River runoff simulation in the INM RAS-MSU land surface scheme

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River runoff – one of the components of the global hydrological cycle

In the INM RAS-MSU Earth system model river runoff:

- set the flow of fresh water into the ocean
- is a convenient criterion for the land model validation

Premises for improvement of runoff calculation in Earth system models are:

- rivers provide significant carbon inflow into the ocean
- the need to account for the flow of heat and radiation from the river surface
- the relevance of the forecast of river level and runoff

Improving of river runoff calculation scheme

- River runoff values was inaccurate [Nasonova et al., 2018], particularly spring flood wasn't simulated
- Here it is the correction of outer parameters and functional form of some parametrizations
- Verification principle – comparing the values of the simulated and observed runoff in the mouths of large (resolved on the model grid) rivers (here it is Northern Dvina)
- Land block of ESM INM-RAS MSU was studied separately from atmosphere block. As a source of meteorological forcing reanalysis ERA-Interim was taken (1979-1994, 1°x1°, 6h)

Successful modifications of the land model INM RAS-MSU

1) Increasing of the resolution of the spatial grid

before: grid 2°x1.5°, geographical parameters from [Wilson and Henderson-Sellers, 1985]

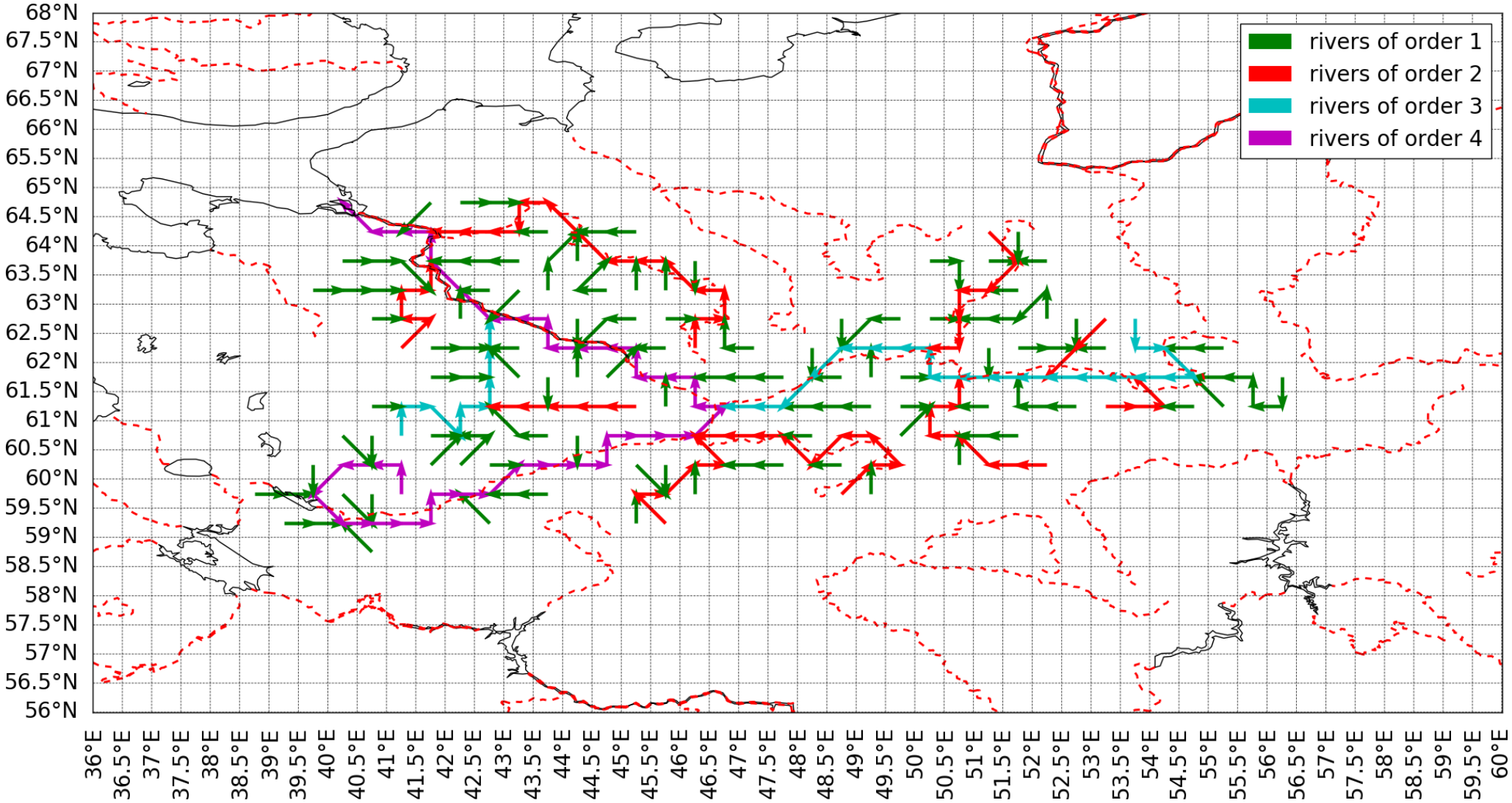
now: grid 0.5°x0.5°, geographical parameters from ECOCLIMAP-I [Champeaux et al., 2005] except for lake distribution that is from ISIMIP2b project data [Lehner and Döll, 2004; Choulga et al., 2014]

2) Modelling of the river net – 1D-kinematic wave equation solving along sides of river net graph – built from flow direction and slope data on the grid 0.5°×0.5° from ISIMIP project (https://www.isimip.org/)

3) Modelling of liquid water in the snow cover:

before: melt water falls into the soil

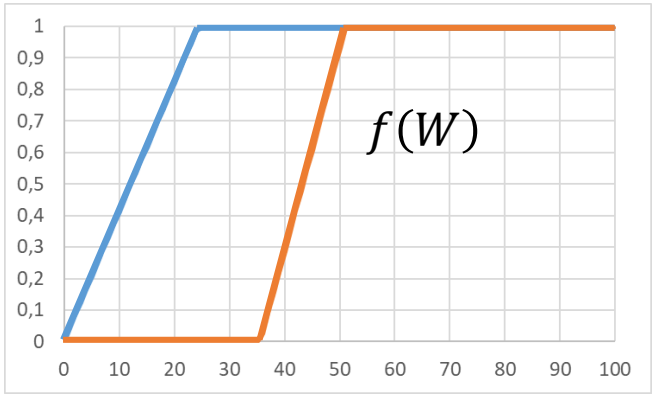
now: melt water flows through snow cover thick; heat effects (e.g., possible refreezing) also included [Machulskaya, 2001]



Flow direction field in land model INM RAS-MSU on the grid 0.5°×0.5, the Northern Dvina basin. Colors show a river order, dashed red lines – actual rivers, black line – shoreline

Successful modifications of the land model INM RAS-MSU

4) Correction of stress-function f shape describing the soil water influence on the vegetation stomatal resistance R_s [Klimarechenzentrum et al., 1992]**:**



before

now

$\frac{W}{W_{max}}, \%$ – soil saturation

$$R_s \sim f(W),$$

where W – function of soil water content in root zone

5) Recalculation of the dynamic roughness z_0 map – tile parameters [Davenport et al., 2000] vs relief absolute height function

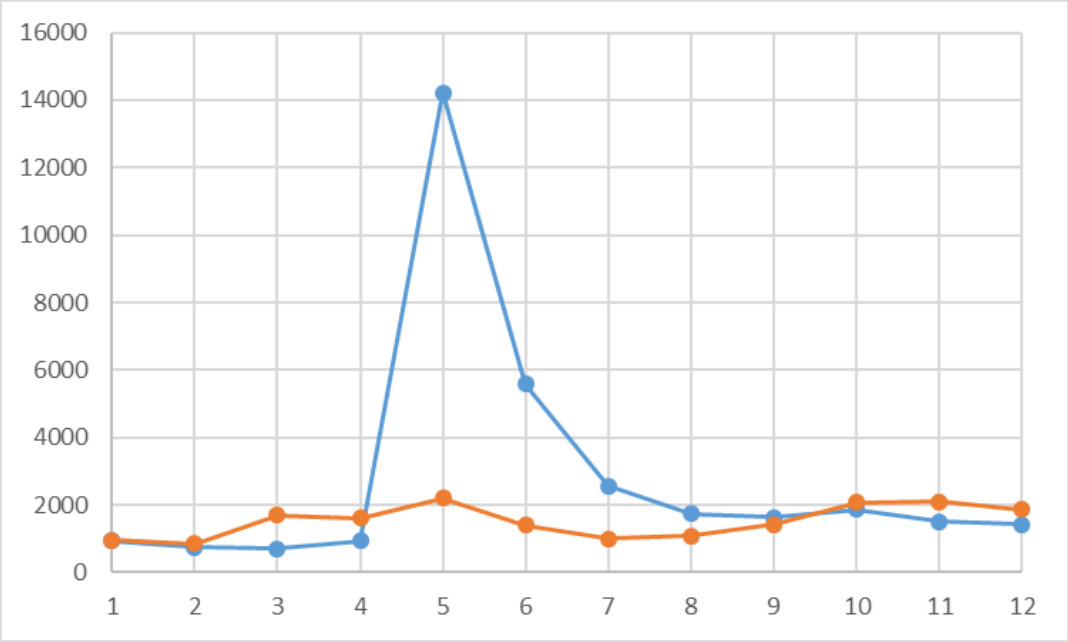
6) Setting of LAI seasonal changes – monthly average values [Bonan, 1996] vs year average [Dorman and Sellers, 1989]

7) Revision of snow-free surface albedo setting – interactive calculation [Bonan, 1996] vs parametric values [Wilson and Henderson-Sellers, 1985]

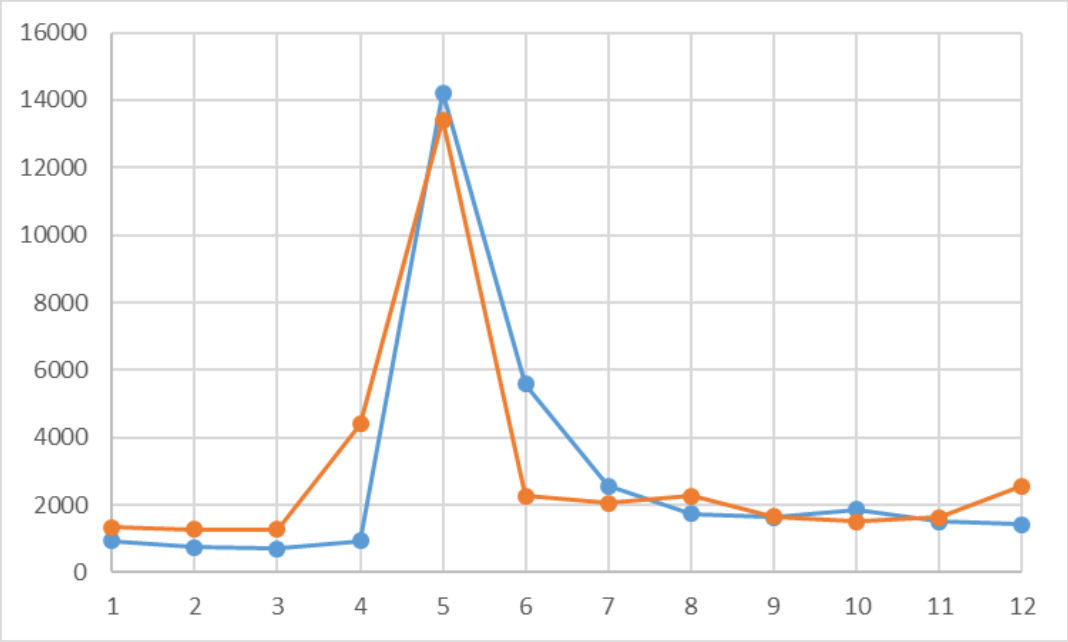
Results

Monthly average discharge of the Northern Dvina in 1980 [m^3/s]

before



now



observed values (g. Ust'-Pinega, 137 km to outlet)

modelled values (in outlet)

Thanks!