ISS | Space Exploration

Cloud-Aerosol Transport System (CATS) for ISS

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An Unprecedented Opportunity

The Japanese Experiment Module – Exposed Facility (JEM-EF) on the International Space Station (ISS). Payloads are robotically attached to the JEM-EF.

- CATS is a lidar remote sensing instrument designed to provide profile measurements of aerosol and clouds.
- CATS is a directed opportunity from the ISS National Laboratory to improve science utilization of the ISS.
- CATS is an attached payload for the JEM-EF – the first such payload developed by NASA.
- CATS is not a "business as usual" project – it is specifically intended to demonstrate a low-cost, streamlined approach to developing ISS payloads, akin to the Shuttle Hitchhiker payloads.
- CATS is one of the first ISS payloads dedicated to Earth Science.

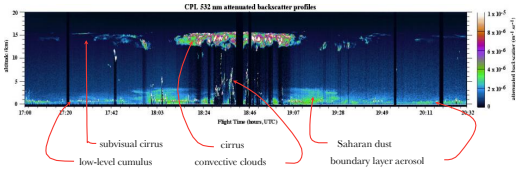
The CATS project has three simultaneous goals:

1. **Provide long-term (6 months to 3 years) operational science from ISS**
   - **airborne instrument heritage ensures success**
   - **provide data continuity beyond CALIPSO**
2. **Provide tech demo on-orbit**
   - **high rep-rate laser**
   - **photon-counting detection**
   - **UV (355 nm) laser operation in space**
3. **Provide risk reduction for future Earth Science missions**
   - **UV (355 nm) laser operation in space**
   - **HSRL receiver concept**

CATS is strongly based on heritage from the ER-2 Cloud Physics Lidar (CPL) and the airborne CATS instruments.

Science Capabilities

The goal of the CATS lidar is to provide near-real-time measurements of clouds and aerosol that can be assimilated into aerosol transport models.



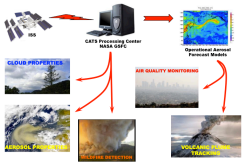
Lidar profiling generates a time-height cross-section of the atmosphere, revealing cloud and aerosol structure. From this data information on layer boundaries, optical depth, extinction, depolarization, and at least a coarse discrimination of aerosol type (e.g., smoke, dust pollution) can be derived.

Data Products

CATS has multiple operational modes, but primary attributes include:

- **A 532 nm HSRL channel to provide aerosol backscatter profile**
  - **extinction profile**
  - **optical depth**
- **355, 532, and 1064 nm backscatter channels, all with polarization sensing capability**
  - **corrected backscatter ratio**
    - **extinction profile (assuming S-ratio)**
  - **color ratio for aid in aerosol typing**
  - **depolarization ratio for phase and aerosol typing**

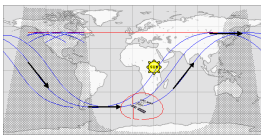
Measurement resolution can be traded for measurement accuracy, but the baseline resolution is 30 m vertical by 1/20 second (~350 m) horizontal.



While data from CATS will be processed to generate standard science data products, an important aspect of the mission is to provide near-real-time input to operational aerosol transport models.

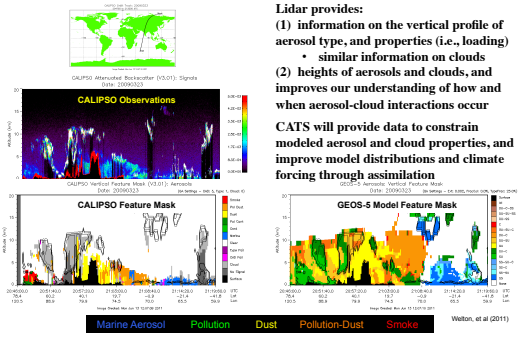
The ability to provide inputs to operational models can impact aerosol plume tracking and air quality forecasts.

Data Applications



The ISS orbit (51-degree inclination) permits extensive measurements over primary aerosol source and aerosol transport regions. The orbit also allows for study of diurnal effects.

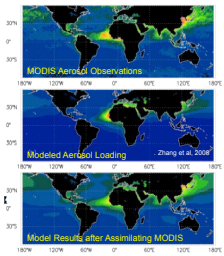
Lidar measurements that can simultaneously identify aerosols, provide vertical context, and monitor the transport of aerosols will make important contributions to NASA science goals.



Lidar provides:
(1) information on the vertical profile of aerosol type, and properties (i.e., loading)
- **similar information on clouds**

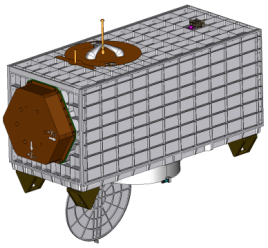
(2) heights of aerosols and clouds, and improves our understanding of how and when aerosol-cloud interactions occur

CATS will provide data to constrain modeled aerosol and cloud properties, and improve model distributions and climate forcing through assimilation

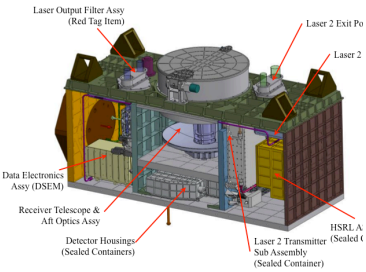


Models are used to determine climate forcing and predict future climate change. Observations provide constraints needed to model aerosol properties and behavior. CATS can help improve the vertical distribution of aerosol and aerosol type.

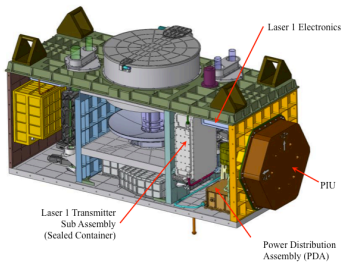
CATS Payload



The CATS payload is a standard JEM-EF volume (approximately 1.5 m x 1 m x 0.8 m). Payload mass is limited to 500 kg.



Cut-away view showing internal payload components. A 60-cm diameter telescope occupies the main portion of the volume. Two lasers (for redundancy and for tech demo purposes) are mount on either side of the telescope.



The Payload Interface Unit (PIU) provides the connection to the JEM-EF. Power, data, and coolant fluid pass through the PIU to the payload.