ORAC

Optimal Retrieval of Aerosol and Cloud

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Introduction

The Optimal Retrieval of Aerosol and Cloud (ORAC – formerly known as Oxford-RAL Aerosol and Cloud) is a versatile retrieval scheme for determining aerosol and cloud properties from visible/IR imaging satellite instruments. The algorithm has been under active development for over 15 years, through a long running collaboration between RAL Space and the University of Oxford, and since 2010 has been developed as an open source community code.

ORAC has been applied to a wide range of instruments:

- AVHRR
- (A)ATSR
- MODIS
- SEVIRI
- VIIIRS
- AHI (Himawari-8)

ORAC is an optimal estimation (Rodgers, 2000) retrieval scheme, which offers the following benefits:

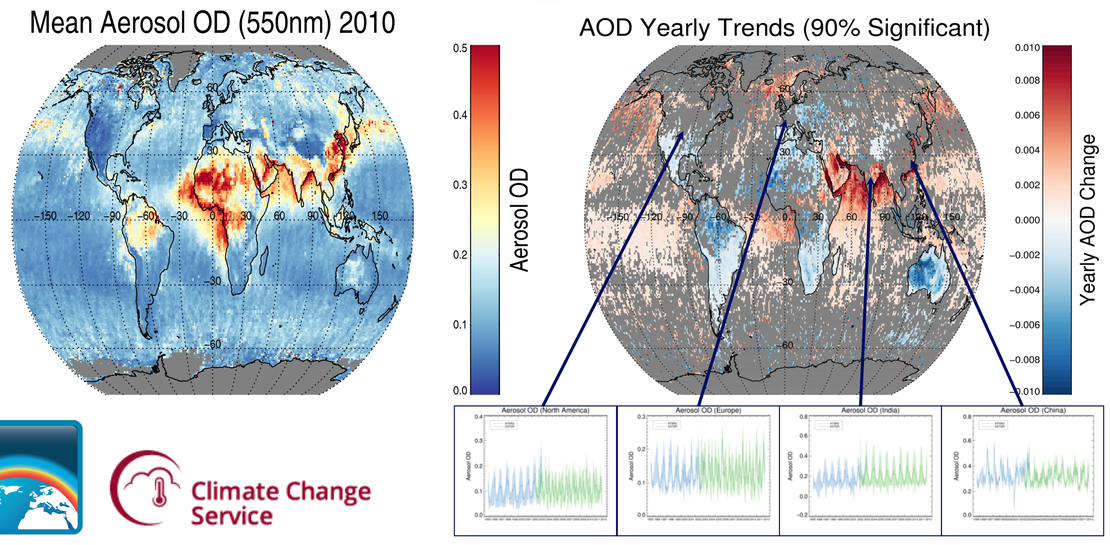
- Simultaneous fitting of all state parameters using all measurements (ensuring radiative consistency of retrieved parameters)
- Full error propagation, including measurement noise and forward model error
- Quantitative goodness-of-fit parameters through Bayesian statistics

A key feature of the algorithm is its versatility and adaptability, which allows the features of different instruments to be exploited in retrieving both aerosol and cloud:

- An arbitrary number of solar and thermal channels can be utilised
- Measurements with multiple viewing geometries can be combined (e.g. the (A)ATSR dual view system)
- Includes modules for:
  - Multi-layer cloud
  - Lambertian or BRDF surface reflectance
  - Bayesian selection of aerosol/cloud type
  - Production of broad-band fluxes (TOA/BOA, direct and diffuse) based on the radiatively consistent retrieved aerosol/cloud parameters
  - Trace gas retrieval (total column) if sensitive channels are included (e.g. SO_2 using 7.3 and 8.7 μm, or H_20_g using 6.2 μm) – *experimental*

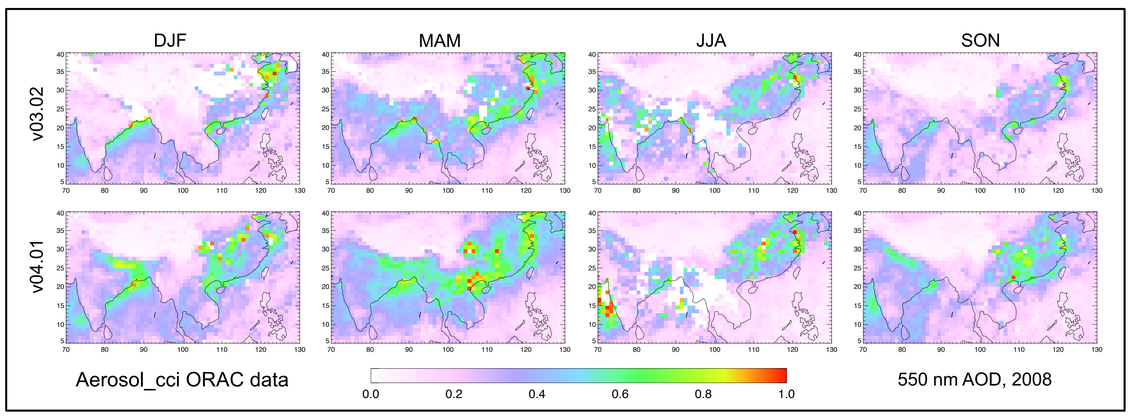
ORAC is an open source community code and new users and developers are welcome. Please get in contact if you are interested in ORAC products, applying the code yourself or getting involved in development/extension of the scheme.

ESA Aerosol_cci products



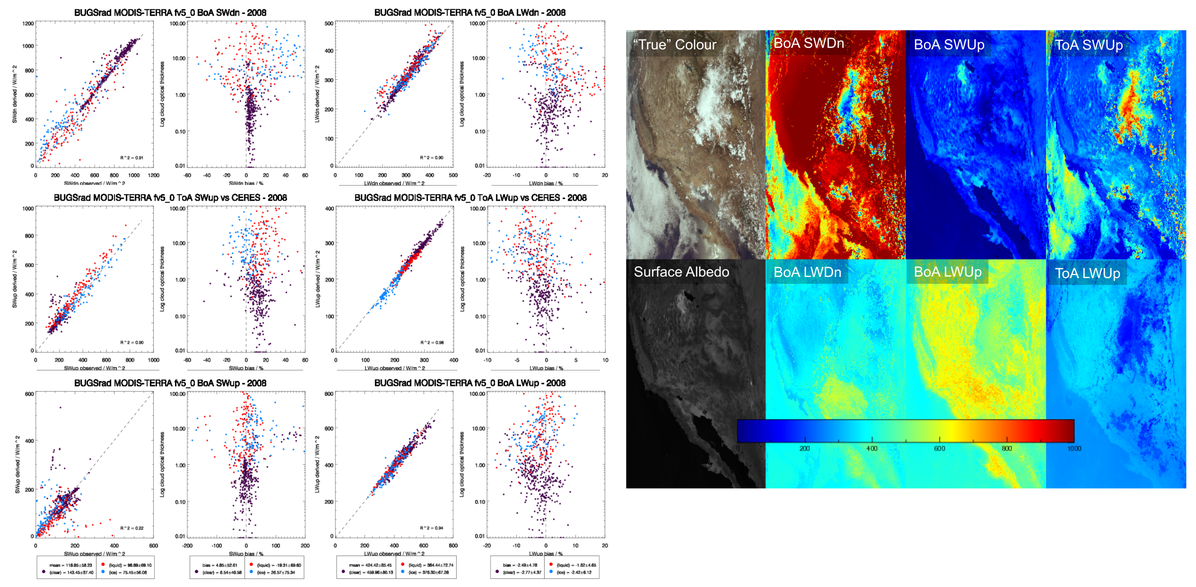
Climate Change Service

ORAC is one of 3 algorithms producing aerosol records from the (A)ATSR instruments in the ESA Aerosol_cci and Copernicus Climate Change Service projects, providing a 17 year (1994 – 2012) aerosol dataset with high accuracy and stability. The time-series will be further extended using the Sea & Land Surface Temperature Radiometer (SLSTR) on the Sentinal-3 platform. The final cci data set, version 4.01, is publically available through the Centre for Environmental Data Archival (CEDA):
http://gws-access.ceda.ac.uk/public/aerosol_cci/cci_products/AATSR_ORAC_v04-01/ AATSR
http://gws-access.ceda.ac.uk/public/aerosol_cci/cci_products/ATSR2_ORAC_v04-01/ ATSR-2



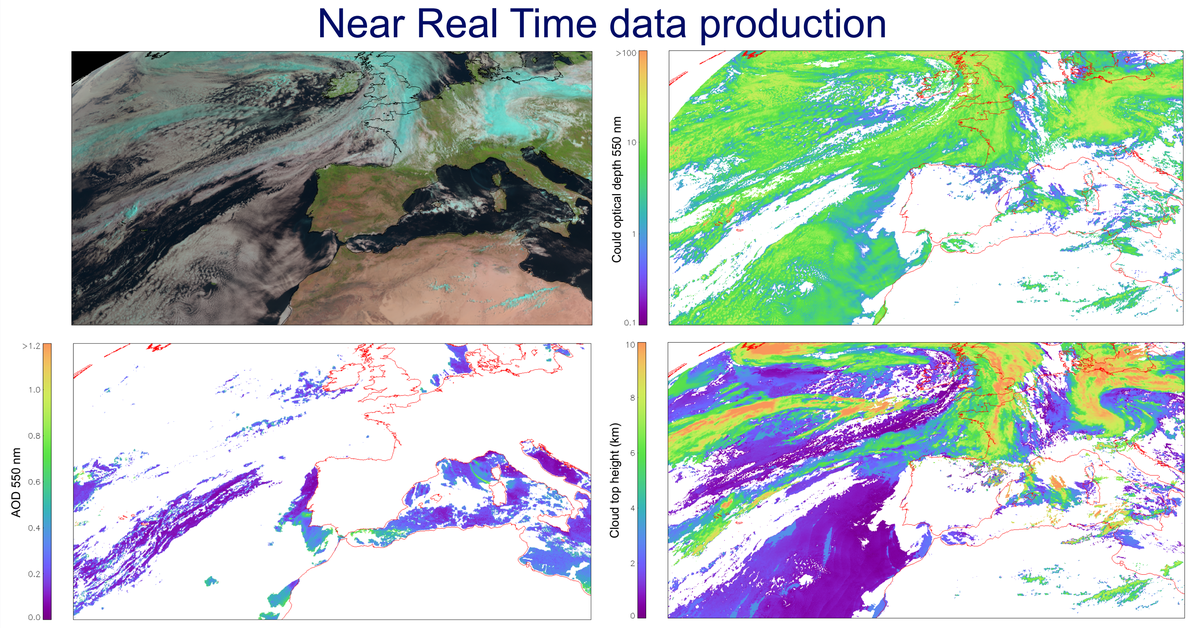
See: Popp et al. (2016) and http://www.esa-aerosol-cci.org/

Broadband flux calculations



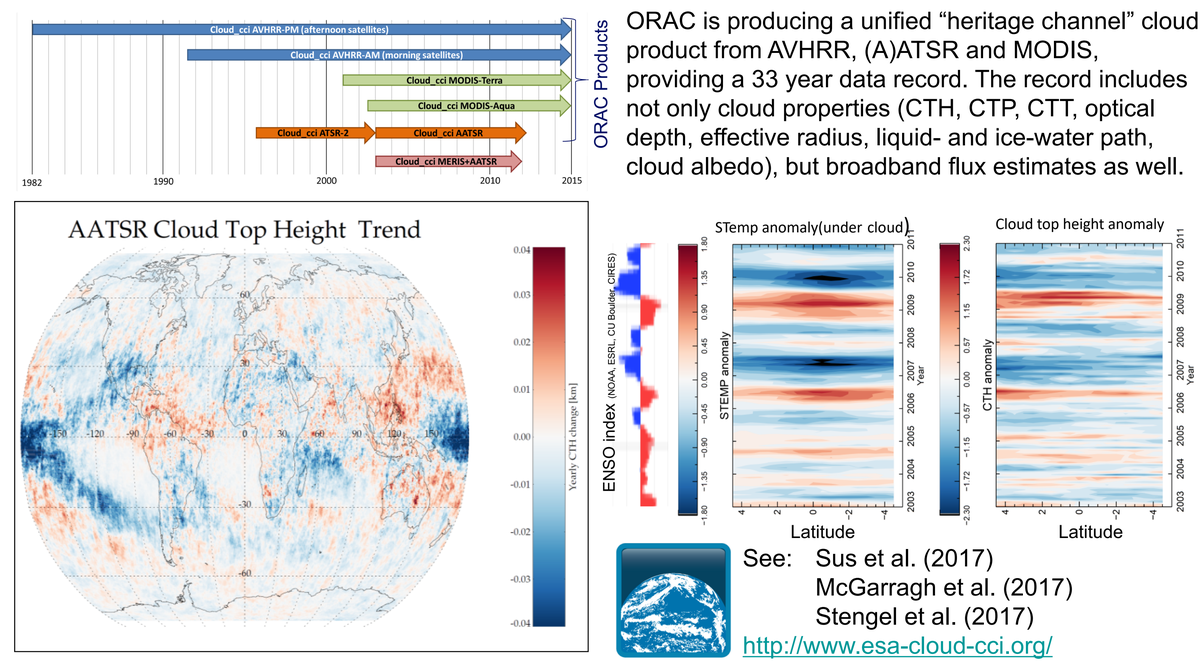
A recent addition to the ORAC suite is the ability to use the derived cloud and aerosol properties to calculate broad-band fluxes (shortwave, longwave, PAR) at TOA and BOA. The broadband radiative transfer is performed using either the BUGSrad (Stevens et al., 2001) or Fu-Liou (1993) models. The radiative consistency from visible to thermal IR provided by the ORAC algorithm is key to these calculations.

Near Real Time data production



RAL has a prototype NRT processing system in place for SEVIRI, producing aerosol and cloud properties from 3-hourly EUMETCast imagery. Quicklook imagery is avialable from: https://goo.gl/6fudqf
The above scene, from 9:00 UTC, 26 July 2017, shows smoke plumes over the Mediterranean Sea and Atlantic from wild fires near Toulon and South of Lisbon.

ESA Cloud_cci products



ORAC is producing a unified "heritage channel" cloud product from AVHRR, (A)ATSR and MODIS, providing a 33 year data record. The record includes not only cloud properties (CTH, CTP, CTT, optical depth, effective radius, liquid- and ice-water path, cloud albedo), but broadband flux estimates as well.

See: Sus et al. (2017)
McGarragh et al. (2017)
Stengel et al. (2017)
http://www.esa-cloud-cci.org/

Useful links

ORAC homepage:
http://proj.badc.rl.ac.uk/orac
Includes a wiki and a Trac interface to the ORAC code SVN repository

ESA Aerosol_cci:
http://www.esa-aerosol-cci.org/

ESA Cloud_cci:
http://www.esa-cloud-cci.org/

ESA Climate Change Initiative open data portal:
http://cci.esa.int/data
Provides access to publically released cci datasets, including ORAC cloud and aerosol

RSG NRT Data Viewer
http://gws-access.ceda.ac.uk/public/rsgnceo/webpages/calendar/rsg_nrt_calendar.html
Graphical interface to NRT data produced by the Remote Sensing Group at RAL Space

References

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Sus, O. et al. (2017): "The Community Cloud retrieval for Climate (CC4CL). Part I: A framework applied to multiple satellite imaging sensors", *Atmos. Meas. Tech.*, in review.
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