Impact of Snow Representation in Seasonal Forecast Systems
UP2.5: EMS2021-147

Danny Risto[1], Kristina Fröhlich[2], Bodo Ahrens[1]
[1]Goethe University Frankfurt, [2]Deutscher Wetterdienst

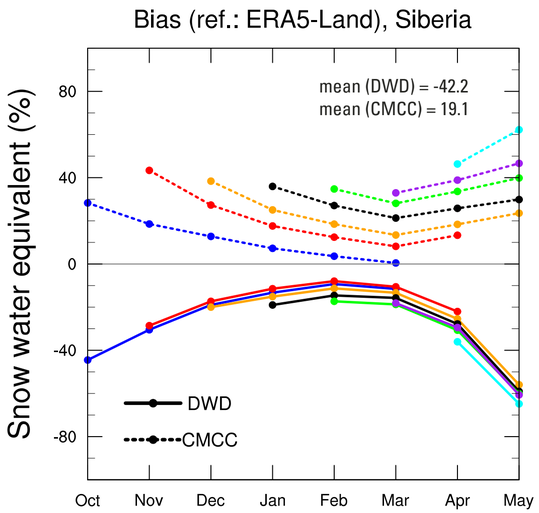
Motivation

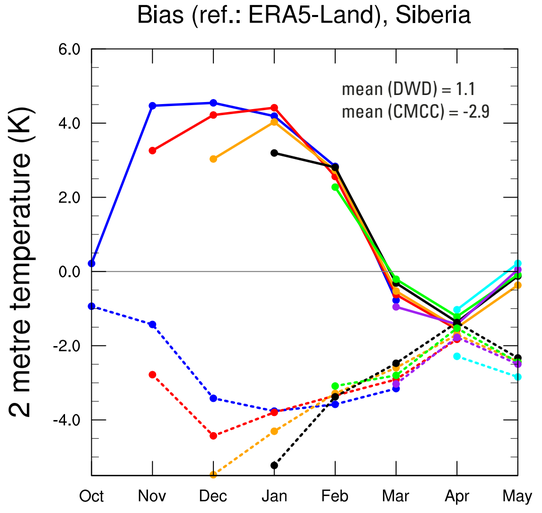
- low predictive skill of seasonal forecasts over continental regions (especially NH winter)
- which role does snow initialization and modelling play in seasonal forecasts?

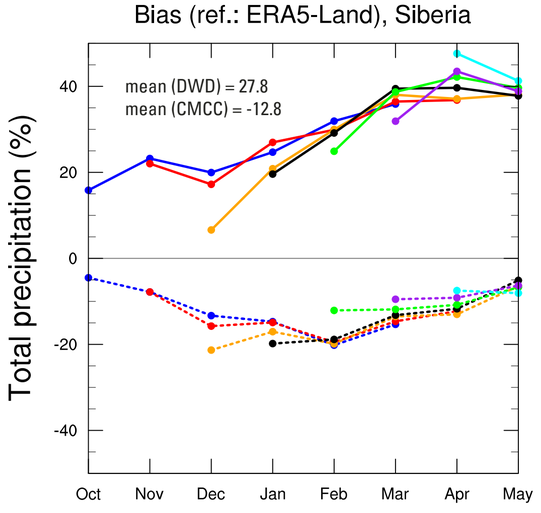
Snow…
- … cools surface air (albedo, emissivity, melt)
- … contributes water to soil and rivers

➢ potential memory effect

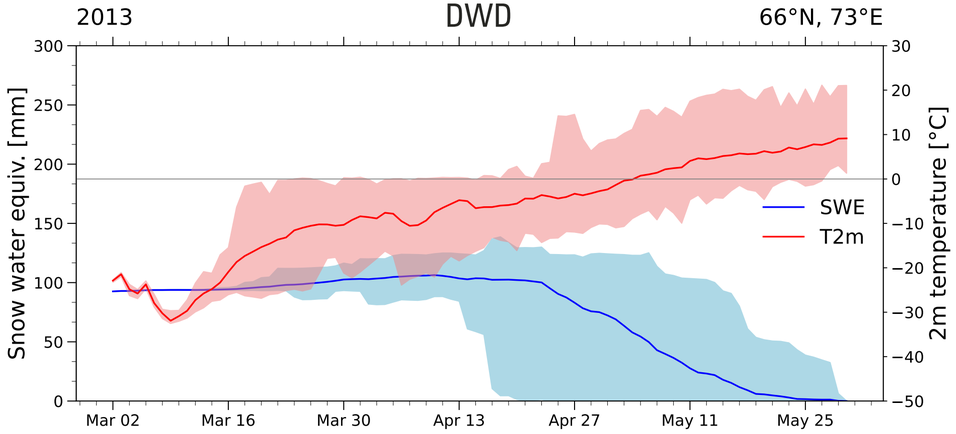
Bias 1993-2016







Onset of snow melt



Ensemble of daily maximum 2m temperature (red) and snow water equivalent (blue) at a single grid cell from ECMWF seasonal hindcast in spring 2013.

Snow representation in 4 systems (DWD, ECMWF, Météo-France, CMCC)

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- single- and multi-layer snow schemes

- high uncertainty in timing of snow melt onset

➢ challenge: timing of T2m in spring (0°C line)

Hypotheses

- snow assimilation to correct initial under-/overestimation
- multi-layer snow to improve melting process

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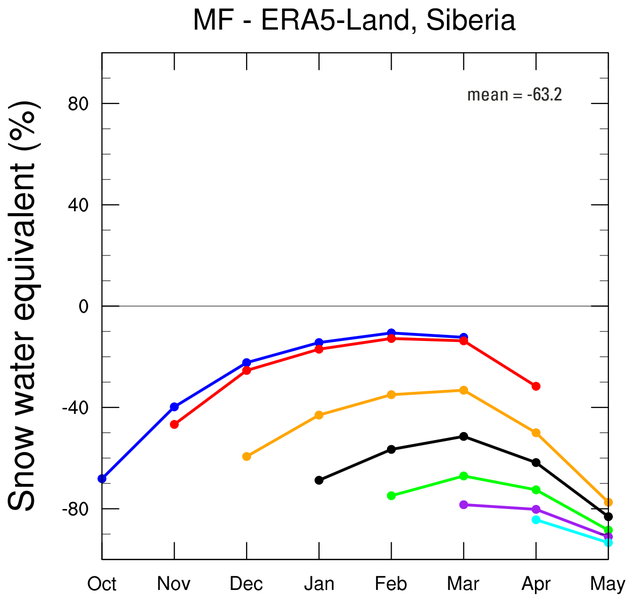
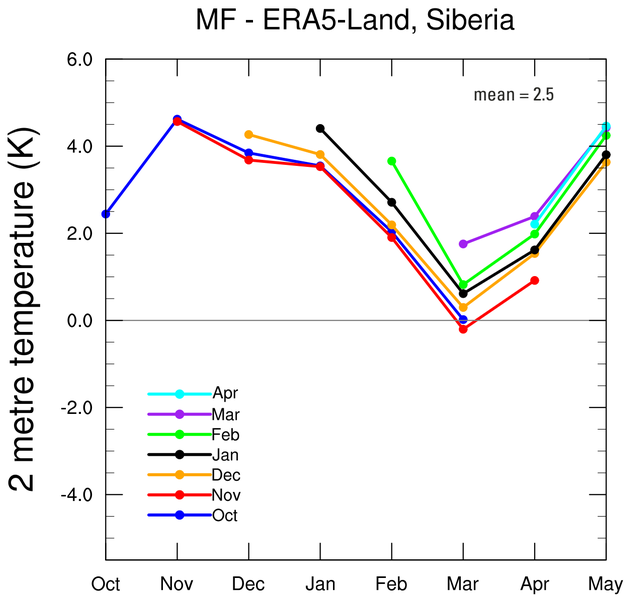
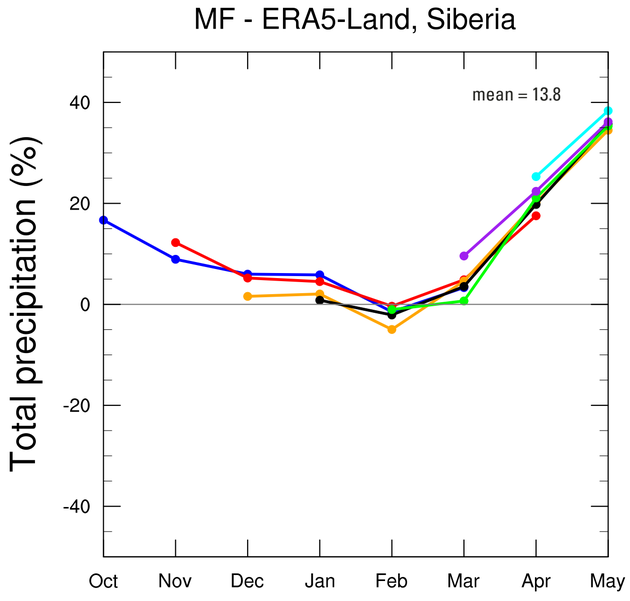
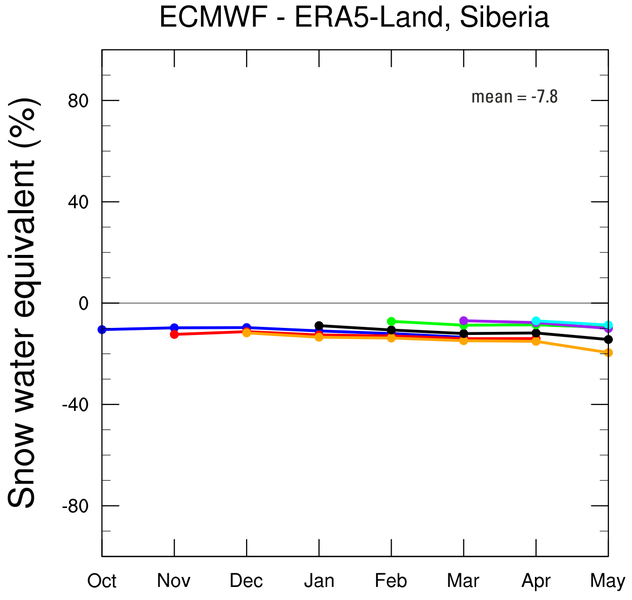
Bias (ref.: ERA5-Land 1993-2016)

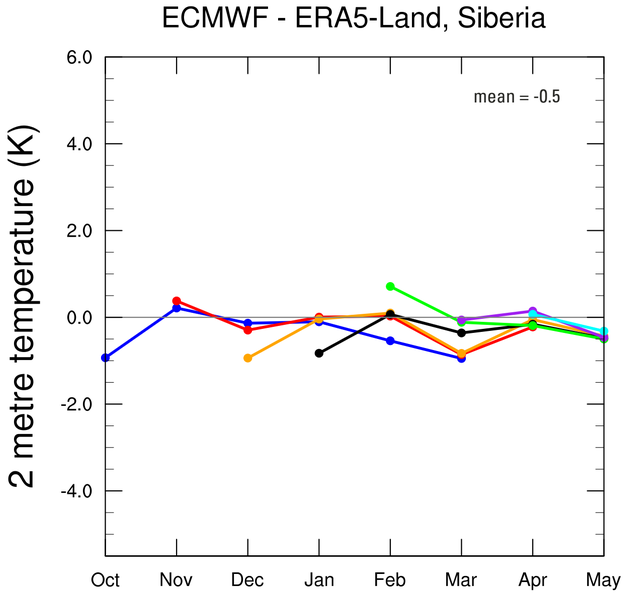


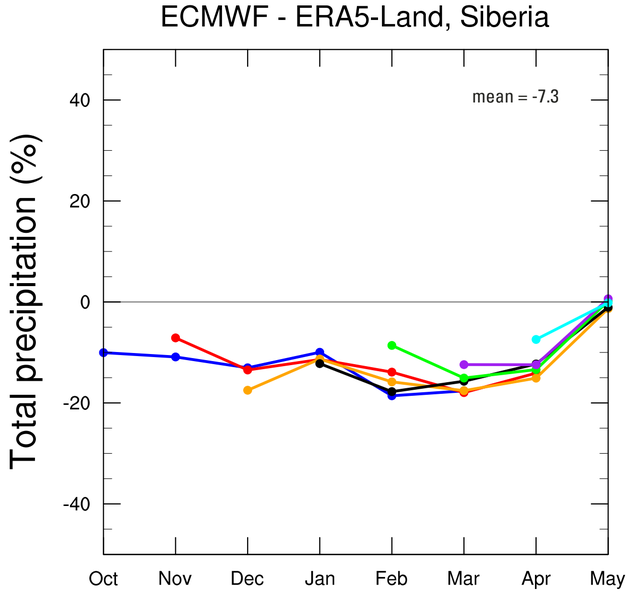




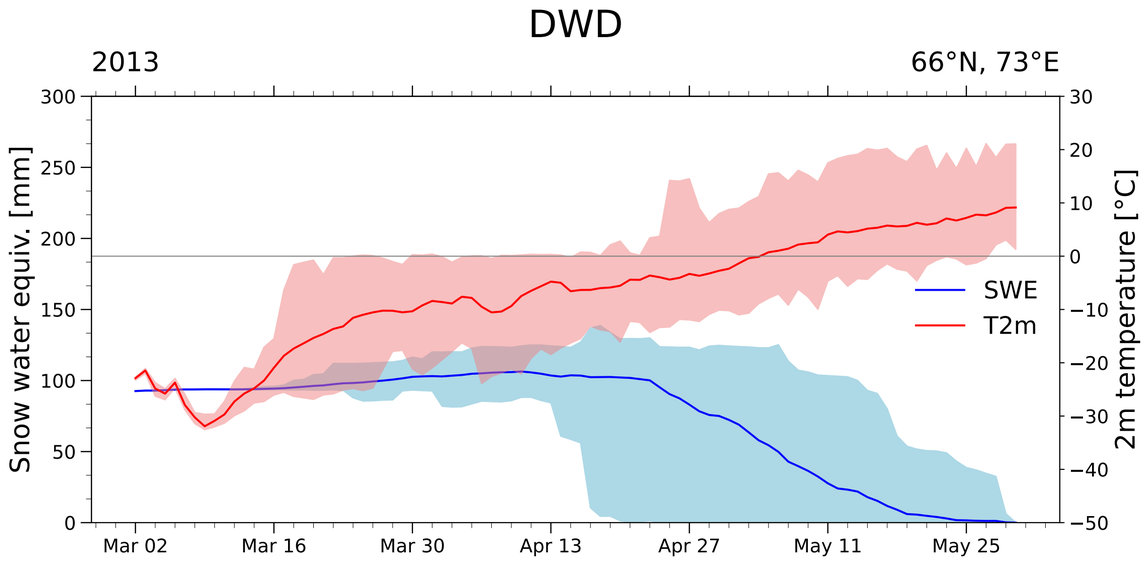
Météo-France







ECMWF



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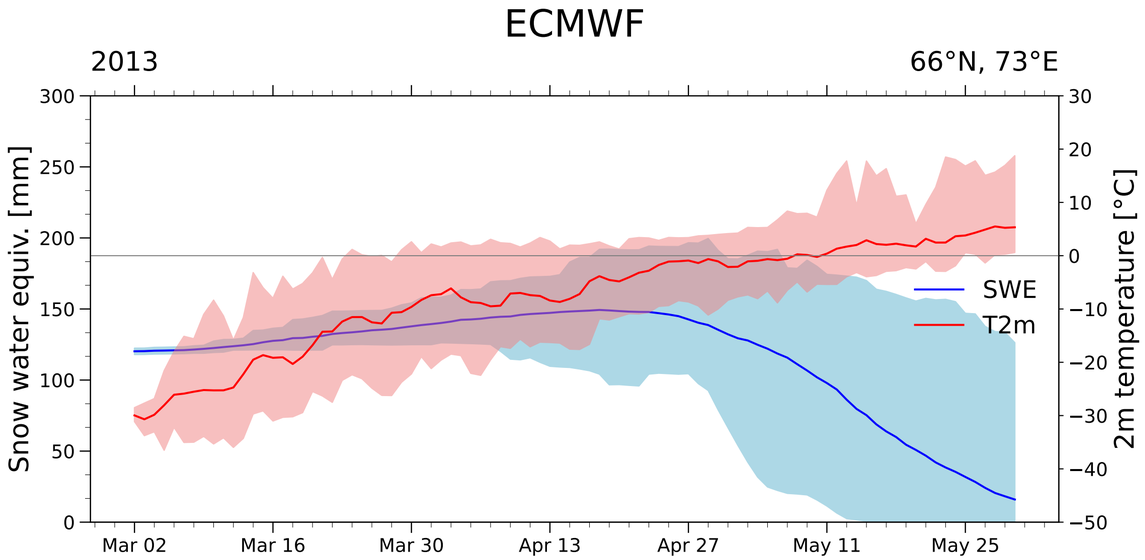

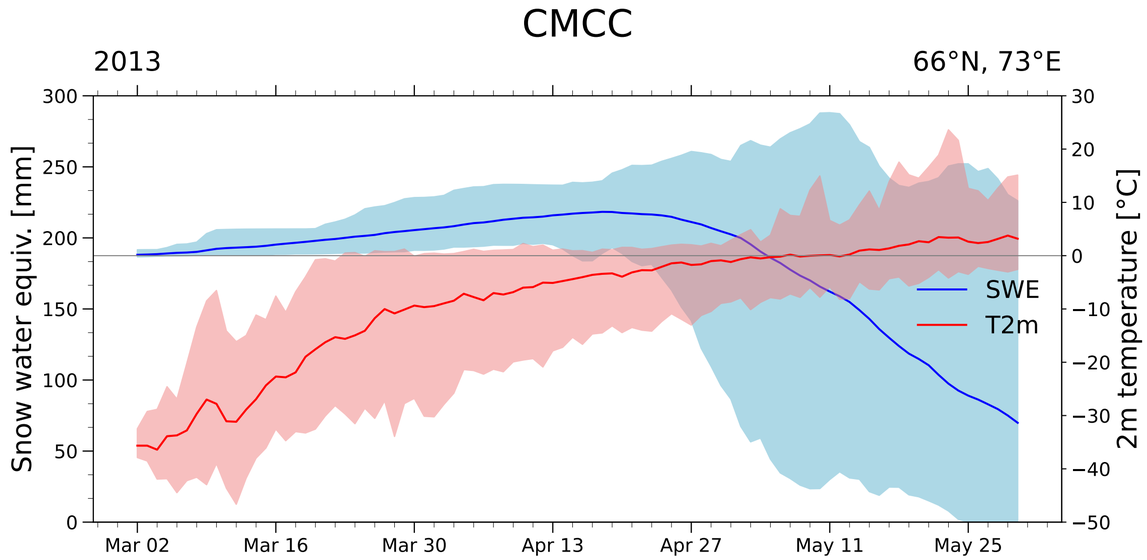

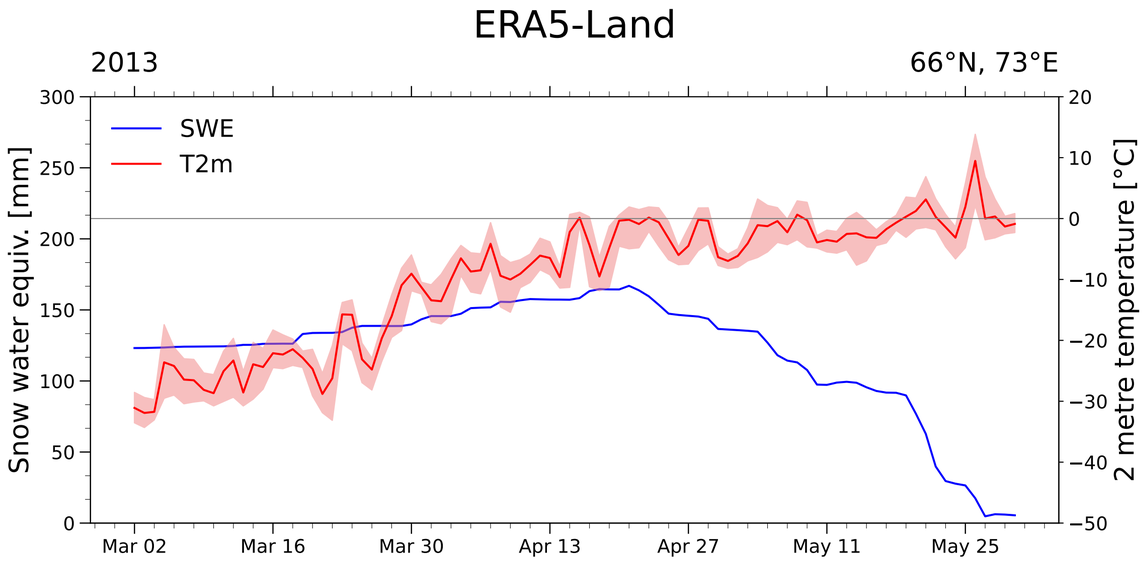

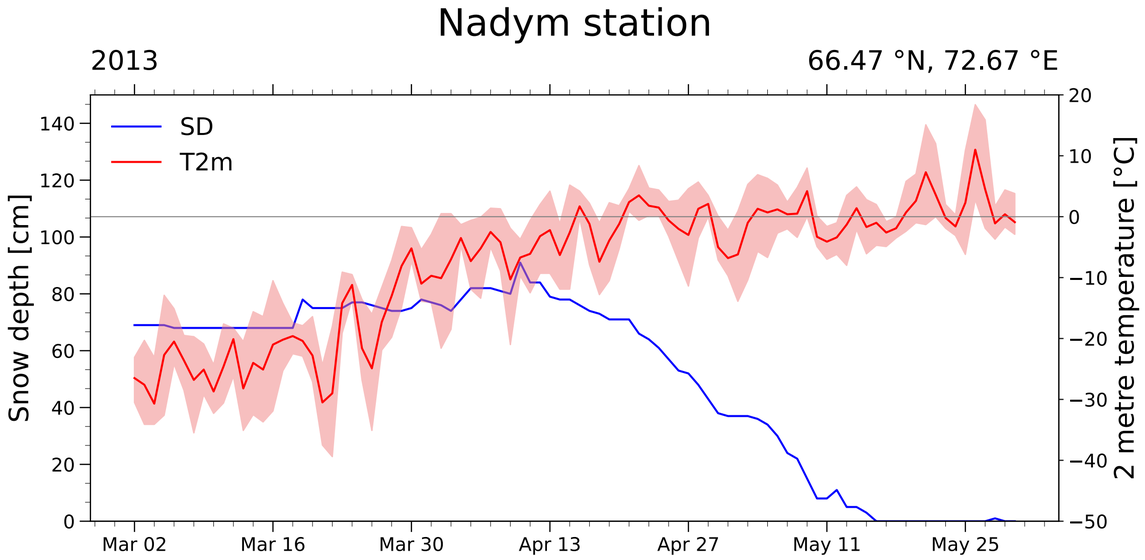

References for daily 2m temperature (red) and snow (blue) in spring 2013.

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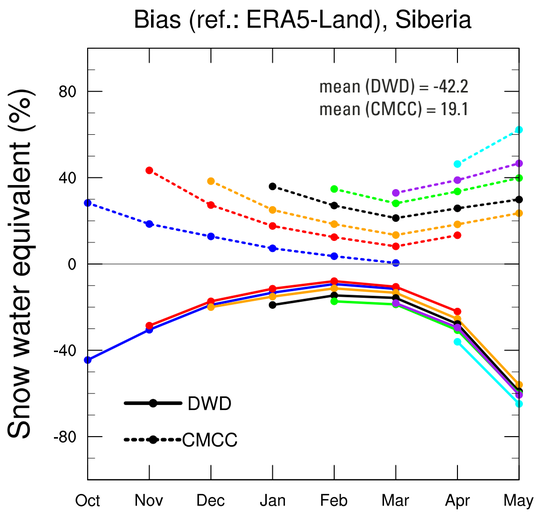

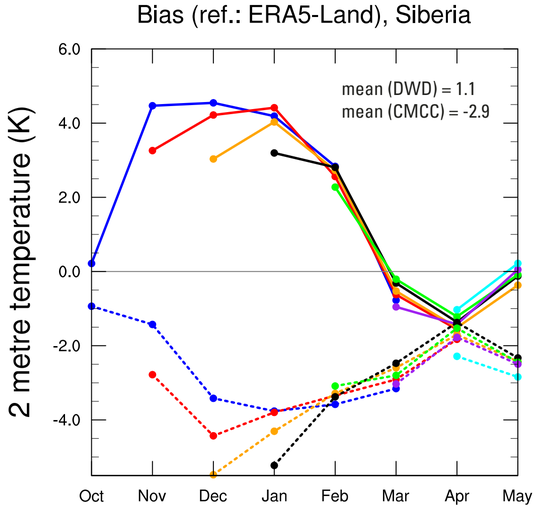

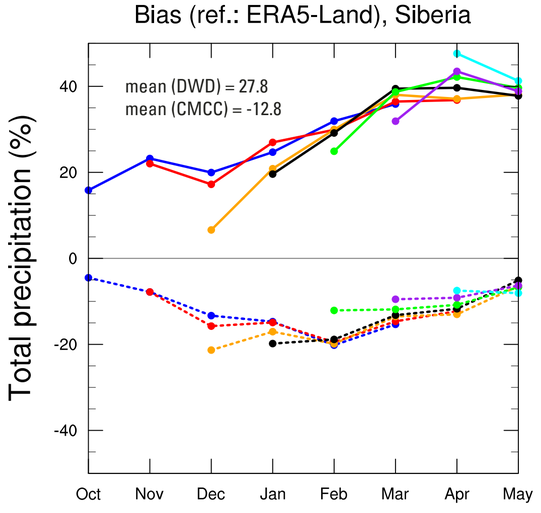

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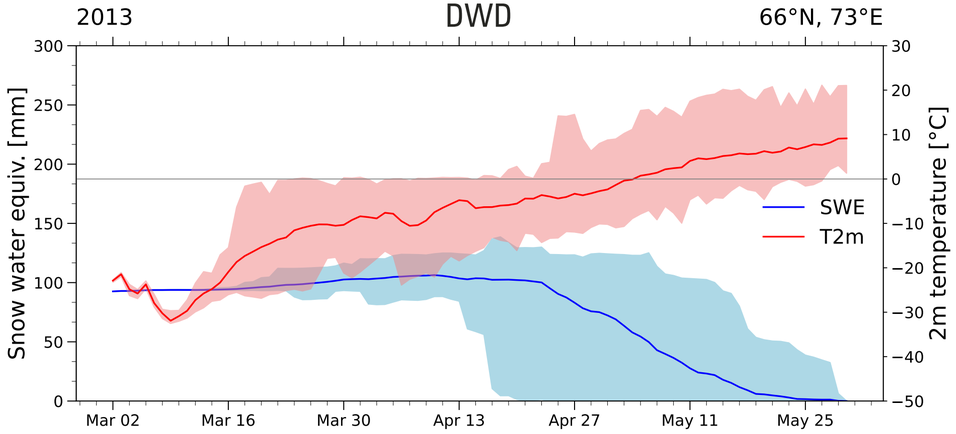

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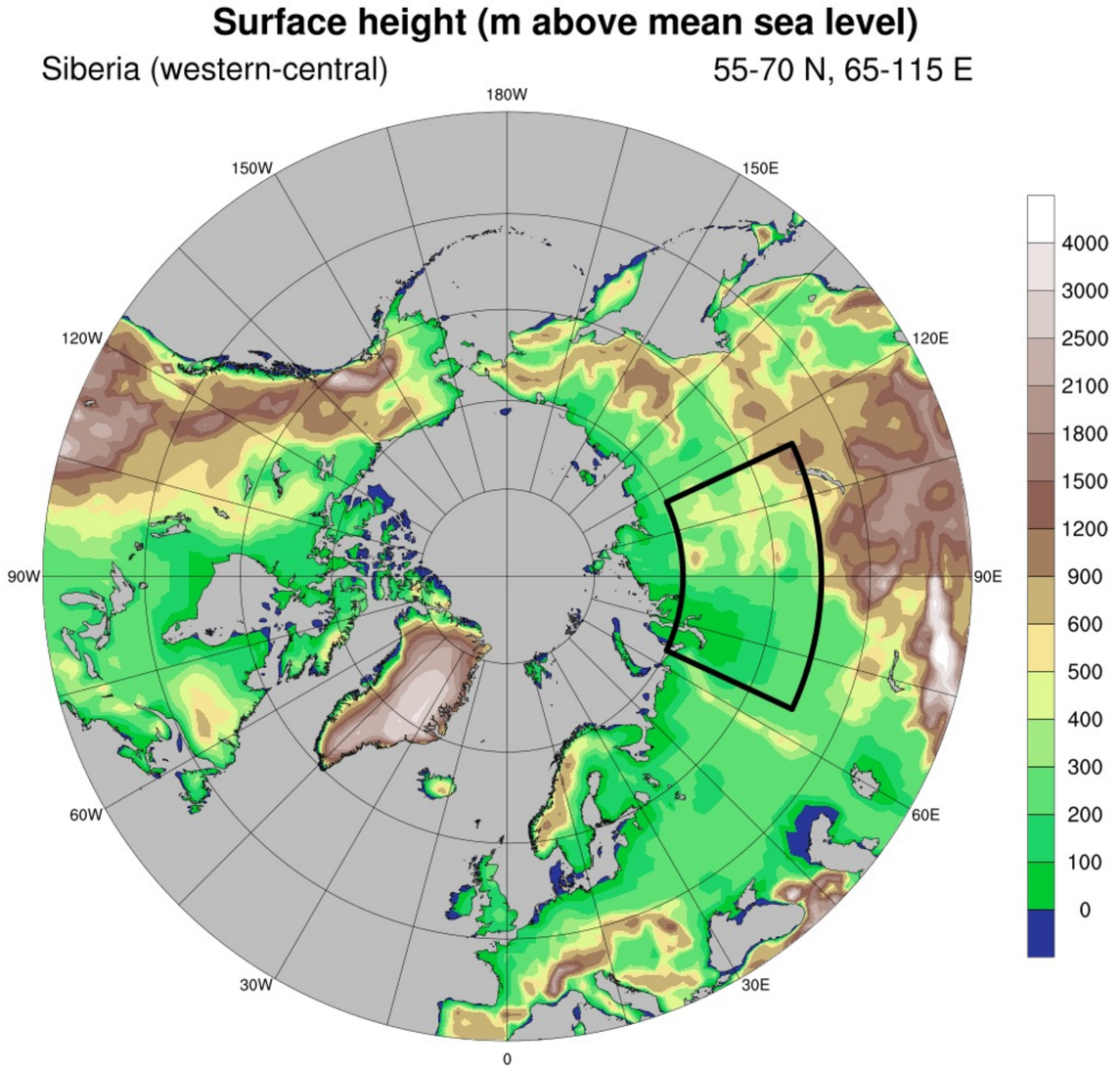
Overview: System configurations (hindcasts)

Centre (system)	DWD/UHH/MPI-M (GCFS2.0)	ECMWF (SEAS5)	Météo-France (System 7)	CMCC (SPS3.5)
Components (atmosphere + land surface + ocean)	ECHAM + JSBACH + MPIOM	IFS + HTESSEL + NEMO	ARPEGE + SURFEX + NEMO	CESM (CAM + CLM + NEMO)
Initialisation	Atmosphere: ERA-Interim (Nudging, no wet variables) Land: indirect by forcing the atmosphere with ERA-Interim Ocean: ORAS5 (Nudging)	Atmosphere: ERA-Interim (4DVAR) Land: ERA-Interim + offline HTESSEL (EDA, snow indirect) Ocean: ORAS5 (3DVAR)	Atmosphere: ERA5 Land: ERA5 (also snow) Ocean: GLORYS12V1	Atmosphere: ERA5 Land: indirect by forcing the atmosphere with ERA5/NCEP2* Ocean: C-GLORS (3DVAR)
Snow layers	Single-layer	Single-layer	Multi-layer	Multi-layer
Ensemble	30 (perturbed)	25 (perturbed)	25 (time lag and perturbed)	40 (time lag and perturbed)

*NCEP2: NCEP-DOE Reanalysis 2

Soon available (hindcasts): Météo-France System 8, DWD GCFS2.1 and ECCC


Surface height (m above mean sea level)
Siberia (western-central)
55-70 N, 65-115 E
180W
150W
150E
120W
120E
90W
90E
60W
60E
30W
30E
0
4000
3000
2500
2100
1800
1500
1200
900
600
500
400
300
200
100
0