Assimilation of Geostationary Satellite Land Surface Skin Temperature into the GEOS-5 Global Atmospheric Modeling and Assimilation System

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Outline

- Recently implemented a land data assimilation within GMAO's GEOS-5 atmospheric modeling and assimilation system.
- Assimilated geostationary land surface skin temperature (T_{skin}) observations into GEOS-5.
- Aim: improve low-level atmospheric forecasts, and enhance assimilation of surface-sensitive atmospheric radiances.

Assimilation methods and data

Geostationary T_{skin}

- Near-real time data set from NASA Langley Research Center, reported 3-hourly (clear sky conditions), at 0.3125°x0.25°, with global (60°S-60°N) coverage (Scarino et al, 2013).

The GMAO LA-DAS

- A weakly coupled Land/Atmosphere Data Assimilation System, consisting of:
- **ADAS**: GEOS-5 AGCM/GSI 3D-Var ADAS (Rienecker et al, 2008). Currently no land surface or screen-level atmospheric assimilation.
- **LDAS**: Catchment land surface model (Koster et al, 2000) and GMAO Ensemble Kalman Filter-based LDAS (Reichle et al, 2014), with new dynamic observation-forecast bias correction scheme.

The assimilation experiments:

- With LDAS and LA-DAS, assimilate 3-hourly GOES-E and GOES-W T_{skin}, to update model T_{skin} and near-surface soil temperature.
- Within the assimilation, the observations are 'corrected' to remove the observation-forecast bias (assimilating the anomaly information, to correct short-lived model errors only).

LDAS experiments

- Assimilate T_{skin} observations into the offline Catchment model, forced with MERRA atmospheric fields, over North America at 0.3125°x0.25°, for one year from June 2012. Compare LDAS assimilation to CNTRL run (openloop ensemble mean).

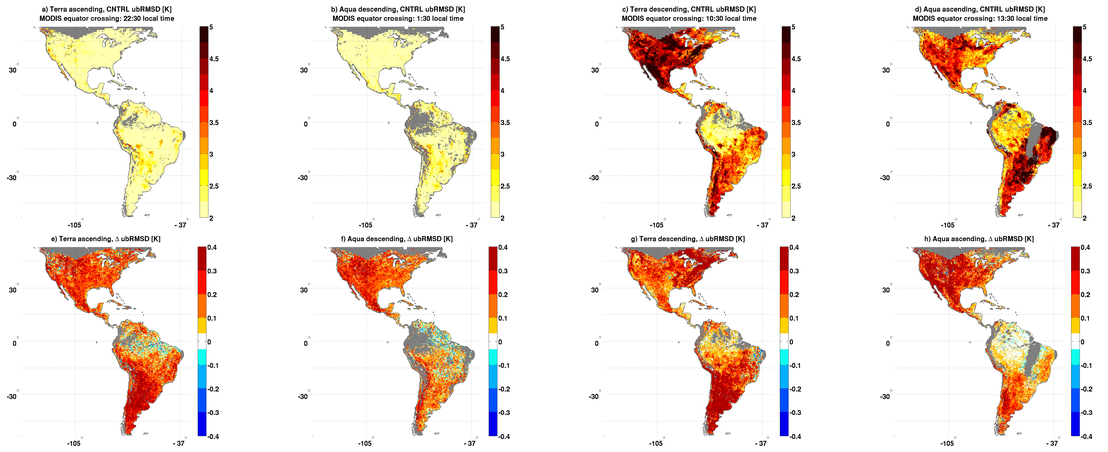

Fig 1. ubRMSD with Aqua and Terra MODIS T_{skin} (MYD11C1/MOD11C1, v4.1).

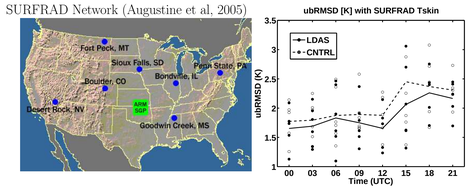

Fig 2. ubRMSD with SURFRAD T_{skin}.

	SURFRAD	MODIS			
		Terra asc	Aqua dsc	Terra dsc	Aqua asc
Open-loop	2.14	1.89	1.94	3.62	3.60
LDAS	1.97	1.70	1.79	3.36	3.42
Difference	0.17	0.19	0.15	0.27	0.18

Tab 1. Spatial mean ubRMSD with independent T_{skin} data.

LA-DAS experiments

- Assimilate T_{skin} observations into the GEOS-5 AGCM/ADAS over Americas, for one month from 14 July 2012, at 0.625°x0.5°. Compare LA-DAS to CNTRL run (AGCM/ADAS without LDAS).

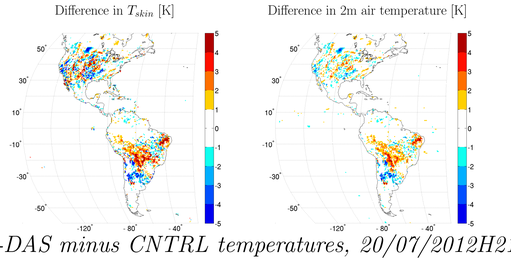

Fig 3. LA-DAS minus CNTRL temperatures, 20/07/2012H21.

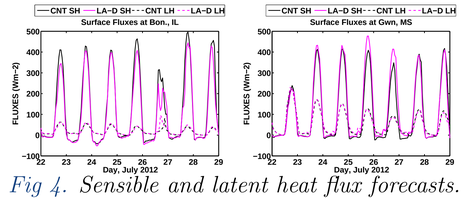

Fig 4. Sensible and latent heat flux forecasts.

Results summary

- In offline experiments (LDAS), the T_{skin} assimilation reduced the ubRMSD compared to independent remotely sensed (Fig. 1) and in situ (Fig. 2) T_{skin} observations by 10% of the open-loop ubRMSD. However the effect on land surface flux forecasts was negligible (not shown), due to the very short memory of model T_{skin}.
- In contrast, in the coupled system (LA-DAS), the T_{skin} assimilation affects land surface flux and low level atmospheric forecasts (Figs. 3&4).

Conclusions

- Used offline LDAS experiments to show that assimilating Geostationary T_{skin} can improve modeled T_{skin}.
- Used preliminary LA-DAS experiments to show that assimilating Geostationary T_{skin} can impact the land surface fluxes and low-level atmospheric forecasts (does not occur for offline system).
- Cannot yet show improvement in low-level atmospheric forecasts, which will likely require that the model T_{skin} biases be corrected (c.f. correction of only short-lived errors in this study).
- Currently developing a bias correction method for Geostationary T_{skin}, based on 2m air temperature observations, to be used in a bias-aware assimilation to correct model T_{skin} biases.

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