



Better small scale topography for Sentinel3
thanks to the new SAR/LR-RMC processing:

new perspectives for DUACS products

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OSTST, Septembre 2018, Azores





Outline

Context & methodology

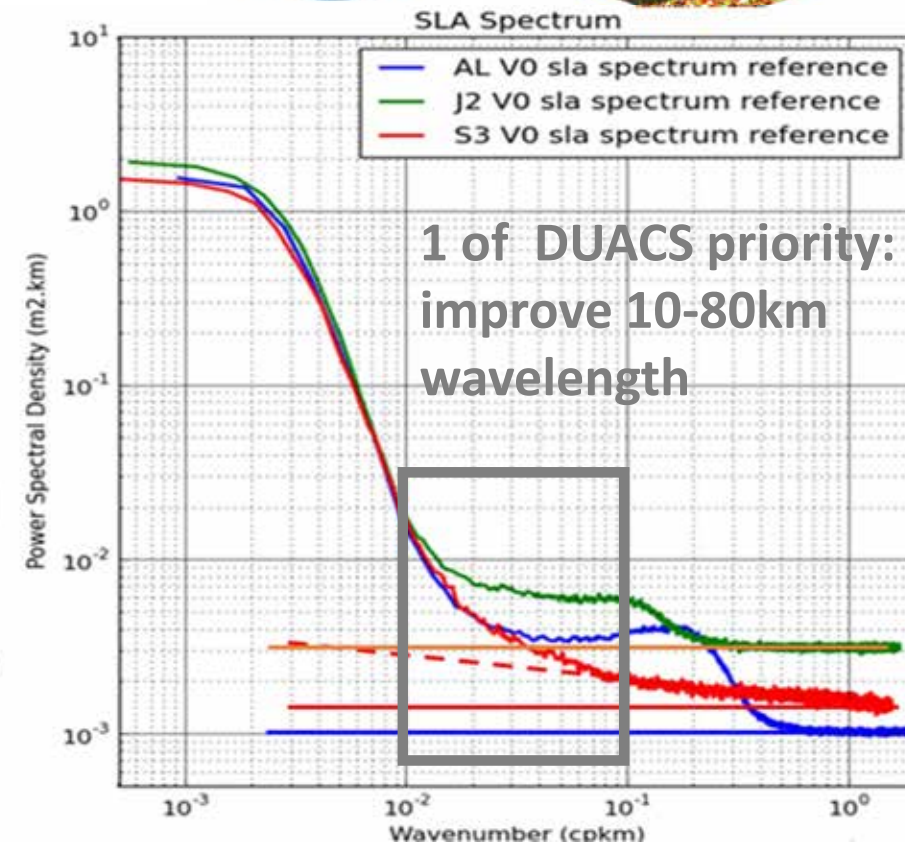
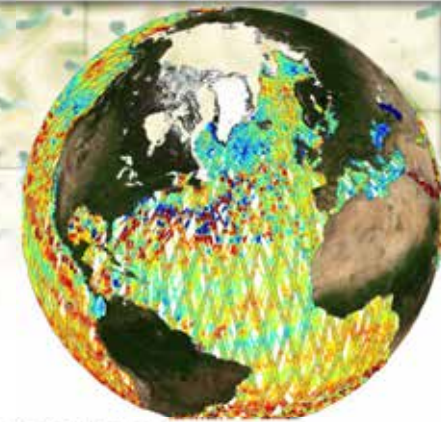
Impact of LR-RMC processing

Impact of LR-RMC processing + improved MSS

Conclusion & discussion

Context: DUACS resolution upgrade

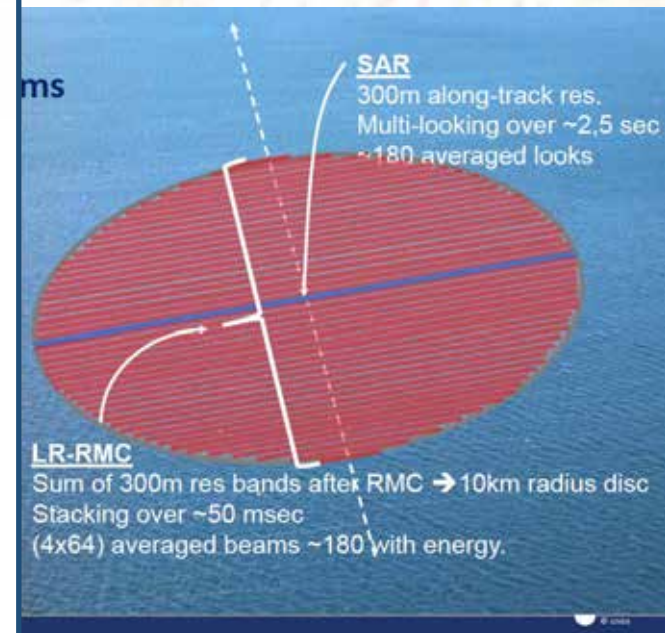
- DUACS is the multimission system that provide homogeneous dataset for operational oceanography centers in the framework of operational services:
 - CMEMS: Copernicus Marine Environment Monitoring Service
 - L2p/L3 service for Sentinel3/A and B
- Sentinel-3A ingested in the system since CMEMS V3 (April 2017) and nominally contribute
- Current L3 products are limited by the
 - The white noise
 - The correlation of high frequency errors
 - for LRM: the hump artifact
 - for SAR: the red coloured noise
 - 1 Hz posting (measurement too sparse to describe small scale features)
- Need of Higher resolution (noise reduced) and smaller posting (5 Hz ~ 1 km) Level-3 on ocean for assimilation in high resolution models (e.g. TAPAS working group of CMEMS)



Context: New SAR processing LR-RMC

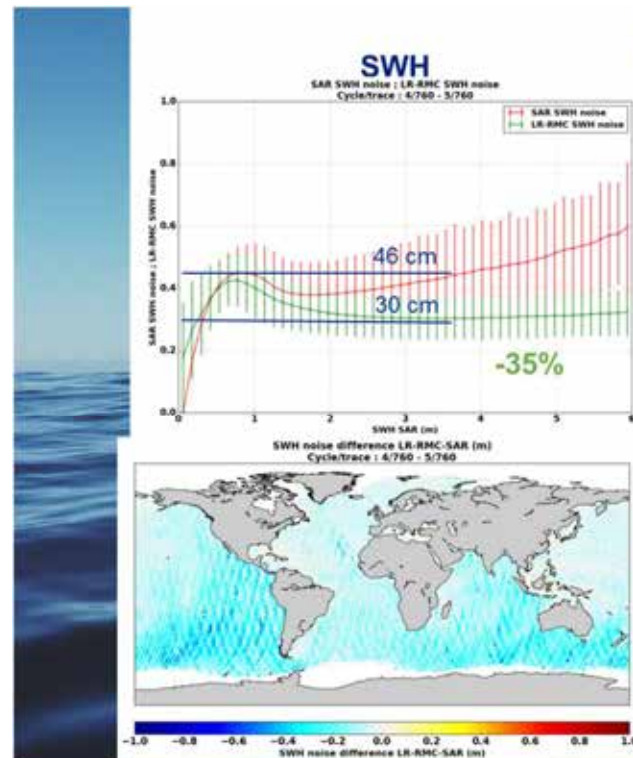
1st version “V2017” presented by Francois Boy at OSTST 2017

Low
Resolution with
Range
Migration
Correction



Conclusions of 1st version “V2017”:

- No bias at global scales
- 10%-40% noise reduction on Range and SWH
- Stable performances whatever swell conditions

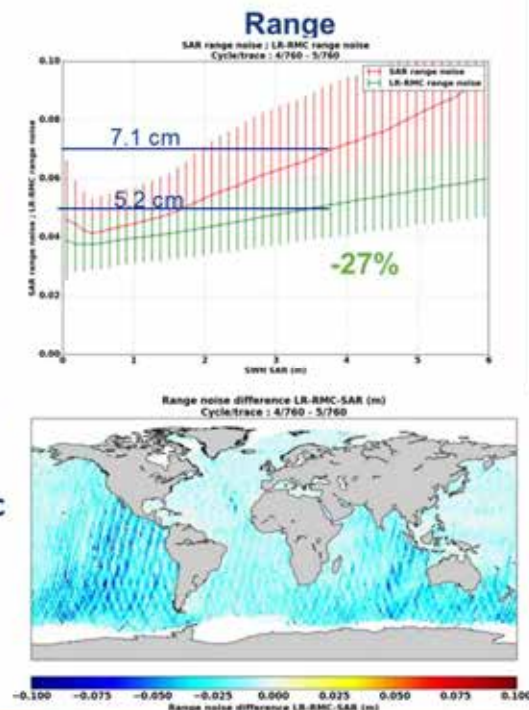


Precision wrt SAR

Large noise reduction

Range STD = 9mm@1HZ (SWH=2m)

Noise difference map
→
High reduction for specific sea conditions
→
Swell conditions?



Context: New SAR processing LR-RMC

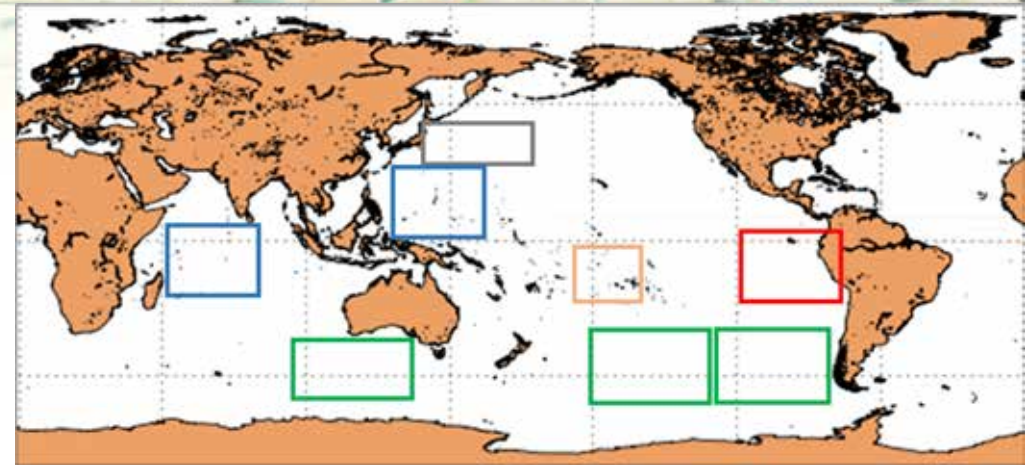
version “V2018” presented by Moreau et al in the instrument session

- New version developed including notably an improvement of RMC accounting for the mean sea surface slope
- Data processed:
 - August-sept 2016
 - Feb-apr 2017

Question: How the ocean energy is impacted at small scales and what interest for Sea Level products and ocean models assimilating them?

Methodology

- Building two S3A SLA data set SLA_SAR & SLA_LRRMC
 - Same geophysical correction
 - Dedicated SSB
 - Dedicated editing (iterative)
 - Selection of common valid points
- spectral analysis over 3 month (2017)
 - Global analysis
 - Regional analysis / Thematic approach
- Attempt to assess using to glider measurements along S3A track



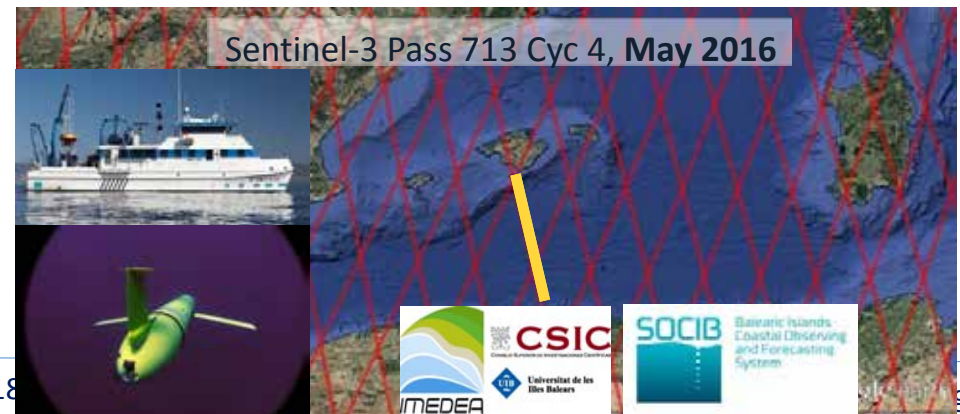
Region of Swell effect

High SWH

High MSS gradient

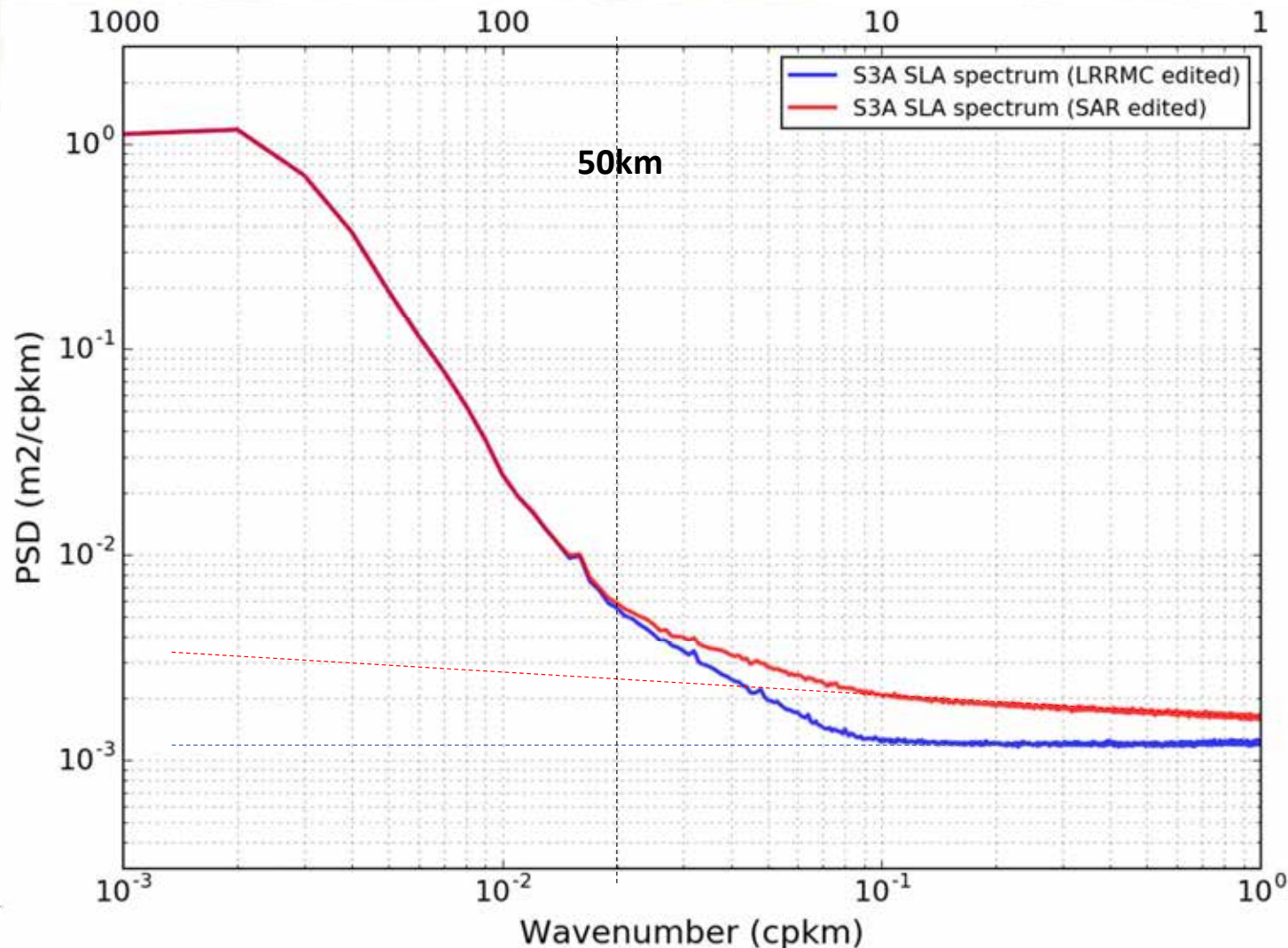
High mesoscale energy

High internal tide



Impact of LR-RMC: global analysis

- S3A SLA Global Spectra for SAR and LR-RMC
- Spectra separation at 50km: LR-RMC lower than SAR spectra
- True white noise plateau: no slope anymore
- =>LR-RMC allows us to have less white noise & avoid coloured noise: **26% reduction of energy for wavelength <100km**

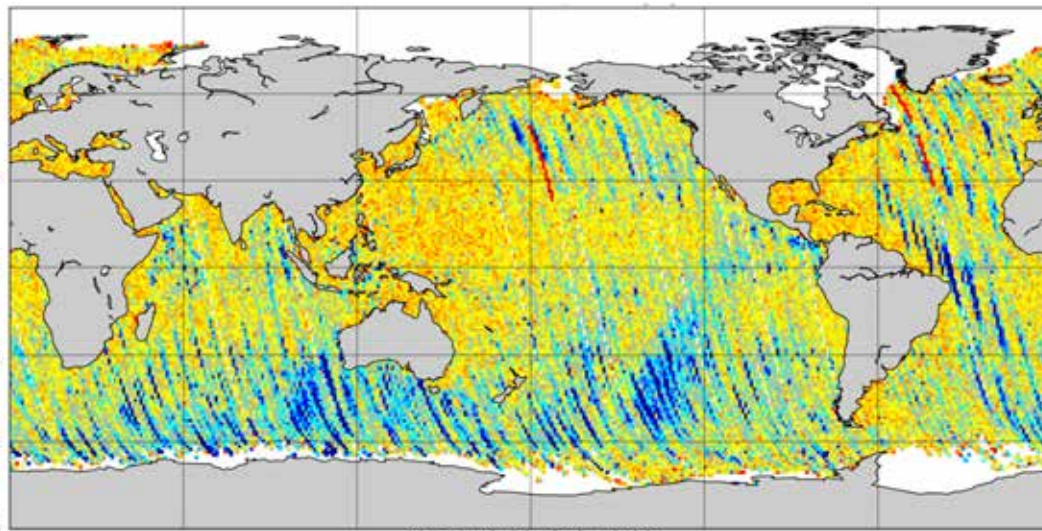


Impact of LR-RMC: global analysis

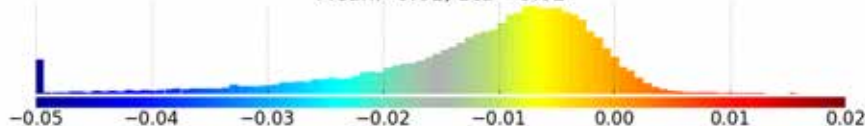
- Analysis of the difference of High frequency content between SARM and LR-RMC
- LR-RMC allows a noise reduction everywhere: higher energy everywhere and especially on descending tracks => Blue pattern in East Pacific
- Signature of SAR error linked to swell in the along track direction => see Sylvie Labroue's slides

**20Hz Range Standard deviation reduction from SARM to LR-RMC – Yellow&Blue color)
for April 2017 (Unit in m)**

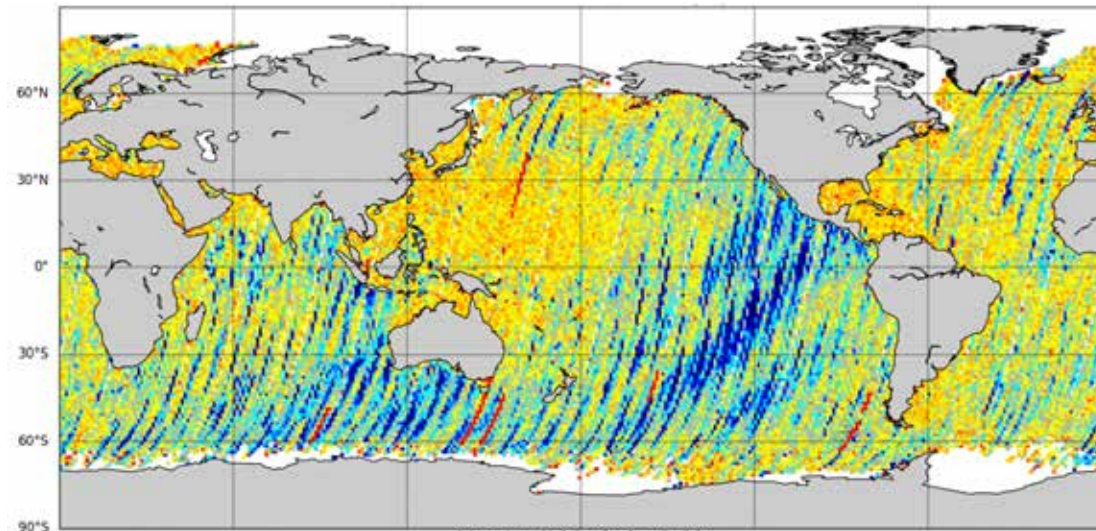
Ascending Tracks



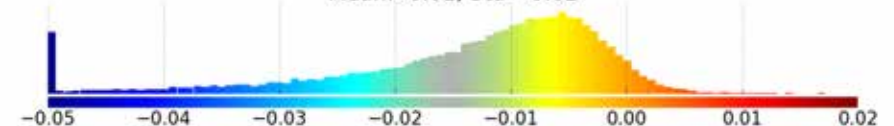
Mean: -0.01, Std= 0.02



Descending Tracks



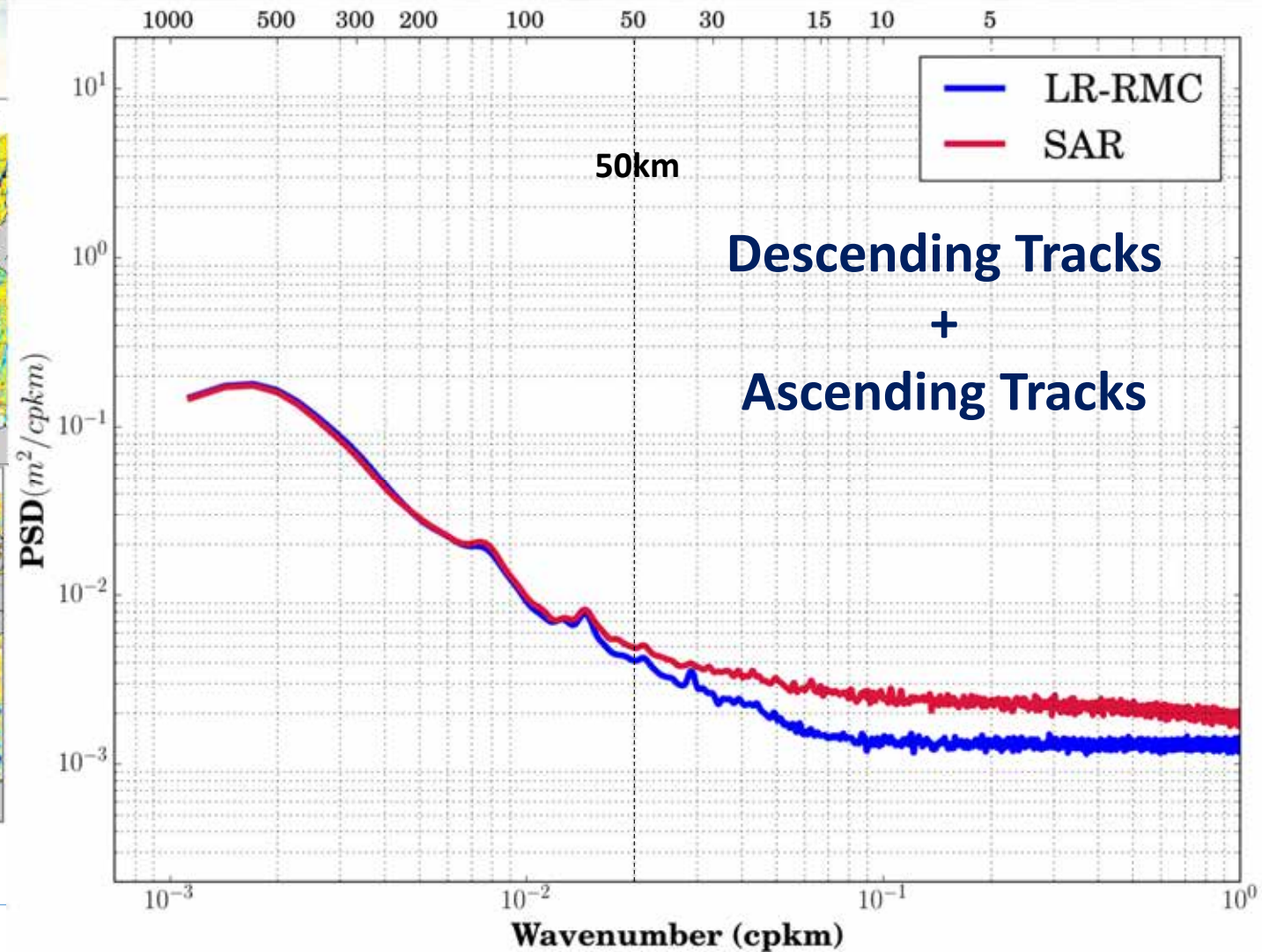
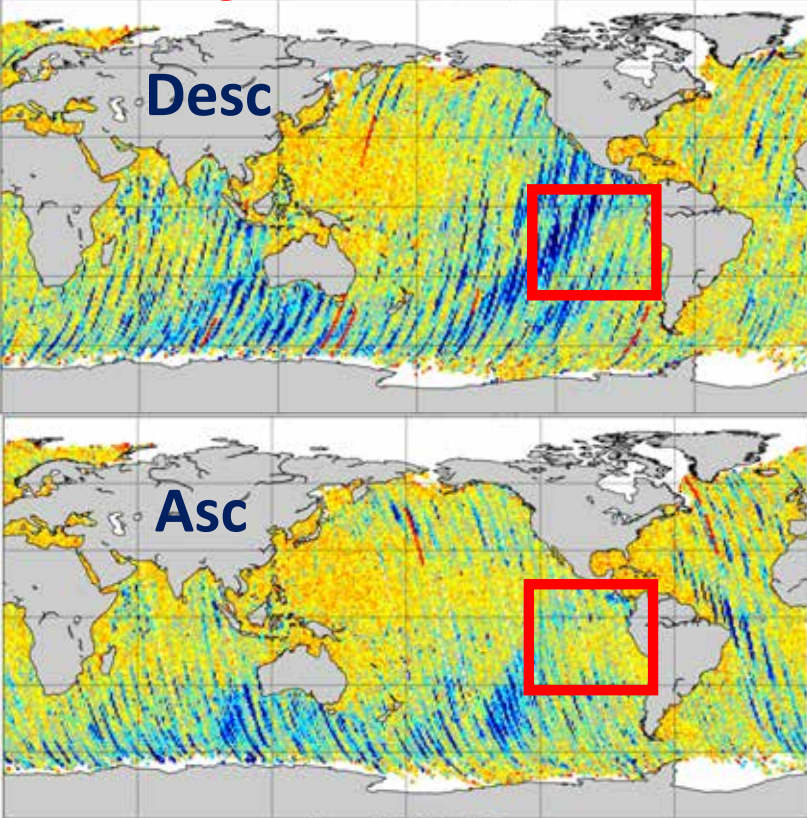
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mbi

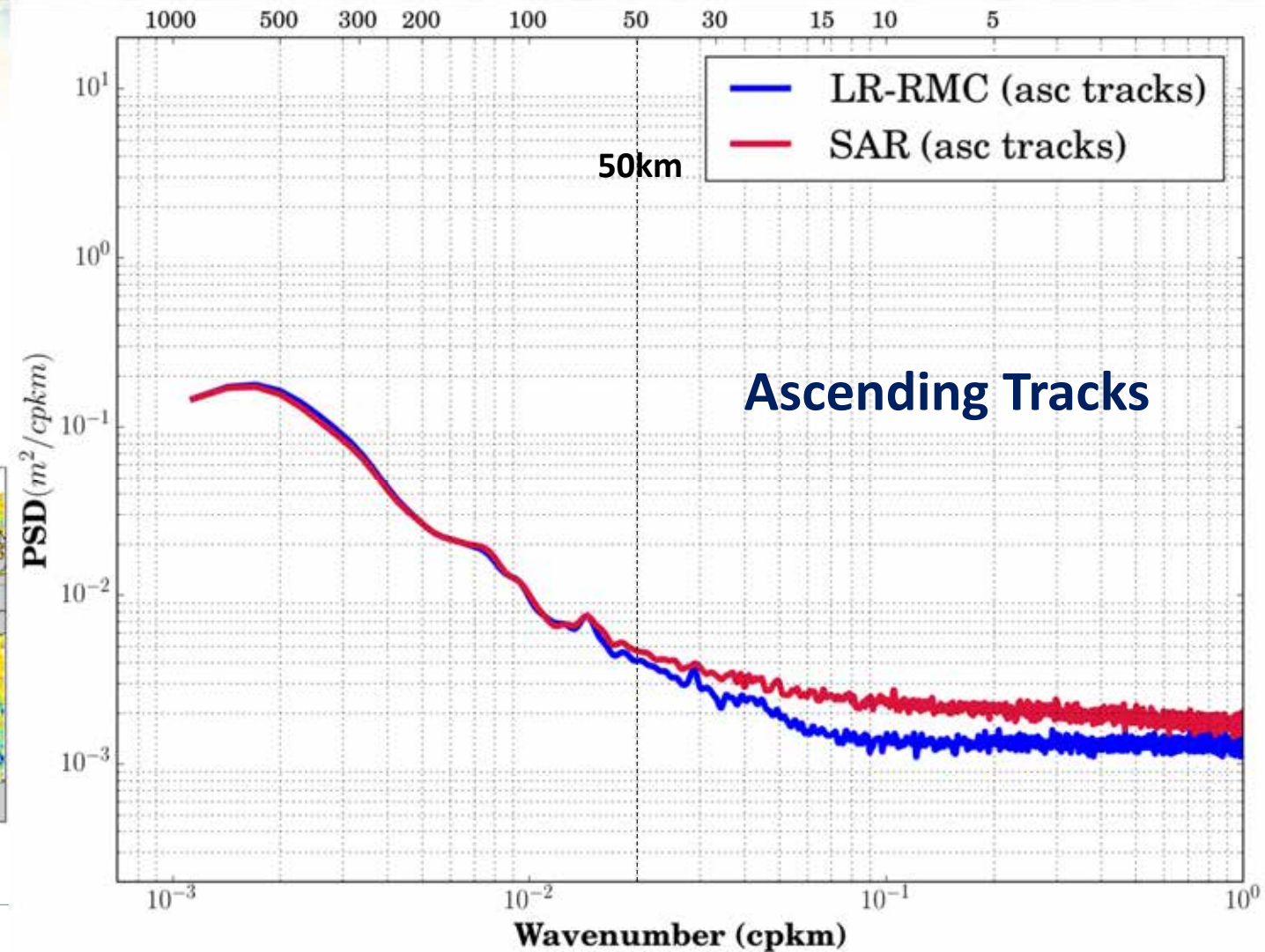
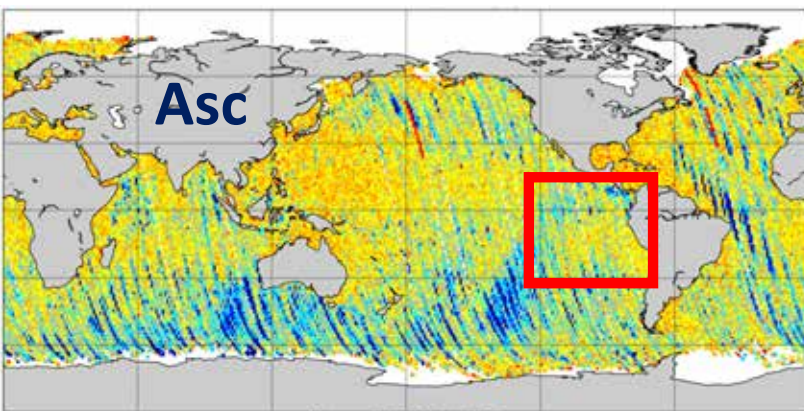
Impact of LR-RMC: Regional analysis

Region of swell effect

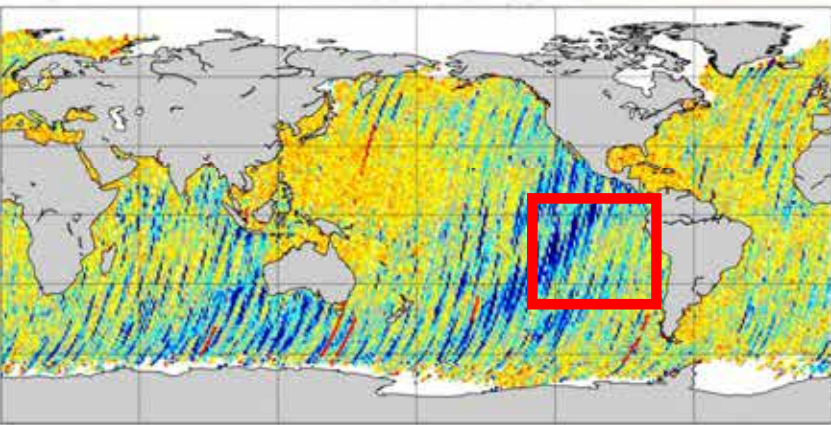


Impact of LR-RMC: Regional analysis

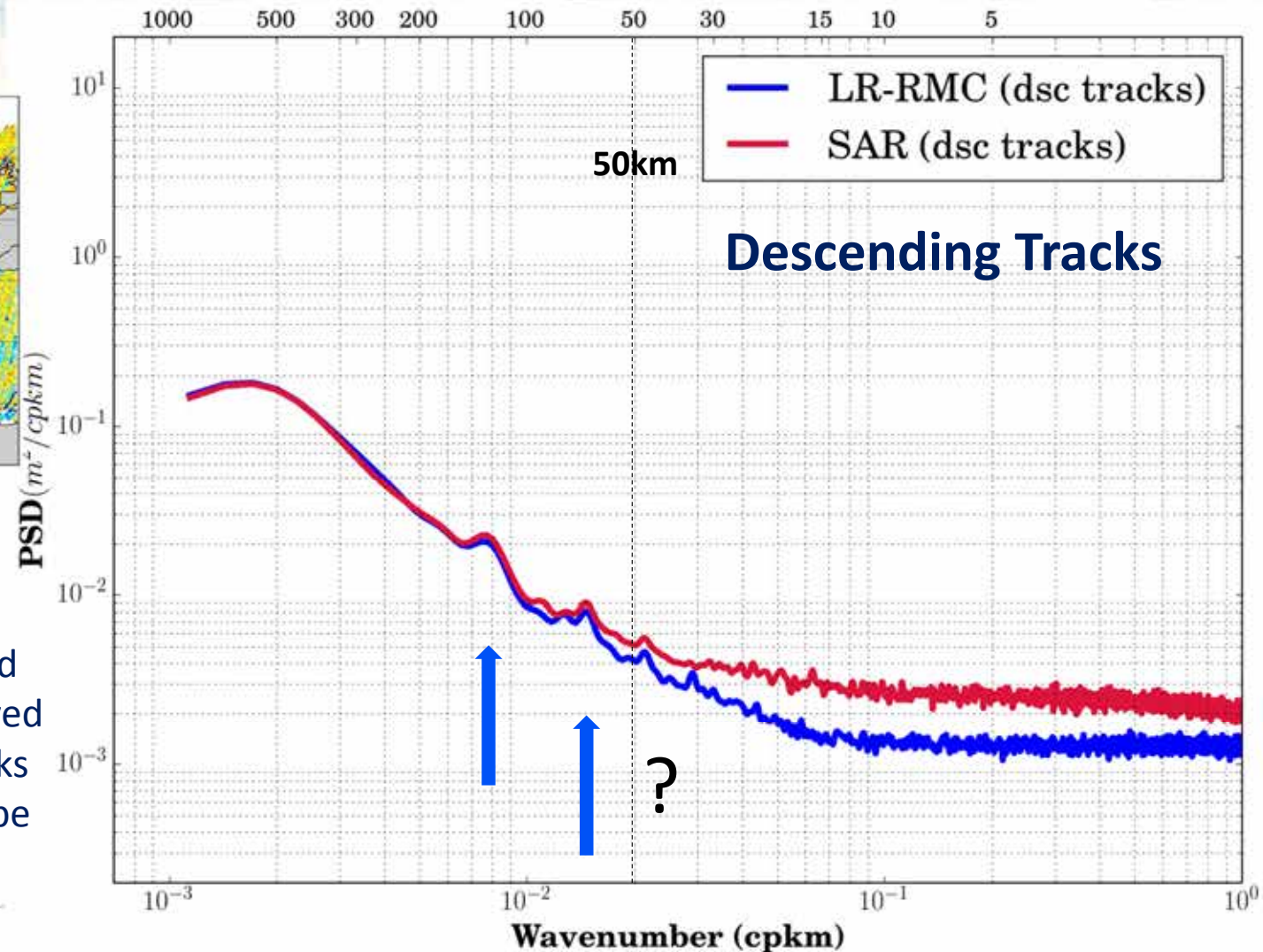
Region of swell effect



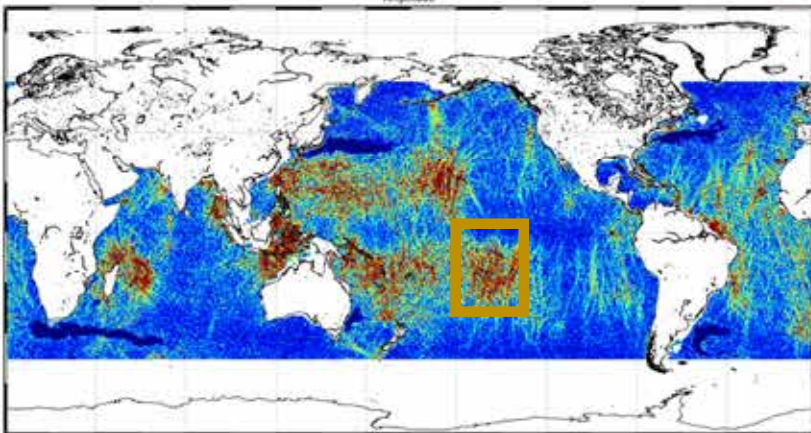
Impact of LR-RMC: Regional analysis



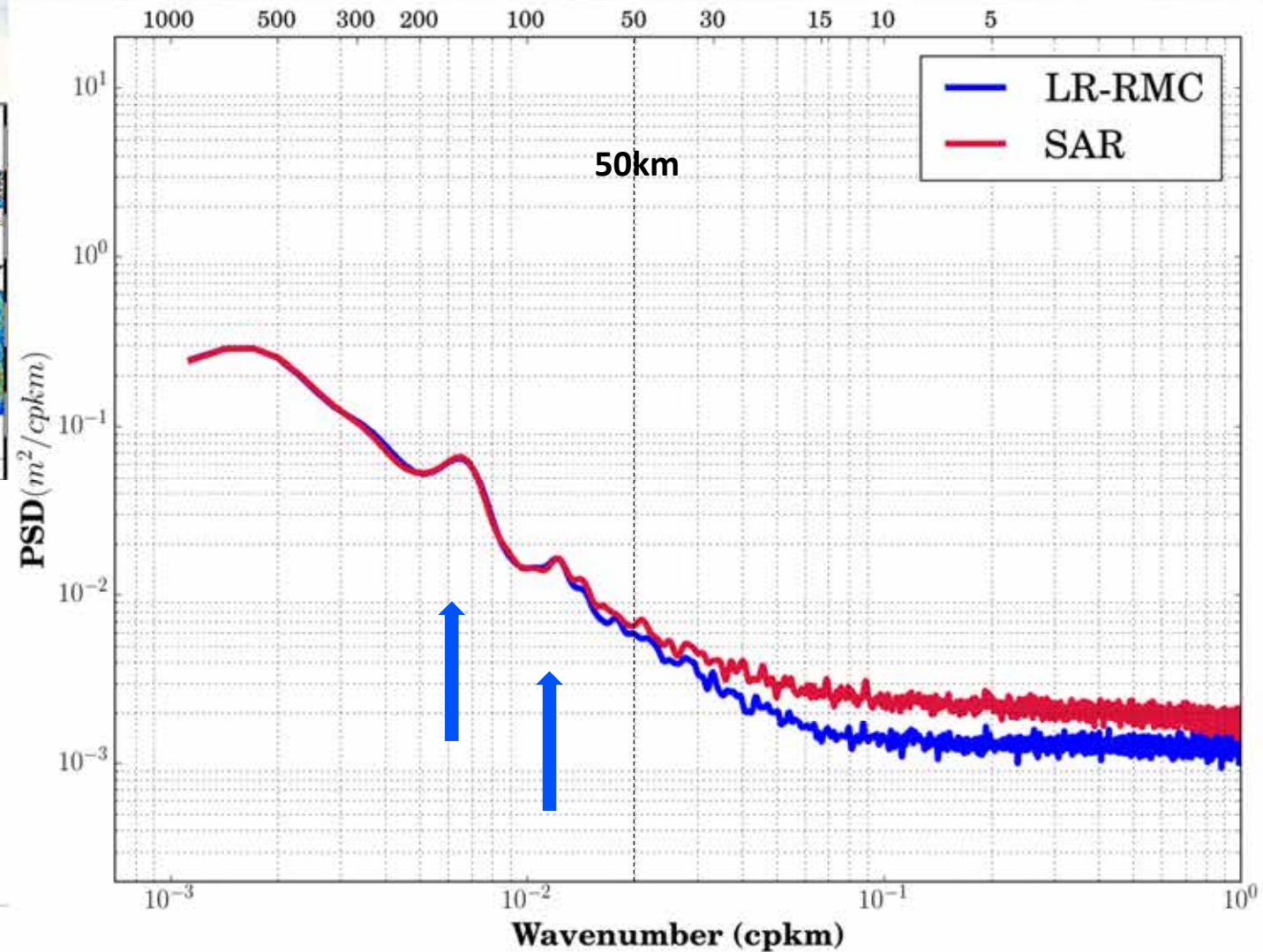
- LR-RMC allows
 - the suppression of coloured noise predominant in high swell area and
 - a consistency on the ocean observed on ascending and descending tracks
- Apparition of peaks below 50km – to be investigated



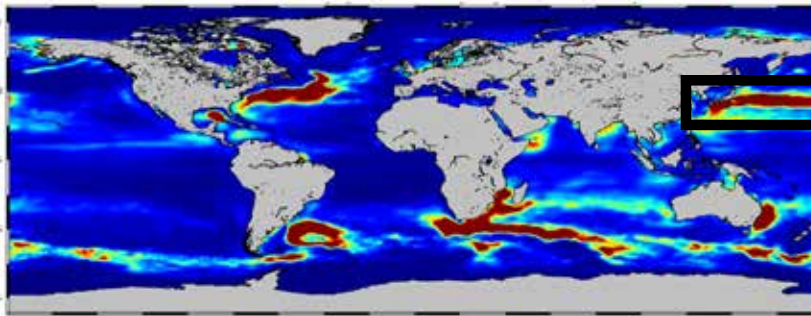
Impact of LR-RMC: Regional analysis



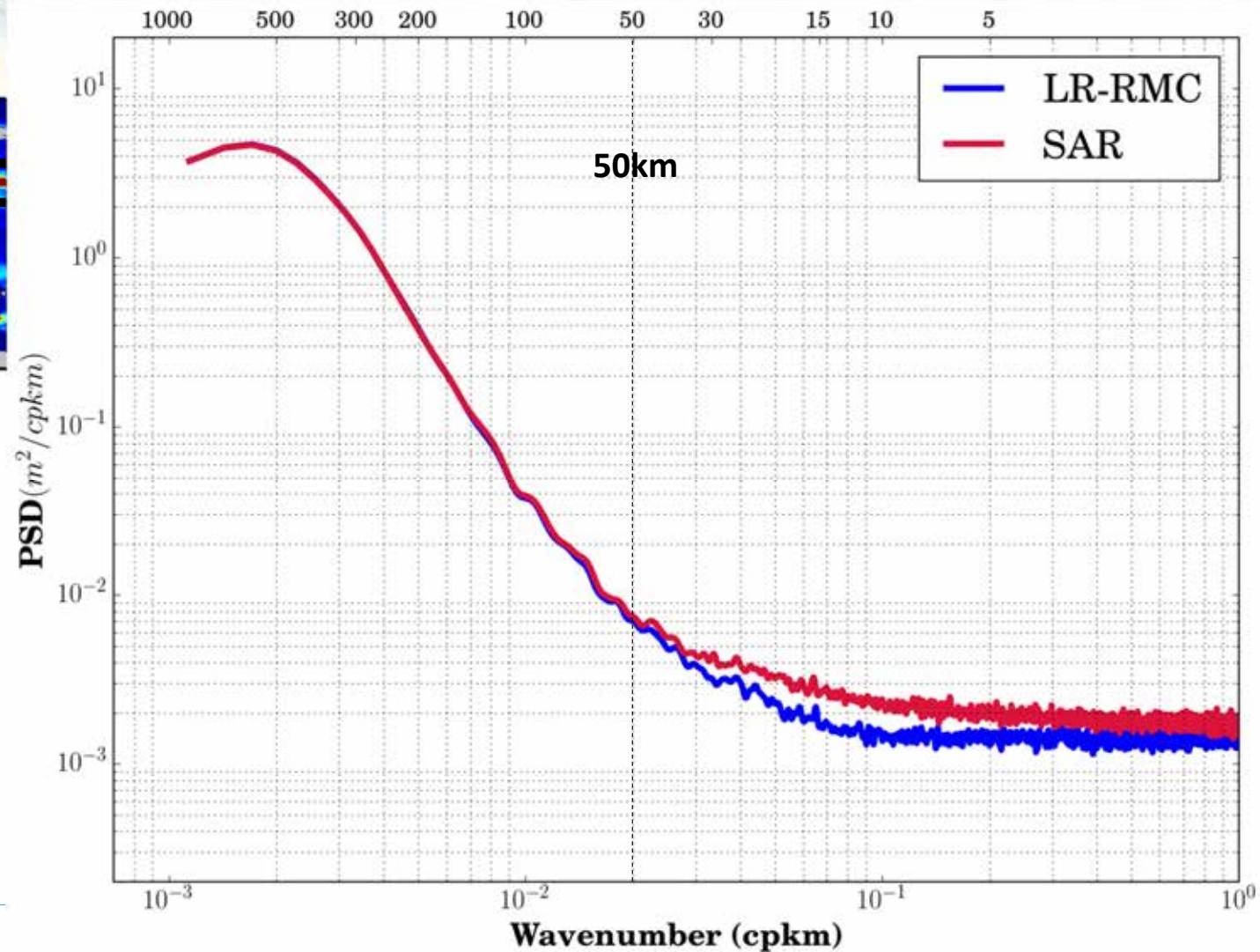
High internal tide



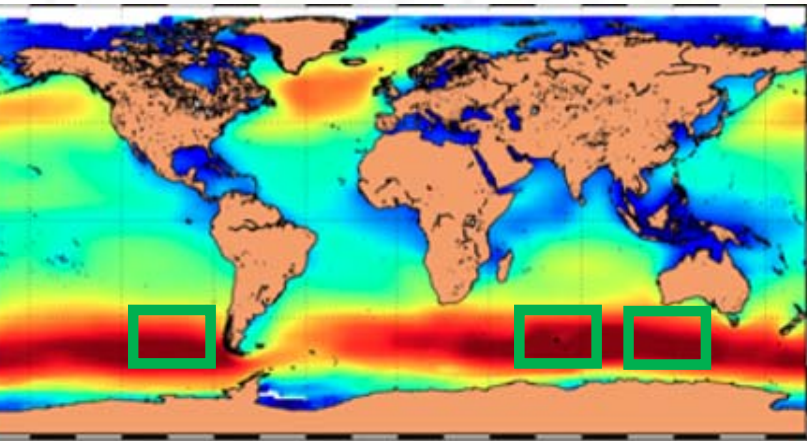
Impact of LR-RMC: Regional analysis



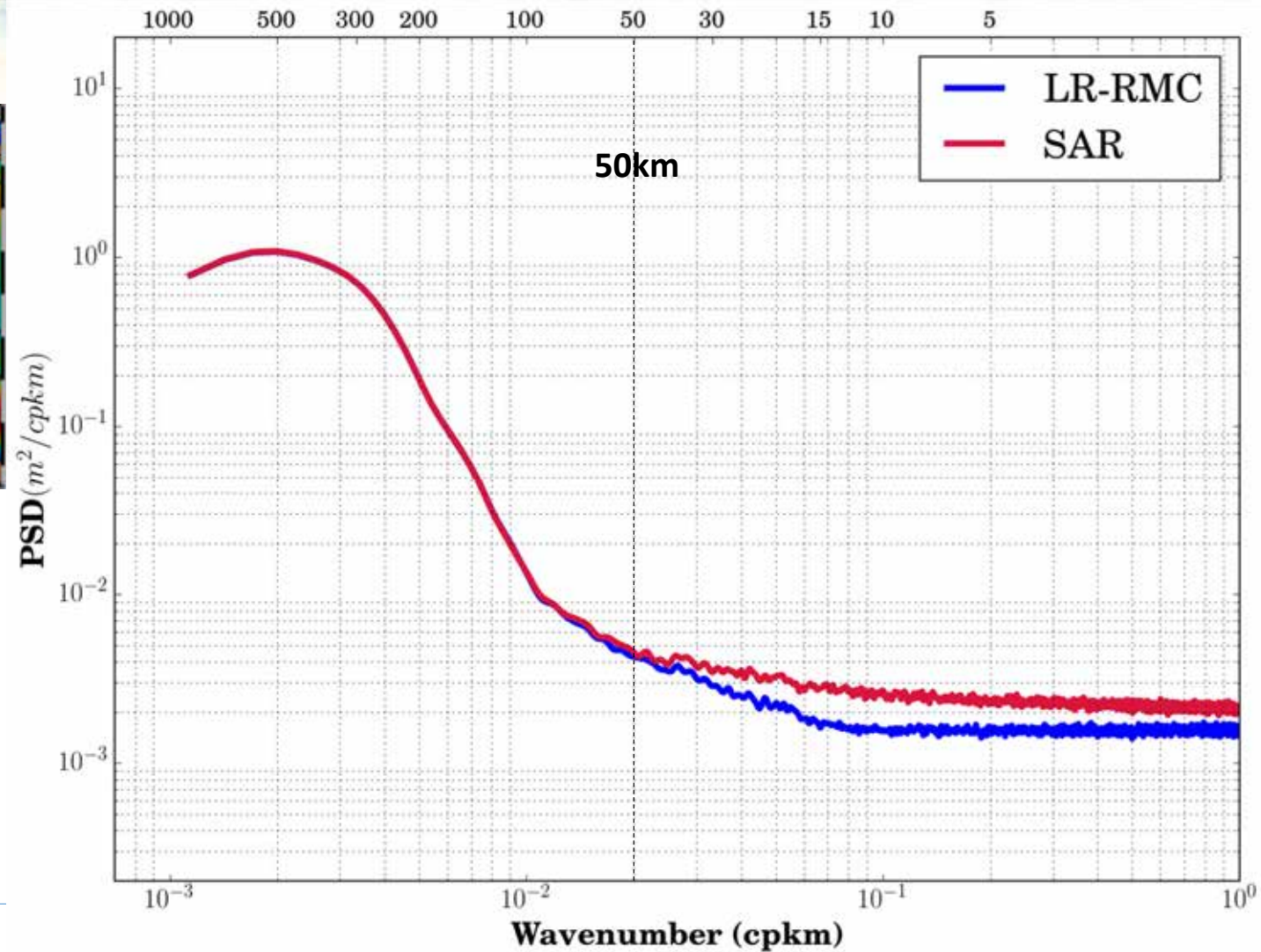
High mesoscale energy



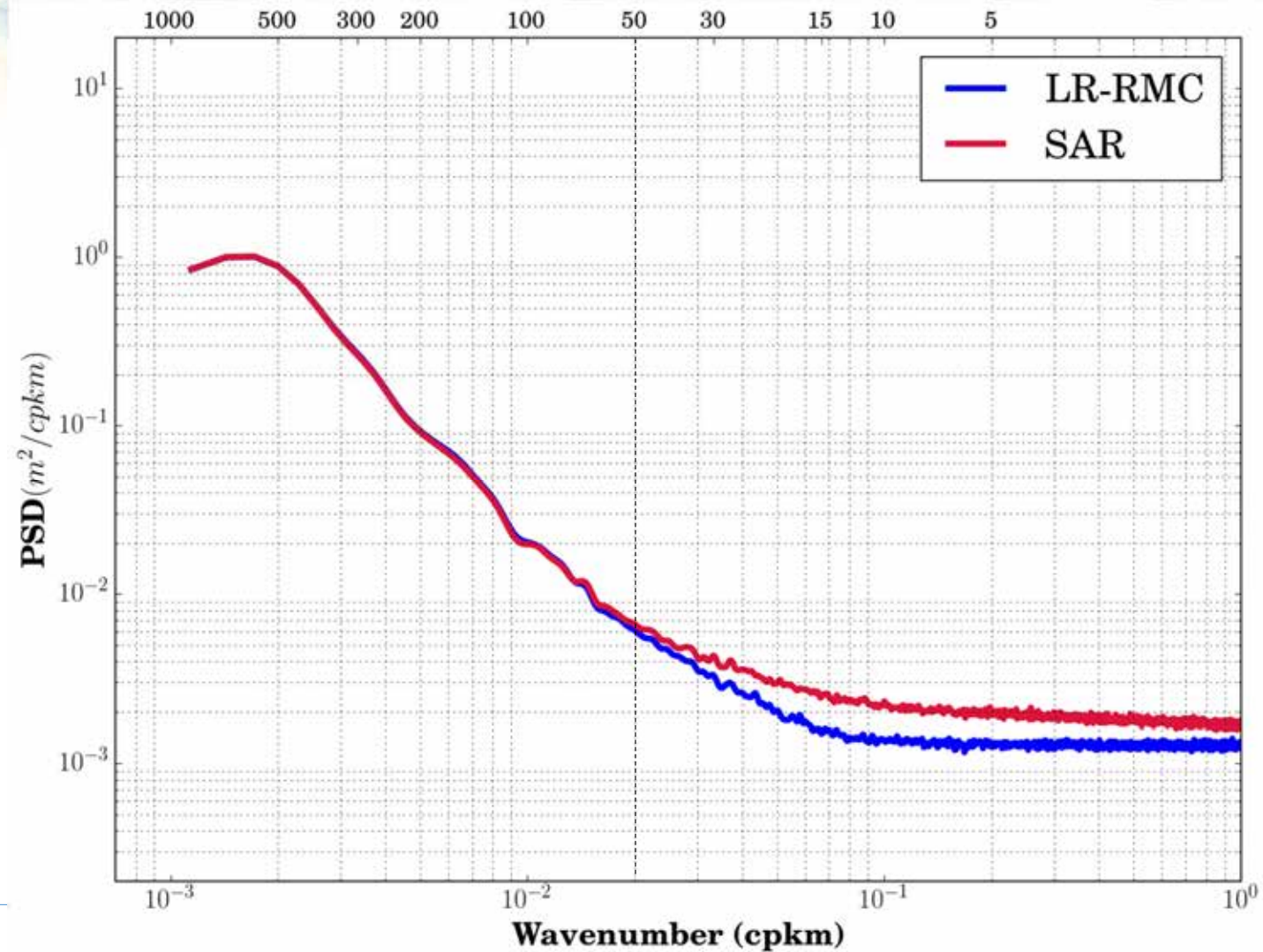
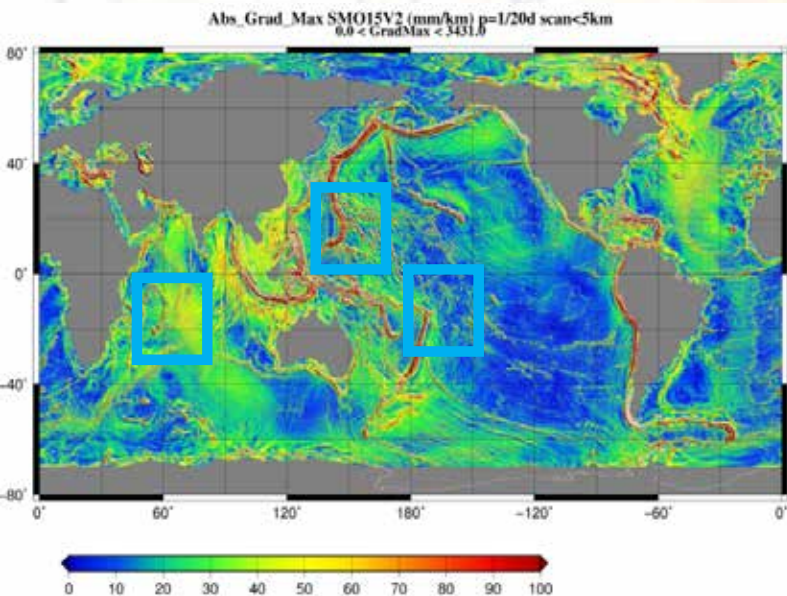
Impact of LR-RMC: Regional analysis



High SWH

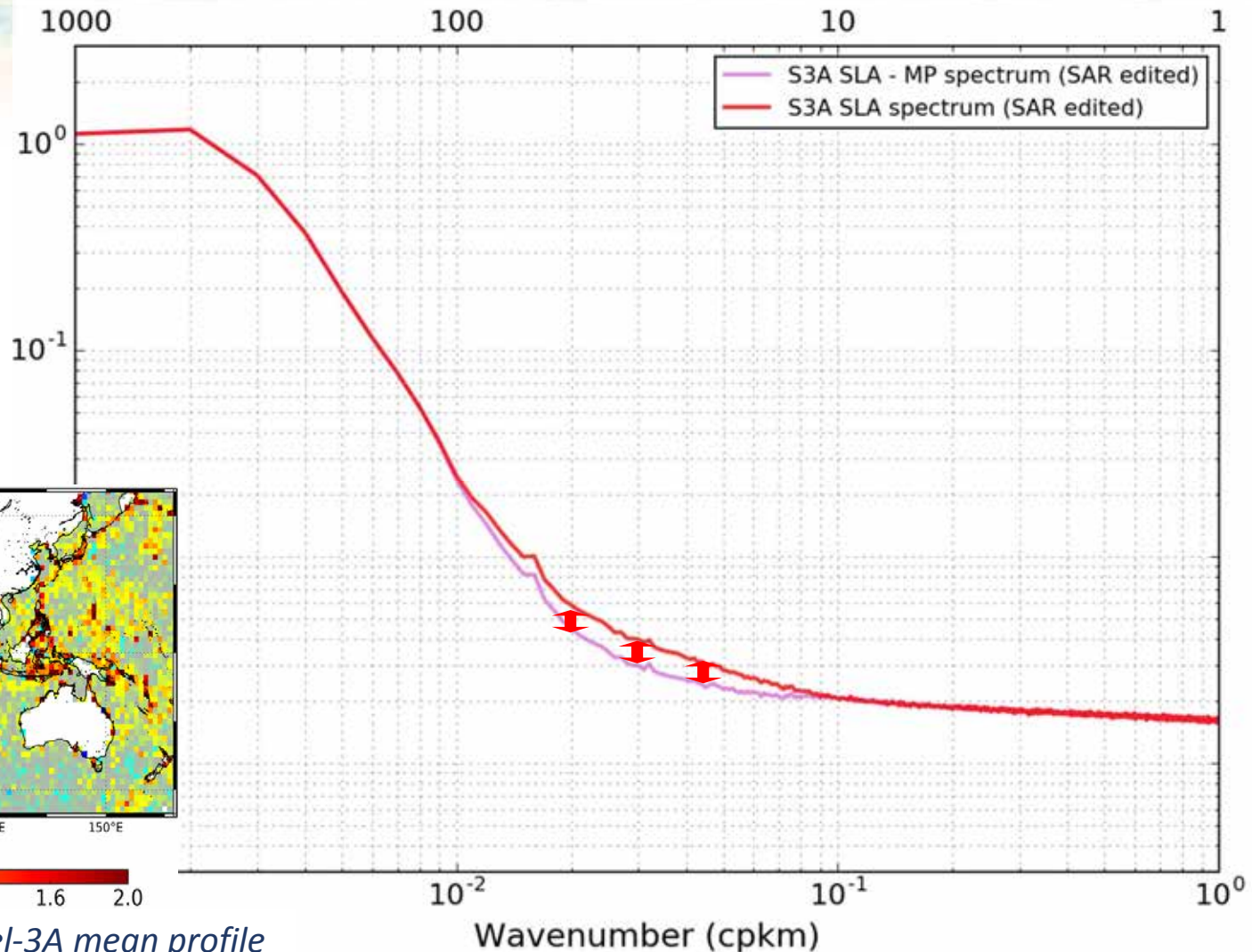
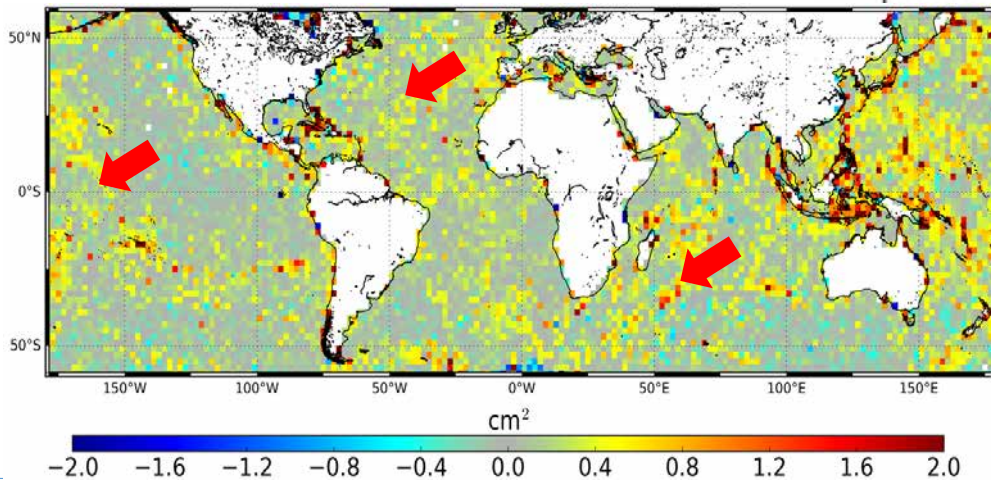


Results: Regional analysis



Impact of LR-RMC + improved MSS

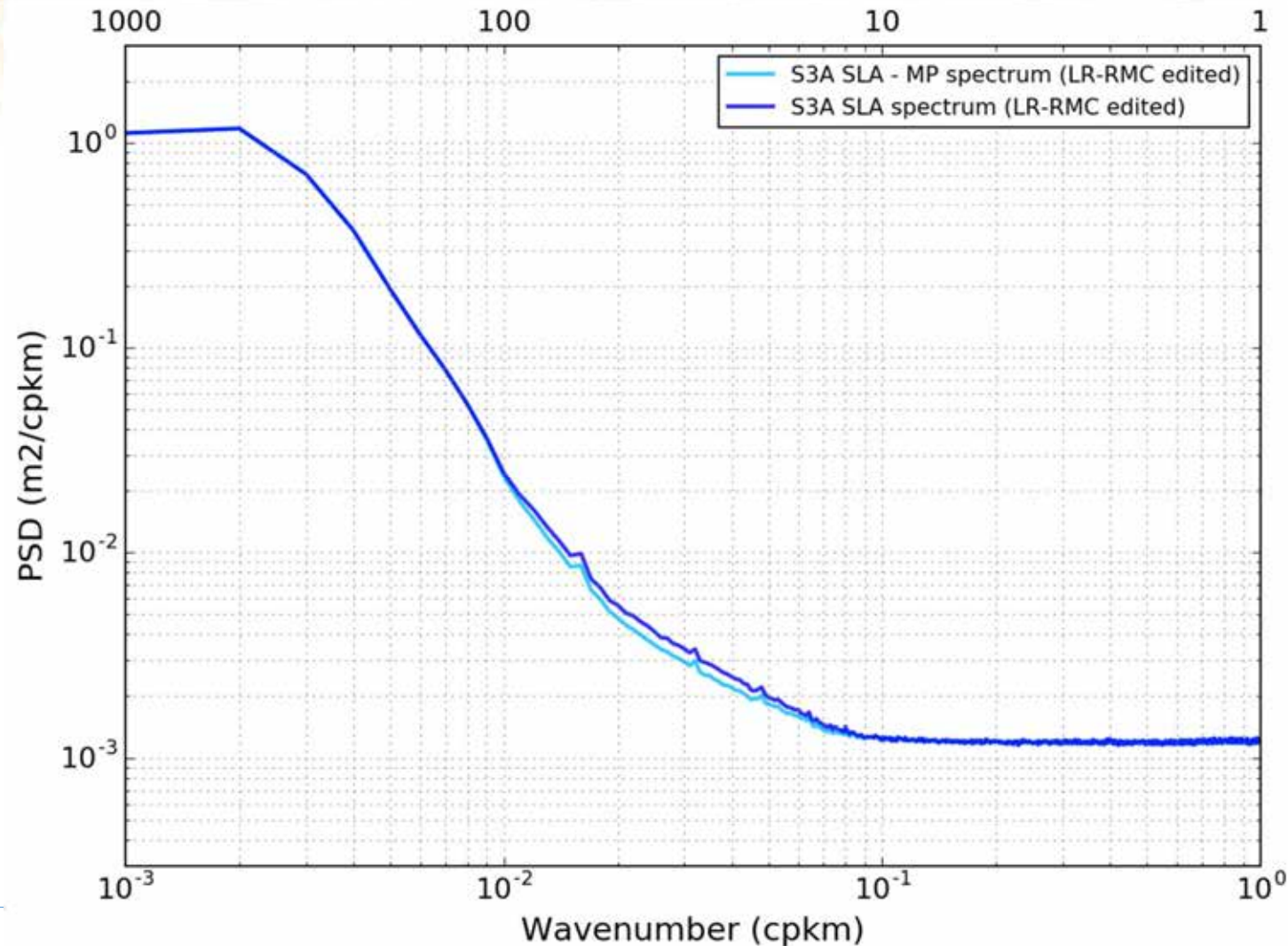
- MSS errors are significant along uncharted Sentinel-3A tracks for wavelengths from 15 to 100 km **Paper from Pujol et al. (JGR 2018).**
=> up to 30% of the SLA variance at these scales
- Computing a dedicated mean profile from classic SAR time series allows to reduce these error by ~50%. **Paper from Dibarboure et al. (in prep) see dedicated poster)**



MSS error reduction from CNES15 to the Sentinel-3A mean profile

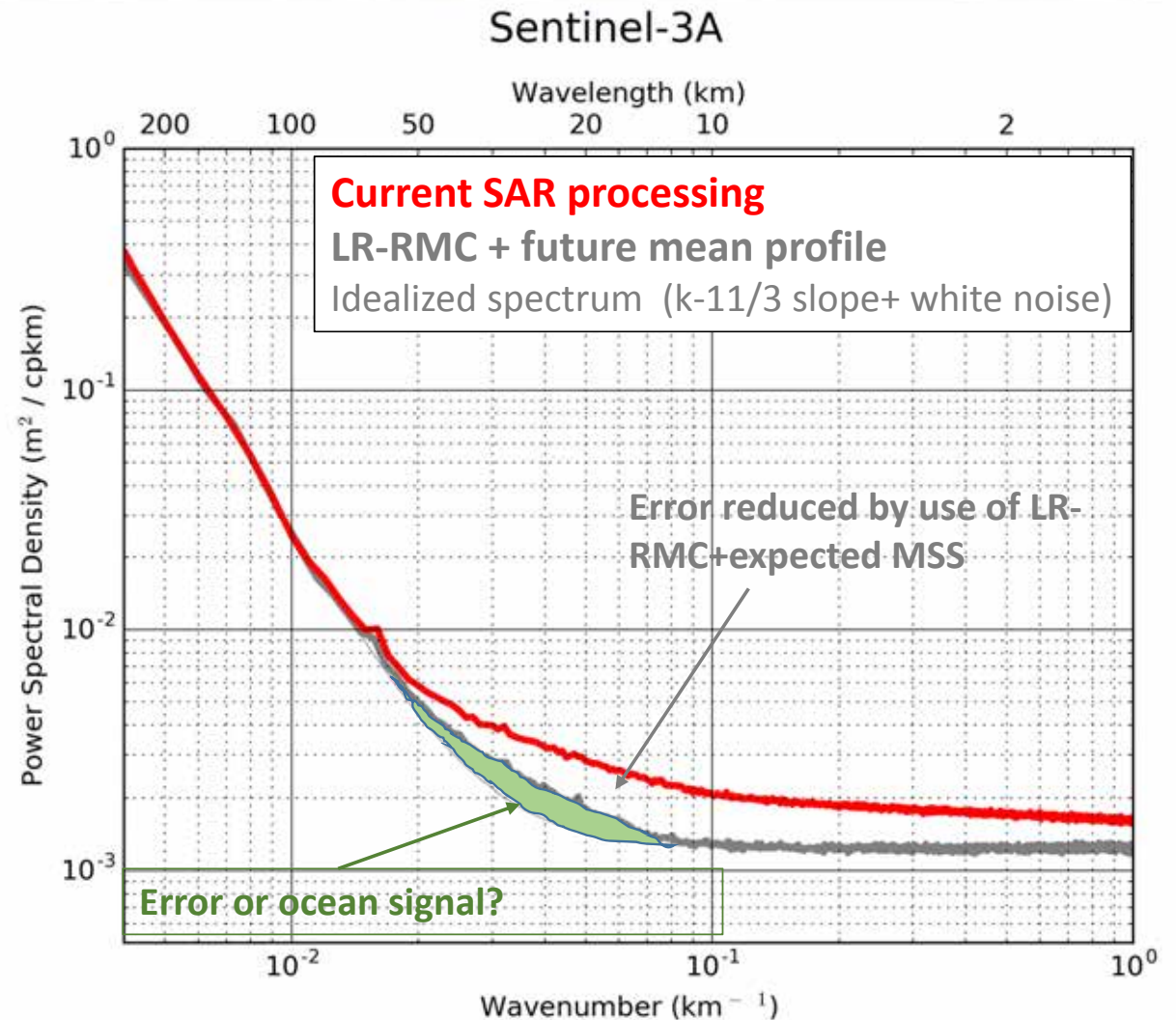
Impact of LR-RMC + improved MSS

- Application of the SAR mean profile to LR-RMC data leads also to a reduction of the MSS errors but less than for SAR
- A proper LR-RMC mean profile is necessary => **need the whole time series reprocessed**



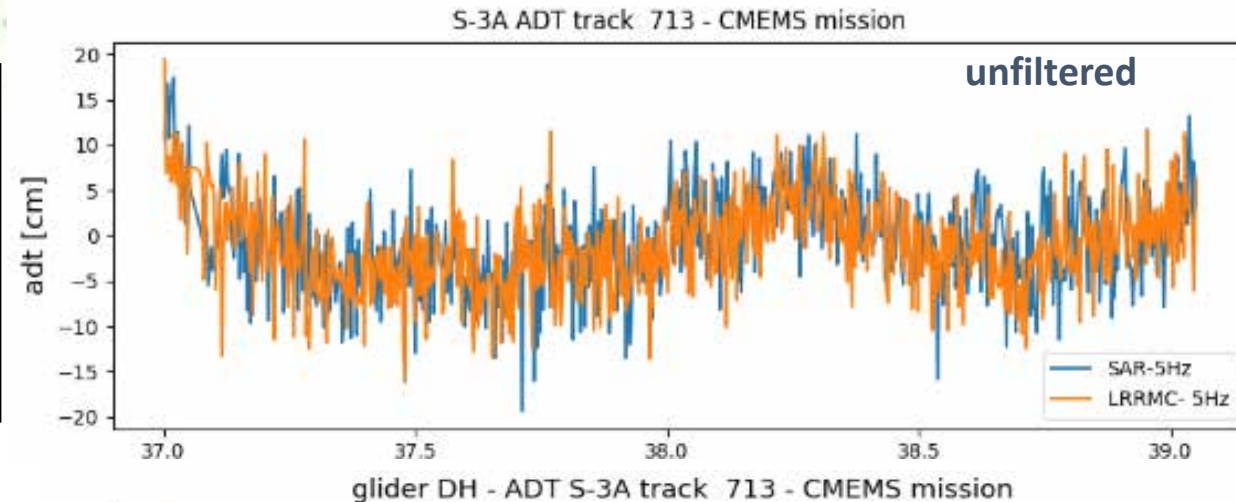
Impact of LR-RMC + improved MSS

- A combination of two different cycles processed in LR-RMC is performed to isolate the permanent (mainly MSS) errors (methodology described in Pujol et al, 2018) and allows us to anticipate the impact of the future LR-RMC mean profile (thick grey curve)
- The resulting SLA spectrum is now closer to the idealized spectrum.
- Running the regional analysis will be necessary to analyse the residual energy (green area)



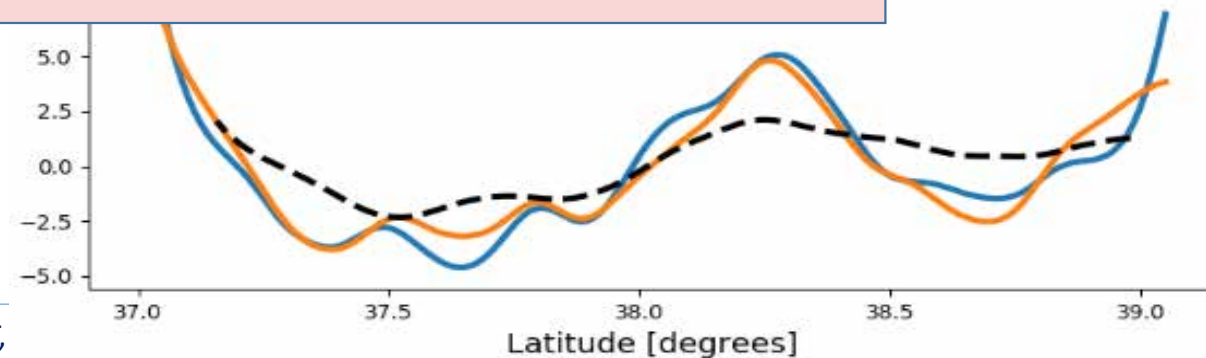
Impact of LR-RMC: Comparison to glider

- Comparison to Sentinel3A Absolute Dynamic topography to glider measurements South of Majorque in May 2016
- Methodology described in Heslop et al, 2017
- Similar results obtained with LR-RMC (calm Swell/SWH conditions)

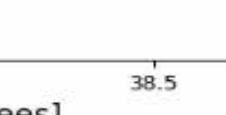
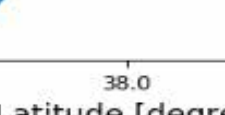
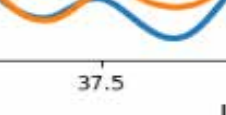
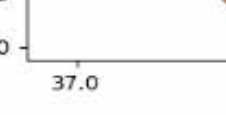


On going work by Antonio Sanchez
et Ananda Pascual

km low-pass filter



Sentinel-3 Pass 713 Cyc 4, May 2016



Conclusion & discussion

- The interest of LR-RMC for ocean DUACS/CMEMS have been analysed using 3 month of data
- Over this sample, LR-RMC allows us to better observe the ocean at wavelength $< 50\text{km}$
 - reduced the noise level in all conditions
 - removes the red noise caused by the Swell

=> LR-RMC always better than SAR-M
- MSS is a strong part of the budget error at these scale. LR-RMC+ dedicated Mean profile should still increase the potential of this method => Need to perform a whole reprocessing to compute a dedicated mean profile, which is also needed also for regional studies
- Future work
 - Release of L3 samples on Aviso soon. Access to instrumental database (L2 + waveforms à 20 Hz) on request.
 - => Feedbacks from user and external expert are welcome !
 - Refine Regional analysis with reduced MSS errors. Complete the assessment with other diagnosis
 - Slope change could be true SSH signal or processing artifacts => investigation on-going

References:

- Pujol et al. (2018). Gauging the improvement of recent mean sea surface models: A new approach for identifying and quantifying their errors. Journal of Geophysical Research: Oceans, 123
- Dibarboure G et al (2018). Improving the quality of Sentinel-3A with a hybrid mean sea surface model, and implications for Sentinel-3B and SWOT. In prep.