Comments on SAMOSA in the Context of the Final Presentation

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Attachments

1. An Annotated Bibliography: Selected milestones of oceanic radar altimetry leading to finer height precision and the CryoSat heritage
2. CryoSat SAR-Mode Looks Revisited

Comments

1. In general, it was good to hear about the progress that the SAMOSA Team has made on interesting and sometimes challenging problems raised by pressing the potential capabilities, limitations, and processing issues presented by the data from SAR-mode radar altimeter architectures.

2. It is noted that the history of oceanic radar altimetry offers opportunities to place in appropriate perspective what has been accomplished, what we may try to achieve in future, and the time scales for these steps. For reference, an Annotated Bibliography is attached to this commentary. The history of the traditional approach to observing the ocean's surface by a nadir-viewing radar shows that it required more than 20 years for a rudimentary understanding of the ocean's response function (1957) to evolve into an operational methodology (early 1980s) for extracting the parameters of interest (principally SSH, SWH, and WS) from the radar's returns.

3. As the Sentinel-3 era approaches, there are those who are eager (as was evident at the SAMOSA Final Review) to have in place operational algorithms for parameter retrieval from SAR-mode altimeter data. Patience is advised. The concept of a combined "pulse-limited and beam-limited" radar has been known to the wider community for only about 13 years, and real data from such an orbital radar (CryoSat-2) has been available for less than one year. Considerable progress has been made by the SAMOSA team and others, but at present there is no consensus on methods, potentials, or limitations associated with parameter retrievals from such a radar.

4. SAR-mode data from an inclined orbit over the global oceans could lead to a two-octave improvement of the spatial scale of retrieved bathymetry. CryoSat-2 data could be exploited to verify this expectation, at least on a small scale. Further, it may be possible for the CryoSat-2 simulator to generate sufficient data to put this claim to the test, although there may still linger concerns about the suitability of such data for this application, which falls outside of the intended purpose for that facility.

5. Tracking and re-tracking approaches seem to be converging, based on exercises with simulated as well as actual SAR-mode data.

6. Efforts within SAMOSA to transform SAR-mode data (either from simulated data sequences or from actual CryoSat data) into pseudo-LRM data have been successful,

passing quantitative statistical tests for their acceptance. This tool should be valuable for comparative evaluations of retrievals from the two modes over a variety of oceanic conditions.

7. Results seem to show consistently that the precision of SSH retrieval from SAR-mode data is significantly better (by approximately a factor of 2) than for retrievals from LRM data. This is in line with early predictions and simulation studies.

8. Retrievals from SARM and pseudo-LRM claimed to have less consistency for SWH retrievals. This may be due to the lack of "fit" between the model and the data for the tails (later time delays) of the waveform distributions. The "width" of the model profile when fitted to the data depends on the fit at the later time delays. Convergence between the model and the data on this aspect should lead to improvements. One way to approach that goal could be to adapt the Jensen re-tracking method to the problem, since the first step in that method is to transform the SARM peaky (hybrid pulse- and beam-limited) waveform into a Brown-style pseudo-pulse-limited waveform.

9. It was argued that the reason for the very high PRF (~18 kHz) in SARM is to assure correlation between adjacent pulses. Strictly speaking, this argument is not correct. Once the PRF is well above the WALSH limit (~2500 kHz), correlation from a user's point of view is guarranteed. The reason for the high PRF in SARM is to assure that the Doppler spectrum across the antenna pattern is adequately sampled. If the PRF is above the Doppler band width, then the Nyqusit lower bound on sampling rate is satisfied. This is purely a radar argument. The Nyquist lower bound assures that there will be minimal ambiguities in the sampled data; it has nothing to do with the inherent correlation within the signal stream due to the properties of the observed scene.

10. The sampling rate question is central to the design and performance of a SAR mode altimeter. The question was addressed in a paper presented at the ESA Living Planet symposium (Bergen, Norway, 2010), a copy of which is attached to this commentary. The main theme of that paper is that future designs of a SAR-mode ocean-viewing altimeter could realize about three times as many statistically independent looks than are possible from the design approach taken for CryoSat.

11. The summary of detailed studies on the tracking and sampling properties of the ASIRIS airborne instrument was informative. The bottom line is that IF an airborne system is to generate data that are similar to those gathered by the intended orbital instrument, THEN the dominant requirement on the airborne system is to replicate as closely as possible (given the limitations of the aircraft's speed and altitude) the geometrical parameters at the surface for the two data sets. These include in particular incidence and footprint resolution. Analysis of ASIRIS data revealed that its very fine along-track resolution (a few meters in contrast to CryoSat's ~200 m) and large off-nadir incidence (~45^{o} in contrast to CryoSat's ~2^{o}) both induced unacceptable behavior in the resulting data.