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High resolution digital soil organic carbon mapping in Western Greenland

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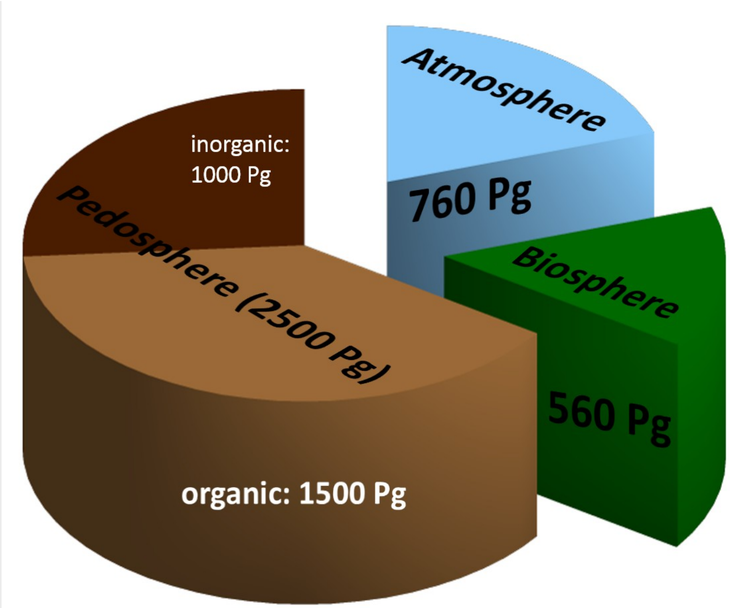
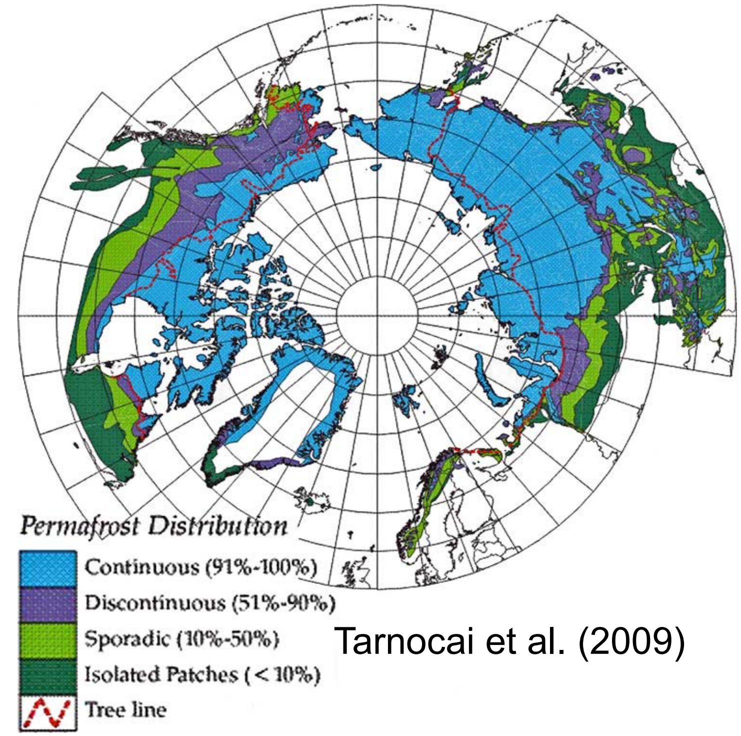
Topics

1. Introduction
2. Goals
3. Study Area
4. Methods and Data
5. Preliminary Results
6. Sampling Design

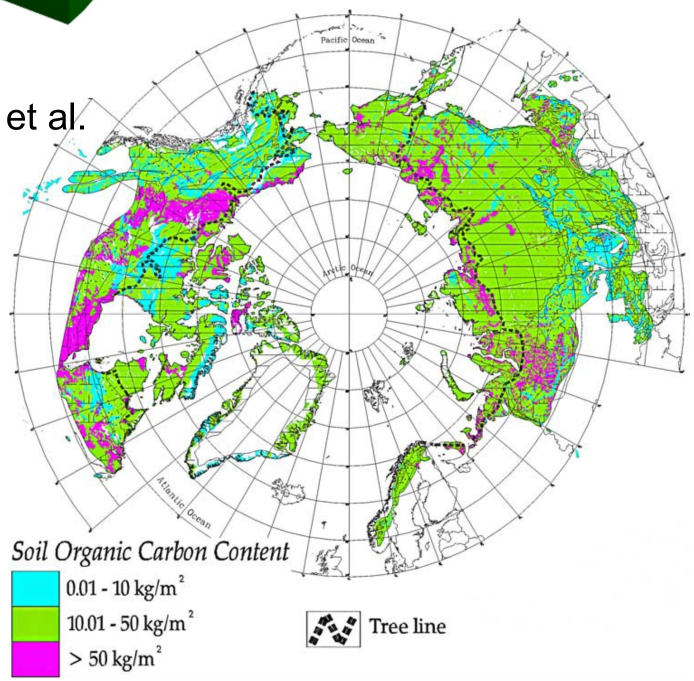
1. Introduction: Soil Organic Carbon (SOC)



Lal (2008), Batjes (1996), Falkowski et al. (2000), Pacala & Socolow (2004)



Tarnocai et al. (2009)



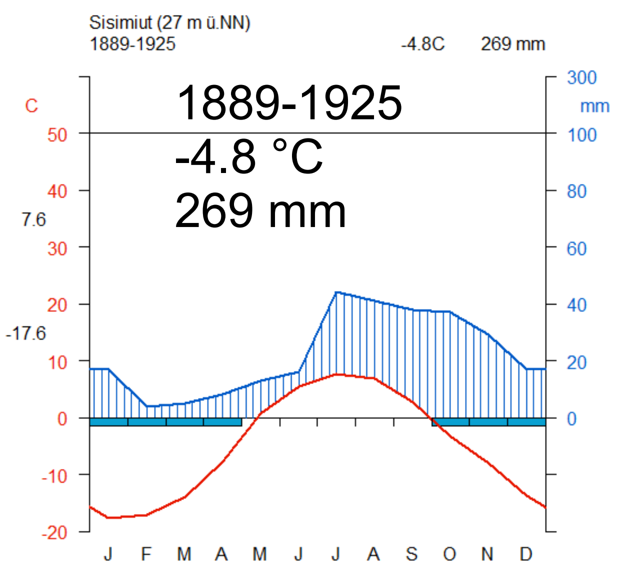
Tarnocai et al. (2009)

organic carbon in permafrost-affected soils: 500 Pg

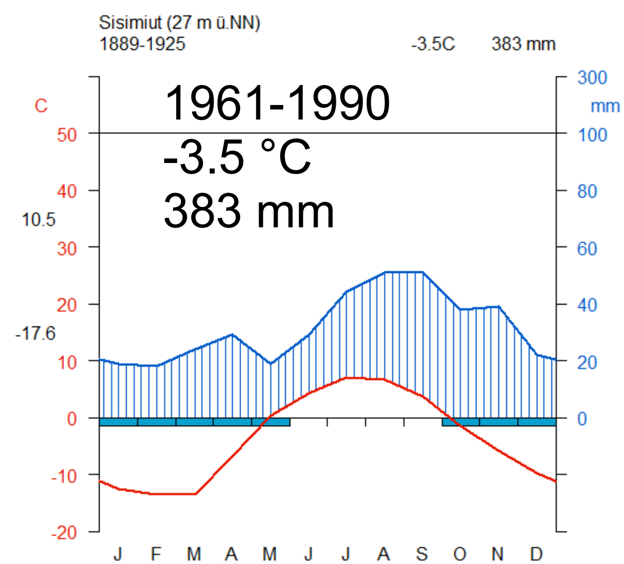
1. Introduction: Climate Change

effects of climate change:

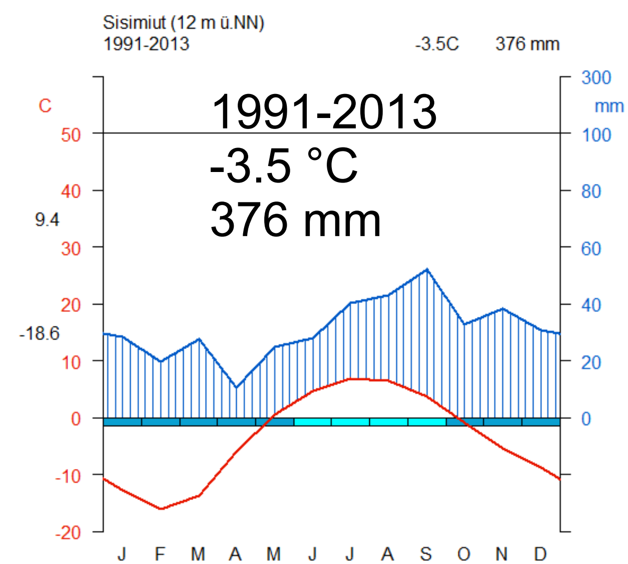
- permafrost-affected soils thawing
  - to greater depth
  - for longer periods
- increasing release of carbon (CO_2, CH_4) to the atmosphere
- example: Sisimiut (~67°N), Western Greenland



Bornträger (1935)



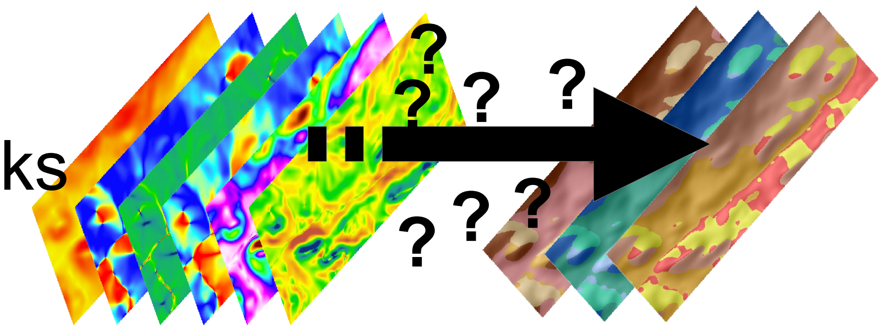
WMO & NCDC (1998)



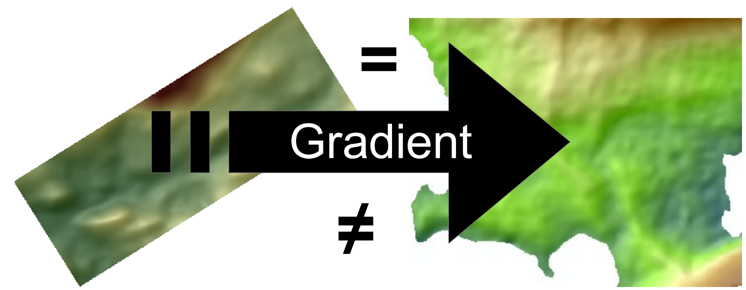
DMI (2015)

2. Goals

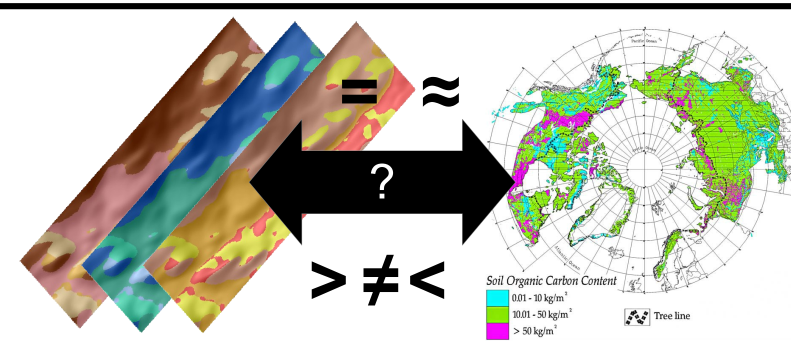
spatial prediction of SOC and C-stocks



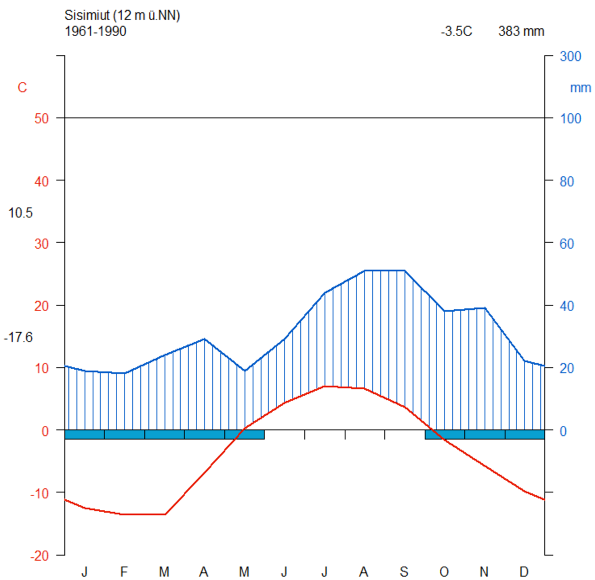
differences by climate gradient

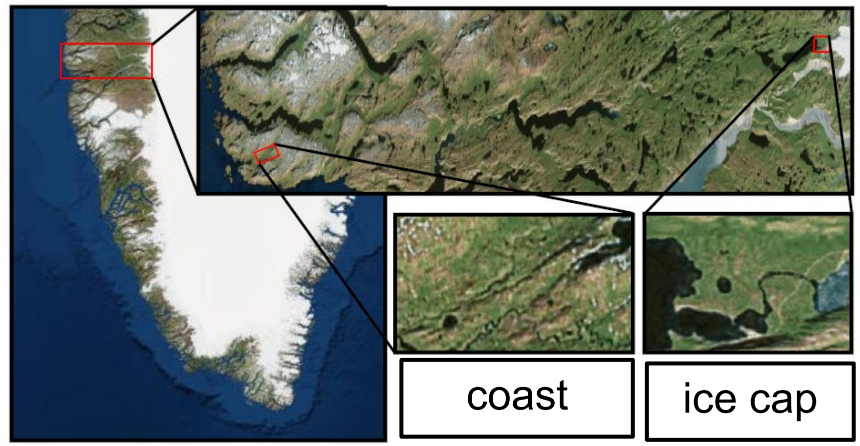


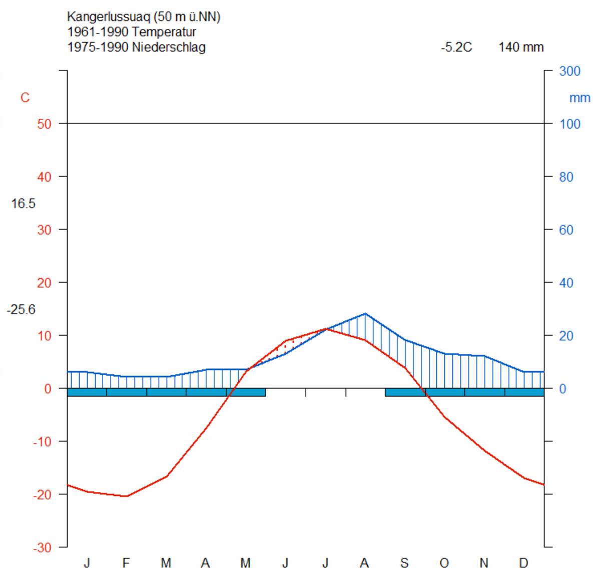
extrapolation, comparability



3. Study Areas







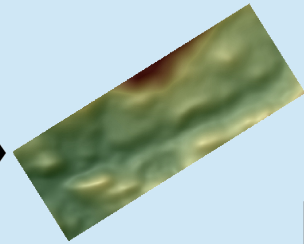
coast	ice cap
oceanic climate	continental climate
onshore/offshore wind	katabatic winds
discontinuous permafrost	continuous permafrost
biomass productivity (30-60 t/ha)	biomass productivity (50-100 t/ha)
plant cover (50-80 %)	plant cover (80-100 %)
plant growth (0-40 cm)	plant growth (0-80 cm)

4. Methods and Data

1) Structure from Motion (SfM)

aerophotos

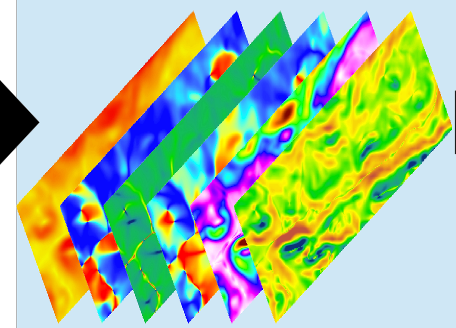
georeferencing
smoothing
resampling



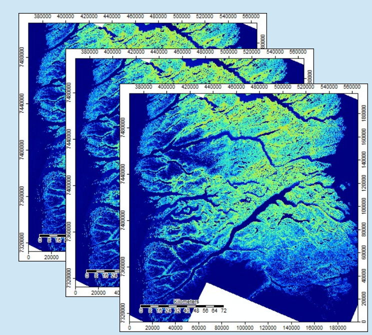
DEMs

2) environmental covariates

Terrain Analysis (16x):

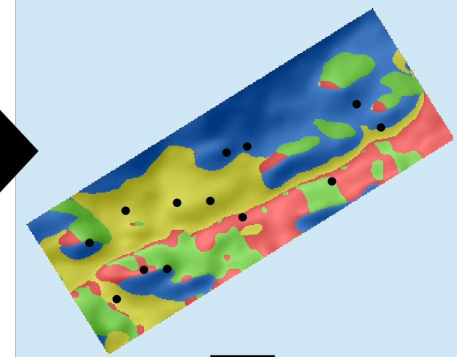


Remote Sensing:



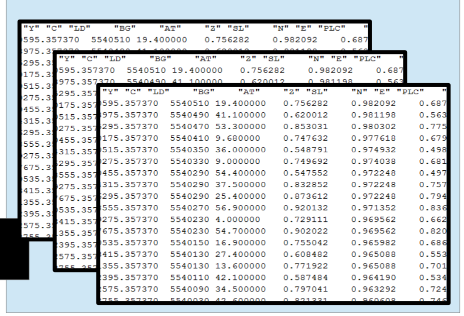
3) sampling design

- based upon terrain
- k-means cluster



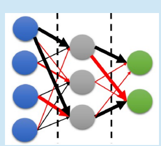
4) field survey & lab

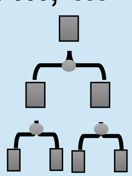
- SOC-content
- bulk density
- 0-200cm (4 intervalls)

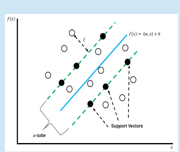


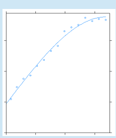
5) modelling & statistics

ANN, RF, SVM, ...



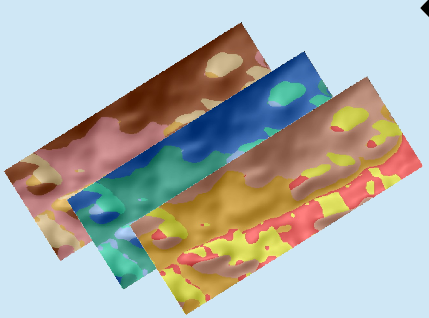




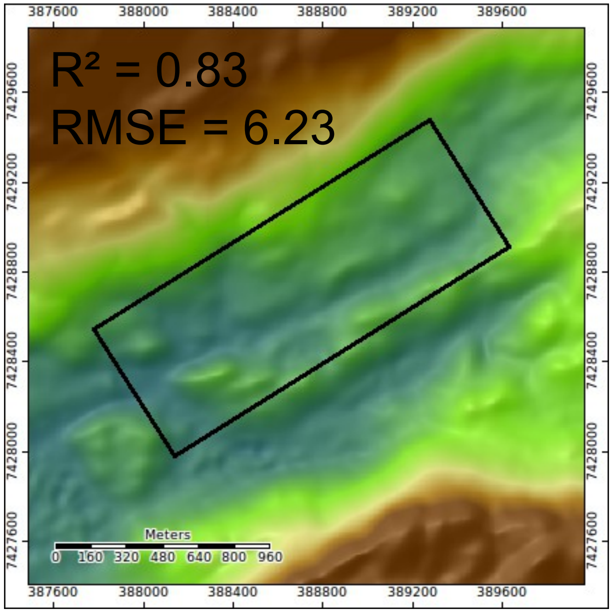


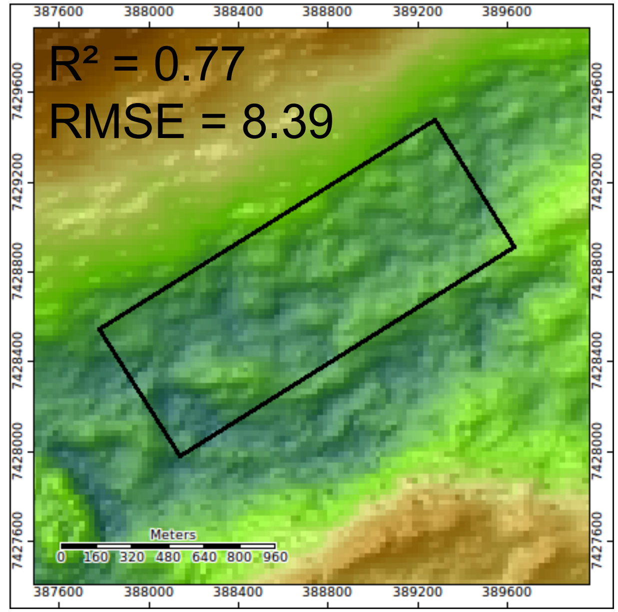
6) results

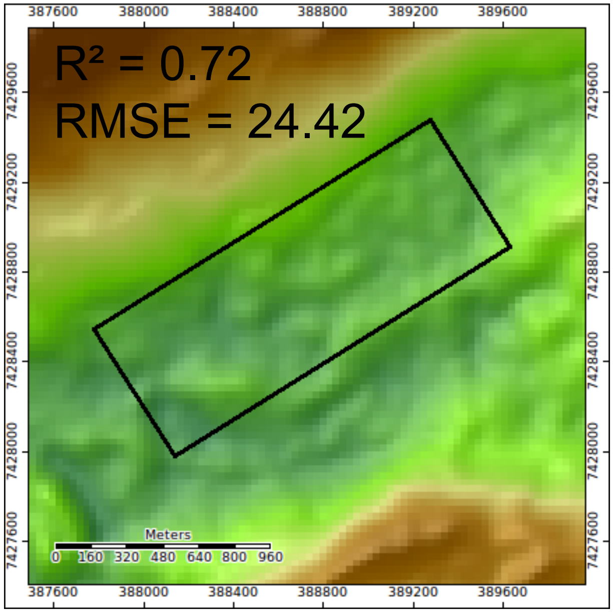
- OC-stocks
- Comparison of study areas
- extrapolation?



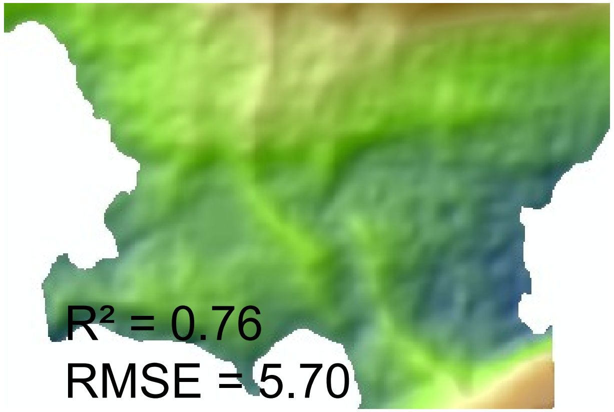
5.1 Preliminary Results: DEM

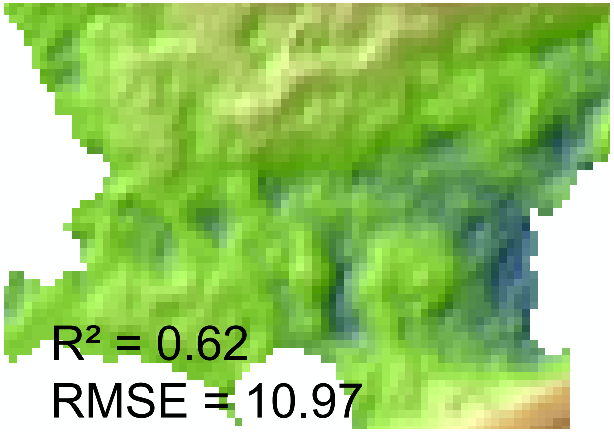


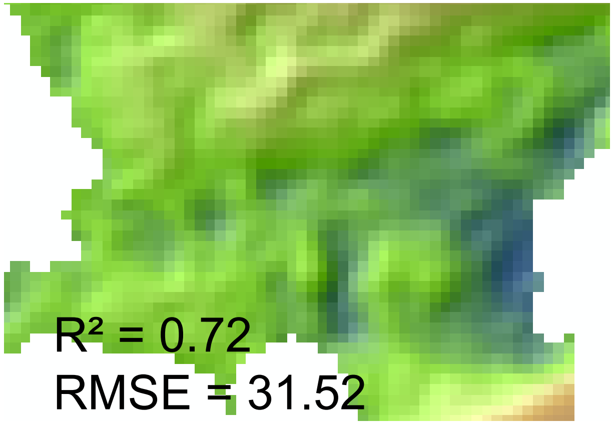




5x5, SfM	23.5x23.5 [ASTER GDEM*]	30x30 [Howat et al. 2015]







*ASTER GDEM is a product of METI and NASA

5.2 Preliminary Results: Terrain Analysis

coast

Terrain	min	max	mean	stddev
z	23	159	56	21
Slope [deg]	0	42	11	8
Northn.	-1	1	-0.3	0.7
Eastn.	-1	1	0.1	0.6
pr.curv.	-0.020	0.030	-0.001	0.004
pl.curv.	-5.700	1.664	-0.002	0.052
Flow dir,	0	7	3.6	2
Fl.pth.len.	0	6.1	5.5	0.6
Flow acc.	25	10^6	4805	33k
Ls factor	0.0	17.3	3.8	3.1
V.depth	0	57	28	14
real area	25	33.6	25.7	1.1
RMB	-3.4	3.4	-0.6	1.6
TWI	5	18	8	1.9
TCIlow	0.2	0.9	0.5	0.2
TPI	-13.6	29.3	-0.3	5.7

Ice cap

Terrain	min	max	mean	stddev
z	195	293	217	13
Slope [deg]	0	40	5	4
Northn.	-1	1	-0.4	0.7
Eastn.	-1	1	0.0	0.7
pr.curv.	-0.012	0.016	-0.0001	0.002
pl.curv.	-2.694	3.677	0.0003	0.053
Flow dir,	0	7	3.7	1.8
Fl.pth.len.	0	6.1	5.4	0.8
Flow acc.	25	500k	2230	11k
Ls factor	0.0	18.3	1.4	1.7
V.depth	0	44	10	6.7
real area	25	32.5	25.1	0.5
RMB	-3.3	3.3	-0.2	1.5
TWI	4	20	9	1.6
TCIlow	0.02	0.9	0.7	0.1
TPI	-3.9	7.7	-0.05	1.0

6. Sampling Design: Initial position

Environmental conditions:

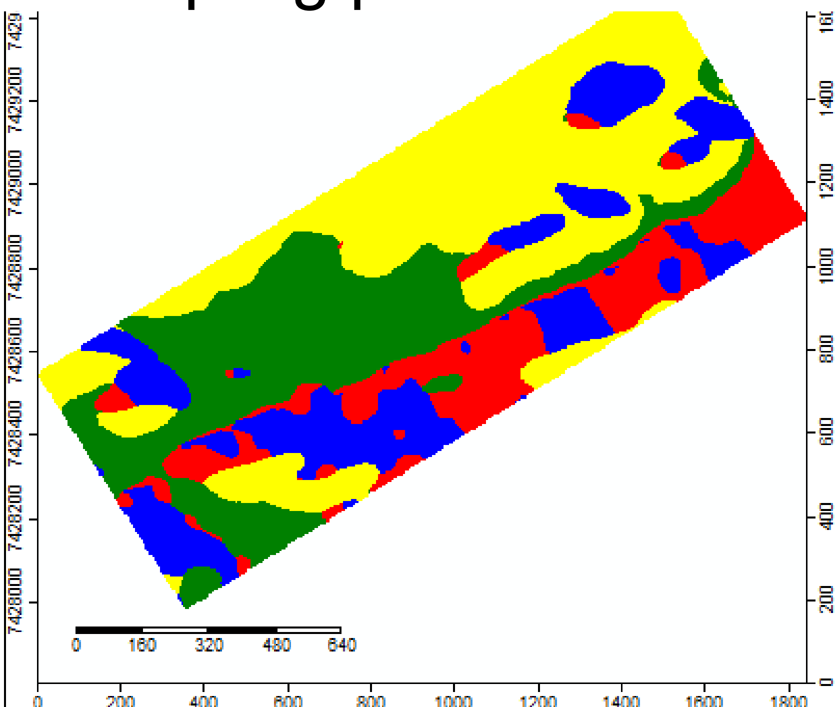
- high spatial variability of soils and terrain attributes

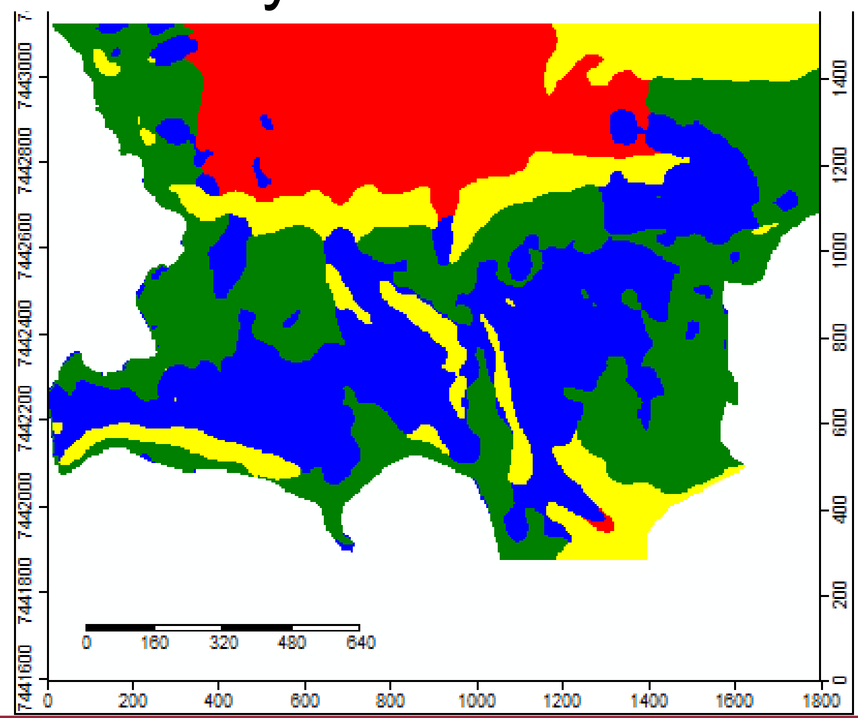
Project options:

- Soil organic carbon
- Bulk density
- A total of 350 soil samples
    - 2 study areas
    - 4 depth intervalls

6. Sampling Desgin

- Simplifying variability of soils by homogeneous classes
- Landscape classification by k-means clustering based on terrain parameters derived from the DEMs
  - > 4 classes: great fragmentation, small units
  - < 4 classes: 1 one major class, > 70% of total area
- 11 sampling points distributed ramdomly within each class





Thank you for your attention.

5. References

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