Mitigation of striping in ACSPO clear-sky radiances and SST products

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Note

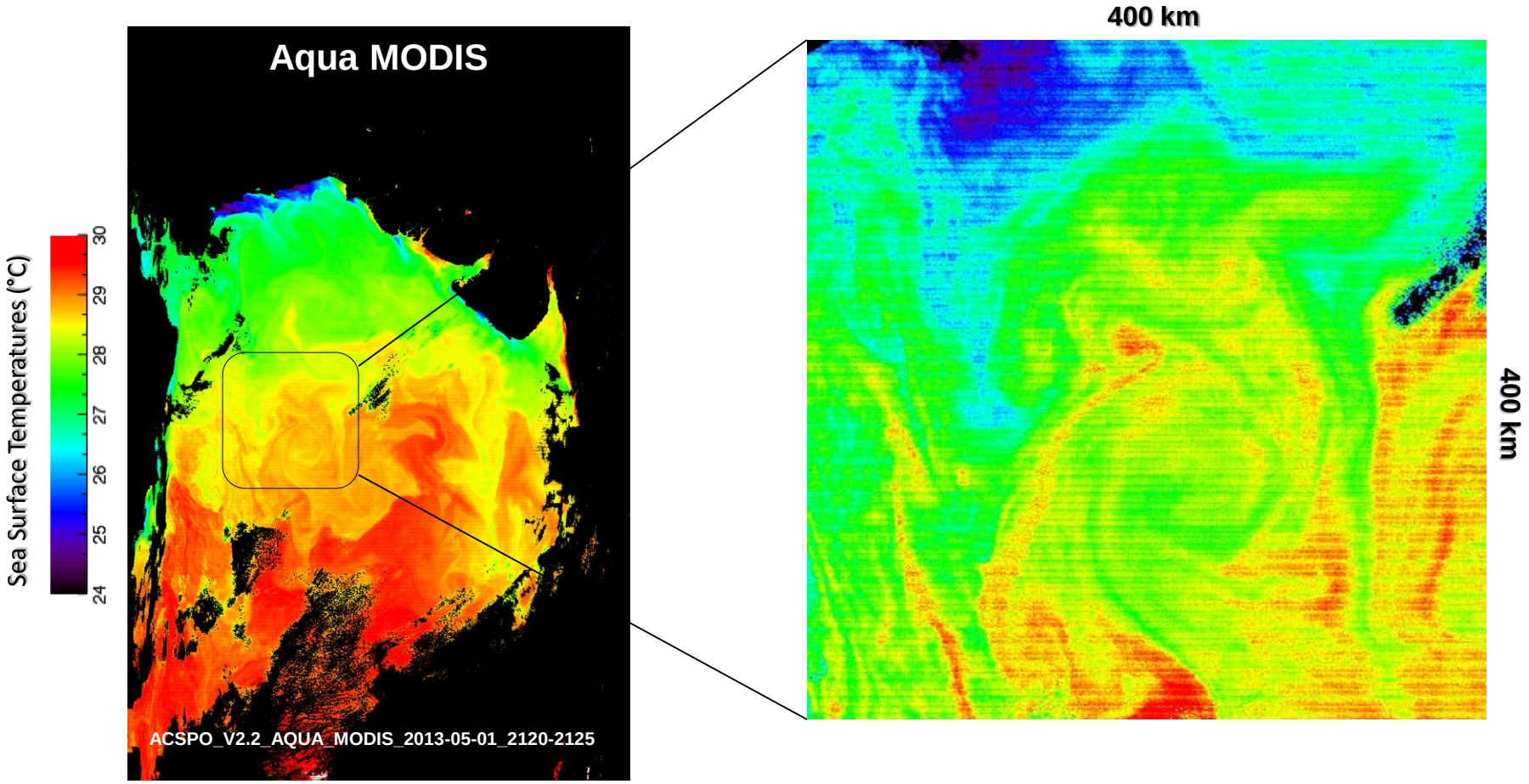
All results shown in this presentation are for **Aqua MODIS**

Similar experiments for **S-NPP VIIRS** and are reported in:

http://www.star.nesdis.noaa.gov/sod/sst/xliang/lannion_agenda/presentations/opesystems

Context

Full sensor resolution SST imagery from MODIS (1 km) and VIIRS (0.75 km) displays clear striping artifacts

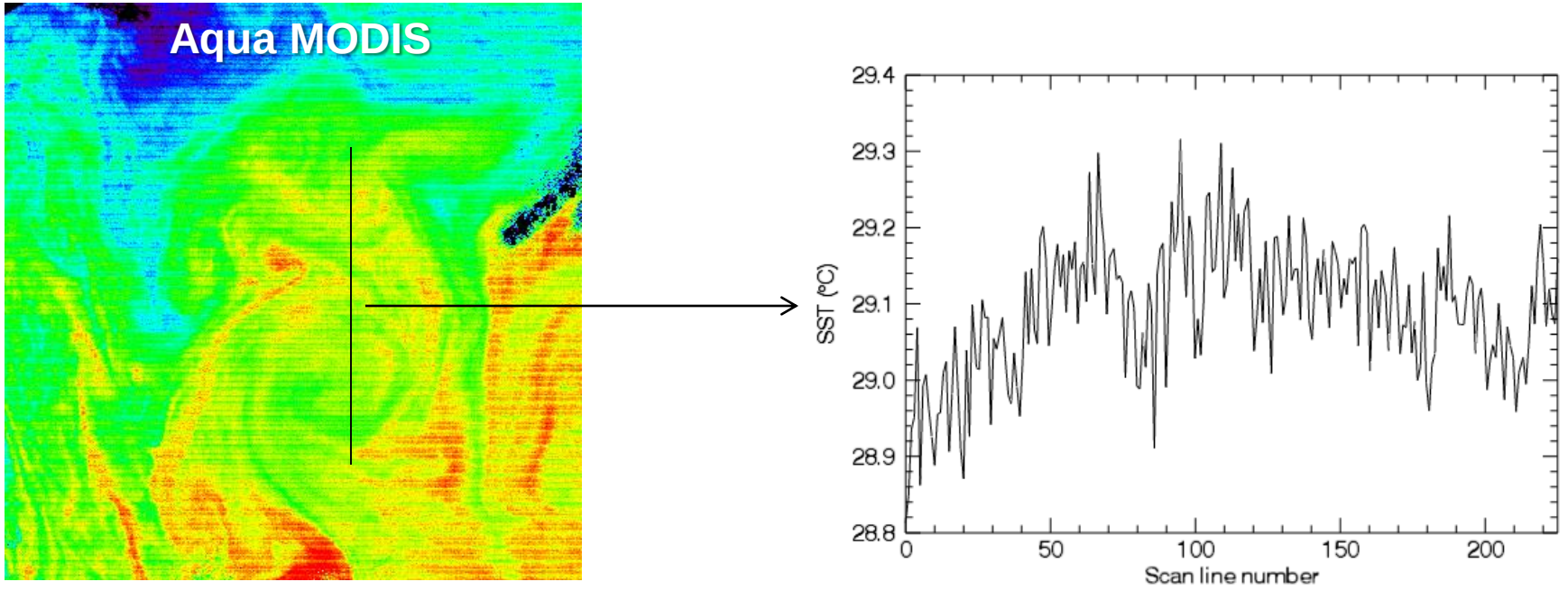


Motivation (1)

Stripe noise in level 1 TOA radiances propagates into level 2 SST and affects downstream applications

- The accuracy of SST retrieval at pixel level is reduced
- The analysis of ocean submesoscale dynamics is highly affected by stripe noise
- Pattern recognition based cloud masking - see presentation by Irina Gladkova presentation

Pixel level accuracy



Scan line noise in L1 TOA radiances can lead to pixel errors of up to ± 0.3K in SST products

Motivation (2)

Stripe noise in level 1 TOA radiances propagates into level 2 SST and affects downstream applications

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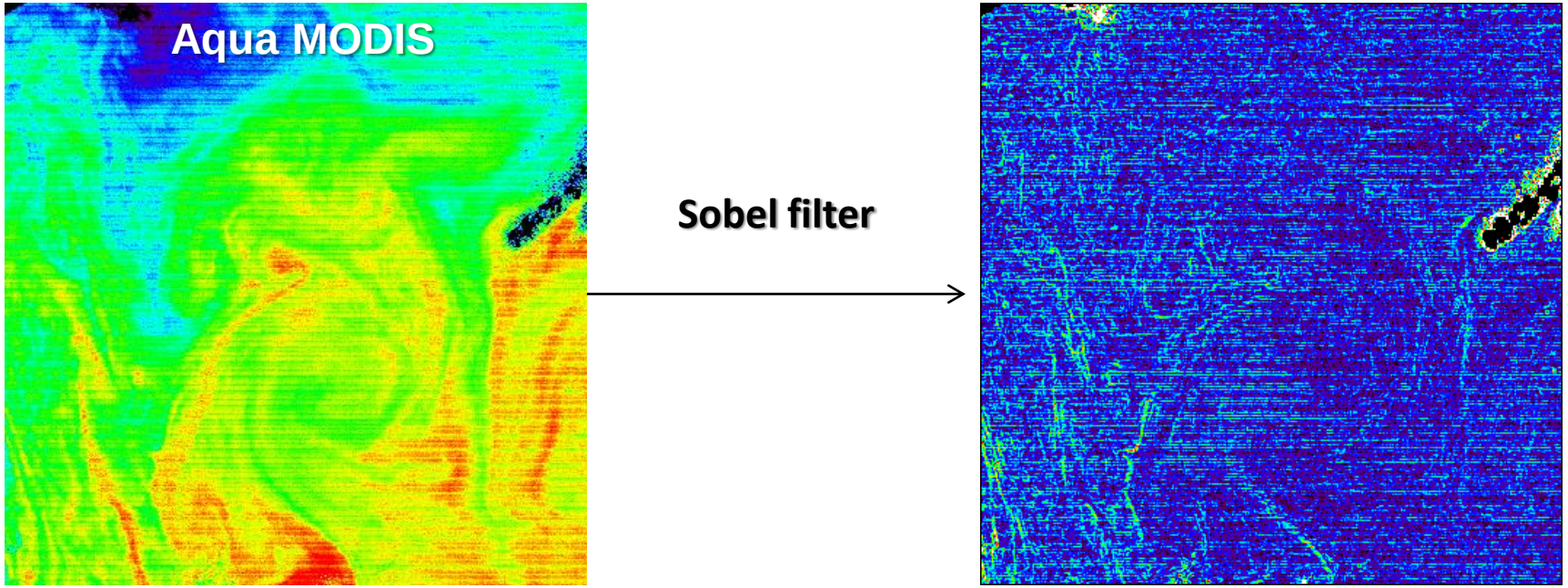
SST Fronts



The identification of SST fronts (i.e., orientation, intensity and location) is highly affected by stripe noise

Motivation (3)

Stripe noise in level 1 TOA radiances propagates into level 2 SST and affects downstream applications

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Objective

Design a destriping algorithm to improve the quality of SST imagery from Terra/Aqua MODIS and S-NPP VIIRS

The algorithm should satisfy the following requirements:

- Fully automatic
- Near real-time capable
  - 288×3 images of 2030×1354 pixels (5-min granules) for 1 day of MODIS (×2 for Terra and Aqua)
  - 144×3 images of 5400×3200 pixels (10-min granules) for 1 day of VIIRS
- Reduces stripe noise in L1B data with minimal distortion/processing artifacts

Methodology

Scene-based denoising algorithm that uses:

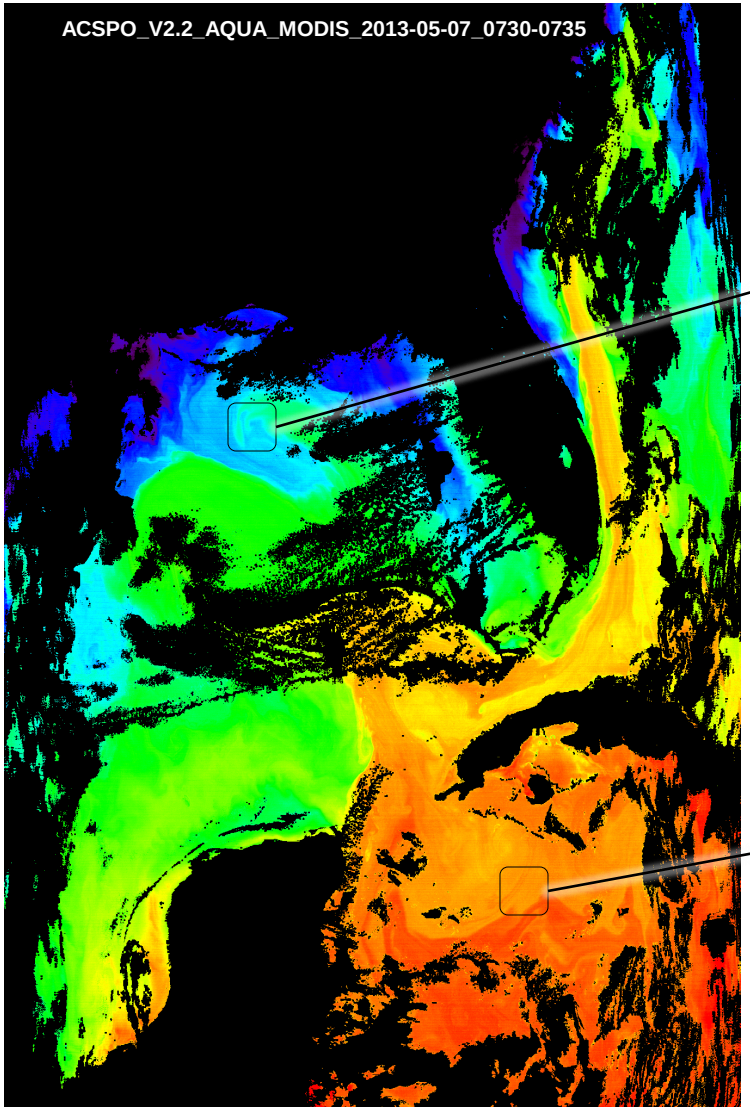
- Directional Hierarchical Decomposition (DHD) with a unidirectional quadratic variational model
- Nonlocal filtering

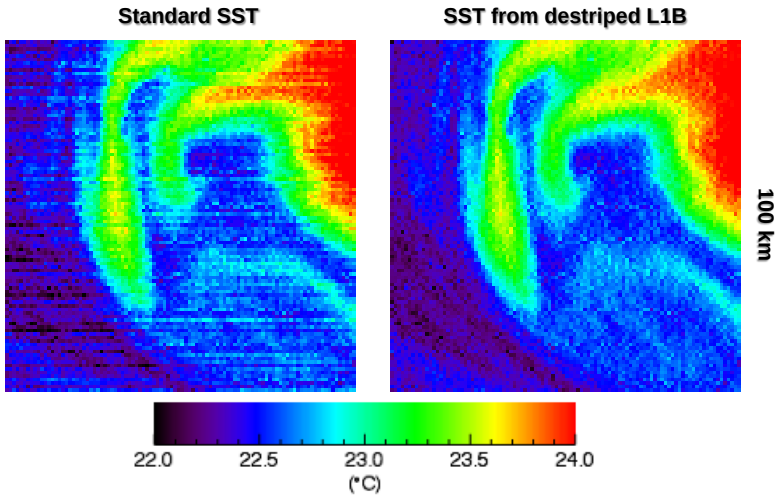
"Adaptive Reduction of Striping for Improved SST Imagery from S-NPP VIIRS", JTech, 2013 (in review)

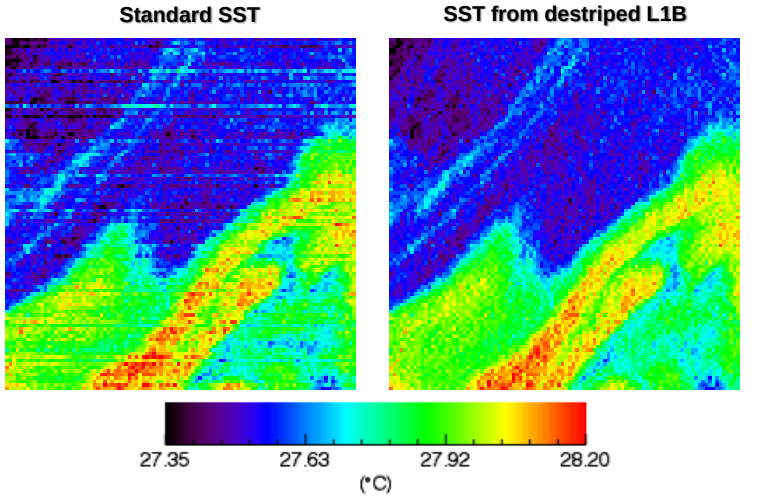
Experimental results

- Initially tested on 3 days of S-NPP VIIRS (January 20-22, 2013)
- More recently tested on 2 weeks of Aqua MODIS (April 25-May 10, 2013)
- Destriping algorithm applied to SST bands @ 3.7, 11 and 12µm, i.e., MODIS B20, B31, B32
- Destriped BTs used as input in ACSPO prior to cloud masking and SST production
- Cloud mask and SST image quality compared with/without destriping

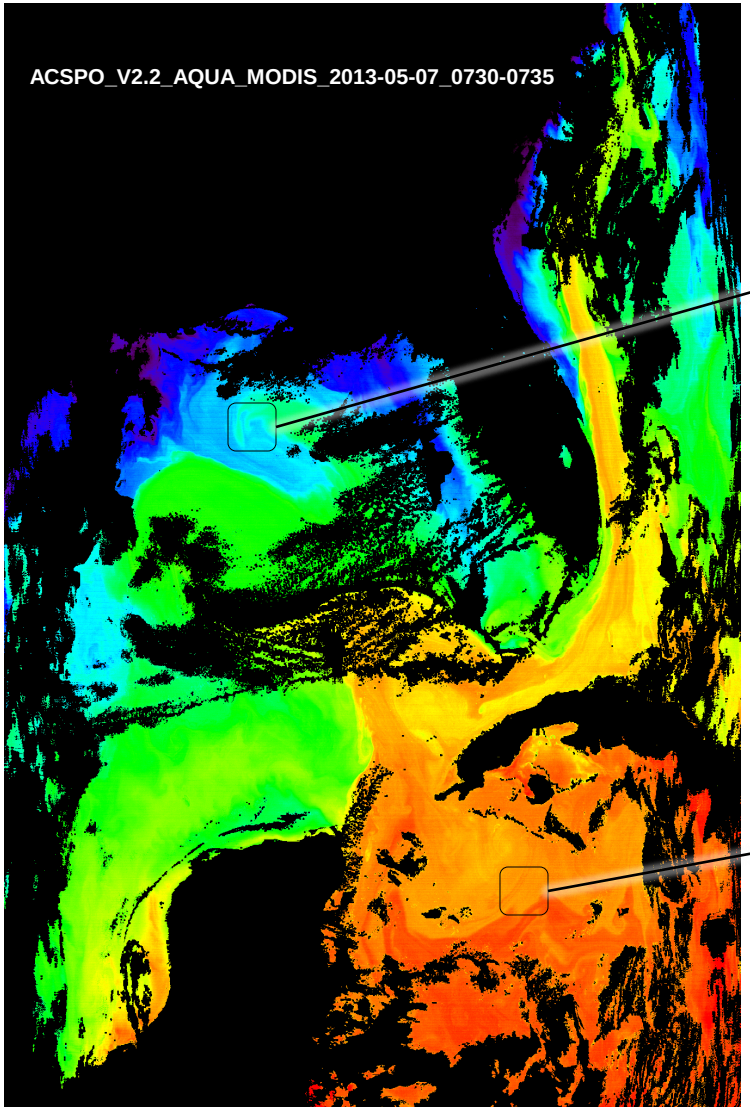
Results: Image quality

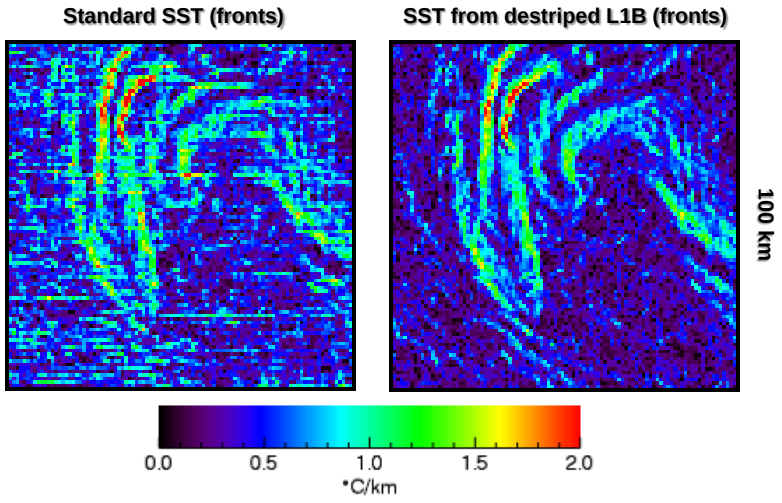


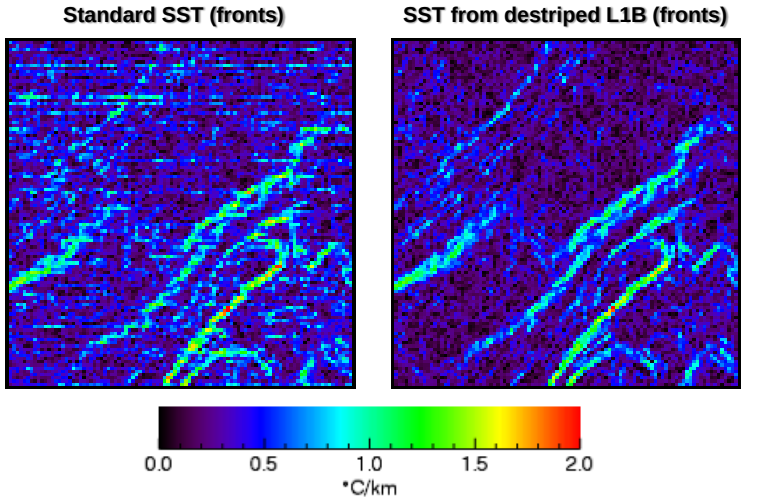




Results: Frontal analysis







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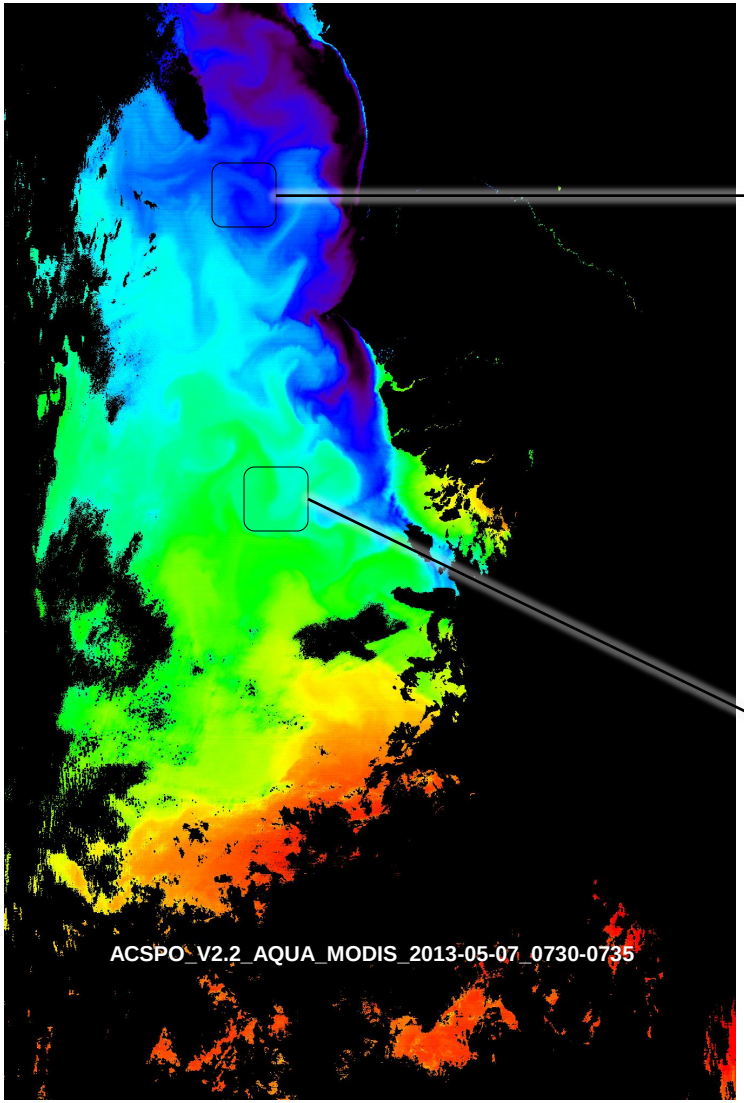

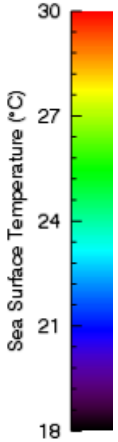

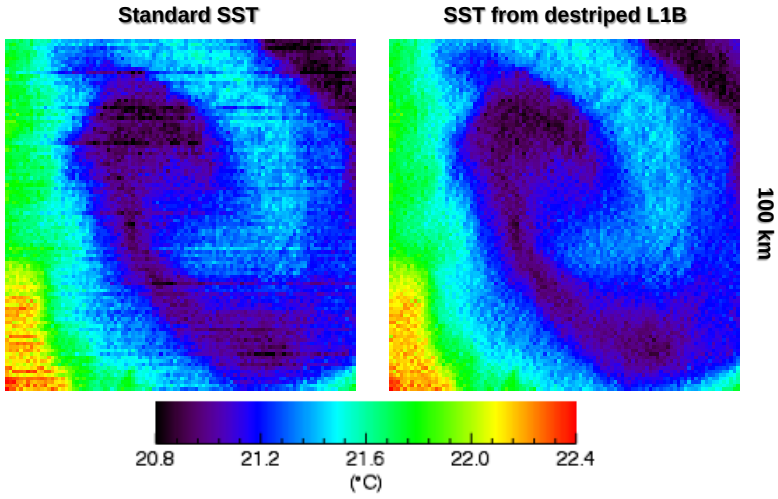

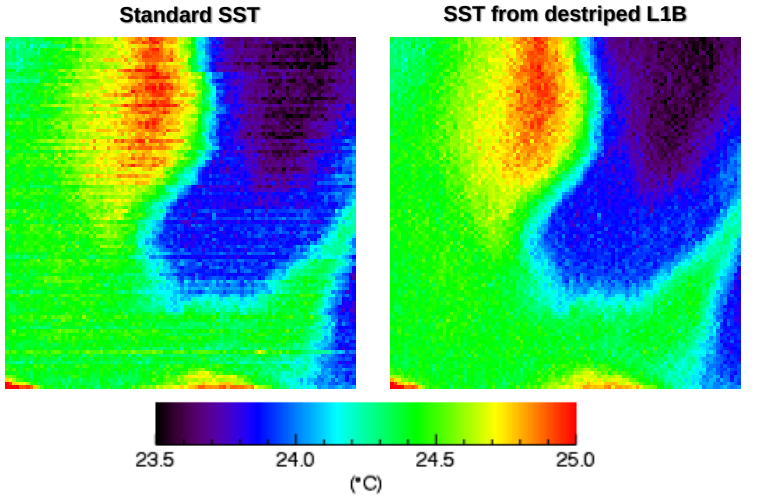

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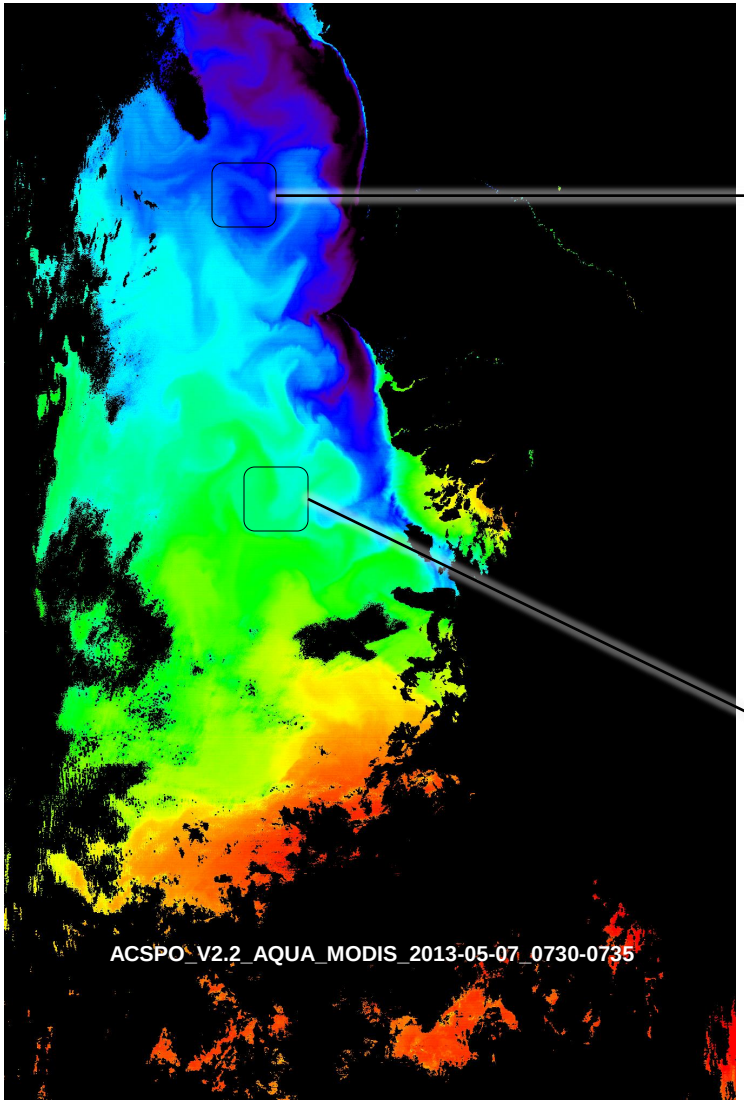
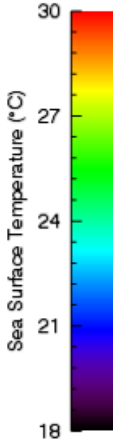
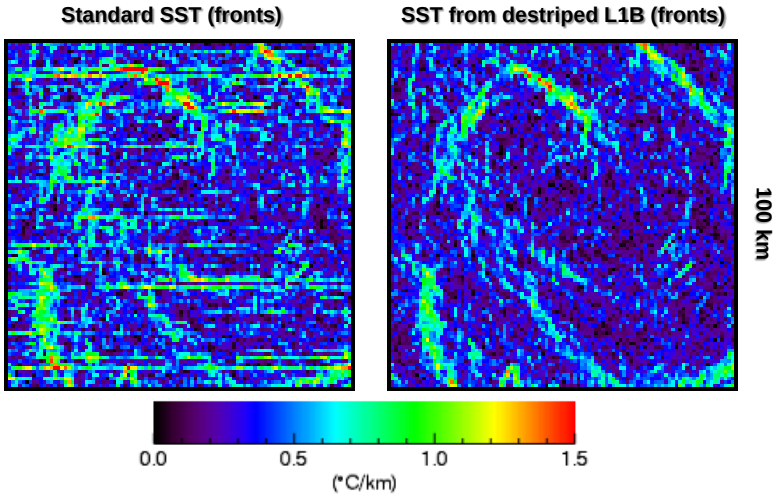
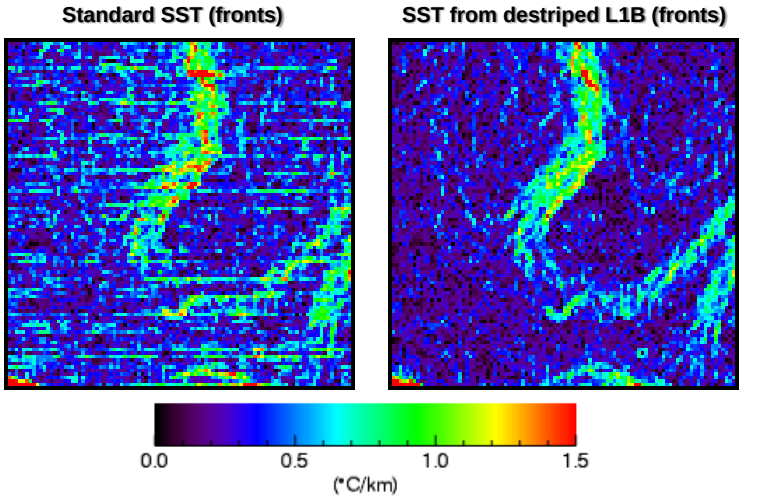


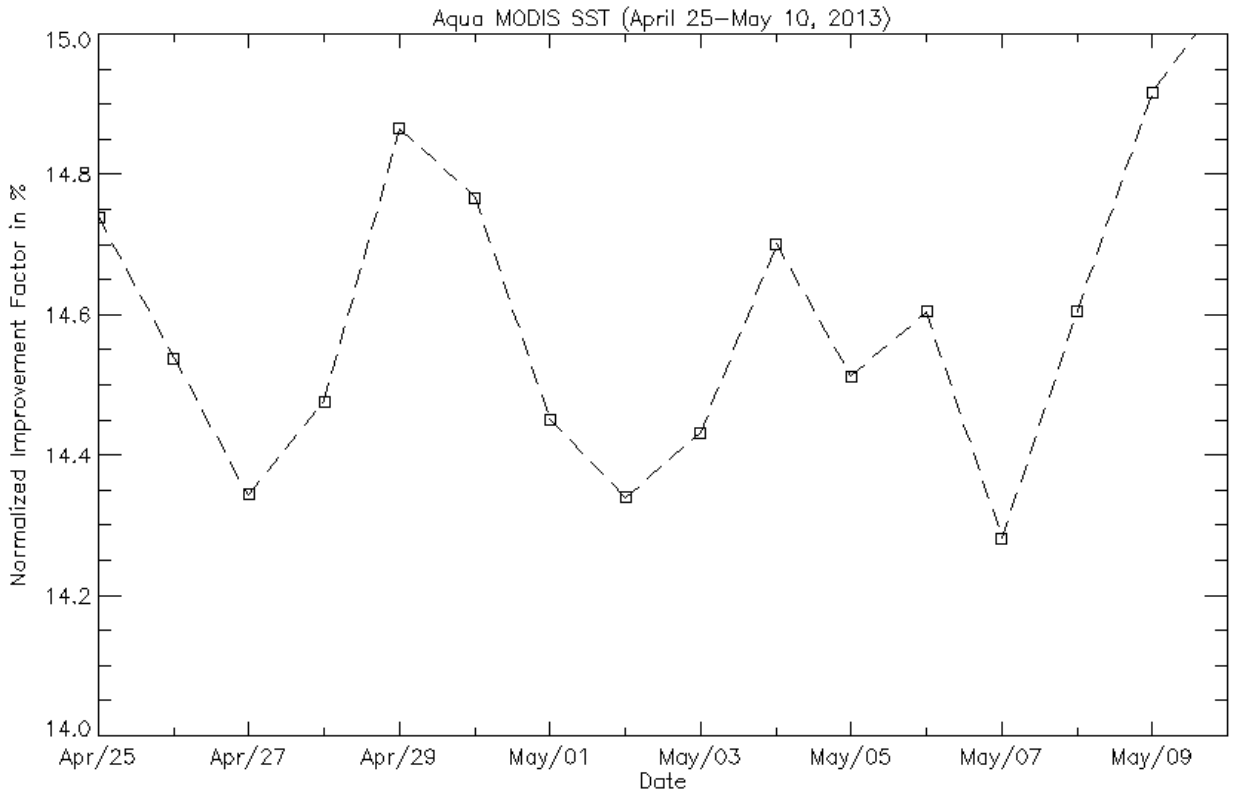






Algorithm performance

Image quality of SST is measured with the Normalized Improvement Factor (NIF)



The NIF index indicates stable destriping performance with values ranging between 14.3% and 15% over a period of 2 weeks

Conclusion

- Stripe noise is clearly visible in MODIS and VIIRS level 2 SST and cloud mask
- It introduces relative errors of up to 0.3 K at pixel level
- Striping poses a serious challenge for the study of SST fronts
- On-orbit calibration/characterization can reduce striping but cannot remove it fully, due to numerous factors contributing to stripe noise
- Scene-based post-processing to reduce stripe noise is the only practical approach for improved SST imagery

Current status/future work

Currently

Rotational buffer of destriped VIIRS SST SDRs (M12, M15, M16)

Rotational buffer of ACSPO VIIRS SST with destriped BTs

Future work

Estimate impact of stripe noise on SST coefficients and SST global statistics for Terra/Aqua MODIS and VIIRS

Estimate the impact of stripe noise on time averaged SST fronts


Questions?