ATSR CLOUDS

Global Retrieval of clouds And Product Evaluation-GRAPE

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Science & Technology Facilities Council

Rutherford Appleton Laboratory

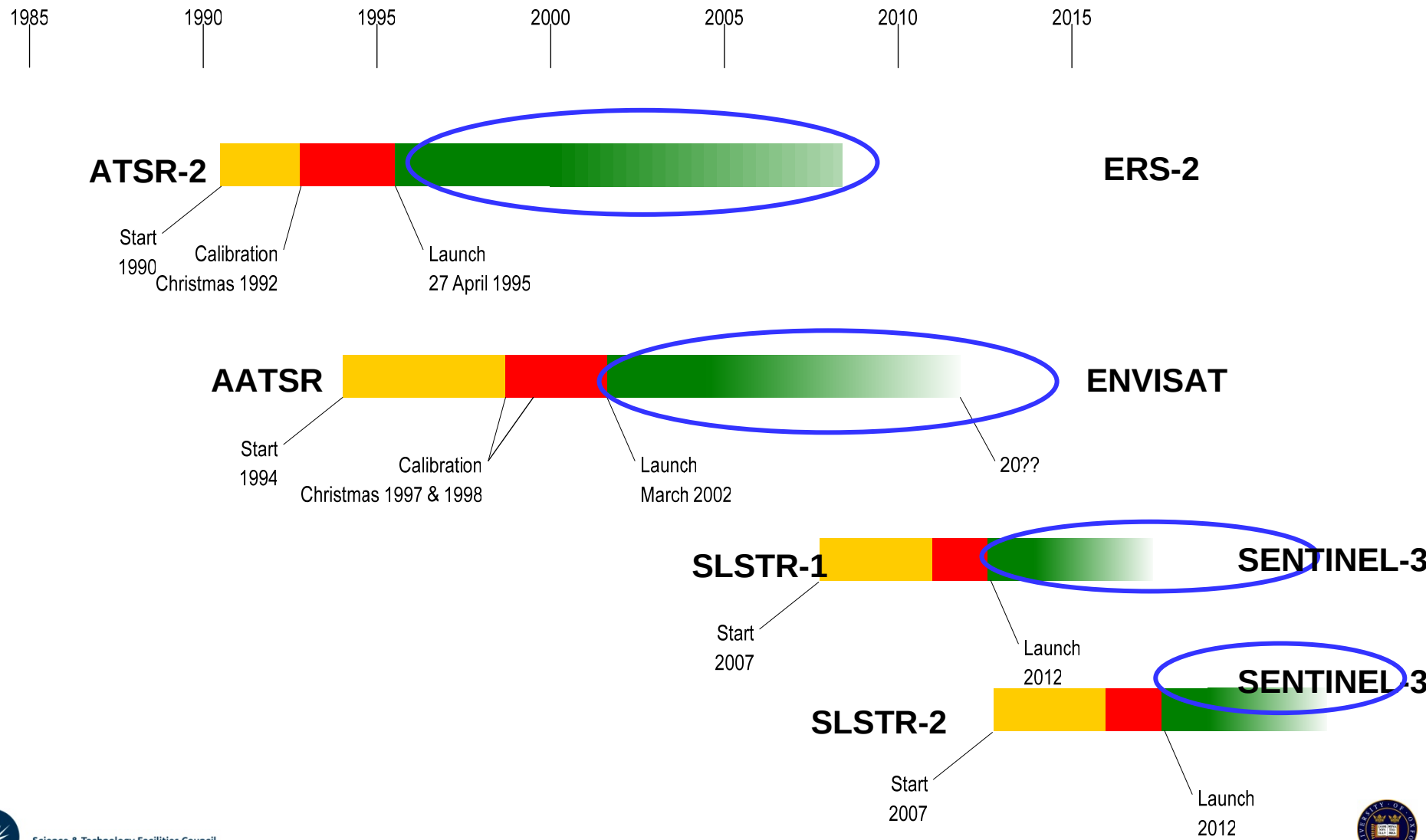
A climatology of cloud properties from ATSR

- ATSR instrument
- Cloud Measurements
- Validation
- Applications
- Future

ATSR image over the UK

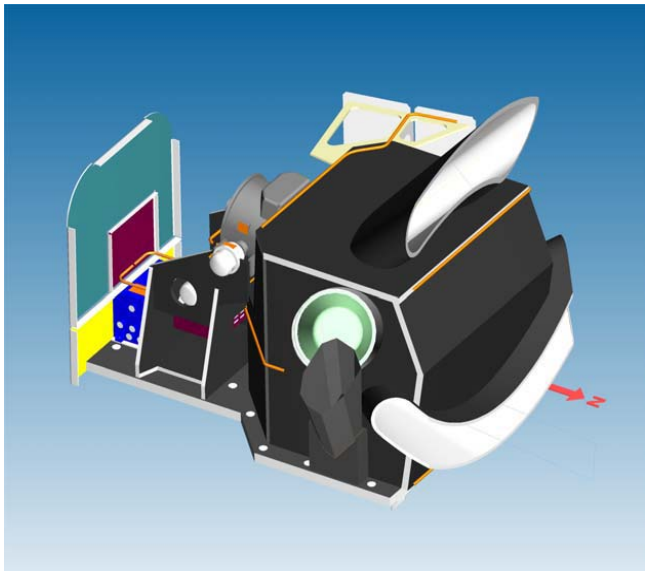
Time line of ATSR (vis/nir and IR) instruments

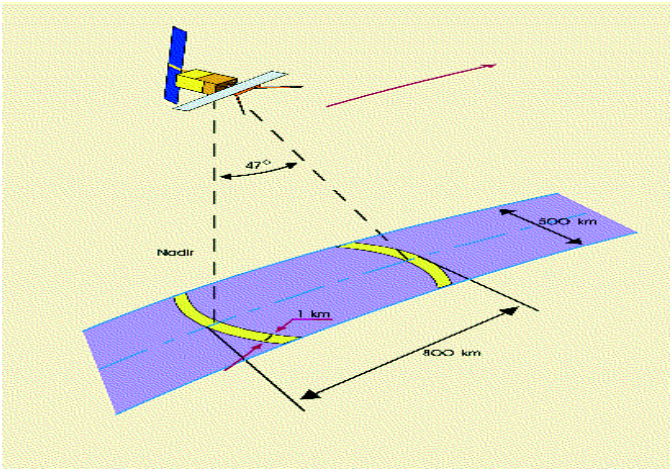
channels: 0.55 0.67 0.86 1.6 3.7 11 12 (1.38 2.25)



ATSR-2/AATSR/SLSTR

SLSTR





ATSR-2

1km resolution

512km swath over land

300km swath over sea

LTDN 10:30

AATSR

1km resolution

512km swath over land

512km swath over sea

LTDN 10:00

SLSTR

0.5-1km resolution

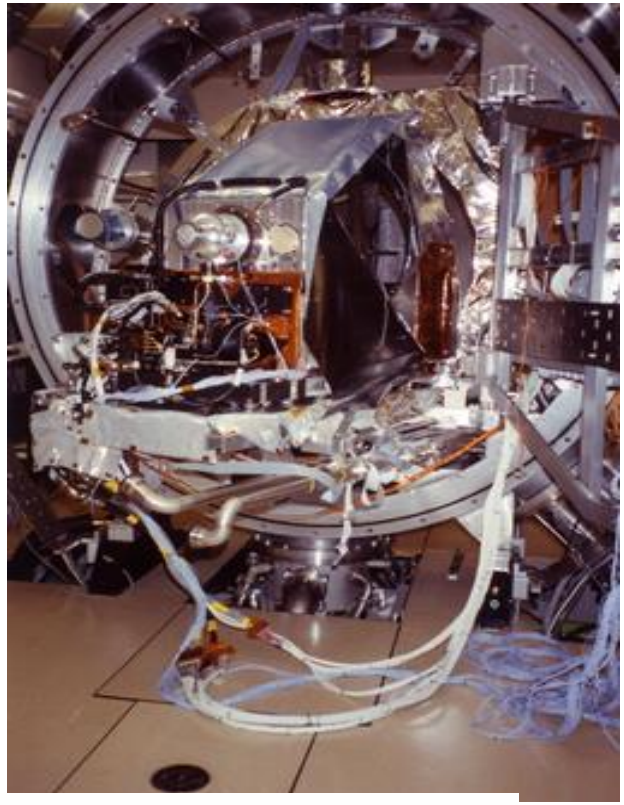
Nadir swath 1300 - 1800 km

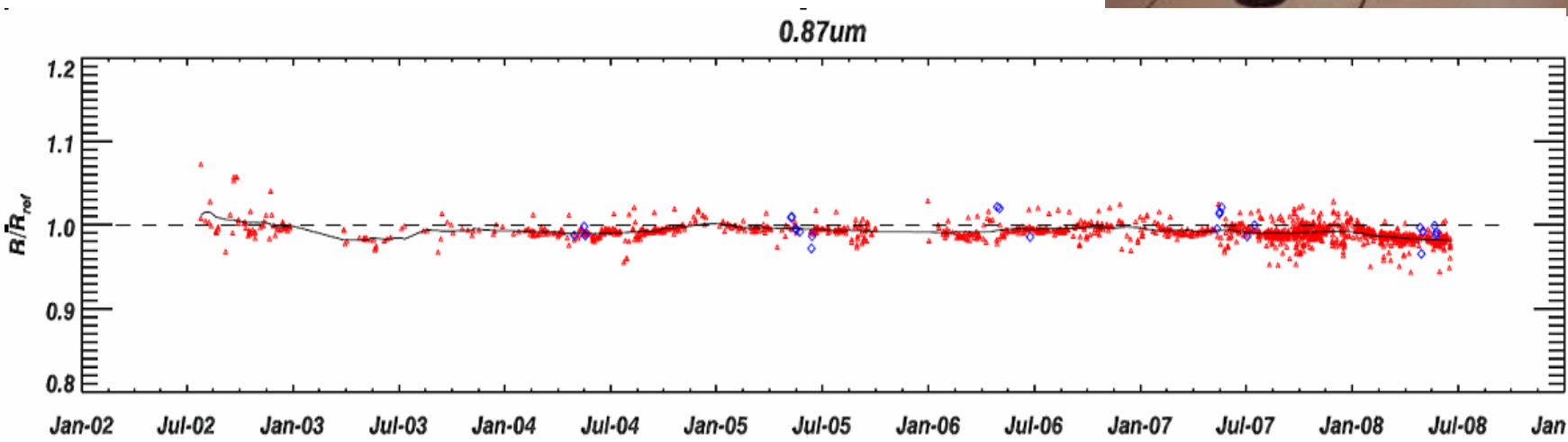
Dual view swath 750 km

LTDN 10:00

Calibration

- ATSR is stable and well calibrated
  - Continuous on-board radiometric calibration of the infrared channels against two stable, high-accuracy blackbody calibration targets
  - Continuous calibration of the visible and near infrared channels with an on-board visible calibration system
  - Calibrated vicariously via desert sites and other satellites (Dave Smith et al)





Calibration accuracy of currently vis/nir <4% -will improve

ATSR Channels and retrieved parameters

Optimal Estimation aims to use all channels together

ATSR SLSTR

- 0.55 µm
- 0.67 µm
- 0.87 µm
- 1.6 µm
- 3.7 µm
- 11 µm
- 12 µm
- 1.38 µm
- 2.25 µm

Cloud Parameters Retrieved

- Cloud top pressure/height
- Cloud fraction
- Cloud optical depth
- Cloud effective radius
- Cloud phase

From the above retrieved parameters we derive

- Cloud liquid water path
- Cloud ice path

ATSR cloud algorithm-Optimal Estimation

– Quality control check of the goodness-of-fit on the solution (retrieval 'cost').

$$J = [y_m - y(x_n)]\, S_y^{-1}\, [y_m - y(x_n)]^T + [x_n - x_b]\, S_x^{-1}\, [x_n - x_b]^T$$

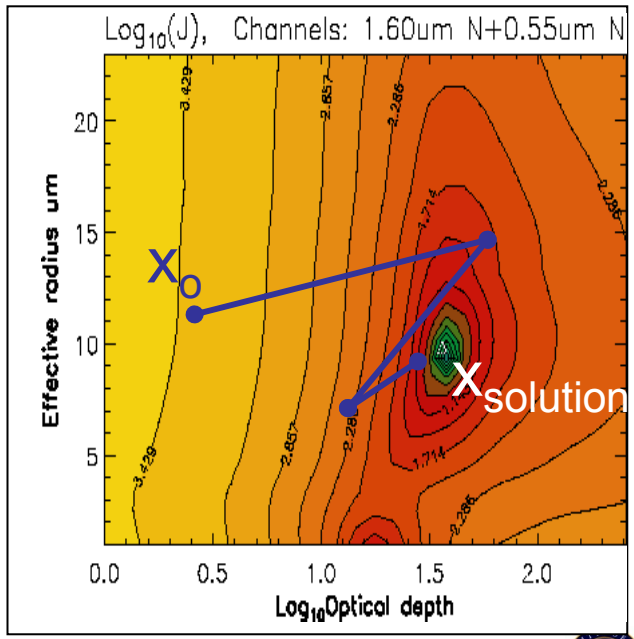
•Thick cloud
•No *a priori,*
•0.55, 1.6 μm –
• τ, R_e only

– Estimates of the uncertainty on retrieved parameters.

$$S_{solution} = J''_{solution} = (S_x^{-1} + K^T.S_y^{-1}K)^{-1}$$

– Use of *a priori* information on the surface and atmospheric state.

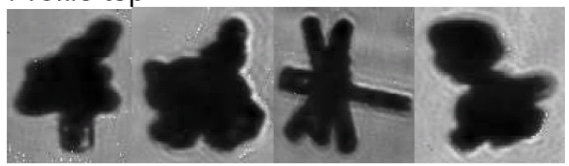
- Here, MODIS data are used for the surface albedo and ECMWF for the atmospheric profile.



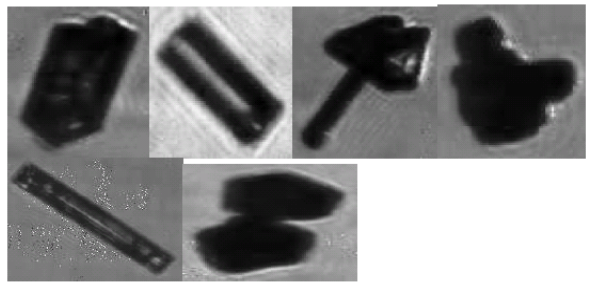
Investigating cloud optical properties

- The ability of OE to test consistency of optical models with measurement
- The framework enables optical models used in climate models (e.g. Baran/BAUM…) to be tested.
  - For the effect of vertical structure
  - Retrievals for τ and r_e could be made consistent with climate models if same optical properties assumed
  - Joint project with UKMO to do this and to compare with flight and ground based data

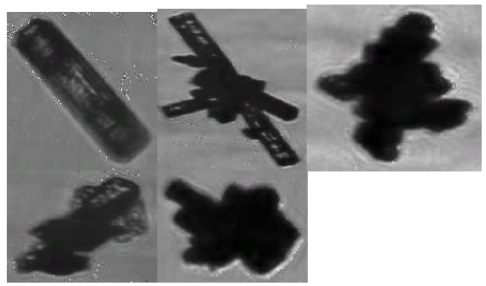
Profile top



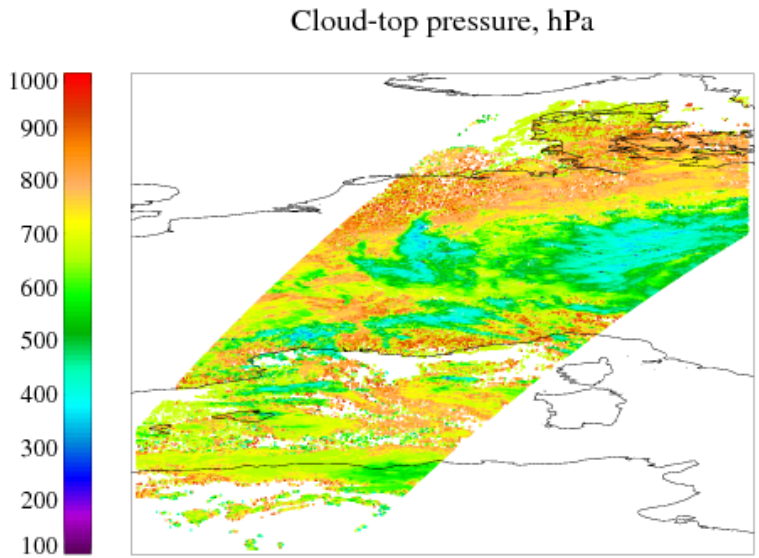
Profile middle

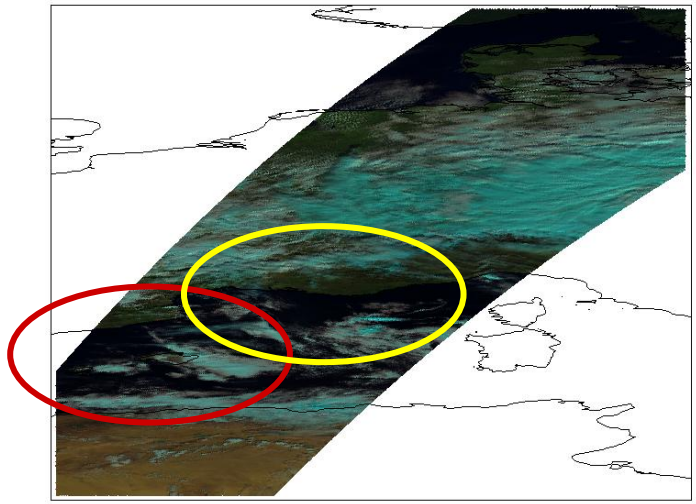


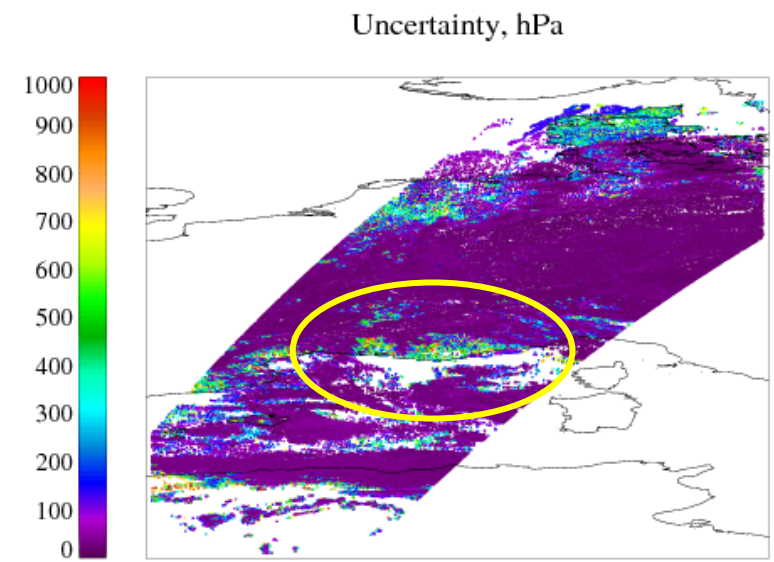
Profile bottom

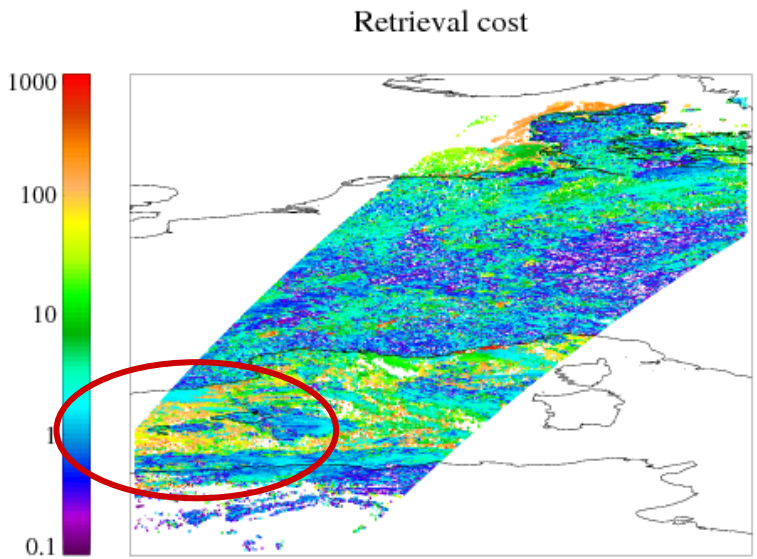


Cloud top pressure



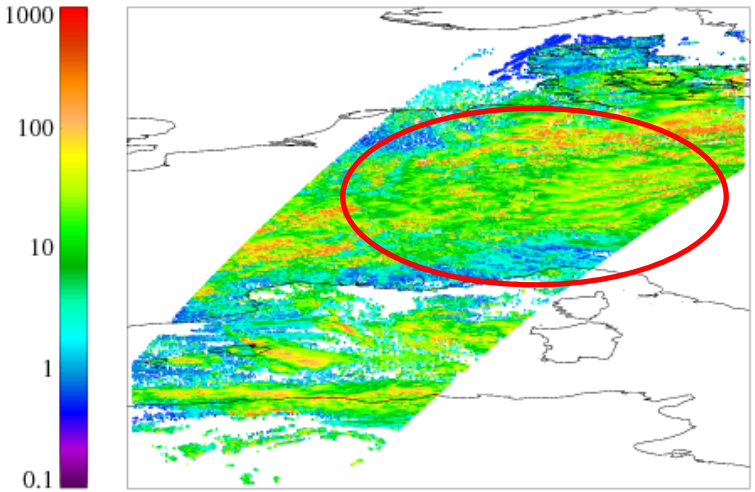


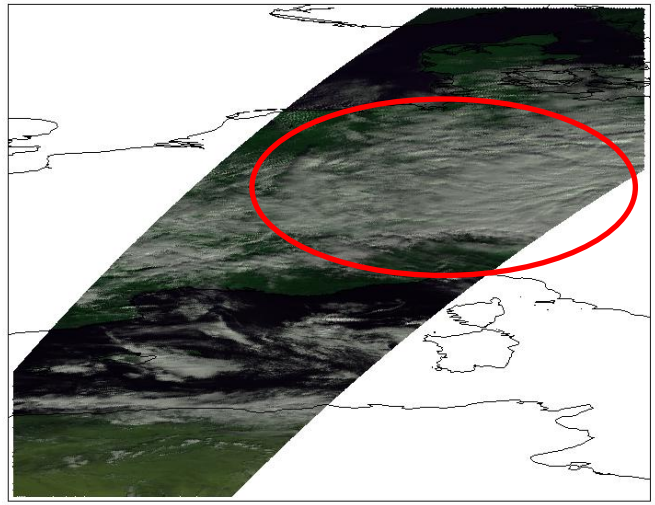




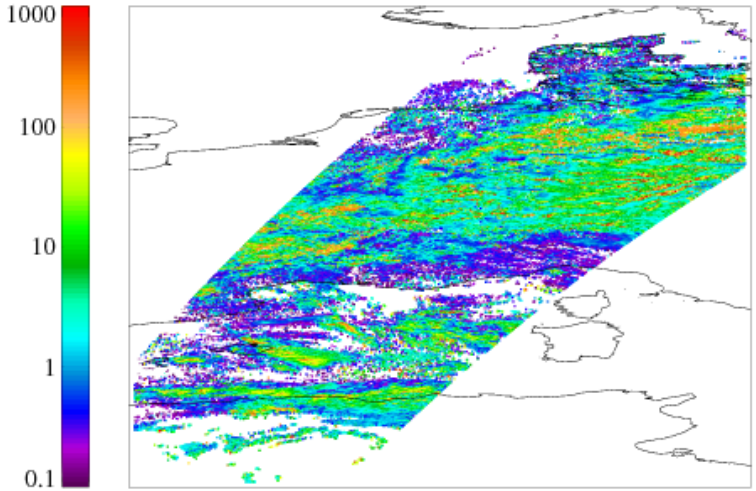
Cloud Optical Depth

Cloud optical depth at 550 nm

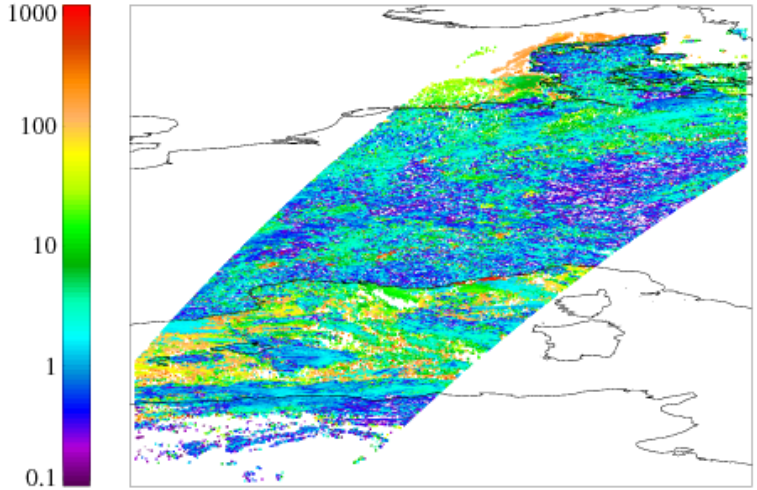




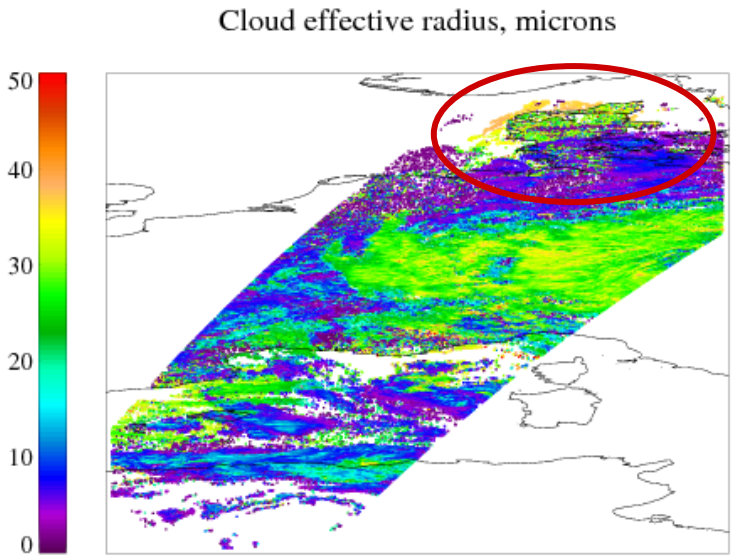
Uncertainty

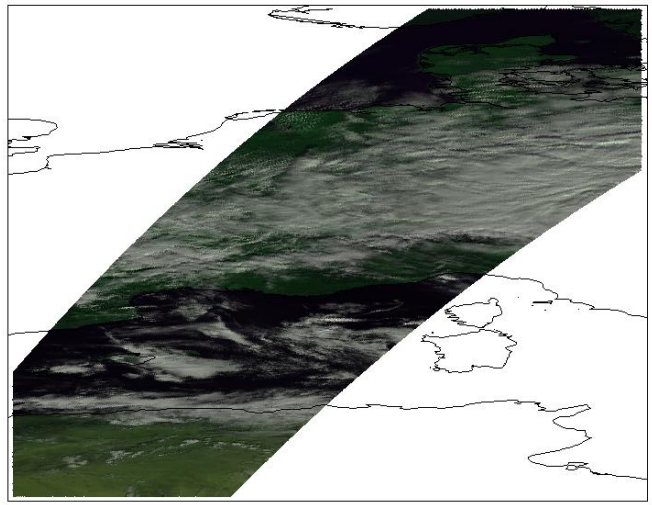


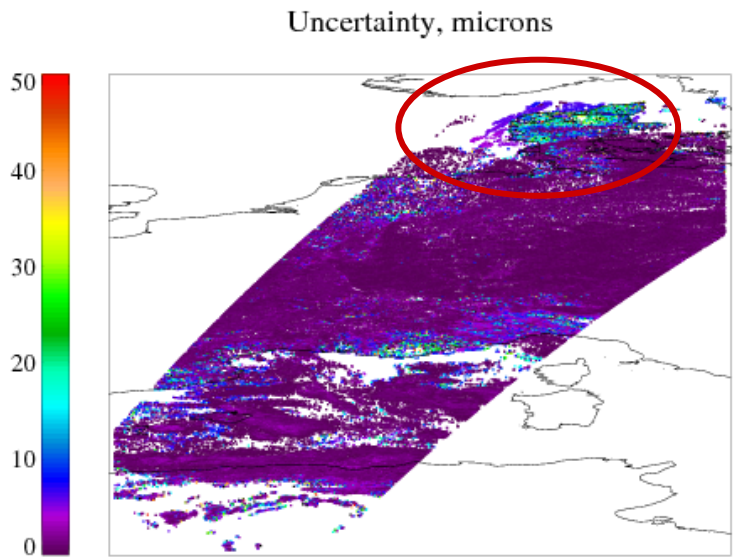
Retrieval cost

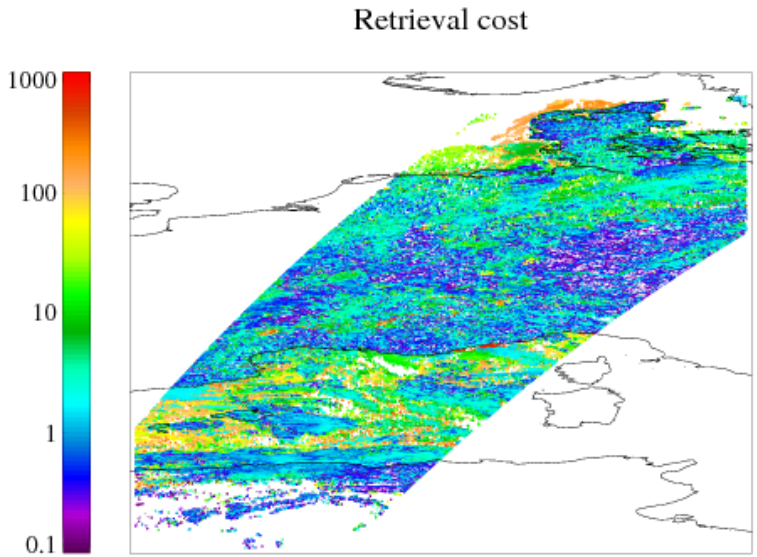


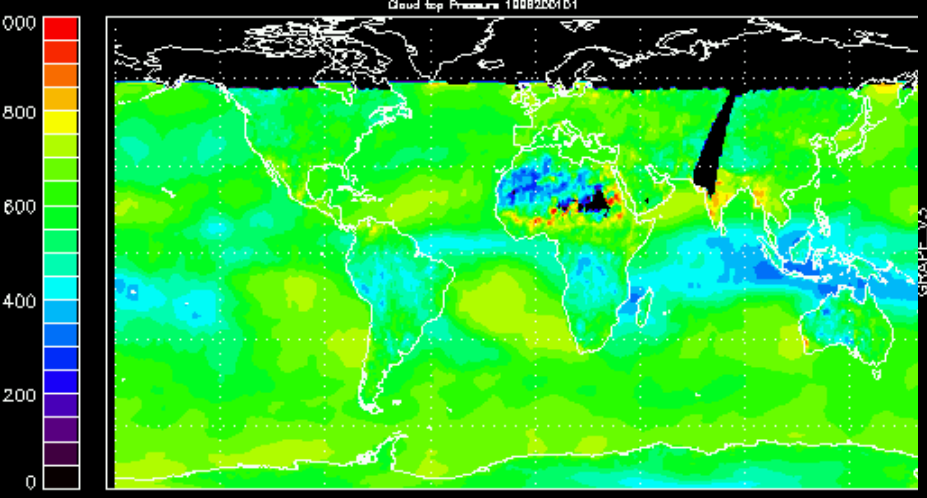
Cloud effective radius



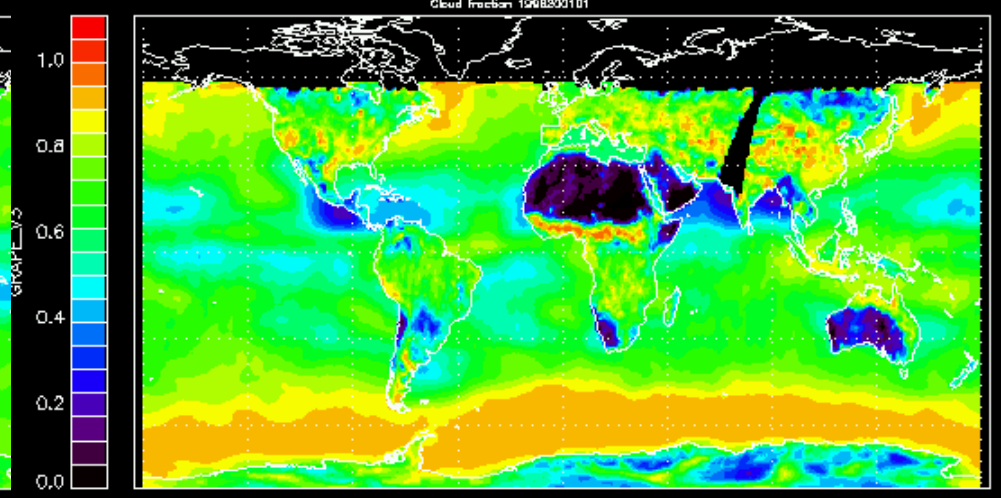




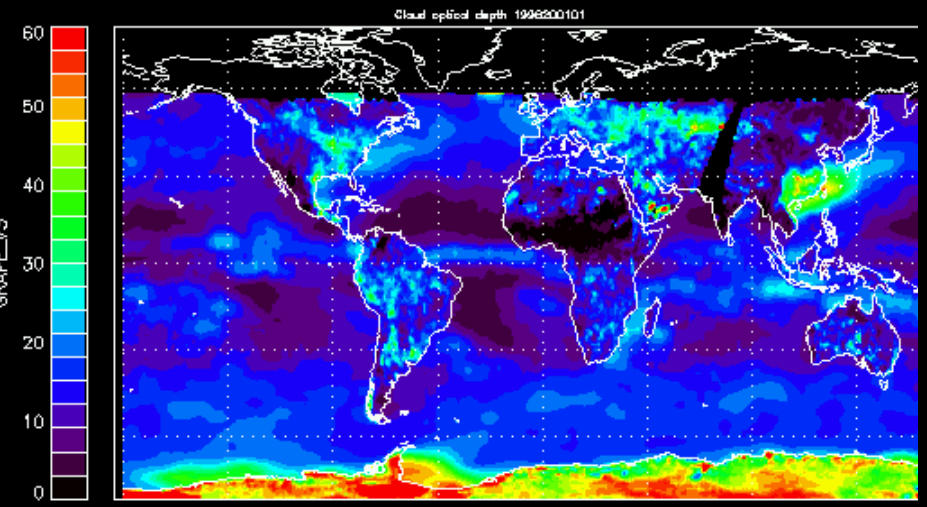




Cloud top pressure 1996-2001



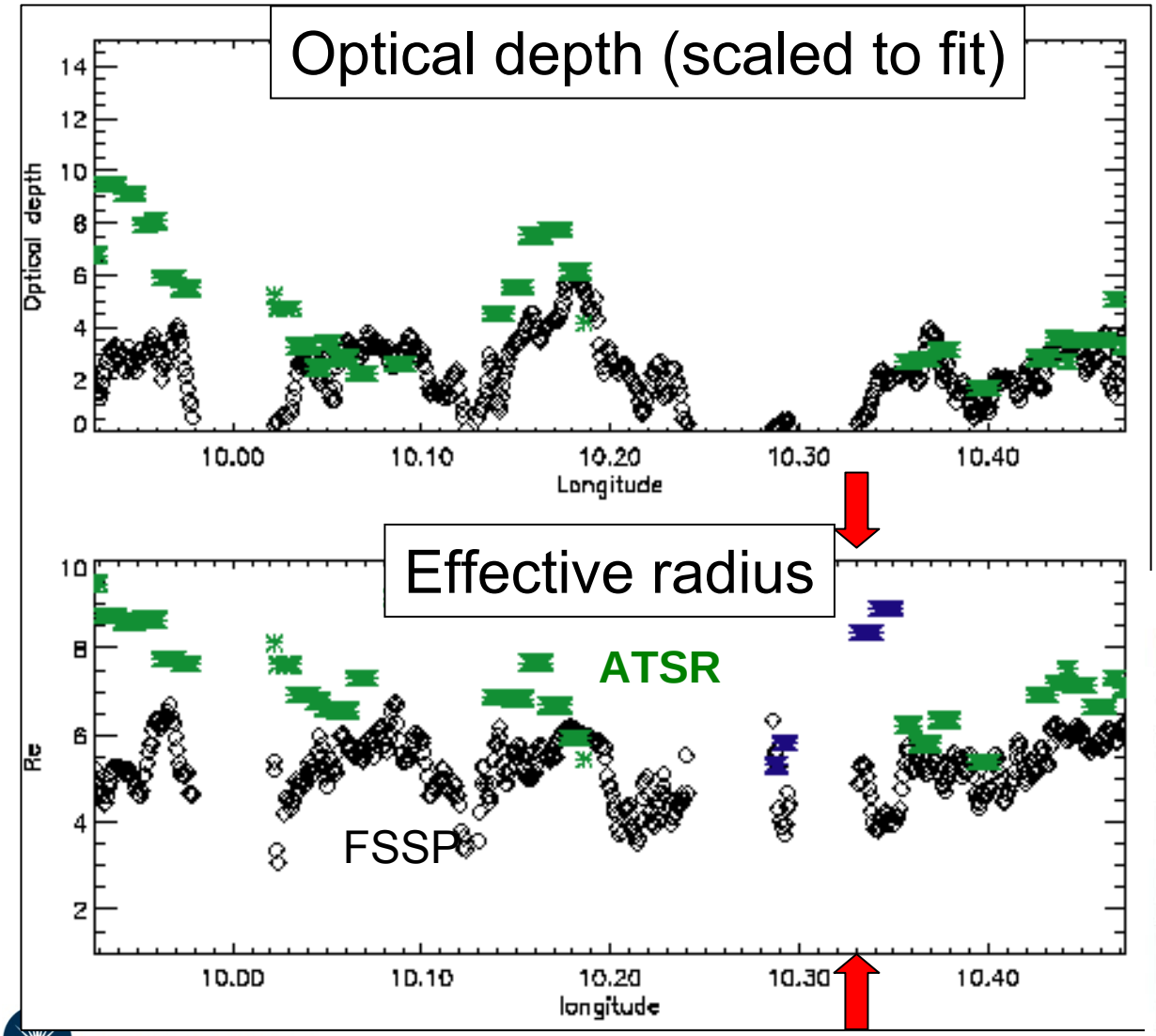
Cloud fraction 1996-2001

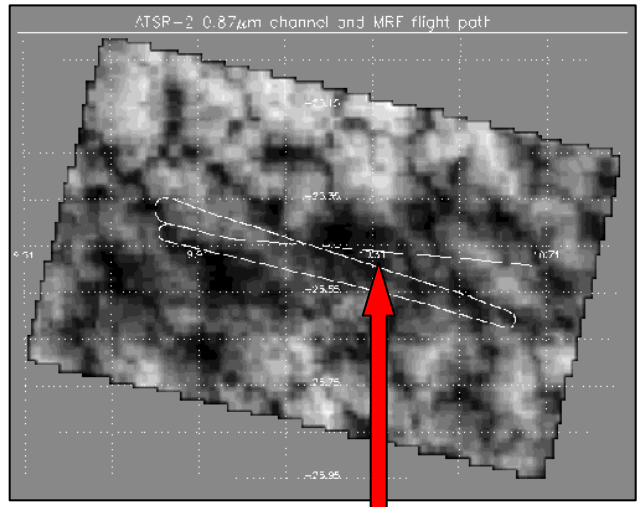


Cloud optical depth 1996-2001

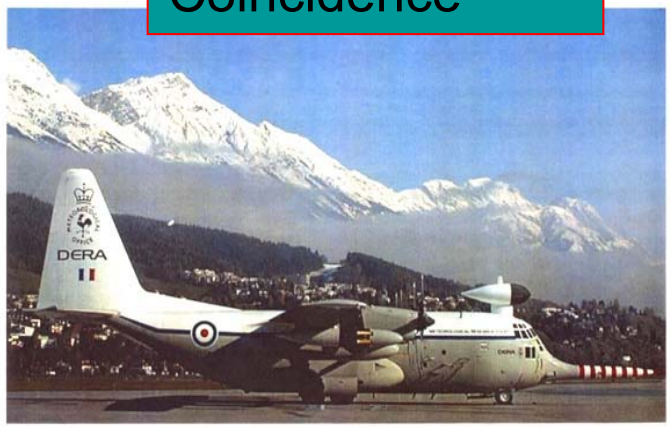
SATE: South Atlantic Tropical Experiment

R_e validation against MRF FSSP probe



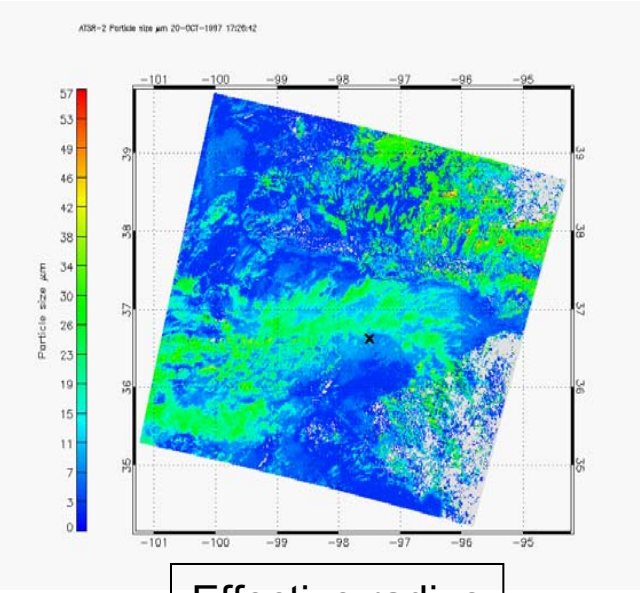


Hercules - ERS-2 Coincidence

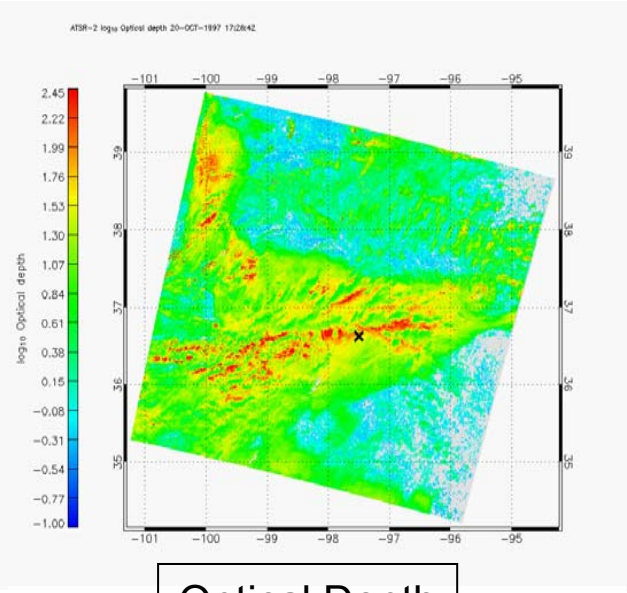


Snoopy

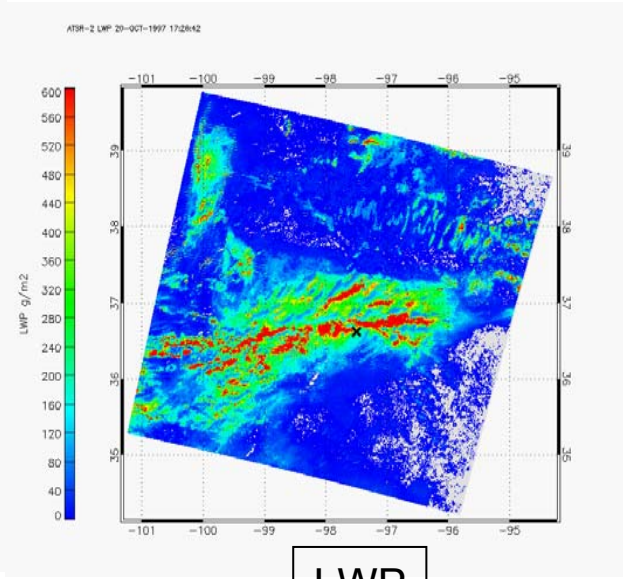
Validation case study 20th October 1997



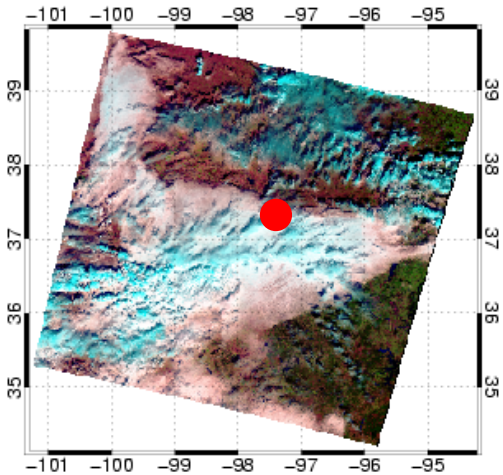
Effective radius



Optical Depth



LWP



MWR courtesy R. Marchand

Validation with radar and microwave radiometer over SGP ARM site

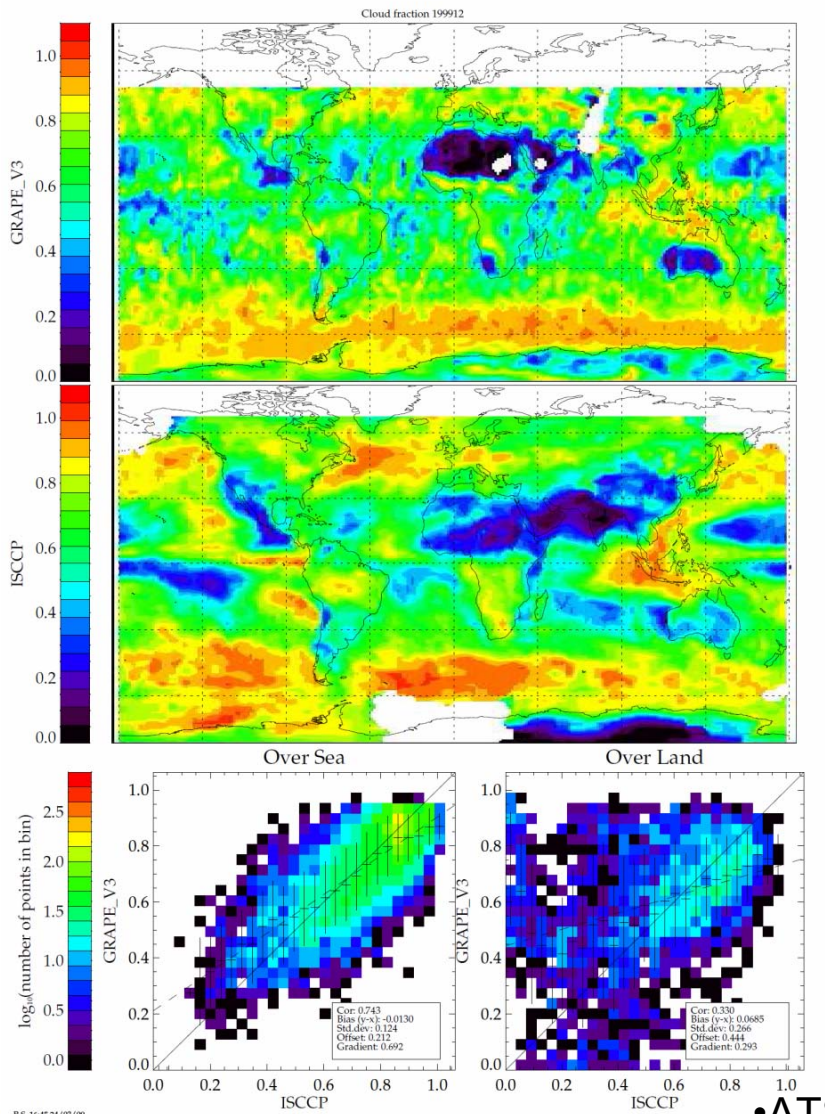
Parameter	ATSR-2	SGP
Optical depth	37.3	35.8
Effective radius	8.8	8.9
Liquid water path	244.0	209.8

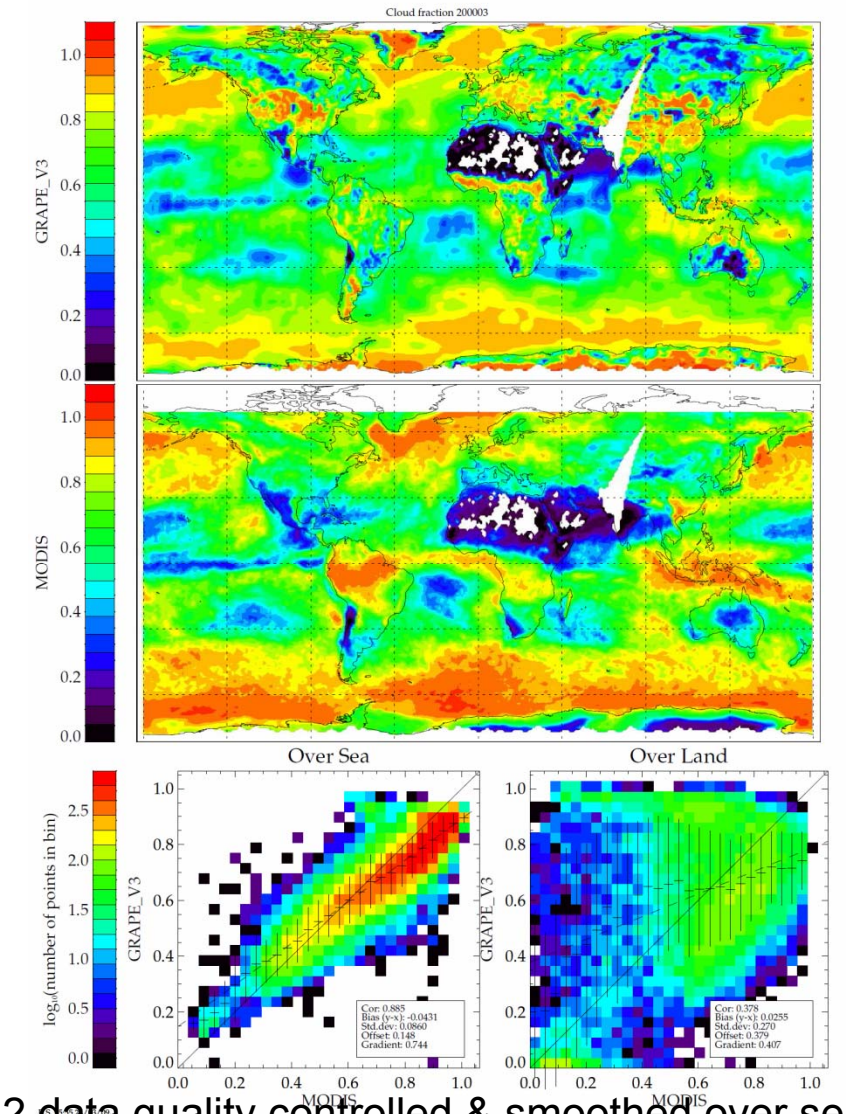
→Total RMS ±34g/m^2

Cloud fraction

ISCCP(1999/02)

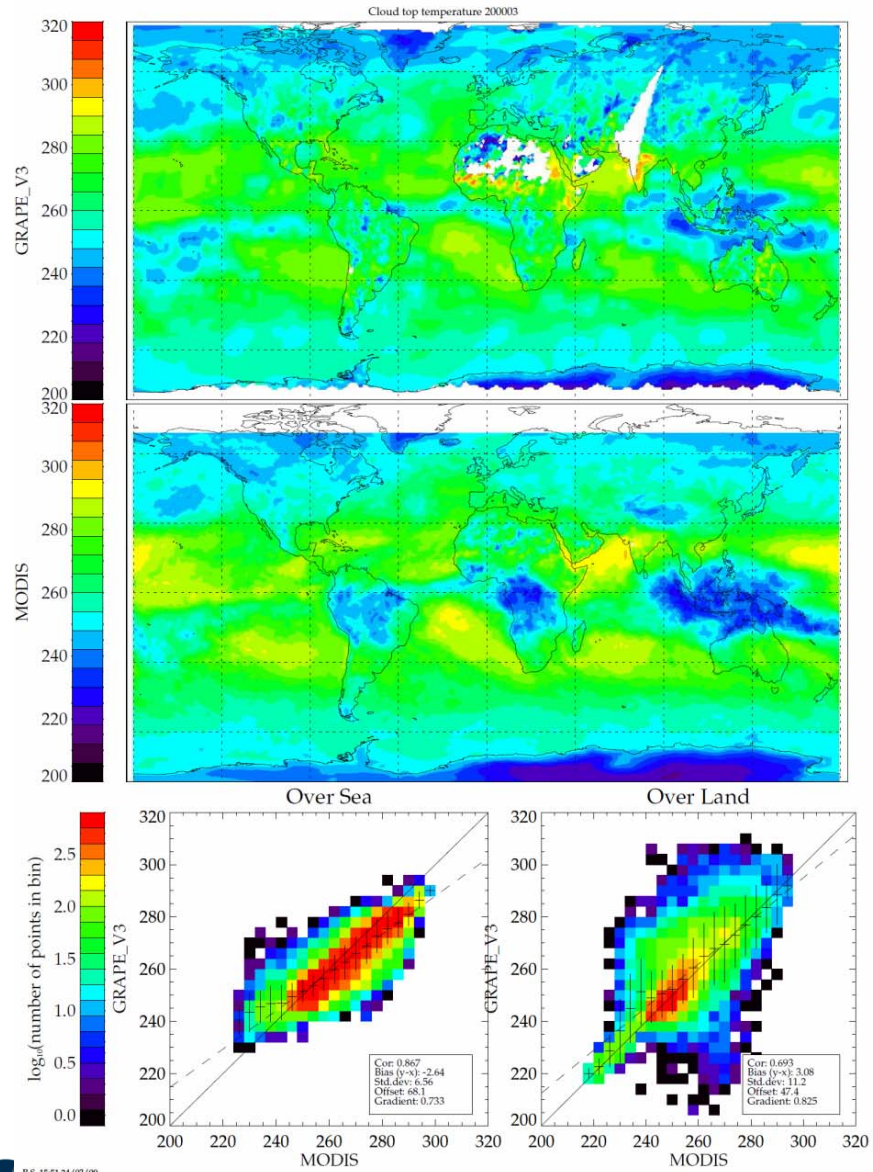
Comparison of ATSR-2 with MODIS Terra (collection 5:MOD08_M3)

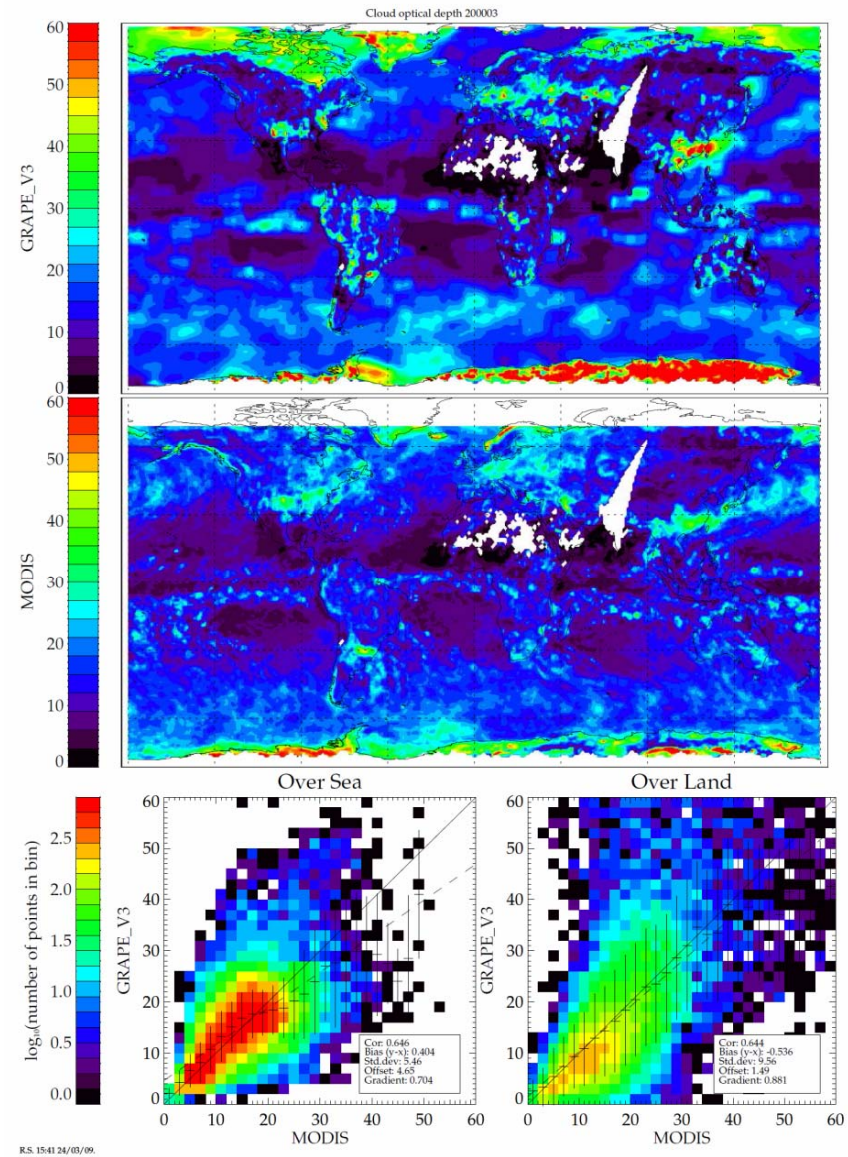




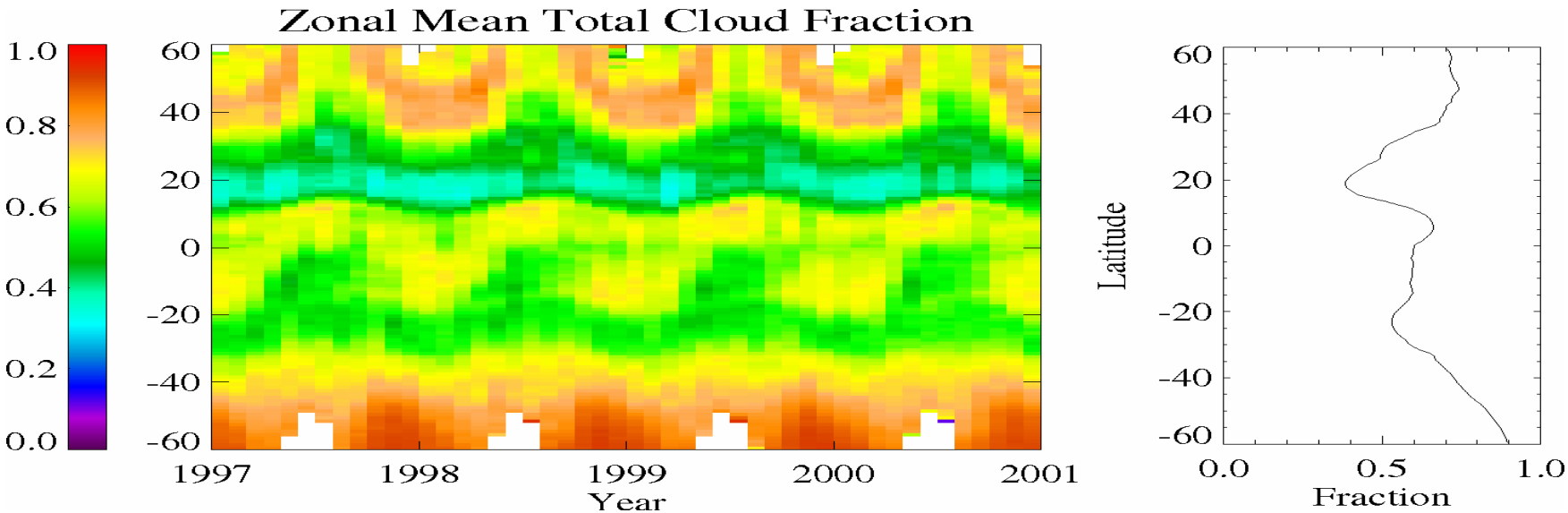
•ATSR-2 data quality controlled & smoothed over sea

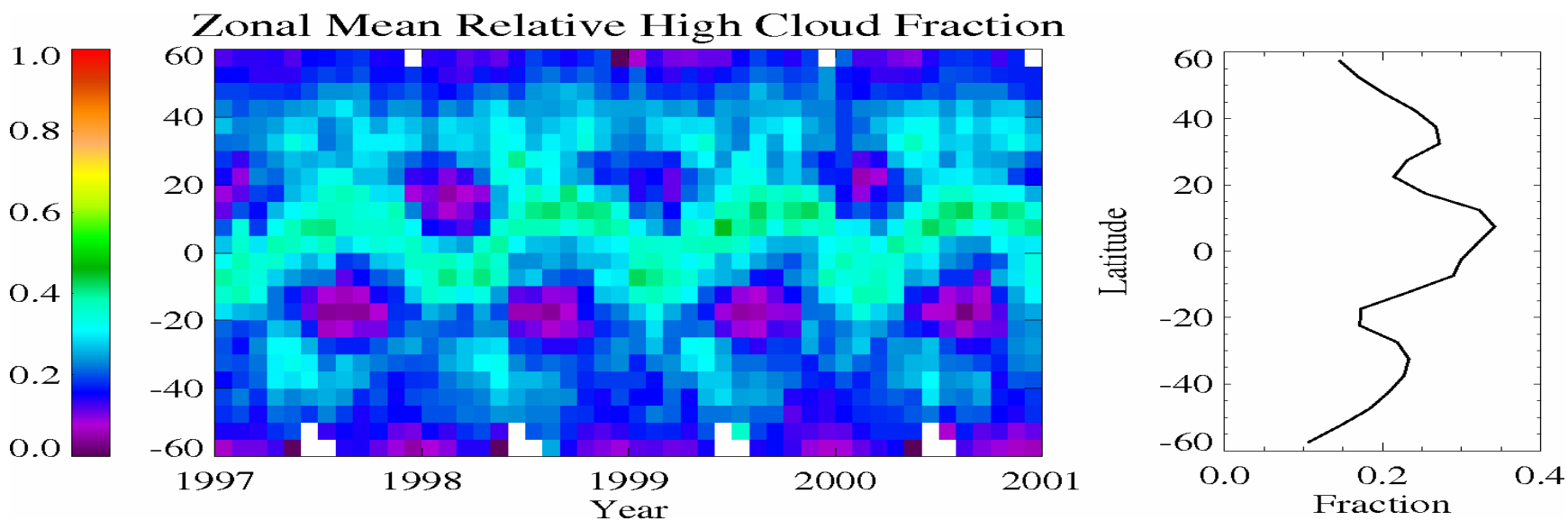
Cloud top temperature and Optical depth



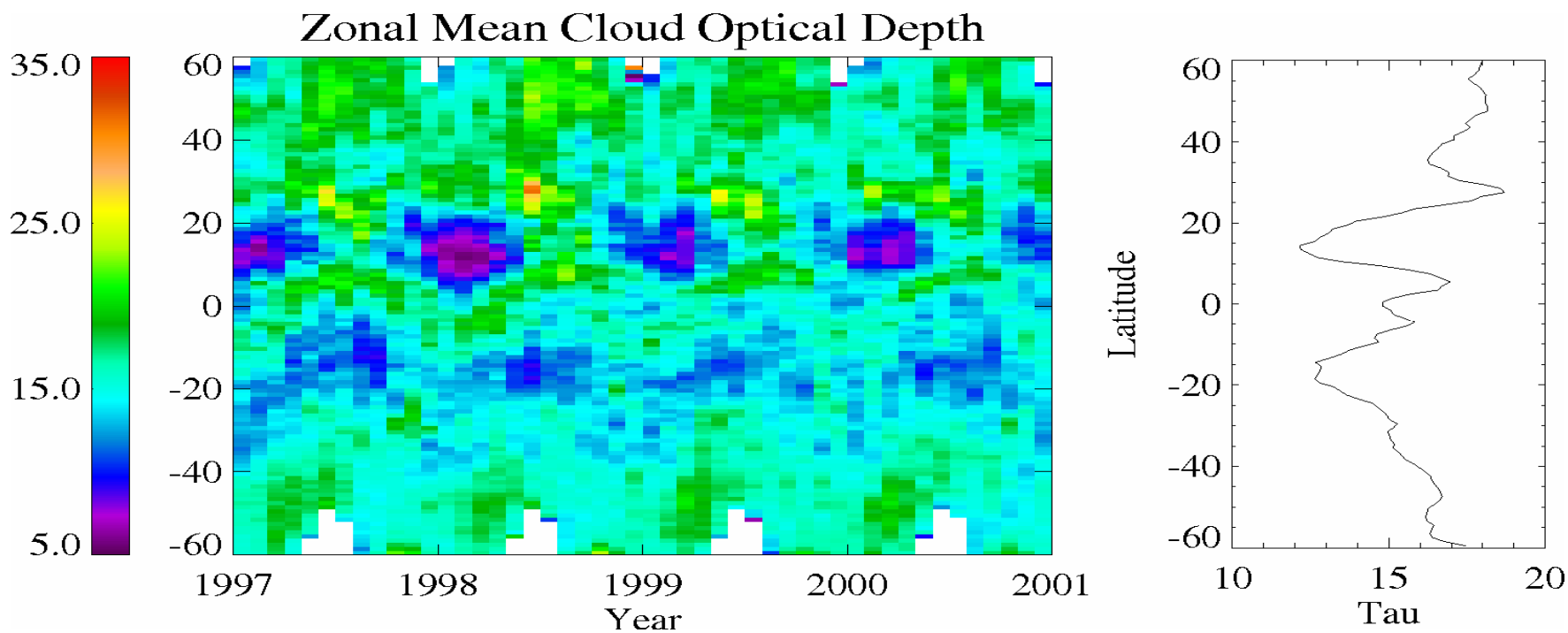


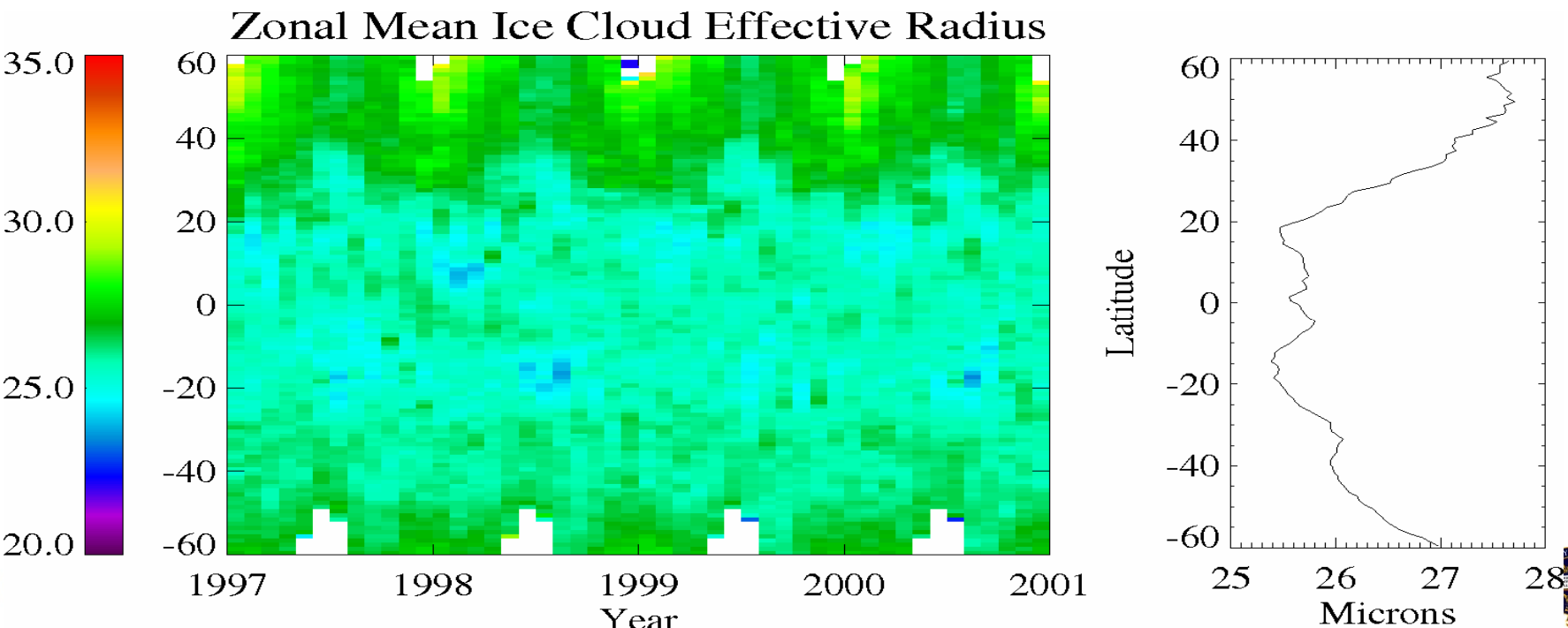
Seasonal patterns in cloud data



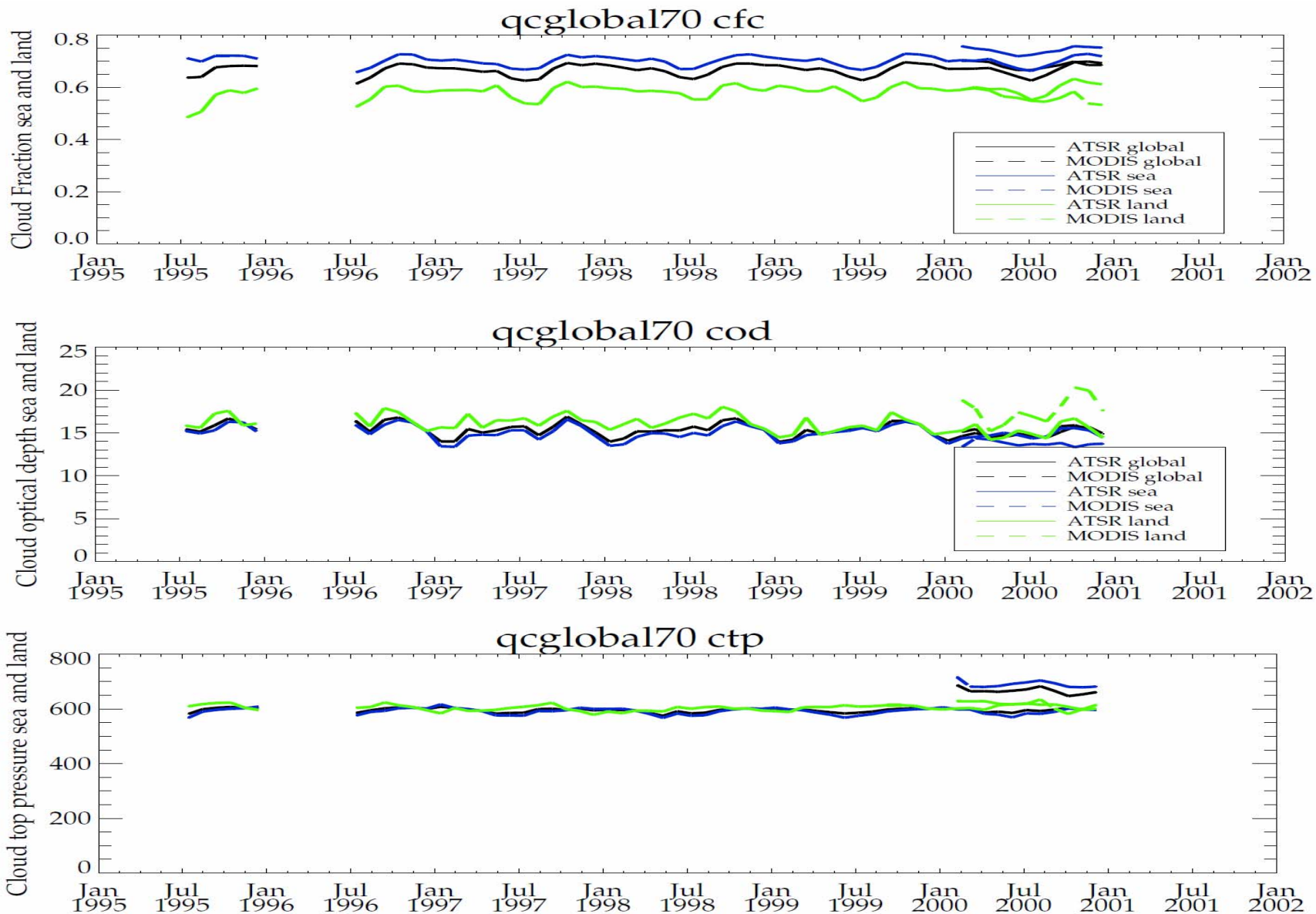


Averages are over sea and land


Zonal Mean Cloud Optical Depth
35.0
25.0
15.0
5.0
60
40
20
0
-20
-40
-60
1997
1998
1999
2000
2001
Year
Latitude
10
15
20
Tau

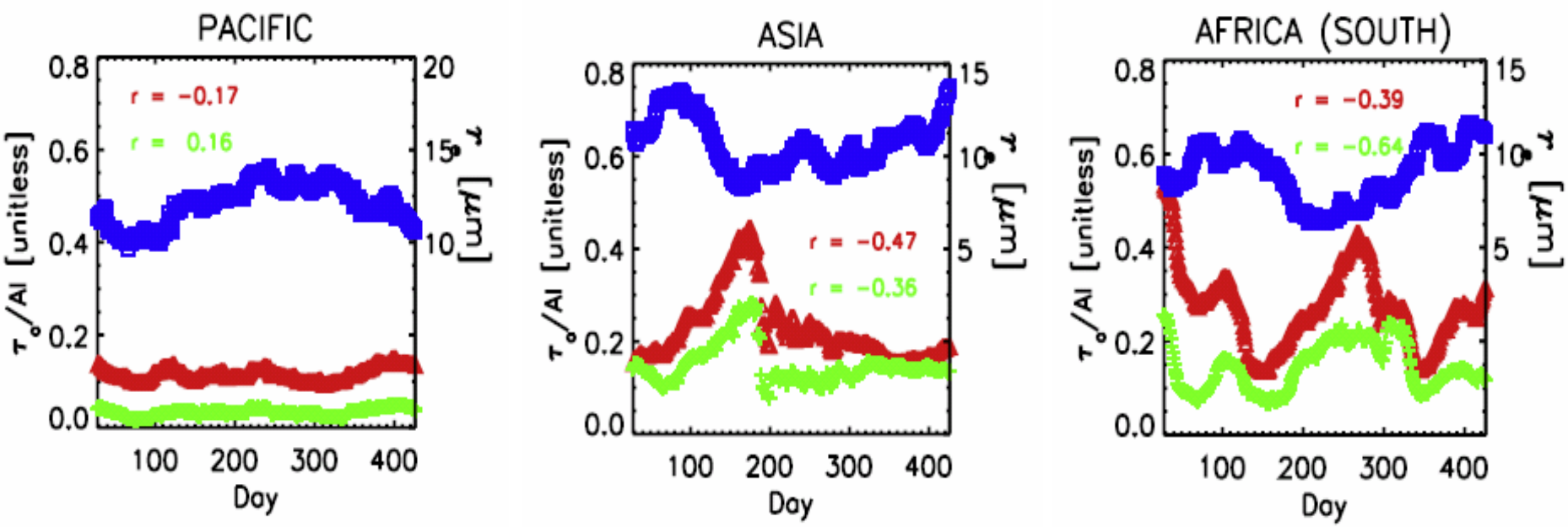

Zonal Mean Ice Cloud Effective Radius
35.0
30.0
25.0
20.0
60
40
20
0
-20
-40
-60
1997
1998
1999
2000
2001
Year
Latitude
25
26
27
28
Microns

Time series of global averages±70°



Data plotted for spatially coincident ATSR and MODIS

Tentative Detection of Twomey effect

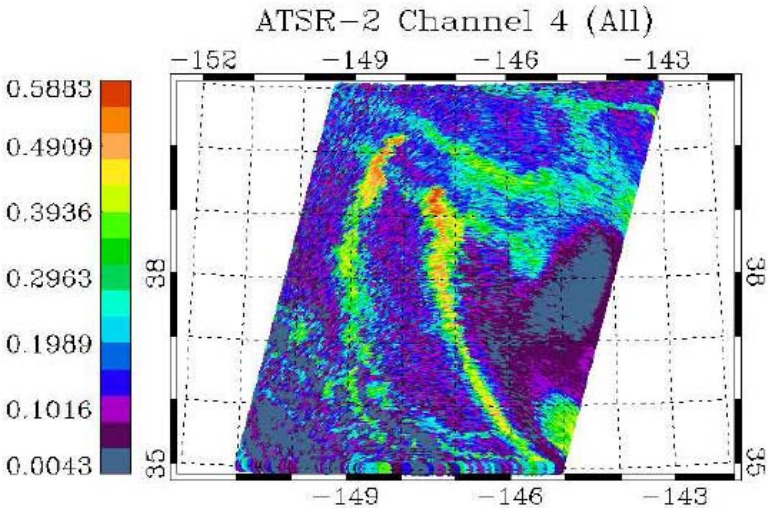


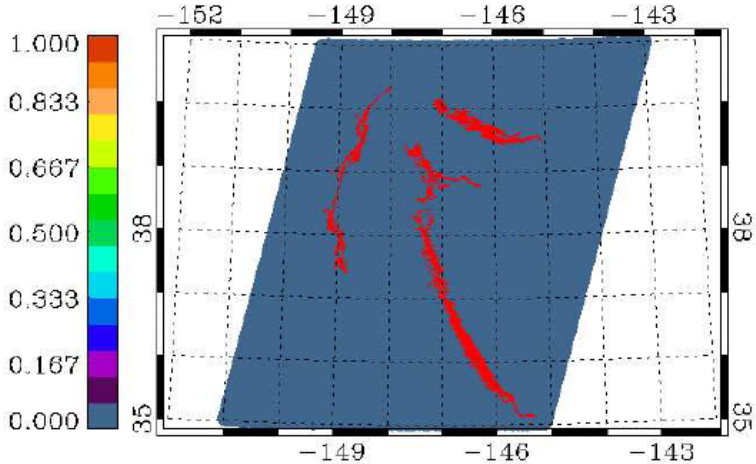
Cloud Re
Aerosol optical depth
Aerosol index

Negative correlation in polluted regions, not in clean pacific

Reference: C. Bulgin et al. Regional and seasonal variations of the Twomey indirect effect as observed by the ATSR-2 satellite instrument GRL, VOL. 35, 2008

Indentifying ship tracks

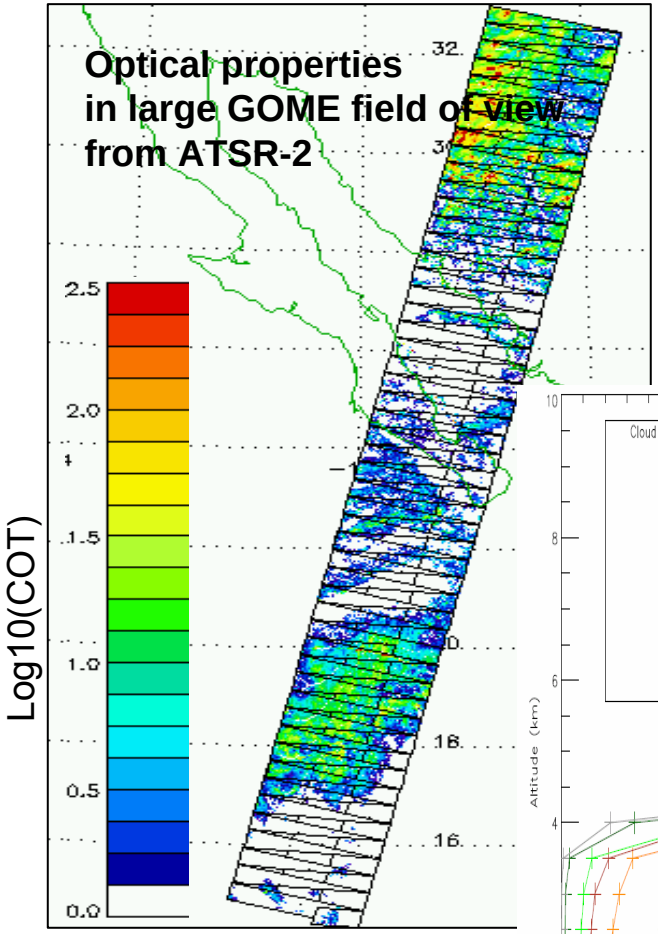




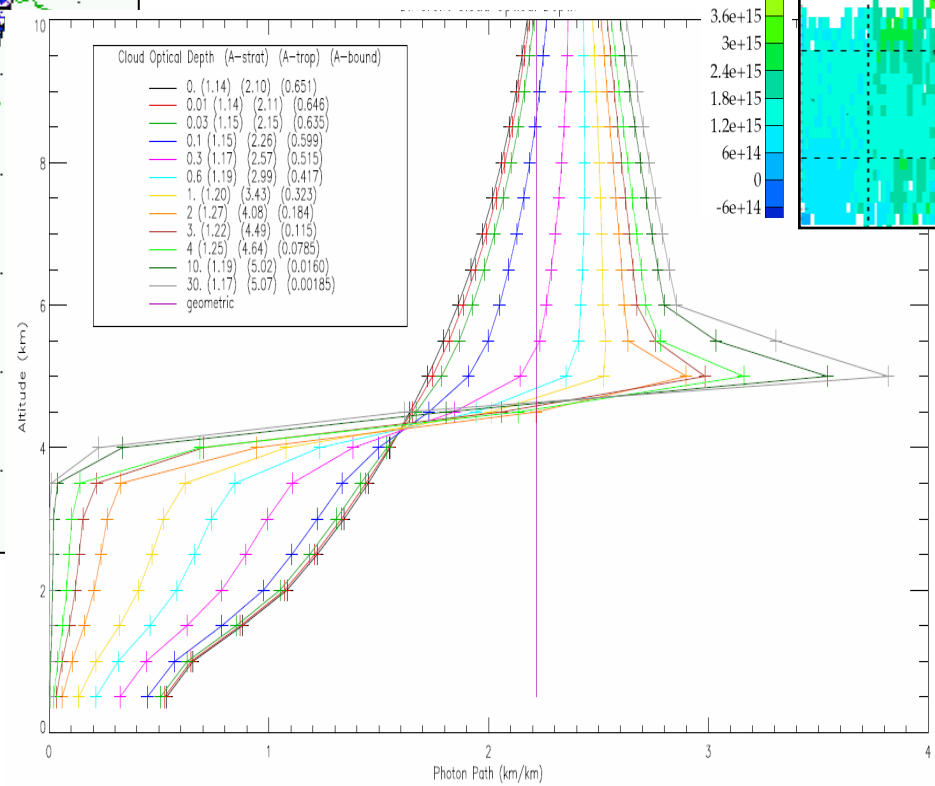
Paper published ACP Elies Campany et al.Last week!

Data available for future re-analyses

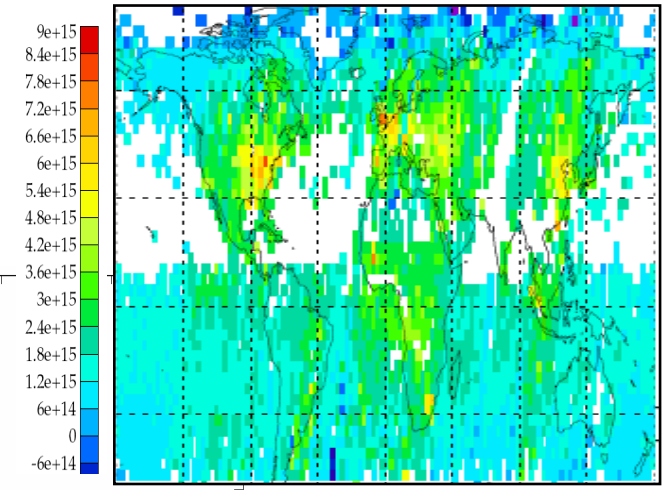
ATSR-2 cloud data used to improve accuracy of trace gas retrievals from GOME-1 (L.Gunn, U.Leeds)



Model photon paths through atmosphere using the cloud properties

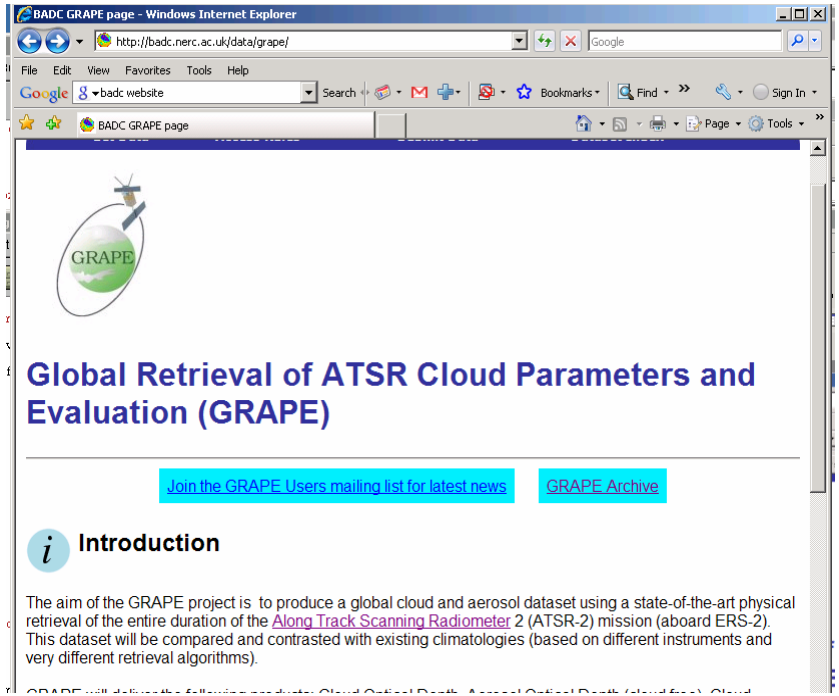


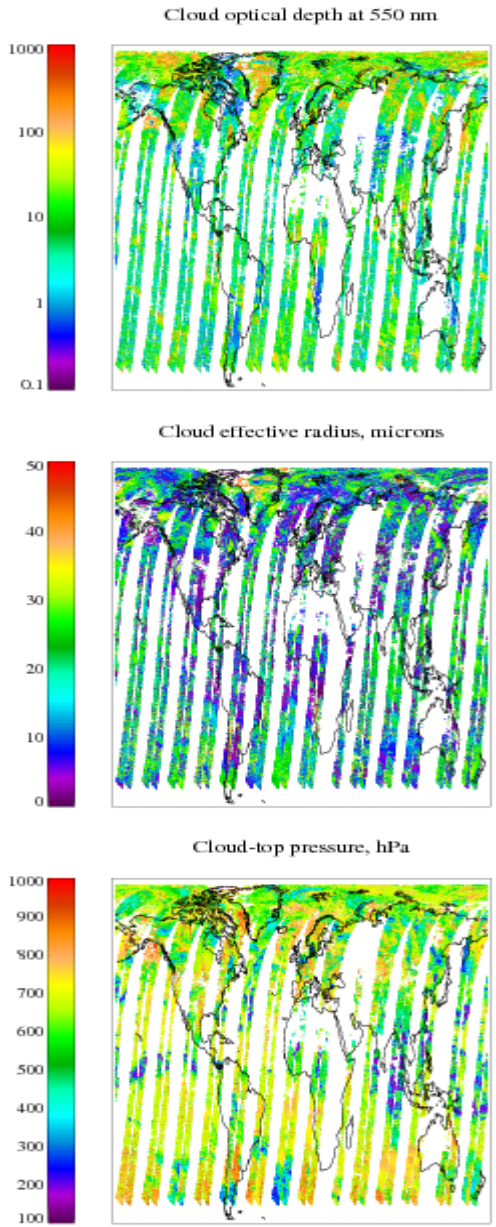
NO_2 tropospheric column / molec.cm^{-2}



Status -How can I get the data?

- ATSR-2 processed
- http://badc.nerc.ac.uk/data/grape/
- V3 latest version
- AATSR processing with same scheme due to complete in next 4 months



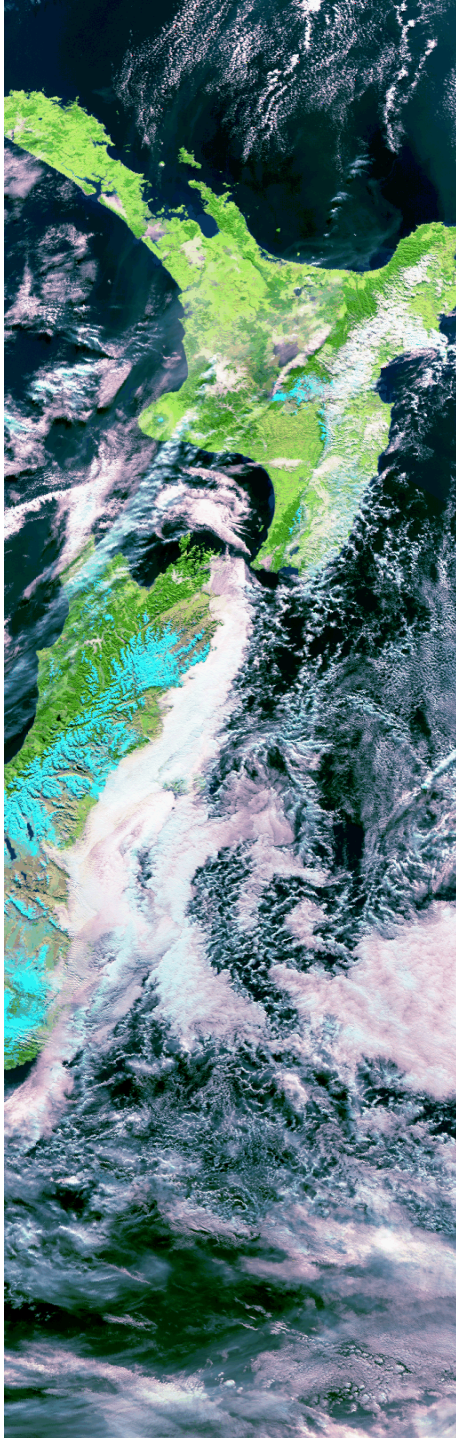


We are very willing to help with interpretation

Future developments

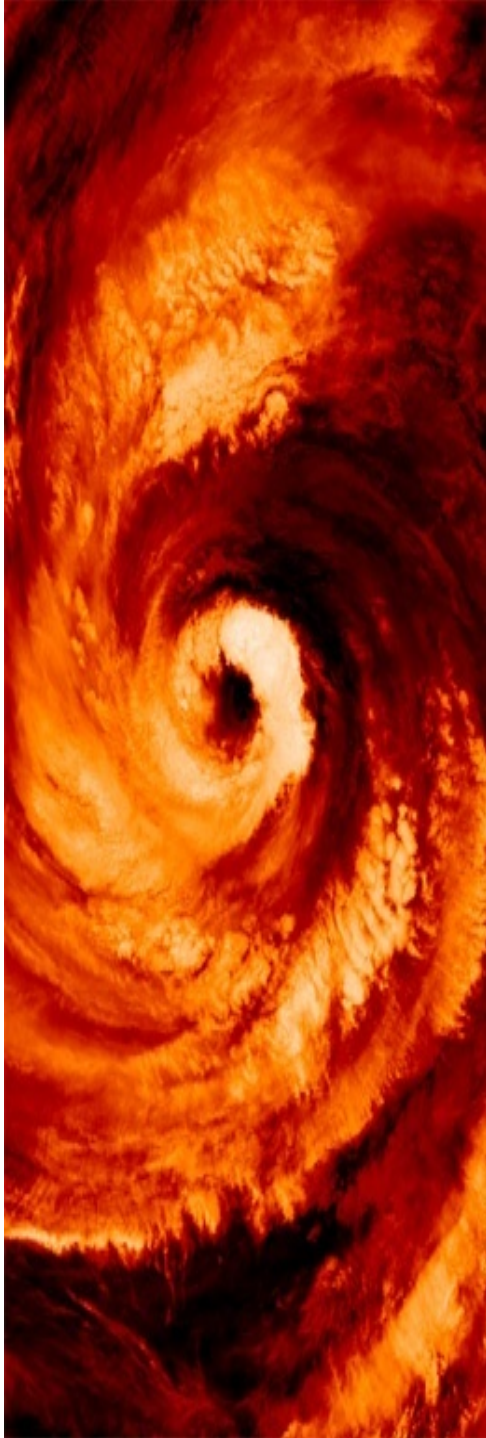
- First processing of AATSR
  – *in progress*

- Improved separation of cloud / aerosol
  – *post-hoc assignment*
- New representation of ice crystal properties
- Representation of multi layer cloud
  – *in progress (Eumetsat study)*
- Utilisation of forward view
  – *information added in current OE frame*
  – *stereo for 3-D (PhD UCL)*

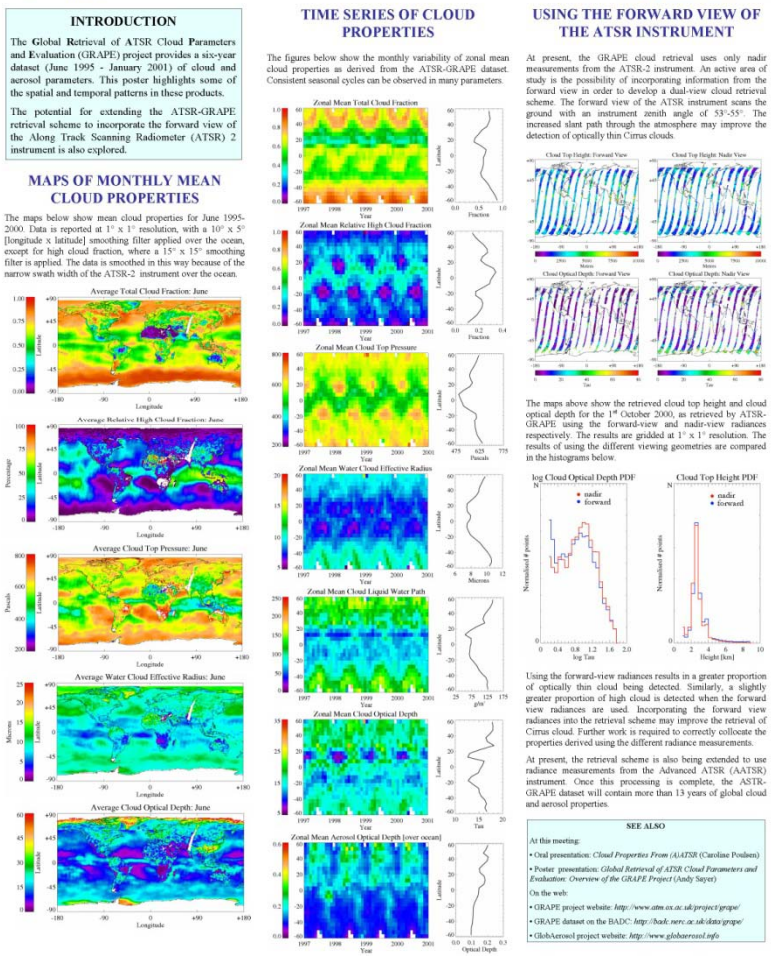


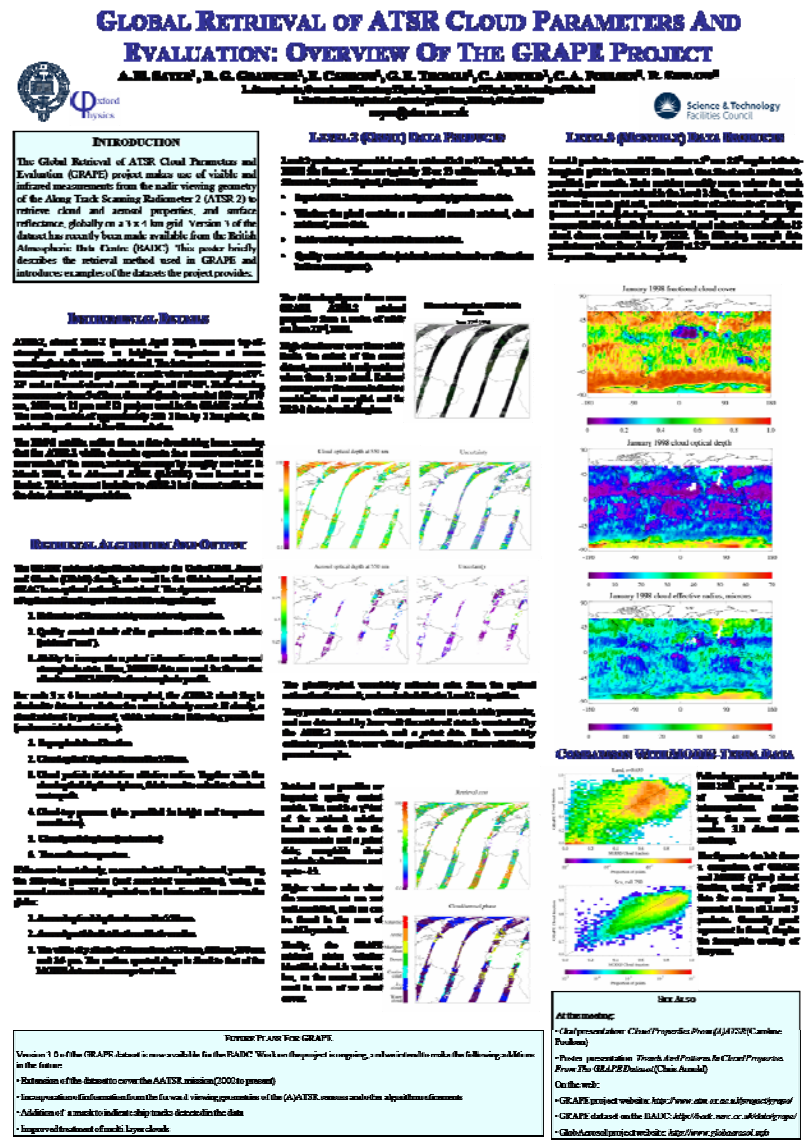
Conclusions

- First climatology of cloud properties available from ATSR-2
- Processing of AATSR data underway with same algorithm
- Optimal Estimation also provides errors on retrieved properties
- The OE scheme allows the possibility testing retrieval with Climate model parameterisations
- Cloud properties evaluated by comparison with ground based and satellite
- Performance is competitive
- Identified improvements for
  - Algorithm developments in progress
- Synergy with MERIS



Posters at this workshop





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