SST sensitivity and its relevance to measuring diurnal variability

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SST sensitivity

$\partial\hat{x}/\partial x$ the degree to which the retrieved SST changes when the true SST changes

$\partial\hat{x}/\partial x = 1$ ideal characteristic of any algorithm

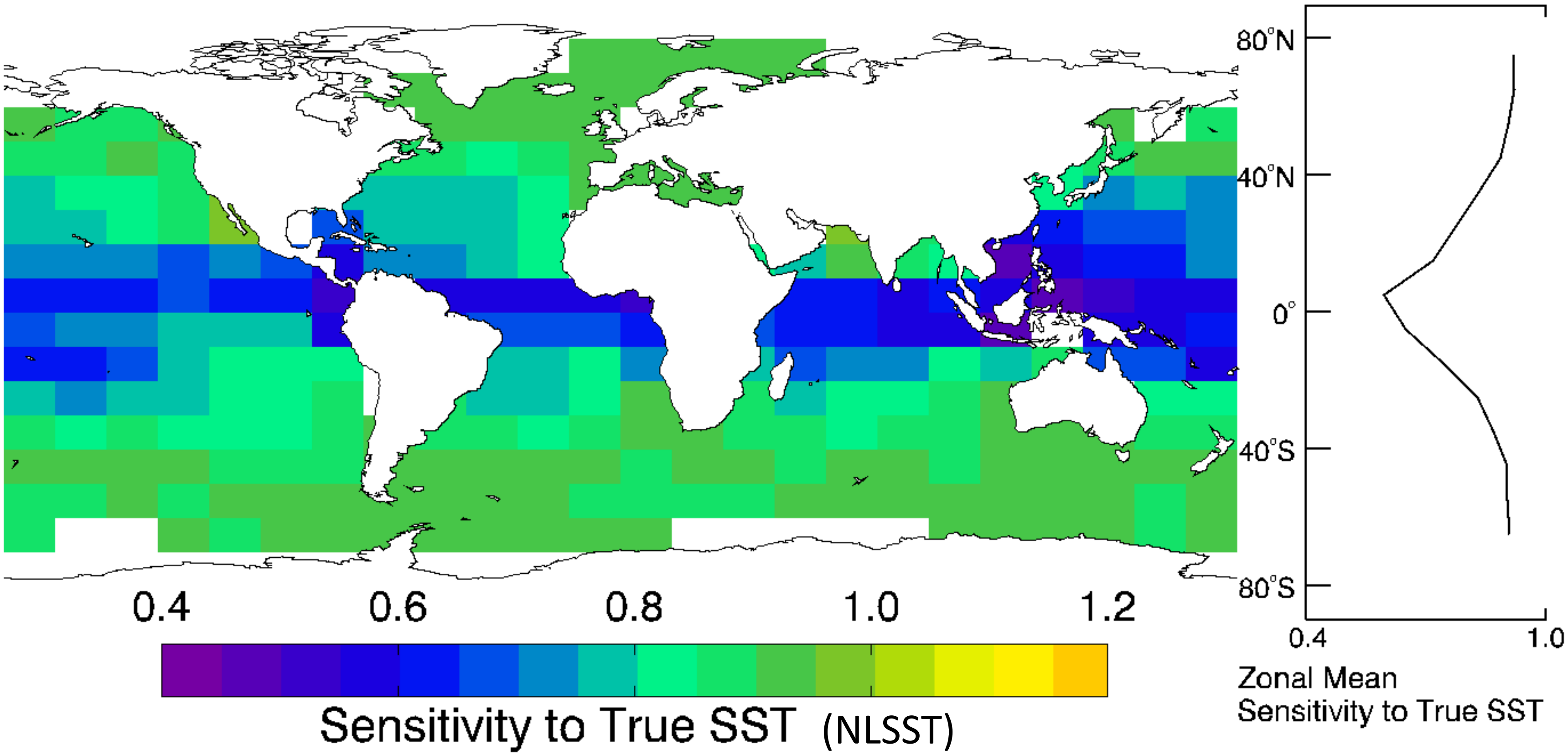
important for

climate ($\partial\hat{x}/\partial x \neq 1$ => prior in result)

fronts

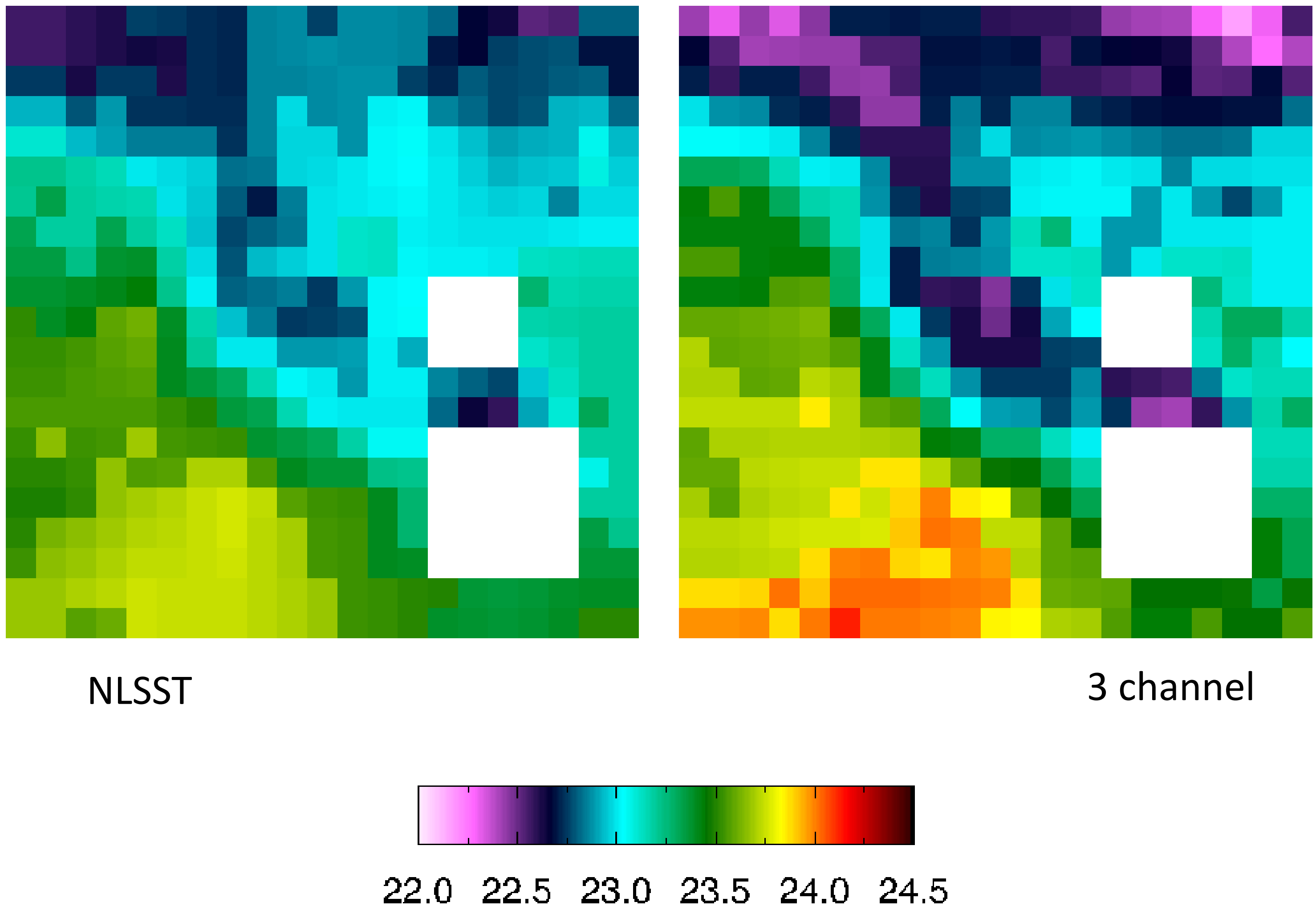
diurnal warming observation

Split-window (NLSST) sensitivity map



Retrievals can have "features" that are not widely appreciated

Same BTs, SSTs from two different co-efficient based retrievals



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Retrieval characteristics of non-linear sea surface temperature from the Advanced Very High Resolution Radiometer

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[1] Criteria are proposed for evaluating sea surface temperature (SST) retrieved from satellite infra-red imagery: bias should be small on regional scales; sensitivity to atmospheric humidity should be small; and sensitivity of retrieved SST to surface temperature should be close to 1 K K^{-1}. Their application is illustrated for non-linear sea surface temperature (NLSST) estimates. 233929 observations from the Advanced Very High Resolution Radiometer (AVHRR) on Metop-A are matched with in situ data and numerical weather prediction (NWP) fields. NLSST coefficients derived from these matches have regional biases from −0.5 to +0.3 K. Using radiative transfer modelling we find that a 10% increase in humidity alone can change the retrieved NLSST by between −0.5 K and +0.1 K. A 1 K increase in SST changes NLSST by <0.5 K in extreme cases. The validity of estimates of sensitivity by radiative transfer

highlighting characteristics of SSTs not thoroughly discussed in existing literature. We illustrate these using SSTs obtained with the Pathfinder methodology to make the results widely pertinent, but the approach is valid for all SSTs based on coefficients. These characteristics are regional bias, sensitivity to water vapour and imperfect sensitivity to SST. Such features are important for applications of SSTs in numerical weather prediction (NWP), operational oceanography and climate.

2. Criteria for Retrieved SST

[5] SSTs from satellites are usually validated against in situ observations, usually drifting buoys [e.g., *Brisson et al.*, 2002]. A typical approach is to find the global mean and standard deviation of satellite-drifter differences. If the re-

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Extended optimal estimation techniques for sea surface temperature from the Spinning Enhanced Visible and Infra-Red Imager (SEVIRI)

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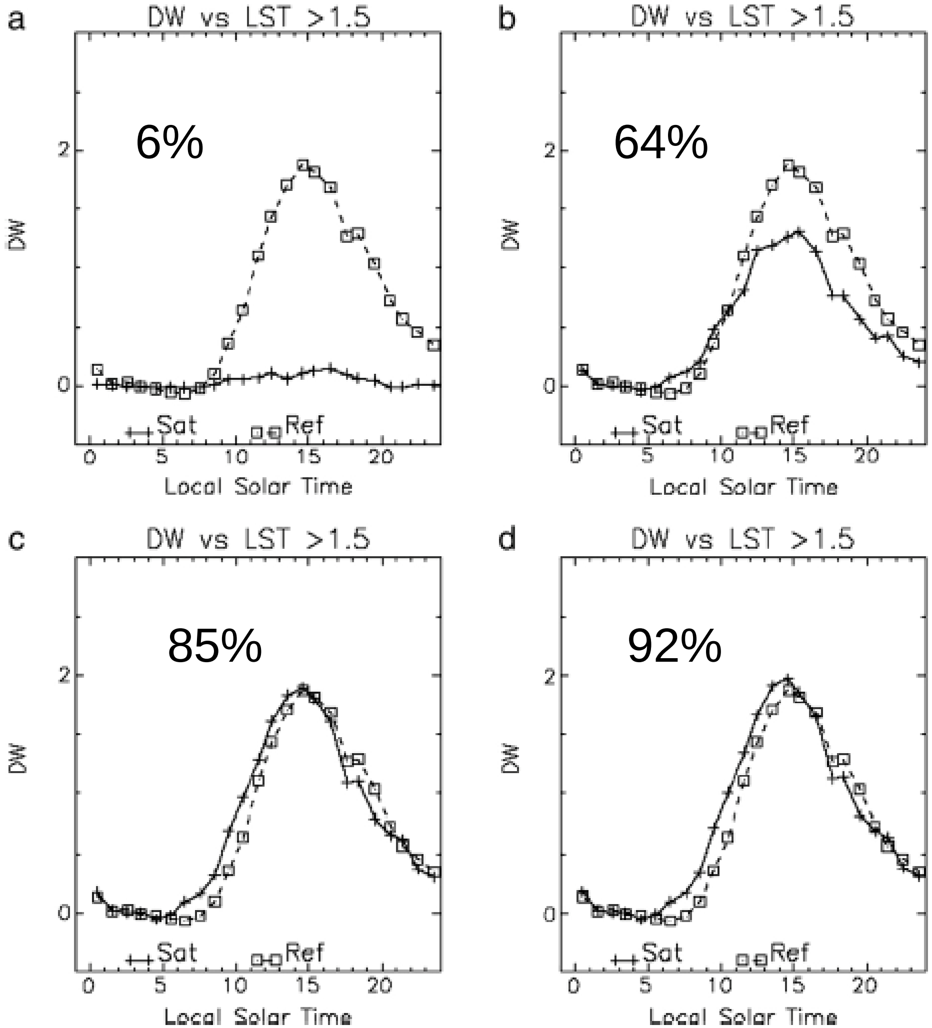
ABSTRACT

Sea surface temperature (SST) can be estimated from day and night observations of the Spinning Enhanced Visible and Infra-Red Imager (SEVIRI) by optimal estimation (OE). We show that exploiting the 8.7 µm channel, in addition to the "traditional" wavelengths of 10.8 and 12.0 µm, improves OE SST retrieval statistics in validation. However, the main benefit is an improvement in the sensitivity of the SST estimate to variability in true SST.

In a fair, single-pixel comparison, the 3-channel OE gives better results than the SST estimation technique presently operational within the Ocean and Sea Ice Satellite Application Facility. This operational technique is to use SST retrieval coefficients, followed by a bias-correction step informed by radiative transfer simulation. However, the operational technique has an additional "atmospheric correction smoothing", which im-

SST sensitivity has practical effect on DV observation



Average over 2700 “large” diurnal cycles.

Low sensitivities under-detect diurnal cycle

At 100% sensitivity, SEVIRI cycle would be 1.13 x the drifting buoy DV amplitude

This is geophysically plausible

Sensitivity is of practical concern, and can be calculated

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Diurnal warm-layer events in the western Mediterranean and European shelf seas

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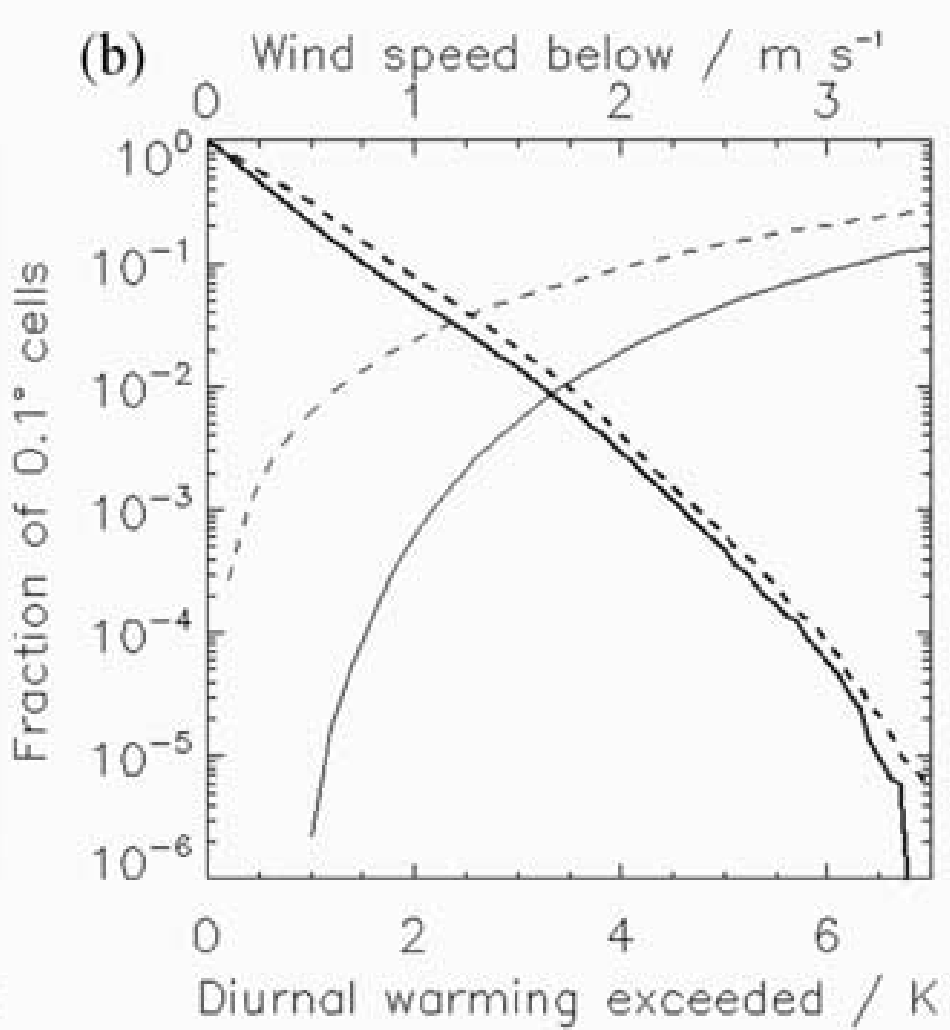
[1] We characterize near-surface ocean diurnal warm-layer events, using satellite observations and fields from numerical weather forecasting. The study covers April to September, 2006, over the area 11°W to 17°E and 35°N to 57°N, with 0.1° cells. We use hourly satellite SSTs from which peak amplitudes of diurnal cycles in SST (dSSTs) can be estimated with error ~0.3 K. The diurnal excursions of SST observed are spatially and temporally coherent. The largest dSSTs exceed 6 K, affect 0.01% of the surface, and are seen in the Mediterranean, North and Irish Seas. There is an anti-correlation between the magnitude and the horizontal length scale of dSST events. Events wherein dSST exceeds 4 K have length scales of ≤40 km. From the frequency distribution of different measures of wind-speed minima, we infer that extreme dSST maxima arise where conditions of low wind speed are sustained from early morning to mid afternoon. **Citation:** Merchant, C. J.,

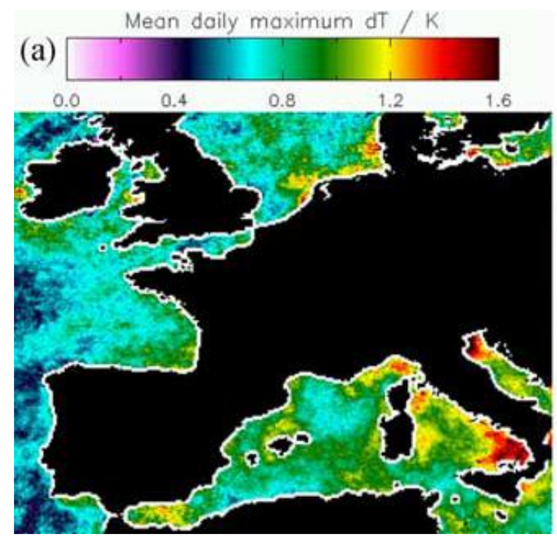
equal to the radiometric SST observed at infra-red wavelengths). The modification of instantaneous air-sea heat flux from diurnal warm-layer formation can be 50 W m^{-2} [*Ward*, 2006]. Climate records from satellite display non-climatic trends [*Kennedy et al.*, 2007] from drift in the overpass time relative to the diurnal SST cycle. Sampling different phases of the diurnal cycle contributes to bias between SST products. Diurnal SST variation also modulates air-sea fluxes of gases [e.g., *McNeil and Merlivat*, 1996].

[4] The dependence of diurnal warming on wind speed was characterized by *Murray et al.* [2000] for satellite observations at ~1030 h local time in the tropical Pacific. SST observations from polar-orbiting [*Stuart-Menteth et al.*, 2003] and asynchronous [*Gentemann et al.*, 2003] satellites have been used to characterize of diurnal warming at other times of day. In none of these studies have full diurnal



Based on SEVIRI using NLSST, 1 in 100,000 chance of DV > 6.5 K in study domain

But NLSST sensitivity is ~90% => underestimate of deviation of skin



Conclusions

- **SST sensitivity is of practical relevance to observing DV**
- **SST sensitivity can be calculated and correlates with observed DV cycle amplitudes**
- **Either our estimates of SST sensitivity are ~13% too large (which would be puzzling)**
- **Or for large DV, amplitude observed by drifters is ~0.87 x skin DV amplitude (which is plausible)**