Global Retrieval of ATSR Cloud Parameters And Evaluation: Overview Of The GRAPE Project

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Introduction

The **G**lobal **R**etrieval of **A**TSR Cloud **P**arameters and **E**valuation (GRAPE) project makes use of visible and infrared measurements from the nadir-viewing geometry of the **A**long **T**rack **S**canning **R**adiometer-2 (ATSR-2) to retrieve cloud and aerosol properties, and surface reflectance, globally on a 3 x 4 km grid. Version 3 of the dataset has recently been made available from the **B**ritish **A**tmospheric **D**ata **C**entre (BADC). This poster briefly describes the retrieval method used in GRAPE and introduces examples of the datasets the project provides.

Instrumental Details

ATSR-2, aboard ERS-2 (launched April 1995), measures top-of-atmosphere reflectance or brightness temperature at seven wavelengths in the visible and infrared. The instrument measures near-simultaneously at two geometries: a nadir view at zenith angles of 0°-22° and a forward-view at zenith angles of 53°-55°. Nadir-viewing measurements from 5 of these channels (bands centred at 660 nm, 870 nm, 1600 nm, 11 µm and 12 µm) are used in the GRAPE retrieval. The swath consists of approximately 500 1 km by 1 km pixels; the retrieval is performed at 3 x 4 km resolution.

The ERS-2 satellite suffers from a data-downlinking issue meaning that the ATSR-2 visible channels operate in a narrow-swath mode over much of the ocean, reducing coverage by roughly one half. In March 2002, the Advanced ATSR (AATSR) was launched on Envisat. This instrument is similar to ATSR-2 but does not suffer from the data-downlinking restriction.

Retrieval Algorithm And Output

The GRAPE retrieval algorithm belongs to the **O**xford-**R**AL **A**erosol and **C**louds (ORAC) family, also used in the GlobAerosol project. ORAC is an optimal estimation retrieval. The rigorous statistical basis of optimal estimation provides the following advantages:

1. Estimates of the uncertainty on retrieved parameters.
2. Quality control check of the goodness-of-fit on the solution (retrieval 'cost').
3. Ability to incorporate *a priori* information on the surface and atmospheric state. Here, MODIS data are used for the surface albedo and ECMWF for the atmospheric profile.

For each 3 x 4 km retrieval superpixel, the ATSR-2 cloud flag is checked to determine whether the scene is cloudy or not. If cloudy, a cloud retrieval is performed, which returns the following parameters (and associated uncertainties):

1. Superpixel cloud fraction.
2. Cloud optical depth referenced to 550 nm.
3. Cloud particle distribution effective radius. Together with the cloud optical depth and phase, this is used to calculate the cloud water path.
4. Cloud-top pressure (also provided in height and temperature coordinates).
5. Cloud particle phase (water or ice)
6. The surface temperature.

If the scene is not cloudy, an aerosol retrieval is performed, providing the following parameters (and associated uncertainties), using an assumed aerosol model dependent on the location of the scene on the globe:

1. Aerosol optical depth referenced to 550 nm.
2. Aerosol particle distribution effective radius.
3. The white-sky albedo of the surface at 550 nm, 660 nm, 870 nm and 1.6 µm. The surface spectral shape is fixed to that of the MODIS data used as an *a priori* value.

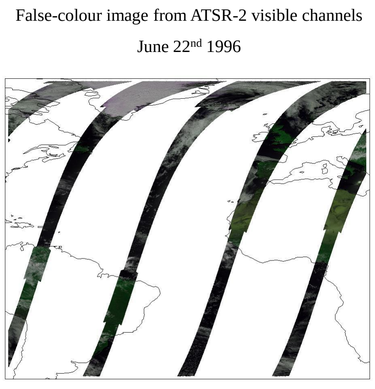
Level 2 (Orbit) Data Products

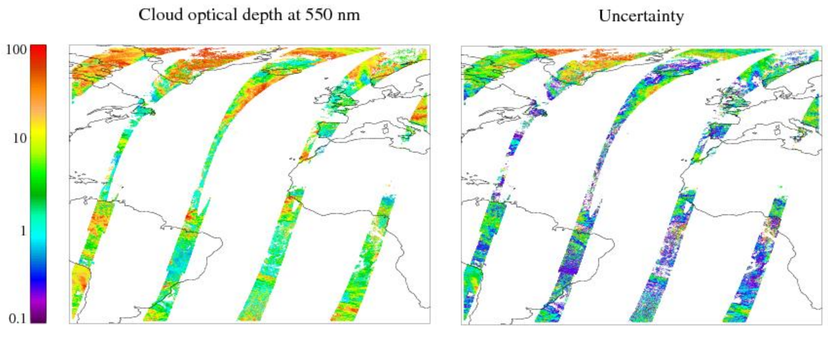
Level 2 products are provided on the retrieval's 3 x 4 km grid in the HDF5 file format. There are typically 14 or 15 orbits each day. Each file contains, for each pixel, the following information:

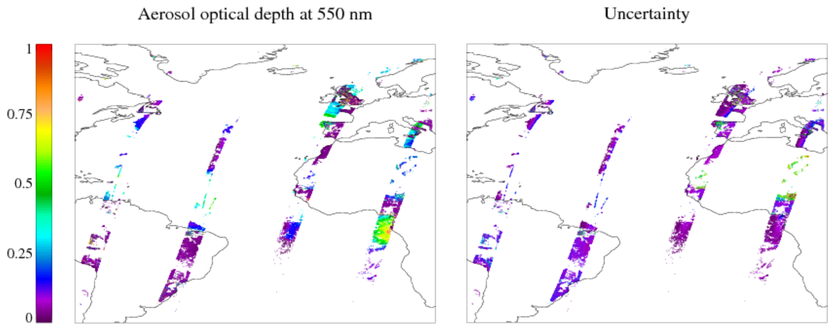
- Input ATSR-2 measurements and geometry/geolocation data.
- Whether the pixel contains a successful aerosol retrieval, cloud retrieval, or no data.
- Retrieved data products and their uncertainties.
- Quality control information (retrieval cost and number of iterations before convergence).

The following figures show some GRAPE ATSR-2 retrieval properties from a series of orbits on June 22nd, 1996.

High cloud cover over these orbits limits the extent of the aerosol dataset, as aerosol is only retrieved where there is no cloud. Reduced coverage over the ocean is due to a combination of sun-glint and the ERS-2 data-downlinking issue.



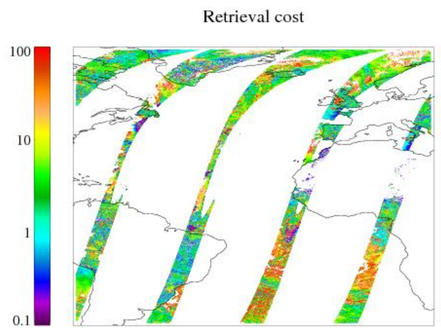




The pixel-by-pixel uncertainty estimates arise from the optimal estimation framework, and are included in the Level 2 output files.

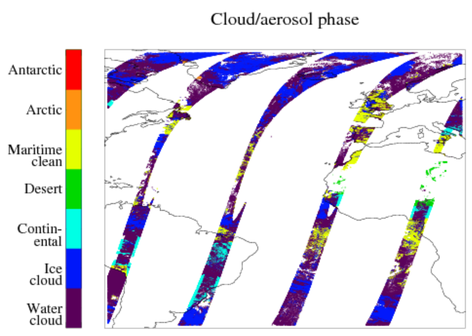
They provide a measure of the random error on each state parameter, and are determined by how well the retrieved state is constrained by the ATSR-2 measurements and *a priori* data. Such uncertainty estimates provide the user with a good indication of how reliable any parameter may be.

Retrieval cost provides an important quality control metric. The cost is a χ^2 test of the retrieval solution based on the fit to the measurements and *a priori* data; acceptable cloud retrievals should have a cost up to ~15.



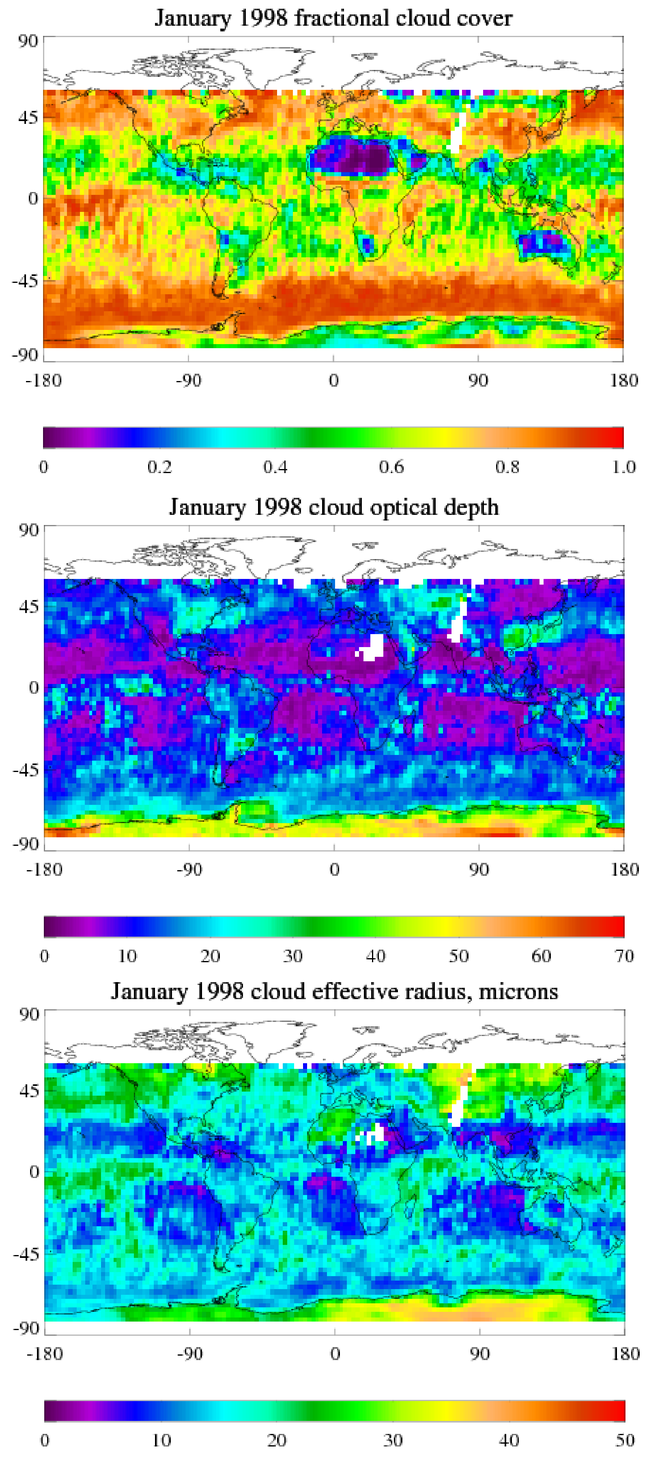
Higher values arise when the measurements are not well-modelled, such as can be found in the case of multi-layer cloud.

Finally, the GRAPE retrieval states whether identified cloud is water or ice, or the aerosol model used in case of no cloud cover.

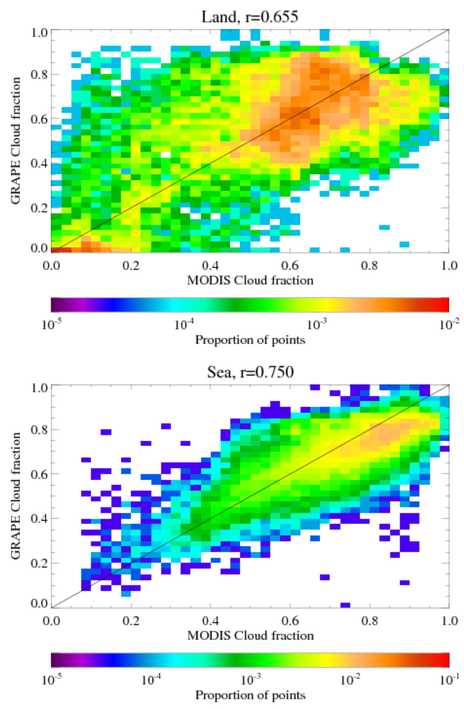


Level 3 (Monthly) Data Products

Level 3 products are available on either a 1° or a 2.5° regular latitude-longitude grid in the HDF5 file format. One file at each resolution is provided per month. Each contains monthly mean values for each retrieved parameter contained in the Level 2 files, the variance of each of these for each grid cell, and the number of retrievals of each type (aerosol and cloud) during the month. Monthly mean cloud properties are provided both for all clouds retrieved, and subset for each of the 12 cloud classes considered by ISCCP. The following example data products are taken from January 1998 at 2.5° resolution and have had a low-pass filter applied before plotting.



Comparison With MODIS-Terra Data



Following processing of the 1995-2001 period, a range of validation and intercomparison studies using the new GRAPE version 3.0 dataset are underway.

The figures to the left show a comparison of GRAPE and MODIS (Terra) cloud fraction, using 1° gridded data for an average June, generated from all Level 3 products. Generally good agreement is found, despite the incomplete overlap of the years.

See Also

At this meeting:

- Oral presentation: *Cloud Properties From (A)ATSR* (Caroline Poulsen)
- Poster presentation: *Trends And Patterns In Cloud Properties From The GRAPE Dataset* (Chris Arnold)

On the web:

- GRAPE project website: *http://www.atm.ox.ac.uk/project/grape/*
- GRAPE dataset on the BADC: *http://badc.nerc.ac.uk/data/grape/*
- GlobAerosol project website: *http://www.globaerosol.info*

Future Plans For GRAPE

Version 3.0 of the GRAPE dataset is now available for the BADC. Work on the project is ongoing, and we intend to make the following additions in the future:

- Extension of the dataset to cover the AATSR mission (2002 to present)
- Incorporation of information from the forward-viewing geometries of the (A)ATSR sensors and other algorithm refinements
- Addition of a mask to indicate ship tracks detected in the data
- Improved treatment of multi-layer clouds