Earth Science Atmospheres Subdivision (Code 610AT)

Mission Statement:

Advance the knowledge and understanding of the atmospheres of the earth and other planets, through scientific research, technology development, and satellite missions

610 Atmosphere Laboratories

- ESD_Atmosphere Office (610AT)

  Interdisciplinary studies: aerosol-water cycle interactions, high impact weather and climate

- Mesoscale Atmospheric Processes Laboratory (612)

  Precipitation, water vapor, aerosols, winds

- Climate and Radiation Laboratory (613)

  Aerosols, clouds, biomass burning and radiation

- Atmospheric Chemistry and Dynamics Laboratory (614)

  Ozone, CH4 other GHGs, NOx , HCHO…

- Wallops Field Support Office (610.W)

  GPM GV facility, suborbital measurements, remote sensing instruments

Major Activities

- Satellite Missions

  Present: TRMM, EOS/Aqua, Terra, Aura, CloudSAT/CALIPSO , SORCE, NPP…

  Planned: GPM, SAGEIII, ACE, GEOCAPE…

- Field Campaigns

  ARCTAS, CATS, HS3, DiscoverAq, …

- Modeling

  GCE, Nu-WRF, MMF, GESO5, Satellite Simulators….

- Long-term data development and analysis

  Ozone, Precipitation, Aerosol, Clouds, ….

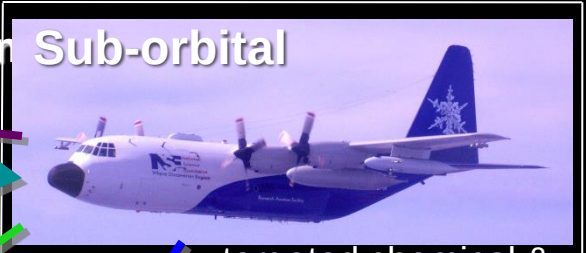
Aerosol-Climate Prediction

Satellites

frequent, global *snapshots*; AOD, aerosol air mass type

Remote-sensing Analysis
- Retrieval Validation
- Assumption Refinemen

Sub-orbital



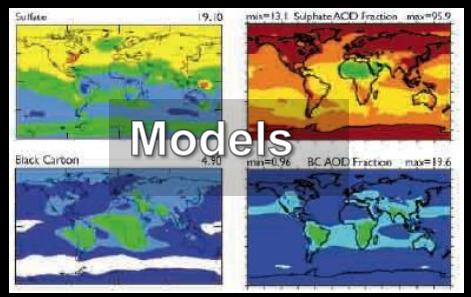
targeted chemical & microphysical detail

ground obs, mobile SMART Labs

Regional Context

CURRENT STATE
- Initial Conditions
- Assimilation

Model Validation
- Parameterizations
- Climate Sensitivity
- Underlying mechanisms



Models

space-time interpolation,

PREDICTION

Recent deployment of Mobile SMARTLabs in Vietnam to study aerosol-clouds interaction in Southeast Asia (7SEAS/SEAC^{4}Rs)

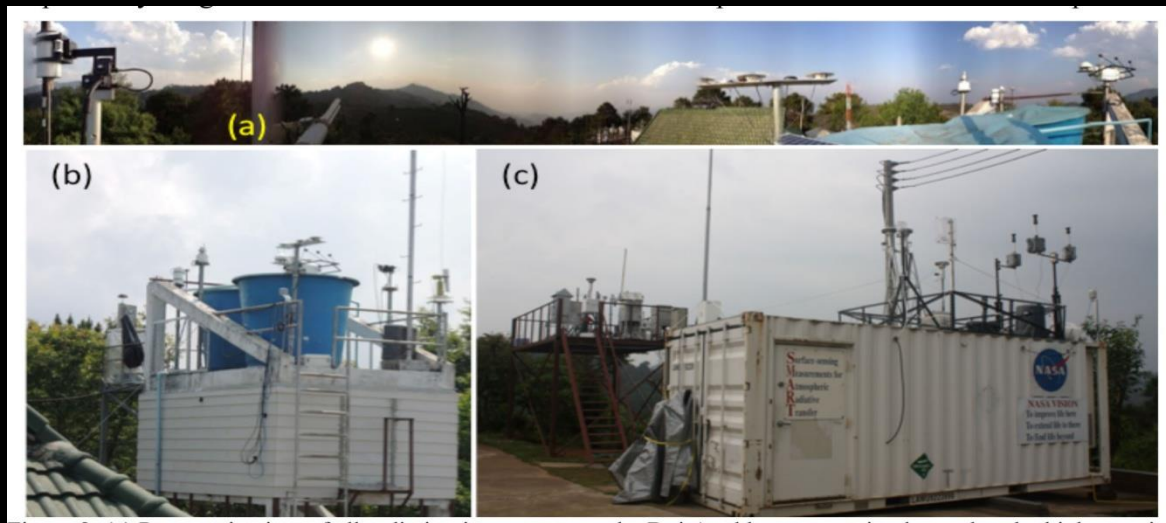
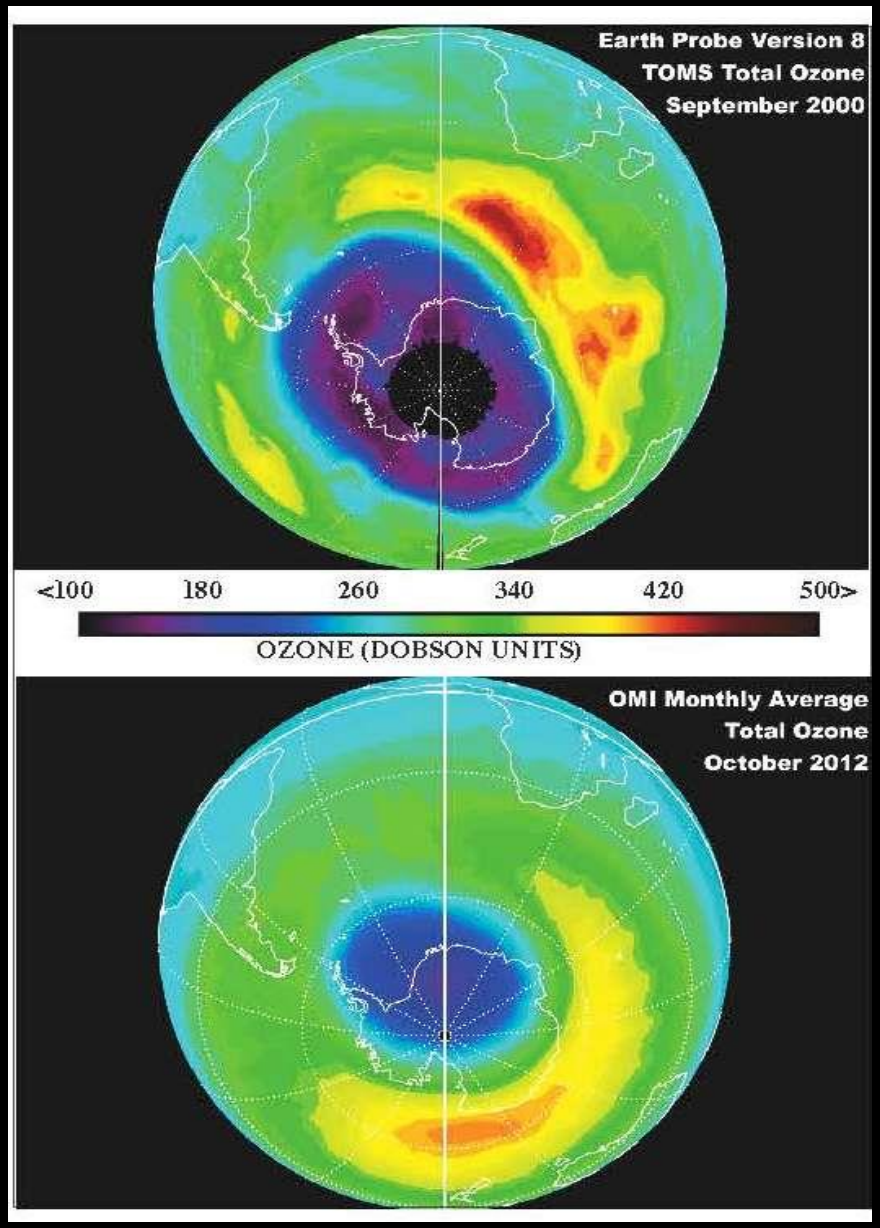


Figure 2. (a) Panoramic view of all radiation instruments at the Doi Angkhang supersite, located at the highest point of the Met. Station water tower, and (b) a simple shelter built on the floor underneath the water tower to host power supplies, dataloggers, computers and daily operations. (c) Major chemistry probes from the Taiwan team were located on the platform next to SMART, which hosted a micro-pulse lidar, additional trace-gas and microphysics instruments with their inlets installed on the roof of SMART mobile laboratory.

Figure 3. At the Son La supersite, COMMIT instrument setup for (a) AERONET/Cimel sunphotometer, TDE-corrected radiometer set, (c) dual-channel (355 & 532 nm) lidar from Taiwan, (d) second set of chemistry probes from the Taiwan team, as of Figure 2c, and (e) the COMMIT mobile laboratory.

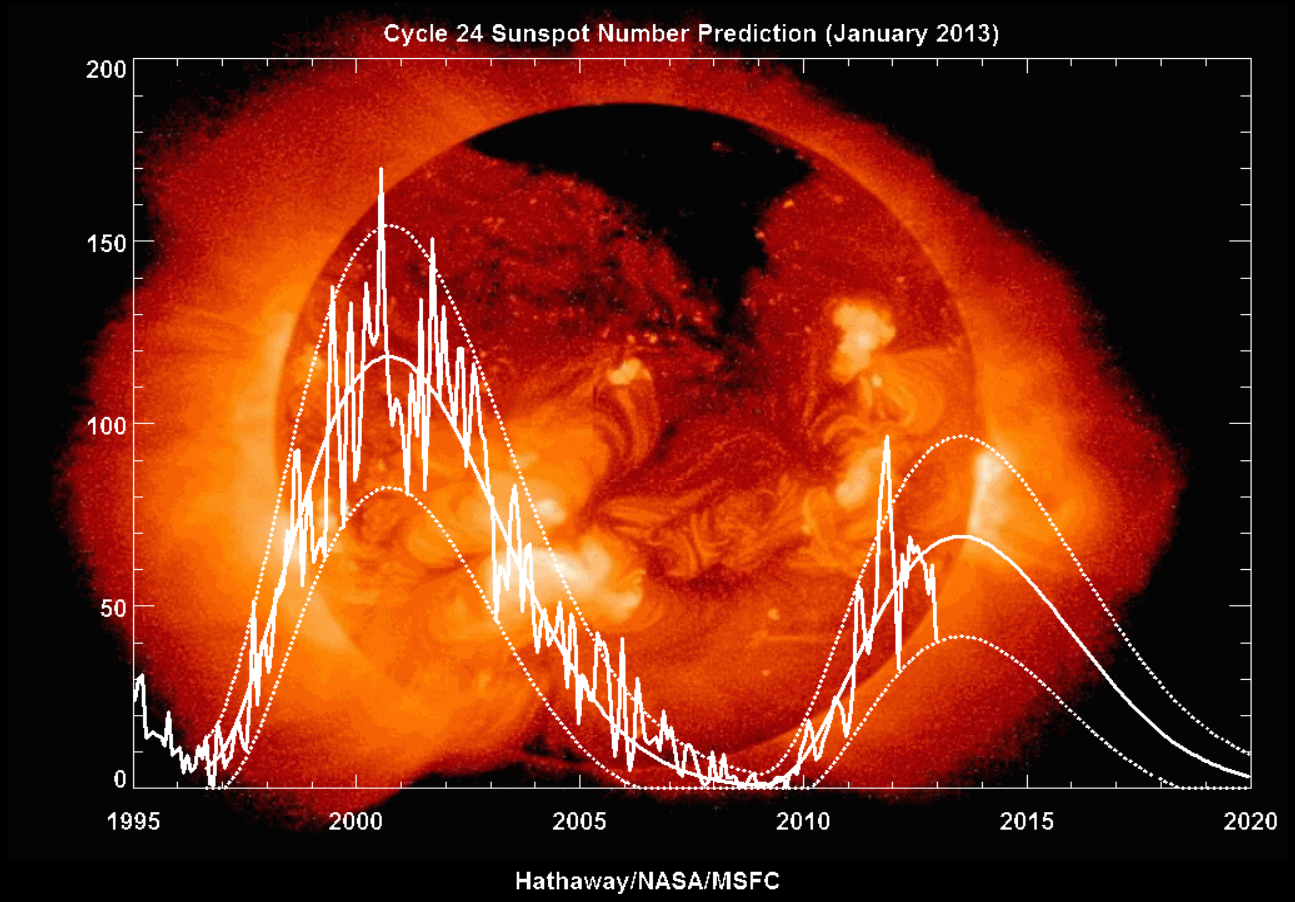


Ozone Hole monitoring process studies, and modeling

Smallest ozone hole in the last 20 years detected in 2012 (bottom), about 62% areal coverage compared to the largest observed in 2000

Interannual fluctuations associated with strong stratospheric warming

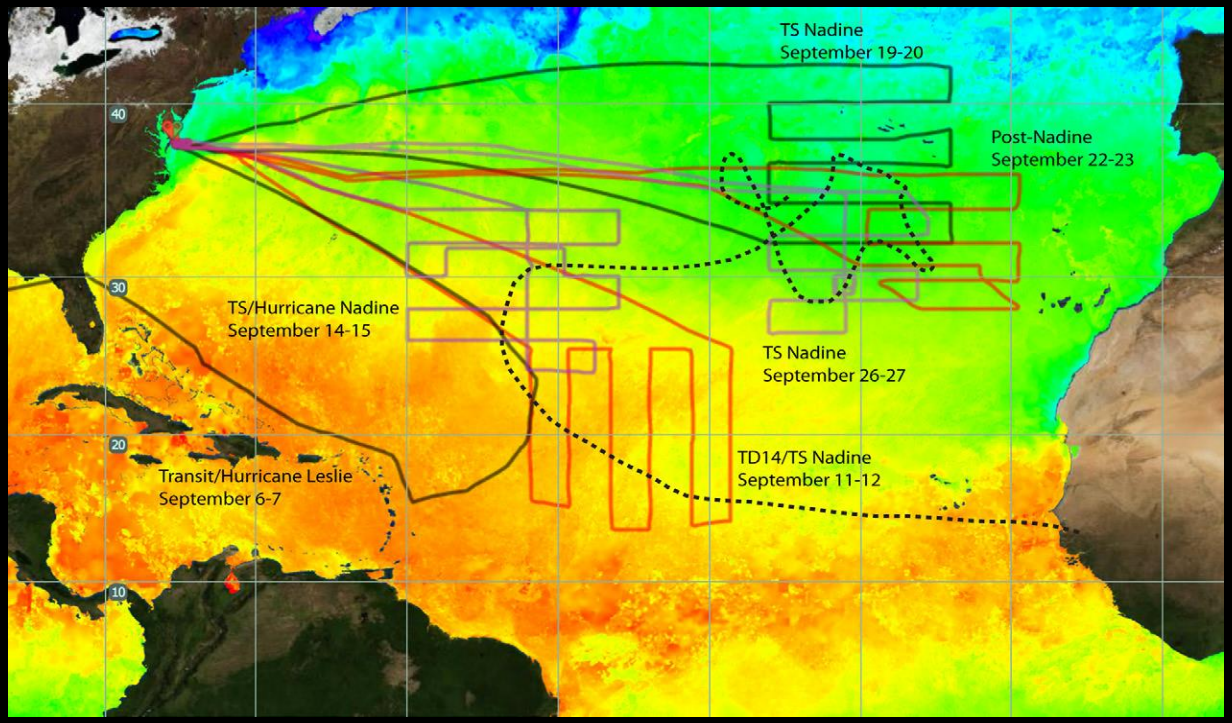
Solar Radiation and Climate Experiment (SORCE), launched Jan,2003
Total solar irradiance (TSI), Solar Spectral irradiance (SSI)

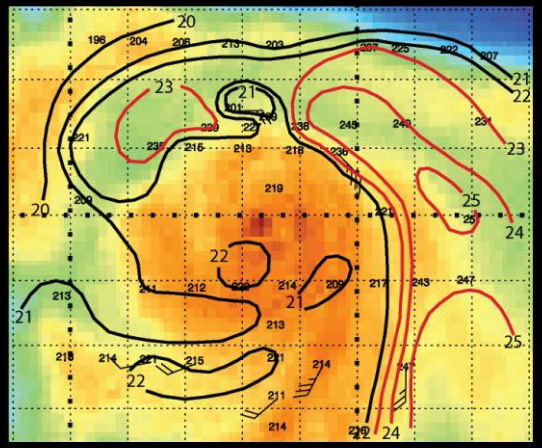


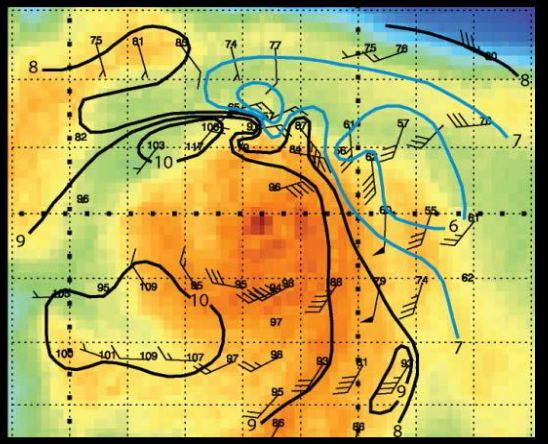
Solar irradiance variations since 1995. SORCE has tracked the decline of solar irradiance in solar cycle 23, through the solar cycle minimum in 2008, and is now entering the maximum phase of solar cycle 24, at least according on predictions of sunspot numbers.

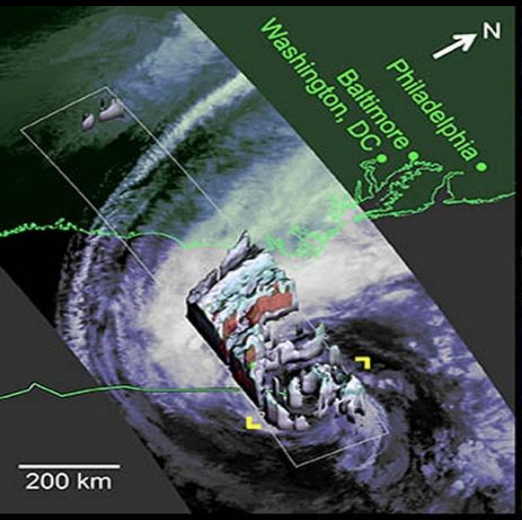
The Hurricane and Severe Storm Sentinel (HS3) — Preliminary Findings

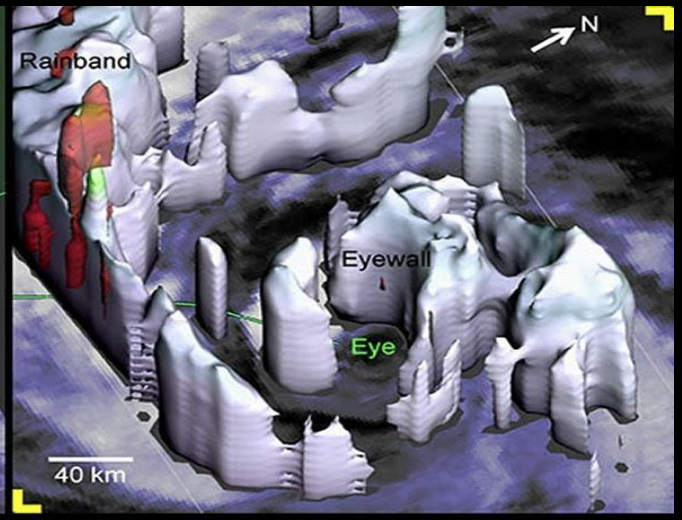
Scott Braun & Paul Newman, NASA GSFC





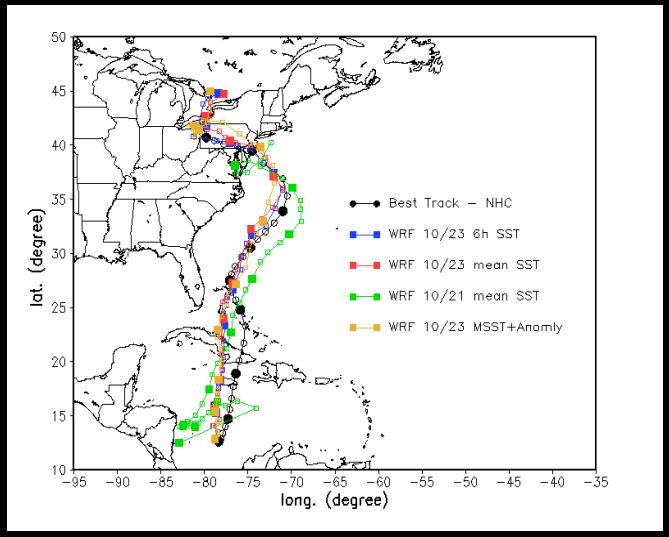


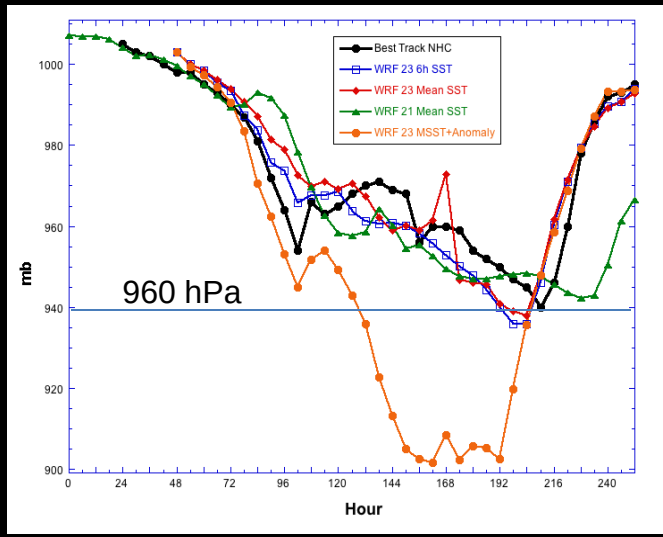




TRMM observation of
3-D structure of Hurricane
Sandy, 28 Oct 2012

Nu-WRF model
simulation
of [Hurricane Sandy]
under a 2xCO_2 world



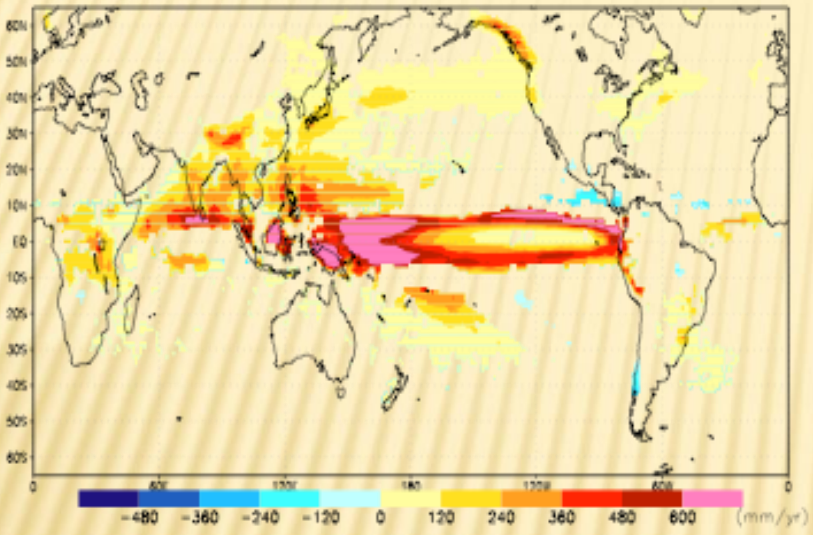


Under a warmer SST in a double CO_2 world, Hurricane Sandy would have moved faster, making land fall 20 hrs earlier in slightly northerly position, with more than 70% increase in max surface pressure depression, lasting over 48 hrs longer, relative to present-day maximum …

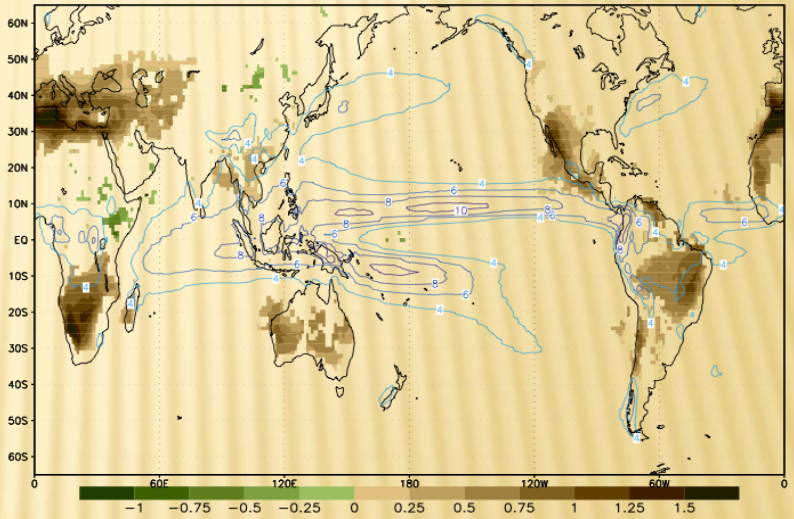
Rolling the Climate Dice: Extreme rainfall and prolonged droughts due to CO_2 warming

(Lau et al. 2013, *GRL*)

Extreme rainfall

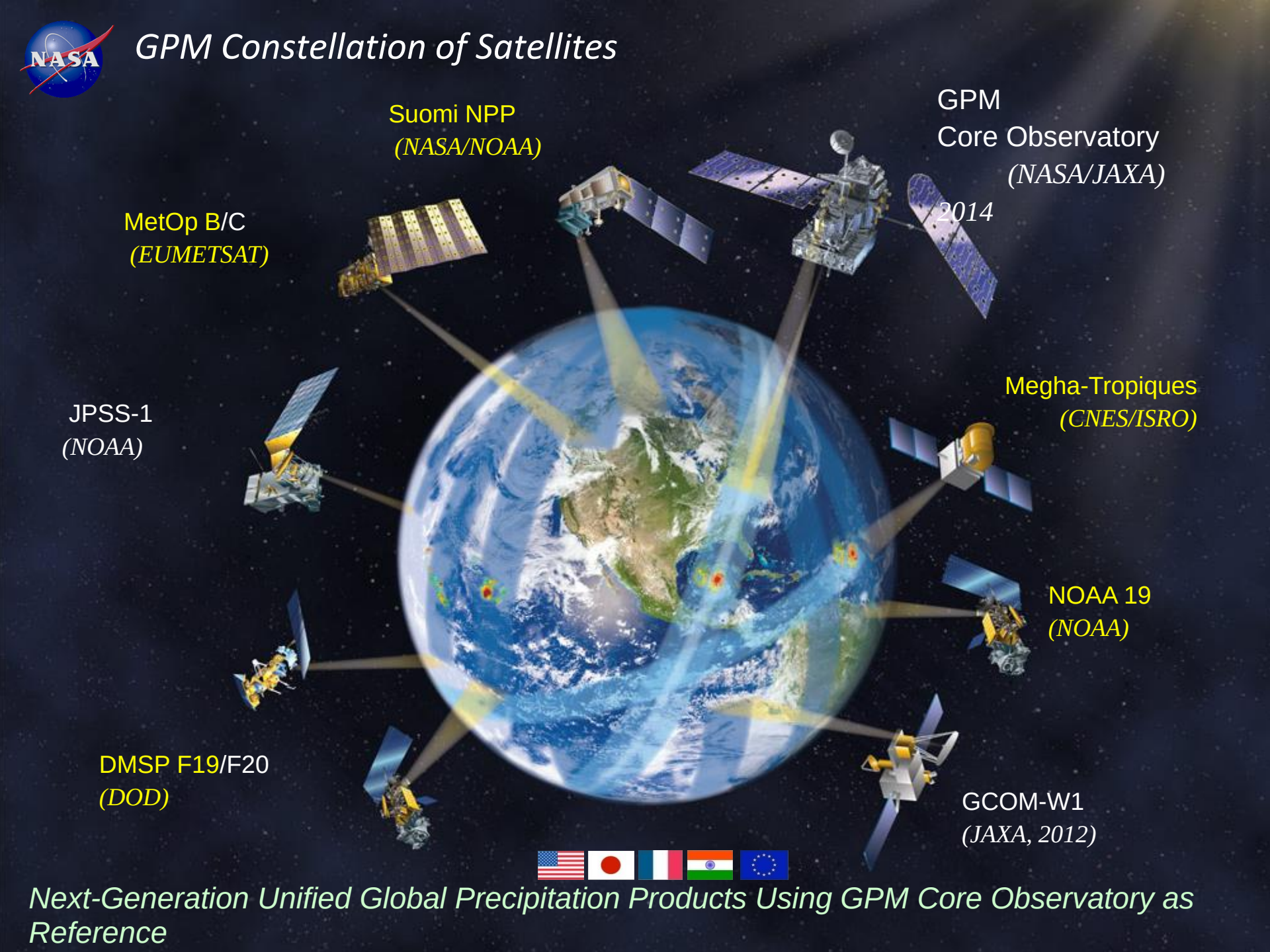


Prolonged drought



- More heavy rainfall, less moderate rain, and prolonged no-rain periods (drought)
- Extreme rainfall and severe drought are connected, occurring in preferred geographical locations
- Wet areas getting wetter, dry areas drier, and marginal convective zones over land getting drier too.

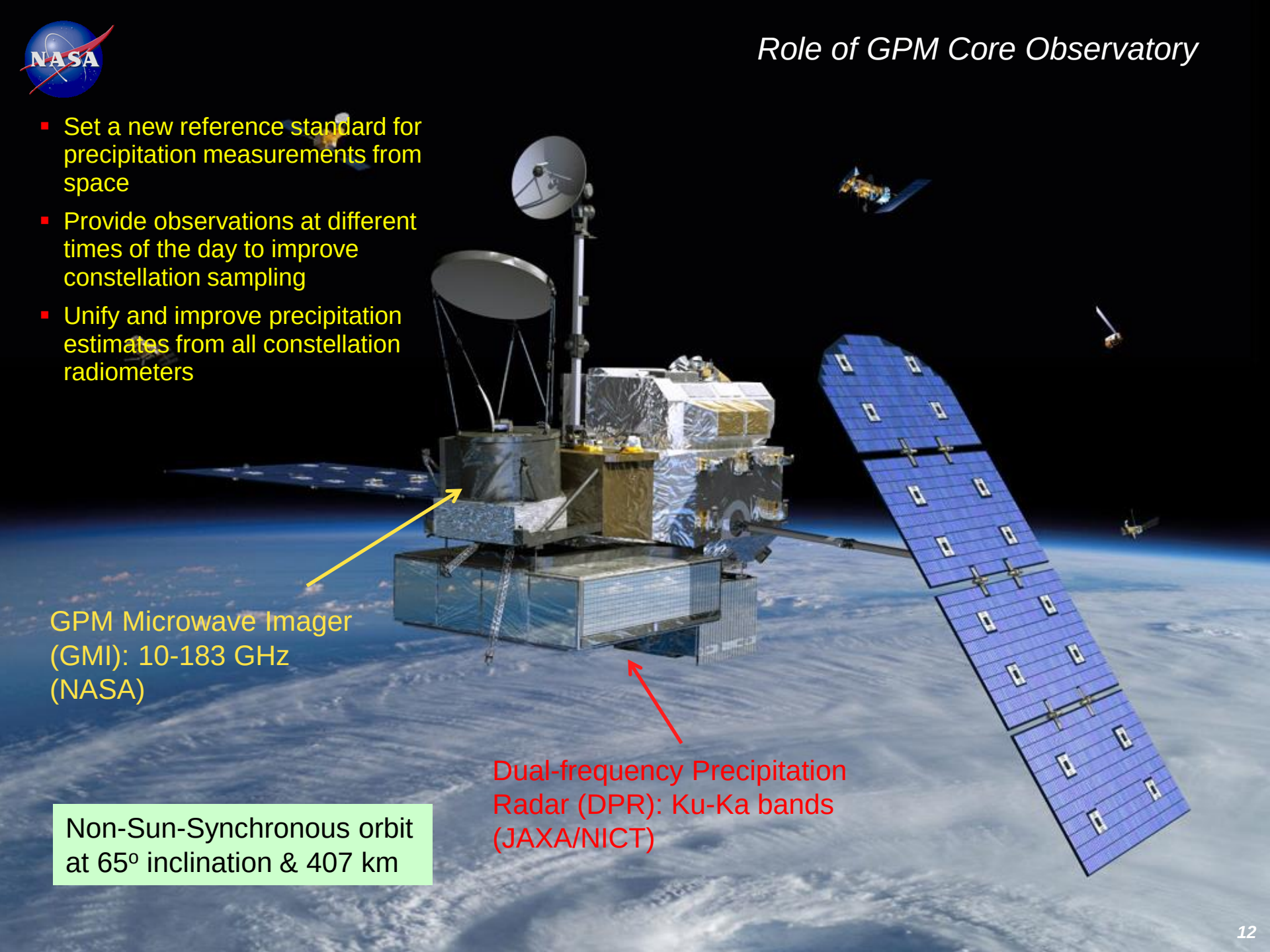
GPM Constellation of Satellites



Next-Generation Unified Global Precipitation Products Using GPM Core Observatory as Reference

Role of GPM Core Observatory

- Set a new reference standard for precipitation measurements from space
- Provide observations at different times of the day to improve constellation sampling
- Unify and improve precipitation estimates from all constellation radiometers



GPM Microwave Imager (GMI): 10-183 GHz (NASA)

Dual-frequency Precipitation Radar (DPR): Ku-Ka bands (JAXA/NICT)

Non-Sun-Synchronous orbit at 65º inclination & 407 km

Next-Generation Global Precipitation Products

- Intercalibrated constellation radiometric data reconciling differences in center frequency, viewing geometry, resolution, etc.
  - Converting observations of one satellite to virtual observations of another using non-Sun-synchronous satellite as a transfer standard
  - International working group (NASA, NOAA, JAXA, CONAE, CMA, EUMETSAT, CNRS, GIST, & universities) in coordination with WMO/CGMS GSICS
- Unified precipitation retrievals using a common cloud database constrained by DPR+GMI measurements from the Core Observatory

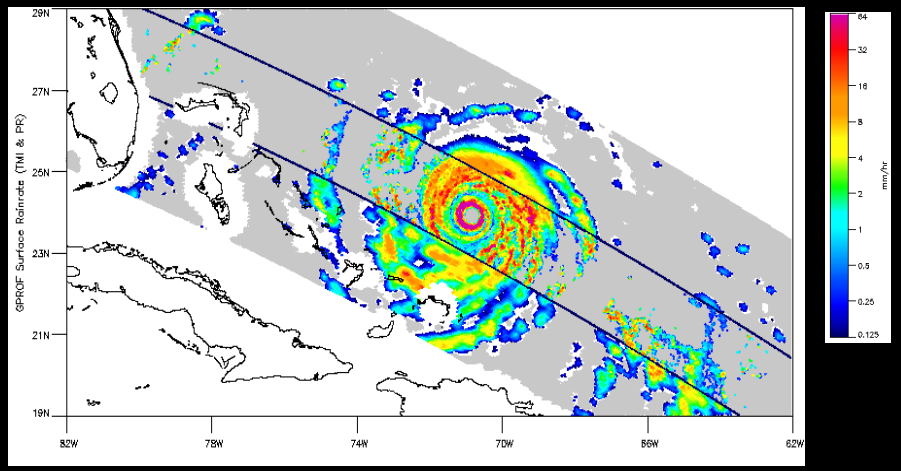
Optimally matching observed T_b with simulated T_b from an a priori cloud database

Simulated T_b *Observed T_b*

TRMM uses a model-generated cloud database

GPM uses a DPR/GMI-constrained database

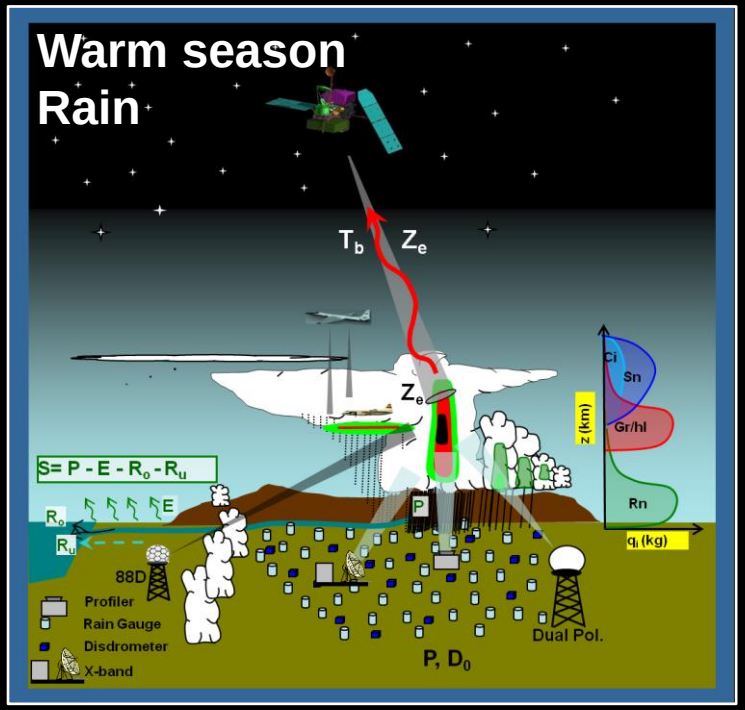
Prototype radiometer retrieval using a database consistent with TRMM PR+TMI measurements

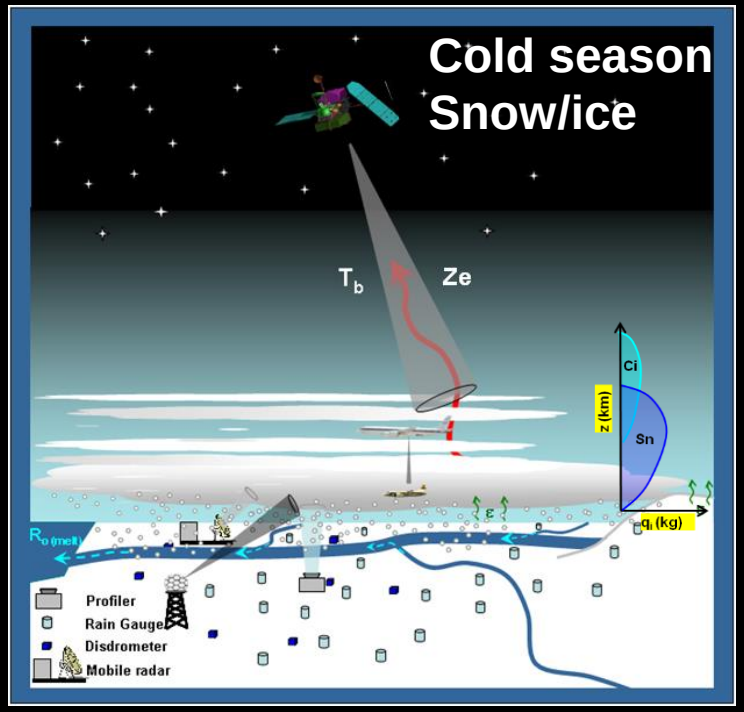


Comparison of TRMM PR surface rain (inner swath) with TMI rain retrieval (outer swath)

GPM Ground Validation Science at WFF

Walt Petersen, GPM GV Science Manager





- GPM retrieval algorithms must produce accurate precipitation estimates over a broad range of warm and cold season conditions- A difficult proposition!
- ***GPM GV Disdrometer and Radar Observations of Precipitation "DROP" activities at WFF support local to global GPM Physical and Direct validation activities .***

walt.petersen@nasa.gov

Wallops 6000 Acre Campus

GPM WFF Network (keeping instruments busy doing science at "home")

Phase 1: Gauges, NPOL, WSR-88D (already there)
Phase 2: Disdrometers, MRR, D3R, SPANDAR
Phase 3: Domain/methods extension

Driving Science:

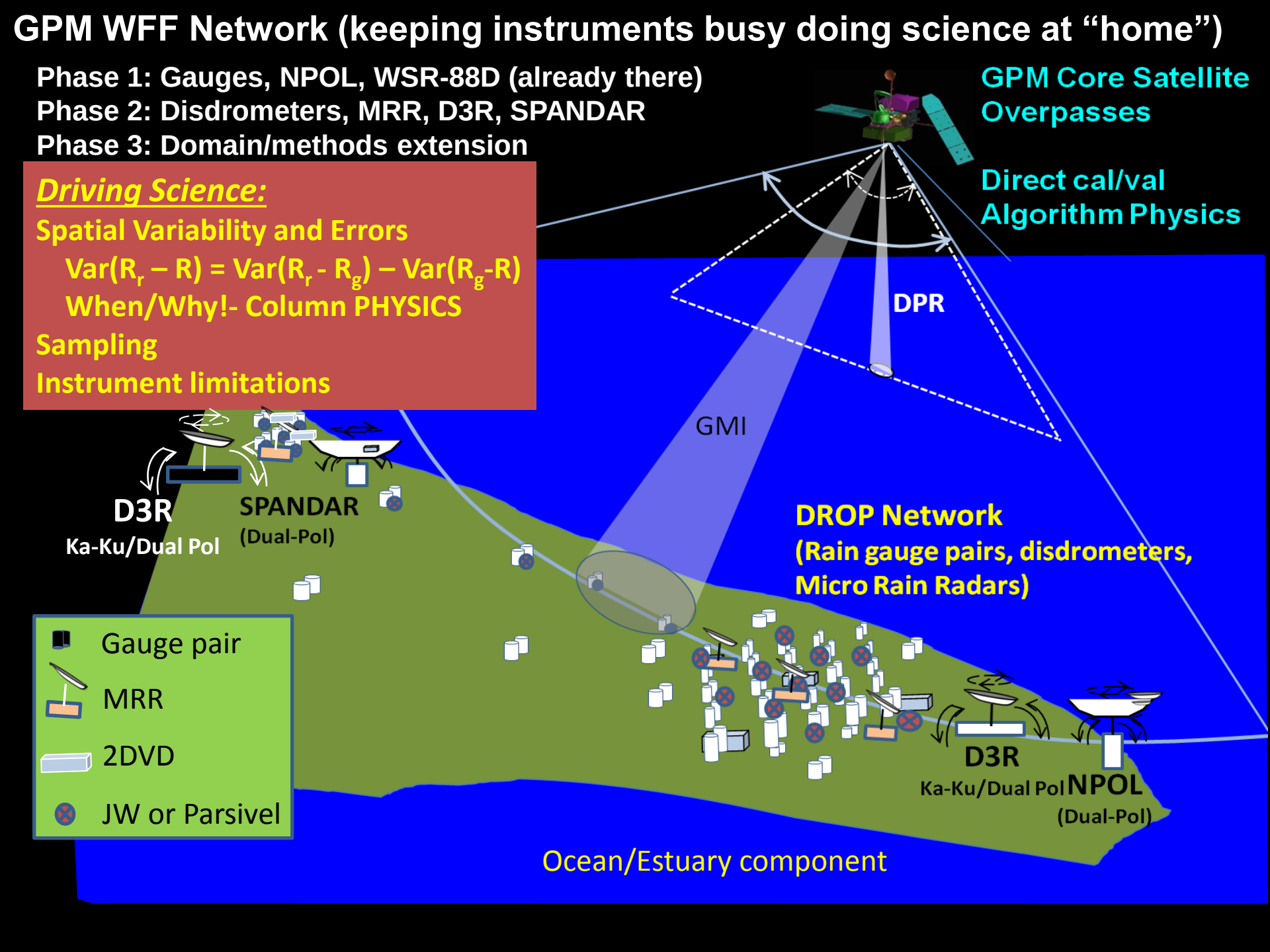
Spatial Variability and Errors

$Var(R_r - R) = Var(R_r - R_g) - Var(R_g - R)$

When/Why!- Column PHYSICS

Sampling

Instrument limitations



Key Infrastructure

DROP Infrastructure (PMM: TRMM to GPM)

Radars: Domain 4-D precip structure, DSD, rates

NPOL Radar: S-band transportable, dual-pol, scanning

D3R radar: Dual-frequency (KA-KU), dual-polarimetric, Doppler radar.

TOGA C-band deployable Doppler radar

3 Metek Micro Rain Radars (K-band), vertically pointing

Disdrometers/Gauges: DSD, particle imager, rain rate and rain/snow water

5 2D Video Disdrometers

24 Parsivel laser disdrometer

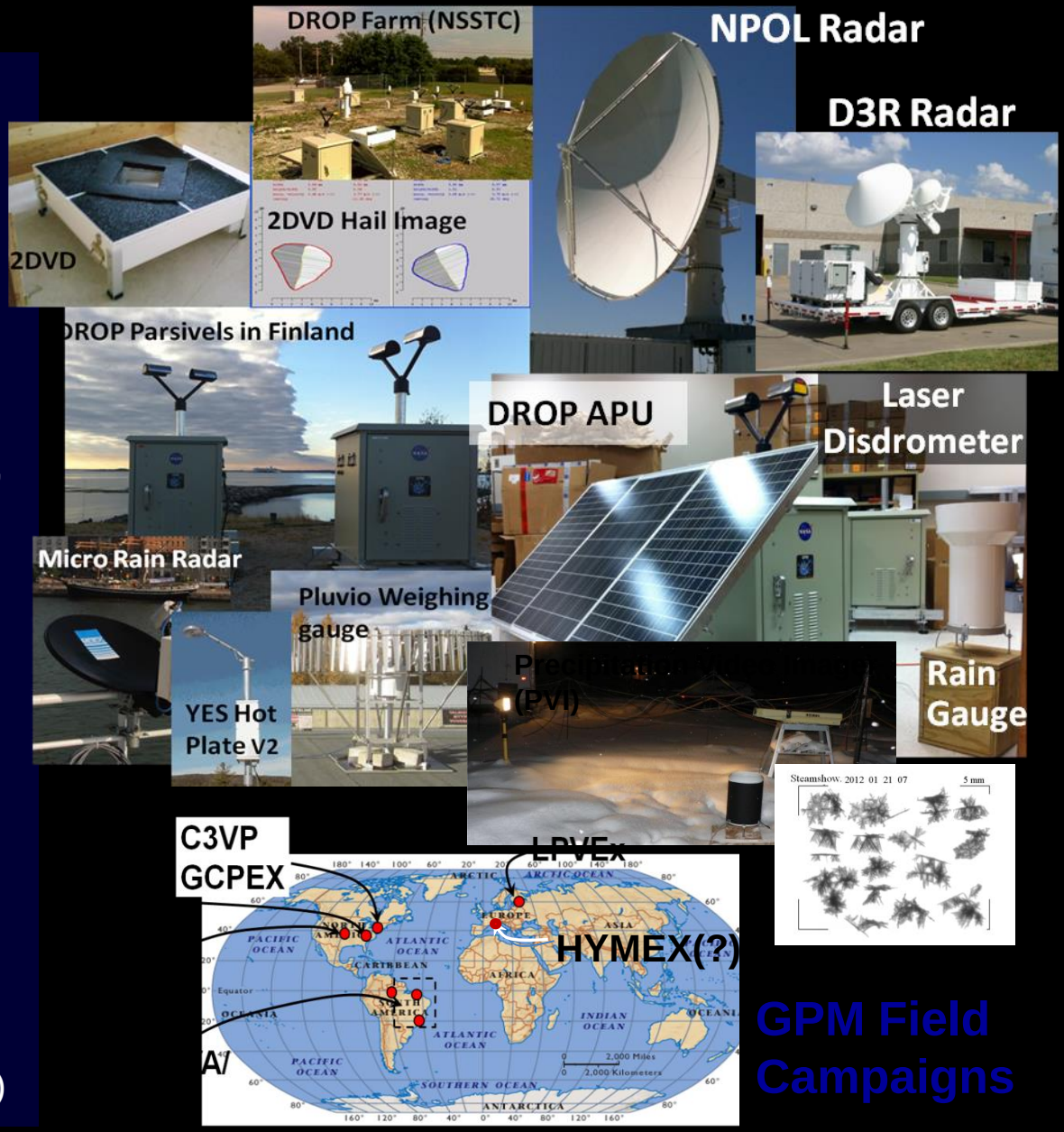
8 Joss Waldvogel

5 Precip Video Imagers (PVI)

100+ Met One rain gauges

7 Hot plate sensors – Snow (70 K)

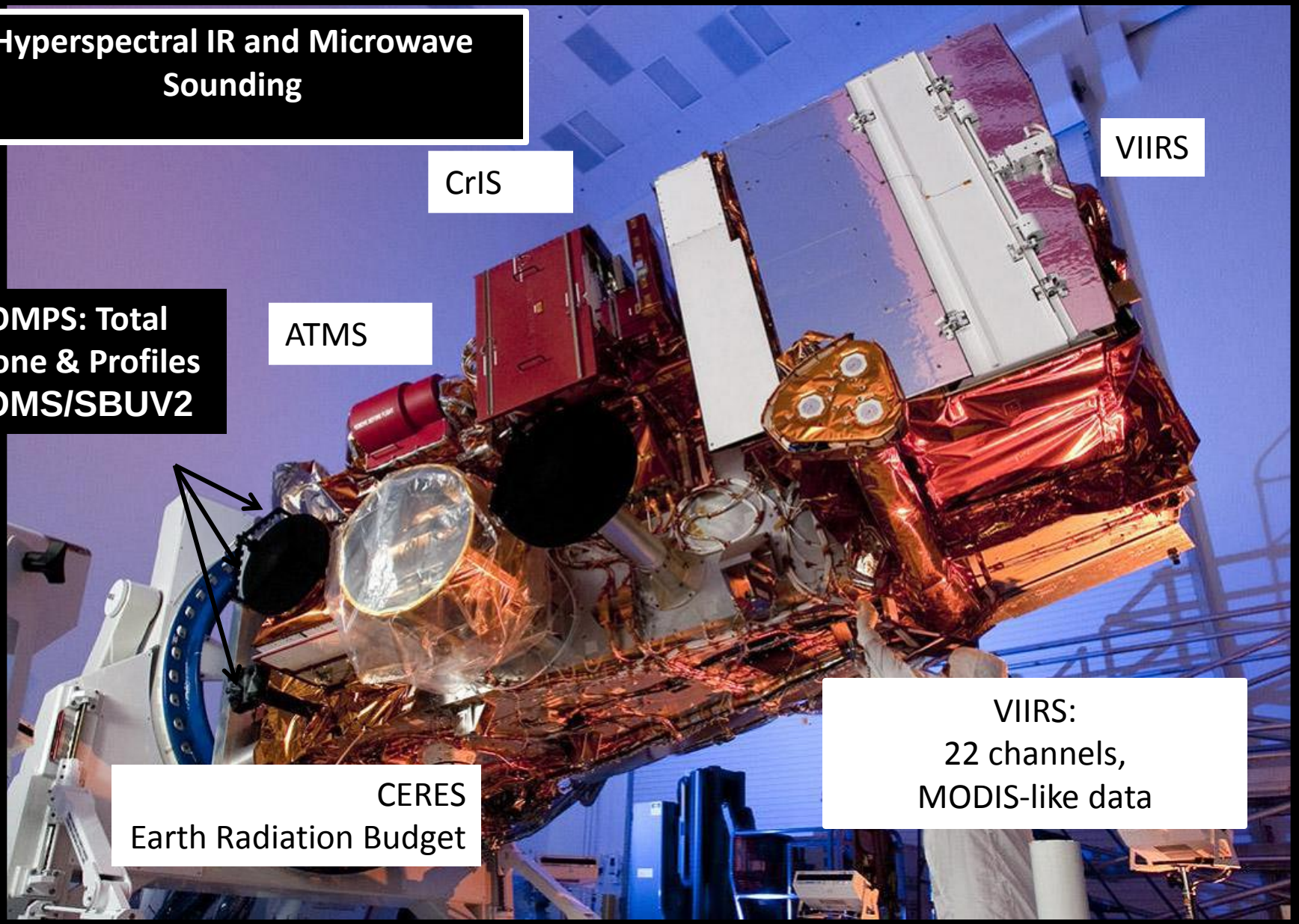
9 OTT Pluvio² gauges – Snow (56 K)



NPP /JPSS NASA/NOAA Collaboration

NPP Launch: Oct 28, 2011

NPP and JPSS-1 (LRD 11/2016)



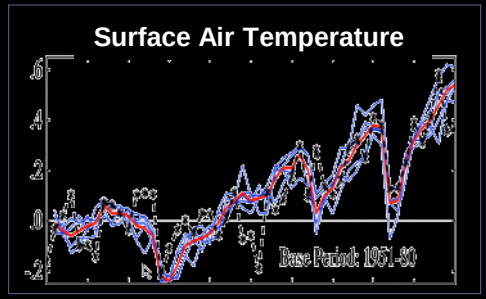
Time Series Data to Reveal Global Change

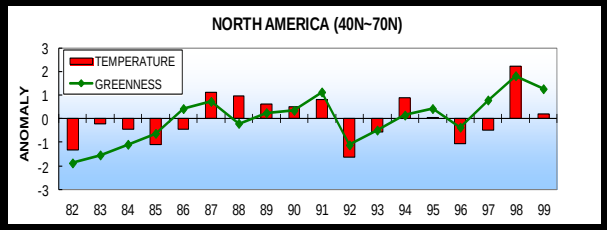
Satellites: Nimbus/POES → EOS → NPP → JPSS

How is the global Earth system changing?

- atmospheric temperature and moisture profiles
- vegetation responses to climate

Atmospheric Sounding

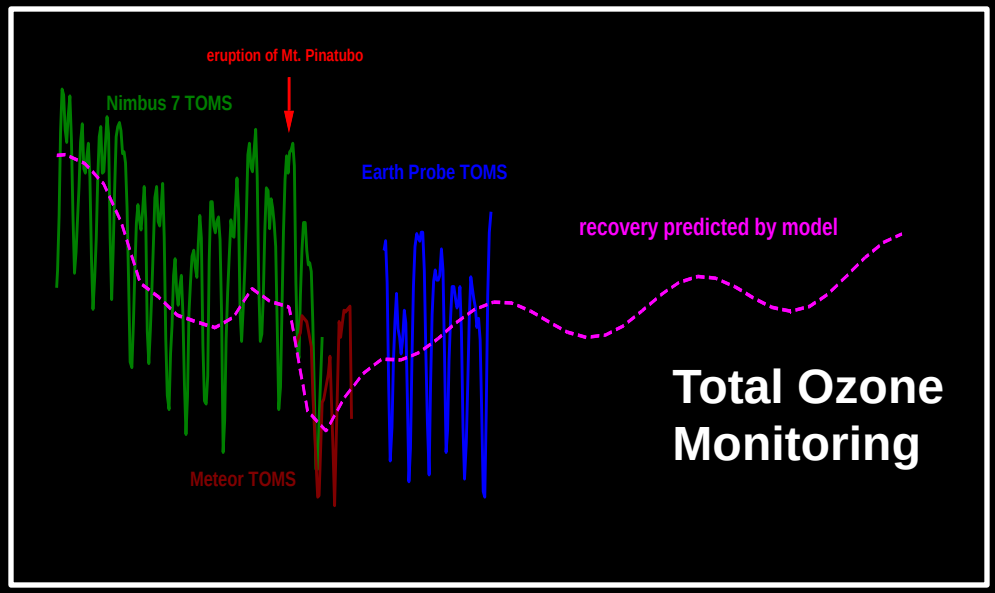




Multispectral Imaging / Surface Biophysical Properties

How does the Earth System respond to natural and human-induced changes?

- ozone layer recovery
- clouds and aerosols



Total Ozone Monitoring

NPP Commissioning Complete February 23, 2012

BACK UP

Wallops and Code 610.W Mission

Wallops Mission

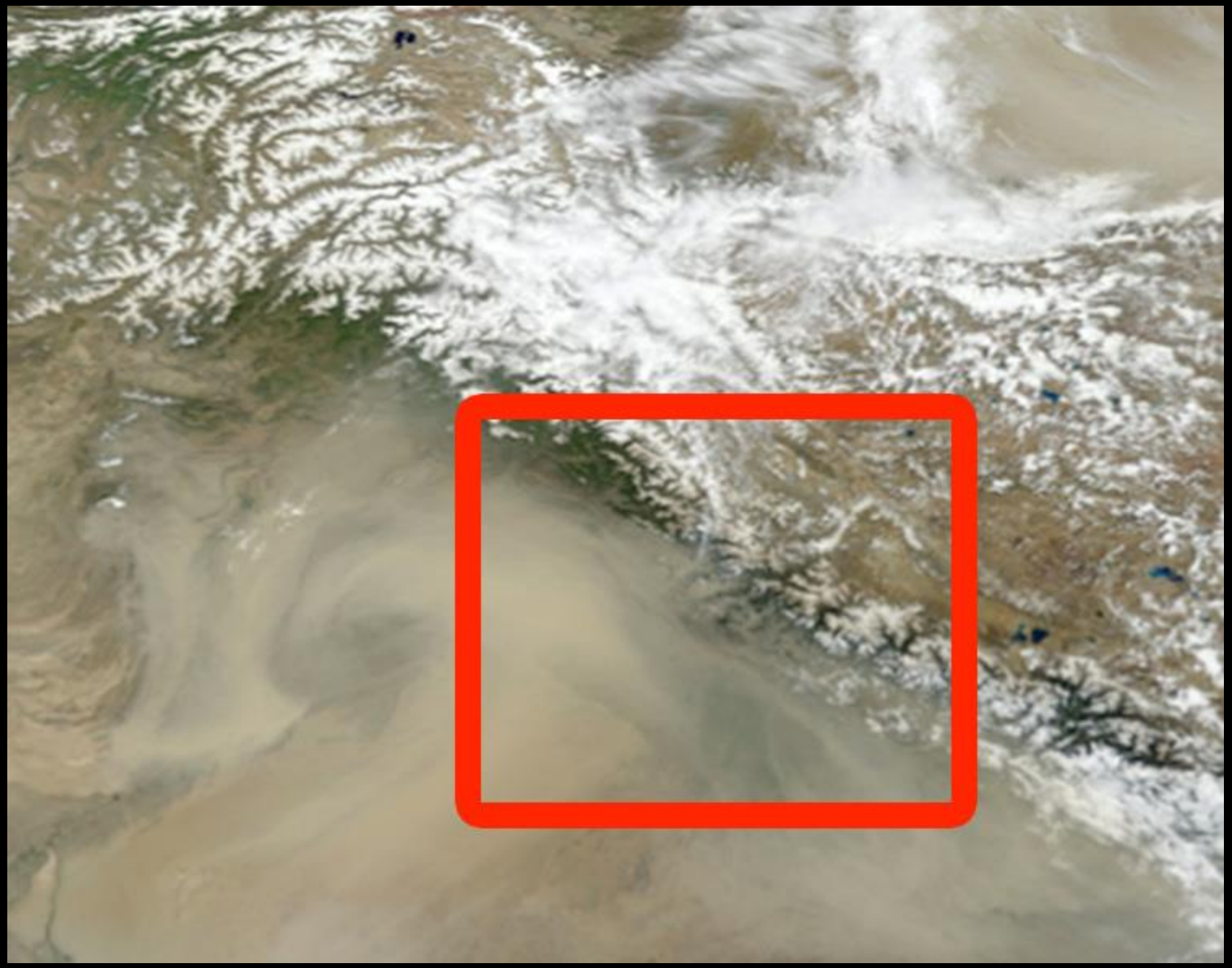
–Enable scientific research through the development and deployment of low-cost, highly capable suborbital and orbital research carriers, project management, and mission services.

–Enable aerospace technology advances supporting NASA's Science, Exploration Systems, and Aeronautics Mission Directorates, through advanced technology development, testing, and operational support,

–Enable education, the commercial development of space, and other innovative partnerships by leveraging Wallops' unique capabilities and expertise to collaborate with industry, academia, and other government agencies.

Code 610.W Mission

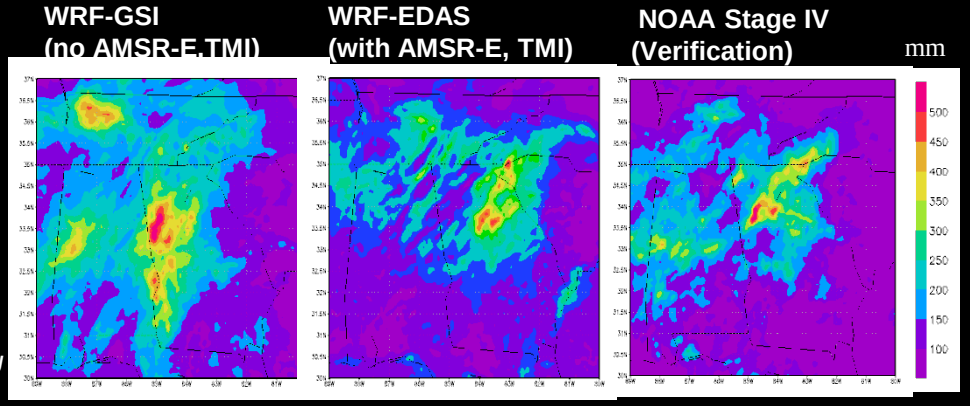
- Support Earth Science research through the development, deployment, and collection of ground-based and sub-orbital earth science measurements and remote sensing instrumentation.
- Devise and conduct targeted cal/val activities for Earth Science missions
- Conduct research using Earth Science datasets, measurements and model simulations
- Support education, outreach, and technology applications as an extension of Wallops Earth Science activities



Strategic Initiatives & Product Development

- Dynamic downscaling using cloud-resolving WRF ensemble data assimilation for hydrological applications

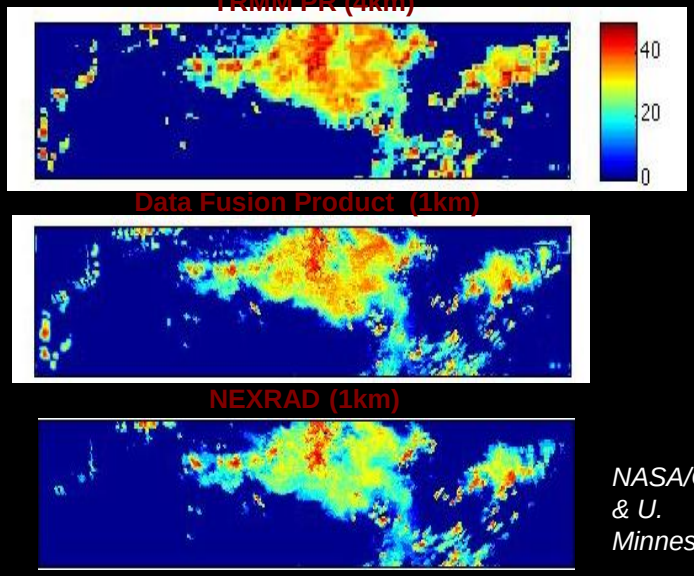
Rain accumulation for 15-22 Sept. 2009 over Southeast US flood region



- Assimilation of rain-affected MW radiances (TMI, AMSR-E, MHS) into the NASA Unified WRF Ensemble Data Assimilation System improves precipitation analysis and short-term forecast.

NASA/GSFC & CSU

- Variable-resolution global precipitation product via data fusion of satellite and ground measurements within the framework of probabilistic estimation and sparse representation



- Statistical characterizations of observation errors at native scales as a function of surface type, geographic location, season, and rain intensity.

- Optimal non-Gaussian estimation and filtering using wavelet decomposition that preserves precipitation extremes at native measurement scales.

- Data fusion at multi-scales according to uncertainties of individual data types

NASA/GSFC & U. Minnesota