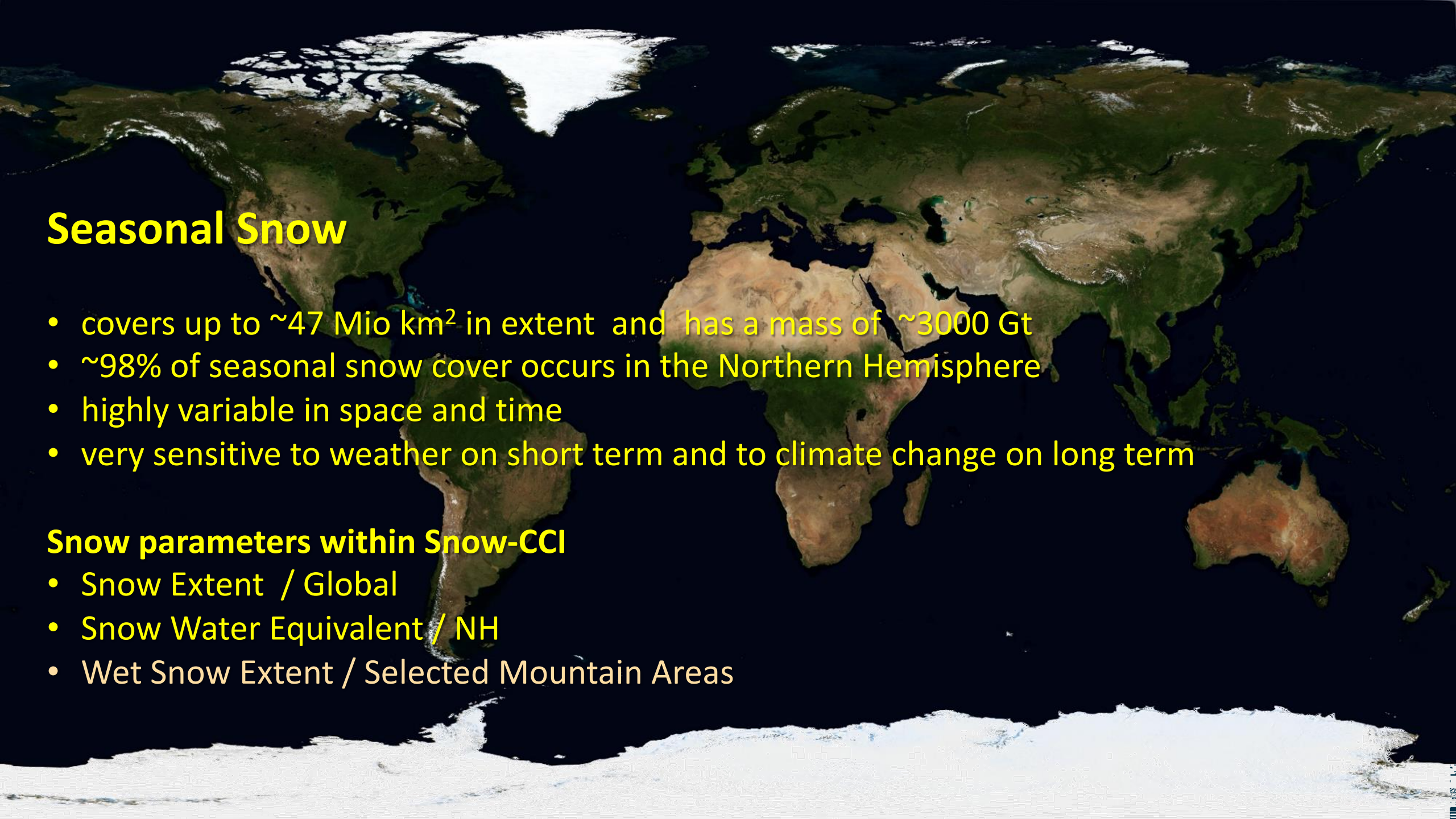
Snow-CCI

Thomas Nagler & Snow-CCI Team

6 October 2021

ESA CCI Collocation Meeting



Seasonal Snow

- covers up to ~47 Mio km^2 in extent and has a mass of ~3000 Gt
- ~98% of seasonal snow cover occurs in the Northern Hemisphere
- highly variable in space and time
- very sensitive to weather on short term and to climate change on long term

Snow parameters within Snow-CCI

- Snow Extent / Global
- Snow Water Equivalent / NH
- Wet Snow Extent / Selected Mountain Areas

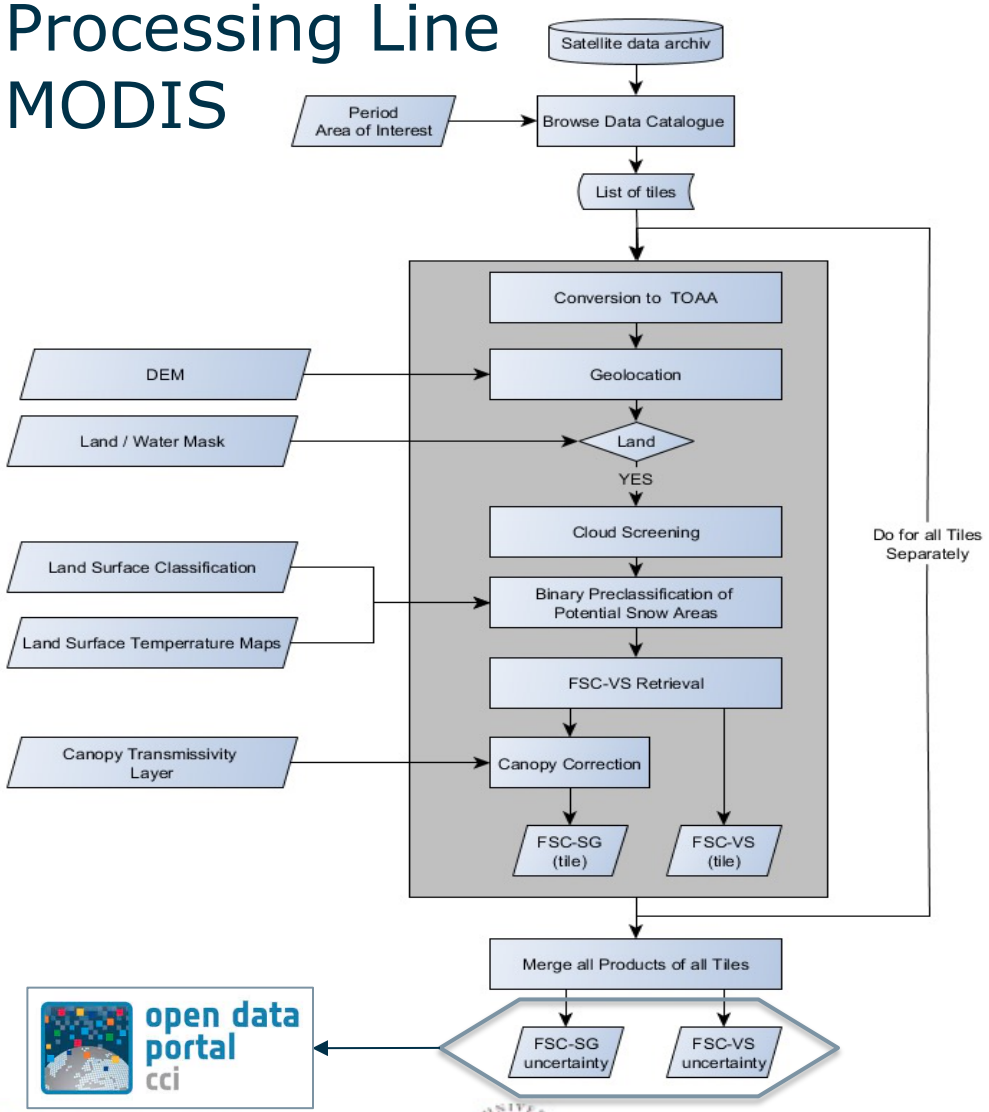
	Snow Cover Area	Snow Water Equivalent
Parameter	Fractional snow extent [%]	Snow mass
Description	Viewable Snow + Snow on Ground attached Uncertainty Maps	Snow water equivalent attached Uncertainty Maps
Spatial Coverage	Global (without Antarctica, Greenland icesheet, land ice, open water)	NH, non-mountain areas (without Antarctica, Greenland, land ice, open water)
EO Data	Medium Resolution Optical satellite data	Passive microwave brightness temperatures
Spatial Resolution	Ca. 5 km (0.05 deg) Ca. 1 km (0.01 deg)	V1.0: Ca. 25 km (0.25 deg) V2.0: Ca. 12.5 km (0.10 deg)
Period	1982 – onwards (5 km) 2000 – onwards (1 km)	1979 - onwards
Frequency	Daily	Daily
Map Projection	Geographic Grid (Lat/Lon)	Geographic Grid (Lat/Lon)
Format	netCDF	netCDF
Uncertainty Metric	Unbiased RMSE	Stdev

Snow CCI Processing Systems

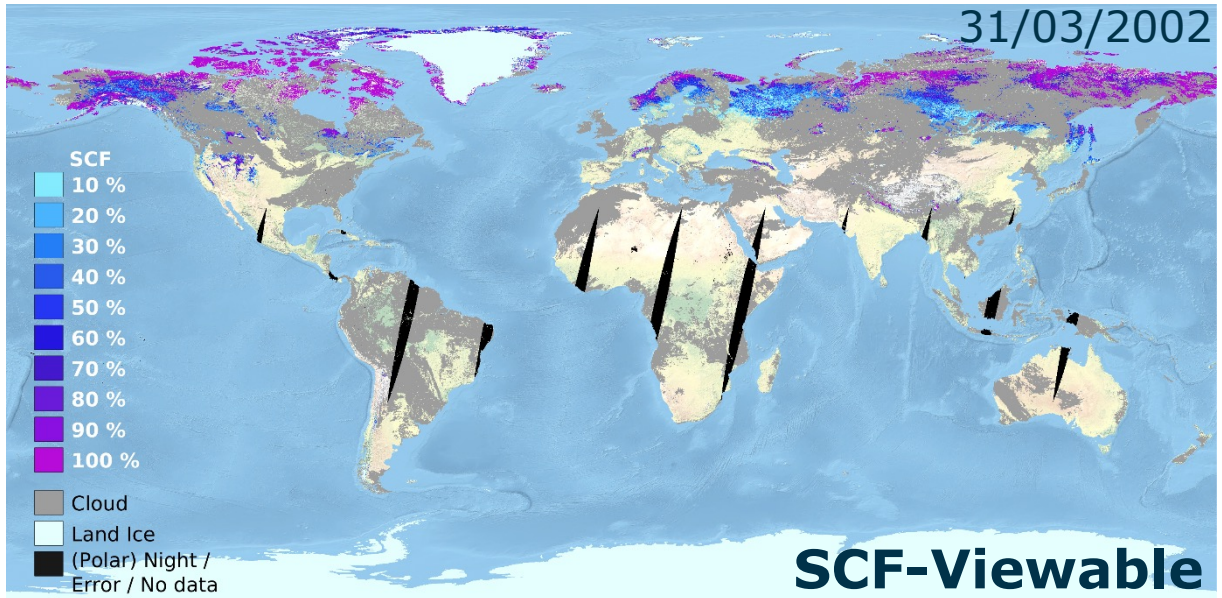
Processing systems for SCF and SWE developed and implemented at HP and cloud computing systems

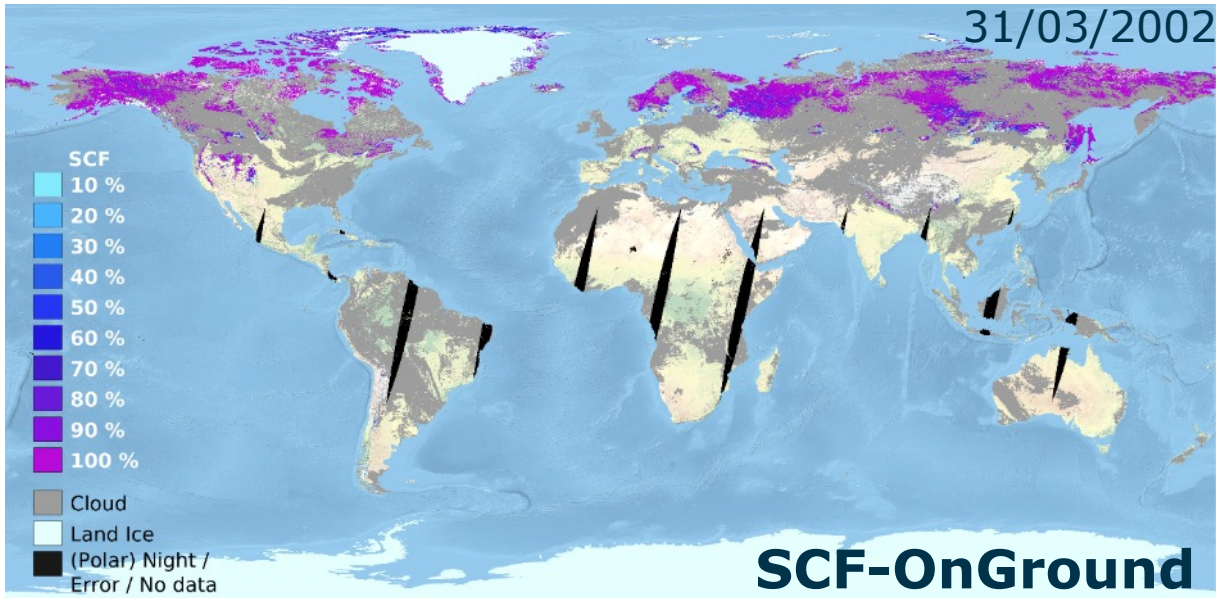
- SCF Multisensors system for MODIS, SLSTR
- SCF AATSR/ATSR-2 Processing system
- SCF AVHRR processing system
- SWE PMW and insitu data assimilation system
- Wet Snow from SAR (ERS, ENVISAT, S1; in development)

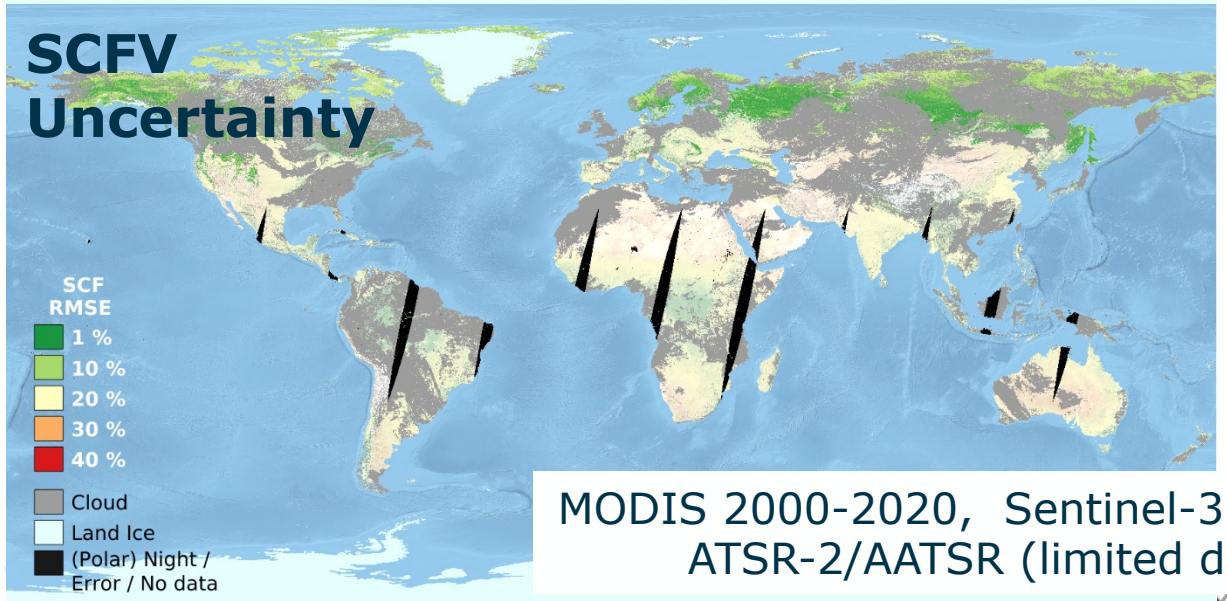
Processing Line MODIS

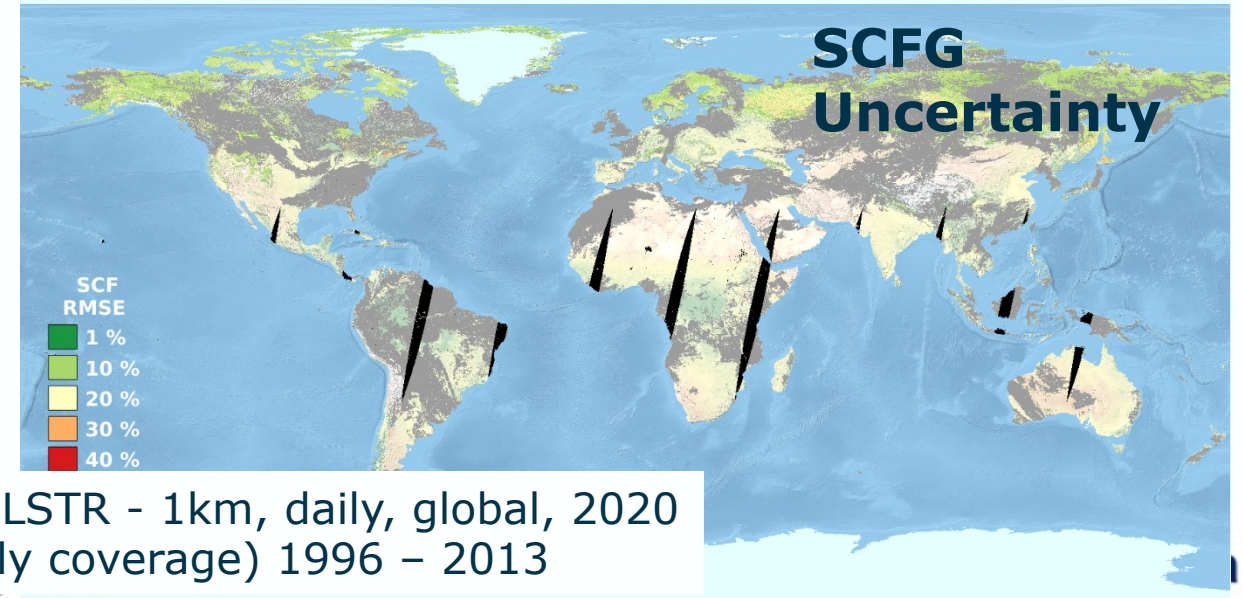


Snow Extent Product V2 – 1 km, global, daily



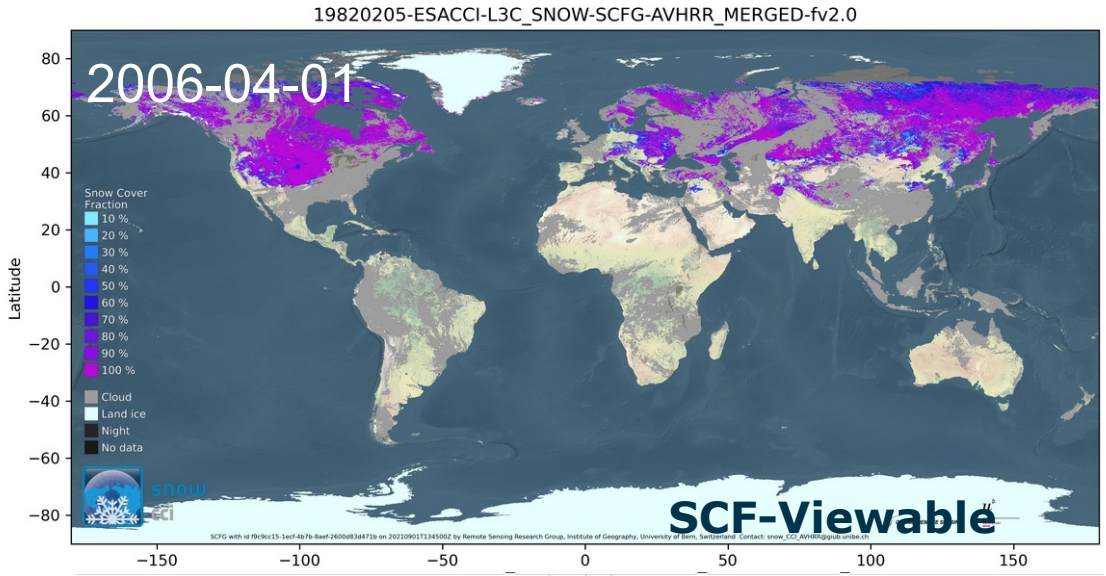


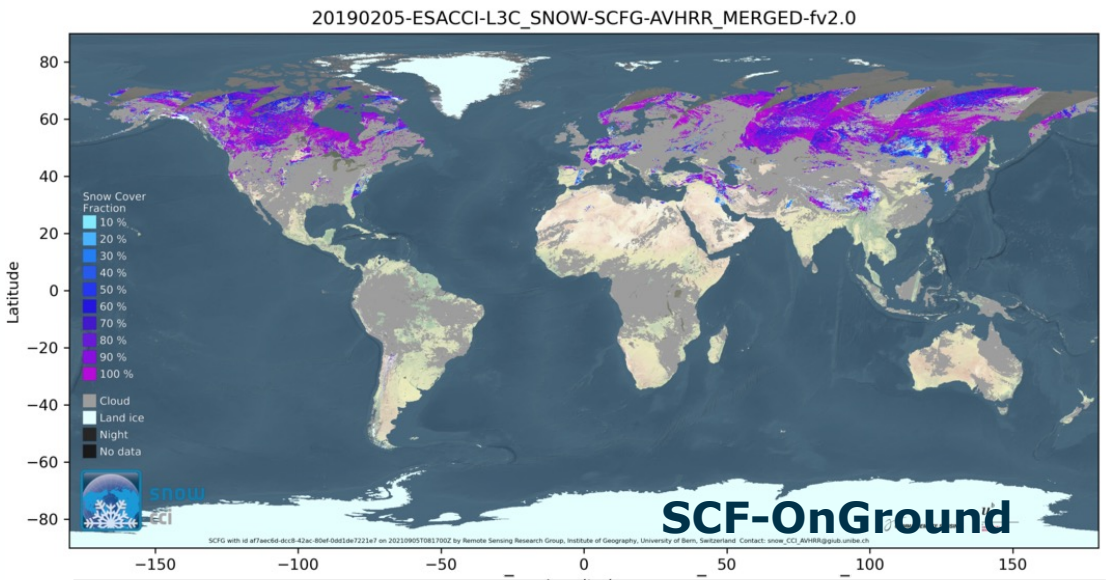


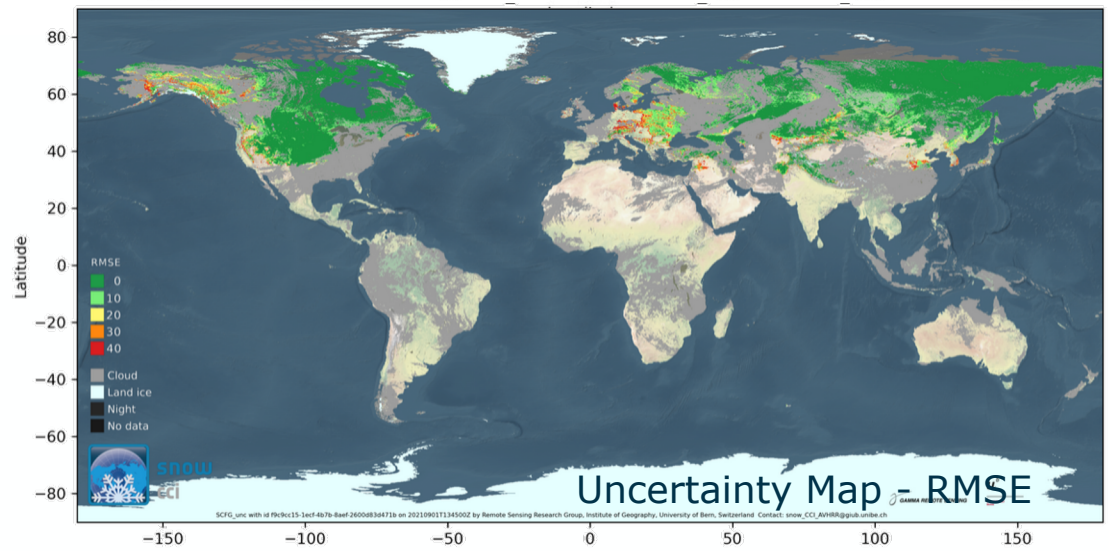


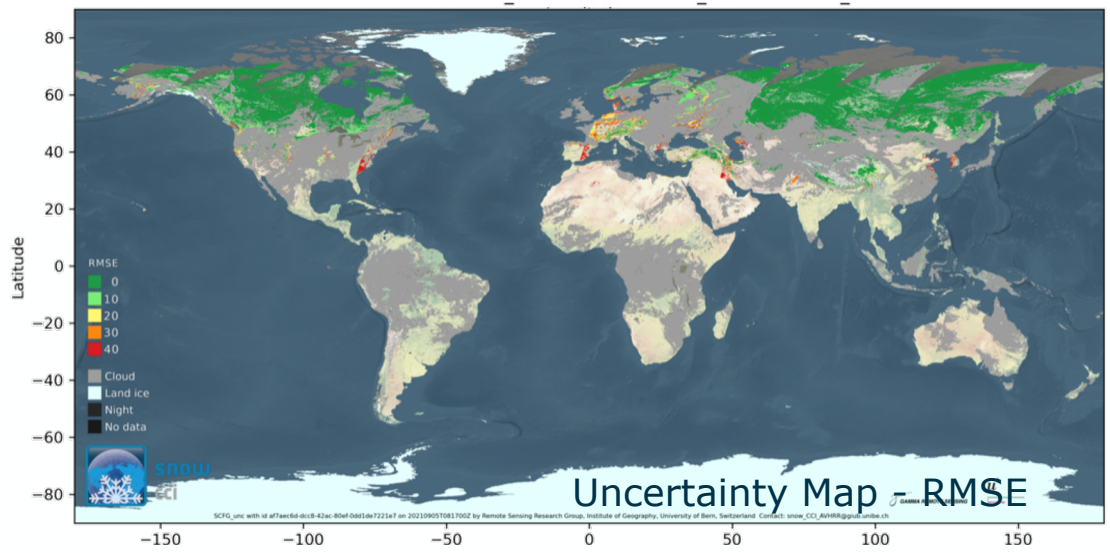
MODIS 2000-2020, Sentinel-3 SLSTR - 1km, daily, global, 2020
ATSR-2/AATSR (limited daily coverage) 1996 – 2013

AVHRR Snow Extent CDR V2 – 5 km, global, daily

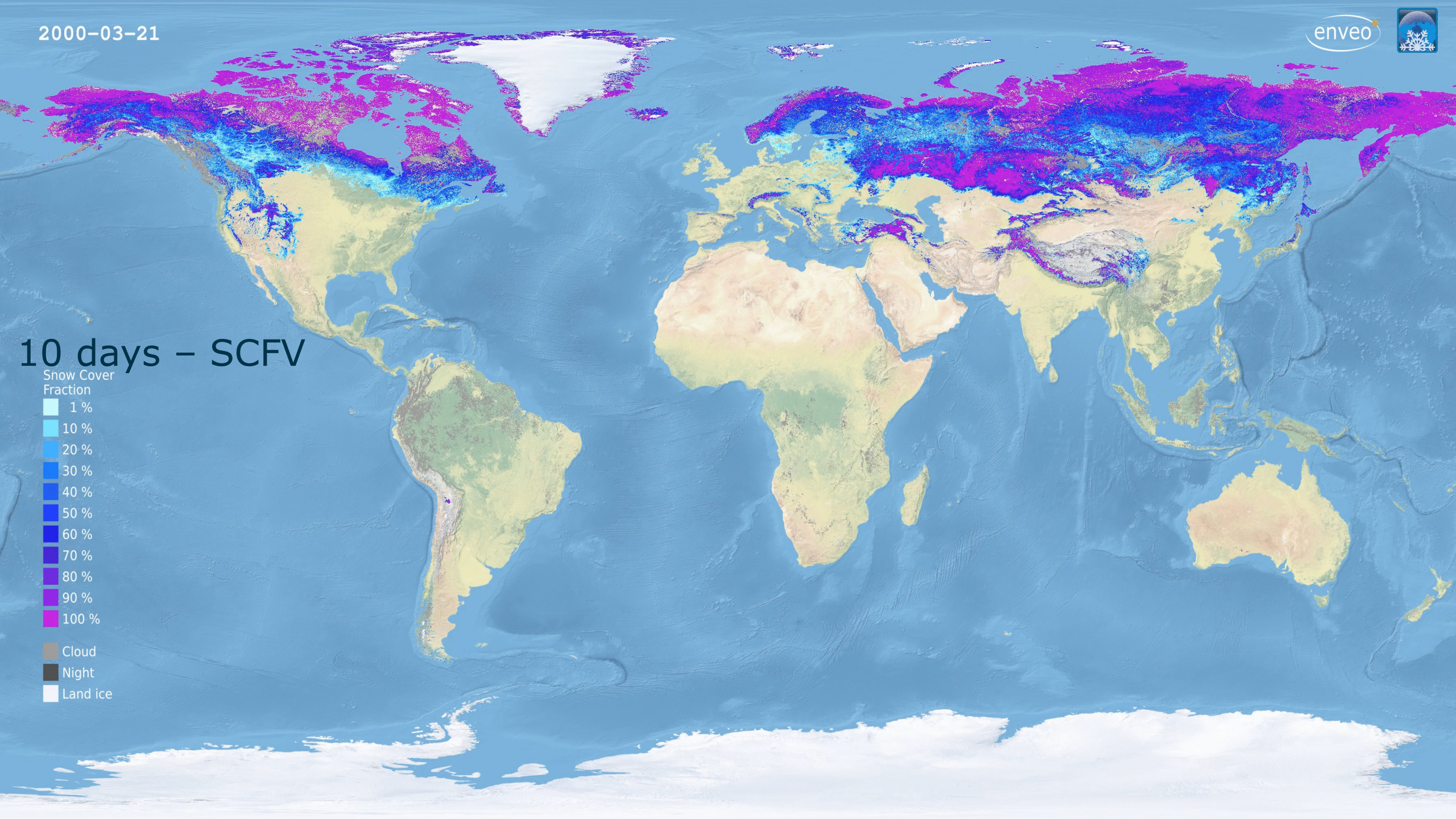








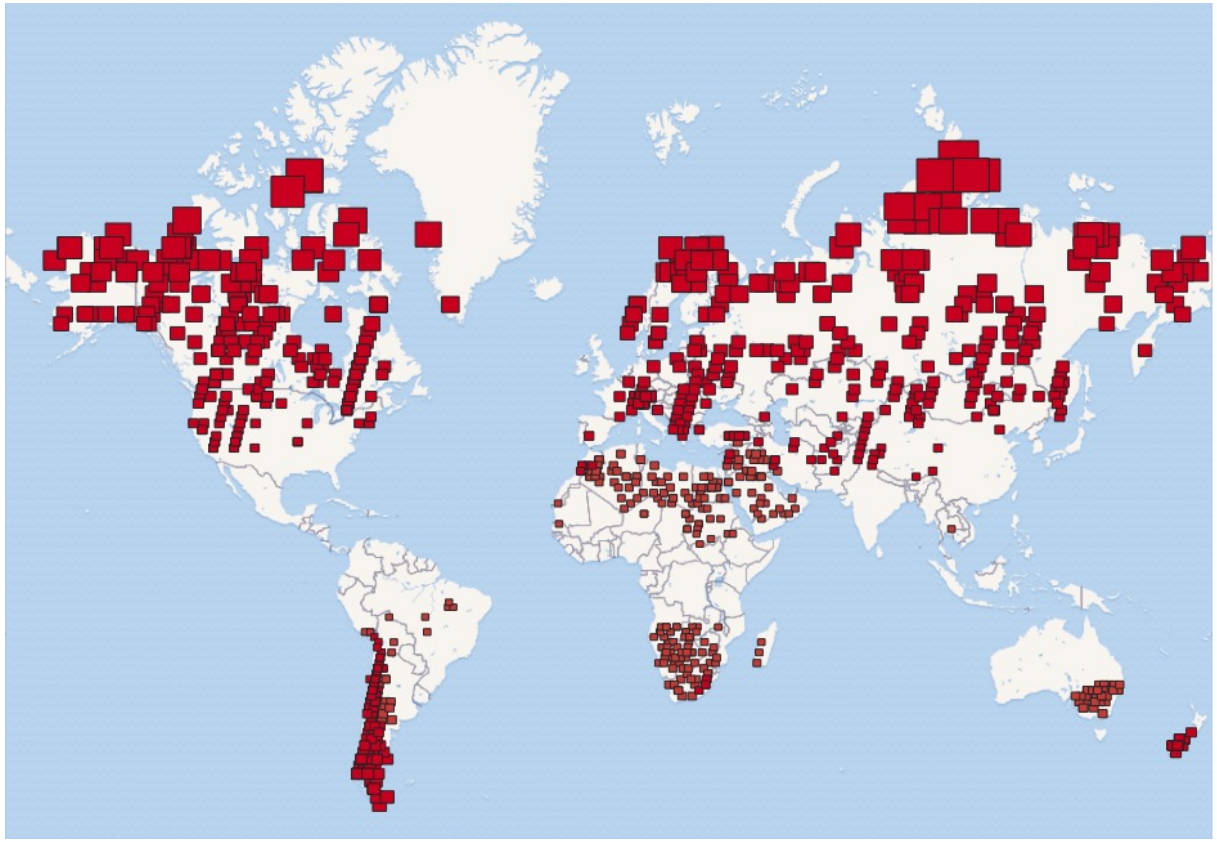
Satellites: NOAA-7/9/11/14/16/18/19, AVHRR/2, AVHRR/3, 01/01/1982 – 31/12/2020


2000-03-21
enveo
10 days – SCFV
Snow Cover Fraction
1 %
10 %
20 %
30 %
40 %
50 %
60 %
70 %
80 %
90 %
100 %
Cloud
Night
Land ice

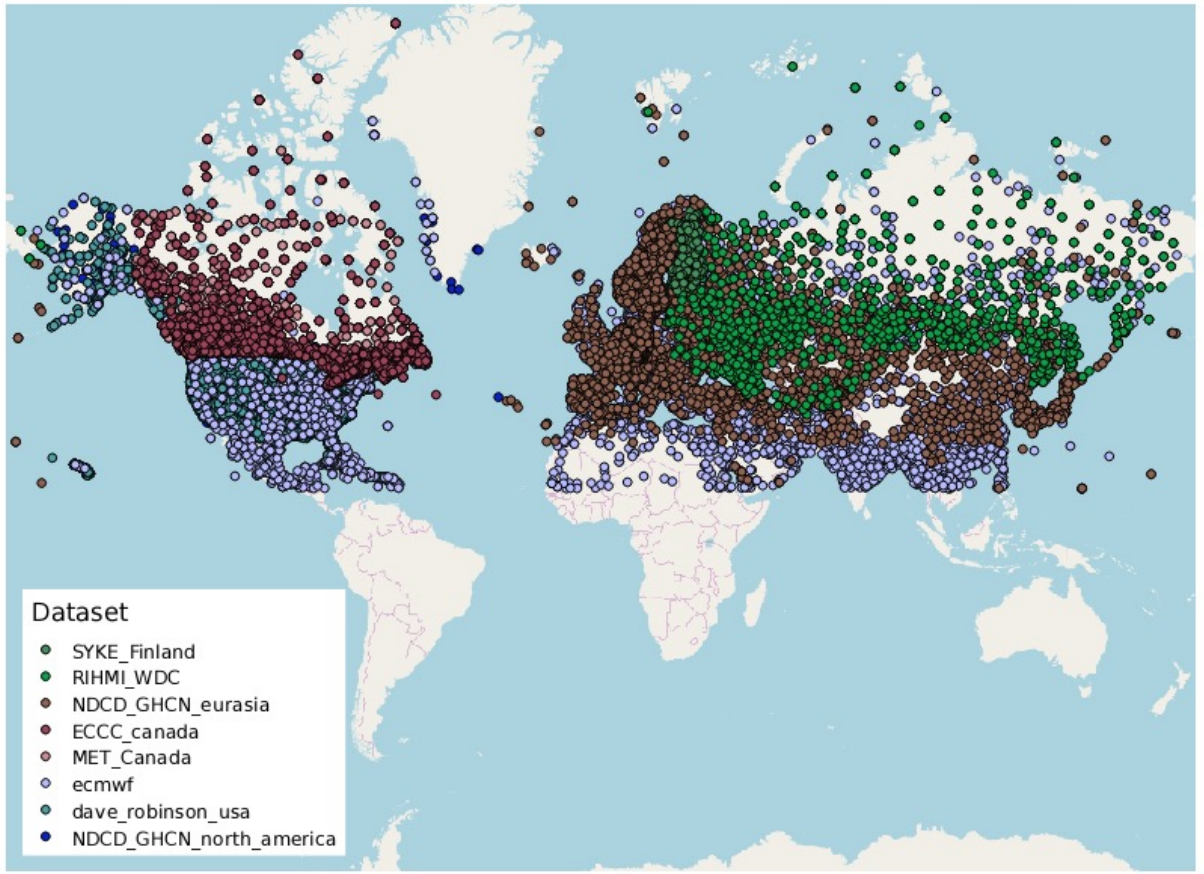
Accuracy Assessment of Snow Extent Products

applys SnowPEx validation protocols

Reference snow maps from Landsat and Sentinel-2 data



In-situ snow measurements



Typical unbiased RMSE in open land < 15% (compared to reference snow maps from Landsat & S2)
Validation with in-situ snow depth measurements in open land: F-Score > 0.80

Snow CCI Snow Water Equivalent Product

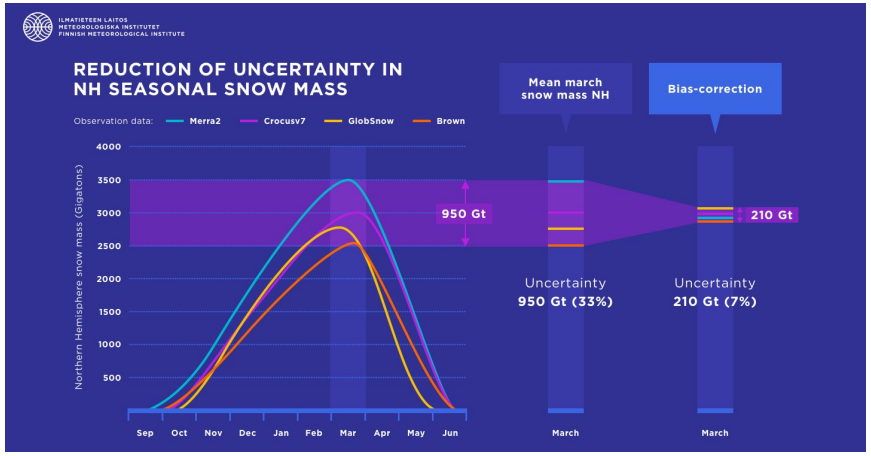
Snow CCI v2 Snow water equivalent (SWE) CDR

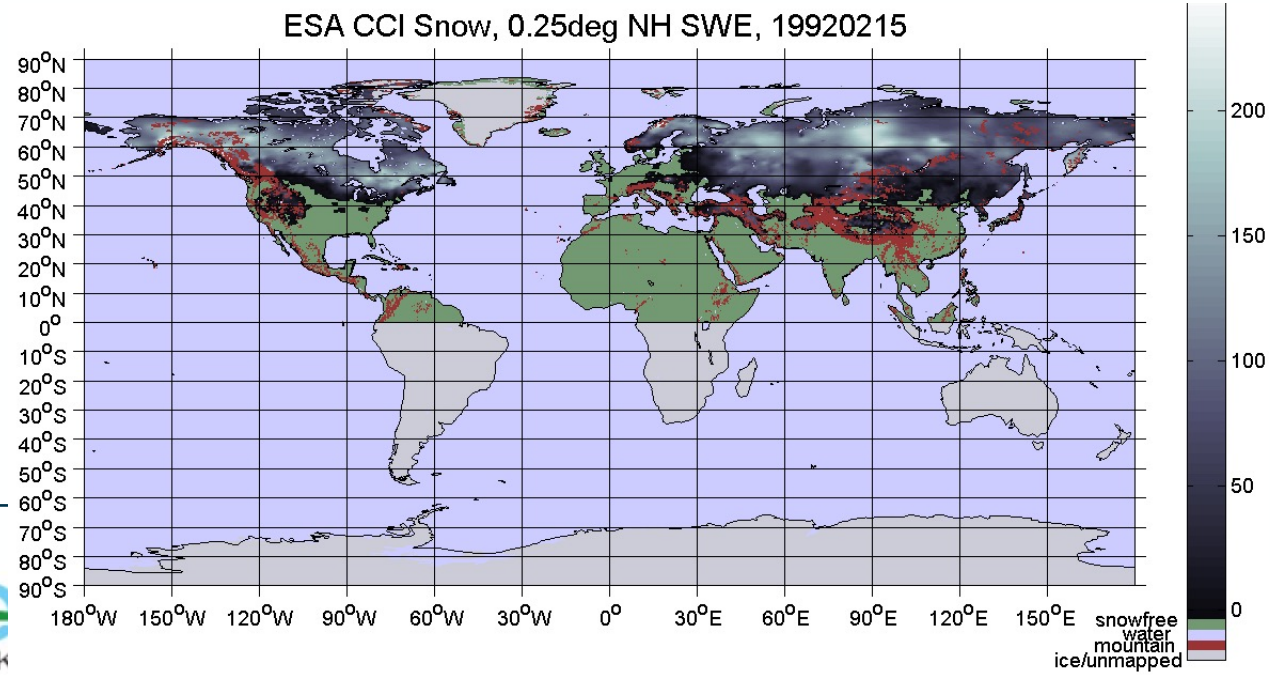
- January 1979 - May 2020
- Northern Hemisphere 0.10° (lat/lon)
- Daily & monthly (+ bias corrected) data
- Excluding mountains & ice sheets

SWE retrieval updates v1.0 -> v2.0

- Improved spatial resolution -> 0.10° lat/lon
- Applies Dynamic Snow Density
- Homogenized & augmented input insitu datasets
- Synergistic optical / PMW SWE product
- Ensemble of SWE products

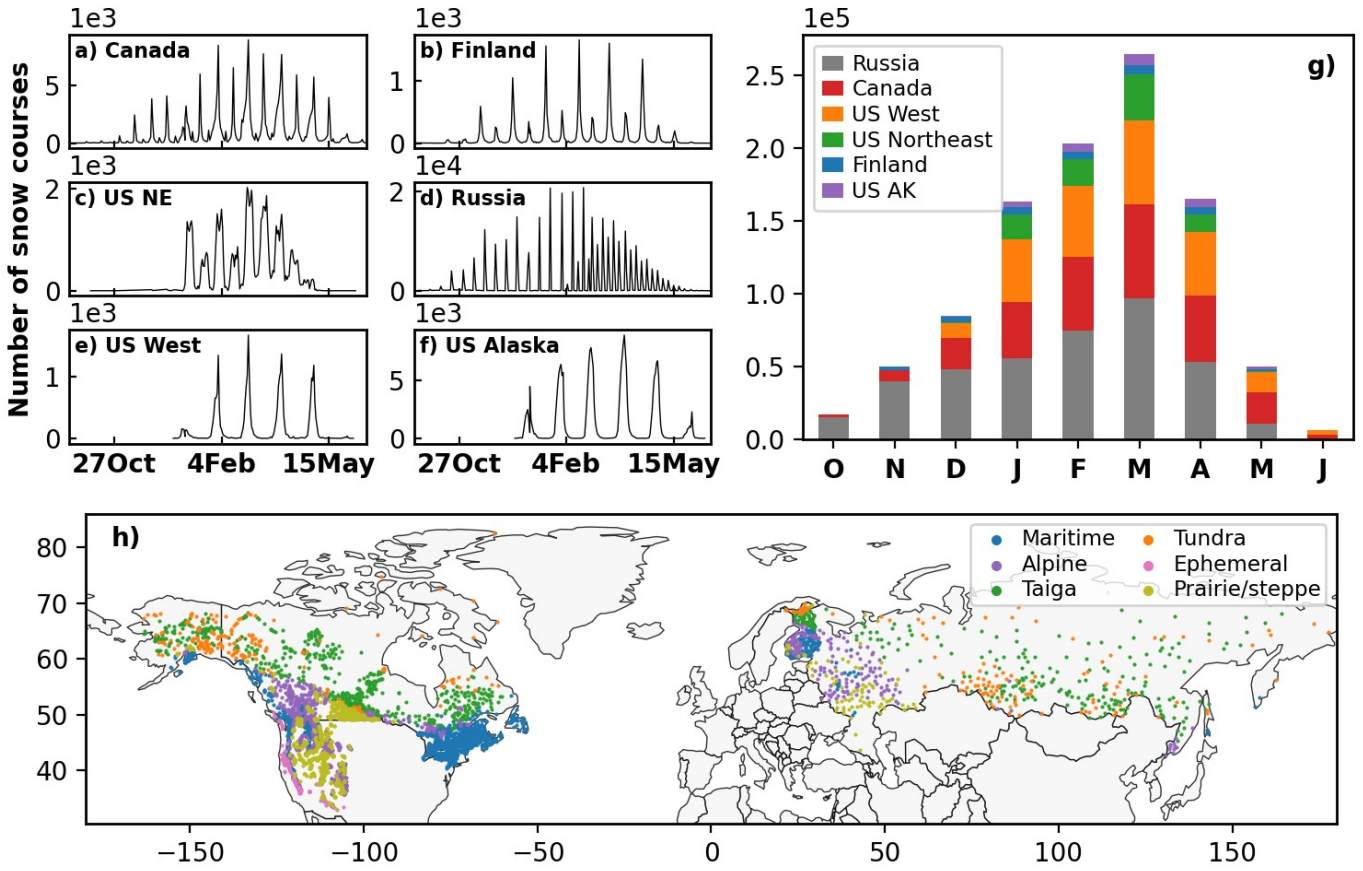
Improved reconstruction of the satellite-era snow mass: **Pulliainen et al. 2020**



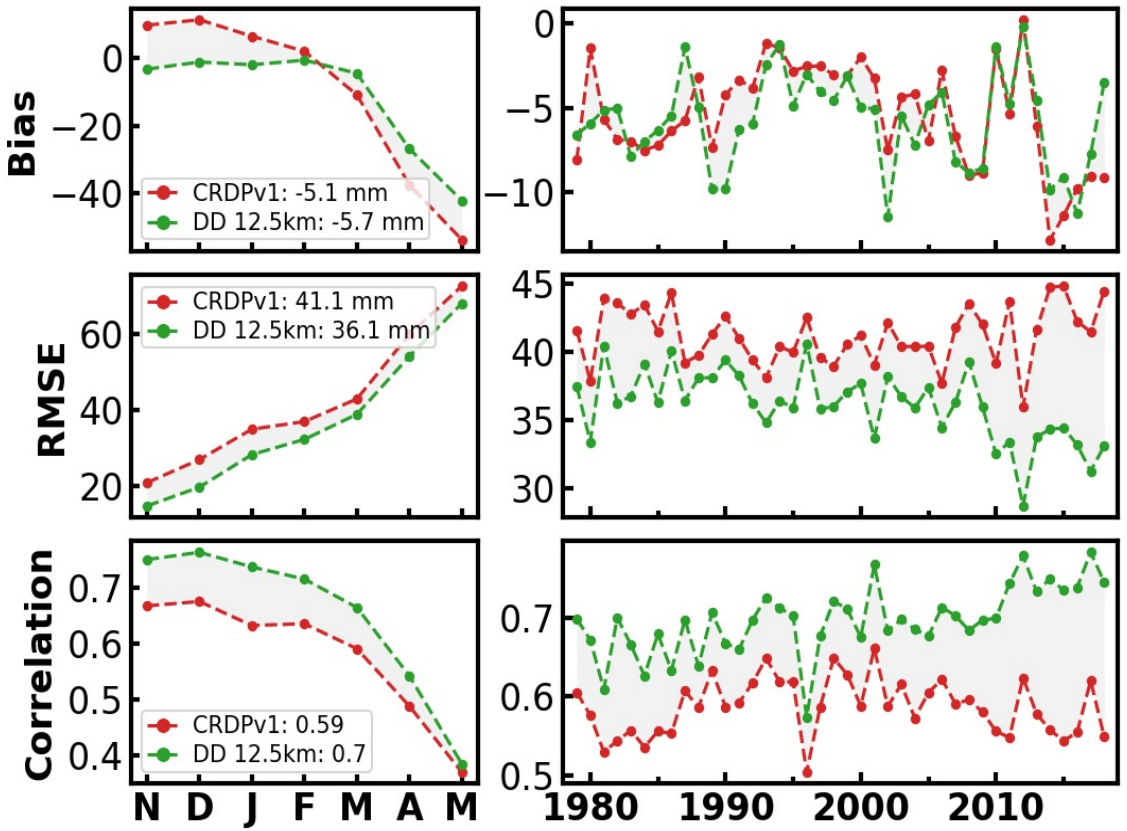


Quality Assessment of SWE Products

In-situ snow course reference data



Bias, RMSE and correlation for CCI SWE CDR v1 (red) and prototype CCI CDR v2 (green).

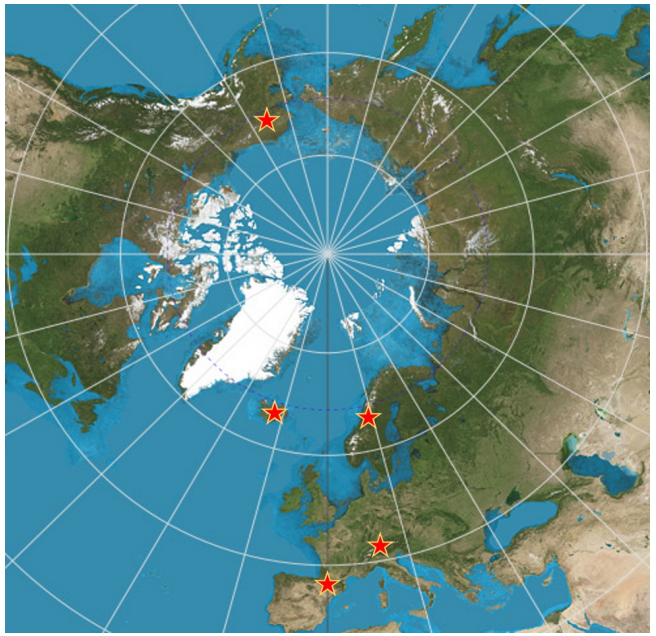


Time Series of Snow Melt Extent in Mountain Areas from SAR

Snow-CCI Option 2021-2023

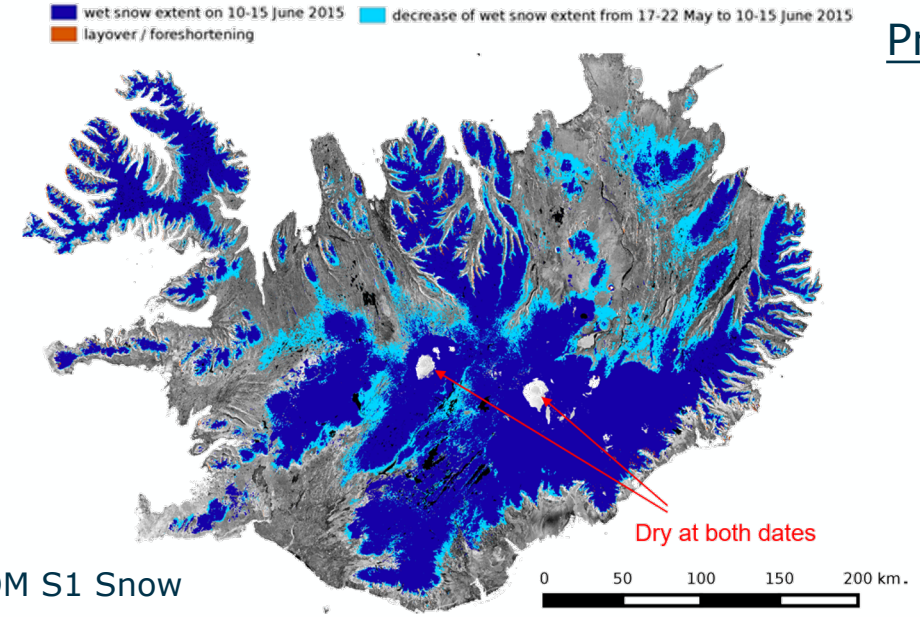
Main Objectives are

- develop, implement and validate a wet snow mapping procedure for mountain regions using C-band SAR
- produce a homogenized timeseries of wet snow products for selected mountain regions in different environments and climate zones starting in 1992 by exploiting the full mission archives of ESA ERS 1/2 SAR, ENVISAT ASAR and Sentinel-1 SAR
- analyse and intercompare the snow melt pattern in the different mountain groups, study changes in onset and duration of snow melt, and investigate the melt pattern in dependence of elevation topographic parameters in different climate zones.



5 Mountain areas in different Climate Zones:

- Mid latitudes: Europe: Alps, Pyrenees,
- Subarctic: Scandinavia, Alaska (Brooks Range & North Slope)
- Maritime Subarctic: Iceland



Products Specs:
100 m
lat/lon grid
(consistent with 1km SCF products)

builts on achievements of SEOM S1 Snow

Case studies performed within Snow-CCI

Case study 1 – Regional & global snow cover trend analysis for IPCC SROCC & AR6

Case study 2 – Assessment of snow and snow feedbacks in CMIP6 models

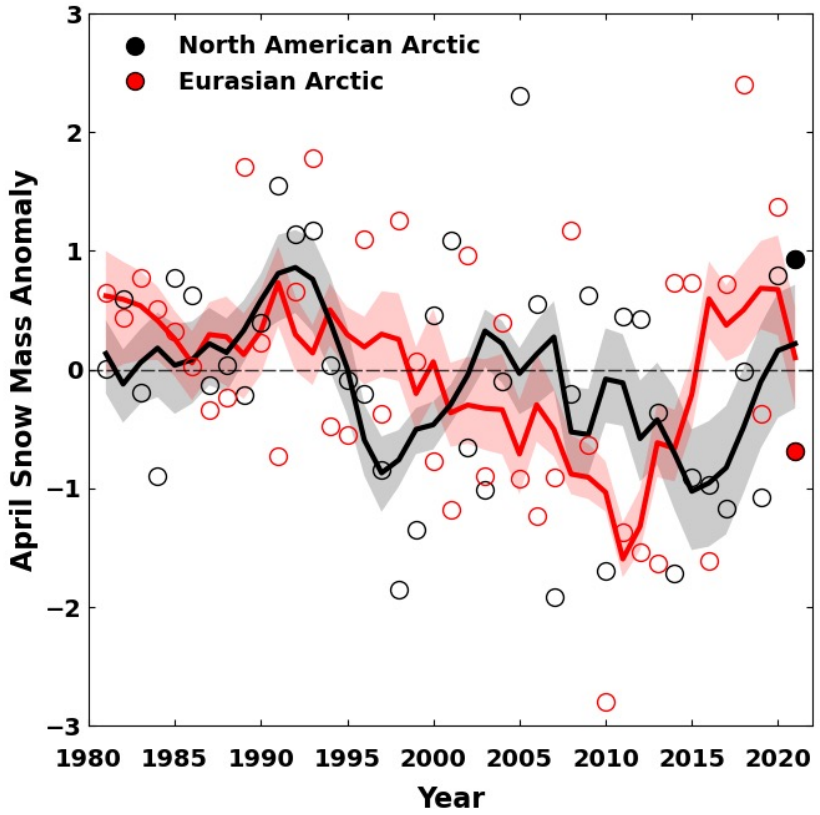
Case study 3 – Evaluation of ESM-SnowMIP simulations (R. Essery, UED)

Case study 4 – Long-term simulations of largescale hydrological regimes in a changing climate

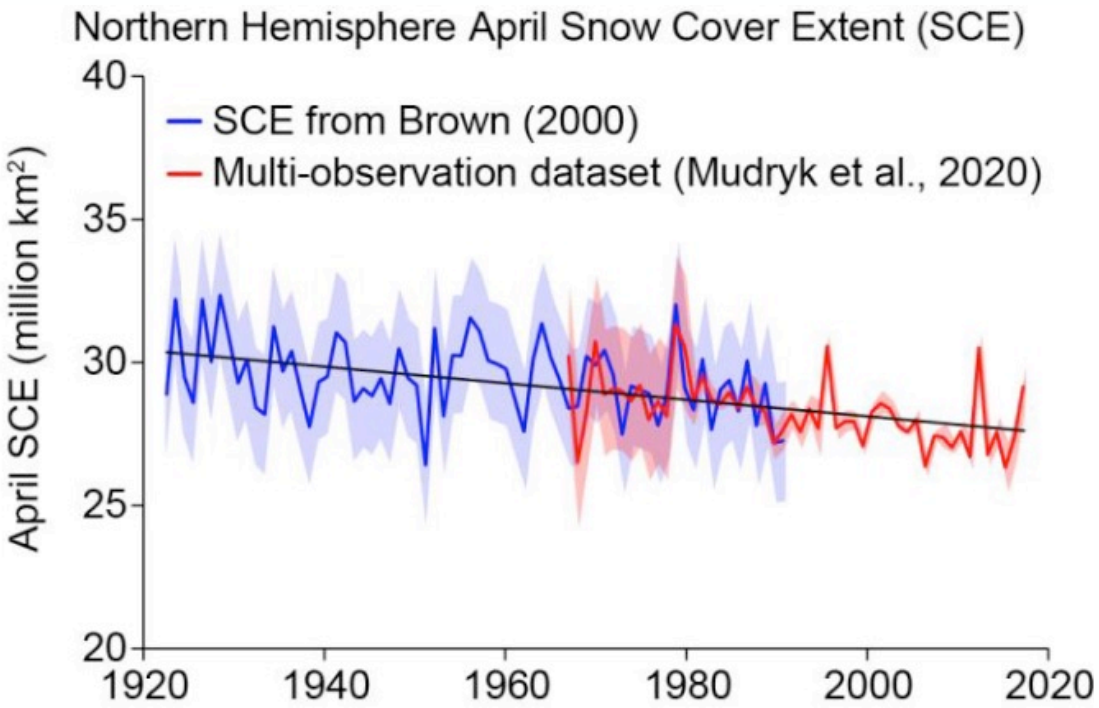
Case study 5 - Multi-decadal comparison between the ECMWF ERA5 climate reanalysis and *snow_cci* products

Trends of Snow Mass and Snow Extent

- Analysis of a multi-product ensemble of SWE products continues to support climate assessments, MIPs, and other analyses
- Snow CCI SWE is the only dataset in the multi-product set which includes EO data, and so is very important for capturing uncertainty across the ensemble (e.g. shading in the plots below)



2021 Arctic Report Card (in prep.)



IPCC AR6 WGI Chapter 2

CMIP6 Simulations over High Mountain Asia

Snow CCI Snow Cover Fraction dataset used for evaluation of CMIP6 simulations over High Mountain Asia

Large snow cover extent spread between datasets across HMA:

- Remote Sensing: Snow CCI improves on positive snow extent bias in NOAA CDR
- Climate Models: challenging to simulate in of complex topography
- Reanalysis: ERA5 bias similar to models (no assimilation >1500m)

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Abstract | Discussion | Metrics

24 Jun 2021

Review status: a revised version of this preprint was accepted for the journal ESD and is expected to appear here in due course.

Climate change in the High Mountain Asia in CMIP6

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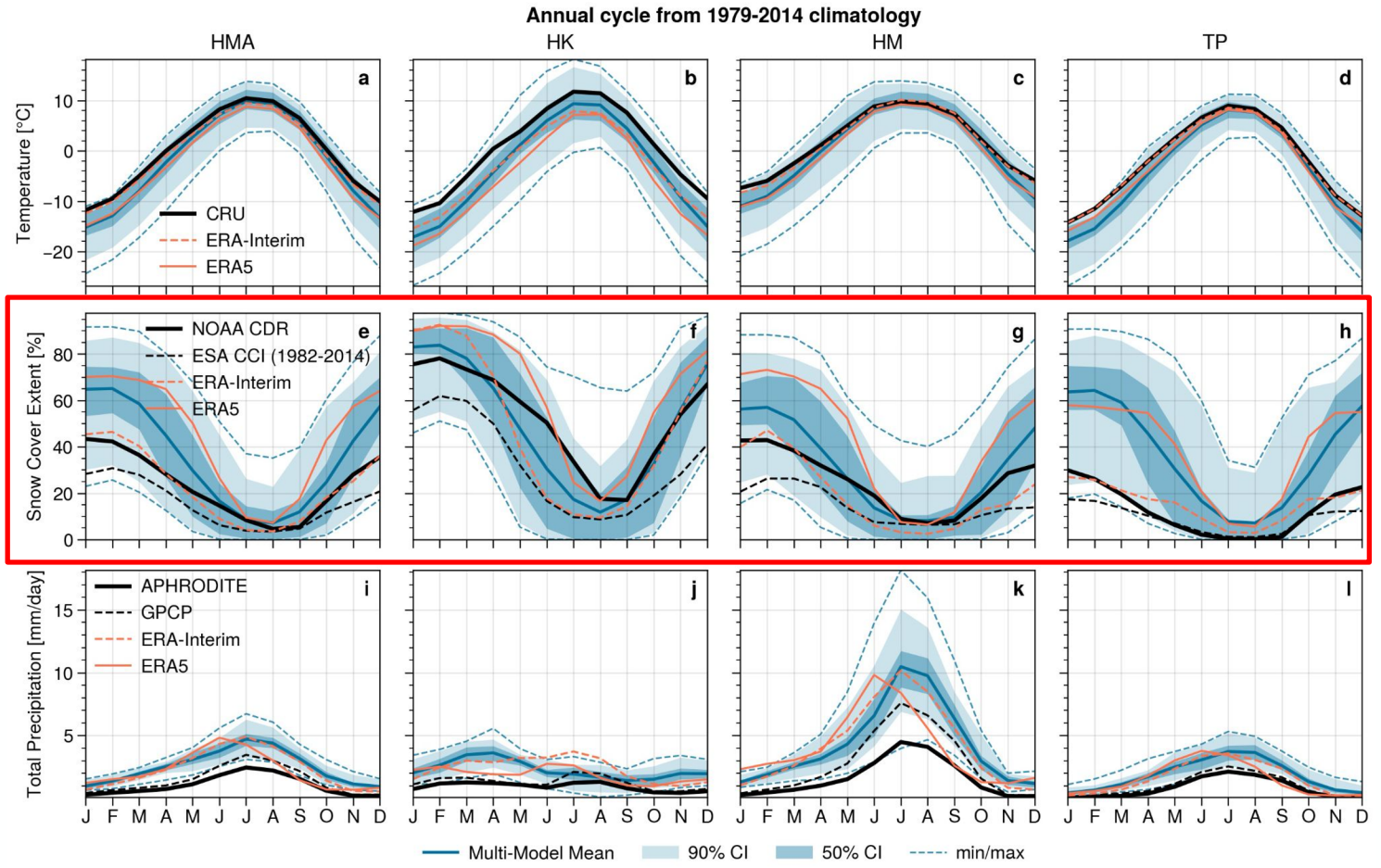
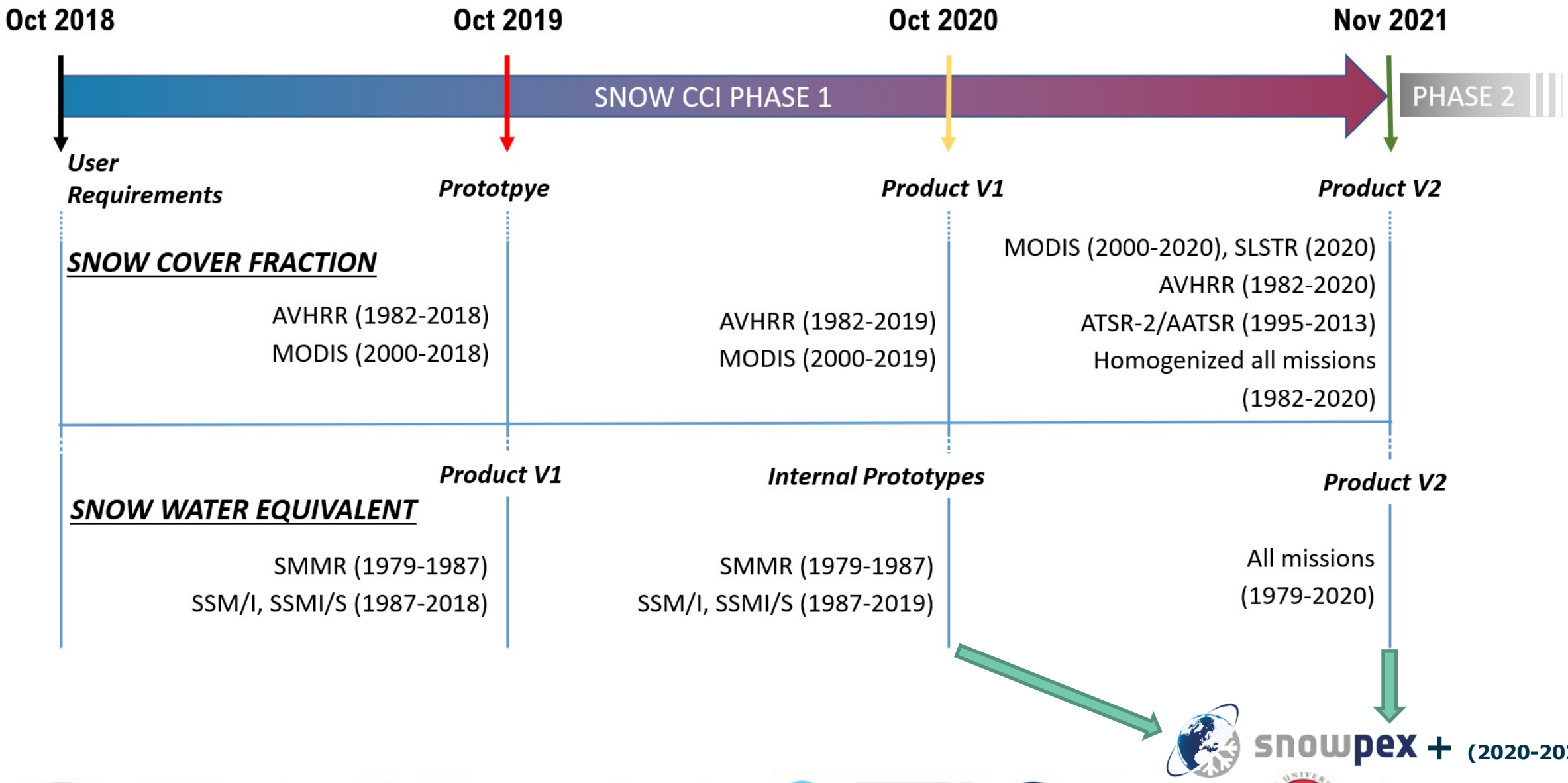


Release Schedule of Snow-CCI Products



snowpex + (2020-2022)


http://snow-cci.enveo.at