Implementation of Multidomain Unified Forward Operators (UFO) within the Joint Effort for Data assimilation Integration (JEDI): Ocean applications

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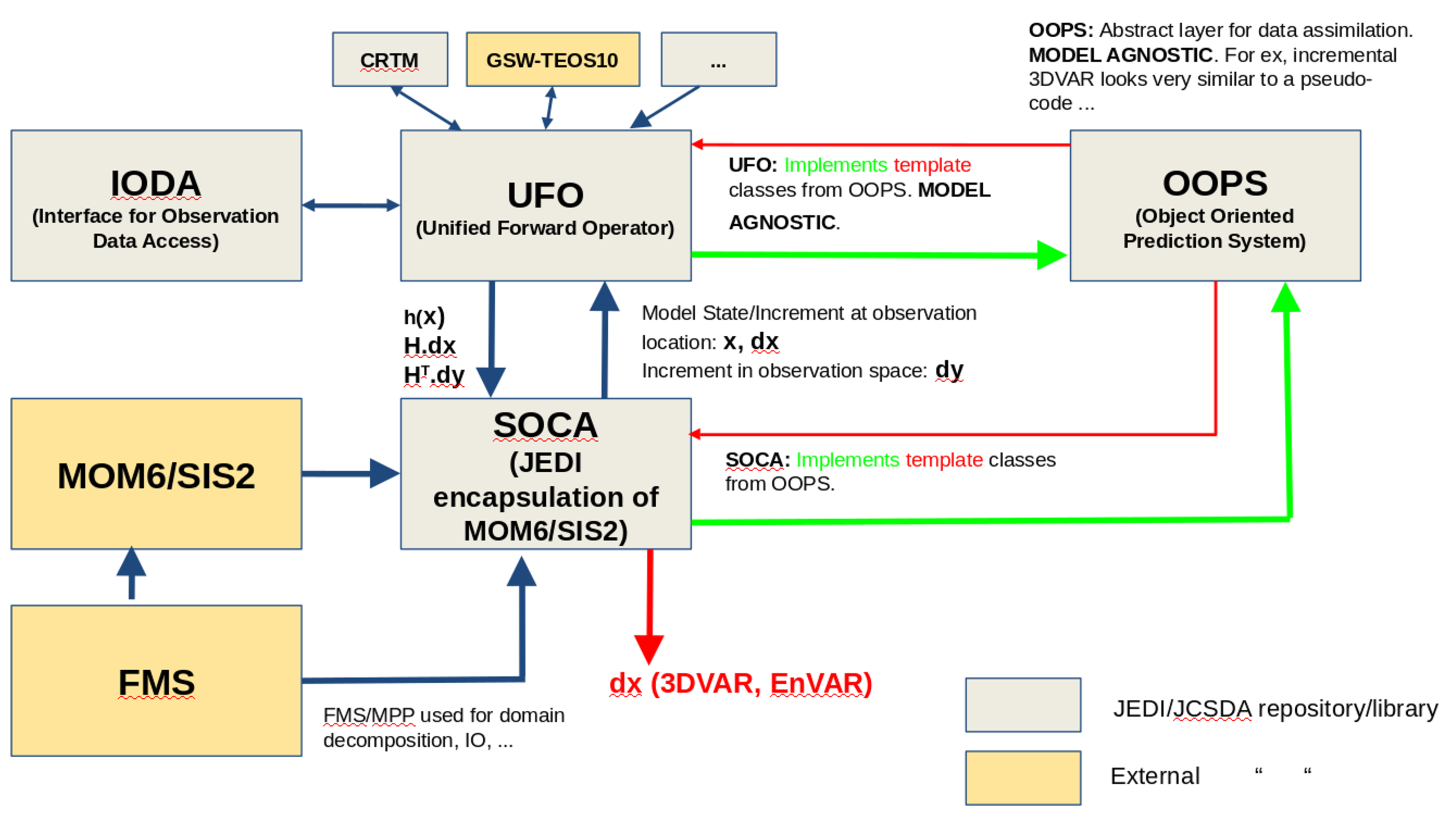
Introduction

The Joint Effort for Data assimilation Integration (JEDI) is a collaborative development led by the Joint Center for Satellite Data Assimilation (JCSDA) in conjunction with NASA, NOAA and the Department of Defense (NAVY and Air Force). The (Sea-Ice Ocean and Coupled Assimilation) SOCA as one of the JCSDA projects, focuses on the application of JEDI to marine data assimilation. One of the goals of SOCA is to make use of surface-sensitive radiances to constrain sea-ice and upper ocean fields (e.g., salinity, temperature, sea-ice fraction, sea-ice temperature, etc.).
The first elements toward an ocean/atmosphere coupled data assimilation capability within JEDI, with a focus on supporting and developing the assimilation of radiance observations sensitive to the ocean and atmosphere has been implemented. The direct radiance assimilation of surface sensitive microwave radiances focusing on Global Precipitation Measurement (GPM) Imager (GMI) for the SST Constraint and Soil Moisture Active Passive (SMAP) for the Sea Surface Salinity (SSS) has been the main focus.

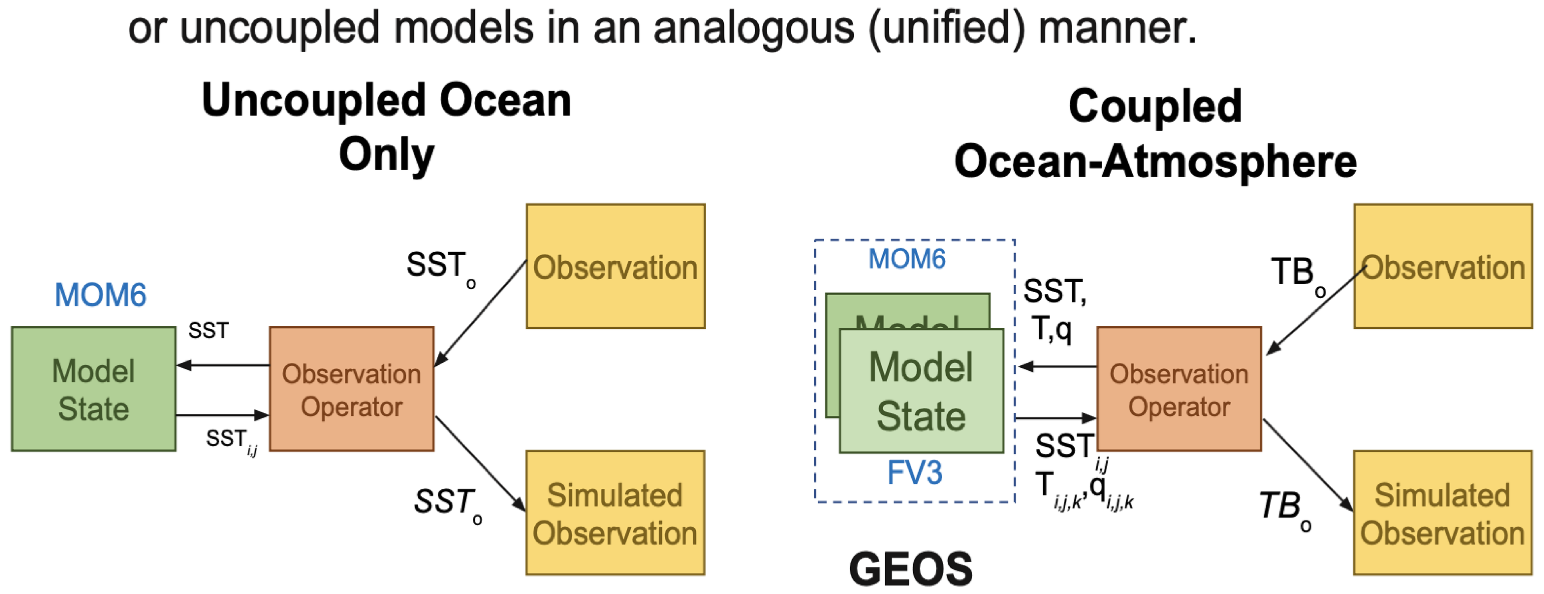
Also, in UFO the capability to calculate the cool skin layer depth and skin temperature has been implemented similar to the GEOS-5. It has been tested with GMI sea surface temperature retrievals. This is important because Satellite and in-situ observations of the Sea-Surface Temperature (SST) show high variability, including a diurnal cycle and very thin, cool skin layer in contact with the atmosphere, and Incorporating a realistic skin SST is essential for atmosphere-ocean coupled data assimilation.

JEDI encapsulation of marine models



Where GEOS and JEDI Come Together

- 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.



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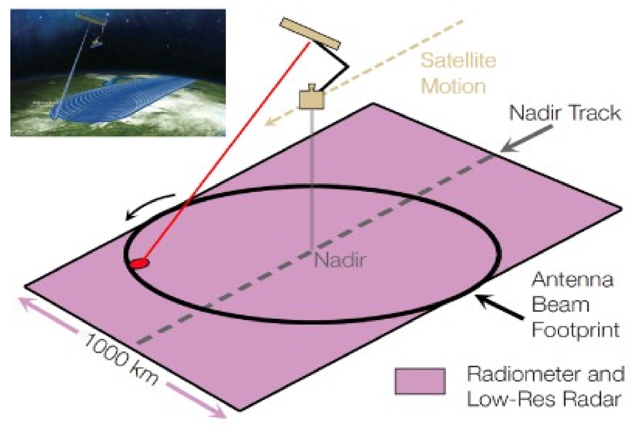
SMAP (Soil Moisture Active Passive)

NASA supports a number of Observational platforms such as SMAP that measure quantities near the air-sea interface and are highly relevant for coupled data assimilation

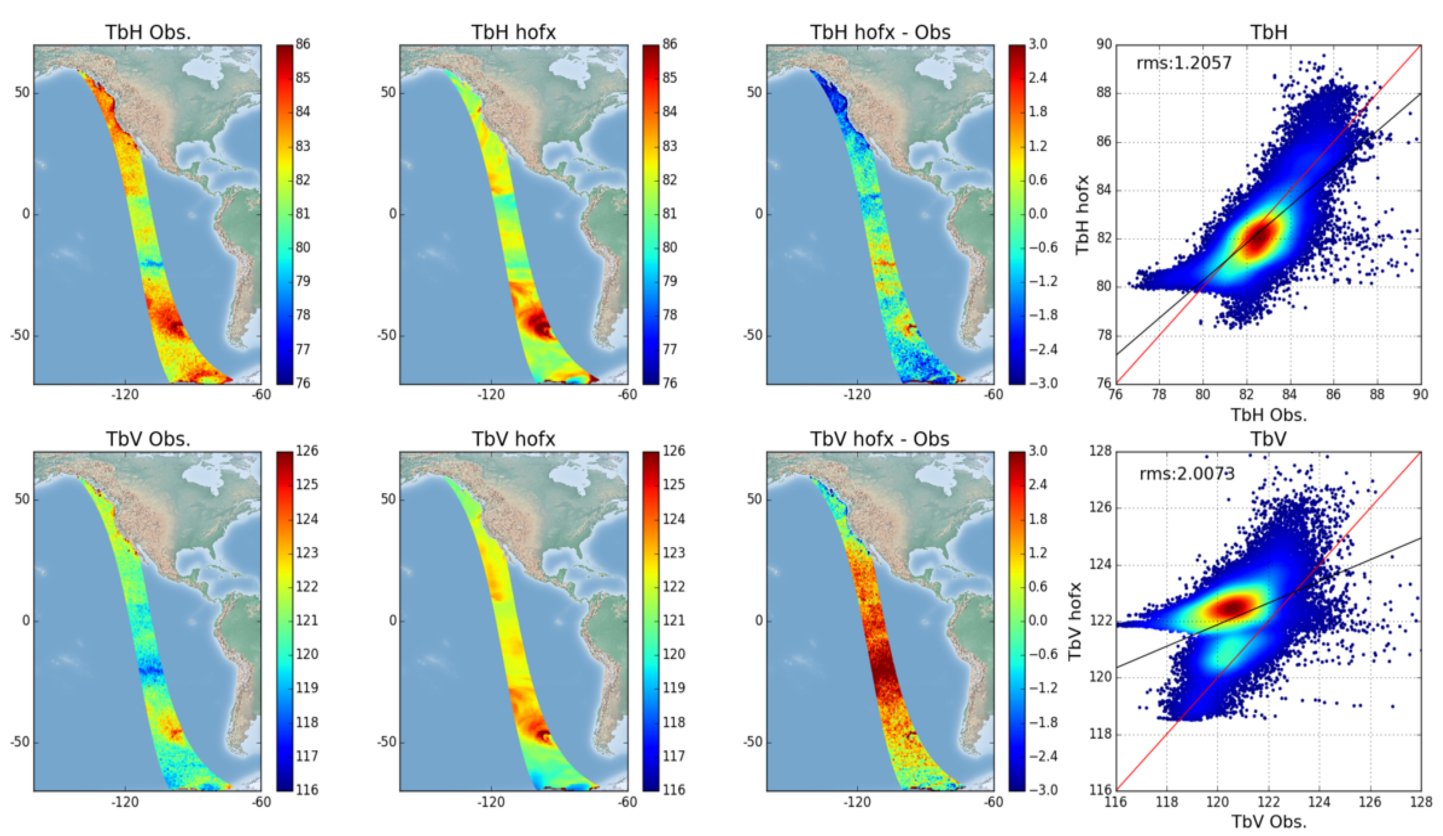
- **Frequency: 1.41 GHz**
  - **sensitivity of Tb to SSS, SST and wind speed**
- **Polarizations: H, V**
- **Soil Moisture**
- **SMAP Sea Surface Salinity (SSS)**
  - **global water cycle**



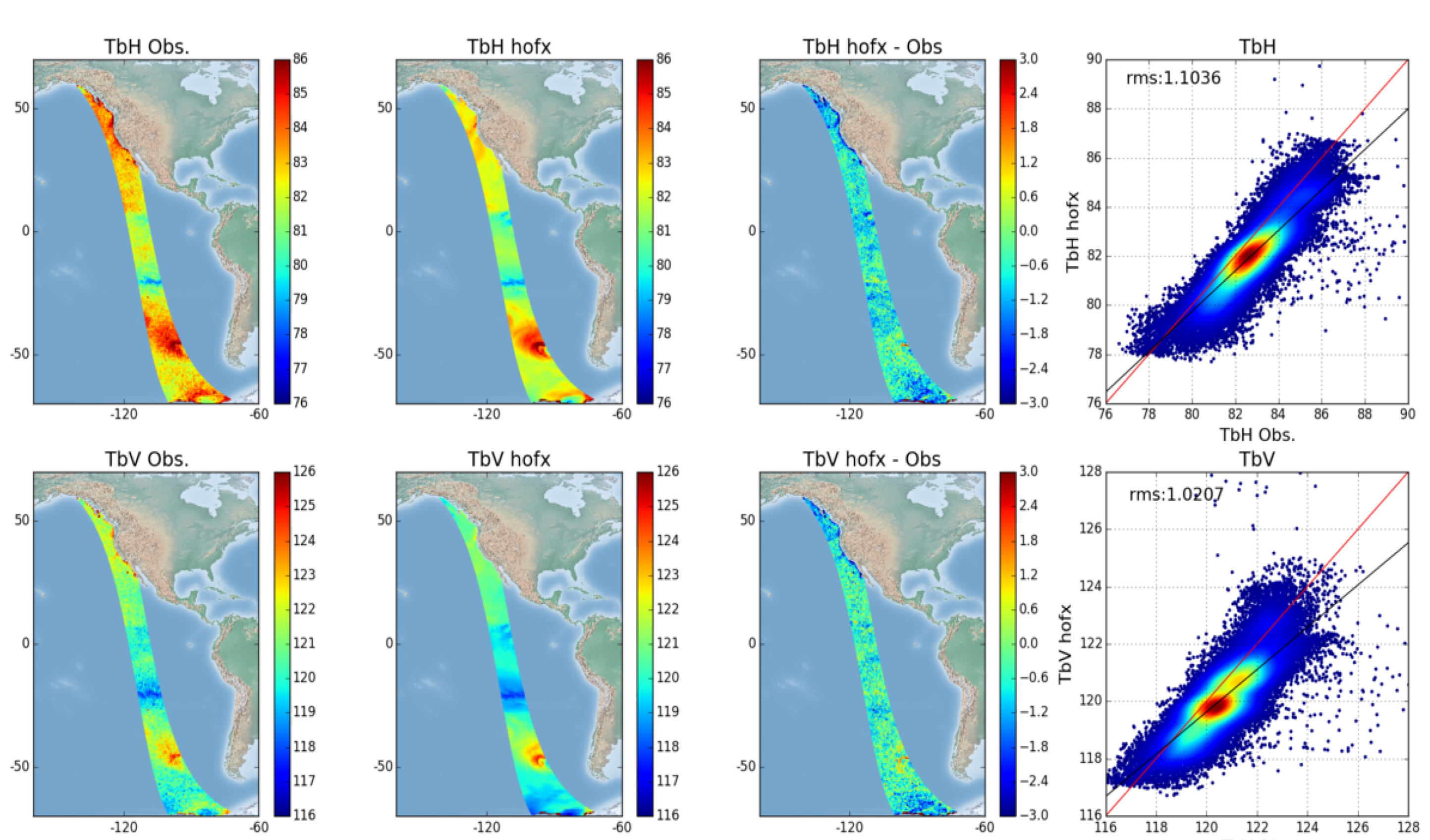
Concerns

- **Uncertainties on sea surface and scattering modeling.**
- **Empirical emissivity models have been developed at high frequencies where numerous satellite data are available**
- **Wind effect on Tb which is uncertain at low frequency**
- **Empirical correction of the wind influence on Tb is possible using normalized radar cross section measurements**

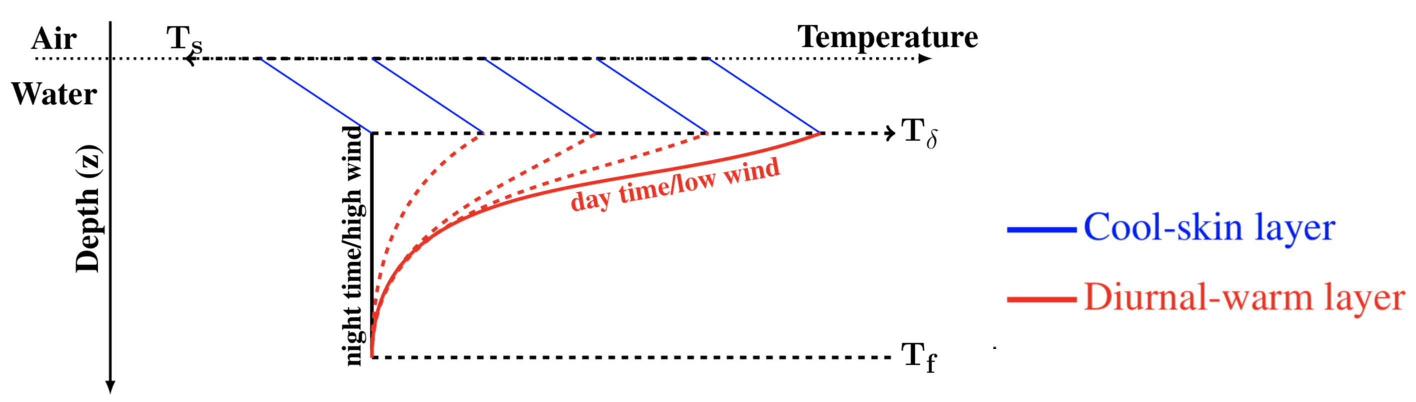
SMAP h(x) using FASTEM with SSS=33



SMAP h(x) using RSS model with WOA SSS

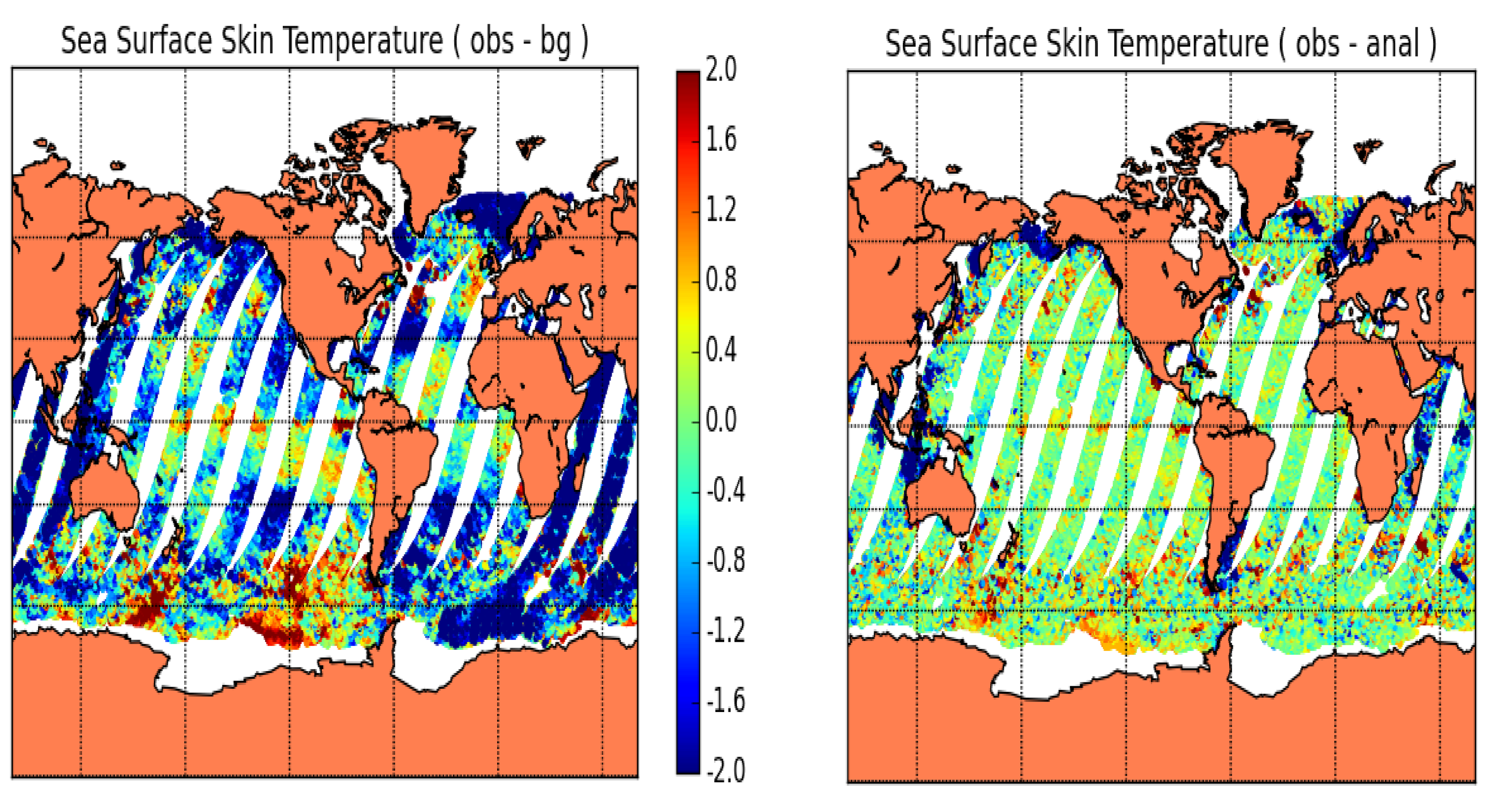


Skin Sea Surface Temperature



- ➢ Friction velocity over water
- ➢ Latent heat flux,
- ➢ Sensible heat flux,
- ➢ Net downwelling longwave radiation
- ➢ Net downwelling shortwave radiation
- ➢ Temperature at model level closest to obs depth

GMI Skin SST Retrievals April 15, 2018 (24 hr)



Conclusion

Developed configurations and started assimilating GMI and SMAP using the FV3-JEDI system and compare simulated and observed brightness temperature and identified issues. for assimilation of low frequency channels such as SMAP, sea surface salinity from the World Ocean Atlas (WOA) has been added to the background data, and also FASTEM has been replaced by the Remote Sensing System (RSS) emissivity model which has shown better results in lower frequencies.

Also, the capability to calculate the cool skin layer depth and skin temperature has been implemented. It has been tested with GMI sea surface temperature retrievals. This is important as a realistic skin SST is essential for atmosphere-ocean coupled data assimilation. Our future work includes testing this implementation in detail with in situ observations.