Comparison of SEVIRI Cloud Vertical distribution with space lidar observations

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A better characterisation of Cloud and Aerosol radiative parameters is needed at the global scale to better understand climate feedback(albedo change, heating rates, dehydratation of the TTL,)

Cloud cover and cloud types are the first parameters of importance

- ➔ frequency of occurrence
- ➔ diurnal cycle
- ➔ life cycle

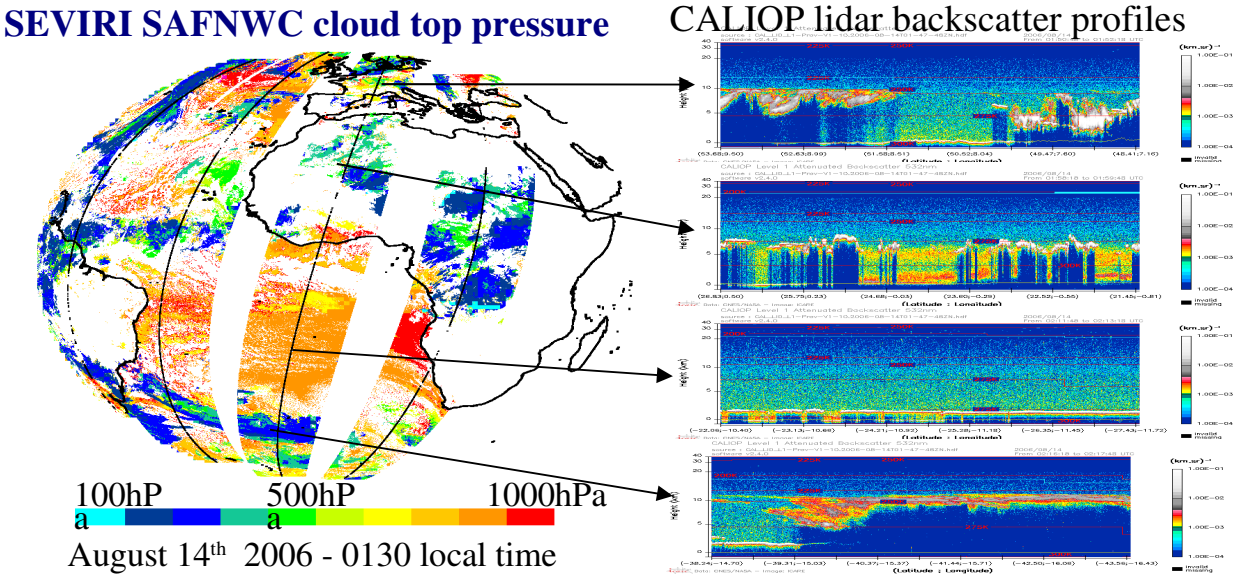
Coincident SEVIRI and LIDAR DATA Analysis

GLAS provides a first space lidar data set over several week periods

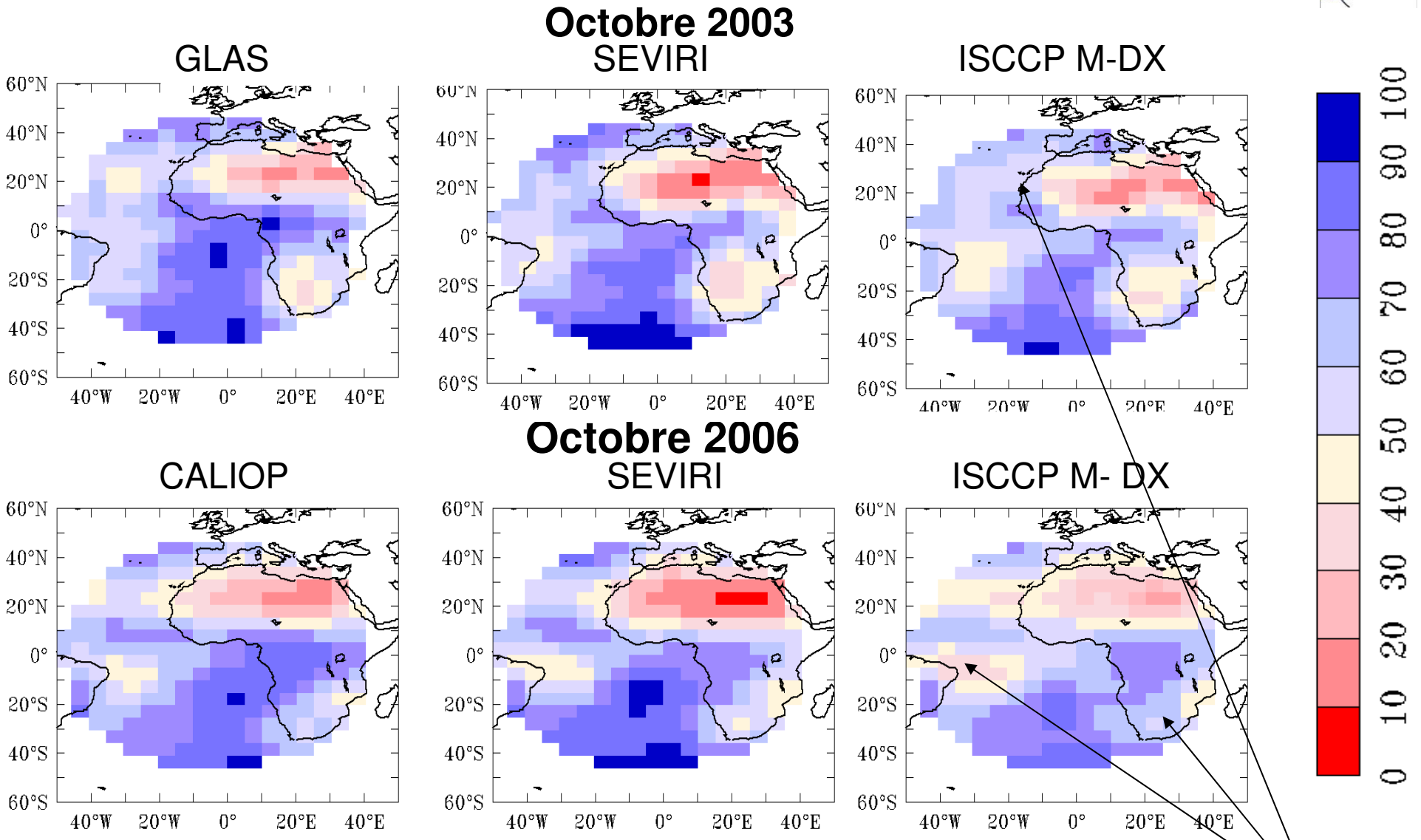
CALIPSO is now providing data since June 2006 and offers a unique opportunity to better characterize vertical cloud and aerosol structure (CALIOP) and microphysics (CALIOP/IIR, coming)

Geostationary (SEVIRI/METEOSAT over Europe and Africa) satellites observations will help to get better global/regional analyses of the cloud cover, its time evolution and its diurnal cycle.

➔ comparative analyses



SEVIRI, GLAS and CALIOP mean cloud cover



Some differences between the two years apparent both in the SEVIRI and lidar data

GLAS SEVIRI CALIOP CLOUD COVER

SEVIRI viewing angle restricted to 55°

October 2003 at 7h30pm - 7h30am

	GLAS (OT>0.02)	GLAS (OT>0.1)	GLAS (OT>0.2)	SEVIRI	ISCCP MDX IR/VIS-IR
Ocean Night	78	74(-6)	72(-8)	70	62
Ocean Day	68	65(-4)	62(-6)	76	63/69
Land Night	61	54(-10)	50(-14)	46	45
Land Day	50	44(-6)	39(-11)	40	42/48

October 2006 at 1h30am - 1h30pm

	CALIOP (OT>0.02)	CALIOP (OT>0.1)	CALIOP (OT>0.2)	SEVIRI	ISCCP MDX IR/VIS-IR
Ocean Night	73	71(-2)	69(-7)	72	61
Ocean Day	62	60 (-3)	59(-7)	71	57/63
Land Night	55	52 (-4)	48(-8)	42	43
Land Day	52	49 (-3)	46(-8)	44	51/61

The lidar cloud cover is larger than SEVIRI cloud cover, excepted over ocean during day time.

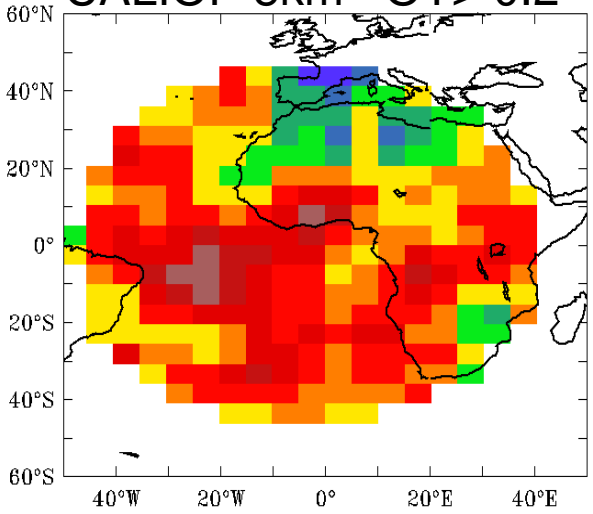
The mean lidar cloud cover after application of a threshold on OT of 0.2 is close from the SEVIRI one.

The IR M-DX cloud cover is close from the SEVIRI one over land but there is a large underestimation over ocean.

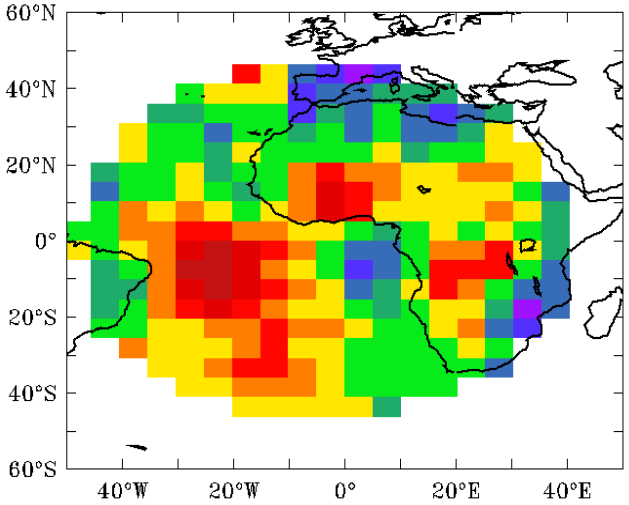
The sign and/or amplitude of the night to day cloud cover variation is not the same in the SEVIRI data set and in the lidar data set as well for midday-midnight October 2006 set than the evening-early morning October 2006 set.

Night minus Day Cloud Cover

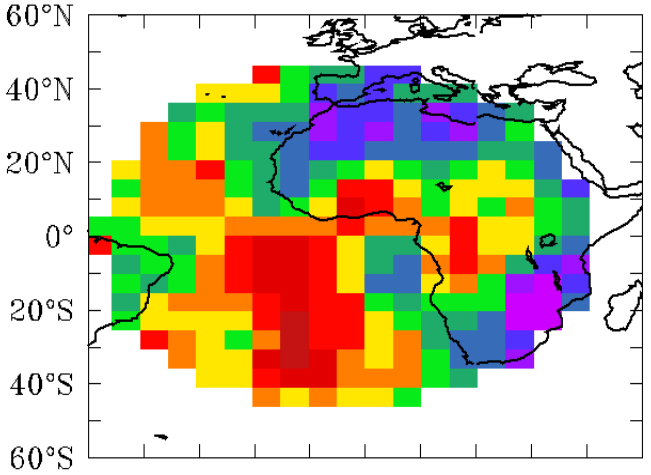
CALIOP 5km OT> 0.2



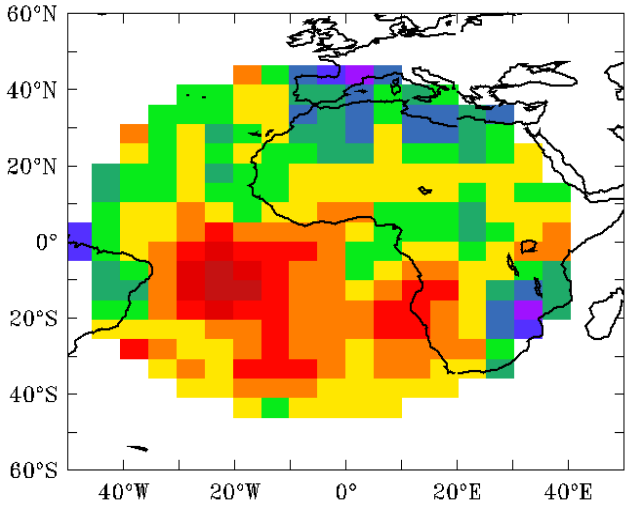
SEVIRI



DX



CALIOP 80km OT>0.2



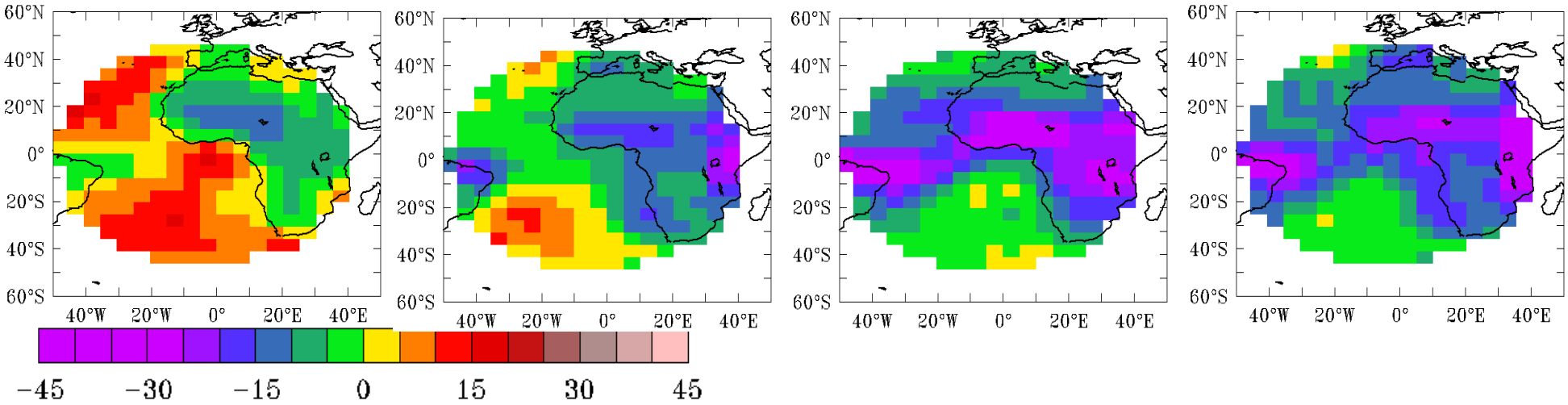
	CALIOP 5km (OT>0.02)	CALIOP 80km (OT>0.02)	CALIOP 80km (OT>0.2)	SEVIRI	ISCCP DX IR/VIS-IR
Ocean Night	73	81	*78* (74)	72	61
Ocean Day	62	79	*76 (69)*	71	57/63
Land Night	55	62	*54* (52)	42	43
Land Day	52	65	*58* (55)	44	51/61

In ( ) OT test also applied to low cloud layers.

SEVIRI and CALIOP Cloud Cover

Difference maps and Comparison at pixel level

5km DAY | 5km NIGHT | 80km DAY | 80km NIGHT



	Ocean Day		Ocean Night		Land Night		Land day	
SEVIRI LIDAR	clear cloudy	cloudy clear	clear cloudy	cloudy clear	clear cloudy	cloudy clear	clear cloudy	cloudy clear
GLAS	5/3	12/17	13/10	5/8	17/9	1/4	14/7	4/8
CAL.								
5km	4/3	14/17	9/7	7/12	15/9	1/3	13/8	5/8
80km	14/7	4/9	14/9	3/7	22/13	1/2	23/16	2/3

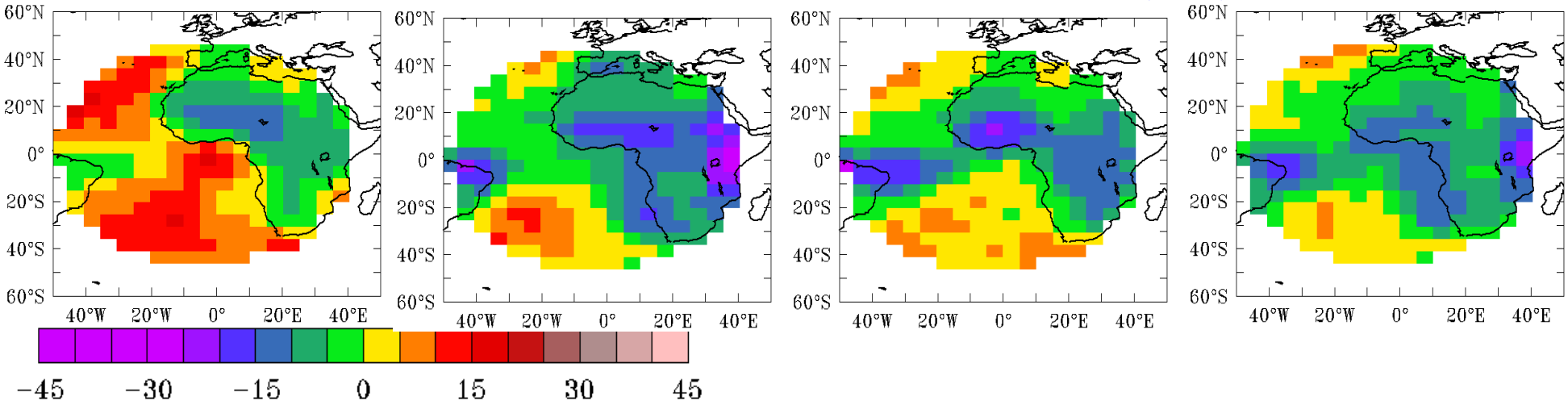
Same behavior of GLAS and CALIOP 5km vs SEVIRI

Over ocean agreement between 80% and 84%

Over land agreement at 5km between 84% and 87% at 80km 75%/85%

SEVIRI and CALIOP Cloud Cover
Difference map and Comparison at pixel level

5km DAY | 5km NIGHT | 80km DAY | OT>0.2 | 80km NIGHT



	Ocean Day		Ocean Night		Land Night		Land day	
SEVIRI LIDAR	clear cloudy	cloudy clear	clear cloudy	cloudy clear	clear cloudy	cloudy clear	clear cloudy	cloudy clear
GLAS	5/3	12/17	13/10	5/8	17/9	1/4	14/7	4/8
CAL.								
5km	4/3	14/17	9/7	7/12	15/9	1/3	13/8	5/8
80km	14/7	4/9	14/9	3/7	22/13	1/2	23/16	2/3

Same behavior of GLAS and CALIOP 5km vs SEVIRI

Over ocean agreement between 80% and 84%

Over land agreement at 5km between 84% and 87% at 80km 75%/85%

GLAS-SEVIRI-CALIOP cloud top pressure over ocean

GLAS >0.02
GLAS >0.2
SEVIRI

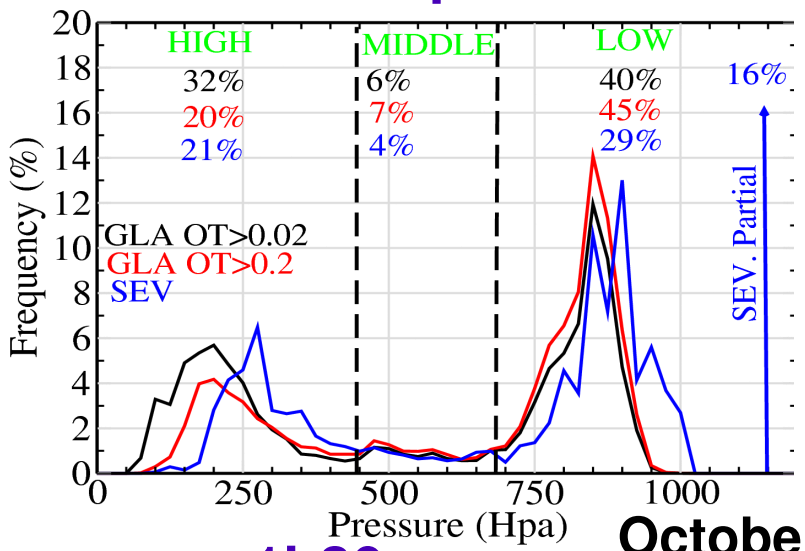
CALIOP >0.02
CALIOP >0.2
SEVIRI

5km
80km

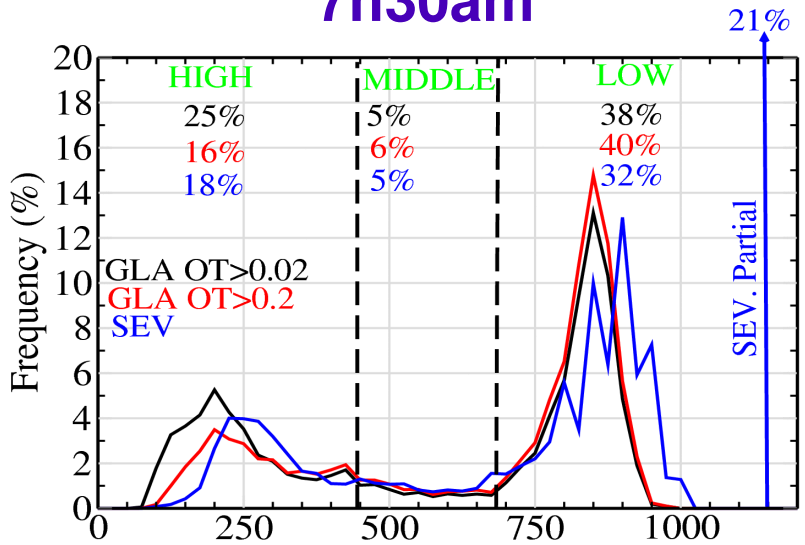
NIGHT **DAY**

October 2003

7h30pm

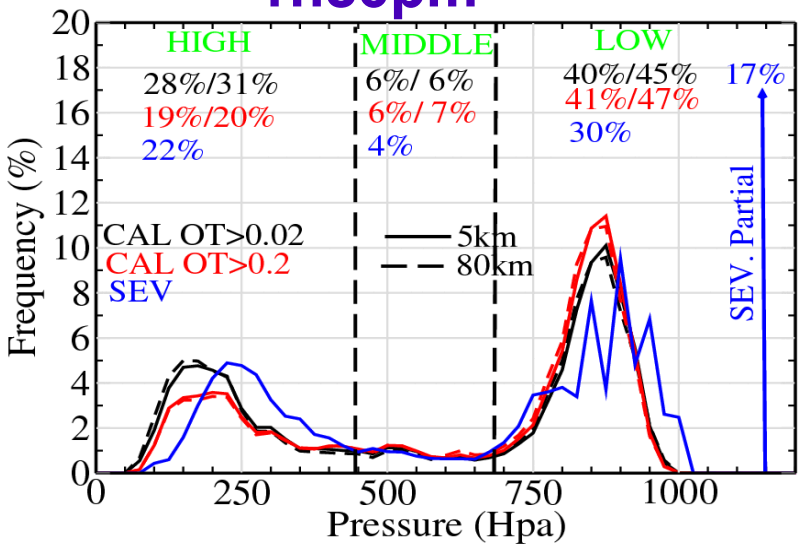


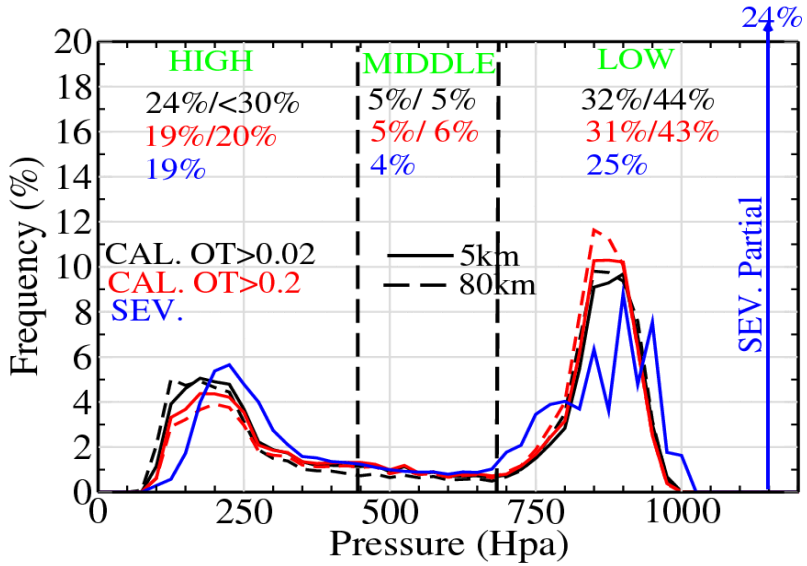
7h30am



October 2006

1h30pm





Distributions normalized by the number of sample in the distribution.

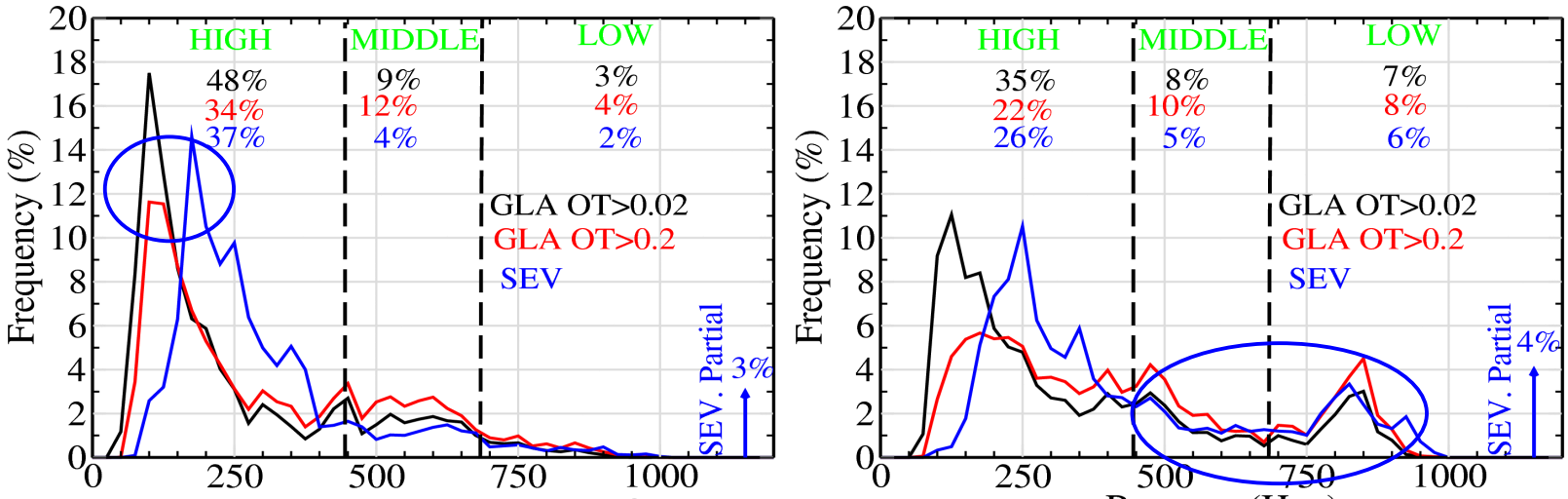
GLAS-SEVIRI-CALIOP cloud top pressure over land

NIGHT **DAY**

October 2003

7h30pm **7h30am**

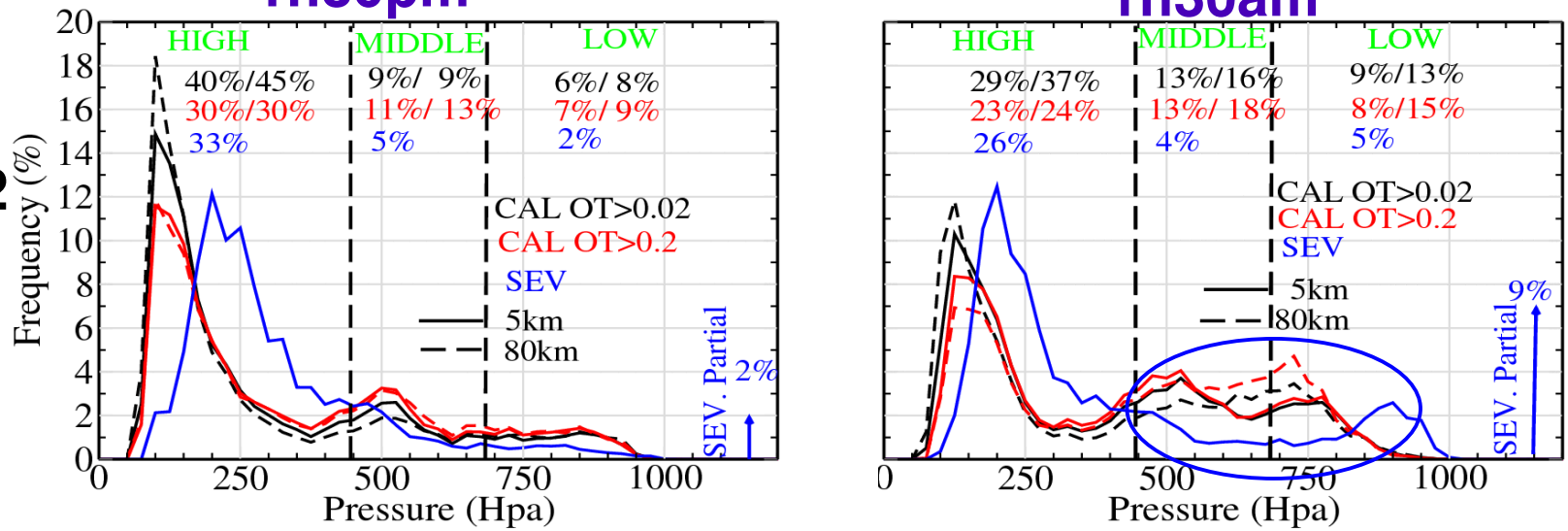
GLAS >0.02
GLAS >0.2
SEVIRI



October 2006

1h30pm **1h30am**

CALIOP >0.02
CALIOP >0.2
SEVIRI



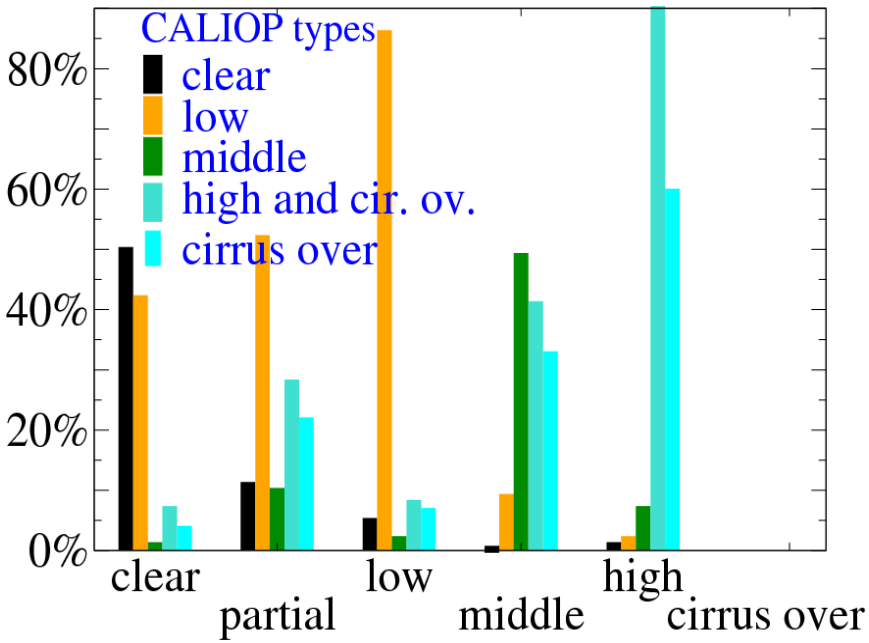
Distributions normalized by the number of sample in the distribution.

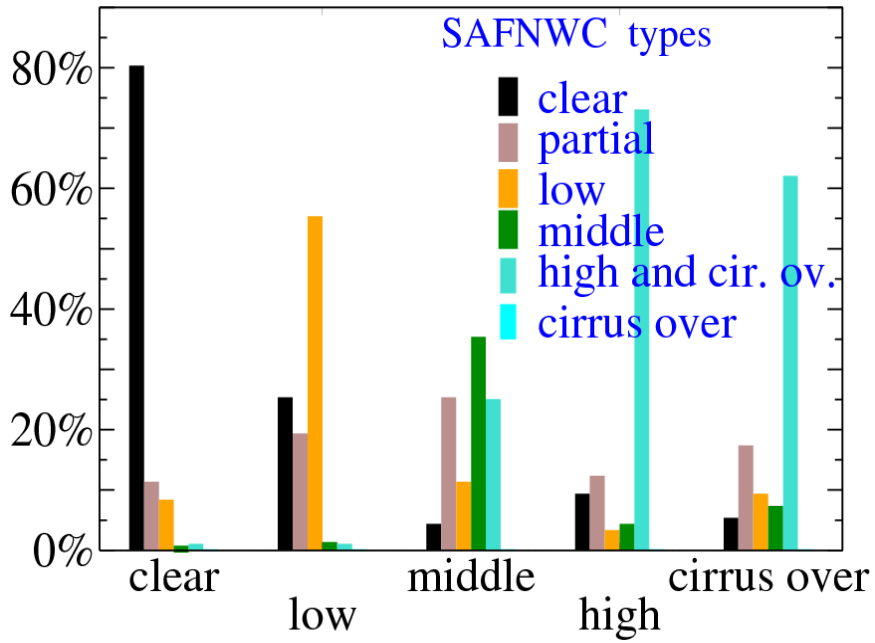
Cloud cover types over ocean

For each SEVIRI/CALIOP class distribution of the CALIOP/SEVIRI classes

CALIOP 80km OD>0.02

NIGHT





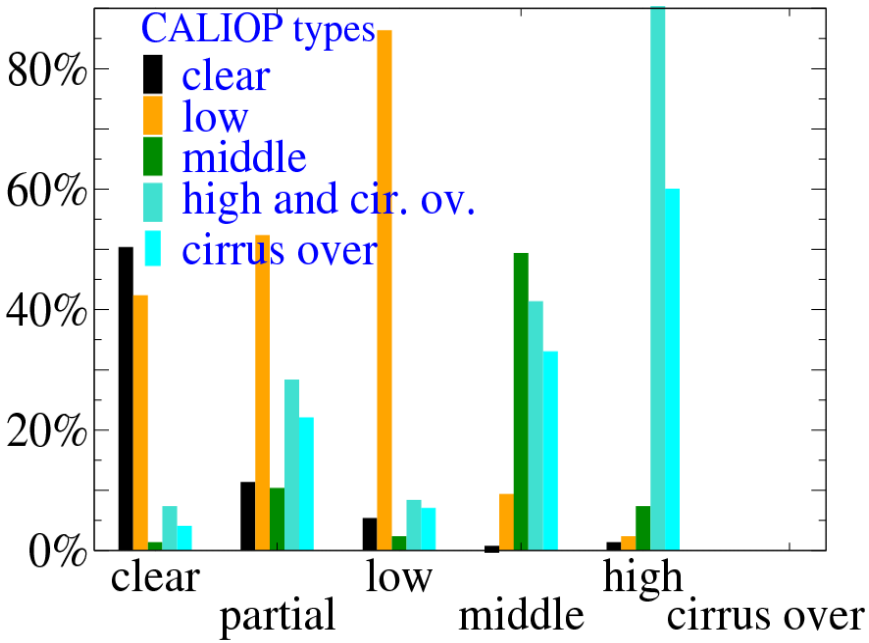
Very often but not all the time (80%), the SEVIRI partially covered pixels are detected as low cloud, low cloud under cirrus or clear by the lidar.

On another end, for a given CALIOP class, the frequency of partially covered pixels is at least of 10%. For the low but also the mid level cloud this frequency is above 20%. The OT of the high only CALIOP clouds classified partially covered by SEVIRI is below 0.2.

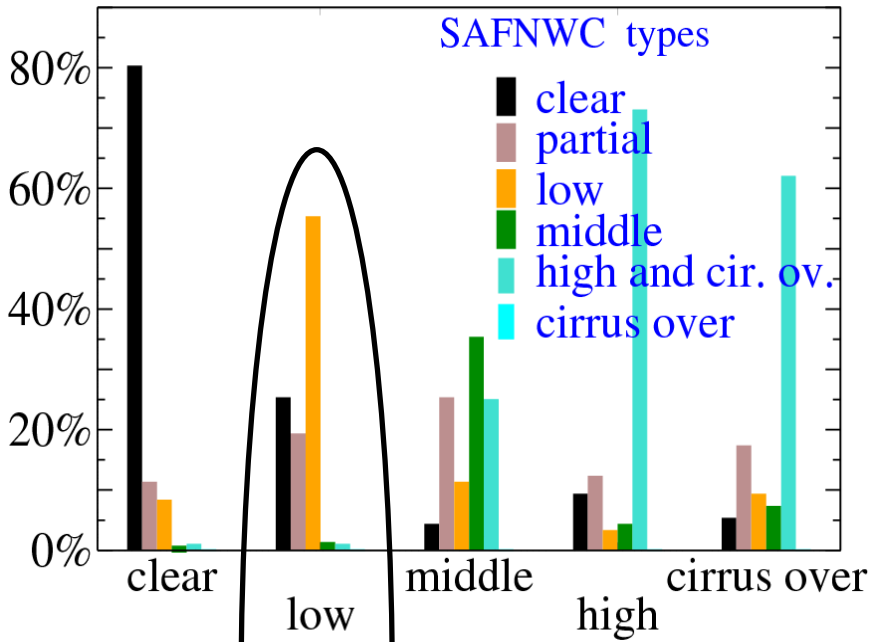
Cloud cover types over ocean

For each SEVIRI/CALIOP class distribution of the CALIOP/SEVIRI classe

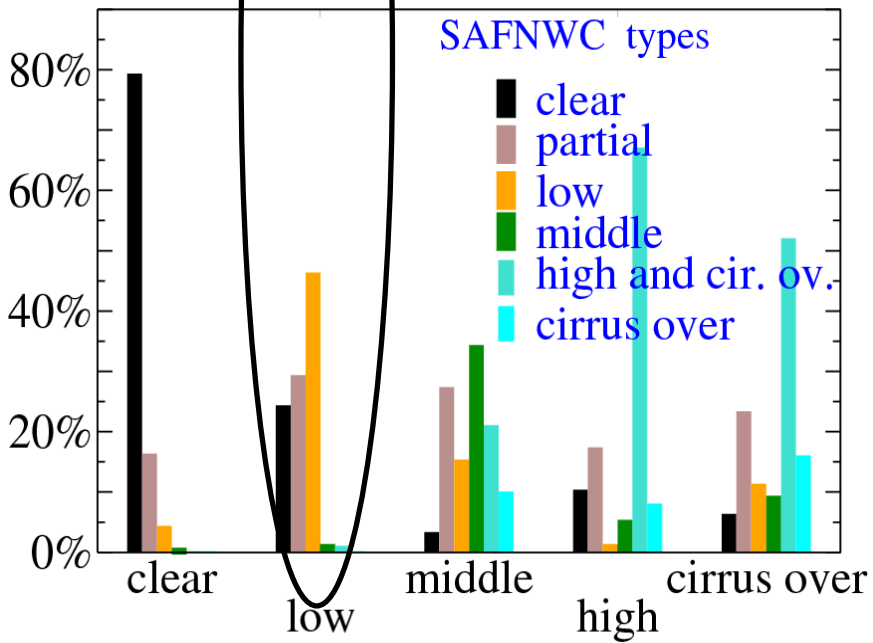
CALIOP 80km OD>0.02 Night



CALIOP 80km OD>0.02 Night



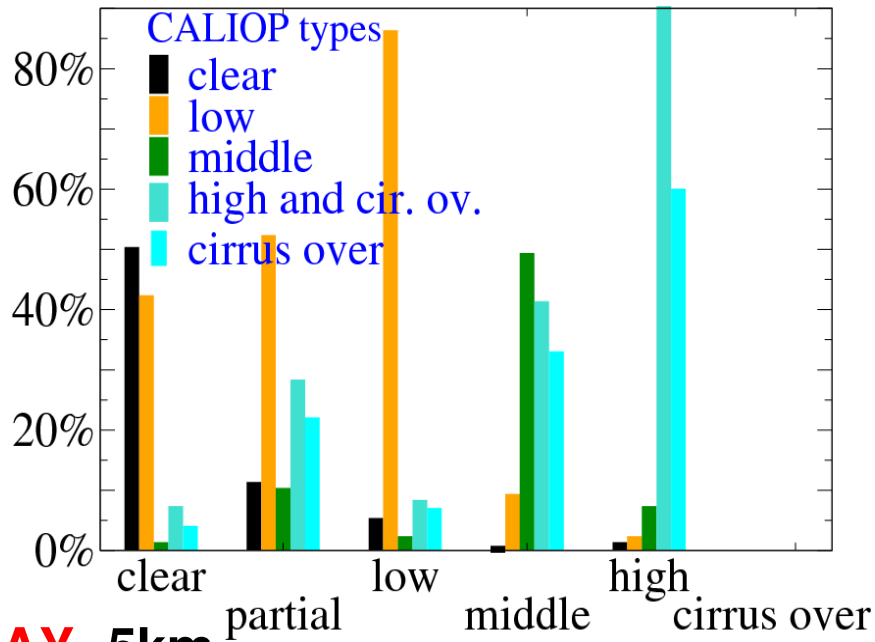
CALIOP 80km OD>0.02 Day



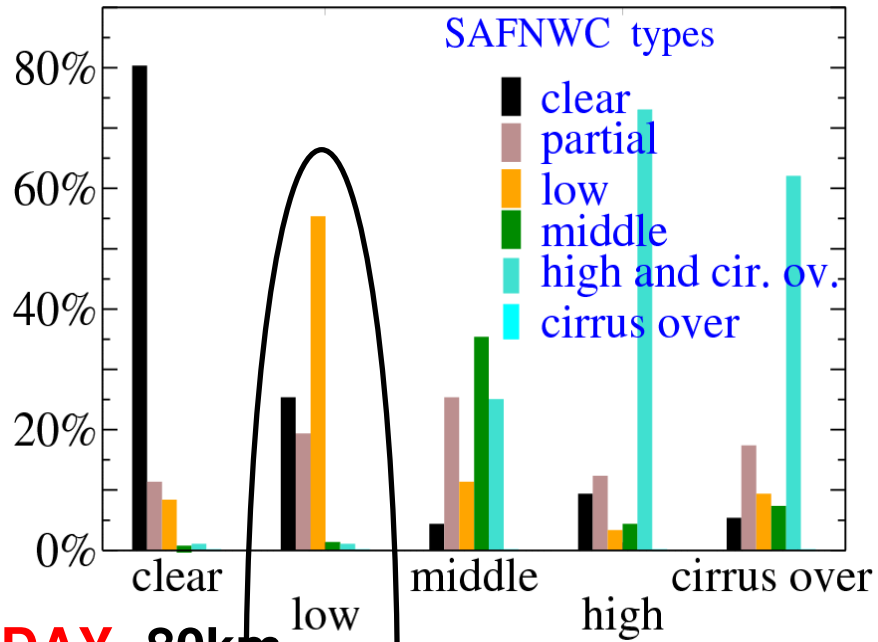
Cloud cover types over ocean

For each SEVIRI/CALIOP class distribution of the CALIOP/SEVIRI classe

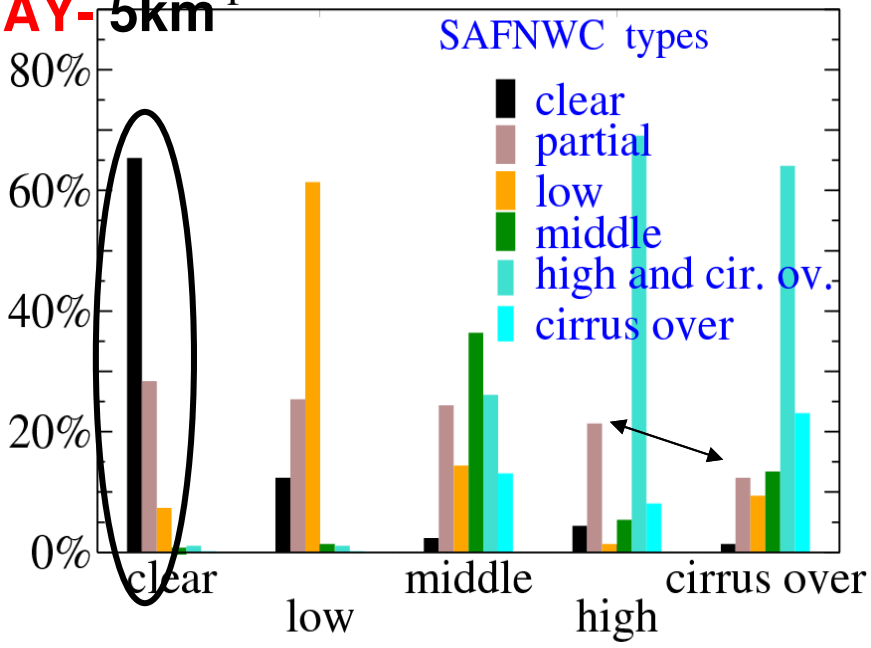
CALIOP 80km OD>0.02 NIGHT



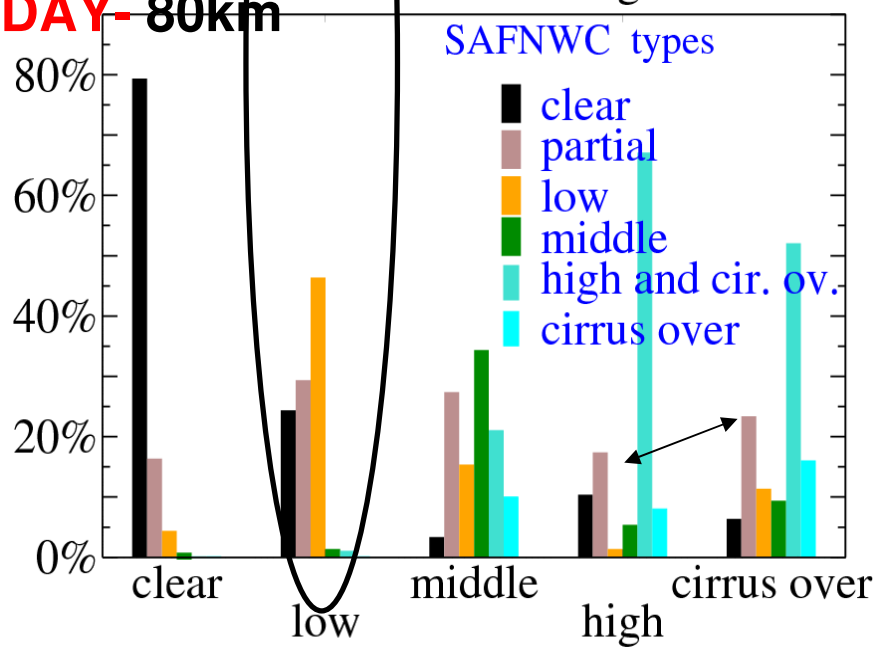
CALIOP 80km OD>0.02 NIGHT



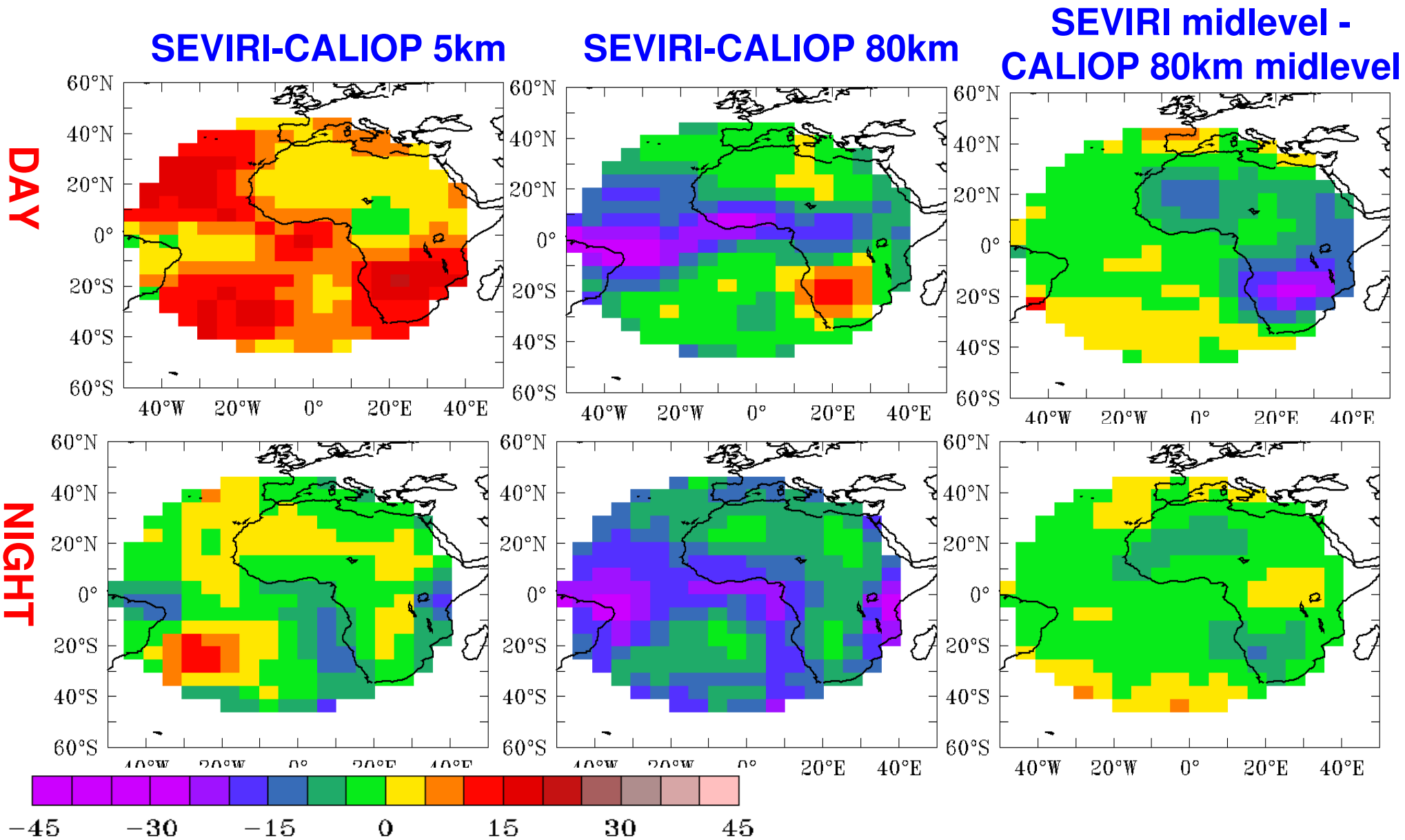
DAY- 5km



DAY- 80km

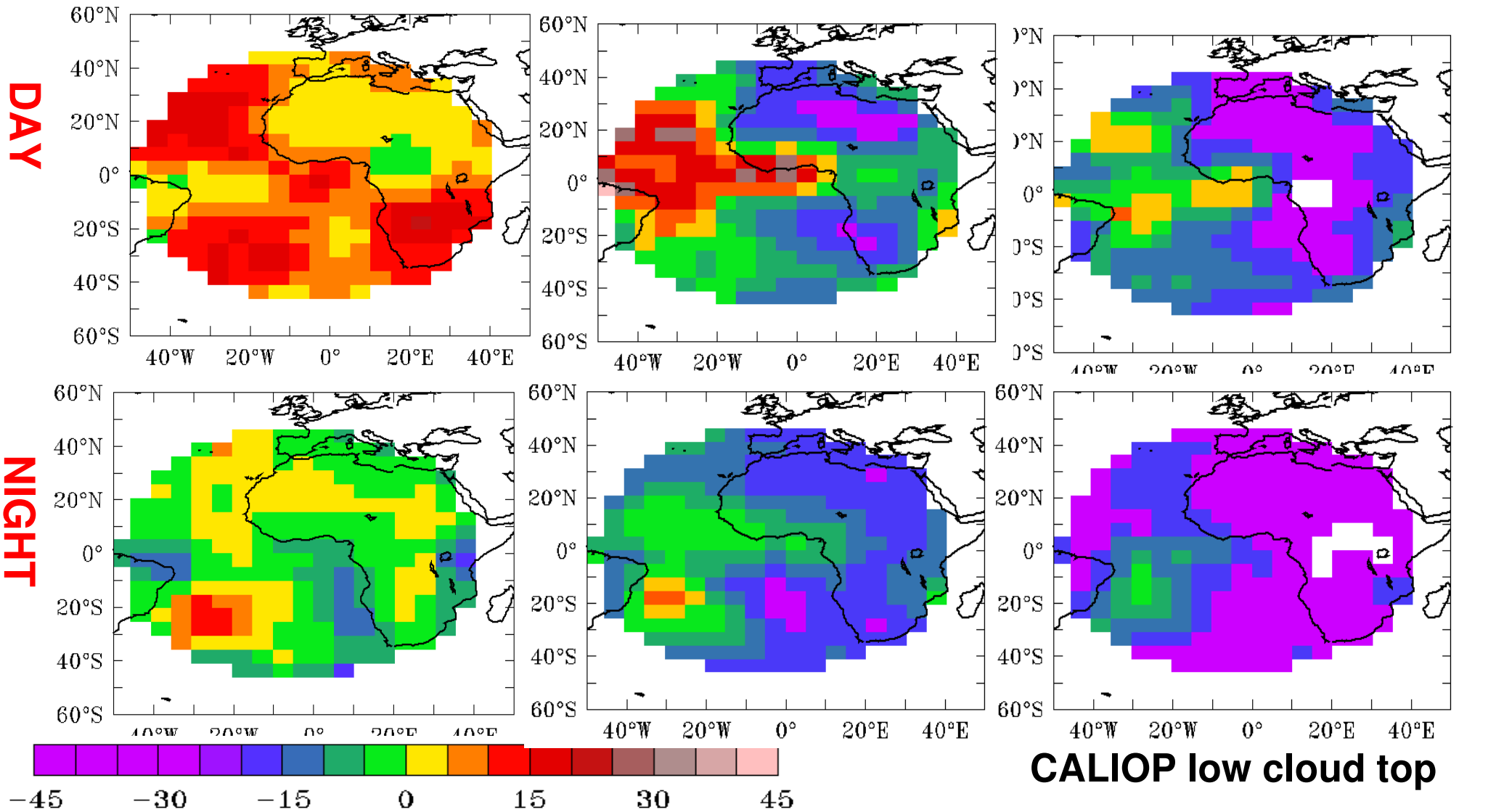


SEVIRI minus CALIOP low and mid-level cloud cover



CALIOP OD>0.02 all low cloud: low cloud top and low under a higher layer

CALIOP 80km minus 5km low cloud cover



CALIOP OD>0.02 all low cloud: low cloud top and low under a higher layer

CONCLUSION (1)

SEVIRI cloud cover and cloud frequency types have been compared with October 2003 GLAS data and October 2006 CALIOP data for land and ocean night and day data separately.

➔The same behaviour of GLAS and CALIOP versus SEVIRI is found.

The lidar cloud cover is larger than the SEVIRI cloud cover,excepted for daytime over ocean for the 5km lidar cloud cover.

Going from the 5km to the 80km cloud cover for CALIOP, a very large increase is found in the cloud cover over ocean during day time.

The mean lidar cloud cover after application of a threshold on OT of 0.2 is close from the SEVIRI one.

The agreement at pixel scale between the 5km lidar and SEVIRI cloud occurrence is above 80%. For CALIOP when a spatial homogeneity test (SEVIRI) plus an 0.2 OT threshold (lidar) are applied the agreement is above 89%.

The lower frequency of very thin clouds detected by CALIOP at 5km over land compared to GLAS could be explained by the differences in the GLAS and CALIOP algorithm?

CONCLUSION (2)

➔High SEVIRI clouds are classified high cloud by the lidar in more than 80% of the cases. Lidar high clouds with OT > 0.2 are rarely not detected by SEVIRI.

The agreement for mid-level cloud is poor and also over land for low cloud.

Over ocean, for the SEVIRI low clouds, the lidar detects a low cloud layer in more than 90% of the cases. The frequency of cirrus above low clouds is under 10%.

➔ No pressure are available for the SEVIRI partially covered pixels. Over ocean, where the frequency of low clouds is large, in more than 80% of the case they corresponds to low cloud cover or clear lidar profil.

➔Differences are observed between the 5km lidar data set and SEVIRI data set in the sign and amplitude of the night to day cloud cover change. In the 80km lidar data set the sign of the night to day cloud cover change is the same than for SEVIRI.

Over ocean, the better detection of small or broken low clouds over ocean during day-time by SEVIRI could increase the frequency of lidar clear profils detected cloudy by SEVIRI.On another hand, the SNR for lidar data is smaller for daytime data than night time data.

A large under-estimation of low clouds under high clouds in the 5km data set compared to the 80km data set in the CALIOP V2 product.

FURTHER WORK

➔ This comparison will continue further to better understand the differences observed between the day and night differences .

➔In the near futur, in the frame of the MEGHA-TROPIQUES mission in order to built a consistent cloud classification over the tropical belt:

The same comparison will be performed between GOES, MTSAT, SEVIRI and CALIOP

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Using the multi-spectral capability of SEVIRI, the performance of the retrieval of cloud cover properties according to the spectral bands used will be tested.

THANKS TO ASDC(NASA) AND ICARE(CNES) FOR THE DATA PROVISION