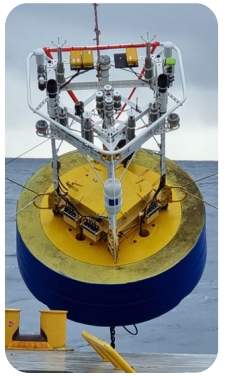
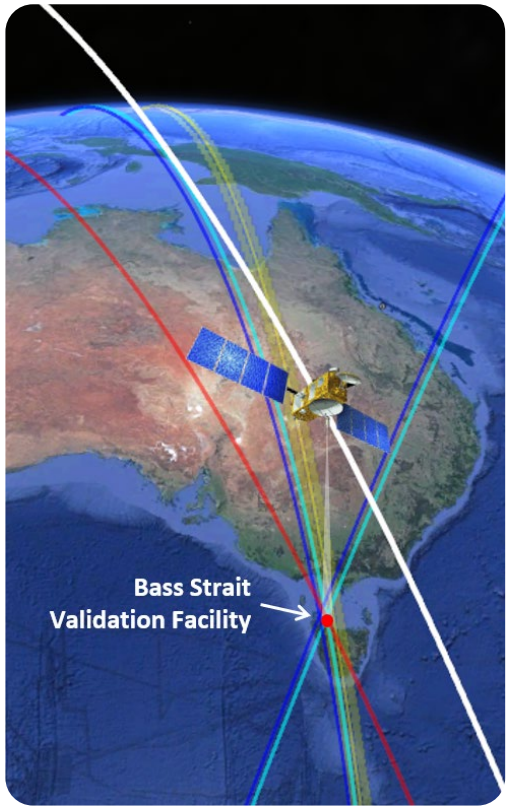
CELEBRATING 20 YEARS
OF SUSTAINED MARINE OBSERVING

IMOS
Integrated Marine Observing System

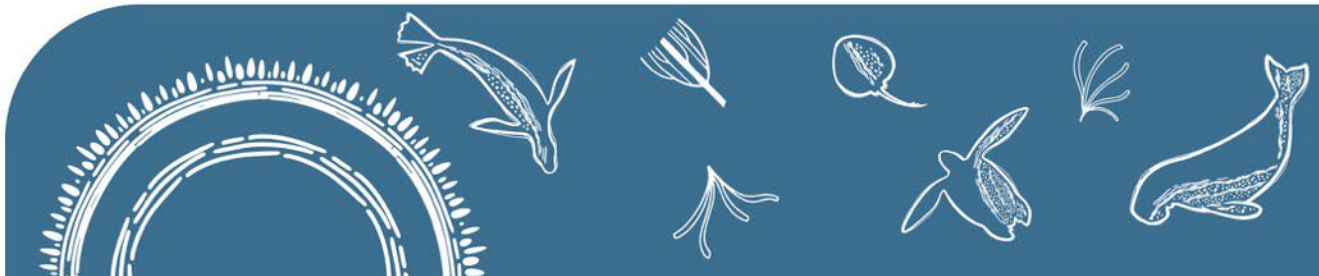




Retrospective: Satellite Altimetry Calibration and Validation

Christopher Watson (UTas)
Benoit Legresy (CSIRO)

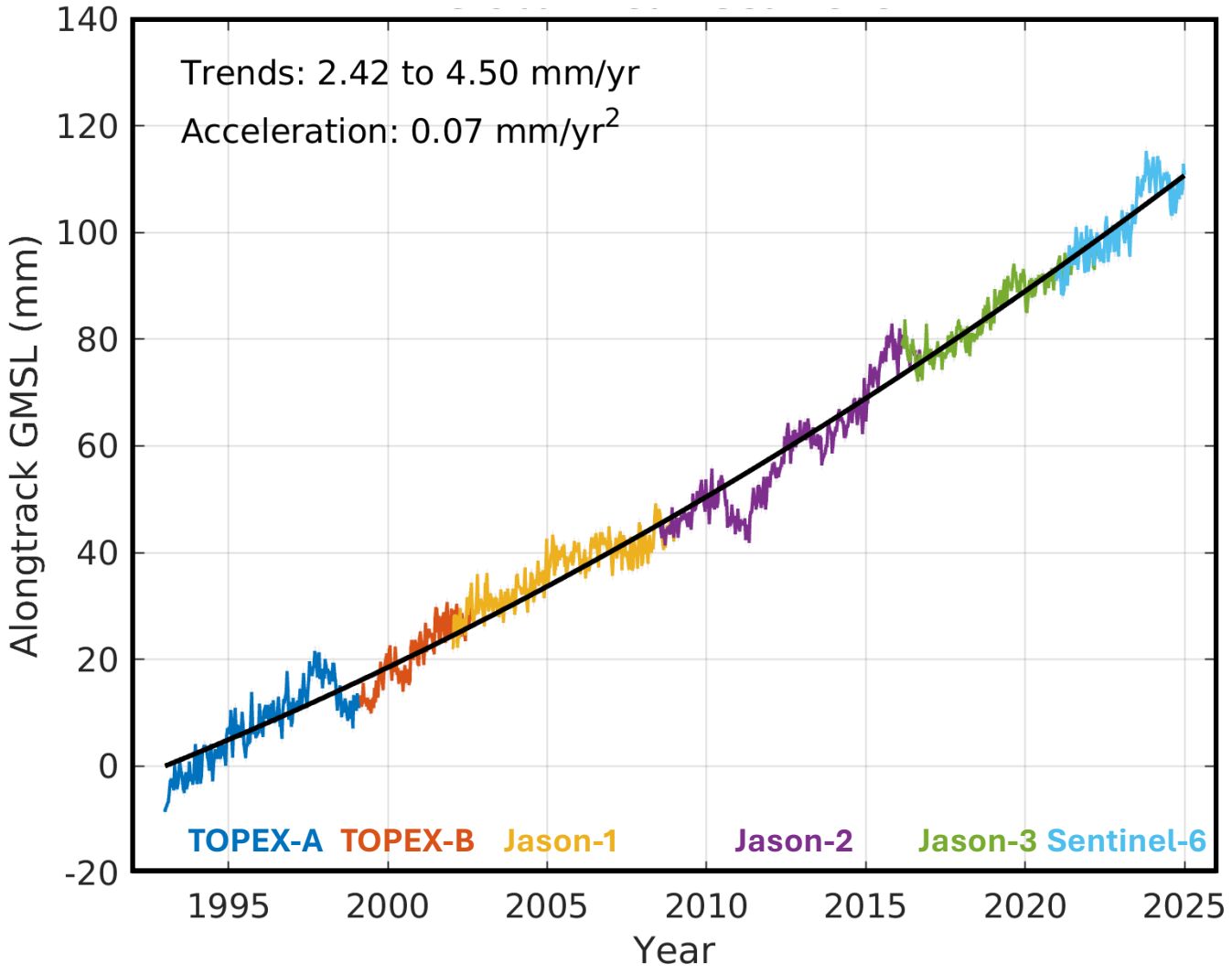
UNIVERSITY of TASMANIA
CSIRO

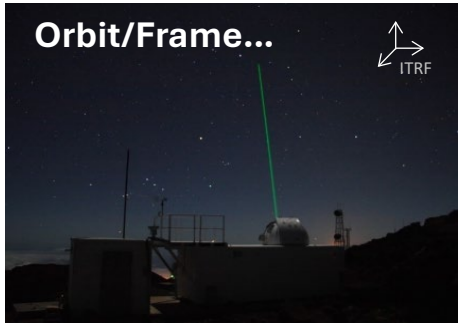


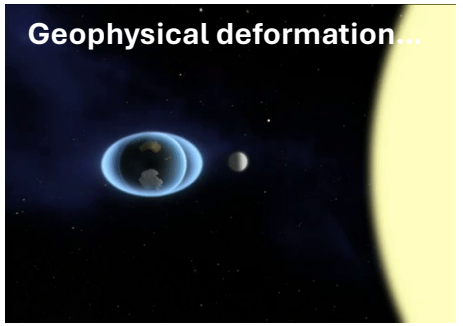
IMOS acknowledges the Traditional Custodians and Elders of the land and sea on which we work and observe, and recognise them as Australia's first marine scientists and carers of sea Country. We pay our respects to Aboriginal and Torres Strait Islander peoples past and present.

- The height of the ocean surface responds to many processes over diverse spatial and temporal scales.
- Satellite altimetry delivers precise measurements of Sea Surface Height (SSH). Global Mean Sea Level has emerged as a fundamental climate data record.

Sea Level Climate Data Record







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Validation is Core to Mission Design:

TOPEX / Poseidon
Aug 1992

Jason-1
Dec 2001

OSTM/Jason-2
June 2008

Jason-3
Jan 2016

Data Release

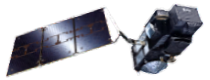
(by agencies, first to science / validation teams, then open to all users)

Validation

(by science / validation teams, diverse array of approaches)

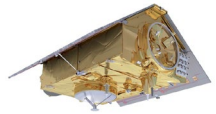
Understand / Improve

(by science, validation and engineering teams)

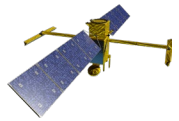


Sentinel-3A
Feb 2016

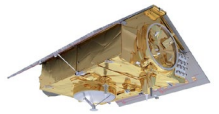
Sentinel-3B
Apr 2018



Sentinel-6 / Michael Freilich
Nov 2020



SWOT
Dec 2022



Sentinel-6B
Nov 2025

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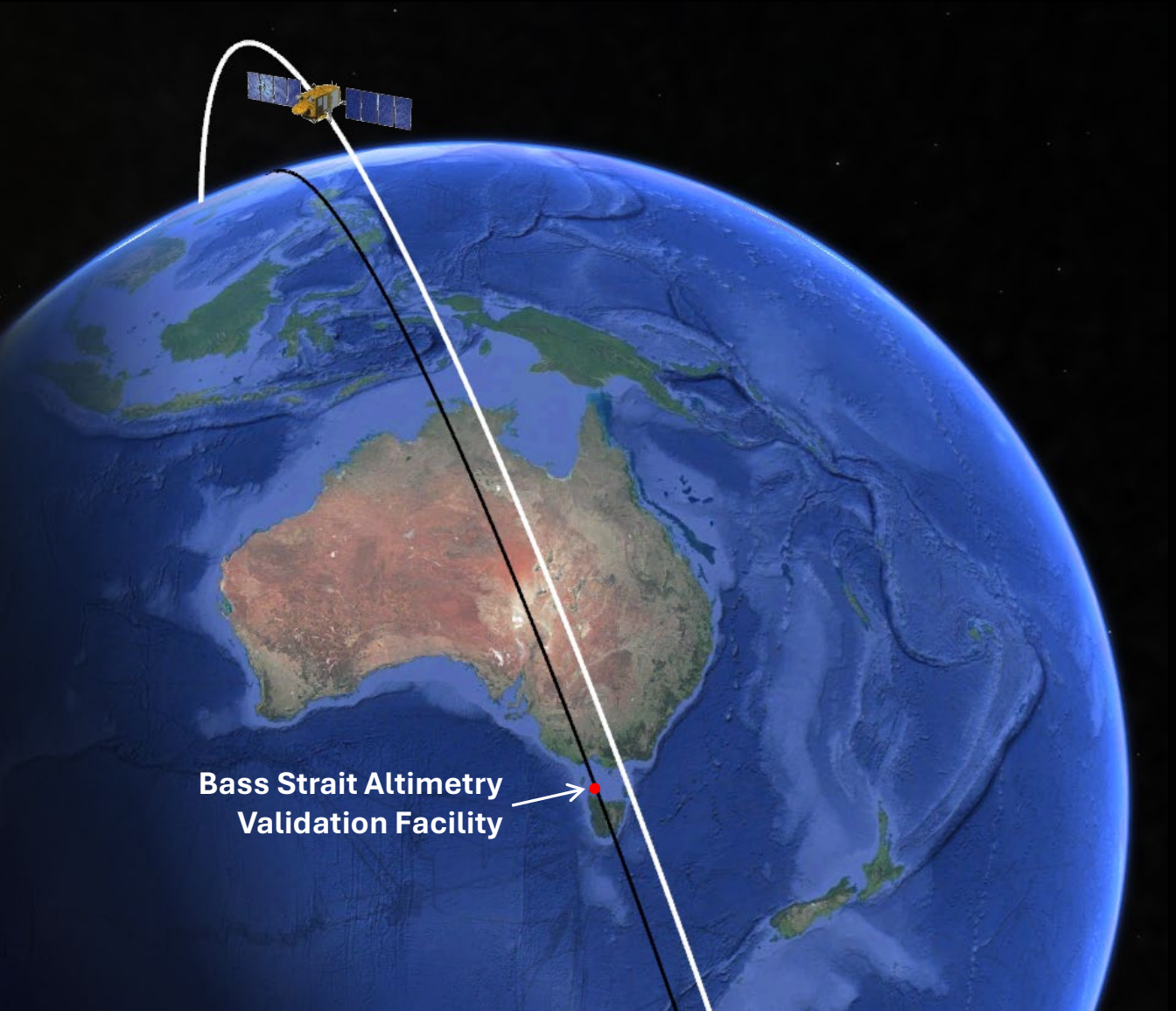
Australian Contribution to Altimetry:

The Bass Strait Validation Facility



Altimeter Sea Surface Height = **In situ** Sea Surface Height

Mission Geophysical Data Records (orbit, range, corrections)

GNSS Buoys (ITRF SSH)

Ocean Moorings (P/T/S/U/V/W)

Coastal TG and GNSS (RSL, VLM)

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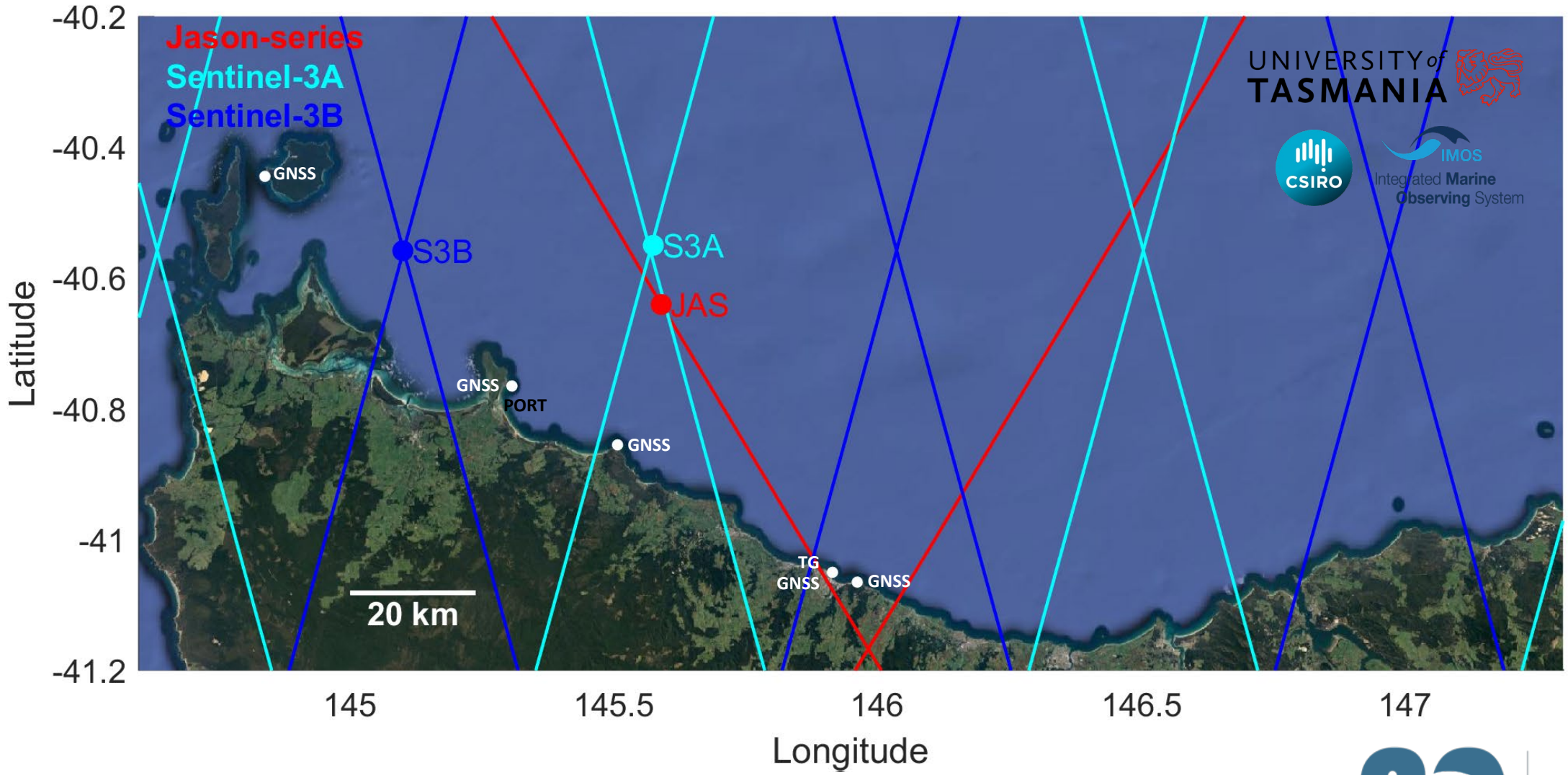
Bass Strait Site Evolution:



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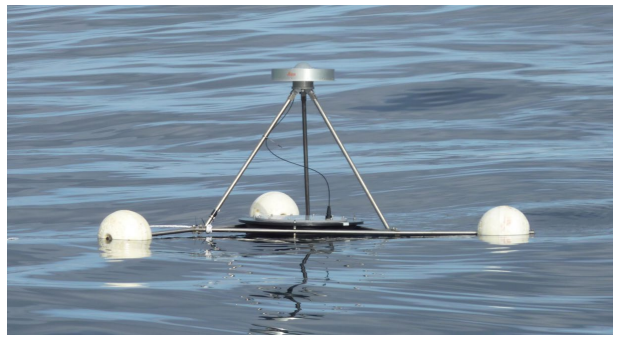
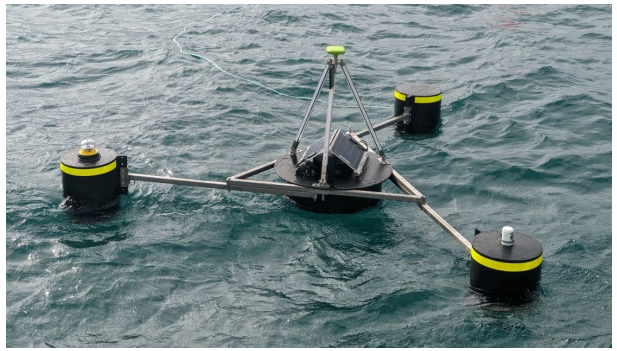
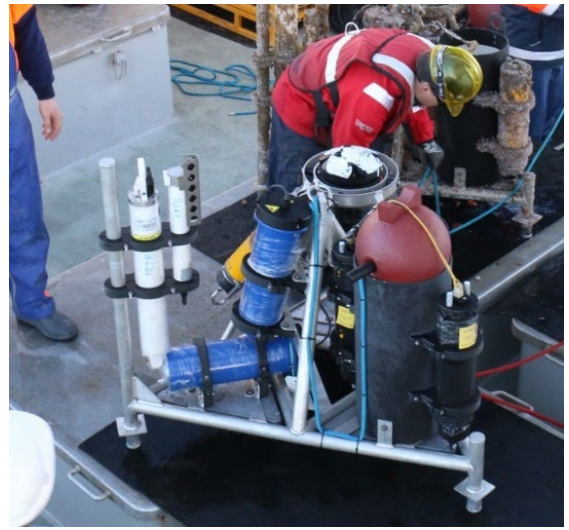
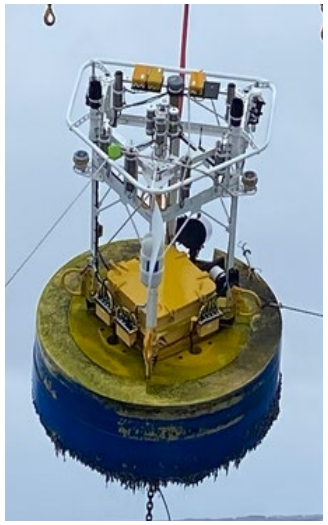
Keeping Pace with Satellite Progression…

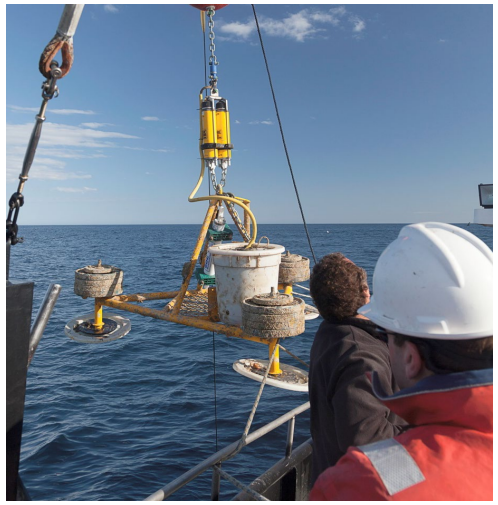
- Satellite altimetry has advanced considerably with recent missions leading to improved precision and spatial resolution.
- Keeping pace with this has required continued development of our in situ instrumentation – both surface and sub-surface.











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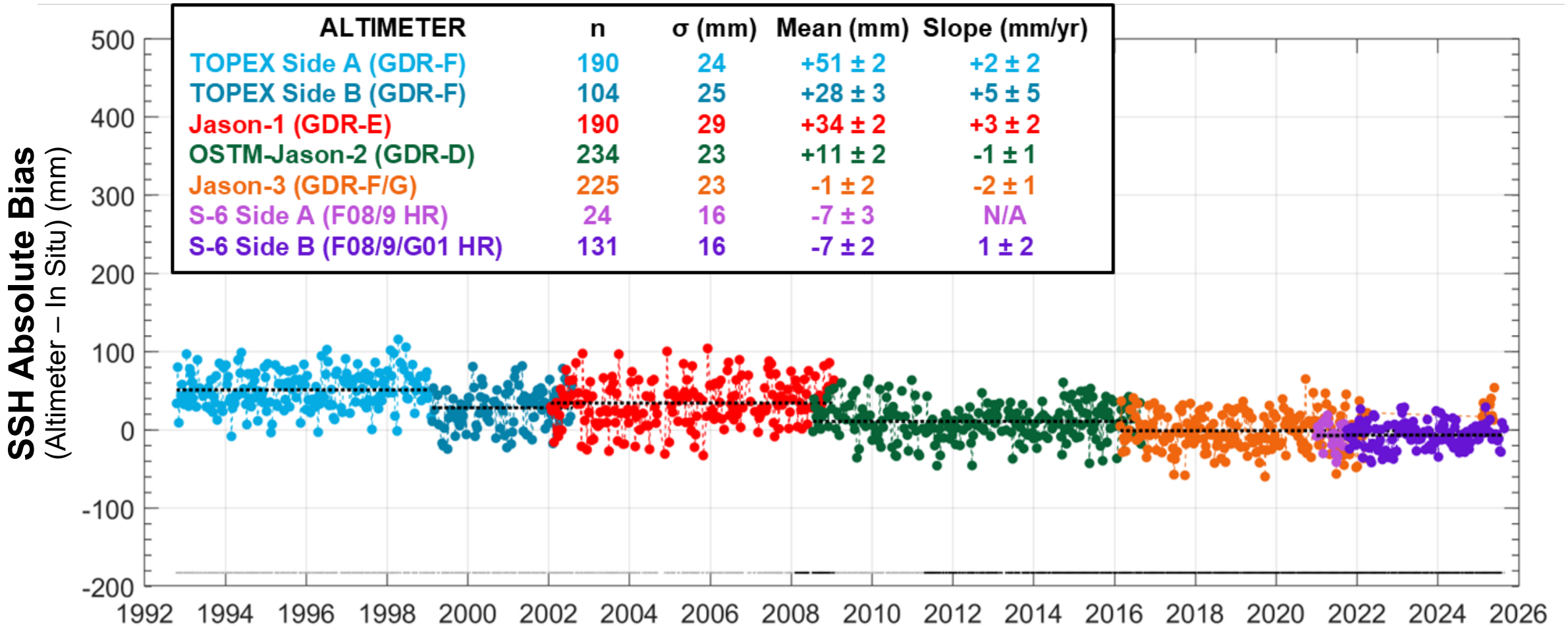
Typical Absolute Bias Results:



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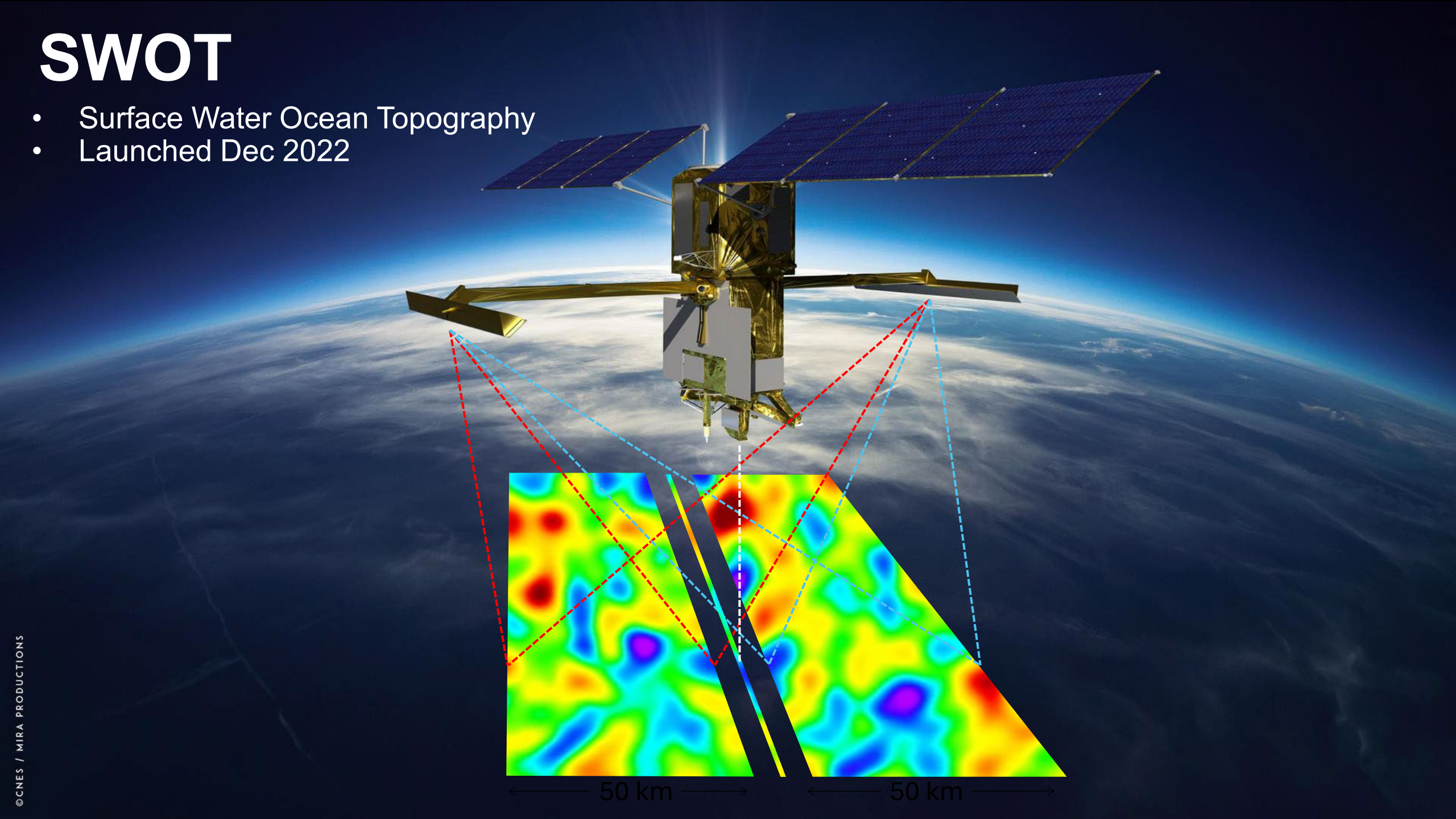
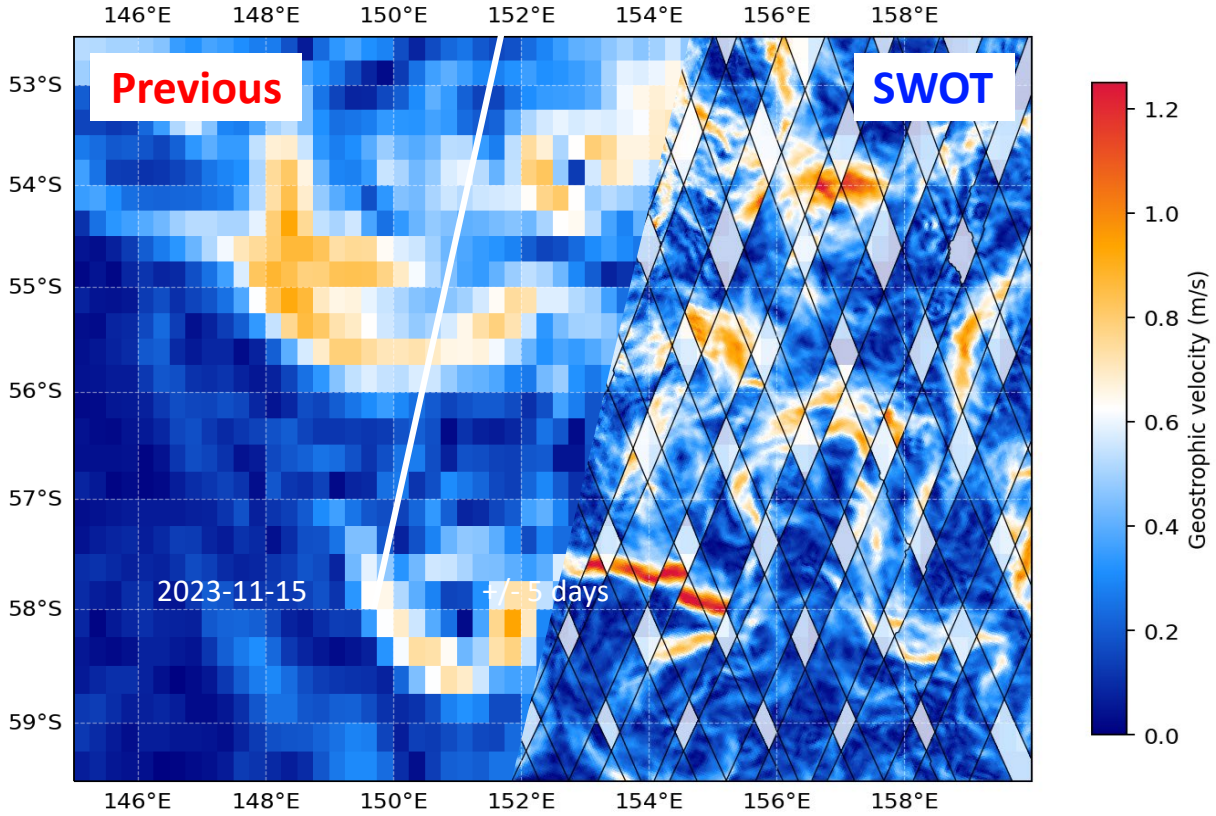
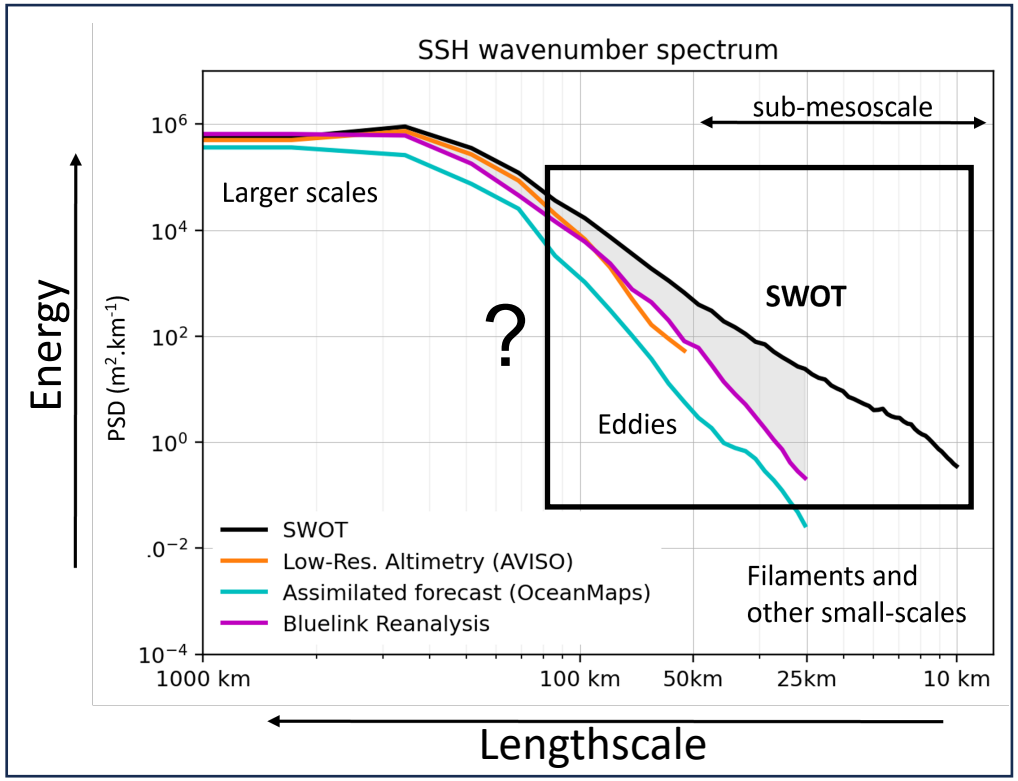
SWOT

- Surface Water Ocean Topography
- Launched Dec 2022



SWOT shows more energy over 10-100km scales than was observable before





- Validation of the observability of fine-scale dynamics with SWOT
- Uncover the finer scale ocean dynamic features and their impact on heat and carbon transfer
- Opening coastal applications very close to the beach or headland (with necessary expertise)

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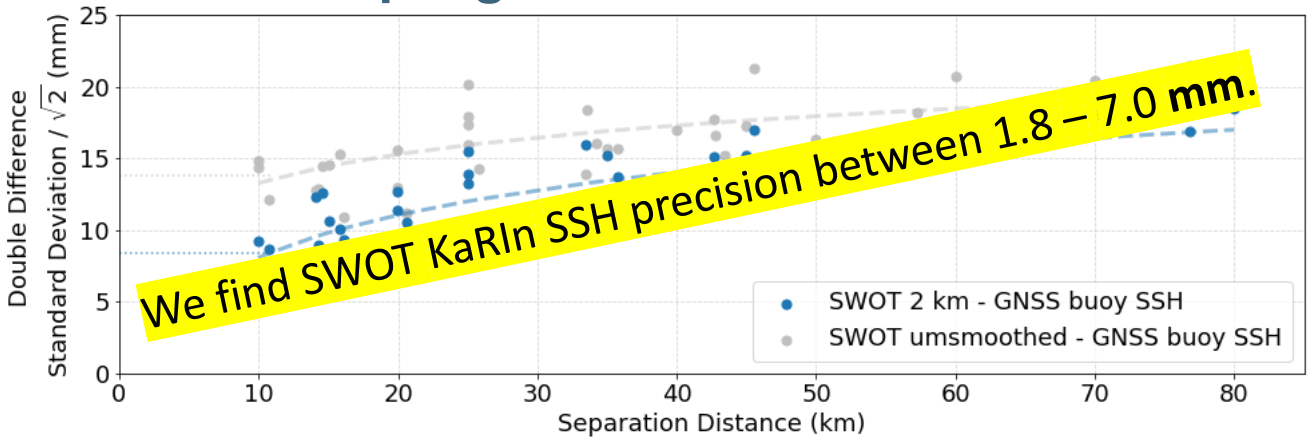
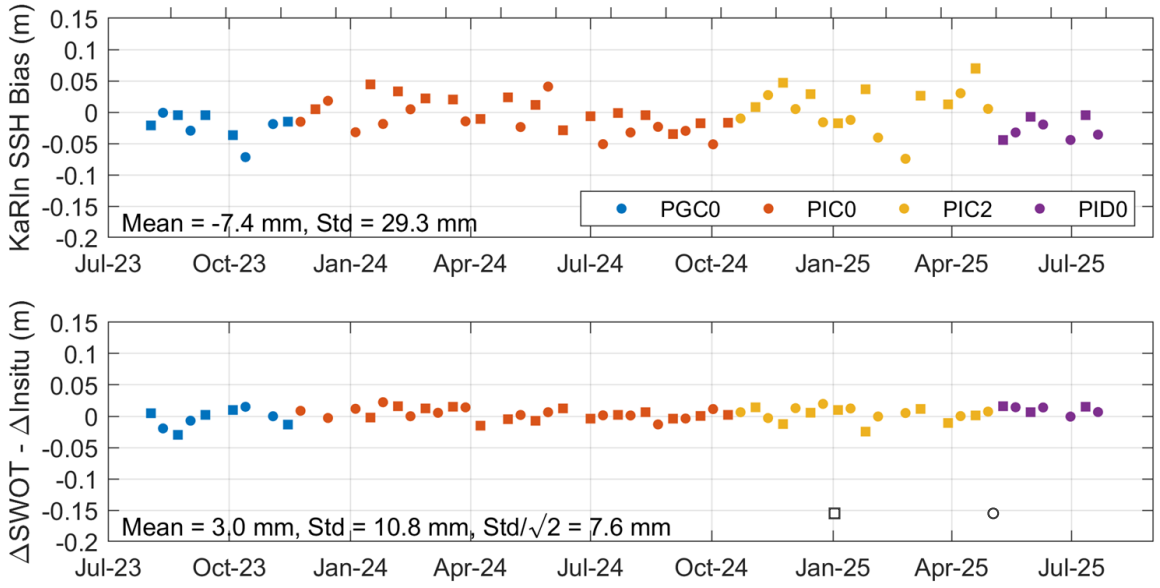
SWOT satellite SSH noise level from Bass Strait

Fast Sampling Phase



Science Phase



Geophysical Research Letters

RESEARCH LETTER
10.1029/2024GL112778

Small Scale Variability in the Wet Troposphere Impacts the Interpretation of SWOT Satellite Observations

Special Collection: Science from the Surface Water and Ocean Topography Satellite Mission

Key Points:

Andrea Hay[1,2], Christopher Watson[1,3], Benoit Legresy[2,3,4], Matt King[1], and Jack Beardsley[1,2,3]

[1]School of Geography, Planning, and Spatial Sciences, University of Tasmania, Hobart, TAS, Australia, [2]CSIRO, Hobart, TAS, Australia, [3]Integrated Marine Observing System, Hobart, TAS, Australia, [4]Australian Antarctic Program Partnership, University of Tasmania, Hobart, TAS, Australia

Earth and Space Science

RESEARCH ARTICLE
10.1029/2025EA004326

In Situ Geometric Validation of SWOT Satellite Observations in Bass Strait, Australia

Special Collection: Science from the Surface Water and Ocean Topography Satellite

Andrea Hay[1,2], Christopher Watson[1,3], Benoît Legresy[2,3,4], Matt King[1], Boye Zhou[5], Jack Beardsley[1,2,3], and Alejandro Bohé[6]

OCTOBER 2023 HAY ET AL. 1137

In Situ Validation of Altimetry and *CFOSAT* SWIM Measurements in a High Wave Environment

ANDREA HAY[a,b] CHRISTOPHER WATSON,[a,c,d] BENOIT LEGRESY,[b,c,a] MATT KING,[a,d] AND JACK BEARDSLEY[a,c,b]

IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING, VOL. 63, 2025 5209319

Measuring Significant Wave Height Fields in Two Dimensions at Kilometric Scales With SWOT

Alejandro Bohé, Albert Chen, Curtis Chen, Pierre Dubois, Alexander Fore, Beatriz Molero, Eva Peral, Matthias Raynal, Bryan Stiles, Fabrice Ardhuin, Andrea Hay, Benoît Legresy, Luc Lenain, and Ana B. Villas Bôas

Geophysical Research Letters

RESEARCH LETTER
10.1029/2024GL109658

Phase-Resolved Swells Across Ocean Basins in SWOT Altimetry Data: Revealing Centimeter-Scale Wave Heights Including Coastal Reflection

Special Collection: Science from the Surface Water and Ocean Topography Satellite Mission

Fabrice Ardhuin[1], Beatriz Molero[2], Alejandro Bohé[3], Frédéric Nouguier[1], Fabrice Collard[4], Isabel Houghton[5], Andrea Hay[6,7], and Benoit Legresy[6,7,8]

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Geophysical Research Letters

RESEARCH LETTER
10.1029/2024GL109658

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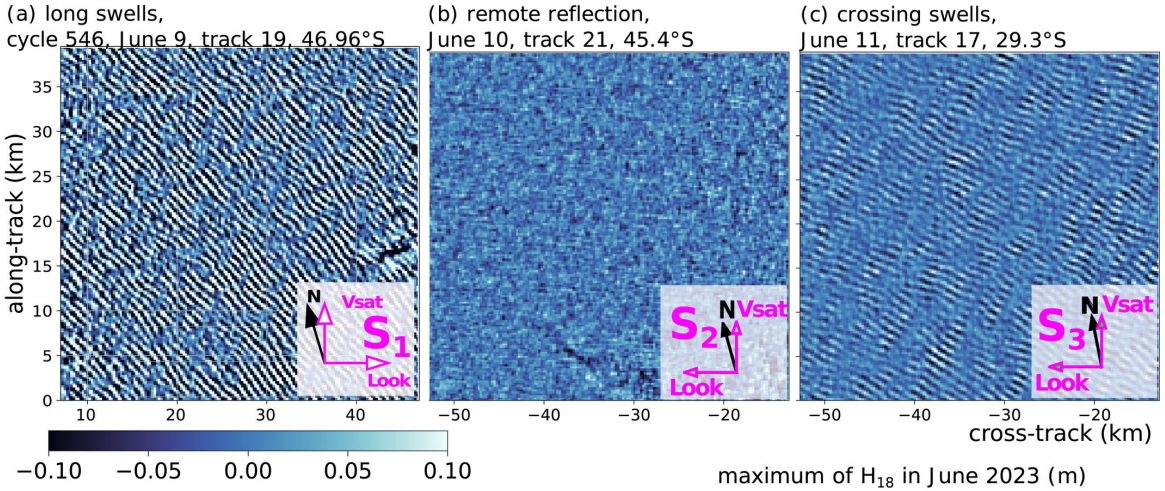
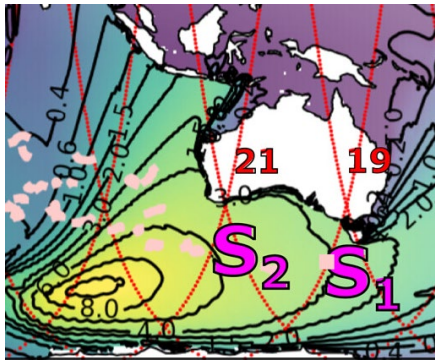


SWOT directly measures long period swell:

- Swell and reflection from coast, an important factor in coastal erosion, visible in SWOT data.
- Validated thanks to accurate wave information from the GNSS instrument on SOFS.



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Measuring Significant Wave Height Fields in Two Dimensions at Kilometric Scales With SWOT

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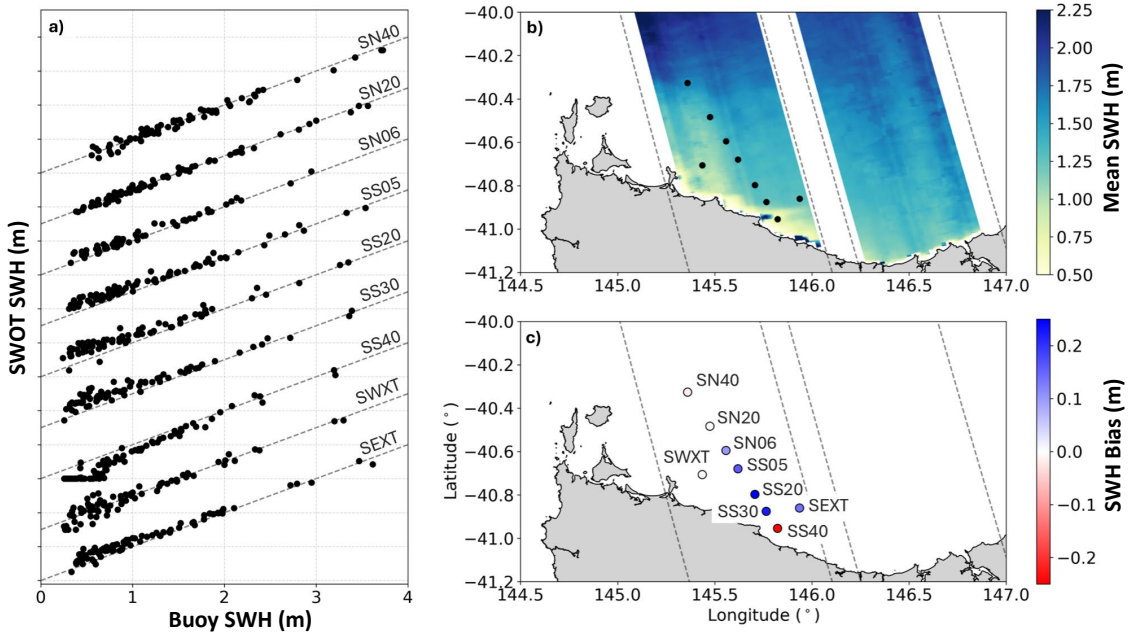
Validation drives development in SWOT wave products:

- SOFS data critical to validation of 2D wave products.
- Data from SOFS and Bass Strait has enabled further evolution in wave algorithms by the agencies.



Hay et al., 2025

Summary and Perspectives

Evolution:

- Started one mission at a time, now optimised to validate up to five at a time.
- Precision of our contribution to mission agencies is leading internationally (~16 mm).
- Successful short-term expansion to validate the game-changing SWOT mission.
- Not just SSH… waves and troposphere too.

Current Focus:

- Maintain optimised, efficient approach.
- Now focused on the new Sentinel-6B (launched Nov 2025) to ensure continuity of sea-level record.
- Sentinel-3C coming soon (end 2026).

Challenges:

- Weather…
- Bulk carriers…
- Scallop trawlers…
- Public concerns over fish farming…
- Oil price / inflation…
- Satellites keep getting better (!)…

Future Opportunities:

- Shift towards SWOT-like altimeters (Sentinel-6NG and Sentinel-3NG).
- International community looks towards our sub-facility – we are well prepared to continue our contribution.

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Thankyou to many people and teams!

Christopher Watson (UTas)
Benoit Legresy (CSIRO)

UNIVERSITY of TASMANIA
CSIRO


CSIRO Moorings Team


Jack Beardsley
Andrea Hay
Arthur Zhou


Puerto Rico

Montpellier

OSTST / S3VT / S6VT / SWOT ST


Chicago

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