



**Growing season and primary production mapped by  
MODIS and Landsat 8 data on Svalbard**

**By Stein Rune Karlsen  
Laura Stendardi, Kjell-Arild Høgda, Bernt Johansen**



Svalbard



King Georg Island

Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
Image Landsat  
Image U.S. Geological Survey

58°10'36.93" S 56°46'35.93"

Image IBCAO  
Image Landsat  
US Dept of State Geographer  
© 2015 Google



## Surface Reflectance, 8-days composite

- a) MOD09A1 product: 7 band, 500m pixels
- b) MOD09Q1 product: Red and NIR (NDVI), 250m

## Removing clouds

**We use a combination of three cloud removing methods:**

For each 8-days period we visually evaluate:

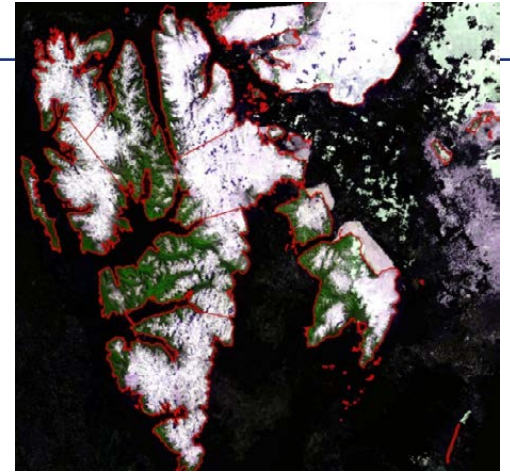
- State quality assessment (QA) values
- Own algorithms
- Manual removal

Altogether we have 16 different combination of using QA values/own algorithms/manual masking in cloud detection. For each combination we developed a python script to removed the clouds.

- Time-consuming as it requires visual inspection of cloud cover, but it is only done once.

## Interpolating cloudy parts

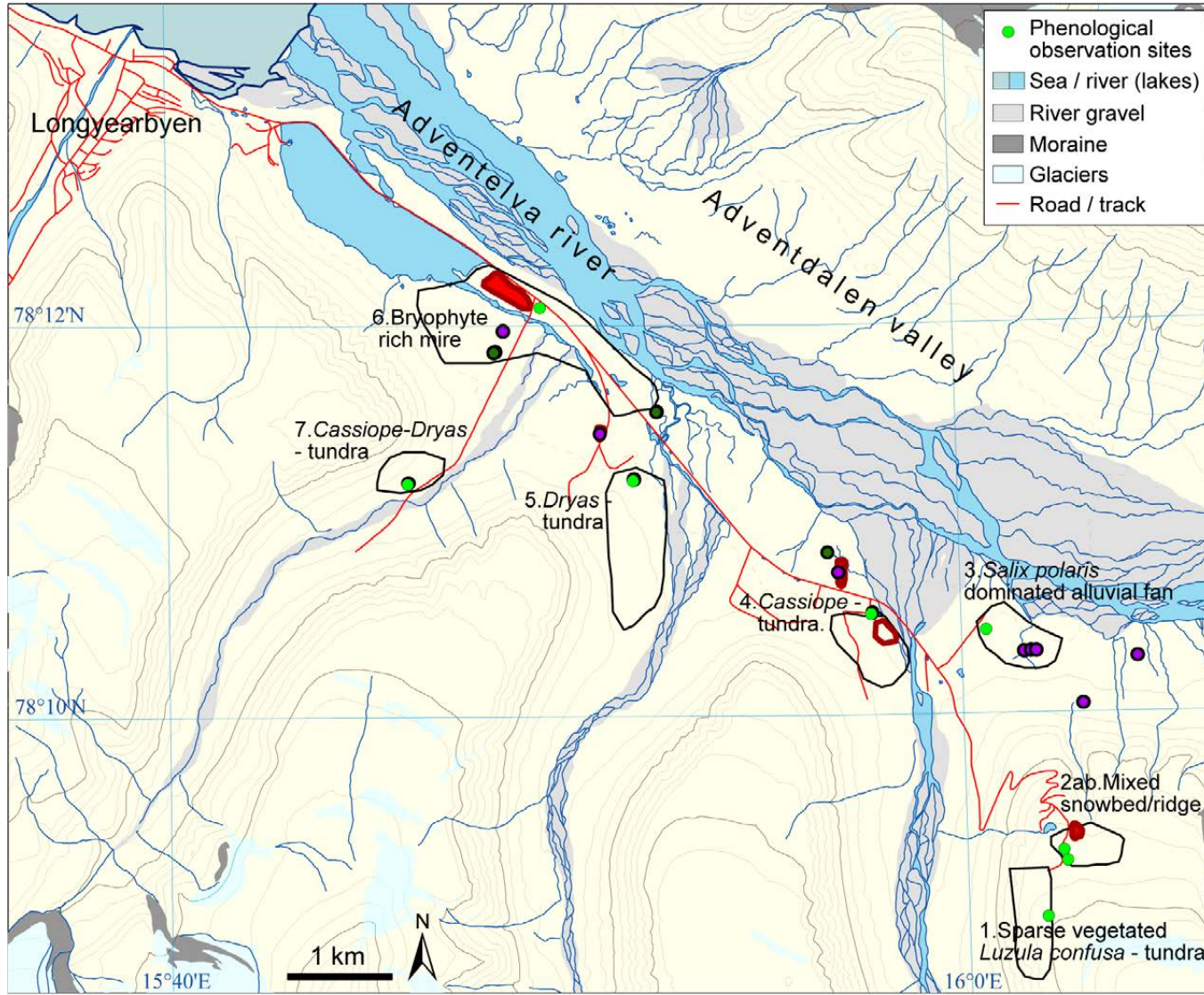
- replace the cloudy pixels based on temporal information (mean value from the periods before and after)
- Then apply Savitzky-Golay filter with down-weighting of the interpolated values.





Phenology : Observations in field 2009-2013. Time-lapse cameras (trail cameras) since 2014 (2013).

Primary production: started in 2015





Arctic Willow (*Salix polaris*)





## Example of images from time-lapse camera – of Mountain Avens (*Dryas octopetala*) 2014



11 July



31 July



10 August



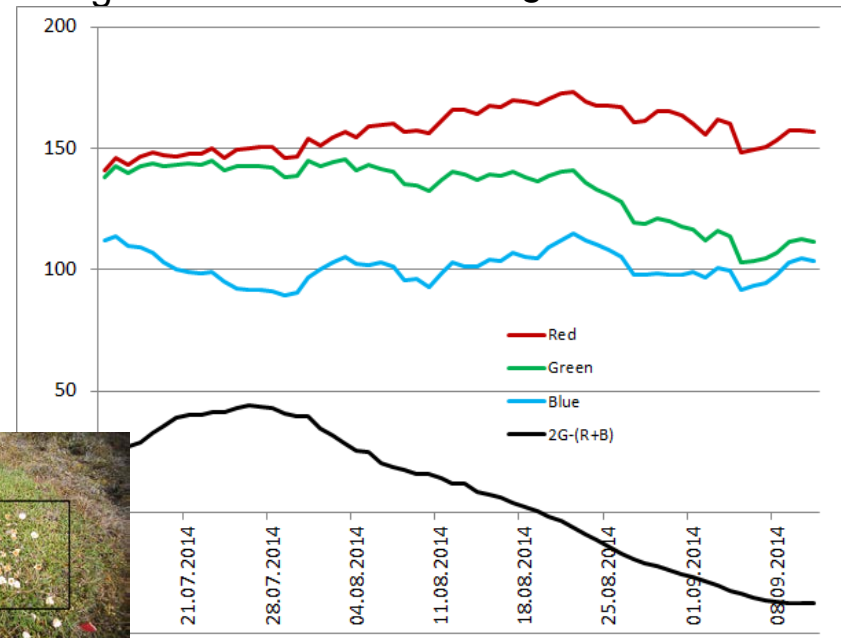
24 August



5 September



9 September



## Methods to map the growing season

**To map the onset of the growing season we use a NDVI threshold method**

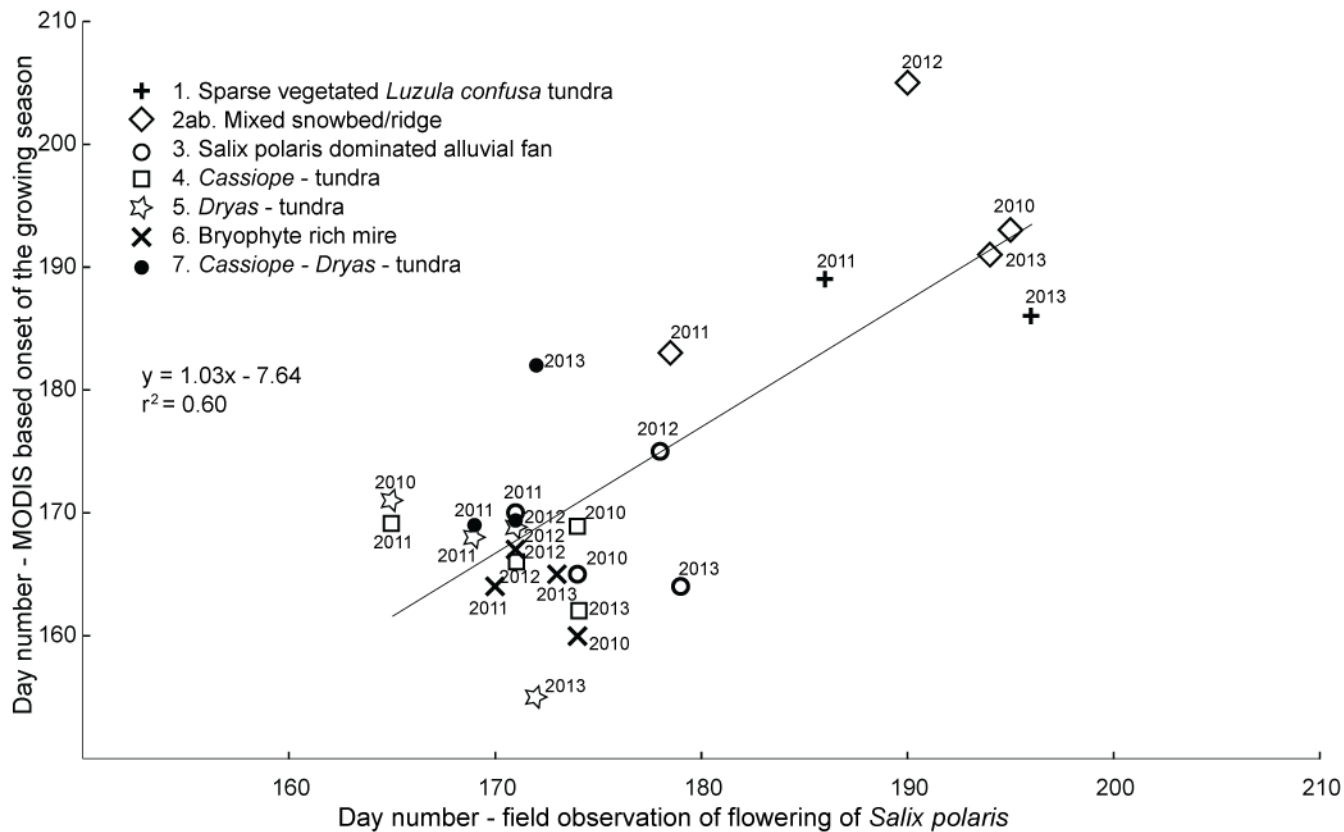
- Calculate the 15-year (2000-2014) mean NDVI value for the July period
- Onset of the growing season occurs each year when the NDVI value exceeded 70% of this 15-years mean NDVI value.

**End of the growing season**

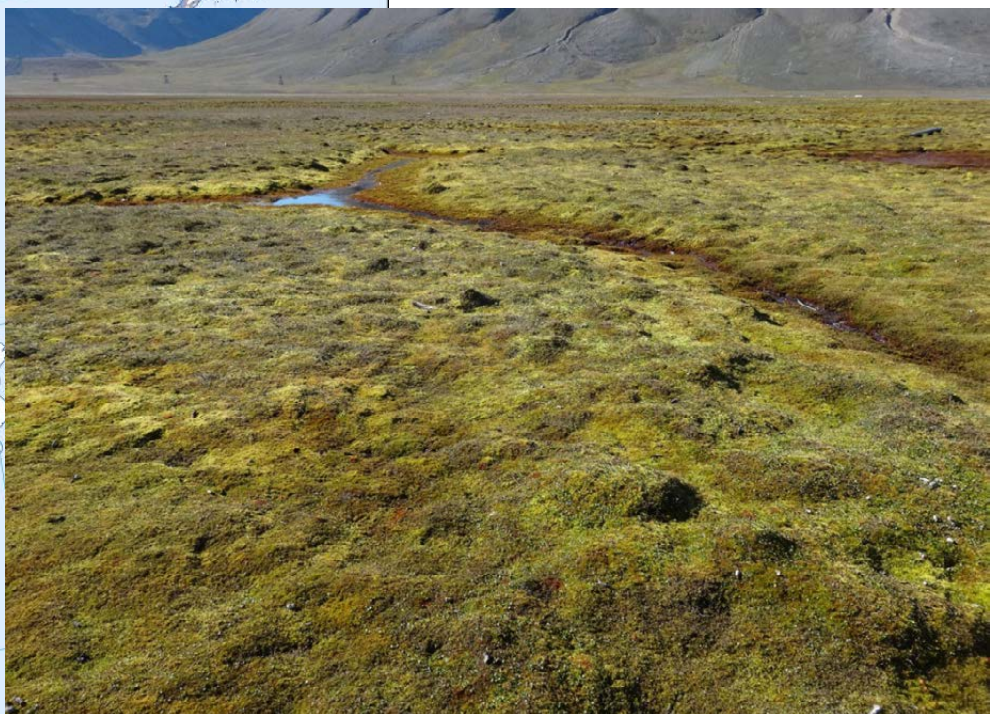
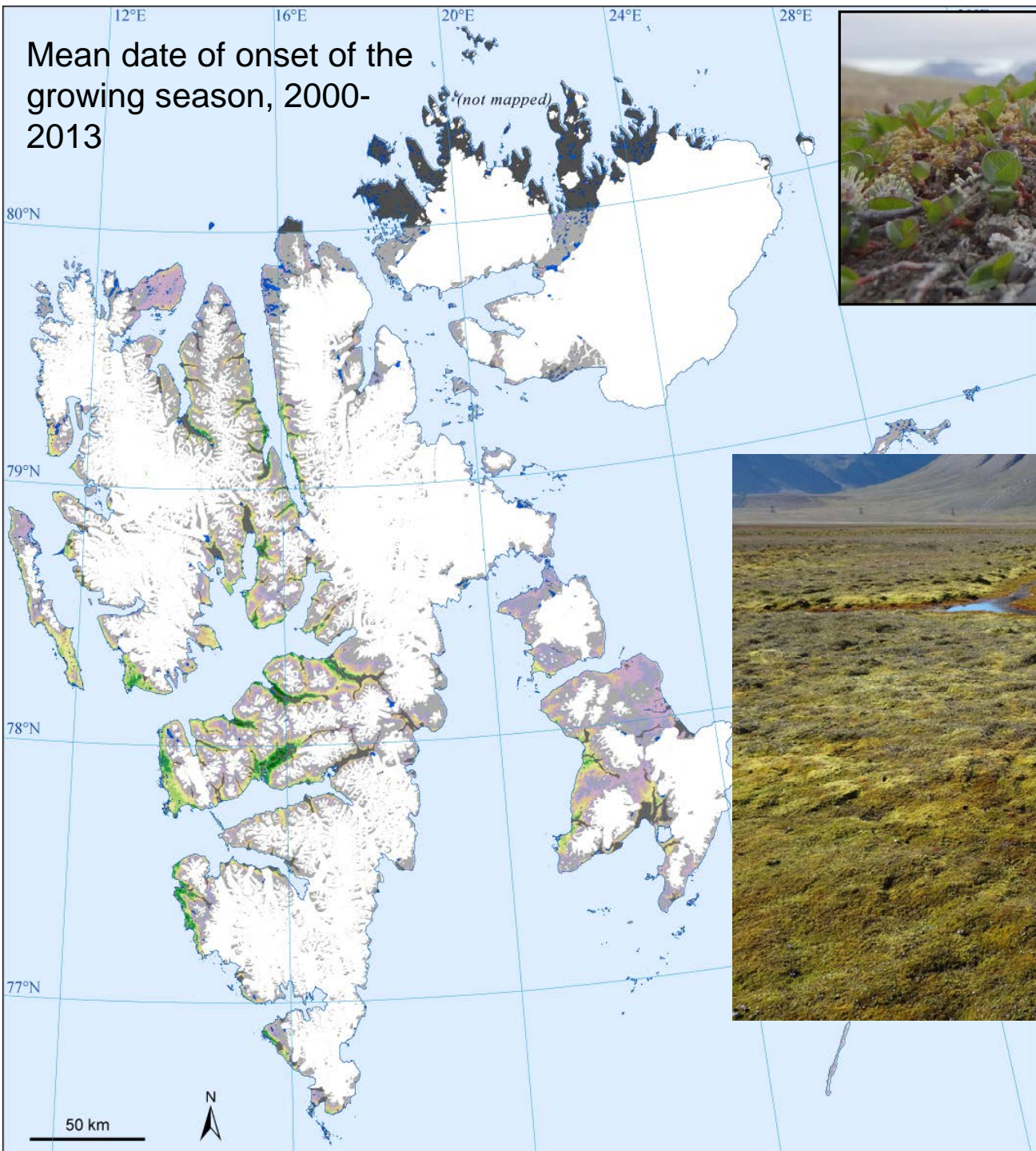
- No methods works for all vegetation types
- Use an index based on the red and the SWIR bands, decrease from annual peak
- Red/green ration – when the bands meet
- NDVI (EVI2), decrease from annual peak



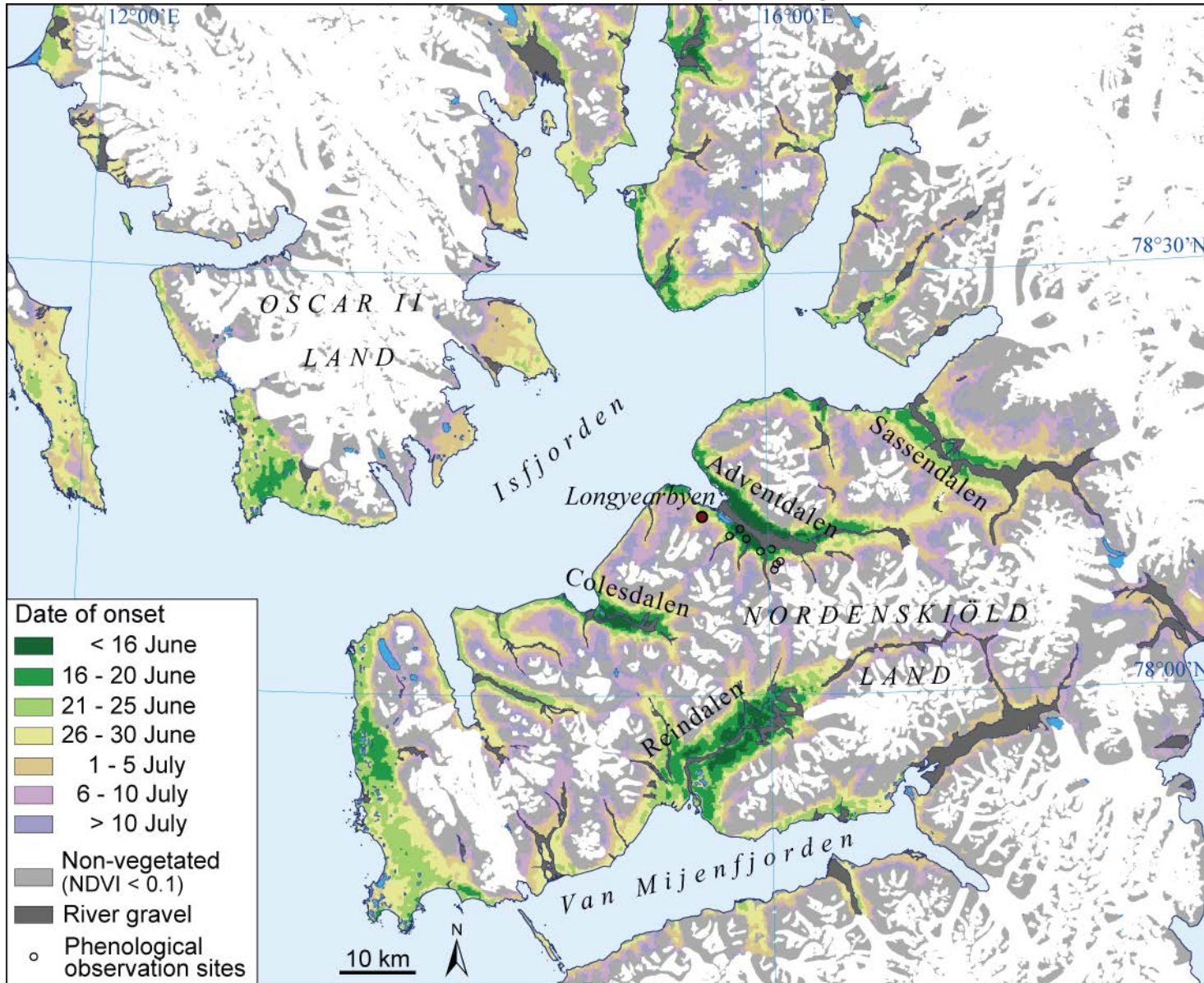
# Correlation between MODIS NDVI-based onset of the growing season and time of flowering of Arctic Willow (*Salix polaris*)



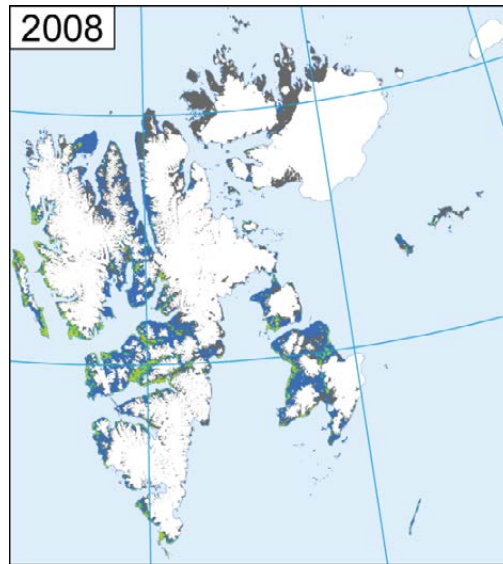
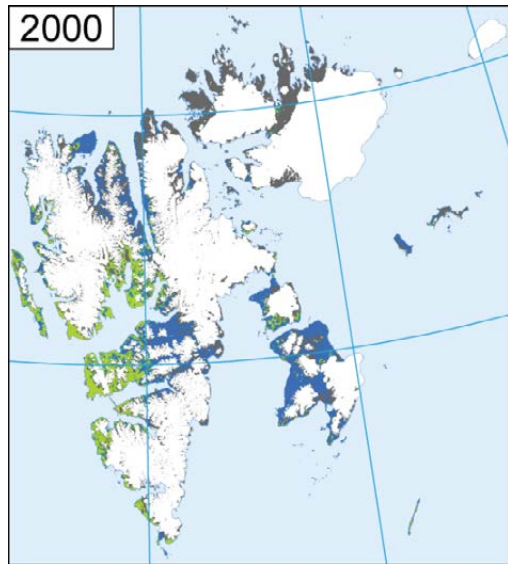
# Mean date of onset of the growing season, 2000-2013



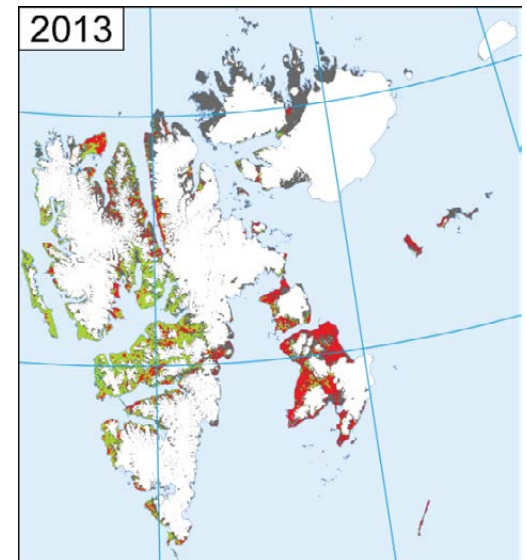
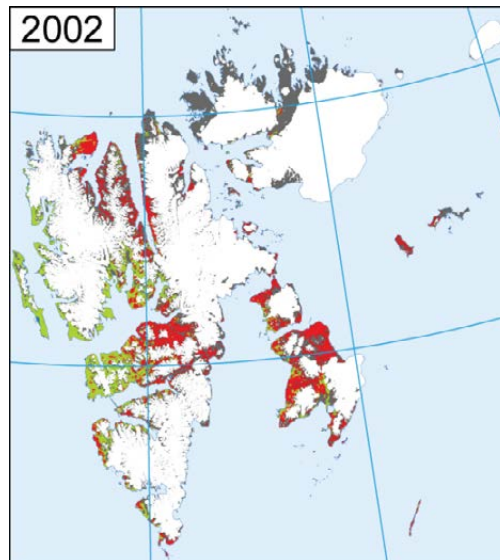
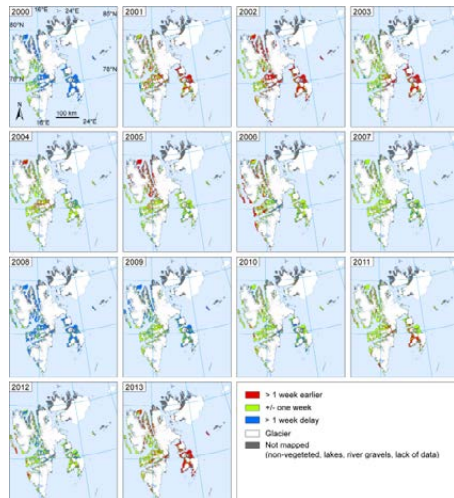
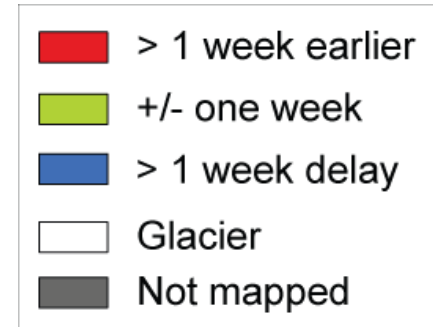
## Central Svalbard. Mean date of onset of the growing season, 2000-2013



# Early/late years in onset of the growing season

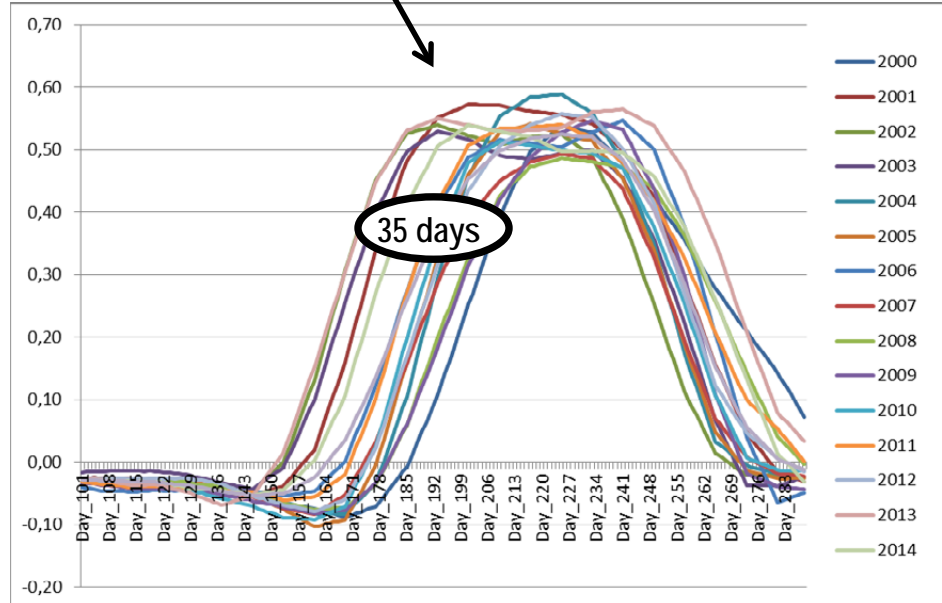
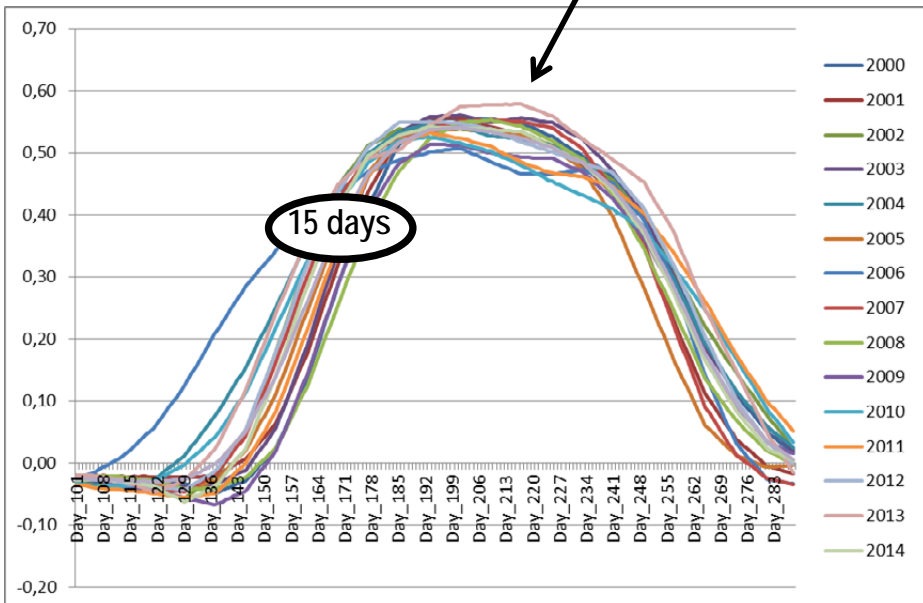
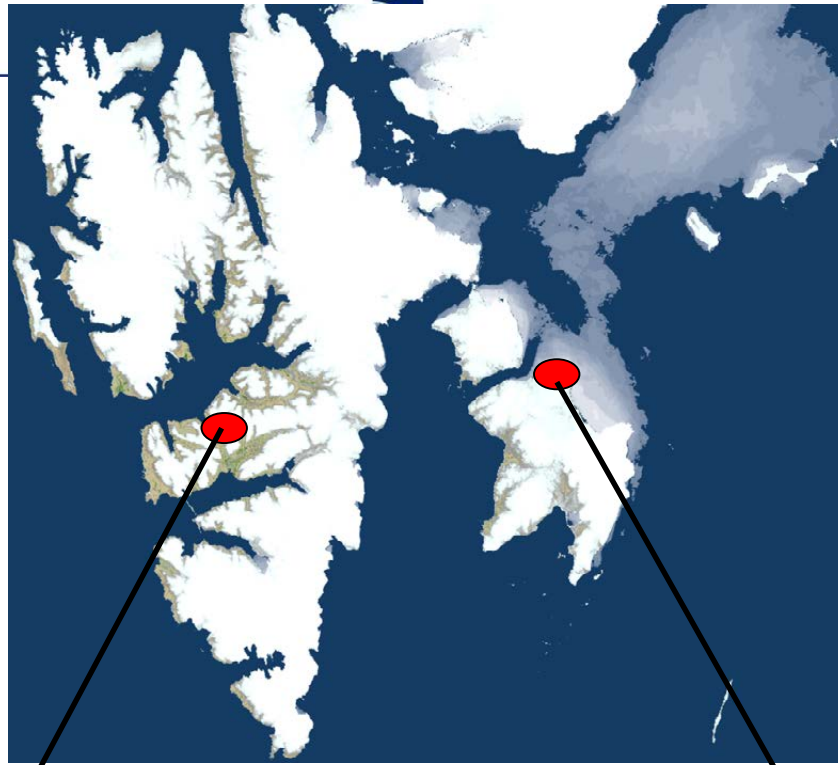


Regional variation in onset of the growing season - from the 2000-2013 average



# MODIS-NDVI

daily data  
year 2000-2014



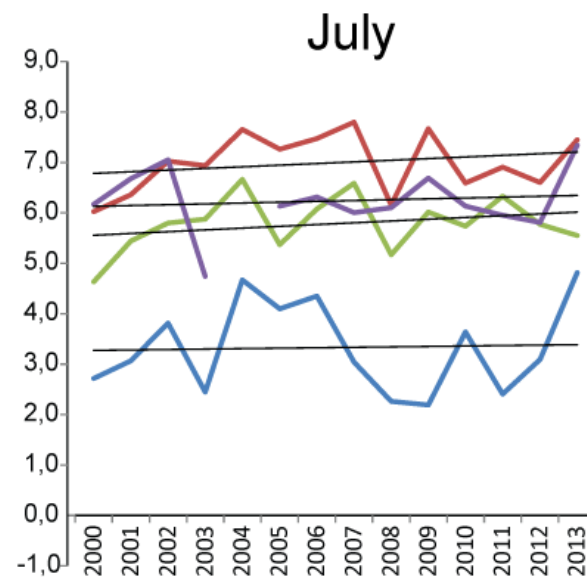
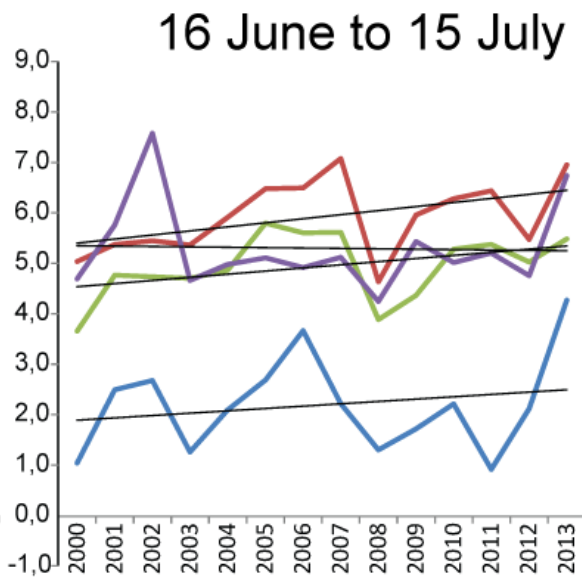
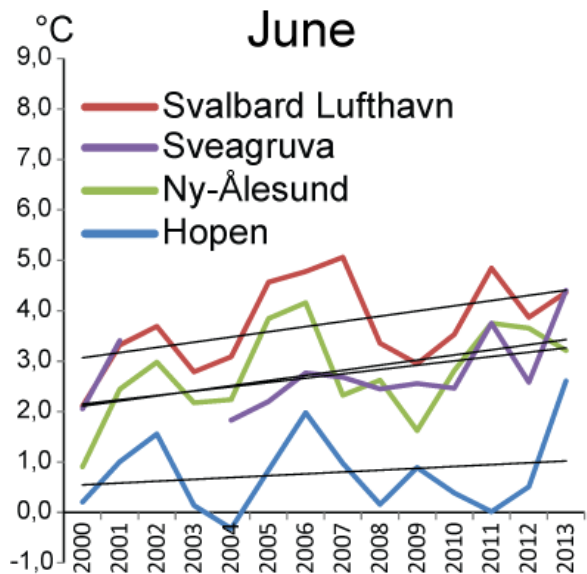
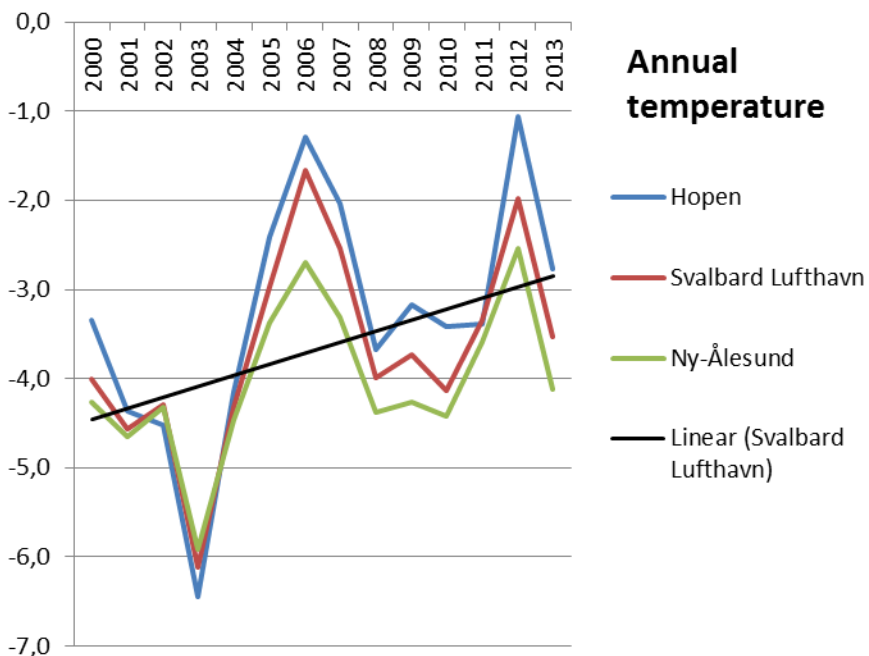
# Linear trend in onset 2000-2013

## Climatic stations

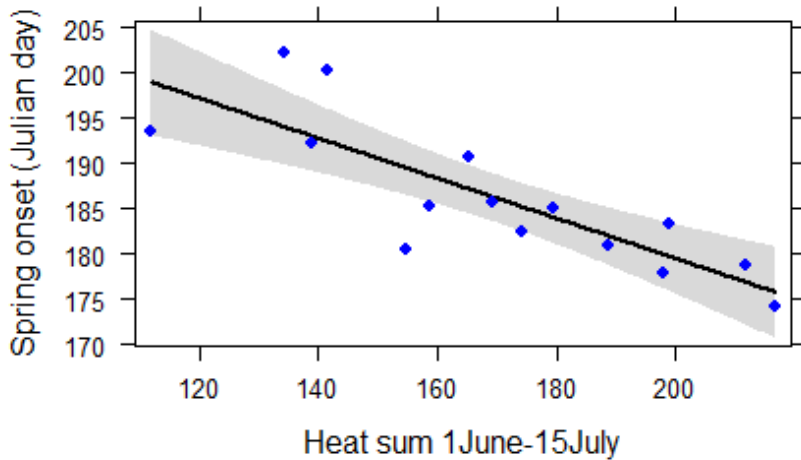
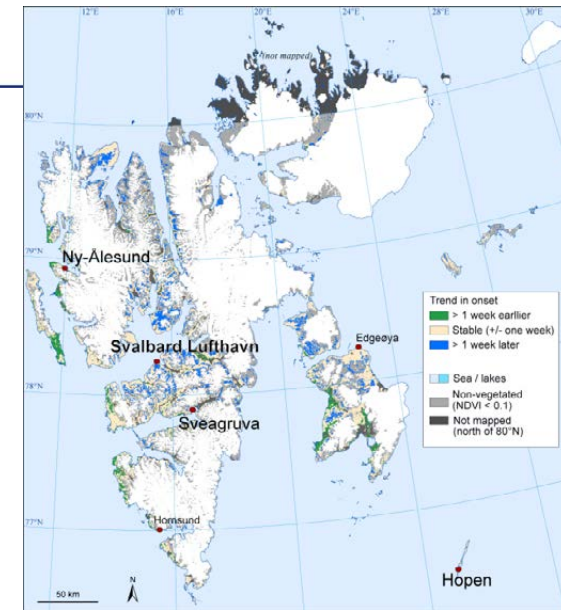
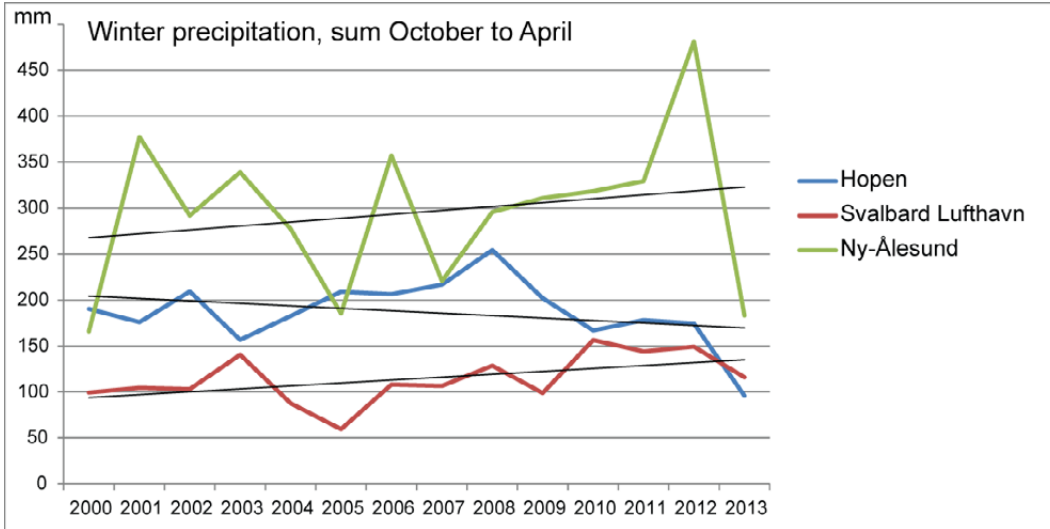




# Climate



# Climate

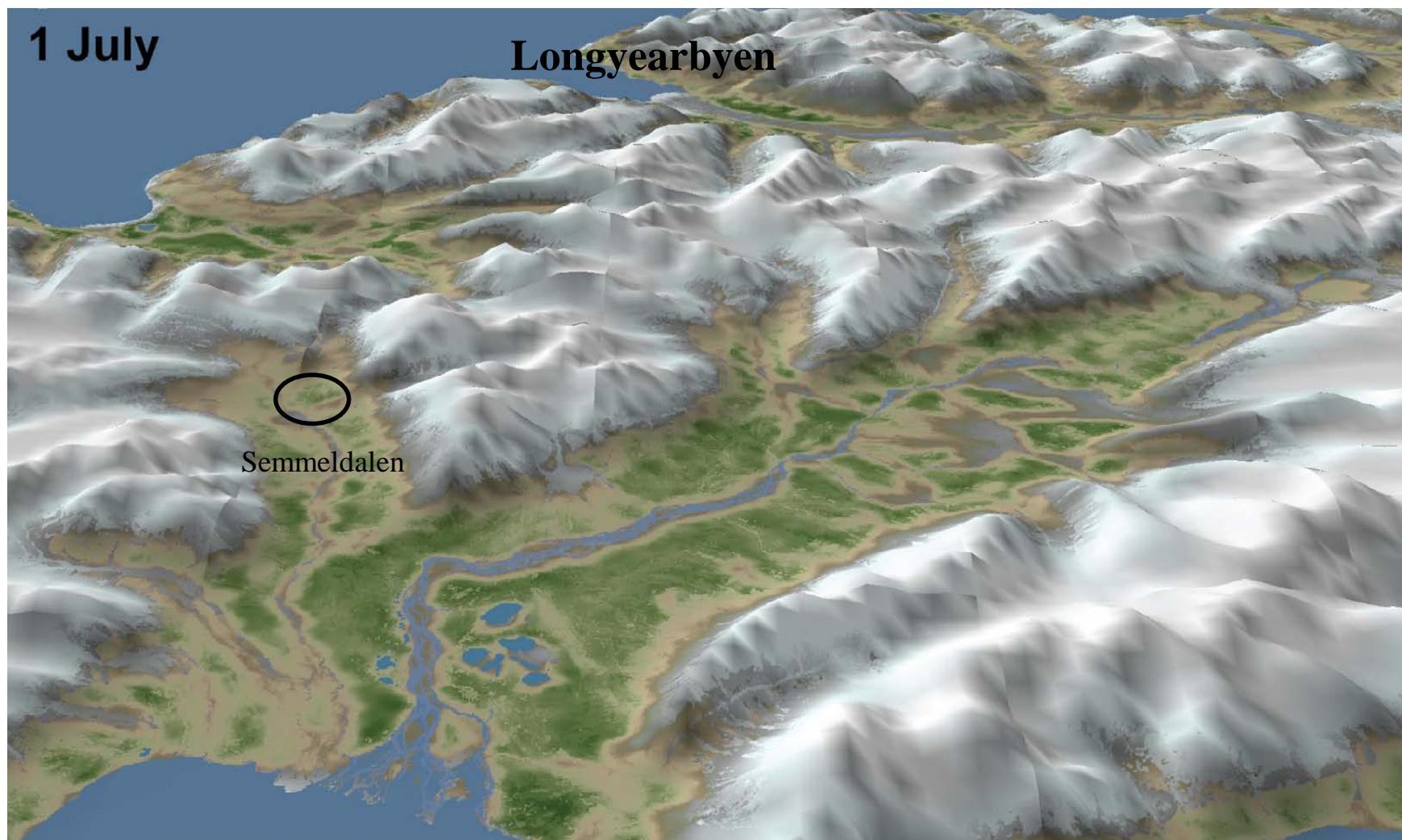


Onset is well correlated with spring (June-July) temperature ( $p < 0.05$  for all climatic stations)

Snow only delay onset in particular snow rich years (MODIS scale)

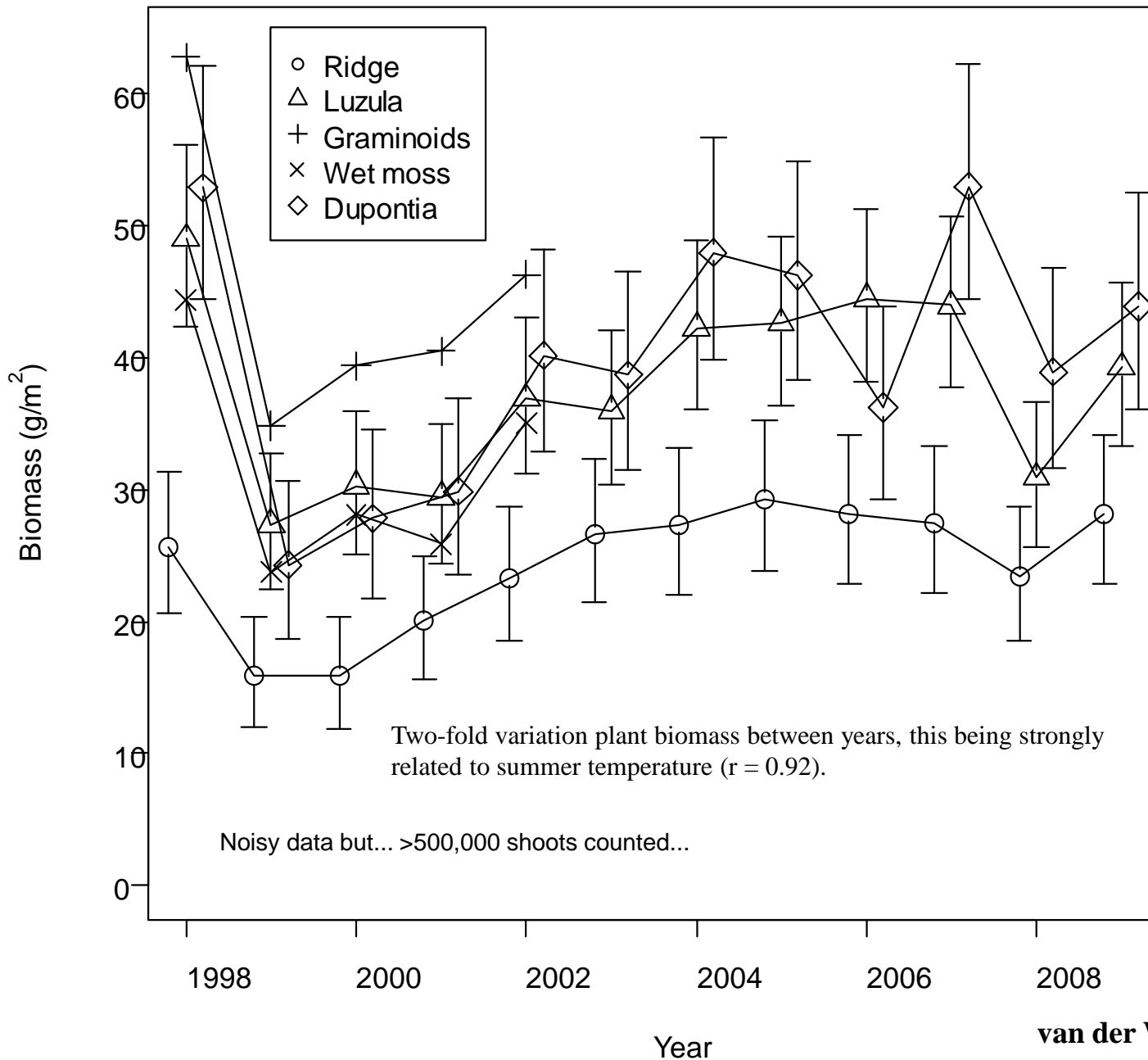


# Plant production – field data from Semmeldalen



Animation





## Correlation value (r) between field biomass data and NDVI/onset

	Time integrated NDVI from onset to peak NDVI	Date of onset of the growing season	Max NDVI
<i>Luzula</i> heath	0.64*	-0.53*	0.33
Ridge	0.76**	-0.32	0.39
<i>Dupontia</i> marsh	0.34	-0.35	0.15
All vegetation types	0.71**	-0.46	

## Summary - MODIS

Combine three methods for cloud detection (Stat QA + own cloud masks + visual masking) for developing cloud-free time-series of MODIS data. Time-consuming, but is only done once.

High variability between the years in onset of the growing season and tundra productivity, in eastern and northern parts of Svalbard.

No clear trend in onset of the growing season, 2000-2014. No increase in temperature when the growing season starts.

Relationship between plant biomass and time-integrated NDVI (Integrated from onset of the growing season to peak of season). Two-fold variation in plant biomass between years on western Svalbard.

# Time-series of Landsat 8 data



Polar orbit: all the paths 22-29 and 211- 217, within row 34 and 240-241, cover Longyearbyen

For the May-September period:

2014 (15 May – 15 Sept): 85 images, 17 used (7-days average interval)

2015: 74 images: 23 used

2015: Sentinel-2 data?

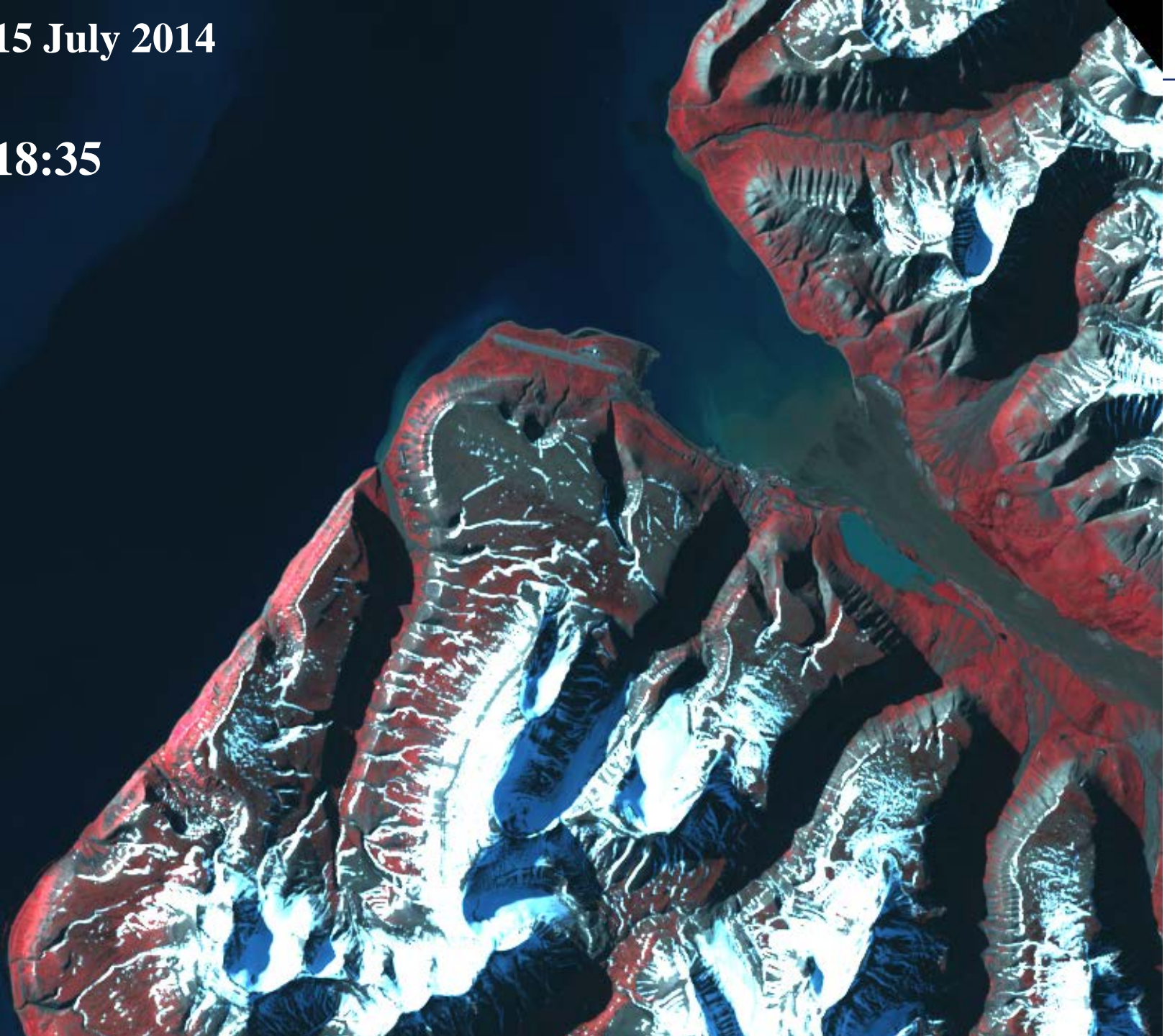




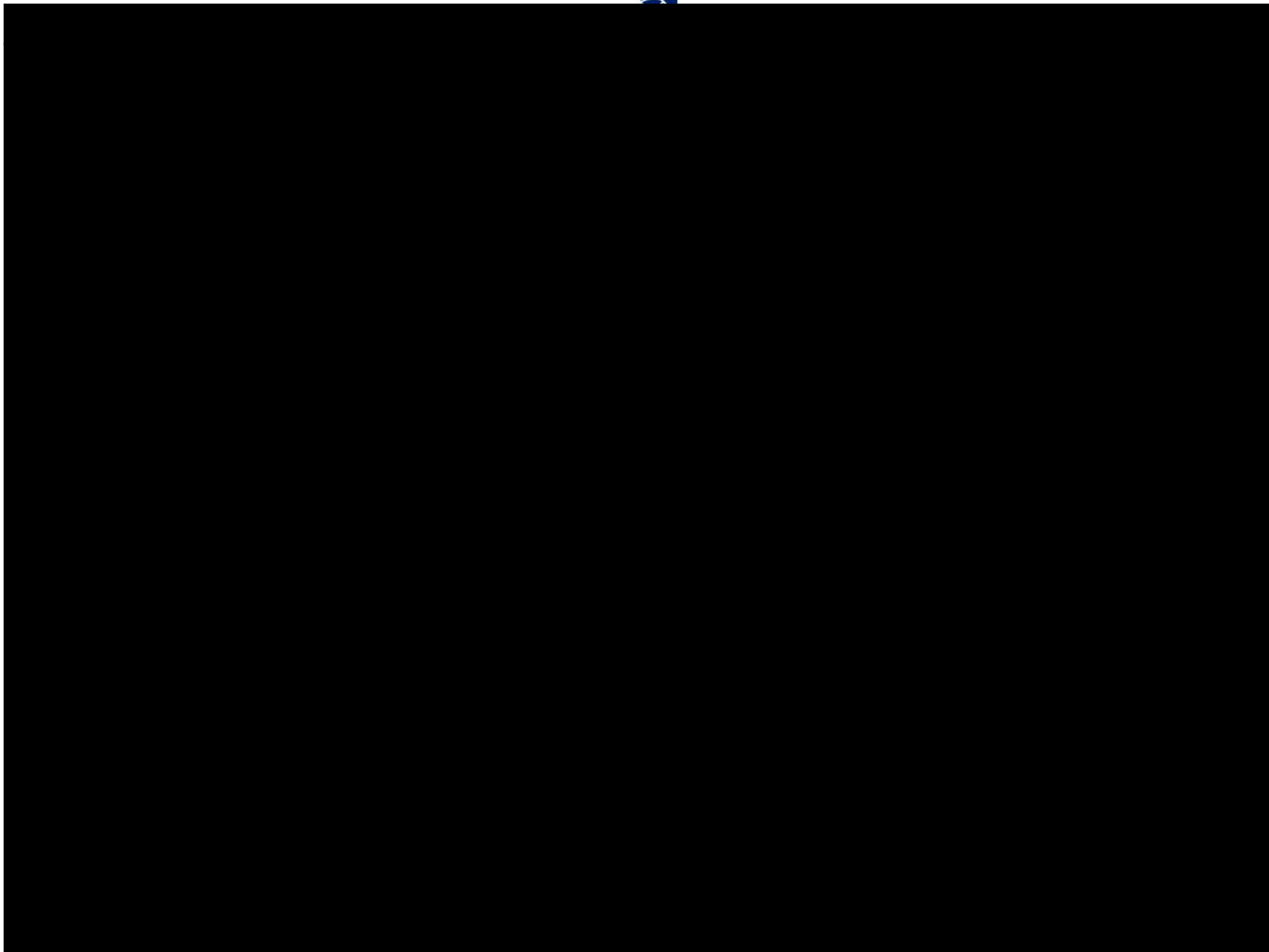
RGB – 15 July 2014

15 July 2014

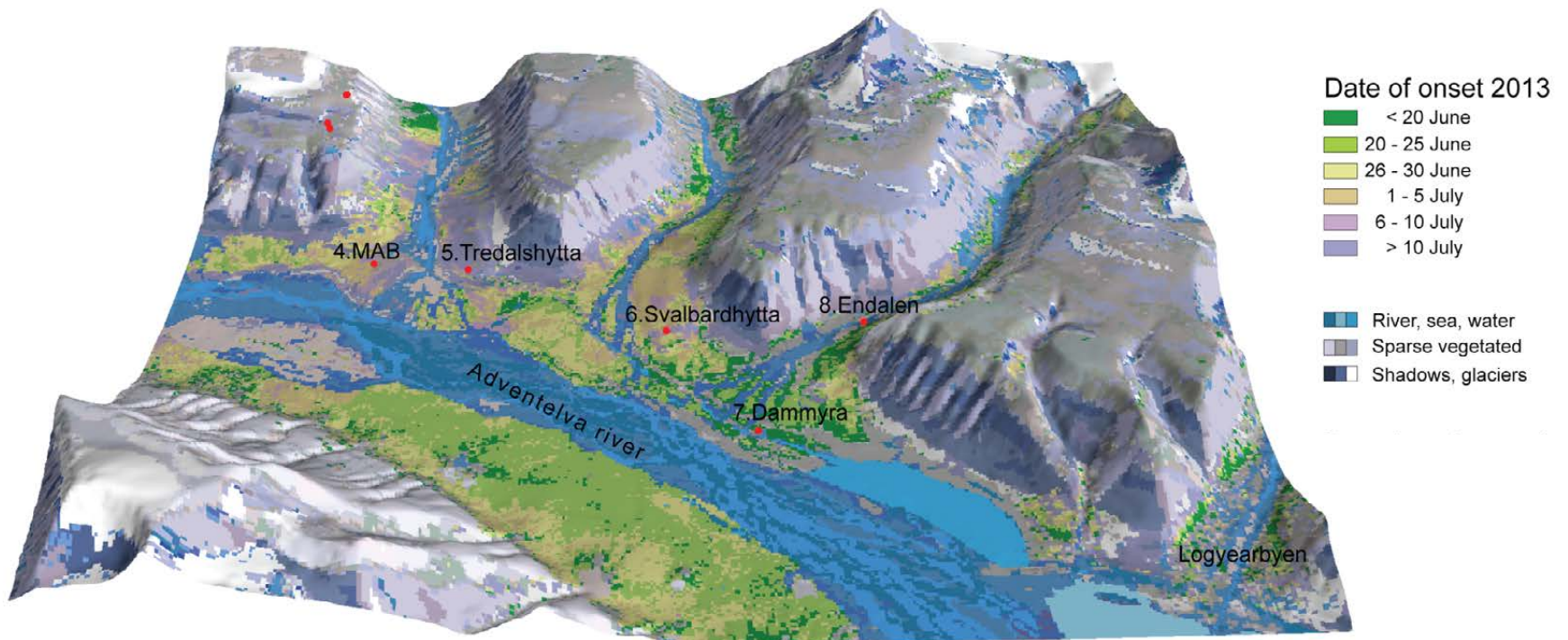
18:35

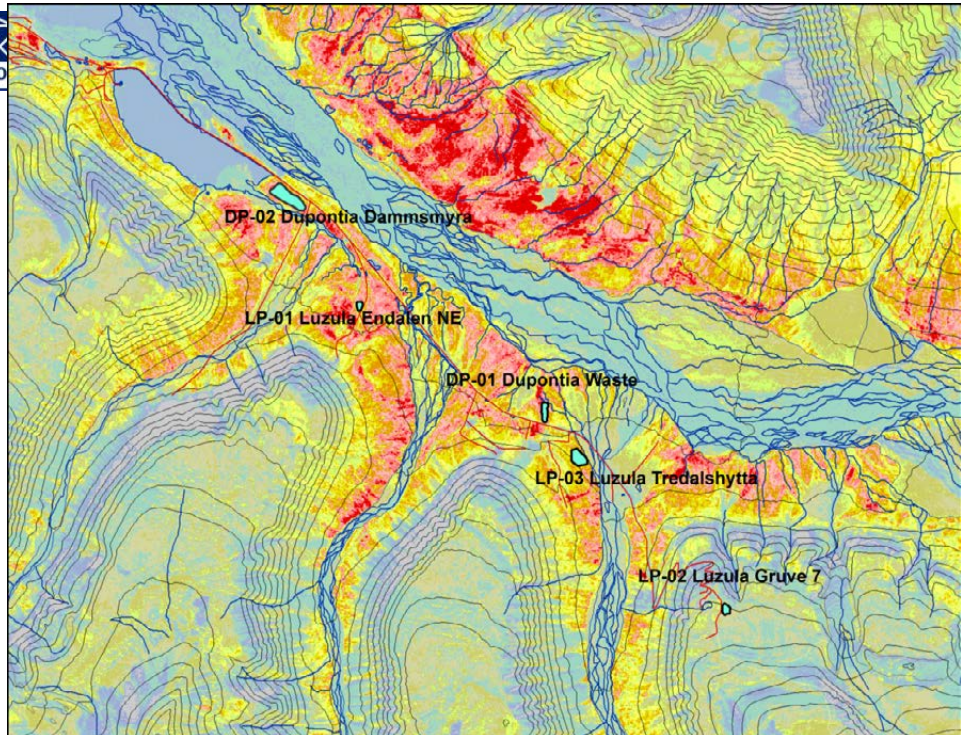






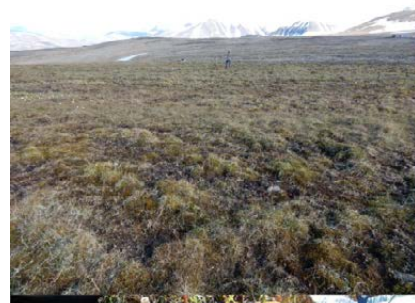
# Landsat 7 and Landsat 8 data mapping the onset of the growing season Test year 2013





Tundragras (*Dupontia fisheri*)

Mean of 160 g/m<sup>2</sup> dry weight in 2015 of green aboveground biomass



## **Next step:**

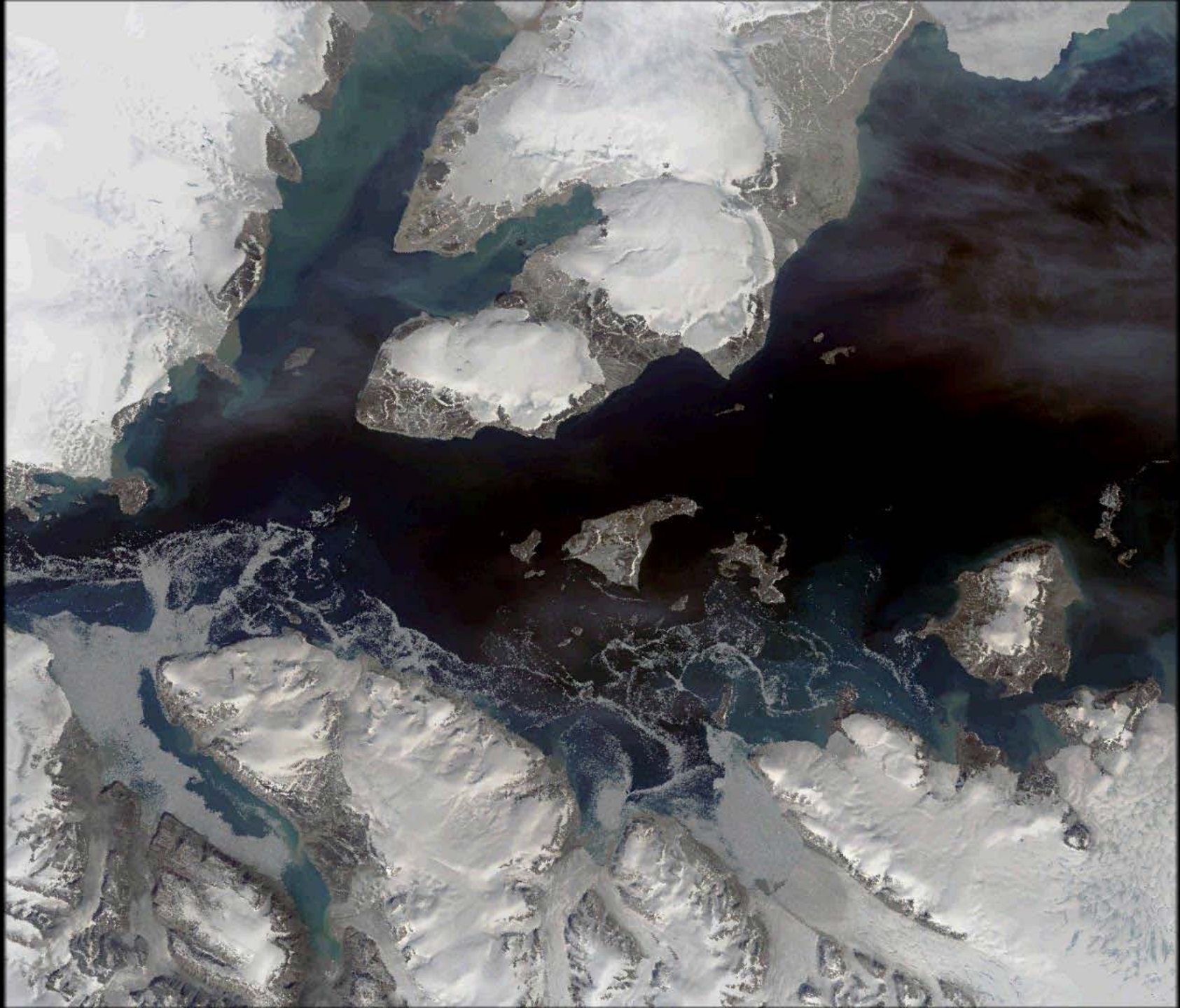
### **Longyearbyen-Adventdalen valley area:**

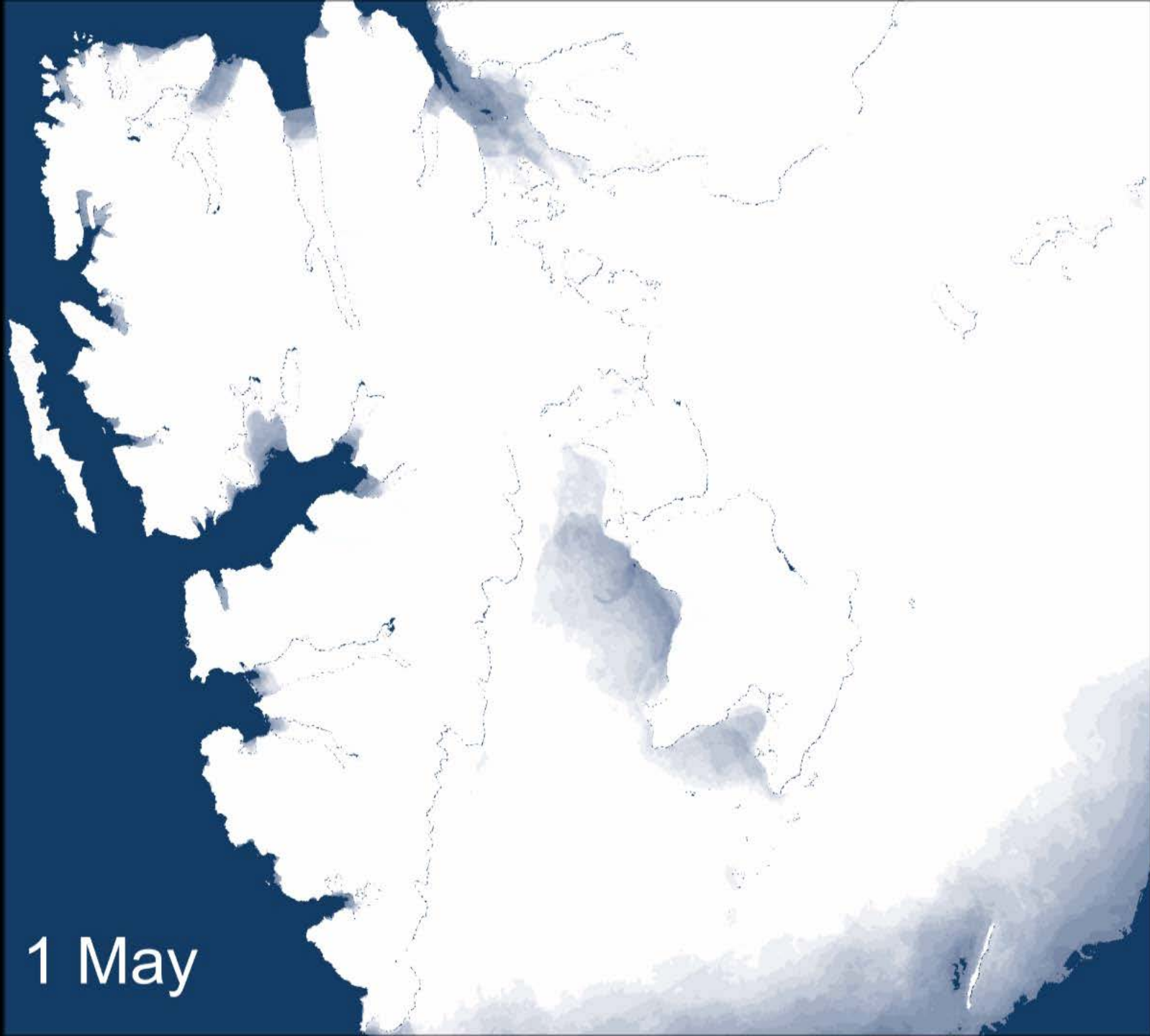
Time-series of Sentinel-2 and Landsat 8 data to map the growing season and estimate primary production of selected vegetation types

Combine Sentinel-1 and Sentinel-2 to characterize the seasonal cycle

**Thank you for your attention!**







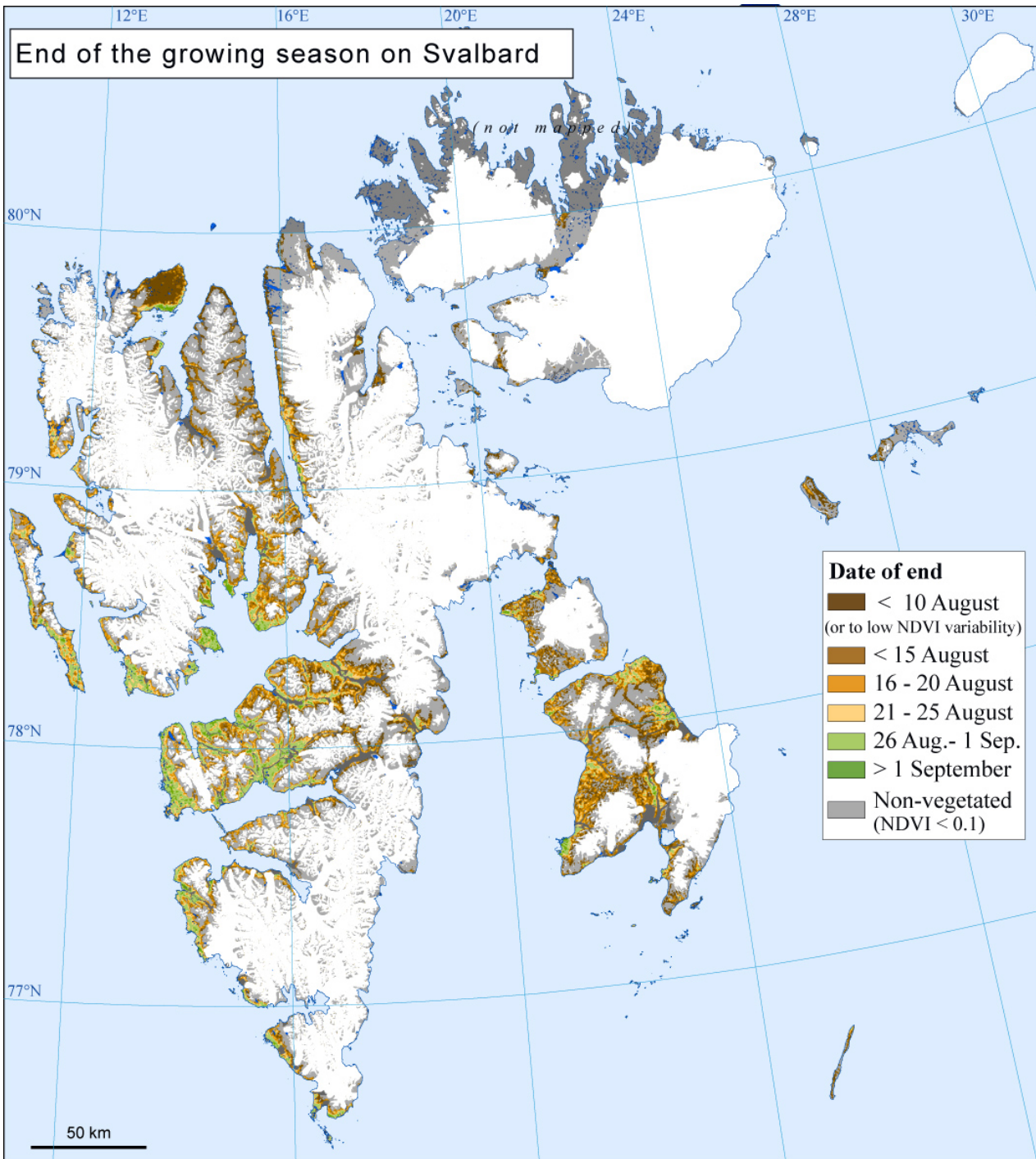
1 May





# Svalbard





End of the growing season

50% yellow leaves of Arctic Willow (*Salix polaris*)

Mapped with an index based on a combination of the red and a SWIR band