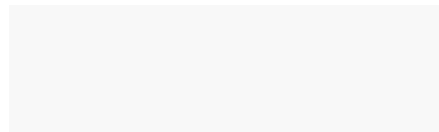




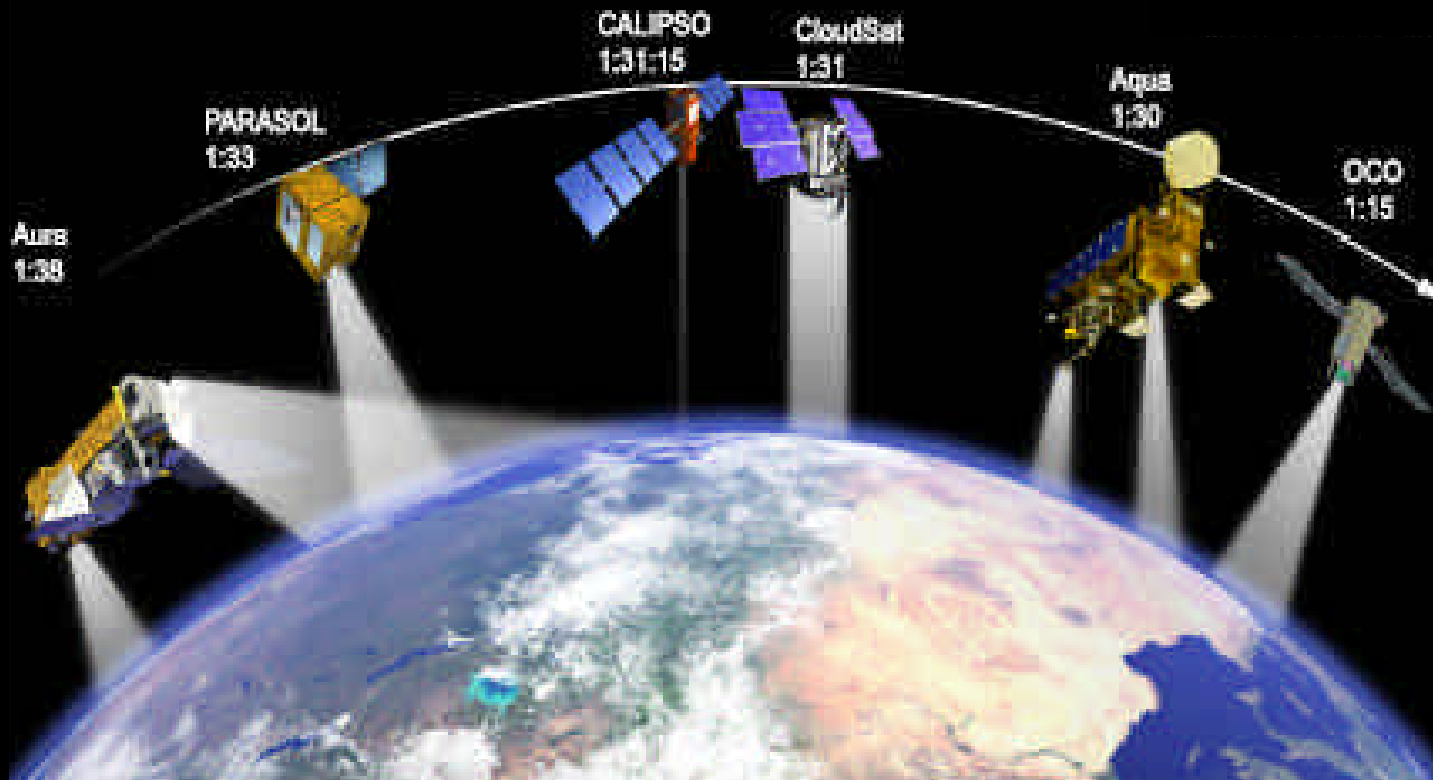
A CloudSat and A-Train Perspective of TWP-ICE

Graeme Stephens

Deborah Vane



The A-Train, mid 2005



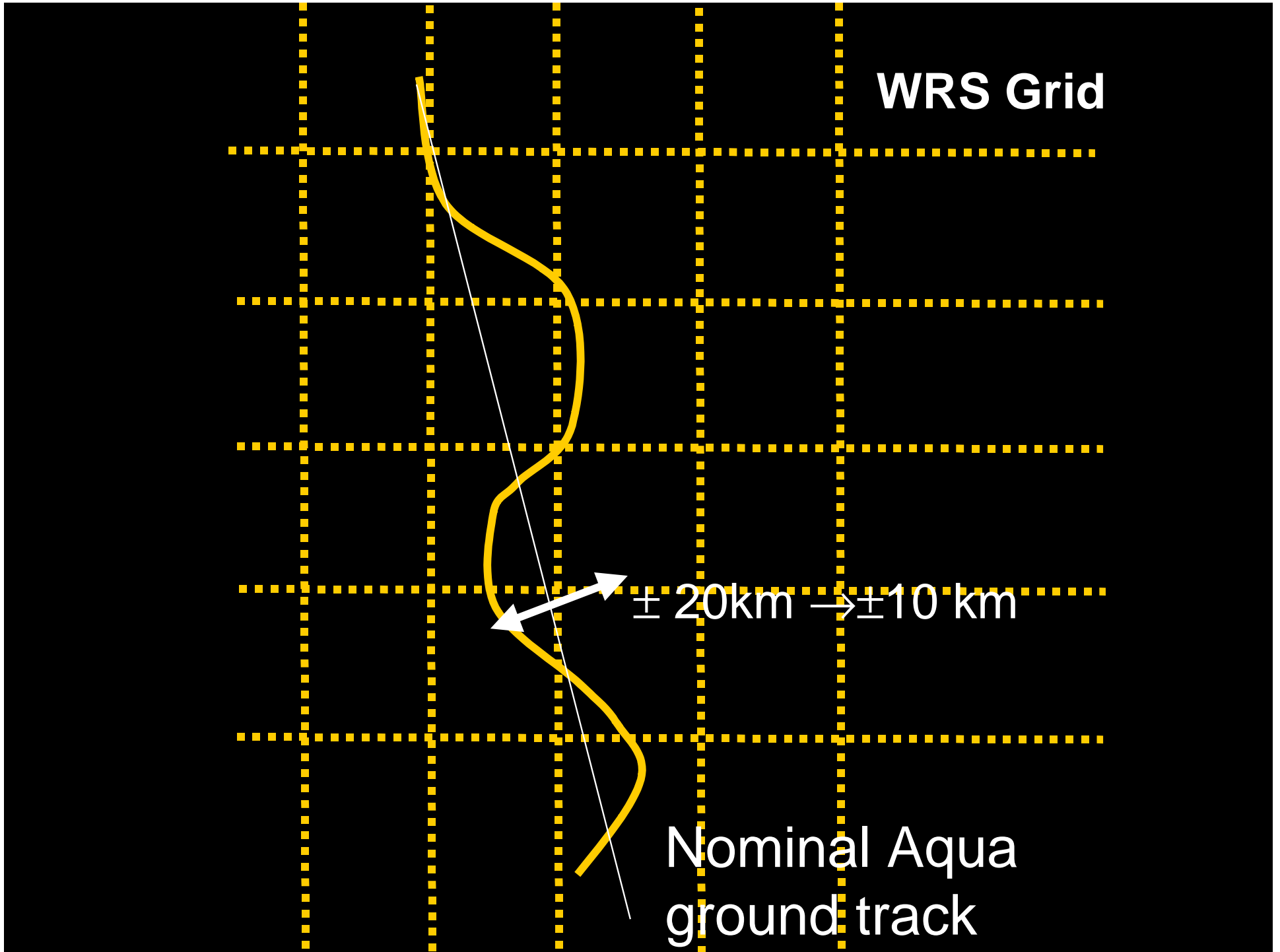
By mid 2005, we expect to have a wide range of different sensors, active and passive, optical, infrared and microwave, hyper-spectral to coarse band, all approximately viewing Earth at the same time.

We are left to pose a strategy that optimally combines these measurements, converting them to meaningful information about clouds, aerosol and precipitation

WRS Grid

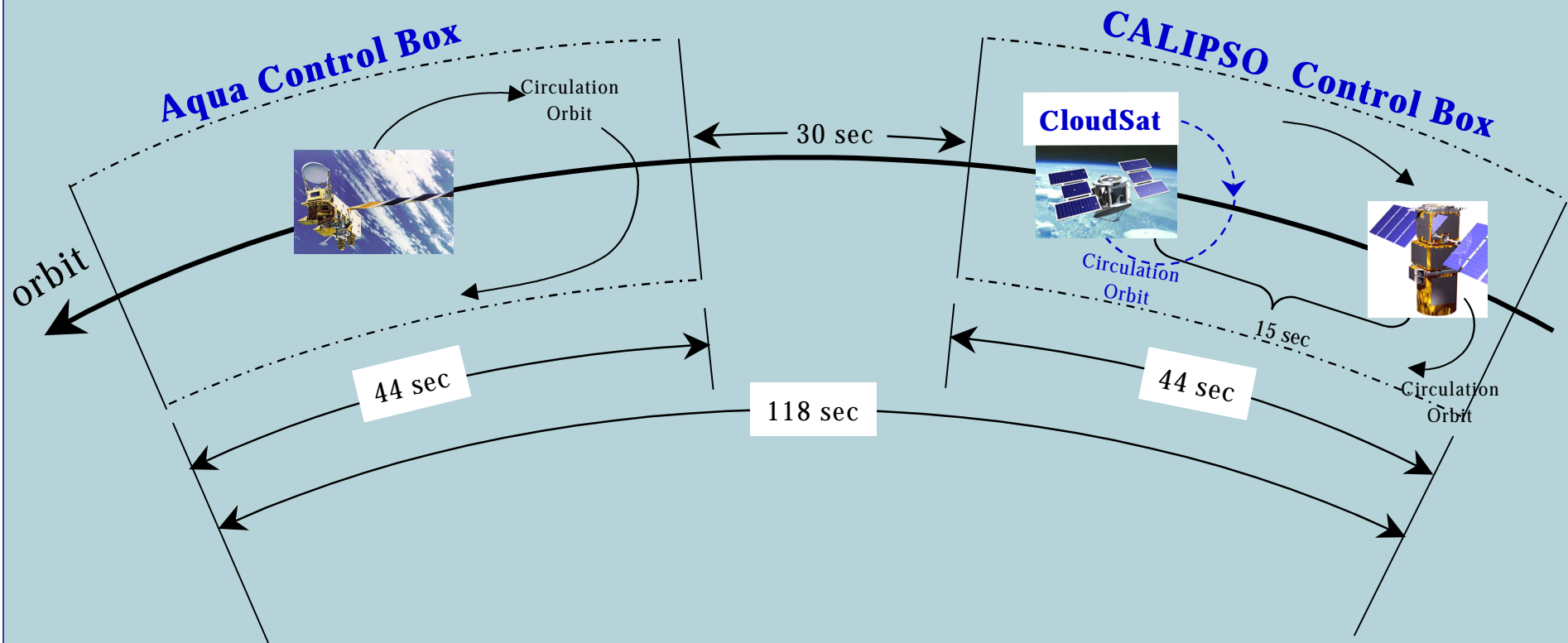
$\pm 20\text{km}$ \rightarrow $\pm 10\text{ km}$

Nominal Aqua
ground track



The A-Train Formation

CloudSat is the burdened spacecraft



Coordination, agreements, etc between missions have been established



- **Nadir-pointing 94-GHz radar**
 - Measure cloud reflectivity vs. altitude
- **One science operation mode**
 - Vertical resolution ~500 m
 - Transmits 3.3-ms monochromatic pulses
 - Horizontal resolution ~1.4 km
 - Uses 1.85-m dia. antenna
 - Sensitivity of -28 dBZ (nominal) is achieved by:
 - High peak power, large antenna, low-noise receiver, and pulse-averaging

Dynamic range: 80 dB

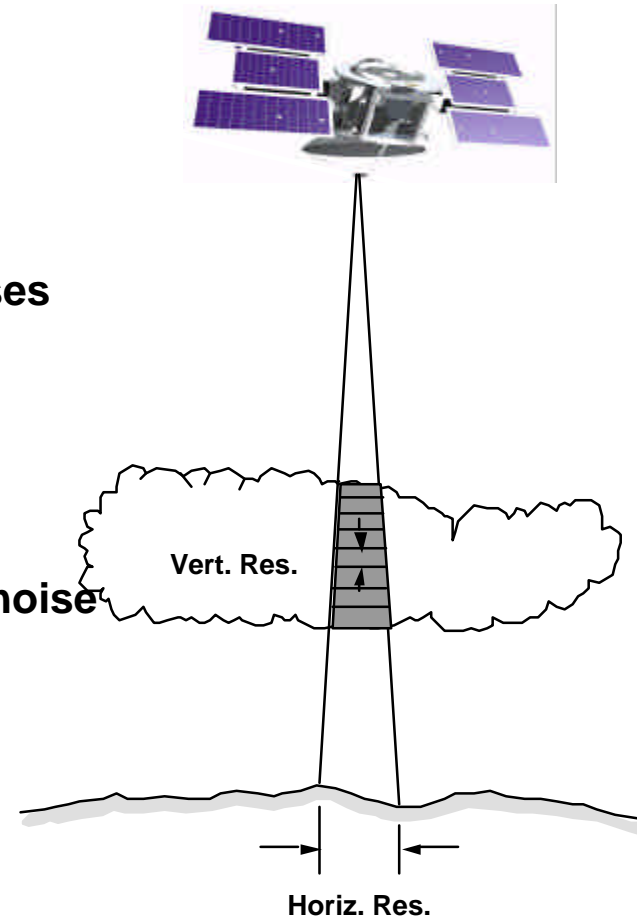
- To capture low reflectivity clouds and surface return
- Height window: 25 km

- **Technical resource allocations:**

Mass: 250 kg

Power: 322 W

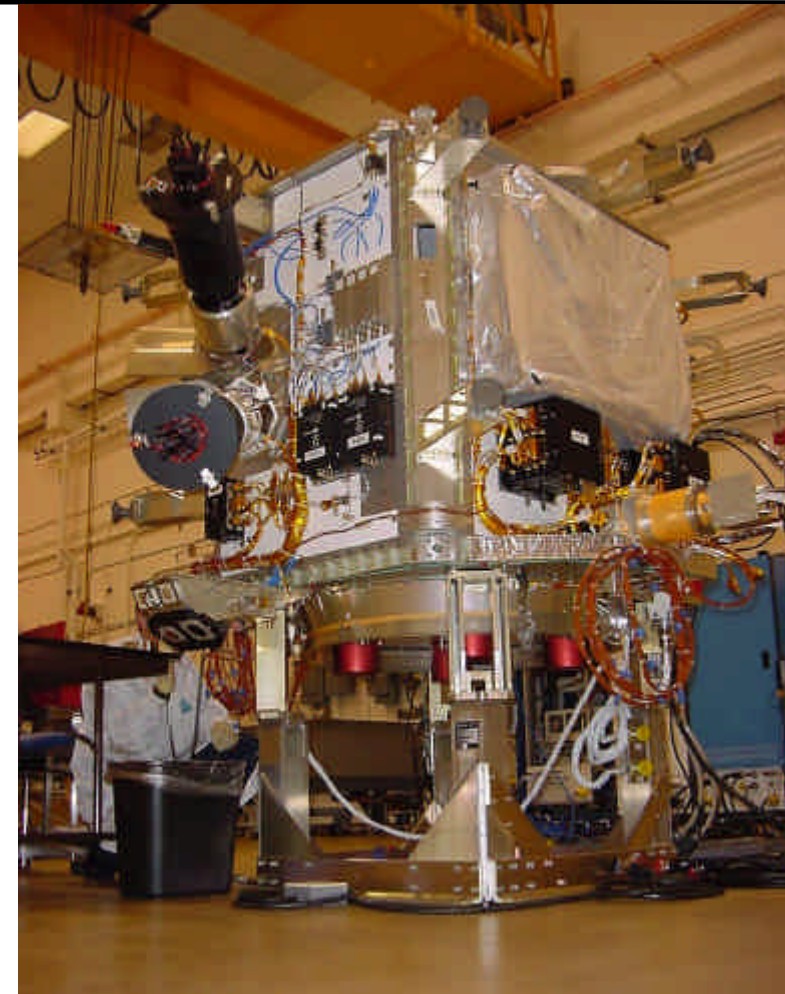
Data rate: 25 kbits/sec





MISSION STATUS

- 1. Spacecraft Bus Integration & Test Is Complete**
- 2. Instrument build & qualification is complete – no expected performance degradation from proposed.**
- 3. Instrument-spacecraft integration and test at Ball completed**
- 4. Data systems, algorithms near final version**
- 5. On schedule for May 2005 Launch**

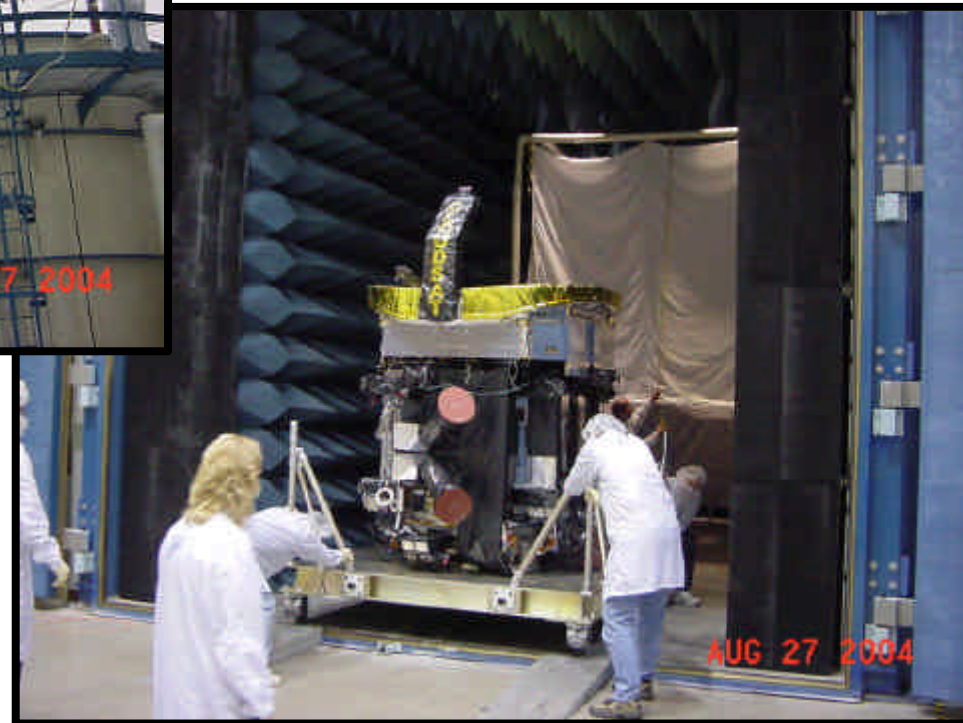


The completed spacecraft at Ball Aerospace

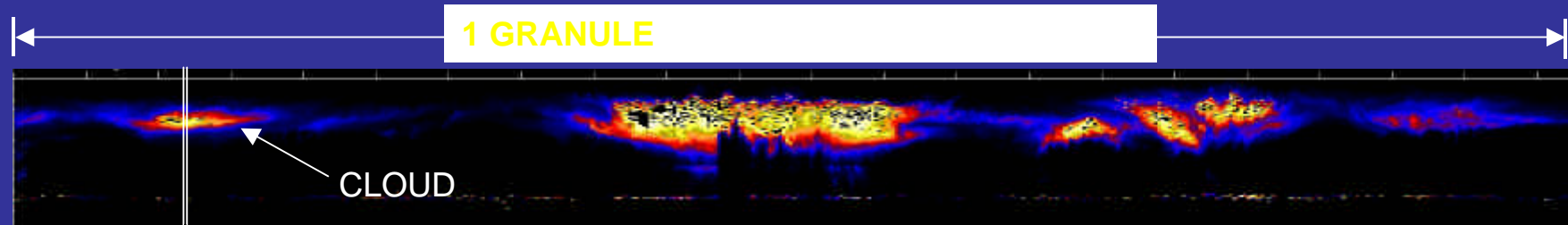


SPACECRAFT integration and test

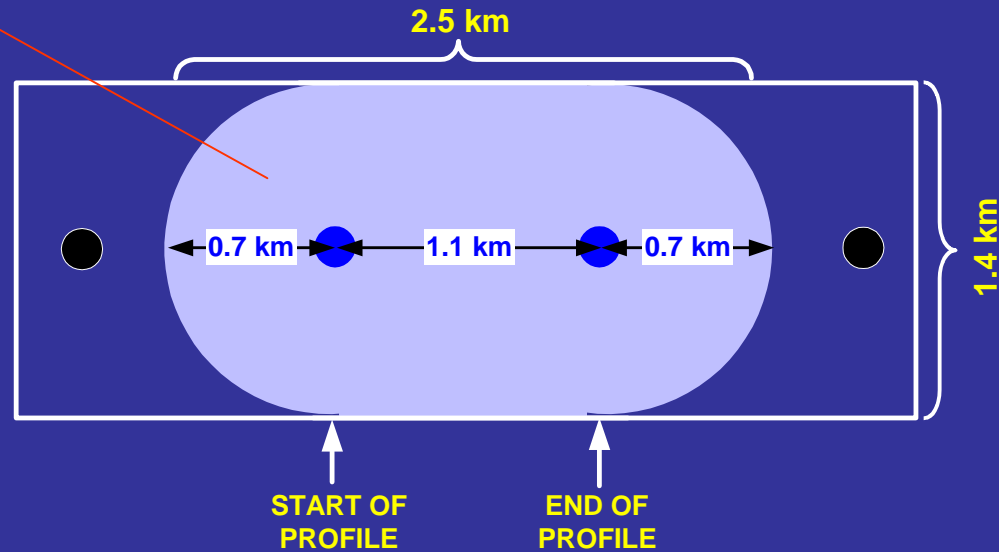
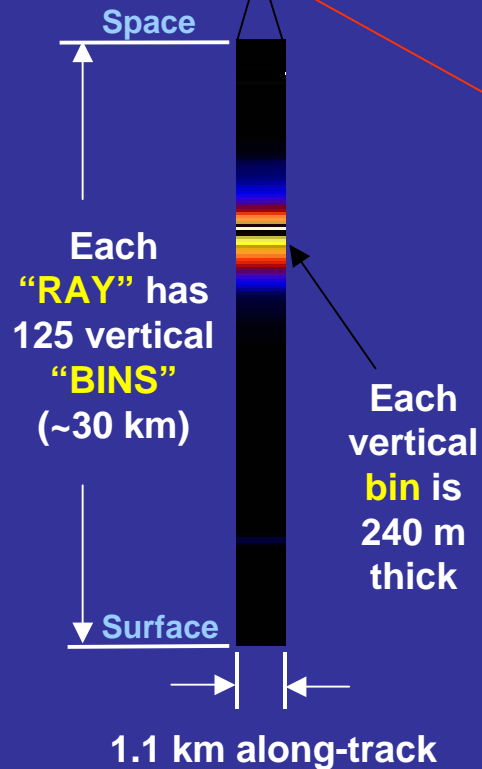
The completed observatory
undergoing thermal-vacuum
test,
Sept 2004



CloudSat DPC: CPR footprint & granule size



- Granule begins on descending node (dark side of Earth)
- Overlap at beginning and end of each granule



CloudSat DPC: CloudSat Data Products

- | **Level 0 (from RSC)**
 - 0A-CPR – raw science data
 - SSOH - stored (instrument) state-of-health data

- | **Level 1 (geolocation and time added to data)**
 - 1A-AUX – Geolocation, time, engr. data
 - 1B-CPR – Calibrated CPR
 - 1B-CPR-FL - Calibrated CPR (First Look)

- | **Level 2 (science data products)**
 - 2B-GEOPROF - geometrical profile
 - 2B-CLDCLASS - cloud type classification
 - 2B-TAU-OFF-N - cloud optical depth (off nadir)
 - 2B-LWC - cloud liquid water content
 - 2B-IWC - cloud ice water content
 - 2B-FLXHR - fluxes and heating rates

- | **Level 3 (summary/statistical data products)**
 - Summary statistics on a global 1 degree grid

All Level 1 and 2 products will be available on-line for distribution to the general Science Community (after release by the PI)

CloudSat DPC: Ancillary Data Sets

AN-MODIS

AN-ECMWF

AN-CALIPSO

AN-MODIS: +/- 260-km swath of MODIS data

Source: NASA Goddard Space Flight Center DAAC

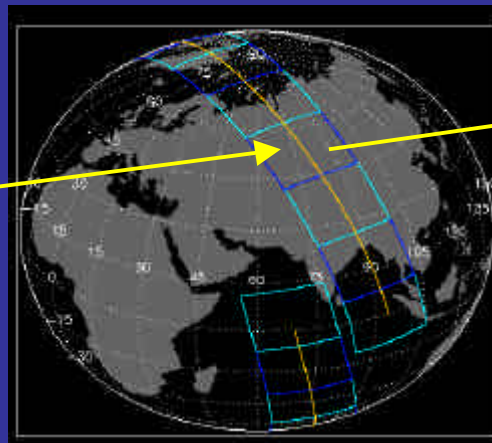
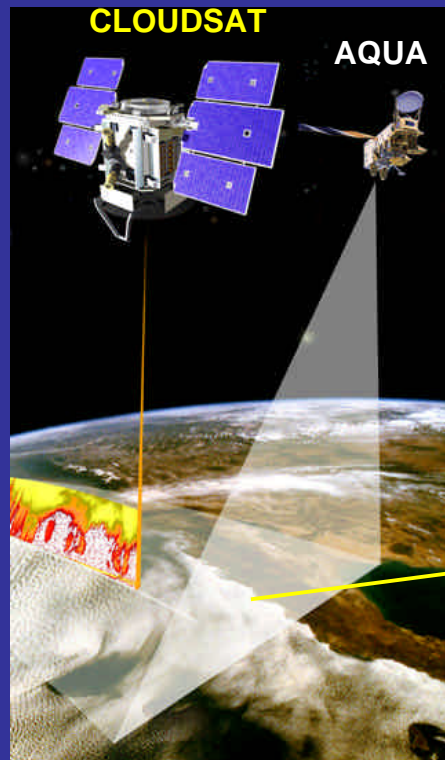
Data: Geolocation, 22 of 36 bands, Cloud Mask

0.25 km resolution -

- Radiance: band 1 (MOD02_QKM_L1B)

1 km resolution -

- Radiance: bands 1-7, 17-20, 26-36 (MOD02_1KM_L1B)
- Geolocation (MOD03)
- Cloud Mask (MOD35_L2)



April 25, 2004
Contrails – NW Europe



Validation Program Objectives

The objective of the CloudSat data product verification and validation activity is four-fold:

1. Validate the radar performance (absolute calibration and stability, etc), thereby validating the output of the level 0-to-1 radar algorithm.
 - -26 dBZ, EOL sensitivity
 - 2dB absolute calibration
2. Verify Sensitivity (e.g..MDS)
3. Validate the pointing knowledge error of the radar footprint, so that CloudSat data can be merged with other satellite datasets.
 - ~1 km (0.0583°, 0.00104 rad)
4. Quantify the accuracy and precision of Level 2 Data Products:
 - Ice
 - Examine underlying assumptions in the retrieval algorithms

**By measurement:
Radar-radar comparisons**

By analysis

By measurement and analysis



Extensive validation activities rely on partnerships with the international community:

Costa Rica – tropical cirrus and convection

Darwin - tropical cirrus, convection and monsoon systems

AMMA - same, European

Canada – cold climate high latitude clouds/ precip jan/may 2006/2007

Japan – mid latitude clouds (local flights, cruise),

tropical (indonesia) cruises

Other Europe

Test flights of RALI – France

UK – Chilbolten

Other ARM related activities – NSA/SGP/TWP and mobile?

ETL- cruises



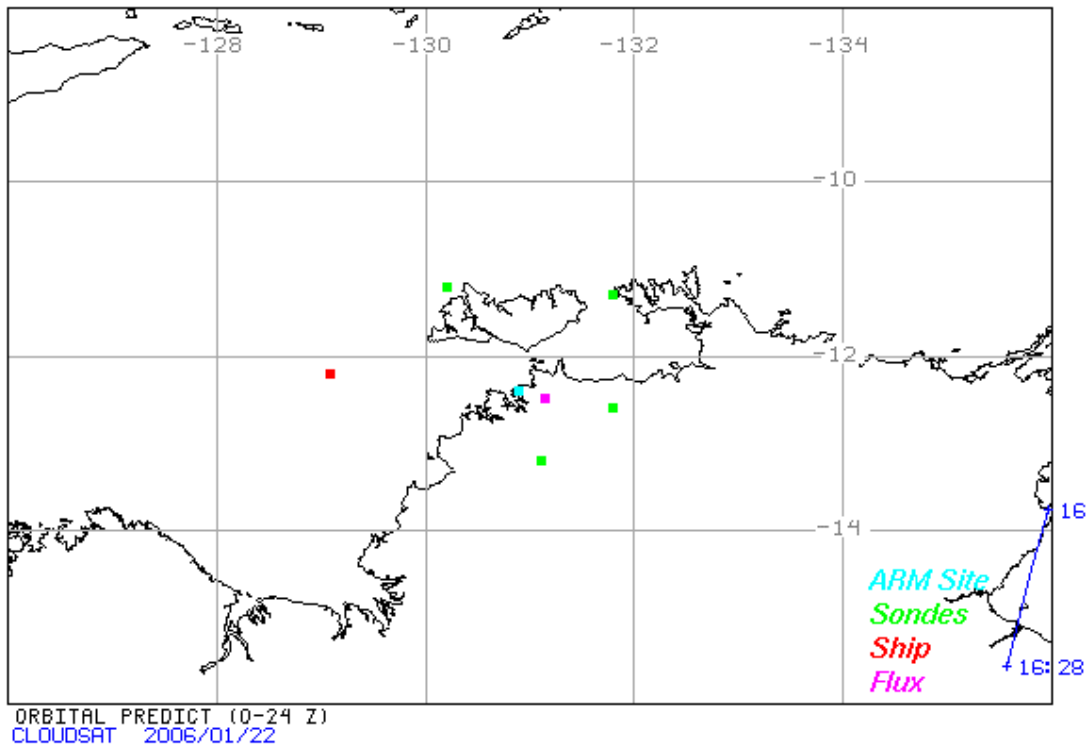
- | **Cloudsat would like:**

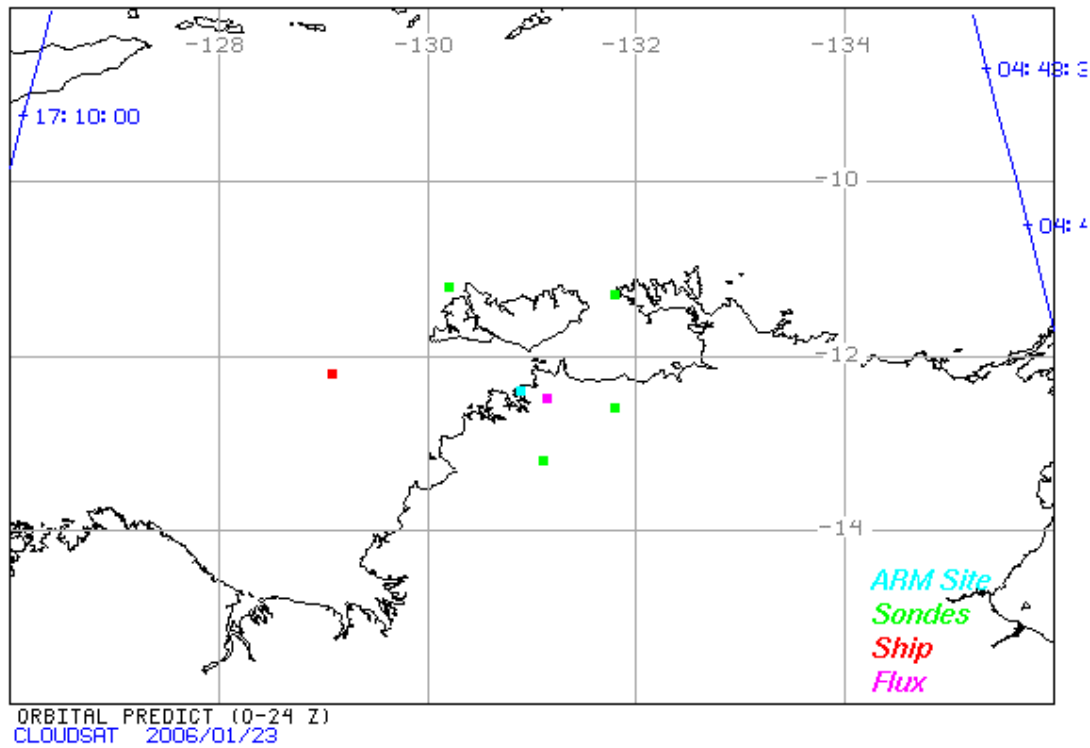
- | **1. Some underflights of the cloudsat and calipso space craft with high altitude aircraft to match lidar & radar on aircraft - deep profiles are better than shallow profiles (level legs)**

- | **2. Extensive cloud property measurements from profile penetrations matched to aircraft remote sensors (level and spirals)**



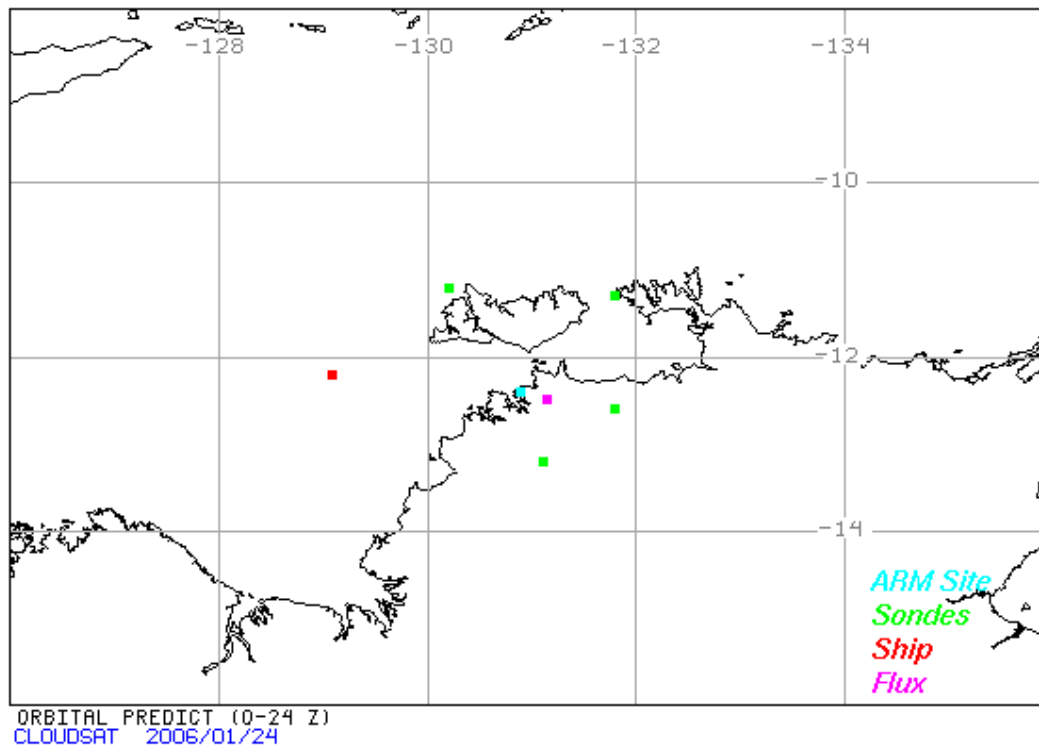
A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION

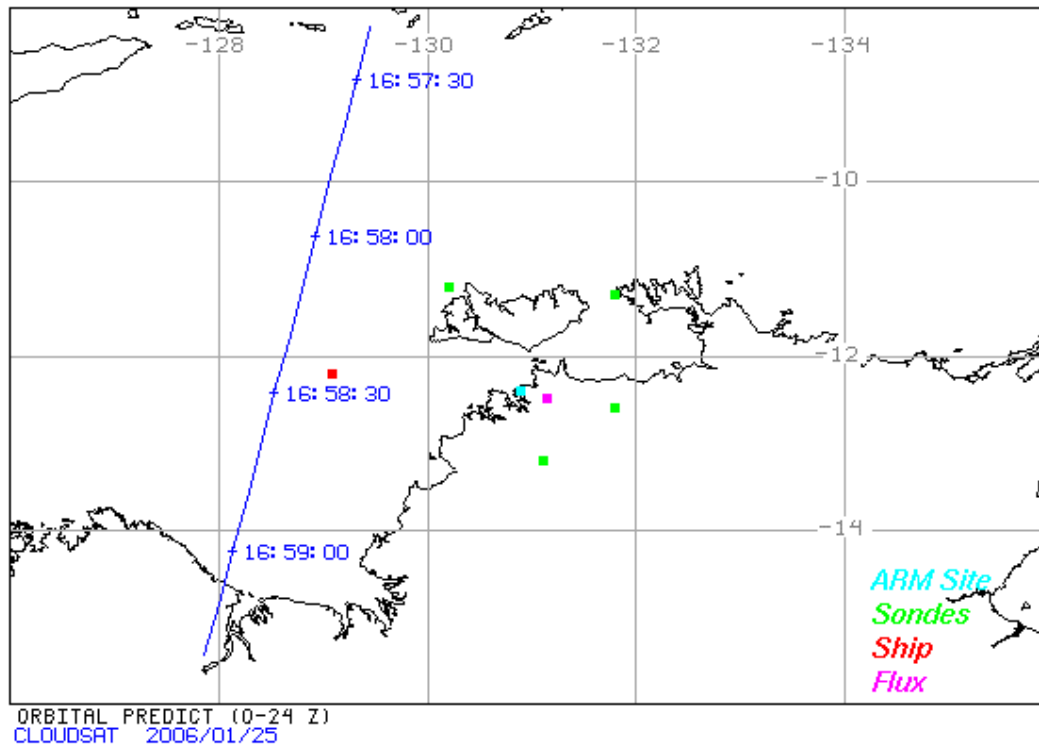


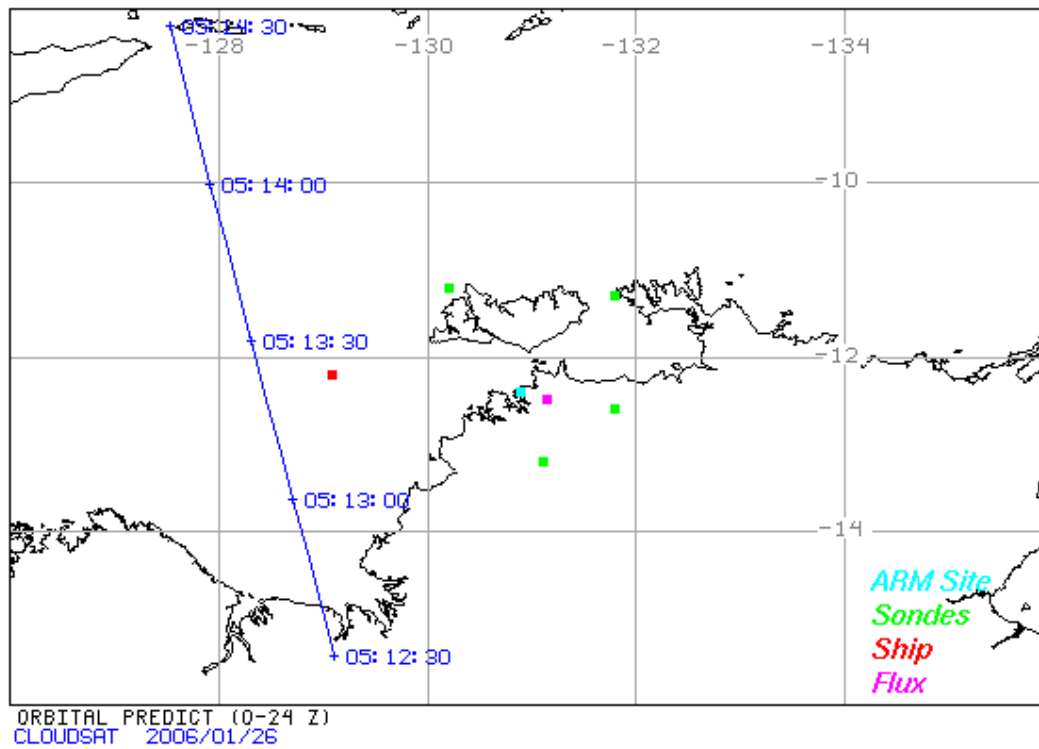


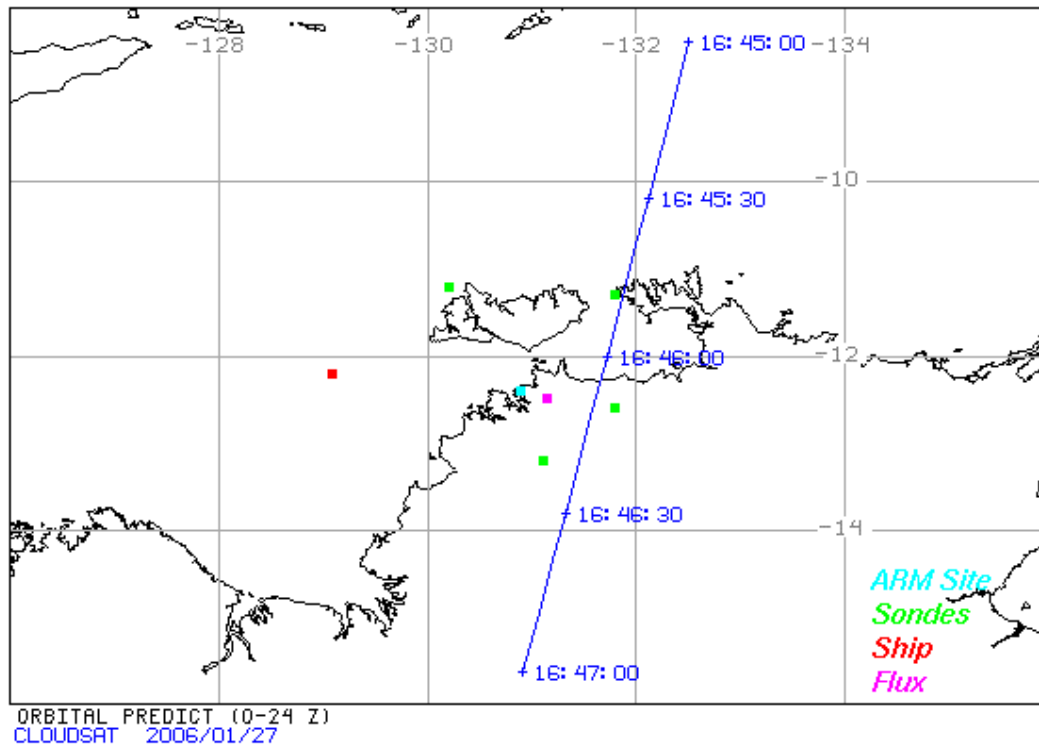


A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION



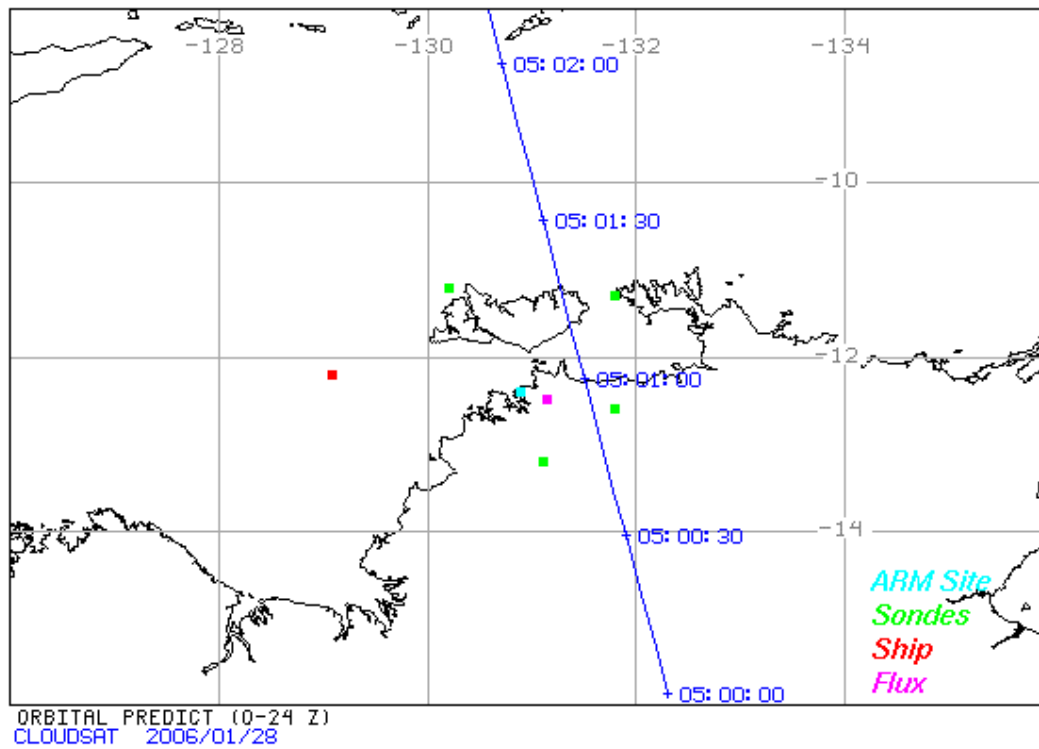


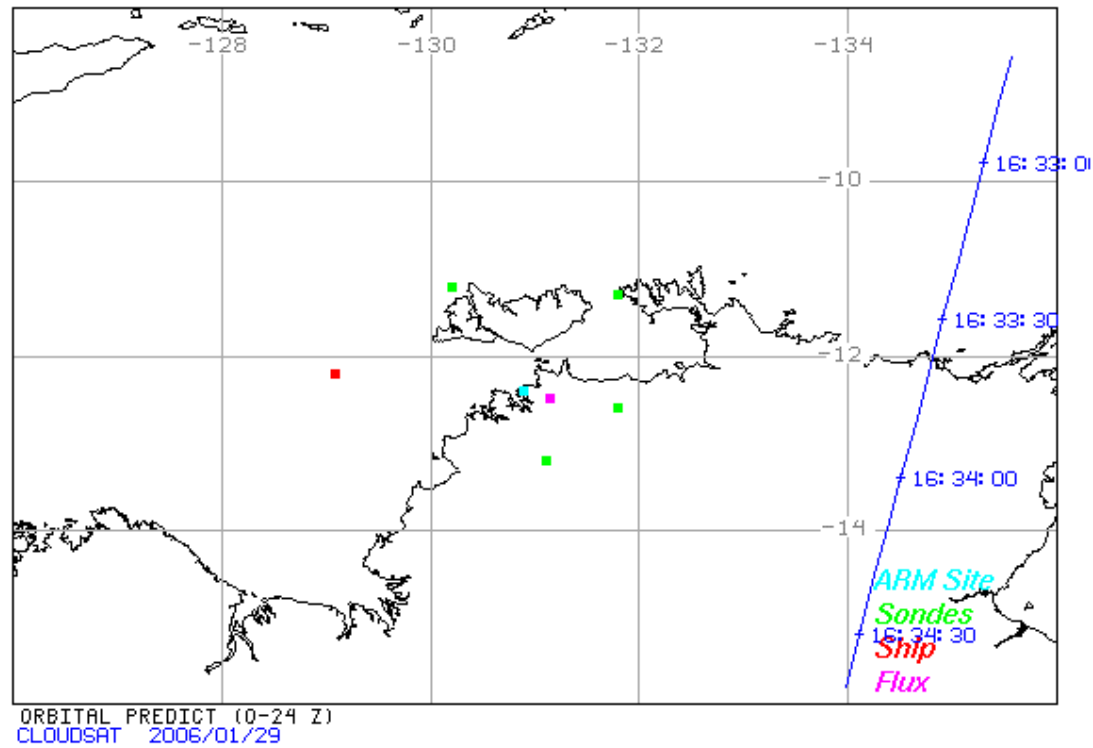






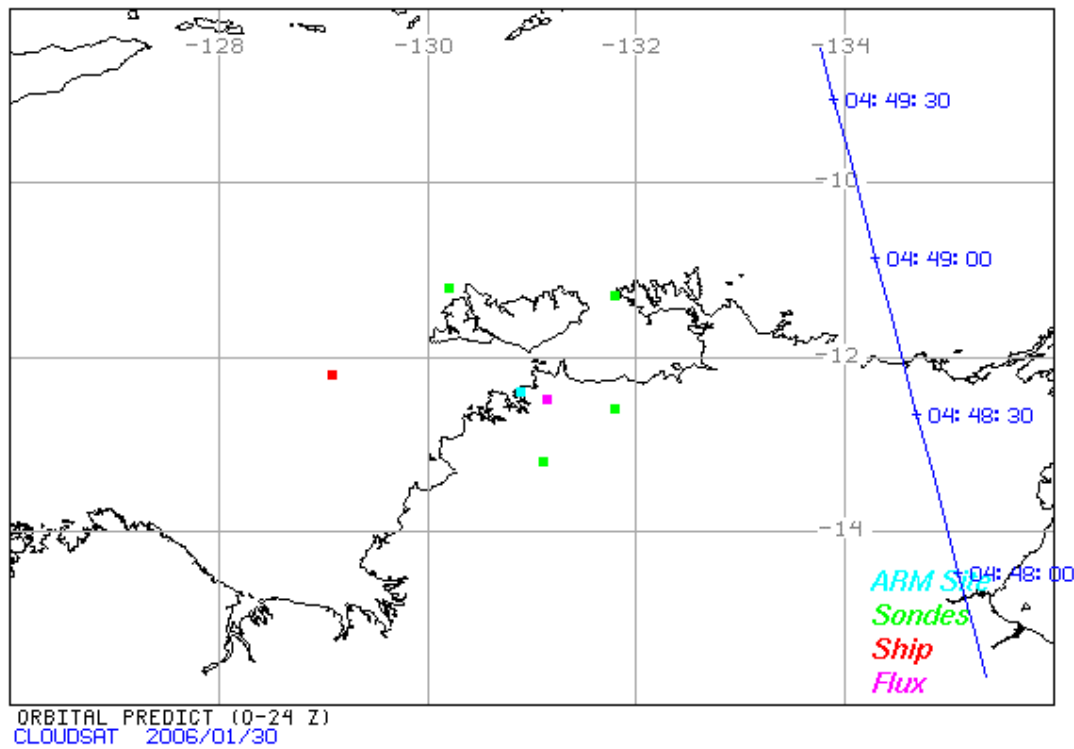
A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION





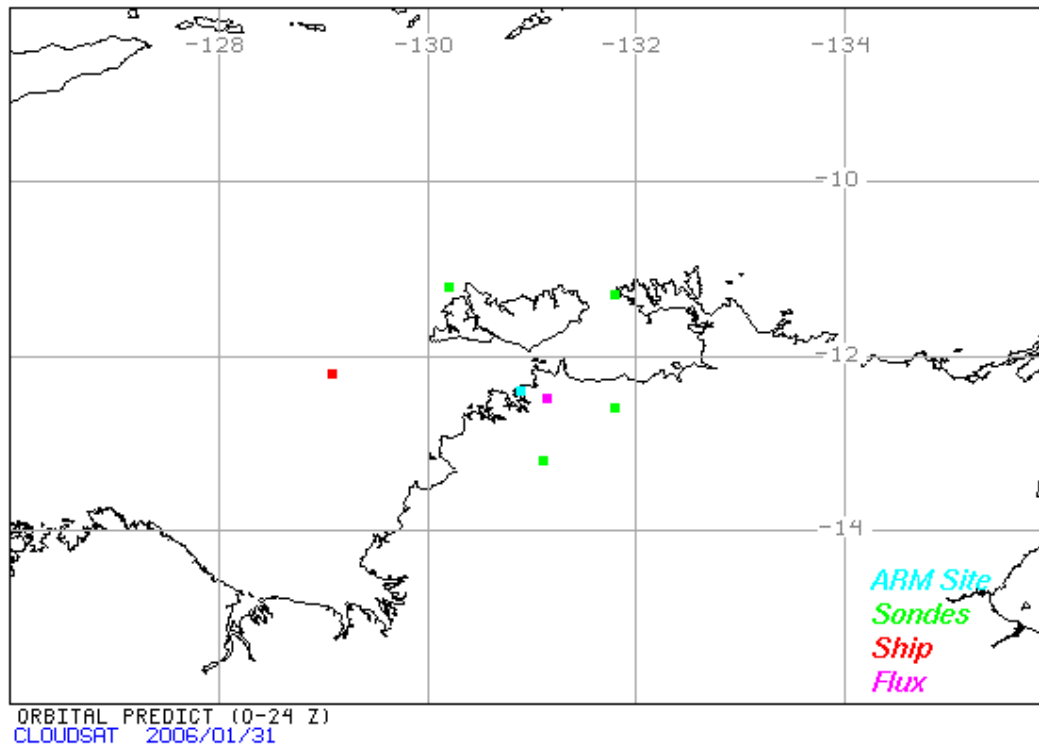


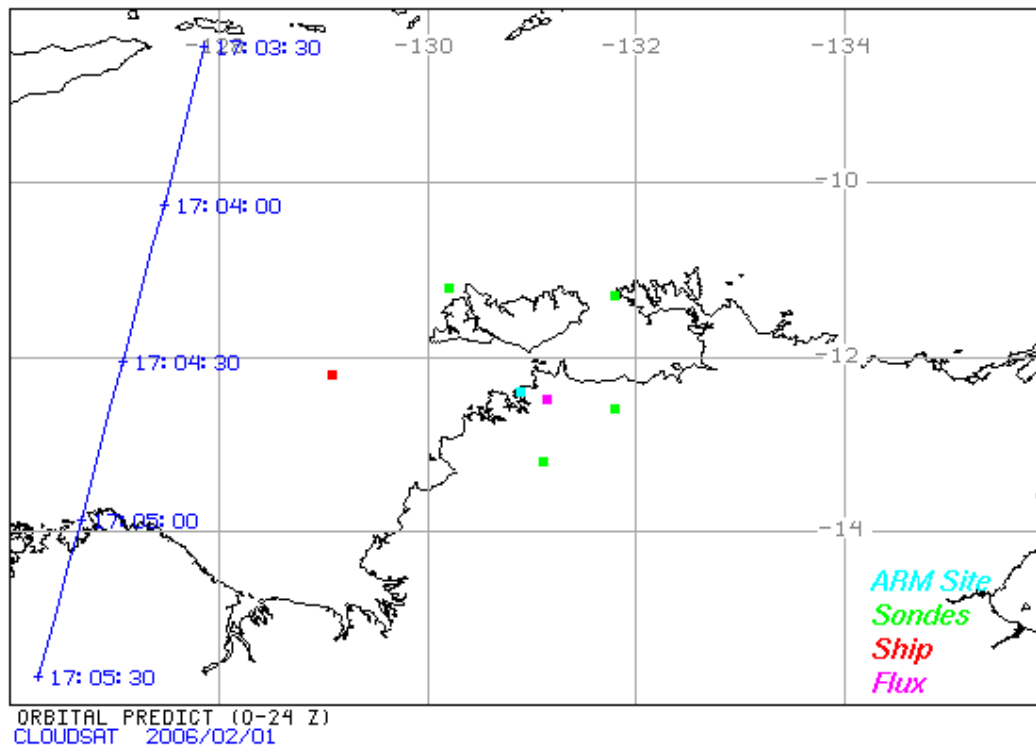
A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION





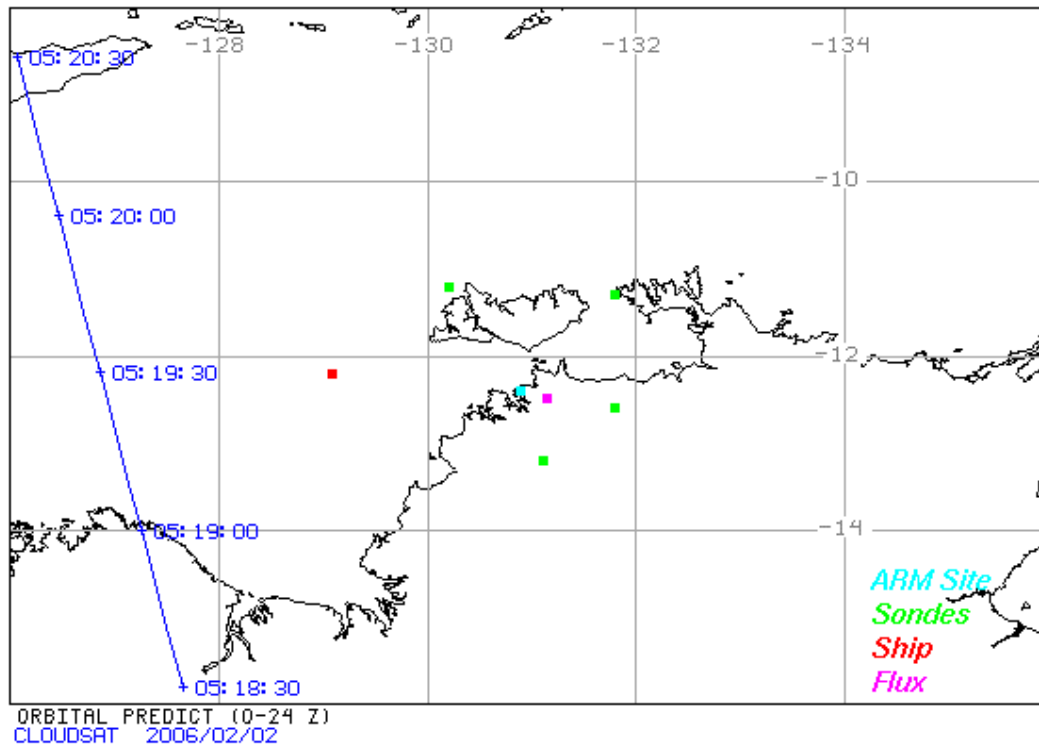
A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION





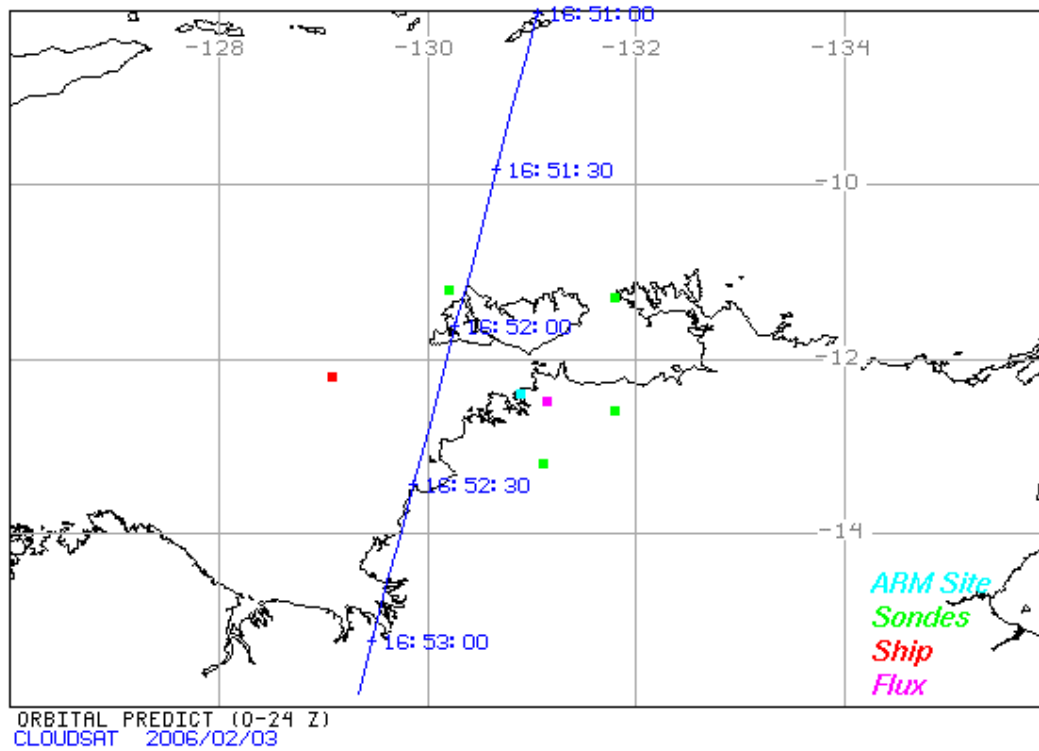


A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION



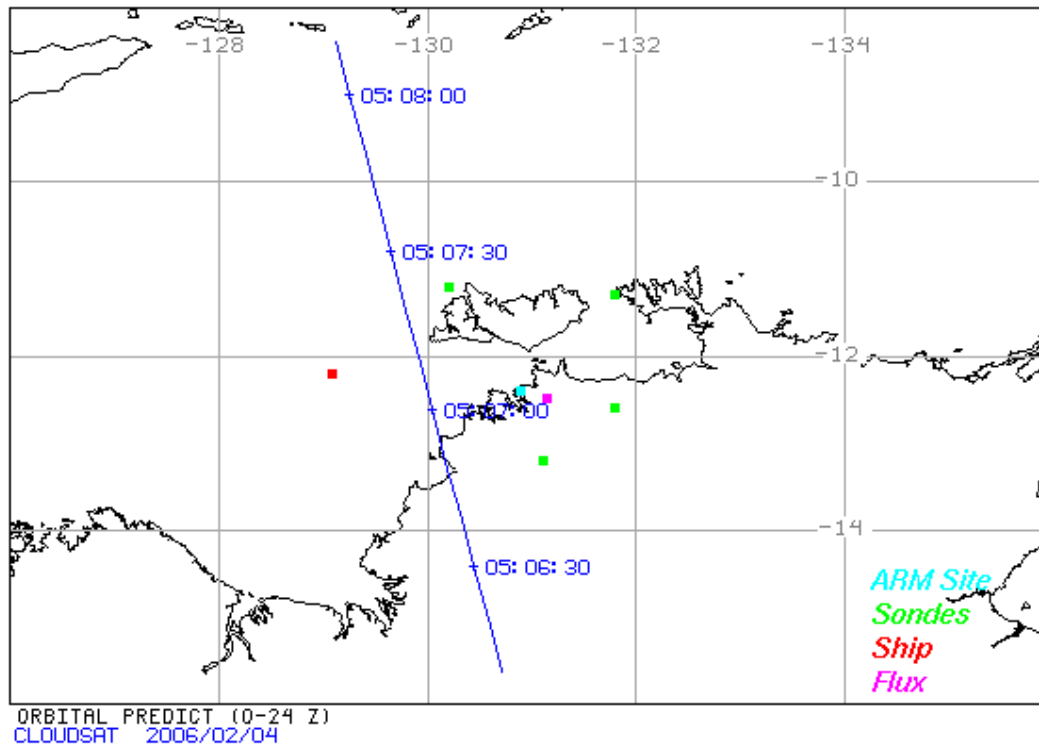


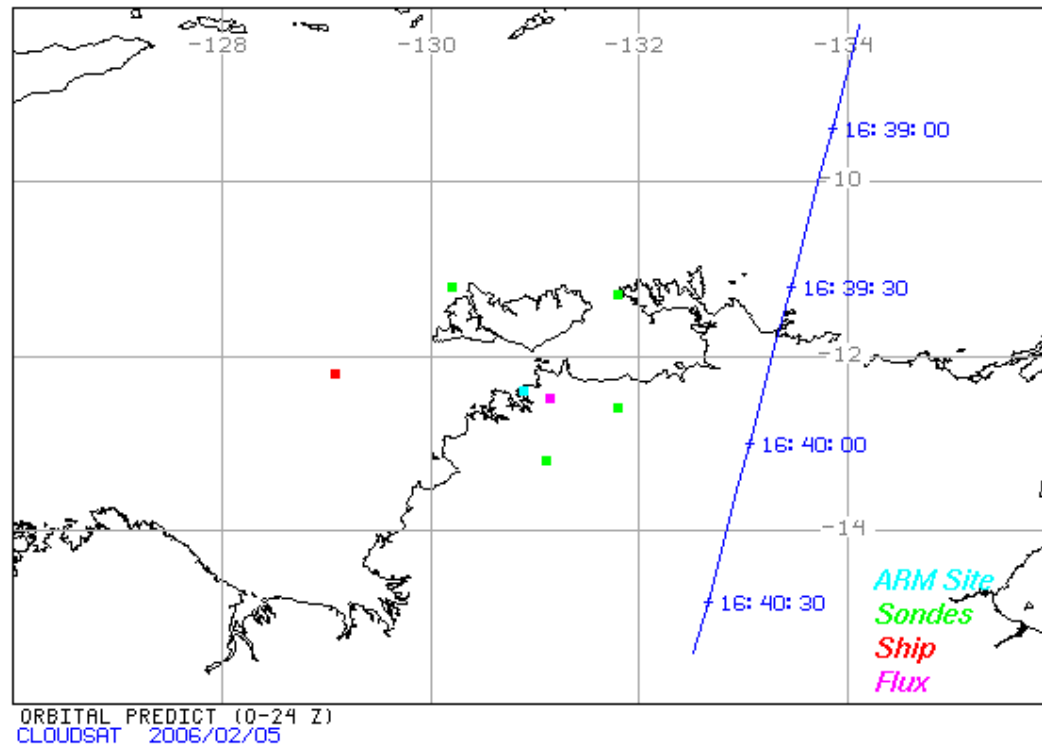
A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION





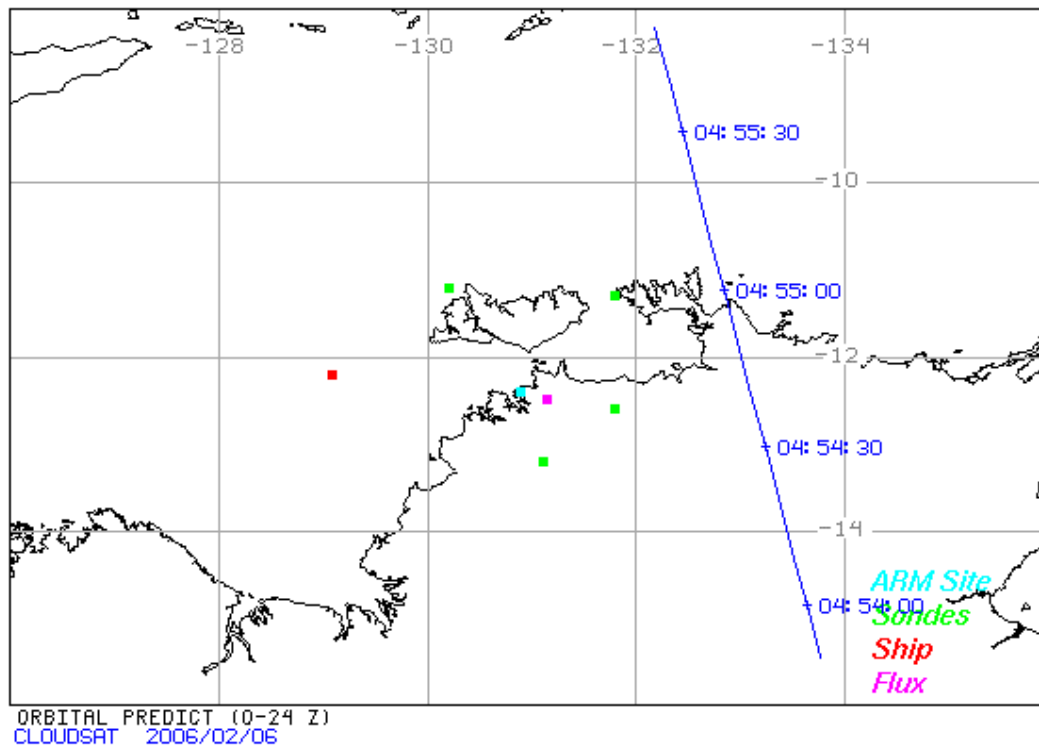
A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION





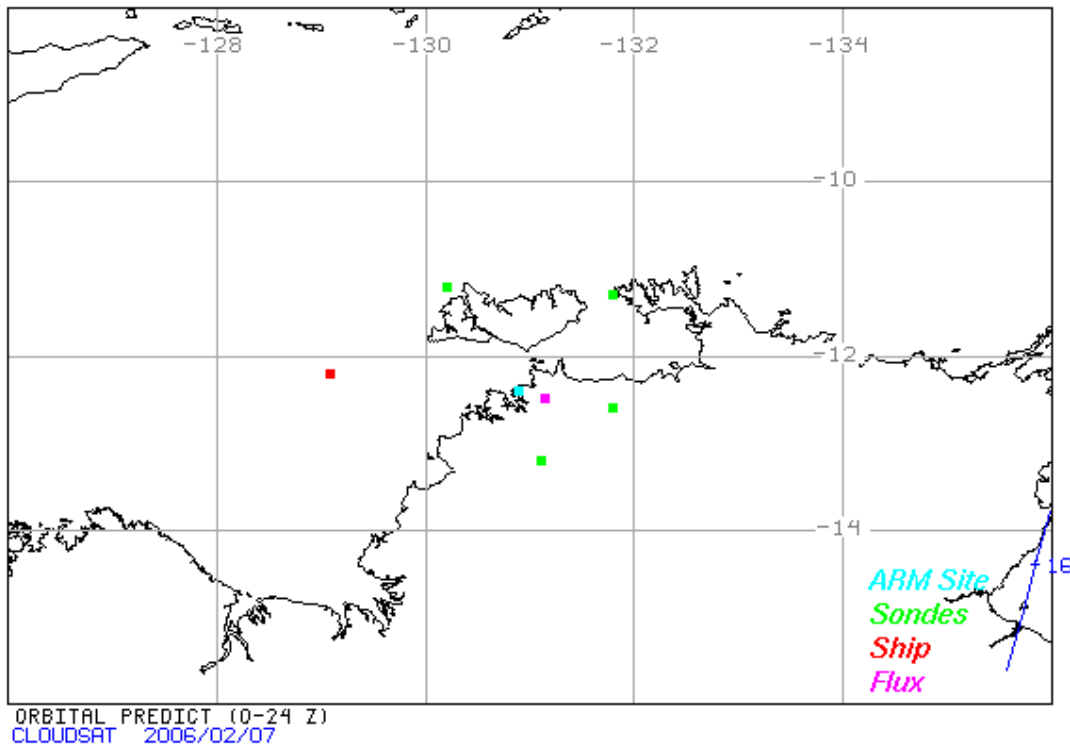


A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION



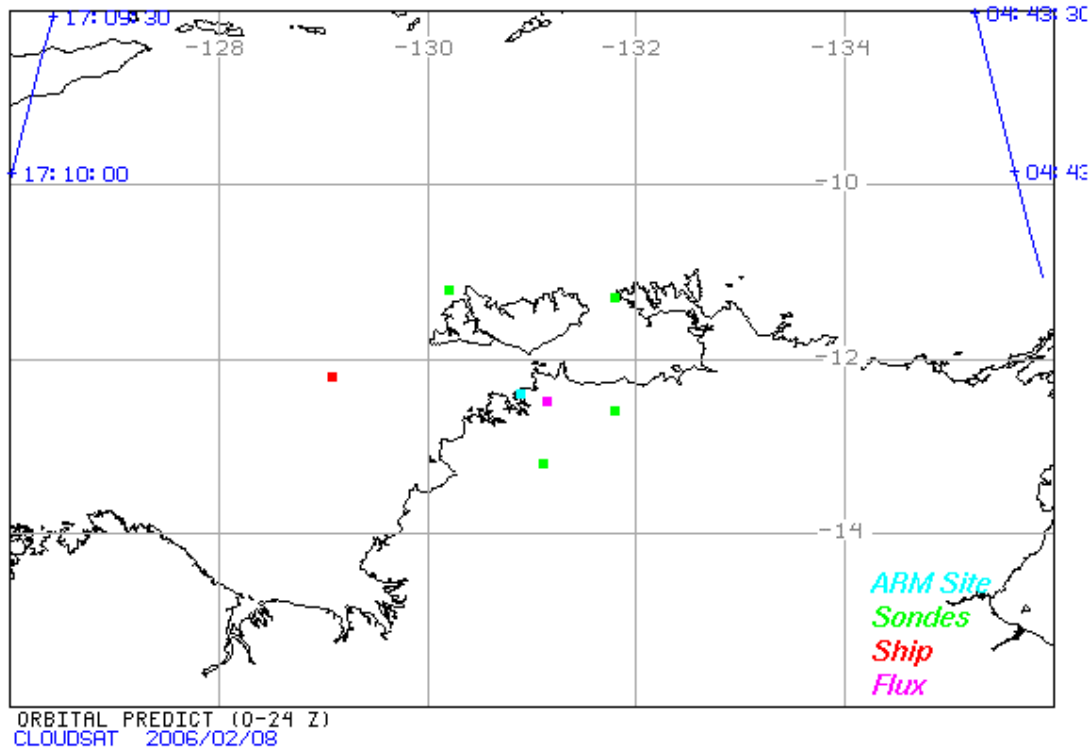


A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION



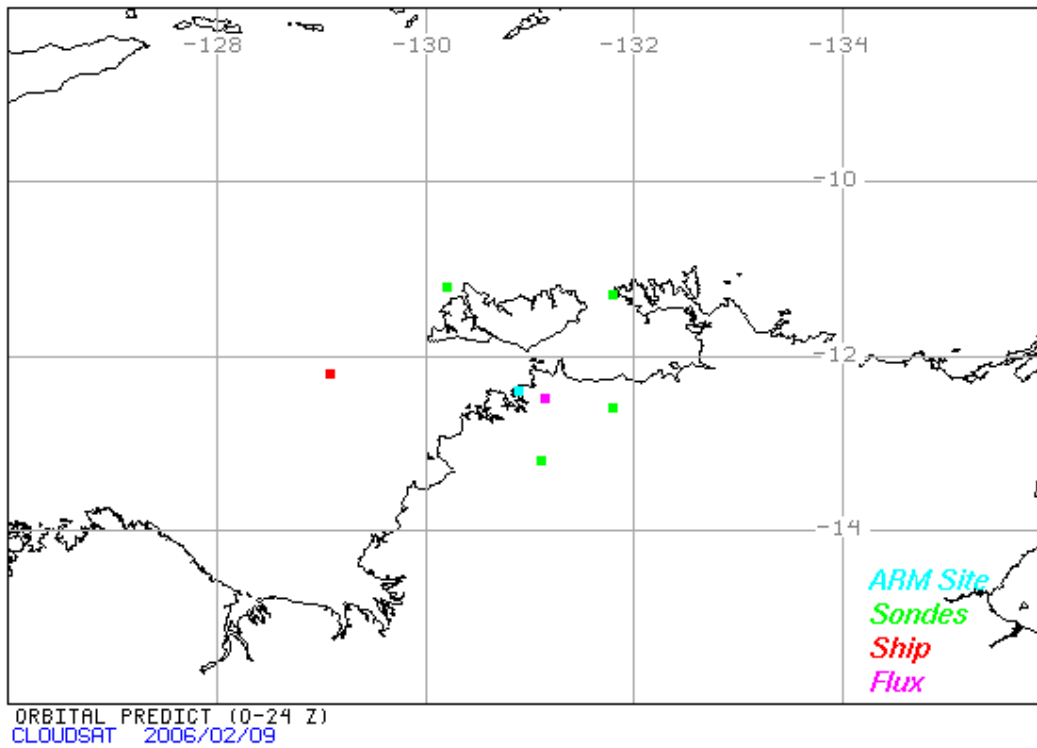


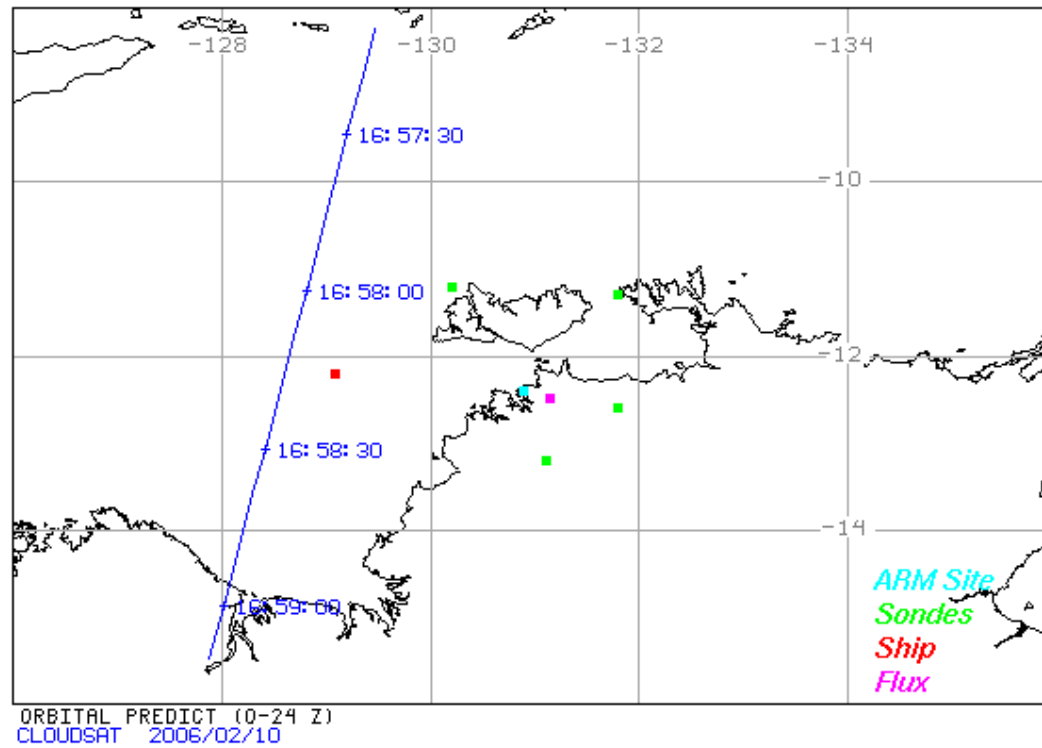
A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION





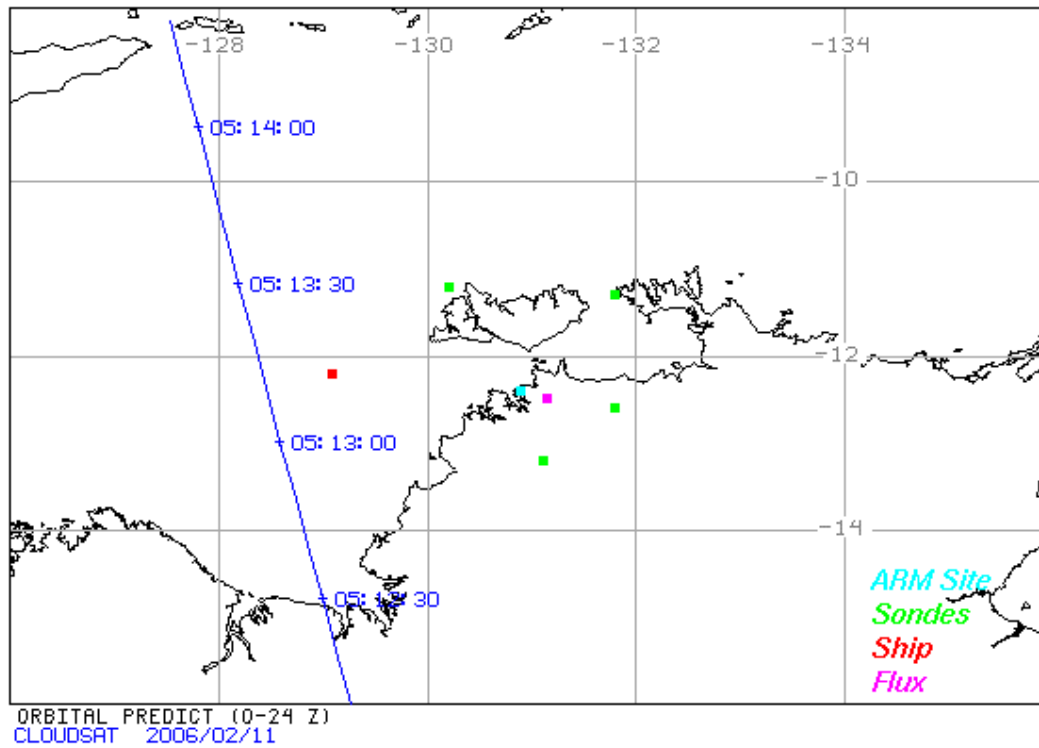
A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION





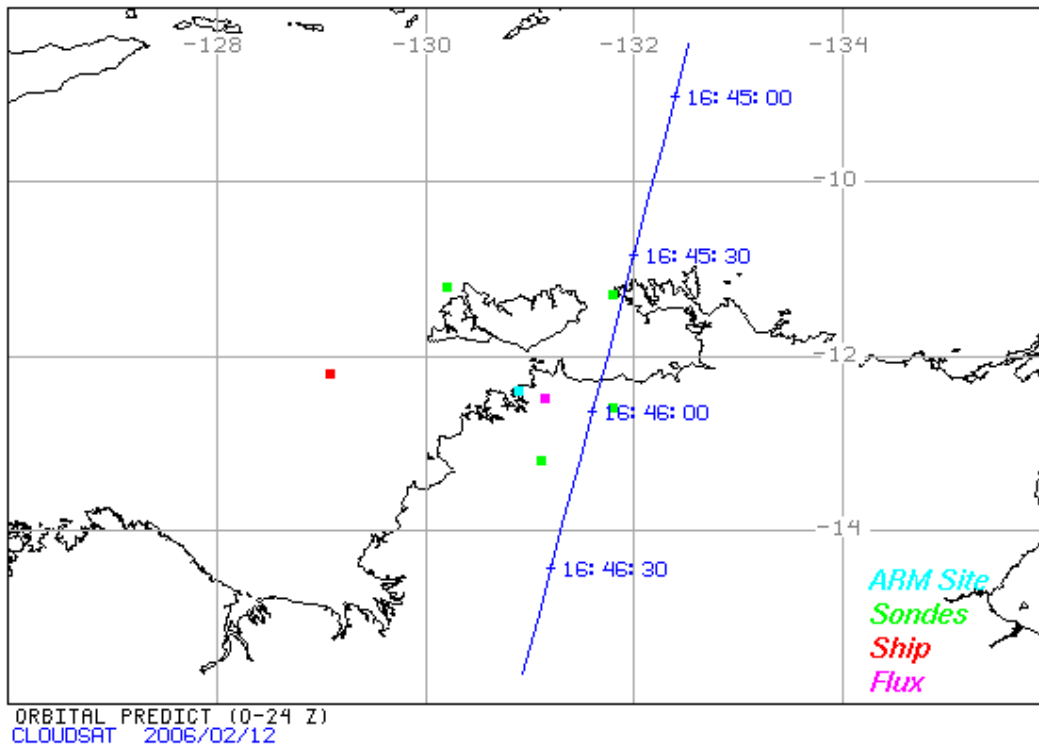


A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION



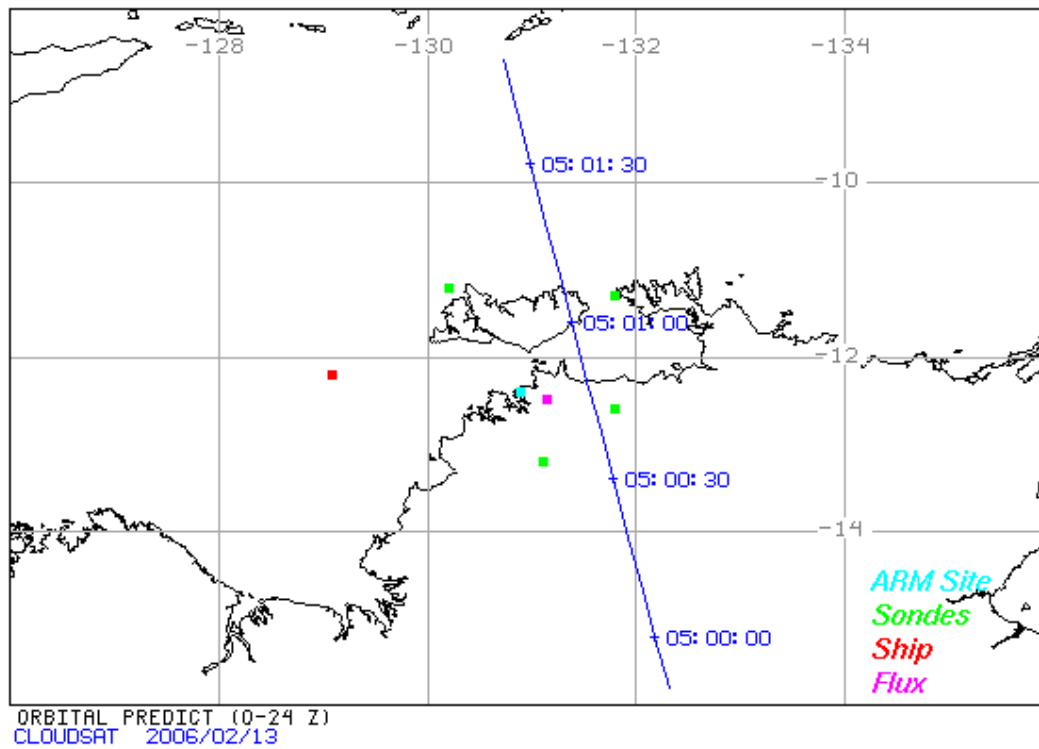


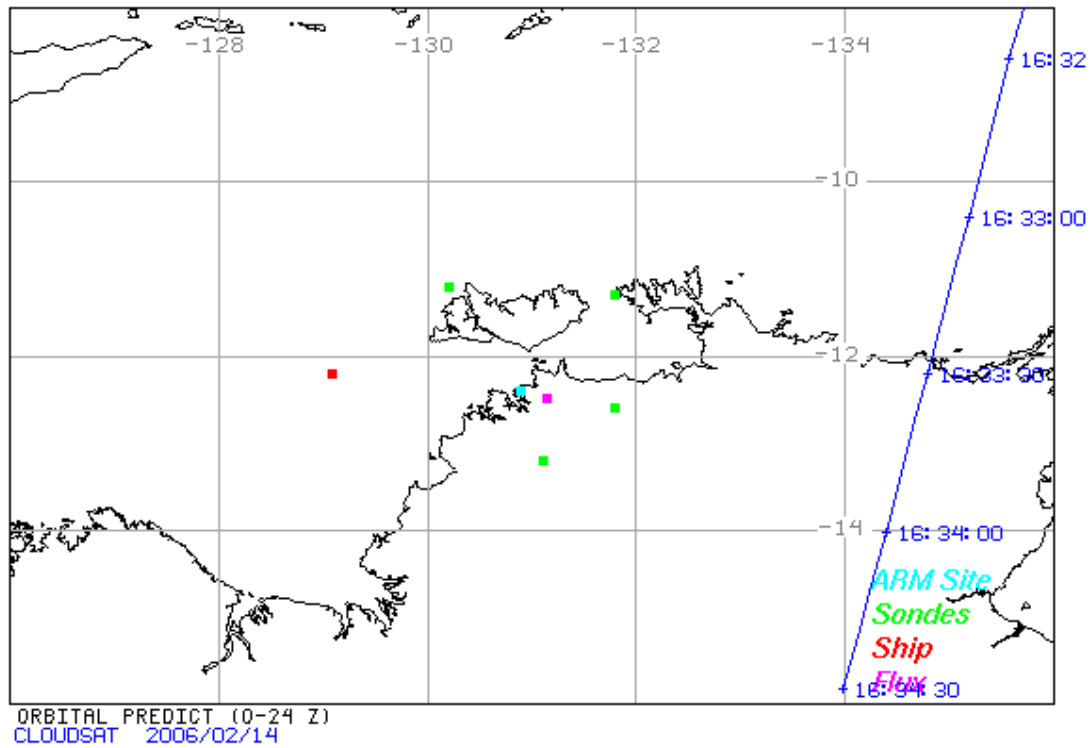
A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION

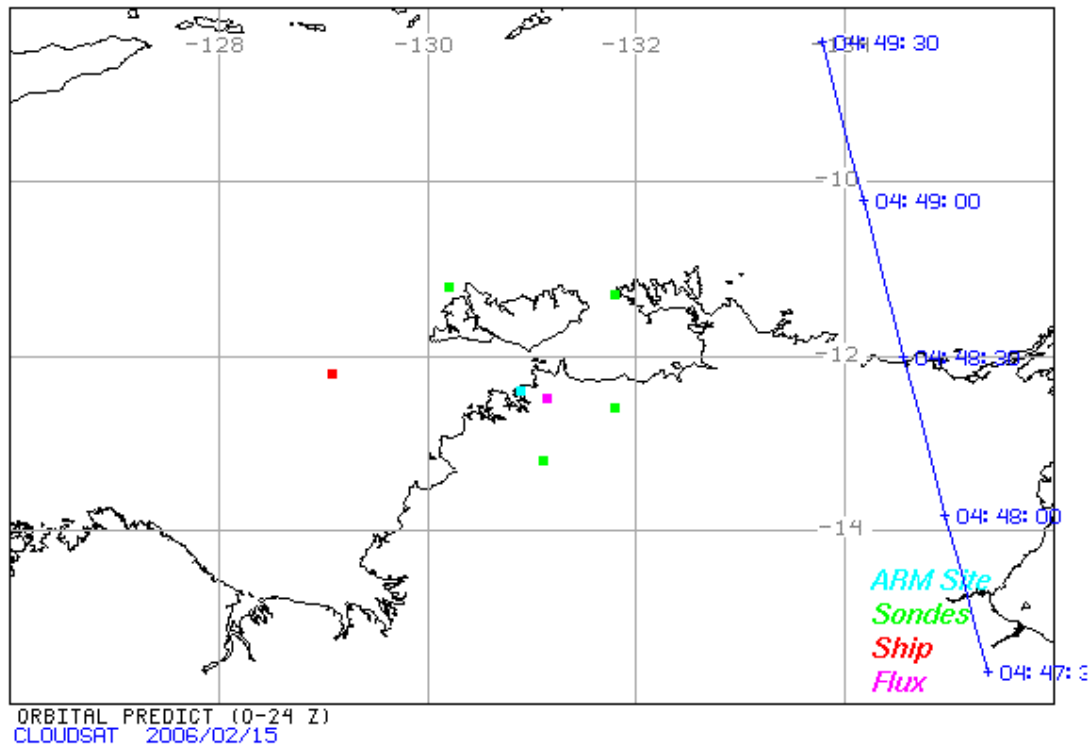




A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION

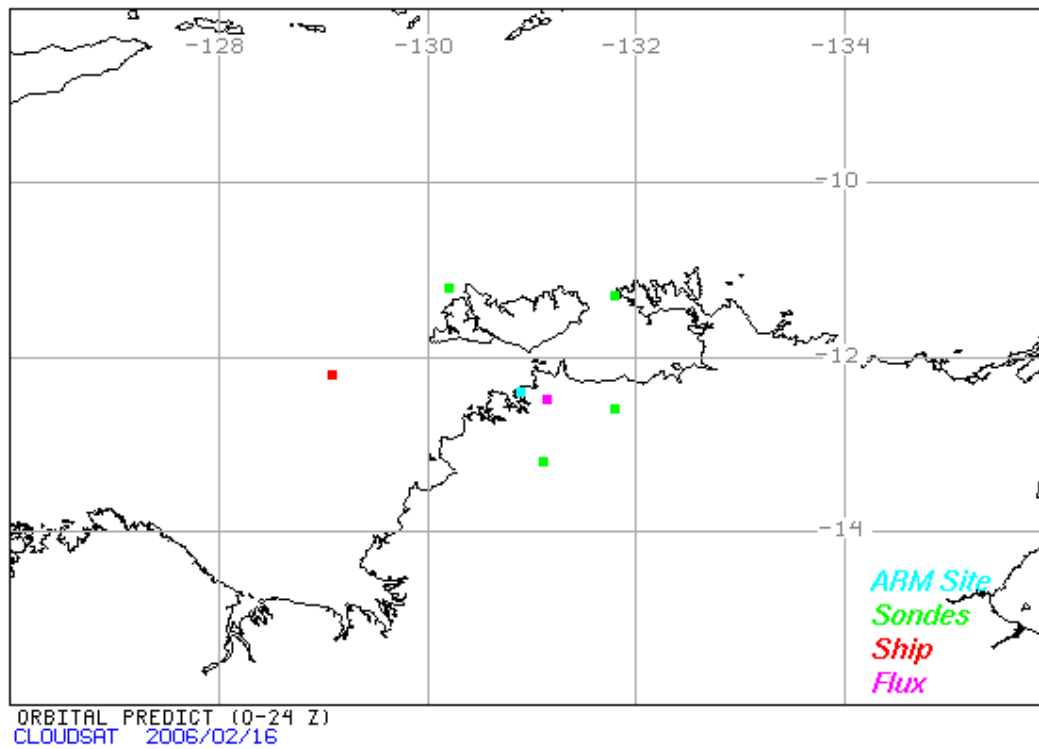






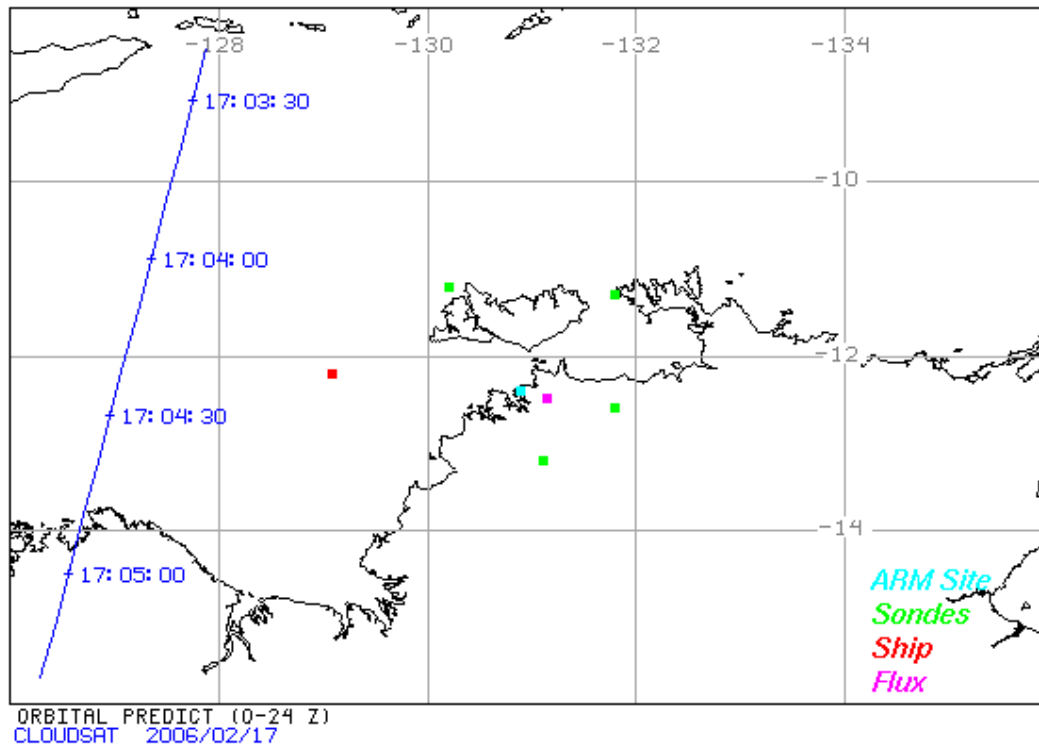


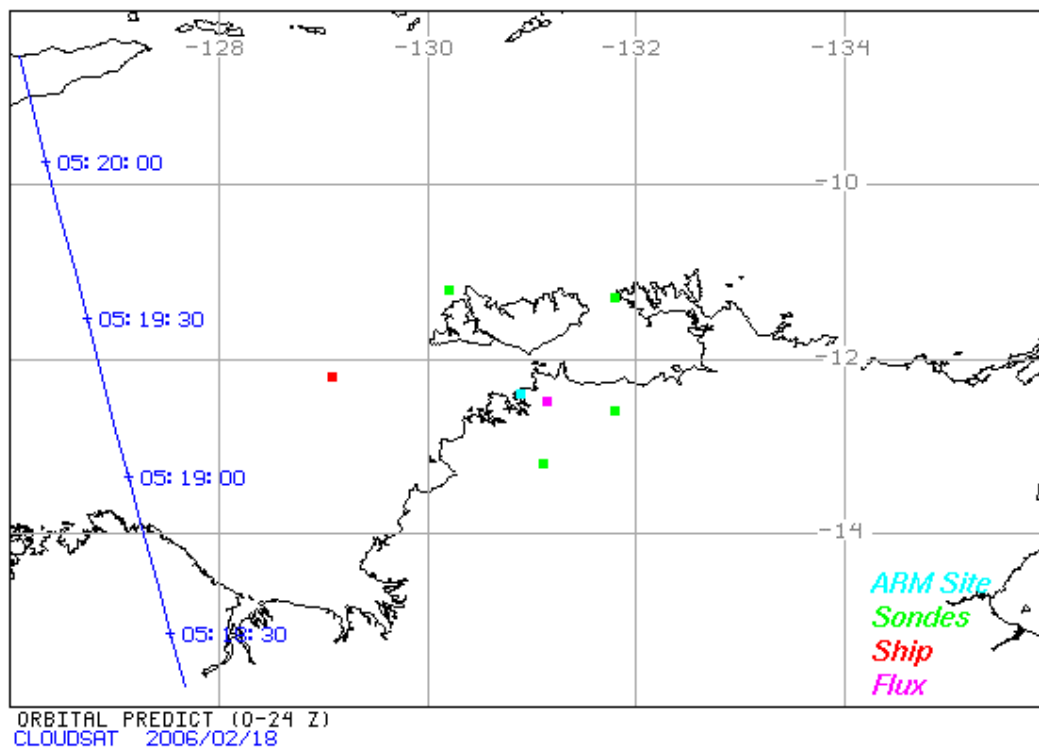
A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION





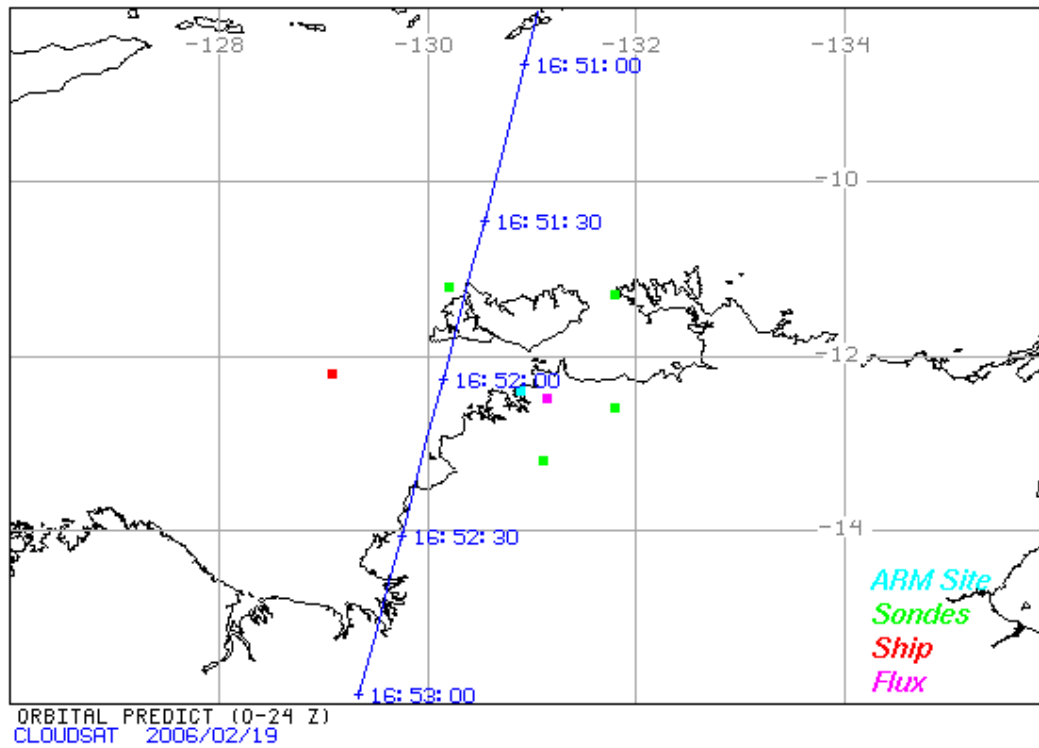
A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION





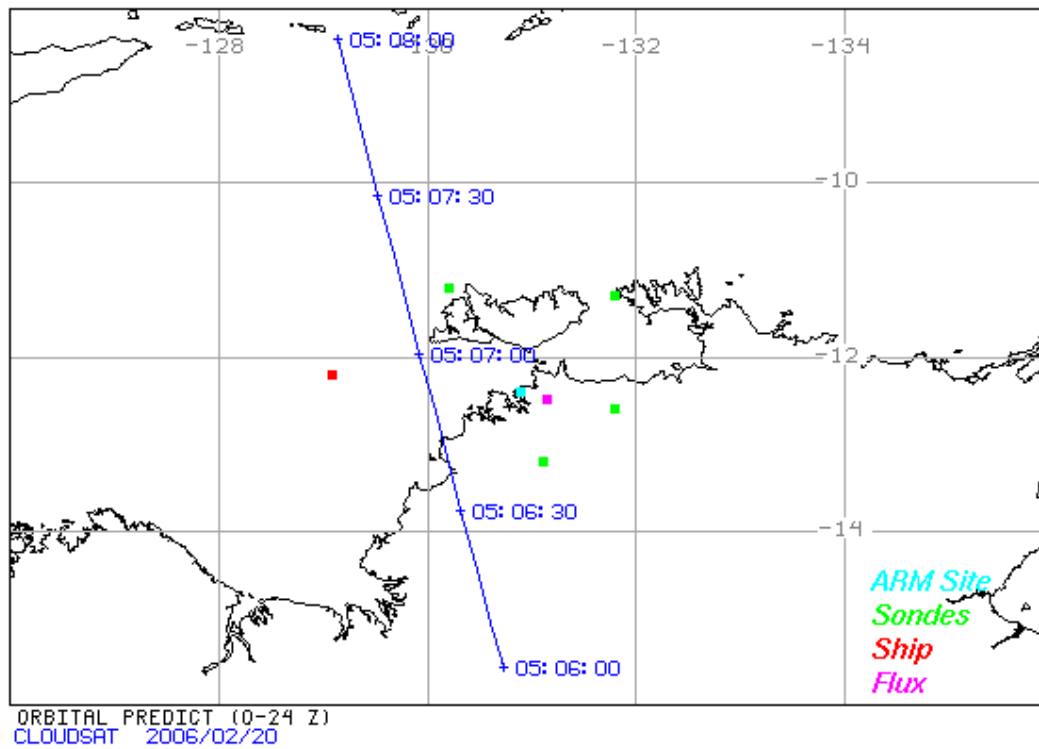


A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION



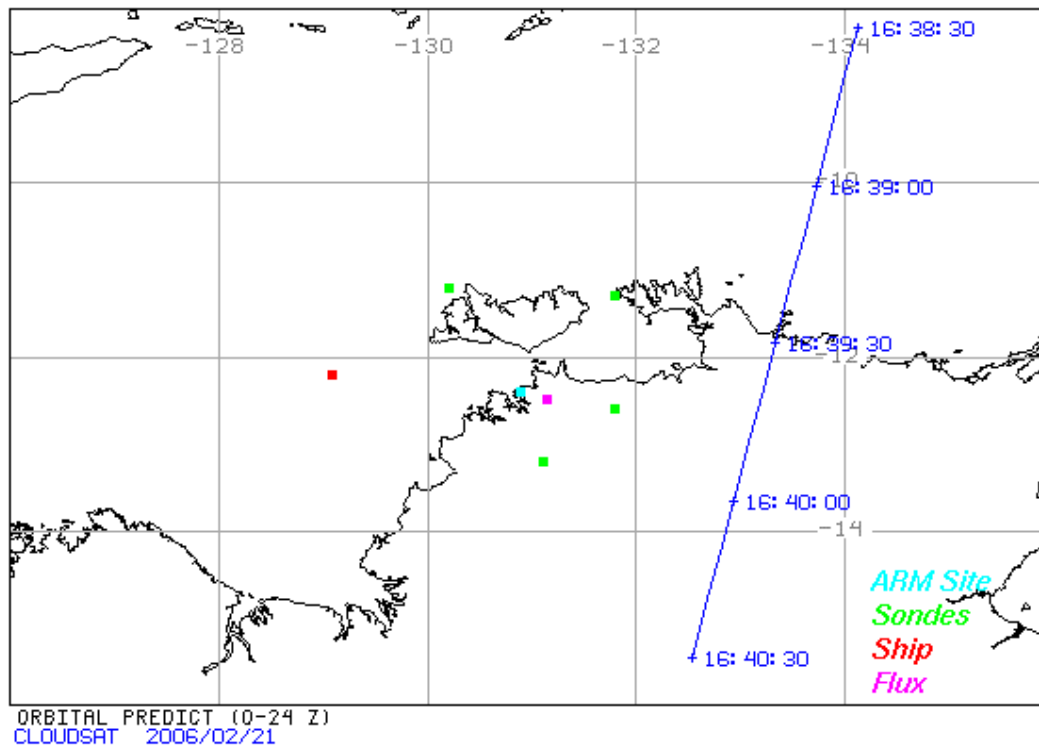


A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION



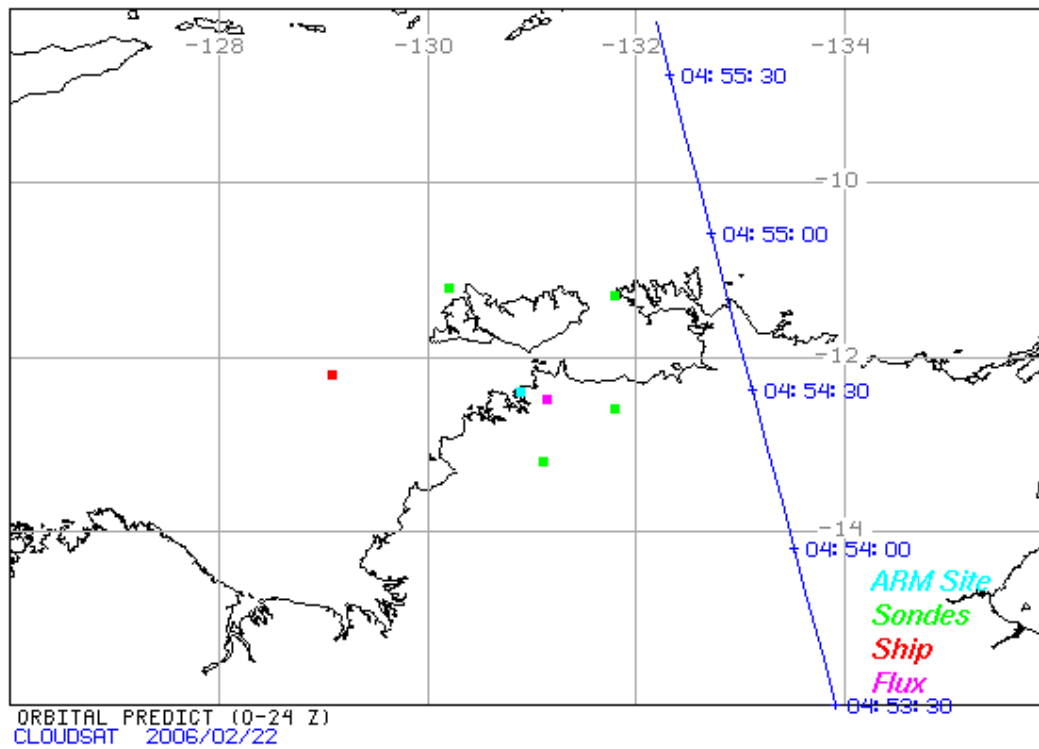


A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION



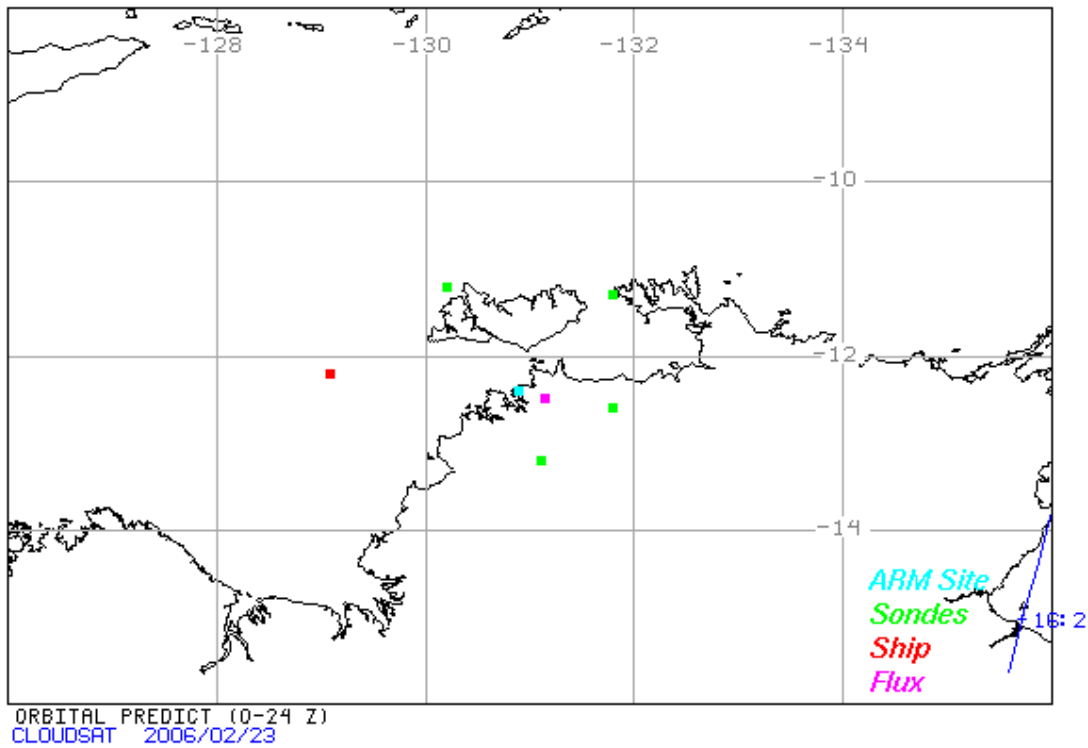


A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION



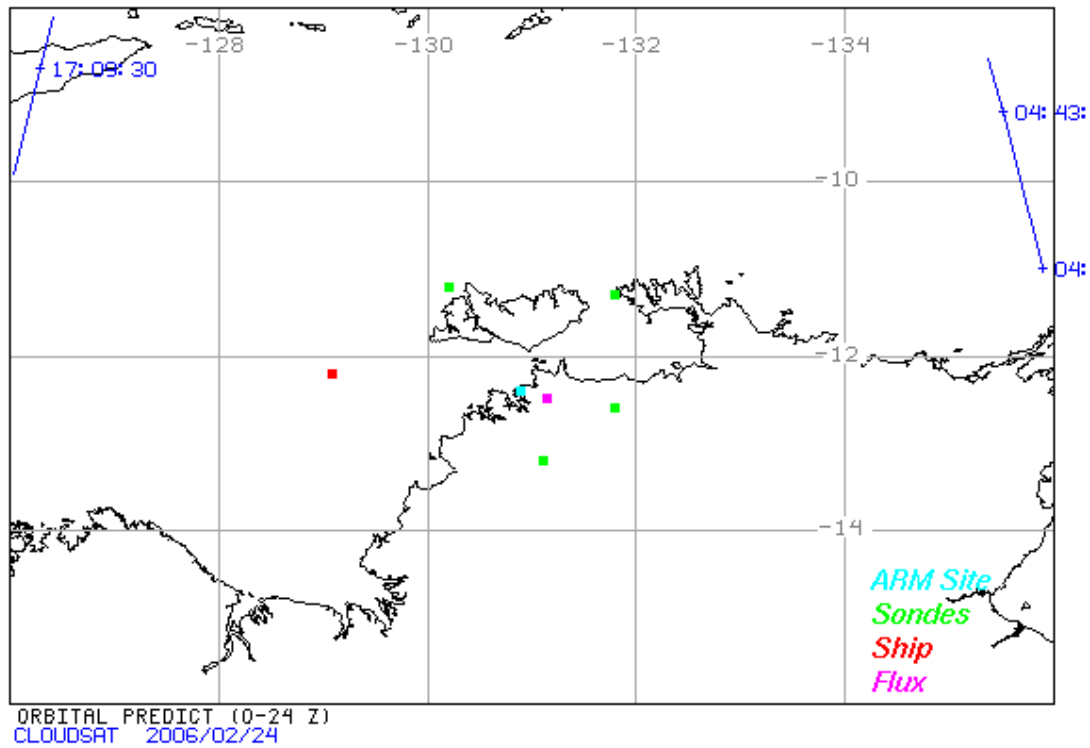


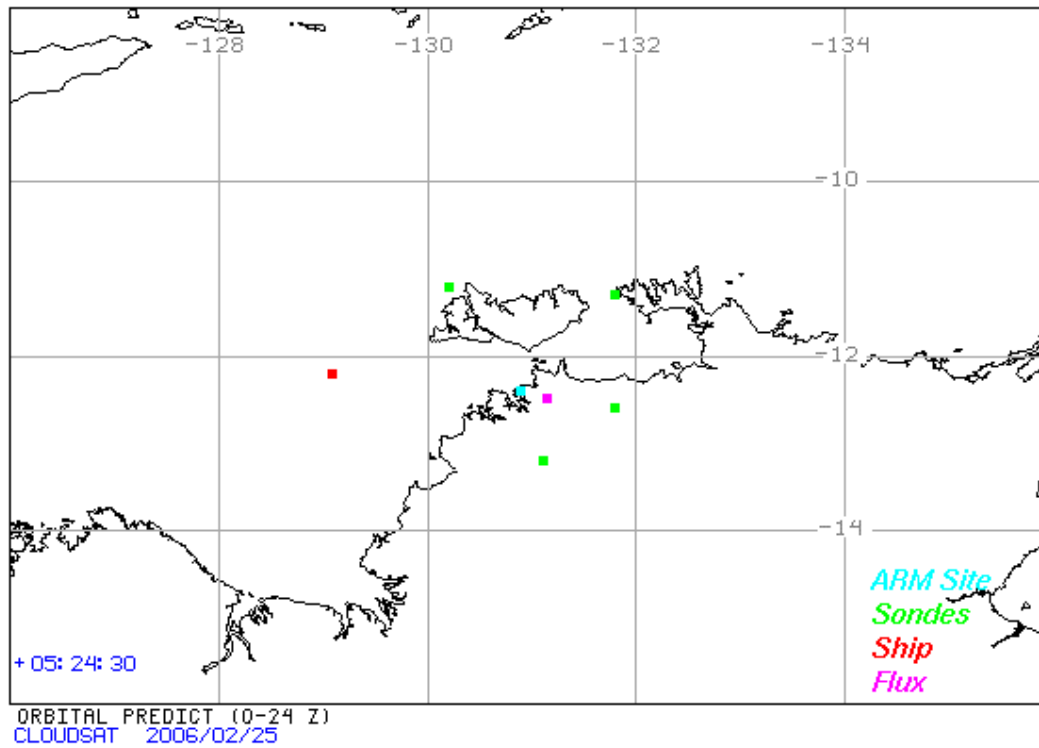
A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION

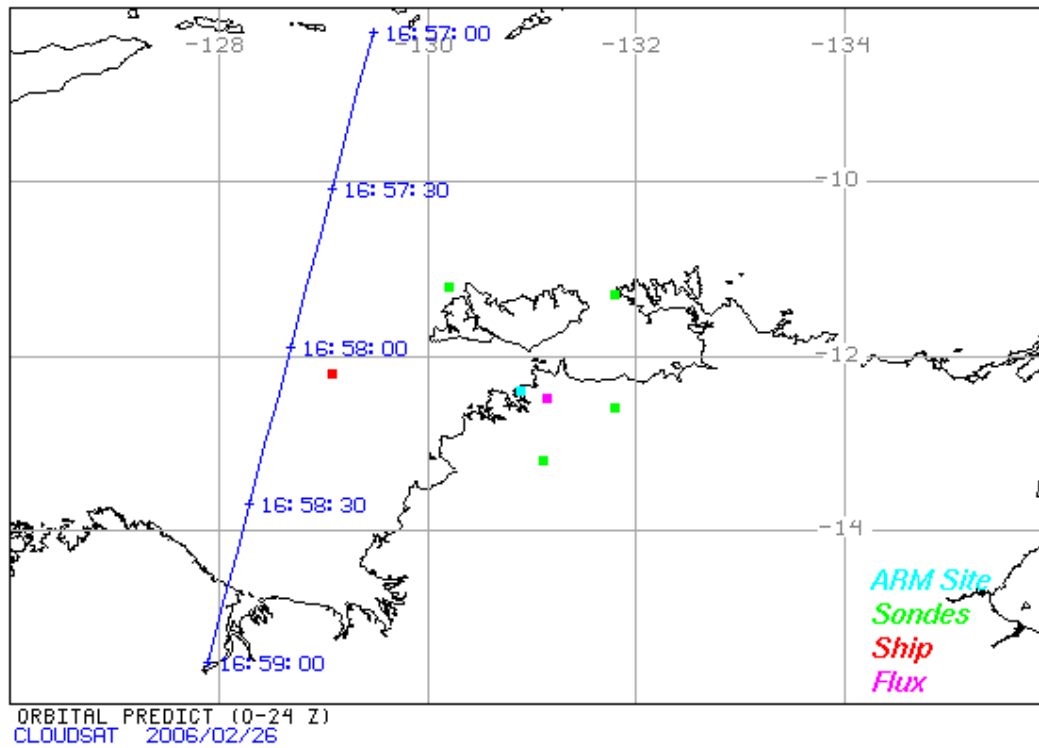




A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION









A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION

