Comparisons of Cloud Diurnal Cycles:
Satellite, Synop and Regional Climate Model Data*

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Motivation

- Clouds play a major role in climate system, but are not consistently defined
- Radiation budget, which drives atmospheric dynamics, is controled by clouds
- In average, clouds warm the earth-atmosphere system during night *(cloud greenhouse effect)* and cool it in daytime *(cloud albedo effect)*
- Clouds present one of the largest uncertainties in climate projections
- Small systematic changes in cloud amount or cloud diurnal cycle (DC) can cause bigger radiative forcing than rising greenhouse gas concentrations
- What are the differences and similarities between the types of cloud data? Where exists a diurnal cycle?

Cloud Amount Data

Type	**Satellite**		**Synop**	Regional **Climate Model**	
Name	ISCCP-DX[a]	CM-SAF[b]	Climatic Atlas of Clouds[c]	CLM[d] (Europe)	CLM[d] (Africa)
Resolution	~30 km	~15 km	variable	0.44°	0.5°
	3 h	1 h	3 h	3 h	3 h
Period	7/2006 - 6/2007		1971 - 1996	1991 - 2000	1996 - 2001

[a]D-series of the International Cloud Climatology Project, (http://isccp.giss.nasa.gov)
[b]Satellite Application Facility on Climate Monitoring, (www.cmsaf.eu)
[c]Ground-based Synop-observations, (www.atmos.washington.edu/~ignatius/cloudmap)
[d]Local Model (LM) of the DWD in Climate Mode, ERA40 driven, supported by the CLM-Community, (www.clm-community.eu, in pers. Dobler A. and Kaspar F.)

Methods

- Interpolation of data to consistent regular grids
- Linear Interpolation of data from UTC to LT (local time)
- Building monthly and seasonal means by keeping diurnal cycles
- Statistical and graphical processing

Results I (Diurnal Cycles in CLM-domains)

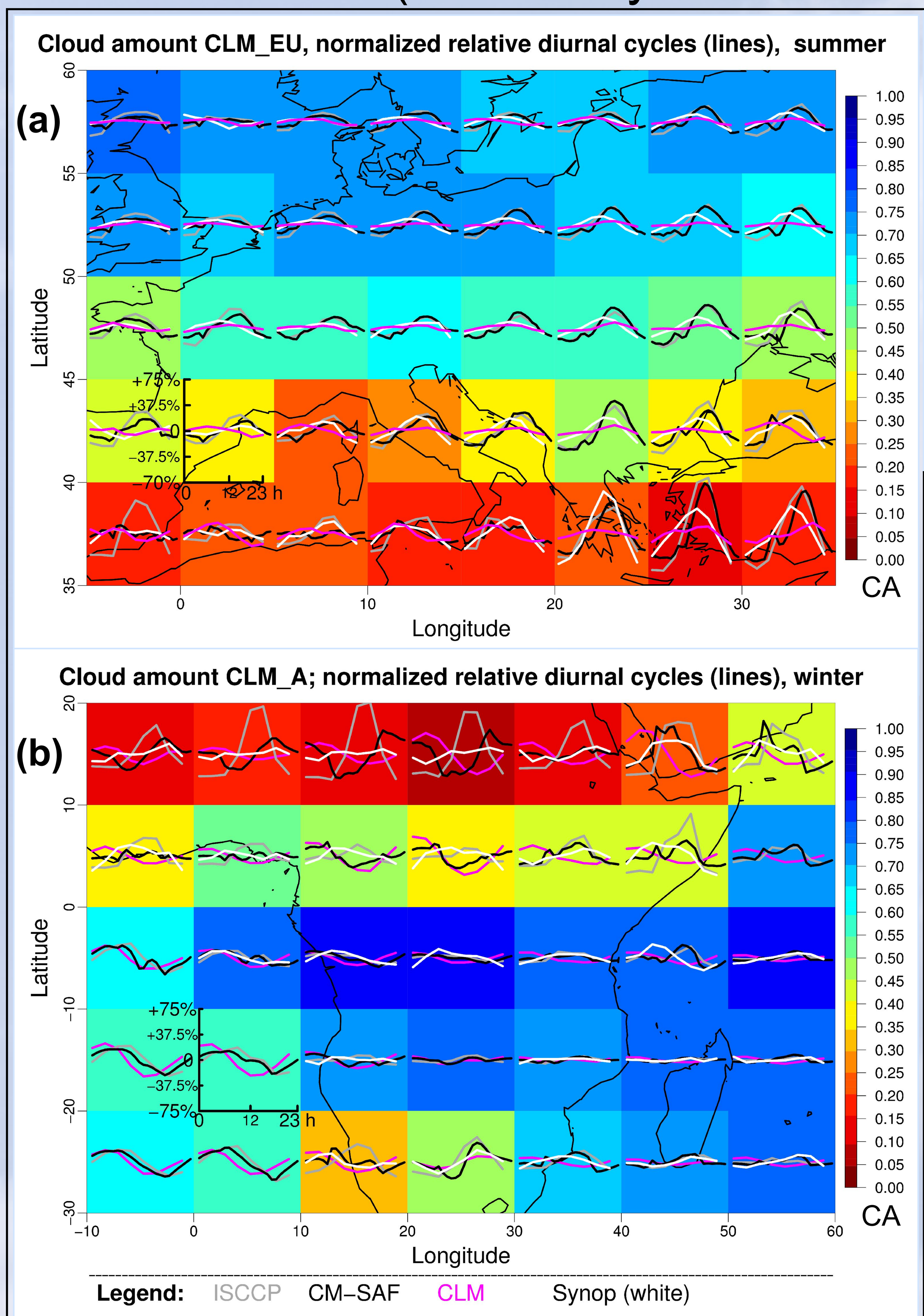

Fig.1: Summer hemisphere CLM cloud amount and mean normalized relative diurnal cycles (lines) of CLM (magenta), Synop (red), ISCCP (grey) and CM-SAF (black) in the European *(a)* and African *(b)* CLM-domain

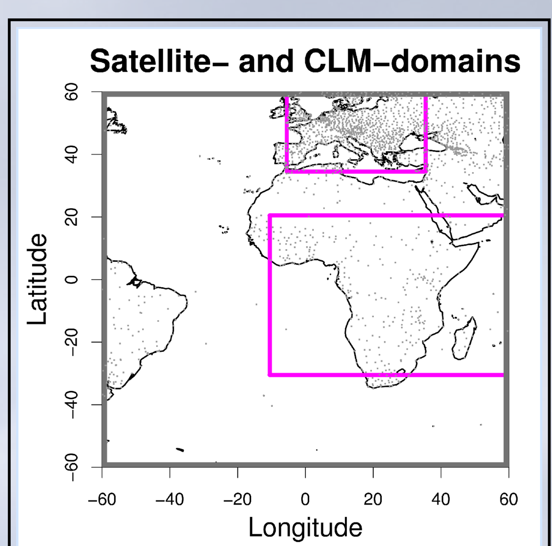

Fig.2: Considered domains of Satellite- (grey) and CLM-Data (magenta), and Synop-stations

Results II (Comparisons of Satellite Products)

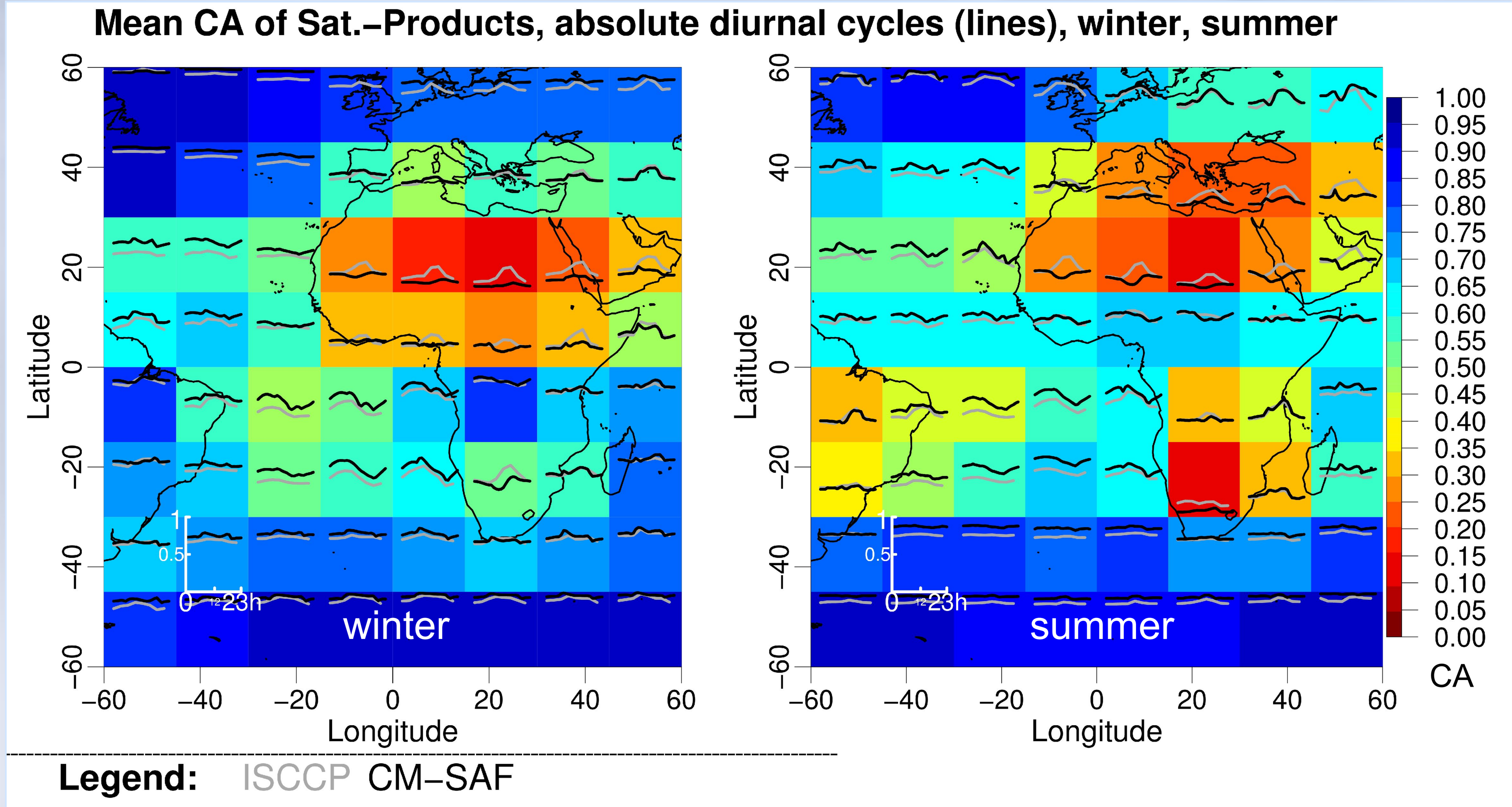

Fig.3: Mean cloud amount (CA) of ISCCP and CM-SAF; diurnal cycles of absolute cloud amount of ISCCP (grey) and CM-SAF (black) in winter (left) and summer (right)

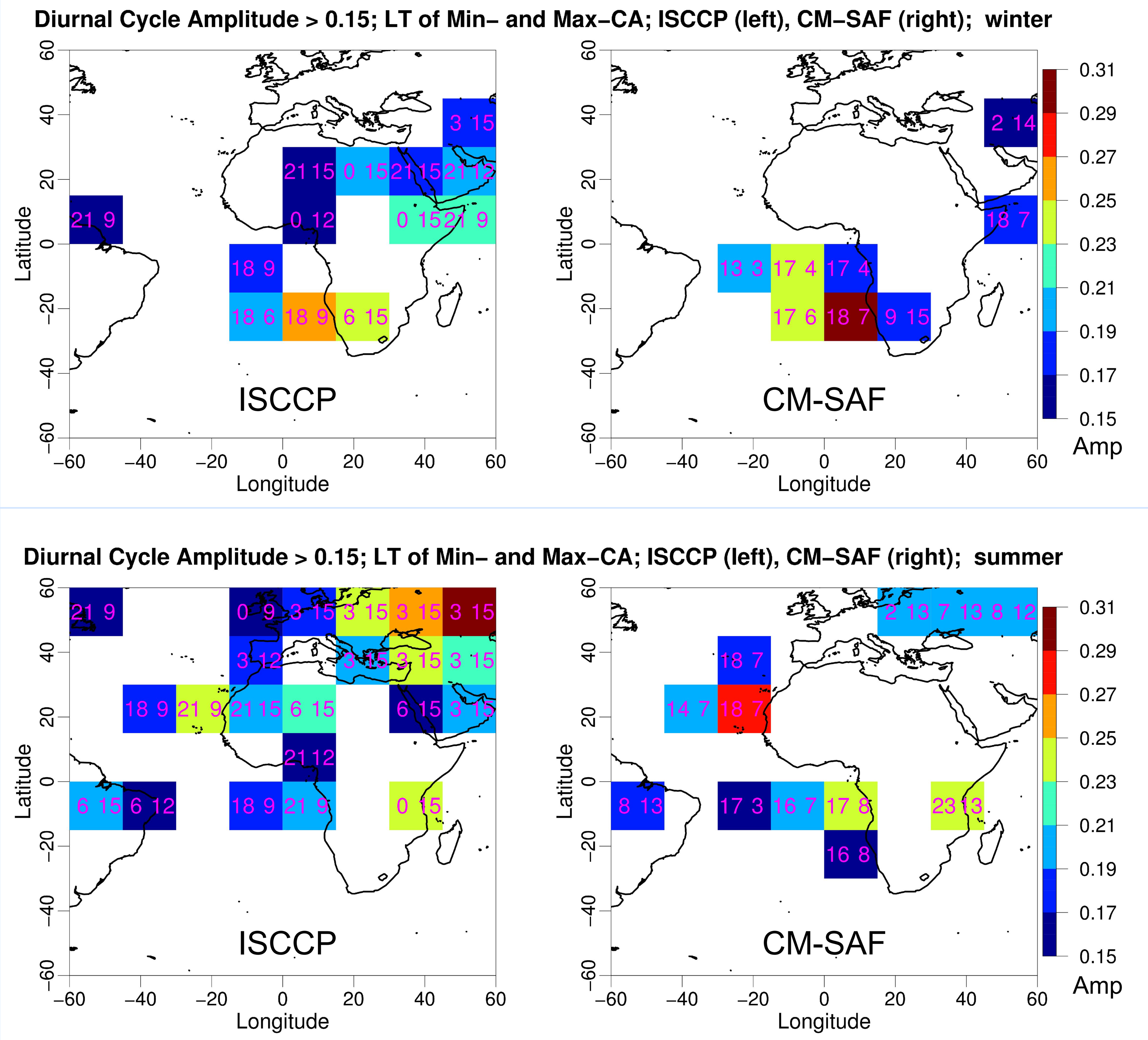

Fig.4: Diurnal cycle amplitude (Amp) of 15°-Pixel greater than 0.15 of ISCCP (left) and CM-SAF (right); local time of minimal and maximal cloud amount (numbers); winter (above) and summer (below)

Summary

- CLM simulates, in opposition to all other data, no diurnal cycle in Europe in summer (Fig.1a)
- All data confirm a diurnal cycle in the subtropical atlantic stratus/ stratocumulus regime west to the South African coast througout the whole year (Fig.1b, 3, 4)
- Big discrepancies between data occur in the subtropical desert areas, as in the Sahara (Fig.1b, 3)
- A general shift exists between ISCCP (lower values) and CM-SAF (higher values) over oceans (Fig.3)
- In avarage, ISCCP shows the biggest diurnal cycles of all data, especially in the northern hemisphere in summer (Fig.4)
- Over summerly mid-latitude land (Fig. 1a, 3), diurnal cycles show morning minima and afternoon maxima
- Over subtropical oceans diurnal cycles show early morning maxima and afternoon minima (Fig.1b, 3, 4)

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