NASA Heliophysics PI Masters Forum

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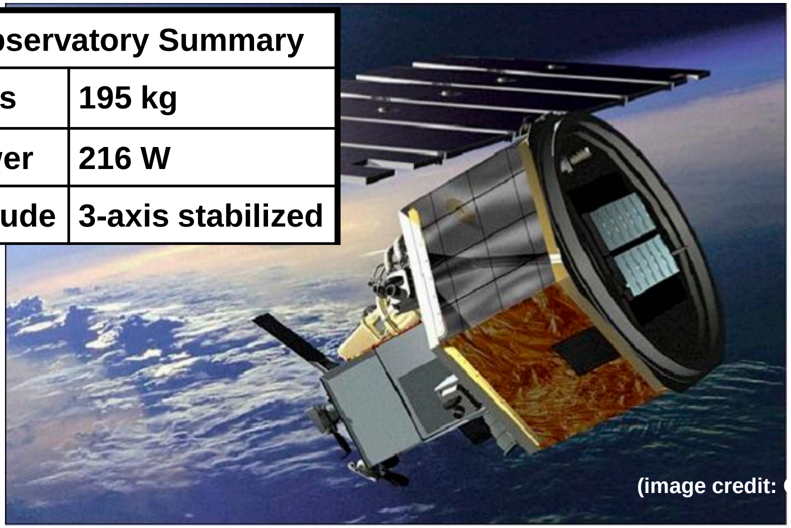
Aeronomy of Ice in the Mesosphere (AIM)

Observatory Summary	
Mass	**195 kg**
Power	**216 W**
Attitude	**3-axis stabilized**



SMall EXplorers (SMEX)

Cost: $140M including launch vehicle

- Class C

Mission: 2 year nominal, still flying

Launch: April 2007

Orbit: 600 km polar orbit

- Noon/midnight sun synchronous

Hampton University

PI: James Russell III

University of Alaska

Co-I: Scott Bailey

Laboratory for Atmospheric and Space Physics (LASP), University of Colorado

Project Manager: Michael McGrath

Science Objective:

- Quantify the connection between Polar Mesospheric Clouds (PMCs) and the meteorology of the polar mesosphere
- Study the long-term change in the mesosphere and its relationship to global change

Science Data

- 1.3 Gbits/day science

AIM Mission Concept

SMEX: PI-led free-flyer mission

- PI: James Russell III, Hampton University

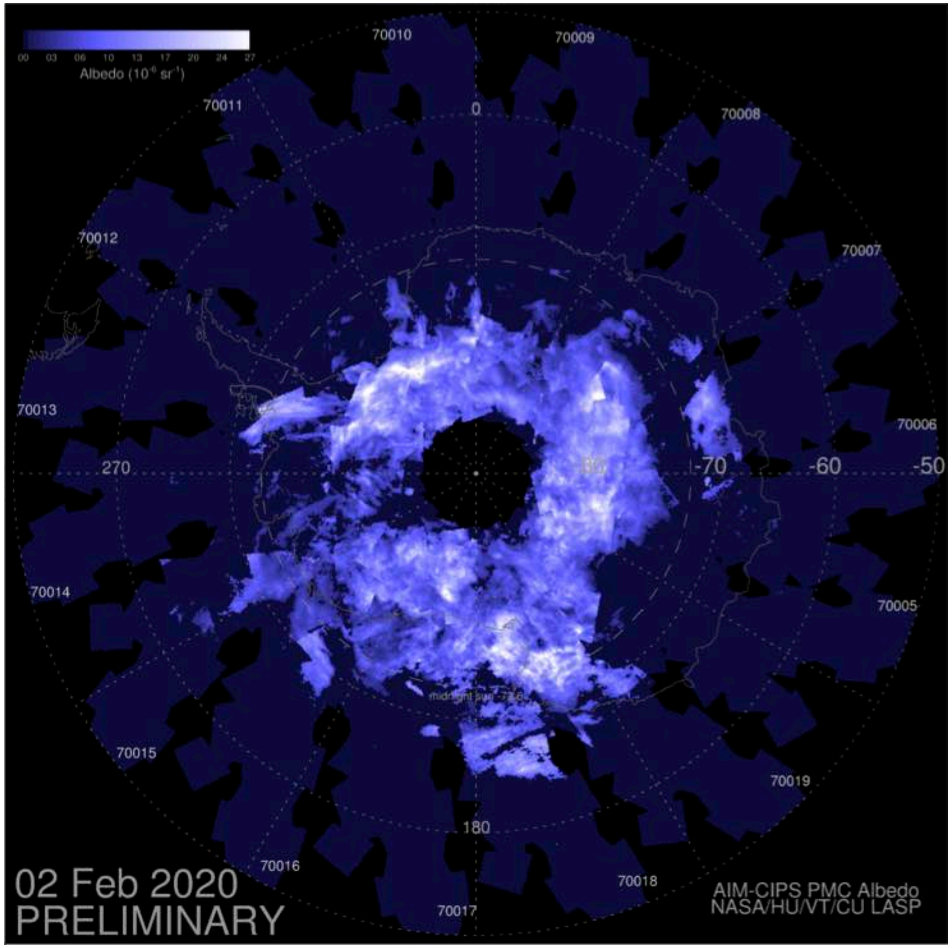
- **Project Management**: LASP, University of Colorado Boulder

Accommodation:

- Spacecraft, LEOStar-2: Orbital Sciences Corporation (now Northrup Grumman)
- Launch: Pegasus-XL

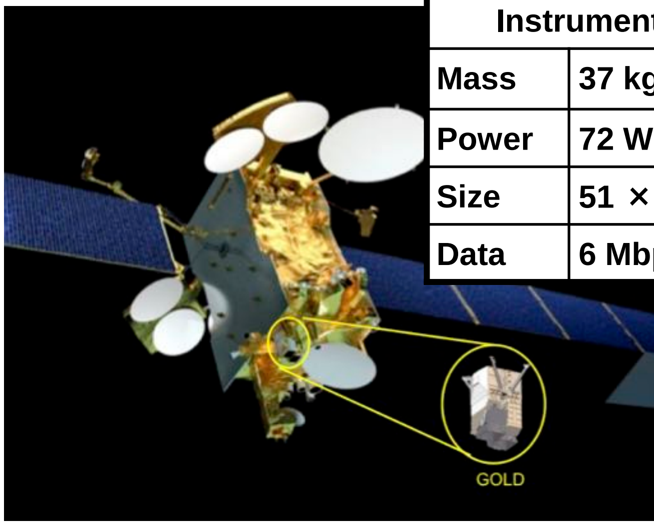
Science Payload: 3 instruments

- Solar Occultation For Ice Experiment (SOFIE): SDL, Utah State University
- Cloud Imaging and Particle Size (CIPS): LASP
- Cosmic Dust Experiment (CDE): LASP



Credit: LASP/University of Colorado

Global-scale Observations of the Limb and Disk



Instrument Summary	
Mass	37 kg
Power	72 W
Size	51 × 55 × 69 cm^3
Data	6 Mbps continuous

Explorer Mission of Opportunity (MOO)

Contract Value: $63.5M
- Class C, Category 3 per NPR 7120.5E

Mission: 2 years ongoing

Launch: January 2018
- Hosted on SES-14 GEO commercial satellite

Florida Space Institute (FSI) University of Central Florida (UCF)

PI: Richard Eastes (now at LASP)

Laboratory for Atmospheric and Space Physics (LASP)

University of Colorado Boulder

Deputy PI: William McClintock

Project Manager: Rory Barrett

Study the temperature and composition structure of the thermosphere

Observations:
- Disk maps of temperature, O/N_2 ratio
- Limb scans (for temperature)
- Disk maps of peak electron density
- Stellar occultations

UV Imaging Spectrograph:
- Two independent, identical channels with MCP, delay line anode

GOLD Mission Concept

Mission of Opportunity: PI-led mission, collaborating with SES to accommodate an instrument in Geostationary orbit on a commercial communications satellite

- Owner - Operator: SES (Luxembourg)
- Spacecraft: Airbus DS (France)
- GOLD Data Handling: SES-GS (USA)
- Instrument: LASP (USA)
- Science Operations Center: LASP (USA)
- Science Data Center: UCF (USA)
- Launch: Ariane-5 (ESA, French Guiana)

Accommodation: SES included GOLD on RFP for SES-14 mission

- SES saw this as a good mission to accommodate GOLD

Science Payload: Single instrument

- Single package for easy accommodation
- Two identical imaging spectrograph channels
    - Operate independently
- Electronics sandwiched between channels

LESSONS LEARNED

Operations Personnel Timing

Lesson: Operations personnel are valuable contributors in development and test

- AIM: Future instrument operators were actively involved by CPT-design stage (prior to PER), participated in I&T
  - Model repeated on GOLD, working even earlier, with SES for planning
- Why it worked
  - Engineers learned from operators how to design with operations in mind
  - Operators were be better prepared when given opportunity to work side-by-side with design engineers

Engineering Model Value

Lesson: An engineering model can make for for a smoother flight build and help identify problems ahead of environmental test

- GOLD built a single optical channel, simple structurally but with optical layout
- EM electronics also built
- Why it worked
  - Used it to dry run alignment and calibration processes
  - Validated science measurement performance early
  - Tested flight boards with EM boards to even out schedule mismatches
  - Flight software was developed on real hardware
  - Operations tested procedures on EM electronics prior to flight model
- What could have been improved
  - Two-channel would have been nice for electronics testing

Early Science Requirements Freeze

Lesson: Concentrating efforts early to freeze science requirements prevents scope creep

- GOLD measurement requirements were set early and remained steady
  - PI & Deputy PI led the effort to gain consensus with science team on what the science *requirements* were
  - Traced science to instrument requirements
  - Much of this effort took place during the Concept Study
- Why it worked
  - Instrument design concept did not change from proposal
  - Allowed engineers to move forward with correct design from start of project
  - PI continued effort to maintain consensus on science requirements

Managing MOO Workload

Lesson: Single-instrument Mission of Opportunity significantly more effort than a single instrument on a SC

- MOO and Host Mission needs both need to be satisfied
  - Receives more scrutiny
    - From NASA management & Host management
  - Increased documentation required
    - NASA & Host required documentation not complete overlap
    - Tailored ERD to work with both NASA and commercial expectations
  - Increased reporting
- Required more systems engineering effort than a single instrument
  - ICD development from the ground up
  - More negotiations with SC
- Why it worked
  - All parties wanted to make the hosted payload model work
  - SES, Airbus were interested in GOLD science

Processor Development Board

Lesson: Development boards provide a boost for FPGA and FSW early development

- Prior to an engineering model GOLD built 2 development boards: reprogrammable FPGA with embedded processor
  - Allowed early and continuous incremental development and test for both FPGA and FSW
- Why it worked
  - The hardware is inexpensive
  - FSW always had access to a board so the FSW design was up and running quickly
  - Scheduled releases were aligned with arrival of EM & FM hardware for both FPGA and FSW
- Word of caution
  - Simultaneous development needs to be managed carefully so changes in FSW or FPGA does not required changes in the other

Observatory I&T Representation

Lesson: Having an on-site project and/or instrument(s) representative(s) streamlines process

- LASP Mission SEs were on-site at Orbital during AIM I&T
  - Instrument engineers and SEs joined MSE team following delivery
- GOLD Mission SE was on-site at Airbus during SES-14 I&T
- Why it worked
  - Face-to-face interaction invaluable
  - Management and instrument teams remained more informed of plans and potential issues
  - Decisions could be made more quickly
    - Not all questions were answerable or decisions able to be made by representative, but they could provide some guidance
  - Small activities can be fit in when opportunities arise if the task matches the representative's skill set