Quasi-dynamically downscaled snowpack simulation in Peñalara Massif (Sierra de Guadarrama, Central Spain)

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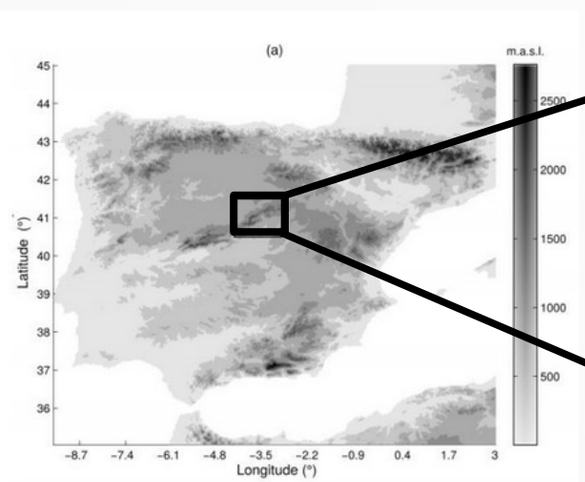
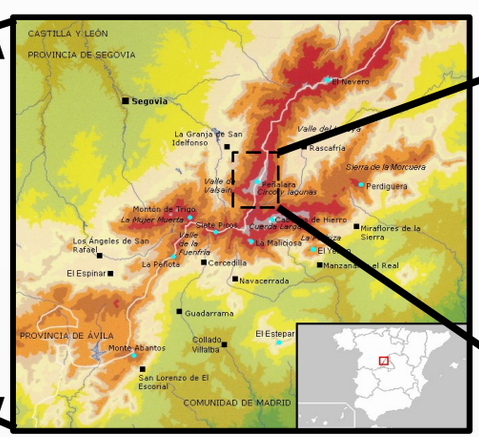
MOTIVATION

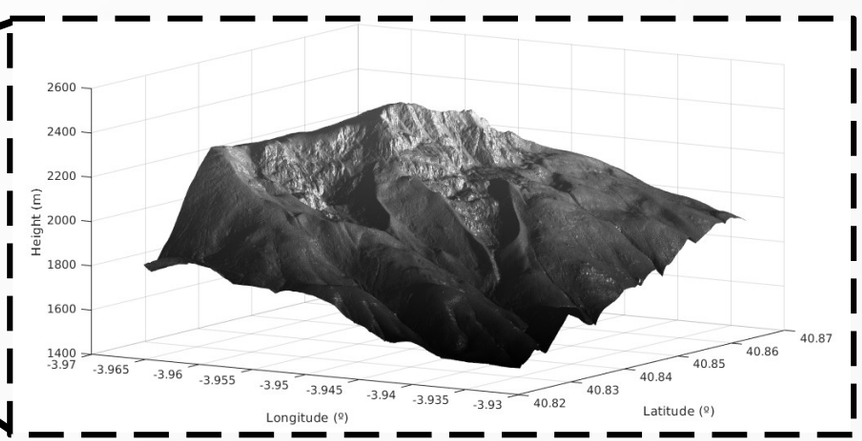
- Sierra de Guadarrama → Mediterranean mountain system with limited snow cover.
- Although scarce, the snow is very relevant to the hydrology, ecology and economy of the region.
- Region of scientific interest (Bosch et al.,2003; Durán et al., 2013; Durán et al., 2015; Durán et al., 2017; Sanchez-López et al., 2015; Vegas-Canas et al., 2020).
- In regions with a snow cover with high spatial and temporal variability, a fine-scale modelization of the snow cover is needed.



Iberian Peninsula



Sierra de Guadarrama National Park



Peñalara Massif. Domain: 3x5 Km

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GOALS

- Get a better understanding of high mountain meteorological phenomenology, especially the processes involved in the growth and melting of the snow cover.
- Validate, improve and research new downscaling schemes.
- Design and test new systems for snow cover observation.
- Implement a functional prototype of an hyper-resolution snow cover prediction model at different temporal scales.

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METHOD

MODELING SYSTEM

Work in progress
Implemented

INPUT DATA

- ERA5 — 25 km
- HARMONIE AROME — 5 km
- OBSERVATIONS

CALIBRATION

ATMOSPHERE SIMULATION

- **600 – 200 m** — ICAR (Intermediate Complexity Atmospheric Research model, Gutmann et al. 2016)
- **2 - 10 m** — RADIATION MODEL: Direct/diffuse decomposition, Longwave parameterization, Skyview and shadow

SNOW COVER SIMULATION

- FSM2 (Flexible Snow Model, Essery, 2015)
- REDISTRIBUTION (wind drift, slope drift)
- ¿SNOWPACK?
- ¿CROCUS?

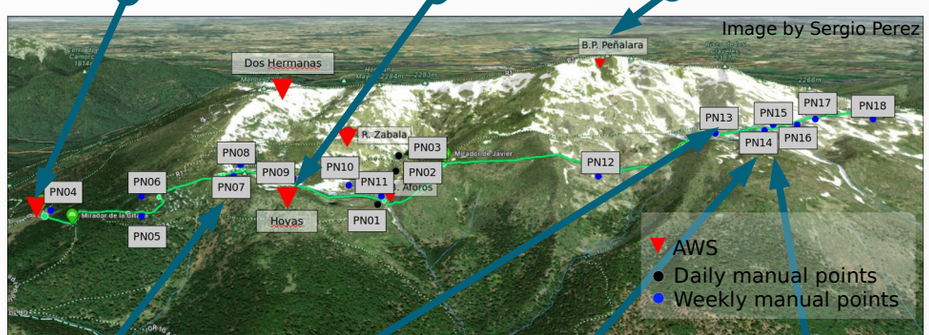
2 - 10 m

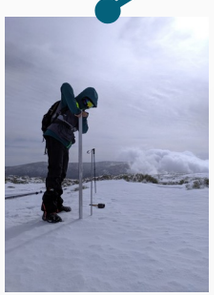
DOWNSCALING

OUTPUT

VALIDATION

OBSERVATIONS
(Automatic and manual data)





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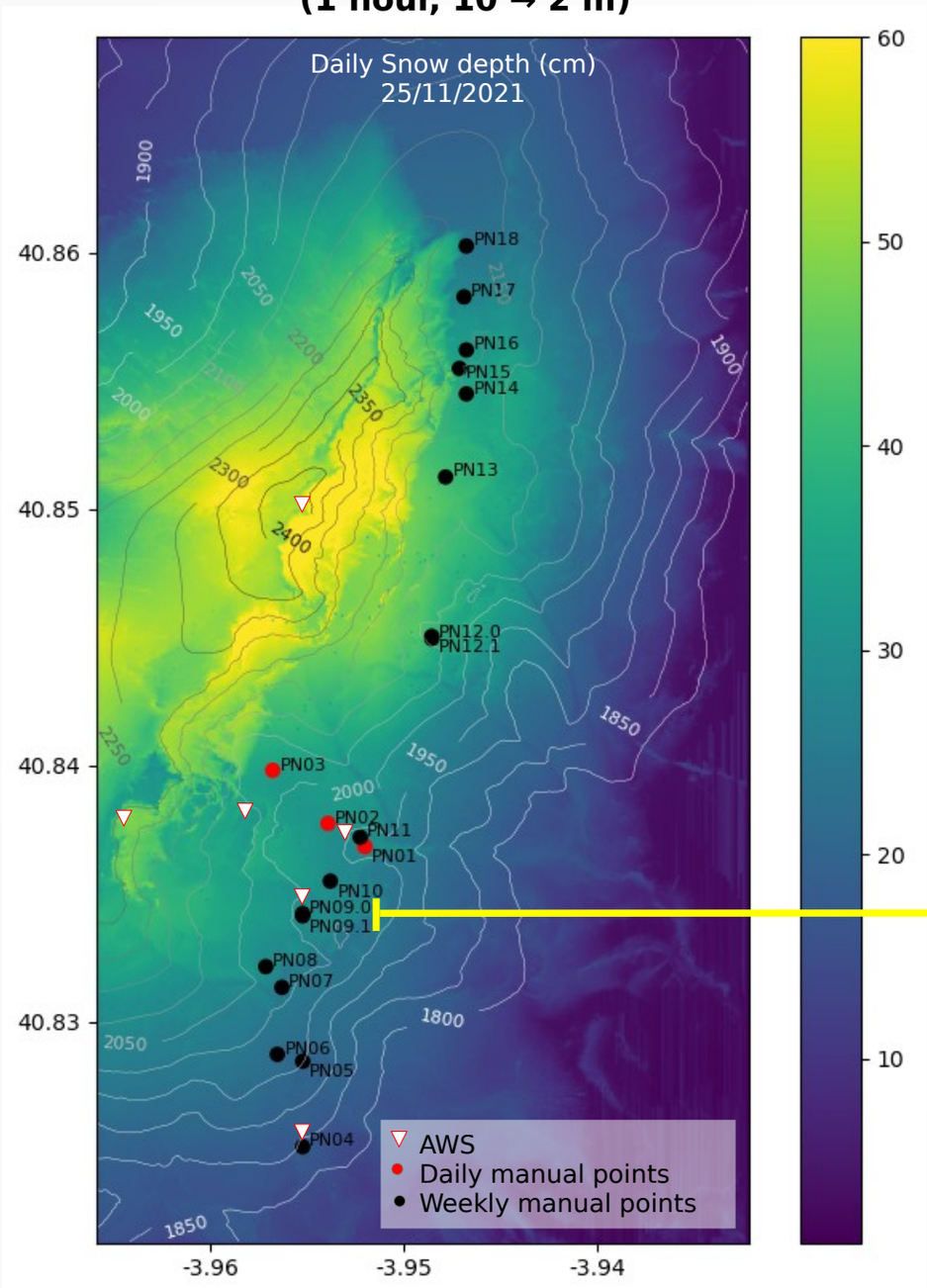
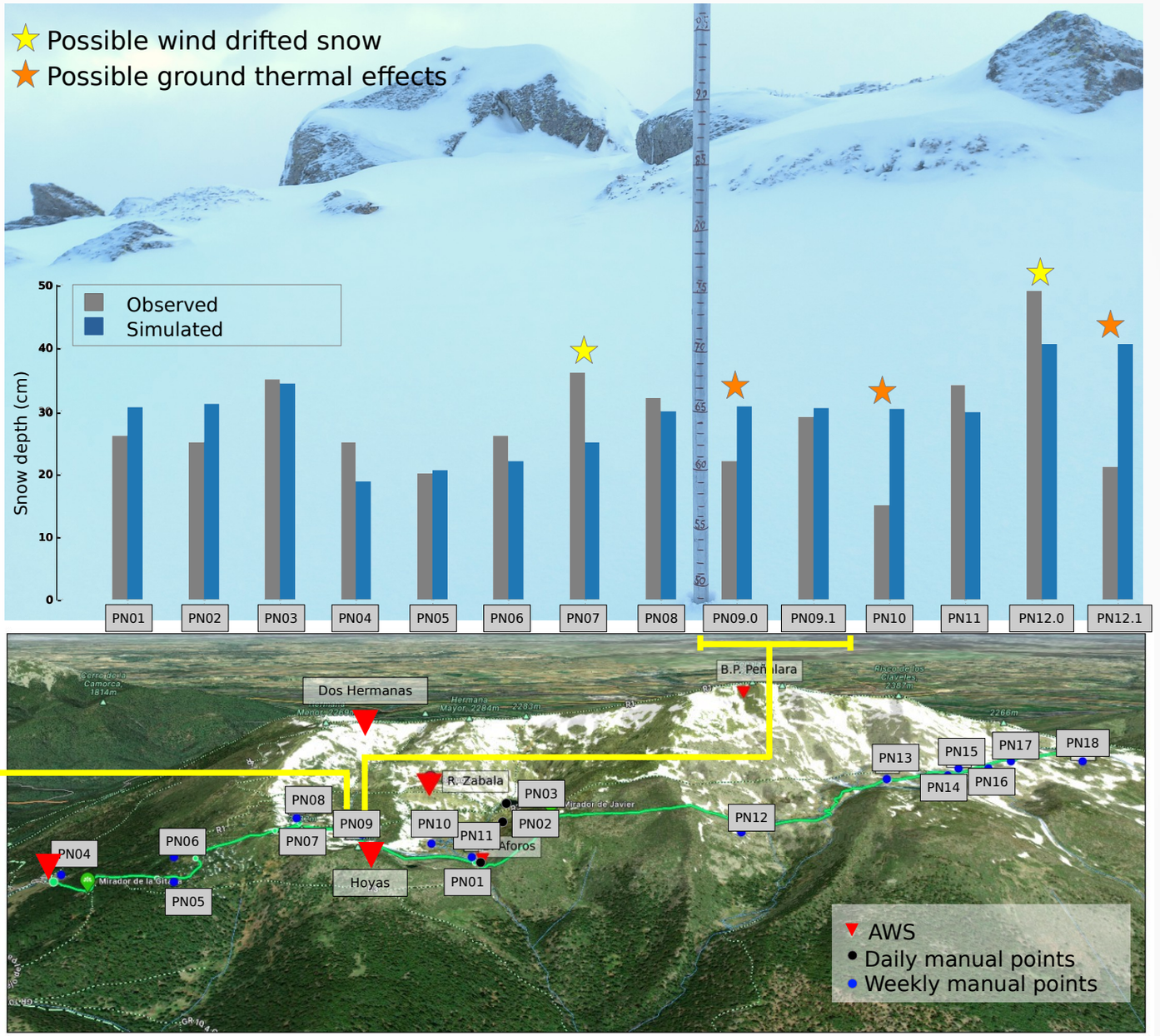
HIGH RESOLUTION SNOW DEPTH ASSESSMENTS (1 hour, 10 → 2 m)



ARE THE RESULTS SPATIALLY COHERENT?



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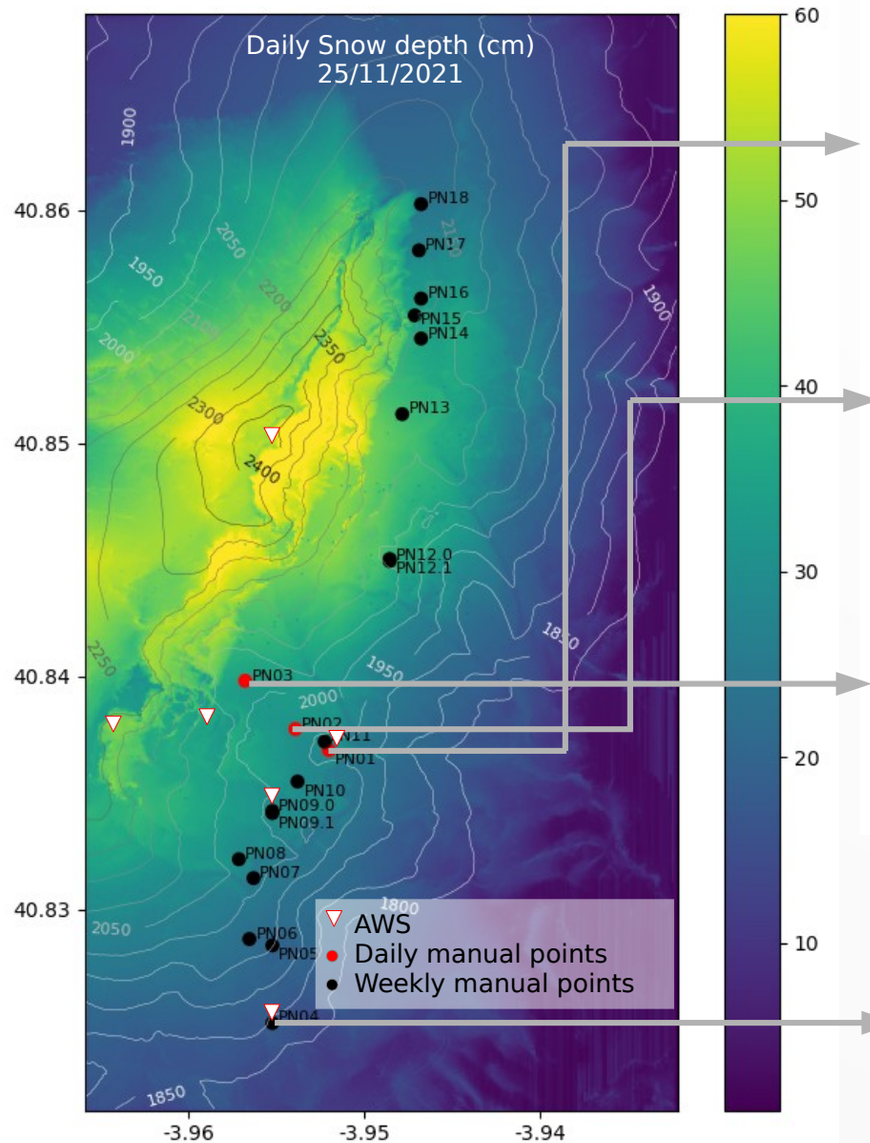
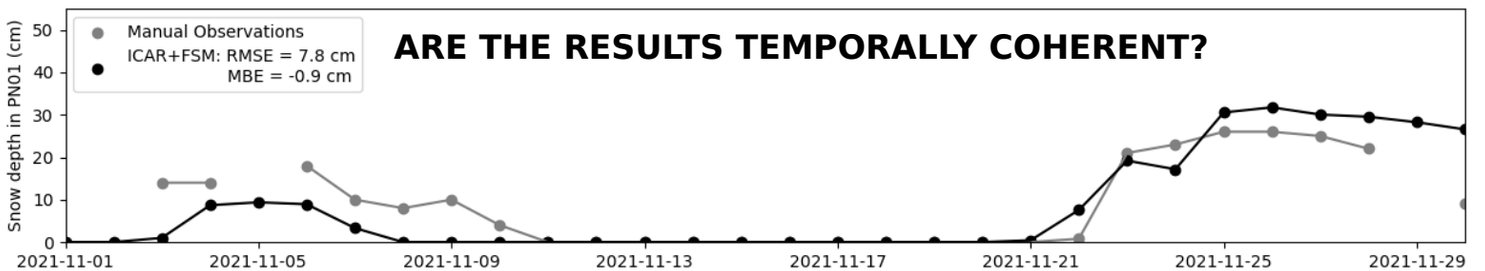
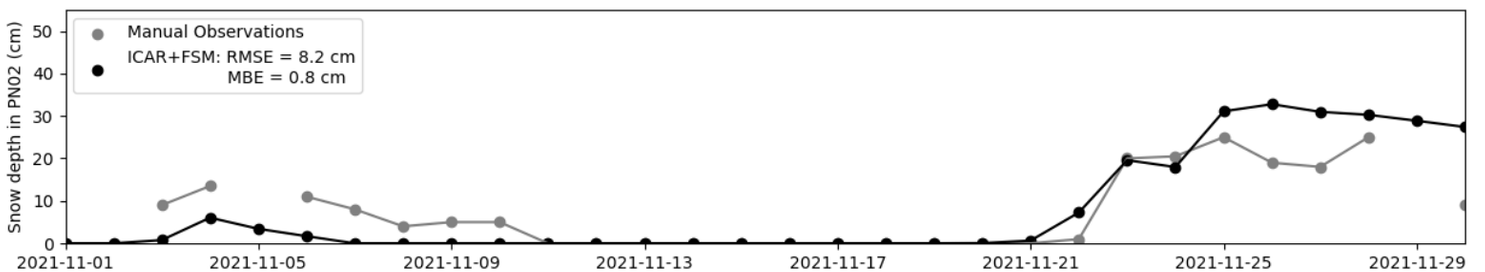
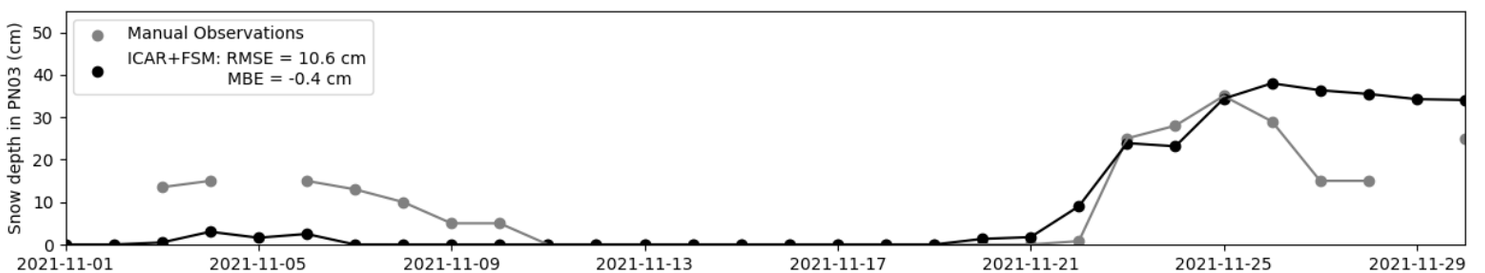
RESULTS

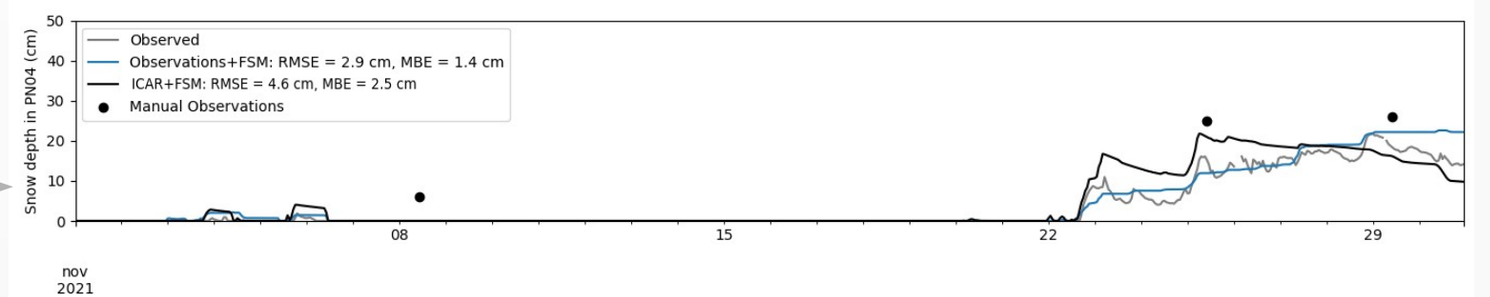


ARE THE RESULTS TEMPORALLY COHERENT?









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CONCLUSIONS

- The chained models seem to perform adequately considering the very high resolutions.
- First results seems to be spatially and temporally coherent.
- Nevertheless, results in certain areas point out the complexity of the phenomena involved, requiring further observation and research.
- Complementary observation methods are necessary to capture the complex phenomena.

OUTLOOK:

- Improve the modeling of the atmospheric forcing.
- Improve the snow cover modeling including snow drifting modules.
- Work on the radiation module and ground characteristics to improve the melting phase of the snow cover.
- Incorporate new high resolution ground measurements, use surface georeferenced photography, drone photogrammetry and satellite products.

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THANK YOU FOR YOUR ATTENTION

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