SAR altimetry over ocean and coastal zone

Current status & outlook

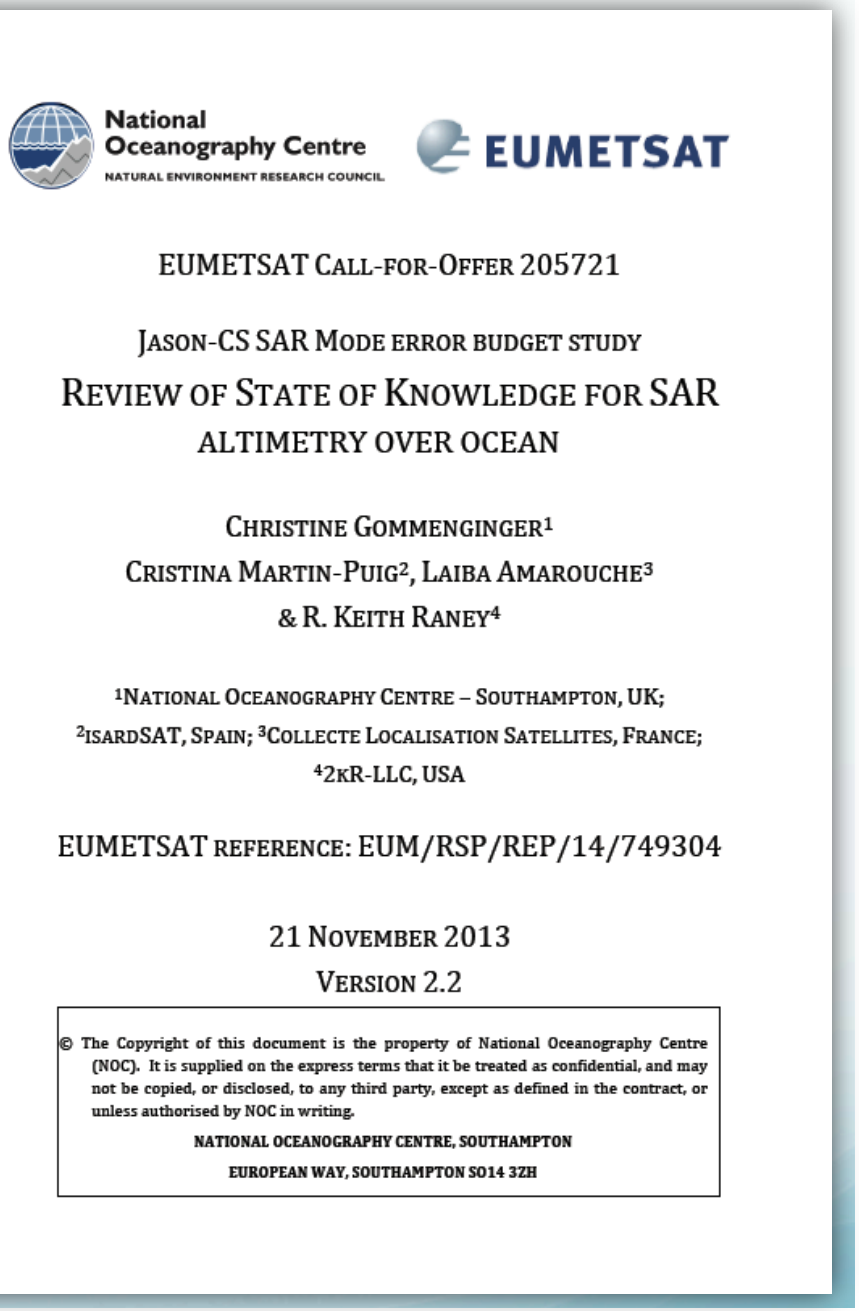
National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

One year ago..

- First-ever SAR altimetry expert group meeting dedicated to SAR altimetry over ocean
- At NOC, Southampton, 26-27 June 2013
  - Sponsored by ESA, EUMETSAT, NOC and SATOC Ltd
- Over 60 attendees from across the world
- 10 invited talks by SAR altimetry experts
- LOTS of discussion time
- Presentations available on:
  - www.satoc.eu/projects/CP4O/meetings.html
- Attendees feedback: “very useful meeting”, “must do it again”,...

EUMETSAT review of SAR altimetry over ocean

- In context of closed-burst/interleaved SAR debate for Jason-CS/Sentinel-6
- Report completed April 2014
- Shortly to be made public
- Report includes:
  - Cryosat-2 SAR mode in the historical context of ocean altimetry
  - Closed-burst v Interleaved SAR mode
  - Advances with SAR altimetry over ocean
  - Recommendations for Jason-CS
  - Technical material in annexes, including open science issues for SAR mode



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EUMETSAT CALL-FOR-OFFER 205721

JASON-CS SAR MODE ERROR BUDGET STUDY

REVIEW OF STATE OF KNOWLEDGE FOR SAR ALTIMETRY OVER OCEAN

CHRISTINE GOMMENGINGER[1]
CRISTINA MARTIN-PUIG[2], LAIBA AMAROUCHE[3]
& R. KEITH RANEY[4]

[1]NATIONAL OCEANOGRAPHY CENTRE – SOUTHAMPTON, UK;
[2]ISARDSAT, SPAIN; [3]COLLECTE LOCALISATION SATELLITES, FRANCE;
[4]2KR-LLC, USA

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SAR review: main conclusions

- Growing consensus between independent teams about significant improvements with SAR altimetry compared to today's best available conventional altimetry
  - Convergence with different SAR waveform retrackers indicates high level of confidence in ability to retrieve geophysical data from SAR mode over ocean
- Cryosat-2 SAR mode provides in-orbit evidence of:
  - 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)
- For Jason-CS, SAR interleaved mode is recommended as the only method to:
  - realize the theoretically optimal performance expected from a SAR mode altimeter
  - ensure continuity with prior and contemporary conventional altimeters
  - ensure continuity of the long-term high-precision sea level time series

SAR review: open issues

- Open issues with SAR mode include:
  - 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
- If Jason-CS SAR mode is interleaved, these issues disappear since SAR mode data can be transformed seamlessly into LRM data for self-calibration
- Issues remain open for Sentinel-3 STM (closed-burst SAR)
  - Sentinel-3 STM also needs to consider how to relate SAR, P-LRM and LRM

PLRM as replacement for LRM?

- Because of the limited time of transmission, PLRM on CryoSat is not equivalent to LRM
- Efforts to deal with the larger noise includes averaging consecutive waveforms
- Overall though, PLRM and LRM waveforms are very similar, which allows cross-validation
- PLRM is used to show that SAR mode altimetry can be at least equivalent to LRM

Issues encountered during CP4O

- The processing of PLRM waveforms was less straightforward than it seemed:
  - Choosing the right way not to blur the waveform (altitude rate i.s.o. range rate)
  - Jensen aliasing paradigm
  - How to deal with the higher noise of the 20-Hz samples: filtering the waveforms, or letting it be?
- Bugs in the LRM processing were uncovered
  - Shift in LRM waveform, compared to SAR/PLRM
  - Multiple errors in gain corrections

Sea state bias

- Big unknown
  - Little bit better now ☺
- PLRM appears to require same SSB model as LRM, but coverage currently too limited to say for sure
- Is the sea state bias for SAR the same?
  - Certainly not, because the retrackers are so different
  - Otherwise, physical effect should be the same
  - Except that with a smaller footprint, SAR is much more susceptible to swell
- Probably new parametrisation of SSB is necessary (3D or 4D models including swell?)
- What does this mean for the climate record? (SSB too much intertwined with models)

What do the users want?

- Oceanographic users are reluctant to change. Only (very) recently have they embraced altimetry in the first place
- Do they now want results that "looked like" they did in the past?
- Do they trust a new altimeter technique after it took so long to pick it up in the first place?
- Should PLRM be provided (perpetually?) next to SAR?
- Can we ensure equal of better precision of wave height and wind speed (still key variables for many altimeter users)?
- Is sea state bias for SAR understood?

Next missions: Sentinel-3

- Altimeter is basically the same as CryoSat, except for the SARin mode (only one antenna)
- 100% SAR (both over ocean and land) is the baseline, but still depends on commitment from EC and ESA
- Some cross-validation of LRM and SAR is planned during commissioning
- Better cross-validation with LRM/SAR on ascending/descending should be feasible
- Are users ready for 100% SAR?
- CP4O helps!

Next missions: Sentinel-6/J-CS

- For Sentinel-6 the issue is different from Sentinel-3
- It will provide a continuous SAR pulsing at a lower rate than Cryosat-2 and Sentinel-3: 9 kHz
- At this rate the echoes will still be coherent
- The LRM on-board is "exactly the same" as it would be creating PLRM on-ground
- It will be the first mission that would be able to provide LRM and SAR simultaneously.

Long term: Climate record

- Should missions continue to have both LRM and SAR mode?
- Can we guarantee that SAR sees the same climate variables as LRM?
- Range:
  - Higher along-track resolution and appears less affected by sigma0 blooms
  - But is it also compatible with LRM?
- Significant wave height is determined differently
  - Are the measurements similar enough?
- Wind speed is determined by backscatter
  - Since it was never determined absolutely, can we make LRM and SAR do the same?
- What about the impact of sea state bias on long time series?

Thank you for your attention