Dynamic Influence of Wetlands on Arctic Climate Revealed by Ensemble RCM Simulation

W. J. Gutowski, Jr. (1,2), H. Wei (1,3), C. Vörösmarty (4) and B. Fekete (4)
(1) Dept. Geological and Atmospheric Sciences, Iowa State Univ., USA
(2) Dept. Agronomy, Iowa State University, USA
(3) Current affiliation: Byrd Polar Research Center, Ohio State Univ., USA
(4) Inst. for the Study of Earth, Oceans and Space and Earth Sciences Dept., Univ. New Hampshire, USA

The Arctic land surface has large areas or relatively flat terrain where surface water flow is poorly organized yielding wetlands characterized by saturated soil and scattered pools of surface water. Arctic wetlands have long been recognized for their importance in the global carbon cycle;. global warming may reduce their areal extent. Changes in the status of wetlands constitute a change in lower boundary conditions for atmospheric simulation. Any manifestation of this change in the circulation must be measured against ongoing fluctuations the circulation will experience by virtue of its own internal, nonlinear dynamics. For the signal to be significant, it must be larger than these fluctuations, otherwise it is obscured by the "noise" of the internal variability. Following the methods of Giorgi and Bi (2000), we simulate an ensemble of RCM pan-Arctic simulations using a version of MM5 to examine how the areal extent of Arctic wetlands influences atmospheric dynamics and thus Arctic energy and water cycles.
The ensemble set includes a 6-month baseline run (April - September 1986) with 4 additional perturbation runs (NONWET set). Two wetlands runs (WET set) use a US Geological Survey database to prescribe substantially larger Arctic wetland area than contained in the standard MM5 land-use data set. WET-NONWET differences remain within the spread of NONWET simulations for most of the pan-Arctic, except for wetlands in central Siberia. There, differences exceeding the NONWET spread occur when the first baroclinic storm of spring penetrates this region that the Siberian high dominates during winter. The WET-NONWET difference is expressed approximately by an equivalent barotropic wave advected by the large-scale flow. Extensive wetland areas in eastern Siberia and northern Canada produce insubstantial WET-NONWET differences because they are outside typical storm tracks. However, even the large WET-NONWET differences in central Siberia are ephemeral and fade as coupled land-atmosphere water cycle processes spread wetlands-induced moisture modifications outside the core wetlands region.