STORMS

A MISSION PROPOSAL TO STUDY THE STORMY WEATHER IN THE INNER MAGNETOSPHERE

Lecture at the Summer School Alpbach 2002
Space Weather: Physics, Impacts and Predictions

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Outline

- Introduction
- The scientific case for STORMS
- Setting up the team and writing the proposal
- The Assessment Study
- Presentations at UNESCO HQ in Paris
- What next ?
- Discussion

Note: This is an example of a mission proposal to study the SCIENCE of space weather, it is not a plan for an OPERATIVE space weather satellite !

ESA Call for Mission Proposals for Two Flexi-Missions (F2 and F3)

- issued 1st October, 1999
- two missions
  - launches possible 2007 – 2009
  - maximum of 176 M€ each (1999 conditions)
- proposal schedule

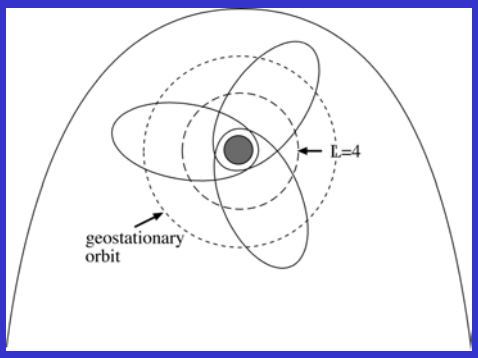
– Letters of Intent	22 October, 1999
– Mission Proposals	31 January, 2000
– Assessment phase (3 – 4 mission)	March–May, 2000
– Selection	September, 2000

How the idea of proposing STORMS was born

- Where we should have spacecraft after Cluster ?
  - successful space weather activities need understanding of the entire chain from the Sun to the surface of the Earth
  - the inner equatorial magnetosphere has remained the least studied domain in this chain (with the exception of the geostationary orbit)

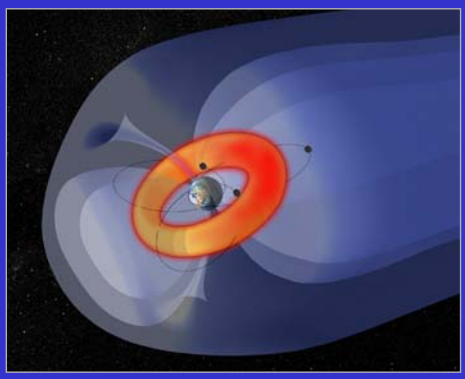
F2/F3 would give ESA and Europe excellent changes of gaining leadership in this critical part of the SCIENCE of space weather

This was the basic idea



as I thought it first

and how an artist drew it later



Writing the Letter of Intent

- e-mail letter to G. Haerendel, 6 Oct
  - presenting the idea of 3 S/C mission
    - baseline following the German Equator-S
    - elliptical orbits
      - 2 < L < 8–9
      - lines of apsides about 120 deg from each other
- first draft of LoI, 15 Oct
- proposal team ready by 17 Oct
  - H. Koskinen (FIN), M. Candidi (I), M. Grande (UK), G. Haerendel (D), J. Lemaire (B), R. Lundin (S), H. Rème (F), K. Szegö (H)
- LoI submitted on 20 Oct

The scientific case for STORMS

- investigation of magnetospheric storms with
  - excellent spatial and temporal coverage
  - good temporal resolution
- emphasis in the inner magnetosphere
  - not well covered within the current ISTP missions
    - AMPTE/CCE (1984 – 1989)
    - CRRES (1990 – 1991)
    - Equator-S (Launch Dec. 1997, failed 1 May 1998)
- additional goals
  - plasmasphere, plasmapause, Alfvén layers, generation of FAC, thin current sheet development, etc.

Proposal writing

- 1st draft of Proposal, 17 Dec, 1999
  - one more proposer included (P. Triska, CZ)
  - difficult issues:
    - How to maintain the focus?
      - there are always so many nice things to add
    - How to do with the relationship to space weather?
      - we were dealing with the Science Programme of ESA
- Intensive work during January, 2000
- Proposal submitted to ESA on 28 Jan, 2000

The STORMS Proposal

- main science goals
  - growth and decay of the ring current and the role of ionospheric oxygen thereupon
  - relationship of different current systems on ground-based determination of storms
  - storm-substorm relationships
  - physical mechanisms for injection of particles to the radiation belts
  - forecasting of storms for space weather purposes
- three well-equipped small S/C
  - elliptical orbit from LEO to 7 – 8 R_E
  - each: 200 – 250 kg with 40 – 50 kg payload
- total budget 120 M€ (we thought!)

Contents

- Executive Summary
- Scientific Objectives
  - Background
  - The inner mangetosphere
  - Magnetic storms and the ring current
  - Radiation belts
  - Plasmasphere
  - Plasma sheet
  - Space weather
  - Relation to other ESA magnetospheric satellites
- Mission
  - Satellites
  - Orbit and satellite constellation
  - Launch requirements
  - Life-time
- Payload
  - Charged particles
  - Energetic neutral atoms (ENA)
  - DC magnetic field
  - DC electric field
  - Waves
  - Science payload vs. scientific goals
- Science Operations
- Data Handling and Archiving
- Management and Funding
  - Spacecraft management
  - Scientific management
  - Funding
  - International contributions
- Communication and Outreach

Selection to the Assessment Study

- In total 49 proposals were received
- All proposers were invited to present their cases to the working groups (SSWG, AWG, FPAG)
  - STORMS was presented to SSWG on 23 February
    - 30 min of which 20 min for me, 5 min for discussion and 5 min for a preliminary ESTEC analysis
    - mostly OK
      - our launch scenario was found to be naive
      - ESTEC price tag was much higher than ours (as expected)
- SSWG recommended STORMS as one of three solar system missions on 25 February

Missions selected to the next round

- Assessment Studies performed now:
  - EDDINGTON
    - stellar physics and planet finder explorer
  - HYPER
    - precision atom interferometry in space
  - MASTER
    - Mars and asteroid mission
  - STORMS
    - three spacecraft constellation for the study of magnetospheric storms
- two missions studied in other contexts
  - NGST
    - ESA participation in the Next Generation Space Telescope
  - SOLAR ORBITER
    - an orbiter for solar observations at very high spatial resolution

Assessment study of STORMS

- Assessment Study team
  - Science:
    - S. Barabash (S), W. Baumjohann (D), M. Candidi (I), M. Grande (UK), H. Koskinen (FIN), J. Lemaire (B), H. Rème (F)
  - ESA representatives:
    - T. Sanderson (Study Scientist, ESA/ESTEC), O. Pace (Study Manager, ESA/ESTEC), M. Coradini (ESA/HQ)
- Technical study
  - Concurrent Design Facility (CDF) of ESA D/TOS
- Three joint meetings (March, May, June)
- Study report
  - ESA-SCI(2000)7, July 2000

Presentations at UNESCO Head Quarters Paris, 12 September 2000

- REMEMBER:
  - If 6 of 49 proposals are selected, they are all very good!
    - small margins decide
    - science politics becomes important
  - you will not win by an excellent presentation only, but you will lose if you do not make a convincing case
- thus all 6 teams had invested considerable effort in their presentations
- let's see the STORMS presentation slides

Selection

- AWG
  - Next Generation Space Telescope
  - Eddington (as a ”back-up” for NGST)
- SSWG
  - Solar Orbiter
    - this was the first priority of SSWG behind which the solar and magnetospheric communities united
  - SSWG did not select a back-up
    - a highly questionable decision
    - note that afterwards Eddington has become a real mission whereas there still is no magnetospheric mission in the agenda of ESA Science Programme!

What next?

- to lose at the first attempt is not a surprise
  - Solar Orbiter, NGST, Eddington had all been proposed and studied earlier, and thus were more mature than STORMS
  - the need for better understanding of the inner magnetosphere is urgent scientifically and for improved space weather capabilities
  - co-operation in the ILWS (International Living With a Star)
- many of STORMS ideas may become realized through operative missions