High-Resolution 3DVAR for Constraining Submesoscale Dynamics

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Motivation

- A convergence of modeling and observing capabilities is underway:

1. 1 km regional simulations, capable of resolving submesoscale eddies, are now readily producible.

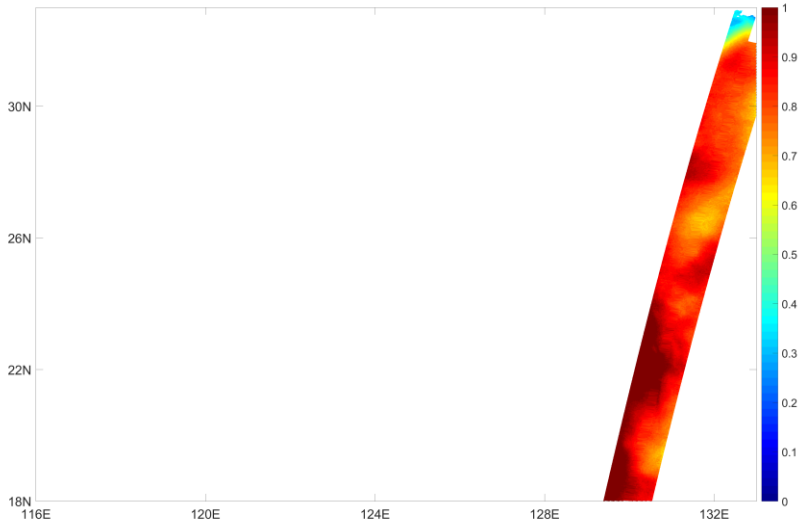
2. The Surface Water Ocean Topography (SWOT) mission will provide the first global observations of sea surface height at horizontal resolutions capable of constraining the high resolution regional models.

- What impact will this new data provide in an operational setting?

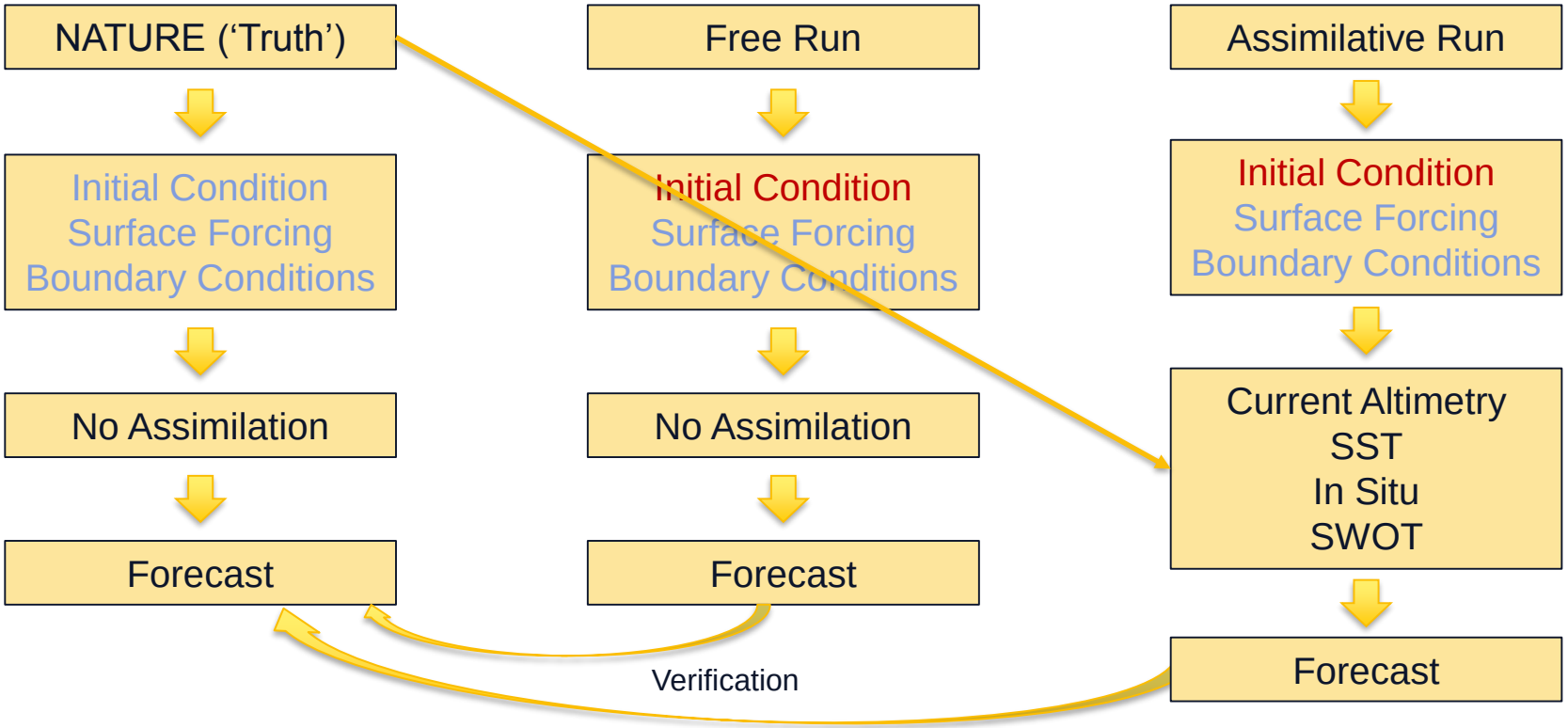
- Using current Navy technology, can submesoscale processes be constrained just by adding finer surface data?

- **Objective: Test the input of simulated SWOT data into the current system to demonstrate improvements in forecast skill and create a baseline error analysis for future comparison with under construction technology (i.e. Multiscale 3DVAR)**

Simulated 21 day SWOT coverage



Observation System Simulation Experiment (OSSE)



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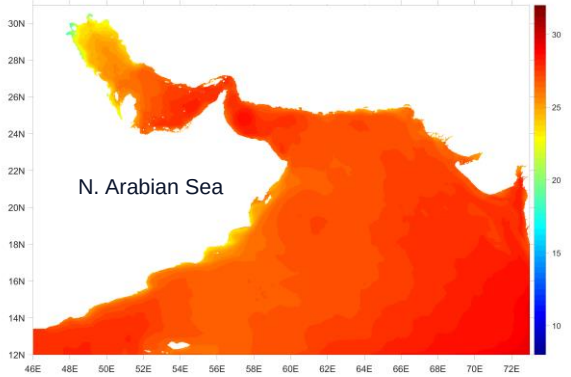
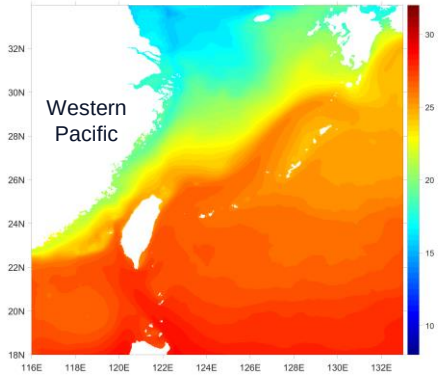
	N. Arabian Sea	Western Pacific
Model	Navy Coastal Ocean Model (NCOM)	Navy Coastal Ocean Model (NCOM)
Data Assimilation	NCODA 3DVAR	NCODA 3DVAR
Temporal Grid	Dec 2015 – Dec 2016	Dec 2015 – Dec 2016
Horizontal Resolution	1 km	1 km
Vertical Layers	50	50
Atmospheric Forcing	NAVGEM	NAVGEM
Boundary Conditions	HYCOM	HYCOM
Grid Points	2791x2110x50 [294,450,500 points]	1684x1777x50 [149,623,400 points]





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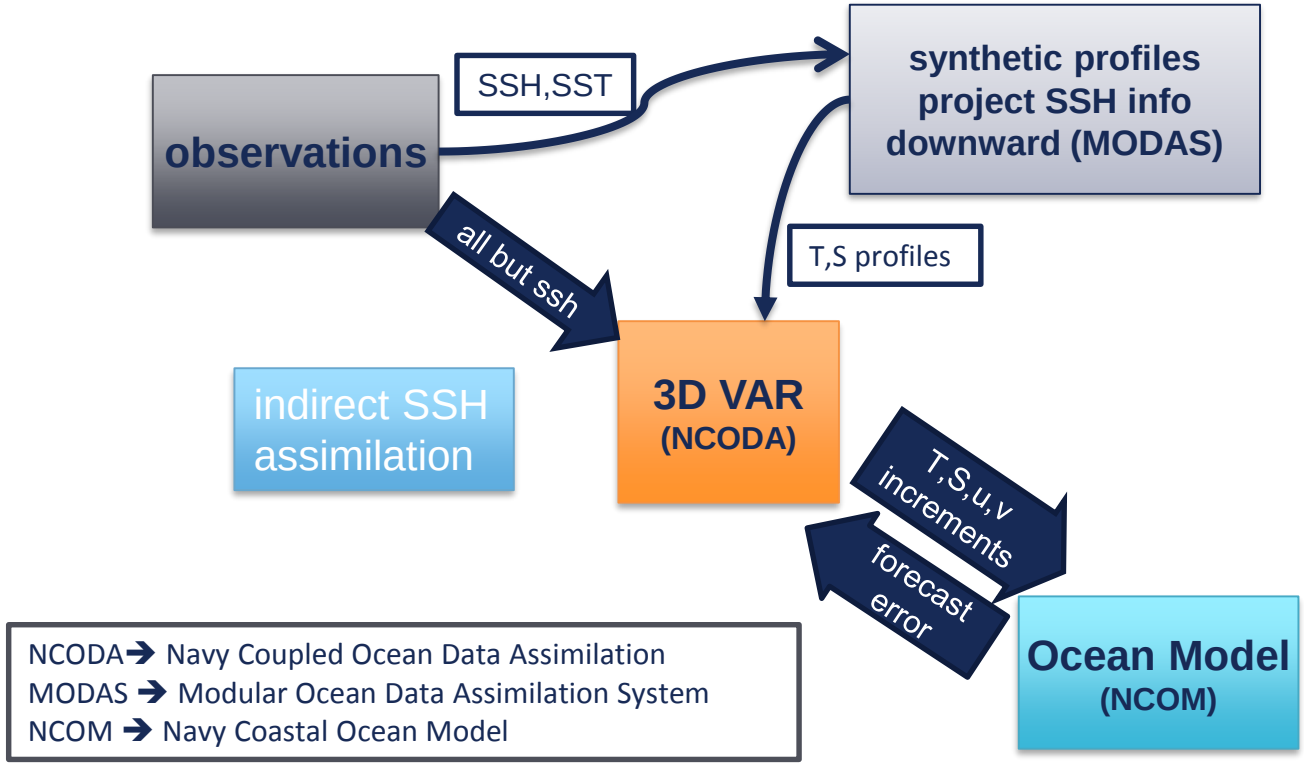
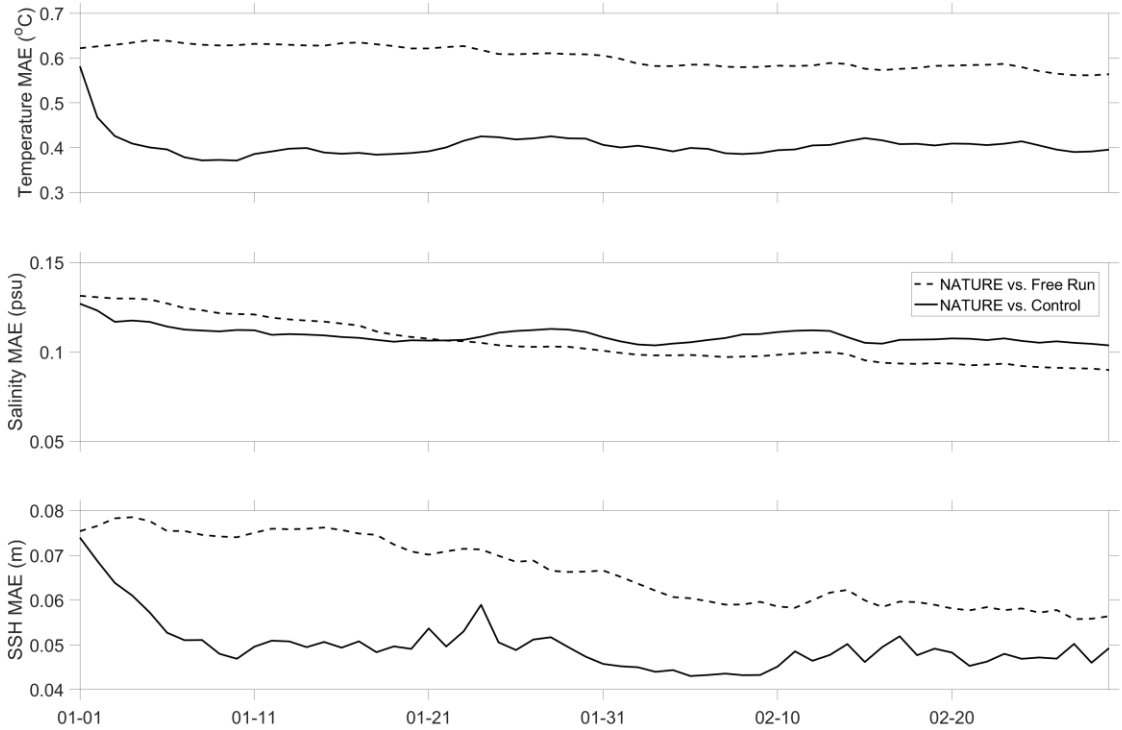
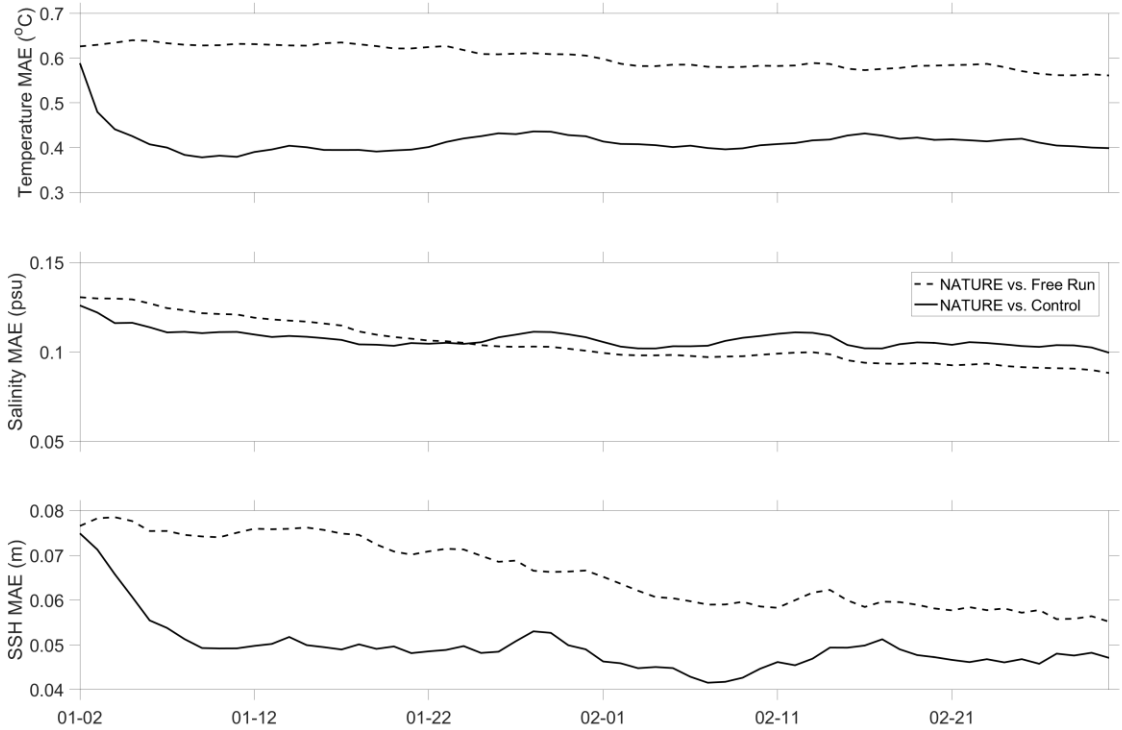


NCODA ➔ Navy Coupled Ocean Data Assimilation
MODAS ➔ Modular Ocean Data Assimilation System
NCOM ➔ Navy Coastal Ocean Model

Error Comparison 00z (Analysis Time)



Error Comparison 24z



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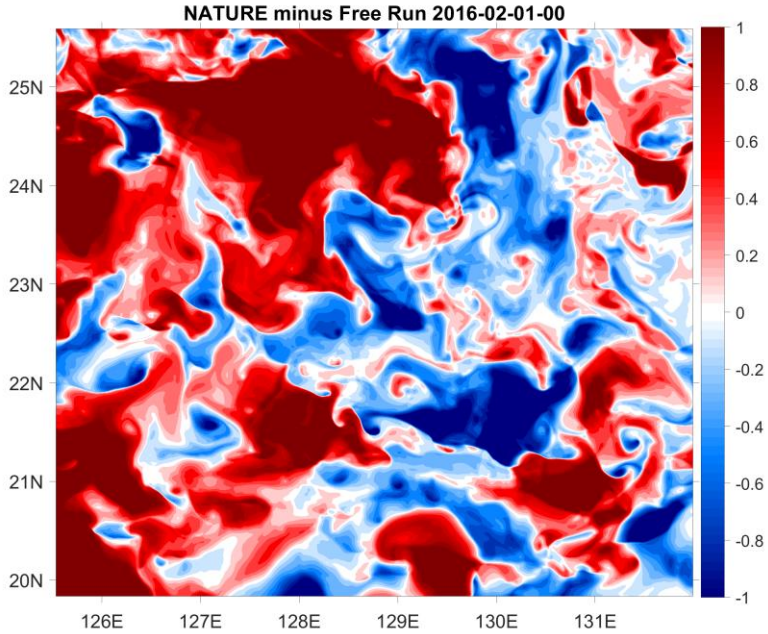

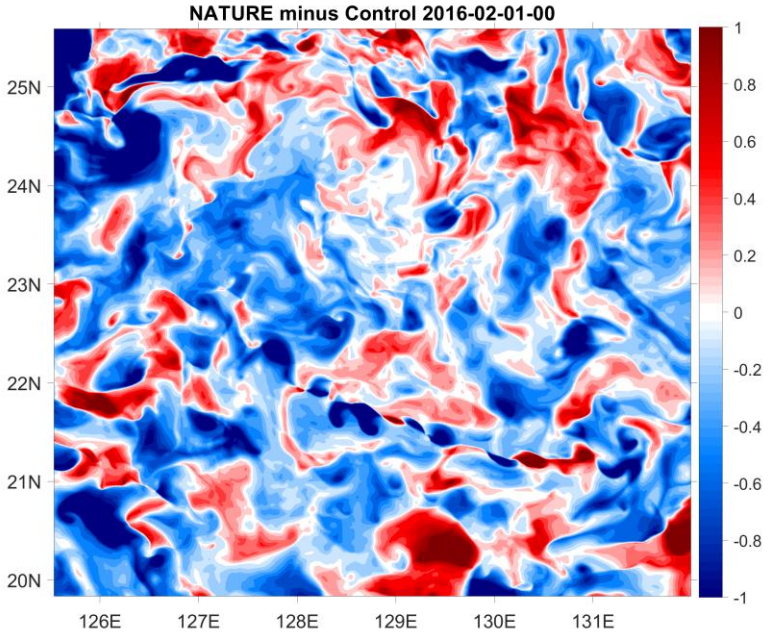

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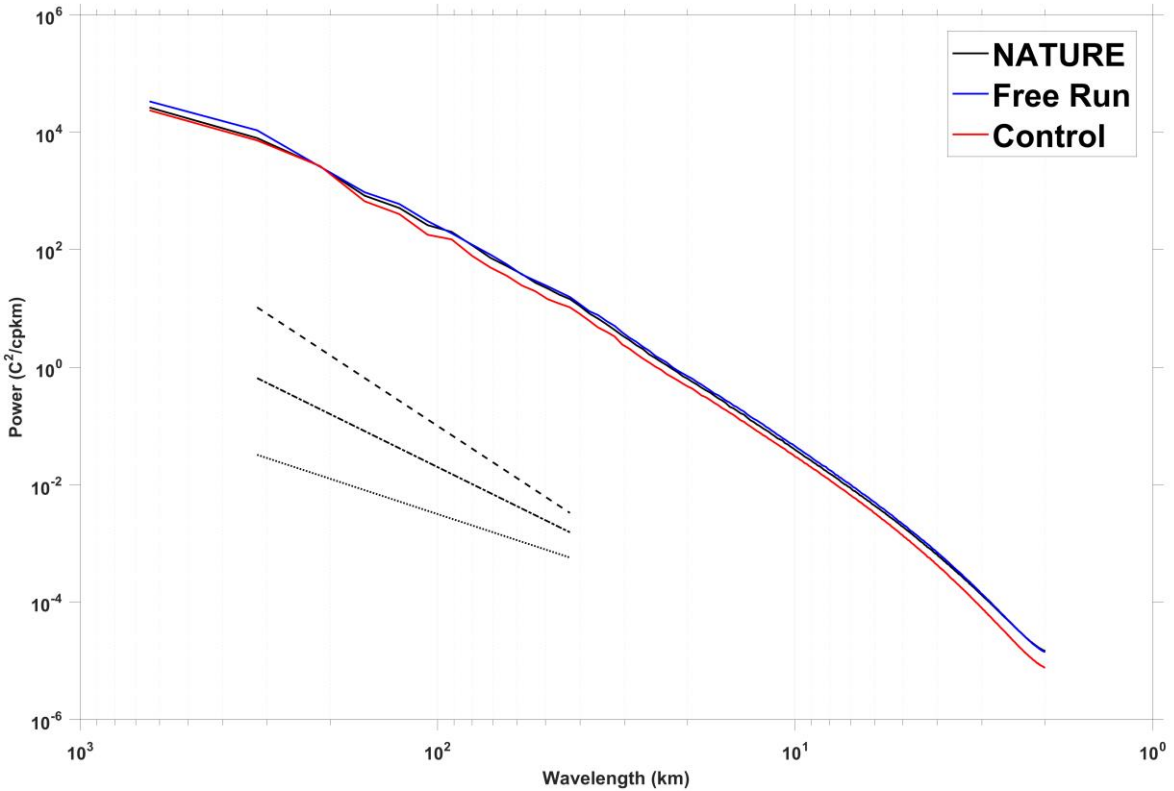

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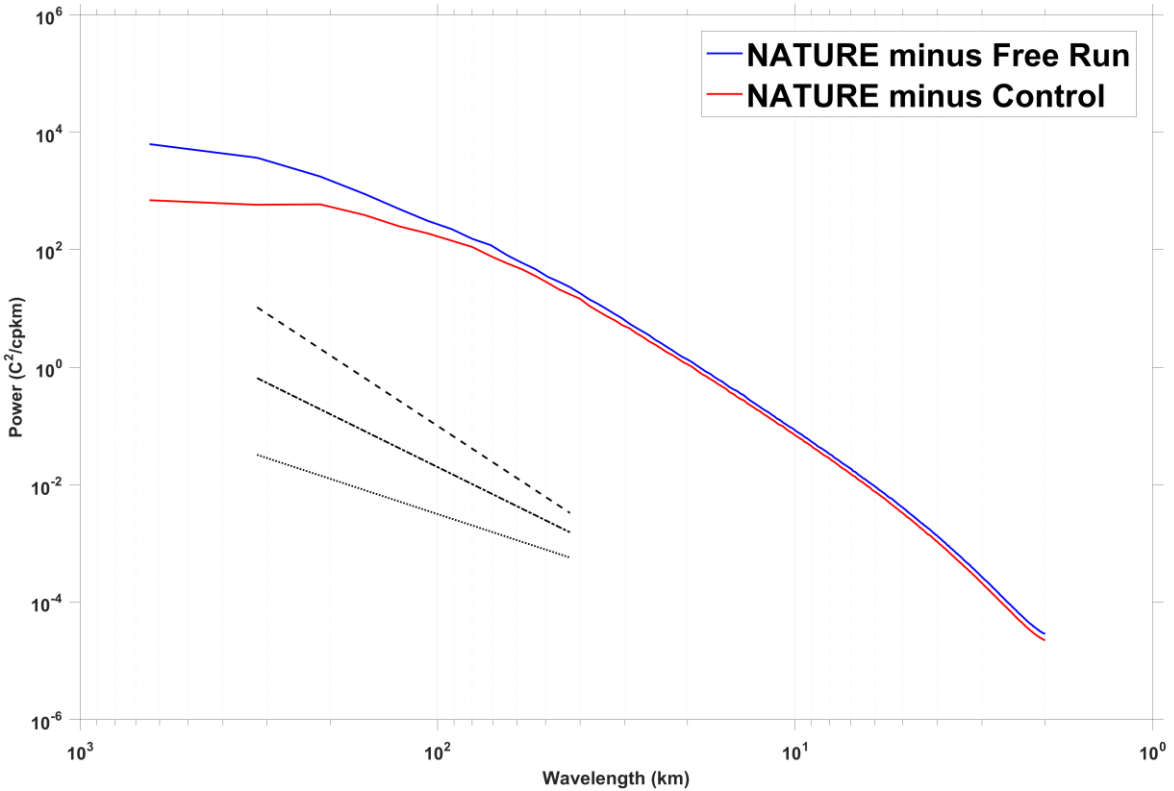

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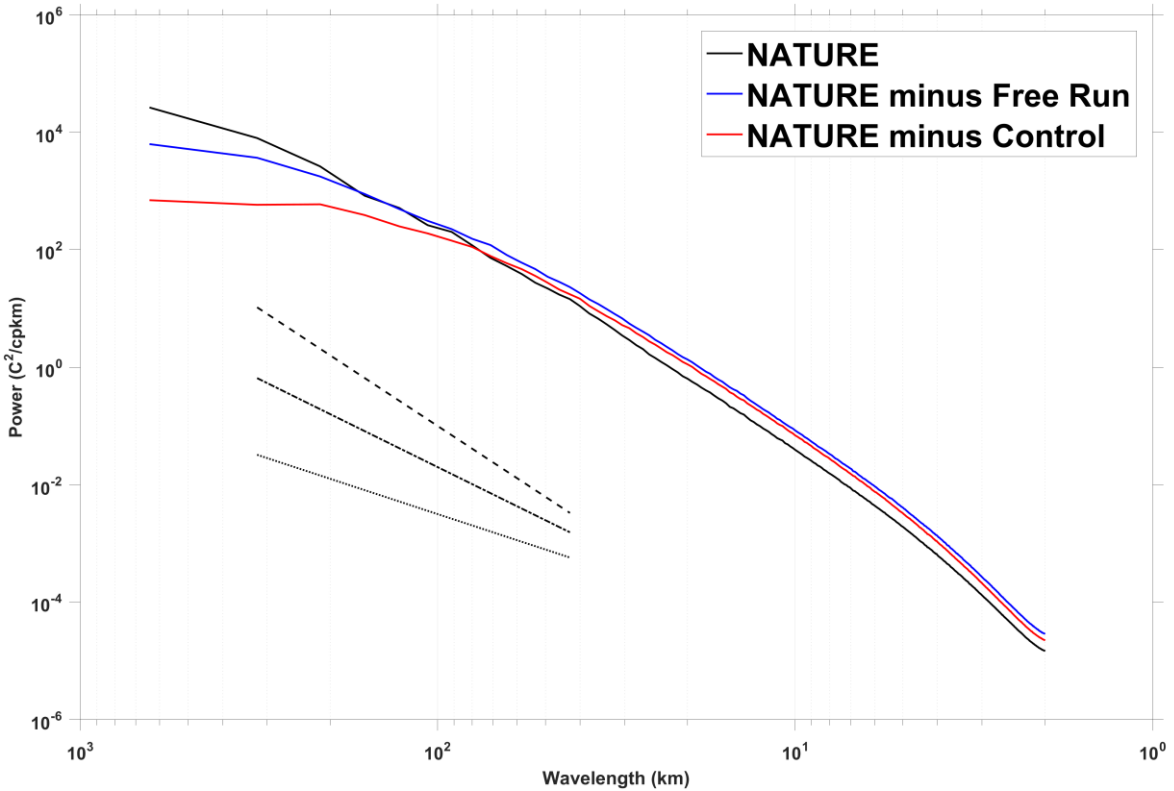

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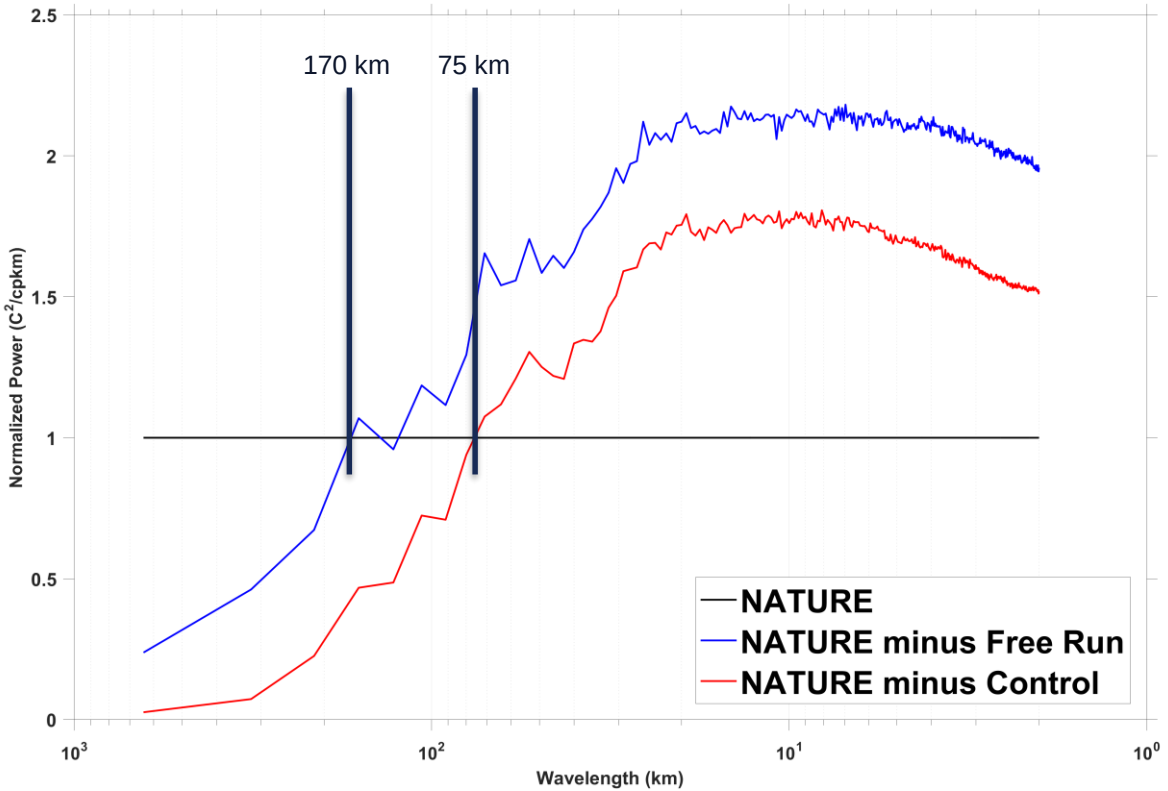

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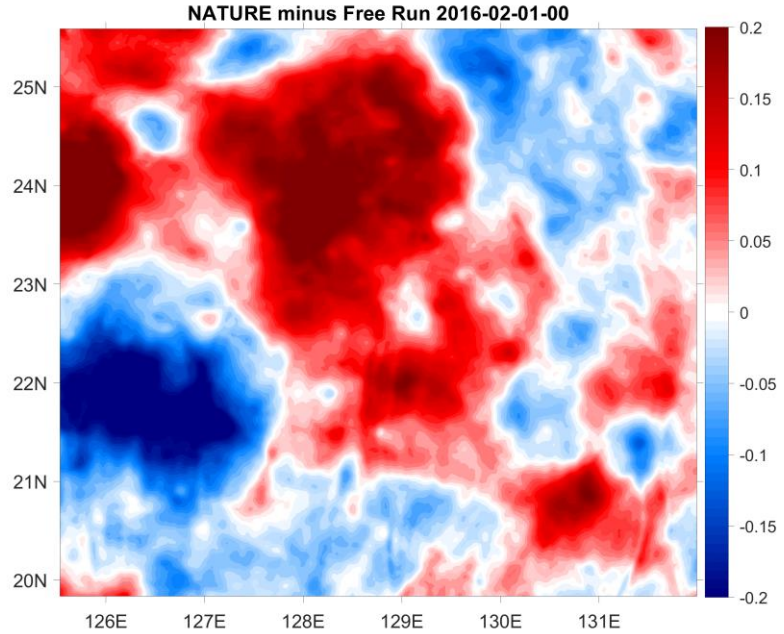
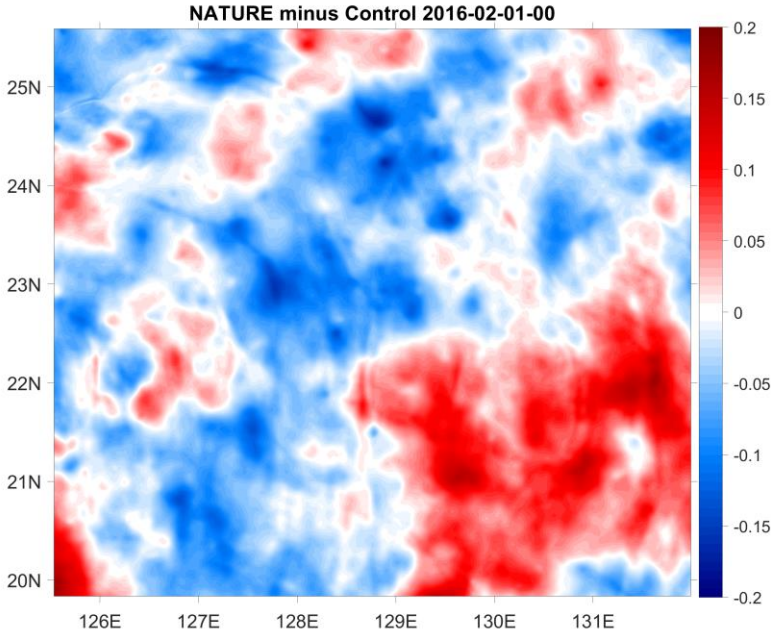
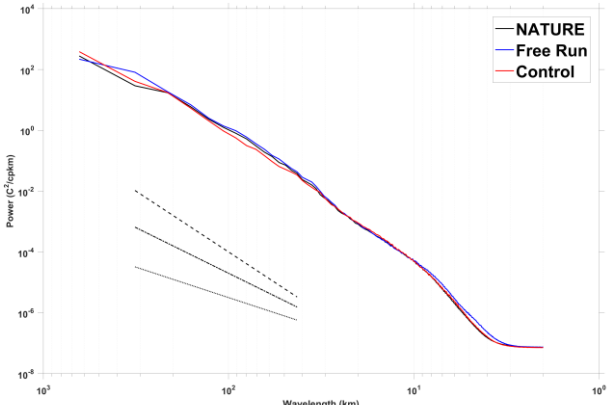
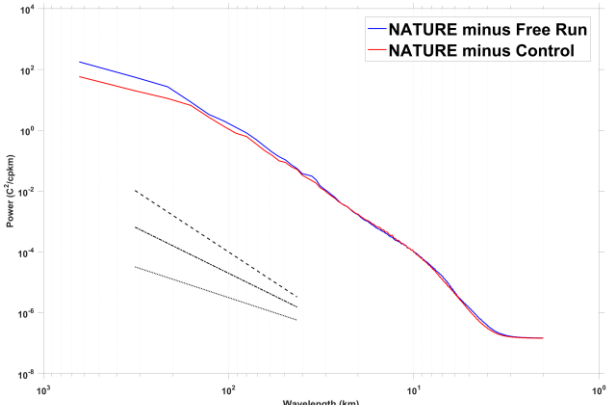
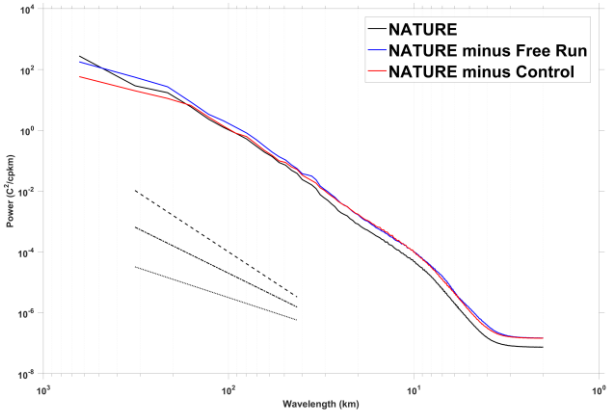
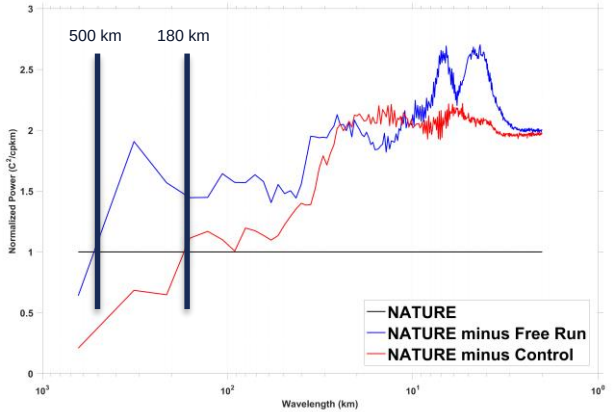




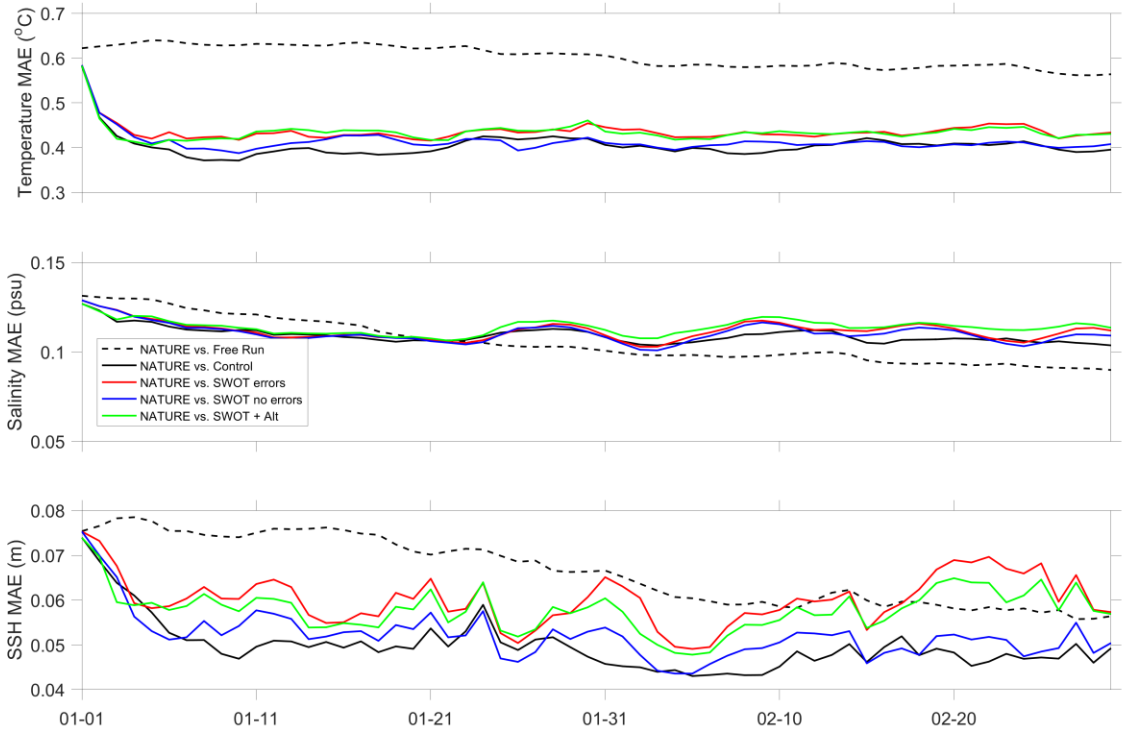

NATURE
Free Run
Control
Power (C²/cpkm)
Wavelength (km)


NATURE minus Free Run
NATURE minus Control
Power (C²/cpkm)
Wavelength (km)


NATURE
NATURE minus Free Run
NATURE minus Control
Power (C²/cpkm)
Wavelength (km)


500 km
180 km
NATURE
NATURE minus Free Run
NATURE minus Control
Normalized Power (C²/cpkm)
Wavelength (km)

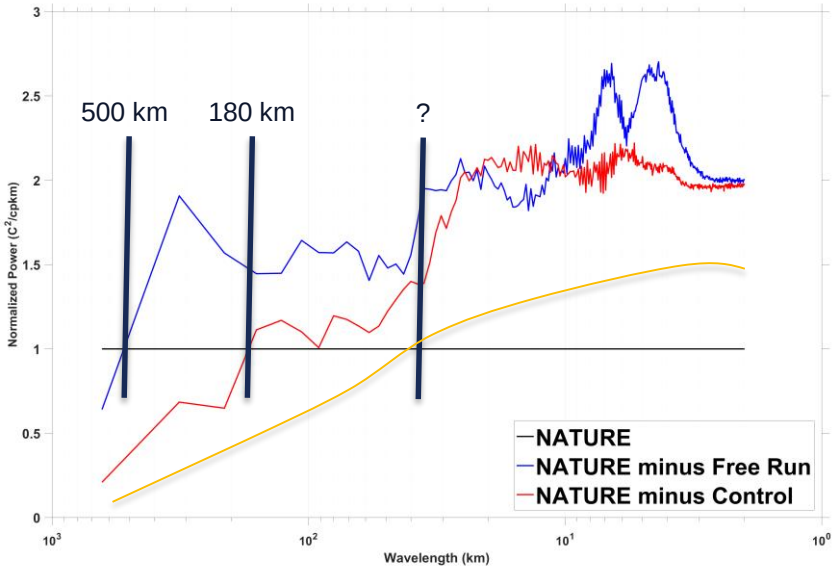
Error Comparison 00z (Analysis Time)



Conclusions

- An OSSE has been constructed to test operational capabilities in a submesoscale permitting numerical model.
- Assimilation of observations of the 'truth' using current observation systems proved effective at reducing errors and constrained spatial scales were quantified.
- SWOT data has been handed to the operational 3DVAR system…
- But initial results proved spurious. Investigations as to why are underway.
- **Moving forward: Properly implementing the SWOT data, how much further can we reduce errors? What is the minimum wavelength we can constrain?**

How low can we go?



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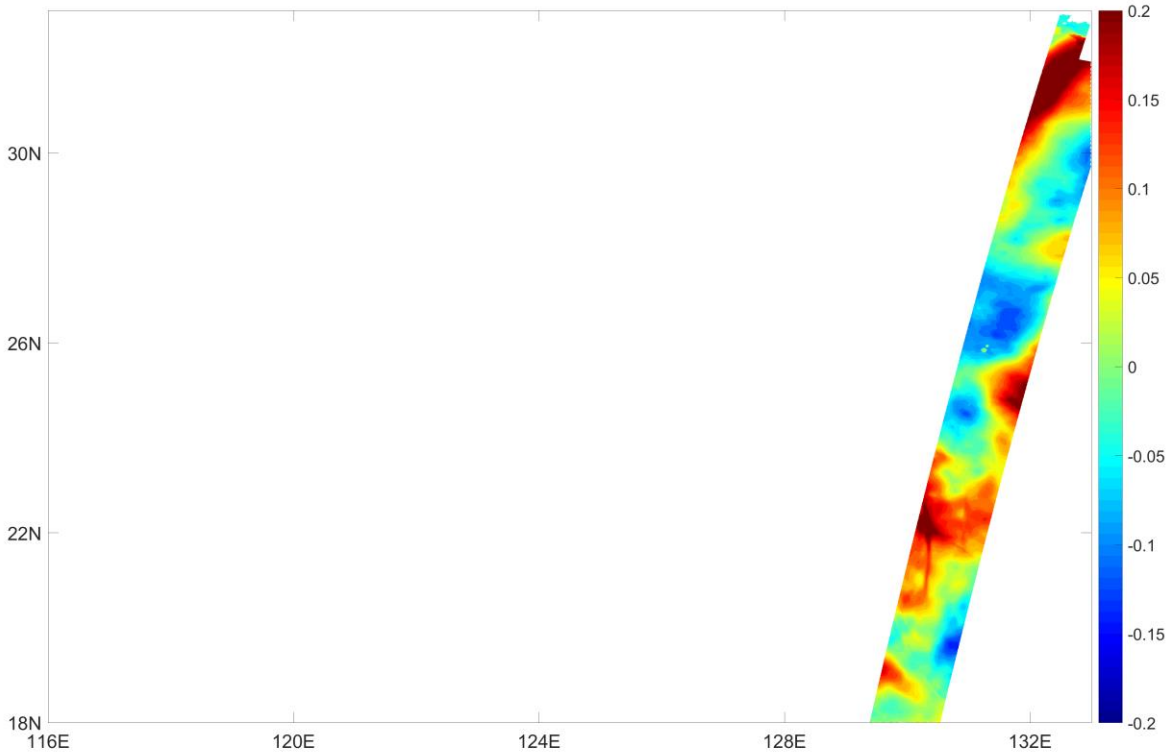

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