



NASA/GMAO Update and JCSDA Activities

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GMAO

JCSDA Executive Team

for the GMAO team

*17th JCSDA Technical Review Meeting and Science Workshop
29 – 31 May 2019, NASA Head Quarters, Washington, D.C.*

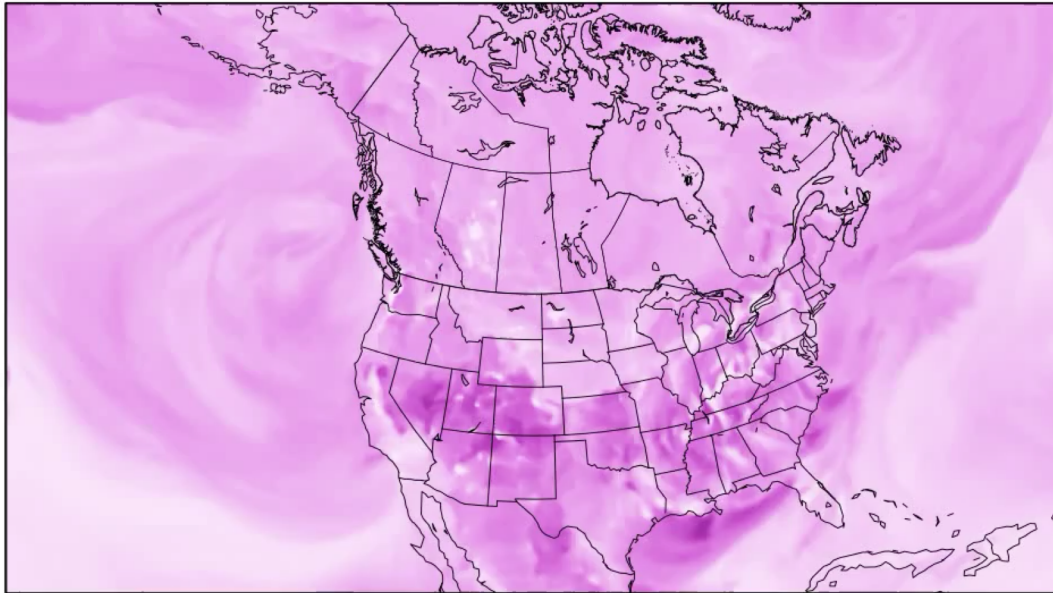
GMAO Systems

New!

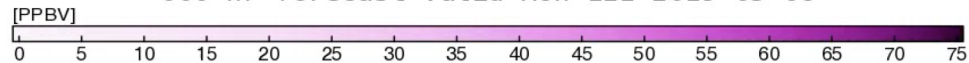
System	Product Description	Distribution	Availability
GEOS FP	Real-time weather analysis and prediction using latest validated GEOS system, includes FSOI	NCCS Portals	Public
GEOS FP-IT	Real-time stable analysis product for NASA Instrument Teams, spanning 2002 onwards	GES-DISC	Subscription
GEOS CF	Once daily near real-time composition forecast, includes full chemistry	NCCS Portals	Public
GEOS S2S	Nine-month coupled AOLI forecasts with ocean DA and including SubX	Push from NCCS	To NMME By request
MERRA-2	Atmospheric reanalysis 1980-present, including meteorology, aerosols, ozone, sea ice	GES-DISC (with DOIs)	Public
M2-AMIP	10-member GEOS model ensemble using MERRA-2 version of GEOS GCM	NCCS	Public
7km-G5NR	7-km GEOS-5 Nature Run (produced in 2014) including aerosols and CO ₂	NCCS Portals	Public
SMAP L4	Soil moisture, carbon fluxes as a part of the SMAP Mission (Level-4 products)	NSIDC (DAAC)	Public

GEOS CF 5-day composition forecast (from GMAO web page)

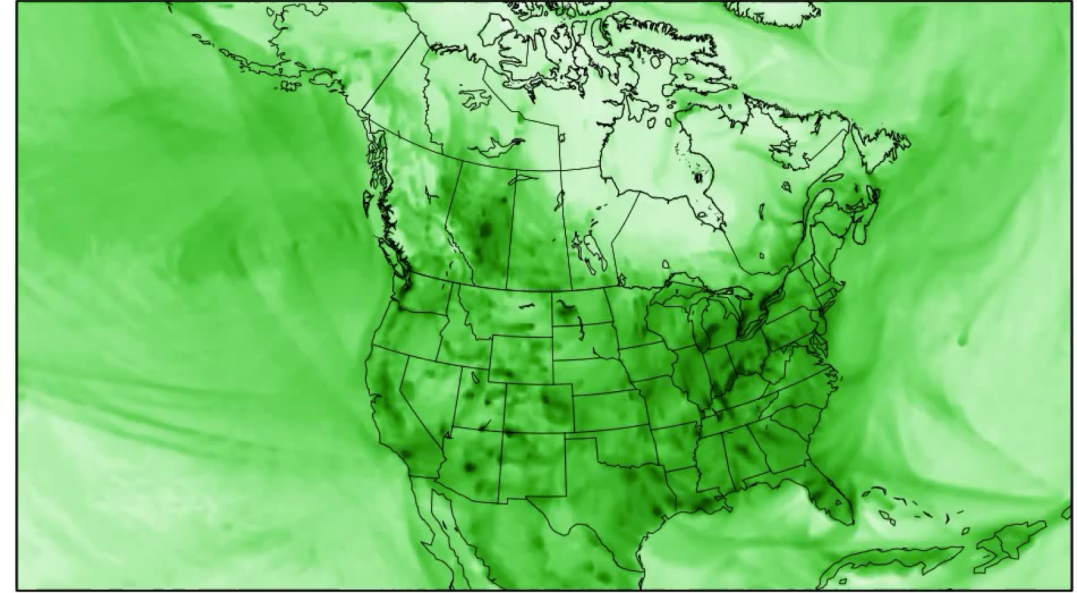
NASA GMAO – GEOS CF Forecast Initialized on 12z 05/06/2019

Surface O₃

000 hr forecast valid Mon 12z 2019-05-06



NASA GMAO – GEOS CF Forecast Initialized on 12z 05/06/2019

Surface NO₂

000 hr forecast valid Mon 12z 2019-05-06



GEOS FP-IT meteorology + GEOS-Chem full chemistry ⇒ GEOS CF

- 1-day replay (DA to come)
- 5-day forecast
- 25-km resolution (c360)
- 250 reactive gases



GEOS FP current status

System configuration

- FV3 dycore + GEOS physics suite
- GSI hybrid 4D-Envar, 6-h cycle
 - GCM: C720 L72 (13 km)
 - GSI: 1152 × 721 L72 (25 km)
 - EnKF: C180 L72 × 32 (50 km)
- Incremental analysis update
- AO interface + skin SST analysis
- Aerosol assimilation
- FSOI at 00UTC

Key updates since last JCSDA workshop

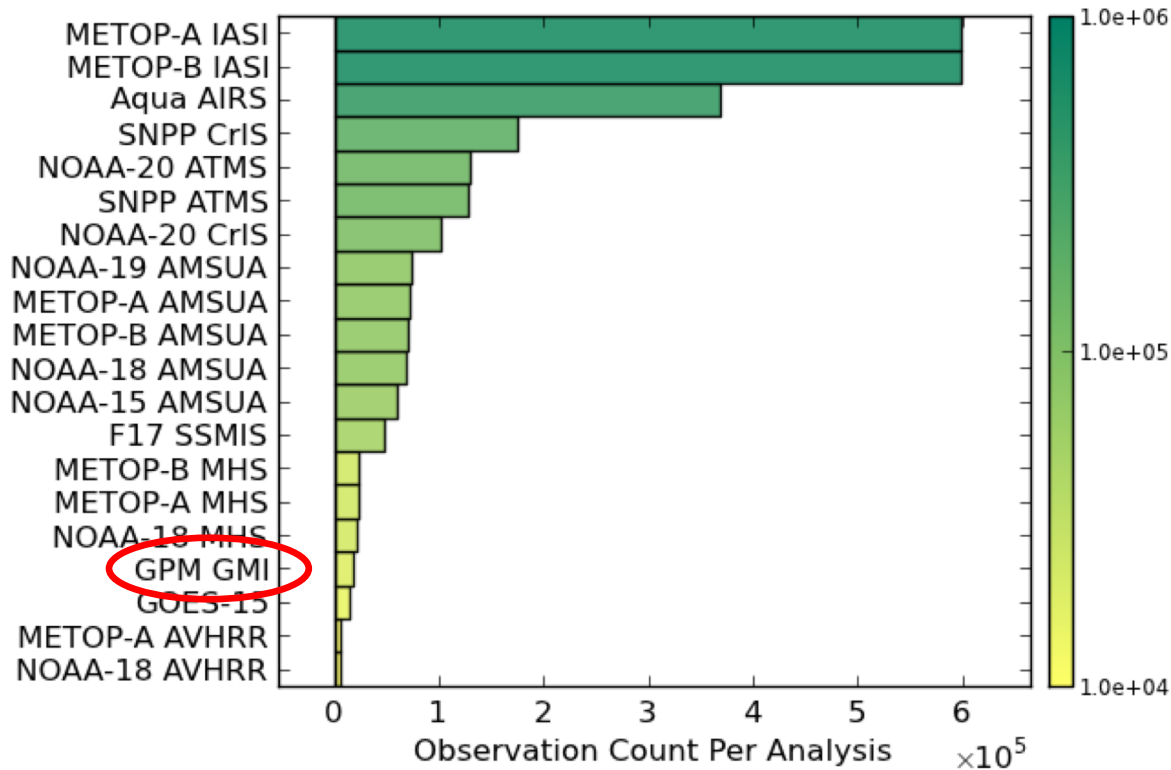
- VLab Version-0 FV3 dycore
- RRTMG LW
- Retuned cloud ice/liquid effective radii
- Retuned topography and GWD
- GPM GMI all-sky radiances ✓
- NOAA-20 CrIS and ATMS
- SNPP OMPS total ozone
- Channel-correlated obs error for AIRS, IASI
- Variational scan-angle bias correction
- Retuned obs error for polar AMVs



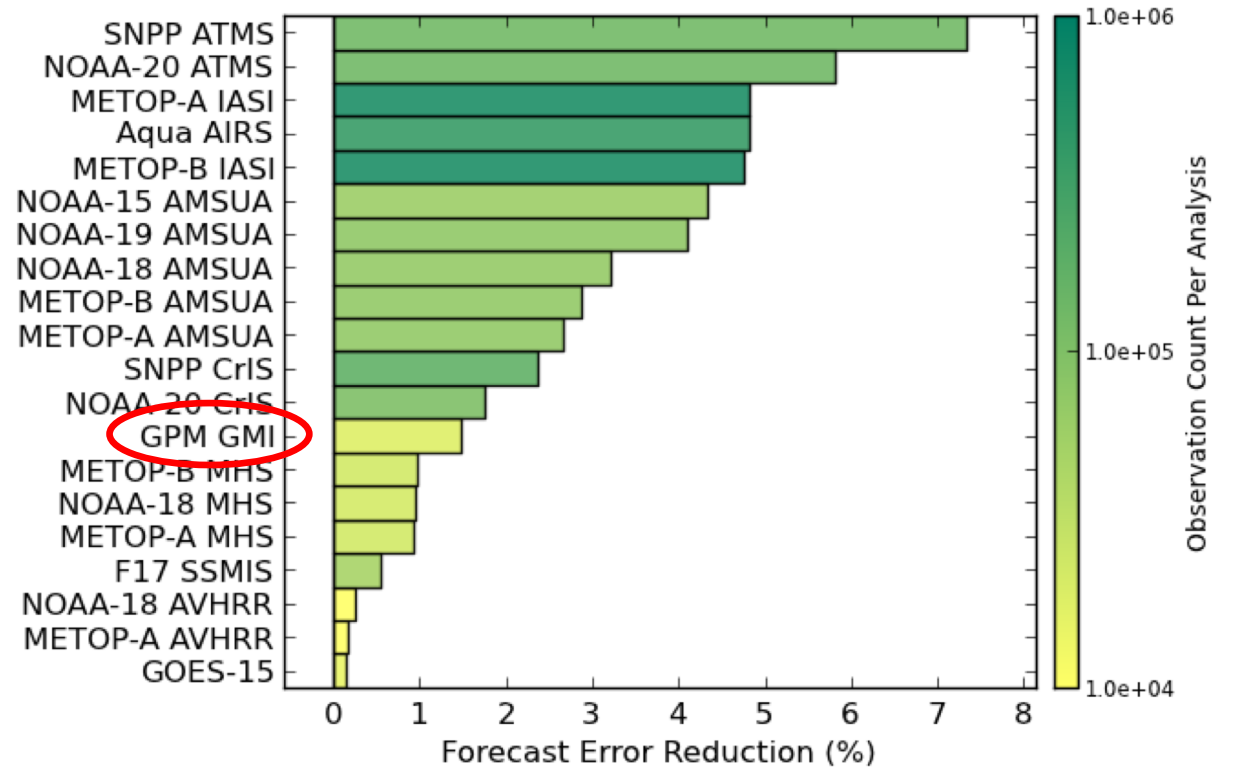
FSOI for satellite radiances in GEOS FP

24-h Global Moist Energy Aug 2018 – Apr 2019

Observation Count



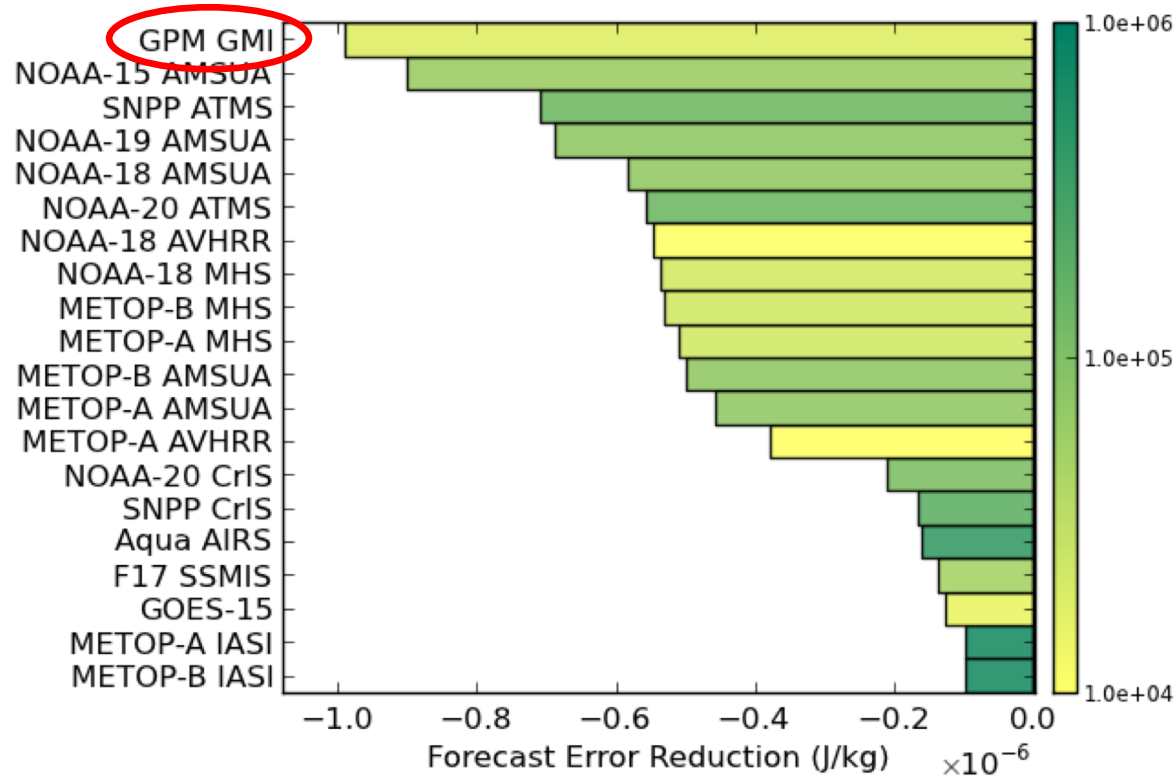
Total Impact



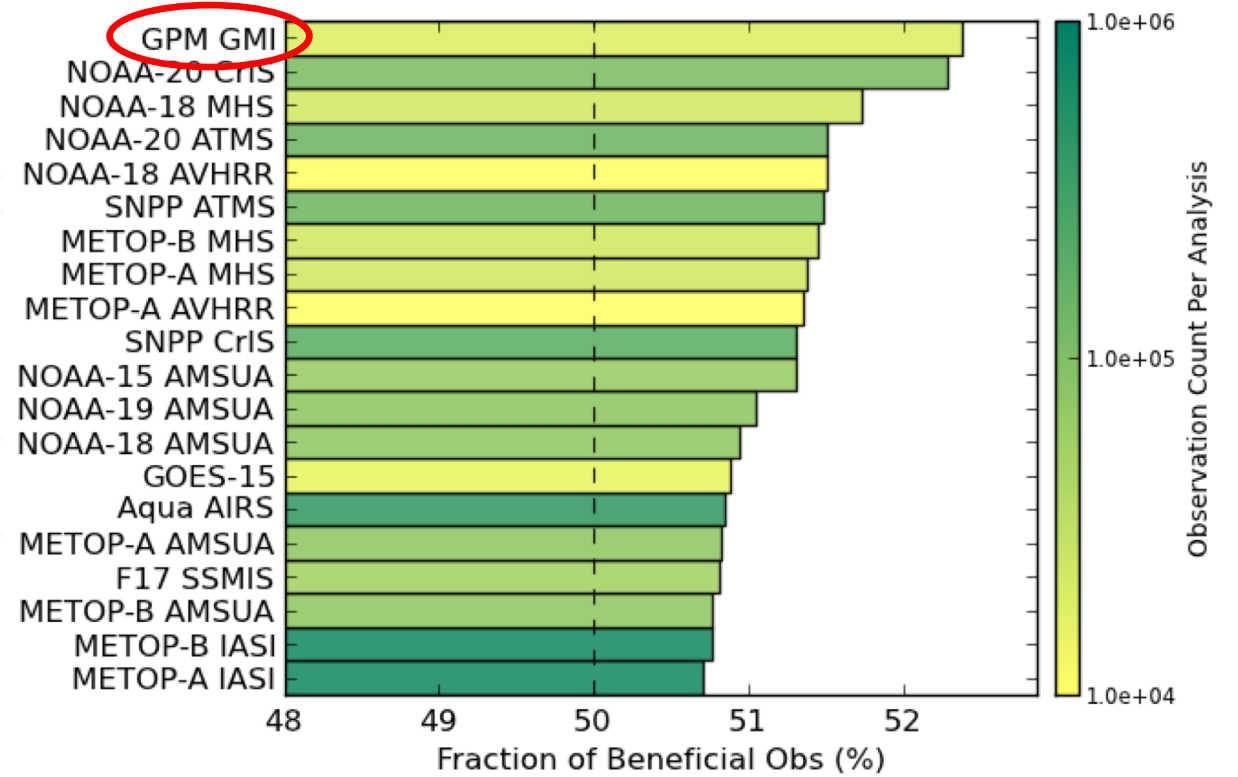
FSOI for satellite radiances in GEOS FP

24-h Global Moist Energy Aug 2018 – Apr 2019

Impact per Observation



Fraction of Beneficial Observations





GEOS FP implementation plans for 2019/2020

2019 Q3

- VLab Version-1 FV3 dycore (as in GFS)
- RRTMG SW
- Grell-Freitas scale-aware deep convection
- UW shallow convection
- Retuned microphysics, PBL, turbulence
- Updated land model
- Coupled AO model-capable

- Stochastic physics in EnKF (SPPT)

2020 Q1

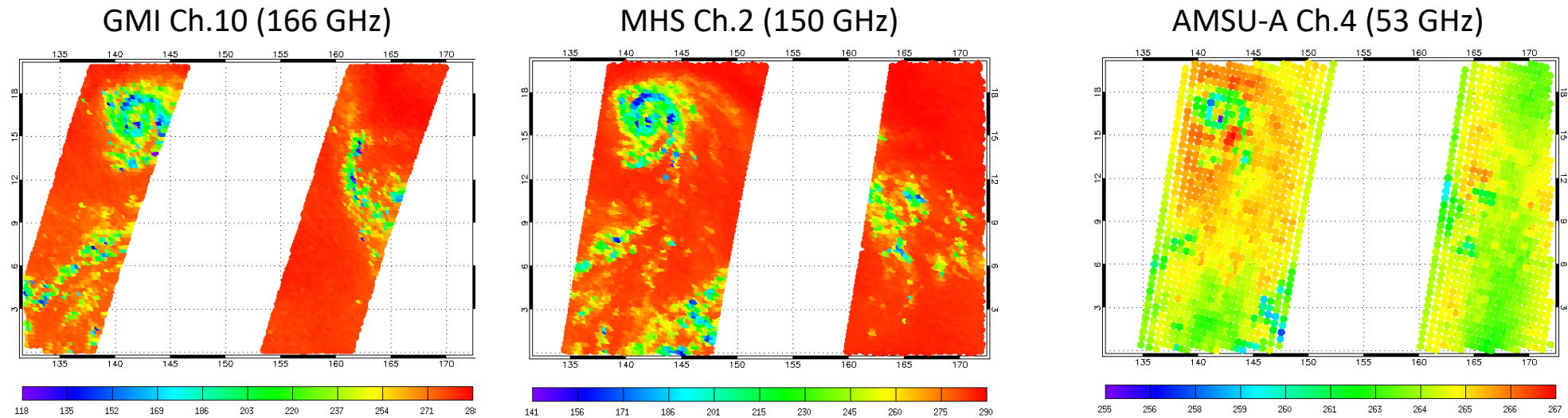
- All-sky MHS, AMSU-A
- Metop-C AMUS-A, MHS, ...
- AIRS AMVs
- Aeolus LOS wind (quality permitting)
- Channel-correlated obs error for CrIS FSR
- Revised thinning of GEO AMVs
- Aircraft bias correction

2020 Q3

- 132 vertical levels
- Unified PBL - EDMF or SHOC
- Unified GWD
- RRTMGp (high-performance)

Extending all-sky MW radiance assimilation to MHS and AMSU-A

GMI, MHS and AMSU-A observed brightness temperatures near Typhoon Maria on 2018-07-06 00UTC



Like GMI, **MHS** has channels near the 183 GHz water vapor absorption band, but flies on more platforms and has a wider swath width (increases refresh rate and coverage).

AMSU-A has channels near the oxygen absorption band and is sensitive to temperature.

Min-Jeong Kim, GMAO

Impact of all-sky MHS and AMSU-A on forecast skill

Early cycling experiments

GEOS Hybrid 4D-Envar, 6h cycle

GCM: 25-km

GSI: 50-km

EnKF: 100-km

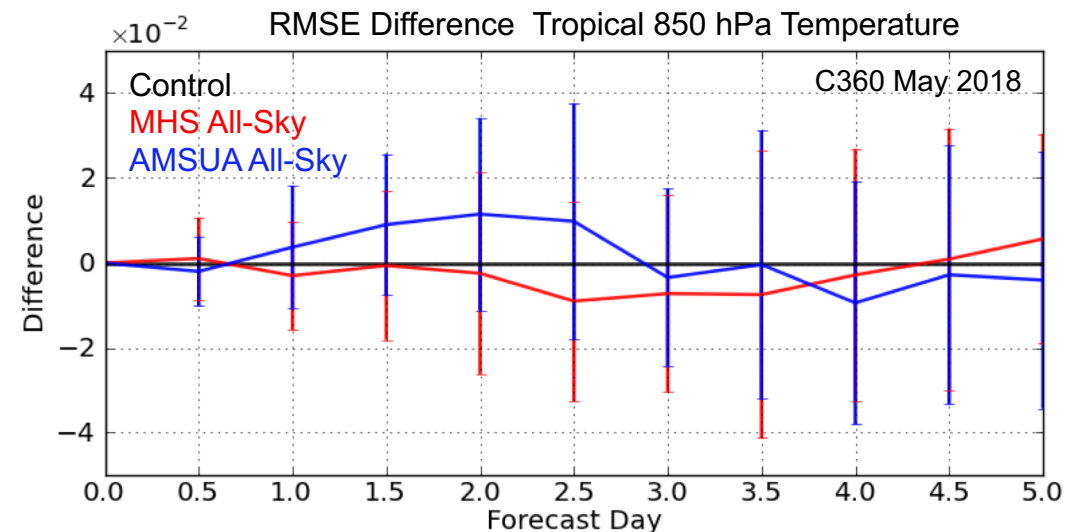
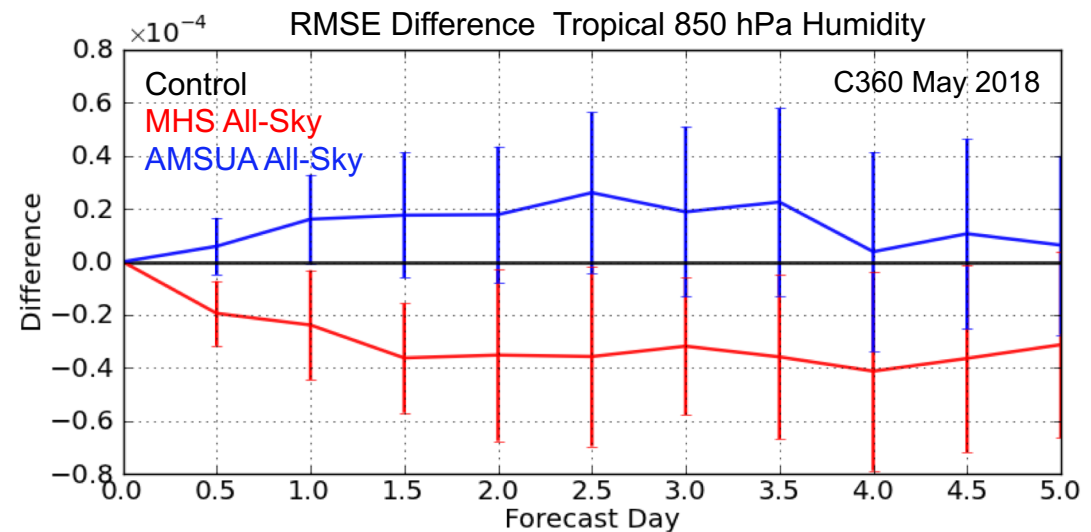
Control: full observing system (includes GMI)

MHS All-sky: Control + MHS all-sky

AMUSA All-sky: Control + AMSUA all-sky

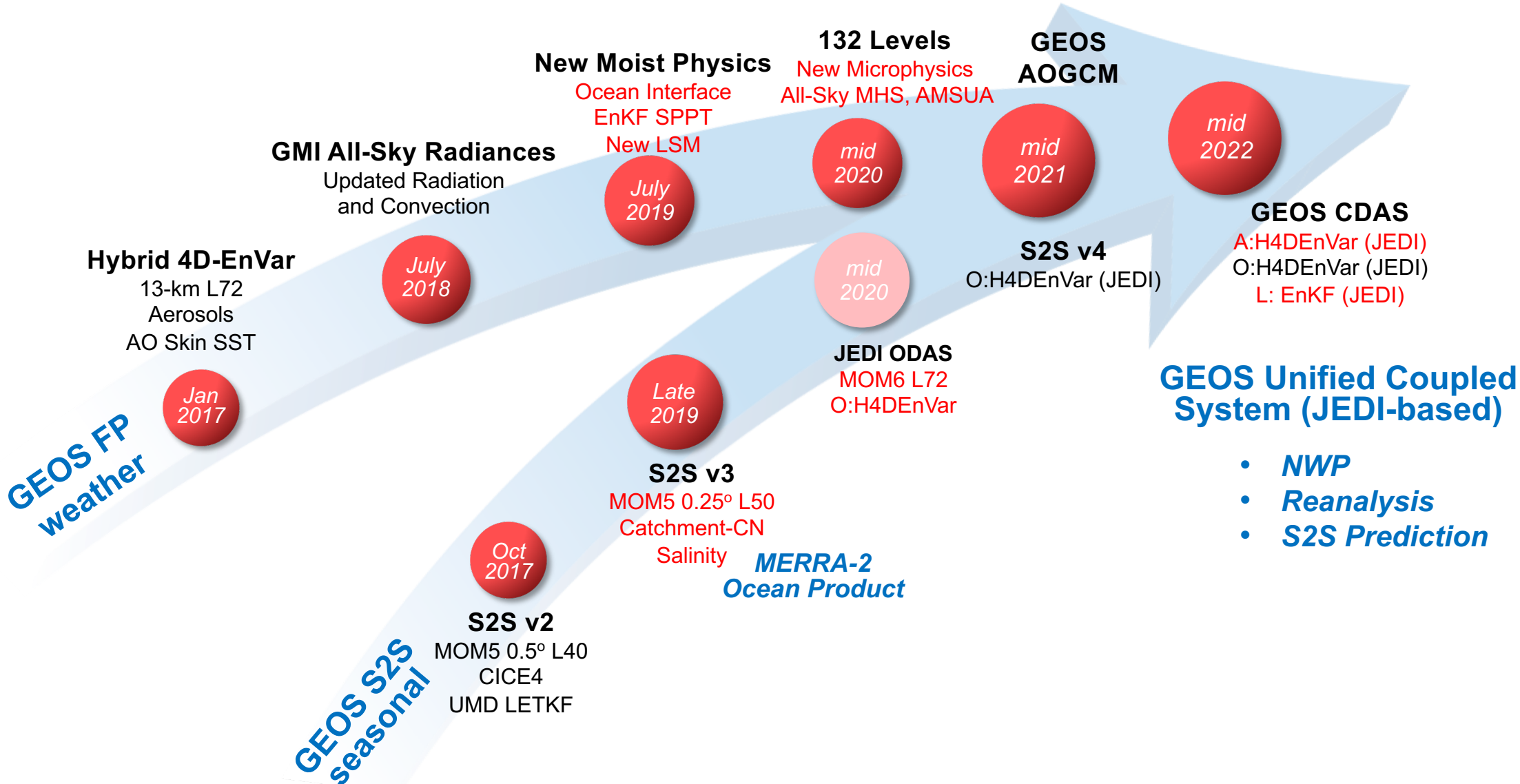
Mostly neutral impact so far, but significant positive impact of all-sky MHS on low-level tropical humidity (95%)

Tuning and experimentation continues...





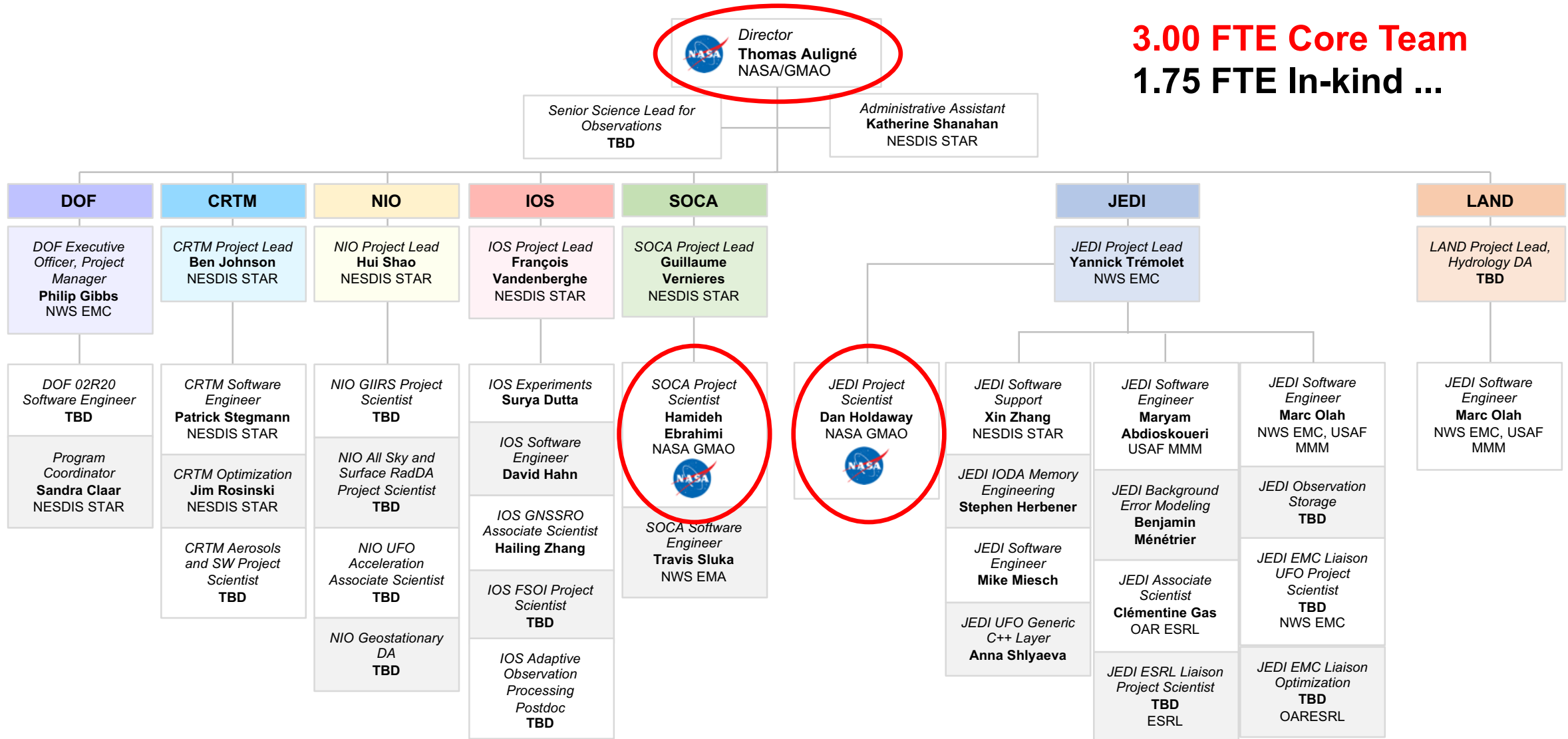
Moving toward a JEDI-based GEOS system for coupled DA





NASA support of JCSDA for 2019

3.00 FTE Core Team
1.75 FTE In-kind ...





GMAO in-kind contributions to JCSDA for 2019

	DOF	CRTM	NIO	IOS	SOCA	JEDI	Total	Work Description
Akella, Santha					0.1		0.1	Unified Forward Operator (UFO) for marine DA
Gelaro, Ron	0.05						0.05	Executive Team
Karpowicz, Bryan						0.2	0.2	UFO support, QC filters
Kim, Min-Jeong			0.1				0.1	GPM/GMI in UFO
Mahajan, Rahul					0.3	0.3	0.6	Work flow for marine DA; SST UFO; coupled UFO
McCarty, Will		0.1	0.1				0.2	SW IR in CRTM; Aeolus in UFO
Moradi, Isaac		0.2					0.2	General CRTM development; coefficient generation
Todling, Ricardo						0.3	0.3	Adjoint DA solver
Total	0.05	0.3	0.2	0	0.4	0.8	1.75	

DOF-Director's Office; **CRTM**-Community Radiative Transfer Model; **NIO**-New and Improved Observations; **IOS**-Impacts of Observing Systems; **SOCA**-Sea-ice, Ocean, Coupled Assimilation; **JEDI**-Joint Effort for Data Assimilation Integration

Ocean observations in JEDI

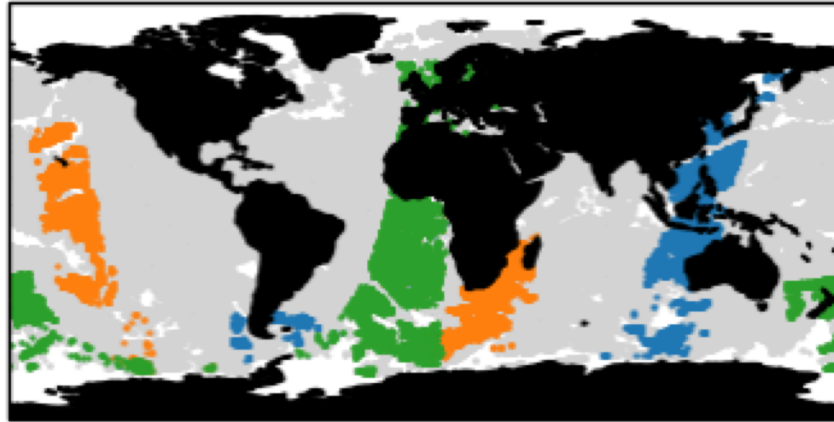
Observation Source	IODA converter	UFO	H(x)	3DVAR
FNMOG Profiles (Profilers, Moorings)	✓	Insitu T/S	✓	✓
FNMOG Surface (Ships, Drifters)	✓	SST	✓	✓
NESDIS RADS	✓	ADT	✓	✓
NCEP L2-SST (AVHRR, GOES-16, SNPP VIIRS, HIMAWARI-8, NOAA-19, METOP-A)	✓	SST	✓	
NCEP Profiles, Ships, Buoys, Drifters, Gliders	✓	Insitu T/S, SST		
NCEP Altimeters	✓	SSHA, SWH		
EMC Ice Fraction	✓	Ice Fraction	✓	✓
JPL & RSS SMAP	✓	SSS	✓	✓
NCEP GODAS	✓	Insitu T/S, ADT, SST	✓	✓
GMAO	✓	Insitu T/S, ADT	✓	✓
NESDIS SST (All sensors)	✓	SST	✓	✓

*Vernieres, Sluka, **Ebrahimi**, Mahajan, Flampouris*

One day of observations in JEDI Ocean 3D-Var

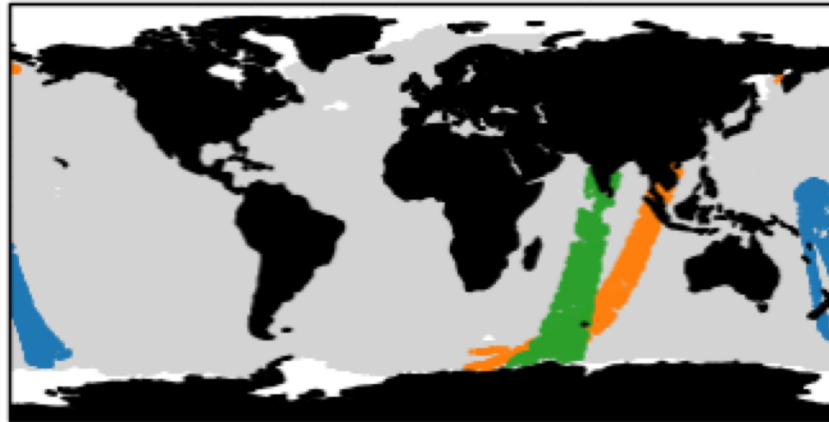
SST (IR)

NOAA-19, Metop-A AVHRR, SNPP VIIRS



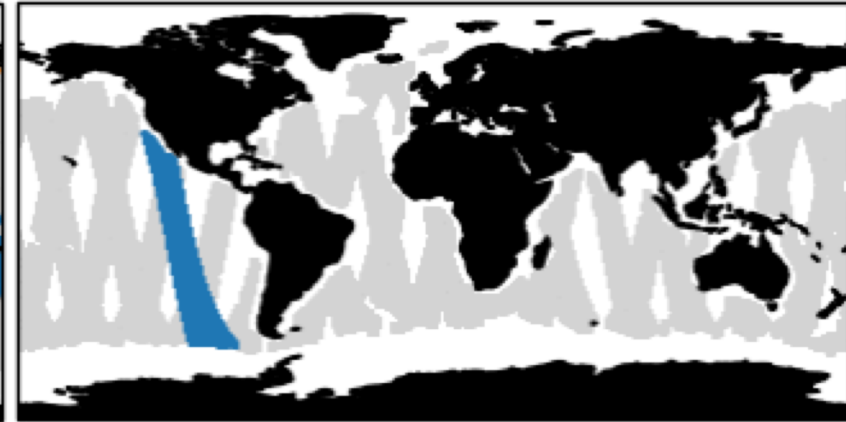
SST (MW)

GMI, AMSR2, WindSat



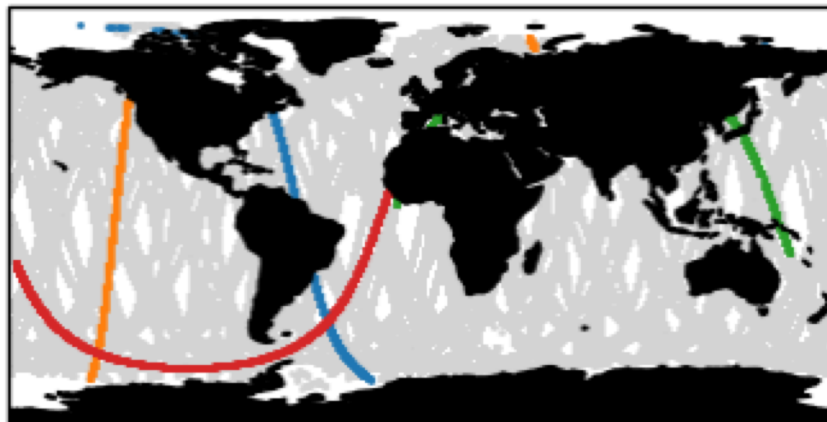
SSS

SMAP



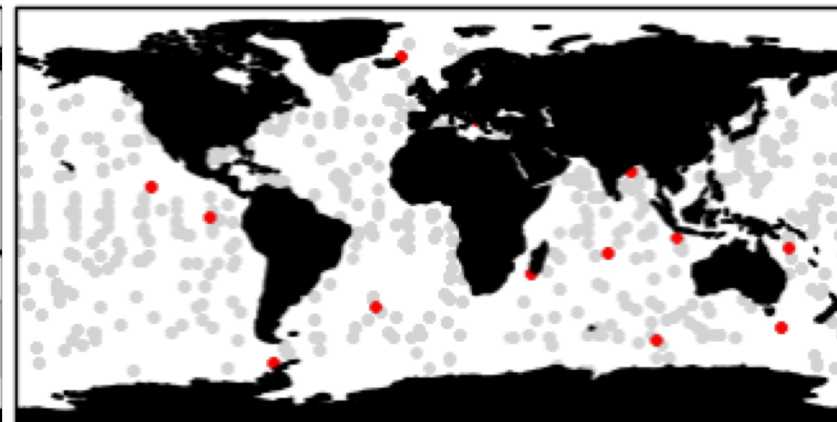
Altimetry

Jason-2,-3, Sentinel-3a, Cryosat-2, SARAL



Insitu T/S

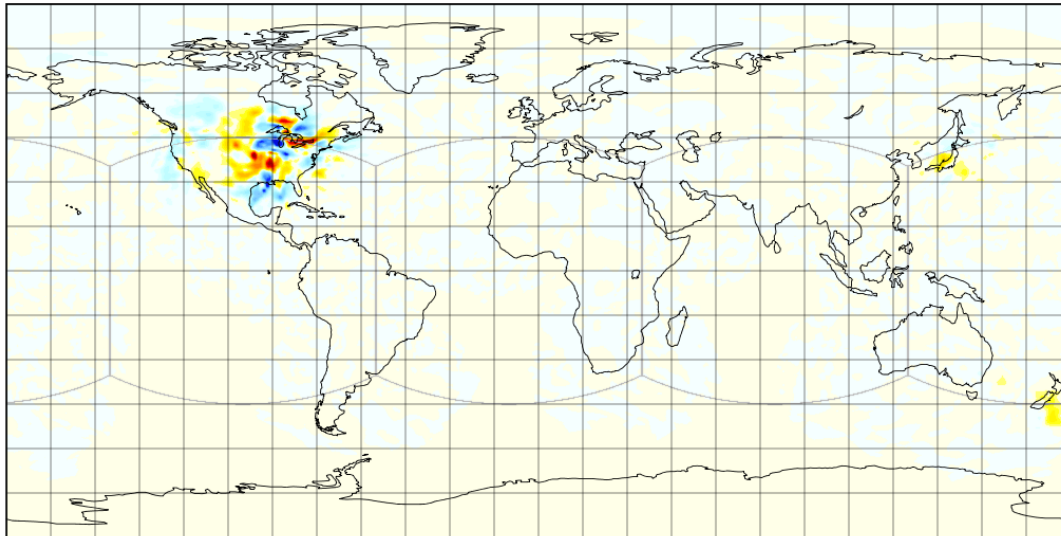
TAO, PIRATA, XBT, CTD, Ships, Drifters



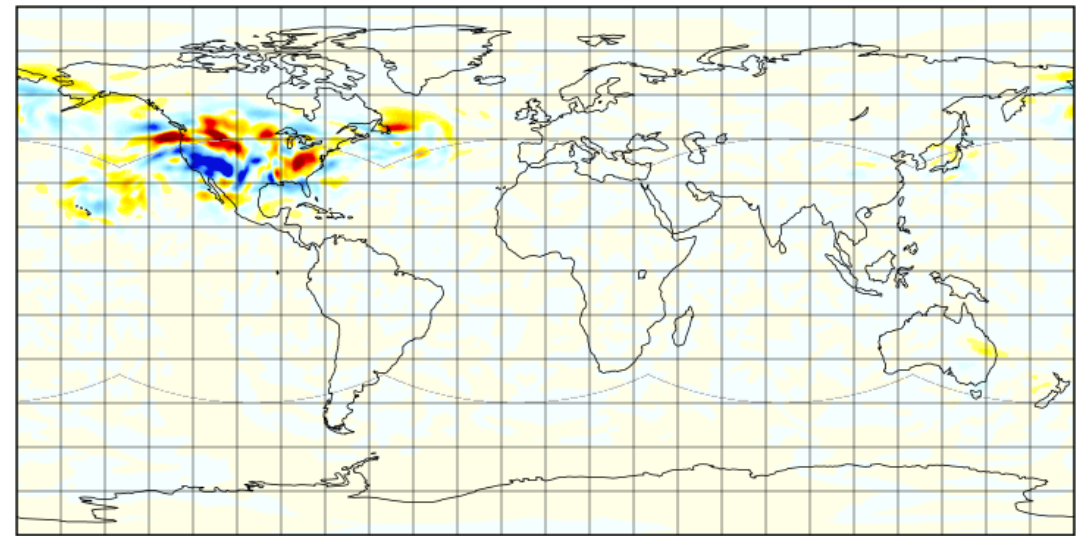
24-hr assimilation window on 15 April 2018

JEDI-based GEOS atmospheric 4D-EnVar tests

850 Temp Increment 2018-04-14 21UTC



250 U-wind Increment 2018-04-14 21UTC



- 6-hr window centered 2018-04-15 00UTC
- GEOS C180 (50-km) 10-member ensemble
- Aircraft and radiosondes (~400K observations)

- 2 sub-windows of 3 hours
- BUMP localization, prescribed length scales
- Background check for QC

Dan Holdaway, JCSDA