

# ESA Cloud cci



Royal Netherlands  
Meteorological Institute  
Ministry of Transport, Public Works  
and Water Management



Jürgen Fischer  
Free University Berlin

Deutscher Wetterdienst  
Wetter und Klima aus einer Hand



VNIVERSITAT  
ID VALÈNCIA

SMHI



# Consortium: Cloud cci



Deutscher Wetterdienst (DWD), Lead

Rutherford Appleton Laboratory (RAL)

University of Oxford (UO)

Free University of Berlin – Institute for Space Sciences (FUB) with University of Valencia

Swedish Meteorological and Hydrological Institute (SMHI)

Koninklijk Nederlands Meteorologisch Instituut (KNMI)

Laboratoire Météorologie Dynamique (LMD)

German Aerospace Centre (DLR)

University of Bremen (UB)



Science & Technology Facilities Council  
Rutherford Appleton Laboratory



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and Water Management



# Clouds in the climate System



Clouds are ...

- affecting the energy budget
- a coupling mechanism to hydrological cycle
- highly variable in space and time
- easy to observe??

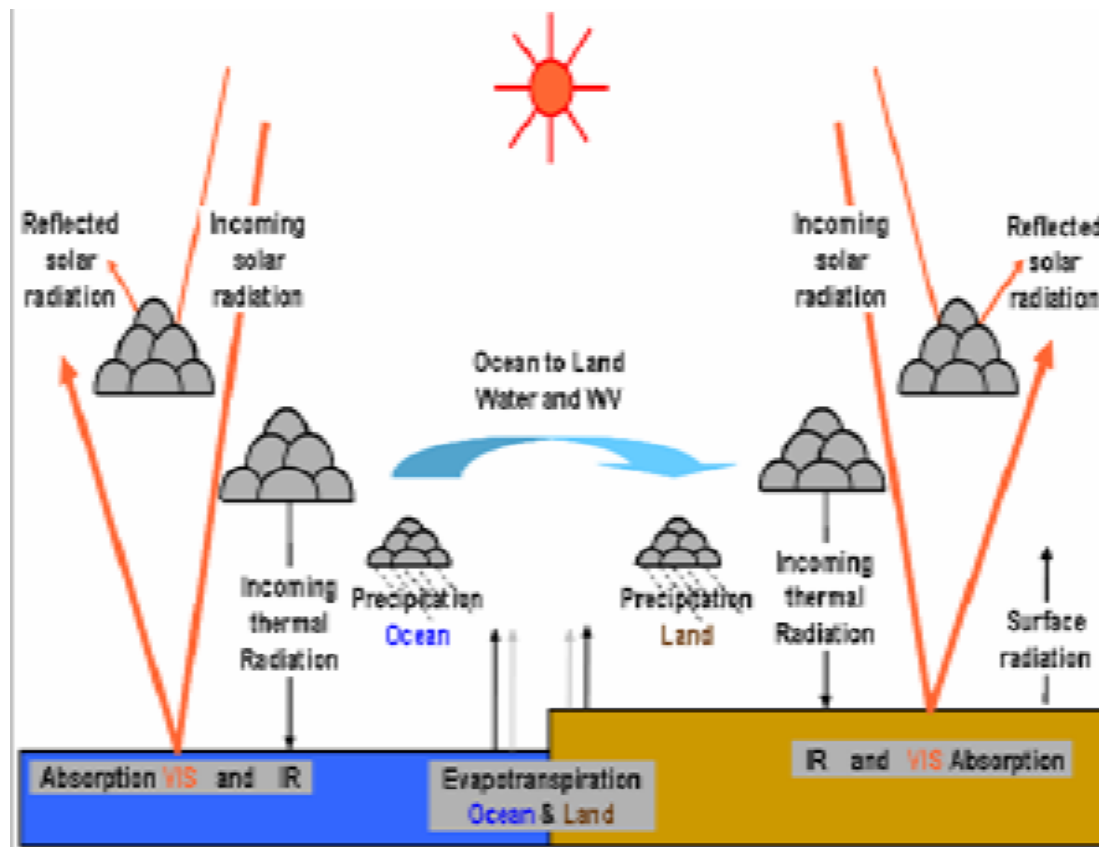


Image:  
Courtesy R. Roebeling

... but not fully  
understood nor  
modelled

# Primary Objectives of Cloud CCI (I)



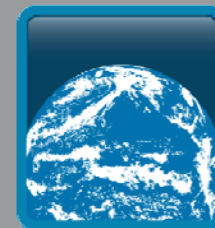
- Development of **inter calibrated radiance data sets for ESA and non ESA instruments** in an international collaboration
- Development of a **coherent physical retrieval framework** for the GCOS cloud property ECVs cloud cover, cloud top height and temperature, liquid and ice water path that can be considered as an open community retrieval framework that will be publicly available and usable by all scientists.
- Development and processing of **two multi-annual global data sets** for the GCOS cloud property ECVs including uncertainty estimates.
  - (A)ATSR – AVHRR – MODIS – **MERIS** (lowest common approach)
  - (A)ATSR and MERIS. (synergy retrieval)

# Primary Objectives of Cloud CCI (II)



- **Validation** of the cloud property products against ground based and other satellite based measurements taking into account the individual error structures of the individual observations as far as possible.
- Providing a common data base and the **necessary assessment of cloud data** sets in the **framework of GEWEX**.
- Development of a **complete processing system distributed over Europe** that can further strengthen operational production of cloud property data sets.
- **Perform a Round Robin Exercise** to identify weaknesses of algorithms

# Addressing the needs from GCOS: Requirements for clouds



Requirements as stated in GCOS-107, product A-4; update 2011<sup>1</sup>

	Accuracy	Spatial resolution	Temporal resolution	Stability (target)	Justification Source
Cloud Cover	0.01-0.05	50 km	3 h	0.01/dec	CFMIP
Cloud pressure	15- 50 hPa	50 km	3 h	3-15 hPa/dec	NISTIR-7047
Cloud temperature	1 K	50 km	3 h	0.25 K/dec	NISTIR-7047
Cloud ice profile	25 %	50 km	3 h	5 %/dec	NISTIR-7047
Cloud water profile	25 %	50 km	3 h	5 %/dec	NISTIR-7047

<sup>1</sup> currently under discussion and in open review y 2011

# State of the art: Existing global Cloud Climatologies



## Longterm cloud climatologies:

<b>ISCCP</b> <i>GEWEX cloud dataset</i>	<i>1983-2006</i>	<i>(Rossow et al. 1999)</i>
<b>PATMOS-x</b> <i>AVHRR</i>	<i>1981-2006</i>	<i>(NESDIS/ORA; Heidinger et al.)</i>
<b>HIRS-NOAA</b> <i>13h30/1h30</i>	<i>1985-2001</i>	<i>(Wylie et al. 2005)</i>
<b>TOVS Path-B</b> <i>7h30/19h30</i>	<i>1987-1995</i>	<i>(Stubenrauch et al. 2006)</i>
<b>SAGE</b> <i>limb solar occultation</i>	<i>1984-1991,1993-2005 (Wang et al. 1996, 2001)</i>	
<b>SOBS</b> (Surface Observations):	<i>1952-1996(sea), 1971-1996(land)</i> <i>(Hahn &amp; Warren 1999; 2003)</i>	

## EOS cloud climatologies (since 2000, 2002):

**MODIS-ST** (*Ackerman et al.*) **MODIS-CE** (*Minnis et al.*)

**AIRS-LMD** (*Stubenrauch et al. 2008*)

## + A-Train (since 2006):

**CALIPSO L2 data (V2)** (*Winker et al. 2007*) *active lidar*

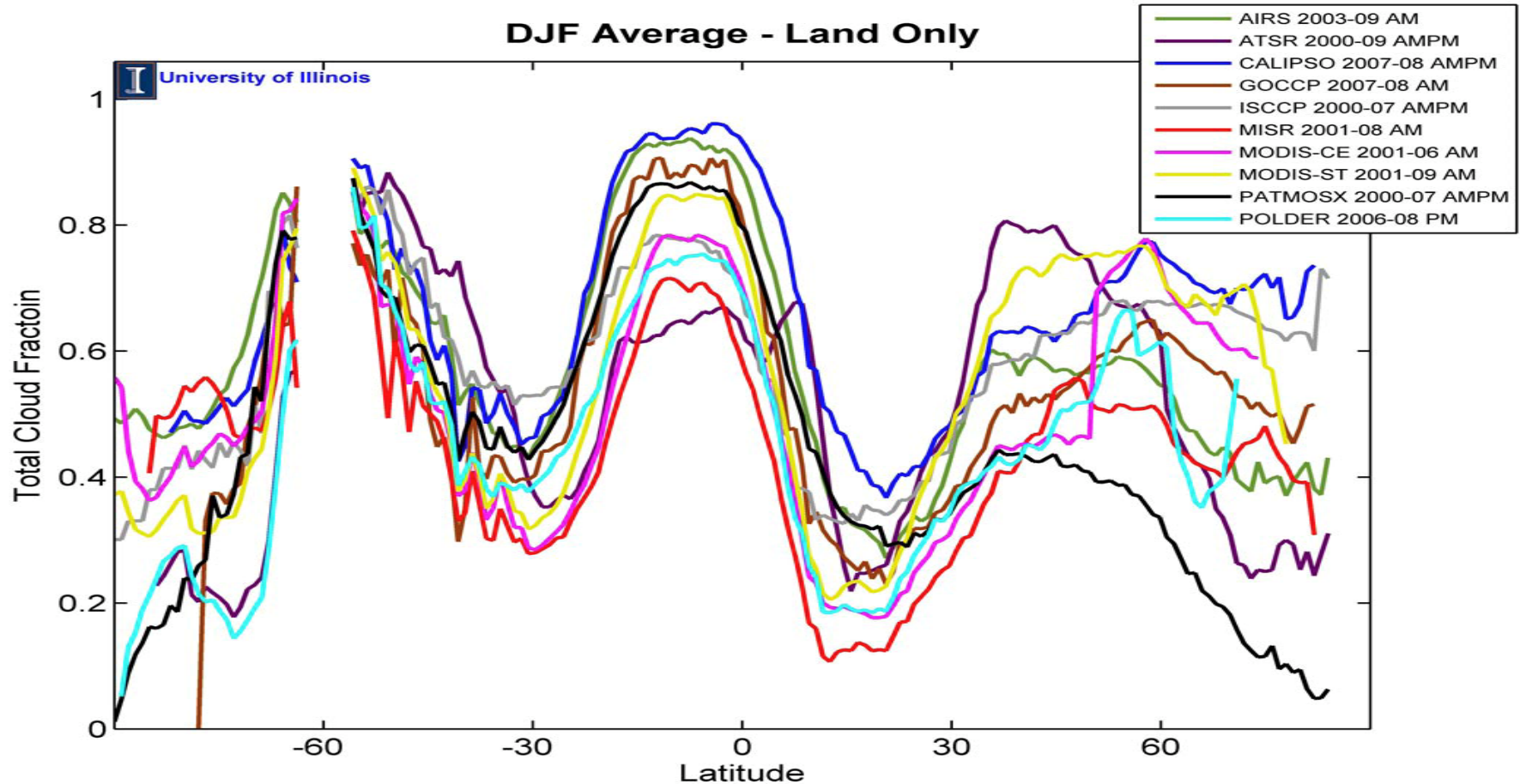
**CloudSat** (*Mace*)      **POLDER** (*Riedi*)      **MISR** (*DiGirolamo*)      **ATSR2** (*Poulsen*)

# State of the art: Cloud fraction



Cloud  
Assessment

Heidinger et al, 2010



Previous GEWEX analysis showed that PATMOS-x cloud amounts over cold land are too low, but the Bayesian mask appears to have brought PATMOS-x “back in line”

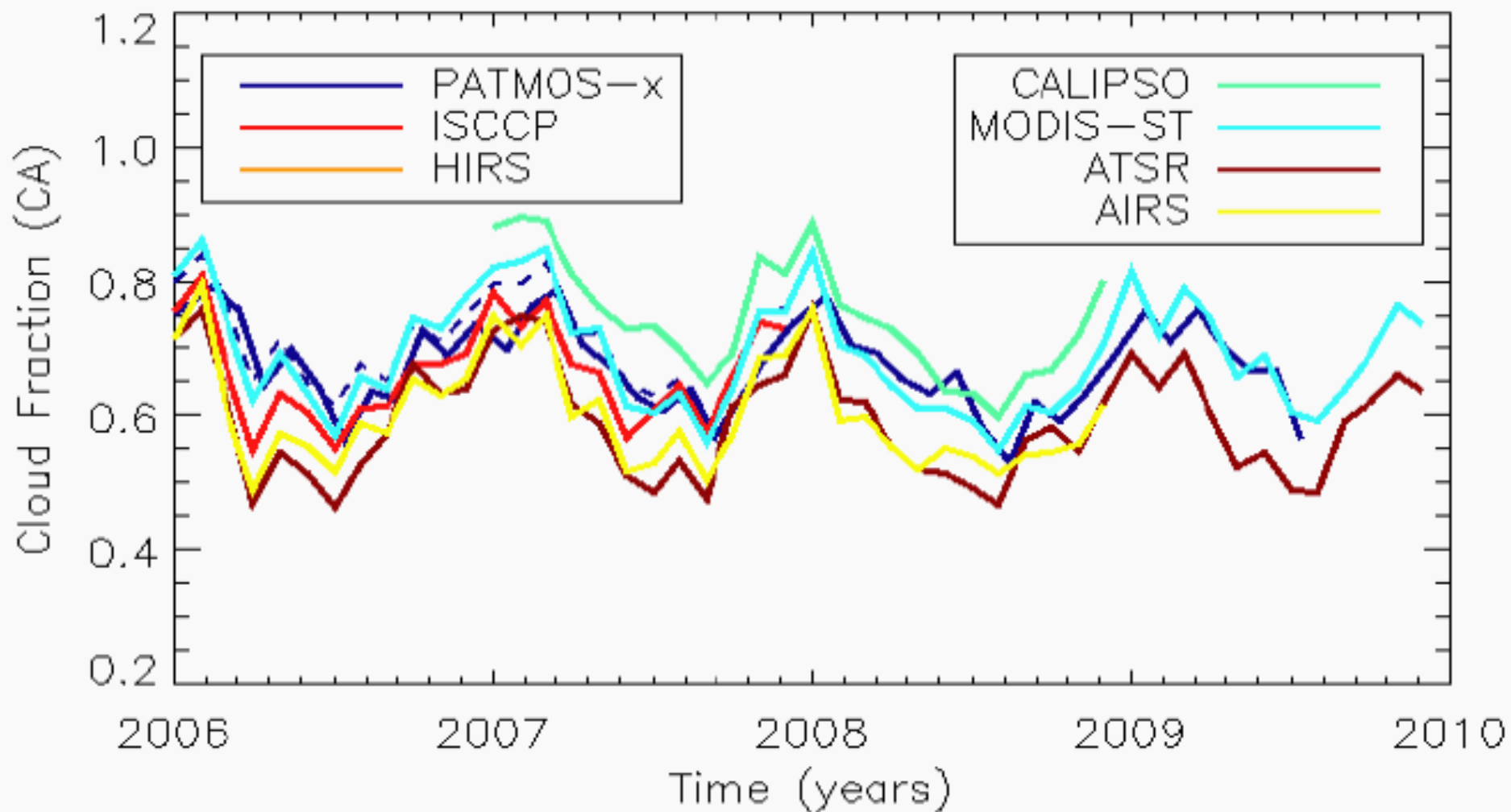


# Cloud amount comparison



Cloud  
Assessment

Heidinger et al, 2010

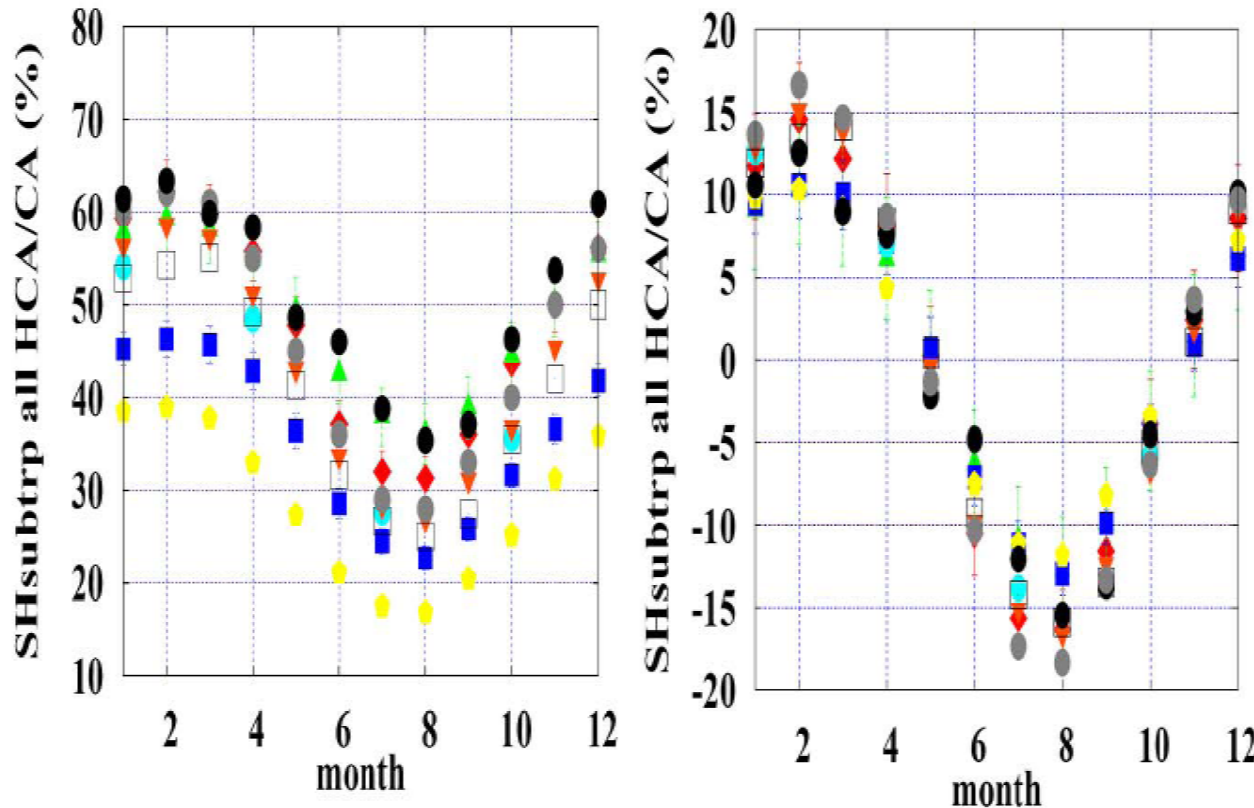


# State of the art: Cloud fraction



## Cloud Assessment

Co-lead C. Stubenrauch, S. Kinne



70% ( $\pm 5\%$ ) clouds: ~  
40% high clouds &  
~40% single-layer low  
clouds

geographical cloud  
structures & seasonal  
cycles agree quite well

absolute values depend  
on instrument sensitivity  
(& retrieval method)

detection thresholds also  
affect average cloud opt.  
depth & T

trend analysis difficult,  
synergy of data sets &  
variables important

# Current baseline: Specifications



## Temporal resolution of final products

(based on local satellite equator crossing time)

- **AATSR/MERIS** (ENVISAT):  
10:00 am/pm
- **AVHRR** (N15, N16, N17, N18, N19, Metop):  
10.00 am/pm (drifting), 02:00 am/pm (drifting), 10:00 am/pm, 01.30 am/pm
- **MODIS** (AQUA, TERRA):  
01:30 am/pm, 10:30 am/pm

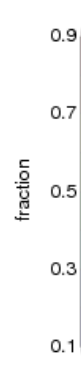
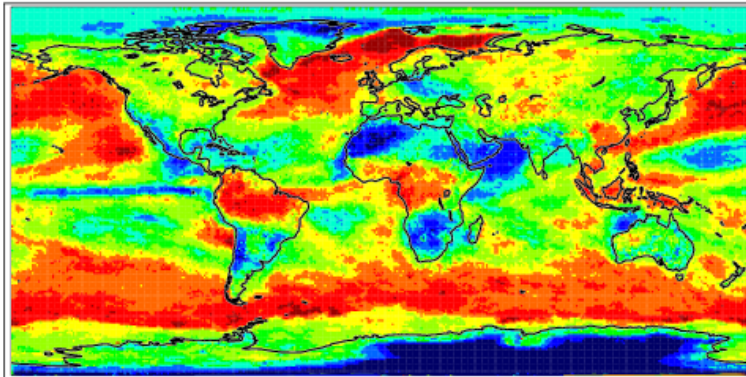
### Providing the final products:

- Monthly means for each individual sensor
- Monthly means for each sensor group (e.g. all AVHRRs)
- Monthly means for all sensors on all satellites
  - **AATSR-MODIS-AVHRR**
  - **AATSR-MERIS**

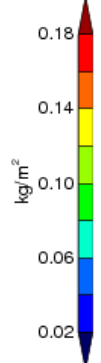
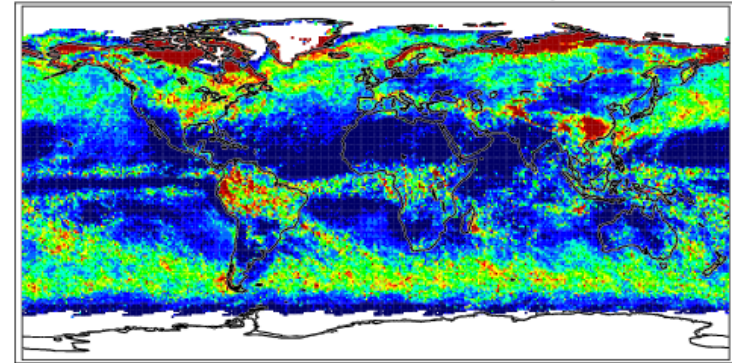
# Product application...



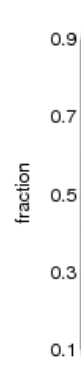
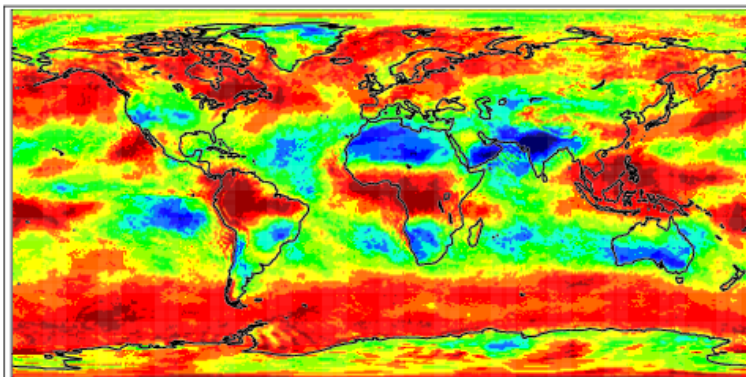
GAC CFC – all satellites



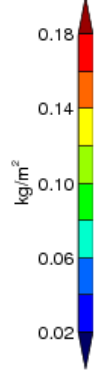
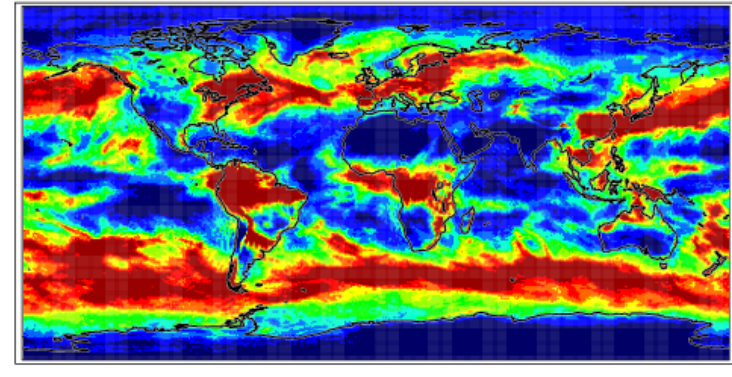
GAC CWP – NOAA18 only



ECHAM CFC



ECHAM CWP



Example: Comparison of Cloud fraction (left) and liq. Water path (CWP) vs. ECHAM 5, April 2009

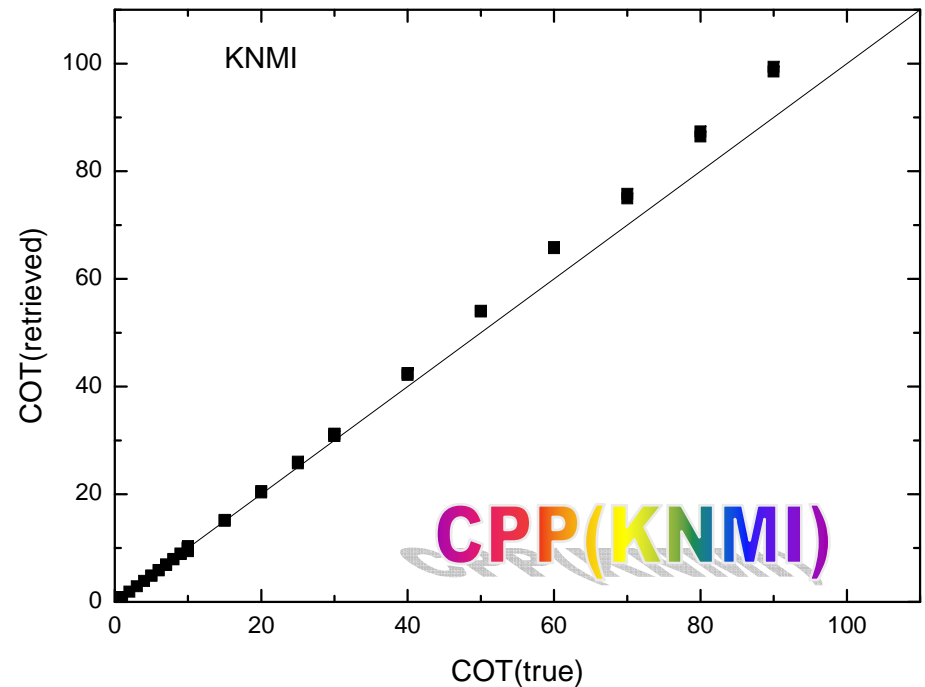
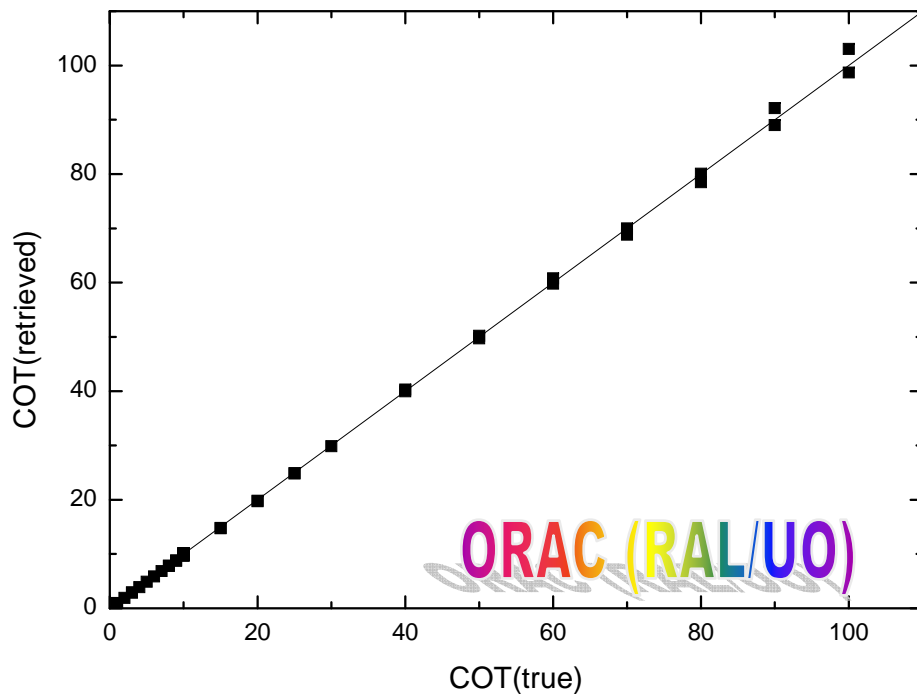
# Synthetic datasets for Round Robin



- Droplet size distribution
- Temperature, pressure and gaseous absorbers profiles (no aerosol) were specified and distributed
- Aerosol scattering was neglected
- Multiple light scattering by water droplets was considered in the framework of discrete ordinates method with single scattering correction term (SCIATRAN 3.1)
- Polarization effects were neglected
- Rayleigh scattering, Absorption by oxygen, ozone, and water vapor
  
- Channels: 0.555, 0.658, 0.753, 0.76175(SRF was supplied by FUB), 0.860, 1.242, 1.585, 2.114, 3.7, 11, 12 micrometers
- SZA=60 degrees
- VZA=0, 20, 40, 55, 75 degrees
- RAA=0, 30, 60, 90, 120, 150, 180 degrees
- Surface albedo: 0.0, 0.4

Courtesy of A. Kokhanovsky

# Prelim. results (nadir view only)



- ORAC/AATSR(0.55, 0.66, 0.87, 1.6, 11  $\mu\text{m}$ )
- CPP/AVHRR(0.6, 1.6  $\mu\text{m}$ )

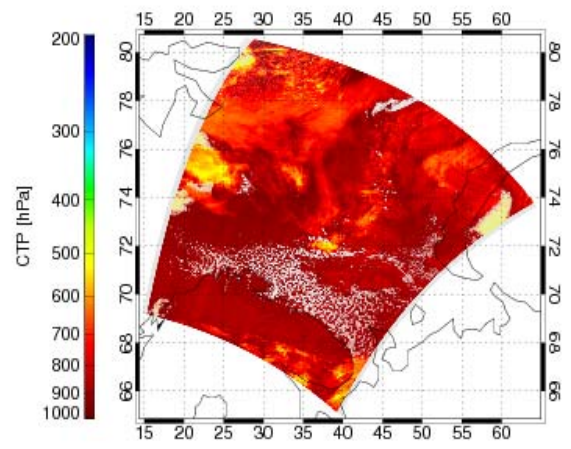
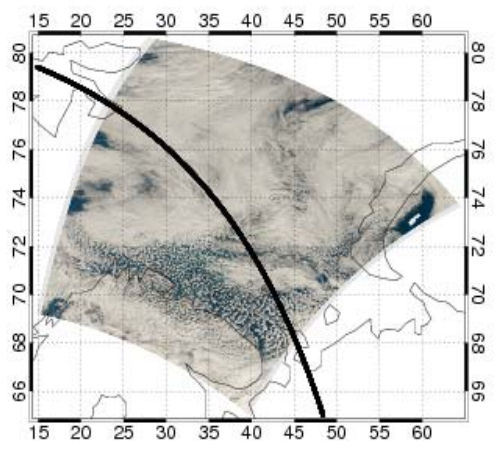
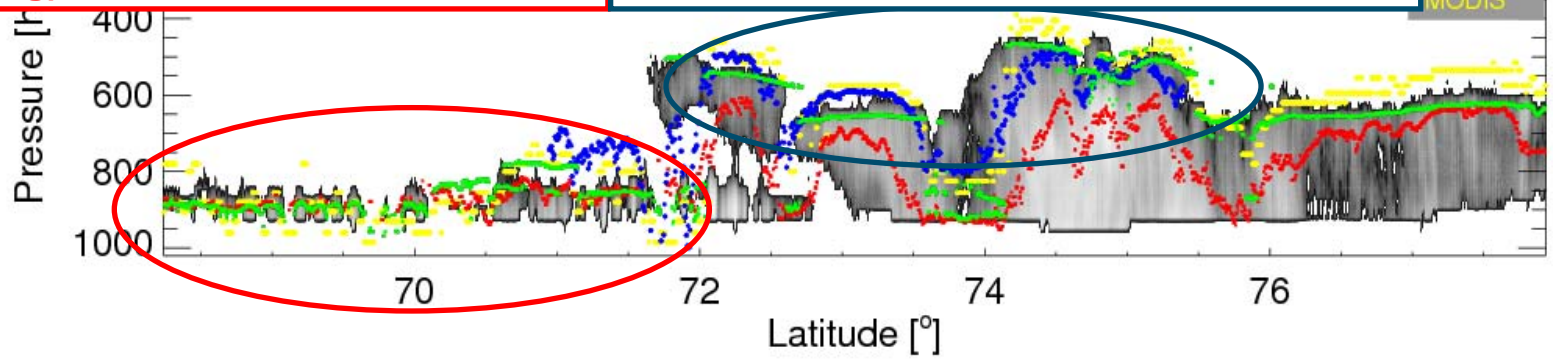
Courtesy of A. Kokhanovsky

# CTP: Thermal vs. O<sub>2</sub> A band measurements

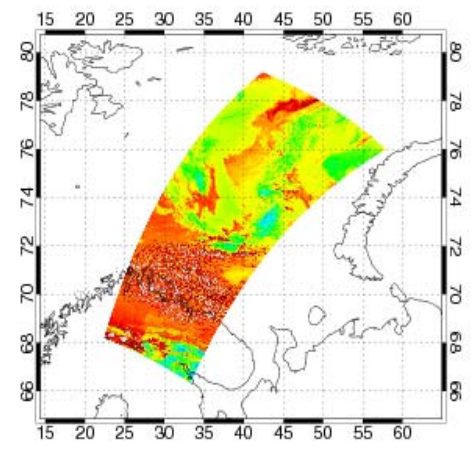


O<sub>2</sub> A cloud height is accurate for low clouds, thermal retrievals are noisy (even CO<sub>2</sub> Slicing)

Thermal techniques detect cloud height of higher clouds accurately, O<sub>2</sub>A height strongly depends on assumed cloud extinction -> uncertain.



MERIS CTP



AATSR CTP

# Cloud products from the combined AATSR-MERIS time series



- **AATSR-MERIS-combination in orbit since 2002.**
- **MERIS was not primarily built for cloud retrievals (No SWIR, no TIR)**
- **So... why are we doing this?**

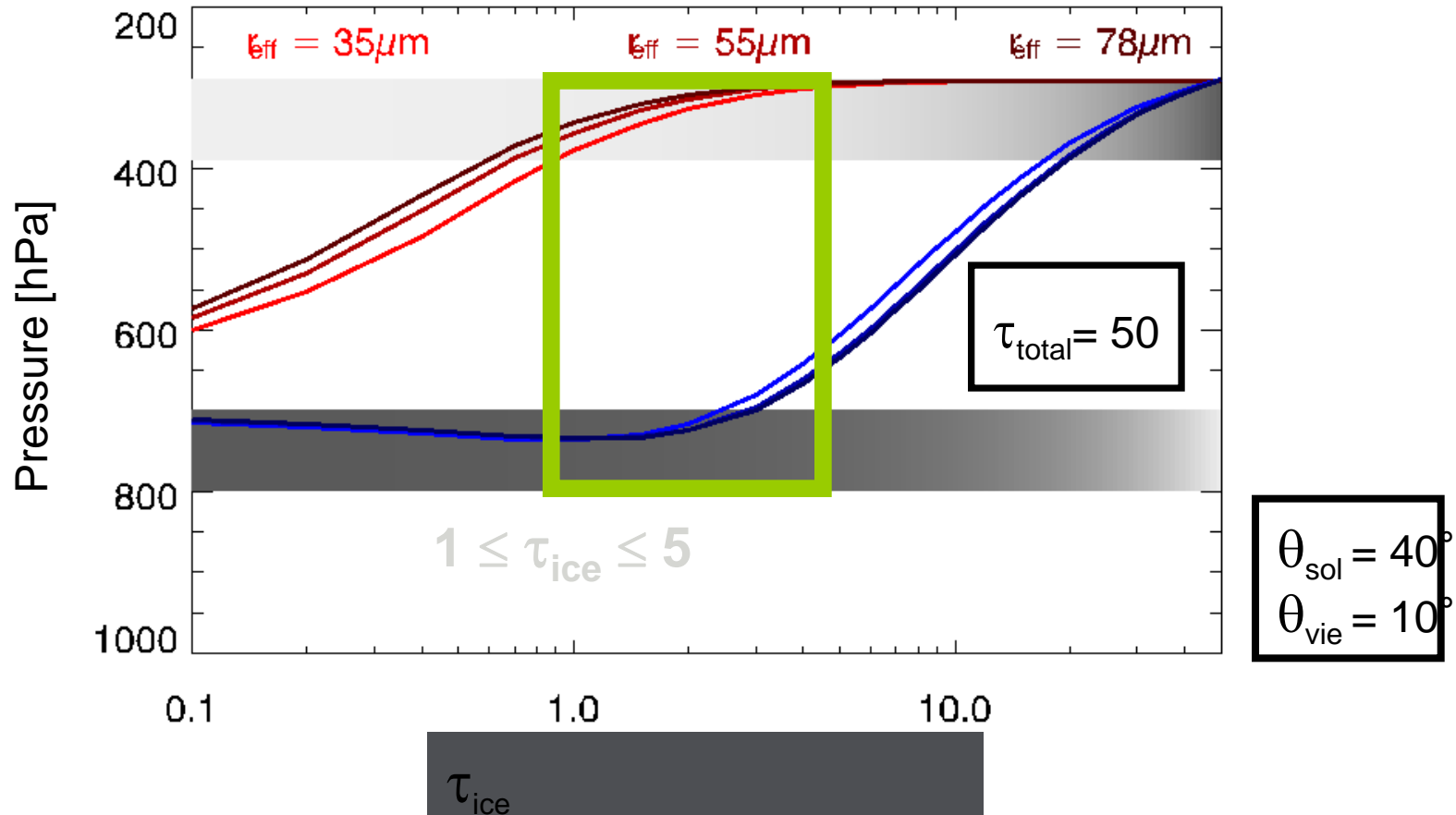


# Motivation



- **So... why are we doing this?**
  - **MERIS provides O<sub>2</sub> A band measurements at high spatial resolution.**
  - **Combination with “classical” cloud retrieval bands from AATSR provides:**
    - Improved cloud detection from sensor synergy
    - Retrieval of cloud phase, CTH, COD,  $r_{\text{eff}}$ , (->LWP, IWP), cloud amount.
    - Improved cloud height detection from sensor synergy.
    - Improved multi-layer cloud flagging.
    - Multi-layer cloud height detection for cirrus-above water cloud (Advanced Retrieval Component)
  - **Combined observations to be continued by SLSTR+OLCI on Sentinel-3 for *several decades*.**

# Advanced Retrieval Components



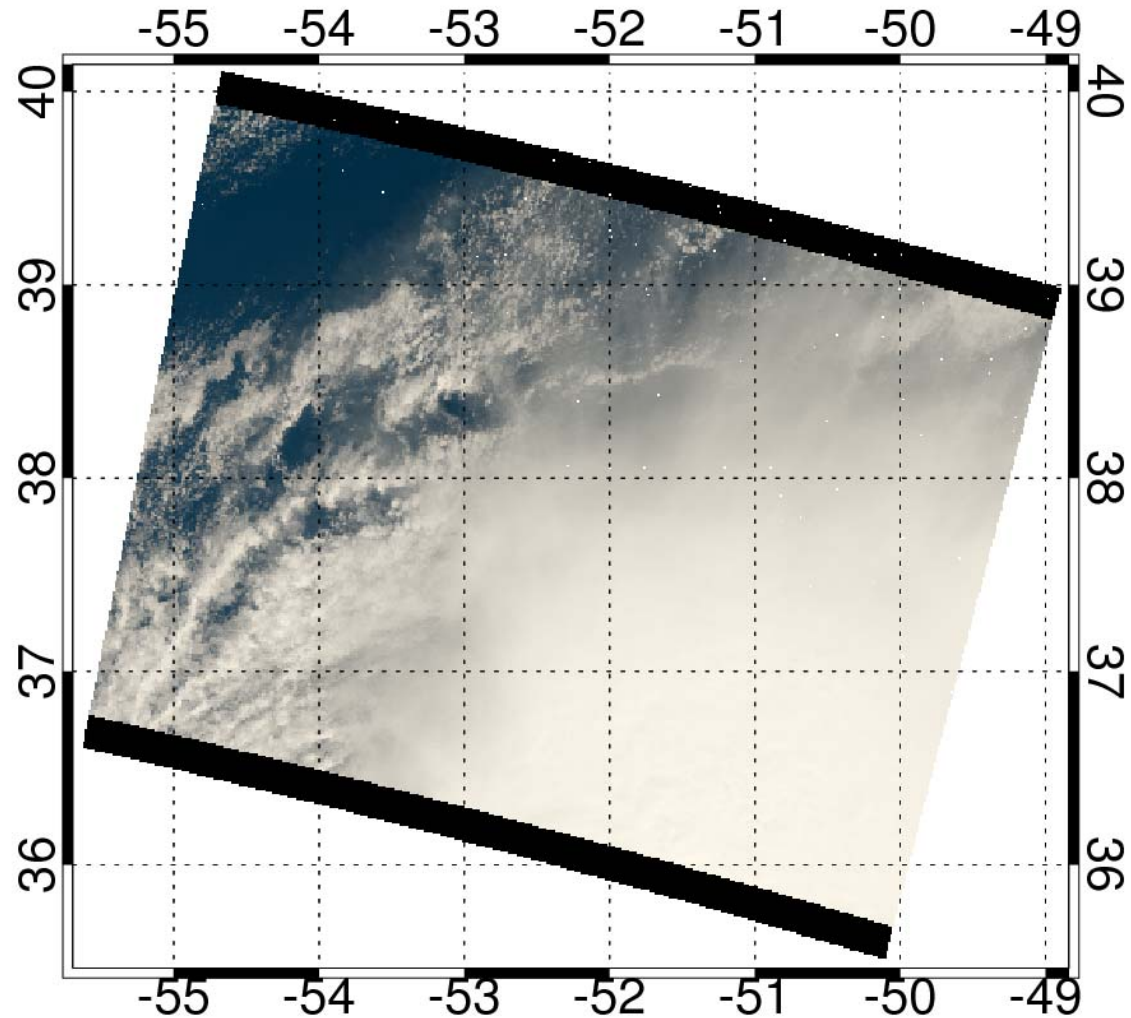
Effective single layer height(MERIS)

Effective single layer height (AATSR)

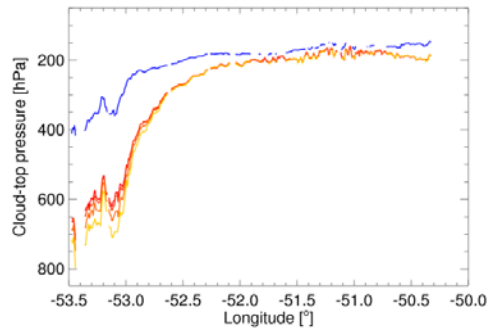
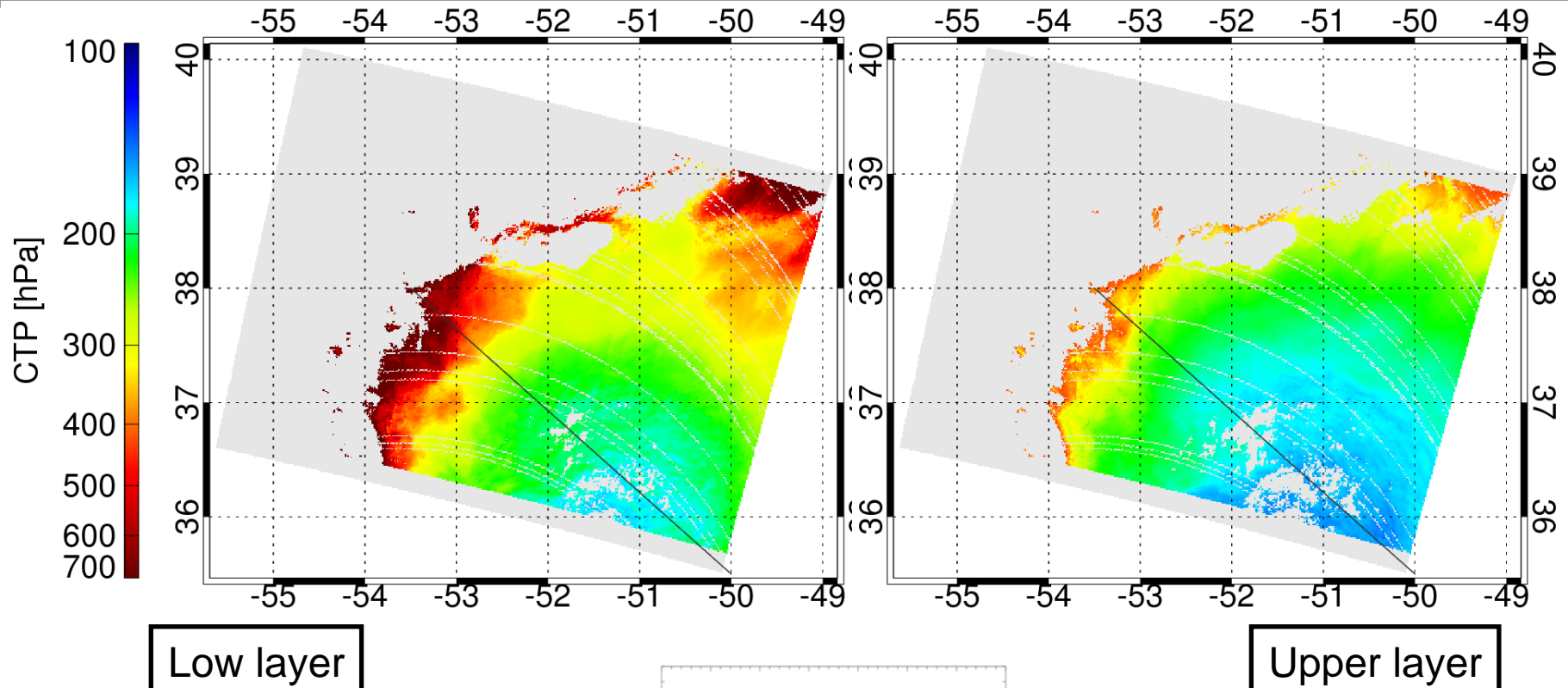
# Case study, 26 September 2005



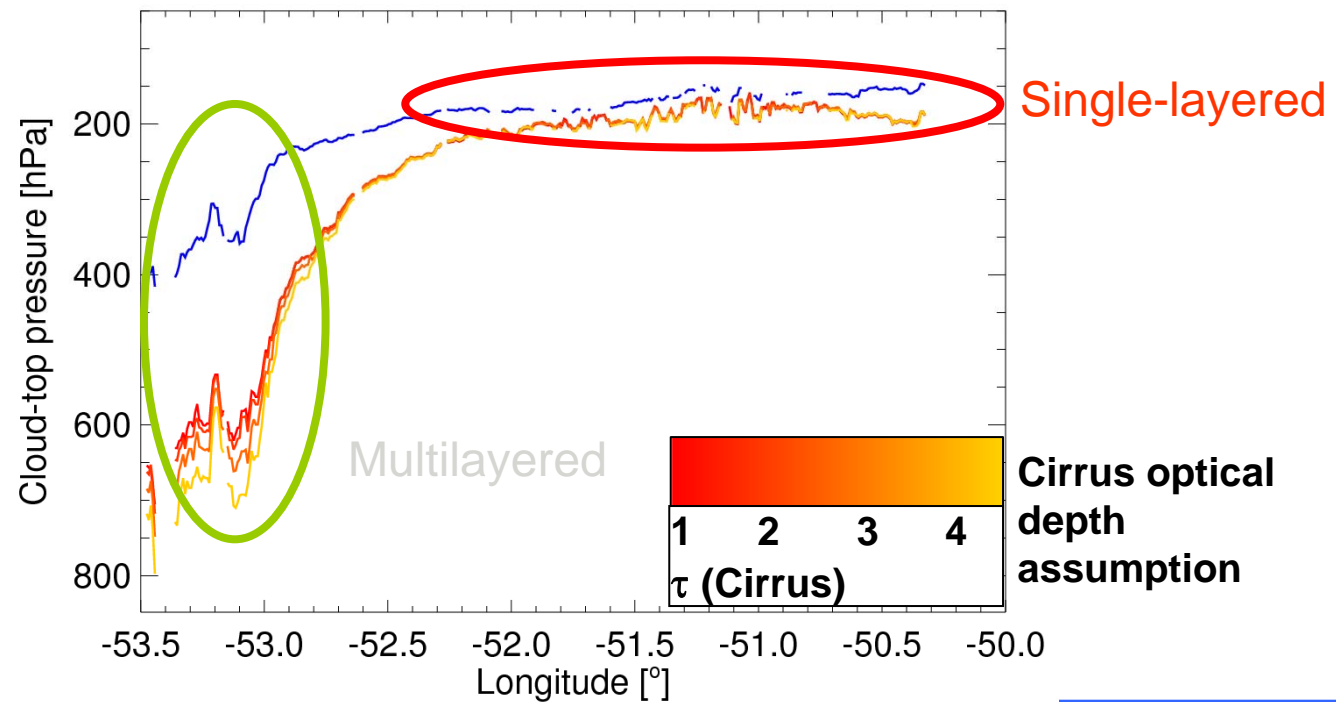
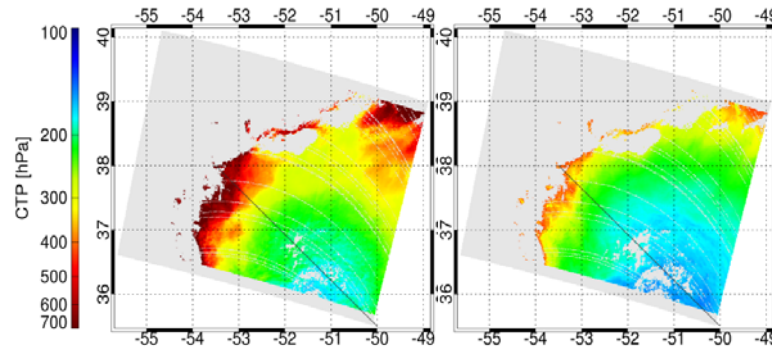
Cumulonimbus above  
North Atlantic with  
cirrus anvil



# Case study, 26 September 2005



# Case study, 26 September 2005



# Summary Cloud cci



- A unique CDR of cloud properties based on a coherent physical retrieval framework from AVHRR-MODIS-(A)ATSR-MERIS
  - to allow for future and historical satellites instruments
  - with superior quality to single polar satellite products
  - with superior and improved error characterisation at pixel scale
- A unique CDR of cloud properties based on a synergetic physical retrieval framework from (A)ATSR-MERIS
  - to allow for future satellite instruments
  - with superior quality
  - with improved multi-layer cloud estimates
- Based on fully characterised and traceable FCDR's.
- a European component of an integrated assessment framework for GEWEX for cloud properties

# Cloud CCI website




The screenshot shows the ESA Cloud CCI website. At the top, the ESA logo and 'climate change initiative' are displayed. A navigation bar contains links for various topics: ESA, CCI, aerosol, cloud, cmug, fire, ghg, glaciers, land cover, ocean colour, ozone, sea ice, sea level, and sst. The main content area is titled 'Cloud' and features a globe image. It contains three news items: 'News from the second progress meeting' (March 2011), 'Start of Round Robin exercise' (February 2011), and 'Website launch on 1 December 2010'. A 'User login' section is on the right, with fields for username and password, a 'Log in' button, and a link to 'Request new password'. A 'Search' section is at the bottom right. The left sidebar includes 'Navigation' (information, resources, development, support, forum), 'Related projects' (CREW, GEWEX Cloud Assessment), and 'Consortium'.

**esa** climate change initiative European Space Agency

ESA | CCI | aerosol | cloud | cmug | fire | ghg | glaciers | land cover | ocean colour | ozone | sea ice | sea level | sst

### Cloud



#### News from the second progress meeting [2011-03-30]

The meeting took place on March 1st and 2nd 2011 at DWD headquarters in Offenbach. [Read more »](#)

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#### Start of Round Robin exercise [2011-02-02]

As of 01 February the Round Robin exercise within the ESA Cloud CCI project has started. [Read more »](#)

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#### Website launch on 1 December 2010 [2010-11-26]

On December 1st 2010 the ESA Cloud CCI website has been launched. In the following weeks the content of this site will be modified and expanded to include all information about the project. Minor and major changes to this site will be posted in this NEWS section.

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#### Collection of user requirements for cloud properties [2010-11-26]

In the recent weeks, the project consortium has been collected the users' requirements on the the cloud property products which will be produced in this project. The collected requirements will strongly affect the technical specifications of the products, which will be defined and posted soon.

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#### Release of the first Cloud CCI Newsletter [2010-11-26]

The first newsletter of the ESA Cloud CCI project was recently released. The Newsletter contains basic information about the Cloud CCI objectives, the produced data sets, and the projects importance with respect to the role of clouds

### Image gallery



### User login

Username: \*

Password: \*

- [Request new password](#)

### Search

Search this site:

### Navigation

- ▶ information
- ▶ resources
- ▶ development
- ▶ support
- forum

### Related projects

CREW  
GEWEX Cloud Assessment

### Consortium

