Report on SWOT Oceanographic Campaign Workshop (October 2018)

Tom Farrar
Woods Hole Oceanographic Institution

SWOT ST meeting, 17 June 2019

Workshop held 4-5 October 2018 in Crystal City, VA

- Focus on opportunities presented by SWOT mission and cal/val for major advances in quantitative understanding of the dynamics of mesoscale, submesoscale, and internal-wave variability.
- More than 40 participants

Registered attendees:

1. Tom Farrar
2. Jessica Hausman
3. Kyla Drushka
4. Eric D'Asaro
5. Cesar Rocha
6. Lee-Lueng Fu
7. Jinbo Wang
8. Brian K Arbic
9. Xujing Davis
10. Ernesto Rodriguez
11. Bruce McKenzie
12. Dhruv Balwada
13. Gregg Jacobs
14. Sarah Gille
15. James Girton
16. Mete Uz
17. Rob Pinkel
18. Kyle Dedrick
19. Uriel Zajaczkovski
20. Matthias Lankhorst
21. Yi Chao
22. Eric Lindstrom
23. Nadya Vinogradova-Shiffer

Remote attendees:

1. Michelle Gierach
2. Pete Gaube
3. Andy Thompson
4. Rosemary Morrow
5. Pascal Bonnefond
6. Ed Zaron
7. Ananda Pascual
8. Joern Callies
9. Bo Qiu
10. Frederic Marin
11. Roger Samelson
12. Luc Lenain
13. Jen MacKinnon
14. Shaun Johnston
15. Dimitris Menemenlis
16. Ryan Abernathey
17. Raffaele Ferrari
18. Parag Vaze
19. Joseph D'Addezio

Workshop goals

1. Identify opportunities for advances on important physical oceanography research challenges
2. Refine and prioritize science goals
3. Develop outline of campaign (goals, timing, milestones)

Opportunities

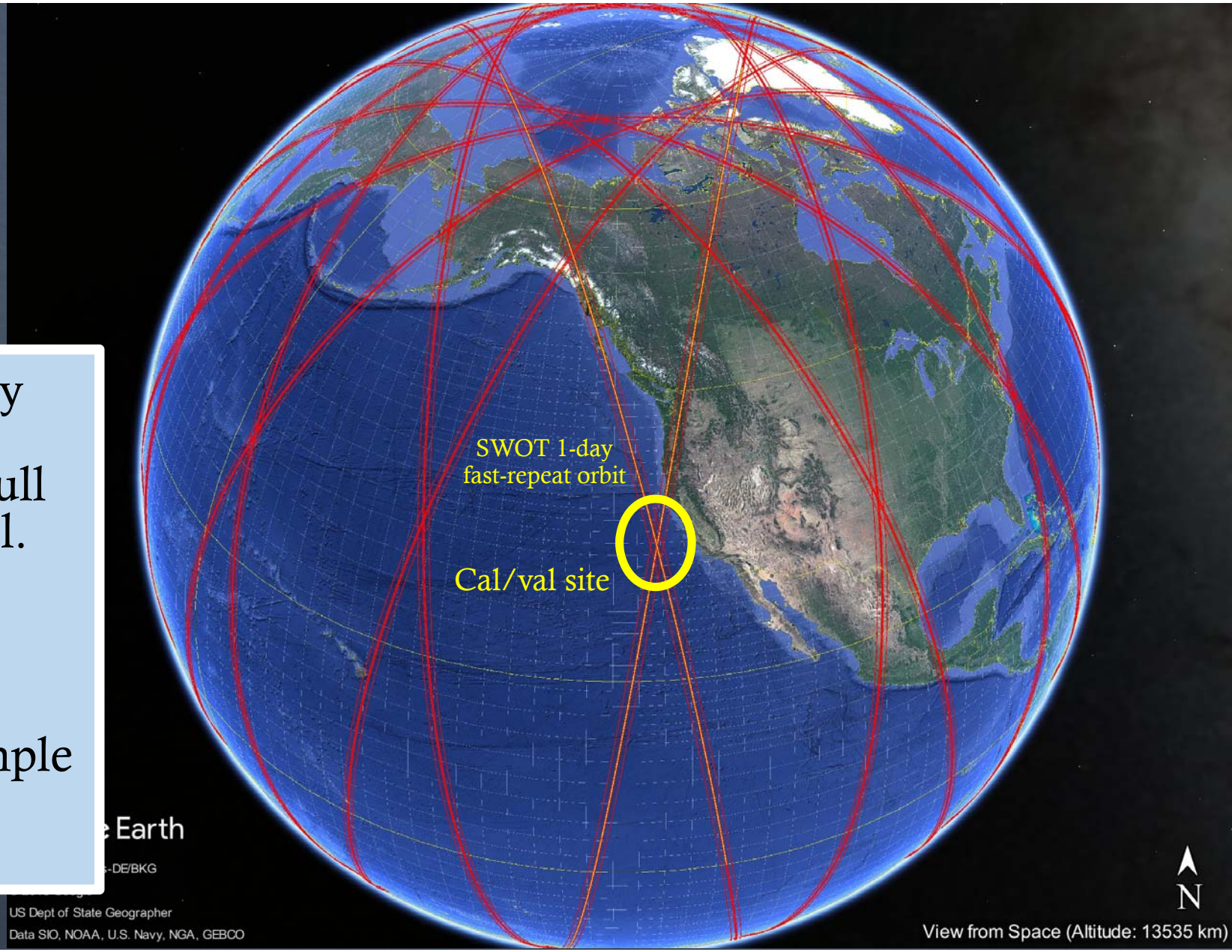
1. Existence of SWOT, which will allow an unprecedented, and probably bewildering, new view of sea surface height
2. SWOT 90-day fast-repeat orbit phase starting around Jan 2022, providing 2 passes per day at select locations
3. In situ measurement array for independent SWOT cal/val
4. S-MODE NASA Earth Venture Suborbital Mission at cal/val site
5. Improving technology for observation, modeling and data assimilation

→We can exploit some of these opportunities.

SWOT fast-repeat orbit

SWOT will normally orbit with a 21-day repeat period with full global coverage (excl. poles).

For 180 days, fast-repeat orbit will sample 2 times per day at crossovers



Constraints

1. SWOT launch is scheduled for September 2021, but schedule may slide
2. Fast-repeat orbit constraints:
   a) First 90 days of SWOT fast-repeat phase is for engineering checkout– data may not be good
   b) Days 90-180 of fast-repeat phase is for cal/val and science
   c) There are very few crossovers of fast-repeat orbit
3. Launch uncertainty makes it more difficult to plan field campaigns to align with fast-repeat orbit

Motivating scientific questions

(1) What is the 4D (x,y,z,t) spectrum of ocean variability at 1-200 km scales? What are the physical processes that produce the SSH variability on these scales?

(2) How much of the upper-ocean variability at 1-200 km scales can be observed and constrained using only surface observations of SSH and buoyancy (SST, SSS)? Can tracer fields (SST, SSS, chlorophyll) be used to infer SSH structure at these scales?

(3) How is energy removed from the large-scale ocean circulation and mesoscale eddy field? That is, how does the ocean energy cascade work, and what are the relative roles of submesoscale variability, internal waves, and other ageostrophic variability in removing energy from the larger scales?

(4) How do the balanced motions interact with the internal tides and waves? How can we separate these two kinds of motions in the SWOT SSH observations? What is the transition scale between these regimes? Can other measurements be used together with SSH to distinguish between balanced and unbalanced motions?

(5) How do dynamics at 1-200 km scales contribute to vertical and horizontal transport in the upper ocean?

(6) Are small-scale barotropic signals really negligible?

Recommendations from workshop

1. Support the Adopt-a-Crossover effort being organized as a PI-driven effort to collect measurements in crossovers of the SWOT fast-repeat orbit
2. Organize some additional measurements in the California Current region to complement the SWOT fast-repeat measurements, the SWOT CalVal array, and S-MODE measurements to make it possible to resolve the 4D ocean variability at a level of detail that has never been possible
3. Have a separate, dedicated SWOT field campaign in the Gulf Stream region 1-2 years after the SWOT launch.

Recommendations from workshop

(1) Support the Adopt-a-Crossover effort being organized as a PI-driven effort to collect measurements in crossovers of the SWOT fast-repeat orbit

(2) Organize additional measurements in the California Current region to leverage existence of SWOT cal/val array and fast-repeat orbit

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Recommendations from workshop

(1) Support the Adopt-a-Crossover effort being organized as a PI-driven effort to collect measurements in crossovers of the SWOT fast-repeat orbit

What: Add coordinated finescale measurements at many locations in fast-repeat orbit

When: Times during months 3-6 after SWOT launch

Why and how: will be discussed by Francesco d'Ovidio next

(2) Organize additional measurements in the California Current region to leverage existence of SWOT cal/val array and fast-repeat orbit

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(2) Organize additional measurements in the California Current region to leverage existence of SWOT cal/val array and fast-repeat orbit

What: Add sustained measurements to enhance extent and resolution of California cal/val measurements

When: At least during first 6 months after SWOT launch

Why: Could resolve 4D ocean variability at a level of detail that has never been possible

How: A small number of PI-driven proposals to US agencies

(3) Have a separate, dedicated SWOT field campaign in the Gulf Stream region 1-2 years after the SWOT launch.

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What: Multi-national campaign focused on the small mesoscale resolved by SWOT

When: 1-2 years after launch, after SWOT measurements better assessed

Why: Address questions about mesoscale-submesoscale-internal wave interaction

How: needs definition
(Where needs discussion, too.)

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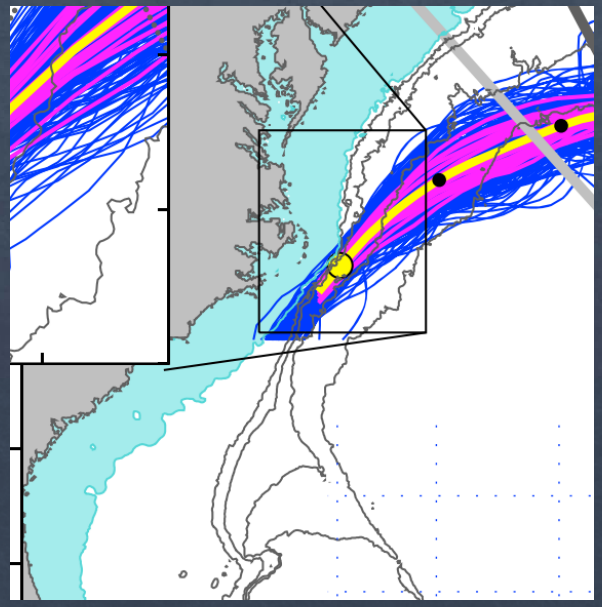

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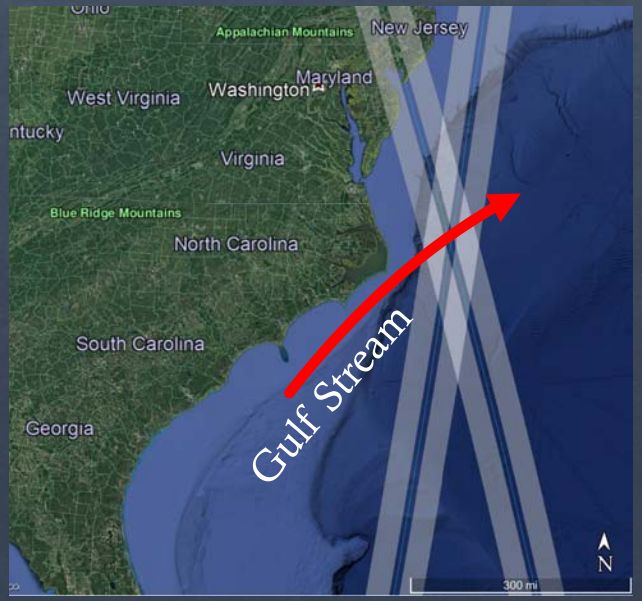

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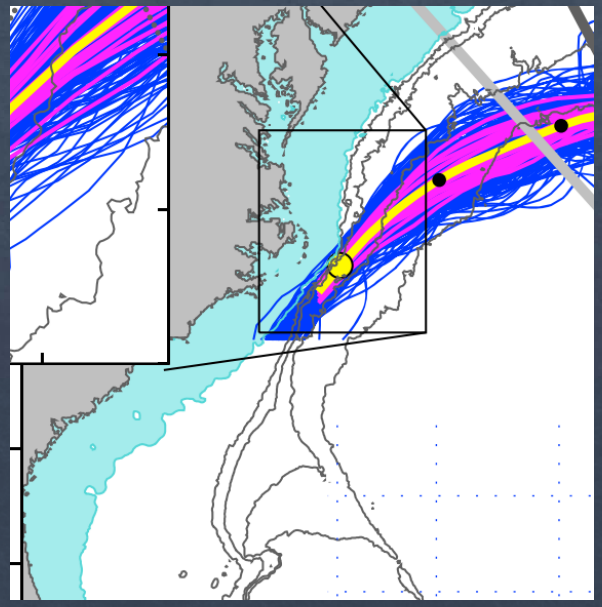

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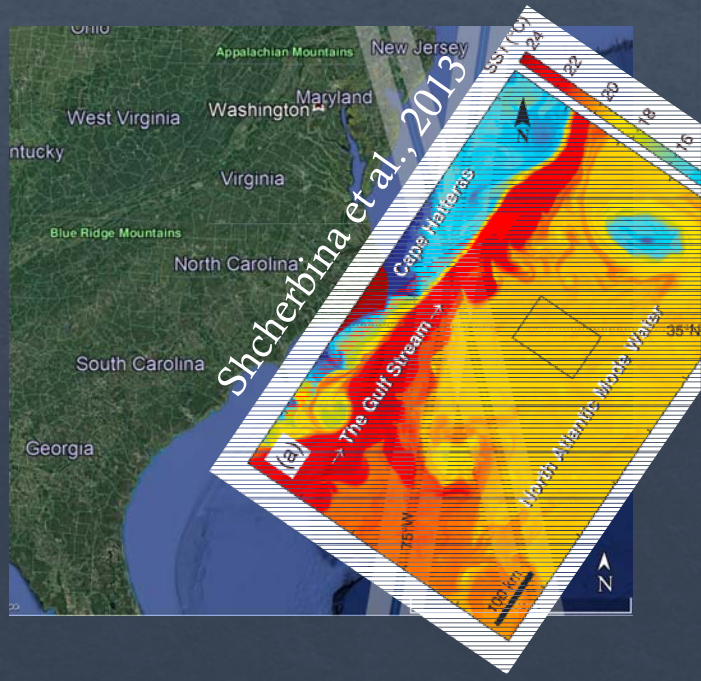

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Conclusion

1. Support the Adopt-a-Crossover effort – ***must be organized in ~1 year***
2. Organize additional measurements in the California Current region to leverage existence of SWOT cal/val array and fast-repeat orbit– ***must be organized in ~1 year***
3. Have a separate, dedicated SWOT field campaign in the Gulf Stream region 1-2 years after the SWOT launch– ***must be organized in ~2-3 years***

SWOT altimeter (Surface Water Ocean Topography)

SWOT will have a noise floor ~30x lower than conventional altimeters (e.g., Jason series)

→~2.7 cm RMS error at 1-km resolution

→Main oceanographic goal is to reach small mesoscale (~30km)

→Two 50-km swaths

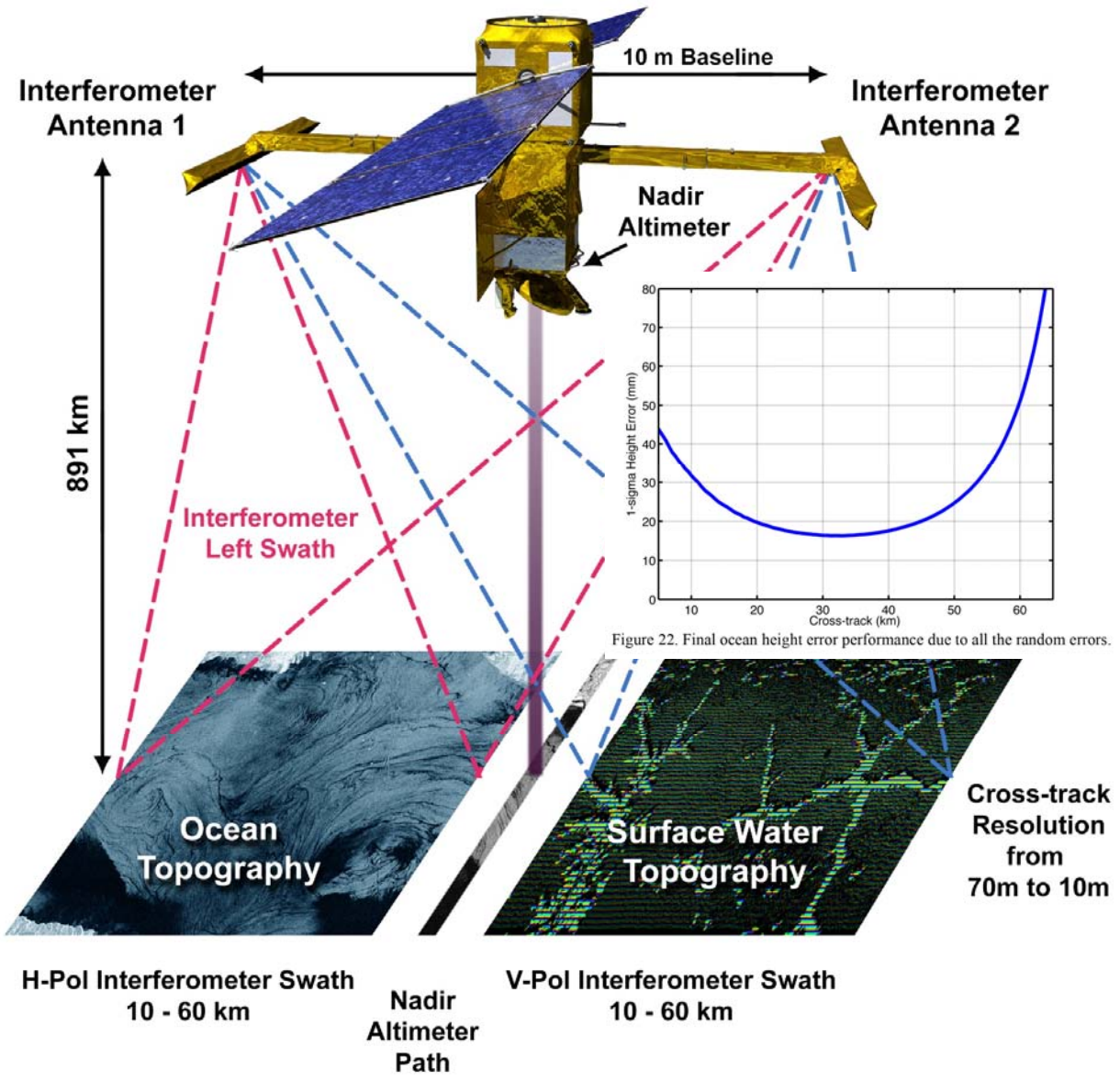

Figure 22. Final ocean height error performance due to all the random errors.

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