A regional climate model hindcast for Siberia – added value assessment of SWE

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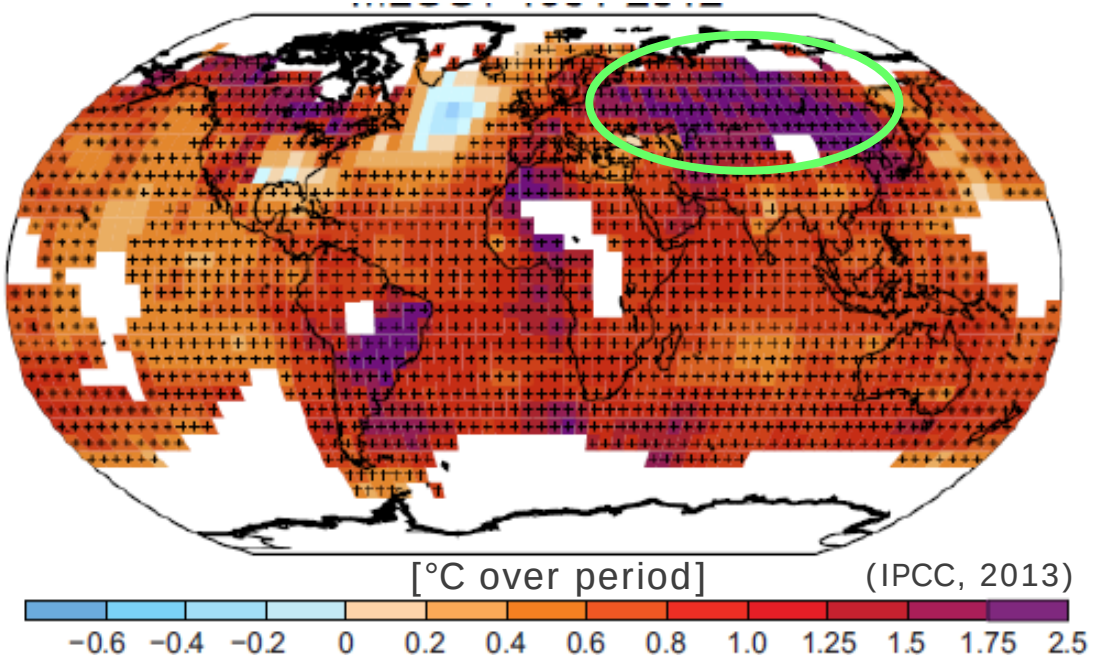
Katharina Klehmet, B. Geyer and B. Rockel
Institute of Coastal Research
Regional Atmospheric Modelling

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

Siberia – hot spot of climate change

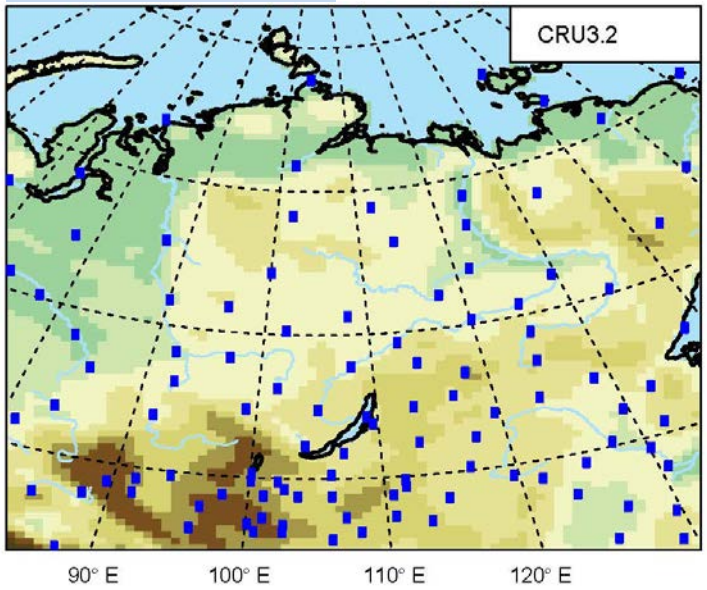
Observed annual trends in surface temperature (1901-2012)



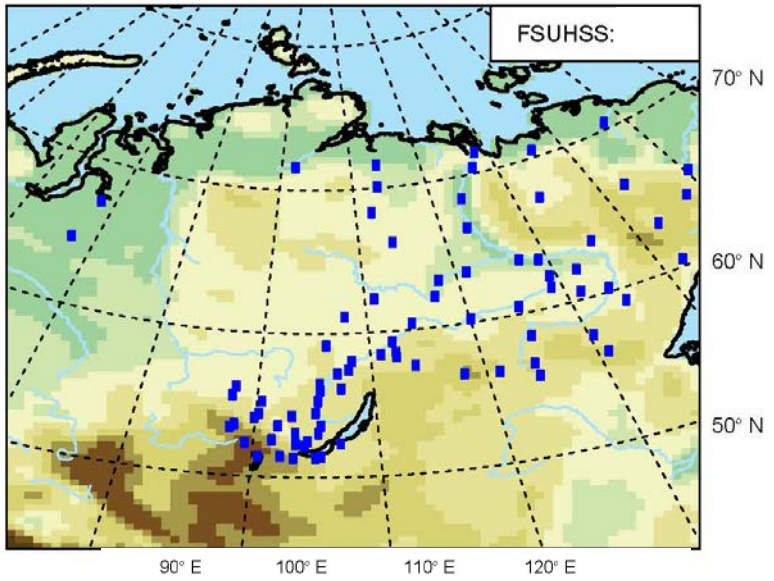
- Strong positive surface temperature trends over 1901-2012
- Hot spot of climate change
- Feedbacks e.g. to the global carbon and hydrological cycle
- Long-term information of climate parameters as basis for change analysis

Sparseness of in situ measurements

Air temperature



Snow water equivalent (SWE)



- Sparse station network - especially in the arctic regions
- Few stations incorporated in gridded observational products
- Unevenly distributed stations

Need for consistent climate information with less spatial and temporal gaps

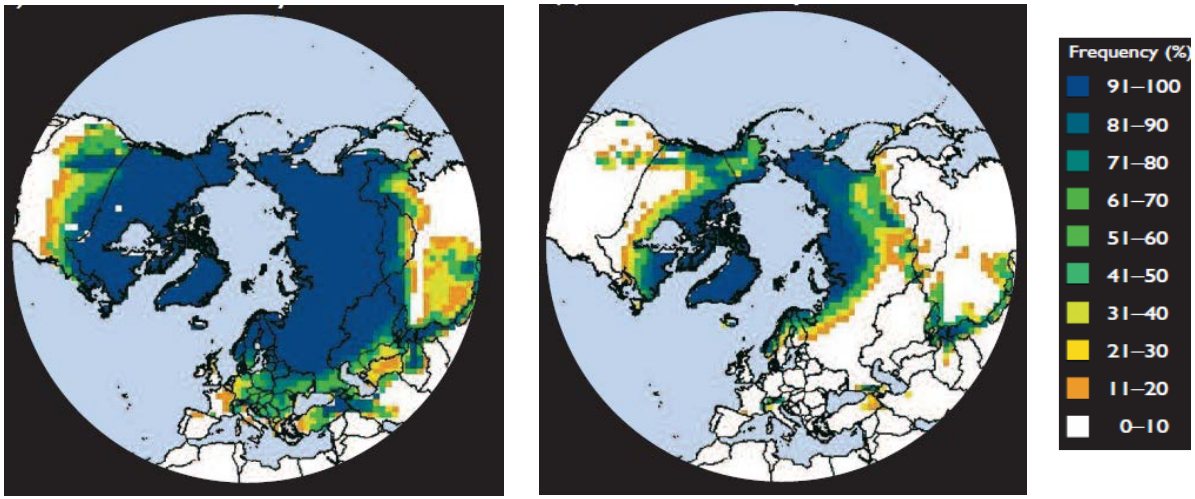
Climate reconstruction using the regional climate model COSMO-CLM (CCLM)

Focus: Snow cover

Snow cover frequency

February

May



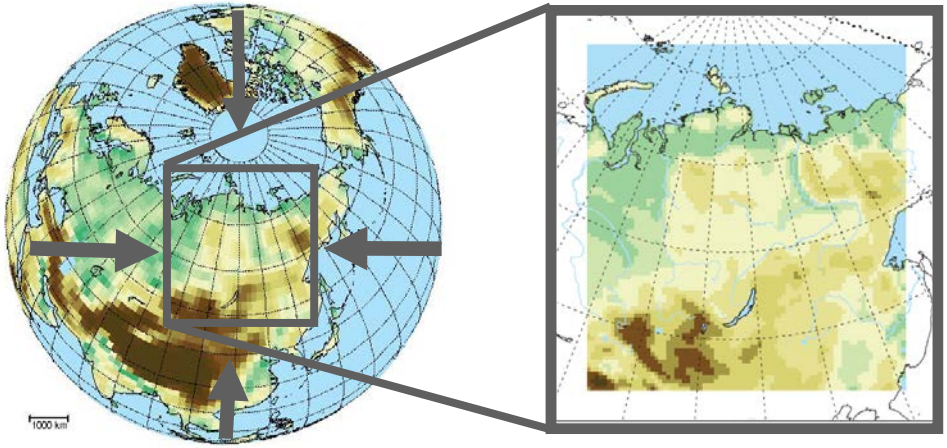
(ACIA, 2005)

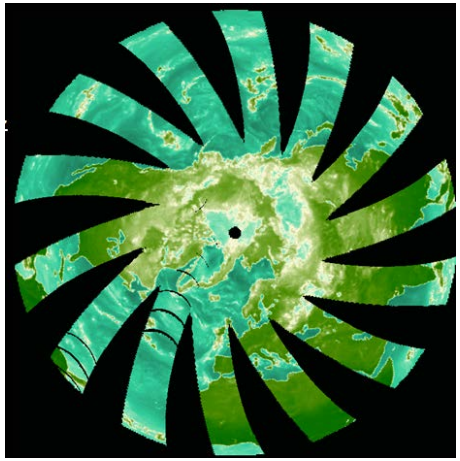
- As largest component of the terrestrial cryosphere
- Shapes the land surface of Siberia, prolonged cold season
- Important properties that effect climate

Multi-decadal climatology of snow parameters with regional detail

Investigate long-term regional changes of snow cover

Model Domain & Datsets

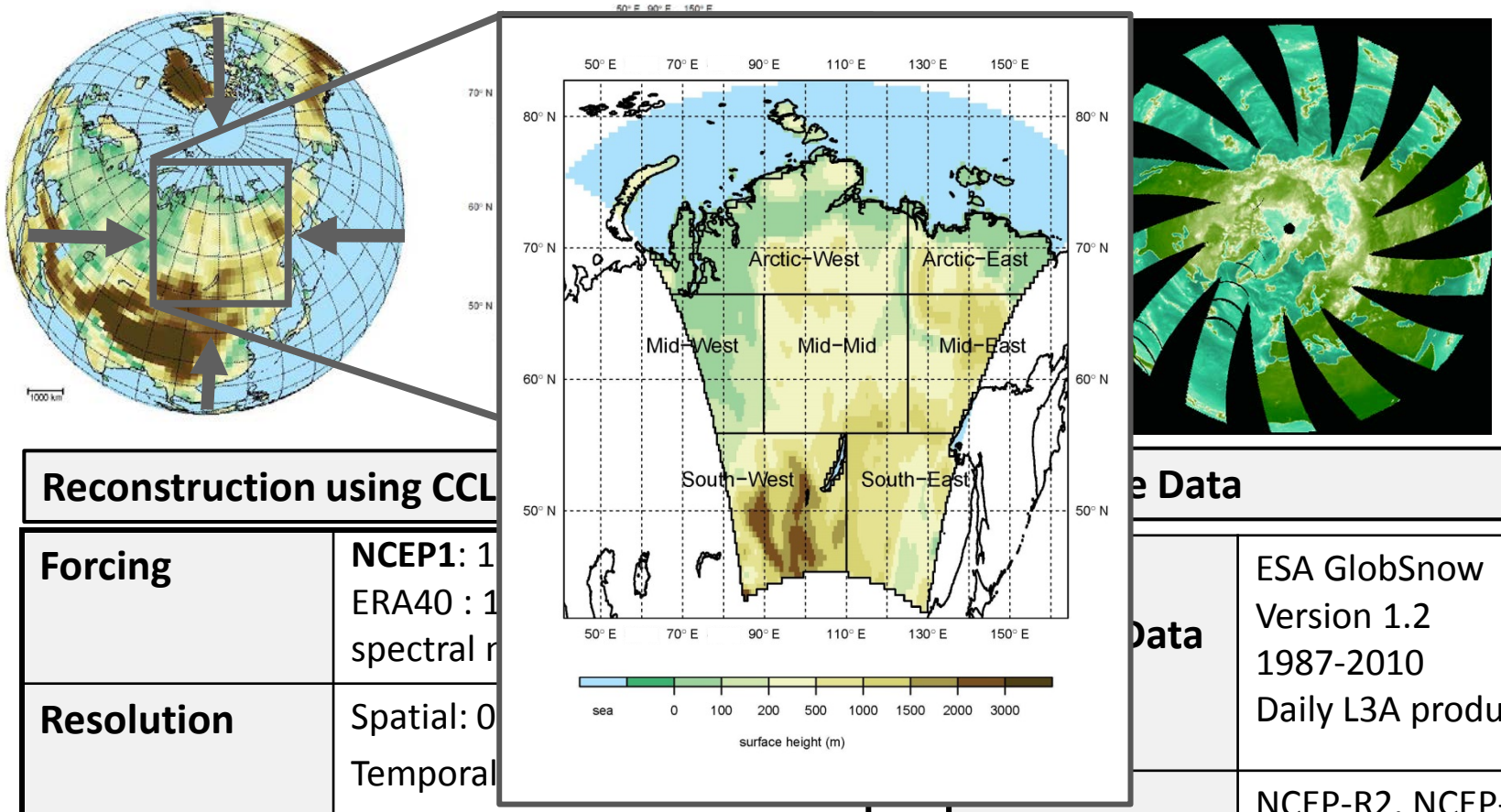




Reconstruction using COSMO-CLM (CCLM)	
Forcing	NCEP-R1: 1948-2010
Resolution	Spatial: 0.44° (~50 km) Vertical: 40 atmospheric layers 13 soil layers (92 m)
Physical Para-meterization	Multi-layer soil and vegetation model TERRA-ML Multi layer snow model
Grid	Rotated coordinate system Number of grid points: 86 x 76

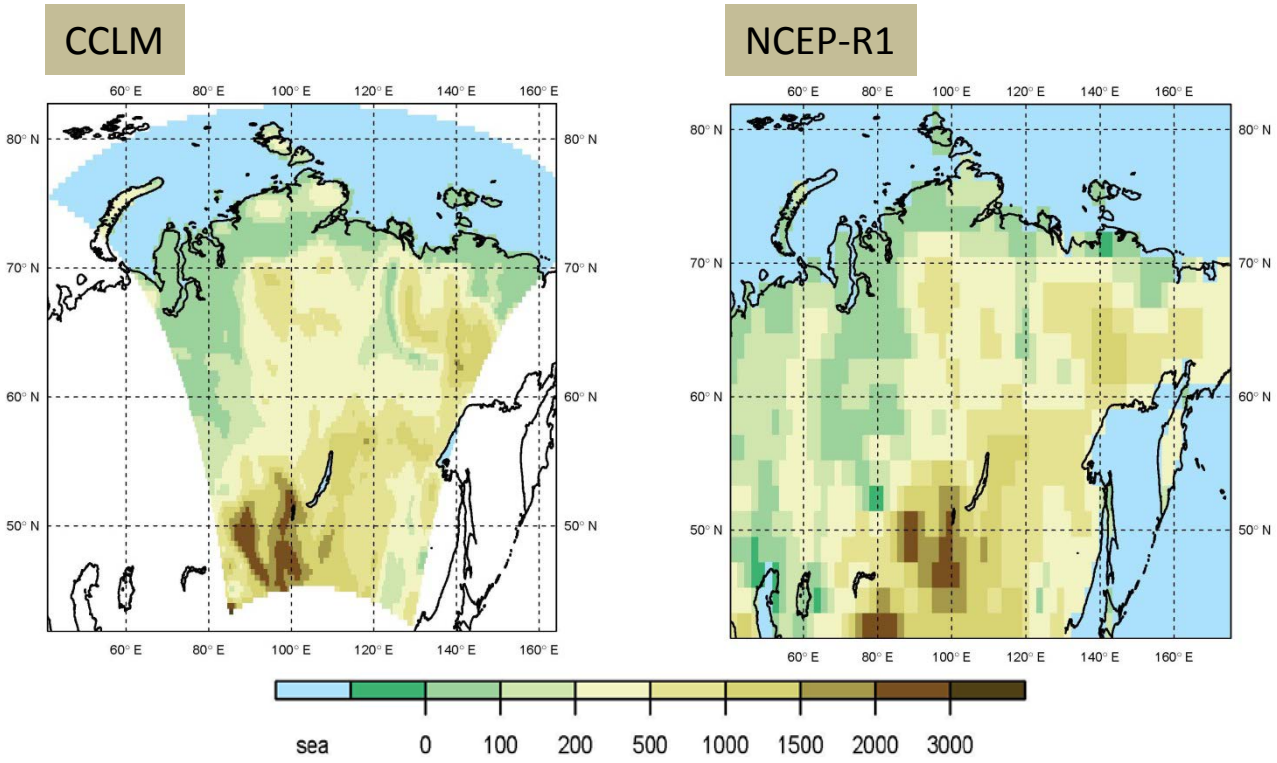
Reference Data	
Satellite-Derived Data	ESA GlobSnow - SWE Version 1.2 1987-2010 Daily L3A product
Reanalyses	NCEP-R2, NCEP-CFSR ERA-Interim

Model Domain & Datsets



Reconstruction using CCL		e Data	
Forcing	**NCEP1**: 1 ERA40 : 1 spectral r	**Data**	ESA GlobSnow Version 1.2 1987-2010 Daily L3A product
Resolution	Spatial: 0 Temporal Vertical: 40 atmospheric layers	**Reanalyses**	NCEP-R2, NCEP-CFSR ERA-Interim
Physical Para-meterization	Multi-layer soil and vegetation model TERRA-ML		
Grid	Rotated coordinate system Number of grid points: 86 x 76		

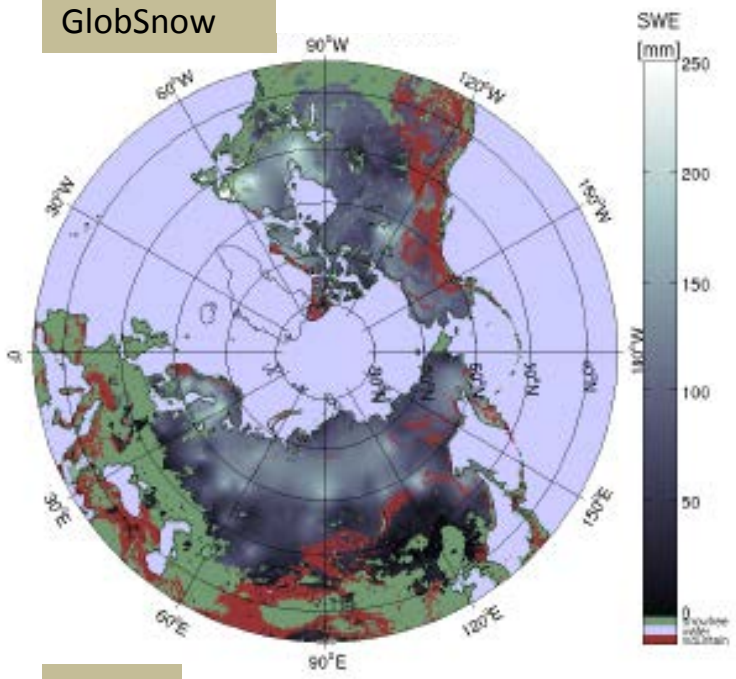
RCM versus Reanalysis – Added value?



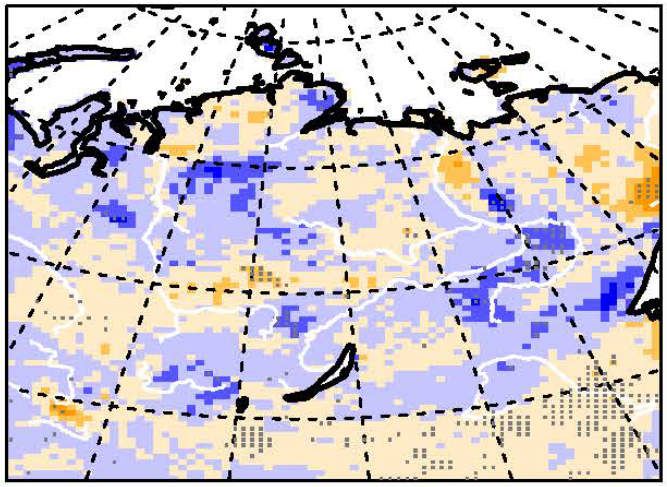
- Added value studies crucial within RCM validation
- RCM provides more detailed representation of surface boundary
- Large-scale features well resolved by global data
- Does the RCM provide more regional detail?

GlobSnow SWE as reference data

GlobSnow



CCLM



Advantage:

- Spatial coverage
- NetCDF data
- Error estimate
- Passive microwave data
- No stand-alone algorithm

Data intercomparison:

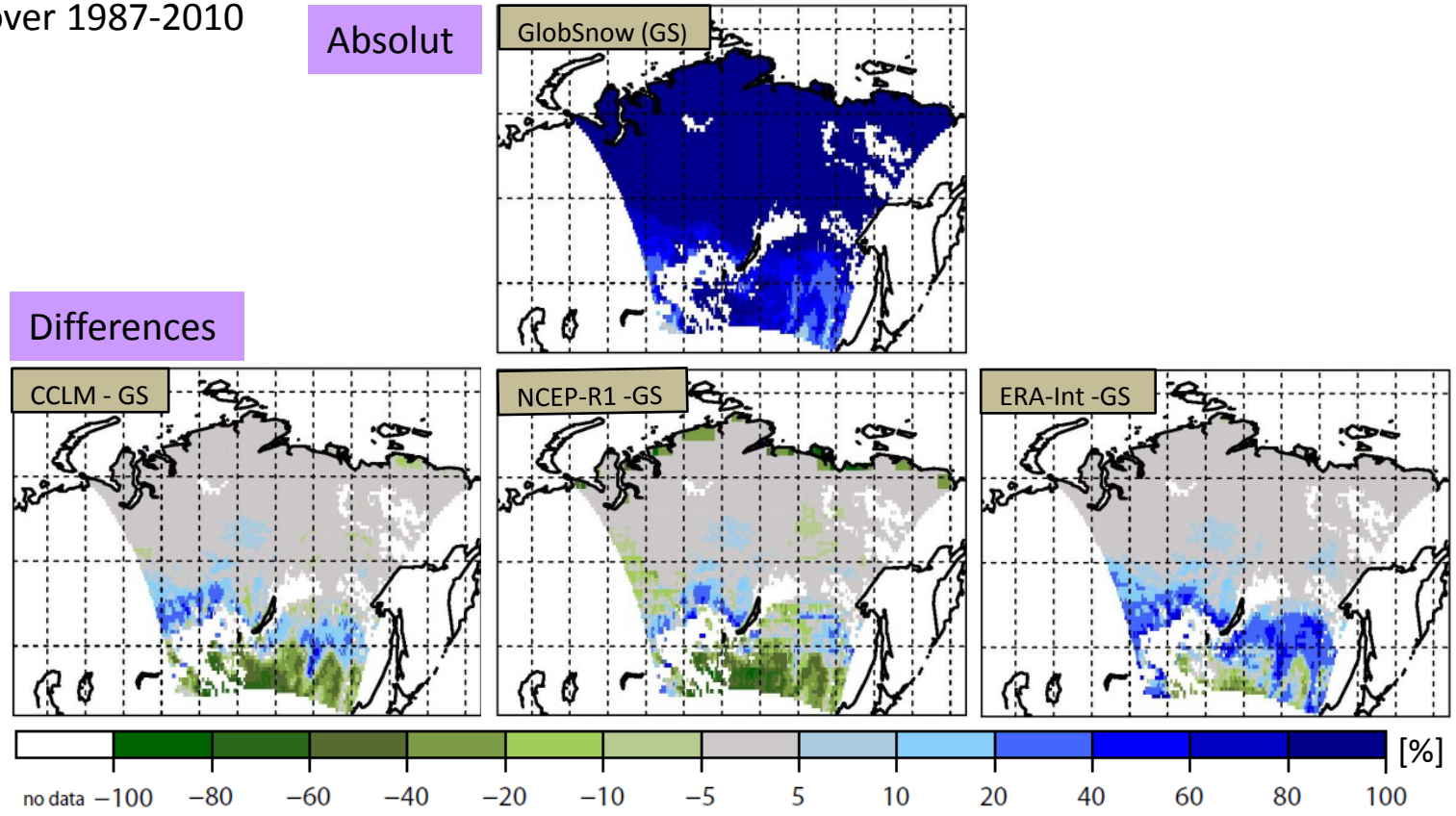
- Remapping on lon/lat grid
  (-> meta data needed)
- Selection of appropriate product
  -> use of daily data (no aggregation applied)
- Extract snow extent information from SWE

Snow cover frequency

April over 1987-2010

Absolut

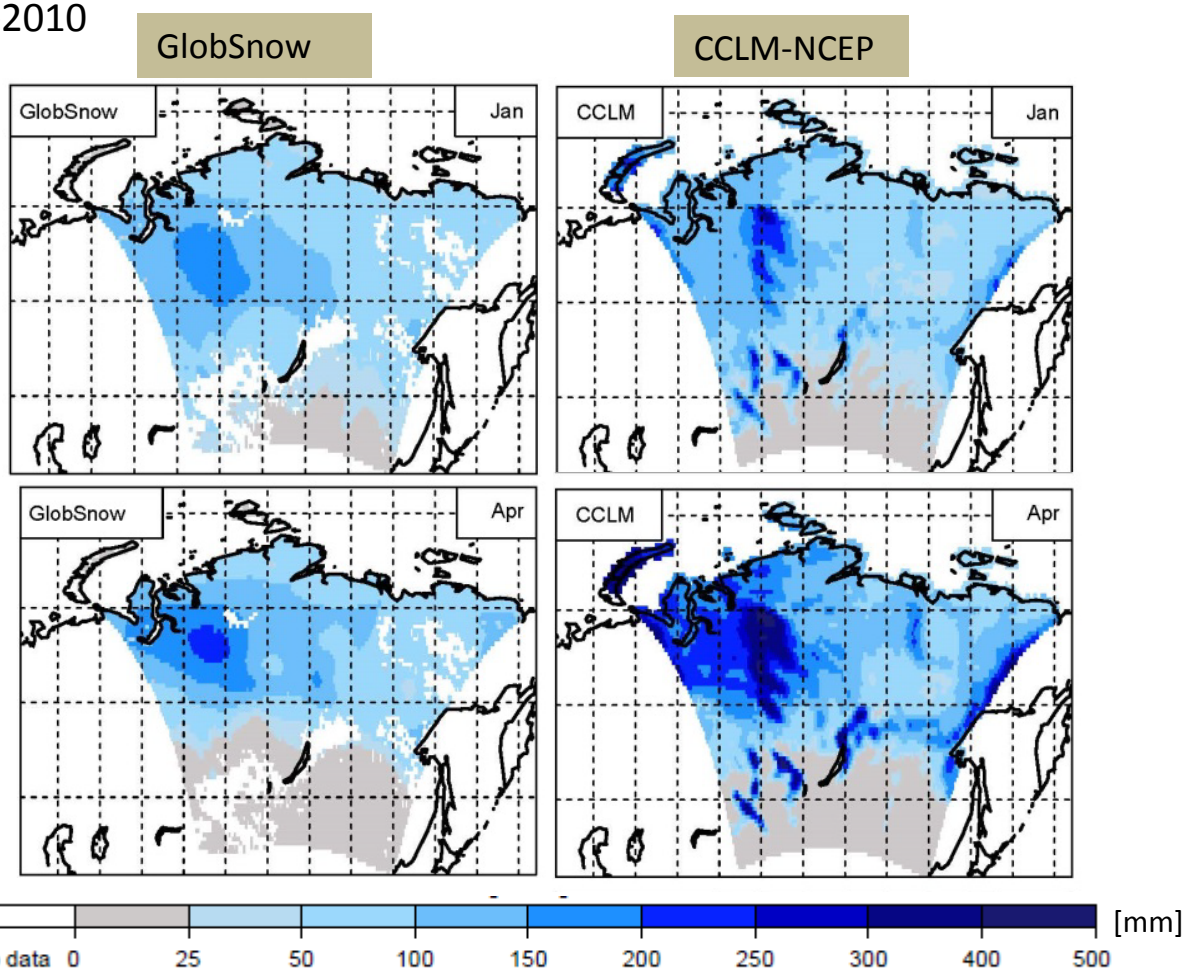
Differences



- Snow extent – important for surface albedo
- > half of region with 80-100 % in GlobSnow
- CCLM and NCEP-R1 have similar patterns – no added value

Spatial distribution of SWE

Monthly mean, 1987-2010



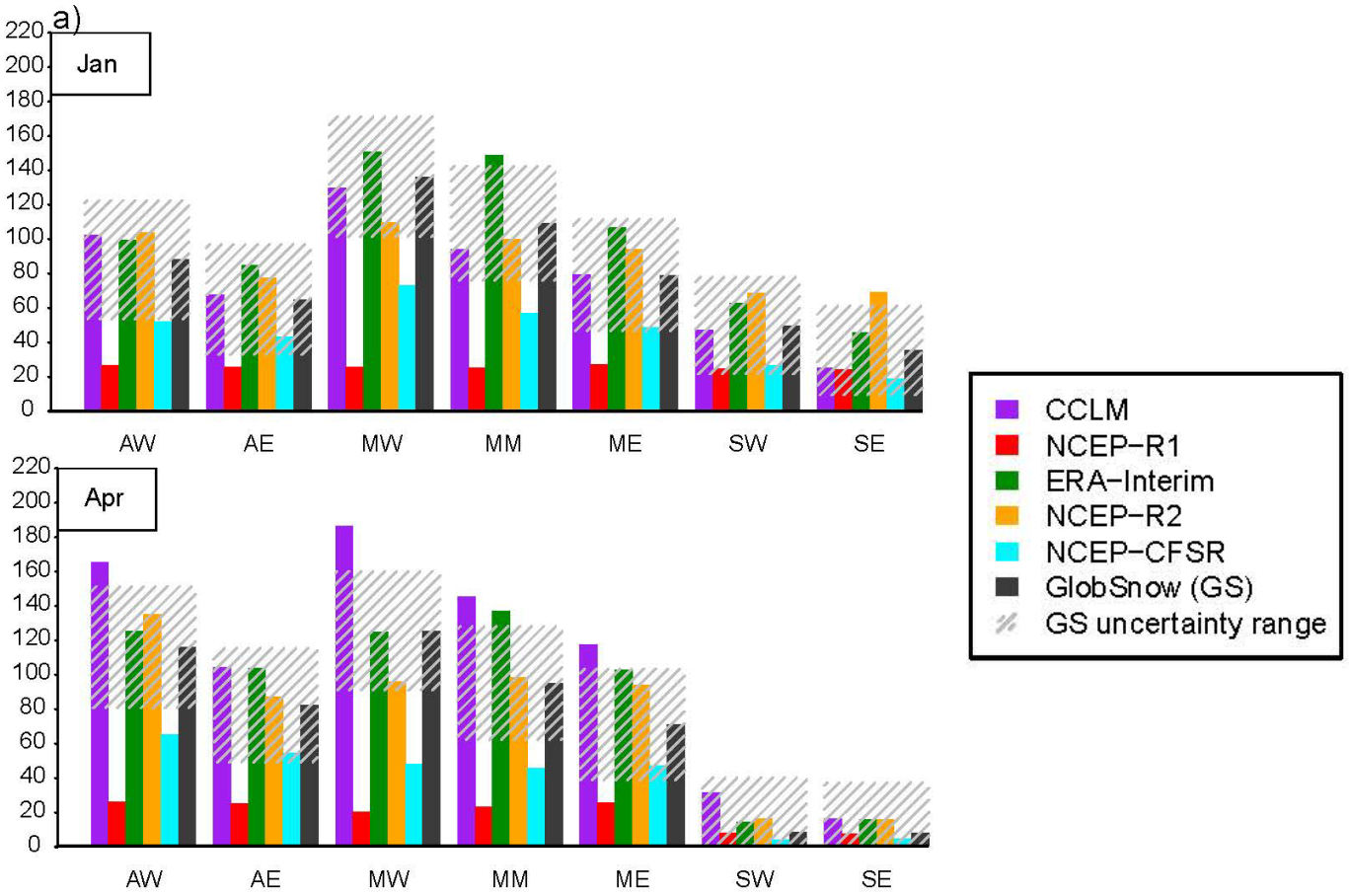
- Smooth patterns in GlobSnow despite 25km resolution
- More spatial detail in CCLM than GlobSnow
- Same location of peaks in CCLM and GlobSnow

Regional variations of SWE

Regional monthly mean [mm], 1987-2010

January

April



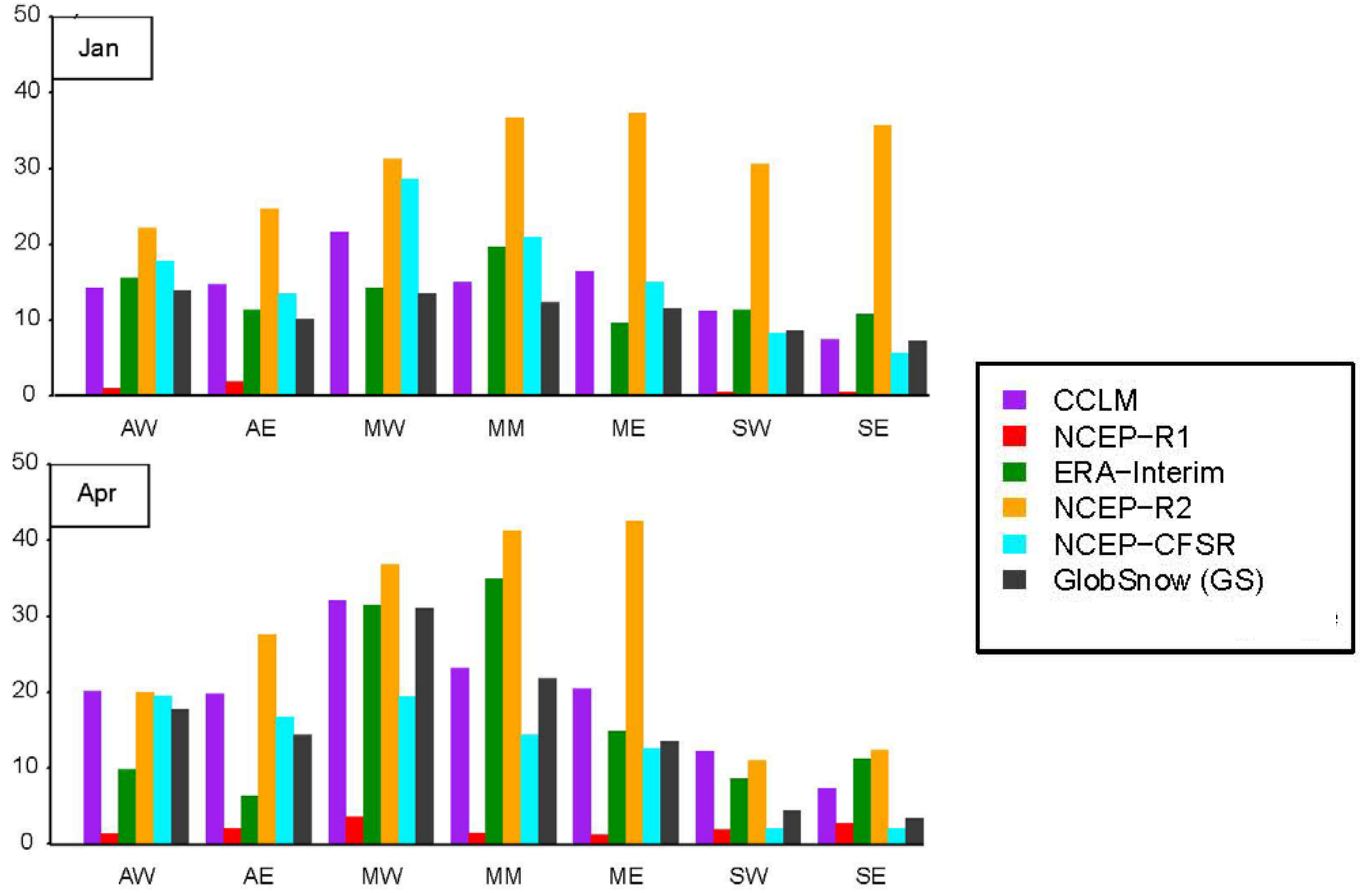
- No regional variation in NCEP-R1 -> CCLM add value
- January: CCLM in good agreement to GlobSnow
- April: CCLM overestimates SWE

Interannual variations of SWE

Regional monthly standarddeviation [mm], 1987-2010

January

April



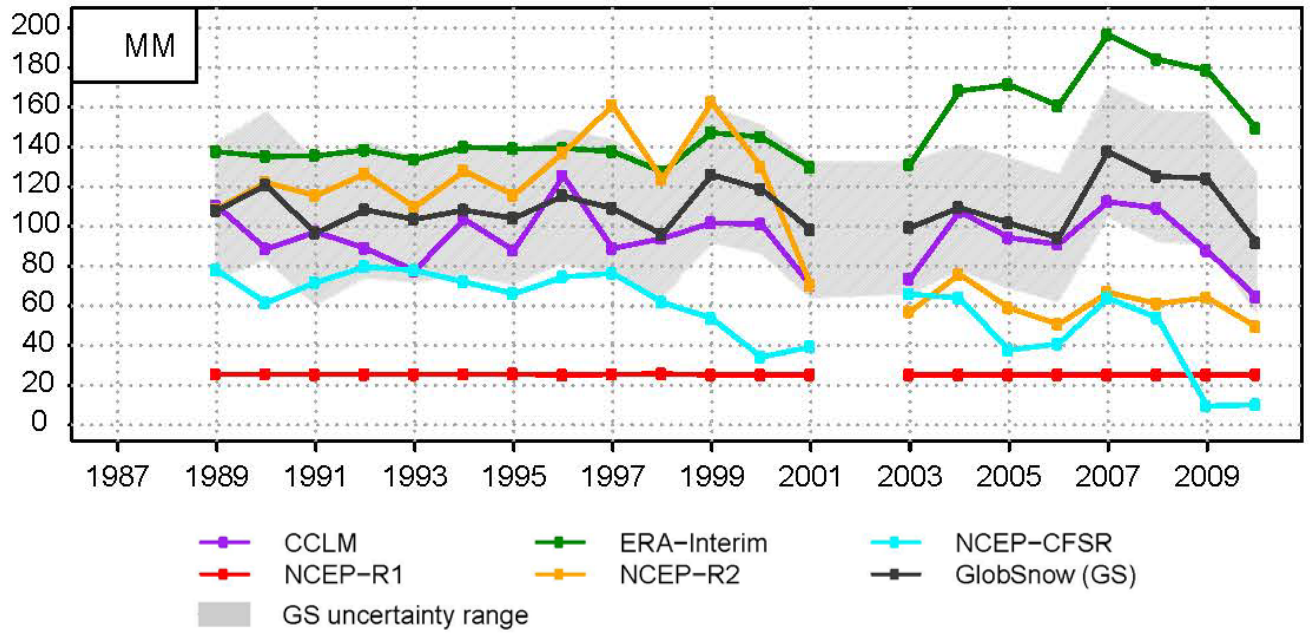
- Strong variability of January mean SWE for NCEP-R2, NCEP-CFSR
- Stronger variability in April than in January except for NCEP-R2
- Low variability in NCEP-R1

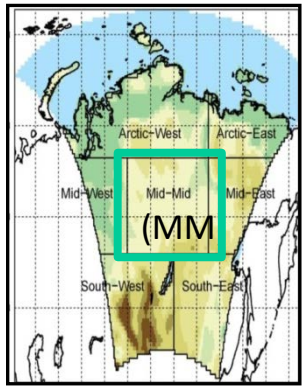
Interannual variations of SWE

Monthly means [mm], 1987 - 2010

Mid-Mid

January

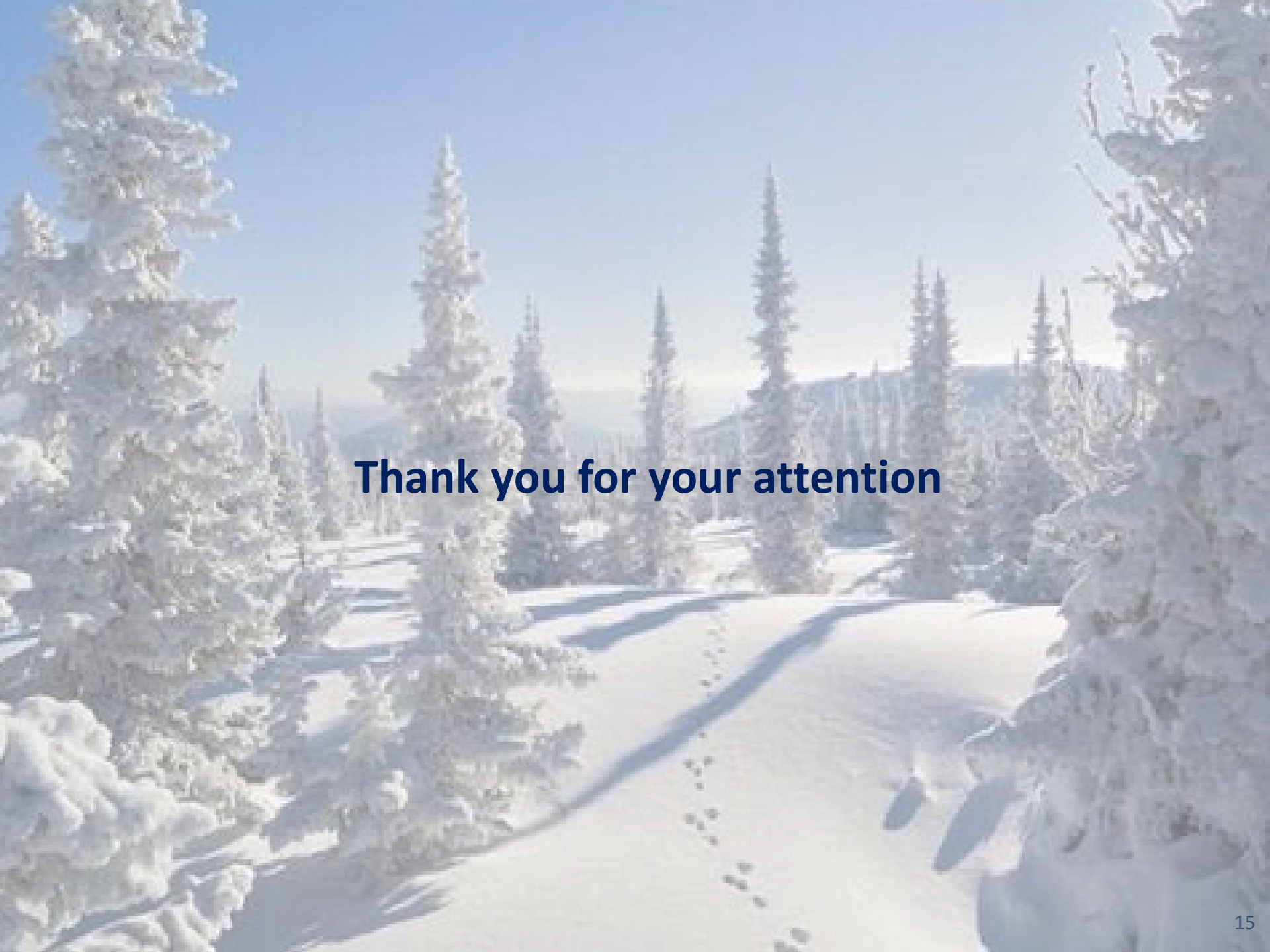




- CCLM: good agreement to ESA GlobSnow
- Temporal inconsistencies in ERA-Interim, NCEP-R2
- CCLM add more realistic information to NCEP-R1
- Strong differences between reanalyses
- Temporal consistency of CCLM is higher than in ERA-Interim, NCEP-R2

Conclusion

- Regional reconstruction of recent past climate for Siberia:
  - -> Siberian setup for regional climate model CCLM
  - -> Alternative climatology of climate parameters at regional scale
- Large-scale added-value assessment using ESA GlobSnow:
  - -> CCLM can add value in terms of SWE
  - -> in good agreement with GlobSnow in January
  - -> CCLM overestimates SWE in April
- Restrictions when using GlobSnow:
  - -> coarse patterns of GlobSnow
  - -> Missing data in mountainous regions
  - -> Wet snow, forest regions
  - -> Missing days in transition seasons
- Need:
  - -> continuity in data availability
  - -> improved performance (-> coarse patterns, consistency, metadata …)
  - -> improved documentation


Thank you for your attention