A new ERS-2 level 2 product at CTOH

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We have reprocessed the ERS2 altimeter data from ESA's waveform altimeter product (WAP) to a new level 2 product. This implies a large number of improvement and corrections to make it compatible with the ENVISAT's v2.1 product; validations are described in the companion poster. Here we show the validation of the whole dataset for ERS2 and compare it to the ENVISAT and REAPER's ERS-2 product in terms of performance and of geophysical signals. The resulting product will be made available to the community through the Aviso+ distribution portal.

CTOH ERS-2 retracking for land surfaces

Land surface Altimetric Product

The goal of CTOH's new altimetric product is to provide global altimetric data using two standard retracking methods, ice-1 and ice-2. Even though the data has global coverage, we have calculated corrections that are suited specifically for land surfaces (e.g. the doppler slope correction). The validation of the product is presented in the companion poster «ERS-2 ENVISAT cross-validation» (Légresy et al.).

Altimetric Corrections

We strive to provide up-to-date homogenous corrections so as to be able to compare ERS-2 data series with other altimetric missions, particularly Envisat. We have computed Ice-1 and Ice-2 parameter large-scale inter-mission functions, by cross-validation processing during the between ERS-2/Envisat tandem phase (cycles 75 to 85). For Ice-1 we provide them for backscatter and range (ice1_sig0_corr_20hz and ice1_range_corr_20hz) and for Ice-2, for backscatter, range, leading-edge width and trailing edge slope (ice2_sig0_corr_20hz, ice2_range_corr_20hz, ice2_le_width_corr_20hz, ice2_1st_te_slope_corr_20hz).

DOPPLER CORRECTIONS

- **Doppler orbit correction:** computed from the improved REAPER combined orbit [8] variation.
- **Doppler range correction:** computed from the altimetric range [1].

GEOPHYSICAL CORRECTIONS

- **Doppler Slope correction:** computed along track from the altimetric range [1].
- **Ocean tides:** GOT 4.7, FES 2004 and *FES2013* solutions
- **Inverse barometer:** **MOG2D solution**: barotropic ocean response to ECMWF wind and surface pressure forcing (6h), calculated using the MOG2D barotropic model. Includes the total non-isostatic ocean response to surface forcing.[7]. **ECMWF solution** calculated from 6-hourly ECMWF surface pressure data and referenced to the global mean surface pressure over the oceans and sea-ice.
- **Solid earth tide:** Cartwright Edden Tayler model.

METEOROLOGICALCORRECTIONS

- **Ionospheric correction:** NIC09[4] and **GIM** models
- **Dry tropospheric correction 20hz:** Dry tropospheric correction computed based on the altimetric range and using ECMWF ERA Interim meteorological field [2].
- **Wet tropospheric correction 20hz: MODEL** solution: Wet tropospheric correction computed based on the altimetric range and using ECMWF ERA Interim meteorological field. **CLS** solution: Wet troposphere correction calculated by CLS over the continents using NCEP data. Wet troposphere correction over the continents is either incorrect or not available on MGDRs.[3]

Other Corrections

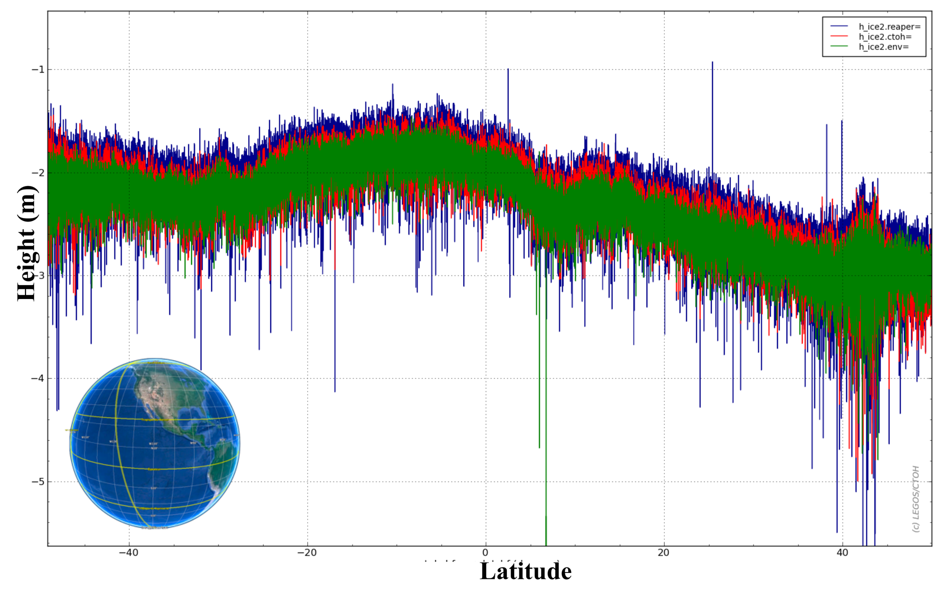
PASS REFORMATTING: The CTOH product data are split by passes using exactly the same convention as that of the ENVISAT product, greatly simplifying comparison between them.

TIME CONTINUITY: Overlapping or non-monotonic time values were deleted.

Comparison with REAPER product

The REAPER product is more ocean-oriented and has implemented 4 retrackers; we only have implemented two of them. Despite having a land-surface goal, we have validated and corrected backscatter estimations for ice-2 based on the ocean. The figure below shows along-track height (altitude – range) for track 11 (envisat numbering) along the Pacific Ocean (for location see globe inset).

	REAPER	CTOH
Retrackers	ocean, ice1, ice2, seaice	ice1, ice2
Iono	Gim, NIC_09	Gim, NIC09
Wet tropo	Wet tropo cls with NCEP	Wet tropo cls with NCEP
	Wet tropo from ECMWF	
	From MWR radiometer	From MWR radiometer
Dry tropo	From model ECMWF	From model ECMWF ERA Interim and based on altimetric range at 20hz (Blarel and Legresy 2013).
Solid earth tide	Cartwright	WAP from Cartwright
Pole tide	Wahr	*Wahr*
Ocean tide	GOT47, FES04	GOT48, FES04, *FES2013*
Inv bar	ECMWF, mog2d	ECMWF, Mog2D
Mean sea surface	CLS01, UCL04	CNES_CLS_11
Geoid	egm2008	eigen6c3 (2013)
File split by	data dump	pass (as Envisat)



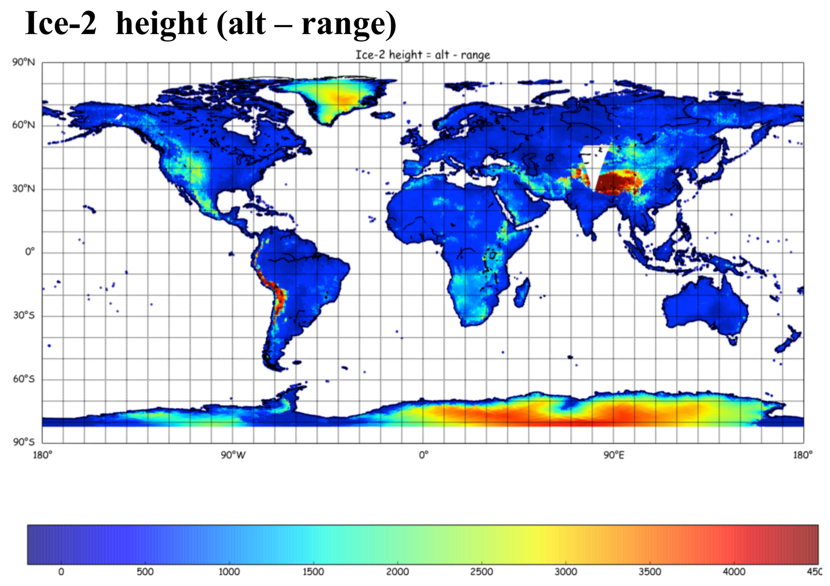
The figure on the left shows 3 distinct plots: The biggest one, blue on the background is **REAPER** data for ERS-2 cycle 80; the red plot is **CTOH** height for the same cycle; on top of tem is the green plot of **Envisat** (tandem phase, 34 minutes ahead of ERS-2). Lowest RMS is Envisat (0.406m), followed by CTOH (0.417m) and REAPER (0.446).

Ice-2 Parameters

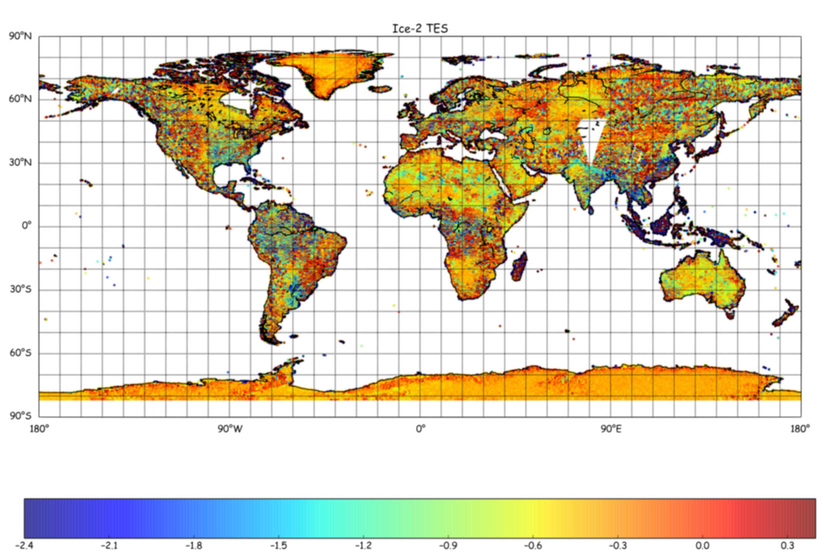
The Ice-2 retracking algorithm (Legresy et al.,2005) provides 4 output parameters: the range, the backscatter(sigma0), leading-edge width (LEW), and trailing edge slope (TES).

We show below the global behaviour of 3 of the 4 parameters of the Ice-2 retracker for cycle 80. The trailing edge slope is related to the specularity in echoes, medium penetration and slope effects; over deserts and sparsely vegetated areas, the trailing edge slope is expected to increase.

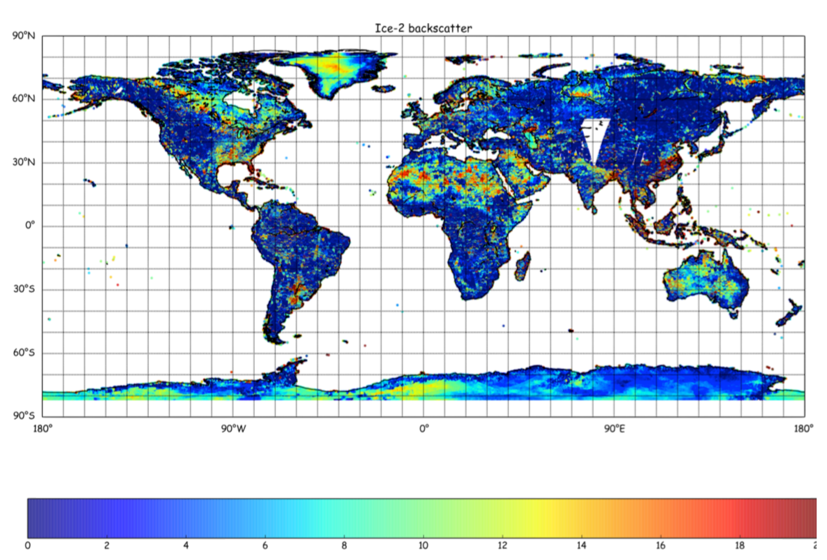
Ice-2 height (alt – range)



Ice-2 trailing edge slope



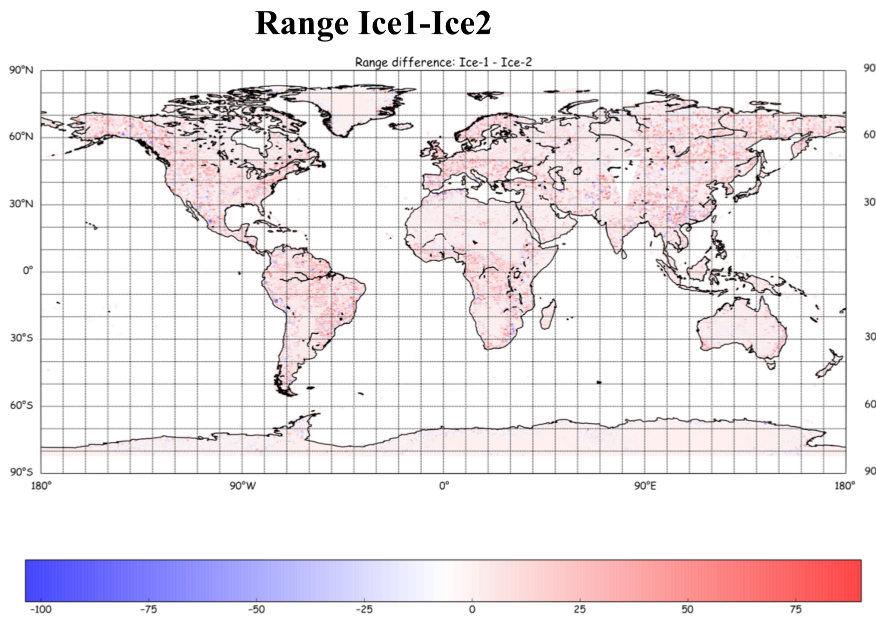
Ice-2 backscatter



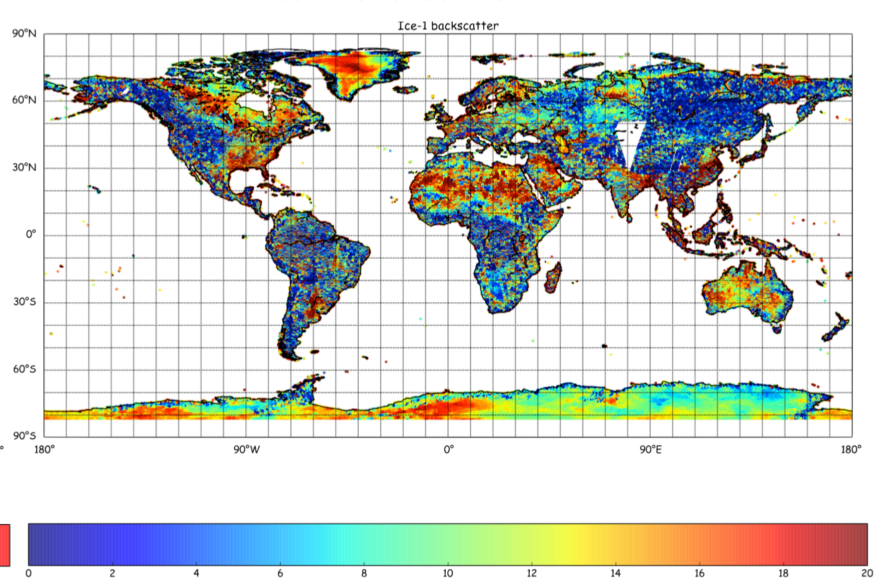
Ice-1 parameters

The Ice-1 retracking algorithm provides 2 output parameters: the range and the backscatter. With the color scale of the Ice-2 range above, the map looks exactly the same; we rather plot the difference range_ice1-range_ice-2 and is shown left, with values between -100 and 90 m. The backscatter is shown at right.

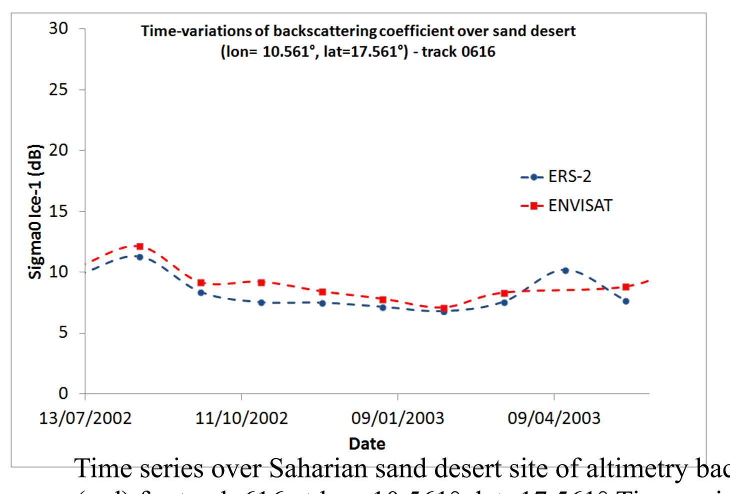
Range Ice1-Ice2

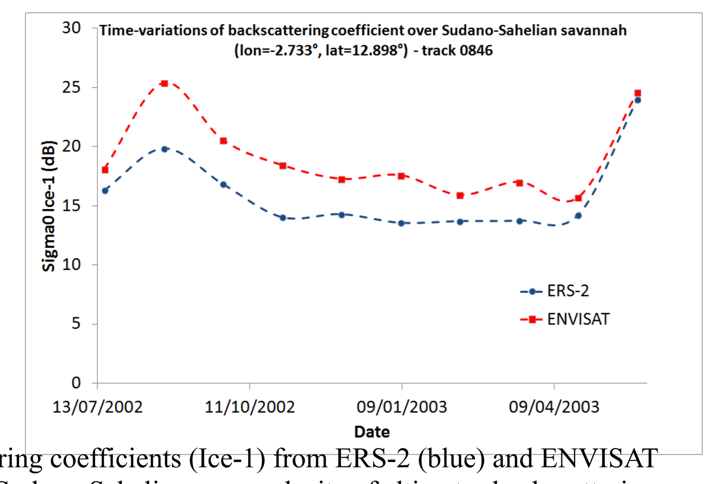


Ice-1 backscatter



Backscatter time series





Time series over Saharian sand desert site of altimetry backscattering coefficients (Ice-1) from ERS-2 (blue) and ENVISAT (red) for track 616 at lon=10.561°, lat=17.561°.Time series over Sudano-Sahelian savannah site of altimetry backscattering coefficients (Ice-1) from ERS-2 (blue) and ENVISAT (red) for track 846 at lon=-2.733°, lat=12.898°.

Altimetry backscattered responses present low variability over sand desert with a mean backscattering around 10 dB. The small differences may be accounted for the different sand dunes pattern below the satellite paths from one cycle to another (Fatras et al., under revision).

Savannahs are characterized by a strong seasonal signal in rainfall, soil moisture (SM), and vegetation, whose amplitude and duration increase from North to South of West Africa. A marked seasonal signal can be observed in the radar backscattering responses. In the core of the dry season, from November to April, there is almost no rainfall, low SM and almost no vegetation dynamics. The altimetry backscattering coefficient remains constant. During the rainy season, rainfall trigger an increase of SM and consequently vegetation activity causing an increase of the backscattering coefficient that can reach more than 15 dB (Fatras et al., 2012 and under revision).

Fatras C., Frappart F., Mougin E., Grippa M., Hiernaux P. (2012). Estimating surface soil moisture over Sahel using ENVISAT radar altimetry, Remote Sensing of Environment, 123(8), 496-507, doi:10.1016/j.rse.2012.04.013.

Fatras C., Frappart F., Mougin E., Frison P-L., Faye G., Borderies P., Jarlan L. (under revision). Spaceborne altimetry and scatterometry backscattering signatures at C- and Ku-band over West Africa, Remote Sensing of Environment.

Dissemination and Demonstration Product

The final validation of the product is underway; a demonstration cycle (cycle 80, part of the tandem phase ERS-2/Envisat) is available at http://ctoh.legos.obs-mip.fr/products/ers-data

In order to improve the synergy between the CTOH research service and the operational service at AVISO/CNES, a joint project has been conducted over the past years with CNES. A common web portal for altimetry (AVISO+), based on the operational AVISO service and the research and development CTOH service is open since February 2014 at http://www.aviso.altimetry.fr

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http://www.legos.obs-mip.fr

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