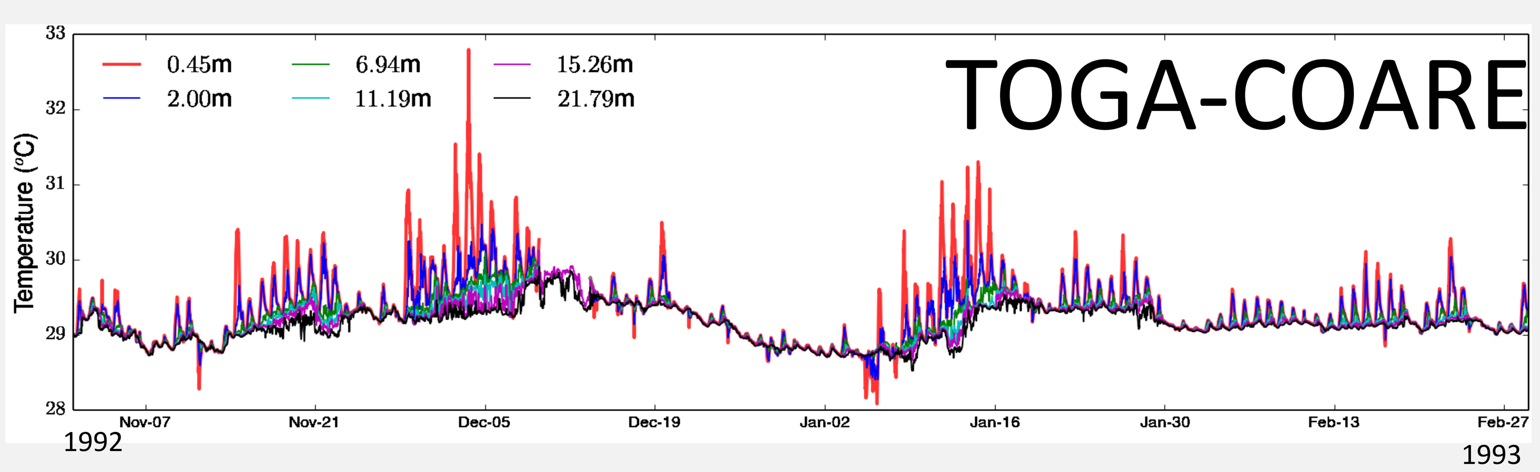
Santha Akella
NASA Global Modeling and Assimilation Office

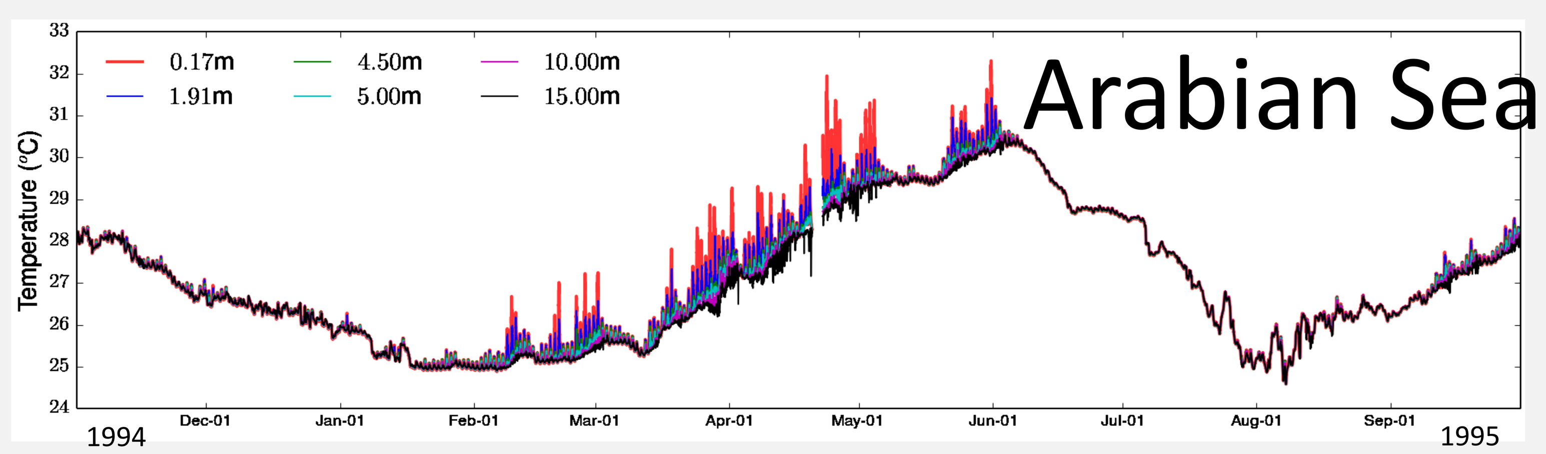
GMAO
Global Modeling & Assimilation Office

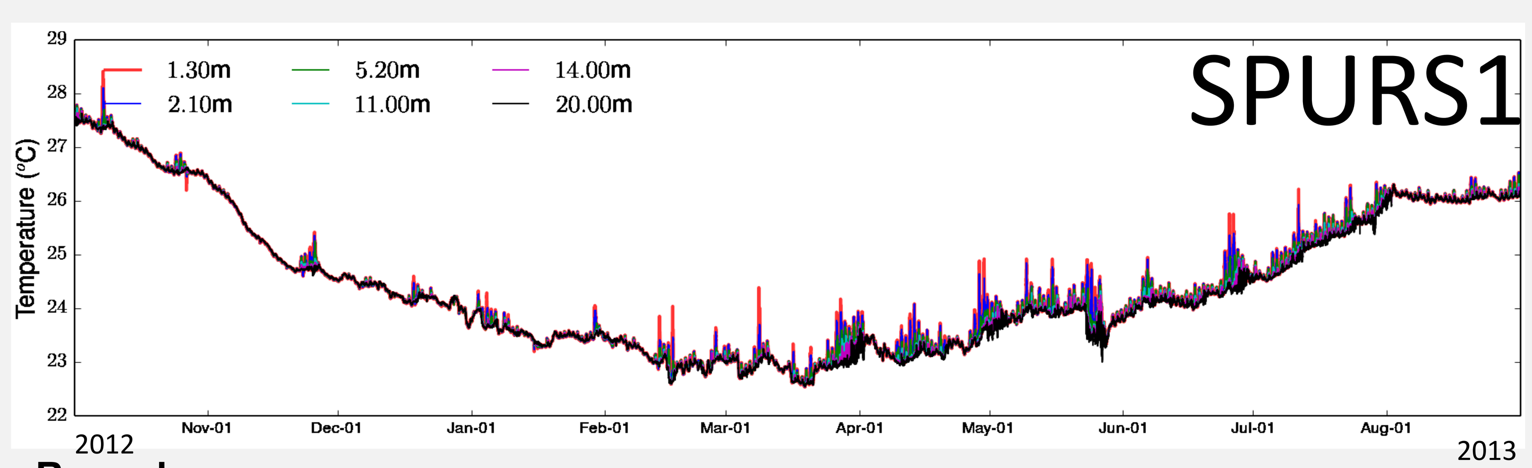
Computationally efficient modeling and data assimilation of near-surface variability

Observed Near-Surface Variability

Process studies (e.g., TOGA COARE, Arabian Sea Experiment, SPURS1) clearly depict a diurnal cycle in surface temperature. Data from WHOI
http://uop.whoi.edu/projects/projects.html







Remarks:
- Notice largest diurnal amplitude (>= 2C) in the first few meters (about 2m; red and blue lines).
- Somedays show a small (<= 0.25C) diurnal warming even at 10- 15m depth, typically around 20m there is none.

Issues:
- How to model such variability? Parameterize or *sufficient* vertical resolution in the model?
- Much of this variability is driven by solar radiation, hence *frequent* shortwave radiation flux is needed.
- Momentum stress due to surface winds and/or waves dissipate this variability, hence high frequency/resolution data is needed.
- Satellite measurements and turbulent air-sea fluxes are sensitive to near-surface temperature.

MORE INFO

Akella and Suarez, 2018
NASA GMAO Tech Memo.

SCAN ME

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

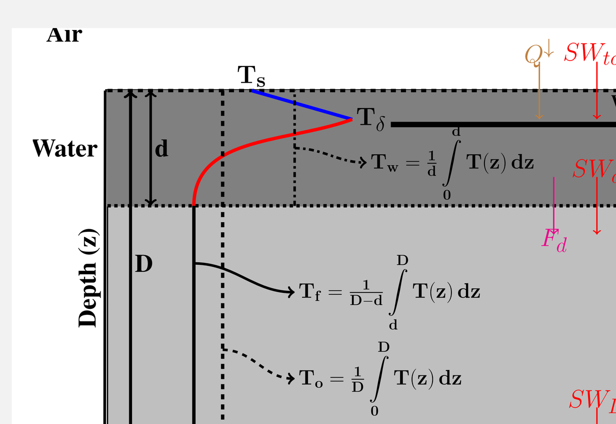
XXXX-XXXX

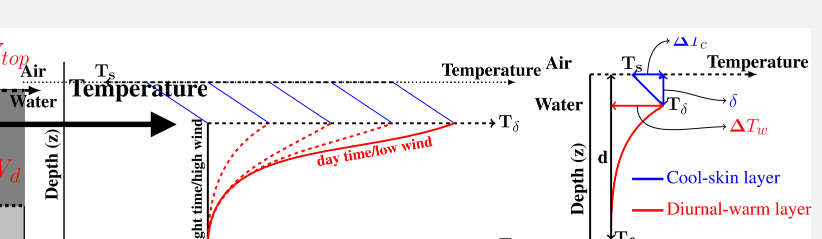
Atmosphere-Ocean Interface Layer (AOIL) of the NASA GMAO GCM

The NASA GMAO GCM is used for:
- Near-real time Weather Analysis and Prediction https://gmao.gsfc.nasa.gov/weather_prediction/
- Seasonal-Decadal Analysis and Prediction https://gmao.gsfc.nasa.gov/cgi-bin/products/climateforecasts/geos5/S2S_2/index.cgi
- Reanalysis (atmospheric) https://gmao.gsfc.nasa.gov/reanalysis/MERRA-2/

Since 01/2017 the Weather Analysis and Prediction system resolves this surface variability (via modeling and assimilation of AVHRR infrared brightness temperatures). See Akella et al, 2017 http://onlinelibrary.wiley.com/doi/10.1002/qj.2988/full for description and Gentemann and Akella, 2018 https://doi.org/10.1002/2017JC013186 for validation. The diurnal variability model was formulated and implemented for atmospheric GCM, with prescribed *foundation* SST that does not have diurnal variability.

The present AOIL is a reformulation:
- Of the exchange of variables and fluxes across the air-sea interface, designed to work *seamlessly* within atmospheric and coupled GCMs.
- It models the near-surface variability; amplitude of the diurnal warming is improved from Akella et al., 2017 model.



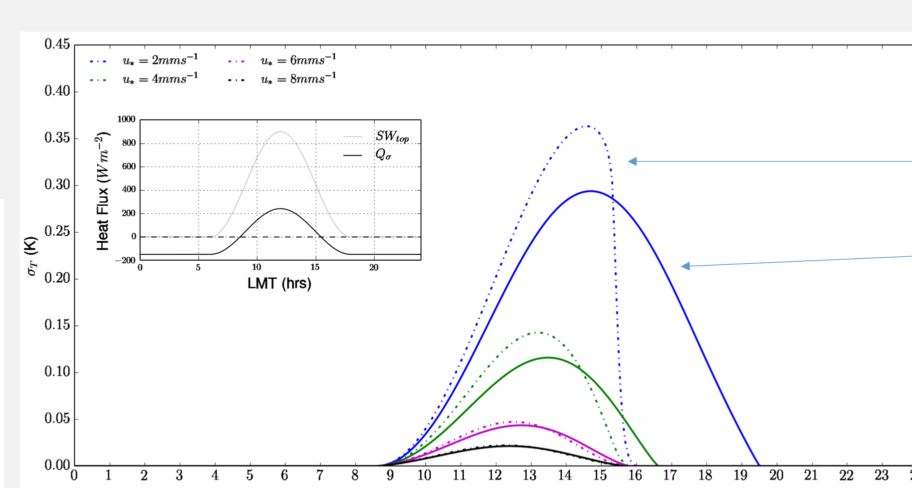


Schematic of the AOIL, embedded in the top layer of the ocean model

We solve for $\sigma_T = T_w - T_f$

$$\boxed{\frac{\partial \sigma_T}{\partial t} = \frac{Q_\sigma}{d\,\rho_w c_w} - \frac{1}{\tau_\sigma}\sigma_T,}$$

$$Q_\sigma = \left(SW_{top} - SW_d + Q^{\downarrow}\right) - \frac{\epsilon}{1-\epsilon}\left(SW_d - SW_D\right) \qquad \tau_\sigma = \frac{d(1-\epsilon)\phi(\zeta)}{\kappa u_*(1+\mu)}$$

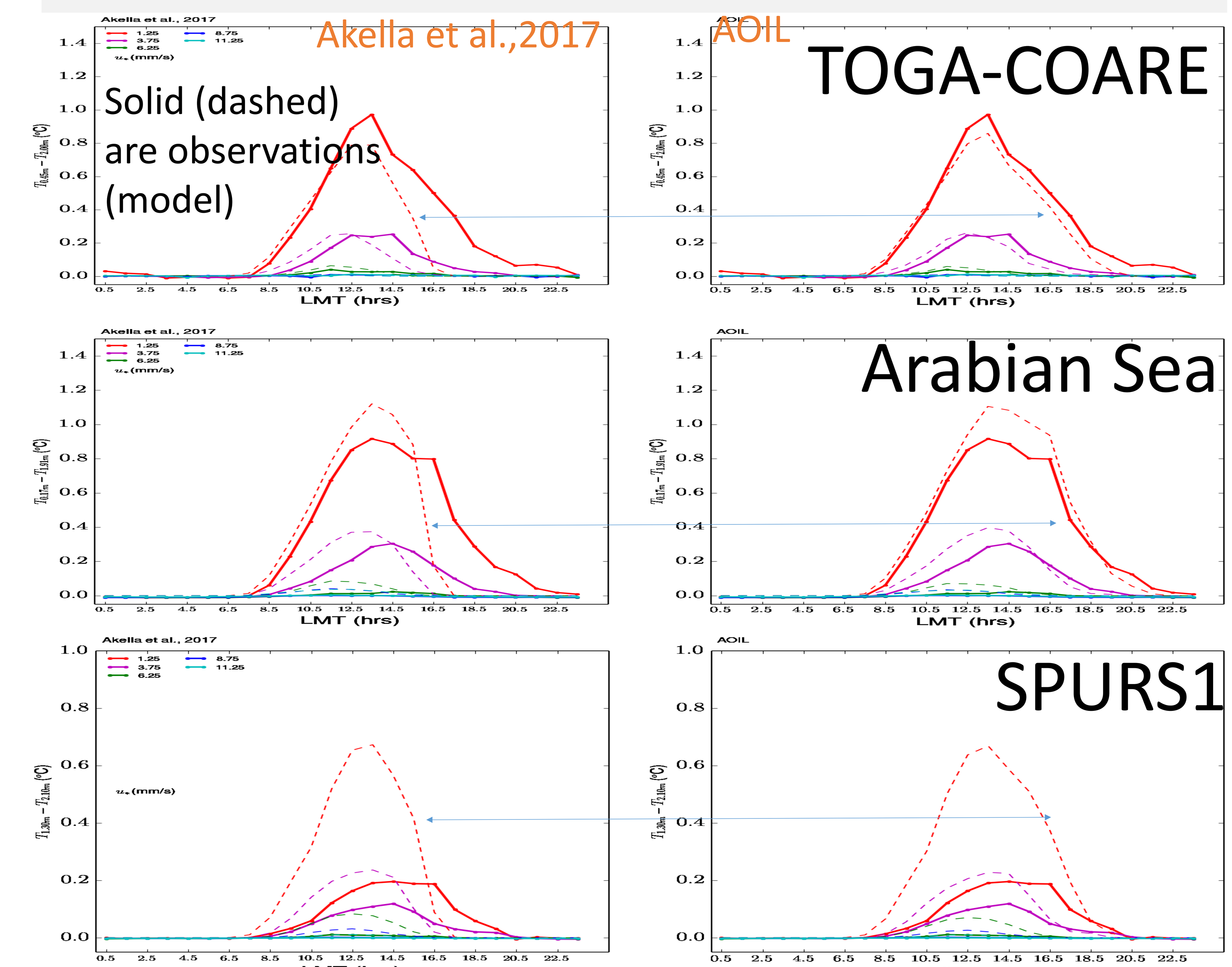


σ_T **versus Local Mean Time (LMT) for an ideal day with constant friction velocity (u_*) and $Q^{\downarrow}$=-150W/m^2.**

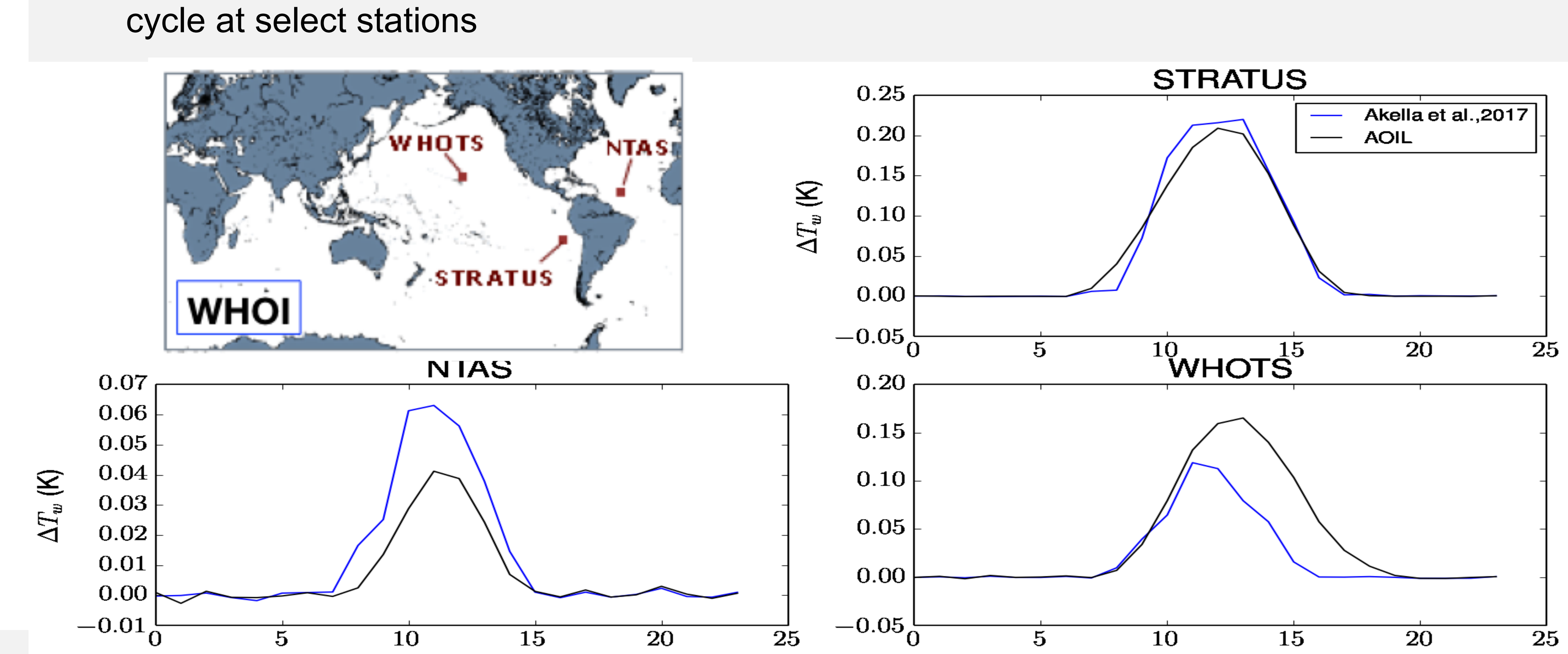
Solid (dashed) lines are with AOIL (Akella et al., 2017) model. The AOIL better models the gradual decay of diurnal warming.

Validation

Offline model runs using the COARE bulk fluxes and measured temperatures from WHOI http://uop.whoi.edu/projects/projects.html



Onine model runs using within GMAO atmospheric data assimilation system. Diurnal cycle at select stations



SUMMARY

The AOIL has been implemented in the NASA GMAO models: both uncoupled (AGCM) and coupled GCM. Improvements to model near surface salinity are underway.

National Aeronautics and Space Administration

NASA