Introduction of mire parameterization into numerical weather prediction model SL-AV

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Including horizontal heterogeneity of soil moisture into the numerical weather prediction (NWP) model is one of the research priorities (e.g., Gedney and Cox, 2003). Mires change significantly the thermal regime and moisture status of the territory in the boreal zone where mires are numerous. Here we present a first attempt to develop a mire parameterization for the NWP model. SL-AV (semi-Lagrangian, absolute vorticity) is a 3D global finite-difference numerical weather prediction model (Tolstykh, 2001) used operationally in the Hydrometeorological Center of Russia. The current version of the model has the horizontal resolution of 0.9×0.72° lon-lat and 50 vertical levels. Mire parameterization consisted of the following model modifications:

(1) force-restore method used to simulate soil temperature was replaced by the solution of the heat diffusion equation in the multilayer model domain (Wania et al., 2009), thermal properties of the peat were specified;
(2) Mixed Mire Water and Heat model (MMWH, Granberg et al., 1999) was used to simulate the water table position, evapotranspiration, and runoff from a mire;
(3) prescribe albedo, emissivity and roughness length for this type of ecosystems were used.

We used data on prescribed mire area extent (Vompersky et al., 2005) shown in Figure 1. The modified version of the NWP model SL-AV was used in online simulations for July-August 2008 starting from the initial conditions at 00 UTC.

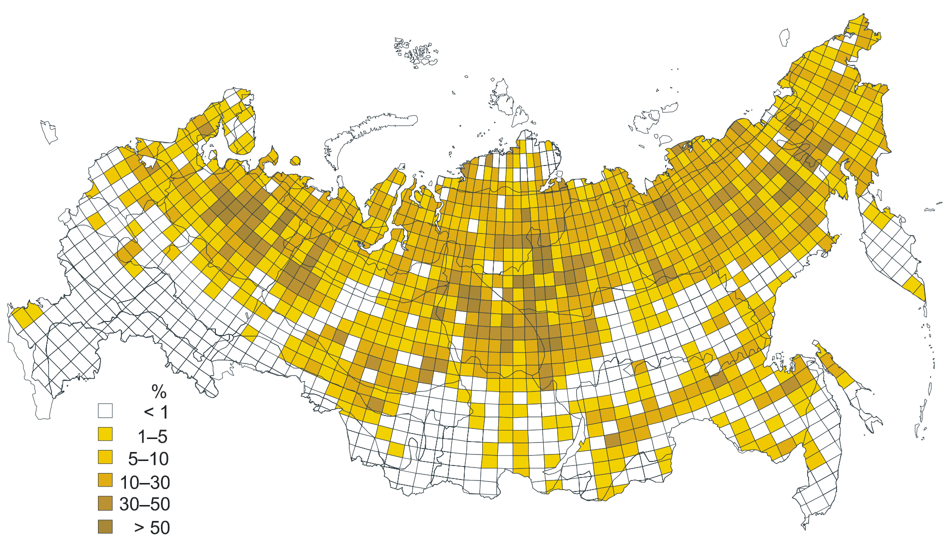

Figure 1. Map of the mire spatial distribution on the territory of Russia (Vomperskij *et al.*, 2005)

The components of the energy balance were estimated for the mire grid cells in the area 60-85°E, 55-63°N (Western Siberian Lowlands) where mires are abundant. The latent heat flux has increased strongly with the incorporation of evaporation from mires into the model. This increase of the latent heat flux has produced a surface cooling. As a result, the sensible heat flux and outgoing terrestrial long-wave radiation decreased.

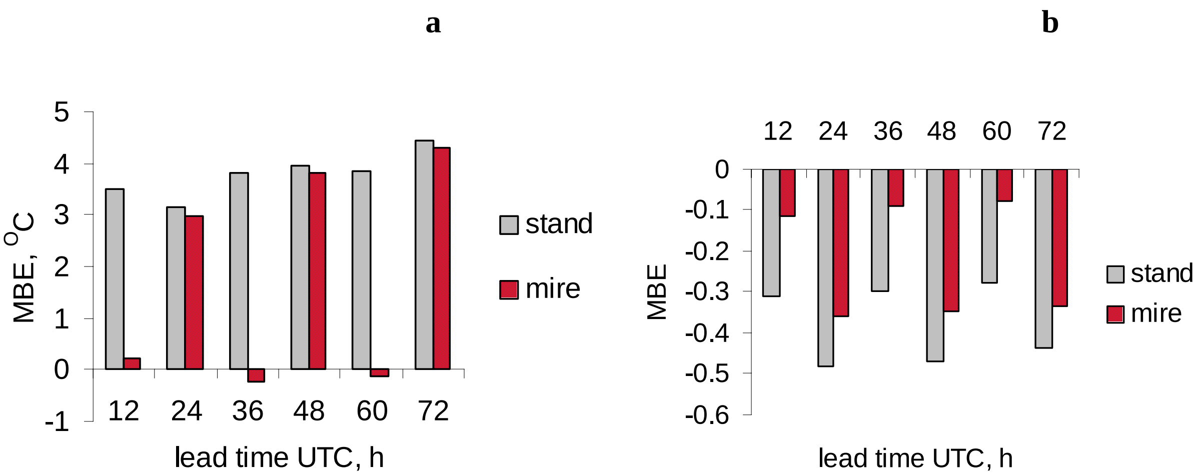

Figure 2. Mean bias error (MBE) for the standard run (stand) and run with included mire parameterization (mire): (a) 2-m temperature and (b) 2-m relative humidity.

Forecast skill was estimated using measurements at the meteorological stations in Western Siberia (60-85°E, 55-63°N) situated in the mire vicinity. Stations included in the analysis had at least 50% covered by mires in each of the 4 adjacent nodes. An error reduction is seen both in 2-m temperature and relative humidity (RH) forecast with lead times of 12, 36 and 60h starting at 00 UTC when mire parameterization was implemented (Fig. 2). Some improvement is seen in RH forecast with lead times of 24, 48 and 72h, but an error reduction in 2-m temperature is more modest at these time points (Fig. 2). Almost two times reduction is seen in root-mean-squared error of temperature and RH for lead times of 12, 36 and 60h, for example, RMS temperature error for 36 hours forecast is reduced from 4.8 to 5.9°C. Therefore, the mire parameterization helped to reduce a large warm temperature bias in the forecast for lead times of 12, 36 and 60h, but did not eliminate forecast bias for lead times of 24, 48 and 72h. We hypothesize that remaining errors in morning hours (local time) is due to model faults in the surface layer mixing dynamics.

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