12th EMS – 9th ECAC meeting

Université de Liège

Laboratoire de Climatologie et Topoclimatologie

RMI

On the possibility to develop a rainfall data set over Belgium and Europe for climate monitoring using SEVIRI data :

Validation and application of Cloud Physical Properties algorithm from the KNMI

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Bi-spectral method and CPP-PP algorithm

- R_{vis} (**0.6** µm) ∝ Cloud optical thickness (COT)
- R_{NIR} (**1.6** µm, 2.1 µm or 3.8 µm) 1/∝ effective radii of particles (R_e)
- $R_{0,6\mu m}$ and $R_{1,6\mu m}$ → LUT(DAK) → Re and COT → CWP (g.m^{-2})

$$CWP = 2/3 \cdot COT_{vis} \cdot Re \cdot \rho l$$

- Delineation of precipitation areas :

$CWP > CWP_T$ (160 g.m^{-2}, Wentz & Spencer, 1997) & phase = ice
or $CWP > CWP_T$ et $Re > Re_T$ (14 µm, Rosenfeld & Gutman, 1994)

Bi-spectral methods and CPP-PP algorithm

Rain Rates :

- Cloud column height : $H = (CTTmax – CTT)/6{,}5 + dH$
- Rain rate (mm/h) :

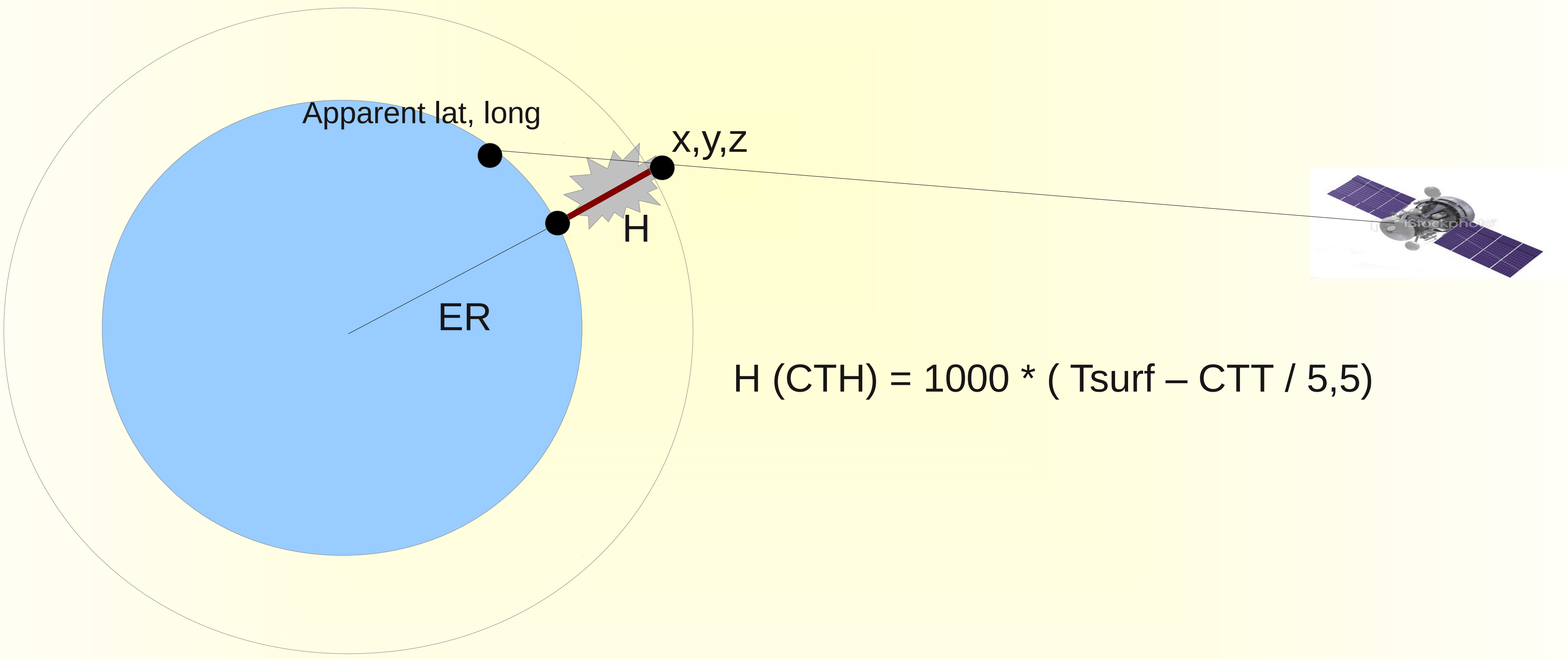
$$R = c/H \, . \, [\, CWP\text{-}CWP_T / CWP_T \,]^{\alpha}$$

- Previous validation :
  - Validation of cloud physical properties with ground measurements (Roebeling *et al.*, 2006)
  - Validation with weather radar from KNMI (Roebeling & Holleman, 2009)
    ! Two months, only convectives precipitations (May-June 2007)!

- **GOAL of this study** : Validation over a longer period (2005-2011) + Test algorithm performances through yearly, daily cycles, for different kinds of precipitation → highlight limitation for potential applications

Processing and parallax shift correction

- Reprojection of radar data → satellite data projection
- Parallax shift correction



H (CTH) = 1000 * (Tsurf – CTT / 5,5)

Validation with radar data

- Delineation of precipitation area : Contingency matrix

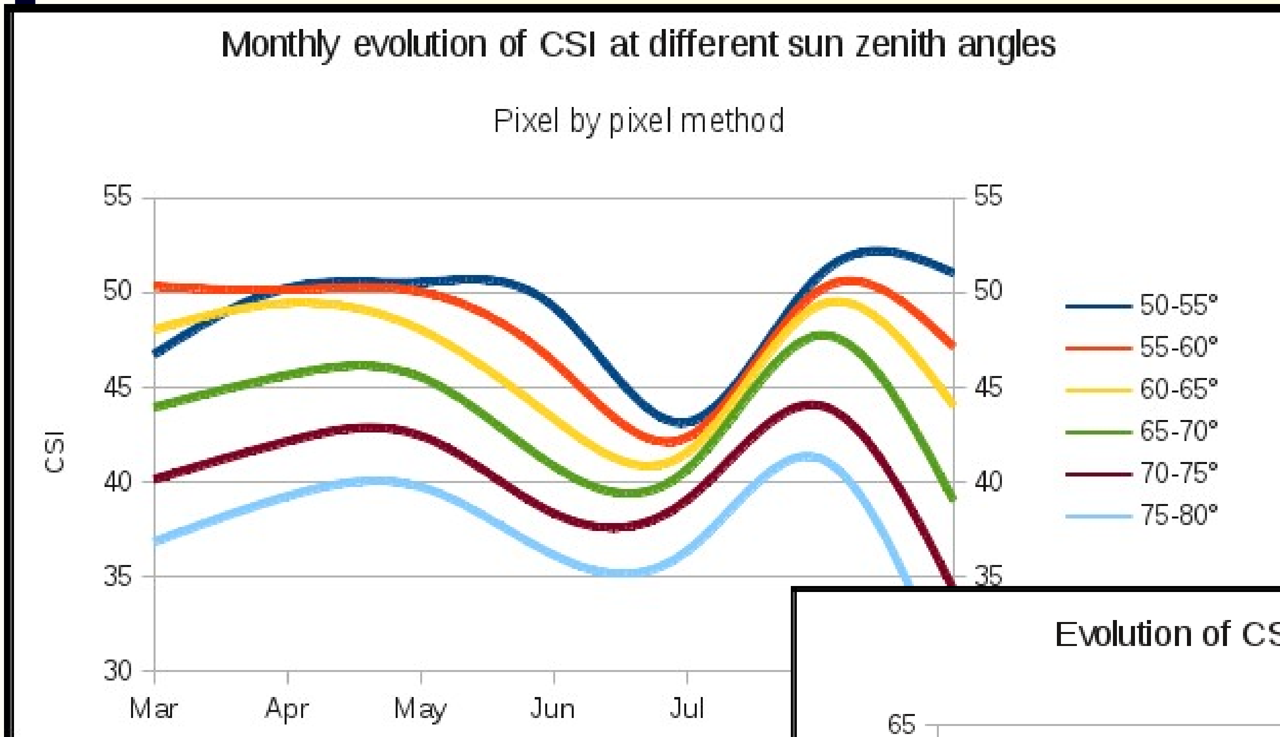
Observed \ Estimated	no rain	rain
no rain	r	m
rain	f	h

FAR = f / (h + f)
POD = h / (h + m)
CSI = h / (h + f +m)

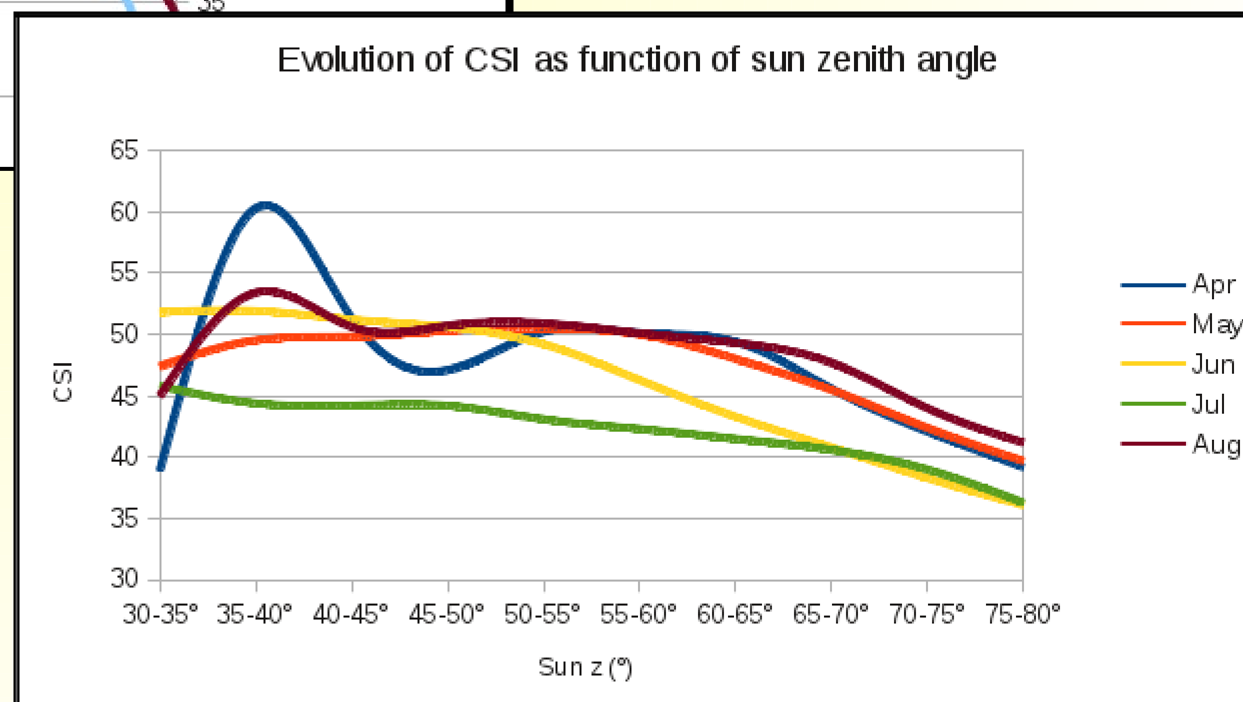
POD	25-30°	30-35°	35-40°	40-45°	45-50°	50-55°	55-60°	60-65°	65-70°	70-75°	75-80°
Jan									54,2 ± 0,312	45,7 ± 0,140	40,0 ± 0,222
Feb							49,0 ± 0,375	39,3 ± 0,194	48,4 ± 0,147	46,4 ± 0,174	41,9 ± 0,237
Mar					49,7 ± 0,207	52,1 ± 0,163	56,3 ± 0,154	53,9 ± 0,181	49,9 ± 0,194	44,9 ± 0,200	41,3 ± 0,259
Apr		59,1 ± 1,820	70,5 ± 0,275	57,7 ± 0,189	52,5 ± 0,195	56,5 ± 0,227	56,2 ± 0,237	54,8 ± 0,244	50,5 ± 0,252	47,0 ± 0,253	43,7 ± 0,321
May	49,8 ± 0,288	57,1 ± 0,142	59,6 ± 0,150	60,2 ± 0,174	60,5 ± 0,184	59,7 ± 0,187	58,6 ± 0,189	56,6 ± 0,188	54,1 ± 0,189	51,1 ± 0,188	48,8 ± 0,236
Jun	59,8 ± 0,155	62,3 ± 0,177	63,0 ± 0,203	62,0 ± 0,213	60,2 ± 0,222	58,2 ± 0,225	55,2 ± 0,225	52,1 ± 0,225	50,0 ± 0,228	47,7 ± 0,231	45,9 ± 0,292
Jul	50,3 ± 0,177	53,4 ± 0,135	53,3 ± 0,166	52,8 ± 0,179	52,5 ± 0,188	50,8 ± 0,195	50,1 ± 0,200	48,9 ± 0,204	47,9 ± 0,206	46,1 ± 0,208	43,6 ± 0,262
Aug		49,7 ± 0,268	61,3 ± 0,137	59,4 ± 0,142	60,8 ± 0,168	61,3 ± 0,177	59,9 ± 0,185	58,2 ± 0,188	56,2 ± 0,190	52,3 ± 0,192	49,4 ± 0,246
Sep				75,5 ± 0,287	64,9 ± 0,224	63,4 ± 0,264	58,2 ± 0,290	56,3 ± 0,331	49,6 ± 0,344	43,4 ± 0,356	37,2 ± 0,480
Oct						67,7 ± 0,333	58,6 ± 0,162	51,1 ± 0,113	46,3 ± 0,094	43,4 ± 0,086	40,1 ± 0,123
Nov								51,0 ± 0,499	44,3 ± 0,093	40,8 ± 0,071	38,0 ± 0,110
Dec										50,2 ± 0,125	46,8 ± 0,154

Validation with radar data

- Delineation of precipitation area



At **equal sun zenith angle (sza)**, scores +- constant from March to August. Decrease from September onwards.



Decrease of scores as function of sza more pronounced from 65-70° onwards

Validation with radar data

- Delineation of precipitation areas

Spatial extent of precipitation (in %) - comparison image per image (slots)

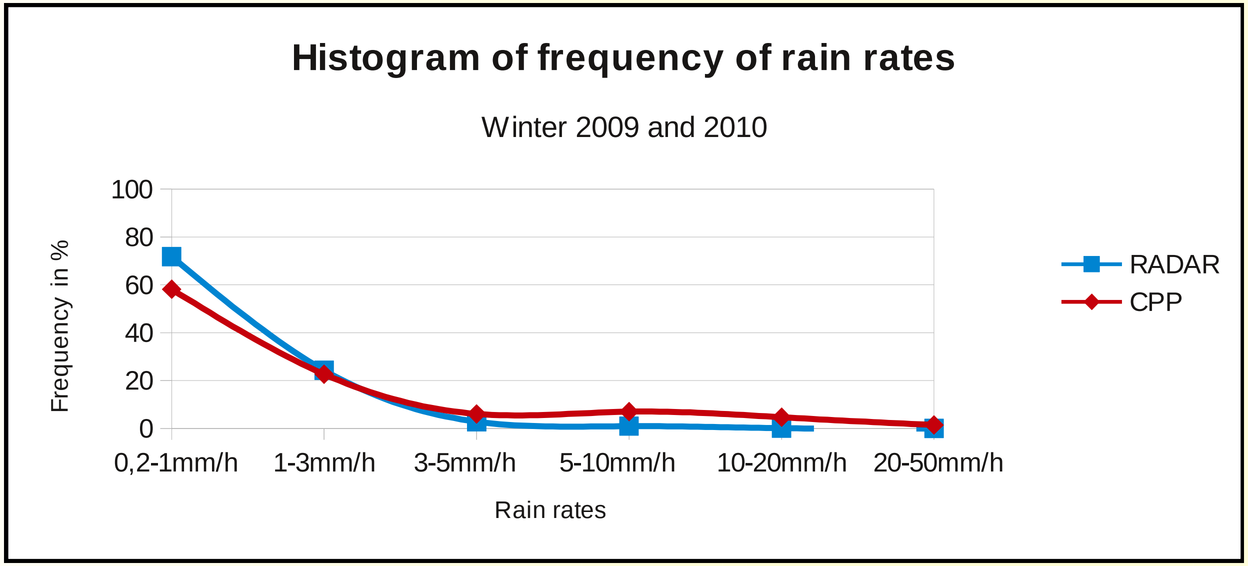
	Mean RAD	Mean SAT(CPP)	Mean err.	Corr. Coeff (R^2)
DJF	6,47%	5,64%	+0,84%	0,69
MAM	6,05%	6,34%	-0,29%	0,83
JJA	6,81%	7,49%	-0,68%	0,87

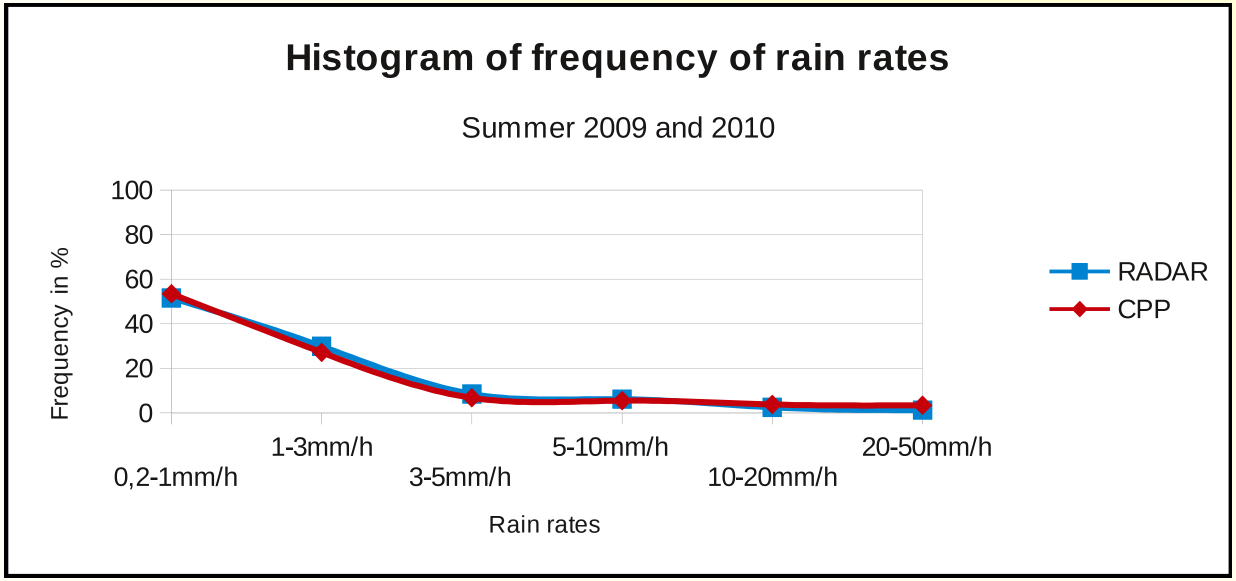
Good correlation + low mean error → ability of the algorithm for the delimitation of precipitation areas

Validation with radar data

- Estimation of rain rates

Histograms





Winter (11-13 UTC)

R (mm/h)	RAD	SAT-CPP
0,1-1	71,8%	58,2%
1-3	24,3%	22,7%
3-5	2,8%	6,1%
5-10	0,95%	7,0%
10-20	0,13%	4,7%
20-50	0,03%	1,43%

Summer (09-16 UTC)

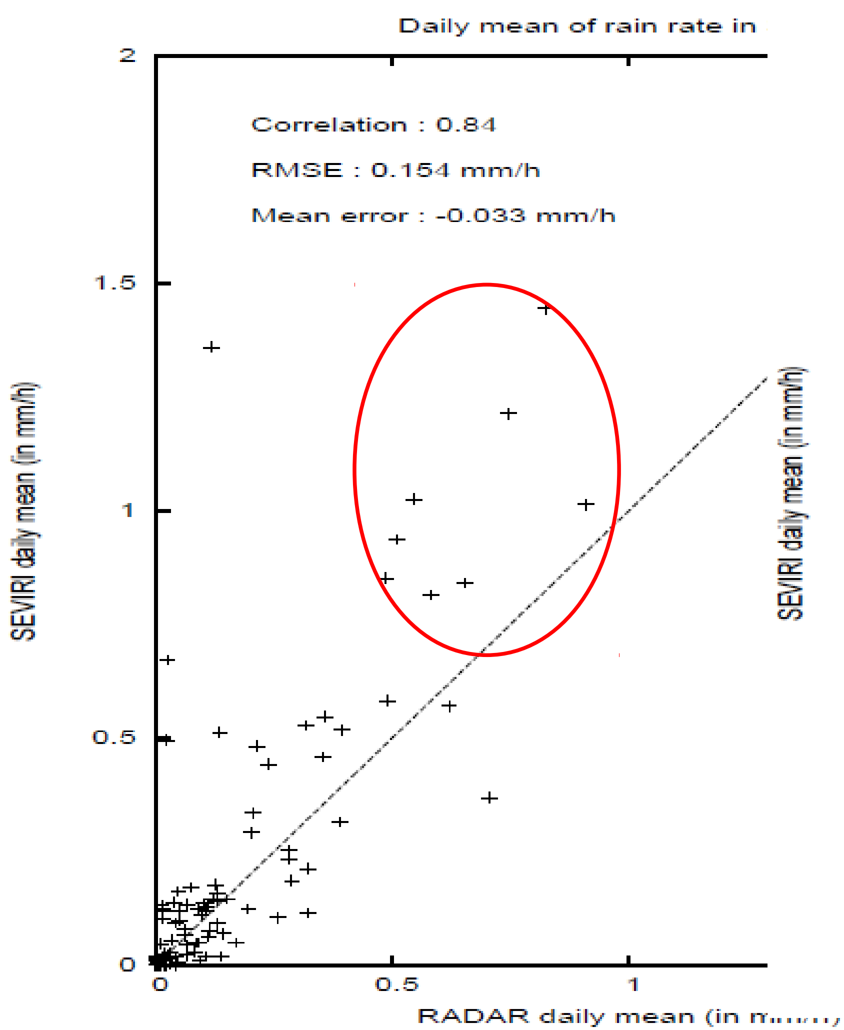
R(mm/h)	RAD	SAT-CPP
0,1-1	51,6%	53,4%
1-3	29,9%	27,2%
3-5	8,5%	6,8%
5-10	6,1%	5,5%
10-20	2,5%	3,8%
20-50	1,2%	3,4%

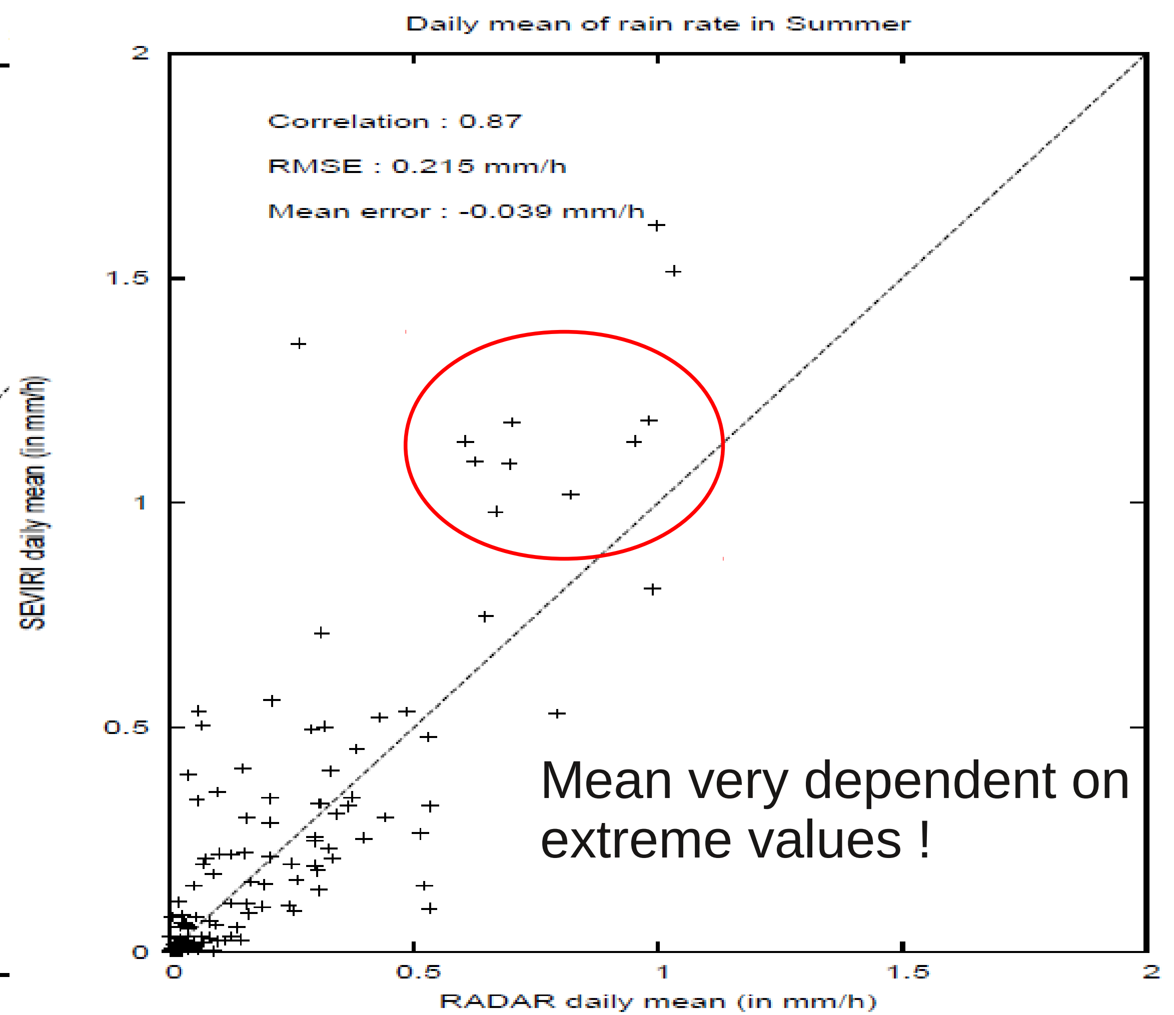
Validation with radar data

- Estimation of rain rates : daily mean

MAM (10-15 UTC)
Mean RAD : 0,09 mm/h
Mean SAT : 0,12 mm/h
Mean err. : + 33% !?

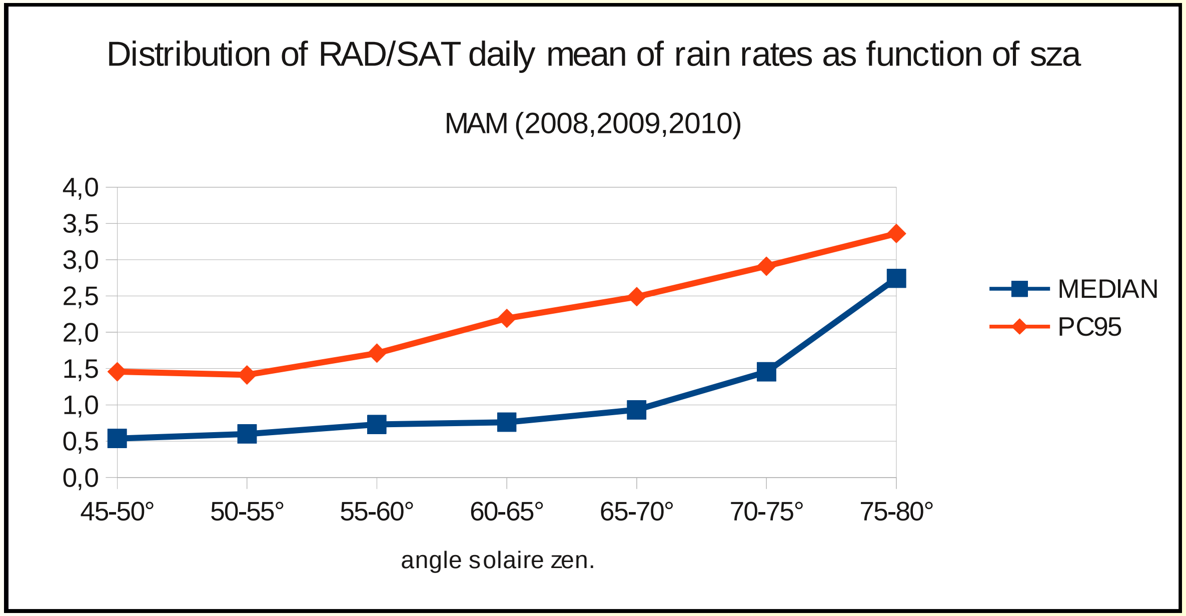
JJA (09-16 UTC)
Mean RAD : 0,16 mm/h
Mean SAT : 0,20 mm/h
Mean err. : + 25% !?

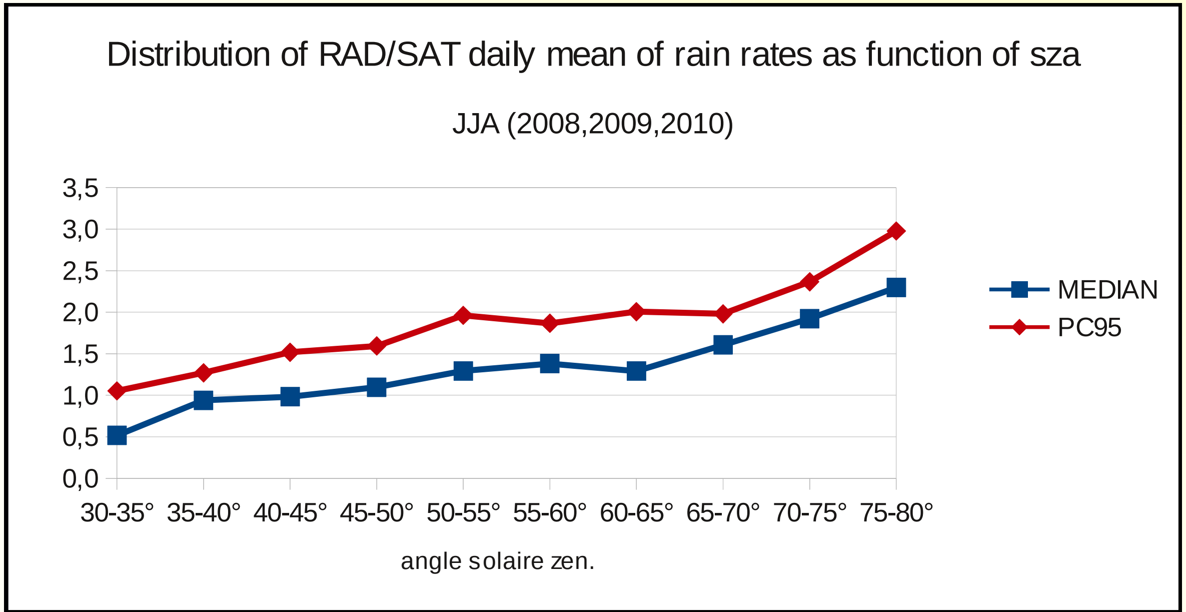




Validation with radar data

- Estimation of rain rates





- MEDIAN sat/MEDIAN rad and PC95 sat/PC95 rad.

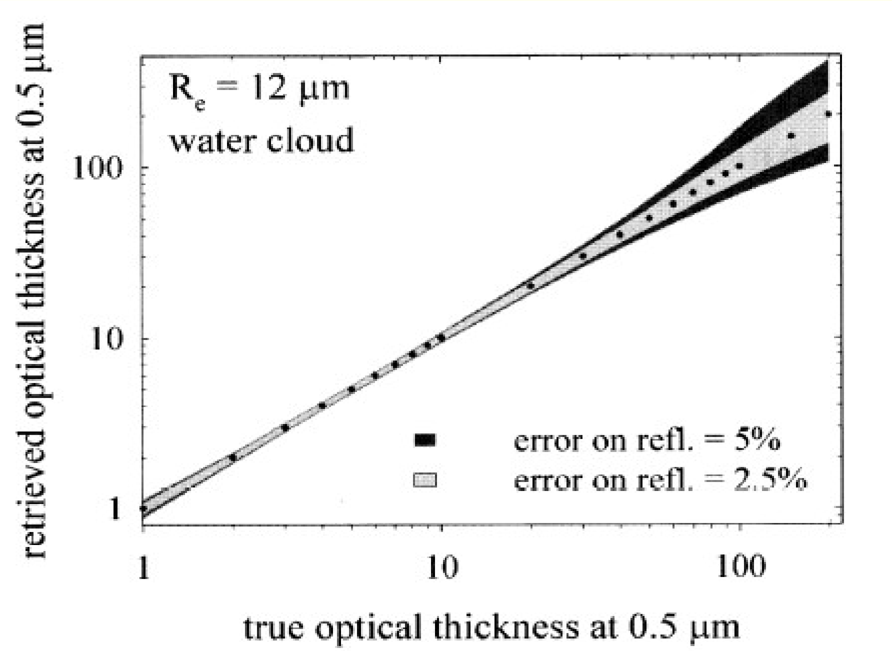
- Strong ↗ toward highest sza.

- PC95 always > 1

- Overestimation of «extreme values» for every sza conditions
- Systematic overestimation for high values of sza (> 60°)

Discussion - Conclusion

→ Overestimation of extreme values with CPP; systematic overestimation for high sza values - WHY ?



- Strongest effects of instrument uncertainties on reflectance measurement (Cattani et al., 2007) →SEVIRI saturates for clouds with LWP > 700 $g.m^{-2}$ (Roebeling et al., 2006)
- Bias on measurements for high values of SZA: Shadows effect, 3D cloud effects, lateral transfer of photon,...

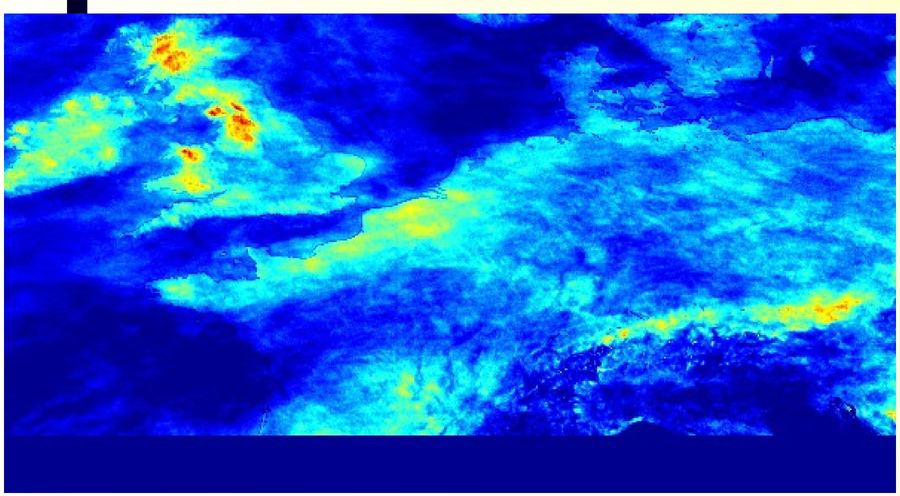
- **Delineation of precipitation areas with CPP accurate and reliable (! effects of sza > 65-70° !)**

- **Overestimation of rain rates for very thick clouds and/or when sza is high (> 60°). Reliable and unbiased assessment of rain rates for March to September at mid-day hours at our latitudes.**

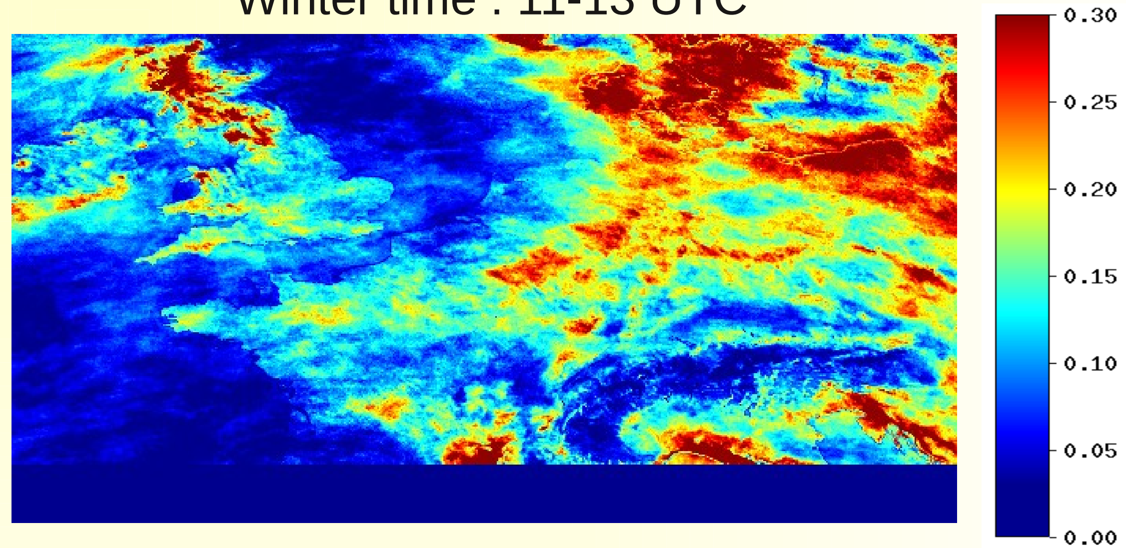
Discussion - Conclusion

- Potential applications :
  - Data assimilation/validation for models, climate monitoring (! limitations on high sza values !)
  - Near real-time
  - Climate monitoring, data on **cloud physical properties** (COT, Re, LWP)

Summer time : 10-15 UTC



Winter time : 11-13 UTC



Frequency of 'non precipitating clouds' – High values of LWP (> 160g.m-2) and low values of Re (< 14 µm) → Effects of strong updrafts VS **aerosols indirect effect** → Earth radiation budget, onset of precipitation, delay of cloud clearance,...

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Questions ?

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