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A passive seismic approach including fiber-optic sensing for permafrost monitoring on Mt. Zugspitze (Germany)

Fabian Lindner, Krystyna Smolinski, Jonas Igel, Daniel Bowden, Andreas Fichtner & Joachim Wassermann

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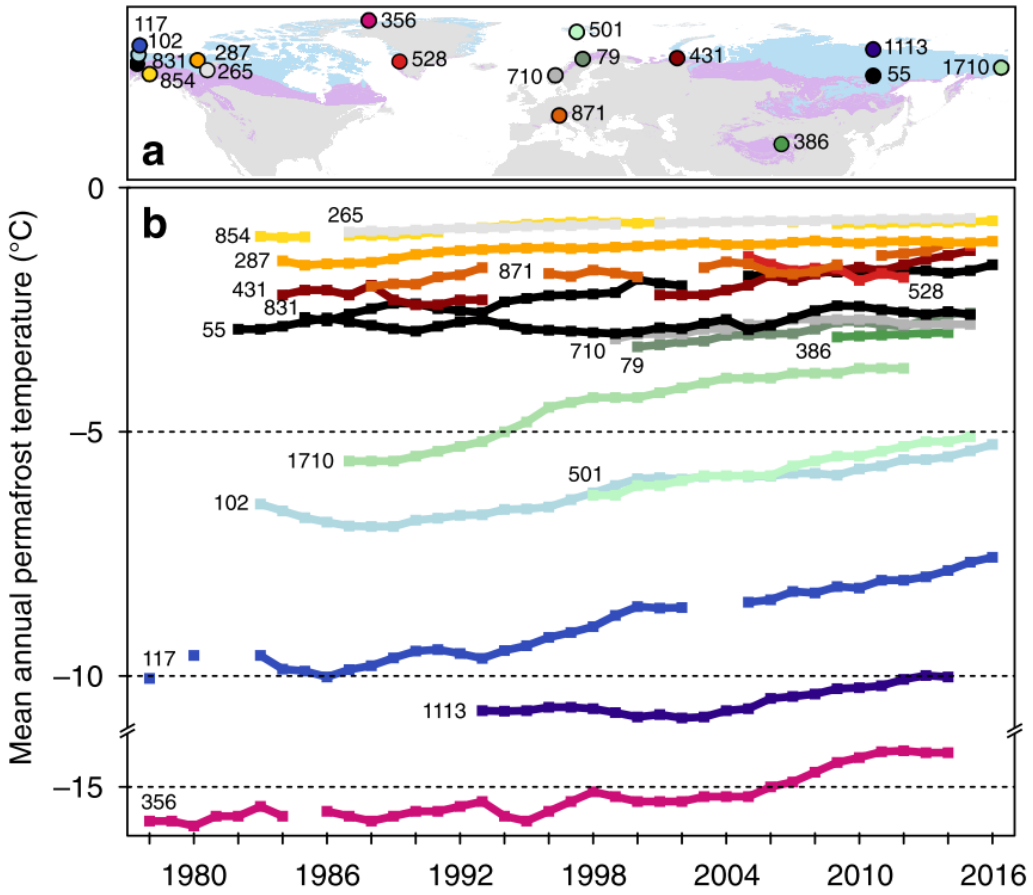
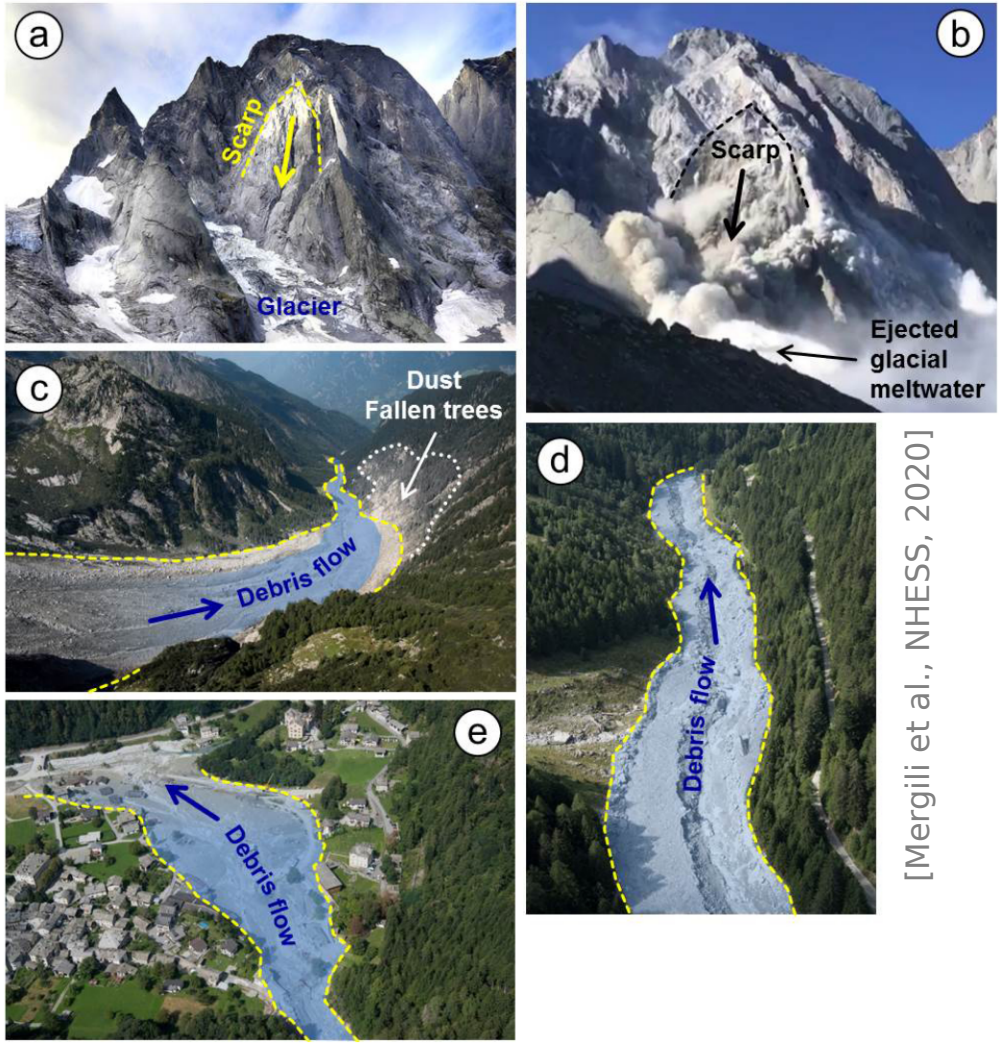
Motivation

Permafrost degradation …



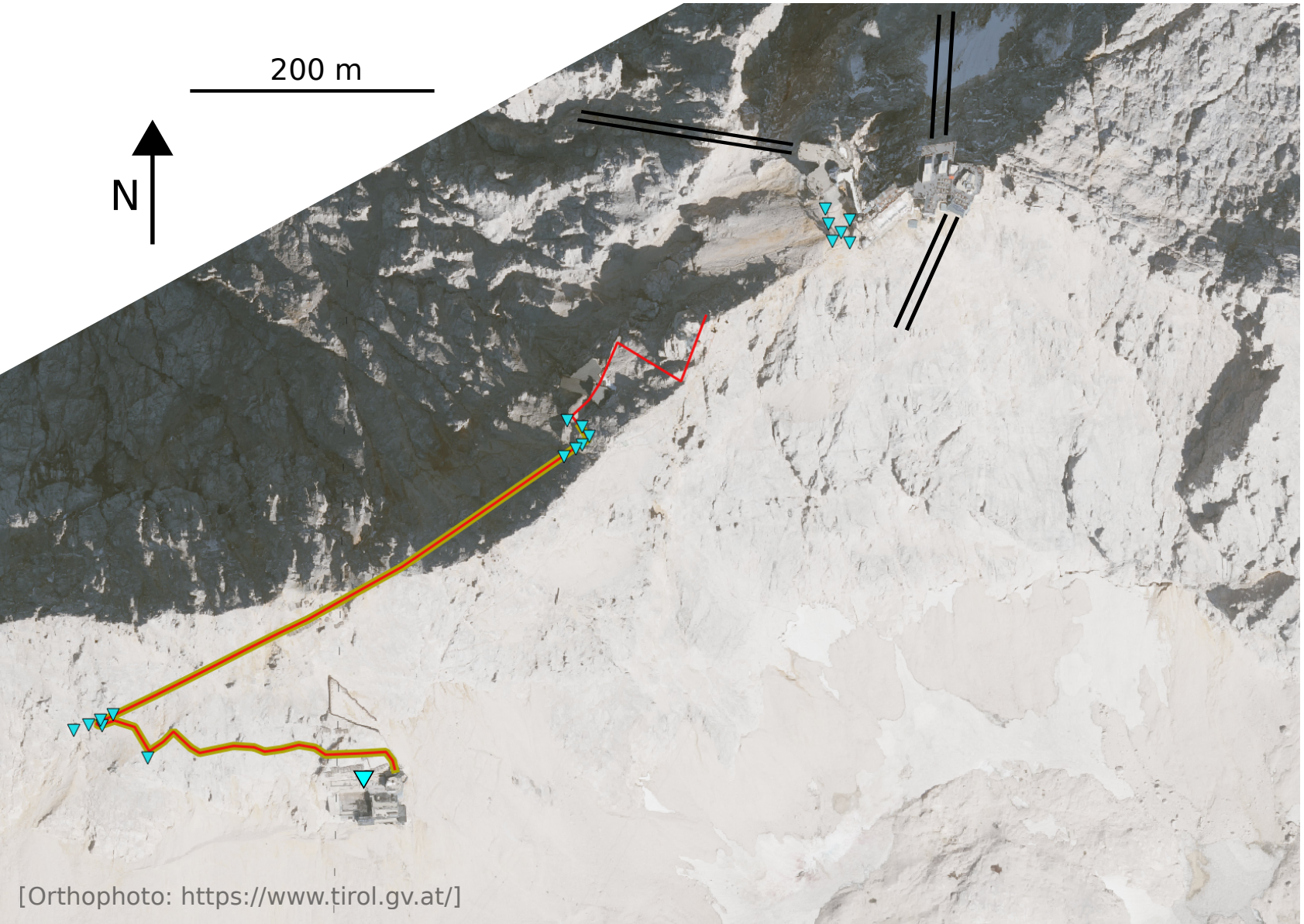
[Biskaborn et al., Nature Communications, 2019]

Rock slope stability …



[Mergili et al., NHESS, 2020]

Mt. Zugspitze & Permafrost

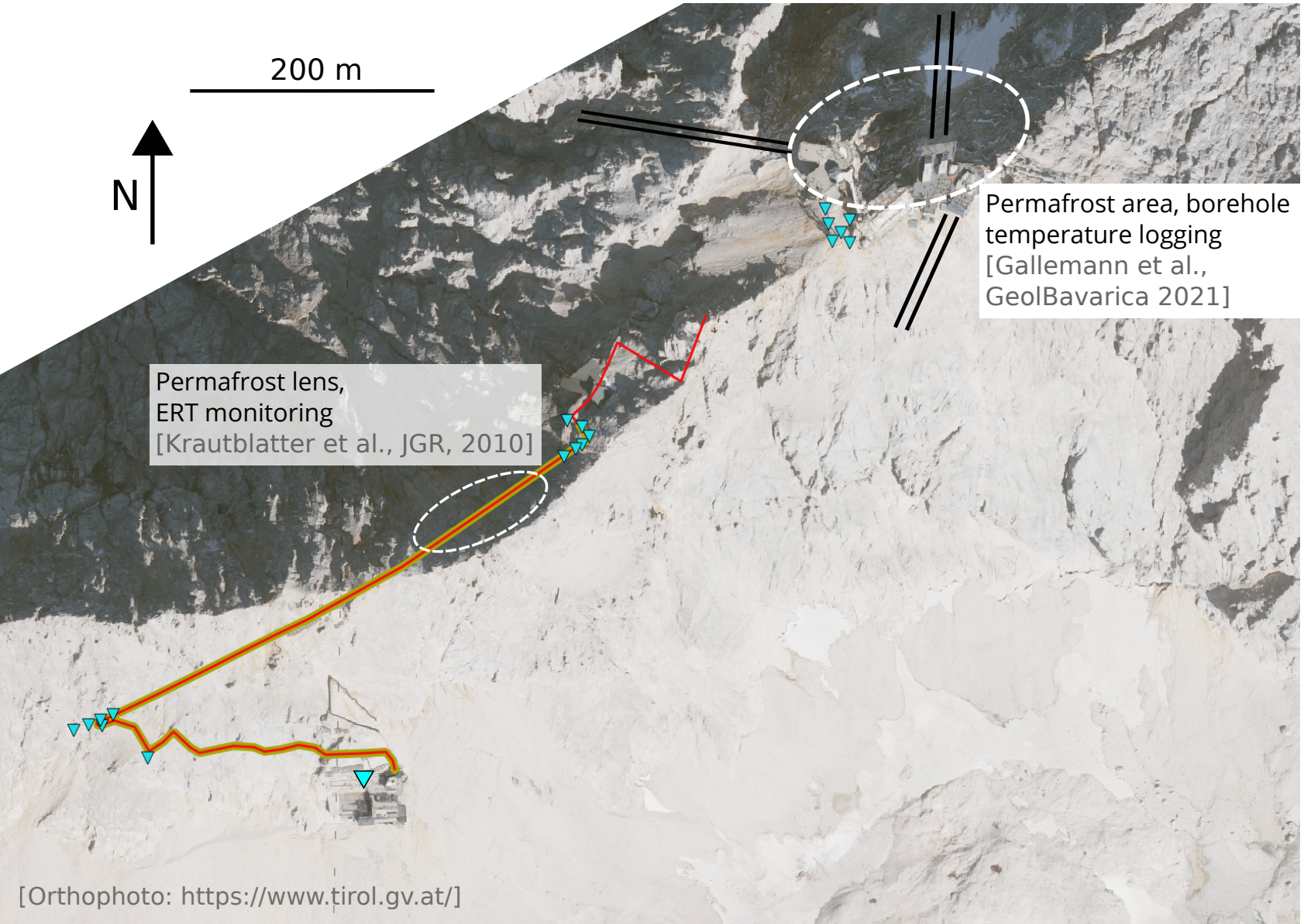


[Orthophoto: https://www.tirol.gv.at/]

[https://www.mapsofworld.com]

[https://schneefernerhaus.de]

Mt. Zugspitze & Permafrost



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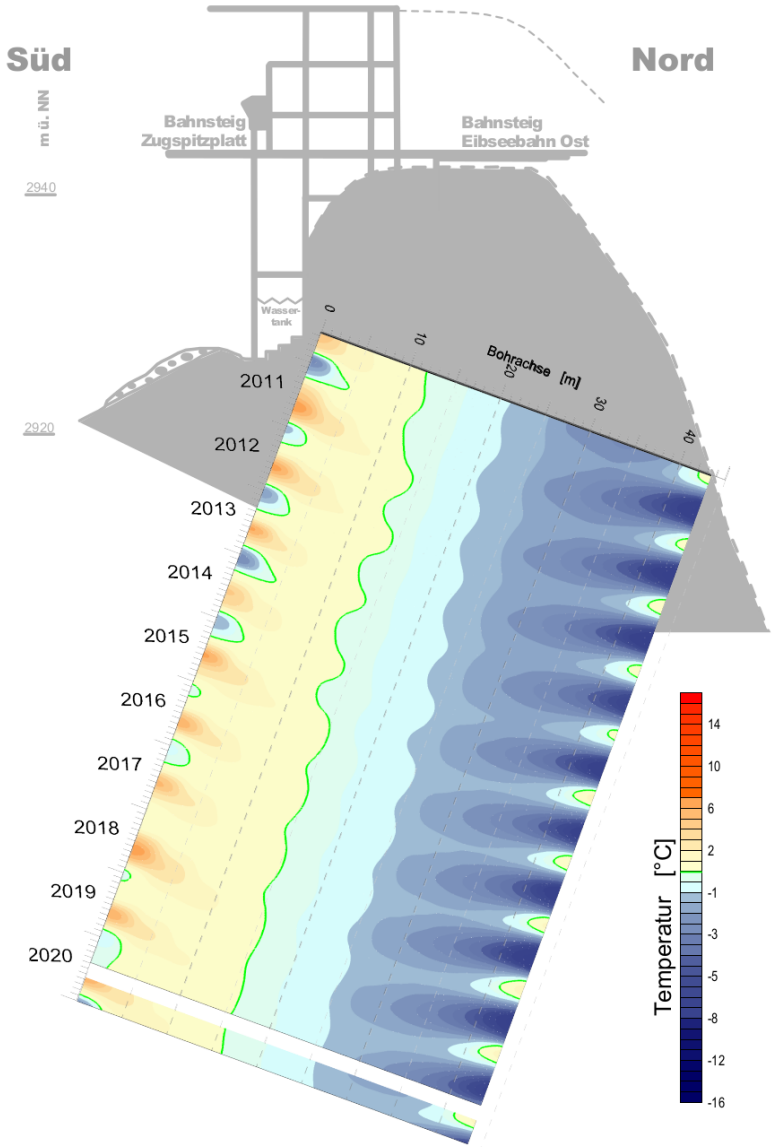
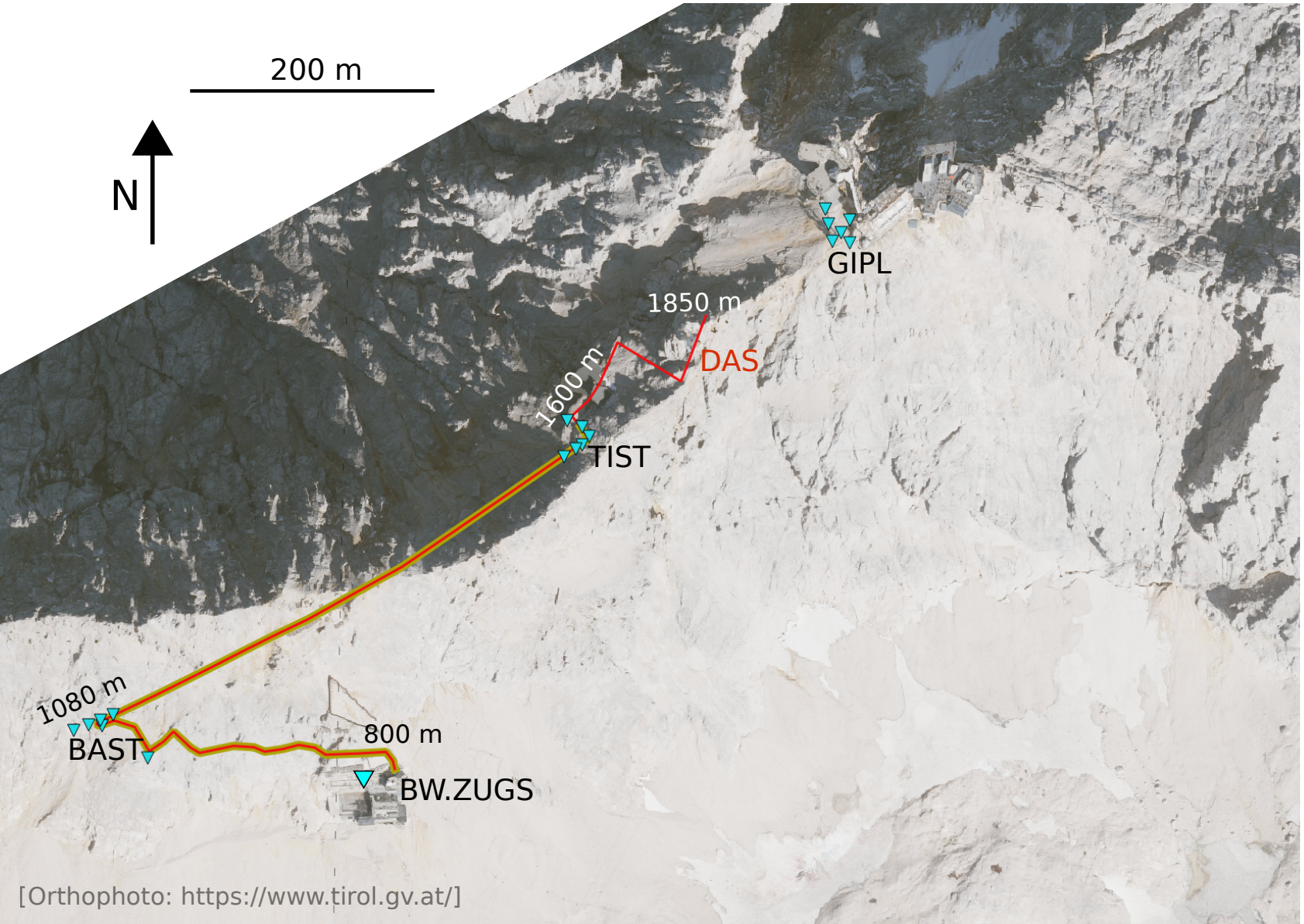


Mt. Zugspitze: seismic instrumentation



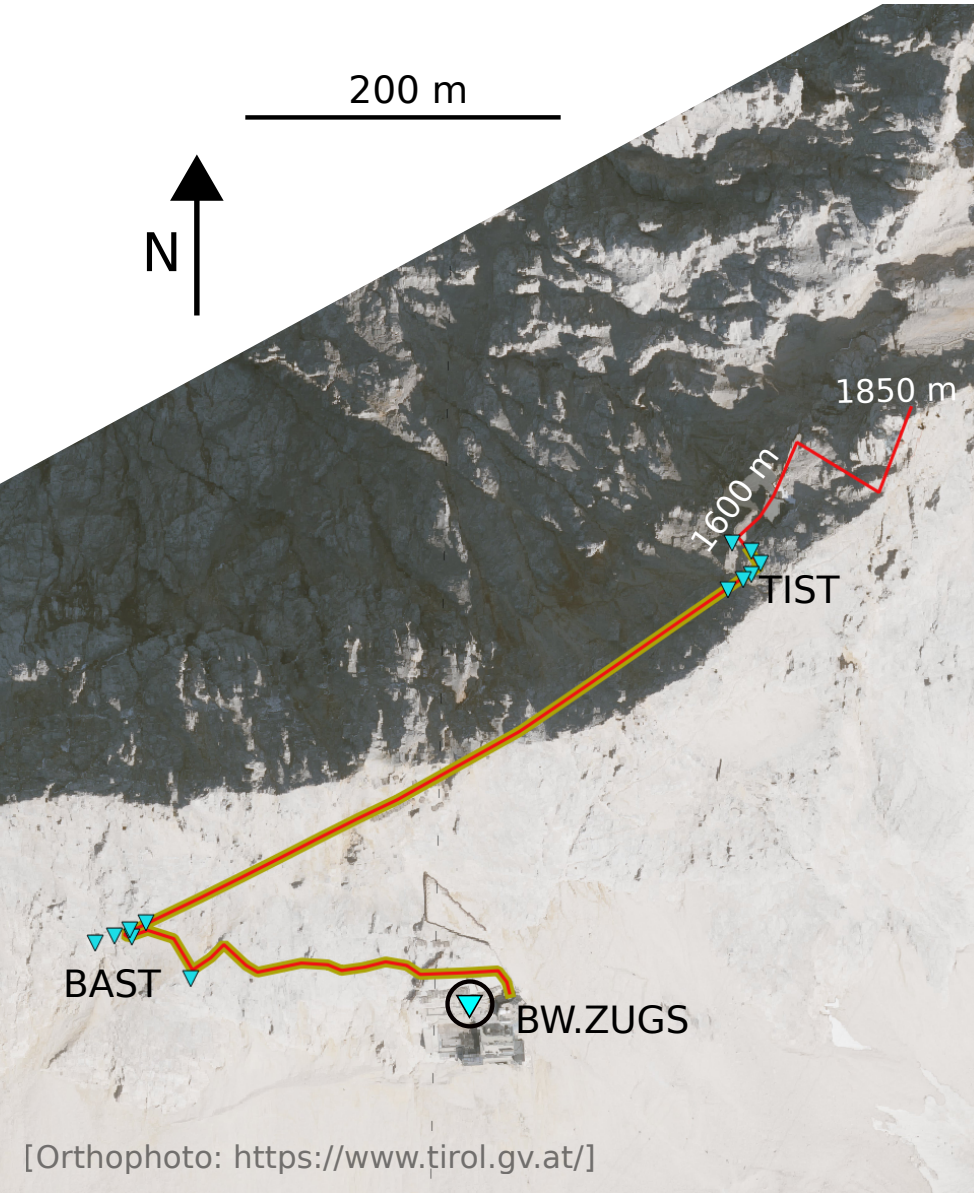
[Orthophoto: https://www.tirol.gv.at/]

BW.ZUGS
permanent station, since 2006

BAST, TIST, GIPL
seismic arrays, since summer/fall 2021

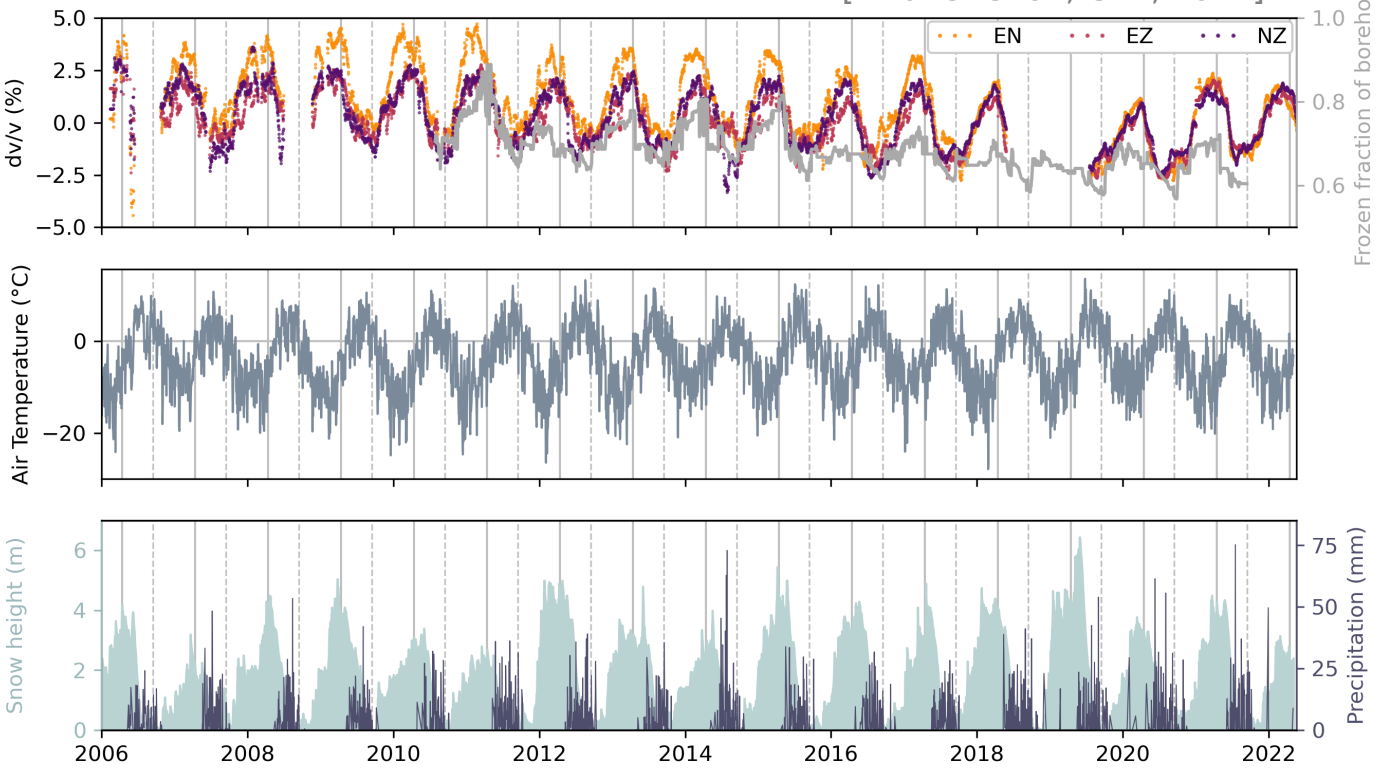
DAS
fiber-optic cable for distributed acoustic sensing, interrogated in Dec. 2021 and Mar. 2022, July 2022, ...

Single-Station Seismic Monitoring: BW.ZUGS

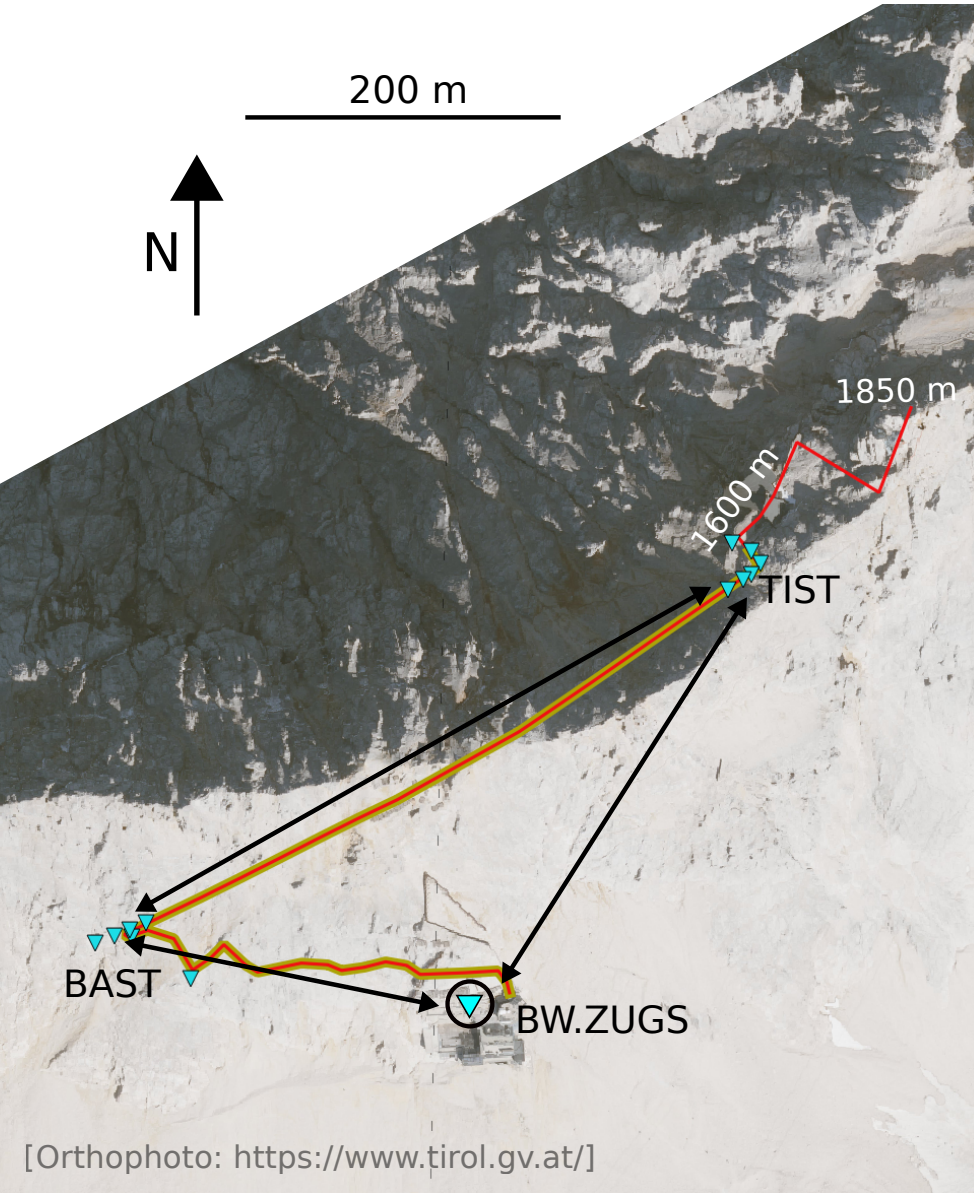


[Orthophoto: https://www.tirol.gv.at/]

[Lindner et al., GRL, 2021]

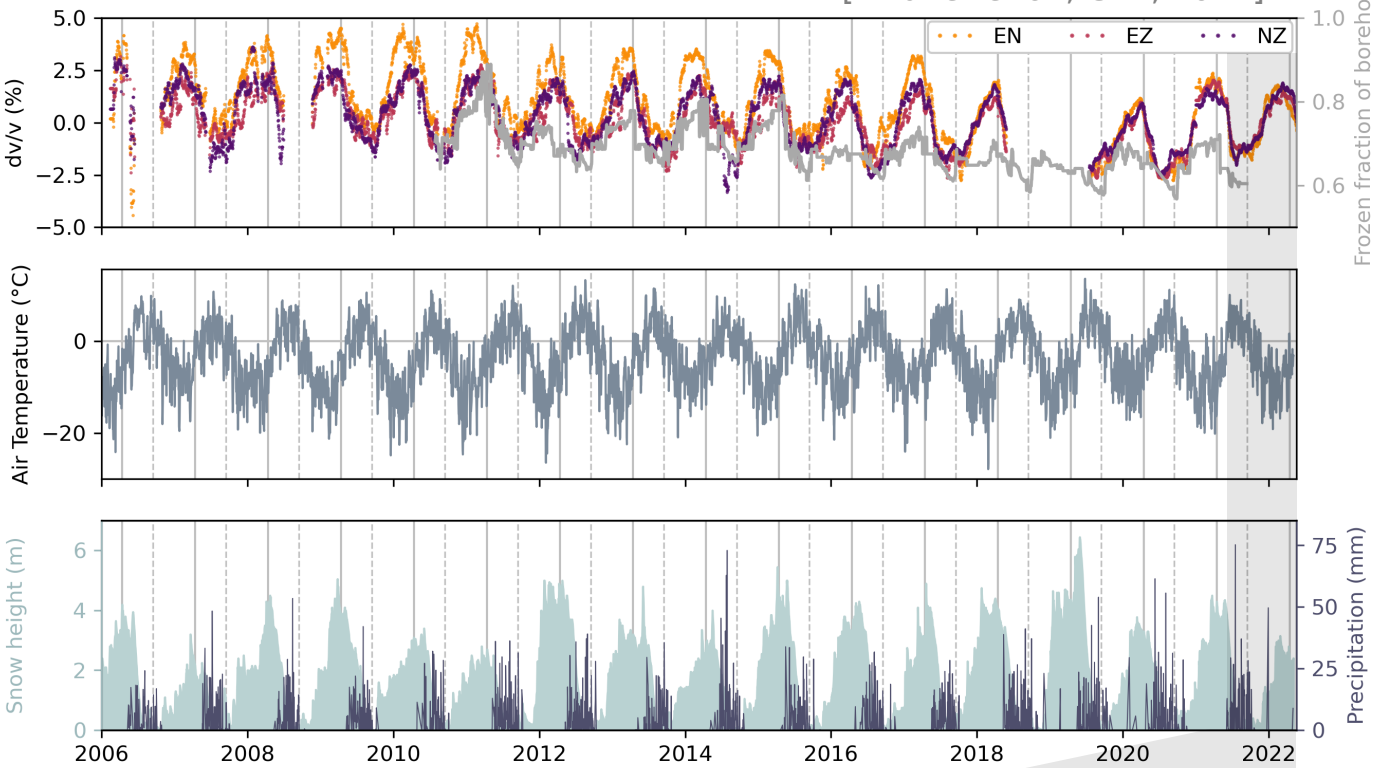


Single Station vs Station Pairs

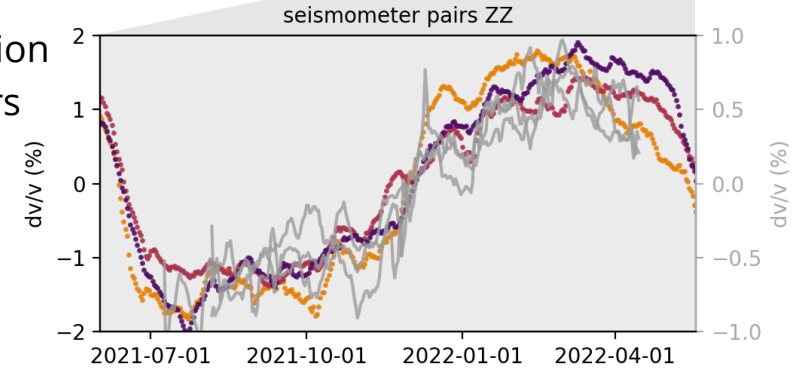


[Orthophoto: https://www.tirol.gv.at/]

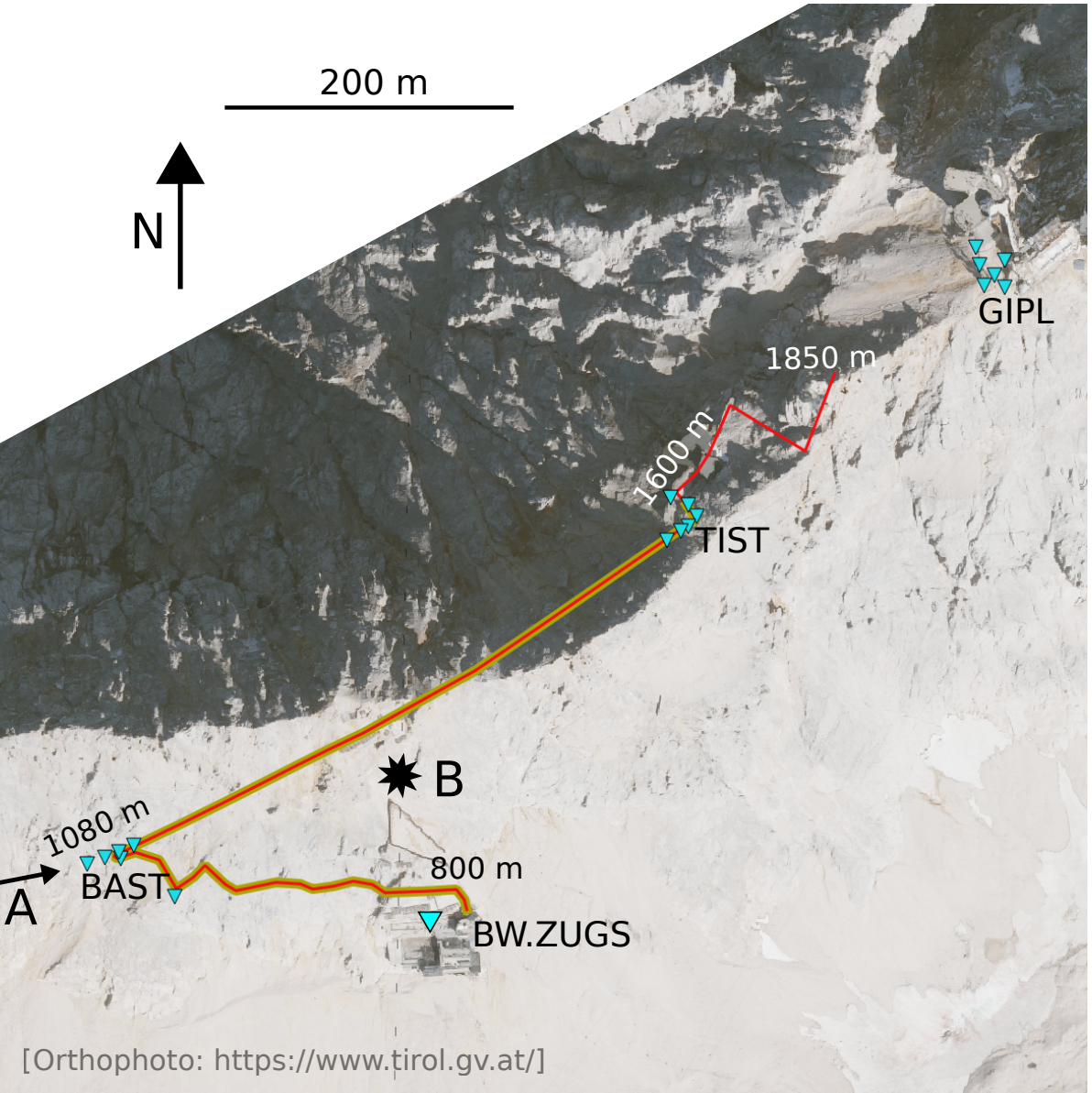
[Lindner et al., GRL, 2021]



color: single station
gray: station pairs



Distributed Acoustic Sensing: avalanche blasts



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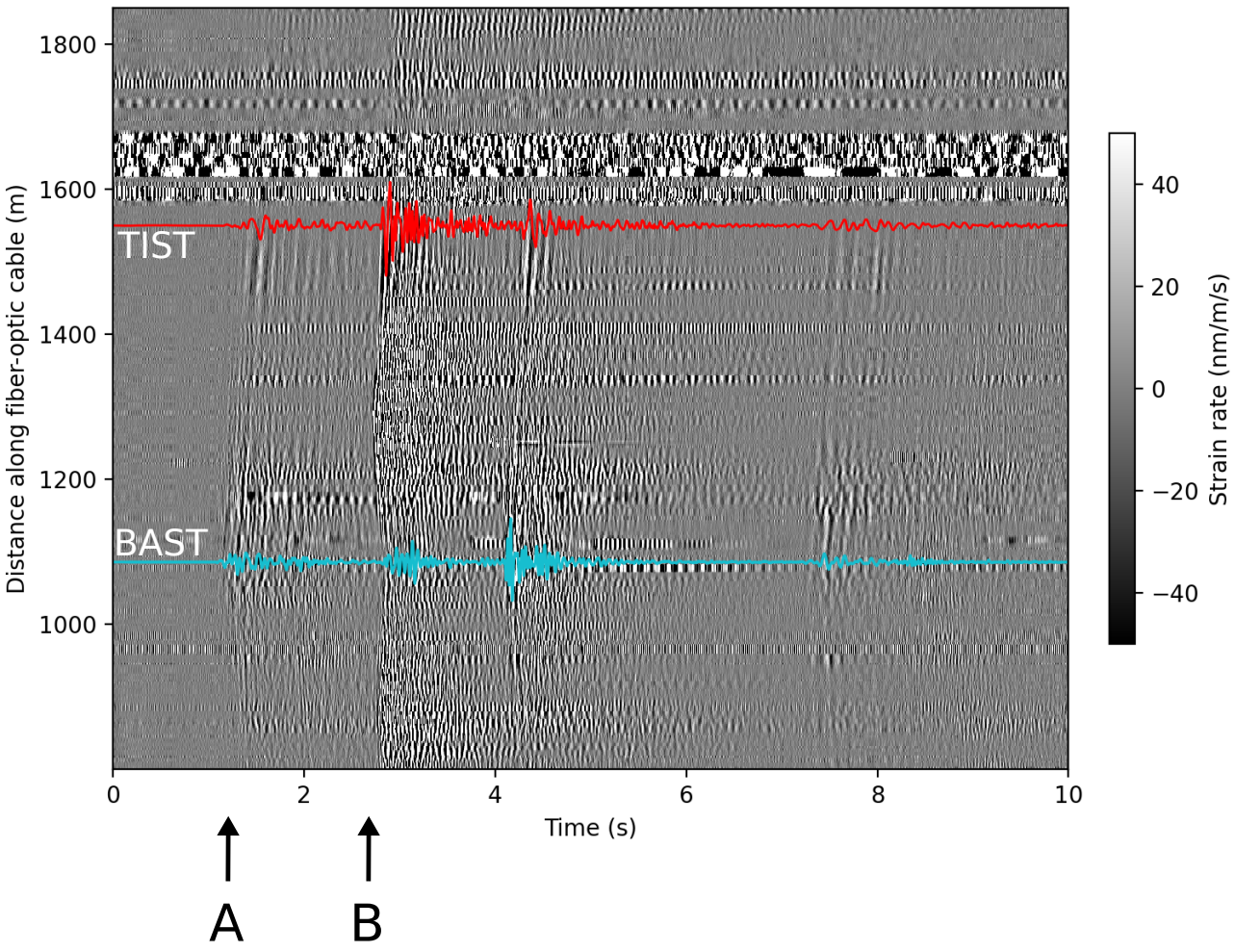
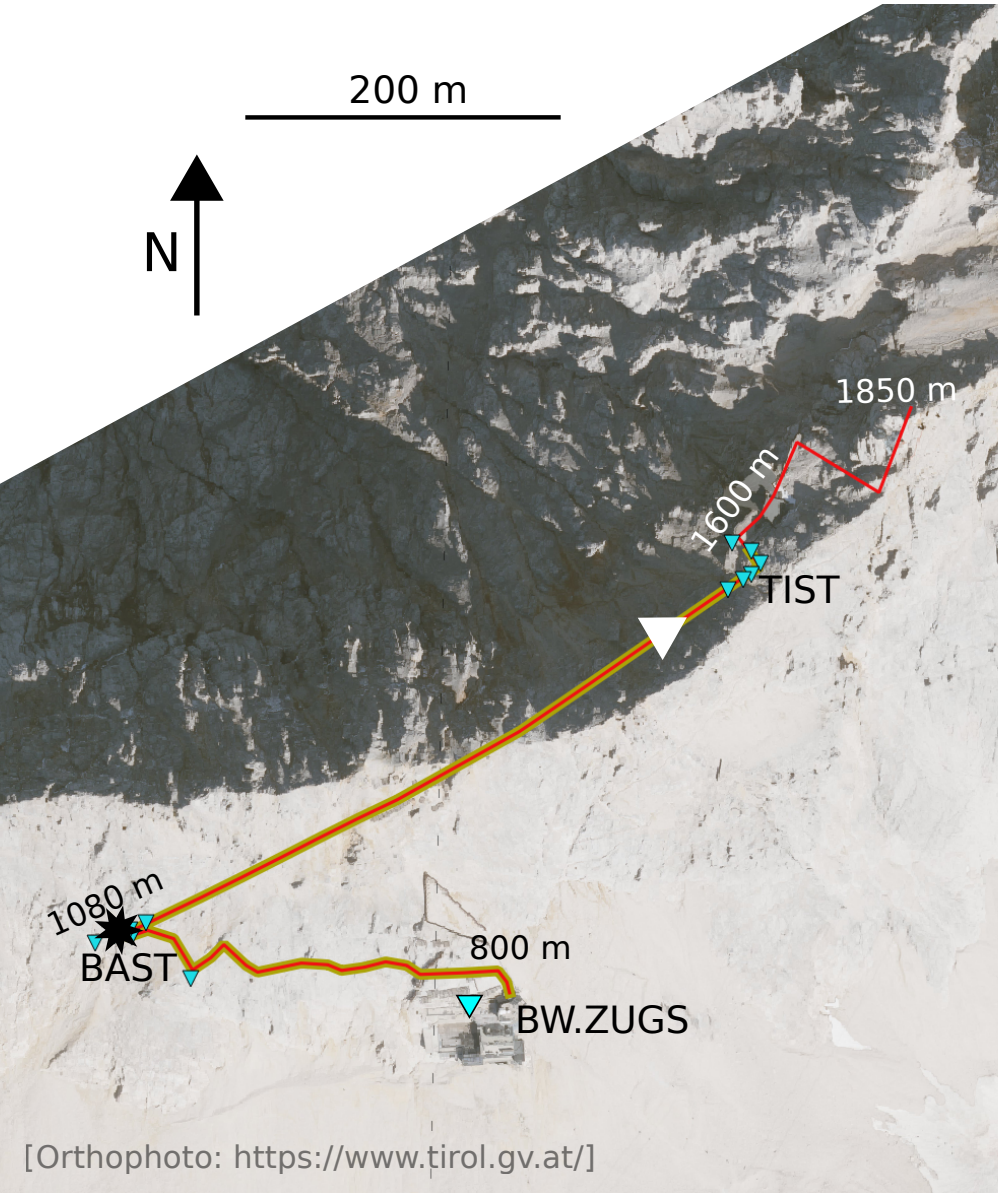


Distributed Acoustic Sensing: cross-correlations with seismometer



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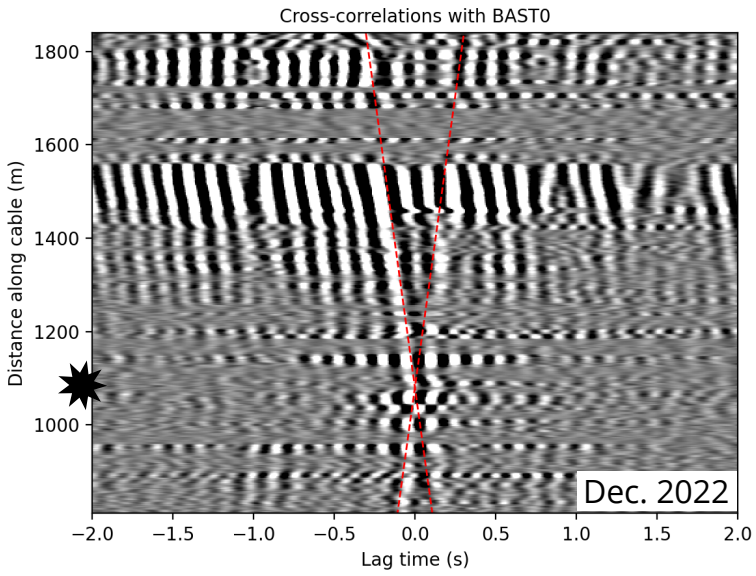

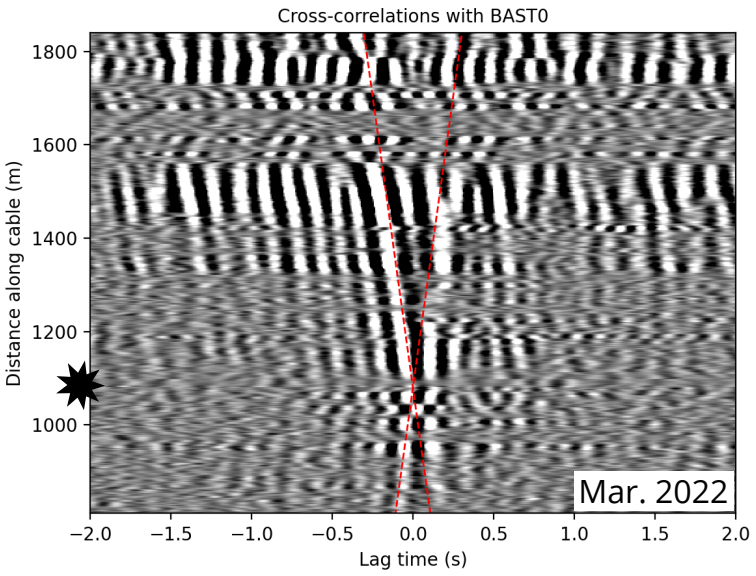

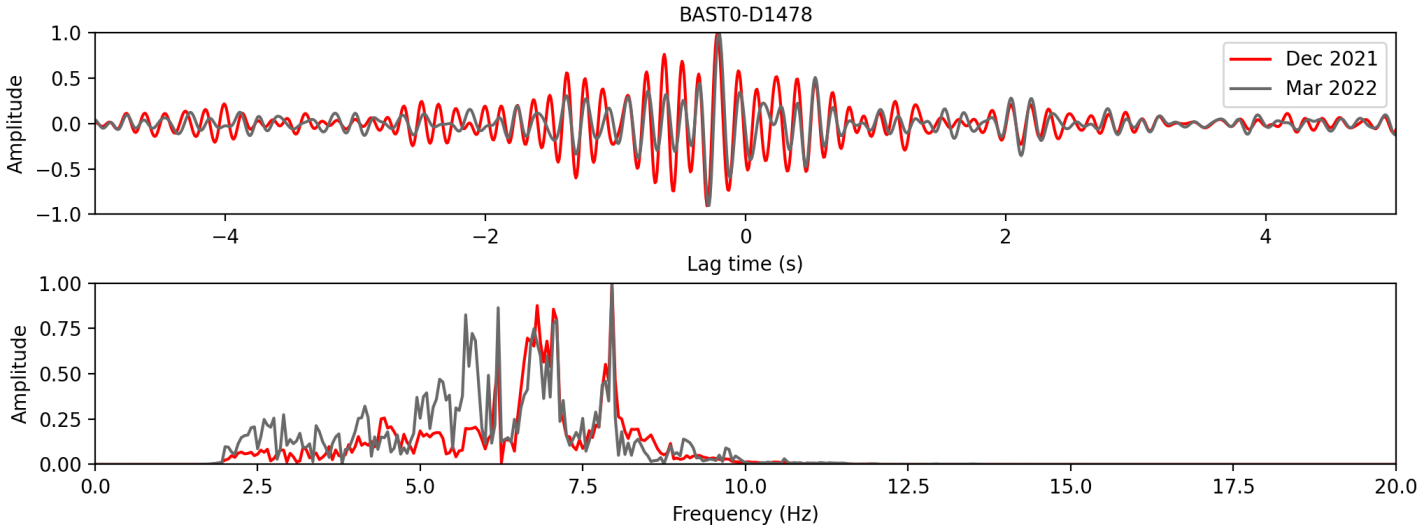

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Conclusions / Outlook

* Seasonal freeze-thaw cycles and permafrost degradation revealed by single seismic station; confirmed by extended instrumentation.

* High temporal sampling with seismometers and geophones, high spatial coverage through distributed acoustic sensing.

* Detailed spatio-temporal permafrost monitoring with passive seismology?

Zugspitze - Permafrost DAS Experiment

Seismology and Wave Physics - E...

https://www.youtube.com/watch?v=veoJEcZx4Zg

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