selected applications of optical remote sensing

UNIS Glaciology Course

vår 2017

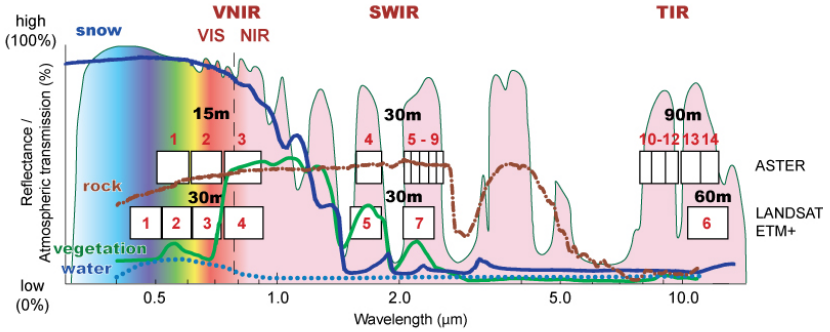
Today's Topics

- glacier mapping
- velocity mapping

glacier mapping: image classification

- broadly speaking, we want to classify satellite images
- can do this manually, but:
  - time-consuming, expensive
  - user-dependent
- instead, we look for automated approaches, exploiting spectral properties of target material
- have two basic approaches:
  - pixel-based approach
  - object-based approach

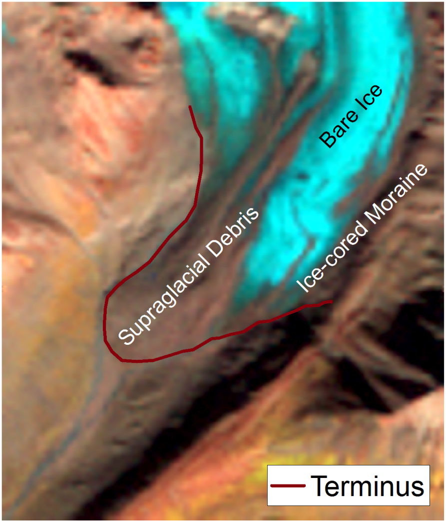
spectral signatures of common materials



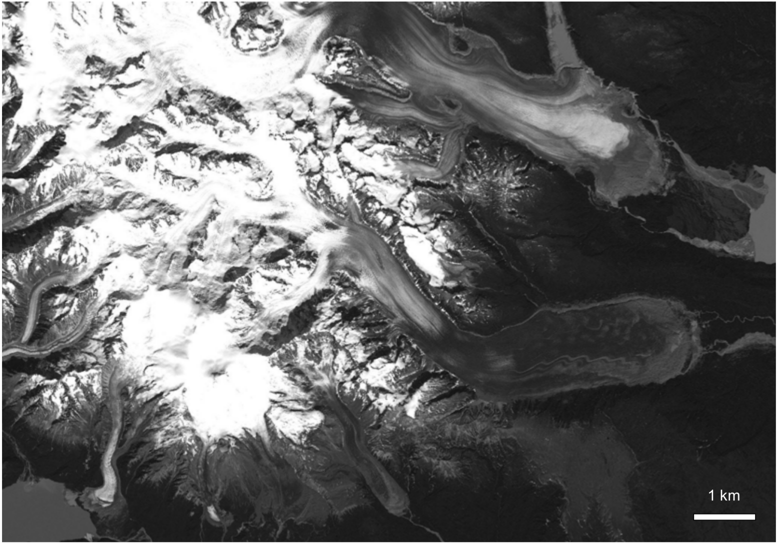
(A. Kääb)

the debris problem

the debris problem

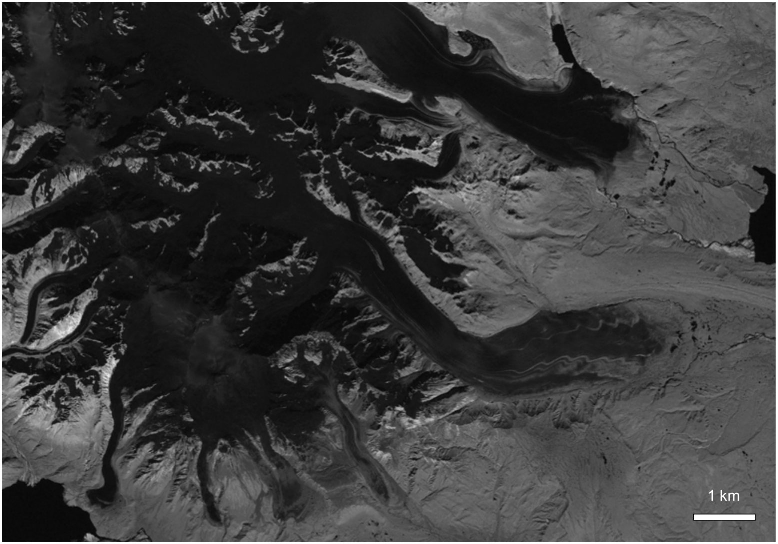


landsat examples (etm3)

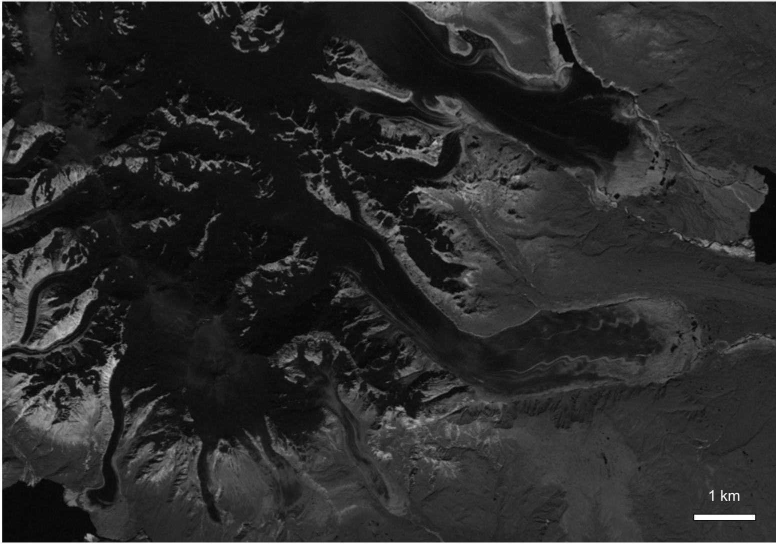


landsat examples (etm4)

landsat examples (etm5)



landsat examples (etm7)

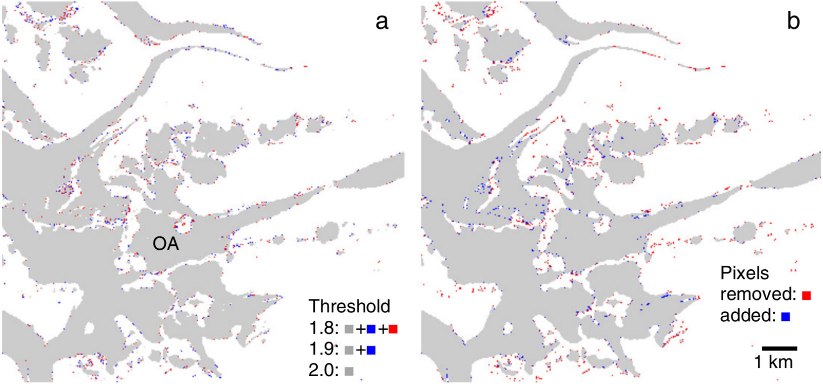


basic approaches: thresholding

several different approaches proposed, utilized:

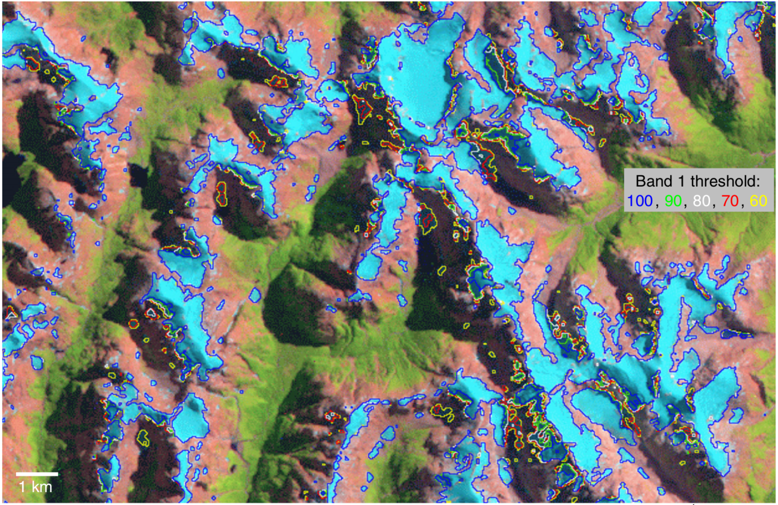
- ratio of red (TM3) to swir (TM5); requires a blue (TM1) threshold to improve mapping in shadow (scattering), remove water
- ratio of nir (TM4) to swir (TM5); no TM1 threshold required, does not mistakenly map water surfaces (but can map vegetation in shadow)
- normalized snow difference index (ndsi) can also be used, but scattering effects have to be considered
- all of these approaches require manual correction/intervention at some stage (the debris problem)
- thresholds are, in general, robust, and exact values not so important
- can still accidentally map perennial snowfields

threshold mapping



(Paul et al., 2015)

threshold mapping

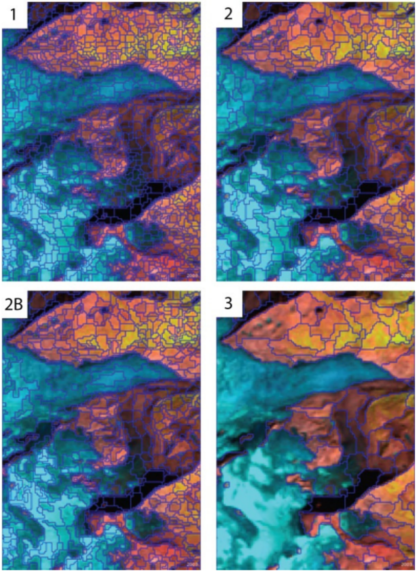


(Paul et al., 2015)

object-based classification

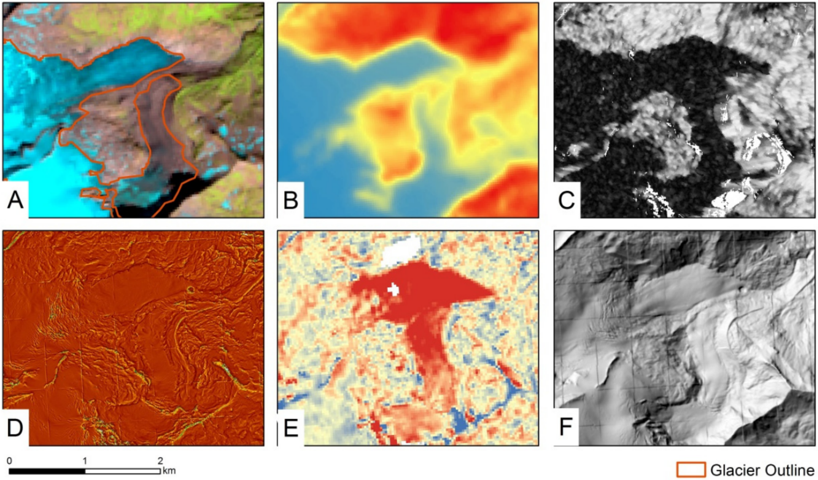
- basic idea: break images into smaller chunks ("objects"), much like our eyes do
- this process is called segmentation:
- once we have created objects, can build classification based on object properties:
  - pixel values in different channels (same as pixel-based methods)
  - texture, brightness
  - size, shape
  - proximity to other objects/classes

object-based classification



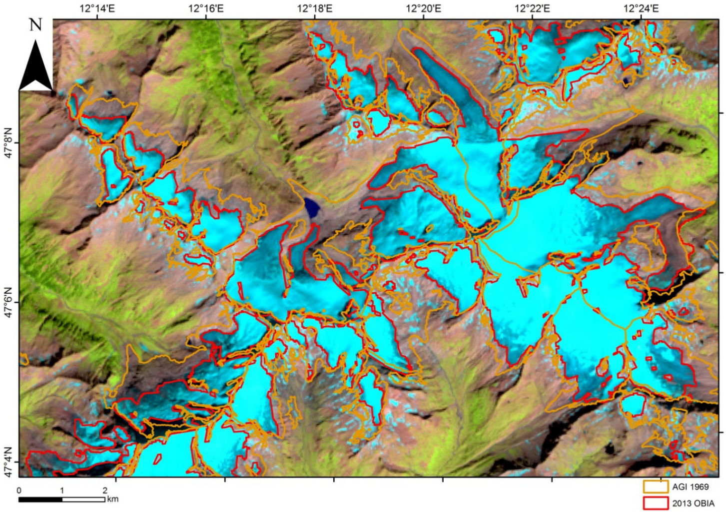
Robson et al., 2016

object-based classification



Robson et al., 2016

object-based classification



Robson et al., 2016

glaciers move

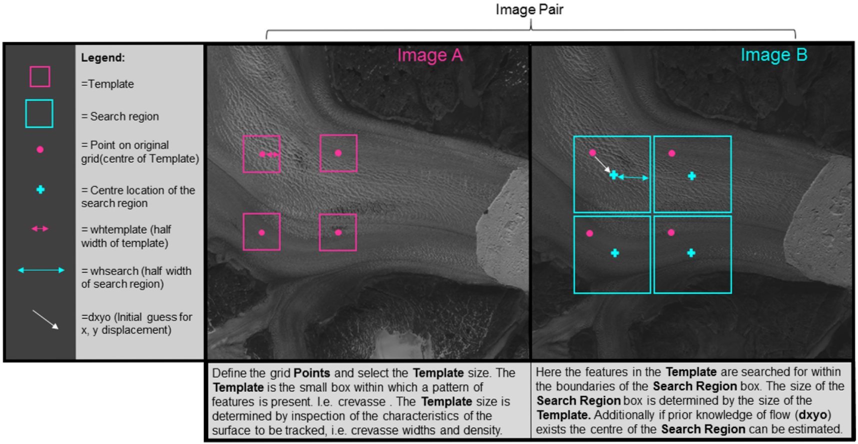
general requirements

- two images separated enough in time to see changes (but no so long as to see too much change)
    - for fast-moving tidewater glaciers, typically $\leq$50 days (or much less)
    - want images from similar times of year, so that changes in snow cover/illumination don't dominate
- images must be orthorectified, preferably using the same DEM
- images must be from the same sensor/kind of sensor (we're looking for similarity)

general approach

- can filter the images (edge filtering, high-pass filter, pc intensity)
- select sub-scenes of image (chips), compare somehow
  - normalized cross-correlation
  - phase correlation (frequency domain)
- post-processing

correlation chips



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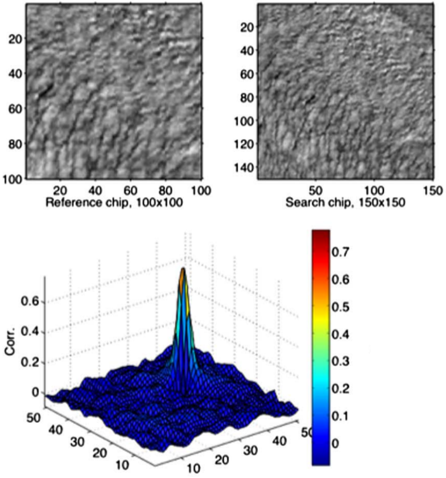
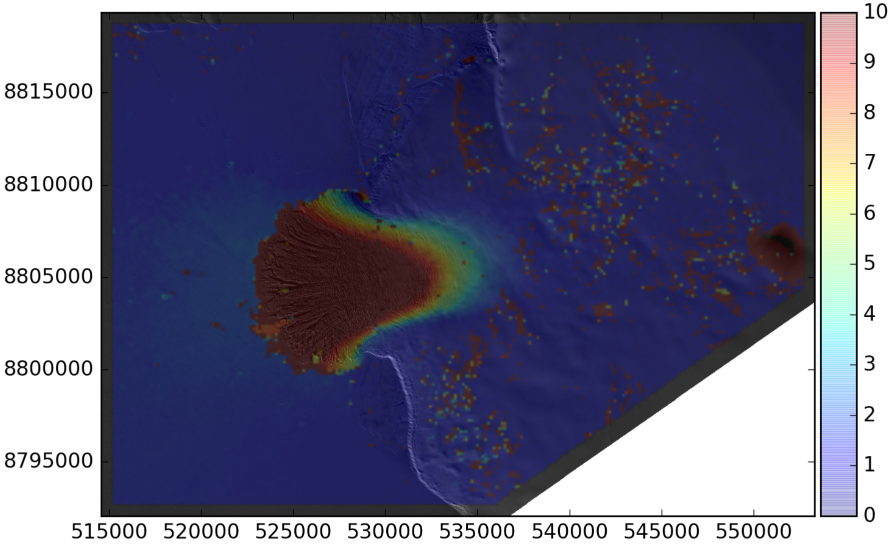
correlation chips



Ahn and Howat, 2011

example results: vavilov ice cap, severnaya zemlya



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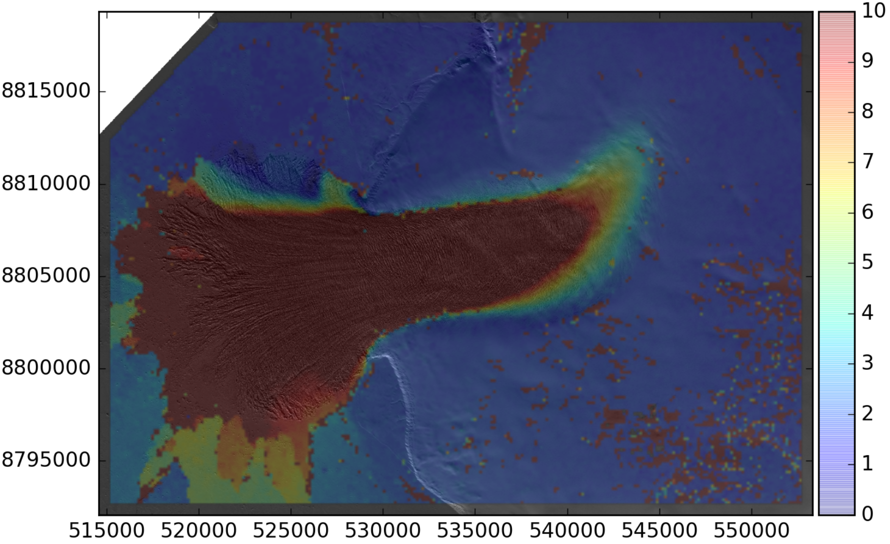

filtering

- errors/spurious matches will happen
- iteratively filter by orientation, magnitude (e.g., Burgess et al., 2012)
- manual editing (e.g., van Wychen et al., 2012)

further reading

- Scambos et al., 1992. *Application of image cross-correlation to the measurement of glacier velocity using satellite image data. RSE* 42(3), 177-186
- Ahn and Howat, 2011. *Efficient automated glacier surface velocity measurement from repeat images using multi-image/multichip and null exclusion feature tracking. IEEE Trans. Geosci. Rem. Sens.*, 49(8), 2838-2846
- Heid and Kääb, (2012): *Evaluation of existing image matching methods for deriving glacier surface displacements globally from optical satellite imagery. RSE*, 118, 339-355.
- Rosenau et al., 2015. *A processing system to monitor Greenland outlet glacier velocity variations at decadal and seasonal time scales utilizing the Landsat imagery. RSE*, 169, 1-19
- Altena and Kääb, *In Rev., Remote Sensing*

questions?