

Impact of Megha-Tropiques data in GPM constellation based rainfall estimation



Rémy Roca (CNRS)
OMP/LEGOS, Toulouse, France
and the french Megha-Tropiques Science Team



1. Status of the Megha-Tropiques mission
 - The archive of MADRAS
 - The SAPHIR instrument
2. Rainfall estimation with two constellations
 - Rationale
 - Method
 - Impact of SAPHIR
3. Intercomparison with other products
 - Quantitative agreement over the West African region
 - Discrepancies over the Indian subcontinent
4. Development of the error model
5. Conclusions & Perspectives

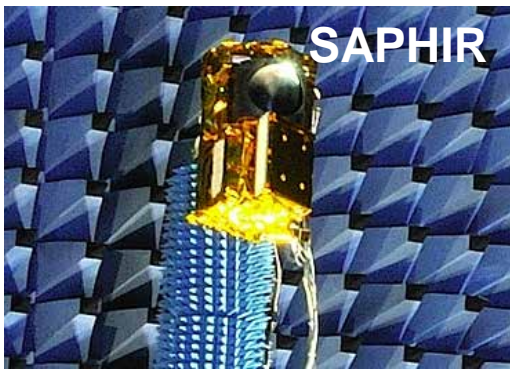
The status of the Megha-Tropiques mission

The mission in 1 slide !

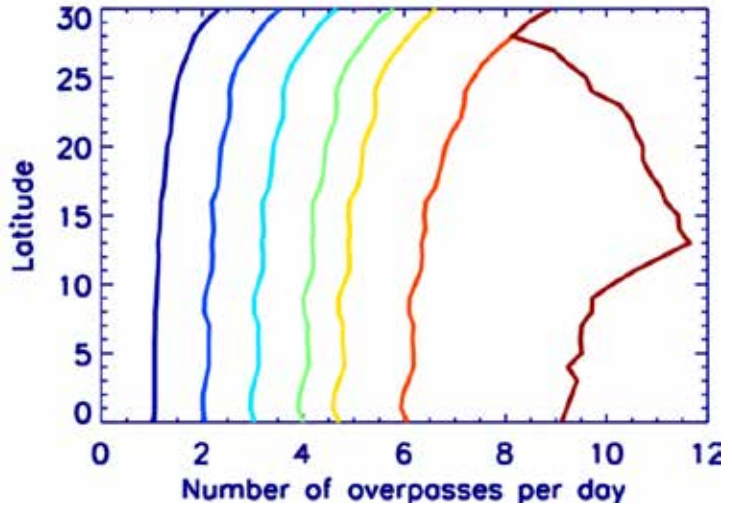


- Indo-French Mission built by ISRO and CNES launched in October 2011
- dedicated to the monitoring of the water and energy cycle in the tropics
- Orbit with 20° inclination on the equator
- Nominal life: 3 years

EXTENDED for 2 years !



GPM constellation configurations



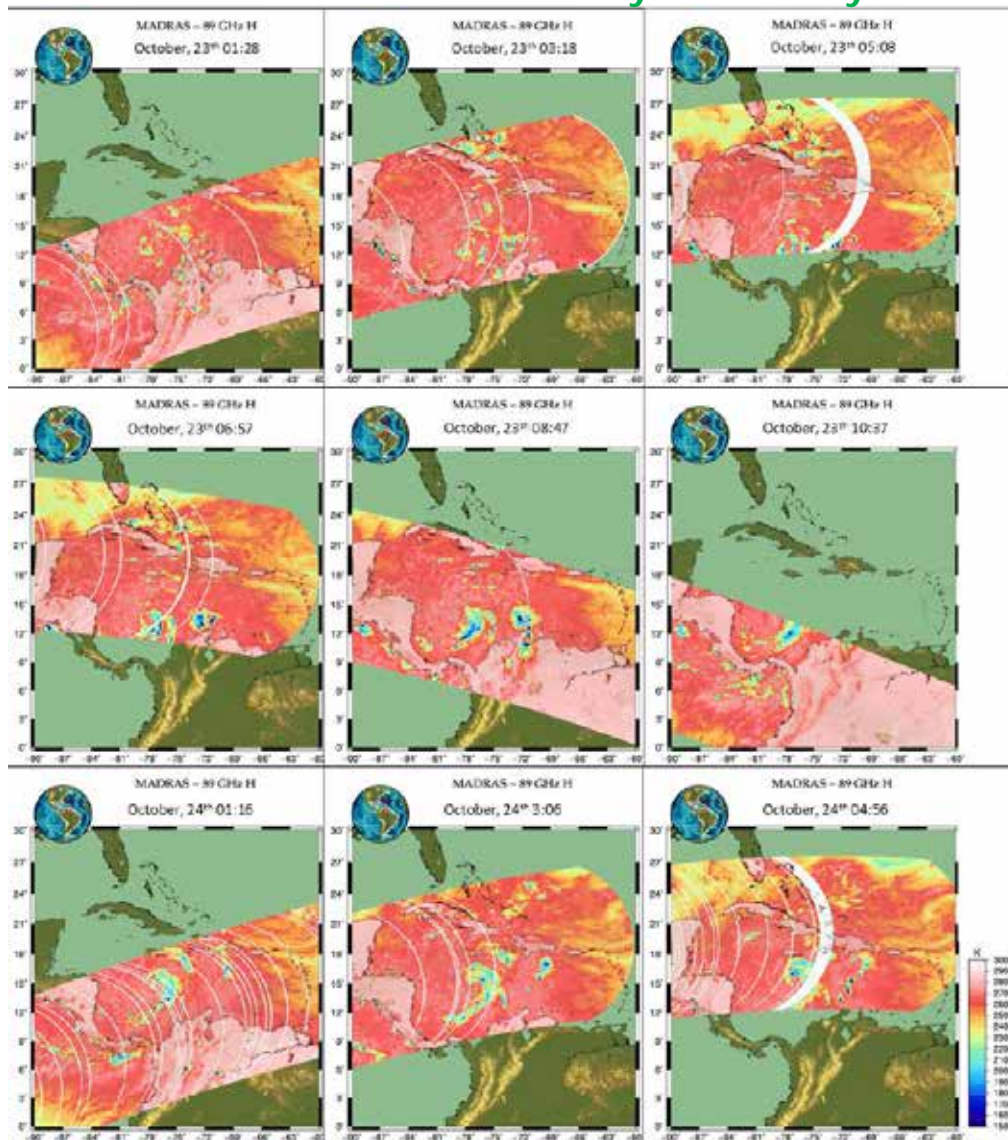
Courtesy CNES

The status of the Megha-Tropiques mission

Past archive: MADRAS archive



MADRAS 89GHz sees Sandy over 2 days !



From Roca et al., 2014

- Worked up to the end of January 2013
- Glitch issues
- Long commissioning phase
 - On going reprocessing with v7000
 - Still under restrictive data policy
 - should be broadly open current 2015

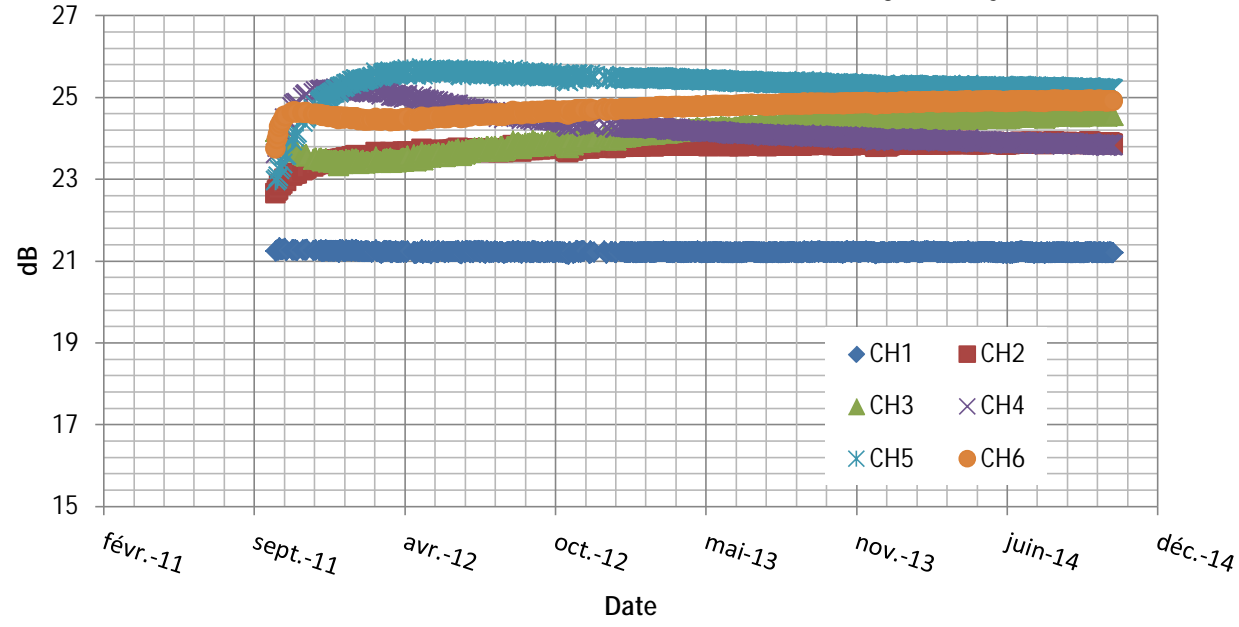
See talk by N Viltard for more details

The status of the Megha-Tropiques mission

The SAPHIR instrument (1/2)



Courtesy M Dejus, CNES



- 148 Parameters monitored
- About 100 alarms
- Every 6 month, calibration control on Amazonia and Titicaca Lake

Courtesy M Dejus, CNES

Gain	C1	C2	C3	C4	C5	C6
On ground	20,46	21,45	22,3	22,02	21,53	21,96
In flight commissioning	21,29	22,85	24,15	24,17	23,32	24,46
Today	21,20	23,84	24,40	23,95	25,26	24,86

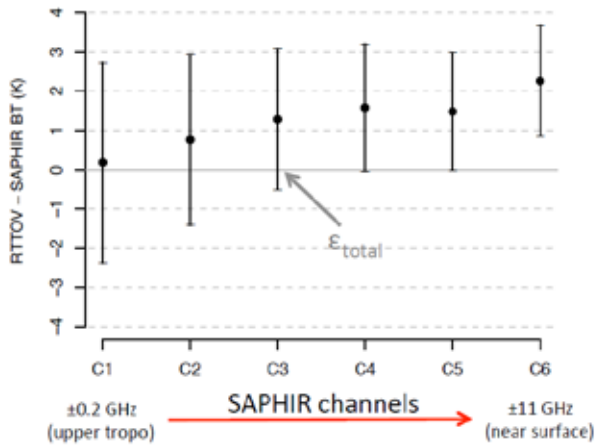
The status of the Megha-Tropiques mission

The SAPHIR instrument (2/2)



Absolute Calibration

Mean bias & total error



From Clain et al., JAOT, 2014

NeΔT (K)	$f_0 \pm 0.2$	$f_0 \pm 1.1$	$f_0 \pm 2.8$	$f_0 \pm 4.2$	$f_0 \pm 6.6$	$f_0 \pm 11.0$
	GHz	GHz	GHz	GHz	GHz	GHz
Theoretical Specifications	2.4	1.8	1.8	1.5	1.5	1.2
Inflight values	1.44	1.05	0.91	0.77	0.63	0.54

Adapted from Karouche et al., 2012

- Radiative transfert computations shows slight warm bias with radiosondes increasing way from 183GHz within the expected methodological uncertainties (but for the warmest channels).
- Same order of magnitude as other 183 GHz sounders (Wilheit et al., 2013)

Real Time delivery

Since May 2013 the SAPHIR L1A data are available in real time to registered users thanks to the EUMETCast link operated by EUMETSAT with the support of CNES/ISRO

Data are assimilated in the Météo-France global model since September 2014

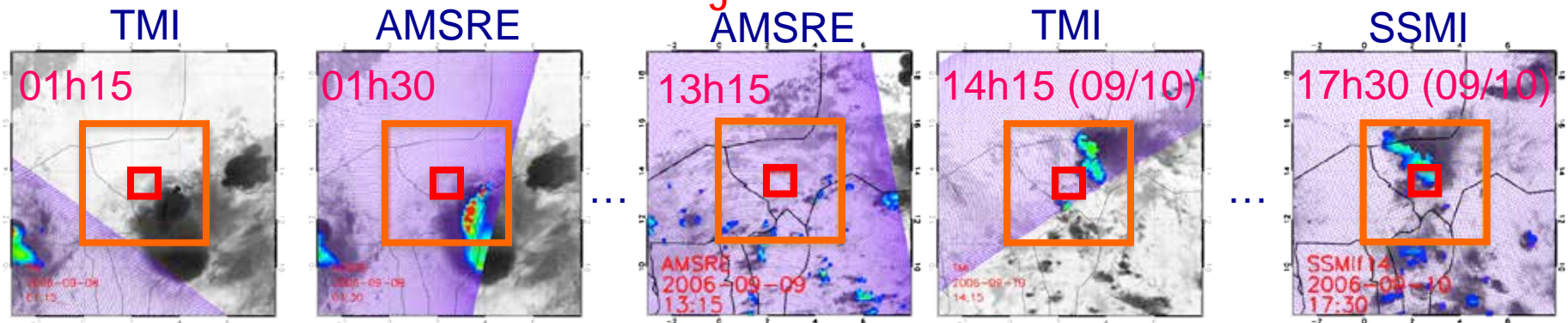
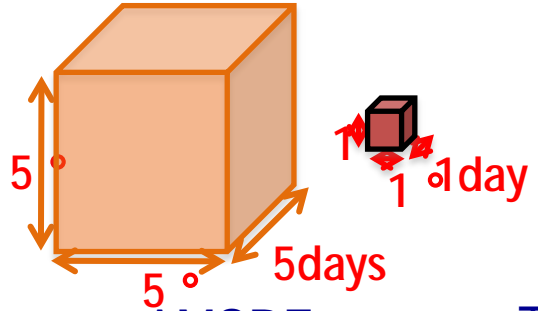
Rainfall estimation with two constellations

Rationale for the TAPEER (UAGPI) at 1°/1 day



$$\text{Accumulated Rainfall (in mm)} = \overline{R_{cond}} \text{ (in mm/day)} \times \text{Fraction (in \%)}$$

1. training over a volume to obtain $\overline{R_{cond}}$ using MW instantaneous rain rates estimates
2. training over a volume to obtain $\text{BTIR}_{\text{threshold}}$ using - MW instantaneous rain mask and - IR imagery
3. use $\text{BTIR}_{\text{threshold}}$ to obtain Fraction of the actual day using the IR imagery



Time

Rainfall estimation with two constellations

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Step 1 relies on the L2 retrieval of rainrates estimation (bias, etc..)

Step 2 relies on the L2 detection (sensitivity, definition, etc..)

Both steps depends (differently) on the training dataset volume and its representativity

**Each step requires to identify
the relevant L2 products
and the adequate training volume**

Rainfall estimation with two constellations

Rationale for the UAGPI at 1°/1 day Summer 2012 configuration



$$\text{Accumulated Rainfall (in mm)} = \overline{R_{cond}} \text{ (in mm/day)} \times \text{Fraction (in \%)}$$

STEP1: Constellation for $\overline{R_{cond}}$

BRAIN Estimation on TMI, AMSR2, SSMI F15, SSMIS F16,F17,F18

5° x 5 days optimized for estimating the mean with as many point as possible

STEP2: Constellation for Frac

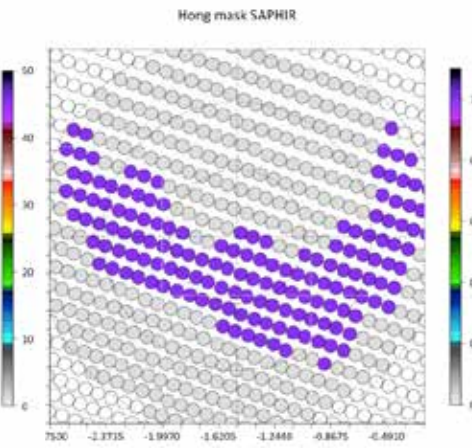
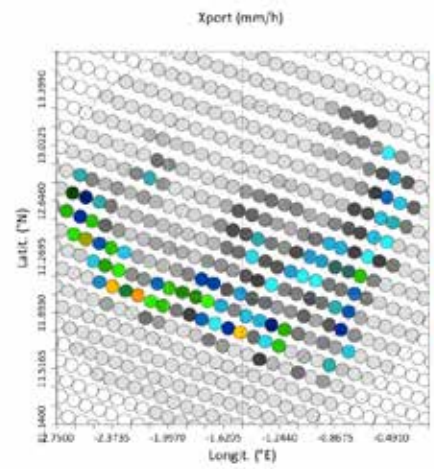
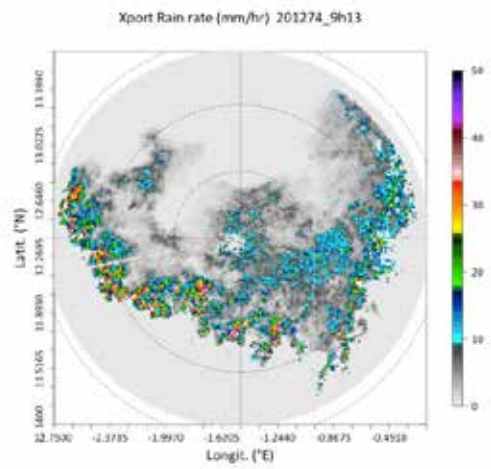
BRAIN Detection on TMI, AMSR2, SSMI F15, SSMIS F16,F17,F18

Hong detection on SAPHIR

3°x1 day optimized for representativity of the BTIR threshold with daily update

See talk of Clément Guilloteau

SAPHIR 183 GHz
« Hong et al » Mask
Available as part of
the SAPHIR UTH
retrieval
(Brogniez et al., 2014)



Courtesy M. Alcoba

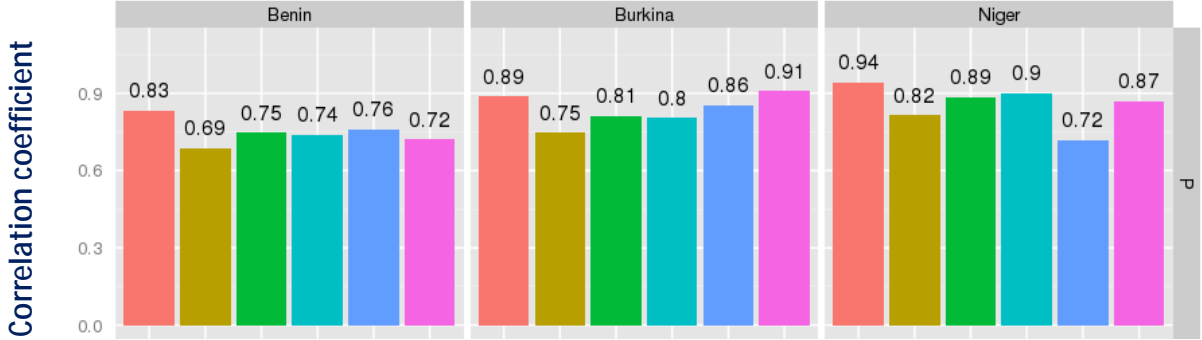
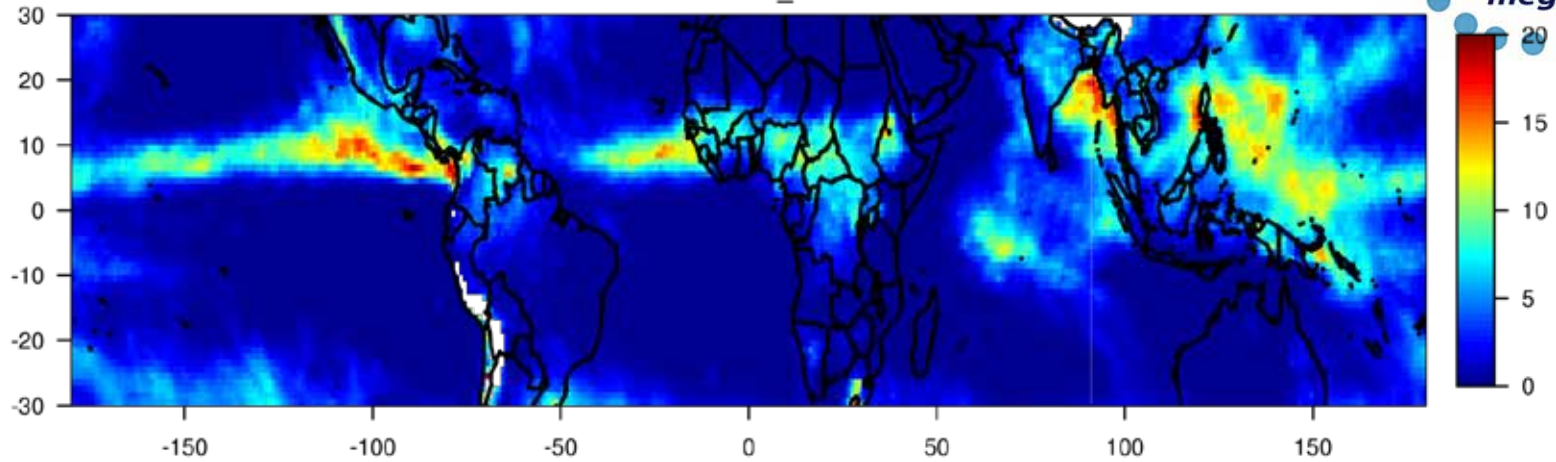
See also Posters :
- Viltard and Martini
- Kacimi and Haddad

Rainfall estimation with two constellations

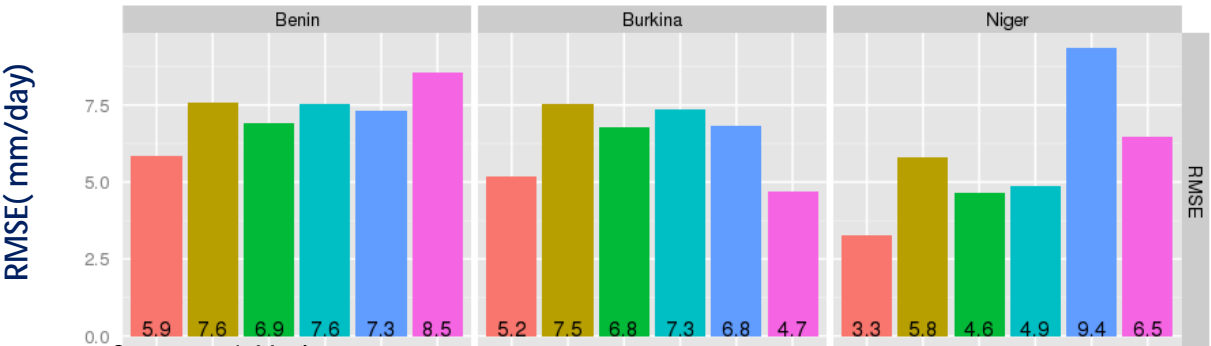
Results for the West African Monsoon region JAS2012



TAPEER_1.5



- tapeer
- gpcp
- tampa
- tmapart
- gsmmap
- cmorph



All products have a very good score compared to our research network

See talk of Marielle Gosset

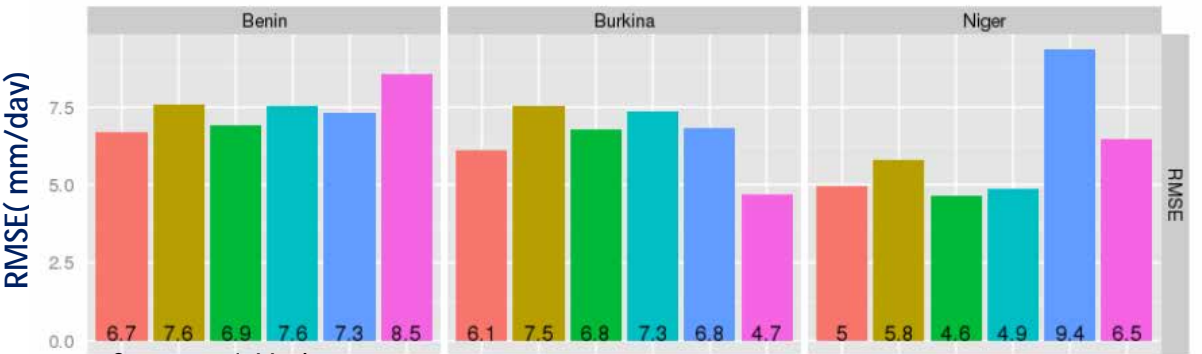
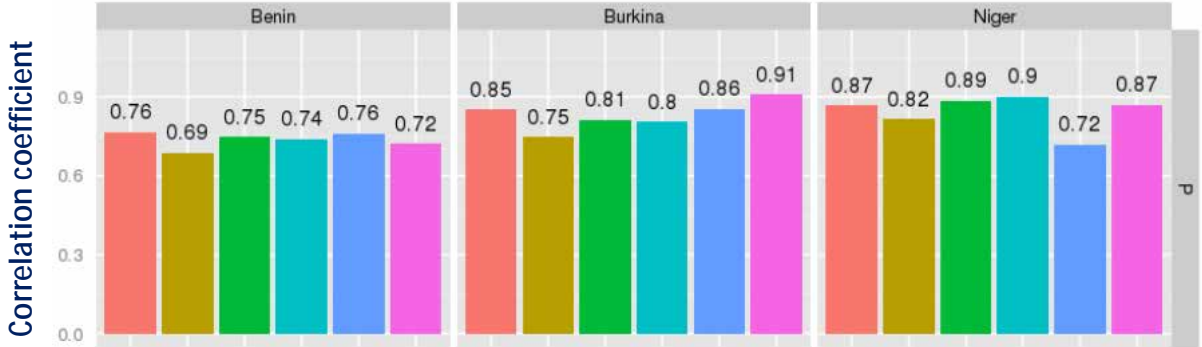
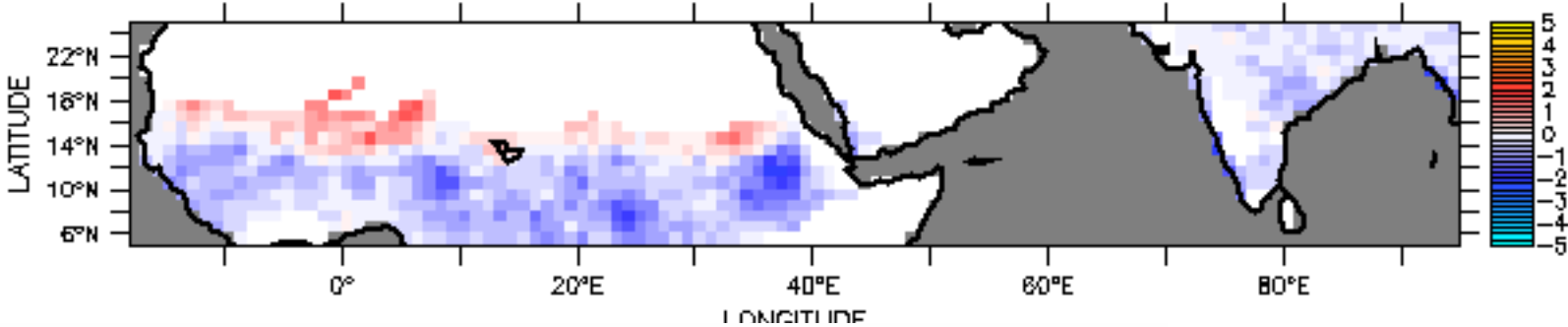
Courtesy J. Veslot

Rainfall estimation with two constellations

The contribution of SAPHIR



TIME : 01-JUL-2012 00:00 to 30-SEP-2012 00:00



- tapeer
- gpcp
- tmpa
- tmpart
- gsmmap
- cmorph

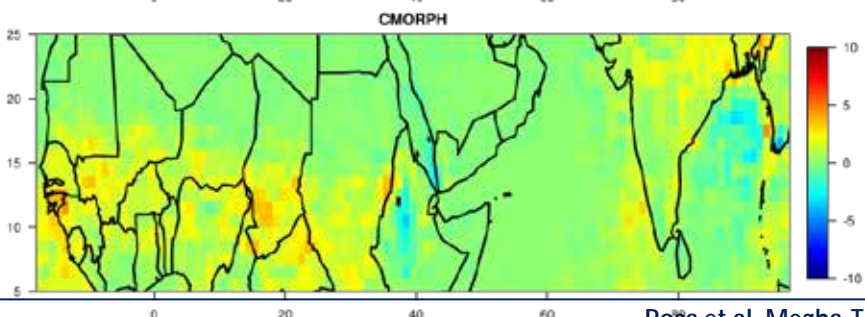
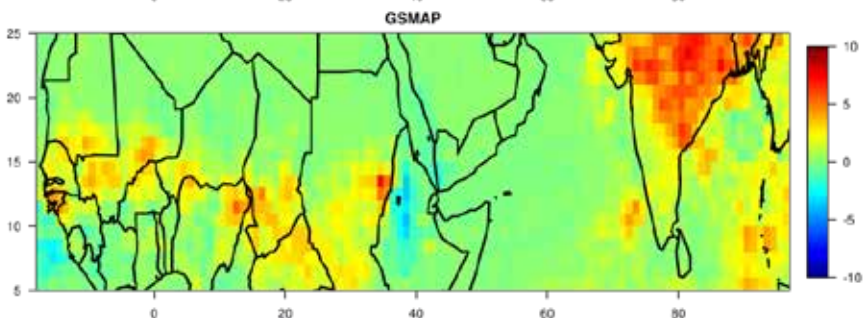
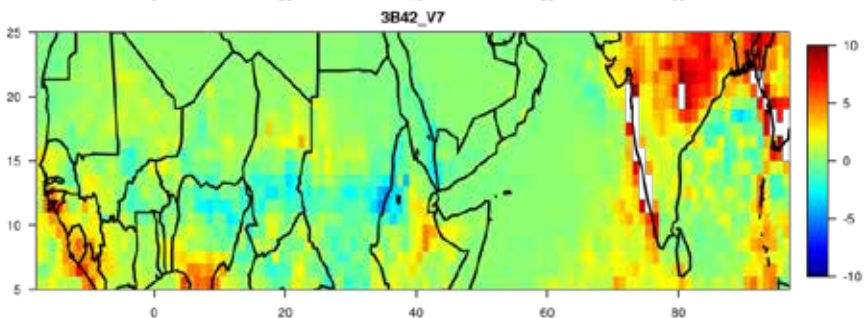
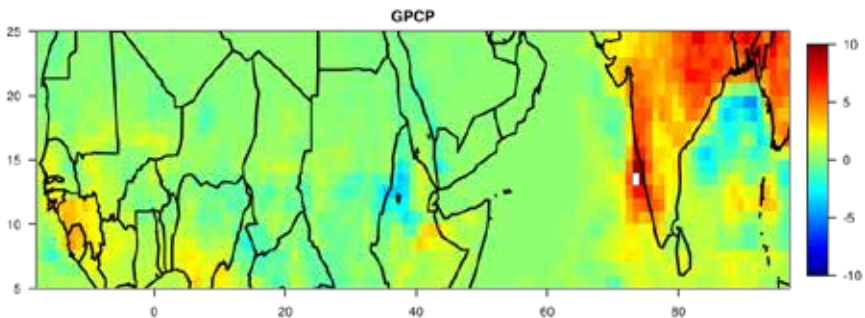
Without SAPHIR the TAPEER product would have

- lower correlation
- higher RMSE

Courtesy J. Veslot

Intercomparison over monsoons regions

Seasonal mean of Product – TAPEER (mm/day)



Large differences in between the products over continental India

Less of a problem over continental Africa

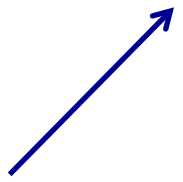
Development of our error model

Tropical Amount of Rainfall with Estimation of Errors (TAPEER)



$$E^2 \approx E^2_{\text{Calibration}} + E^2_{\text{Algorithm}} + E^2_{\text{Sampling}}$$

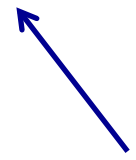
Calibration / inter-calibration
of instruments



Instantaneous rain product errors +
Multiple data merging method errors



Space/time
measurements
occurrence



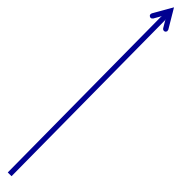
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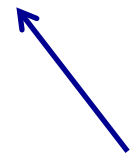
Neglected (small)



Instantaneous rain product errors +
Multiple data merging method errors
Recent efforts on this aspect



Estimation based on variograms
(Roca et al., 2010)



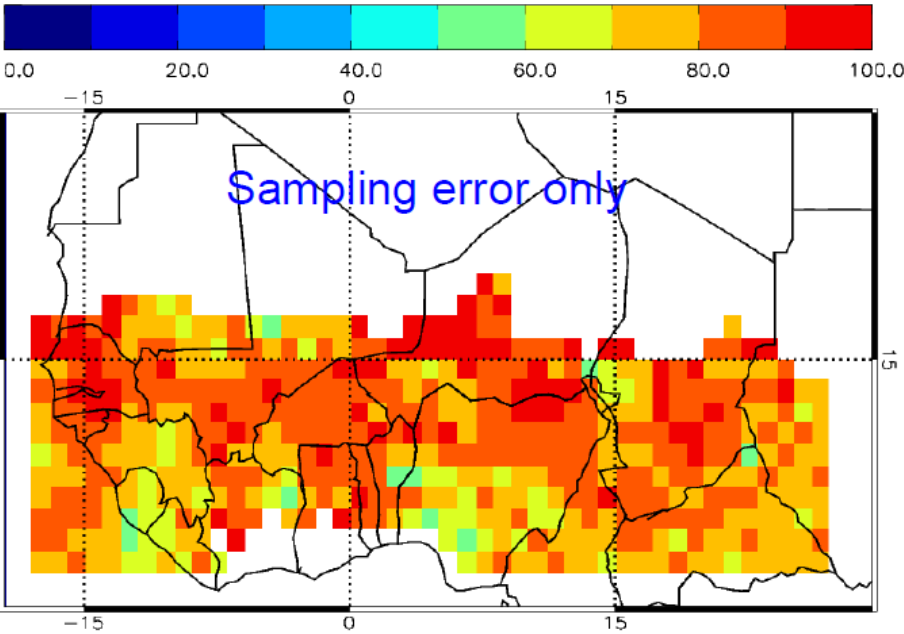
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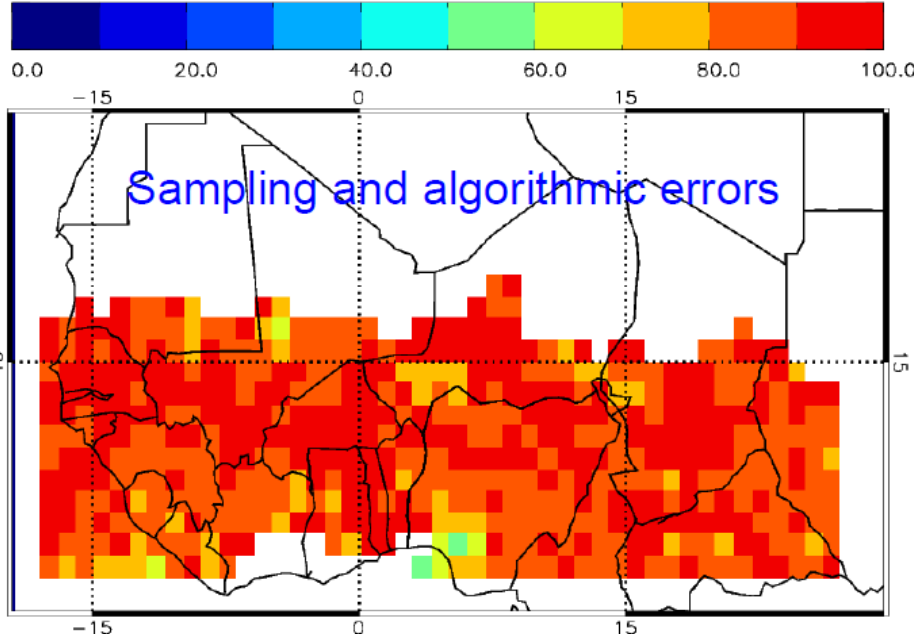


Comparing the results of the 1998 constellation vs the 2012 constellation for JAS 2012

$$F(|Rain_{12} - Rain_{98}|) < 3 \sqrt{Var(Rain_{12} - Rain_{98})}$$



$$F(|Rain_{12} - Rain_{98}|) < 3 \sqrt{Var(Rain_{12} - Rain_{98})}$$



See Poster of Nicolas Taburet

See talk (next) from G. Huffman on the constellation sustainability



- The SAPHIR instrument is in good health and the mission is extended for 2 years
- Developments are going on the use of the SAPHIR data for precipitation
- TAPEER products shows improvement when SAPHIR is used
 - Very good comparisons with rain gauge in Africa
 - Large divergence among the products over continental india
- On going analysis of summer 2012, 2013 and 2014 with research algorithm
- Megha-Tropiques data are available at www.icare.univ-lille1.fr/mt
 - Level 1 data from SAPHIR and SCARAB
 - Level 1 data from MADRAS (restricted access)
 - Precipitation products operationnal production in commissioning stage soon to be released
- **Conférence in Paris 2nd half of November 2015 in preparation dedicated to the « Water and Energy cycles in the tropics »**

[Check www.megha-tropiques.ipsl.polytechnique.fr](http://www.megha-tropiques.ipsl.polytechnique.fr)