SAR ALTIMETRY at 80 Hz

S. Dinardo¹, B. Lucas², J. Benveniste³
(1) SERCO/ESRIN, (2) DEIMOS/ESRIN, (3) ESA/ESRIN
The presentation is structured in the following points:

- Introduction
- Concept
- 80 Hz L1b and examples of Concept Application (inland water)
- 80 Hz L2 over open sea and coastal zones
- Conclusions
ESRIN EOP-SER Section, for validation purposes and preparation to Sentinel-3 mission (SAR Retracker Algorithm Definition), implemented an ESRIN SAR Processor Prototype in order to Delay-Doppler process CryoSat FBR data and re-track Delay-Doppler Echoes

- SAR/SARin FBR/L1b DATA Archiving and Cataloguing
- SAR/SARin L1b & L2 Processor Prototype
- Input: CRYOSAR SAR FBR DATA
- Coding Language: MATLAB
- At L1b, Standard Delay-Doppler Processing (description on line in https://wiki.services.eoportal.org/tiki-download_wiki_attachment.php?attId=2540)
- At L2, Re-tracker with SAMOSA-Analytical Model using Levmar Least Square Estimator
- Output L1b → Radar Echogram
- Output L2 → SLA (W/O SSB), SSH , SWH, sigma0, wind speed
THE CONCEPT
WE CAN HAVE A SAR ALTIMETRIC MEASUREMENT IN ANY GROUND POINT ALONG THE TRACK!
SAR ALTIMETRIC MEASUREMENT @ FINER GRID STEP

Above Image from Keith Raney

WE DON'T CHANGE THE ALONG TRACK RESOLUTION, ONLY THE GRID STEP SIZE!
Why 80 Hz posting rate?

The orbit height at 20 Hz are provided by means of an interpolation operation.

Fixing the grid at rate of $\approx 80$ Hz, the grid cell is co-located with the burst center. This allows to skip the cumbersome interpolation operation because the orbit and geo-location information are already given at each burst center in the FBR data products.
Frequently Asked Questions

- Beamforming approximated
- Total Number of looks don’t change (220-230)
- Gridding is pretty uniform
- The price to pay is to have 4 times bigger data volume and 4 slower computational time
- We can do all this just because we have FBR data downlinked to ground!
PASS OVER RIO TAPAJOS (AMAZON) IN SAR ALTIMETRY AT 80 Hz – Received Power in db
PASS OVER RIO TAPAJOS (AMAZON) IN SAR ALTIMETRY AT 80 Hz – Received Power in db
SAR ALTIMETRY 20 Hz

SAR ALTIMETRY 80 Hz

750 meter wide
80 Hz L2 in open sea
The 4 consecutive SAR Echoes at 80 Hz are not fully correlated!! Speckle noise on top of them is slightly different. .. Echoes partially uncorrelated.
Over open sea, we retrack the SAR Multilooked Echoes at 80 Hz and then we generate the altimetric geophysical parameters (Sea Level Height, Significant Wave Height and Wind Speed) at 80 Hz.

Therefore, what we are implementing is to carry out a sub-pixel (sub-footprint) re-tracking of the SAR Echoes (i.e. retracking SAR echoes at 80 m whereas the SAR space resolution is 300 m in along track direction).

This is in line with Pulse-limited (LRM) altimetry wherein the retracking is operated at 20 Hz (300 m) whereas the instrument resolution (pulse-limited circle diameter) is varying between 1.5 km (flat sea) - 7 km (at SWH=10) i.e. 5Hz-1 Hz.

That makes sense: by Nyquist’s Theorem, if you have a signal at resolution of 300 meters, you have to sample at least at half of the resolution (150 m) to represent properly the signal’s dynamic.

Over open sea, to generate 20 Hz geophysical parameters (SSH, SWH, U10), we average 4 consecutive values of SSH, SWH, U10.
DATASET USED in GERMAN BIGHT

RADS PLRM (PSEUDO-LRM) 2011-2012

ESRIN SAR 2011-2012
Bias: 0 cm
Diff std: 4 cm
Regression Slope: 0.98
80 Hz L2 in Coastal Zone
Sigma Nought in SAR 80 Hz (blue) and in SAR 20 Hz (red)

Distance to Coast (m)
Things to do

- Spectral Analysis of SSH at 80 ! (to be done !)
CONCLUSIONS

- The SAR Radar images (Radar Echogram) over inland water scenarios at 80 Hz appear much more sharp rather than at 20 Hz
- Gridding with a space step of 80 meter allows to sample more properly high-variable surfaces and distinguish better short scale-signals (especially in land water domain and coastal zones)
- Slight Margin of improvement in term of range precision over open sea
- For details and further discussion, poster in the room (poster number 1)