Toward coupled data assimilation in NASA's GEOS: Developments in the ocean context

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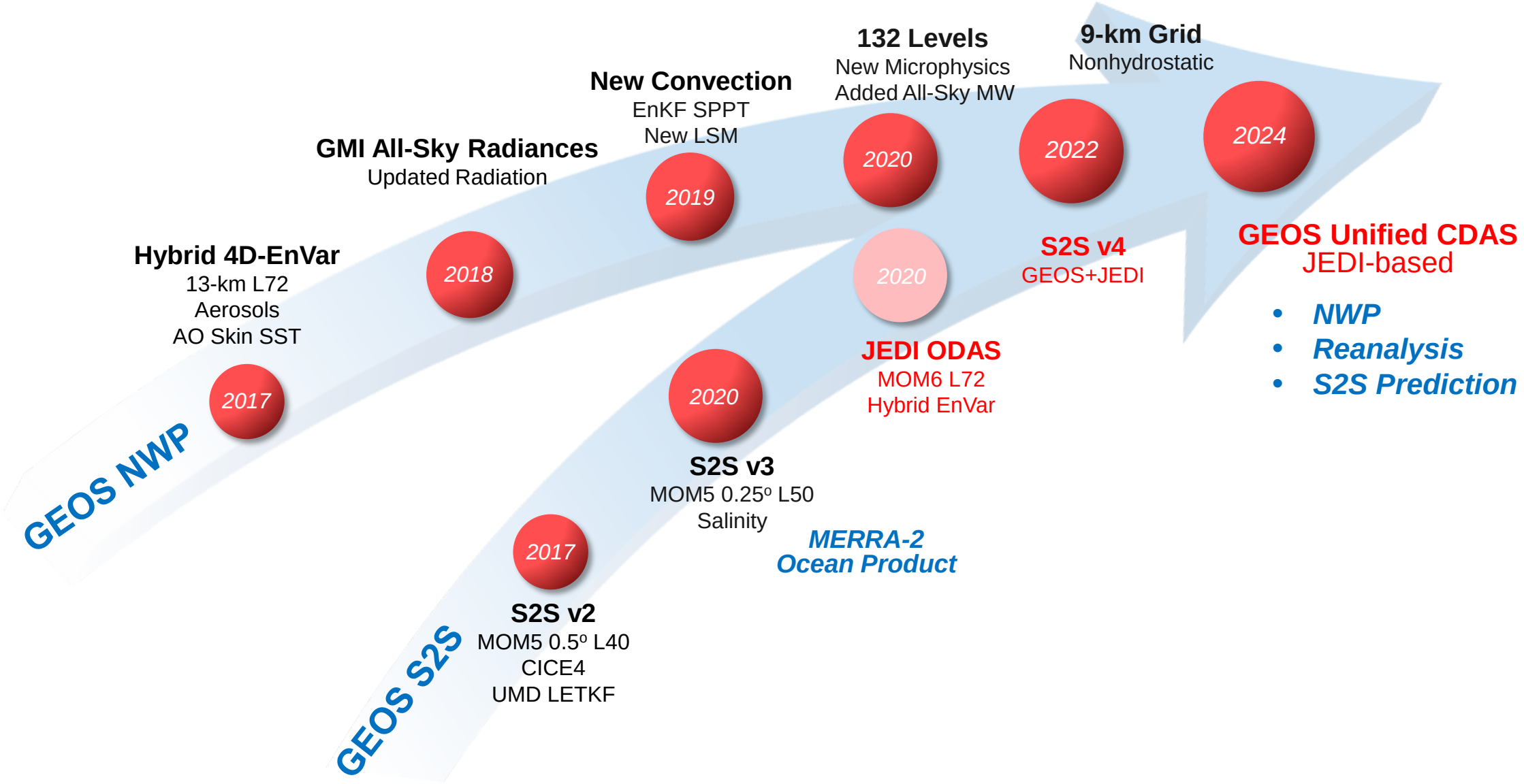
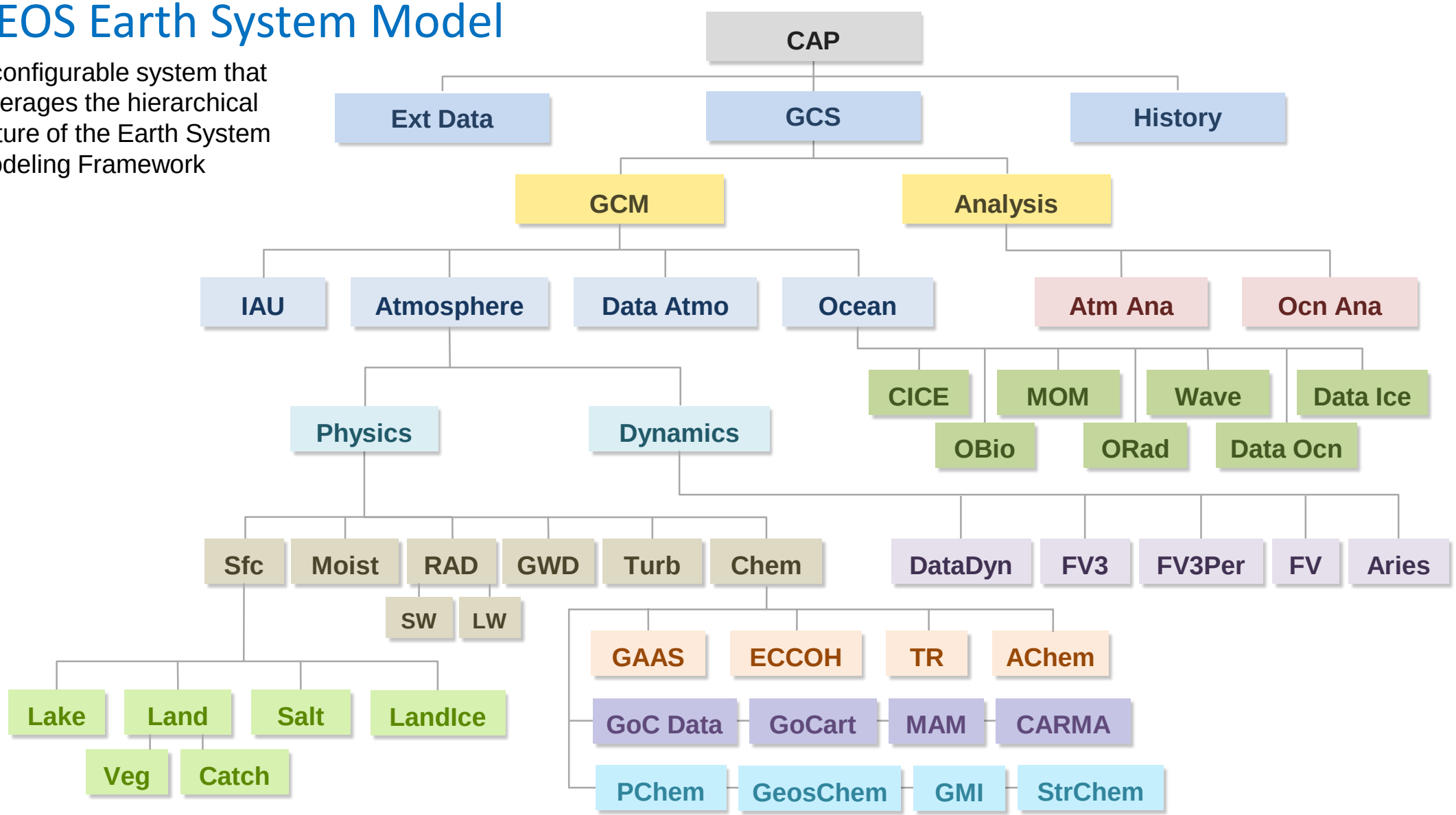
Moving toward a JEDI-based GEOS system for coupled DA

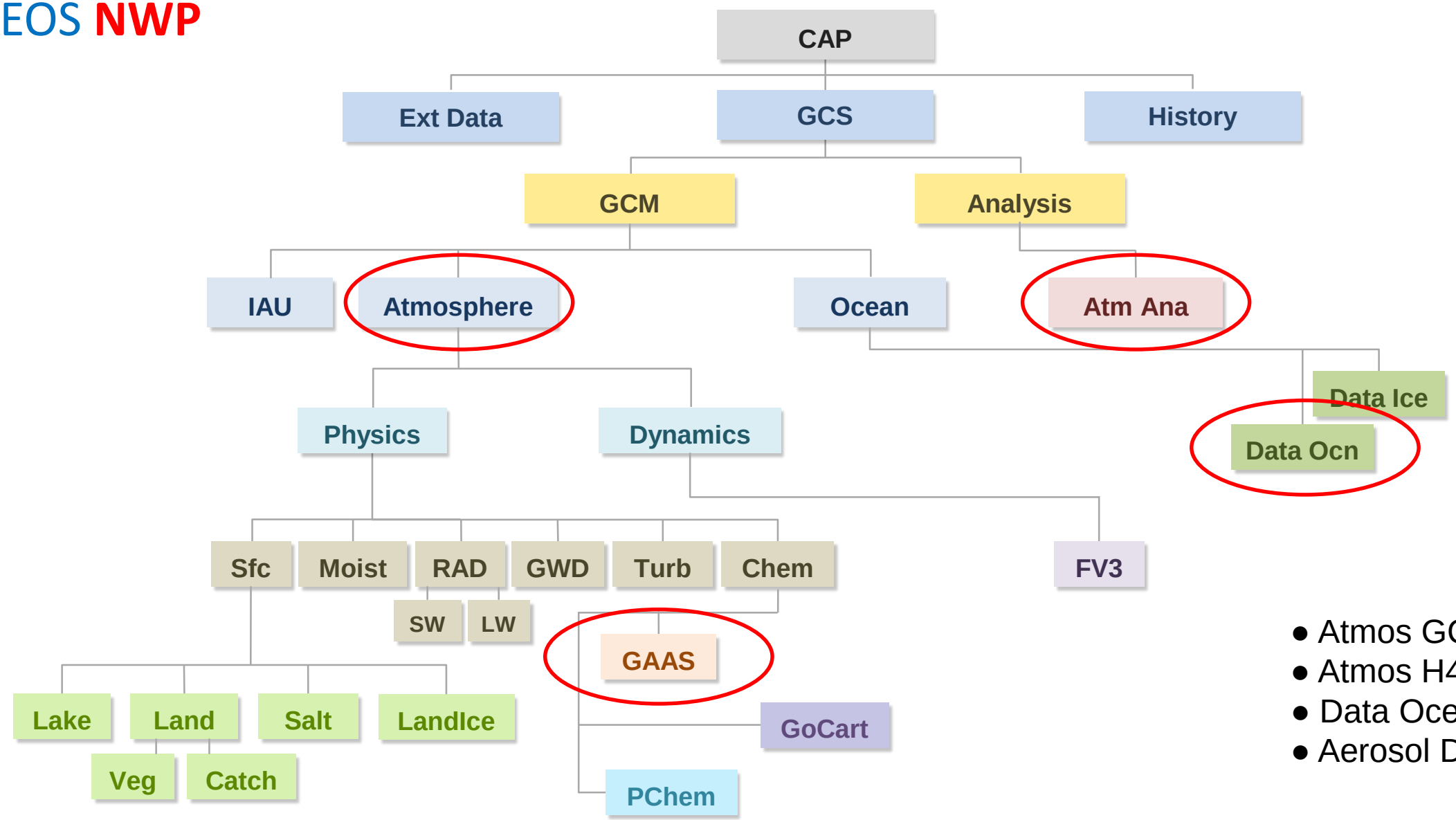


GEOS Earth System Model

A configurable system that leverages the hierarchical nature of the Earth System Modeling Framework

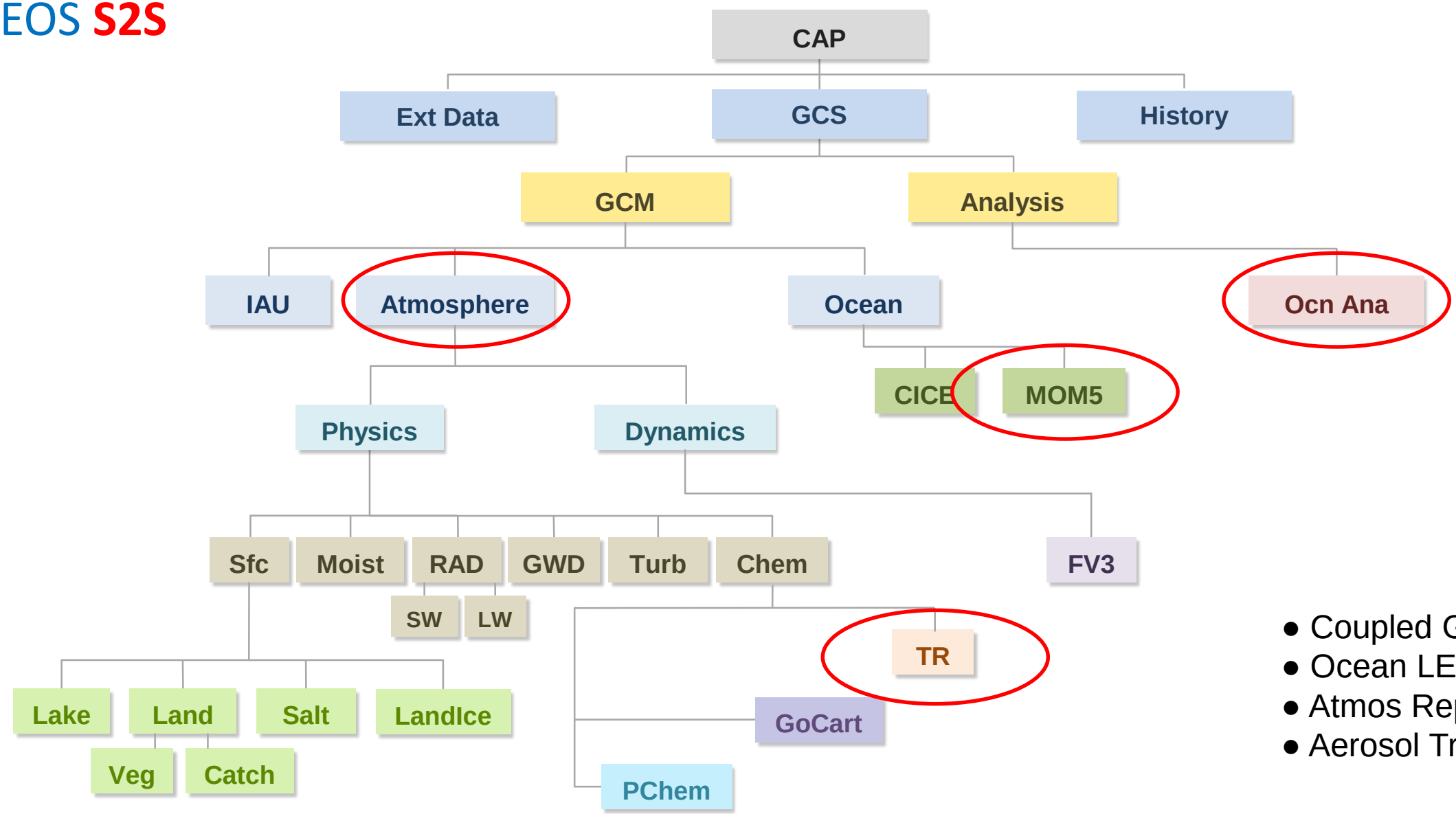


GEOS **NWP**



- Atmos GCM
- Atmos H4D-EnVar
- Data Ocean
- Aerosol DA

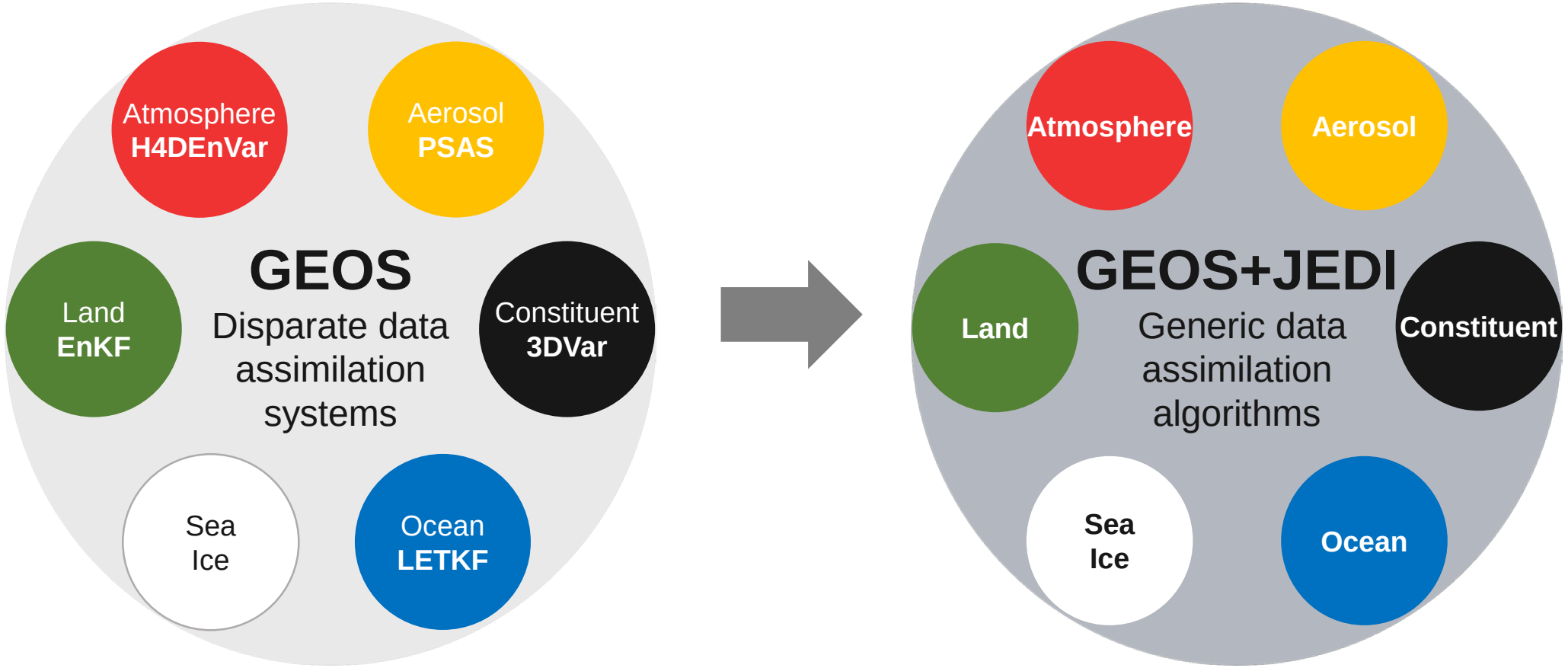
GEOS S2S



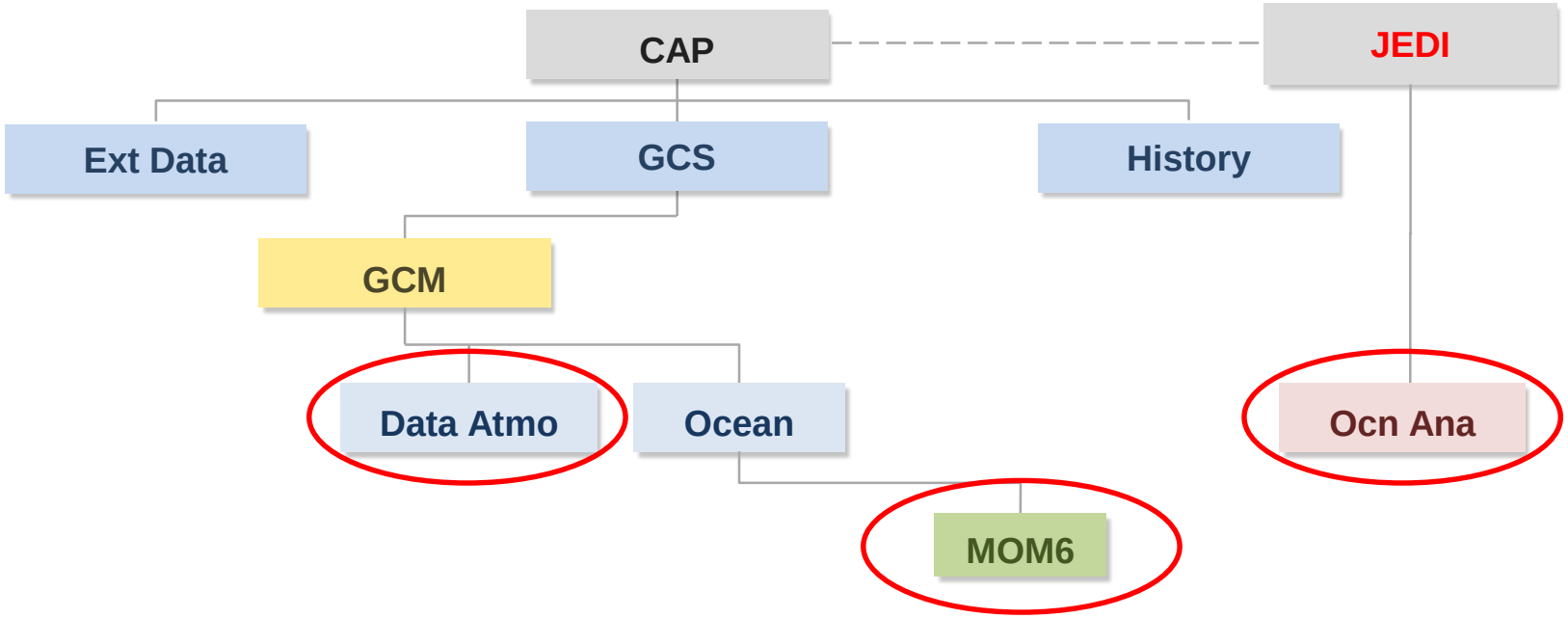
- Coupled GCM
- Ocean LETKF
- Atmos Replay
- Aerosol Transport

Building a GEOS unified data assimilation system

Up to now GMAO's data assimilation systems have been developed for individual GEOS components as disparate entities.



GEOS+JEDI ODAS



- Ocean GCM
- **JEDI DA**
- Data Atmos

Experimental setup

Not a toy system...

- GFDL MOM6 at 1^{o} L72
- Full suite of observations
- 24-h assimilation window
- JEDI-SOCA 3D-Var
  - Balance operators for variable transforms
  - Vertical correlations parameterized based on model mixed layer depth
  - Horizontal correlations using B-Matrix on an Unstructured Mesh Package (**BUMP**)
- 1 Nov 2015 – 30 April 2016

Also...

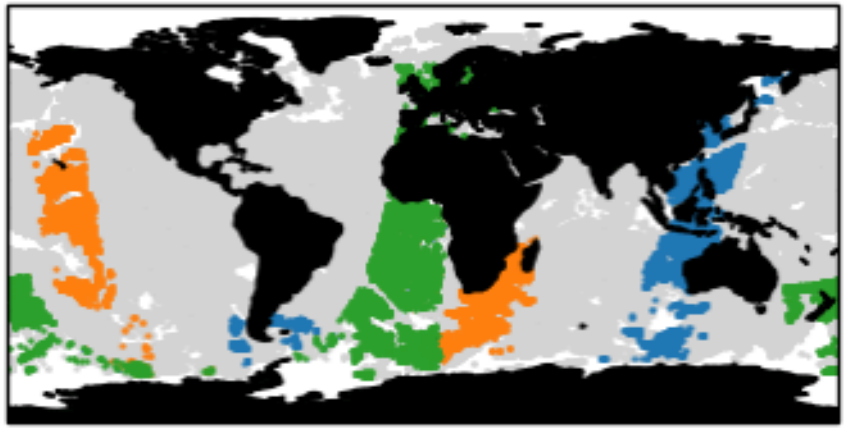
- Two sets of atmospheric forcings:
  - CFSR
  - MERRA-2
- Two sets of observations:
  - NCEPobs (HGODAS)
  - GMAOobs (GEOS S2S)

(GMAOobs do not include satellite SST)

Sample observation counts in a 24-h assimilation window

SST (IR) - 486,923
SST (MW) - 337,773
Salinity - 458,886
Ice Fraction - 93,157
Altimetry - 240,017
1,616,756

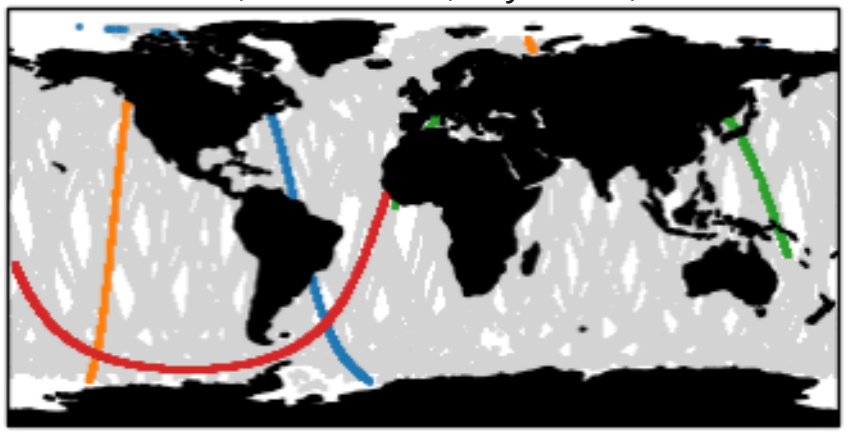
SST (IR)
AVHRR (Metop-A, NOAA 19) VIIRS (SNPP)



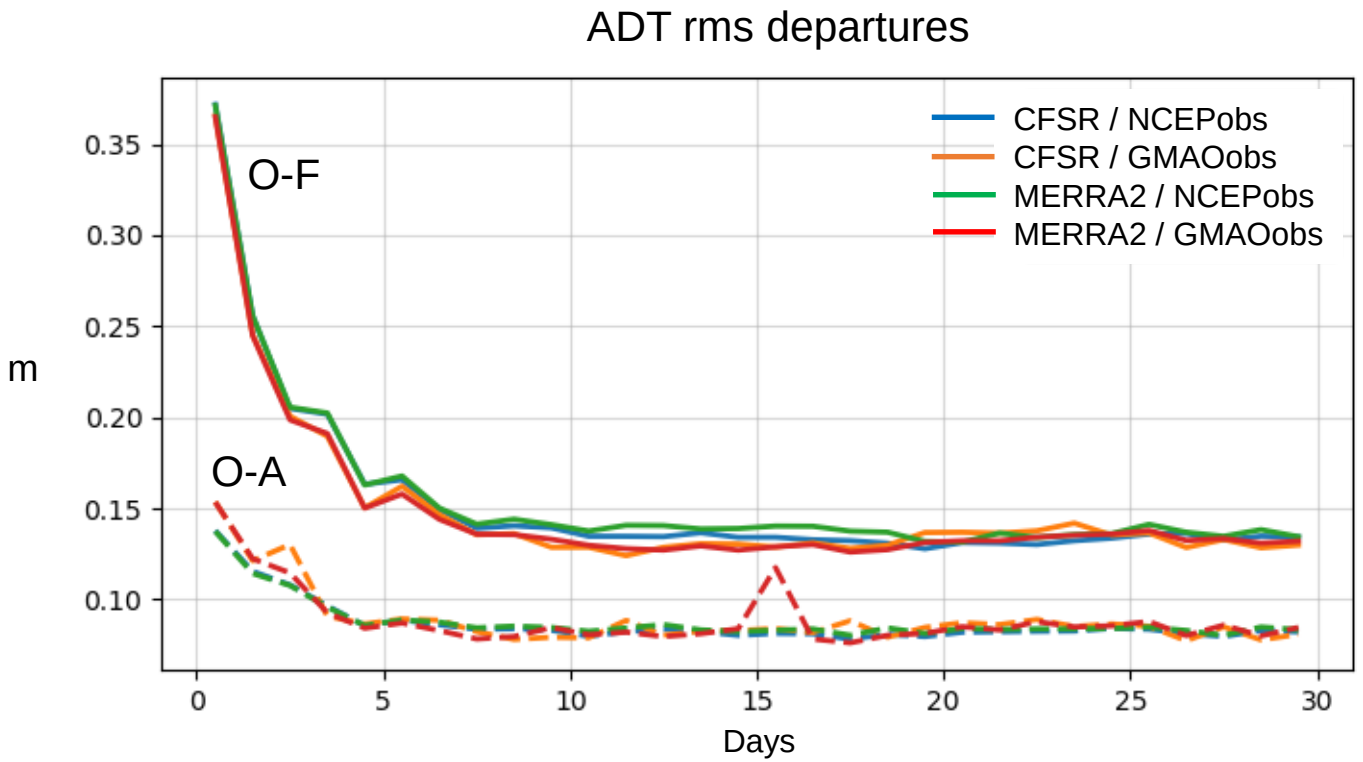
Salinity
SMAP

SST (MW)
GMI, AMSR-2, WindSat

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



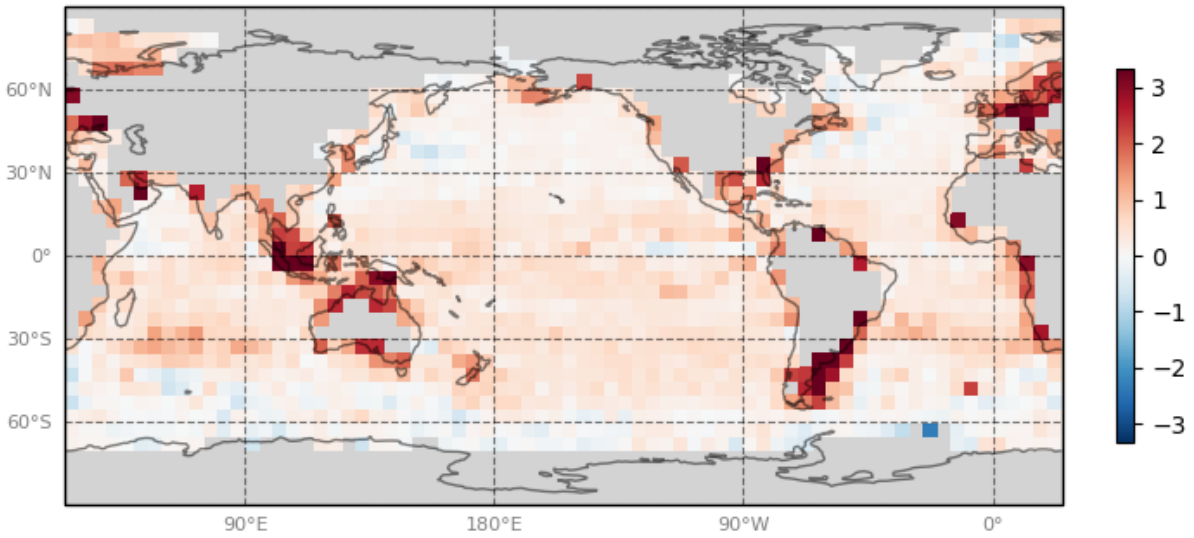
Assimilation sanity check



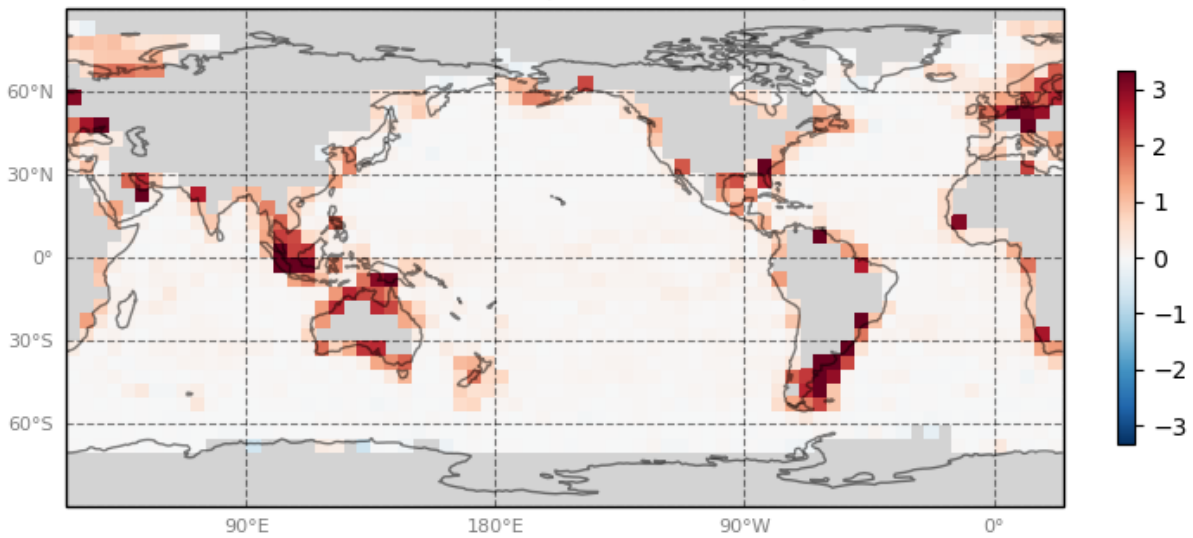
Atmospheric forcing effects

Departure differences between MERRA2 / NCEPobs and CFSR / NCEPobs

Difference in SST rms O-F



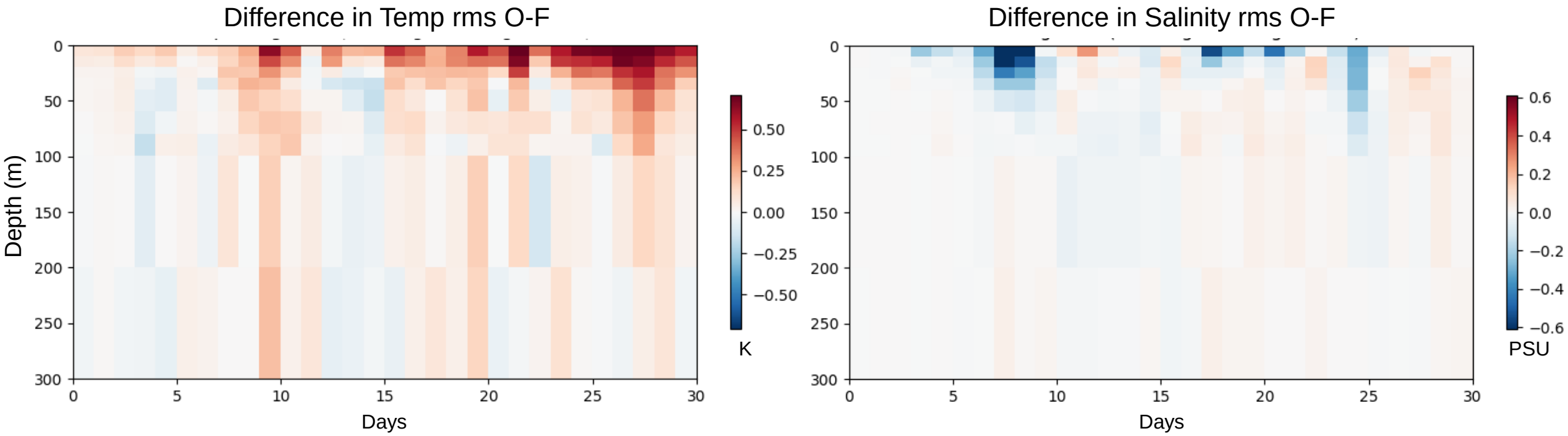
Difference in SST rms O-A



Red shades imply MERRA2 forcing drives the SST away from the observations compared with CFSR forcing, which is reduced somewhat after the assimilation.

Atmospheric forcing effects

Departure differences between MERRA2 / GMAOobs and CFSR / GMAOobs



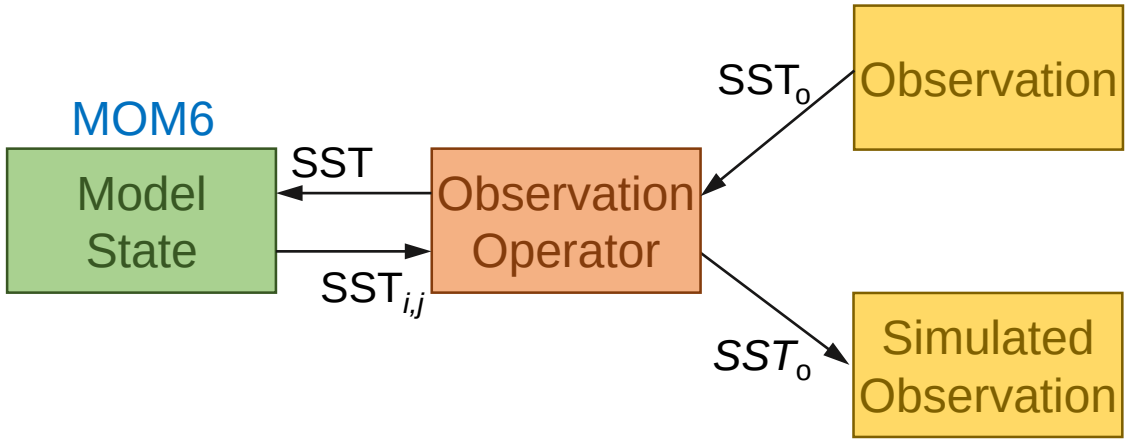
Temperature error with MERRA2 forcing grows with time and shows some deepening; Salinity error shows no obvious trend.

Animation of SSH: 2 panels TBD

Future work

- A key component of JEDI is the Unified Forward Operator (UFO), which introduces standard interfaces for **observation operators** that link the model and observation worlds.
- The UFO accommodates the assimilation of observations for coupled or uncoupled models in an analogous (unified) manner.

Uncoupled Ocean Only



Coupled Ocean-Atmosphere