Ocean Data Assimilation Towards Submesoscales

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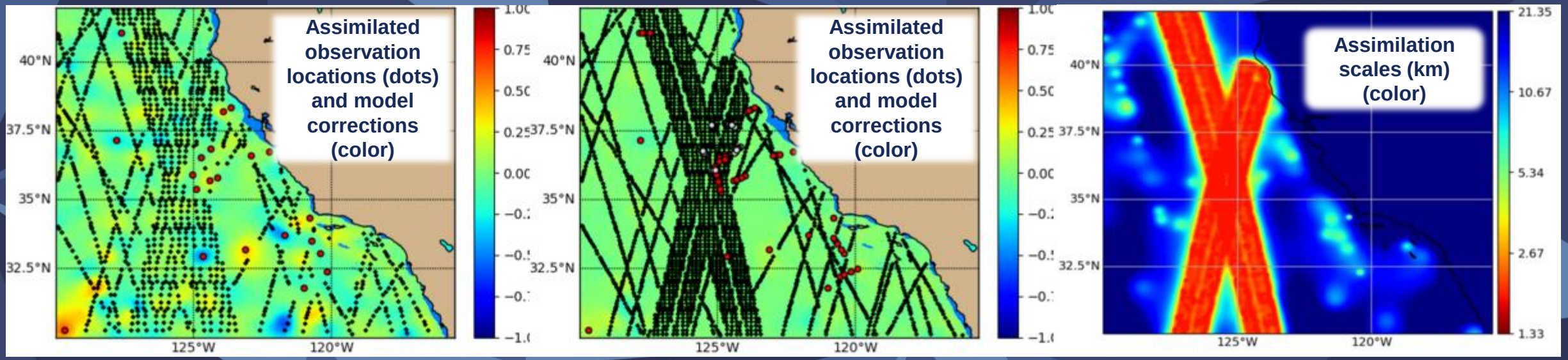
Standard Assimilation | **Variable Scales** | **SWOT variable scales**



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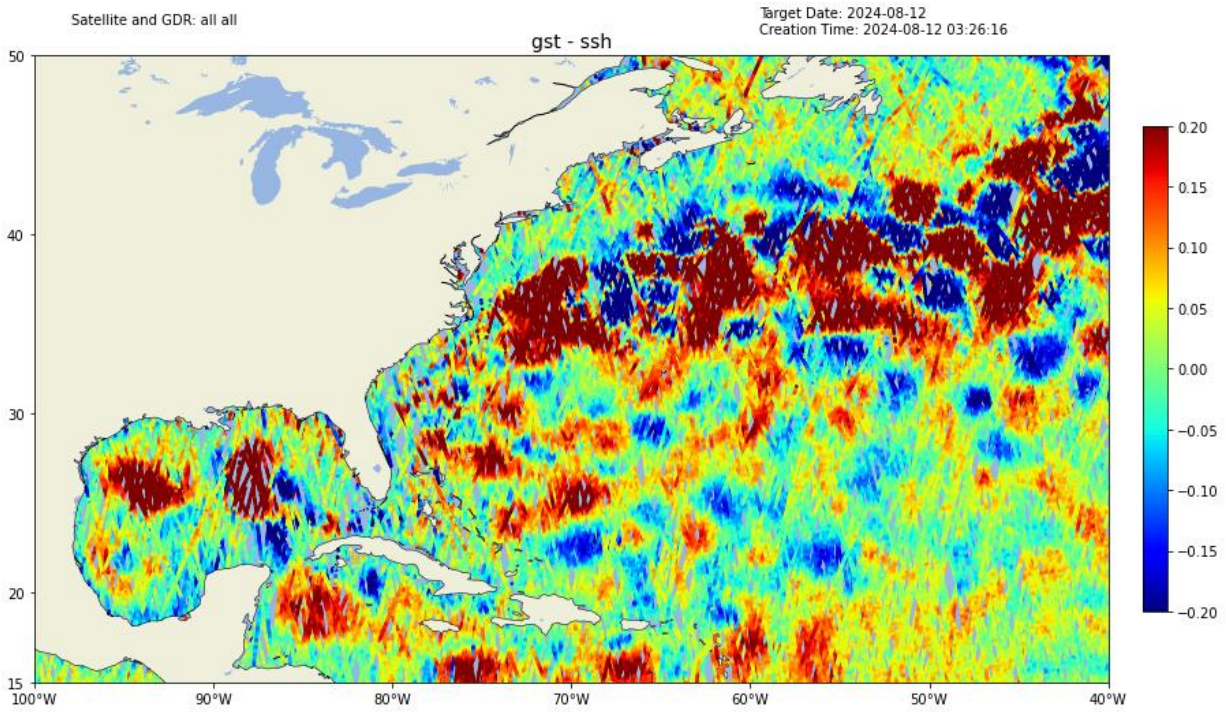
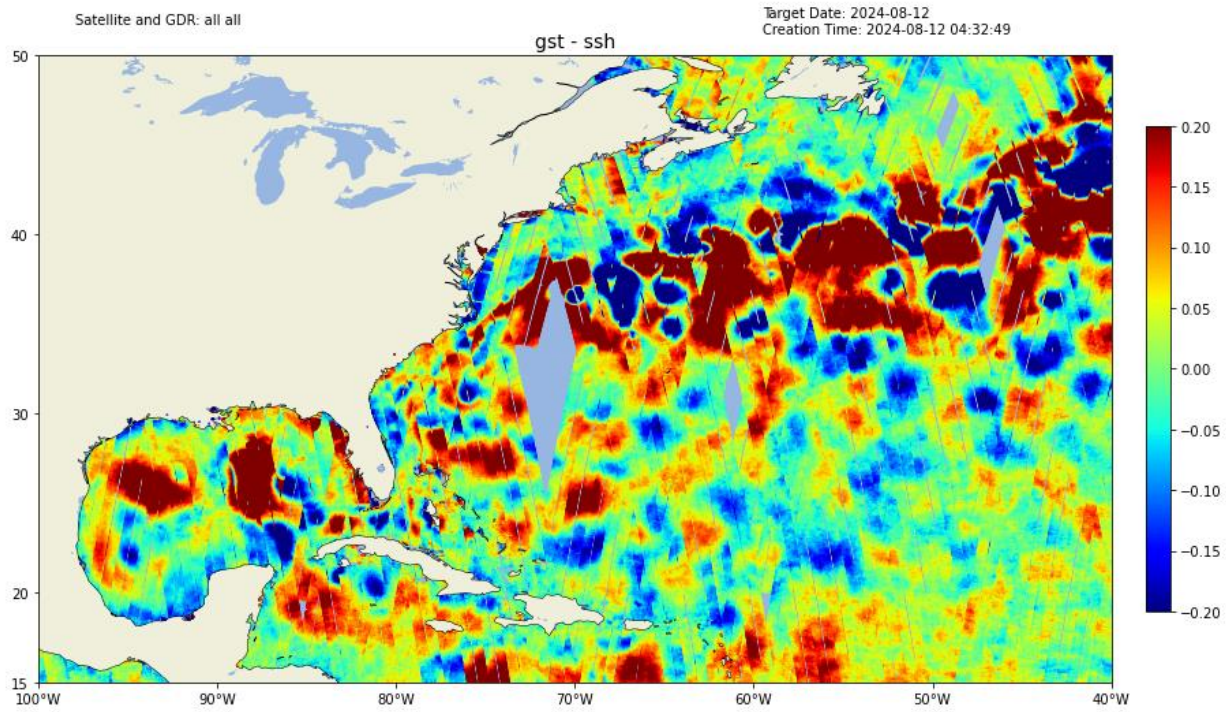
Introduction

Legacy nadir altimetry – 1D



New SWOT – 2D



In order to simultaneously correct the large- and small-scales in the SWOT observations, we need **multi-scale** data assimilation

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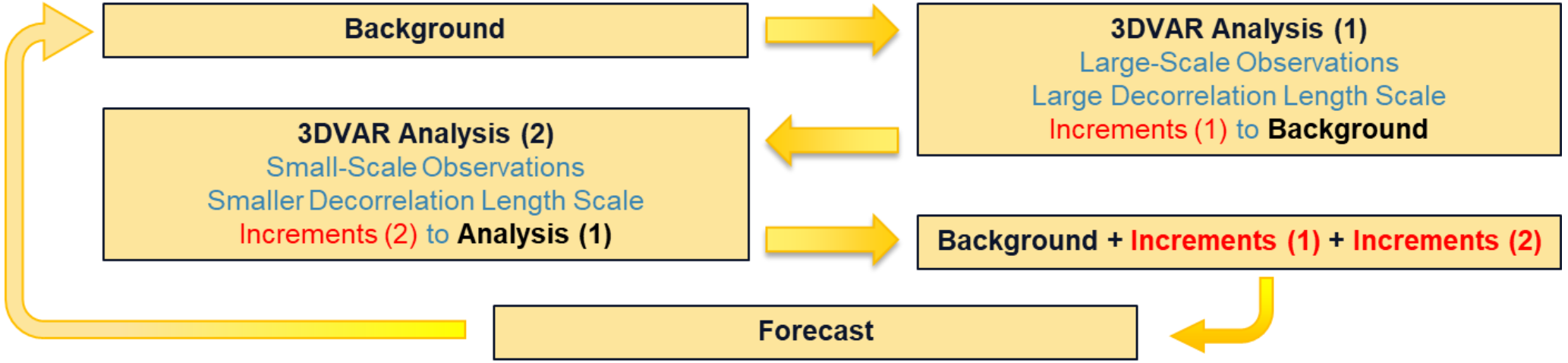
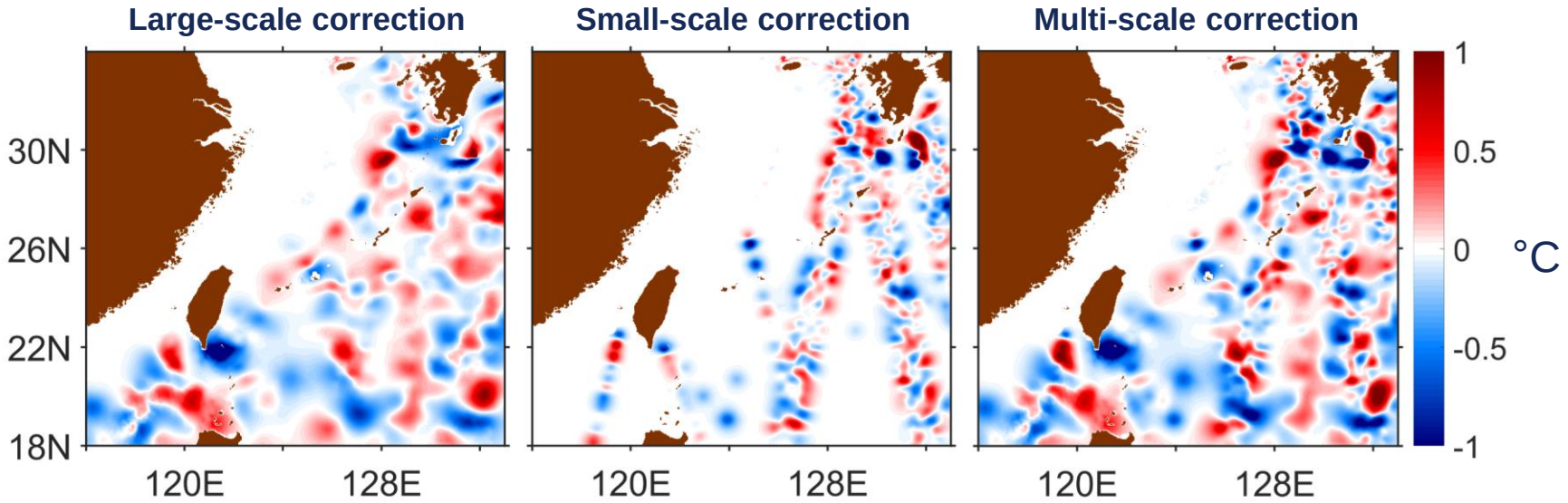
Two-Step Multi-Scale





Souopgui et al., 2020

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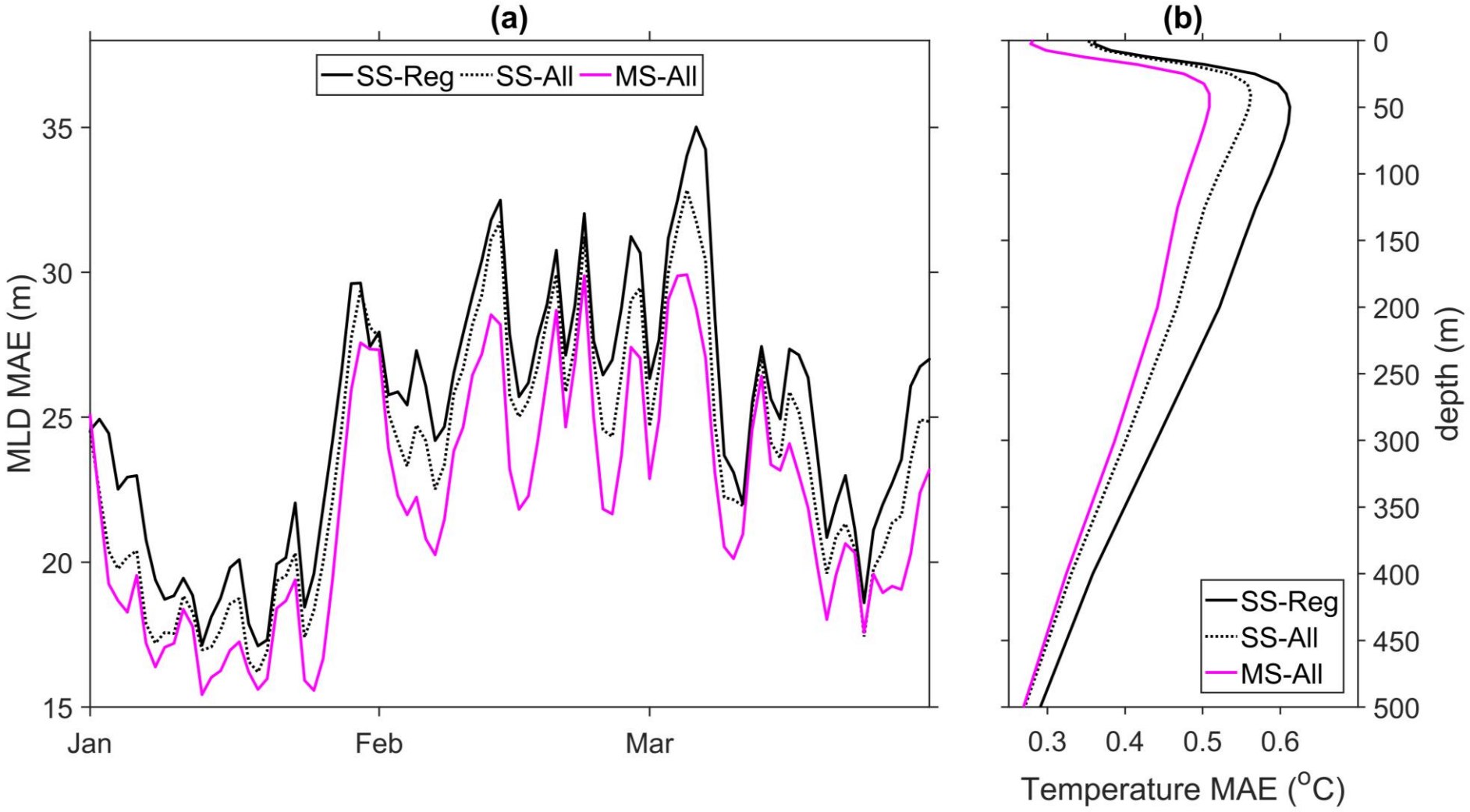
Two-Step Multi-Scale



SS-Reg = Single-scale, no SWOT

SS-All = Single-scale, with SWOT

MS-All = Multi-scale, with SWOT

Souopgui et al., 2020

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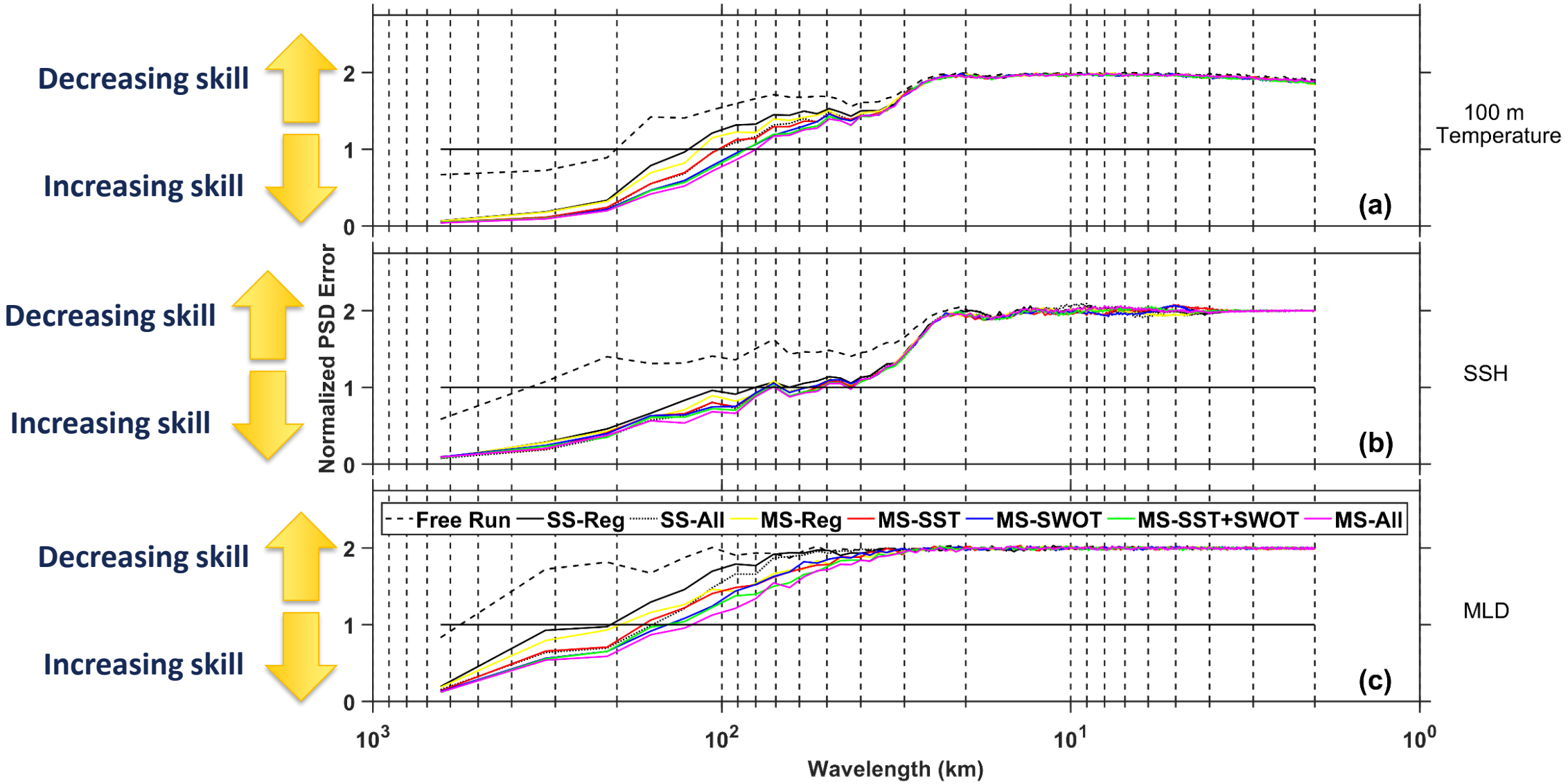
Two-Step Multi-Scale



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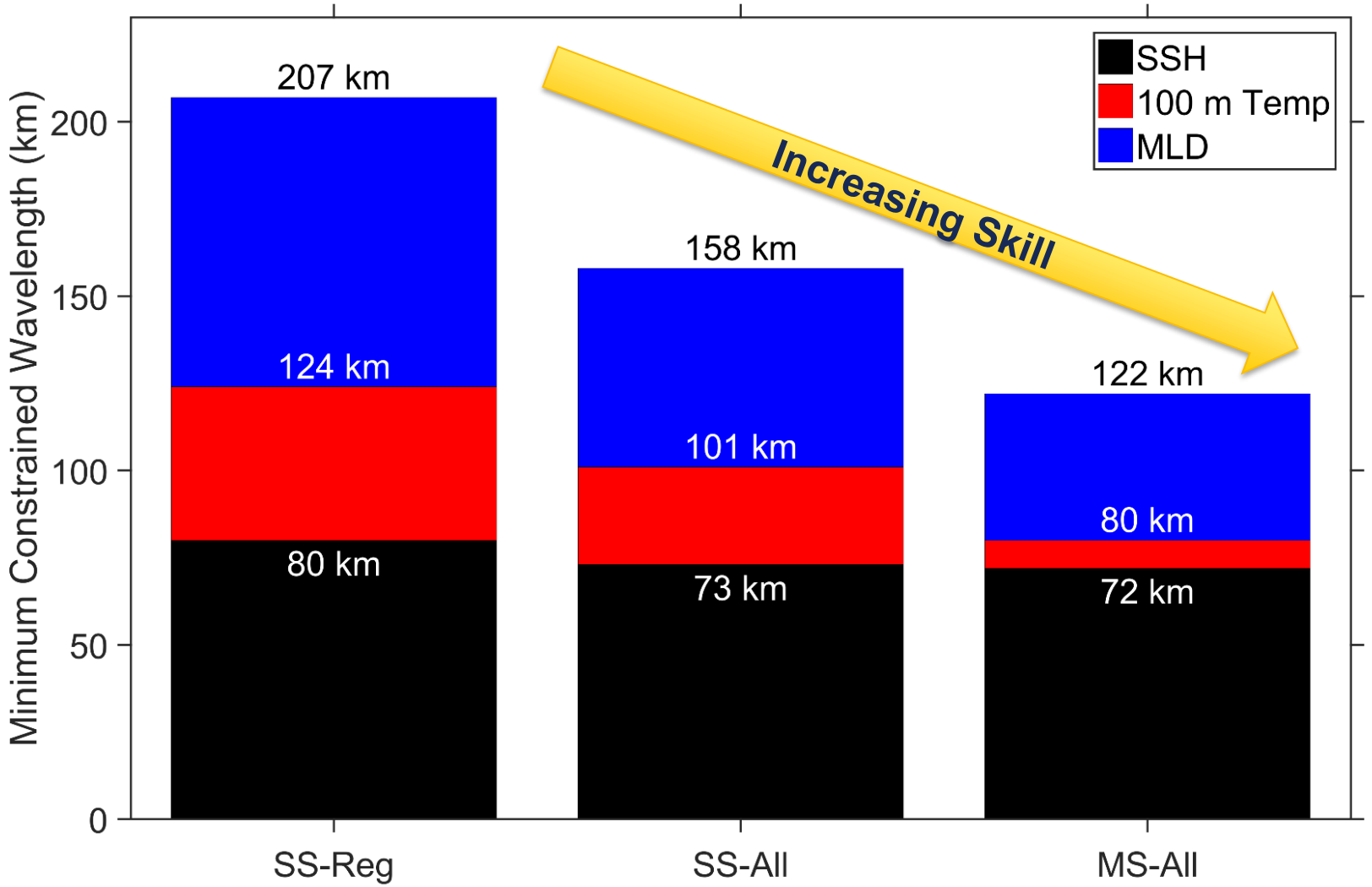
Two-Step Multi-Scale



SS-Reg = Single-scale, no SWOT

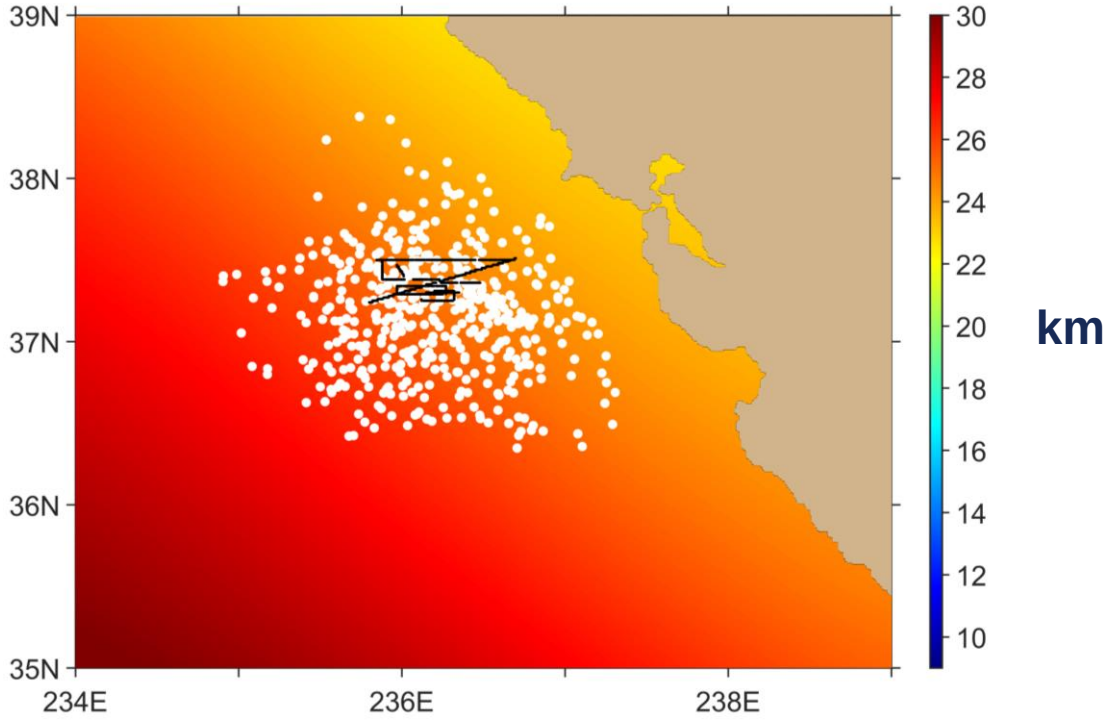
SS-All = Single-scale, with SWOT

MS-All = Multi-scale, with SWOT

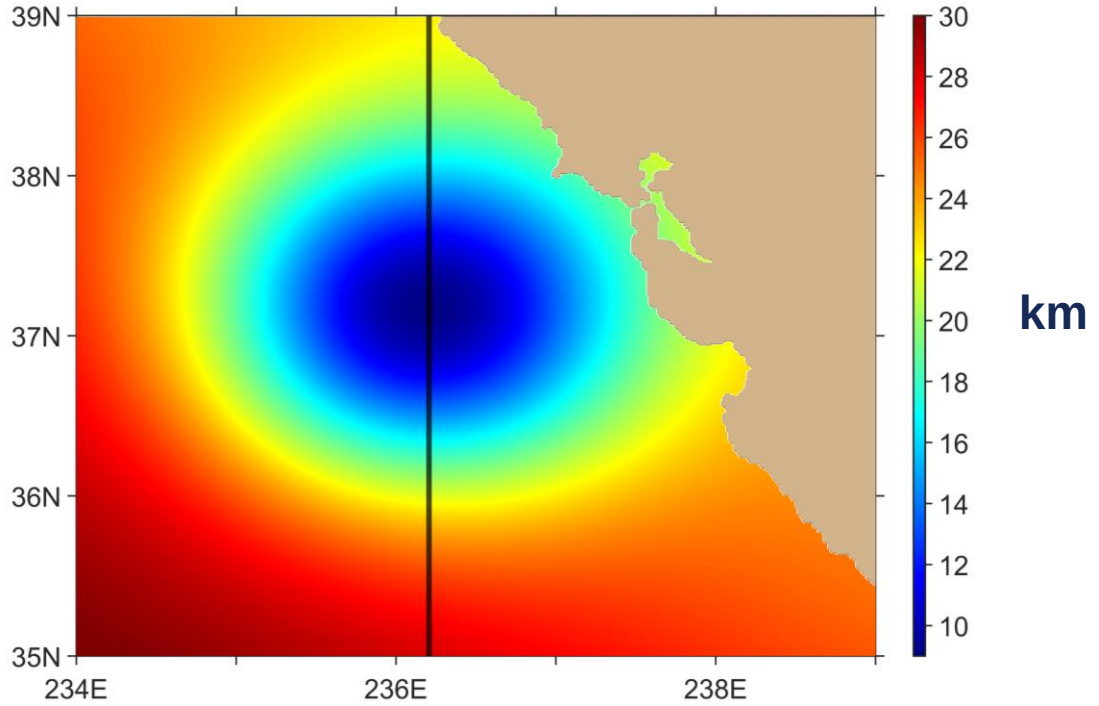
Souopgui et al., 2020

Variable Scales

Standard Single-Scale Assimilation



Variable Scale Assimilation



We reduced the horizontal scales of the assimilation where high-resolution glider observations were concentrated.

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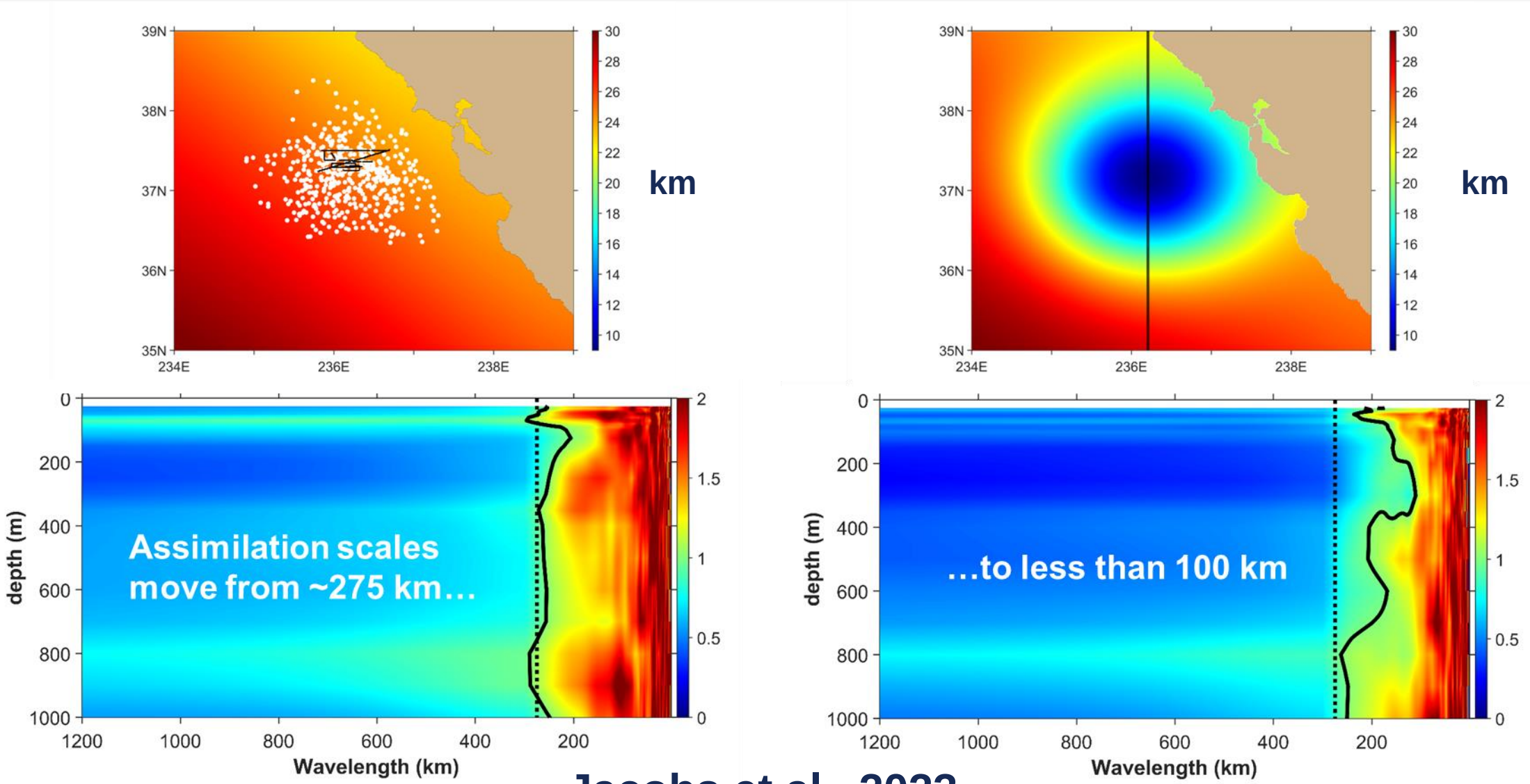
Variable Scales



Jacobs et al., 2023

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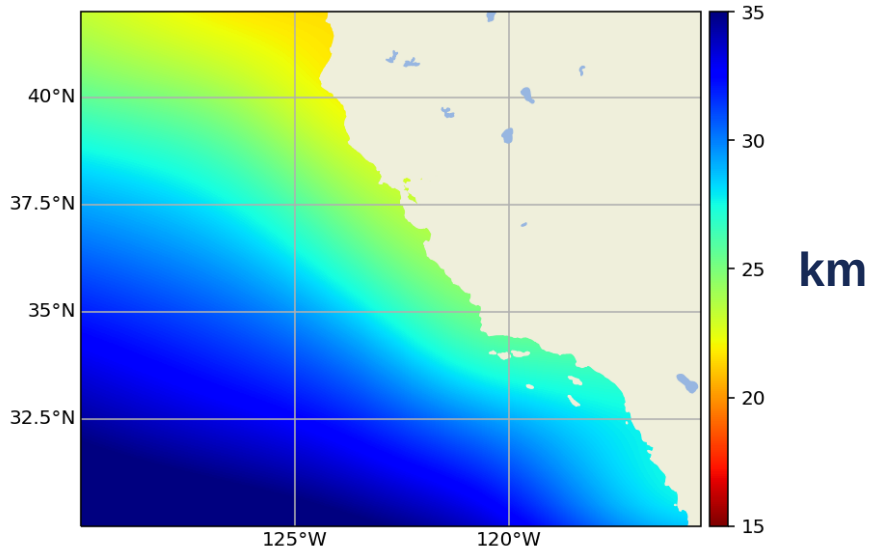
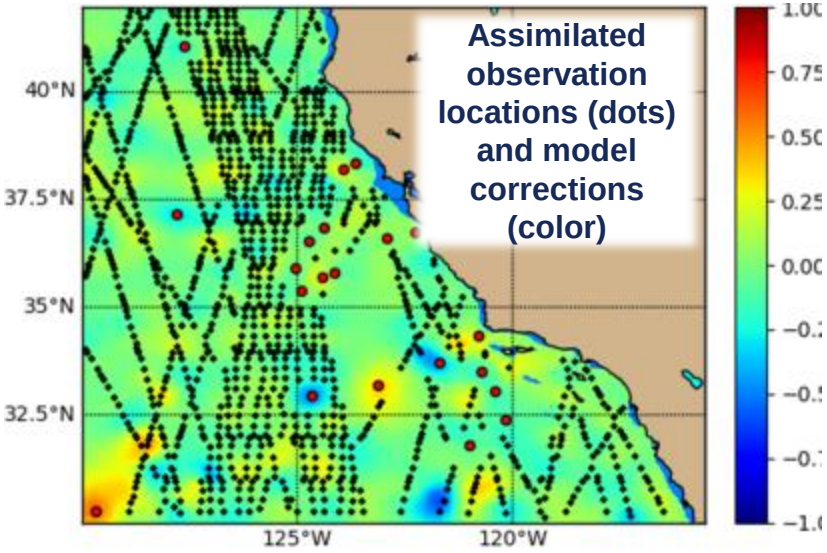
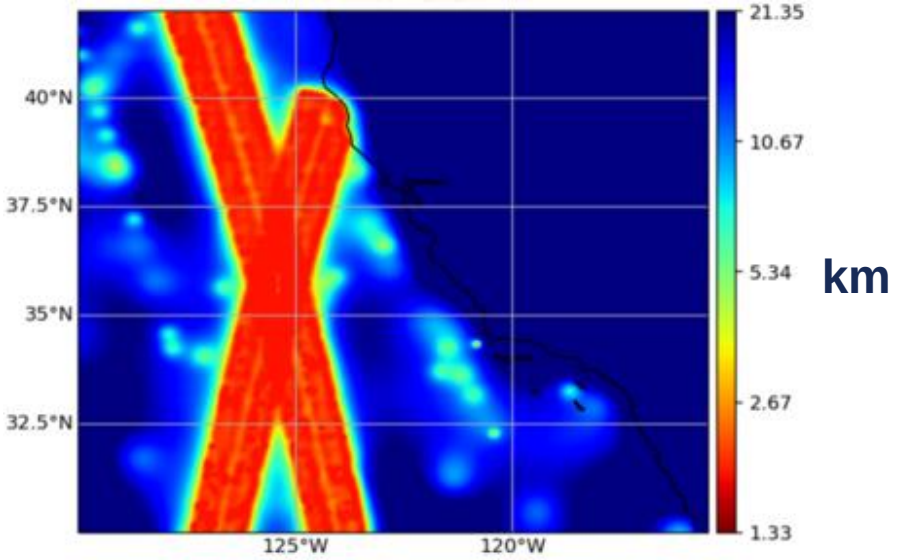
Variable Scales

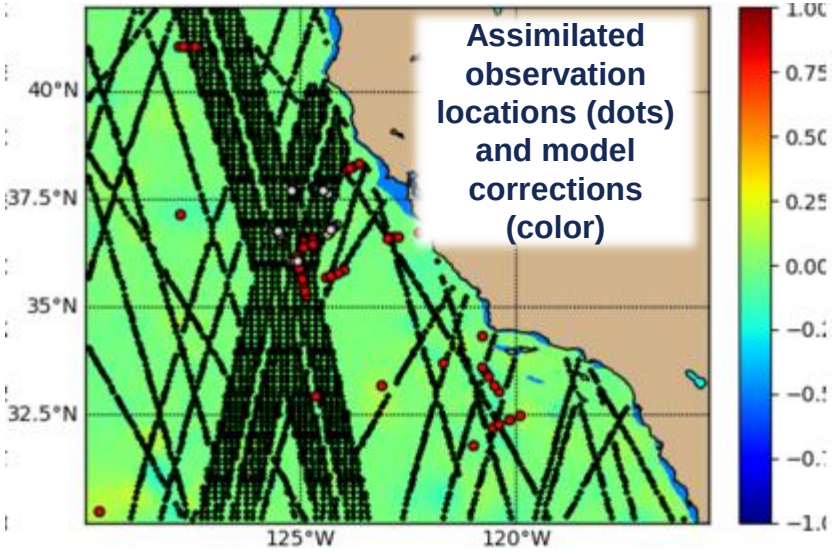
Standard Assimilation





Variable Scale Assimilation





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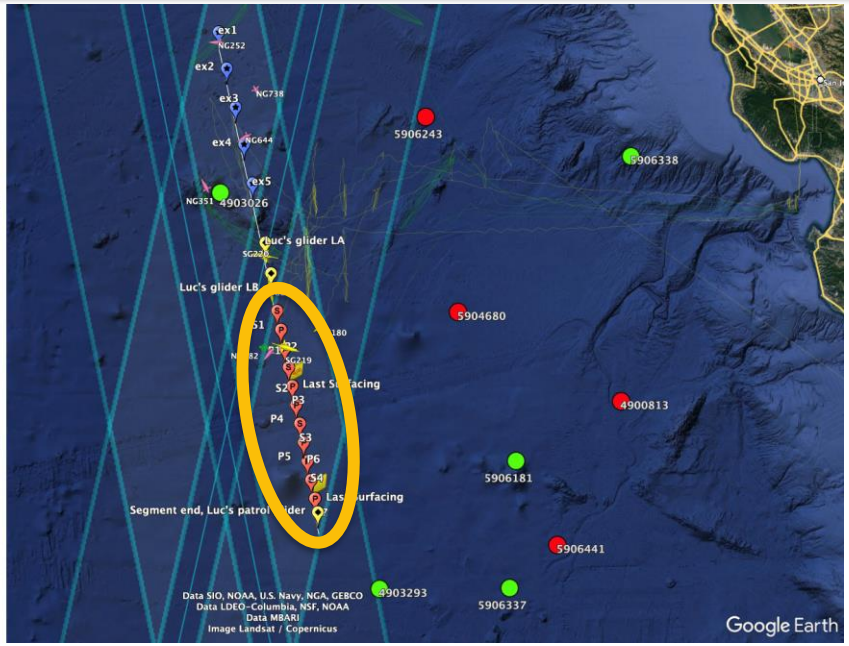
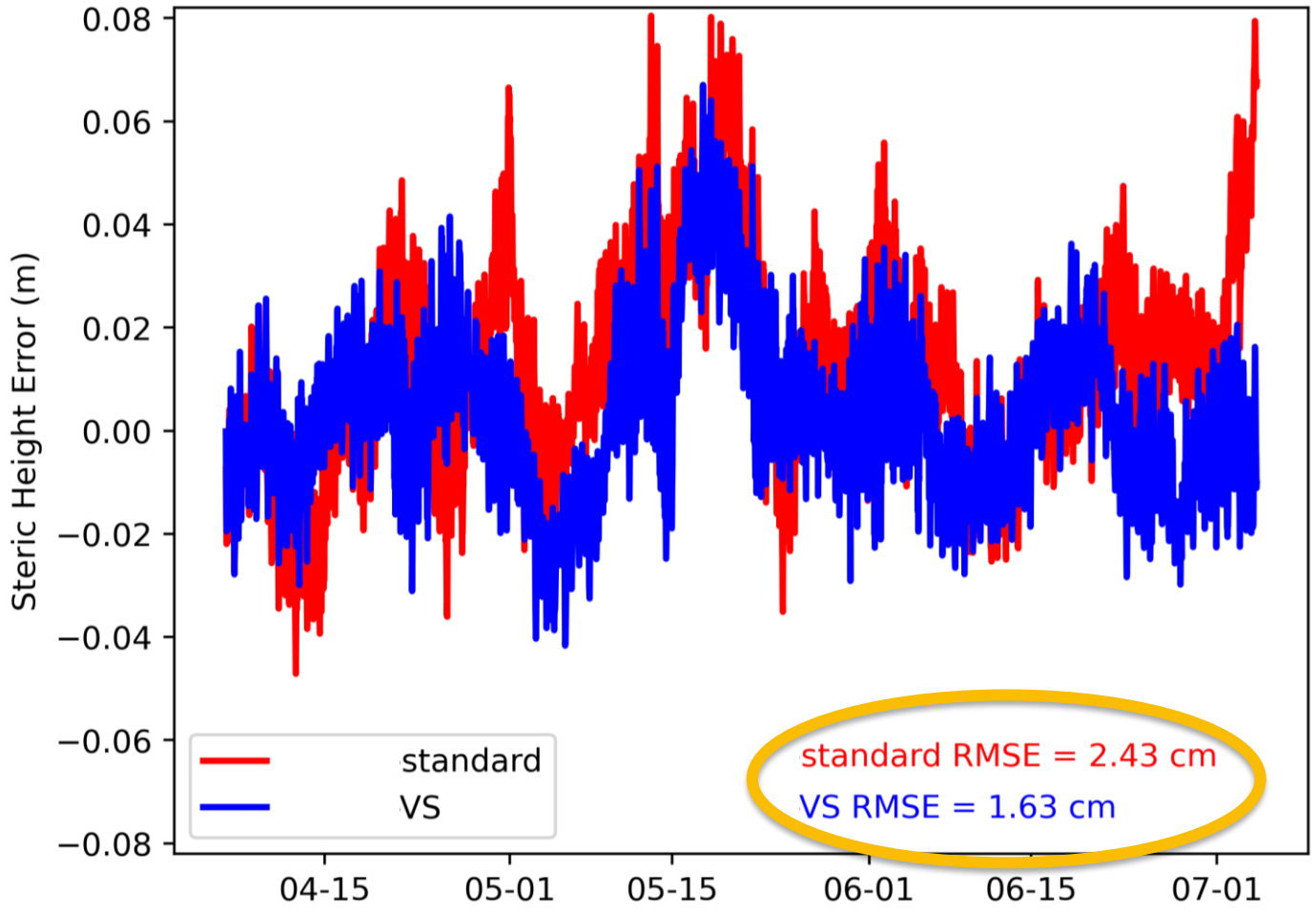
Variable Scales

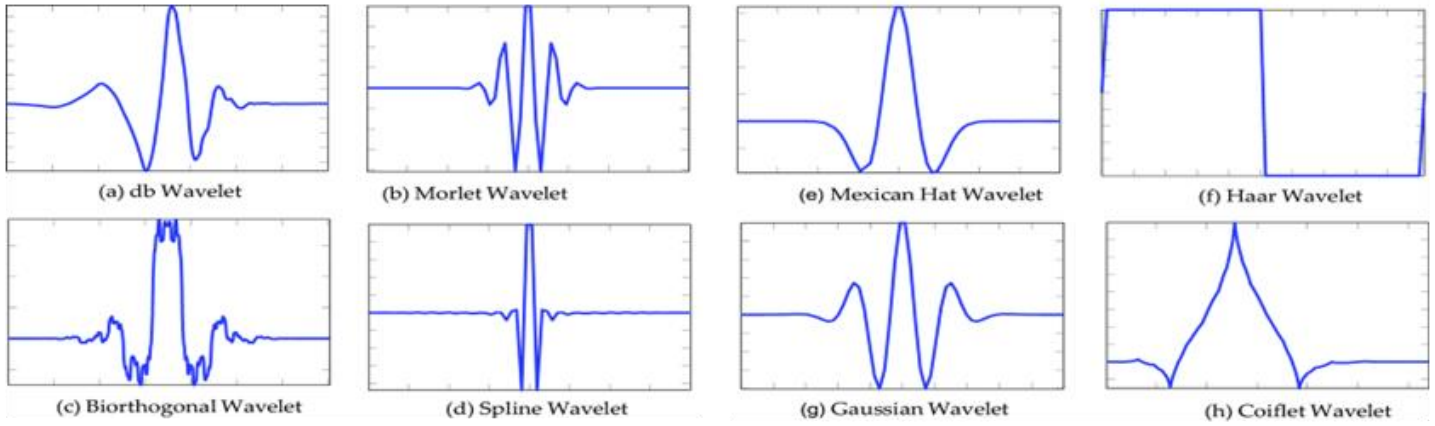
- Argo floats
- 2 Rutgers gliders
- 3 PIES under S moorings
- 4 UW gliders
- 4 SIO deep moorings
- 5 NAVO gliders
- 7 NOAA/PMEL moorings
- Numerous drifters (not shown)





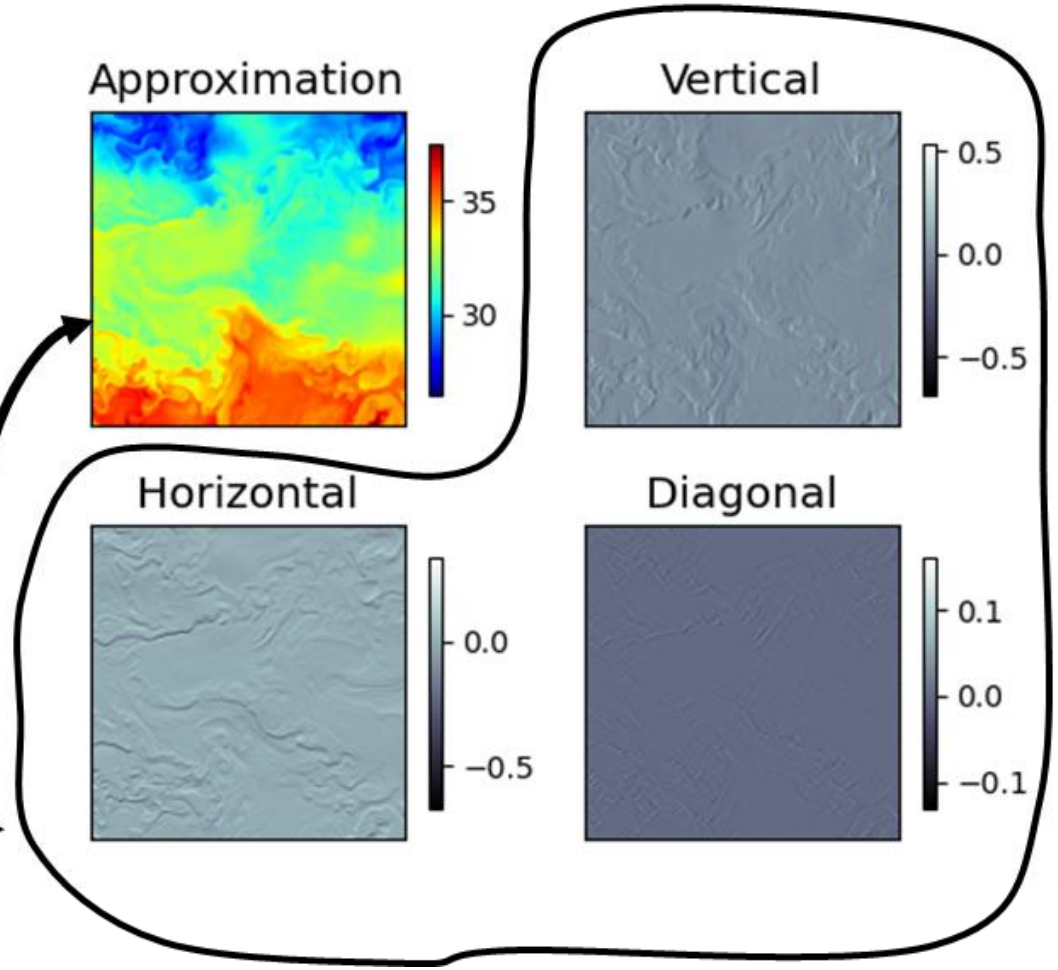
Variables scales assimilation has 55% less error variance when compared to standard assimilation

Wavelets



- Wavelets are composed of different basis functions convolved over a signal to separate that signal into frequency/wavelength components.

- The wavelet decomposition produces:
  1. Approximation (low-pass filter)
  2. Details (high-pass-filter)



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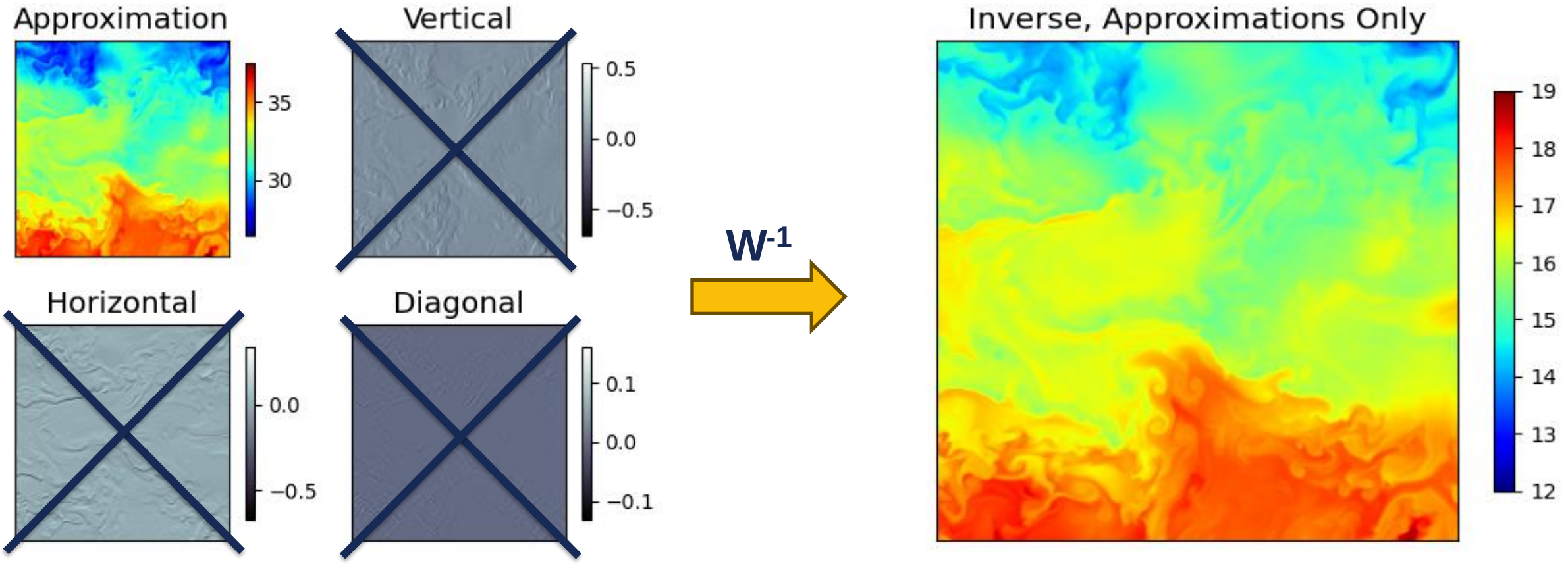
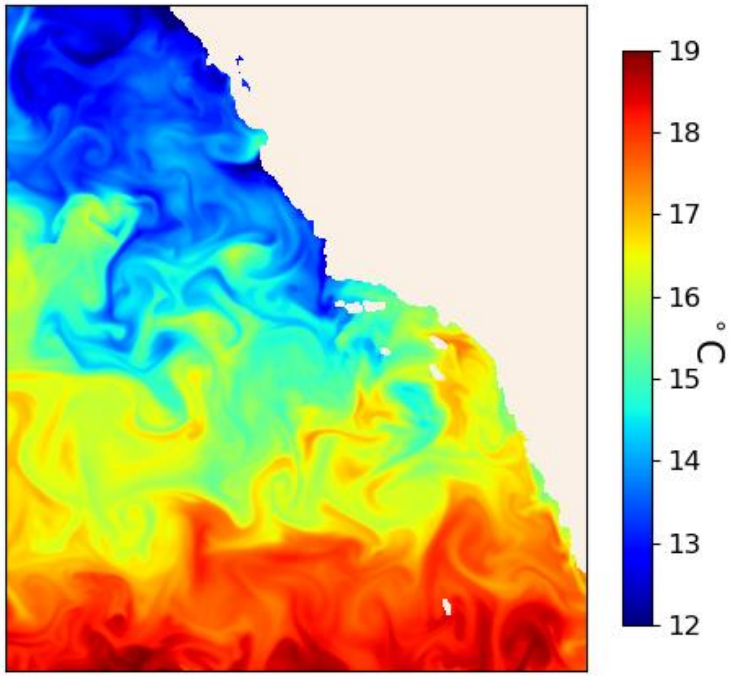
Wavelets



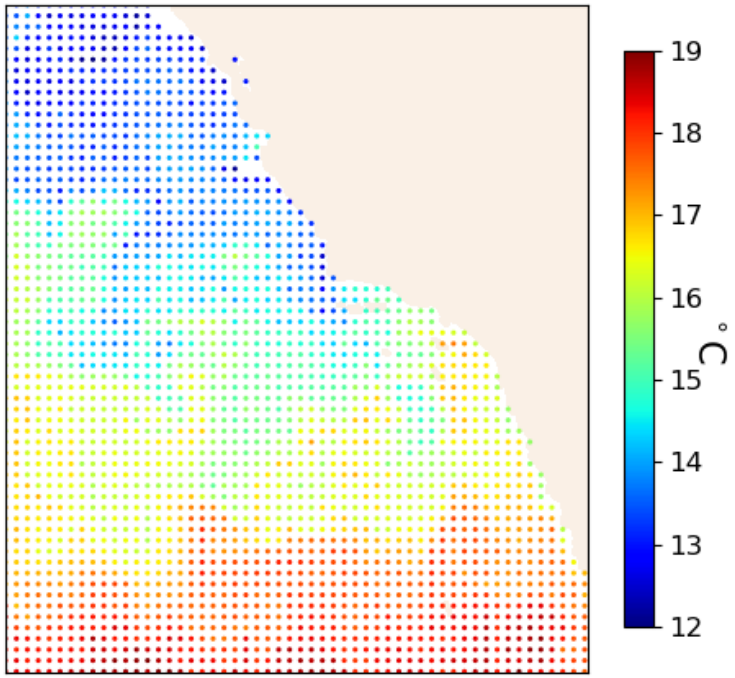
Thresholding allows us to control the wavelengths retained in the wavelet assimilation process

Overall effect is the ability to assimilate a much denser set of observations in a single assimilation step

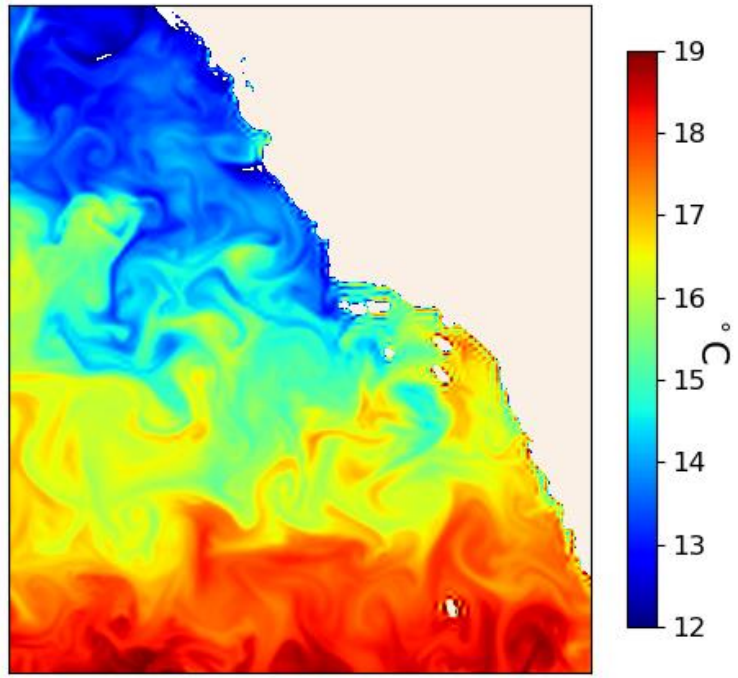
SST Observations



Super Observations



Wavelet



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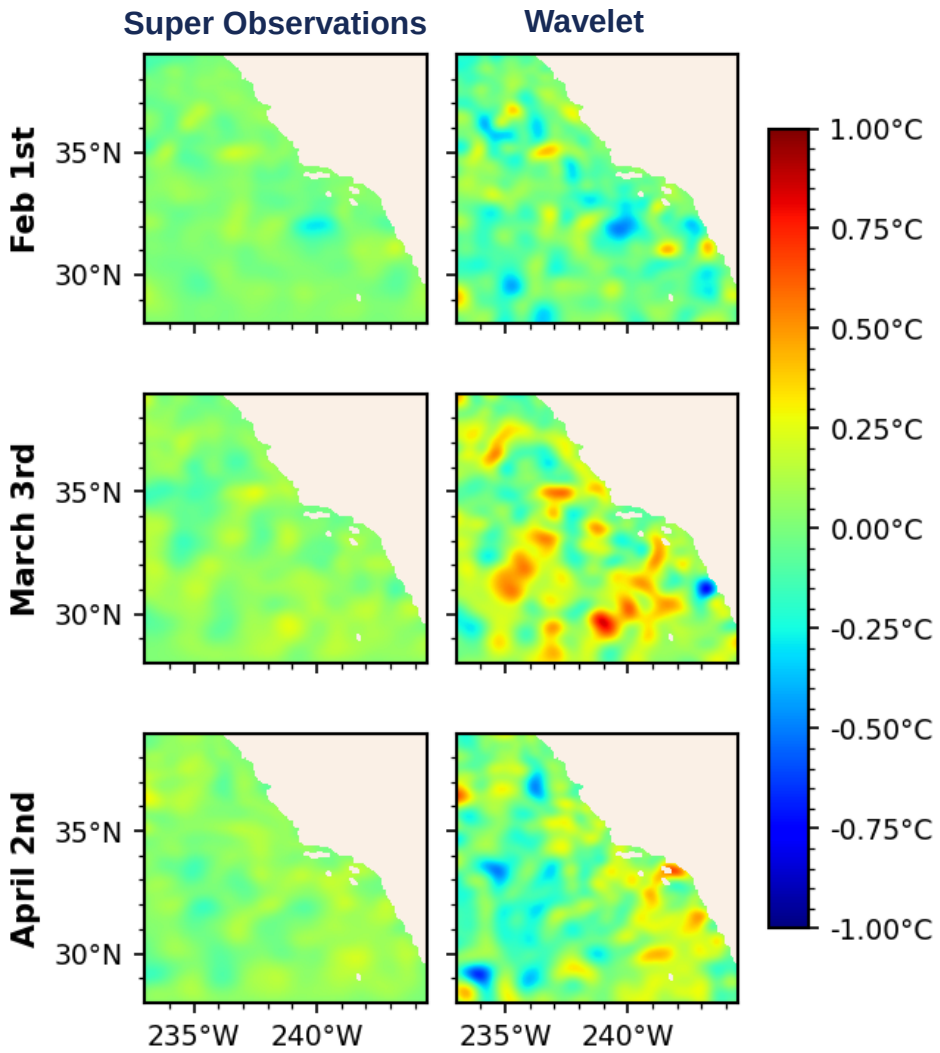
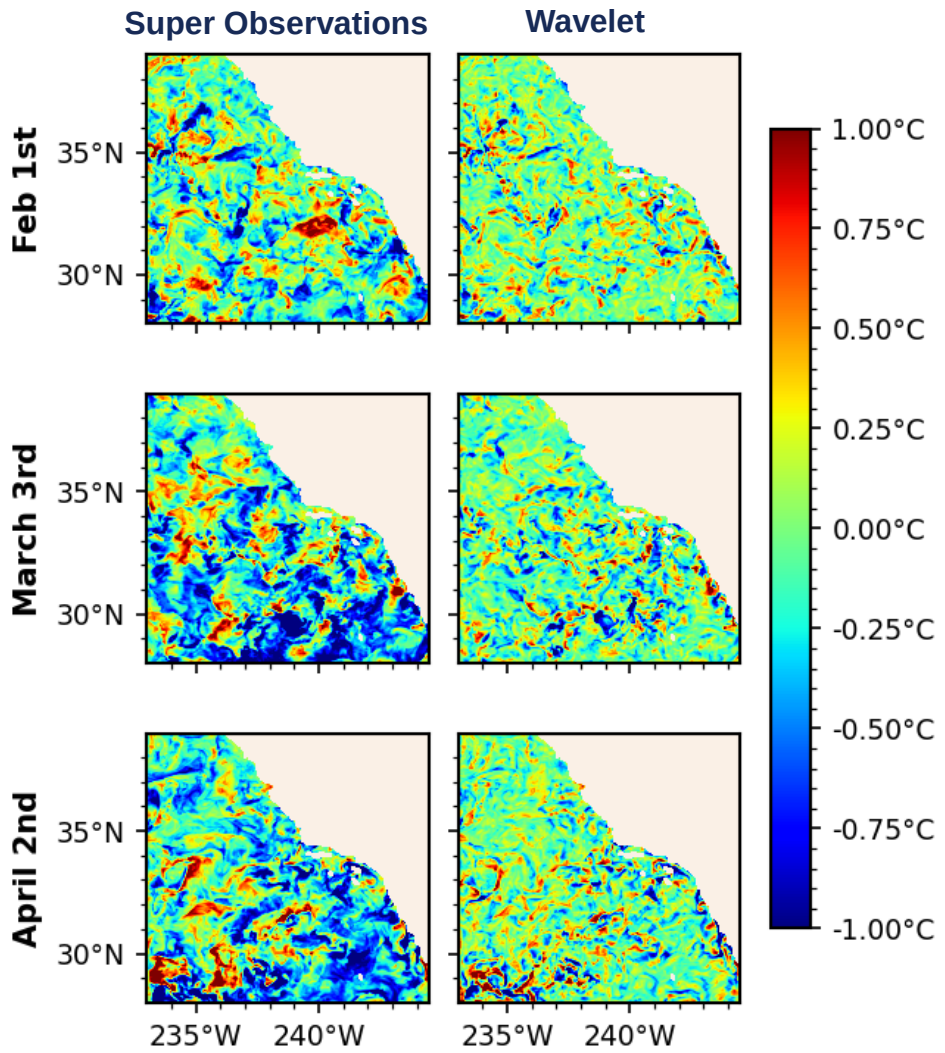
Wavelets

SST increments

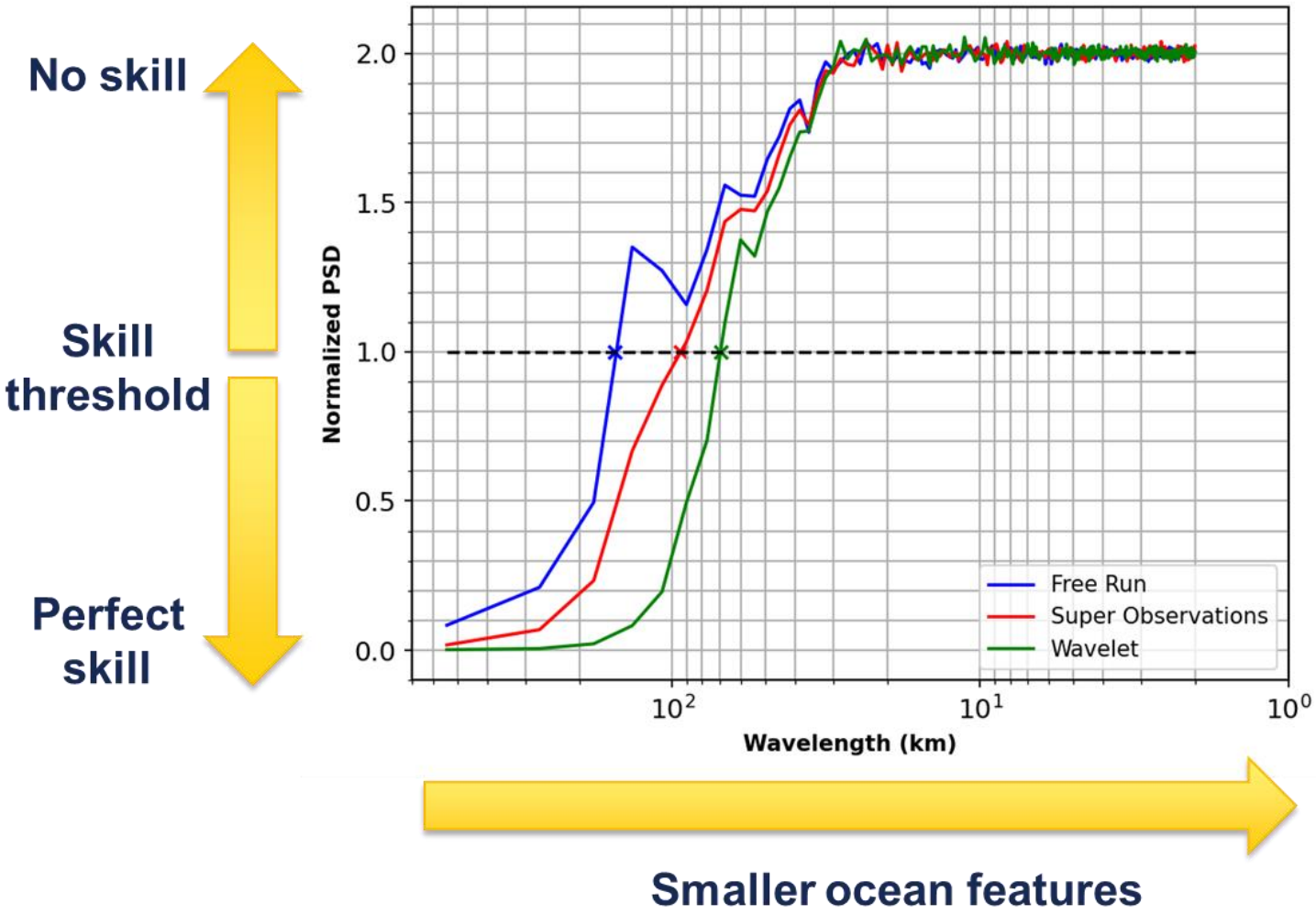


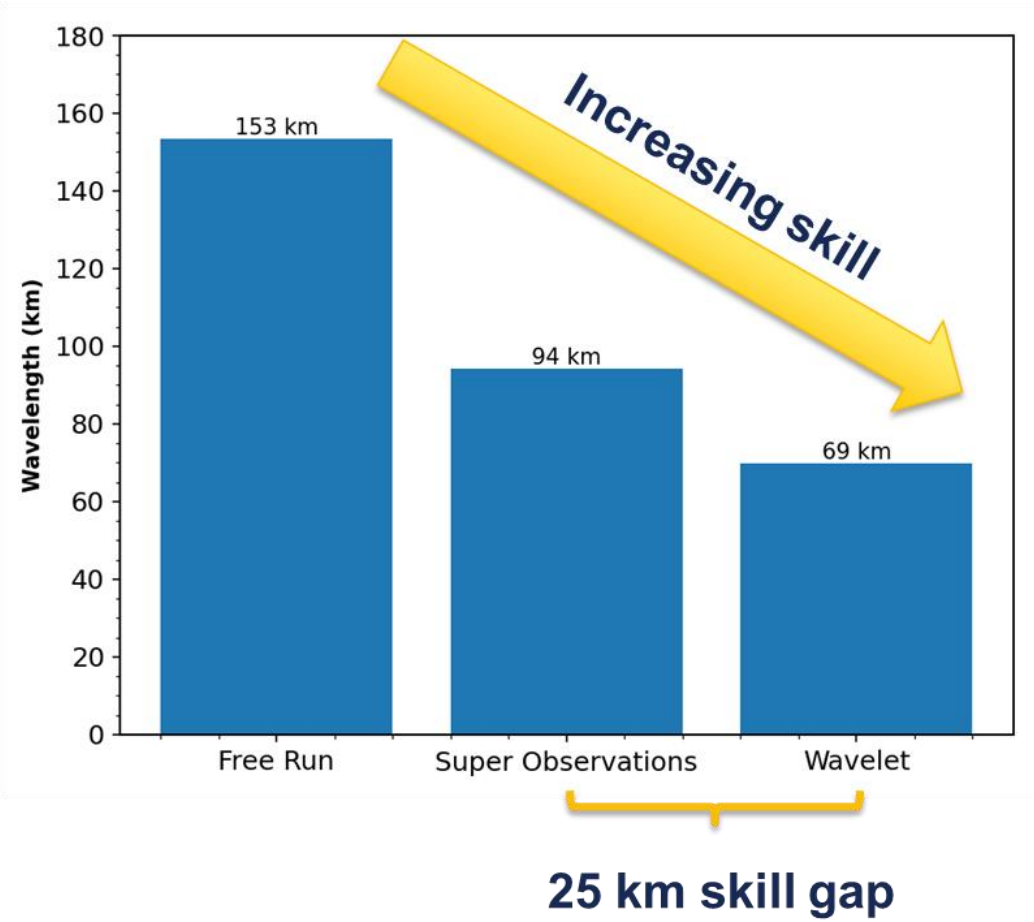
SST errors



Wavelets

Sciacca et al., 2024





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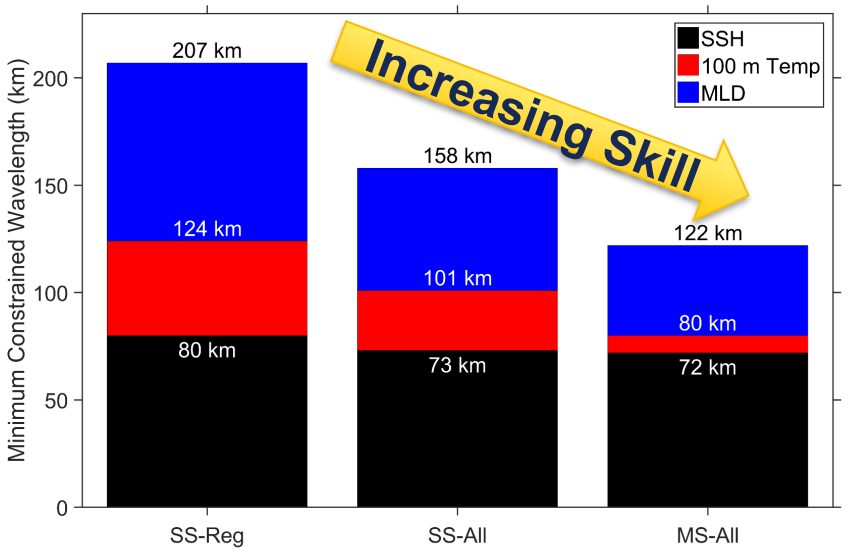
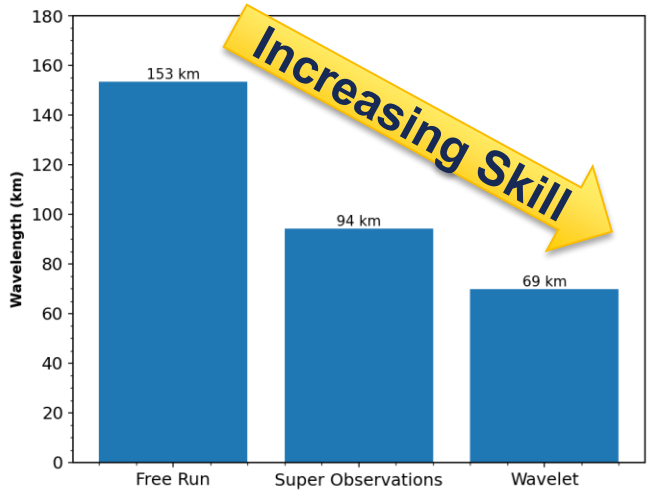
Summary

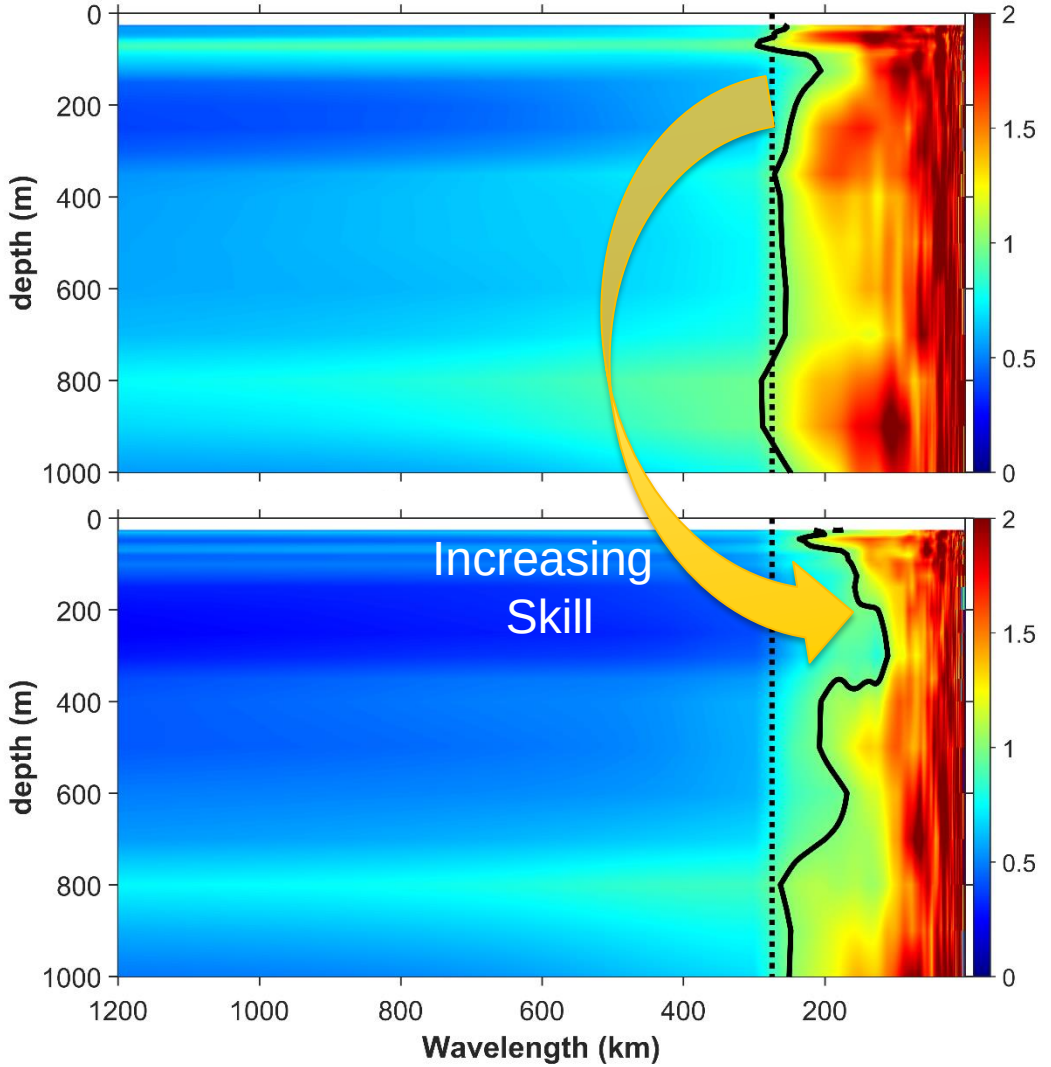
Two-Step Multi-Scale





Wavelets

Variable Scales



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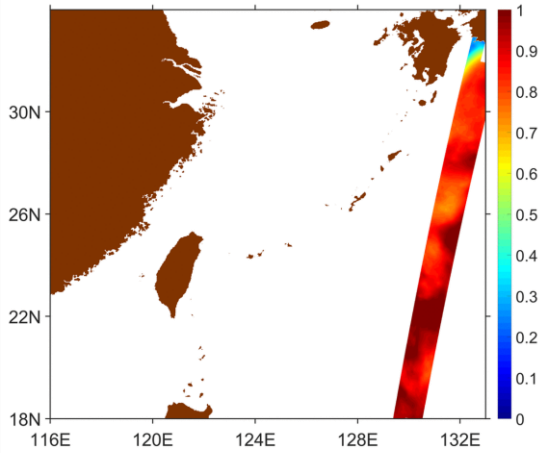

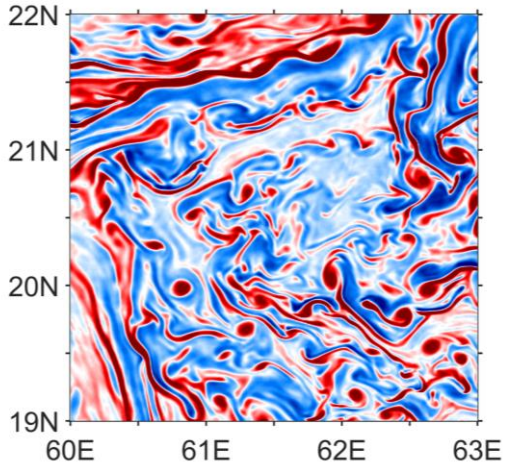

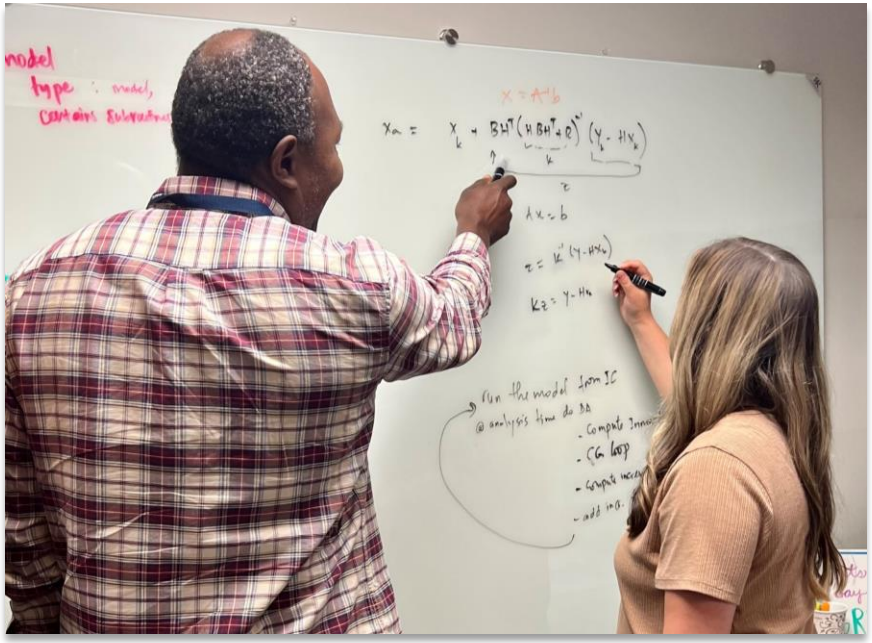

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