GRAPE

A five year global aerosol and cloud properties database from ATSR-2 data

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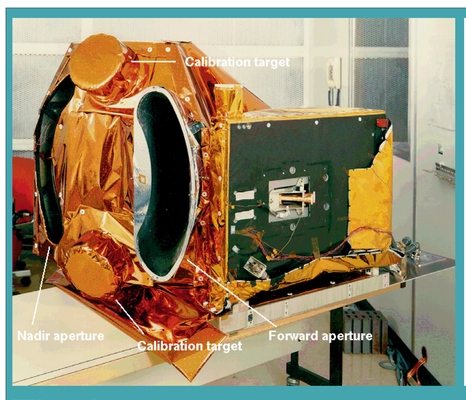
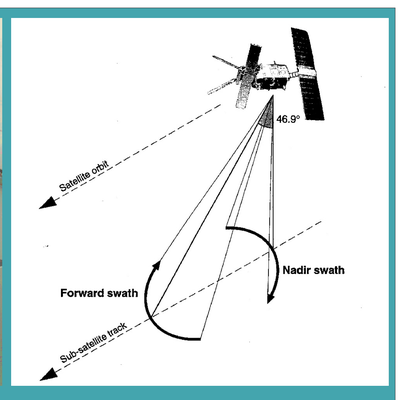
Introduction:

The Global Retrieval of ATSR Cloud Parameters and Evaluation (GRAPE) Project is producing a global database of cloud and aerosol properties from the ATSR-2 data set (1995 - 2001). The completed data set will comprise of two main products. The first of these, GRAPE Level 2, are orbit by orbit measurements of cloud or aerosol properties at a 3× 3 km resolution, whereas GRAPE Level 3 consists of global monthly composites of both cloud and aerosol properties on a 2.5°× 2.5° grid.

GRAPE processing is currently underway and should be completed within the next 2 months. Access to GRAPE data will be restricted to project participants until one year after the completion of the project, after which time the data set will be available from the British Atmospheric Data Centre (BADC).





The instrument:

The Along Track Scanning Radiometer 2 (ATSR-2) is the second of a series of scanning radiometers primarily designed for sea surface temperature measurements flown by ESA. The ATSR instruments have a native resolution of approximately 1× 1 km with a nominal swath width of 512 km. ATSR utilises a unique scan pattern that first provides a scan angled at 46.9° ahead of the satellite, followed by a nadir scan. This system provides two co-located measurements of the atmosphere and surface separated by only a few minutes. Currently GRAPE processing only uses data from the nadir geometry, but it is planned to incorporate the forward view in future analysis of ATSR data.

ATSR-2 is on board the ESA satellite ERS-2 and has been operational since July 1995. Although the instrument is still functioning, problems with data storage and satellite pointing on ERS-2 mean that processing data after 2001 is not practical.

Data analysis:

The GRAPE project has utilised a new combined cloud and aerosol retrieval system dubbed the Oxford/RAL Aerosol and Cloud (ORAC) retrieval scheme. This scheme is a development of the Enhanced Cloud Processor (ECP) developed at the Rutherford Appleton Laboratory. The retrieval uses a plane-parallel atmosphere radiative forward model in conjunction with a Levenburg-Marquardt optimal estimation scheme. Cloud flagging is the first stage of each retrieval and is performed at full instrument resolution, using the difference between the 0.87 and 0.67 μm channels over the sea and the original ECP cloud flag over land. The pixels are then averaged to the 3 × 3 km level 2 resolution and either a cloud or aerosol retrieval is performed.

The cloud forward model assumes an infinitely thin, plain parallel cloud sandwiched between two layers of Rayleigh scattering and gas absorption. Both liquid water and ice clouds can be modelled, with the phase being determined by temperature and particle size.

The aerosol forward model is based on the cloud model, with a scattering layer sandwiched between two gas layers. However, the aerosol layer has a vertical extent of 100 km whereas the gas layers are defined to be infinitely thin. The optical properties of the aerosol and its vertical profile within the aerosol layer are defined by a set of five aerosol types from the GADS (Hess 1998) database: maritime, desert, continental, Antarctic and Arctic.

Processing is currently underway with approximately one year of the five year data set completed.

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GRAPE products:

Both GRAPE level 2 and level 3 products contain the following data:

.Cloud fraction[1]
.Cloud optical depth[1]
.Cloud droplet effective radius[1]
.Cloud top temperature[1]
.Cloud top pressure[1]
.Cloud top height[1]
.Phase (water/ice cloud or aerosol type)[1,2]
.Aerosol optical depth at 0.55 μm [2]
.Aerosol effective radius[2]
.Surface reflectance at 0.66, 0.87 and 1.6 μm [2]

(In level 2 data values denoted with [1] are only given for cloudy pixels, whereas those denoted with [2] are only given for clear (aerosol) pixels.)

In addition, level 2 files also give:

.Top of atmosphere radiances for all ATSR-2 channels.
.Solar zenith angle
.Satellite zenith angle
.Relative (satellite to Sun) azimuth angle
.Value of the cost function at the retrieved solution
.Number of iterations required for the retrieval to converge

In addition, level 2 data provides uncertainty estimates, and level 3 data provides variances, for all relevant parameters.

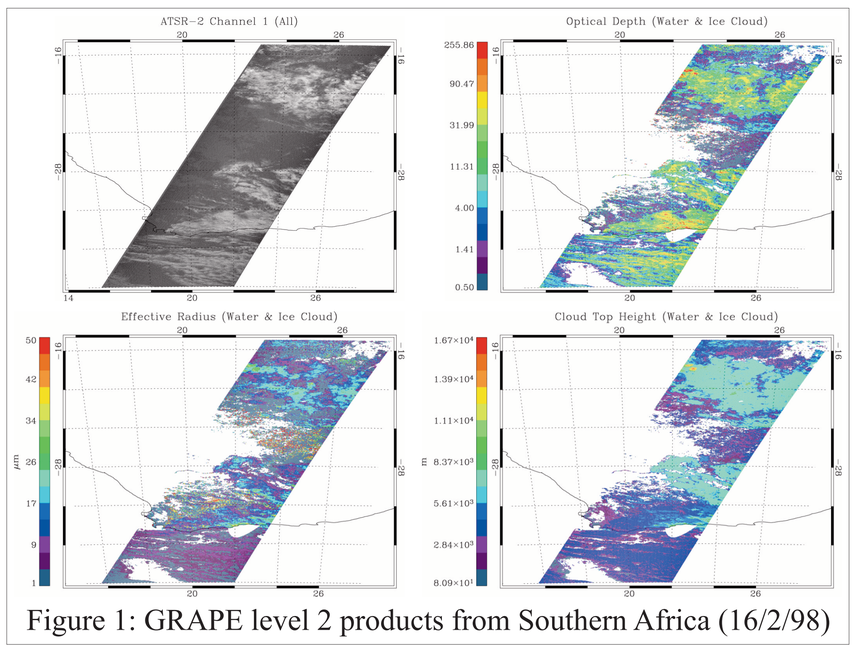

Figure 1: GRAPE level 2 products from Southern Africa (16/2/98)

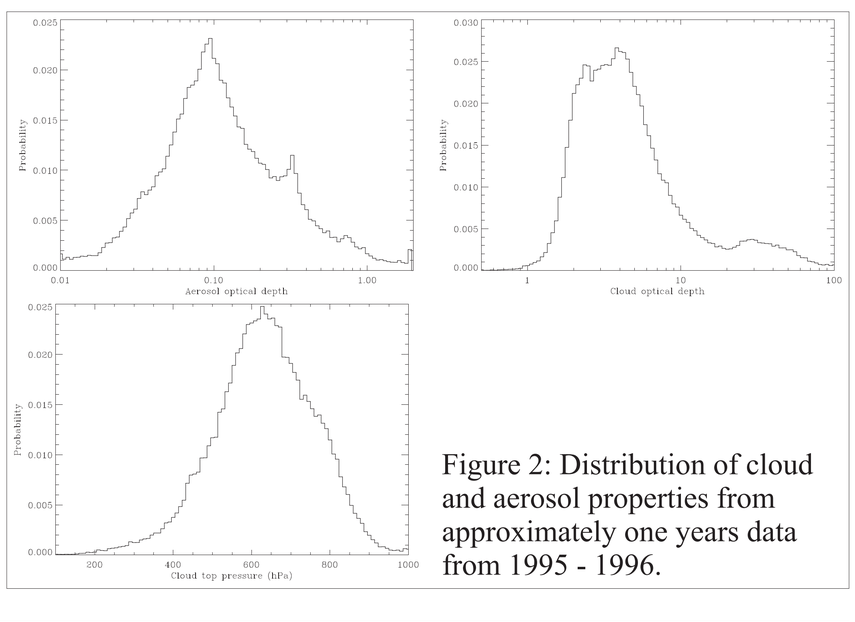

Figure 2: Distribution of cloud and aerosol properties from approximately one years data from 1995 - 1996.

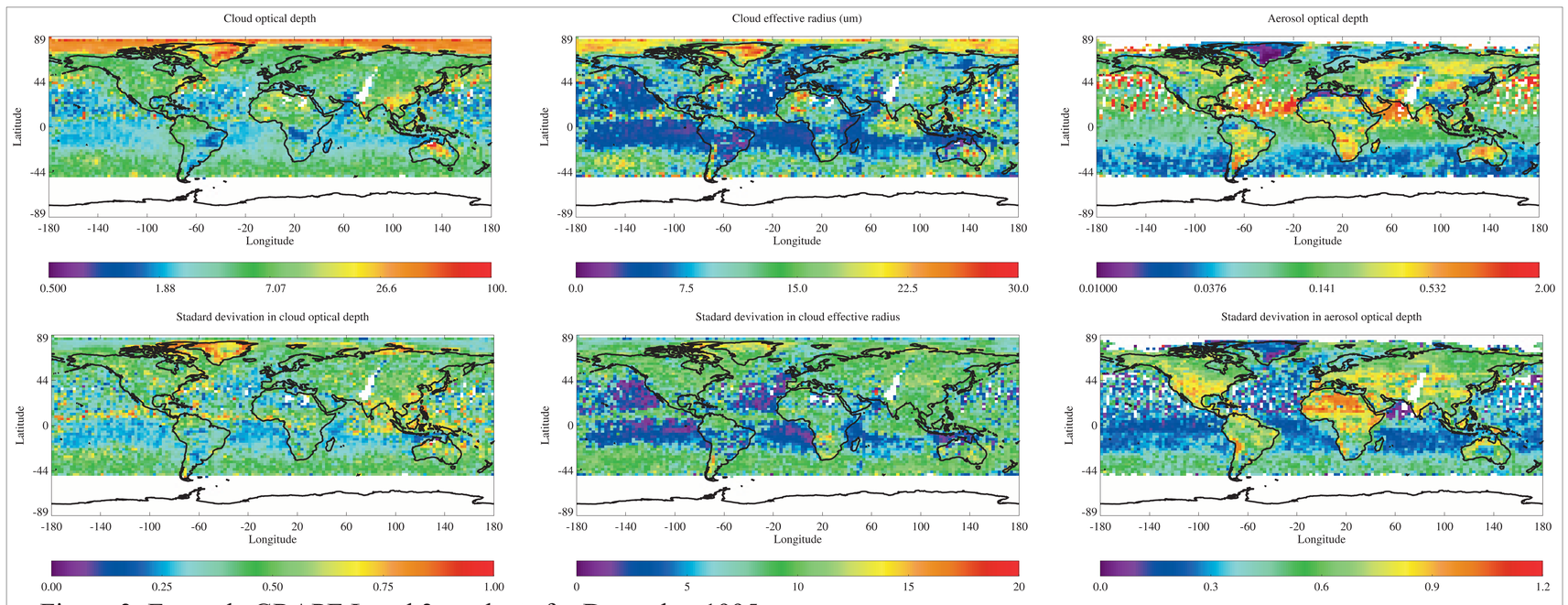

Figure 3: Example GRAPE Level 3 products for December 1995

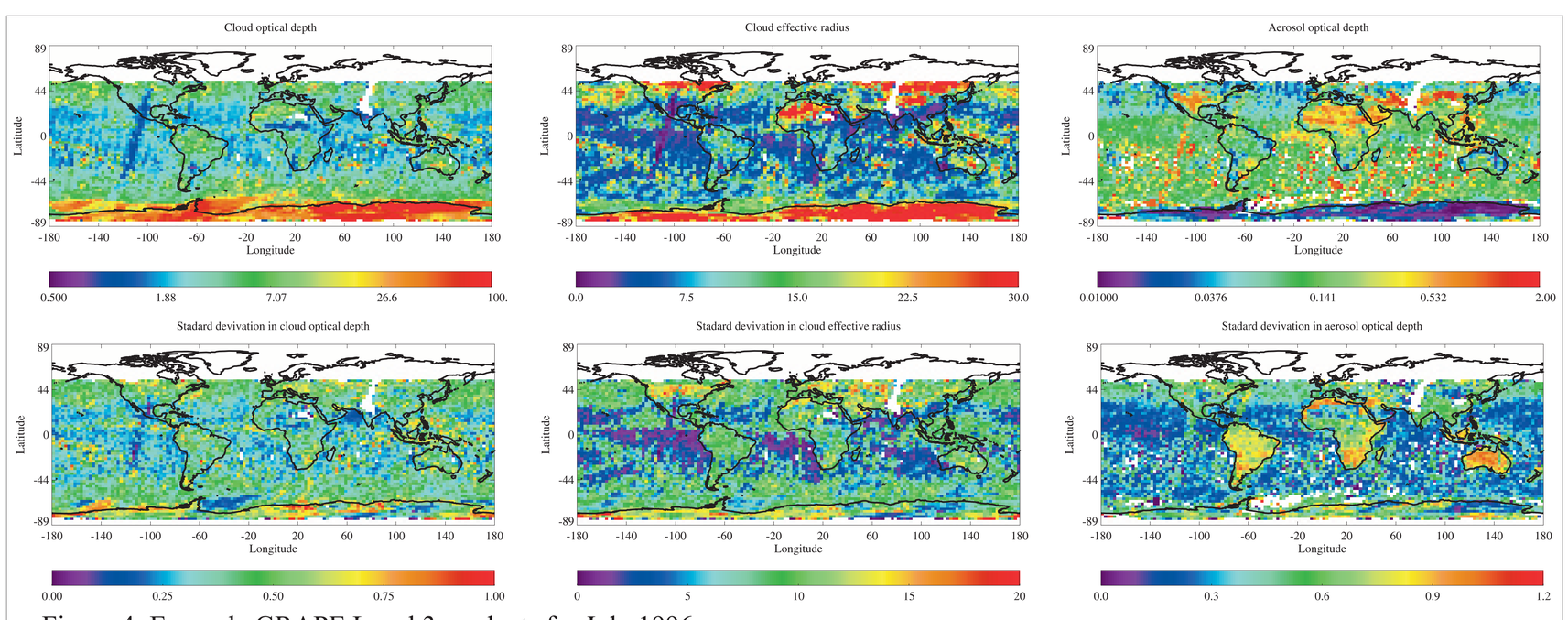

Figure 4: Example GRAPE Level 3 products for July 1996

References:

Watts P..D., C.T. Mutlow, A.J. Baran, A.M. Zavody, “Study on Cloud properties derived from Meteosat Second Generation Observations”, EUMETSAT ITT no. 97/181, 1998.

Hess, M., P. Koepke, I. Schult; “Optical Propertiesof Aerosols and Clouds: The software package OPAC”, *Bul. A. Met. Soc.*, **79**, 831-844, 1998.

Concluding remarks:

The GRAPE data set represents the first long term atmospheric data set derived from the ATSR series of instruments. It will provide a complimentary source of information to existing data sets and should be of great use in modelling studies.

In particular, the inclusion of both cloud and aerosol properties in the same data set will make it uniquely well suited to the study of aerosol cloud interactions.