Time series analysis of mountain snow cover from MODSCAG and VIIRSCAG

Kat J. Bormann, Karl Rittger &

Thomas H. Painter

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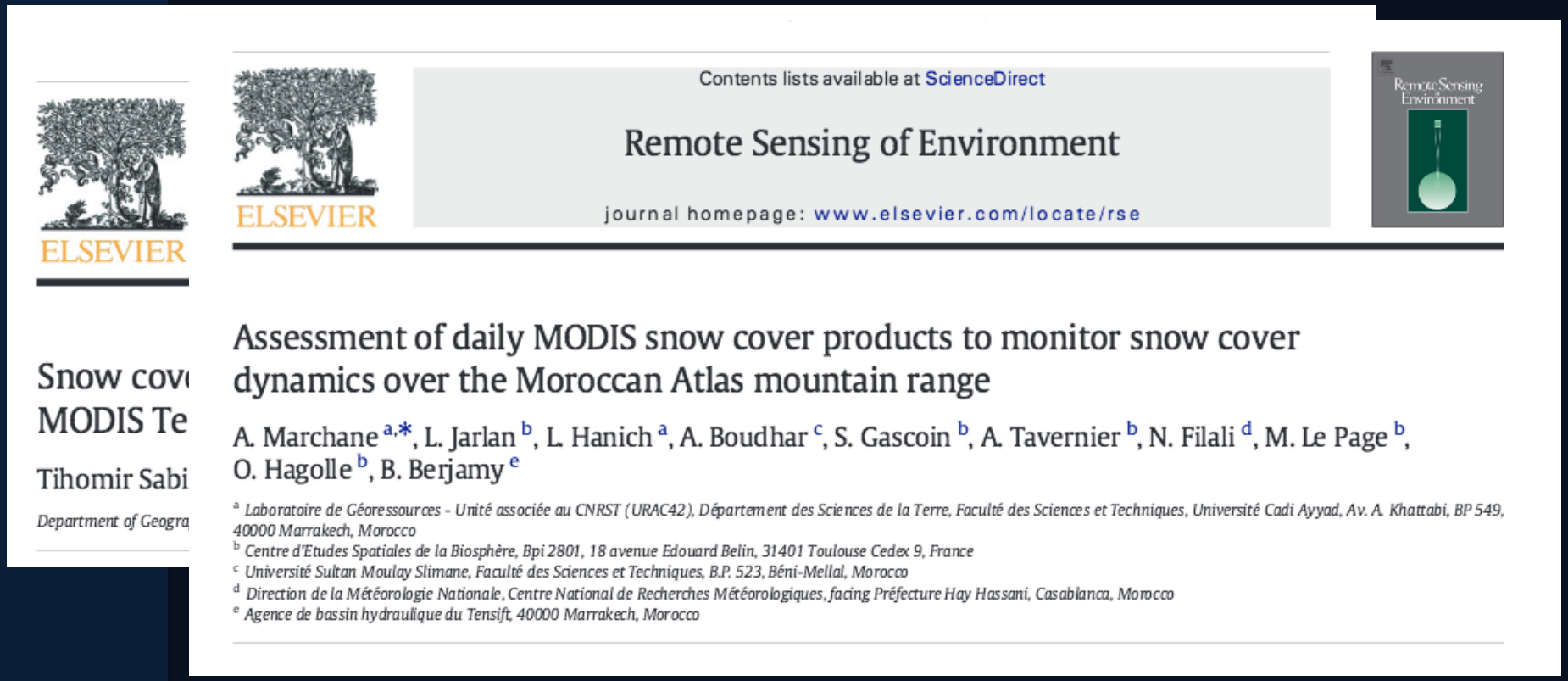
Background

- MODIS-derived products have become the workhorse for snow cover monitoring
- 15 year time series



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MODIS Te

Tihomir Sabi

Department of Geogra

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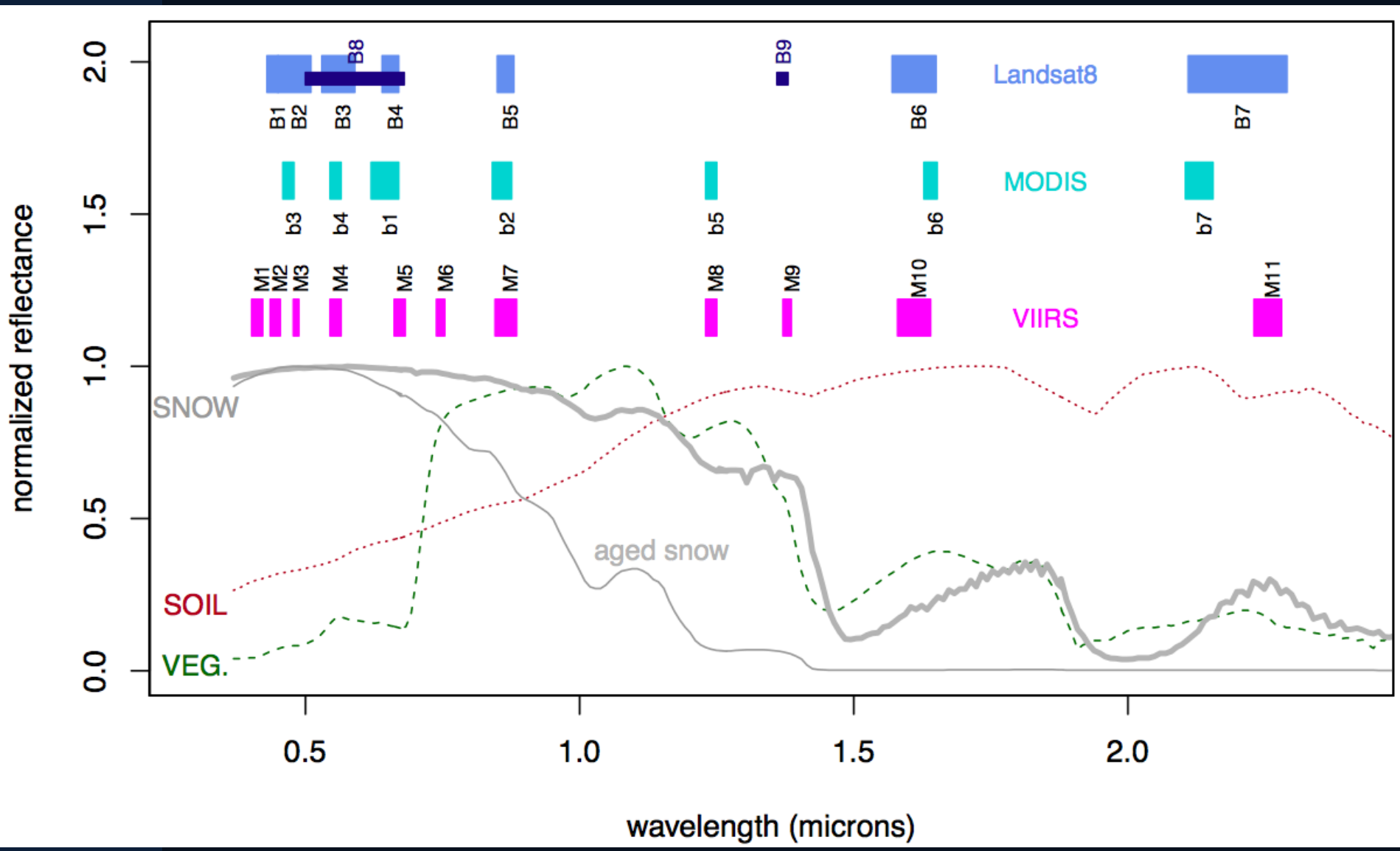
Assessment of daily MODIS snow cover products to monitor snow cover dynamics over the Moroccan Atlas mountain range

A. Marchane [a,*], L. Jarlan [b], L. Hanich [a], A. Boudhar [c], S. Gascoin [b], A. Tavernier [b], N. Filali [d], M. Le Page [b], O. Hagolle [b], B. Berjamy [e]

[a] Laboratoire de Géoressources - Unité associée au CNRST (URAC42), Département des Sciences de la Terre, Faculté des Sciences et Techniques, Université Cadi Ayyad, Av. A. Khattabi, BP 549, 40000 Marrakech, Morocco
[b] Centre d'Etudes Spatiales de la Biosphère, Bpi 2801, 18 avenue Edouard Belin, 31401 Toulouse Cedex 9, France
[c] Université Sultan Moulay Slimane, Faculté des Sciences et Techniques, B.P. 523, Béni-Mellal, Morocco
[d] Direction de la Météorologie Nationale, Centre National de Recherches Météorologiques, facing Préfecture Hay Hassani, Casablanca, Morocco
[e] Agence de bassin hydraulique du Tensift, 40000 Marrakech, Morocco

Introduction to VIIRS

- Visible Infrared Imaging Radiometer Suite
- Successor instrument to MODIS
  - Spatial resolution 375m (n=3), 750m (n=7)
  - Slightly different bandwidths
  - Different handling of along-scan ground sampling at high scan angles


normalized reflectance
wavelength (microns)
0.0
0.5
1.0
1.5
2.0
0.5
1.0
1.5
2.0
Landsat8
MODIS
VIIRS
B1
B2
B3
B4
B5
B6
B7
B8
B9
b1
b2
b3
b4
b5
b6
b7
M1
M2
M3
M4
M5
M6
M7
M8
M9
M10
M11
SNOW
aged snow
SOIL
VEG.

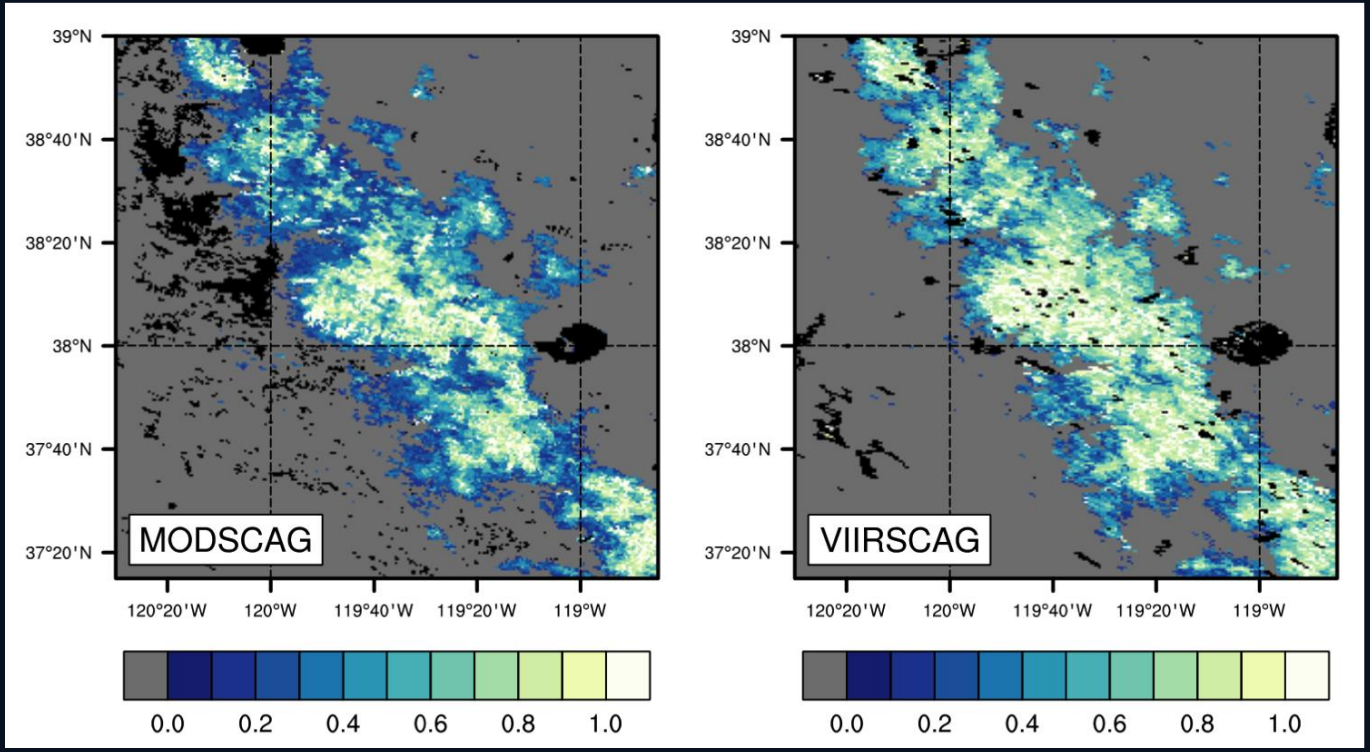
VIIRS fractional snow cover products

- VIIRS Snow Cover Products
  - Aggregated fractional cover 750m
  - Fractional product has no similarity with MODIS fractional product

- VIIRSCAG
  - Spectral unmixing 1km gridded
  - Applied to maximize similarity with existing MODSCAG fractional product
  - Good dataset to compare with MODIS

Evaluation of VIIRSCAG

- SnowPEX workshop 1

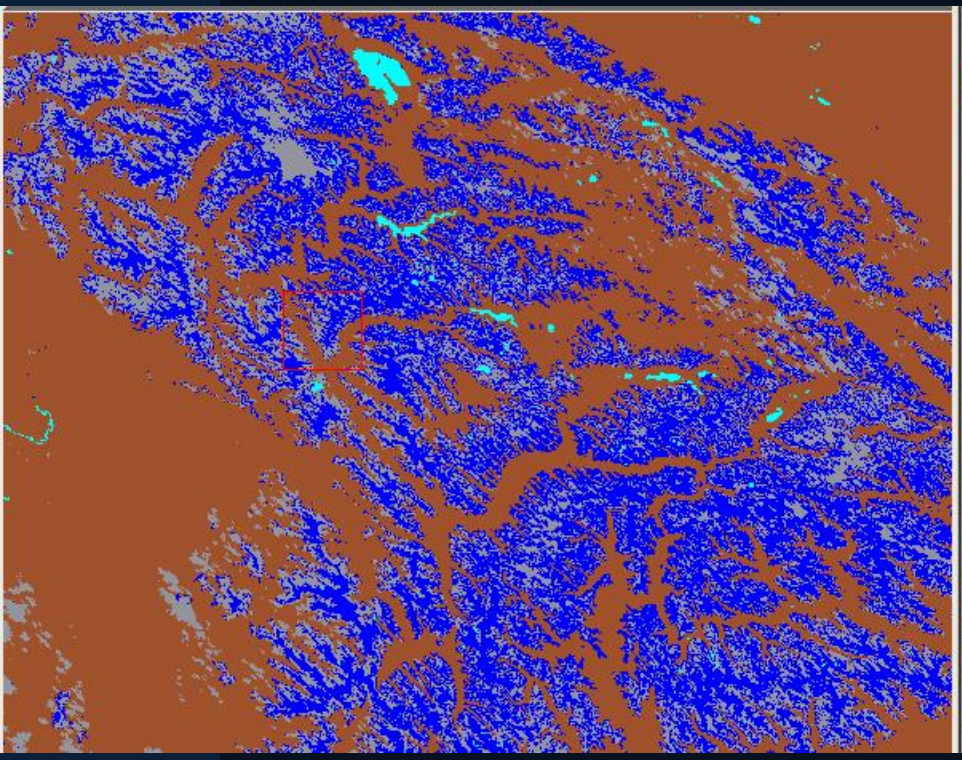


- Since then we have extended evaluation

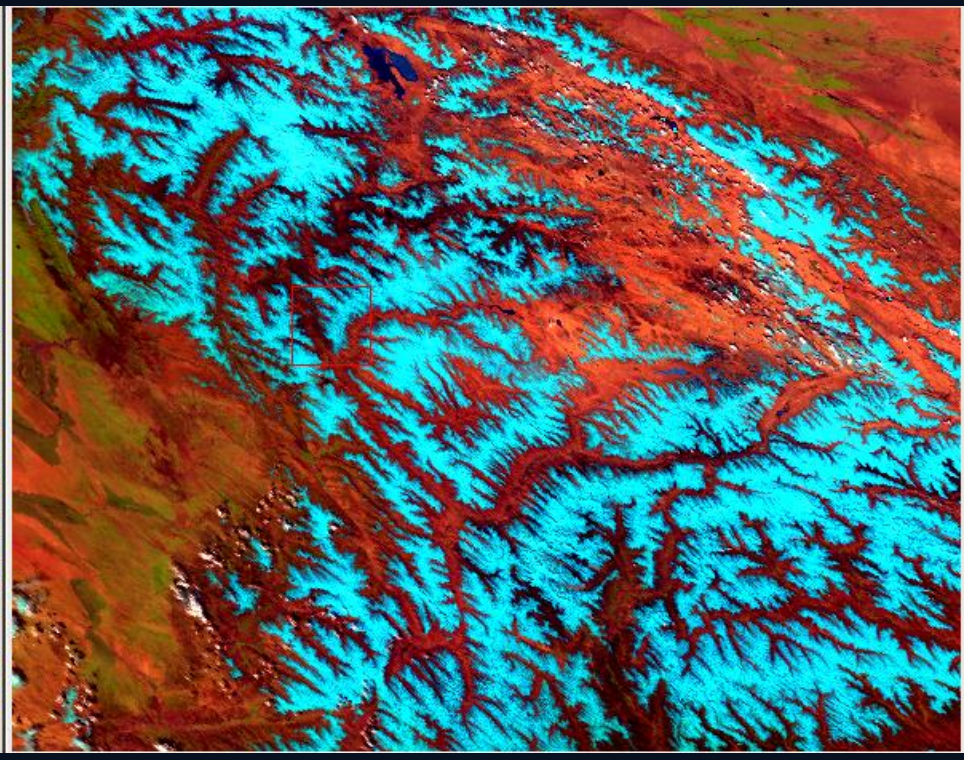
Image Landsat
Image IBCAO
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Evaluation of VIIRSCAG

- VIIRS cloud mask
- Masking 100% snow covered areas on very clear days



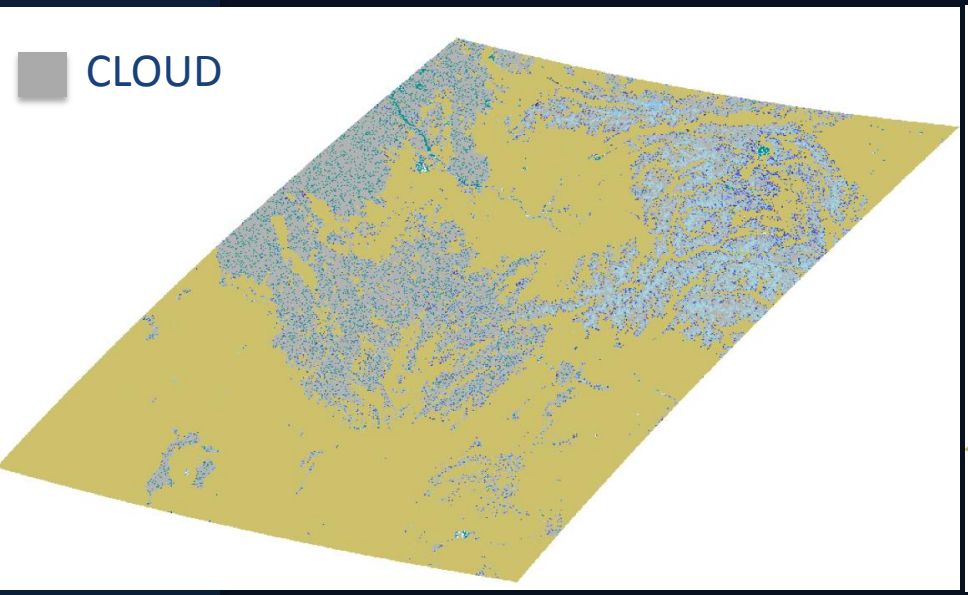
SNOW CLOUD SNOW-FREE



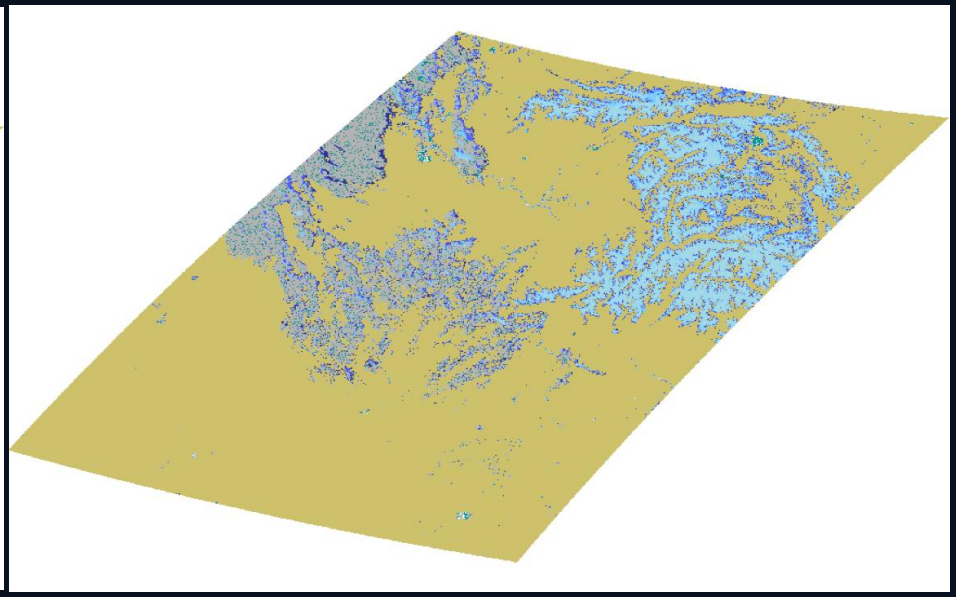
COMPOSITE IMAGE

Evaluation of VIIRSCAG

- To address the VIIRS cloud mask issue, we implemented a custom cloud algorithm
- Comparison of cloud masks on a very clear day (in the Karakoram)



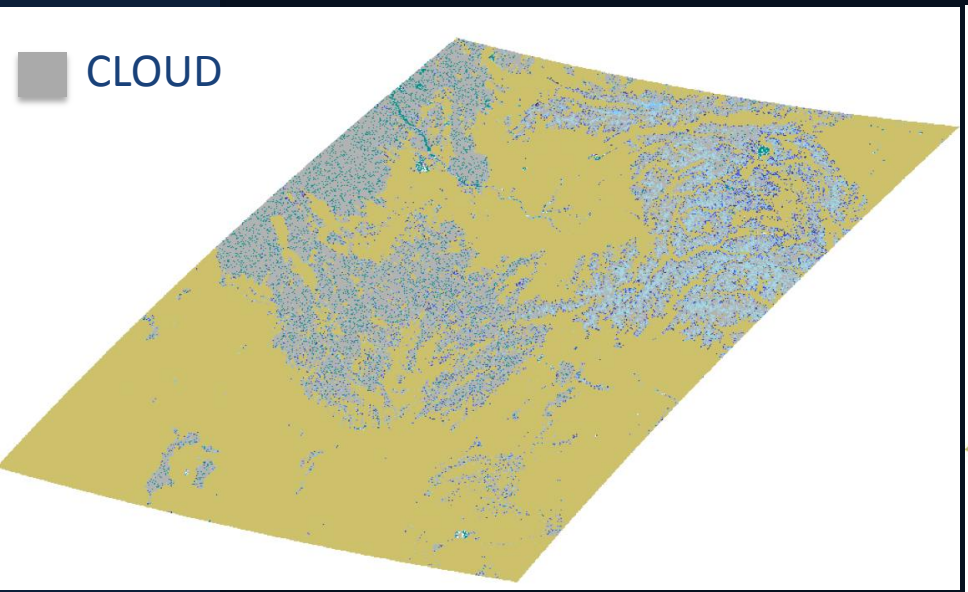
Original VIIRS cloud mask

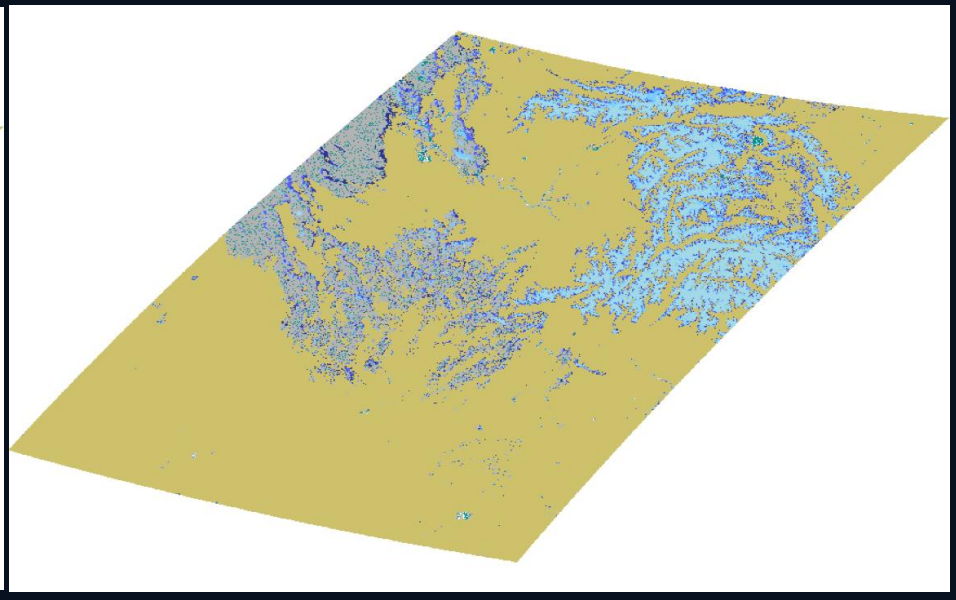


New VIIRS cloud mask

Evaluation of VIIRSCAG

- To address the VIIRS cloud mask issue, we implemented a custom cloud algorithm
- Comparison of cloud masks on a very clear day (in the Karakoram)





Mon-5.3			Fractional snow cover for Landsat OLI, MODIS, and VIIRS from spectral mixture analysis	Karl Rittger, Kathryn Bormann, Richard, Armstrong, Thomas, Painter, and Jeff Dozier

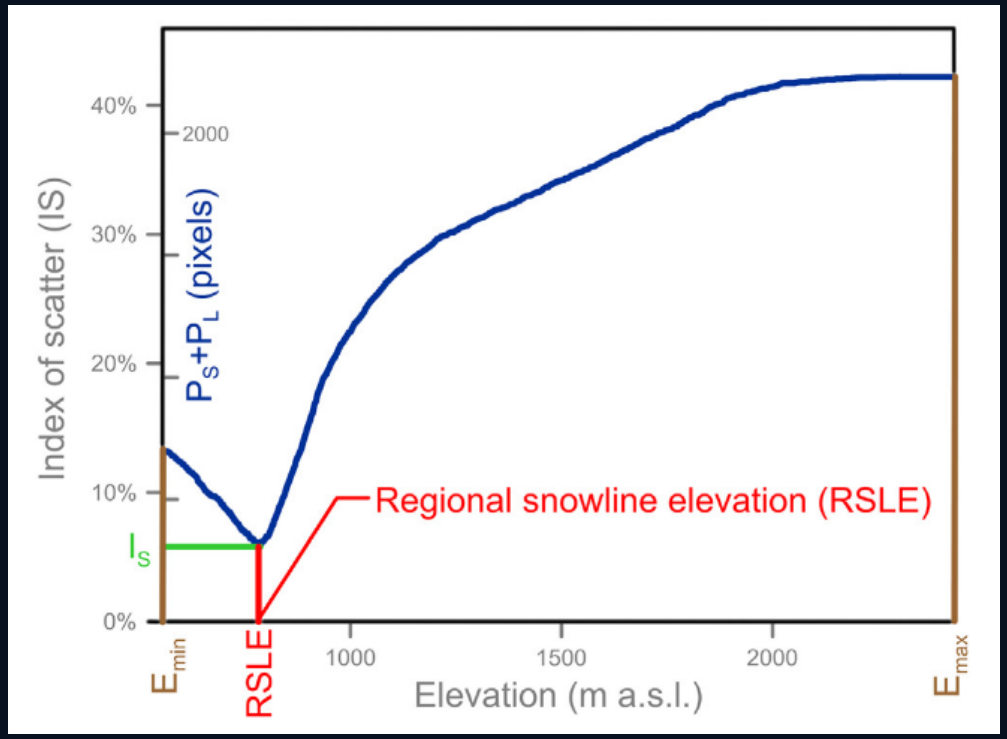
Snow metrics from satellite snow cover

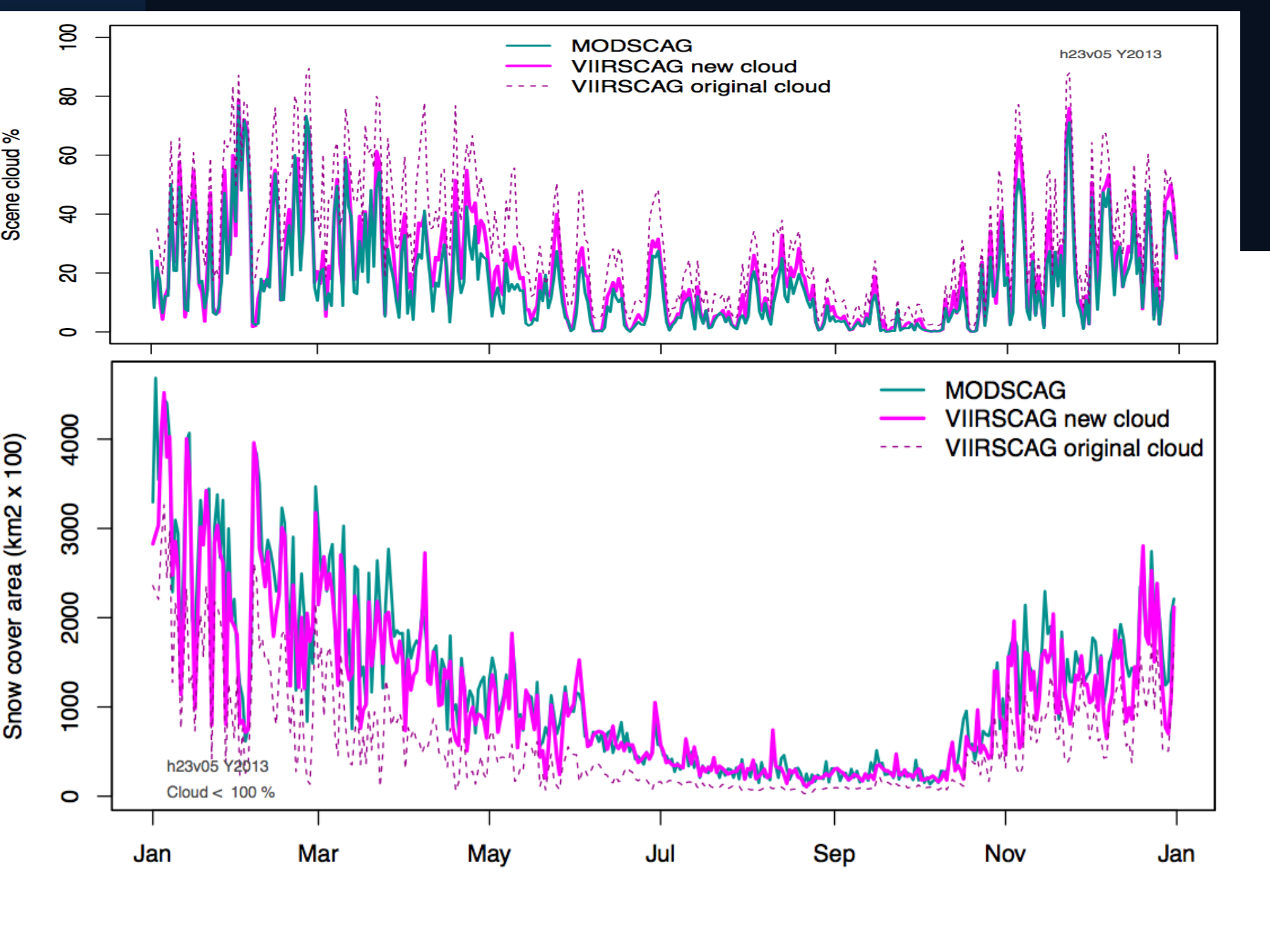
- Typically reported are:
  - Snow cover area (+ fractional, + %)
  - Albedo
- With our growing 15 year long-term record (MODIS/VIIRS) we can look to metrics that will highlight regional variability and climate change impacts
  - Regional snowline elevation →

Derivation of snowline elevation

- Estimation of regional snowline elevation
  - Not straightforward
  - Recent method from Krajčí et al. (2014) JHyd

Elevation at which land pixels *above* and snow pixels *below* is minimized

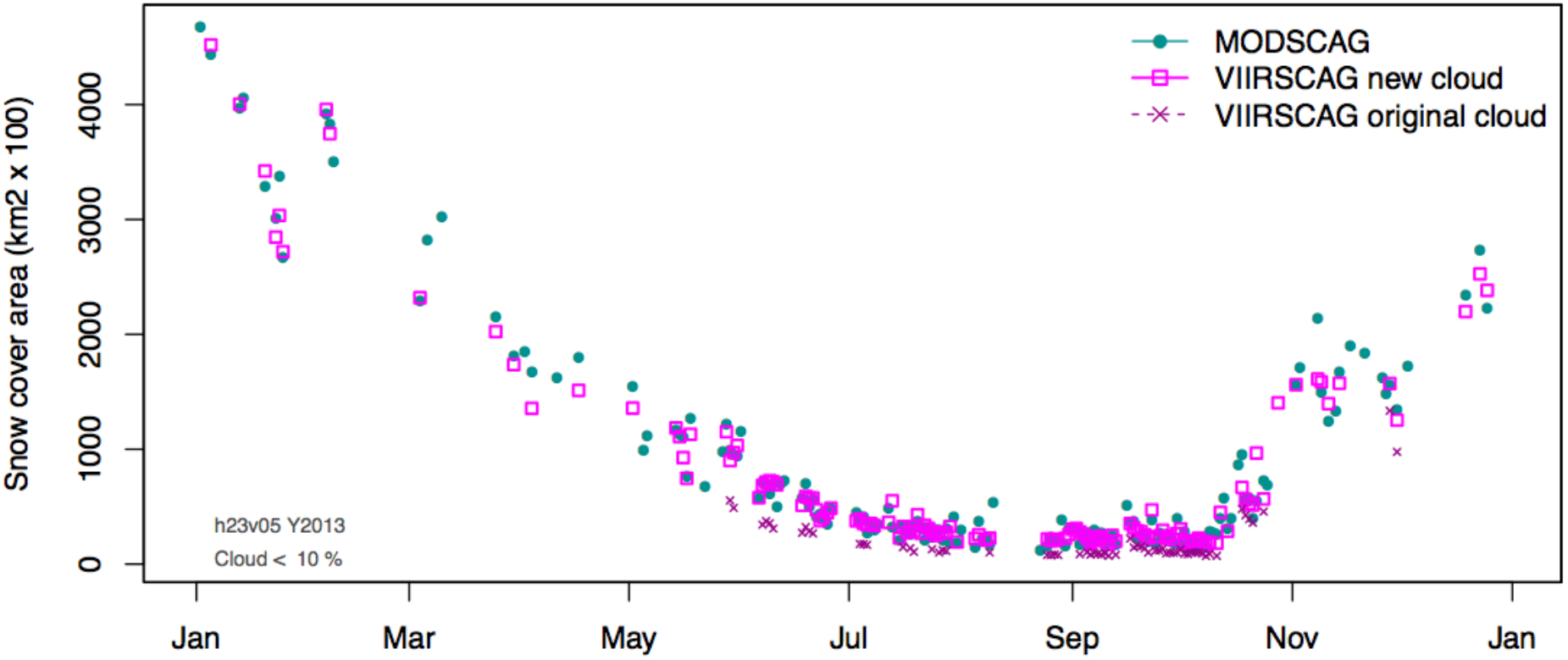



MODSCAG
VIIRSCAG new cloud
VIIRSCAG original cloud
h23v05 Y2013
Scene cloud %
0
20
40
60
80
100
MODSCAG
VIIRSCAG new cloud
VIIRSCAG original cloud
h23v05 Y2013
Cloud < 100 %
Snow cover area (km2 x 100)
0
1000
2000
3000
4000
Jan
Mar
May
Jul
Sep
Nov
Jan

Time series

- Snow Cover Area

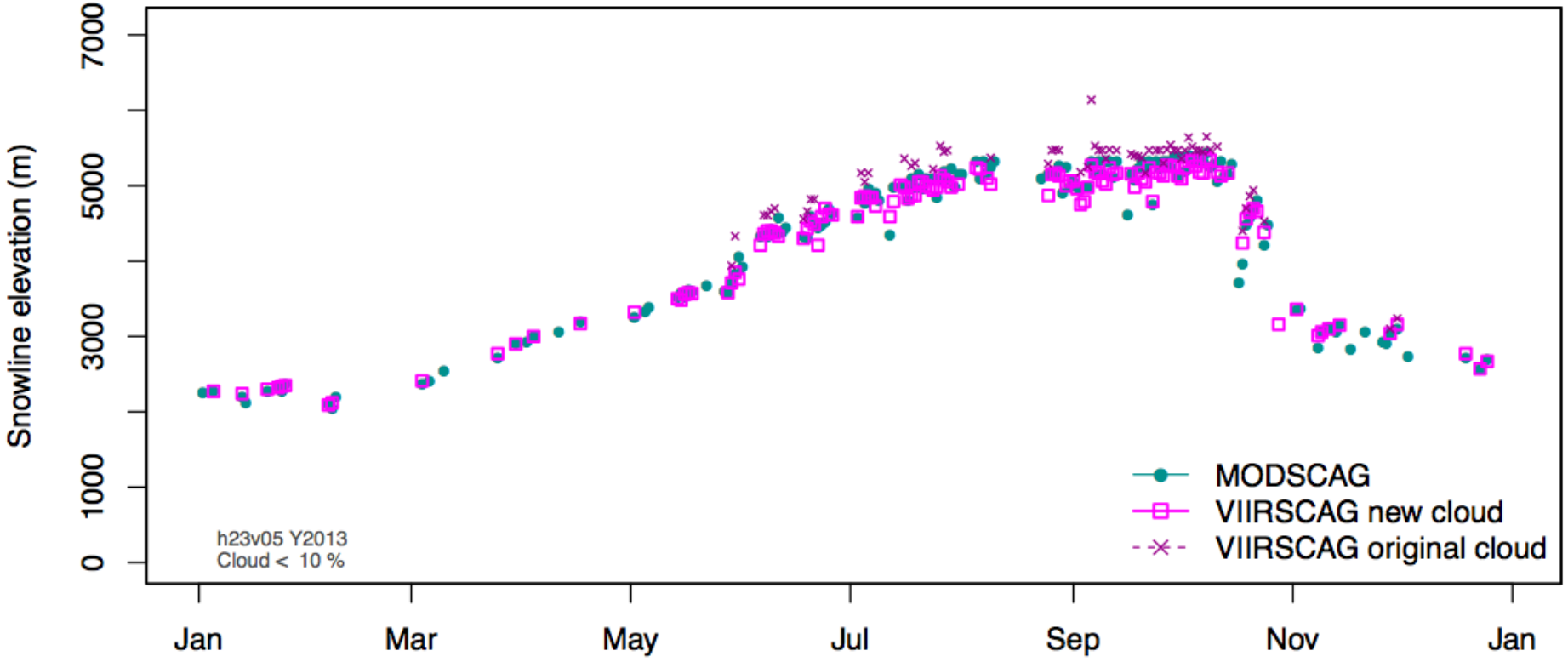
8.4% MAE -13.9% Bias



- Snowline elevation

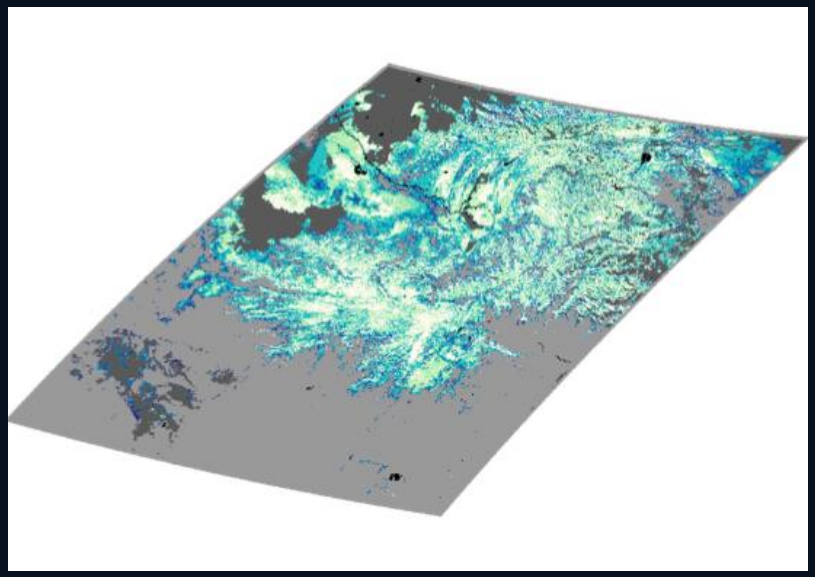
105m MAE

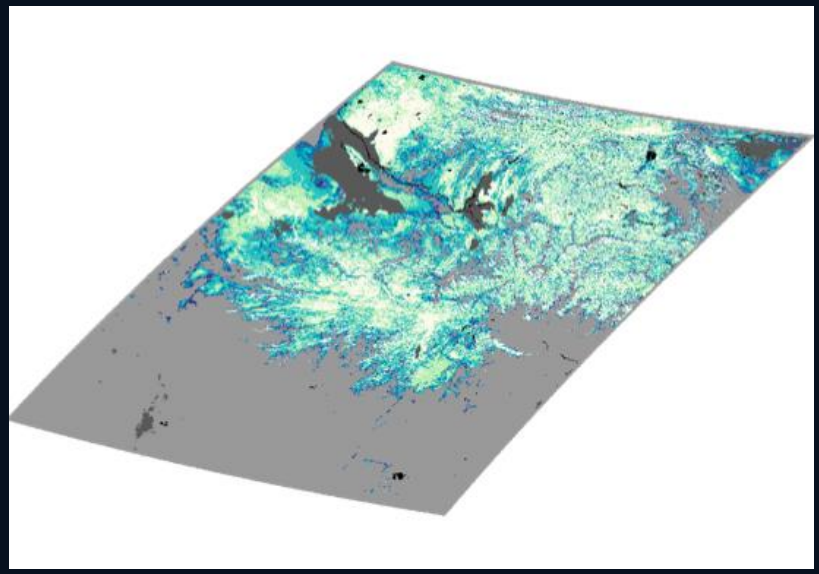
85m Bias



Long-term monitoring implications

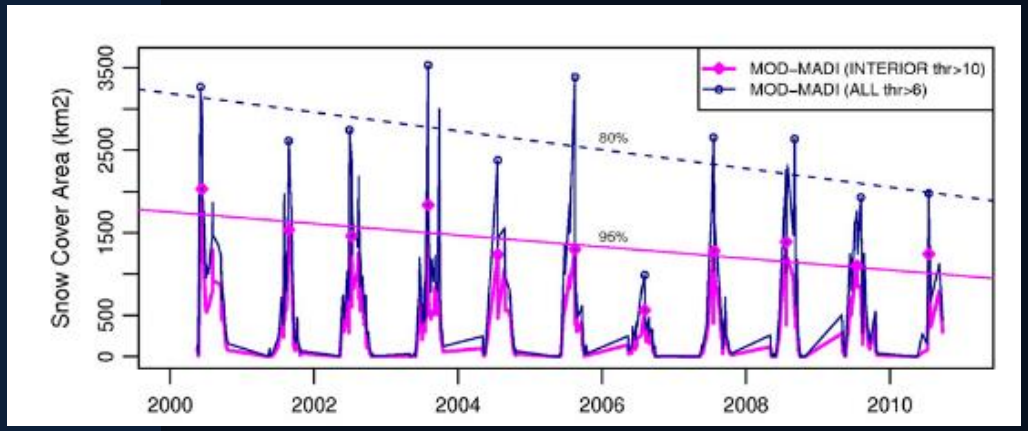
- With improved cloud masking VIIRSCAG agrees exceptionally well with MODSCAG*
- The small biases we saw in VIIRSCAG are very likely just spatial resolution issues.

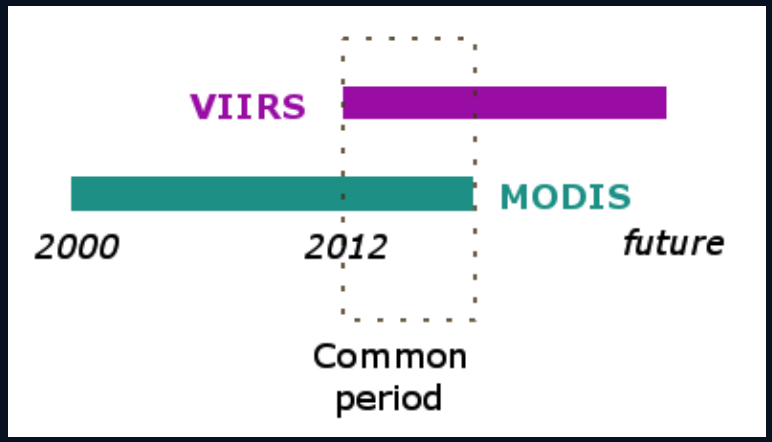




Where to next?

- Expand the evaluation
- Understand the differences between VIIRSCAG and MODSCAG across a range of metrics
- So when we stitch the 15+ year multi-sensor time series together we can properly assess snow cover trends





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