Investigations of Reconstructing Upper Ocean 3-D Velocity Field with the SWOT Simulator

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www.jpl.nasa.gov/missions/surface-water-and-ocean-topography-swot/
AVISO rms SSH variability in the North Pacific Ocean

Two 10-day sub-cycles in each repeat cycle

For a 6° x 6° box, time difference of various swaths in one sub-cycle < 4 days
OFES 1/30° N Pacific OGCM Simulation:

- SWOT-equivalent 3-km horizontal grid resolution; 100 vertical levels (60 in upper 500 m)
- Model domain 100°E-70°W, 20°S-66°N
- Initialized with T/S from output of the 1/10° North Pacific hindcast simulation on 1 January 2010
- Forced by JRA-25 6-hourly reanalysis data (1° resolution)
- Analysis of daily-mean SSH field of 2001 and 2002

*Sasaki et al. (2014, Nature Comm.)*
Focus on 17 Jan 2001:

Input: SSH $\eta$ field (upper left)

Targets: Near surface relative vorticity $\zeta$ field (lower left)
        200m vertical velocity $w$ field (lower right)

Reconstruction method: Effective SQG of Lapeyre and Klein (2006, JPO) and Ponte et al. (2013, JPO)
"Best" Scenario: use of modeled $\eta$ field, no noise & no swath gaps
Comments on mapping of $\eta$ field:

A non-trivial issue !!

Adding temporal information from other subcycles (±10 days) is NOT helpful

Determined “optimal” spatial mapping scales by trial-and-error
Scenario with optimal smoothing: simulator-sampled $\eta$ field

eSQG 199m

OFES 199m

OFES 204m

OFES 2.5m

eSQG simulator reconstruct

OFES original
Scenario with optimal smoothing: simulator-sampled $\eta$ field

eSQG simulator reconstruct

eSQG best reconstruct

eSQG best

eSQG 199m

eSQG 199m

eSQG 5.0m

eSQG 5.0m
Scenario with optimal smoothing: simulator-sampled $\eta$ field

- eSQG simulator reconstruct
- eSQG simulator reconstruct

- evaluated in swaths
- evaluated in entire box
Reconstructed w and $\zeta$ correlations as a function of time

- eSGQ best reconstruct
- eSQG simulator reconstruct (in swaths)
- 2-yr averaged w and $\zeta$ correlations
Reconstructed w and \( \zeta \) correlations as a function of time

- eSGQ best reconstruct
- eSQG simulator reconstruct (in entire box)
- 2-yr averaged w and \( \zeta \) correlations
Concluding Remarks

- Effective SQG theory is a promising formulation to reconstruct 3-D circulation field, including $w$, from the expected SWOT SSH measurements.

- Within the 10-day subcycle, reconstructed $\zeta$ and $w$ can reach $c \approx 0.7$ and 0.5-0.6, respectively, when compared to the “true” field along swaths.

- A full 2D reconstruction is hampered by interpretation errors in “holes” between the swaths. Better interpolation methods that retain meso/submeso-scale features are called for.