TEAMx cold-air pool model intercomparison study

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EMS Annual Meeting 2024, Barcelona, Spain

TEAMx model intercomparison studies

Four ongoing **TEAMx model intercomparison studies**

- Thermally driven circulations
- Cold-air pools
- Convection: NWP
- Convection: LES

TEAMx model intercomparison studies

Four ongoing **TEAMx model intercomparison studies**

- Thermally driven circulations
- Cold-air pools
- Convection: NWP
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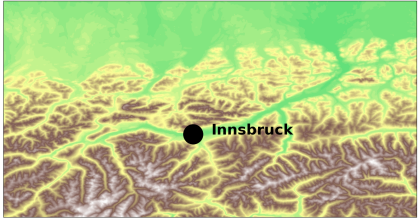
Cold-air pool (CAP) intercomparison study

- CAPs are challenging for NWP
  - inadequate surface-layer parameterizations for high stability
  - small scales require high resolution
- mesoscale simulations
- full life cycle of a CAP
- representation of the strength, depth, and spatial extent of the CAP in the model

Case study

- PIANO field campaign in the Austrian Inn Valley (foehn-CAP interactions, *PI: A. Gohm*)

  e.g., Haid et al. (2022), BLM, doi: 10.1007/s10546-021-00663-9



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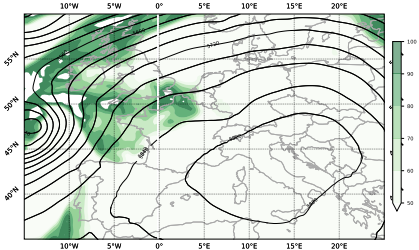
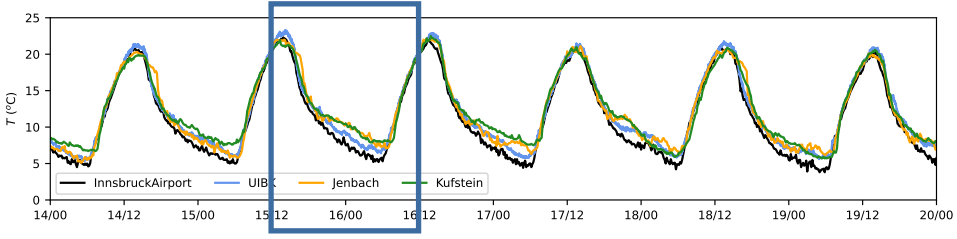
- Night from a period of undisturbed conditions in October 2017

500-hPa geopotential height and RH





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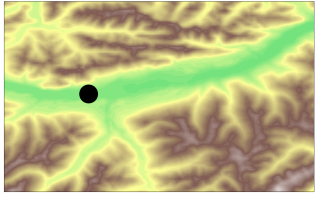
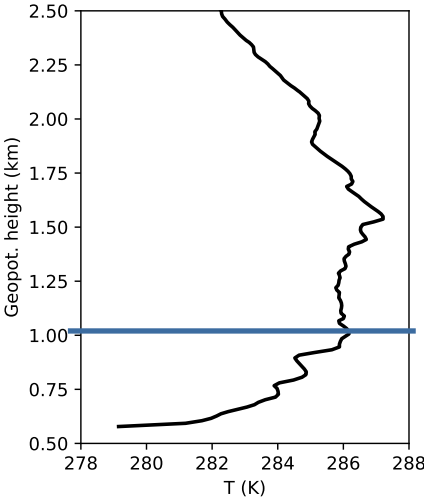
  e.g., Haid et al. (2022), BLM, doi: 10.1007/s10546-021-00663-9
- Night from a period of undisturbed conditions in October 2017
- Approx. 500-m deep inversion at 0300 UTC



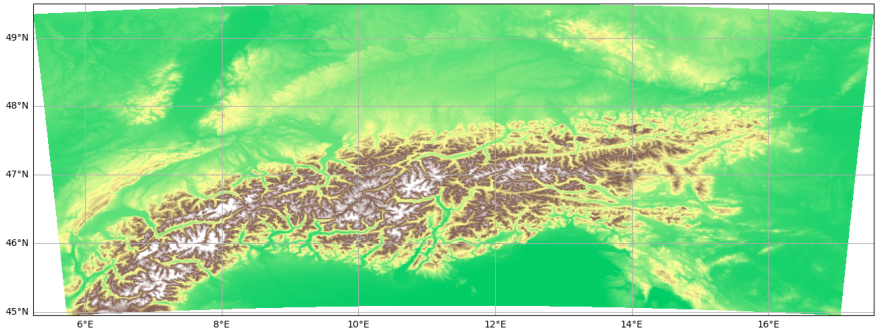


Participating models/groups

Model	Group	Presentation
AROME	GeoSphere Austria	x
AROME	Météo-France	
ICON	Goethe Universität Frankfurt	x
Meso-NH	Météo-France	
UM	Met Office	x
WRF	University of Innsbruck	x
WRF	Université Grenoble Alpes	

Model setup

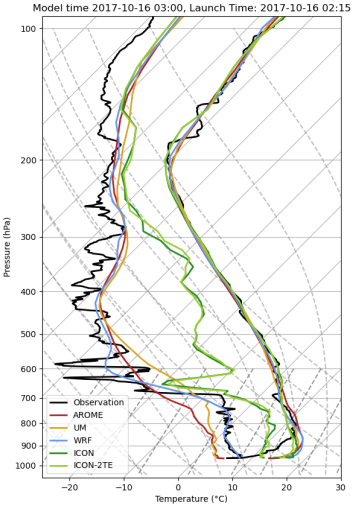
- 24-h simulation starting at 12 UTC
- 1-km horizontal grid spacing

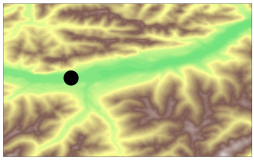


Example:

UM

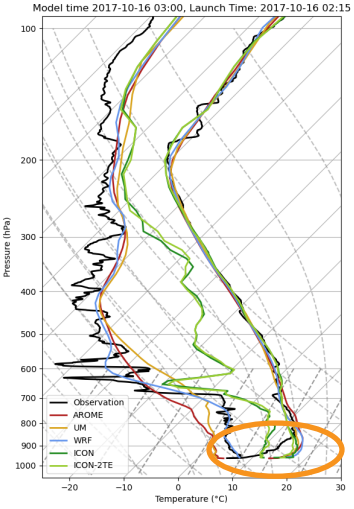
Temperature profiles at Innsbruck

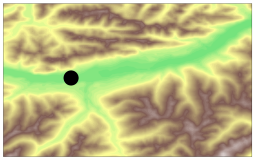




- Radiosounding at Innsbruck (03 UTC)
- All models are too warm in the lowest layer.
- Dew point temperature varies more strongly than temperature.

Temperature profiles at Innsbruck





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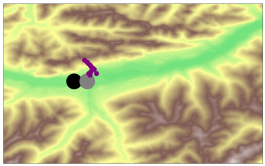
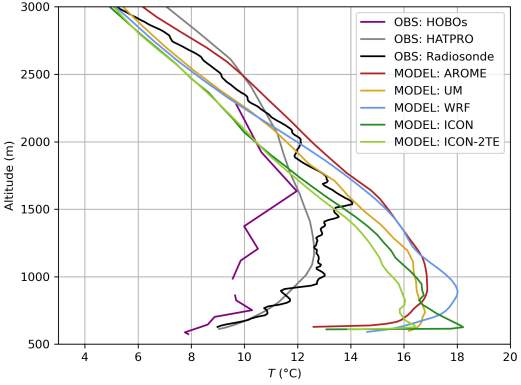
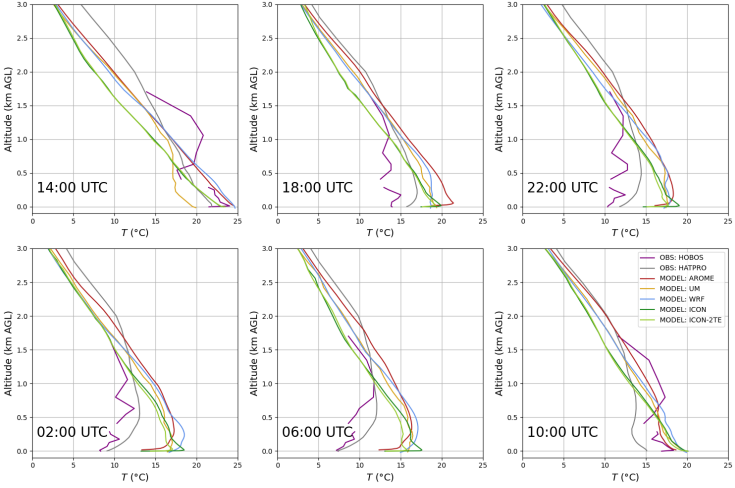




- Continuous (pseudo-)vertical profiles from
  - a microwave T/RH profiler (HATPRO)
  - a line of temperature sensors running up the north valley sidewall (HOBOs)

Temperature profiles at Innsbruck

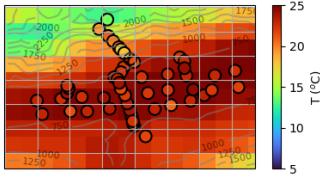


- Daytime profiles agree well with observations.
- Nighttime inversion is too shallow.
- Temperatures remain too warm throughout the night.

Near-surface temperature field

Afternoon (14 UTC)

AROME



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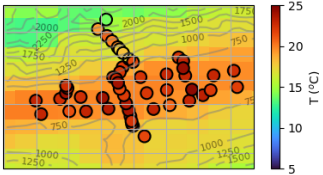
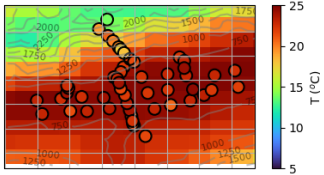


WRF



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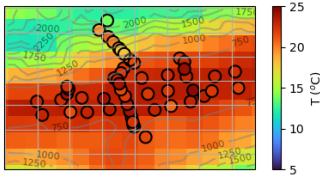
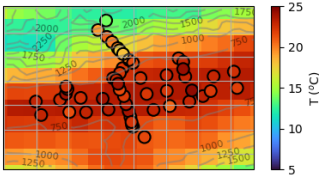


ICON-2TE



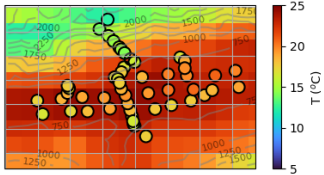
HOBO obs

Models agree with observations before sunset.

Near-surface temperature field

Evening (16 UTC)

AROME



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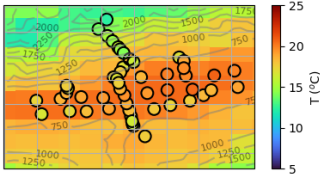

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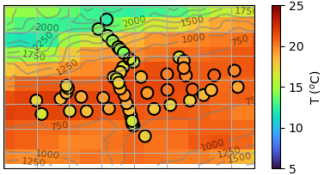

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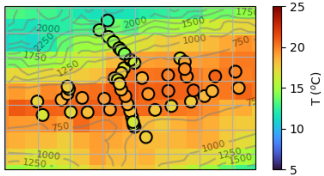

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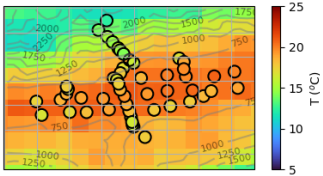


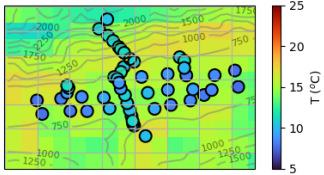
HOBO obs

Evening cooling too weak.

Near-surface temperature field

Night (00 UTC)

AROME



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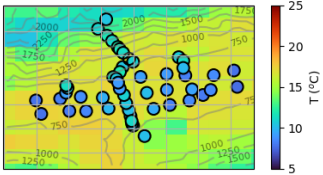

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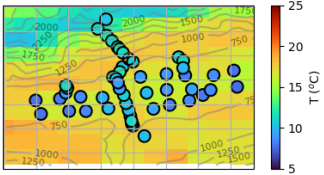

HOBO obs

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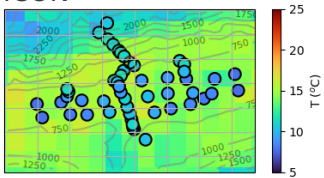

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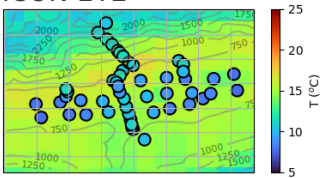
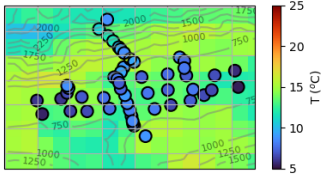


- All models too warm during nighttime.

Near-surface temperature field

Early morning (06 UTC)

AROME



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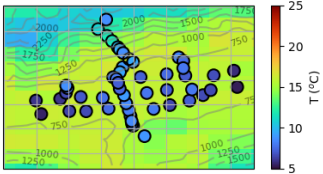

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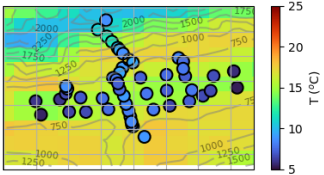
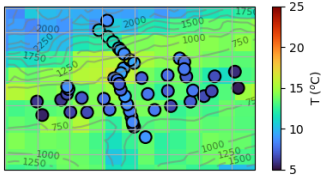


HOBO obs

ICON



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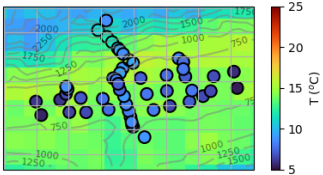
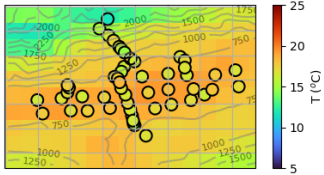


All models too warm during nighttime.

Near-surface temperature field

Late morning (10 UTC)

AROME



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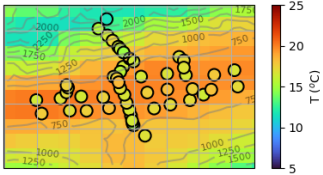

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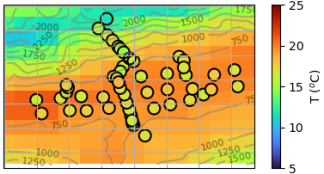
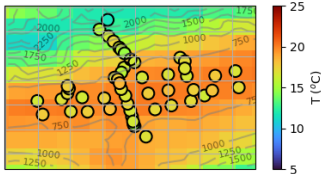


HOBO obs

ICON



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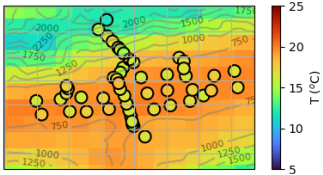
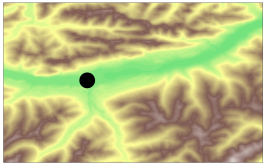
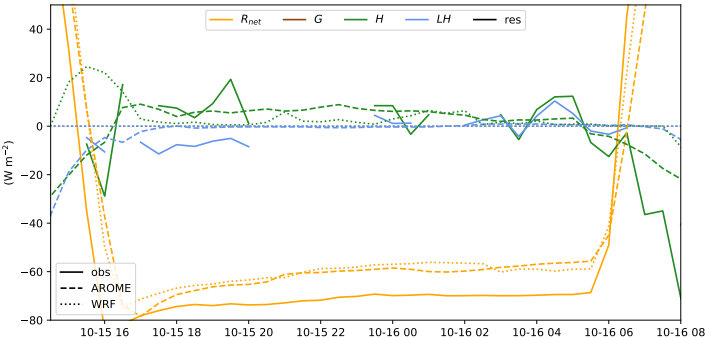


Models agree again with observations after sunrise.

Surface-energy budget (SEB)

Innsbruck

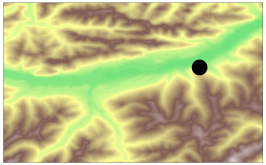


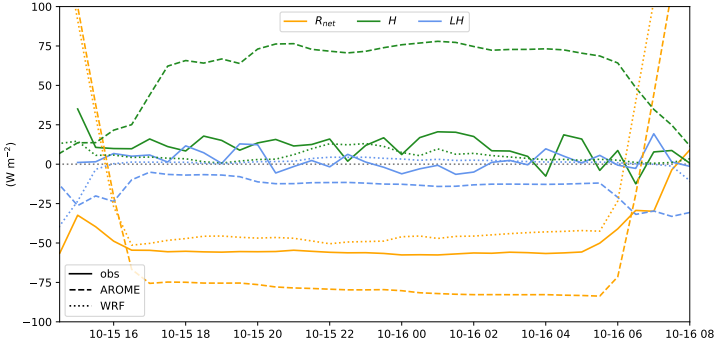


- Models capture the magnitudes of the SEB components.
- Net radiation slightly underestimated in the CAP.

Surface-energy budget (SEB)

Example: steep grass-covered slope

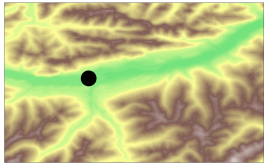




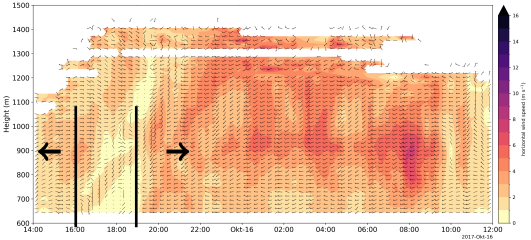
- Agreement between models and observations depends on the location.

Wind profiles

Valley atmosphere



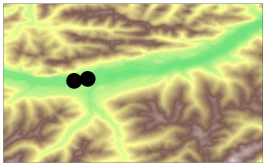
Wind lidar at Innsbruck



- Thermally driven valley-wind circulation
- Jet maximum at approx. 300 m AGL
- Transition from up-valley to down-valley between 16 and 19 UTC

Wind profiles

Valley atmosphere



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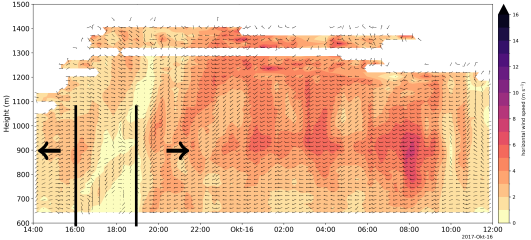
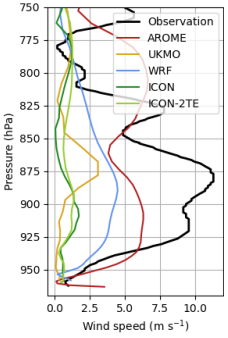
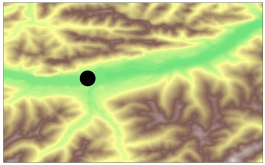


Radiosounding (03 UTC)

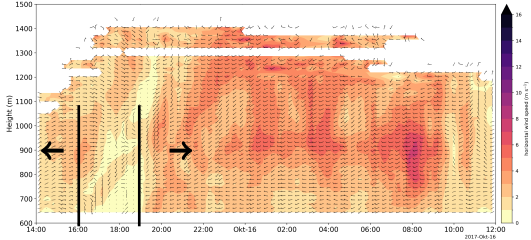


Wind profiles

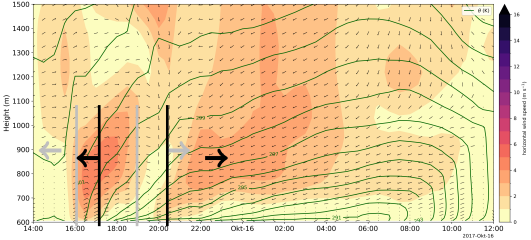
Valley atmosphere



Wind lidar at Innsbruck



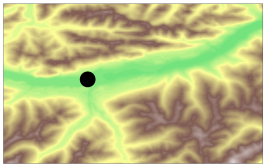
AROME



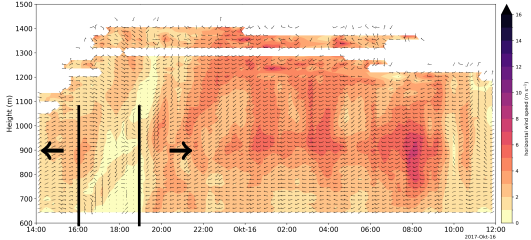
- Down-valley winds too weak
- Transition too late

Wind profiles

Valley atmosphere

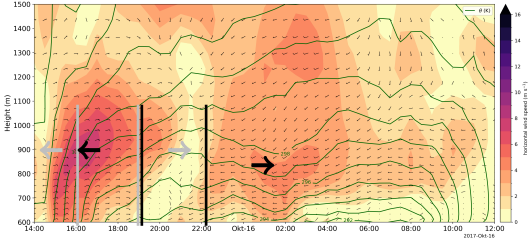


Wind lidar at Innsbruck



- Down-valley winds too weak

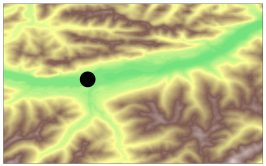
WRF



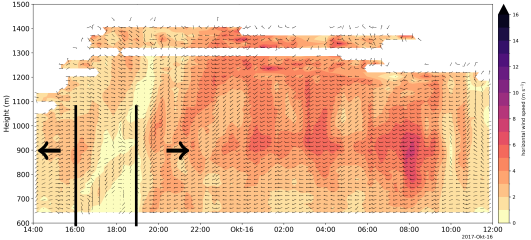
- Transition too late

Wind profiles

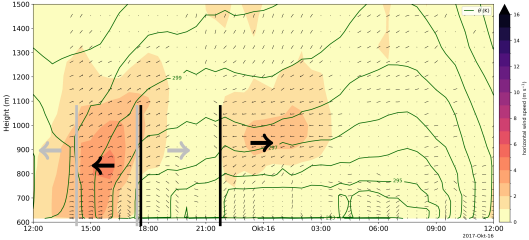
Valley atmosphere



Wind lidar at Innsbruck



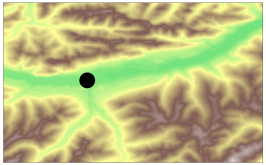
ICON

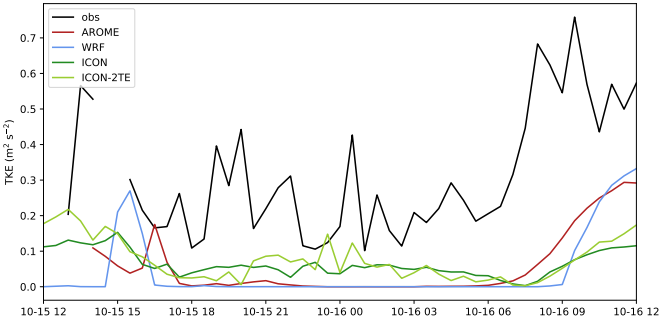


- Down-valley winds too weak
- Transition too late

TKE

Innsbruck

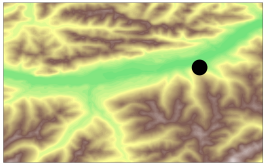


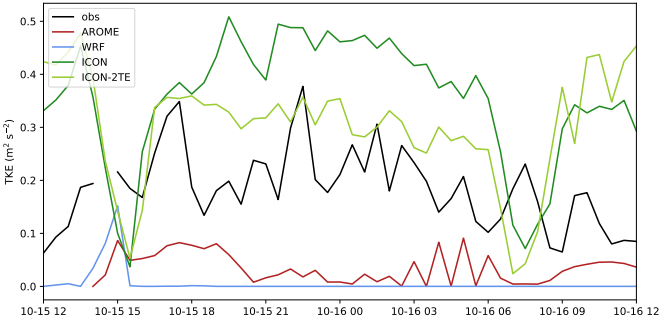


- Approx. 35-m high building
- Models underestimate TKE

TKE

Example: steep grass-covered slope





- Site above the CAP
- ICON captures TKE well
- Varying performance of models at different locations

Summary and first conclusions

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- Comparison of 4 models (5 simulations)

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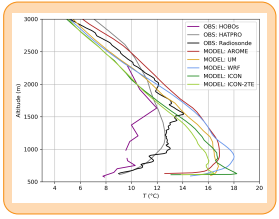

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- underestimate the depth of the CAP

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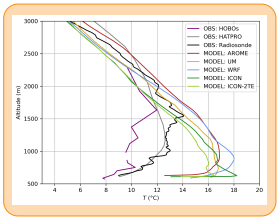

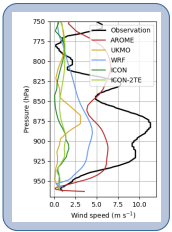

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- vary in wind speed and atm. humidity
- underestimate TKE in the CAP