Evaluation of MODIS albedo product over ice caps in Iceland

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Glacier albedo in Iceland

- Albedo is a key variable of a glacier’s energy balance

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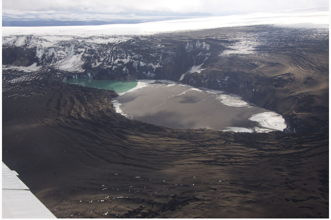
- Glaciers in Iceland are exposed to volcanic ash deposition

(a) Eyjafjallajökull eruption in April 2010 (wikimedia)



(b) Grímsvötn in August 2011. Ash covering the ice cap (wikimedia)

Glacier albedo in Iceland: monitoring

- Ten automatic weather stations in Vatnajökull and Langjökull ice caps (collaboration of the Institute of Earth Sciences, University of Iceland and the National Power Company)
- Large variability not captured by station measurements

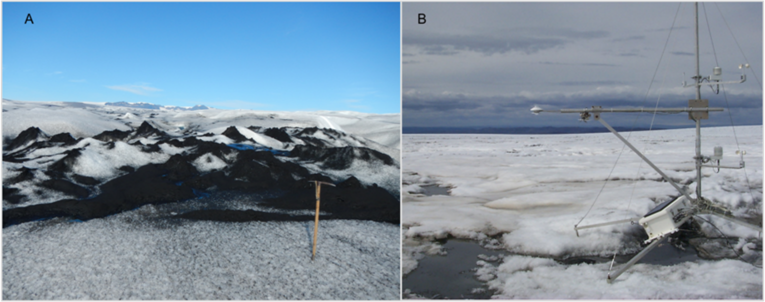


Figure 2: Vatnajökull ablation area in (A) 2014 and (B) 2001.

MODIS albedo product

- Global product MCD43 (Terra and Aqua) including shortwave broadband albedo since 2000 distributed by NASA [Schaaf et al., 2002]
- Preliminary evaluation of MCD43 v005 (16-days, MODIS collection 5) in Iceland at 2 AWS [Möller et al., 2014]
- New version MCD43A3 v006 (1-day, MODIS collection 6)

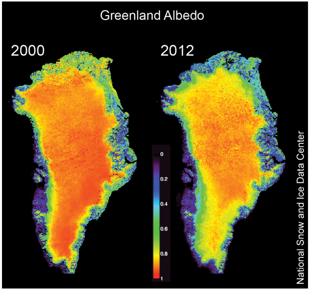


Figure 3: Greenland albedo [Stroeve et al., 2013] (NSIDC)

Comparison of MODIS albedo with AWS data on ice caps

Albedo computed from 10 AWS over 2001-2012

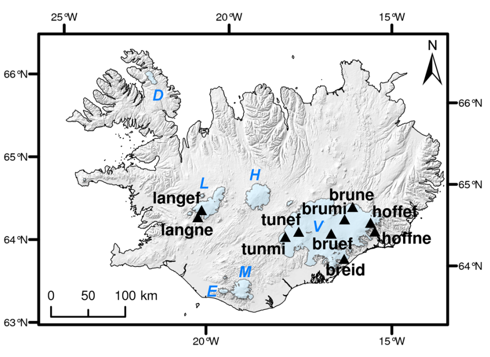


Figure 4: Map of AWS on ice caps (D: Drangajökull, E: Eyjafjallajökull, H: Hofsjökull, L: Langjökull, M: Mýrdalsjökull, V: Vatnajökull)

MODIS data

- Albedo computed as the average of the black-sky and white-sky broadband shortwave albedo
- Data flagged as bad quality are kept
- Data retrieved when sun elevation is lower than 30° are discarded

Time series: MODIS vs. AWS daily albedo

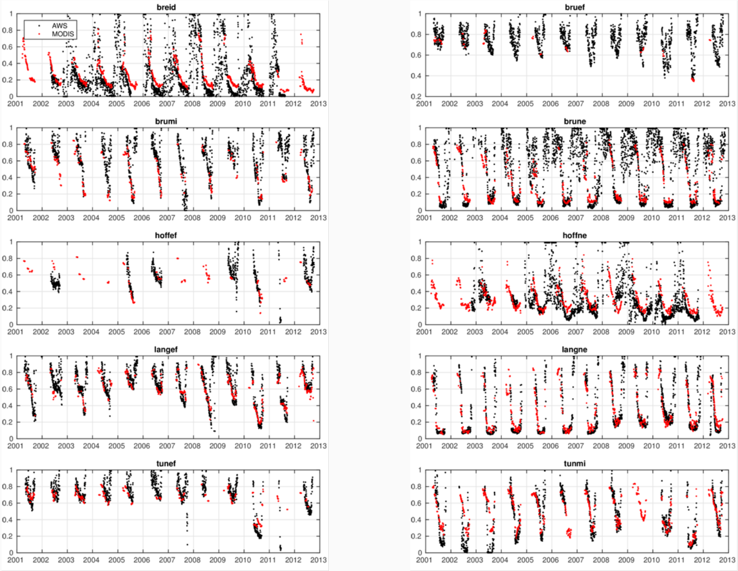


Figure 5: Daily albedo (black: AWS, red: MODIS)

Statistics: MODIS vs. AWS daily albedo

Name	Size	RMSE	Pearson R	Bias
hoffef	203	0.08	0.74	-0.015
brune	1762	0.16	0.86	0.044
brumi	786	0.21	0.62	0.092
bruef	216	0.08	0.85	0.023
tunmi	1135	0.16	0.77	-0.038
tunef	694	0.09	0.90	0.030
hoffne	1211	0.15	0.47	-0.042
breid	1506	0.12	0.83	-0.067
langef	1131	0.10	0.88	0.022
langne	1531	0.12	0.86	-0.008

Table 1: all correlations significant at 1% level.

Effect of sub-pixel variability?

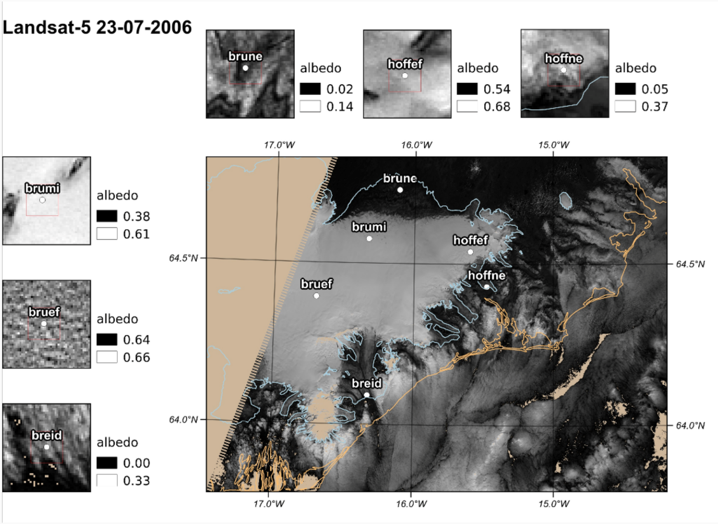


Figure 6: Landsat albedo from surface reflectance after [Greuell et al., 2002]

Effect of sub-pixel variability: results

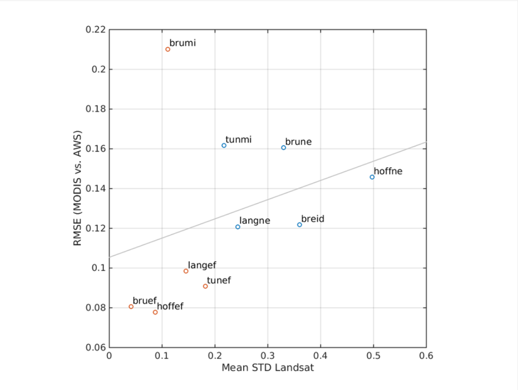


Figure 7: MODIS albedo RMSE (AWS data) vs. the mean STD of the Landsat albedo within the MODIS pixel.

o AWS in the accumulation area

o AWS in the ablation area.

Impact of 2010 and 2011 eruptions

Temporal evolution of the summer albedo

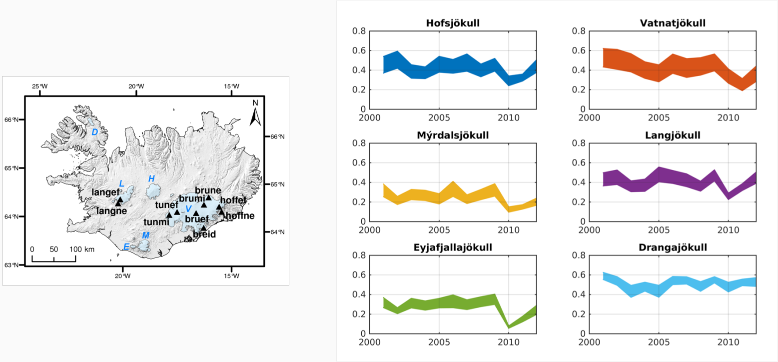


Figure 8: Spatial average of the summer albedo by ice cap and by year (01-July to 31-August composite). The spread corresponds to the standard deviation within the ice cap and indicates the spatial variability).

Mapping albedo changes after the eruptions

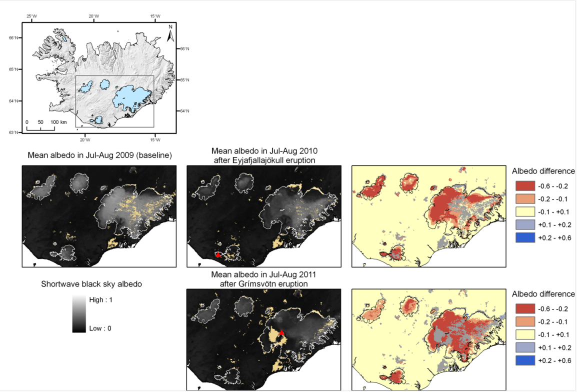


Figure 9: Albedo of the main ice caps before and after the Eyjafjallajökull (2010) and Grímsvötn (2011) eruptions, and associated albedo changes. ◀ volcanoes.

Conclusion

Conclusion

- MODIS is useful to track albedo changes in large flat glaciers like Icelandic ice caps [Gascoin et al., 2017]
- Glacier evolution in Iceland can be influenced by volcanic activity in addition to climate change
- Recent work to include MODIS glacier albedo in the HIRHAM5 Regional Climate Model [Schmidt et al., 2017]

Questions?

Yesterday’s Terra/MODIS natural color image.

Download slides here: https://frama.link/albedo

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Cloud cover and other no-data

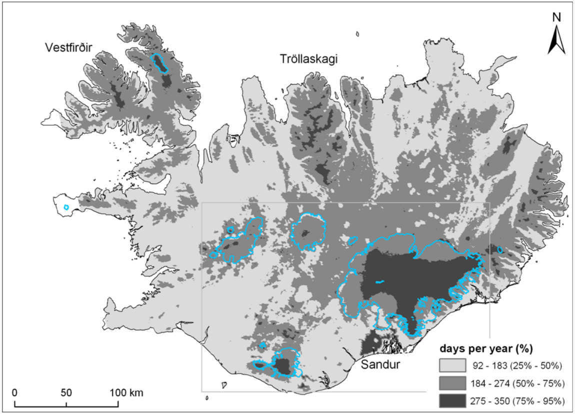

Figure 11: Mean annual number of days with missing data during the period 2001-2012 in the MCD43A3 product