Patil, S., P.J. Wigington Jr., S.G. Leibowitz, E.A. Sproles, and R.L. Comeleo (2013), How does spatial variability of climate affect catchment streamflow predictions?
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Spatial variability of climate can negatively affect catchment streamflow predictions if it is not explicitly accounted for in hydrologic models. In this paper, we examine the changes in streamflow predictability when a hydrologic model is run with spatially variable (distributed) meteorological inputs instead of spatially uniform (lumped) meteorological inputs. Both lumped and distributed versions of the EXP-HYDRO model are implemented at 41 meso-scale (500 – 5000 km^2) catchments in the Pacific Northwest region of USA. We use two complementary metrics of long-term spatial climate variability, moisture homogeneity index (I_M) and temperature variability index (I_{TV}), to analyze the performance improvement with distributed model. Results show that the distributed model performs better than the lumped model in 38 catchments, and noticeably better (>10% improvement) in 13 catchments. Furthermore, spatial variability of moisture distribution alone is insufficient to explain the observed patterns of model performance improvement. For catchments with low moisture homogeneity (I_M < 80%), I_M is a better predictor of model performance improvement than I_{TV}; whereas for catchments with high moisture homogeneity (I_M > 80%), I_{TV} is a better predictor of performance improvement than I_M. Based on the results, we conclude that: (1) catchments that have low homogeneity of moisture distribution are the obvious candidates for using spatially distributed meteorological inputs, and (2) catchments with homogeneous moisture distribution benefit from spatially distributed meteorological inputs if those catchments have high spatial variability of precipitation phase (rain vs. snow).