HS10.7 – Peatland Hydrology
EGU2018-4258.

1St
High resolution 3D dynamic modeling of a complex mire

Dynamics of water stage and runoff of a pristine bog complex in Central West–Siberia calculated with a high resolution three–dimensional PCRaster MODFLOW model

Modeling with **PCRaster-Modflow** [www.pcraster.geo.uu.nl]
freeware on Python platform for use in Windows & Linux. PCRMF is a coupled system of PCRaster and Modflow2000
developed by Oliver Schmitz

Objectives
- To obtain dynamic and spatial data of (ground) water level and water depth data (e.g. for methane flux prediction);
- To improve the understanding and quantification of waterflows through the peatlayers and by overland flow in relation the vegetation structure of bog-mires;
- To quantify the export of dissolved Carbon from mires by running water: missing factor in Carbon balance studies of wetlands;
- To provide relevant data to engineers for land use planning (e.g. road construction through mire landscapes)
- To enhance scientific knowledge of pristine bog ecosystems

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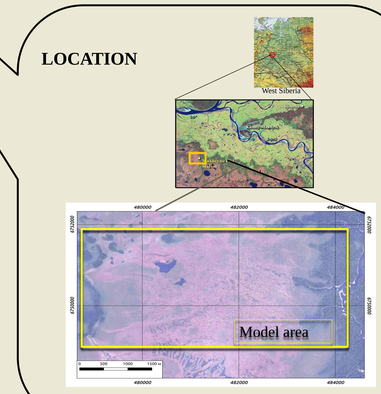
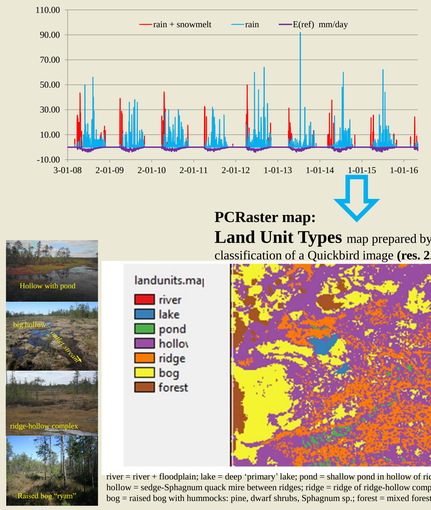
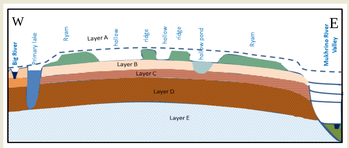
LOCATION







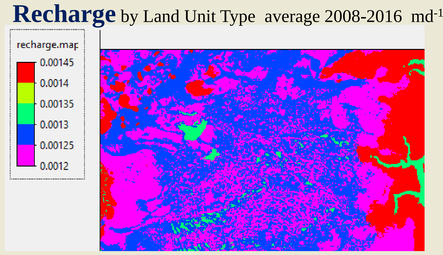
Schematical West-East cross section through the model area

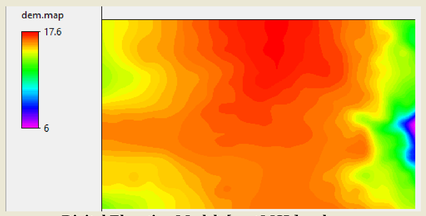
PCRaster map:
Land Unit Types map prepared by supervised classification of a Quickbird image **(res. 2.4 m)**

river = river + floodplain; lake = deep 'primary' lake; pond = shallow pond in hollow of ridge-hollow complex;
hollow = sedge-Sphagnum quack mire between ridges; ridge = ridge of ridge-hollow complex: ,pine, dwarf shrubs, Sphagnum Sp.;
bog = raised bog with hummocks: pine, dwarf shrubs, Sphagnum sp.; forest = mixed forest on mineral soil: Populus, Pine, Betula

PCRaster map for Steady State Model: recharge.map

Recharge by Land Unit Type average 2008-2016 md^{-1}





Digital Elevation Model: [m +MSL] dem.map

Top model

calculation model area distributed Recharge (recharge.map)

$R_i = Sm + P - f_i E_{ref}$ $[md^{-1}]$

Ri = Recharge of Land Unit Type (i)
Sm = snow melt
P = rain
$f_i E_{re}$ = refrence Evapotranspiration (Makkink)
f = Land Unit Type specific reduction factor

PCRaster-Modflow

5 layers (A – E), 464 x 743 cells/layer,
cell length 7 m,
Model period 1/3/2008 - 30/11/2016

INPUT maps:
Clone.map, Ibound.map, ihead.map
Conductivity maps/layer kh*.map, kv*.map
Drains rivers, margins: N and S: layerB
West margin: drains in Layer C;
East margin: drains in layer D

INPUT
Condcutivity/Layer
Kh*.map, kv*.map
Drains/Layer
Drain_Elevation.map
Drain_Conductience.map

Steady State
For model calibration
Steady State (average of 8 year **recharge.map**)

Transient
timestep 1 day: Timeseries of
Recharge/Land Unit Type
Frost period 1/12 – 1/3 no recharge
Frozen subsoil 1/12 - 1/6 model layer B

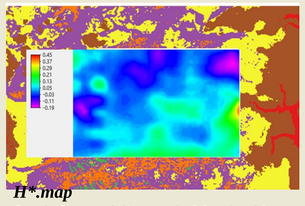
Result maps:
H*.map

|h*.map – DEM | > 0.02 m. & |water balance |> 1%

|h*.map – DEM | < 0.02 m. & |water balance | < 1 %

Output (up to 60 Gb):
time series of
PCRaster maps per layer:
Head maps
Flux maps X, Y, Z

Post processing

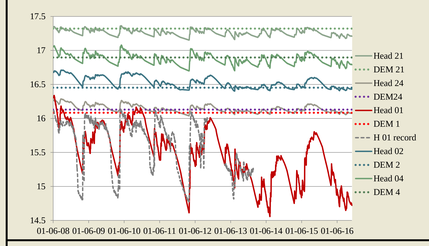


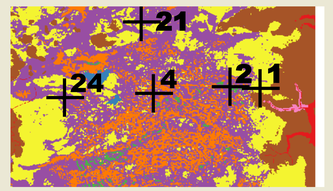
H*.map
Steady Sate modeling result: Waterlevel in m. above (>0) or below (<0) DEM in a selected central part of the model area

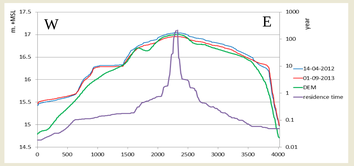
	elevation m.		river	lake	pond	hollow	ridge	ryam	forest
top A =	DEM + 0.5	kh A	10^1	10^1	10^1	10^1	10^1	5.10^1	21
top B =	DEM	kh B	5.10^1	10^1	10^1	10^1	5.10^1	2.10^2	21
top C =	DEM - 0.3	kh C	5.10^1	10^1	10^1	10^1	10^1	10^1	21
top D =	DEM - 1.0	kh D	5.10^1	5.10^4	2	2	2	2	21
top E =	DEM-3.5	kh E	20	20	20	20	20	20	20
Bottom E	MSL	kv A	10^1	10^1	10^1	10^1	10^1	10^1	500
		kv B	5.10^1	10^1	10^1	5.10^1	25.10^1	10^1	21
		kv C	5.10^1	10^1	10^1	50	50	50	21
		kv D	5.10^1	5.10^4	1	1	1	1	21
		kv E	2.10^1	2.10^1	2.10^1	2.10^1	2.10^1	2.10^1	2.10^1

Input conductivity of the 3D model:
elevation of model layers in m. relative to DEM,
kh = horizontal conductivity (md^{-1}),
kv = vertical conductivity ($kv\ md^{-1}$)

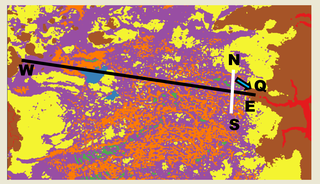
Some MODEL results

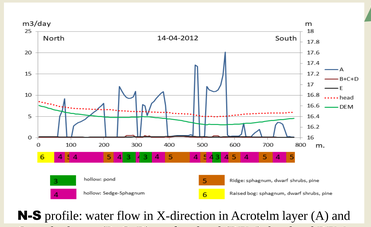




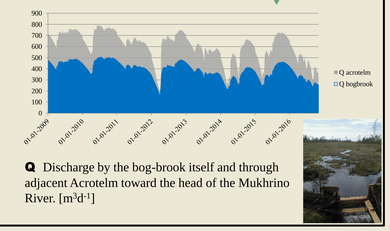


W-E profile: surface level (DEM); heads in spring and autumn; residence time along the profile





N-S profile: water flow in X-direction in Acrotelm layer (A) and Catotelm layers (B+C+D); surface level (DEM); head and DEM



Q Discharge by the bog-brook itself and through adjacent Acrotelm toward the head of the Mukhrino River. [m^3d^{-1}]

Presentation by PC (***Oliver Schmitz***) : dynamic results