A comparison of reanalysis products for Alaska to facilitate impact studies

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Motivation
• Evaluate monthly reanalysis products from NARR (Messinger et al. 2006), CFSR (Saha et al. 2010), NCEP/NCAR R1 (Kalnay et al. 1996), 20TH CR (Compo et al. 2011) and validate these with station observations for 2-meter temperature and precipitation from 1979-2009 for 8 Alaska climate divisions (Bieniek et al. 2012).
• Provide stakeholders in the applications community with a model ranking system for these variables for each model based on these climate divisions.

Data and Methodology
• Data from 36 stations was used to validate monthly area means of 2-meter temperature and precipitation for 8 Alaska climate divisions.
• Each reanalysis required a separate climate division mask.
• Reanalyses were ranked by division for each variable according to total annual departure from station means.

Table 1. Model resolution used in this study and number of grid points in each division are listed below. Station data are primarily located at low altitudes and the column labeled ‘HEIGHT’ indicates the highest elevation of any station in the corresponding division (blue). The high-resolution models (NARR and CFSR) allowed masking out of grid points at elevations higher than maximum station altitude to permit a more consistent comparison with station data.

<table>
<thead>
<tr>
<th>Division</th>
<th>Resolution</th>
<th>NARR</th>
<th>CFSR</th>
<th>NCEP/NCAR</th>
<th>20TH CR</th>
<th>STATIONS</th>
<th>HEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bristol Bay</td>
<td>0.5 x 0.5</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>36</td>
<td>121.05</td>
</tr>
<tr>
<td>North Slope</td>
<td>0.5 x 0.5</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>36</td>
<td>115.50</td>
</tr>
<tr>
<td>Northeast interior</td>
<td>0.5 x 0.5</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>36</td>
<td>155.04</td>
</tr>
<tr>
<td>South Central</td>
<td>0.5 x 0.5</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>16</td>
<td>459.83</td>
</tr>
<tr>
<td>Southeast</td>
<td>0.5 x 0.5</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>14</td>
<td>467.96</td>
</tr>
<tr>
<td>West Coast</td>
<td>0.5 x 0.5</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>14</td>
<td>320.42</td>
</tr>
<tr>
<td>West Interior</td>
<td>0.5 x 0.5</td>
<td>26</td>
<td>26</td>
<td>26</td>
<td>26</td>
<td>10</td>
<td>183.75</td>
</tr>
<tr>
<td>Total</td>
<td>173</td>
<td>173</td>
<td>173</td>
<td>173</td>
<td>173</td>
<td>64</td>
<td>517.86</td>
</tr>
</tbody>
</table>

Figure 1. Stations used for validation (left). CFSR climate division mask with Bristol Bay (orange), North Slope (yellow), Northeast Interior (dark yellow), South Central (light green), Southeast (red), Southeast Interior (green), West Coast (aqua), West Interior (blue) (right).

• Reanalyses were ranked by division for each variable according to total annual departure from station means.

Accumulated departures from station observations indicate that certain reanalyses outperform others

Figure 2. Accumulated departures from station observations for 2-meter temperature (top) and precipitation (bottom) are shown. The climate divisions from left to right in the leftmost charts are Bristol Bay, North Slope, Northeast Interior, South Central, Southeast, Southeast Interior, West Coast, and West Interior. Reanalyses are NARR (red), CFSR (blue), NCEP/NCAR R1 (green), and 20TH CR (black). The rightmost figures are a summation of all climate divisions for each model.

Main Results
• CFSR performed best overall for monthly 2-meter temperature
• NARR modeled monthly accumulated precipitation most accurately
• Seasonal cycles (despite biases) compare favorably with observations

Reanalyses capture the seasonal cycles of 2-meter temperature and precipitation

Figure 3. Mean monthly 2-meter temperature (left) and precipitation (right) for NARR (red), CFSR (blue), NCEP/NCAR R1 (green), 20TH CR (black) and stations (pink) for 1979-2009.

Summary and Future Work
• CFSR had the closest agreement to station observations for monthly 2-meter temperature on average for 8 Alaska climate divisions.
• NARR ranked second for 2-meter temperature, which indicates superior performance of fine-resolution models and height masking.
• NARR exhibited the best agreement to monthly accumulated precipitation across the climate divisions.
• The reanalyses data were able to capture the seasonal cycles of 2-meter temperature and precipitation.
• Validation of the reanalyses data using these stations is limited due to the sparseness of the observing network in Alaska. An increased number of stations will provide a more reliable analysis.
• Next => this study will investigate additional variables (e.g. snow depth, sea-level pressure), daily data, more evaluation measures (e.g. variance), and additional reanalysis models.

References

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