SSST Analysis in GEOS GCM

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Abstract

An analyzed Sea Surface Temperature (SST) will provide improved estimates of surface fluxes in order to better predict short-timescale weather features such as tropical cyclones and also yield balanced initial conditions for longer climate predictions.

Here we present improvements to skin SST modeling in the GEOS AGCM, which includes modeling of a cool-skin layer and diurnal warming layer. In addition, preliminary results from assimilation of brightness temperature (Tb) includes modeling of a cool-skin layer and diurnal warming layer. In addition, preliminary results from assimilation of brightness temperature (Tb) using the Gridpoint Statistical Interpolation (GSI)-highlighting the observation-minus-forecast obtained using AVHRR Tb are also presented.

Motivation

Current Status of Skin SST:

OGCMs typically use a bulk SST which is a blend of satellite retrievals calibrated based on in-situ measurements.

AGCMs consider SST to be the ‘mean’ temperature of the surface of the ocean (for e.g., the upper layer of the model, typically 1-5 m thick)

Our Objectives:

Model diurnal variation of temperature near the air-sea interface

Assimilate for the vertical profile of temperature: T(z)

Estimate the surface skin temperature (Ts) using Tb to compute air-sea fluxes

Modeling T(z) Profile

Cool-skin layer: In the upper surface (few mm) molecular (thermal) diffusion is dominant, it is due to the combined effects of net longwave radiation and sensible and latent heat fluxes.

Warm Layer: mm to few meters thick, follows diurnal warming

Cool layer: always persistent (day & night)

Warm later builds up due to solar heating

Clouds and strong winds erode stratification

Warm layer can persist into the night or the next day

Cool layer is always persistent (day & night)

Turbulent diffusion dominates molecular diffusion effects in the warm layer

IR & MW sat. retrievals: temperature decreases due to cool layer

In-situ measurements: diurnal warming w.r.t. foundation temperature

Comparison with Buoy:

In-situ measurements clearly show diurnal variability dominated by diurnal warming

Bulk SST products such as the weekly Reynolds do not resolve this variability

Our diurnal skin temp model is able to simulate diurnal warming

Though the in-situ data was not assimilated, Ts analysis (Exp) most closely follows measured temp; however significant differences can be seen.

Summary & Work in progress

Accurate modeling & estimation of skin temperature requires modeling and analyses of T(z) profiles

Within the GEOS we now model the vertical temperature profile including diurnal warming & cool-skin layer

Ts analysis components using the GEOS & GSI are ready

Work is in progress to use in-situ observations (modadsf) in analysis

We are reformulating and tuning the diurnal warming model to be in-sync with the in-situ data

Adding TRMM-TMI Ts to the observation system

GSI Analysis for Skin Temperature

Observation (or penetration) depth (Zob) for radiance measurements

Read in additional background fields to compute temp. T(z) at any Zob

IR: AVHRR, AIRS, HIRS, IASI, Sounders, Imagers, etc, Zob = 15 mm

MW: AMSUA, AMSUB, MHS, SSMI, AMSR, etc, Zob = 1.25 mm

in-situ observations have Zob recorded

Given Zob, time, and location of the observation, background temperature is:

T(z) = (Tb - a) + (c1 * C + c2 * N + c3 * V + c4 * T + c5)

CRTM surface requires specification of the Jacobian, currently set to 1

Analysis writes out analyzed and the model applies increment

Additional relevant observations are from AVHRR (N-18, 19, METOP-A)

Figure 1: Time-series of Temperature at Two Mooring Locations

Figure 2.1: Time-series of RMS OMF for AMSUA N18

Results: RMS of OMF AMSUA and AVHRR

Figure 2 shows the time-series of AMSUA and AVHRR N-18 RMS OMF for one month.

Neutral or no change to surface peaking MW window channels

Systematic reduction in RMSE of OMF for AVHRR indicates better simulation of Ts during day & night

Figure 2.2. Time-series of RMS OMF for AVHRR

Day of Assimilation after 2012/04/01-00z

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