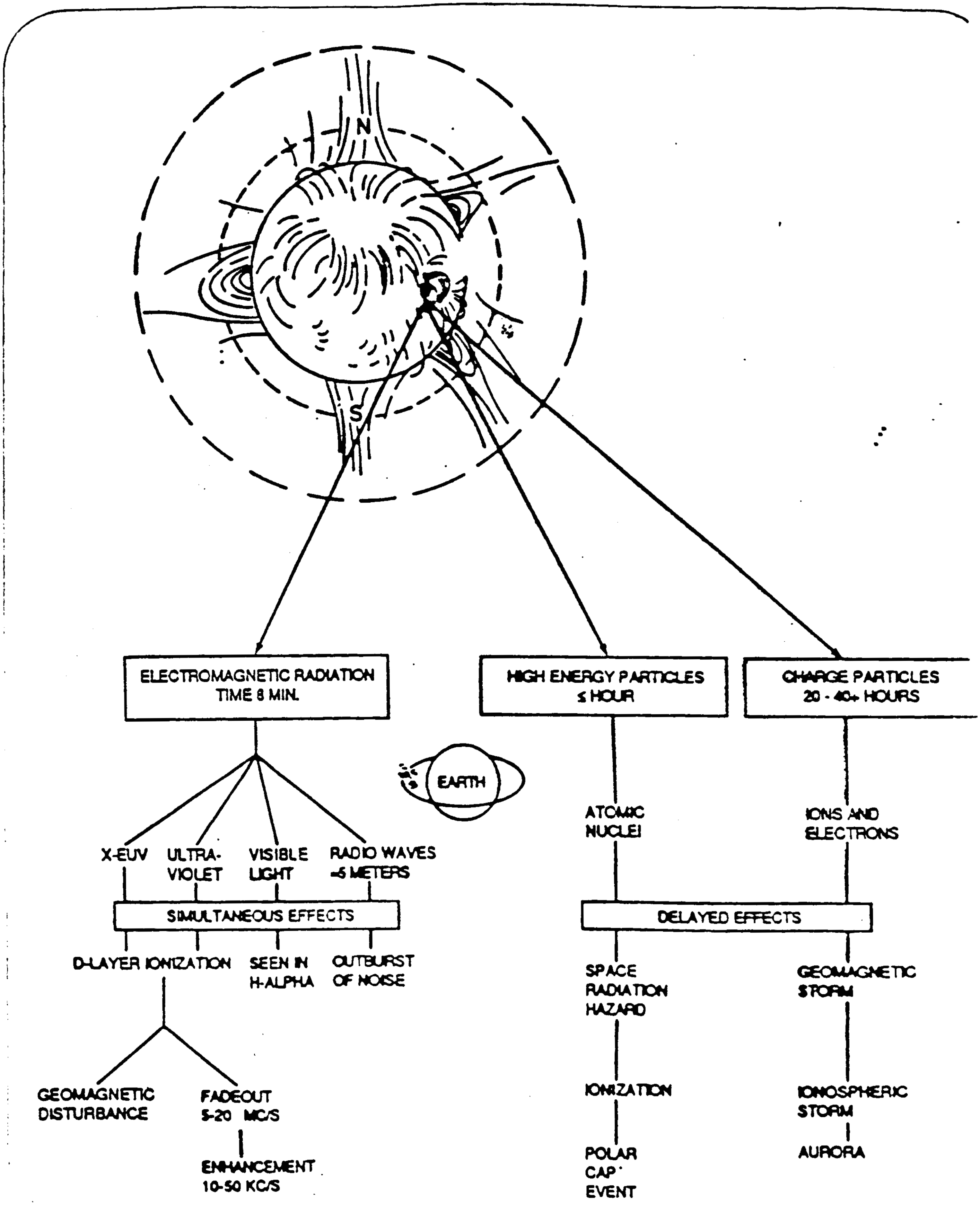


Figure 11. Second half of STEM/2000 strategy for geomagnetic storm prediction: the magnetosphere-ionosphere connection as it is driven by the solar wind.


N
S
ELECTROMAGNETIC RADIATION
TIME 8 MIN.
HIGH ENERGY PARTICLES
≤ HOUR
CHARGE PARTICLES
20 - 40+ HOURS
EARTH
X-EUV
ULTRA-
VIOLET
VISIBLE
LIGHT
RADIO WAVES
≈5 METERS
SIMULTANEOUS EFFECTS
D-LAYER IONIZATION
SEEN IN
H-ALPHA
OUTBURST
OF NOISE
GEOMAGNETIC
DISTURBANCE
FADEOUT
5-20 MC/S
ENHANCEMENT
10-50 KC/S
ATOMIC
NUCLEI
IONS AND
ELECTRONS
DELAYED EFFECTS
SPACE
RADIATION
HAZARD
IONIZATION
POLAR
CAP
EVENT
GEOMAGNETIC
STORM
IONOSPHERIC
STORM
AURORA

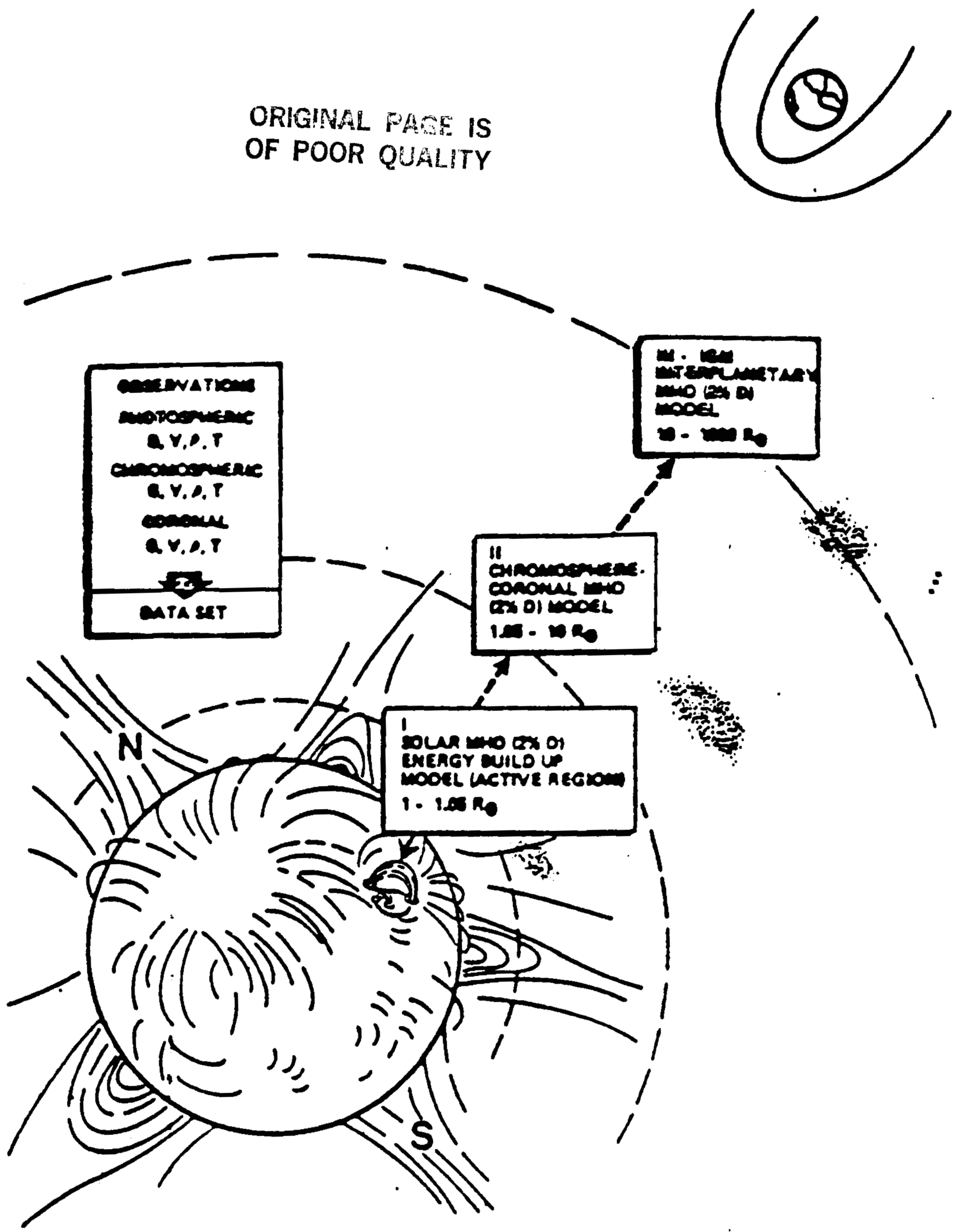


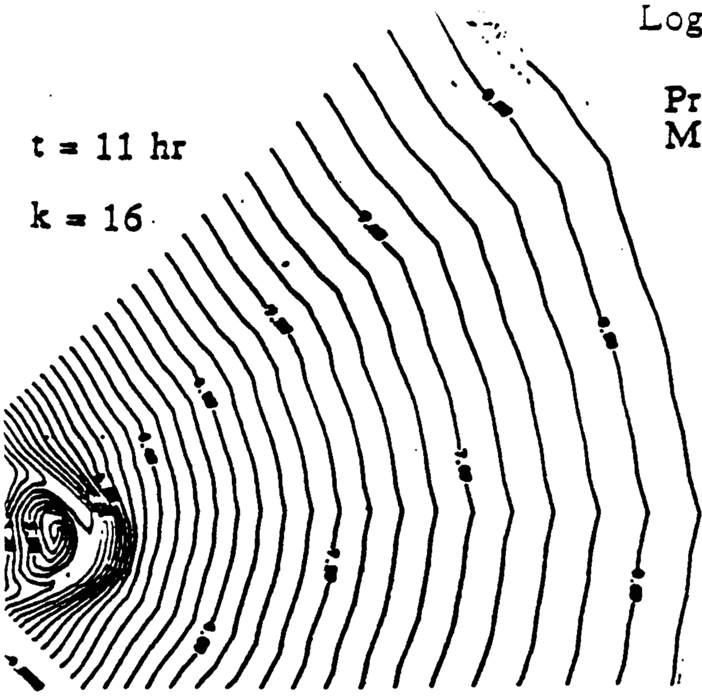
Figure 4. Schematic Representation of the Regime of the Solar-Interplanetary Models of DANSF.

$\log_{10}[2nkT + \frac{B^2}{8\pi}]$, dyn cm^{-2}

Projections on Meridional Planes

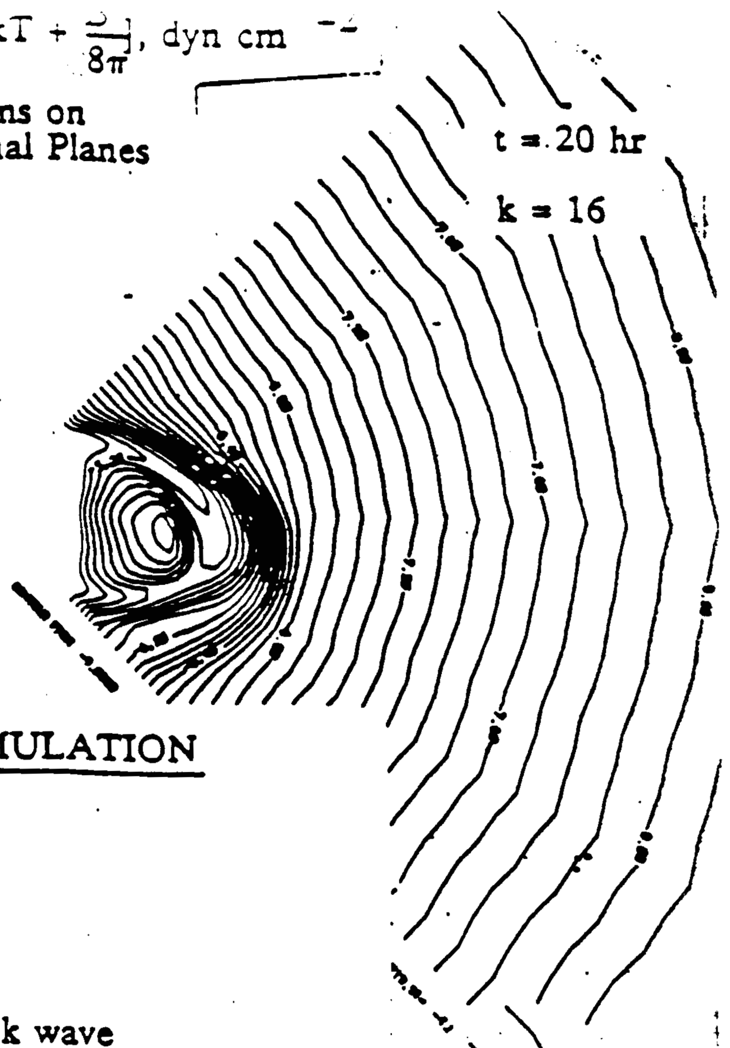
t = 11 hr

k = 16



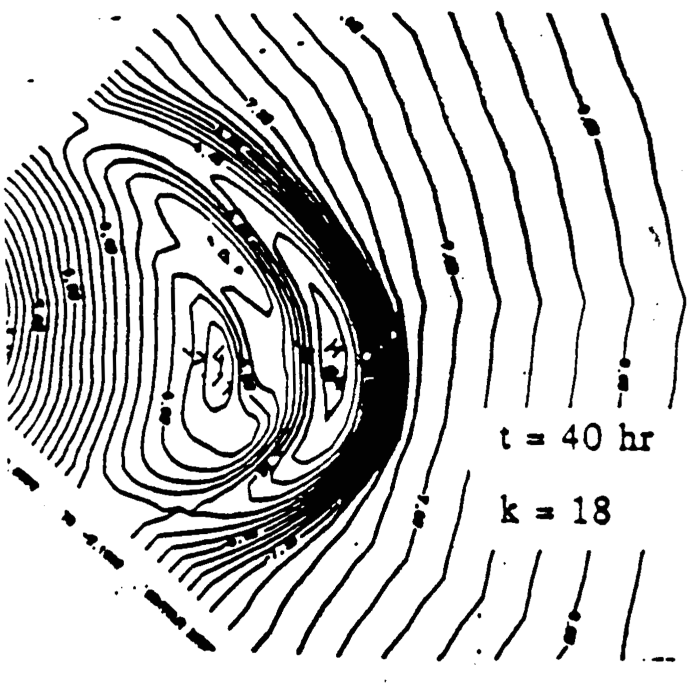
t = 20 hr

k = 16



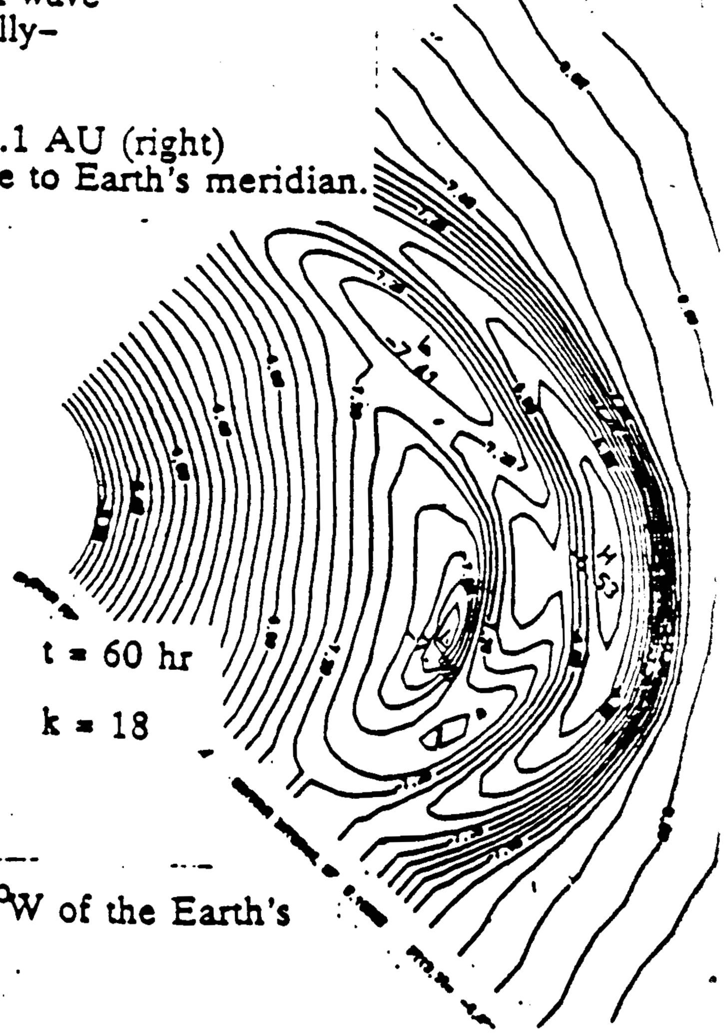
THREE-DIMENSIONAL MHD SIMULATION

- Only Events #1 and #2 are considered.
- k = 16...refers to the meridional plane that contains the Sun–Earth line.
- Note development of asymmetrical shock wave due to off-axis source of flare and initially-assumed symmetrical solar wind.
- Domain is from 18 solar radii (left) to 1.1 AU (right) and $\pm 45^{\circ}$ latitude and longitude relative to Earth's meridian.



t = 40 hr

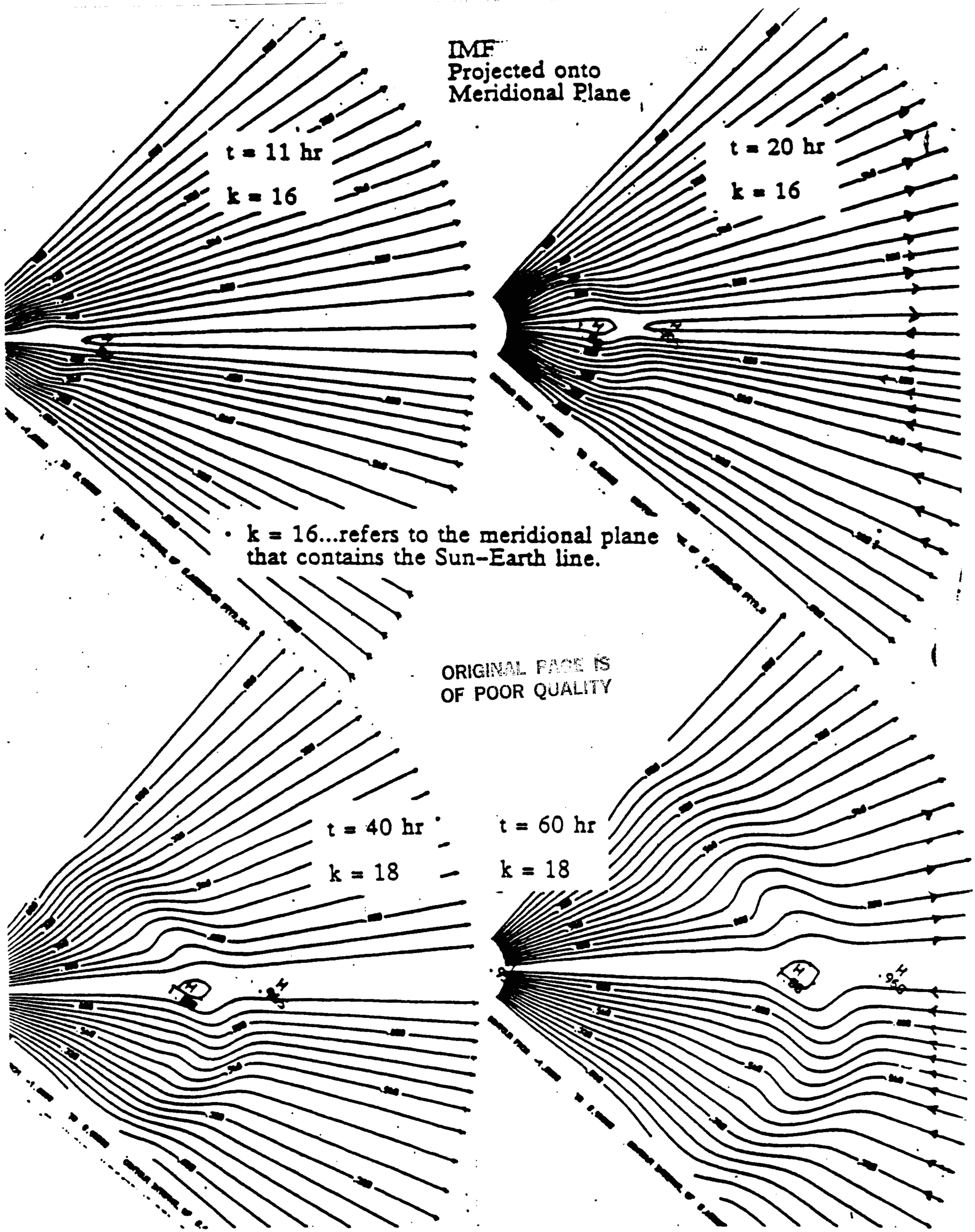
k = 18



t = 60 hr

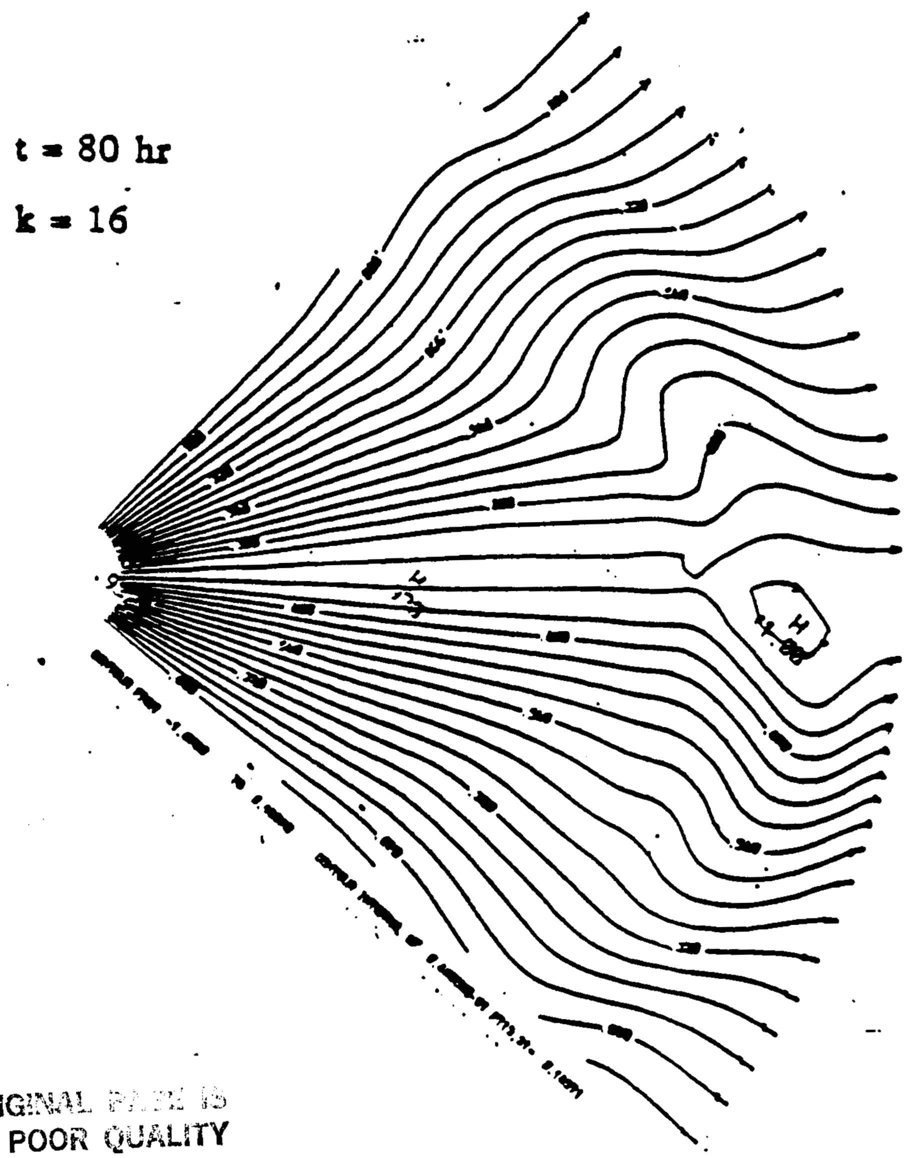
k = 18

- k = 18 refers to the meridional plane 6 $^{\circ}$W of the Earth's central meridional plane.



• k = 16...refers to the meridional plane that contains the Sun–Earth line.

• k = 18 refers to the meridional plane 6 °W of the Earth's central meridional plane.



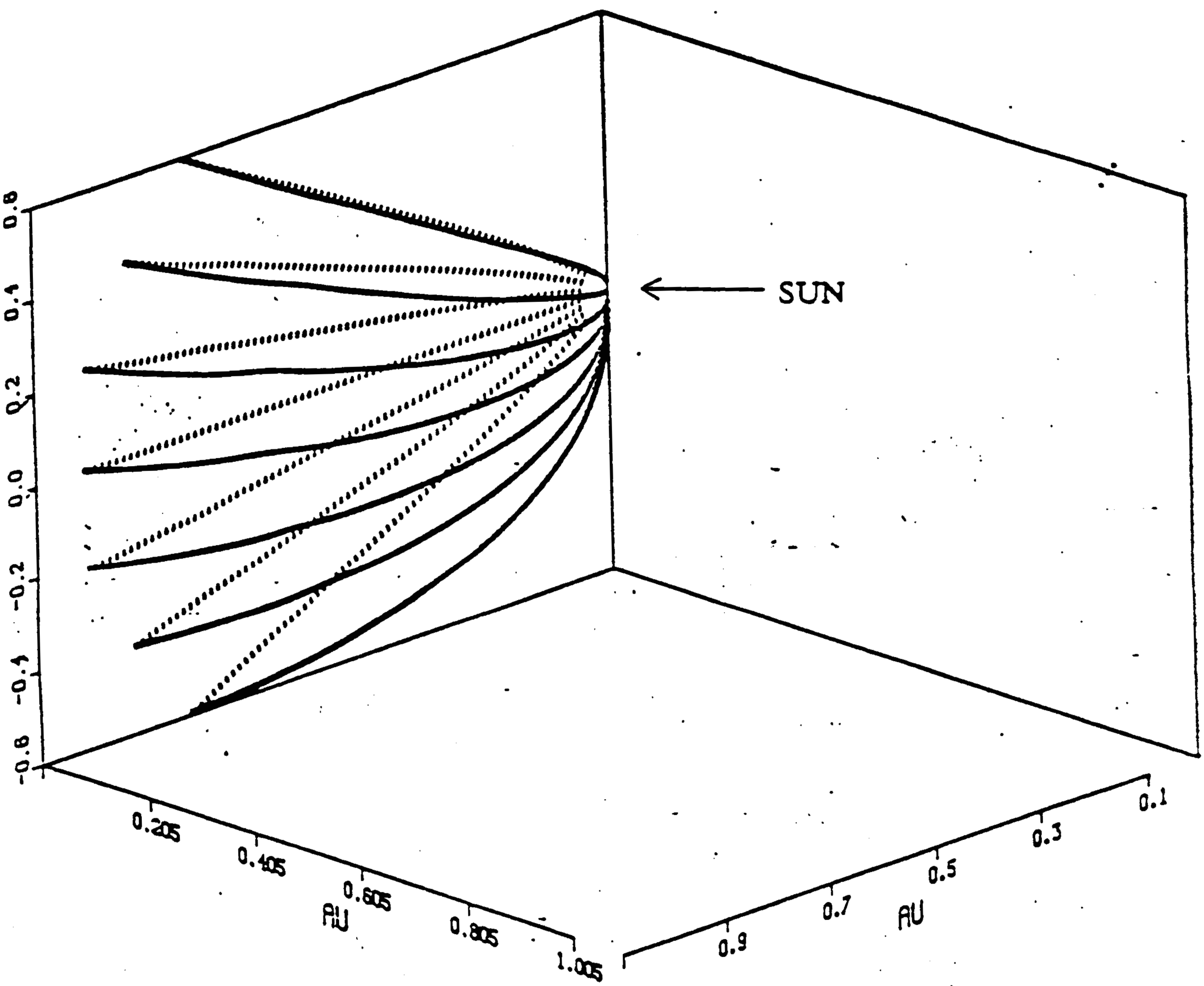
NOTE: The 3-D MHD Model incorporates infinite electrical conductivity. Hence the numerical "reconnection" (fore, then aft, of the bubble shown here) is caused by numerical diffusive effects that are generated by thermal and magnetic pressure gradients (see, for example, Brecht et al., JGR, 87 6098, 1982). We believe (but have not proved as yet) that incorporation of finite resistivity in the model may produce a similar effect.

THREE-DIMENSIONAL MHD SIMULATION

IMF (Polarity: "away")

t = 80 hr

k = 16 (refers to Central Meridional plane of Earth from which the IMF emanates at 18 solar radii).



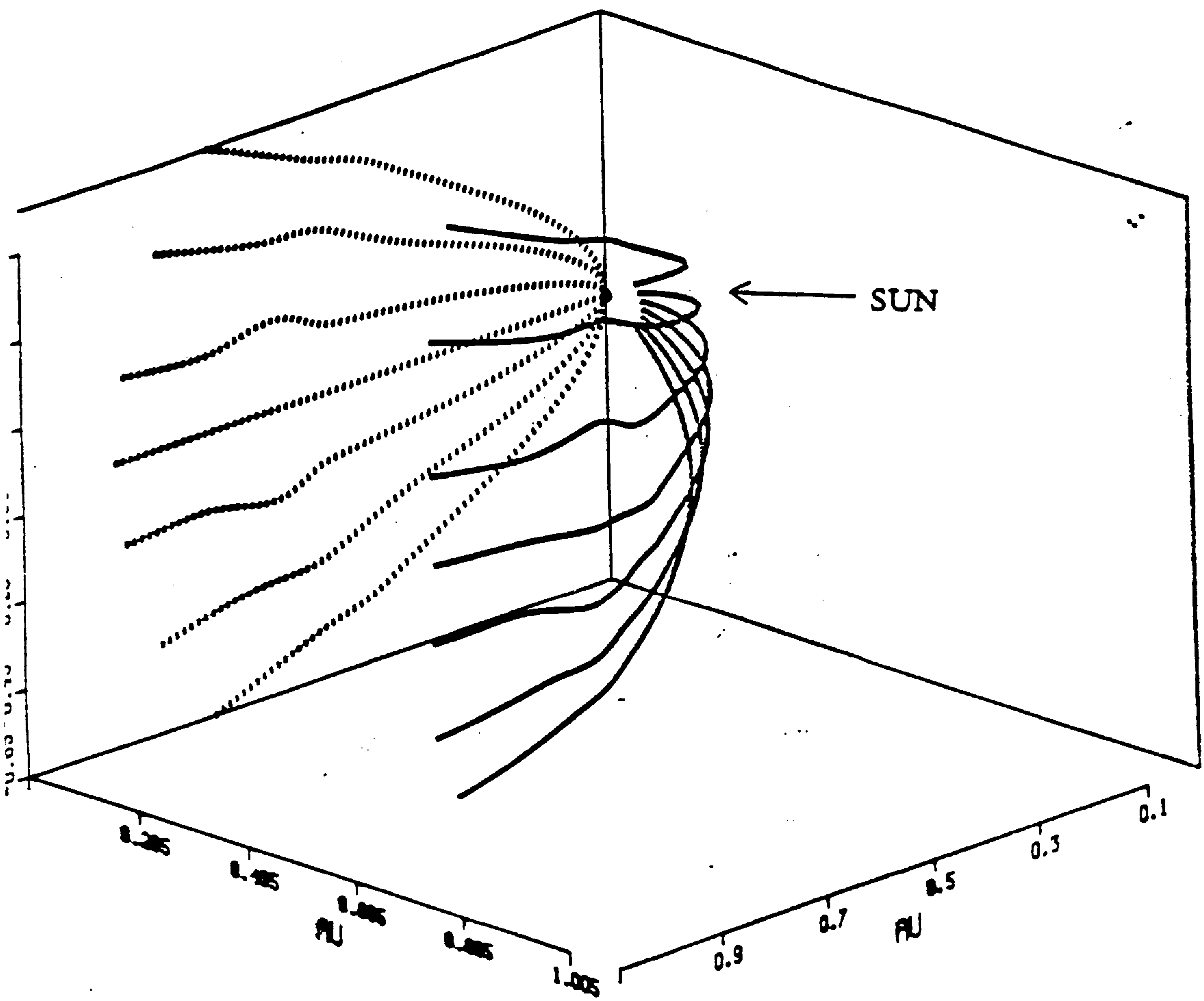
Dotted curves are projections of IMF onto a meridional plane 45°E of Earth.

THREE-DIMENSIONAL MHD SIMULATION

IMF (Polarity: "away")

t = 80 hr

k = 28 (refers to the meridional plane 36 °W of Earth from which the IMF emanates at 18 solar radii).



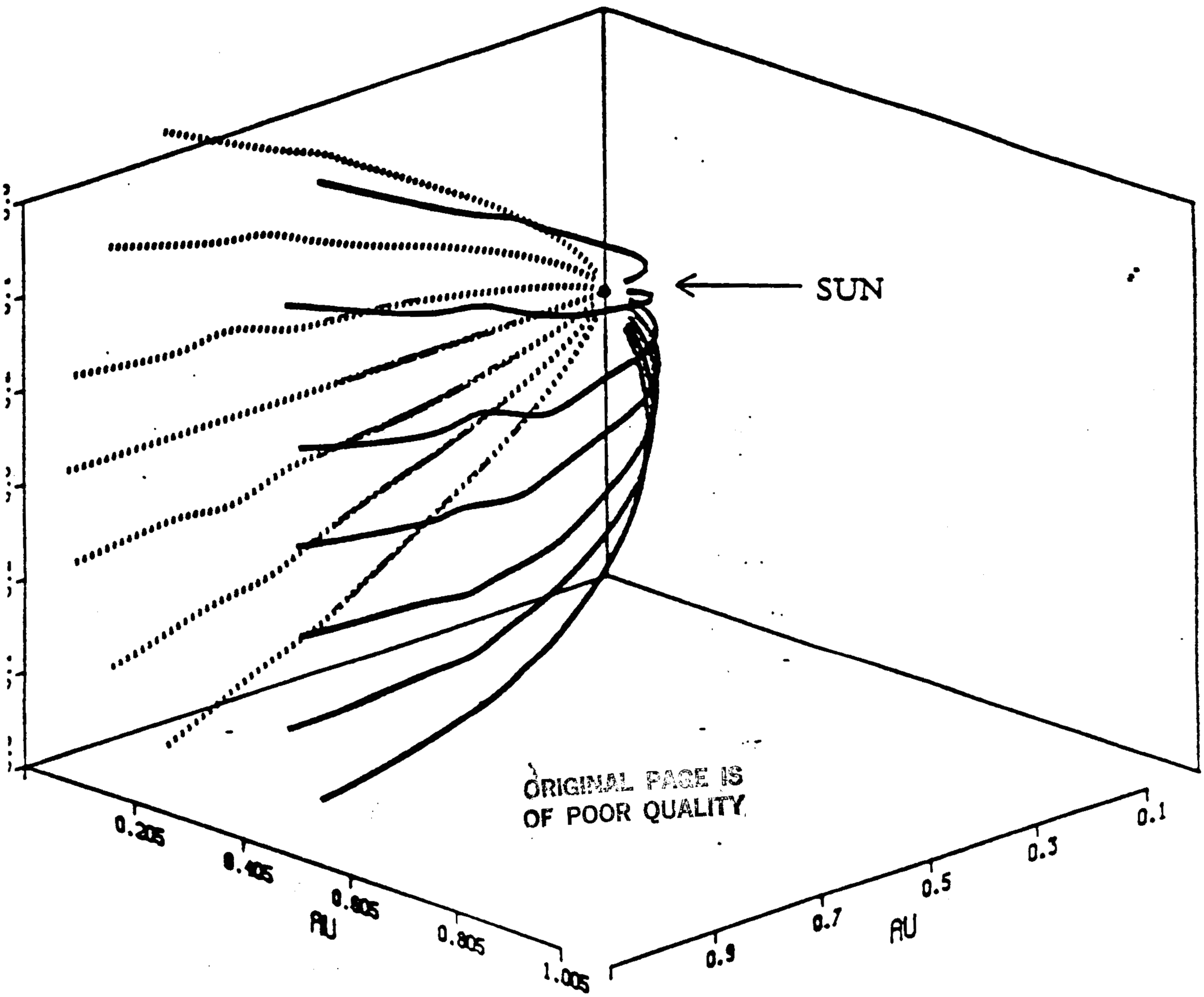
Dotted curves are projections of IMF onto a meridional plane 45 °E of Earth.

THREE-DIMENSIONAL MHD SIMULATION

IMF (Polarity: "away")

t = 80 hr

k = 24 (refers to meridional plane 24 ° W of Earth from which the IMF emanates at 18 solar radii).



Dotted curves are projections of IMF onto a meridional plane 45 ° E of Earth.

APPENDIX V.

Canadian Position on the Use of the Space Station for research in Solar Terrestrail Physics

Presented by

Dr. David J. W. Kendall
National Research Council of Canada

Second International Meeting On The
Use Of the Space Station
For Research in Solar Terrestrial Physics

CANADIAN POSITION

David J.W. Kendall

Space Division

National Research Council of Canada

Paris, 21-23 September 1987

o AT PRESENT CANADA HAS A (RELATIVELY) STRONG PROGRAMME IN STP THROUGH TO MID-1990'S

- CANOPUS GROUND-BASED ARRAY (MAGNETOMETERS, RIOMETERS, AURORAL RADAR, MERIDIAN SCANNING PHOTOMETERS, ALL-SKY IMAGERS)	1987/1988
- SUPRATHERMAL ION MASS SPECTROMETER (SMS) ON EXOS-D SATELLITE	1989
- ULTRA-VIOLET AURORAL IMAGER (UVAI) ON AURORAL PROBE SATELLITE	1990
- WIND IMAGING INTERFEROMETER (WINDII) ON UARS	1991
- WIDE ANGLE MICHELSON DOPPLER IMAGING INTERFEROMETER (WAMDII) ON SHUTTLE	1992/1993
- WAVES IN SPACE PLASMAS EXPT (WISP) ON SHUTTLE	1994/1995
- CLUSTER EXPT (UNDER REVIEW)/ISTP	1995
- FOCUS (PLANNING)	1991 →
- ROCKET EXPTS	1989 →

Second International Meeting On The Use Of the Space Station For Research in Solar Terrestrial Physics

- o WHAT SCIENCE CAN BE DONE USING SPACE STATION?
  - SUPPORT STO CONCEPT
  - INTERNATIONAL COLLABORATION (WORKSHOP)
  - CORE STATION - SPACE PLASMA PHYSICS, ATMOSPHERIC PHYSICS
    - CANADIAN CONTRIBUTION
      - WISP/HFSS
      - WAMDII (?)
      - GEMINI (?)
      - OTHER ELEMENTS (T.B.D.)
  - POLAR PLATFORM - AURORAL PHYSICS, SPACE PLASMA PHYSICS, ATMOSPHERIC PHYSICS
    - CANADIAN CONTRIBUTION
      - UVAI (AURIO?)
      - HFSS (GEM?)
      - WAMDII
      - CANOPUS
      - OTHER ELEMENTS (T.B.D.)
- o CAN THIS SCIENCE COMPLEMENT ISTPP?

Paris, 21-23 September 1987
D. Kendall, Space Division

- ISSUES
  - SPACE STATION NEGOTIATIONS
  - LACK OF ENTHUSIASM FROM CANADIAN SCIENTISTS
  - CANADIAN SS FUNDING FOR TECHNOLOGY, MICROGRAVITY SCIENCE
  - HOW DO WE UTILIZE OUR 3%(?) ALLOTMENT?
  - UNCERTAINTY OF UTILIZATION OF POLAR PLATFORM FOR STP
  - UNCERTAINTY OF QUALITY OF CORE STATION (CONTAMINATION, STABILITY, EMC, ACCESS, COSTING)
  - LACK OF MOMENTUM IN SS/STP (FUNDING)
  - UNCERTAINTY OF SCIENTIFIC THRUST (JUSTIFICATION)
  - LACK OF COORDINATION WITH OTHER STP ACTIVITIES
  - ISTPP LIKELY TO BE MAJOR INITIATIVE - HOW DOES SS/STP FIT?
  - CAN "QUICK" SCIENCE BE PERFORMED?
  - WILL THE COST BE PROHIBITIVE? (COORDINATION OF MEETINGS)

Second International Meeting On The Use Of the Space Station For Research in Solar Terrestrial Physics

- SUPPORT SETTING UP FORMAL INTERNATIONAL SS/STP WORKING GROUP (À LA PPCC)
- SUPPORT SERIES OF INTERNATIONAL WORKSHOPS TO DEFINE SCIENCE AND STRAWMAN INSTRUMENT PAYLOAD COMPLEMENT
- RELEASE OF AO (CORE STATION) WITHIN 2 YEARS
- NEGOTIATE PERCENTAGE OF POLAR PLATFORMS FOR STP
  - AO AT SAME TIME AS CORE STATION
- CLOSELY COORDINATE WITH ISTPP
- PROVIDE STRONG SUPPORT FOR SMALL ATTACHED PAYLOADS CONCEPT

APPENDIX VI

Space Station Utiization

Presented by

Alan C. Hold
Utilization and Operation Group
Space Station Program Office
NASA Headquarters

SPACE STATION UTILIZATION

September 21, 1987

Alan C. Holt
Utilization and Operations Group
Space Station Program Office

USER INTEGRATION DIVISION

- **Three Branches:**
  - User Requirements and Accommodations Branch
  - User Integration and Operations Branch
  - Utilization Planning Branch
- **Personnel**
  - Permanent - 8 → 20 (Full Staffing)
  - Temporary - 2 (One to three years)
- **Program Support Contractors**
  - FY87 - 7
  - FY 88 - 21 → 40-50 (Full Staffing)

SPACE STATION

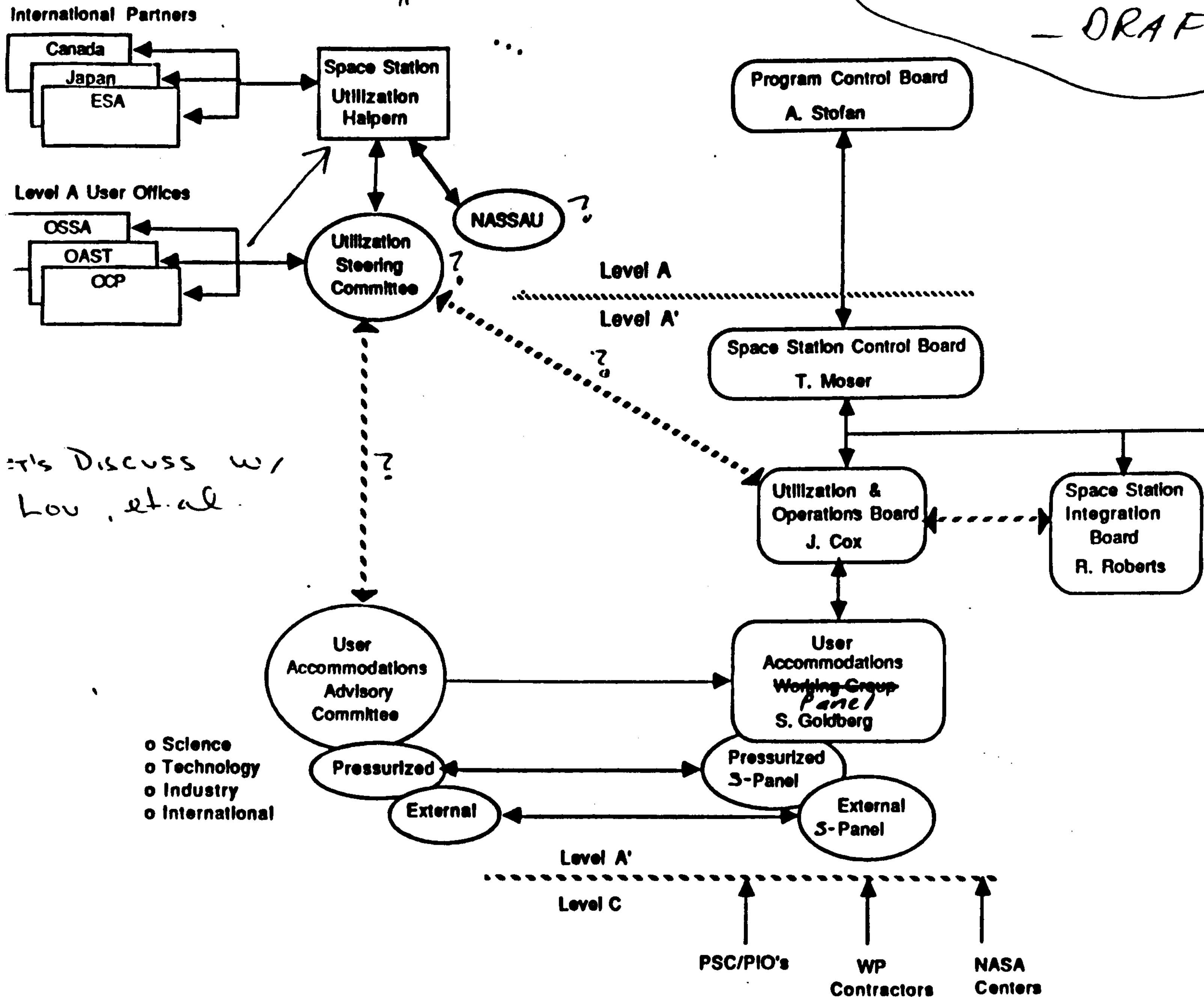
USER ACCOMMODATION ACTIVITIES

- o Program Utilization and Operations Board established.

- o <u>User Accommodations Panel</u>
  - Chartered by U. + O. Board.
  - Evaluation and initiation of Space Station design changes.
  - Forum for presentation of user concerns and participation in design review activities.
  - <u>Planning/Organization Meetings</u>
    - Early October and November.
    - Identify known issues and concerns.
    - Initiate utilization review of PDRD, ACD's, + BCD's in support of [redacted] block CR update in mid-November.
  - <u>Sub-Panels</u>: External Payloads (Attached, Platform and Freeflyer Payloads)
    Pressurized Payloads (Labs, Node, Logistics Module,

SPACE STATION USER WORKING GROUPS
Structure and Communications Flow

PROPOSED. - DRAFT



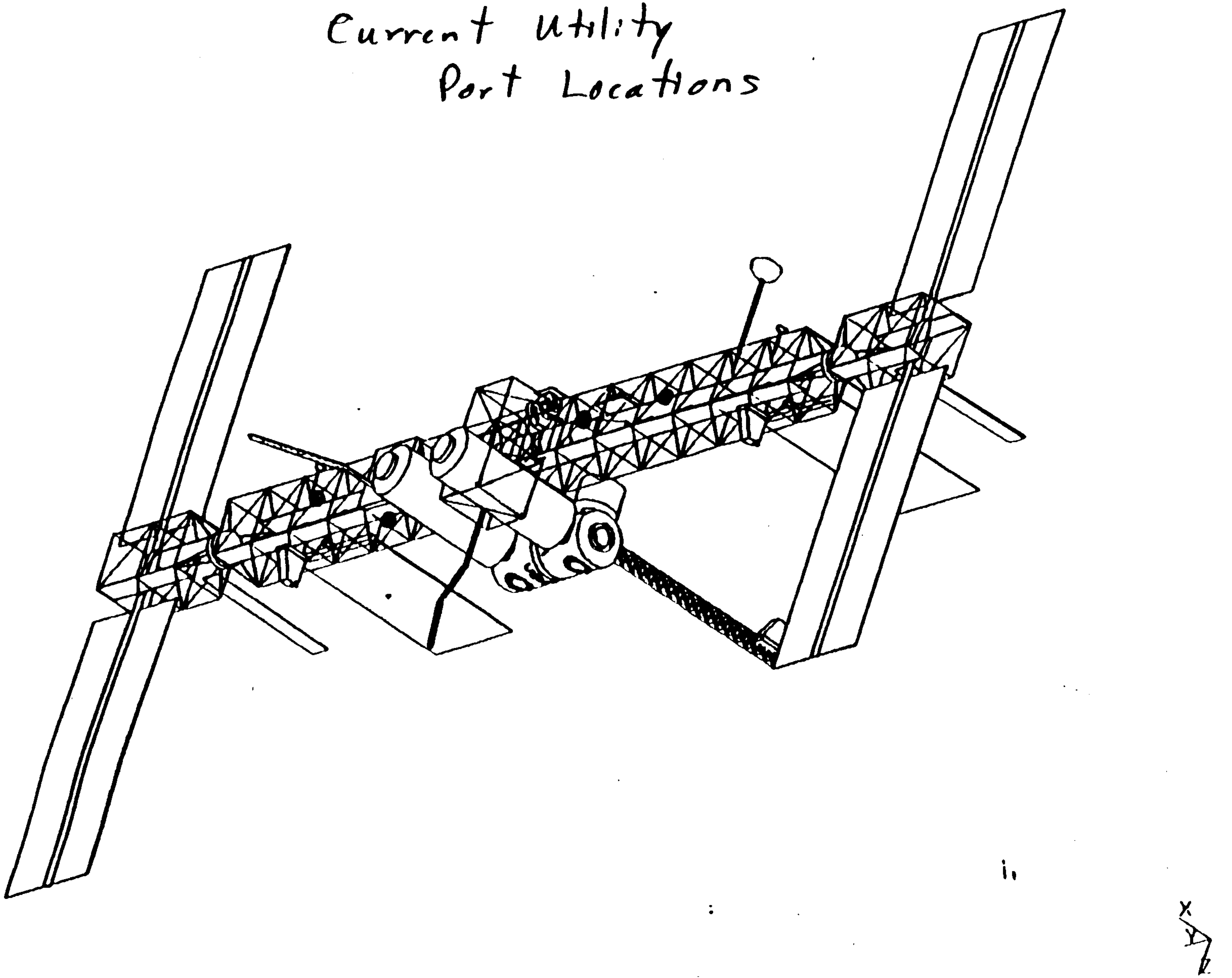
Let's Discuss w/ Lou, et al.

ISA IDEAS**2 SDRC L3.4 LARC V2.0: System Assembly 24-APR-87 11:31:56

ABASE: CETF REFERENCE CONFIGURATION
VIEW:NEW
ask: HIERARCHY
tem: 74-MB6

UNITS = '
DISPLAY:No stored OPTIO
Bin: 1-MAIN
Component: No stored COMPONENT

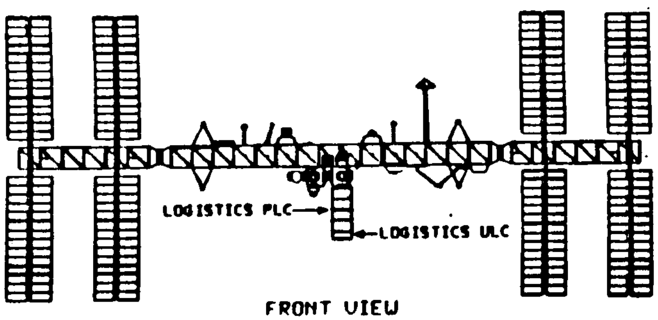
Current Utility
Port Locations

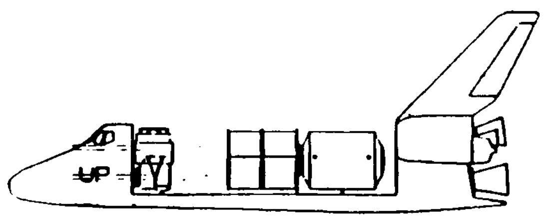


- Adhoc Trial Payload Manifest Working Group
  - Meetings to incorporate detailed manifesting of international payloads.
  - Update of U.S. payload manifesting also.
  - Requires participation of international program utilization accommodation personnel (, user sponsors, and users (as appropriate).
  - Objective: Development of un-official payload manifest to support various user accommodation studies.

- Utilization and Operations Information Planning Group
  - October 14-15, 1987, Washington, D.C.
  - Definition and establishment of payload and payload accommodation data bases.
  - "Kick-off" meeting.

TRIAL PAYLOAD MANIFEST
FLIGHT 16 (L-3): LAB RESUPPLY/OUTFITTING

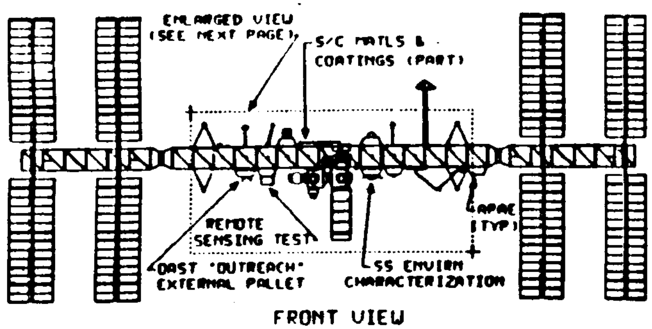


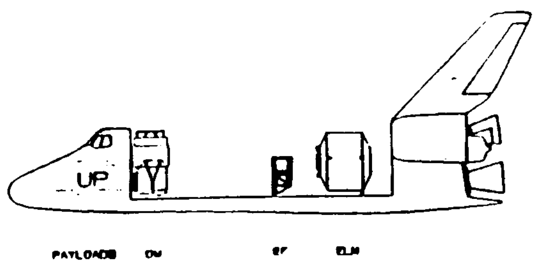


MANIFEST U.S. LAB	Weight (Lbs)	Aver. power (kw)	Peak power (kw)	No. of Racks
1. RESUPPLY - COMMERCIAL PROTEIN CRYSTAL GROWTH FACILITY (I)	56			
2. RESUPPLY - 1.8M CENTRIFUGE & BRP EXPERIMENT (E)	92			
3. RESUPPLY - CODE A (A)	64			
4. RESUPPLY - VHSIC FAULT TOLERANT PROCESSOR (R)	44			
5. RESUPPLY - PROTEIN CRYSTAL GROWTH (E)	65			
6. RESUPPLY - ISOELECTRIC FOCUSING (E)	100			
7. RESUPPLY - MANNED OBSERVATIONS TECHNIQUES (R)	130			
8. LSE - HPLC/GCMS/LIFE SC	1058	4.0	4.0	1.0 (USL)
9. COLUMBUS OUTFITTING	1345	TBD	TBD	1.5 (ESA)
10. JEM OUTFITTING	1345	TBD	TBD	1.5 (JEM)
TOTAL	4429	TBD	TBD	4.0

OSS-6491
07/22/87

TRIAL PAYLOAD MANIFEST
FLIGHT 17 (MB-12) ATTACHED PAYLOADS

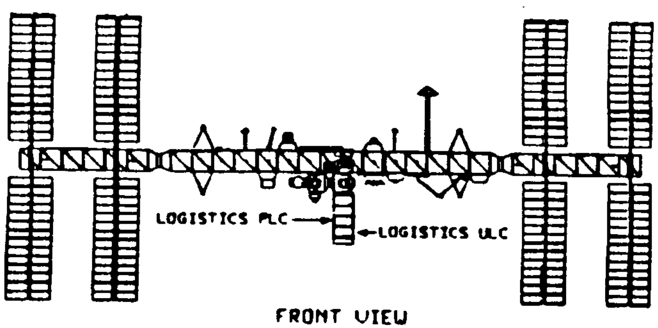


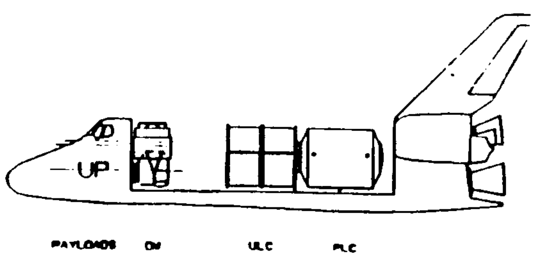


MANIFEST	Weight (Lbs)	Aver. power (kw)	Peak power (kw)
1. SPACECRAFT MATERIALS & COATINGS (Partial - R) (PIA #1)	489	0.16	0.16
2. OAST "OUTREACH" EXTERNAL PALLET EXPERIMENT (R) (PIA #4)	770	1.0	1.0
3. SPACE STATION ENVIRONMENTAL CHARACTERIZATION (R) (PIA #4)	506	0.75	0.75
4. REMOTE SENSING TEST, DEV & VERF (I) (PIA #4)	850	6.0	6.0
5. JAPAN #1 (EF #1)	540	0.2	0.2
6. JAPAN #2 (EF #1)	850	0.3	0.3
7. CANADA #1 (EF #1)	400	0.2	0.2
8. CANADA #2 (EF #1)	285	0.1	0.1
9. RESUPPLY - COSMIC DUST COLLECTION (E)	200		
10. PAYLOAD ACCOMMODATION EQUP			
A. Station Interface Adapter (SIA #4)	825		
B. Payload Interface Adapter (PIA #4)	735		
C. Multiple Payload Adapter (MPA #2)	1005		
D. Flight Support Equipment	828		
TOTAL	8,283	8.7	8.7

OSS-6493
07/21/87

TRIAL PAYLOAD MANIFEST
FLIGHT 18 (L-4): LAB OUTFITTING/RESUPPLY

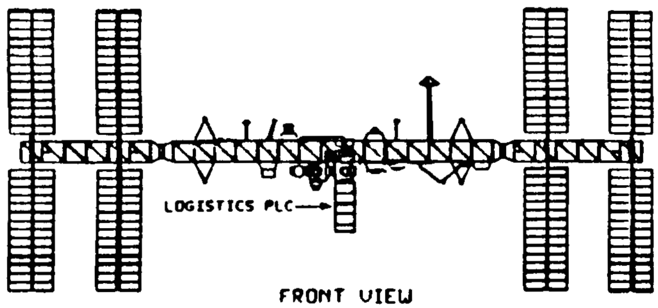


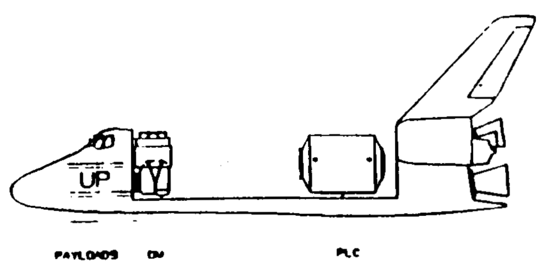


MANIFEST U.S. LAB/NODE OUTFITTING/RESUPPLY	Weight (Lbs)	Aver. power (kw)	Peak power (kw)	No. of Racks
1. RESUPPLY - VHSIC FAULT TALERANT PROCESSOR (R)	11			
2. RESUPPLY - CODE A (A)	64			
3. RESUPPLY - COM PROTEIN CRYSTAL CROWTH (I)	14			
4. RESUPPLY - 1.8M CENTRIFUGE AND BRP EXPERIMENT (E)	121			
5. RESUPPLY - PROTEIN CRYSTAL GROWTH (E)	22			
6. RESUPPLY - ISOELECTRIC FOCUSING (E)	100			
7. RESUPPLY - MANNED OBSERVATIONS TECHIQUES (R)	130			
8. RESUPPLY - TRANSIENT UPSET PHENOMENA (R)	22			
9. RESUPPLY - MODULAR CONTAINERLESS PROCESSING (E)	14			
10. RESUPPLY - ORGANIC CRYSTAL SYSTEM (I)	160			
11. COLUMBUS OUTFITTING	1821	TBD	TBD	2.0 ESA
12. JEM OUTFITTING	1821	TBD	TBD	2.0 JEM
TOTAL	4300	TBD	TBD	4.0

OSS-6494
07/21/87

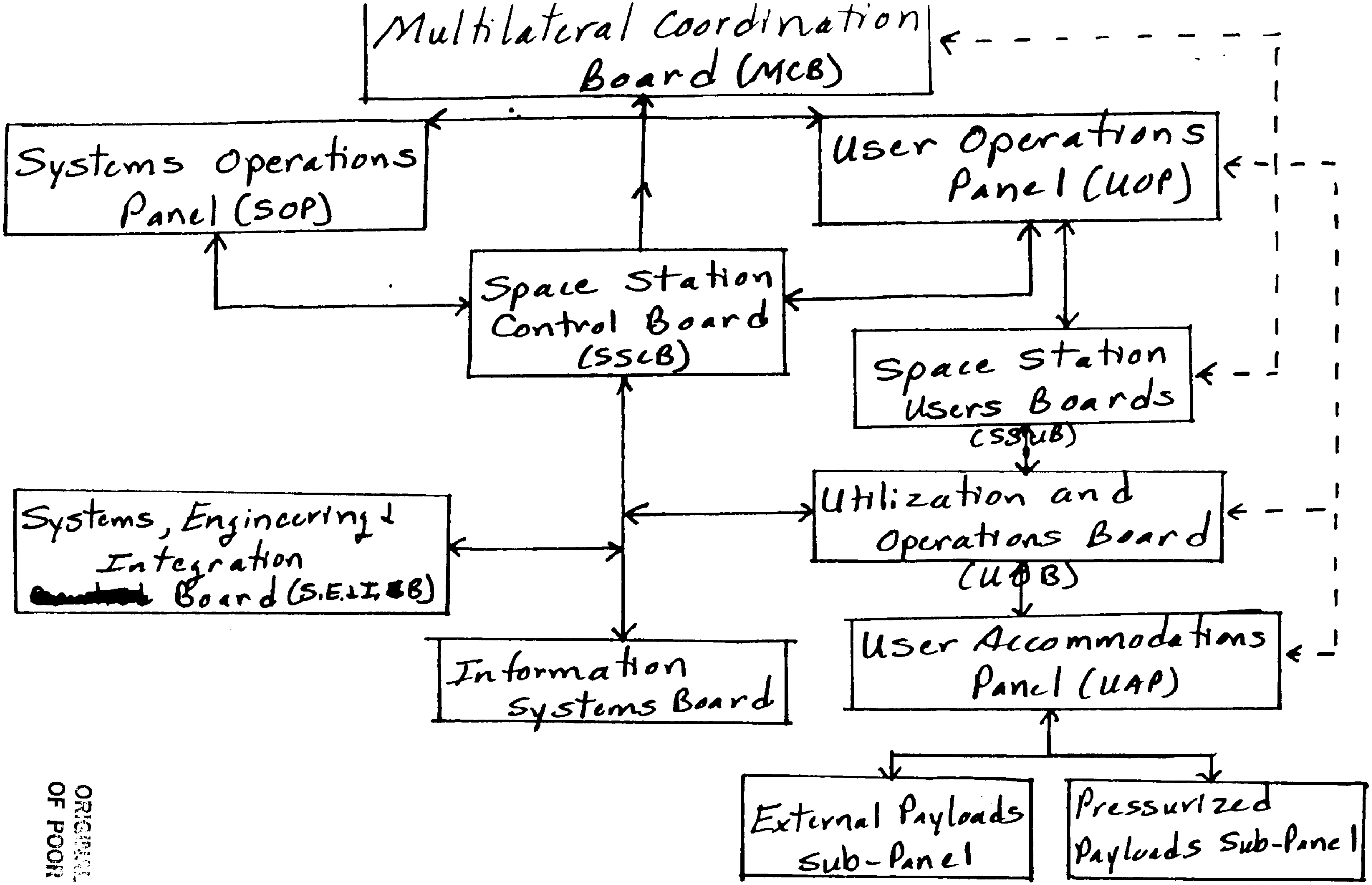
TRIAL PAYLOAD MANIFEST
FLIGHT 19 (OF-2): LAB OUTFITTING/RESUPPLY





	MANIFEST U.S. LAB OUTFITTING	Weight (Lbs)	Aver. power (kw)	Peak power (kw)	No. of Racks
1.	ADV AUTO DIRECTIONAL SOLID FURN (I)	2855	1.0	6.0	2.5ESA
2.	PHYSICAL VAPOR SYSTEM (I)	311	1.8	3.2	1.0ESA
3.	MODULAR MULTIZONE FURN (E)	2860	6.0		2.0JEM
4.	CHEMICAL VAPOR DEPOSITION (I)	446	0.5	0.7	0.5JEM
5.	COLUMBUS OUTFITTING	2615	TBD	TBD	3.0ESA
6.	JEM OUTFITTING	2615	TBD	TBD	3.0JEM
7.	PAYLOAD RACKS	2775			
	TOTAL	14,477	TBD	TBD	12.0

OSS-6495
07/17/87



What are the interfaces and responsibilities?

APPENDIX VII

Columbus PHASE B2 Utilization Study

Presented by

Mr. B. Schmitz
CUPG/DFVLR, West Germany

Append.

CUPG/DFVLR

COLUMBUS PHASE B2 UTILISATION STUDY

WP 4000 ATTACHED P/L'S

1. Study purpose and aim
2. Study assumptions and boundary conditions
3. Payload set
4. B/I model mission
5. Study main findings

STP on Space Station, meeting Paris 21 – 23 Sept. 1987

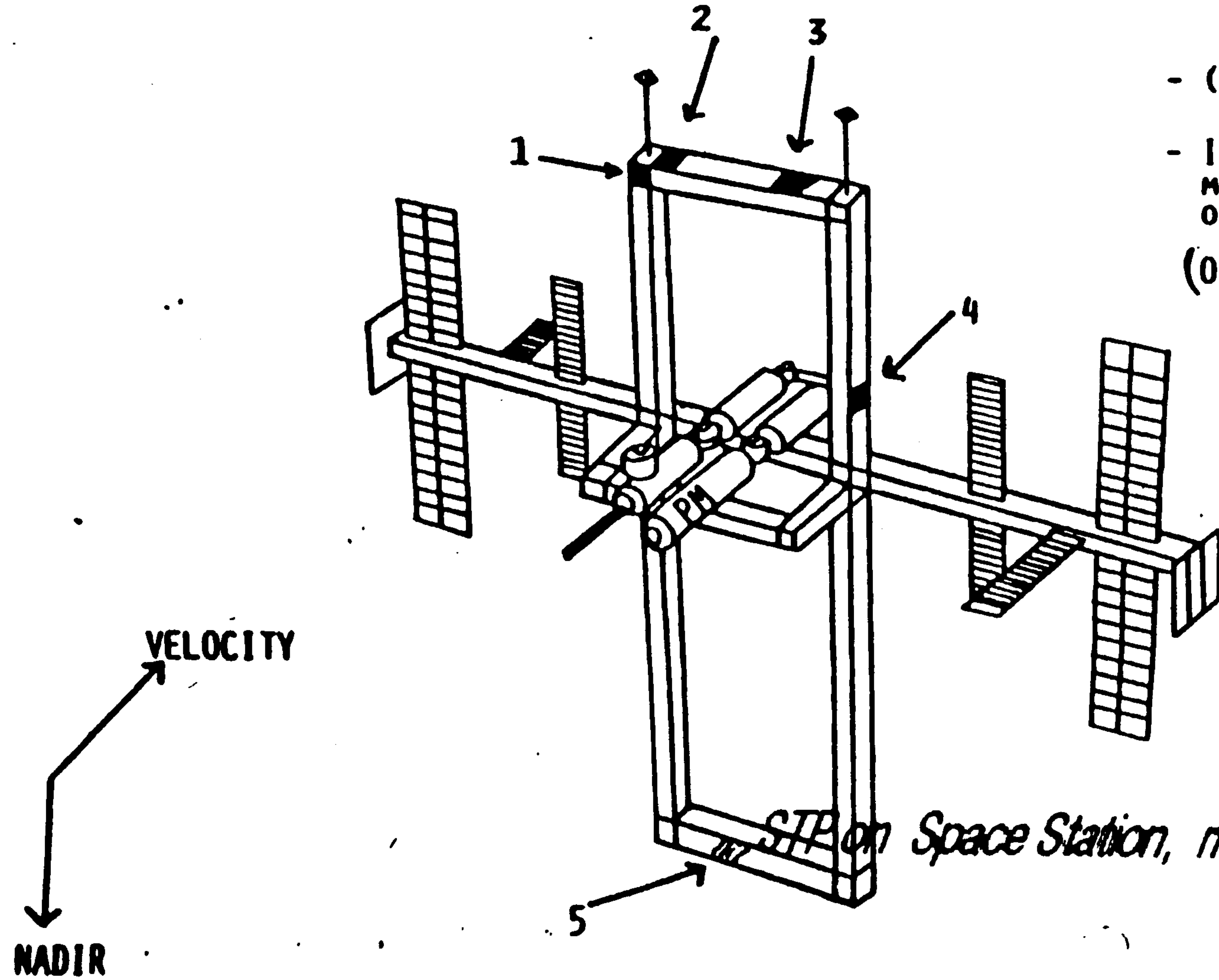
ADVANTAGES TO PAYLOADS OF SPACE STATION

- NO MAJOR ENGINEERING TASKS FOR MISSION OR USER IN CONNECTION WITH SUPPORT SERVICES AND RESOURCES - THESE ARE PROVIDED BY SPACE STATION.
- REGULAR OPPORTUNITIES FOR EVA AND ROBOTIC ACTIVITIES - REPLENISHMENT, PRODUCT/WASTE REMOVAL, SERVICING AND UPGRADING.
- MICROGRAVITY ENVIRONMENT FOR EXTENDED PERIODS.
- POSSIBILITIES FOR COORDINATED OR COMPLEMENTARY MISSIONS ON A CONTINUING BASIS IF SUFFICIENT COMMONALITY IS ACHIEVED.
- INACTIVE STORAGE OF HARDWARE AWAITING DISPOSAL OR LATER RE-USE.
- OPERATION OR INTERVENTION BY CREW POSSIBLE DURING OPERATIONS

GUIDELINES FOR ESA PAYLOAD ACCOMMODATION ON SPACE STATION

- ONLY ONE NASA PAE FOR ESA PAYLOADS AT ANY TIME
- PM END CONE ATTACHMENT WITH PAE LEVEL RESOURCES AVAILABLE FOR PAYLOADS (REMOVAL FOR CONTINGENCIES)
- ONE 'NON-STANDARD' ATTACHMENT POINT ON SPACE STATION STRUCTURE AVAILABLE AT ANY TIME FOR PASSIVE OR LOW RESOURCE PAYLOADS.
- MTFF AVAILABLE FOR EXTERNALLY ATTACHED PAYLOADS.
- POINTING REQUIREMENTS MET BY ESA IPS OR NASA CPS. THESE TO BE ATTACHED AT A NASA PAE.
- TECHNOLOGY DEMONSTRATION MISSION (TDM/TOS) PAYLOADS TO BE FLOWN AS EARLY AS POSSIBLE.
- PAYLOAD GROUPINGS ON DEDICATED (ESA) CARRIERS WILL BE NECESSARY TO OPTIMISE USE OF ATTACHMENT POINTS.
- MINIMUM STORAGE OF PAYLOADS OR CONSUMABLES BEFORE THEIR MISSION.

SPACE STATION PAYLOAD ATTACHMENT LOCATIONS



- (1) - (5) IOC NASA PAE's (ESA USES ONE)
- IN ADDITION ESA P/L's MAY USE PM END CONE AND ONE 'NON-STANDARD' I/F.

(OTHER ESA P/L's ON MTFF)

Attachment points

Standard PAE	Non-standard
– 10 kW of power	– 1 kw of power
– 10 kW of cooling	– no active cooling
– 50 Mbps data link	– 10 kbps data link
– 6000 kg CPS ltd. mass	– 500 kg p/l – mass

CUPG/DFVLR

Coarse Pointing System capabilities

– Hemispherical FOV	
– Pointing Accuracy	1 '
– Pointing Knowledge	36 "
– Jitter	15 "
– Stability	30 "
– Mass	max. 6000 kg
– Power and heat rejection	5 kW
– Data rates incl 2 vid.chan	50 Mbps

ATTACHED PAYLOAD DISCIPLINES AND PRIORITIES

I	TECHNOLOGY (TOS/TDM)	SHORT LIVED MISSIONS (~ HOURS OR DAYS) TO PROVE AND DEMONSTRATE TECHNOLOGY NEEDED FOR FUTURE EUROPEAN SPACE ACTIVITIES.
II	SPACE SCIENCE (SPA)	RANGE OF MISSIONS PROPOSED BY SCIENCE COMMUNITY (ASTRONOMY, SOLAR PHYSICS, ATMOSPHERE). IN MOST CASES A FREE FLIER SPACECRAFT CAN ALSO BE CONSIDERED.
III	MATERIALS SCIENCE (MAT) LIFE SCIENCES (LIF)	WIDE RANGE OF FACILITIES CARRYING OUT PROCESSING OF MATERIAL, PHARMACEUTICAL AND BIOLOGICAL PRODUCTS. THESE REQUIRE REPLENISHMENT AND PRODUCT REMOVAL AT 30 - 365 DAY INTERVALS.

ATTACHED PAYLOADS - MODEL MISSIONS (A)

DISCIPLINE	ESA NUMBER/TITLE	OBJECTIVES
TECHNOLOGY (TDM)	TOS 116 ESTEF TOS 216 WORKBENCH	EXPOSURE OF SAMPLES TO SPACE ENVIRONMENT INTERNAL (PM?) AND EXTERNAL ELEMENTS TO PROVIDE FACILITIES FOR IN-ORBIT SERVICING OF PAYLOADS
	TOS 235 ROSE	TO DEMONSTRATE CAPABILITIES OF ROBOTIC ARM
	TOS 236 FTMS	DEMONSTRATION OF FUEL TRANSFER MANAGEMENT SYSTEM IN SPACE
	TOS 241 LARGE SPACE STRUCTURES	THREE SEPARATE LARGE (TENS OF METERS) DEPLOYABLE OR INFLATABLE STRUCTURES DEMONSTRATION OF ASSEMBLY AND CONTROL
	TOS 244 TS	TO DEMONSTRATE POWER AND THRUST GENERATION USING A LONG CONDUCTING TETHER

ATTACHED PAYLOADS - MODEL MISSIONS (B)

DISCIPLINE	ESA NUMBER/TITLE	OBJECTIVE
SPACE SCIENCE	SPA 801 FIRST	FAR-INFRARED AND SUB-MILLIMETRIC ASTRONOMY
	IFTS	SOLAR UV OBSERVATIONS WITH A 50 M GREGORIAN TELESCOPE AND AN IMAGING FOURIER TRANSFORM SPECTROMETER
	PRISMA	STUDY OF STELLAR INTERIORS
	GRASP	GAMMA RAY ASTRONOMY AND SPECTROSCOPY
	DUSTWATCH	CAPTURE AND ANALYSIS OF MICRON SIZED PARTICLES IN ORBITAL ENVIRONMENT
MICROGRAVITY	MAT 130 MATERIALS SCIENCE	MULTI-FACILITY ASSEMBLY TO CARRY OUT A RANGE OF PROCESSES UNDER ZERO-G (CRYSTAL GROWTH, CONTAINERLESS PROC....)
	LIF 311 LIFE SCIENCES	FACILITIES FOR CLOSED CYCLE ENVIRONMENT, RADIATION EFFECTS, BIOPROCESSING.

CUPG/DFVLR

USSS SCENARIO	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
USSS SEQUENCE	CROSS BEAM		PRESS. MODULES	DUAL KEEL	I O C						
STS FLIGHTS USSS SERVICE	6 - 10	11 - 15	16 - 20	21 - 25	26 - 30	31 - 35	36 - 40	41 - 45	46 - 50	51 - 55	56 - 60
HERMES FLIGHTS USSS SERVICE					1		2		3		4

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
CROSS BEAM	CELSS + ERA + IFTS ESTEF + DUST WATCH			E S T E F							
PM INTERNAL			T W B			T T B - C W S					
PM EXTERNAL			TWB GROWTH TO TTB-I	ROSE FTMS TTB-II	M A T - 1 3 0 + B C						TDM's
TOP BEAM				CELSS + ERA + IFTS		P R I S M A				T S	FIRST
LOW BEAM					TTB-II LSS						

STS AND HERMES FLIGHTS SCHEDULE - PAYLOAD MISSION BASELINE

STP on Space Station, meeting Paris 21 – 23 Sept. 1987

OPTIONS TO BASELINE SCHEDULE

OPTION	IMPACT
- ATTACH MAT 130/BIOCHAMBER TO PAE ON KEEL	- PM END CONE AVAILABLE FULL TIME FOR CONTINUING TECHNOLOGY PROGRAMME - START DELAYED UNTIL DUAL KEEL BUILT - POSSIBLE PROBLEMS OVER VISIBILITY TO CREW
- USE FREE FLIER SPACECRAFT FOR PRISMA AND FIRST MISSIONS	- REMOVES NEED FOR IPS AT SPACE STATION IN BASELINE SEQUENCE.
- FLY ESTEF AND/OR DUSTWATCH SUN-POINTING ELEMENTS FOR PRIORITY REASONS EARLY IN SPACE STATION BUILDUP (BEFORE MTFF)	- ADD TO CARRIER FOR [CELSS, ERA, IFTS] MOUNTED ON SUN POINTING TOP BEAM CPS OR REPLACE SOME OR ALL OF THESE PAYLOADS UNTIL MTFF AVAILABLE
- USE 'GET-AWAY SPECIALS' TO INCREASE UTILISATION	- POSSIBILITIES FOR DEVELOPMENT OF MATERIALS AND LIFE SCIENCE FACILITIES
- START MAJOR ACTIVITIES BEFORE BUILD-UP OF DUAL KEEL STATION IS COMPLETED. (POSSIBLE DELAYS TO STATION PROGRAMMING)	- INTERRUPTIONS TO OPERATIONS WHEN PAYLOADS MUST BE RELOCATED AS BUILD-UP PROCEEDS. (LARGE SPACE STRUCTURES MUST WAIT FOR DUAL KEEL).

BASELINE MISSION SEQUENCE - 'CONCLUSIONS'

- 'PAE EQUIVALENT' PAYLOAD ATTACHMENT AND CARRIER AT PM END CONE IS ESSENTIAL FOR BASELINE SEQUENCE.
- MTFF USED FOR LOW RESOURCE, COARSE SUN POINTING PAYLOADS.
- PAYLOADS WITH SEVERE μG REQUIREMENTS ARE LOCATED IN CENTRAL REGION OF THE SPACE STATION
- FEW OPPORTUNITIES FOR ESA ASTRONOMY AND SOLAR OBSERVING MISSIONS DUE TO LIMITED AVAILABLE ACCOMMODATION AND THEIR LONG MISSION LIFETIMES.
- LONG TERM, BUT FLUCTUATING NEED FOR HARDWARE STORAGE AT SPACE STATION. MAINLY FOR ITEMS AWAITING DISPOSAL.
- LONG TERM REQUIREMENT FOR CONTROL AND MONITORING FACILITIES INSIDE PRESSURISED MODULE OR JEM.
- COMPATIBILITY OF PAYLOAD CARRIER GROUPINGS TO BE CONFIRMED (EMC, CONTAMINATION).

CONCLUSIONS - ACCOMMODATION

- SIGNIFICANT HARDWARE DEVELOPMENT WILL BE NEEDED FOR AN ESA ATTACHED PAYLOADS PROGRAMME - PAYLOAD CARRIERS. ATTACHMENT DEVICES. SERVICING TECHNOLOGY. IPS DEVELOPMENT.
- INTERNAL FACILITIES FOR CREW AND/OR CONTROL FACILITIES IN ESA PM OR JEM WILL BE NEEDED THROUGHOUT THIS PROGRAMME.
- SIMILARLY A NEED FOR HARDWARE STORAGE (GENERALLY PASSIVE) HAS BEEN IDENTIFIED. LEVEL WILL FLUCTUATE AND WILL DEPEND PARTLY ON TECHNIQUES OF HARDWARE DISPOSAL.
- THE BASELINE ESA MISSION SEQUENCE WILL REQUIRE ROBOTIC SERVICING CAPABILITY AT THE PM END CONE REGION TO MEET MATERIALS SCIENCE GOAL OF AUTOMATED PROCESSING AND TO REDUCE EXCESSIVE EVA.

Summary of the major findings, cont.

- upper beam potential is reduced by long duration of ESA – SPA – p/l's and international competition

- therefore non/standard attachment should support ESA – attached p/l's

- there is a need for storage volume for att. p/l's awaiting their downlink logistics flight

APPENDIX VIII

ESA's Program on Earth observation

Presented by

C. Reading
ESA Head Office

ATTRACTIONS OF COPE TO EARTH OBSERVATION

1 NON-SUN-SYNCHRONOUS ORBITS

2 LOW INCLINATION

3 LOW ALTITUDE

4 RELATIVE ACCESSIBILITY

5 LARGE WEIGHT AND POWER LIMITS

OVERALL RECOMMENDATIONS

1. POLAR PLATFORMS ARE THE PRIORITY FOR EARTH OBSERVATION
2. SPACE-TIME SAMPLING STUDY OF COPE ALONE AND IN CONJUNCTION WITH POLAR PLATFORMS

ATMOSPHERIC INSTRUMENTATION FOR COPE

Meteorological

- Doppler Wind Lidar
- Precipitation Radar
- Earth Radiation Budget Instrument
- Imaging Radiometer

Atmospheric Chemistry

a) Tropospheric Chemistry

- DIAL Lidar
- High Resolution Spectrometer
- Imaging Absorption Spectrometer

b) Stratospheric Chemistry

- Limb Sounders
- Limb, Imaging and Occultation Spectrometers
- Fabry Perot and Michelson Interferometers

SOLID EARTH INSTRUMENTATION FOR COPE

GEOKINEMATICS

	SCANNING ALTIMETER
	PRARE RANGING PACKAGE
	CORNER CUBE REFLECTOR
	INVERTED LASER

GEOPOTENTIAL FIELD DETERMINATION

1 MAGNETIC FIELD DETERMINATION	MAGNETOMETER
2 GRAVITY FIELD DETERMINATION	GRADIOMETER
	CACTUS MICROACCELEROMETER

LAND INSTRUMENTATION FOR COPE

Instrument	Applications
IMAGING SPECTROMETER	GEOLOGY INLAND WATER VEGETATION MONITORING
MULTI-BAND MICROWAVE RADIOMETER	SOIL MOISTURE COASTAL ZONE SALINITY WINDSPEED SEA SURFACE TEMPERATURE/TOPOGRAPHY
LASER INDUCED FLUORESCENCE SENSOR	VEGETATION MONITORING
THERMAL INFRA-RED LASER	NON-RENEWABLE RESOURCES
METRIC CAMERA	TOPOGRAPHIC AND THEMATIC MAPPING
THERMAL INFRA-RED IMAGER	GEOLOGY VEGETATION MONITORING HYDROLOGY ENVIRONMENTAL (HAZARD) MONITORING

OCEAN INSTRUMENTATION FOR COPE

NO SPECIFIC INSTRUMENTATION PROPOSED PENDING REVIEW OF TOGA PLANS

SUPPORT FOR DOPPER WIND LIDAR AND PRECIPITATION RADAR

APPENDIX IX

ESA's CSTP Operation Status

Presented by

Gerd Tomaschek
ESA/ESTEC

ESA'S CSTP

OPERATIONS STATUS

1. OPS STATUS
2. INSTRUMENT SPECIFIC ITEMS
3. UOC CONCEPT ITEMS
4. FURTHER ACTIVITIES
5. MESSAGE

2nd International Meeting on the use of the Space Station for Research in Solar Terrestrial Physics.

GERD TOMASCHEK
ESA/ESTEC 22/9/87

STATUS

- FLIGHT OPERATIONS ORGANISATION STUDY COMPLETED. CONTINUATION/EXTENSION IN PROGRESS.

- STP PRIME REQUIREMENTS ESTABLISHED FOR MODEL PAYLOAD. IMPACT BEEING ANALYSED FOR COLUMBUS OPS ELEMENTS (MAINLY PPF).

- ESA HAS STARTED A CONCENTRATED EFFORT BY A WORKING GROUP, CONCEPT:
  - HEADED BY ESA, SUPPORTED BY NATIONAL AGENCIES
  - DEFINITION OF OVERALL OPS CONCEPT FOR COLUMBUS INFRA-STRUCTURE, INCLUDING:

STATUS

- PPF
- MTFF
- APM
- DRS
- HERMES

- INCLUDE ESA CENTRAL MISSION CONTROL CENTRE AT ESOC

- HERMES FCC, TOULOUSE :

- APM / MTFF FCC, OBERPFAFFENHOFEN WITH OPTION APM AT TURIN

- PPF FCC, UK

ESA HAS CENTRAL DESIGN AUTHORITY, NATIONAL CENTRES BEEING PART OF OPS SYSTEM

CONCEPTUAL PHASE HAS STARTED, LASTING 7 MONTH

- ESTABLISH TECHN. CONCEPT IDENTIFY COMMON ELEMENTS FOR ECONOMIC DEVELOPMENT APPROACH, STANDARDS etc.

- ESTABLISH REQUIREMENTS FOR GROUND FACILITIES SUPPORTING IOI ELEMENTS

- PREPARE GROUND SEGMENT. PROPOSALS INCLUDING MANPOWER, FUNDING, SCHEDULE.

- KEY REQUIREMENTS FROM USERS :
  - TRANSPARENCY TO USERS
  - DISTRIBUTED BUT CENTRAL CONTROL APPROACH
  - SIMPLE INTERFACES
  - INDEPENDANCY

- CSTP MAIN DRIVERS (PPF):
  - RT OPERATIONS UP TO 20MBPS
  - SCIENTIST IN LOOP

- DISCIPLINE ORIENTED APPROACH, ONE USER OPS CENTRE HANDLING ALL STP

  - ACCESS OF TBD DATA FROM HOME INSTITUTE

- PRESENT CONCEPT DIFFICULTIES:

  - USER INTERFACES ON ELEMENT LEVEL FOR SCIENCE DATA

  - INFRASTRUCTURE DOES NOT FORSEE PROVISION OF SCIENCE DATA

  - DATA DELIVERED IS:
    UP/DOWN LINK - LOW RATES
    (2 MBPS FOR ALL)

MTFF:

STP REQUIREMENTS ESTIMATED MODERATE, NOT BASED ON MODEL PAYLOAD.

ATTACHED PAYLOADS:

OPERATIONS NOT ADRESSED IN WORKING GROUP, THEREFORE:

- STP WILL ESTABLISH OPS REQUIRE. FOR THEIR PAYLOADS WITHIN USER DIRECTORATE, DISCUSSIONS WITH NASA ENVISAGED TO:

- ESTABLISH INTERN. STP/AP OPERATIONS WORKING GROUP AIMING TO
  - DEFINE COMMON INTERESTS, GOALS, TASKS BASED ON STP REQUIREMENTS
  - ESTABLISH COMMON UNDER-STANDING, ASSUMPTIONS, GUIDELINES, PRIORITIES
  - ESTABLISH CONCEPTS, PRIME INTERFACES

STA

- DEFINE FACILITIES

- ESTABLISH JOINT TASKS FOR ANALYSIS, STUDIES, REPORTS, OPTIONS, SCHED
TO ADVICE
DECISION AUTHORITIES

INTN. OPS WORKING GROUP SHOULD BE BASED ON:

- BEST TECHNICAL, EFFICIENT APPROACHES

- GOOD WILL, NO COMITTMENT APPROACH

- ECONOMIC AND FEASIBLE OPTIONS ENABLING COMITTMENT WHEN INTERNATIONAL SITUATION PERMITS

AN INTERNATIONAL,
COMPLEX AND COSTLY
ISSUE REQUIRES

EFFICIENT TECHNICAL
OPTIONS

ENABLING COMITMENTS

ESA IS READY TO SUPPORT
THIS ACTIVITY !

INSTRUMENT SPECIFIC ITEMS

- IFTS (ON CORE STATION)

  . VERY HIGH DATA RATES, RF REQUIREMENTS

  REDUCTION OF DATA RECOMMENDED (DATA COMPRESSION)

  . SCIENCE OPERATIONS FROM CENTER RECEIVING "BULK" OF DATA (WHITE SANDS?) ?

  OR

  TRANSFER OF DATA TO EUROPE

  . CONTROL VIA US OR EURO OPS CENTER ?

AURIO (PPF)

HIGH RT DATA RATE, OPERATIONS FROM CSTP - UOC.
DATA DIRECT OR VIA COLUMBUS INFRASTRUCTURE

GEM (RPF)

AS AURIO

PAF and FPI

NO PROBLEMS EXPECTED

UOC CONCEPT

- DISTRIBUTED APPROACH

- DISCIPLINE ORIENTED, ALL COLUMBUS AND (?) SS (EUROPEAN?) INVESTIGATIONS TAKEN INTO ACCOUNT

- REDUCTION OF DATA - A HIGH. PRIORITY

- REDUCTION OF DATA TO BE ARCHIVED A HIGH PRIORITY

- EACH PI PROVIDES HIS OWN PROCESSING AND (?) ARCHIVING AT THE UOC, DISTRIBUTED APPROACH.

- COMMON FACILITIES REQUIRED FOR GENERAL PURPOSES APPLICATIONS

UOC CONCEPT

DIRECT COMMANDING ?

- REQUIRES ~~[illegible]~~ UP LINK FACILITIES COMPATIBLE WITH ~~DRS~~ AND PPF. COSTLY

- TECHNICALLY FEASIBLE, NOT RECOMMENDED FROM OVERAL OPS POINT OF VIEW (SAFETY, COMMAND BLOCKING)

- LINK TO USER HOME FACILITIES, A QUESTION OF DATA RATES. A SCIENCE 'QUICK LOOK' MAY BE O.K. NON REAL TIME (?)

- CORRELATED OBSERVATIONS: WHERE IS WHAT DATA COMING FROM, WHAT REQUIREMENTS. REQUIRES SCIENCE ANALYSIS OF A "MODEL PAYLOAD" PRIOR TO INVESTIGATION

UOC CONCEPT

- RT PROCESSING OF IMAGES NEEDS STUDY / DEMONSTRATION FOR HIGH RATE INSTRUMENTS.
  IS "RT" REALLY FEASIBLE, TO WHAT EXTEND ?
  WHAT IS TOTAL LOOP DELAY

- HARDEST REQUIREMENT COMES FROM RT, HIGH RATE INSTRUMEN. WORKING IN 'CAMPAIGN MODE'
  TYPICAL SCENARIO SHOULD BE ESTABLISHED TO FIND OUT IMPACTS

FURTHER ESA STP ACTIVITIES

WORK OUT TECHN. CONCEPTS AND DETAILS FOR THE CSTP DISCIPLINE

USER OPERATIONS CENTRE

ENABLING : - DETAILED ANALYSIS ON TECHNICAL GROUNDS

- ~~MODEL~~ BASED ON DISTRIBUTED RESPONSIBILITY / COST APPROACH. NO COMITTMENT.

- PROVIDE OPTIONS I.E. OF LOCATION OF UOC.

- CONSIDER LINKAGE TO INTERNATIONAL ENVIROMENT ENABLING JOINT SCIENCE INVESTIGATIONS

- PROVIDE OPTIONS FOR DECISION AUTHORITIES INCLUDING COSTING

FURTHER EIF

- INVESTIGATE SCHEDULE ASPECTS

- MANAGEMENT ASPECTS

- ESA INTERNAL APPROVAL REQUIRED

- OPERATIONS REQUIREMENT DATA BASE WILL BE ESTABLISHED AND CONTROLLED / UPDATED BY ESA SCIENCE DIRECTO.

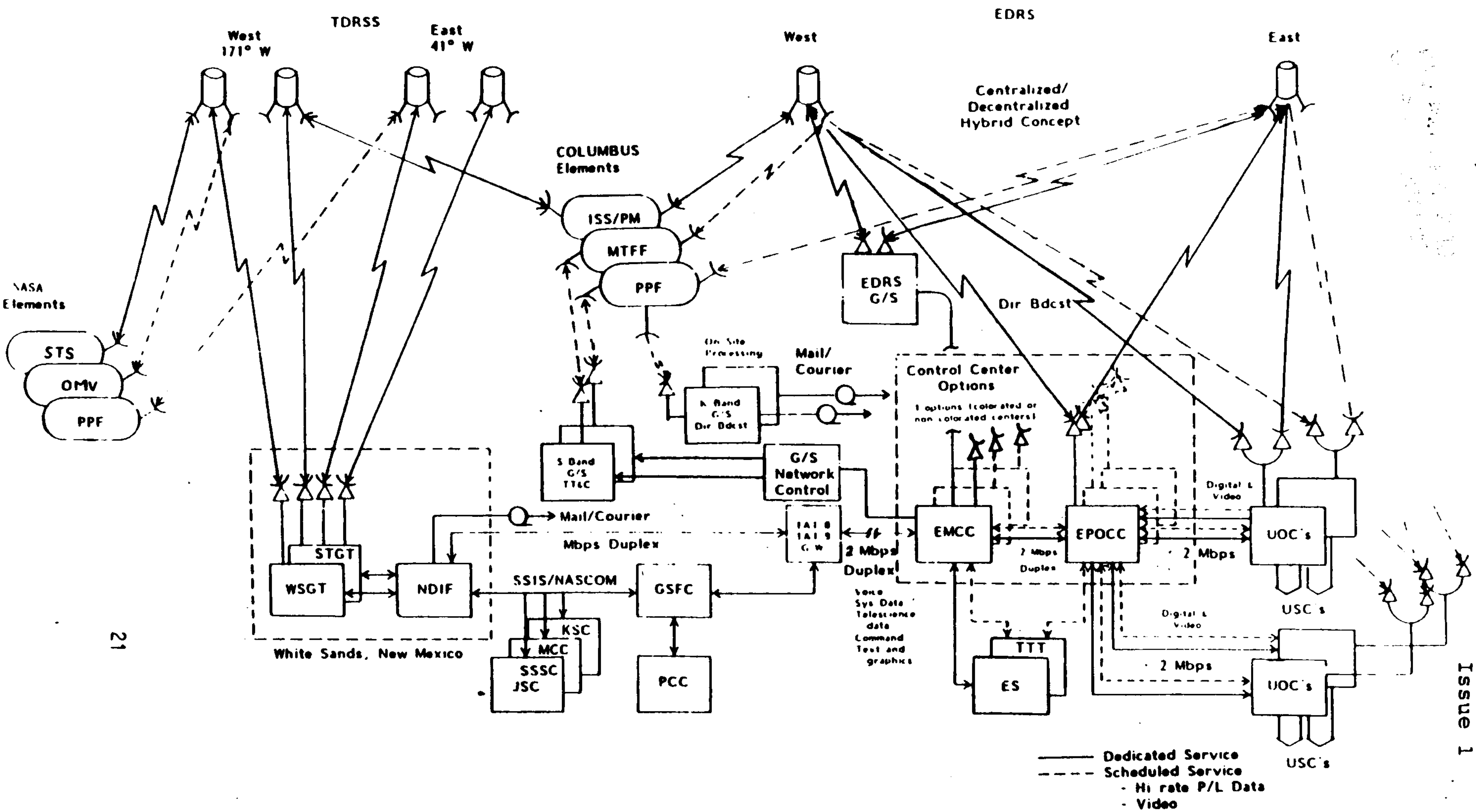
- AO ISSUES IN VIEW OF OPERATIONS. ESA / NATIONAL DISTRIBUTION OF RESPONSIBILITIES AND RESOURCES, DEFINITION.

MESSAGE :

PROGRESS ON INTERNATIONAL OPERATIONS HAS TO START.

THIS MEETING SHOULD DECIDE ON NEXT STEPS INCLUDING

- AIMS, KEY ISSUES
- DATES
- PARTICIPATION



- EDRS COMMS End-to-End Concept Diagram

FIGURE 3

AHH/10 Dec 86

APPENDIX

3.2. Agenda of the ASO Science Working Group Meeting

Mid Term Review

Advanced Solar Observatory

Wednesday, August 24, 1988
Conference Room Teledyne Brown Engineering*
Cummings Research Park
Huntsville, AL 35887

9:00 a.m.	Welcome	R. Chappel
9:10 a.m.	Introductory Remarks	S. Shawhan, D. Bohlin W. Roberts, A. Walker
9:30 a.m.	Instrument Baselines	A. Walker
9:35 a.m.	High Resolution Telescope Cluster	A. Walker
9:50 a.m.	Pinhole Occulter Facility	H. Hudson
10:05 a.m.	High Energy Facility	E. Chupp
10:20 a.m.	Low Frequency Radio Facility	D. Sime
10:25 a.m.	Discussion	
10:45 a.m.	Break	
11:00 a.m.	Study Status Report	W. Bailey
12:30 p.m.	Lunch	
1:30 p.m.	Study Status Report (continued)	W. Bailey
2:30 p.m.	Discussion of Study Status and Generation of Action Items	A. Walker
	(i) Issues Relation to Instrument Configurations Generation of Action Items for ASO SWG	A. Walker

* Teledyne Brown is located in Cummings Research Park opposite the University of Alabama, Huntsville campus

2:30 p.m. continued

	(ii)	Issues Related to Accommodation of Instrument Generation of Action Items for Teledyne Brown	W. Roberts
	(iii)	Issues Related to ASO Operations Generation of Action Items for NASA	A. Walker
3:35 p.m.	Break		
4:00 p.m.	Development of an Evolutionary Plan for ASO Instrument Development		A. Walker
	(i)	Relationship of ASO to Other NASA Missions	
	(ii)	The Impact of Non-U.S. Programs on ASO Planning	
	(iii)	Discussion of ASO Development Strategies and Priorities	
	(iv)	Development of Action Items	
5:30 p.m.	Adjourn		

APPENDIX

3.3. Proceedings of Prediction of Solar Activity and Its Effect in the Upper Atmosphere.

MINUTES OF THE APRIL 11-12, 1989 MEETING ON

PREDICTIONS OF SOLAR ACTIVITY AND

RESPONSE OF THE TERRESTRIAL ATMOSPHERE

Boulder, Colorado
April 11-12, 1989

Prepared by:

Department of Mechanical Engineering
and Center for Space Plasma and Aeronomic Research
The University of Alabama in Huntsville

This work is supported by a NASA/MSFC Grant NAG8-682.

MINUTES OF APRIL 11-12, 1989 MEETING ON PREDICTIONS OF SOLAR ACTIVITY AND RESPONSE OF THE TERRESTRIAL ATMOSPHERE

REPORT OF THE WORKING GROUP

AGENDA AND ATTENDEES

MAILING LIST

* SUMMARY OF DISCUSSIONS ON THE MAGNITUDE OF SOLAR CYCLE 22

* SUMMARY OF DISCUSSIONS ON THE PHASE OF CYCLE 22

* SUMMARY OF DISCUSSIONS ON THE SHAPE OF CYCLE 22

* VIEWGRAPHS AND OTHER MATERIAL FROM PRESENTATIONS

*These summaries are bulky and therefore not included in this final report. However, they are available upon request.

REPORT OF THE WORKING GROUP ON PREDICTION OF SOLAR ACTIVITY AND THE ATMOSPHERIC RESPONSE

Results of the April 11-12, 1989 meeting of the Working Group

BACKGROUND

1. The current solar cycle (Cycle 22) may fall outside the range of previous experience. Throughout most of its early rise phase Cycle 22 has had sunspot numbers which were higher than those in previously observed cycles.

2. The solar activity cycle is very irregular (e.g. Figure 1) and the historical data base is limited. Hence, the statistical data for making predictions is poor.

3. At the present time a physical model for the solar cycle suitable for predictive purposes does not exist. Hence, predictions of solar activity are based on numerology, not physics.

4. Measurements of the correct solar parameters (e.g. solar EUV flux) are not being made. It is necessary to use proxy data (e.g. 10.7 cm radio flux) to infer the radiative energy input which heats the upper terrestrial atmosphere.

5. The atmospheric models are marginally acceptable for drag calculations and yield densities accurate to ±15% for a known solar input. For high levels of solar activity (levels comparable to those in Cycle 19) it is necessary to extrapolate the non-linear parameters in the models beyond the range of the data base used to derive these models.

RECOMMENDATIONS

1. Solar 10.7 cm Flux: The consensus position of the Working Group is that Cycle 22 appears to correspond to Cycle 19 (see Figure 2), the largest solar cycle in the past 150 years. We note that there is evidence for larger cycles in the past.

The consensus best estimate for the magnitude of the smoothed (13 month smoothing) 10.7 cm flux at solar maximum is 235. The range of possible values at maximum is estimated to be 205 to 290.

We estimate that maximum will occur in late 1989 to early 1990, with the consensus position being a maximum in February 1990 plus or minus two months.

For the shape of the cycle we suggest using Cycles 19 and 21. These are two of the three full cycles for which 10.7 cm measurements are available. (Measurements of the 10.7 cm flux started in 1947.)

Curves giving the above estimates are presented in Figure 3 (final version in preparation).

2. Geomagnetic Data: The Working Group suggests that the method used by MSFC for estimating the behavior of the geomagnetic index used in their atmospheric model provides a reasonable approach to the problem.

3. LDEF: The Working Group agrees that the approach being used by the LDEF project for estimating the solar 10.7 cm flux is reasonable for calculations of atmospheric drag. This method makes use of estimates of the future monthly 10.7 cm flux. For three months into the future, estimates of the monthly 10.7 cm flux from the NOAA Space Environment Laboratory are used. For subsequent months the 90% upper prediction limit for the 13 month smoothed 10.7 cm flux calculated by the NOAA/SEL are used. This procedure is updated each month. This is a reasonable approach to a difficult prediction problem. The monthly 10.7 cm flux is more highly variable than the smoothed flux.

4. The Working Group commends the MSFC for their efforts in calculating drag and the reboost altitudes for the Hubble Space Telescope. The approach utilized for using basic solar and geophysical data and solar predictions is sound. The work emphasizes the importance of both geomagnetic and solar radiative heating of the thermosphere. MSFC Option c (natural data base with distribution about the prediction, see Figure 4) falls close to the consensus estimate of the Working Group (for the Cycle 19 shape).

5. The Working Group recommends updating these recommendations for solar activity prior to the September 1989 Flight Operations Readiness Review. We recommend that a representative of the Working Group attend this review.

6. The present (April 1989) estimate for solar activity implies that there may be times when the density at the altitude of the Hubble Space Telescope may exceed the 5×10^{-12} density criteria for reboost. We recommend that the HST Project should estimate the frequency and magnitude of such density enhancements, and evaluate their impact on HST operations.

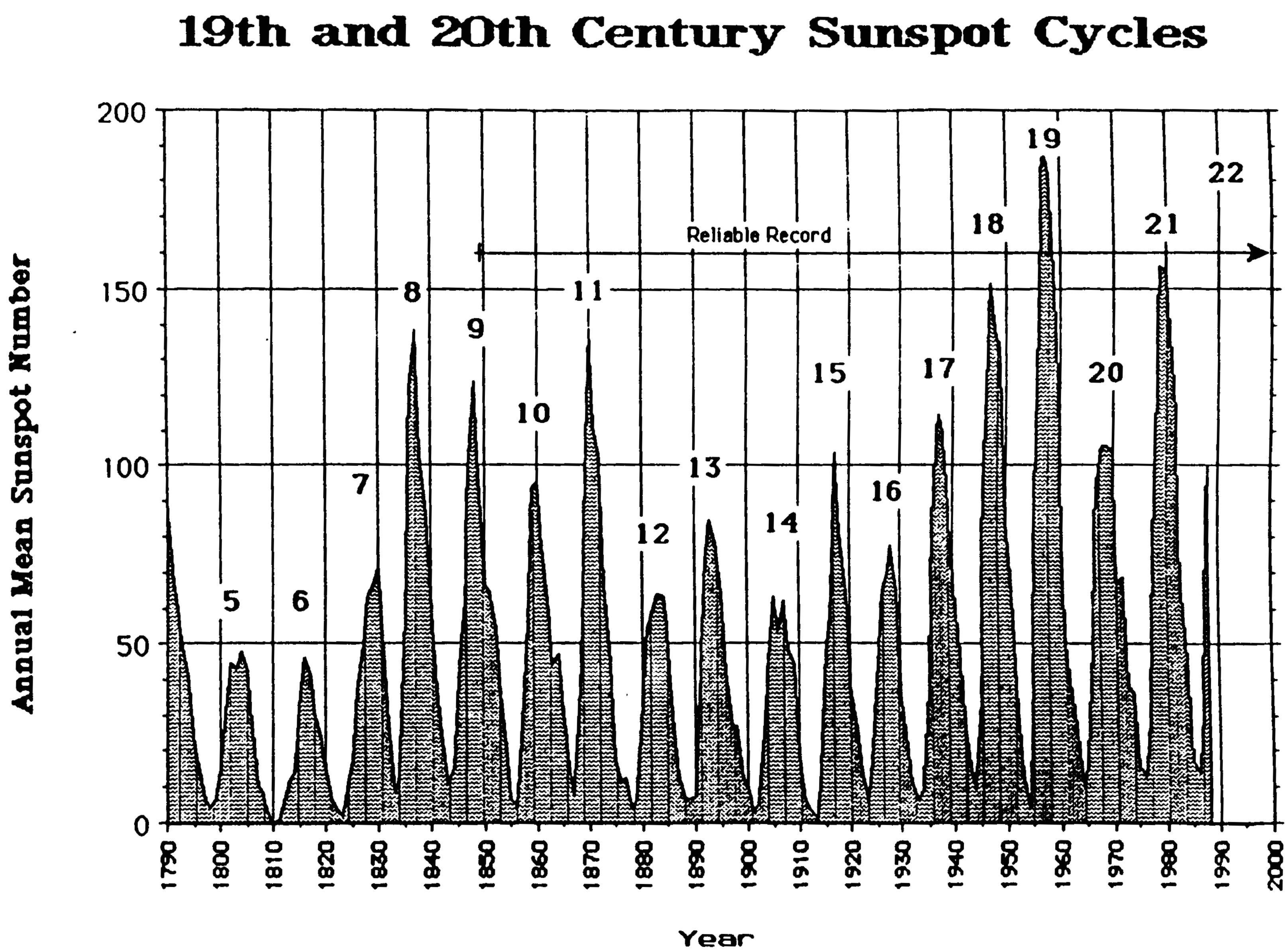
7. To avoid problems for future space operations (e.g. those in Cycles 22 and 23), more effort should be devoted to:

- Monitoring the solar EUV flux
- Measuring concurrently atmospheric parameters
- Developing improved atmospheric models
- Improving techniques for predicting solar cycles
- Developing physical models for the solar cycle
- Making long-term synoptic measurements of relevant solar parameters from the ground and space (e.g. magnetic fields; chromospheric indices; He I λ10830 observations; EUV flux; photospheric, chromospheric and coronal images).
- Continuing operations of SME to the end of its useful lifetime (e.g. it has provided measurements of the EUV hydrogen Lyman alpha line throughout the decline of Cycle 21 into the rise of Cycle 22). It is important to extend these measurements as far into Cycle 22 as is possible.

8. Cycle 23: The sun may be experiencing a period of high activity (four out of the last five cycles are among the largest on record). If so, Cycle 23 could also be a large cycle. The possibility of high levels of solar activity near the end of the century should be factored into plans for operating spacecraft such as the Great Observatories and Space Station.

9. HST Orbit: New calculations should be made to assess the effect of the proposed estimates for solar activity on the altitude and the reboost criteria for HST. Some results of the existing calculations are shown in Figures 5-8.

[Note: The quantity sigma in Figures 4-8 is used to mean two different things. The sigma in Figure 4 and in the top line of the legends in Figures 5-8 refers to how high the solar activity is, for example, a level two sigma above the predicted value (solar activity given by upper dashed curve in Figure 4c) or a level two sigma above the mean of all solar cycles (solar activity given by upper dashed curve in Figure 4b). The other sigma in the legends (plus two sigma density) of Figures 5-8 refers to the way short-term solar and geomagnetic variations are treated in the MSFC computer code for calculating the altitude for reboost of HST. The dashed curves in Figures 5-8 indicate the altitude where the density at the daily maximum in the terrestrial atmosphere is expected to equal or exceed the 5×10^{-12} criterion 2.2% of the time due to short-term solar-geomagnetic variations.]

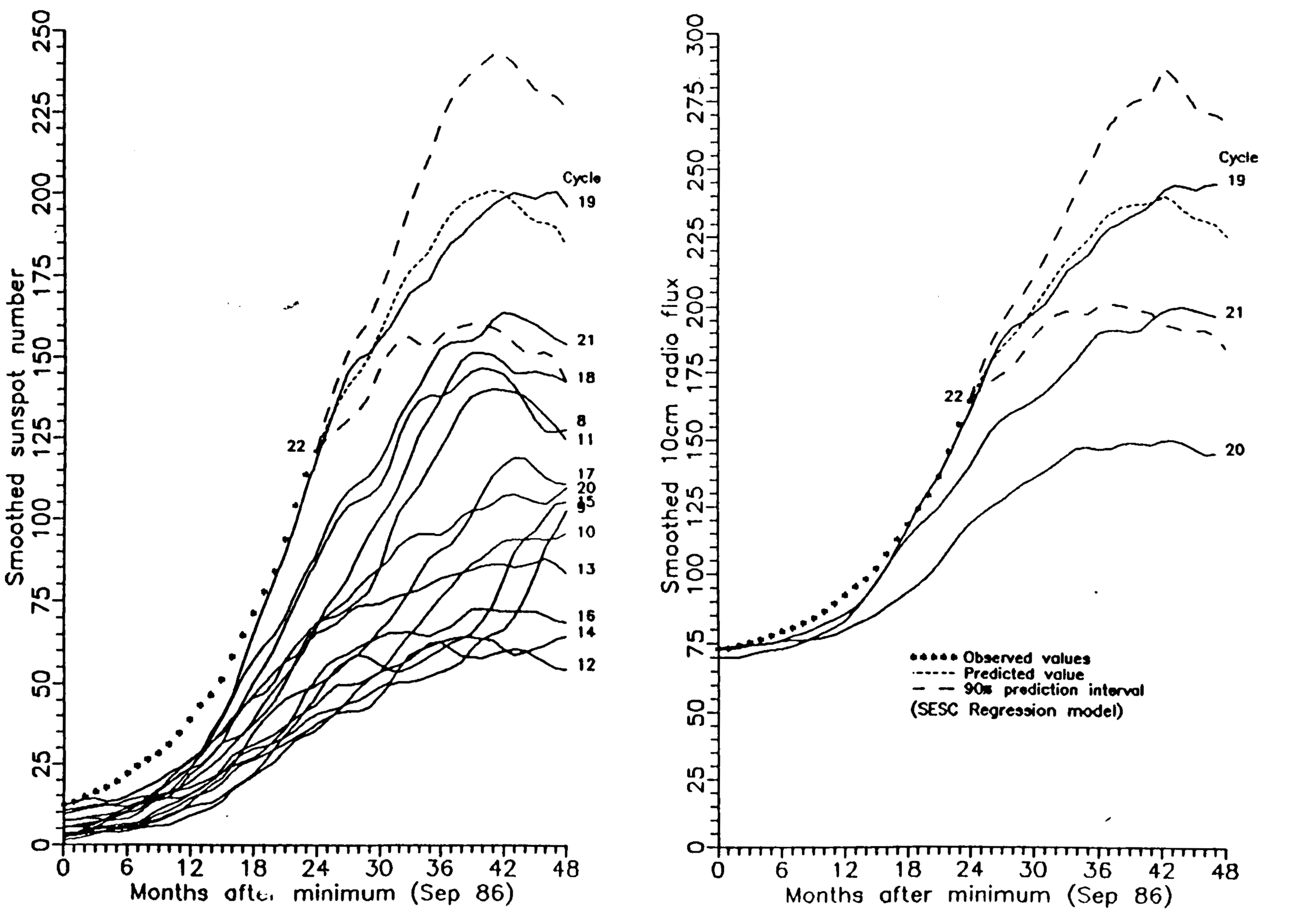


19th and 20th Century Sunspot Cycles
Annual Mean Sunspot Number
0
50
100
150
200
Year
1790
1800
1810
1820
1830
1840
1850
1860
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
Reliable Record
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

Figure 1

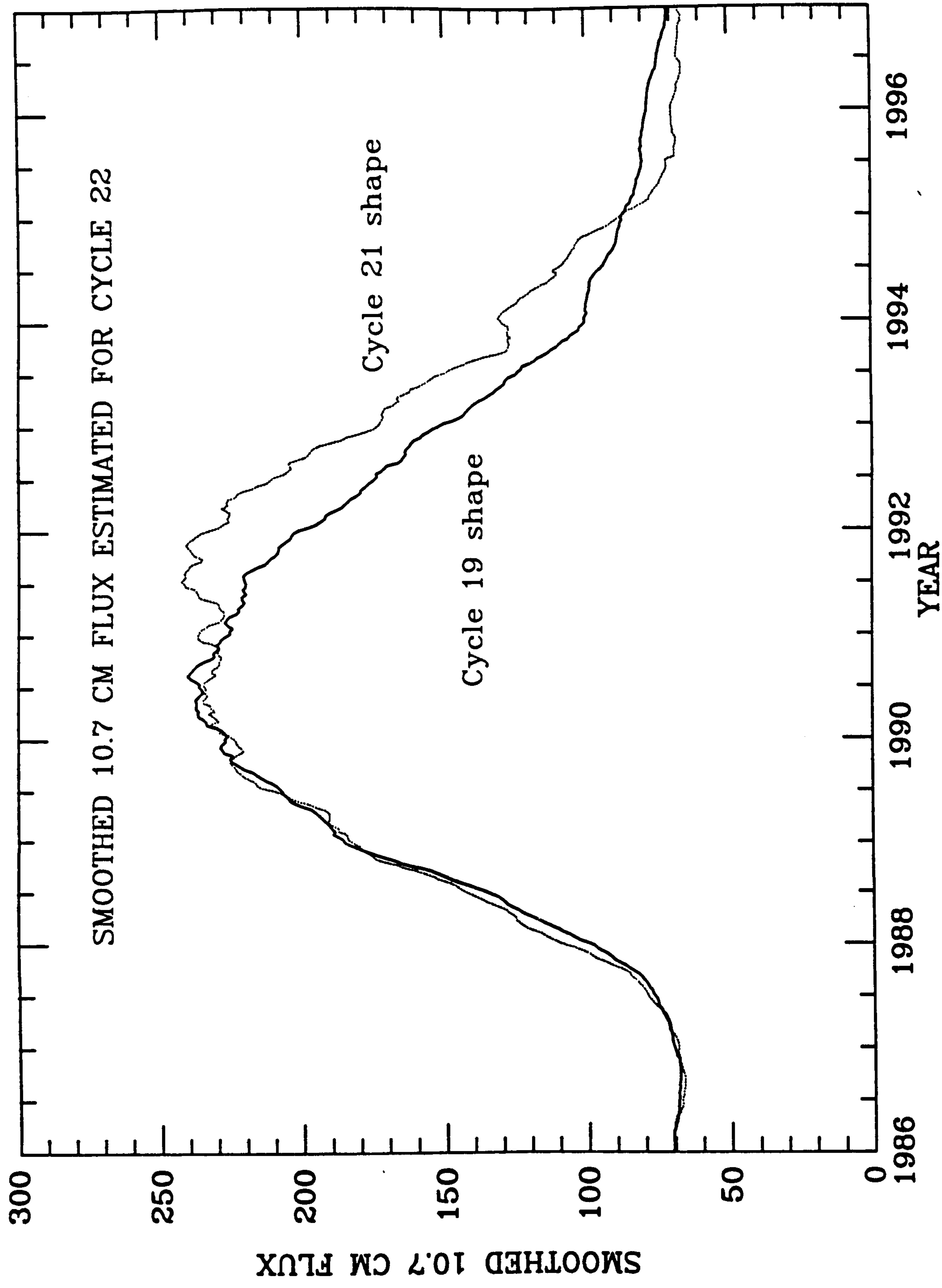
Figure 2

RISE OF SOLAR CYCLE 22 COMPARED TO PREVIOUS CYCLES



NOAA Space Environment Laboratory, 03 Apr 1989

Figure 3


SMOOTHED 10.7 CM FLUX ESTIMATED FOR CYCLE 22
Cycle 21 shape
Cycle 19 shape
SMOOTHED 10.7 CM FLUX
YEAR
0
50
100
150
200
250
300
1986
1988
1990
1992
1994
1996

Figure

MAR'89 PRED SA WITH DIFFERENT DATA BASES & DIST

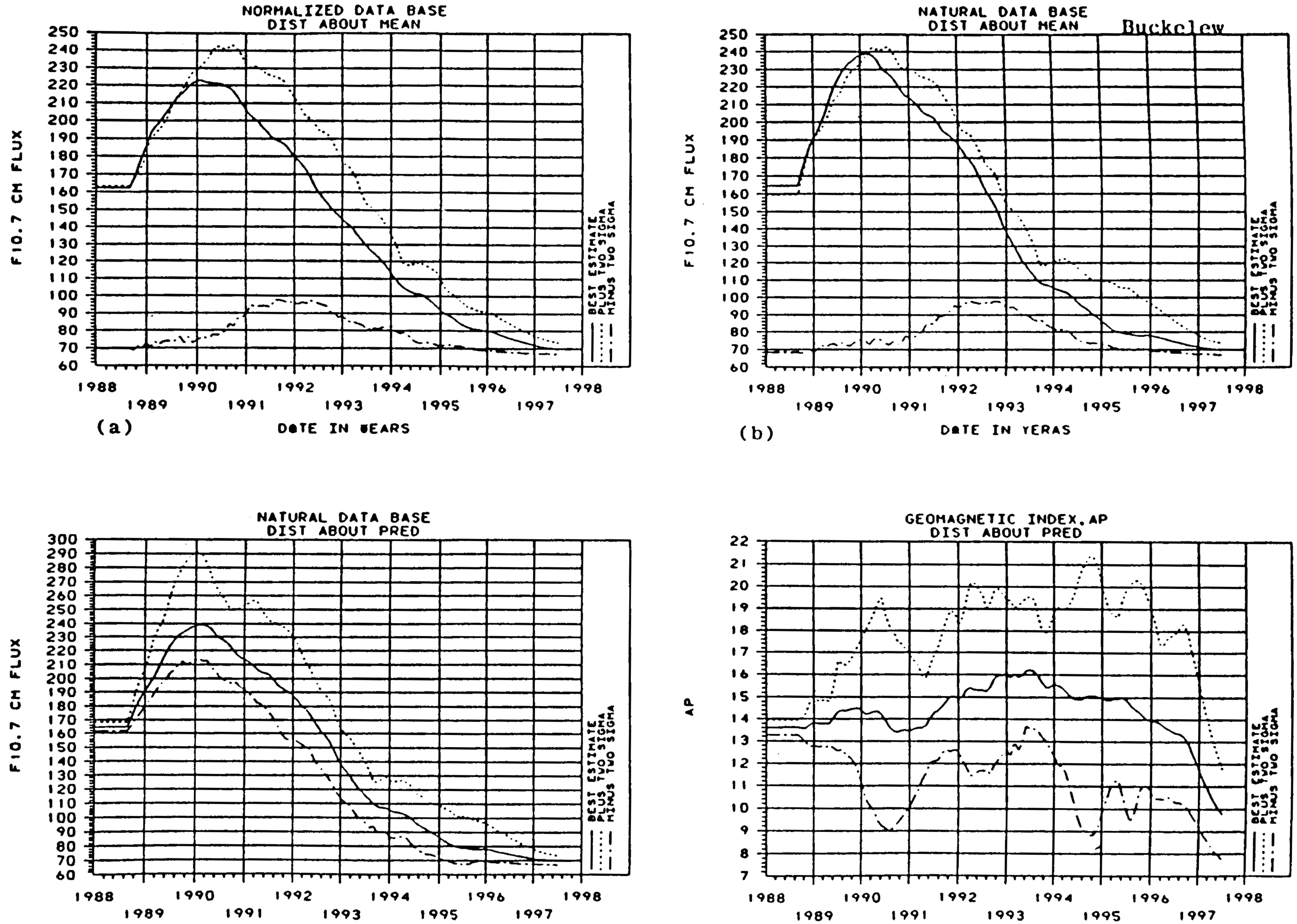


CHART 1

MAR'90 PRED SA NATURAL DB & DIST ABOUT MEAN (1b)

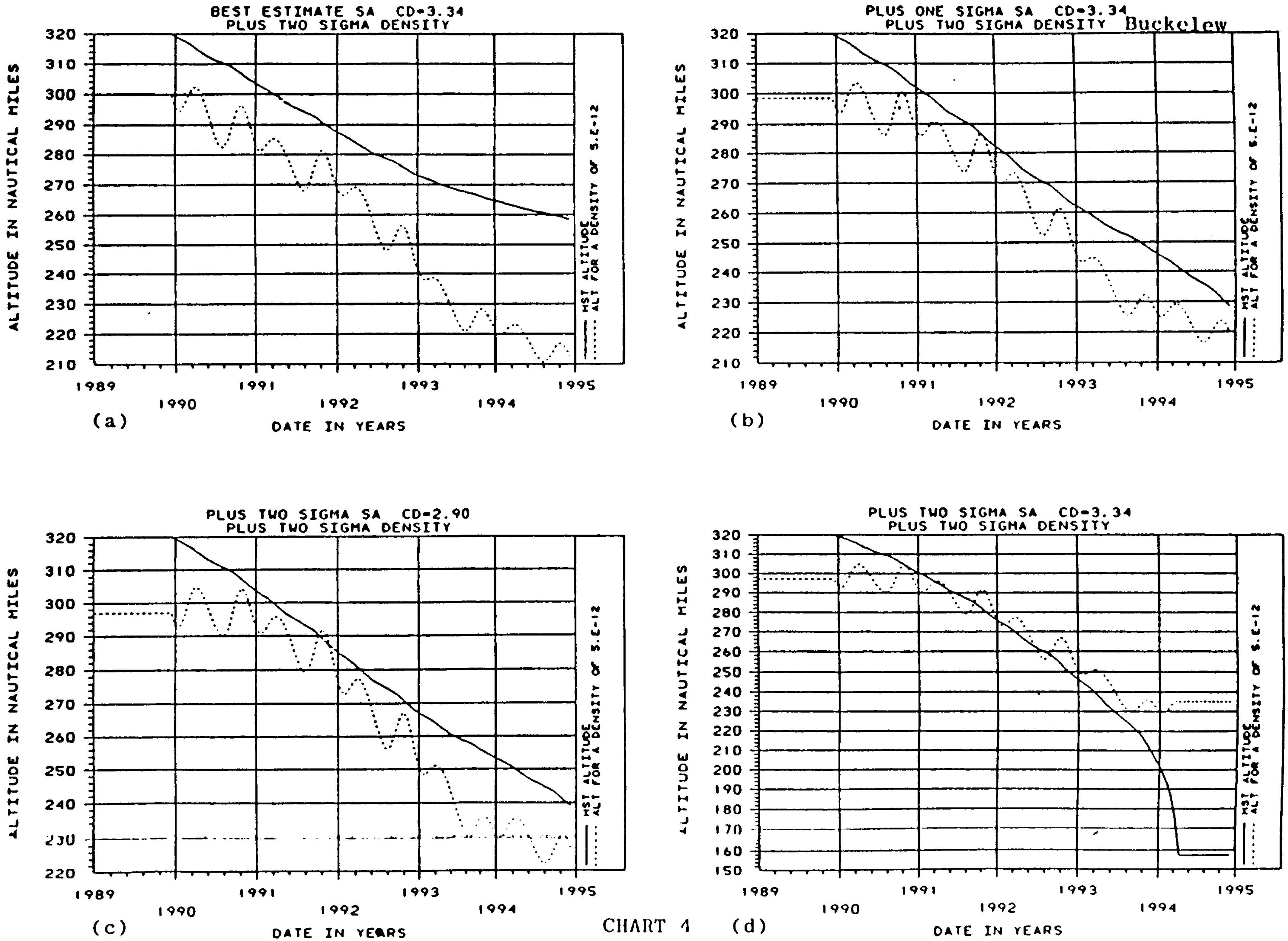


CHART 4

Figure 5

Figure 6

MAR'89 PRED SA NATURAL DB & DIST ABOUT MEAN(1b)

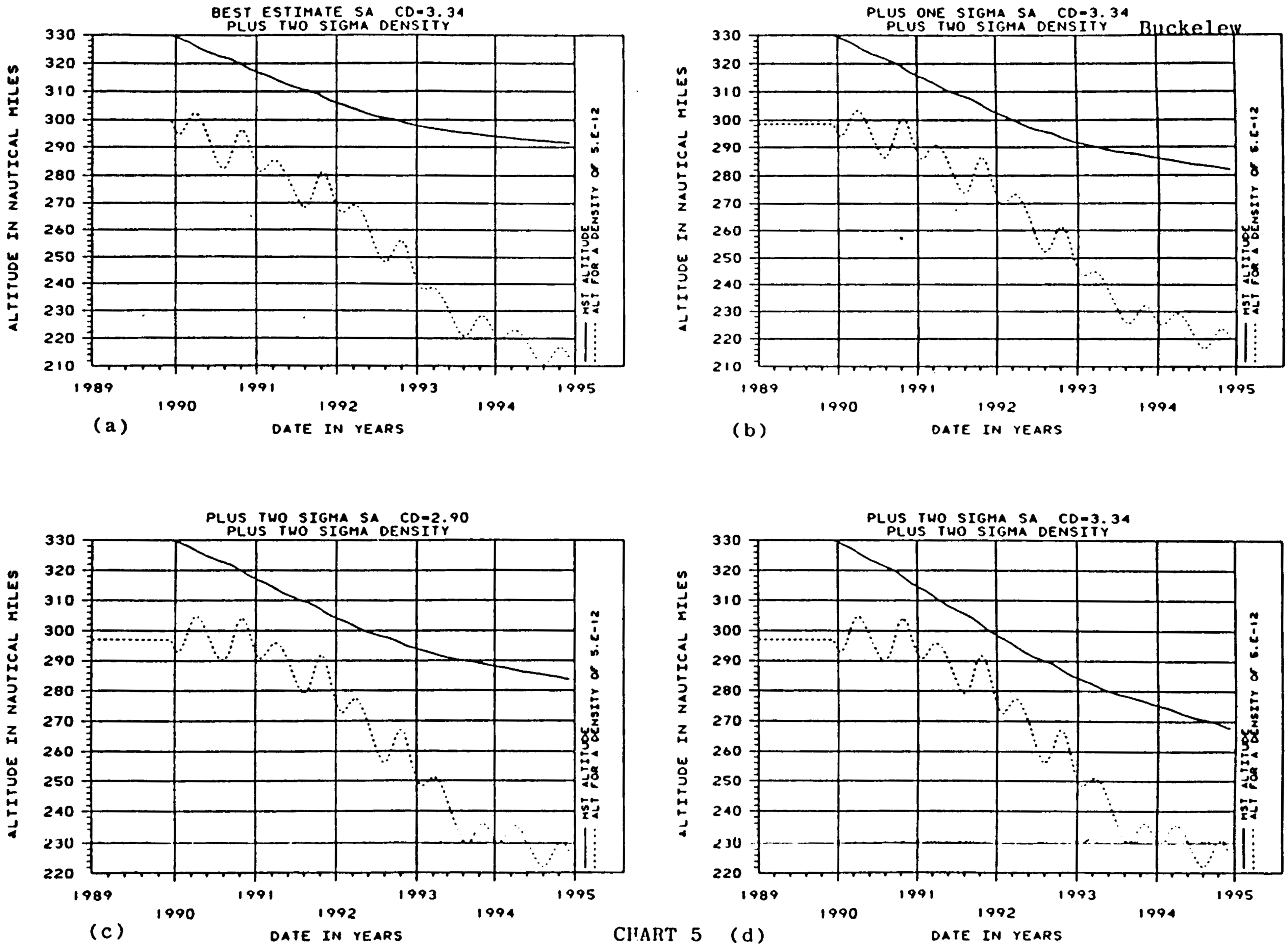


CHART 5

MAR'89 PRED SA NATURAL DB & DIST ABOUT PRED (1c)

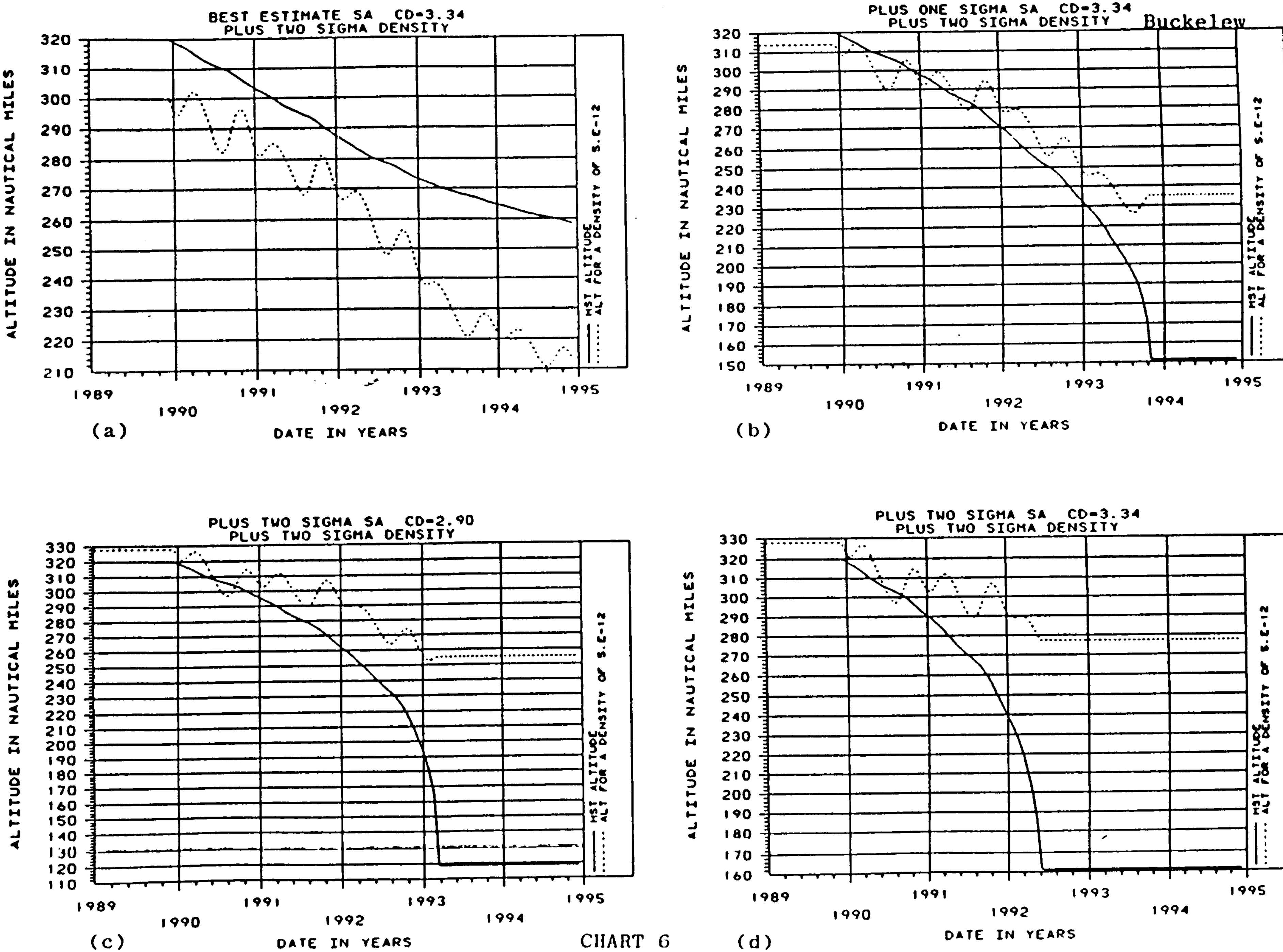


CHART 6

Figure 7

MAR'89 PRED SA NATURAL DB & DIST ABOUT PRED(1σ)

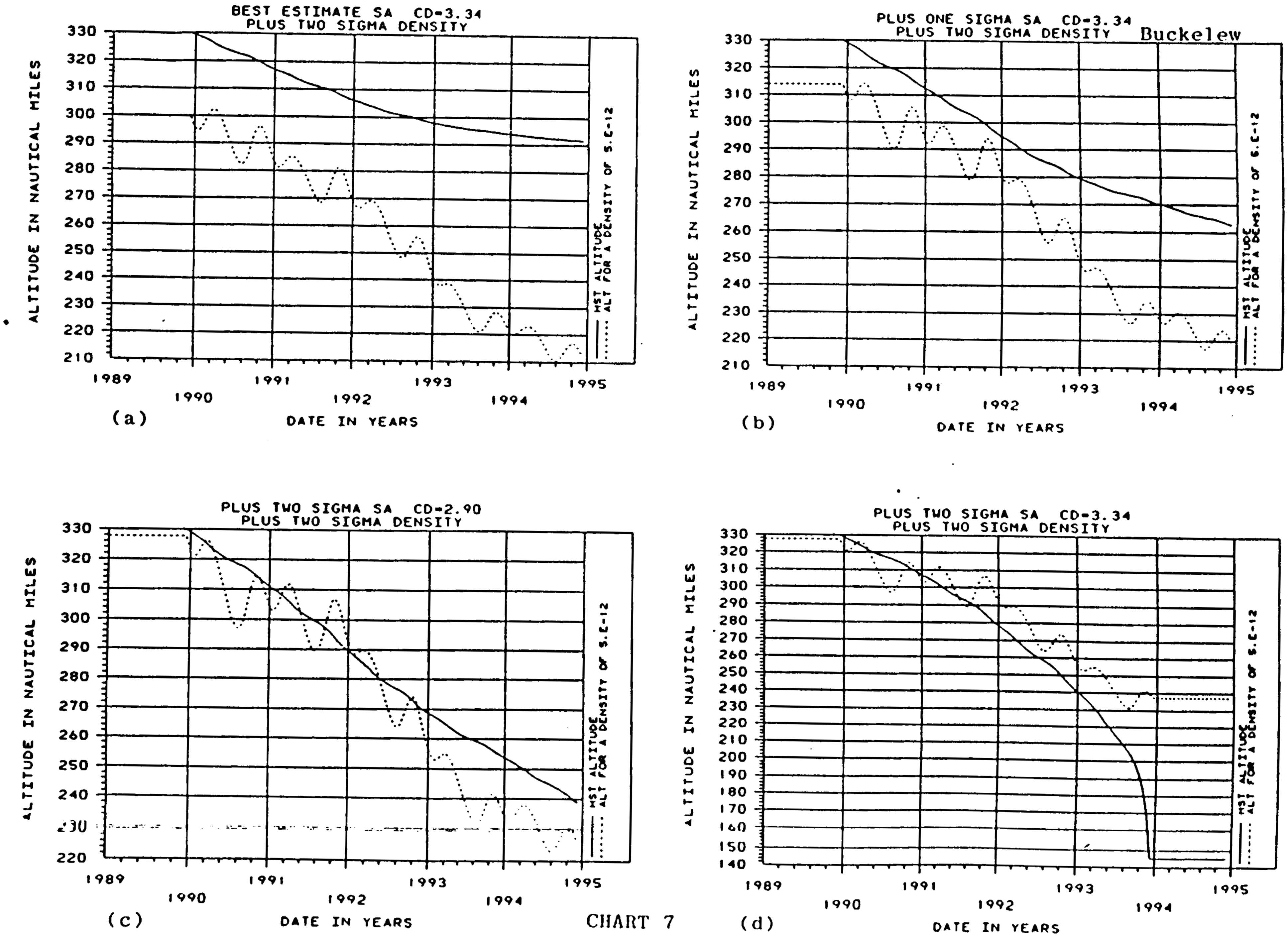


CHART 7

Figure 8

Agenda for April Meeting on Prediction of Solar Activity and the Response of the Terrestrial Atmosphere

Location: Room 1105, U. S. Department of Commerce, NOAA, Environmental Research Laboratory, 325 Broadway, Boulder, CO 80303

Tuesday April 11 1989

0830 Overview (Chappell/Withbroe)
0900 Update on Progress of Solar Cycle 22 (Hirman)
0930 10.7 cm Solar Flux Climatology (Joselyn/Brown)
0945 Use of a Box-Jenkins method to make 3-month 10.7 cm Solar Flux Predictions (Brown)
1010 Coffee Break
1025 New Indicators of Solar Cycle Characteristics and the Future Course of Cycle 22 (McIntosh)
1100 Variance and Reliability of 10-cm Flux Predictions around Solar Maximum (Heckman)
1120 Reliability of the McNish-Lincoln Method for Predicting Time and Intensity of Solar Maximum (Hildner/Greer)
1140 Looking Ahead: What Do We Do After Maximum (Heckman)
1150 Model for predicting behavior of Cycle 22 (Currie)

1240 Lunch (Tours of SEL's Forecast Center)

1345 Expectations based on historical and precursor data (Wilson)
1450 Behavior of solar indices, UV, EUV (White, Donnelly)
1520 Coffee Break
1540 Helium 10830 and magnetic observations (Harvey)
1600 Coronal Observations of Cycle 22 (Neidig/Altrock)
1610 Expectations for Cycle 22 (Smith)
1640 Calculations of atmospheric drag for HST (Buckelew)
1710 Calculations of atmospheric drag for HST (Tobiska)
1730 Adjourn for dinner

Wednesday 12 April 1989

0830 Effects of short term fluctuations (solar, geomagnetic) on atmosphere and on satellite drag/pointing (O'Dell, Buckelew, Withbroe, Hedin)
1015 Coffee Break
1030 Calculations of atmospheric drag for LDEF (Kinard)
1050 Discussion of solar activity predictions for LDEF

1100 General discussion (best estimate for amplitude, shape, phase of Cycle 22, and uncertainties in these estimates; development of consensus and recommendations; form and content of report to NASA)

1200 Lunch

1300 Continued discussion on recommendations, report to NASA
1500 Break
1515 Continued discussion
1600 Adjourn meeting

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