2nd Baltic Earth Conference

“The Baltic Sea in Transition”

Hydrological regime modelling in the eastern part of the Baltic Sea basin (Western Dvina (Daugava) river basin)

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Helsingør, Denmark, 11 to 15 June 2018

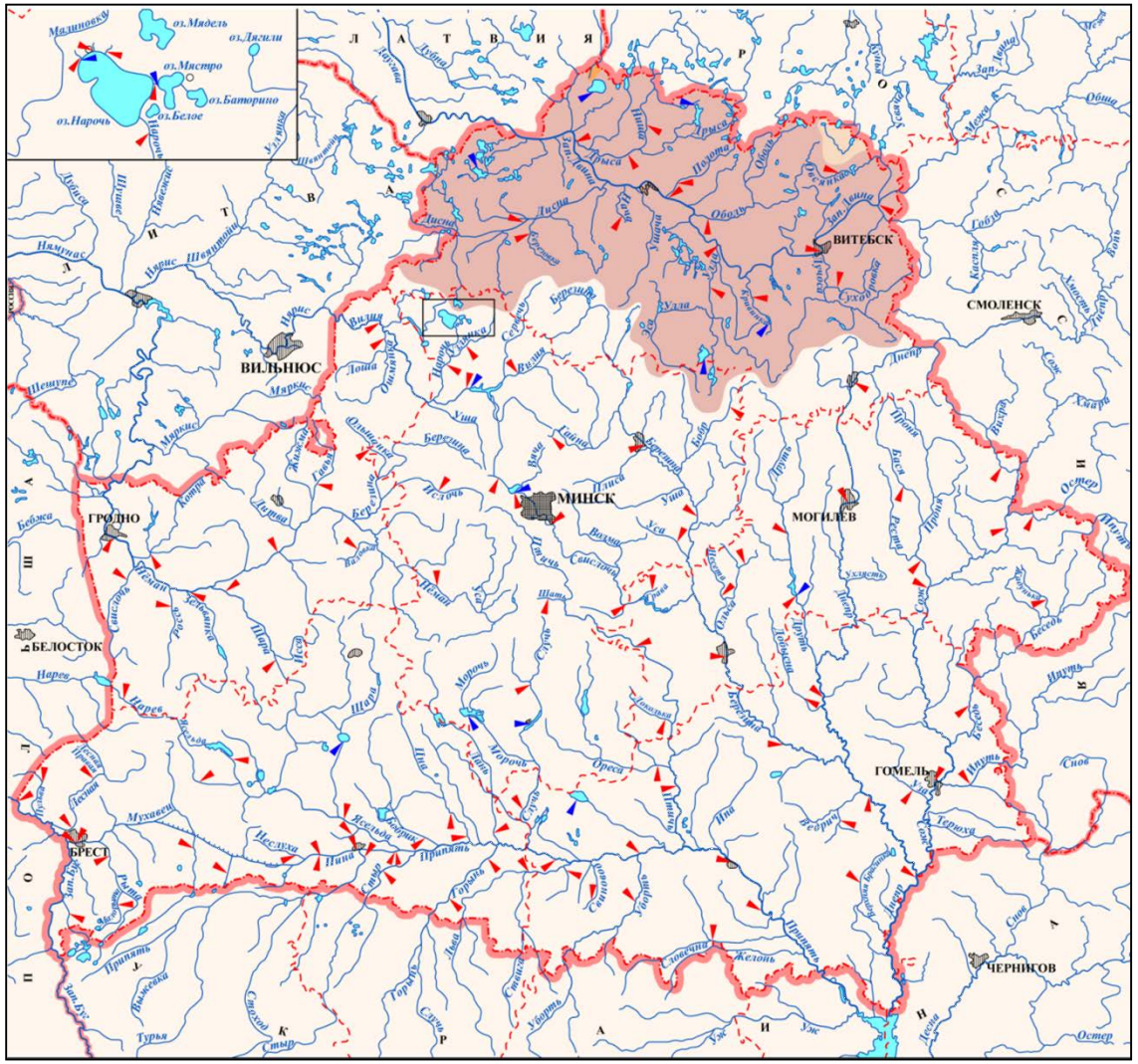
Outline & questions

1. Runoff regime over eastern part of the BSB and it's change
2. Modelling scheme
3. Climate input data
4. Runoff modelling
5. Runoff projections
6. Uncertainties

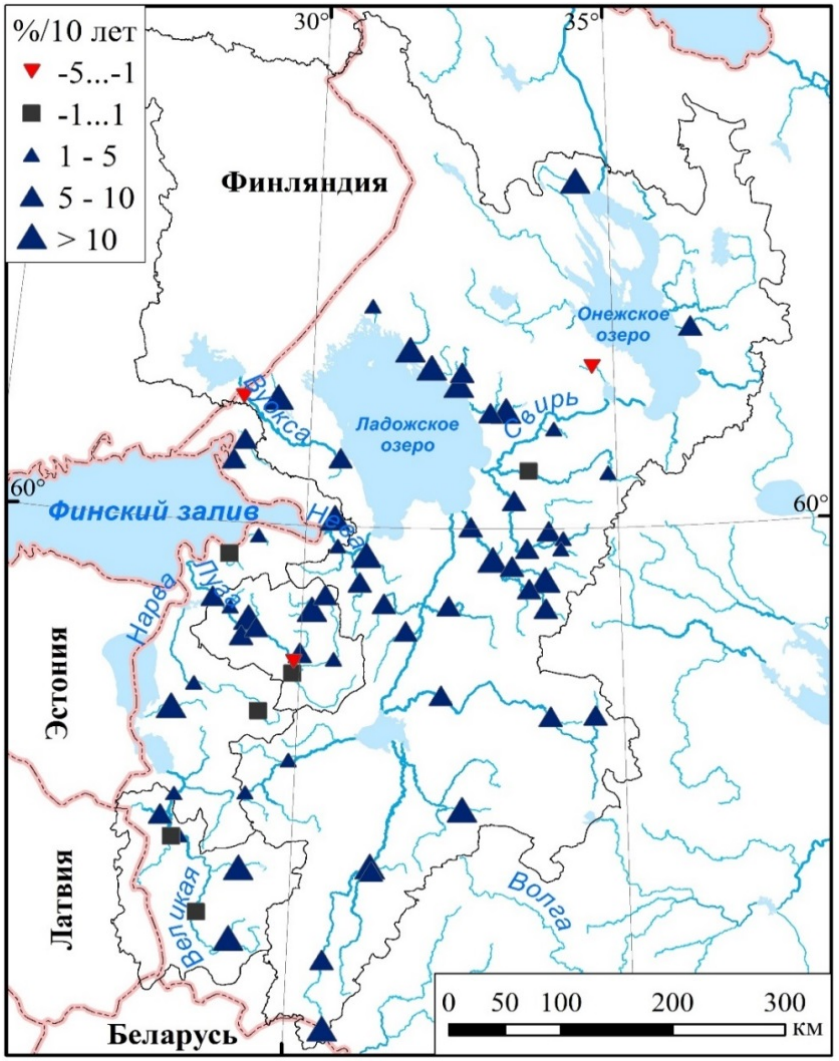
1. What are the future changes of Western Dvina streamflow regime?
2. Are we able to project changes correctly?

Study object –
Western Dvina (Daugava) river basin

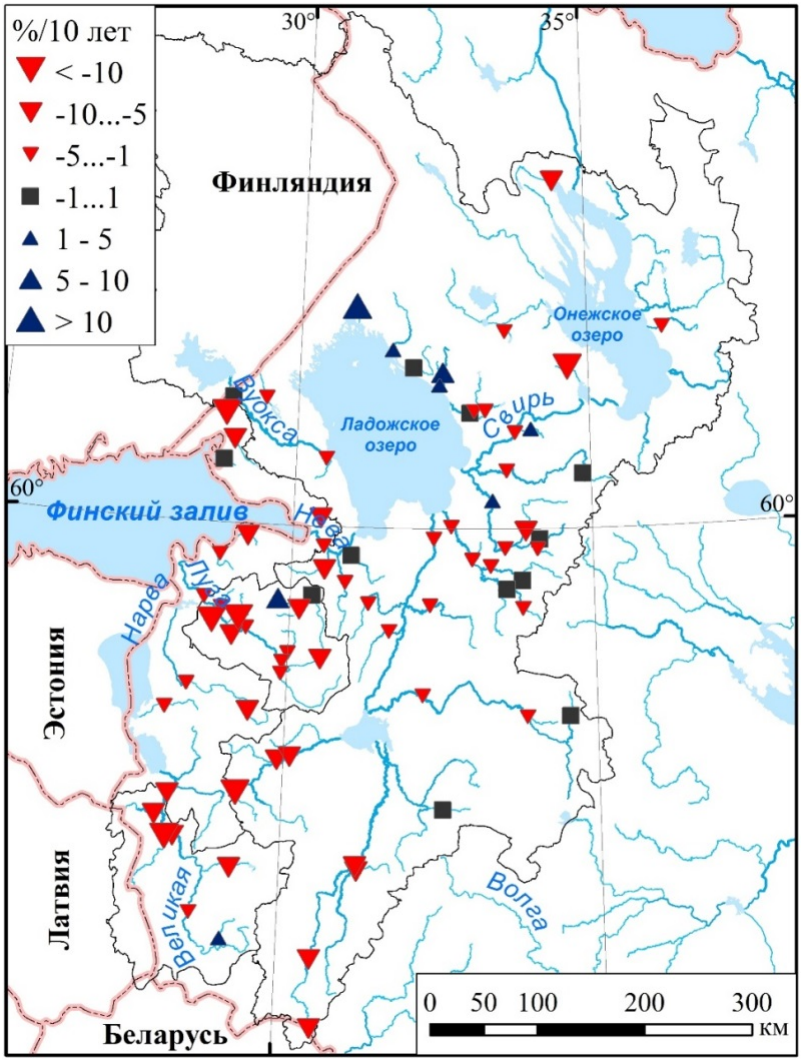
The West.Dvina (Daugava) river basin within the territory of Belarus



Runoff changes in the eastern part of the BSB (Russia territory)



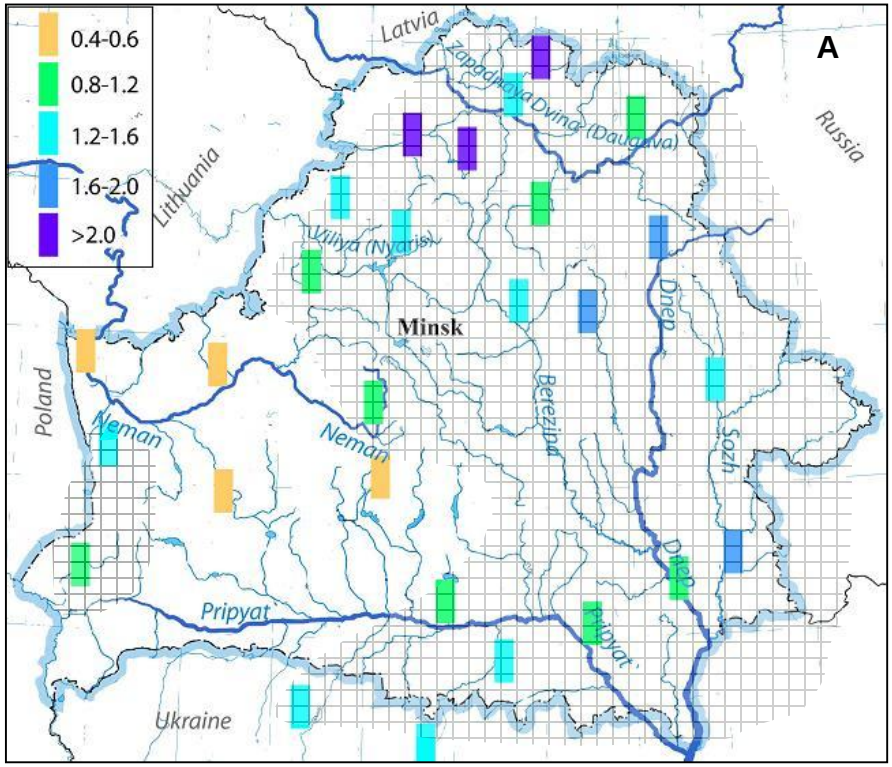
Spring flood peaks



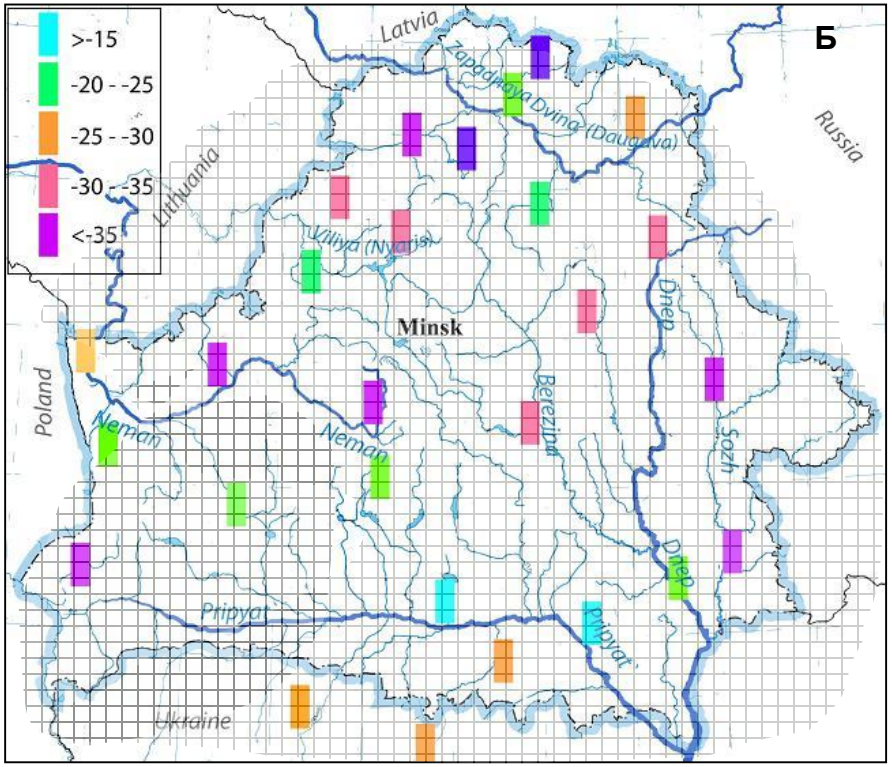
Winter low flow

(Zhuravlev etc, 2015)

Runoff changes in the eastern part of the BSB (Belarus territory)



Winter low flow modules change



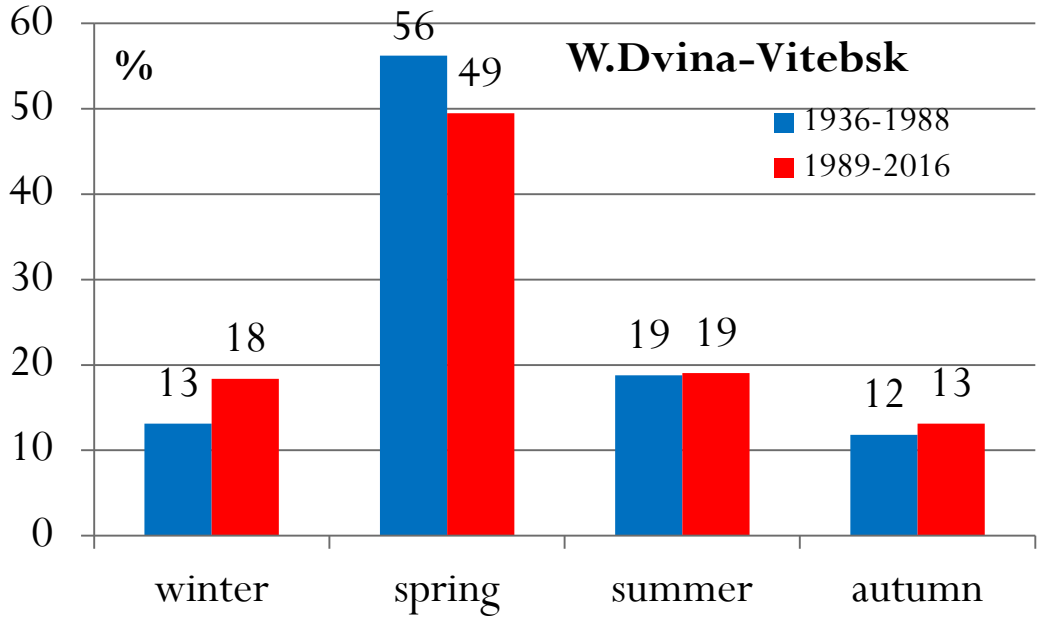
Spring flood max modules change_

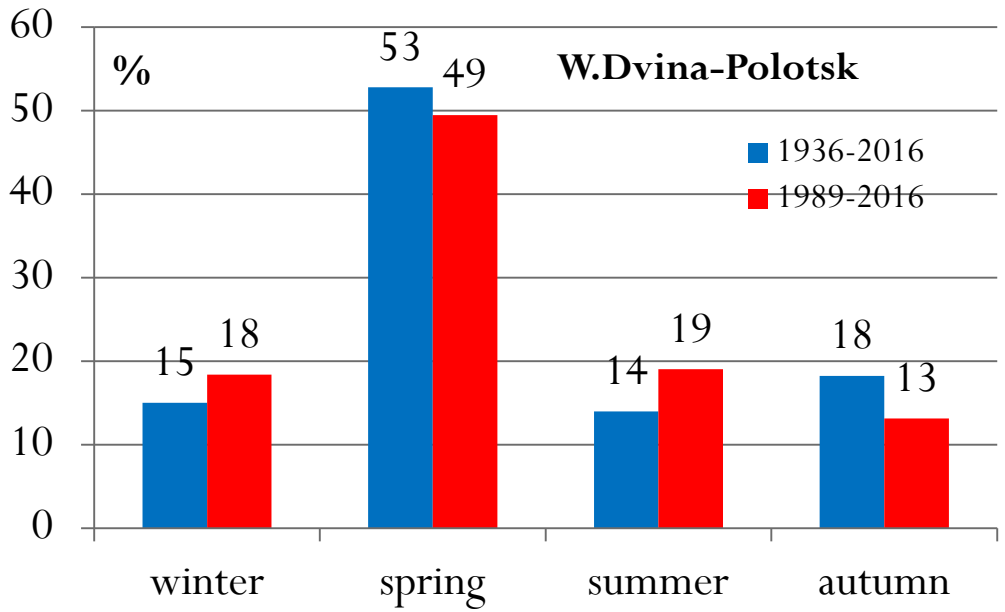
shaded area has statistical significant values

(Partasenok etc, 2014)

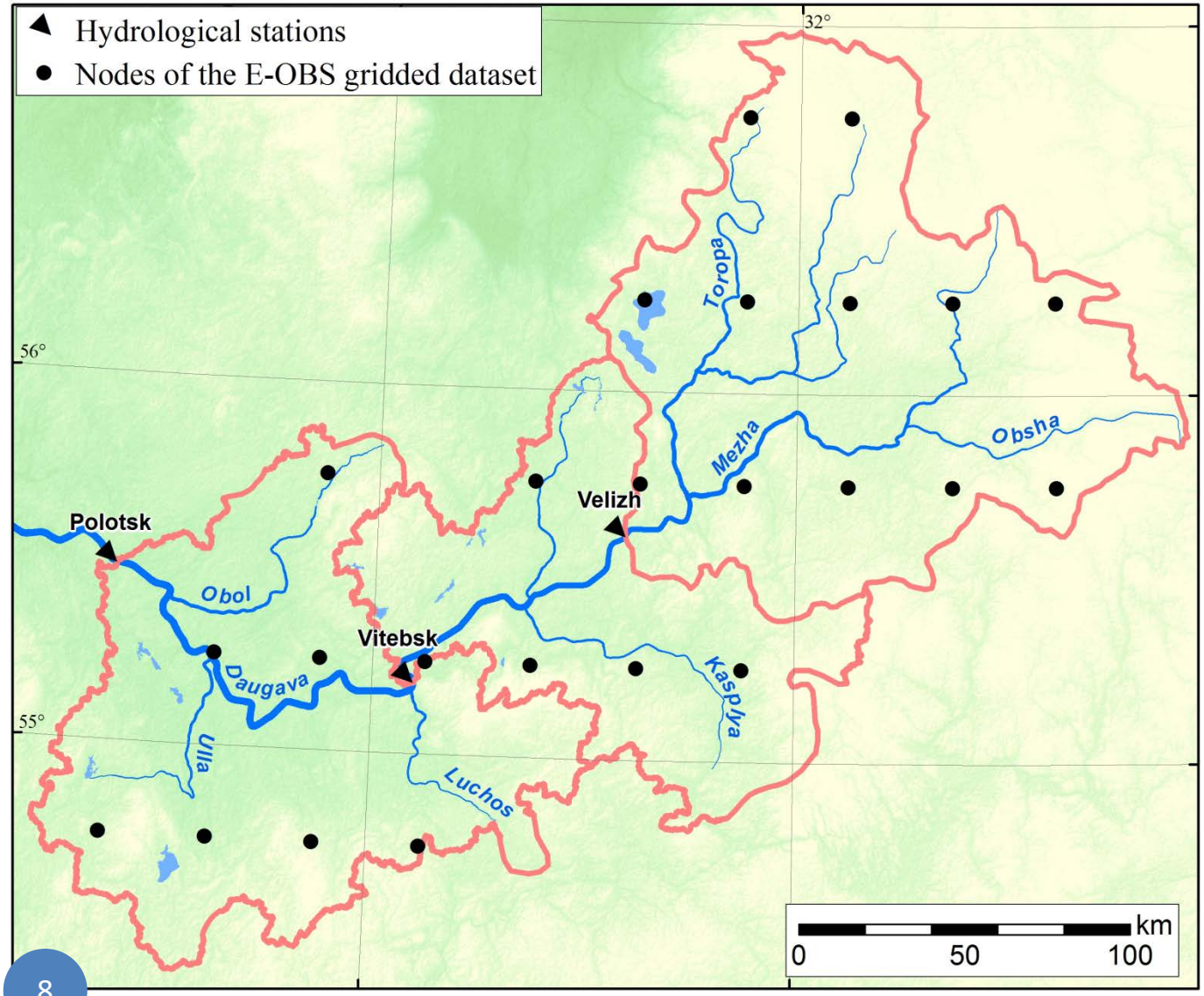
Intra-annual distribution of streamflow in Belarus part of Western Dvina

According to State Hydrological Cadastre of Belarus





Hydrometeorological Data Source



Velizh:

F=17600 sq.km

Q=80 cub. m/s

Vitebsk:

F=27000 sq.km

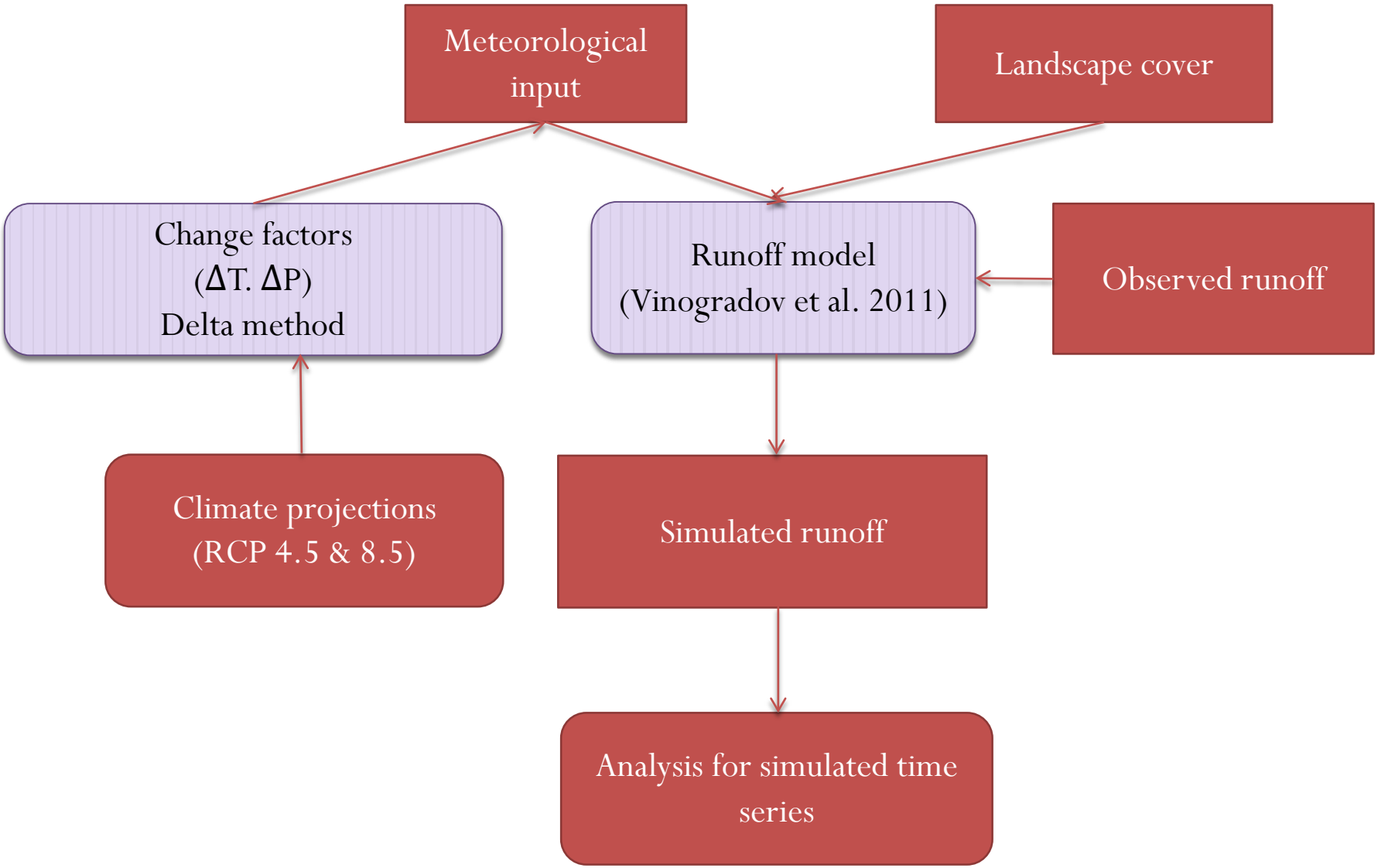
Q=230 cub. m/s

Polotsk:

F=41700 sq.km

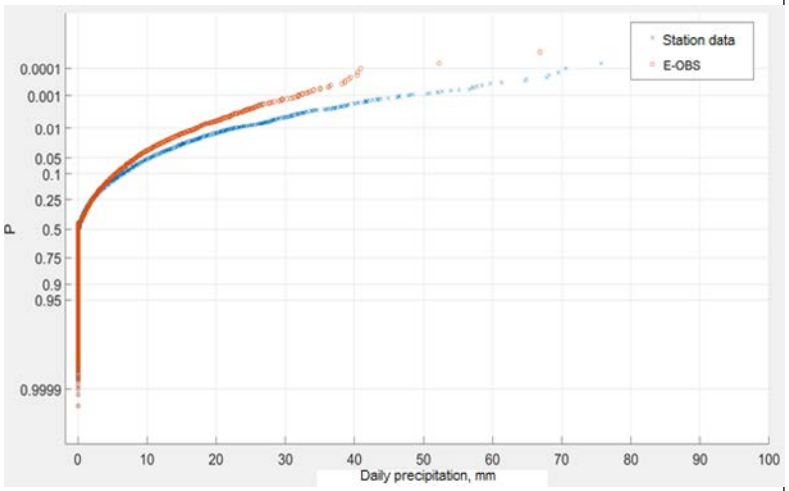
Q=305 cub. m/s

Modeling scheme



Meteorological data

1. E-OBS gridded dataset. 0.5°×0.5°. daily T & P, 1970-2015, derived through interpolation of station data (Haylock et al.. 2008) http://www.ecad.eu/dailydata/index.php



2. Projected
Data-set from EURO-CORDEX
Radiative forcing: RCP2.6. RCP4.5. RCP8.5
Period:
For simulation: 2011-2100
Historical: 1970-2000

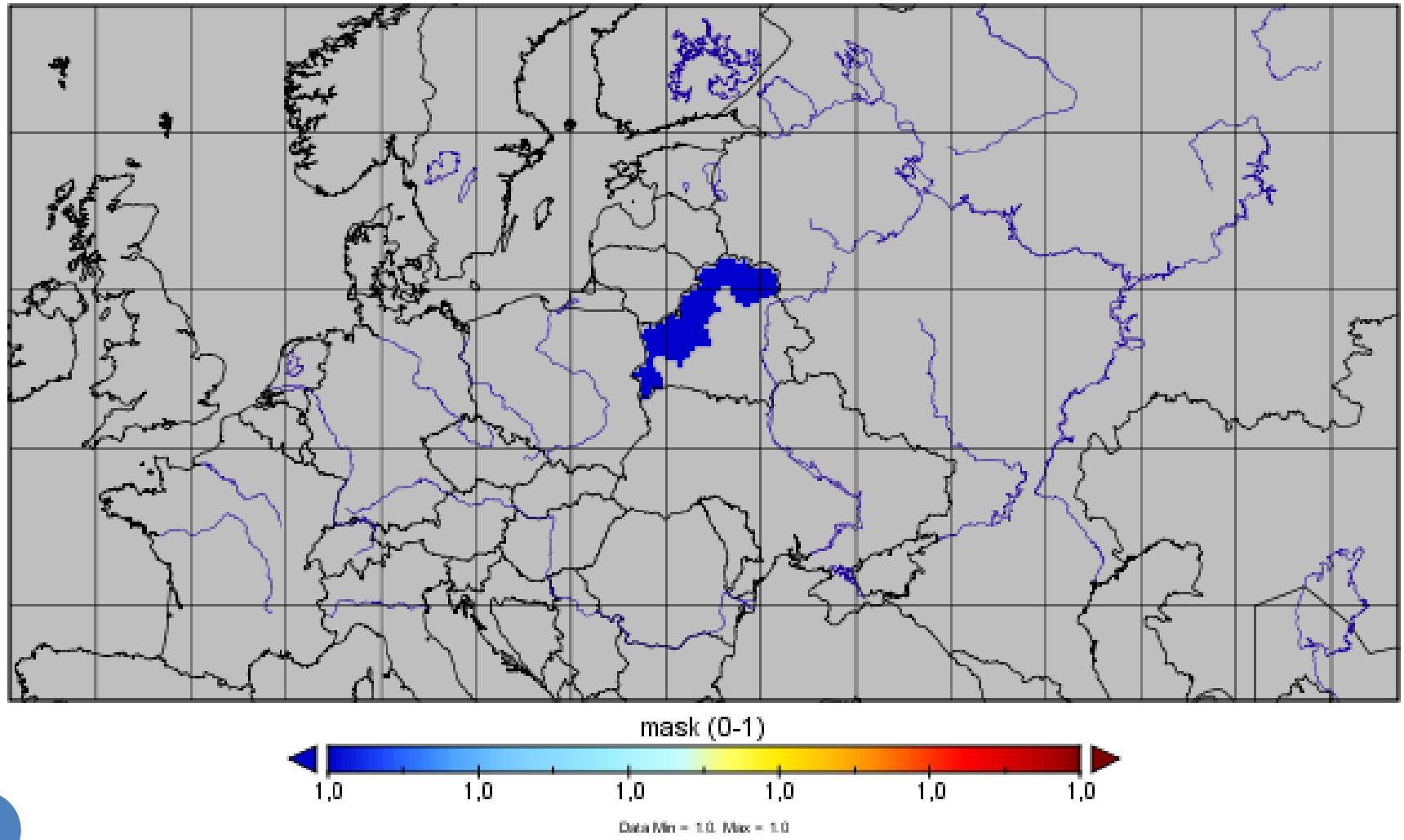
Data: air temperature. precipitation

Time interval: year and seasons: winter XII-II. spring III-V. summer VI-VIII. autumn IX-XI.

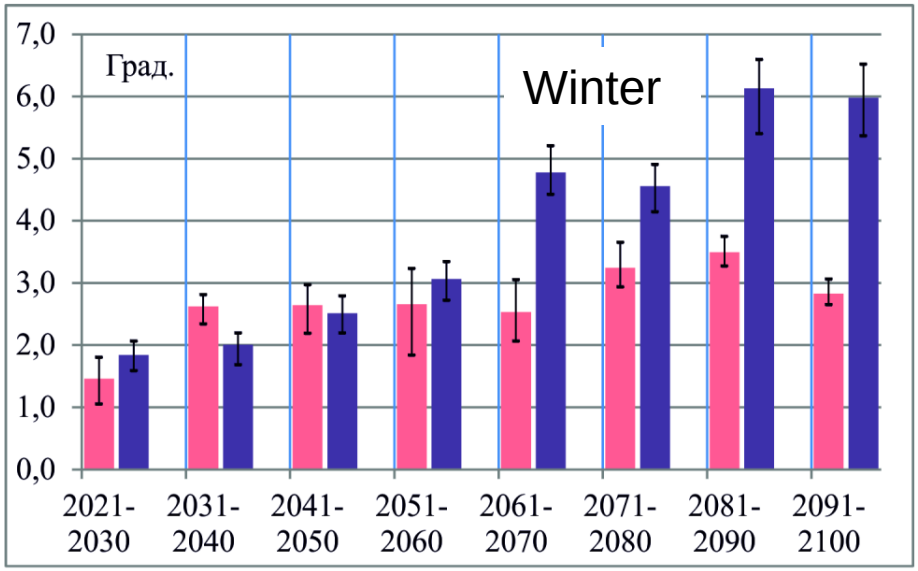
List of Euro-CORDEX models

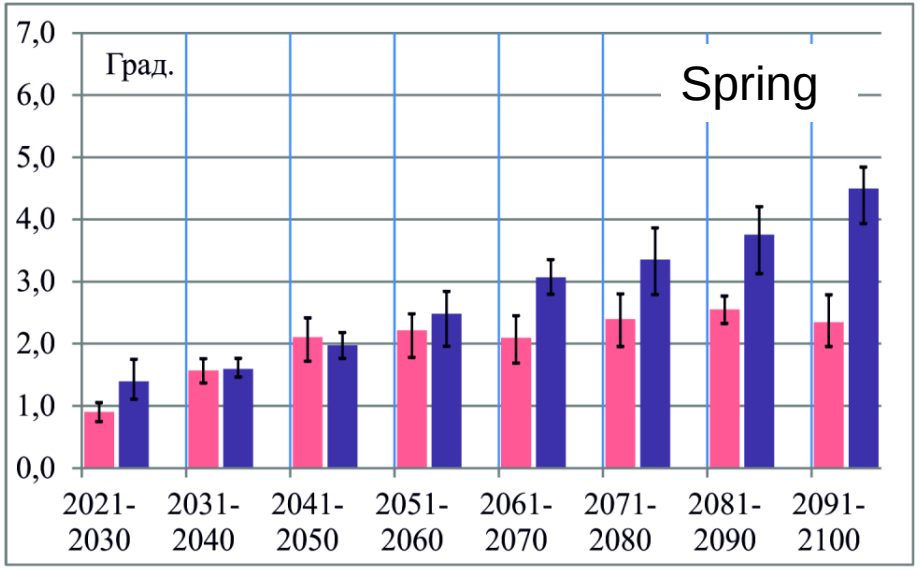
Air temperature	Precipitation
1. CLMcom-CCLM4-8-17.MPI-M-MPI-ESM-LR;	1. CLMcom-CCLM4-8-17.MPI-M-MPI-ESM-LR;
2. DMI-HIRHAM5.ICHEC-EC-EARTH;	2. DMI-HIRHAM5.ICHEC-EC-EARTH;
3. IPSL-INERIS-WRF331F.IPSL-IPSL-CM5A-MR;	3. IPSL-INERIS-WRF331F.IPSL-IPSL-CM5A-MR;
4. KNMI-RACMO22E.ICHEC-EC-EARTH;	4. KNMI-RACMO22E.ICHEC-EC-EARTH;
5. SMHI-RCA4.CCCma-CanESM2;	5. SMHI-RCA4.CCCma-CanESM2;
6. SMHI-RCA4.CNRM-CERFACS-CNRM-CM5;	6. SMHI-RCA4.CNRM-CERFACS-CNRM-CM5;
7. SMHI-RCA4.ICHEC-EC-EARTH;	7. SMHI-RCA4.ICHEC-EC-EARTH;
8. SMHI-RCA4.IPSL-IPSL-CM5A-MR;	8. SMHI-RCA4.IPSL-IPSL-CM5A-MR;
9. SMHI-RCA4.MIROC-MIROC5;	9. SMHI-RCA4.MPI-M-MPI-ESM-LR;
10. SMHI-RCA4.MPI-M-MPI-ESM-LR;	10. SMHI-RCA4.NCC-NorESM1-M;
11. SMHI-RCA4.NCC-NorESM1-M;	11. SMHI-RCA4.NOAA-GFDL-GFDL-ESM2M
12. SMHI-RCA4.NOAA-GFDL-GFDL-ESM2M.	

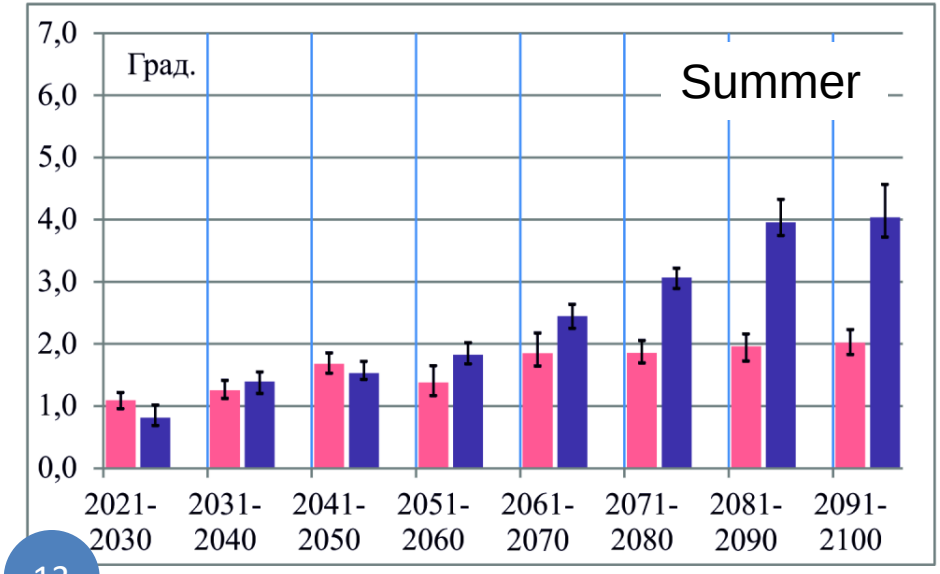
Region for projected characteristics of air temperature and precipitation

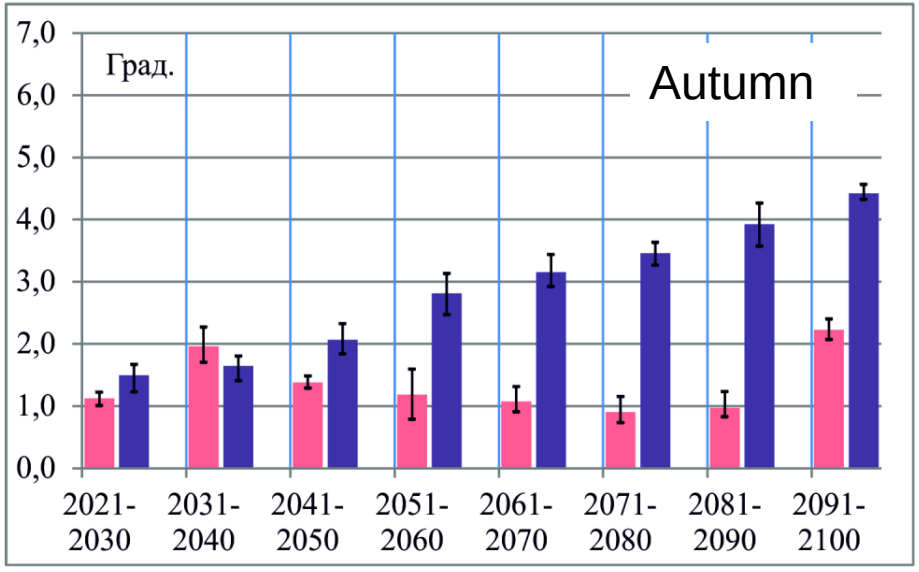


Projected anomalies of air temperature

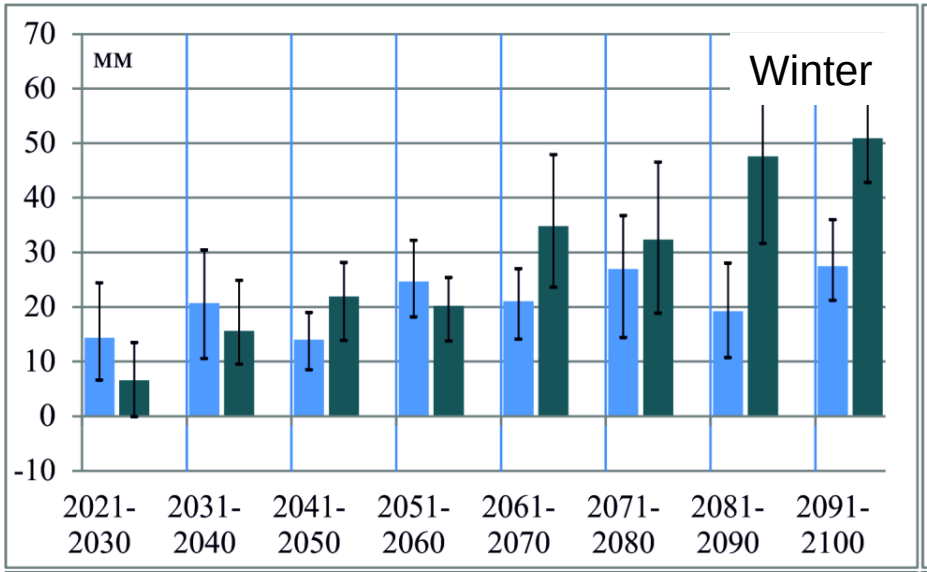


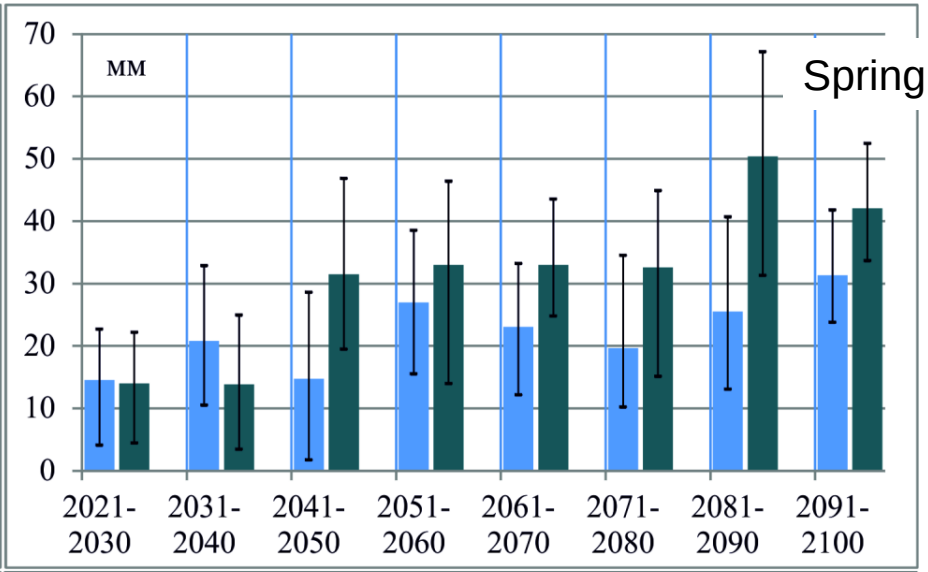


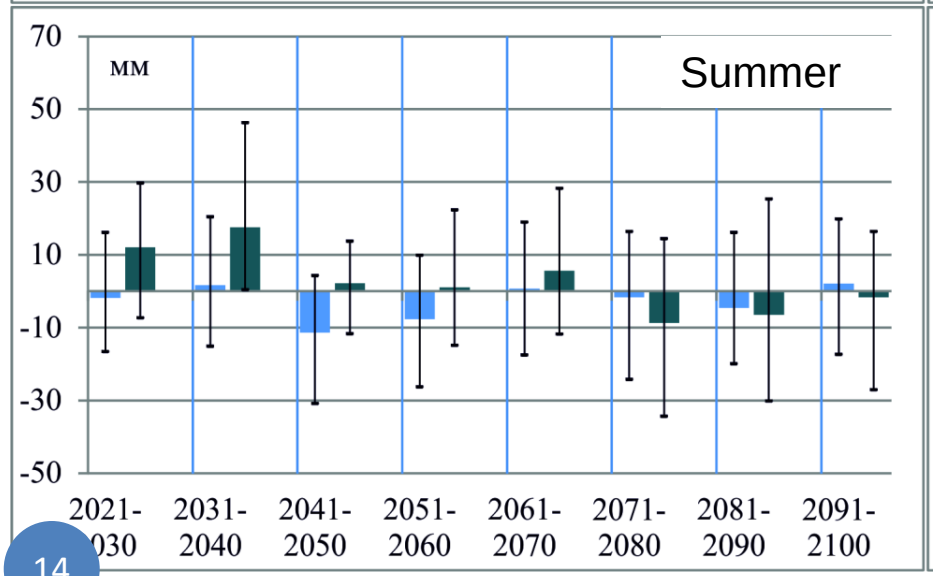


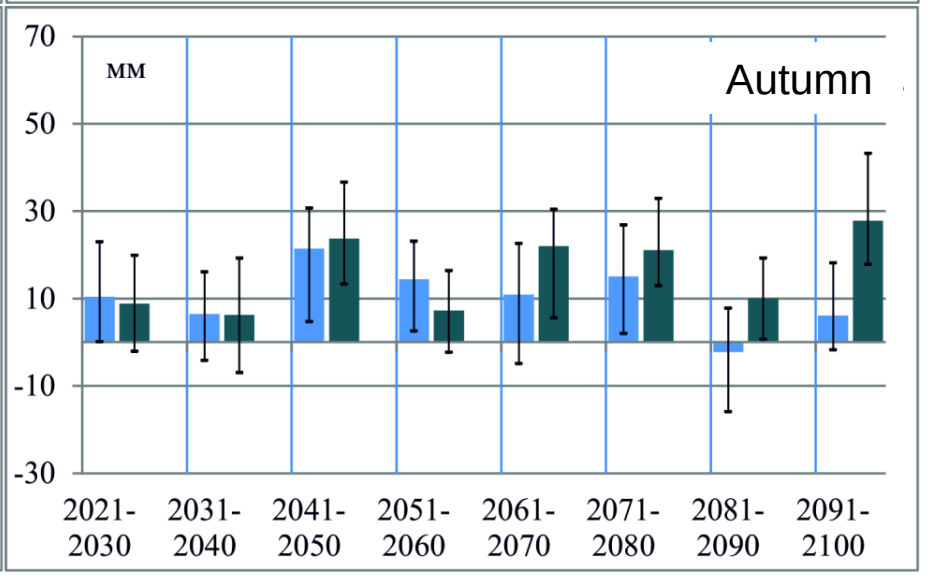


Projected anomalies of precipitation sums



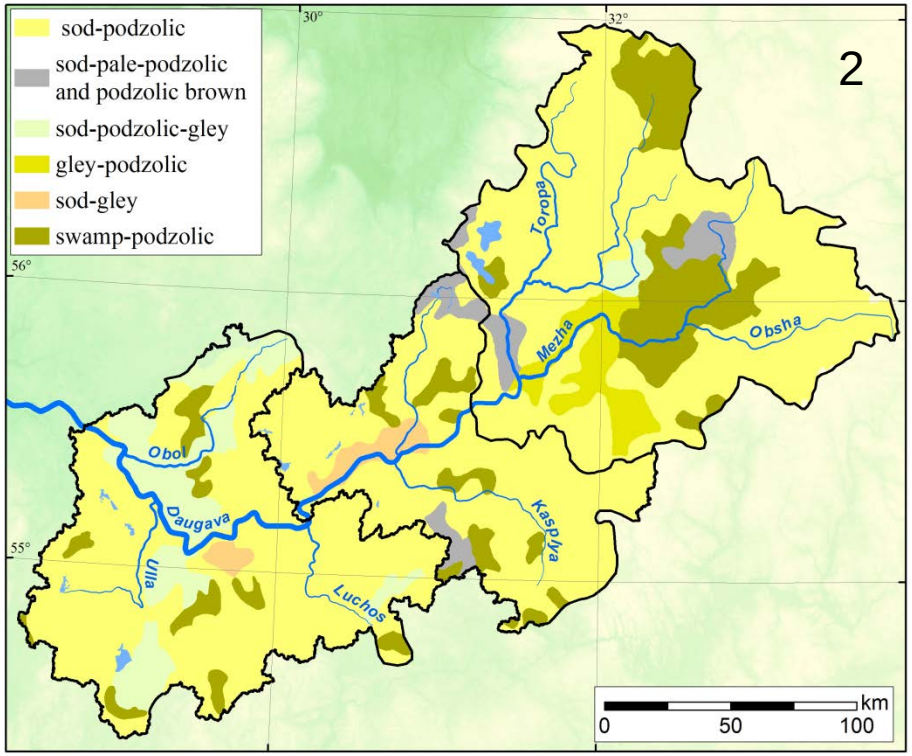


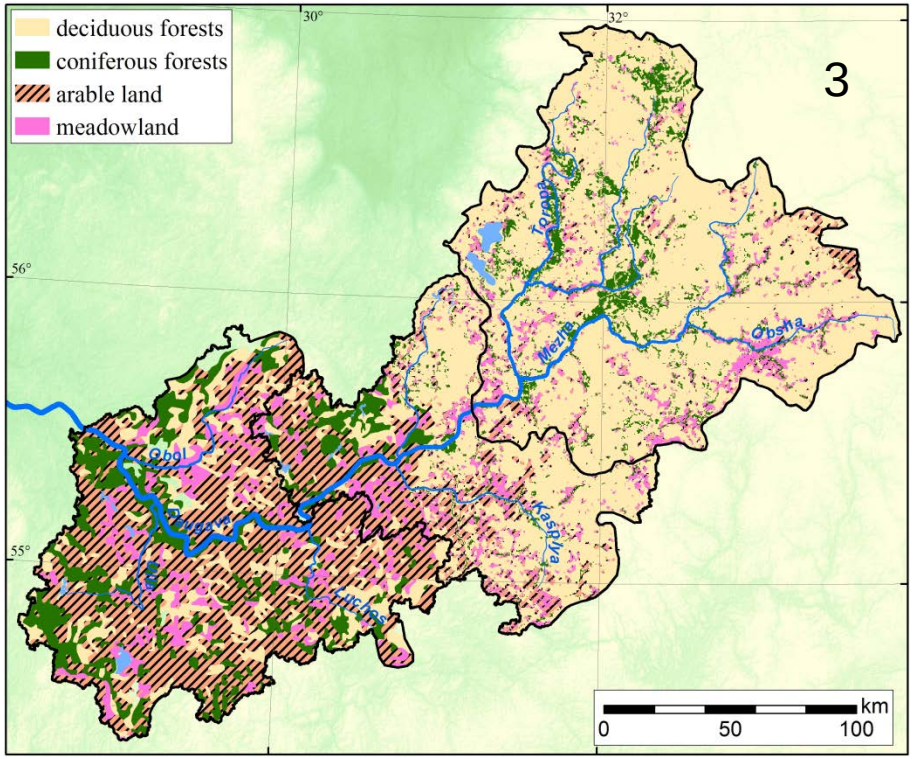




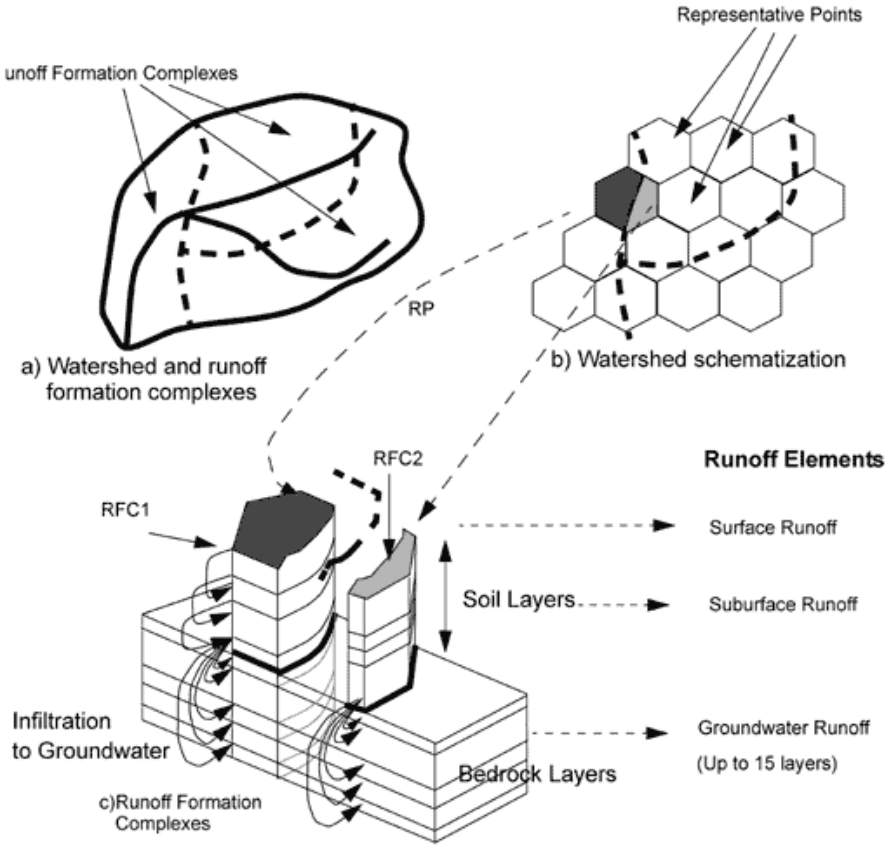
Hydrological & other data

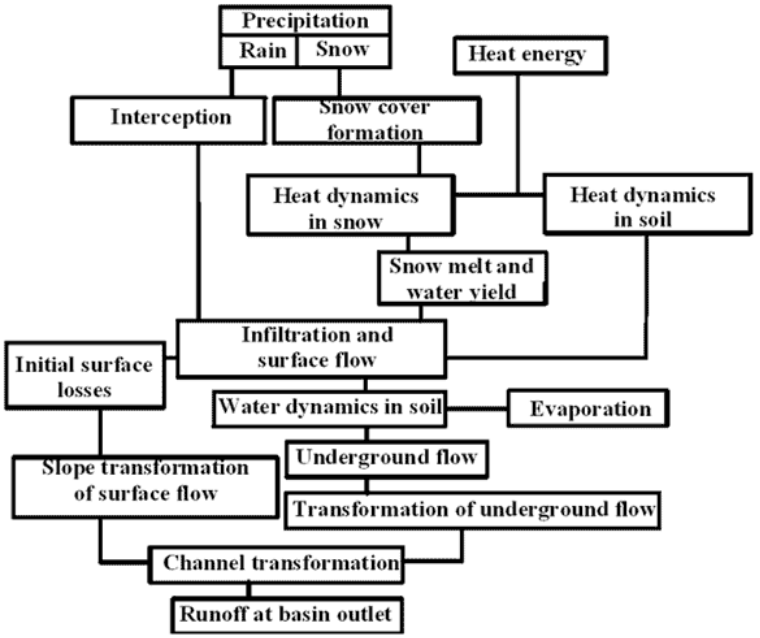
1. Historical instrumental daily discharges for period 1970-2015
2. Soil & landscape maps
3. SRTM DEM





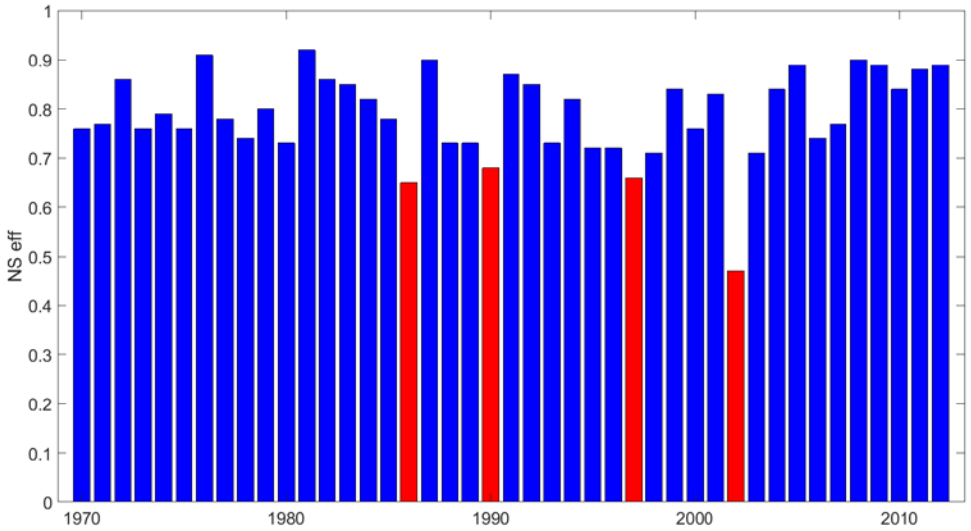
Hydrograph model (Vinogradov. 2011)





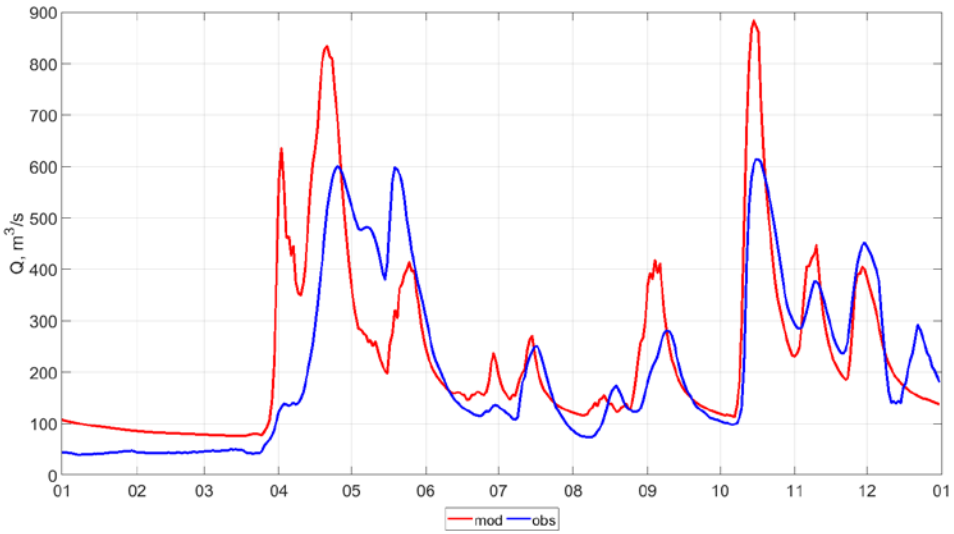
Program realization
by O.Makarieva
hydrograph-model.ru

Model verification

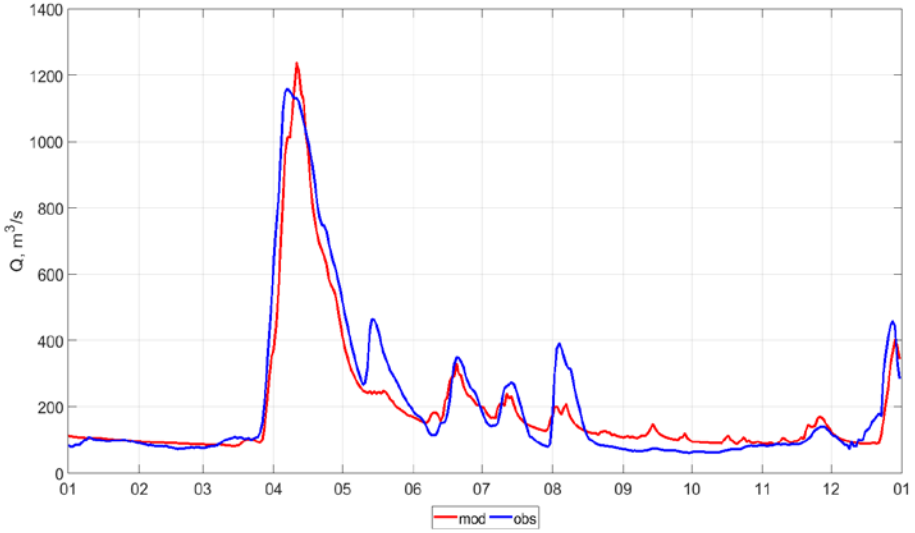


Mean: NS=0.77
Best: NS=0.92
Worst: NS=0.47

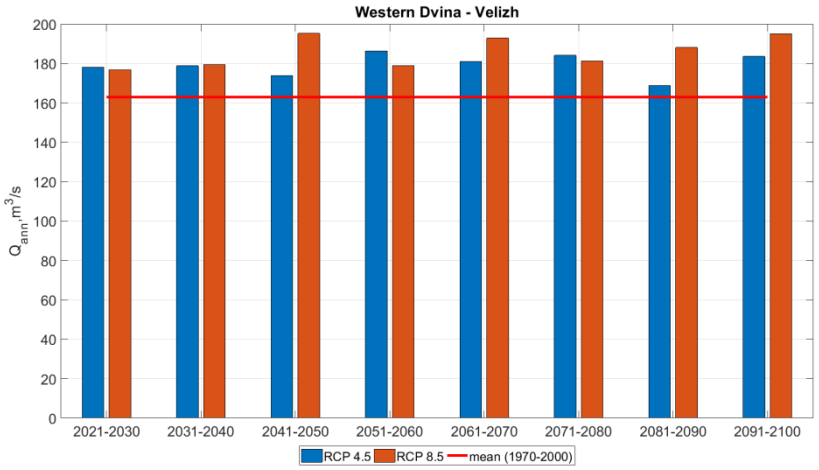
The worst

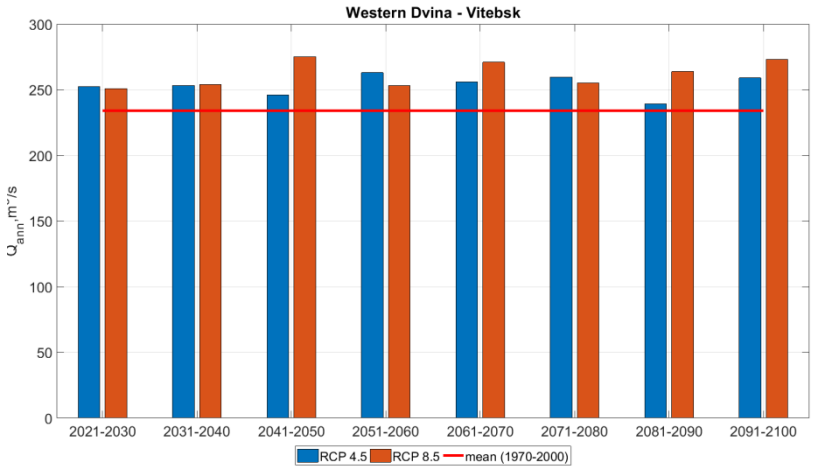


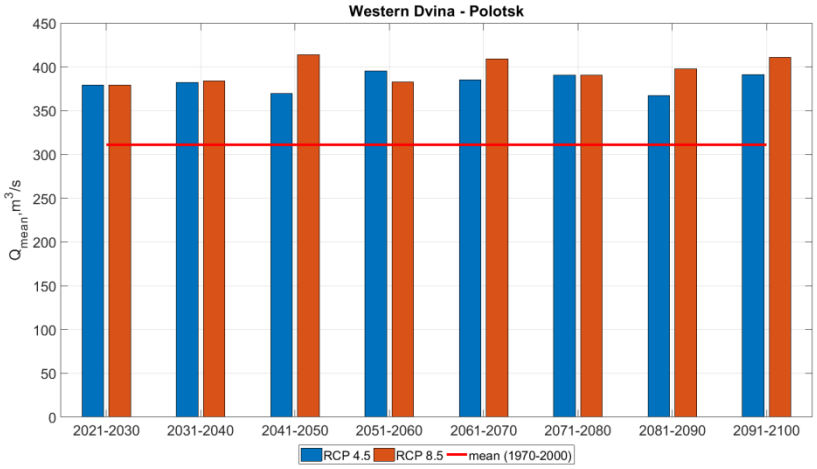
The best



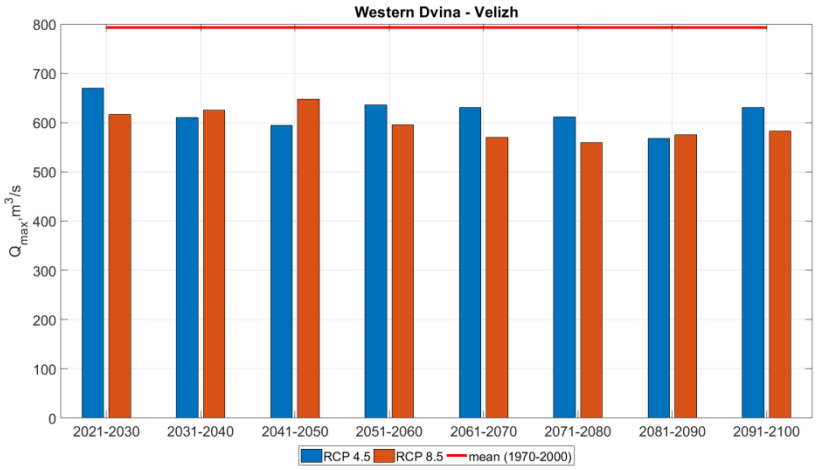
Projected streamflow: average runoff

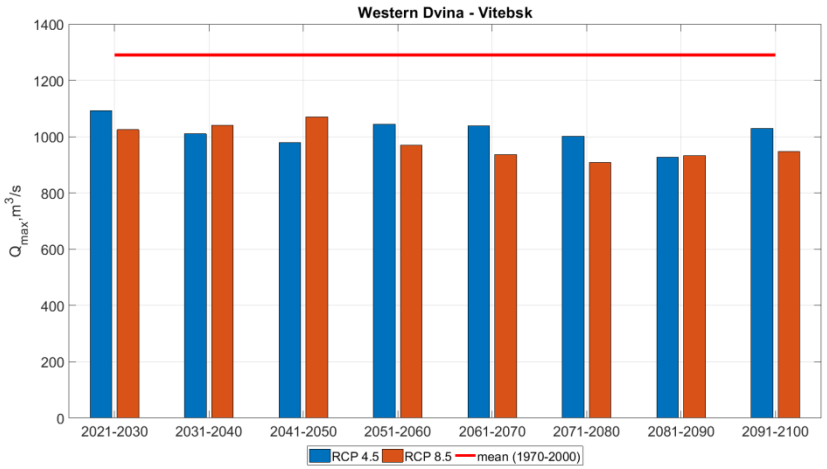


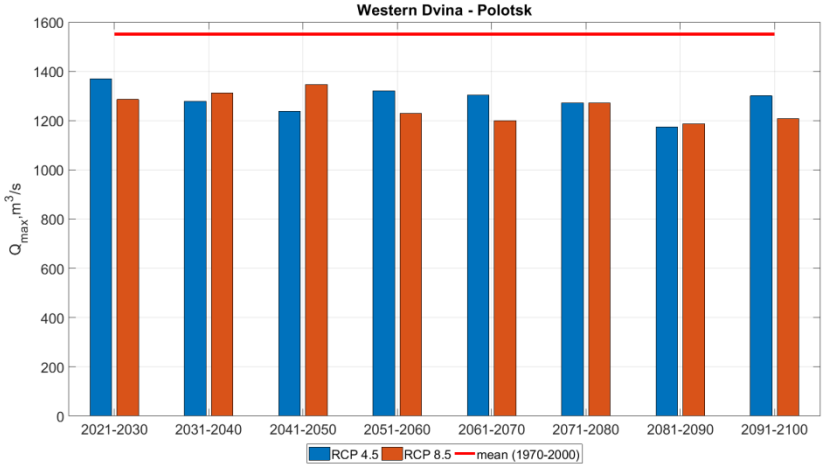




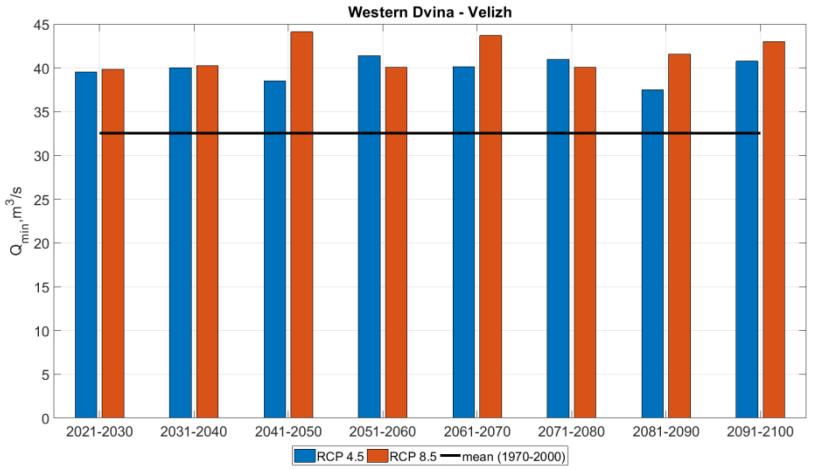
Projected streamflow: spring floods

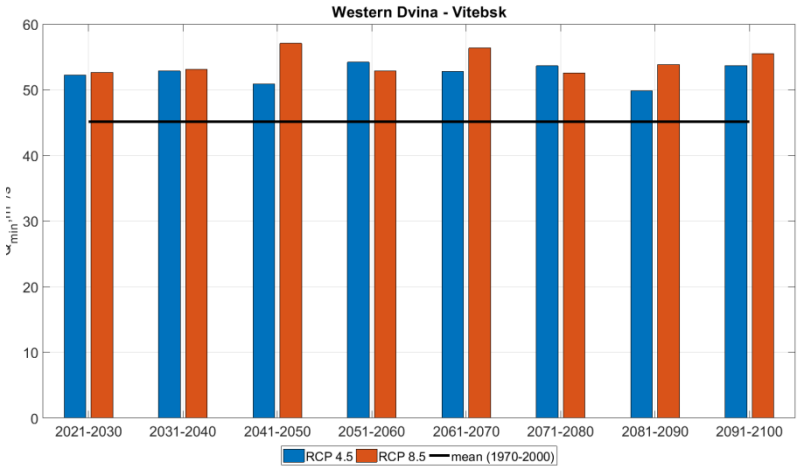


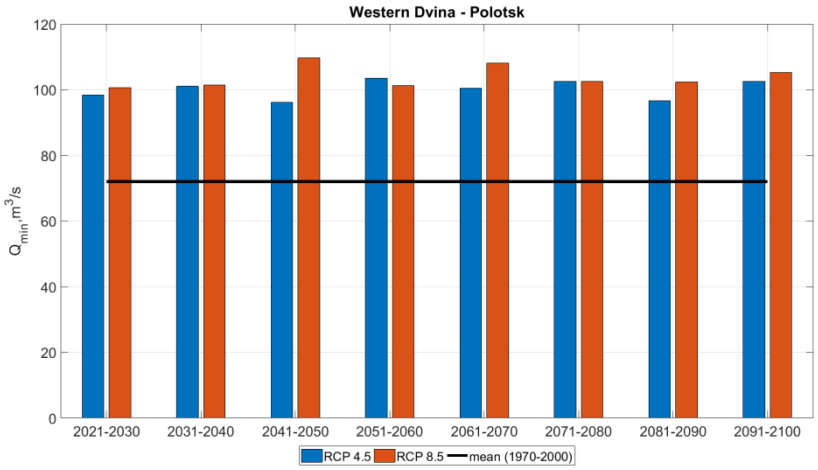




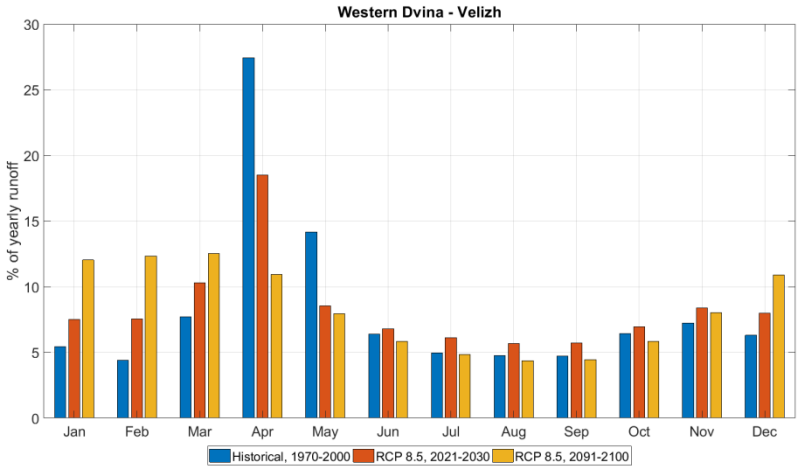
Projected streamflow: low flow

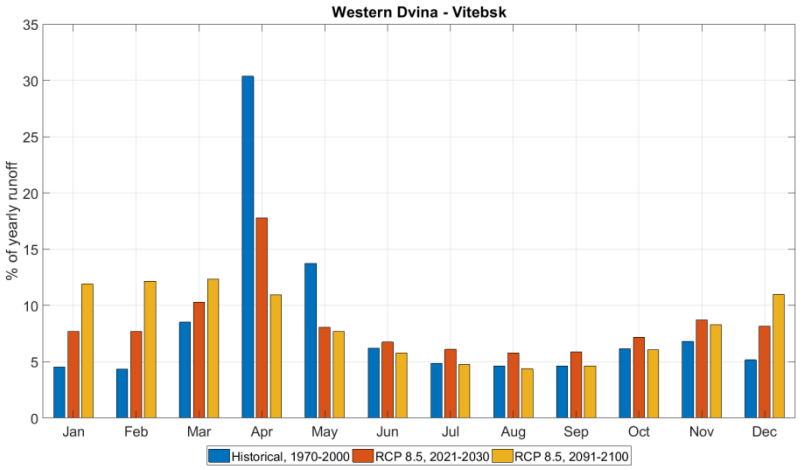


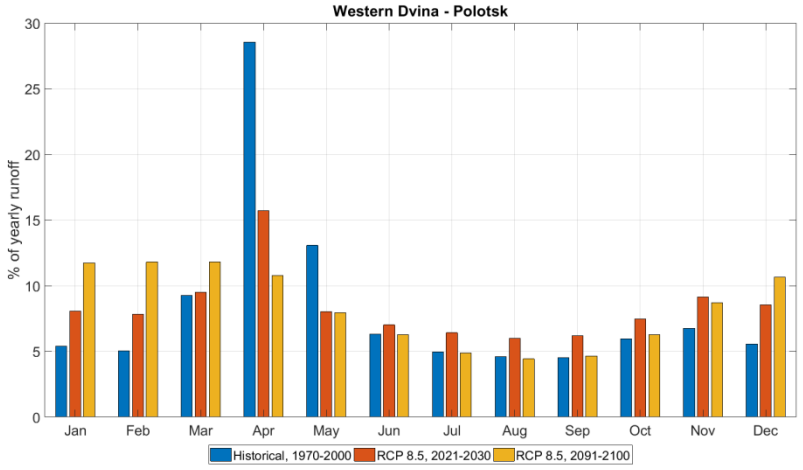




Projected streamflow: intra-annual distribution







Signal-to-noise analysis (2071-2100 vs 1971-2000)

$$SNR = \frac{\overline{W}_{XXI} - \overline{W}_{obs}}{\sqrt{\sigma^2_{XXI} + \sigma^2_{obs}}}$$

Q/scenario	RCP 2.6	RCP 4.5	RCP 8.5
Q max	0.49	0.75	0.88
Q mean	0.06	0.07	0.07
Q min	0.21	0.15	0.13

Sources of uncertainty

1. Data over-smoothing by E-OBS (new datasets should be used)
2. No change of precipitation patterns
3. Hydrological model structural uncertainty
4. Climate projection uncertainties

Thank you for listening!

Acknowledgements:
Institute of Coastal Research HZG & personally B. Geyer
Russian geographical society