OSCAR: looking at continental surfaces with radar altimetry.

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Abstract : The OSCAR project (observing continental surfaces with radaraltimetry) intends to develop applications of the radar altimetry outside the ocean. It is based mainly on TOPEX, ERS and ENVISAT data. We processed the whole ERS2 mission dataset from WAP to retracked level using an equivalent of the ICE2 retracking procedure used on ENVISAT groundsegment. In addition to the ice caps, we show here applications to continental surfaces, snow depth survey, sea ice, inundated surfaces, lakes, rivers and ocean coastal zones.

The Ice2 retracking procedure :

The Ice2 retracker consists in detecting the waveform edge, fitting an erf function to the leading edge and an exponential function to the trail (Rémy & al. 1996, Legrésy and Rémy, 1997).

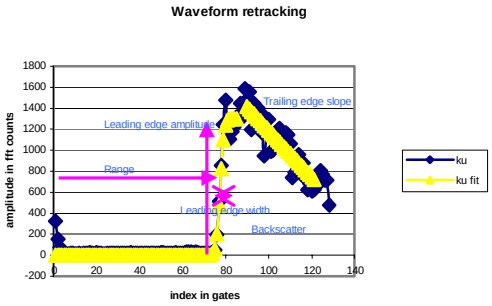


Figure 1 : All parameters output are computed in both Ku and S band. The result of this processing is available in the ENVISAT GDR products.

Application field: Time series of water stage

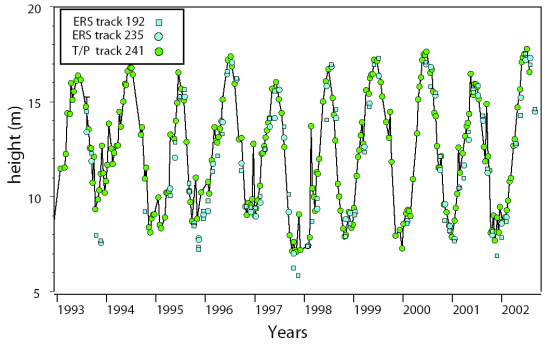
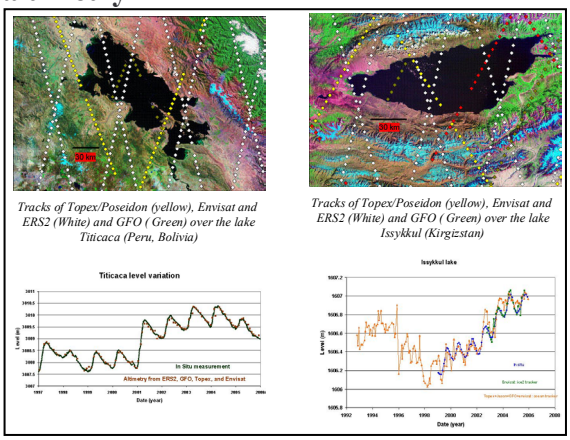


Figure 2 : Time series of water stage (Rio Negro, Amazon basin) established using the ERS1 & 2 ranges derived by the OSCAR project by retracking the radar "waveforms" bounced by the water free surface using the "ICE-2" algorithm.

There, the ERS ground track crosses the TOPEX/Poseidon one. The ERS-derived stage measurements are merged with the TOPEX ones to produce a series at high sampling rate.

Application field: Lake study from altimetry



Tracks of Topex/Poseidon (yellow), Envisat and ERS2 (White) and GFO (Green) over the lake Titicaca (Peru, Bolivia)

Tracks of Topex/Poseidon (yellow), Envisat and ERS2 (White) and GFO (Green) over the lake Issykkul (Kirgizstan)

Figure 3 : Water level time series for lakes Titicaca (left) and Issykkul (right).

- For Titicaca, figure shows that the agreement between In situ and altimetry is excellent: validation of the altimetry over lake surface.
- For Issykkul: figure shows that the agreement between in situ and altimetry increases when the Ice2 tracker is used.

Both lakes present good demonstration of quality of altimetry over inland seas or lakes: this may be good argument to use this technique when no in situ information are available.

Application field: Altimetry for the study of lake/sea ice.

Discriminating ice and open water using the combination of simultaneous active (altimeter) and passive (radiometer) microwave data.

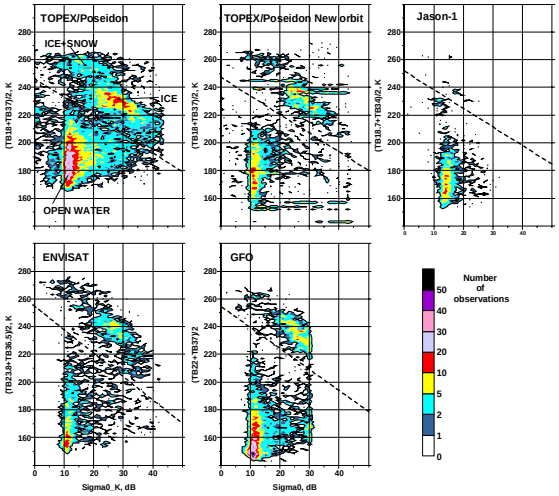


Figure 4 : Lake Baikal: 2D histograms (number of cases) for 1992-2002. Various altimetry missions in the space of backscatter coefficient versus the average value of temperature brightness at two frequencies.

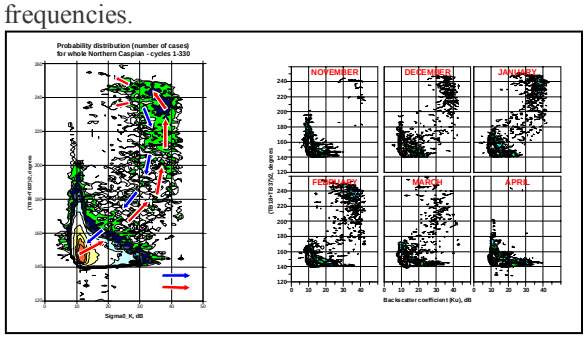


Figure 5 : Temporal evolution of observations in the 2D space (left) and developed and tested for Caspian (right) and aral seas and Baikal Lake.

Application field: ERS/ENVISAT radar altimeter measurements over continental sufaces and ice caps using the ICE-2 retracking algorithm.

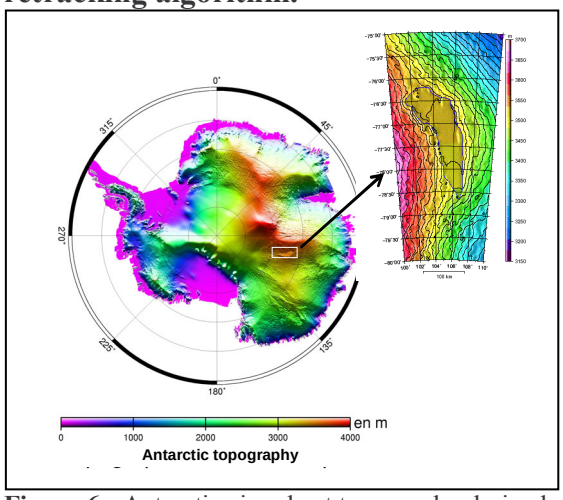


Figure 6 : Antarctica ice sheet topography derived from the ERS-1 geodesic orbit. Note details : such as : 20-km scale undulations, lakes, hydrological subglacial,.. The Vostok lake is enlarged

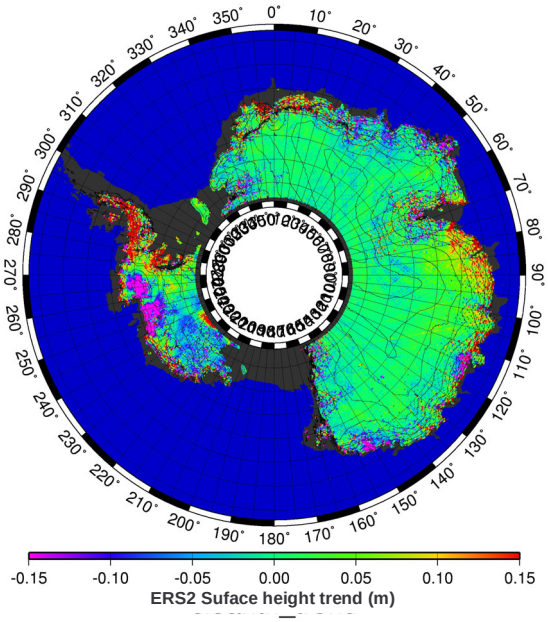


Figure 7 : Map of the surface height trend, derived from the 8 years of ERS2 satellite radar altimetry and along track repeat processing. A small global average surface height change is found with significant local thickening or thinning.

Application field: Water level time series derived from satellite altimetry

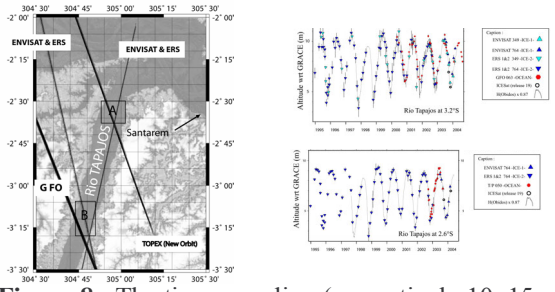


Figure 8 : The time sampling (respectively 10, 15 and 35 days for T/P, GFO and ERS-1&2/ENVISAT) of the present radar altimetry missions is not sufficient to monitor rapid changes in hydrological processes. The combination of water levels derived from the different satellites increases the time sampling at cross-over points. Two zones were identified on the lower Tapajos where ENVISAT tracks are crossing other altimeter tracks. ENVISAT track 349 intersects T/P track 50 at 2.6° S. ENVISAT tracks 764 and 349 form a cross-over point and both intersect GFO track 063 at 3.2° S.

Conclusion : We showed here a number of applications of radar altimetry over continental surface where retracking has been useful. The OSCAR project promotes and develops such applications of radar altimetry over continental surfaces.

References :

Aladin N.V., Crétaux J-F., Plotnikov I.S., Kouraev A.V., Smurov A.O., Cazenave A., Egorov A.N., Papa F., Modern hydro-biological state of the Small Aral Sea, *Environmetric*, Vol 6, Issue 4, June 2005

Cazenave A., Bonnefond P. and DoMinh K., 1997. Caspian Sea Level from Topex/Poseidon Altimetry: Level now Falling. Geophysical Research Letter, 24, 8 : 881-884.

Crétaux J-F and C. Birkett, lake studies from satellite altimetry, submitted to Compte Rendu de l'Académie des Sciences, 2005

Crétaux J-F, Kouraev A.V., Papa F., Bergé Nguyen M., Cazenave A., Aladin N.V., and Plotnikov I.S., water balance of the Big Aral sea from satellite remote sensing and in situ observations, *Journal of Great Lakes Research*, 31 (4), 2005.

Crétaux J-F., Kouraev A.V., Bergé-Nguyen M., Cazenave A., Papa F., Satellite altimetry for monitoring lake level changes, NATO Sciences Series, Transboundary water resources: Strategy for regional security and ecological stability, 141-146, Springer 2005

Kouraev, A. V., F. Papa, P. I. Buharizin, A. Cazenave, J-F Cretaux, J Dozortseva, and F. Remy, 2003, sea ice cover variability in the Caspian and Aral seas from active and passive satellite microwave data, Polar Research 22 (1), 43-50.

Kouraev A., F Papa, N. Mognard, P. Buharizin, A. Cazenave, J-F Cretaux, J Dozortseva, and F. Remy, 2004, Sea ice cover in the Caspian and Aral seas from historical and satellite data, J. of Marine Systems 47, 89-100.

Kouraev A., F Papa, N. Mognard, P. Buharizin, A. Cazenave, J-F Cretaux, J Dozortseva, and F. Remy, 2004, Synergy of active and passive satellite microwave data for the study of the first-year sea ice in the Caspian and Aral seas, IEEE Transactions and geoscience remote sensing, 42 (10), 2170-2176.

Kouraev A.V., S.V. Semovski, M.N.Shimaraev, N.M. Mognard, B. Legresy, F. Remy. "Observations of lake Baikal ice from satellite altimetry and radiometry". Remote Sensing of Environment, submitted.

Legresy B. and Remy F, 1997, Surface characteristics of the Antarctic ice sheet and altimetric observations, J. of Glacio, 43 (144), 265-275.

Legresy, B., F. Papa, F. Remy, G. Vinay, M. VandenBosch, O.Z. Zanife. 2005. ENVISAT radar altimeter measurements over continental surfaces and ice caps using ICE-2 retracking algorithm. Rem. Sens. Environment 95 pp 150-163.

Legrésy B. and F. Rémy. 2006. Along track repeat satellite radar altimetry over land surfaces, applications in Antarctica. Rem. Sens. Environment.

Papa F., Legresy B., Mognard N. M., Josberger E.G. and Remy F., 2002. Estimating terrestrial snow depth with the Topex-Poseidon Altimeter and Radiometer. IEEE Trans. Geosci. Remote Sensing, 40 (10): 2162-2169.

Papa F., Legresy B. and Remy F., 2003. Use of the Topex-Poseidon Dual-frequency Radar Altimeter over Land Surfaces. Remote Sensing of Environment, 87 pp 136-147.

Papa F., C. Prigent, Legrésy B. and F. Rémy, Inundated wetlands dynamics from remote sensing : a first retrieval method using Topex-Poseidon dual-frequency radar altimeter observations over Boreal regions, in press Int. Journal of Rem. Sens.

Remy F.,B. Legresy, S. Bleuzen, P. Vincent, and J.F. Minster, 1996, Dual-frequency Topex altimeter observation of Greenland, J. of Electrom Waves and Apll., 10, 1505-1523.

Remy F., Schaeffer P and Legresy B., 1999. Ice flow physical processes derived from ERS-1 high resolution map of the Antarctica and the Greenland ice sheets. Geophys. J. Int.,139: 645-649.