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Seasonal snow melt season of the Northern Hemisphere from 1982 to 2015

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Motivation

- Melt season albedo has been studied
  - Typically as monthly means
- The observed changes in melt season albedo are explained by earlier melt

➢ **Has the albedo changed already before the melt season?**

➢ **Where has the occurence of the melt season changed and how much?**

Outline

- Data
- Methods
- Trends in albedo and timing on melt
- Variability in melt season timing
- Extreme values in melt season timing

Data and Analysis

Data

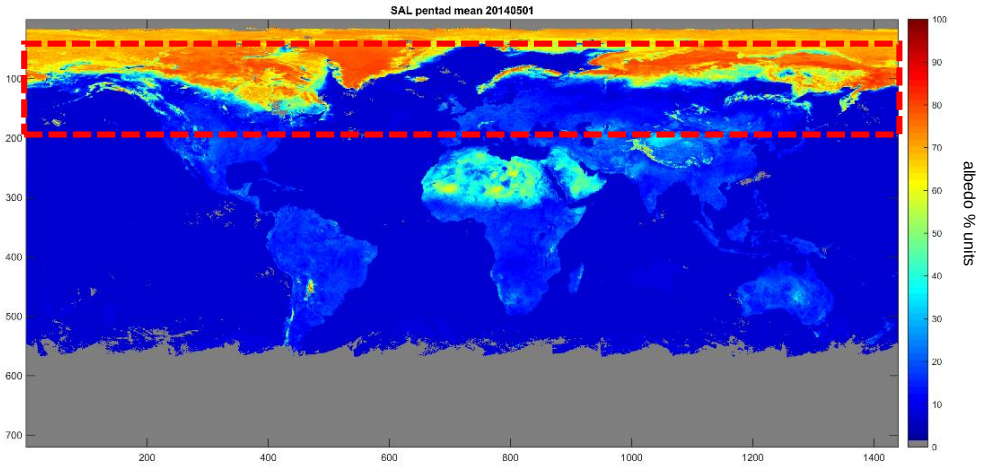
- CLARA-A2 SAL surface albedo data
- Based on AVHRR
- Global pentad means
- 1982-2015
- 0.25 degree resolution

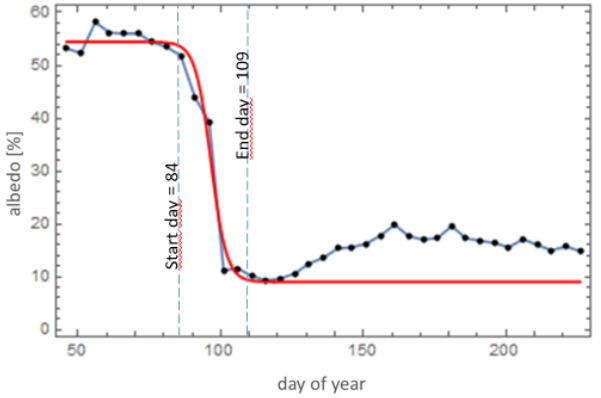
Study area:

- 40°N to 80°N land areas

Methods:

- For each grid cell
  - Yearly pentads
    - ->sigmoid fitting (Böttcher et al. 2014)
  - Define:
    1. **Start of melt season**
    2. **End of melt**
    3. **Length of melt season**
    4. **Albedo level prior to melt season**
    5. Albedo level at the end of melt season
- For each parameter and grid cell
  - 34 year trends using moving 5 year average
  - Max & min values (detrended) and their timing
  - Variation during the study period



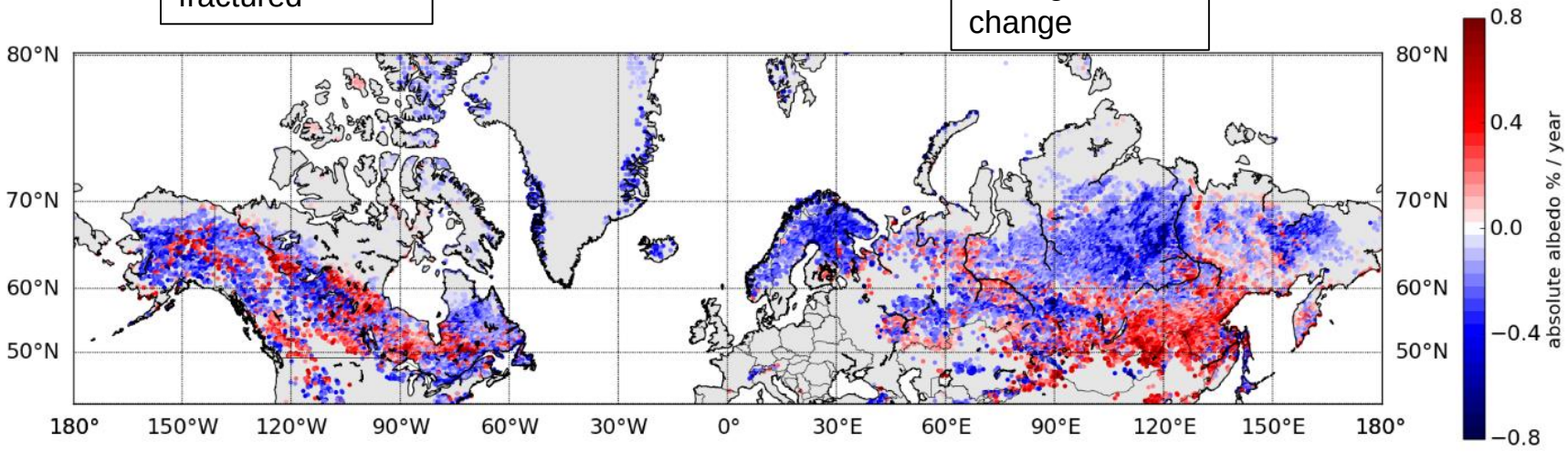


Trends in albedo and melt season timing

Observed changes in albedo prior to melt season concentrates in the boreal forest zone

In North America features more fractured

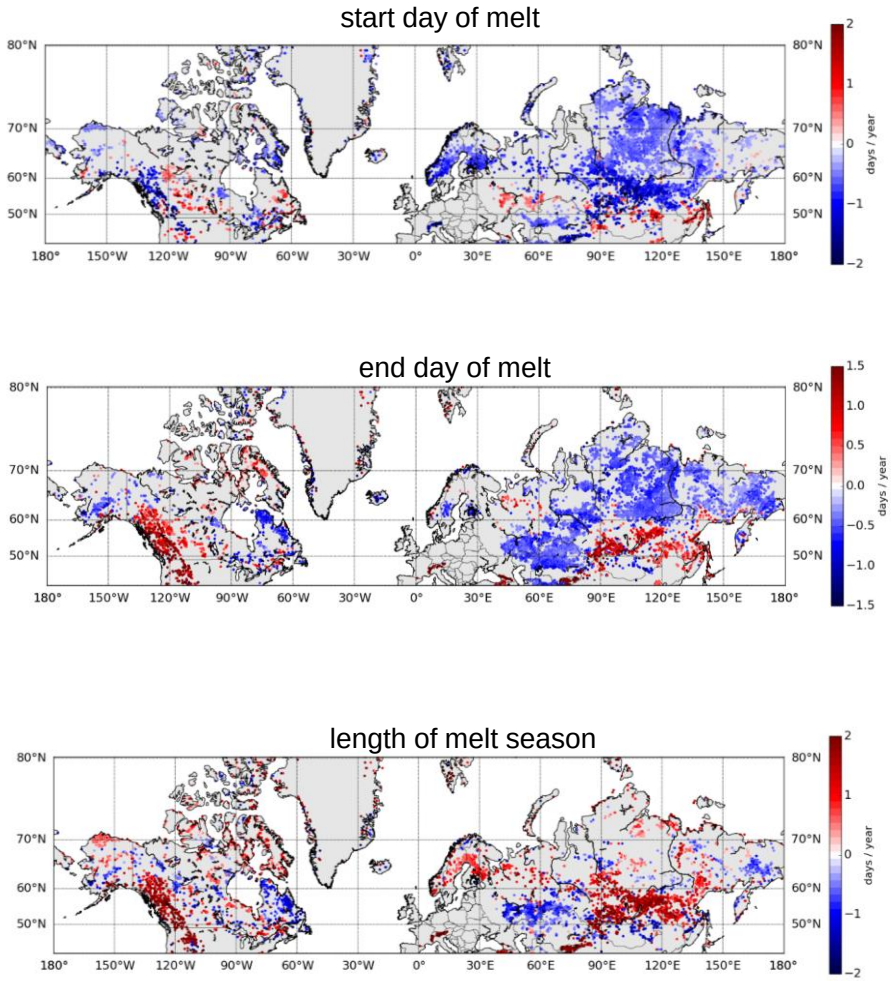
In Eurasia large areas with homogenious change



Areas with clear trends (R^2> 0.5) in boreal forest zone

Trends in melt season timing

- Observations with clear trends (R^2> 0.5) are clustered
- In the Rocky Mountains the melt season is getting longer
- In Central Siberian Plain the melt season takes place earlier



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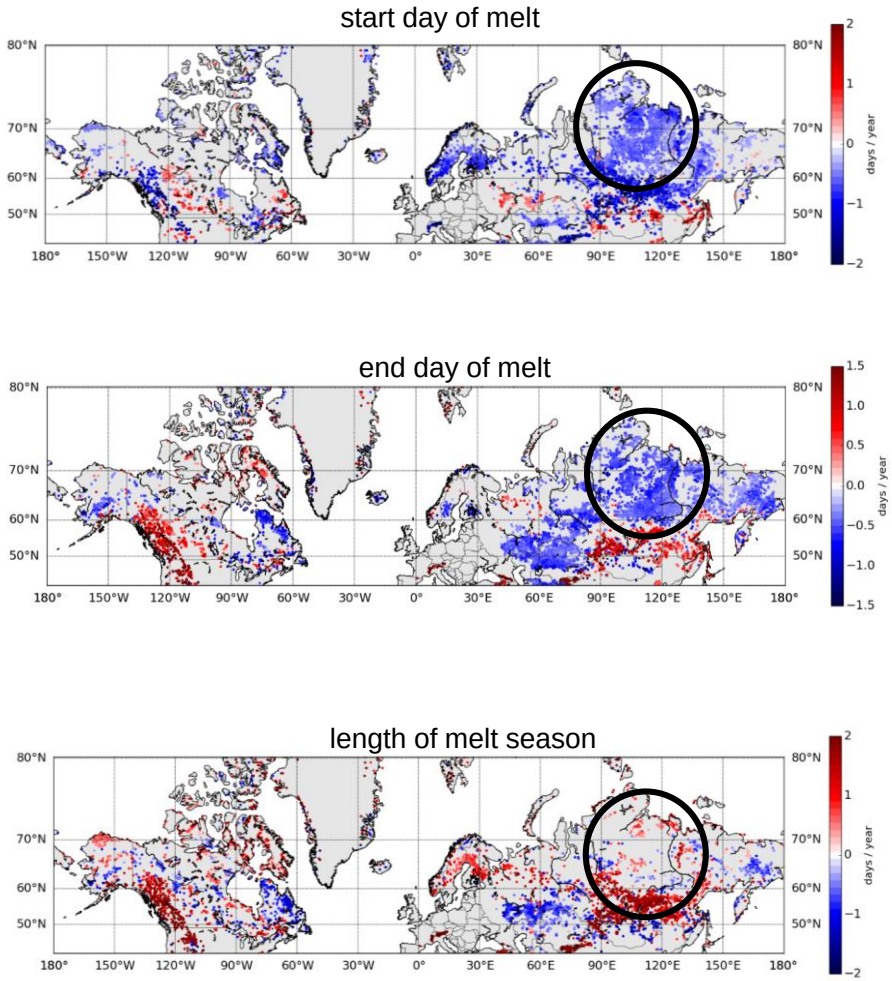

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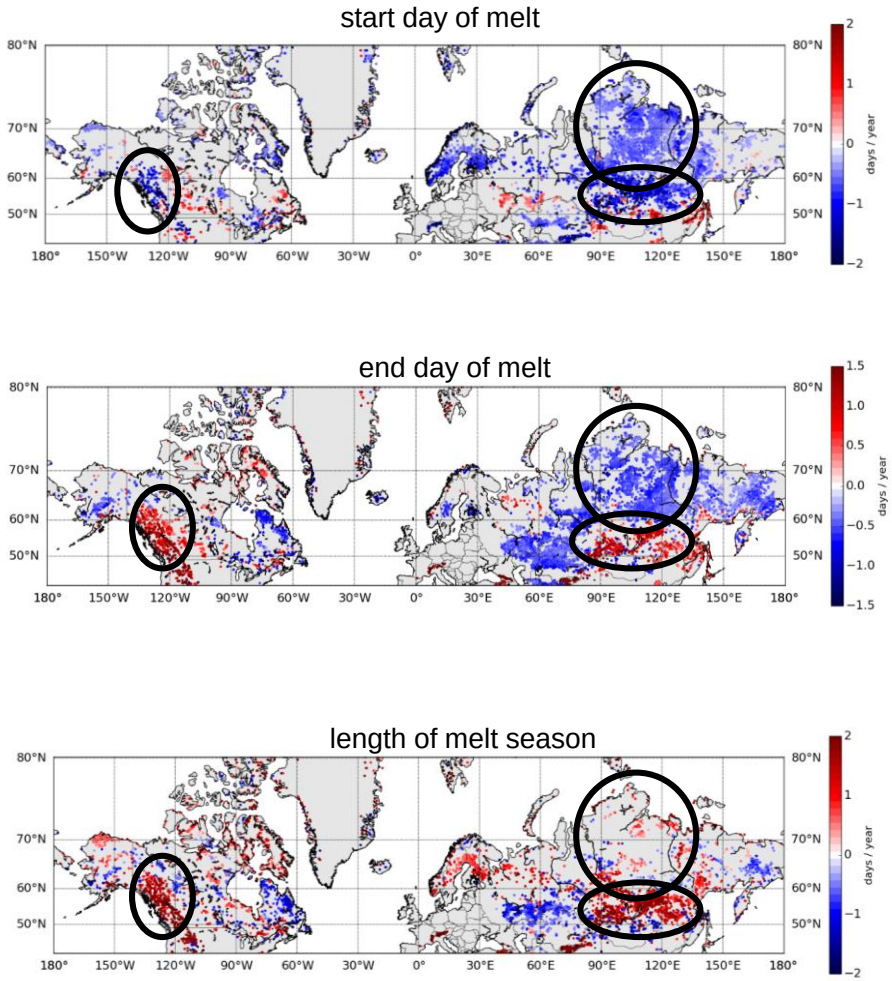
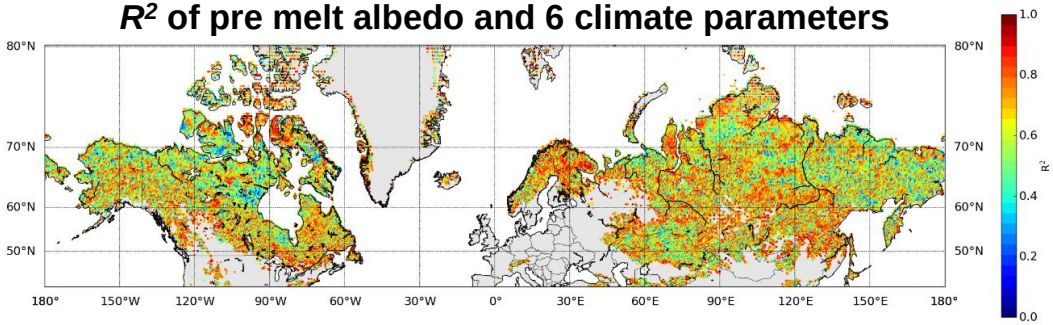


Climate can explain the changes in start day of melt but not for pre melt albedo

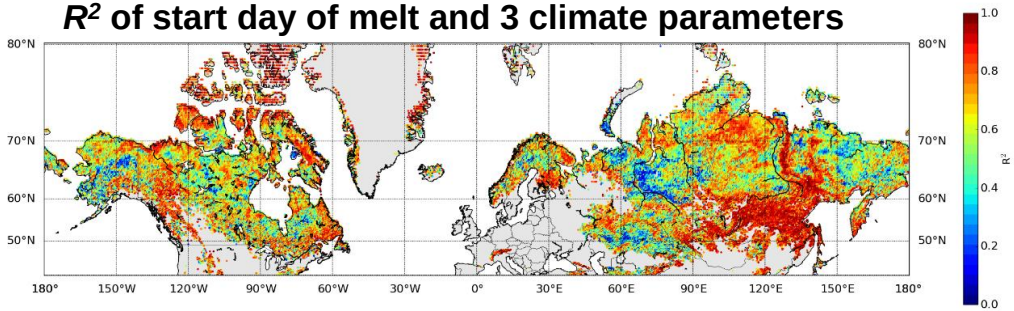
- ERA INTERIM data
  - Mean air temperature
  - Number of days when max T above 0°C, -4°C and -10°C
  - Mean wind speed
  - Accumulated precipitation
- 14 days prior to onset of melting

R^2 of pre melt albedo and 6 climate parameters



- Albedo before melting season
  - 6 parameters needed for R^2 = 0.61
  - mean air temperature most significant
- Start day of melting season
  - 3 parameters sufficient for R^2 = 0.61
    - Mean air temperature, wind speed and precipitation

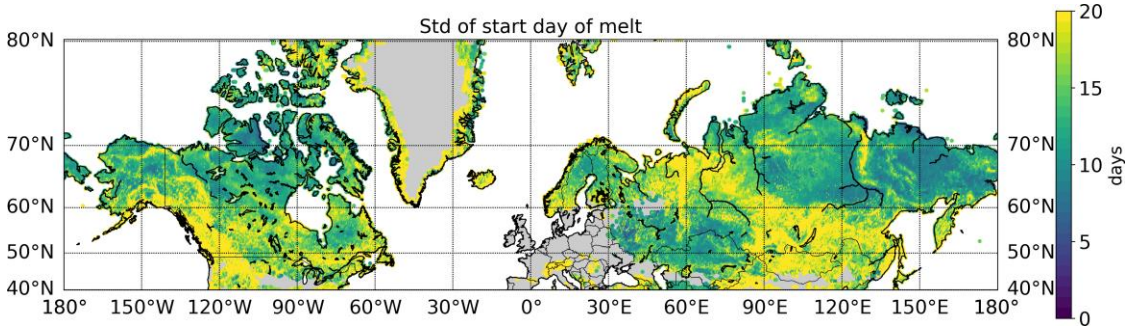
R^2 of start day of melt and 3 climate parameters

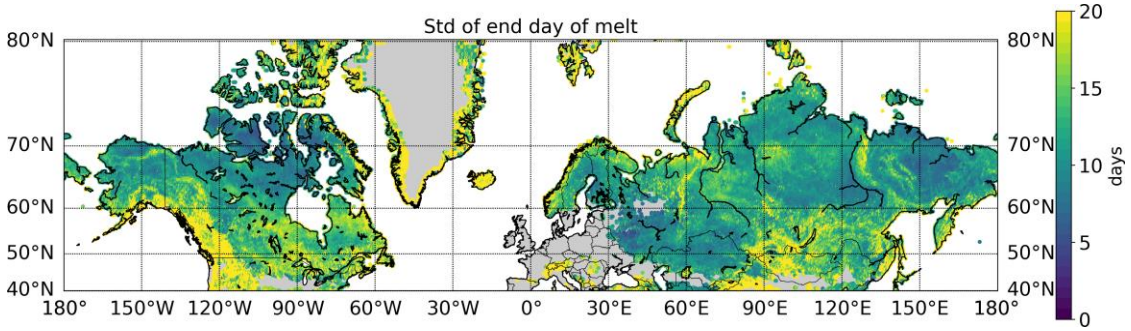


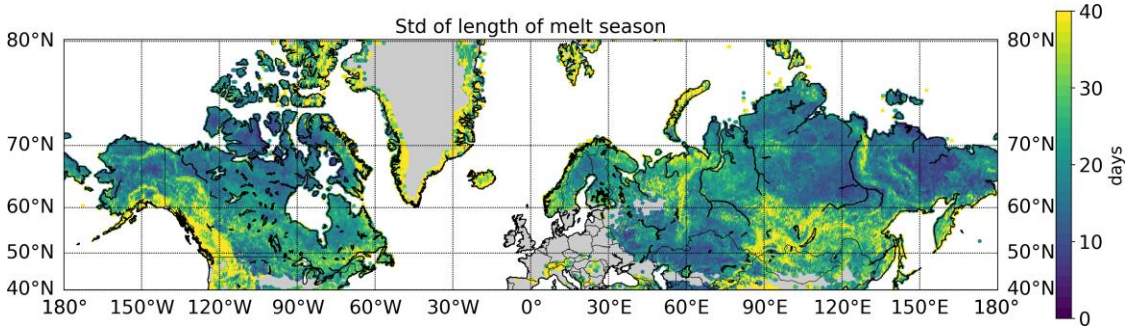
Variability in melt season timing

Start day of melt varies more than the end day of melt

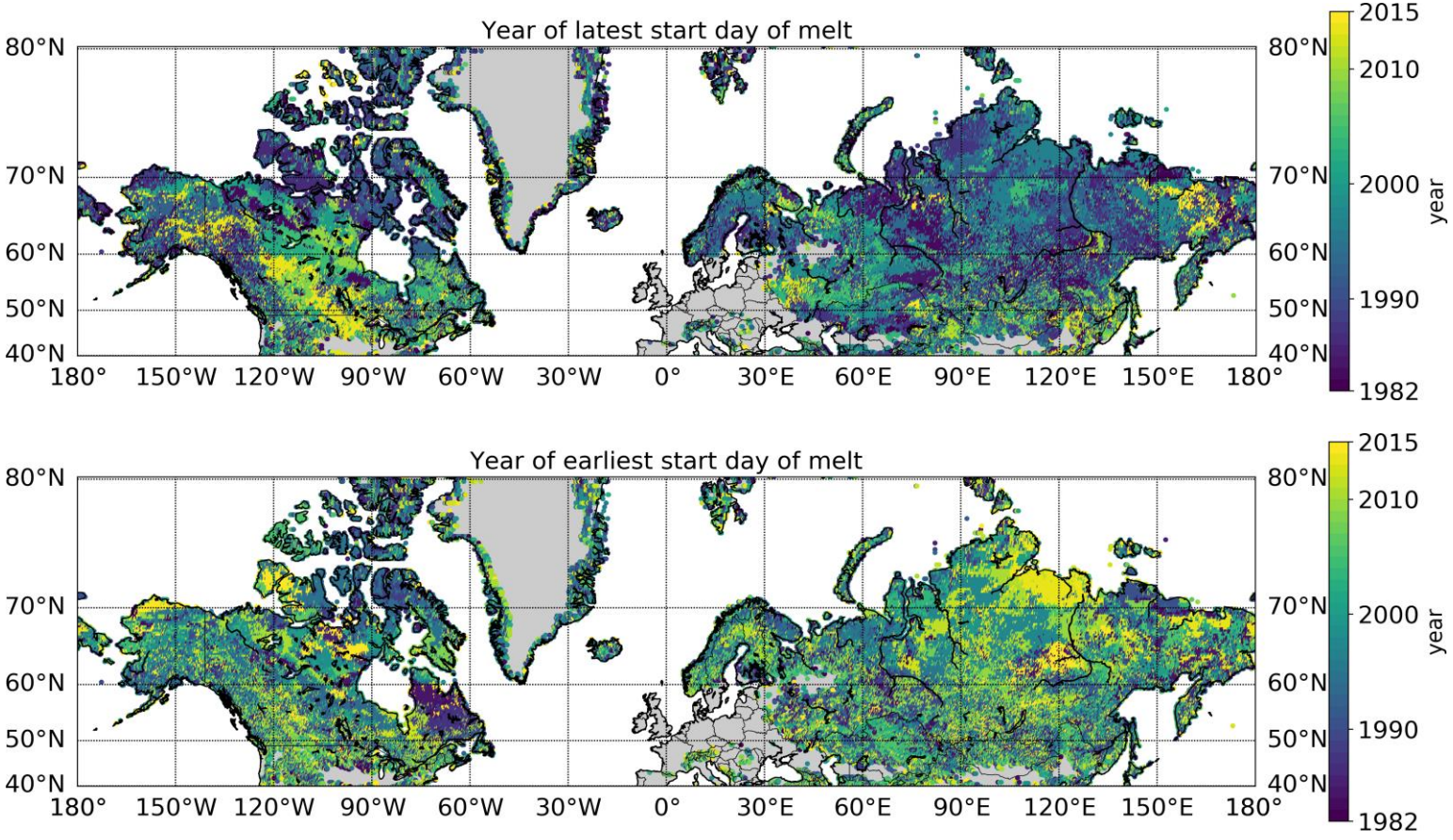
- Variation largest in mountaineous areas
- No large differences in variation between decades







The earliest start days at the beginning and latest start days at the end of the study period



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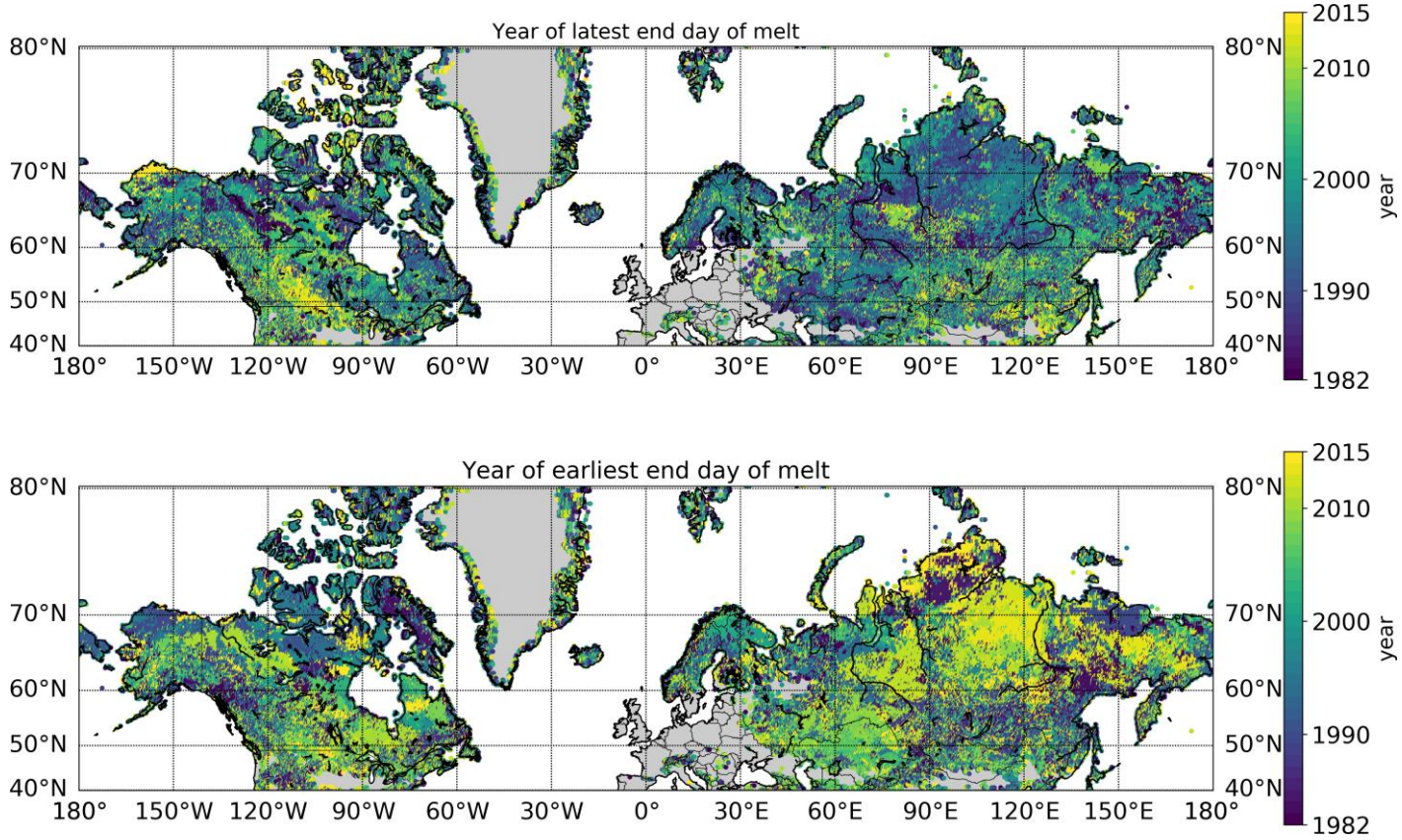
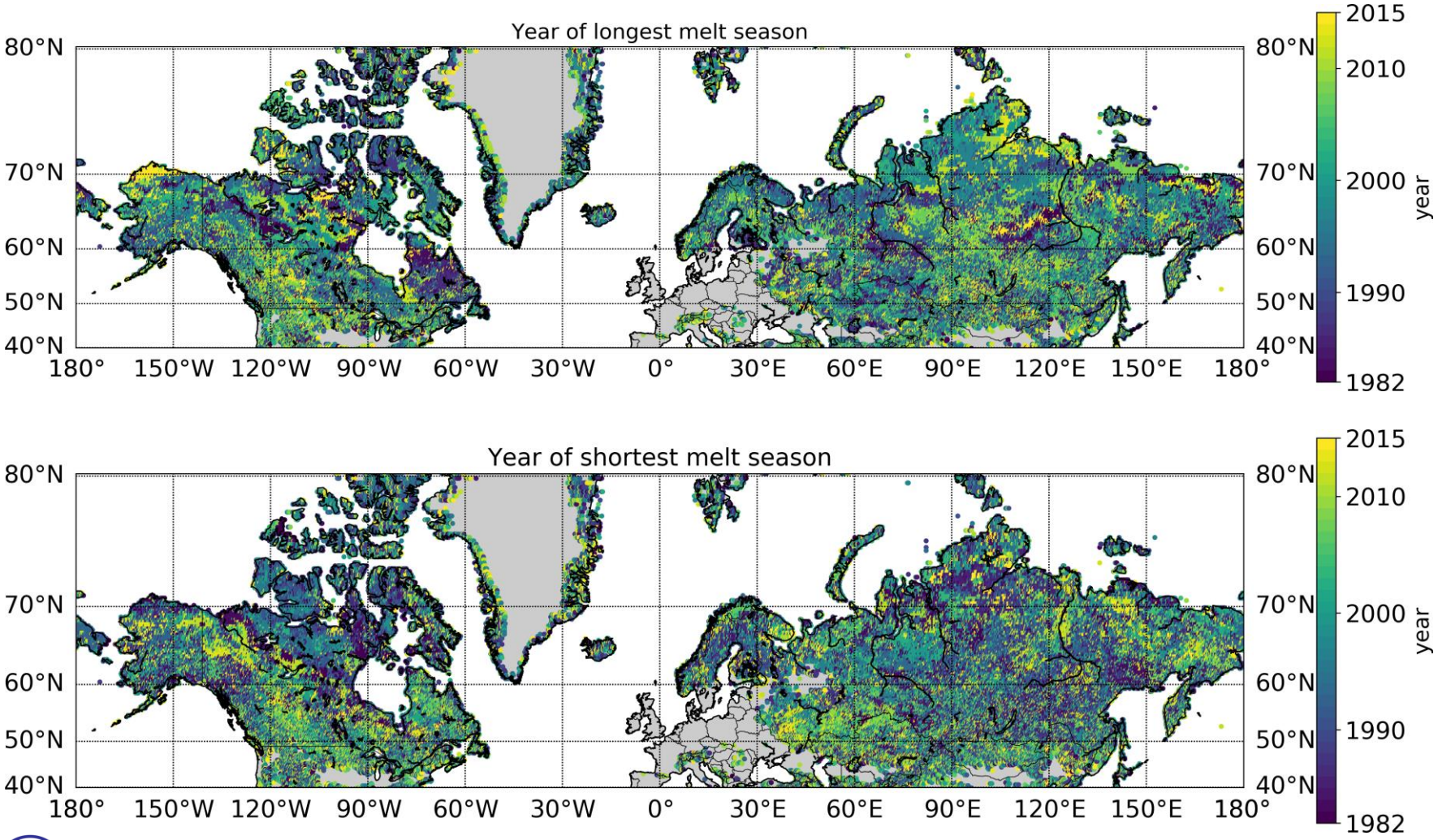


Year of shortest and longest melt season



Summary

- The pre melt season albedo of Northern Hemisphere land areas north of 40°N has changed
- The Changes vary spatially
  - Changes concentrate in the boreal forest zone

- The timing of the seasonal snow melt season has changed in large areas in the Northern Hemisphere
  - For most areas the changes in the start day of melt can be explained by climate

- The year to year variation is larger for the end day than for the start day of melt

- The earliest start and end days of melt have typically taken place in the 80's and 90's
- The latest start and end days of melt have typically taken place after year 2000

ACKNOWLEDGEMENTS:

- CM SAF project team, CLARA product family team

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