NOAA

Satellite and Information Service

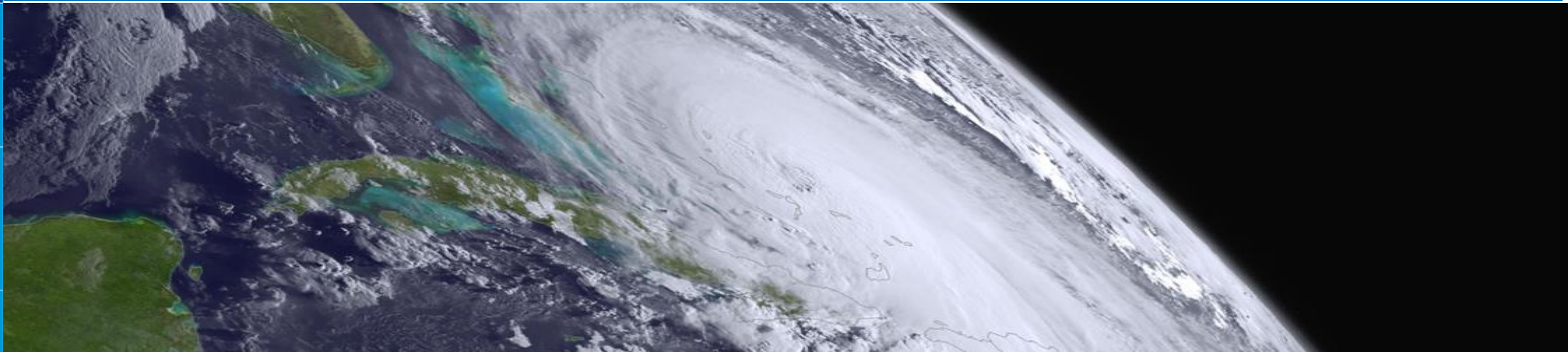
29 MAY 2019

NOAA/NESDIS Agency Partner Overview

Kevin Garrett

NOAA/NESDIS Center for Satellite Applications and Research
Associate Director, Joint Center for Satellite Data Assimilation

With inputs from many contributors



NESDIS Assimilation and NWP Priorities

PRIORITY AREAS

1. Satellite Architecture Studies and Planning

- Next-gen architecture (NSOSA, SPRWG)

- Explore commercial sources
- Explore payload hosting/ride-shares
- Agile satellite observing system
- Meet NWP requirements

2. Observations and Ground Services

- High mission assurance (reliability and availability) of products

- NOAA and partner data
- Low-latency dissemination and archive

3. R&D/R2O

- Increase volume and effectiveness of observations assimilated

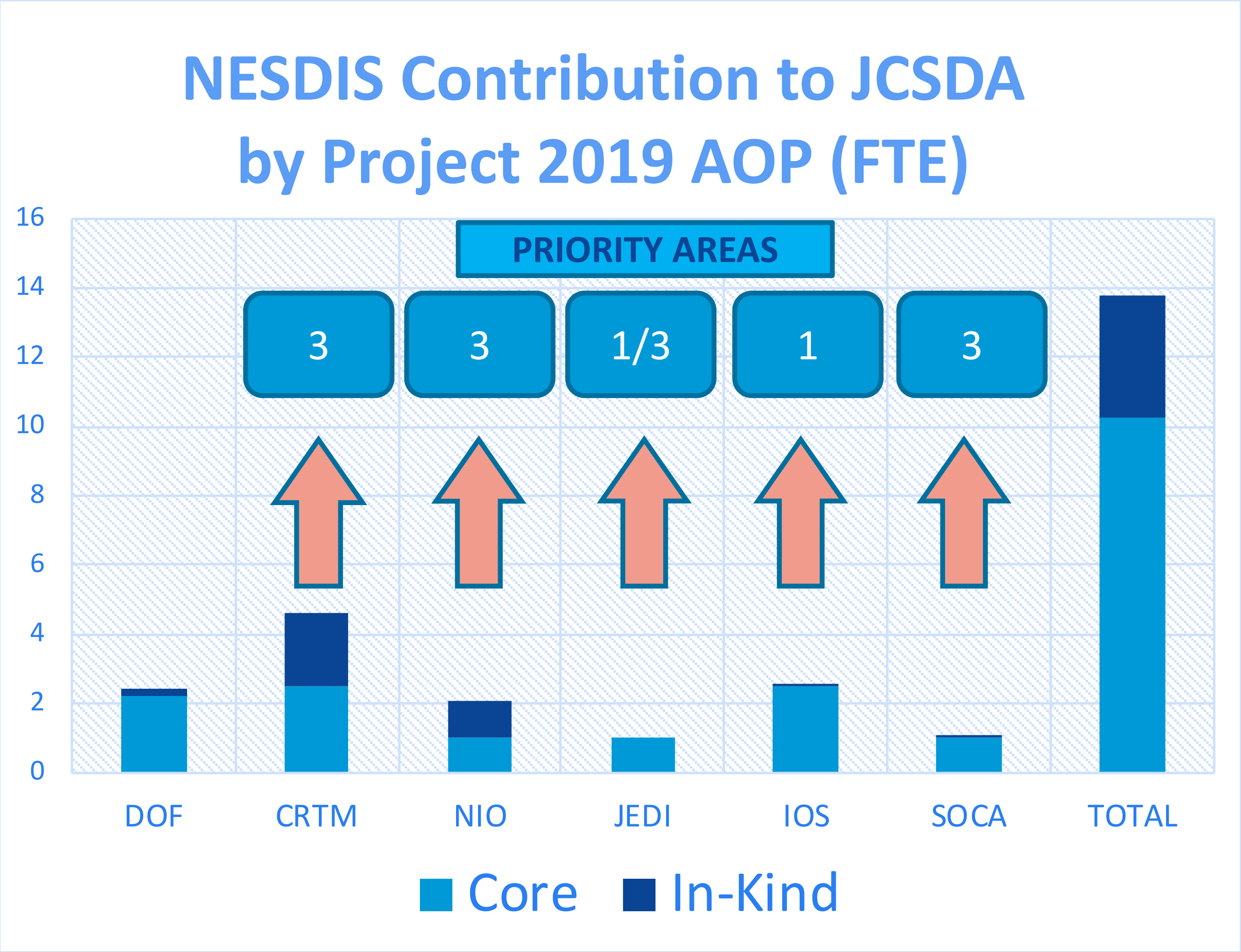
- Cal/val, sensor data quality
- Forward modeling
- QC

- Explore benefit of future satellite systems

- Support NOAA's mission through new/enhanced technology

- Acceleration of R2O

NESDIS Contribution to JCSDA Mapped to Priorities



CRTM/NIO/SOCA/JEDI

- Increase volume and effectiveness of observations assimilated

JEDI

- Accelerate R2O

IOS

- Explore commercial data

NESDIS contributes to internal efforts focused on priorities

- Technology Maturation Program (OPPA)
- JPSS/GOES-R PGRR
- Ad-hoc coordinated efforts (land, ocean, aerosol, etc.)

NESDIS In-Kind Activities

Community Radiative Transfer Model

The Community Radiative Transfer Model (CRTM) is used extensively in NESDIS/STAR for sensor cal/val and in Level 1/Level 2 algorithms.

CRTM1
- CRTM repository maintenance
- New sensors (coefficients)
- User support
- Test and software delivery

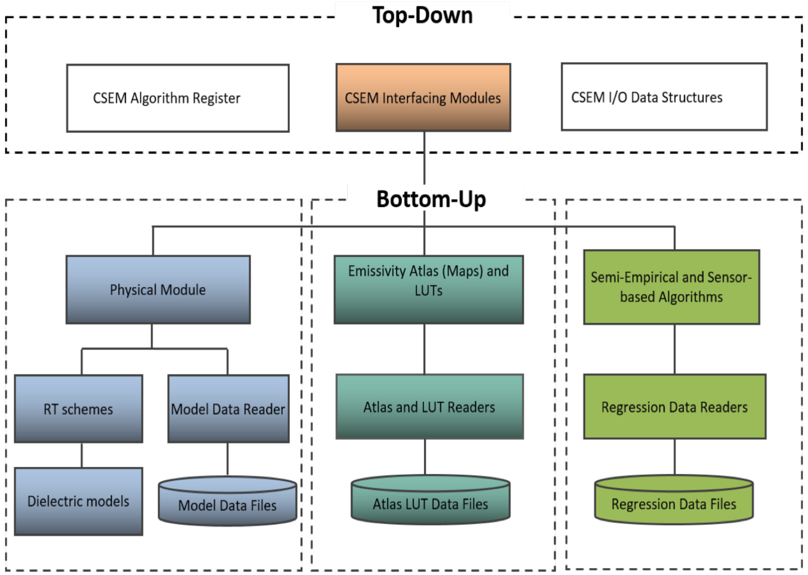
CRTM2
- Sensor coefficient generation package

CRTM3
- Vectorized RTM (UV, Vis)
- Community Surface Emissivity Model
- IR Sea Surface Emissivity update (IRRSEM)

Extension of CRTM to vectorized radiative transfer for UV/Vis supporting OMPS DA. Cross comparisons among various algorithms.

	I	Q	U	V
DA	0.557838	0.003928	−0.012050	0.000044
VLIDORT	0.557727	0.003927	−0.012050	0.000044
ADA	0.557839	0.003928	−0.012050	0.000044
AMOM	0.557828	0.003928	−0.012050	0.000044

Liu and Cao, 2019, JQSRT https://doi.org/10.1016/j.jqsrt.2019.01.019.

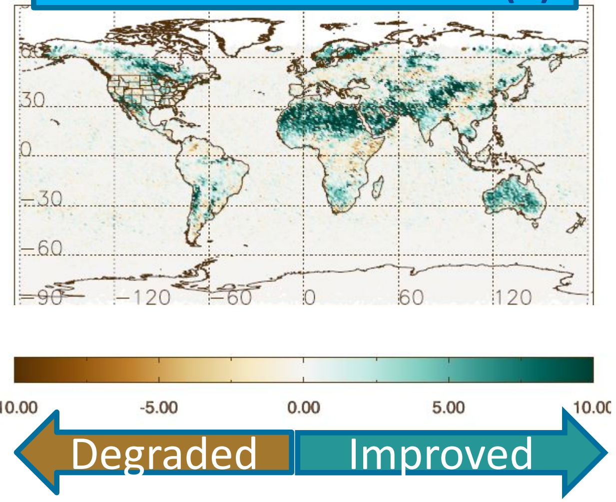


Community Surface Emissivity Model (CSEM) architecture.

New and Improved Observations / Impact of Observing Systems

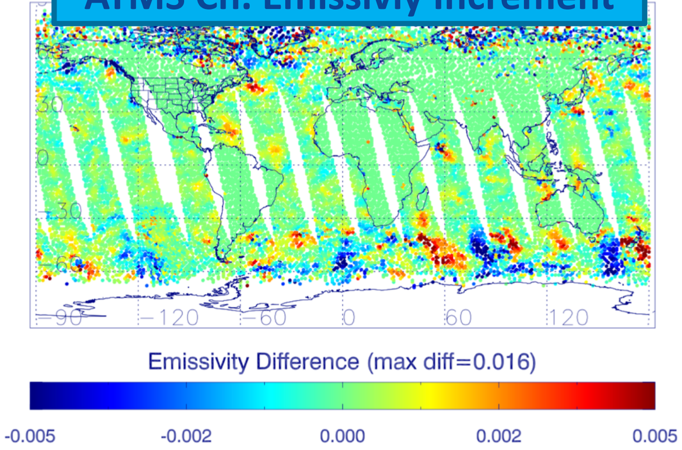
Surface Emissivity control variable to improve passive microwave radiance assimilation over land

ATMS Ch. 1 O-B Abs. Diff (K)



Emissivity increments over land are small. Need for new QC, tuning of emissivity background error, and verification of physical emissivity in analysis field.

ATMS Ch. Emissiviy Increment



O-B for descending orbit is improved using TELSEM2 as background for ATMS (channel 1 shown). Error in Tskin dominates ascending.

Activities supporting GNSS-RO assimilation

1 Advance assimilation

- COSMIC-2 assimilation in lower troposphere and moisture rich regions.

2 Data quality evaluation

- Assessment and monitoring

3 Data processing

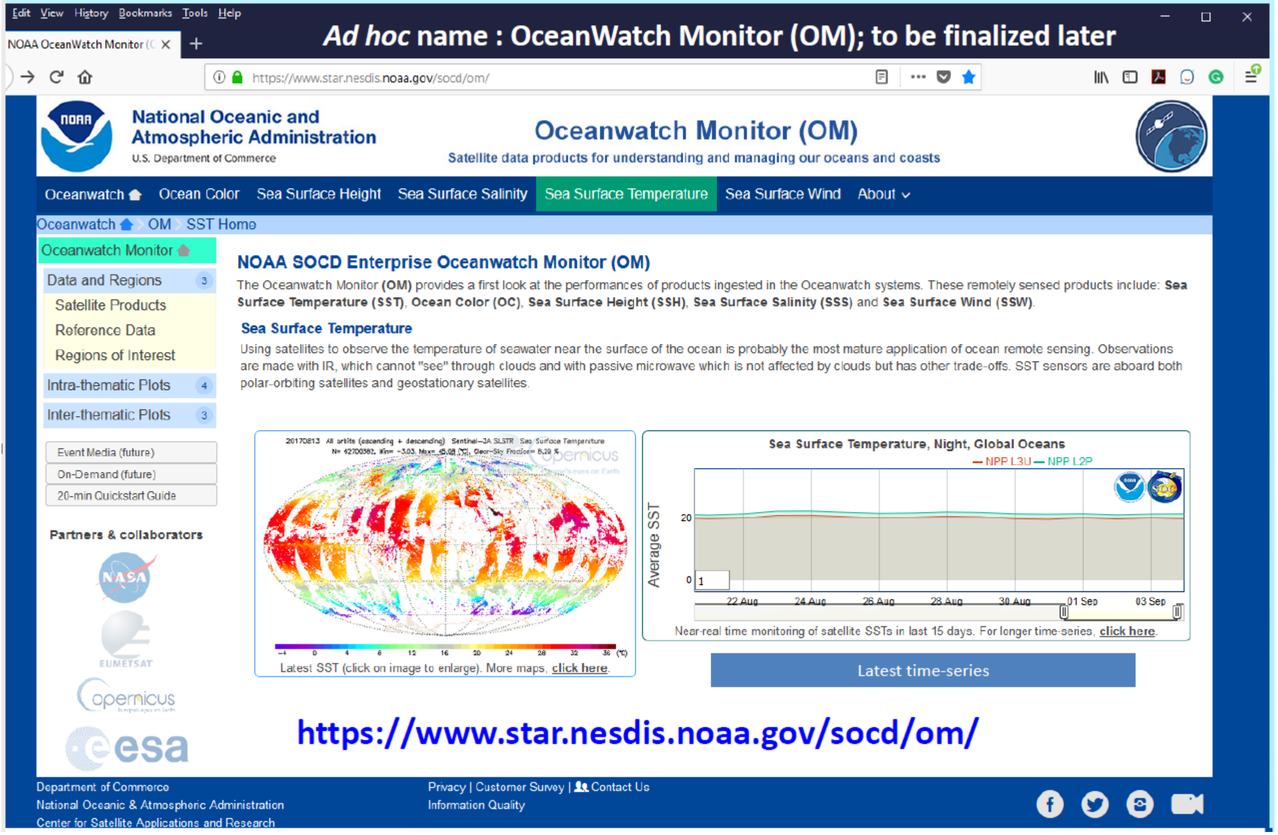
- L0-L1 and L1-L2 processing

4 Data Sharing

- Access to GNSS-RO data through STAR Mission Science Network

Broader NESDIS Activities

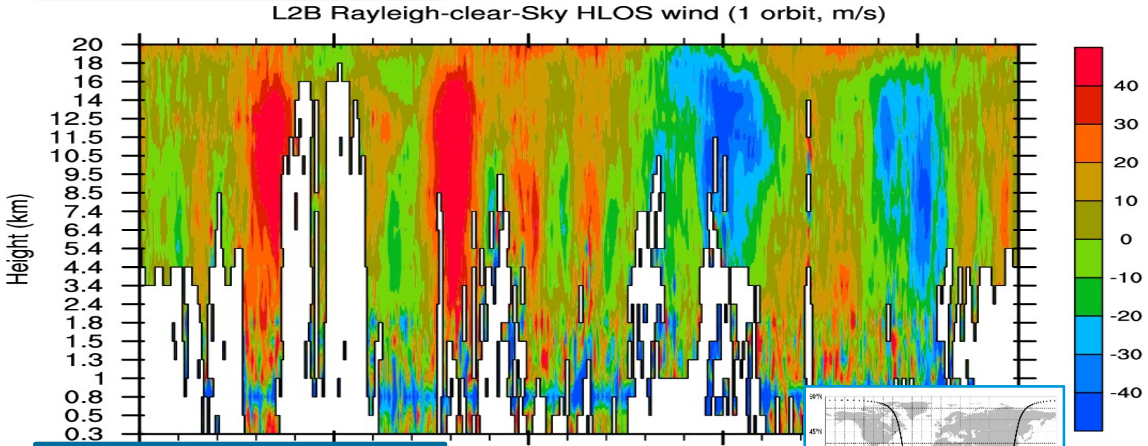
Ocean Data Assimilation

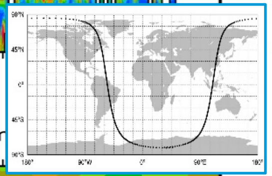


- Robust QA/QC for ocean, coupled ocean-atmosphere data assimilation
  - Altimetry, SST, SSS, SWH, winds, sea-ice, chlorophyl
- Extension of CRTM to SMAP/SMOS
- Development of scatterometer winds from SCATSAT

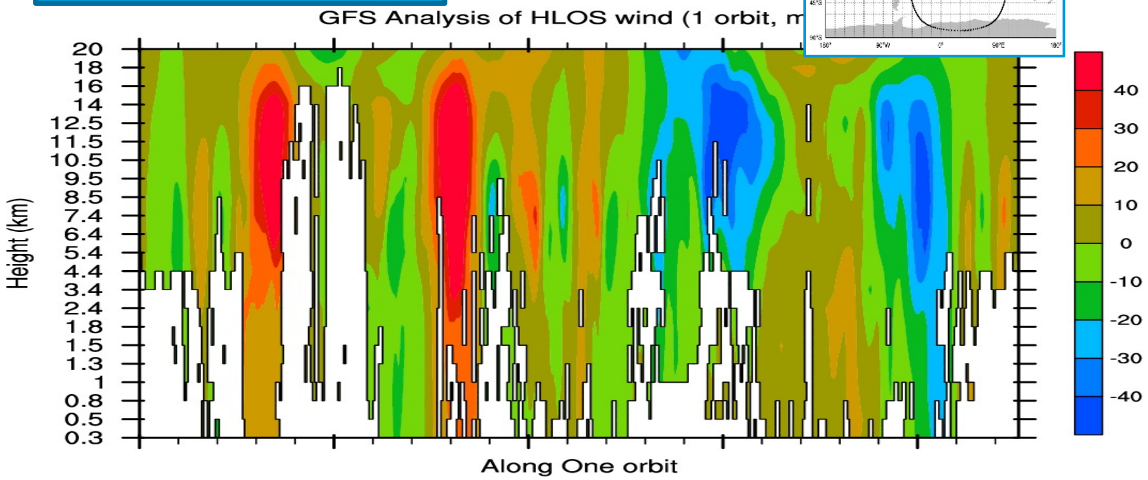
ADM-Aeolus HLOS Winds/3D-Winds

L2B HLOS





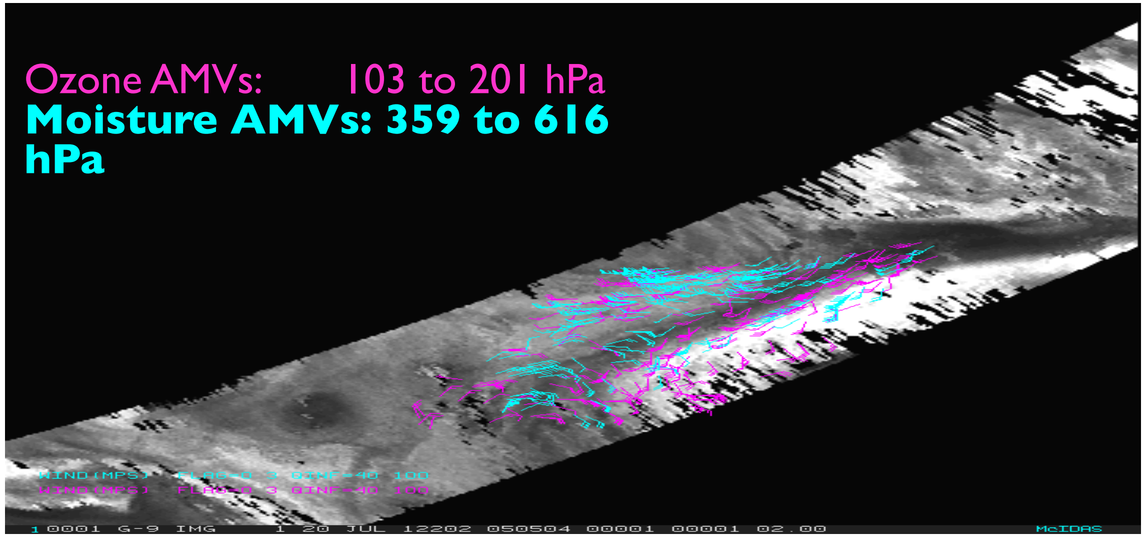
GFS HLOS



ADM-Aeolus Horizontal Line of Sight winds (Rayleigh) for 1 orbit on 2019-02-25 (top) and GFS model equivalent (bottom).

Benefits of satellite-based wind profiles to NOAA

- Coordination between STAR, AOML, CIs, GMAO, EMC, JPL
- Compare Aeolus to AMV, radisonde, aircraft, 3D-Winds, NWP, HRD recon (TCs, SAL)
- Assess NWP impacts (FV3GFS, HWRF). Both HLOS and 3D-WInds

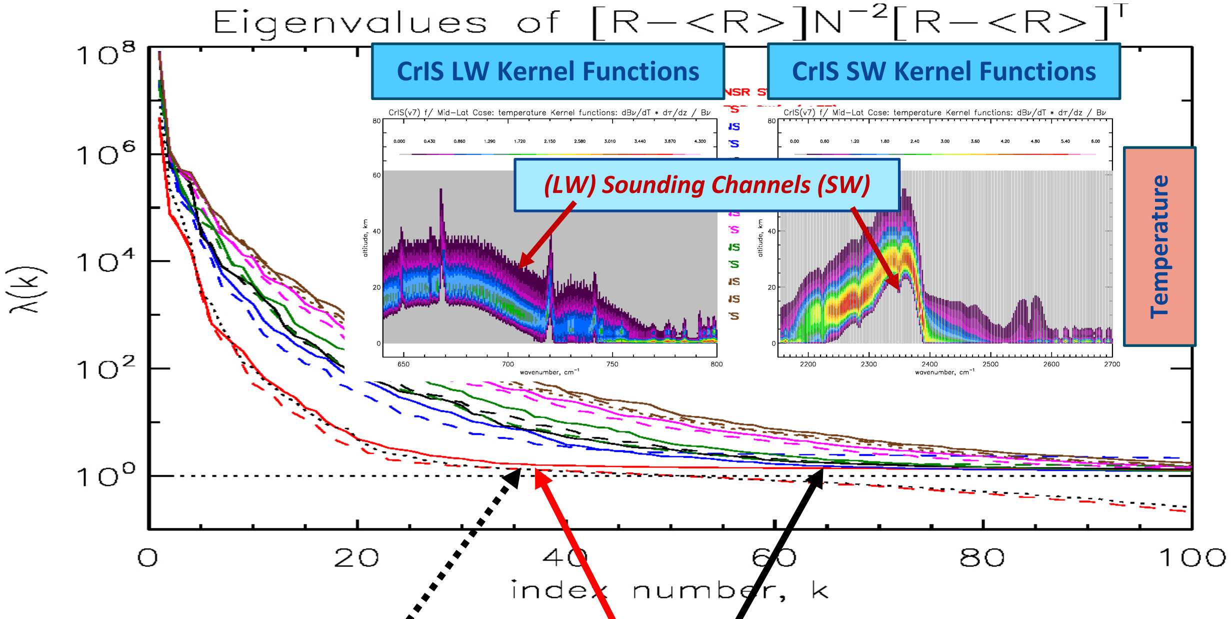


AIRS-derived 3D-Winds over north Polar region.
(David Santek, CIMSS)

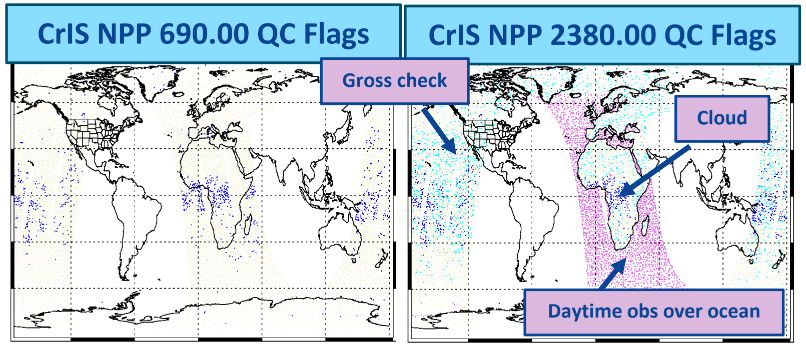
Assimilation of Shortwave Infrared

Can we achieve similar forecast impacts assimilating shortwave IR bands from hyperspectral IR sounders, as is achieved with longwave IR bands?

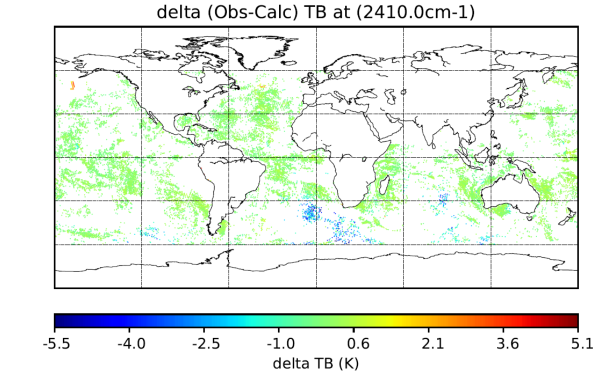
- More cost-effective smallsat constellation?



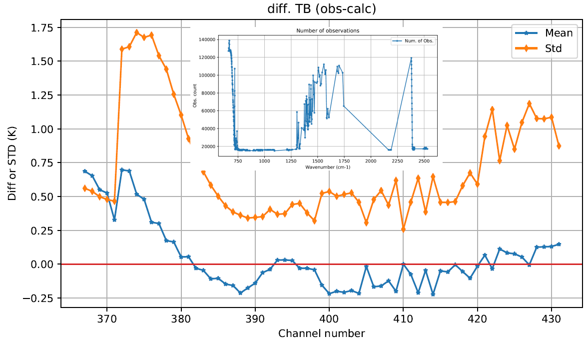
~35 dof for SW (red)
~65 dof for LW (black)
~35 dof for LW (690-790, black dots)



Revisit current quality control procedures (CrIS 431 FSR)



GSI cloud detection scheme based on SW-only channels (2380-2507 cm^{-1})

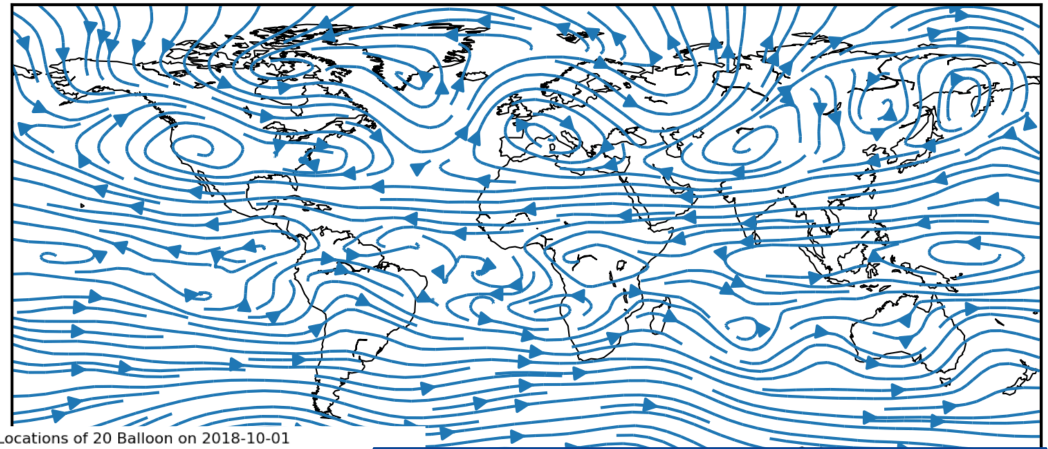


Scene dependent observation errors (noise)

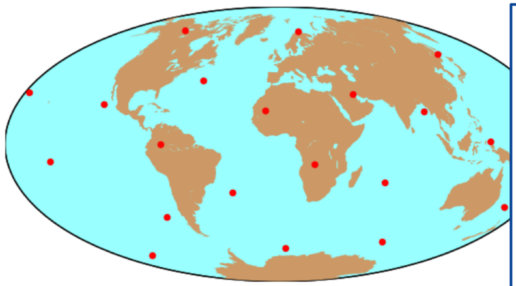
Alternative Hosting Payloads

Hosting sensors on non-traditional platforms
- Space-based or near-space
- Match technology with payload capacity
- Explore value for NOAA applications

Stream at level 70.0 mb at 20060801 00Z



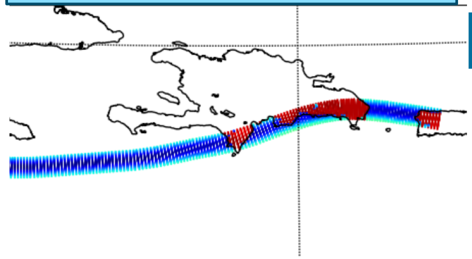
Locations of 20 Balloon on 2018-10-01



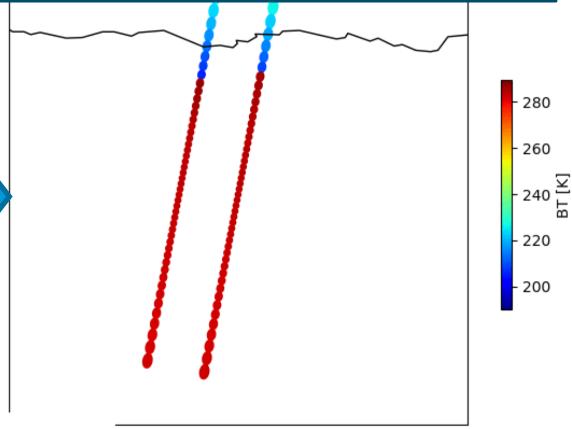
Near-space observations:
Use Community Global OSSE Package (CGOP) and G5NR (with trajectory model) to simulate stratospheric balloons constellation. 20 balloons.

Simulate an ATMS-like and GPSRO instrument from ballon platform.
Assess impact on NWP.

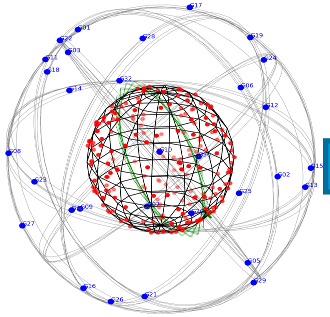
Sample balloon flight

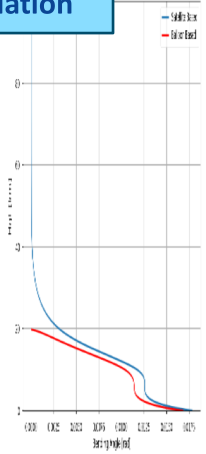


ATMS-LX Simulation (10 minute resolution)
Channel 1



RO Prediction and Bending Angle Simulation



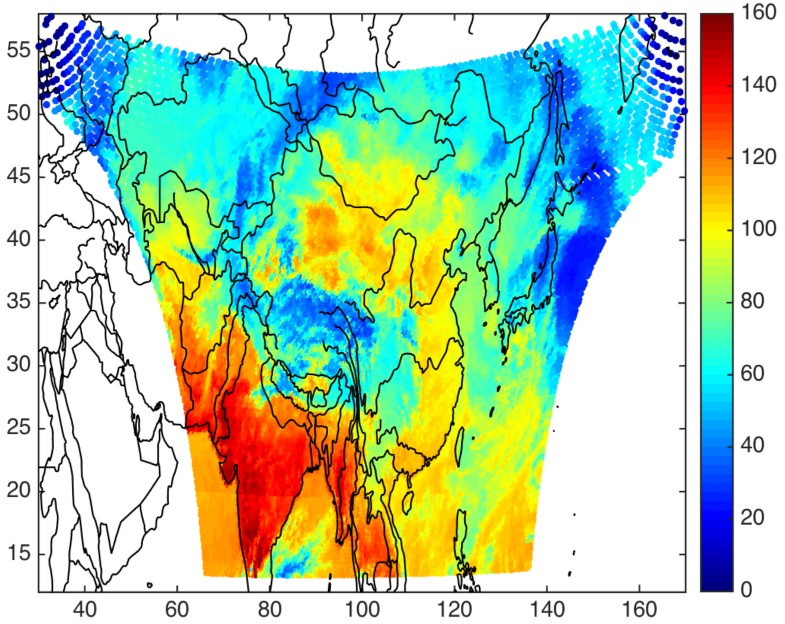


Additional effort will focus on space-based hosting opportunities.
- Space-X (Starlink ~12k satellites)
- Amazon (~3k satellites)
- Facebook

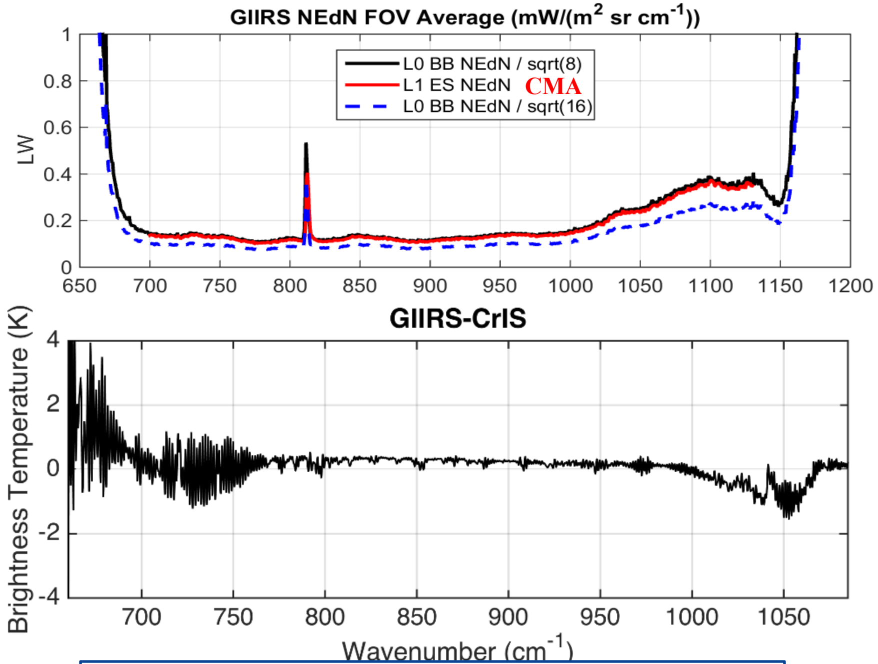
Geostationary Infrared Sounder

What benefit would NOAA gain from hyperspectral GEO infrared sounder?

- UW-Madison, UCAR/JCSDA funded to explore benefit of FY-4A GIIRS
- UW-Madison focus on calibration, demonstration of information content
- UCAR/JCSDA focus on QC, assimilation and impact assessment



900 cm-1 Calibrated Radiance March 2, 2017 0600 UTC (2.5 hours of data)



TOP: Comparison of SSEC and CMA NEdN (30% reduction in noise)
BOTTOM: GIIRS-CrIS BT Comparison

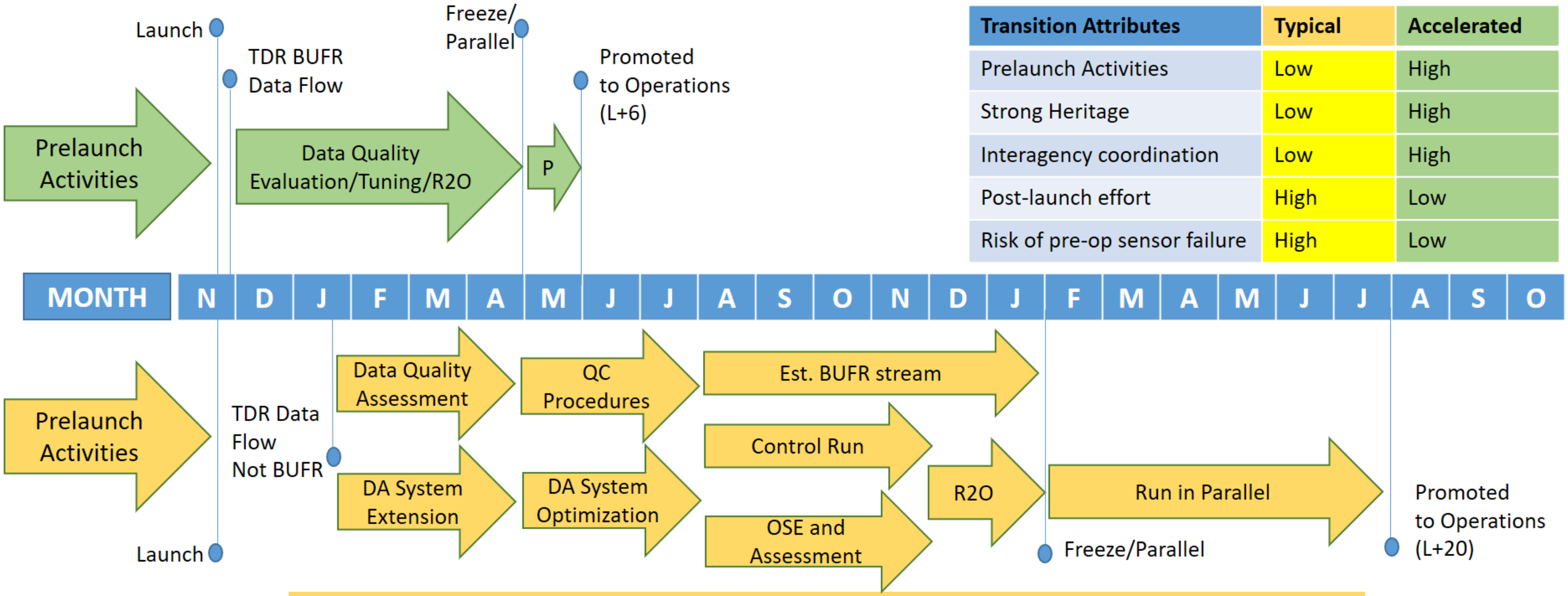
Figures courtesy
Hank Revercomb and
Bob Knuteson, UW-SSEC

Acceleration of Data Exploitation

How do we transform from Typical ***beyond*** Accelerated Data Assimilation R2O in the Smallsat era?

Timeline of New Satellite Data R2O Transition (Accelerated Example)

Transition Attributes	Typical	Accelerated
Prelaunch Activities	Low	High
Strong Heritage	Low	High
Interagency coordination	Low	High
Post-launch effort	High	Low
Risk of pre-op sensor failure	High	Low



Timeline of New Satellite Data R2O Transition (Typical Example)

Continued discussion

- Himawari AHI worked stopped 10/31/2018; transition to EMC
- Attempting to restart AMSR2, GMI assimilation
- S4 support
- GEO sounder OSSE work beginning
- AI/ML applications for NWP, data assimilation
- Welcome further opportunities to collaborate/contribute to land, aerosol, trace gas data assimilation (global/regional models)