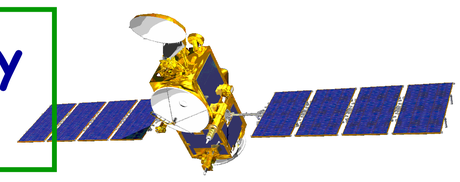
Prototype Innovant de Système de Traitement pour les Applications Côtières et Hydrologiques

PISTACH

Recent Improvements in the Processing of JASON-2 Altimetry Products for Continental Waters (PISTACH Project)



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OVERVIEW

The core of the PISTACH (Prototype Innovant de Système de Traitement pour les Applications Côtières et l'Hydrologie) prototype consists in several algorithms dedicated to the processing of Jason-2 altimetry data over coastal areas and continental waters.

Over continental waters, the altimeter waveforms are highly perturbed by emerged lands within the radar footprint. Nearly specular echoes are also frequently encountered. Dedicated retracking algorithms are required to properly retrieve the altimetric range and possibly other waveforms parameters. The retracking strategy (classification of the waveforms + multi-retracking) implemented in the PISTACH prototype is presented along with preliminary results on Jason-2 data.

The wet tropospheric correction, that is also crucial over continental waters, cannot be computed from the onboard radiometer because the land emissivity overwhelms the signal coming from water bodies. The model backup correction has proved to be not accurate enough over continental waters. Therefore we developed for PISTACH a new wet tropo model correction based on a more accurate integration of the atmospheric parameters.

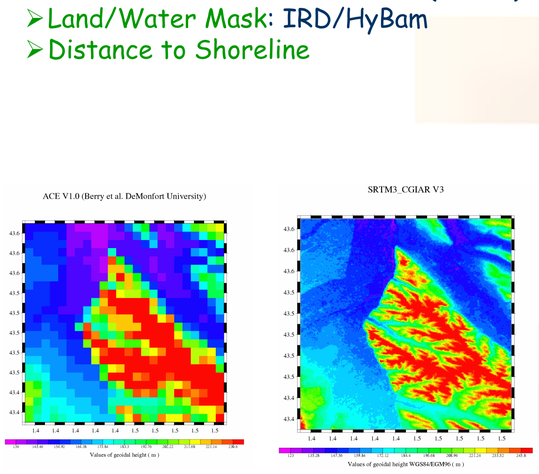
The PISTACH "hydrological" products, that are additionally enriched with state-of-the-art geophysical parameters (geoid, DEM, land cover class, Land/water mask, …) are presented.

The implementation of the prototype is now completed and **products in V1.0 are accessible** since cycle 12 of Jason-2.

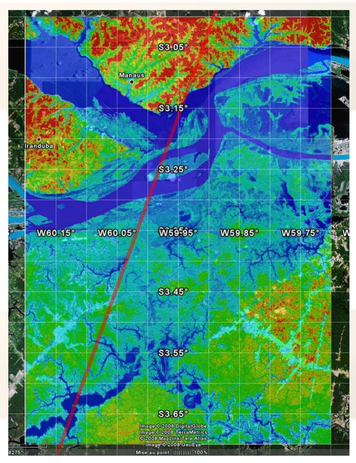
GEOPHYSICAL CORRECTIONS – LOCAL MODELS

The **PISTACH** products include **several** state of the art geophysical corrections as well as higher resolution global/local models, in addition to the content of standard Jason2 I-GDR. For the continental part of the prototype, the following data sets have been selected and corresponding values are computed for each 20Hz altimetric measurement:

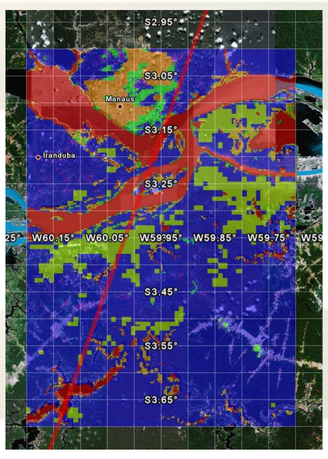
- Geoid: EGM2008 (Pavlis 2008, NGA)
- DEM: SRTM3_CGIAR (Jarvis et al. 2008, http://srtm.csi.cgiar.org) to be replaced by ACE2 (3"arc)
- Land Cover Class: GLOBCOVER (10"arc) (ESA Globcover Project, led by MEDIAS-France)
- Land/Water Mask: IRD/HyBam
- Distance to Shoreline



Left: ACE V1.0 DEM around the city of Toulouse (France) with a resolution (1/120°) similar to the DEM used for standard Jason-2 GDR.
Right: SRTM3_CGIAR DEM over the same area with the resolution (1/1200°) used for PISTACH products



SRTM3_CGIAR topography over the Amazon near the city of Manaus (superimposed on GoogleEarth plot with Jason-2 track # 63)



GLOBCOVER Land Class model over the Amazon near the city of Manaus (superimposed on GoogleEarth plot with Jason-2 track # 63)

WET AND DRY TROPO CORRECTIONS

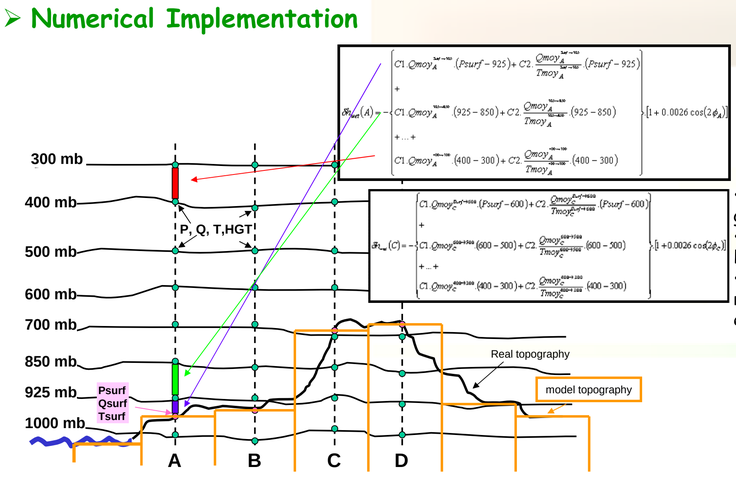
Over land, the radiometer correction is erroneous and the ECMWF model geometry does not restitute small-scale topography, especially over water bodies in mountaineous terrains.

Basic formula (wet tropo)

$$\delta h_{wet} = -\left\{1.116454\,10^{-3}\int_{Psat}^{Psurf} q\,dp + 17.66543928\int_{Psat}^{Psurf}\frac{q}{T}\,dp\right\}.[1+0.0026\cos(2\phi)]$$

with
- δh_{wet}: wet tropo. correction (m)
- q: specific humidity (kg/kg)
- p: atmospheric pressure (hPa)
- Psurf: surface atm. pressure
- Psat: atm. press. at the satellite
- T: air temperature (K)
- Φ: latitude

Numerical Implementation



Description of the ECMWF model outputs used in this study

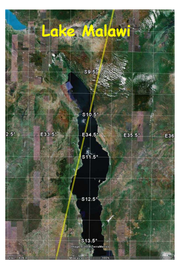
- N400 (~0.25°x0.25°) 4x-daily gaussian grids
- Required fields available on 91 hybrid levels + surface fields
- Surface values recomputed at the real altitude: interpolation/ extrapolation/specific formulae

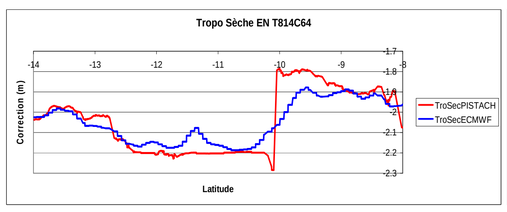
The **wet tropospheric correction** is recomputed from ECMWF 3D meteo fields with the bottom (and thus thickness) of the atmosphere column given by each altimetric measurement.

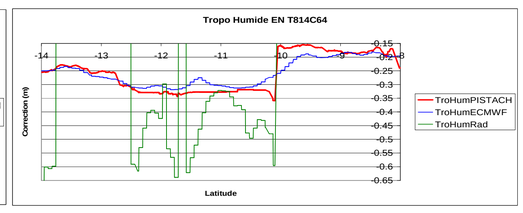
Similar considerations apply to the **dry troposphere correction**, that is computed using the Saastamoinen formula:

$$\Delta h_{dry} = -0.002277 * P_{surf} * (1 + 0.0026*\cos(2*\Phi))$$

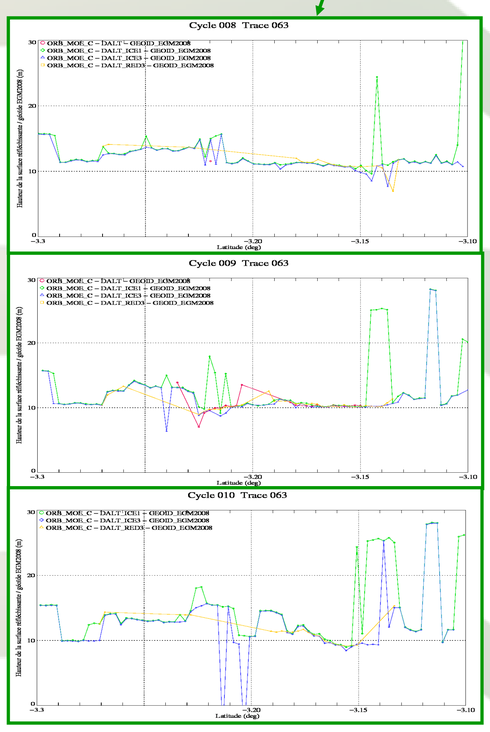
Φ: latitude Psurf: surface pressure computed as explained above.







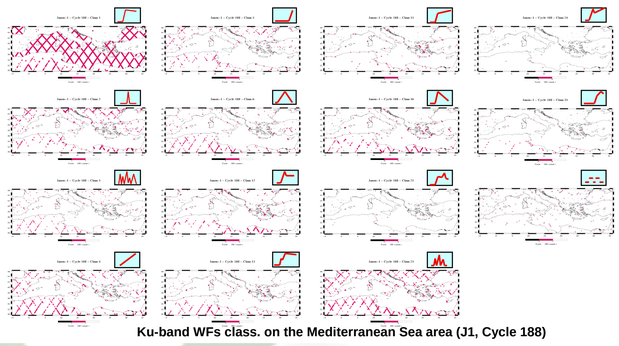
WAVEFORM RETRACKING



Altimeter echoes (waveforms) are highly perturbed by emerged lands wrt. open ocean returns and thus require a dedicated retracking strategy.

Within **PISTACH**, the retracking is organized around the following steps:

- Classification of the waveforms



Ku-band WFS class. on the Mediterranean Sea area (J1, Cycle 188)

- Filtering of the waveforms (only before MLE4 retracking)
- Application of 4 different retrackings:
  - Ice1: position of the center of gravity of the echo
  - Ice3: ~Ice1 but restricted to a portion of the echo indicated by the classification
  - Oce3: MLE4 retracking after filtering of the waveforms
  - Red3: MLE3 retracking restricted to a portion of the echo indicated by the classification

The 20Hz retracking ouputs (class, ranges, sigma0, SWH, …) are included in the **PISTACH** products.

The figures on the left show early Jason-2 results over the Amazon near the city of Manaus.
The main river beds (Rio Solimoes in blue/brown and Rio Negro in black) are located between 3.32°S and 3.12°S along track # 063 (green rectangle).
A smaller water body is identified by the orange rectangle.
For cycle 8 (September 2008), waveforms are acquired all along this track segment, indicating a much better tracking strategy for Jason-2 than for Jason-1.
Epochs, i.e. the displacement of the leading edge of the echo wrt. the tracker nominal gate, are presented for the 4 retracking algorithms implemented in the prototype. The backscatter coefficient (Sigma0) deduced from these retracking are also presented. Sigma0 is often superior to 20 dB over inland water bodies (about 12 dB over the ocean).

Finally, the height of the reflecting surface is reconstructed on the Rio Negro and Rio Solimoes for the 4 retrackings and for cycles 8, 9 and 10. As the levels of these 2 rivers decrease by about 2 to 3 meters for that period, one can distinguish the emergence of banks/islands that are usually submerged during the high-water season. The Ice3 algorithm seems to give the best results for that example.

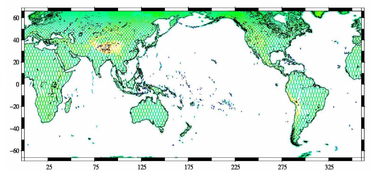
PRODUCTS

Version 1.0

- **Experimental** products ➔ feedback from users welcome and product assessment to be pursued !
- High resolution along-track products: 20 Hz sampling rate, 1 file per track, no editing
- Format (NetCDF) and variables/files nomenclatures similar to standard Jason2 I-GDR
  - ➔ **PISTACH** products easily handled by Jason-2 GDR users
  - ➔ extensive variable description in the headers
- ~ 80 additional fields wrt to standard Jason2 I-GDR
- I-GDR fields interpolated/copied at 20Hz
- CALVAL report to be issued for each cycle

- 2 products:
  - « **Coastal** »: whole ocean + 25 km fringe over lands → ~ 7 Go/cycle (uncompressed)
  - « **Hydro** »: all emerged lands + 25km fringe over oceans ~ 3 Go/cycle (uncompressed)

Coverage of the « Hydro » product



Data Access: ➔ **ftp://ftpsedr.cls.fr/pub/oceano/pistach/**

Future evolutions

- Possibility of adding new fields (land/water masks, snow cover climatology ….).
- Conception of a lighter, easy-to-use product and with primary editing → gain new users!

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2008 Ocean Surface Topography Science Team

Nice, November 2008

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