On the use of MCSST and NLSST for the study of spatio-temporal trends in ocean thermal gradients

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1. MOTIVATION
The analysis of thermal dynamics from high-resolution satellite images of sea surface temperature (SST) provides valuable information on the state of the ocean and its future long term changes. While extensive research has been conducted for the statistical validation of satellite-based SST via comparison with in situ measurements, little effort has been dedicated to the validation of ocean thermal gradients.

There are currently many SST products available to users derived from different satellite sensors and with different SST retrieval formulations. When it comes to the study of spatio-temporal trends in SST gradients, one major question arises:

Do SST products generated with different SST formulations lead to similar synoptic and time-averaged representations of ocean dynamics?

2. METHODOLOGY and DATA
In this work we focus on two operational SST formulations namely, the Non Linear SST (NLSST):

\[ \text{NLSST} = a_1 + a_2 BT_{11} + a_3 \text{SST}_{\text{ref}} (BT_{11}-BT_{12}) + a_4 (BT_{11}-BT_{12})(\sec(\theta)-1) \]

and the Multichannel SST (MCSST):

\[ \text{MCSST} = a_1 + a_2 BT_{39} + a_3 (BT_{39}-BT_4) + a_4 (BT_{39}-BT_4)(\sec(\theta)-1) \]

More specifically, we use the 4 µm (MCSST) and 11 µm (NLSST) nighttime Level 2 Aqua MODIS SST (http://oceancolor.gsfc.nasa.gov) acquired over the Brazil-Malvinas confluence region for the period from 2005 to 2010.

3. SYNOPTIC DATA (Level 2, 1 km resolution)
The analysis of level 2 SST imagery from MCSST and NLSST shows how the amount of Gaussian noise in level 1 Brightness Temperatures (BTs) affects the observation of thermal gradients. This can be seen in Fig 1 in both the SST fields and the magnitude of SST gradients.

4. COMPOSITE DATA (Level 3, 0.05° grid)
Level 2 SST products were post-processed with a destriping algorithm and a cloud masking scheme that mitigates the misclassification of sharp thermal fronts as clouds. Synoptic Level 3 maps of SST gradient magnitudes were averaged in time to produce monthly, seasonal, annual and 5 years composite maps. The use of a reference SST in the NLSST introduces a systematic correlation between SST gradient magnitudes and SST values that is not observed in the MCSST dataset.

5. SST VALUES vs SST GRADIENTS
The use of a reference SST in the NLSST introduces a systematic correlation between SST gradient magnitudes and SST values that is not observed in the MCSST dataset. This inevitably results in a spatial and possibly a temporal correlation between SST gradient magnitudes and SST values.

6. CONCLUDING REMARKS
- SST products derived from MCSST and NLSST are consistent statistically but not geometrically.
- Unlike the MCSST, the NLSST uses a reference SST as a multiplier of the noisy term (BT11-BT12).
- Consequently, any existing trend in the SST could be transferred into the trend of SST gradient magnitudes which may lead to erroneous interpretation of the spatial distribution and long term changes of ocean dynamics.
- The introduction of time/latitude dependent coefficients in the SST retrieval equation (collection 6 of MODIS) may further affect the study of spatio-temporal trends in thermal fronts.

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