High resolution regional climate simulations over Alaska

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Introduction

In order to appropriately plan future projects to build and maintain infrastructure (e.g., dams, dikes, highways, airports), a number of U.S. federal agencies seek to better understand how hydrologic regimes may shift across the country due to climate change. Building on the successful completion of high-resolution WRF simulations over the Colorado River Headwaters and contiguous USA, our team is now extending these simulations over the challenging U.S. States of Alaska and Hawaii. Here we summarize preliminary results from a newly completed 4-km resolution WRF simulation over Alaska spanning 2002-2015 (Fig.1). Our aim is to gain insight into key precipitation processes, particularly the extremes that are most damaging to infrastructure.

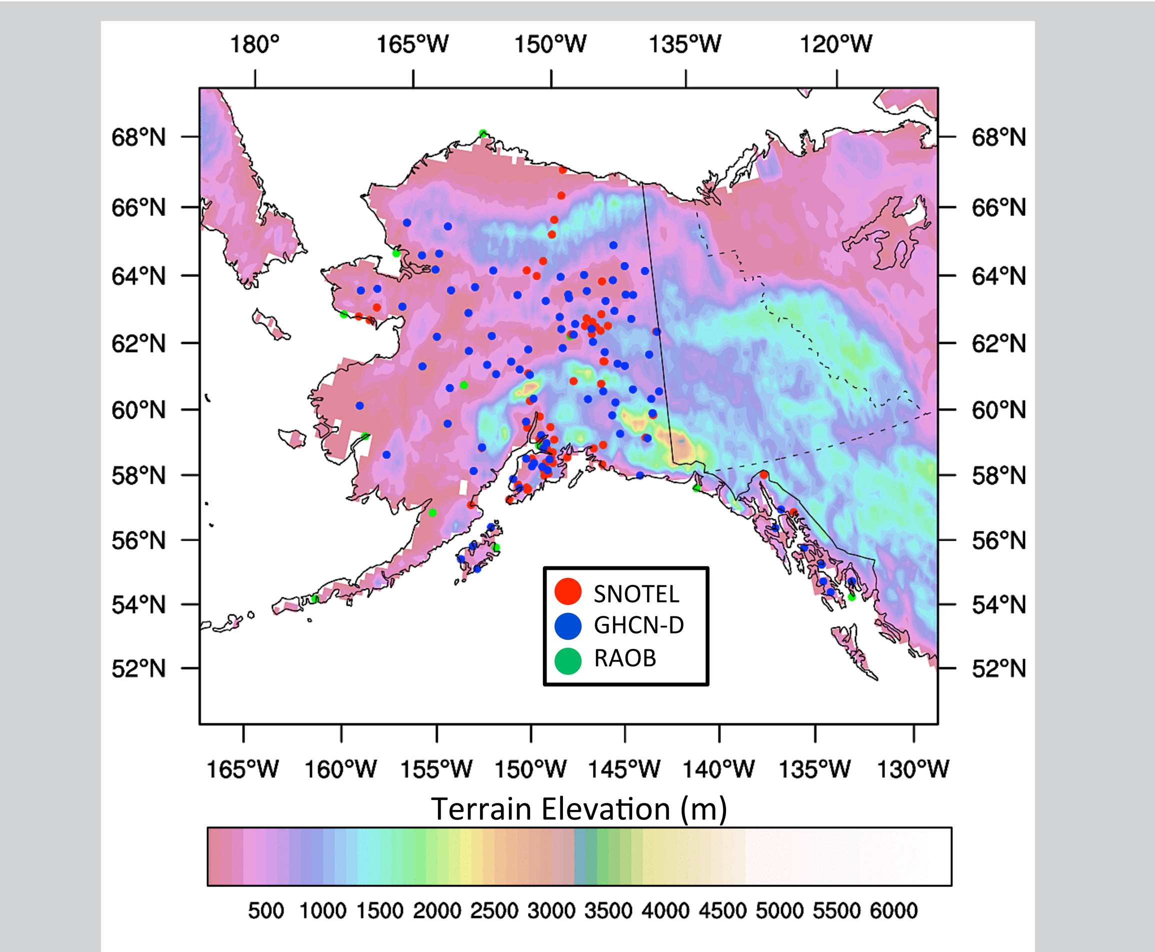

Fig. 1. 4-km WRF domain. Ongoing validation employs surface observations (sites shown on map) and gridded products including the Scenarios Network for Alaska and Arctic Planning (SNAP) temperature and precipitation grids.

WRF Configuration

The model was forced by the ERA-Interim reanalysis, with sea surface temperature and sea ice fraction fields provided by the 0.01 degree Multi-scale Ultra-high Resolution (MUR) SST analysis (NASA JPL). See Table 1 for parameterizations.

Parameterization name	Option	Option #
Cloud microphysics	Thompson	8
Longwave radiation	RRTMG	4
Shortwave radiation	RRTMG	4
Surface layer	MM5 Similarity	91
Surface	Noah MP	4
Lake	FLAKE	1
Planetary boundary layer	YSU	1
Cumulus	Off	0

Table 1. WRF physics options.

WRF Evaluation

WRF precipitation fields are being compared to SNOTEL and SNAP datasets for evaluation. Here, WRF and SNAP are compared for the mean (Fig. 2) and coefficient of variation (Fig. 3) of the 2002-2009 annual and winter precipitation.

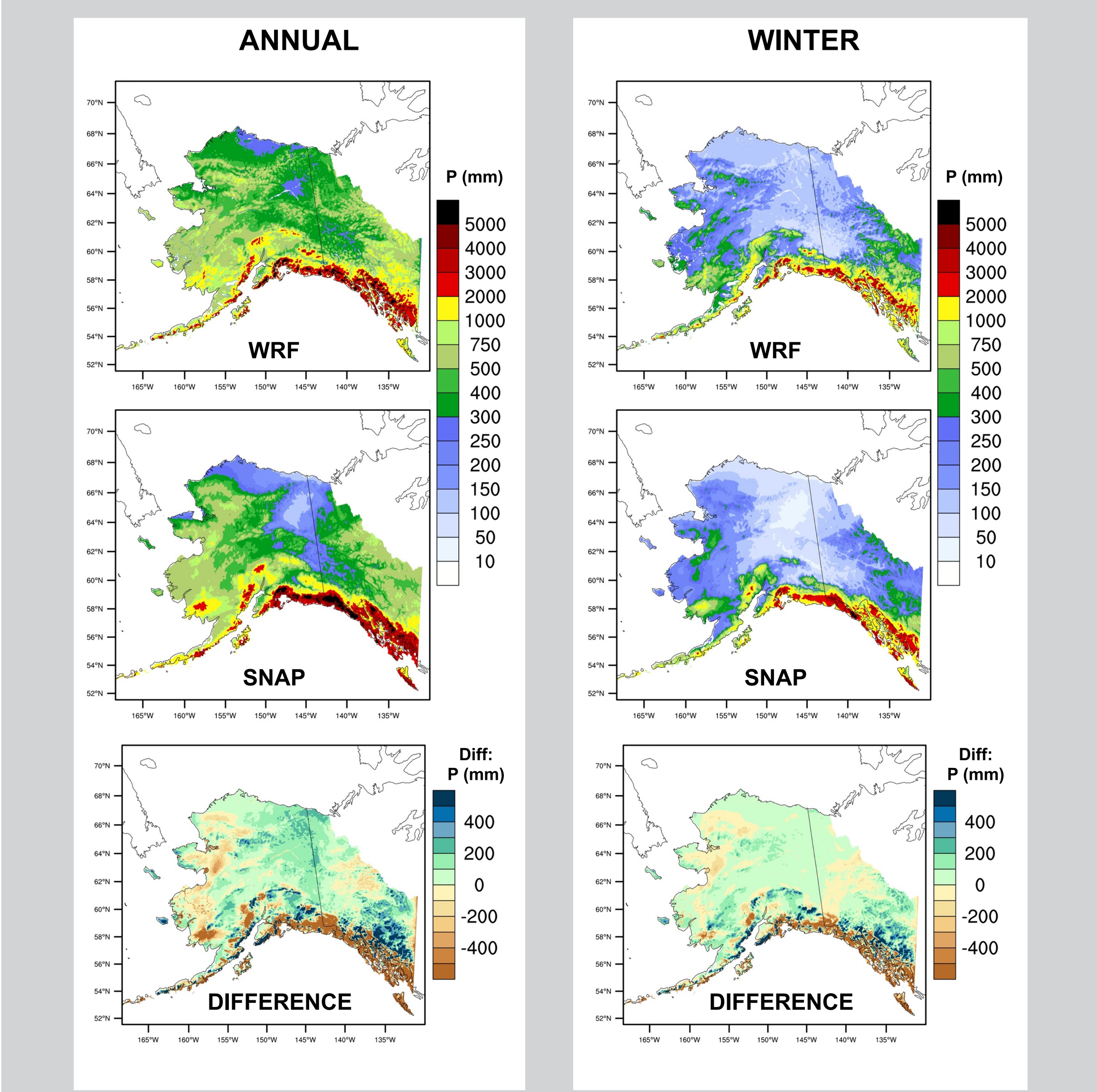

Fig. 2. 2002-2009 annual (left) and winter (right) precipitation for WRF (top), SNAP (middle) and the difference (bottom). Winter = Oct-Mar.

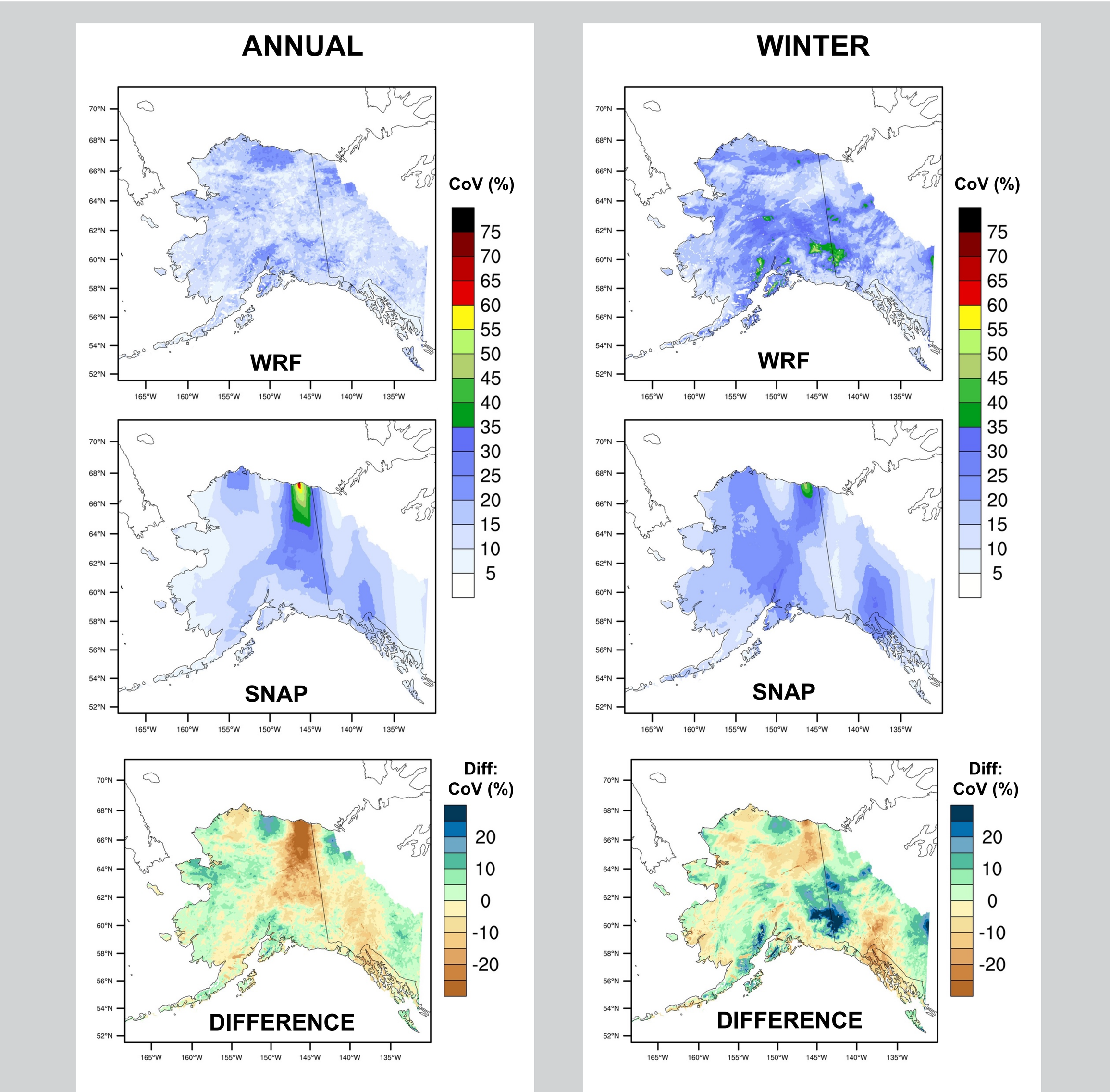

Fig. 3. As in Fig. 2, but for the coefficient of variation (st.dev/mean).

Extremes

Daily precipitation maxima for the 2002-2015 annual and winter periods are summarized (Fig. 4). Annual average maxima in excess of 300 mm/day water equivalent occur in numerous coastal mountain regions. Comparison of winter and annual values indicates that coastal maxima tend to occur in winter months (Oct-Mar), whereas interior maxima often occur during the comparatively warm months (Apr-Sep).

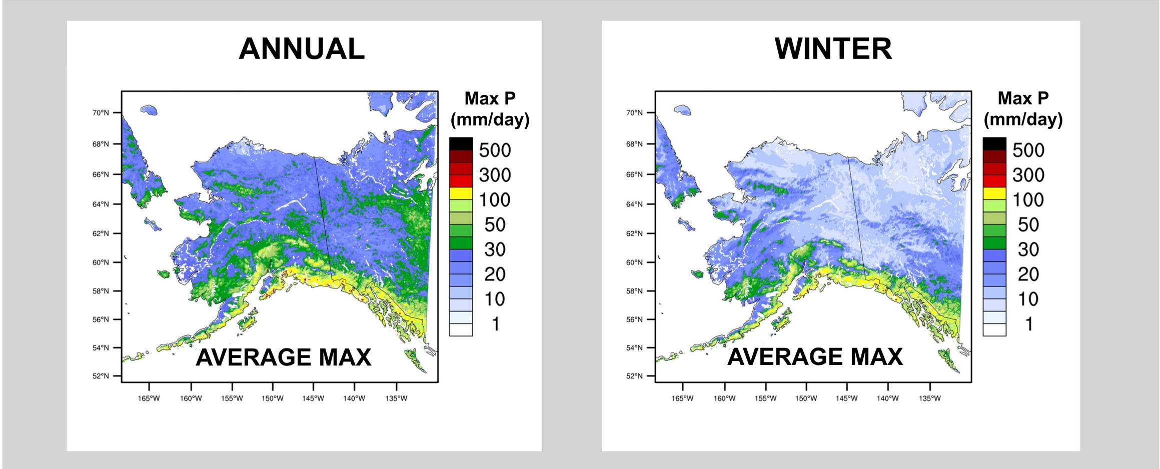

Fig. 4. 2002-2015 annual (left) and winter (right) average maximum daily precipitation.

Individual precipitation events can comprise a substantial fraction of seasonal totals. Daily average and overall precipitation maxima for 2002-2015, expressed as percentages of annual and winter totals, are shown in Fig. 5. On average, the largest annual (winter) precipitation event in a given year will comprise up to 10% (20%) of the period total. However, examination of the greatest 1-day totals over the entire 13-year record indicates that some events are equivalent to about 75% of the average precipitation in winter (e.g., in the Wrangell Mountains). Considering that many events last for more than 24 hours, multi-day precipitation events (not yet analyzed) likely comprise a much greater fraction of total precipitation.

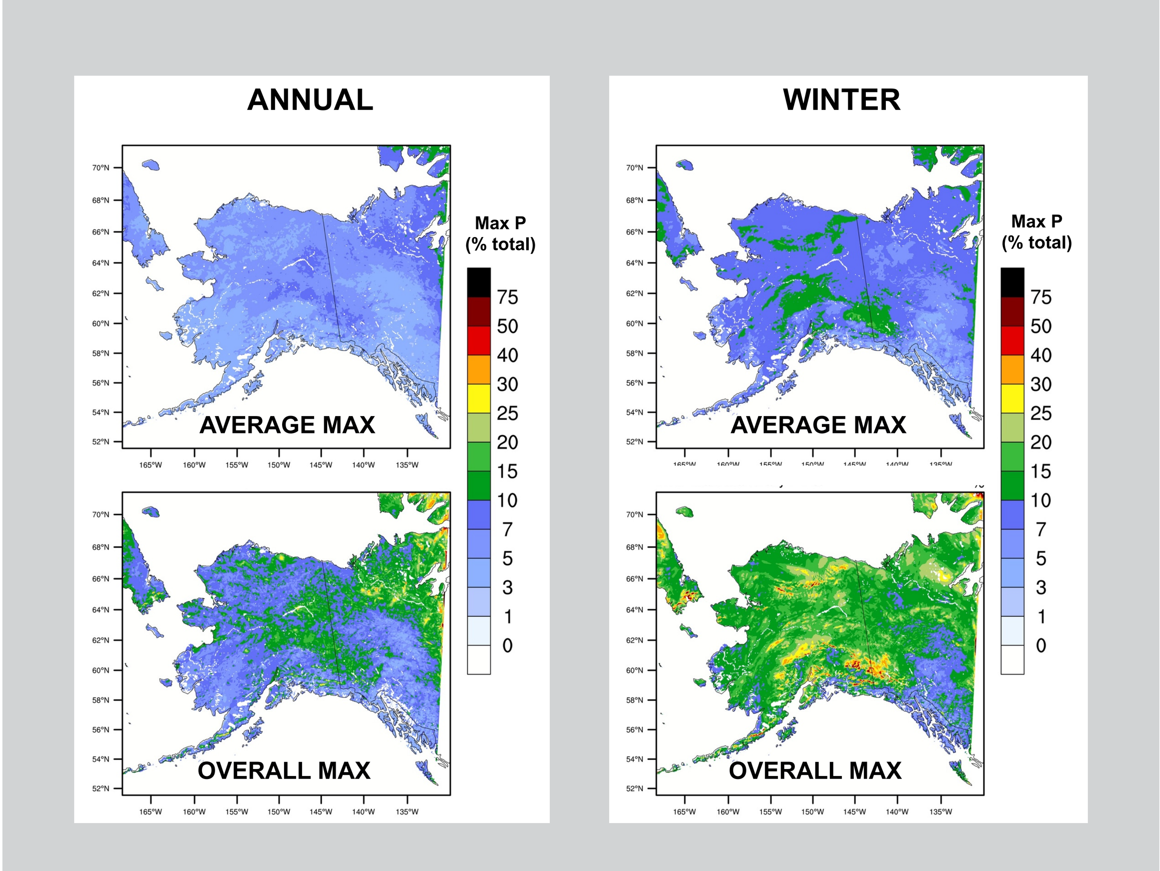

Fig. 5. 2002-2015 annual (left) and winter (right) average maximum daily precipitation (top), and greatest 1-day precipitation event during the 13 year period (bottom), both expressed as a percentage of the average total annual or winter precipitation.

Conclusions

- WRF simulations over Alaska with 4-km resolution offer insight into key hydrologic processes.
- Preliminary evaluation versus SNAP and SNOTEL (not shown) suggests WRF accurately resolves the spatiotemporal characteristics of solid and liquid precipitation.
- The dataset is particularly well suited for examining the characteristics of extreme precipitation events.
- Next steps: a comprehensive evaluation, writing a publication examining historical extreme snowfall characteristics, and conducting simulations for a future time slice to assess potential changes in extreme precipitation characteristics over Alaska.

Acknowledgments

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