15 years of SST gradients in the California Current System from the MODIS sensor

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1. MOTIVATION

The California Current System (CCS) displays a significant amount of frontal activity that can be seen all year long in high resolution satellite imagery of Sea Surface Temperature (SST). Oceanic fronts in this region are mostly a result of wind driven coastal upwelling that generates meanders, filaments and other small scale structures.
Fronts provide pivotal information on the physical state of the ocean, its biological composition, its interaction with the atmosphere and have therefore become an important variable for the study of long term changes in ocean dynamics.

2. METHODOLOGY and DATA

The MODIS sensor onboard Terra and Aqua platforms has been continuously providing high resolution SST for more than 15 years. This offers a unique opportunity to study the spatial distribution and temporal variability of SST gradients.
In this work, we used ~15 years (2003-2018) of nighttime Level 2 Short Wave Infrared SST generated with the MCSST algorithm (https://oceancolor.gsfc.nasa.gov/). Native resolution (1km) Level 2 SST were post-processed with an improved cloud masking algorithm to reduce the misclassification of ocean fronts as clouds. Synoptic data were composited into monthly, seasonal and annual maps (0.05˚) of SST gradient magnitudes over the California Current System.
Similarly to the work described in (Kahru et al., 2012, 2018) the temporal variability of frontal activity was conducted seperately for sub-areas depending on the distance from the coast, i.e., coastal (0-100km), offshore (100-300km) and transition (>300km) regions.

3. SPATIAL DISTRIBUTION

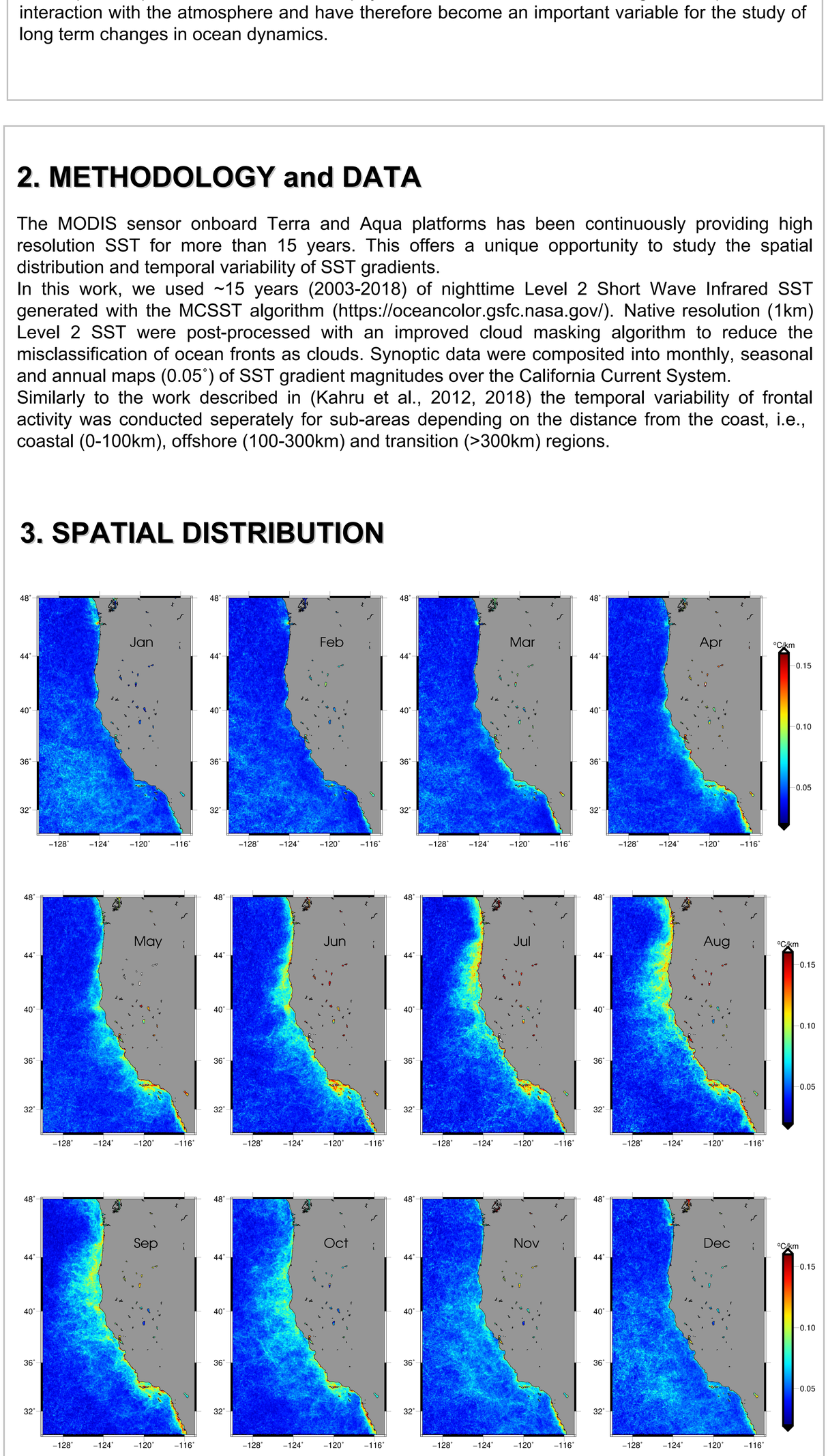

Fig. 1. Monthly climatologies of SST gradient magnitudes over the California Current System using Terra and Aqua MODIS data acquired from 2003 to 2018.

4. TEMPORAL VARIABILITY

Annual cycle

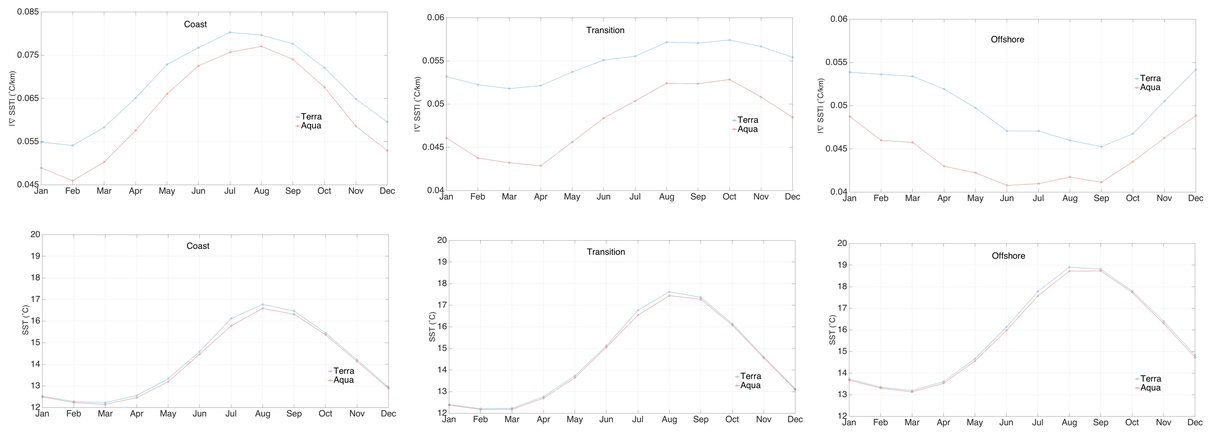

Fig. 2. Annual cycle of SST gradient magnitudes and SST in the California Current System

Long term trends

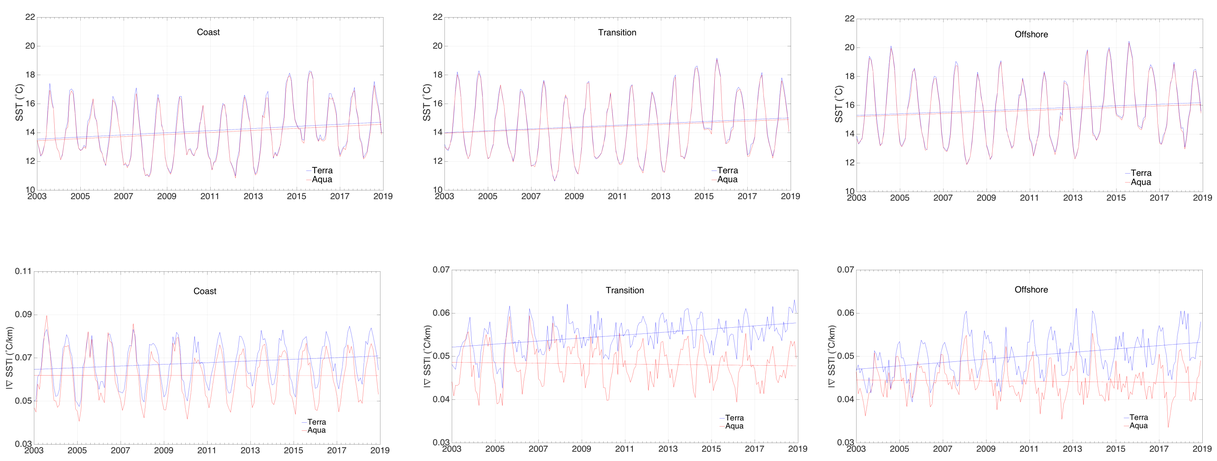

Fig. 3. 15 years time series of SST gradient magnitudes and SST from Terra and Aqua MODIS

	Coast		Transition		Offshore	
	SST	|∇SST|	SST	|∇SST|	SST	|∇SST|
Terra MODIS	+0.54%/year	+0.60%/year	+0.45%/year	+0.67%/year	+0.36%/year	+0.83%/year
Aqua MODIS	+0.53%/year	0.00%/year	+0.43%/year	-0.10%/year	+0.34%/year	-0.08%/year

Table 1. Long term trends of SST gradient magnitudes and SST in coastal, transition and offshore regions from Terra and Aqua MODIS.

5. CONCLUDING REMARKS

* The annual cycle of frontal activity in coastal, transition and offshore regions differs significantly. Off the coast, SST gradient magnitudes follow a similar cycle to that observed in SST with intense upwelling during summer time. We also note that the intra-annual variability of frontal activity is significantly higher off the coast.

* Analysis of the 15 years time series from Aqua MODIS does not indicate a significant trend in the magnitude of SST gradients

* The magnitude of SST gradients from Terra MODIS displays a significant positive trends that is not observed in Aqua MODIS. This is due to the continuous degradation of Terra MODIS individual detectors that have lead to an increase of stripe noise in the spectral channels used in SST algorithms.

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