Endurgreining á árstíðarbundnum snjó og sumarleysingu jökla með fjarkönnun á snjóhulu, endurkasti yfirborðs og reikningum á veðri

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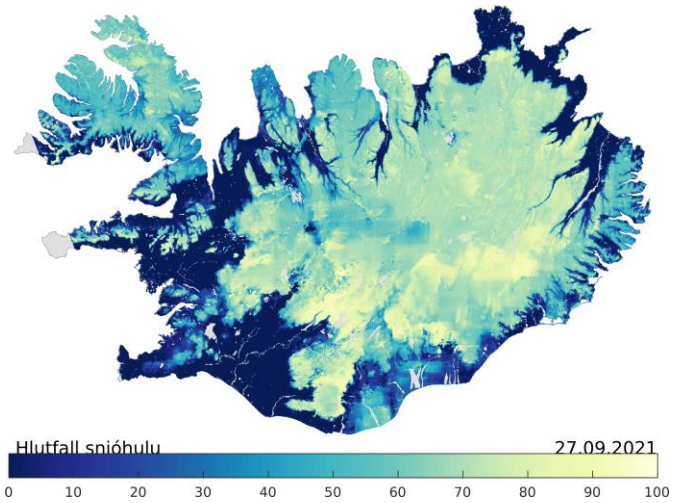
Inngangur / Markmið

- **Markmið að bæta mat á sumarleysingu jökla og árstíðarbundnum vetrarsnjó**
  - Spá daga og mánuði fram í tímann með betri spágetu en í dag
- **Nýta fjarkönnun í rauntíma til að meta stöðubreytur í orkuskiptalíkani**
  - **Endurkast yfirborðs** (e. albedo) → ~80% af leysingarorku frá stuttbylgju
    - Endurkastsstuðull jökla getur verið krefjandi að herma
    - fok á sandi og ösku, eldgos
    - Endurkastsstuðull nýtist til aðgreiningar á yfirborði sem er hulið snjó/ís (snjólína)
  - **Hlutfall snjóhulu** (e. fractional snow cover) → er snjór eða ekki ?

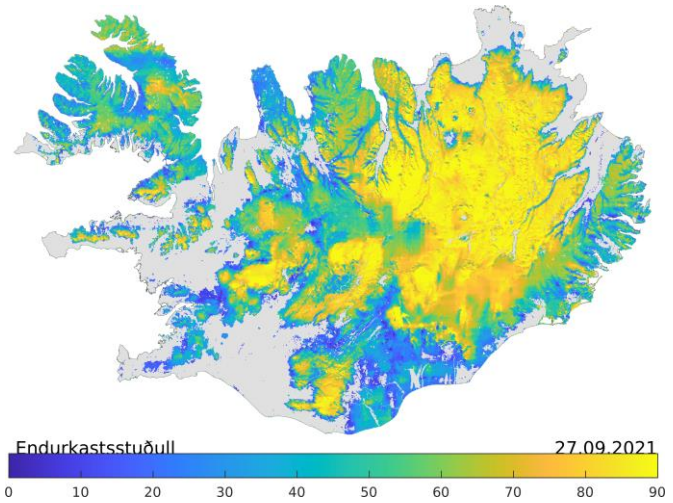
Snjóhula og endurkast

- Dagleg greining á MODIS gögnum
- ~76% skýjahula á Íslandi
  - Tölfræðileg úrvinnsla (10% göt eftir)
  - ML learning til “holufyllingar”
- Samfelld gögn fyrir allt Ísland
  - 2000 til dagsins í dag
  - 500 m upplausn

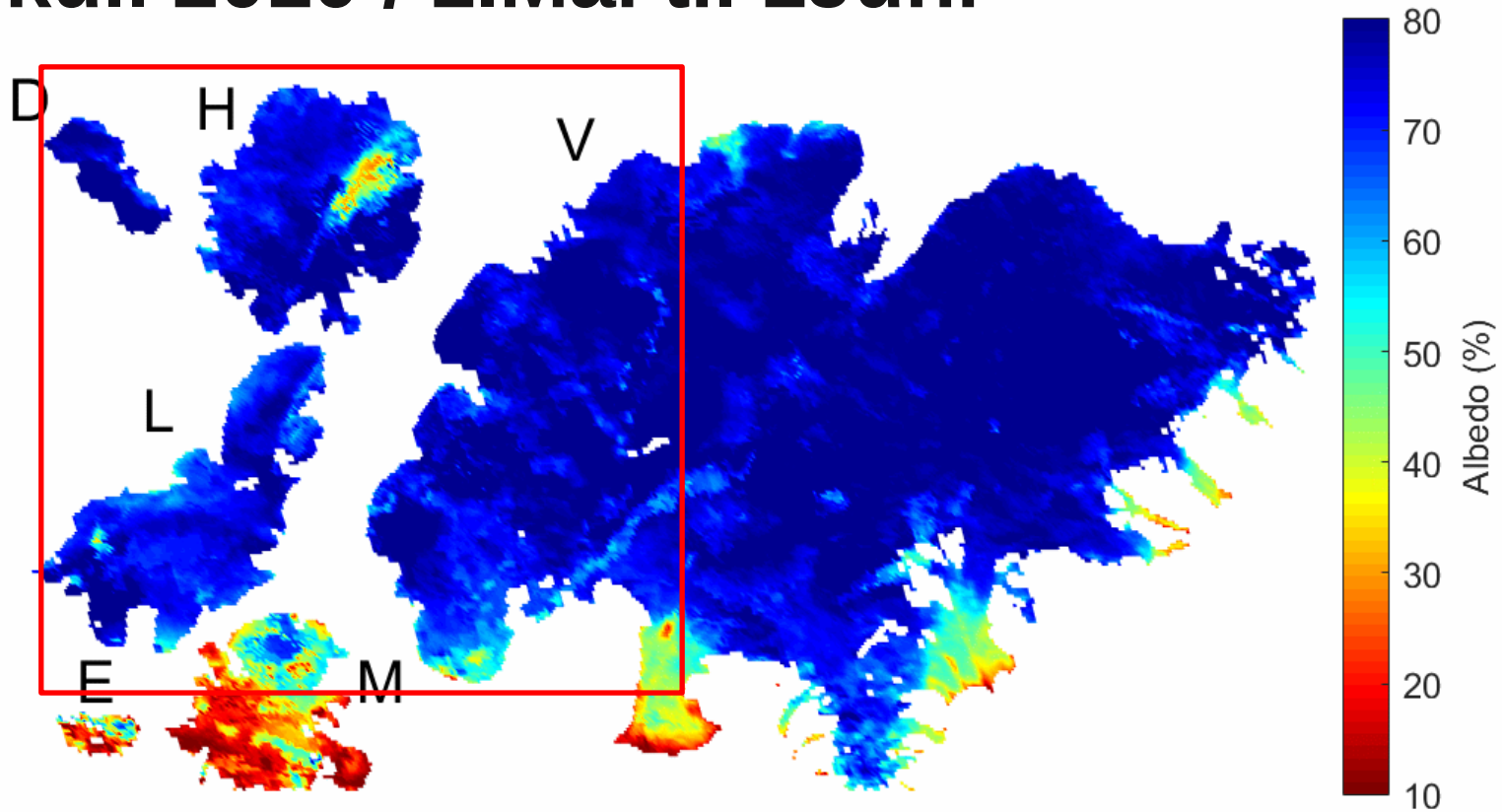
Hlutfall snjóhulu

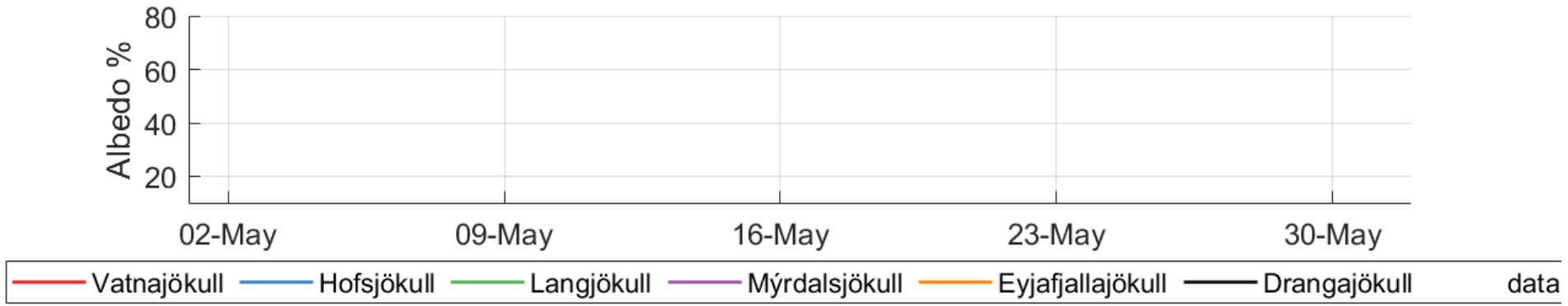


Endurkastsstuðull



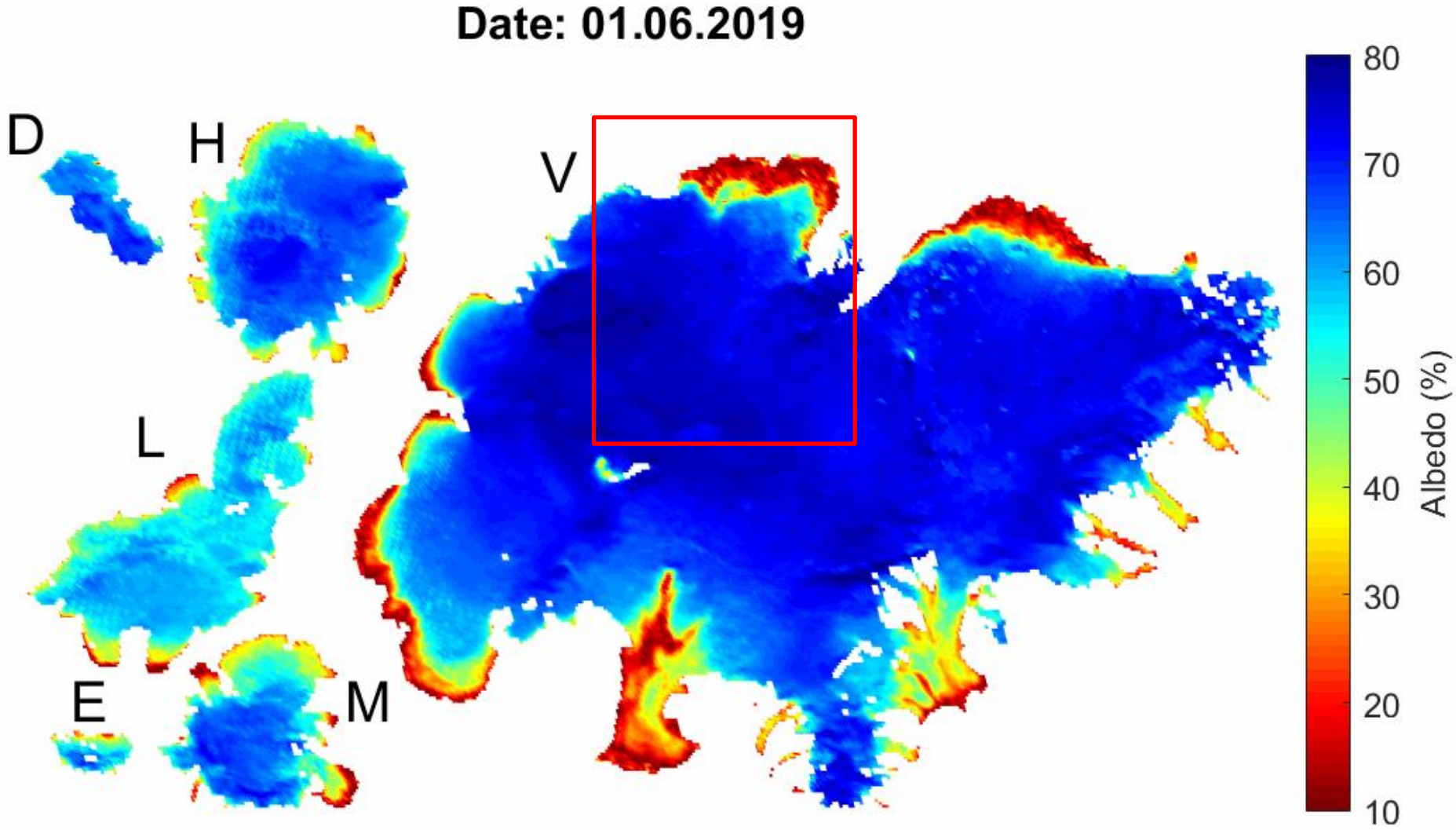
Eyjafjallajökull 2010 / 1.Maí til 1Júní





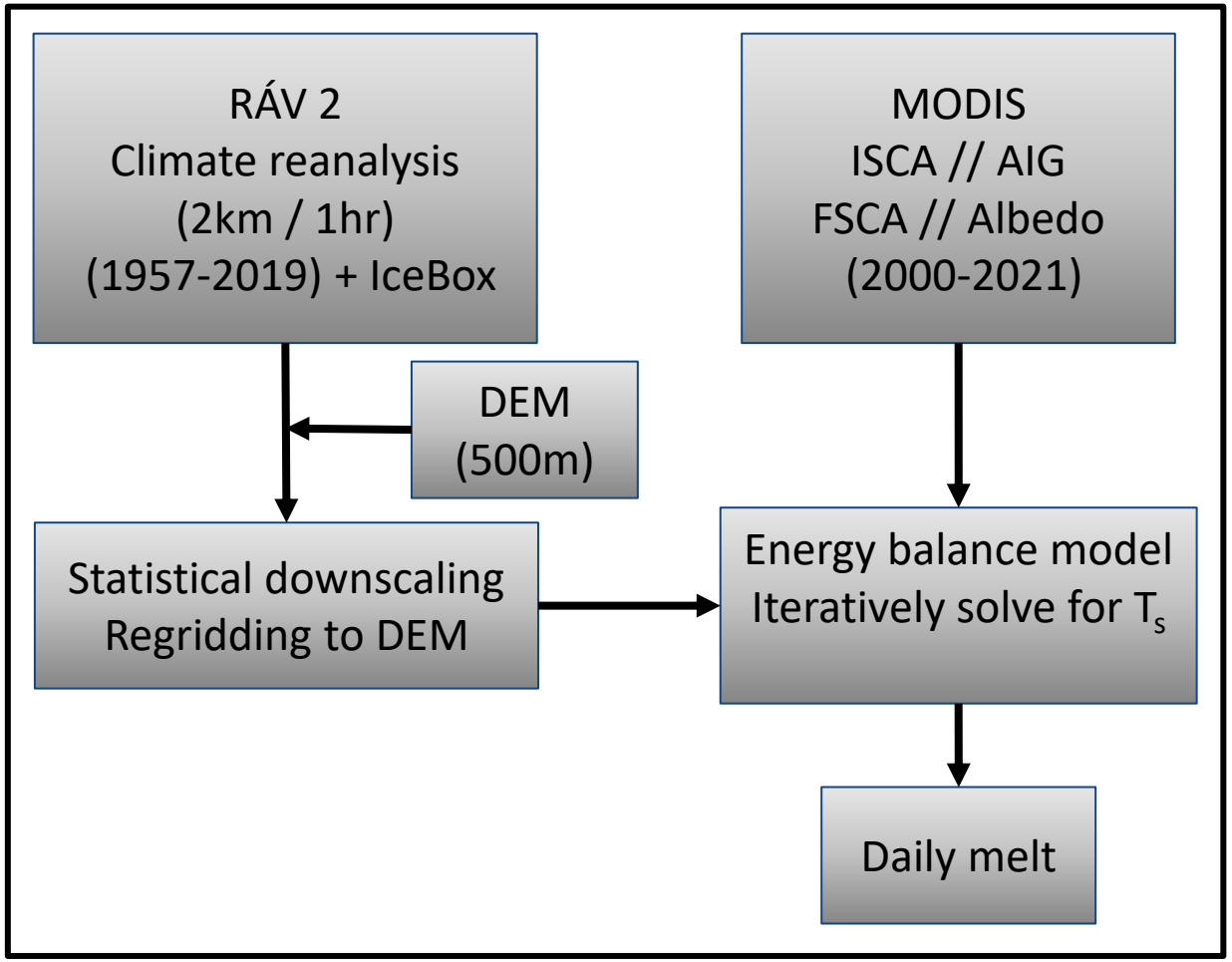
Albedo of Icelandic glaciers

Airborne dust patterns Dyngjujökull – June 2019



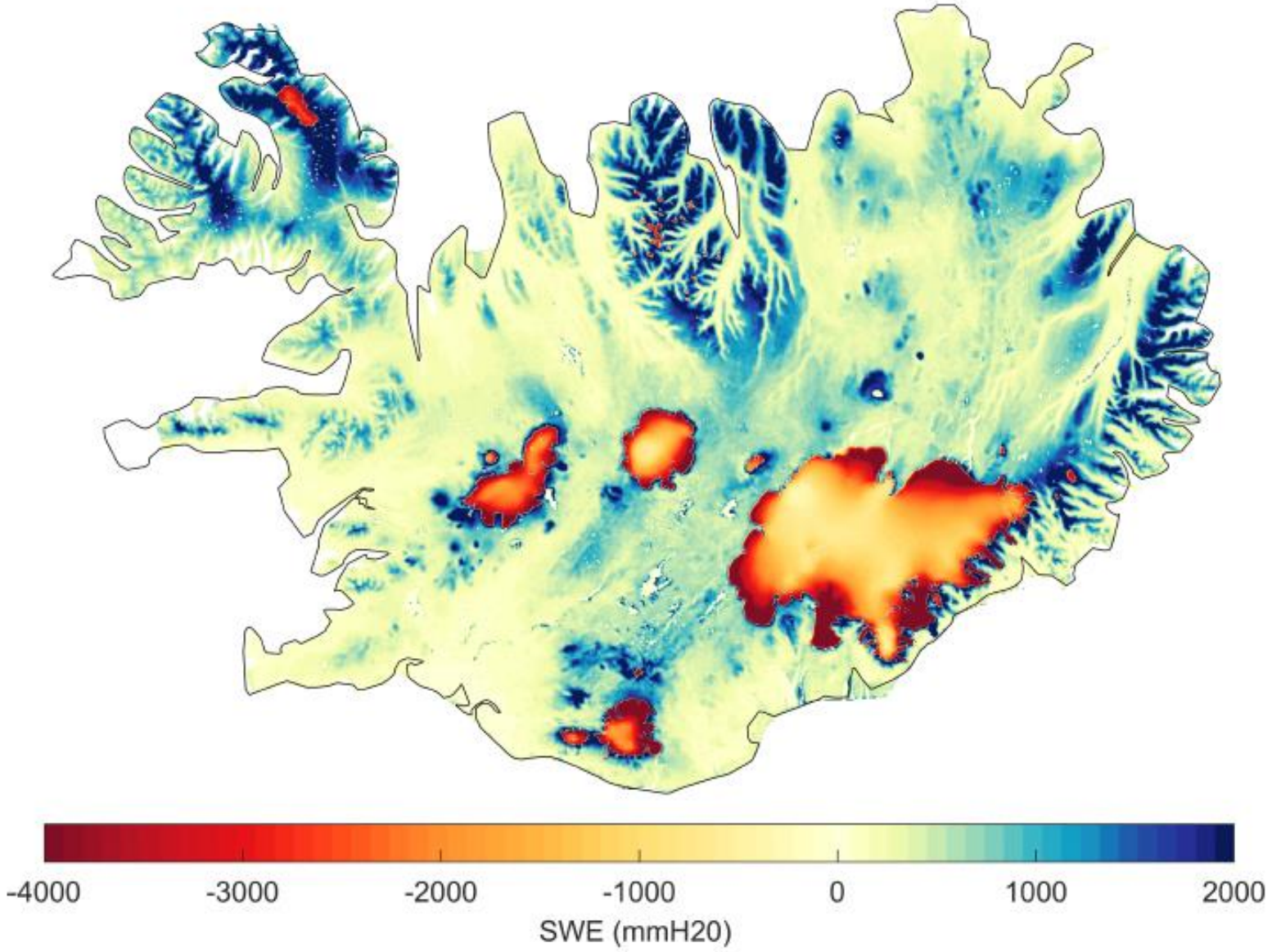
Endurgreining á árstíðarbundnum snjó og sumarleysingu jökla
Reconstruction of seasonal snow and glacier melt

- WRF RÁV 2 endurgreining
  - 2km → downscaling → 500 m
- Orkujöfnuður reiknaður fyrir hvern reit
  - SW↓ skalast með MODIS endurkastsstuðli
  - Fræðileg leysingarorka í pixli sköluð með hlutfallstölu snjóhulu (fSCA)
- Leysing f. snjó utan jökla er lögð saman til að “endurgreina” snjó fyrir liðin vetur

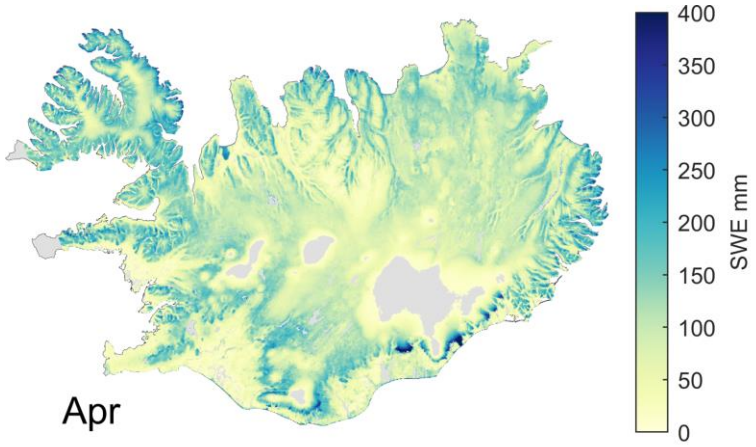


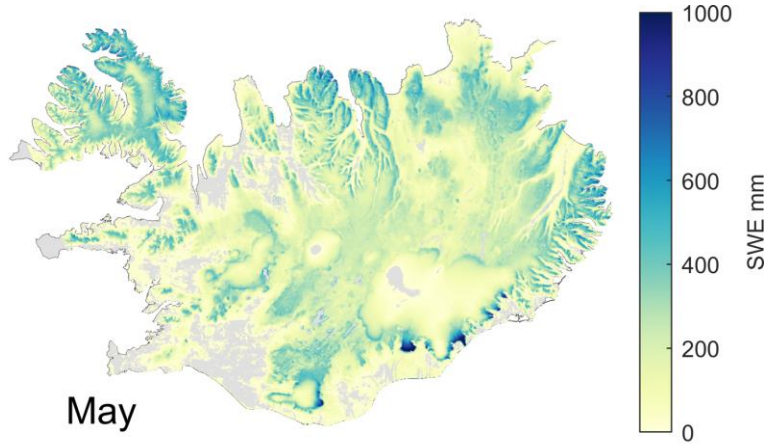
$$M = [\mathrm{SW}^{\downarrow}(1-\boldsymbol{\alpha}) + LW_{\downarrow} + LW_{\uparrow}(T_S) + \mathrm{H}(\mathrm{T_S}) + \mathrm{L}(\mathrm{T_S})] \times \mathbf{f_{SCA,j}}$$

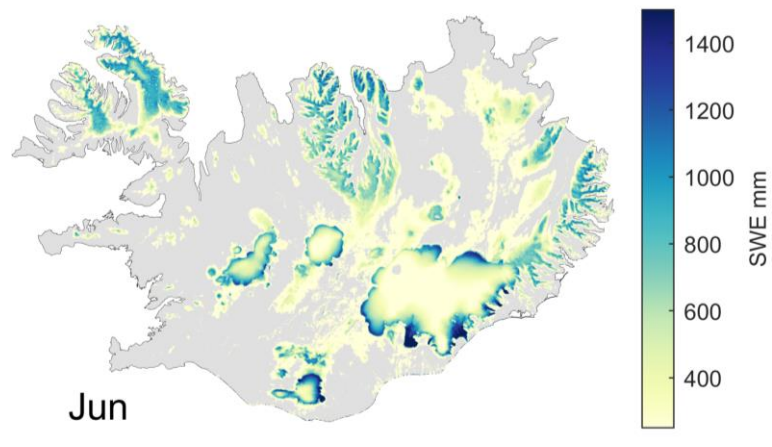
Meðalvatnsgildi snjós/sumarleysingar jökla 2000-2019

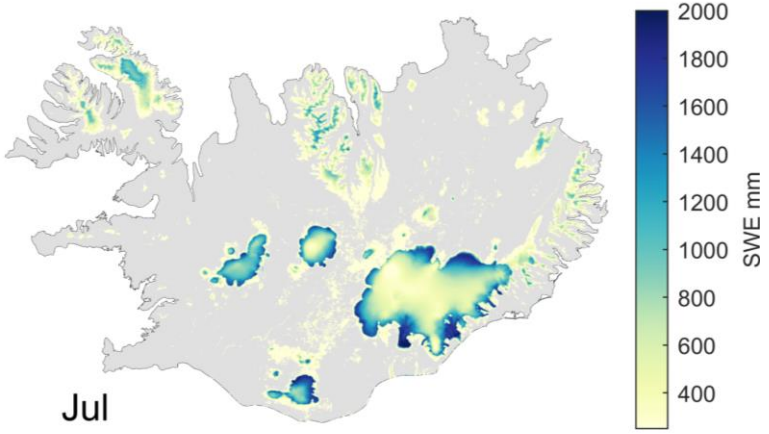


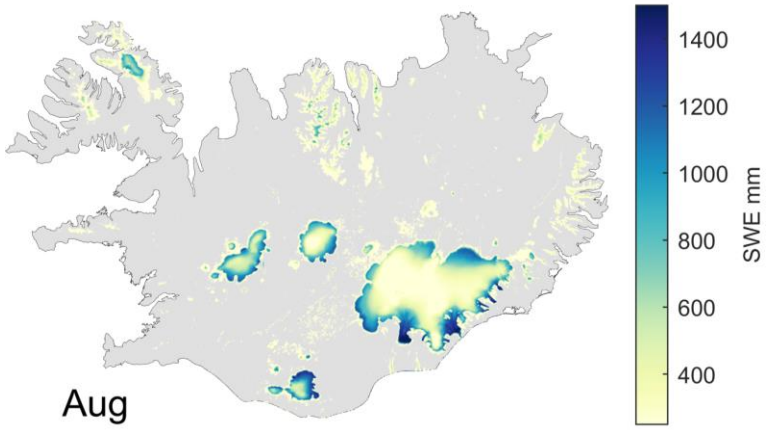
Meðalleysing eftir mánuðum 2000 - 2019

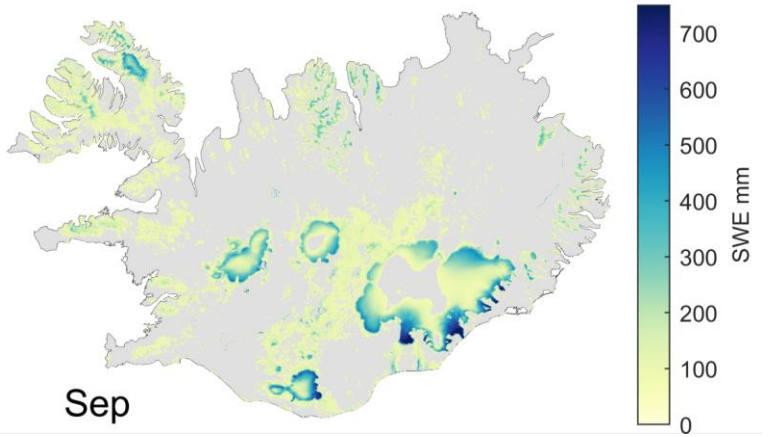




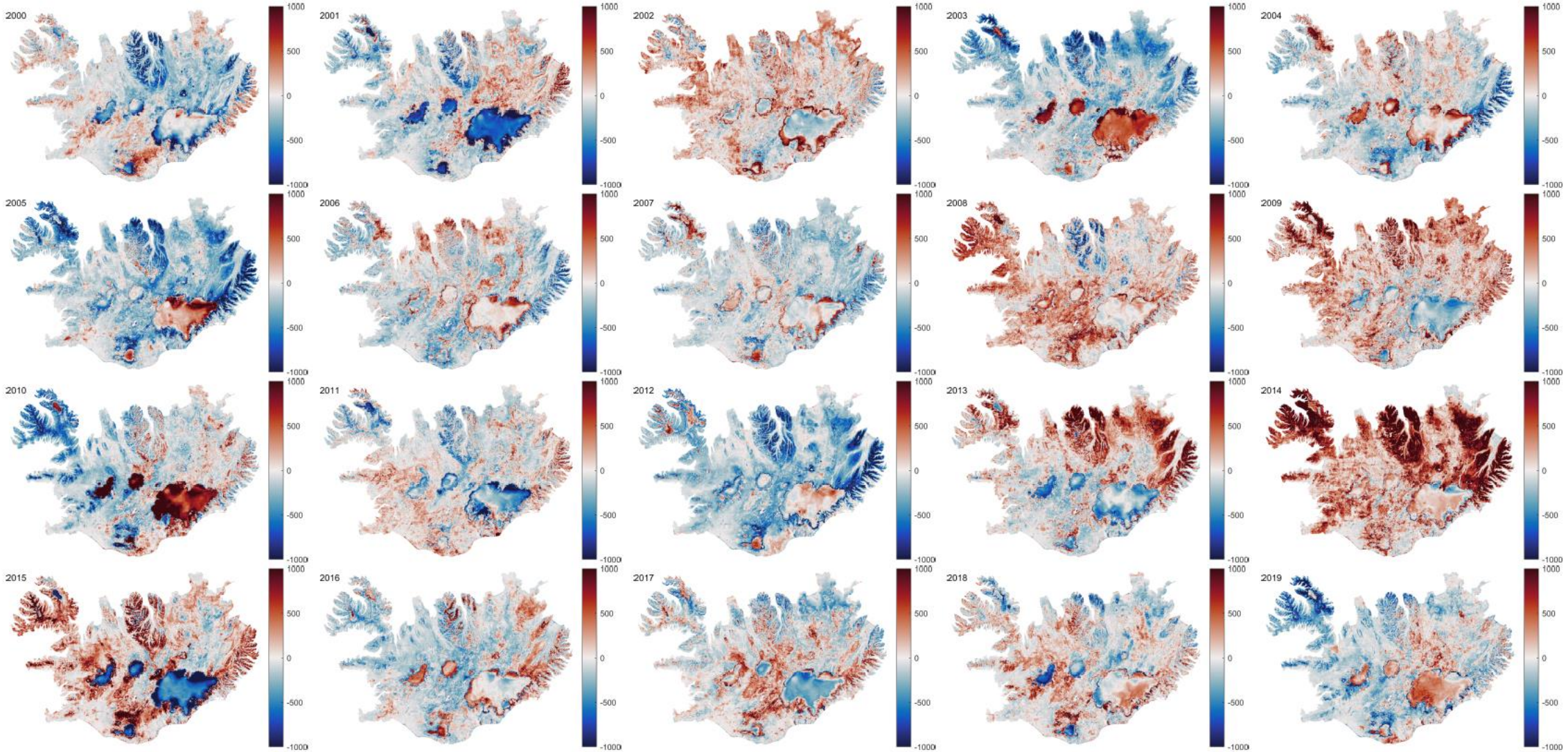




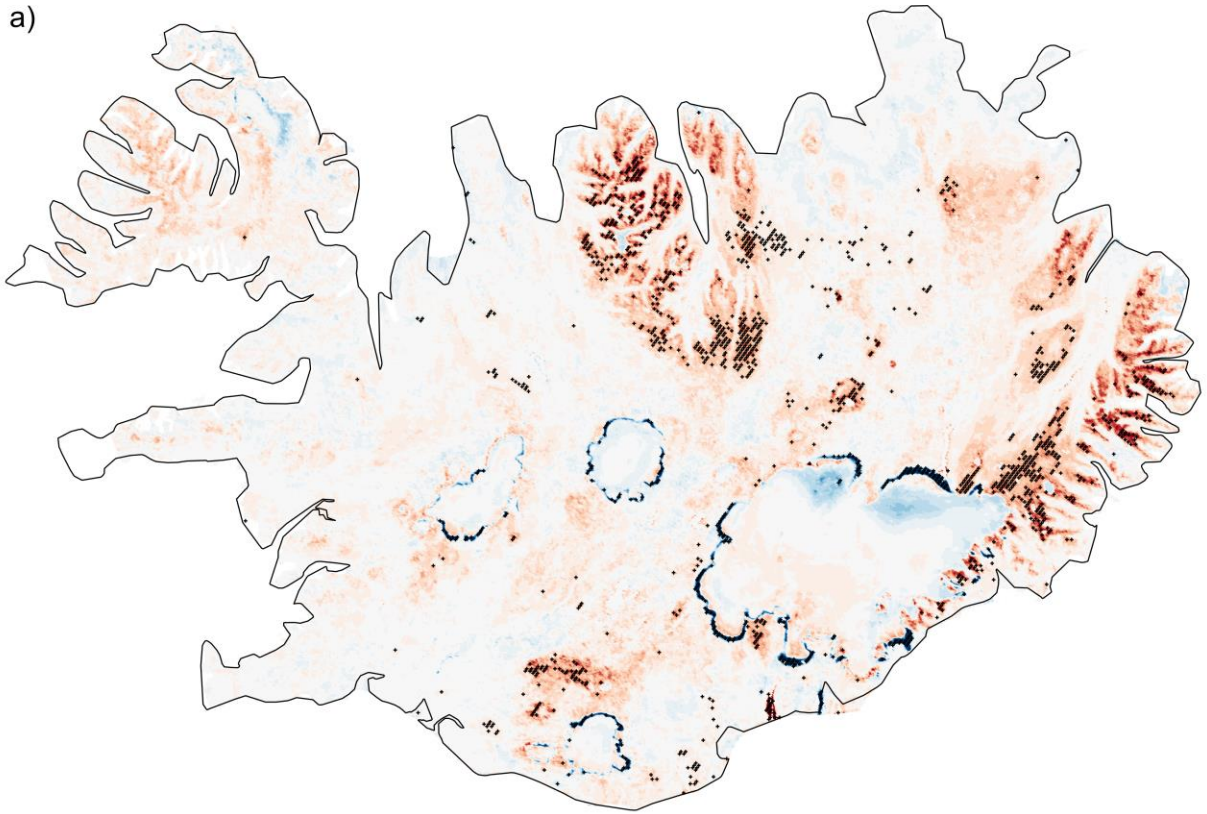


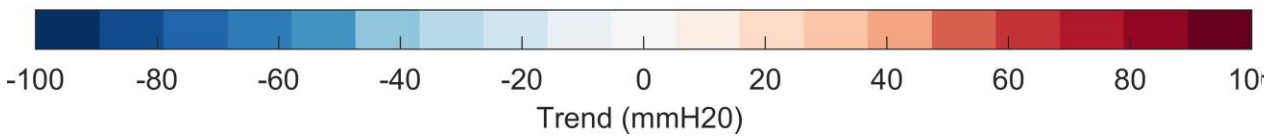


Frávik vatnsgildis
2000 - 2019

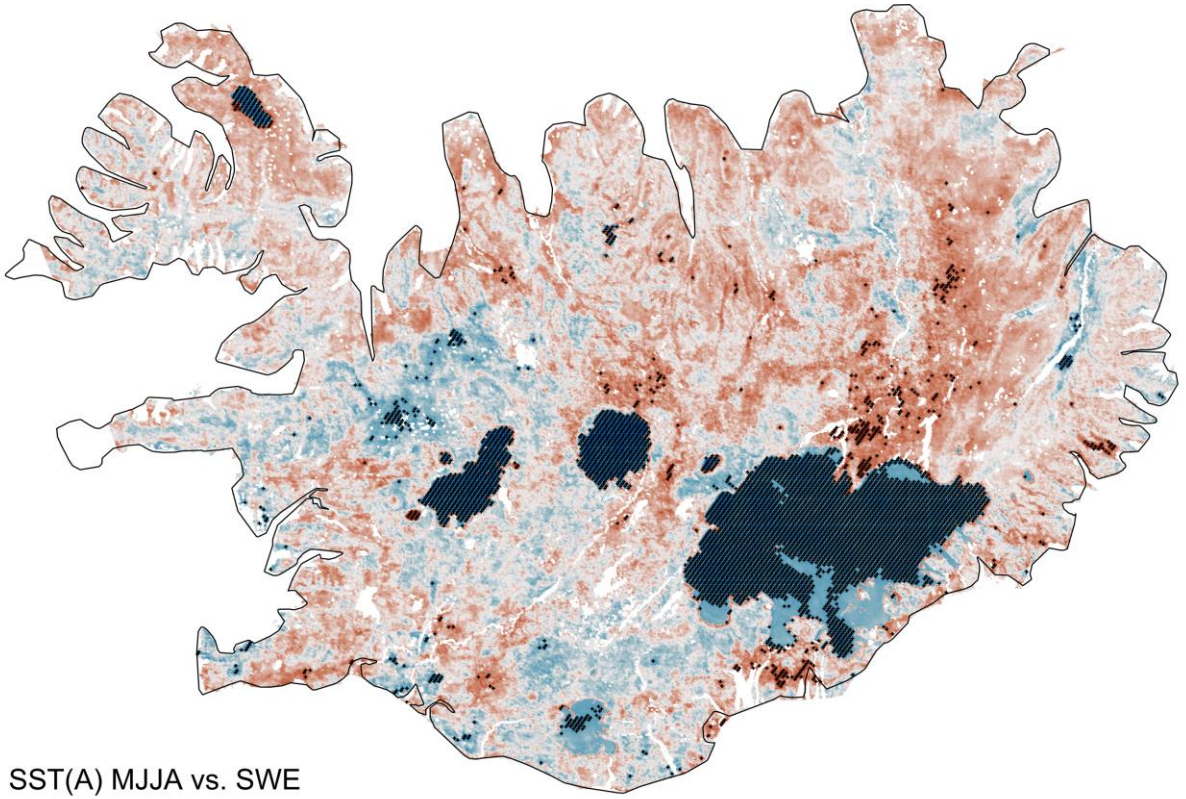


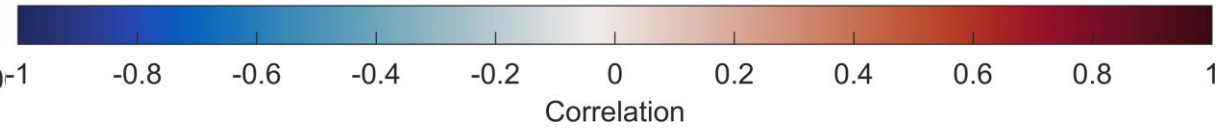
Leitni vatnsgildis 2000-2019





Vensl vatnsgildis og SST(A) 2000-2019



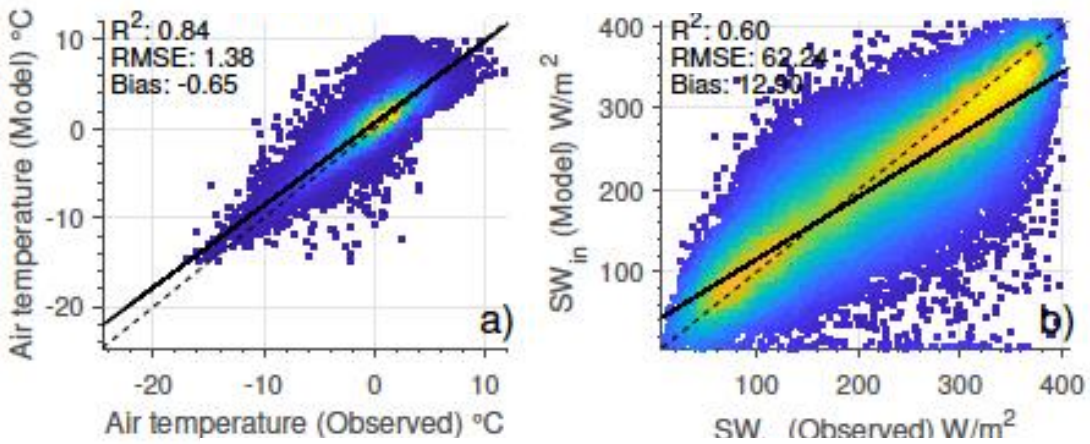


Takk fyrir

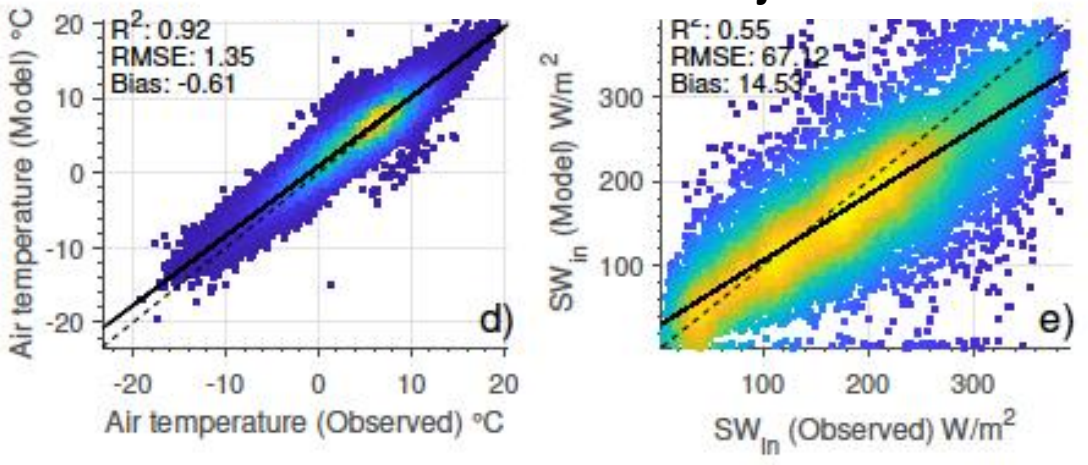
Sannprófun á inntaki og úttaki

- Veðurinntak borði saman við mælingar
  - 22 jöklaveðurstöðvar
  - 70 stöðvar á landi
- Borið saman við afkomumælinga
  - 2000 punktar af sumarafkomu
  - RMSE: 0.35-0.45 mH20
- Borið saman við snjómælingar

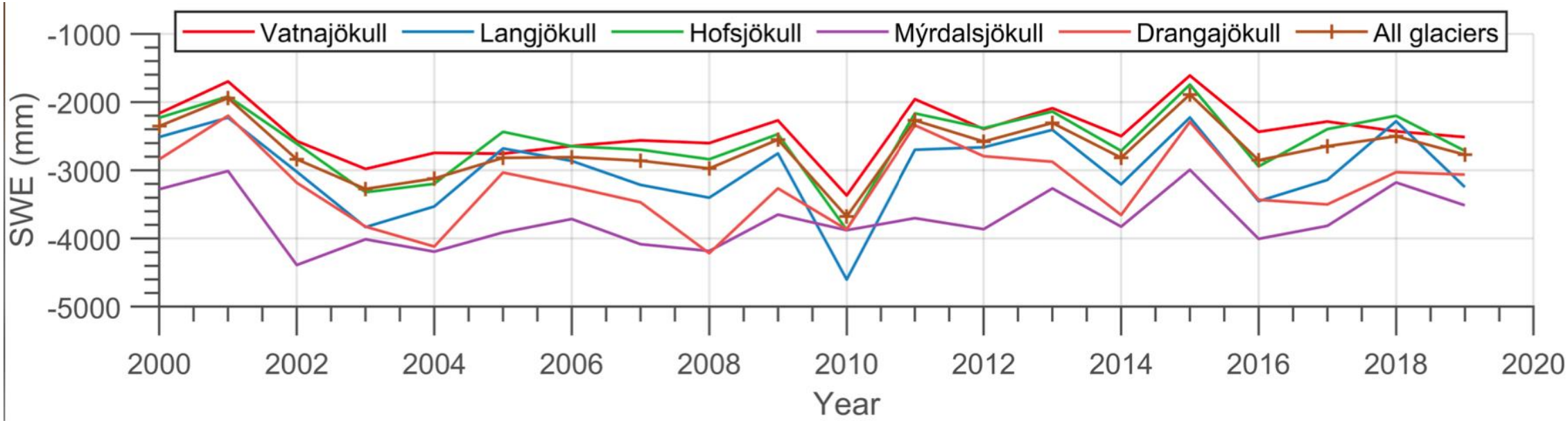
Veðurstöðvar á jökli

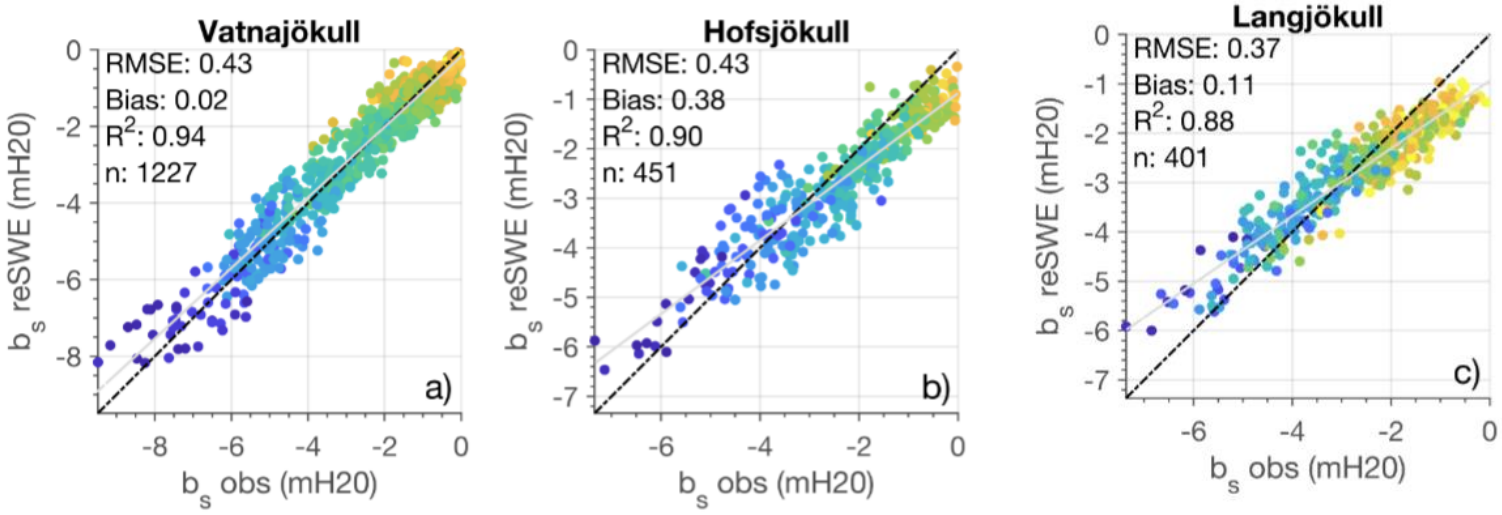


Veðurstöðvar utan jökla

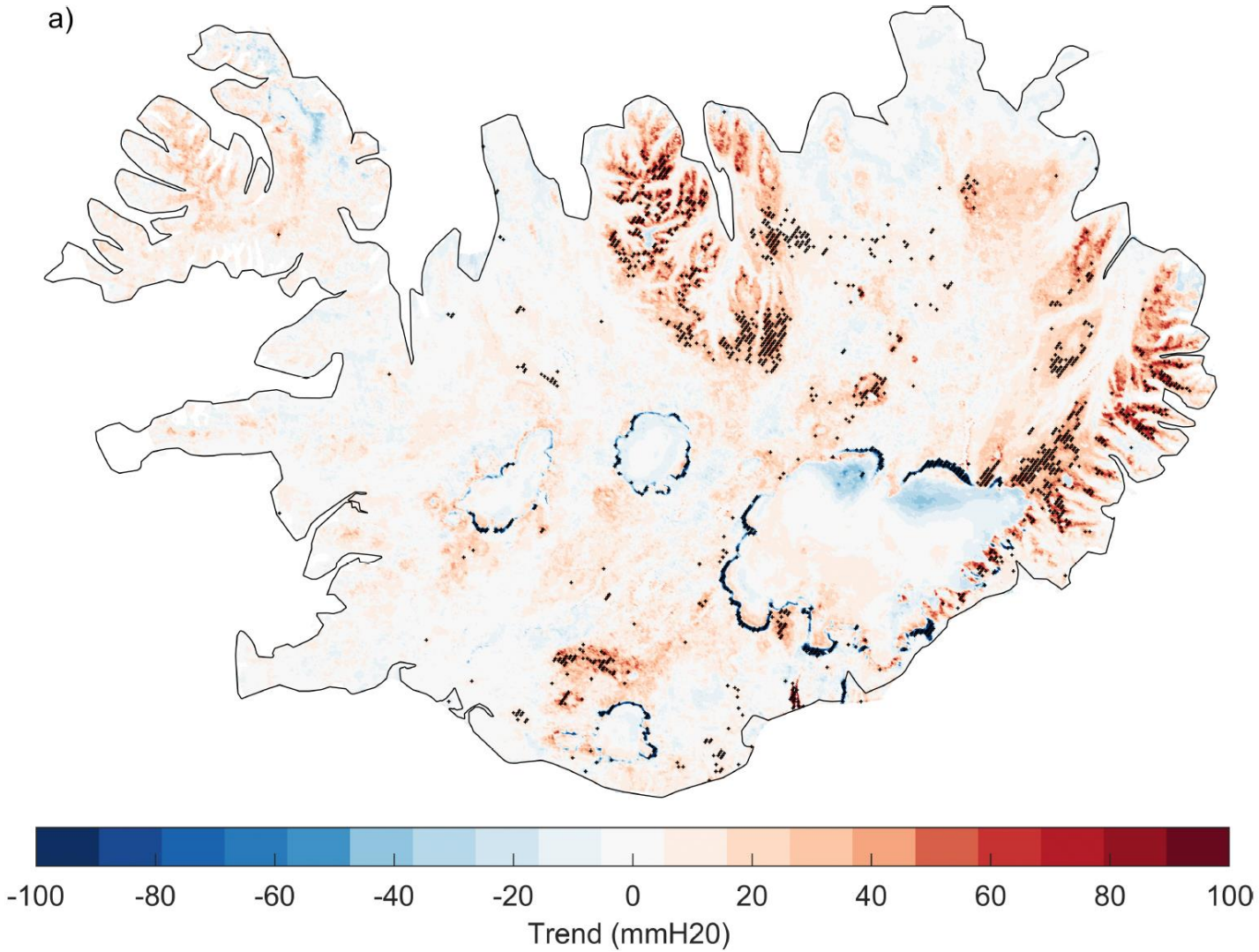


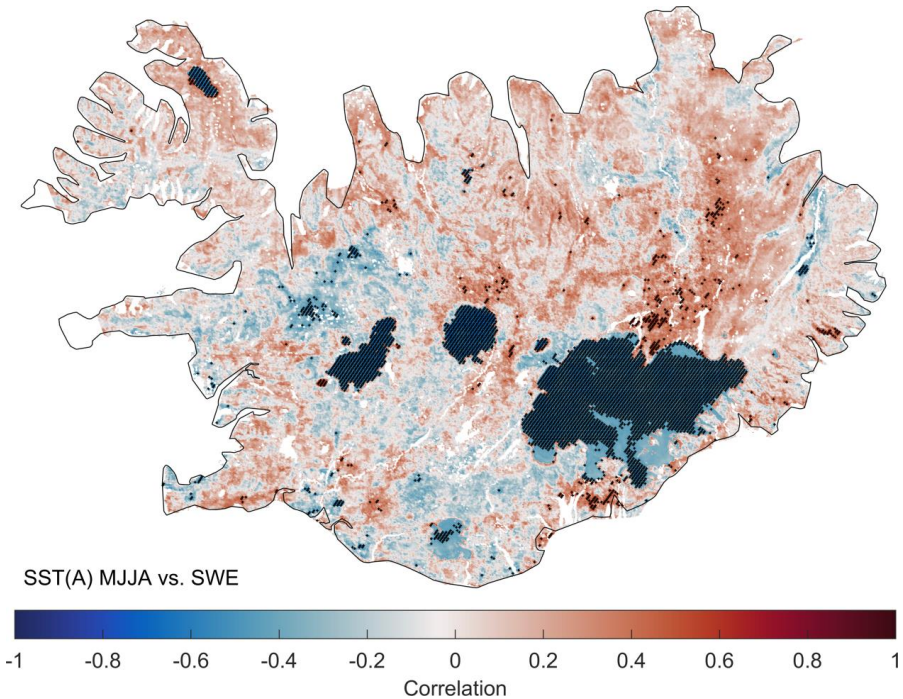
Sumarleysing helstu jökla



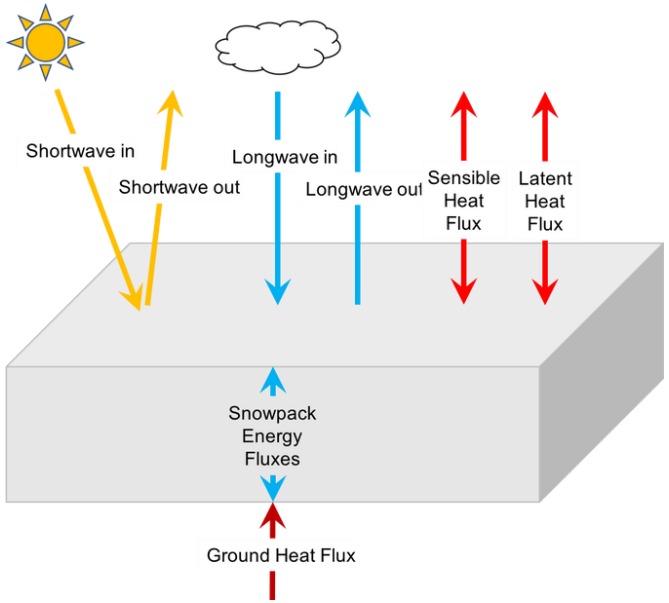


Leitni snjós/sumarleysingar 2000-2019




SST(A) MJJA vs. SWE
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
Correlation

Orkuskipti



Endurkastsstuðull

$$R_j = SW_j^{\downarrow}\left(1 - \boldsymbol{\alpha_j^*}\right) + LW_{\downarrow} + LW_{\uparrow}(T_S)$$

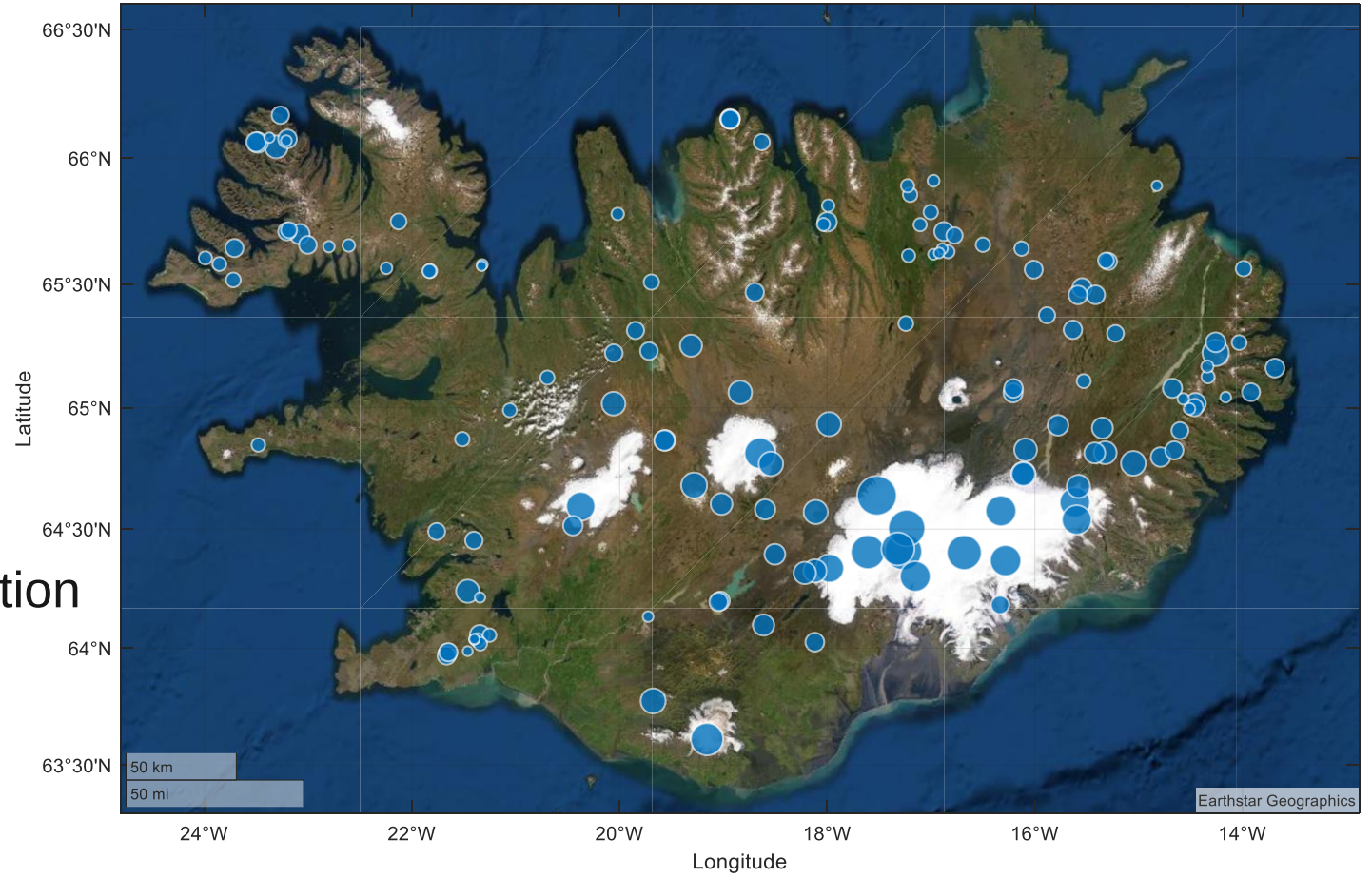
$$M_{P,j} = m_q\left(R_j + H(TS)_j + L(TS)_j\right) \rightarrow M_J = M_{P,j} \times \mathbf{f_{SCA,j}^{**}}$$

W/m^2 í mH20

Hlutfall snjóhulu

Validation – Energy/Climate
Energy balance components

- T, SW_in og LW_in
- Only sites above 250 m a.s.l.
- IMO + LV
- In total (89):
  - 20 sites at glaciers (GAWS)
  - 6 sites on land with temp and radiation
    - Land (RT)
  - 63 sites on land with temp
    - Land (T)



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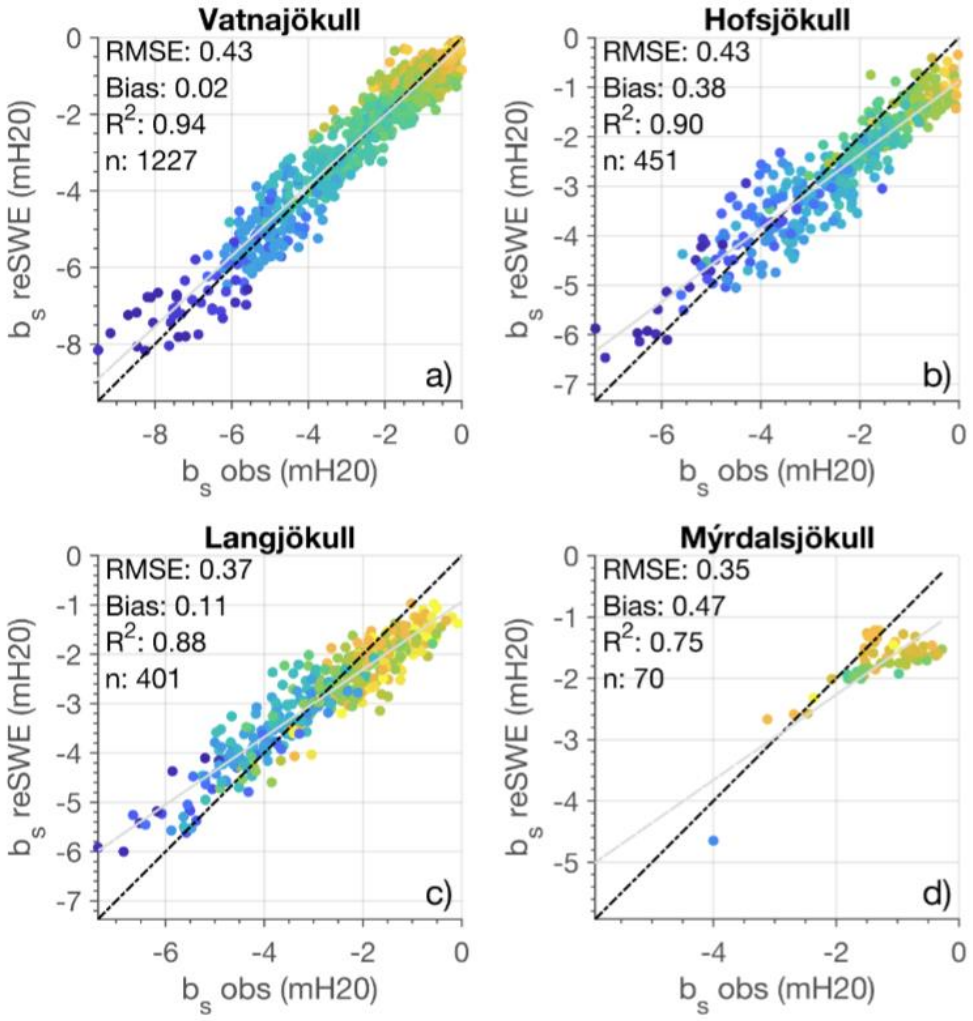
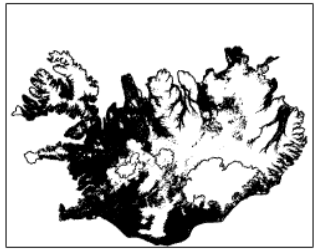


Icelandic snow cover from MODIS

SCA 15th May 2000 - 2019

15-May-2000 SCA: 41.5%

15-May-2001 SCA: 52.0%



15-May-2002 SCA: 56.9%

15-May-2003 SCA: 29.9%

15-May-2004 SCA: 43.2%

15-May-2005 SCA: 38.9%

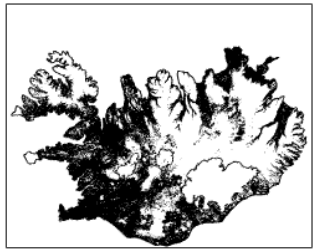
15-May-2006 SCA: 45.9%

15-May-2007 SCA: 53.5%

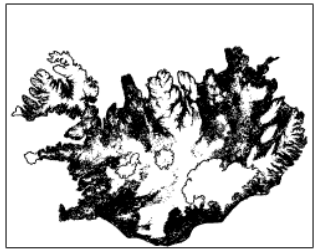
15-May-2008 SCA: 57.9%

15-May-2009 SCA: 51.7%

15-May-2010 SCA: 53.6%



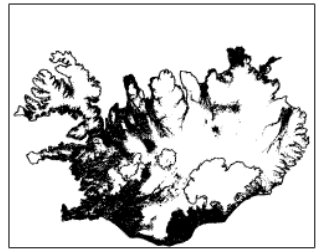
15-May-2011 SCA: 50.8%



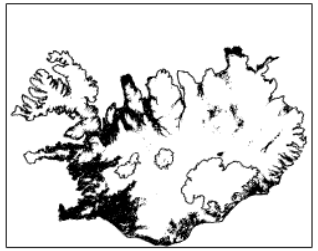
15-May-2012 SCA: 66.6%

15-May-2013 SCA: 65.9%

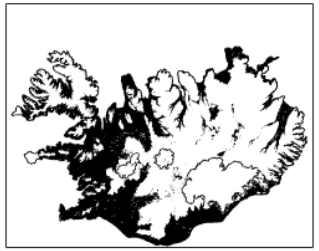
15-May-2014 SCA: 64.4%



15-May-2015 SCA: 77.8%



15-May-2016 SCA: 62.0%



15-May-2017 SCA: 49.9%

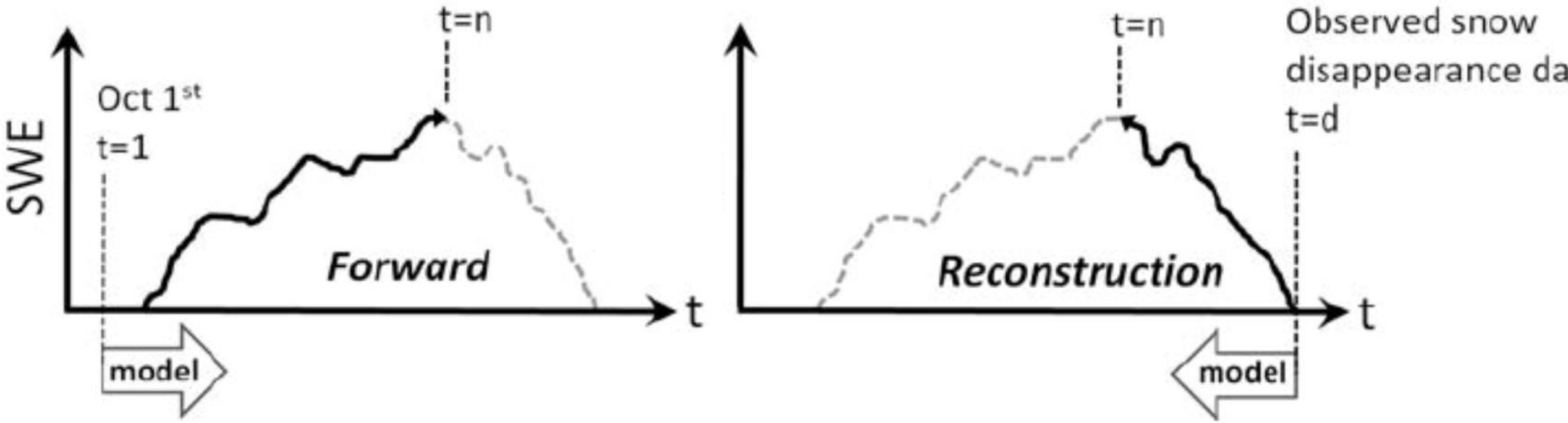
15-May-2018 SCA: 55.1%

15-May-2019 SCA: 34.4%

Validation – Energy/Climate
Energy balance components

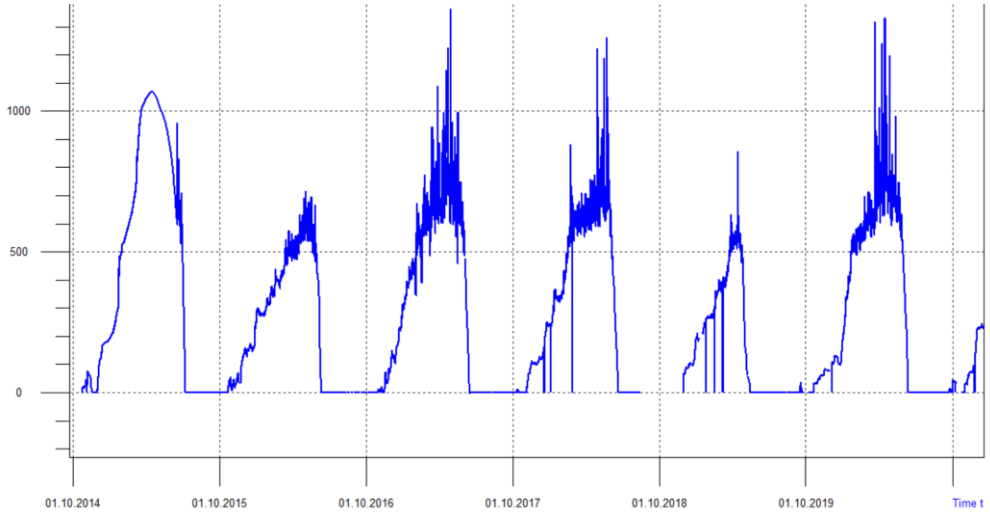
		Z	Air temperature			SW_in			LW_in		
		m a.s.l.	RMSE	R$\hat{2}$	Bias	RMSE	R$\hat{2}$	Bias	RMSE	R$\hat{2}$	Bias
Glaciers	Min	529	0.65	0.04	-1.68	45.4	0.14	-17.0	12.0	0.32	-13.7
	Mean	1154	1.53	0.74	-0.74	56.5	0.62	15.0	16.7	0.63	-6.6
	Median	1199	1.30	0.80	-0.65	50.1	0.67	10.3	16.2	0.68	-6.0
	Max	1946	6.16	0.96	0.64	103.4	0.77	90.5	26.5	0.78	3.3
Land (RT)	Min	282	0.84	0.94	-1.22	44.0	0.45	-2.3	11.9	0.18	-17.8
	Mean	599	1.01	0.95	-0.58	58.0	0.63	9.1	22.5	0.69	-15.6
	Median	666	0.96	0.96	-0.68	49.5	0.68	4.4	13.3	0.81	-16.2
	Max	750	1.23	0.96	0.10	88.8	0.74	29.6	60.1	0.83	-12.1
Land (T)	Min	279	0.67	0.81	-2.80						
	Mean	544	1.07	0.94	-0.53						
	Median	530	1.07	0.94	-0.76						
	Max	1689	1.52	0.97	2.35						

Reconstruction of seasonal snow

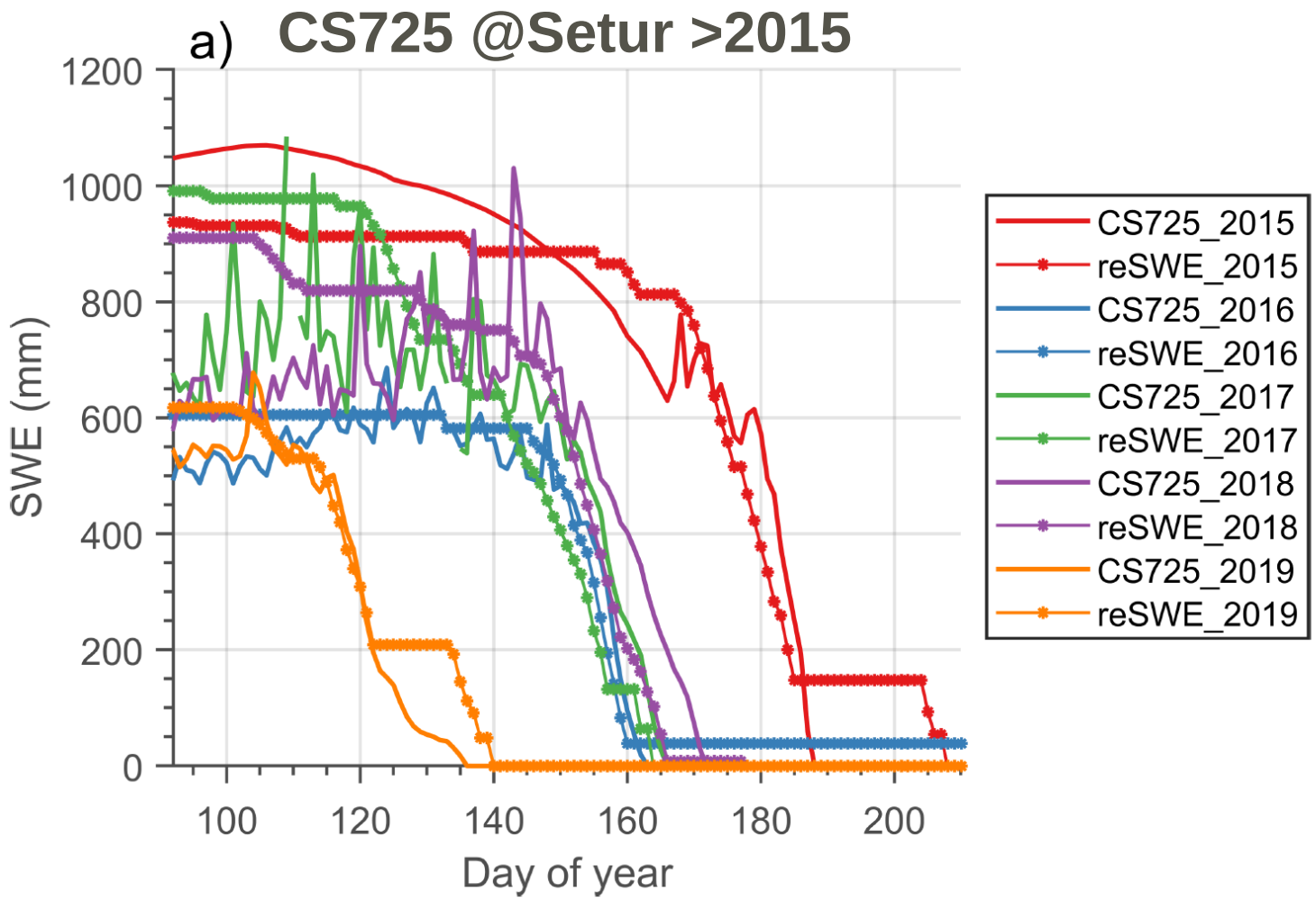


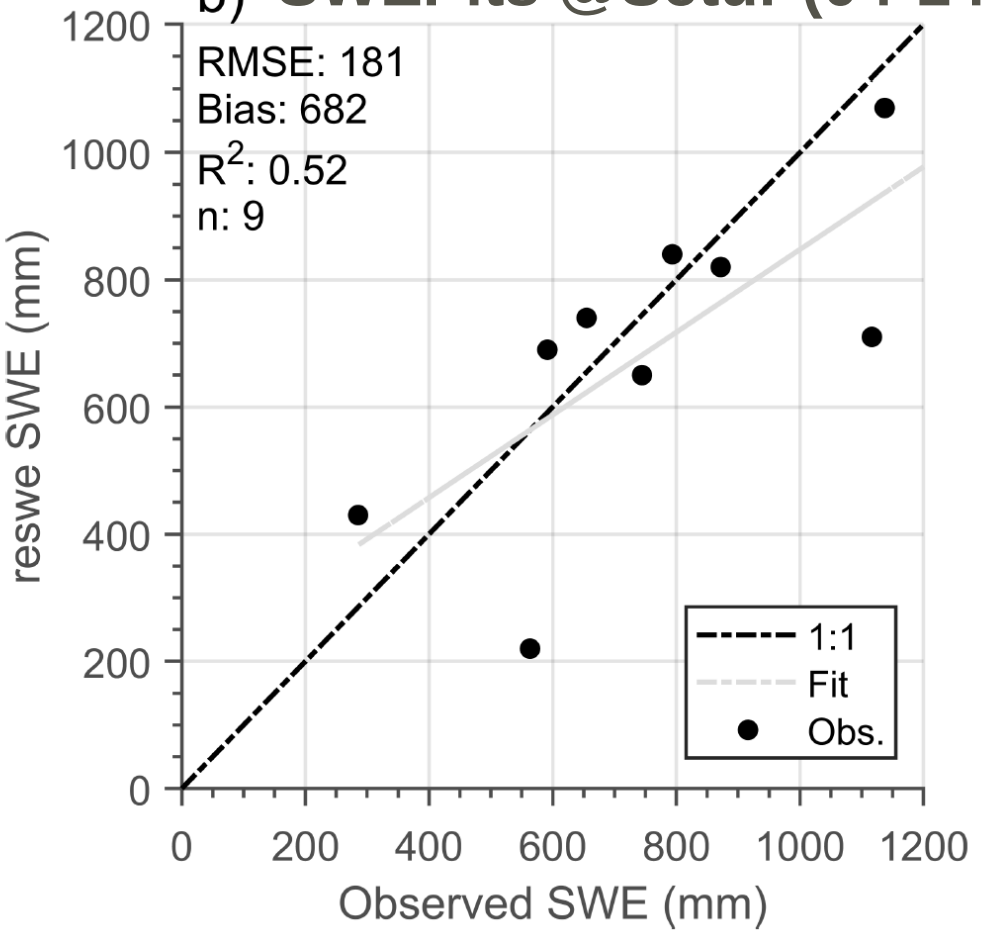
Validation – Sesonal snow

- One high quality site (Setur)
  - Snow pit observations from 2005
  - Stake average
  - Time of observations from Mars to April
  - Since 2015 CS725 time series of SWE

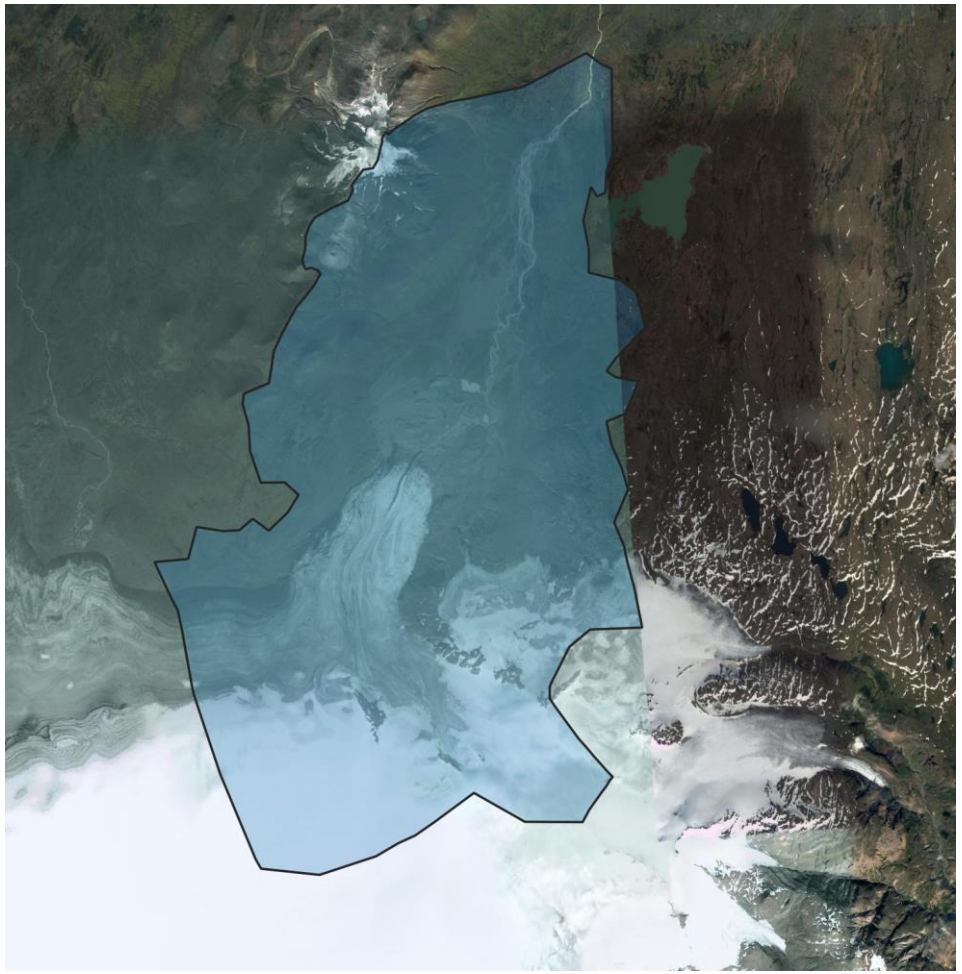


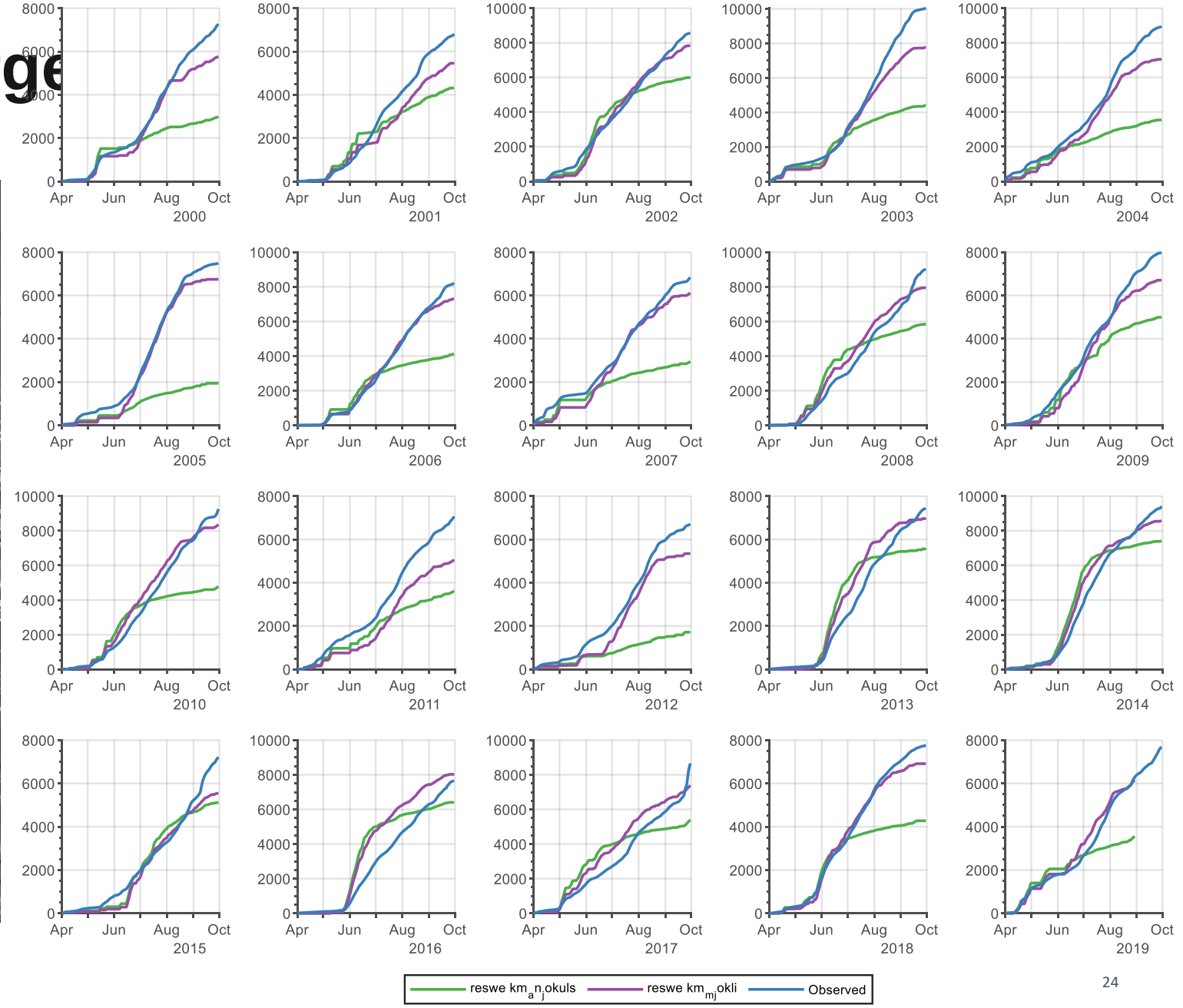
Validation – Sesonal snow

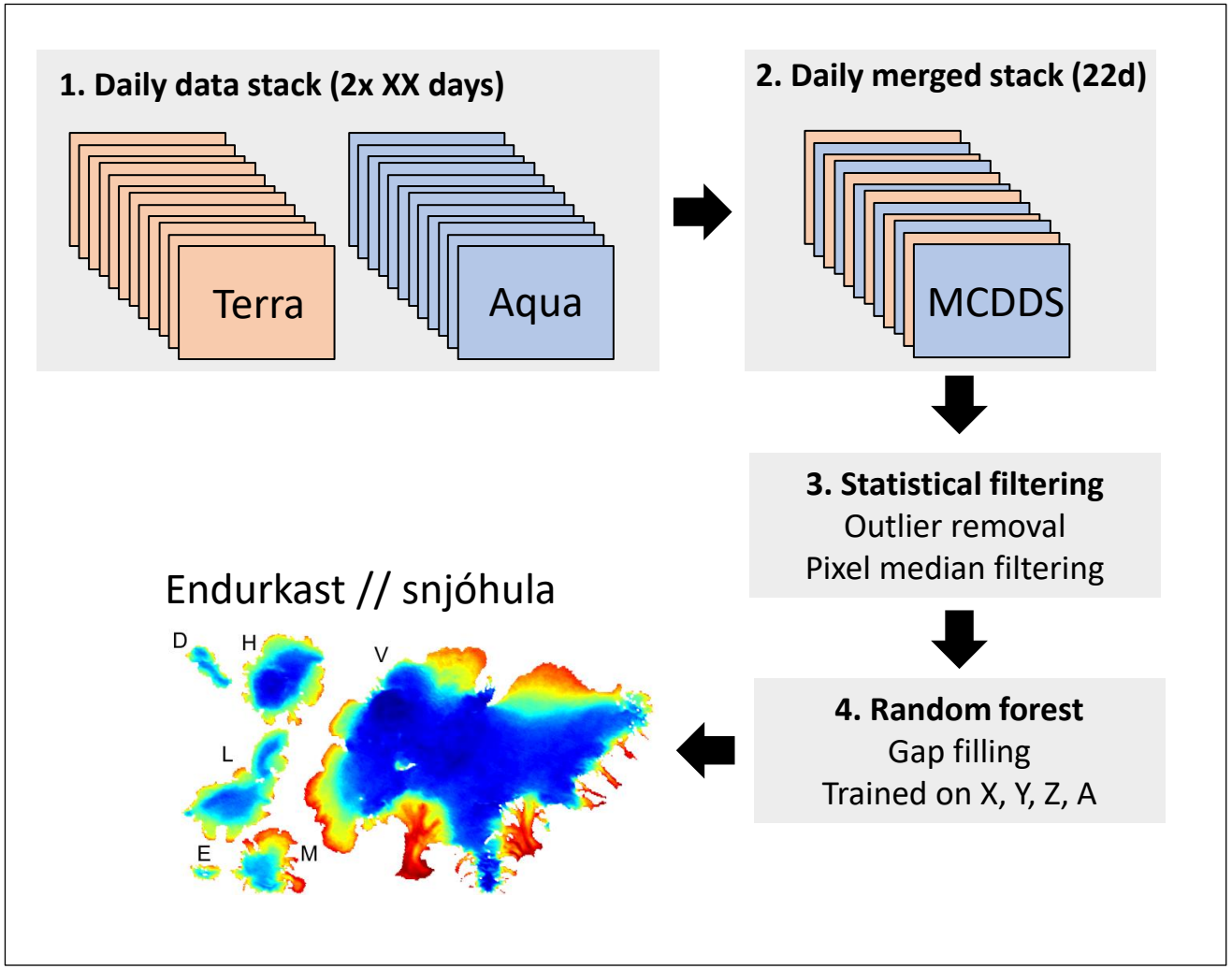




Validation – Discharge






1. Daily data stack (2x XX days)
Terra
Aqua
2. Daily merged stack (22d)
MCDDS
3. Statistical filtering
Outlier removal
Pixel median filtering
4. Random forest
Gap filling
Trained on X, Y, Z, A
Endurkast // snjóhula
D
H
V
L
E
M