



European Union



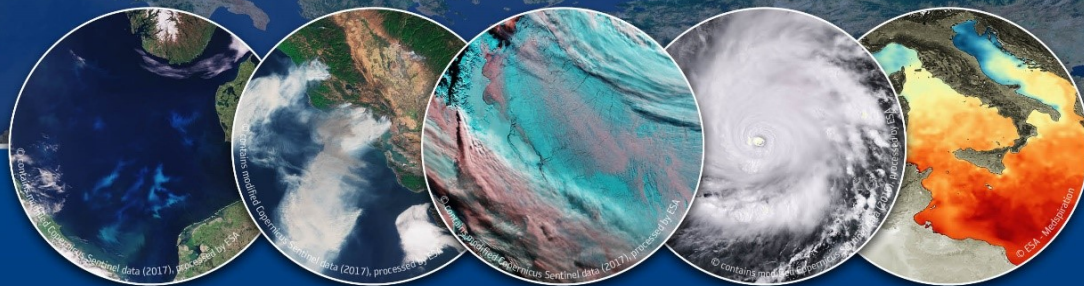
European Space Agency

Status of S3A-B Products over Land Ice and Sea Ice

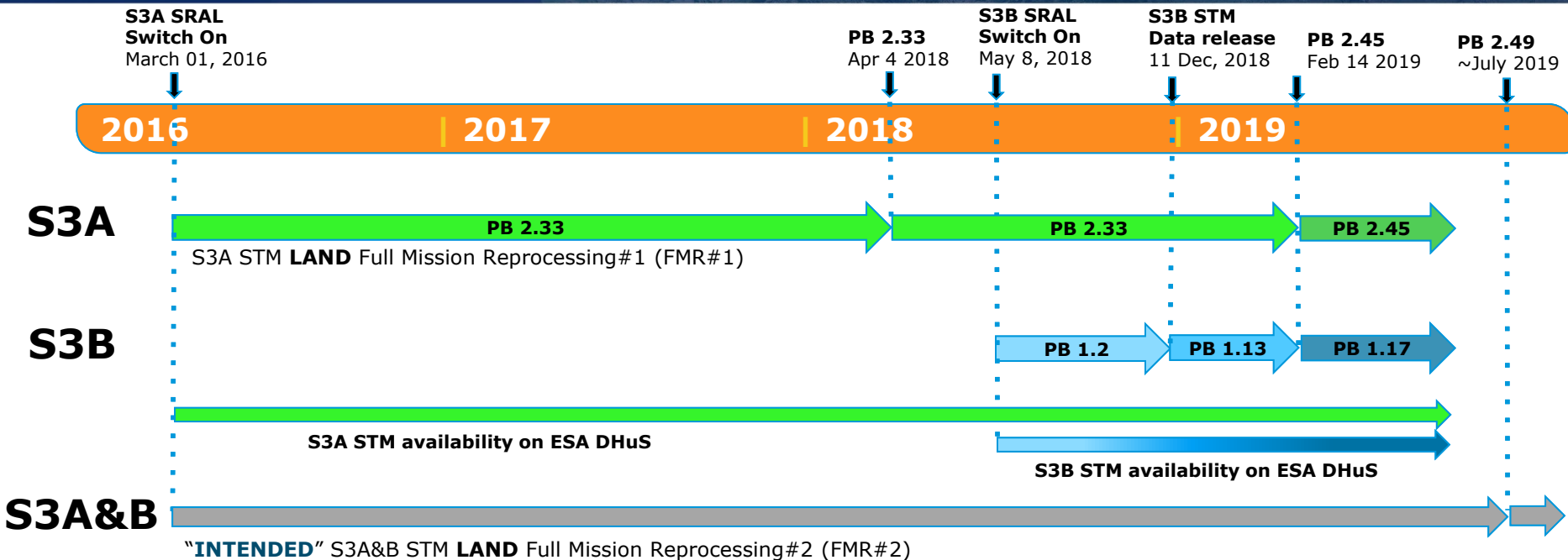
Pierre Féménias ESA ESRIN

25 June 2019

Atelier Glaciologie
Toulouse



S3A & S3B STM: LAND Mission Data Set



PB = Processing Baseline

S3A PB = S3B PB

Current PB 2.45

- 23 anomalies and evolutions implemented for all levels SRAL & MWR L1 & L2 processing chains
- **Sea ice processing corrected (Meaningful free-board comparable to CS2!)**
- Improved OCOG retrieval over land ice and sea ice (LRM mode)
- Ice concentration corrected around coastline
- ...

Next PB 2.49

- 19 anomalies and evolutions implemented for all levels SRAL & MWR L1 & L2 processing chains
- New surface slope model
- Updated geoid model - EGM2008
- Updated MSS - DTU18
- ...

S3 STM Sea Ice Outlook: Freeboard



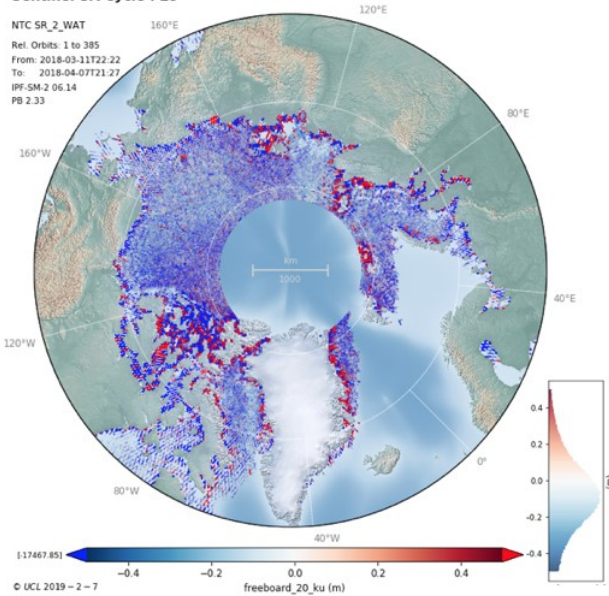
Sentinel-3A L2 Parameter:
freeboard_20_ku

area: Arctic

PB 2.33

Sentinel-3A Cycle : 29

NTC SR_2_WAT
Rel. Orbits: 1 to 385
From: 2018-03-11T22:22
To: 2018-04-07T21:27
IPF-SM-2 06.14
PB 2.33



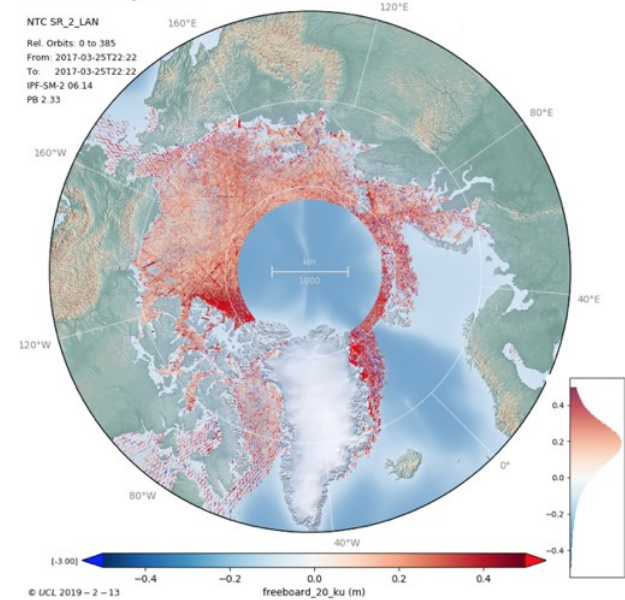
Sentinel-3A L2 Parameter:
freeboard_20_ku

area: Arctic

PB 2.45

Sentinel-3A Cycle : 37

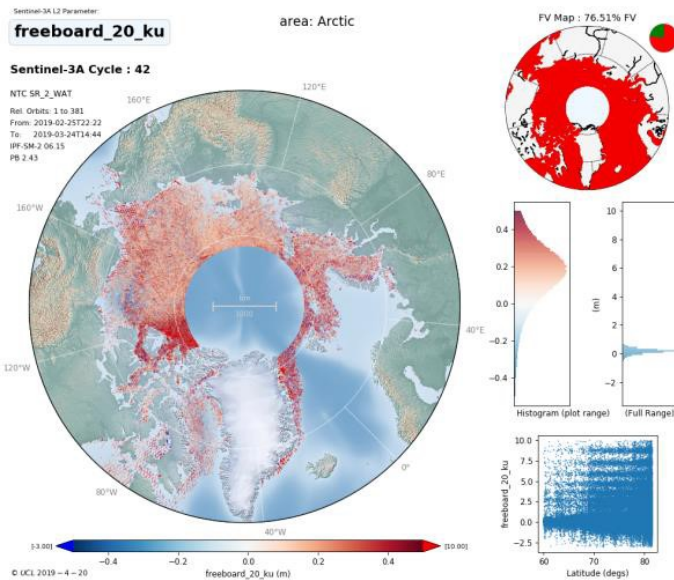
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To: 2017-03-25T22:22
IPF-SM-2 06.14
PB 2.33



S3 STM Sea Ice Outlook: Freeboard

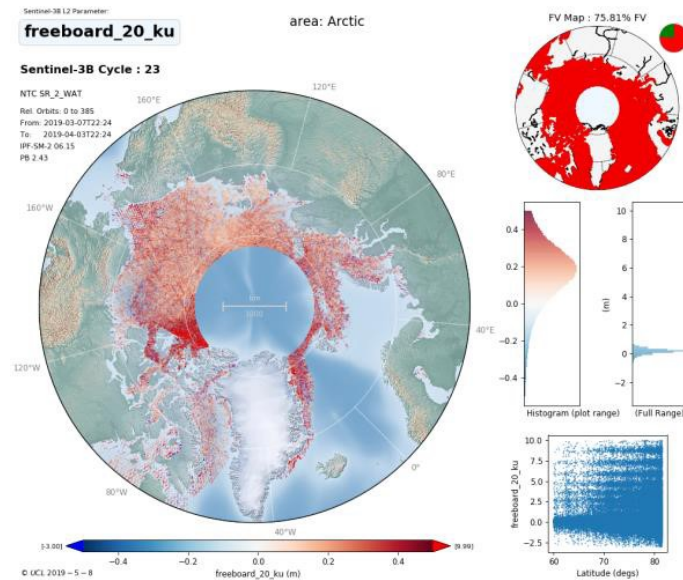


S3A



PB 2.45

S3B



➔ Same Freeboard elevation measured for both S3A & S3B

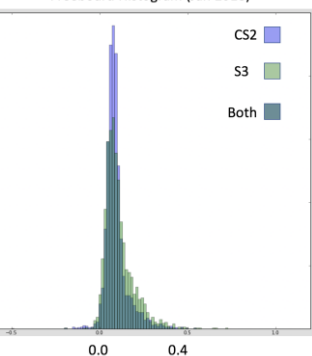
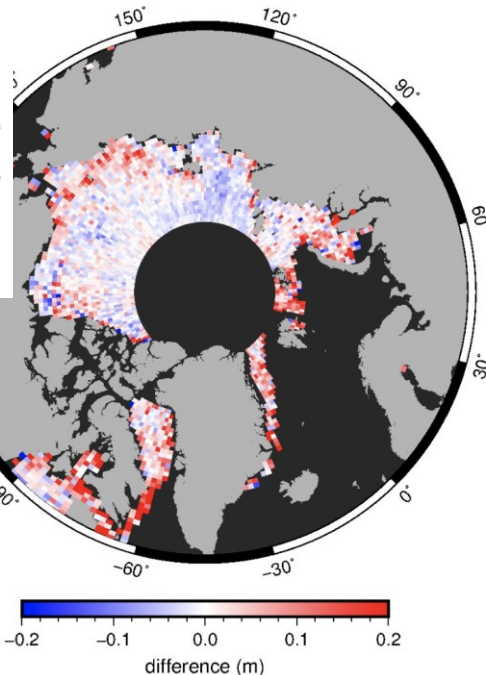
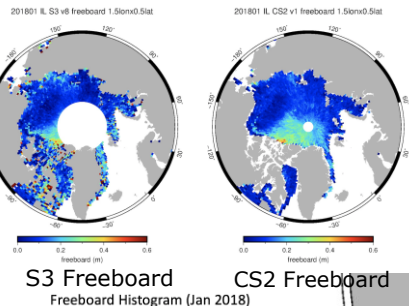
S3 STM Sea Ice Outlook: Freeboard



Without Hamming/Zero Padding

IPF L1 as input

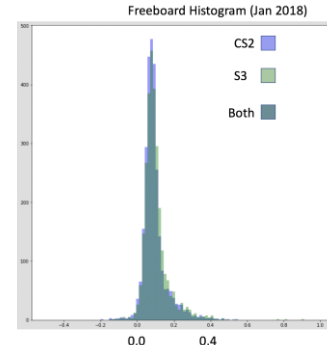
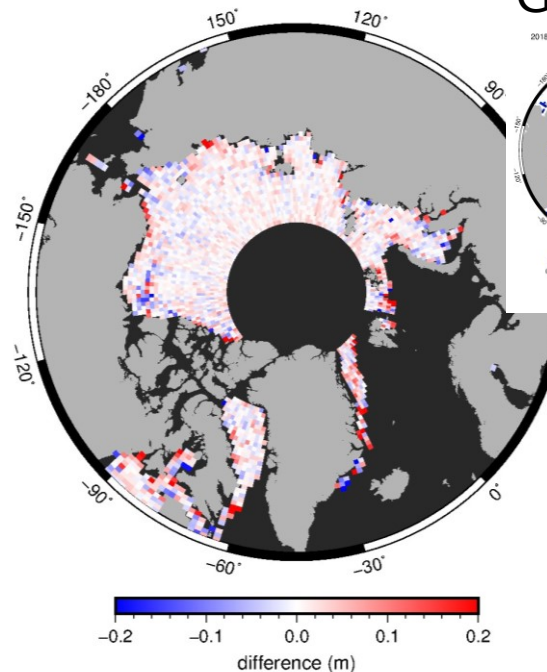
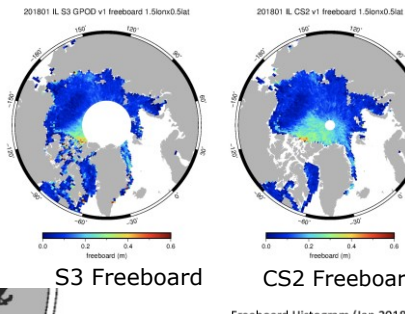
201801 S3 minus CS2 freeboard



With Hamming/Zero Padding

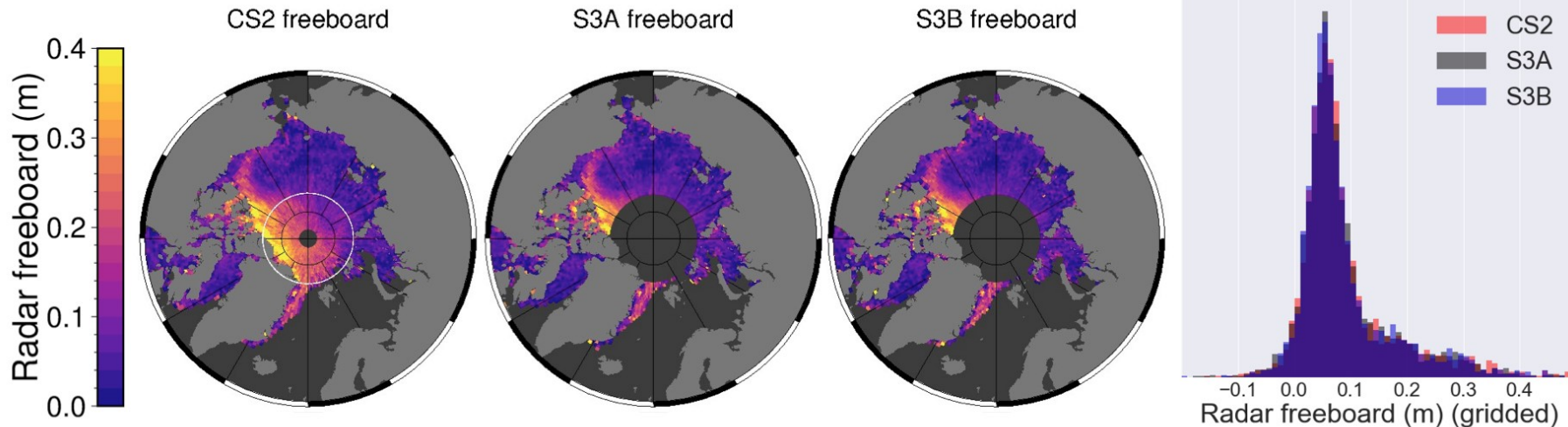
201801 S3 minus CS2 freeboard

GPOD L1 as input



Gridded difference to CS2 Freeboard

Validation of L1 Improvements Required for Sea Ice



Radar freeboard for December 2018 from Cryosat-2, Sentinel-3A and Sentinel-3B, where Hamming weighting and zero padding were applied during L0 -> L1B processing. White circle on CS2 map shows latitudinal limit of Sentinel-3 (81.5°). Credit: I. R. Lawrence, CPOM, UCL.

L1 Processor Evolutions Recommended for Sea-Ice

- Application of Hamming windowing to reduce side lobe effects and lead contamination
- Zero padding to improve accuracy and interpolation of specular waveforms

S3 STM Land Ice Outlook: Ice Sheet Elevation



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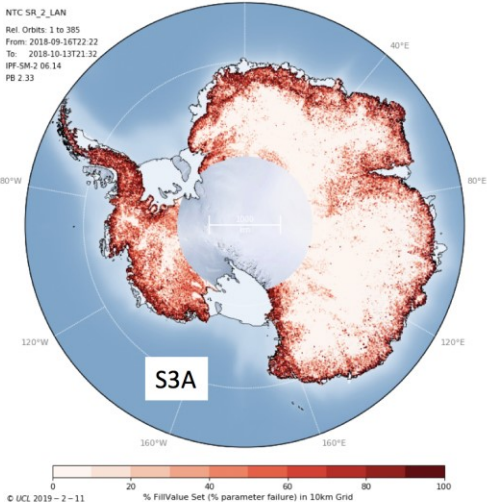


European Space Agency

Failure Maps of Elevation (Ice Sheet Retracker)

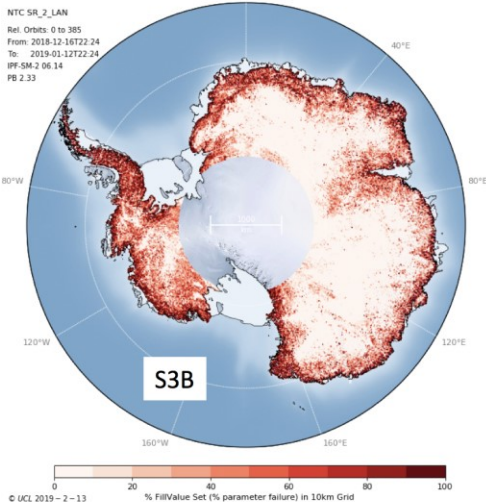
Sentinel-3A L2 Parameter
elevation_ice_sheet_20_ku area: Antarctic Ice Sheets
 mask applied: antarctic_icesheet_mask

Sentinel-3A Cycle : 36 10km Grid of % Failure (FillValue)



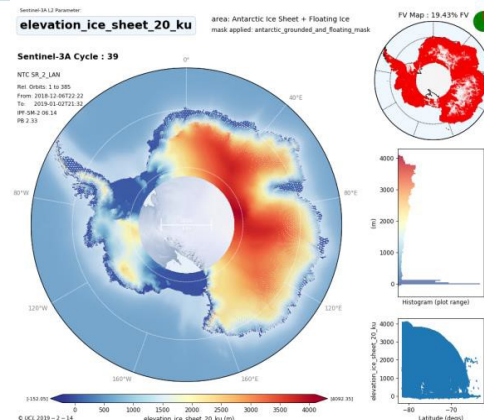
Sentinel-3B L2 Parameter
elevation_ice_sheet_20_ku area: Antarctic Ice Sheets
 mask applied: antarctic_icesheet_mask

Sentinel-3B Cycle : 20 10km Grid of % Failure (FillValue)

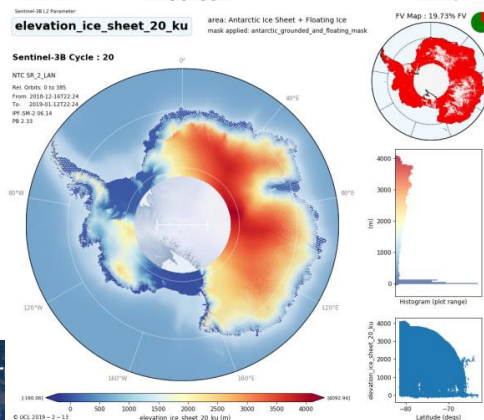


- ➔ Expected failure rate observed for both satellites
- ➔ Similar Ice sheet elevations measured

S3A



S3B

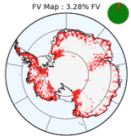


S3 STM Land Ice Outlook: Surface elevation



Failure Maps of Elevation (OCOG Retracker)

3.28%



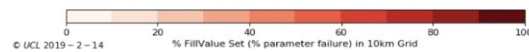
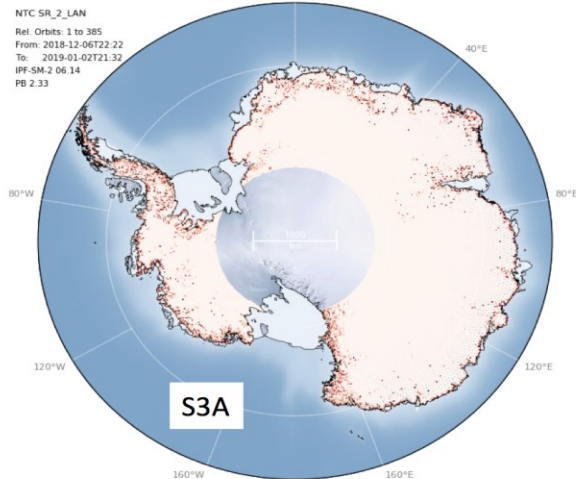
Sentinel-3A L2 Parameter:

elevation_ocog_20_ku

area: Antarctic Ice Sheets
mask applied: antarctic_icesheet_mask

Sentinel-3A Cycle : 39 10km Grid of % Failure (FillValue)

NTC SR_2_LAN
Rel. Orbits: 1 to 385
From: 2018-12-06T22:22
To: 2019-01-02T21:32
IPF-SM-2 06:14
PB 2.33



© UCL 2019 - 2 - 14 % FillValue Set (% parameter failure) in 10km Grid

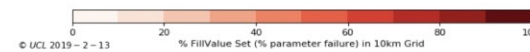
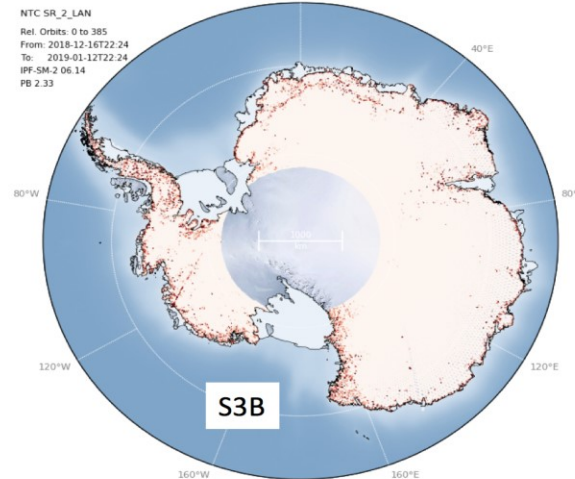
Sentinel-3B L2 Parameter:

elevation_ocog_20_ku

area: Antarctic Ice Sheets
mask applied: antarctic_icesheet_mask

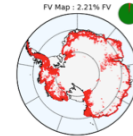
Sentinel-3B Cycle : 20 10km Grid of % Failure (FillValue)

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IPF-SM-2 06:14
PB 2.33



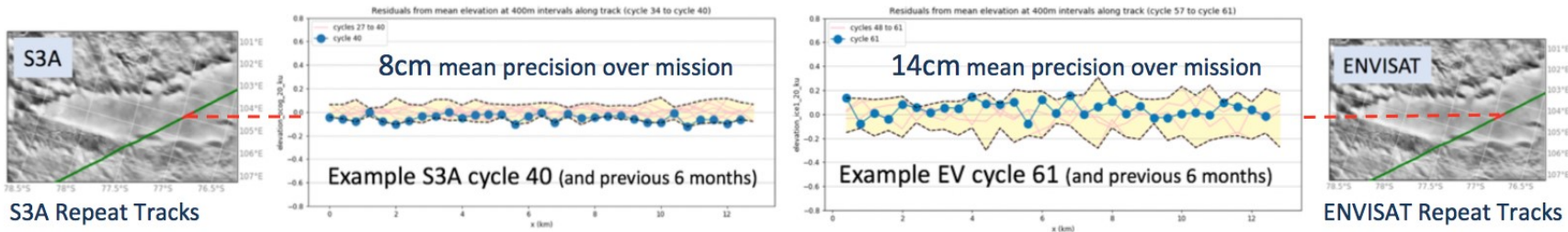
© UCL 2019 - 2 - 13 % FillValue Set (% parameter failure) in 10km Grid

2.21%

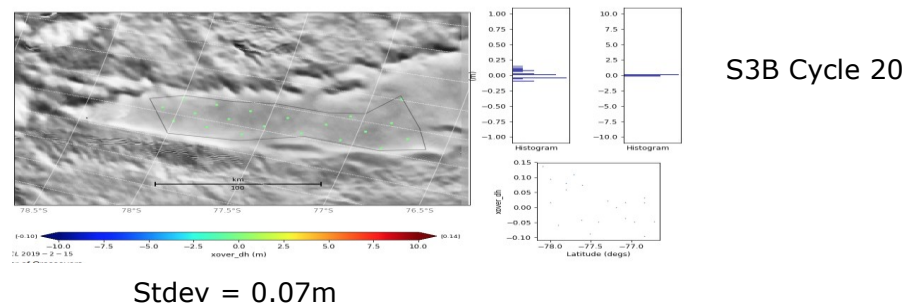
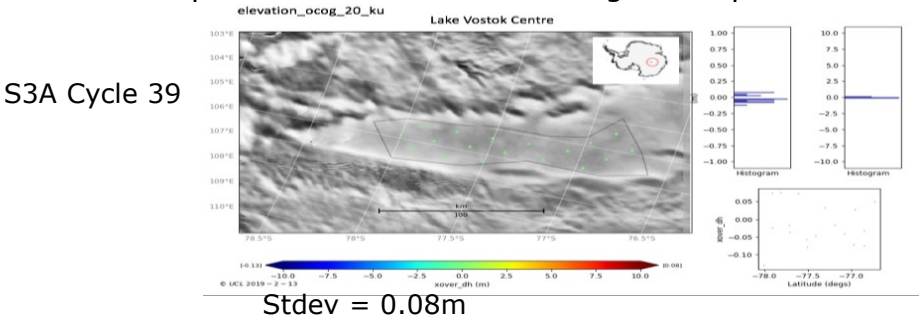


➔ Expected failure rate observed for both satellites

S3 STM Precision over Land Ice (Repeat Tracks and Crossovers)



➔ S3 SAR precision is almost twice as good as previous LRM missions such as ENVISAT and CS2 (LRM mask)

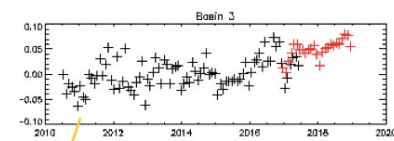
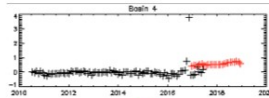
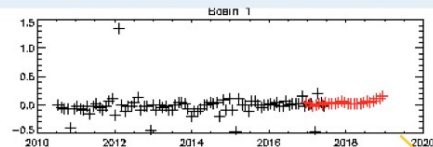


➔ Very high precision measured at crossovers over Vostok lake

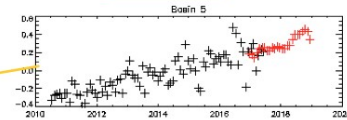
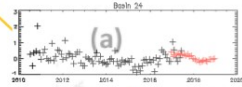
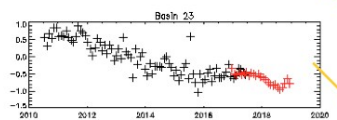
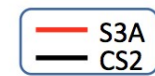
S3 STM Land Ice Outlook: Surface Elevation Change (SEC)



S3 Land Ice Studies: SEC Cross-Cal with CS2



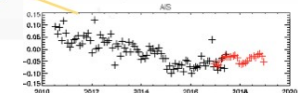
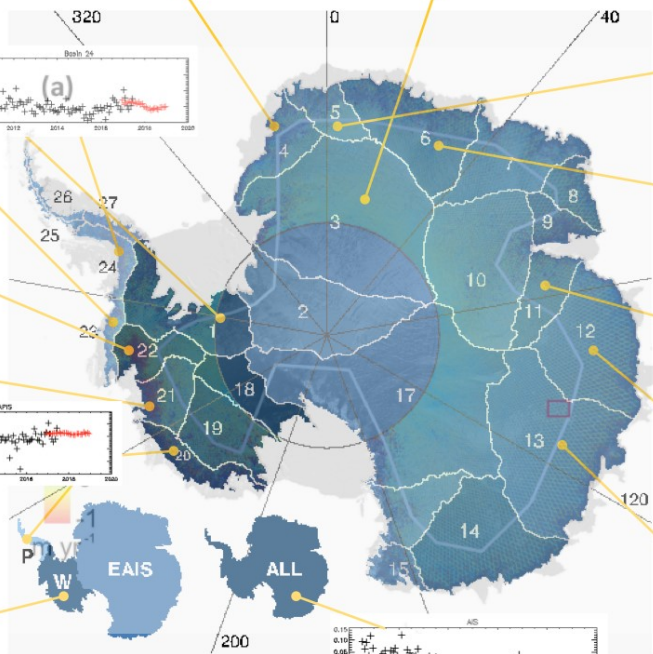
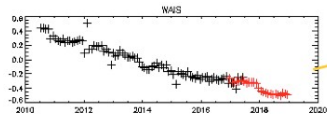
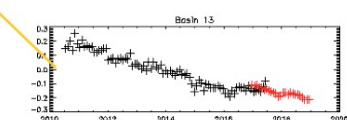
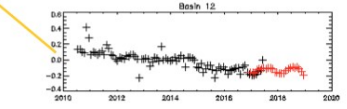
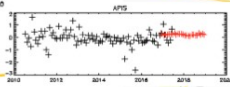
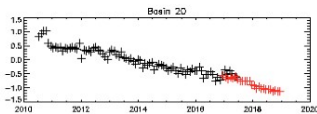
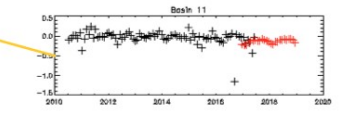
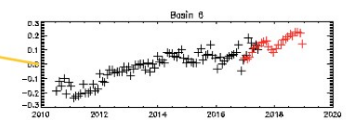
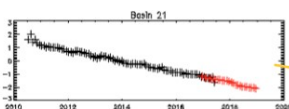
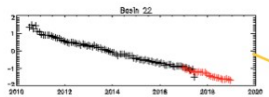
Cross-calibrated dh/dt Basin Timeseries

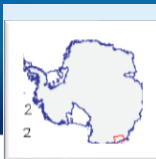


S3 STM ability in extending CryoSat time series!

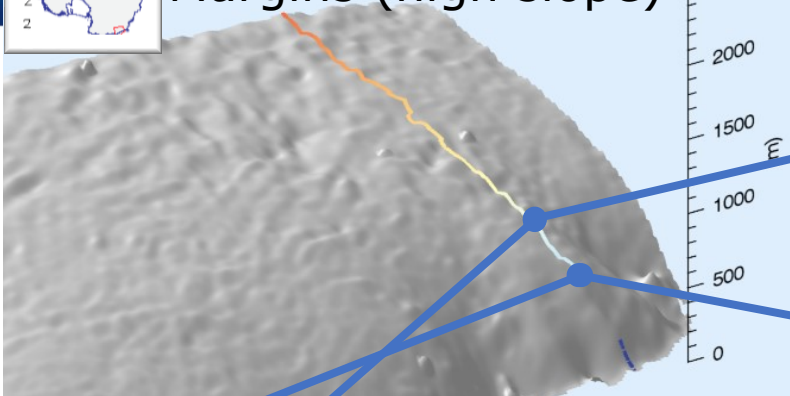
Except for high latitude due to S3 inclination limitation!

Credit McMillan, CPOM





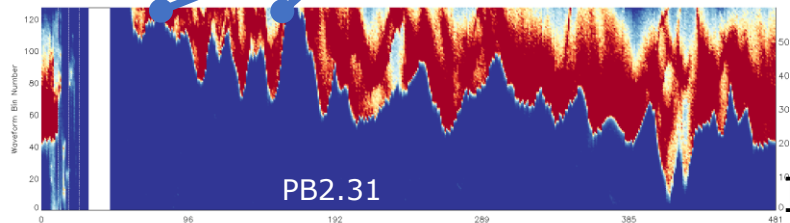
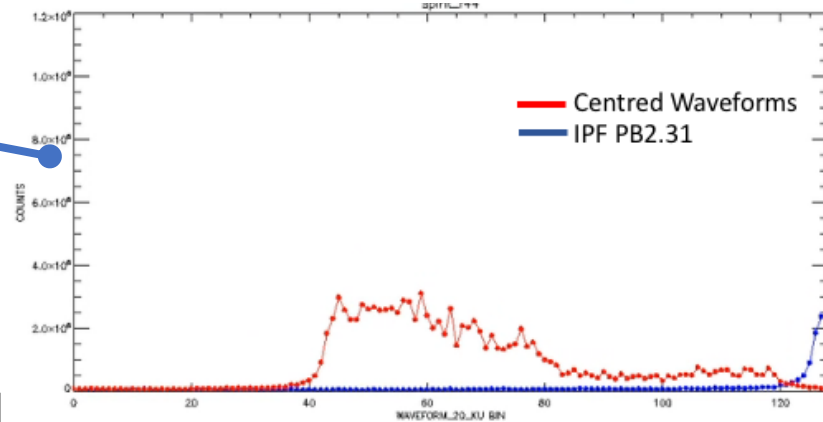
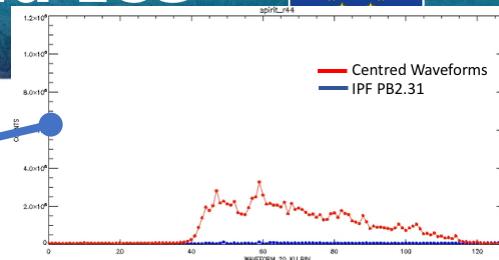
SPIRIT Zone, Antarctica Margins (high slope)



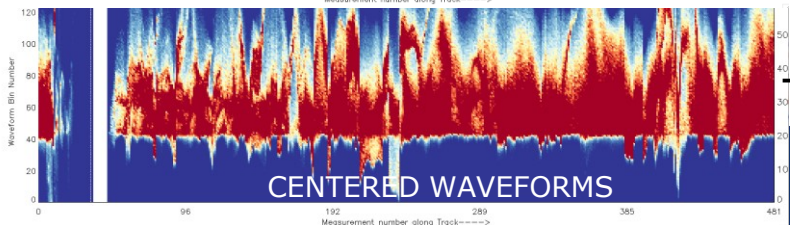
Counts to Land Ice



European Space Agency

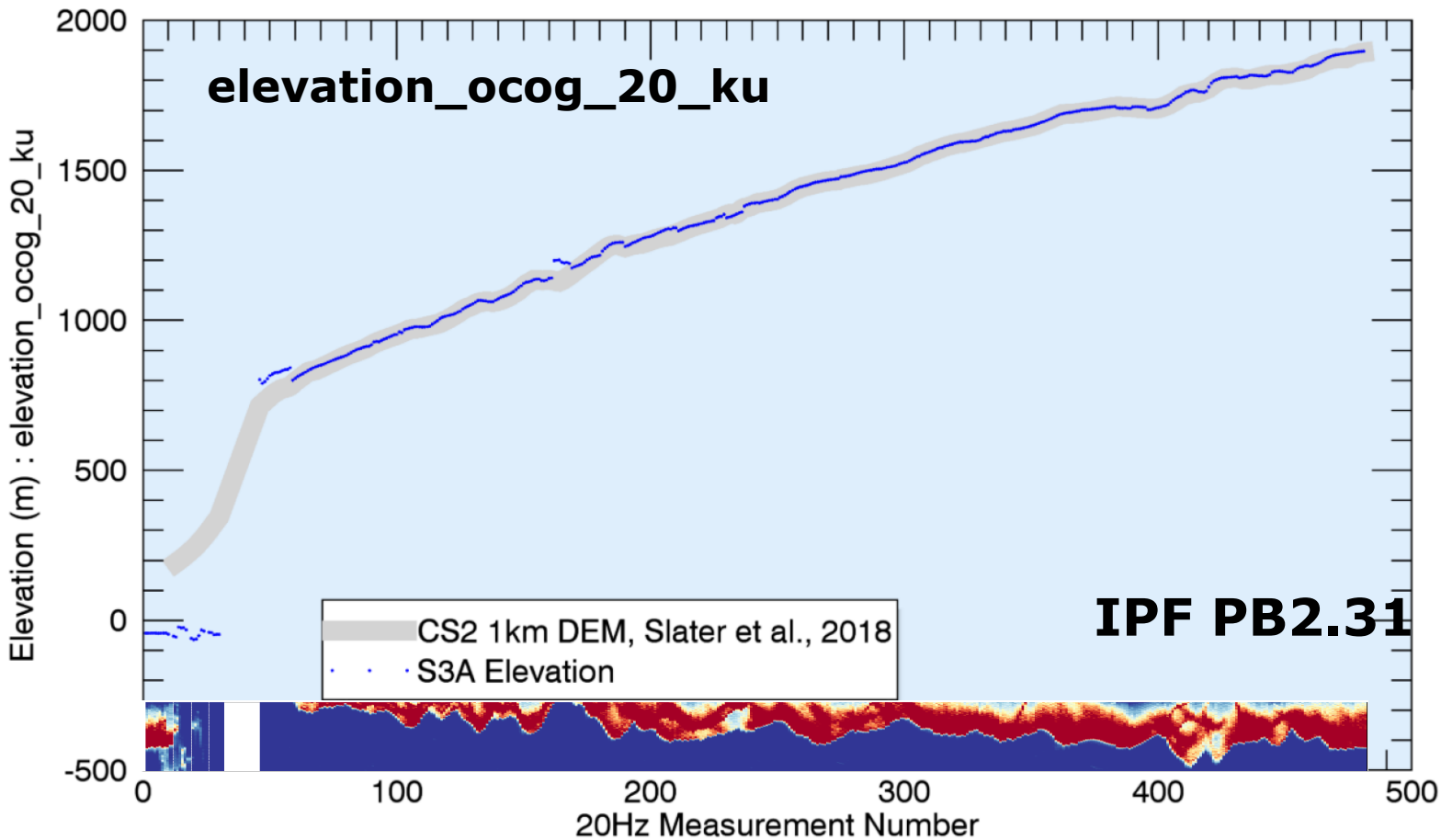


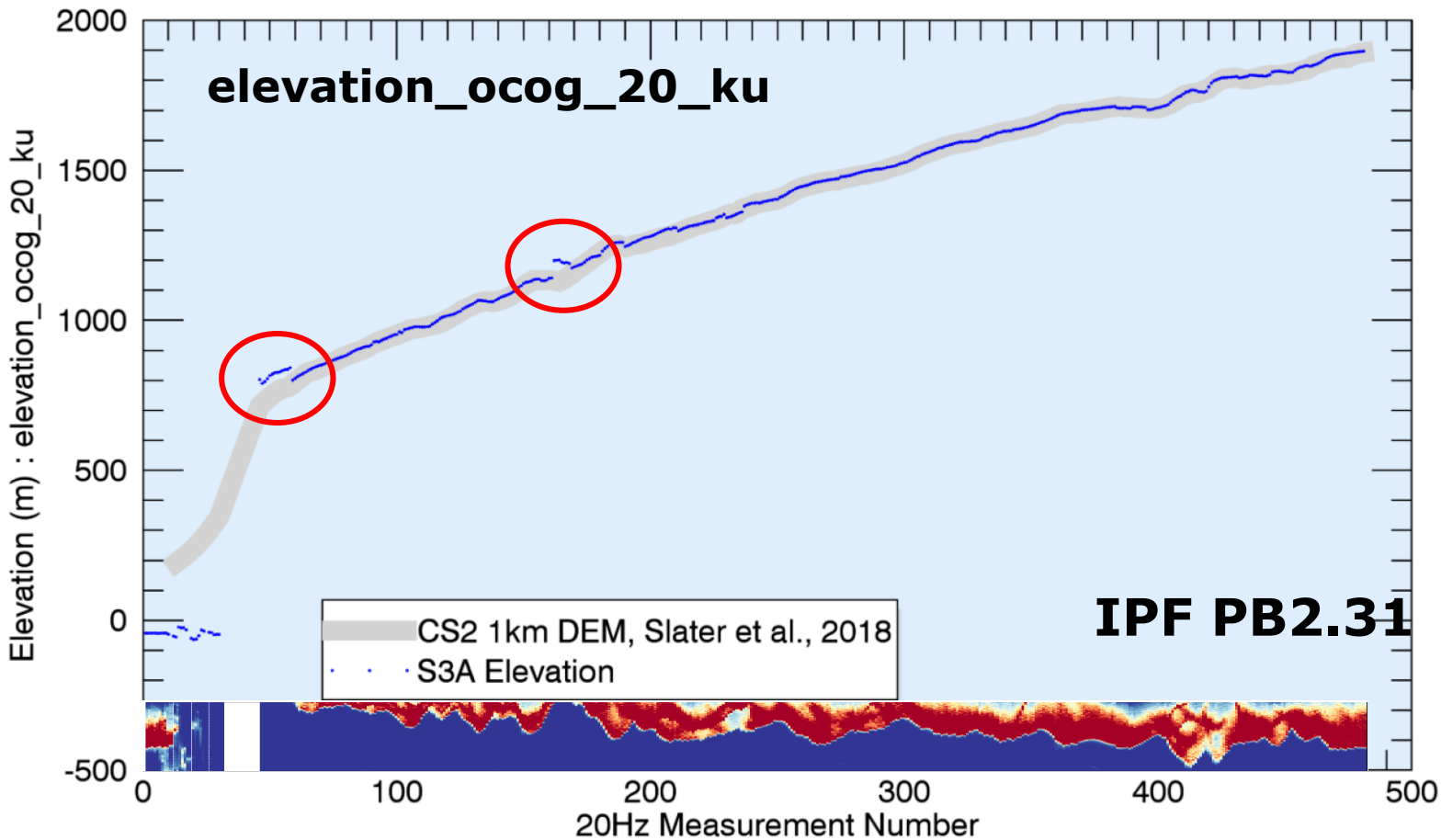
IPF PB2.31

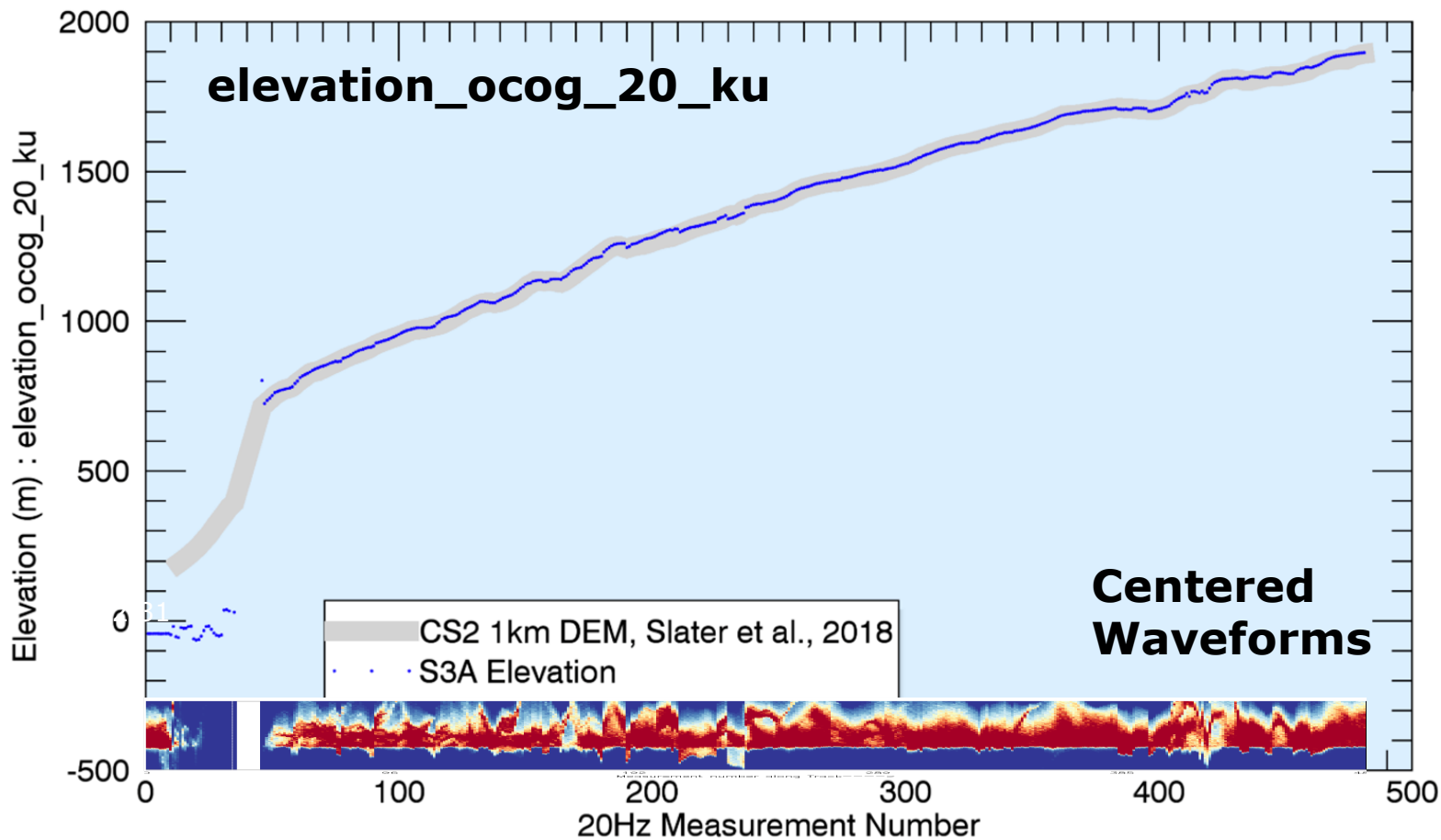


TDS Prototype L1 Processor







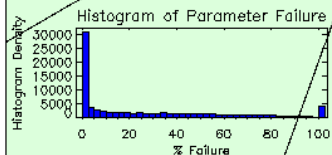
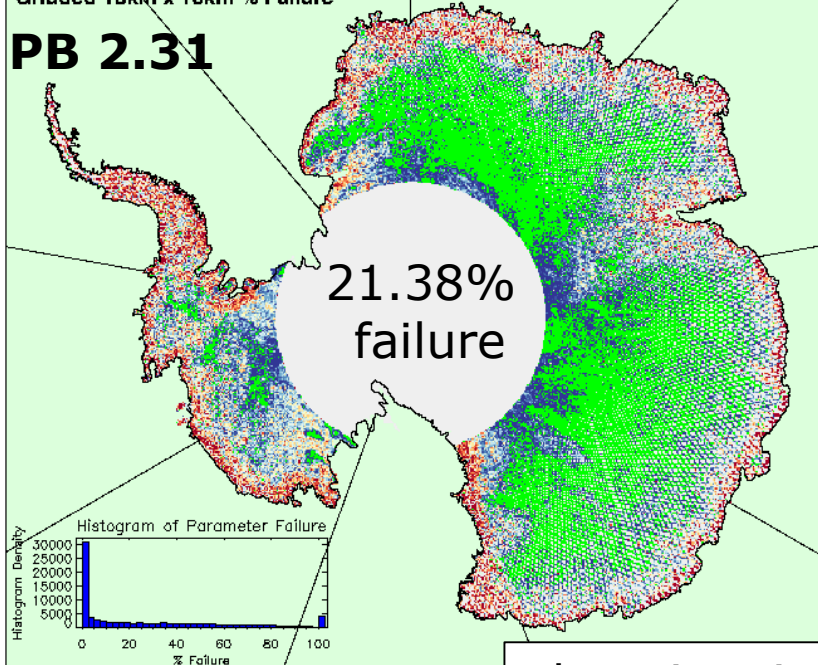


Planned Improvements to Land Ice



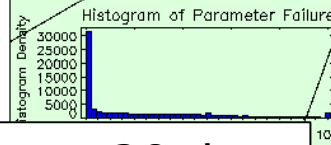
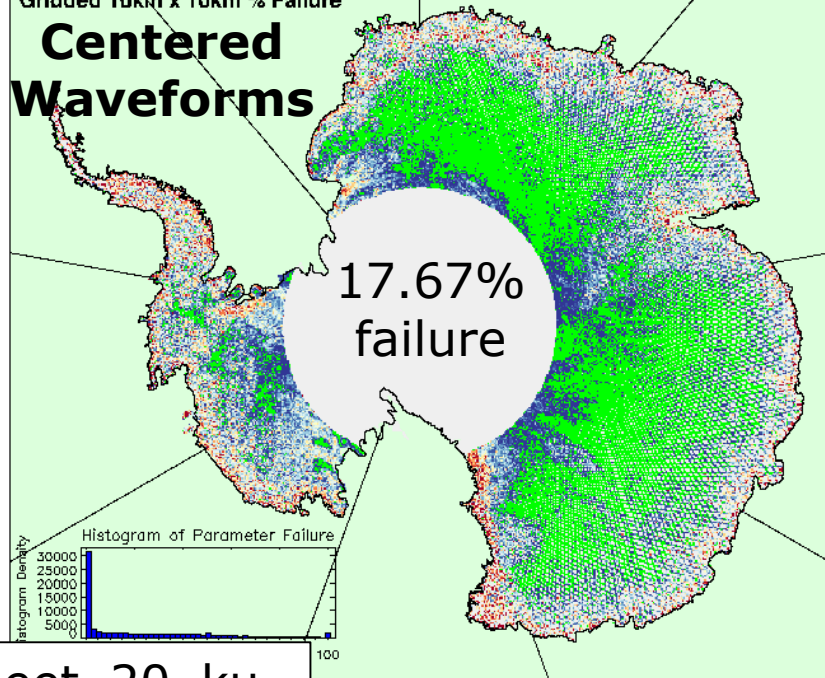
Gridded 10km x 10km % Failure

PB 2.31

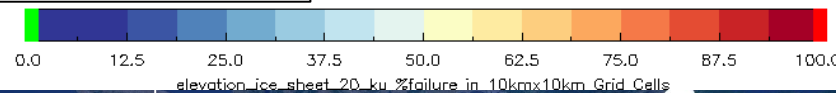
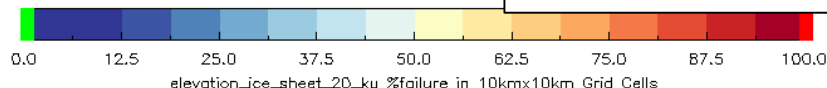


Gridded 10km x 10km % Failure

Centered Waveforms



elevation_ice_sheet_20_ku



Planned Improvements to Land Ice



- Accuracy and measurement density over margins will be improved with change in L1 processing as demonstrated in Centered Waveform TDS.
- L1 Improved Processor delivered to ESA in March 2019
- Recommendation from scientific community to perform a full mission reprocessing both for S3A and S3B (SRAL L1 + L2 products)
- Land Ice reprocessing expected to be completed by end of the year

- The S3A & S3B STM LAND products are today fulfilling the mission requirements over all surfaces (e.g. Inland, Coastal, Sea-Ice, Land ice)
- A continuous effort is done to improve the performance of the S3 STM data products over all surfaces
- S3A & S3B STM Cyclic Performance Reports available from <https://sentinel.esa.int/web/sentinel/technical-guides/sentinel-3-altimetry/data-quality-reports>
- S3 STM Annual Performance Reports available from <https://sentinel.esa.int/web/sentinel/user-guides/sentinel-3-altimetry/document-library>



S3 STM OLTC includes now GLACIERS!

- *Open Loop Tracking Command (OLTC)* is efficient and very powerful and provides better results than the *Close Loop* over Land Surfaces.
- OLTC has however some limitations linked to the required accuracy of the "a priori" elevation ($\pm 10\text{m}$) and to the altimeter footprint size (we can't track two different targets in the SRAL footprint)

Adding Glaciers to the S3 OLTC is a tentative exercise, but stands today as the best chance to get valuable data from continental glaciers



Pyrenees : 2 PVS
Glacier d'Ossoue (S3A) (see next slide)
Glacier Brèche de Roland (S3B)

Alps : 22 PVSs over continental ice
(18 S3B, 4 S3A)

S3A & S3B STM & Acquisition mode



Space Agency

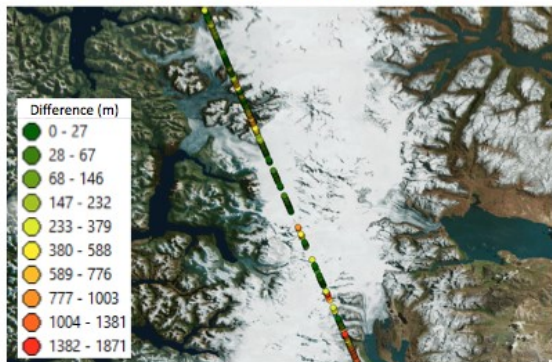


Google Earth

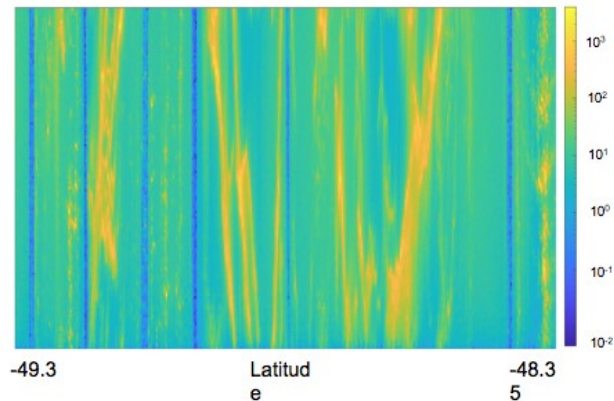
Patagonia

Credit Liam Taylor,
University of Leeds,
Leeds, UK

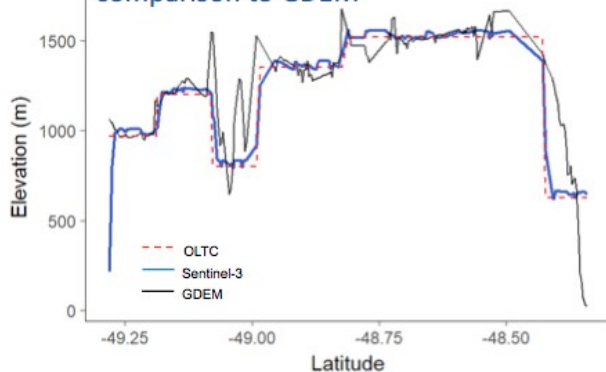
a. Differences relative to reference DEM



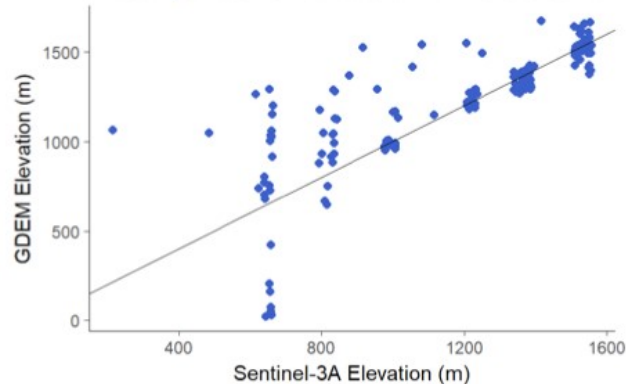
b. Radargram



c. Along-track updated OLTC & comparison to GDEM



d. Comparison of S3 and GDEM elevations



Fedche from co
• Longest glac
• Volume of g

→ 3 virtual stat

Pleiades DEM (M
provided by E. B
(OMP/LEGOS)

LEGOS in-situ ca
2019 will provid
profiles

→ S3V
look
glaci
→ KML



Slide 20

ETSAT

Thank you!