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Lumituotteita Eurooppaan ja pohjoiselle pallonpuoliskolle

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ESA DUE GlobSnow

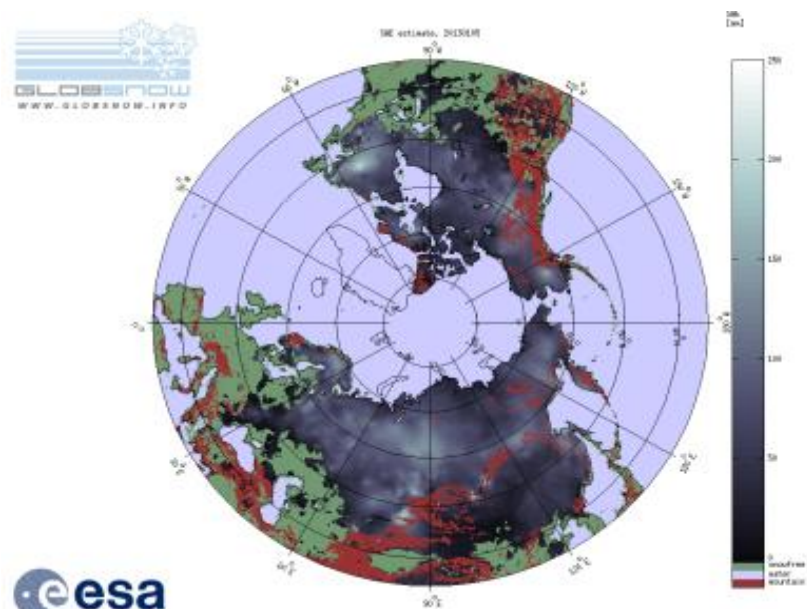
– Operational Snow monitoring of Northern Hemisphere, combined with long term climate records

Snow Water Equivalent (SWE)

- 35 year-long CDR time-series on snow conditions of Northern Hemisphere (25x25 km grid)
- Passive microwave radiometer data combined with ground-based synoptic snow observations

Snow Extent (FSC)

- 15 years Snow Extent data record from ESA ATSR-2 (1995-) and AATSR (2002-2012) on a hemispherical scale.
- Methodology developed especially for forested regions
- **Suomi NPP VIIRS & Sentinel 3 SLSTR** for continuation





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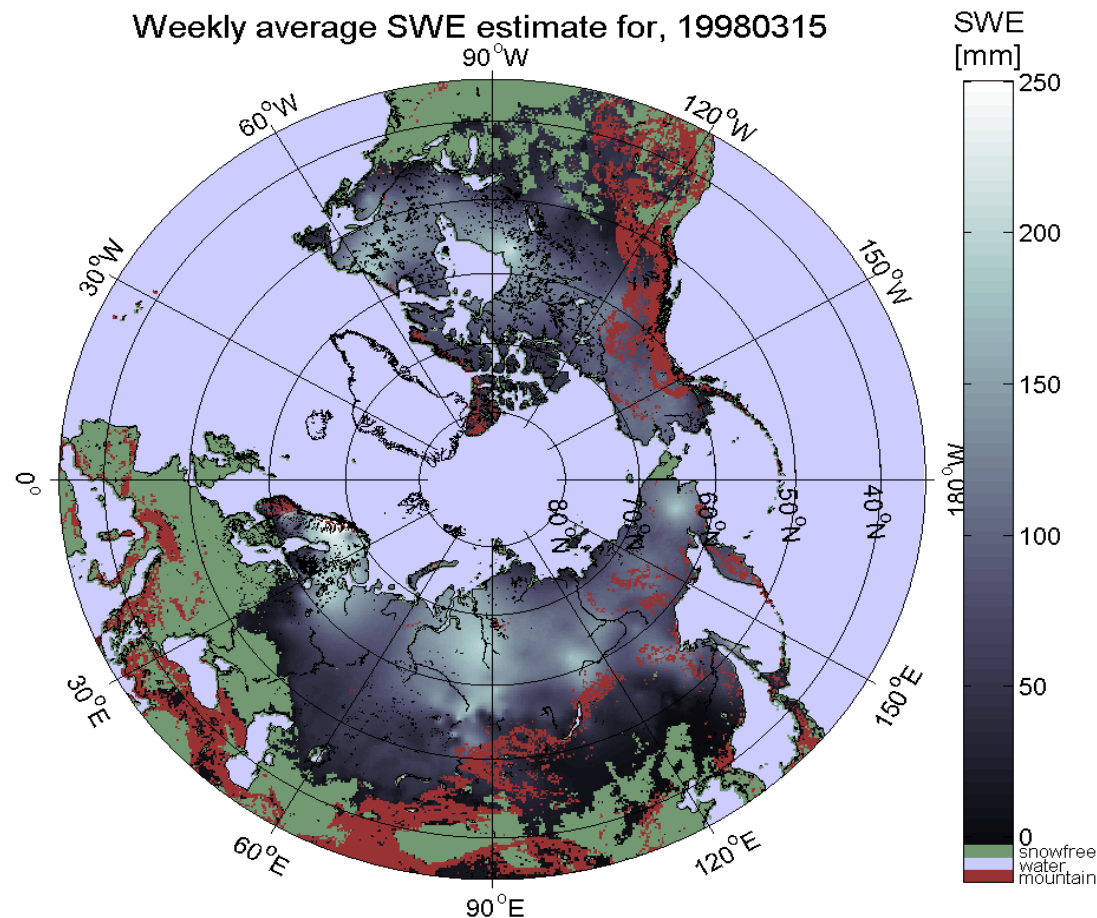


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35 year-long CDR time-series on snow conditions of Northern Hemisphere

- First time reliable daily spatial information on SWE (snow cover):
 - Snow Water Equivalent (SWE)
 - Snow Extent and melt (+grain size)
 - 25 km resolution (EASE-grid)
 - Time-series for 1979-2014
- Passive microwave radiometer data combined with ground-based synoptic snow observations
 - Variational data-assimilation
- Available at open data archive (www.globsnow.info)
- Demonstration of NRT processing since October 2010
- Greenland, glaciers & mountains masked out



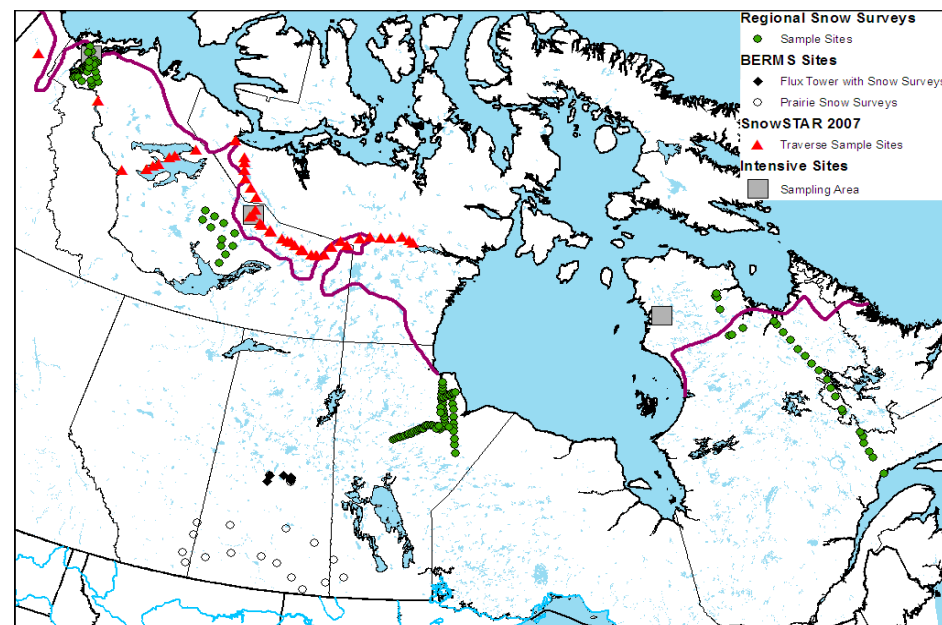
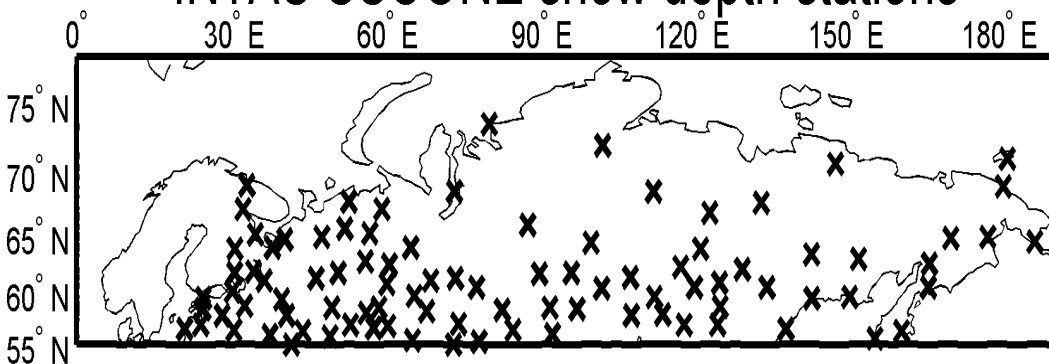
Validation using distributed data: Northern Eurasia & Canada

Snow Survey data (from former USSR and Russia)

- There are 517 snow path stations with data for (1979 – 2009)
- Manual ground-based measurements on snow depth/SWE
- 1 - 2km snow transects, measurements every 100m - 200m

Land Cover	Reference Dataset	Year	n	Mean SWE (mm)
Tundra	Intensive Sites; SnowSTAR 2007	2006-2008	28	120
Northern Boreal	EC Snow Surveys	2006-2007	105	135
Northern Boreal	EC Snow S. (SWE < 150mm)	2006-2007	73	134
Southern Boreal	EC Snow Surveys	2005-2007	57	75
Southern Boreal	BERMS Towers	2005-2008	468	70
Prairie	EC Snow Surveys	2005-2007	41	44

INTAS SSCONE snow depth stations





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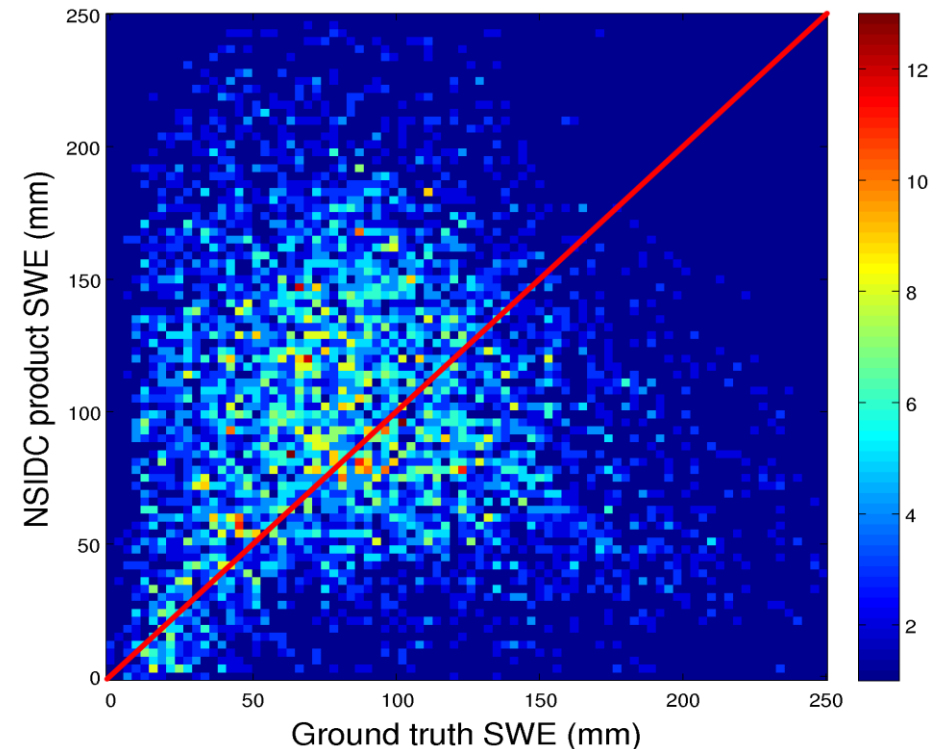
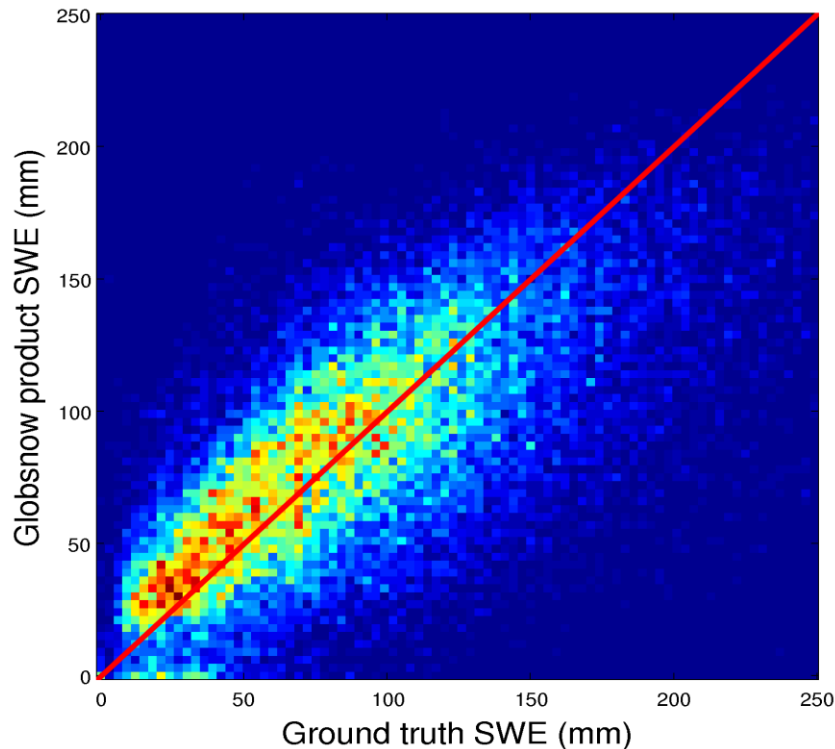


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SWE retrieval (data assimilation vs. channel diff.)

- Density scatterplot (assimilated vs. satellite only SWE)
- Russian INTAS SCCONE **SWE** transect data as reference





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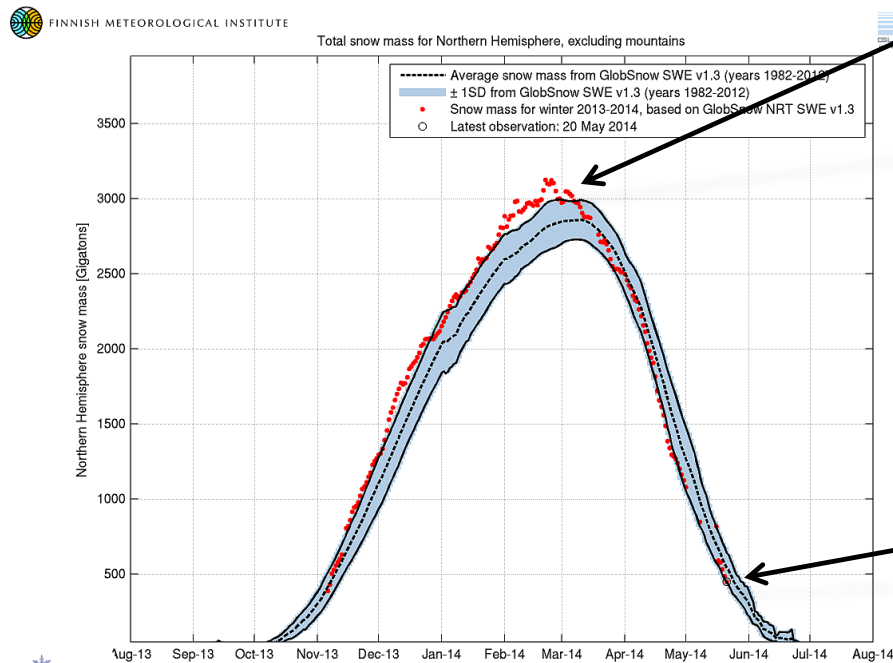
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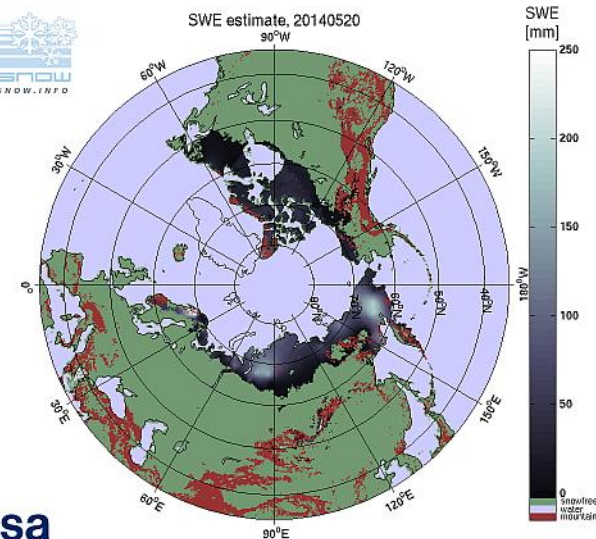
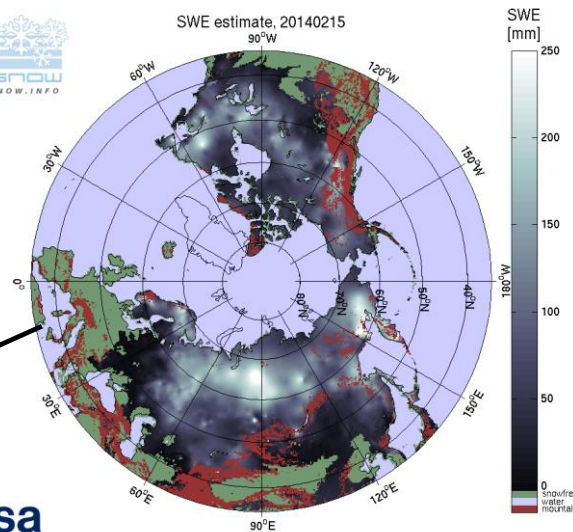
Tracking NH snow cover evolution in NRT

WMO GCW NH Snow tracker (based on FMI GlobSnow SWE processor)

- Tracking of hemispherical scale SWE/snow mass (anomalies) in NRT utilizing the GlobSnow long term time-series as a "reference"



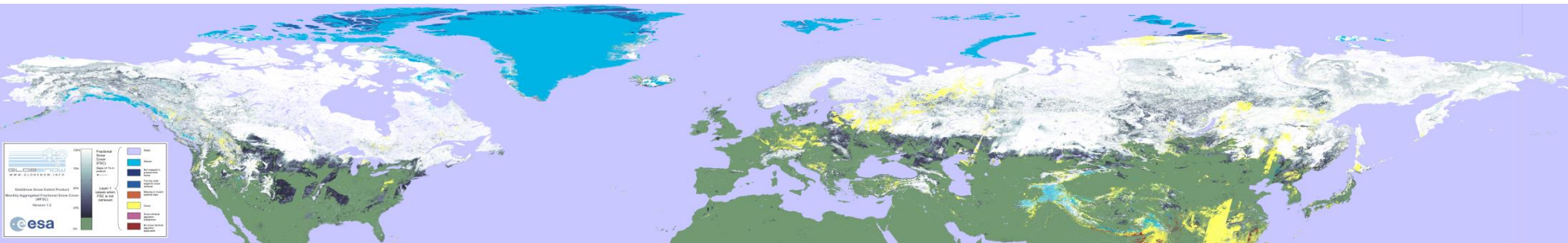
20 May 2014





GlobSnow Snow Extent (SE) dataset

- 17 years SE data record has been produced using optical imagery from ESA ATSR-2 and AATSR (1995-2012) on a hemispherical scale. 2012 -> Suomi NPP/VIIRS.
- SYKE's *SCAmod* method for fractional snow cover mapping implemented for Northern hemisphere
- Cloud detection algorithm developed by SYKE (+ contributed by ENVEO, FMI & NR)



- Methodology developed especially for forested regions – basically a tough challenge for optical SE retrieval

Metsämäki, S., Mattila, O.-P., Pulliainen, J., Niemi, K., Luojus, K., Böttcher, K. (2012), "An optical reflectance model-based method for fractional snow cover mapping applicable to continental scale", *Remote Sensing of Environment*, Vol 123, pp. 508-521, August 2012.

Metsämäki, S., Pulliainen, J., Salminen, M., Luojus, K., Wiesmann, A., Solberg, R., Böttcher, K., Hiltunen, M., Ripper, E. (2015), "Introduction to GlobSnow Snow Extent products with considerations for accuracy assessment", *Remote Sensing of Environment*, Vol 156, pp. 96-108, January 2015.



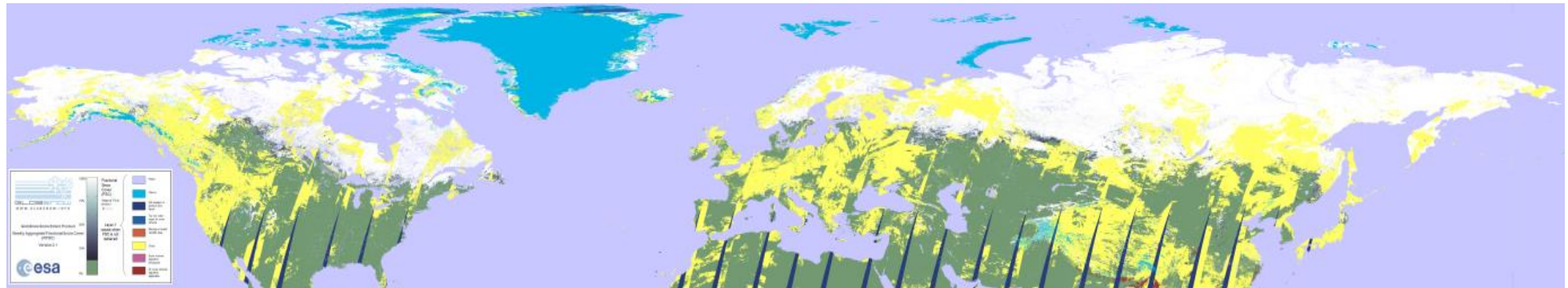
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Sensor limitation with (A)ATSR: daily coverage -> data gaps





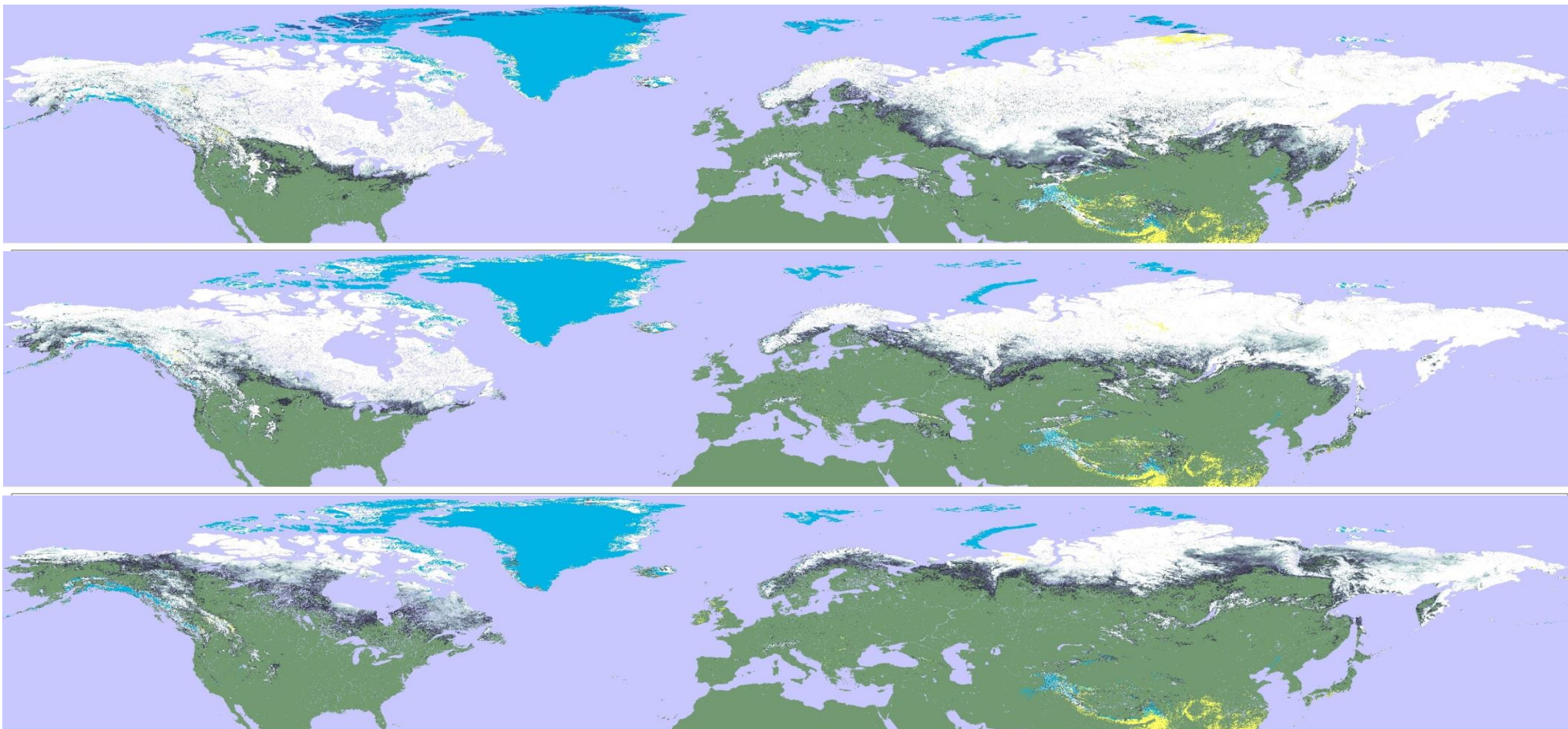
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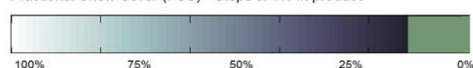


SE algorithm (SCAmod) applied to alternative data with improved spatial coverage
example on Suomi NPP/VIIRS (Sentinel-3 SLSTR in the future)

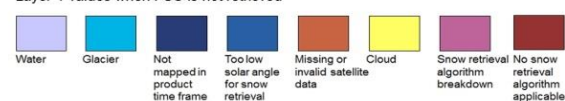


GlobSnow Snow Extent Product
Monthly Aggregated Fractional Snow
Cover (MFSC)
Version 2.0

Fractional Snow Cover (FSC) - Steps of 1% in product



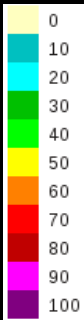
Layer-1 values when FSC is not retrieved



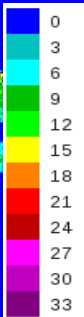
Mean Absolute FSC Difference MOD10 versus GlobSnow - 1.3.-31.5.2010

$$(\sum |FSC_{MOD10} - FSC_{GlobSnow}|) / N$$

forest



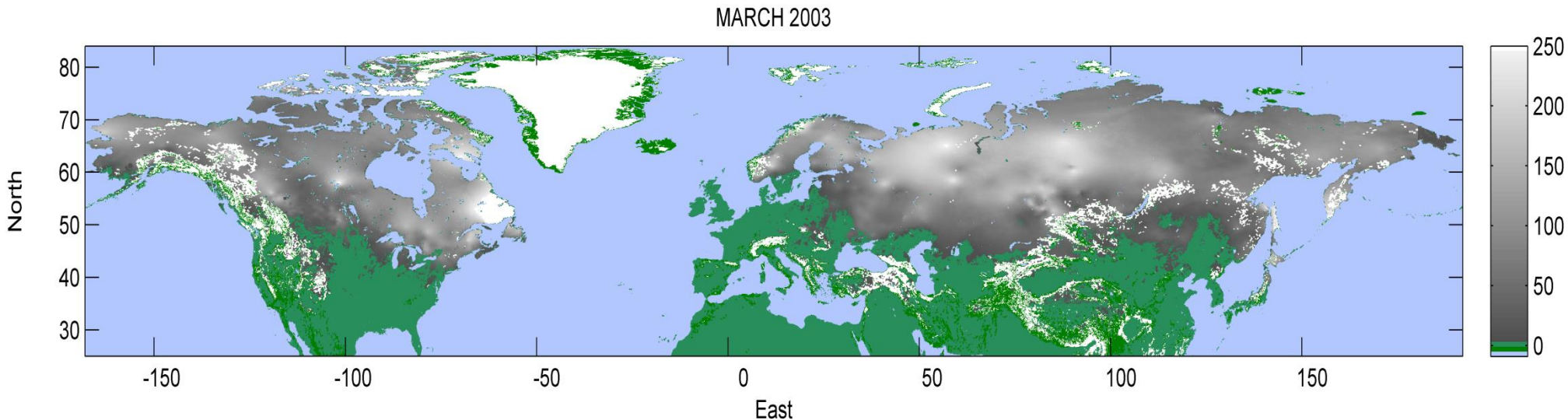
number of pixels (N)

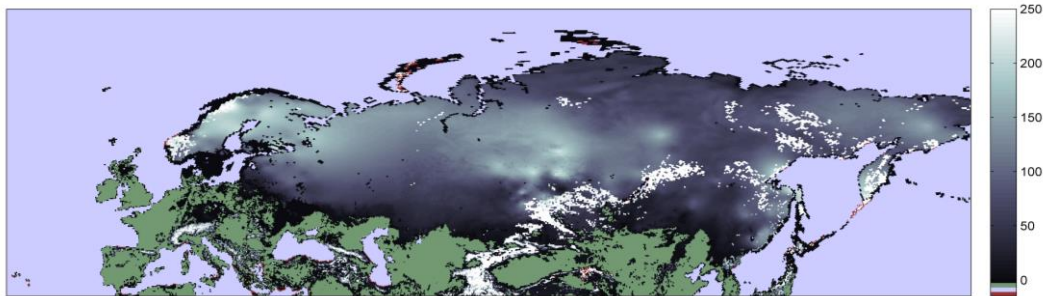
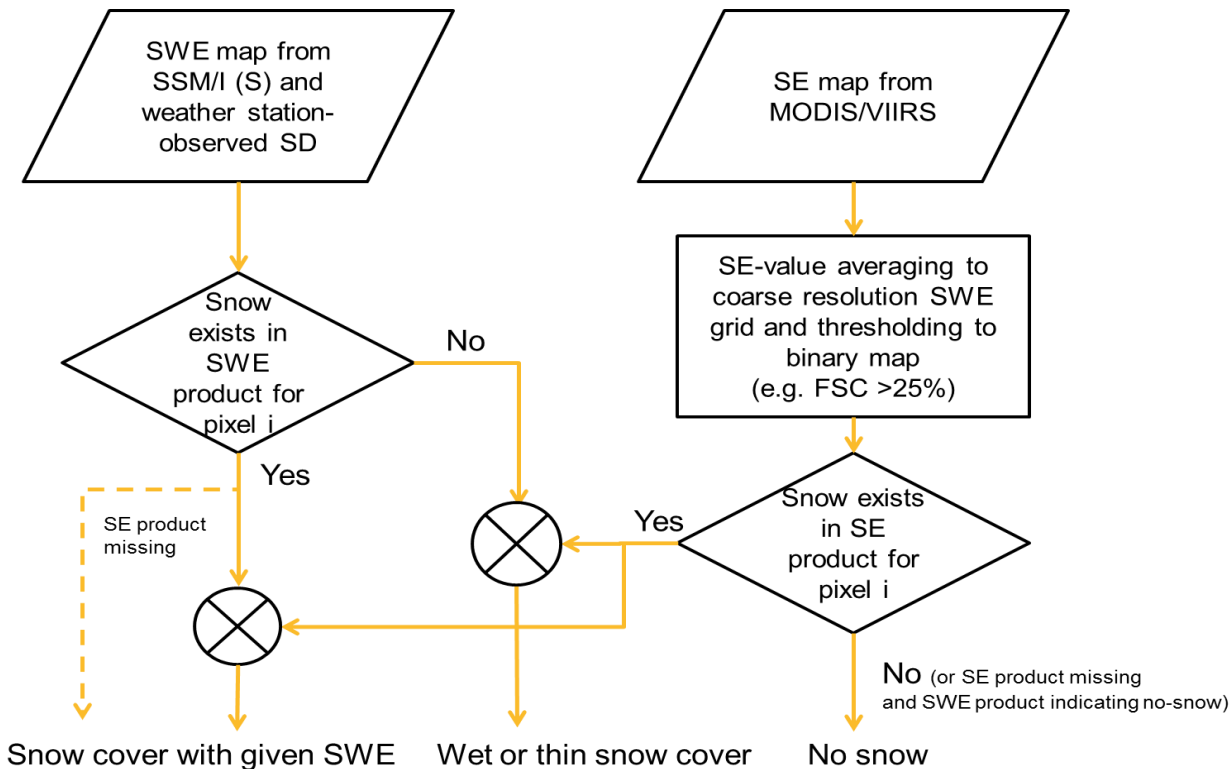
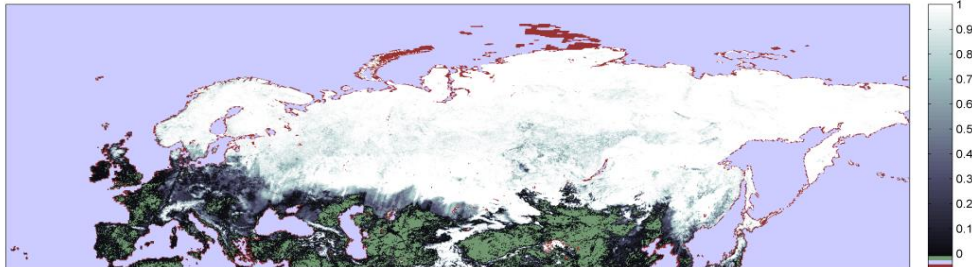
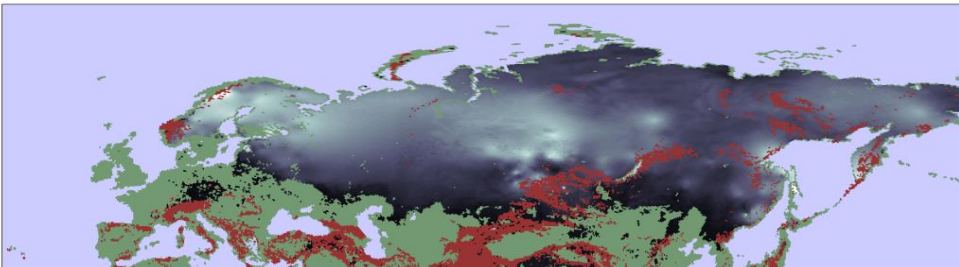




Combination of SE & SWE retrievals for the generation of concise snow cover information

- Reprocessing of long term SE-SWE time series (since ~1980) by combining **ESA GlobSnow SWE CDR** and a **suitable daily (weekly) SE dataset**
- NRT northern hemisphere daily snow monitoring product combining GlobSnow SWE and SE products (based on SSMI-S and VIIRS+Sentinel-3)

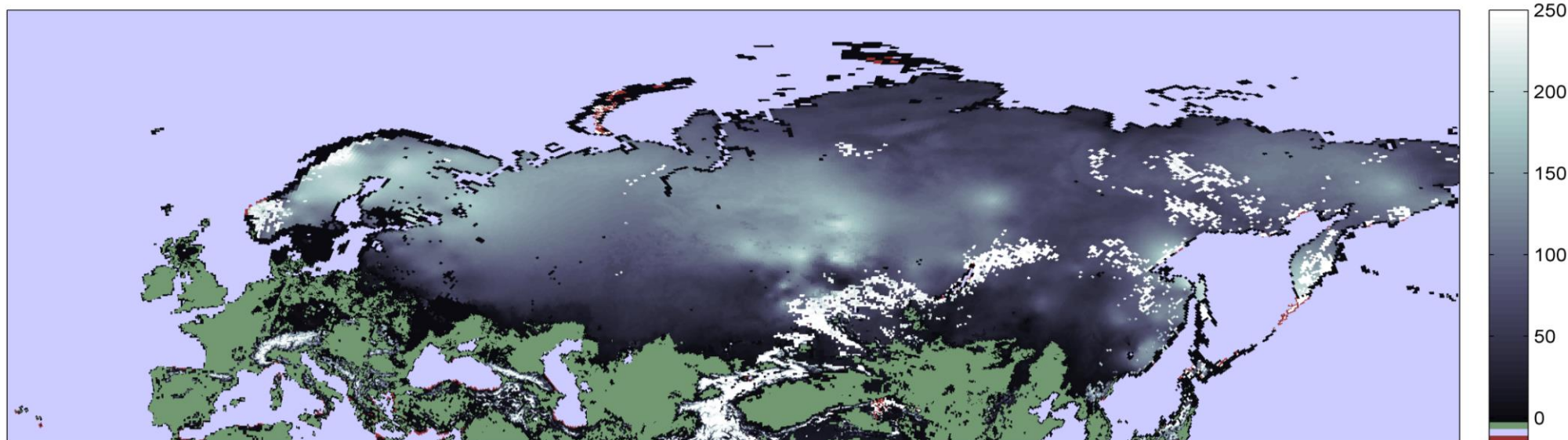






Combined Northern Hemisphere snow cover product

- NRT north-hemisphere daily snow monitoring product combining GlobSnow SWE and SE products (based on SSMI-S and NPP VIIRS / Sentinel-3 SLSTR)
- Utilization of NOAA IMS as an SE source for NRT production (esp. winter)

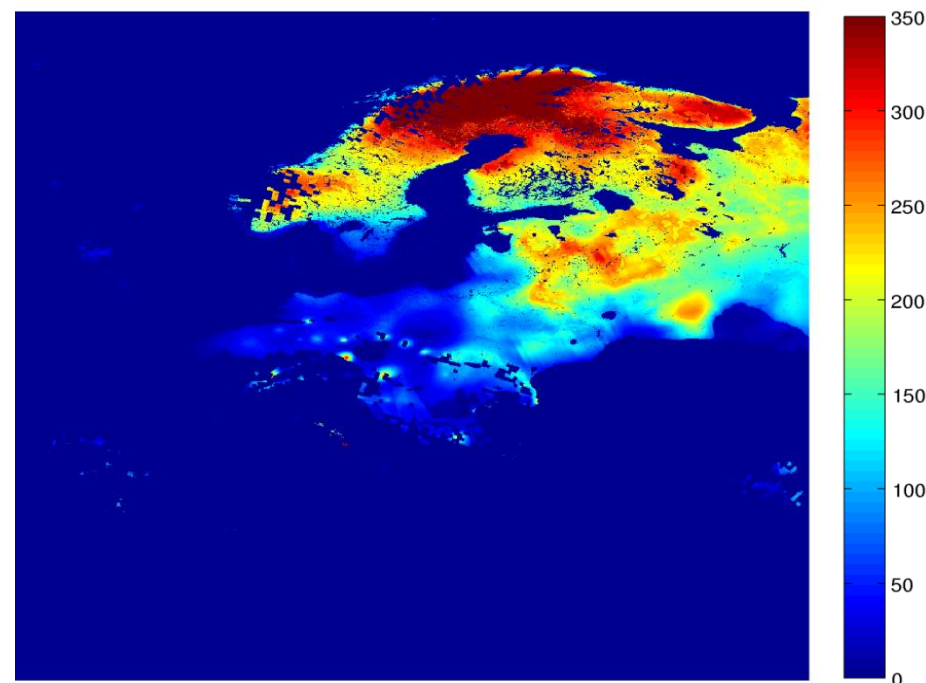




High resolution (5km) Pan-European SWE product

High resolution SWE (in development stage)

- SWE retrieval based on enhanced GlobSnow approach (development on-going)
- Fractional snow cover information used for:
 - improved snow detection during winter snow accumulation period
 - Improved melt detection during spring
- Utilization of optical (VIIRS-based) data in combination with NOAA IMS (4km) product
- Processing for Pan-European domain
- Test phase: winter 2014-2015
- Initial operations: winter 2015-2016



Example of current development version of high resolution SWE product (SWE for 16 March 2013)