Project to Intercompare Regional Climate Simulations: Advancing the CLIVAR Agenda

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CLIVAR Exchanges (to be submitted)

The CLIVAR Initial Implementation Plan recognizes the need to understand local and regional realization of global climate variability. During CLIVAR's lifespan, global models will continue to improve but likely will not reach resolution sufficient to simulate regional (country-scale) behavior accurately. For this reason, the Initial Implementation Plan promotes "evaluation of regional models driven by reanalysis data to determine the accuracy of the regional response when drive by perfect boundary conditions." The Project to Intercompare Regional Climate Simulations (PIRCS) is engaged in such evaluation through its mission to evaluate strengths and weaknesses of regional climate models and their component procedures by systematic, comparative simulations.

PIRCS has been a largely volunteer, community effort organized and implemented through a series of developmental meetings (Takle, 1994, Gutowski *et al.*, 1998). The first PIRCS simulations are designed to complement the GEWEX Continental International Project (GCIP), and thus cover two hydrologic extremes in the central United States: 15May – 14 July 1988 (drought, Exp. 1a) and 1 June – 31 July 1993 (flood, Exp. 1b). These simulations are relatively short for climate (2 months), a limitation imposed by computing resources available for a volunteer effort at the time the project began. Participating models simulate a domain covering the continental United States at approximately 0.5 degree resolution. Further details appear at the PIRCS web site, http://www.pircs.iastate.edu, and in Takle *et al.* (1999), which also gives initial results for the 1988 case.

A CLIVAR concern is modeling regional effects of global teleconnections. For PIRCS, this prompts two questions:

(1) How well do models ingest large-scale boundary conditions?

(2) How well do models develop regional climate in response to the boundary conditions?

The summers of 1988 and 1993 had very different large-scale environments (Trenberth and Guillemot, 1996). Anomalies of 300 hPa height over North America for the period May-June-July tended to be opposite in sign between the two years. Strong ridging occurred in the central U.S. with coincident weak moisture flow from the Gulf of Mexico, a prime moisture source for the region. These features contributed to the dry conditions of the period. The summer of 1993 was marked by persistent stationary fronts in the central U.S. along which mesoscale convective systems propagated and strong atmospheric moisture flow from the Gulf of Mexico, features that helped produce widespread flooding.

Figure 1 shows the change in 500 hPa height between the 1988 and 1993 periods given by the NCEP/NCAR reanalysis (Kalnay *et al*., 1996) and the ensemble average of 7 models that have simulated both cases. The models simulate well the change in large-scale teleconnection patterns linking the region to remote sources. The ensemble average shown here is representative of the behavior of individual models. In addition, for most models, daily root-mean-square differences between reanalysis and simulated 500 hPa heights across the U.S. tend to be about 10 – 20 m, i.e., about the accuracy of 500 hPa height estimates.

Although the models ingest teleconnection patterns well, they have difficulty simulating some of the regional outcomes of the patterns, such as precipitation extremes. Fig. 2 shows ensemble average bias of simulated precipitation versus observed precipitation for the months of June 1988 and July 1993, using half-degree, gridded observed monthly precipitation from the VEMAP project (Kittel *et al*., 1997). As with 500 hPa heights, the ensemble average is representative of the behavior of individual models. The models do show relatively large changes in precipitation between 1988 and 1993, but they are producing too much rain in the central U.S. during the drought and too little rain during the flood. The 1993 bias pattern also shows that models tend to shift the location of maximum precipitation to the northeast (essentially downstream) relative to the observed maximum. However, even accounting for this shift, there is still a shortfall of simulated precipitation versus the VEMAP data set.

The models thus can ingest large-scale teleconnection patterns faithfully for these cases and can produce local (but muted) responses in an important field, precipitation. Results indicate a need to explore further and improve the coupling of precipitation to large-scale circulation patterns (at both high and low extremes). Resolving this issue is important not only for regional model "downscaling", but also because global models may face the same problem when they eventually start running at the scale of contemporary regional models. The results also demonstrate the value of side-by-side model comparison in a common framework.

Model output from the 1988 simulations is now available to the general community. The PIRCS web site (http://www.pircs.iastate.edu) gives the data release

policy. Requests for output and further information should be directed to pircs@iastate.edu.

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Figure Captions

Figure 1: 500 hPa geopotential height difference, 1993 – 1988 [time period??], from (a) the NCEP/NCAR reanalysis and (b) ensemble average of PIRCS simulations. Contour interval: 20 m.

Figure 2: PIRCS ensemble average minus VEMAP observed precipitation for (a) July 1993 and (b) June 1988. Contour interval: 1 mm-d^{-1}.

PIRCS 1b – PIRCS 1a

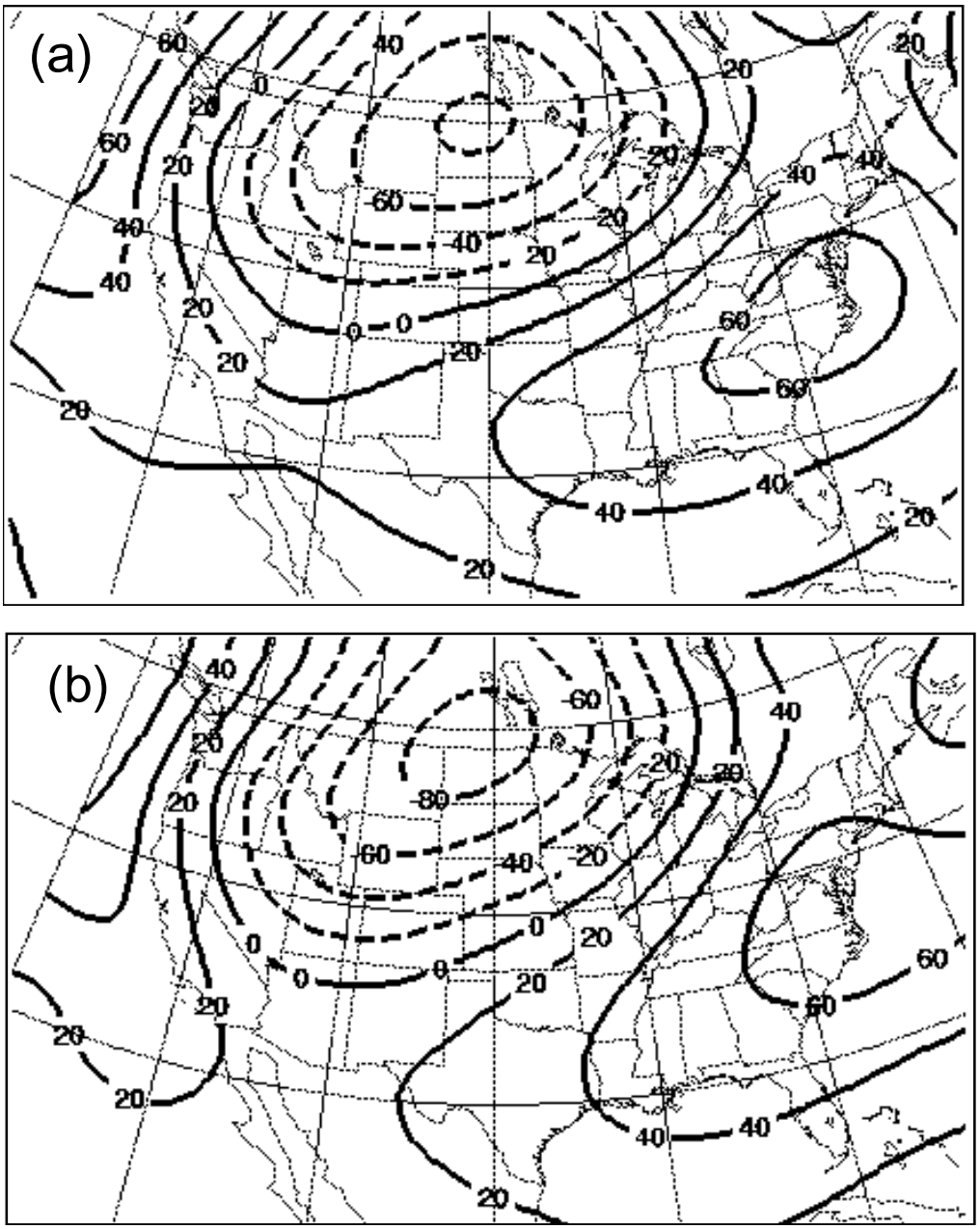
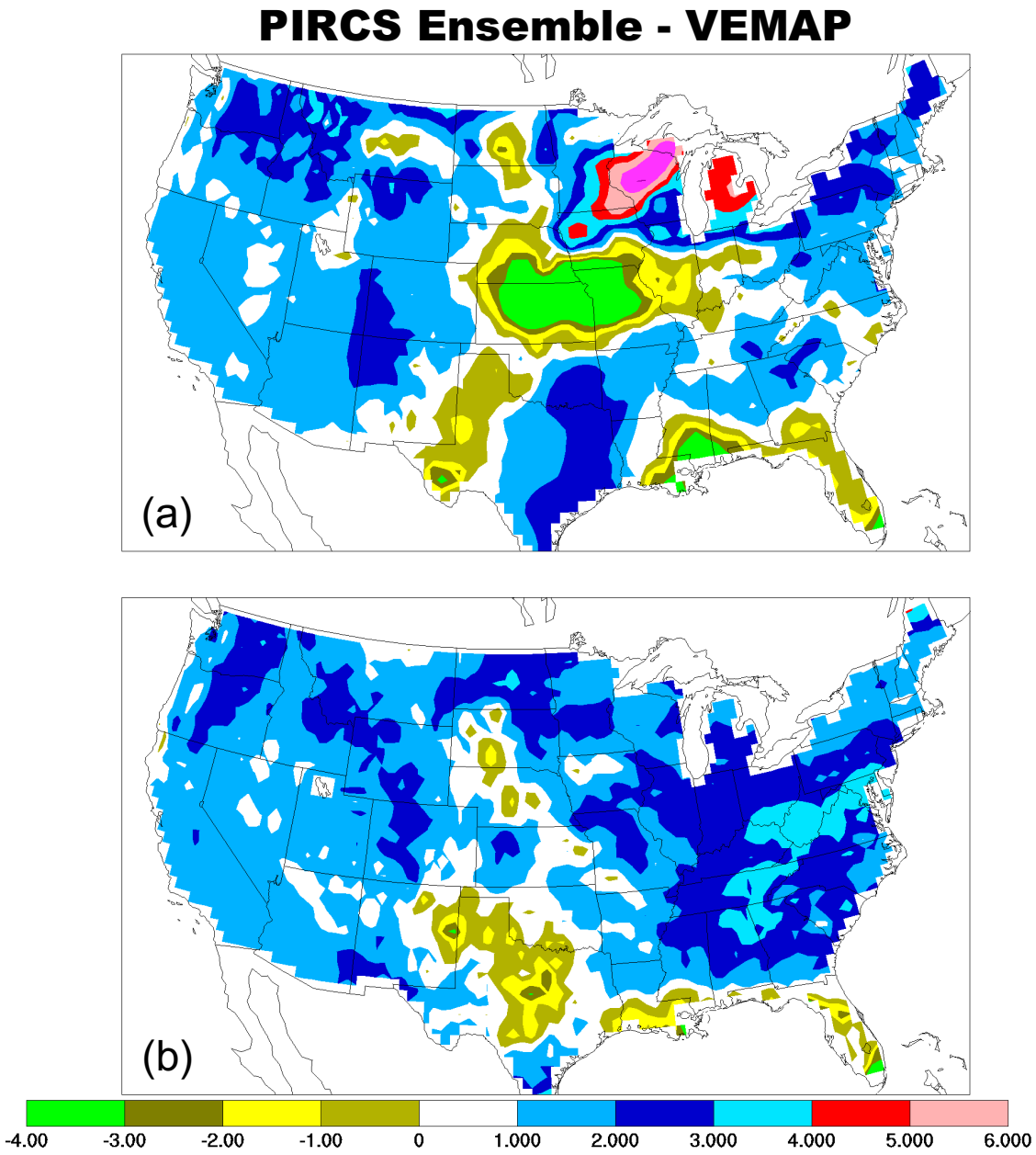


Figure 1: 500 hPa geopotential height difference, PIRCS 1b – PIRCS 1a, from (a) the NCEP/NCAR reanalysis and (b) ensemble average of PIRCS simulations. Contour interval: 20 m.



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