Aerosol and Cloud Products From SLSTR and AATSR with ORAC

A.C. Povey[1,2,*], G.E. Thomas[2,3], S.R. Proud[1], C.A. Poulsen[4], R.G. Grainger[1,2]
[1]University of Oxford, UK; [2]NCEO, UK; [3]RAL Space, UK; [4]Monash University, Australia; *adam.povey@physics.ox.ac.uk

Introduction

The Optimal Retrieval of Aerosol and Cloud (ORAC) [1, 2] is a generalised optimal estimation scheme [3] to retrieve aerosol, cloud, and surface properties from passive visible and/or infrared satellite imagery. The code currently supports AVHRR, ATSR-2, AATSR, SLSTR, MODIS, VIIRS, SEVIRI, ABI, and AHI for:

- aerosol optical thickness (AOT) and effective radius with surface reflectance (all at 550 nm);
- aerosol optical thickness, effective radius, and layer height with sea surface temperature;
- cloud optical thickness (COT), effective radius, and top pressure with surface temperature; or
- volcanic ash optical thickness, effective radius, and plume top pressure.

This poster introduces ongoing work within the Copernicus Climate Change Service to generate climate records of aerosol and cloud. Further details on the datasets can be found in [4, 5]. The data can be downloaded from `ftp://ftp.icare.univ-lille1.fr/SPACEBORNE/CCI-Aerosols` with username and password `cci`.

Publicly accessible code

ORAC is open-source software developed by an international community of researchers. The Fortran 90 source code can be obtained from `https://github.com/ORAC-CC/orac` with a Python interface managing processing. A conda environment is now available to facilitate installing the various dependencies, by request to Dr. Povey. ORAC's modular structure usually simplifies intgration into other codes, and introducing new radiometers is straightforward. Planned developments in the near future include introducing thermal channels into the aerosol retrieval to provide layer height for thick plumes and to update the various instrument calibrations.

Improving cloud masking

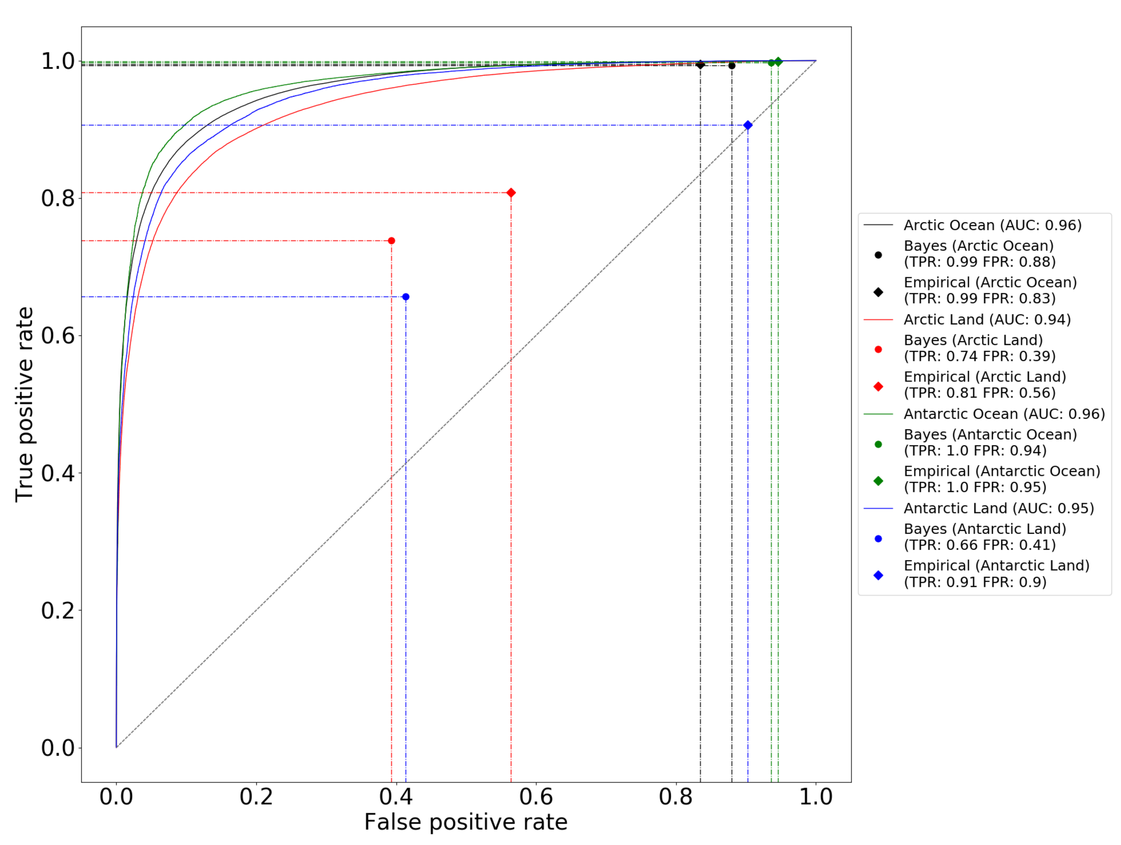

Figure 1: A cloud masking neural network can be tuned to balance the true and false positive rates (lines), achieving better performance than our existing methods (dots) in a variety of environments (colours).

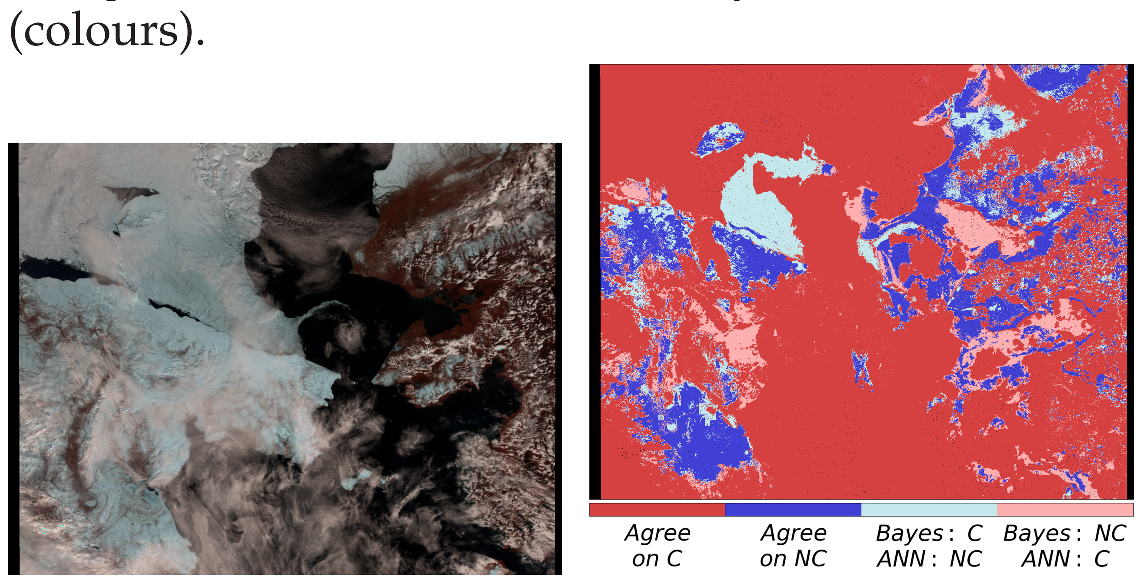

Figure 2: Comparing the new neural net cloud mask to a Baysian classification (right), over a complicated scene (shown in false-colour below left) shows **the new mask is better at identifying bright surfaces as not cloud** (NC), though more work is needed.

Comparison of aerosol satellite datasets

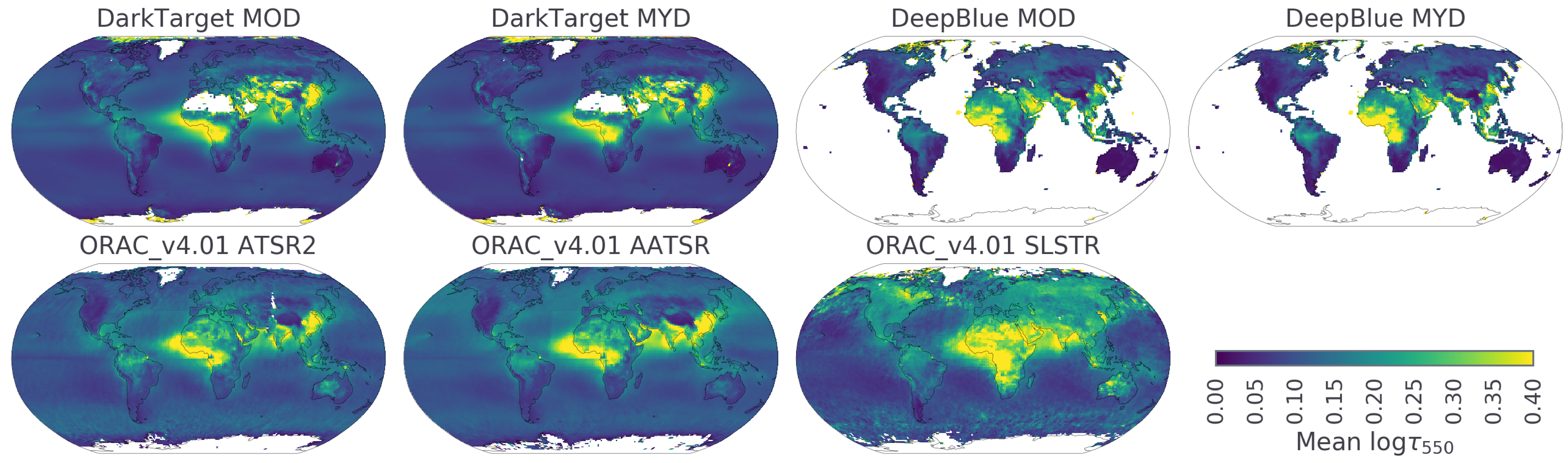

Figure 3 (above): All-time averages of log AOT at 550 nm for the ORAC, Dark Target and Deep Blue algorithms with various sensors. Though work remains to reduce noise in the ORAC SLSTR aerosol product, especially near the poles, it exhibits a number of useful properties: lower AOT over remote ocean which is **more consistent with the MODIS products**, reduced sensitivity to mountains, and higher AOT over the Arabian peninsula.

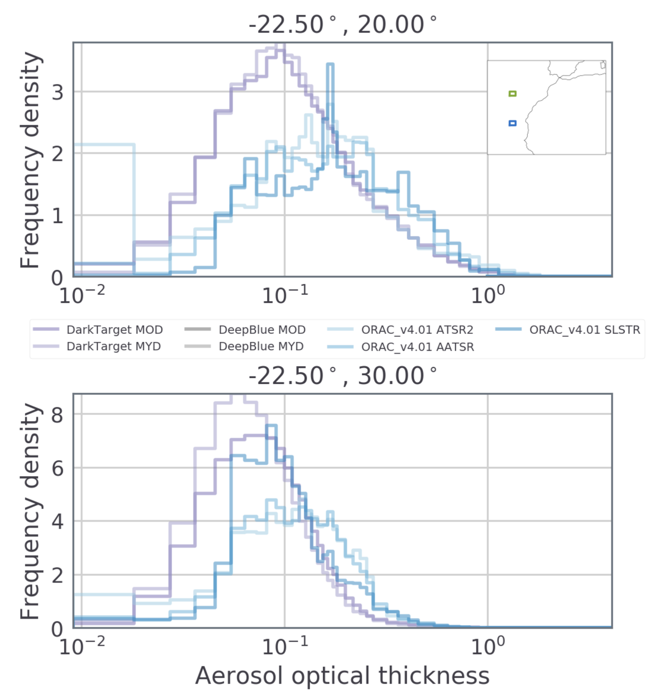

Figure 4 (right): Distribution of AOT observed by each instrument above for two grid cells: one slightly north of the Saharan outflow (bottom) and one within it (top). Within the dusty region, **the SLSTR product more closely resembles MODIS**. This is in part due to the years each sensor observed, but note that the shift is primary for AOT < 0.15, indicating better quality control.

Comparison of cloud satellite datasets

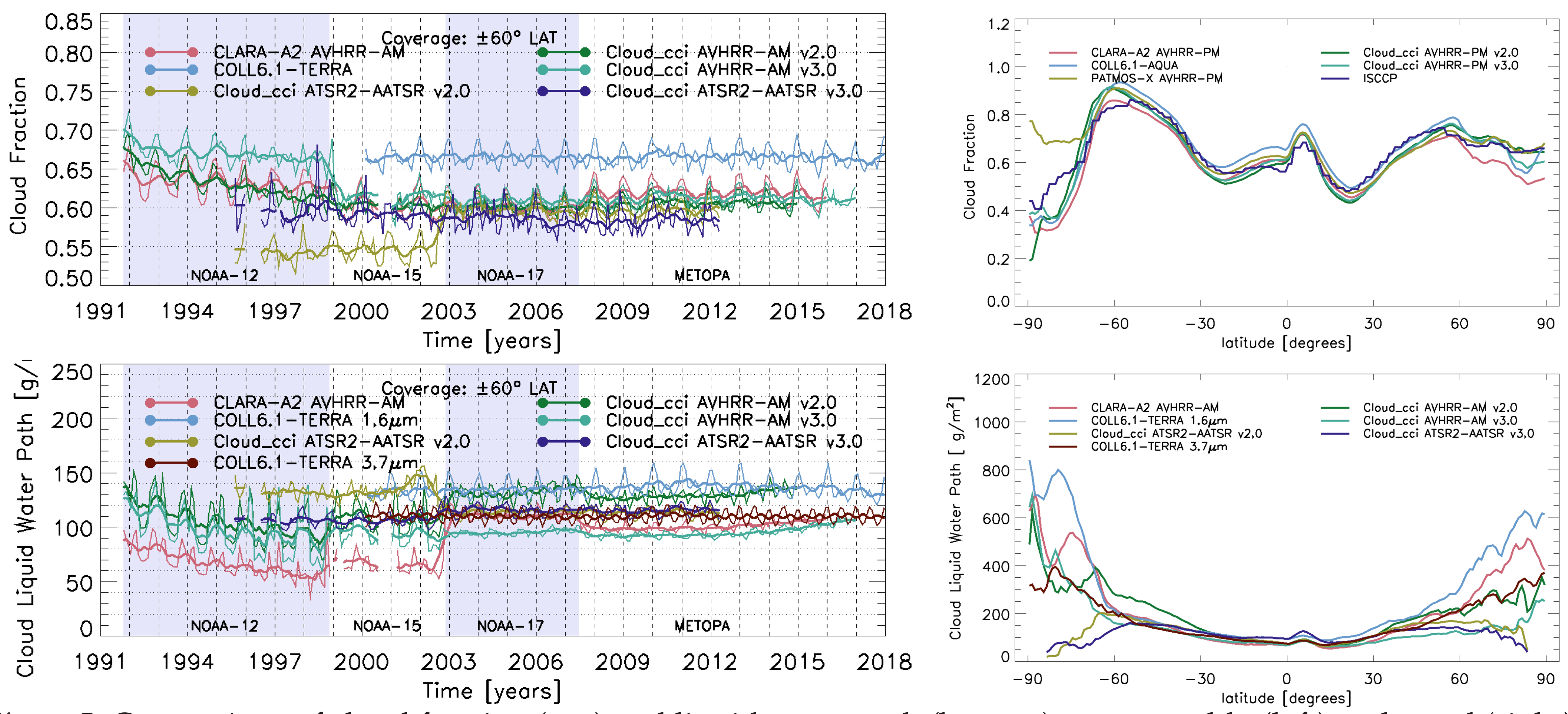

Figure 5: Comparison of cloud fraction (top) and liquid water path (bottom) over monthly (left) and zonal (right) averages for CLARA-A2 (pink), MODIS Collection 6.1 (brown/grey), old ORAC products (yellow/green), and new ORAC products (blues). We have substantially **improved constitency between different instruments** [6] and mostly avoid anomalous behaviour over the poles.

Changed distribution of uncertainty

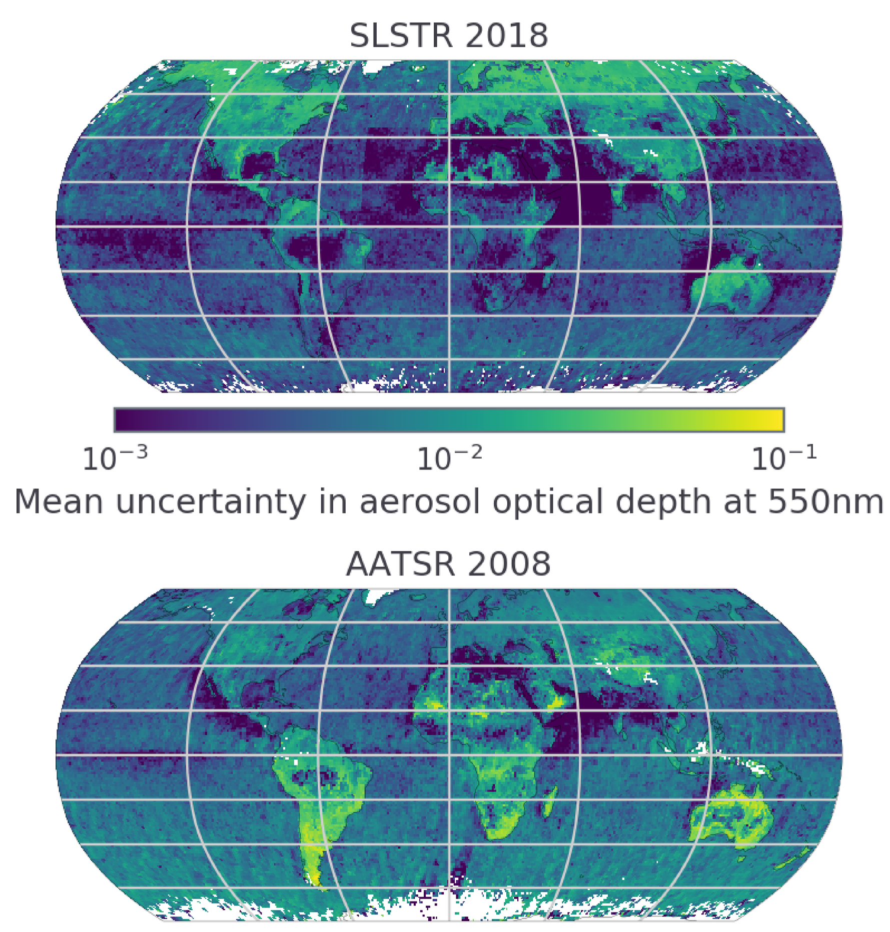

Figure 6: The mean uncertainty in aerosol optical depth from SLSTR during 2018 (top) and AATSR during 2008 (bottom). **Uncertainties over the Southern hemisphere have decreased while those over Northern Hempisphere land have increased** because of the switch from a forward to a reverse view between instruments changing the scattering angle observed.

Improving deep convective clouds

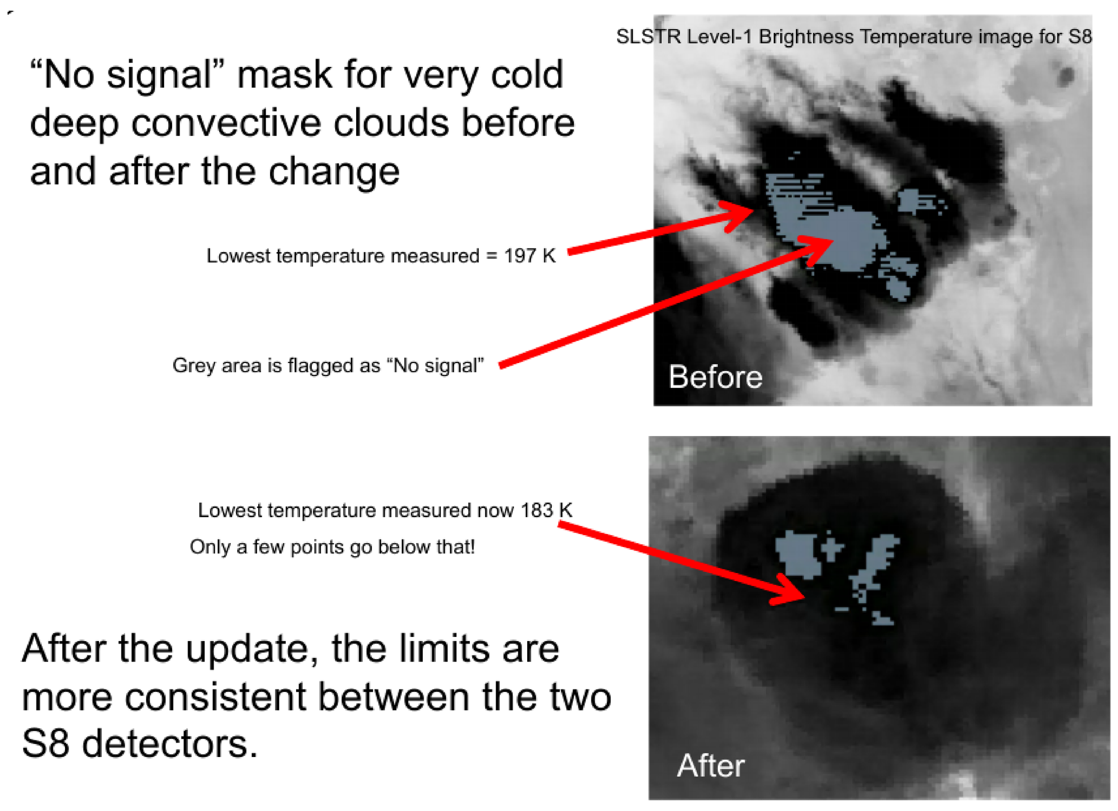

Figure 7: Working with the SLSTR calibration team, the **dynamic range of the thermal channels was adjusted to resolve the cold tops** of deep convective clouds on both Sentinel-3 A and B.

Final thought

ORAC's products are waiting for you to use. Please tell us what you find!

References

[1] G.E. Thomas et. al. (2009), doi:10.5194/amt-2-679-2009.
[2] G.R. McGarragh et. al. (2018), doi:10.5194/amt-11-3397-2018.
[3] C. Rodgers (2000), Inverse Methods for Atmospheric Sounding: Theory and Practice, World Scientific.
[4] T. Popp et. al. (2016), doi:10.3390/rs8050421.
[5] M. Stengel et. al. (2017), doi:0.5194/essd-2017-48.
[6] L. Klüser and S. Stapelberg (2013), `www.esa-aerosol-cci.org/?q=webfm_send/507`.