Summer Extreme Daily Precipitation Events in the CORDEX Arctic Domain as Simulated by Pan-Arctic WRF

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EXPERIMENTAL GOALS

1. **Use composites of extreme events to analyze the processes producing precipitation extremes.**
2. **Compare circulation, pressure, temperature and humidity fields from the ERA-Interim reanalysis and the model output.**
3. **Establish the physical credibility of the simulations for extreme behavior by comparing atmospheric processes producing extremes in observations and the model.**

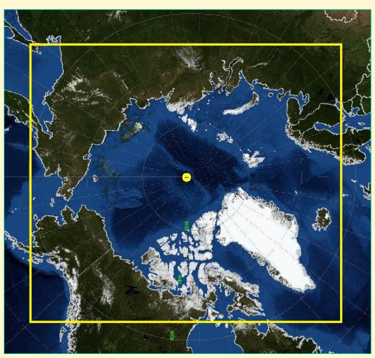

Figure 1: CORDEX Arctic 50-km domain

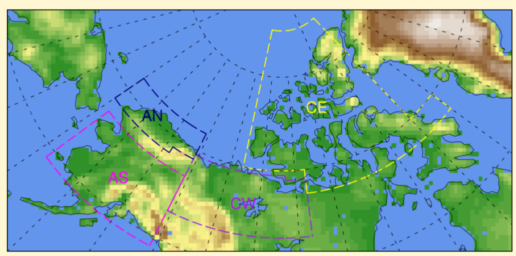

Figure 2: North American analysis regions

SIMULATION SETUP

- For this study, we used a polar-modified version of the Weather Research and Forecasting (WRFv3.1) model, using the CORDEX Arctic Domain
  - Contains most of the Arctic's sea ice and most major surface drainage system
  - Includes critical inter-ocean exchange and transport features important for regional climate modeling
- Model initial and boundary conditions were provided by the ECMWF ERA-Interim reanalysis and NSIDC sea ice concentration
  - Six-member ensemble produced using a 24-hr staggered start
  - Simulations for 1989-2007
  - First three years of the simulations discarded for spin-up purposes

Daily Precipitation Extremes
Summer: 1997 – 2007
Southern Alaska Analysis Region

- Four analysis regions were selected over North America using local weather patterns, climatology, and topography (Fig. 2)
  - North Alaska (North of Brooks Range)
  - South Alaska (South of Brooks Range
  - East Canada
  - West Canada
- PAW – EI 16-year biases show that simulated mean behavior (MSLP shown in Fig. 3) agrees well with observations.

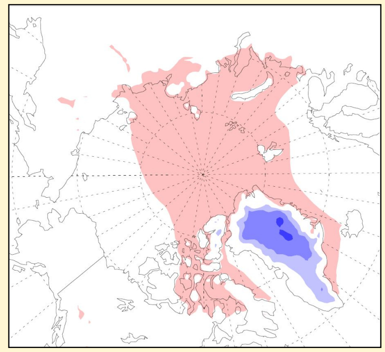

Figure 3: PAW – ERA-Interim 16-year JAS MSLP Bias

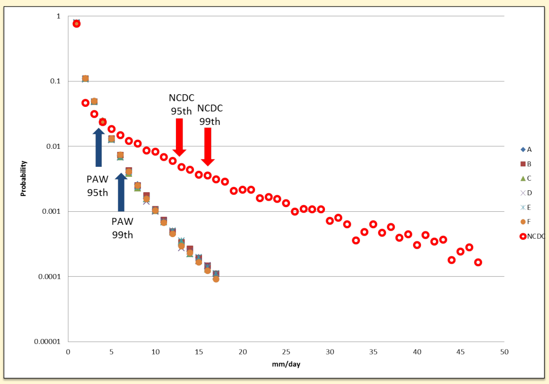

Figure 4: Frequency versus intensity distribution of pan-Arctic WRF ensemble (A - F) and NCDC station observations for the southern Alaska analysis region

- PAW consistently underestimates precipitation amount, compared to the NCDC station observation (Fig. 4)
  - Simulation and observations come into agreement at the lower end of the intensity spectrum
- PAW simulates too few higher intensity extreme events.
- The spatial scale of extreme events (not show) tends to be larger in PAW than the observations.

- Composites of observed extreme events show the model reproduces well environmental conditions conducive for extreme events
  - Simulated composite circulations agree well in analysis region (Fig. 4)
  - Composite high humidity anomalies (not shown) co-located with extreme events in both observations and simulations

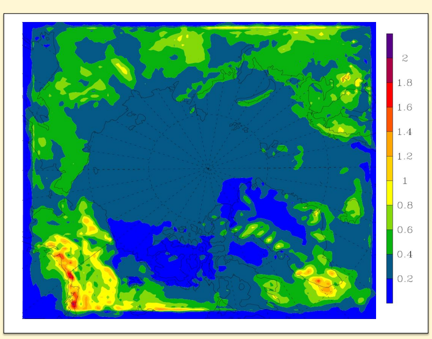

Figure 5: Composited summer extreme precipitation [mm/d] for Alaska South showing concentration of precipitation where circulation feeds moisture into the region.

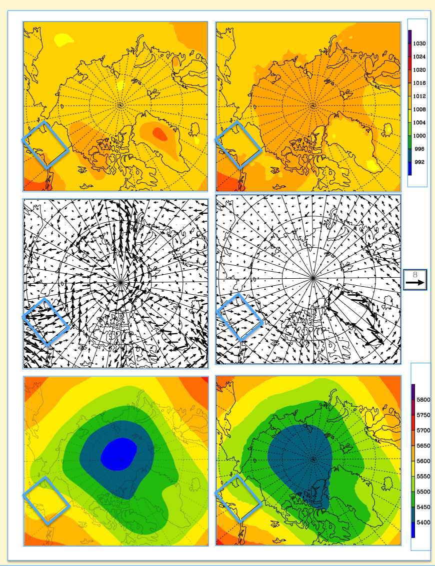

Figure 4: Composite fields for Alaska South (box in panels) extreme events: mean sea level pressure [mb] (top) 850-hPa wind vectors [m/s] (middle) and 500-hPa geopotential heights [m] (bottom) from ERA-Interim (left) and Pan-Arctic WRF (right).

CONCLUSIONS

- The model produces well the physical causes of extremes, despite lower precipitation intensity
- Similar physical consistency between model and observations appears for all analysis regions (not shown)