EGU General Assembly 2020

Towards long term SWE and melt trends for Europe:

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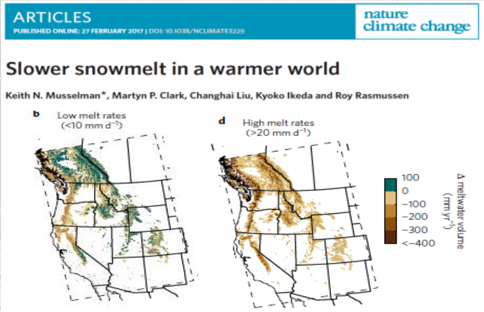
Background and Objectives

1) How does warming affect snowmelt dynamics?

- Slower snowmelt in a warmer world



(Musselman et al. 2017)

- Future reductions in high melt rates and increases in low melt rates
- **Snowpacks are shallower and melt earlier in the season when less solar radiation is available**
- Decreasing spring melt rate observed from station data over the US (Harpold and Brooks, 2018)
- High variability in spring melt rate trends over NH from remote sensing (Wu et al. 2018)

But:

- **These dynamics are not investigated over Europe from in-situ data**
- **There is no available network of SWE stations over Europe**

2) What is the impact on streamflow generation and water resources?

- What hydrological processes connect changing melt rates and changing streamflow? (Barnhartt et al. 2016; Li et al. 2017; Milly and Dunne, 2020)
- What is the role of climate, altitude and other factors?

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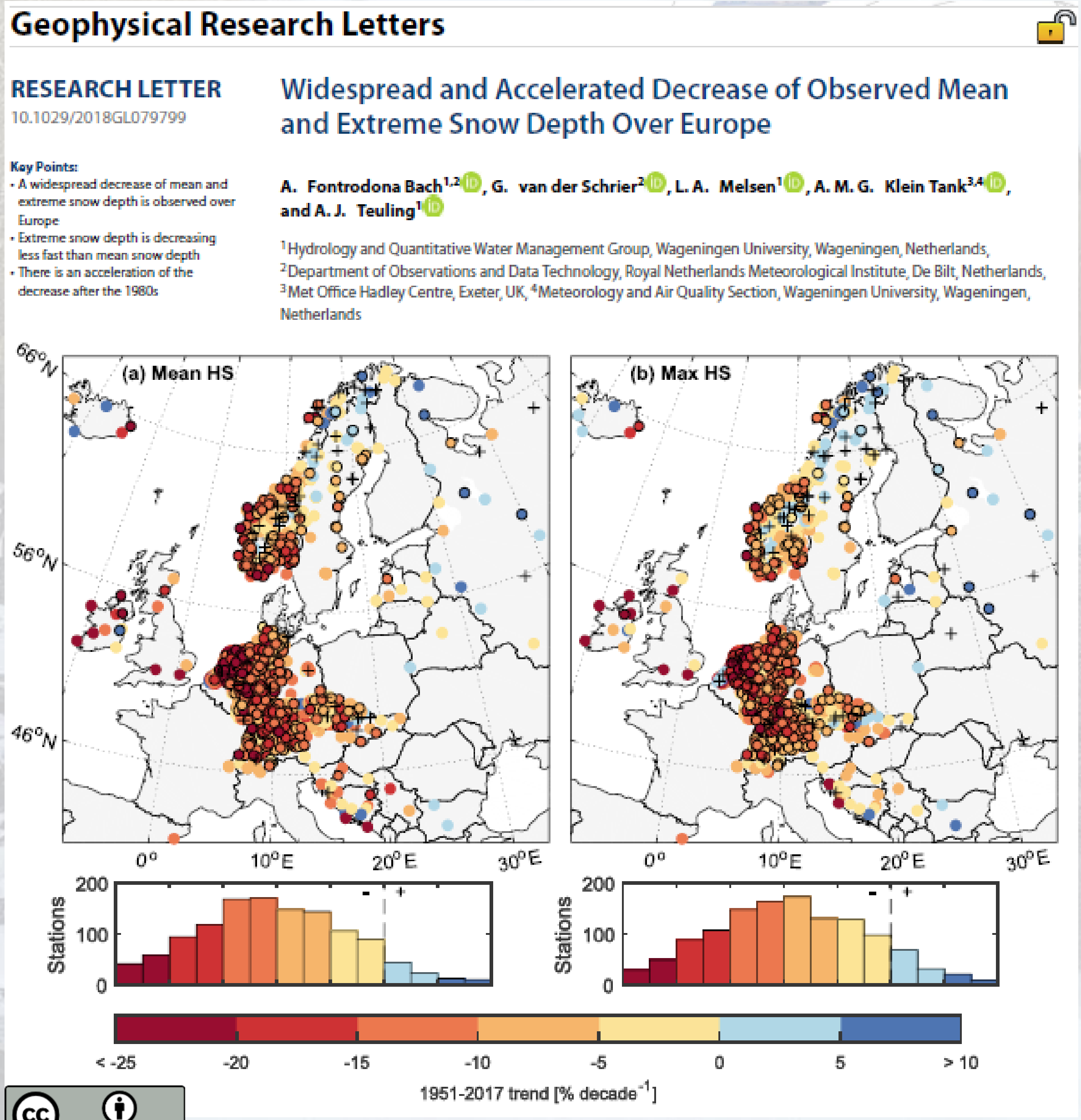
Current research: **From Snow Depth trends to Snowmelt trends**


Geophysical Research Letters

RESEARCH LETTER
10.1029/2018GL079799

Widespread and Accelerated Decrease of Observed Mean and Extreme Snow Depth Over Europe

Key Points:
- A widespread decrease of mean and extreme snow depth is observed over Europe
- Extreme snow depth is decreasing less fast than mean snow depth
- There is an acceleration of the decrease after the 1980s

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- Converting the pan-European **daily** snow depth dataset in [Fontrodona-Bach et al. (2018)] **to a SWE dataset**
- Methods: Empirical models of snow bulk density:
  1. Winkler et al. 2020 (in HESS discussion, **Display 76 in this same shareEGU session!**)
  2. Jonas et al. 2009
  3. Pistocchi, 2016
  4. Sturm et al 2010
  5. Guyennon et al. 2019
  6. Hill et al. 2019
  7. **Any other suggestions?**
- Currently converting only seasonal snow cover stations, for simplicity

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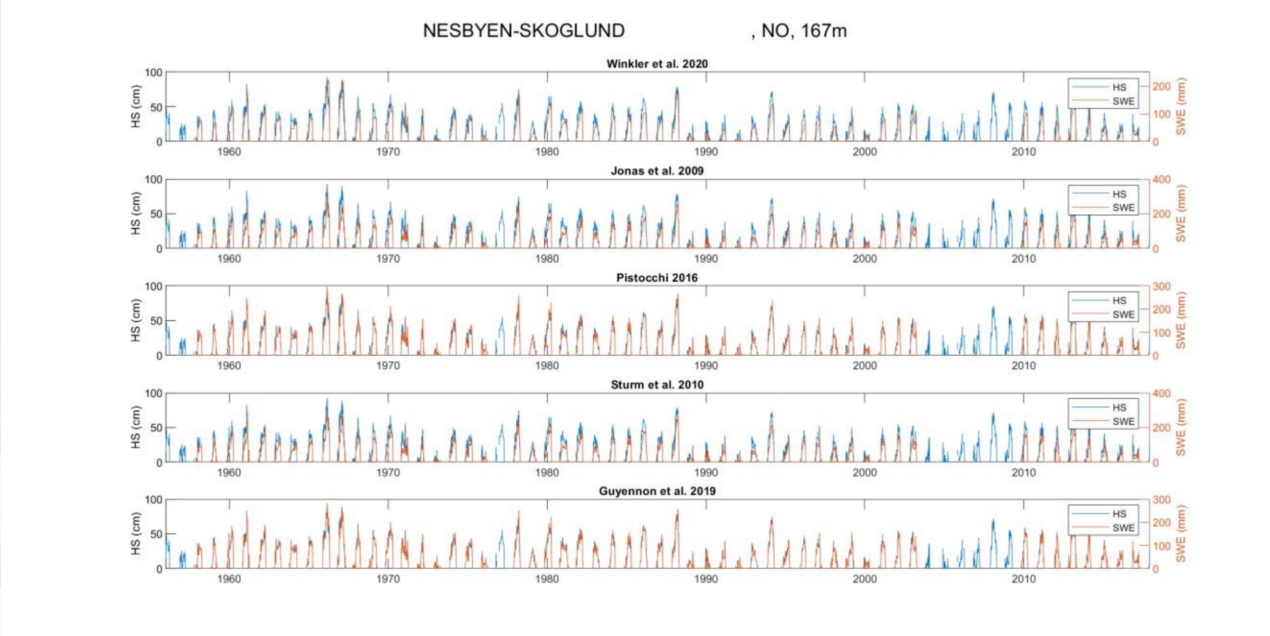
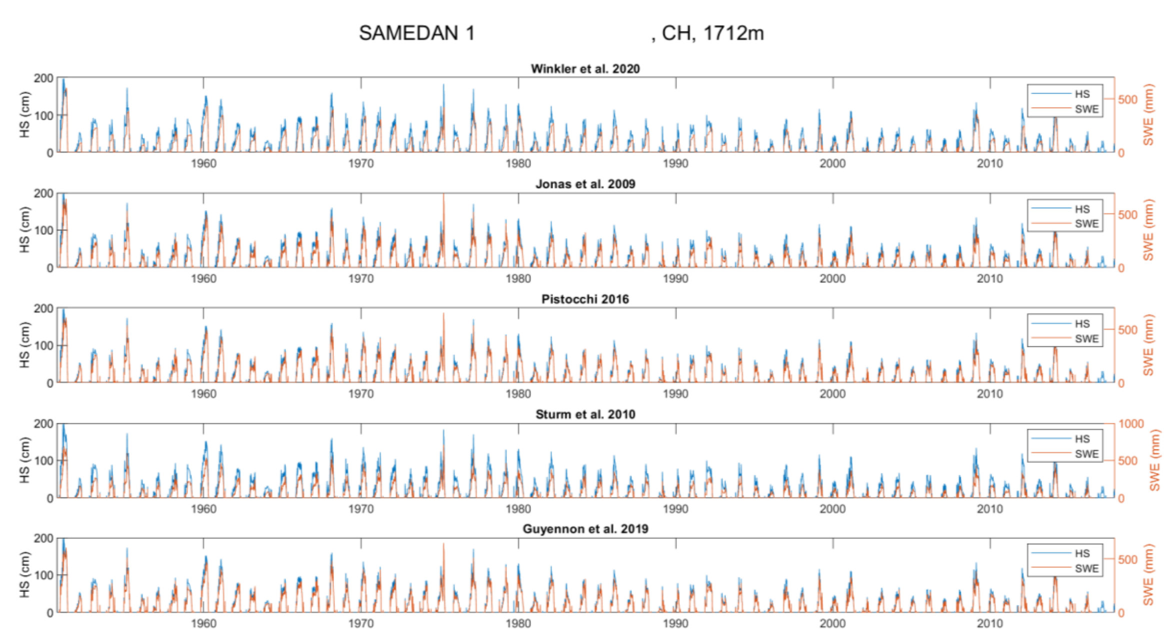
Preliminary Results:

Snow depth to Snow Water Equivalent (HS-SWE): Two example time-series of snow depth converted to SWE by 5 models with **"good performance"**

Station in Norway. Altitude 167m



Station in Switzerland. Altitude 1712m



- Models reasonably convert the seasonal snow dynamics from snow depth to SWE
- The long records of snow depth (from 1950s to 2010s) allow the study of long-term trends
- Inter-Model conversion agreement to be further explored

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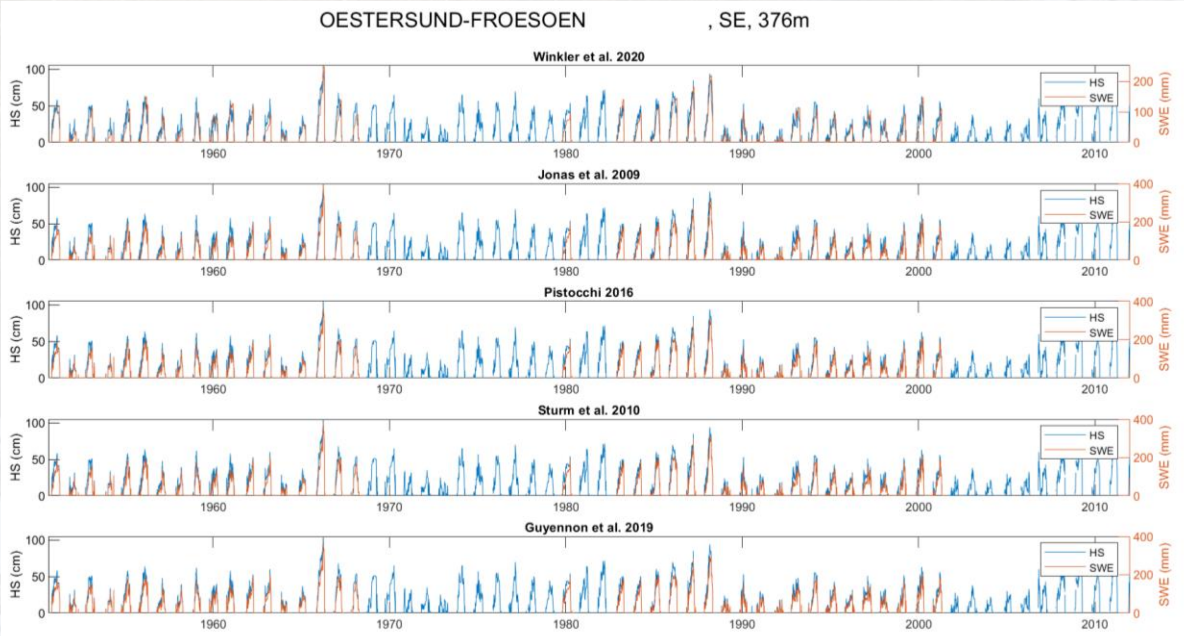
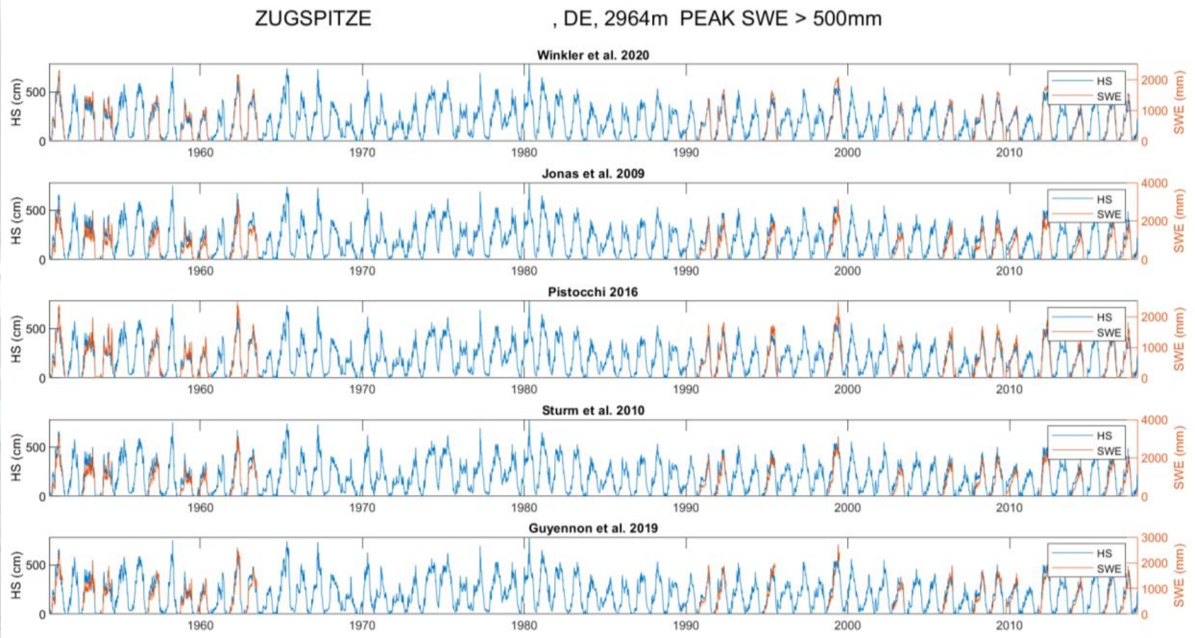
Preliminary Results:

Snow water equivalent (SWE) from snow height (HS) : Two example time-series of snow depth converted to SWE by 5 models with **“bad performance”**

Station in Sweden. Altitude 376m



Station in Germany. Altitude 2964m



- Some years not converted due to gaps in snow depth time-series → **Do gap filling?**
- If snow does not fully melt at the end of the season, empirical models cannot estimate density
- Trends not available for these stations. How to solve?

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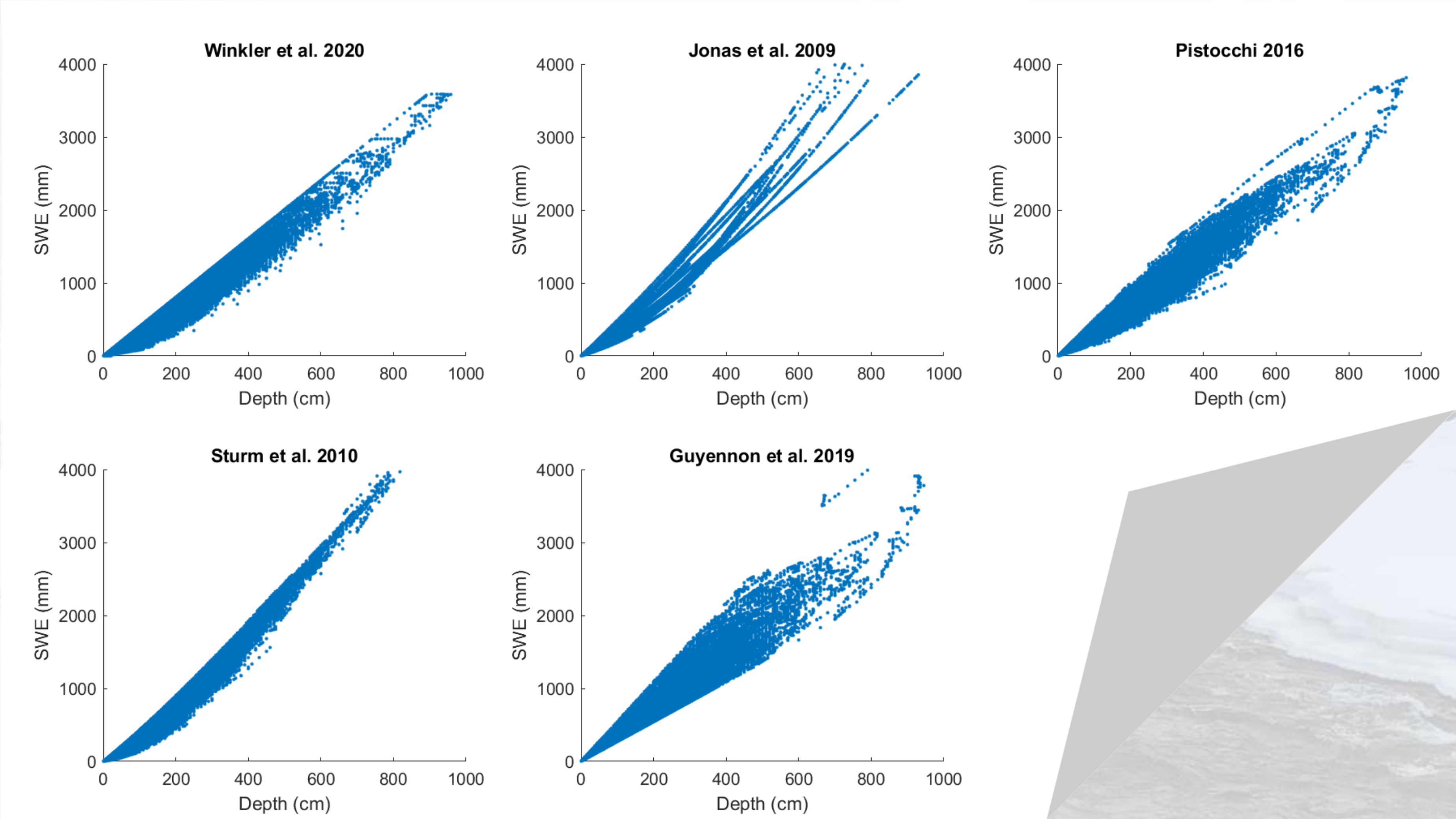
Preliminary Results: HS-SWE conversion: all daily data points over the dataset



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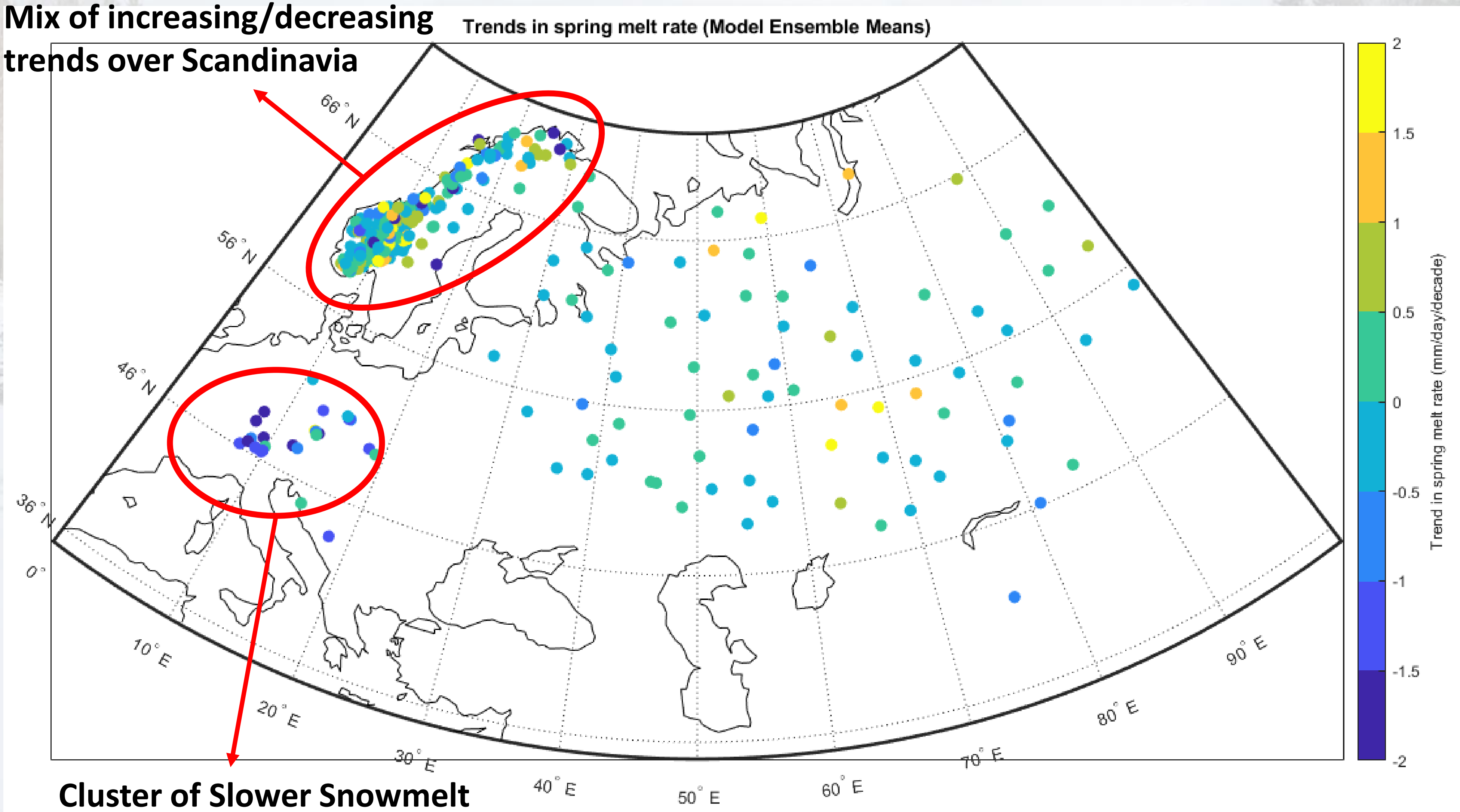
Preliminary Results: Spring melt rate trend (1951-2017)

Linear trend calculation:

- Only seasonal-snow stations
- Minimum 30 years of valid data over the whole period
- 5-model mean trend

Mix of increasing/decreasing trends over Scandinavia



Cluster of Slower Snowmelt over the Alps?

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Preliminary Results: Spring melt rate trend (1951-2017)

Upcoming work and ideas:

- Finding drivers of trends: Altitude, temperature, snowpack type?
- Exploring trends over shorter periods (long-term trends might be lowest in magnitude)
- Extending research to ephemeral snow locations
- Using more models
- Validating model conversion for key stations
- Start investigating the impacts on the hydrological side – How to connect findings to changing streamflow?

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Thank you for your attention!

Happy to hear what you think about my research and PhD plan:

- Live chat: 5 May 2020 – 10.45h – 12.30h

https://meetingorganizer.copernicus.org/EGU2020/displays/35493

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