Assimilation of snow cover data in a distributed rainfall-runoff model

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Outline

- Background
- Study area
- Snow cover patterns
- Snow Cover Area (SCA) interpolation
- Snow melt model
- Hydrological modeling results
- Conclusions

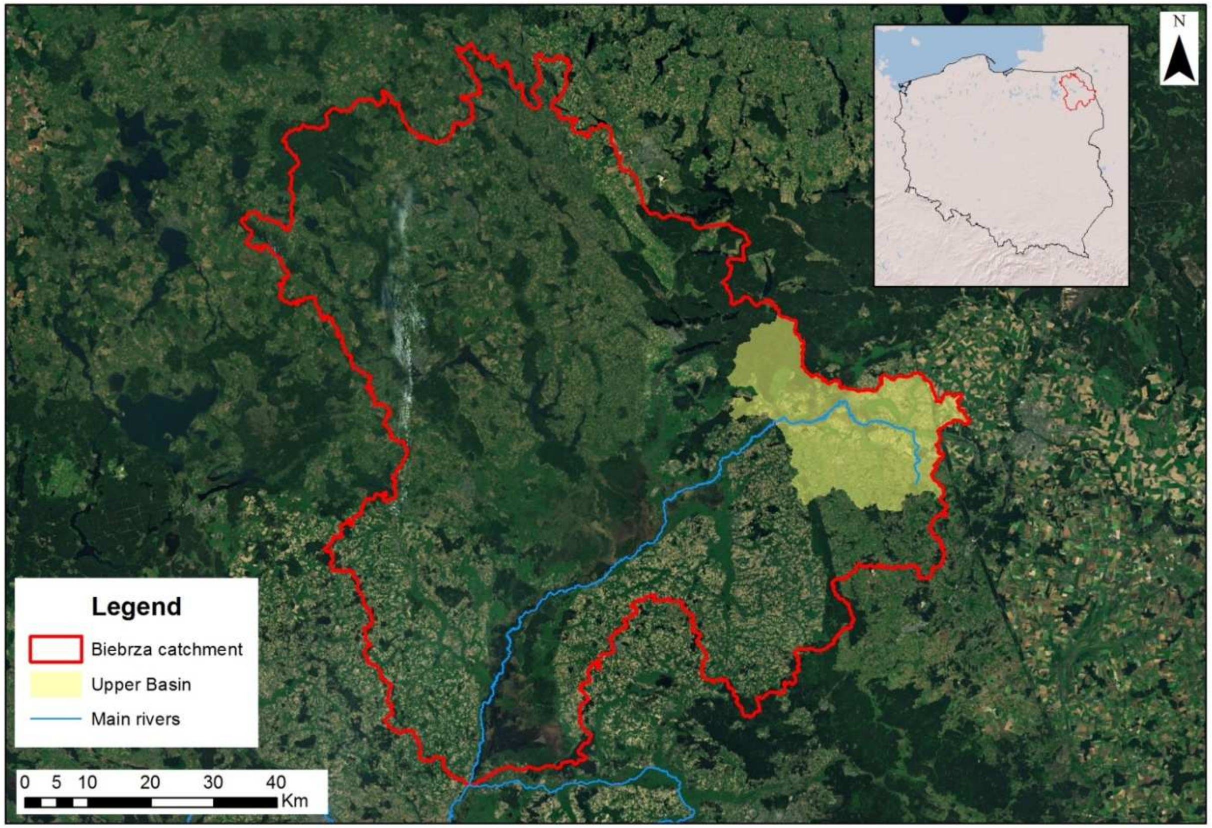
Background

- Glen E. Liston (1998) Interrelationships among snow Distribution, Snowmelt, and Snow Cover Depletion…

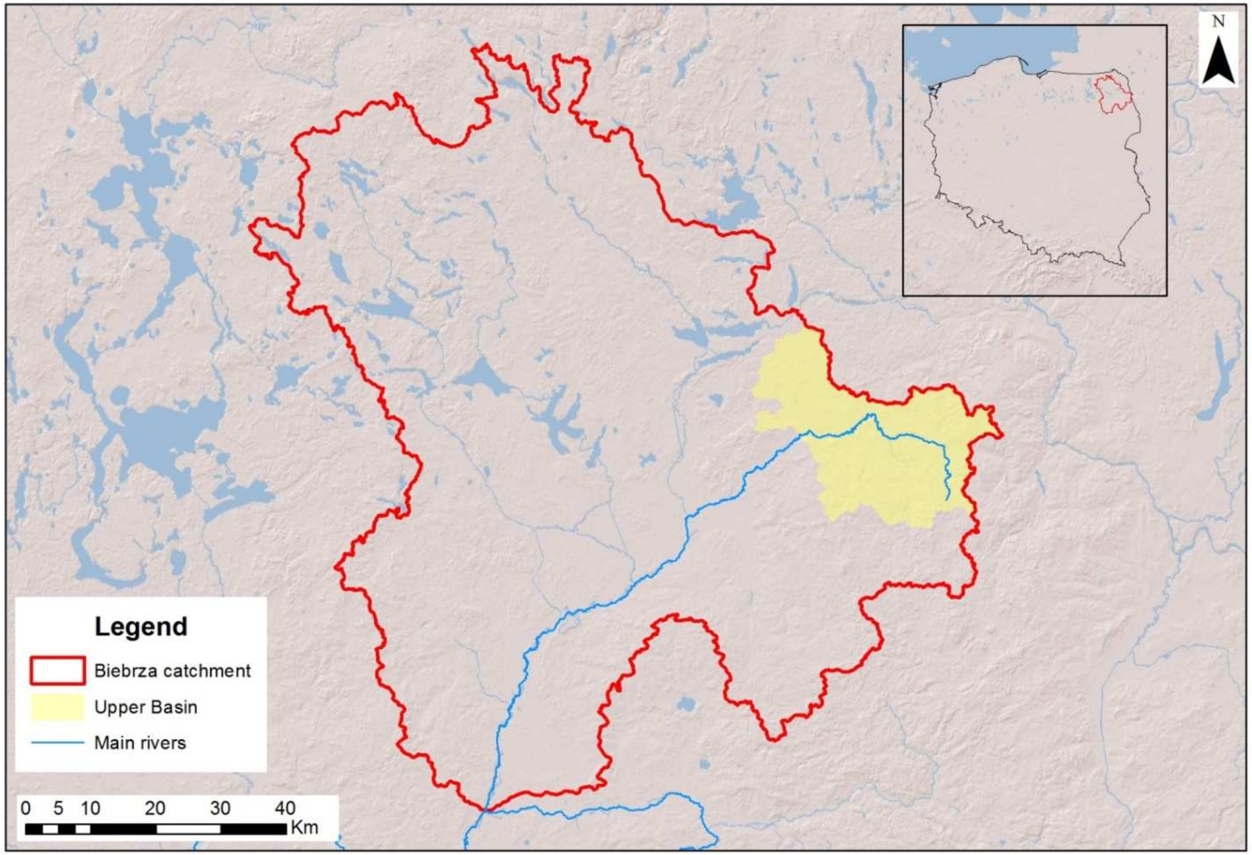
  *Melt volume (t) = Area * Melt Rate(t) * SC fraction(t) * dt*

- Parajka J. et al. (2010) A regional snow-line method for estimating snow cover from MODIS during cloud cover
- Matt Sturm and Anna M. Wahner (2010) Using repeated patterns in snow distribution modelling…

Biebrza River Catchment

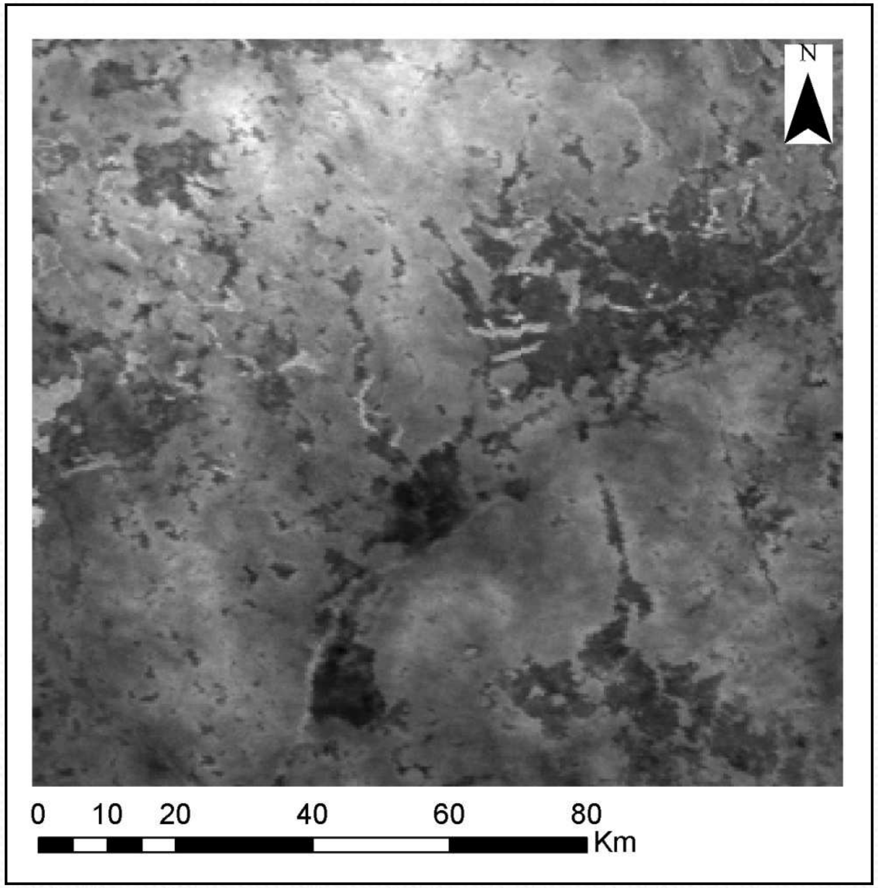


Biebrza River Catchment



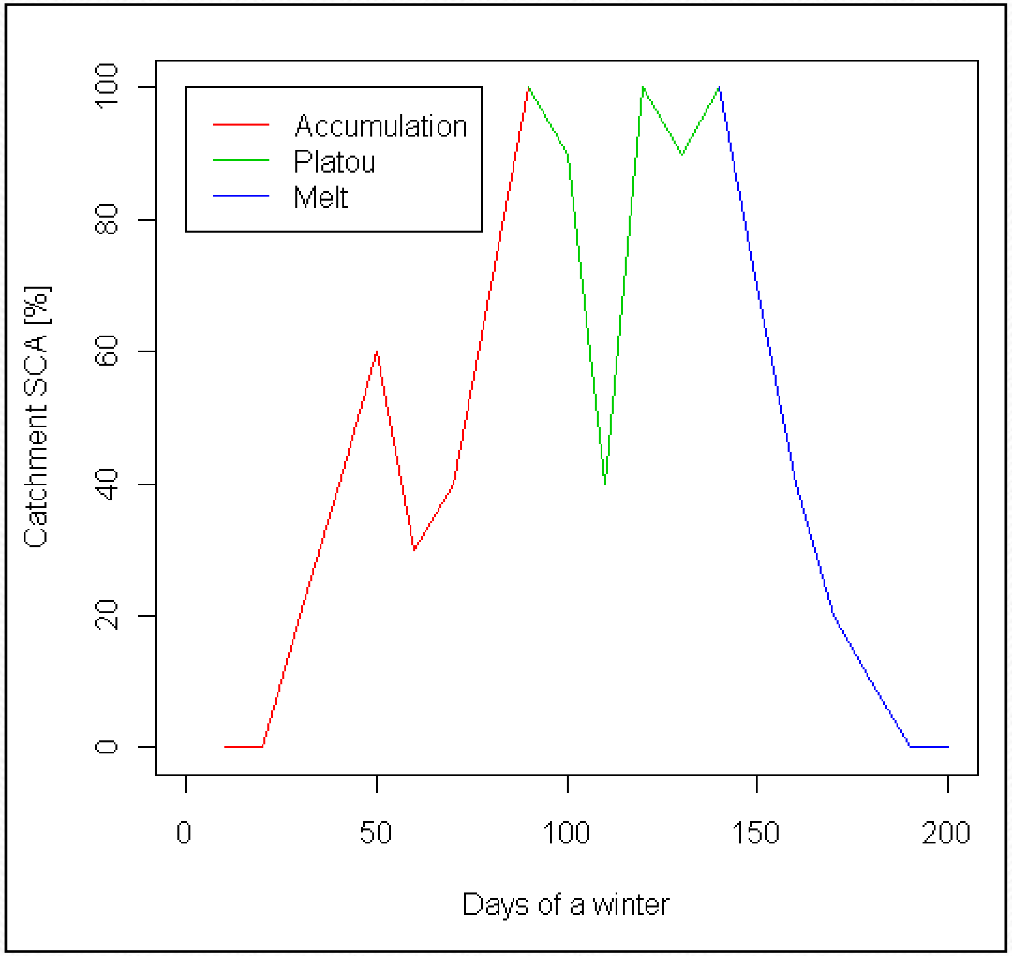
Subpixel Snow Frequency Patterns

- Summary of 10-yr (2001-2011) daily MOD10A1 snow cover fraction time series



Frequency:
White – 56%
Black – 14%

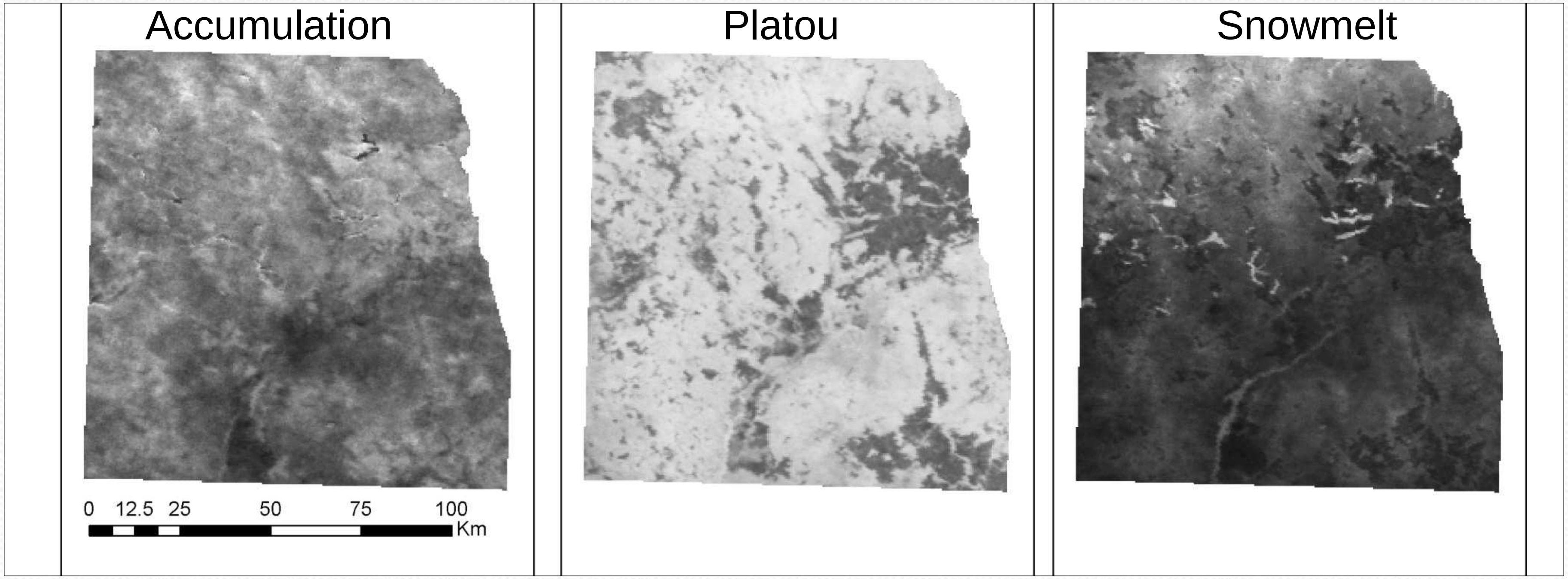
Subpixel Snow Frequency Patterns



Subpixel Snow Frequency Patterns

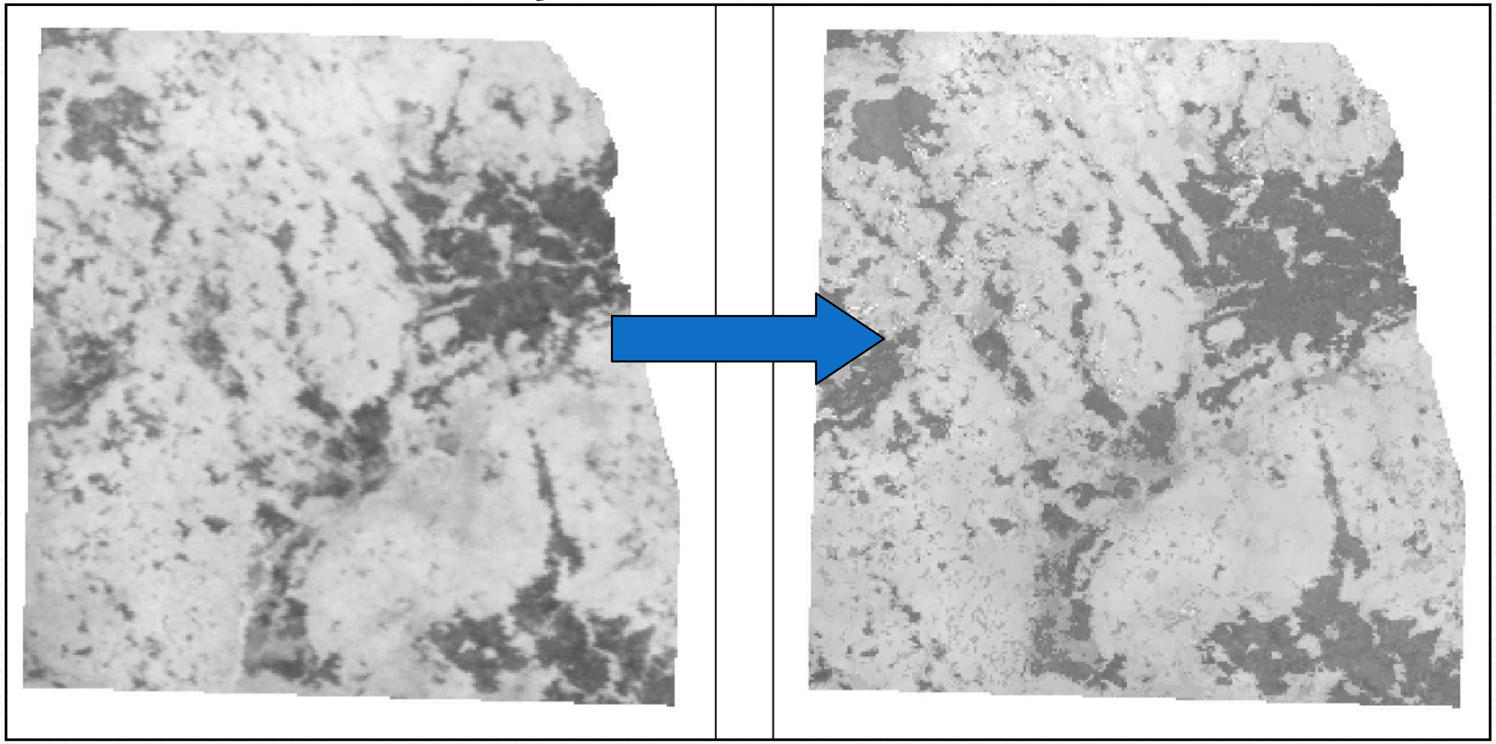
- Summary of 10-yr (2001-2011) daily MOD10A1 snow cover fraction time series

Frequency:
White – 100%
Black – 0%



Identification of Patterns

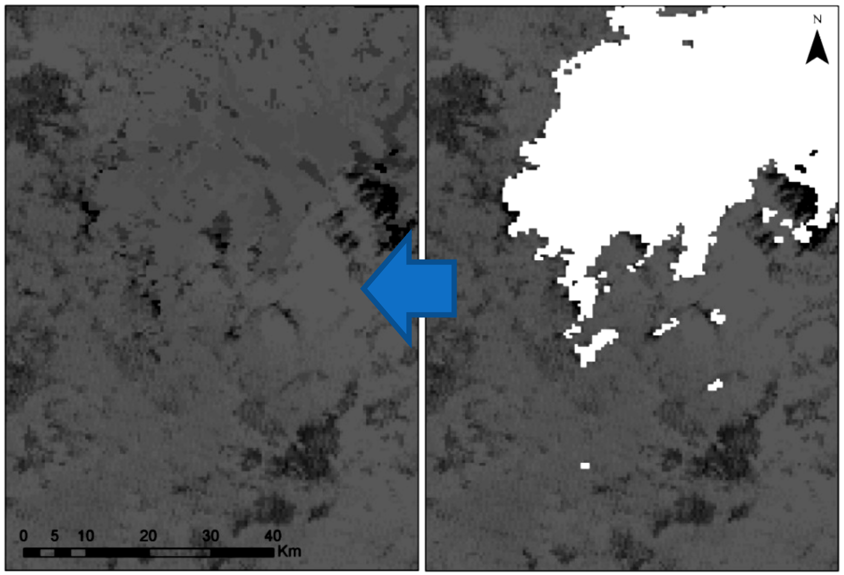
- Stepwise selection of multiple linear model
- Input: Land-use, geology, peat type, elevation
- Insignificant input: slope & aspect
- Mean absolute error ~5% SCA, $r^2 = 0.75$



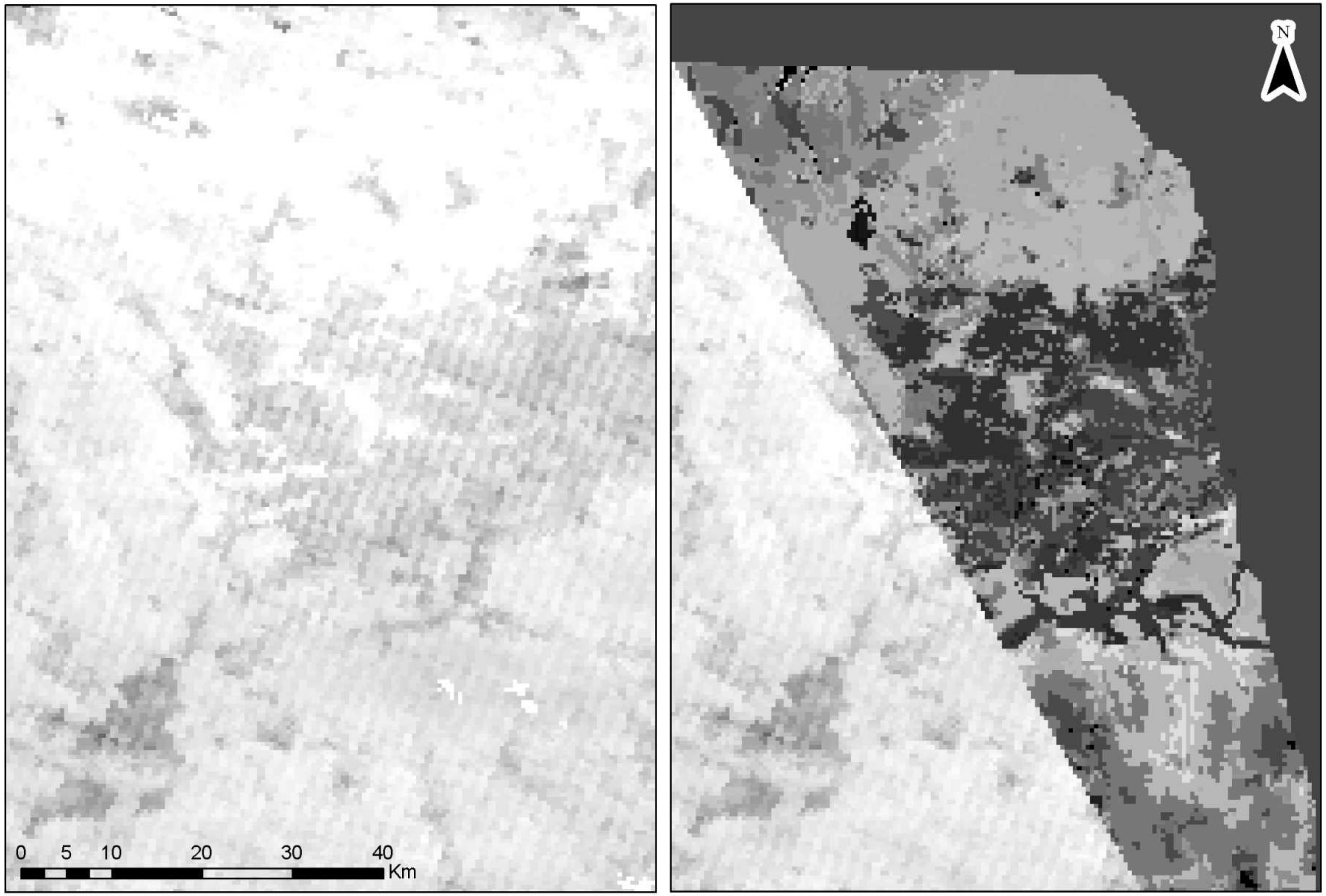
SCA Interpolation:

1. Missing Data is replaced with SCA obtained from the most corelated patches
2. If Missing Data > Treshold, changes in SCA are simulated in refference to snow depth in a meteo station

- Mean absolute error: 20% to 40% SCA



SCA Interpolation:



Snowmelt model

- Instantaneous melt depth from subcatchment:

$$M = SCA \text{ x } temperature \text{ x } day\text{-}degree\ constant$$

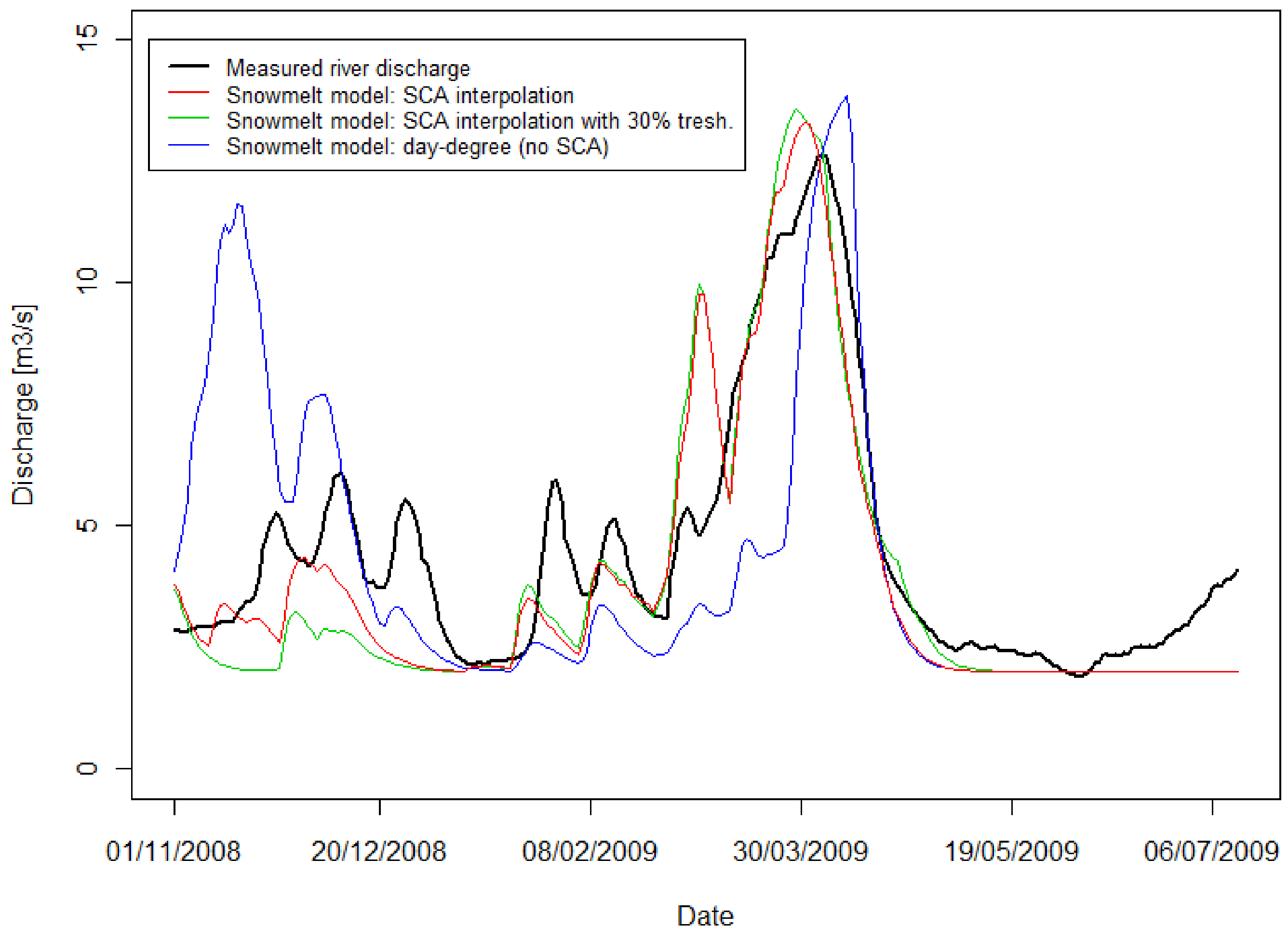
- Series of linear reservoirs:

$$q = k \text{ x } M$$

- River routing with the WetSpa IUH:

$$U_i(t) = \frac{1}{\sqrt{2\pi\sigma_i^2 t^3 / t_i^3}} \exp\left[-\frac{(t-t)^2}{2\sigma_i^2 t / t_i}\right]$$

Hydrological modeling results



Conclusions

- Snow distribution is related to elevation, land-use and other features like groundwater discharge areas
- SCA patterns allows to interpolate missing data under cloud cover
- SCA variability in catchment is important for distributed hydrological modeling
- Snowmelt runoff is rather a slow flow than a quick flow