

## 2A.9

### GLOBAL TO LOCAL SCALE SIMULATIONS OF STREAMFLOW IN THE MERCED, AMERICAN, AND CARSON RIVERS, SIERRA NEVADA, CALIFORNIA

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Atmospheric moisture transport and moisture budgets during winter (December-April) simulated by the National Centers for Environmental Prediction (NCEP) regional spectral model (RSM) are examined and used to simulate streamflow variations in the Sierra Nevada. The RSM was nested in 2°-latitude x 2°-longitude NCEP-reanalyzed atmospheric-data fields (as a surrogate for a perfect forecast system operating at the global scale). Precipitation, temperature, and solar insolation simulated by the RSM on a 50-km grid were inputted directly to precipitation-runoff models of the Merced, American, and Carson Rivers in an evaluation of the potential for end-to-end forecasting of streamflow and snowmelt runoff from the Sierra Nevada, near 39°N 120°W. Over the western United States, the RSM captures both patterns and magnitudes of precipitation (e.g., Fig. 1 illustrates observed and simulated precipitation for winter 1982-83). The RSM has dry biases in the Southeast and over the Gulf of Mexico, but it captures interannual and intraseasonal variations well. During most El Niños, it simulates a precipitation dipole over the western states with wetter-than-normal conditions in California and drier-than-normal in the Pacific Northwest. The Northeast is relatively dry and the southern states are wet, as in observations. The RSM did equally well during La Niña winters.

The RSM simulations at grid points over the Sierra Nevada were inputted directly to precipitation-runoff models of three river basins. The runoff models simulate daily water and energy balances within basin areas of about 900 (North Fork American), 700 (East Fork Carson), and 500

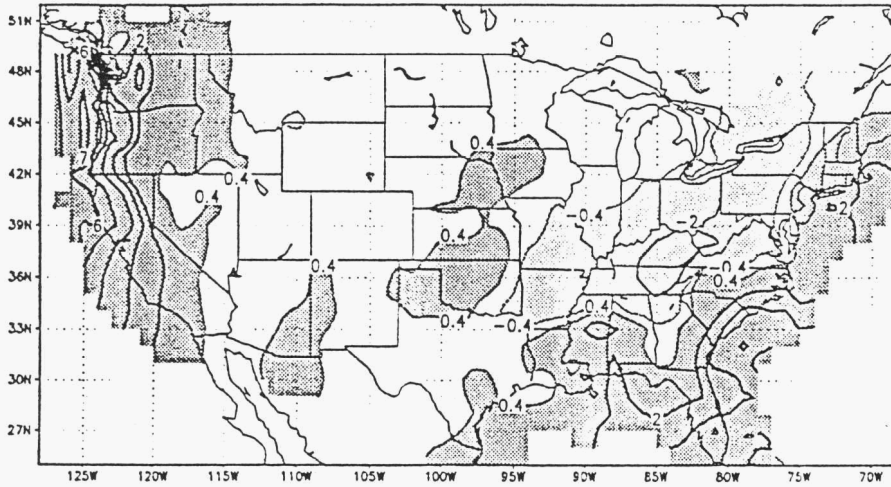
km<sup>2</sup> (Merced above Happy Isles), with internal variations of elevation, slope, aspect, soils, and vegetation represented at a spatial resolution of 100 m. The river basins range from 200 m to as much as 4,000 m above sea level, with the American River being lowest and warmest. Because it is a lower basin, streamflow in the American River is about half wintertime rainfall runoff and half springtime snowmelt runoff; the higher and cooler Carson and Merced Rivers are dominated by springtime snowmelt runoff.

The different altitudes and temperatures of the basins result in different requirements from, and sensitivities to, global-to-local downscaling: The snowmelt-dominated Merced and Carson River models accumulate cool-season precipitation in thick snowpacks that release most of their water in one major surge during the spring time. Downscaling to these models is sensitive to the overall cool-season precipitation total and to the simulated timing of the regional springtime transition from cool winter to warm spring temperatures (Fig. 2a, b). Downscaling to the mixture of rainfall and snowmelt runoff in the American River, in contrast, depends on the timing, temperatures, and precipitation totals of individual winter storms and thus is a more difficult task (Fig. 2c). The simulated streamflows are encouragingly like the historical flows in most years, but years with poor performance also occur. Much of the success of this downscaling effort is attributed to the regional scale of the most hydrologically important weather fluctuations affecting Sierra Nevada rivers.

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a) Observed winter precipitation anomalies, 1983



b) Simulated winter precipitation anomalies, 1983

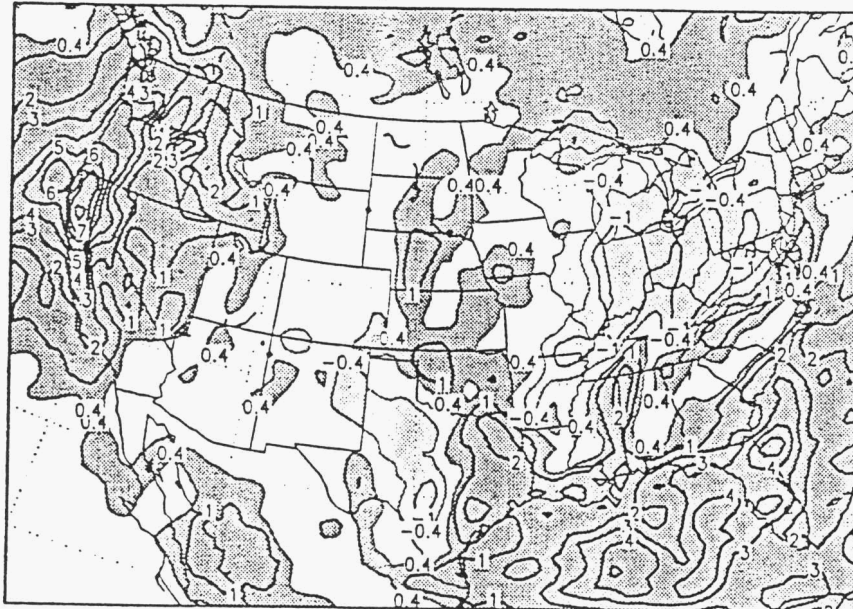
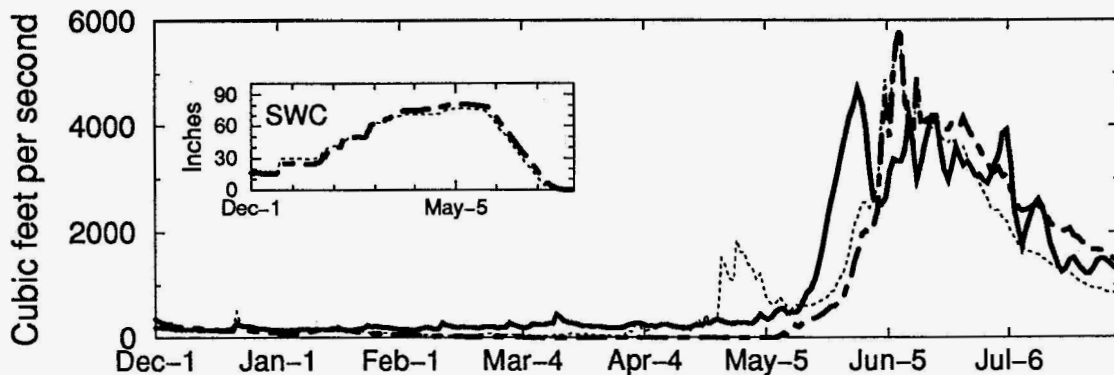
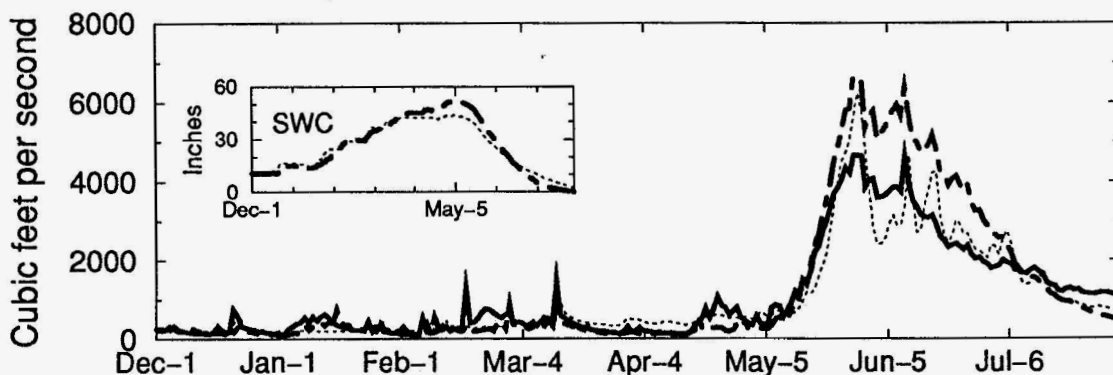


Figure 1. (a) Mean winter (January-March) differences in observed precipitation between 1982-83 and the 1992-96 climatology, and (b) same as (a) but for RSM simulation. Contour interval is 1 mm day<sup>-1</sup> with contours for -0.4 and 0.4 mm day<sup>-1</sup> added. Values greater (less) than 0.4 (-0.4) mm day<sup>-1</sup> are dark (light) shaded.

a) Merced River streamflow, 1982-83



b) Carson River streamflow, 1982-83



c) American River streamflow, 1982-83

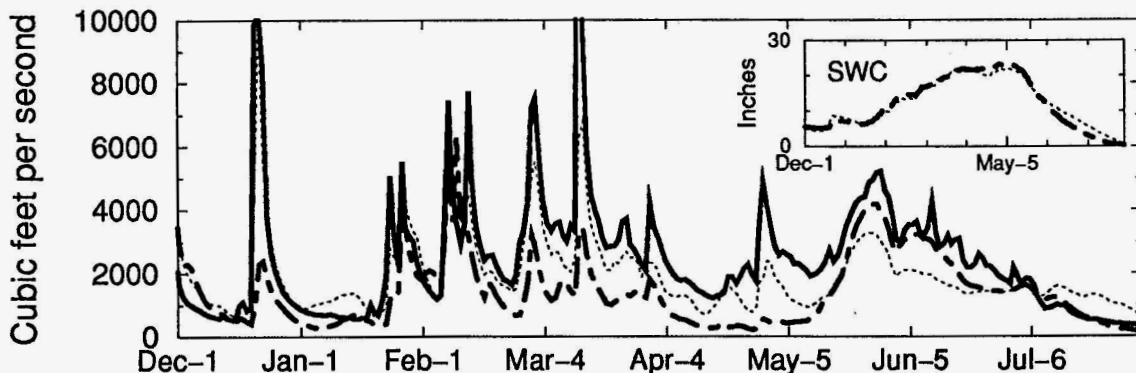


Figure 2. Comparisons of streamflows during winter and spring 1982-83 as observed (heavy solid curves), as simulated with weather observed at surface sites (light, dotted curve), and as simulated with weather from the Regional Spectral Model (RSM) simulation (heavy, dot-dashed curve), in Merced (a), Carson (b), and American (c) Rivers. Inset are basin-averaged snow-water contents (SWC), in inches, as simulated with observed weather (light, dotted) and with RSM-simulated weather (heavy, dot-dashed). After April 30, both simulations use observed weather.