Training SST Algorithms for Geostationary Sensors Against L4 Analysis

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1. INTRODUCTION

The new generation geostationary (GEO) sensors, Advanced Baseline/Himawari Imagers (ABI/AHI) onboard GOES-16/17 (G16/17) and Himawari-8/9 (H08/09), are fully capable of monitoring the diurnal cycle in SST [1]. The algorithms adopted in the NOAA Advanced Clear-Sky Processor for Oceans (ACSPO), employ 4-band (8.4, 10.3, 11.2, 12.4μm) regression equations, consistent across day and night [1-2]. However, quantitative estimation of the magnitude of the diurnal cycle (DCM) requires optimization of their sensitivity. This presentation describes the improvements implemented in ACSPO 2.60, and other potential enhancements currently being explored.

2. Training regression algorithms against L4 SST vs. *in situ* SST

- The GEO sensors observe tropical regions under more favorable conditions (near-nadir, with higher spatial resolution) than mid-to-high latitude regions. As a result, the training matchup dataset (MDS) includes mainly *in situ* SSTs with T_S>285 K. Therefore, regression algorithms trained against *in situ* SST (**R-IS SST**) are optimized mainly for tropical regions, have low sensitivity and may be subject to biases in the underrepresented regions.
- To improve the sensitivity to SSTskin, the ACSPO SST algorithms for ABI and AHI are now trained by matching nighttime satellite clear-sky observations with L4 analysis by Canadian Meteorological Center (CMC), available in every ACSPO pixel. Although the distribution of clear-sky pixels is also very non-uniform, the number of clear-sky pixels in the high-to-mid latitudes is much larger than the number of *in situ* matchups. This allows to improve training by giving larger weights to the pixels from underrepresented regions.

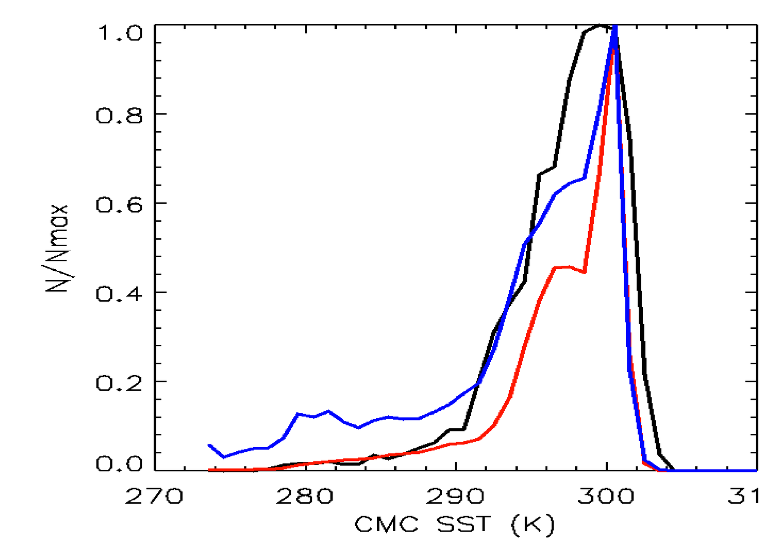

Fig. 1. Normalized histograms of ABI SSTs data matched with ***(1) In situ, (2) CMC (original), (3) CMC (weighted) SSTs.***

3. ACSPO SST algorithms with improved sensitivity to SSTskin

Two SST algorithms were constructed taking the advantages of training against L4 analysis.

- The regression algorithm with coefficients trained against CMC **(R-L4 SST)**, which increases the mean sensitivity to ~0.9 (from ~0.7 for the **R-IS SST**).
- The piecewise regression algorithm for SSTskin (**PWR-L4 SST)**, which optimizes the sensitivity in every SST pixel. The PWR-L4 SST exploits segmentation of the SST domain in terms of the **R-L4 SST** sensitivity, with first guess PWR coefficients calculated separately for every segment under the constraint, setting the mean sensitivity to 1 [2]. During processing, the coefficients in each pixel are further corrected to provide the continuity of the coefficients as functions of the **R-L4 SST** sensitivity, and to bring the **PWR-L4 SST** sensitivity exactly to 1.

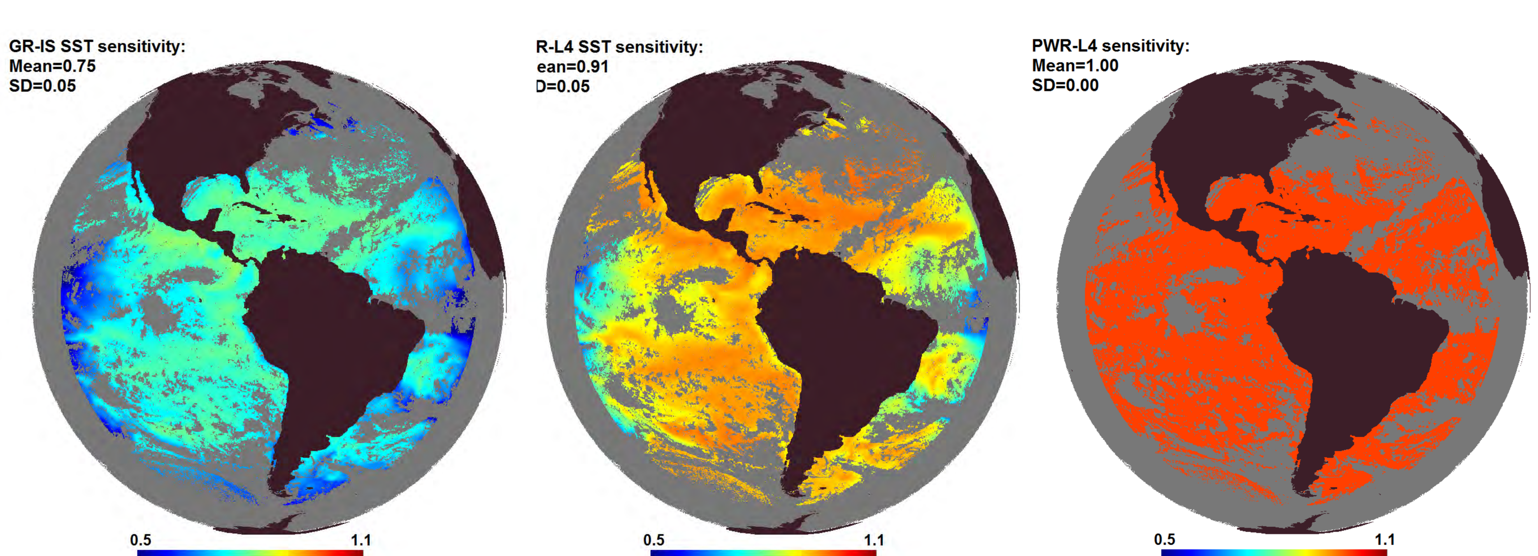

Fig. 2. Sensitivities of (left) ***R-IS SST****, (middle)* ***R-L4 SST*** *and (right)* ***PWR-L4 SSTs*** *from G16 ABI observations on 1 March 2018 at 20:00 UTC.*

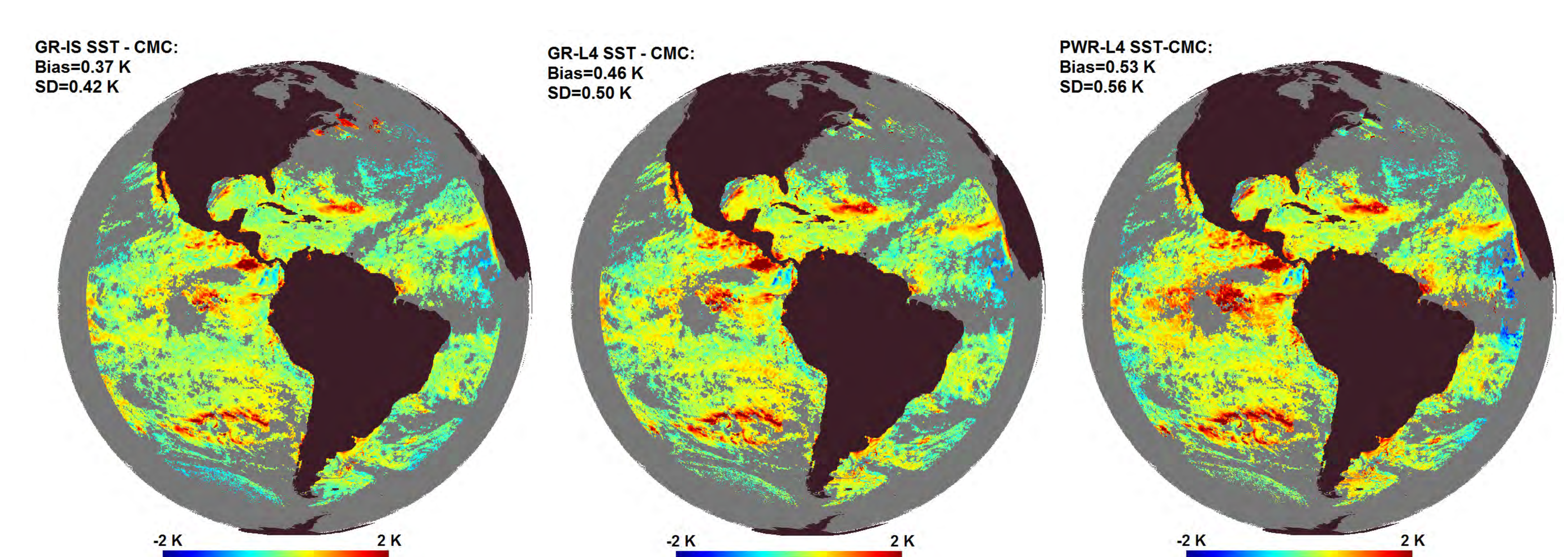

Fig. 3. Deviations from CMC L4 SST of (left) ***R-IS****, (middle)* ***R-L4*** *and (right)* ***PWR-L4 SSTs****, for the same date and time as in Fig. 2.*

- In Fig. 2: (Left) The sensitivity of the **R-IS SST** (trained against *in situ* SST) is ~0.75 on average, and variable in space. (Middle)The mean sensitivity of the **R-L4 SST** (trained against CMC) is 0.91 on average, and also variable. (Right) The sensitivity of **PWR-L4 SST** sensitivity is always 1.

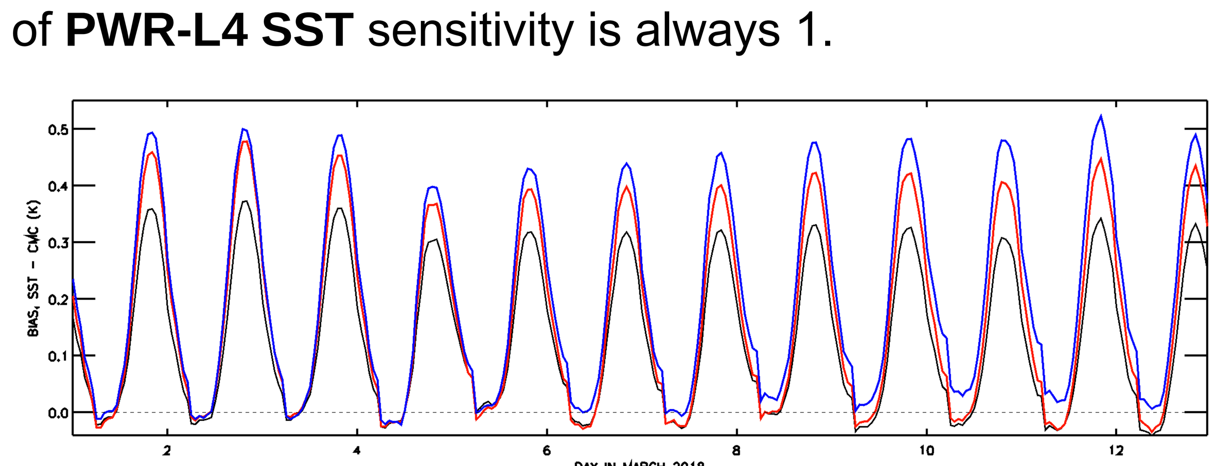

Fig. 4. Time series of bias, SST - CMC, averaged over the GOES-16 ABI domain, from 1 – 12 March 2018, from ***GR-IS SST, GR-L4 SST*** *and* ***PWR-L4 SST.***

- In Fig. 3: The **R-L4 SST** increases the magnitudes of the diurnal warming patterns compared with the **R-IS SST**. Large warm anomalies of **R-IS SST** in the N. Atlantic are the artifact of training against *in situ* SST. The **PWR-L4 SST** further increases the deviations from CMC, especially in the regions with relatively low **R-L4** sensitivity (e.g., warm anomalies in the Equatorial Pacific and cold anomalies, caused by the Saharan dust outbreak in the E. Atlantic).
- In Fig. 4: The transition from training against *in situ* SST to training against L4 SST (i.e., transition from **R-IS SST** to **R-L4 SST**) increases the magnitude of the diurnal cycle and so does the adjustment of the sensitivity in the **PWR-L4 SST**. The mean magnitudes of the diurnal cycle for March 2018, estimated with three algorithms are 0.~33 K for **R-IS SST**, ~0.42 K for **R-L4 SST** and ~0.44 K for **PWR-L4 SST**.

SUMMARY

- The regression SST algorithm trained against L4 analysis (**R-L4 SST**) essentially improves the sensitivity of ABI and AHI SST to SSTskin, compared with similar algorithm trained against *in situ* SST (**R-IS SST**), and makes it comparable with sensitivity for polar-orbiting sensors [3].
- The newly developed Piecewise Regression SST algorithm for SSTskin (**PWR-L4 SST**) provides optimal and uniform sensitivity in every sensor's pixel
- The **R-L4 SST** algorithm is currently used as the primary ACSPO SST algorithm for GOES-16/17 ABI and Himawari-8 AHI.
- The accuracy of DCM estimation depends not only from sensitivity but also from diurnal variability of biases in retrieved SST. Therefore, the further development of SSTskin algorithms in ACSPO will be focused on exploring the effects of the diurnal variability of SST biases.

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