In-flight calibration/validation of ENVISAT and JASON radiometers

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Calibration methodology

Extraction of 6 global ECMWF analyses at 12:00 for April and May 2002

Global meteorological fields interpolated from the European Center for Medium range Weather Forecast (ECMWF), containing analyses and geophysical surface parameters (temperature, pressure and wind) and profiles of atmospheric parameters (pressure, temperature, contents of water vapor and cloud liquid water content). Parameters given in meshes of 0.5x0.5 degrees all over the globe.

Validated brightness temperatures and backscattering coefficients if available :
TOPEX TB18, TB21, TB37, σ^0_{Ku},σ^0_C
JASON TB18.7, TB23.8, TB34, σ^0_{Ku},σ^0_C
ERS TB23.8, TB36.5
ENVISAT TB23.8 TB36.5

Extraction of Radiometer measurements between 11 a.m. and 1 p.m.

Selection of meshes for which measurements are available

Other processings give similar results

Average of measured brightness temperatures in each mesh

Simulations of brightness temperatures

Use of a preliminary algorithm obtainedwith linear regression over a representative database

Exclusion of cloudy pixels

Exclusion of cloudy meshes

Meshes with a predicted integrated liquid water content > 20 mg/cm2 are removed

Comparison bewteen measurements and simulations for brightness temperatures for backscattering coefficients if available

Radiative transfer model

Atmospheric model
The radiative transfert through the atmosphere is described with Liebe MPM model for gaseous absorption by oxygen and water vapor , and Rayleigh theory for absorption by cloud liquid water.

Double-scale model (UCL model)
This model has been developed at the Université Catholique de Louvain by Guissard and Sobieski, and recently improved by D. Lemaire. Small structures (capillary waves, small gravity waves) are superimposed on the large undulations (gravity waves). The scattering coefficients are expressed as the sum of two contributions. The first term concerns the large scale and is given by the geometric optics solution and the second term results from the average of the scattering coefficients due to the small irregularities over the large-scale slope distribution. This electromagnetic approach is combined to the sea surface spectrum proposed by T. Elfouhaily.

The foam contribution
The foam is represented as a porous dielectric layer of water and air. The sea surface emissivity is corrected using the thickness of the foam layer (fixed at 1 cm), the foam emissivity (Droppleman model) and the foam coverage rate (Monahan model).

The sea water permittivity
We use the Debye model for sea water in natural conditions, validated using both spaceborne and airborne radiometer data (Guillou et al).

Geophysical algorithms formulation

Meteorological fields interpolated from ECMWF : Integrated water vapor content, Integrated cloud liquid water content, Atmospheric attenuation for backscattering coefficients

Constitution of a representative database with several ECMWF analyses at 12:00

3 diurnal analyses (one per season) representative by in latitude

Simulations of brightness temperatures and backscattering coefficients with the UCL model

Simulations of brightness temperatures and backscattering coefficients

Regression for the computation of the algorithms

Classical log-linear regression

Pxdh or wv or wc or att

For TOPEX :
P = c0 + c1 ln(280.-TB18.0) + c2 ln(280.-TB21.0) + c3 ln(280.-TB37.0)

For JASON :
P = c0 + c1 ln(280.-TB18.7) + c2 ln(280.-TB23.8) + c3 ln(280.-TB34.0)

For ERS2 :
P = c0 + c1 ln(280.-TB23.8) + c2 ln(280.-TB36.5) + c3 (U-7.)

For ENVISAT :
P = c0 + c1 ln(280.-TB23.8) + c2 ln(280.-TB36.5) + c3 / (σ^0_{Ku})²

Neural network inversion

Pxdh or wv or wc or att

For TOPEX :
P =f(TB18.0,TB21.0,TB37.0)

For JASON :
P = f(TB18.7,TB23.8,TB34.0)

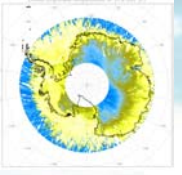
For ERS2 :
P =f(TB23.8,TB36.5,U)

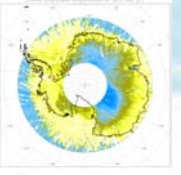
For ENVISAT :
P = f(TB23.8,TB36.5 ,σ^0_{Ku})

Calibration over continental areas

Intercalibration over ocean

Brightness temperatrures over South Pole





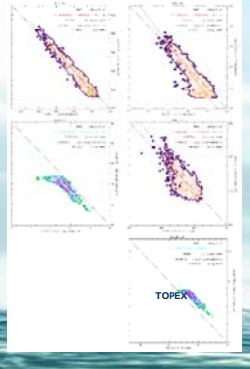
Selection of 4 geographical areas (2 cold and 2 hot) :

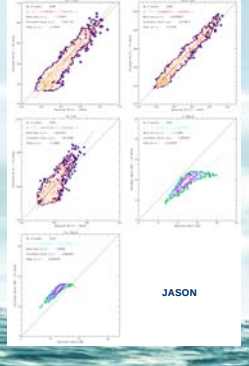
- interannual stability
- weak spatial variability in the area
- weak annual cycle
- very dry atmosphere

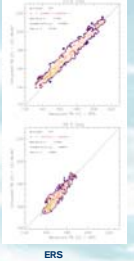
➨ Greenland glacier : 65 66N ; 47.5 46 O
➨ Sahara desert : 19 21 N ; 6.5 4.5 O
➨ Amazonian forest : 6.5 4. S ; 67.5 65.5 O
➨ Antarctic plateau : 81.3 81 S, 116 117 E

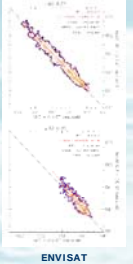
All the measurements falling in these areas for ERS2, Envisat, Jason (23.8 GHz) February and May 2002

	ANTARCTIC	GREENLAND	SAHARA	AMAZONIAN
TMR/18.0 GHz		160.7	274.4	280.8
JMR/18.7 GHz		161.0	273.5	280.8
TMR/21.0 GHz		156.2	272.3	279.4
JMR/23.8 GHz		157.0	270.1	278.2
ERS/23.8 GHz	196.0	157.2	269.7	278.3
ENV/23.8 GHz	197.0	157.4	269.7	278.4
TMR/37.0 GHz		169.4	266.4	280.0
JMR/34.0 GHz		167.6	268.4	279.6
ERS/36.5 GHz	196.2	167.3	268.1	279.2
ENV/36.5 GHz	196.2	167.5	268.2	279.2

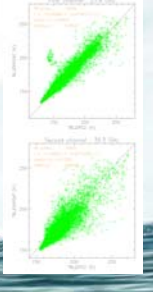


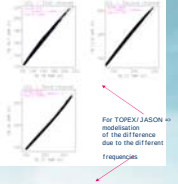




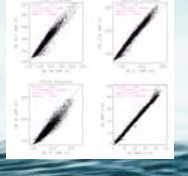


For ERS2/ENVISAT ⇔ direct intercalibration





For TOPEX/JASON ⇔ modelisation of the difference due to the different frequencies



Jason-1 Science Working Team Meeting
Biarritz, June 2002

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