Discrepancies in Sentinel-6MF Sea Surface Parameters Estimated from Low- and High-Resolution Data

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Shameless Advertisement

- We are looking for a PhD to support our team
- Focus lies on SWOT and classical radar altimetry in coastal areas
- If you are interested, please feel free to contact me via cbuchhau@umd.edu
- For more information: https://essic.umd.edu/joom2/index.php/employment/3148-post-doctoral-research-associate-in-remote-sensing-altimetry

Introduction

For further information about this topic please read our paper:

Towards the Mitigation of Discrepancies in Sea Surface Parameters Estimated from Low- and High-Resolution Satellite Altimetry

by Christopher K. Buchhaupt [1,*], Alejandro Egido [2], Douglas Vandemark [3], Walter H. F. Smith [4], Luciana Fenoglio [5] and Eric Leuliette [4]

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Introduction

- LR signals sampled w.r.t. range (epoch) and pulse-to-pulse-time (slow-time)
  - Incoherent processing with integration time of pulse width
  - Signal stable w.r.t slow-time
  - Retracking only focuses on fitting power within range samples

- HR signals sampled w.r.t. range (epoch) and relative velocity between scatterer and platform (azimuth)
  - Coherent processing with integration time of burst length
  - State-of-the-art focuses on fitting power in range samples
  - Sensitive to velocities occurring on the sea surface -> inconsistencies

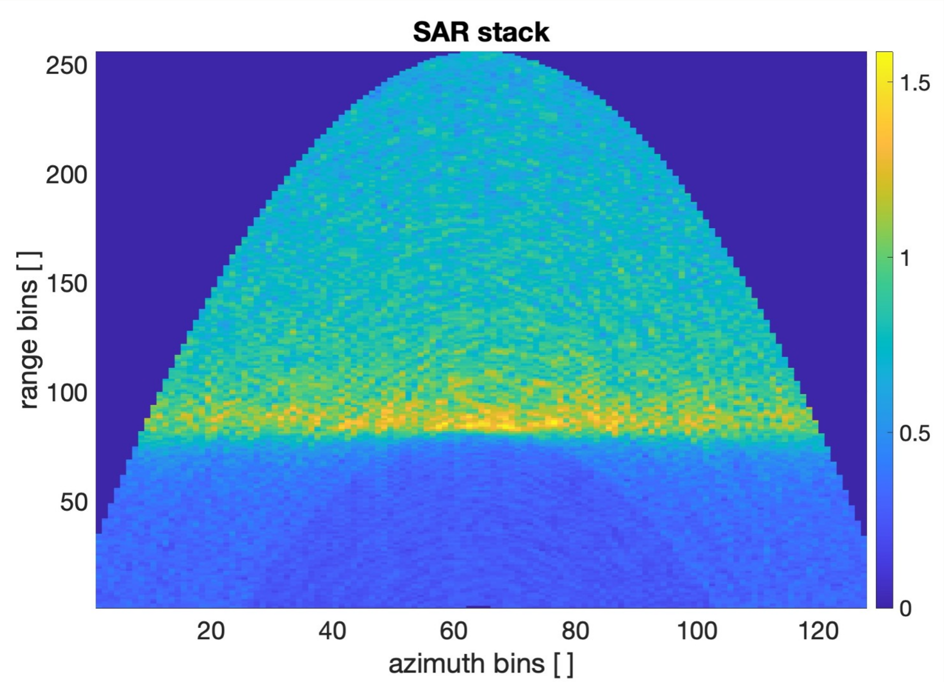
Introduction: HR Specific Effects

- Random effects
  - Causes azimuth blurring effect leading to SWH errors.
  - Depends on the observable variation of vertical wave particle velocities (VWPV) occurring in a wave field.
  - Can be addressed in retracking or via a look-up-table (F09).

- Non-random effects
  - Cause a scaling of Delay-Doppler map (DDM) leading mostly to SSH errors.
  - Depends on mean vertical velocities at a given incidence angle, atmospheric refraction, and currents.
  - Effects and possible solutions will be shown here.

Introduction: 2D SAR Retracking

- Idea: Use of Doppler information given in stack
- Estimated parameters
  - Wind speed
  - SSH
  - SWH = $4\sigma_z$
  - VWPV variation σ_v
  - Along-track surface velocity u_x
- Aim: Minimization of LR-HR inconsistencies



Note: Stack retracking requires handing of exponential distributed sample noise.
Here we transform it towards a symmetric Weibull distributed. This is further called ZSK.

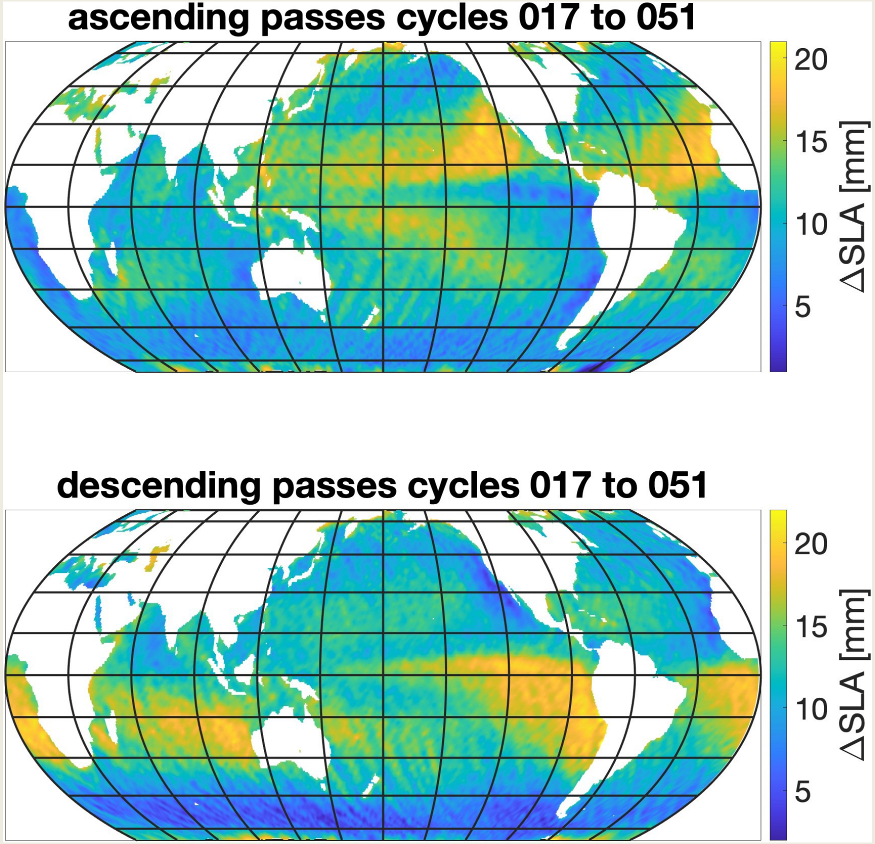
Sentinel-6A Cycle 1 Year Global Analyses

- Three different SAR (HR) retrackers used:
  - SINCS STD: Close to current state-of-the-art
  - SINCS-OV ZSK: VWPV stack retracker
  - SINCS-OV2 ZSK: VWPV plus u_x stack retracker

- Reduced SAR (LR) retrackers used:
  - SINC2 STD: Close to current state-of-the-art
  - SINC2 ZSK: Zero Skewness version of SINC2 STD

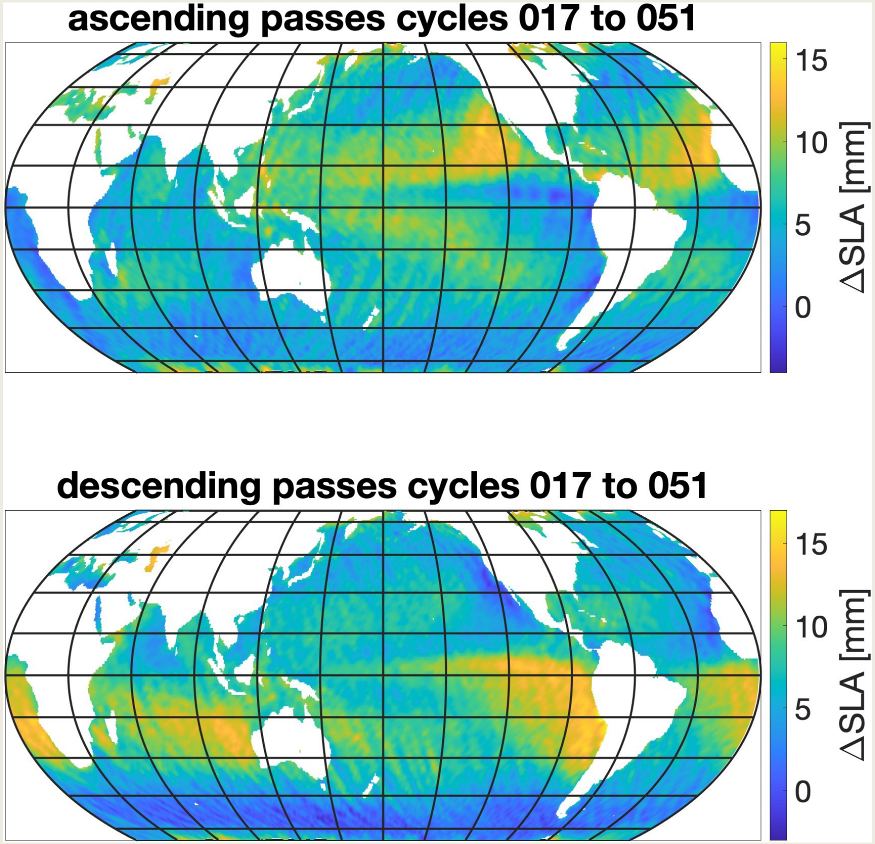
- SINCS STD is compared with SINC2 STD
- SINCS-OV ZSK and SINCS-OV2 ZSK with SINC2 ZSK

Sentinel-6A 1 Year SSH HR-LR Differences



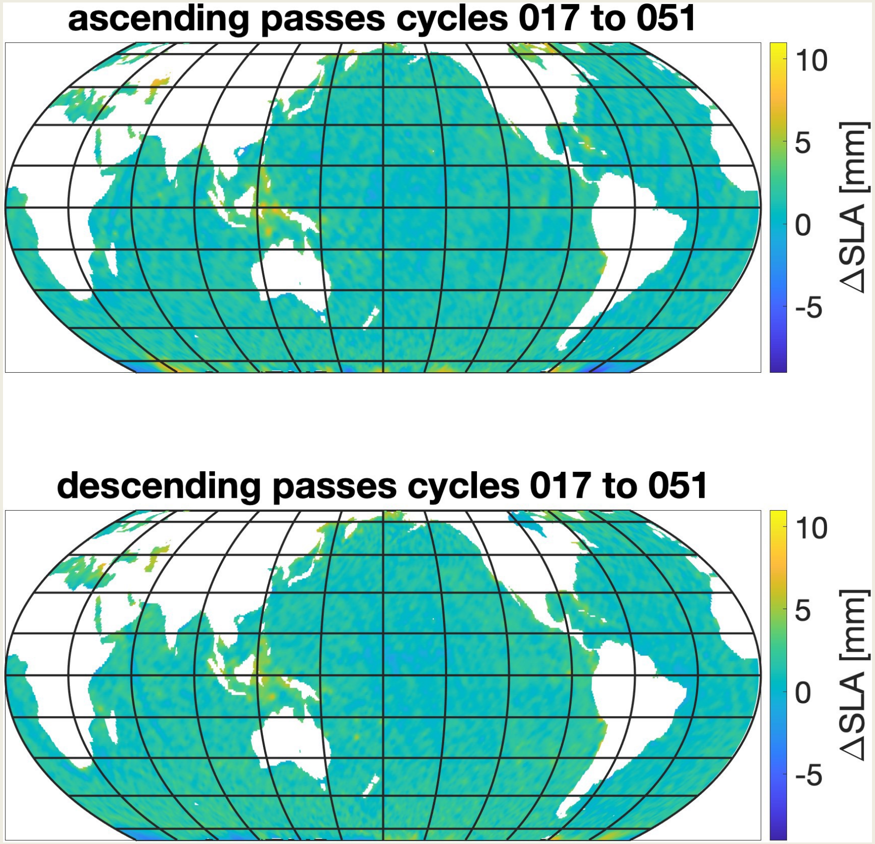
HR – LR SSH estimates. LR retracker is SINC2 STD. HR retracker is SINCS STD. We computed it by stacking the maps for each cycle and calculate the average value in the stack dimension.

Sentinel-6A 1 Year SSH HR-LR Differences



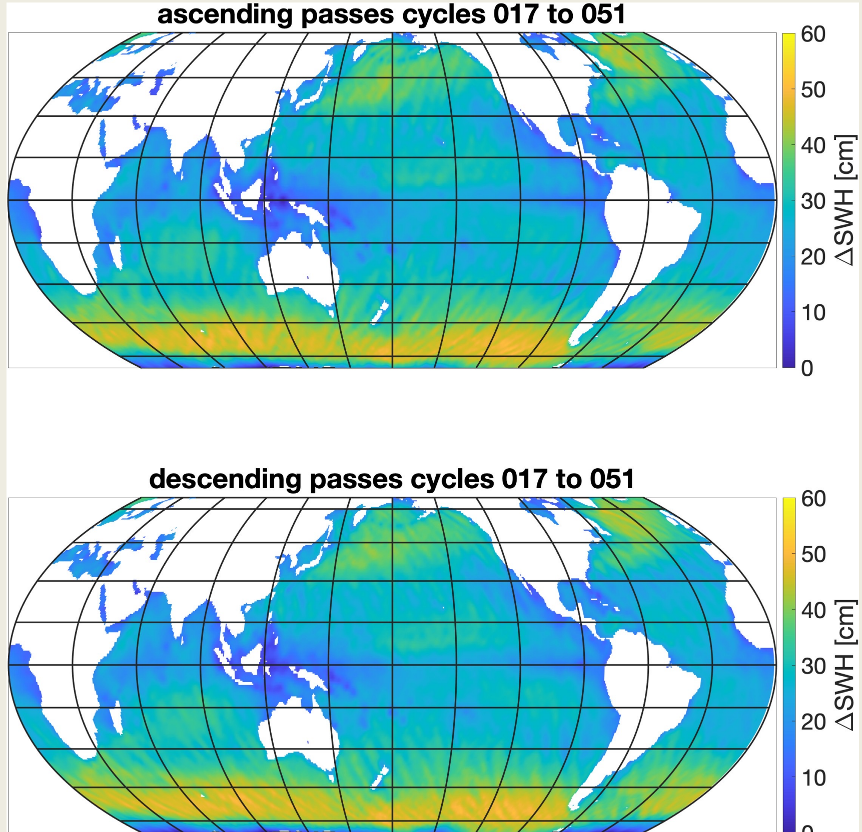
HR – LR SSH estimates. LR retracker is SINC2 ZSK. HR retracker is SINCS-OV ZSK. We computed it by stacking the maps for each cycle and calculate the average value in the stack dimension.

Sentinel-6A 1 Year SSH HR-LR Differences



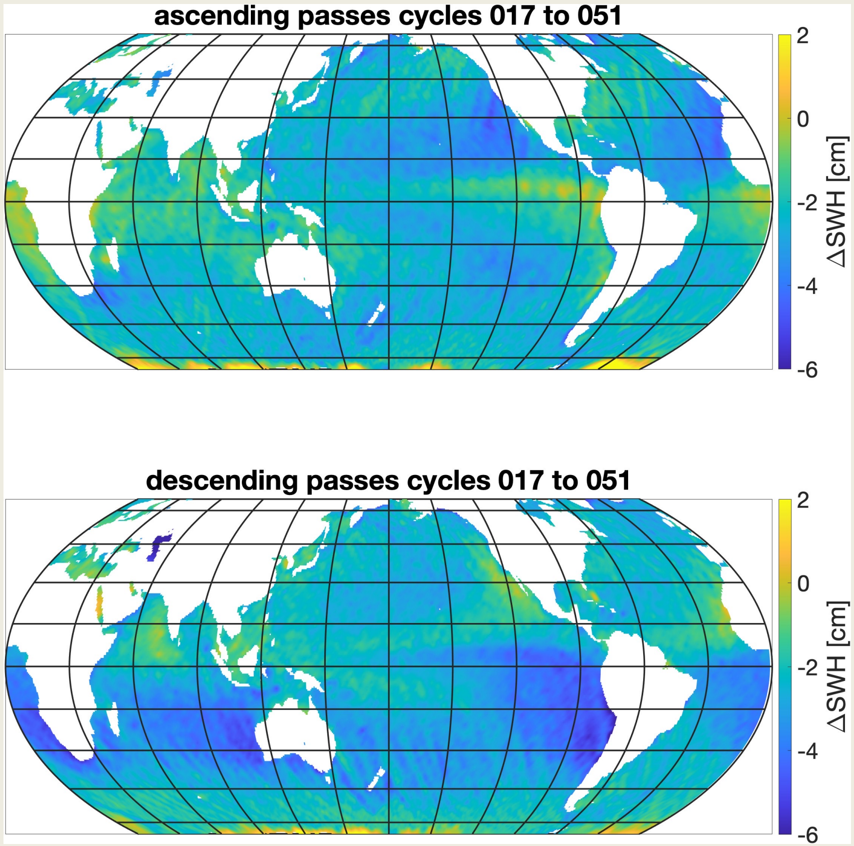
HR – LR SSH estimates. LR retracker is SINC2 ZSK. HR retracker is SINCS-OV2 ZSK. We computed it by stacking the maps for each cycle and calculate the average value in the stack dimension.

Sentinel-6A 1 Year SWH HR-LR Differences



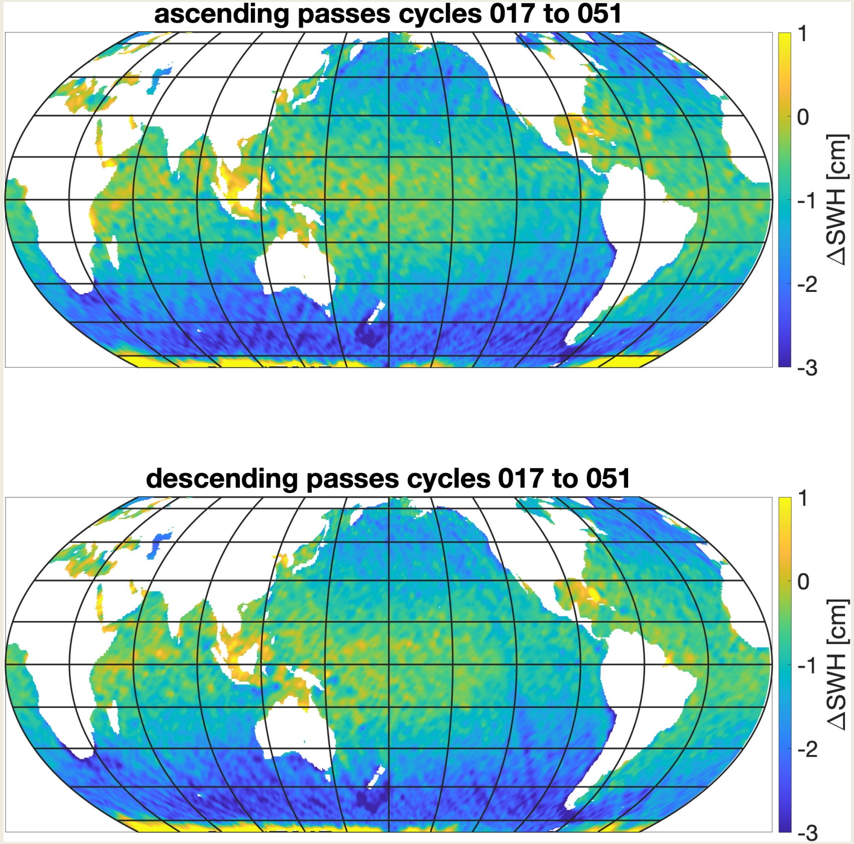
HR – LR SWH estimates. LR retracker is SINC2 STD. HR retracker is SINCS STD. We computed it by stacking the maps for each cycle and calculate the average value in the stack dimension.

Sentinel-6A 1 Year SWH HR-LR Differences



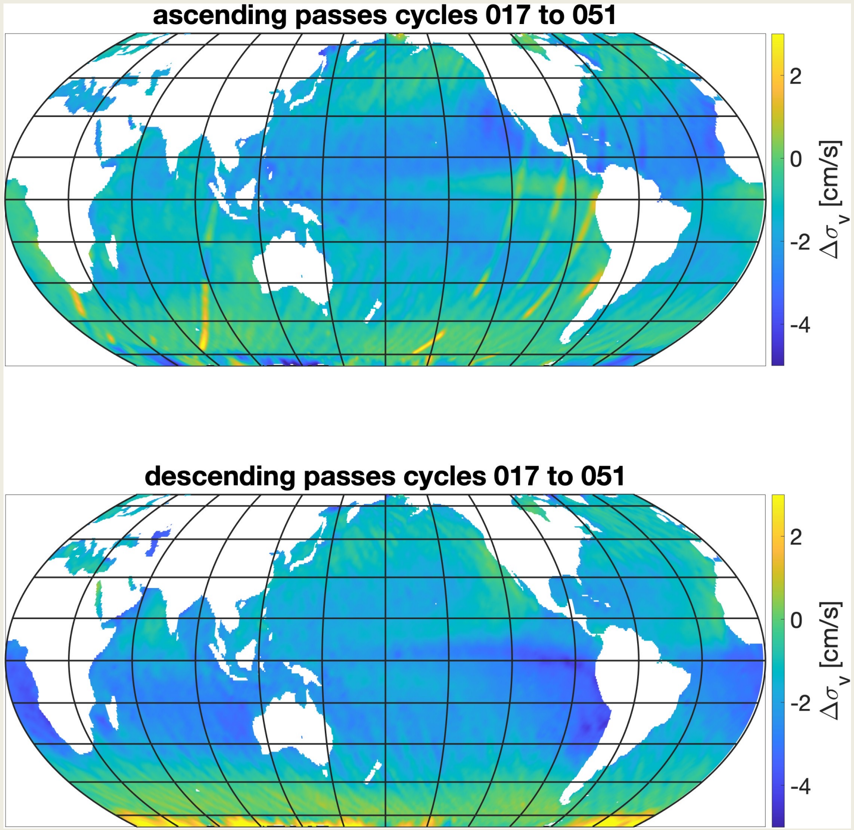
HR – LR SWH estimates. LR retracker is SINC2 ZSK. HR retracker is SINCS-OV ZSK. We computed it by stacking the maps for each cycle and calculate the average value in the stack dimension.

Sentinel-6A 1 Year SWH HR-LR Differences



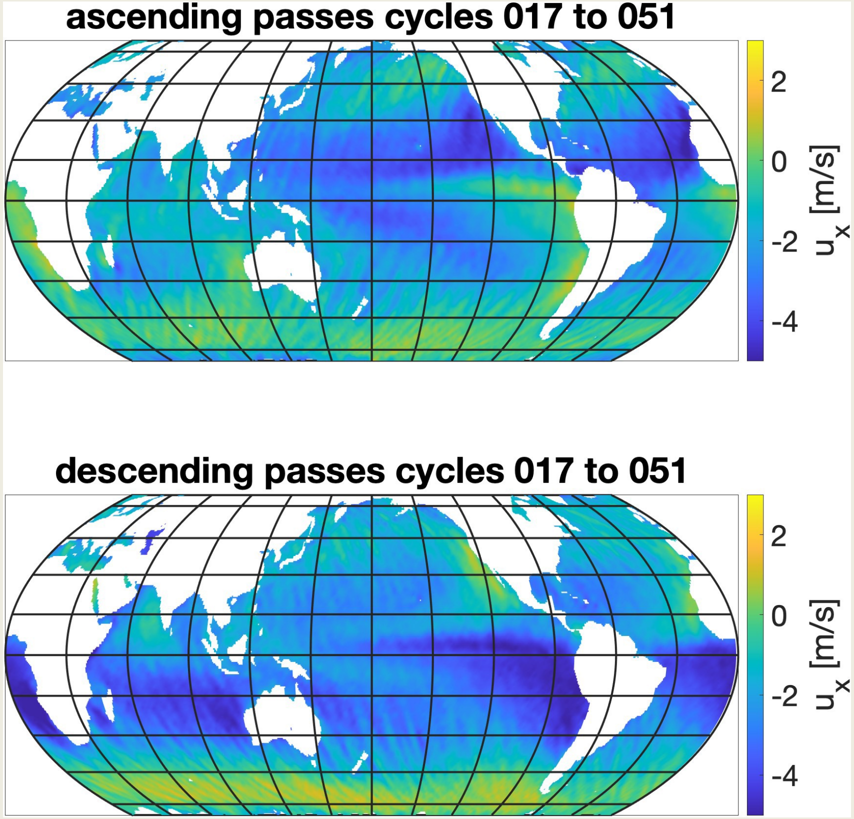
HR – LR SWH estimates. LR retracker is SINC2 ZSK. HR retracker is SINCS-OV2 ZSK. We computed it by stacking the maps for each cycle and calculate the average value in the stack dimension.

Sentinel-6A 1 Year σ_v Differences



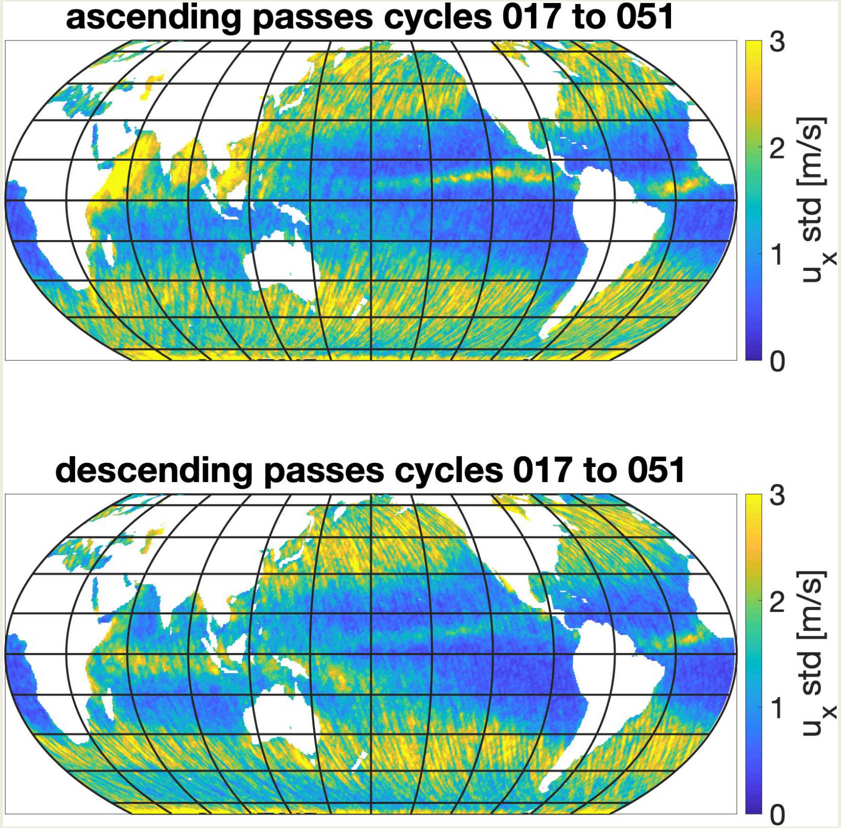
Mean σ_v differences between SINCS-OV ZSK and SINCS-OV2 ZSK. We computed it by stacking the maps for each cycle and calculate the average value in the stack dimension.

Sentinel-6A 1 Year Mean u_x



u_x mean value over all cycles. We computed it by stacking the maps for each cycle and calculate the average value in the stack dimension.

Sentinel-6A 1 Year STD u_x

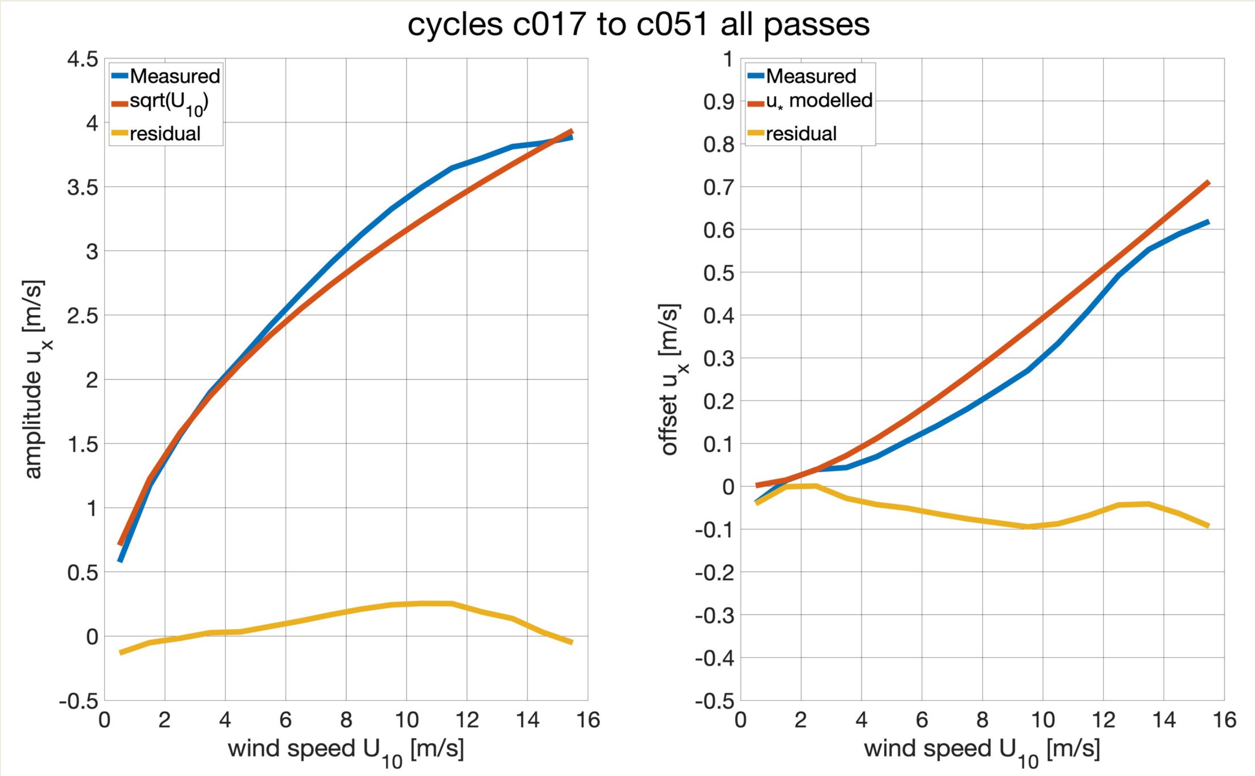


u_x standard deviation over all cycles. We computed it by stacking the maps for each cycle and calculate the standard deviation in the stack dimension.

u_x w.r.t. ERA5 Windspeed and Direction

We fitted estimated u_x w.r.t ERA5 windspeed and direction w.r.t the track using the equation:

$$u_x = \text{amplitude x} \cos(\text{winddir wrt track}) + \text{offset}$$



u_x with respect to ERA5 wind-speed and direction. u_* is the friction velocity.
However, the offset might be affected by something else, which behaves like the friction velocity.

Conclusion

- We presented a solution to mitigate the vast majority of HR-LR inconsistencies by introducing a new parameter to SAR stack retracking.
- In principle it should be possible to address effects on SSH and SWH of this new parameter via a look-up-table, but it would be necessary to check how this parameter behaves with other mission, e.g. Sentinel-3.
- Otherwise, implementing the retracker directly should be the preferable choice since more retrievable information from SAR altimetry is a good outcome.