Parallel retrieval of aerosol and cloud properties

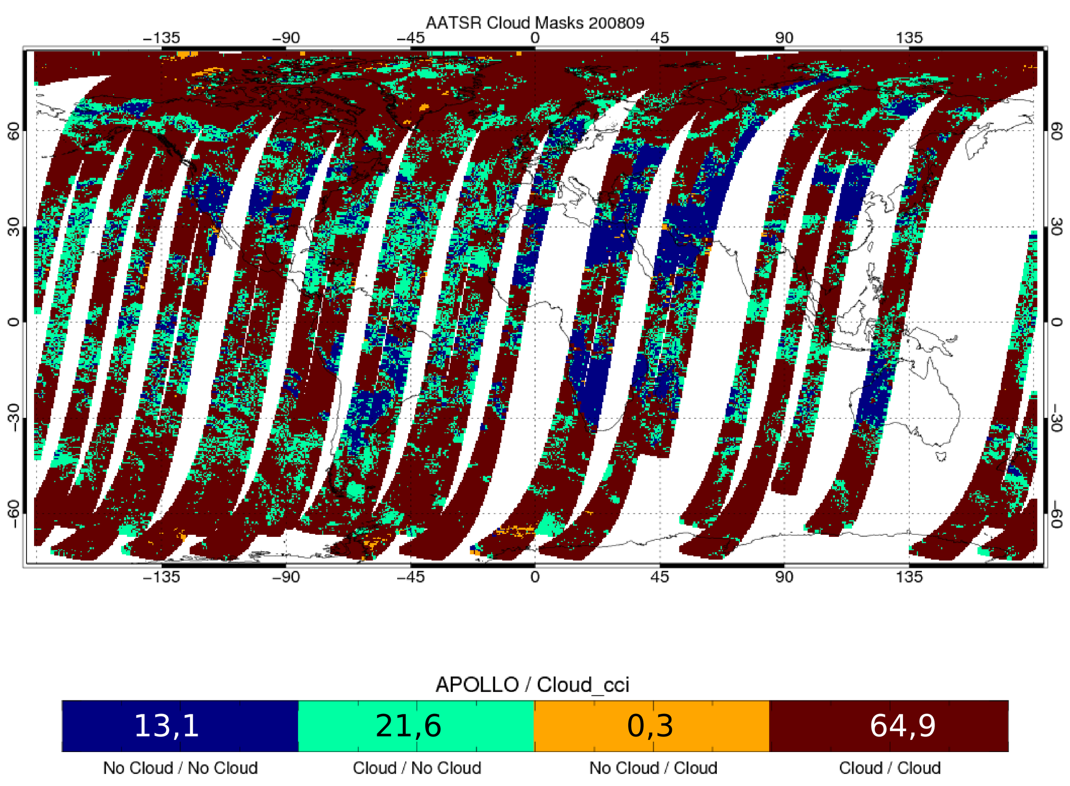
Development of the Optimal Retrieval of Aerosol and Cloud

A. Povey[1,2], G. McGarragh[1], C. Poulsen[2,3], G. Thomas[2], M. Christensen[1,3], R. Grainger[1,2]

[1]University of Oxford; [2]National Centre for Earth Observation, UK; [3]RAL Space, Harwell

Introduction

From the top of the atmosphere, a thin cloud resembles a thick aerosol plume, such that it is not usually possible to retrieve aerosol and cloud properties simultaneously from passive, nadir observations. In fact, cloud and aerosols are a significant source of error in the retrieval of the other. Current practice is to apply stringent filtering to confine analysis to observations that should be well-modelled, but this limits the spatial coverage of the data.



Above is a comparison of the cloud masks from the ESA CCI Cloud and Aerosol projects over five days in September 2008 [1]. Dark blue and brown indicate the masks agree in the classification. Note that 20 % of the globe is rejected by both masks (light blue), representing a significant limitation of the spatial coverage for a global product.

Optimal retrieval of aerosol and cloud

ORAC [2, 3] is a generalised optimal estimation scheme [4] to retrieve cloud, aerosol, and surface properties from satellite-based visible and/or infrared measurements. Various implementations exist to process observations from (A)ATSR, AVHRR, MODIS, SEVIRI, and other sensors to retrieve:

- aerosol optical thickness (AOT) and effective radius with surface reflectance (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.

By integrating these modules, ORAC products can bypass the need for cloud or aerosol masking. Instead, observations are processed using each model and the probability that it conforms to a given type is determined from the fit of the model to the observations.

This poster outlines ongoing work to integrate these modules into one computer code and homogenise the pre-processing of satellite data, the modelling of surface reflectance, and numerous efficiencies made over the past decade of development. Applications of ORAC data will be presented in the second Aerosols and Clouds session on Wednesday afternoon.

Community code

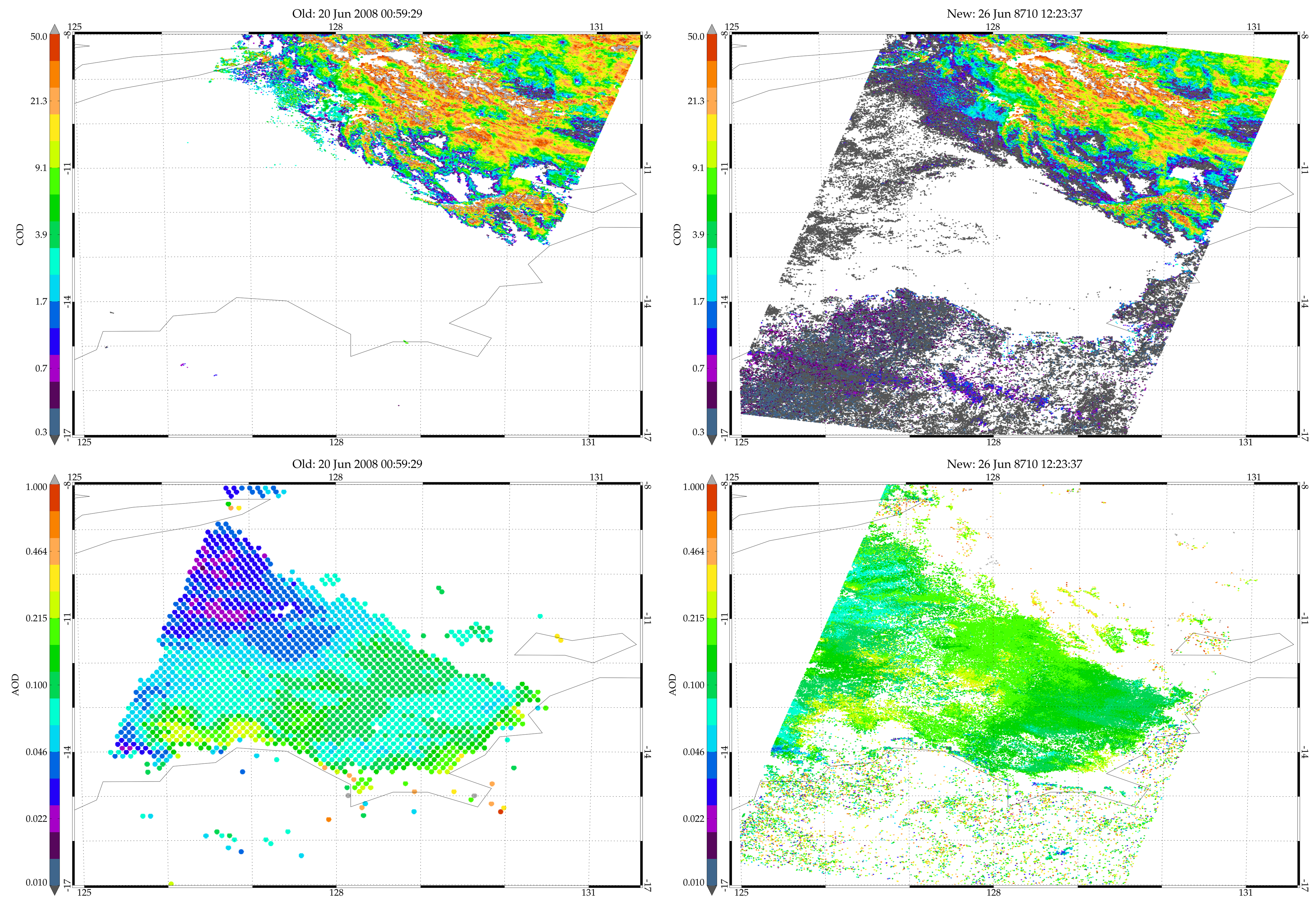
ORAC is open-source software developed by a worldwide community of researchers within a version control system managed by the British Atmospheric Data Group (BADC). The Fortran 90 source code can be obtained from `http://proj.badc.rl.ac.uk/orac`. Introducing additional radiometers, if desired, is generally straightforward.

First demonstration of new code version

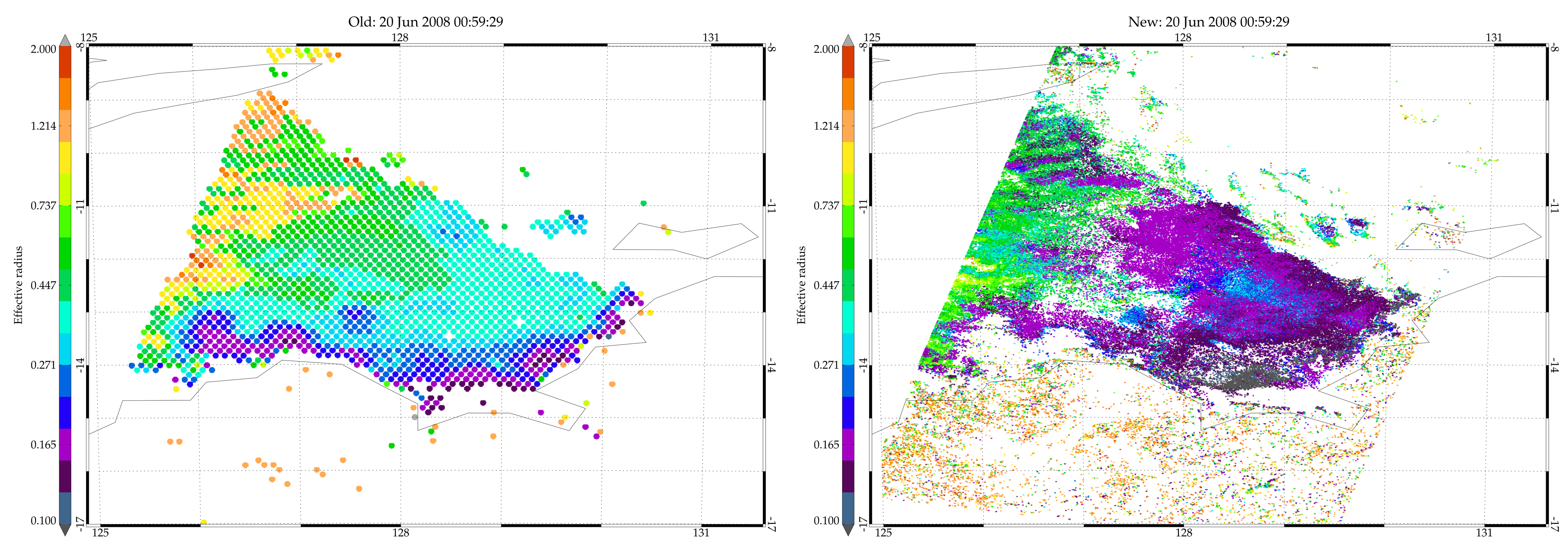
An (extremely preliminary) example of the ORAC retrieval is shown below for a section of an AATSR orbit over northern Australia, near Darwin, on June 20th 2008. The left plots are cloud and aerosol properties (top and bottom, respectively) from the previous algorithm version (where aerosol and cloud were retrieved with different codes at 10 and 1 km resolutions, respectively). Right plots are for the new version, where both products are retrieved at 1 km resolution with the same code. (The aerosol retrieval uses channels 1–4 and 8–11 while the cloud retrieval uses channels 2–7.) Only converged retrievals with uncertainty less than 100% and cost less than 10 are shown, though data is available for every single satellite pixel and particle type evaluated.

The previous retrieval identifies type based on the quality of the retrieval and a number of qualitative flags (e.g. cloud flagging). The new retrieval considers only the quality of the retrieval. The new retrieval provides superior coverage, but could clearly benefit from taking account of the qualitative flags. This will be done through a Bayesian type-identification algorithm that is currently under development.

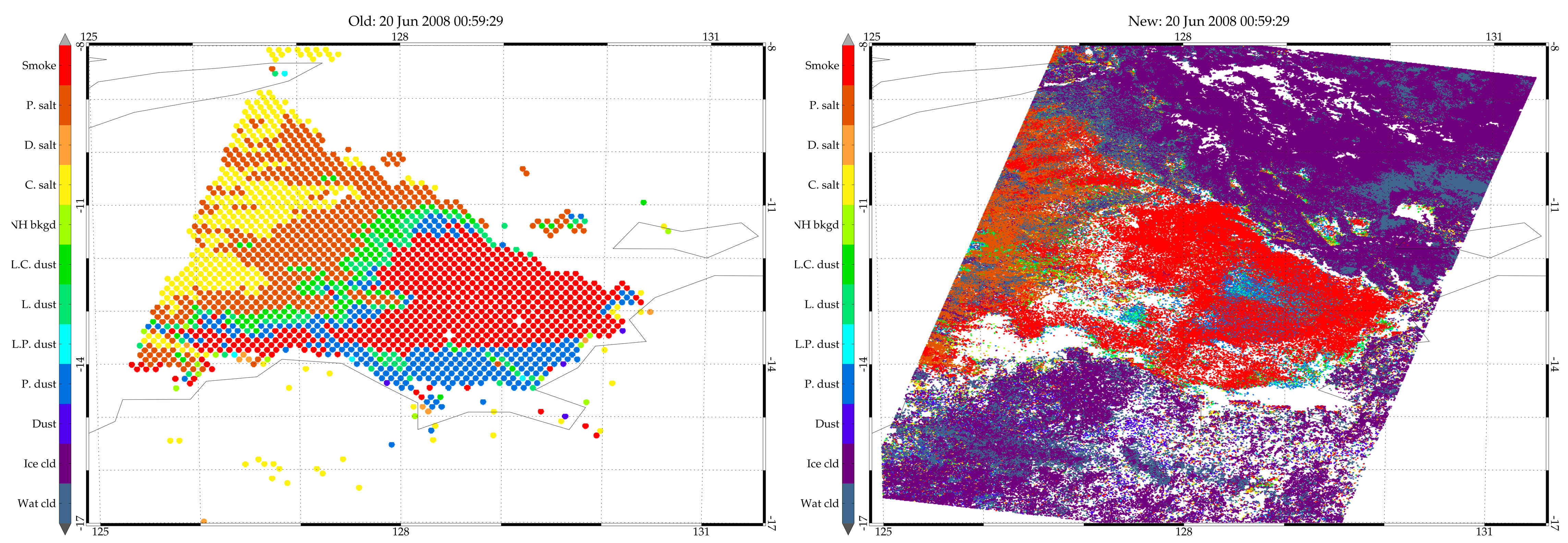
Comparison of aerosol and cloud properties



Comparison of aerosol particle size



Comparison of type identification



References

[1] L. Klüser and S. Stapelberg (2013), `www.esa-aerosol-cci.org/?q=webfm_send/507`.

[2] G.E. Thomas et. al. (2009), doi:10.5194/amt-2-679-2009.

[3] C.A. Poulsen et. al. (2012), doi:10.5194/amt-5-1889-2012.

[4] C. Rodgers (2000), Inverse Methods for Atmospheric Sounding: Theory and Practice, World Scientific.