New retrieval algorithms for TOPEX-POSEIDON
Comparison with standard algorithms and validation

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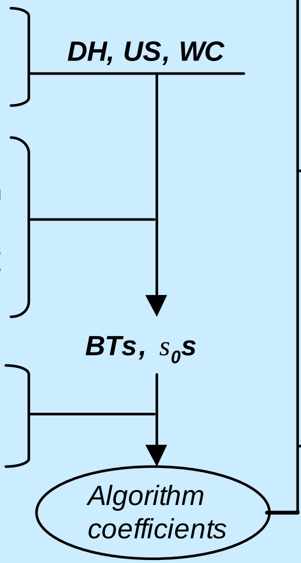
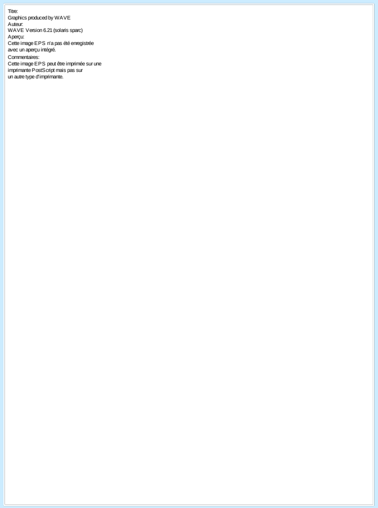
INTRODUCTION : The objective of this study is to propose a new set of retrieval algorithms for wet tropospheric correction (**dh**), cloud liquid water content (**clw**) and sea surface wind speed (**us**). These algorithms are formulated using regression on a representative database of geophysical parameters and corresponding simulations by a radiative transfer model. Validation is performed by comparison with radiosounding measurements for dh and us, and we propose a validation of the methodology in SSM/I configuration for clw.

Database : The database consists of 12 global meteorological fields from the European Center for Medium range Weather Forecast, containing both analyses and guesses of surface and atmospheric parameters (sea surface temperature, surface wind speed, profiles of temperature, pressure, water vapor, cloud liquid water content). These parameters are given in 1.125x1.125 degree meshes (Bourras et al, 99).

Radiative transfer model : The radiative transfer model is composed of an atmospheric model (Liebe 93 for water vapor and oxygen absorption, Rayleigh approximation for absorption by clouds) and of a sea surface model. The latter was developed at the Université Catholique de Louvain by Guissard and Sobieski (1987) and recently improved by Lemaire (1998). This double scale electromagnetic model is associated to the sea spectrum proposed by Elfouhaily (1997) and allows us to compute brightness temperatures (**BTs**) and corresponding backscattering coefficients (**s_0s**). Sea water permittivity follows Guillou et al (1998) formulation and foam effect in active and passive modes (cover and permittivity) are described by Monahan and Lu (1990) and Droppleman (1970) models.

Multi-linear regression : A gaussian noise is added to the brightness temperatures and backscattering coefficients. After choosing the form of the algorithms, a multi-linear regression is applied, providing coefficients involved in each algorithm.





Preliminary adjustement between simulations and measurements : This is done through a systematic comparison between measurements made by TOPEX and simulations by the radiative transfer model on coincident meteorological fields. These fields contain surface and atmospheric parameters in meshes of 1.125°x1.125°. Satellite measurements are averaged in any grid mesh within an accuracy of +/- 2 hours in time , thus similar to the temporal window used for assimilation in the model.

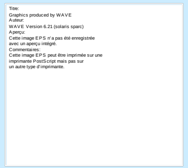
Before comparison we exclude some points in order to avoid contamination by cloud : a preliminary clw algorithm is applied on the measured brightness temperatures and pixels corresponding to an integrated liquid water content up to 20 mg/cm2 are excluded. In the same way, meshes where clw predicted by the meteorological model is up to the same threshold are excluded.

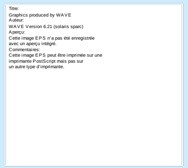
$$TBsim_{18} = TBsim_{18} + 0.05K$$
$$TBsim_{21} = TBsim_{21} - 1.70K$$
$$TBsim_{37} = TBsim_{37} - 1.75K$$
$$\sigma sim_C = \sigma sim_C + 1.04dB$$
$$\sigma sim_{Ku} = \sigma sim_{Ku} - 1.42dB$$

All radiosoundings available at ECMWF for 1997 and 1998 have been extracted. We have made a systematic comparison between radiosounding measurements and retrieved geophysical parameters. Coincidence criteria are +/- one hour in time and +/- 0.5° in space. Statistic parameters used for the comparisons are the number of points, the mean bias, the correlation factor, the standard deviation, and the equation of the regression line.

dh algorithm

$$dh(cm) = 32.3183 + 61.3538 * \ln(280. - TB_{18}) - 78.2221 * \ln(280. - TB_{21}) + 10.8793 * \ln(280. - TB_{37})$$
$$+ \text{dry atmosphere correction : if } dh \leq 8\,cm,\ dh = 1.25dh - 2cm$$

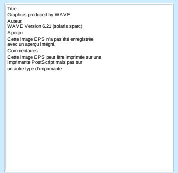


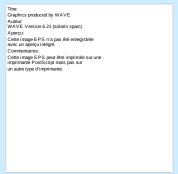


Dh classes (cm)	Number of points	Algo.	Bias (cm)	Cor. Coeff.	Stdev. (cm)	Reg. Coeff.	
	2027	GDR PRO	0.06 0.03	0.99 0.99	1.38 1.33	0.003 0.02	1.03 1.00
dh<5	*470*	GDR PRO	0.05 0.01	0.98 0.98	0.70 0.75	0.001 0.001	1.03 1.05
5<dh<10	*729*	GDR PRO	0.019 0.019	0.99 0.99	1.01 0.93	-0.002 -0.0006	1.04 1.04
10<dh<15	*451*	GDR PRO	0.014 -0.004	0.99 0.99	1.49 1.40	0.002 0.002	1.02 0.99
15<dh<20	*154*	GDR PRO	-0.001 -0.001	0.99 0.99	2.18 2.18	-0.0004 -0.0003	0.998 0.964
20<h<30	*127*	GDR PRO	0.01 0.002	0.997 0.997	2.07 1.92	0.015 0.013	1.03 1.002
h>30	*143*	GDR PRO	0.01 0.001	0.997 0.997	2.46 2.47	0. 0.	1.02 1.004

us algorithm

$$us(m.s^{-1}) = -0.444783 + 1.33214.10^9 * \left(\frac{1}{\sigma_C}\right)^7 - 1.53524.10^7 * \left(\frac{1}{\sigma_{Ku}}\right)^7$$





Us classes (ms^{-1})	Number of points	Algo.	Biais (ms^{-1})	Cor. Coeff.	Stdev. (ms^{-1})	Reg. Coeff.	
	1830	GDR PRO	-0.03 0.001	0.97 0.96	2.22 2.48	0.04 0.04	0.96 0.98
us<5	*274*	GDR PRO	-0.001 0.005	0.82 0.83	2.14 2.22	0.001 0.001	0.97 1.05
5<us<10	*847*	GDR PRO	0.02 0.03	0.97 0.97	1.88 1.96	0.005 0.006	1.03 1.04
10<us<15	*519*	GDR PRO	-0.02 -0.02	0.98 0.97	2.37 2.84	0.004 0.004	0.96 0.95
15<us<20	*182*	GDR PRO	-0.02 -0.01	0.99 0.98	2.26 2.95	0.001 0.001	0.92 0.96
20<us	*8*	GDR PRO	-0.006 -0.002	0.89 0.89	11.82 11.38	0.001 0.001	0.67 0.87

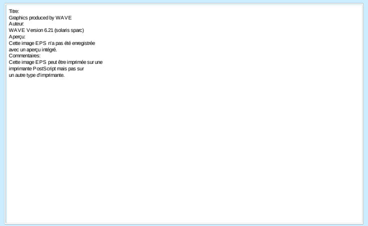
clw algorithm

$$clw(mg.cm^{-2}) = 280.966 + 112.163 * \ln(280. - TB_{18}) + 53.5164 \ln(280. - TB_{21}) - 230.339 * \ln(280. - TB_{37})$$

Since there is no cloud liquid water content measurement made by radiosounding, we validate the methodology in SSM/I configuration. We have used exactly the same methodology (same database, same radiative transfer model) to compute dh, us and clw retrieval algorithms in SSM/I configuration. A systematic comparison of clw retrieved from shipborne radiometer and from SSMI has been performed in the framework of CLOREVAL (Eymard, 1999).

Proposed algorithms

Standard algorithms



CONCLUSIONS : We propose a new method to formulate retrieval algorithms. A first adjustment between measurements and simulations is realized in order to correct errors coming from calibration problems, from inacurracy in the radiative transfer model or from modification of the meteorological model (assimilation of new data for example). The radiative transfer model is applied on a global and representative database of geophysical parameters. Coefficients involved in each algorithm are then obtained through a multi-linear regression. For wet tropospheric correction and surface wind speed, validation is performed by comparison with radiosounding measurements. Proposed algorithms performances are equivalent to standard ones and sometimes better, for very dry atmosphere or high wind speed conditions. A validation of the methodology in SSM/I configuration is presented, especially for clw retrieval since there is no in-situ measurement. Proposed algorithm for clw is as good as one of the best tested during the CLOREVAL experiment. Results obtained for dh and us are also very satisfactory, since proposed water vapor algorithm is as good as Alishouse one and obtained wind speed algorithm fit better direct measurements made on the ship.