A comparison of reanalysis products for Alaska to facilitate impact studies

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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

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.
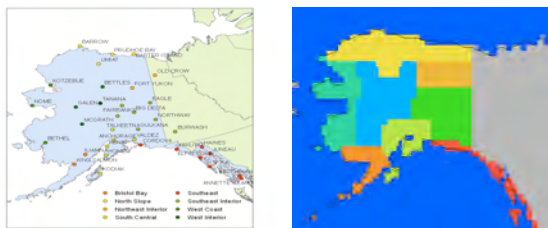
Data and Methodology

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).

- 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.

	NARR	CFSR	NCEP/NCAR	20TH CR	STATIONS	HEIGHT
Resolution	0.33 X 0.33	0.5 X 0.5	2.5 X 2.5	2.5 X 2.5		
Bristol Bay	27	32	7	7	2	121.05
North Slope	131	84	14	14	4	185.90
Northeast Interior	90	40	10	10	2	390.04
South Central	49	34	9	9	6	459.83
Southeast	24	64	12	12	8	887.99
Southeast Interior	231	155	10	10	7	1397.83
West Coast	183	102	14	14	3	183.79
West Interior	393	205	18	18	4	517.98
Total points	1128	716	94	94	36	

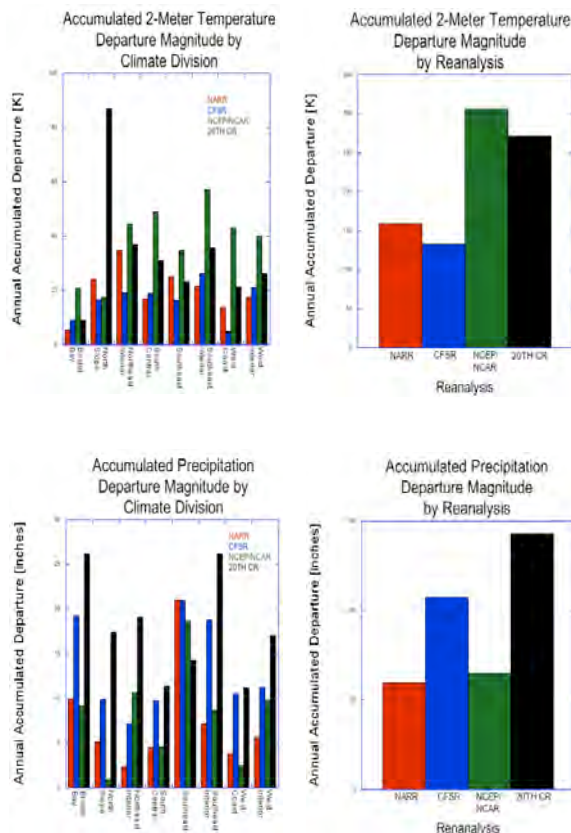## Accumulated departures from station observations indicate that certain reanalyses outperform others

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.

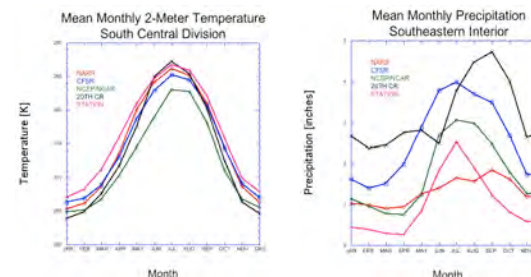## Reanalyses capture the seasonal cycles of 2-meter temperature and precipitation

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.

- Useful for statistical forecasts (e.g. forest fires and river breakup)

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

- Bieniek, P. A., U. S. Bhatt, R. L. Thoman, H. Angeloff, J. Partain, J. Papineau, F. Fritsch, E. Holloway, J. E. Walsh, C. Daly, M. Shulski, G. Hufford, D. F. Hill, S. Calos, and R. Gens, 2012: *Climate divisions for Alaska based on objective methods*, (in press) J. Applied Meteorology and Climatology
- Compo, G. P., and Coauthors, 2011: The Twentieth Century Reanalysis Project. *Quaterly J. Roy. Meteorol. Soc.*, **137**, 1-28. doi: 10.1002/qj.776
- Kalnay et al., The NCEP/NCAR 40-year reanalysis project, *Bull. Amer. Meteor. Soc.*, **77**, 437-470, 1996
- Messinger, Fedor, and Coauthors, 2006: North American Regional Reanalysis. *Bull. Amer. Meteor. Soc.*, **87**, 343-360
- Saha, Suranjana, and Coauthors, 2010: The NCEP Climate Forecast System Reanalysis. *Bull. Amer. Meteor. Soc.*, **91**, 1015-1057. doi: 10.1175/2010BAMS3001.1