Evaluation of NARR and CLM3.5 outputs for surface water and energy fluxes in the Mississippi River Basin

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The North American Regional Reanalysis (NARR) and Community Land Model (CLM, version 3.5) outputs are analyzed to characterize the surface water and energy fluxes in the Mississippi River Basin (MRB). NARR and CLM performance are evaluated with reference to energy flux observations from 16 AmeriFlux sites in MRB. The issue of point scale observations versus climate model grid cell outputs is addressed by analyzing the spatial variability in long-term monthly precipitation and temperature observations from 71 United States Historical Climatology Network (USHCN) stations in Indiana and Illinois. NARR outputs are compared to the observation at two different resolutions: (1) 32 km, NARR original resolution (2) 280 km, NARR outputs aggregated to CLM resolution. The model outputs are also evaluated for their ability to capture spatial and temporal variability in total runoff.

NARR monthly outputs of near surface air temperature and precipitation are comparable to the observation and CLM forcing data. However, sensible heat flux and latent heat flux differ significantly between NARR and CLM outputs. Compared to average values at 11 AmeriFlux sites in MRB, NARR show higher biases (compared to CLM) in incoming solar radiation (24%), sensible heat flux (27%), and latent heat flux (59%), whereas CLM show smaller biases (compared to NARR) in incoming solar radiation (0.5%), sensible heat flux (−2%), and latent heat flux (11%). The seasonal cycle of observed sensible heat flux in the crop region shows two peaks (bimodal pattern), which is captured by NARR, but CLM do not show any bimodal pattern. Based on 25 years (1980–2004) monthly climatology in MRB, NARR has 11% energy balance closing error (latent + sensible + ground heat flux = 1.11 net radiation) and 12% water balance closing error (evapotranspiration + runoff = 1.12 precipitation), whereas CLM does not have water and energy balance closing errors, primarily due to model design.

The issue of comparing point scale observations with gridded model outputs is addressed by using 113 years of monthly precipitation and temperature records at 71 USHCN stations in Indiana and Illinois. It is found that monthly precipitation and temperature are not statistically different for at least 248 km distance in Indiana and Illinois. Analysis of pair wise energy flux observations from neighboring stations show that effects of land cover type on summer latent heat flux/ET (which is greater than 80% of annual total ET) is minimal. Sensible heat flux show

higher difference compared to latent heat flux at neighboring stations with different land cover types.

In comparison to the observed mean annual runoff (237 mm/year), NARR highly underestimate total runoff in the basin (89 mm/year), where as CLM runoff (281 mm/year) is closer to the observations. Overall, CLM provides relatively better characterization of surface water and energy fluxes in the MRB compared to NARR. Runoff is an abundantly available observation in many parts of the word. The runoff observation also provides a constrain term for surface energy and water balance equations. Hence, we argue the assimilation of runoff observation in the reanalysis data may improve its performance, particularly for Hydrologic applications.

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