Forcing an Arctic Sea Ice Model with NARR Surface Winds

*How to Stitch Datasets*

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Sea Ice Models Increase in Resolution

- 1979 – 125 km
- 1985 – 222 km
- 1992 – 160 km
- 1995 – 160 km
- 1997 – 40 km
- 2002 – 55 km
- 2003 – 9 km

... but the wind forcing fields are still at ~ 1° resolution.
Why are modeled ice fields so smooth?

- Coarse grid?
- Diffusive advection scheme?
- Continuity assumption?
- Yield curve?
- Wind field too smooth?
The Canadian Arctic Archipelago

- Plenty of channels, straits and sounds.
- Low-res winds do not capture orographic effects.
- Need high-res wind to model sea ice motion properly in this region.
North American Regional Reanalysis (NARR)
Stitching NARR and NCEP winds

- **Merge and interpolate**
  Combine data points unto an unstructured grid and interpolate (e.g., kriging) on the model grid.

- **Interpolate and merge**
  Interpolate the two data sets on the model grid, then merge them using a weighted average.
Interpolate and Merge

1. Interpolate NARR and NCEP on the model grid using Akima's revised bicubic interpolator.
2. Apply a weighted mask to each dataset.
3. Merge the $u$ and $v$ winds using a weighted average.
Step 1: Interpolate on the model grid
Step 2: Apply a weighted mask
Step 3: Weighted average of both
The Scale Problem

- Mean wind speeds are not compatible.
- One or the other data set must be scaled to avoid large discrepancies at the seam.
- NARR wind speed < NCEP2 wind speed
- Which one fits better with observations?
Wind Speed Intercomparison

- Compare NARR and NCEP2 10m winds with meteorological stations data.
Interpolating... again.

- Interpolate NARR and NCEP2 winds at the stations location.
- Delaunay Nearest Neighbor interpolation – Voronoi tessellation.
Delaunay Nearest Neighbor Interpolator

1. $z = f(x,y)$
Delaunay Nearest Neighbor Interpolator

1. \( z = f(x, y) \)
2. Delaunay tessellation
Delaunay Nearest Neighbor Interpolator

1. $z = f(x,y)$
2. Delaunay tessellation
3. Circumcenters
Delaunay Nearest Neighbor Interpolator

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1. $z = f(x,y)$
2. Delaunay tessellation
3. Circumcenters
4. Voronoi tessellation
Delaunay Nearest Neighbor Interpolator

1. \( z = f(x,y) \)
2. Delaunay tesselation
3. Circumcenters
4. Voronoi tesselation
5. Interpolation point
Delaunay Nearest Neighbor Interpolator

1. \( z = f(x,y) \)
2. Delaunay tessellation
3. Circumcenters
4. Voronoi tessellation
5. Interpolation point
6. Weigh neighbor points according to the \textit{stolen area}
Wind Time Series
# Time Series Statistics

## Resolute

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std</th>
<th>Autocorrelation</th>
</tr>
</thead>
<tbody>
<tr>
<td>NARR</td>
<td>3.74</td>
<td>1.76</td>
<td>0.94</td>
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<tr>
<td>NCEP2</td>
<td>5.94</td>
<td>3.38</td>
<td>0.87</td>
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<tr>
<td>Station</td>
<td>5.05</td>
<td>3.24</td>
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</table>

## Kugluktuk

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<tr>
<td>NARR</td>
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<td>1.62</td>
<td>0.91</td>
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<tr>
<td>NCEP2</td>
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<tr>
<td>Station</td>
<td>4.38</td>
<td>2.67</td>
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### Global Results

<table>
<thead>
<tr>
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<th>Mean (m/s)</th>
<th>Std (m/s)</th>
<th>Autocorrelation</th>
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</thead>
<tbody>
<tr>
<td>Station</td>
<td>4.8</td>
<td>3.1</td>
<td>0.51</td>
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<tr>
<td>NCEP2</td>
<td>5.6</td>
<td>3.2</td>
<td>0.85</td>
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<tr>
<td>NARR</td>
<td>3.5</td>
<td>1.8</td>
<td>0.92</td>
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</tbody>
</table>
Conclusion

- NCEP2 winds seem fast for grid averaged winds.
- NARR shows little variability and high auto-correlation.

What's next?

- Discuss those differences with data sets authors.
- Study differences in modeled sea ice fluxes and shear.
Line Integral Convolution