High resolution process modelling of a high latitude catchment

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CLASSIC

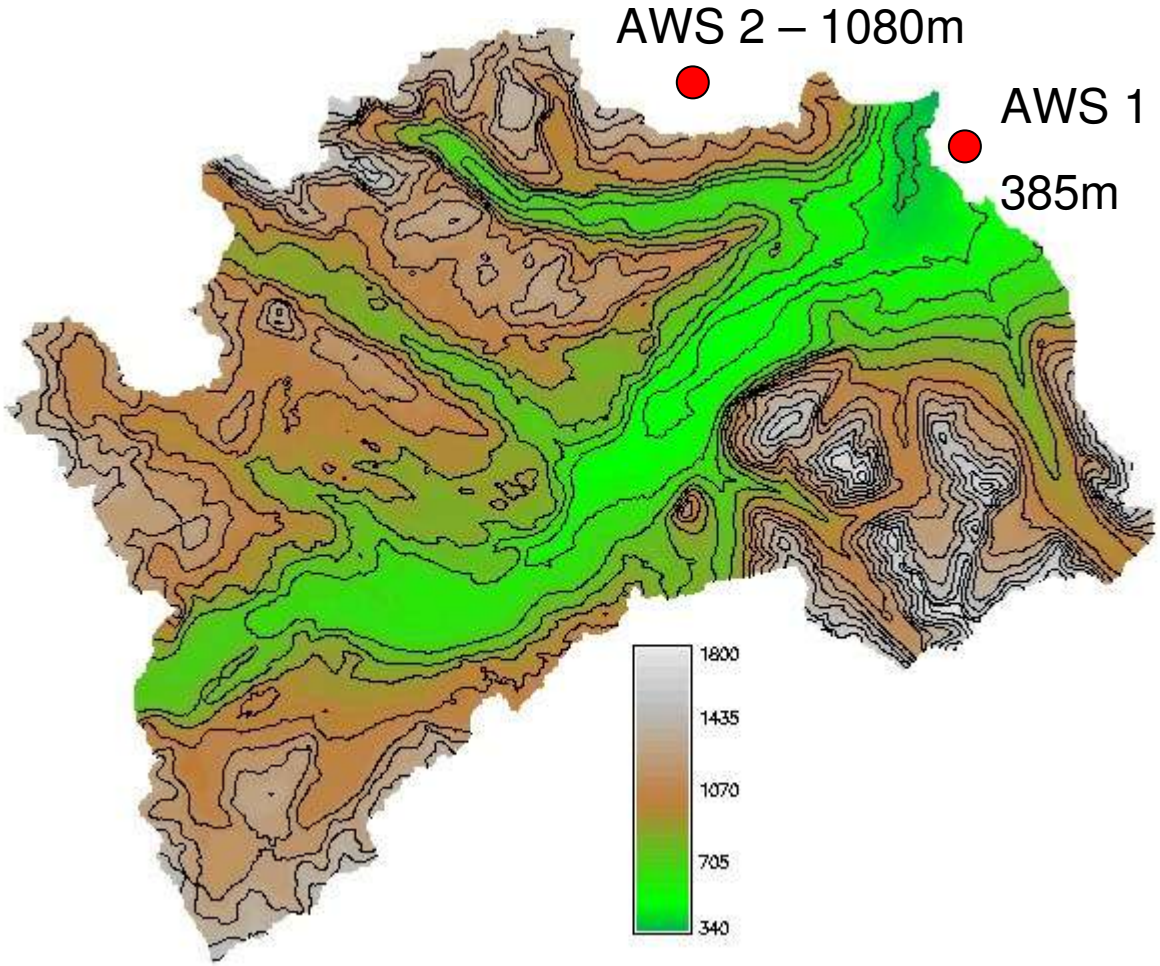
Aim

- To understand the role landscape heterogeneity plays in the heat, water and carbon cycle.
- From this, develop surface tiling scheme and surface parameterisations to improve the seasonal heat, water and carbon fluxes.

Landscape Snow Heterogeneity



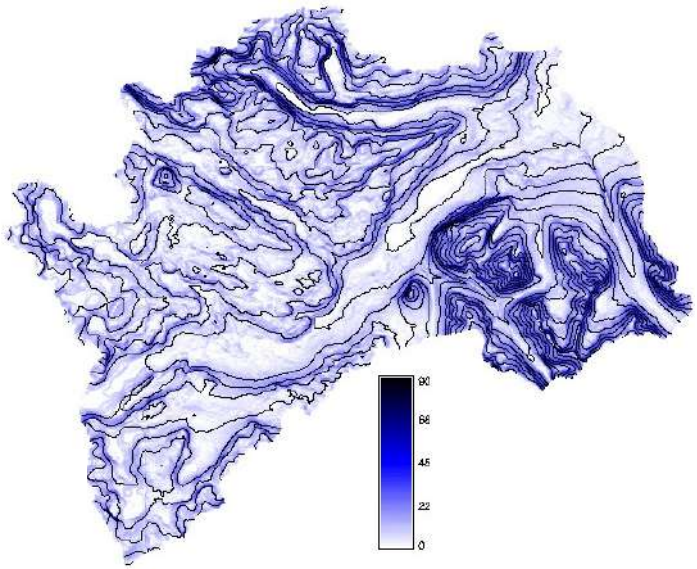

Abiskojokk Catchment



- Seasonally frozen catchment
- Approx 600km^2
- Spans elevation range of 340 to 1800m
- Model simulations 50m resolution
- Approx. 240,000 grid points
- 3 years: 2003-2005

Topography

Slope



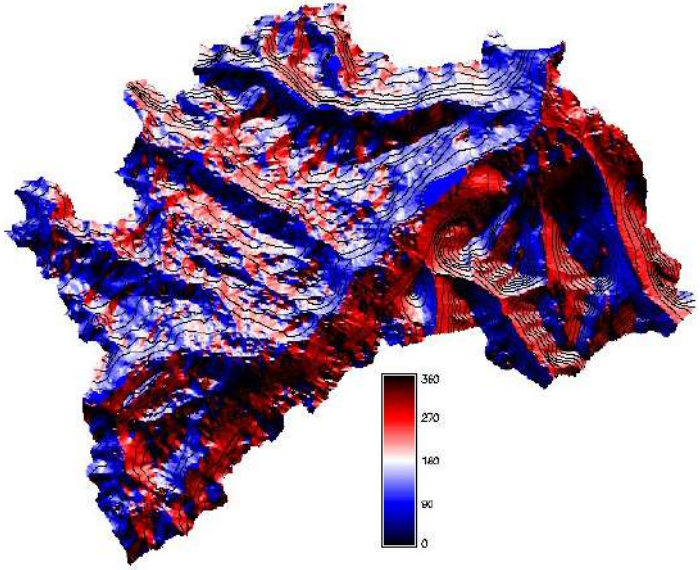
Aspect

Dark Red/Blue - N Facing

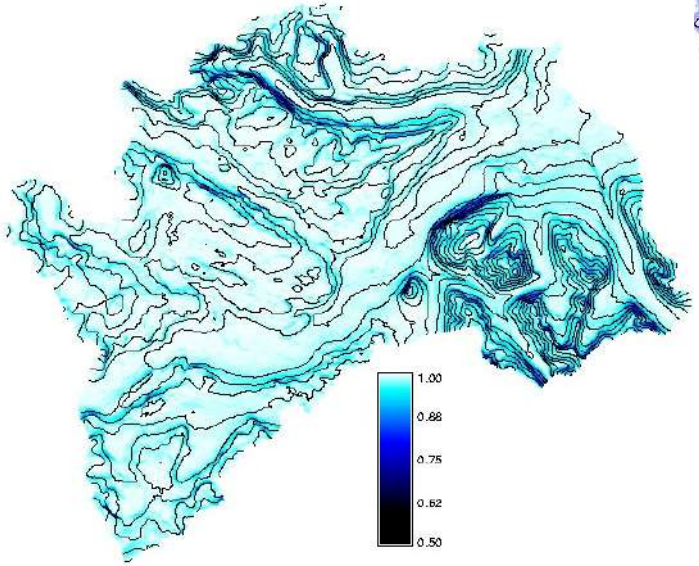
Blue – E Facing

Red – W Facing

White – S Facing



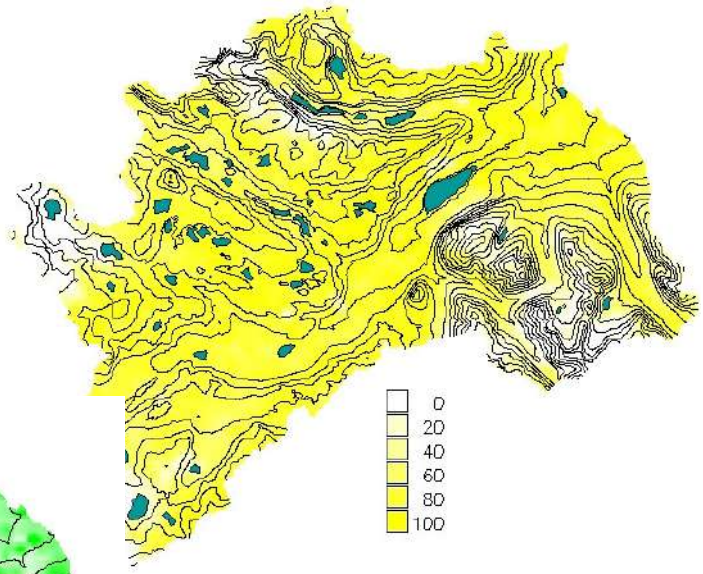
Sky-View Factor



Derived from 50m DEM

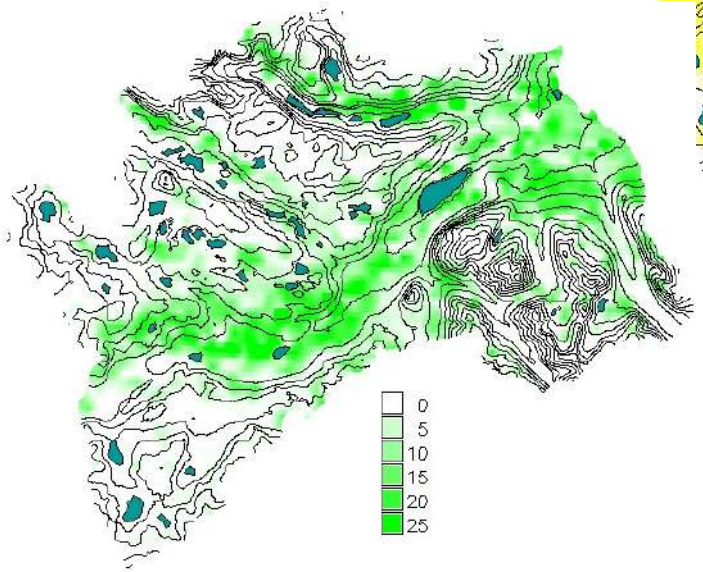
Vegetation Cover

% Grass/Shrubs



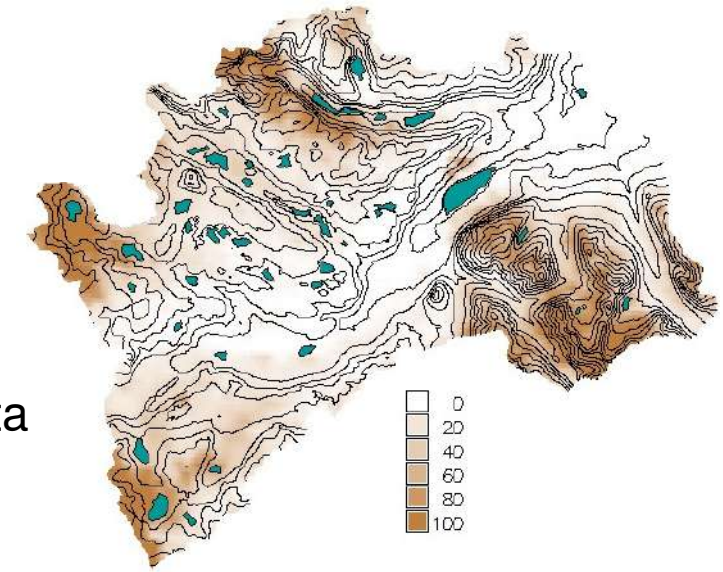
Survey data suggests ratio of Shrubs to Grass is 95:5

% Tree cover



Interpolated from 500m MODIS vegetation cover data

% Bare Ground



Distributed Model Driving Data

- Driving data distributed across the catchment according to topography
- Downwelling Shortwave Radiation
  - Observations split into Direct/Diffuse using estimate of cloud index
  - Direct and diffuse solar radiation fluxes calculated for each point
  - Diffuse radiation adjusted for sky-view factor
  - Direct radiation adjusted for slope, aspect and shading, including self-shading
- Downwelling Longwave Radiation
  - Adjusted for sky-view factor, where the radiating temperature of surrounding topography assumed equal to air temperature
- Air temperature
  - Lapse rate – 0.39K per 100m derived from AWS observations

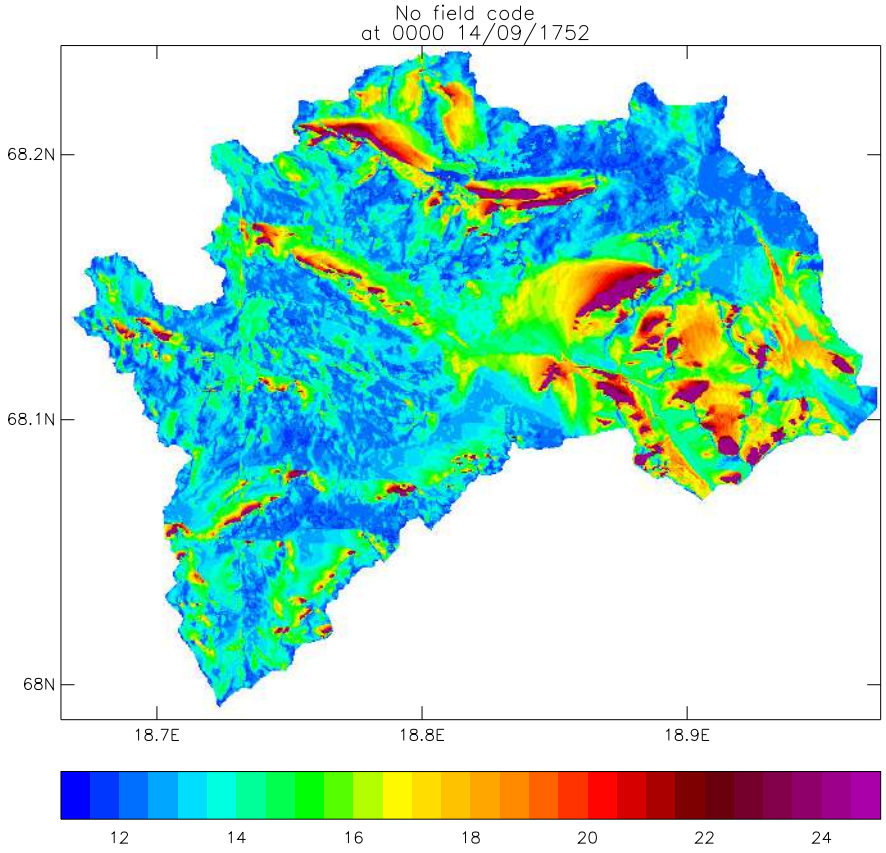
Distributed Model Driving Data

- Humidity
  - Kept uniform across domain, but prevented from becoming super-saturated
- Windspeed
  - Held uniform
- Precipitation
  - Gauge corrected observations indicate a 20% increase in precipitation per 100m
  - Air temperature used to split precipitation into solid and liquid components

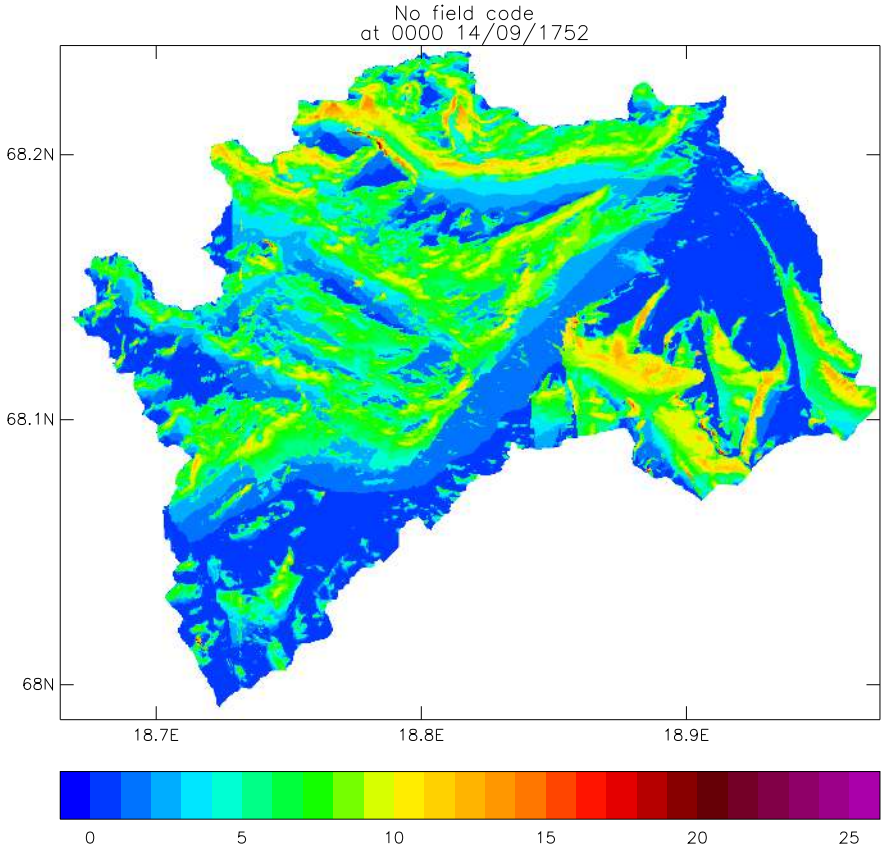
Topographic Shading

Hours of shade

Equinox



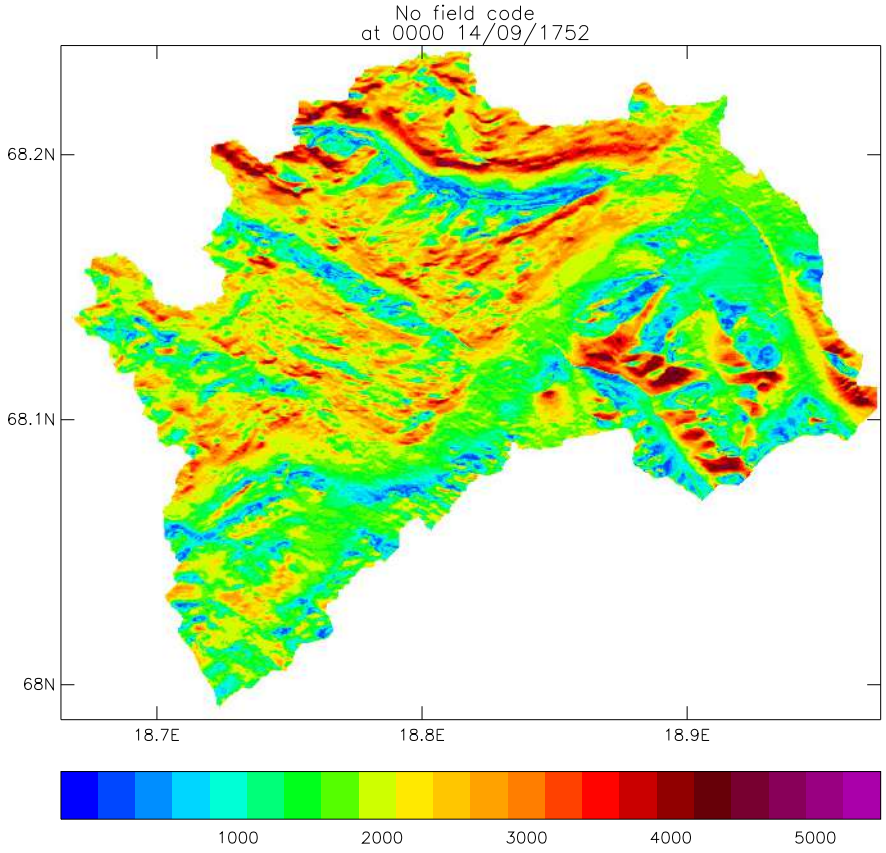
Midsummer



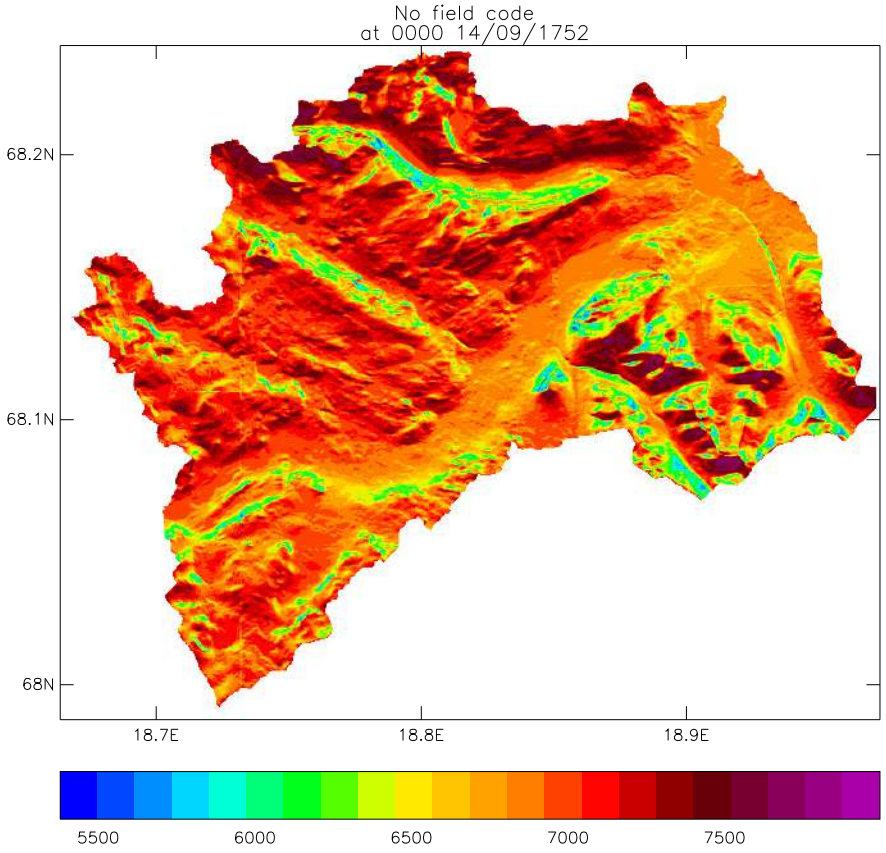
Direct Radiation

24hr Integrated Solar Index

Equinox

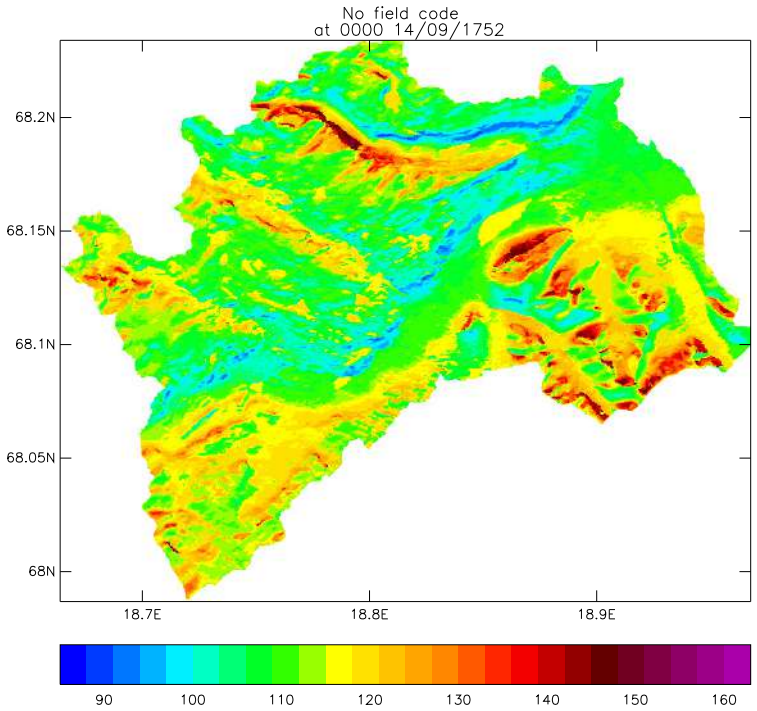


Midsummer

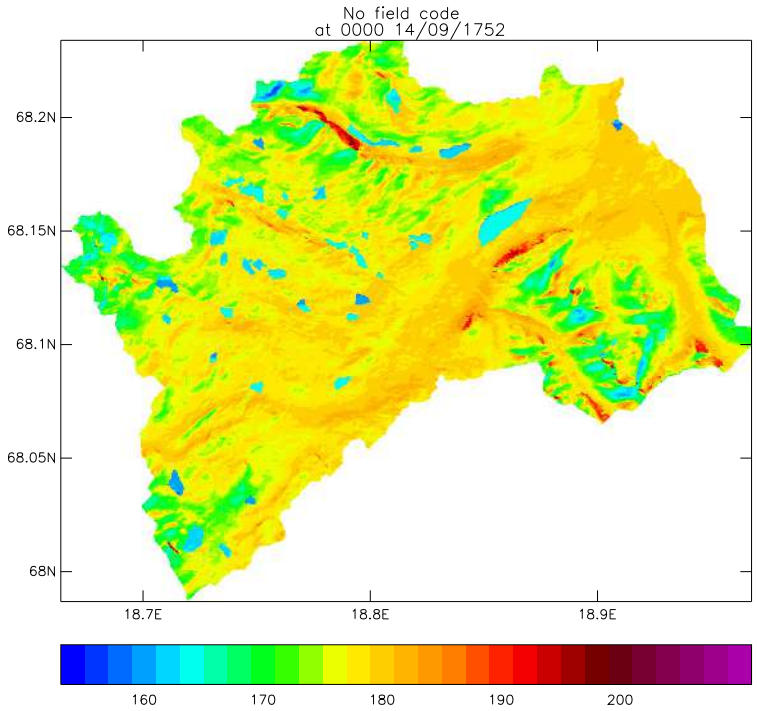


Soil Freeze-Thaw

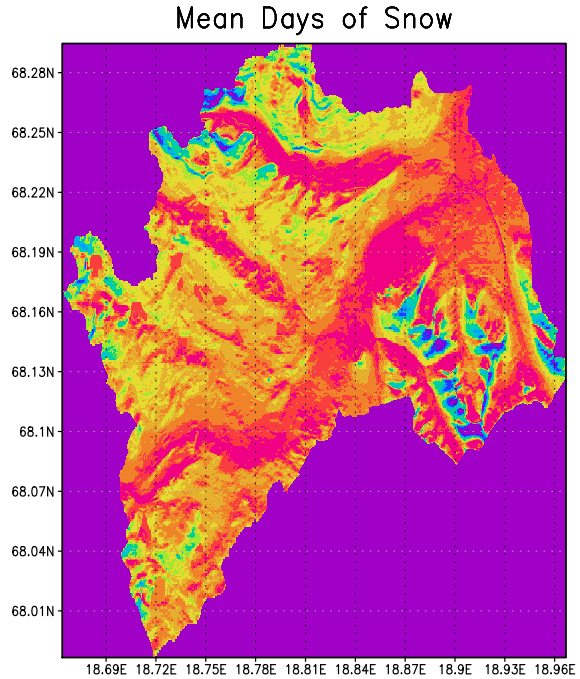
Soil Thaw DOY

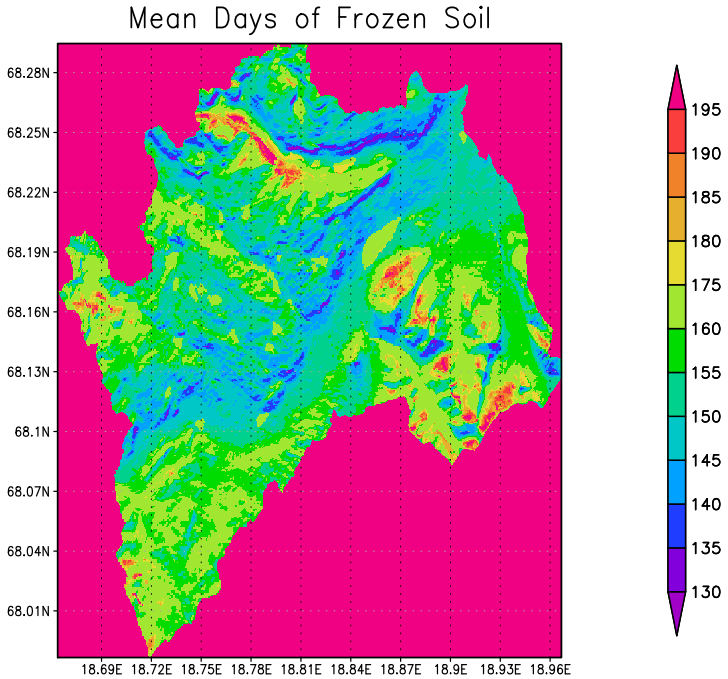


Soil Freeze DOY

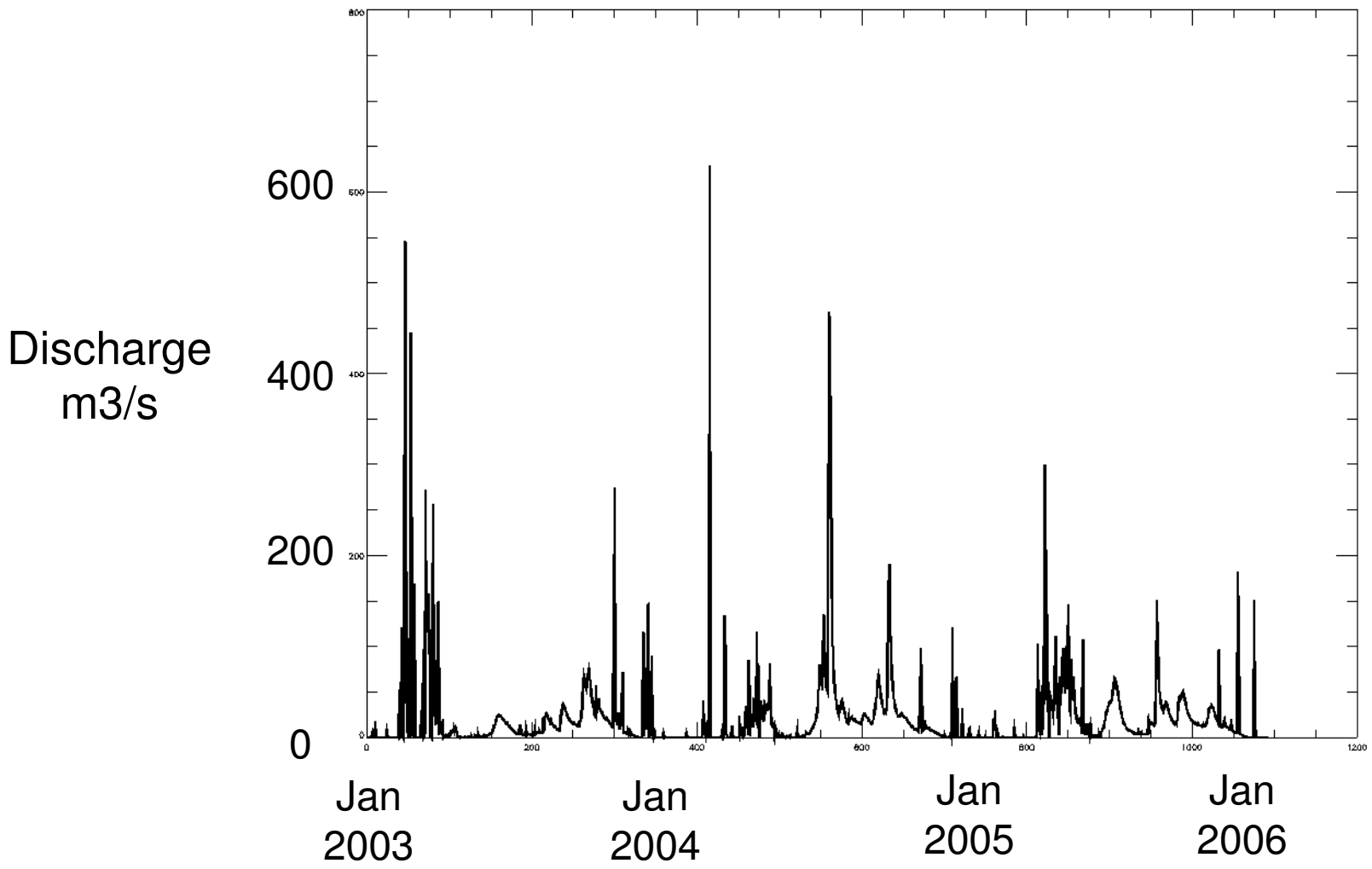


Days of Snow and Frozen Soil



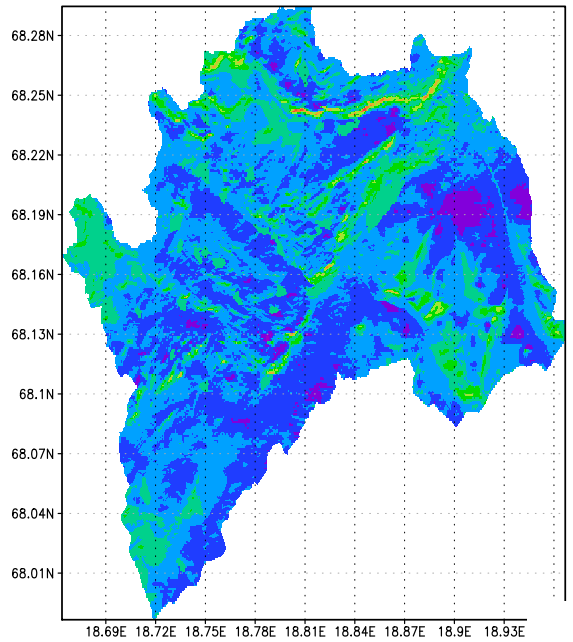


River Discharge



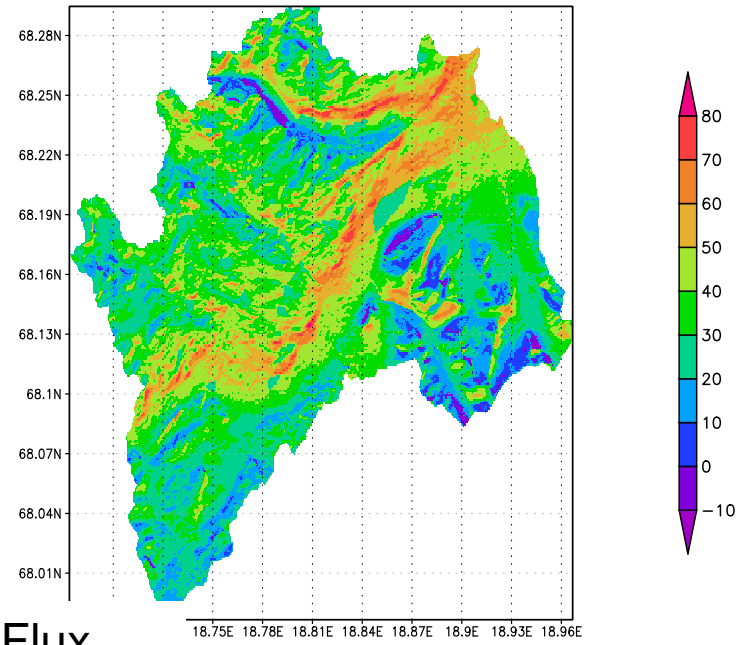
Sensible Heat Flux (W/m2)

JFM



GrADS: COLA/IGES

AMJ



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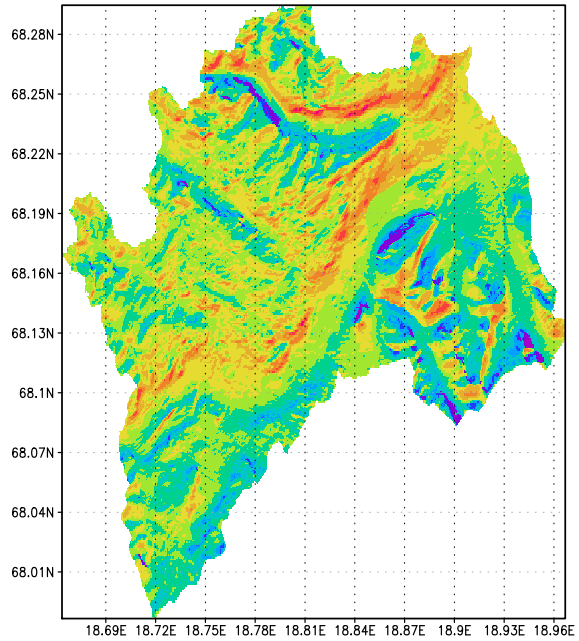
JAS



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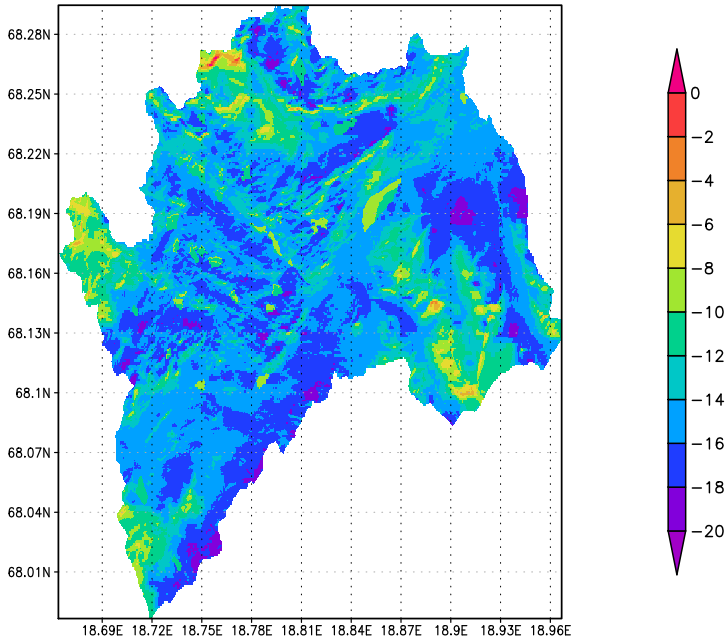

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Further work

- Validate model against river discharge data and MODIS snow cover data
- Analyse the relationship between surface exchange and topography
- Model development of tiled topography and parameterisations of heterogeneity