Seasonal forecasting of water resources at Landsvirkjun

ARCTIC REGIONAL CLIMATE CENTRE (ARCRCC) NETWORK
7TH ARCTIC CLIMATE FORUM (ACF)
May 26th – 27th, 2021

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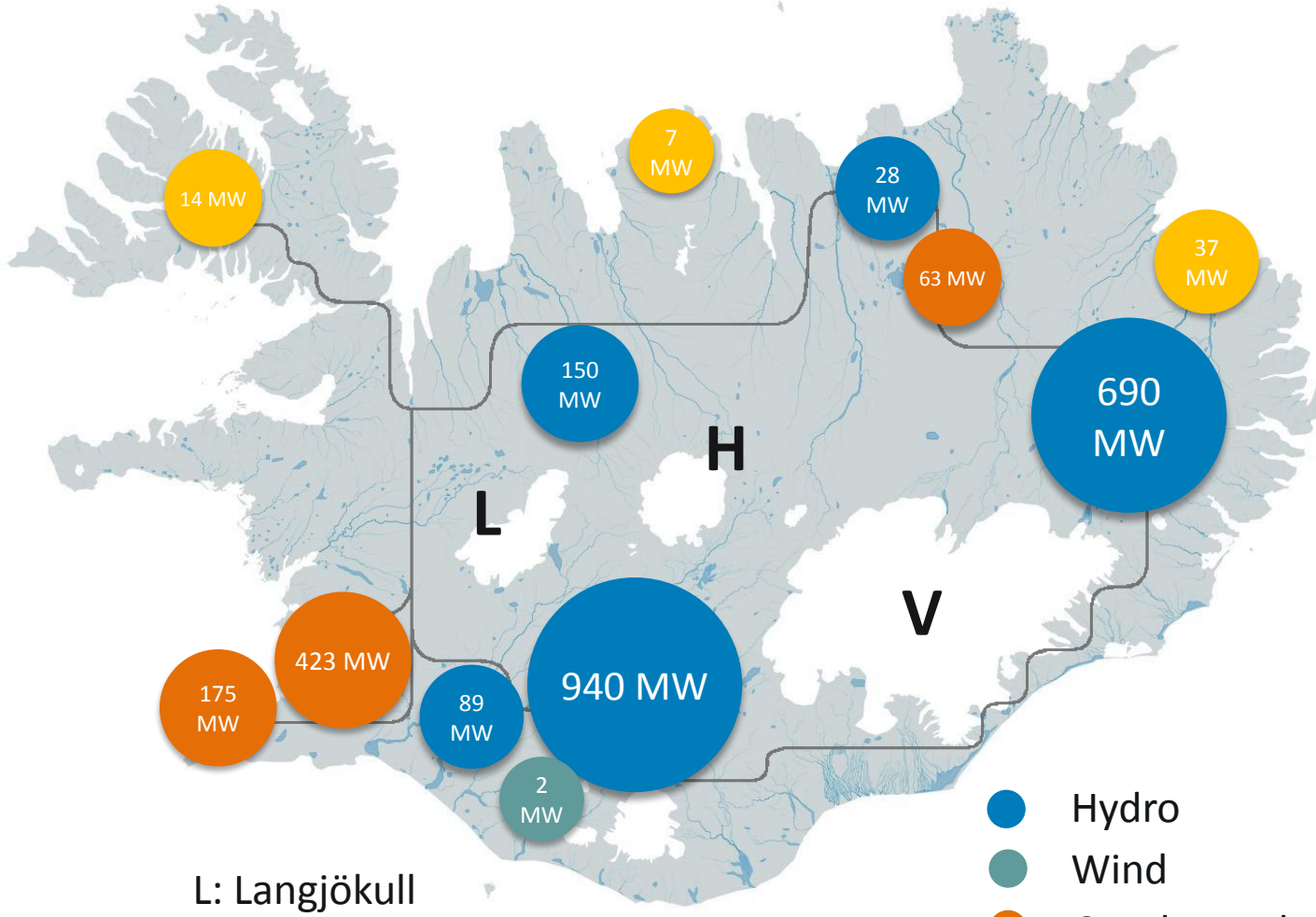
Landsvirkjun / R&D

Energy system in Iceland…
…from the perspective of resource forecasting

- **100% renewable sources**
- **+80% power intensive load**
- **No interconnections**
  - >50% of inflow energy from glaciers
  - 2-15% of inflow energy from snow
- **Annual natural variability high**
- **Climate is changing**
  - More glacier melt observed since 1995
  - Provide opportunities for increased production

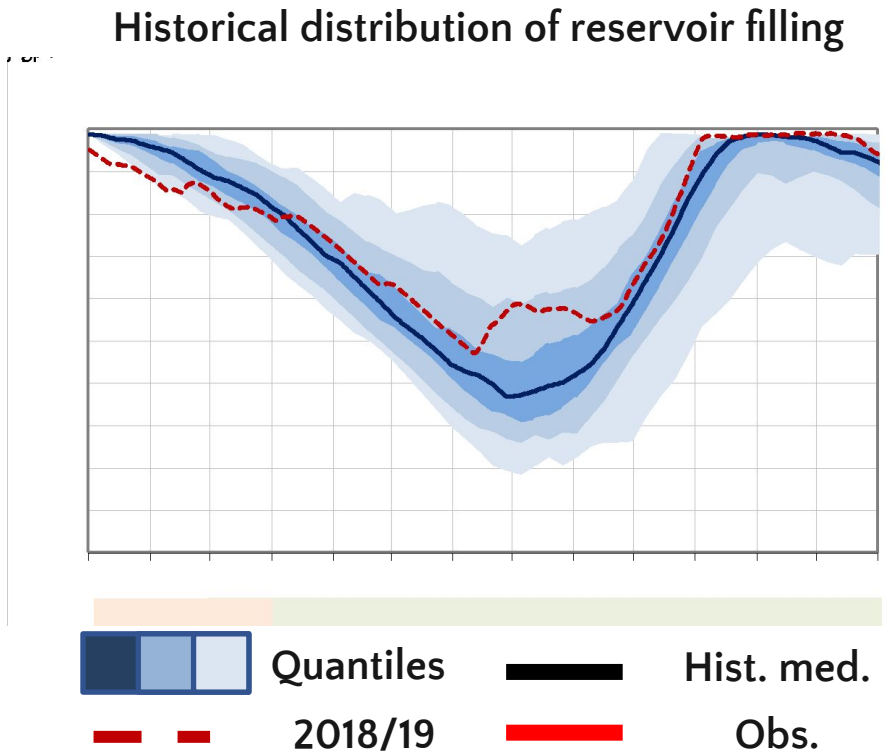


Installed Power 2650 MW

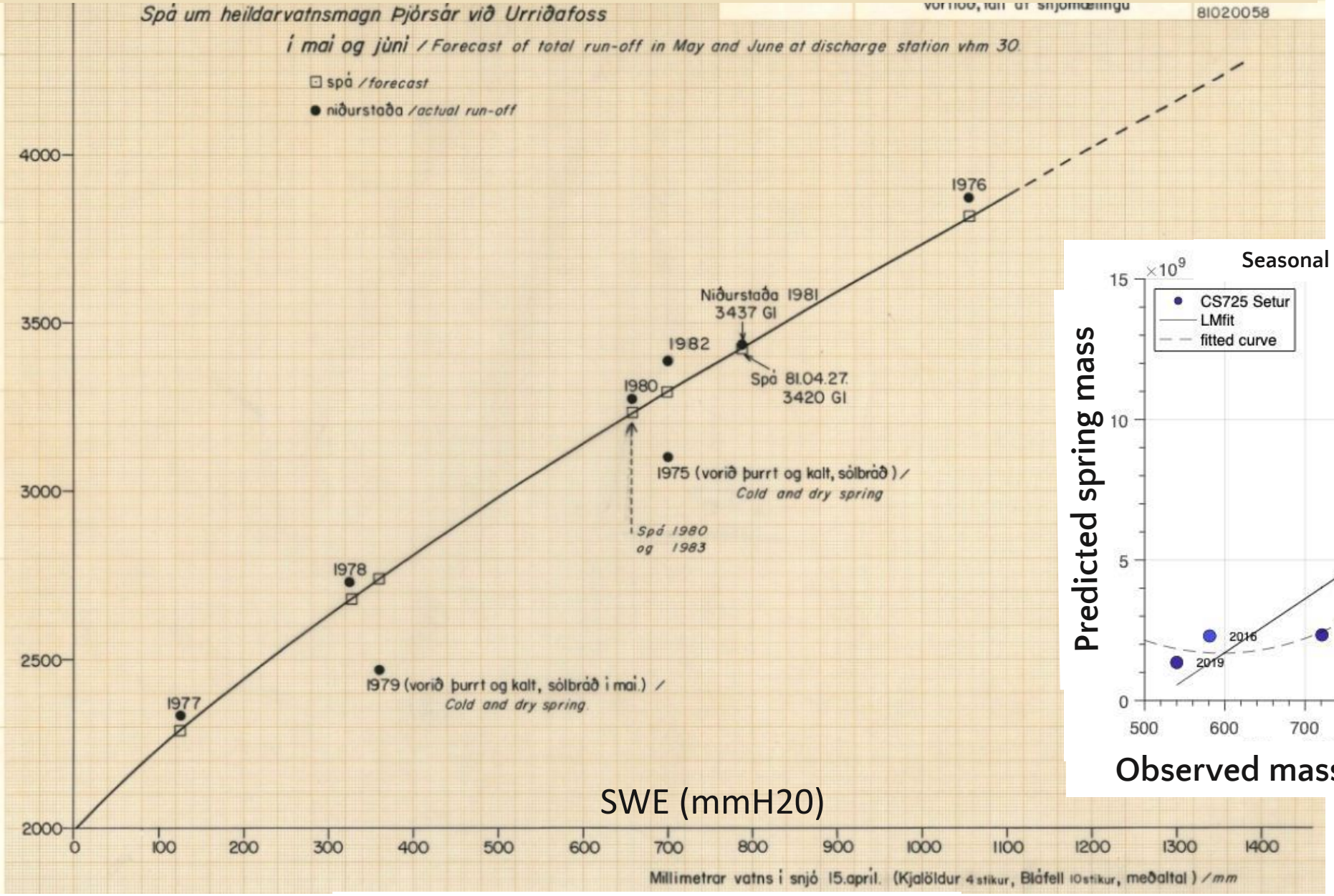
Source Orkustofnun, National Energy Authority

Water resources forecasting
Principle of operational decisions

- Models are used to forecast resource development to support operational decisions
  - Data driven, conceptual, physically based
- Field observations and remote sensing is used to provide real time estimates
- The challenge is to reduce variability in the forecast
  - **Historical approach:** Statistical representation of know history / climate adjusted (1956-2019)
    - Current hydrological conditions not considered
  - **Future approach :** Cross-scale integration of ground-based and remotely sensed observations
  - Long term climate forecasting



One of the first seasonal resource assessment for Þjórsá river



Observed mass at snow pit location

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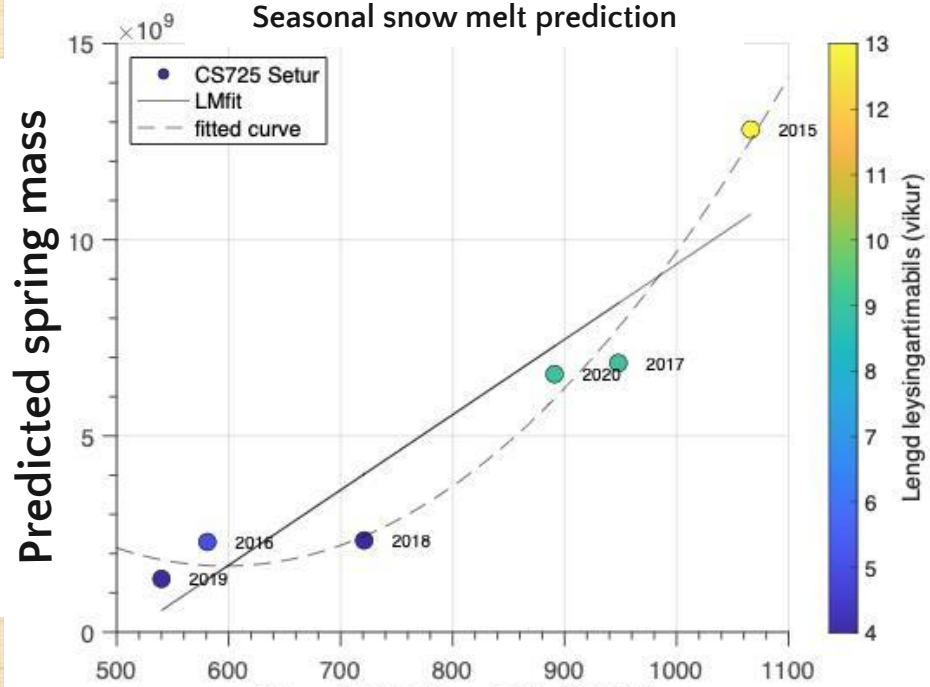
Seasonal snow melt prediction



Observed mass at snow pit location

Teikning Sigurjóns Rist, 1981, Orkustofnun frumritanr. 81020058

Spatio-temporal glacier albedo

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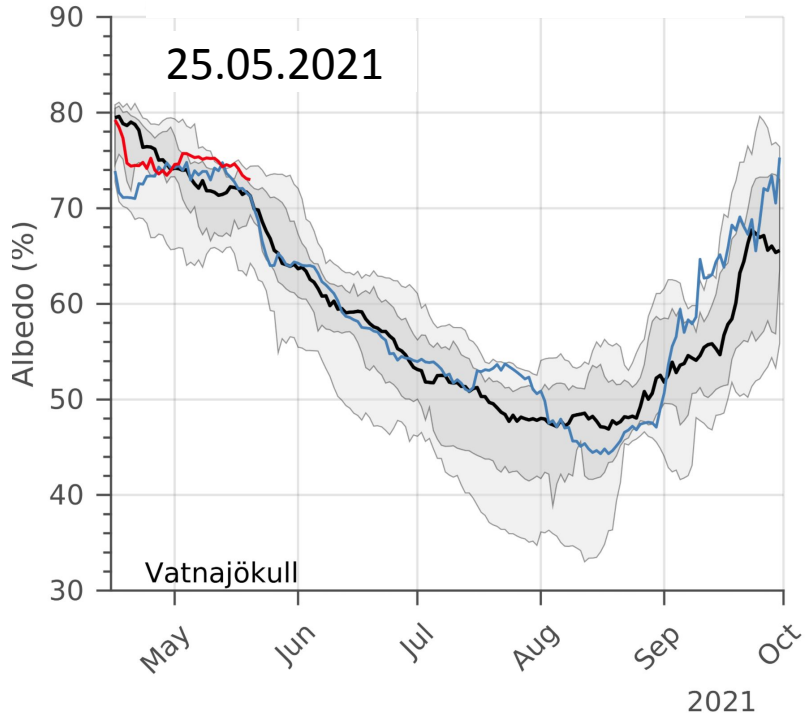
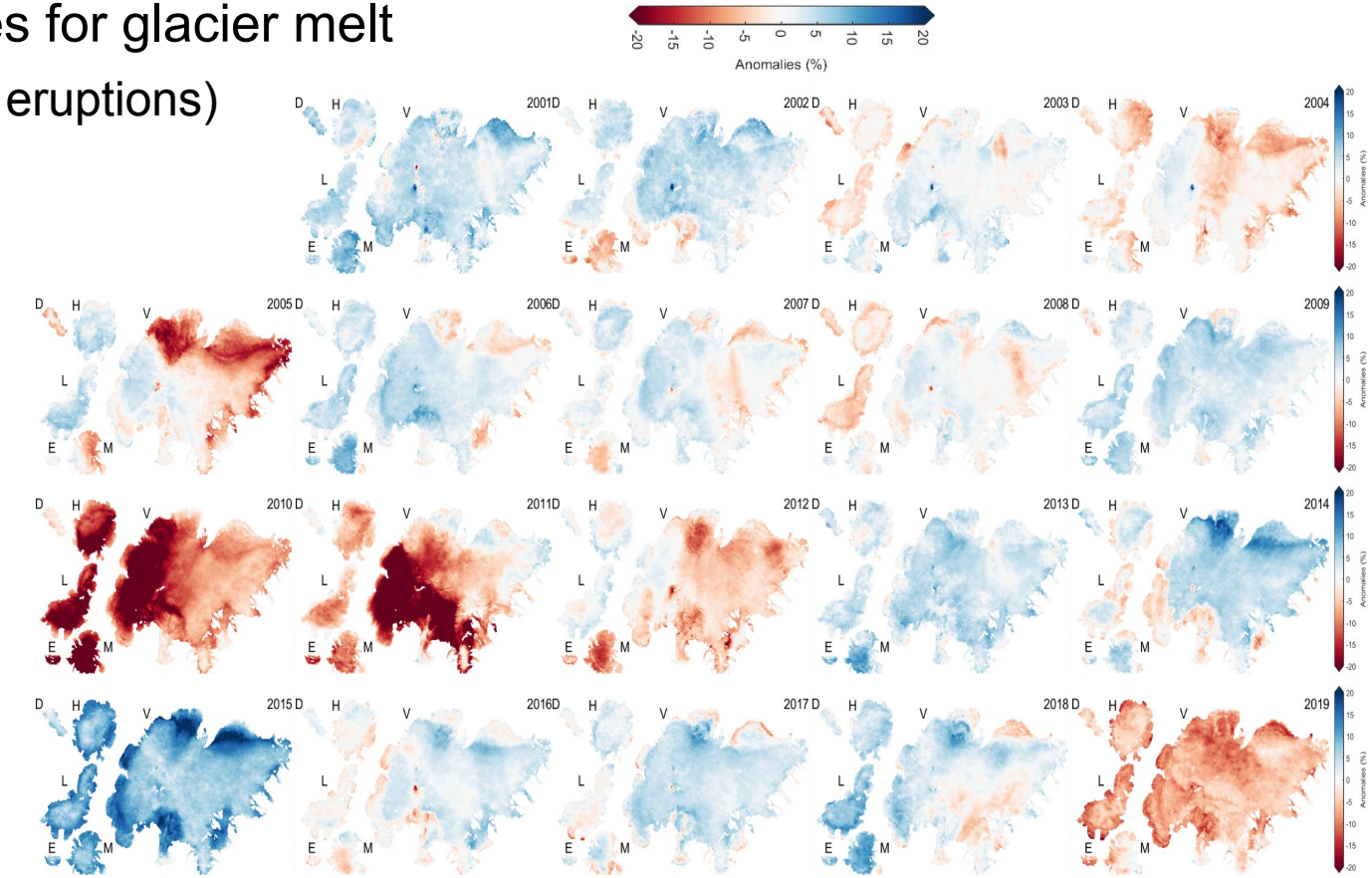
- Daily update based on MODIS remote sensing
- Glacier albedo has predictive capabilities for glacier melt
  - Processes hard to model (LAIs, volcancic eruptions)

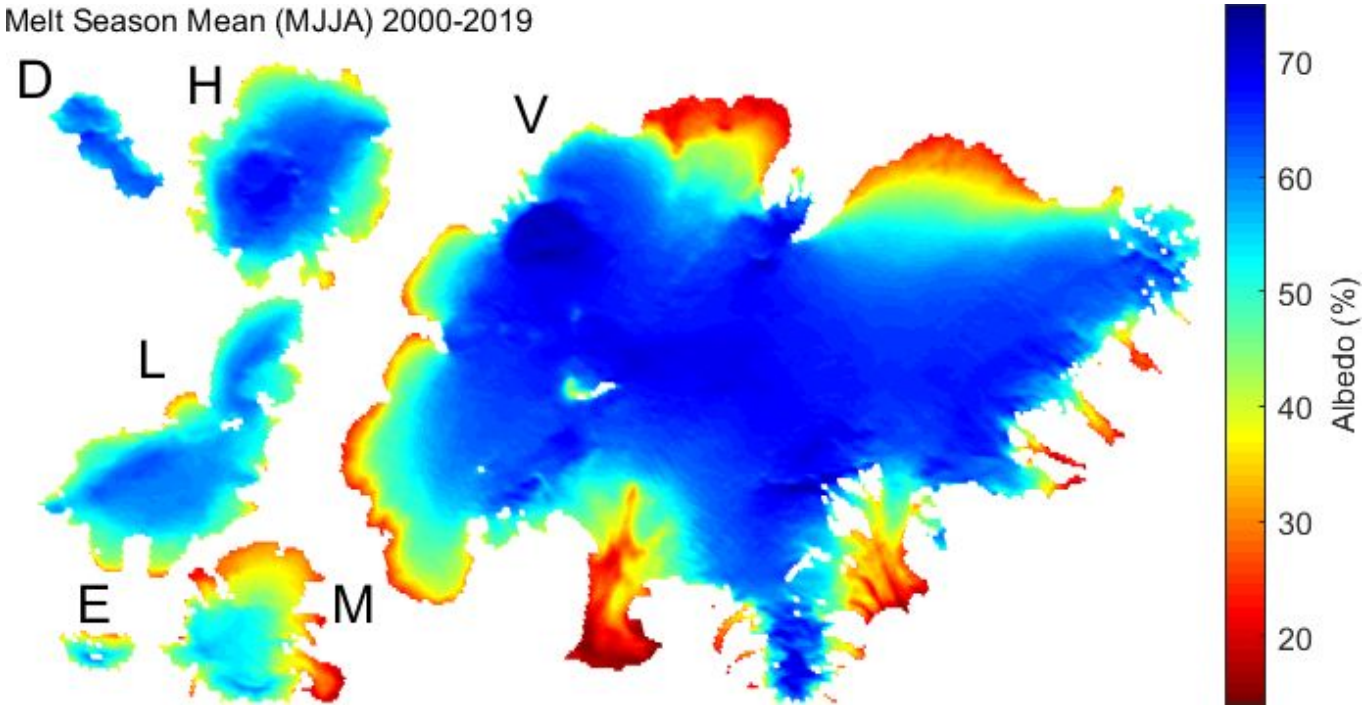


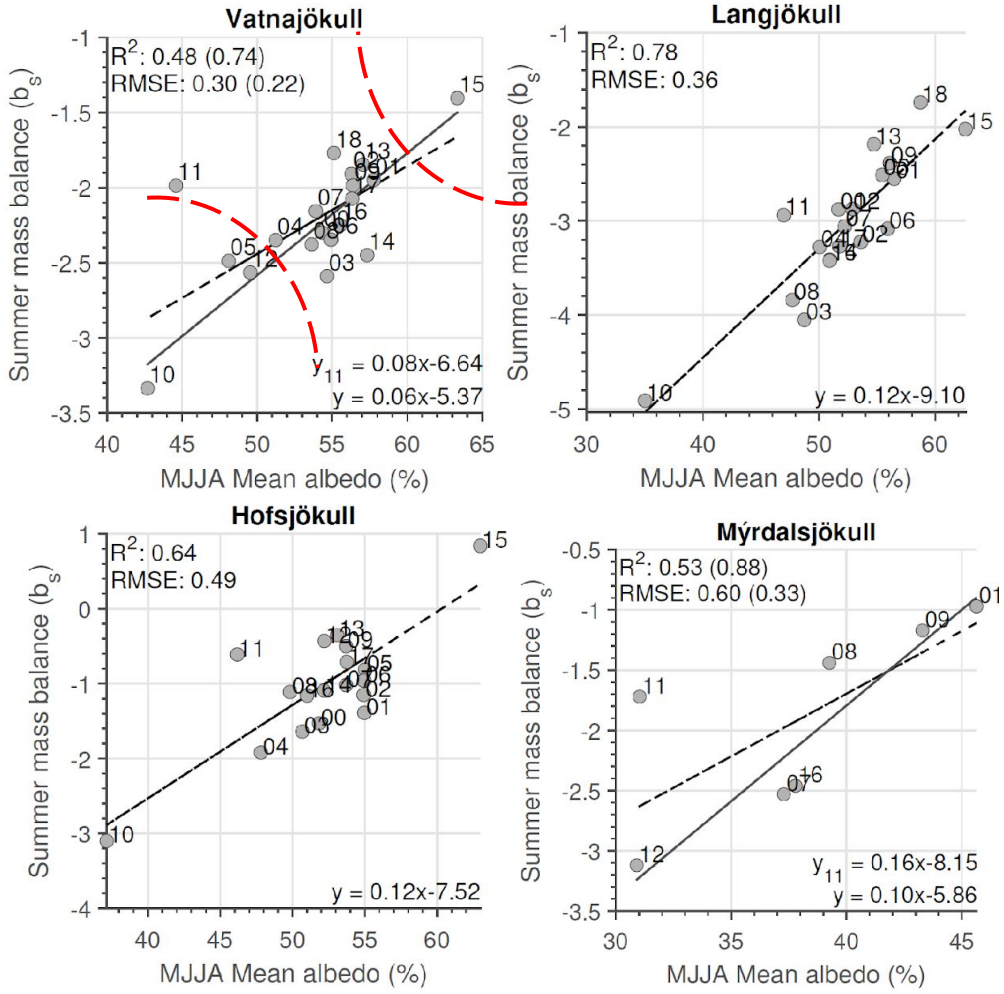


Red: below average **Blue: above average**

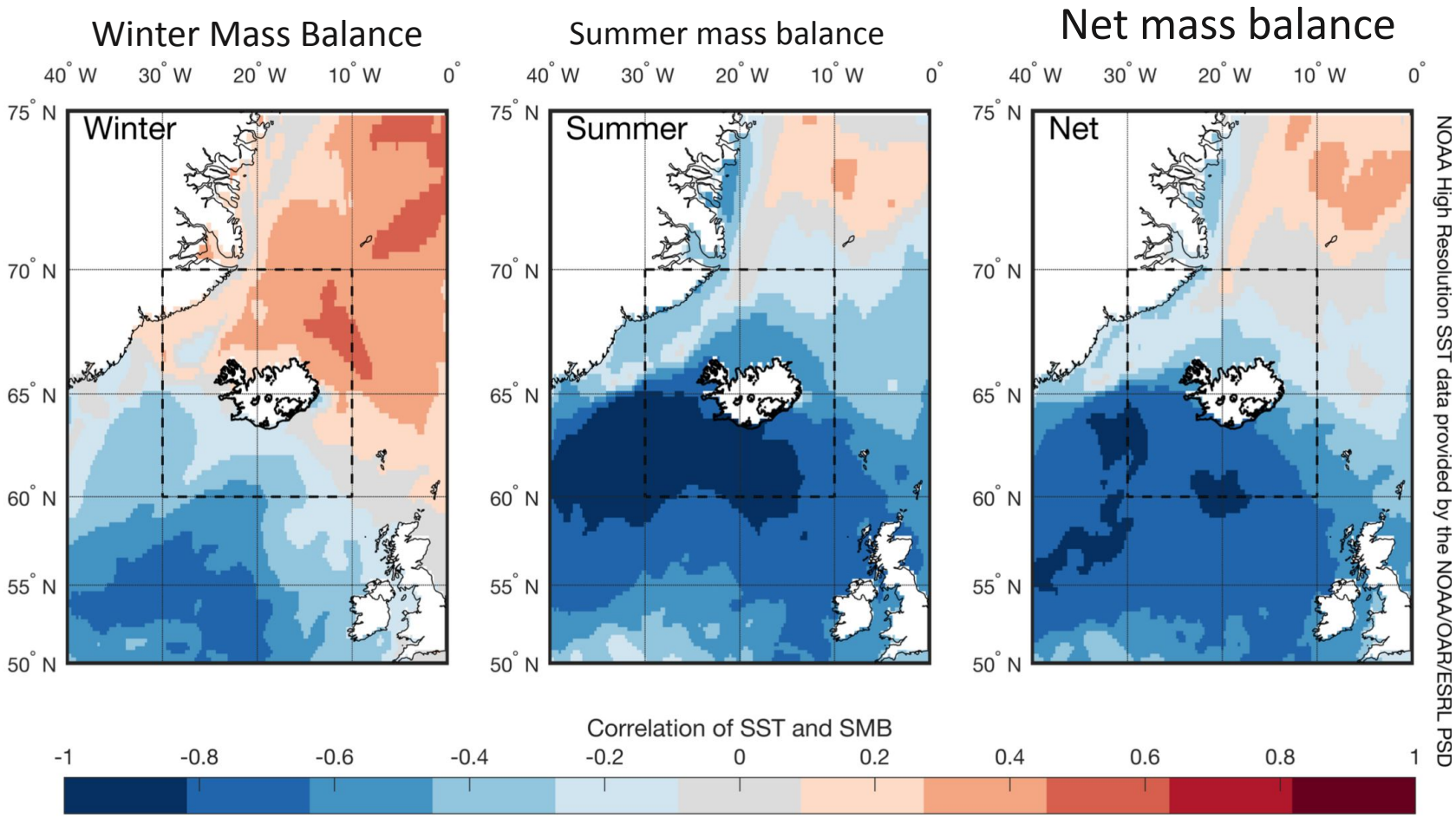
Albedo of Icelandic glaciers and SMB

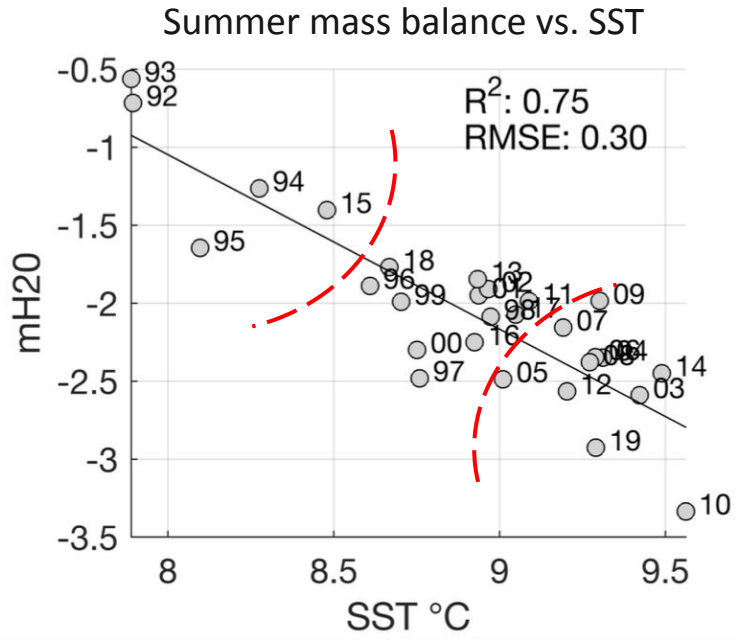
Results - Gap filled melt season mean (MJJA) 2000-2019





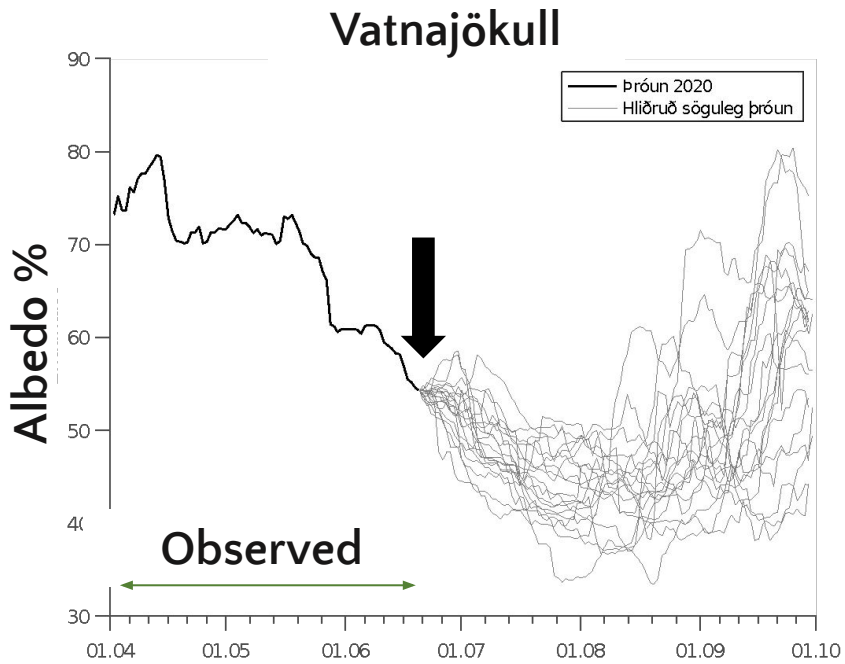
Sea Surface Temperatue and SMB

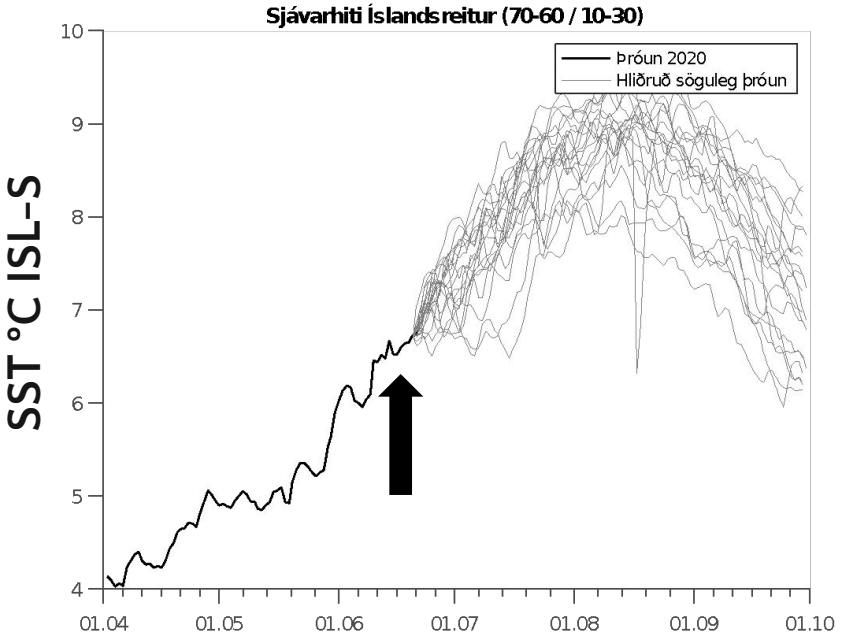




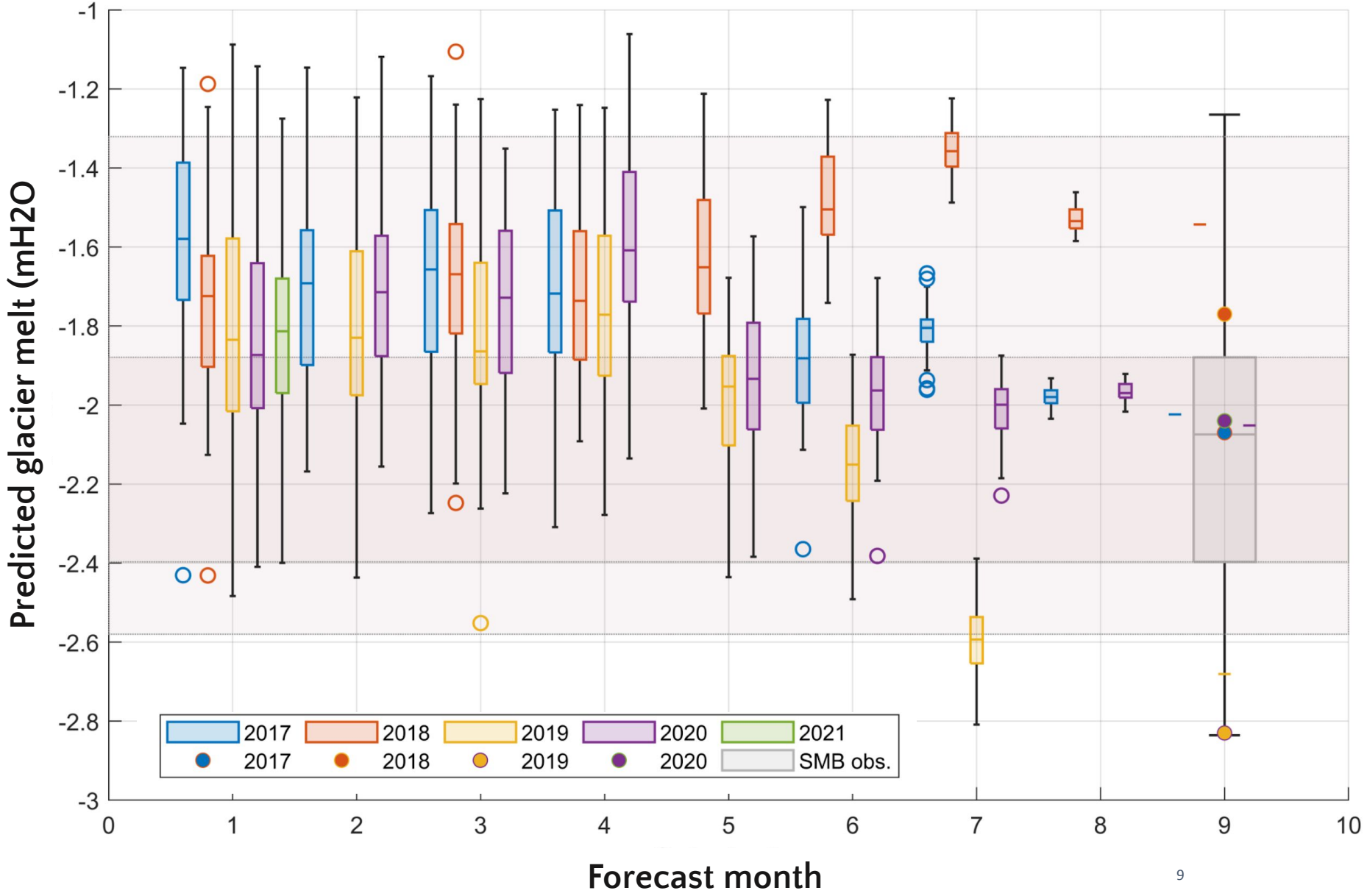
Seasonal outlook model

- A seasonal melt model based on glacier albedo and SST has been developed
- SST from ECMWF SEAS7 forecast
  - 51 ensamble // updated monthly
  - Forecast data since 2017 / Hindcast since 1993
  - Provides an estimated distribution of glacier melt
- ERA5 reanalyzed SST used as „truth“
- MODIS reSWE albedo
  - Daily 500 m albedo for Iceland (snow and ice)
- Observed mass balance



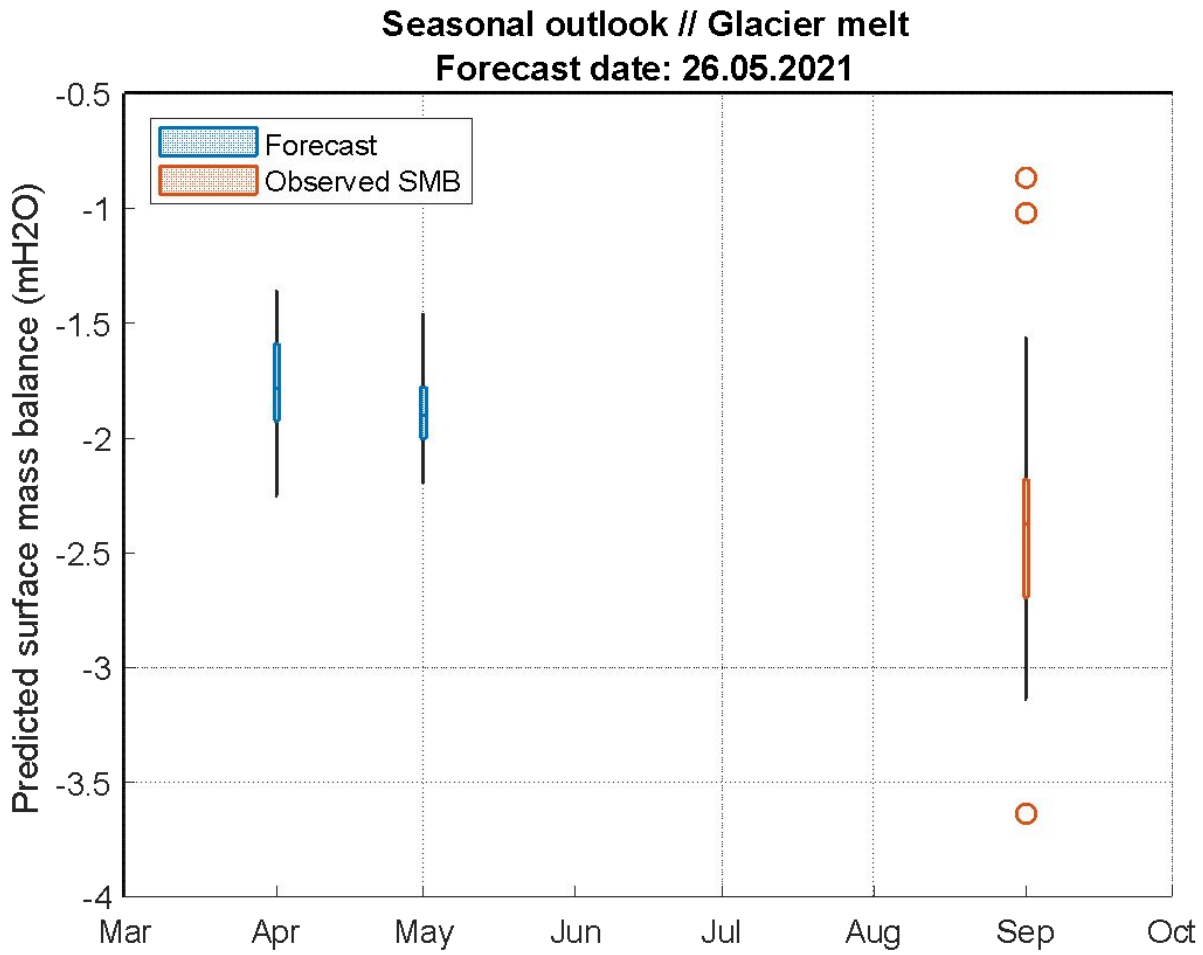


Seasonal outlook – glacier melt



Seasonal outlook – glacier melt

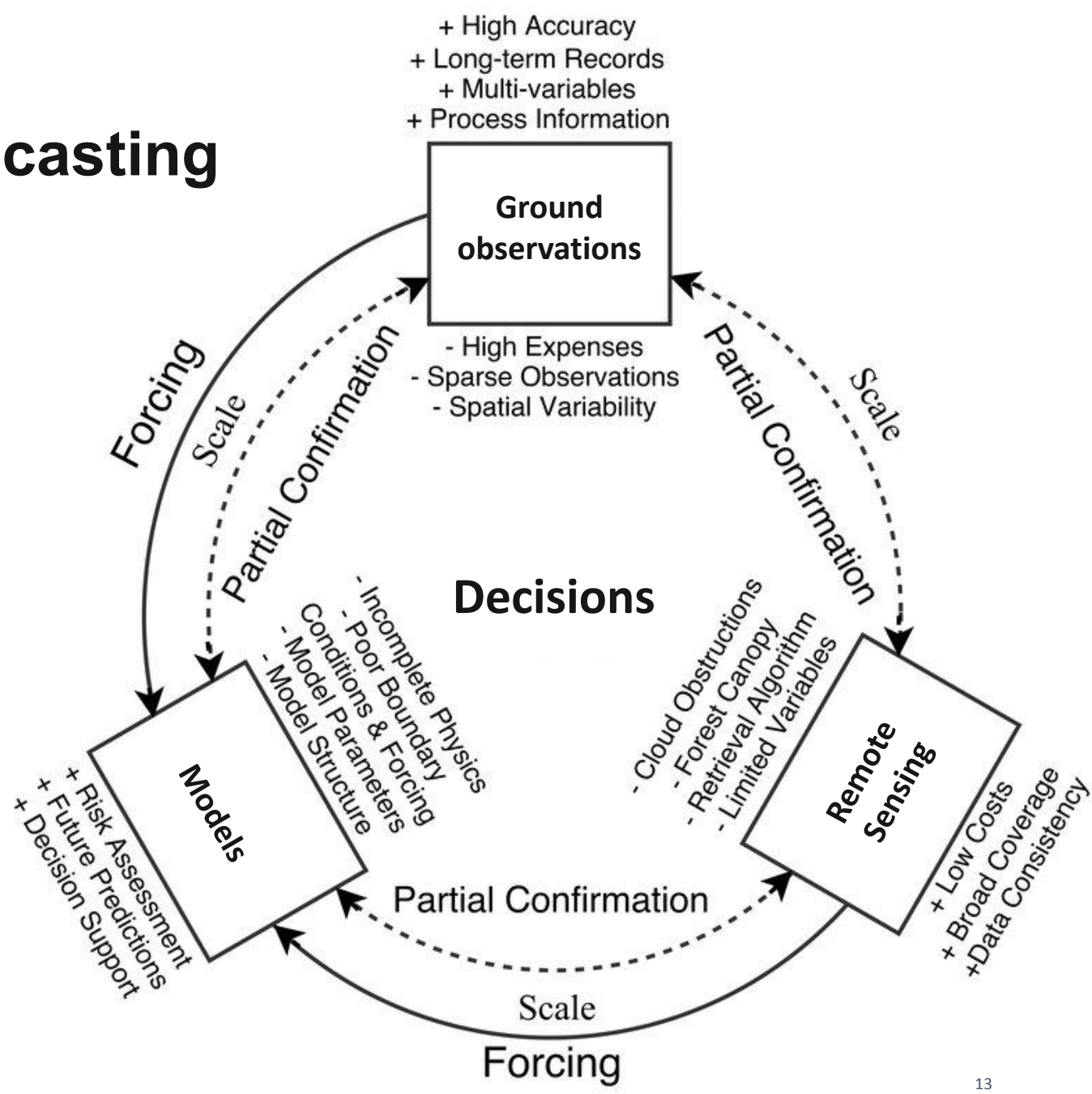
- Less melt predicted than in recent years
- Variability in forecast used to scale historical data
  - Reduce spread in historical series
  - more realistic decisions




Thank you

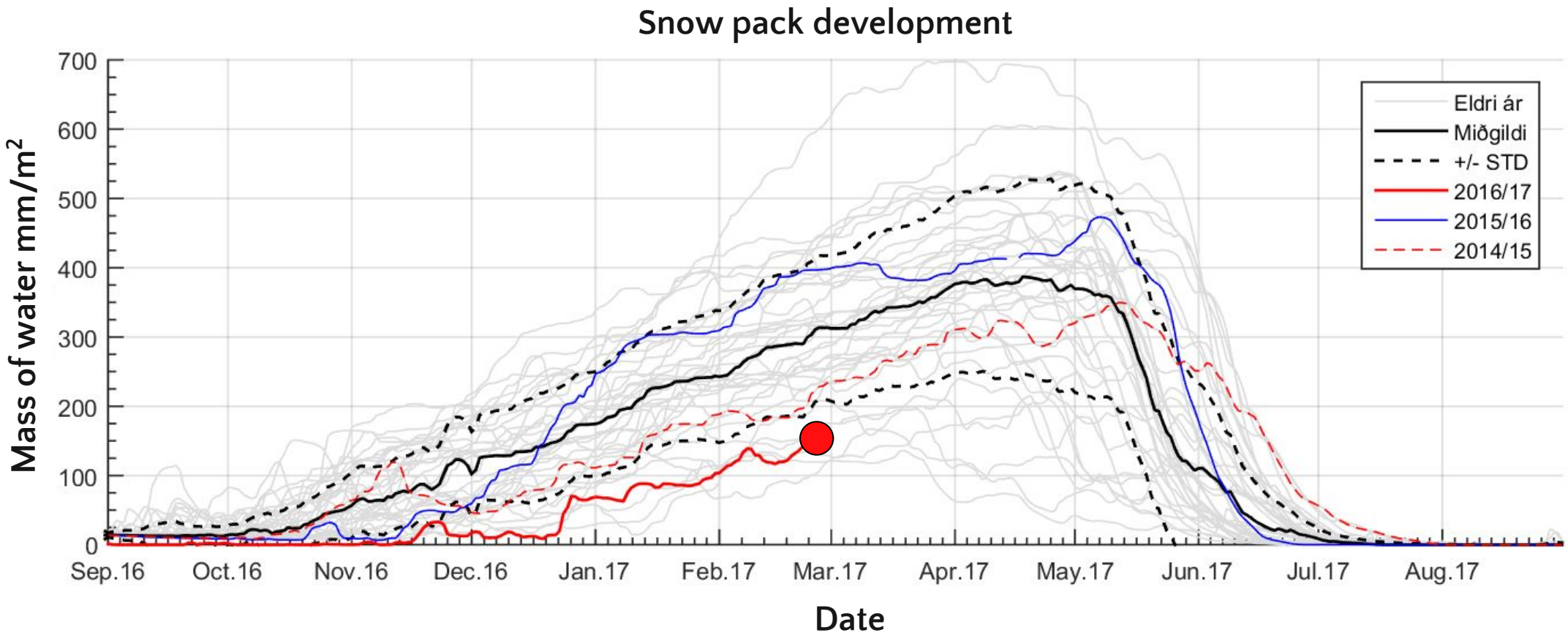
Future of water resource forecasting

- Synthetic framework for the future water resource forecasting
  - Data assimilation with observations and remote sensing
  - Update model state variables
- Existing ground observation network
- Emphasis on remote sensing
  - Snow cover, snow water equilivent
  - Albedo of snow and glaciers
  - Surface temperatures



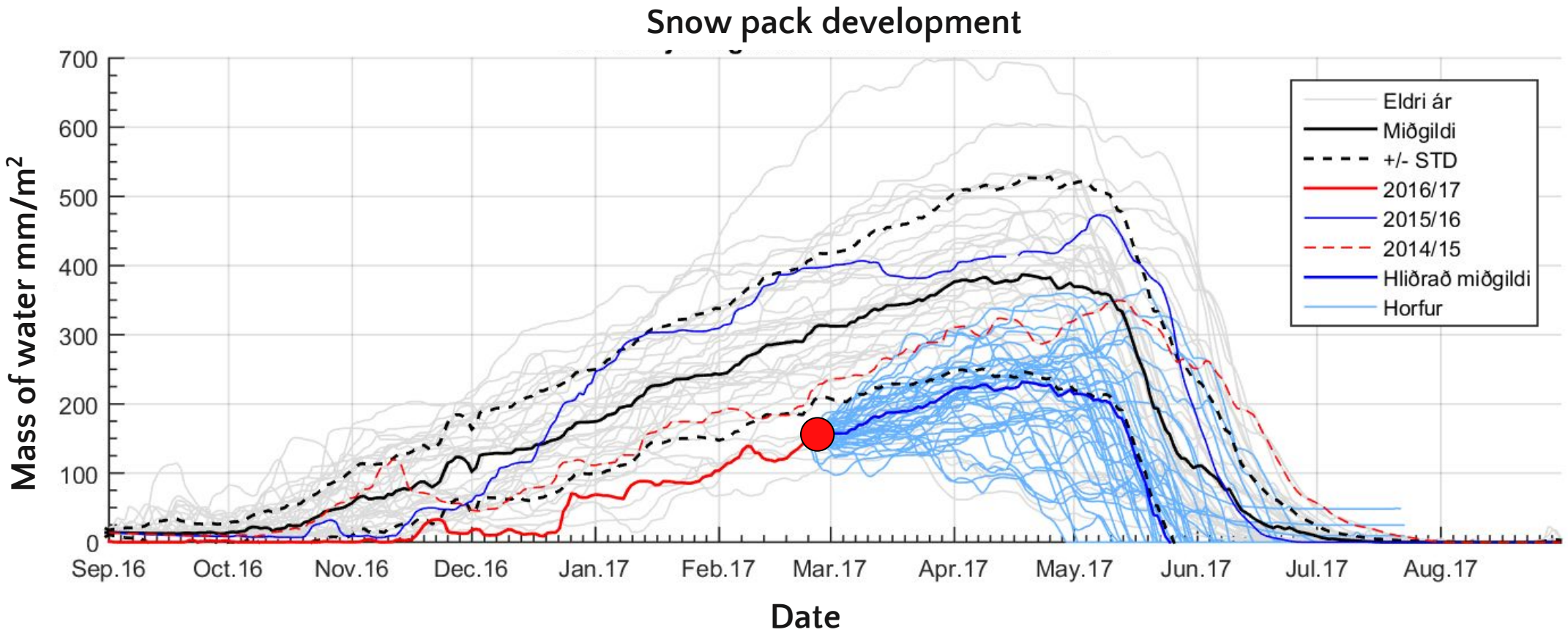
Historical approach – seasonal snow

- Historical (climate adjusted) variability assumed to represent the near future



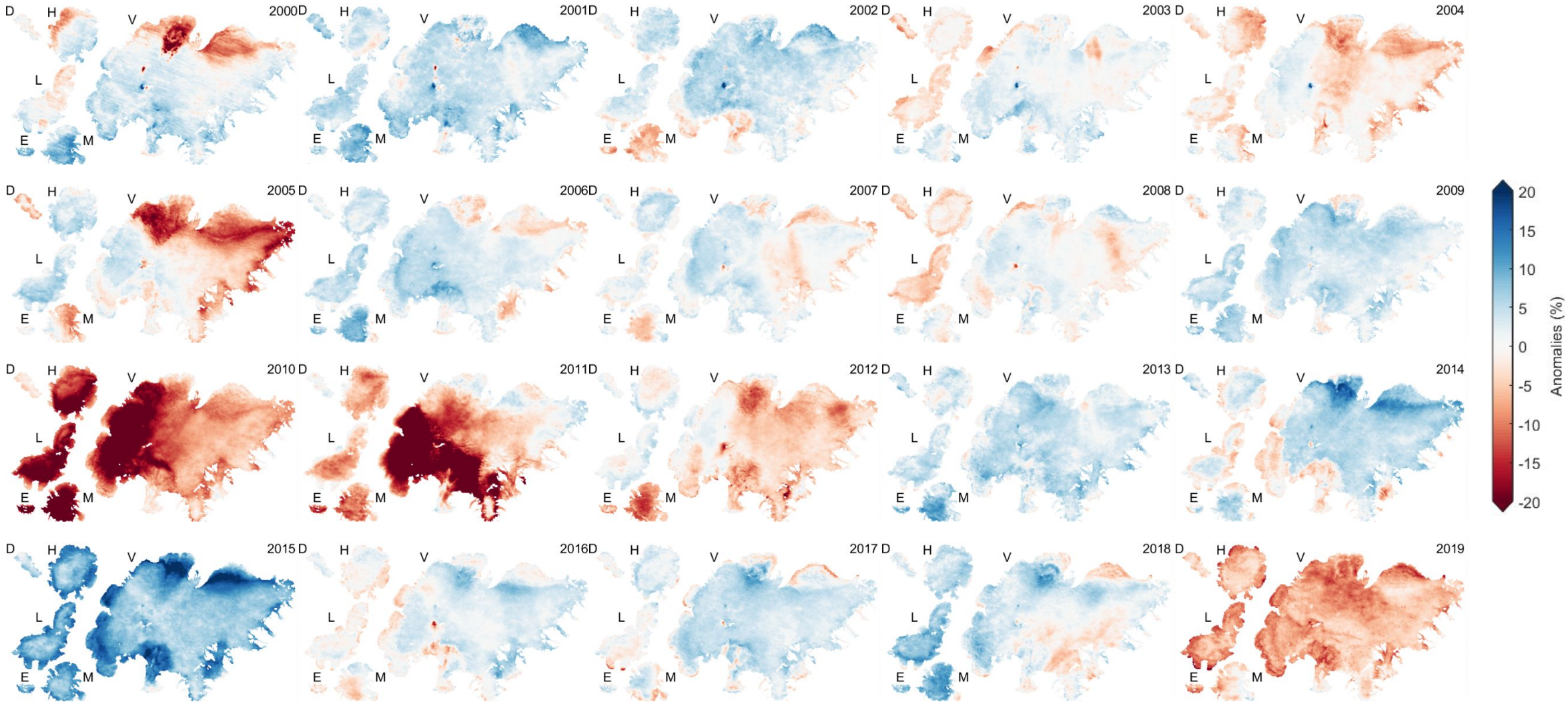
Future development – seasonal snow

- Historical variability assimilated to a known state and projected to near future
- Excludes physically unlikely developments



Albedo of Icelandic glaciers

Melt season albedo ananomalies 2000-2019



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