



Processes of runoff formation at the Putorana Plateau (Central Siberia, Russia)

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Relevance



The study area is still unexplored in hydrological terms

the lack of observations ->
the lack of understanding of the rivers and permafrost interaction
-> the complexity of developing reliable estimation and forecasting methods



Climate change

the increase in the thickness of active layer->
the changes of the runoff formation conditions



Using the hydrological model "Hydrograph"

minimum standard meteorological information ->
parameterization of physical and geographical conditions ->
assessment the water balance formation

Aim and tasks of the study

The purpose of the work is to study the factors of runoff formation, the research of geocryological conditions based on short-term expedition data of the State Hydrological Institute collected in small catchments in 1990.

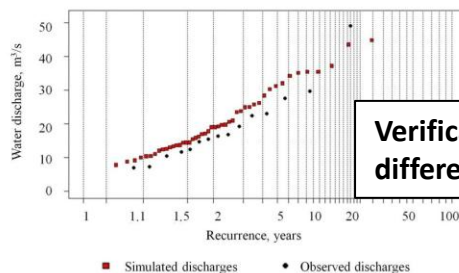
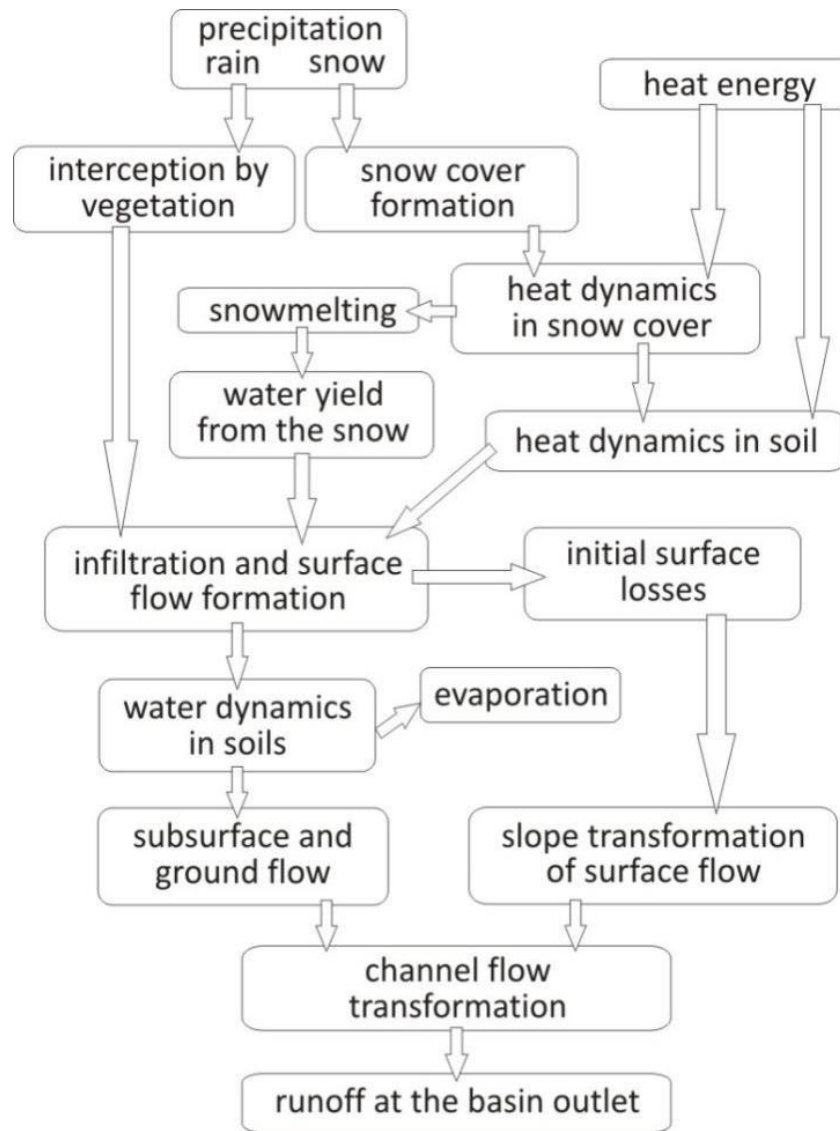
- 1) Parameterize and verify hydrological model using available short-term expedition data.
- 2) Apply hydrological model and restore continuous gaps in recent hydrological data.



Methods

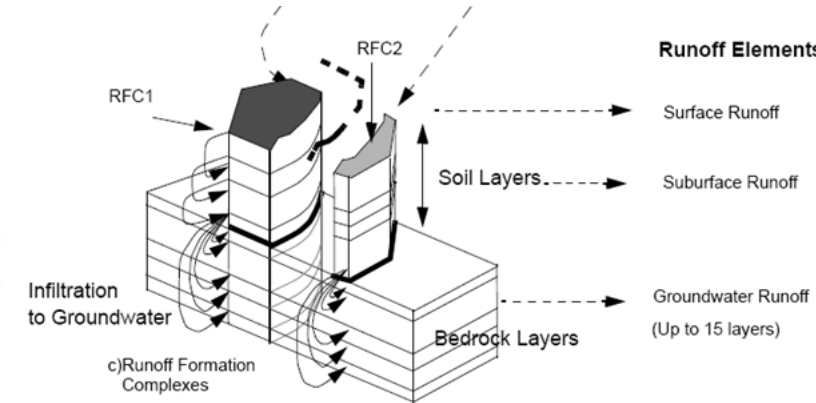
Hydrograph model

- **Distributed hydrological process-based model** with single structure for watersheds of any scale.
- Most parameters are transferrable to other basins with similar landscapes of any size without change (**free of scale problem**).
- **Simple input data:** daily data of air temperature, air moisture deficit and precipitation

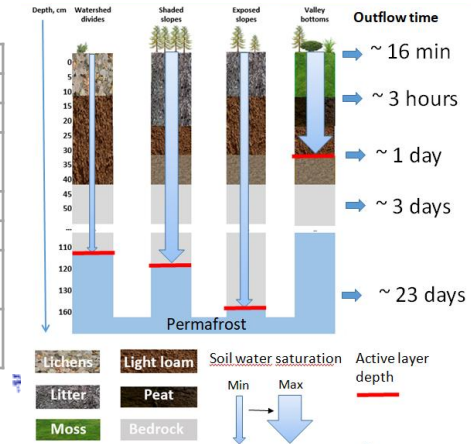


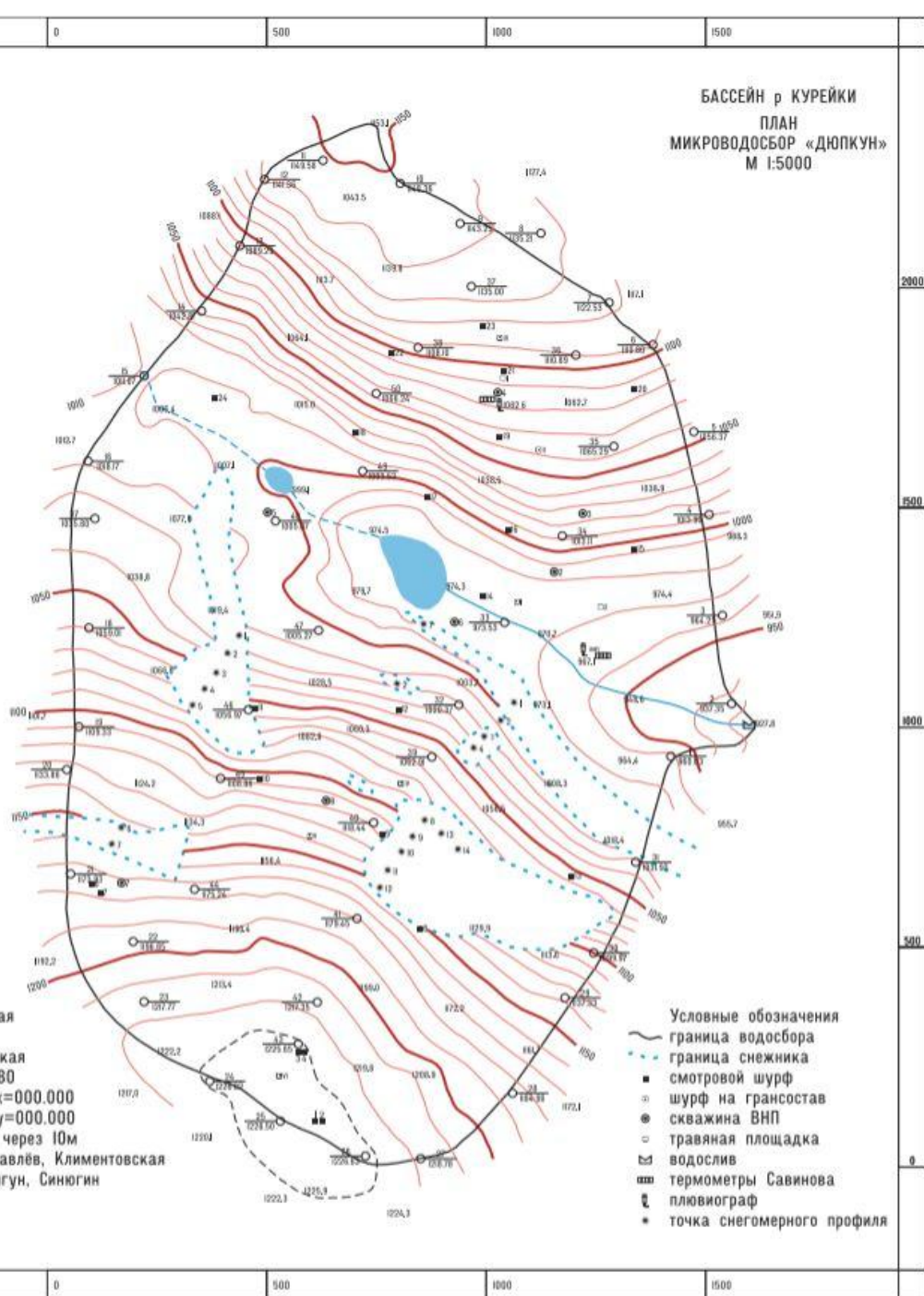
Verification model at the different regions->

Landscapes govern specific hydrological processes. The set of model parameters develop for each of them.



Soil parameters	
Density, kg/m ³	
Porosity, m ³ / m ³	
Maximum water holding capacity, m ³ / m ³	
Infiltration coefficient, mm/min	
Specific heat capacity, J/(kg°C)	
Specific heat conductivity, W/(m°C)	
Hydraulic parameter of soil runoff elements, m ³ /s	





Study area



The stream Dupkun (area 2.75 km²)

- The southwestern part of the Putorana Plateau.
- Altitude: 305-1228 m.
- The climate: sharply continental.
- The temperature:
the maximum in July is 32-34 °C,
the absolute minimum in January is -57- -68 °C.
- Precipitation: 600-750 mm.
- The average height of the snow cover is 150-200 cm.
- The average active layer is 0.5 m.

The average annual temperature -11.4 °C.
The average annual precipitation 452 mm.

Parameterization



Short-term expedition data of the State Hydrological Institute in 1990

Model meteorological input
from 1 weather stations.

The runoff formation complexes (RFC):

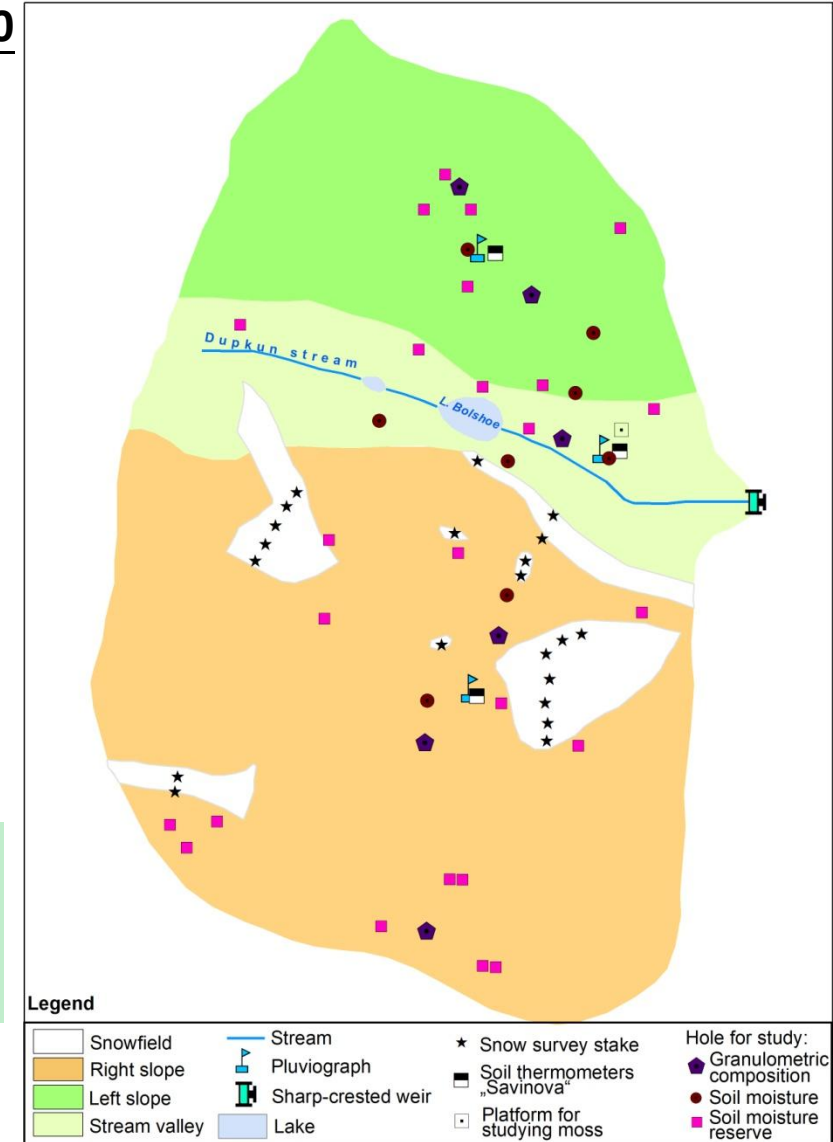
homogeneous in soil,
vegetation and landscape
characteristics:

- Tundra right slope
- Tundra left slope
- Stream valley

Each RFC has its own set of soil and
vegetation parameters.

The parameters were adopted from the
special observation data from:

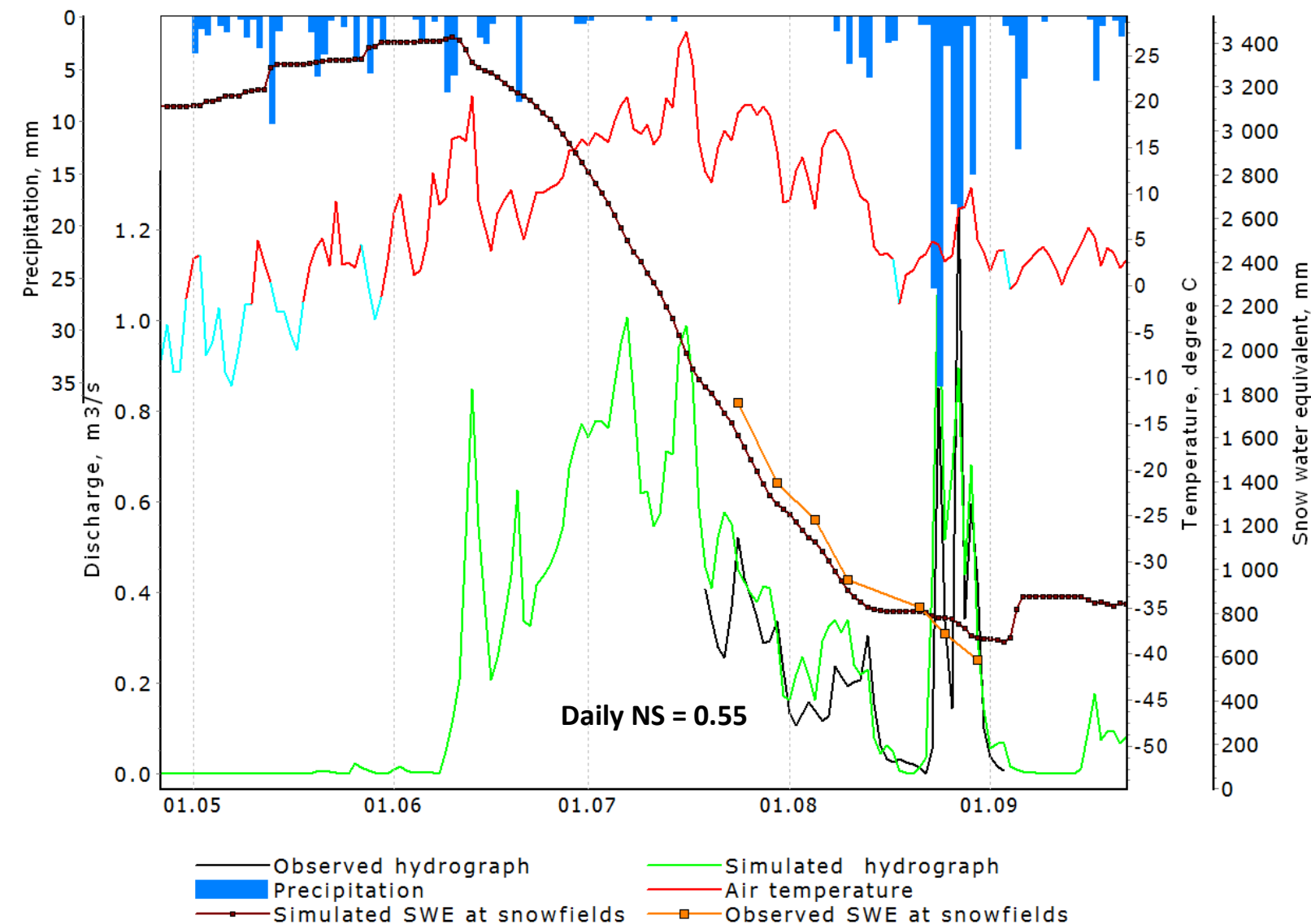
- the Kolyma water balance station
(<https://doi.org/10.5194/essd-10-689-2018>);



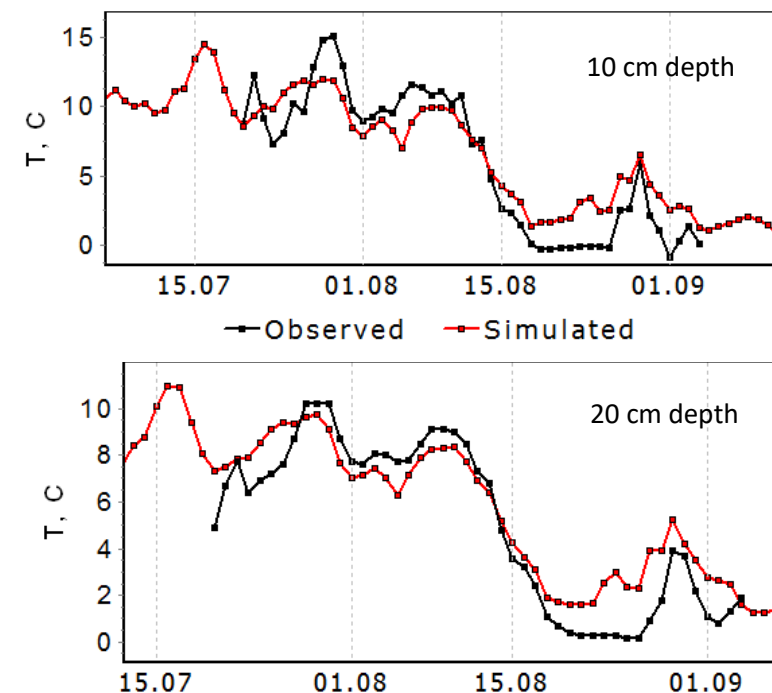
Results of simulations (without calibration)



The simulation of daily streamflow and variable states of snow and soil was carried for the period from 19 July to 3 Sept 1990.



Observed and simulated soil temperature



Water balance, mm

Observed flow	356
Simulated flow	456
Snowmelt	259
Precipitation	196
Evaporation	46

Most of the flow is produced by snowmelt from snowfields (15% of the watershed territory), rainstorms provide the peaks of the flow hydrograph.

The parameters of soil require additional adjustments.

Conclusions

1. The results of simulations can be considered satisfactory considering the limitations of available information.
2. The results confirm the possibility to apply the hydrological model Hydrograph to assess the water balance and hydrological characteristics in the southwestern part of the Putorana Plateau.
3. These observations are considerable value due to the lack of knowledge of the geocryological, landscape and hydrological conditions of this region.
4. Short-term observations in unexplored regions of the world should be systematized and analyzed as the expansion of the observing network in the nearest future is highly unlikely.



The left slope of the valley of Lake Dupkun below the mouth of the Talnikovaya River (1990)

Thank you for your attention!

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