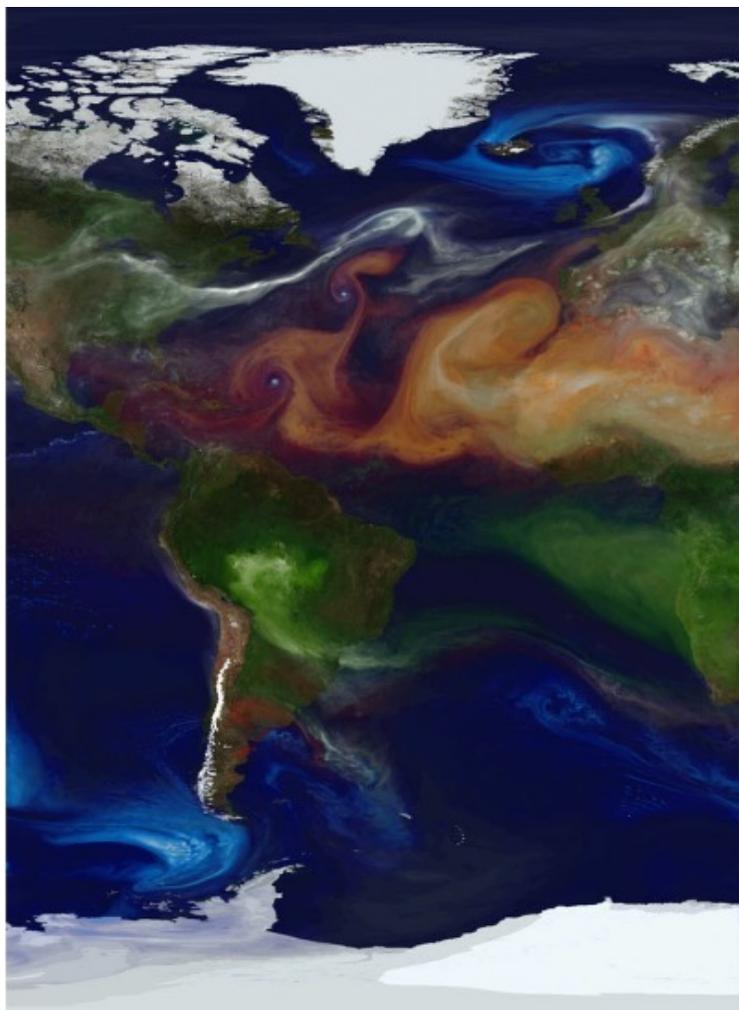
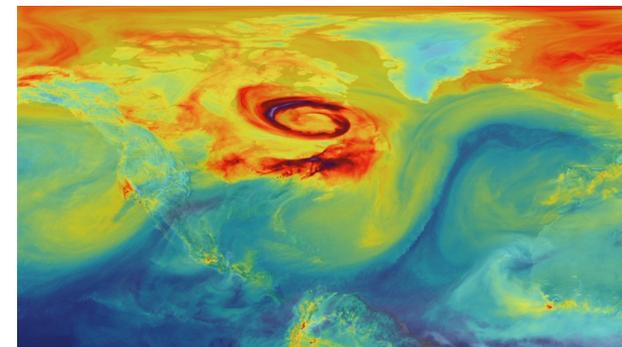




National Aeronautics and Space Administration



Status Update on GMAO's Upcoming GEOS-IT and GEOS R21C Retrospective Analyses

CERES Science Team Meeting

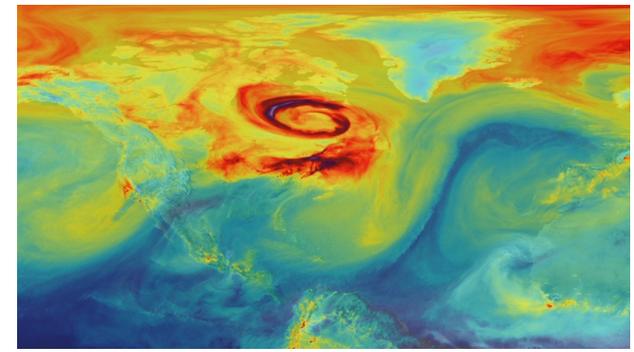
Presented by Gary Partyka

Contributors: Austin Conaty, Amal El Akkraoui, Rob Lucchesi, Mike Bosilovich

October 12-14, 2021

GMAO

Global Modeling and Assimilation Office
gmao.gsfc.nasa.gov



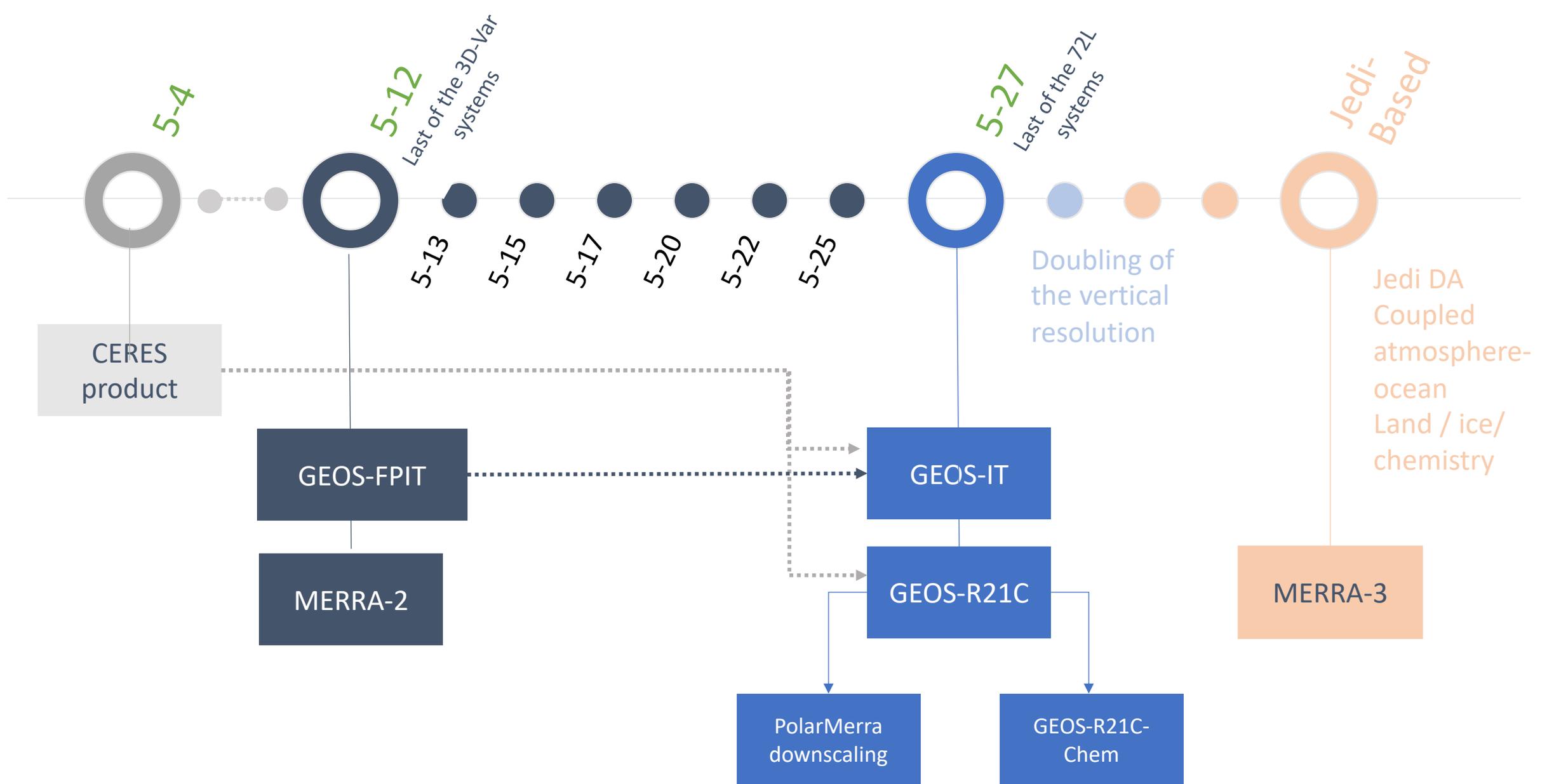
The GMAO is preparing to produce two retrospective products bridging the gap from NASA's EOS to the post-EOS observations:

model base same as the current GEOS-FP system

- **GEOS-IT** for use by NASA instrument teams
- **GEOS-R21C** a retrospective analysis for the 21st century for reanalysis research

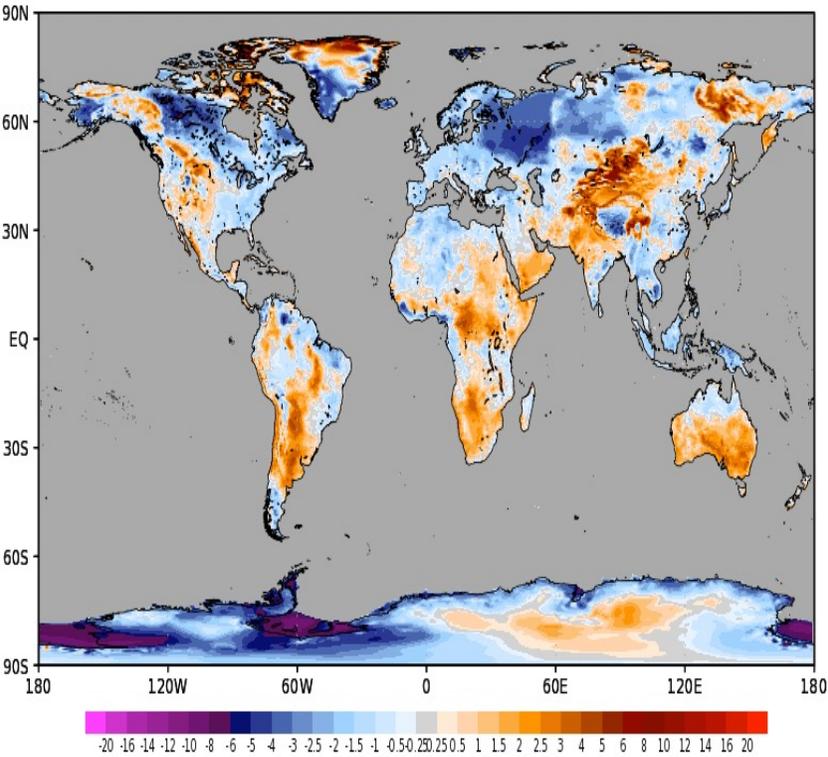
For this briefing, we will focus on the GEOS-IT system and comparisons of GEOS-CERES 5.4.1, GEOS-FPIT, and GEOS-IT

- **Surface temperature**
- **T and q profiles; UTH**
- **Top of the atmosphere energy balance**
- **Diurnal temperature range**
- **O-F statistics**

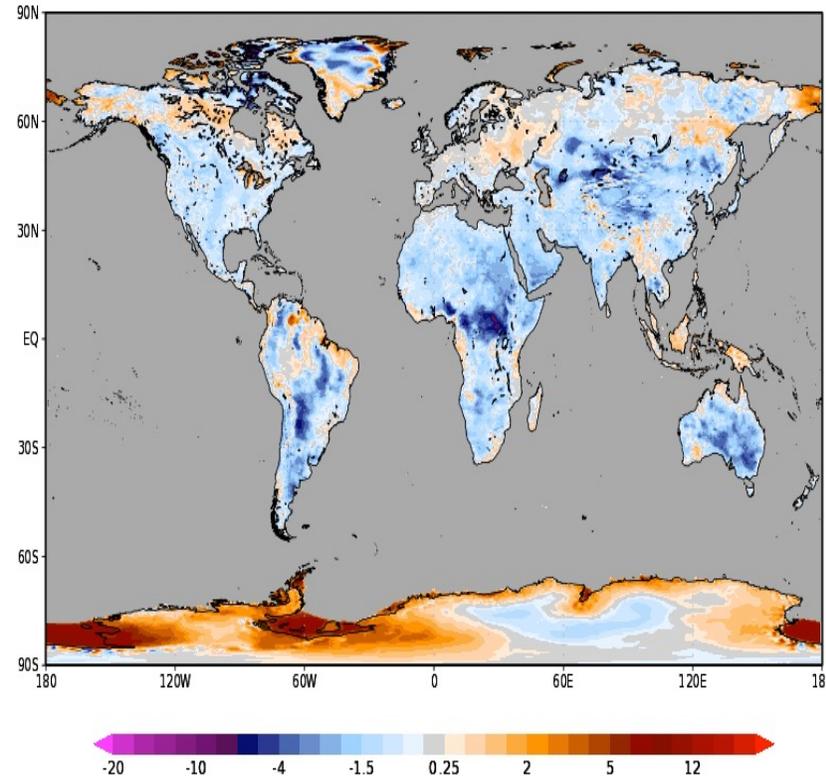


2-meter Temperature Difference (K) with ERA5; January 2018

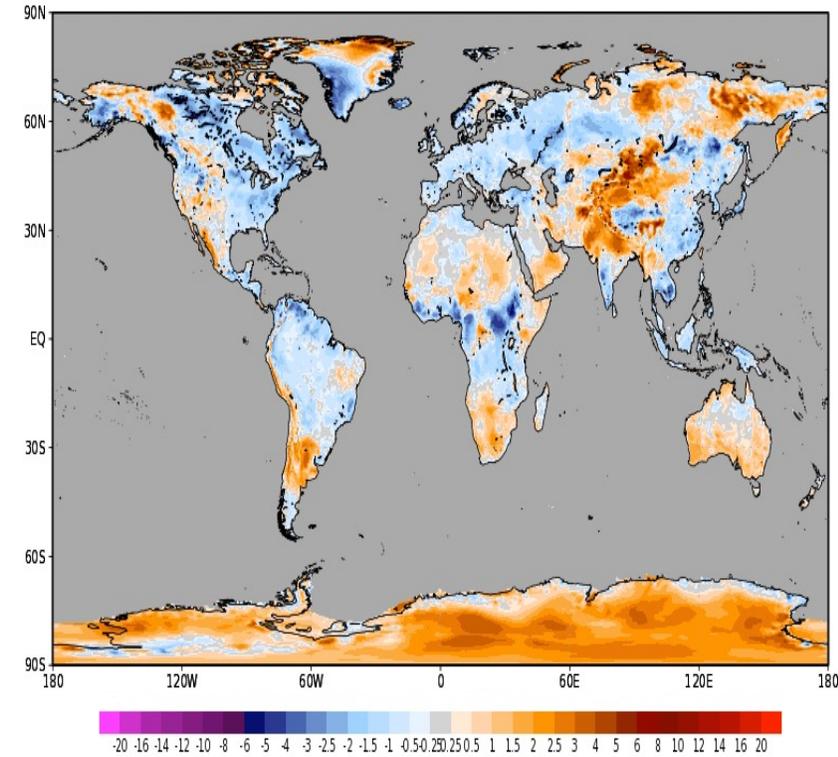
CERES 5.4.1 – ERA5



FPIT – ERA5



GEOS-IT – ERA5

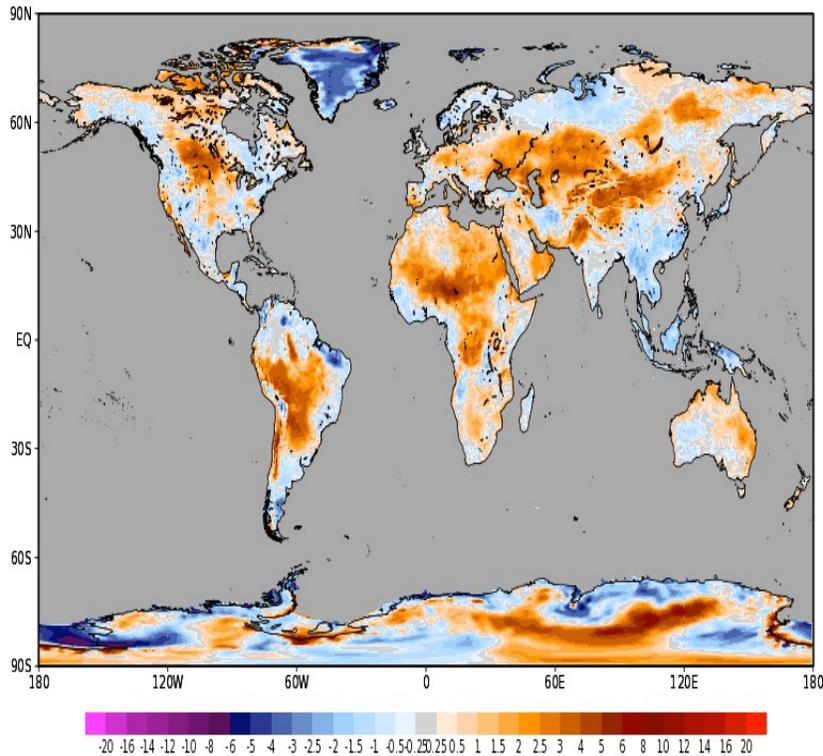


Substantial mean biases with respect to ERA5 (which we have vetted in-house)

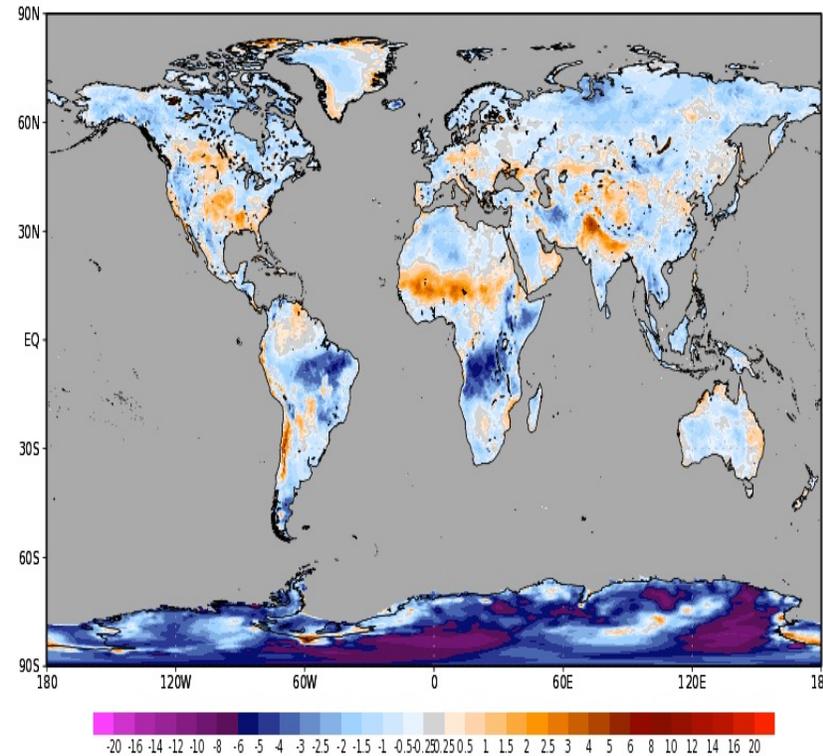
GEOS-IT employs an updated land model which has been carefully validated by GMAO

2-meter Temperature Difference (K) with ERA5; July 2018

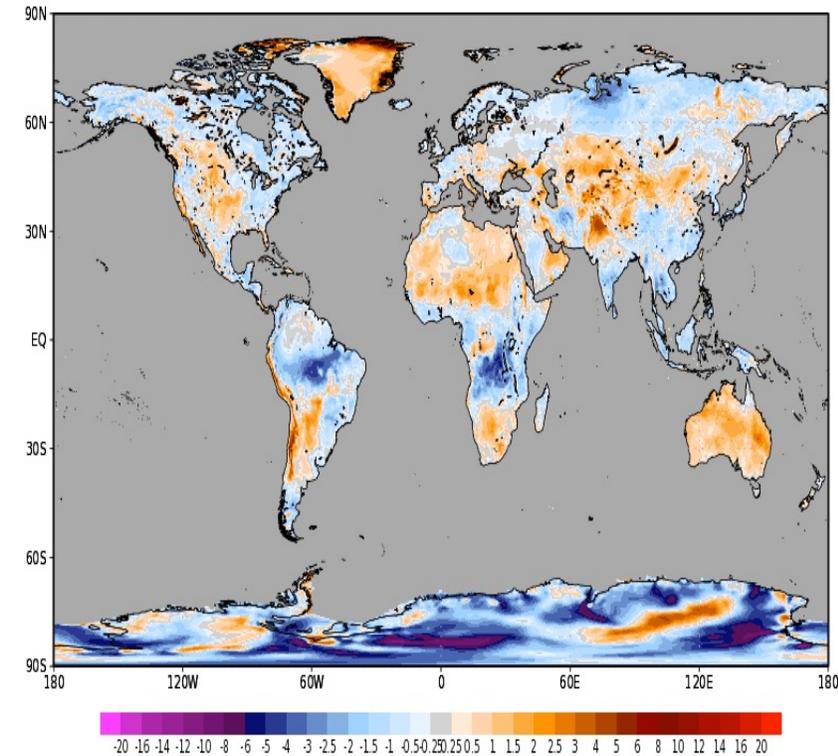
CERES 5.4.1 – ERA5



FPIT – ERA5



GEOS-IT – ERA5

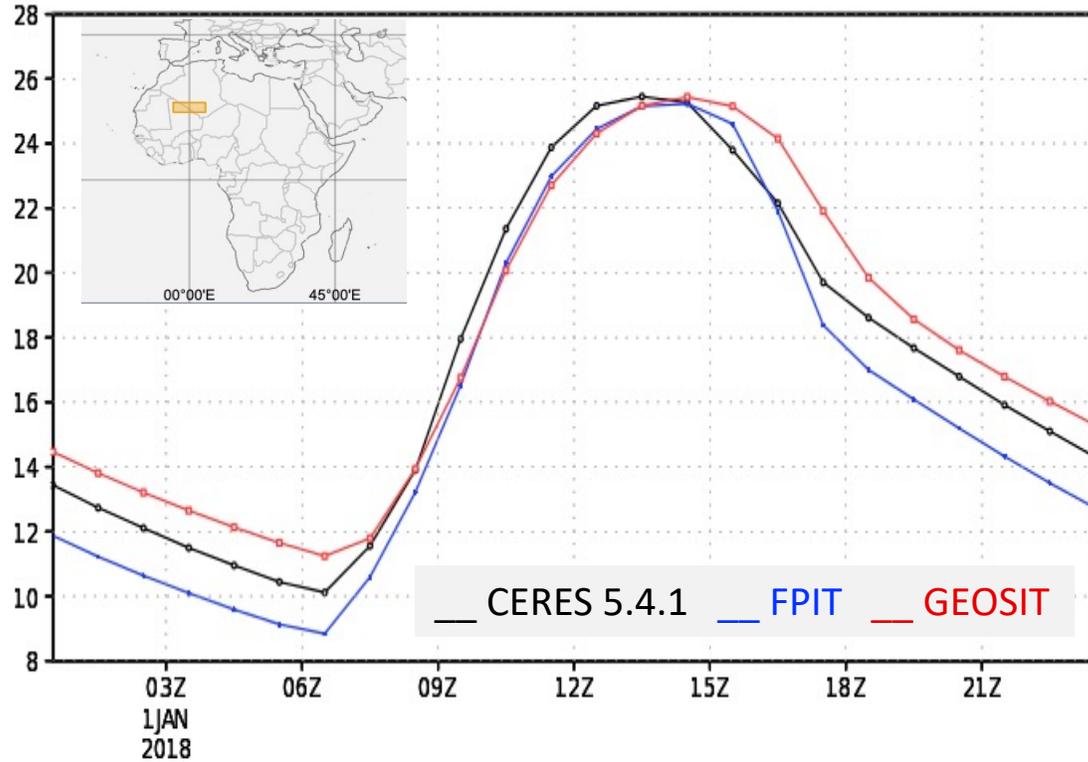


Substantial mean biases with respect to ERA5 (which we have vetted in-house)

regional cold biases (Africa, SAM) result from an exaggerated water cycle in these areas (i.e. enhanced evaporation)

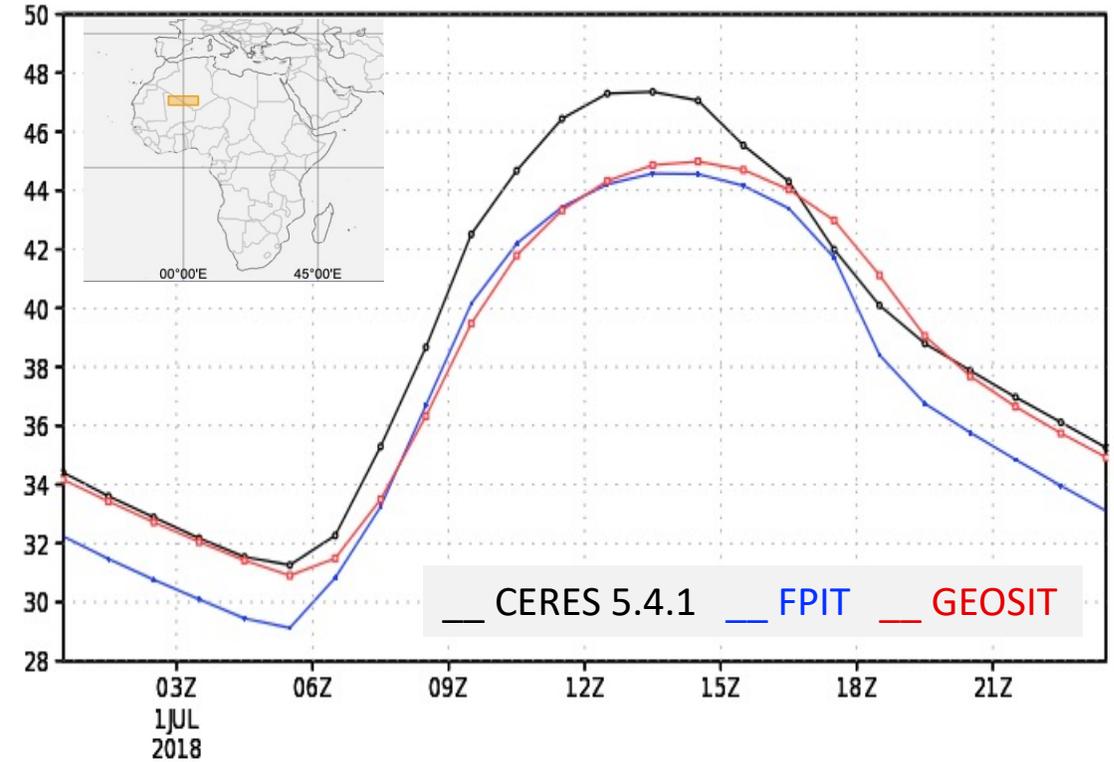
The Diurnal Temperature Range (DTR) will be more realistic in GEOS-IT

Local Sahara Regional DTR; January 2018



In January, the diurnal maximum over the Sahara appears similar between the systems. Updated heat capacity in GEOS-IT allows other hours to not drop as rapidly as before.

Local Sahara Regional DTR; July 2018

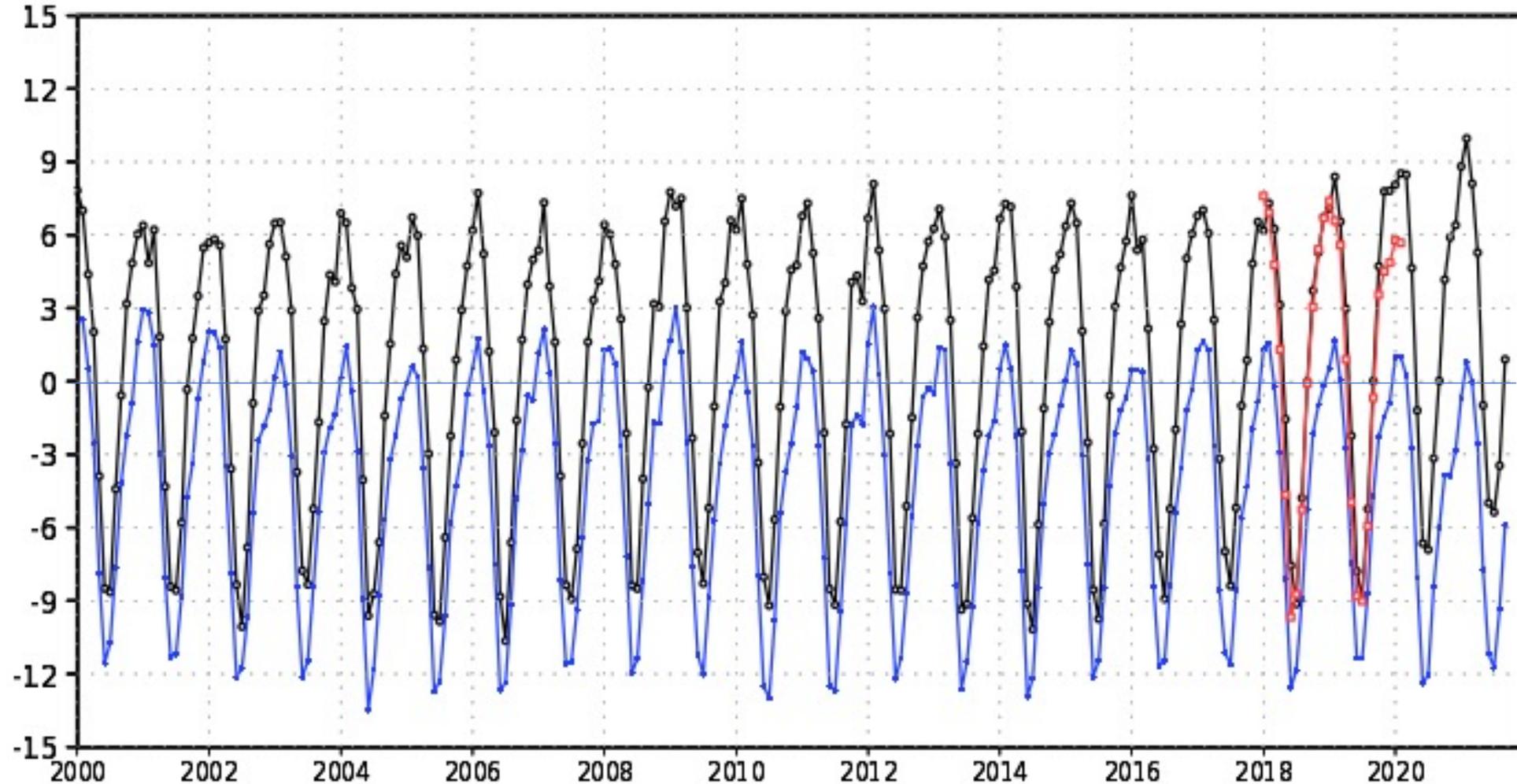


The July DTR exhibits a significantly smaller amplitude better aligned with observations. CERES 5.4.1 maximum is too hot.

many other climate regimes need to be monitored

Top of the Atmosphere Energy Balance (W/m²)

— CERES 5.4.1 — FPIT — GEOS-IT

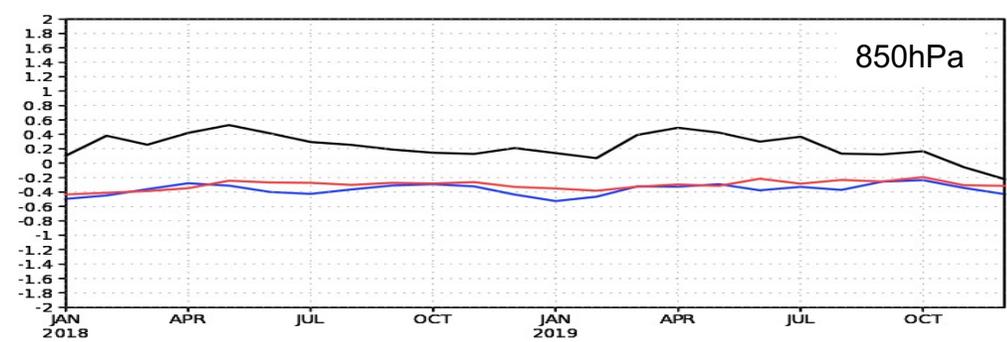
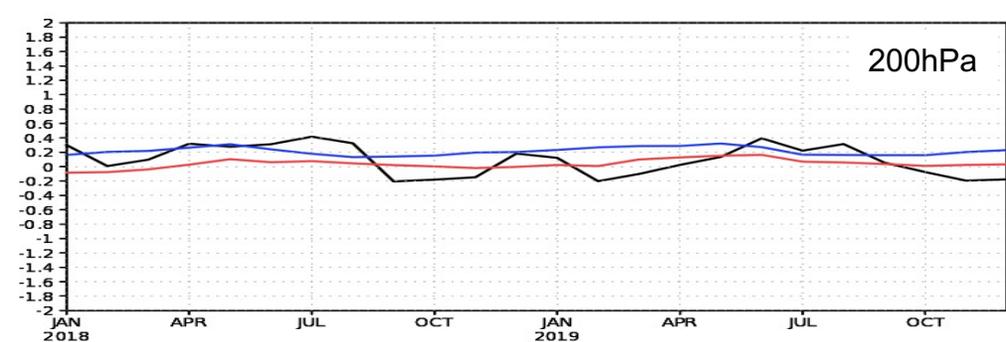
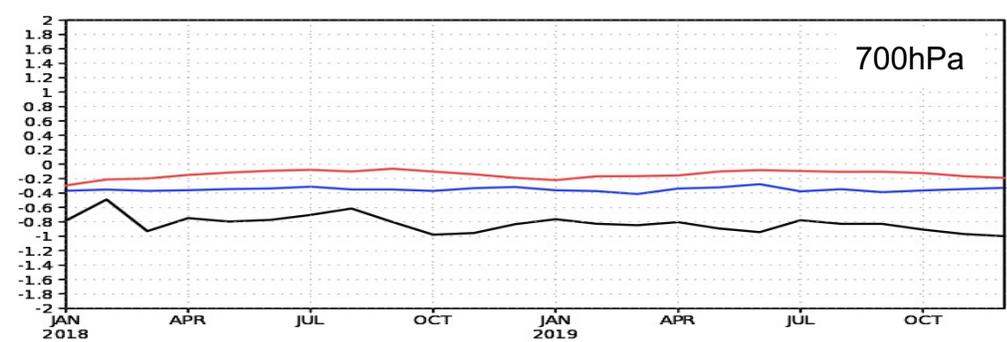
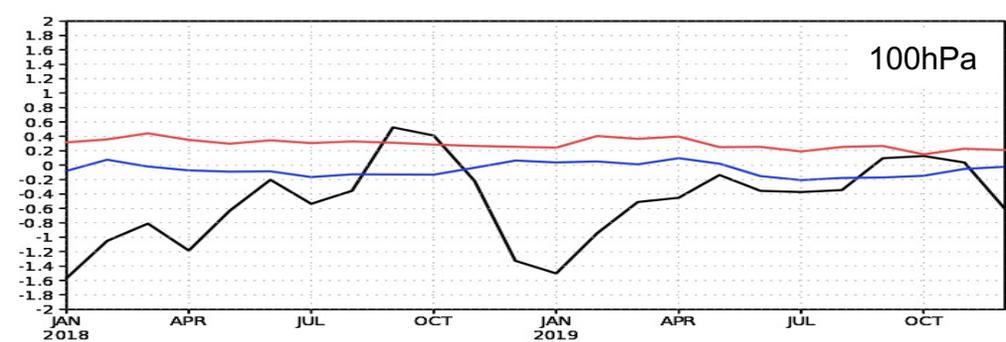
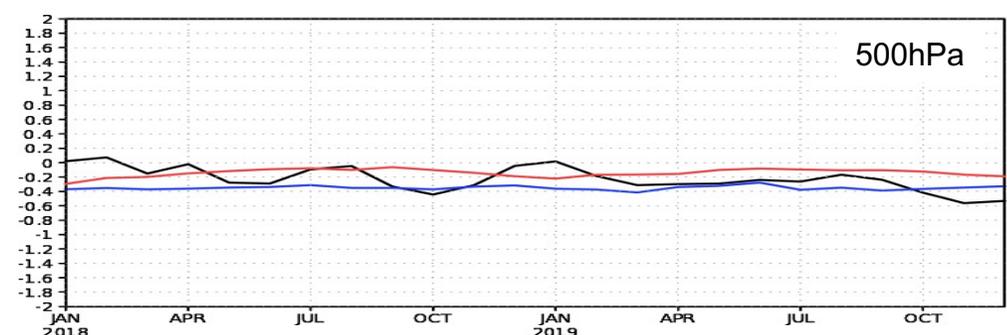
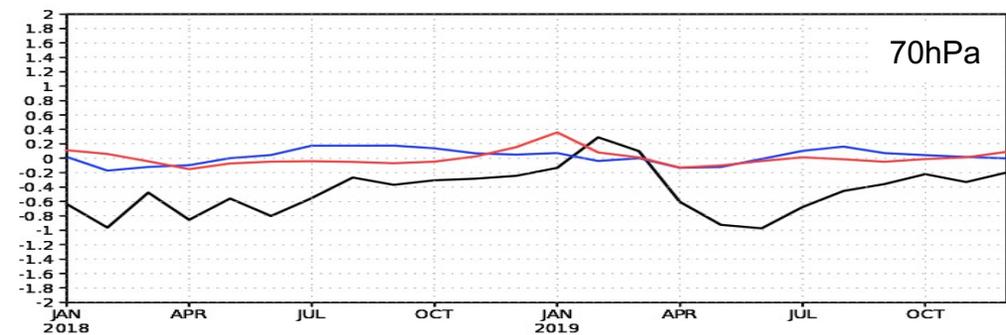
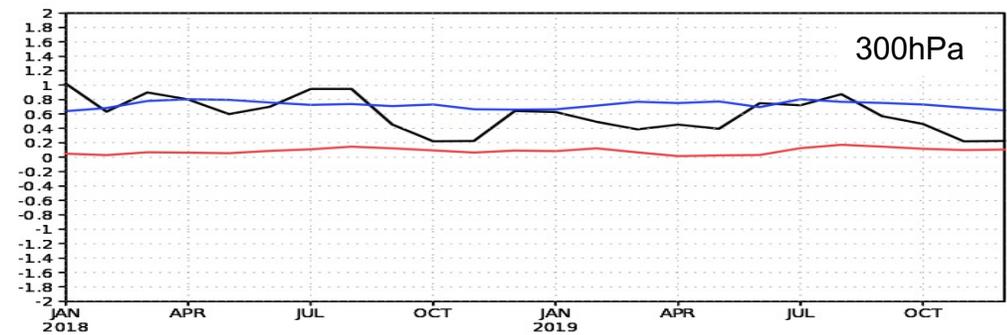
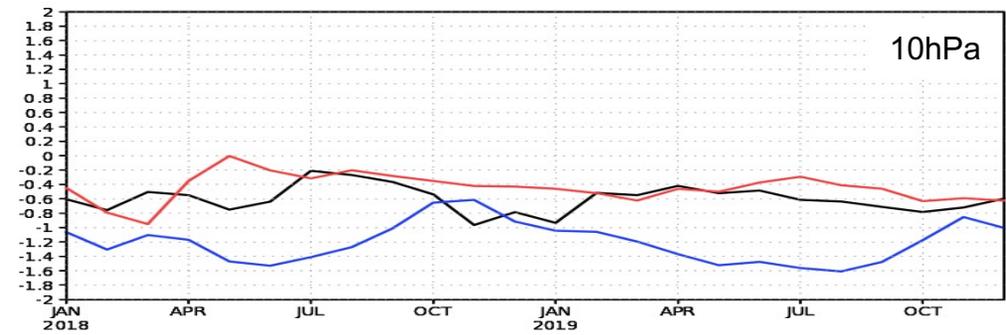


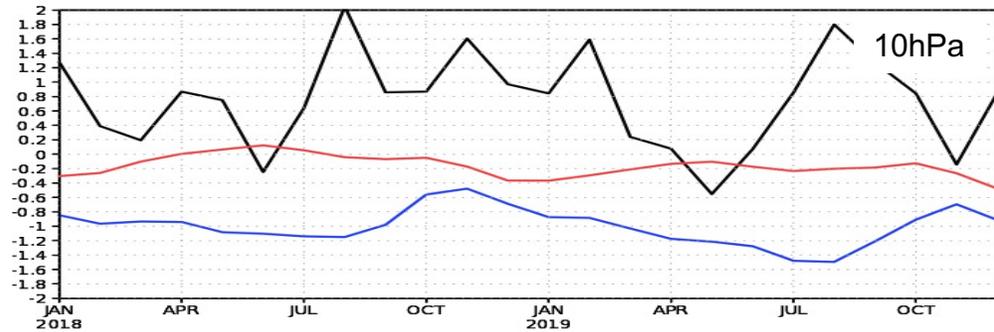
defined as net shortwave (SWTNT) minus outgoing longwave (LWTUP)

Tropics (20N,S)

Monthly Mean
2018 – 2019
Temperature (K)
difference w/ ERA5

— CERES 5.4.1
— FPIT
— GEOS-IT

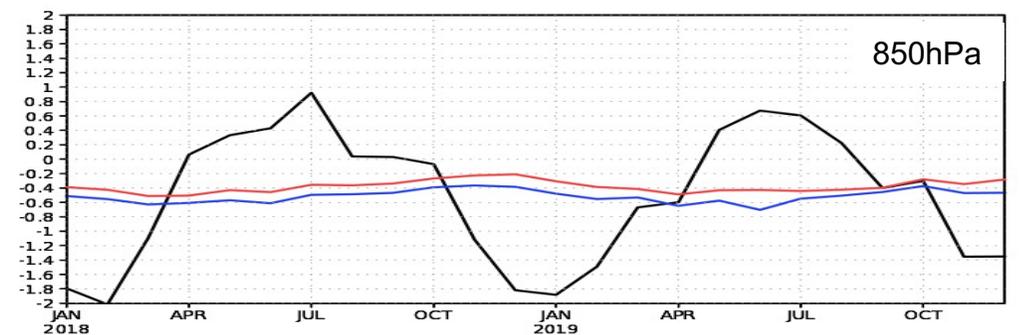
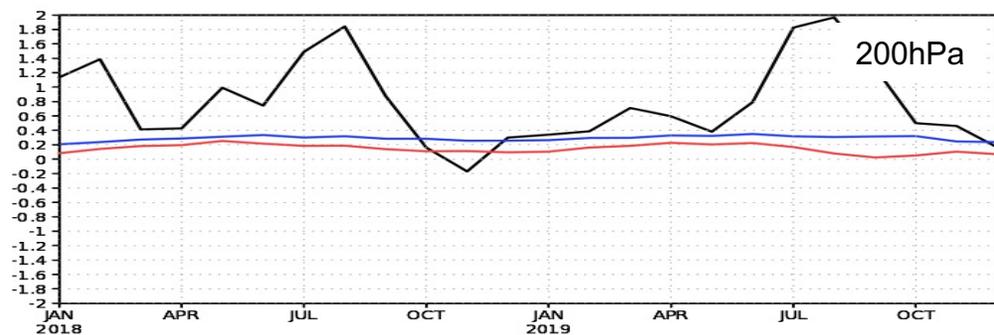
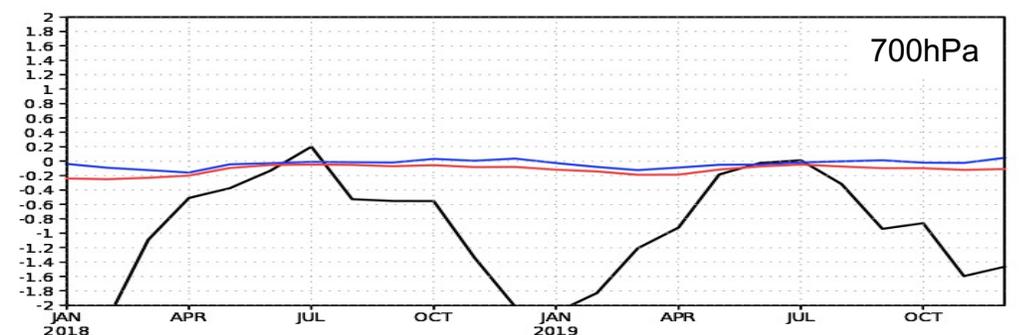
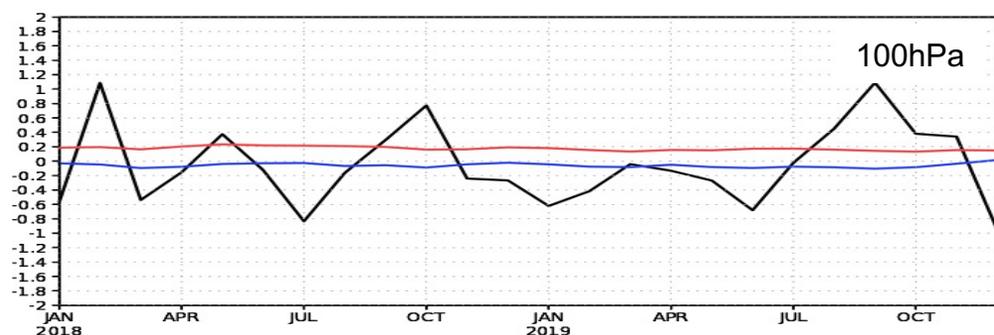
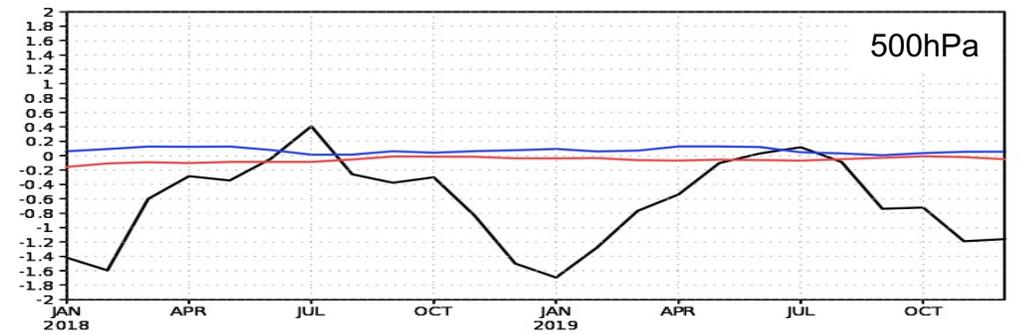
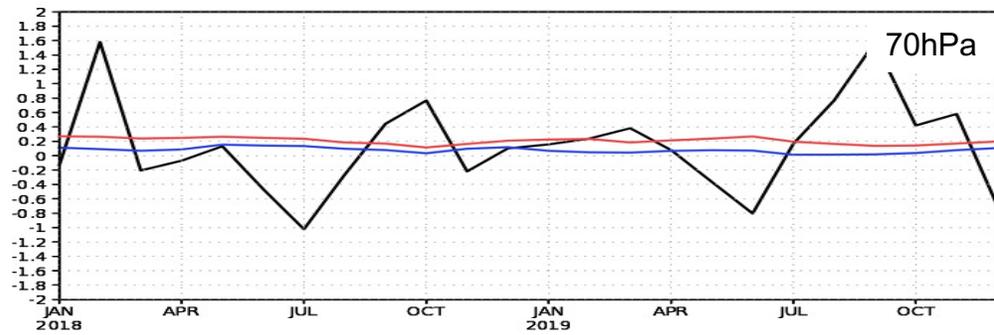
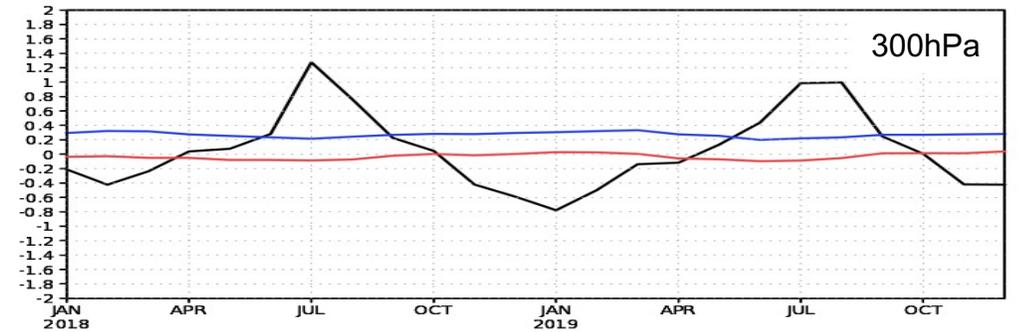




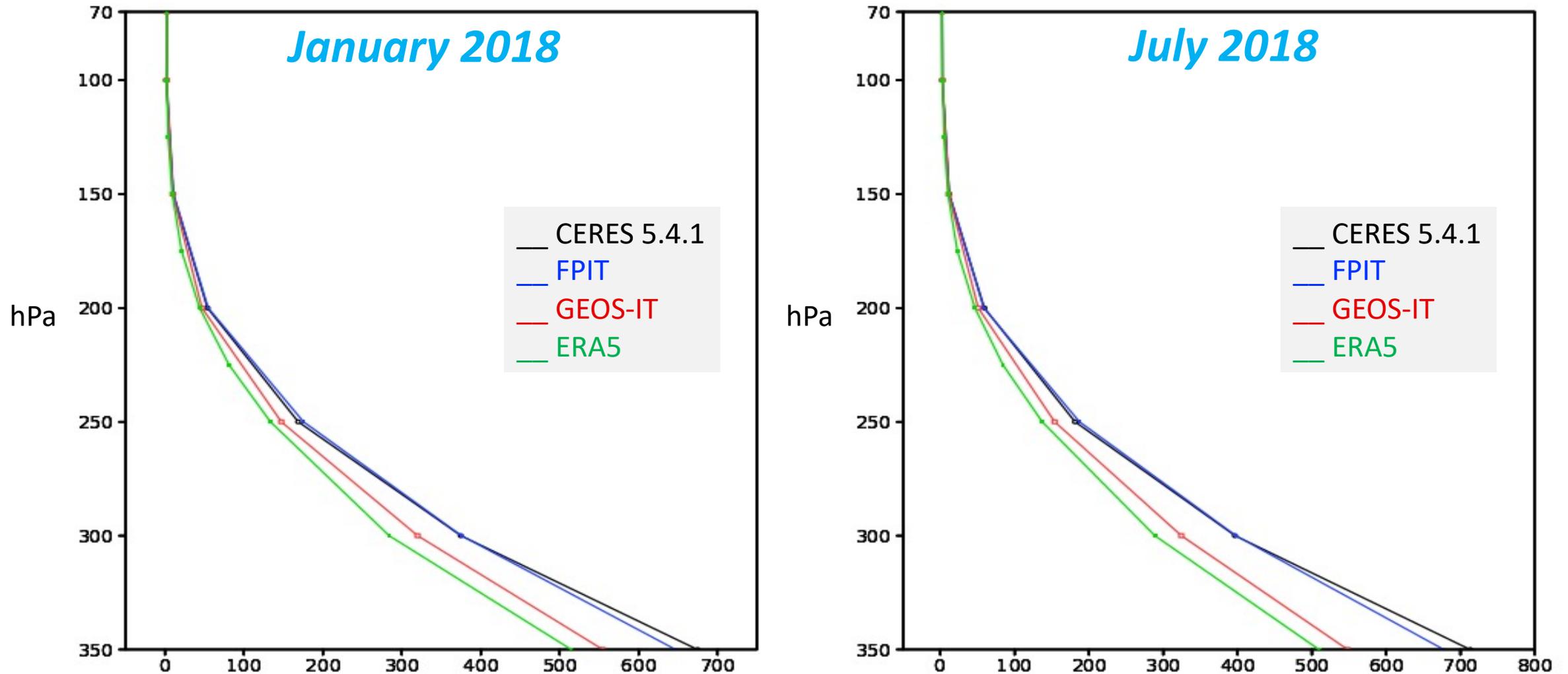
Middle Latitudes
(30-60N,S)

Monthly Mean
2018 - 2019
Temperature (K)
difference w/ ERA5

— CERES 5.4.1
— FPIT
— GEOS-IT



Tropical UTH (mg/kg) Profiles among GMAO Systems

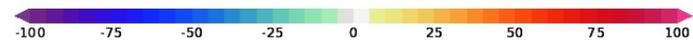
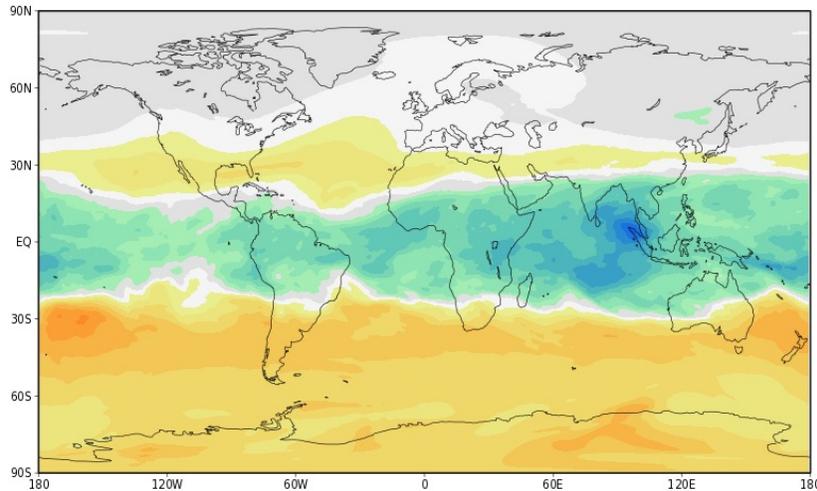


The new GEOS-IT system exhibits a significantly drier and closer-to-ERA5 q-profile in the 200-350hPa levels; what about 100, 150hPa?

CERES 5.4.1 – ERA5; 100hPa Q (% diff)

January 2018

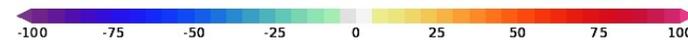
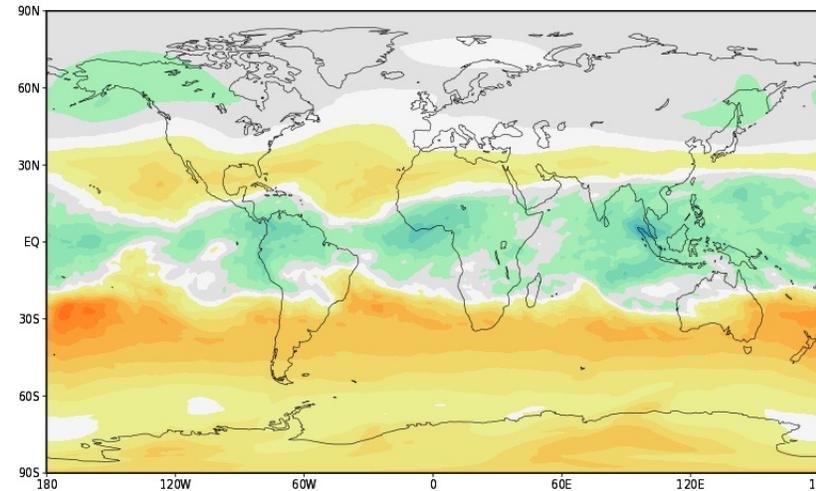
aave = 0.905



FPIT – ERA5; 100hPa Q (% diff)

January 2018

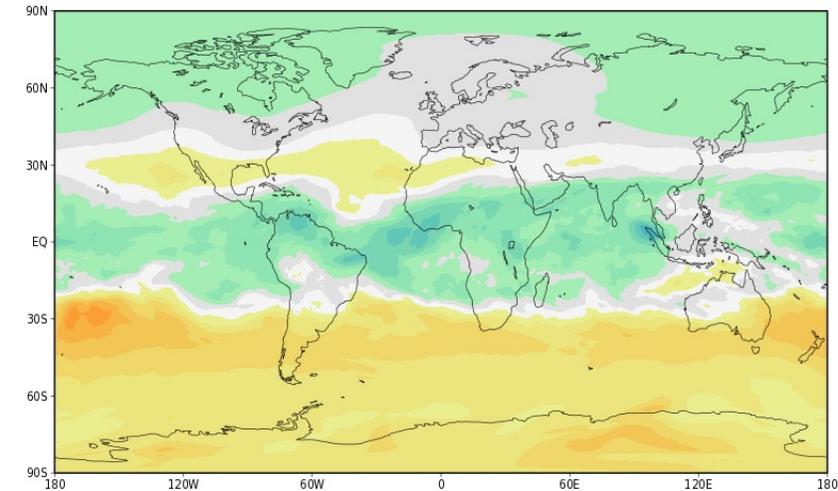
aave = 4.178



GEOS-IT – ERA5; 100hPa Q (% diff)

January 2018

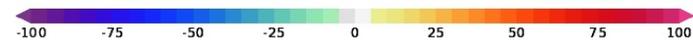
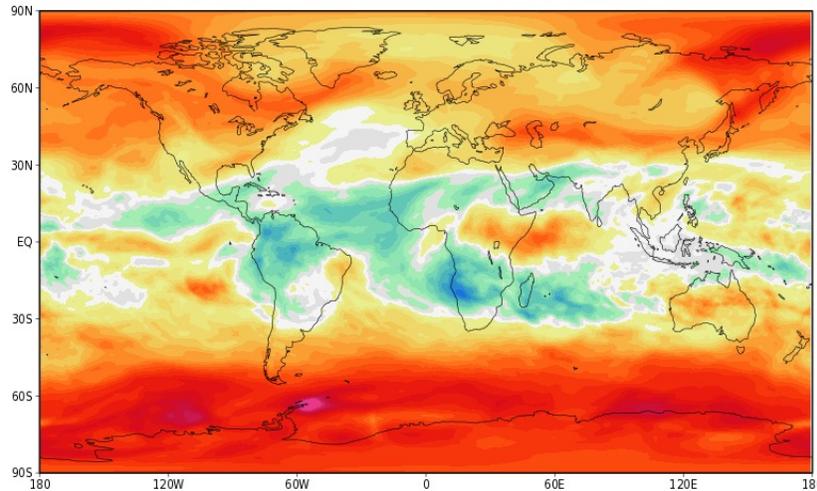
aave = 0.954



CERES 5.4.1 – ERA5; 150hPa Q (% diff)

January 2018

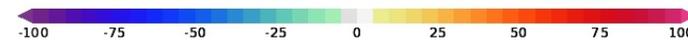
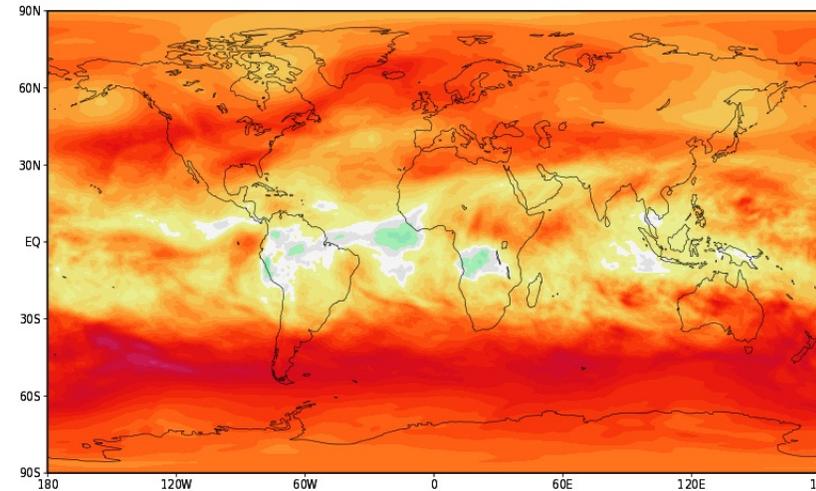
aave = 19.09



FPIT – ERA5; 150hPa Q (% diff)

January 2018

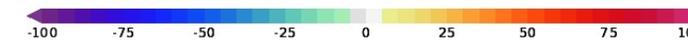
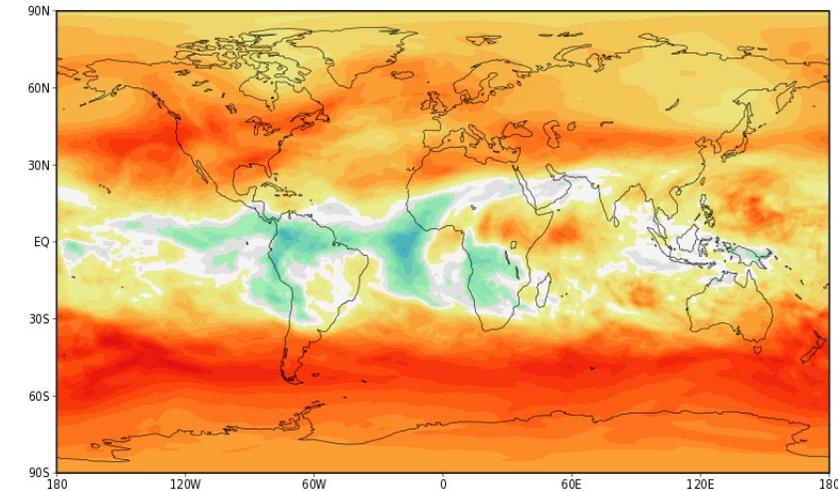
aave = 36.77



GEOS-IT – ERA5; 150hPa Q (% diff)

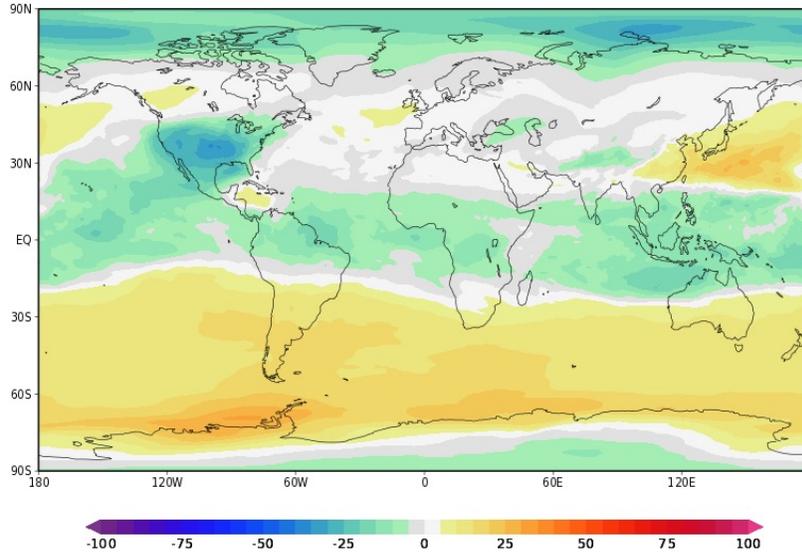
January 2018

aave = 23.97



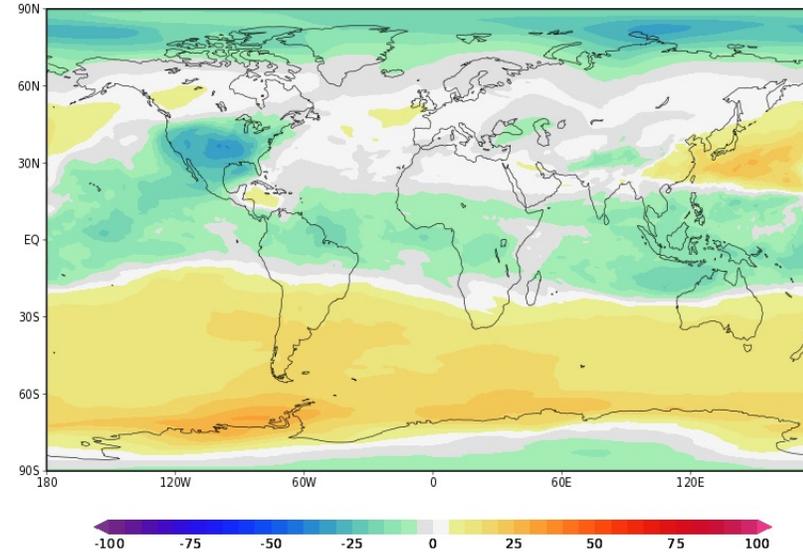
CERES 5.4.1 – ERA5; 100hPa Q (% diff)
July 2018

aave = 1.050



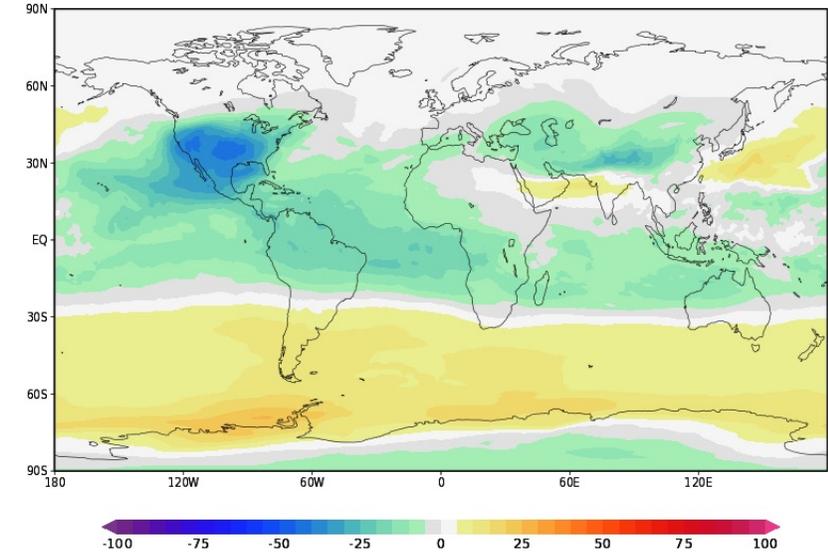
FPIT – ERA5; 100hPa Q (% diff)
July 2018

aave = 1.050



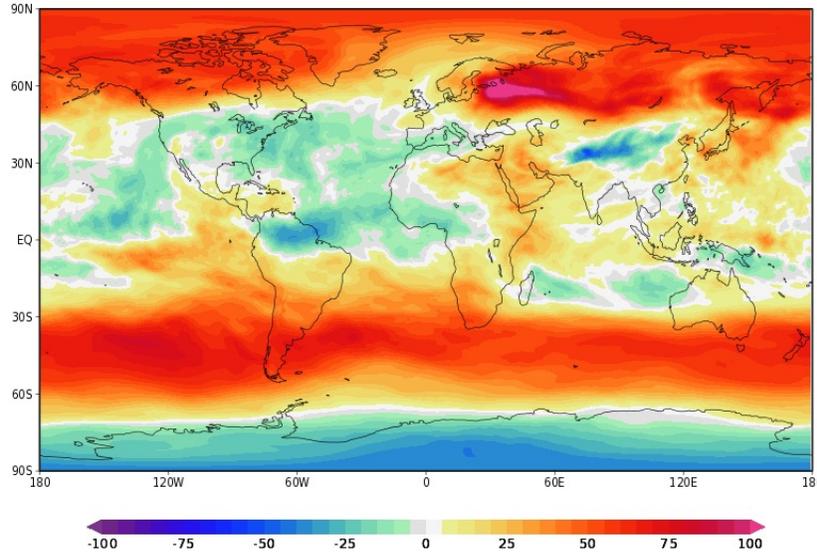
GEOS-IT – ERA5; 100hPa Q (% diff)
July 2018

aave = -2.59



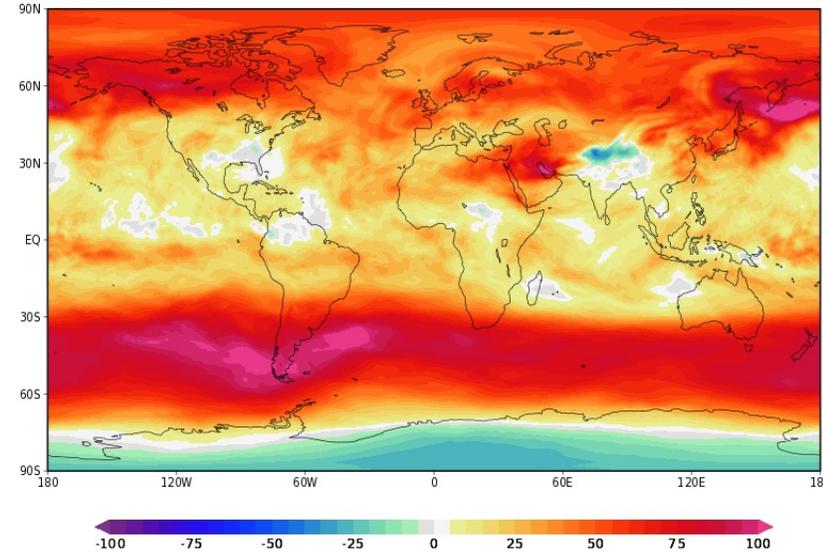
CERES 5.4.1 – ERA5; 150hPa Q (% diff)
July 2018

aave = 19.64



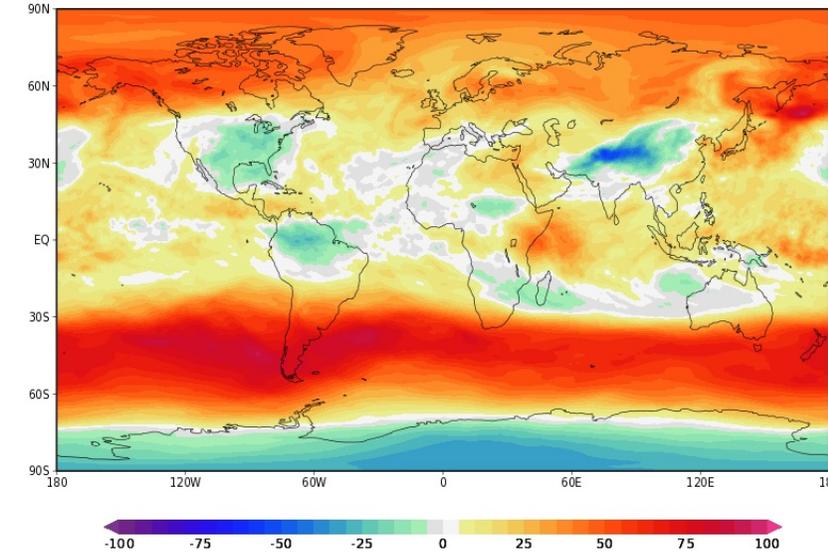
FPIT – ERA5; 150hPa Q (% diff)
July 2018

aave = 36.37



GEOS-IT – ERA5; 150hPa Q (% diff)
July 2018

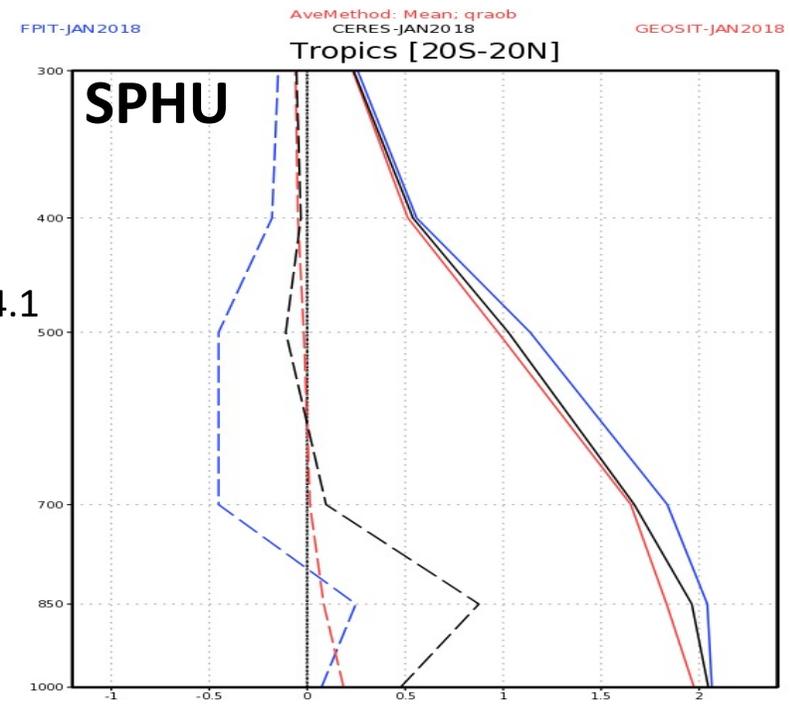
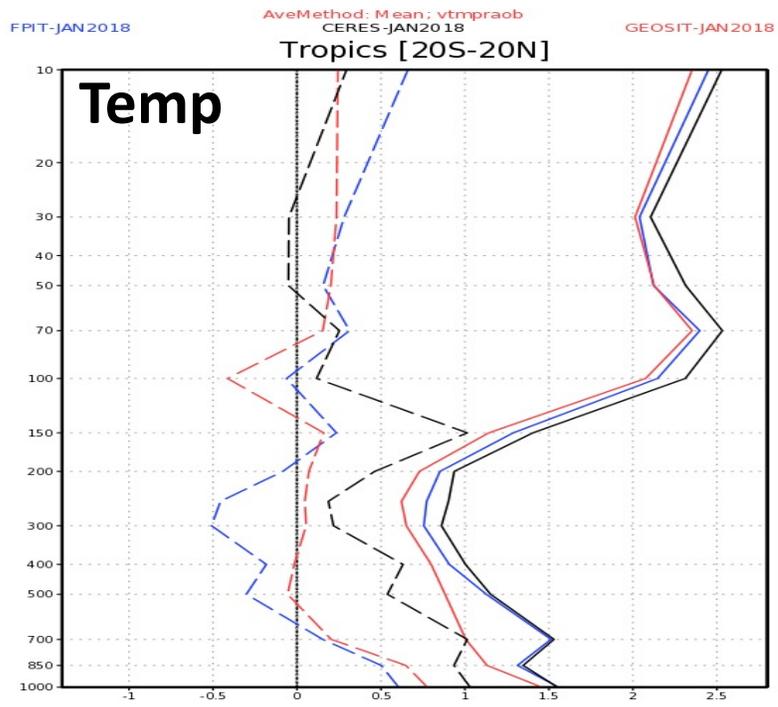
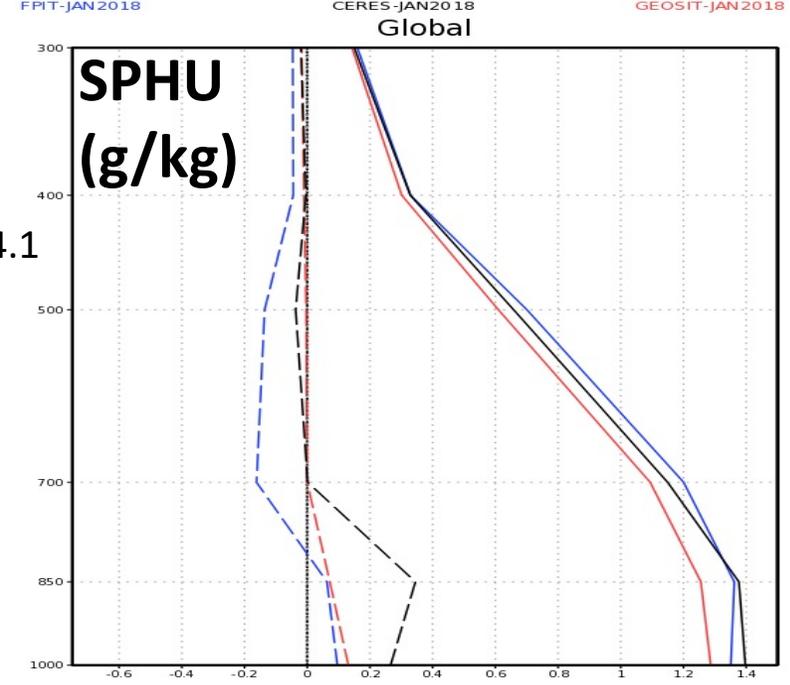
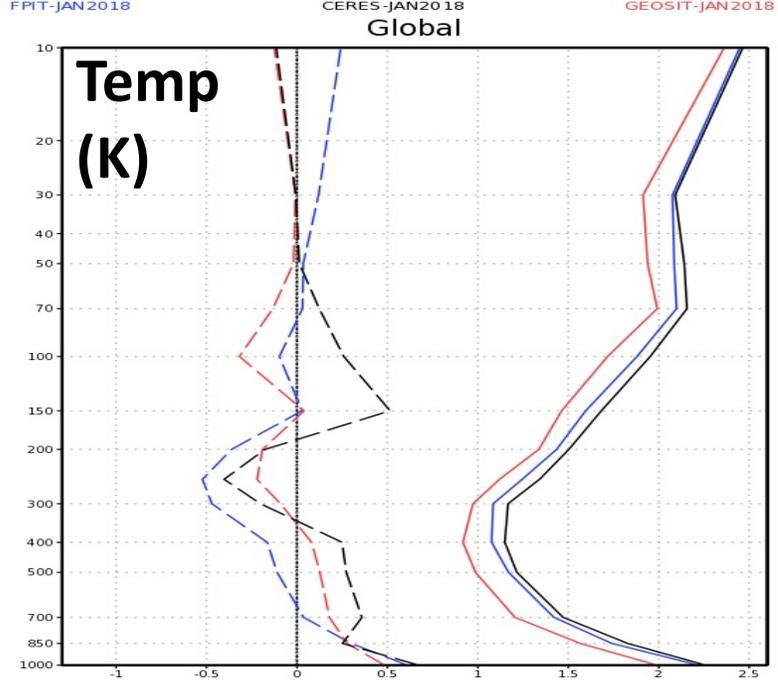
aave = 22.26



O-F Statistics vs. RAOB

January 2018

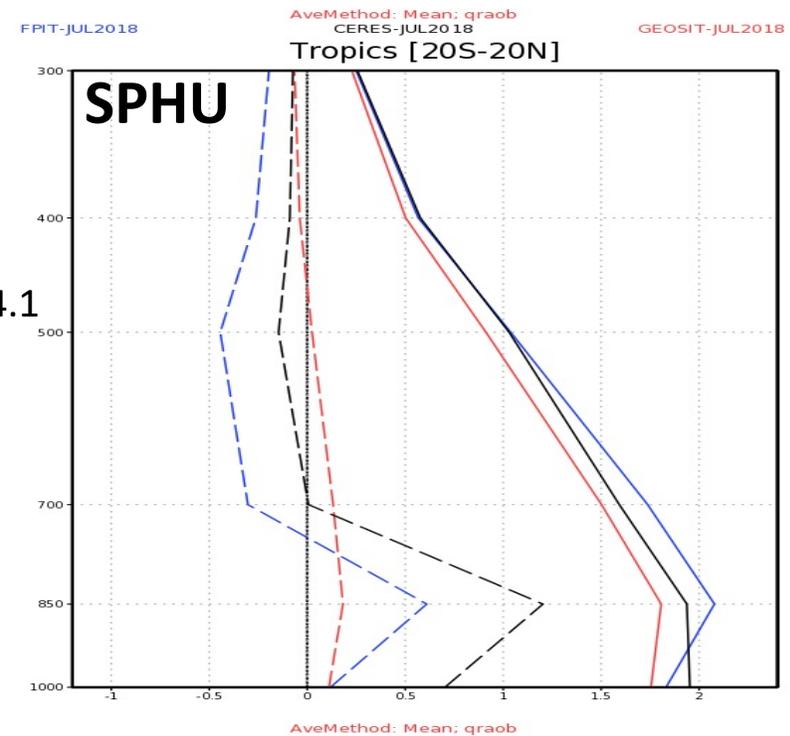
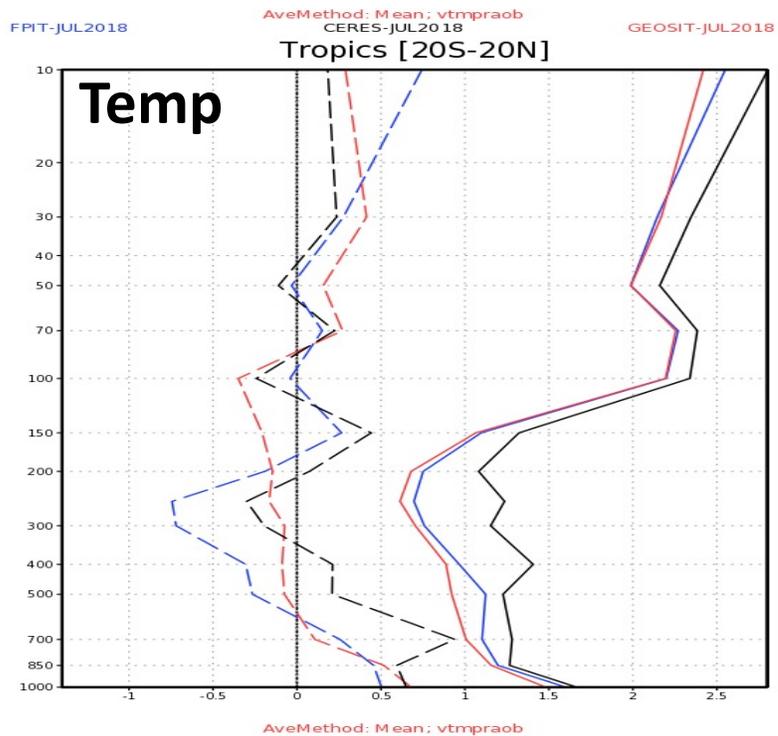
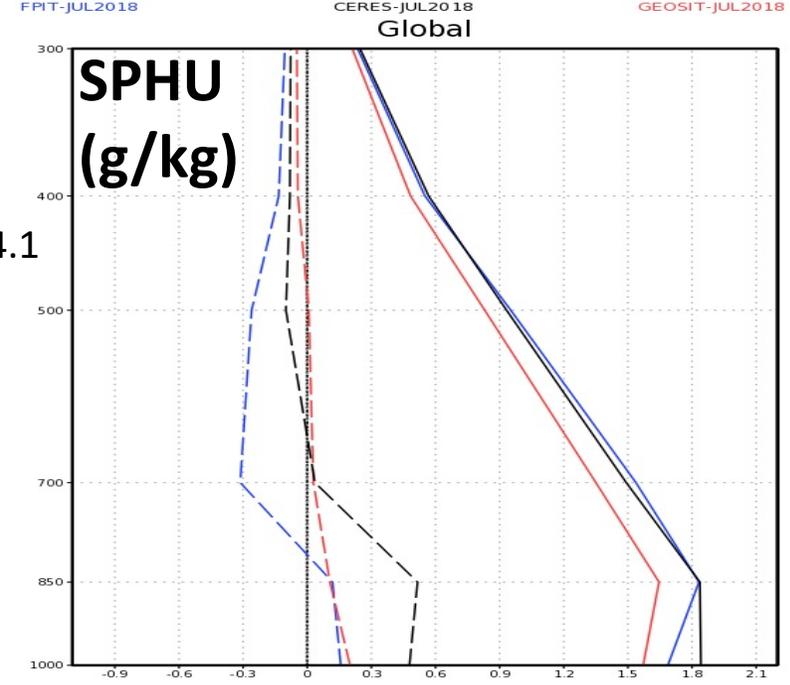
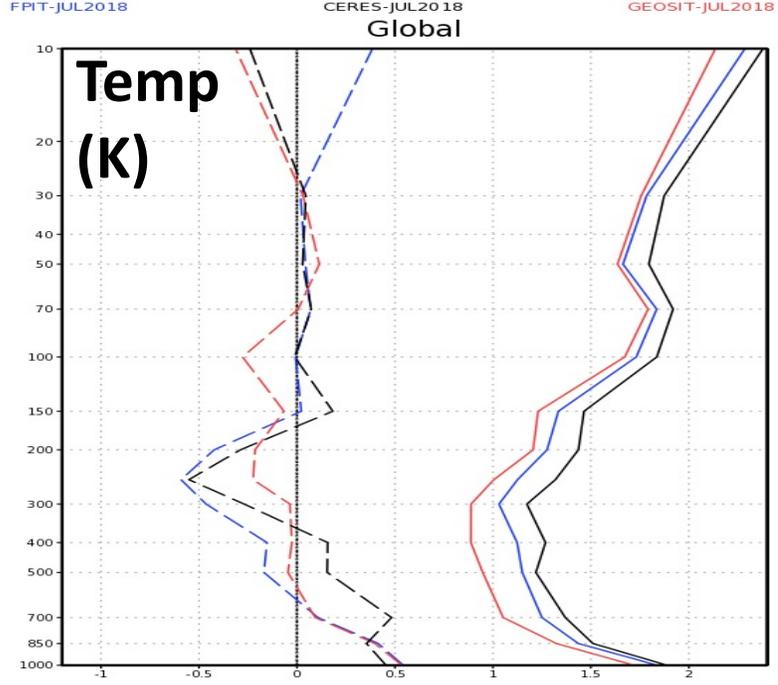
Mean (dash)
Std. Dev. (solid)



O-F Statistics vs. RAOB

July 2018

Mean (dash)
Std. Dev. (solid)





Summary

- The GMAO is preparing to produce two retrospective products bridging the gap from NASA's EOS observations to the post-EOS observations: GEOS-IT for the instrument teams and GEOS-R21C for reanalysis research applications.
- Build on the advances in modeling and data assimilation introduced into GEOS-FP since MERRA-2.
- Opportunity to use upgraded observing system.
- The GEOS-IT is planned as a replacement to the current GEOS-FPIT.
 - Production team is working on a sample data to be validated internally and shared with FPIT users for further validation.
- The GEOS-R21C is planned as a stepping-stone towards the decadal goal of producing MERRA-3, an integrated Earth System reanalysis, coupling atmosphere, ocean, land and ice.
 - Preliminary test results with a prototype-R21C are encouraging.
 - On-going work: dry-mass conservation, land-ice mask in OSTIA boundary conditions, use of IMERG product for the observation-corrected model precipitation, production stream strategy.