



# Improving Cloud Climatology analysis using Space Lidar observations:

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## comparison of SEVIRI/MSG with GLAS and CALIPSO

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# CLOUD Climatology



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

**Cloud cover** and cloud types are the first parameters of importance

analyze frequency of occurrence  
diurnal Cycle

**GLAS provides a first 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 vertical structure (CALIOP) and microphysics (CALIOP/IIR, to come later)

general overview

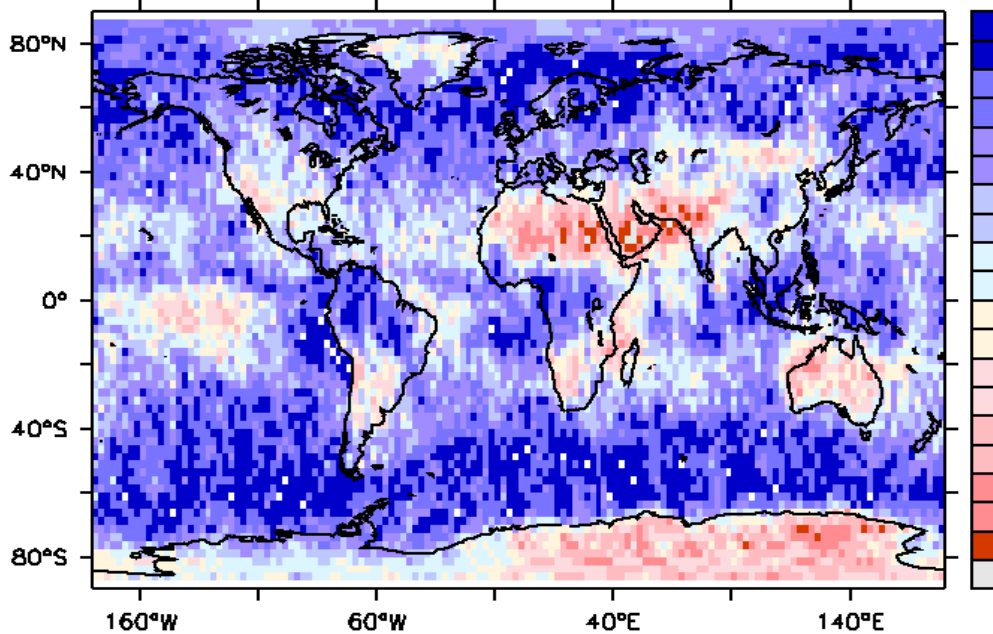
**Geostationary** (SEVIRI over Europe and Africa) satellites observations will help to get better global/regional analyses of the cloud cover, its time evolution and its diurnal cycle

t comparative analysis

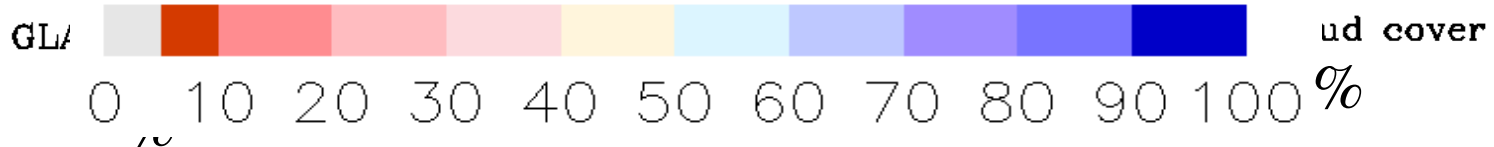
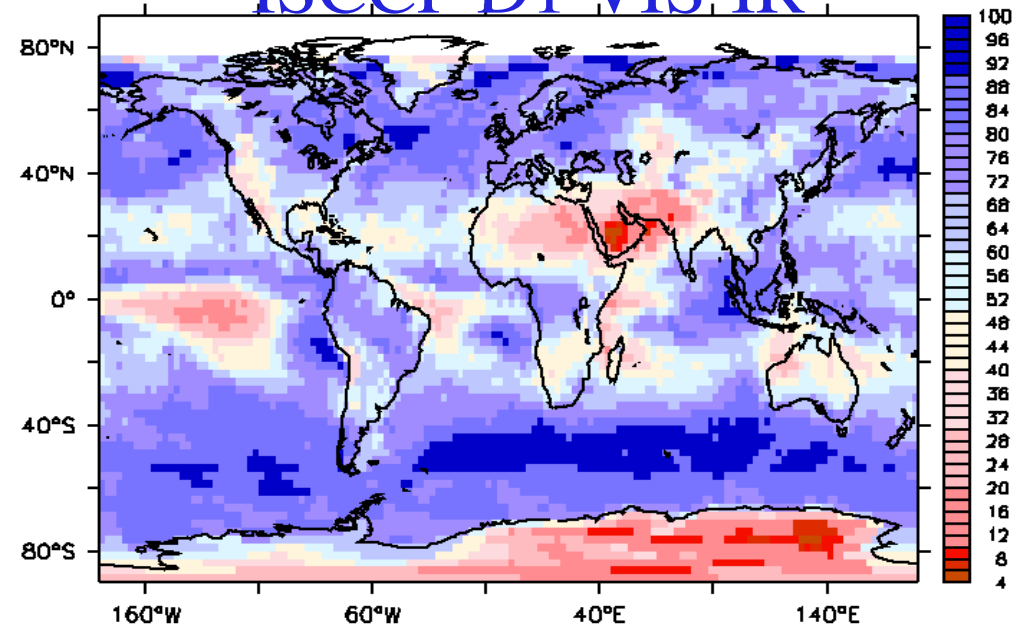
# GLAS and ISCCP Total Cloud Cover

29 September to 18 November 2003

GLAS



ISCCP D1 VIS-IR



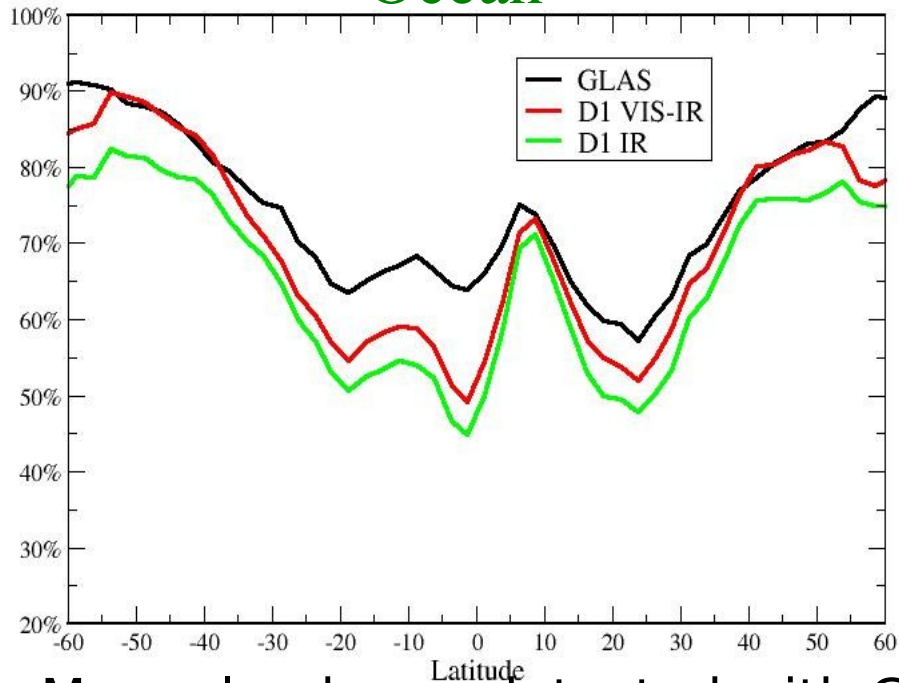
**GLAS:** night and day data    **ISCCP:** 7h , 8h, 9h, 10h30, 12h, 15h, 16h, 17h local time average

**Minimum of Cloud cover well observed over desert areas, south pole,  
and west side of oceanic subsidence areas linked to tropical convection**

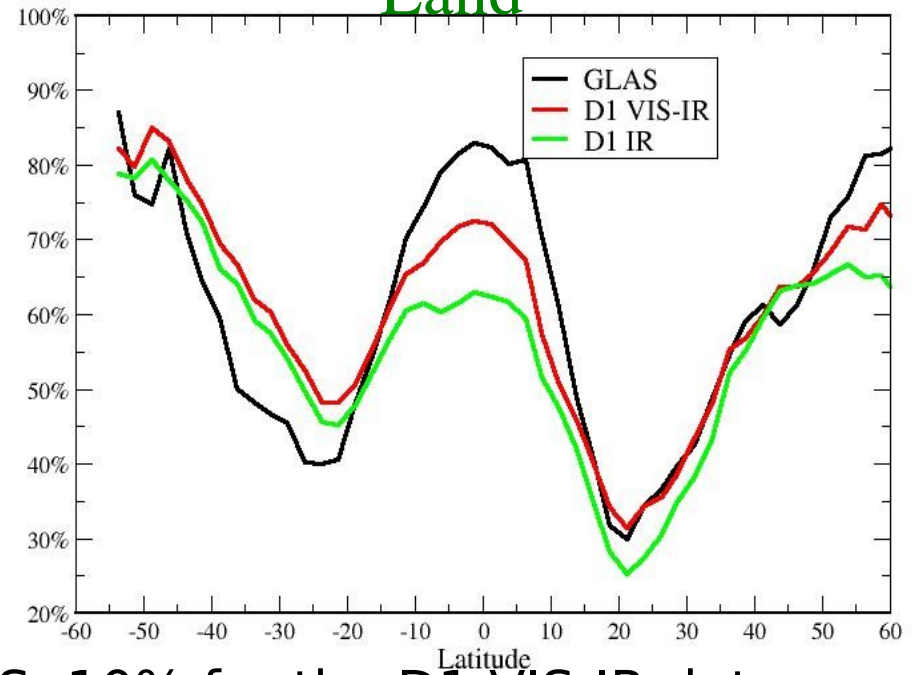


29 September to 18 November 2003

## Ocean



## Land



More clouds are detected with GLAS: 10% for the D1 VIS-IR data, 15% for the D1 IR data.

Differences vary with latitude. Large differences are found at the equator over land and in the south tropical region over ocean.

Differences between the DI VIS/IR and IR cloud cover vary also with latitude.

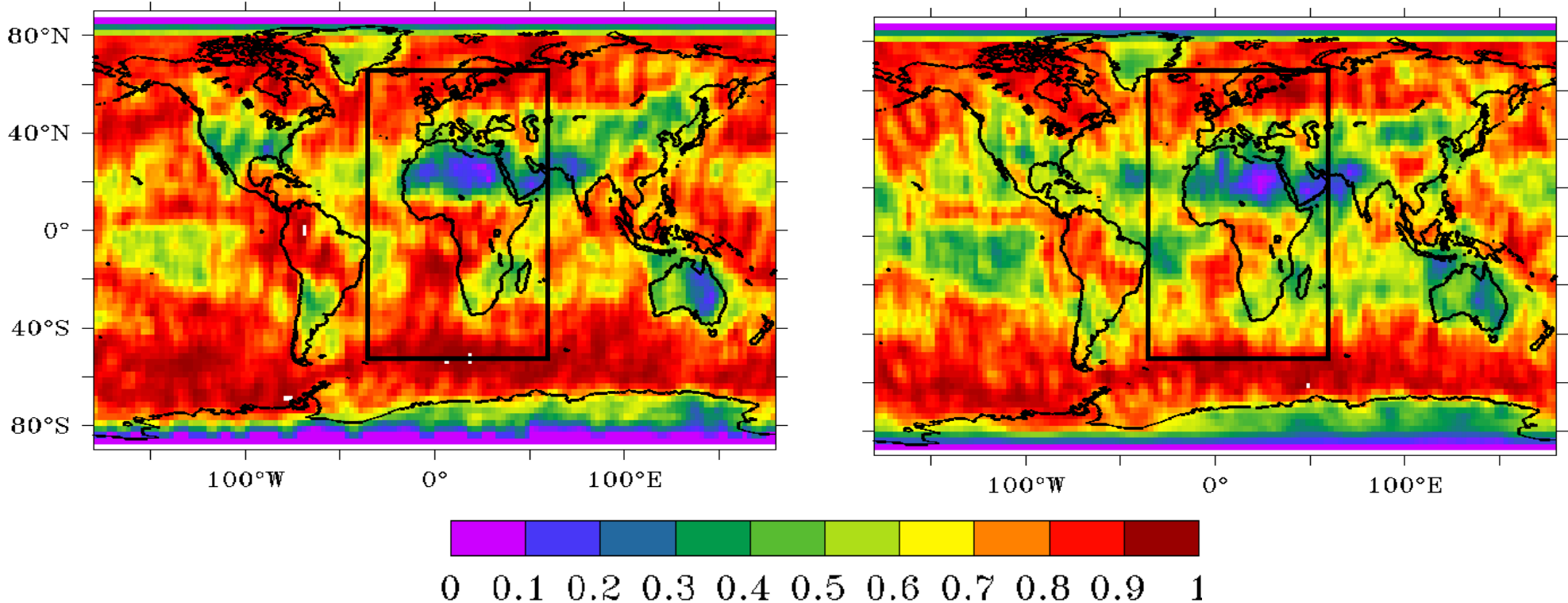
# CALIPSO CLOUD COVER



Night

October 2006

Day

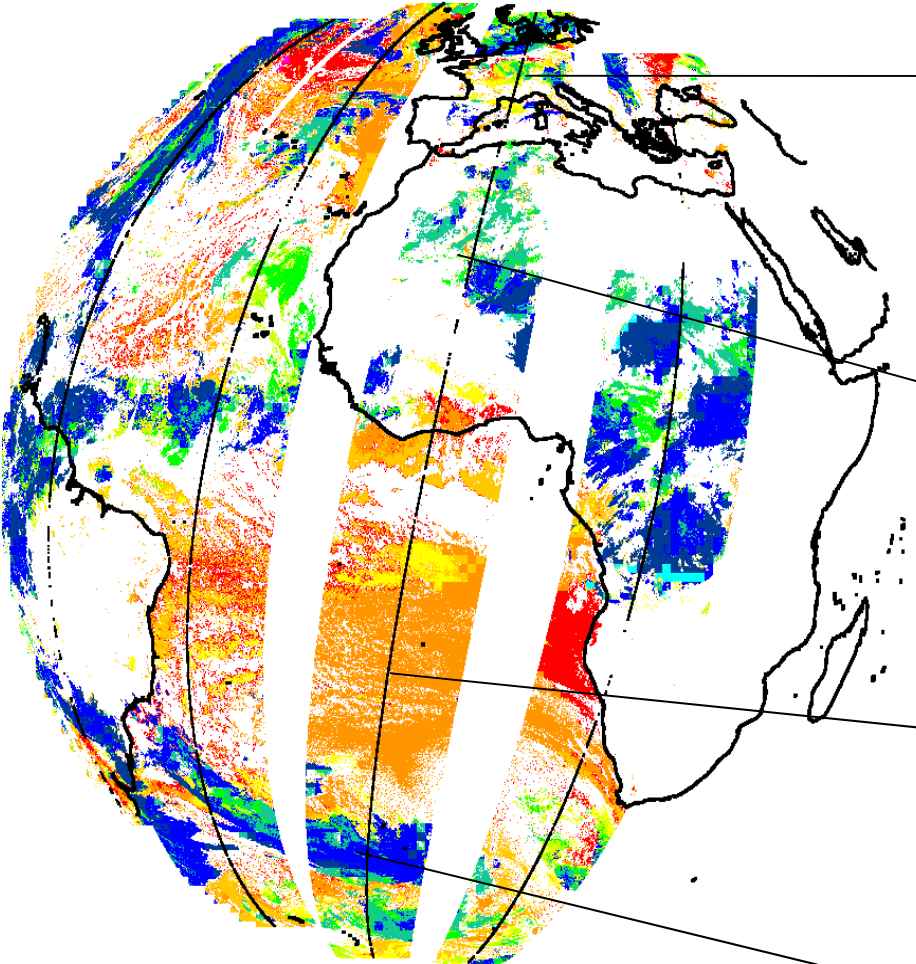


**Importance of diurnal cycle (> 20 % change at tropical and mid-latitudes in southern hemisphere -low clouds-)**

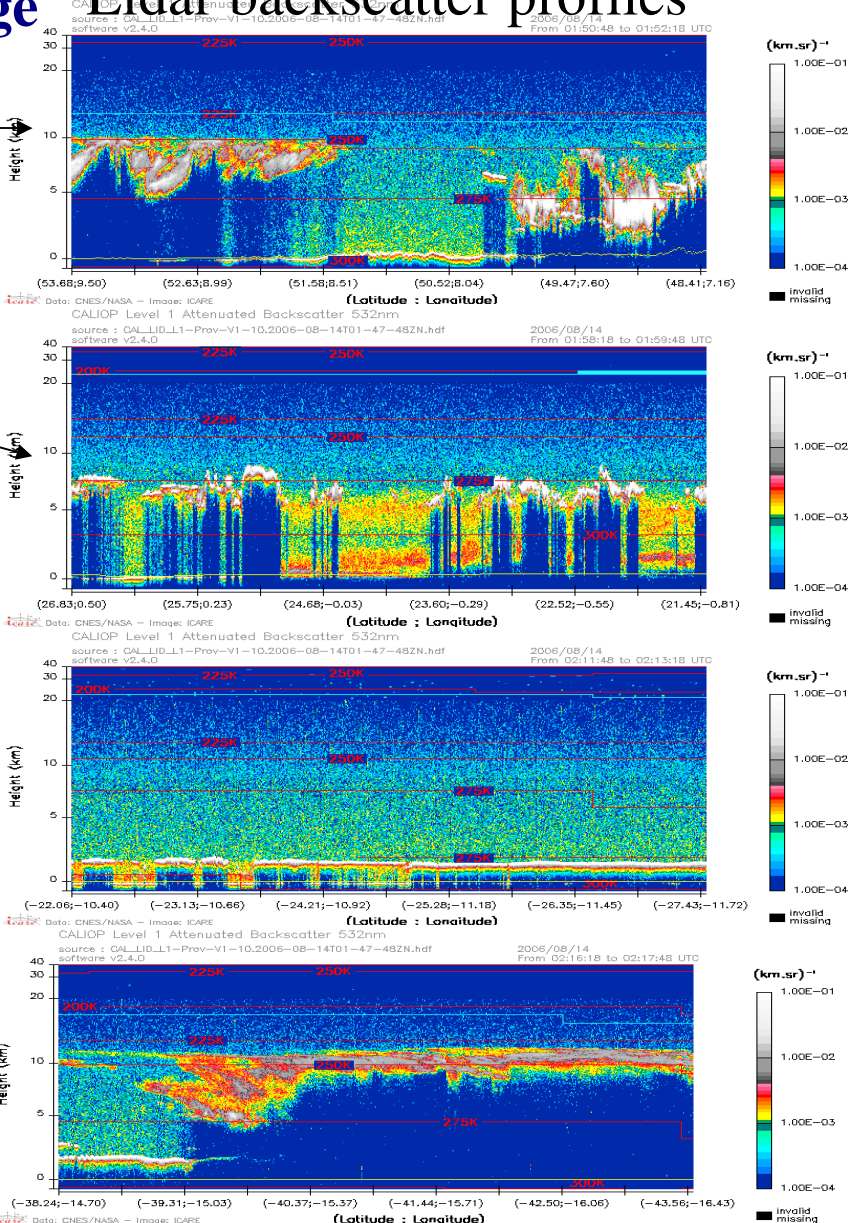
**Lidar SNR larger during night-time than day-time**

# Coincident SEVIRI and LIDAR DATA Analysis

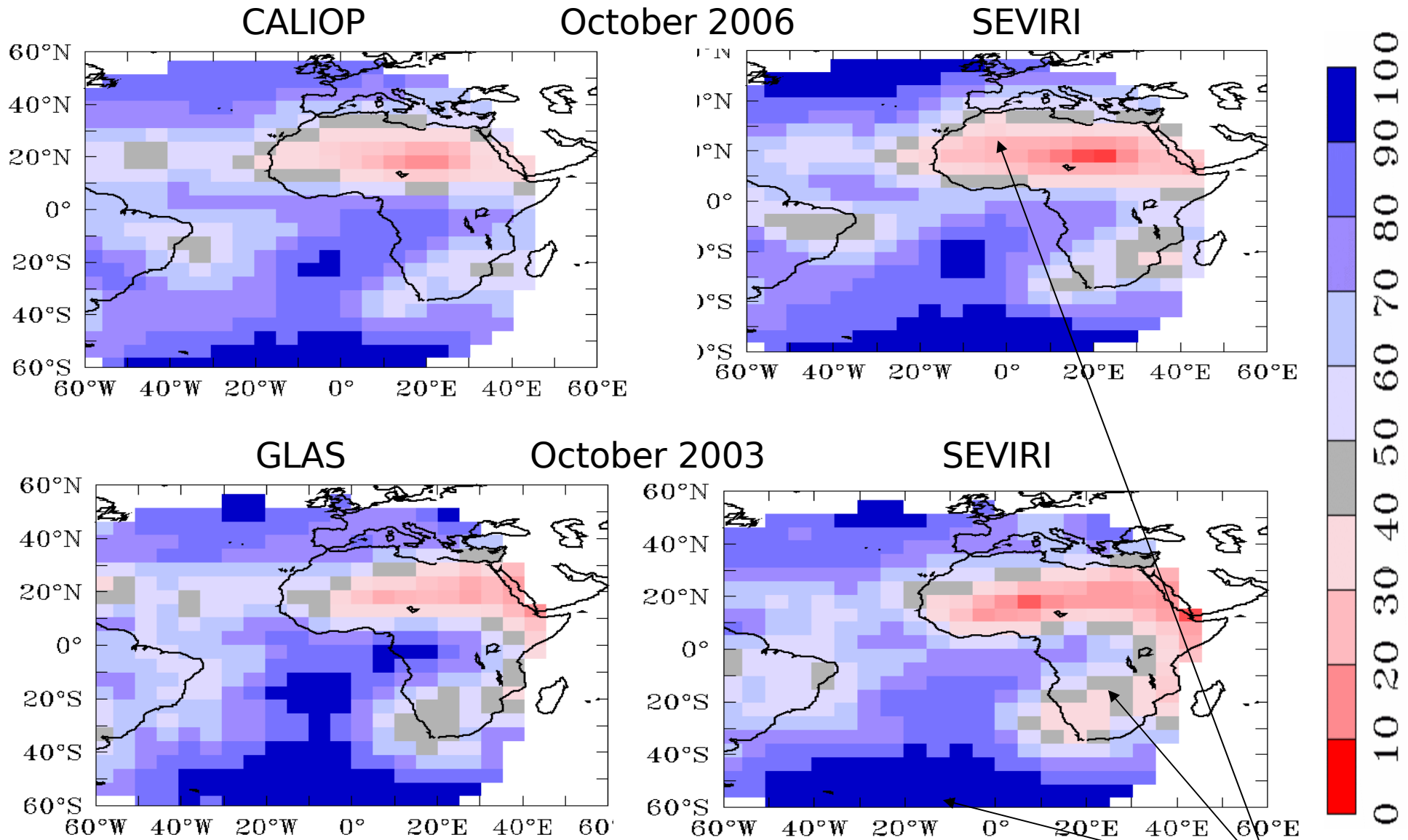
## SEVIRI cloud top pressure composite image



## Lidar backscatter profiles



# SEVIRI, GLAS and CALIOP CLOUD COVER



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

# GLAS and SEVIRI CLOUD COVER



**October 2003 at 7h30am - 7h30pm** SEVIRI viewing angle restricted to 55°

	<b>SEVIRI</b>	<b>GLAS (All)</b>	<b>GLAS (OT&gt;0.1)</b>	<b>GLAS (OT&gt;0.2)</b>	<b>ISCCP DX IR/VIS-IR</b>
<b>Ocean Night</b>	<b>70</b>	<b>80</b>	<b>74(-6)</b>	<b>72(-8)</b>	<b>62</b>
<b>Ocean Day</b>	<b>76</b>	<b>69</b>	<b>65(-4)</b>	<b>62(-6)</b>	<b>63/69</b>
<b>Land Night</b>	<b>46</b>	<b>64</b>	<b>54(-10)</b>	<b>50(-14)</b>	<b>45</b>
<b>Land Day</b>	<b>40</b>	<b>50</b>	<b>44(-6)</b>	<b>39(-11)</b>	<b>42/48</b>

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

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

The IR DX cloud cover is close from the SEVIRI one over land but there is a large underestimation over ocean. During daytime over ocean, DX VIS/IR and GLAS mean cloud cover are close.

With SEVIRI from night to day (19h30 to 7h30), the cloud cover over land/ocean increases/decreases. In both cases, GLAS CC decreases.





**October 2006 at 1h30am - 1h30pm**

	<b>SEVIRI</b>	<b>CALIOP (All)</b>	<b>CALIOP (OT&gt;0.1)</b>	<b>CALIOP (OT&gt;0.2)</b>	<b>ISCCP DX IR/VIS-IR</b>
<b>Ocean Night</b>	<b>72</b>	<b>75</b>	<b>72(-3)</b>	<b>68(-7)</b>	<b>??</b>
<b>Ocean Day</b>	<b>70</b>	<b>63</b>	<b>60(-3)</b>	<b>56(-7)</b>	<b>??</b>
<b>Land Night</b>	<b>41</b>	<b>56</b>	<b>52(-4)</b>	<b>48(-8)</b>	<b>??</b>
<b>Land Day</b>	<b>44</b>	<b>53</b>	<b>50(-3)</b>	<b>45(-8)</b>	<b>??</b>

As between GLAS and SEVIRI, the CALIOP cloud cover is larger than SEVIRI cloud cover, excepted over ocean during day time.

Over ocean at night, the differences observed are smaller than between GLAS and SEVIRI.

The decrease of CALIOP cloud cover with an increasing OT threshold is smaller than those observed for GLAS.

With SEVIRI, from 1h30 to 13h30, the cloud cover over land/ocean increases/decreases. In both cases, CALIOP CC decreases.

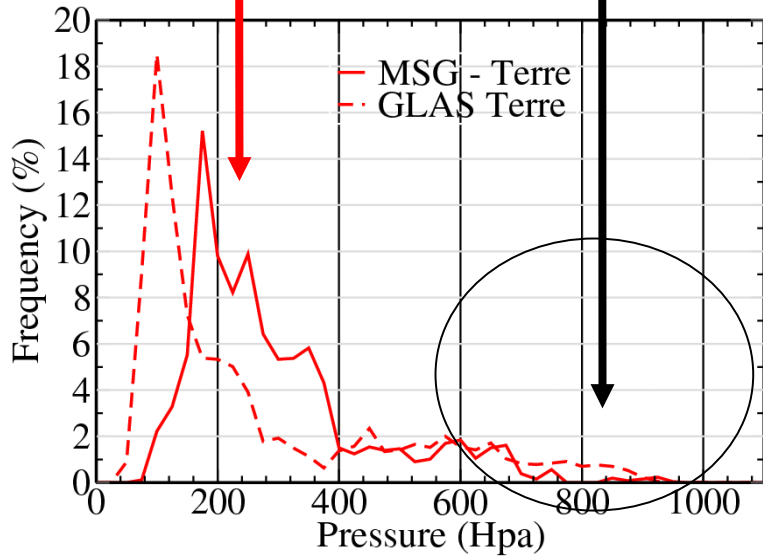
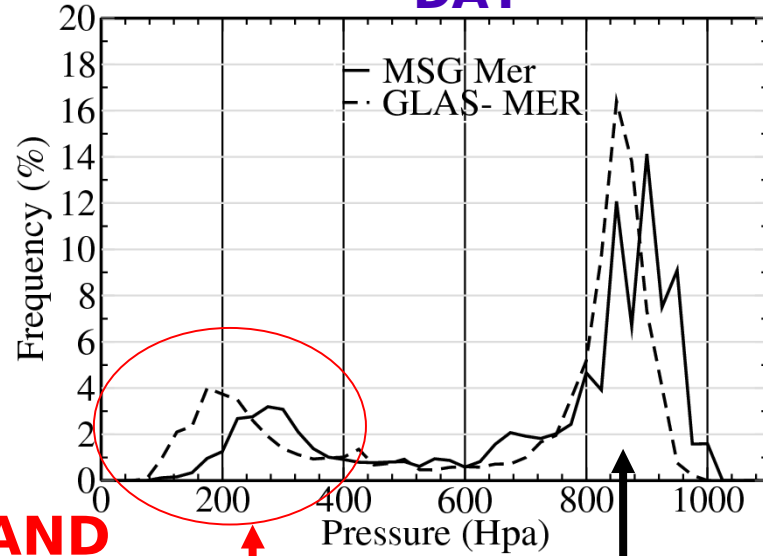
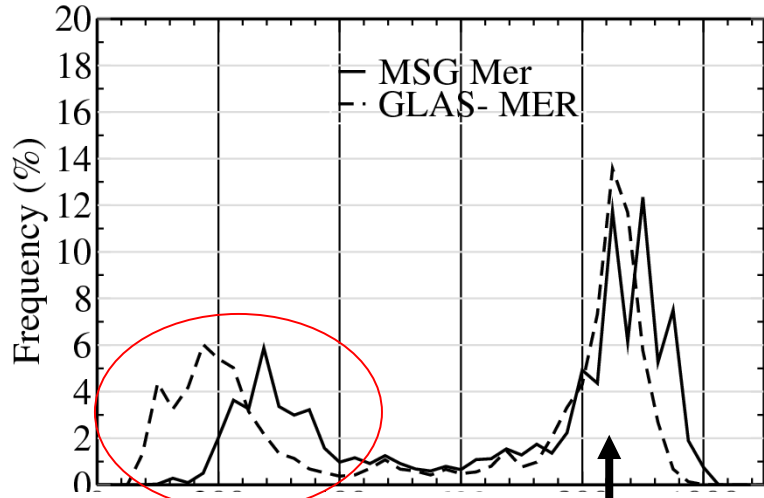
# GLAS-SEVIRI CLOUD COVER

October 2003 OVER ALL MSG-COVERED AREA

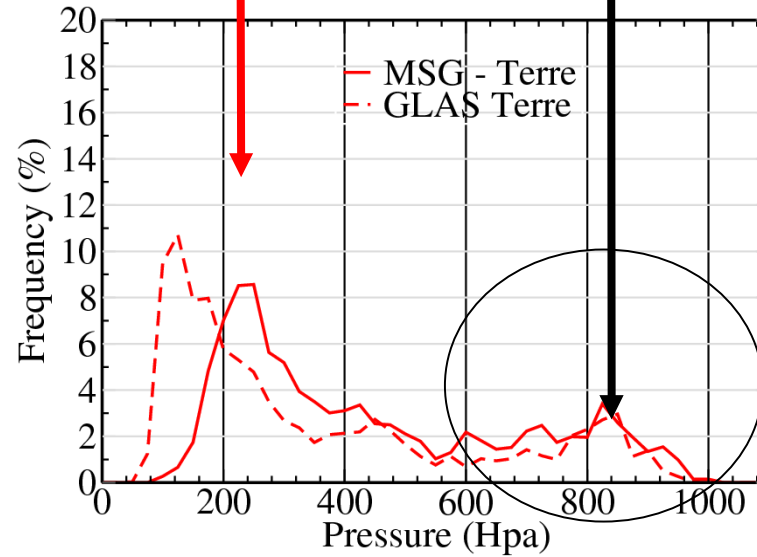
**NIGHT**

**OCEAN**

**DAY**



**LAND**



# CALIPSO-SEVIRI CLOUD COVER

October 2006

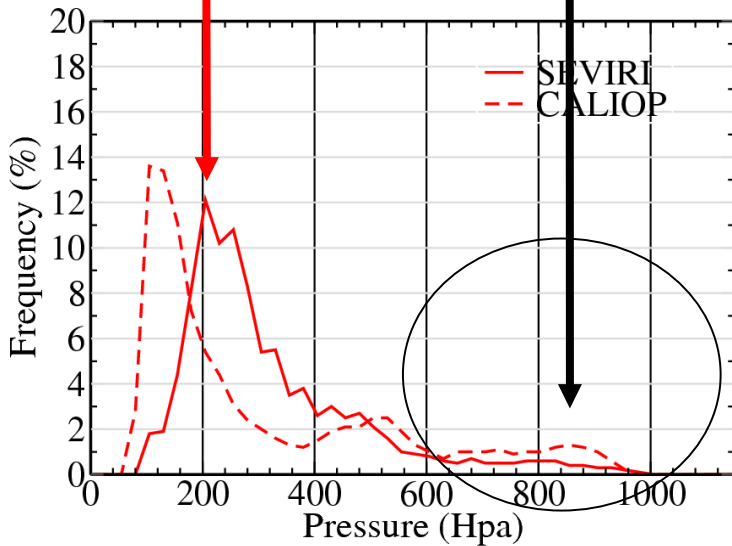
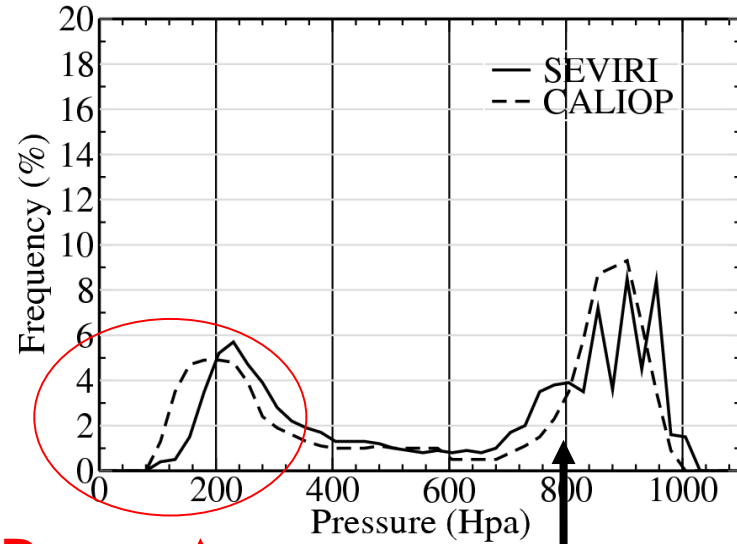
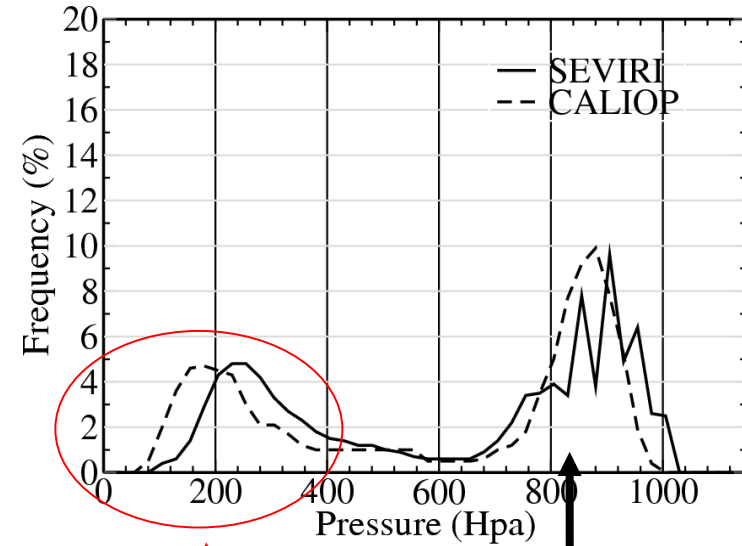
OVER ALL MSG-COVERED AREA



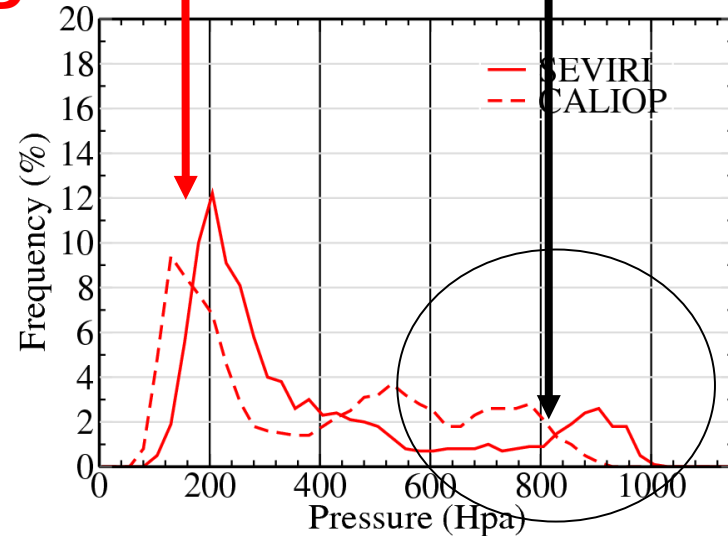
**NIGHT**

**OCEAN**

**DAY**



**LAND**



# MAIN CLOUD TYPES OVER OCEAN



GLAS/GLAS OT<0.2/GLAS ALL LAYERS/SEVIRI/DX IR/DX VIS-IR

	HIGH<440hPa (Cir.ov)	Middle	LOW>680hPa	Part
Night	36/20 21 20/9 10	6/7/10 4 14	38/45/54 29 38	16
Day	25/16 18 9/4 6 10/18	5/6/8 5 15/16	38/40/43 32 39/35	21

Decrease of the high cloud cover from night to day. Increase of the low cloud amount for SEVIRI.

SEVIRI and DX VIS-IR high cloud close from GLAS OT>0.2.

Large amount of partially covered pixels for SEVIRI.

# MAIN CLOUD TYPES OVER OCEAN



**GLAS/GLAS OT>0.2/GLAS ALL LAYERS/SEVIRI 7h30 - 19h30**

	HIGH<440hPa (Cir.ov)	Middle	LOW>680hPa	Part
Night	36/ <b>20</b> <b>21</b> 20/ <b>9</b>	6/ <b>7</b> / <b>10</b> 4	38/ <b>45</b> / <b>54</b> <b>29</b>	<b>16</b>
Day	25/ <b>16</b> <b>18</b> 9/ <b>4</b> <b>6</b>	5/ <b>6</b> / <b>8</b> 5	38/ <b>40</b> / <b>43</b> <b>32</b>	<b>21</b>

## **SAME BEHAVIOUR OF GLAS and CALIOP VS SEVIRI**

Some differences : GLAS high cloud before application of an OT threshold is larger, High cloud, same behaviour than in 2003. SEVIRI low cloud opposite behaviour.

**CALIOP/CALIOP OT>0.2/CALIOP ALL LAYERS/SEVIRI 1h30 - 13h30**

	HIGH<440hPa (Cir.ov)	Middle	LOW>680hPa	Part
Night	28/ <b>19</b> <b>22</b> 14/ <b>8</b>	6/ <b>6</b> / <b>10</b> 4	41/ <b>42</b> / <b>51</b> <b>29</b>	<b>17</b>
Day	24/ <b>19</b> <b>18</b> 7/ <b>7</b> 4	5/ <b>5</b> / <b>9</b> 4	33/ <b>31</b> / <b>40</b> <b>24</b>	<b>24</b>

# MAIN CLOUD TYPES OVER LAND



**GLAS / GLAS OT>0.2 / GLAS ALL LAYERS / SEVIRI / DX IR / DX VIS-IR**

	HIGH<440hPa (Cir.ov)	Middle	LOW>680hPa	Part
Night	53/34 37 19/11 20	9/12/18 4 16	3/4/8 2 11	3
Day	36/22 26 10/4 8 10/17	8/10/13 5 16/16	7/8/9 6 16/15	4

## SAME BEHAVIOUR OF GLAS and CALIOP VS SEVIRI

Some differences : GLAS high cloud before application of an OT threshold is larger, CALIOP mid-cloud amount is larger during day time

**CALIOP / CALIOP OT>0.2 / CALIOP ALL LAYERS / SEVIRI 1h30-13h30**

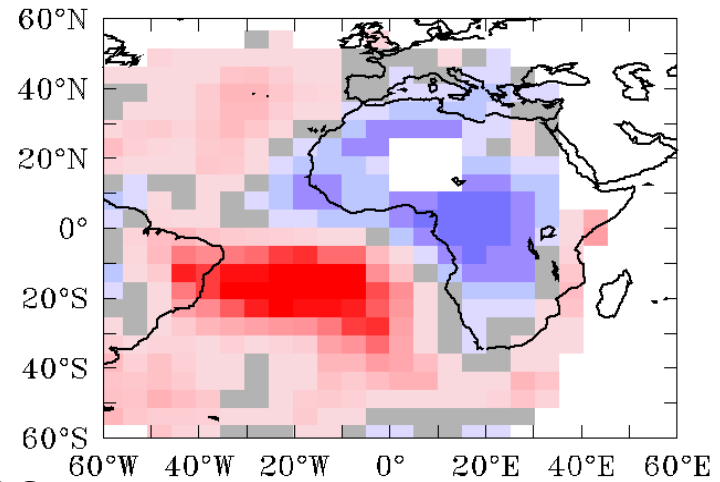
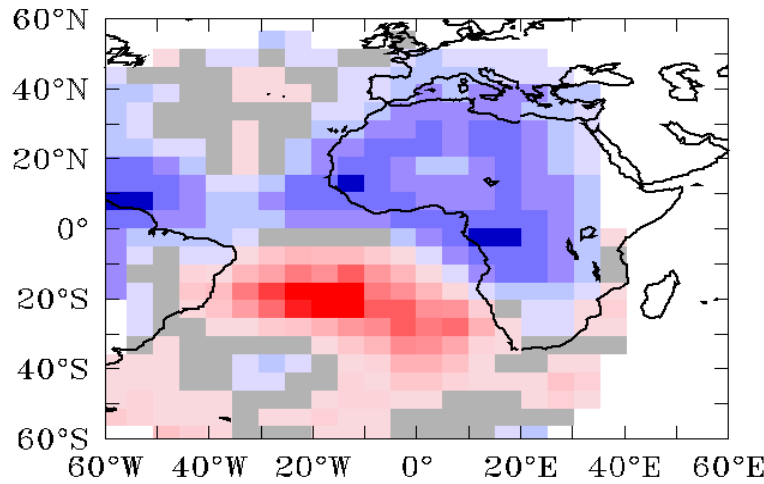
	HIGH<440hPa (Cir.ov)	Middle	LOW>680hPa	Part
Night	40/30 32 16/10	9/11/19 5	6/7/10 2	3
Day	30/23 26 9/6 6	14/13/19 4	9/9/12 5	9

# HIGH CLOUD COVER DAY and NIGHT (total)



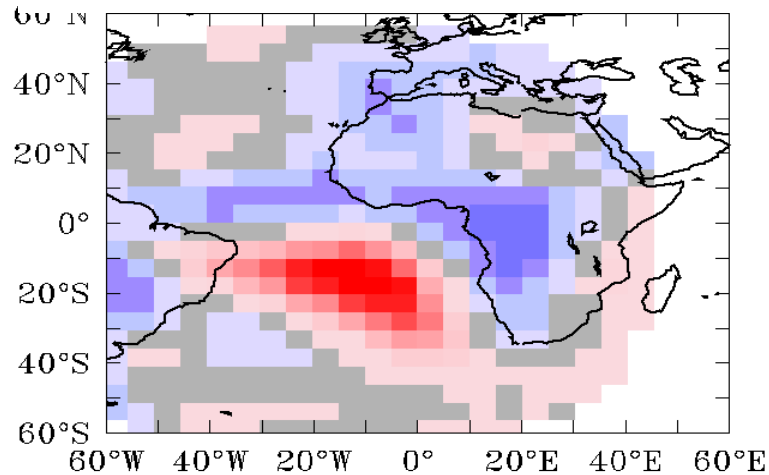
October 2003

GLAS

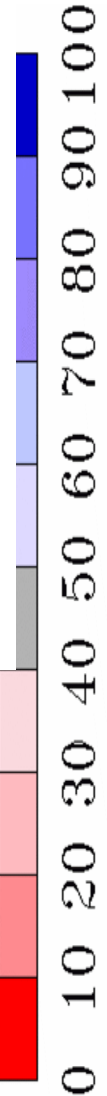
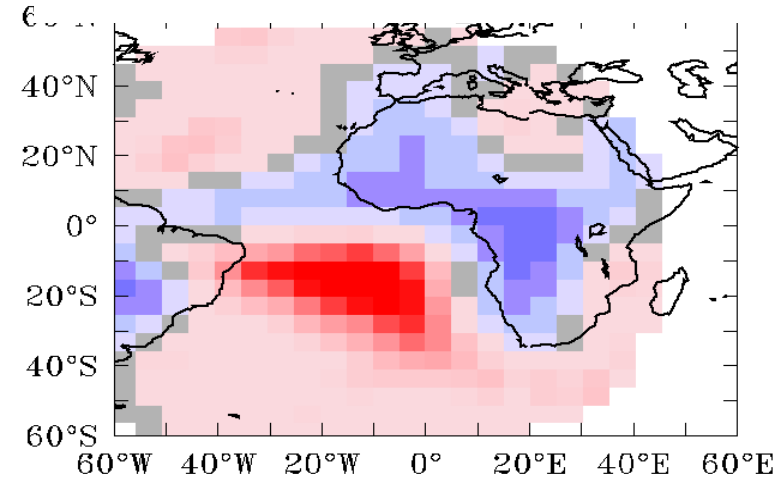


October 2006

CALIOP



SEVIRI

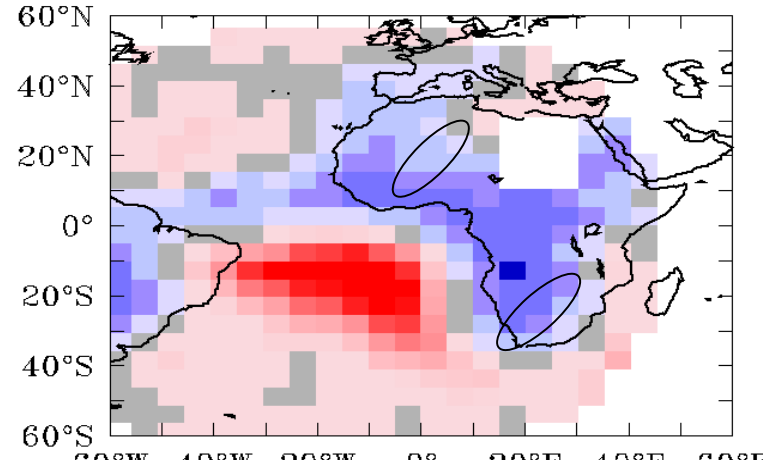
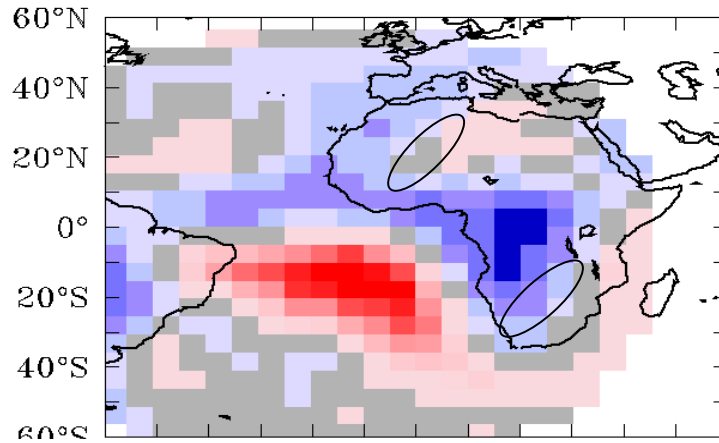


# HIGH CLOUD DAY and NIGHT (sep.)

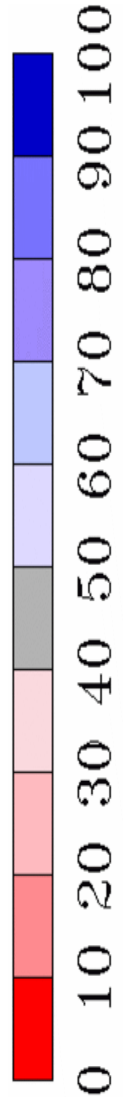
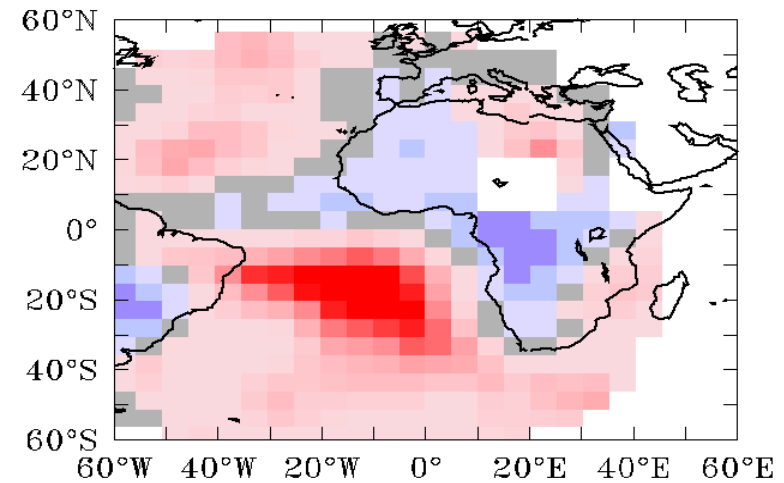
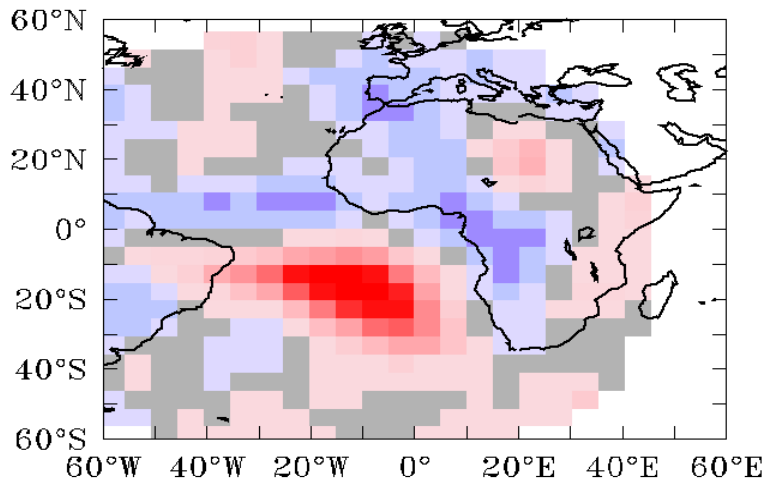
CALIOP

SEVIRI

Night



Day



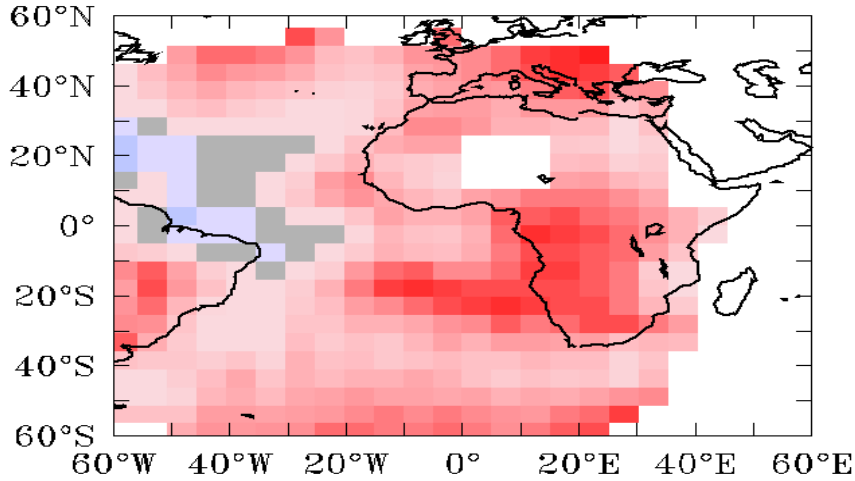
For some regions SEVIRI high cloud frequency larger than CALIOP one's



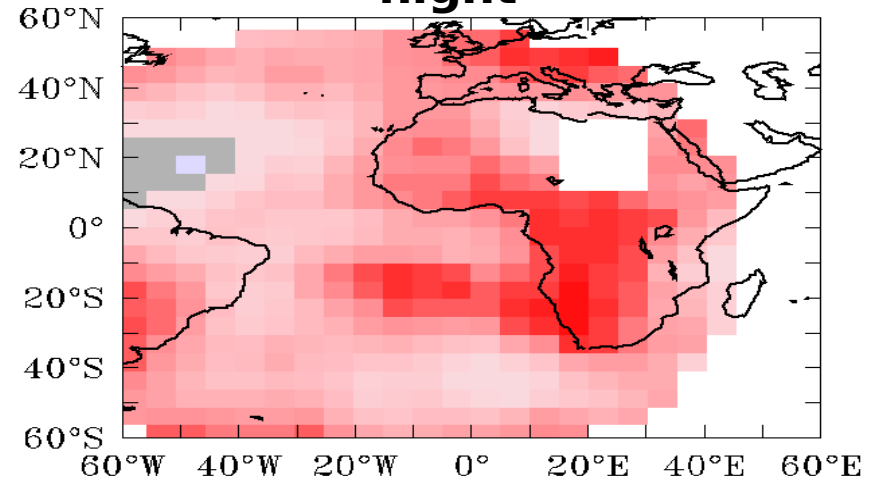
# SEVIRI PARTIAL CLOUD COVER



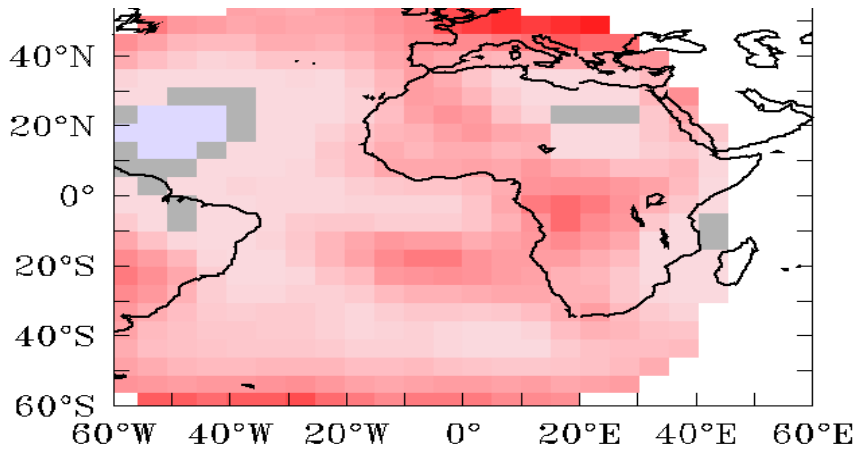
day and night  
October 2003



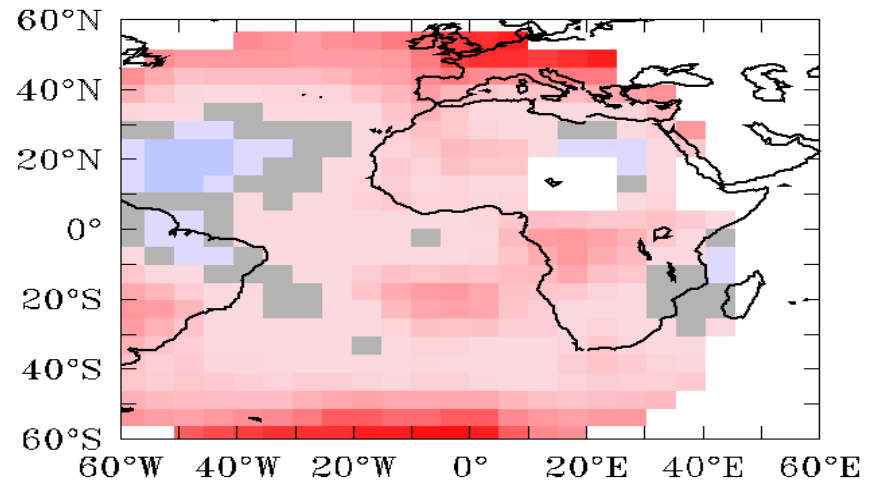
October 2006  
night



October 2006



day

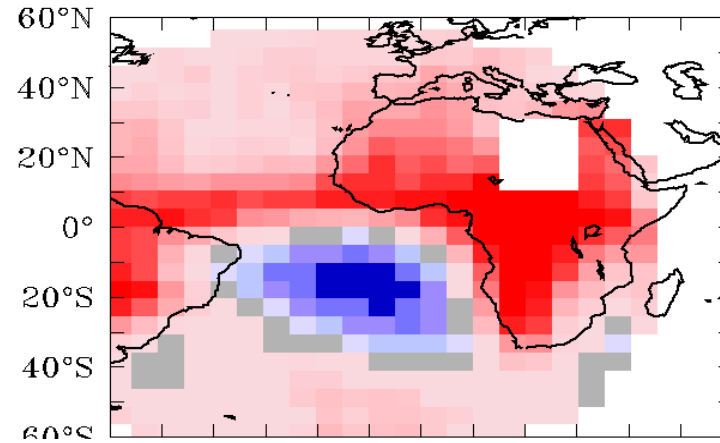
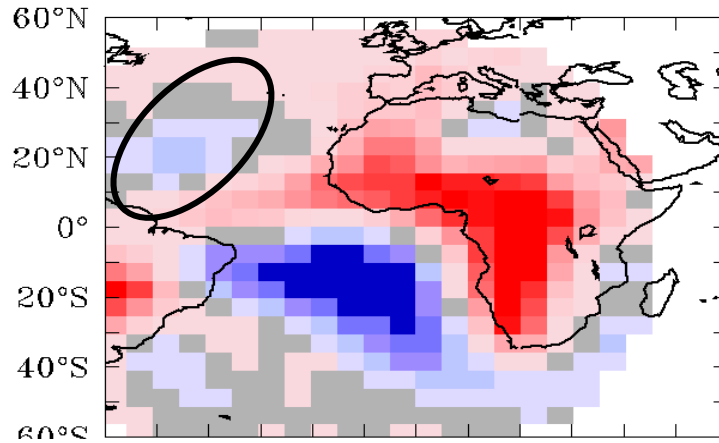


# LOW CLOUD DAY and NIGHT (sep.)

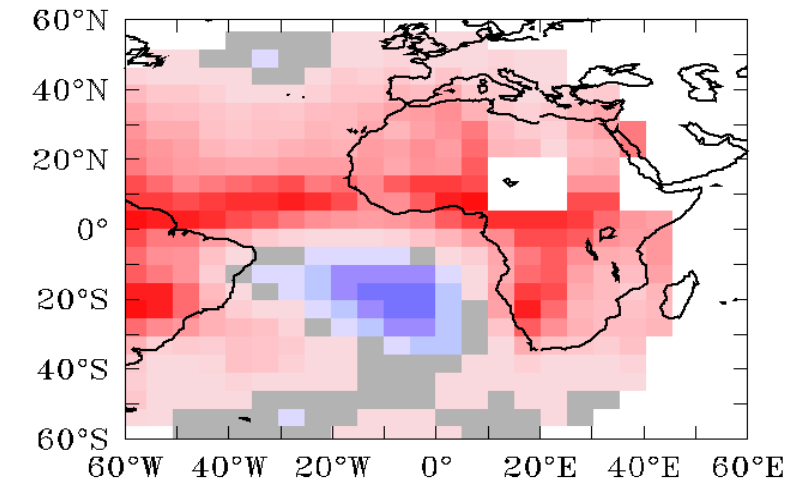
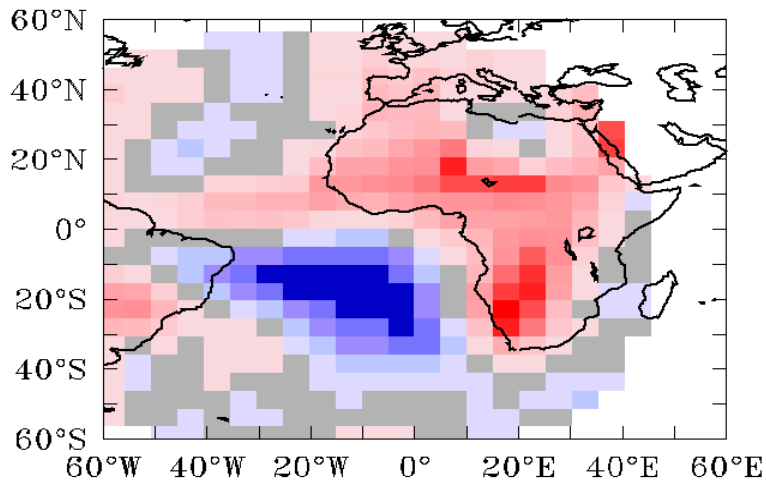
CALIOP

SEVIRI

Night



Day



# COMPARISON AT PIXEL LEVEL:



## CLOUD COVER CO-OCCURENCE MATRIX

		83%/89%			82%/92% SEVIRI			83%/92%			81%/94%			
C		Ocean Night			Land Night			Ocean Day			Land Day			
	A	clear	cloud	par	clear	cloud	part	clear	cloud	part	clear	cloud	part	
L	I	cle.	18/25	8/4	4/2	43/55	1/1	0/0	24/32	13/7	10/5	42/60	6/34	3/0
	O	clo.	10/6	65/64	13/3	16/7	40/37	2/0	5/2	58/60	14/5	14/5	39/35	7/0

**SAME BEHAVIOR OF GLAS and CALIOP VS SEVIRI**

Partial cloud coverage included in SEVIRI CC

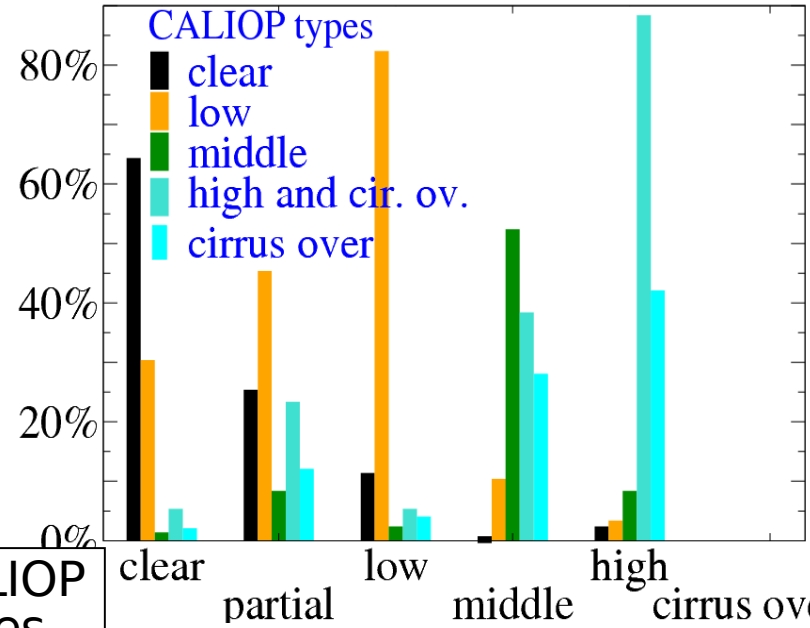
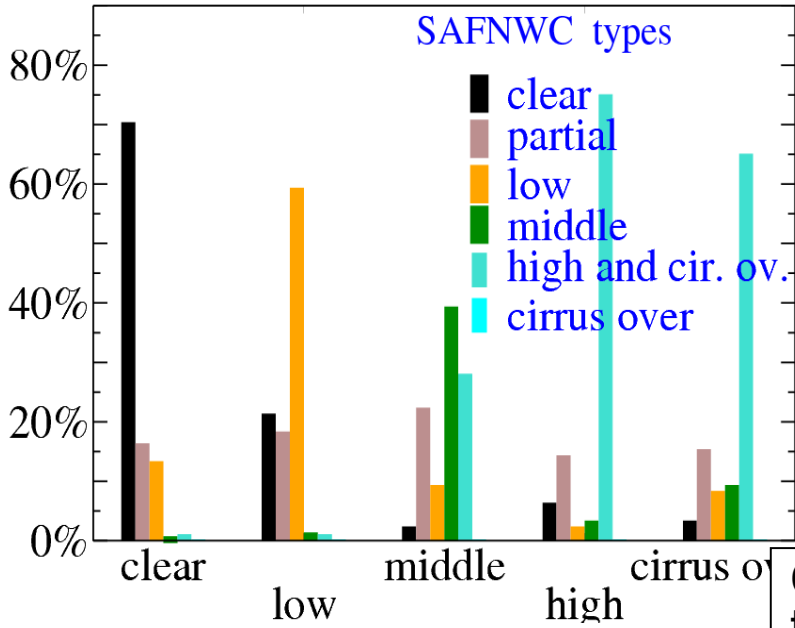
Application of a spatial homogeneity test on SEVIRI data and excluding the cloud layer with optical thickness smaller than 0.2 increase the agreement in all cases.

# CALIOP and SEVIRI over OCEAN

## Ver. 2 October 2006



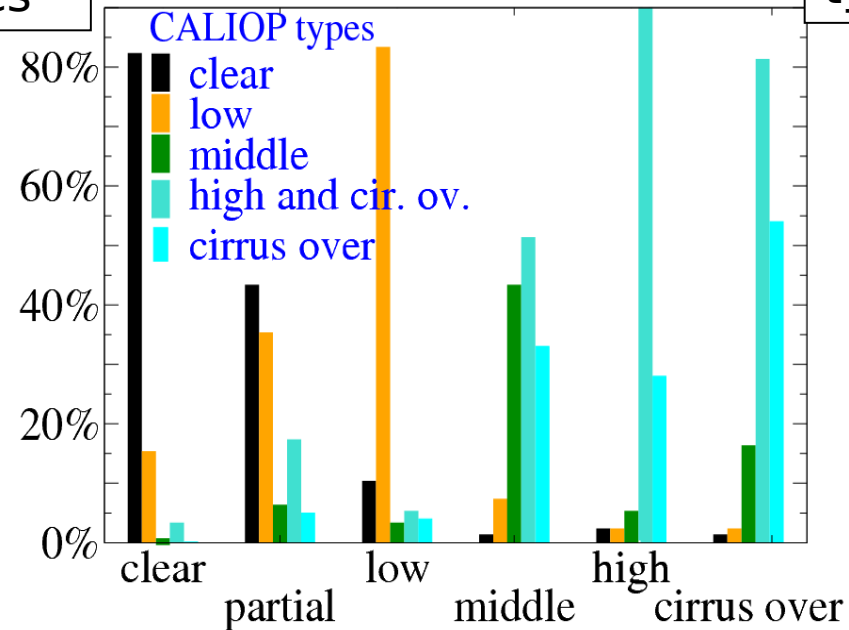
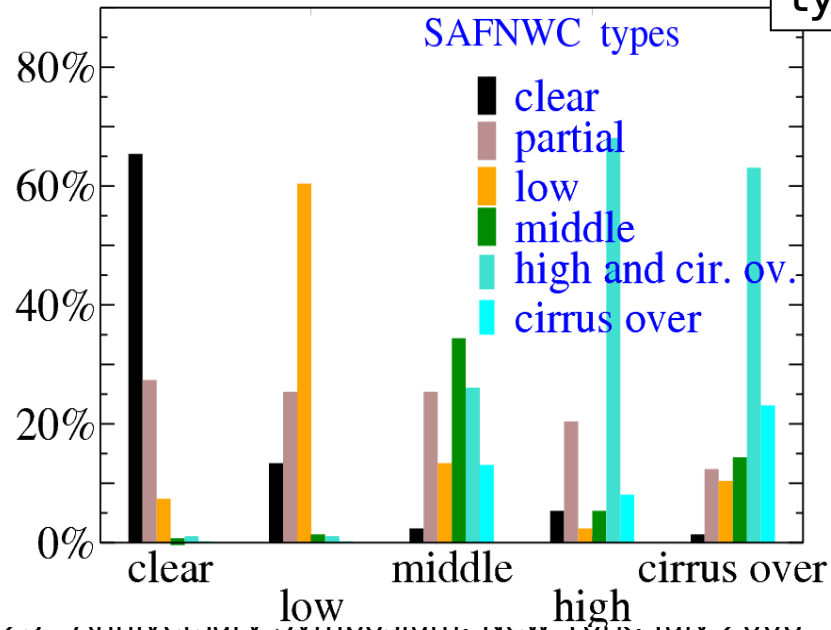
Night



CALIOP types

SEVIRI types

Day

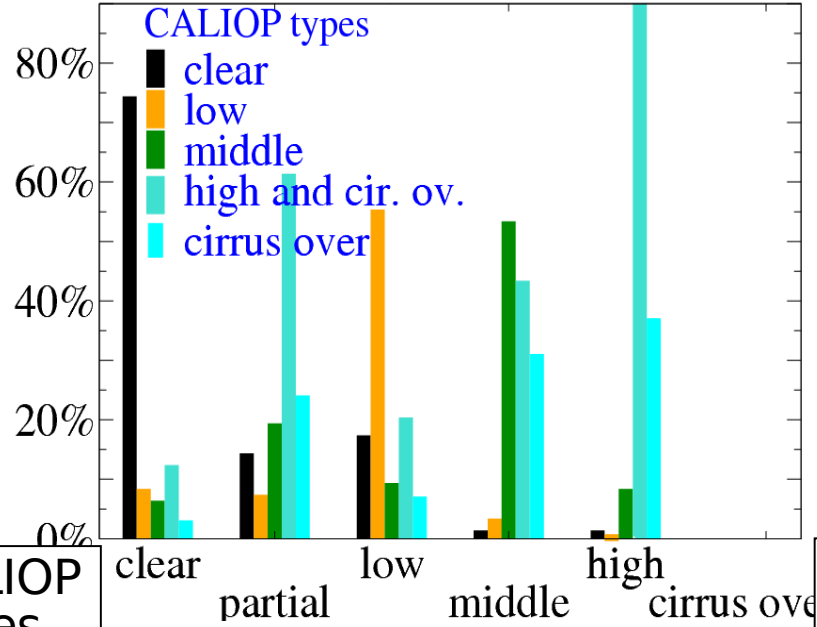
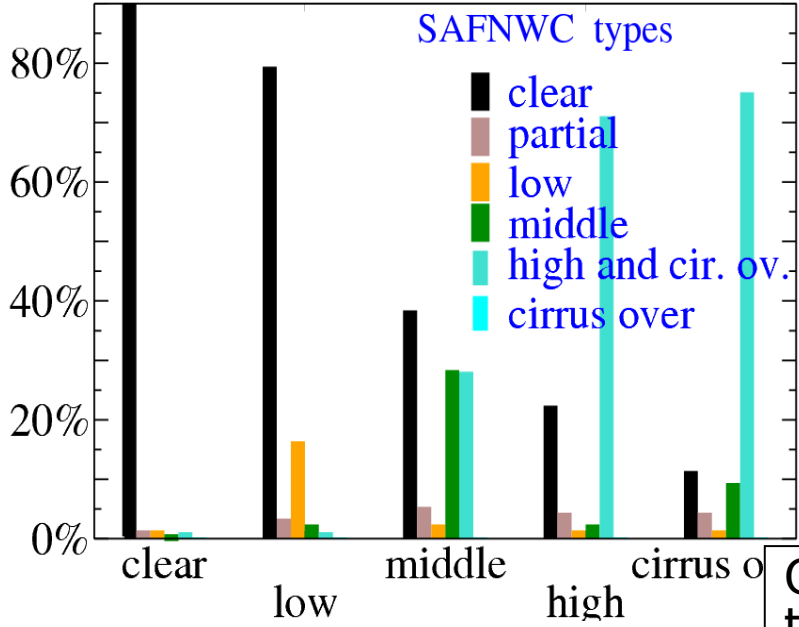


# CALIOP and SEVIRI over LAND new October 2006



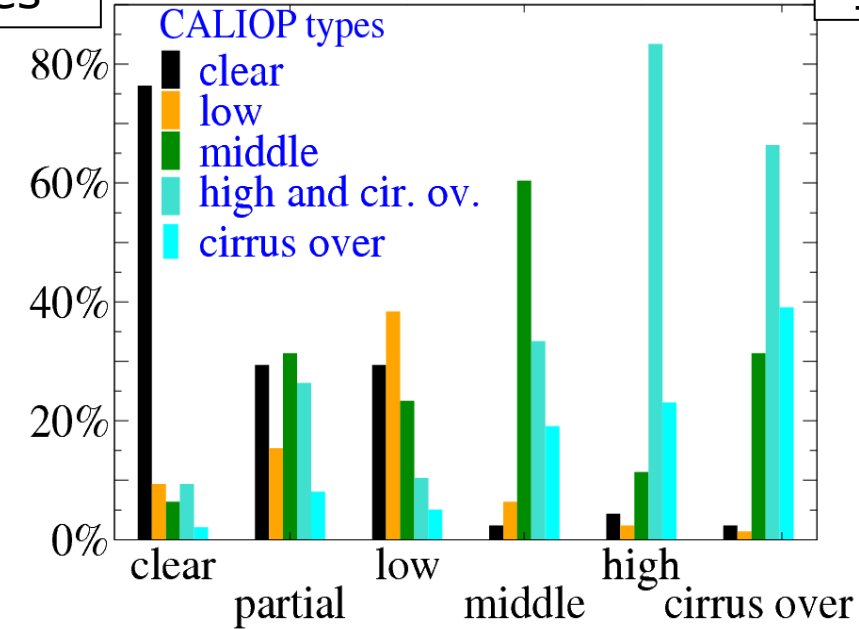
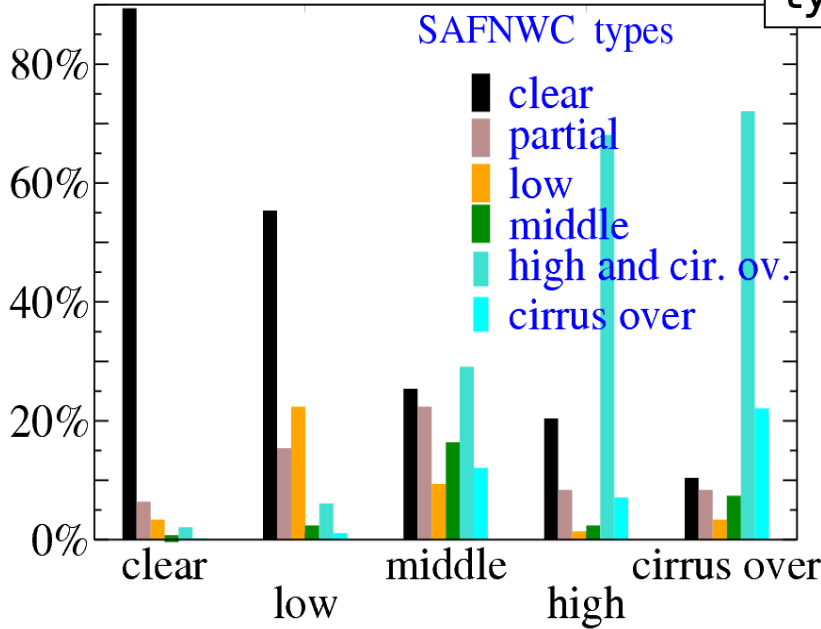
Night

Day



CALIOP types

SEVIRI types



ISCCP

# CONCLUSION



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 agreement at pixel scale is above 79%. For CALIOP when a spatial homogeneity test (SEVIRI) plus an 0.2 OT threshold (lidar) are applied the agreement is above 89%.

High SEVIRI clouds are classified high cloud by the lidar in more than 80% of the cases. The agreement for mid-level cloud is poor and also over land for low cloud.

The better detection of small or broken low clouds over ocean during day-time by SEVIRI must increase the frequency of lidar clear profiles detected cloudy by SEVIRI.

Some differences, not large for the CALIOP/SEVIRI comparison, are observed between night and day in the behavior of the lidar data and SEVIRI data. More investigations are required.

# FURTHER WORK



Pursue the comparison between SEVIRI and CALIOP on a longueur data set and as a function of latitude and cloud systems in the aim to improve the cloud diurnal and life cycle obtained with the geostationnary data.

Do the same type of analyses for other geostationnary data set in the frame of the MEGHA-TROPIQUE experiment.

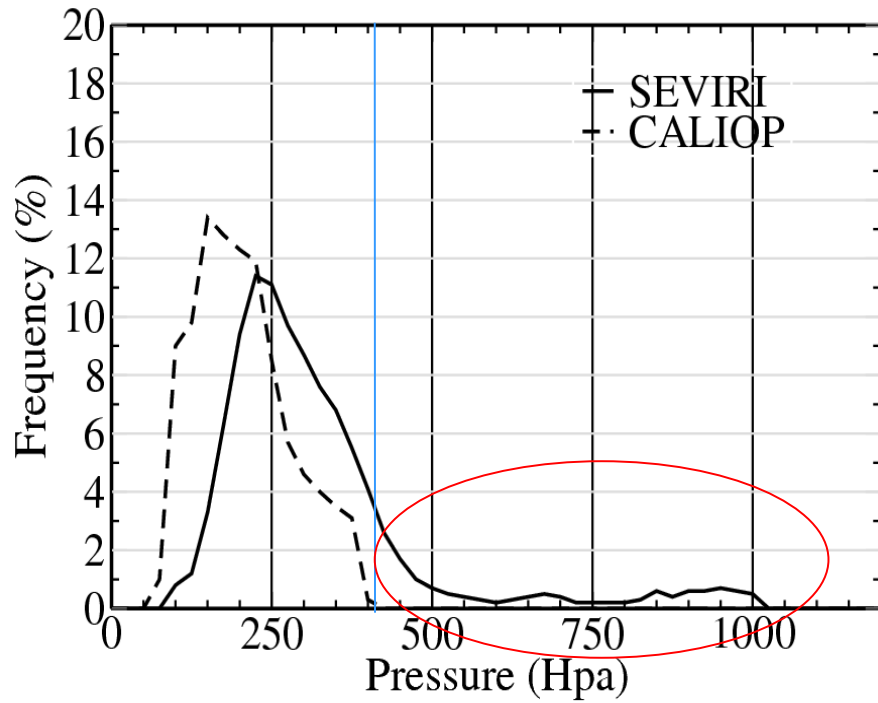
Analyses the results in order to improve the existing ISCCP climatology.

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

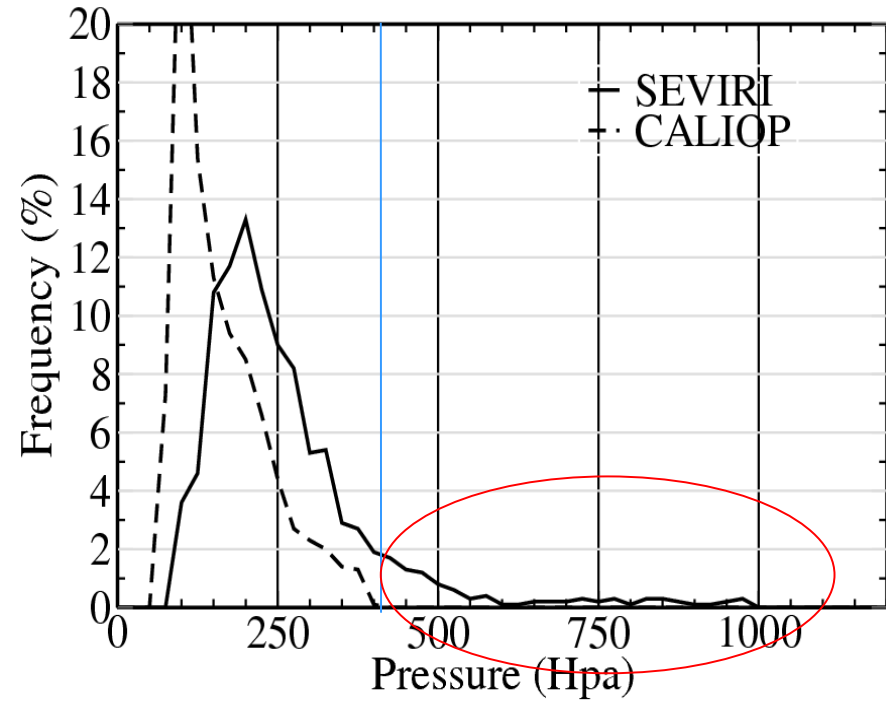
# DISTRIBUTION OF SEVIRI CLOUD TOPS



FOR CALIOP high clouds tops below 400 hPa Night data



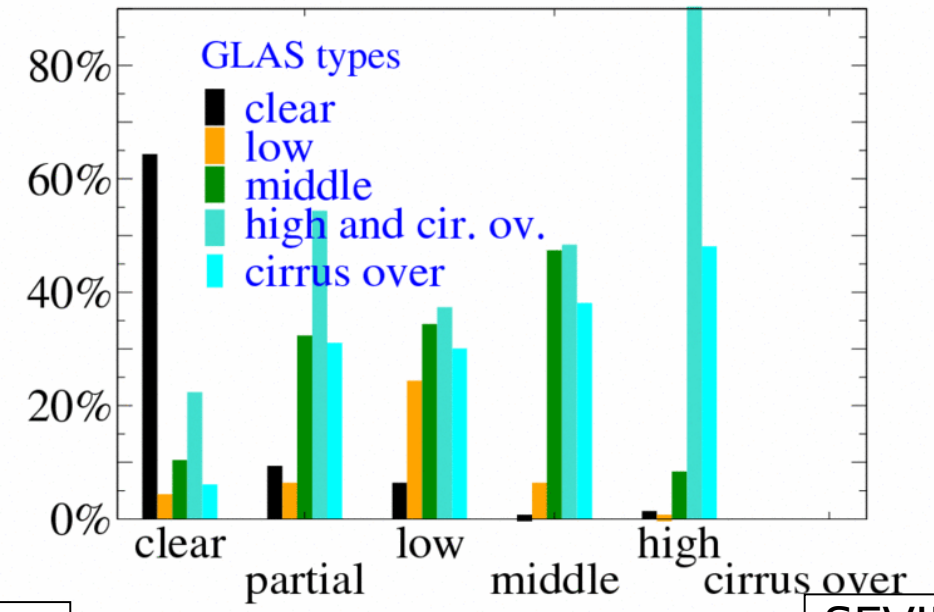
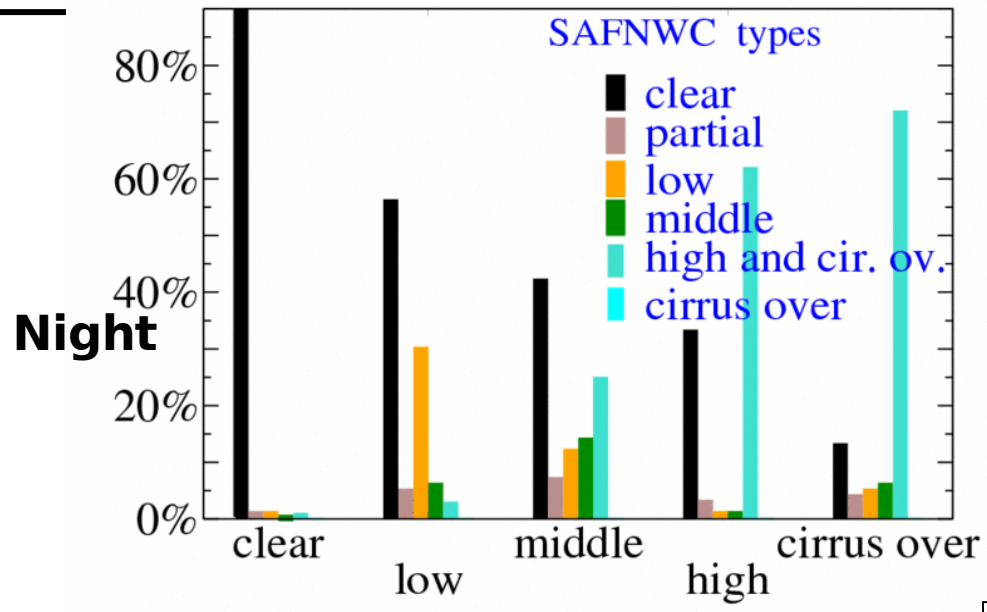
OCEAN



Land

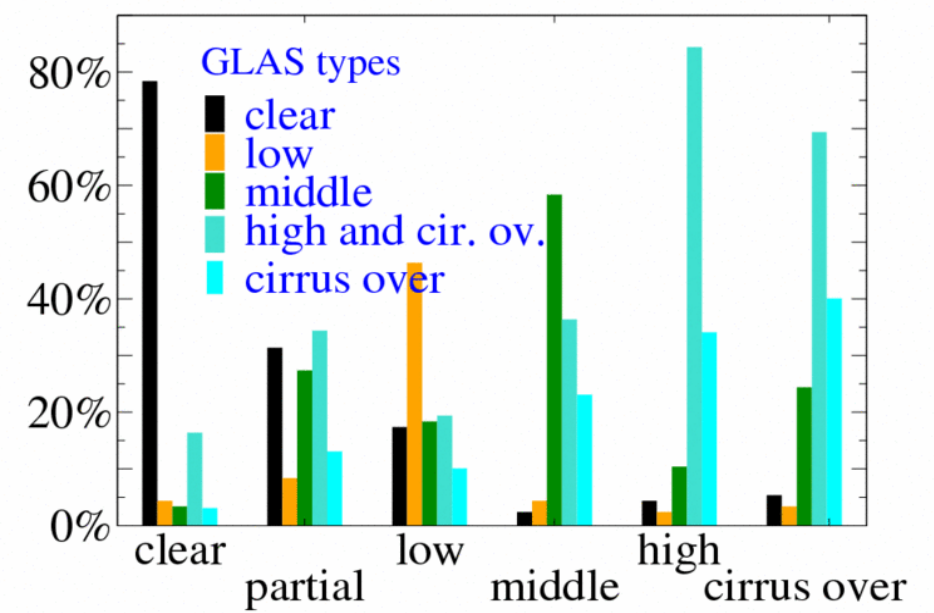
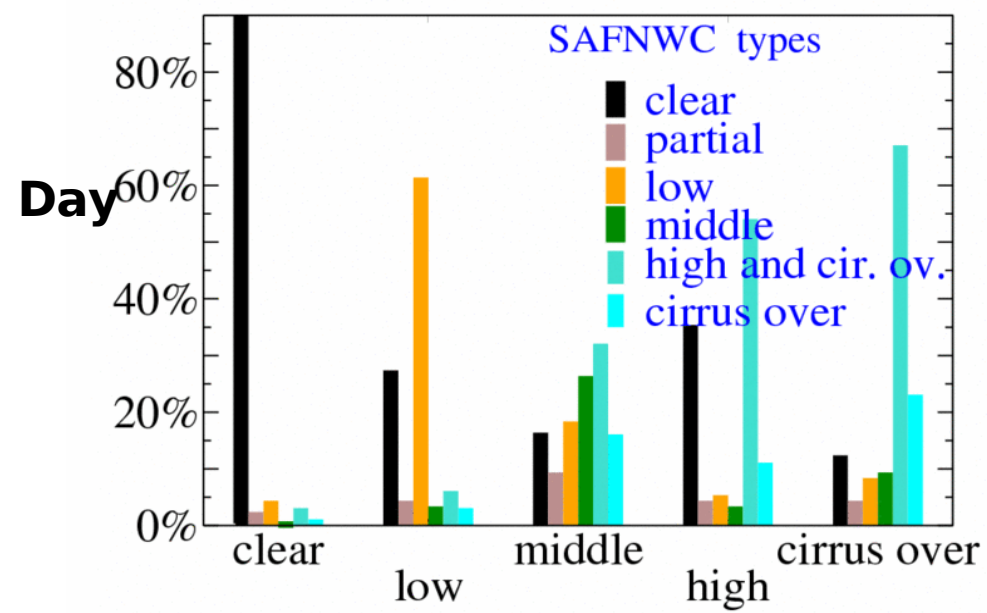


# GLAS and SEVIRI over LAND October 2003

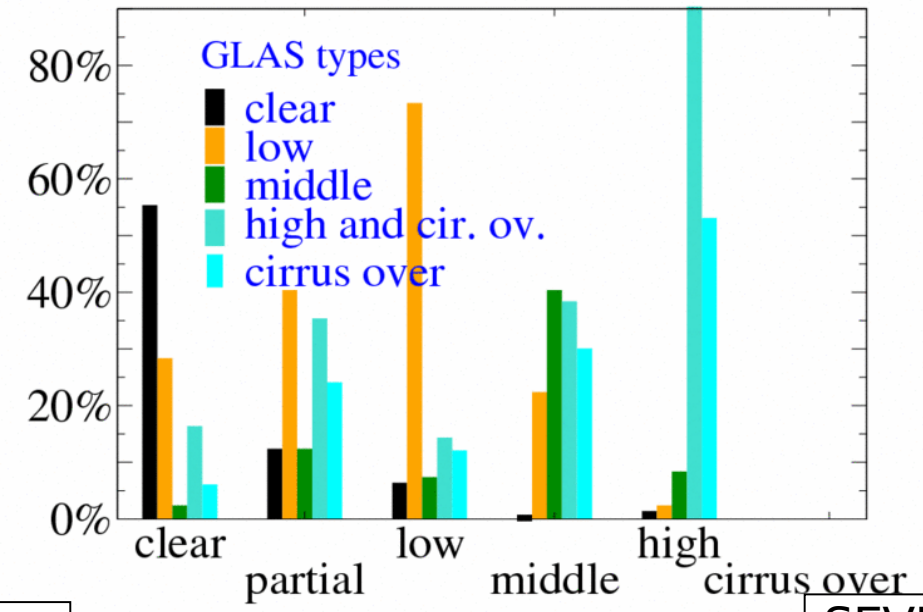
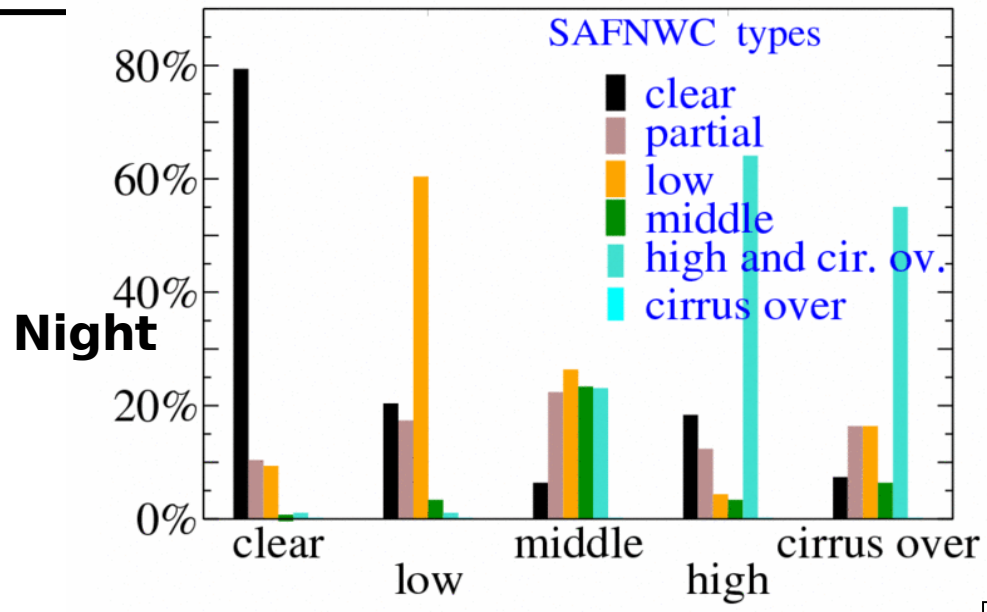


GLAS types

SEVIRI types

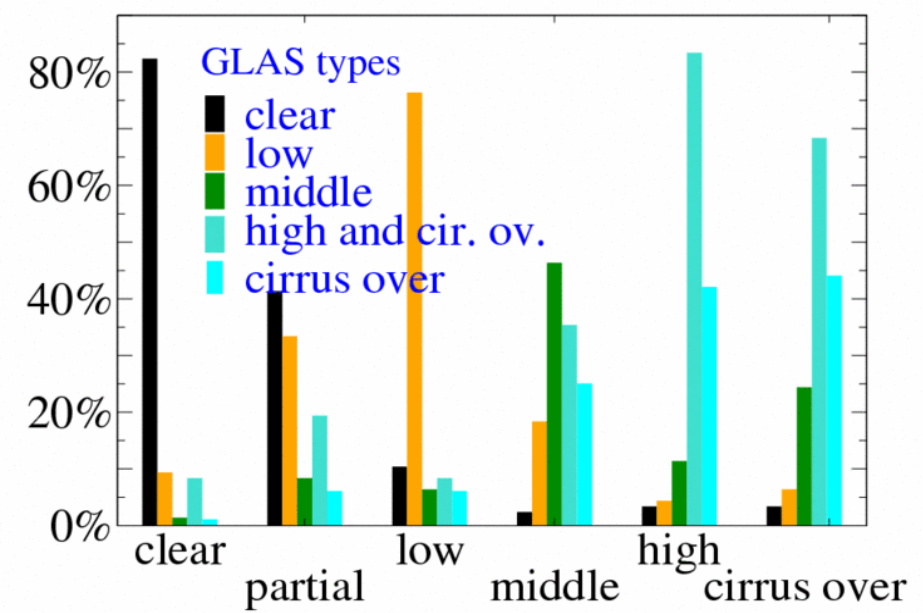
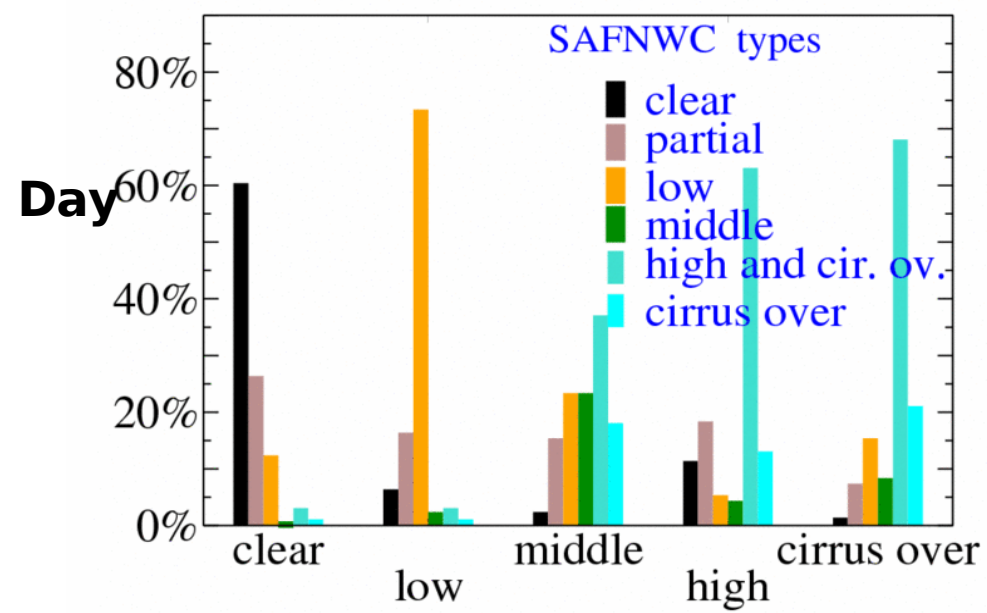


# GLAS and SEVIRI over OCEAN October 2003



GLAS types

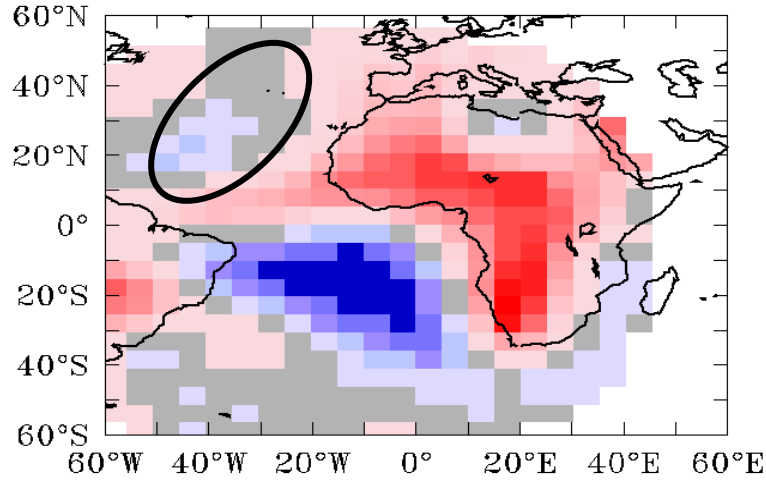
SEVIRI types



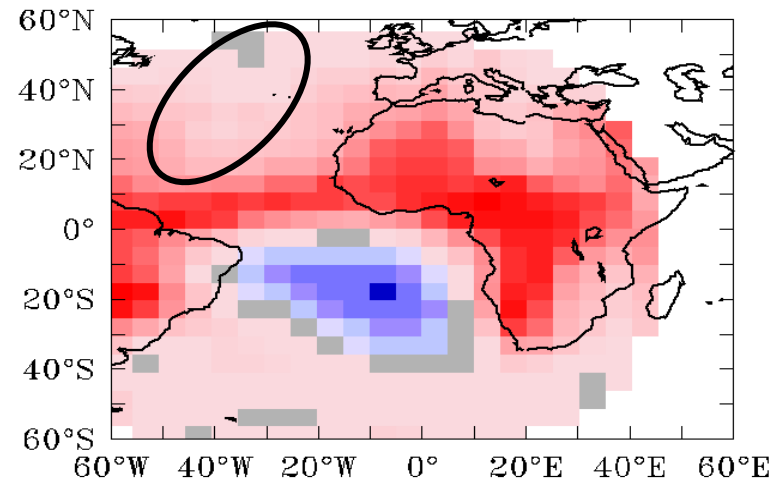
# LOW CLOUD COVER (day + night)

October 2003

CALIOP



SEVIRI



GLAS

