



Science Mission Directorate Earth Science Division

ICCAGRA

**Interagency Coordinating Committee
for
Airborne Geosciences Research and Applications**

**May 21, 2008
Michael H. Freilich**

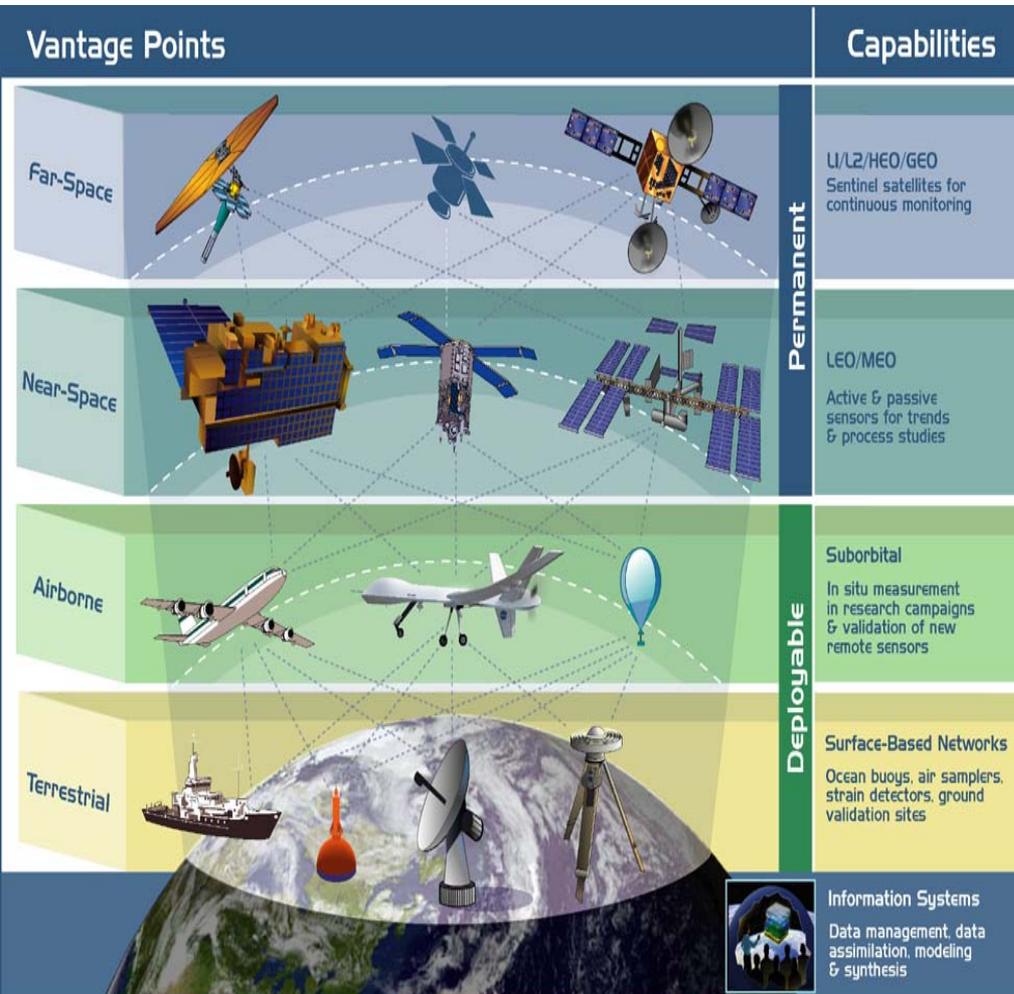


Earth **SCIENCE** Division Overview

- Overarching goal: to advance Earth System science, including climate studies, through data acquisition (spaceborne, **airborne**, surface), research and analysis, and predictive modeling
- Six major activities:
 - Building and operating Earth observing satellite missions, many with international and interagency partners
 - Making high-quality data products available to the broad science community
 - Conducting and sponsoring cutting-edge research in 6 thematic focus areas
 - **Field campaigns to complement satellite measurements**
 - Modeling
 - Analyses of non-NASA mission data
 - Applied Science
 - Developing technologies to improve Earth observation capabilities
 - Education and Public Outreach



Airborne Science Program



Program Objectives:

Satellite Calibration and Validation

Conduct Cal/Val data acquisition for Earth Observing System satellites

New Sensor and Algorithm Development

Reduce risk for new sensor concepts and algorithm development prior to committing sensors to spacecraft

Process Studies

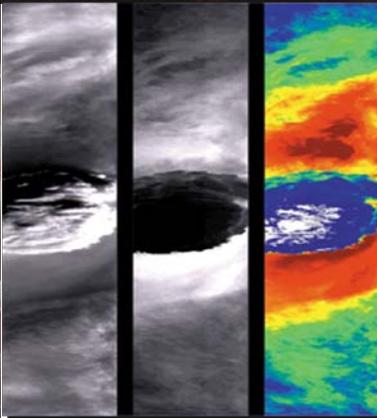
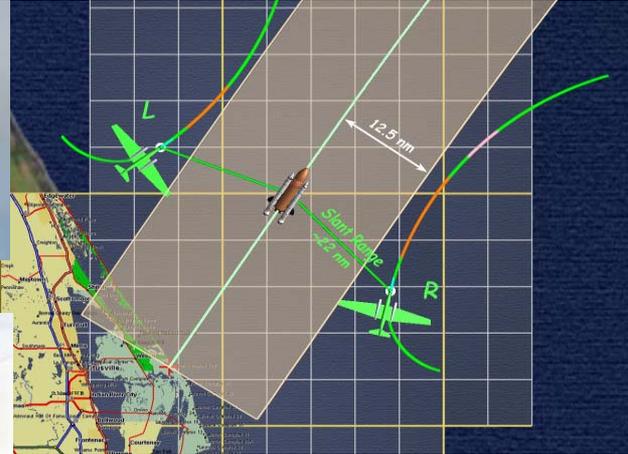
Acquire focused measurements with high spatial/temporal resolution, to understand small atmospheric and surface structures and to complement satellite data

Next Generation NASA Scientist and Engineer Development

Facilitate the development of our future NASA workforce by maturing our PI's, Project Scientists, Instrument Engineers, and Science Managers. Airborne programs typically last 12 to 24 months (compare with satellite programs lasting years to decades)



Heavy Lift High altitude fleet (50k+ feet)



MAMS, Hurricane Danielle

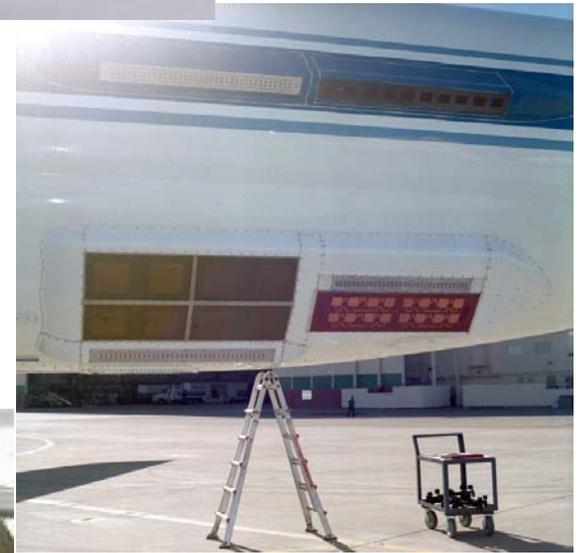


Freilich





Reconfigurable Large Flying Laboratories

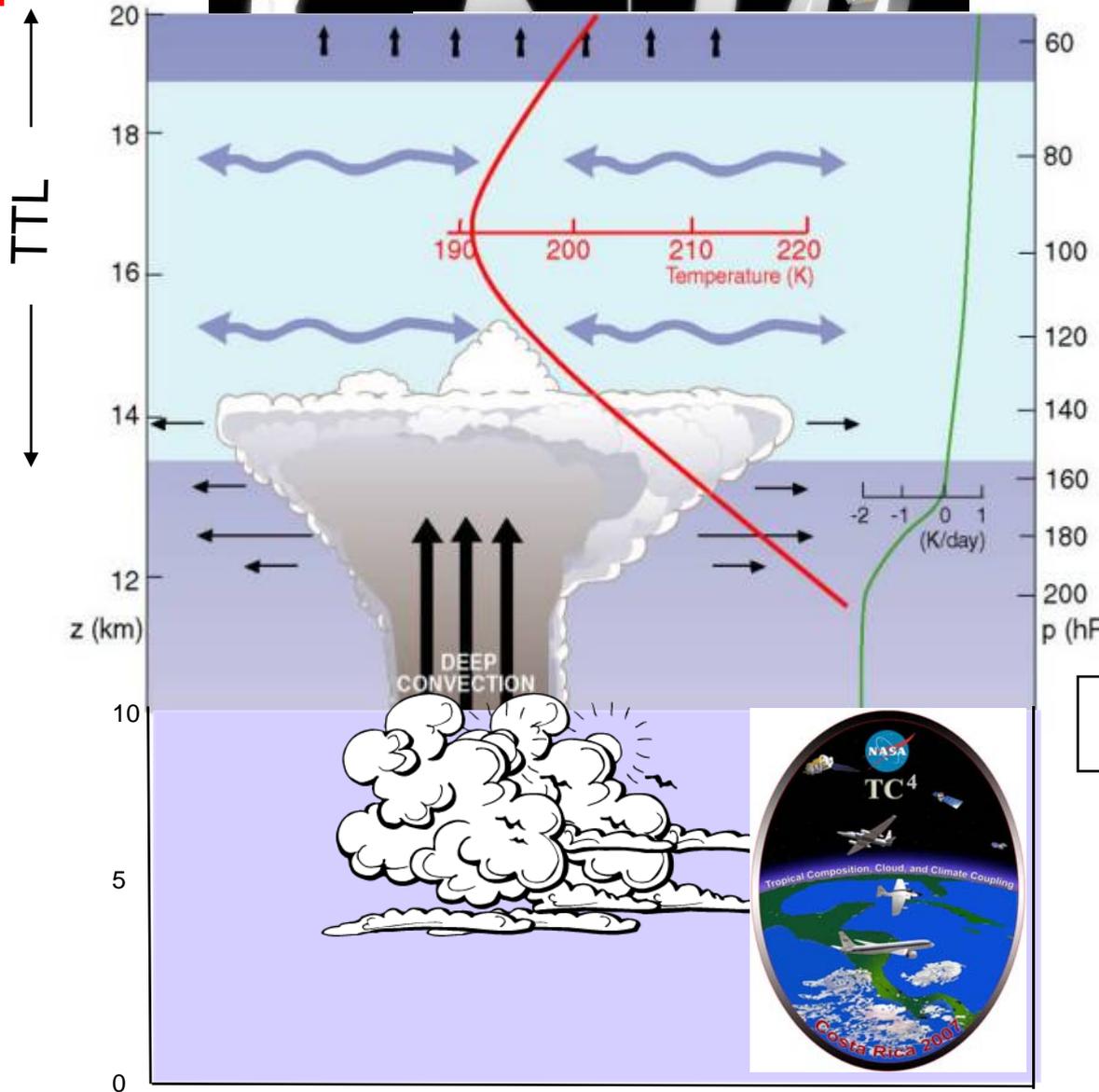




New Palmdale facility and DC-8, ER-2, G-III and SOFIA Program Stabilization



Sampling Strategy: TC⁴ Costa Rica, Panama, Galapagos, Houston



Remote Sensing
ER-2



Cloud physics,
TTL chemistry
WB-57



Cloud physics,
TTL chemistry,
Remote sensing
DC-8

**NPOL, SMART Ground Radar
& Balloon Sondes**





UAS NASA/NOAA Hurricane Mission 2007

- **Mission Review Status**

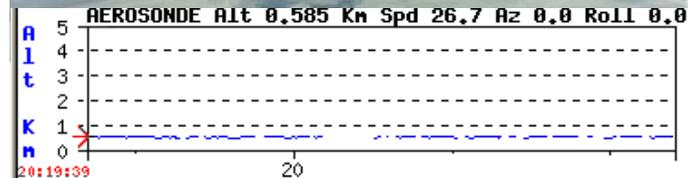
- Mission Readiness Review completed 8/31/07
- WFF King Air is the Aerosonde escort aircraft

- **Mission documentation completed**

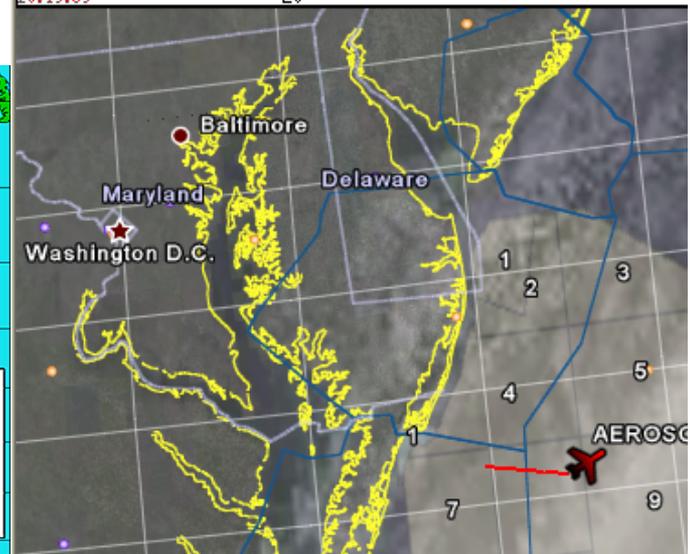
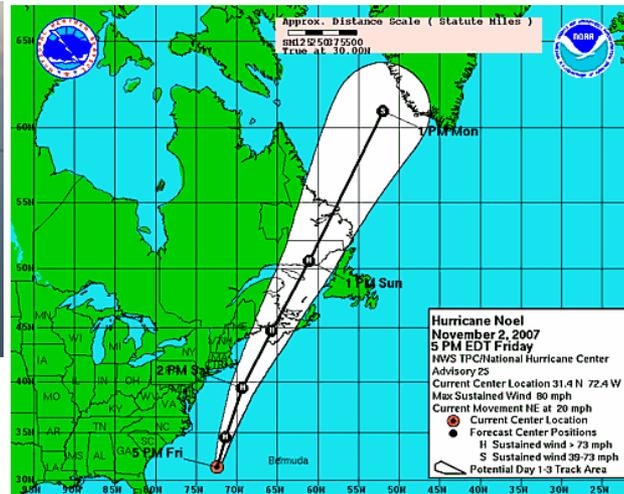
- Required mission documents signed off
- Improving display capability in Real Time Mission Monitor (RTMM) in Google Earth

- **Hurricane Noel 11/2/07**

- Flew Nov 2 from WFF
- Flew 17.5 hours at 500 feet from edge to eye, several vertical profiles to 5000 ft. First time this interaction data has been obtained
- Over 10 hours in the storm, before a controlled termination in the water
- Flown jointly with the NOAA P-3
- Potential FAA issue regarding interpretation of authorization to fly between Wallops and the COA issuing authority at FAA



7/21/2008



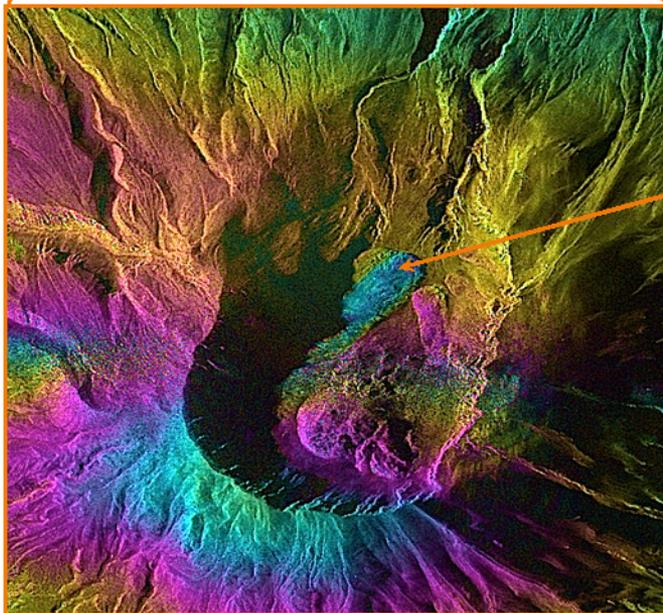
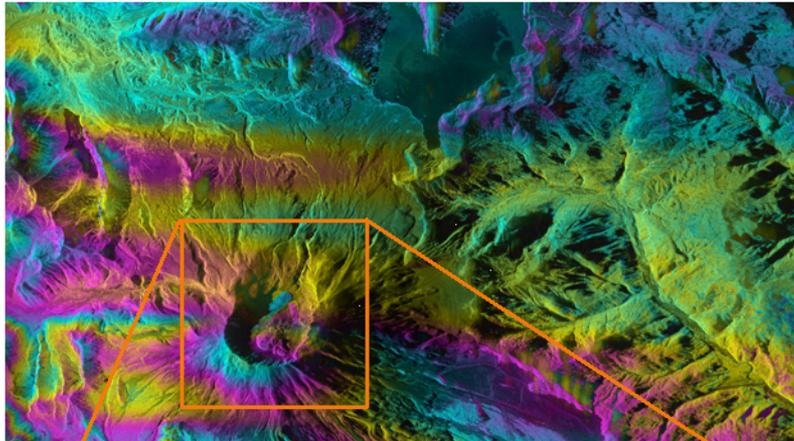


First Glacier Motion from UAVSAR

This ice field movement was validated using independent in situ measurements

JPL

Mt St Helens Interferogram - 4 hour Repeat

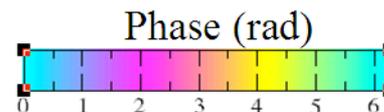


- This is a first cut interferogram



- Since time between observations is 4.2 hours or .174 days, the estimated rate of motion for an approximate π radians of phase change is

$$\dot{\rho} = \frac{\lambda\phi}{4\pi\Delta t} = \frac{0.24}{4 \cdot 0.174} = 0.344 \frac{m}{day}$$



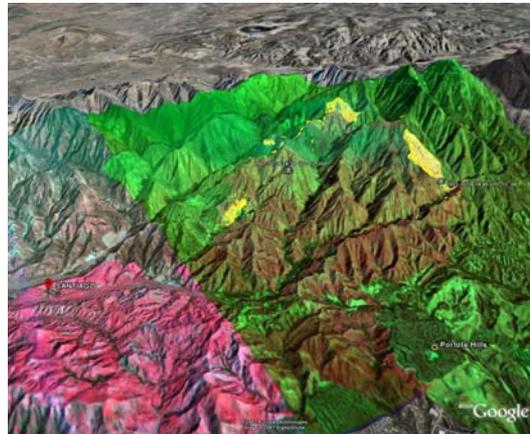


Western States Fire Mission 2007 – NASA/USFS/DHS - FEMA/CA OES

- Completed DFRC Airworthiness and Flight Safety Review Process
- Received Certificate of Authorization (COA) from the FAA
- Completed final checkout of Ikhana systems and Western States Fire Mission Payload
- Flew Fire Mission From Washington thru Idaho to San Diego – was on CNN, DHS supported the southern California extended mission
- Flights lasted up to 20 hours
- Presidential Briefing on mission



Southern California Oct 26, 2007 Santiago Fire

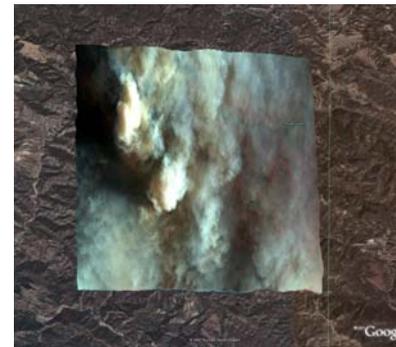


Zaca Fire
Morning Collect

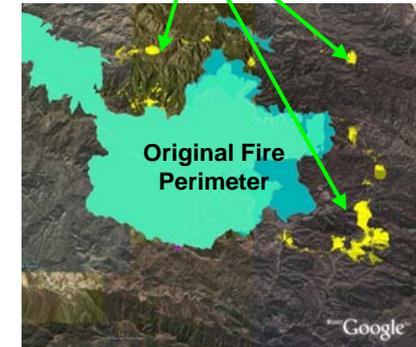
Afternoon - 6 hours later



Visible image below



Unknown Fires



I consider this an extraordinary success. I was standing in Area Command for the Zaca incident on the morning of the first flight. Our conversation surrounded the "fog of war" existing due to an inversion on the southeast corner of the fire... the incident management teams did not know where the fire was, and that information was critical to modify their strategy and initiate action. The intel provided by the UAV, real time and geospatially oriented, answered that critical question and saved precious hours.

Ed Hollenshead, Director
Fire and Aviation Management, Pacific Southwest Region - R5



MASTER on DOE B200 BAER and Post Rain October 07 & April 2008



Southern California Burn Areas (post rain)



**San Francisco Predawn Thermal
15 April**

Re-flw SoCal burn areas with MASTER
Re-flw MASTER over SF
For temporal change datasets



Arctic Research of the Composition of the Troposphere from Aircraft and Satellites

(ARCTAS)

A NASA contribution to IPY and the international POLARCAT initiative

<http://cloud1.arc.nasa.gov/arctas>



Conducted in spring and summer 2008 with the following foci:

1. **Long-range transport of pollution to the Arctic** (including arctic haze, tropospheric ozone, and persistent pollutants such as mercury)
2. **Boreal forest fires** (implications for atmospheric composition and climate)
3. **Aerosol radiative forcing** (from arctic haze, boreal fires, surface-deposited black carbon, and other perturbations)
4. **Chemical processes** (with focus on ozone, aerosols, mercury, and halogens)

April 2008: Fairbanks and Barrow, Alaska; Thule, Greenland

July 2008: Cold Lake, Alberta; Yellowknife, NW Territories

Partners: NASA, NOAA, DOE, NSF, Canada, France, Germany



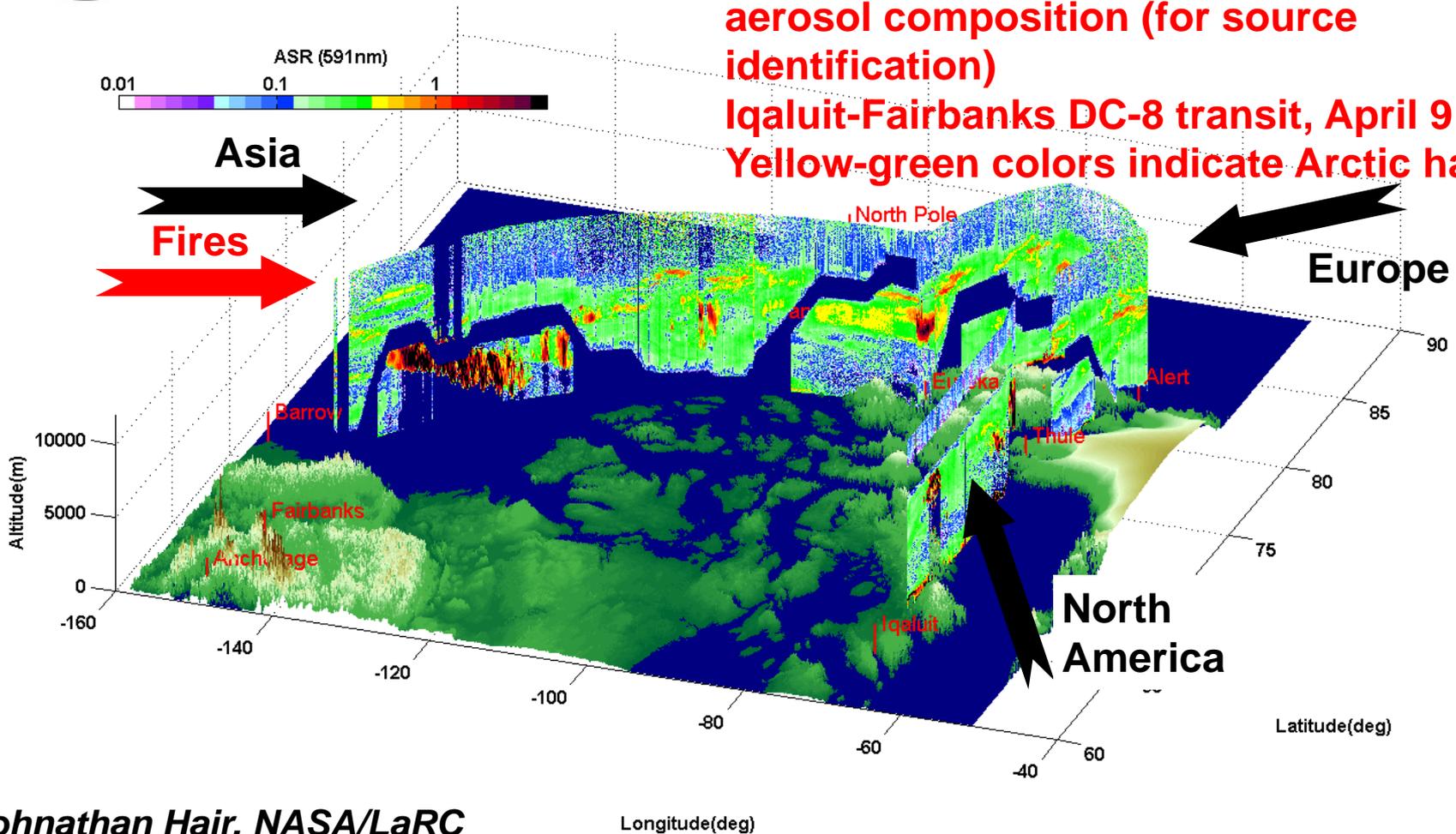


LIDAR INSTRUMENTS ON THE AIRCRAFT OBSERVE ARCTIC HAZE FROM THE SURFACE TO 30,000 FEET

Other instruments on the aircraft pinpoint the origin of this haze

DC-8 DIAL data show vertical aerosol distributions; DC-8 and P-3 measured aerosol composition (for source identification)

Iqaluit-Fairbanks DC-8 transit, April 9; Yellow-green colors indicate Arctic haze

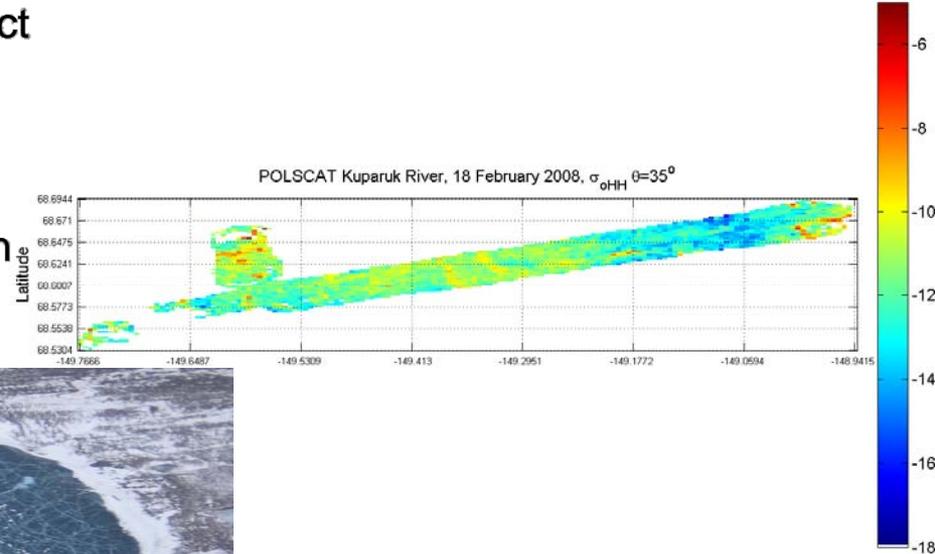




Cold Land Processes CLPXII

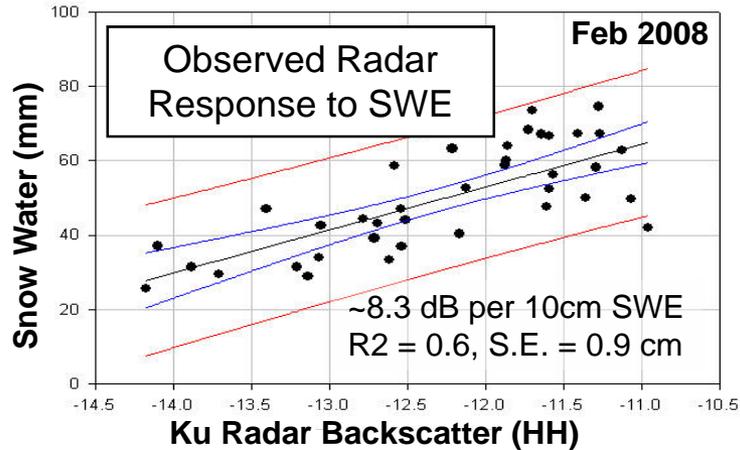
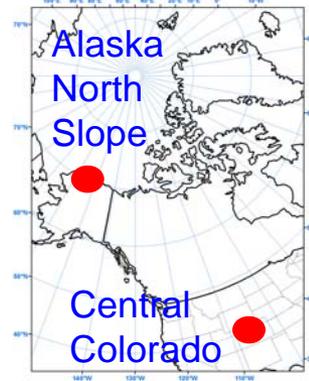
PolSCAT- Alaska Twin Otter flight Summary

- 45 Data flight hours over the North Slope project sites: Chandalar Shelf, Kuparuk River and Sag River.
- Twin Otter Based out of Fairbanks FBO
- Daily refueling stop at Bettles (midway between Fairbanks and North Slope)



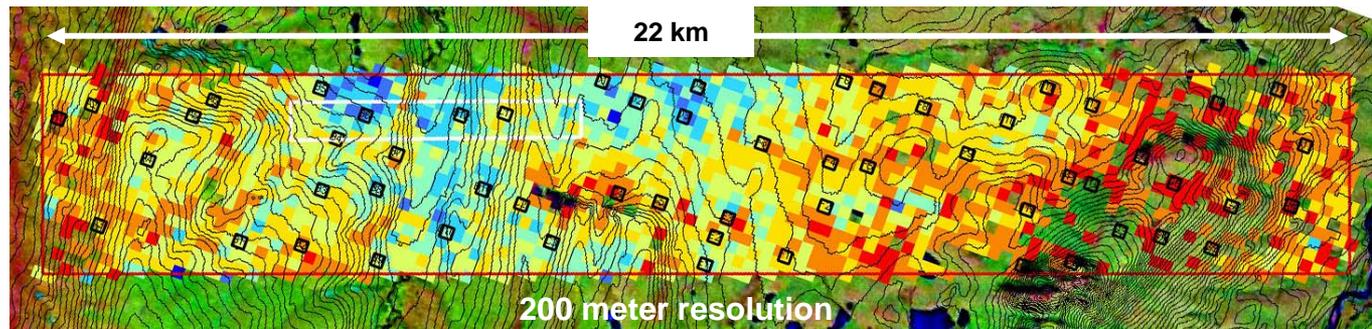
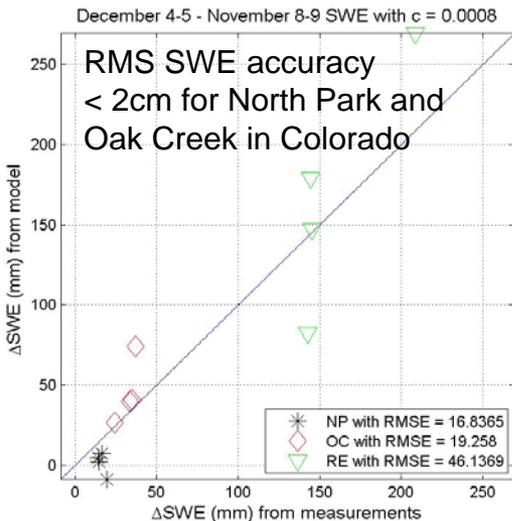
Objective: Validate use of radar remote sensing for high-resolution measurement of snow water storage (SWE) in Arctic and Mountain environments

CLPX-II Sites



CLPX-II quantified the high-sensitivity of Ku-band radar to the water content of typical snowpacks found in high-Arctic tundra regions and the Rocky Mountains.

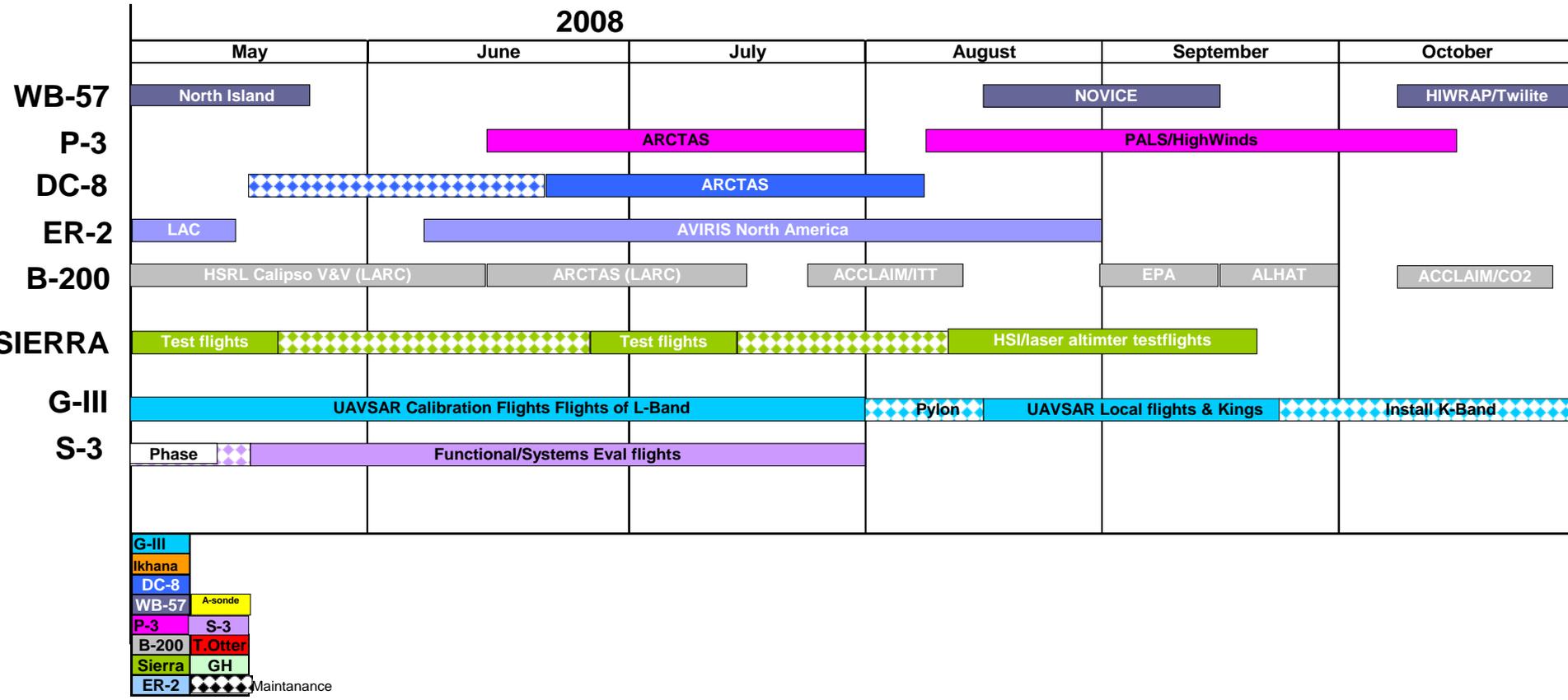
CLPX-II data verify strong radar sensitivity to SWE, and demonstrate that Ku-band radar can be used effectively for measuring SWE. Accuracy of 2 cm SWE or better was achieved in Colorado.



Result of SWE algorithm (inversion of first-order radiative transfer model) for one Alaska study area, correctly showing spatial patterns of observed snow water storage (red = low, blue = high). Intensive data collected on each black square will be used to examine algorithm results in greater detail.

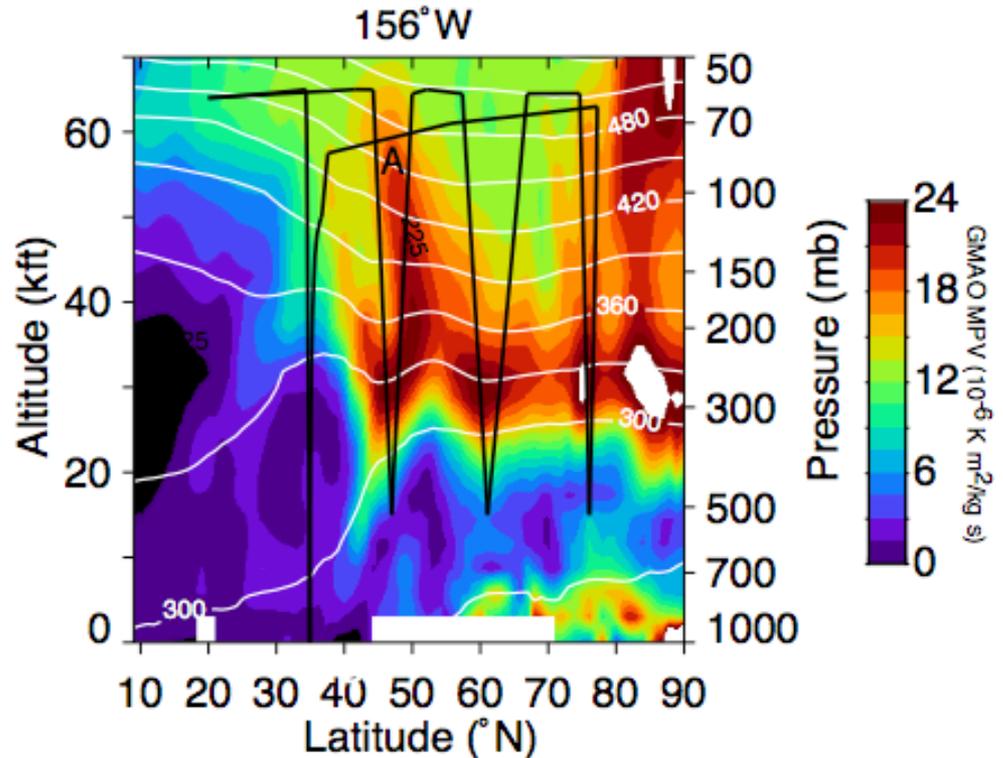
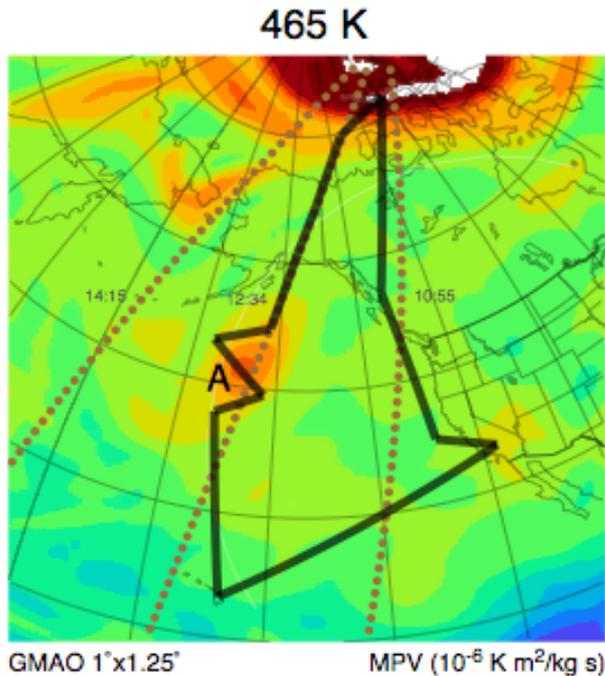


Near Term Earth Science Division Aircraft Activity





Coming Attractions (2009): GH UAS-AVE vortex fragment flight



30 hour flight

Objective 1: sample remaining polar vortex for ozone depleted air

Objective 2: sample polar fragment over Pacific

Objective 3: Coordination with Aura satellite overpass

Objective 4: Pole-to-tropics sampling of air masses

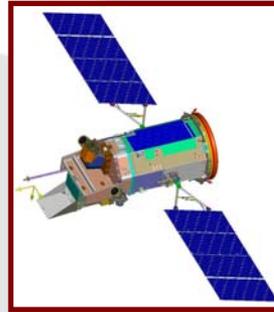
Missions in Formulation and Implementation



OSTM
6/2008



OCO
12/2008



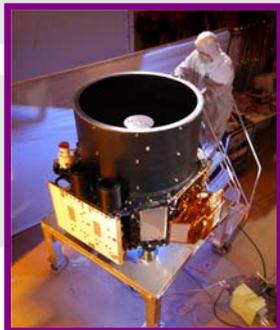
GLORY
6/2009



AQUARIUS
5/2010



NPP
6/2010



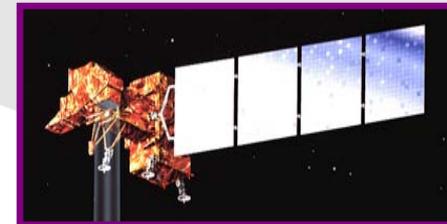
ICESat-II
2015



GPM
6/2013, 11/2014



SMAP
2012



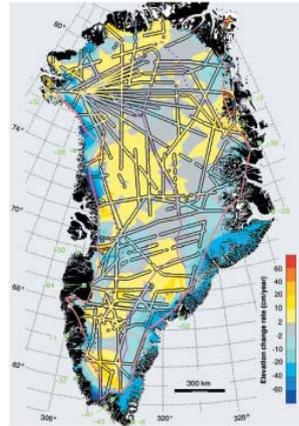
LDCM
7/2011



Airborne Science Program support to Early NASA Decadal Survey missions:
Instrument development and testing; on-orbit calibration; algorithm refinement

ICESAT II

Airborne instrument analogues: ATM, LVIS, GIFS, PSR



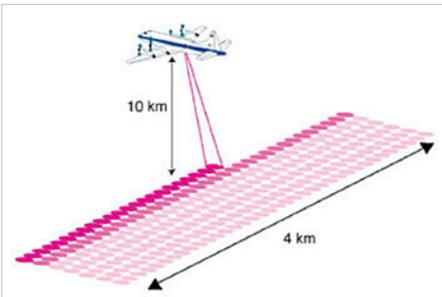
SMAP

Airborne instrument analogues: PALS, UAVSAR, Mirage Systems, IIP various



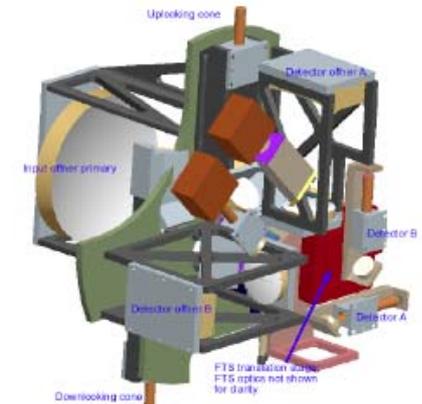
DESDynI

Airborne instrument analogues: LVIS, INFLAME, UAVSAR, IIP lidars



CLARREO

Potential airborne instrument analogues: INFLAME





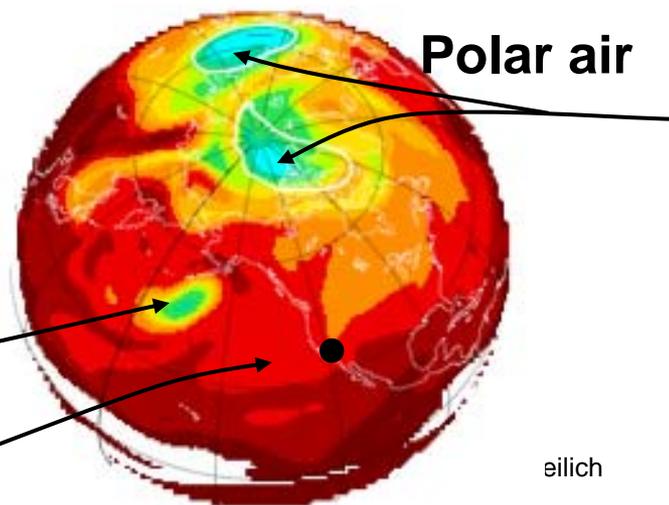
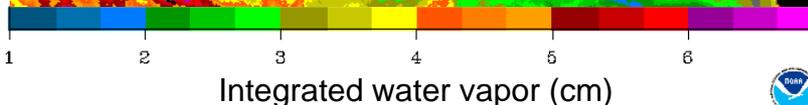
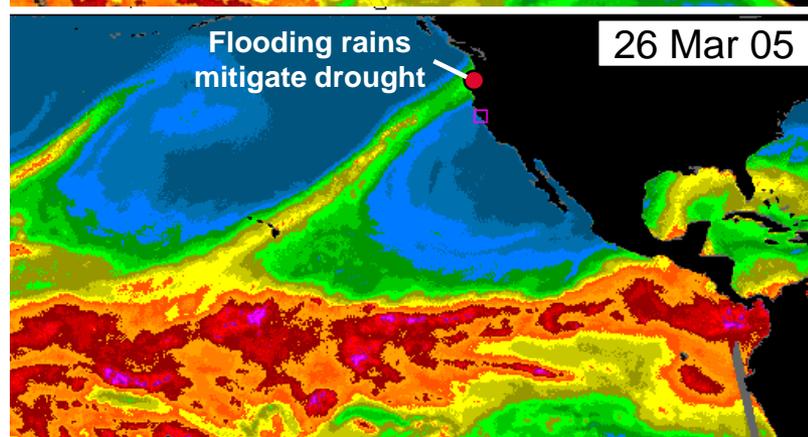
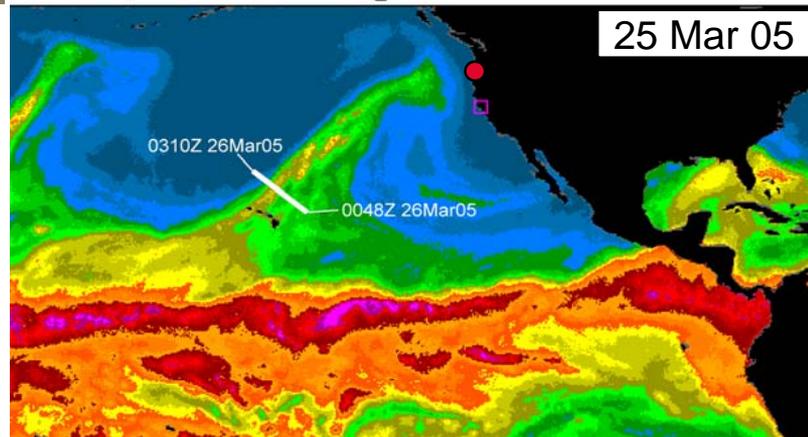
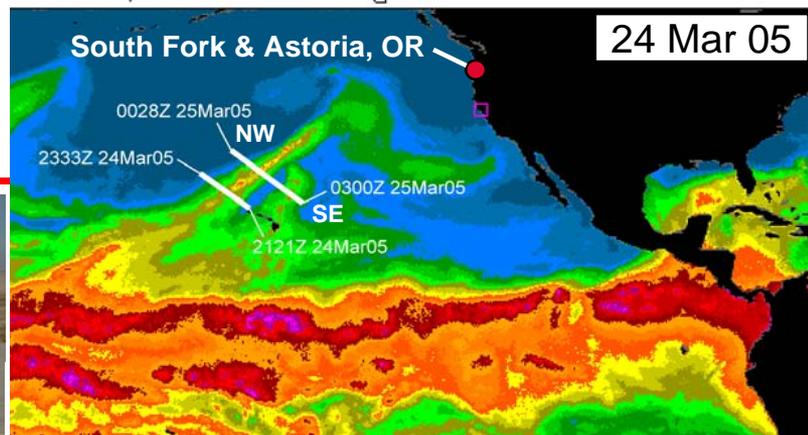
• BACKUP



NASA/NOAA Aura Validation Experiment 2009 UAS Mission

Instruments & Measurements:

- Long-lived gases:
 - CO, H₂, CH₄,
 - F11, F12, halon-1211
 - ozone, H₂O
- Aerosols
 - CNC (0.008 - 2µm)
 - FCAS (0.09 - 1µm)
- Cirrus ice particles
- UV-Vis spectrometer
- Meteorological parameters
- Dropsondes
- Cloud properties



Polar air in the mid-latitudes

Dryden

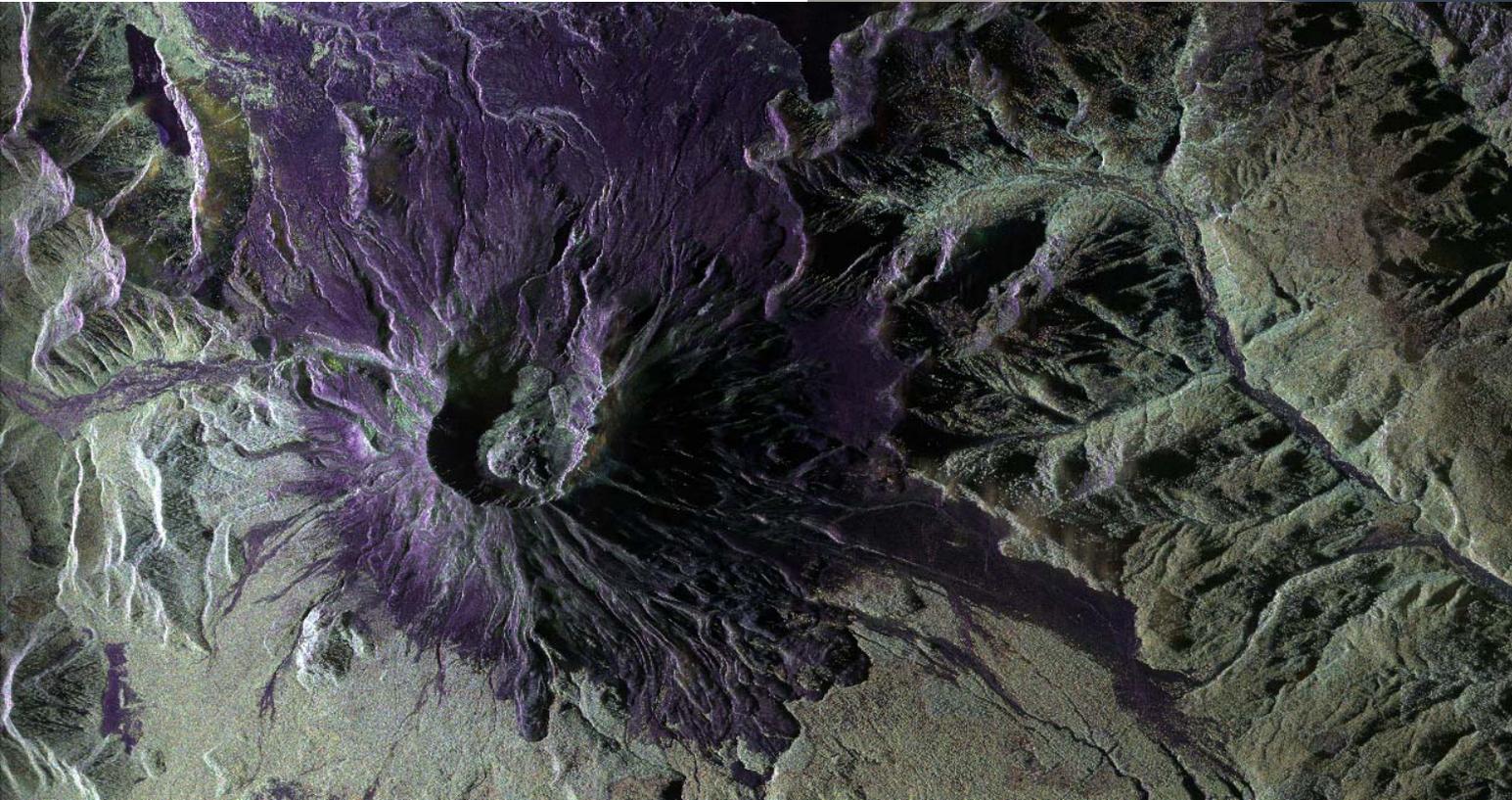
eilich





UAVSAR Image of Mt St Helens

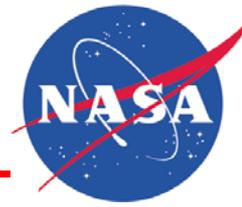
Using auto mode with full 24 element array





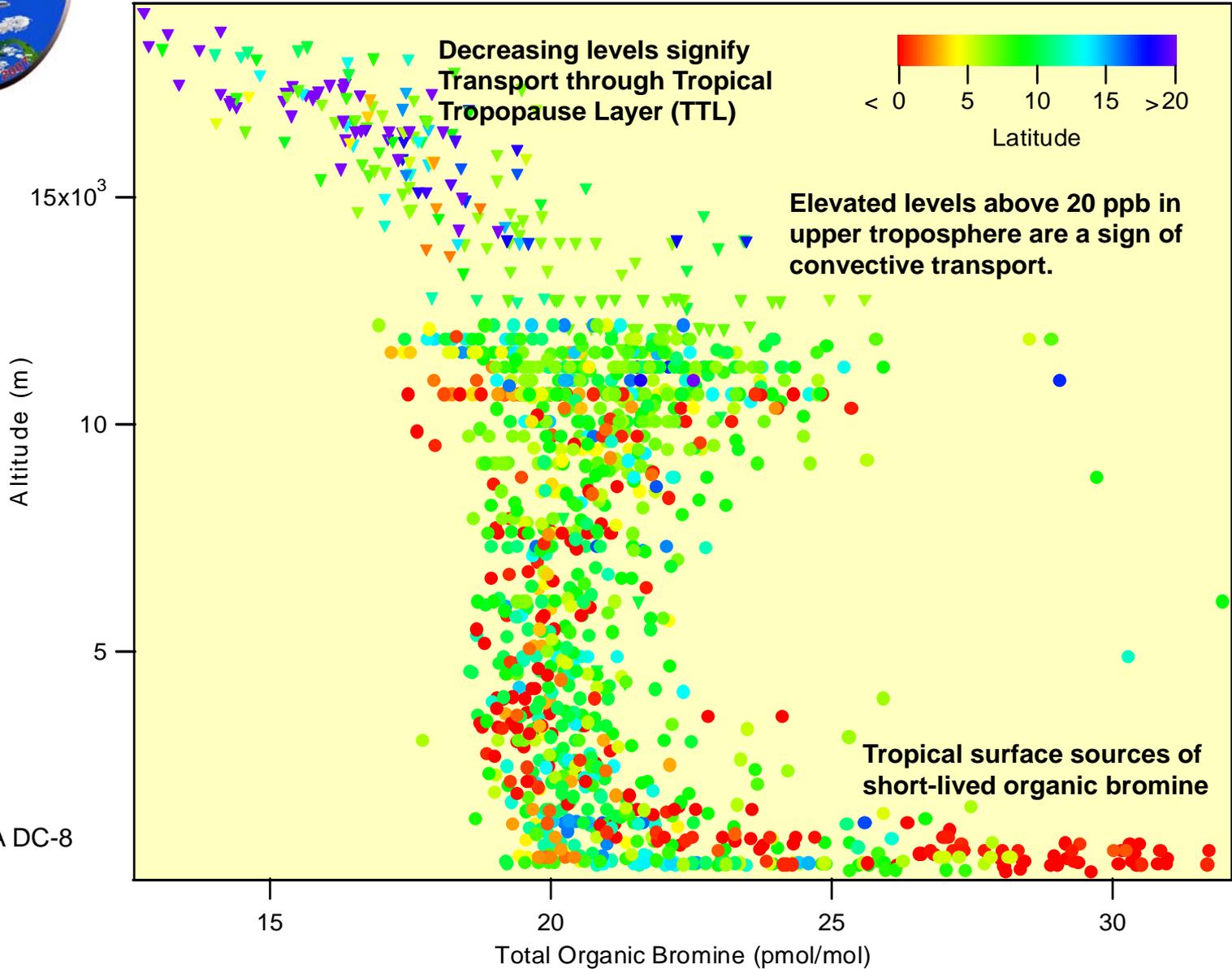
TC-4

- Mission Slide
- Data Slide



Tropical surface to stratosphere profile of ozone-depleting bromine source gases

Validating the models for the uplifting of these molecules



From NASA DC-8 and WB-57



UAVSAR

- Mission Slide
- Data Slide

- ESTO Developed



Western States Fire Mission

- Ikhana Mission Slide
- BAER DOE B-200 Slide
- City of San Francisco Thermal Budget tag along flight requested by ARC Center Director

- Applied Science Program

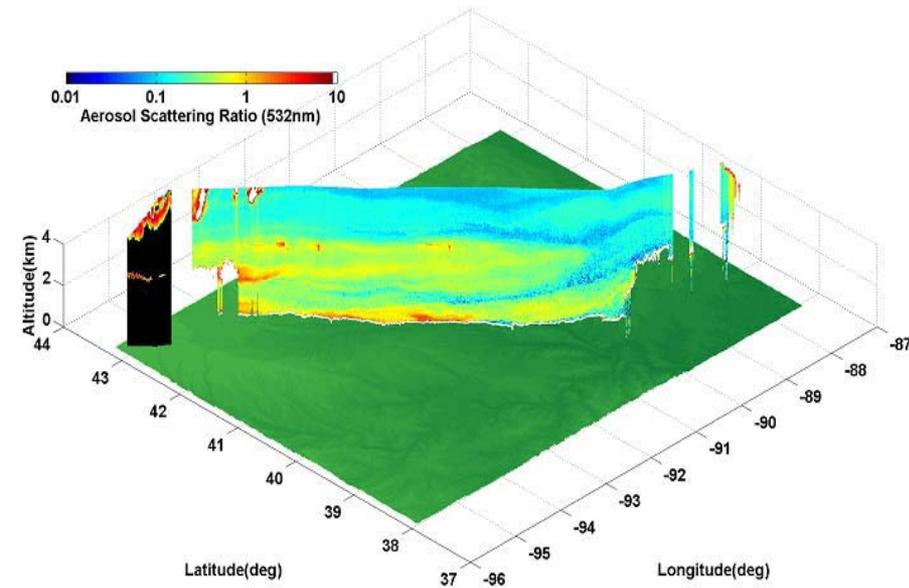


ARCTAS

- Mission Slide
- Early Data Slide, Only first phase completed second phase starts in a month
- Aircraft Slide with Movie in formation flight with NOAA P-3 and low altitude arctic sea flight from DC-8
- NASA/NOAA/Canadian/German



ARCTAS MISSION





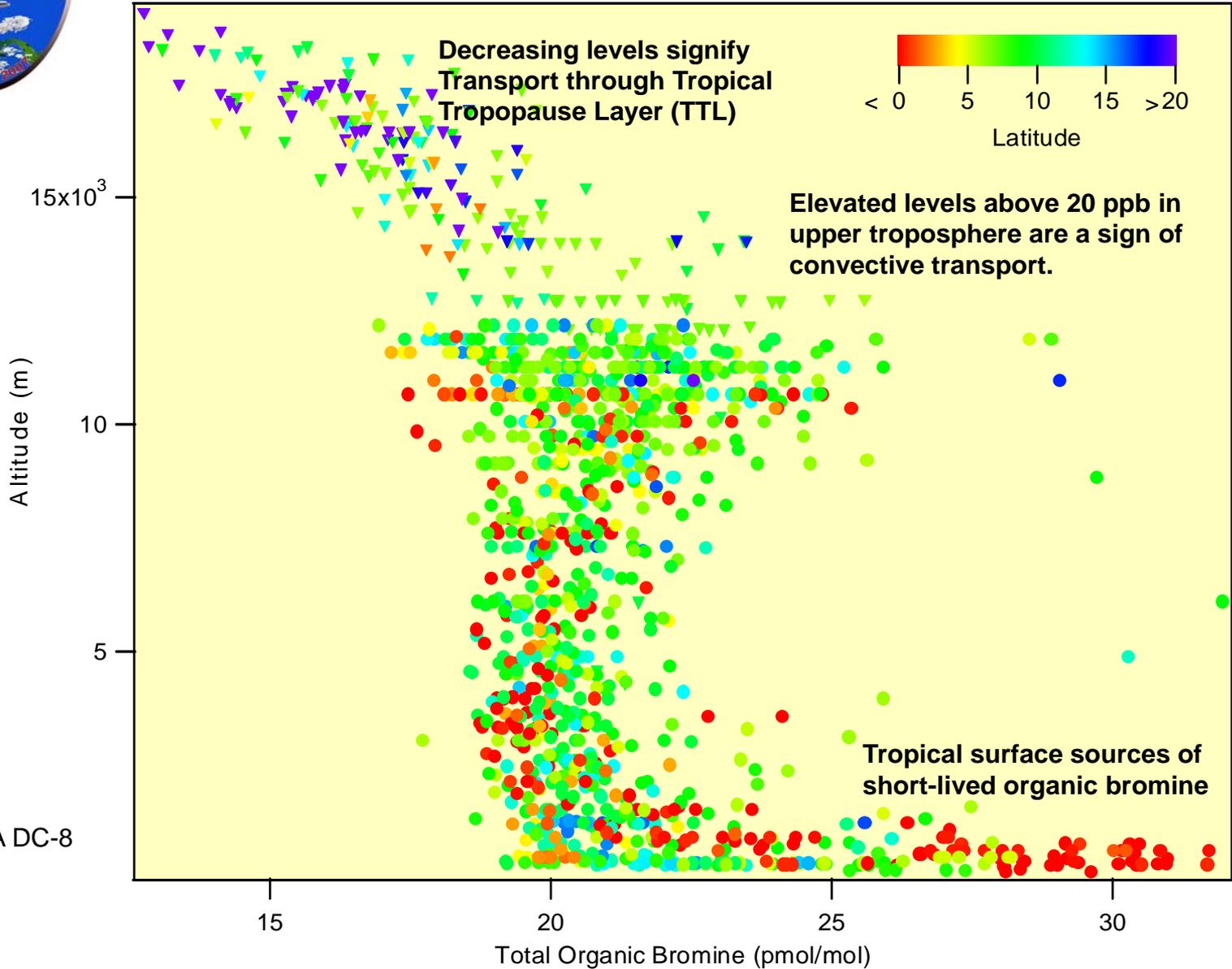
Cold Land Processes Exp.

- Mission Slide
- Data Slide



Tropical surface to stratosphere profile of ozone-depleting bromine source gases

Validating the models for the uplifting of these molecules



From NASA DC-8 and WB-57



NASA Unique Airborne Science Facilities

Unique, critical tools for the science community and the global observation satellite programs at NASA.

- Largest airborne science basing facility (Palmdale)
- Unique set of science aircraft routinely flying above 52,000 feet
- Unique set of rapidly reconfigurable large flying laboratories