

Validation of Envisat rain detection and rain rate estimates by comparing with TRMM data

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Abstract - One year of Envisat RA-2 altimeter data from 2003 has been used to estimate the updated rain-free relations necessary to accurately flag rain affected data, while 18 months of them have been used to evaluate the performances of this new version of Envisat algorithm. This assessment has been done from collocations with respectively measurements from the Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI) and the Precipitation Radar (PR).

Validation of rain detection

The results of the validation (Table II) show that the rain flag has overall good performances. The score of detection is about 99%, while the false alarm rate is lower than 10% compared to TMI and PR. The percentage of RA2 flagged samples is quite stable with time at ~3% per 35-day cycle.

Table I: Yes-No discrimination definitions

yes-no discrimination	TMI or PR rain flag		
	Yes	No	
Envisat	Yes	Hits	False alarms (FA)
Rain flag	No	Misses	Correct negatives (CN)

Table II: Dichotomous discrimination (defined in Table I and in percent) between TRMM (TMI and PR) and RA-2 for different collocation criteria. The number of samples is given in parentheses.

TRMM Sensor	TMI					PR				
	N	misses	hits	CN	false alarms	N	misses	hits	CN	false alarms
10 min, 10 km	76 022	0.41 (0.38)	1.24	96.69	1.65 (1.48)	50 766	0.17 (0.15)	0.72	97.78	1.32 (1.24)
10 min, 5 km	59 004	0.41 (0.38)	1.22	96.73	1.63 (1.48)	50 007	0.16 (0.15)	0.73	97.79	1.32 (1.24)
5 min, 5 km	29 433	0.39 (0.38)	1.29	96.60	1.72 (1.57)	25 428	0.13 (0.11)	0.79	97.80	1.27 (1.22)
5 min, 2.5 km	12 555	0.38 (0.36)	1.34	96.66	1.62 (1.47)	13 836	0.09 (0.07)	0.77	97.91	1.23 (1.16)
1 min, 5 km	5 755	0.43 (0.43)	1.16	96.61	1.80 (1.77)	5 118	0.20 (0.17)	0.98	97.61	1.21 (1.17)

Validation of rain rate estimates

The RA-2 rain rate estimates, especially when corrected using the calibration relation of Tournadre [2006], are comparable to the PR estimated surface rain rate with a small bias of -0.1 mm/h and a 1.8 mm/h std (see Figure 2 and Table III). The comparison to TMI shows that TMI rain rates have a small positive bias of ~0.2 mm/h and a std of ~2 mm/h (see Figure 1 and Table III). TMI rain rates are thus larger than the RA-2 ones themselves larger than the PR ones.

This is in agreement with the comparison of TMI and PR rain rates conducted by Ikai and Nakamura [2003] which showed a general overestimation of rain by TMI. The analysis shows that the RA-2 rain estimates can certainly be used as an independent data set complementary to the ones used in GPCP for climatological studies and can be of interest for precipitation climatology at mid latitude where no data from TRMM are available.

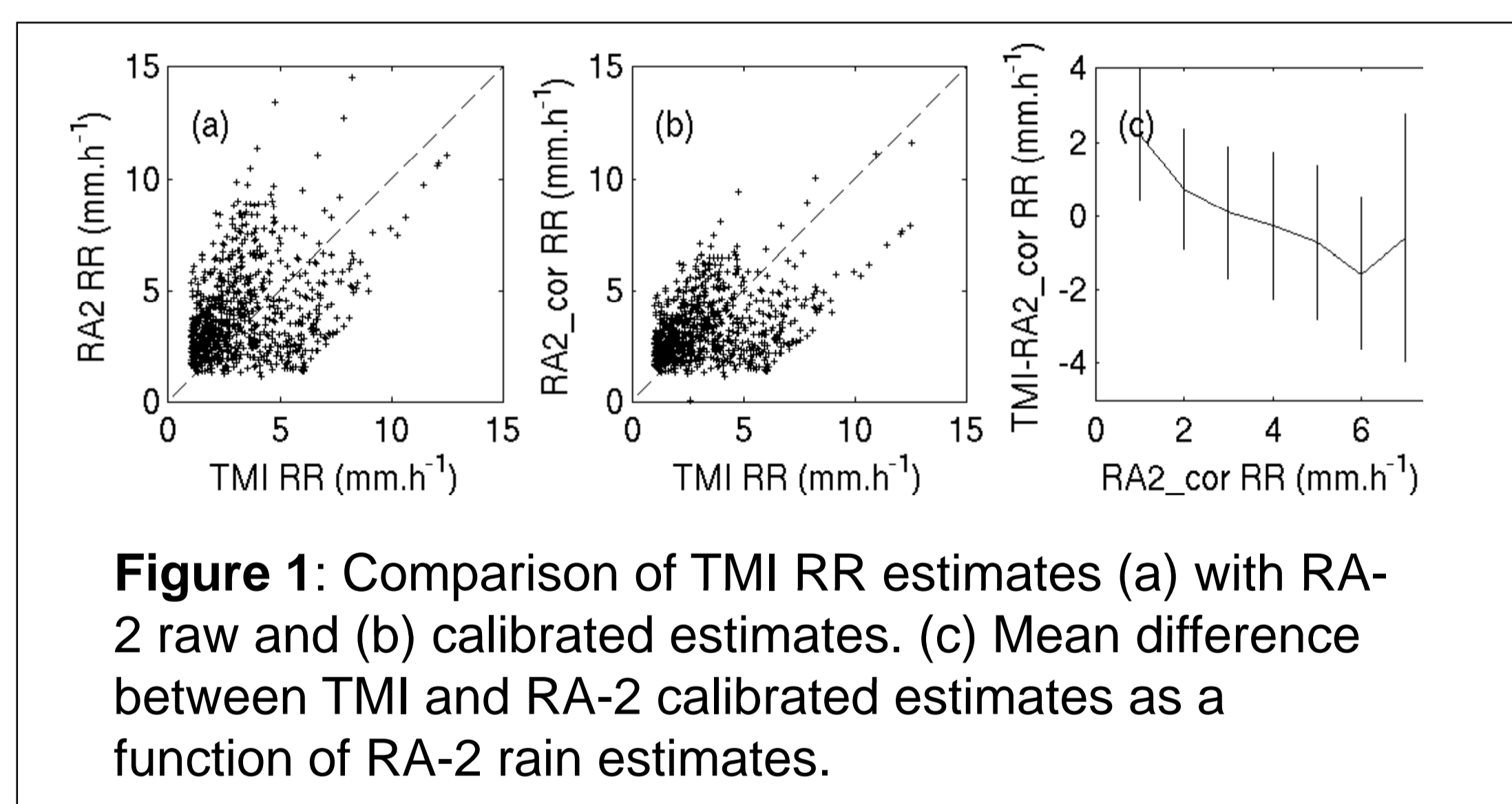


Figure 1: Comparison of TMI RR estimates (a) with RA-2 raw and (b) calibrated estimates. (c) Mean difference between TMI and RA-2 calibrated estimates as a function of RA-2 rain estimates.

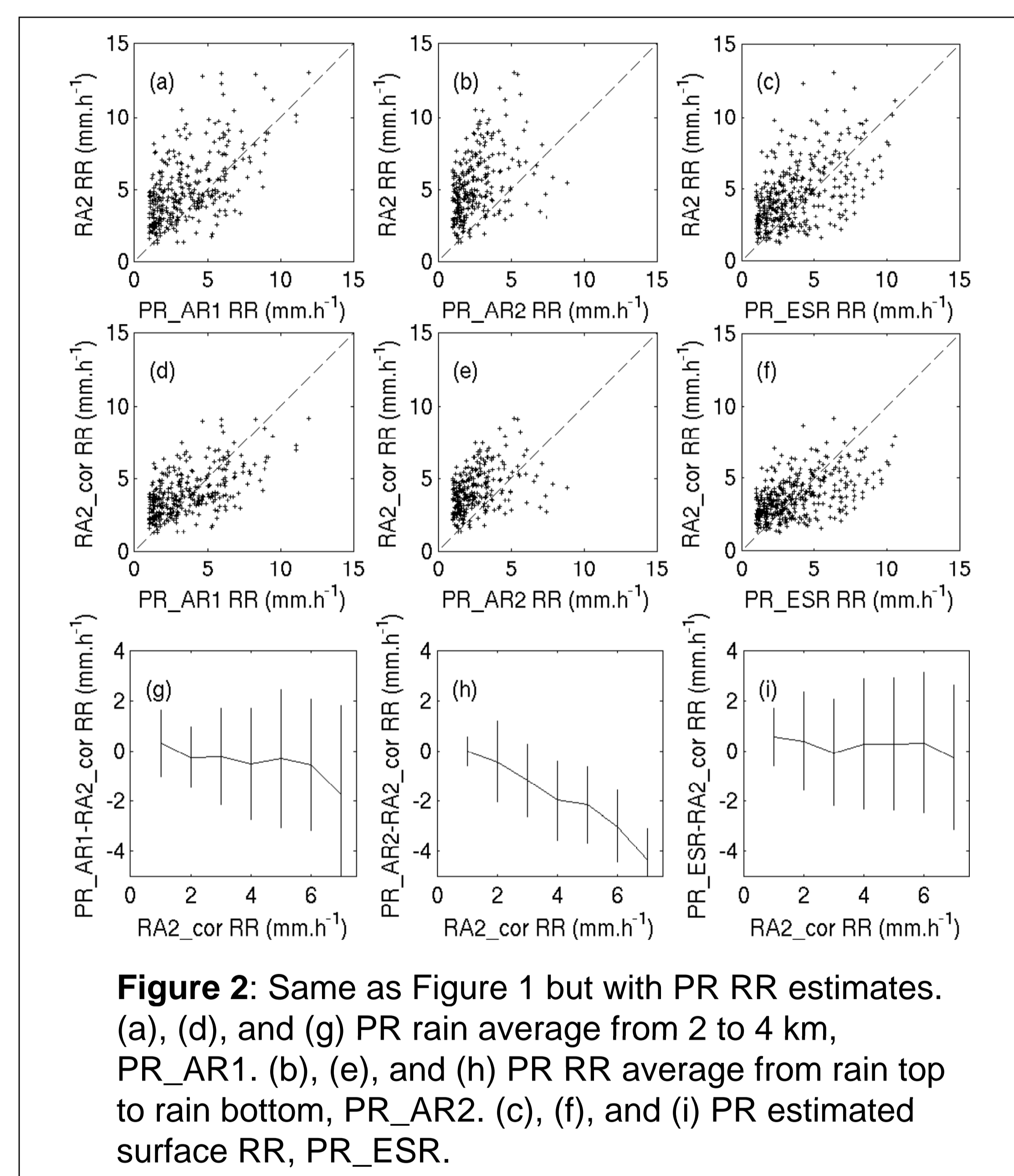


Figure 2: Same as Figure 1 but with PR RR estimates. (a), (d), and (g) PR rain average from 2 to 4 km, PR_AR1. (b), (e), and (h) PR RR average from rain top to rain bottom, PR_AR2. (c), (f), and (i) PR estimated surface RR, PR_ESR.

Table III: Mean difference and STD (in mm/hr) between the TMI (or PR) and RA-2 RR raw and calibrated values.

TRMM Sensor	TMI surface rain rate					PR_AR1				PR_AR2				PR_ESR				
	N	RA2 raw		RA2 corr.		N	RA2 raw		RA2 corr.		RA2 raw		RA2 corr.		RA2 raw		RA2 corr.	
		mean	std	mean	std		mean	std	mean	std	mean	std	mean	std	mean	std	mean	std
10 min, 10 km	833	-0.52	2.30	0.14	2.00	334	-1.42	2.06	-0.44	1.78	-2.65	2.05	-1.55	1.55	-0.91	2.07	-0.06	1.81
10 min, 5 km	655	-0.49	2.33	0.16	2.04	330	-1.41	2.04	-0.42	1.77	-2.63	2.05	-1.56	1.55	-0.90	2.05	-0.04	1.84
5 min, 5 km	350	-0.49	2.40	0.19	2.07	186	-1.40	2.06	-0.38	1.79	-2.85	1.87	-1.73	1.31	-1.04	2.07	-0.13	1.82
5 min, 2.5 km	158	-0.36	2.49	0.32	2.16	100	-1.51	2.05	-0.45	1.79	-2.93	1.79	-1.80	1.26	-1.26	1.97	-0.35	1.72
1 min, 5 km	64	-0.65	1.91	-0.07	1.80	48	-1.06	1.86	-0.24	1.58	-2.37	1.38	-1.54	1.01	-1.00	2.07	-0.12	1.86

References

- Ikai J. and K. Nakamura, "Comparison of rain rates over the ocean derived from TRMM microwave imager and precipitation radar", *J. Atmos. Oceanic Technol.*, 20, 1709-1726, 2003.
- Tournadre J., "Improved level-3 oceanic rainfall retrieval from dual-frequency spaceborne radar altimeter systems", *J. Atmos. Oceanic Technol.*, 23, 1131-1149, 2006.
- Tran N., J. Tournadre and P. Féménias, "Validation of Envisat rain detection and rain rate estimates by comparing with TRMM data", accepted for publication in IEEE GRSL on 26 June 2008, in press.