

State of Knowledge for SAR altimetry over ocean & the case for Interleaved SAR altimetry on Jason-CS

Christine Gommenginger (1), R. Keith Raney (2), Cristina Martin-Puig (3)
Laiba Amarouche (4), Hans Bonekamp (5)

(1) National Oceanography Centre – Southampton UK (2) 2kR-LLC, USA
(3) isardSAT, Spain (4) Collecte Localisation Satellites, France (5) EUMETSAT, Germany

First SAR ocean altimetry expert workshop

The first SAR ocean altimetry expert workshop was held at the National Oceanography Centre, Southampton, UK, on 26-27 June 2013. Over 60 scientists from across the world attended the meeting. Presentations from 10 invited speakers are available on:

www.satoc.eu/projects/CP40/meetings.html

The objective of the meeting was three-fold:

- to review the state of knowledge about SAR altimetry over the ocean.
- to review the case for interleaved SAR mode on Jason-CS.
- to provide necessary input for a report commissioned by EUMETSAT on these issues.



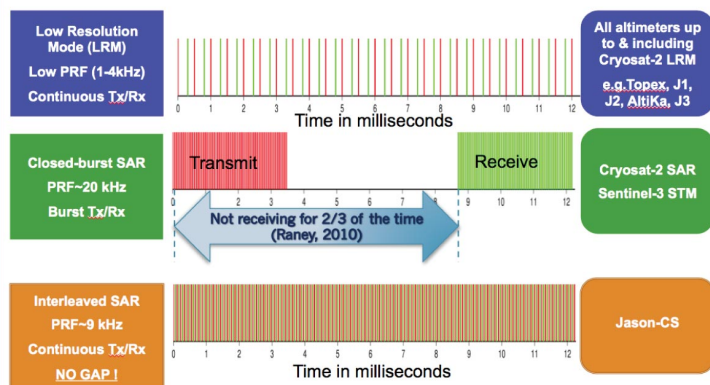
State of Knowledge for SAR altimetry over the ocean: summary

The review covered research reported in the public domain over 2010-2013. The main conclusions are:

- There has been considerable attention and remarkable progress in SAR ocean altimetry in a short time since 2010.
- Different teams have independently demonstrated that SAR altimetry brings significant improvements compared to today's best available conventional altimetry. Evidence of improvements with Cryosat-2 SAR mode includes:
 - reduced ranging noise (1 cm SSH noise v 1.6 cm in LRM)
 - improved altimeter data in coastal regions
 - improved ocean mesoscale spectral content for Sea Level Anomaly (10-100km)
- The convergence of results obtained by different groups with different SAR waveform retracers gives a high level of confidence in the ability to retrieve geophysical data from SAR mode over ocean.
- There remain some open issues with SAR mode, including:
 - sensitivity to platform mispointing
 - lack of a sea state bias model in SAR mode
 - effects of swell and swell direction on SAR mode due to fine along-track footprint

It is noted that these open issues disappear if Jason-CS SAR mode is interleaved, since SAR mode data can then be transformed seamlessly into LRM data for self-calibration.

LRM, Closed-burst SAR and Interleaved SAR



Adapted from Walter Smith, 2013

Closed-burst SAR, LRM and pseudo-LRM

The report provides an in-depth review of issues relating to the reconstruction of LRM-type waveforms ("pseudo-LRM") in closed-burst SAR and interleaved SAR mode.

The main conclusions are:

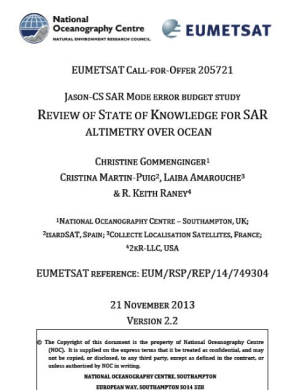
- Closed-burst SAR mode data cannot be transformed into pseudo-LRM waveforms that are statistically equivalent to real LRM waveforms
 - Closed-burst SAR pseudo-LRM is noisier than LRM
 - CryoSat-2 pseudo-LRM is not equivalent to real LRM
- Sentinel-3 will provide more SAR data over larger regions, perhaps even globally, which will be useful to examine SAR mode Sea State Bias, but Sentinel-3 Closed-burst SAR will yield the same noisier pseudo-LRM as Cryosat-2.
- Closed-burst SAR mode precludes direct SAR/LRM cross-calibration
 - Cannot relate with sufficient confidence and precision the closed-burst SAR sea level measurements to the existing sea level record
 - Closed-burst SAR on Jason-CS would compromise the continuity of the high-precision sea level 20-year time series.

Interleaved SAR on Jason-CS would realize the theoretically optimal performance expected from a SAR mode altimeter and ensure continuity with conventional altimeters.

Recommendations for Jason-CS

- Jason-CS should be implemented with the SAR Mode, which is the state-of-the art in radar altimetry, having been **demonstrated in orbit with CryoSat-2, with significant benefits for many ocean applications.**
- The Jason-CS SAR mode should be **interleaved**, since it is the **only mode of operation** that delivers SAR mode data that can be successfully transformed into **pseudo-LRM data that are statistically equivalent to true LRM data.**
- The Jason-CS SAR mode should be interleaved to assure that SAR mode data could be transformed into conventional LRM data, thus providing **a foundation for self-calibration of the SAR altimeter against LRM.**
- The Jason-CS SAR mode should be interleaved so that LRM products could be generated that would support **statistically significant comparisons with LRM products from other missions.**
- The Jason-CS SAR mode should be interleaved so that its products could provide **seamless continuity with the sea level measurement record established by prior altimeters in the TOPEX orbit, and**
- The Jason-CS altimeter should be implement in a SAR interleaved mode of operation so that its measurements **satisfy its prime mission requirements for long-term continuity of sea level monitoring.**

Final report available in PDF from <http://nora.nerc.ac.uk/507775/> or http://www.satoc.eu/projects/CP40/docs/SARAltimetry_Review_JasonCS_EUMETSAT.pdf



References

- Raney, R. K., 2010: CryoSat SAR-Mode Looks Revisited. ESA Living Planet Symposium, Bergen, Norway.
- W. Smith & R. Scharroo, 2013. Experiments with FBR SAR data over oceans, including an investigation of aliasing. First SAR ocean altimetry expert group meeting, National Oceanography Centre, Southampton, UK, 26-27 June 2013