Resolving the diurnal cycle in satellite derived sea surface temperatures and its significance on surface heat fluxes

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Abstract

Marine surface heat fluxes across the globe need to be resolved on a smaller time scale in order to determine how changes in their diurnal cycle contribute to surface turbulent fluxes. In order to do this, the sea surface temperatures used to calculate the fluxes also need to accurately represent diurnal changes. Since most satellite derived sea surface temperature products are time-averaged and smoothed so that intradiurnal variations are neglected, and insitu measurements are scarce in global spatial coverage, modeling of the diurnal cycle of SSTs becomes necessary. Though many diurnal models exist, the focus of the study will be on 3 types of models; empirical models, turbulence closure models, and bulk flux models. Five of these models will each be used to calculate a global field of diurnally varying sea surface temperatures (dSSTs) over the course of 2 months in two different annual seasons, winter and summer. The input parameters, including the input SST are taken from the MERRA, or Modern Era Retrospective-Analysis for Research and Applications reanalysis dataset. MERRA sea surface temperatures are smoothed over a 7 day period, so they do not represent diurnal changes. Instead, the MERRA SST product will serve as a foundation temperature, or the temperature that is independent from the effects of diurnal heating (Donolan, et al., 2007), of which the amplitude of the diurnal heating will be added to. As each model produces a dSST field, surface heat fluxes will be calculated using the Bourassa (2006) flux model. Finally, 2-monthly average biases (differences dSSTs versus MERRA SSTs) and uncertainties in the biases for each model are compared to isolate key aspects of each diurnal SST model and evaluate the climactic and modeling significance of the inclusion of diurnal heating. We find that latent heat fluxes in the tropics are increased by roughly 10 Wm^{-2} when the diurnal variability is considered (Fig. 1). This change in flux decreases poleward. The tropical changes are sufficient to be important on interannual and larger time scales.

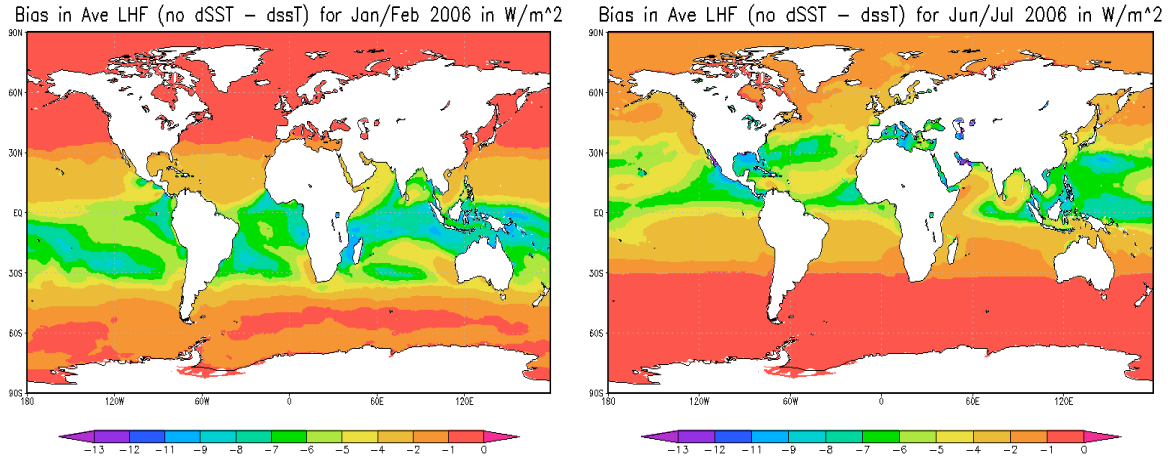

Fig. 1. Biases of two-monthly averaged surface latent heat fluxes calculated for winter (Jan/Feb) and summer (Jun/Jul) of 2006. Model used to calculate diurnal heating was an empirical model developed by linear regressions fitted to SEVIRI solar irradiance observations along with wind measurements from multiple microwave sensors (SSM/I, TMI, QUIKSCAT, AMSR-E) (Filipiak, et al. 2008).

References :

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Filipiak, M. J., C. J. Merchant, H. Kettle, P. Le Borgne, C. Gentemann, 2008. Diurnal variability in sea surface temperatures derived from geostationary satellite observations: seasonal patterns and dependence on wind speed and insolation. [np.]