IMGI
Institute of Meteorology and Geophysics Innsbruck

FWF Der Wissenschaftsfonds.

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On snow cover modeling in complex alpine terrain and it's relevance to the regional climate.

Sascha Bellaire, Mathias W. Rotach & Jürg Schweizer

FWF-Project: SAINT – **S**now cover **A**tmosphere **INT**eractions

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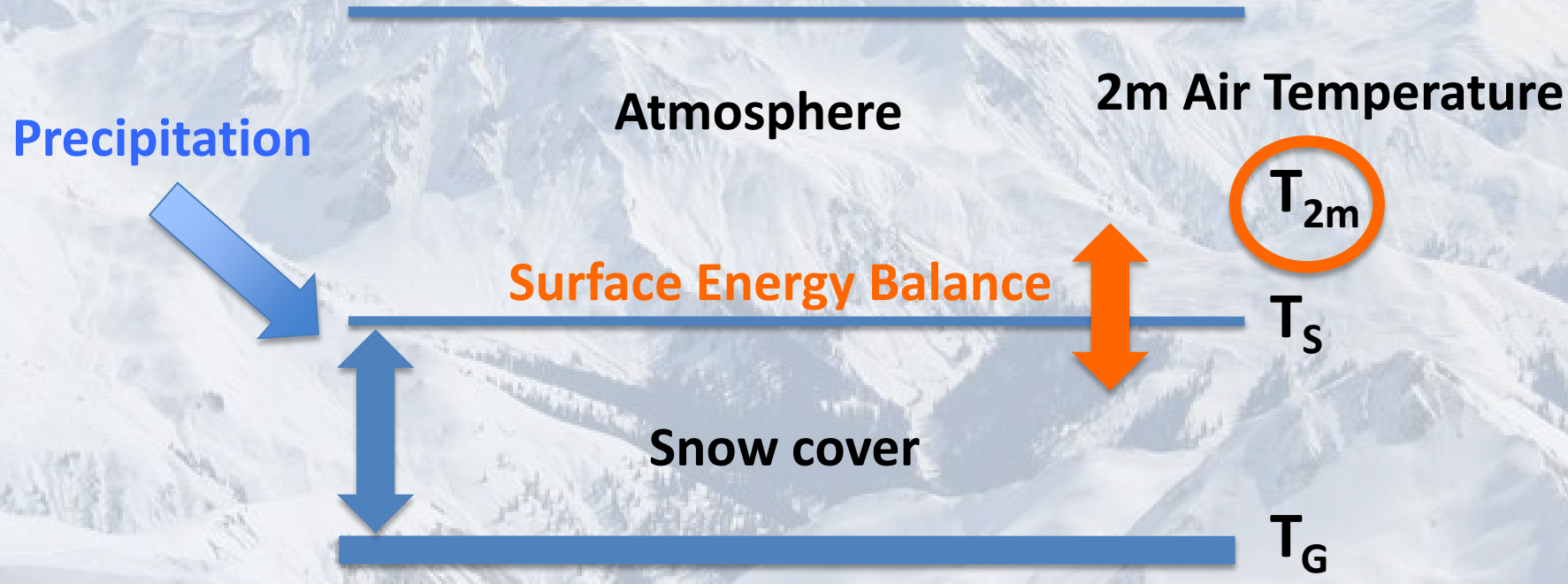
- The **snow cover mean** winter maximum areal extent covers about **10% of the earth-land area**, of which **98%** are located in the **Northern Hemisphere** (National Snow and Ice Data Center, Boulder, Colorado, U.S.A).
- **High albedo** of the snow cover is **critical** for the **global radiation budget** and therefore **influencing the global climate**.
- **Modeling** the evolution and spatial distribution of the **seasonal mountain snow cover** would therefore substantially **improve global circulation and climate models**.

SAINT – **S**now cover **A**tmosphere **INT**eractions

Aim:

- **Coupling of a complex snow cover model (SNOWPACK) with a high-resolution numerical weather prediction model (COSMO-2).**

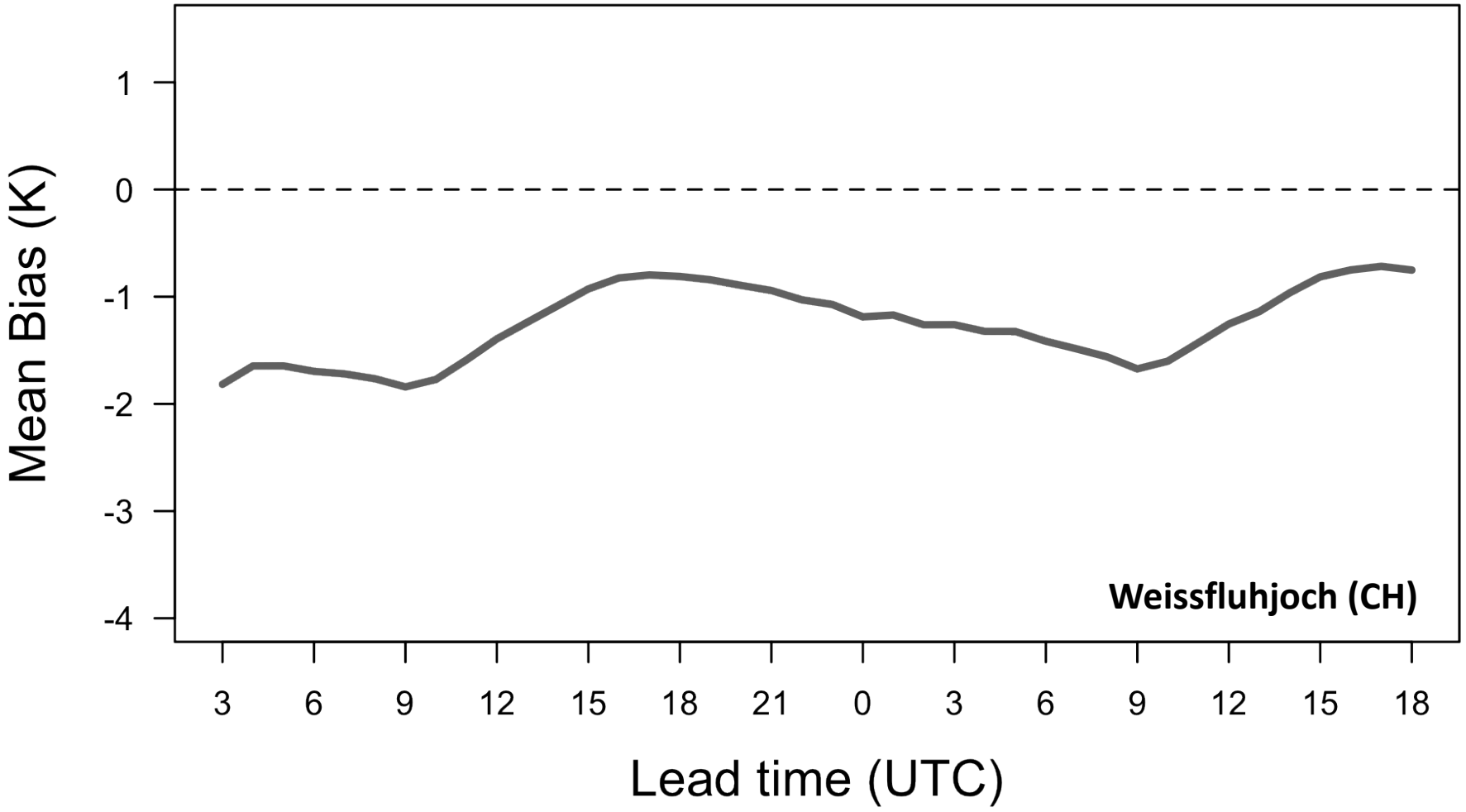



Davos, Switzerland
SLF experimental site


Picture: www.slf.ch

Mean Bias of 2 m air temperature (Mod. – Obs.)

All



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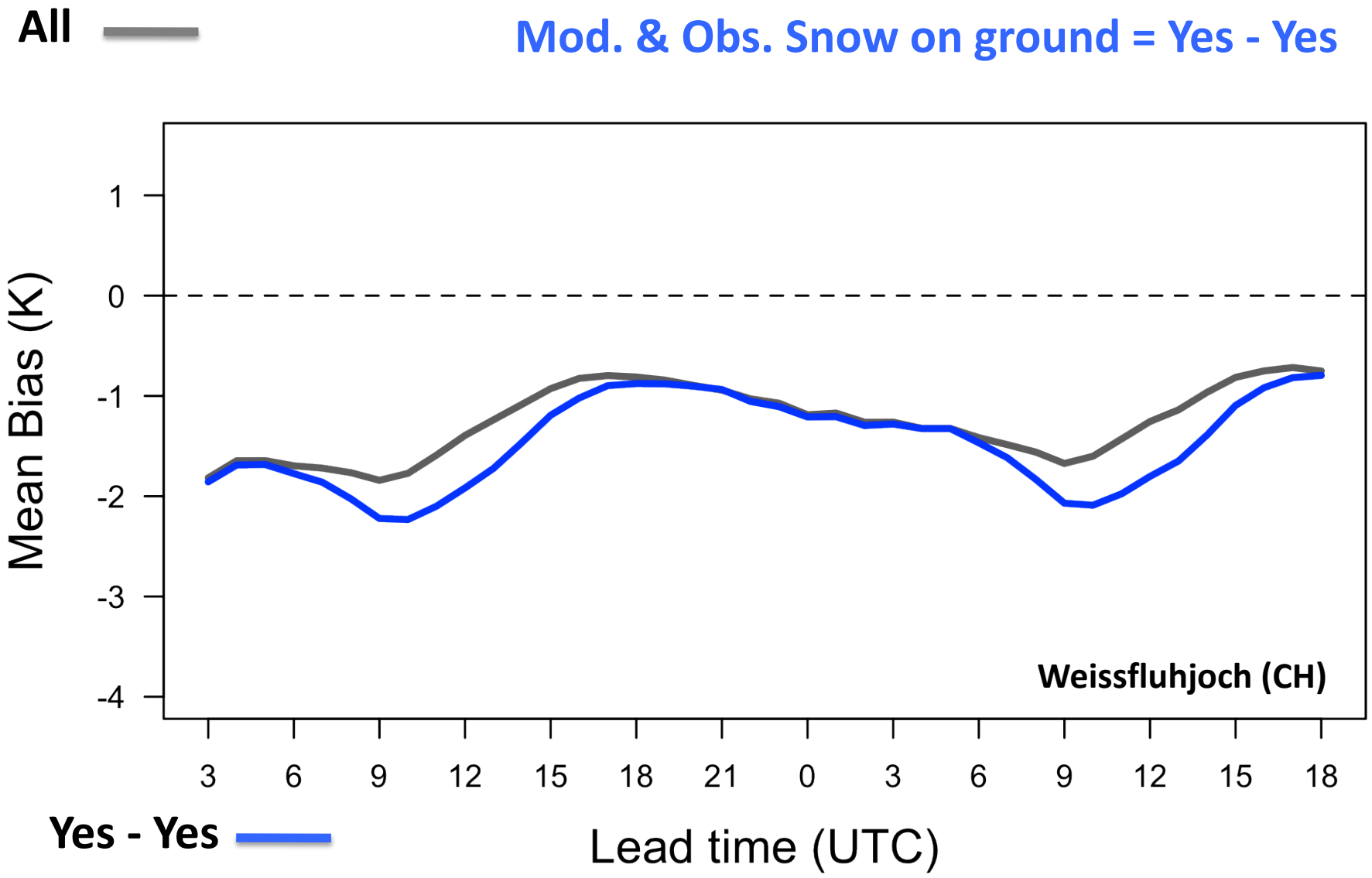

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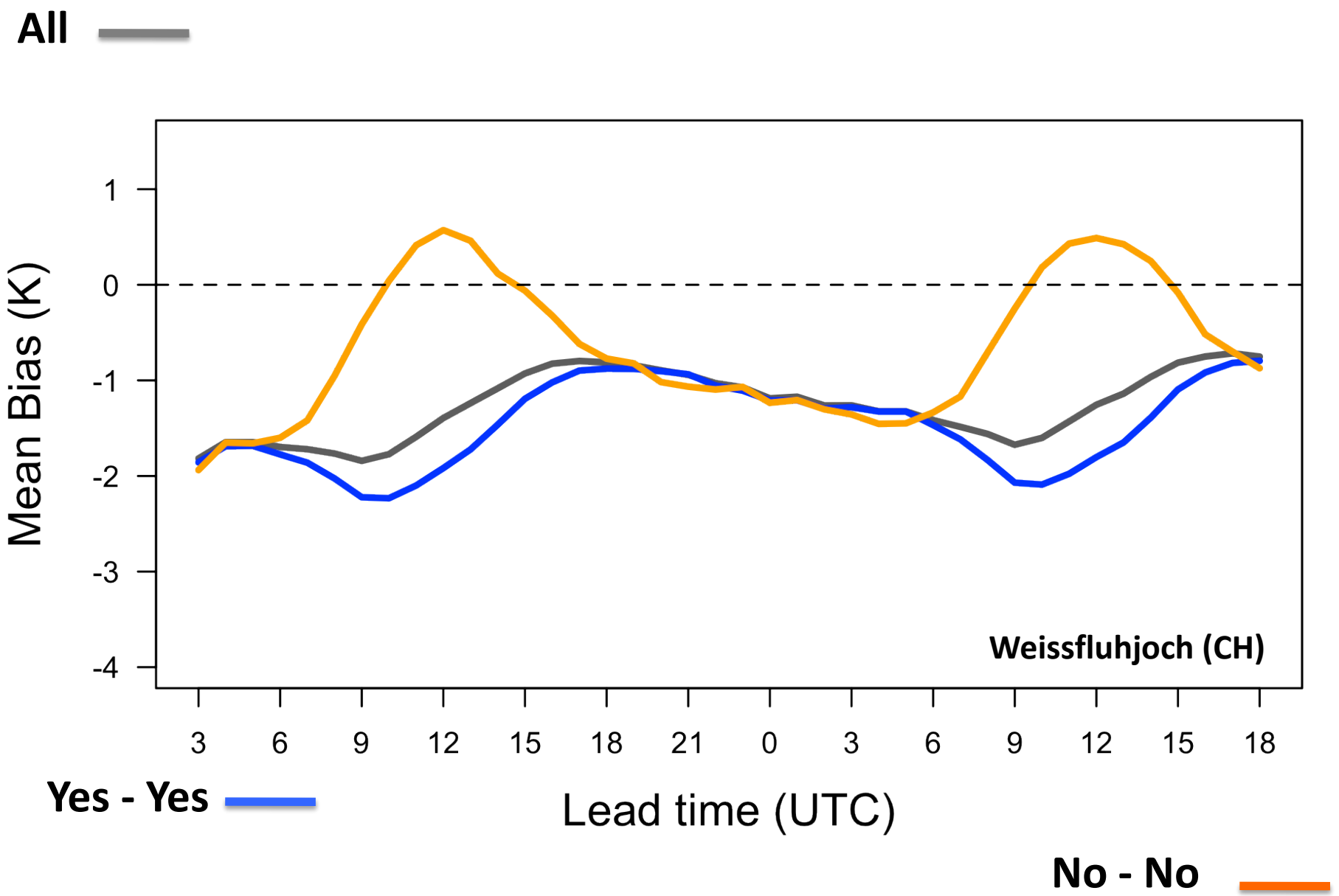

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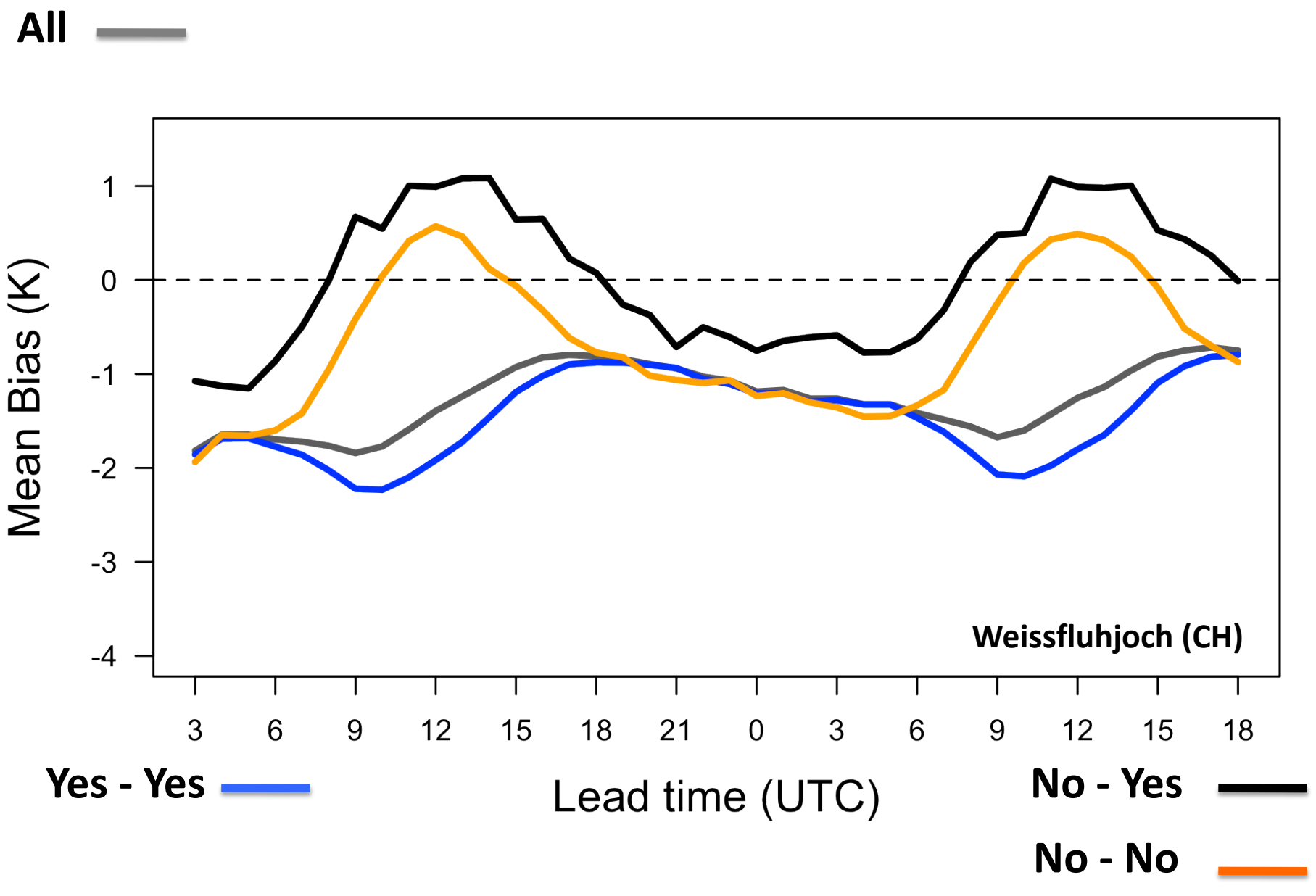

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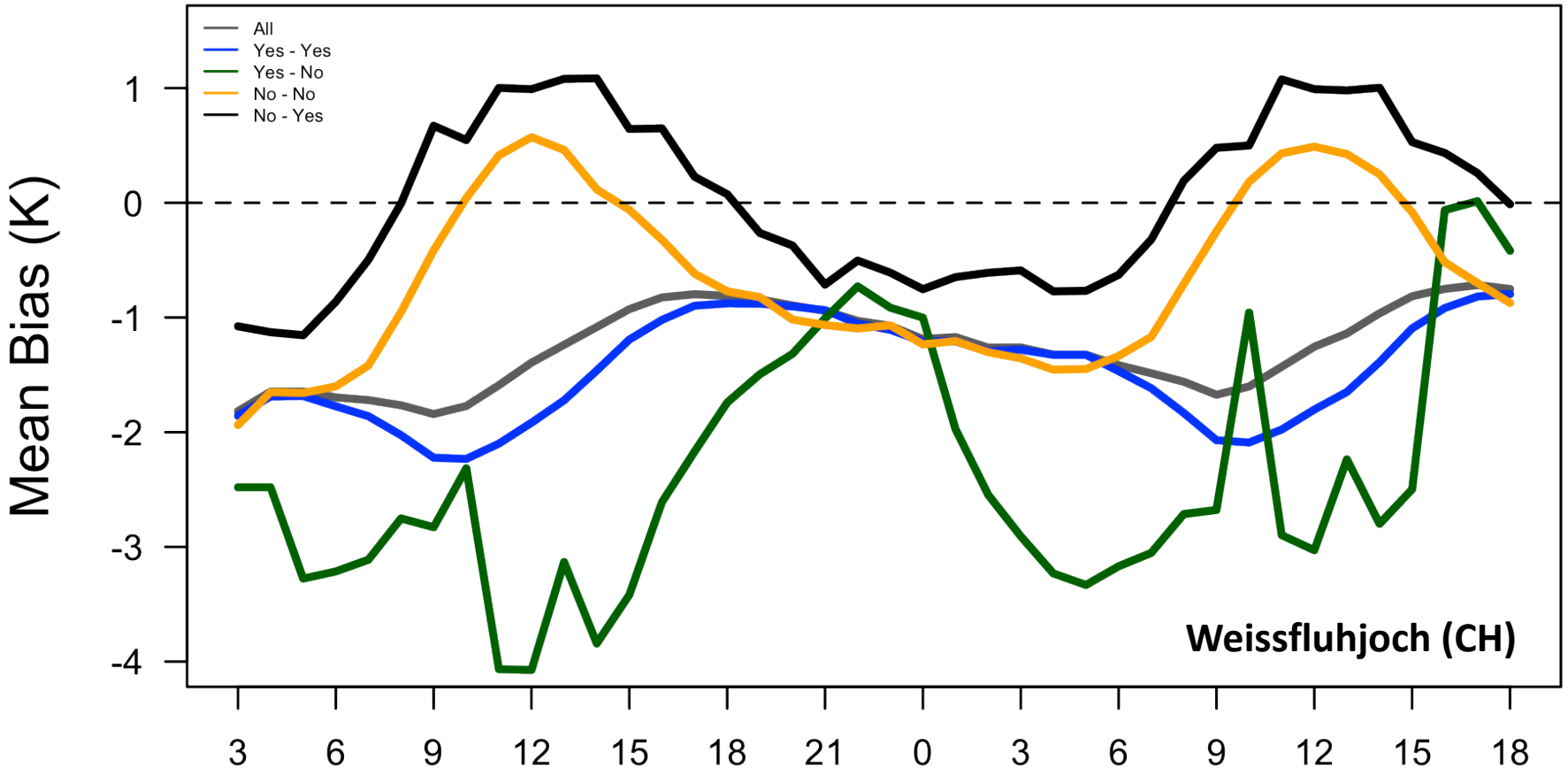


Yes - Yes

Yes - No

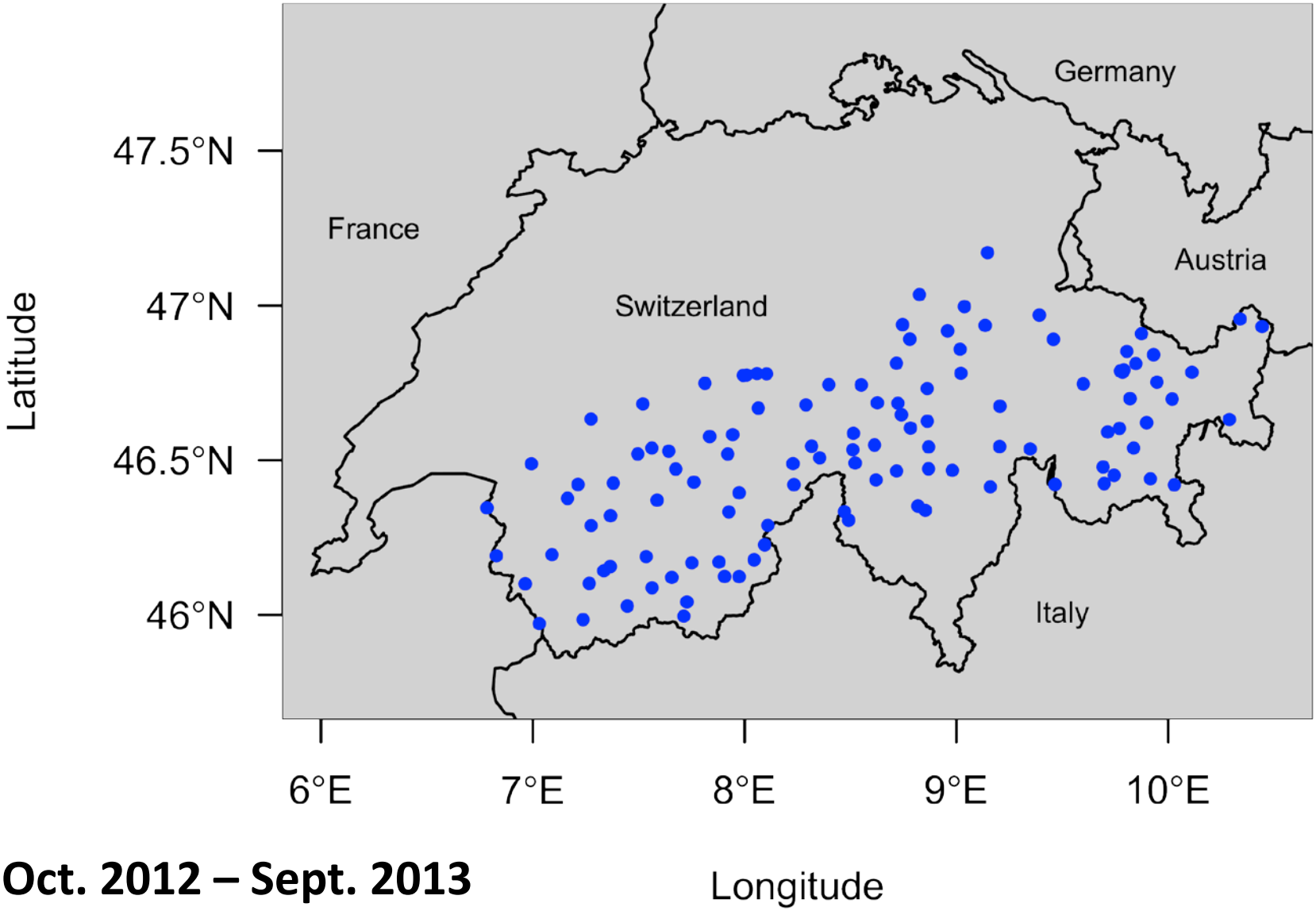
No - Yes

No - No

Intercantonal Measurement and Information System (IMIS)

- **102 IMIS Stations**
- Air temperature **NOT ventilated**
- **Alpine terrain** between **1560 m and 2972 m**

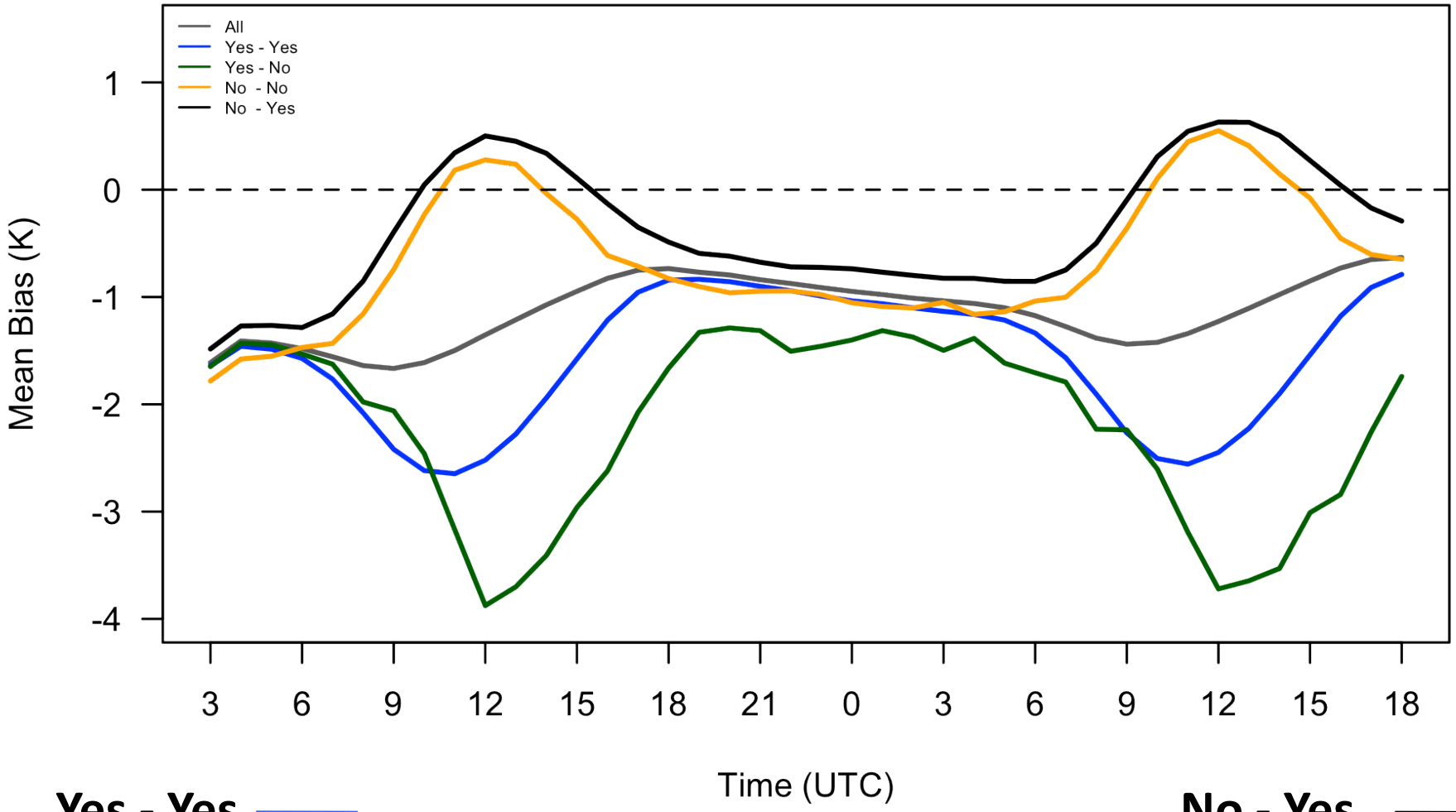
Intercantonal Measurement and Information System (IMIS)



Oct. 2012 – Sept. 2013

Mean Bias of 2 m air temperature (102 IMIS-Stations)

All



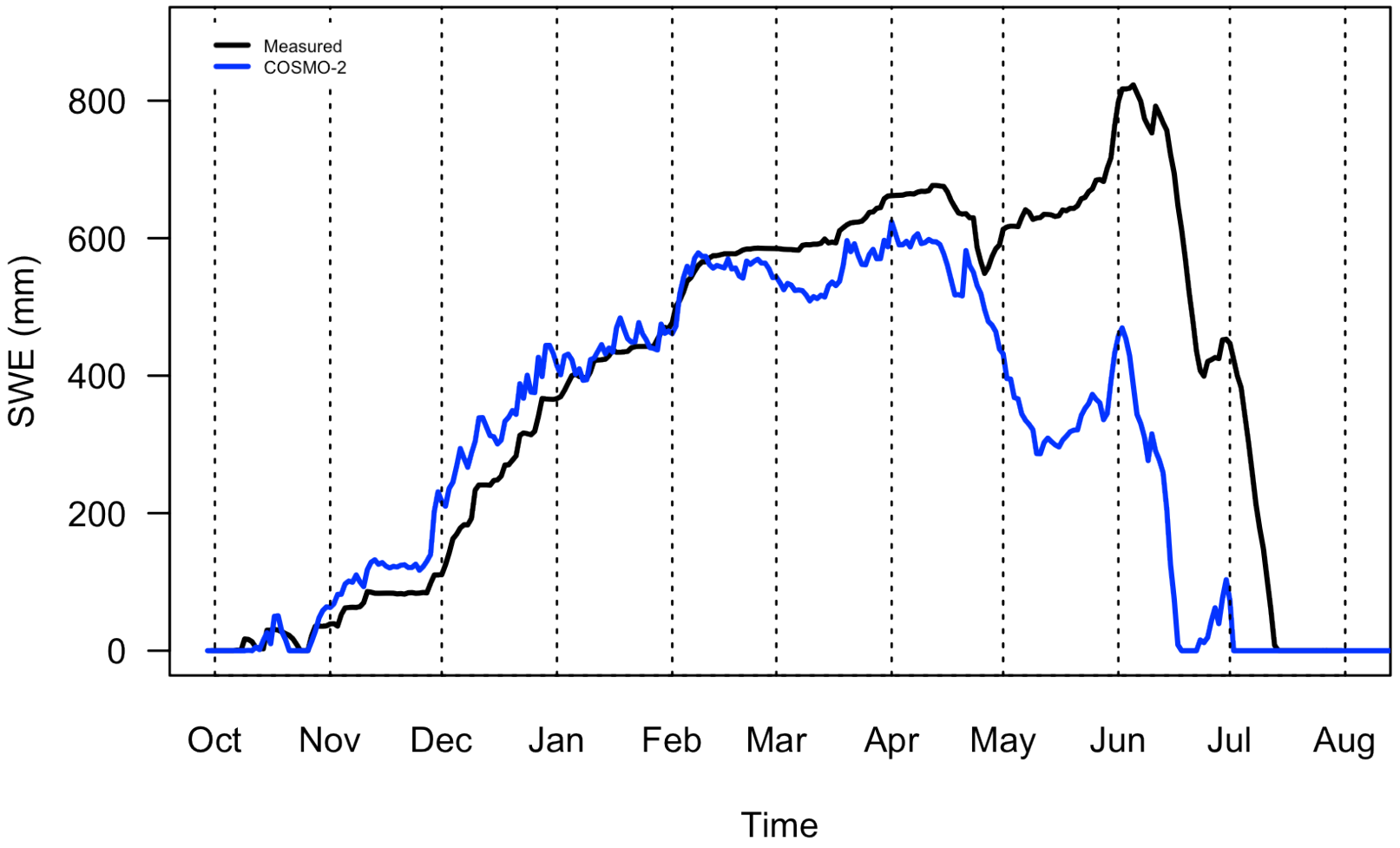
Yes - Yes

Yes - No

No - Yes

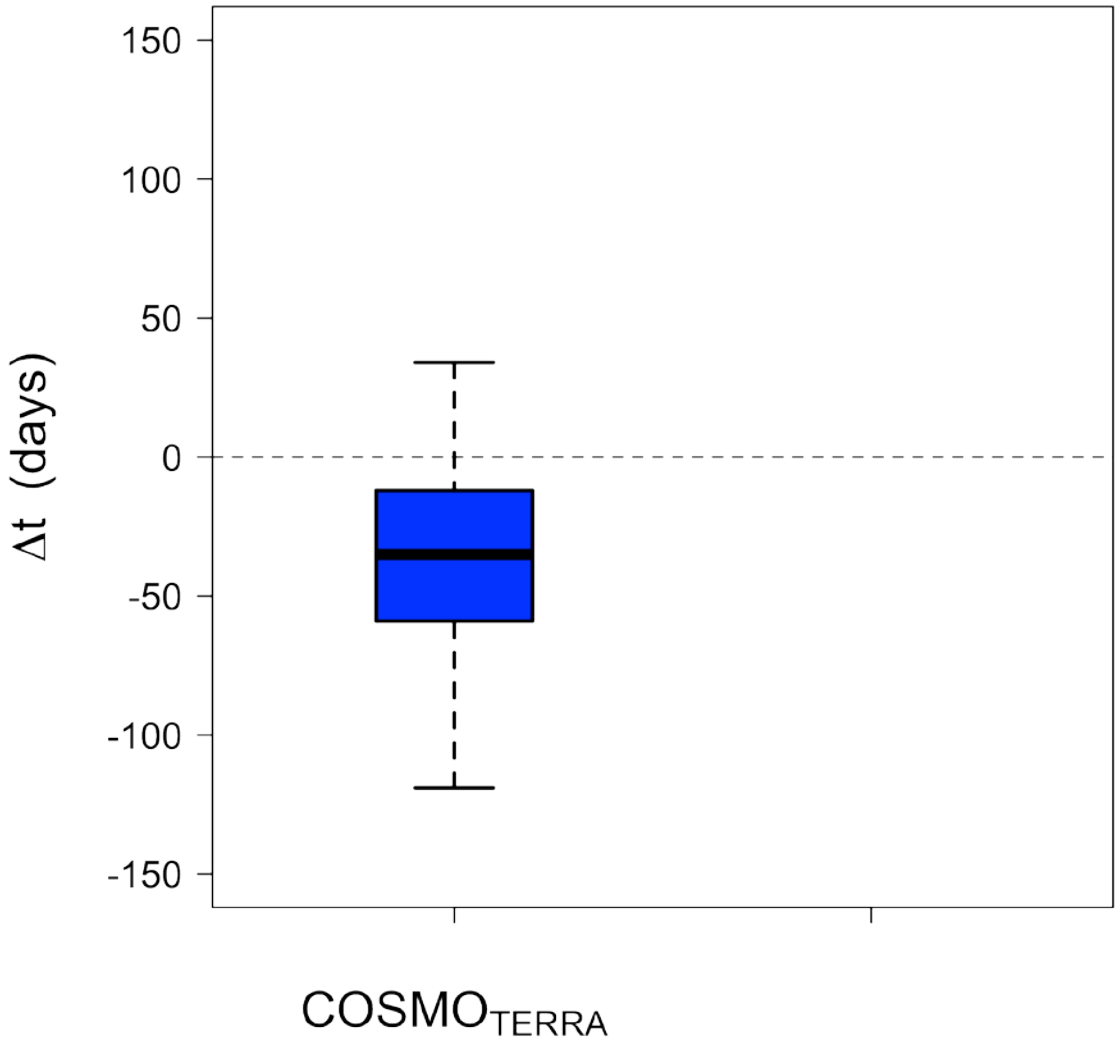
No - No

Snow Water Equivalent (SWE) – Weissfluhjoch (2340 m)



Winter 2012 - 2013

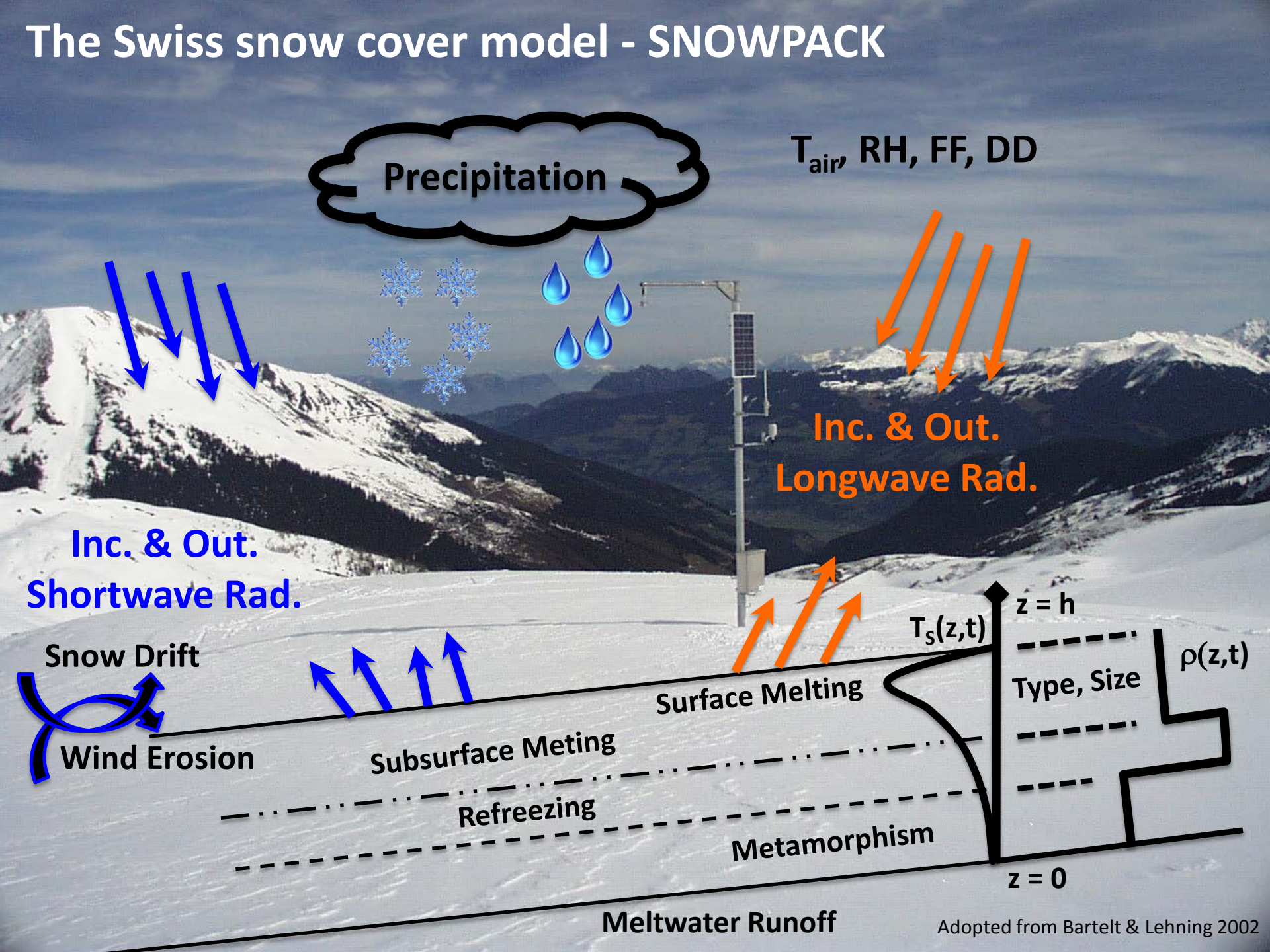
Snow free for the first time - (Model's – IMIS)



Too late

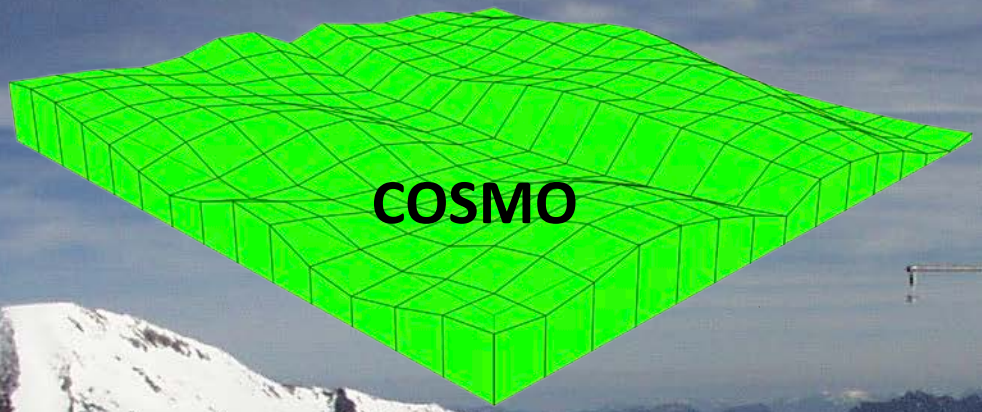
Too early

The Swiss snow cover model - SNOWPACK

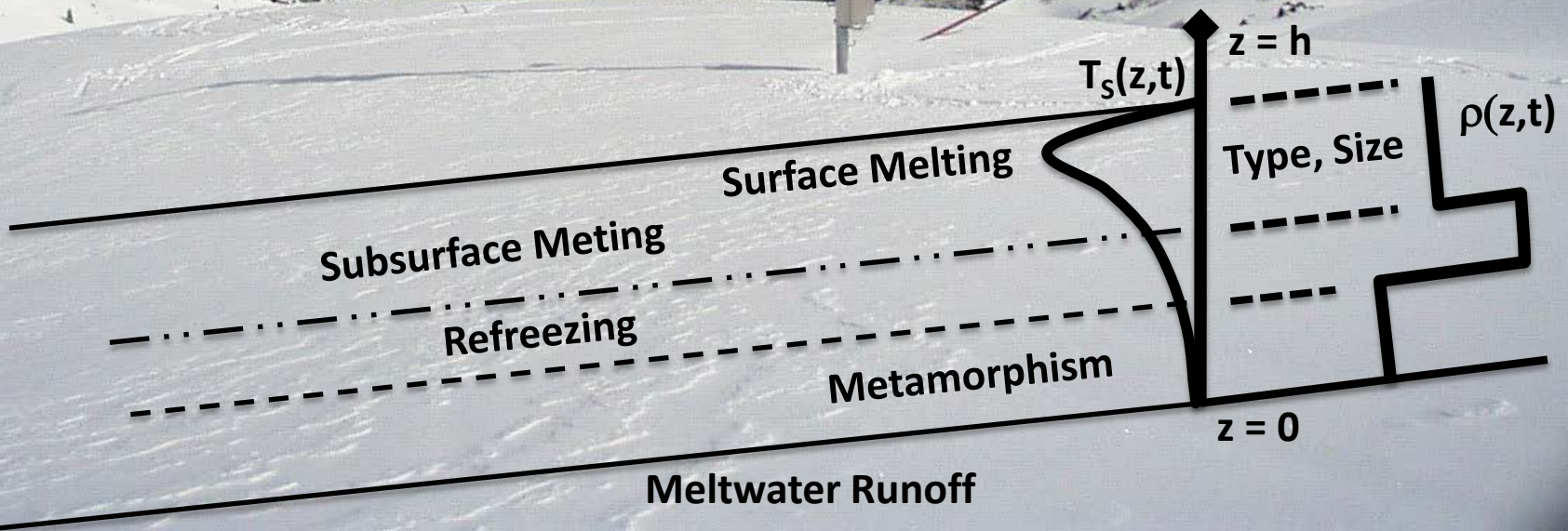


Adopted from Bartelt & Lehning 2002

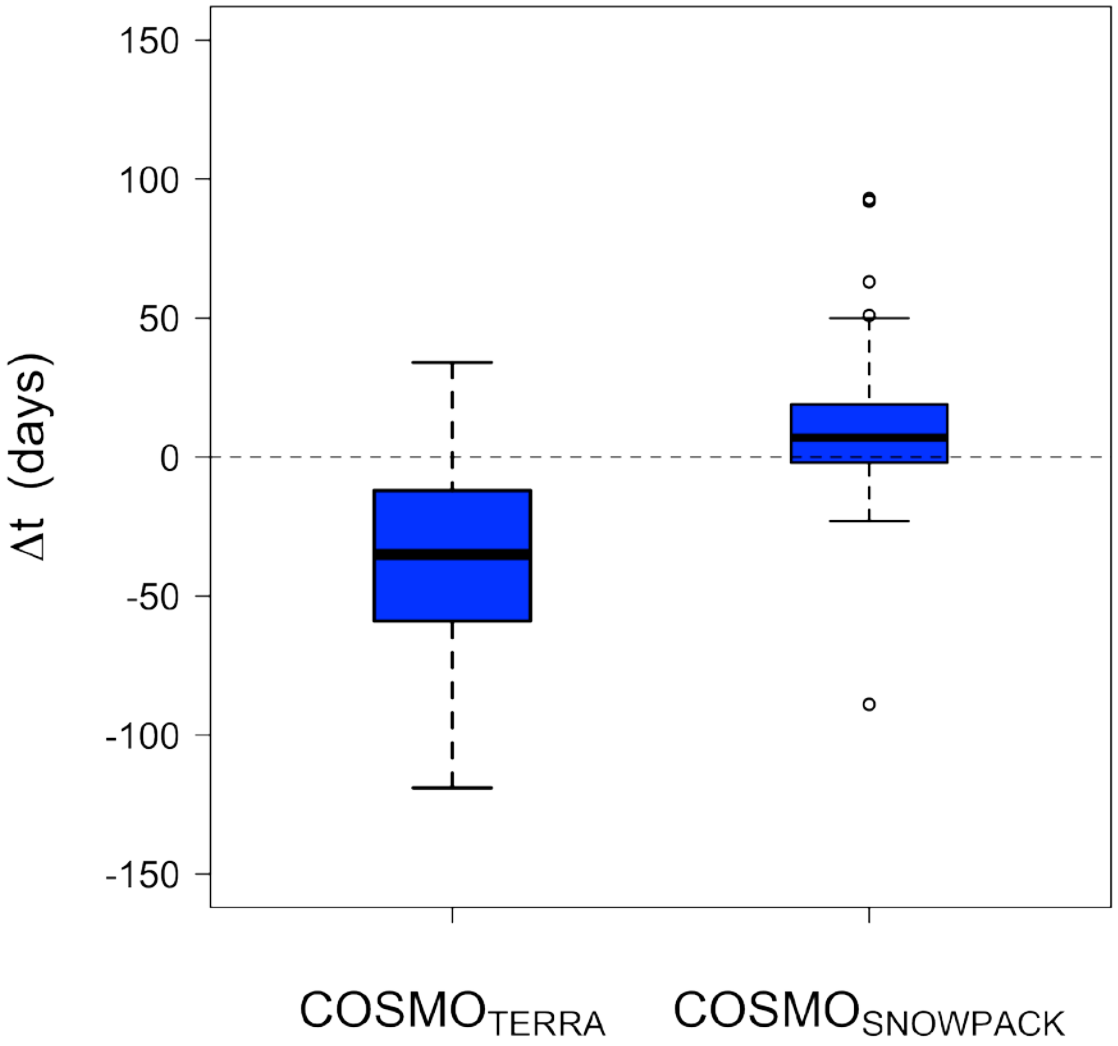
The Swiss snow cover model - SNOWPACK



Used Fields:
TOT_PREC,
T (2 m), RELHUM,
U, V,
GLOB, LW_IN_TG



Snow free for the first time - (Model's – IMIS)



Too late

Too early

Conclusions

Air temperature (2 m)

- Air temperature (2 m) has cold bias during the night.
- During the day amplified cold bias over snow.
- Decreasing cold bias becoming positive during the day without snow.

Snow module (TERRA_ML vs. SNOWPACK)

- COSMO is becoming snow free too early – melting rates.
- Coupled high-resolution model shows better timing – better formulation of snow cover micro-physics.

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Thanks for your attention!
Any questions?

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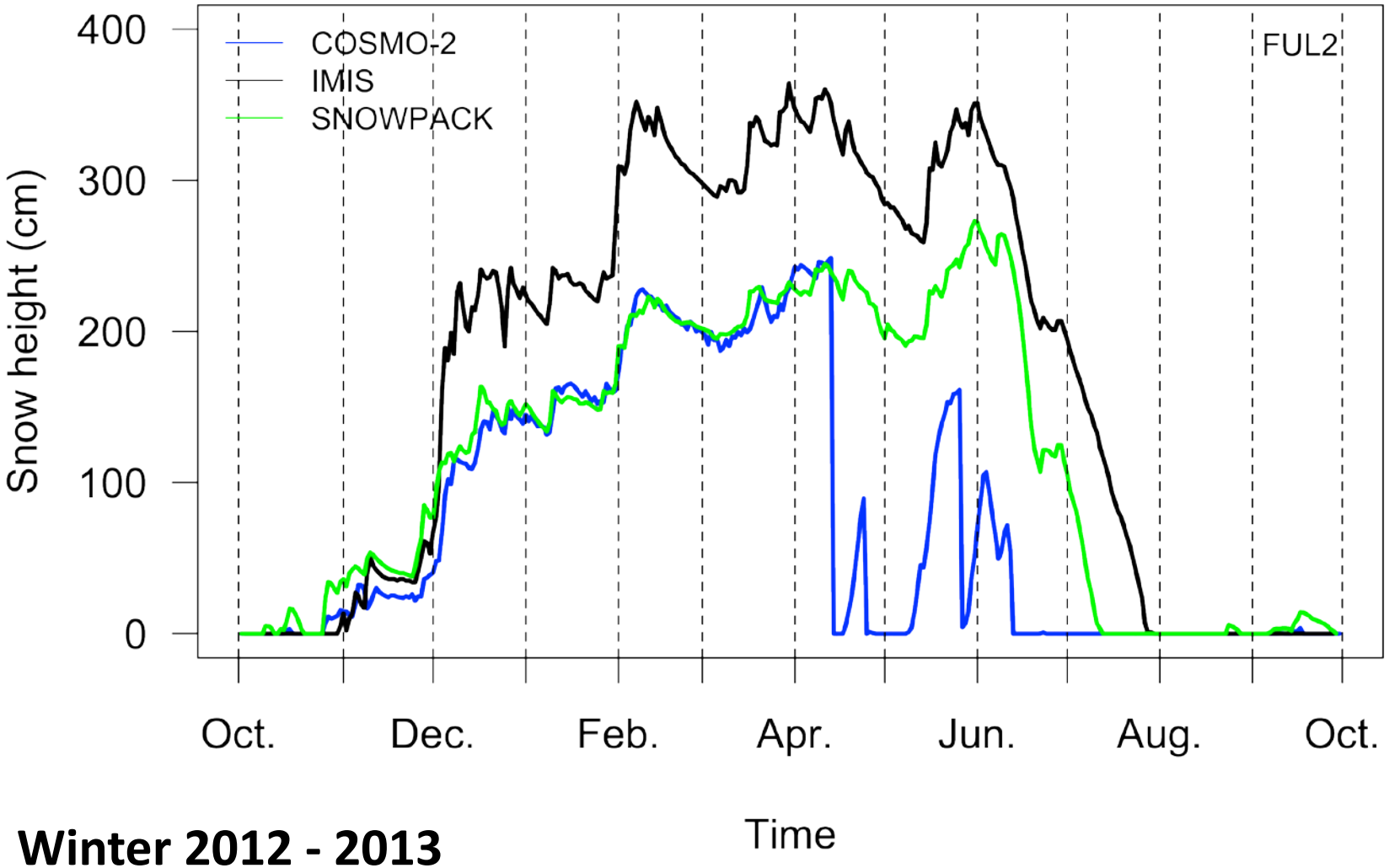
Outlook & Further research (SAINT)

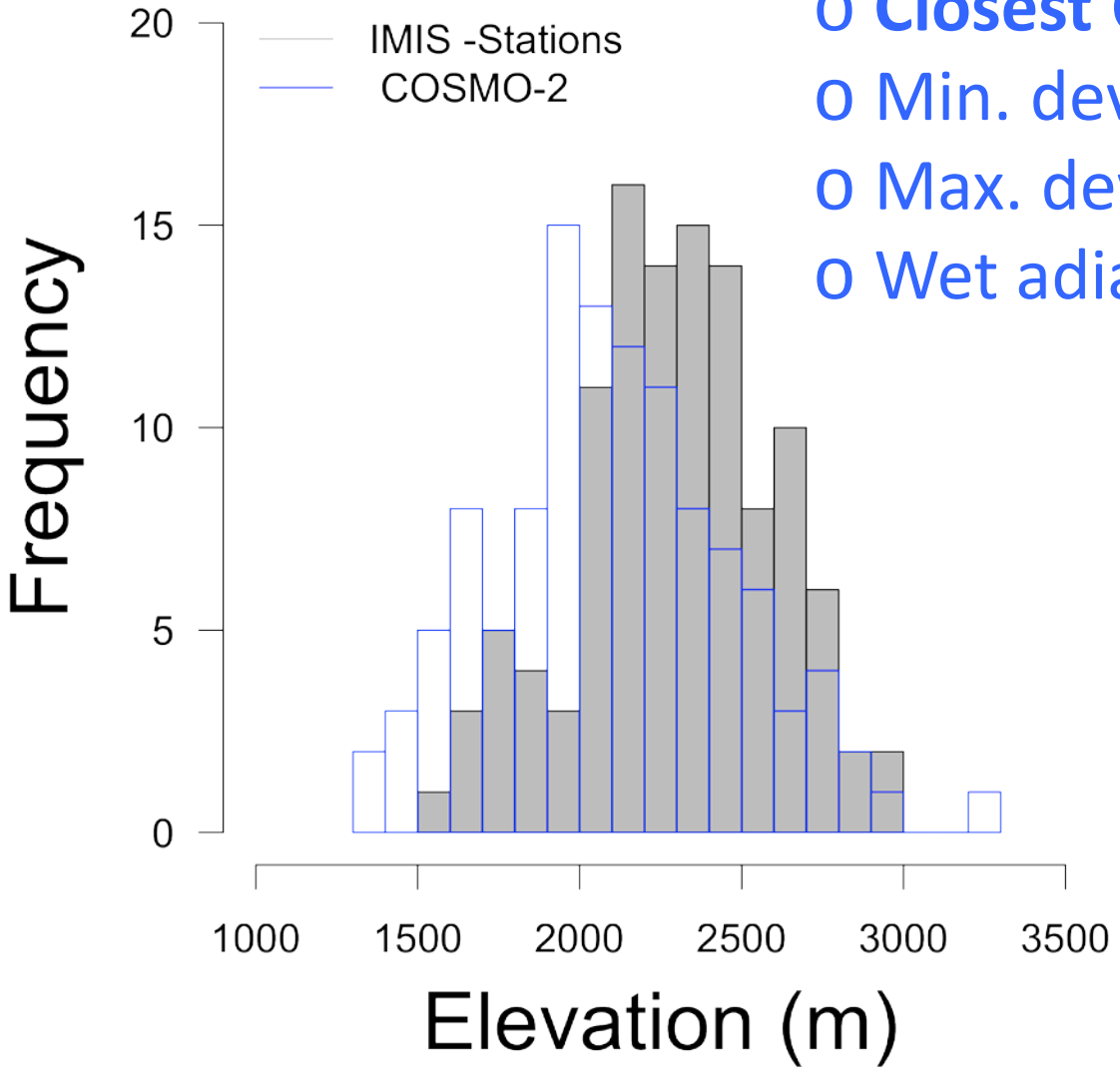
- **Validation of predicted (COSMO-2) surface energy balance over snow covered complex alpine terrain.**
- **Validation of the build in snow module (TERRA_ML)**
- **Assess benefits of higher-resolution snow modules on NWP model performance.**

Snow Height – (Fully – Grand Cor, Switzerland (2340 m)



Winter 2012 - 2013

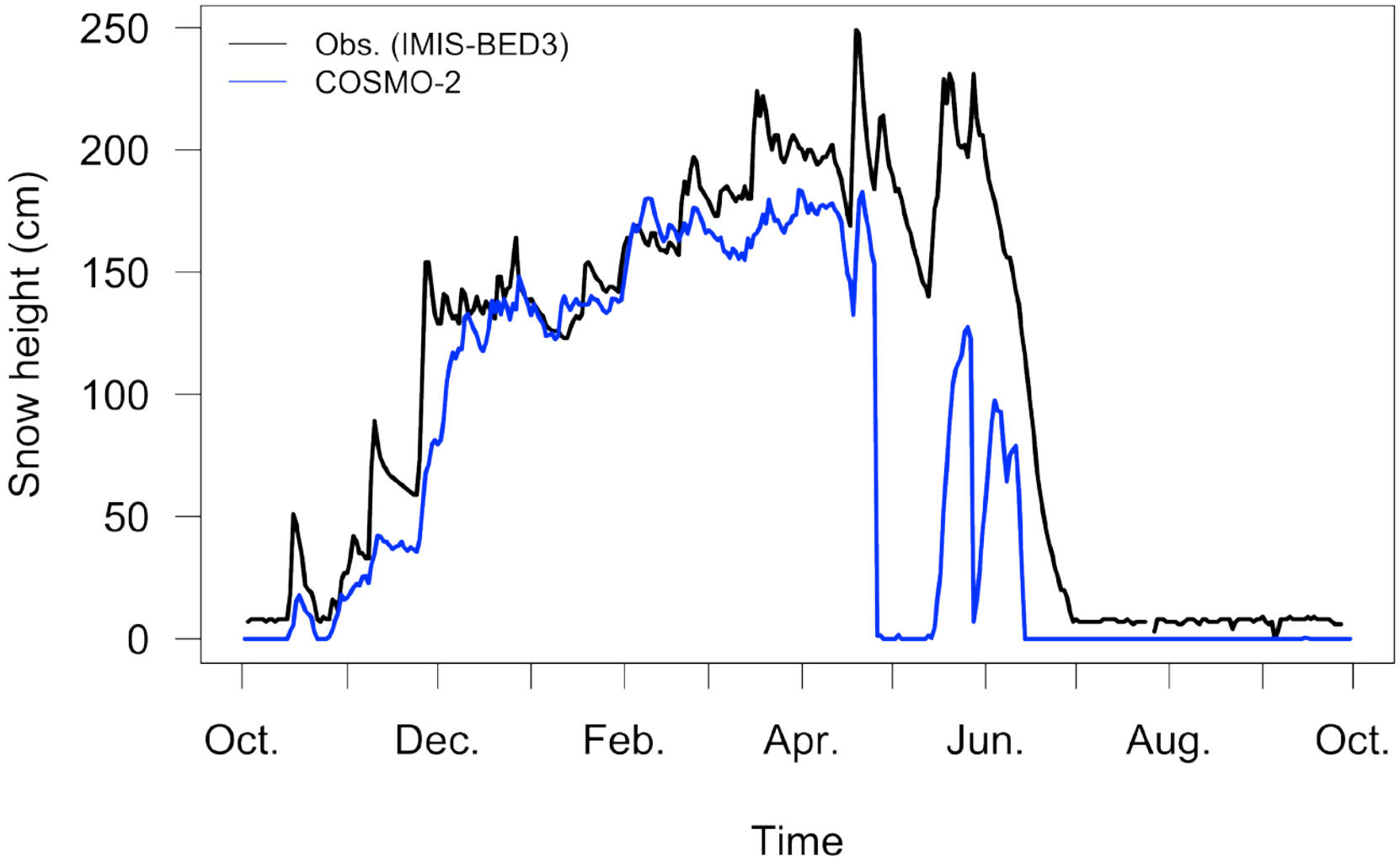
Elevation difference - COSMO-2 vs. IMIS



- **Closest** COSMO-2 **grid point**
- Min. deviation **1 m**
- Max. deviation **728 m**
- Wet adiabatic lapse rate **0.65 °C**

Observed (IMIS) & Modeled (COSMO-2) snow heights

Elevation difference IMIS – COSMO = 75 m



Mean bias ± Standard Deviation – Yes – Yes & No – NO