The TAPEER 1.5 algorithm: a double constellation implementation

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TAPEER : a double constellation

TAPEER stands for Tropical Amount of Precipitation with an Estimate of ERrors. The TAPEER-BRAIN algorithm combines microwave and infrared observations to provide precipitation estimates and their associated error bars at the one-degree/one-day accumulated scale, over land and ocean.

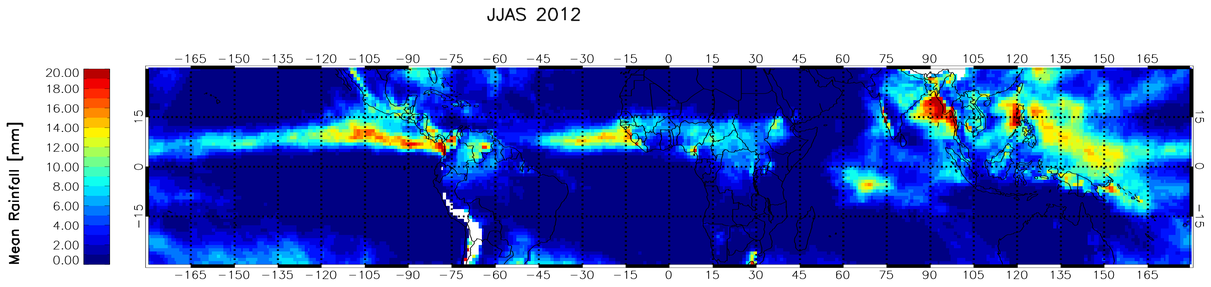

Fig. 1 Average of accumulated rainfall over JJAS 2012

The major improvement in this 1.5 version of the TAPEER algorithm is to separately deal with rain detection and rain rates estimation. As a result different satellite configurations can be used for both aspects, in particular this allows to benefit from the use of microwave sounder (SAPHIR) for rain detection. The current implementation therefore relies on rain detection from LEO microwave imagers and sounder with a training volume of 3°x3°x1day as well as instantaneous precipitation retrievals from LEO microwave imagers using the BRAIN algorithm (Viltard et al, 2006) with an another training volume of 5°x5°x5days. Those detections and rain rates estimates are then merged with full space/time resolution data from the thermal window channel onboard GEO platforms (MSG, Meteosat 7, GOES-E, GOES-W, MTSAT). The product is further corrected statistically using the TRMM PR v7 near surface rain rates data.

LEO microwaves imagers for rain rates estimation Training volume : 5°x5°x5days	F15/SSMI, F16/SSMIS, F17/SSMIS, F18/SSMIS, GCOM-W/AMSR2, TRMM/TMI
LEO microwaves imagers and sounders for rain detection Training volume : 3°x3°x1day	F15/SSMI, F16/SSMIS, F17/SSMIS, F18/SSMIS, GCOM-W/AMSR2, TRMM/TMI, MT/SAPHIR
Geostationary Platforms	MSG2,METEOSAT7,MTSAT-2,GOES-E,GOES-W

Tab. 1 Double microwaves constellation and geostationary platform over JJAS 2012

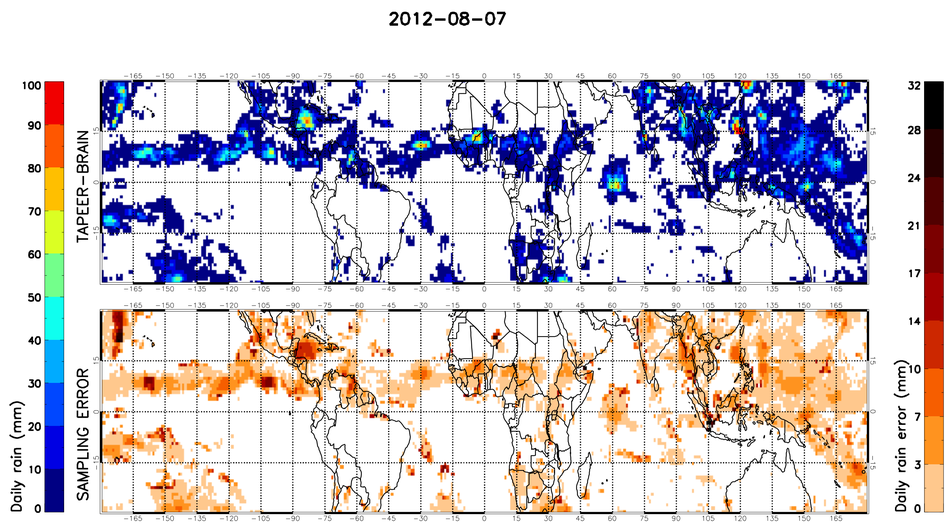

Fig. 2 Illustration of a typical TAPEER-BRAIN product with SAPHIR. Top: daily accumulated rainfall (mm). Bottom: sampling error (mm)

SAPHIR Sensitivity

		Corr	Bias (%)	RMS (%)	POD	FAR	F-score
3d1j Ref Run	Burkina	0,96	-18,9	26,1	0,58	0,11	0,98
3d1j No Saphir		0,91	-25,1	38,6	0,54	0,10	1,19
5d5j		0,78	-3,5	63	0,56	0,12	1,22
5d5j No S		0,78	-6,8	62,5	0,56	0,12	1,25
3d1j Ref Run	Niger	0,99	-5,7	14,4	0,51	0,15	0,84
3d1j No Saphir		0,95	-19,5	32,1	0,48	0,14	1,18
5d5j		0,93	-10,0	42,6	0,43	0,14	1,24
5d5j No S		0,92	-22,9	40,9	0,43	0,13	1,34

Tab. 2 Comparison of the estimations over JJAS 2012, with and without SAPHIR data in the 2012 microwave constellation with a 3°x3°x1day (3d1j) training volume and with a 5°x5°x5days (5d5j) training volume

The reference run gives rain estimations with SAPHIR data in the 2012 microwave constellation and a 3°x3°x1day training volume. The comparison of the estimations with and without SAPHIR data in the 2012 microwave constellation and a 3°x3°x1day training volume emphasizes the Megha-Tropiques contribution, especially in term of bias and RMS, leading to a better F-score. With a larger (5°x5°x5days) training volume, the SAPHIR contribution is not as significant but such a large training volume degrades the representativity of the IR threshold temperature which degrades the RMS and F-scores.

The Megha-Tropiques orbit specificity implies a significant contribution in the tropical band of the SAPHIR data to the overall microwave data therefore allows to use a smaller training volume in the TAPEER algorithm. The data in such a volume are more representative of the 1°x1°x1day grid point meteorological conditions and therefore yields better rainfall estimations. These results confirm the theoretical predictions of the Chambon et al. (2012) OSSE.

We want to estimate the contribution of the Megha-Tropiques mission to the overall performances of the daily accumulated rainfall product and to compare with ground based rainfall measurements, including the uncertainty estimates in the comparison.

- The Kelly (2007) approach that is based on a maximum likelihood estimate technique is used in order to compute the correlation, bias and RMS of the regression between TAPEER daily rainfall and error estimates with ground based rainfall measurements. Details about those rain gauges data can be found in the validation article of the TAPEER rain estimates by Gosset et al. (2015).
- The F-score metric is used to compare the performances of constellations with and without the Megha-Tropiques data as well as different training volumes in the TAPEER algorithm. The F statistic accounts for the biases, RMS, POD and FAR between the TAPEER estimates and the ground measurements and their associated uncertainties. The bias and RMS are computed using the Kelly regression so as to account for the error bars as indicated by the reg subscript in the equation below :

$$F = 1 + \frac{[(Bias)]\_reg}{\bar{R}} + \frac{[(RMS)]\_reg}{\bar{R}}\text{-POD+FAR}$$

where $\bar{R}$ stands for the mean of the ground measurements. The probability of detection (POD) is defined as the ratio of the number of cases where RainSat+errorSat>0 over the number of cases where RainGauges>0. The false alarm rate (FAR) is defined as the ratio of the number of cases where RainSat>0 over the number of cases where RainGauges+errorGauges=0. With this metric, the lower the F-score, the better the TAPEER estimations are.

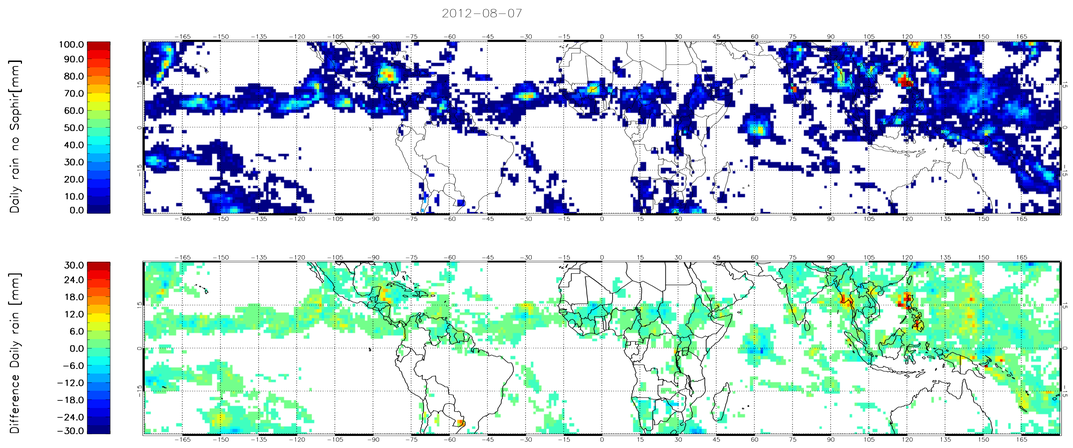

Fig. 3 Daily accumulated rainfall without SAPHIR. Top: daily accumulated rainfall (mm). Bottom: difference of daily accumulated rainfall : without SAPHIR – with SAPHIR (mm)

Conclusion and perspectives

- SAPHIR contribution is significant into the TAPEER daily rainfall estimation and better with a smaller training volume.
- TAPEER-BRAIN 1.5 version has started its operational phase at AERIS/ICARE center.
- A quality flag will be implemented to give a confidence index on the TAPEER daily rainfall retrieval, depending on the available input GEO data.
- A new fleet of high resolution geostationary is coming (HIMAWARI-8, GOES-R …) : future work is to integrate them.
- Use GPROF as level 2 rain for all microwave platforms including GMI.