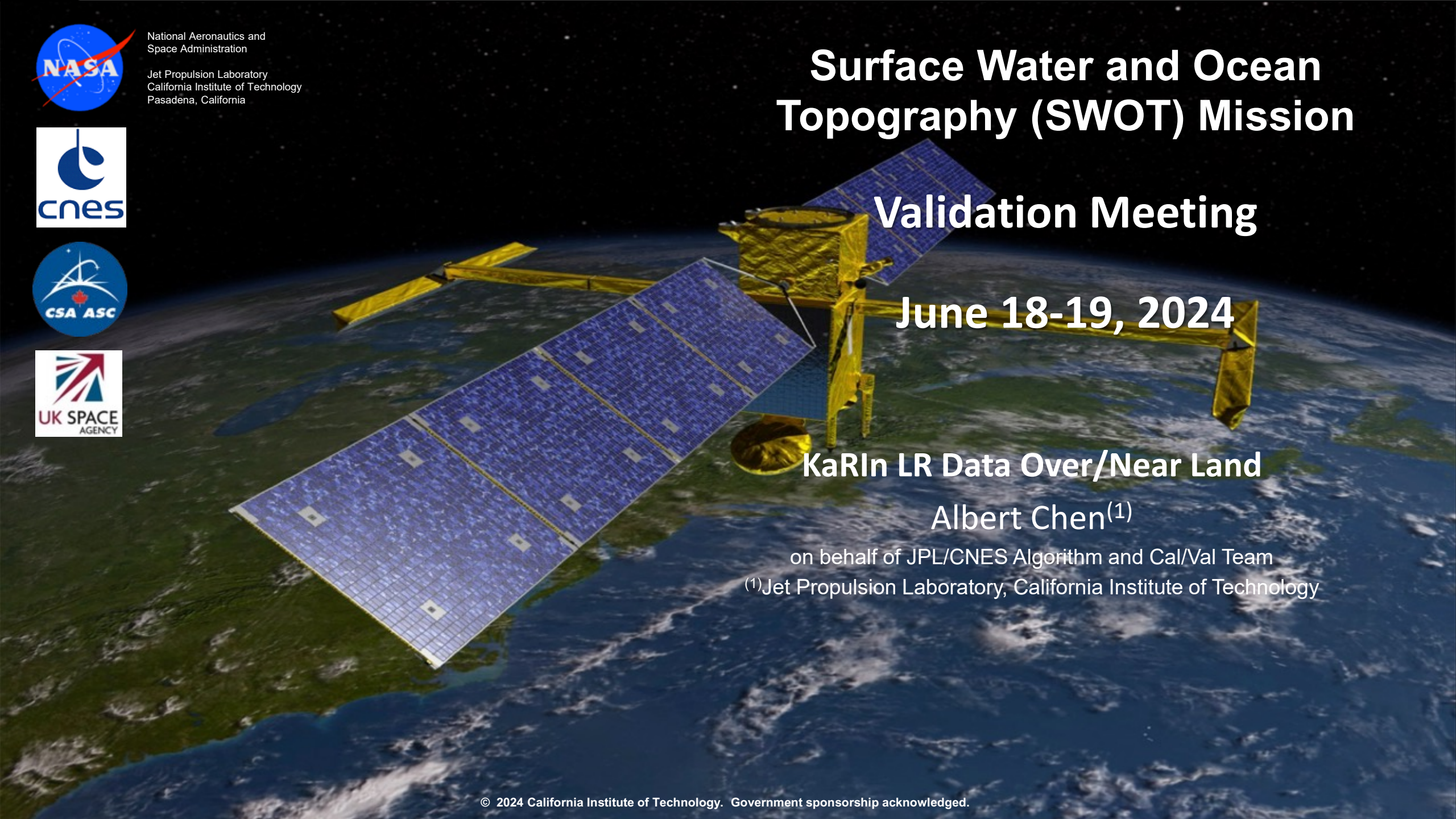

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Surface Water and Ocean Topography (SWOT) Mission

Validation Meeting

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KaRIn LR Data Over/Near Land

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on behalf of JPL/CNES Algorithm and Cal/Val Team

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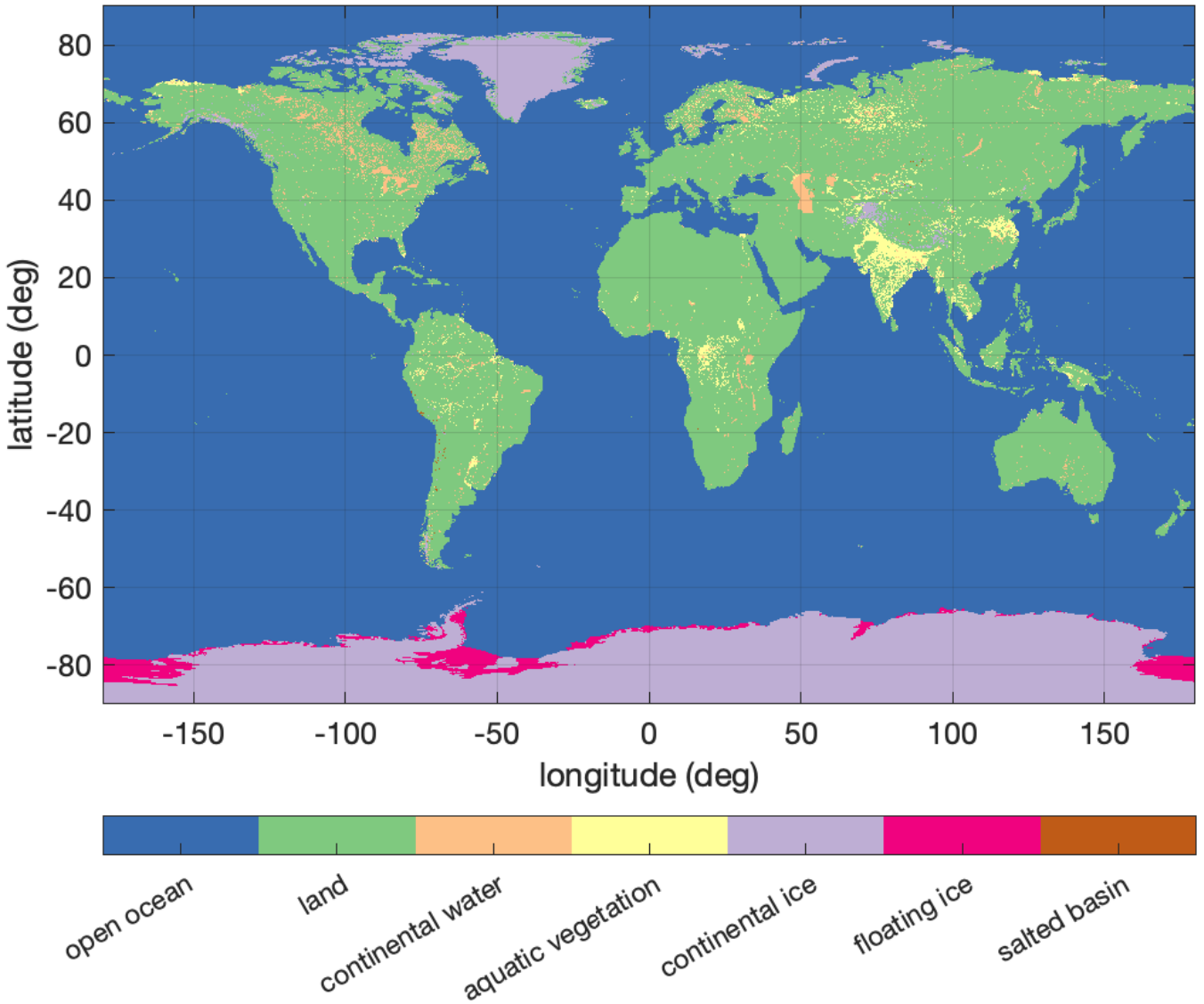
LR Processing Surface Types

- LR algorithms are optimized for *open ocean* [Blue region on the map.]
- Outside open ocean:
  - SSHA is analogous to WSE (SSHA = SSH – geoid – solid_earth_tide – load_tide – pole_tide)
  - Sea state bias is zero.
  - L1B reference surface is set to OBP reference surface
- For phase bias correction, “land” and “continental ice” are modeled with sigma0 = 0 dB.
- Users are advised to use HR data whenever possible for regions outside open ocean.
- LR validation focuses primarily on “open ocean”.

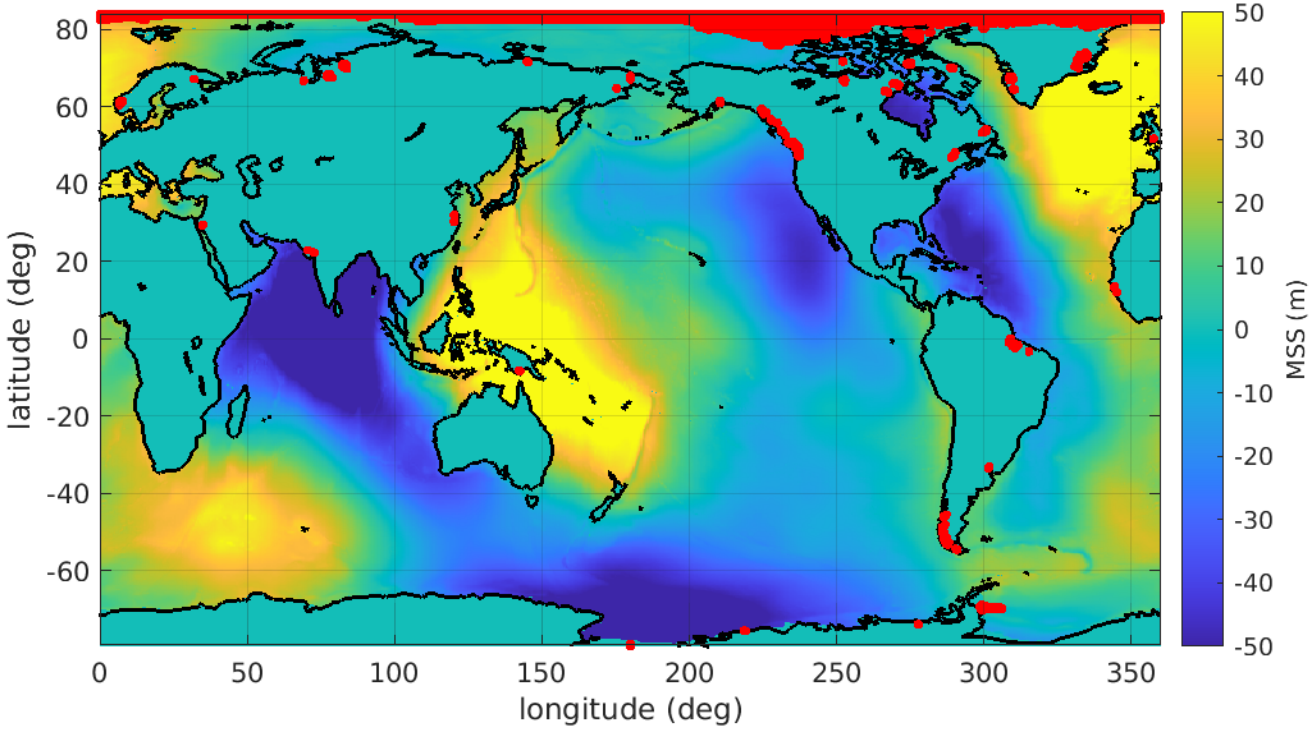
Surface Type Map for LR processors



Fill Values in Reference Surface

- Many of the fill values in the reference surface occur near coasts, and at estuaries.
- This causes fill values in SSHA in Version B and Version C.
- This has been fixed in the Developmental Version and will not affect future releases.

CNES/CLS 2015 MSS



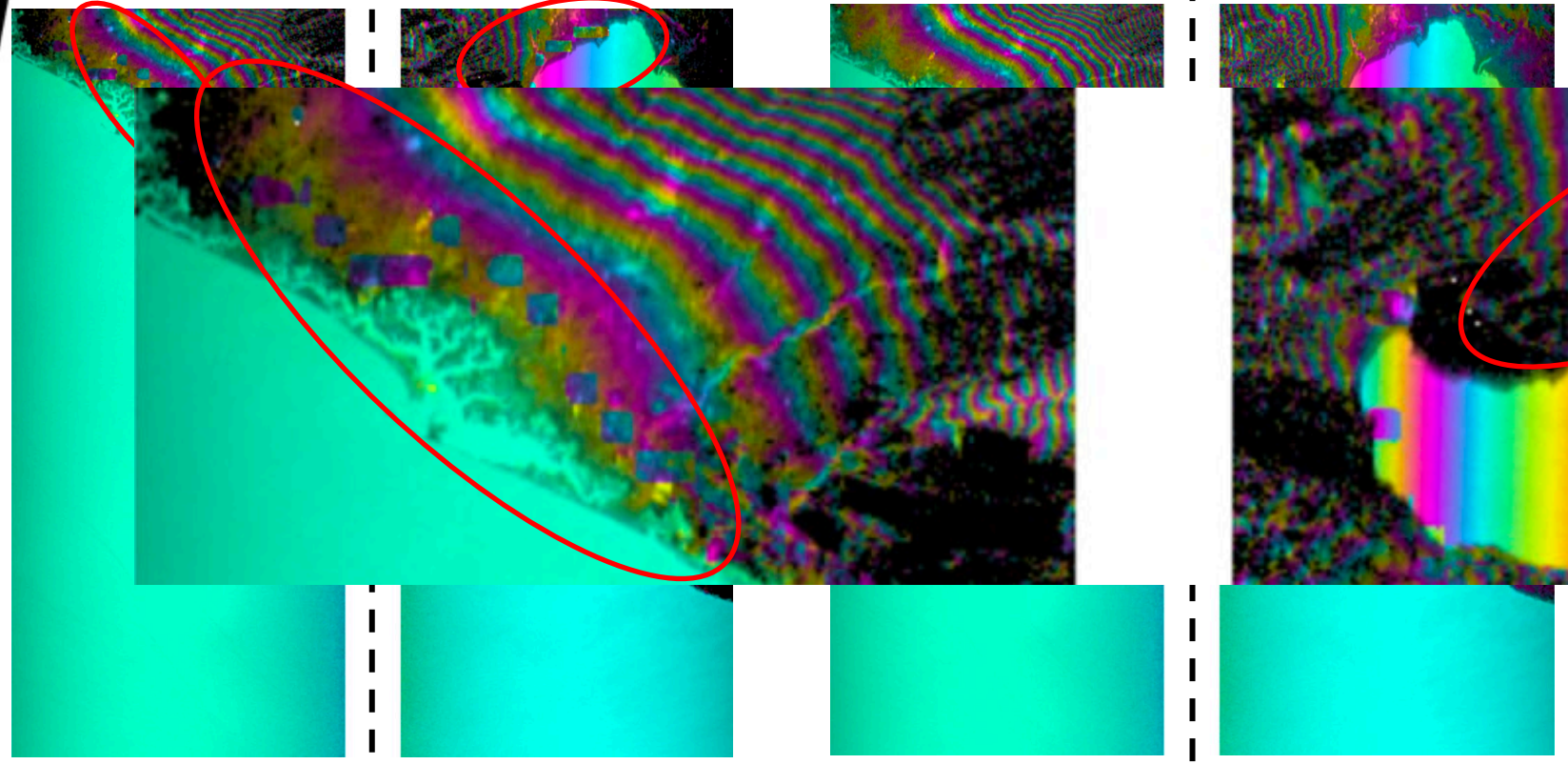
Red indicates fill values in open ocean.

L1B_LR_INTF processing over land

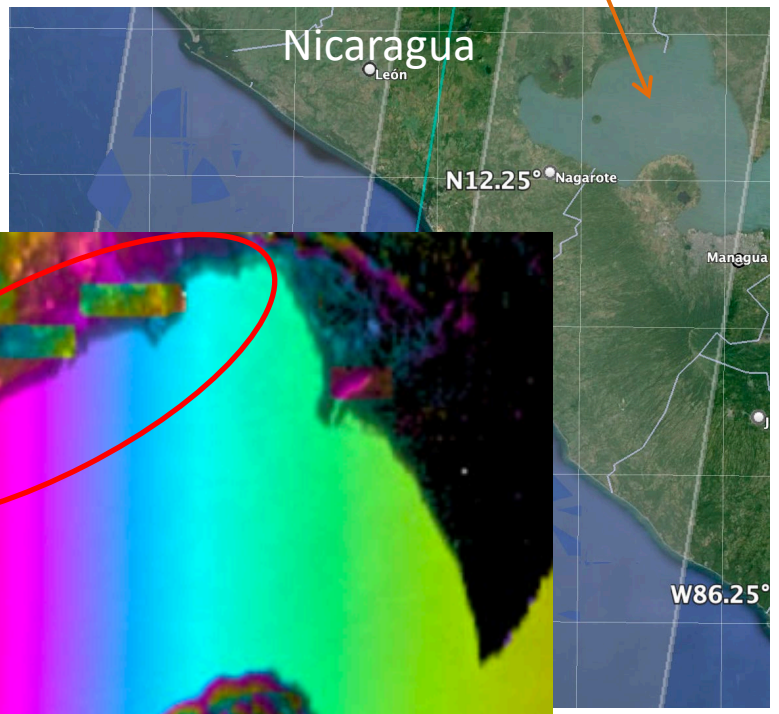
- PIC0 products have a known issue that causes artifacts near land/water boundaries.
- Fix will be delivered to operational processing later this year.

PIC0 cycle 013 pass 425
L1B Interferogram, beam 5

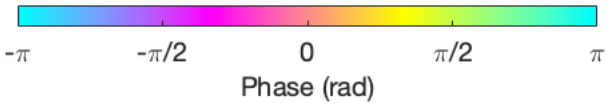
Development Version



Lake Managua (Xolotlan)



Plots show interferogram phase superimposed on uncalibrated radar power.

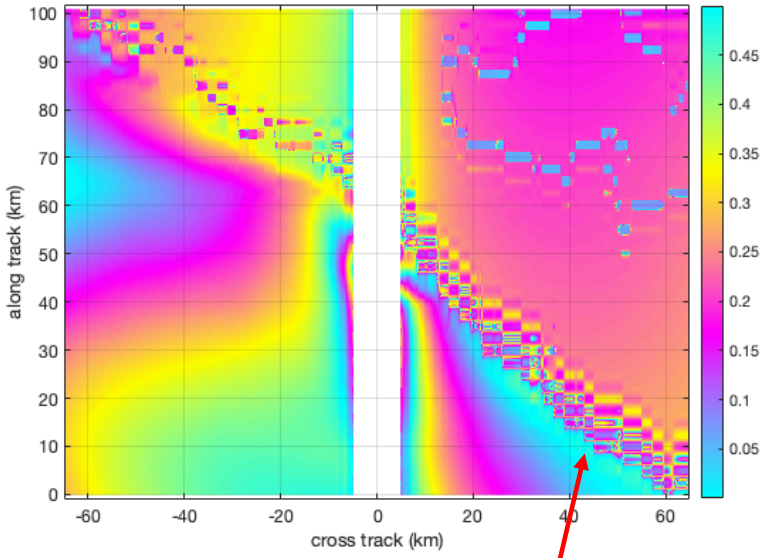


LR data near coasts

- L1B phase bias correction is only computed once every 2.5 km, and then interpolated to 250m.
  - It may not capture the ocean/land boundary exactly.
- At coastlines, interpolator kernels (for phase bias correction, beam combining, and native-to-fixed grid resampling) will be partially over land and partially over water, potentially resulting in sub-optimal performance.
  - Users advised to check *distance_to_coast* variable.

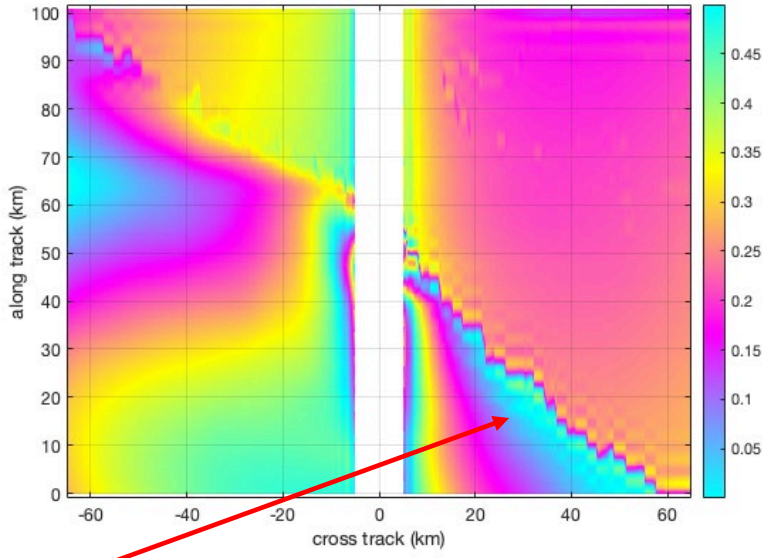
Version C

L1B phase bias correction modulo 0.5 rad, beam 5



Development Version

L1B phase bias correction modulo 0.5 rad, beam 5

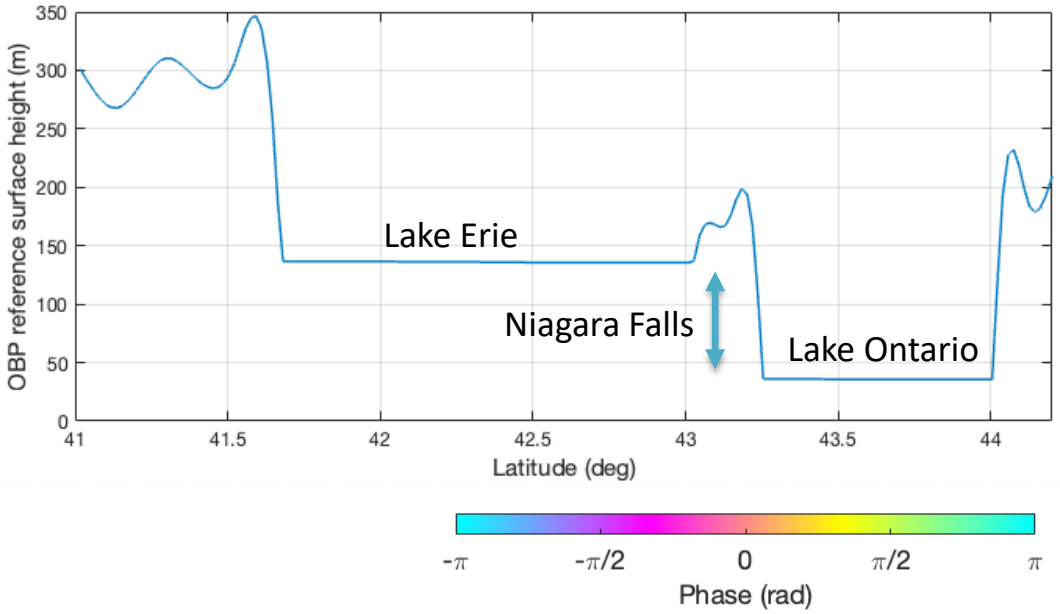


Edge effects in L1B phase bias correction extends ~10 km from coast.

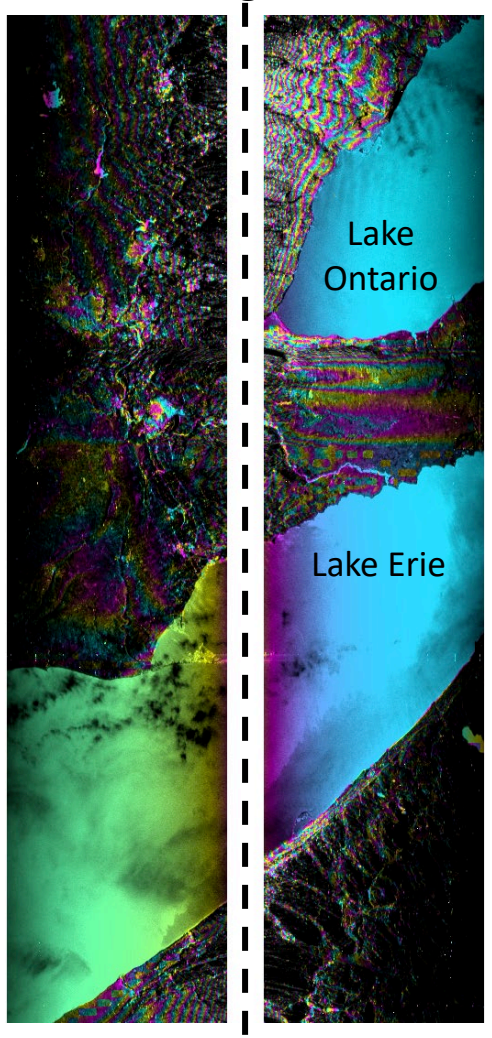
On-board Processor Reference Surface

- OBP reference surface is a smooth spline in along-track and constant in cross-track for each swath. Due to this limitation, it cannot be close to every lake's true elevation.
- Users should check whether the *obp_ref_surface* is close to the true lake elevation. Expect large errors in SSHA when OBP reference surface is too far away from true elevation.

obp_ref_surface is close to ocean elevation, but tens of meters away from Lake Managua elevation.



PIC0 cycle 013 pass 425
L1B Interferogram, beam 5

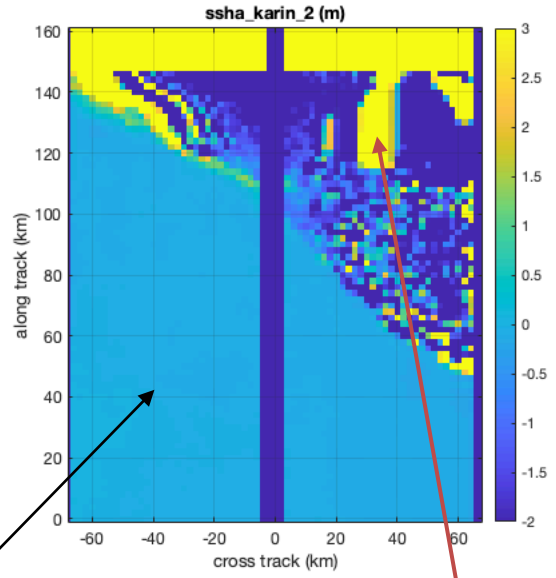


Left swath - nadir - Right swath

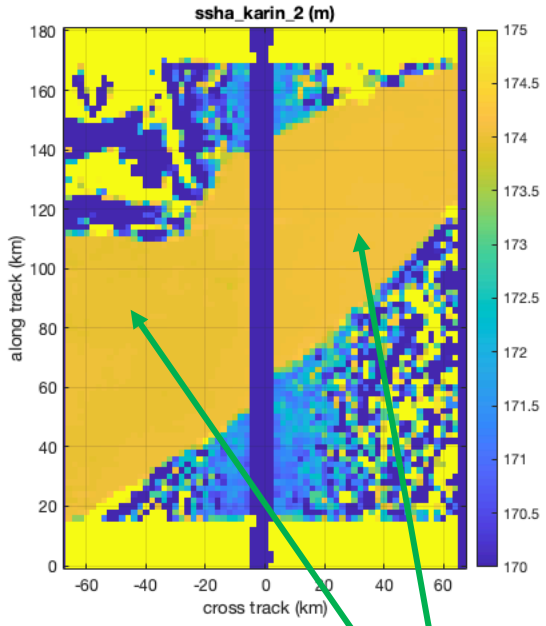
OBP Reference Surface

PIC0 cycle 013 pass 425, L2_SSH Basic ssha_karin_2

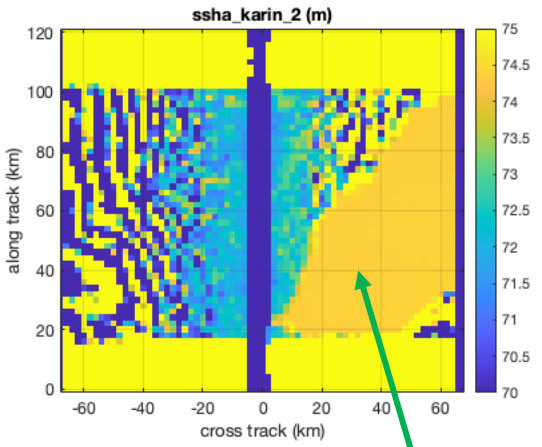
Lake Managua (approx. 39 m elev.)



Lake Erie (approx. 174 m elev.)



Lake Ontario (approx. 74 m elev.)



OBP and LR algorithms prioritize ocean, getting good performance as close to the coast as possible.

SSHA over Lake Managua is clearly erroneous.

SSHA is reasonably accurate over Lake Erie.

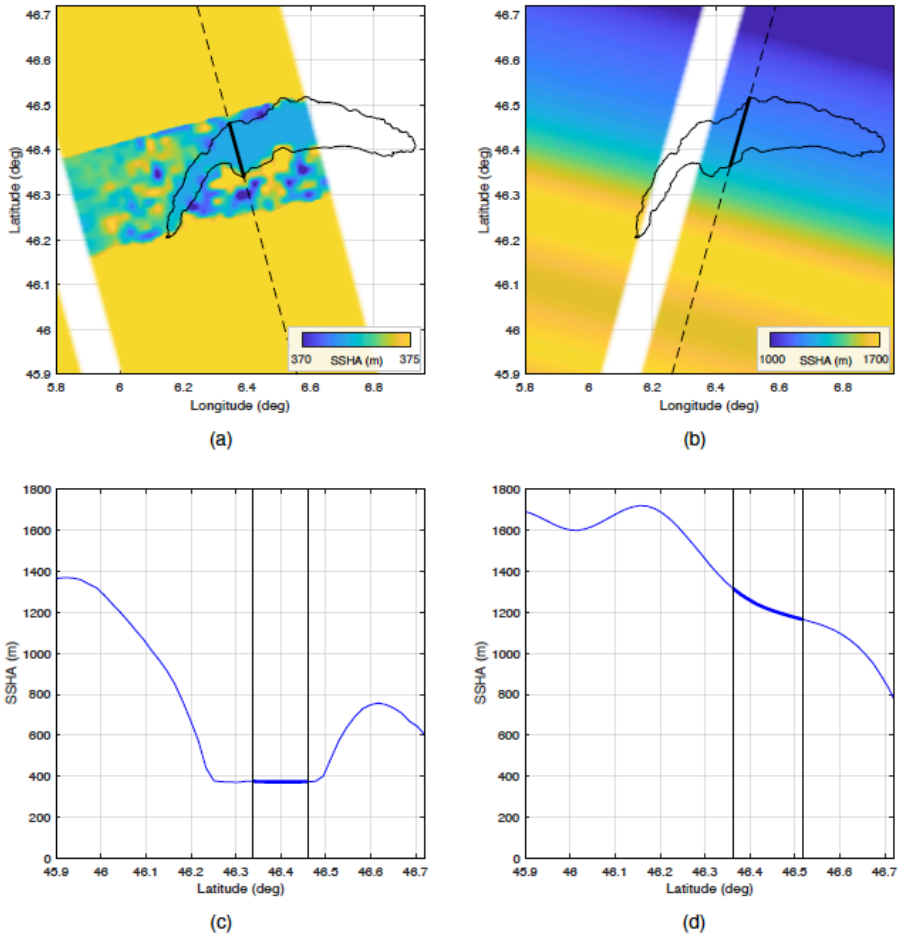
SSHA is reasonably accurate over Lake Ontario.

OBP Reference Surface

- When there are multiple passes over a particular lake, the OBP reference surface may be close to the true lake height for one pass, but not another.
  - This applies to ascending vs. descending passes, adjacent passes, science vs. cal orbit passes.
  - This is due to OBP hardware/firmware constraints and the OBP table optimization algorithm.
- Plots show example from Lake Geneva.
  - See SWOT User Handbook Section 10.12

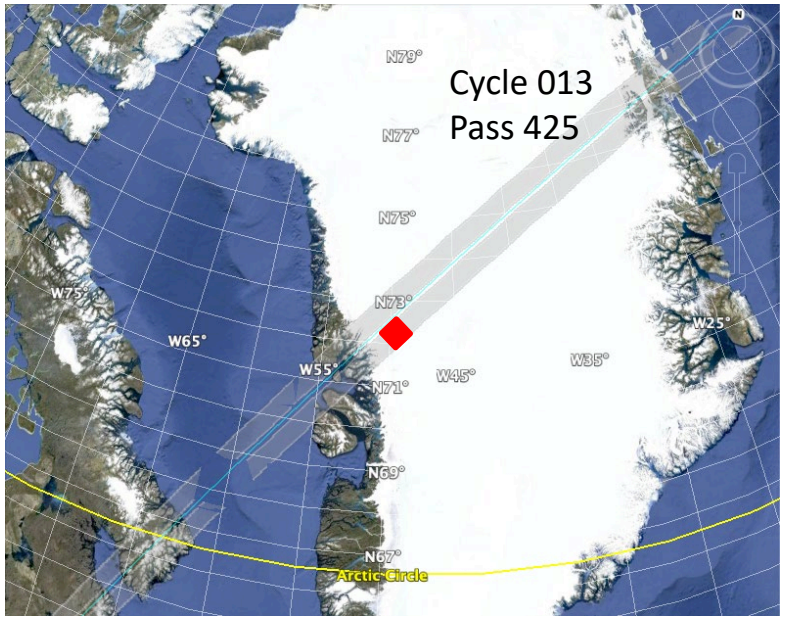
SSHA
cycle 007, pass 264

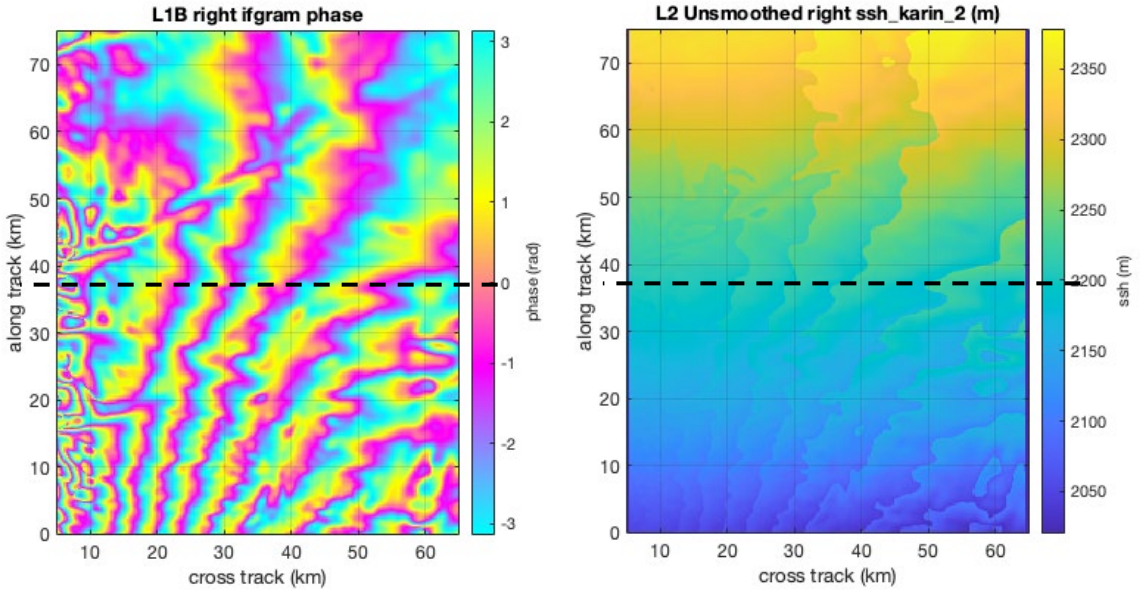
SSHA
cycle 007, pass 335

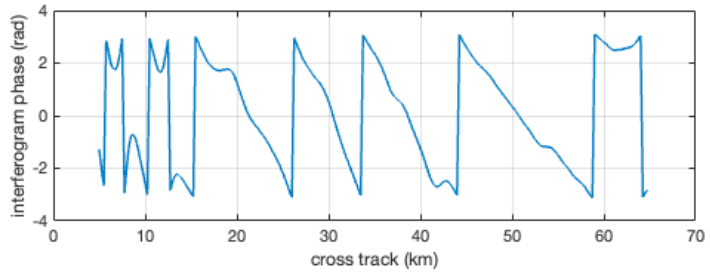


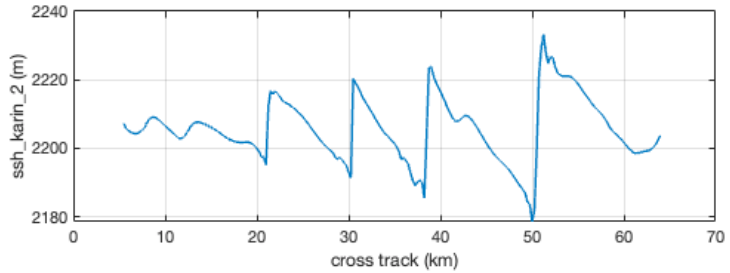
LR data over Ice Sheets

- SNR is generally good over ice sheets.
- In PIC0, large height errors (tens of meters) because LR processors do not do phase unwrapping.
  - Potential improvements in the future using phase unwrapping or improved reference DEM. (Not yet planned.)
- Similar behavior over large deserts and other relatively flat land areas.









Plot shows a cut along the dashed line in the images.

- Jumps in ssh are artifacts due to lack of phase unwrapping.
- In Basic/Expert product, 2km averaging kernel makes the artifacts harder to see visually.
- Jumps occur in different places in L1B and L2 because static phase calibration has not been applied in L1B.

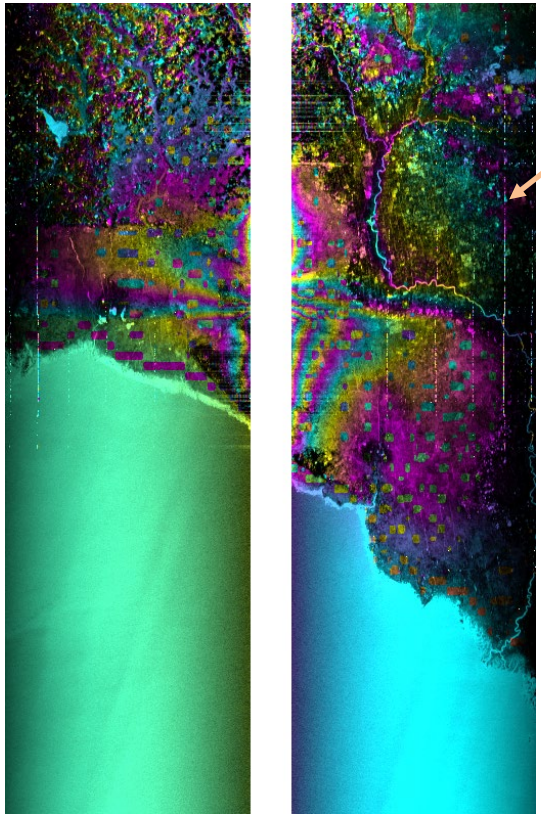
Other Phenomenology

- Numerical overflow during Inverse Fast Fourier Transform (IFFT) happens much more often over land and sea ice than in open ocean.
  - Often caused by specular ringing (see HR presentations).
- Much of the phenomenology observed in HR data are also observed in LR data over land, such as layover, dark water, etc.

PIC0 cycle 013 pass 425
L1B Interferogram, beam 5

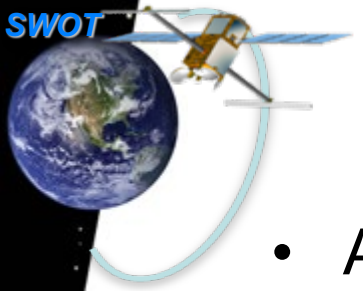
Florida

Gulf of Mexico



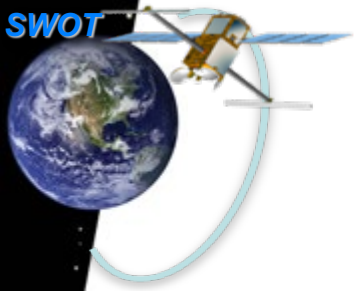
IFFT overflow occurred during on-board processing.

(degraded_karin_ifft_overflow bit set in *ssh_karin_2_qual*).



Summary

- ADT advice to users:
  - Outside of open ocean, use HR products whenever possible
  - LR products potentially not as accurate <10 km away from coast
  - LR lakes must be examined on a case-by-case basis
    - When *obp_reference_surface* is too far away from true lake surface height, LR ssha will be highly erroneous.
      - This typically happens for small lakes. Large inland water bodies that are not in HR mask are not usually affected.
    - Or check whether L1B interferogram has > 1 fringe.
    - Or check for jumps in lake elevation (due to phase wrapping).
- Missing data in Version C has been addressed, and these regions will have valid data in the next version.



Backup