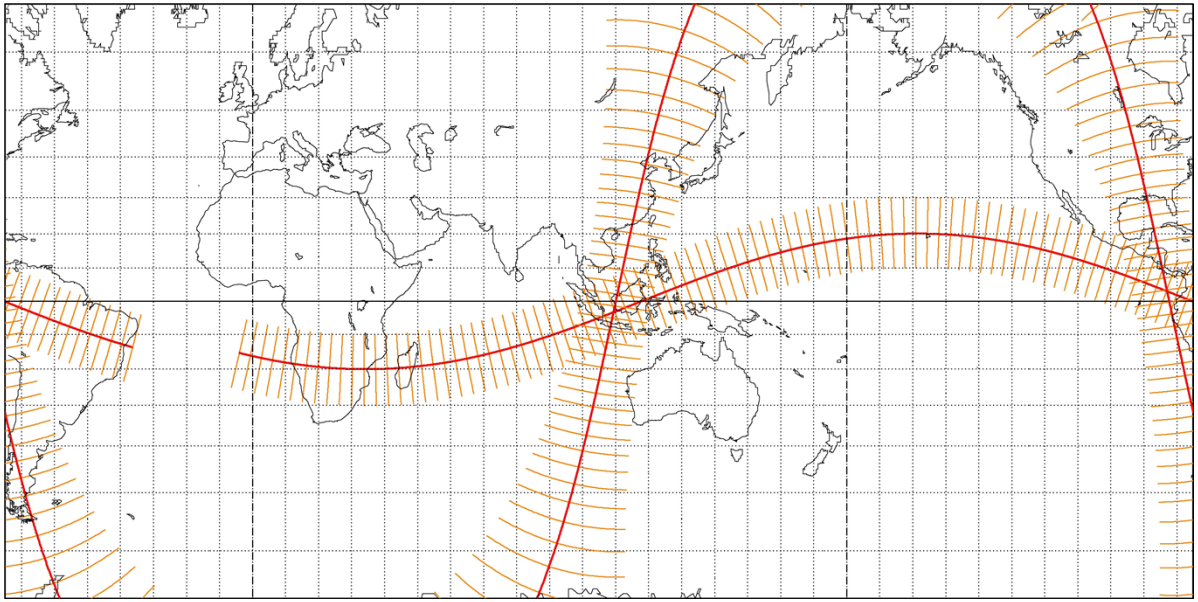
SCARAB-3 on board Megha-Tropiques

- Status and overview -



Geometry of the Terra-MT rendez vous

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O. Chomette, P. Raberanto and M. Capderou, LMD, Palaiseau, France
D. Bouniol, CNRM, Toulouse, France

20th CERES Science team meeting, 27-29 October 2013, Scripps Institution of Oceanography, San Diego, California, USA

Outline of the presentation

- **The status of the MT mission**
- **Can SCARAB provide an independant confirmation of the CERES measurements and vice versa ?**
  - The theoritical error budget of SCARAB and CERES
  - Comparing the two radiances: method & results
- **Can we quantify the role of MCSs to the water and energy budget ?**
  - 1°x1° 1day scale & 1°x1° instantaneous scale
  - Towards the Mesoscale Convective Systems life cycle scale
- **Conclusions and Outlook**

The Megha-Tropiques mission

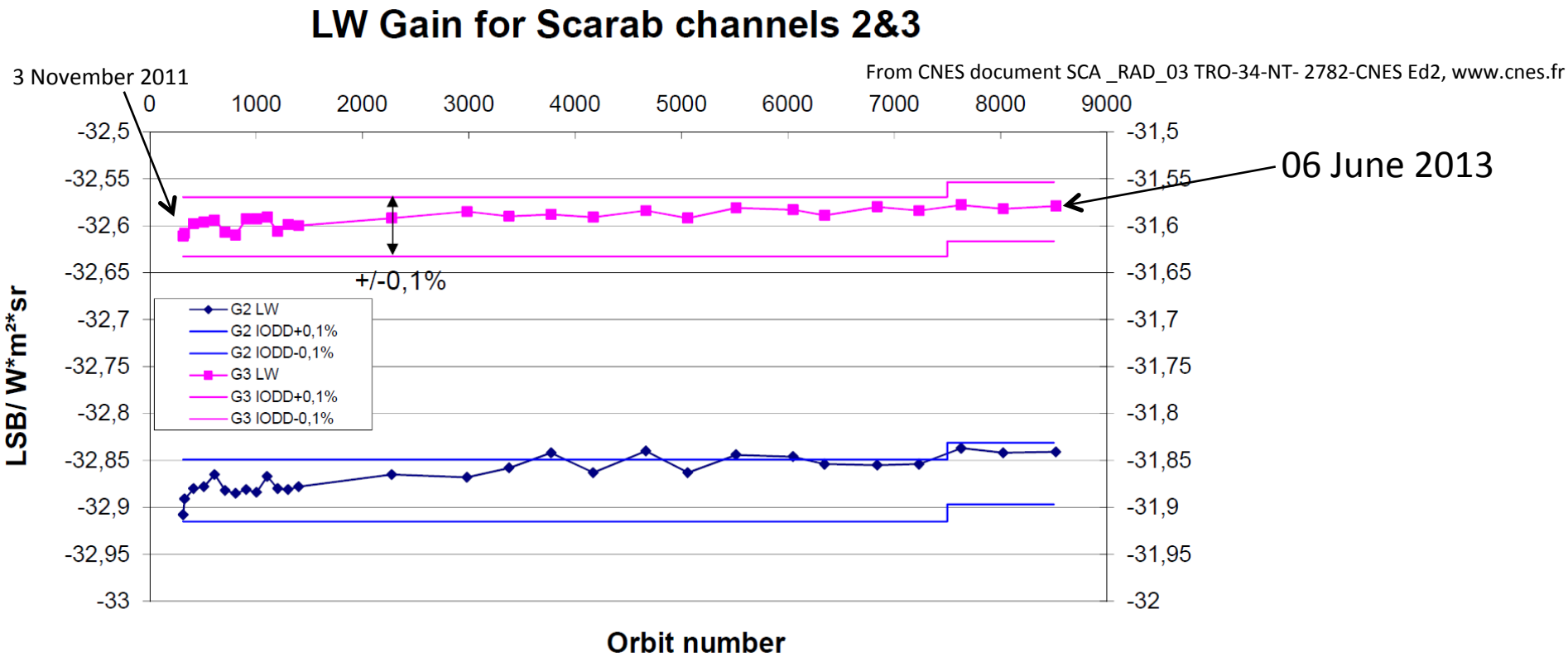
SCARAB-3/MT : A well-known instrument on board a new orbit !

Capderou M. et al., 2011

The Megha-Tropiques mission

Status of the instruments

MADRAS: **no data since end of January 2013.**
SAPHIR: **nominal functionning**
SCARAB: **nominal functionning**



Due to a slight evolution in the radiometric gain, gain values in the IODD have been changed after orbit 7500. After the orbit 7500, the gain values have been decreased of 0.05% for channels 2&3.

The Megha-Tropiques mission

Status of the products : no restriction on access

SCARAB L1A/L1A2 (segment wise) **HDF5**	**C0/V1.02,V1.03,V104**	**Nov 2011 -> 2013-01-24**	**Preliminary version, calibration, no quality flag**
	C1/V1.05-V1.06	**Nov 2011->Aug 2013** **Aug 2013-> on going**	**OK & streaming**
SCARAB L2 (from L1A2) **(segment wise)** **HDF5**	**C1/V1.05-V1.06**	**Nov 2011 -> now and streaming**	**Unfiltered radiances ($Wm^{-2}sr^{-1}$)**
	C1/V1.05-V1.06	**Nov 2011 -> now and streaming**	**LW flux at TOA (Wm^{-2}) SANN** **SW flux at TOA (Wm^{-2})** **Albedo at TOA (%)**
SCARAB L2B **(segment wise)** **1°x1° regular grid /netCDF**	**C1/V1.05-V1.06**	**Nov 2011 -> now and streaming**	**LW flux at TOA (Wm^{-2})** **SW flux at TOA (Wm^{-2})** **Albedo at TOA (%)**

http://www.icare.univ-lille1.fr/mt

Can we provide independant confirmation of CERES (and vice versa)?

Requirements for such a comparison to be useful: theoritical error budgets in the SW

Loeb et al., show CERES SW radiance error budget is compatible with climate monitoring

SCARAB SW error budget @ 1 sigma

Items	Value	Type	
Short wave calibration (sphere)	3% @2σ	Biais	1.5%
Error on spectral response		Biais	0.4%
Thermal gain correction	0.08%/°	Random	0.03%
	dT= 0.04° @1σ		
Thermal leak correction	20% of the thermal leak@1σ	Random	0.04%
Location	0.06°@1σ	Random	0.4%
Budget at 1 sigma			1.6%

Rosack et al., CNES, 2012

SW SCARAB budget @ 1 sigma ~ 1.6%

CERES FM 2 error budget @ 2 sigma

Source	Bias errors of unknown sign (W m^{-2}) Incoming solar	Outgoing SW	Outgoing LW	Net incoming	Comment
Total solar irradiance	±0.2	0	0	±0.2	Absolute calibration (95% confidence)
Filtered radiance	0	±2.0	±2.4 (N) ±5.0 (D)	±4.2	Absolute calibration (95% confidence)
Unfiltered radiance	0	±0.5	±0.25 (N) ±0.45 (D)	±1.0	- Instrument spectral response function - Unfiltering algorithm

Loeb et al., 2009 J Climate

SW CERES budget @ 1 sigma ~ 1%

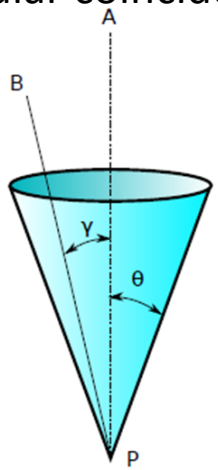
Here we are assessing this using two **different technologies** of instruments and **independant** making and operations via **direct comparison** at the instantaneous and pixel scale

Note that DCC technique for instance while useful for stability is not accurate enough for absolute calibration results (e.g., Sohn et al., 2009)

Can we provide independant confirmation of CERES (and vice versa)?

Comparing the radiances of two different instruments on board two platforms (1/3)

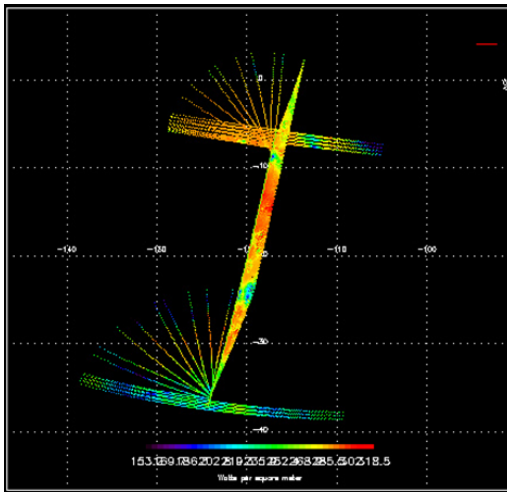
- Angular coïncidence < 5°



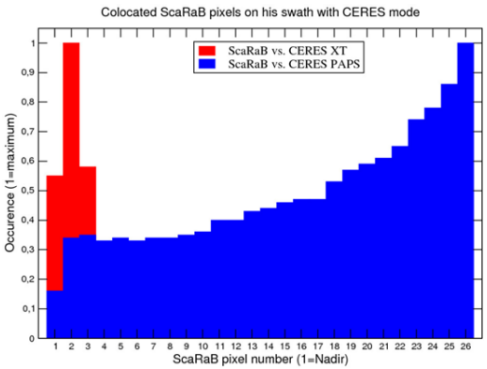
- Time coïncidence < 5 minutes

  -PAPS mode over 51 days (April 17 to June 8, 2012) for each CERES & ScaRaB crossing.

  -XT track nominal DATA

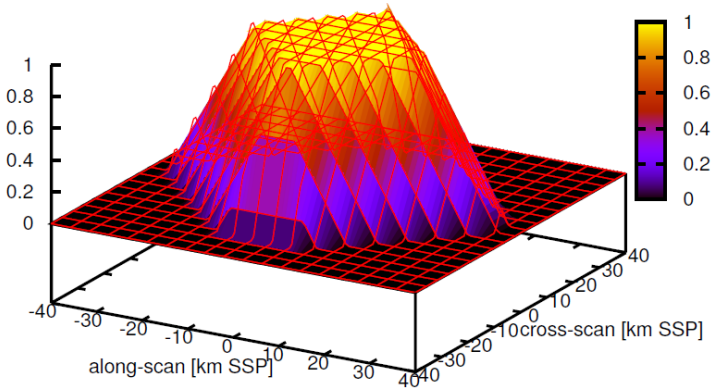


Exemple : FM2 on PAPS mode (backward scan only)

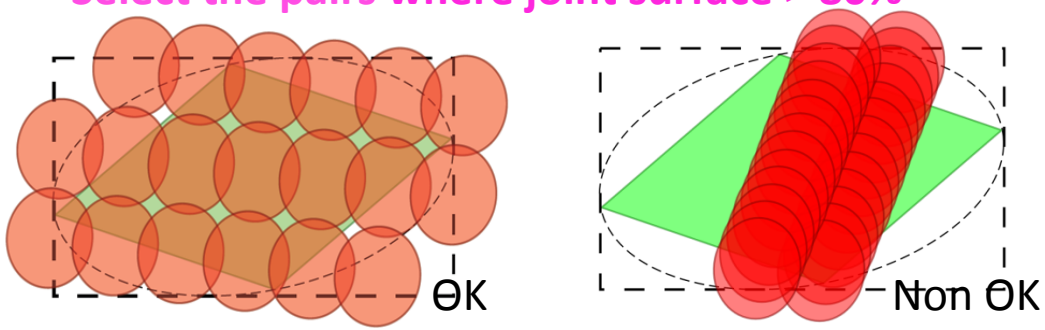


- Payed attention to definition of ES8, SSF, geodetic, altitude of TOA ,…

- Using the Point Spread Function



- **Select the pairs where joint surface > 80%**



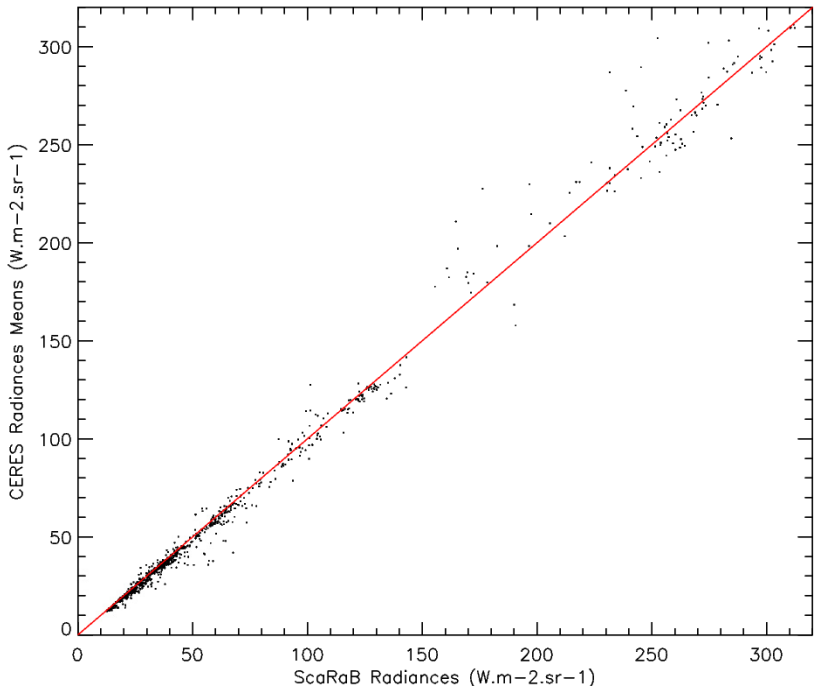
Can we provide independant confirmation of CERES (and vice versa)?

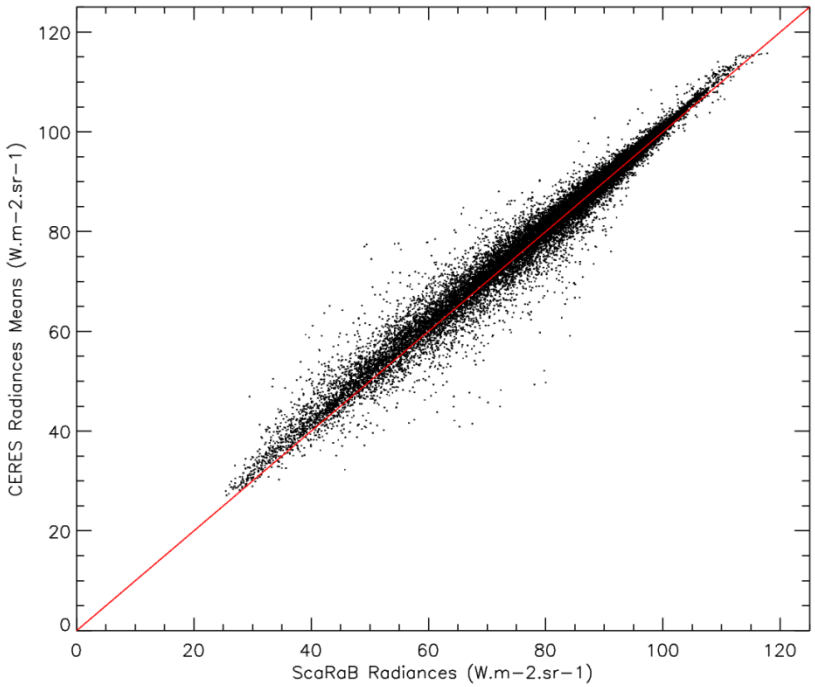
Comparing the radiances of two different instruments on board two platforms (2/3)

Comparisons CERES-FM2-PAPS-SSF vs. ScaRaB-V1.05-L1A2 **51 days** – April 17, June 6 2012

5° – 5 min

80% joint surface





SW Radiances
(**1998** colocated pixels)
1.3 ± 6.98 W.m-2.sr-1
1.8 ± 9.71 **%**

LW Radiances
(**36888** colocated pixels)
-0.83 ± 2.22 W.m-2.sr-1
-0.98 ± 1.36 **%**

Can we provide independant confirmation of CERES (and vice versa)?

Comparing the radiances of two different instruments on board two platforms (3/3)

5° – 5 min

SCARAB-3 XT vs. CERES SSF (PSF>0.7)	LW radiance (%) Bias	LW radiance (%) Standard Dev	SW radiance (%) Bias	SW radiance (%) Standard Dev
FM1 XT	-0.96	2.13	+1.62	7.81
FM2 XT vs FM1 XT			+0.37	8.15
(PSF > 1 – surface >0.8)				
FM2 PAPS	-0.98	1.36	+1.81	9.71

5° – 2 min

(PSF > 1 – surface > 0.8)				
CERES FM2 PAPS			+0.95	9.99

- **Consistency among the cross comparison exercices from PAPS, XT, FM1 and FM2**
- **Compute the confidence interval for rejecting/accepting the instrumental errors models**
- **Deepen the sensitivity study**

The role of MCSs to the water and energy budget

Importance of large clusters to the distribution of CRF

CERES on board TRMM product

1 APRIL 2001 WILCOX AND RAMANATHAN

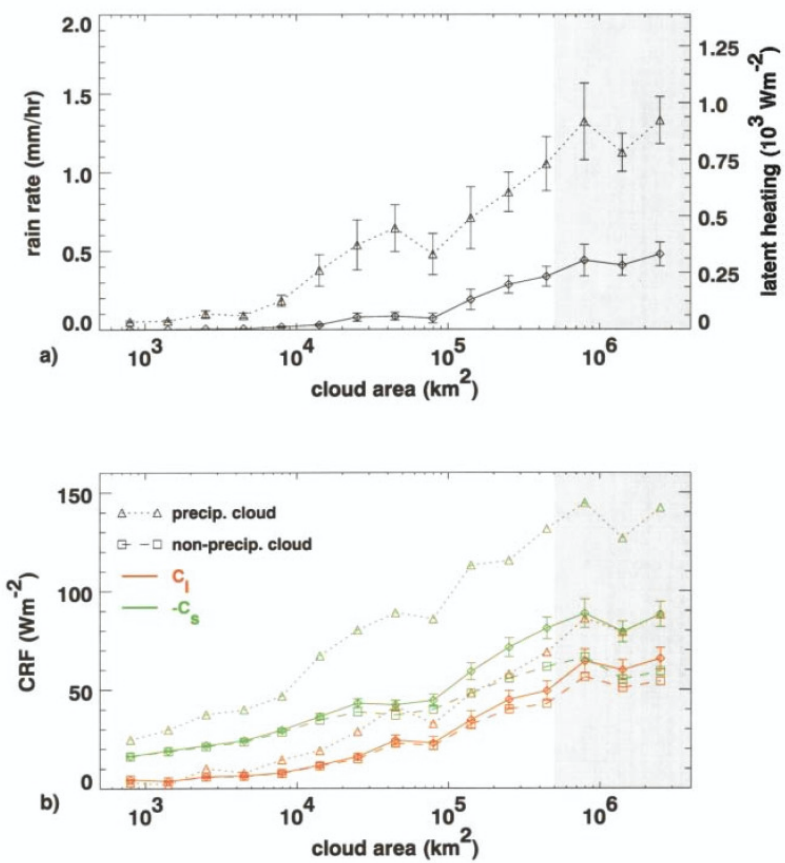


FIG. 5. Cloud-averaged properties as a function of cloud area. (a) Rain rate; right-side axis scaled to show vertically integrated latent heating; (b) C_l (red) and $-C_s$ (green). Solid lines are averages over entire cloud, dotted lines are averages over precipitating portions of cloud, and dashed lines are averages over nonprecipitating portions of cloud. Error bars indicate one standard deviation of the mean.

15 SEPTEMBER 2002 DEL GENIO AND KOVARI

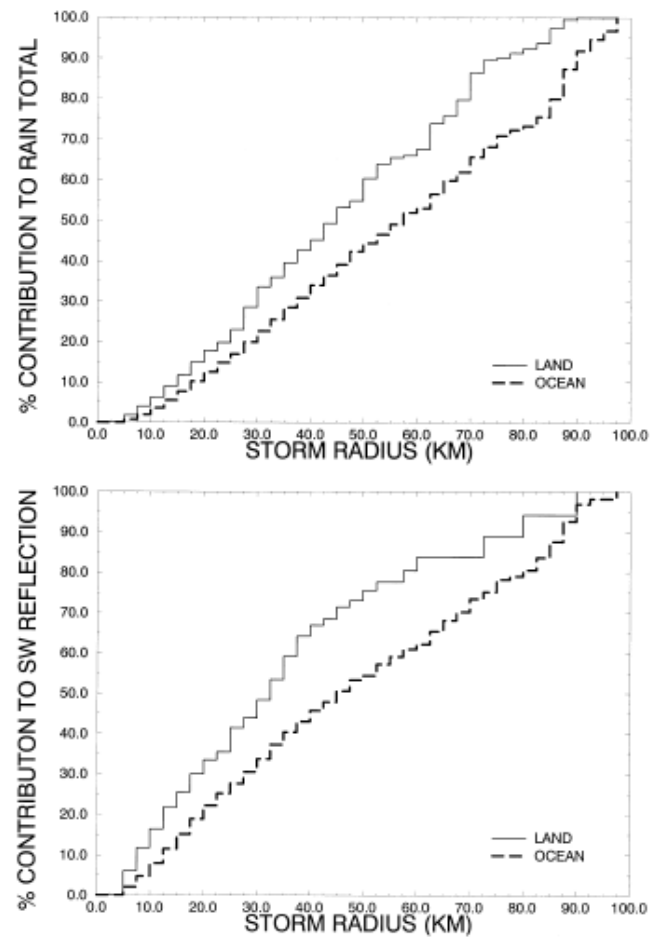
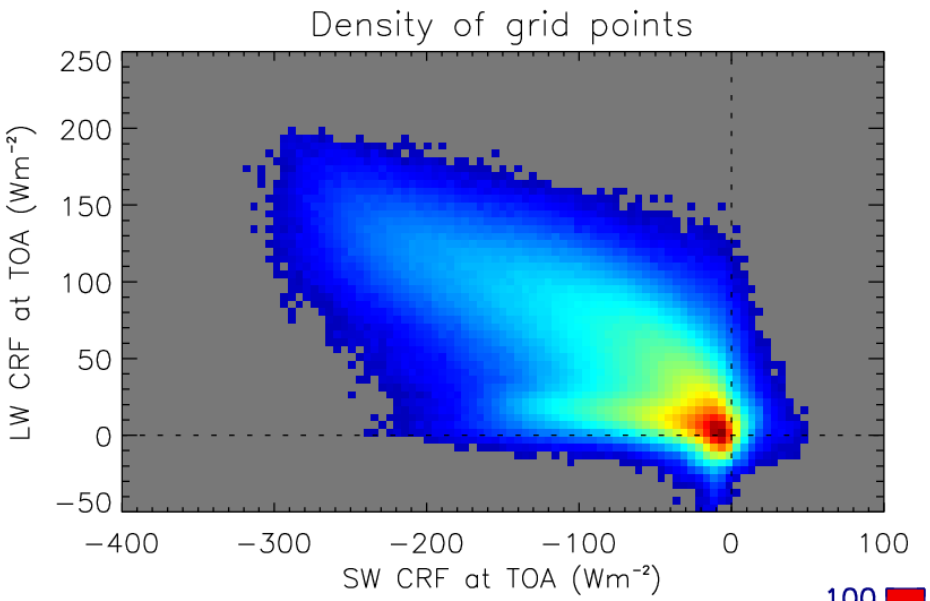


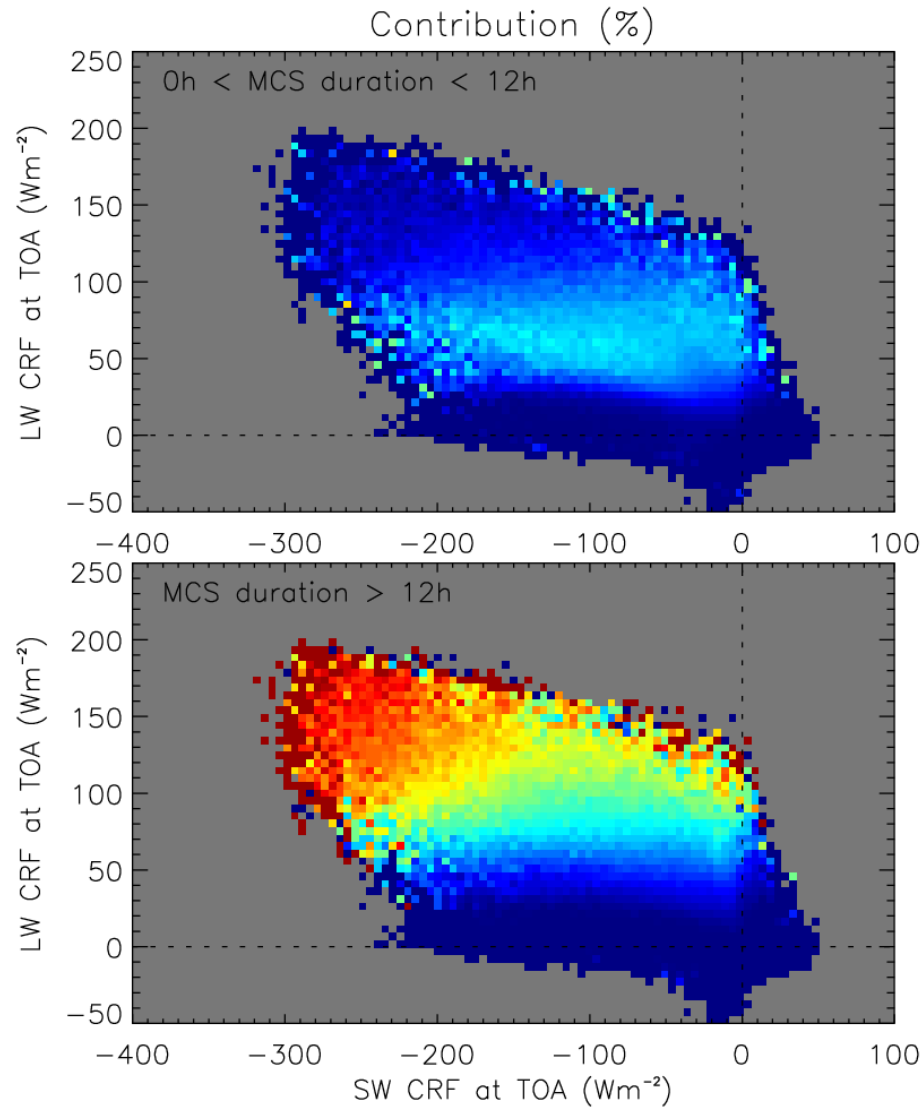
FIG. 2. Cumulative distribution functions of the percent contributions to (upper) rain total and (lower) shortwave reflection by land and ocean storms.

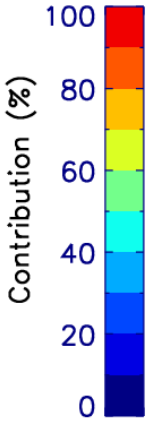
The role of MCSs to the water and energy budget

Importance of long lasting systems to the distribution of CRF

JJAS 2009 / 30°s-30°n / 1°-1day/ SYN products + « Most representative MCS of the day » product







Weighted contribution in %

%	Occ	Rain	SWcrf	LWcrf	Netcrf
All	34	93	58	68	42
>12h	16	68	35	40	24

The role of MCSs to the water and energy budget

Preliminary results from Megha-Tropiques (1/3)

Flux comparison like the radiance approach with no more angular restrictions

5 min – June 2012

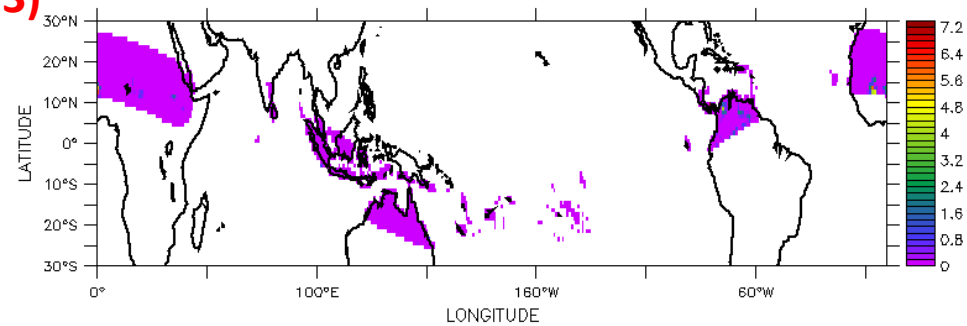
SCARAB-3 XT vs. CERES SSF FM1 (PSF>0.7 & homogeneous scene)	LW flux (%) Bias	LW flux (%) Standard Dev	SW flux (%) Bias	SW flux (%) Standard Dev
All scene types	0.31	2.75	3.86	9.80
Ocean	0.50	2.63	5.90	12.68
Land	0.31	3.54	4.84	12.68
Desert	3.21	4.92	1.67	4.93

SCARAB-3 XT vs. CERES SSF FM2 (PSF>0.7 & homogeneous scene)	LW flux (%) Bias	LW flux (%) Standard Dev	SW flux (%) Bias	SW flux (%) Standard Dev
All scene types	0.23	2.81	3.41	10.20
Ocean	0.53	2.85	4.75	13.07
Land	0.04	4.07	2.88	13.05
Desert	3.39	4.50	0.32	5.44

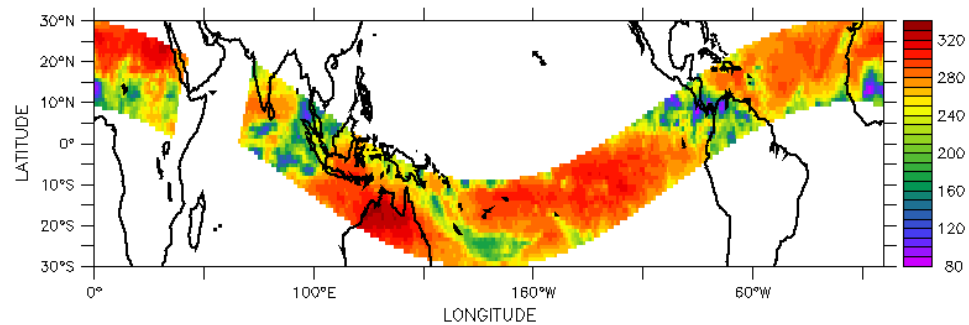
The role of MCSs to the water and energy budget

Preliminary results from Megha-Tropiques (2/3)

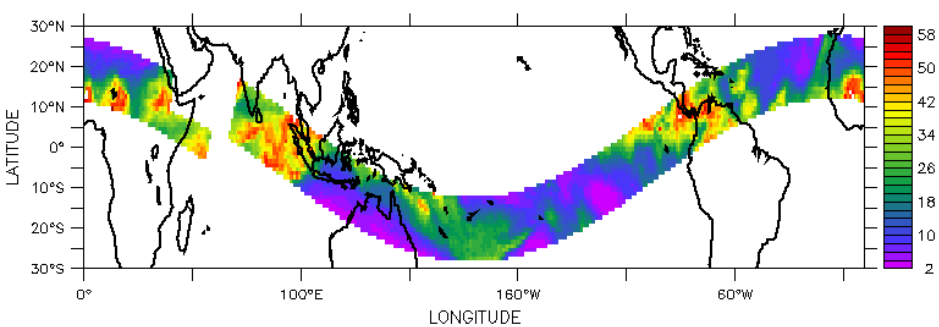
JJA 2012 / 30°s-30°n / 1°-instantaneous/
MT L2B products /LAND only for rainfall



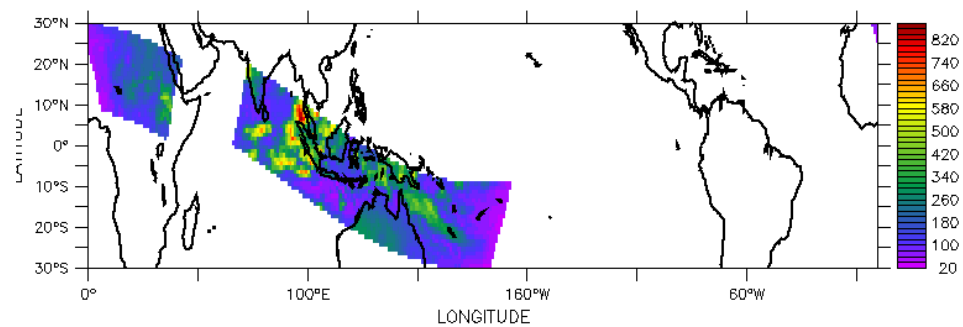
Average surface rain rate (mm/h)



TOA longwave flux (Wm−2)



Upper Tropospheric Humidity 1 (%)

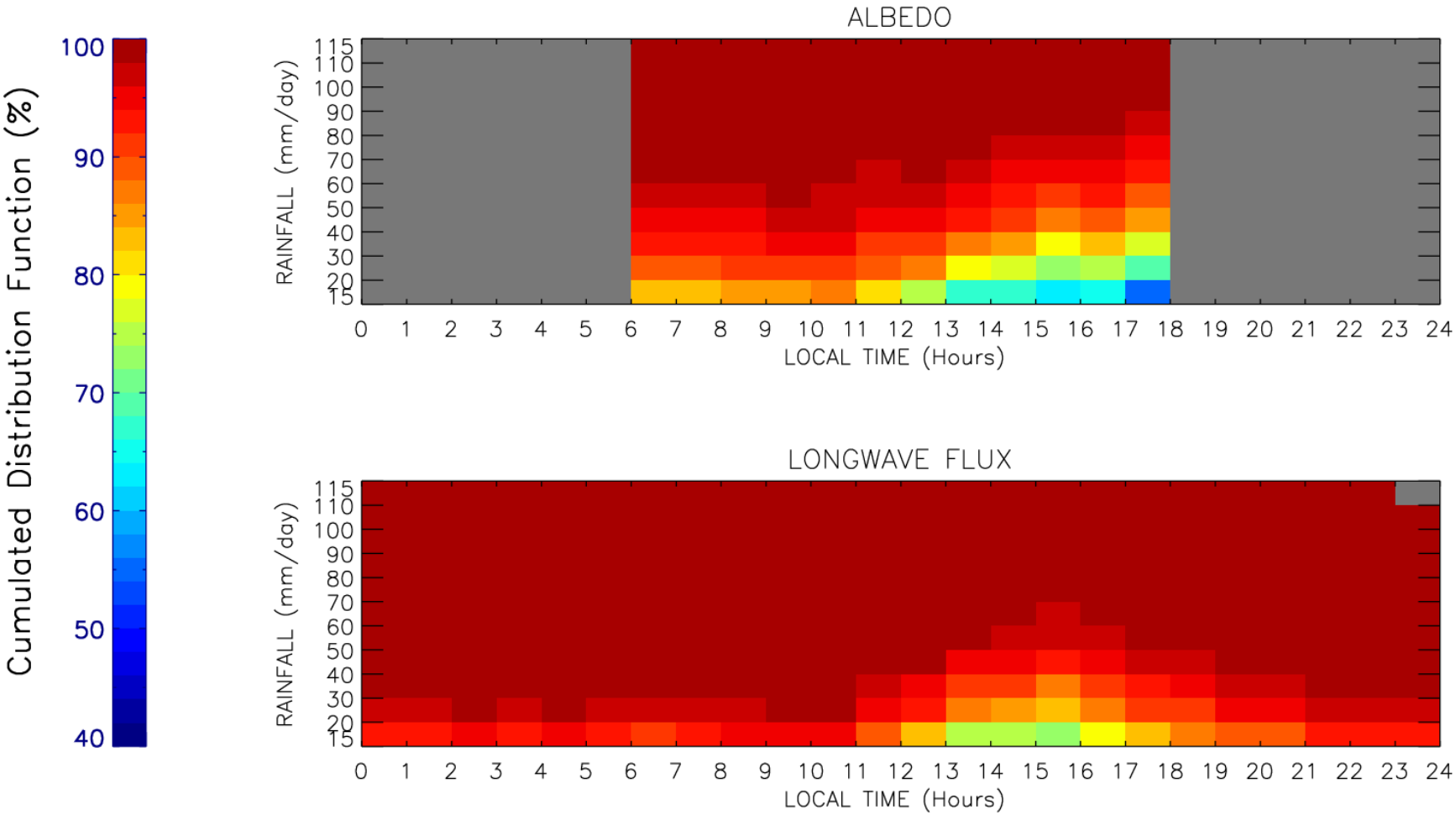


TOA shortwave flux (Wm−2)

The role of MCSs to the water and energy budget

Diurnal contribution of rainy scenes to radiation (3a/3)

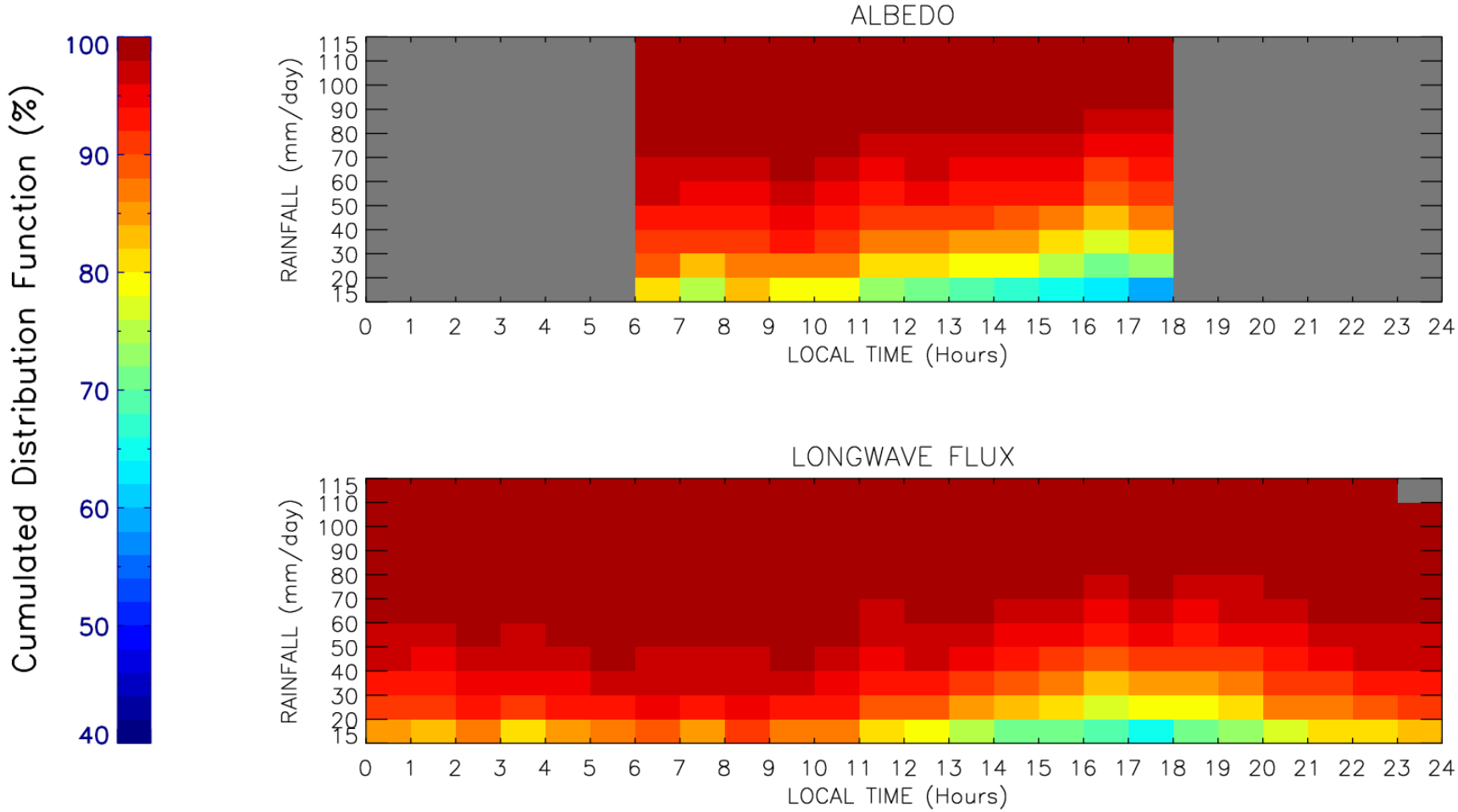
JJA 2012 / 30°s-30°n / 1°-instantaneous/ LAND only / MT L2 products



The role of MCSs to the water and energy budget

Diurnal contribution of rainy scenes to radiation (3b/3)

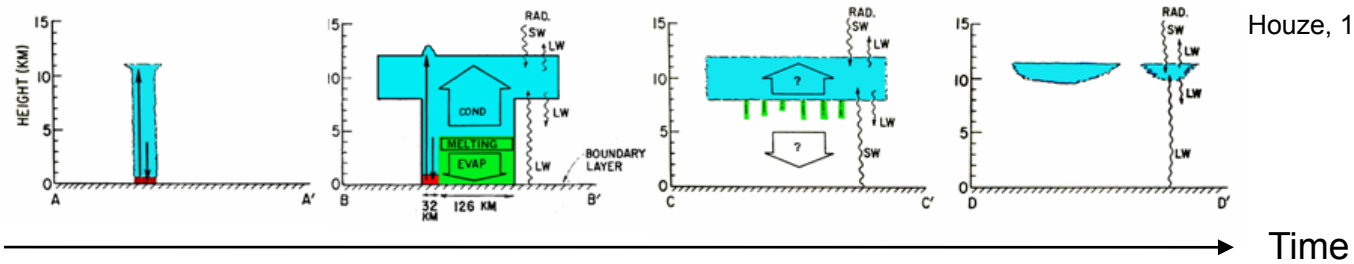
JJA 2012 / 30°s-30°n / 1°-instantaneous/ LAND only West African Monsoon region/ MT L2 products



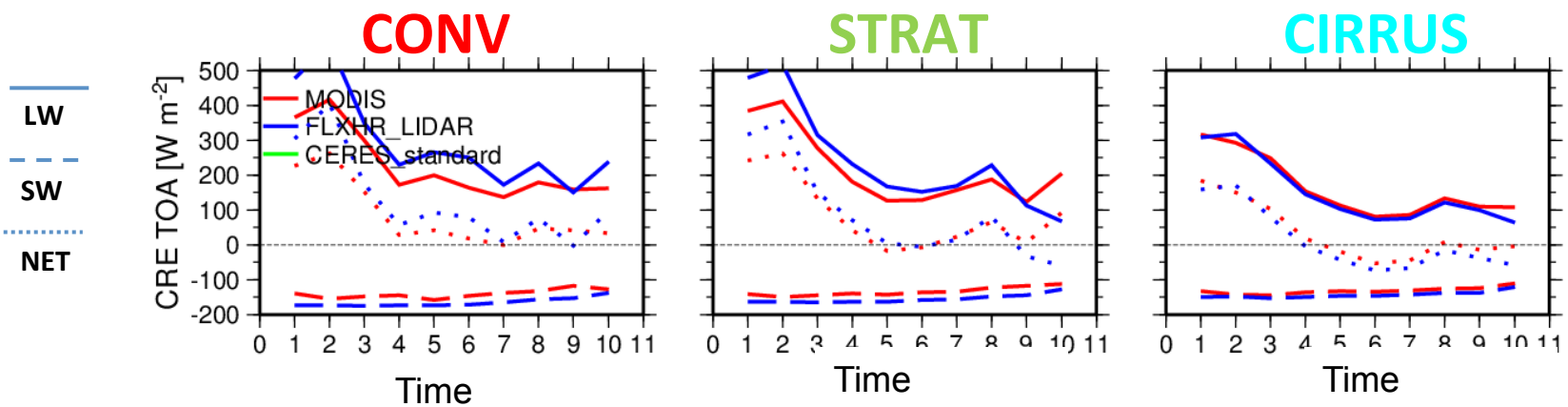
The role of MCSs to the water and energy budget

Down to the life cycle of the MCS scale over the West African Monsoon region

JJAS 2009 / instantaneous/ CERES, CLOUDSAT, Caliop A-Train products/MCS tracking from MT



Houze, 1982



Bouniol et al.., in preparation

Conclusions & Outlook

Two years of nominal functionning of SCARAB-3 on board Megha-Tropiques !

L1 are within spec and stable over the two years period
L1 archive still difficult to manipulate (files are provided in DUMP instead of ORBIT)

Successfull coincidence campaign with CERES-FM2 on board Terra (PAPS mode)
Difference in **SW radiance** between **0.95% and 1.8%**
Difference in **LW radiance** less than **1%**
Seems that we can not reject the hypothesis that the two instruments theoritical error budget are different (wrong) at 1.5% @ 1 sigma confidence

Level -2 are released **http://www.icare.univ-lille1.fr/mt**
L2 for LW and SW TOA **unfiltered radiance** based on L1A2 (HDF4)
L2 for LW and SW TOA **flux** based on L1A2 (HDF4)
L2-B are the same but on a 1°x1° regular grid in netCDF
Level-2 agree well with CERES-L2

Level-4
MEGHA-TROPIQUES « life cycle composite » in the process of being finalized (2014)
Towards SRBAVG-GEO-Terra-Aqua-MT product ! (D. Doelling)

Preliminary results combining rainfall and radiation instantaneous estimates

Hope for more years of nominal functionning of SCARAB-3 on board Megha-Tropiques !