Santha Akella

NASA Global Modeling and Assimilation Office

GMAO
Global Modeling & Assimilation Office

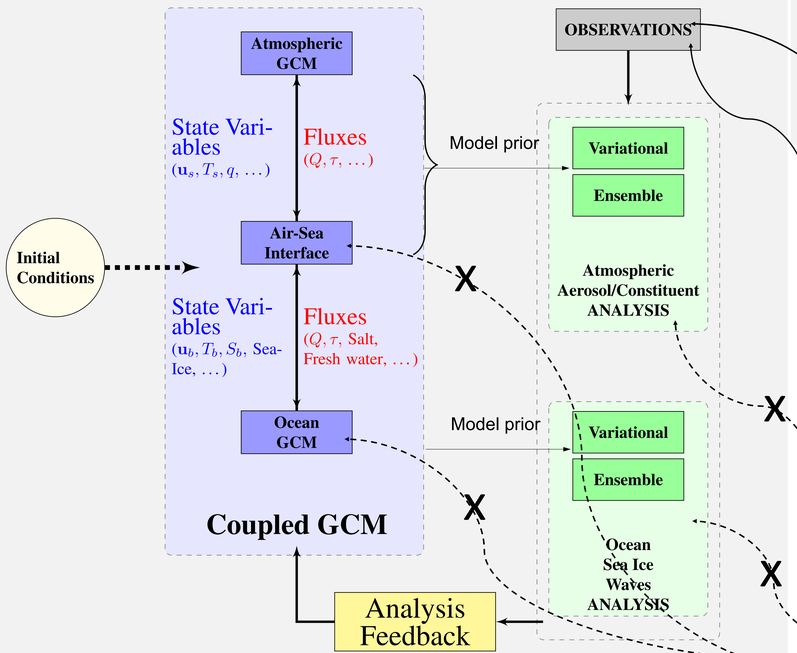
Diurnal Cycles in SST:

Coupled Data Assimilation and future observational requirements

CONTEXT

Most operational centers are developing coupled (atmosphere-ocean) Data Assimilation systems as an alternative to uncoupled counterparts (atmosphere- or ocean-only). This Coupled DA is expected to:

- **Improve short- and long-range predictions** (weather, seasonal, decadal scales).
- **Provide better Earth system reanalysis state** (cross-component constrained and *balanced).*
- ***Enhance the usage of satellite measurements***.



Schematic of a coupled DA

SATELLITE OBSERVATIONS

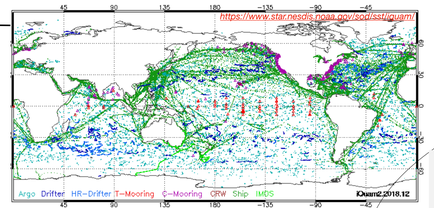
The Sea Surface Temperature (SST) is one of the key variables:

- Tightly connects the atmosphere and ocean states.
- Air-sea fluxes.
- Essential for Weather & Ocean prediction.

Current prototype coupled DA systems rely on external (L4) gridded SST or along-track (L3 or L2) SST **retrievals** as *observed* data or model relaxation field.

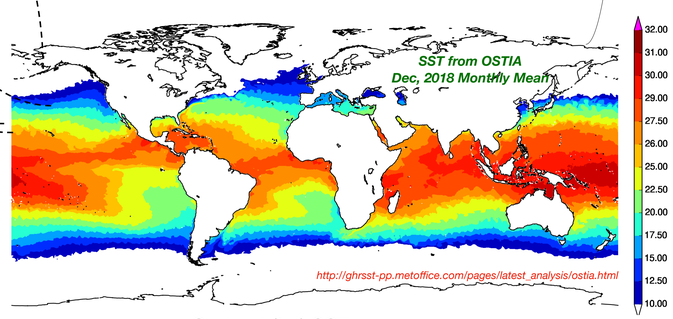
In reality, **SST measurements are available from sparse in-situ network of ships, moorings, and buoys.**

Satellites do not measure SST, and inferring SST from satellite measured radiances requires a radiative transfer model, its calibration and also bias correction. **All of this is possible with coupled DA.**



Coupled DA:
Directly Assimilate Observations

Instead of relying on SST *products*



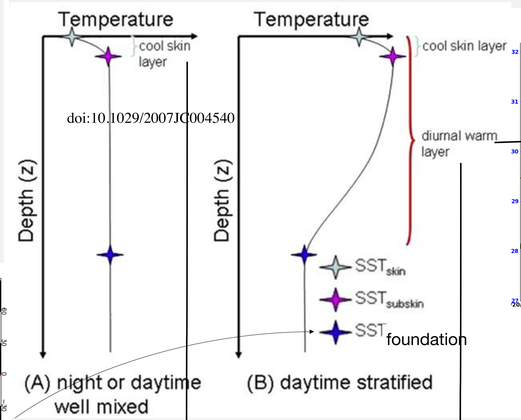
Gridded (L4) $SST_{foundation}$

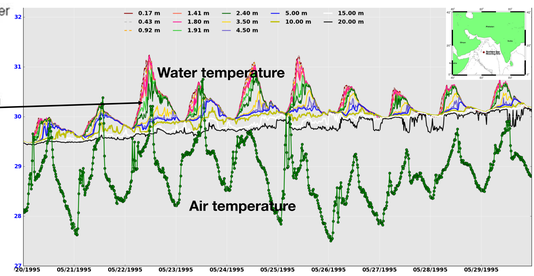
NEAR-SURFACE SST

Upper ocean temperature is highly variable:

- **Diurnal warming**: daytime solar heating results in a diurnal warm layer: intensity varies with the momentum stress (wind/waves).
- **Cool skin layer**: close to the air-sea interface, always present, due to non-solar heat fluxes (sensible, latent and upward longwave).
- Gridded SST products poorly delineate this variability.

Satellite measurements are sensitive to both diurnal warming and cool skin.

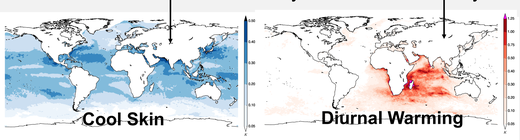




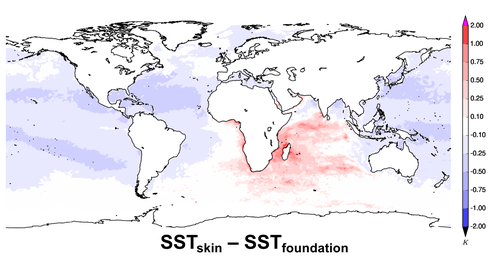
Arabian Sea Mooring experiment (1995)
Data from WHOI
http://uop.whoi.edu/projects/projects.html

The NASA Global Modeling and Assimilation Office (GMAO) is developing a coupled DA system which assimilates SST directly from the raw observations, i.e., satellite radiances and in-situ observations.

The methodology to directly assimilate radiances for SST became operational in Jan, 2017 in the GMAO's near-real time Weather Analysis and Prediction System. https://gmao.gsfc.nasa.gov/weather_prediction/



GMAO Weather and Analysis and Prediction System
Dec 2018 Monthly Mean at 09UTC



SST_{skin} – $SST_{foundation}$

SUMMARY

To maintain and further improve coupled DA, we advocate for the availability of a **infrared and microwave satellite radiometers to measure SST and surface salinity.**

For improved modeling of the near-surface temperature, salinity and mixing processes, we suggest adding more than one temperature sensor and salinity sensors to the drifting buoy network.

MORE INFO

Penny et al., 2019 (Community White Paper)
https://doi.org/10.3389/fmars.2019.00391

E-mail: santha.akella@nasa.gov
Web: gmao.gsfc.nasa.gov

Scan me

XXXX-XXXX

National Aeronautics and Space Administration

NASA