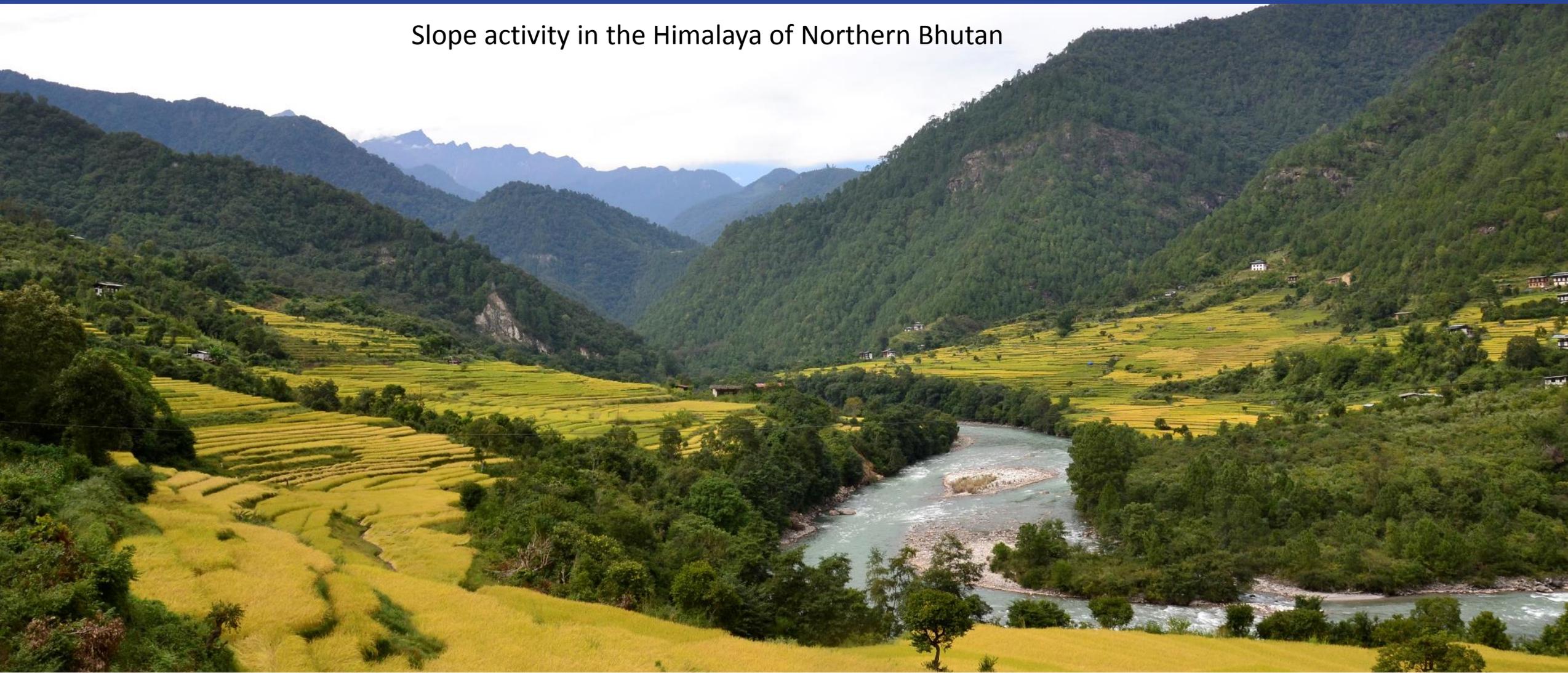


Slope activity in the Himalaya of Northern Bhutan

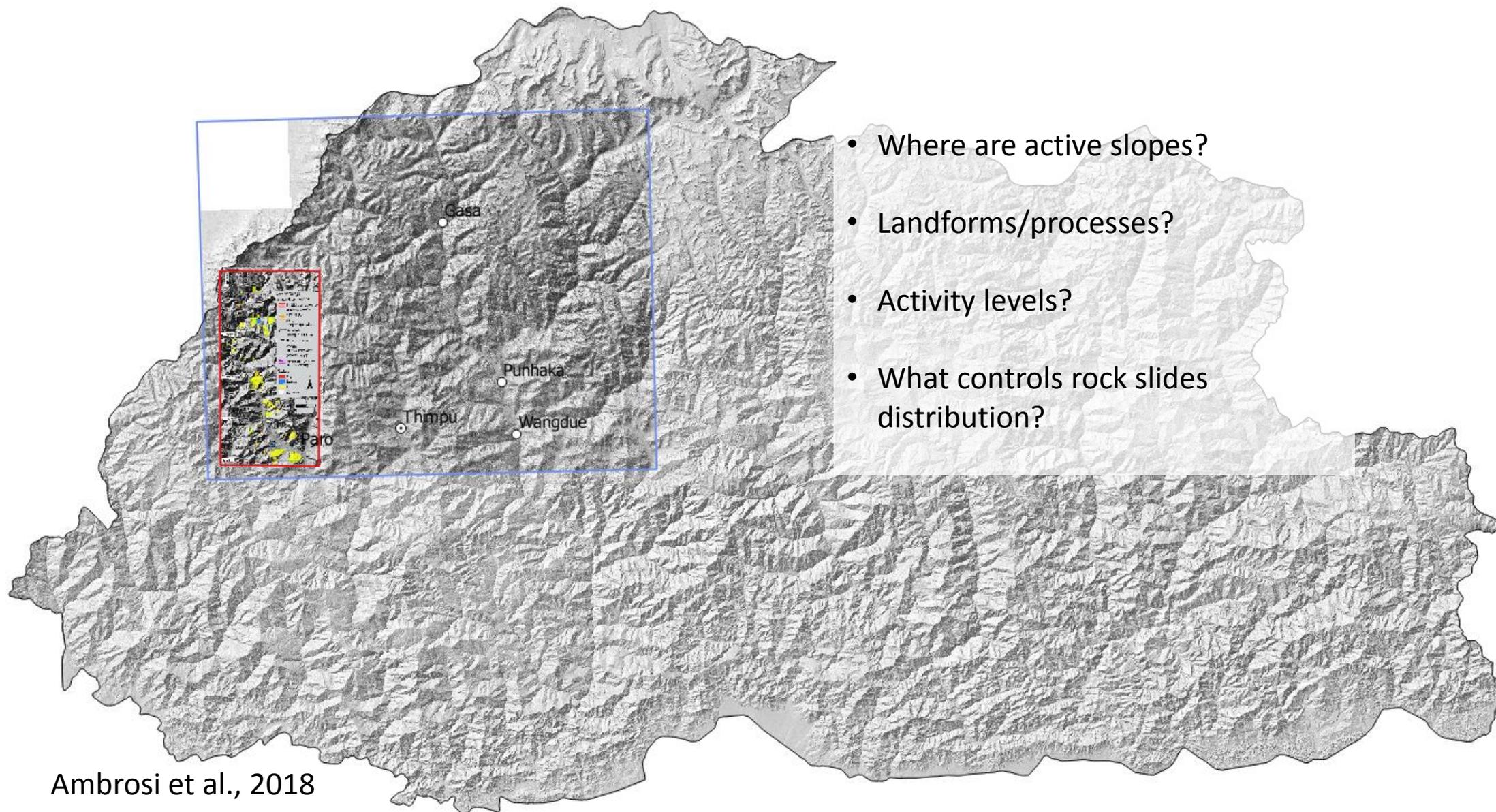


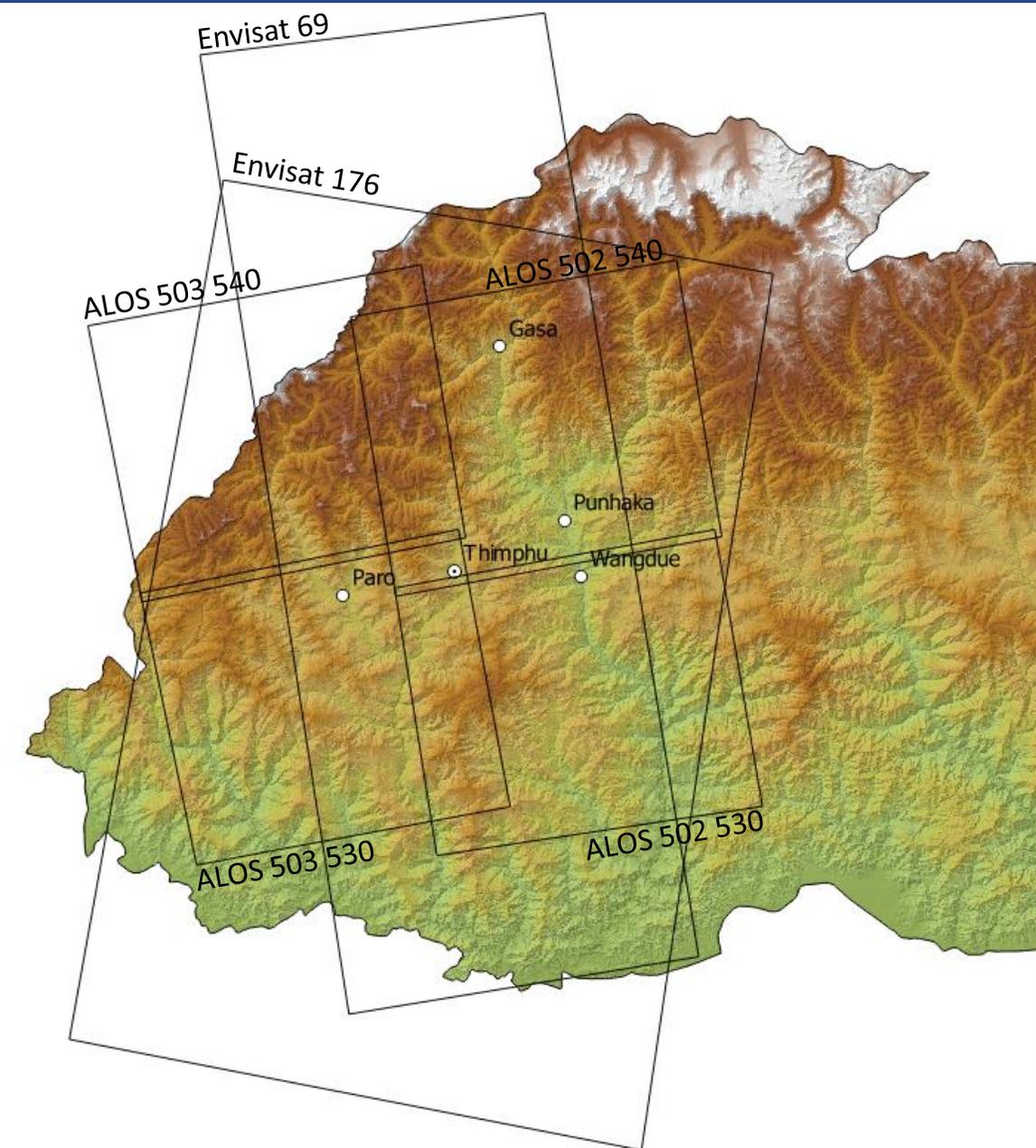
Benedetta Dini^{1*}, Andrea Manconi¹, Simon Daout², Simon Loew¹

¹ETH Zürich, Geological Institute, Engineering Geology

²Christian-Albrecht University zu Kiel, Dept. of Geosciences

*benedetta.dini@erdw.ethz.ch

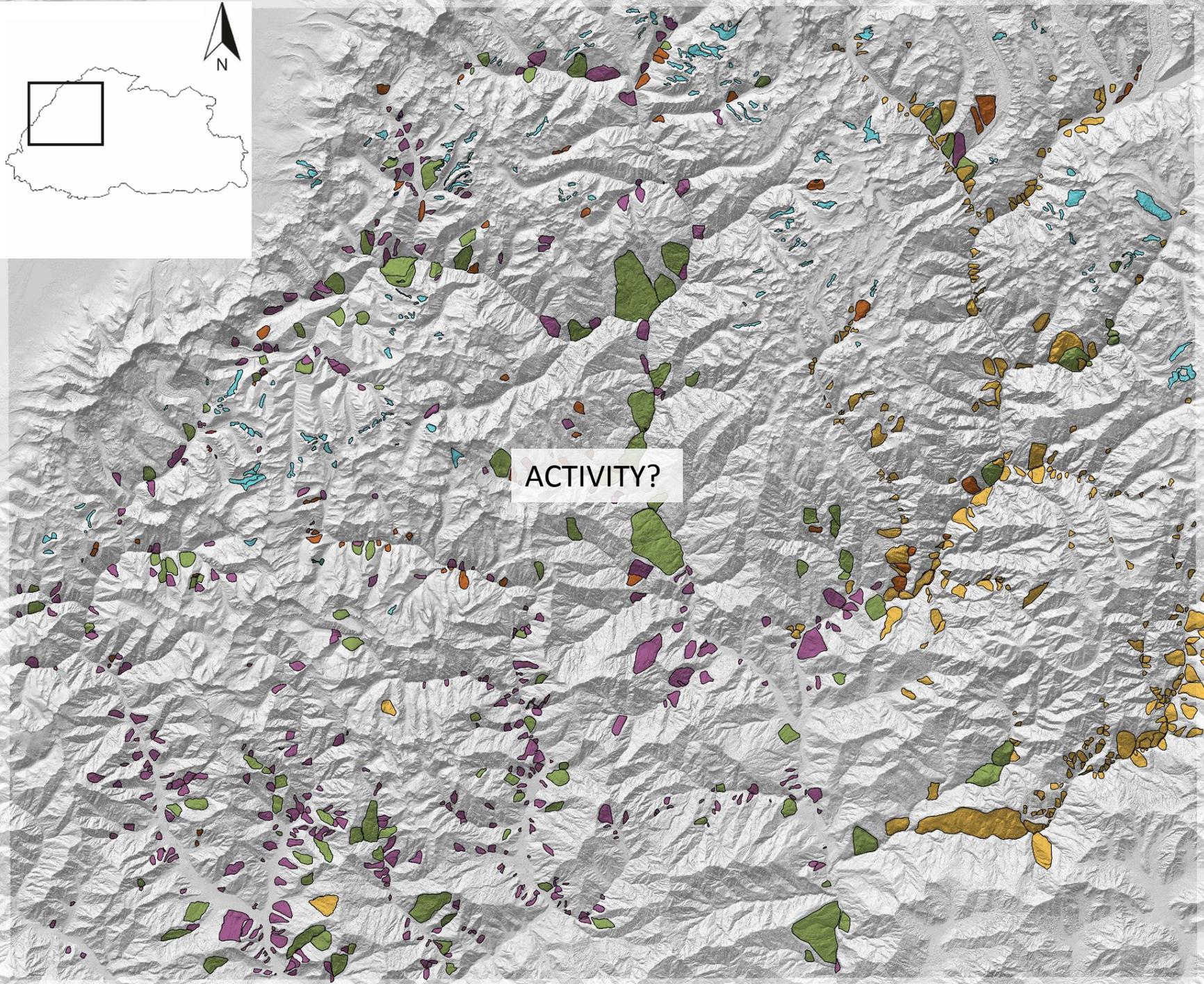




- Google Earth optical images
- High resolution DSM
- Satellite based synthetic aperture radar differential interferometry

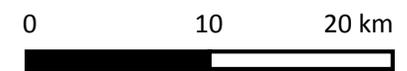


Satellite/ Sensor	Band	Incidence angle	Track/ Frame	Orbit type	Images number	Period	Interf. number	SBAS	% of winter images	Temporal sampling
ENVISAT ASAR	C	~23°	176	D	25	20070415- 20100822	105	YES	40	49
ENVISAT ASAR	C	~23°	69	A	9	20050820- 20090516	24	NO	66	152
ALOS 1 PALSAR	L	~34°	502/530	A	18	20070201- 20110212	81	YES	55	82
ALOS 1 PALSAR	L	~34°	502/540	A	18	20070201- 20110212	115	YES	55	82
ALOS 1 PALSAR	L	~34°	503/530	A	15	20070218- 20110301	105	YES	66	98
ALOS 1 PALSAR	L	~34°	503/540	A	15	20070218- 20102911	91	YES	66	98

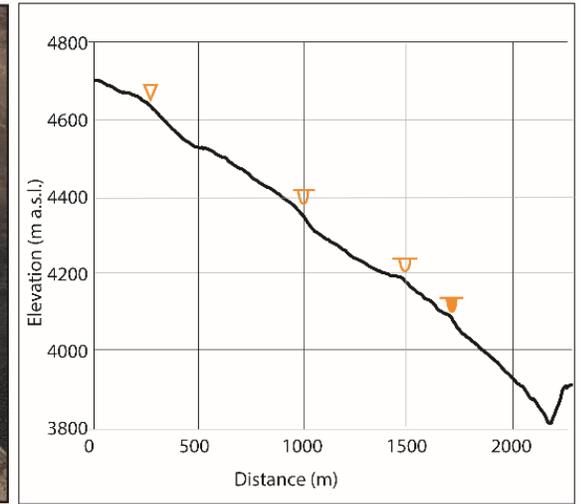
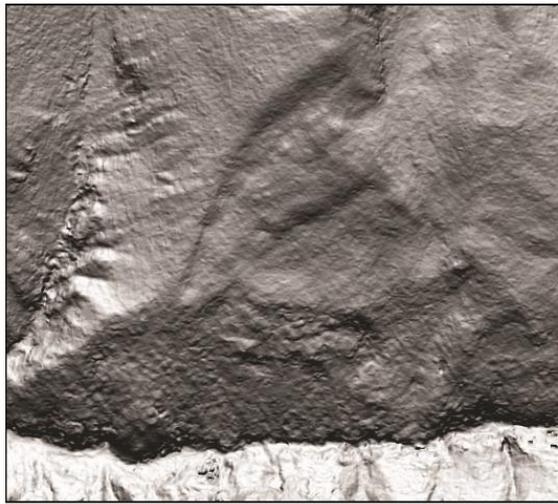
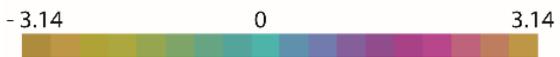
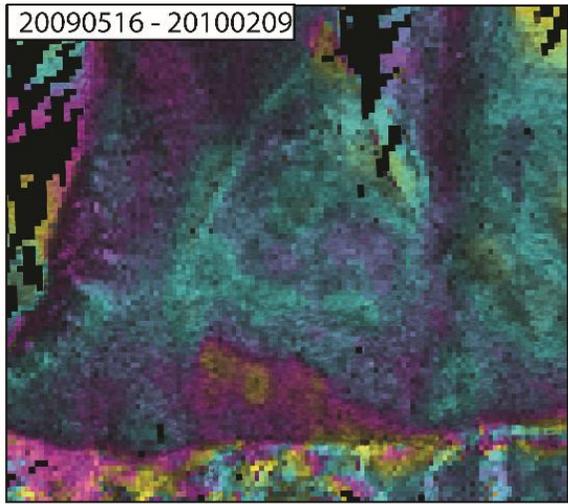


Slope instabilities optical/DSM inventory

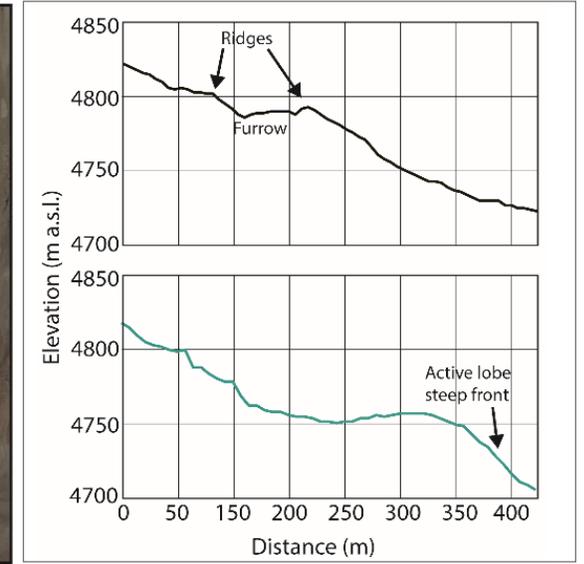
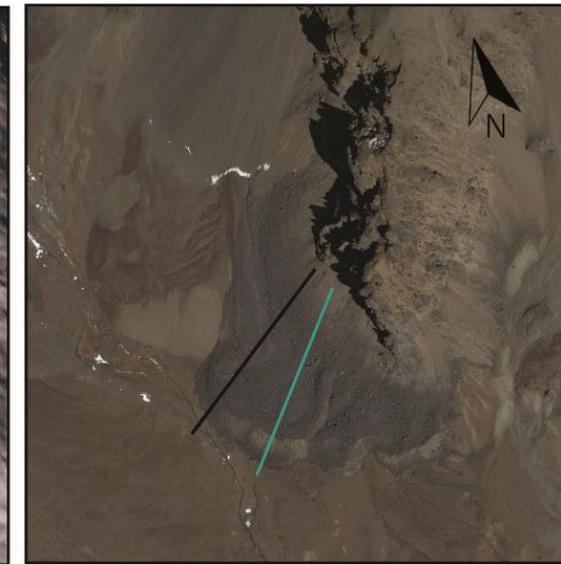
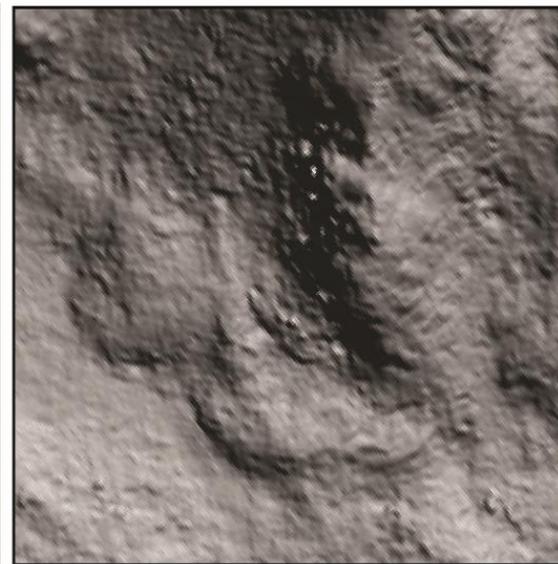
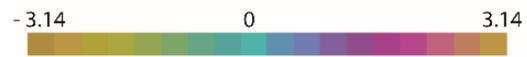
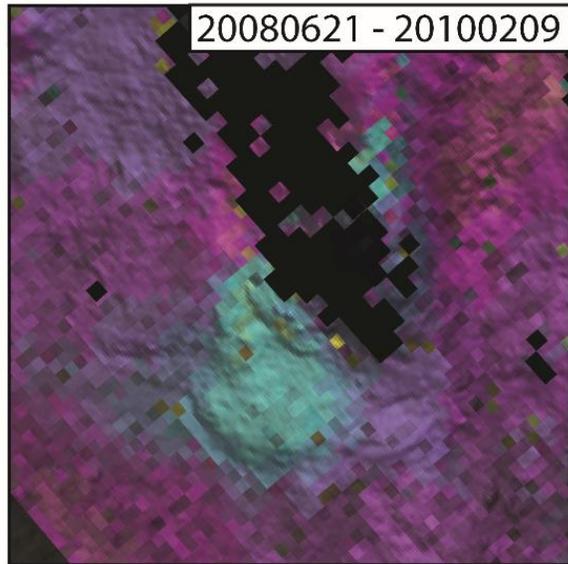
- Rock glacier
- DSGSD
- Rock slide
- Rock avalanche deposit
- Rock fall
- Debris flow/avalanche
- Unknown
- Not yet classified



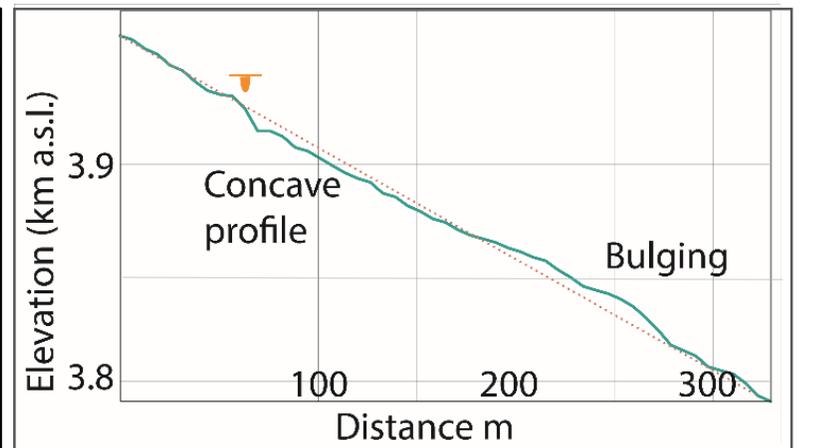
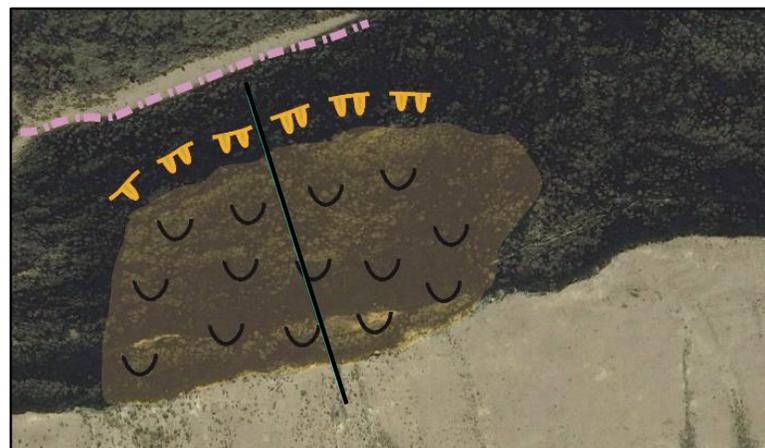
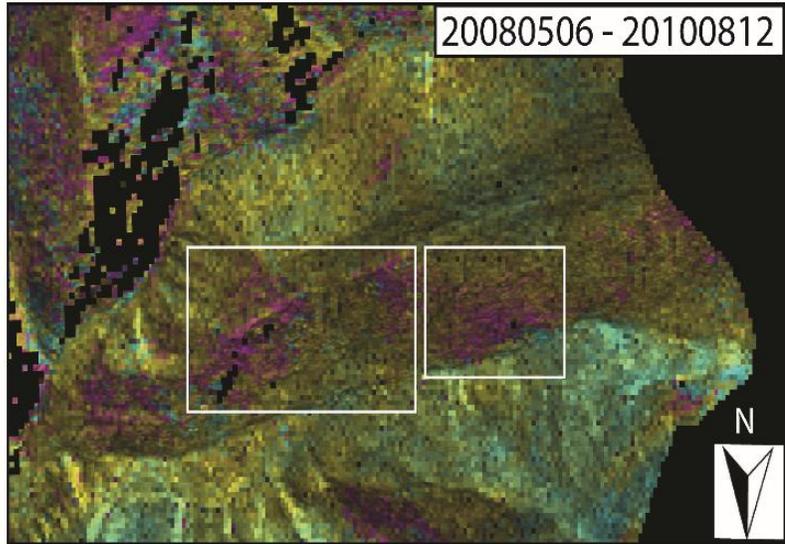
Deep seated gravitational slope deformation (DSGD)

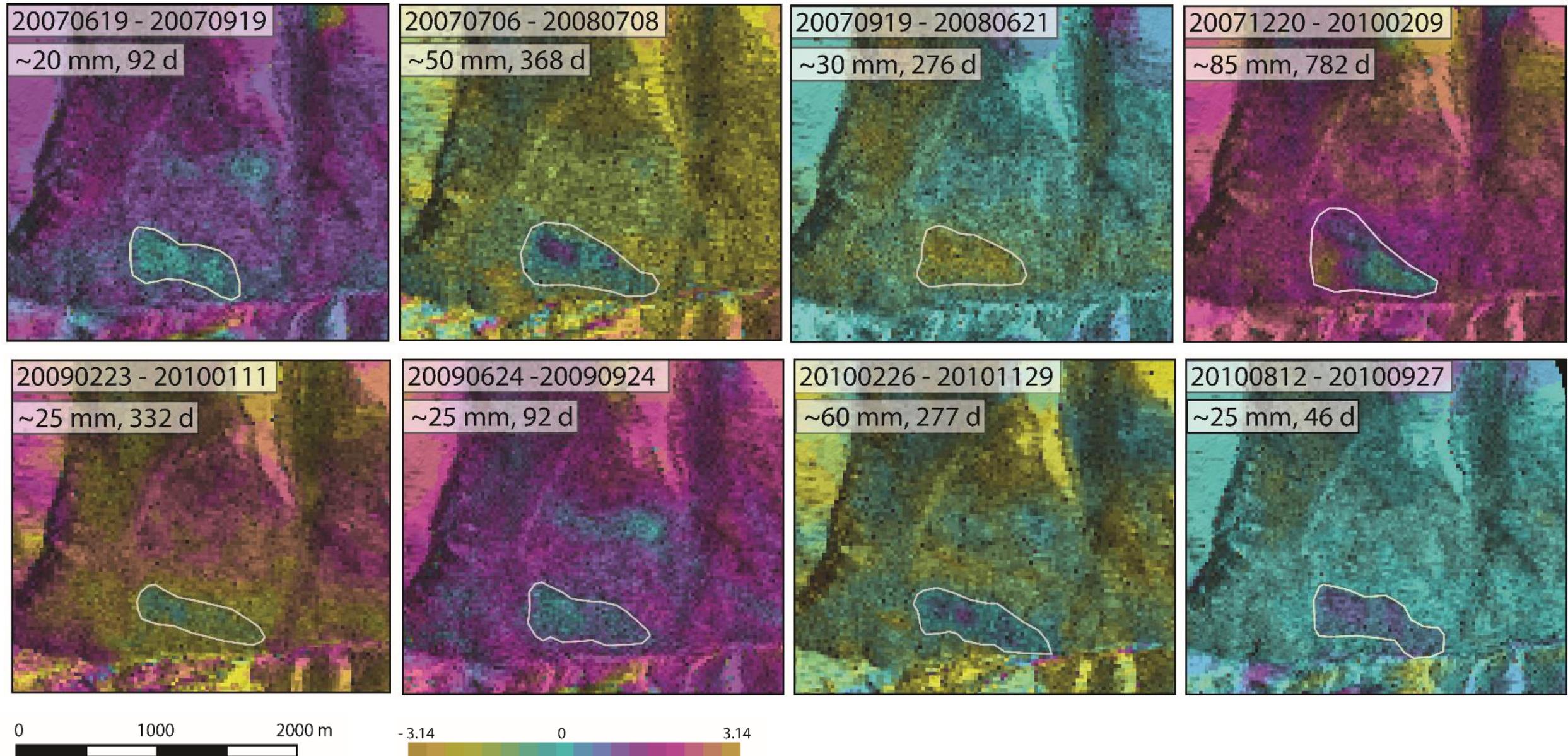


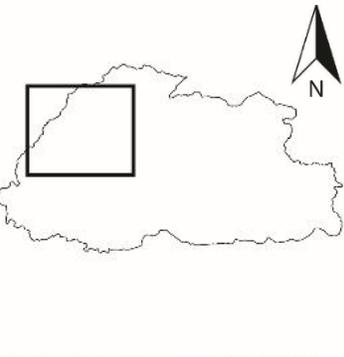
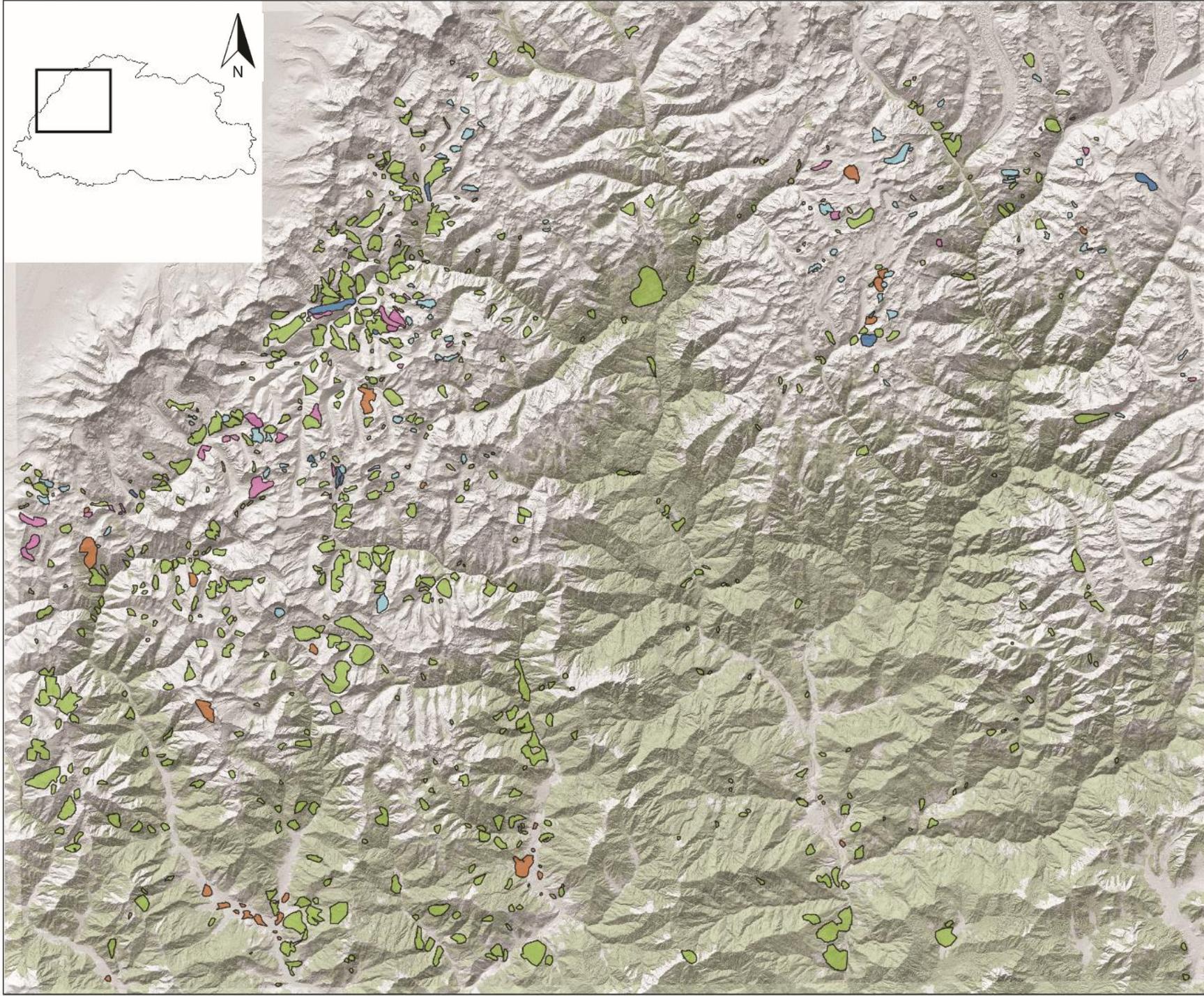
Rock glacier



Moraines



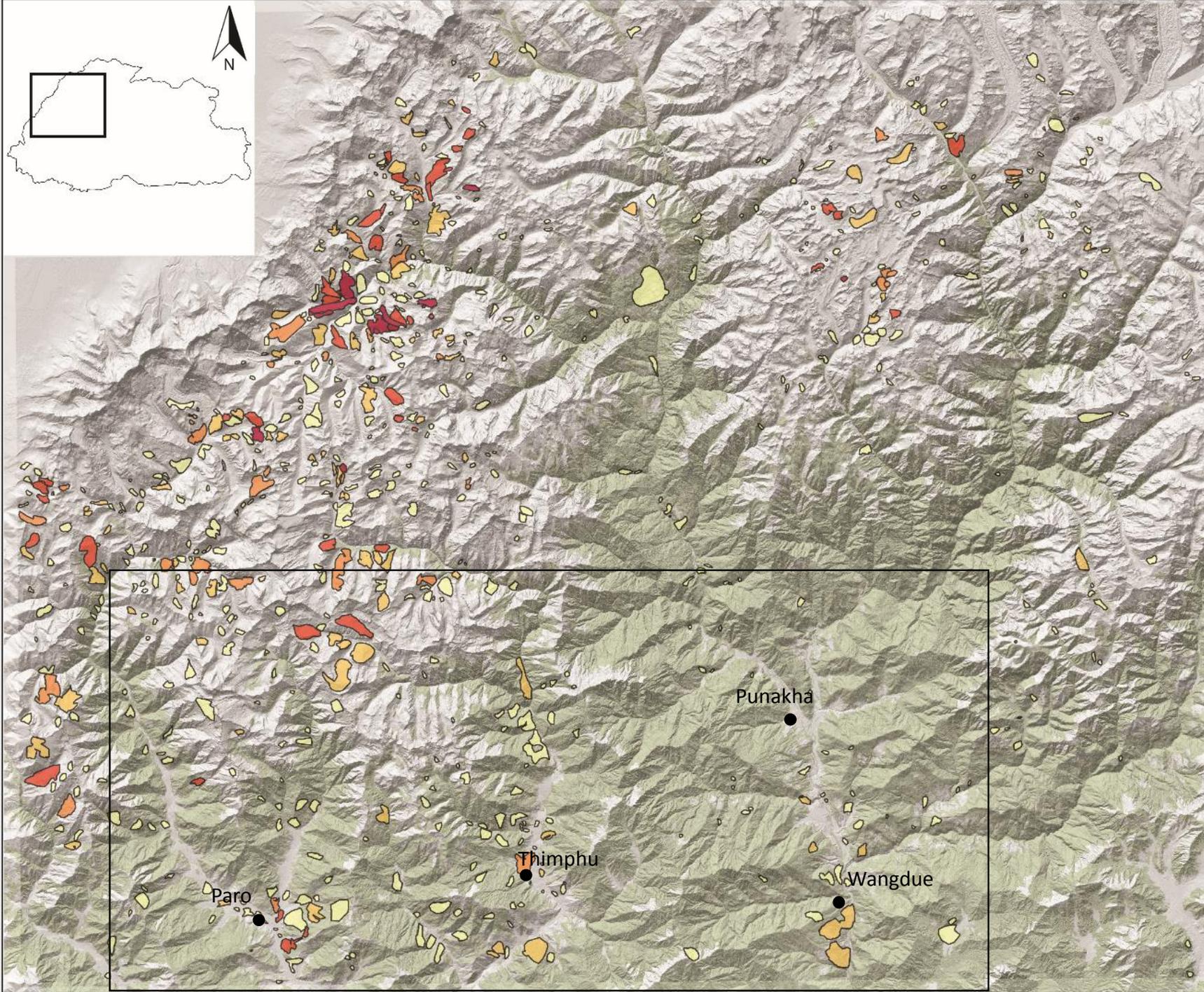




Observed displacement areas

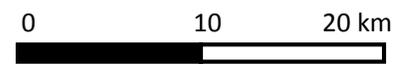
-  Rockslide
-  Rock glacier
-  Moraine
-  Talus/scree/
slope debris
-  Unkown



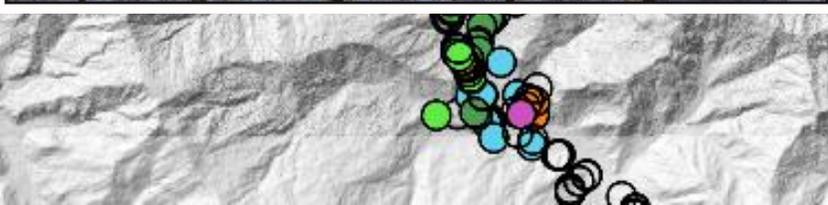
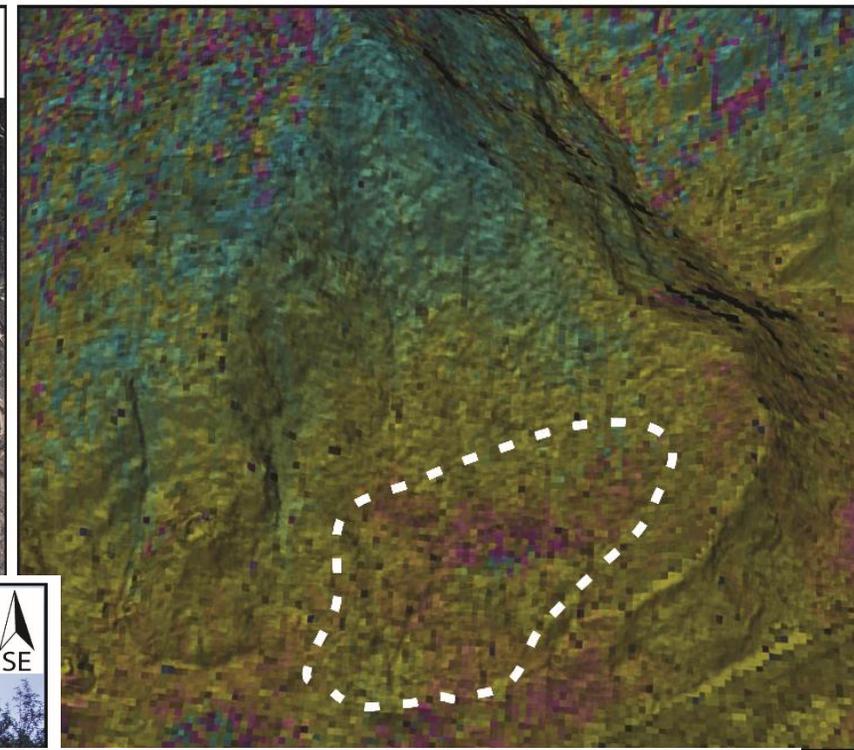
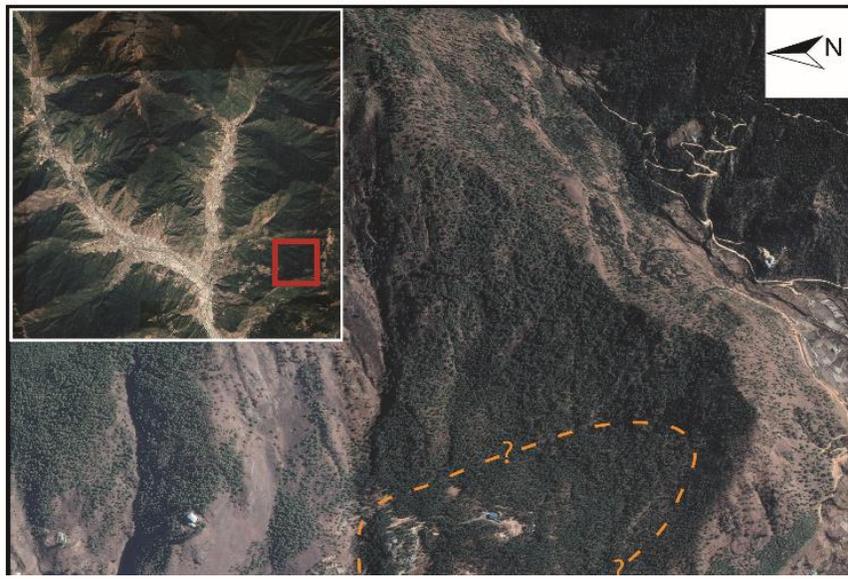


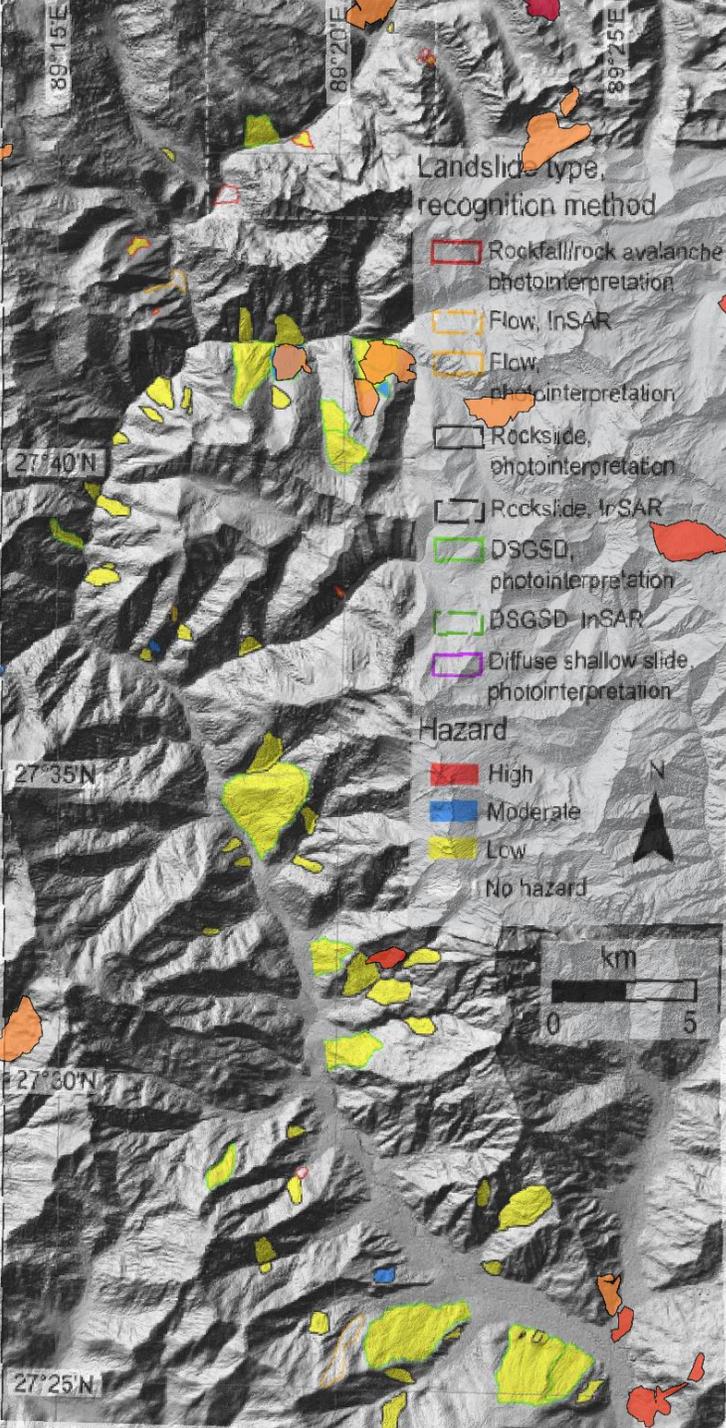
Activity likelihood

- High
- Medium
- Low



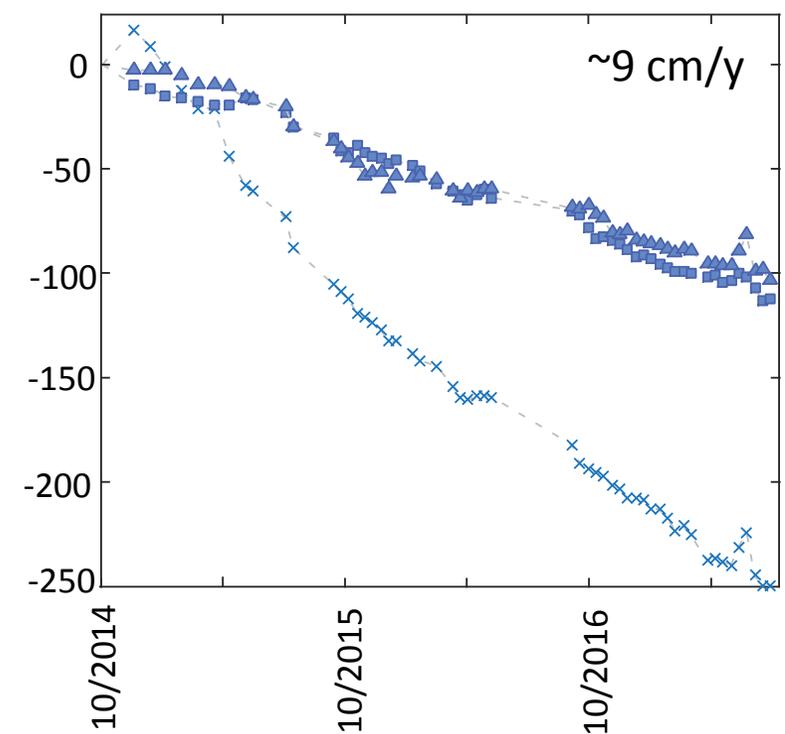
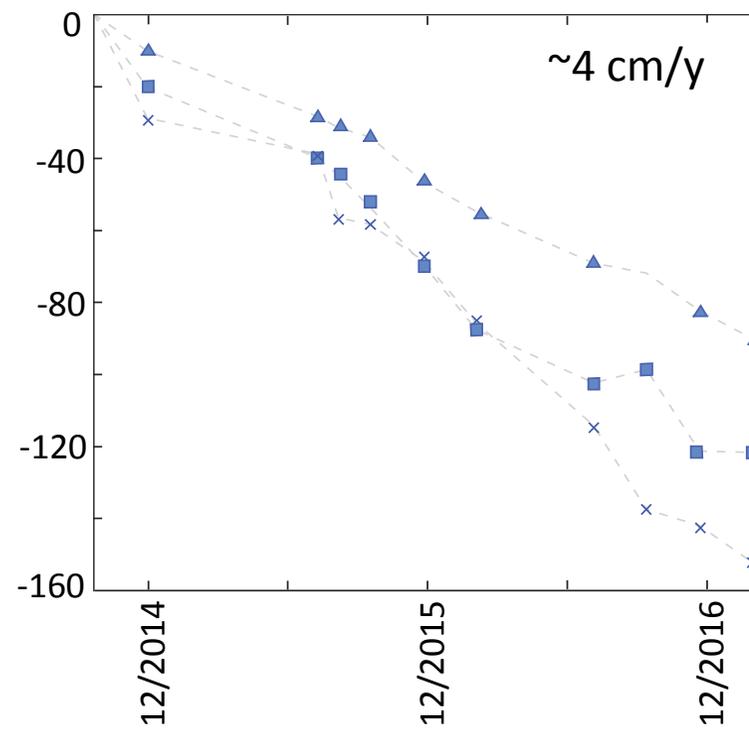
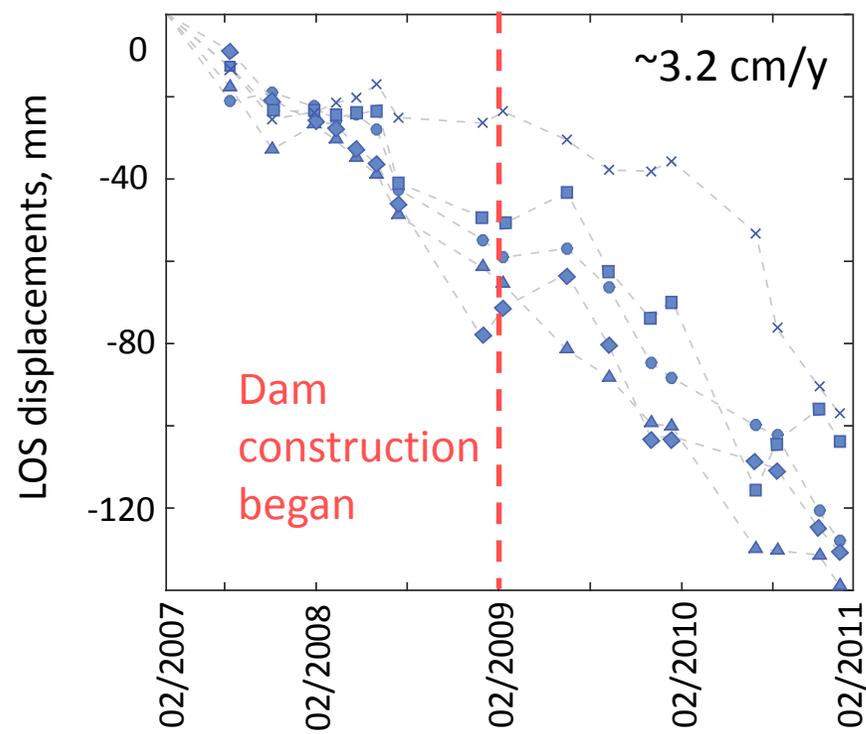
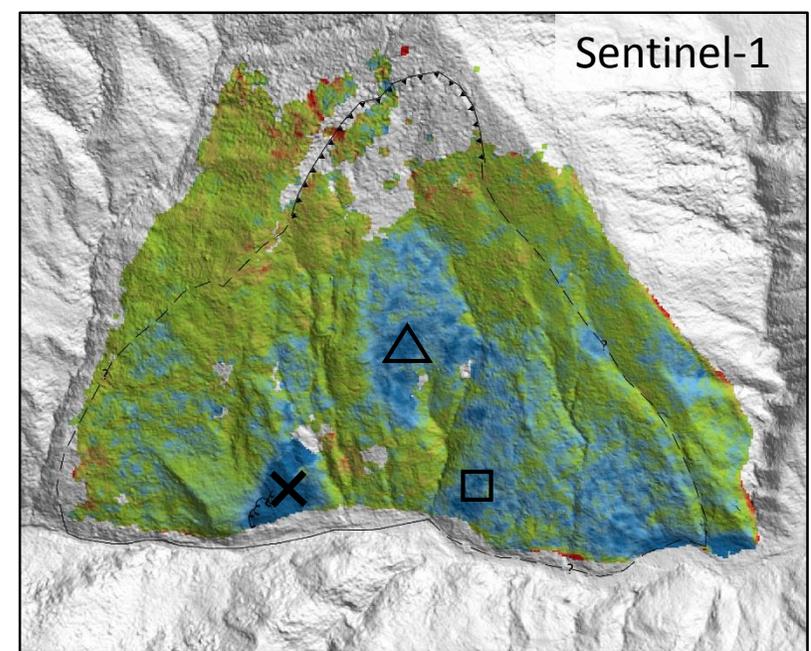
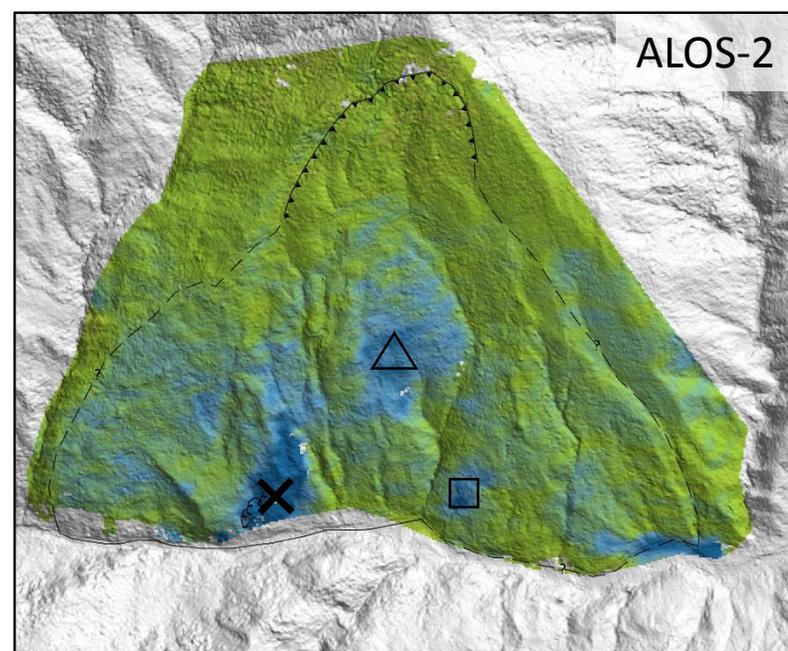
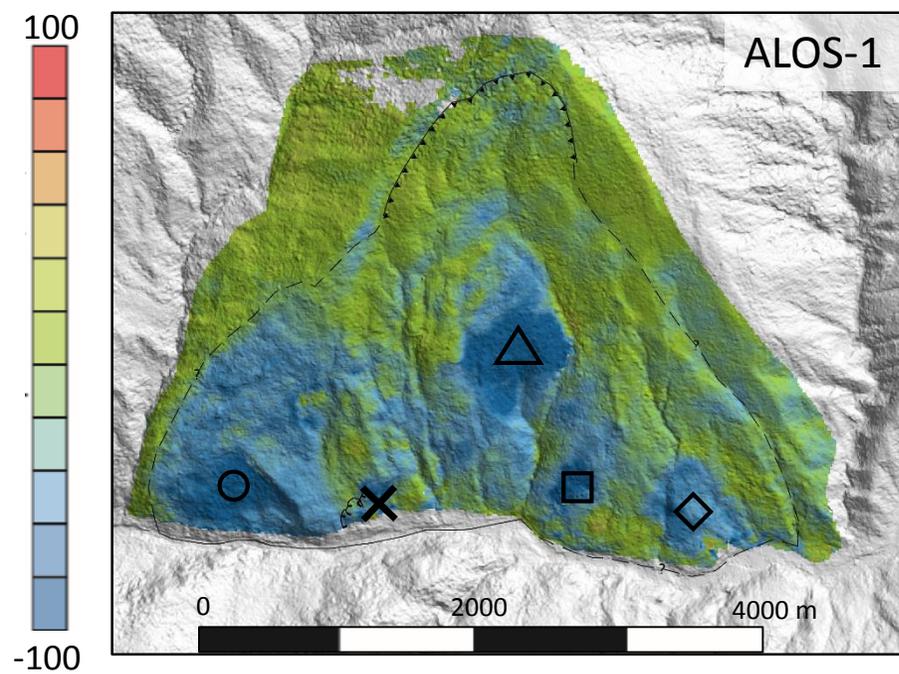
Field validation

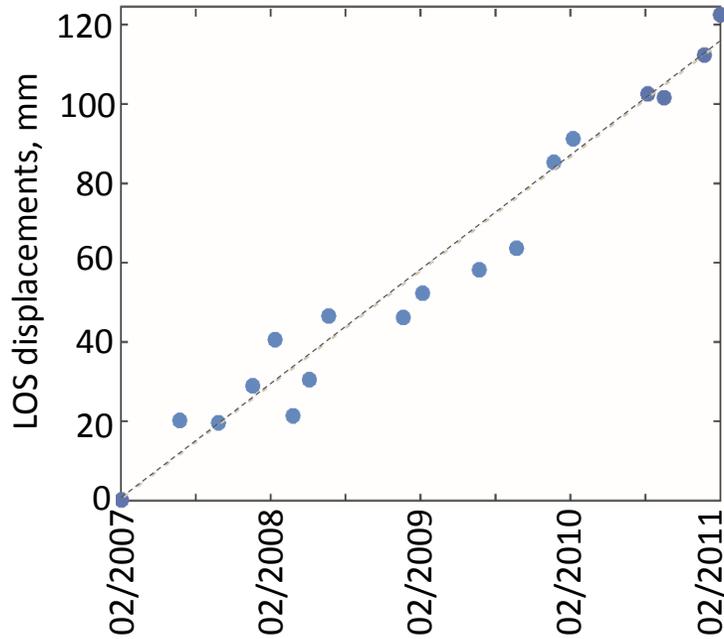
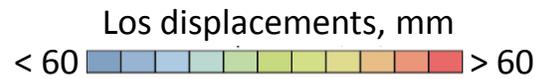
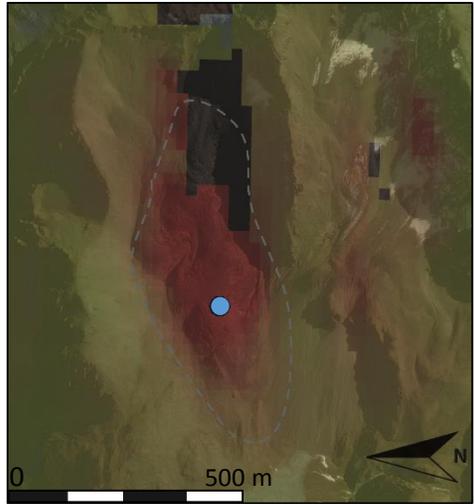




- Low slope activity ?







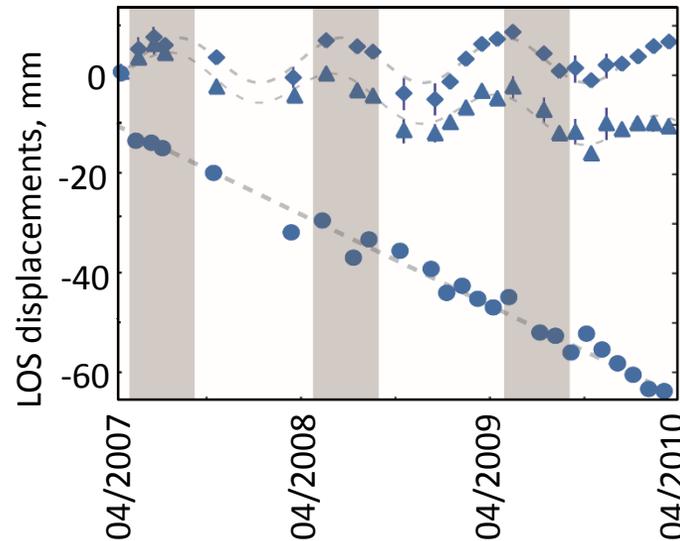
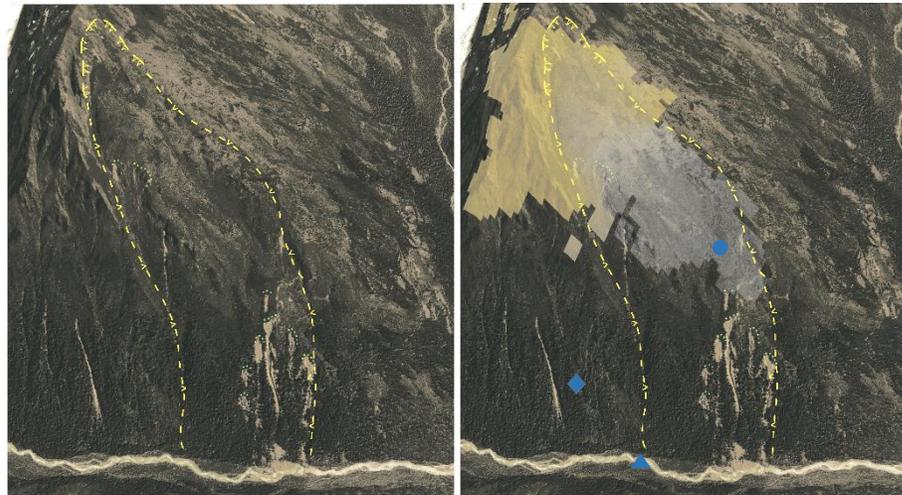
3 cm/year in LOS

(visibility around 30-40%)

~ 7.5 cm/year

Some insights....

- Rock glaciers generally slower than in the Alps
- No destabilising rock glacier observed
- Upper bound of rockslide range of activity are not high
- No increased activity levels around glaciers terminuses

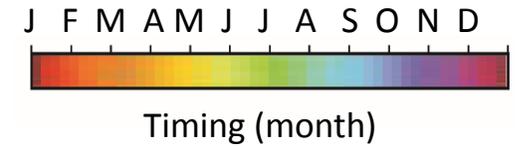
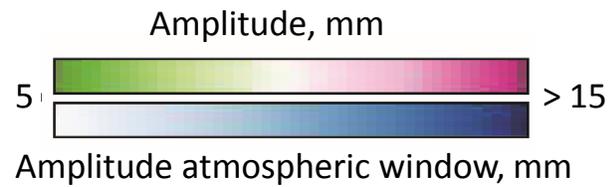
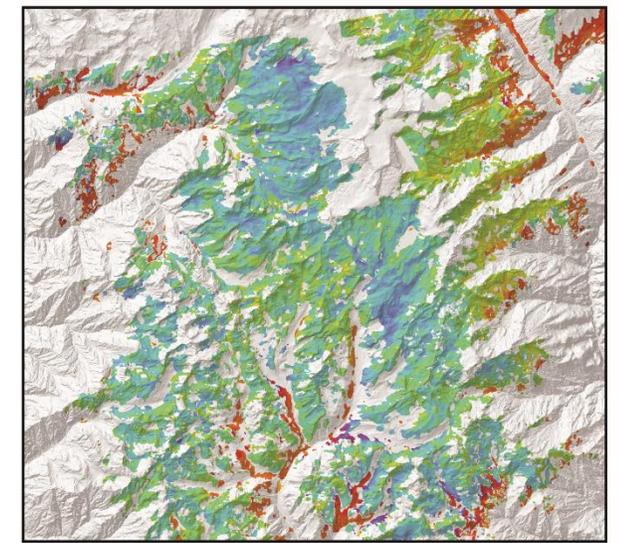
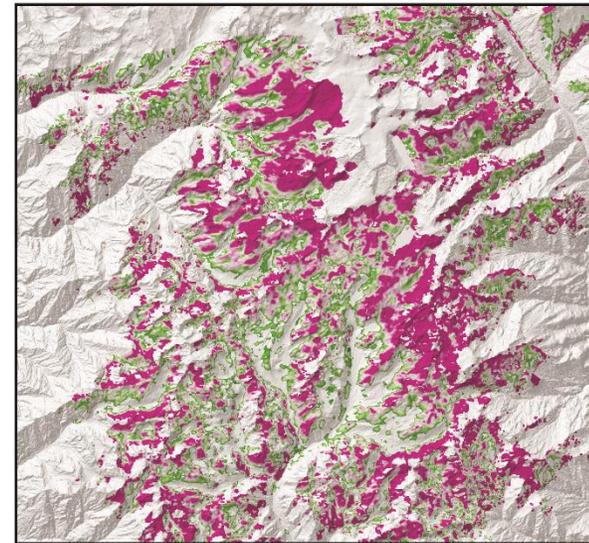
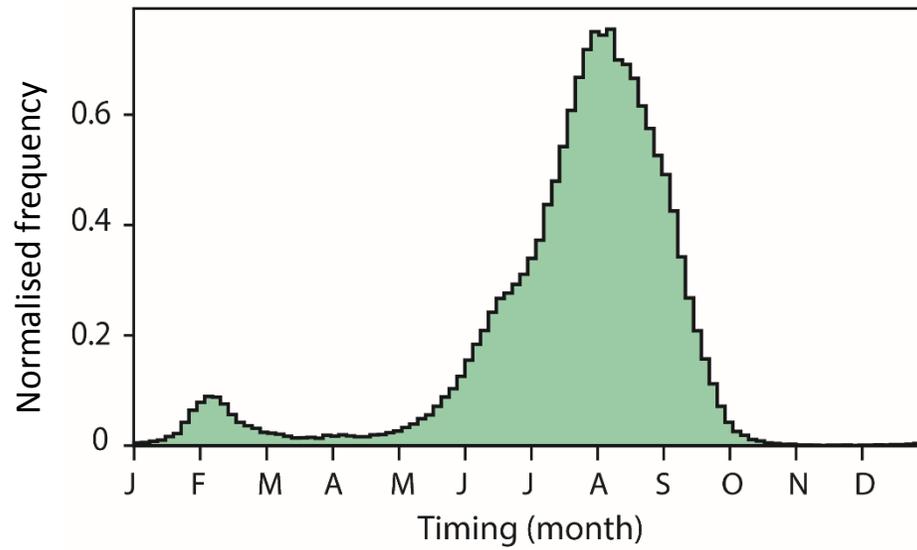


~ 2.3 cm/year in LOS

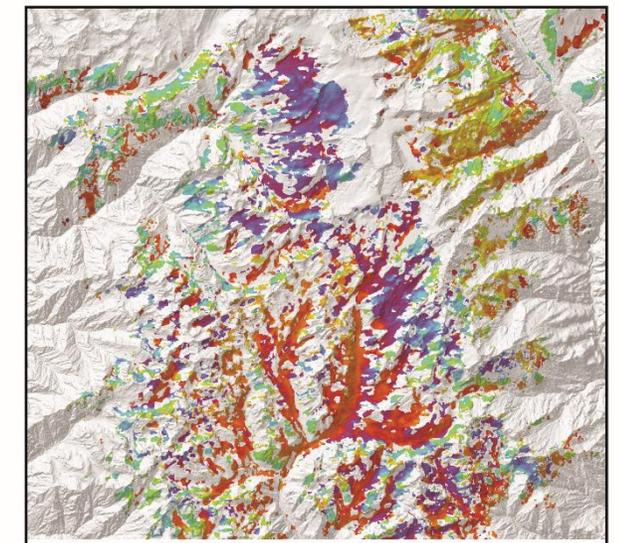
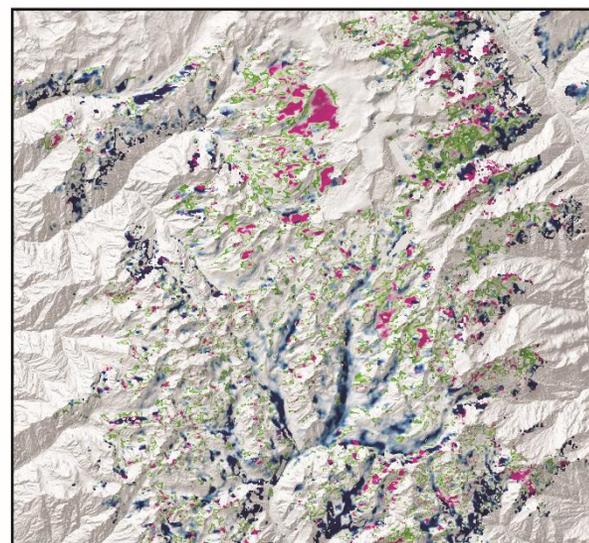
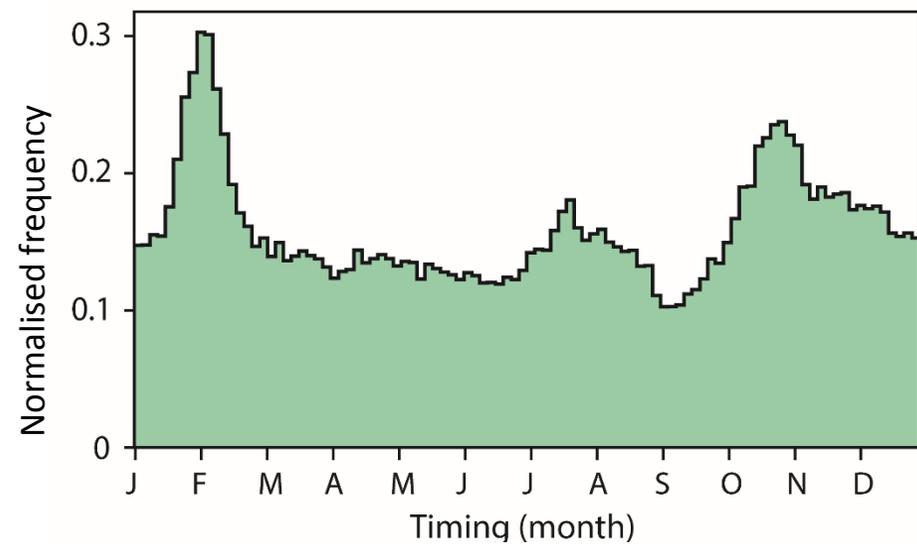
(visibility around 50%)

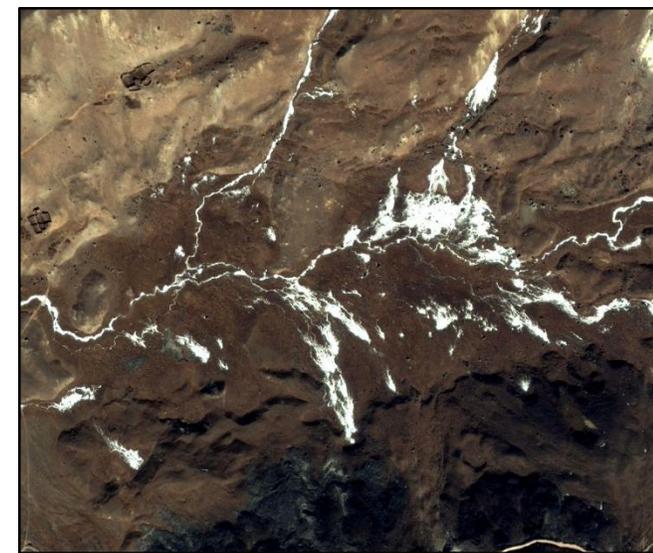
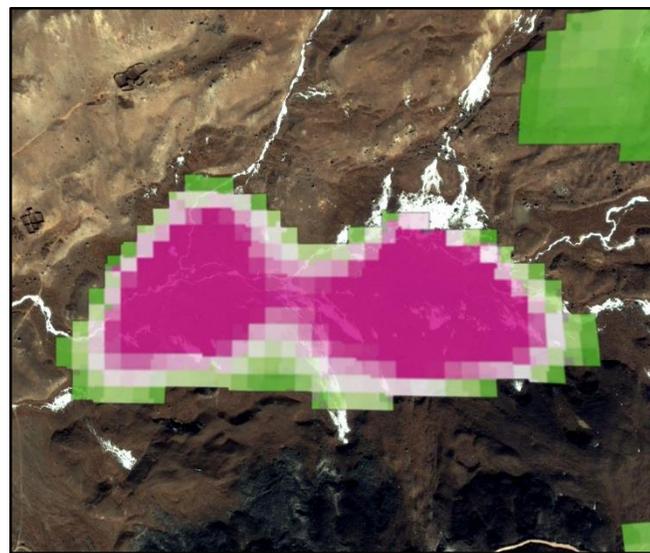
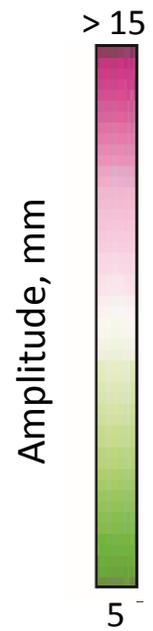
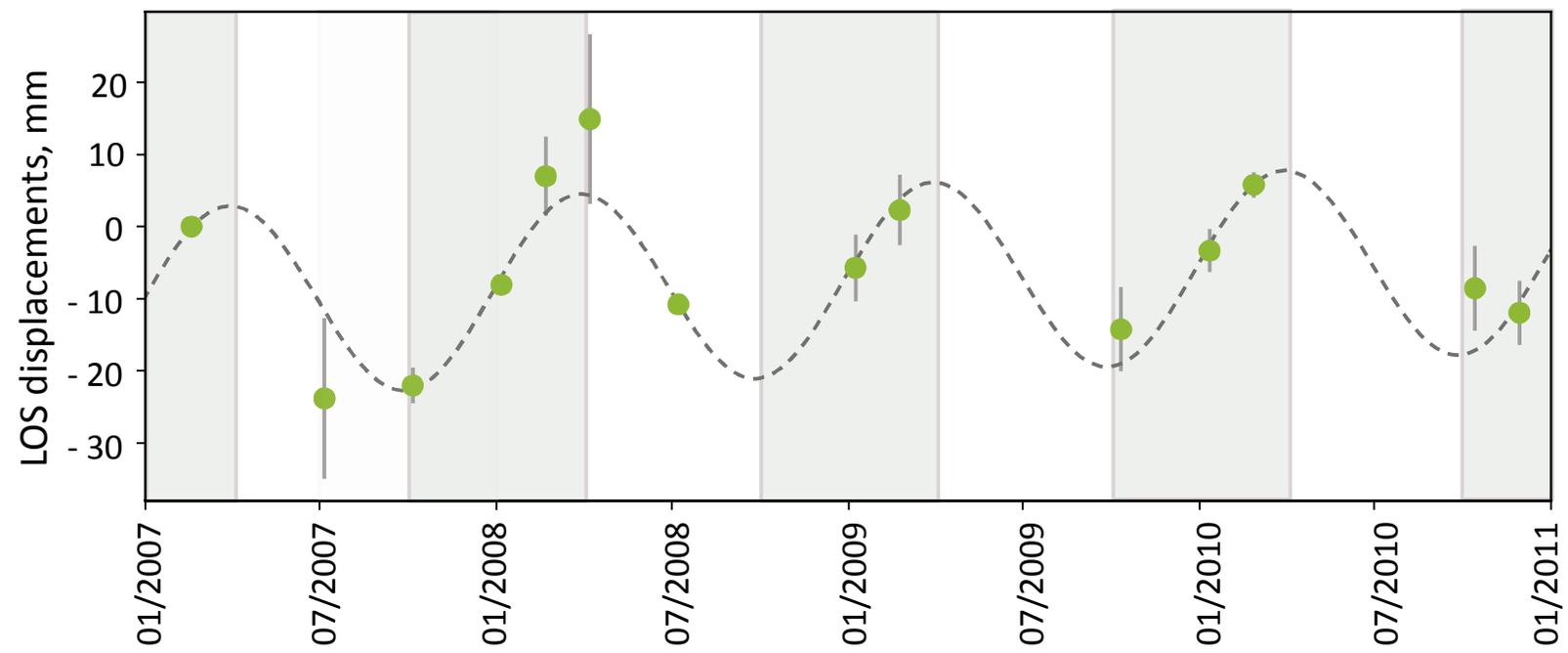
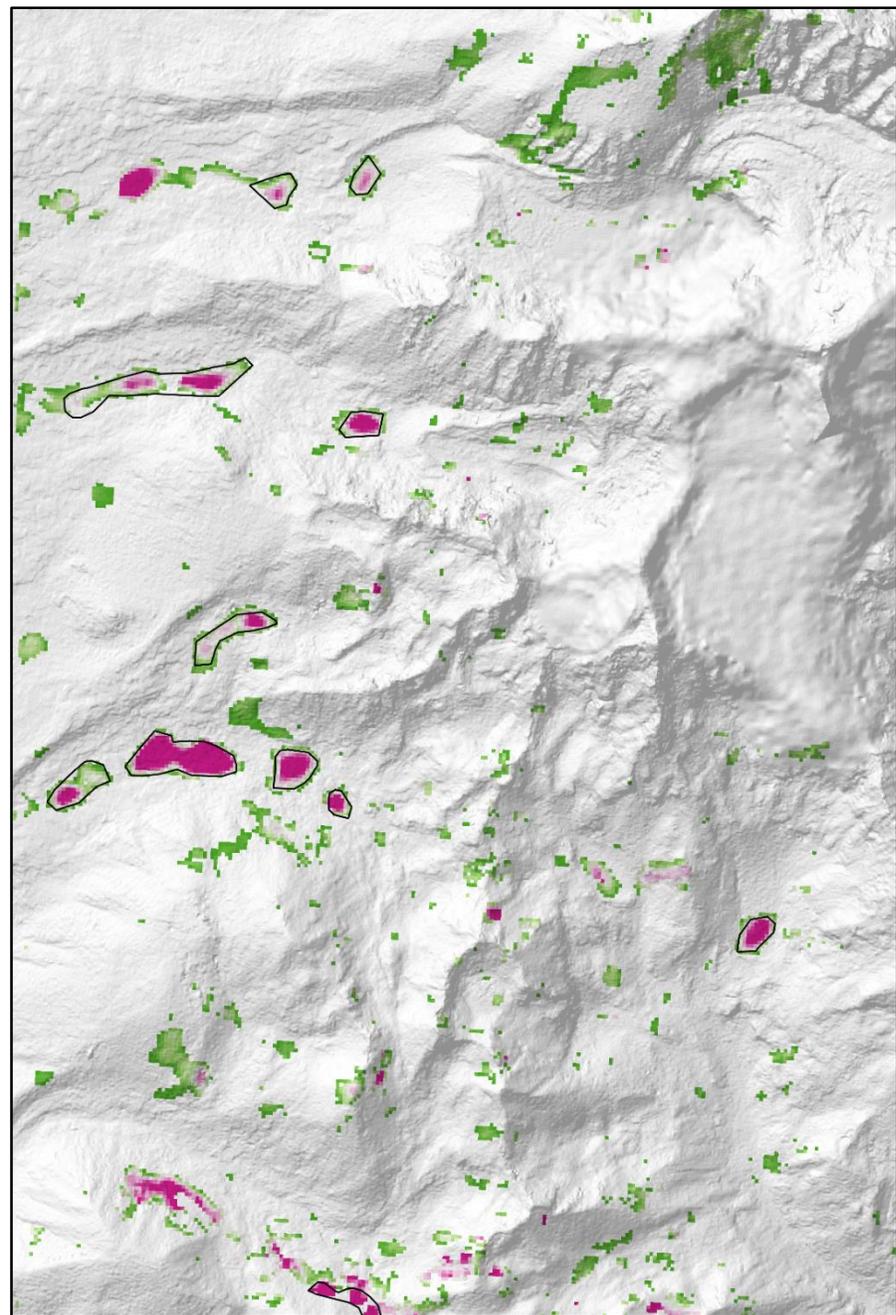
~ 4.6 cm/year

Without correction



With correction





Thank you

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²Christian-Albrecht University zu Kiel, Dept. of Geosciences

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