

# Satellite Cloud and Aerosol climate records for the ESA Climate Change Initiative (CCI)

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RAL and University of Oxford  
and thanks also to CCI teams.



NERC National Centre  
for Earth Observation  
NATURAL ENVIRONMENT RESEARCH COUNCIL



# Outline

- Science
- Ingredients for a cloud and aerosol climatology
  - Instruments
  - Calibration
  - Algorithm
- Aerosol/Cloud consistency
- Future

# Clouds responses to greenhouse warming

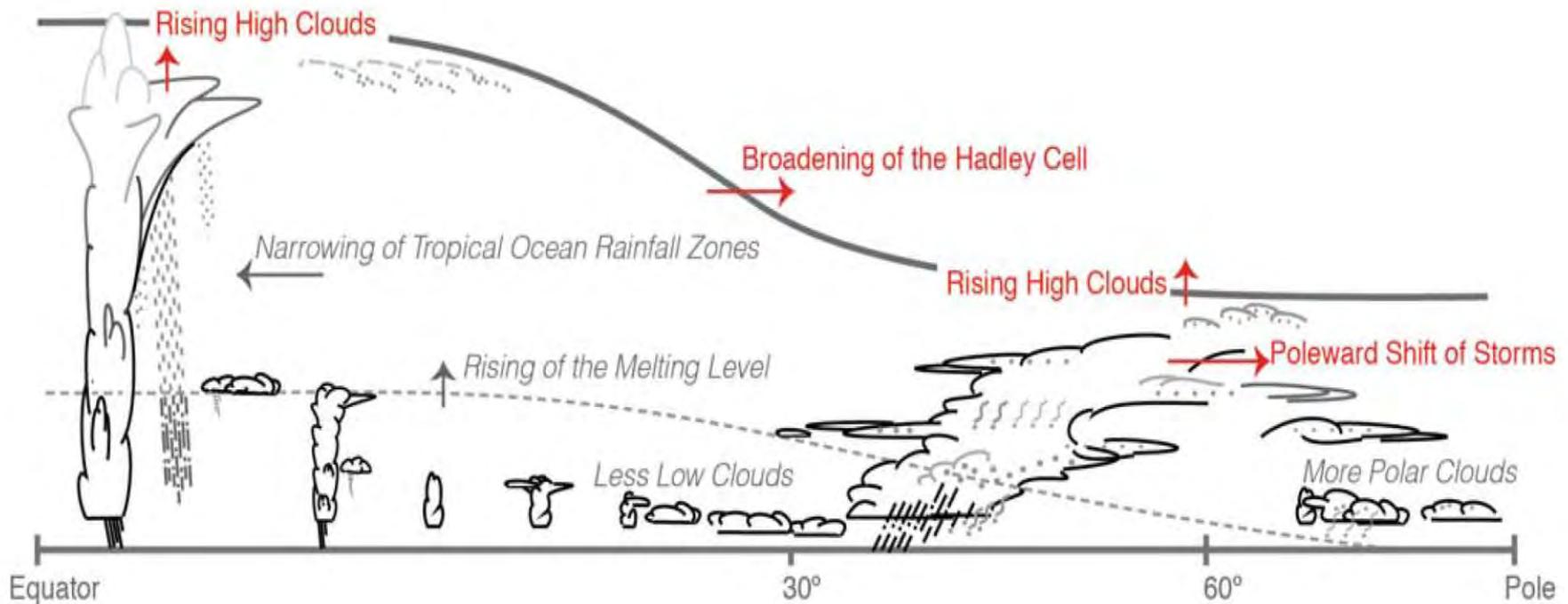


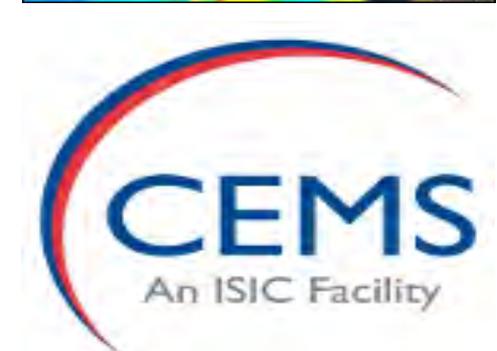
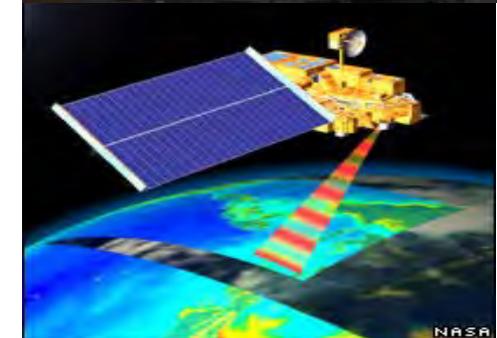
Image from IPCC report

We need long term observational records to verify and quantitatively assess

# Instruments

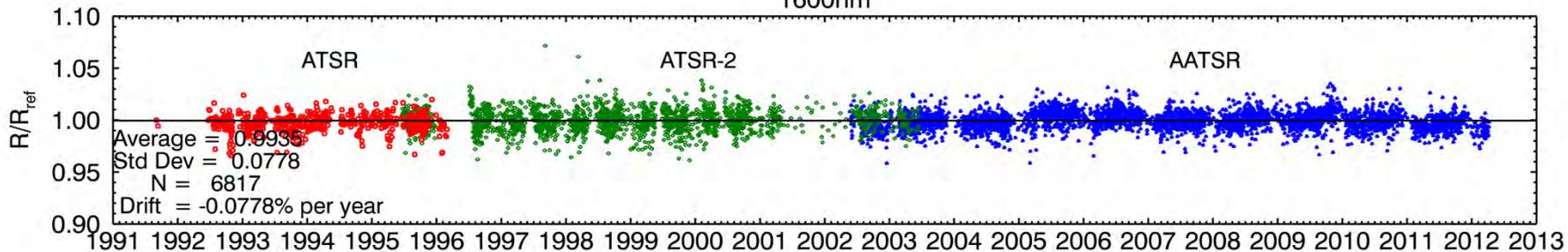
(which will be processed using ORAC algorithm)

- Visible/IR
  - AVHRR 1982-2012 (Cloud)
  - A/ATSR (1991)1995-2010  
(Cloud and Aerosol)
  - MODIS 2000-2014 (Cloud)
- Approx 300 TB output products.
- 3,600,000 CPU processing hours

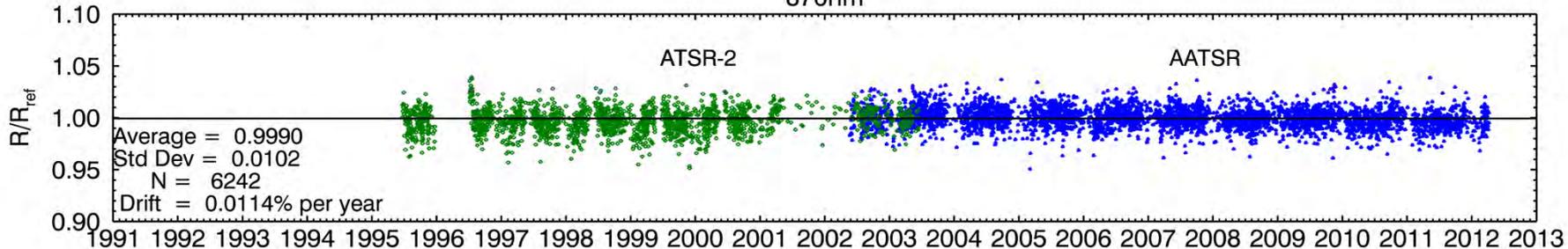


# Calibration and Stability

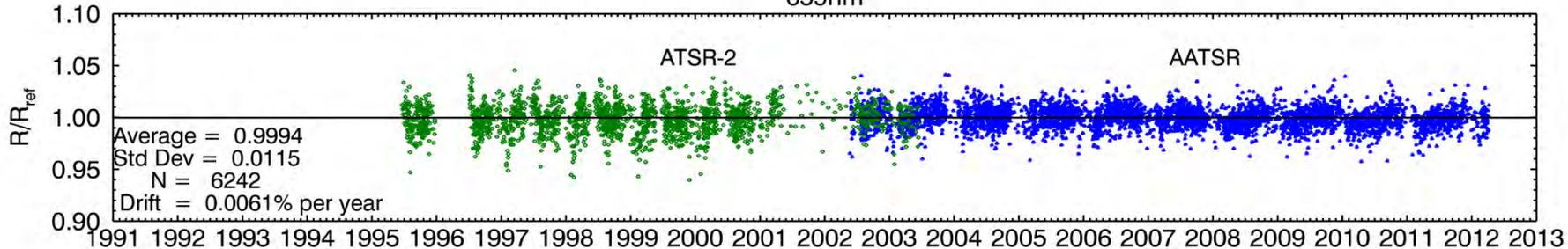
1600nm



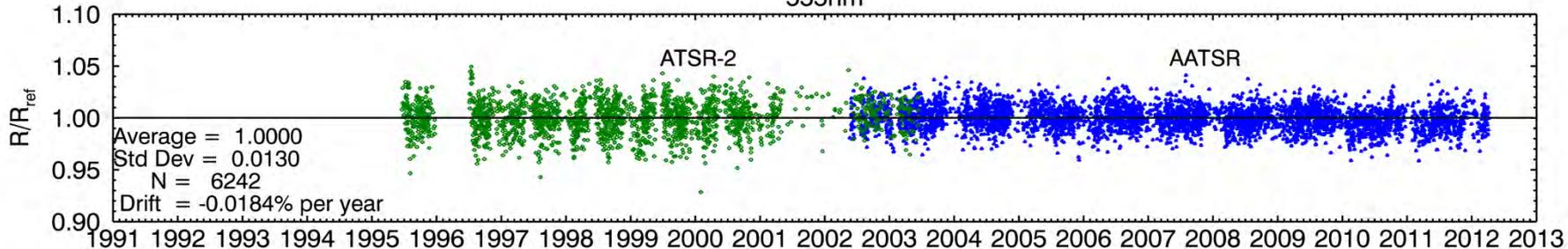
870nm



659nm



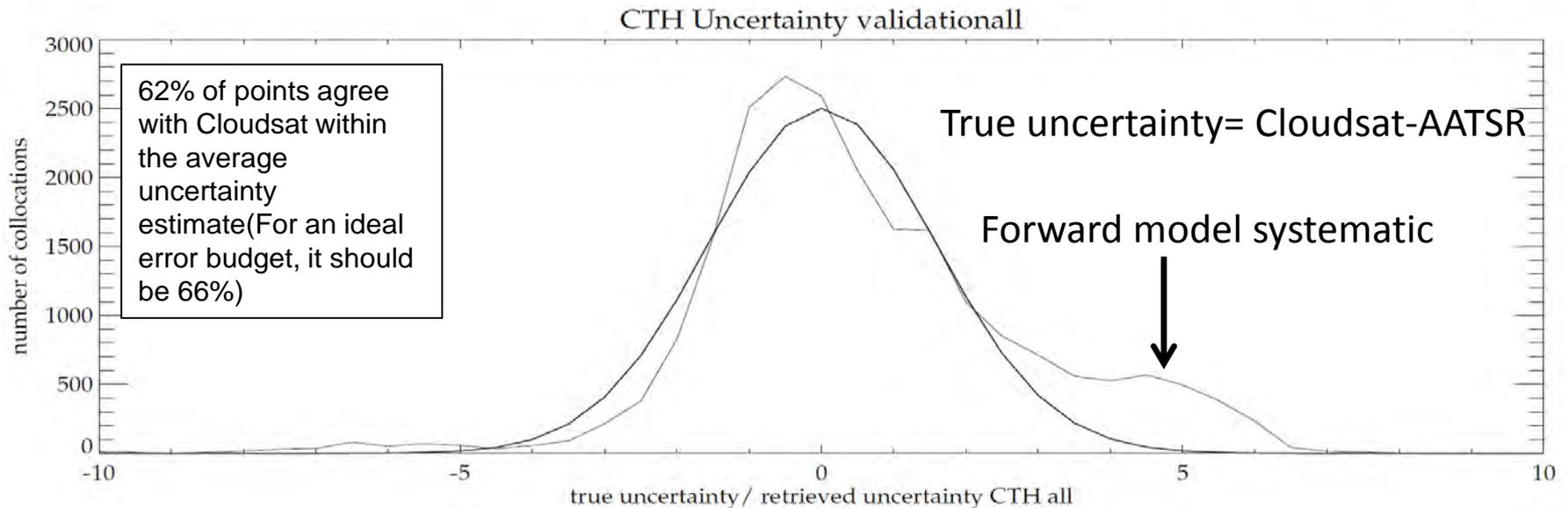
555nm



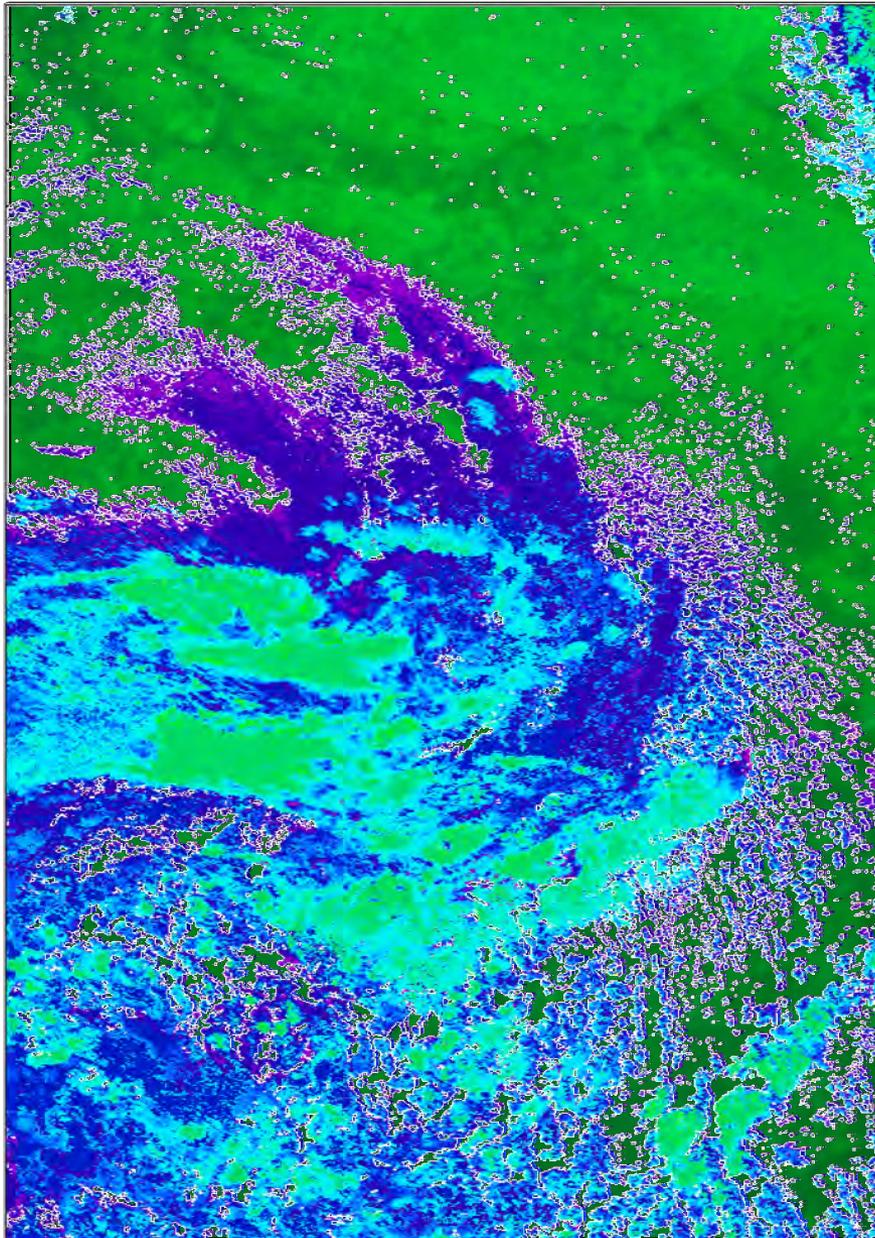
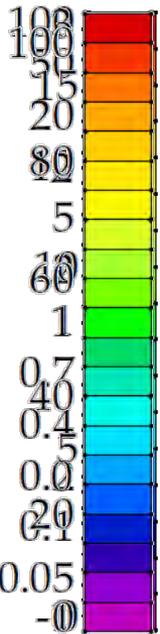
ATSR stability, slides courtesy Dave Smith RAL

# ORAC (Oxford RAL Aerosol and Clouds)

- Optimal estimation algorithm
  - <http://proj.badc.rl.ac.uk/orac>
  - Pixel level uncertainty
  - Visible and IR channels used together to ensure:
- Radiative consistency
  - All surface-atmosphere properties determined from a satellite instrument are consistent with the TOA radiance field.



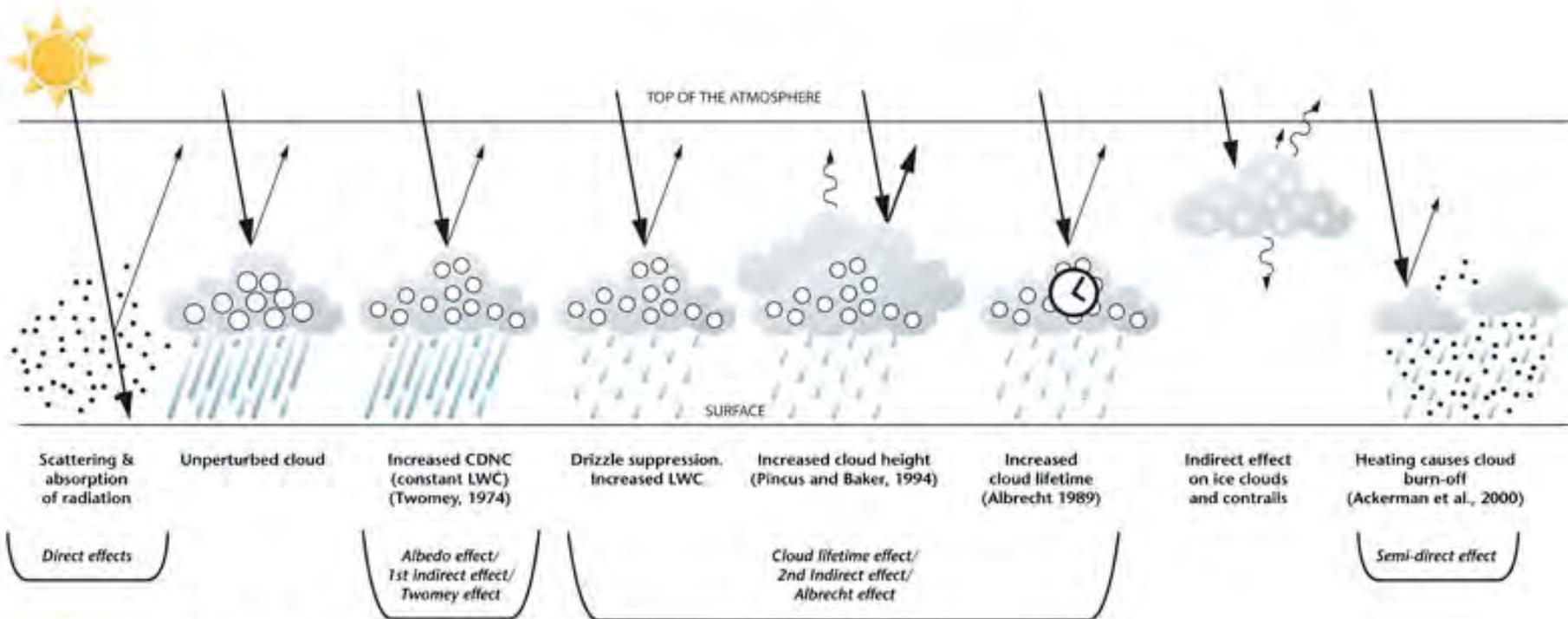
Refractive Index

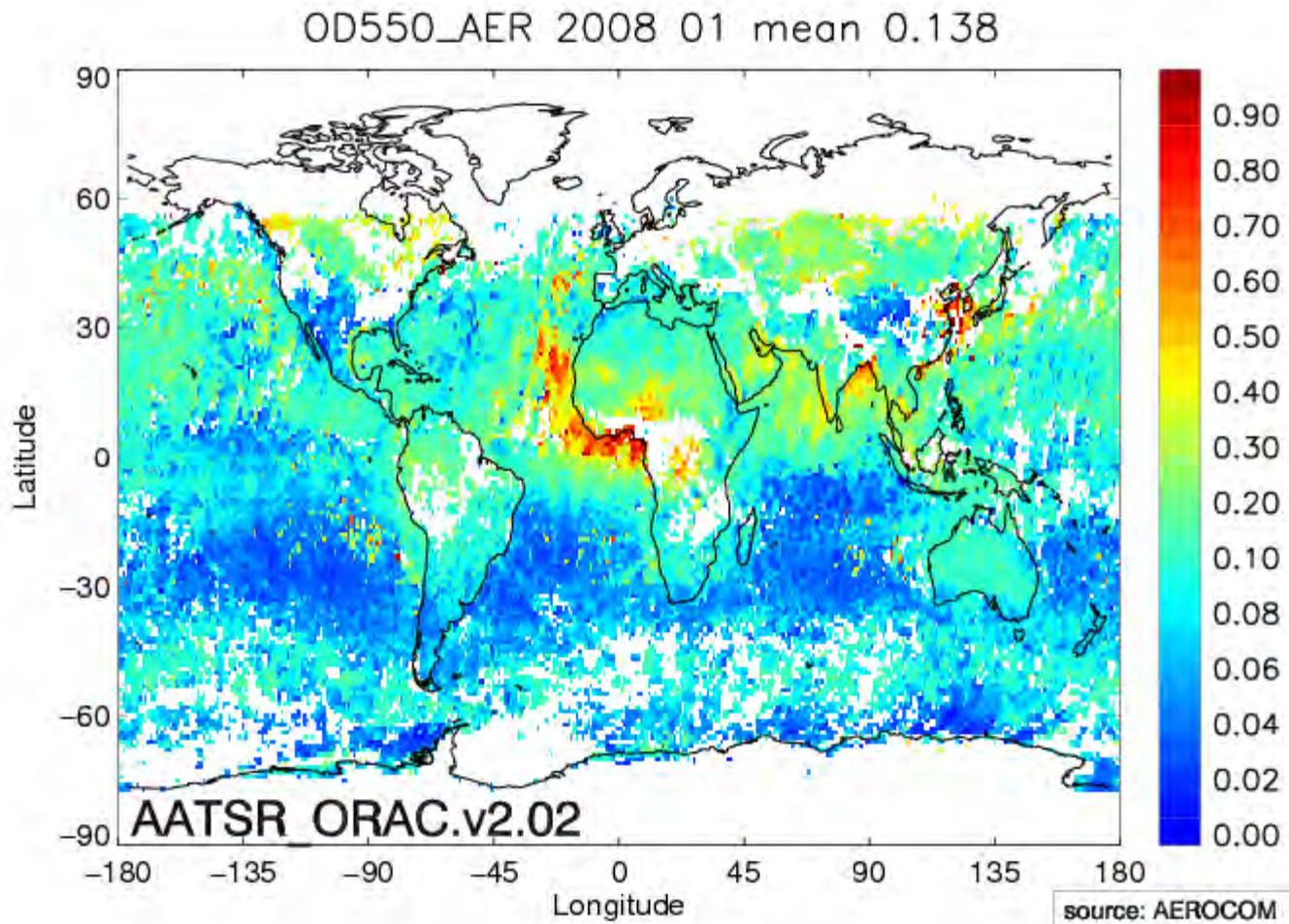


- Less low clouds?
- More clouds at the poles?
- Poleward shift in clouds?
- Rising of the melting layer?
- Rising level of high cloud?
- ??

Example AATSR cloud products

# Aerosol effects on clouds

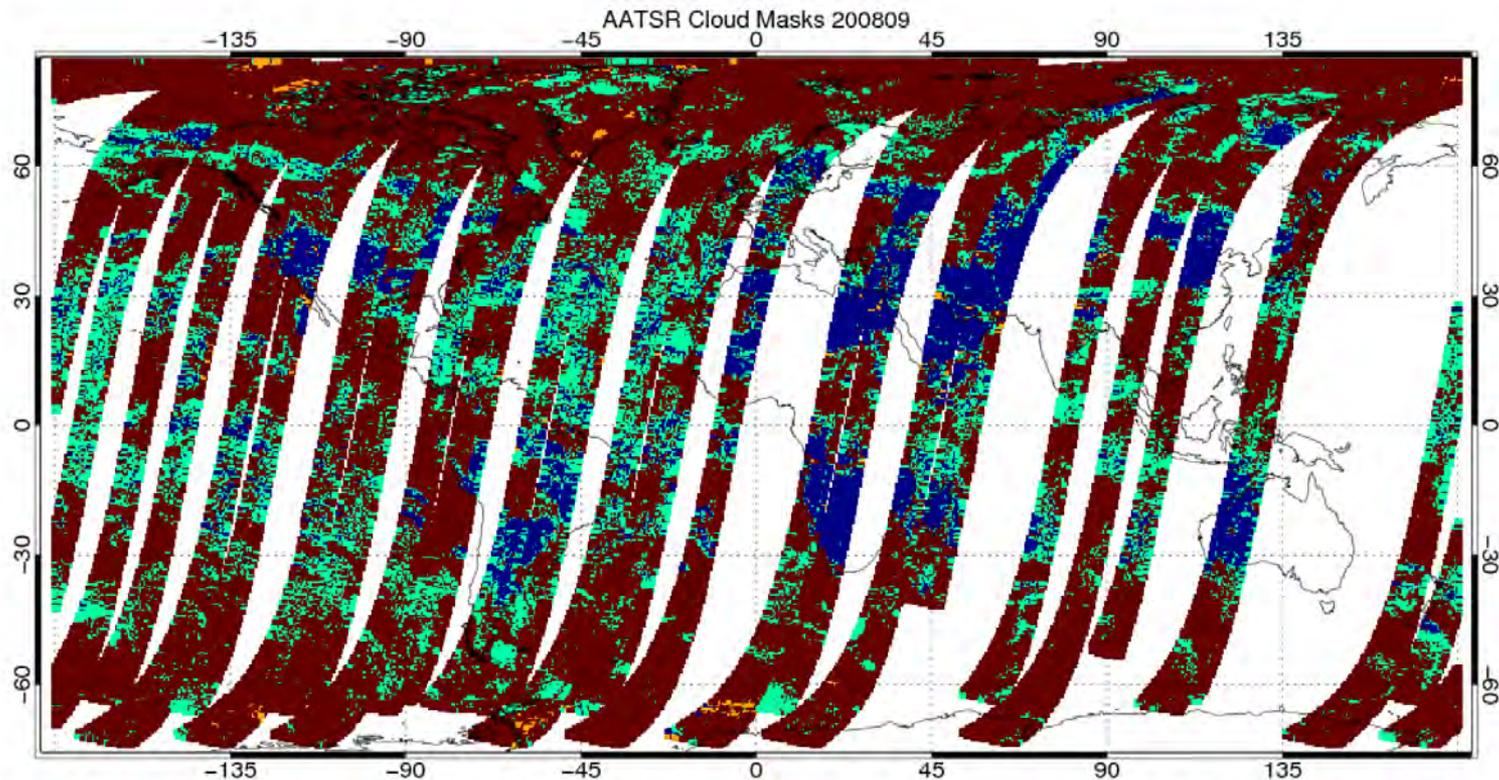




Consistency: The global TOA radiation field is generated from a mixture of clear and cloudy skies.

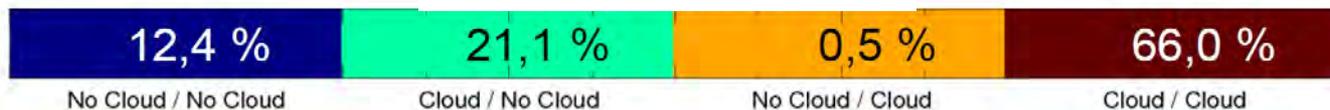
- Aerosol and Cloud retrieved using similar algorithm
- Aerosol and Cloud will use a consistent cloud identification

# Comparison of aerosol CCI and cloud CCI cloud masks



5 selected days Sep 2008 – safety zone included by Aerosol\_cci

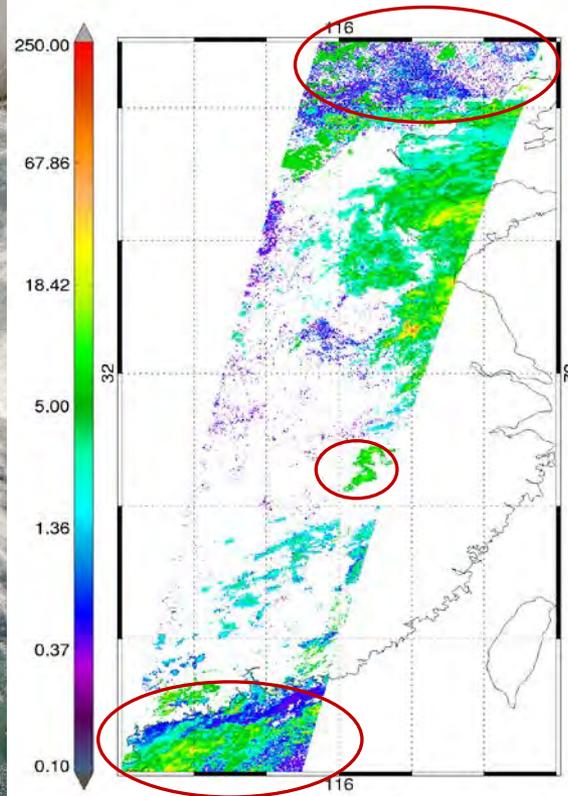
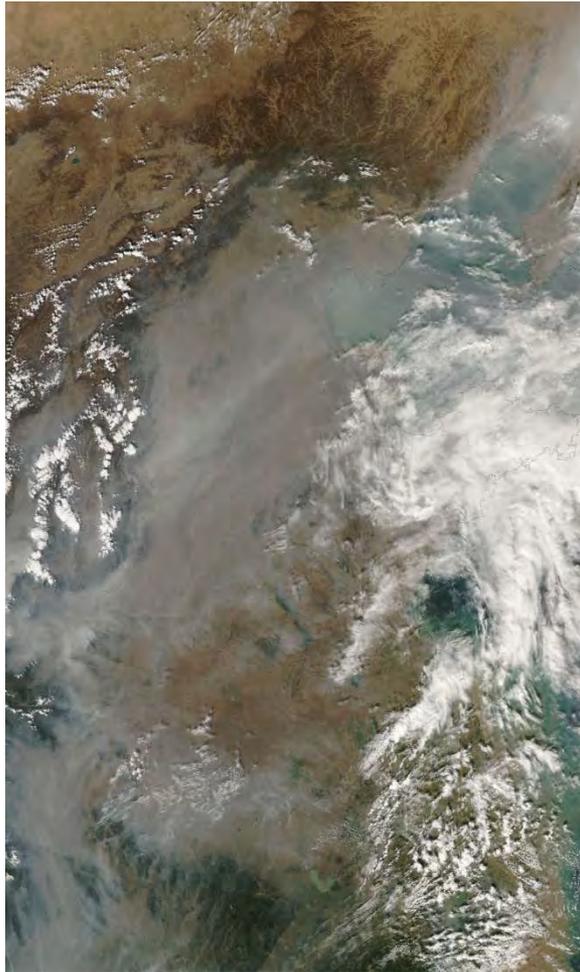
## AEROSOL CCI/ CLOUD CCI



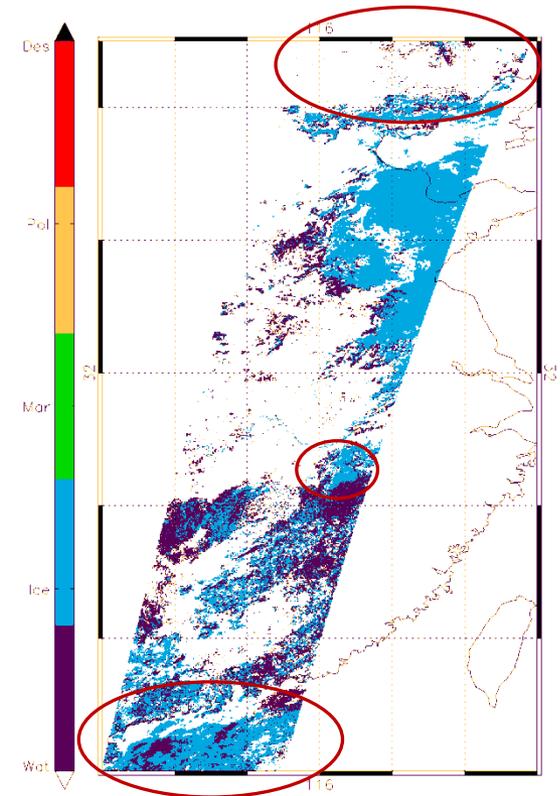
- Aerosol CCI applies a tight cloud flagging criteria.
- Cloud CCI misidentifies some thick aerosol as cloud
- Many observations are considered neither clear nor cloudy so that the global TOA radiance field simulated from the two products is not representative of the satellite measured field.

# Cloud and Aerosol CCI identification consistency

## Cloud and Aerosol retrievals over polluted China



Cloud\_cci L2 (CC4CL/ORAC)  
cloud optical depth



Aerosol\_cci L2 (ORAC)  
aerosol identification  
Blue/Purple:ice/water

# Summary

- Algorithm development
  - Focusing on radiative consistency and minimising the differences between cloud and aerosol CCI products
  - Uncertainty definitions and representation and validation.
  - See Adam Povey's poster in this session
- We are preparing to process a lot of data
  - Evaluation and science analysis