

Dynamic changes of a large ice–debris complex in the Central Andes of Argentina

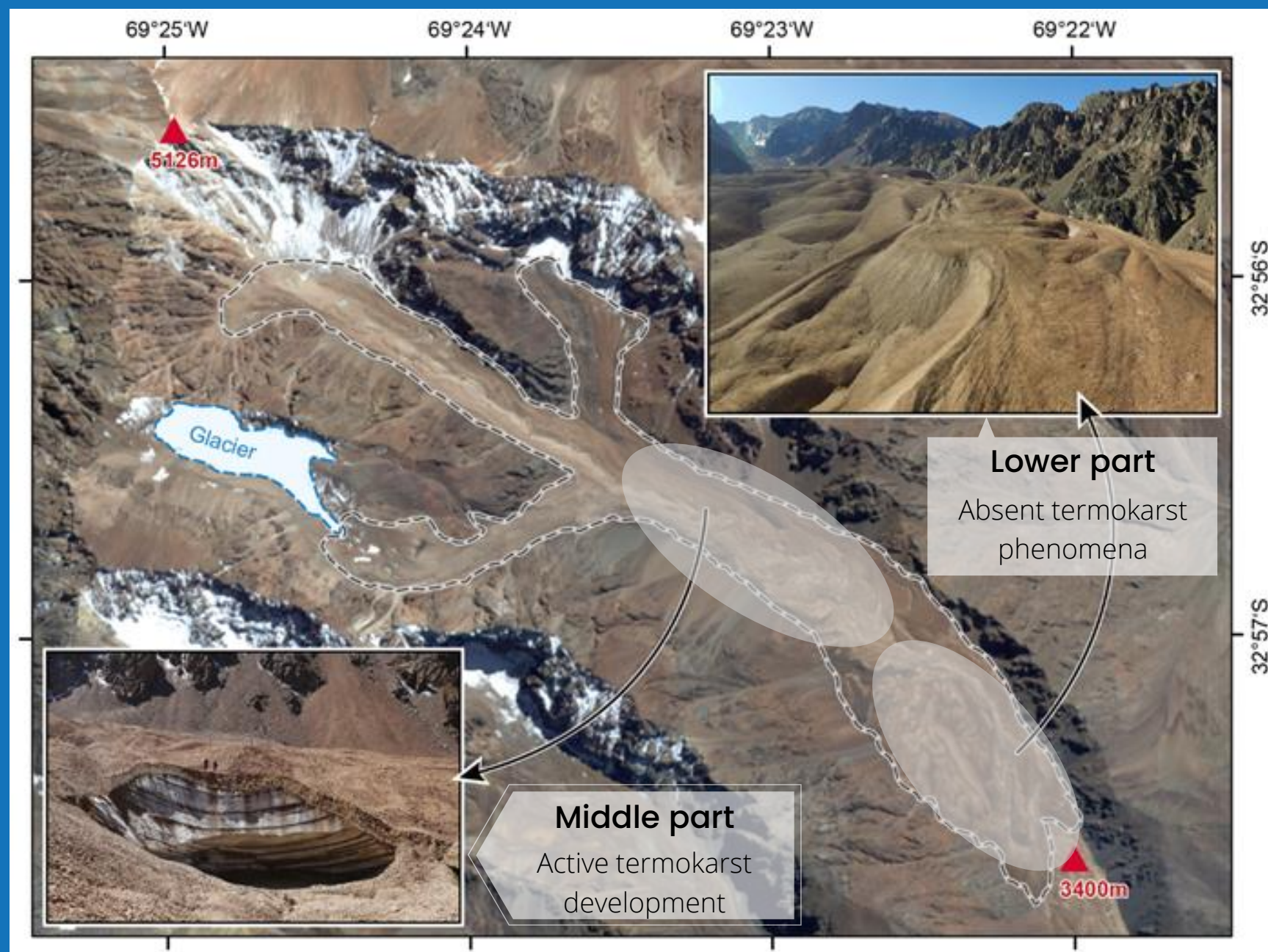
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Morenas Coloradas (MC) ice-debris complex

Ice-debris complex: debris-covered glaciers that gradually transition into rock glaciers. Very common in the Andes.

Semi-arid Central Andes of Argentina (Prec. ca. 200 mm/yr) "Cordón del Plata" range (hosts 77 ice-debris complexes and 404 rock glaciers)

Area ~2.4 km², Elevation ~3500 – 4500 m

Study area and objectives

Internal composition (Geophysics)

Electrical resistivity tomography (ERT)

Seismic refraction tomography (SRT)

Petrophysical model (4PM)

Surface velocities*

(2017–2018): UAV-derived + dGNSS

(2010–2018): RapidEye-derived

(1960s–2018): Historical aerial image + manual tracking

Volumetric changes*

Comparison between DEMs from consecutive surveys

SURFACE VELOCITIES: Kinematics (recent)

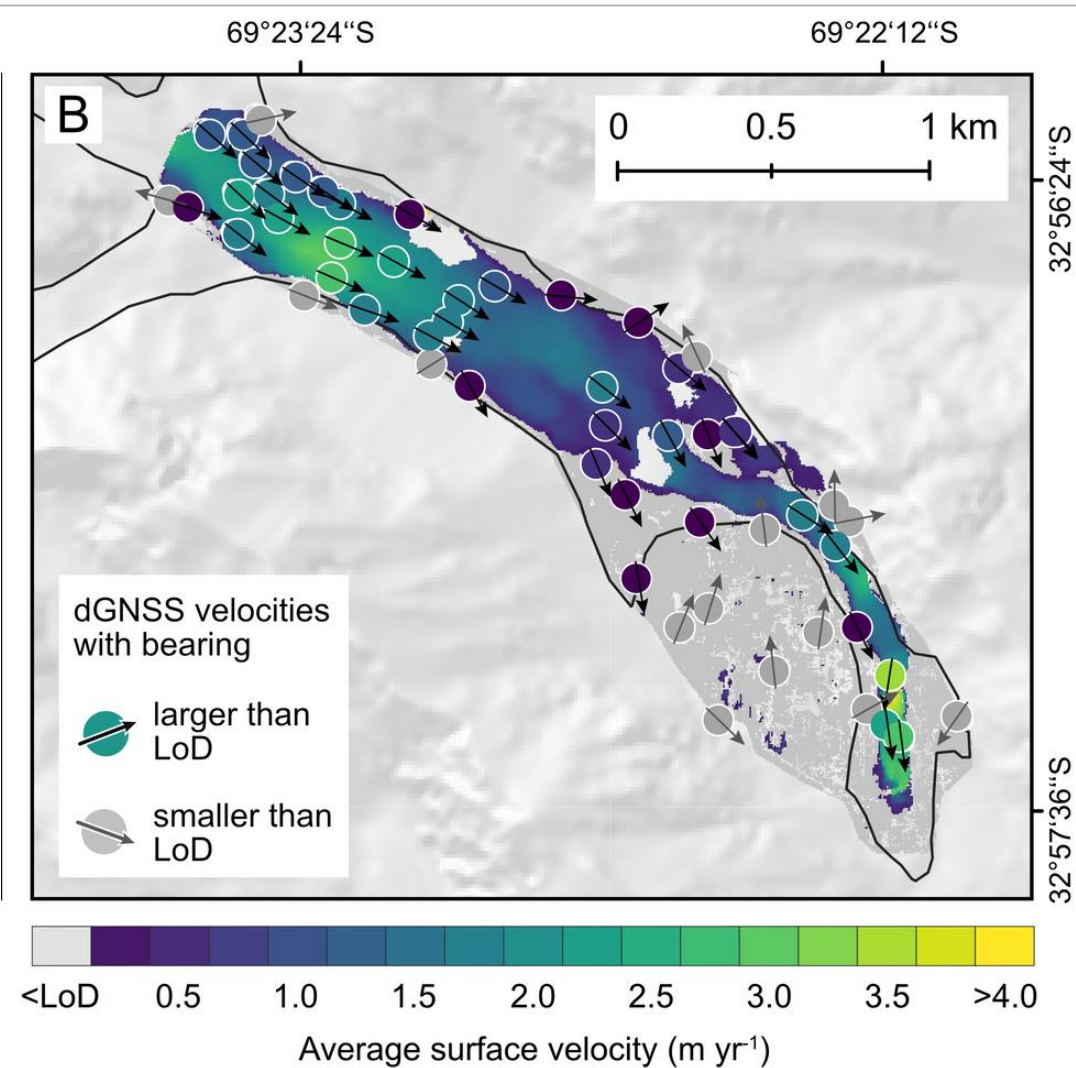
Is the behaviour similar to the ice-complexes in the European Alps?

UAV-derived (2017-2018)

Velocities varied between 0.5 and 4 m/yr

Active deformation in the upper and middle part

Active displacement in the lower part, close the frontal position



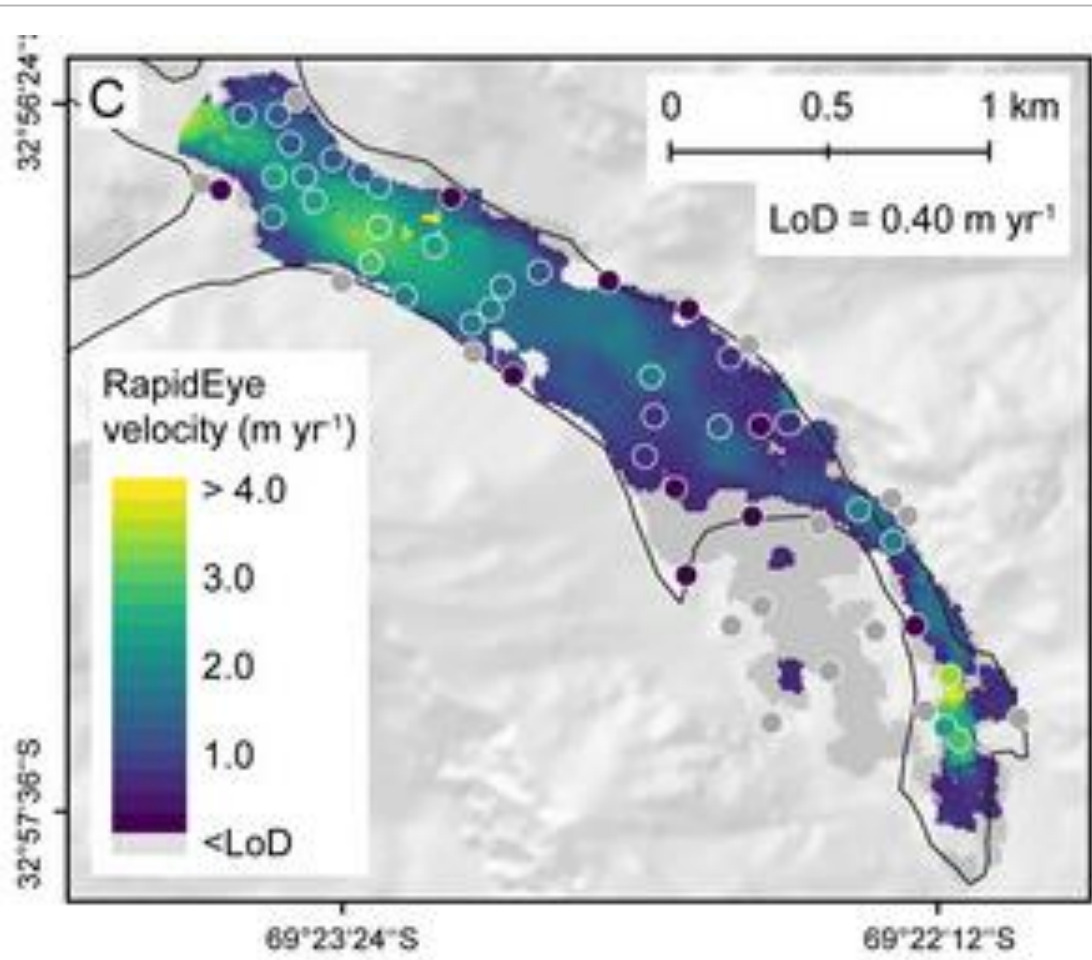
Blöthe et al. (2021)

RapidEye-derived (2010-2018)

Velocities varied between 0.5 and 4 m/yr

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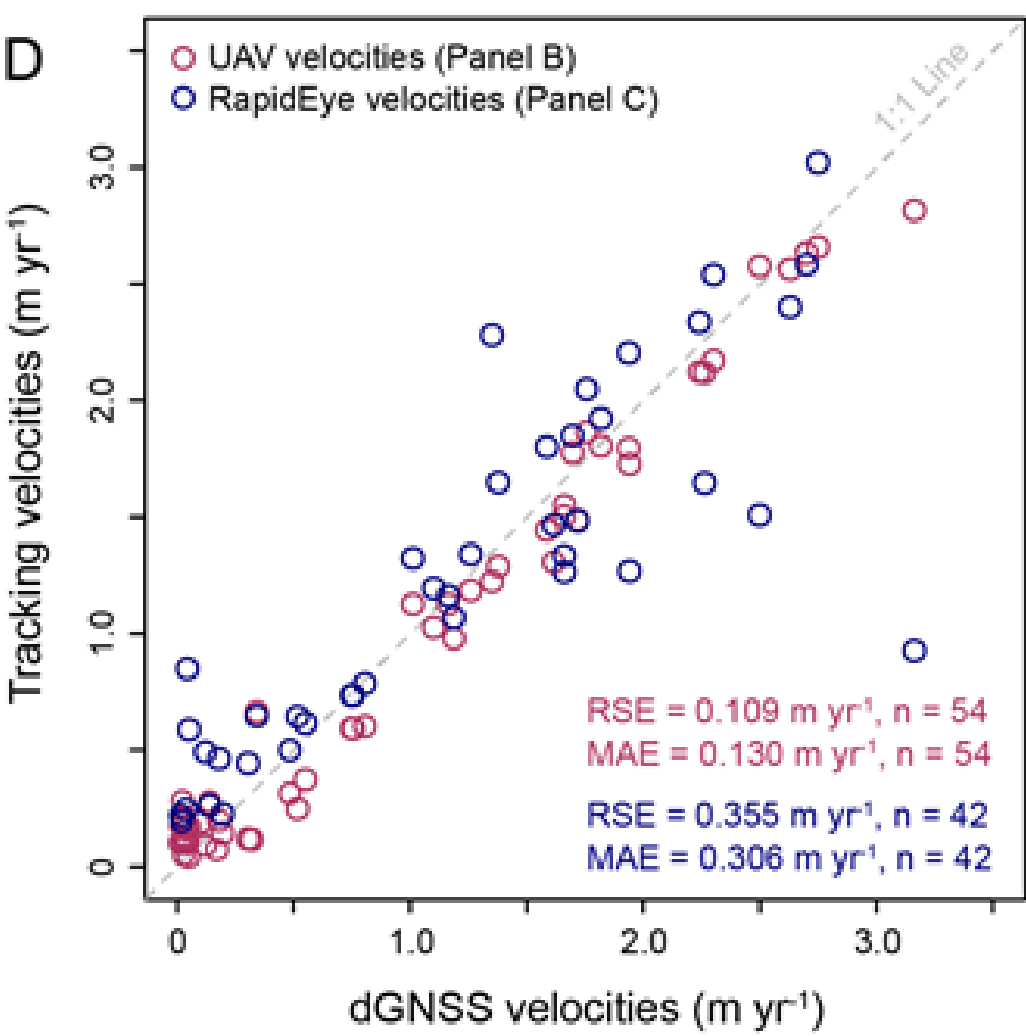


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(2017-2018) vs (2010-2018)

No observed changes in pattern or behaviour

Rather constant velocities

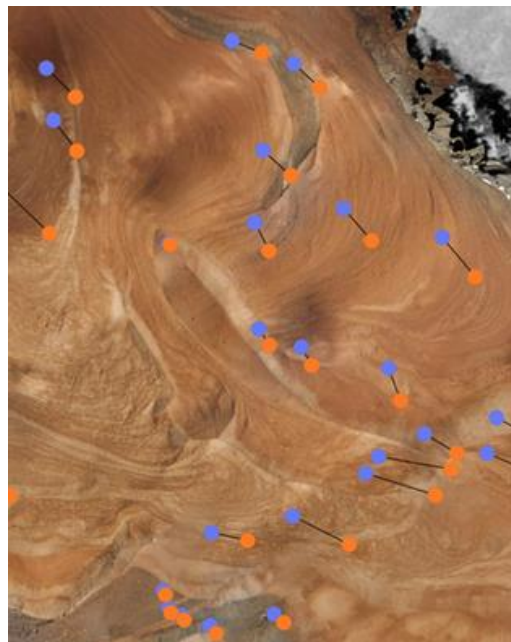
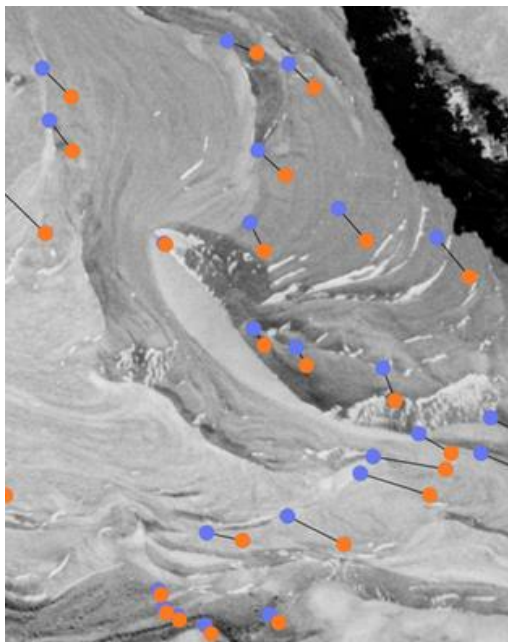
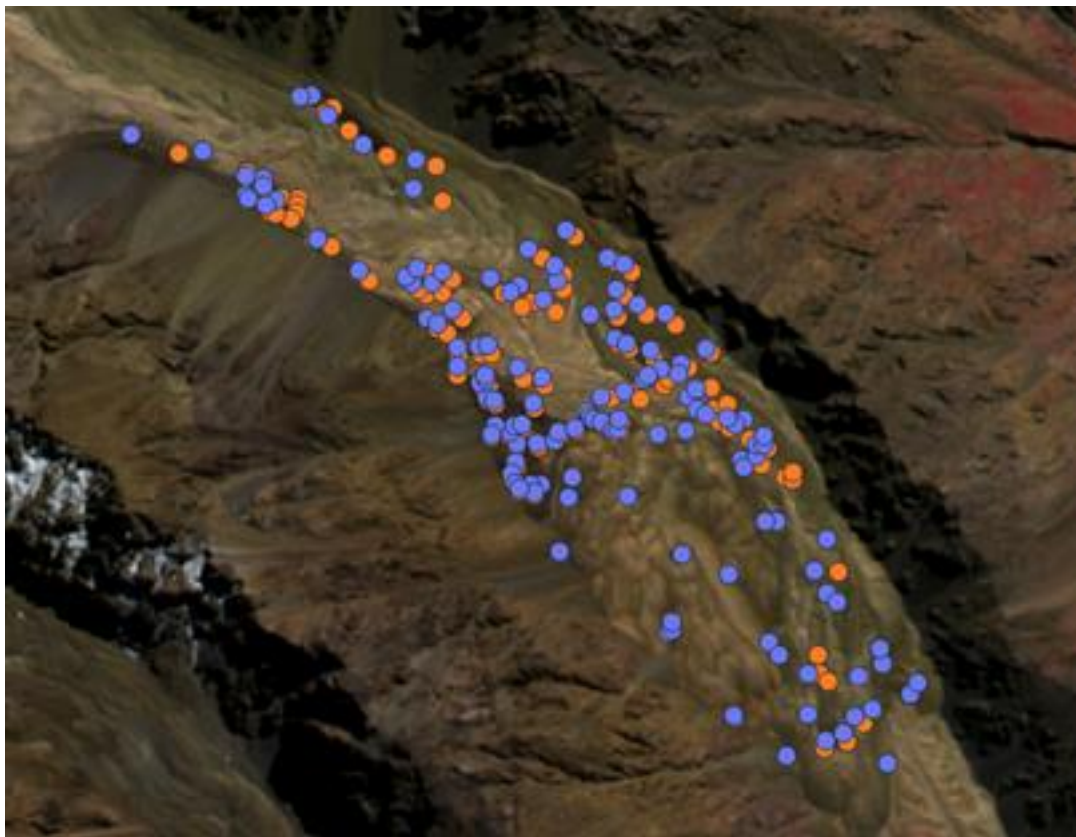


Blöthe et al. (2021)

SURFACE VELOCITIES

Kinematics (past decades)

Manual tracking of 141 features between aerial images (1968) and UAV-derived orthoimage (2018)



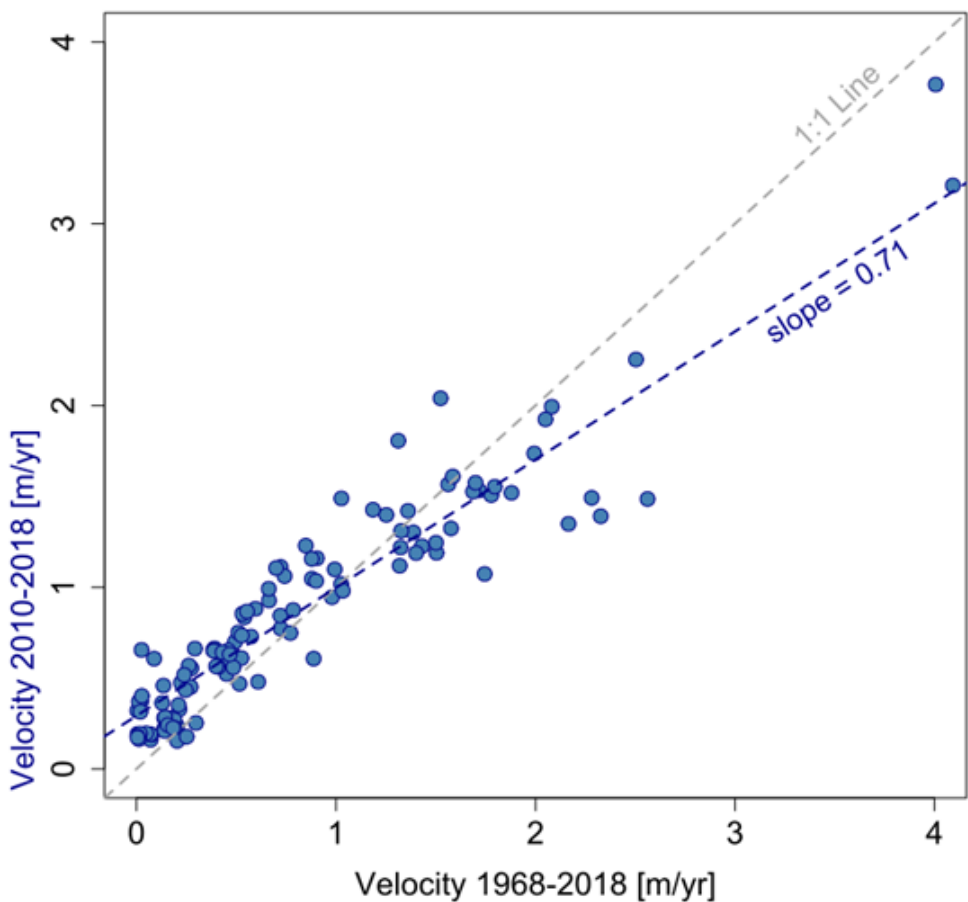
Blöthe et al. (in prep.)

(1968-2018) vs (2010-2018)

Little variation in the displacement pattern and magnitude

Slightly increasing velocities below ~ 1 m/yr

For higher velocities, data indicate deceleration

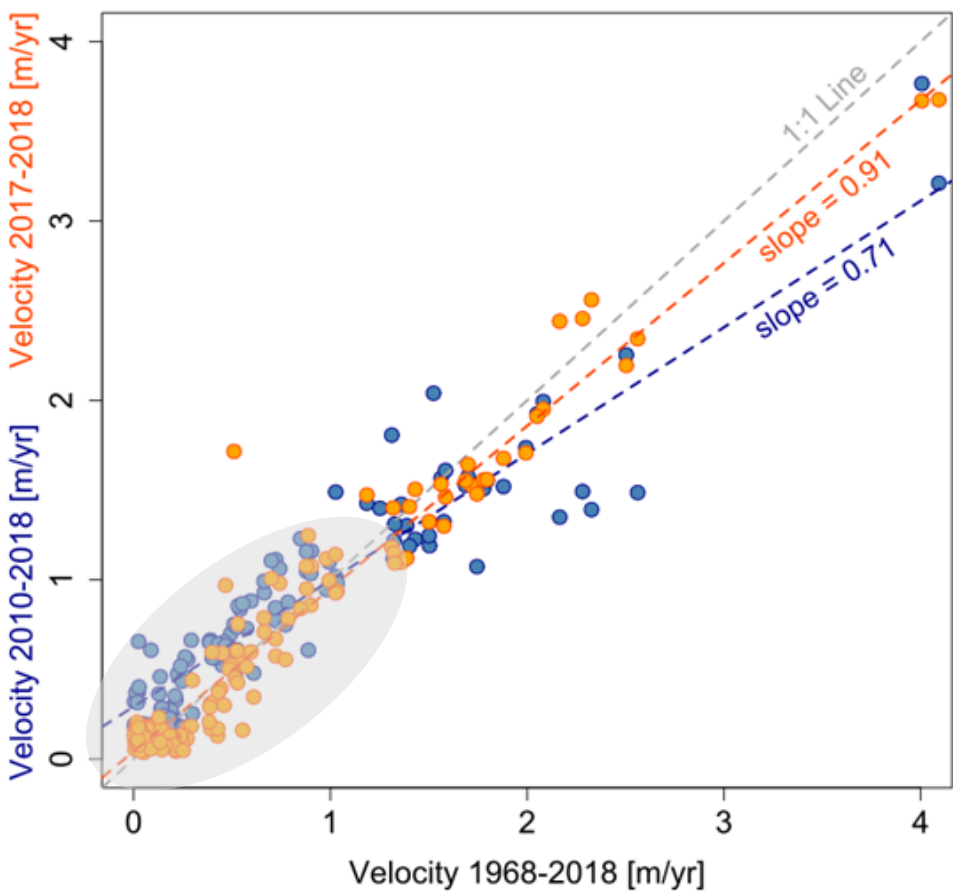


Blöthe et al. (in prep.)

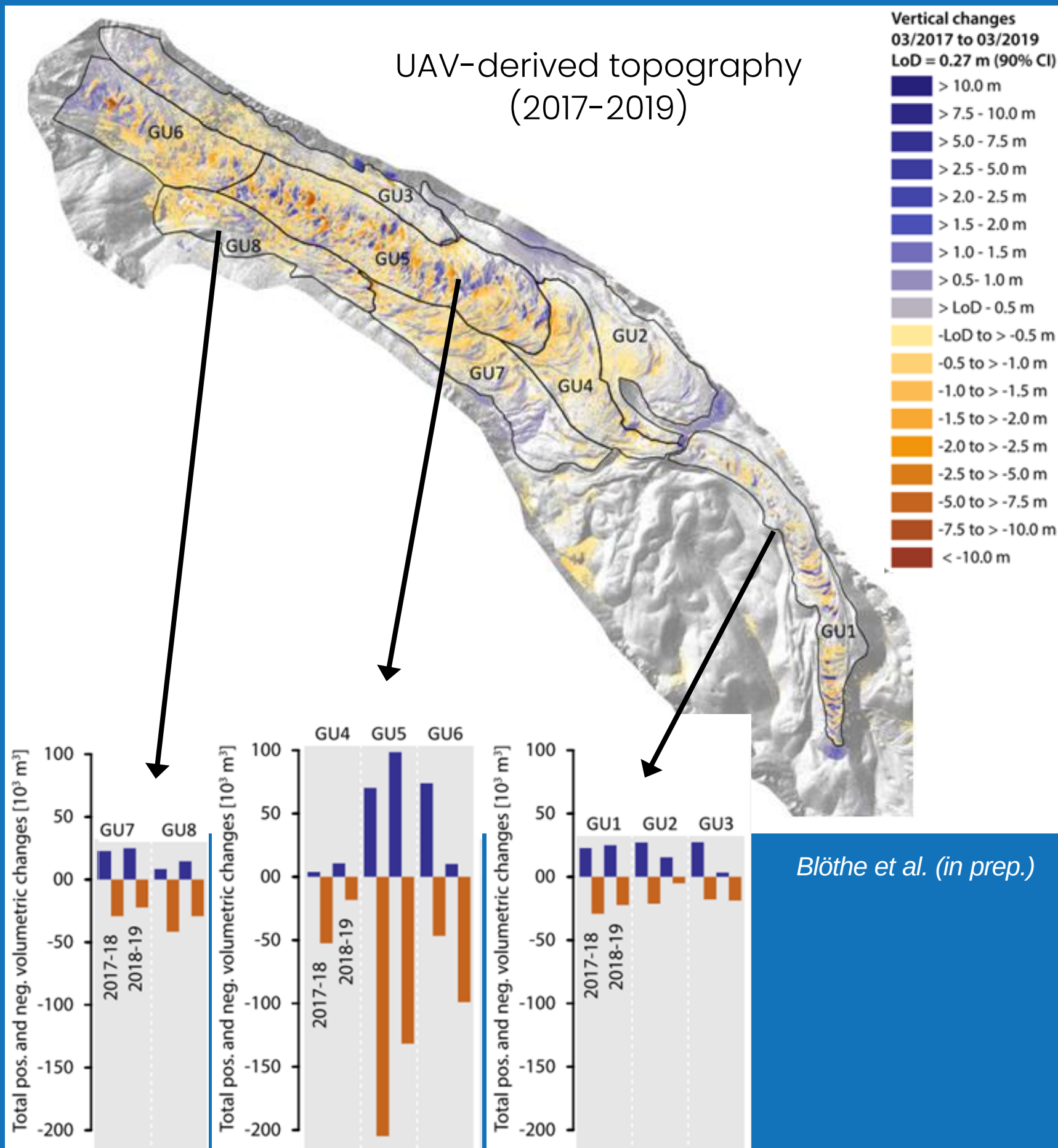
(1968-2018) vs (2017-2018)

No significant variation in the displacement pattern and magnitude. Slightly deceleration in the lower part approaching the frontal position

Contrasting with findings in the European Alps where a large number of rock glaciers accelerate in the recent decades (dominant process)



Blöthe et al. (in prep.)



Volumetric changes

Morenas Coloradas ice-debris complex has lost roughly 110 000 m^3 between 2017 and 2019

Volumetric loss is notorious in the Middle part where the large thermokarst ponds attest a rapid degradation

Mass budget by segment

Middle: **NEGATIVE**

Lower: **BALANCED**

Southern: **NEGATIVE**

Northern: **BALANCED**

Conclusions

- Agreement between kinematics data, volumetric changes and geophysical surveys
- Ice-debris complexes seem to be cinematically stable in the Central Andes
- Ground-ice quantification in ice-debris complexes is relevant under the meteorological drought context and for future climatic scenarios

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THANK YOU!