First observations of the low cloud cover with the lidar GLAS, comparison with ISCCP

Geneviève Sèze, Jacques Pelon, Mathieu Lalande

For the first time, the **fifty days in October-November 2003** of lidar measurements **from GLAS** (Geoscience Laser Altimeter System) onboard the ICESAT platform, give the opportunity of a **global observation** with a lidar of the spatial and diurnal variation of the **vertical cloud cover distribution**

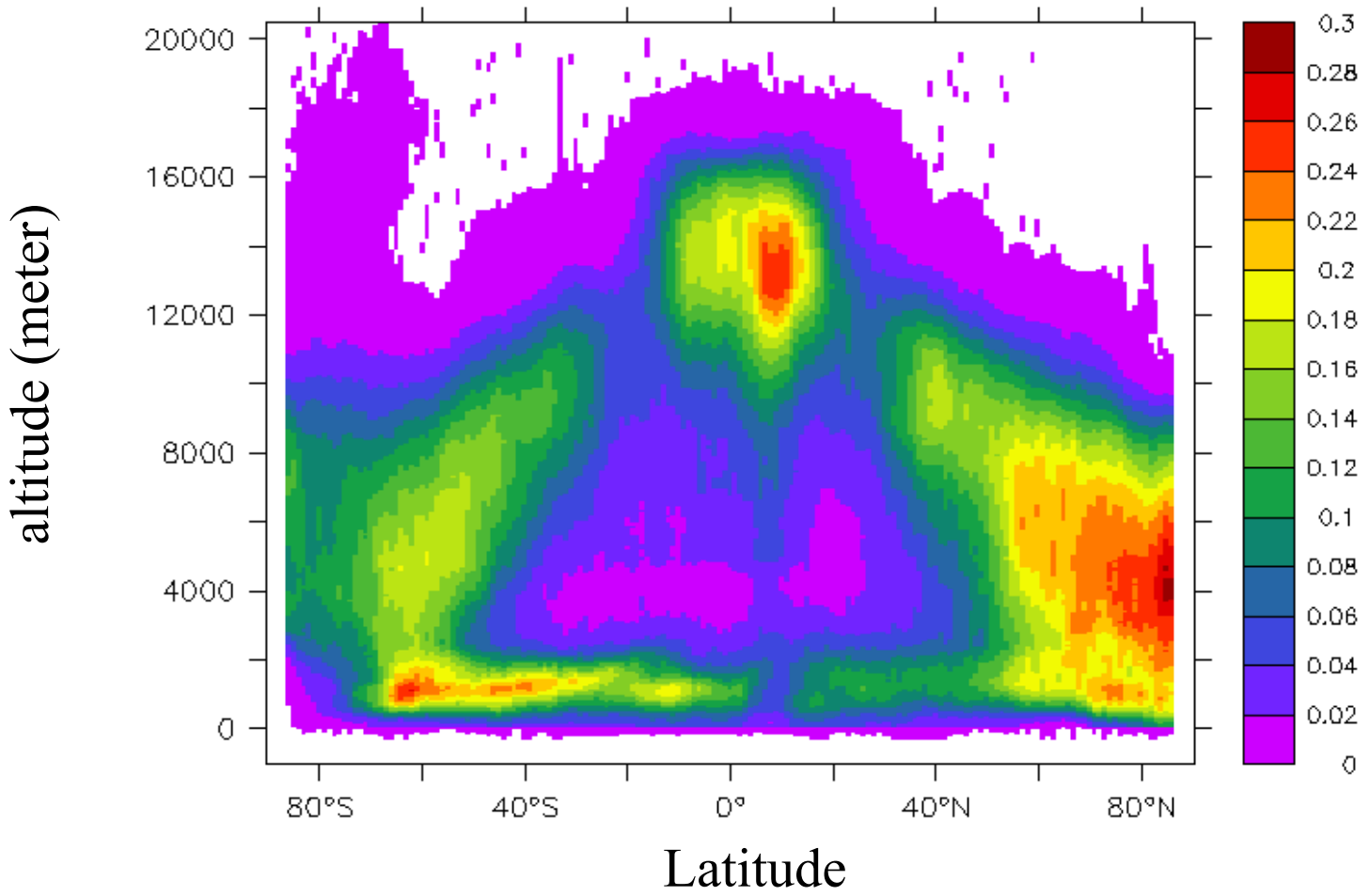
The **ISCCP** (International Cloud Climatology project) climatology now gives more than **20 years of cloud cover statistics**, allowing to study both the diurnal cycle of the cloud cover and its evolution. However, due to the lack of valuable validation measurements, interpretation of the results obtained with this data set, can be difficult.

Can data sets such as GLAS and very soon from CALIPSO and CLOUDSAT allow a least a partial validation of ISCCP cloud properties ?

Questions tackled in this exploratory study

- What does the vertical distribution of the cloud cover observed with GLAS look like ?
- What are the main characteristics of the total and low cloud cover distributions observed with the lidar GLAS?
- How do they compare with those given by ISCCP for the same period ?
- Are fifty days of data sufficient to obtain significant statistics?
- Does this data set allow to study a part of the diurnal evolution of the low cloud cover?
- More precisely, in spite of less precise measurements during daytime as compared to nighttime, can we use the differences observed between the day and night data to bring information on the diurnal evolution of the cloud cover?
- Are the main characteristics of the low cloud cover over ocean observed in the subtropical an tropical region consistent with what is known?

GLAS CLOUD COVER – 29 September to 18 November 2003

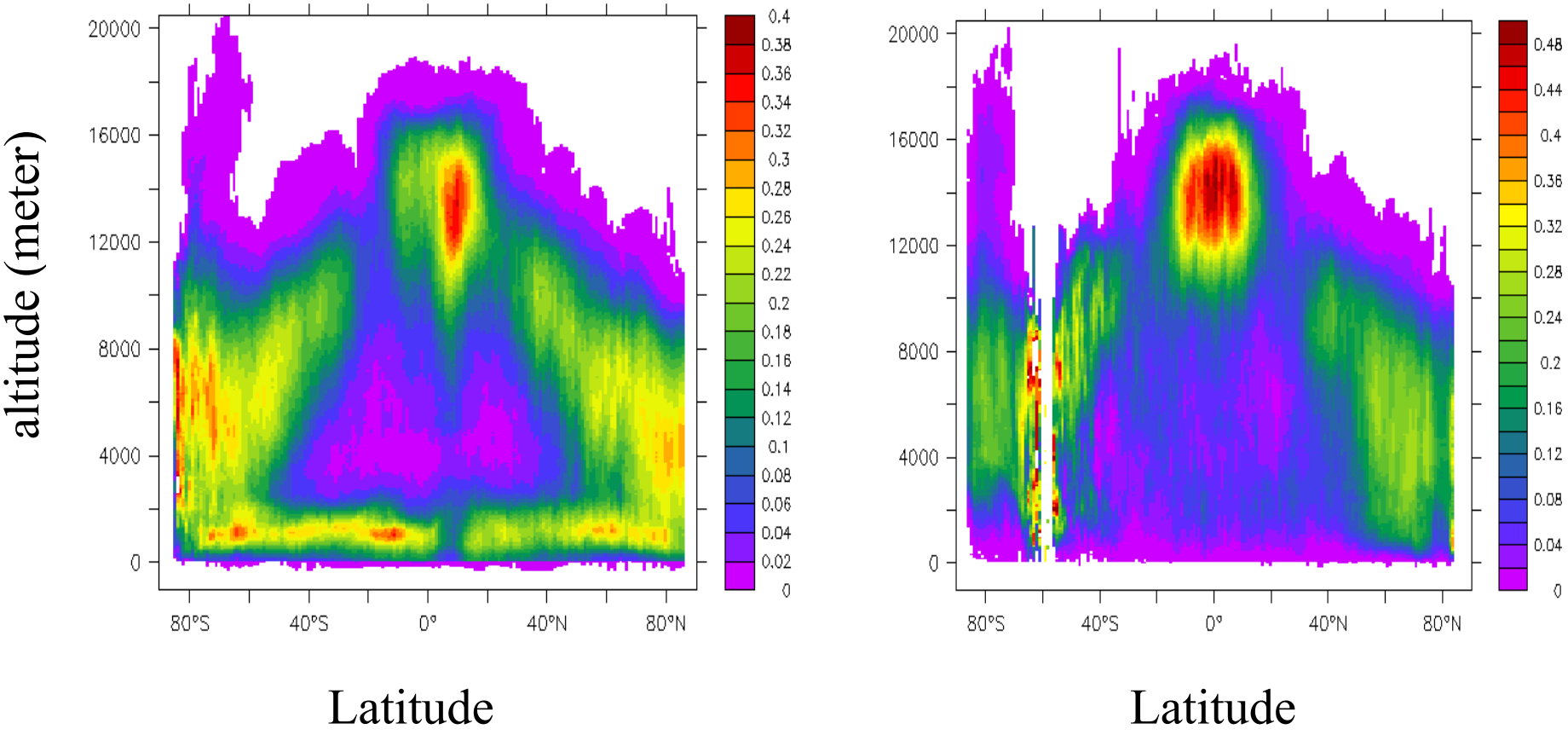


GLAS CLOUD COVER – 29 September to 18 November 2003

Night

Ocean

Land



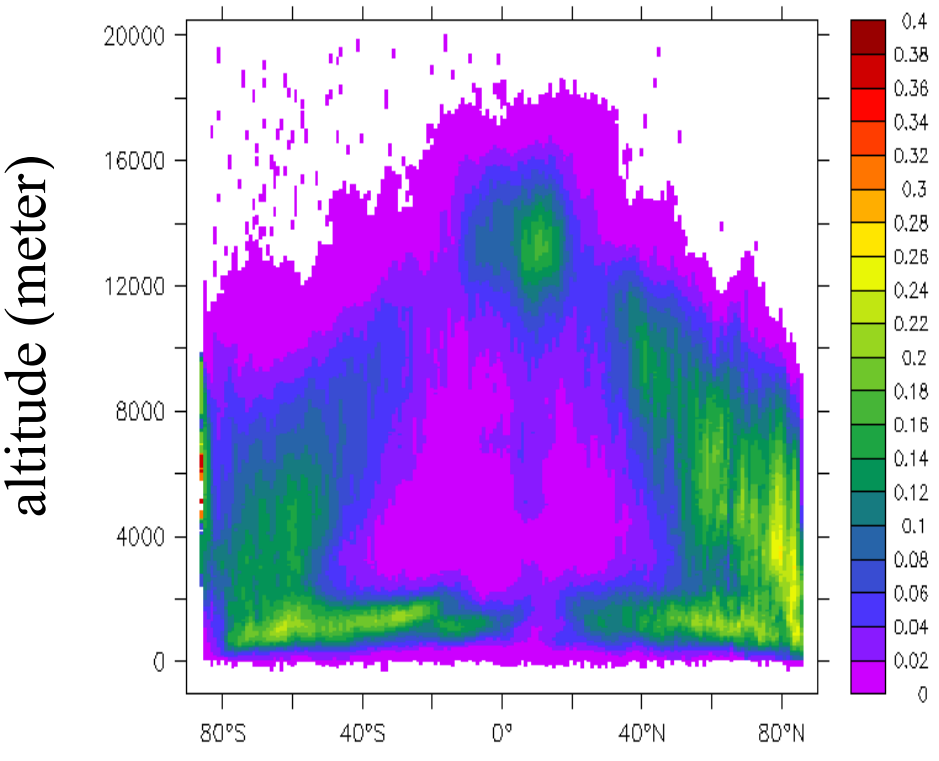
Latitude

Latitude

GLAS CLOUD COVER – 29 September to 18 November 2003

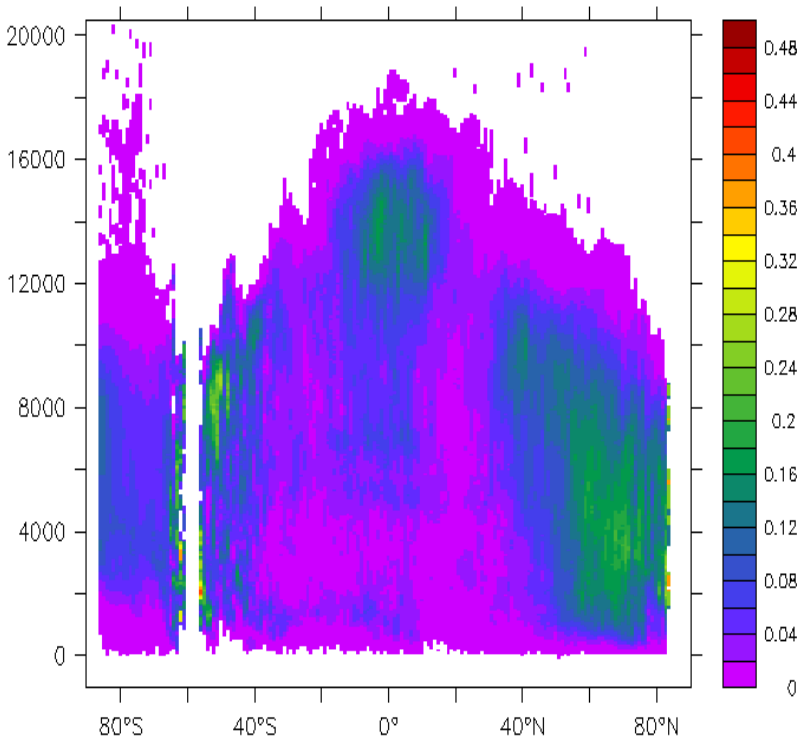
Day

Ocean



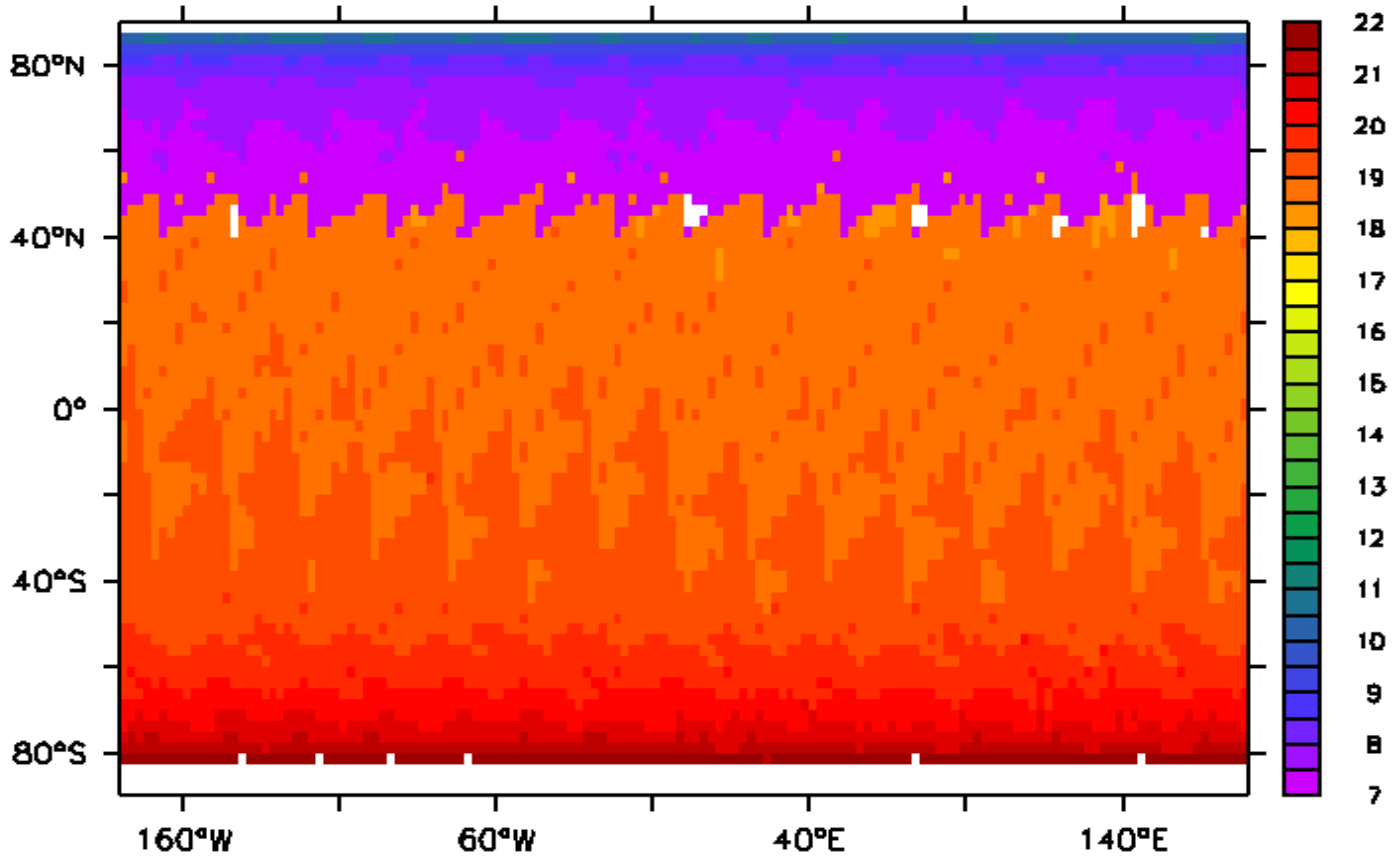
Latitude

Land



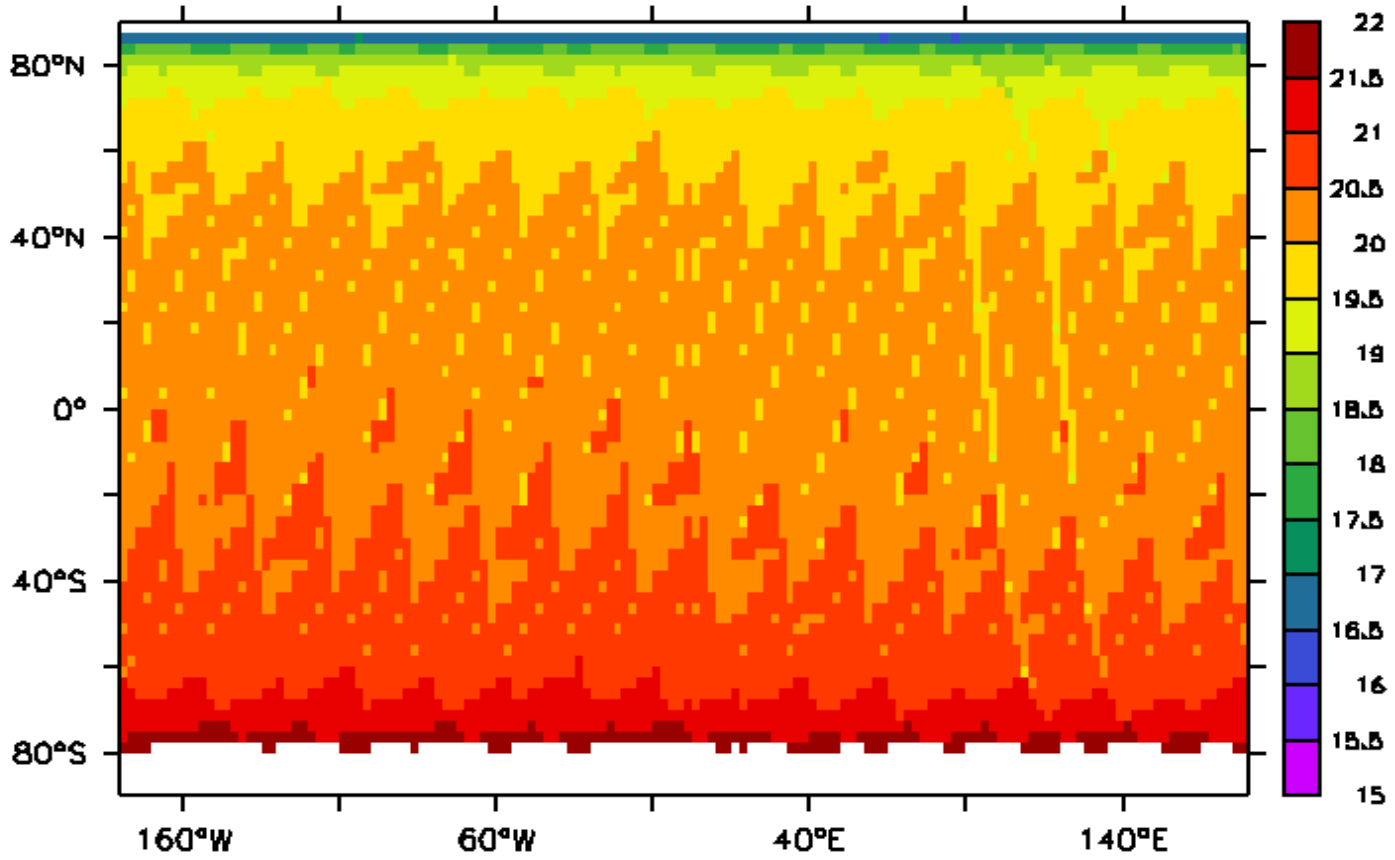
Latitude

Night time data
Local time of ICESAT overpass – 29 September to 18 November 2003



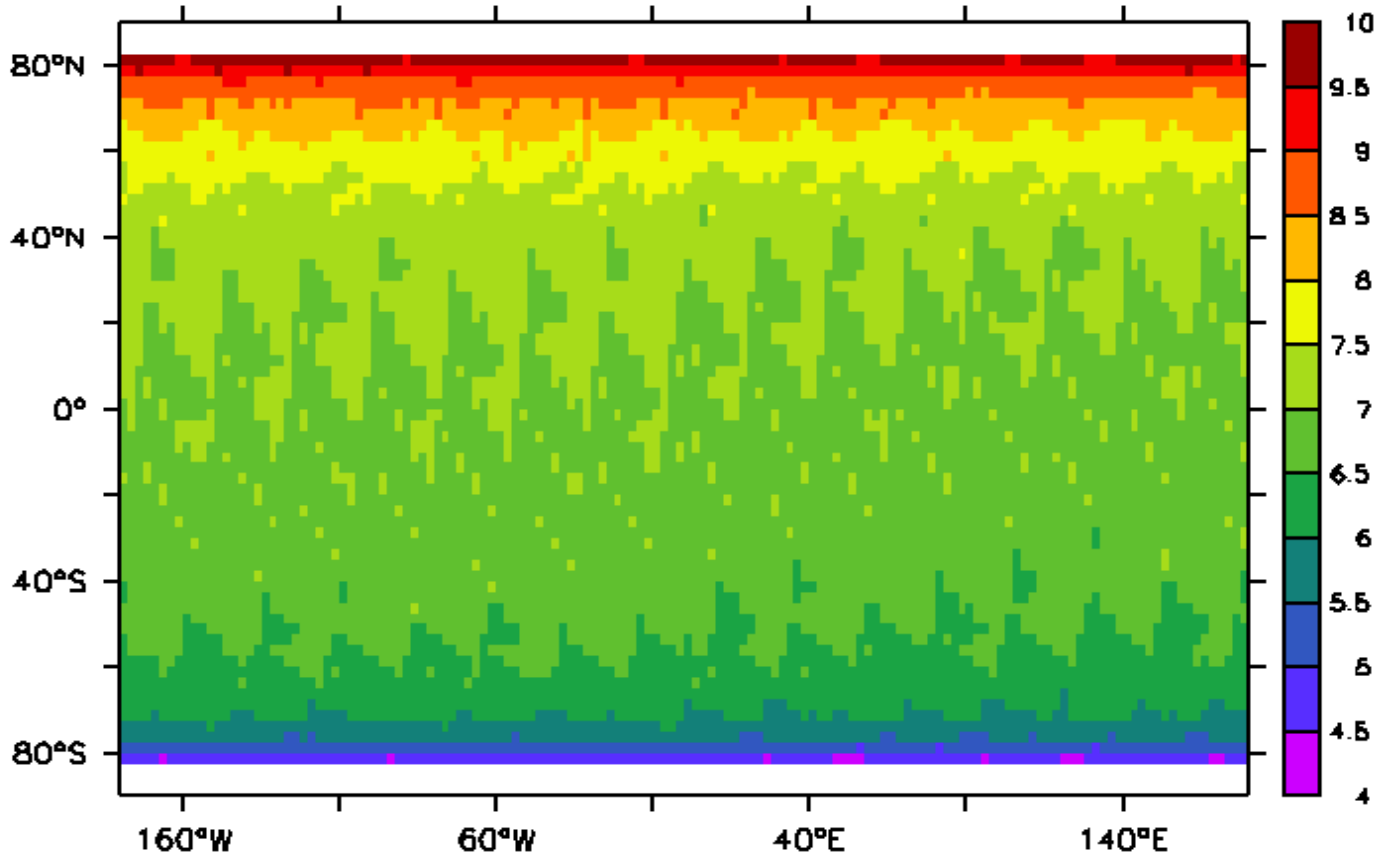
Minimum for the 53 day period

Night time data
Local time of ICESAT overpass – 29 September to 18 November 2003



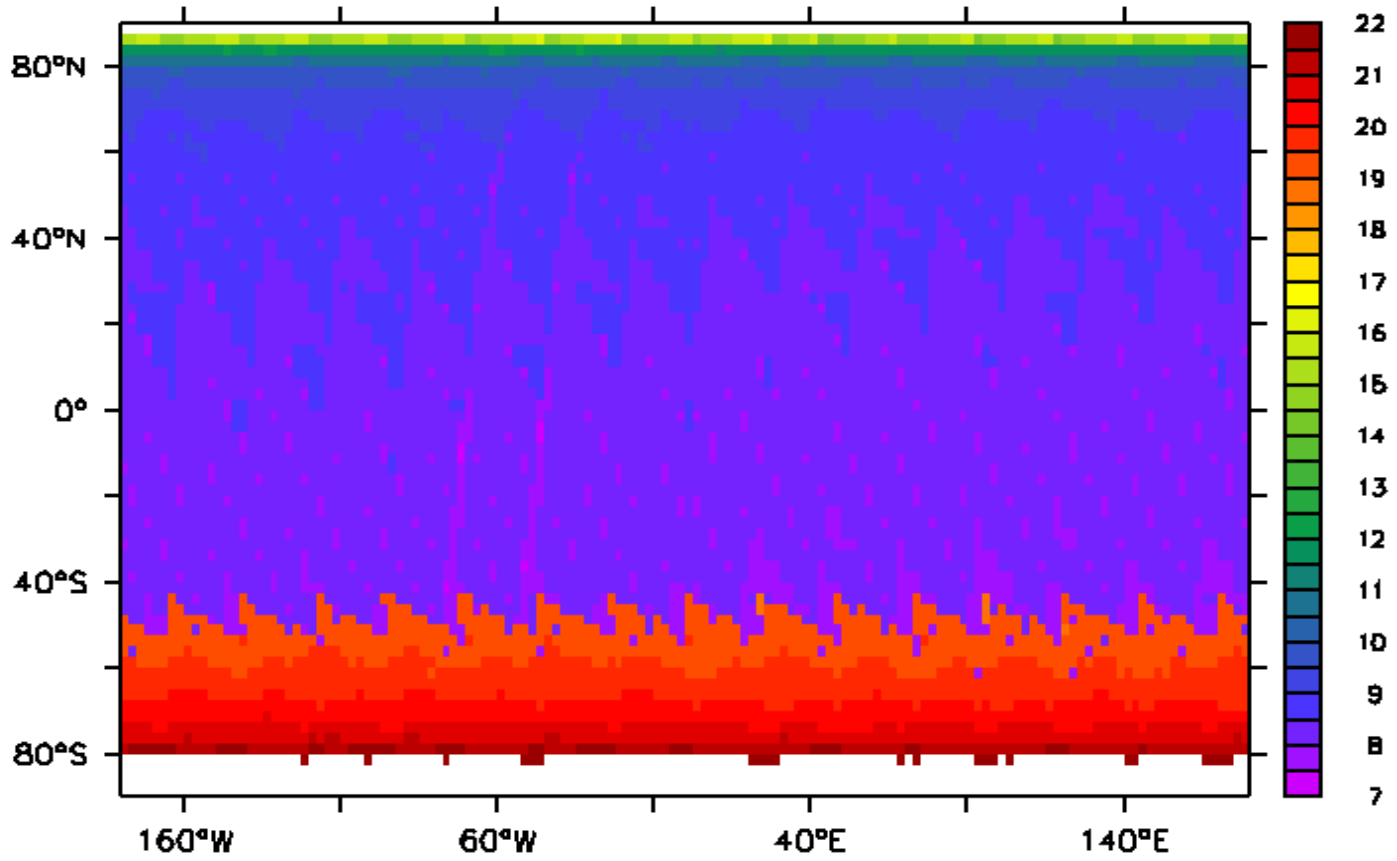
Maximum for the 53 day period

Day time data
Local time of ICESAT overpass – 29 September to 18 November 2003



Minimum for the 53 day period

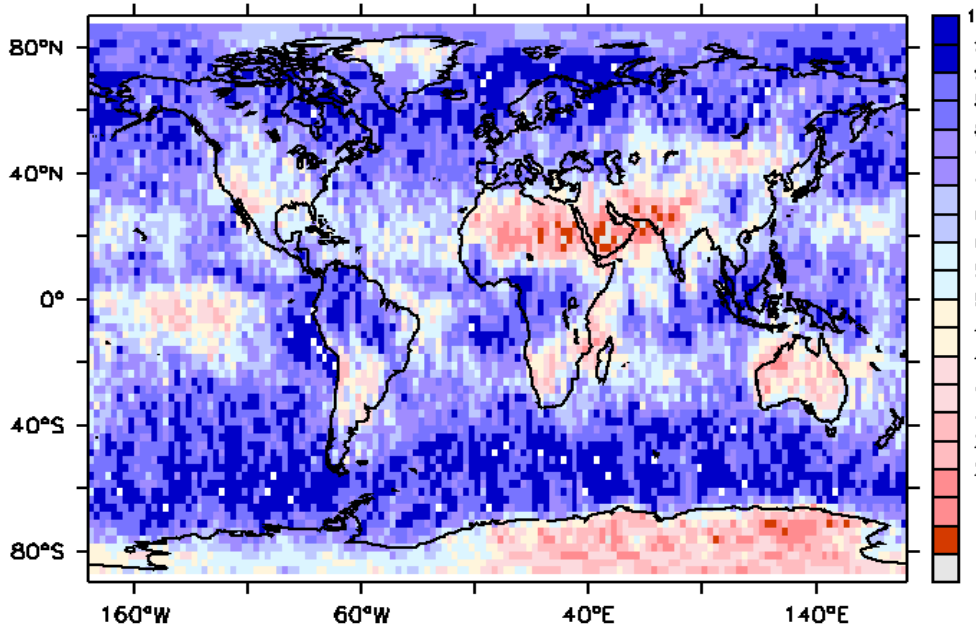
Day time data
Local time of ICESAT overpass – 29 September to 18 November 2003



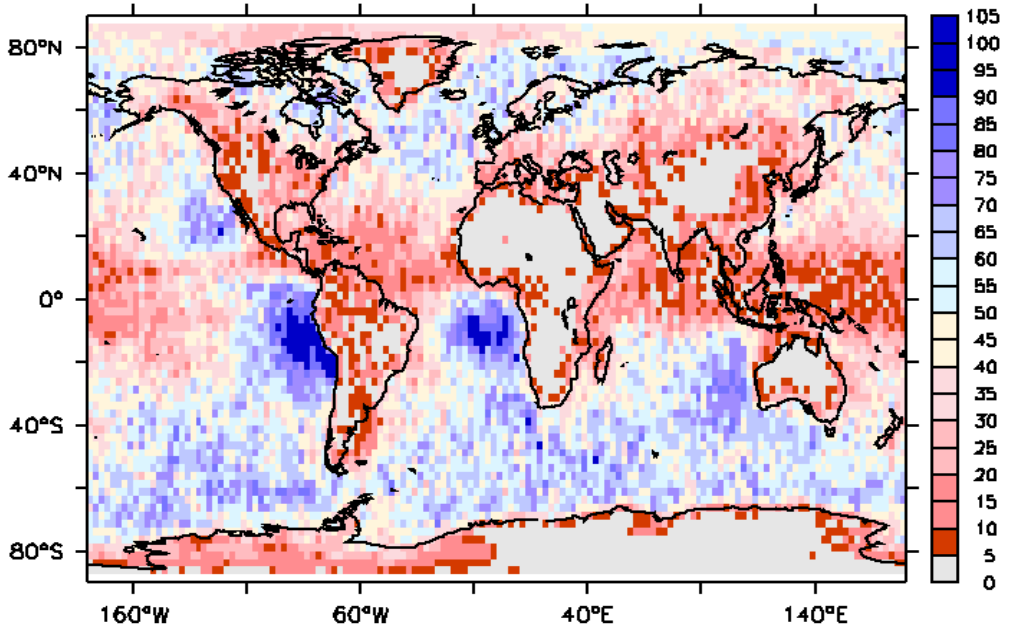
Maximum for the 53 day period

GLAS CLOUD COVER – 29 September to 18 November 2003

Total



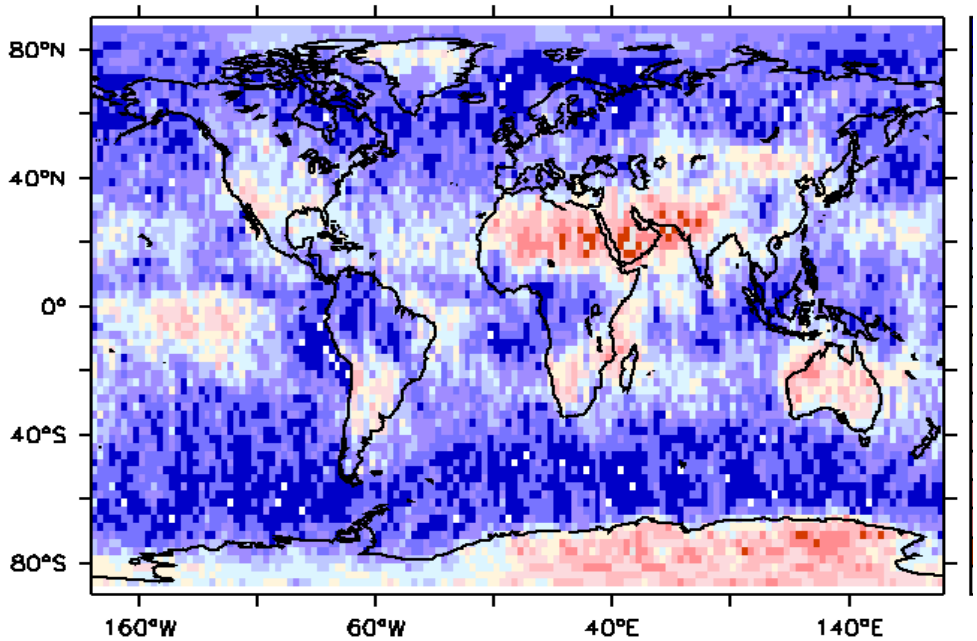
Low Clouds



Total Cloud

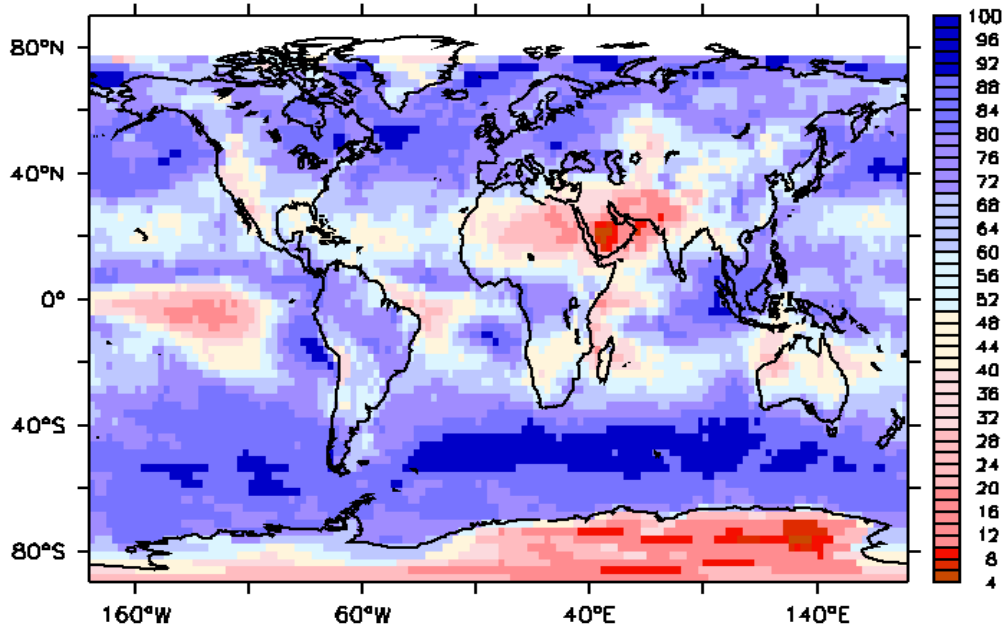
29 September to 18 November 2003

GLAS

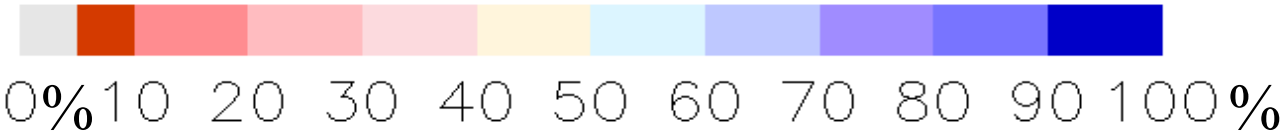


GLAS Cloud cover

ISCCP D1 VIS-IR



ISCCP D1 VIS-IR Cloud cover



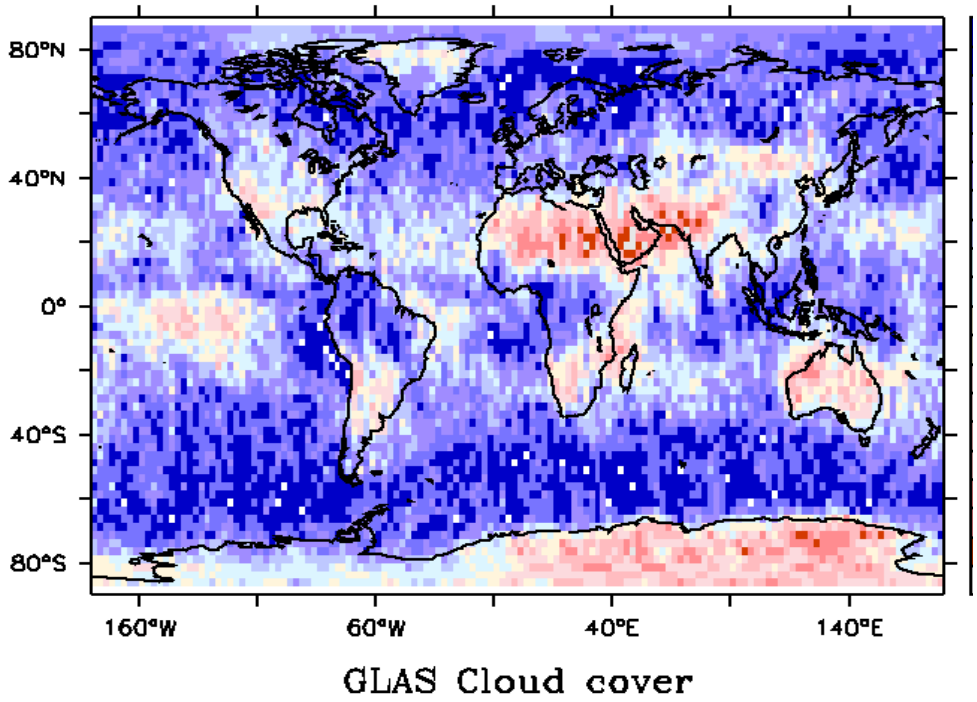
GLAS: night and day data

ISCCP: 7h , 8h, 9h, 10h30, 12h, 15h, 16h, 17h local time average

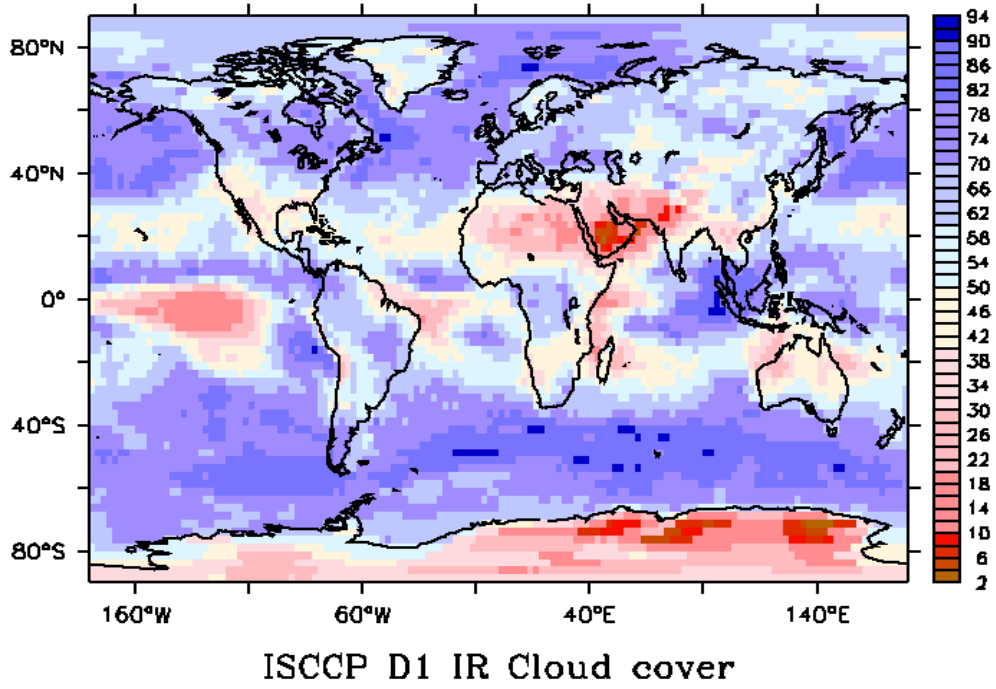
Total Cloud

29 September to 18 November 2003

GLAS



ISCCP D1 IR



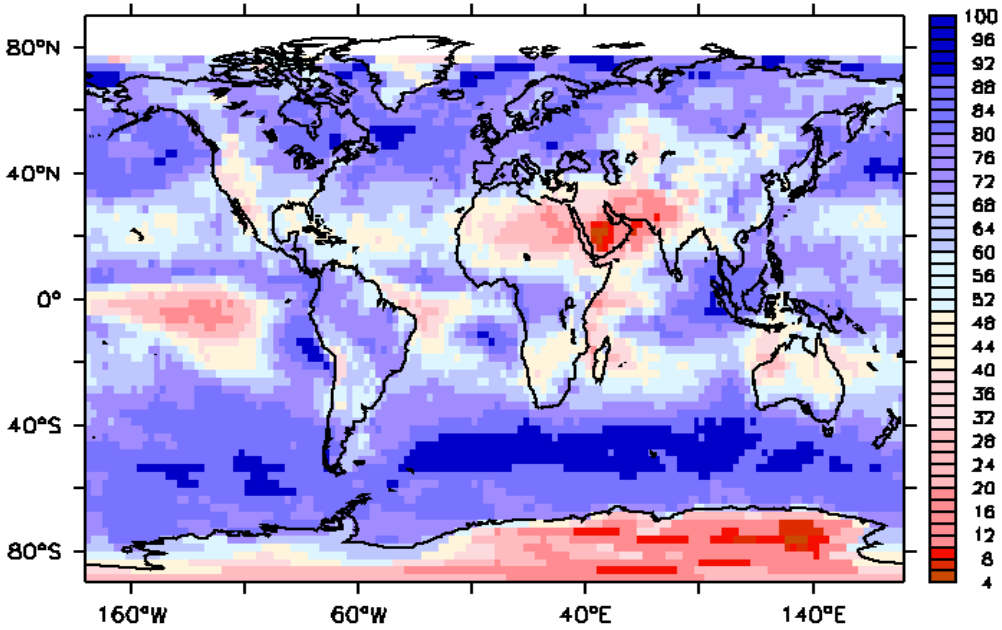
GLAS: night and day data

ISCCP: 7h , 8h, 9h, 10h30, 12h, 15h, 16h, 17h, 19h, 21h local time average

Total Cloud

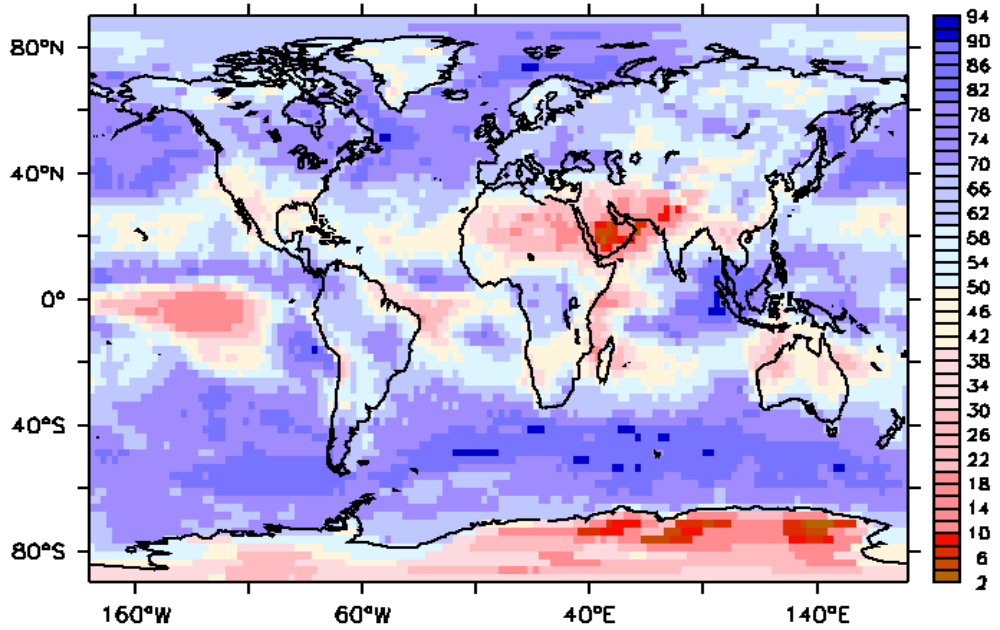
29 September to 18 November 003

ISCCP D1 VIS-IR



ISCCP D1 VIS-IR Cloud cover

ISCCP D1 IR



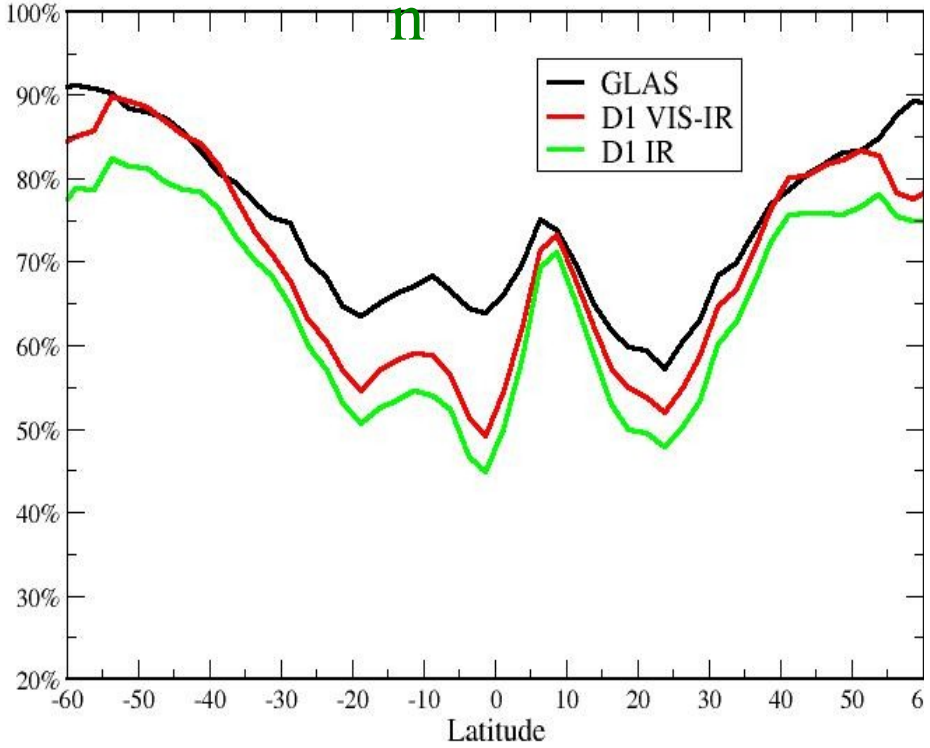
ISCCP D1 IR Cloud cover

GLAS and ISCCP D1

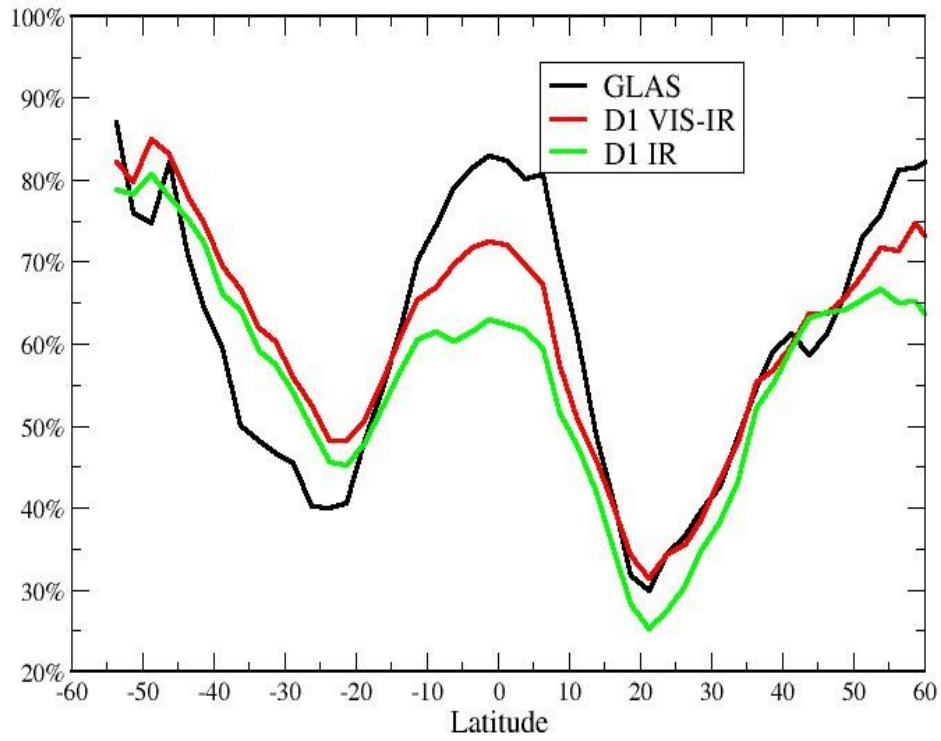
29 September to 18 November 2003

Total Cloud Cover between 60S and 60N

Ocean



Land

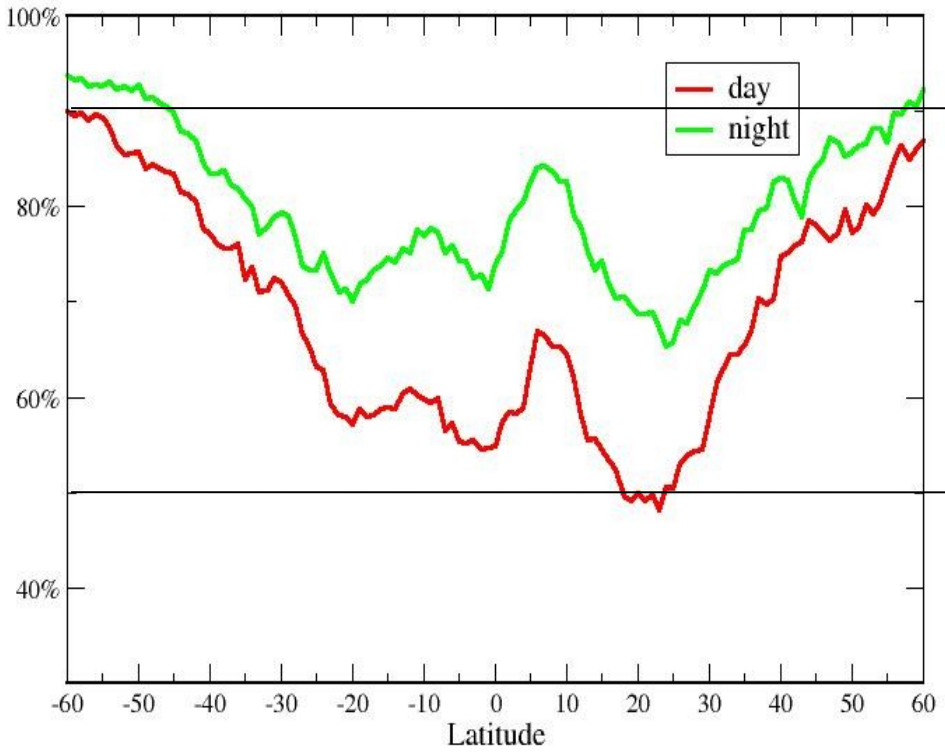


GLAS and ISCCP D1 VIS-IR

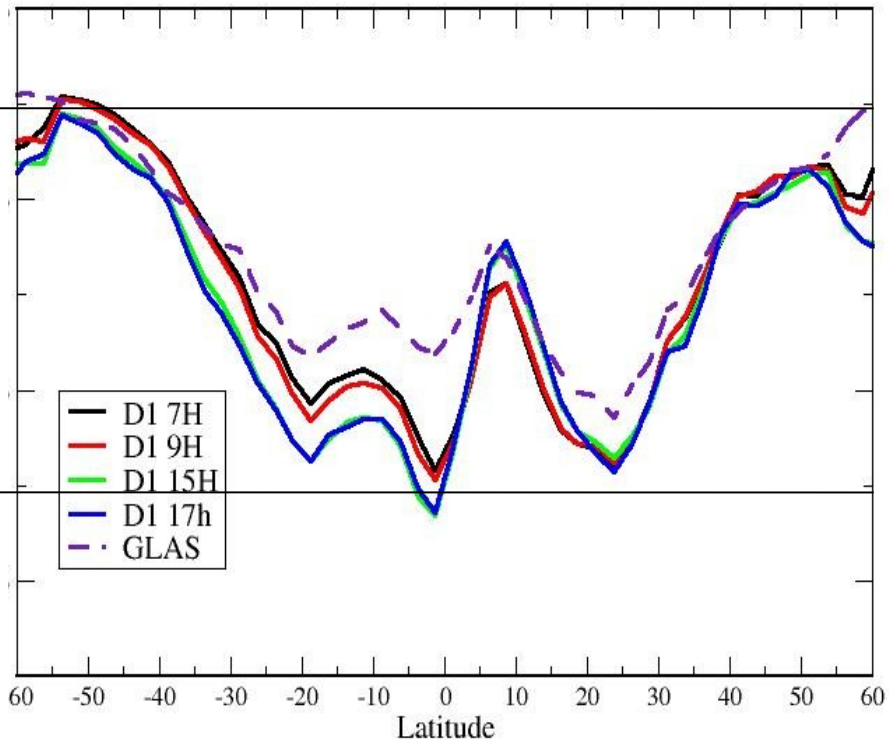
29 September to 18 November 2003

Total Cloud Cover over ocean: 60S - 60N

GLAS



D1 VIS-IR



GLAS, 2curves: night and day data

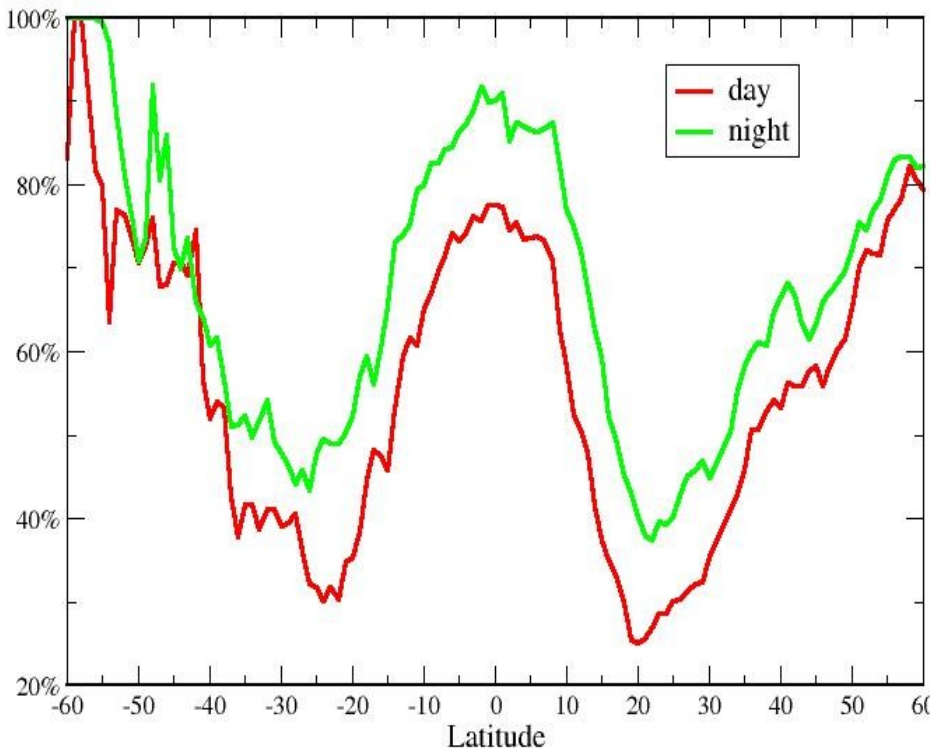
D1, 4 curves with day data: 7h, 9h, 15h, 17h

GLAS and ISCCP D1 VIS-IR

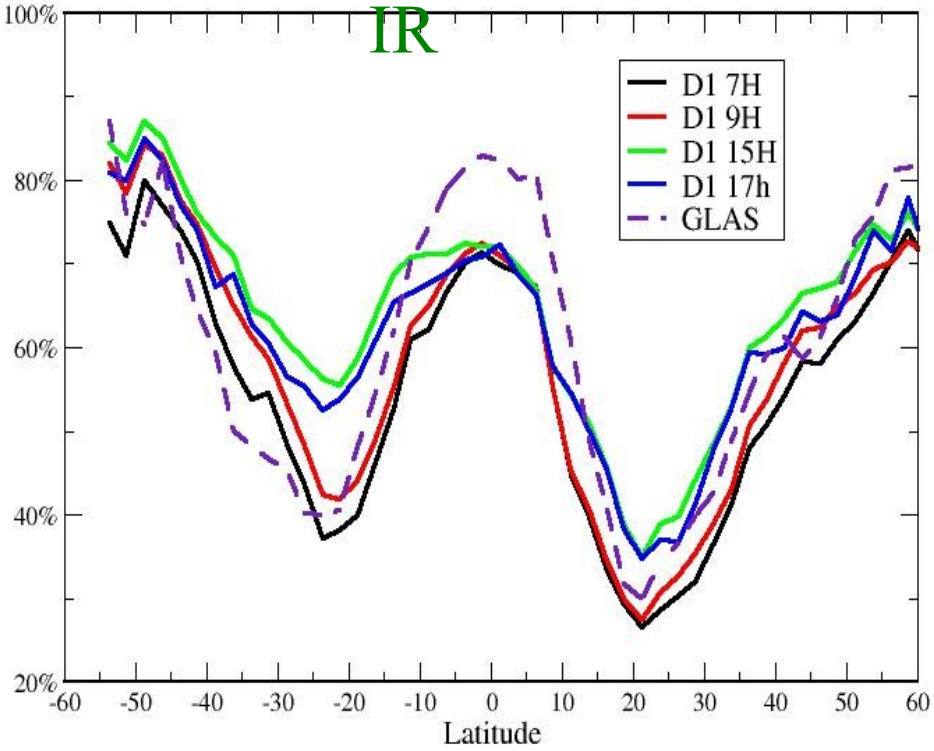
29 September to 18 November 2003

Total Cloud Cover over land 60S - 60N

GLAS



D1 VIS-IR



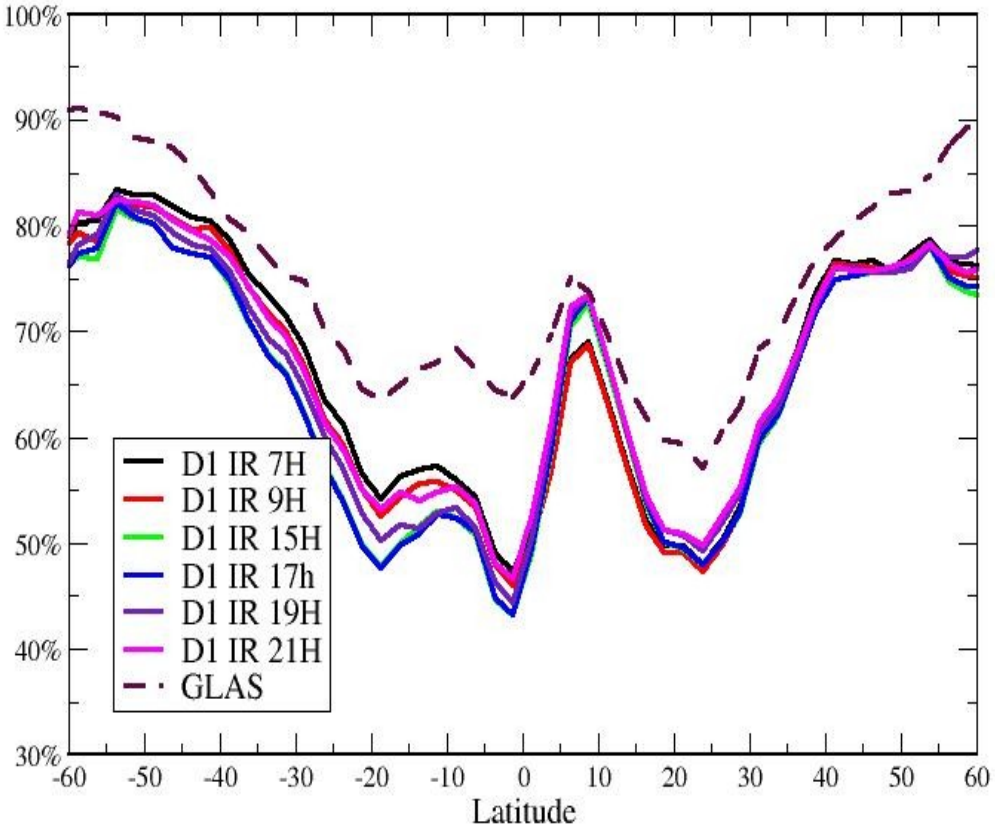
GLAS, 1curve: all data average - D1, 4 curves: 7h, 9h, 15h, 17h

ISSCP D1 IR Total Cloud Cover

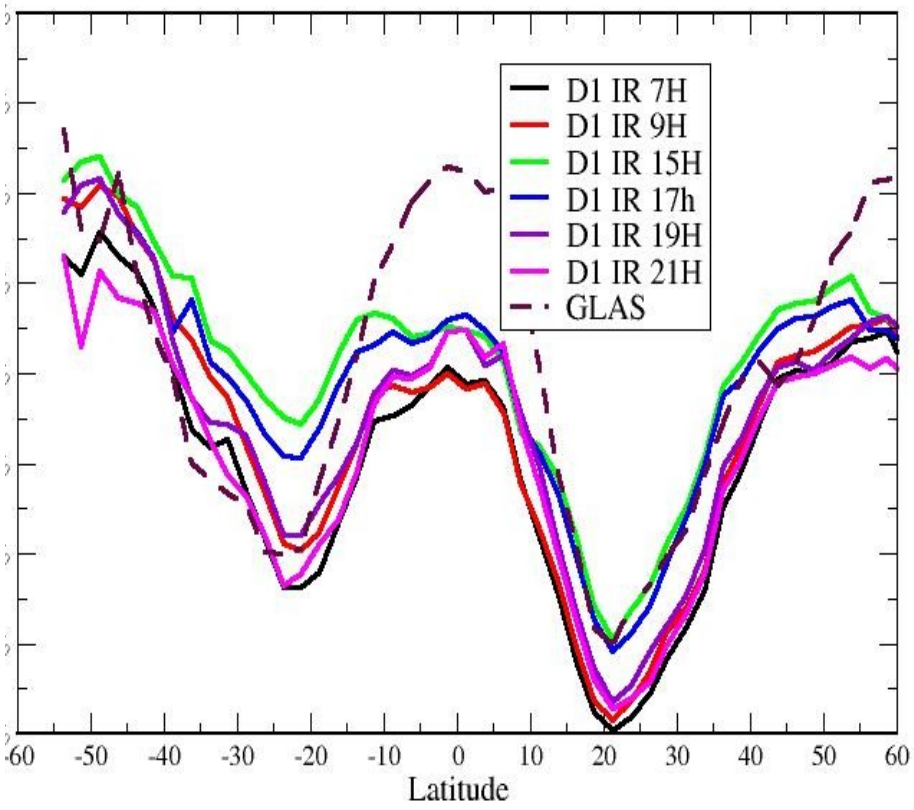
29 September to 18 November 2003

Diurnal variation

Ocean

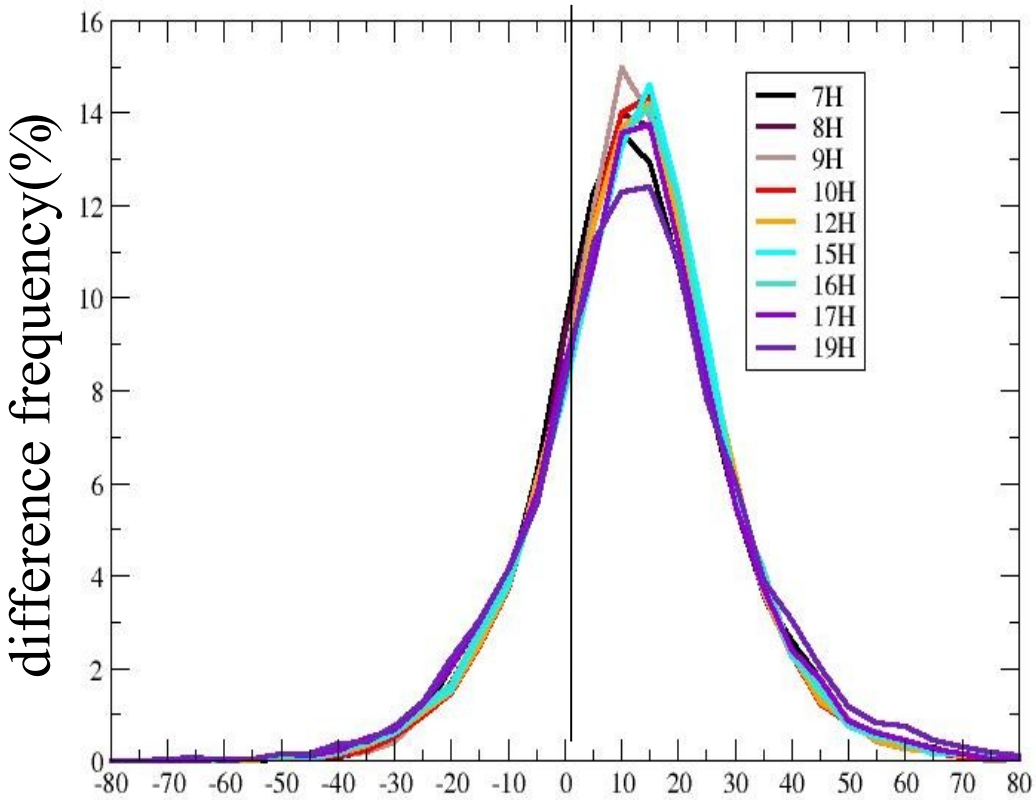


Land

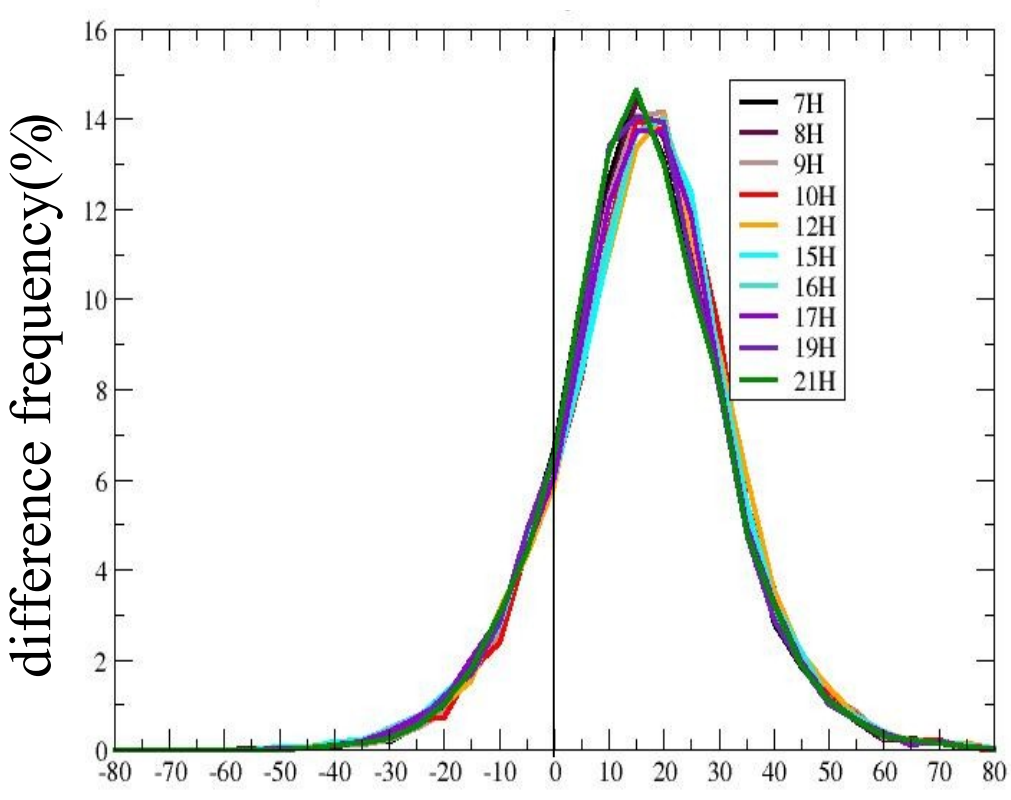


Total Cloud Cover frequency differences at 2.5°x2.5° scale

GLAS – D1 VIS-IR



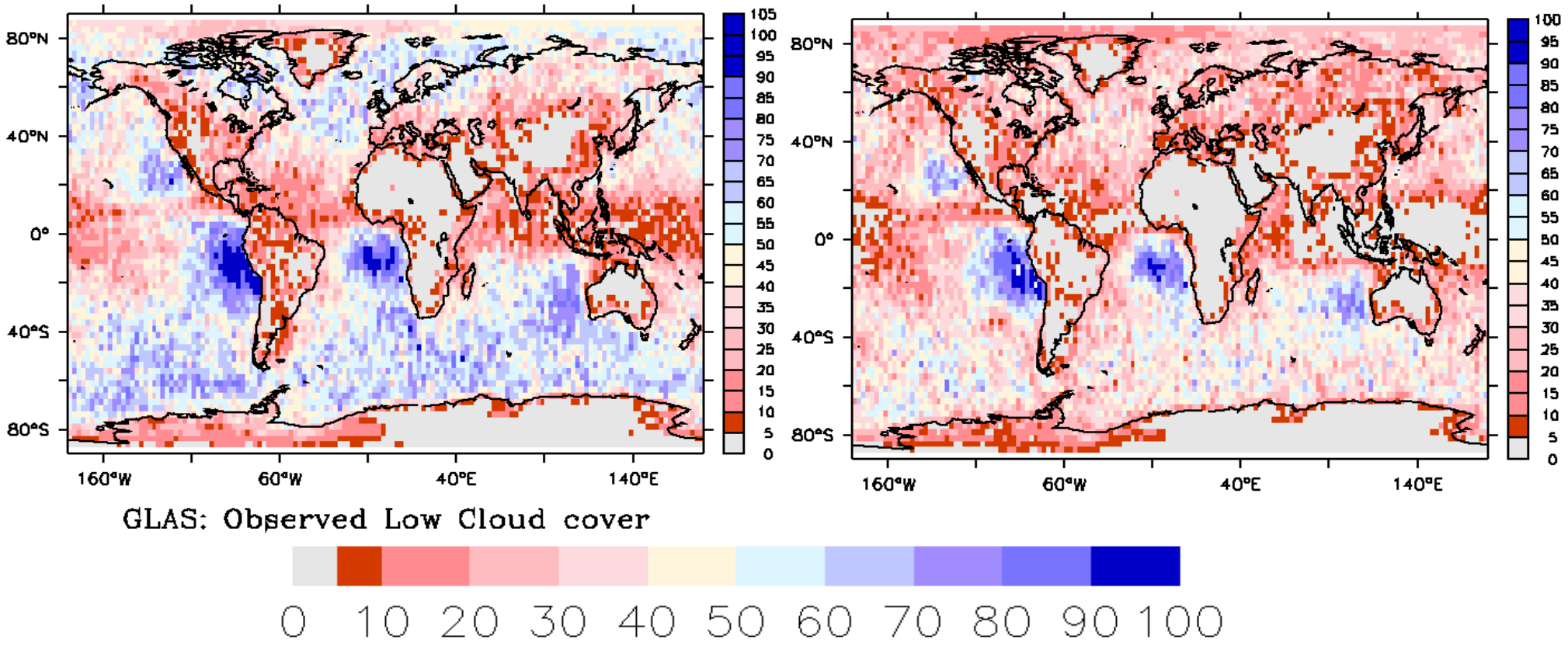
GLAS – D1 IR



GLAS LOW CLOUD COVER
29 September to 18 November 2003

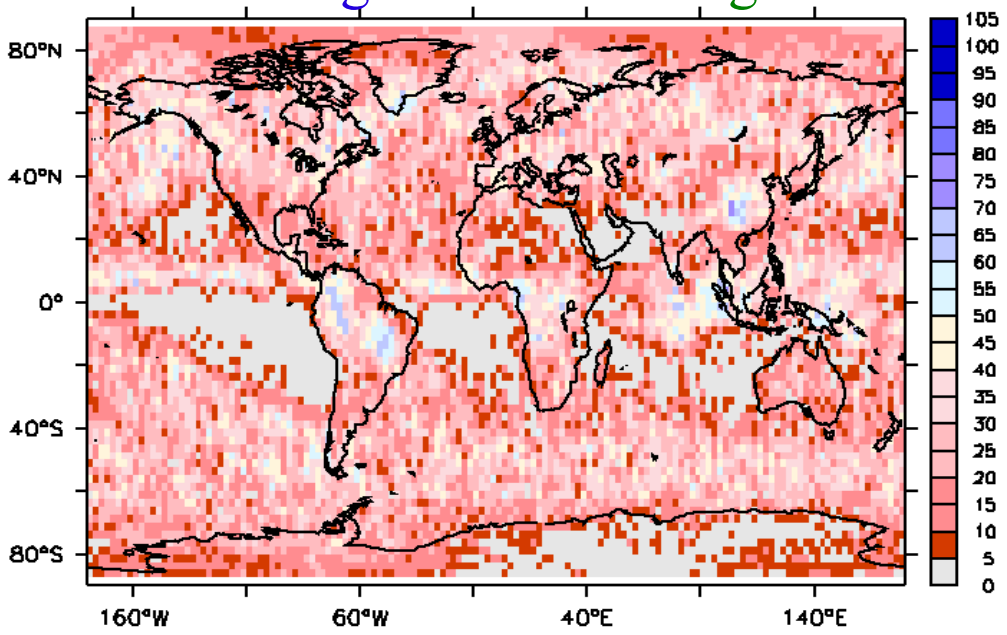
Low with or without an upper cloud layer

Only Low clouds



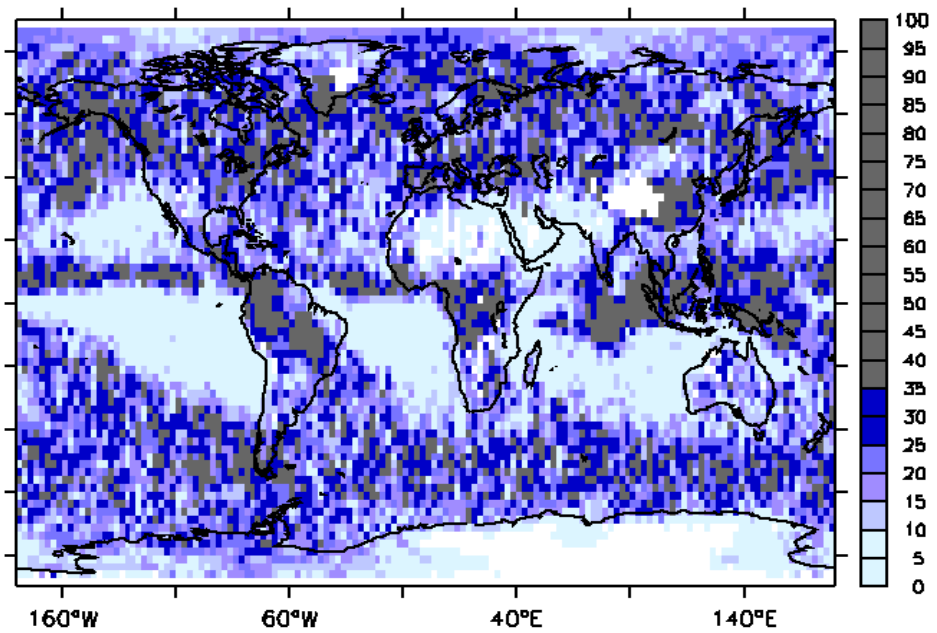
Low Cloud Cover Underestimation
GLAS: 29 September to 18 November 2003

Only middle + high level cloud
no lidar ground return: nlgr case

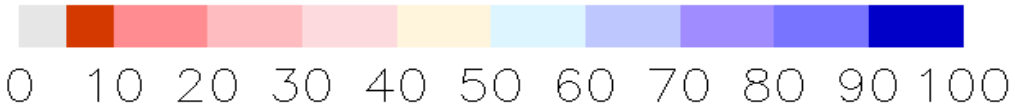


GLAS: The possibility to observe Low Cl. is null

Relative percentage of low clouds
due to the nlgr cases

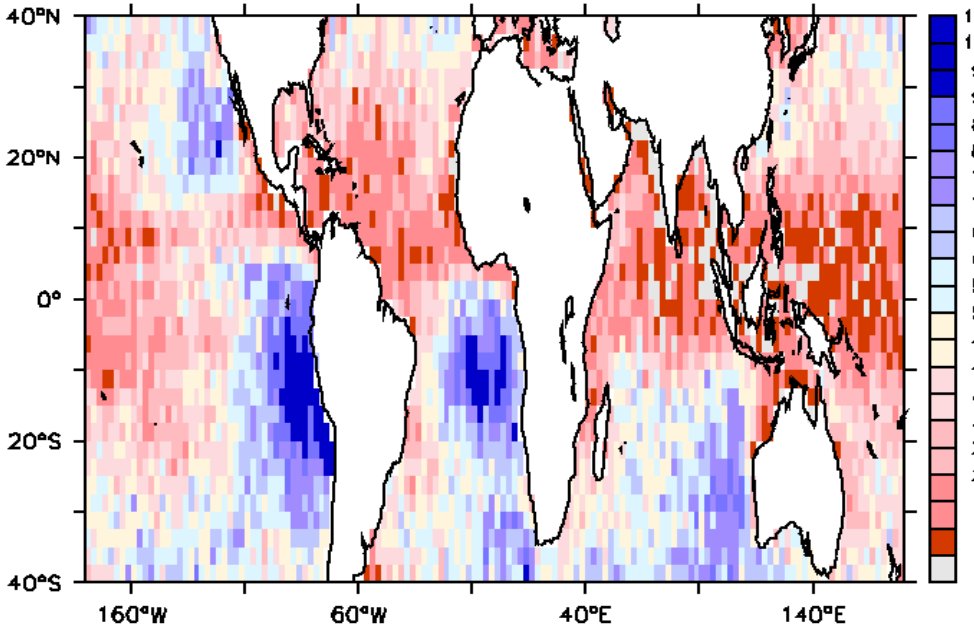


GLAS: Mean Incertitude in Low Cl. cover



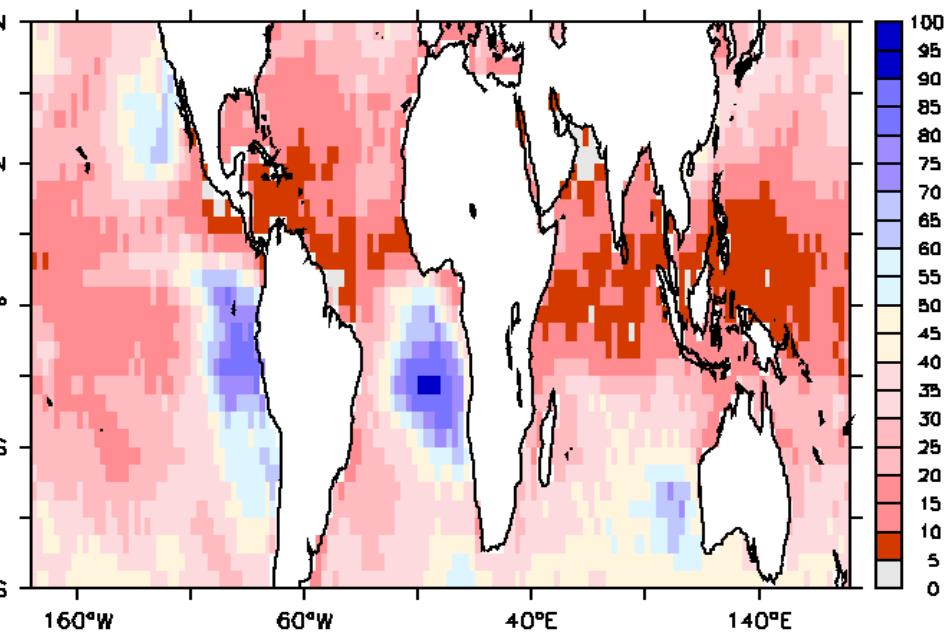
Low cloud cover in the tropical marine boundary layer
29 September to 18 November 2003

GLAS

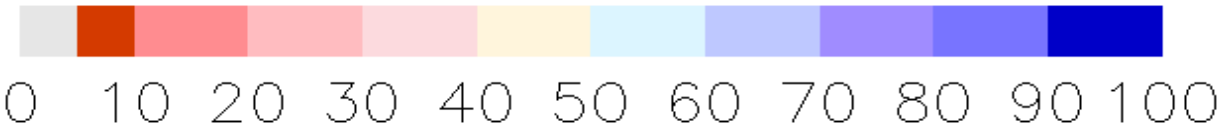


GLAS: Low Cloud frequency

D1 VIS-IR(9h)

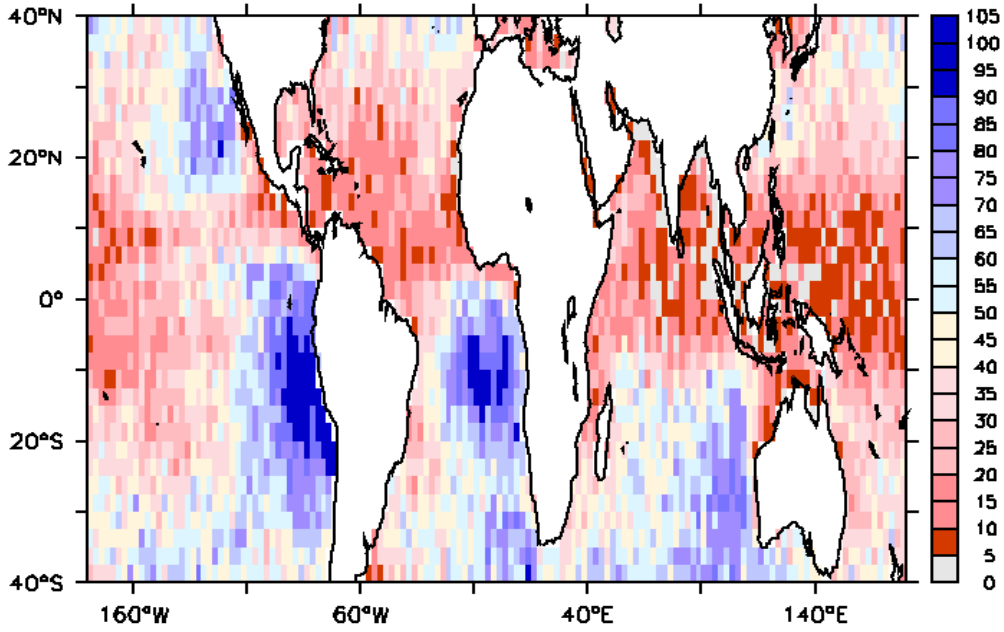


D1 VIS-IR: Low Cloud frequency



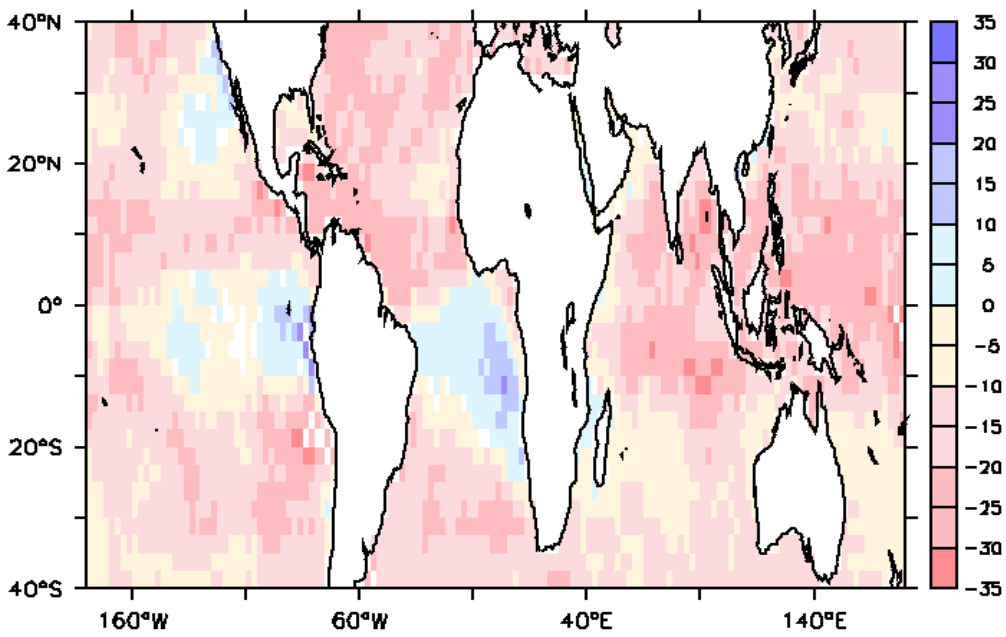
Low cloud cover in the tropical marine boundary layer
29 September to 18 November 2003

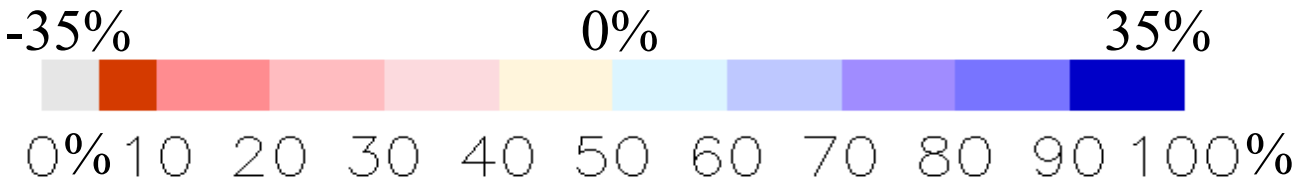
GLAS



GLAS: Low Cloud frequency

D1: VIS-IR minus IR- 9h

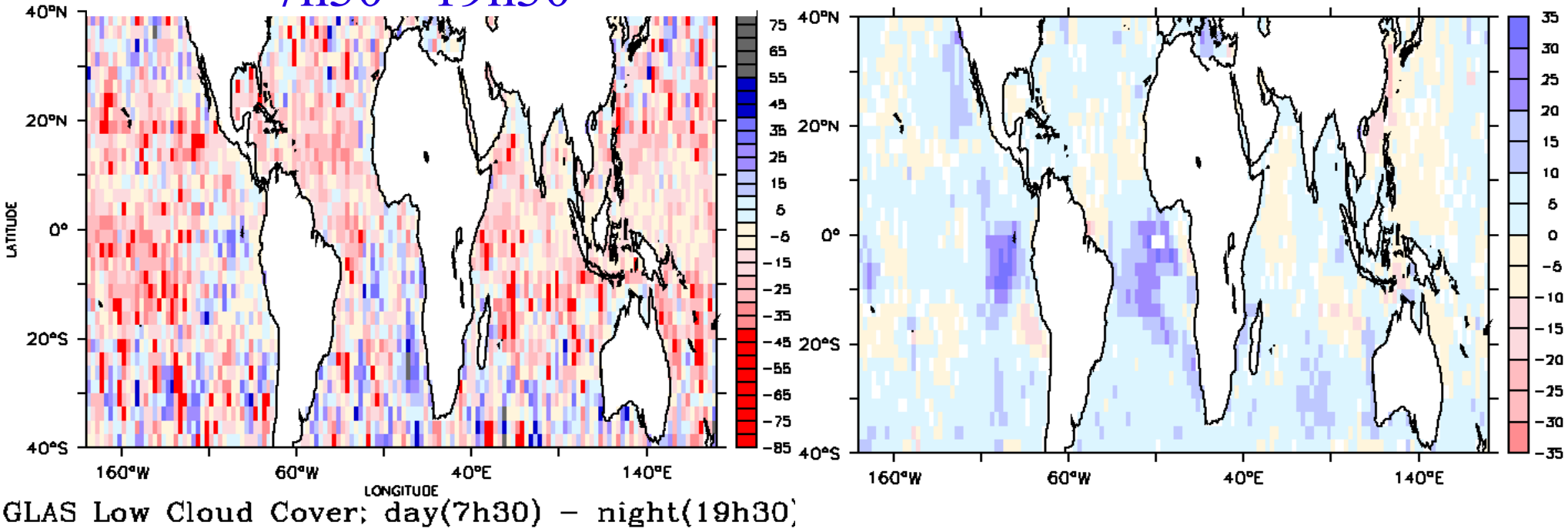




Low cloud cover in the tropical marine boundary layer

GLAS: day minus night
7h30 - 19h30

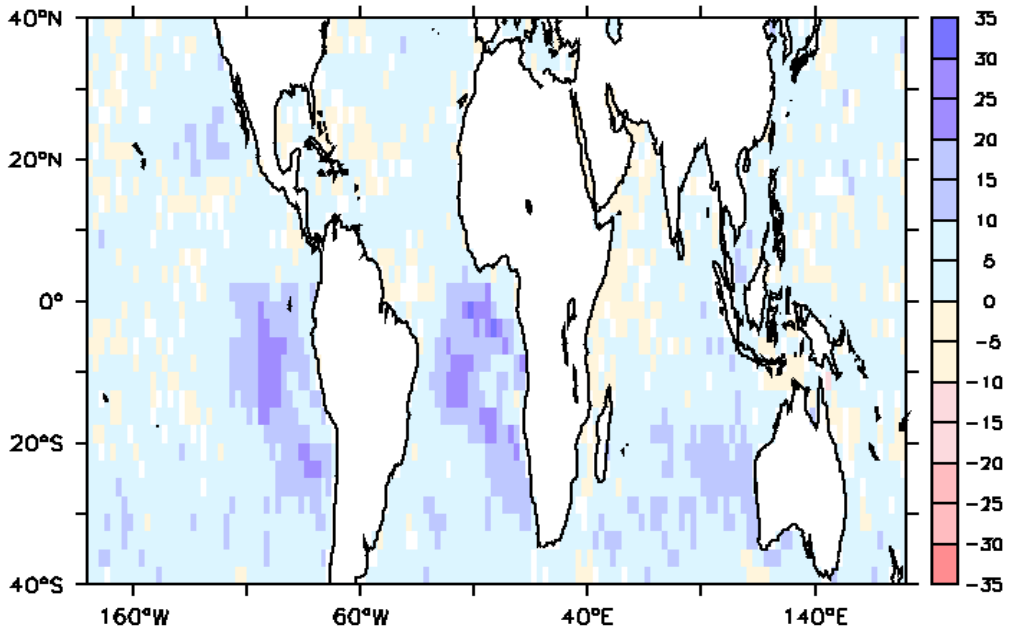
D1VIS-IR: 9h minus 17h



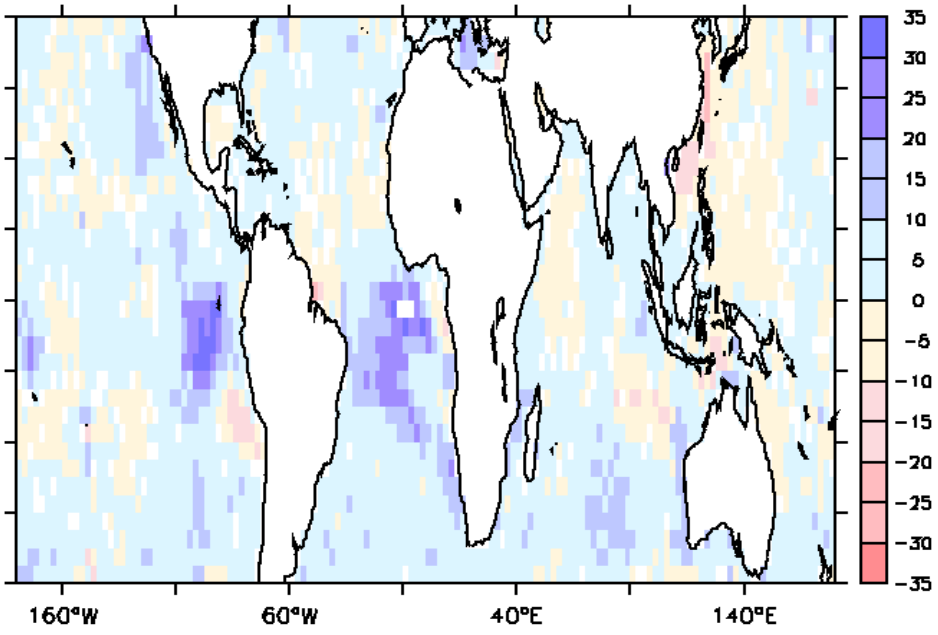
G. Sèze, J. Pelon, M. lalande, WS Cloud diurnal cycle, Toulouse, 21/11/05

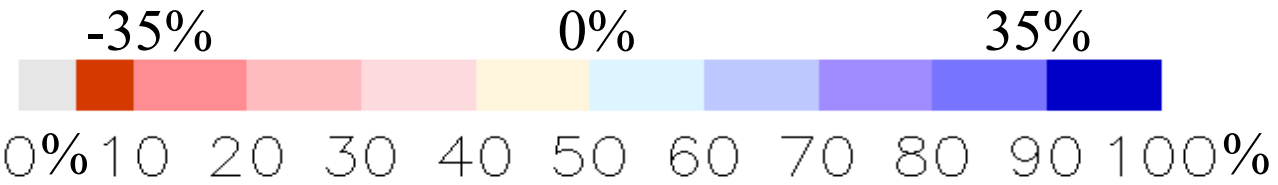
Low cloud cover in the tropical marine boundary layer

D1IR: 9h minus 17h



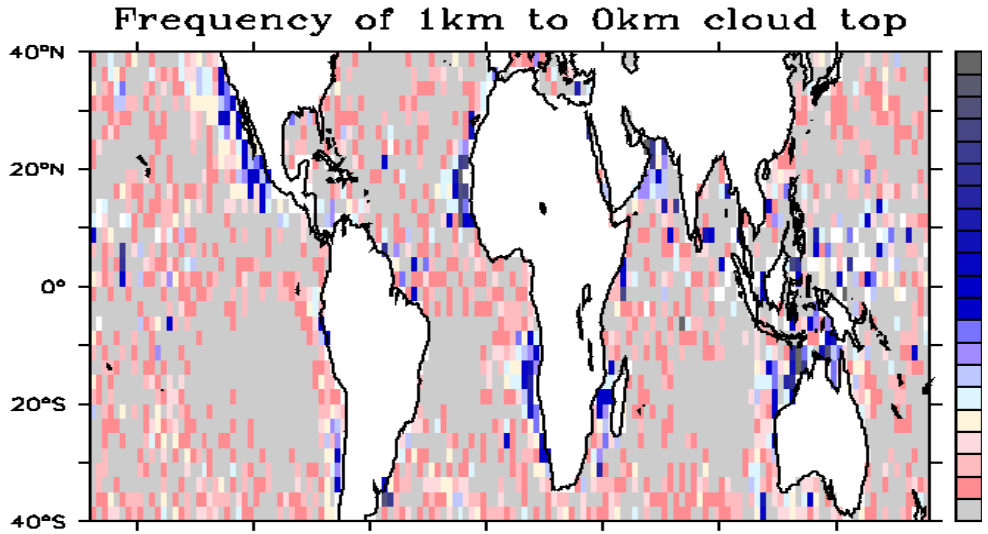
D1VIS-IR: 9h minus 17h

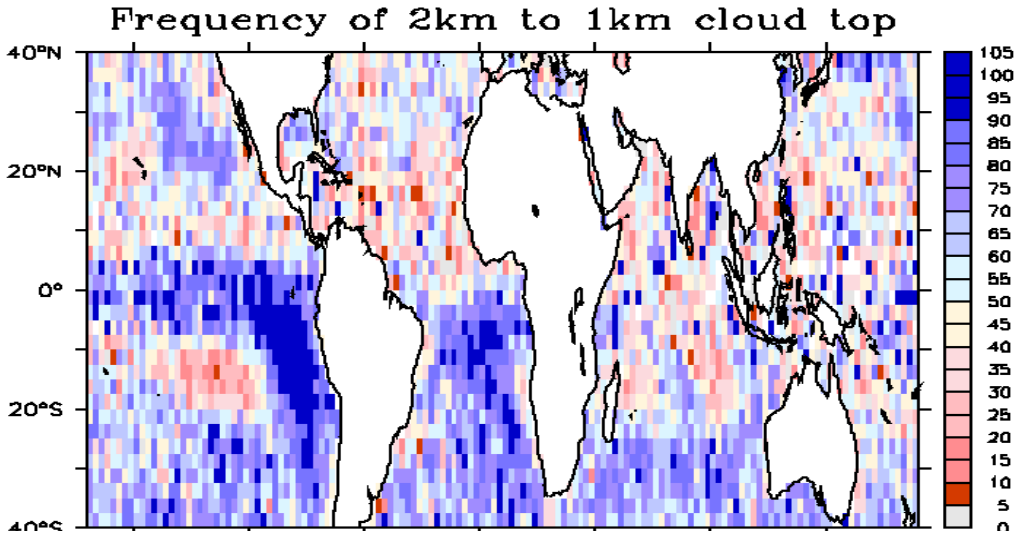


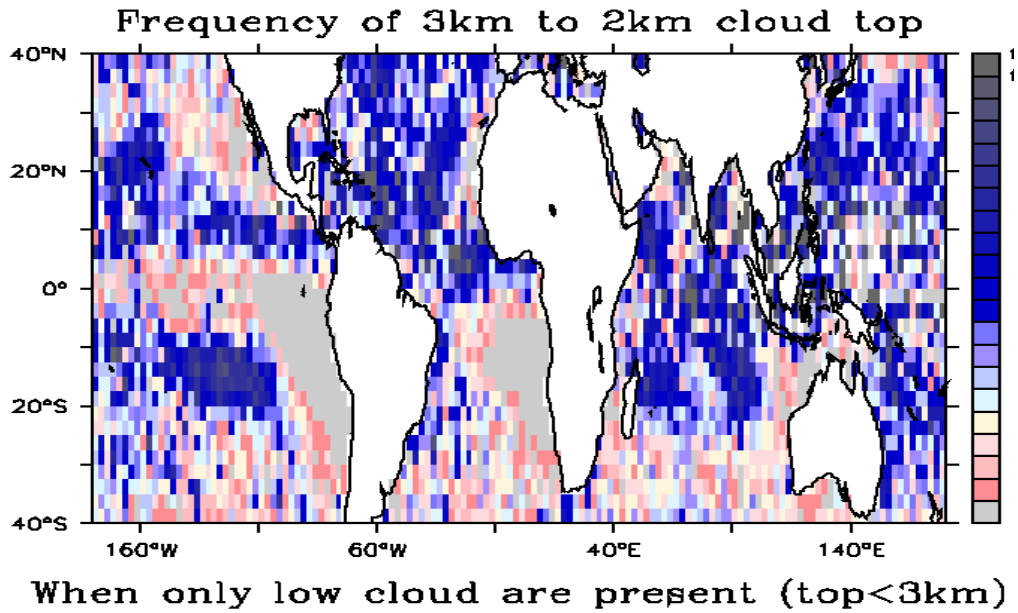


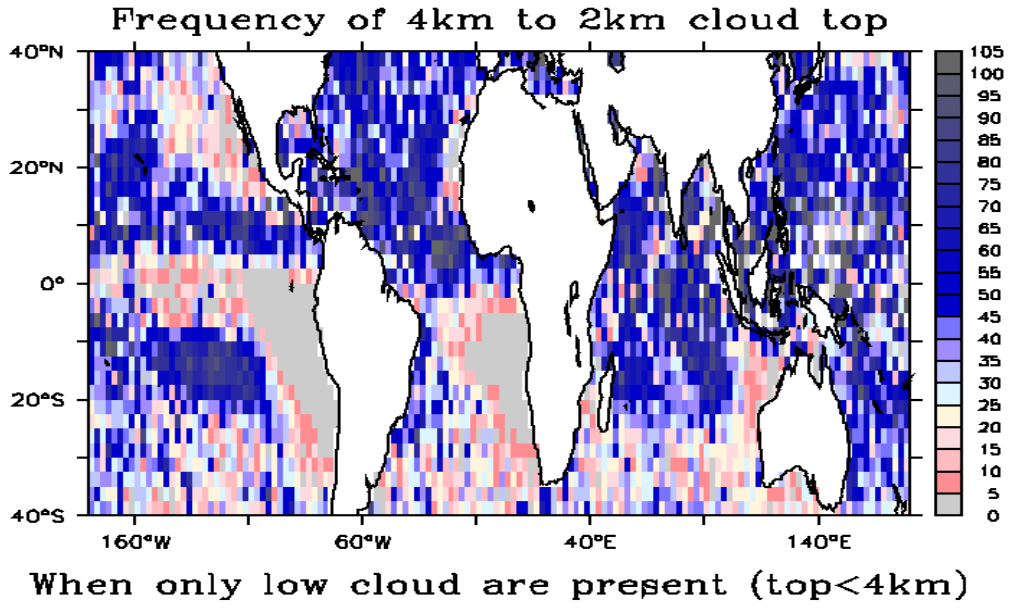
When only low cloud are present

frequency in function of cloud top altitude







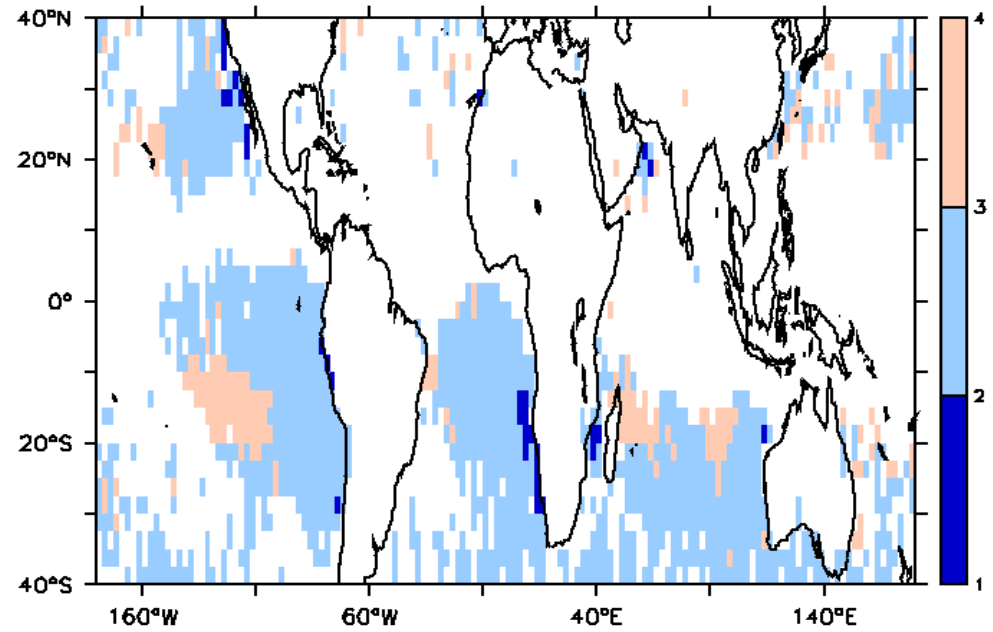


Low cloud in the tropical marine boundary layer

more frequent cloud top altitude

cloud top < 3km

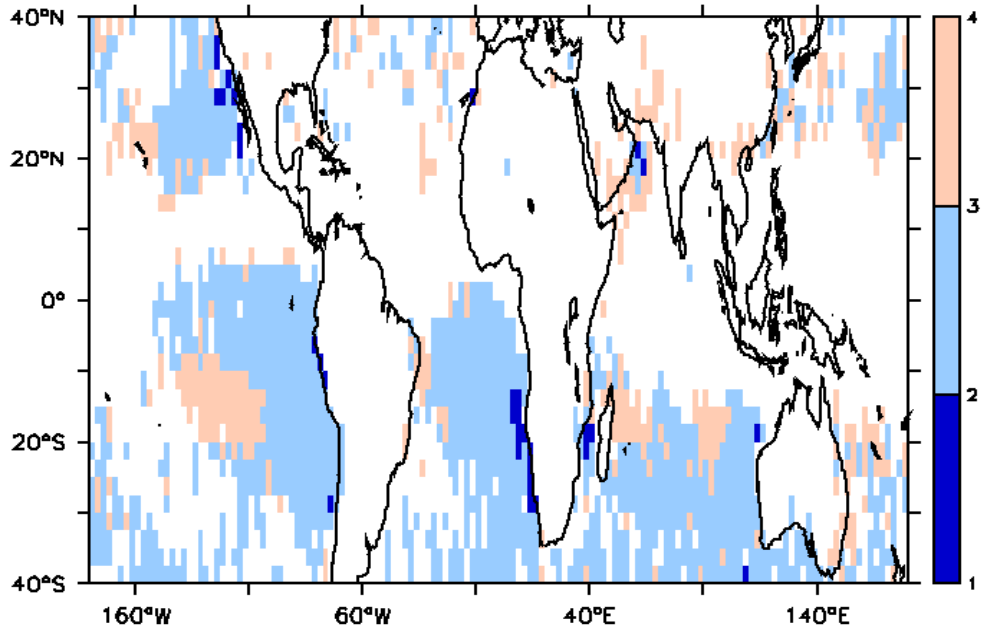
cloud top: 0 -1 km 1-2km 2-3km



More frequent cloud top: 2-3km, 1-2km, 0-1km?

cloud top <4km

cloud top: 0 -1 km 1-2km 2-4km



More frequent cloud top: 2-4km, 1-2km, 0-1km?

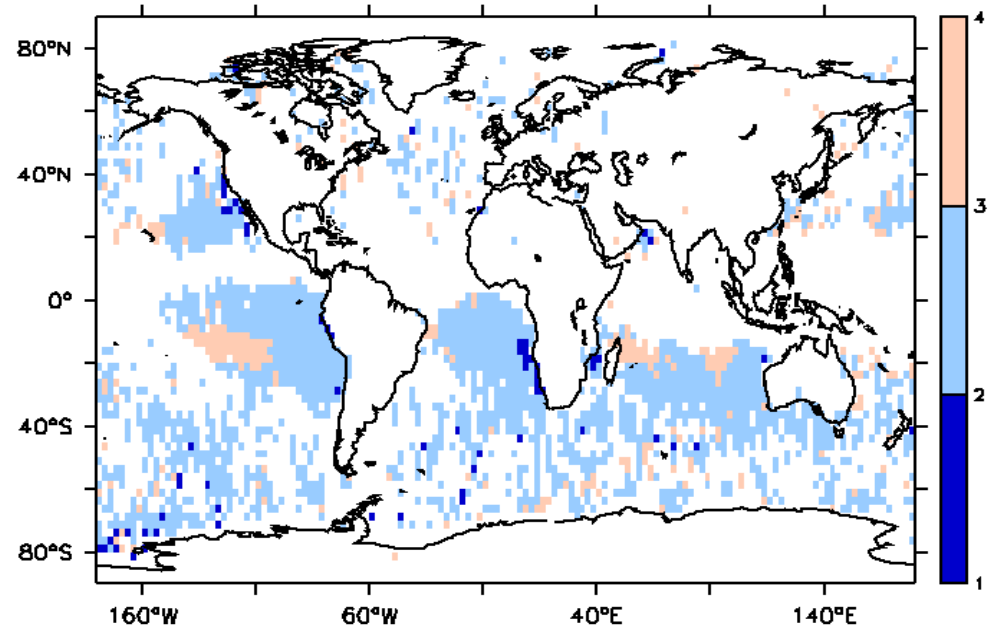
Regions for which the case only low cloud is the most frequent case

Low cloud in the tropical marine boundary layer

more frequent cloud top altitude

cloud top < 3km

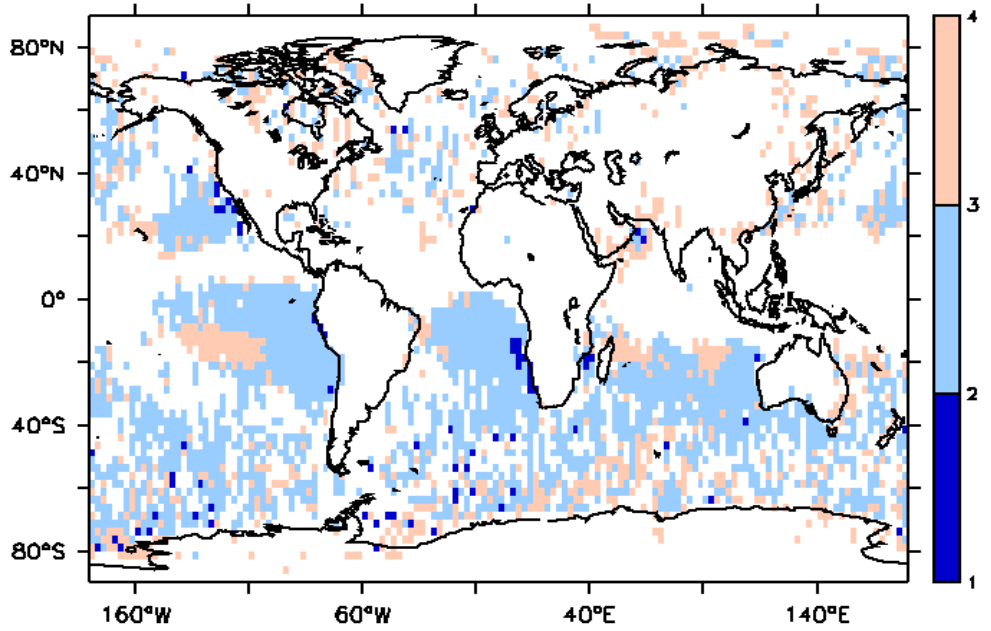
cloud top: 0 -1 km 1-2km 2-3km



More frequent cloud top: 2-3km, 1-2km, 0-1km?

cloud top <4km

cloud top: 0 -1 km 1-2km 2-4km



More frequent cloud top: 2-4km, 1-2km, 0-1km?

Regions for which the case only low cloud is the most frequent case

Conclusion

The vertical distribution of the cloud cover observed with GLAS as a function of latitude gives precise information on the main characteristics of the cloud cover:

- The high convective cloud tops in the tropics range between twelve and sixteen kilometres, few of them are above sixteen kilometre.In this region, low cloud are rarely detected, compared to the other regions.

- A remarkable feature is observable for the low cloud cover very frequent over ocean: the cloud top is under two kilometres.

- Over land, the low cloud cover is rare compare to the ocean distribution.The high convective cloud top in the ITCZ are more present.

The comparison of those distributions for daytime et nighttime data, shows the deficit in cloud cover in the daytime plot compared to the nighttime plot.

GLAS – ISCCP comparison

The comparison of the global maps and the latitudinal distributions of the total cloud cover distributions observed with the lidar GLAS and ISCCP, shows that more cloud are detected with GLAS. On the average, at the mesh scale, this difference is at least 10% for the D1VIS-IR data. For the D1 IR data the average difference is more than 15% Large differences are found at the equator over land and in the south tropical region over ocean.

The differences observed between GLAS and ISCCP are larger than the variations of cloud cover observed by ISCCP during the day time period (7h-21h).

The differences observed in the GLAS total cloud cover between day and night (7h30- 19h30) are large. Almost 20%at the equator over ocean. The nighttime cloud cover is almost always larger than the daytime cloud cover.

Low cloud

The low cloud map main features resemble to those of the ISCCP low cloud maps.

Compared to the ISCCP data set, the GLAS data set can detect low cloud even when a higher level cloud is present. The presence or not of ground return allows to estimate the percentage of low cloud which could be missed.

A first attempt to characterize the variation of low cloud top altitude in the oceanic subtropical regions has been performed.

Cloud top under 1km have been found to be the more frequent in very few regions close from the coast One of them is situated in the “Eurocs” pacific ocean region.
The more frequent cloud top altitude is between 1km and 2km.
Cloud tops between 2 and 4km are found to be more frequent than under 2km in few well defined places.
The occurrence of cloud top between 3 and 4km is weak.

Perspectives

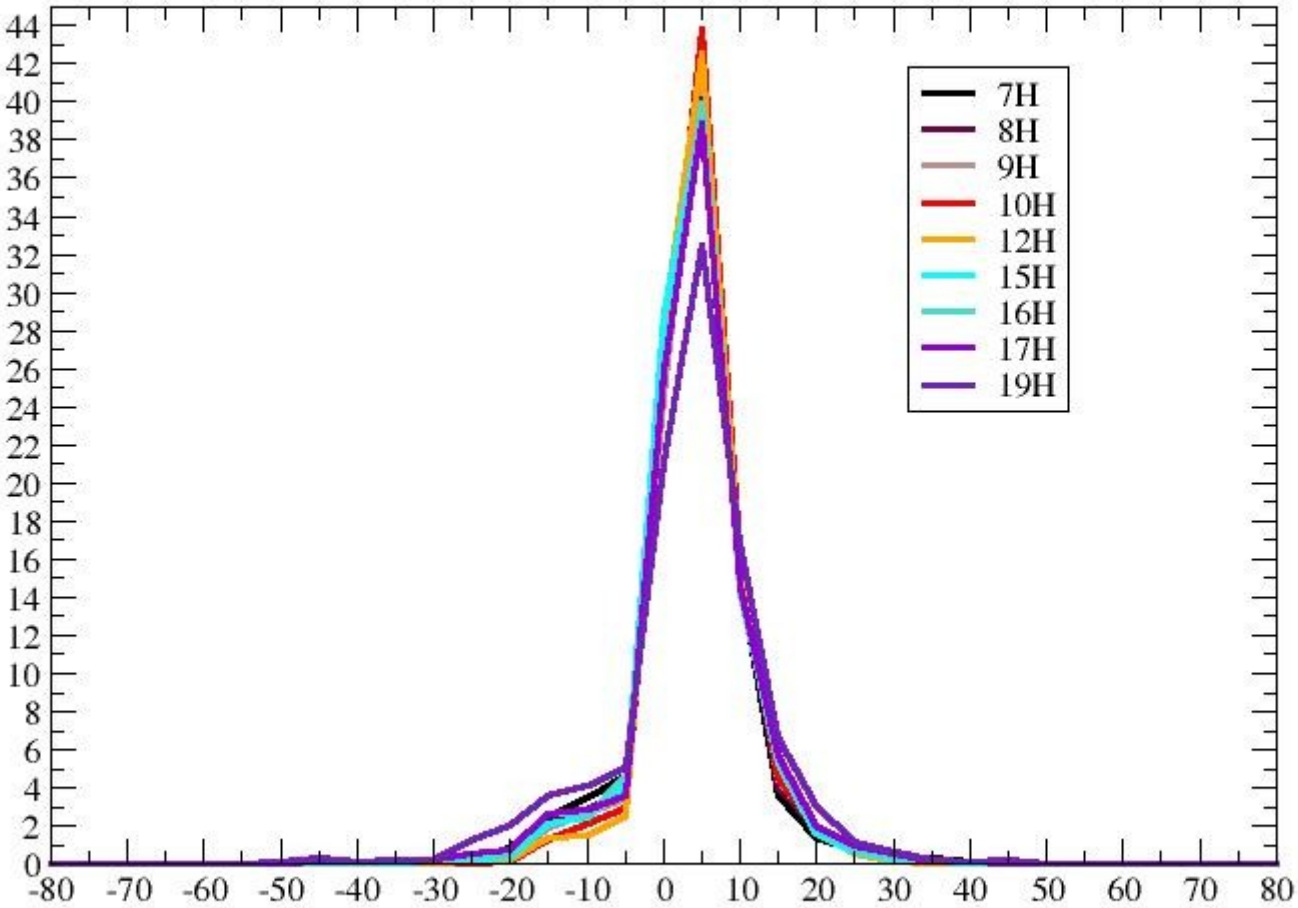
The GLAS-ISCCP comparison must be pursued to better quantify the differences observed in function of the different cloud type and the differences observed between the IR and VIS-IR data set.

A more precise evaluation of the cloud top altitude in the tropical and subtropical Marine boundary layer will be performed. The relation between this cloud top altitude and surface and cloud top temperature will be studied.

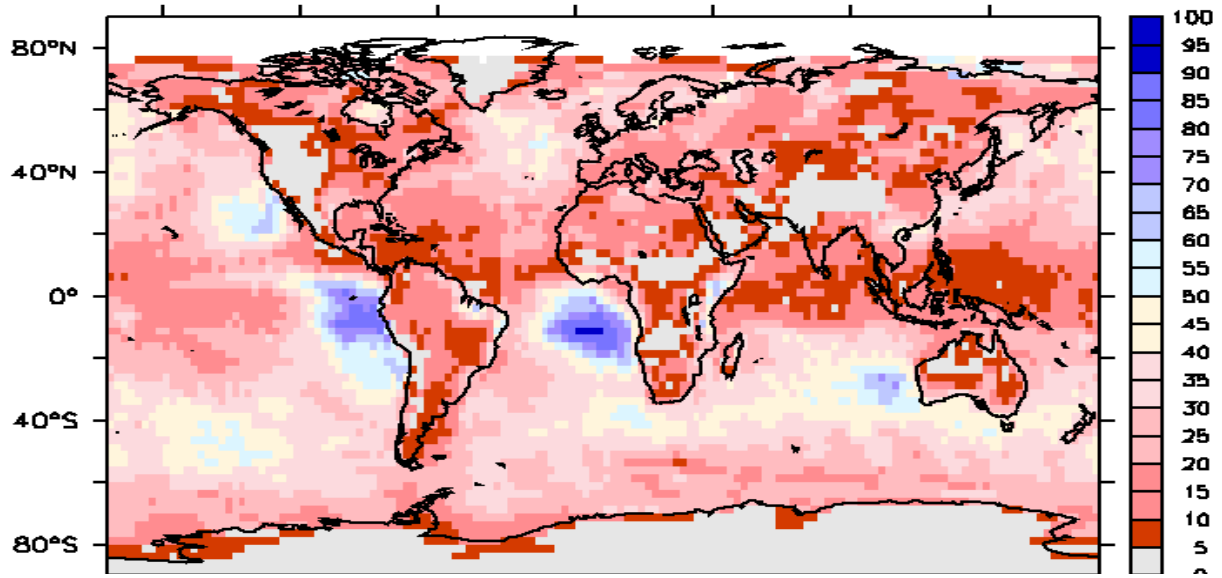
A study comparing GLAS data with SEVIRI data and POLDER data is engaged. This comparison which will be performed at a finer spatial scale and on instantaneous measurements will be an interesting complement to the present study.

D1 VIS-IR – D1 IR cloud cover differences at 2.4°x2.5° scale

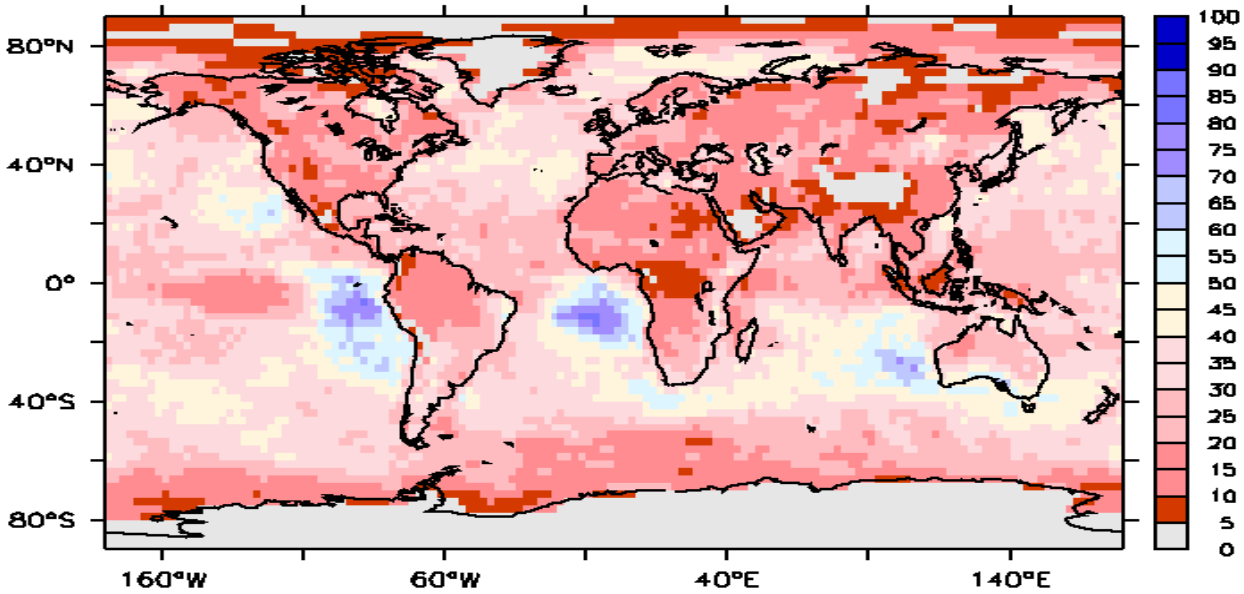
40S - 40N



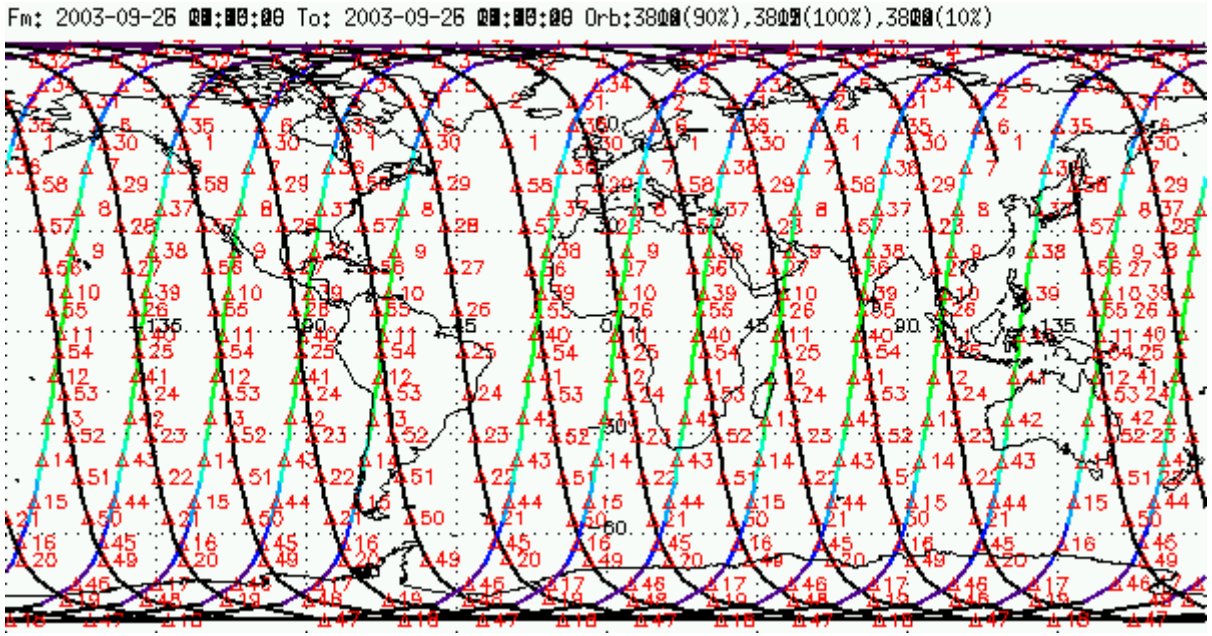
D1 VIS-IR Low Cloud - 9H



D1 IR Low Cloud - 9H



One day of Icesat overpass



The whole period