esa

→ MWBS | MAPPING WATER BODIES FROM SPACE 2015 CONFERENCE

Mapping water bodies with SAR in high latitudes

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(4) esa
(5)

18–19 March 2015 | ESA-ESRIN | Frascati (Rome), Italy

European Space Agency

WB in high latitudes?

Lake dynamics represent many different processes

fires

Geomorphological processes such as thermokarst, erosion ..

plant growth patterns

Variations in the local water balance, redistribution of water at the surface …

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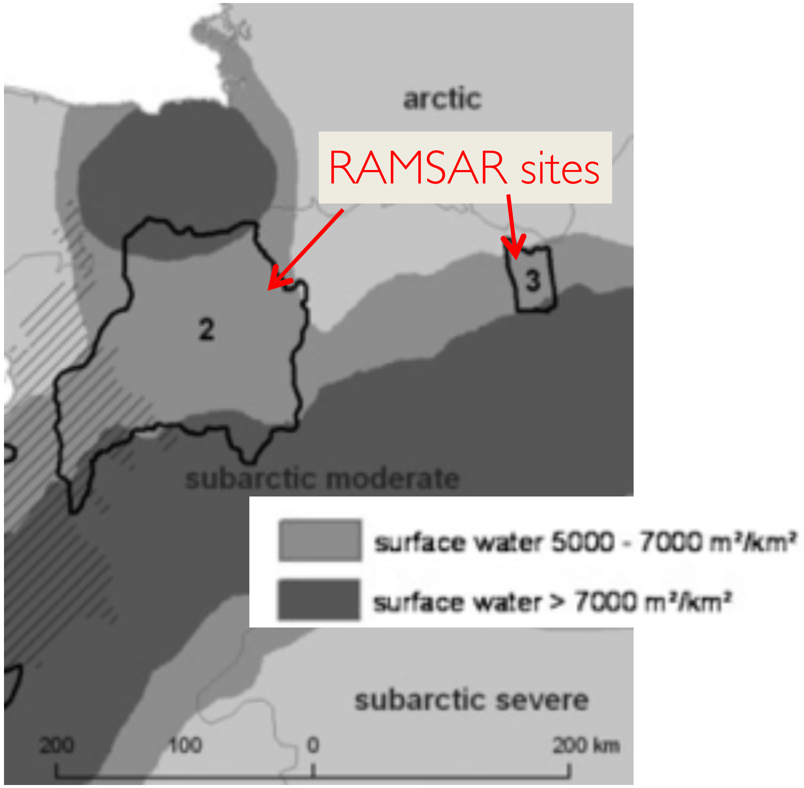
WB in high latitudes?

- Important for wild life habitats
- Coarse resolution products improvements
  – Issues for retrieval of biogeophysical parameters
  – Impact long term trend analyses
- …

Western Taymir



Bartsch A., Kidd R., Pathe C., Wagner W., and K. Scipal (2007): Satellite radar imagery for monitoring inland wetlands in boreal and sub-arctic environments. Journal of Aquatic Conservation: Marine and Freshwater Ecosystems 17: 305-317, DOI: 10.1002/aqc.836.

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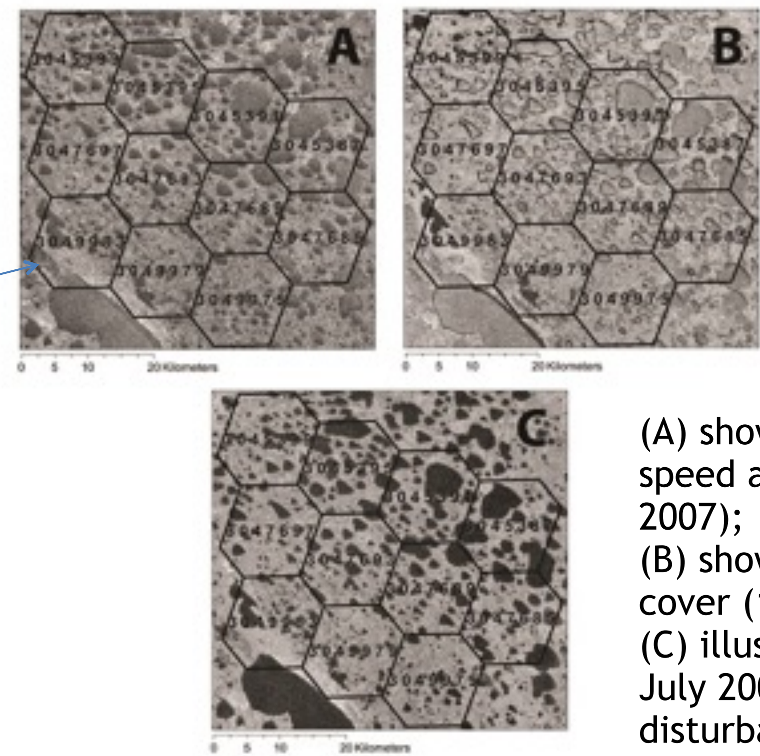
Example: C-Band scatterometer

ASAR WS
Cherskii, Russia

Approximation of
ASCAT foot prints



(A) shows a time with high wind speed and precipitation (11 August 2007);
(B) shows a time with prevailing ice cover (17 June 2007);
(C) illustrates an acquisition from 6 July 2007 when there is no disturbances on the water surface

Högström, E.; Trofaier, A.M.; Gouttevin, I.; Bartsch, A. (2014): Assessing Seasonal Backscatter Variations with Respect to Uncertainties in Soil Moisture Retrieval in Siberian Tundra Regions. Remote Sensing 6, 8718-8738.

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Permafrost

- Bartsch A. + 26 Authors (2014): Requirements for Monitoring of Permafrost in Polar Regions - A community white paper in response to the WMO Polar Space Task Group (PSTG).
- Includes discussion at ESA DUE Permafrost CliC IPA/GTN-P workshop, February 2014
- Application of satellite data to
  - **identify hot spots of surface change** and thus advice on extension of in-situ monitoring networks
  - **support modelling** of sub-surface conditions
  - provide higher resolution (spatial and temporal) measurements in the proximity of long-term in-situ monitoring sites; and place the **in-situ measurements into a wider spatial and temporal context.**

Requirements for Monitoring of Permafrost in Polar Regions

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Permafrost – thaw lakes and wetlands

- Current global land cover datasets cannot capture tundra lakes since a significant proportion of lakes and ponds in tundra regions have an extent below 200 m, many even below 30m.
- lake ice may freeze to the bottom of such lakes and prevent the formation of thawed zones under lakes, whereas lakes that do not freeze to the bottom will develop perennially thawed zones
- thermokarst lake ice has been demonstrated to capture methane ebullition from thawing permafrost under lakes
- sediment influx and redistribution: water colour, measurements of lateral erosion along thermokarst lake shores

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Permafrost - SAR

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WMO PSTG SAR group – specific recommendations and comments

Parameter	Spatial res.	Temporal res.	Band	Polarization	Comment
Subsidence	10-20 m	Bi-weekly during snow free season	L, C, X	Single (HH or VV)	InSAR
Rock glaciers	3-10 m	Bi-weekly during snow free season	L, C, X	Single (HH or VV)	InSAR
Surface status	< 30 m	Better than weekly, shoulder seasons	L, C, X	any	
Wetlands and lakes	< 30 m	Weekly, shoulder and snow free seasons	L, C, X	HH plus HV/VH, HH/VV or quad	
Coastal erosion	1 m	Annually during the ice and snow free season	L, C, X	Single (HH or VV)	Be-weekly for highly active areas (figure 3)
Lake depth and thawed zone characteristics	1-30 m	Weekly during winter	C, X	Single (HH or VV)	Detecting whether lakes have grounded or floating ice; indication of thermokarst activity under lakes
Methane emissions from lakes	1-20 m	Weekly during should seasons (freeze-up, ice-out)	L, C	Single (HH or VV), HH/VV, quadpol	Quantification of methane ebullition bubbles

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Why weekly?

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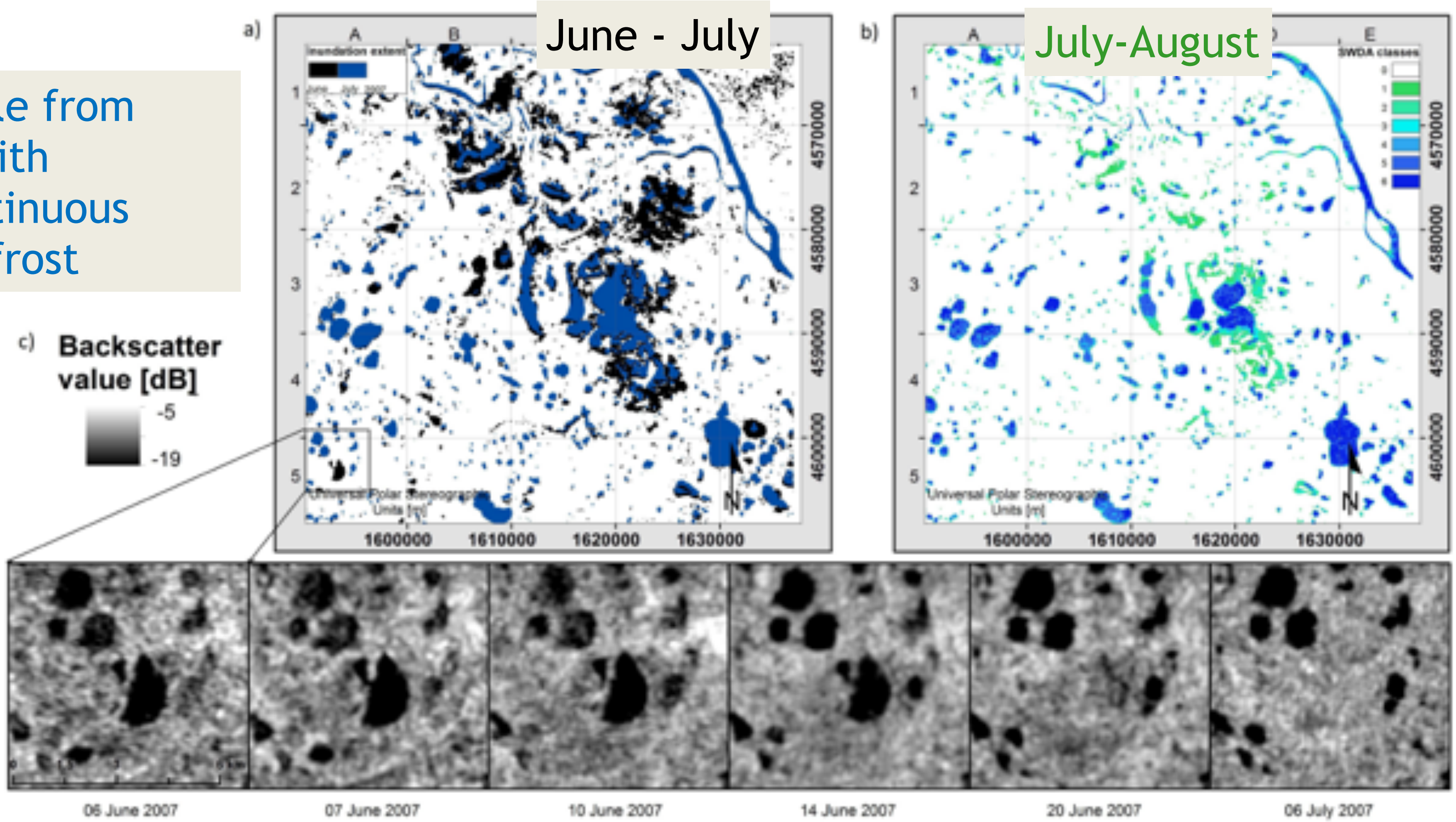
Example from area with discontinuous permafrost



Trofaier A. M., Bartsch, A., Rees, G. & M. Leibman (2013): Assessment of spring floods and surface water extent over the Yamalo-Nenets Autonomous District. Environ. Res. Lett. 8 045026 doi:10.1088/1748-9326/8/4/045026

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Why weekly?

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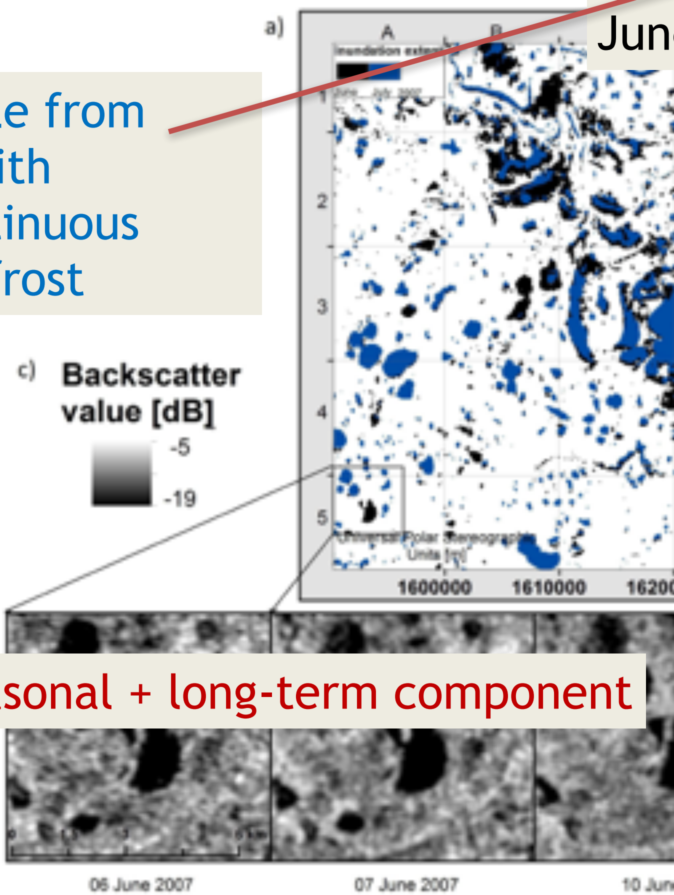

-> Seasonal + long-term component

Science: Disappearing Arctic Lakes, 2005, L. C. Smith, Y. Sheng, G. M. MacDonald, L. D. Hinzman

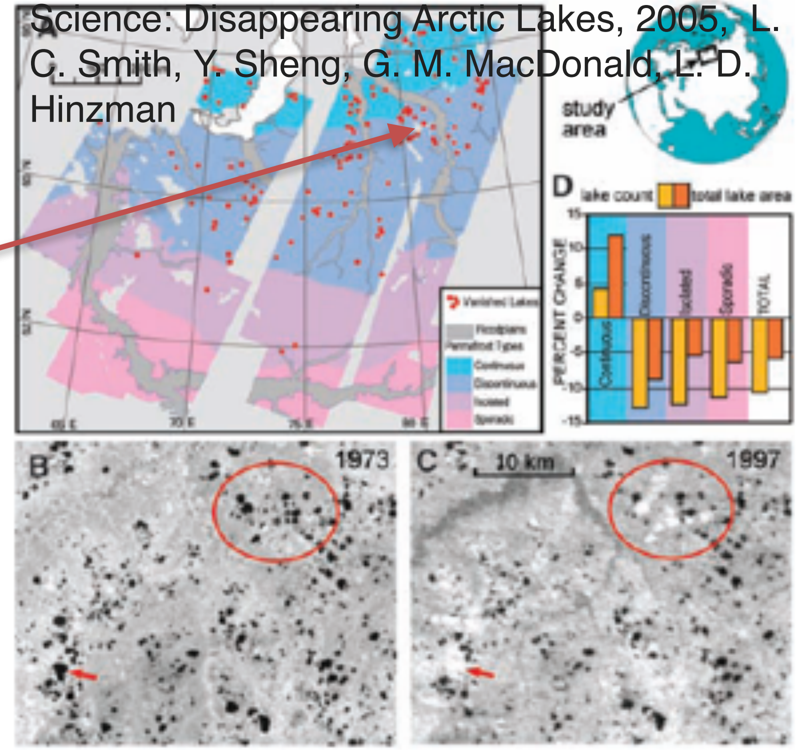

Fig. 1. (A) Locations of Siberian lake inventories, permafrost distribution, and vanished lakes. Total lake abundance and inundation area have declined since 1973 (B), including (C) permanent drainage and revegetation of former lakebeds (the arrow and oval show representative areas). (D) Net increases in lake abundance and area have occurred in continuous permafrost, suggesting an initial but transitory increase in surface ponding.

Trofaier A. M., Bartsch, A., Rees, G. & M. Leibman (2013): Assessment of spring floods and surface water extent over the Yamalo-Nenets Autonomous District. Environ. Res. Lett. 8 045026 doi:10.1088/1748-9326/8/4/045026

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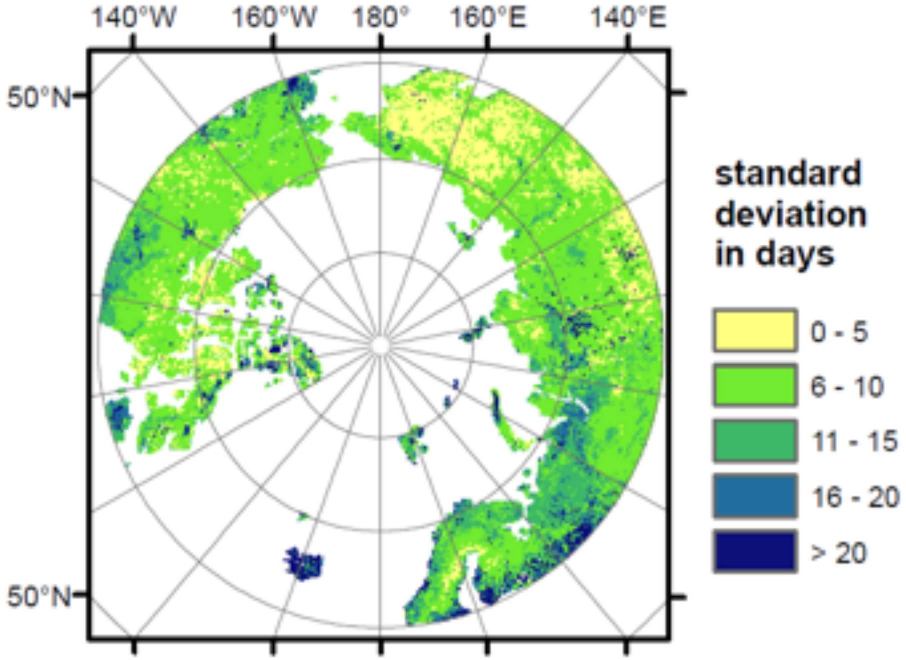
Seasonal patterns?

Variation of snowmelt timing ->
Different timing of flooding



Bartsch, A. (2010): Ten Years of SeaWinds on QuikSCAT for Snow Applications .Remote Sens. 2010, 2(4), 1142-1156;
Bartsch, A., Kidd, R., Wagner, W. and Z. Bartalis (2007): Temporal and spatial variability of the beginning and end of daily spring freeze/thaw cycles derived from scatterometer data. Remote Sensing of Environment, 106(3), 360-374,

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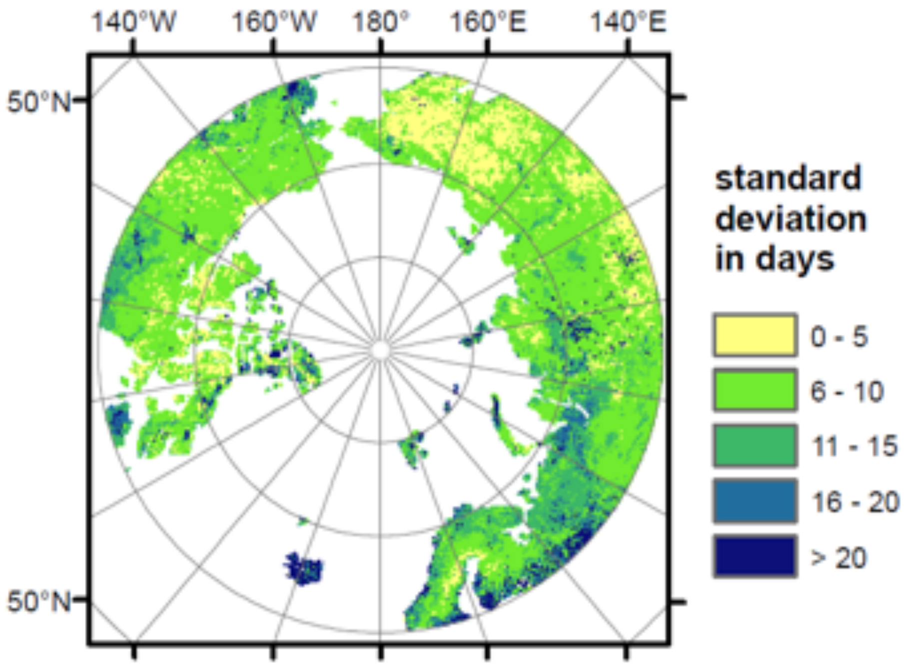

Bartsch, A. (2010): Ten Years of SeaWinds on QuikSCAT for Snow Applications .Remote Sens. 2010, 2(4), 1142-1156; Bartsch, A., Kidd, R., Wagner, W. and Z. Bartalis (2007): Temporal and spatial variability of the beginning and end of daily spring freeze/thaw cycles derived from scatterometer data. Remote Sensing of Environment, 106(3), 360-374,

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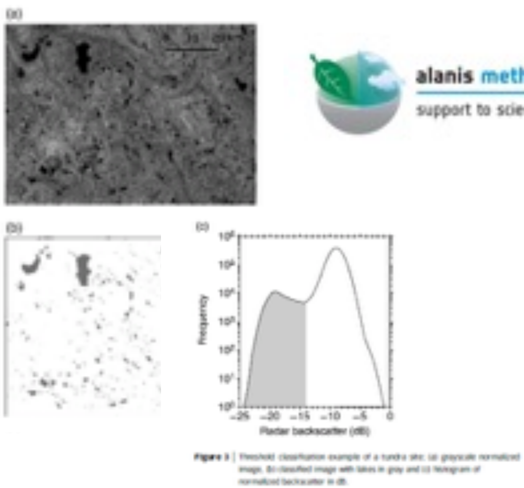
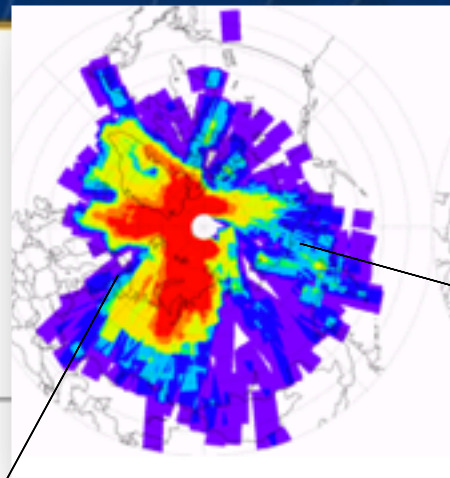
Seasonality from STSE ALANIS Methane





Example of ASAR WS monthly coverage

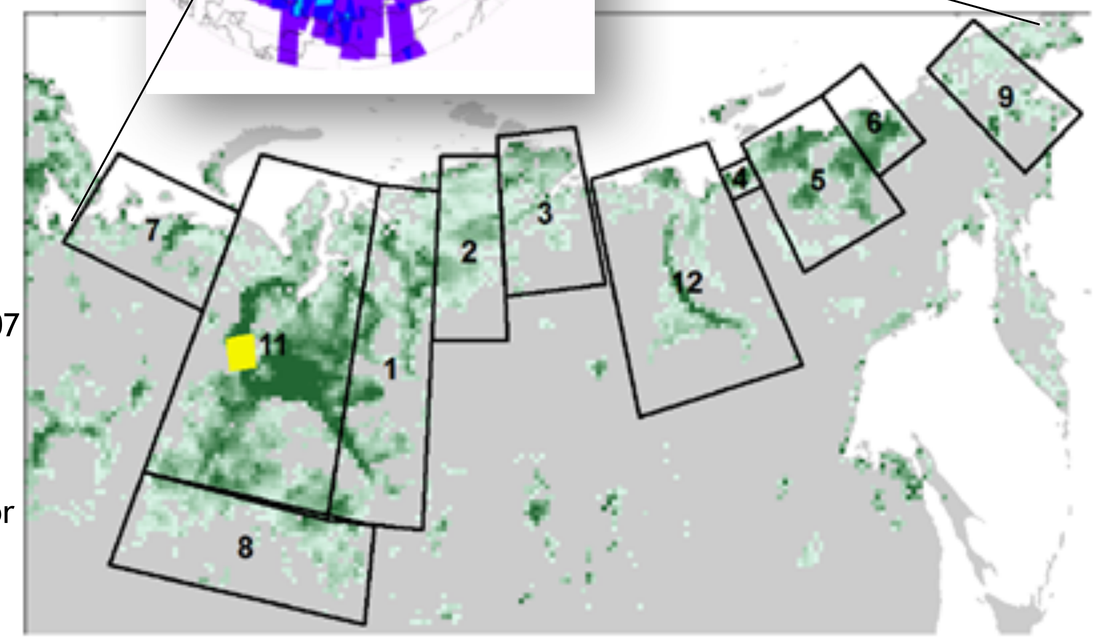


Fig. 1: Extent of subzones of the local wetland product. Green areas indicate wetland extent from the regional wetland product. The yellow area shows the extent of the sample dataset.

Reschke, J et al. (2012): Wetland maps including open water extent dynamics based on ENVISAT ASAR WS for Siberia, 2007 and 2008, links to GeoTIFFs. **doi:10.1594/ PANGAEA.834502,**
Supplement to: Reschke, Julia; Bartsch, Annett; Schlaffer, Stefan; Schepaschenko, Dmitry (2012): Capability of C-Band SAR for operational wetland monitoring at high latitudes. Remote Sensing, 4(12), 2923-2943, doi:10.3390/rs4102923

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Seasonality from STSE ALANIS Methane

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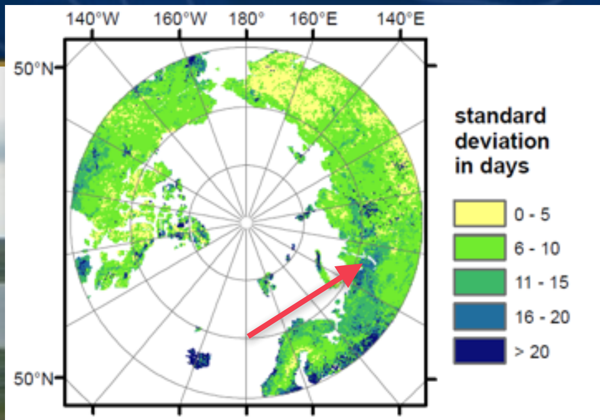
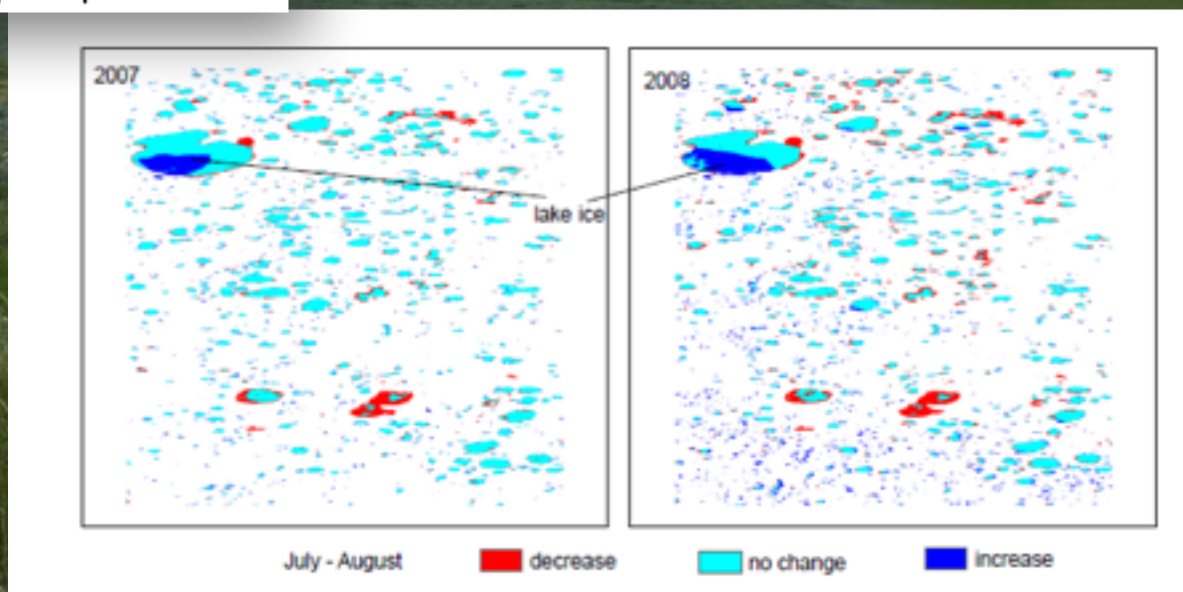


Photo: Beginning of July 2012



alanis methane
support to science element

7 July to 28th of August 2007

6 July to 21th of August 2008

Bartsch et al. 2012

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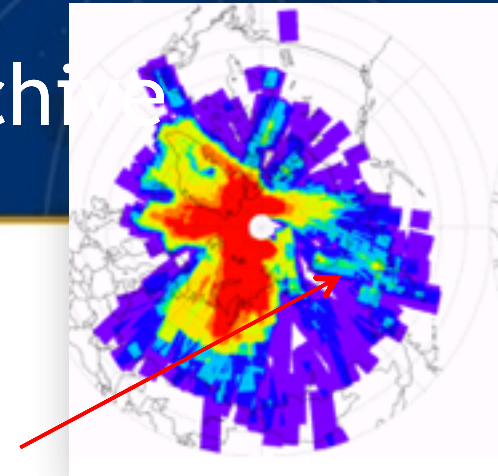
Exploitation of the ASAR WS archive

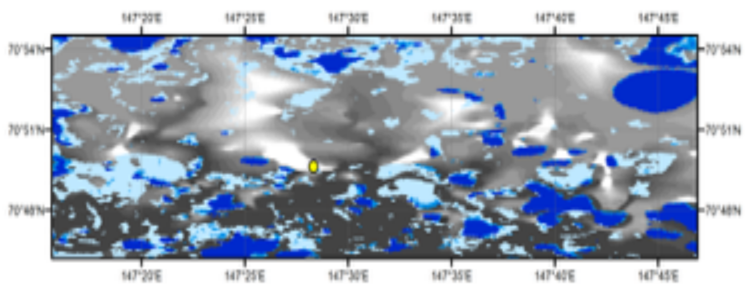


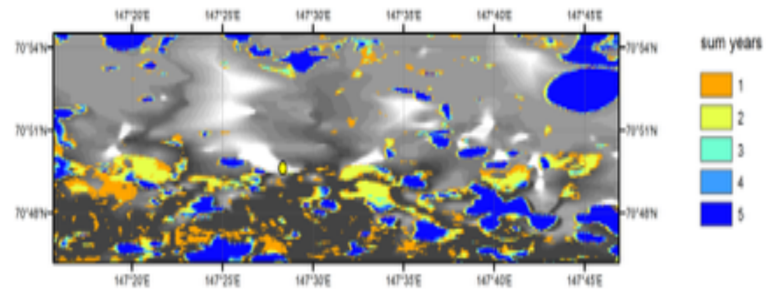
DUE Permafrost

PAGE21 Primary site Kytalik

alanis methane
support to science element

June
July
August





Seasonal variations 2007 - not much seams to change between July and August

Year to year variations (July/August-> Maximum)

Demonstrates that variations from year to year are huge

Widhalm, Barbara; Högström, Elin; Ressl, Camillo; Trofaier, Anna Maria; Heim, Birgit; Biasi, Christina; Bartsch, Annett (2014): Land surface hydrology from remotely sensed data at PAGE21 sites with links to geotiff images. doi:10.1594/ **PANGAEA**.834200

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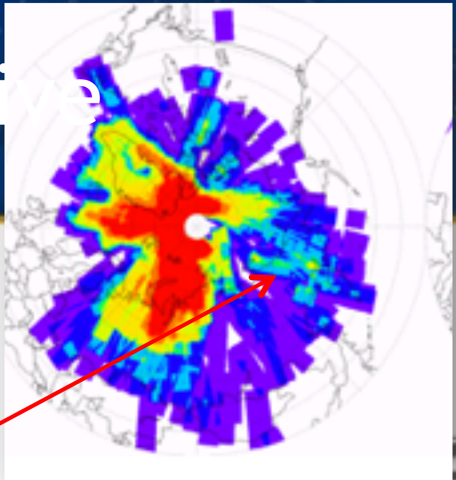
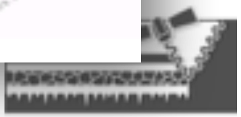
Exploitation of the ASAR WS archive



Primary site Kytalik

How to make a product?



DUE Permafrost

alanis methane
support to science element

June
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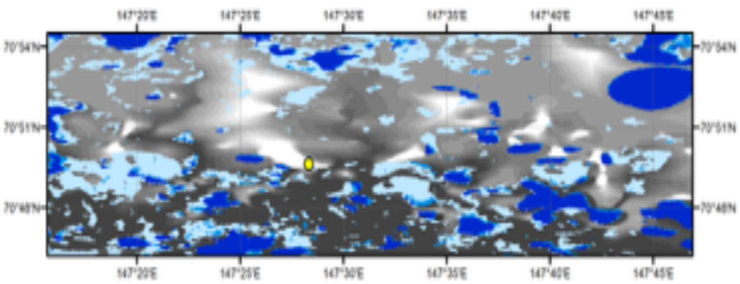

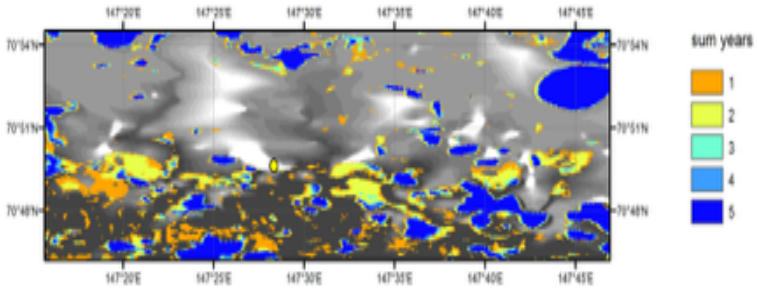

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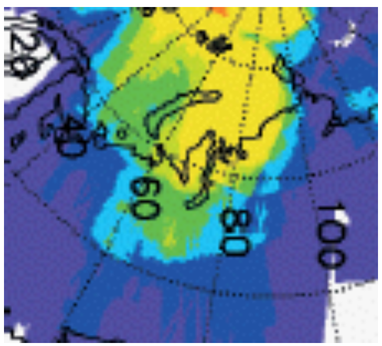
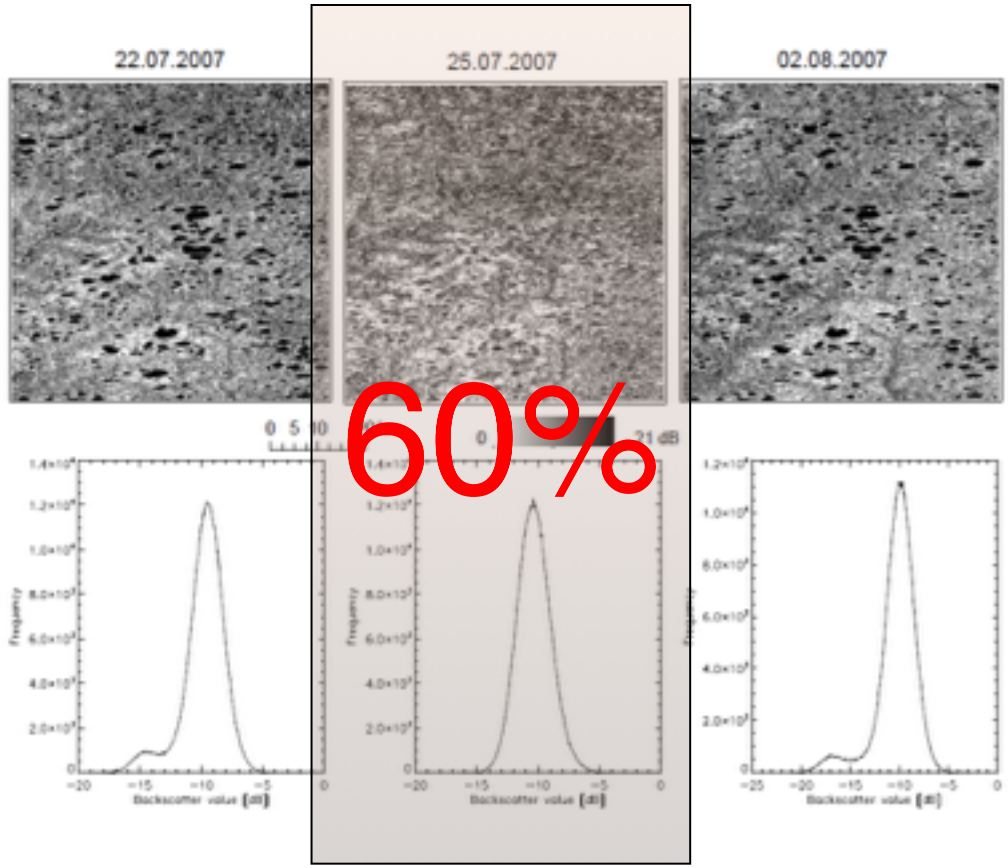
Product showing dynamics?

West Siberien Lowlands
Test with more than 4000 subsets of 0.25°
only VV





Bartsch, A., Trofaier, A., Hayman, G., Sabel, D., Schlaffer, S., Clark D. & E. Blyth (2012): Detection of open water dynamics with ENVISAT ASAR in support of land surface modelling at high latitudes; Biogeosciences, 9, 703-714.

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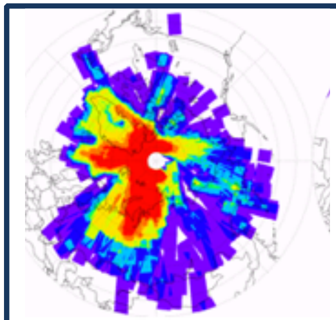

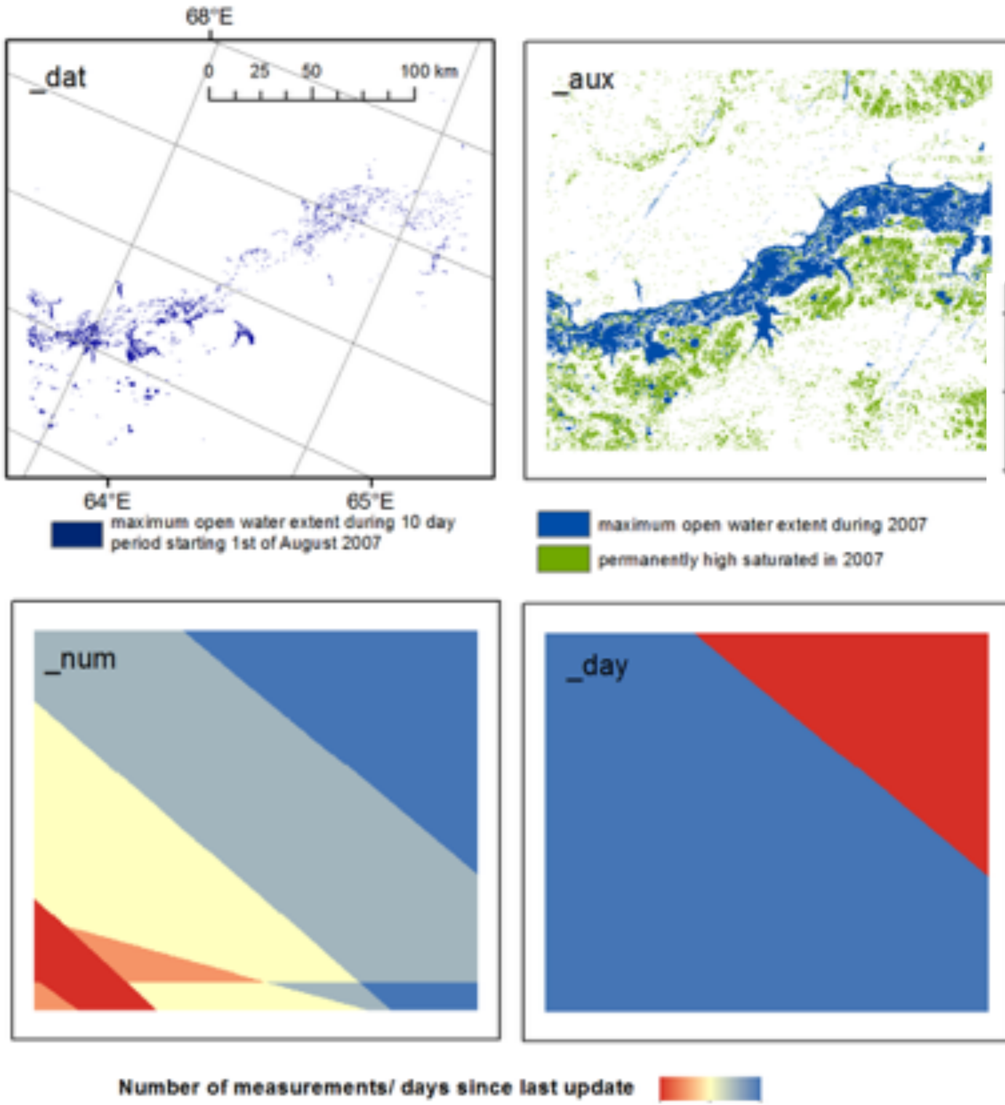

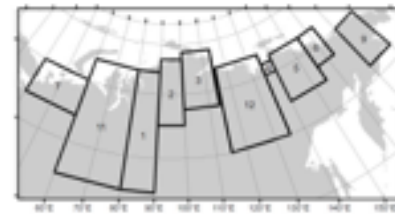

10 day intervals

Irregular in time and space, only VV

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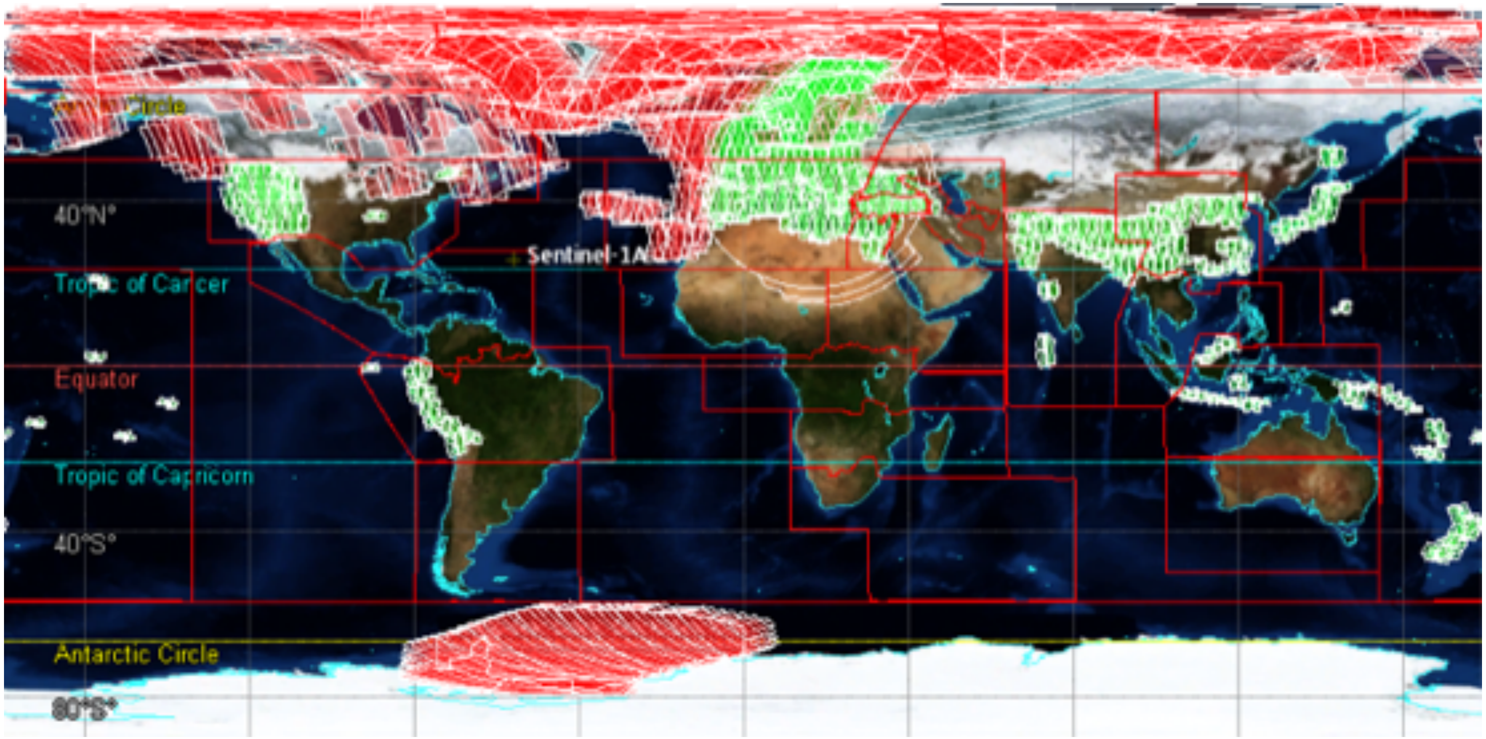
- Potential of S1 for circumpolar monitoring?



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Alternative – dynamics from global datasets

- Issues - water fraction dataset
  - many lakes are close to the coasts
  - In-situ measurements stations are usually close to coast or along wide rivers – problematic when linking up
- Issues - wetland fraction dataset
  - proportion to be attributed to lakes not available

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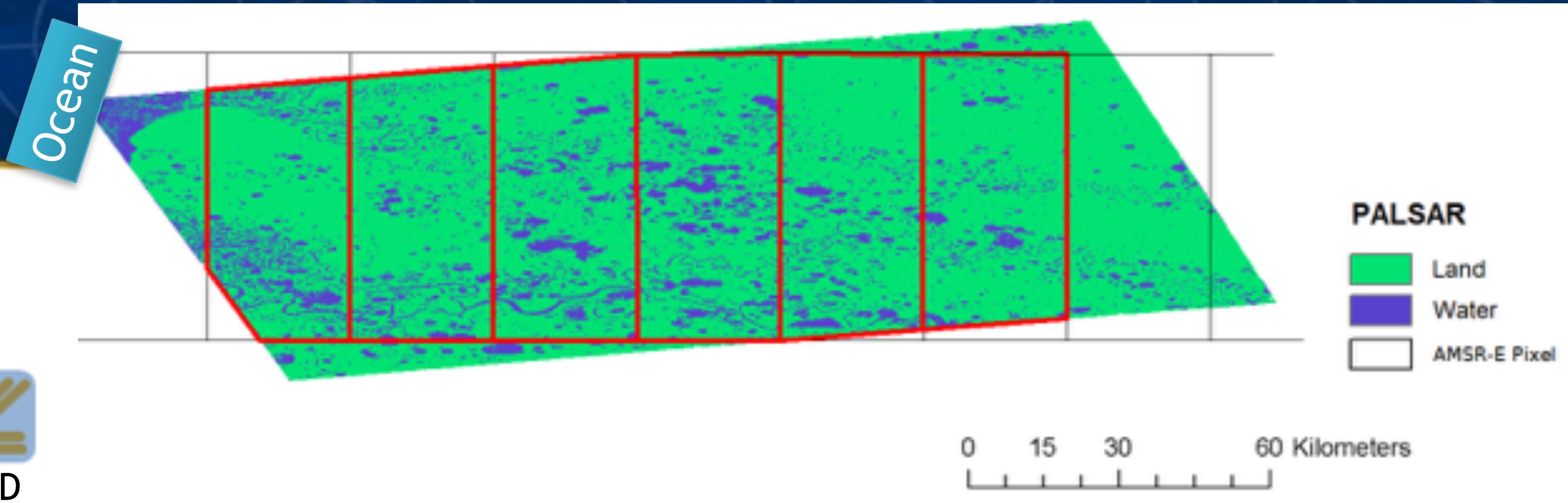
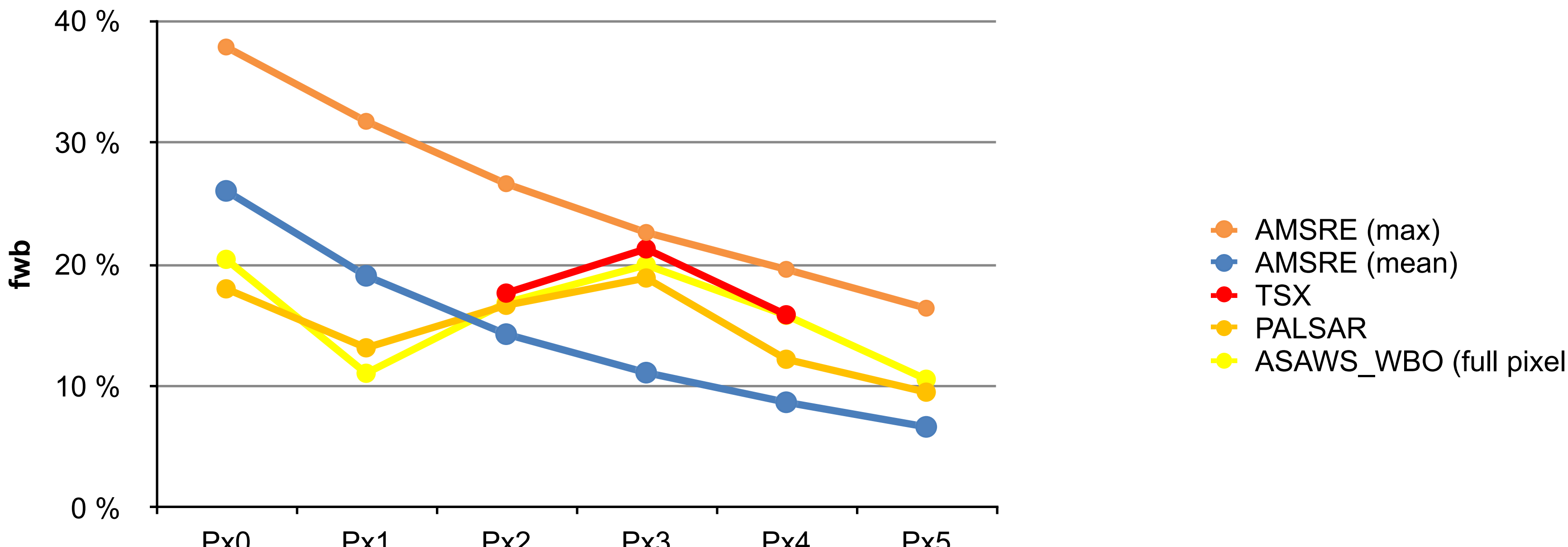
COLD
Yamal





Widhalm et al. 2014

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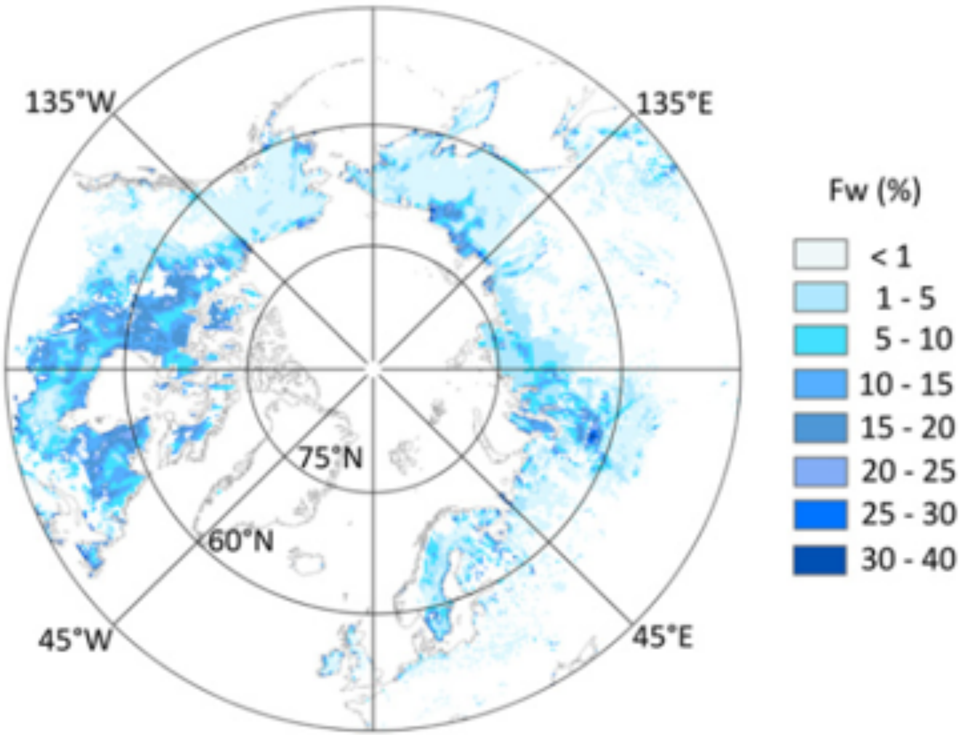
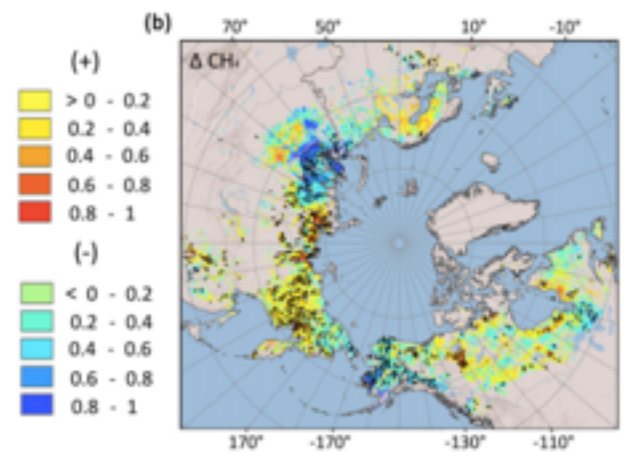


Still applicable for circumpolar studies



Watts, J. Kimball, J., Bartsch, A, K. McDonald, K. (2014): Surface water inundation in the boreal- Arctic: potential impacts on regional methane emissions. Environmental Research Letters, 9 (2014), 7 doi:10.1088/1748-9326/9/7/075001

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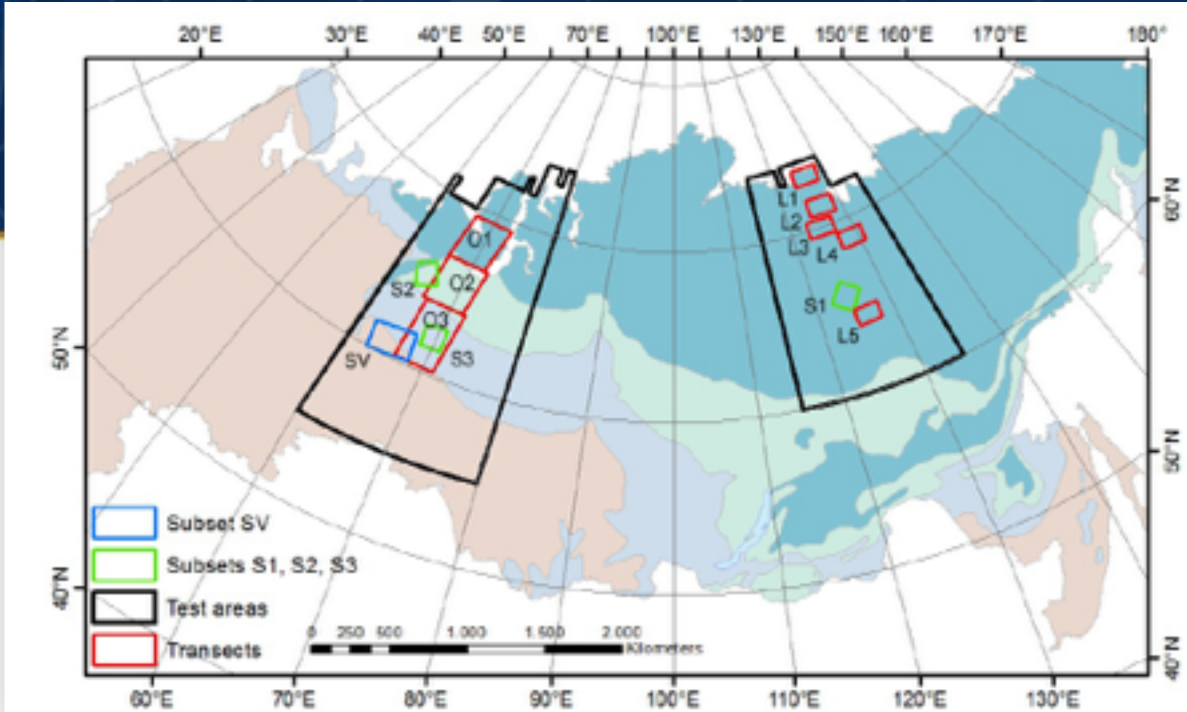

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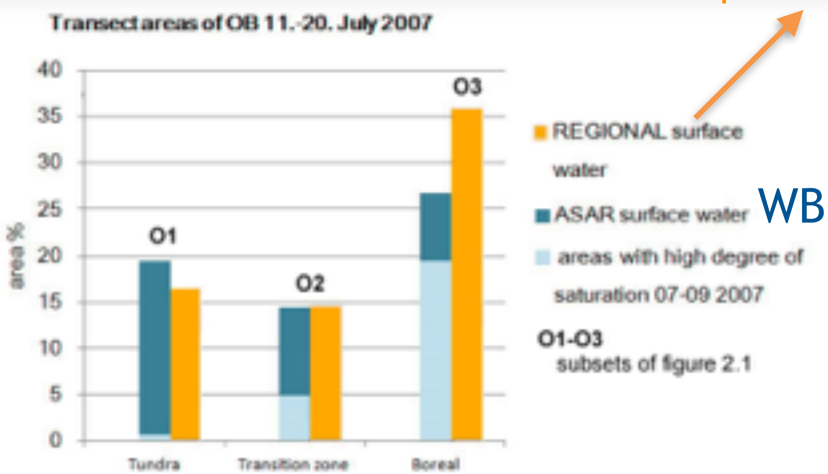
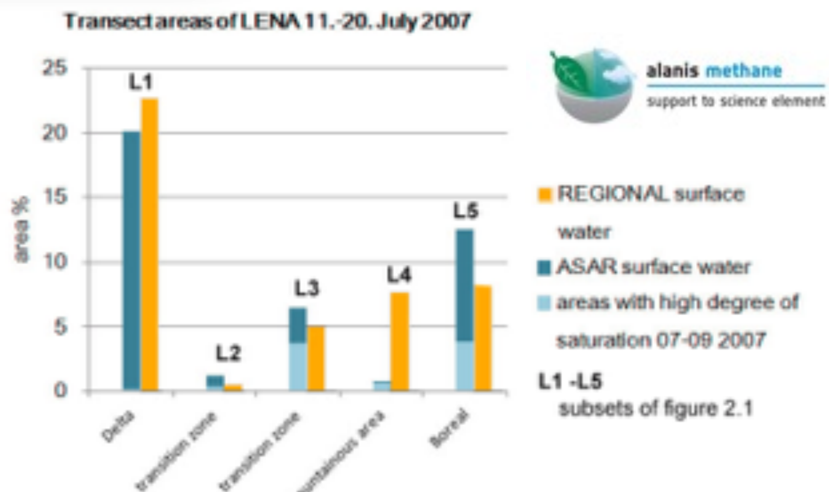
adaption of Prigent et al. 2001 (SSMI, AVHRR, ASCAT)



WB



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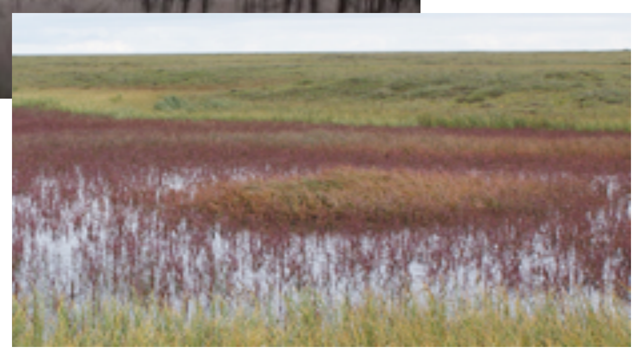
Summary

- We are theoretically able to obtain seasonality from SAR - this has been demonstrated by a range of ESA projects
- No circumpolar monitoring service yet foreseen for the future
- Global coarse resolution data cannot thematically and spatially consistently substitute higher resolution products



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