ATSR
Optical depth, Effective Radius
LWP/IWP Calibration

ORAC Oxford/RAL retrieval of aerosol and clouds

Caroline Poulsen, Andy Sayer[3] Richard Siddans, Barry Latter and Brian Kerridge, Chris Mutlow, Chris Arnold[2], Don Grainger[2](PI), Gareth Thomas[2] and Phil Watts[1]

Space Science and Technology Department

Rutherford Appleton Laboratory

UK

1. *Now at EUMETSAT*
2. *University of Oxford*
3. *UO/RAL*

Science & Technology Facilities Council

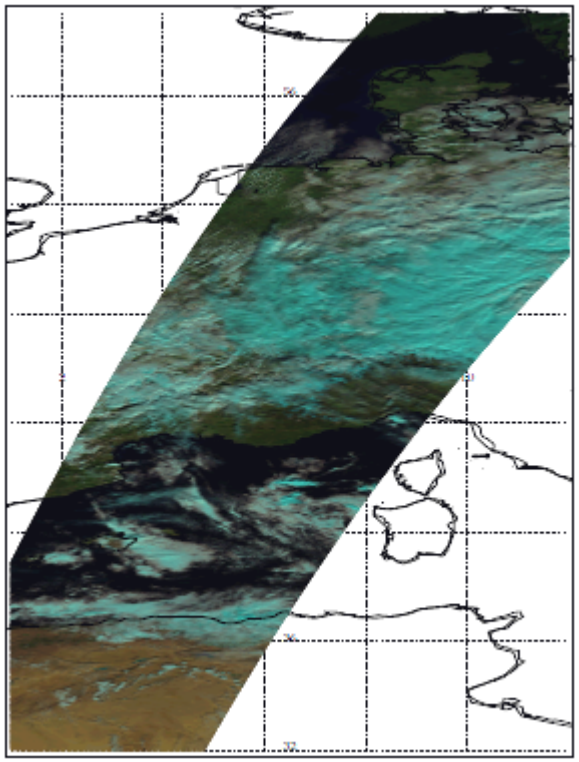
Rutherford Appleton Laboratory

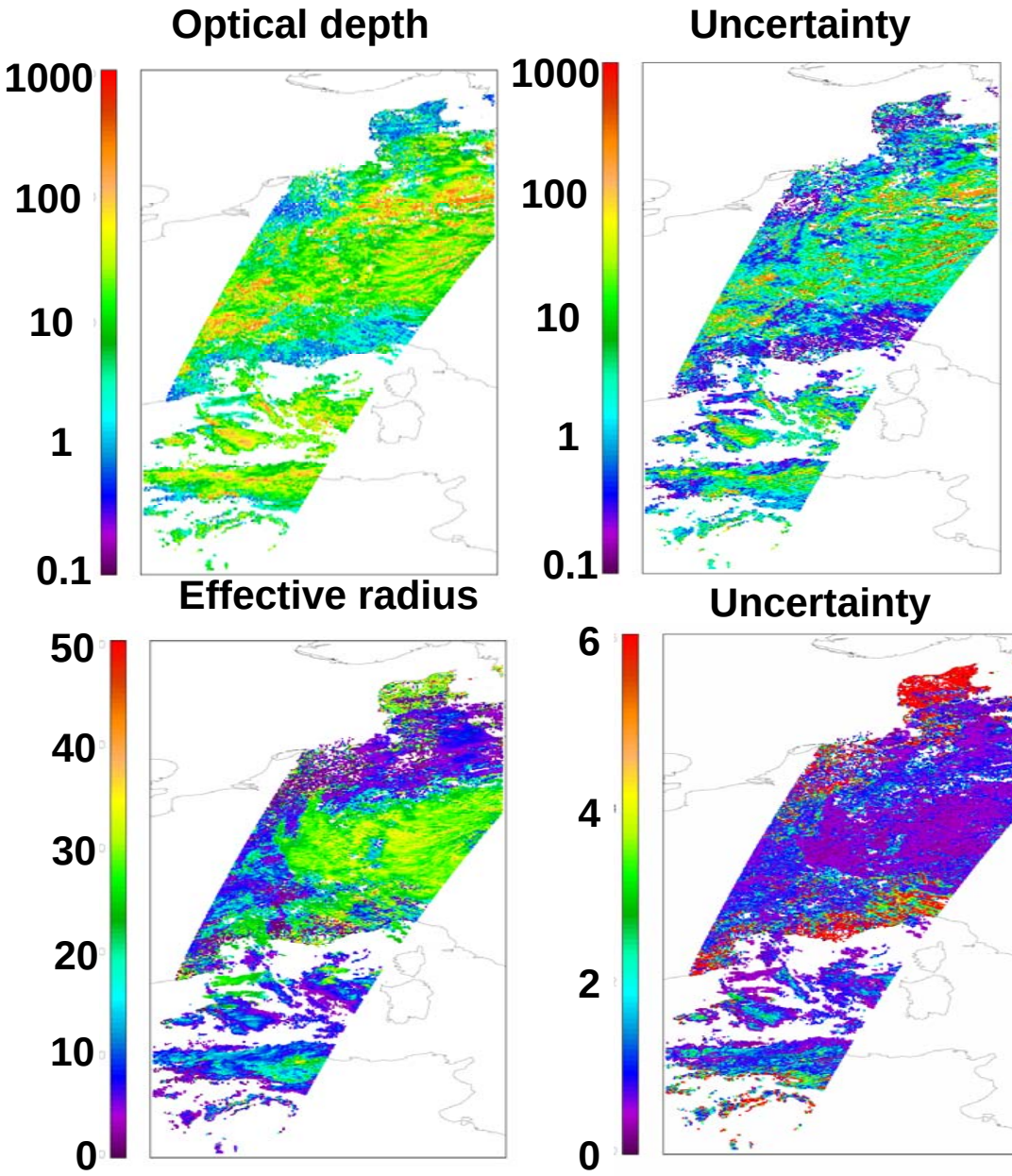
ORAC CLOUDS: REMINDER

- Algorithm: Poulsen et al.(in prep)
- Validation:Sayer et al. (in prep)
- Optimal estimation algorithm
  - Simultaneous fit of all cloud properties to observations in all spectral channels
  - Robust error propogation
  - Single layer model
  - Ice crystal properties from Baran

Retrieved in state vector	Derived
Cloud optical depth at 550 nm	Liquid/ice water path
Cloud effective radius	
(Phase)	
Cloud-top pressure	Cloud-top height
	Cloud-top temperature
Surface temperature	

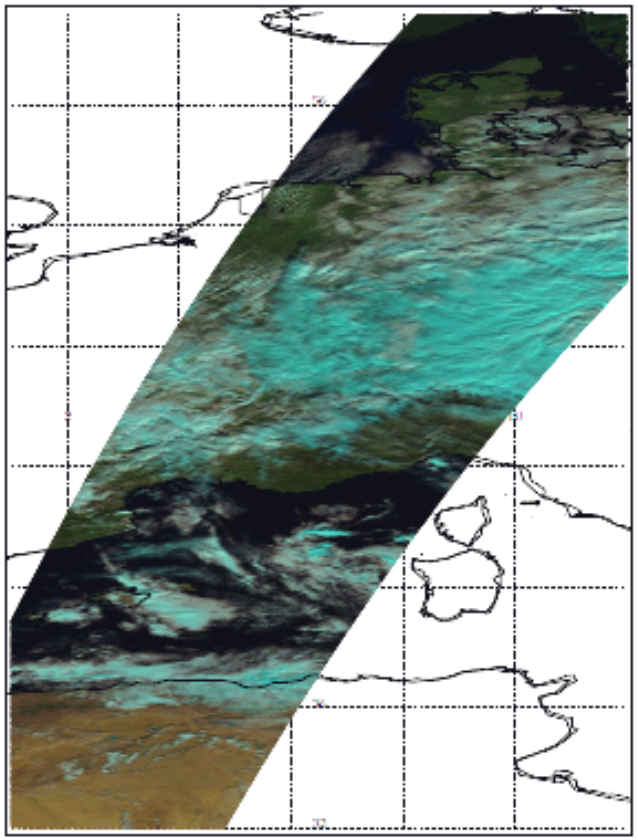
Since submitting data sets to Gewex we found a small bug in data**





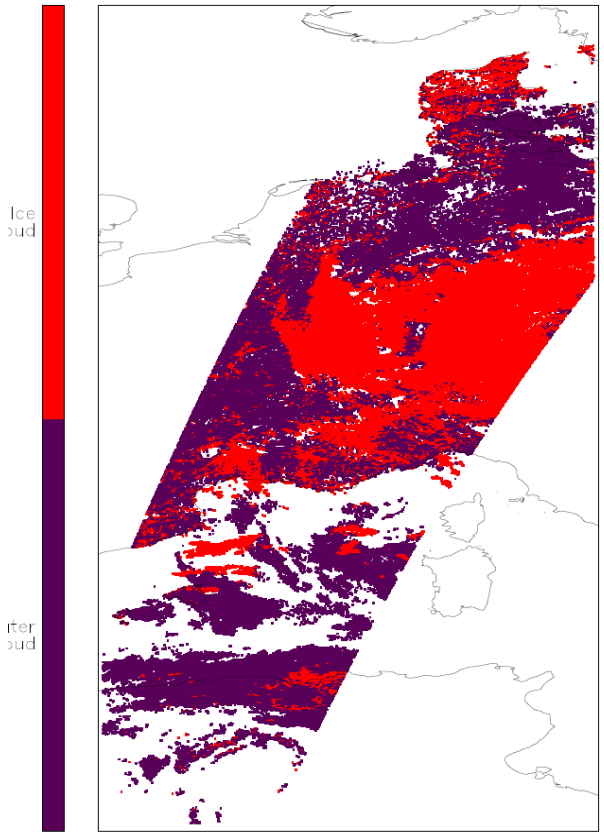
- Optical depth uncertainty related to magnitude
- Effective radius uncertainty ~1 µm or better, except for thin clouds

Phase Identification



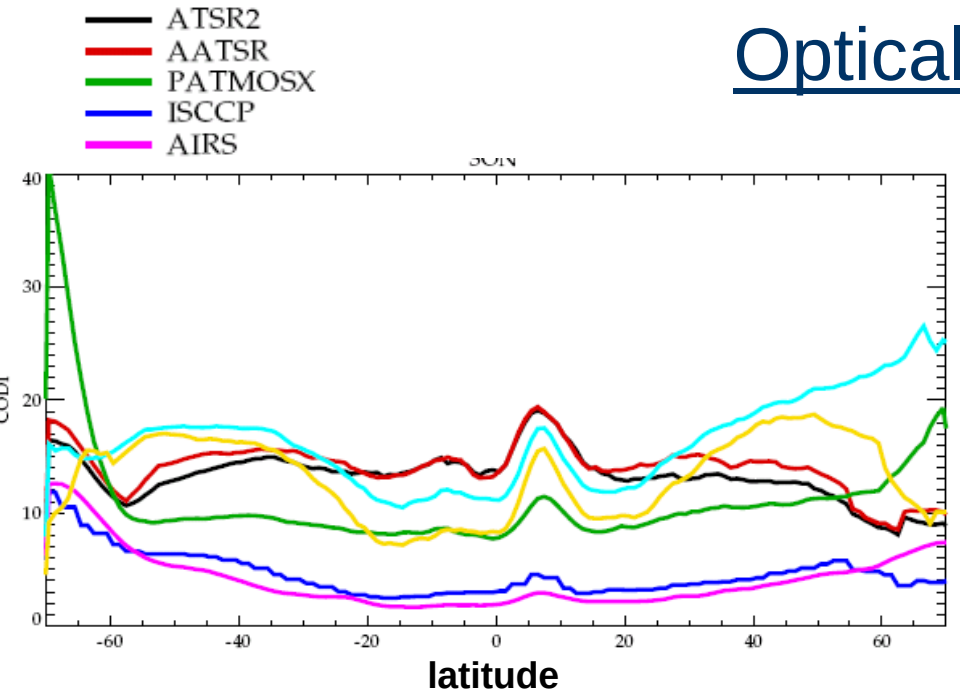
ICE

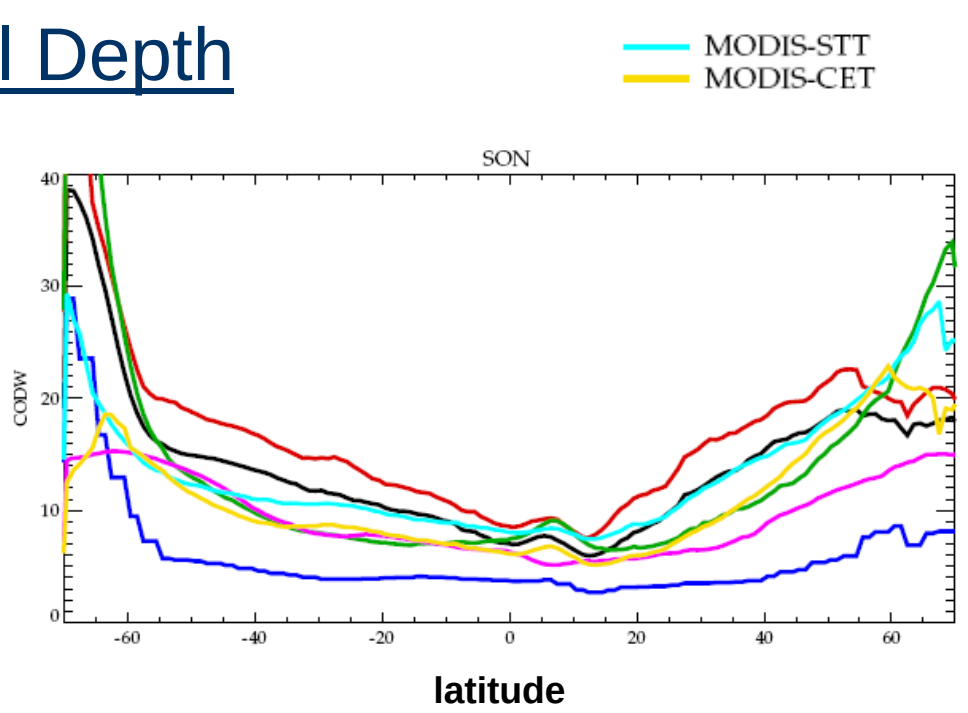
WATER



- Phase corresponds approximately to what might be expected from false-colour, but remains a binary choice whereas real scene is often ice over liquid.

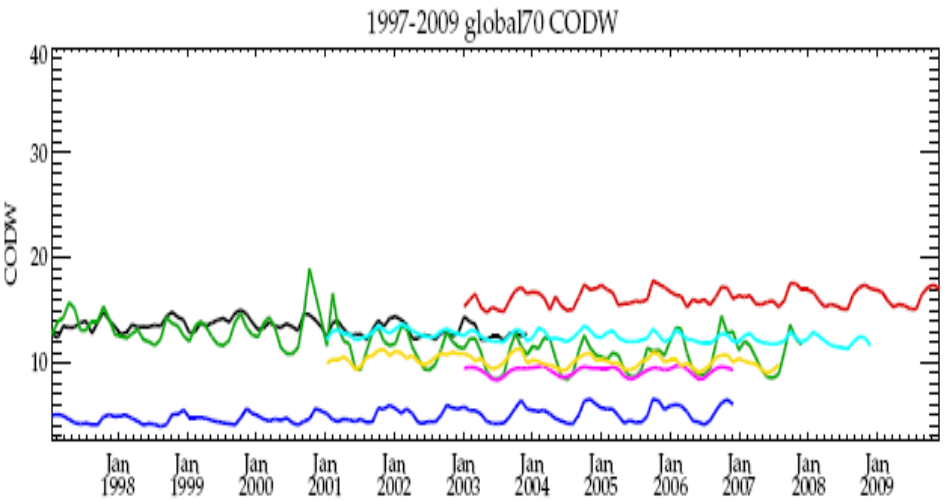
Optical Depth

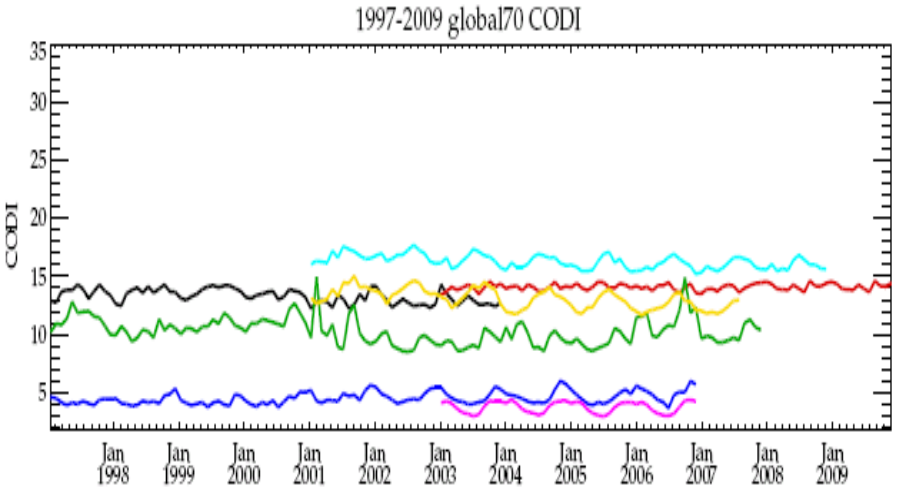




Optical depth ice

Optical depth water

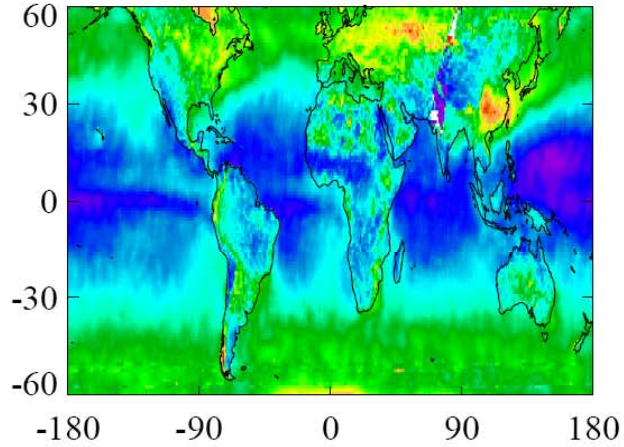




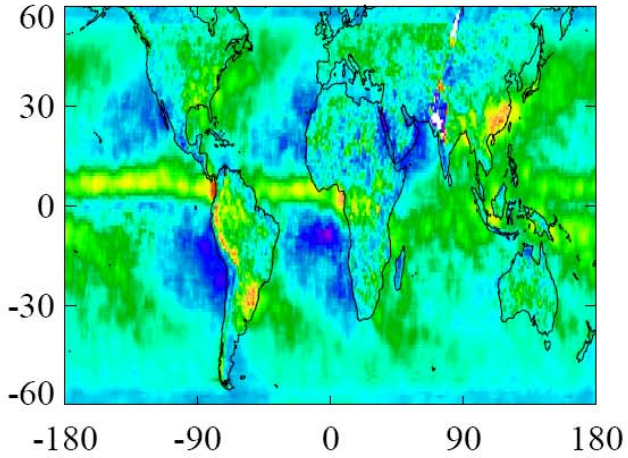
Comparison of Cloud Optical depth

0.65/0.87/1.6μm

ATSR-2 liquid COD

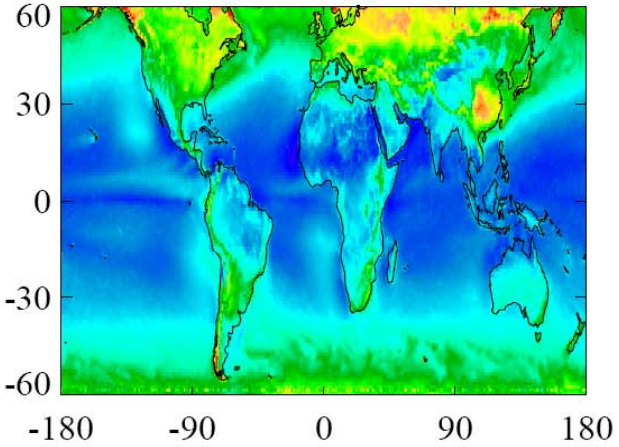


ATSR-2 ice COD

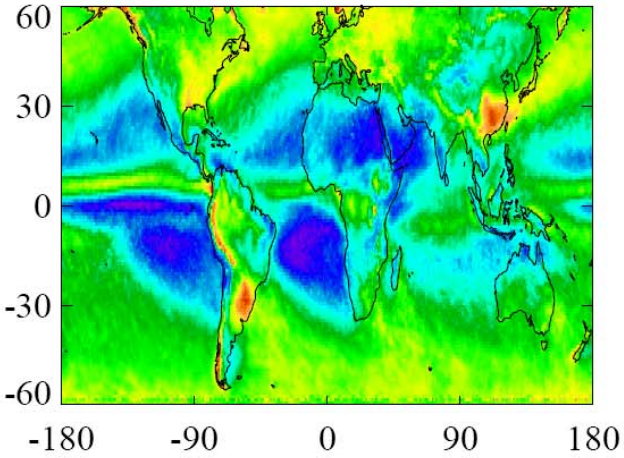


0.65(land)/0.86(ocean)μm

MODIS-ST liquid COD

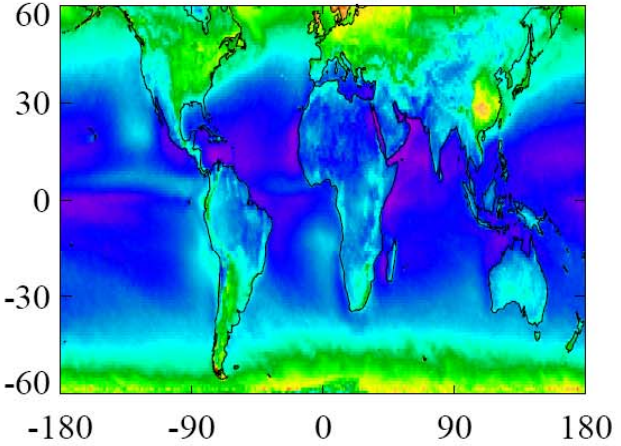


MODIS-ST ice COD

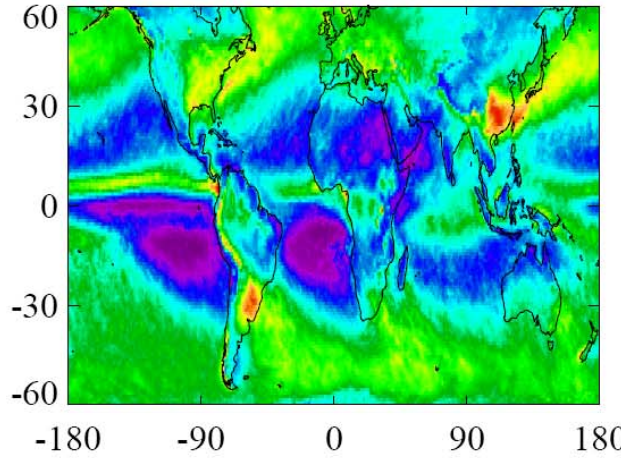


0.65/1.6(bright surfaces)μm

MODIS-CE liquid COD



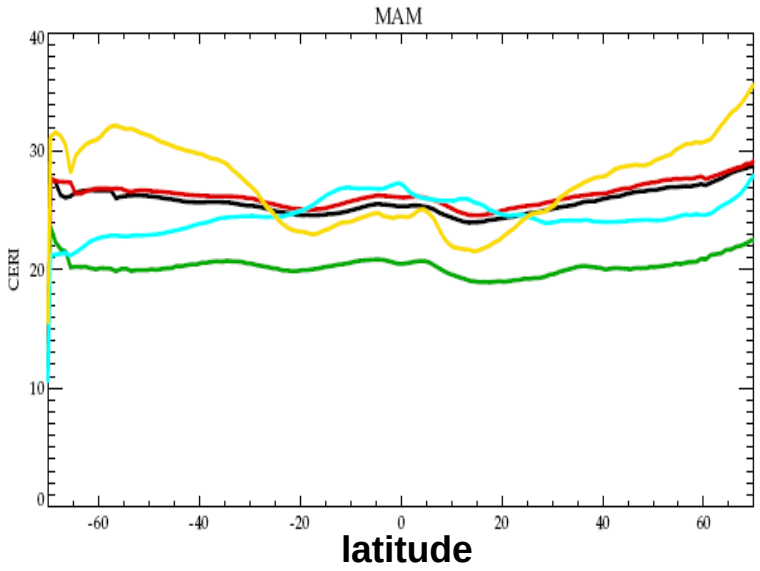
MODIS-CE ice COD

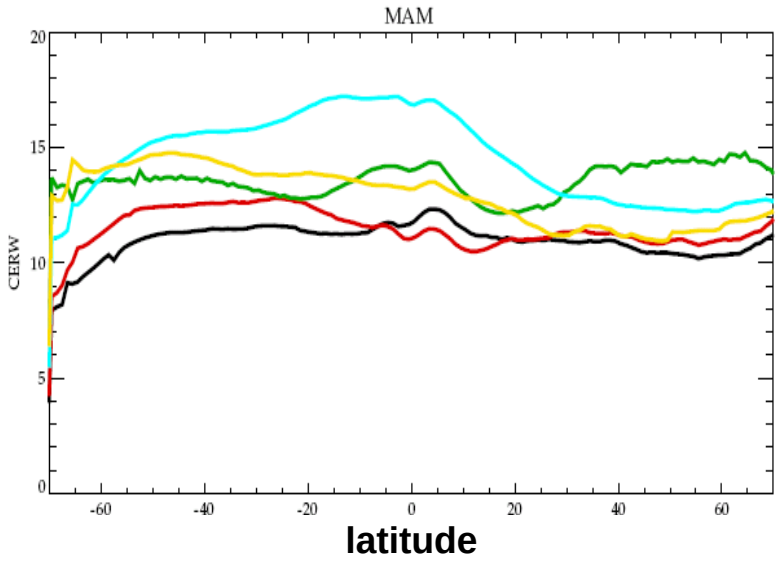


ATSR2
AATSR
PATMOSX

Effective radius

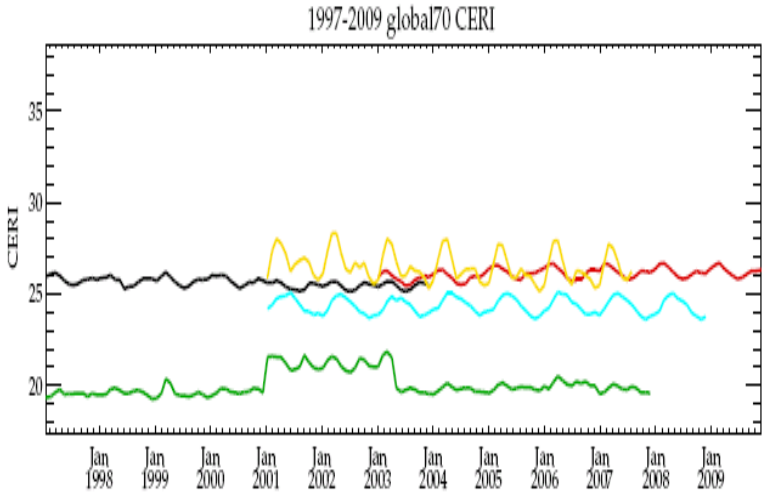
MODIS-STT
MODIS-CET

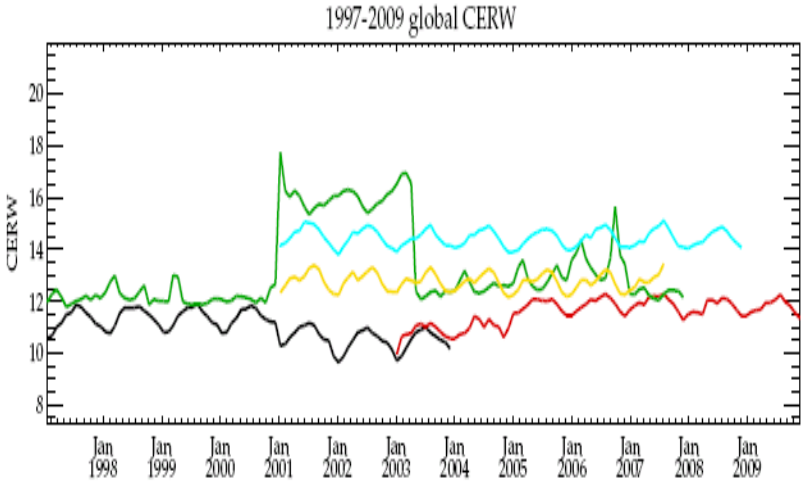




Effective radius ice

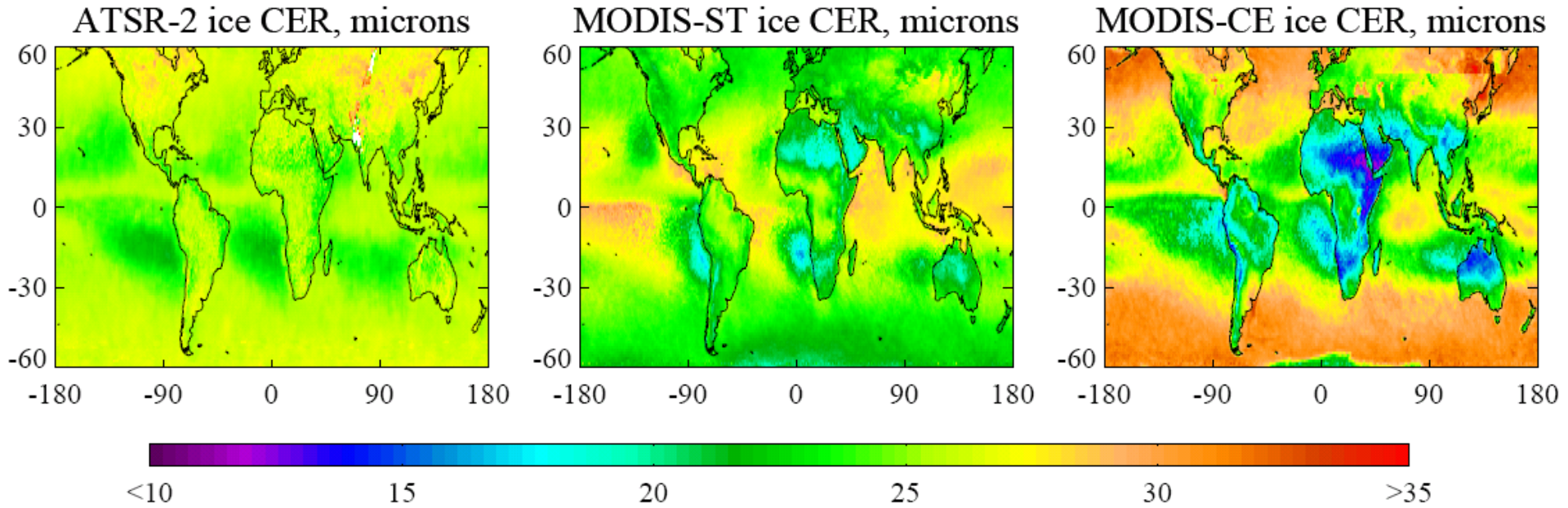
Effective radius water





Comparison of ice effective radius regional comparison-multi annual mean

1.6μm **2.1μm** **3.7μm**



Differences between MODIS products (Minnis 2010)

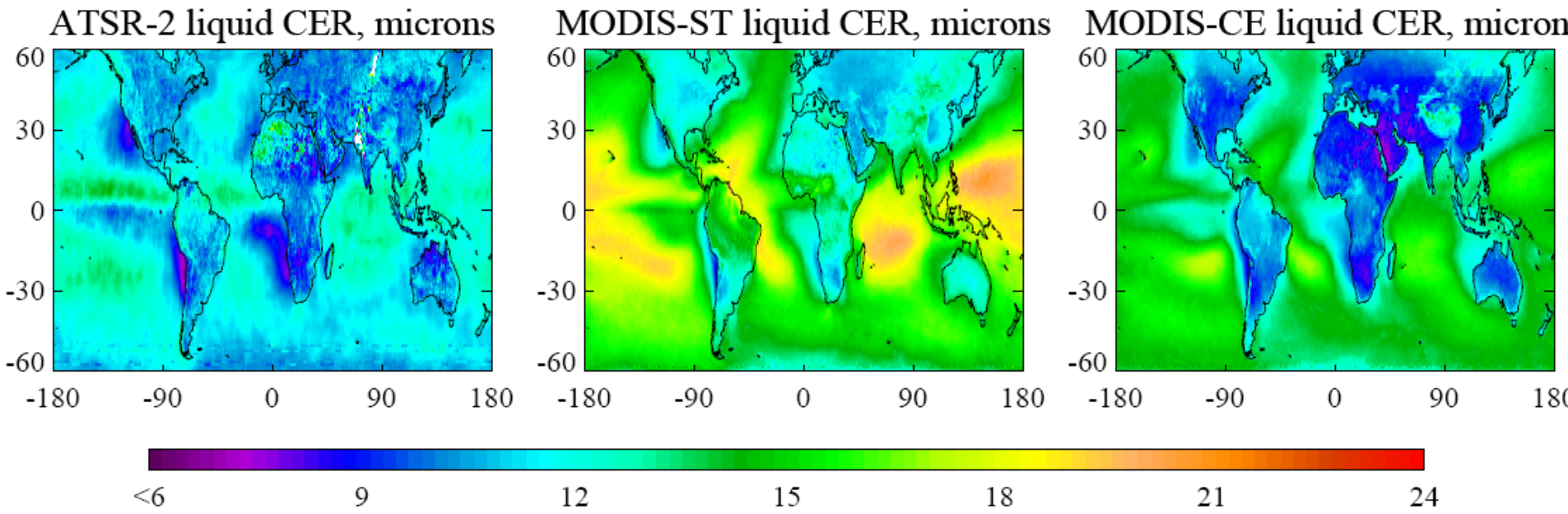
- **Different channels used**
- **Different ice models used**
- **Different averaging**

We use Baran ice crystal properties-aggregates

Comparison of liquid effective radius

Absorption coefficient of water

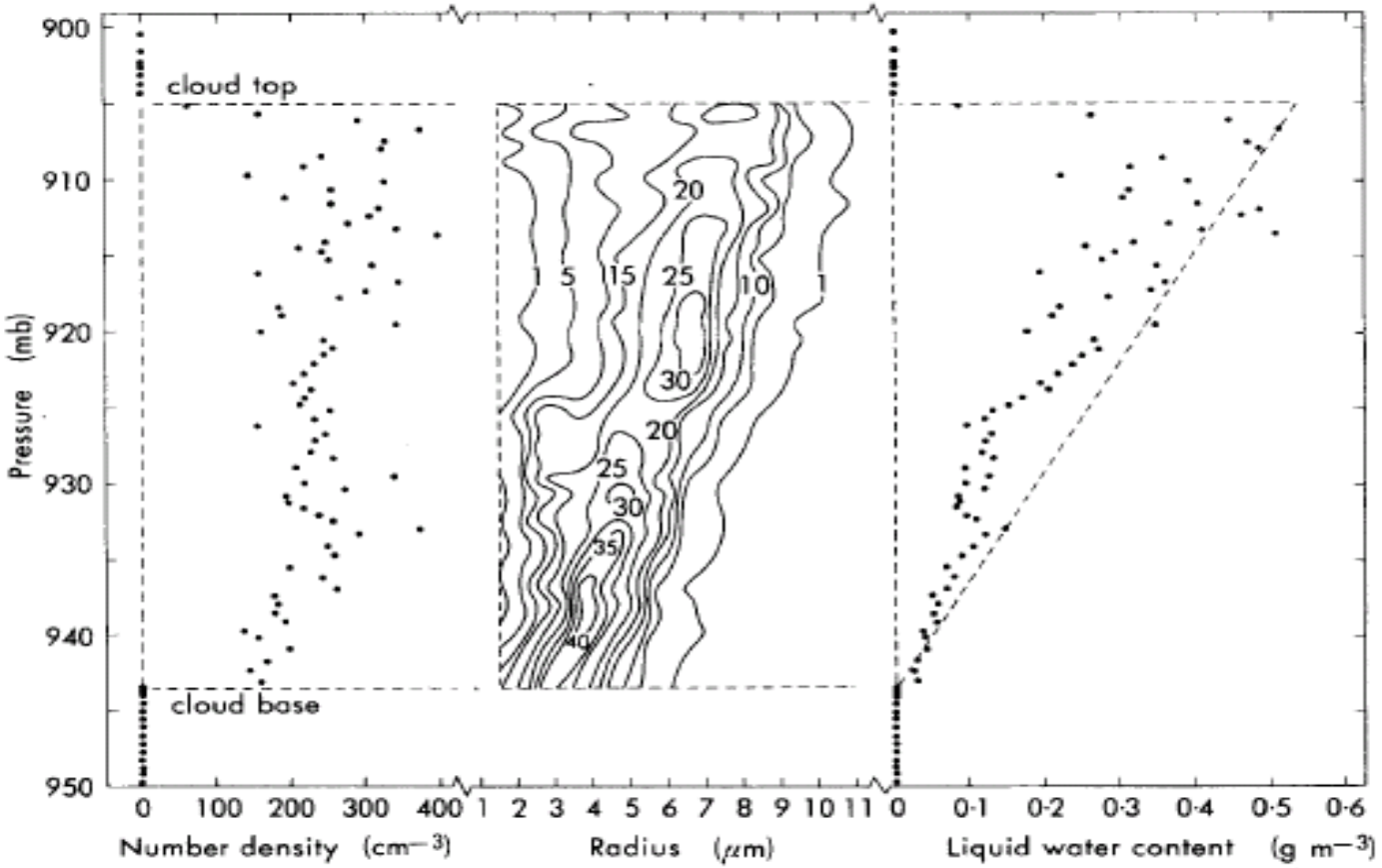
1.6μm **2.1μm** **3.7μm**



penetration

If no vertical gradient then should not be a problem

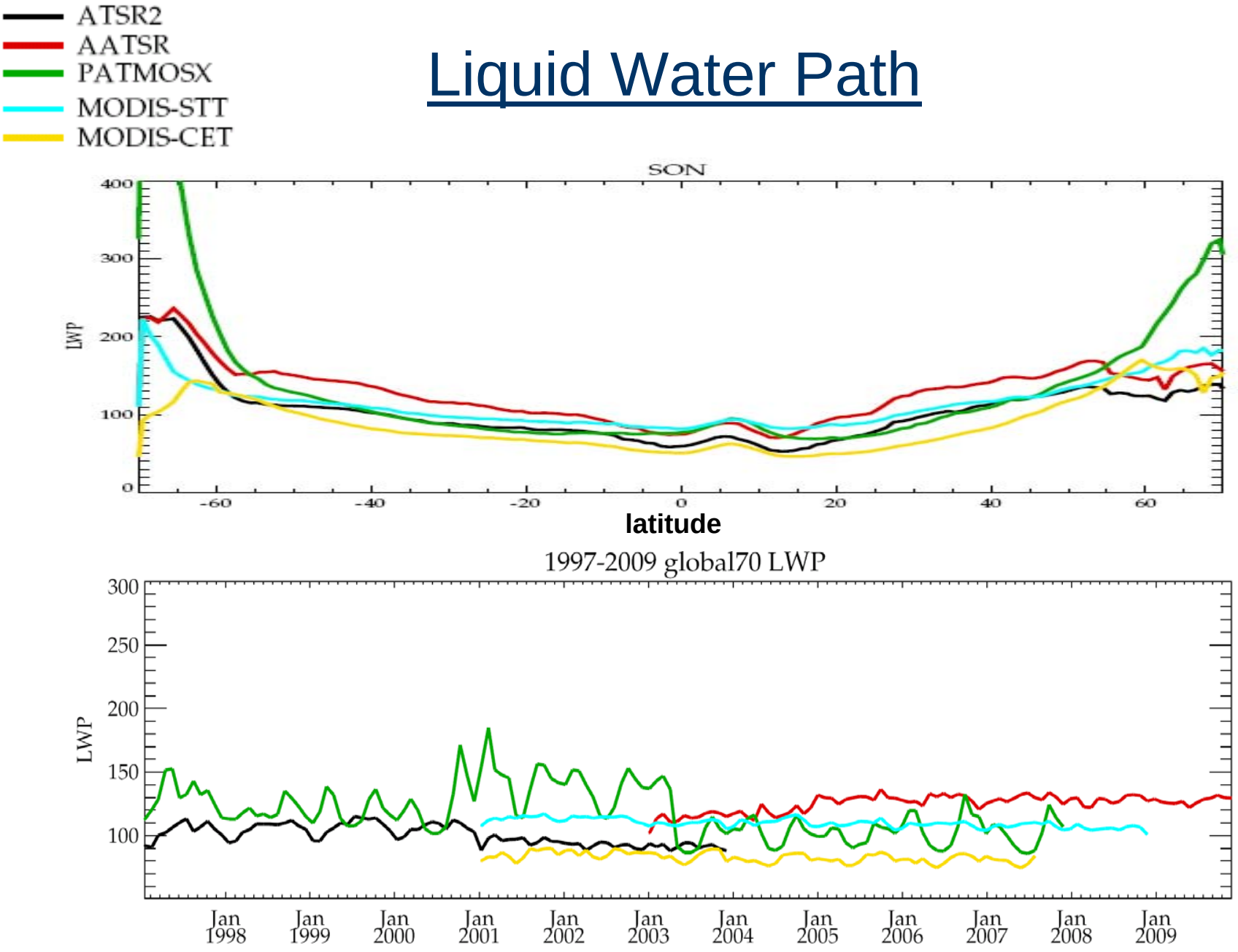
Air craft Measurements of (non precipitating)cloud droplet water size



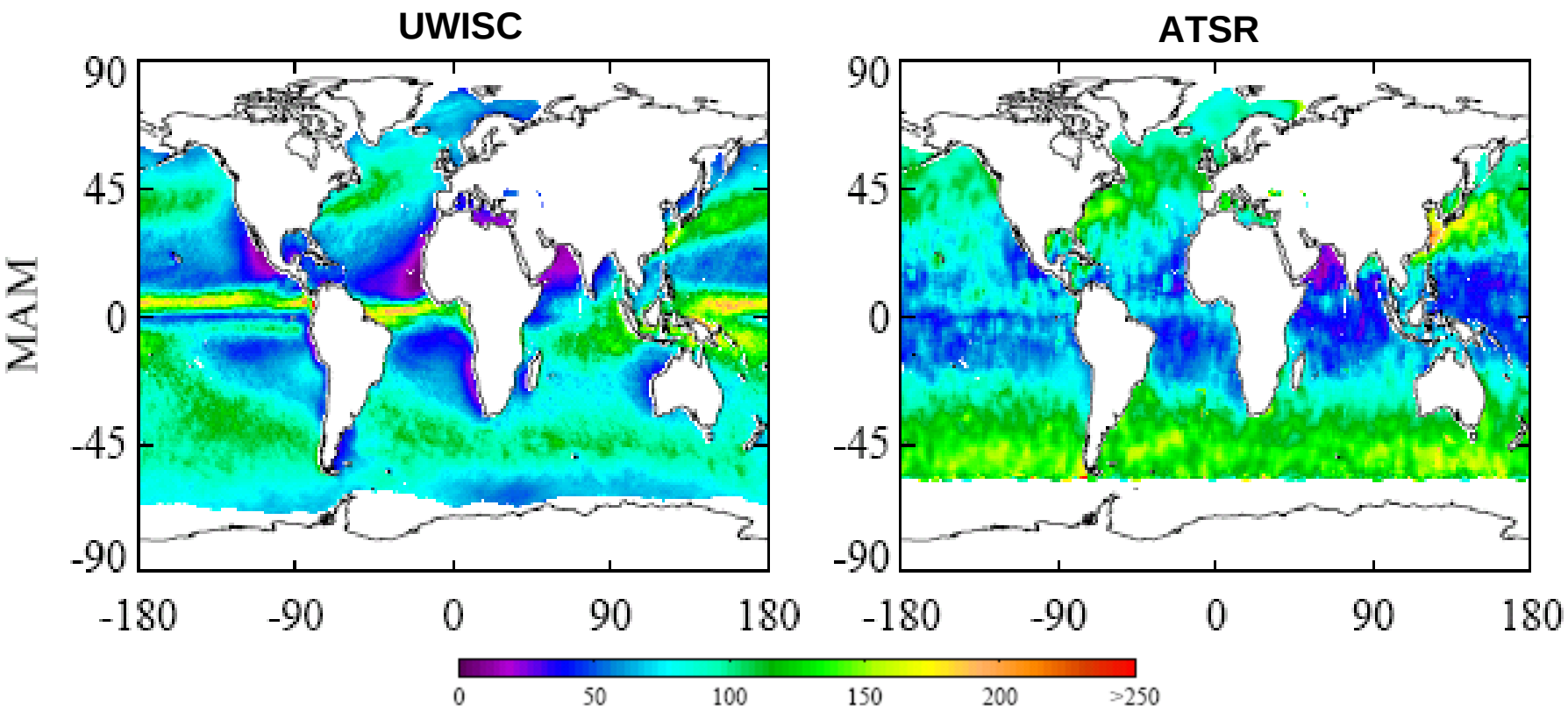
From Slingo et al. Quarterly Journal of Meteorology ,1992

Kobayashi , GRL, 2007 uses 3.7um (TRMM VIRS)
CER 13 um for non precipitating
CER 17 um for precipitating clouds

Liquid Water Path



LWP Comparison with UWISC data set.



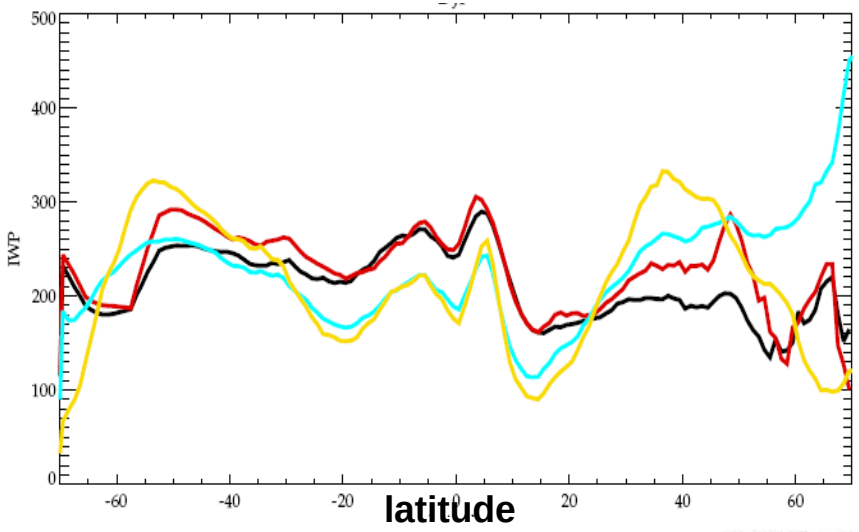
UWISC(V2): Multi year composite of TRMM SSM/I AMSR-E interpolated to 10:30
From O'Dell et al 2008 JoC

Difference correspond to areas of multi- layer cloud
-ATSR retrieves this as ice in tropics→ underestimates
-ATSR retrieves as water in extra tropics → over estimates

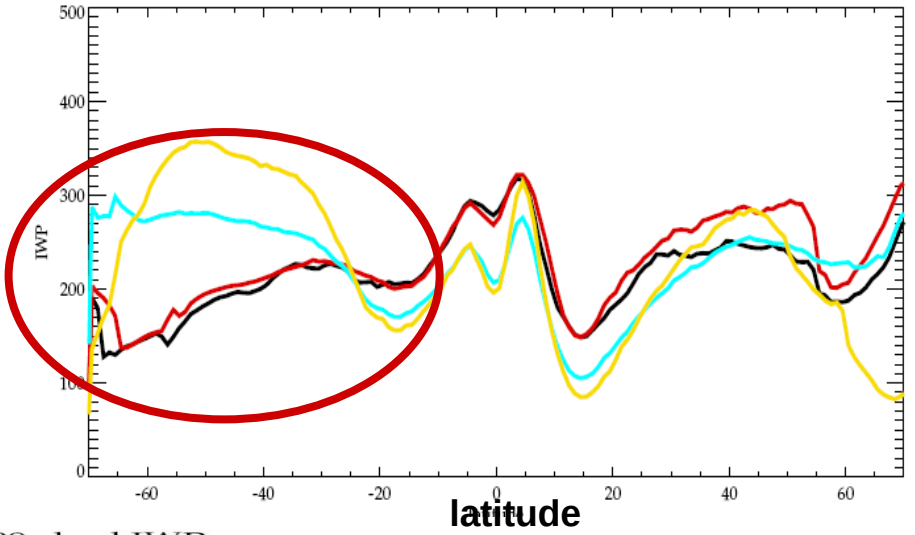
Ice Water Path

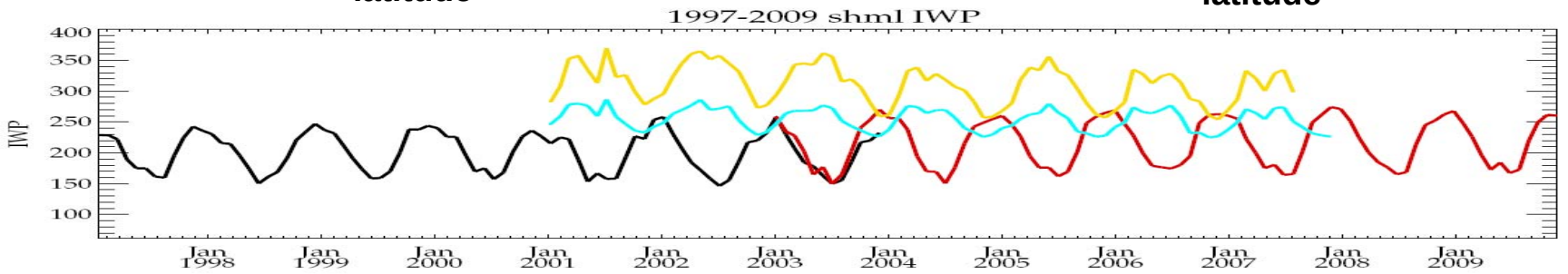
MODIS-STT
MODIS-CET
ATSR2
AATSR

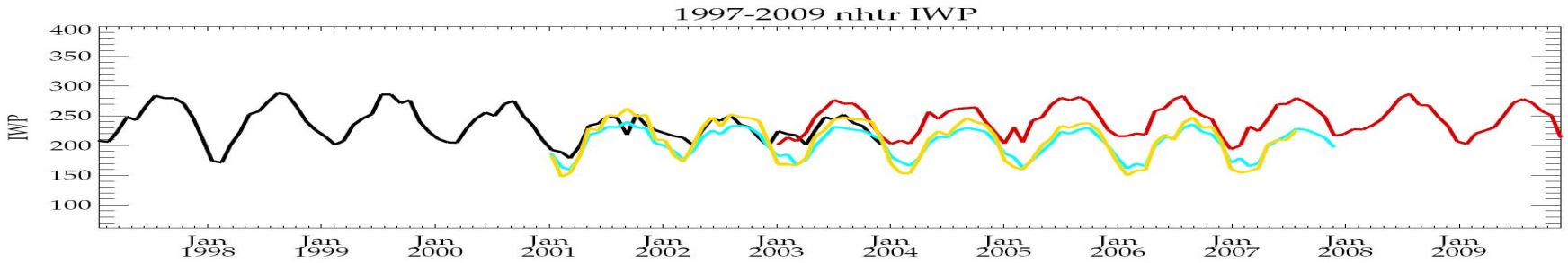
DJF IWP



MAM IWP

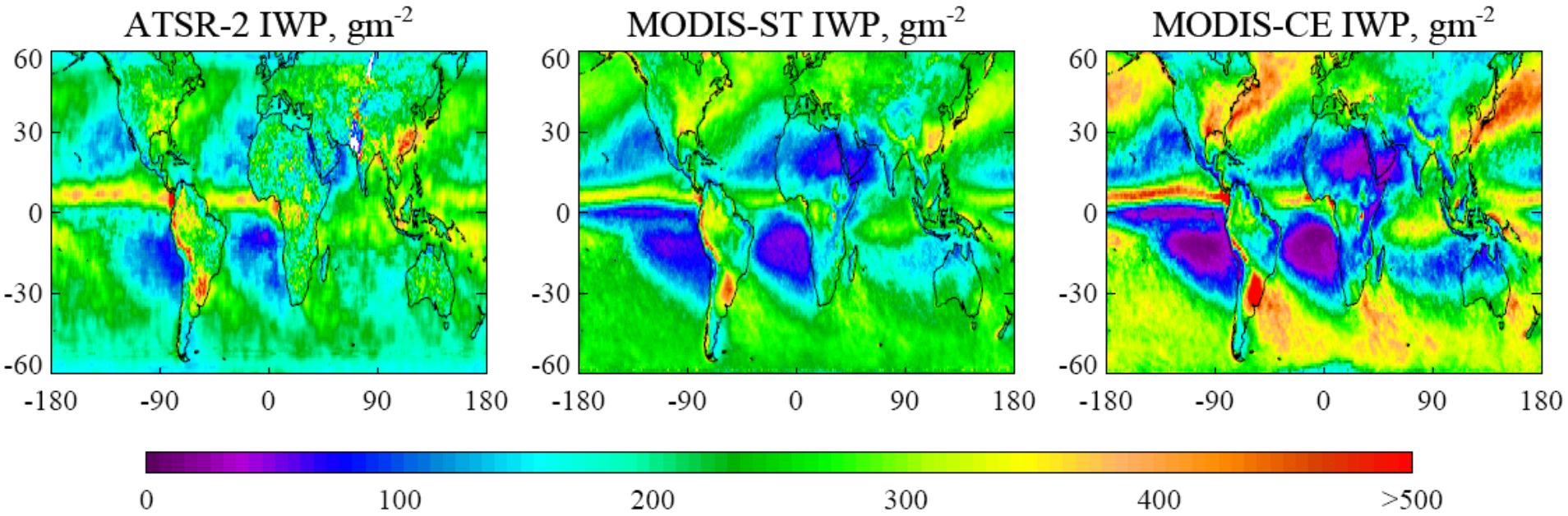






Comparison of IWP

Annual Mean



ATSR detects less IWP in the mid latitudes
-Sampling
-Different optical properties

Difference correspond to areas of multi- layer cloud reverse of LWP case
-ATSR retrieves this as ice in tropics→ over estimates
-ATSR retrieves as water in extra tropics → under estimates

Calibration

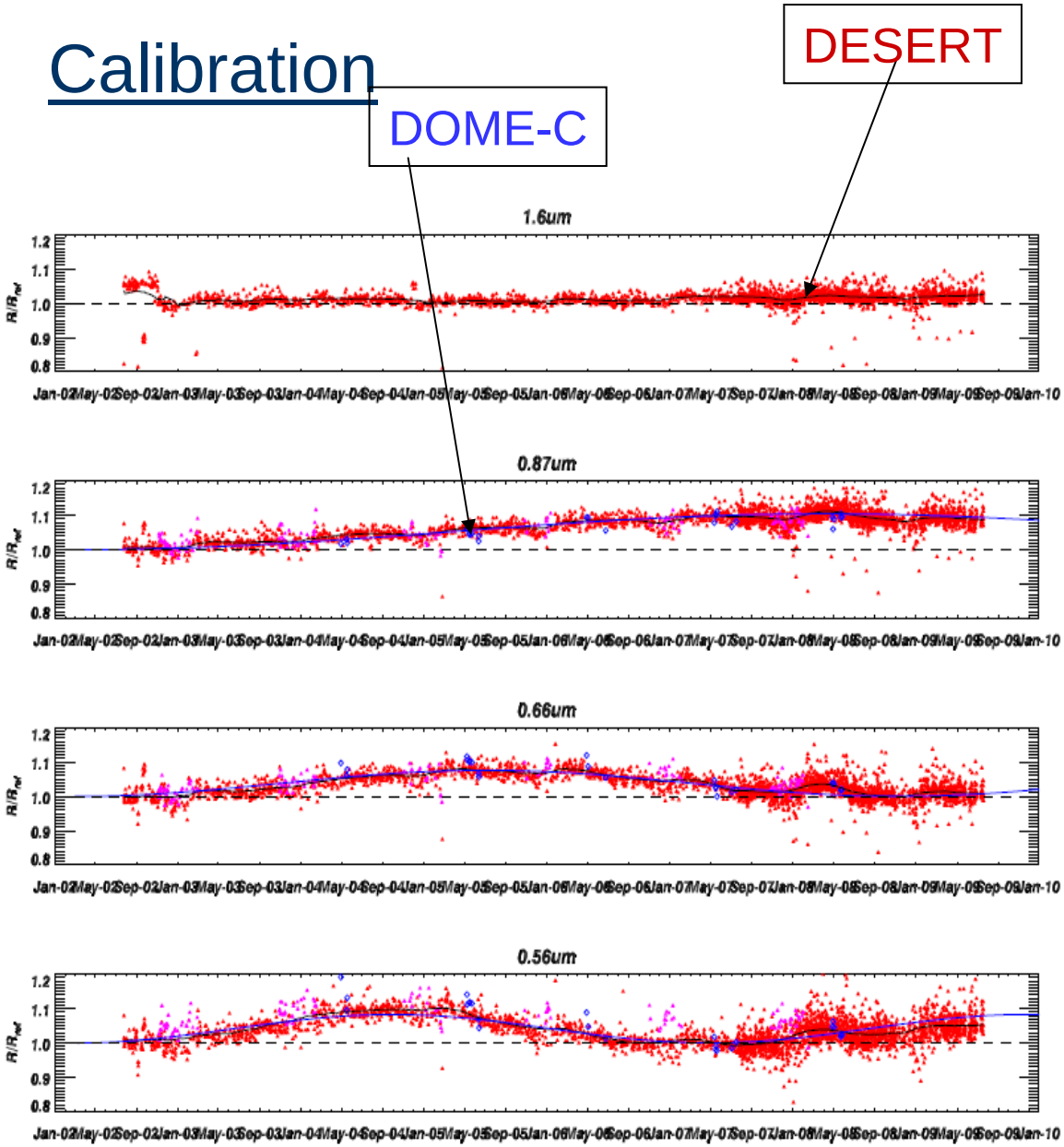
Continuous on-board radiometric calibration of the infrared channels against two stable, high-accuracy blackbody calibration targets

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) at RAL

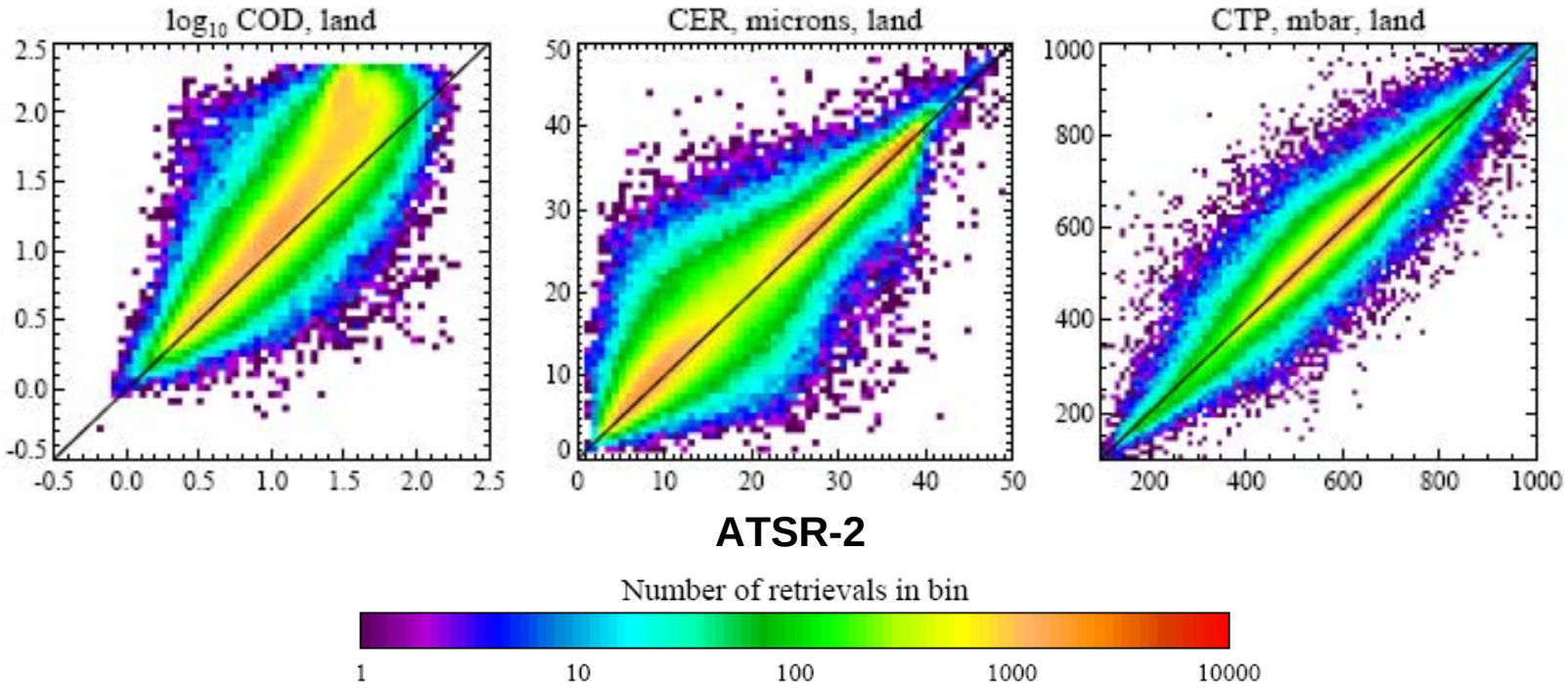
Calibration is being continually improved.

Will be important to look at calibration in relation to other instruments



Vicarious DRIFT Calibration of AATSR visible/NIR channels

ATSR-2 vs AATSR
Effect of calibration differences on products



Apparent offset between ATSR-2 and AATSR
Should be corrected by analysing vicarious calibration and analysing Simultaneous Nadir Observations with other well calibrated satellites i.e MERIS/MODIS

Conclusions

- Optical depth shows similar patterns to comparable sensors
  - Some differences may be attributed to effects of not modelling multi layered cloud
- Some differences in effective radius may be attributed to channels used.
- Quality of Re retrieval depends strongly on cloud optical depth, so comparisons weighted by errors or only for thick cloud might be useful.
- LWP assumes vertically homogenous clouds
- IWP compares well with MODIS products
  - except in southern storm tracks
- ATSR-2 and AATSR visible channels have small radiometric offset to be corrected in next processing

FUTURE PLANS

Of particular relevance to optical depth phase selection and effective radius

- Evaluate benefits of
  - Baum vs Baran ice (or both)
  - Use of 3.7 microns
  - Explicit detection of multilayer cloud & multi-layer retrieval for identified scenes
- Implement full surface BRDF treatment (building on ORAC-aerosol developments)
- Improved calibration correction
- Better specification of measurement / FM errors