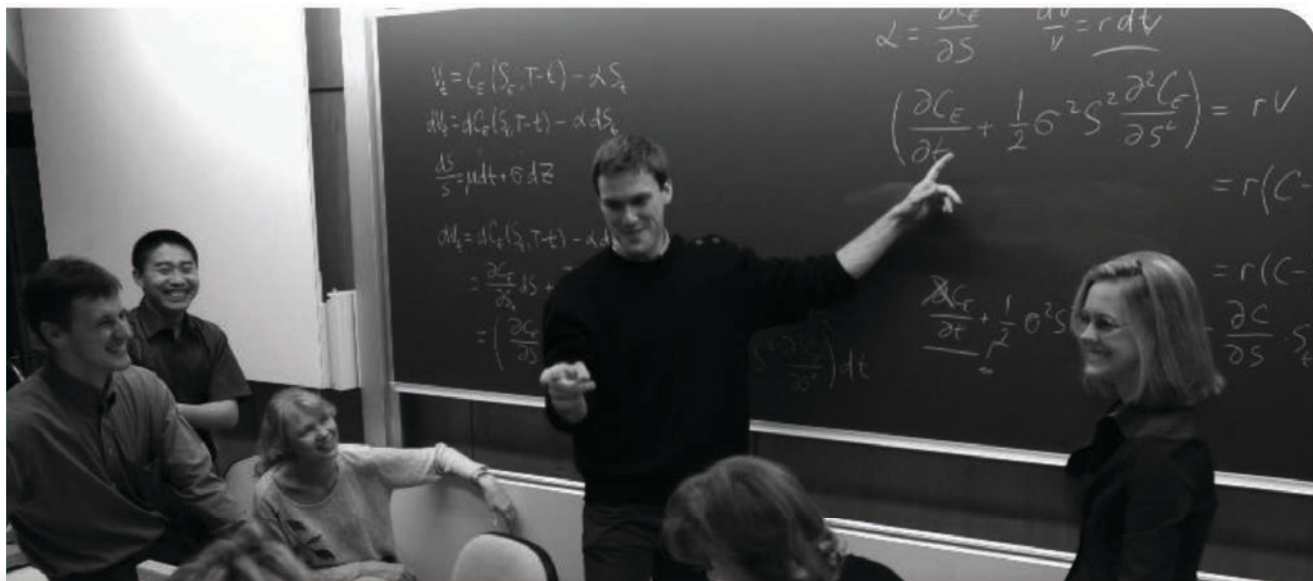




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Reconstructing sediment connection in Alpine landscapes undergoing rapid glacier recession

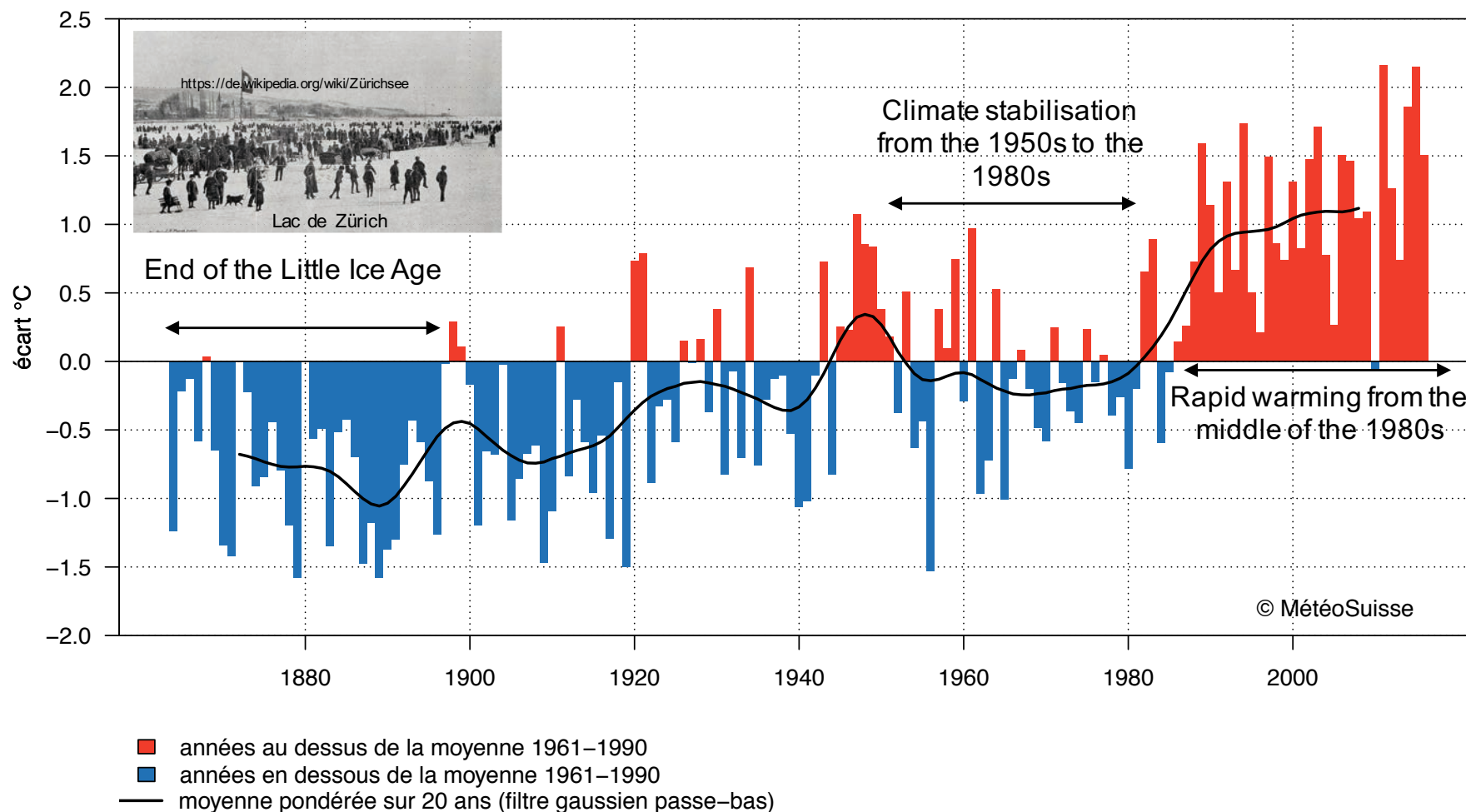
Stuart N. Lane, Chrystelle Gabbud, Natan Micheletti

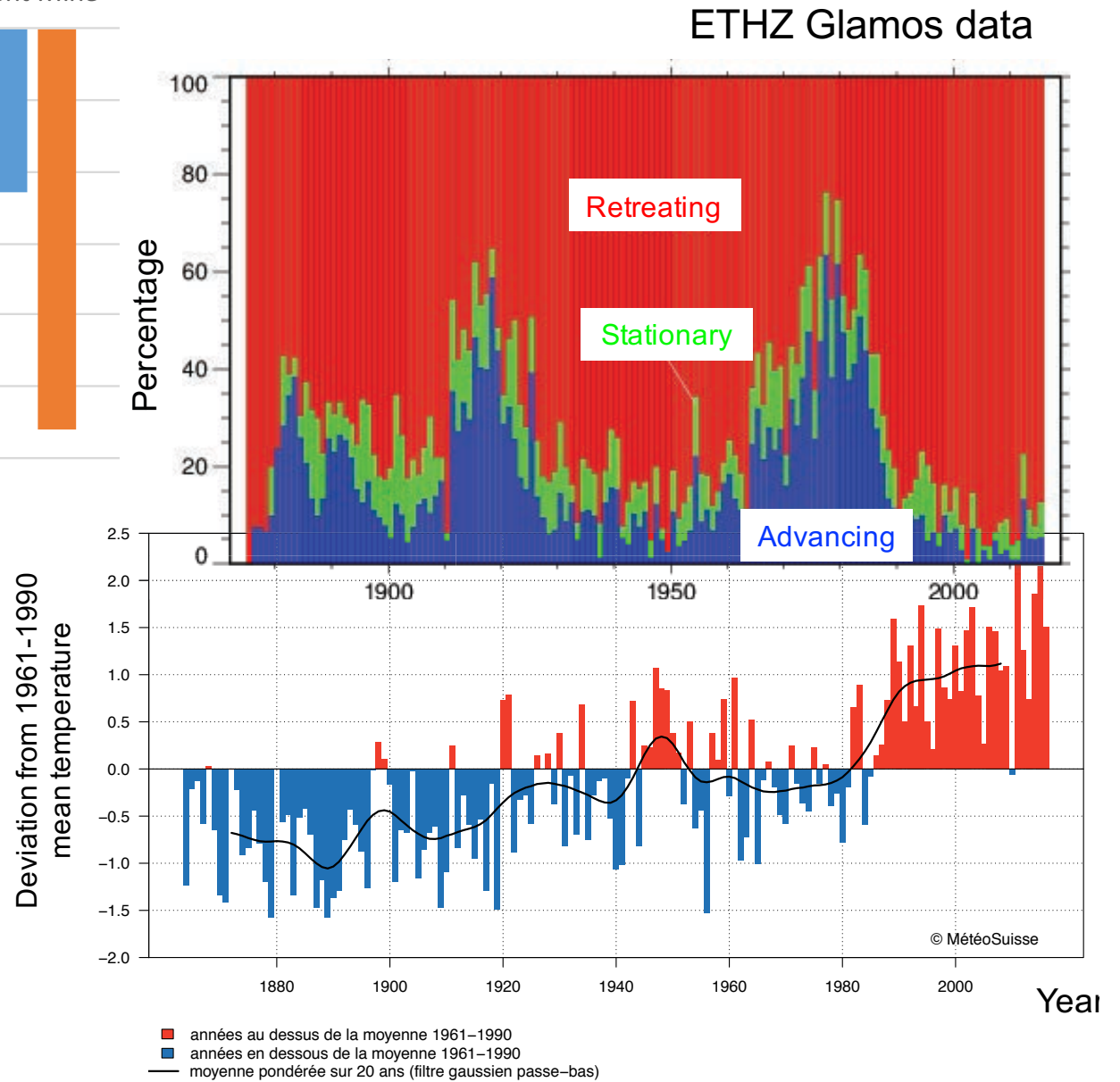
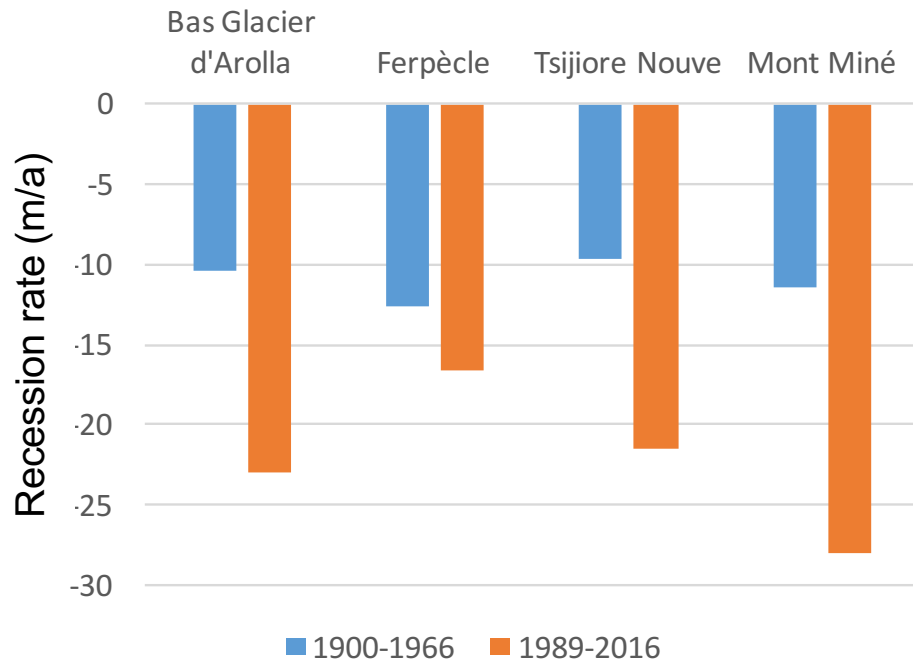
Institute of Earth Surface Dynamics

stuart.lane@unil.ch

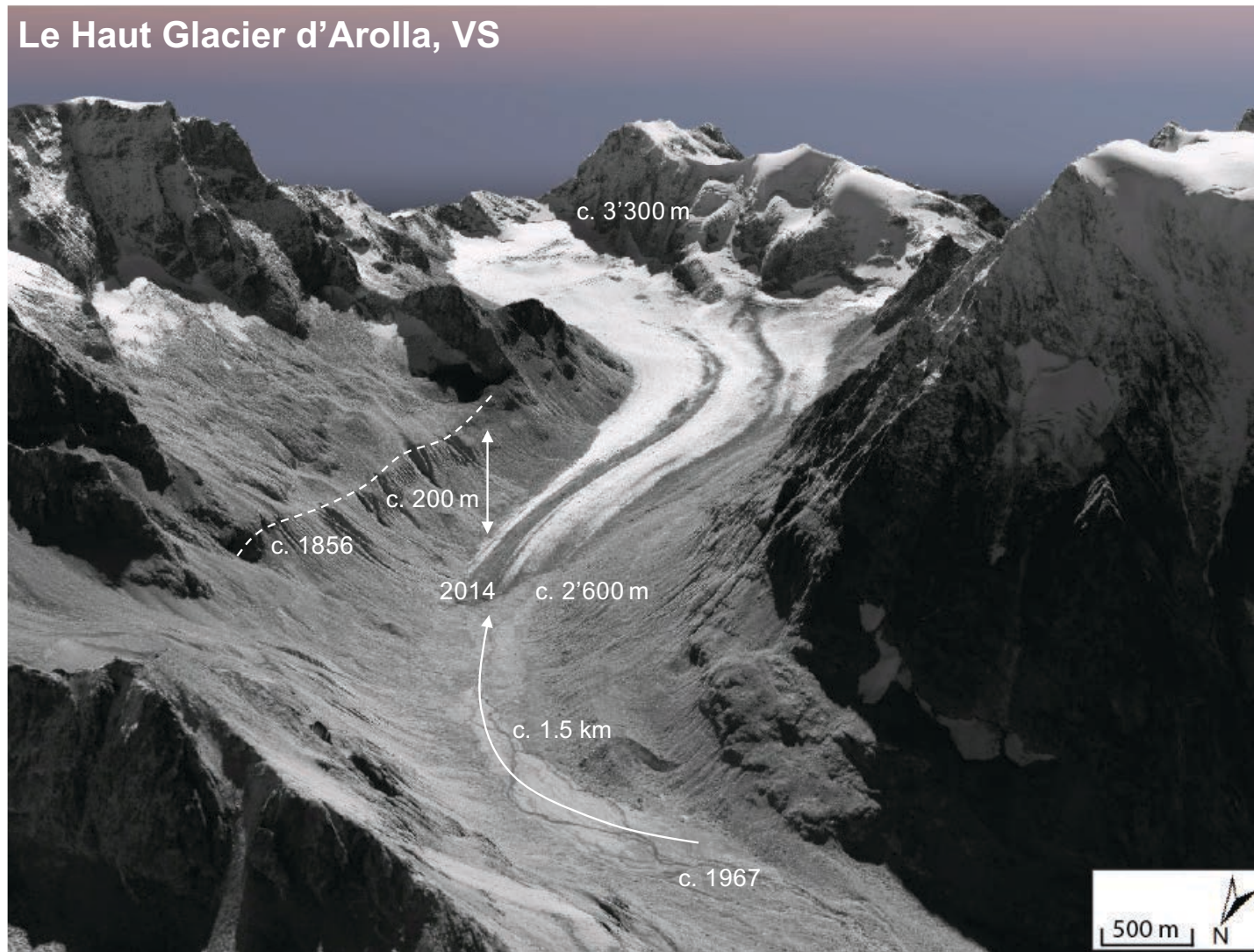
The Context

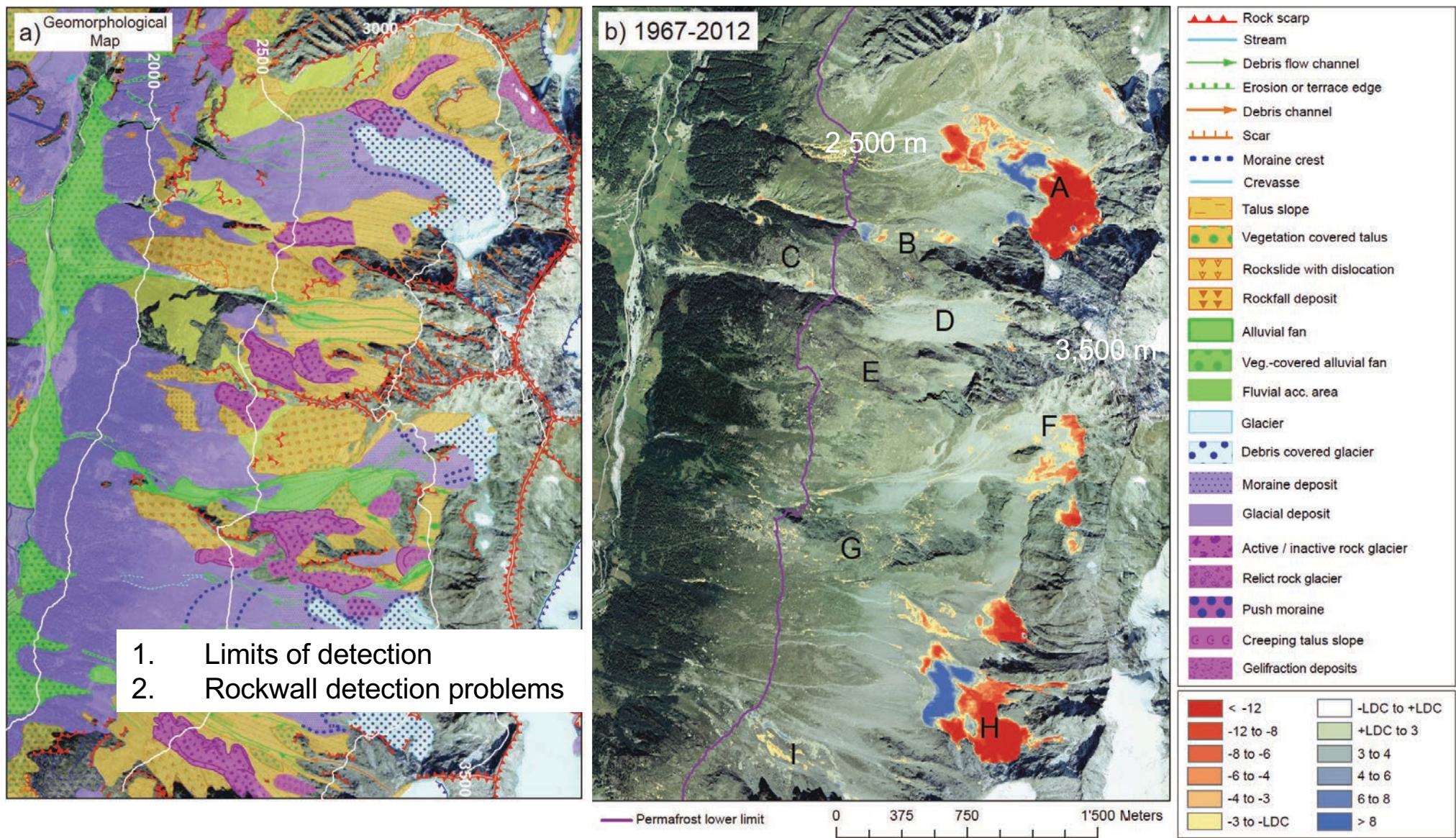
mean annual temperature deviation from the 1961-1990 mean





How does connection respond, *geomorphically* ?



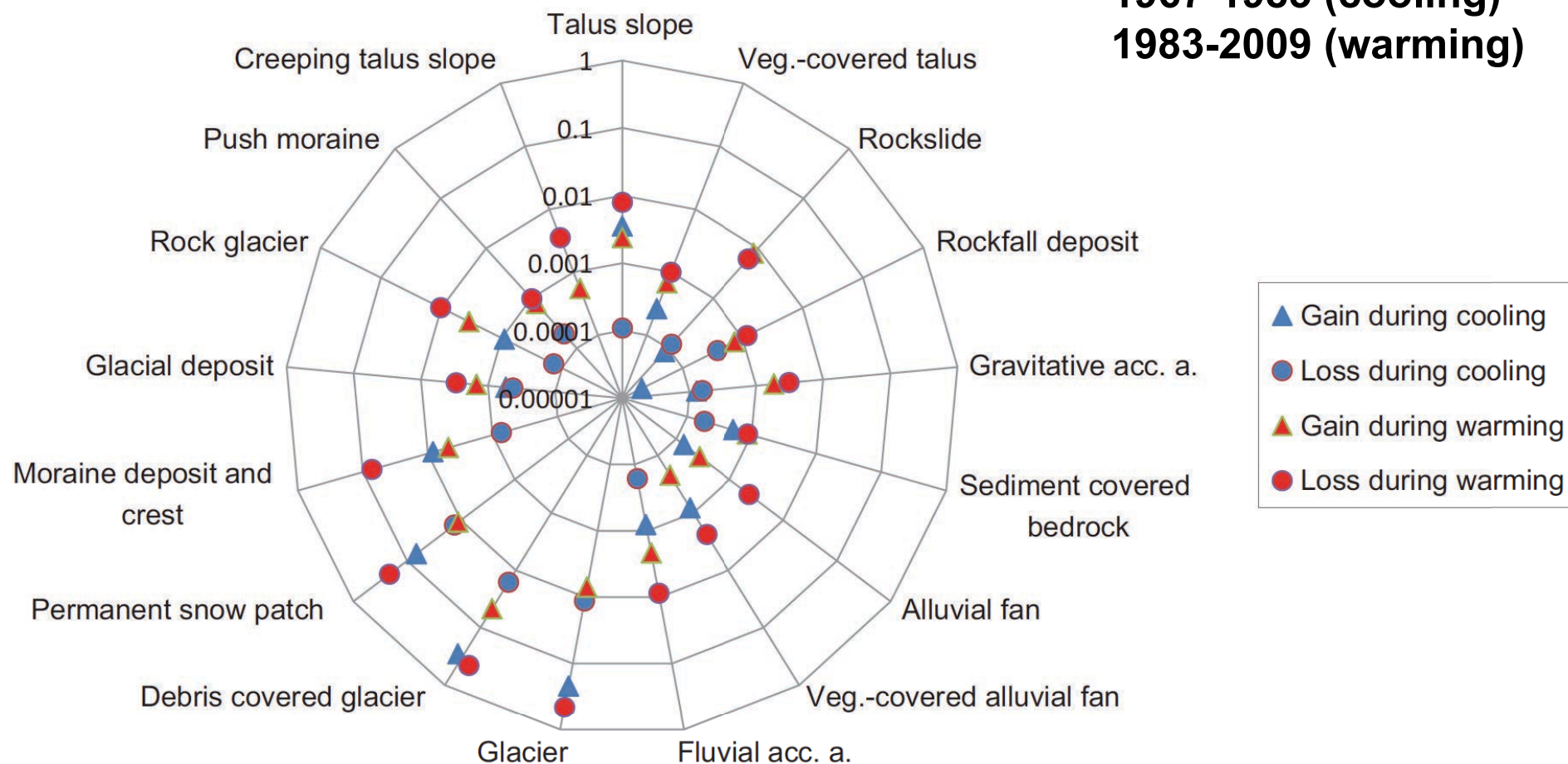


Micheletti, N., Lambiel, C. and Lane, S.N. 2015. *Journal of Geophysical Research - Earth Surface*, 120, 2155-75

Micheletti, N. and Lane, S.N. 2016. *Water Resources Research*, 52, 4924–4943

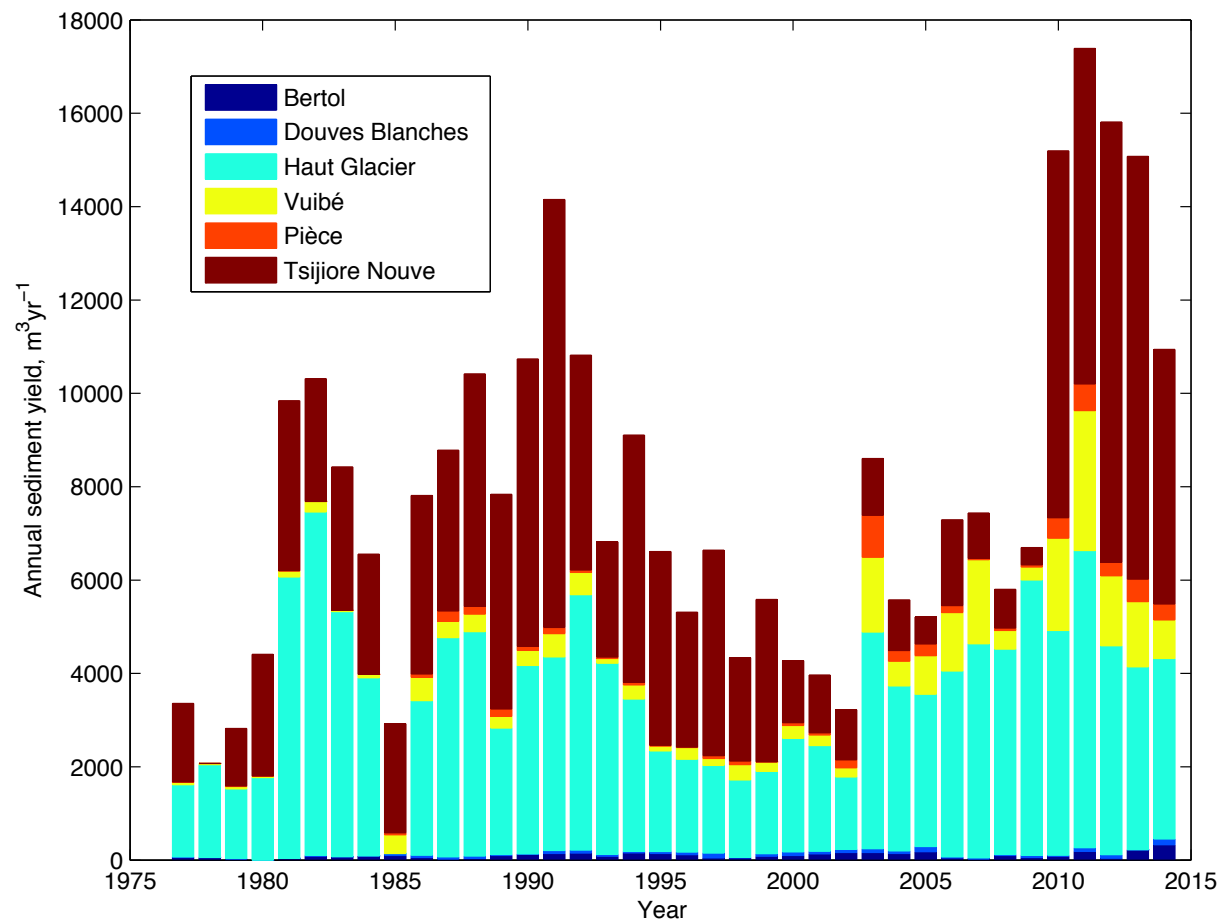
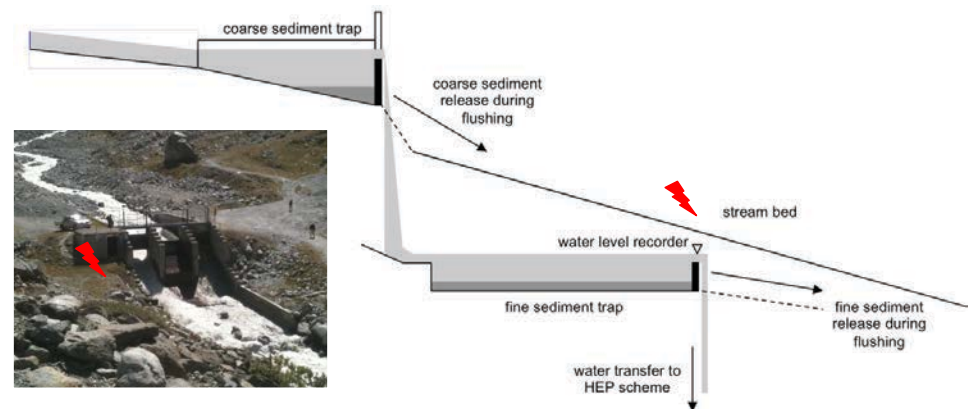
The Context

Change in m / year
1967-1983 (cooling)
1983-2009 (warming)



Micheletti, N., Lambiel, C. and Lane, S.N. 2015. *Journal of Geophysical Research - Earth Surface*, 120, 2155-75
Micheletti, N. and Lane, S.N. 2016. *Water Resources Research*, 52, 4924-4943

The Context



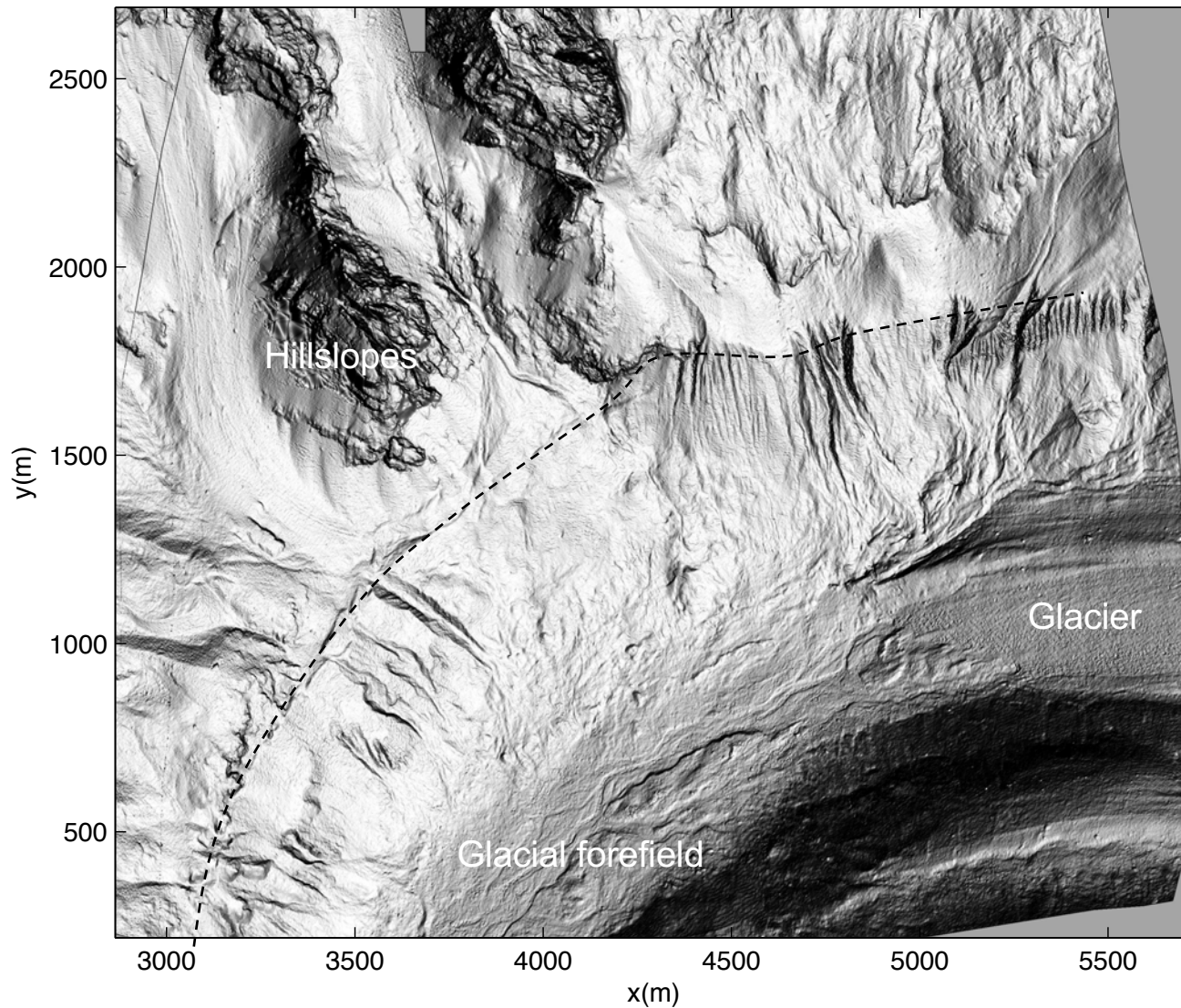
Lane, S.N. et al., 2017.
Geomorphology, 277, 210-27

Micheletti, N. and Lane, S.N.
2016. *Water Resources Research*, 52, 4924–4943

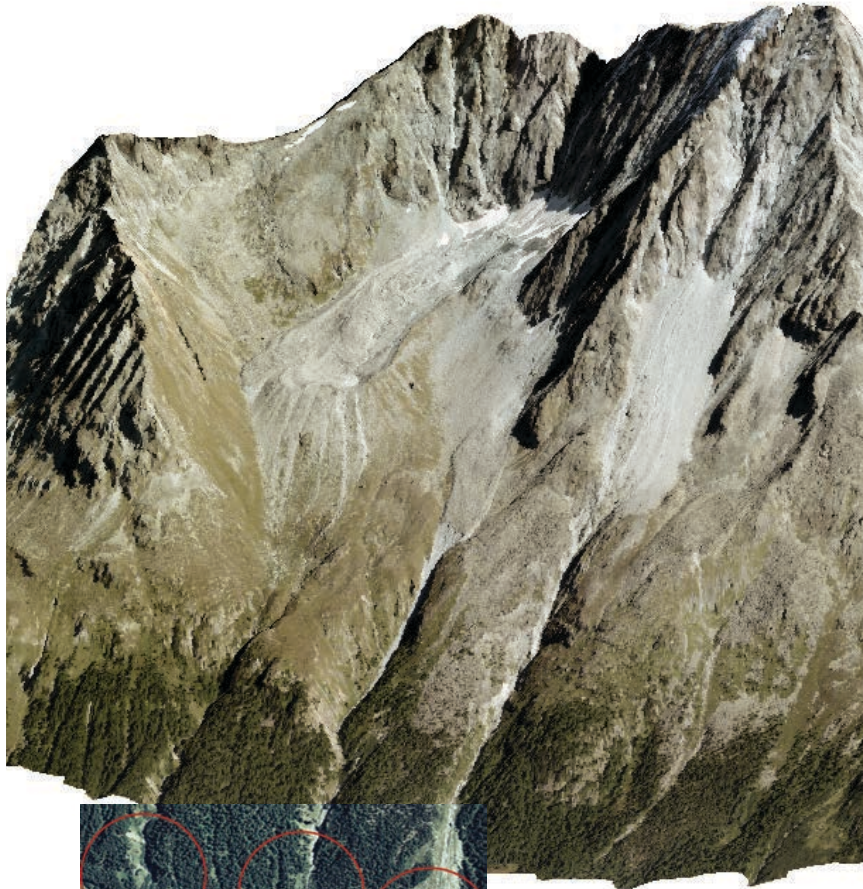
Connection, disconnection and connectivity indices : structure

1. The importance of disconnection in deglaciated basins
2. The challenge of distinguishing between artificial and true disconnection
3. The evolution of connection (and disconnection) following rapid glacier recession

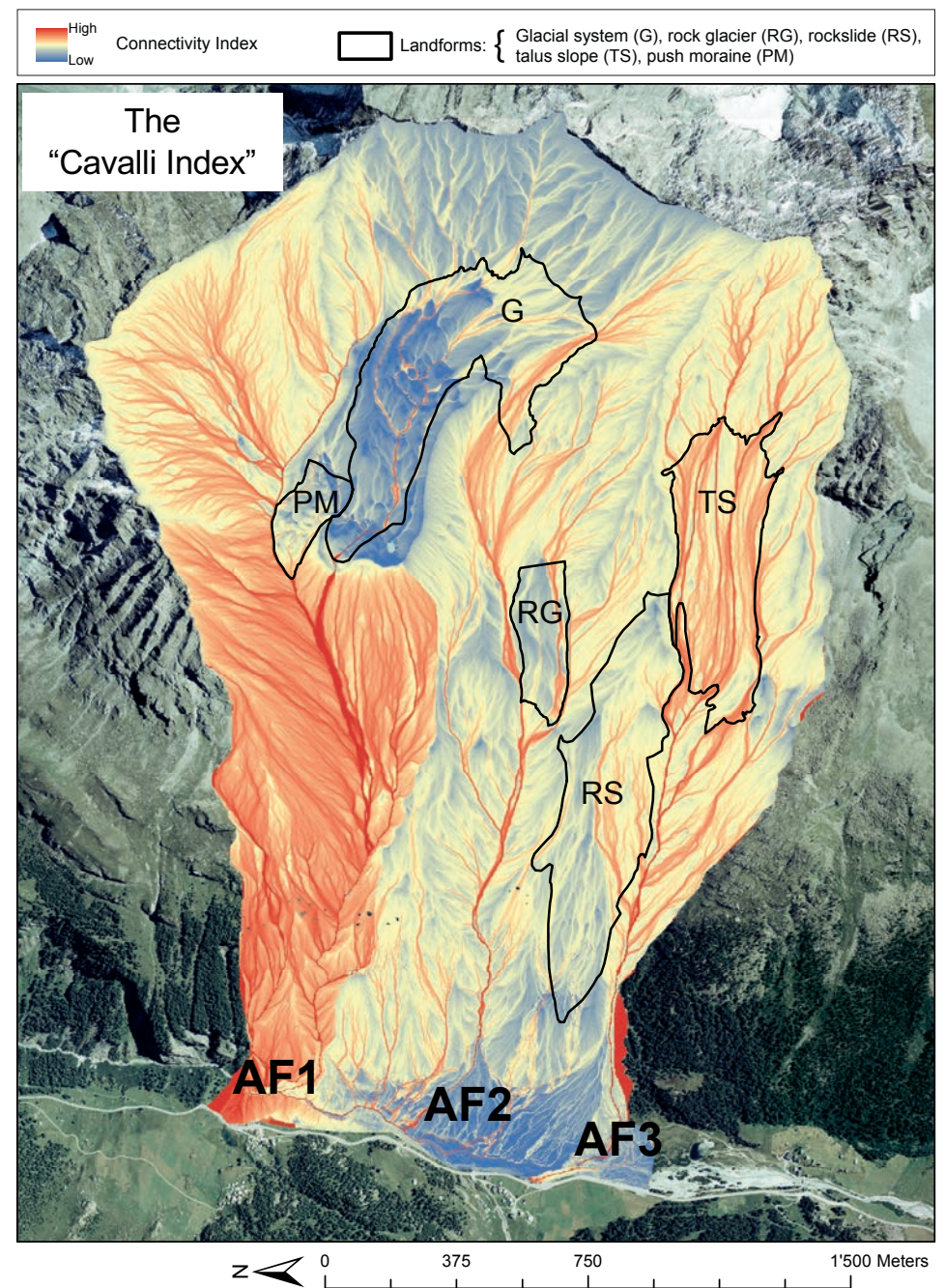
1. The importance of disconnection



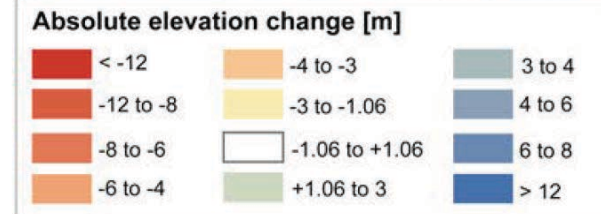
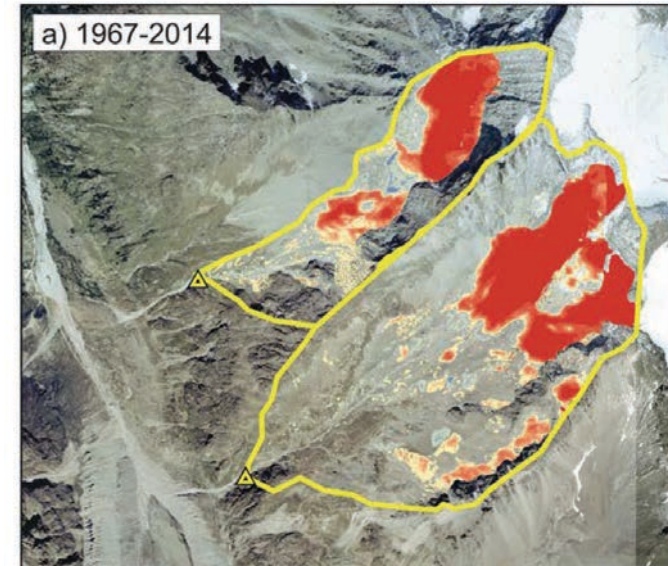
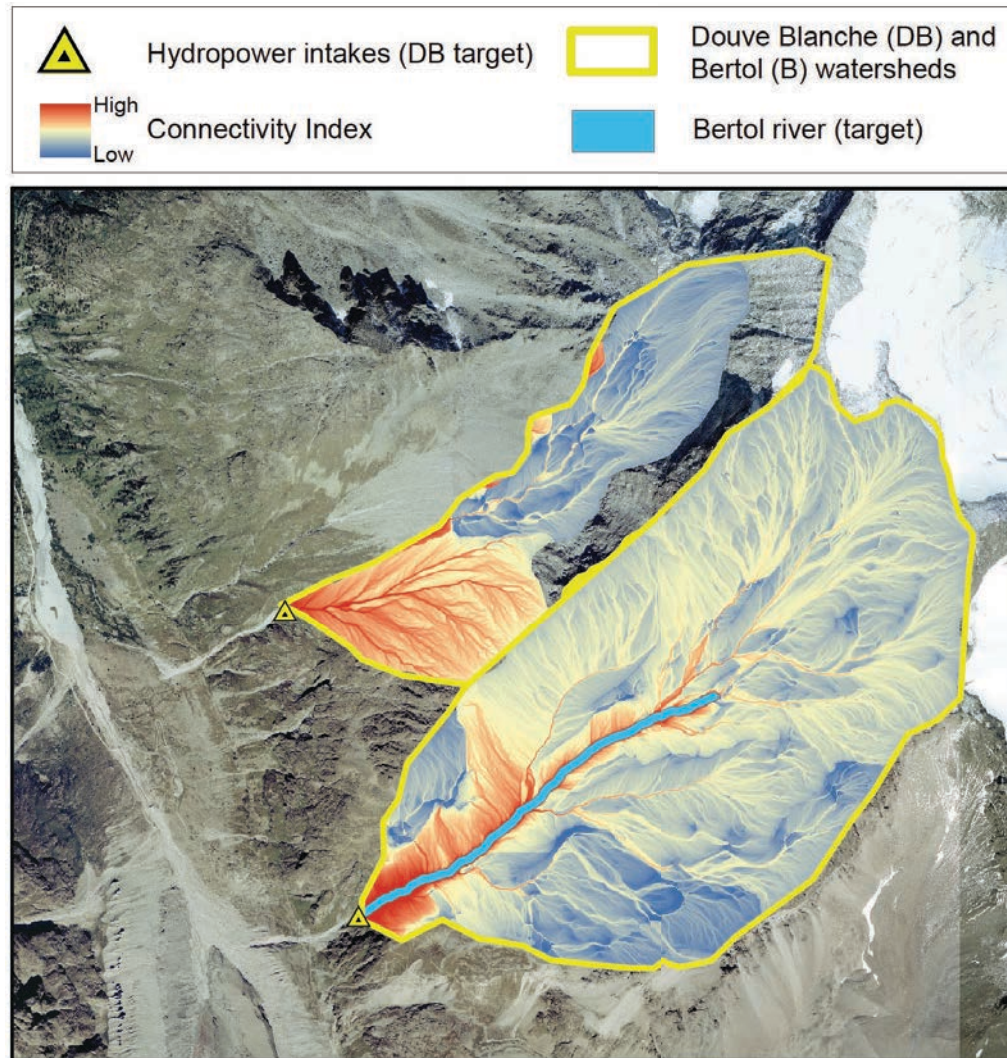
1. The importance of disconnection



Cavalli, M. et al., 2013.
Geomorphology, 188, 31–41.



1. The importance of disconnection



Micheletti, N. and Lane, S.N. 2016. *Water Resources Research*, 52, 4924–4943

2. Artificial versus true disconnection

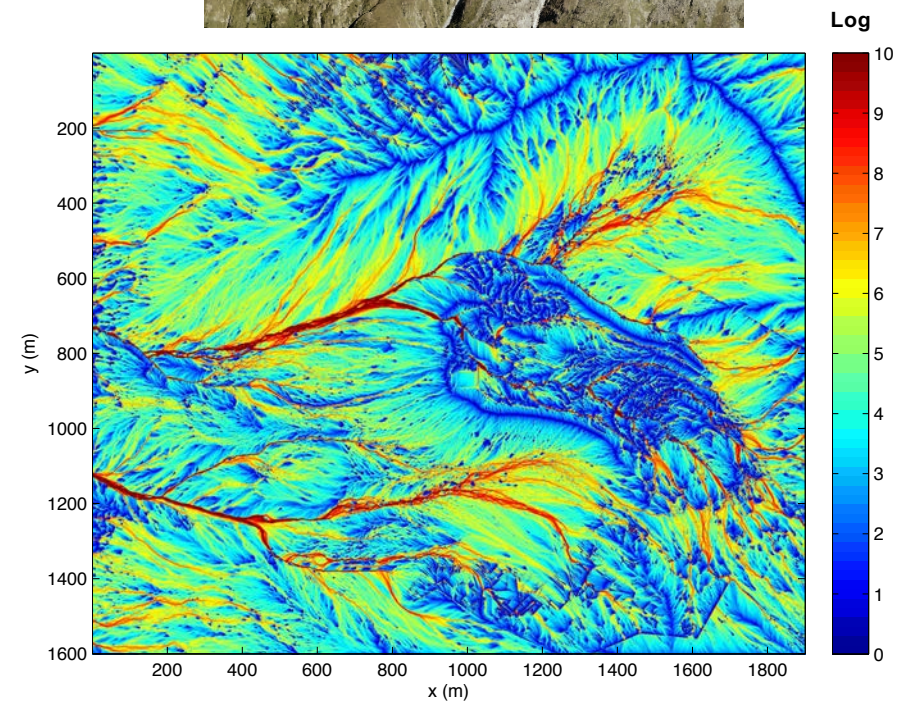
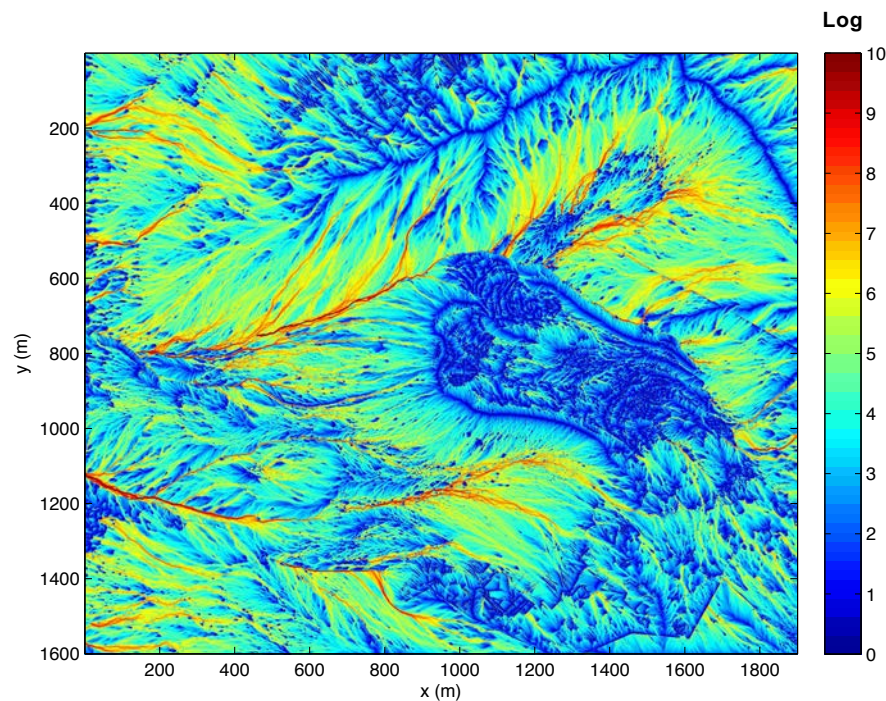
Upslope contributing area

0.50 m resolution DEM

DEM precision c. 0.05m

Based on analytical photogrammetry

2012 data



2. Artificial versus true disconnection

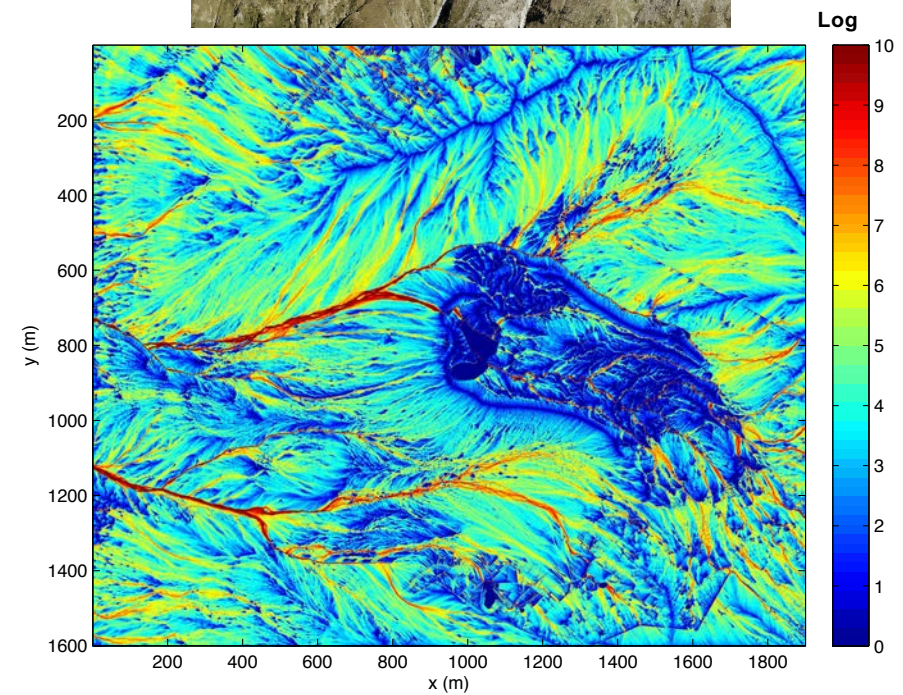
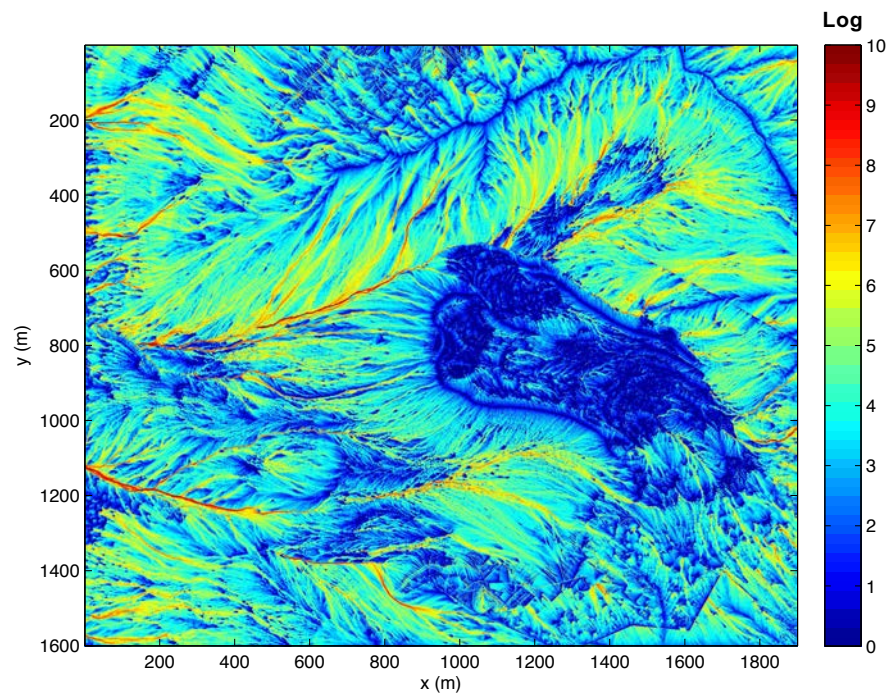
Stream power

0.50 m resolution DEM

DEM precision c. 0.05m

Based on analytical photogrammetry

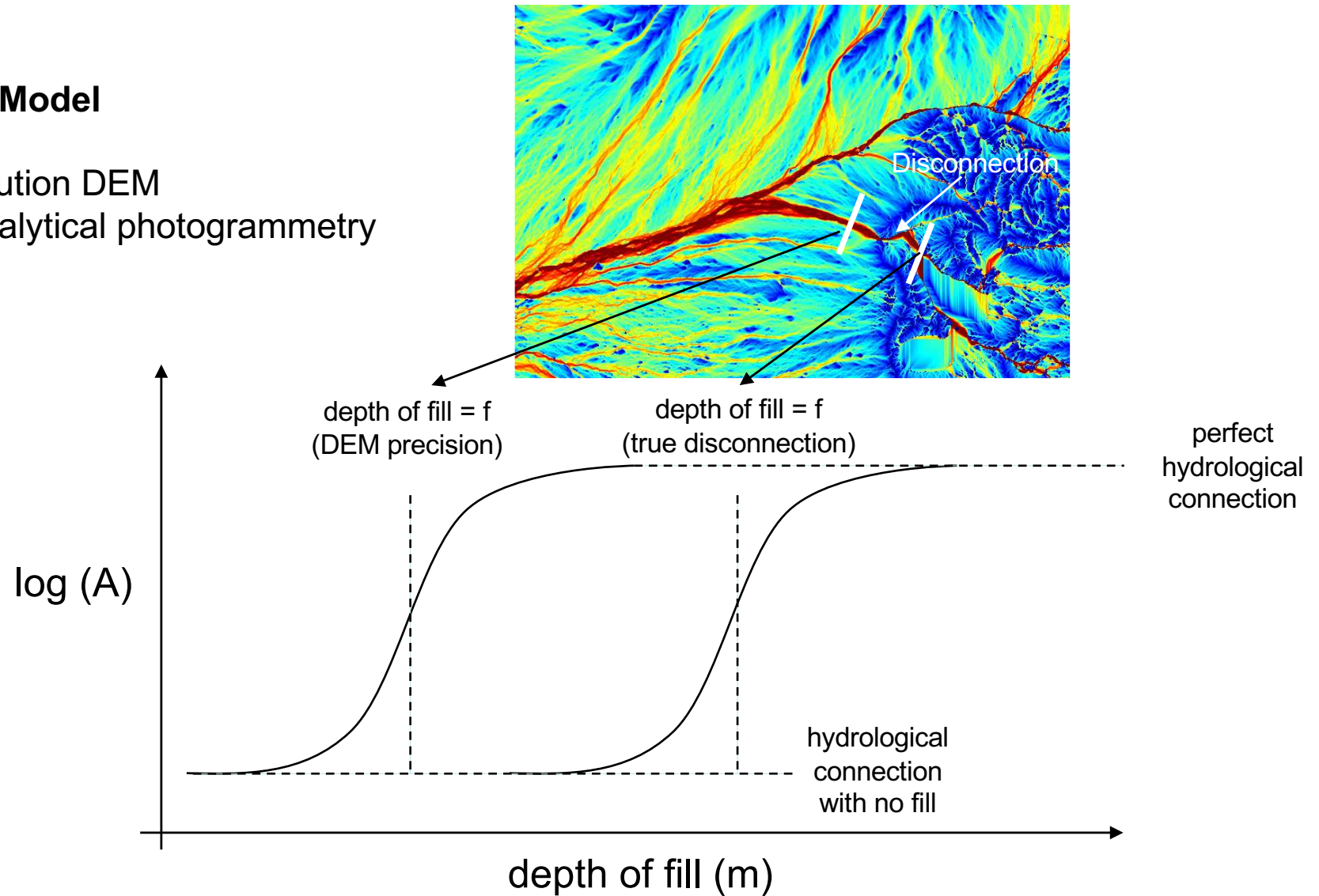
2012 data



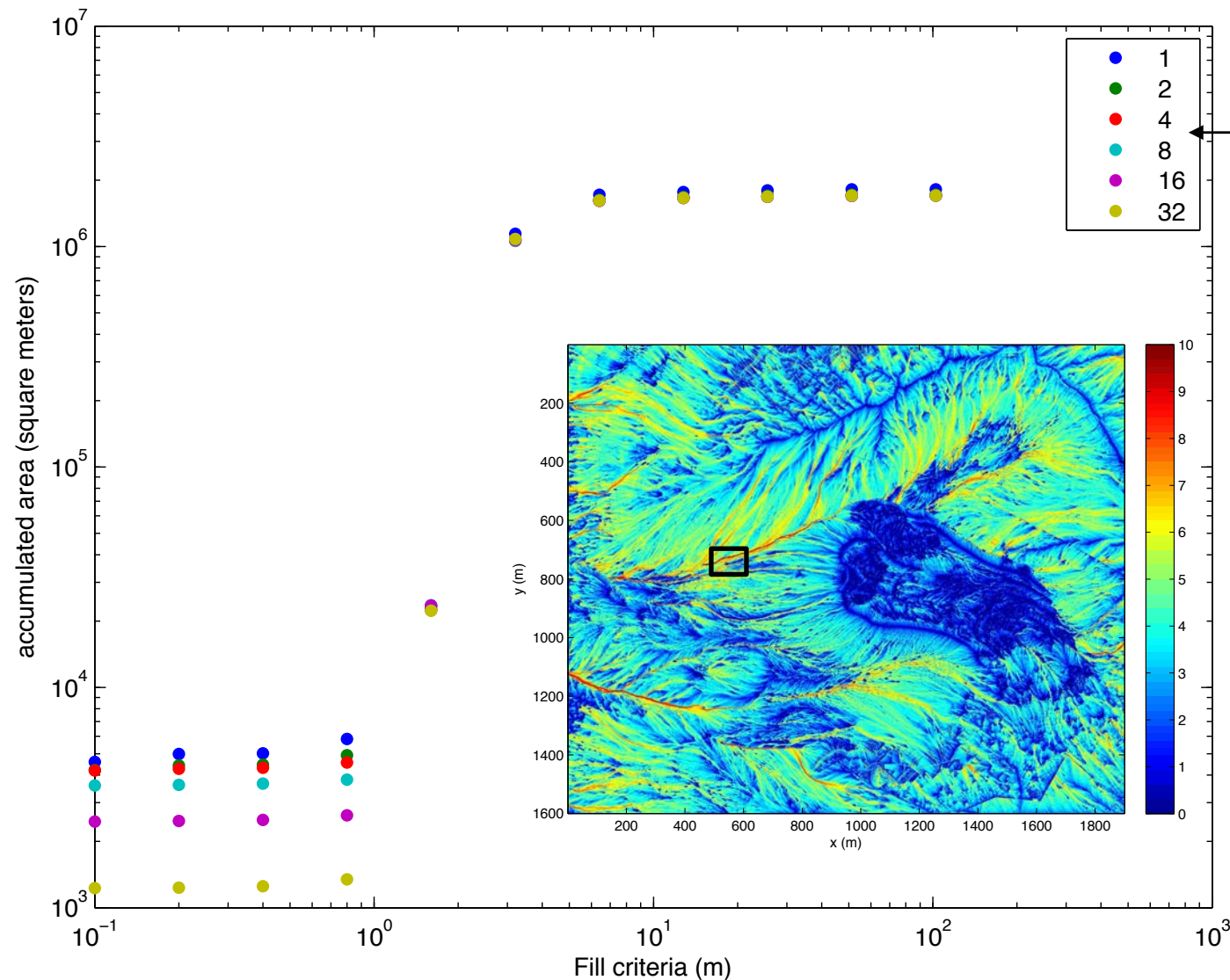
2. Artificial versus true disconnection

Theoretical Model

0.50 m resolution DEM
Based on analytical photogrammetry
2012 data



2. Artificial versus true disconnection



Holmgren
(1994)
Routing
Function

$$f_i = \frac{(\tan \beta_i)^x}{\sum_{i=1}^8 (\tan \beta_i)^x}$$

for all $\tan \beta > 0$

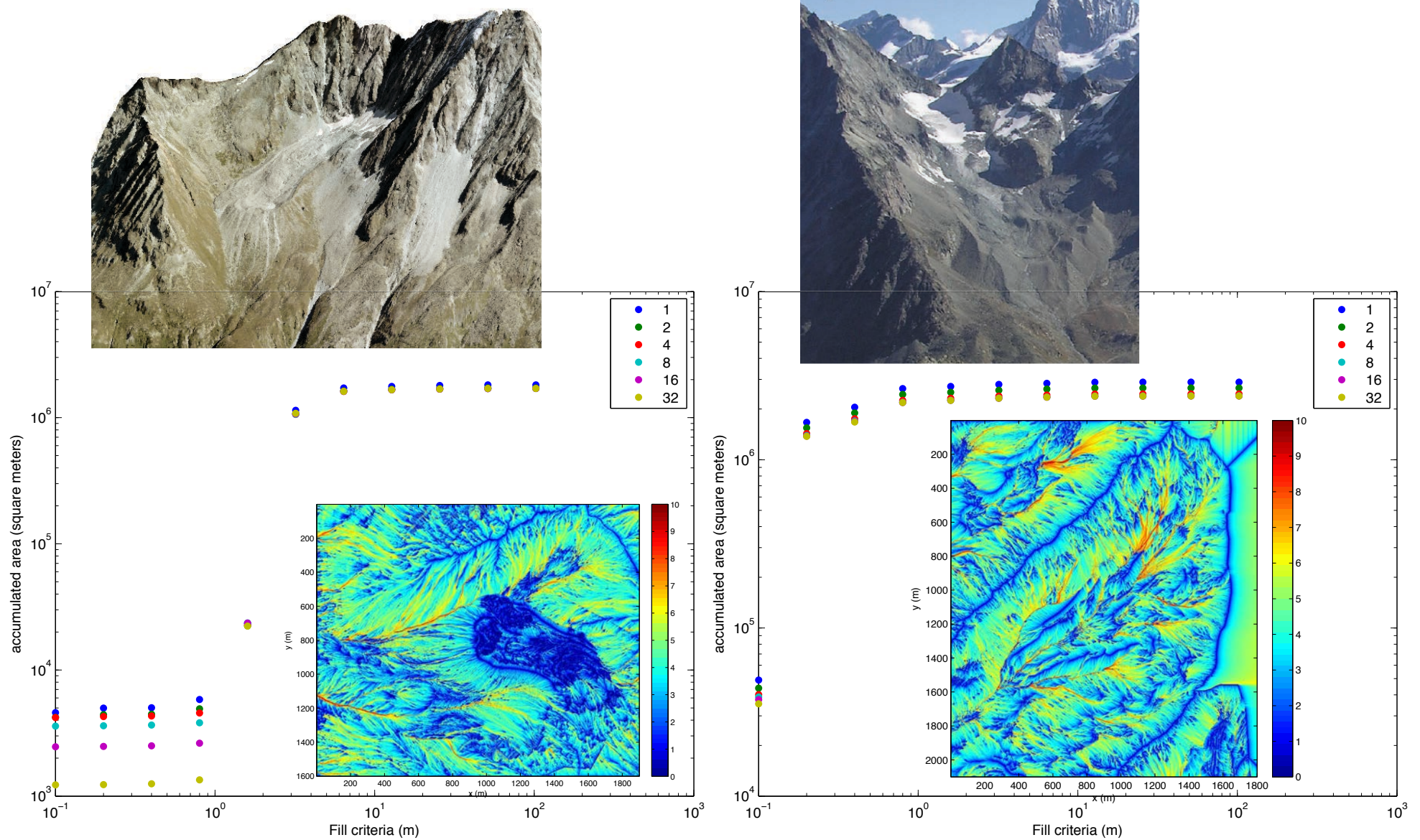
$x = 0$, routing is slope independent

$x = 1$, multiple flow routing

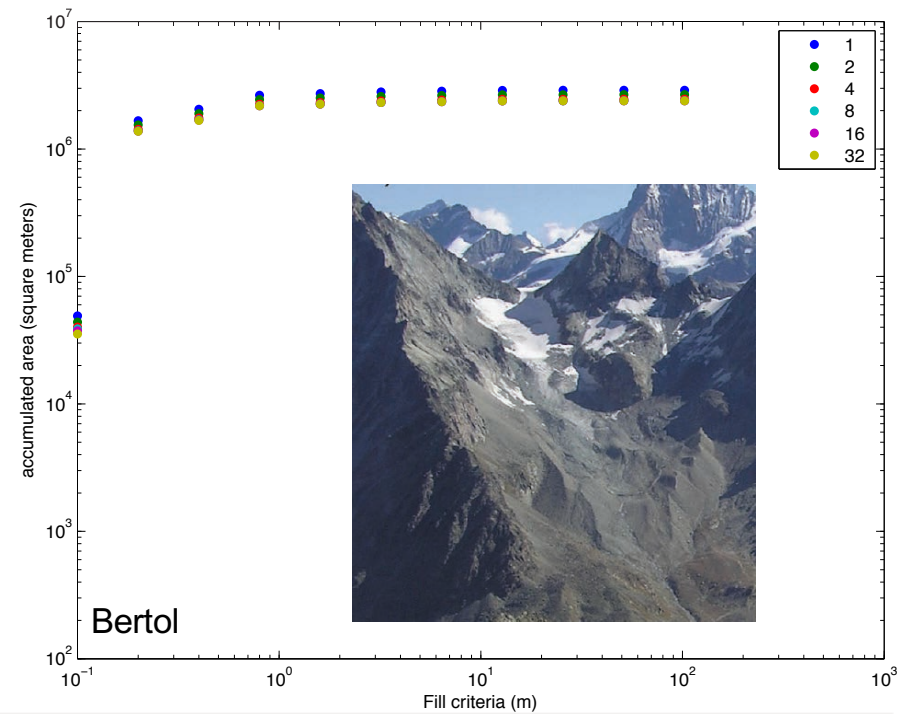
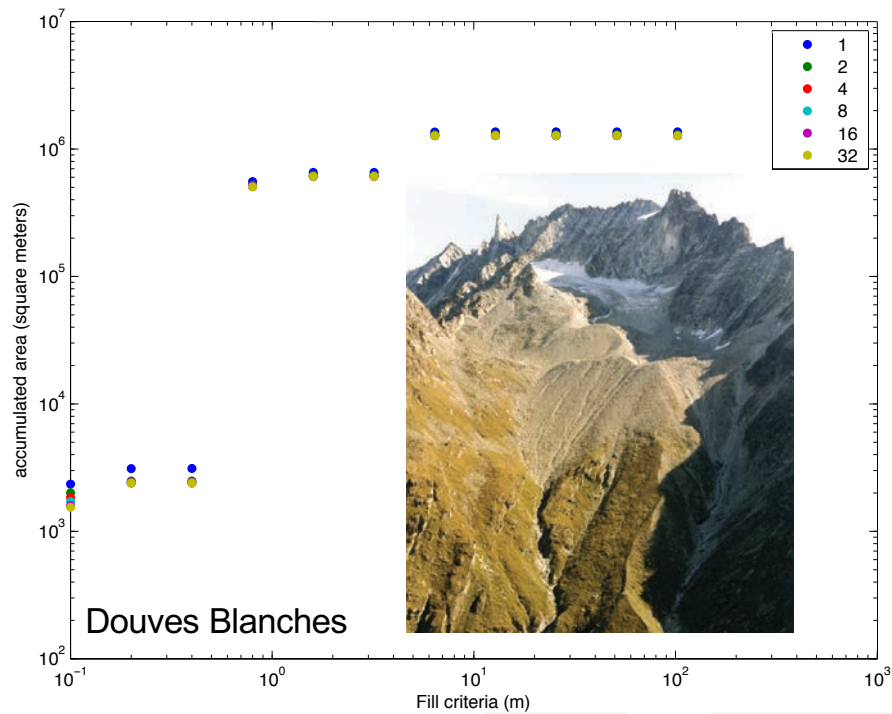
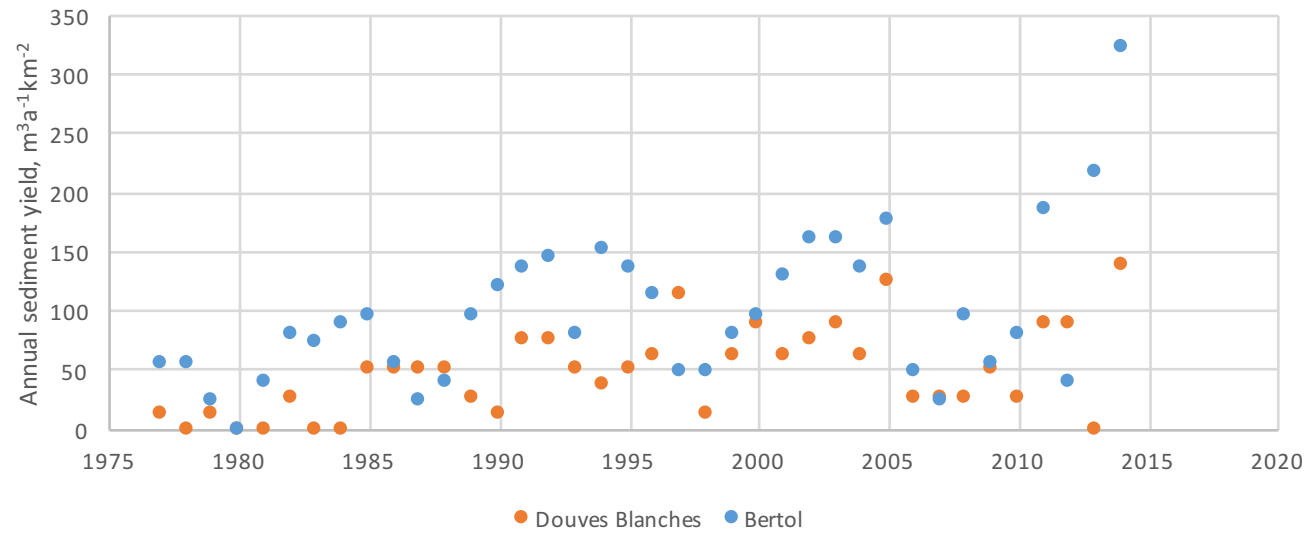
$x = \text{inf.}$, D8

Holmgren, P. (1994), Multiple flow direction algorithms for runoff modelling in grid based elevation models: An empirical evaluation. Hydrol. Process., 8: 327-334

2. Artificial versus true disconnection



Annual sediment yield (suspended sand and coarser)



3. Evolution of connection

Theoretical Model

0.50 m resolution DEM

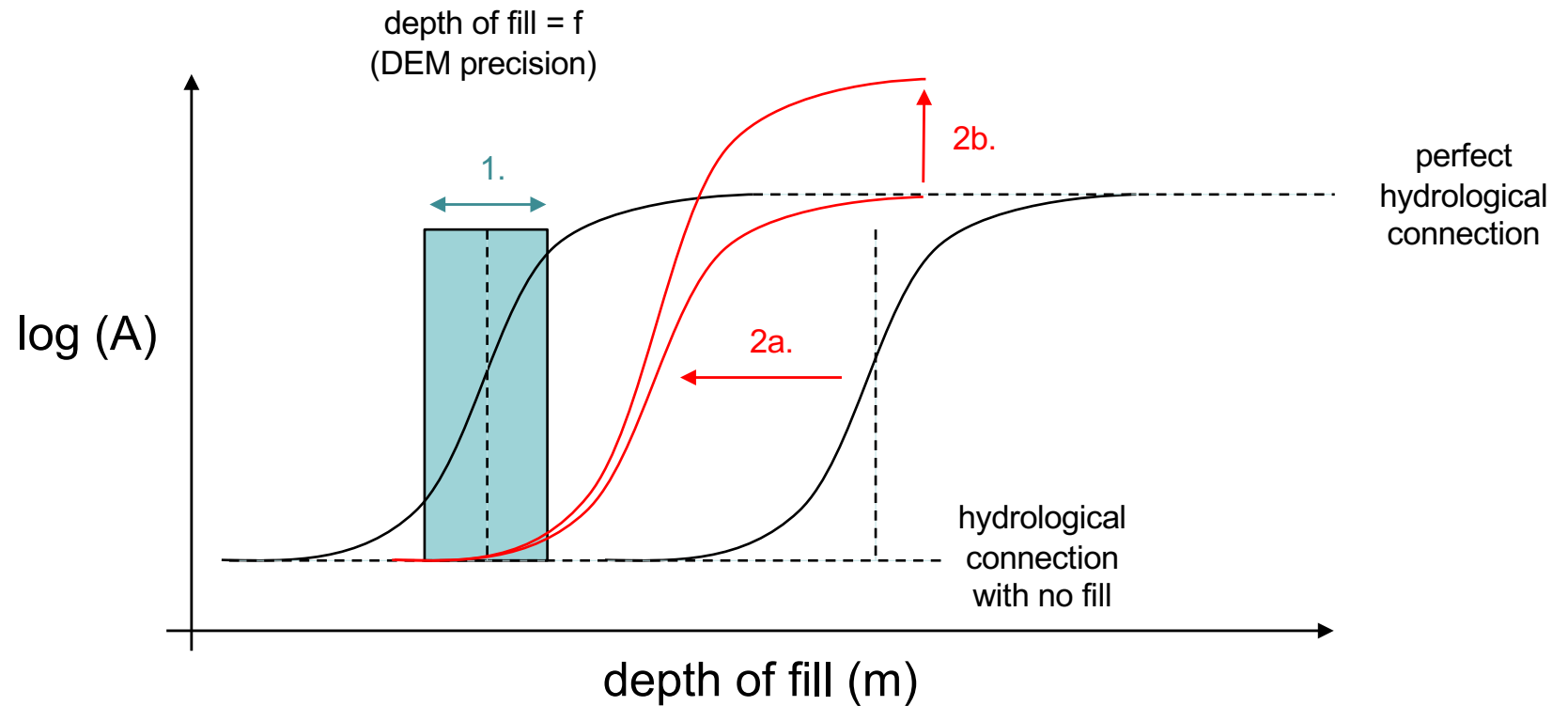
Based on analytical photogrammetry

2012 data

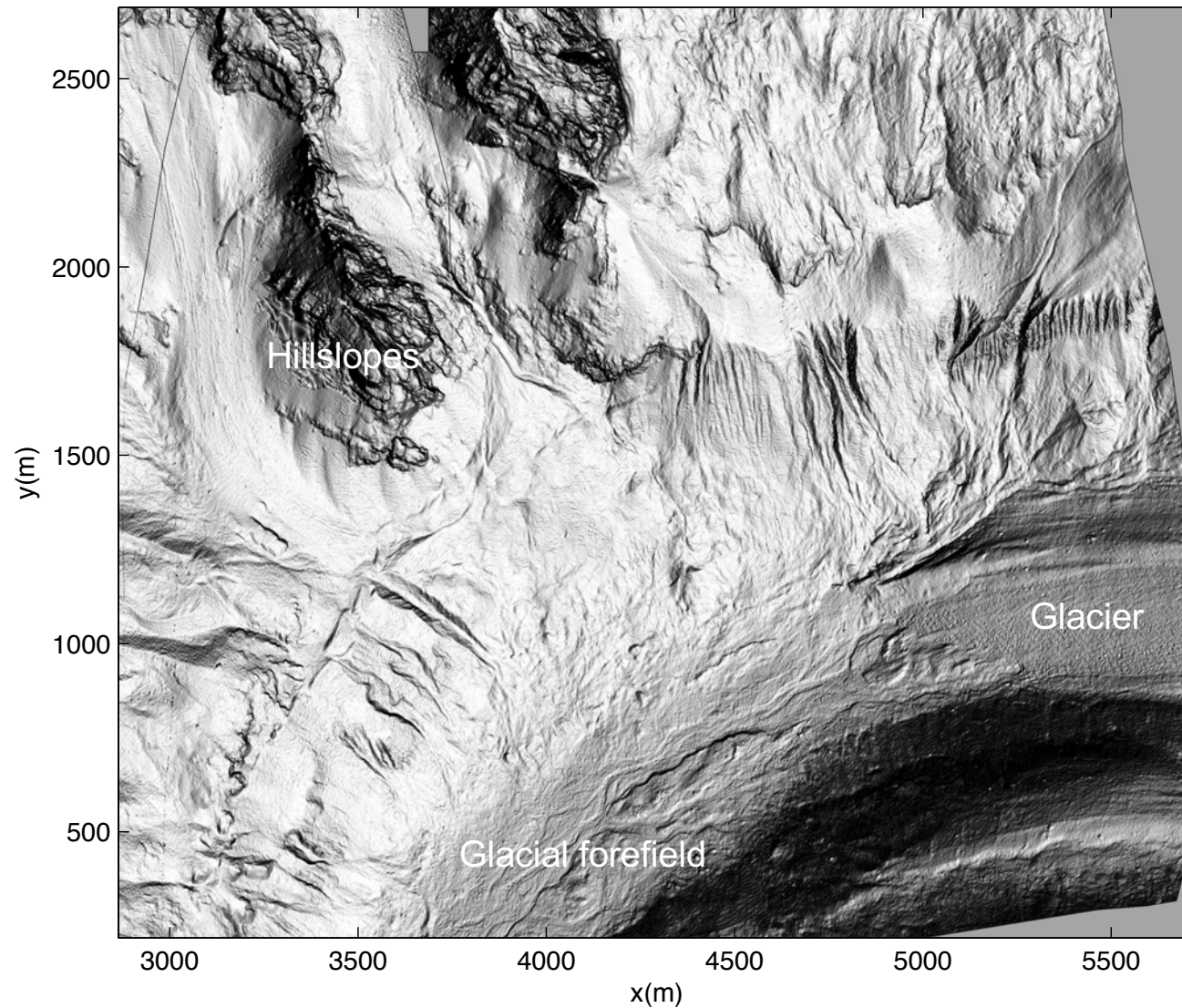
1. Images with different resolutions (precision is a $f(\text{resolution})$)

2a. Base-level fall, erosion

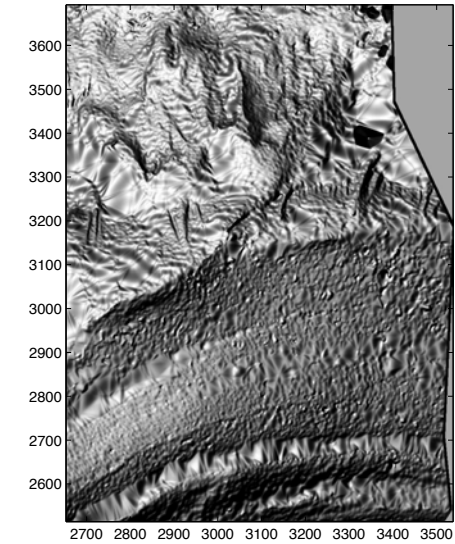
2b. Upstream basin re-organisation



3. Evolution of connection



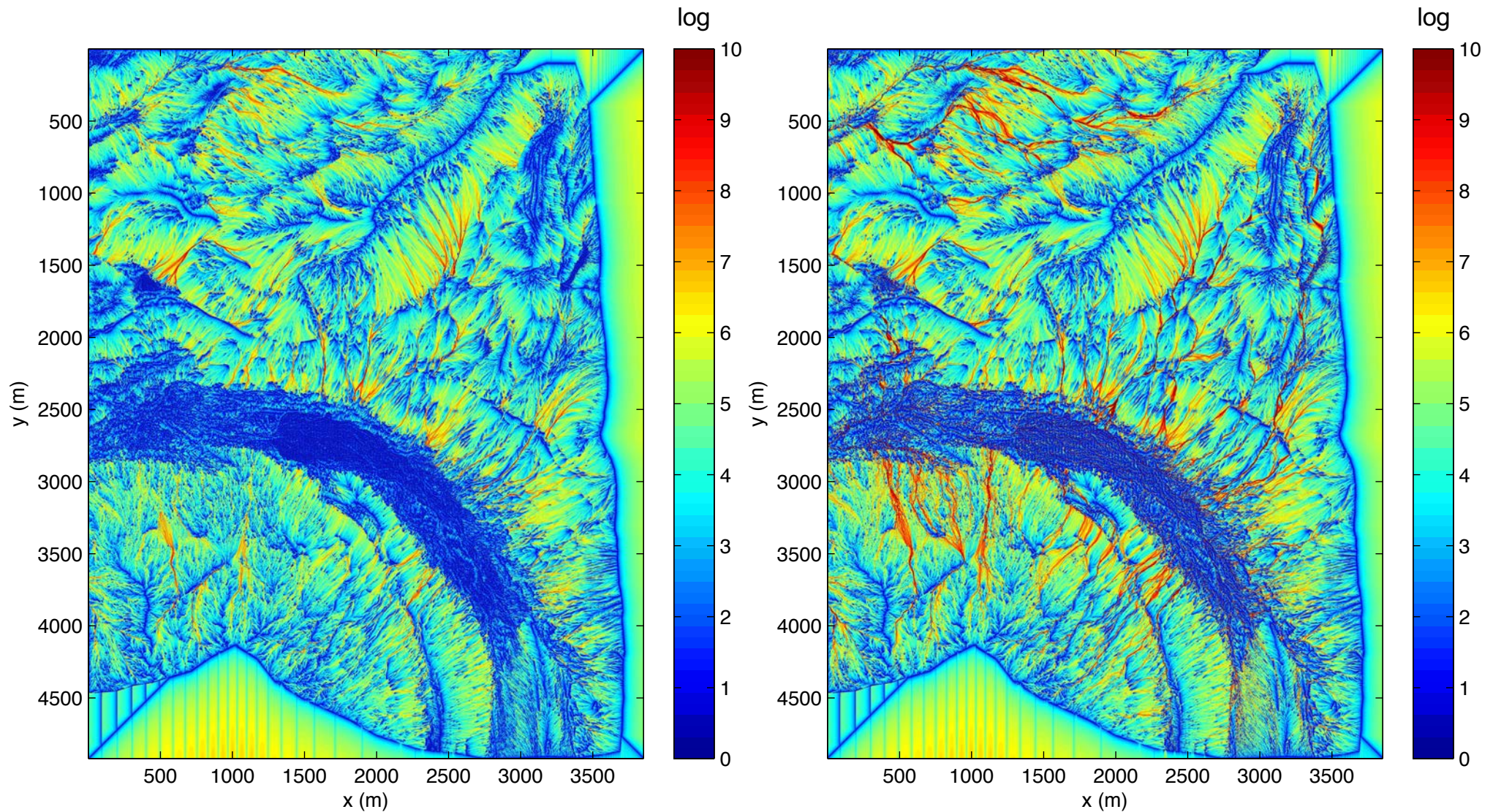
1983



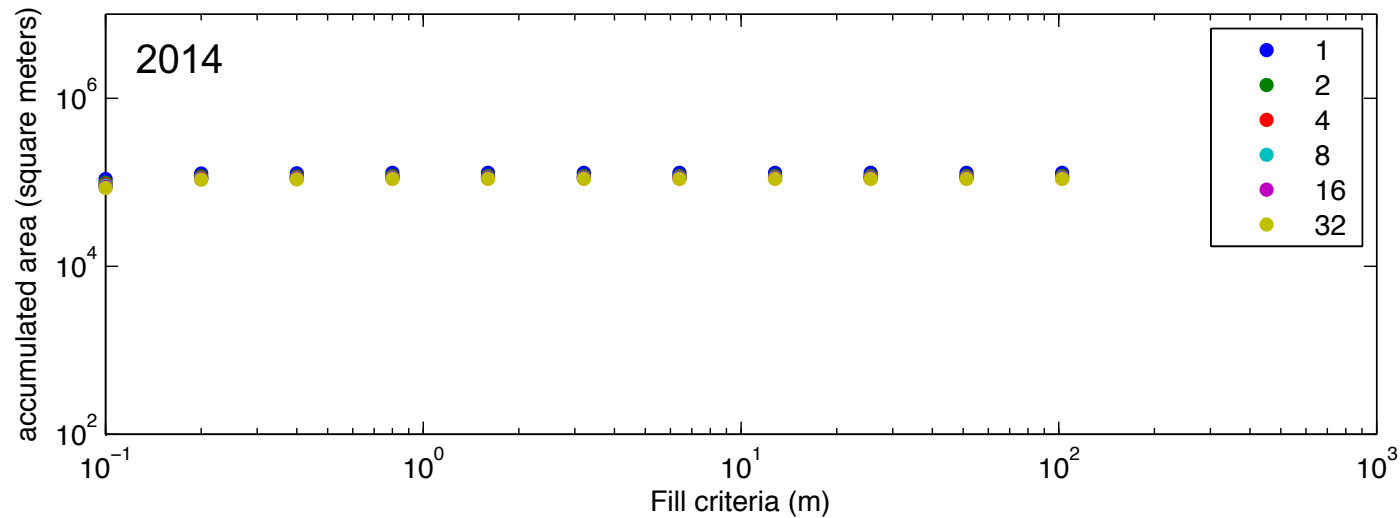
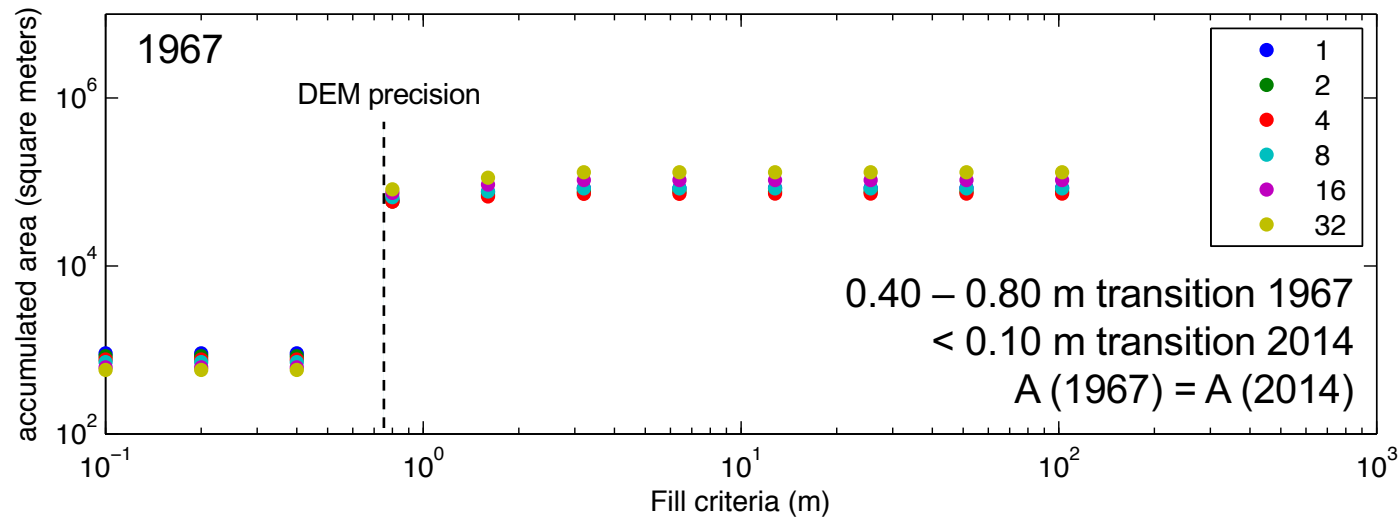
2014

3. Evolution of connection

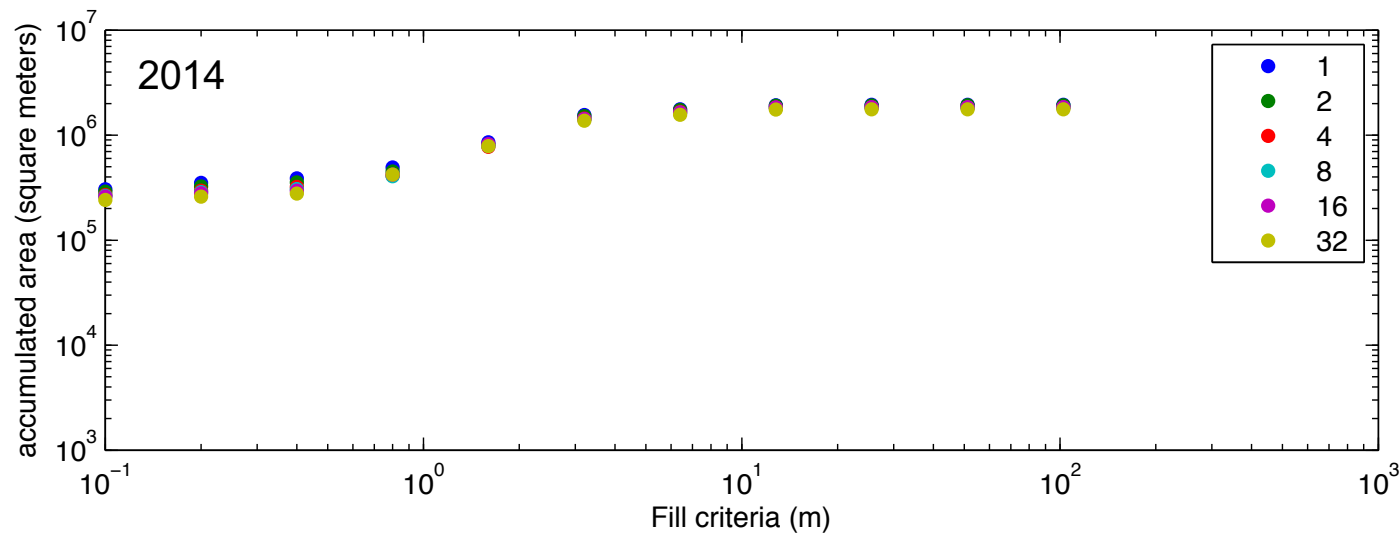
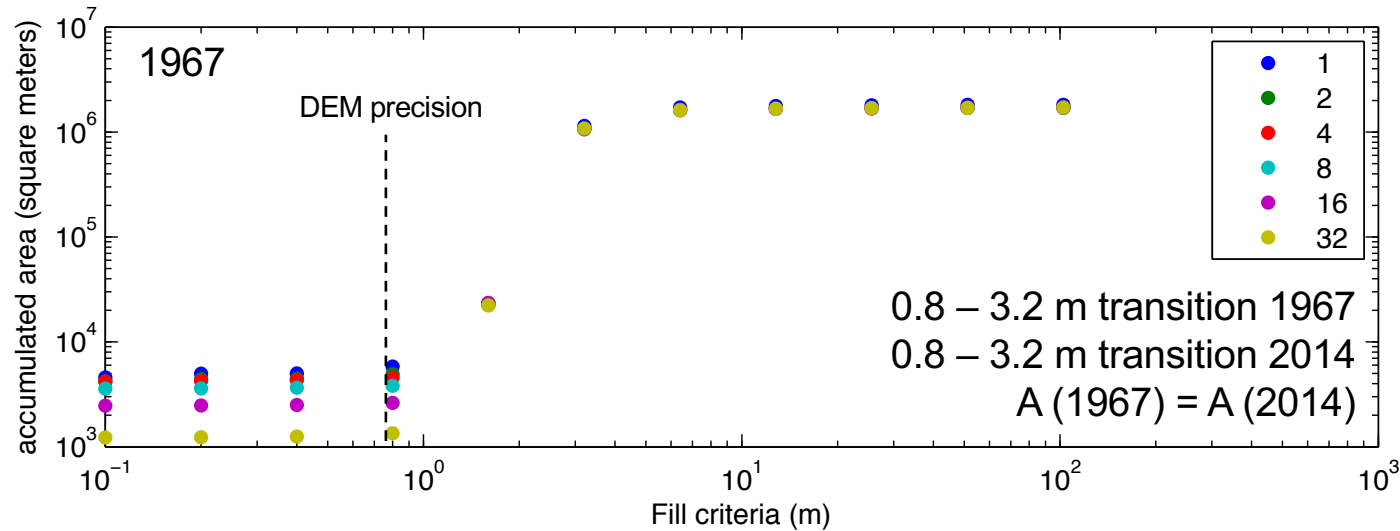
2014 Static Analysis
Upslope contributing area



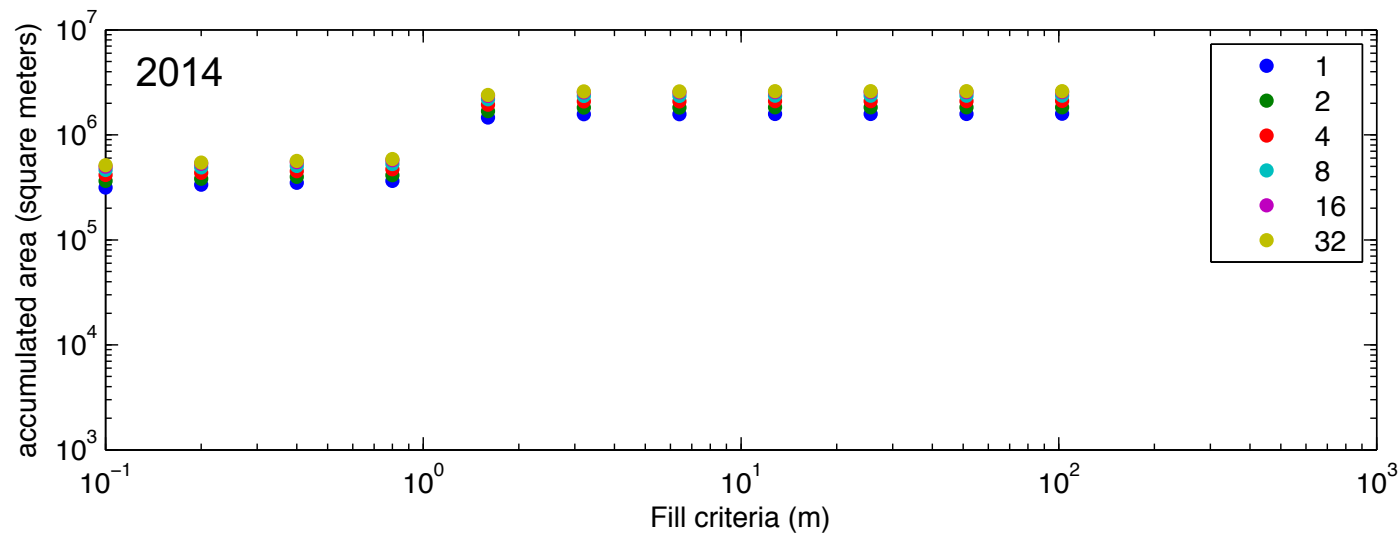
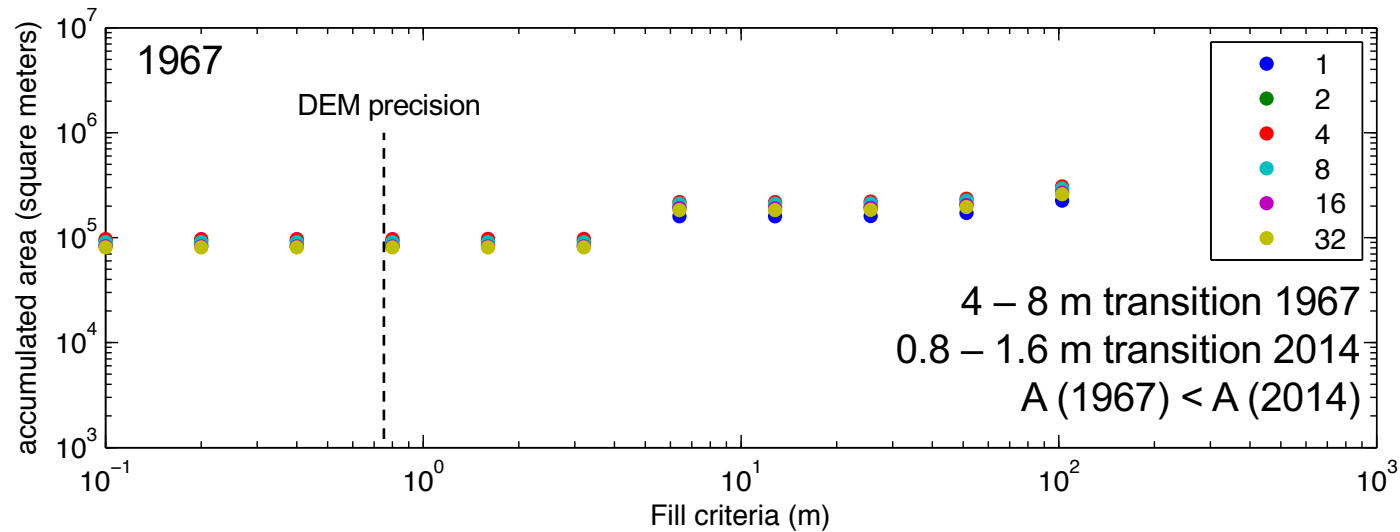
3. Evolution of connection



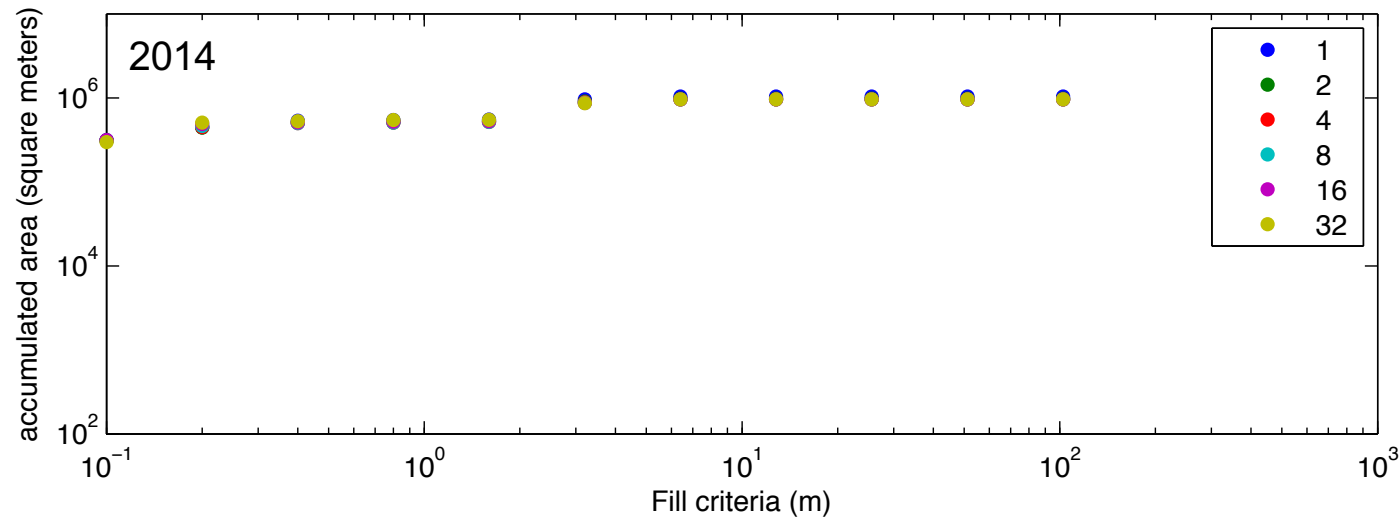
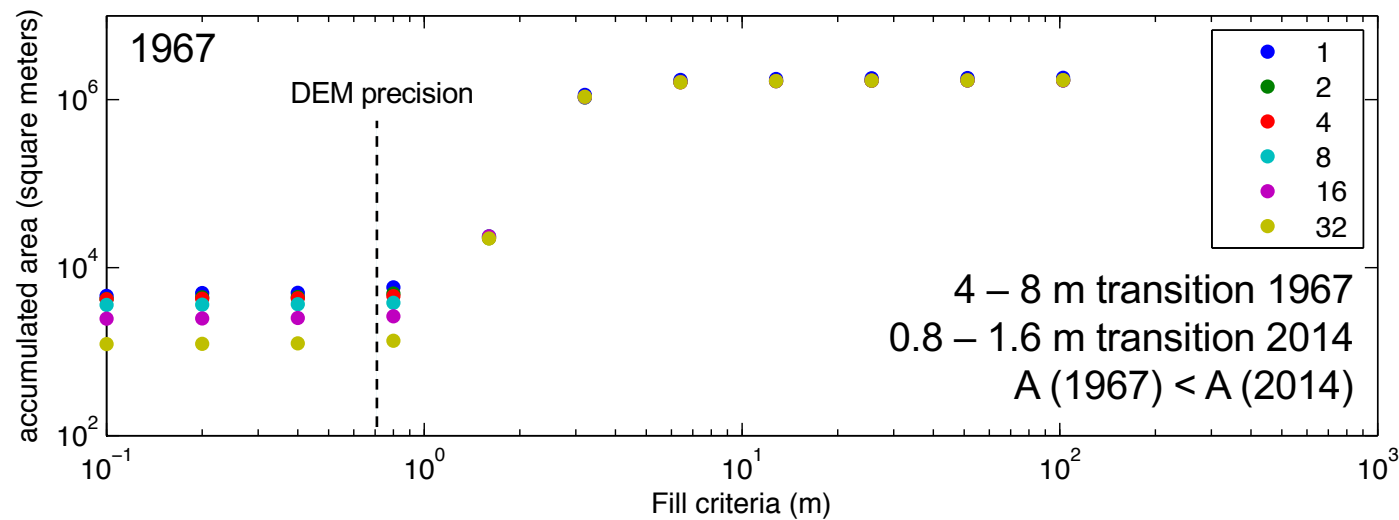
3. Evolution of connection



3. Evolution of connection



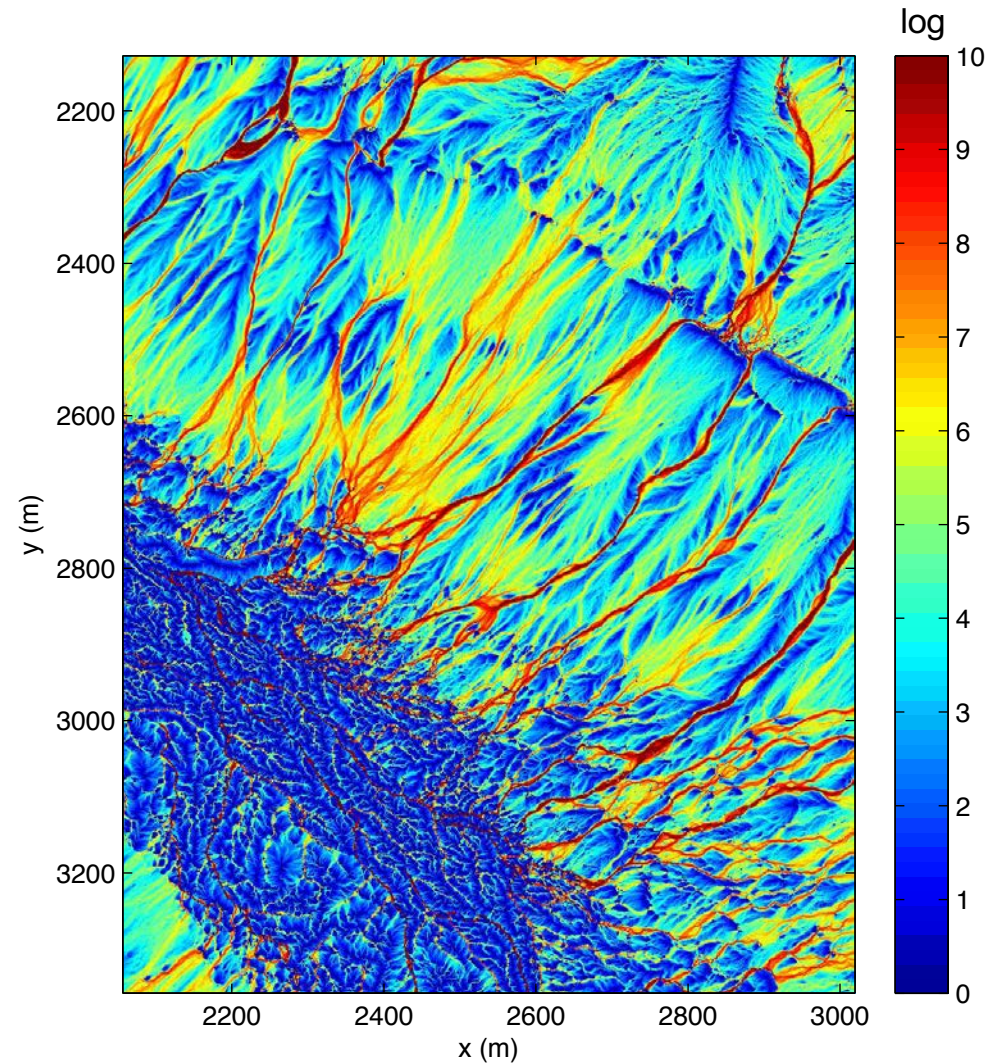
3. Evolution of connection



3. Evolution of connection

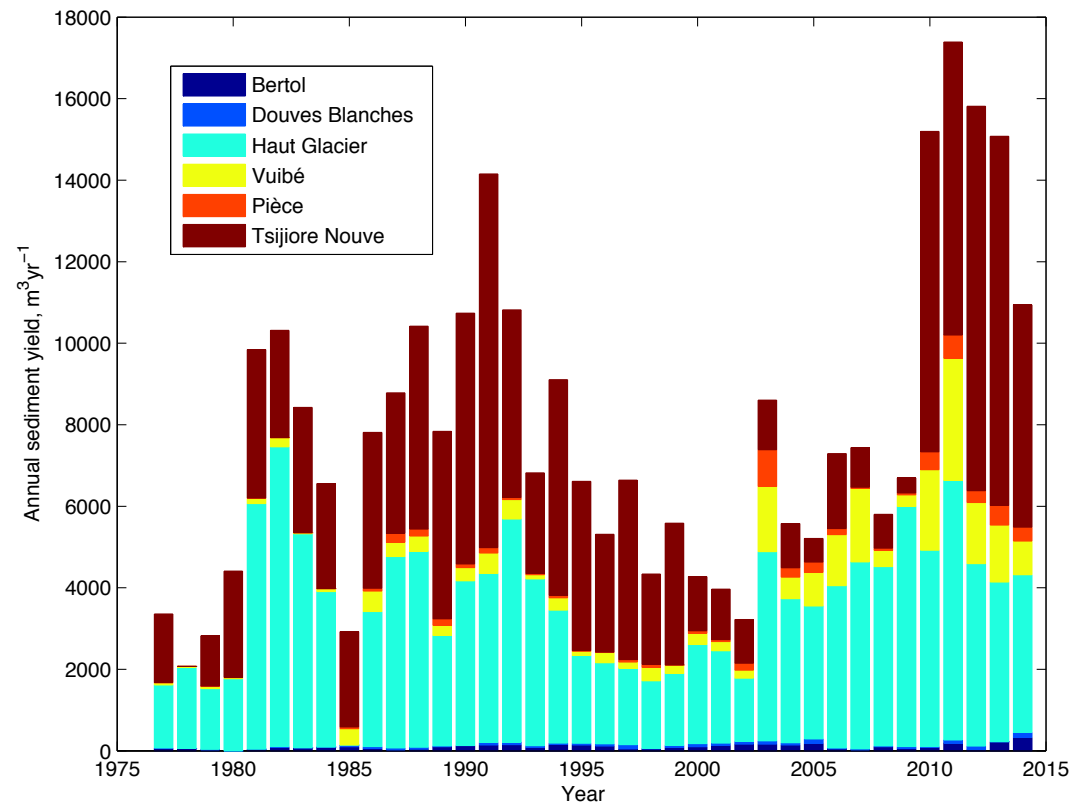
2014 Static Analysis
Upslope contributing area

Connection seeds disconnection



Conclusions

1. Need to think carefully about how to represent connection (and disconnection) in deglaciating basins
2. Sensitivity of sediment yield to climate warming seems to be conditioned by connectivity
3. Connectivity itself does evolve in response to climate warming ; but this can involve tendencies to both connection and disconnection
4. Disconnection remains important



Thank you for listening and ...

... many thanks to

1. The funders of the work (Swiss National Science Foundation, the Etat de Vaud and the Commune of Evolène)
2. Grande Dixence, Alpiq SA and Hydroexploitation SA for granting us permission to use their data (Michel Follonier, Christian Constantin, Damien Courtine, Michael Imboden, Eric Zimmerli)
3. Sébastien Ruttiman for some of the images

We are progressively making these datasets available via ebibalpin.unil.ch

