6.3730 PSet 5 Part 1

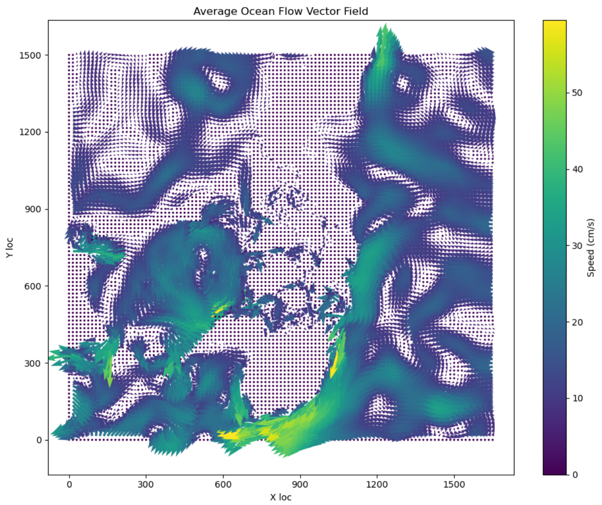
Stephen Andrews

April 26, 2025

5.1

a)

Our visualization of average flow is shown below:



The locations with the 10 highest flows are here:

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Top 10 highest-flow locations:
 1. (54km, 762km): u=-61.1255, v=-15.1715, flow=62.9802 cm/s
 2. (51km, 762km): u=-61.1339, v=-14.8087, flow=62.9020 cm/s
 3. (54km, 765km): u=-60.5207, v=-16.1124, flow=62.6288 cm/s
 4. (51km, 759km): u=-61.0141, v=-13.5549, flow=62.5016 cm/s
 5. (51km, 765km): u=-60.4871, v=-15.5990, flow=62.4661 cm/s
 6. (54km, 759km): u=-60.9294, v=-13.7327, flow=62.4578 cm/s
 7. (405km, 1068km): u=-16.6628, v=-60.1305, flow=62.3965 cm/s
 8. (51km, 756km): u=-60.8942, v=-12.3010, flow=62.1242 cm/s
 9. (54km, 756km): u=-60.7332, v=-12.2938, flow=61.9649 cm/s
10. (402km, 1068km): u=-17.0937, v=-59.4559, flow=61.8644 cm/s
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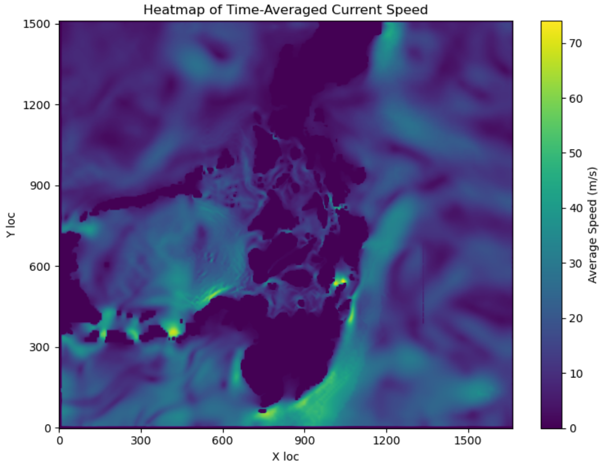
Note that for one particular region of nearby locations, the flow vectors uniformly align in the same direction and show similar magnitudes, reflecting the coherent movement of water within a single current. This consistency is intuitive, since nearby locations of water in a current would travel together.

b)

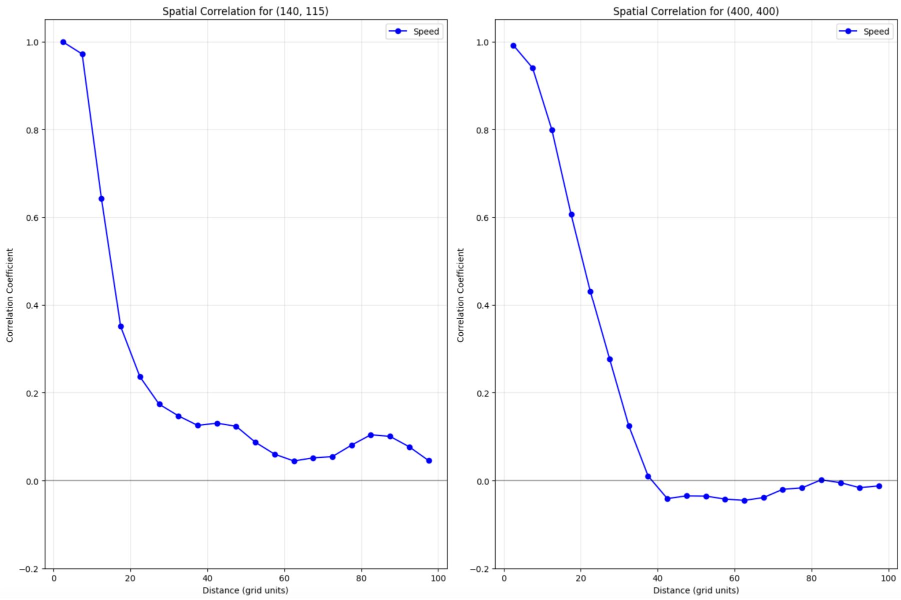
A heatmap for the highest average speed is shown below:



In general the flow and the speed are pretty similar, which makes sense but there are places where there is a discrpancy. More specifically we see areas of high speed and small flow. For example, the circular eddy in the mid-region: the heatmap is bright, indicating that water locations there move rapidly, but the vector arrows are short. That happens because the flow in an eddy spins one way and then the opposite way over successive timesteps—so although instantaneous speeds remain large, the vector sum cancels out to near zero. Similar behavior appears along the boundaries, where tidal or wave-driven oscillations drive strong back-and-forth motions that register as high speed but yield little net movement when averaged.

c)

Here are the spatial correlations for the two points for speed.



Across both locations, the speed correlation falls off very rapidly with L1-distance. At (400, 400), correlation drops from nearly 1 at zero distance to almost zero by around 40 grid-units, and even becomes slightly negative, signalling a reversal in flow at that scale. At (140,115), the distance to decorrelation is a bit longer, about 60 grid-units. In neither case is the decay perfectly smooth or purely exponential.

Because these correlation functions differ by location, show evidence for directional eddies, and even go negative, a GP model with a simple squared-exponential kernel would struggle to capture the true behavior. Such kernels assume a single, smooth decay scale and strictly positive correlations, whereas our data require multiple length-scales and spatially varying covariance.