The Role of Partnerships in Implementing NASA's Earth Science Research Program

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Overview of Talk

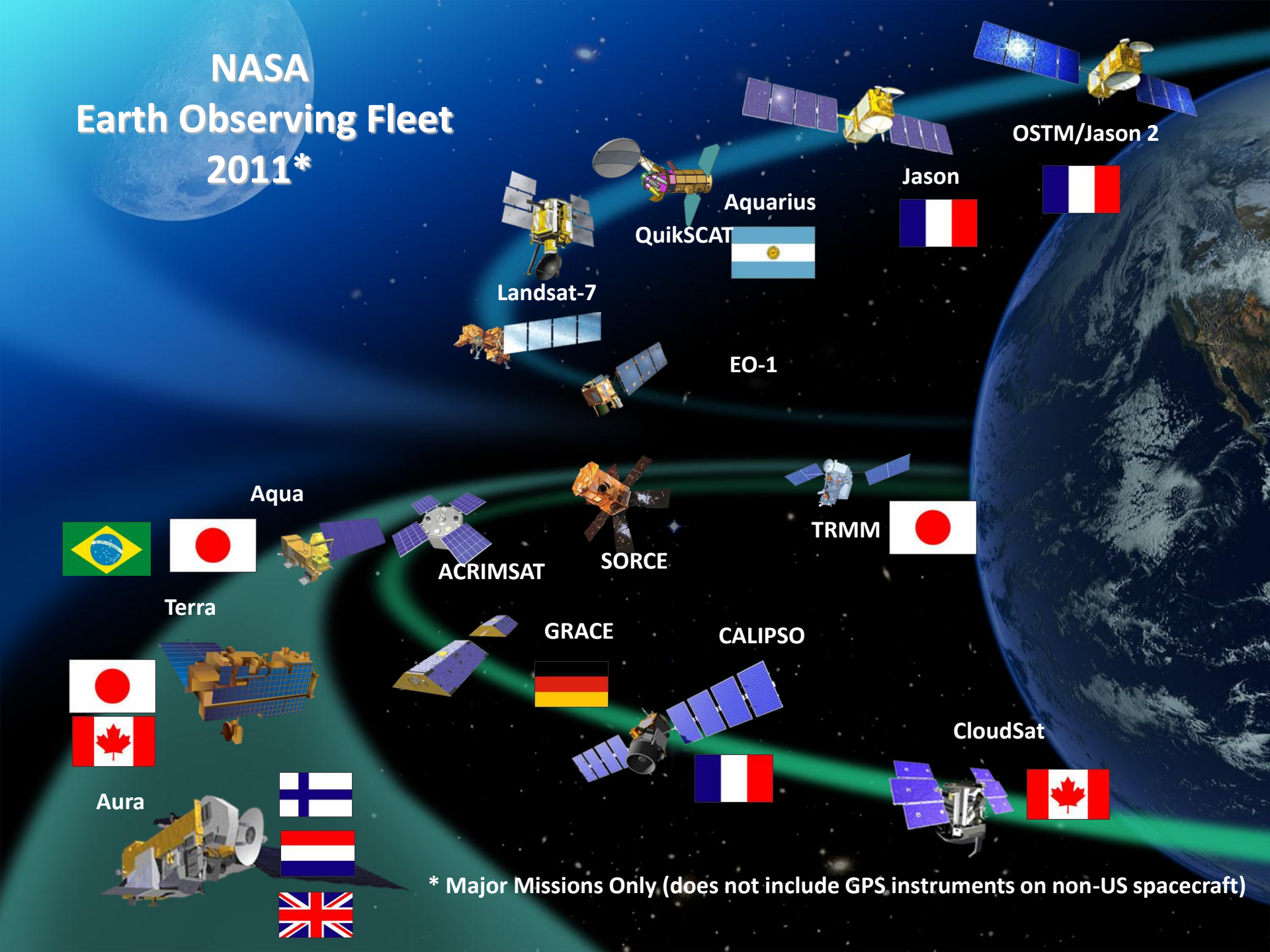
- Types of Partnerships critical to implementation of NASA Earth Science research program
  - Partnerships in obtaining data
  - Partnerships in storing, producing, and distributing data and products
  - Partnerships in conduct of scientific research
  - Partnerships in use of scientific data for societal benefit (discussed more fully in panel to follow by Lawrence Friedl)
  - Partnerships in education and public outreach
- Classes of partnerships can include (not limited to)
  - Interagency partnerships
  - International partnerships
  - Research community partnerships

Classes of Partnerships

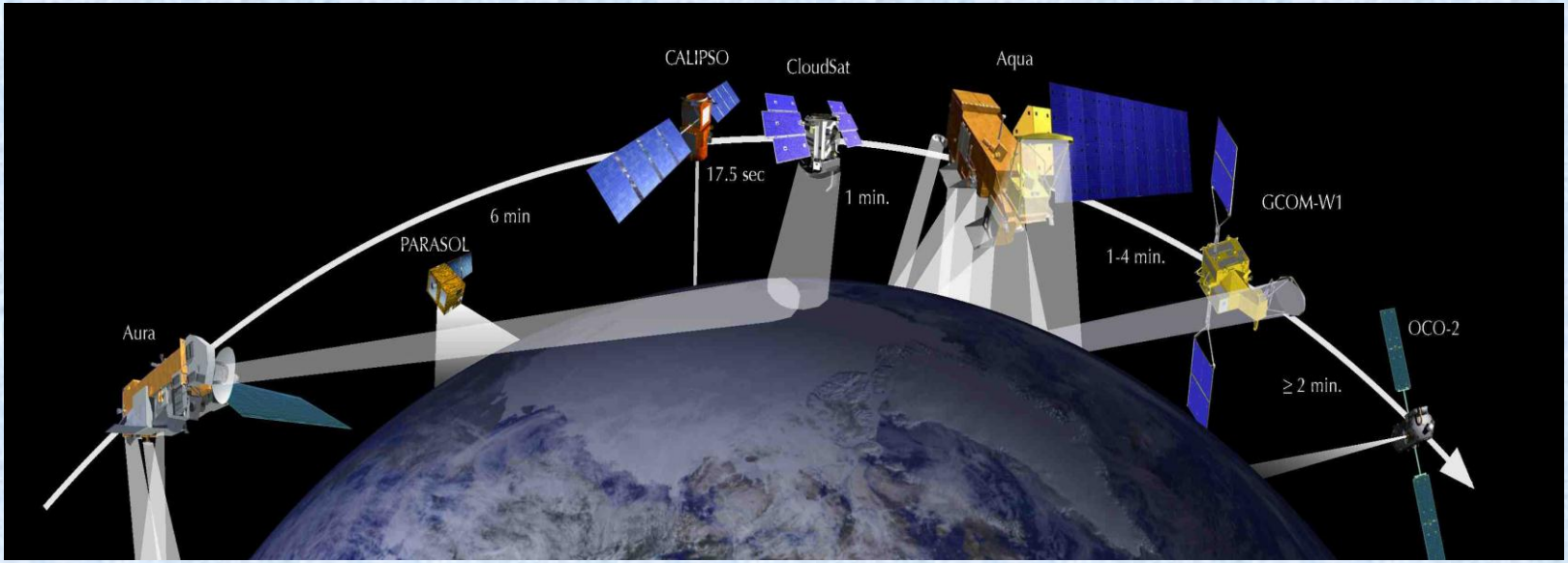
- Interagency Partnerships
  - Bilateral – especially for program implementation (NOAA for operational satellites, USGS for land imaging satellites)
  - Multiagency – especially through Congressionally and/or Administration developed programs
    - US Global Change Research Program
    - National Ocean Council
    - US Group on Earth Observations
    - Interagency Arctic Research Policy Council
    - Other Subcommittees of Committee on the Environment, Natural Resources and Sustainability
- International Partnerships
  - Bilateral – especially for program implementation
  - Multilateral – carried out under auspices of formal groups
    - Committee on Earth Observing Satellites
    - Coordinating Group on Meteorological Satellites
    - Group on Earth Observations
    - World Meteorological Organization
- Partnerships with Research Community
  - Groups traceable to UN and ICSU – e.g., World Climate Research Programme, International Geosphere-Biosphere Programme

Partnerships in Obtaining Data

- A significant fraction of data produced by and for NASA Earth Science Research Program involves partnerships
  - *Satellite data* – many missions are international (see diagram) and some involve close interagency partnerships
    - Operation of A-train requires close partnership
    - Validation efforts benefit enormously from partnerships
  - *Airborne missions* – many are carried out internationally, with basing and overflight required, and involve investigators from other agencies and nations
    - Availability of Global Hawk platforms involves a partnership
  - *Surface measurements* – majority are located internationally; several are part of international networks; some involve stations that are co-located with other observational infrastructure


NASA
Earth Observing Fleet
2011*
OSTM/Jason 2
Jason
Aquarius
QuikSCAT
Landsat-7
EO-1
Aqua
ACRIMSAT
SORCE
TRMM
Terra
GRACE
CALIPSO
CloudSat
Aura
* Major Missions Only (does not include GPS instruments on non-US spacecraft)

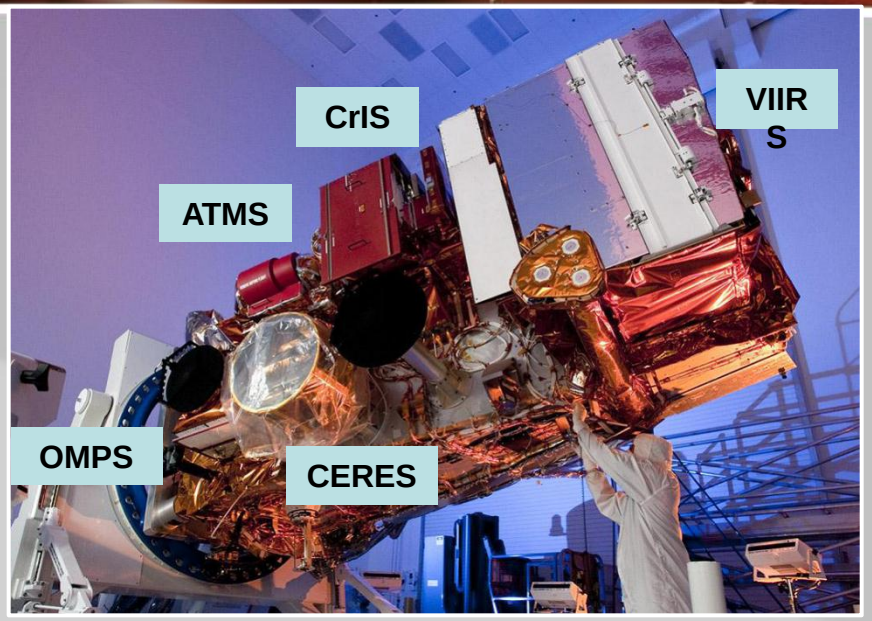
Formation Flying: the A-Train



CloudSat track

CALIPSO track; CALIOP laser

NPOESS Preparatory Project 10.26.11



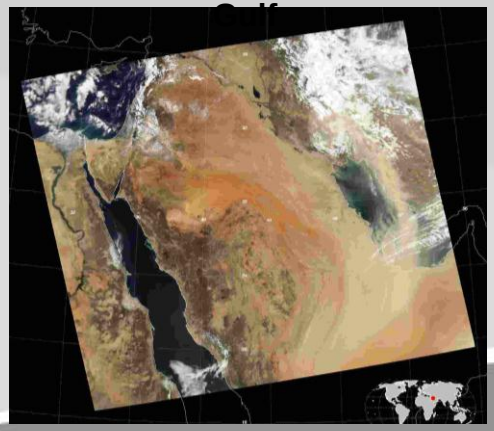
NPP observatory in the clean room

NPP's five-instrument suite of advanced ultraviolet, visible, infrared, and microwave imagers and sounders will improve the accuracy of climate observations, advance Earth science research, enable expanded applications of spaceborne measurements for societal benefit, and enhance weather forecasting capabilities for the nation. NASA has worked closely with NOAA and DoD in developing NPP.

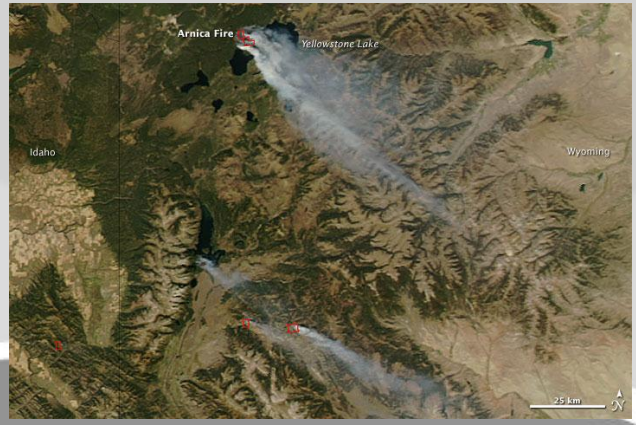
Glory's position in the A-Train

Hurricane Ike Forecast

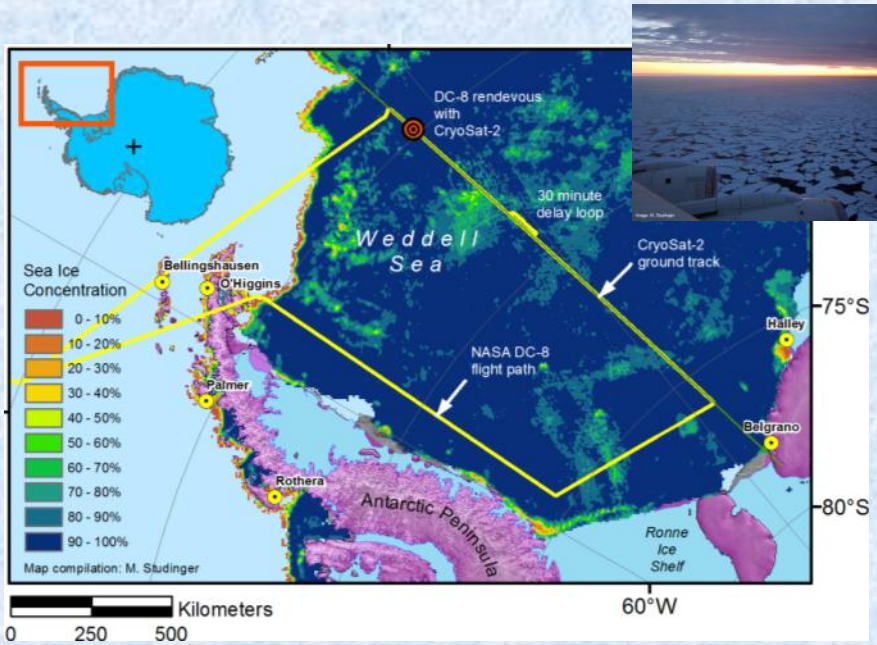
Heavy Dust over the Persian



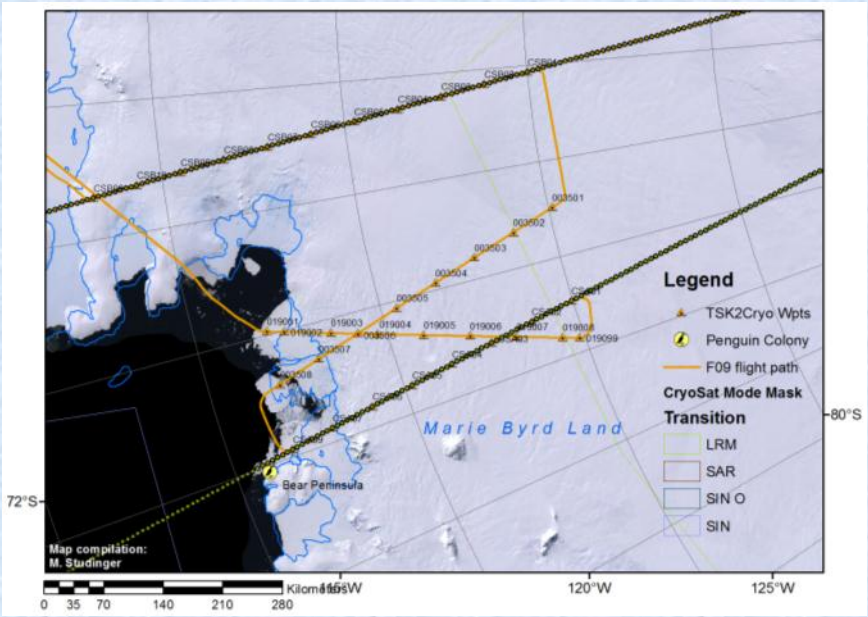
Smoke from Yellowstone Fires



Operation IceBridge (OIB) & CryoSat-2: Collaboration with ESA



- Two CryoSat-2 underflights conducted in near real-time during FY11 Antarctic campaign:
  - over sea ice in the Weddell Sea (left)
  - over the ice sheet in Marie Byrd Land (below)
- OIB team downloaded CryoSat-2 orbit data from ESA immediately before taking off from Punta Arenas
- They generated ground track and determined the rendezvous point in-flight to Antarctica



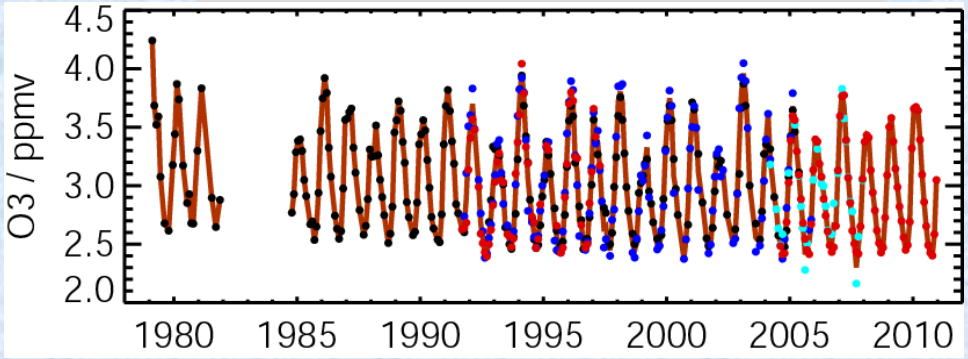
- During this campaign, ESA postponed a software patch to the CryoSat-2 mass memory to avoid interfering with planned OIB activities
- ESA has proposed developing a joint campaign implementation plan with NASA to coordinate future IceBridge and CryoSat-2 activities
- They believe that this would be a natural extension of the more intensive cooperation already in place for CryoSat-2 and ICESat calibration/validation

Changes in stratospheric composition

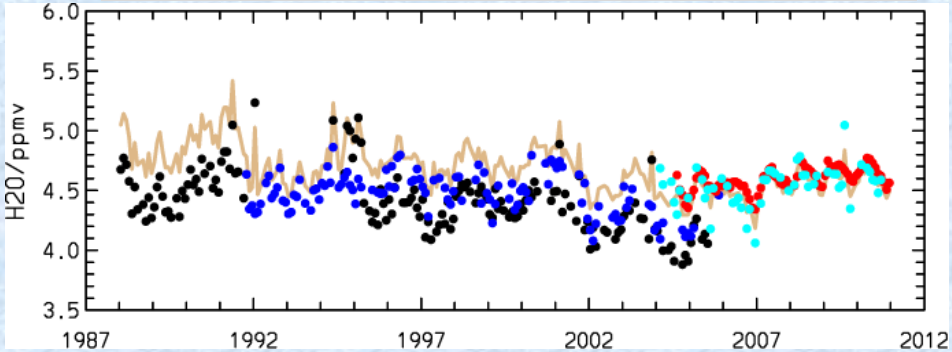
- **Projects are being developed to follow long-term global time series for ozone and other gaseous profiles - and merge various datasets**

Ozone (O_3) and water vapor (H_2O)

Ozone (46 hPa, 40˚N - 50˚N)

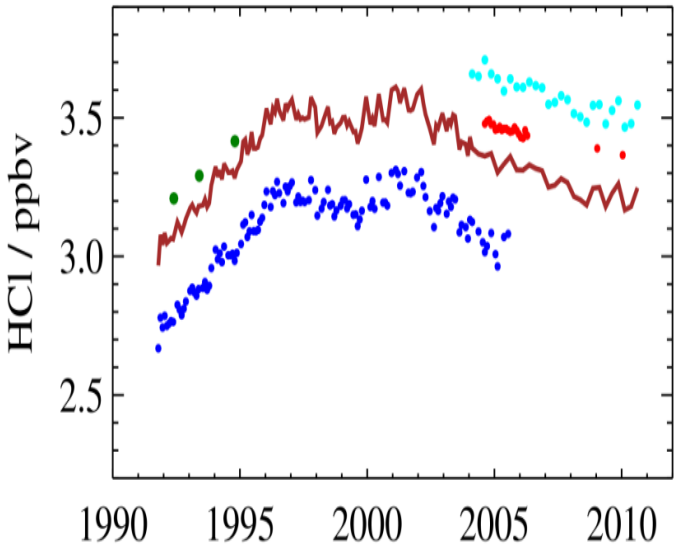


Water Vapor (46 hPa, 40˚N - 50˚N)



Reservoir for strat. chlorine: HCl (from CFC emissions)

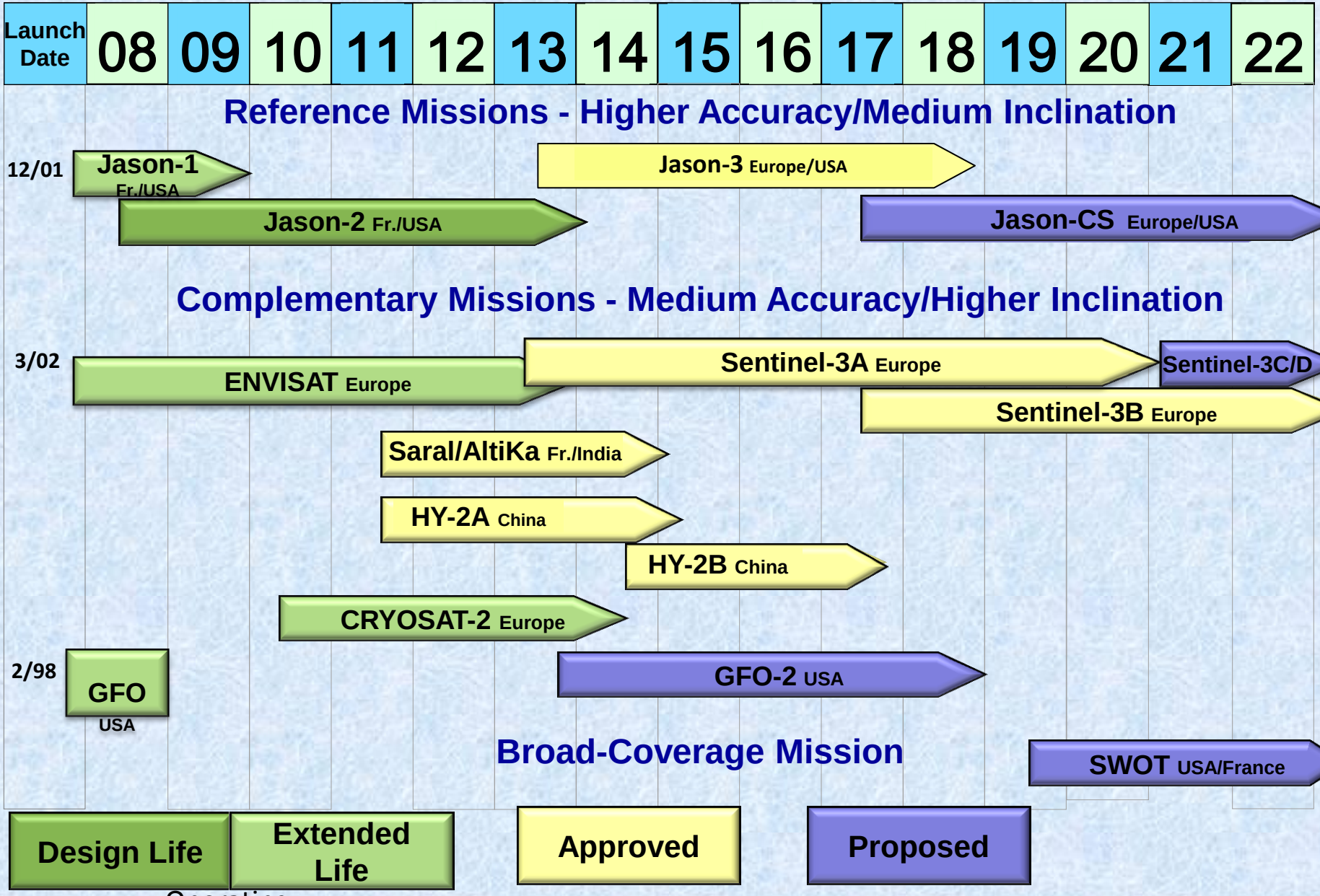
Global HCl (0.5 hPa)



Data: SAGE I & SAGE II, HALOE, MLS (UARS & Aura), ACE-FTS, ATMOS + merged data

NASA MEaSUREs GOZCARDS project (Lucien Froidevaux et al.)

GLOBAL ALTIMETER MISSIONS



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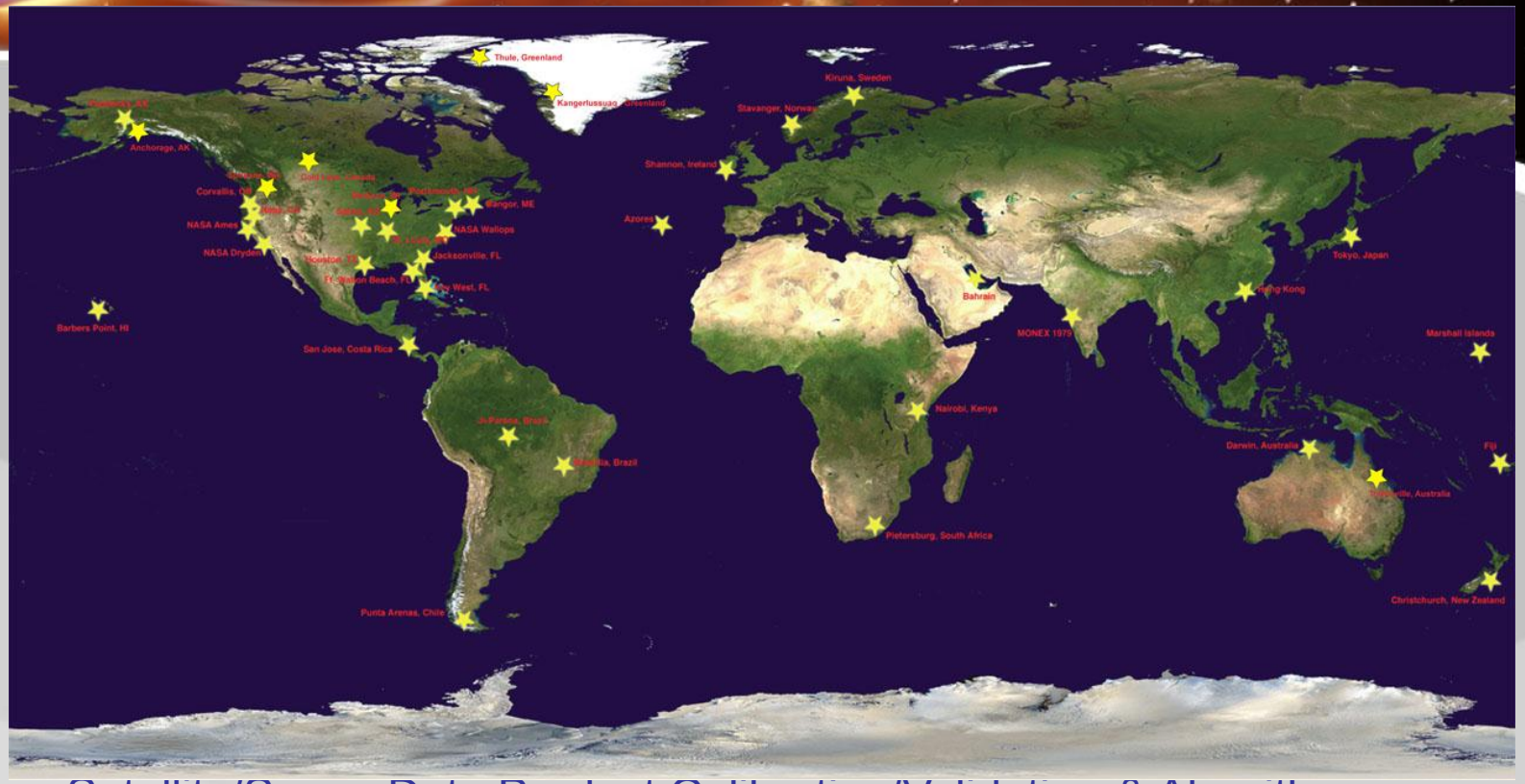
National Aeronautics and Space Administration

Airborne Science Program

Observing Platforms for Earth System Science Investigations

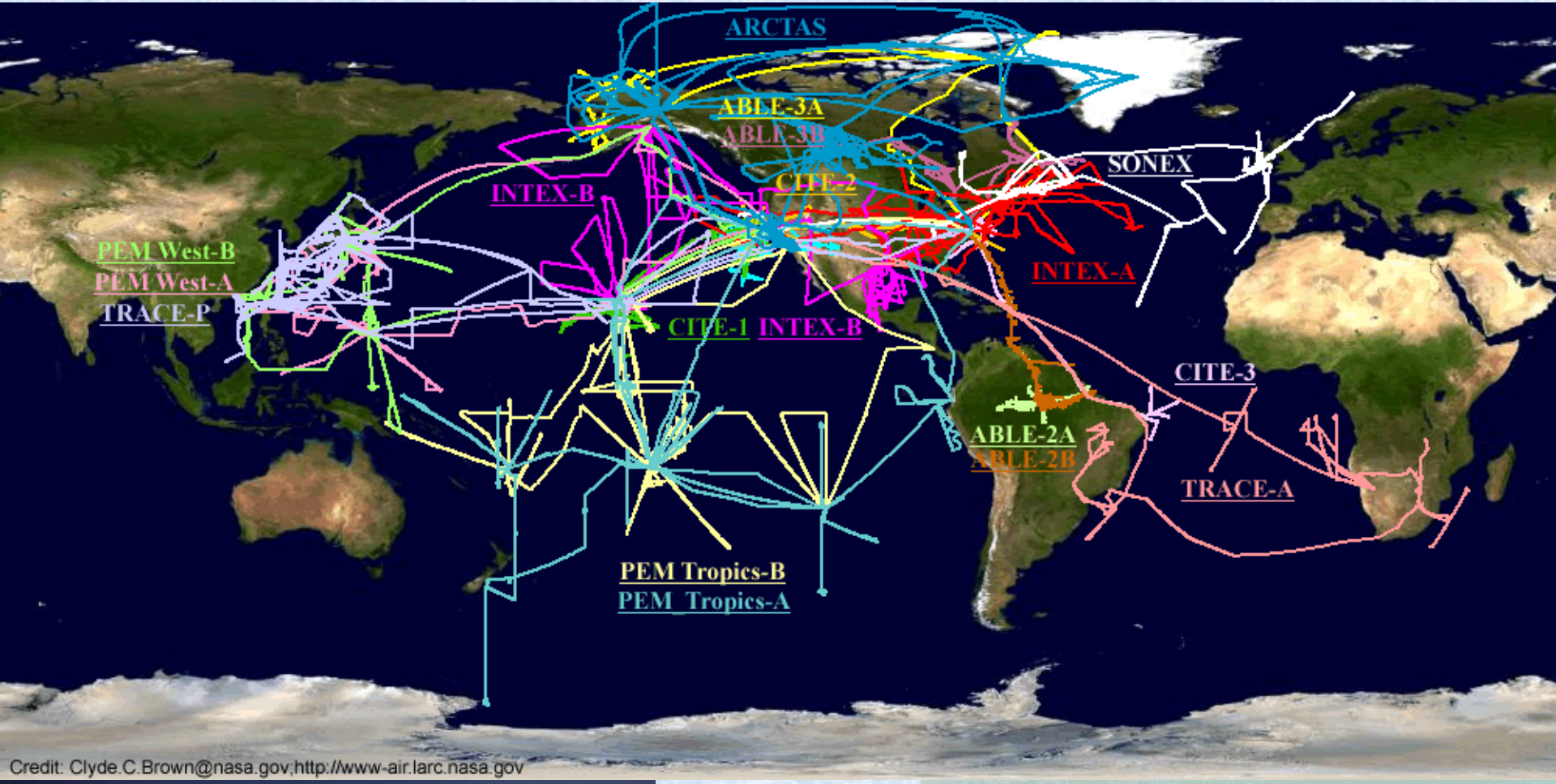
www.nasa.gov

Airborne/Suborbital Campaigns Provide Global Access to Regional Processes



- Satellite/Space Data Product Calibration/Validation & Algorithm Development
- Process Studies & Model Validation
- Applications Development & Demonstration
- Space Sensor and Remote Sensing Technology Development & Demonstration
- Future capability for focused observations of persistent but finite phenomena and hazardous operations (UAVs)

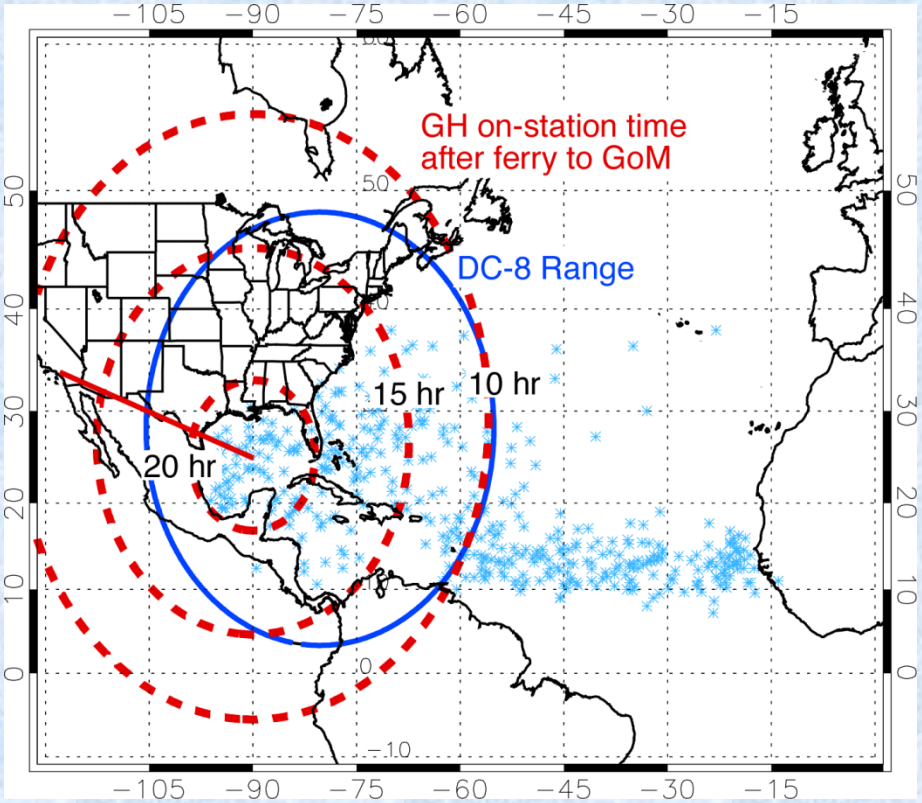
NASA Tropospheric Chemistry Field Campaigns (1983-2008)



GRIP: (Hurricane) Genesis and Rapid Intensification Processes Field Experiment

- Global Hawk (UAV) (240 hours)
  - Radar (Heymsfield/GSFC), Microwave Radiometers (Lambrigtsen/JPL), Dropsondes (NOAA), Electric Field (Blakeslee/MSFC)
  - Geosynchronous Orbit Simulation
- DC-8 four engine jet (120 hours)
  - Dual frequency precipitation radar (Durden/JPL)
  - Dropsondes (Halverson/UMBC), Variety of microphysics probes (Heymsfield/NCAR)
  - Lidars for 3-D Winds (Kavaya/LaRC) and for high vertical resolution measurements of aerosols and water vapor (Ismail/LaRC)
  - In-situ measurements of temperature, moisture and aerosols (Bui/ARC)
- WB-57 (60 hours, funded by NOAA)
  - Advanced Microwave Precipitation Radiometer
  - Hurricane Imaging Radiometer
- Six to Eight week deployment centered on September 1, 2010

RED= IIP, GREEN= IIP+AITT



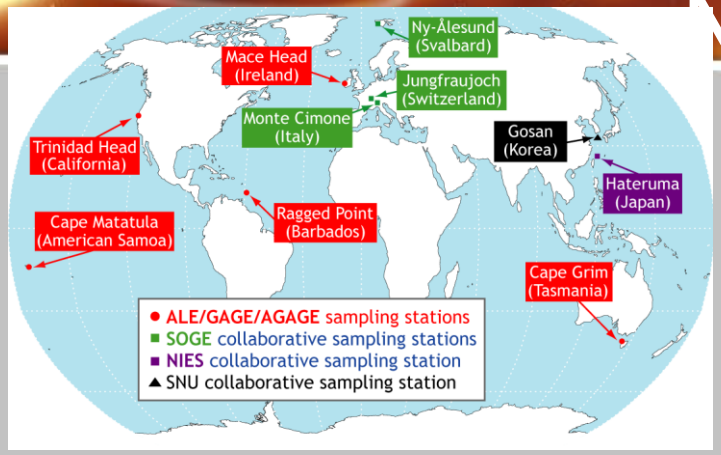
Blue line: DC-8 range for 12-h flight, 6 h on station

Red lines: GH range for 30-h flight with 10, 15 and 20 h on station

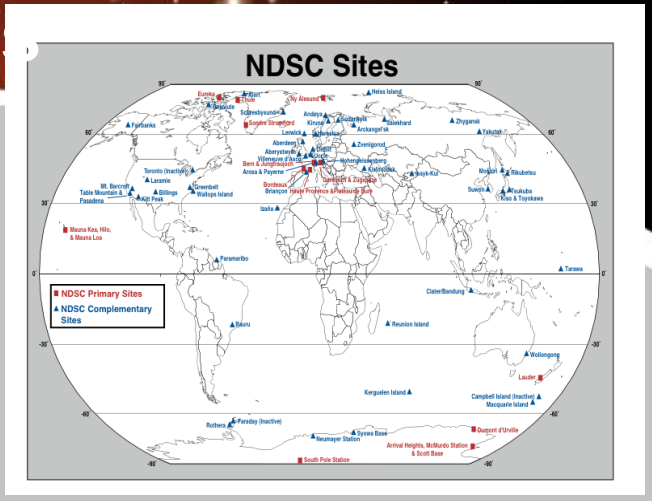
Light blue X: Genesis locations for 1940-2006

Examples of NASA-Supported Ground Networks

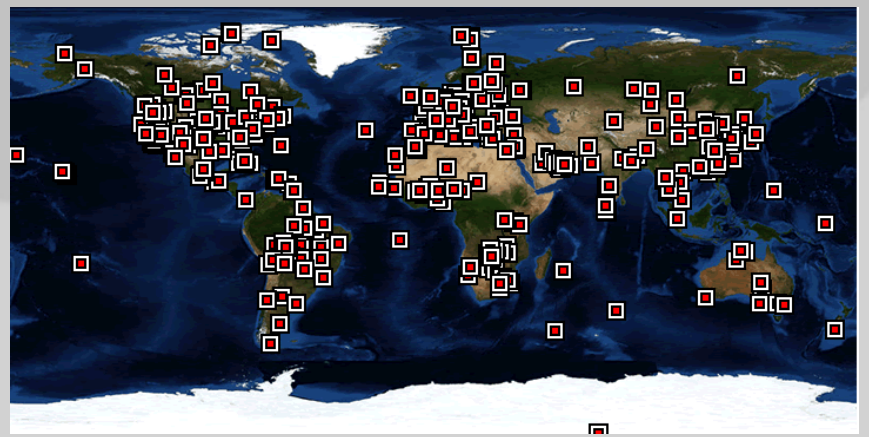
AGAGE



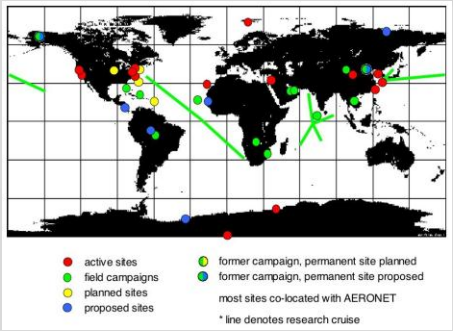
NDACC



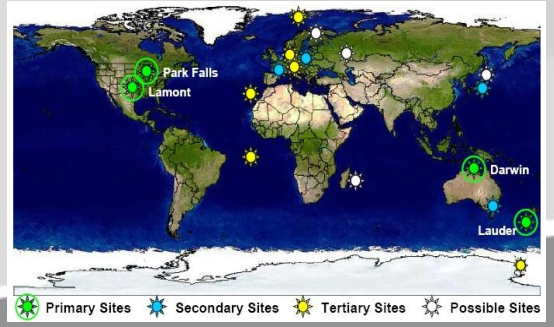
ILRS



AERONET



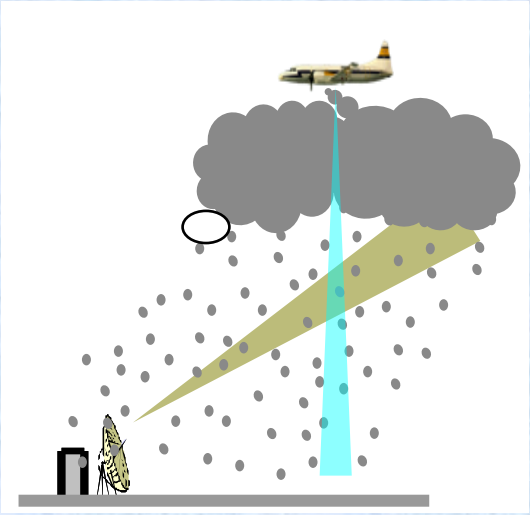
MPLNet



TCCON

International GV Science Collaboration

- *Direct statistical validation (surface)*
- *Precipitation physics validation (vertical column)*
- *Integrated science validation (4-dimensional)*



Active Projects

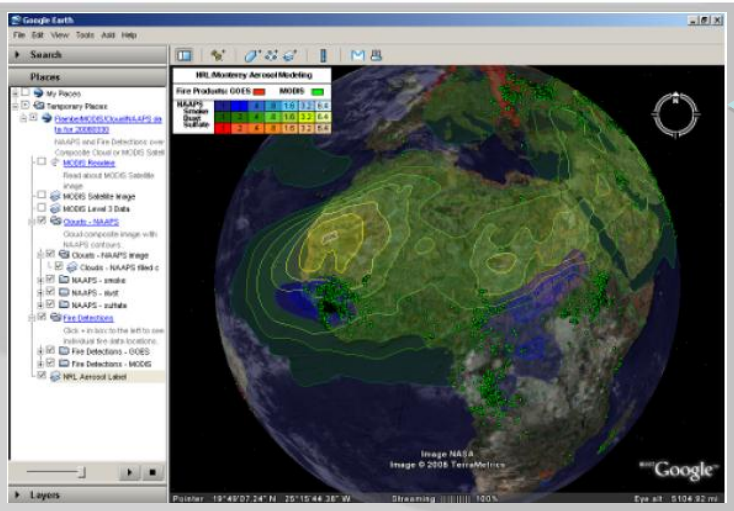
- Argentina (U. Buenos Aires)
- Australia (BOM)
- Brazil (INPE)
- Canada (EC)
- *Ethiopia (AAU)*
- Finland (FMI)
- France (CNRS)
- *India (ISRO)*
- Germany (U. Bonn)
- Israel (Hebrew U. Jerusalem)
- Italy (CNR-ISAC)
- *Italy (Sapienza U. Rome)*
- South Korea (KMA)
- Spain (UCLM)
- United Kingdom (U. Birmingham)

Proposals in Development

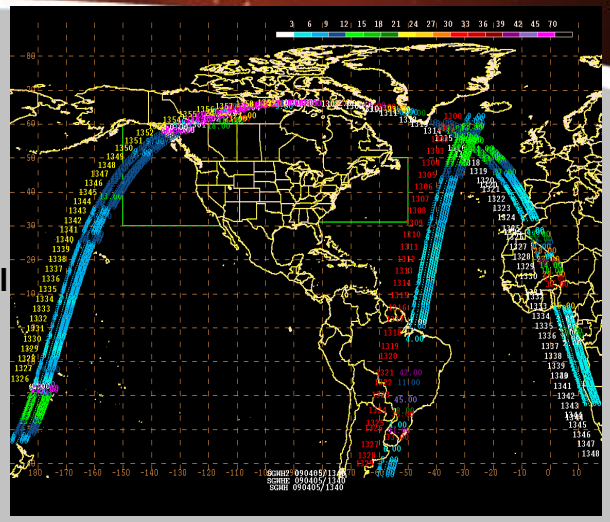
- Cyprus (CMS)
- Germany (MPI)
- Spain (Barcelona)
- Taiwan

Through No-Cost Proposals to NASA PMM Science Program

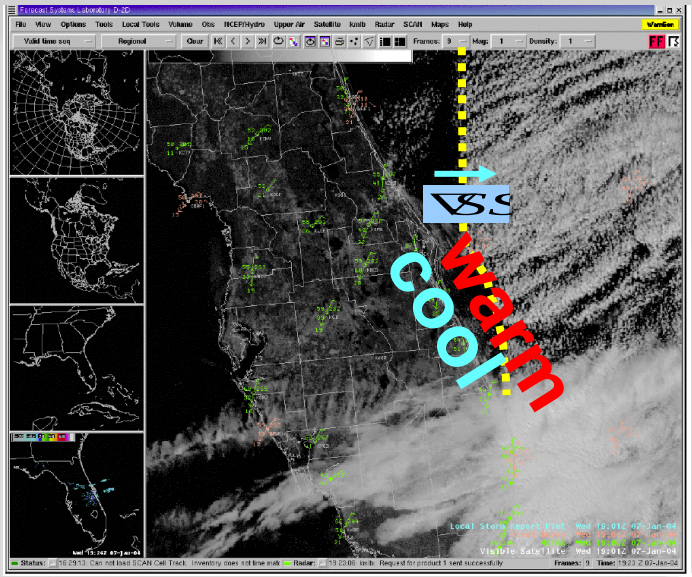
Research – Operation Transitions



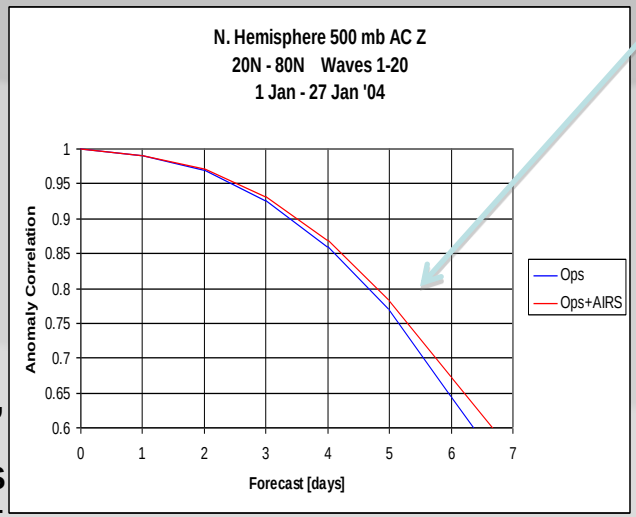
NRL FNMOC use of Near Real Time MODIS Aerosol Optical Thickness (AOT) data in operational weather forecasting.



Altimeter Significant Wave Height (SWF) Used operationally at NOAA/Ocean Prediction Center Operations (Jason, Jason-2, ENVSAT).



Short-term Prediction Research and Transition (SPoRT) project transitioned MODIS, AMSR-E, and AIRS products to NWS weather forecast offices.



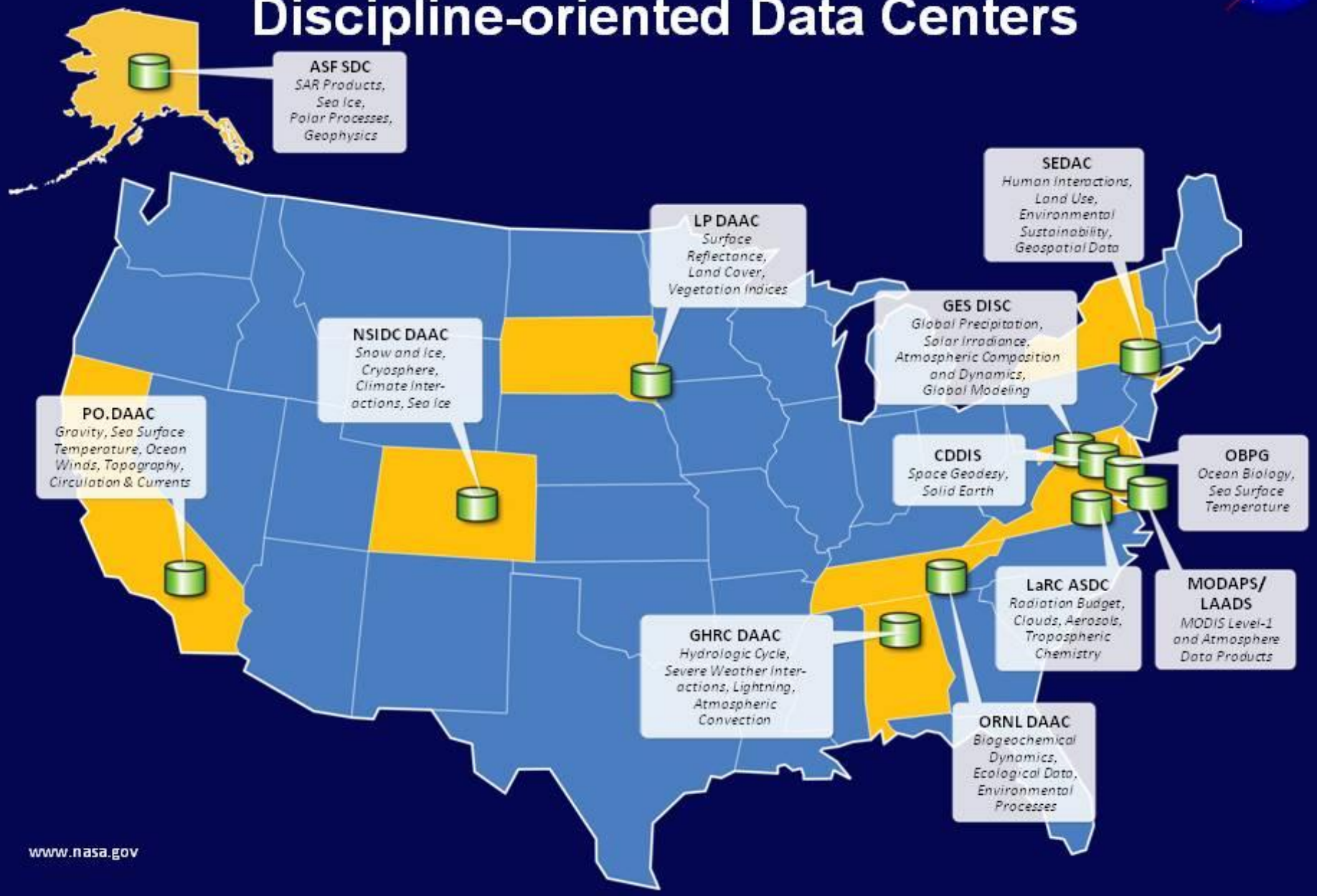
AIRS improved NOAA weather forecast (Joint Center for Satellite Data Assimilation) by 6 hours at day 5.

Partnerships in Storage, Production, and Distribution of Data and Products

- Partnerships are critical to the production and distribution of data
  - *Data Archives* – Several of the Distributed Active Archive Centers (DAACs) are implemented in partnership with other agencies (e.g., LPDAAC with USGS, Oak Ridge DAAC with DOE/ORNL, NSIDC and ASF with multiple supporters)
  - *Data products* – many are from international collaborations (e.g., ASTER DEM, LIMA)
  - *Data sharing* – NASA's open data sharing principles are setting an example for the world, and allow users around the world to utilize NASA data for scientific and societal benefit (e.g., Direct Broadcast from Terra/Aqua/NPP is supported by Direct Readout Laboratory)
  - *Modeling* – NASA models are closely linked to those of other agencies

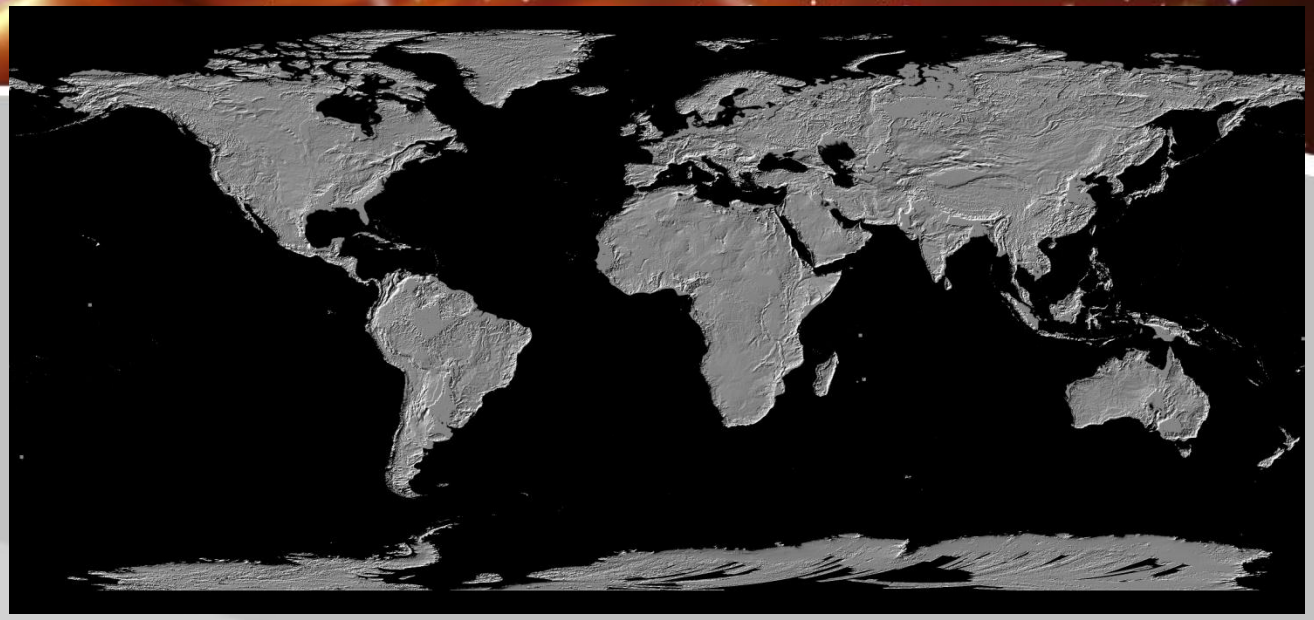
National Aeronautics and Space Administration

Discipline-oriented Data Centers



www.nasa.gov

Release of Version 2 of ASTER Global Digital Elevation Model



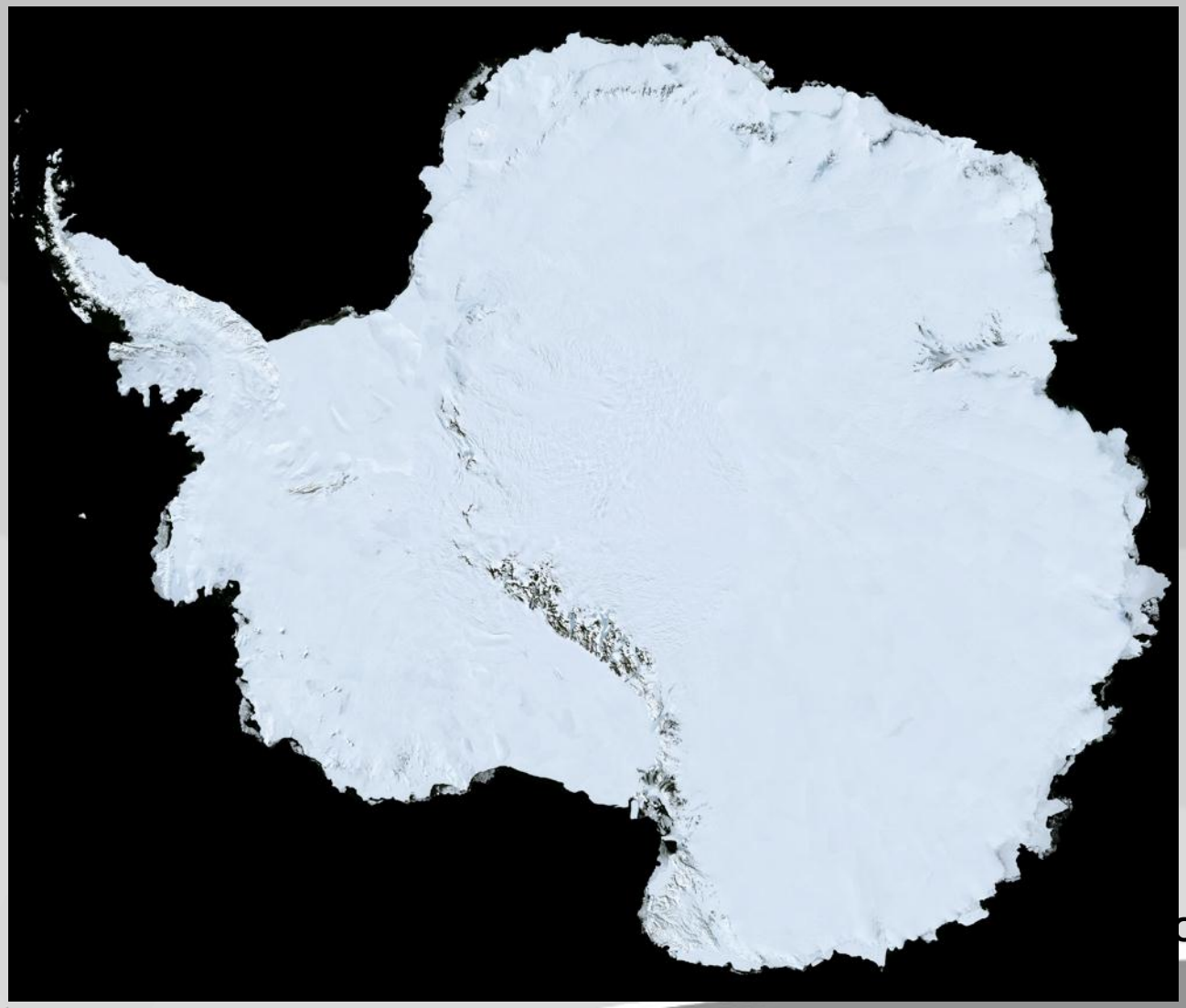
ASTER GDEM

- Japan's Ministry of Economy, Trade and Industry (METI) ASTER sensor flies on NASA Terra s/c
- June 2009, METI and NASA released jointly-funded Global Digital Elevation Model (GDEM) of Earth's land surface from 83° N to 83° S composed of ASTER stereo-pair images
- October 17, 2011, METI and NASA release significantly-improved Version 2 of GDEM

What Makes Version 2 Better?

- 260,000 scenes added to the original >1.2 million scenes in V1 to improve coverage/fill gaps
- Improved masking of water bodies
- Removal of many artifacts, e.g.: step boundaries, pits, bumps, and mole runs
- Better horizontal resolution: from ~114m to ~72m—comparable to high resolution SRTM data and ~20% superior to the publicly-released global SRTM while extending to higher latitudes than SRTM

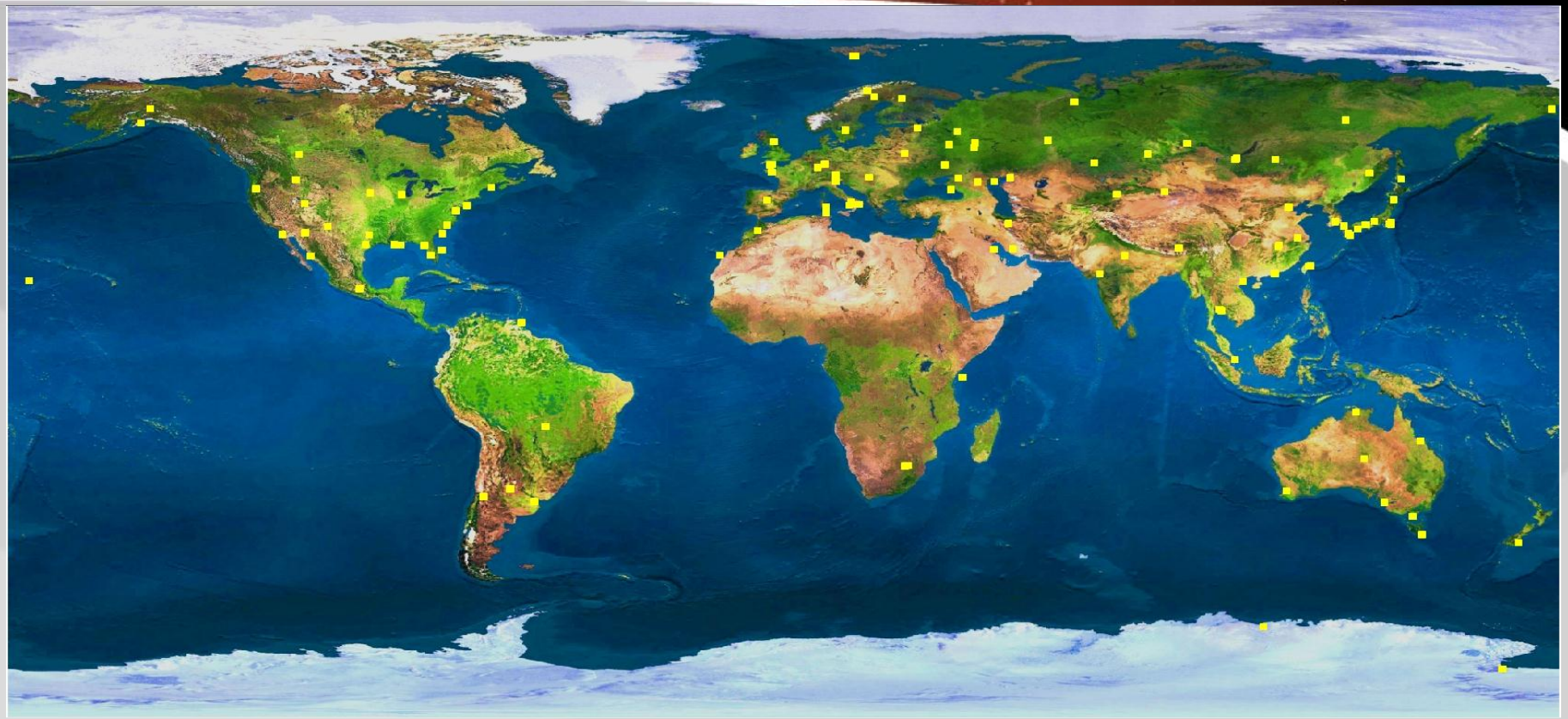
IPY success story: LIMA Landsat Image Mosaic of Antarctica



- True color
- 15-m clarity
- Over 100 Billion pixels
- Like it <u>really</u> looks
- US-UK

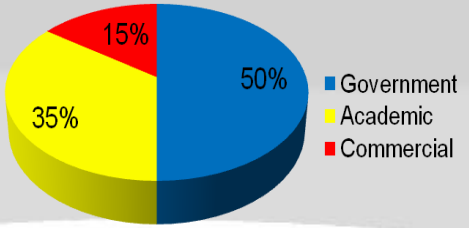
Courtesy R. Bindschadler, GSFC

EOS/NPP Direct Readout User Ground Stations



- Over 150 EOS and NPP compatible sites world-wide

- All Direct Readout sites use at least one of NASA/NOAA algorithm/tool. 85% of these ground stations support real-time applications



Partnerships advance NASA Modeling and Assimilation Efforts

- Earth System Modeling Framework (ESMF):
  - Infrastructure software to facilitate code interoperability, sharing, and standardization.
  - Originally funded by NASA Earth Science Technology Office, now receives multiagency support and utilization in NASA, NOAA, NSF, and DOD models.
- NASA models and assimilation systems rely on externally and jointly developed components:
  - GEOS 5 System: NCEP/NASA Gridpoint Statistical Interpolation data assimilation scheme, NOAA MOM4 ocean model, DOE/LANL sea ice module.
  - GISS Model E: HYCOM consortium ocean model.
  - NASA Unified – WRF model built on NSF-developed Weather Research and Forecast (WRF) model.
- Joint Center for Satellite Data Assimilation:
  - Fosters utilization of NASA observations in operational weather, climate, and environmental analysis and prediction.
  - Supported by NASA, NOAA, USAF, and USN.

Partnerships with Research Community

- NASA works closely with national and international research community to produce and utilize results from research program
  - NASA solicits research and related proposals from US investigator community – more than half of our principal investigators are non-NASA (from academia, industry, other government agencies, private sector, and non-profit entities)
  - NASA and its investigators participate in international programs (e.g., WCRP, IGBP) and their projects (e.g., GEWEX)
  - NASA and its investigators participate in assessments, both international (e.g., IPCC, WMO/UNEP) and national (e.g., National Climate Assessment).

Earth Science Division

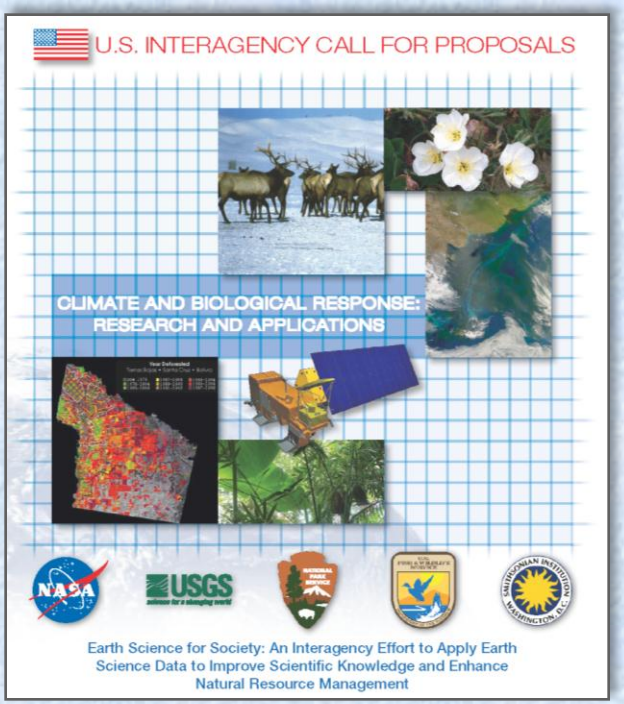
ROSES-2010 Special Joint Solicitation

Featured Joint Solicitation (A.30)

An Interagency Effort to Apply Earth Science Data to Improve Scientific Knowledge and Enhance Natural Resource Management

Research and applications to study how ecosystems are responding to changes in climate.

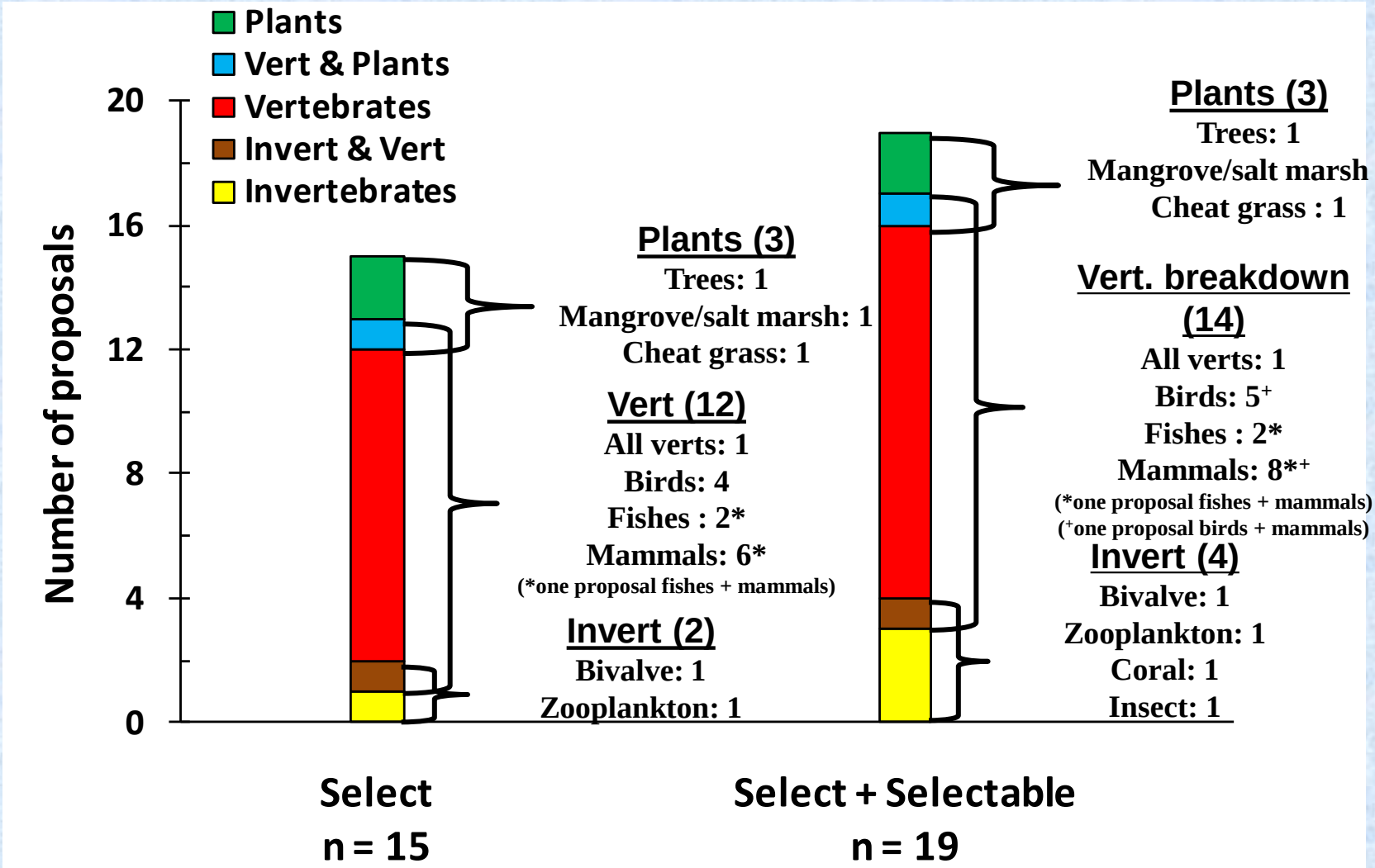
Goal is to place the science and data in the hands of decision makers - Federal, state, and local managers - to help as they craft practical strategies for managing the impacts of a changing climate.



Brochure announcing the interagency solicitation

ROSES A.30 Climate and Biological Response Selections

Interagency call, NASA lead with NPS, USFWS, USGS, Smithsonian
151 proposals received, Program Manager: Woody Turner



ROSES A.30 Climate and Biological Response Selections

Interagency call, NASA lead with NPS, USFWS, USGS, Smithsonian
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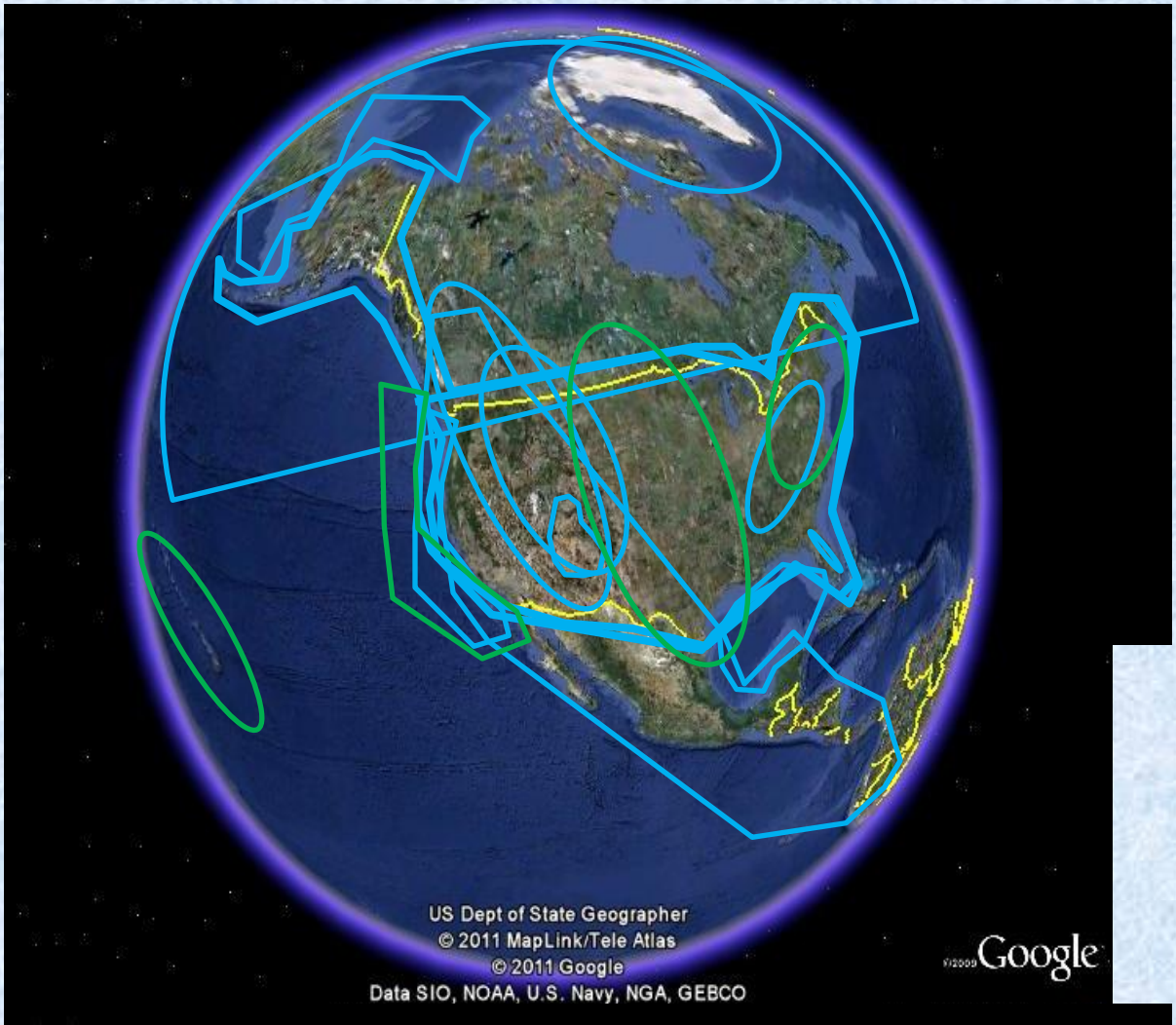
Selects

- One additional global
- One North America/Europe



Select

Selectabl

National boundary

The GLOBE Program

Global Learning and Observations to Benefit the Environment

- 111 active international partners and 136 domestic partners in the U.S.A.
- Worldwide Student Climate Research Campaign to be launched in fall 2011
  - To emphasize student research and cross-country and cross-region analysis

GLOBE Asia-Pacific

- 16 Country Partners, with several in discussion
- Currently active
  - 2,206 schools
  - 2,836 teachers
  - 327 trainers
  - 12 master trainers
- Since the beginning in 1995
  - 1,117,619 observations logged into GLOBE database
  - 820 Honor Roll Citations (66 schools in 8 countries)

- Australia (GLOBE site)
- Bangladesh
- Fiji
- India (GLOBE site)
- Japan (GLOBE site)
- Korea, South
- Maldives
- Marshall Islands
- Micronesia
- Mongolia
- Nepal (GLOBE site)
- New Zealand (GLOBE site)
- Palau
- Philippines
- Sri Lanka
- Thailand (GLOBE site)

Summary

- Partnerships are essential to NASA's earth science program – from data collection through dissemination and utilization
- Partnerships can be interagency, international, and with broader research community
- Partnerships can be bilateral or multilateral
- NASA's emphasis on open data policy sets example for the world and is critical to our ability to form and sustain partnerships