

NARCCAP-First Analyses Concerning the Snow Regime in the Upper Colorado River Basin



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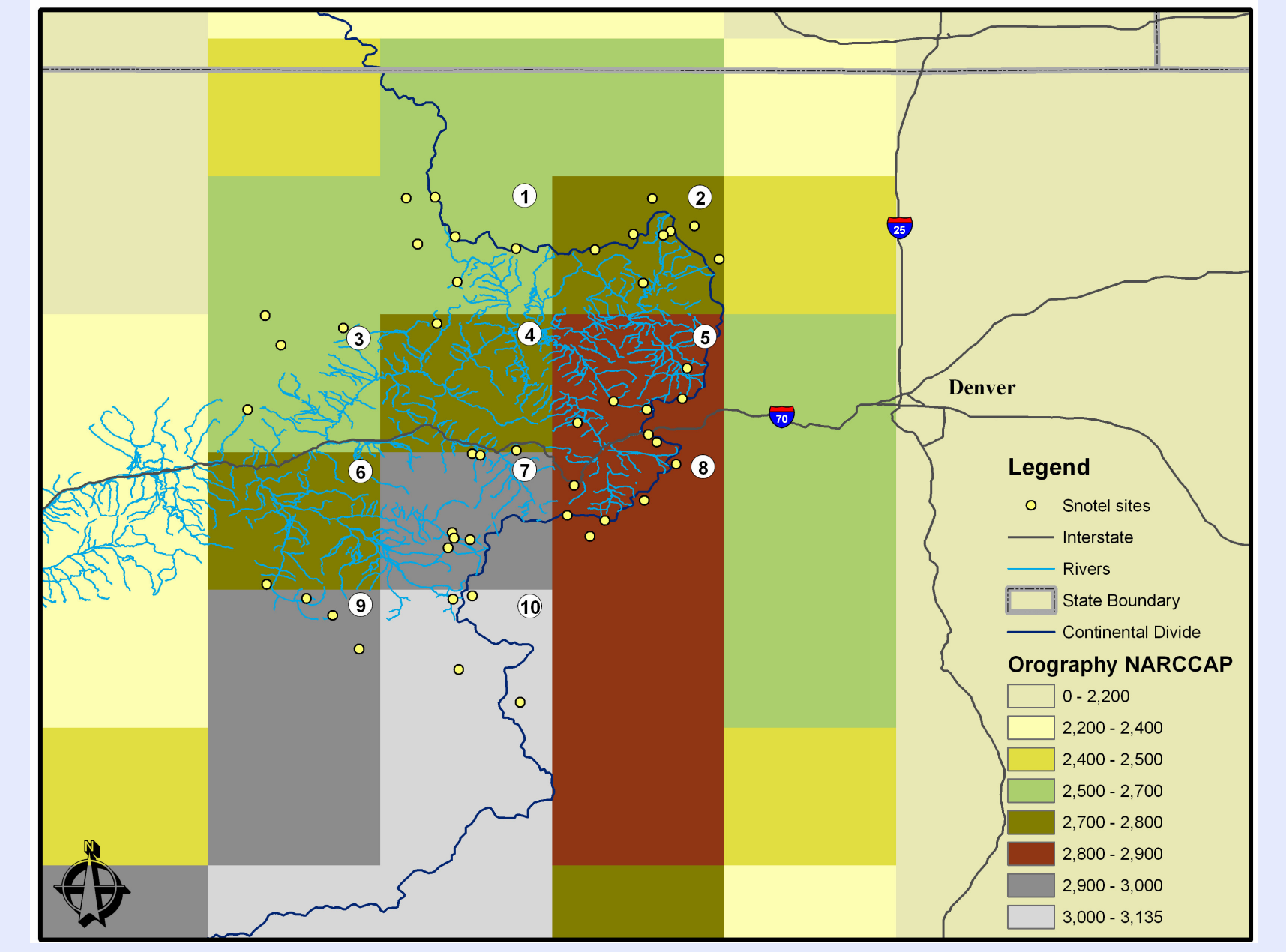
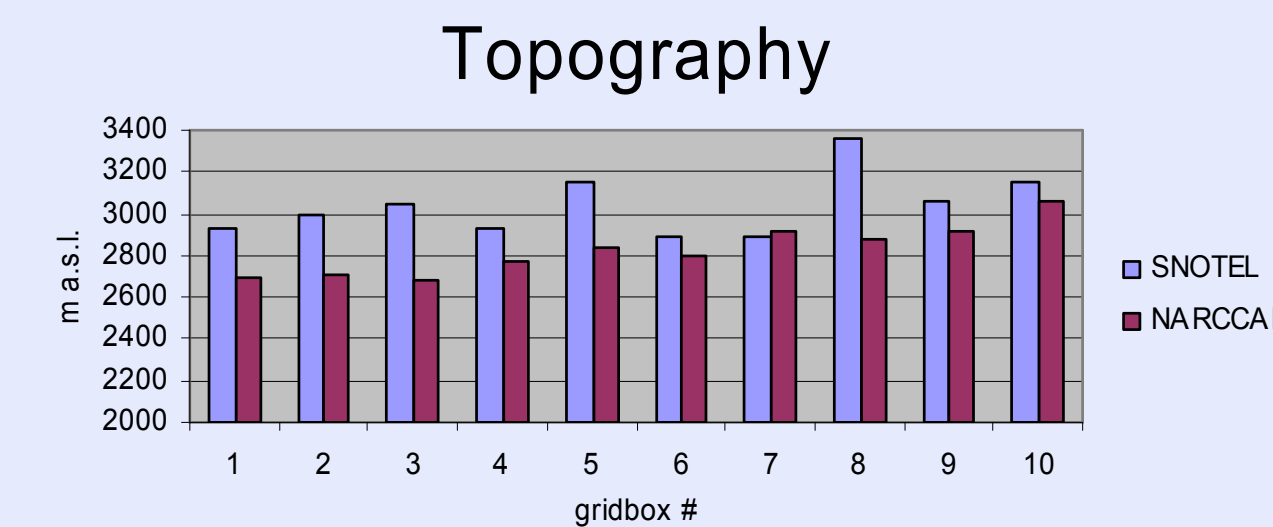
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Introduction

Performance analyses of first NCEP reanalysis-driven NARCCAP simulations are presented concerning the snow regime in the **Upper Colorado River Basin (UCRB)**. The Colorado River is the major water resource for millions of people living in the surrounding areas. The **high elevation seasonal snow pack** contributes about 70% of the annual runoff. On average, about 90% of the annual streamflow is generated in the UCRB (e.g. Christensen et al. 2004).

The map on the right shows the UCRB region. The NARCCAP RCMs (grid spacing = ~50km) cover the UCRB area by 10 gridboxes (# 1 – # 10; here shown with

the orography used in the NARCCAP simulations). SNOTEL^{*1)} observations and NARR^{*2)} reanalysis (grid spacing = 32km) were used to test the performance of the NARCCAP simulations. All SNOTEL stations assembled within one NARCCAP gridbox were averaged to represent the observation of the related gridbox. The bar chart below shows the differences between mean elevation of the SNOTEL sites per gridbox and the NARCCAP model elevation.



First Analyses

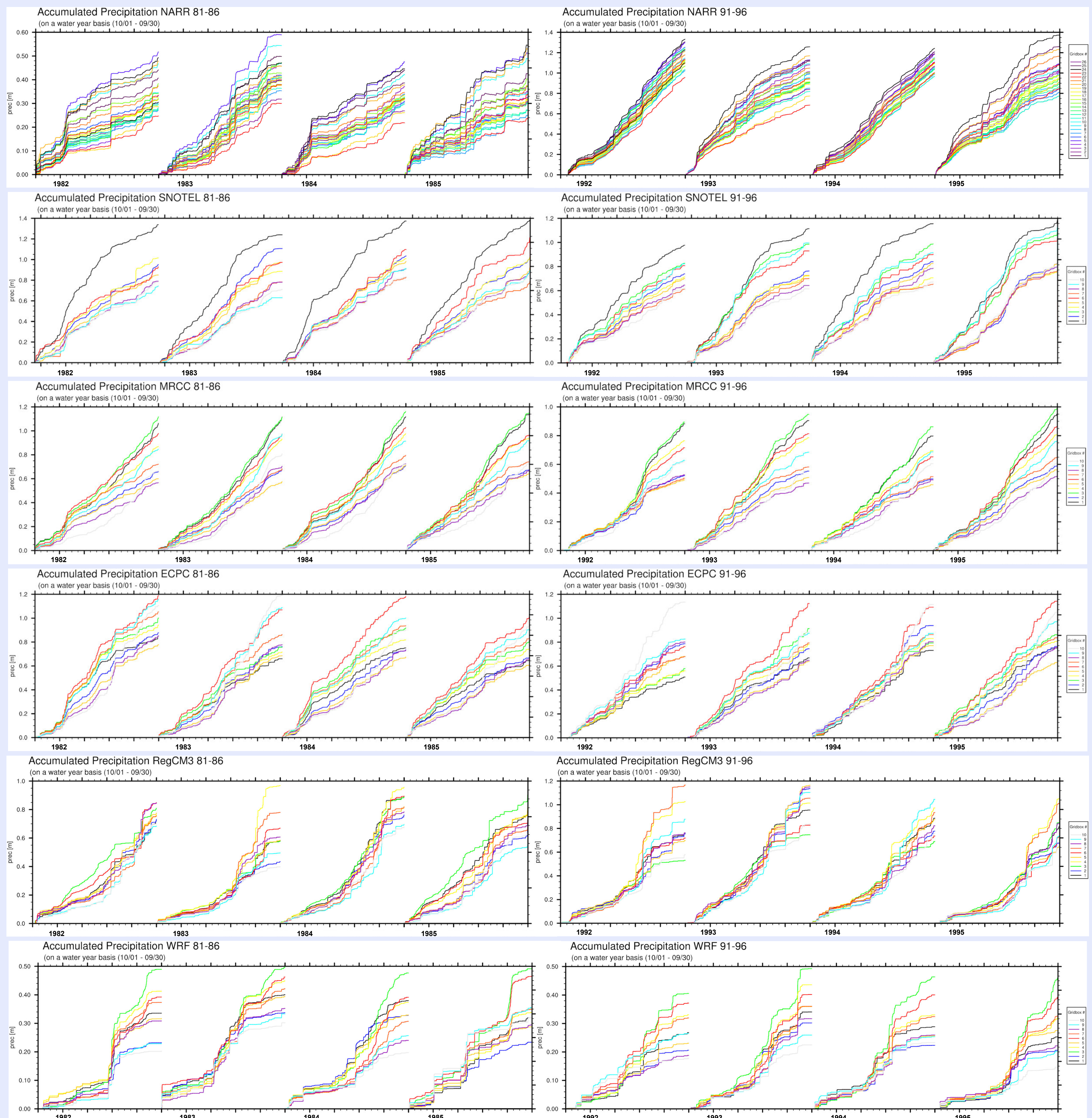
The variables 'snow water equivalent' (**swe**), 'precipitation' (**prec**) and '2m temperature' (**tas**) are available so far for NCEP reanalysis-driven RCM simulations (1979-2004) from:

- **MRCC** (Modèle Régional Canadien du Climat): Ouranos Consortium, Montreal (Quebec), Canada
- **ECPC** (Experimental Climate Prediction Center): Scripps Institution of Oceanography, La Jolla, CA, USA
- **RegCM3** (REGional Climate Model): UC Santa Cruz, ITCP, USA
- **WRF** (Weather Research and Forecasting Model): NCAR/PNNL, USA

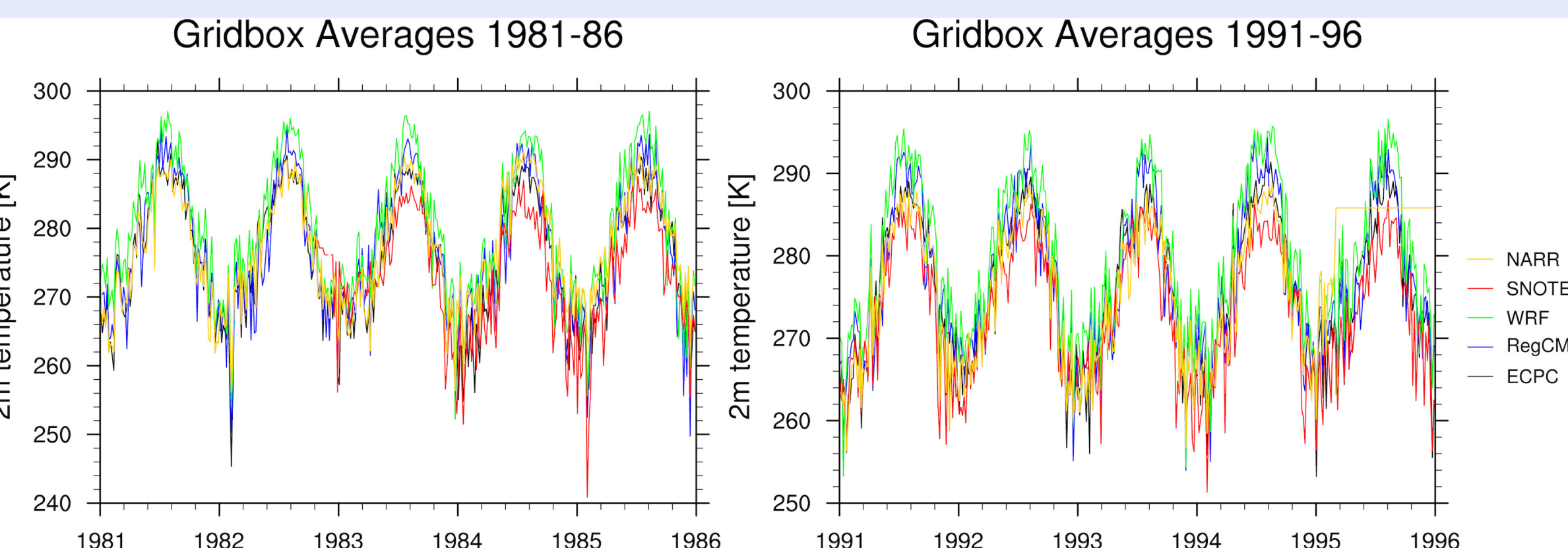
Here, we present analyses regarding the annual accumulated precipitation, the annual snow cycle and 2m temperature for the two time-slices 1981-86 and 1991-96.

On the right, the accumulated precipitation of four NARCCAP simulations compared to SNOTEL and NARR data is shown. Total volume of annual precipitation and temporal distribution of the accumulation of precipitation show overall good agreement for ECPC and MRCC, and somewhat greater deviations for RegCM3 and WRF.

Annual Accumulated Precipitation

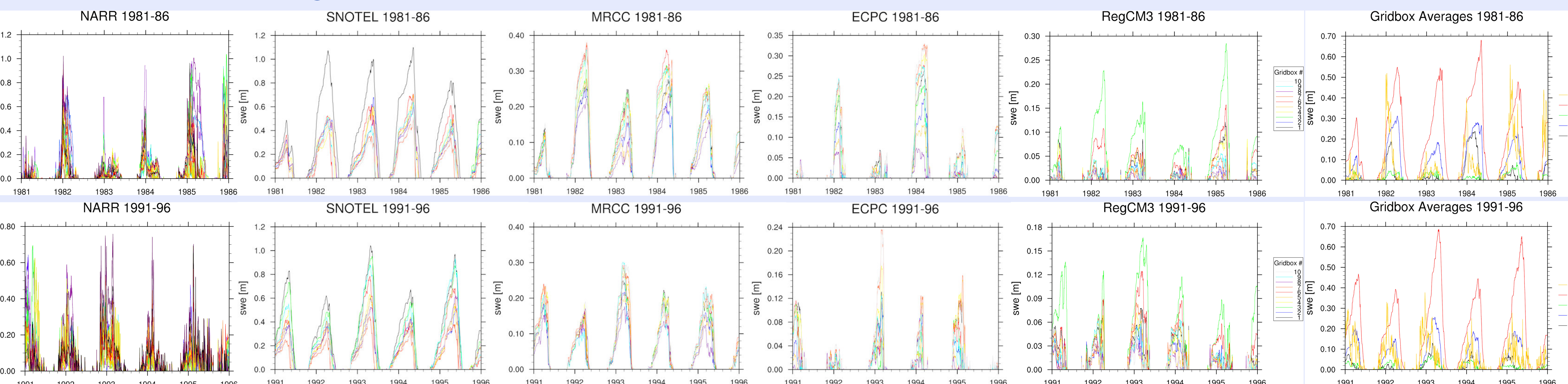


Annual Temperature Cycle



Above, the average over the 10 gridboxes are shown for 2m temperature compared to SNOTEL and NARR. NARCCAP temperatures are generally higher than NARR, and particularly than SNOTEL.

Annual Snow Cycle



Above, the annual snow cycles are shown. Most obvious are the deviations between NARCCAP (and NARR!) and SNOTEL. Some of these deviations can certainly be explained by elevation differences between NARCCAP

and SNOTEL (see bar chart on top), which is also apparent from air temperature, where SNOTEL overall shows lowest temperatures. Furthermore, the SNOTEL site are generally located where the snow pack lasts long.

Therefore, it can be assumed that SNOTEL observations slightly overestimate 'swe' relative to the average of 'swe' over the whole region of UCRB.

References:

Christensen, N.S., Wood, A.W., Voisin, N., Lettenmaier, D.P., Palmer, R.N., 2004: The effects of climate change on the hydrology and water resources of the Colorado River Basin. *Climatic Change* 62: 337-363.

*1) SNOTEL (SNOWpack TELemetry) data provided by Natural Resources Conservation Service, United States Department of Agriculture

*2) NARR (North American Regional Reanalysis) data provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their Web site at <http://www.cdc.noaa.gov/>

Acknowledgement:

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Outlook

Once all NARCCAP simulations are realized, NCEP reanalysis-driven runs and GCM driven time-slice experiments will be available. In addition to model performance analyses the following research is planned:

- Investigating changes in the snow regime under climate change scenario conditions
- Coupling NARCCAP results to hydrological run off models
- Analyzing the impact of changes in streamflow on the water availability for the Colorado River region