Comparison of the two Jason-1 rain flags

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Abstract-

We evaluate and compare the ability of two different Jason-1 dual-frequency altimeter algorithms (referred as Tournadre's (2004) and Quartly's (2004) rain flag respectively) to detect rain events in order to flag rain-contaminated altimeter range measurements. They are based on departures from a defined relationship between the Ku- and C-band radar cross-sections observed in no-rainy conditions. The algorithms performances were assessed via collocations of these dual-frequency based estimates with rain rates an rain/no-rain flag from the Tropical rainfall measuring mission (TRMM) Microwave Imager (TMI). The Jason-1/TMI analysis lies on a yes-no discrimination. This latter would be helpful to provide a good insight on the altimeter rain detection flags efficiency through estimations of the percentages of hits, misses, false alarms and correct negatives when comparing with TMI measurements.

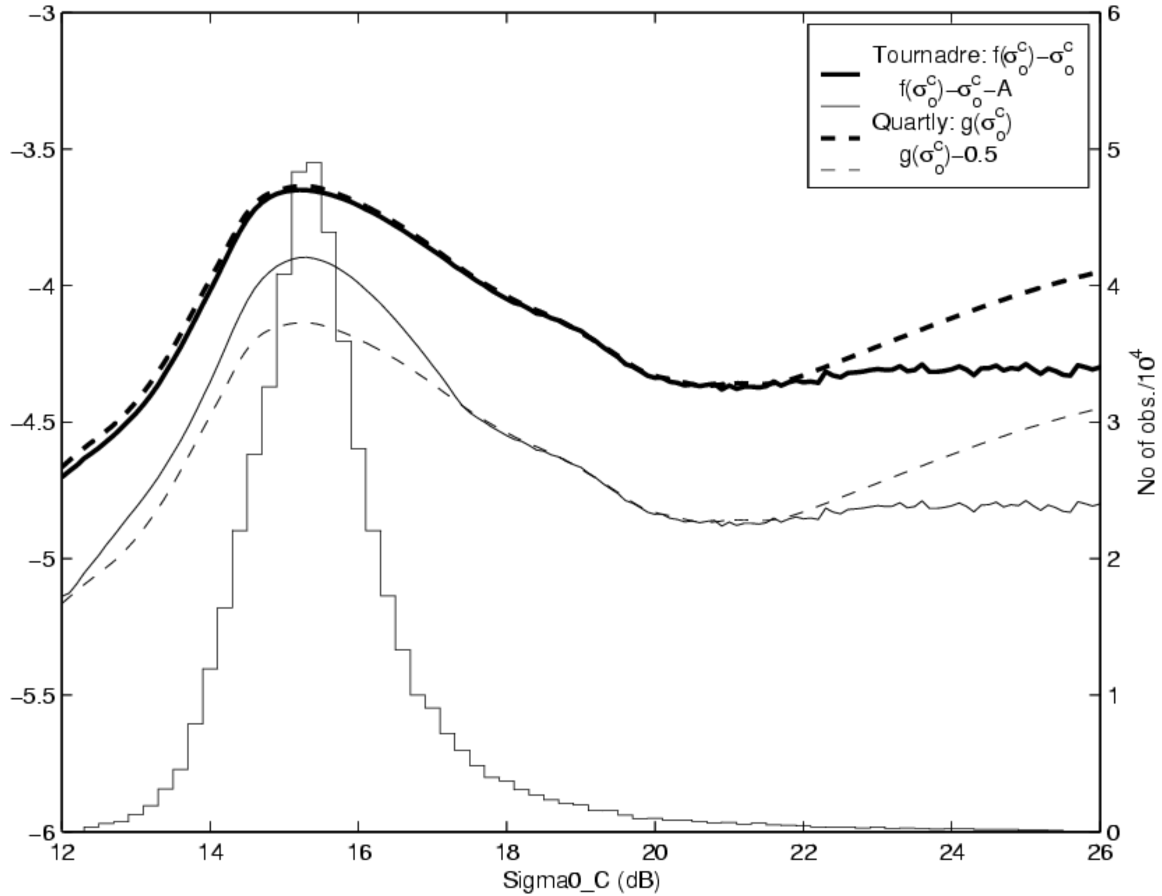

Figure 1: Comparison of the two mean relationships (after adjustment of the sigma0 values since these relationships are derived from different disseminated products) with respect to C-band sigma0. Also provided are the thresholds and the histogram of C-band sigma0 over a cycle. The two mean relationships overlie one another closely over the 12-22 dB interval. Discrepancies between the rain flagging will come from the different choice of threshold and the inclusion or not of a radiometer based criterion.

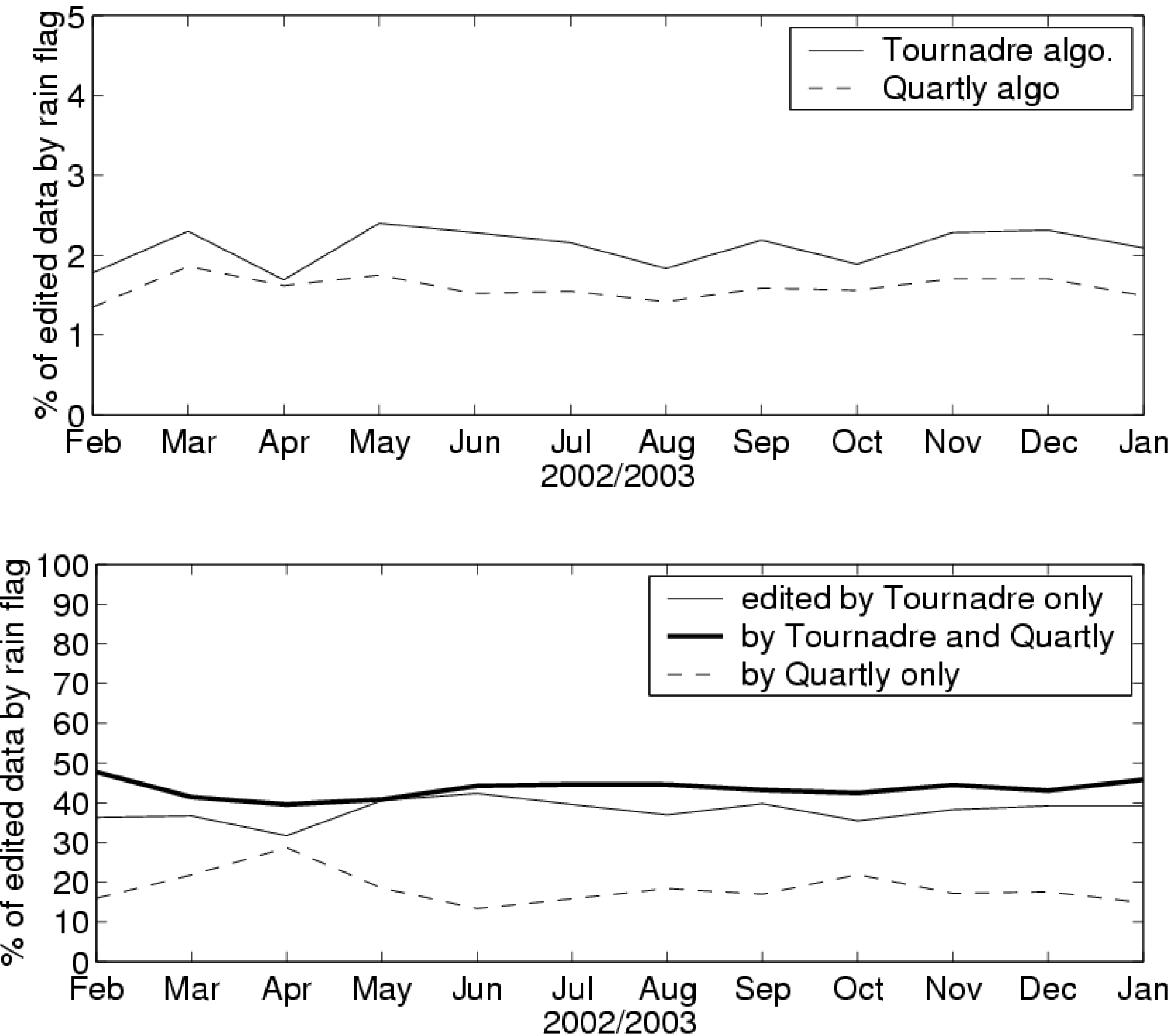

Figure 2: (top) Percentage of data edited by Tournadre's and Quartly's algorithms as function of time; (bottom) Percentage of data edited as function of time (ratio of number of cases edited over the total number of data edited when using simultaneously both algorithms).

The percentages of edited data are rather stable as function of time for both algorithms. Tournadre's rain flag edits about 2% of the data while Quartly's algorithm edits less data with only 1.5% flagged. Only 50% of the edited data are flagged by the two algorithms simultaneously.

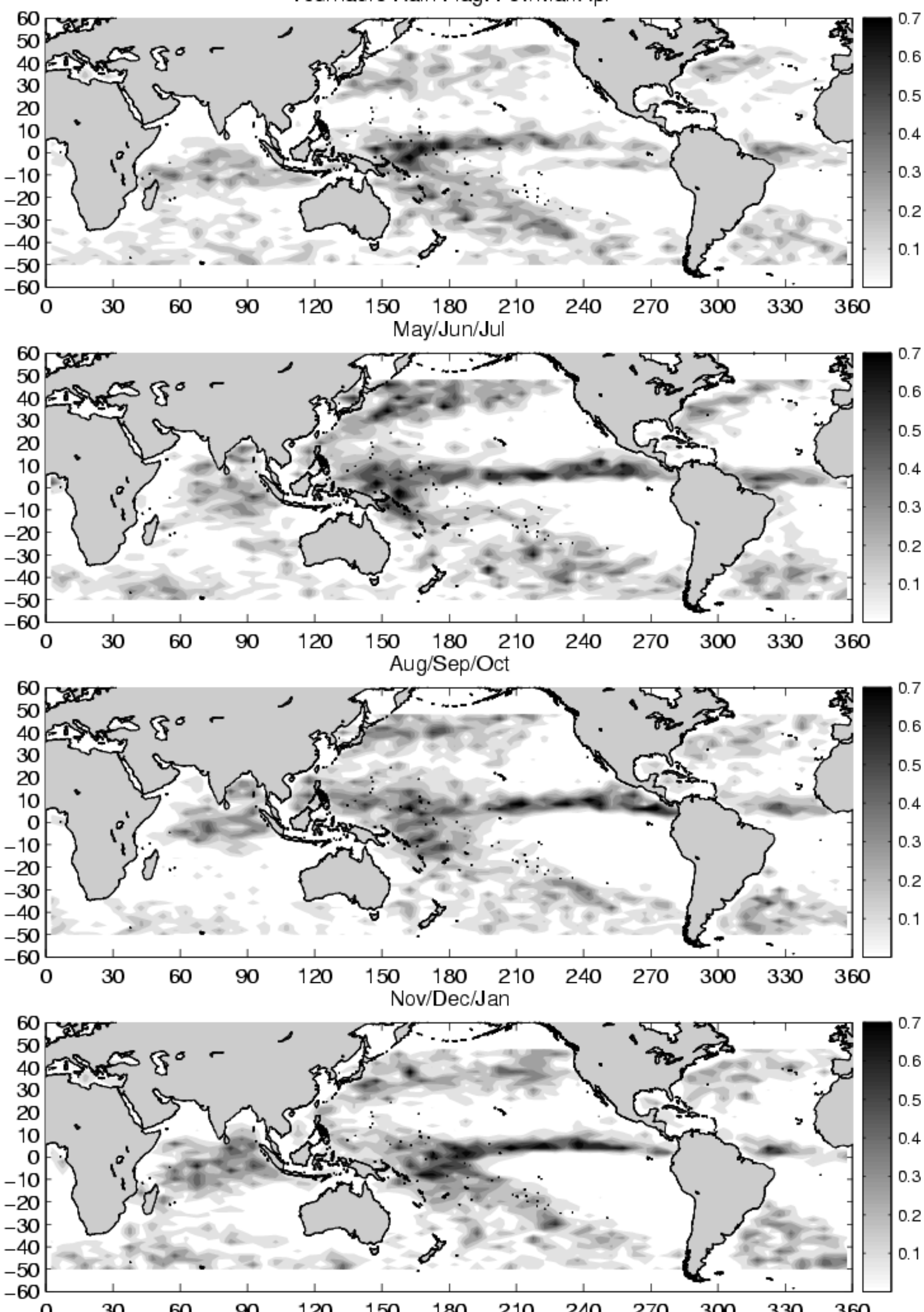

Figure 3: Seasonal number of occurrences of rain events detected by Tournadre's rain flag in boxes of 5° of longitude by 2° of latitude.

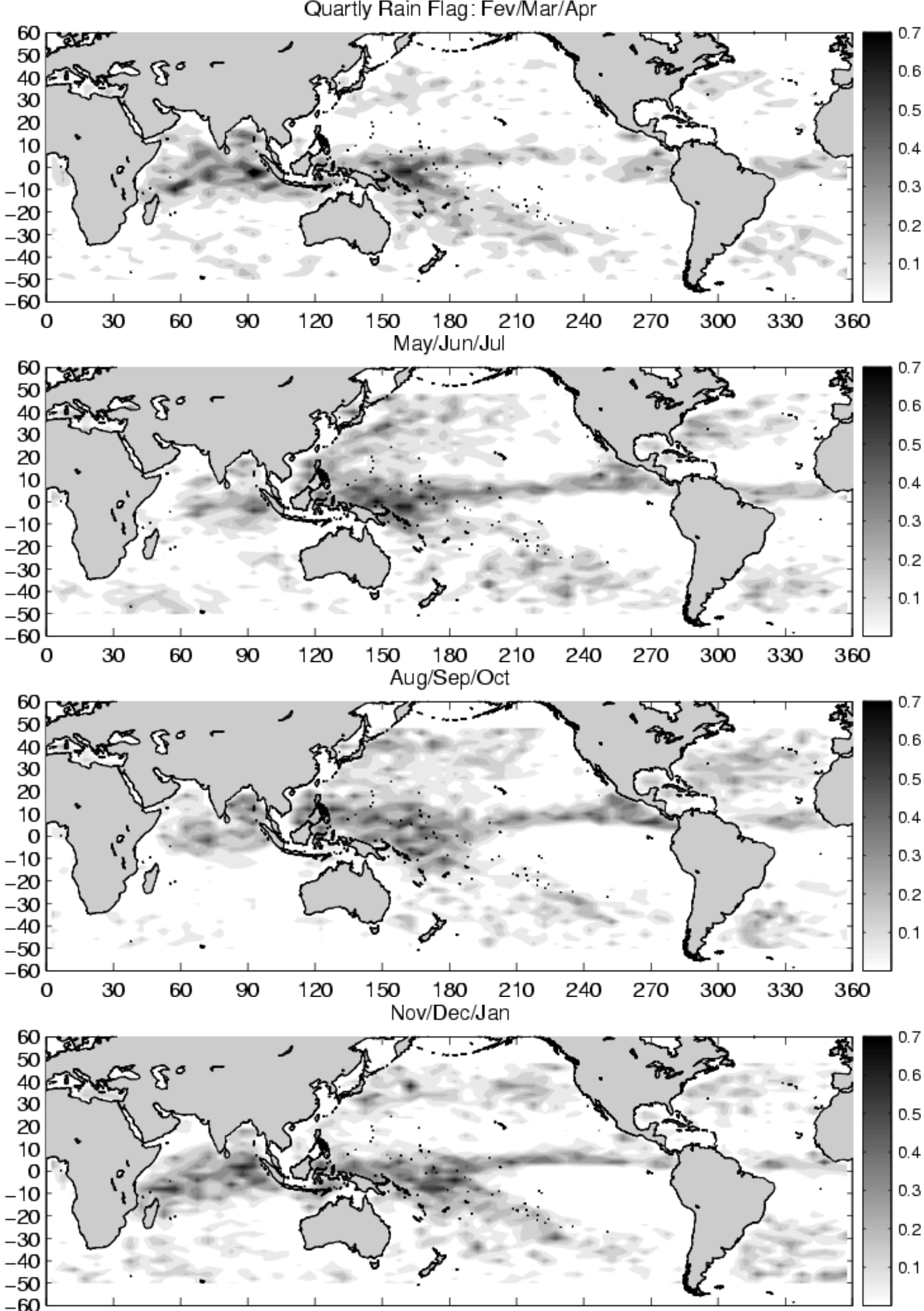

Figure 4: Seasonal number of occurrences of rain events detected by Quartly's rain flag in boxes of 5° of longitude by 2° of latitude.

We can observe a good agreement between the maps over the same months especially in the tropical regions. Common features between the maps include a prominent rain belt in the Intertropical Convergence Zone (ITCZ), a dry zone in the mid-latitudes of each hemisphere in the East Pacific, East Atlantic, and East Indian Oceans, and a wet area in the western parts of the three basins. These characteristics are in good agreement with existing rain climatologies. But despite the overall similarity in the general patterns, it is also evident that the extent and area of maximum occurrences of rain events are different between the two algorithms.

yes-no (dichotomous) discrimination		TMI rain flag	
		yes	**no**
Jason-1 rain flag Algorithm	**yes**	hits	false alarms
	no	misses	correct negatives

Table 1: yes-no discrimination definition

Table 2: Inter-comparison between the two Jason-1 rain flags setting when comparing with TMI rain flags for three pairs of collocation criteria.

The percentage of correct negatives is always higher for Tournadre's algorithm than for Quartly's one whatever the selection filter. The percentage of hits and misses are respectively higher and lower for Tournadre's rain flag. Note also that the percentage of false alarms is null for this algorithm.

	N	Jason-1 algo vs TMI	hits	misses	false alarms	correct negatives
	100 %		%	%	%	%
30 mn/ 50 km	**47374**	**GQ**	1.09	4.45	0.54	93.90
		JT	1.78	3.75	0.0	94.43
15 mn/ 10 km	**22027**	**GQ**	1.13	3.64	0.59	94.64
		JT	1.83	2.94	0.0	95.23
5 mn/ 1 km	**361**	**GQ**	0.55	0.83	0.28	98.34
		JT	0.83	0.55	0.0	98.61

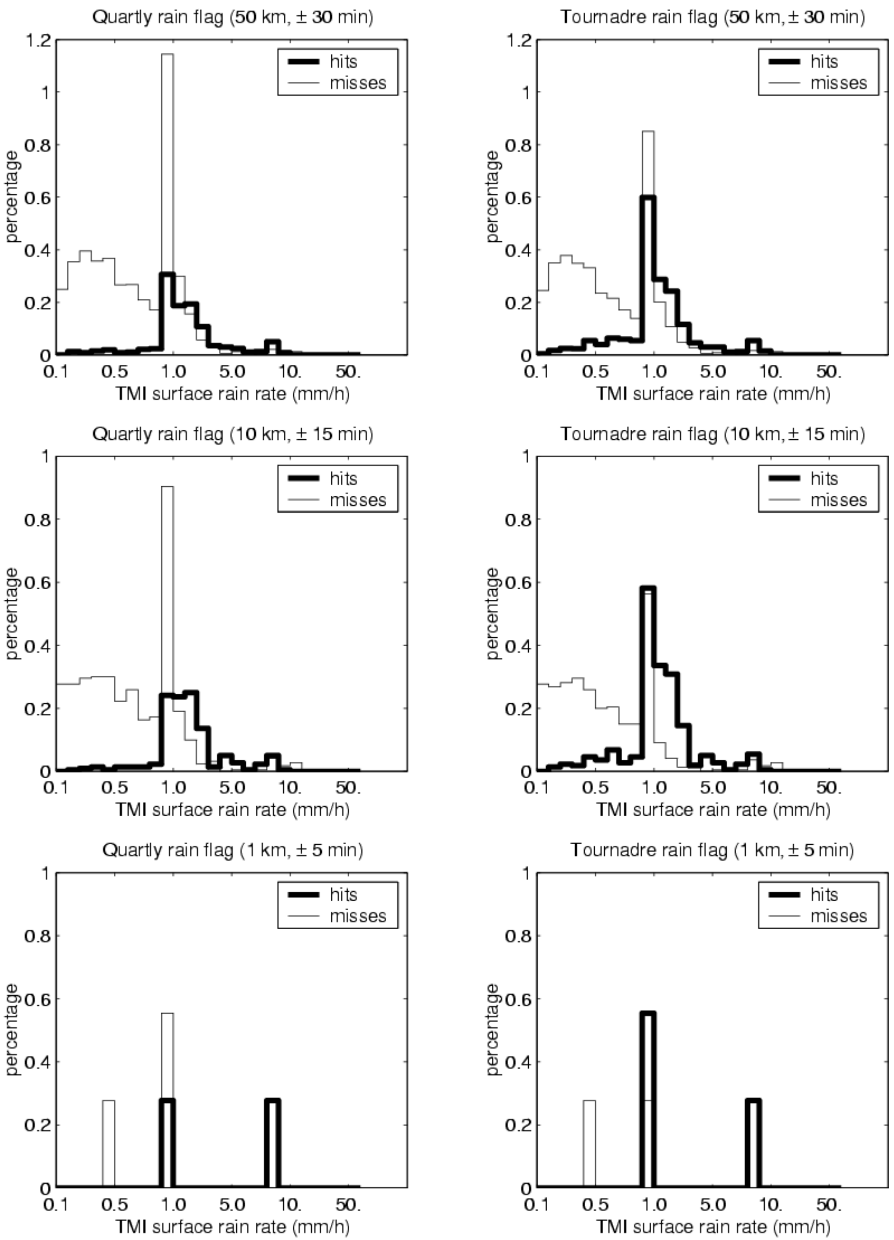

Figure 5: Distribution of the occurrence of hits and misses as a function of TMI rain rates. For clearer display of the histogram distributions (due to the logarithmic interval of variation of the rain rate), the bar width represents an interval of 0.1 mm/hr between 0.1 mm/hr and 1 mm/hr, of 1 from 1 to 10 mm/hr, then of 10 above 10 mm/hr.

The discrepancies between the two Jason-1 algorithms certainly results from a difference in sensitivity due to the different thresholds used. The two algorithms perform quite well since the detection of light rain (< 1 mm/hr) by altimeter is illusory. A 0.5 mm/hr rain rate and a 5 km rain thickness gives 0.16 dB of attenuation. This latter is comparable to the geophysical/ instrumental radar cross section variability. Moreover, in general light rain does not lead to erroneous altimeter estimates of geophysical parameters and should not be discarded.

Concluding remarks-

As pointed out by Quartly (2004), a threshold of -0.5 dB is effective at removing the majority of spurious data records from the Jason-1 GDRs and discards about 1.5% of global data.

The main conclusion is that the Tournadre's rain flags are closer to the TMI ones with a lower sensitivity threshold than the Quartly's ones. The results are as expected since the algorithms were established with different purposes, i.e. Tournadre's formulation aims at detecting precipitation to flag contaminated data while Quartly's one was thought to detect bad altimetric data, rain being one of the source of degradation.

Results show that the rain flag detection of the data affected (rain rate > 1 mm/hr) is better with Tournadre's algorithm than with Quartly's one. From Figure 5, it appears that for rain rate above 1 mm/hr the number of misses by Tournadre's algorithm is quite low. For rain rate above 2 mm/hr, it is close to zero.

These results corroborate previous observations by Cailliau and Zlotnicki (2000) who highlighted, in their independent validation of TOPEX rain flags, that an altimeter/radiometer based algorithm performs better than an altimeter-only one.