Determination of the snow melting intensity in nowadays climate conditions by example of the Neman river basin

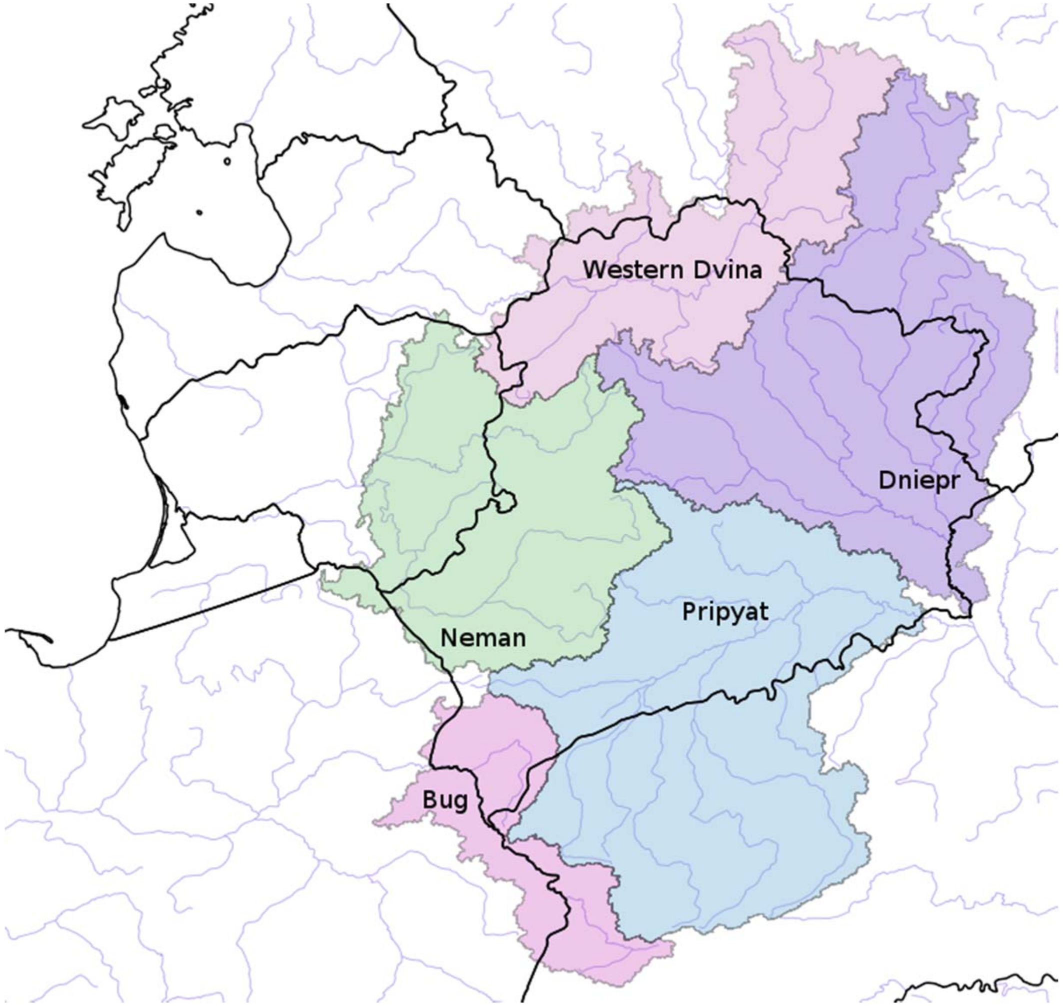
Alexander Volchak, Dmitriy Kostiuk, Dmitriy Petrov, Nikolay Sheshko

Brest State Technical University, Brest, Belarus

Main goal of the research

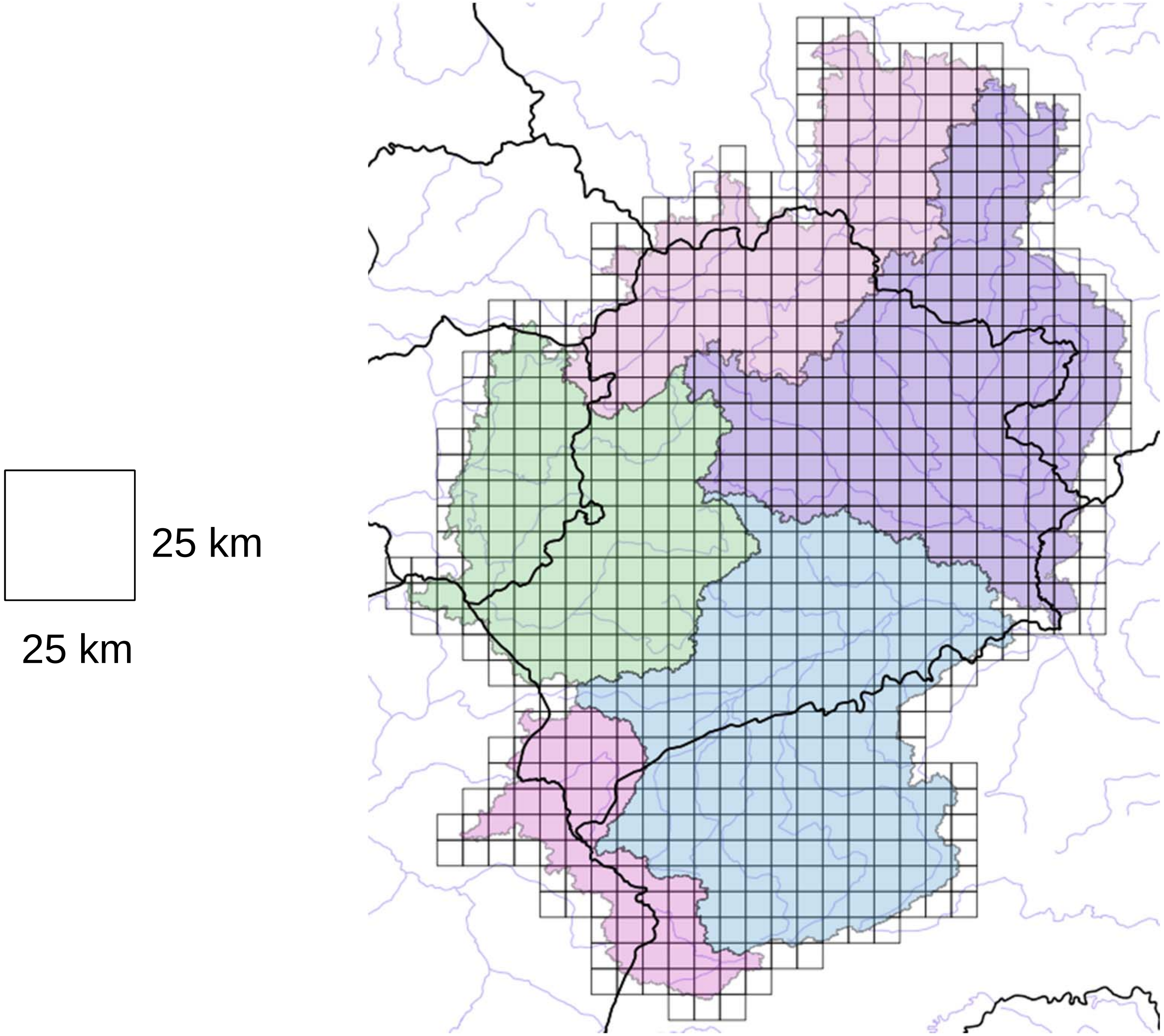
- The main goal of our research group is to develop the reliable flood prediction system
- Snow melt in spring frequently leads to major river floods
- So, to predict such dangerous events we have to estimate following factors:
  - water reserves of the snow cover
  - amount of water release from snow

Origins of the presented research



1. All major river watersheds in Belarus are transboundary ones
2. Snow melt process in spring contributes to formation of severe river flood conditions
3. Relatively infrequent snow mass monitoring by traditional time-consuming technologies leads to investigation of practical reliability of space-borne passive remote sensing of snow, which is performed on daily basis

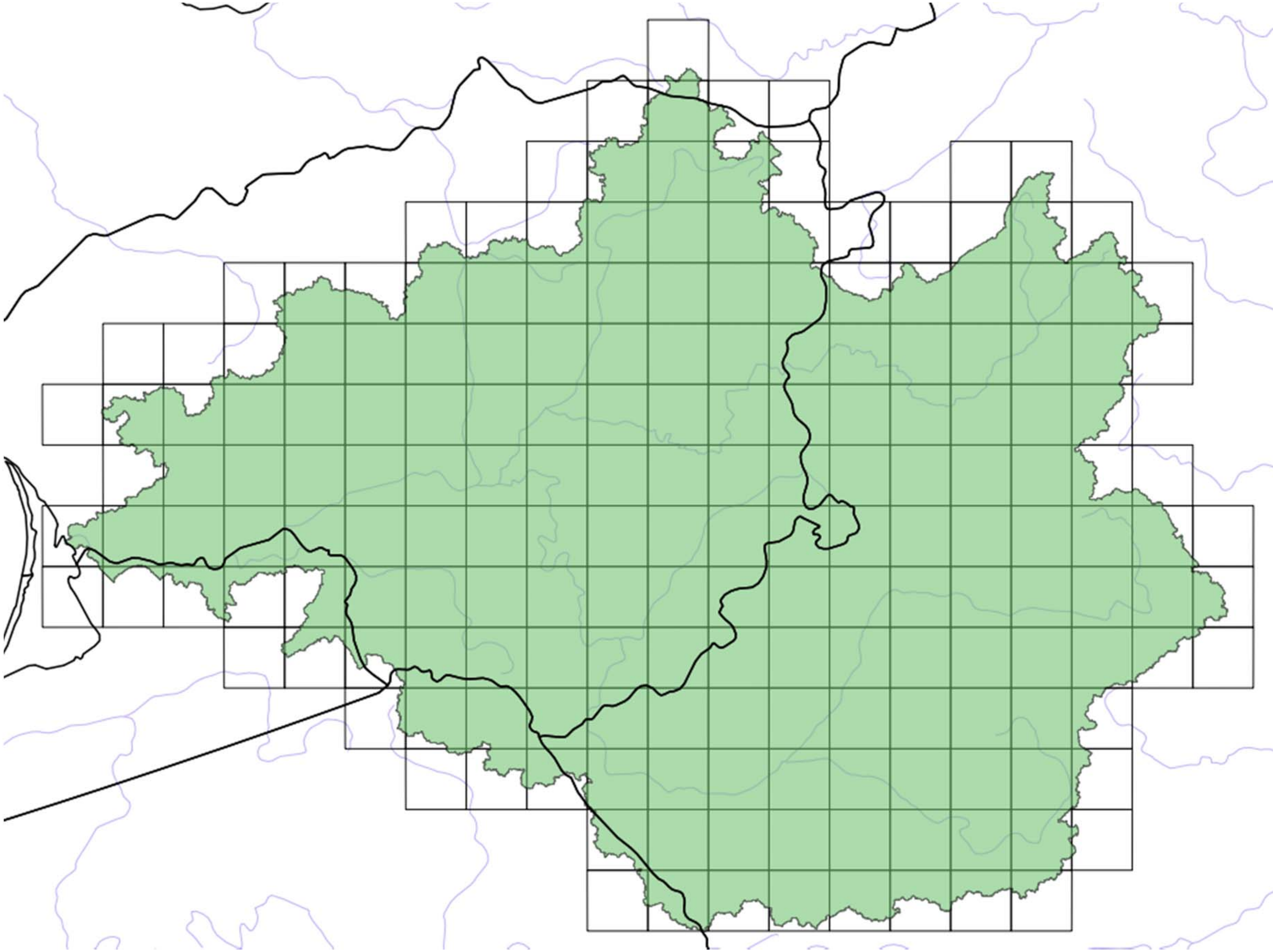
Spatial resolution of space-borne passive microwave remote sensing



Used Data Sources

- Daily snow water equivalent maps for land areas of Northern Hemisphere, produced by assimilation of space-borne radiometer data and ground-based measurements, provided by GlobSnow Consortium
  - http://www.globsnow.info
- Archive of daily observations of European meteorology stations, provided by European Climate Assessment & Dataset project
  - http://eca.knmi.nl

Arrangement of daily SWE map elements over Neman watershed

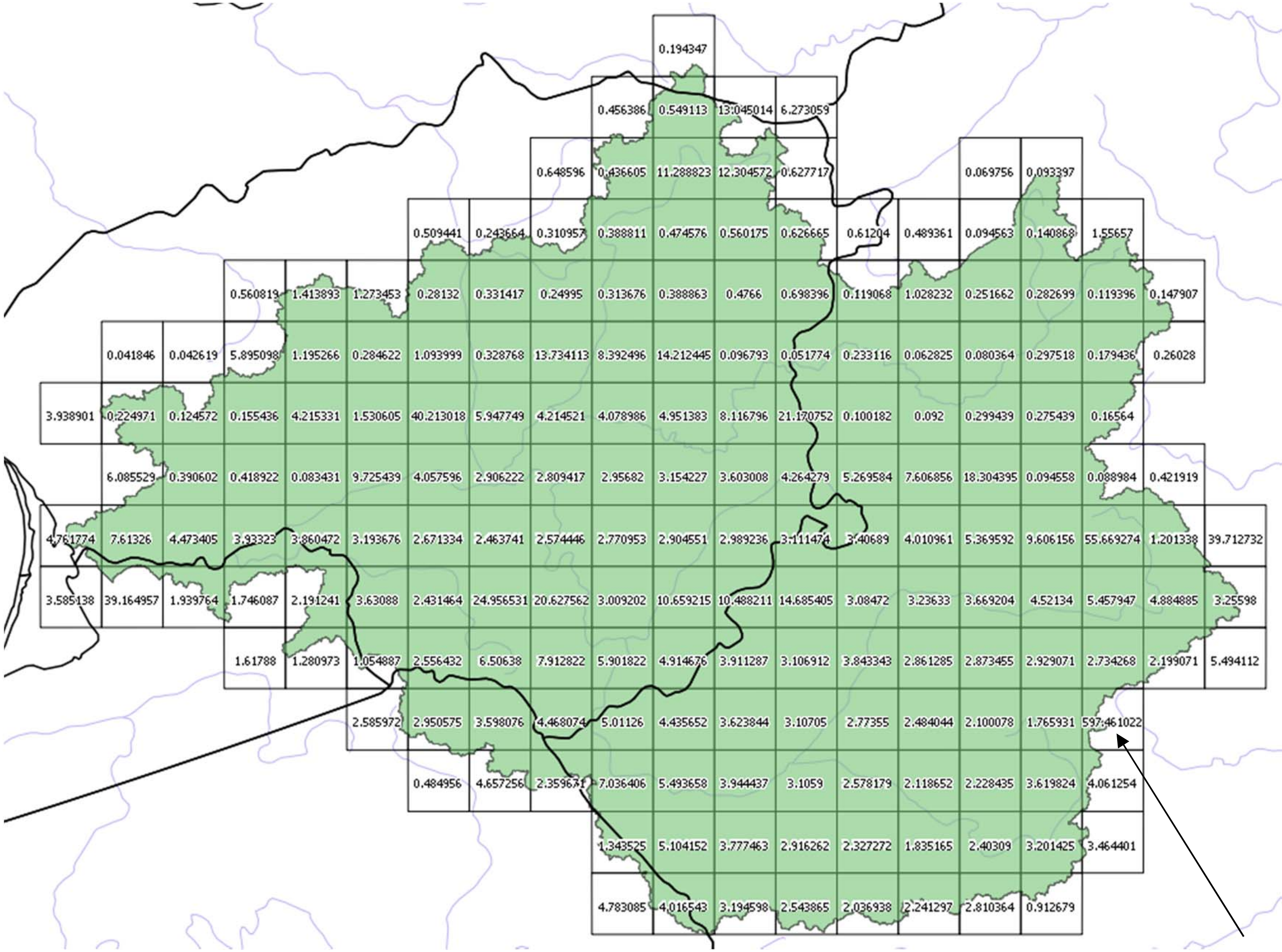


Methodology of the research

- Snow melt process was observed from 1987 till 2011 on daily basis.
- Daily air temperature over SWE cells was calculated by interpolation of weather stations recorded observations.
- When SWE value in a cell had decreased next day and corresponding air temperature was positive — then calculation of snow melt coefficient* was performed and it's value recorded.

* mm of water per tº of positive air temperature

Raw research results
(average snow melt coefficient value)



597 mm/tº

Validation methodology

Simplified equation of daylight time snow melting

$$h_d = 7.1[(1-\beta)(\theta_{max}-\theta_{daily}-0.2)-0.2(\theta_{daily}-\theta_{min})+0.1\omega_d(\theta_d-0.5)]\ mm$$

β - albedo of snow in unit fraction;
θ_{min} - minimal air temperature
θ_{max} - maximal air temperature
θ_{daily} - average daily air temperature
θ_d - average daylight hours air temperature
ω_d - average wind speed on the air vane height for daylight hours

To achieve the theoretical maximum of melted water:

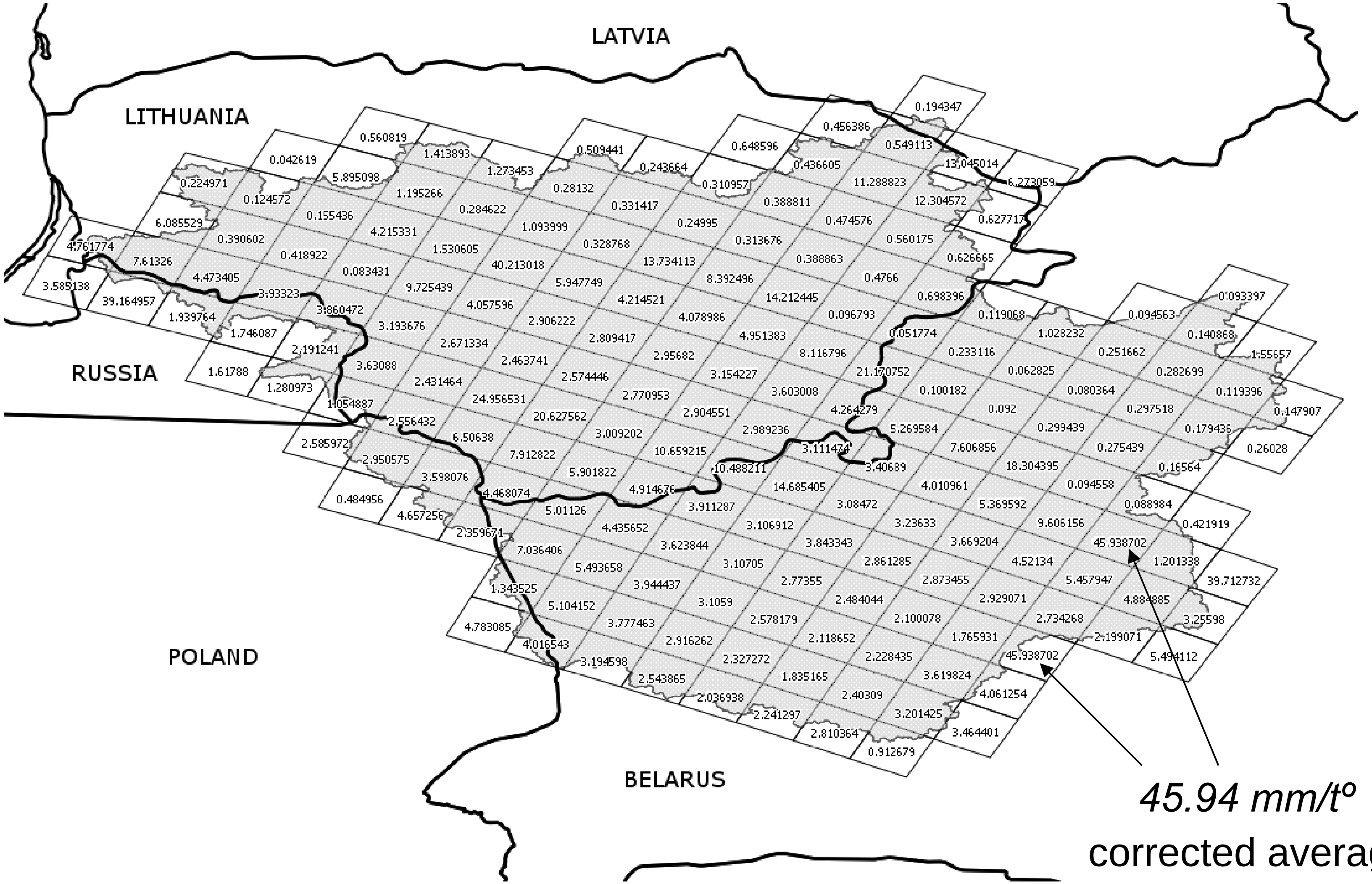
β was taken equal to 0.1 (mixture of snow with water)
θ_d was taken equal to θ_{daily} and average daily wind speed was taken as ω_d

h_n - amount of water melted through night was taken equal as h_d

Theoretical maximum of melted water was calculated as sum of h_n and h_d

Validation results

Theoretical maximum of snow melt coefficient for Neman watershed was calculated equal to 91.877 mm/tº



45.94 mm/tº

corrected average value

Conclusion

- Results of space-borne passive microwave sensing of snow mass could be used in case of no ground-based snow observation stations
- If some ground-based stations are present in the area, they can be used to verify and correct space-borne sensing data
  - different approximation/mapping methods can do it
  - we have successfully tried artificial neural networks to estimate snow mass based on space-borne sensing and ground-based measurements