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GOES-R3 Dynamics: Estimating Sea Surface Velocity from Sequential GOES SST Part I, Image Analysis

Overall Project Goal:

Evaluate two types of estimates of Sea Surface Velocity (SSV) from sequential Sea Surface Temperature (SST) fields:
1) Image Analysis Techniques – Part I (This poster).
2) Data Assimilative Coastal Ocean Modeling – Part II (See the Part II poster).

Accomplishments:

Methods that estimate displacement of SST features have been evaluated, using the SST and SSV vectors from a 1-km resolution coastal ocean model.

Ocean surface velocities are derived using two types of "feature tracking" (similar to cloud motion estimates). Both methods are tested under cloudless, ideal conditions using sequences of realistic, high-resolution (1 km grid spacing) SST and SSV fields from a coastal circulation model, allowing simulations of SST fields from GOES, GOES-R, AVHRR and MODIS sensors.

Frontal Displacements: Methods such as the Horn-Schunk (HS) optical flow algorithm (Horn and Schunk, 1981; Kesrarat and Patanavijit, 2011) calculate the movement of gradients and fronts between image pairs (Figure 1, below). Vectors are often found "perpendicular to fronts".

Horn-Schunk Analysis on Model-SST fields along the Oregon coast

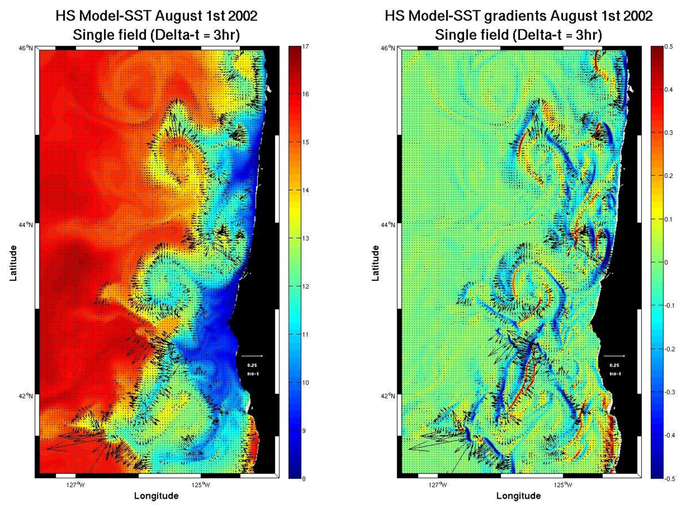

Figure 1: Sea surface velocity (SSV) fields derived from HS approach, using model outputs along the Oregon coast, applied to a single field with delta-t = 3 hr. Arrows represent velocity vectors on background SST (left panel) and gradient magnitude (right panel).

MCC: The Maximum Cross Correlation method (Emery et al. 1986; Kelly and Strub 1992; Mathews and Emery 2008) estimates linear displacements of small areas of SST features between two sequential images (Figure 2, to the right). *To date, this is the most successful method, producing more dynamically realistic vectors "along fronts".*

Other Methods Tested (not shown): Minimum Quadratic Differences; Particle Image Velocity Distribution; and Hierarchical Search Algorithms.

Accomplishments anticipated at end of year 2:

We will simulate the pixel size of cloud-free GOES and GOES-R fields, comparing results to GOES data from periods that are relatively cloudless. An evaluation of the error characteristics of the SSV fields will be completed for these optimal conditions.

Initial feedback from potential users:

See the Part II poster for the positive feedback we have received from fishers on the data assimilating model fields. The same users will evaluate the feature-tracking velocities.

What could be accomplished with a 3rd year of funding:

-Extend the evaluation to include data loss due to clouds (simulated and real)
-Run an experimental test of real-time fields, posting the fields on the NANOOS Visualization System to receive feedback from the same potential users who are evaluating the model fields.

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Maximum Cross Correlation (MCC) Velocity Analysis along the Oregon coast: August 1, 2002

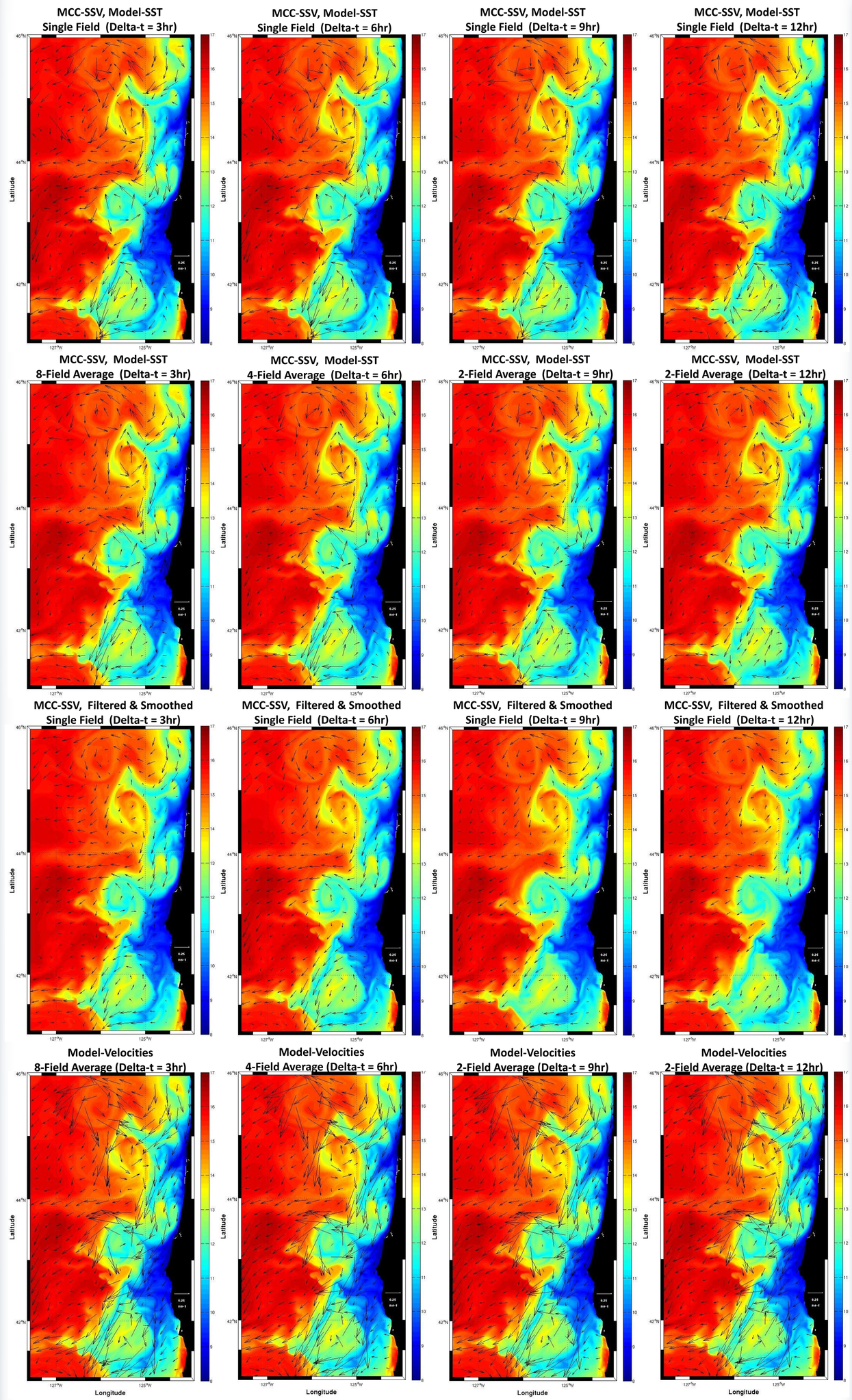

Figure 2: Sea surface velocity (SSV) fields derived from MCC approach, with SST as background:
1st row: MCC "single" fields using delta-t of 3, 6, 9 and 12 hours (left to right).
2nd row: MCC average for 24 hr period, using 8, 4, 2 and 2 fields (Delta-t = 3, 6 9 and 12 hr, respectively from left to right).
3rd row: MCC "single" fields (using same delta-t as 1st row, after apply spatial filter and smoothing.
4th row: Model-derived SSV fields (Comparable to 2nd road).