

TEAMx



The TEAMx Observational Campaign—First findings from the winter campaign

Manuela Lehner, Mathias W. Rotach, Ivana Stiperski, Lena Pfister, Alexander Gohm, Christophe Brun, Jutta Vüllers, Jan Cermak, Andrew Orr, Ian Renfrew, Helen F. Dacre, Charles Chemel

EGU General Assembly 2025 (Session AS1.38—Mountain Weather and Climate), Vienna, Austria

TEAMX

Multi-scale transport and exchange processes in the atmosphere over mountains—programme and experiment

TEAMX

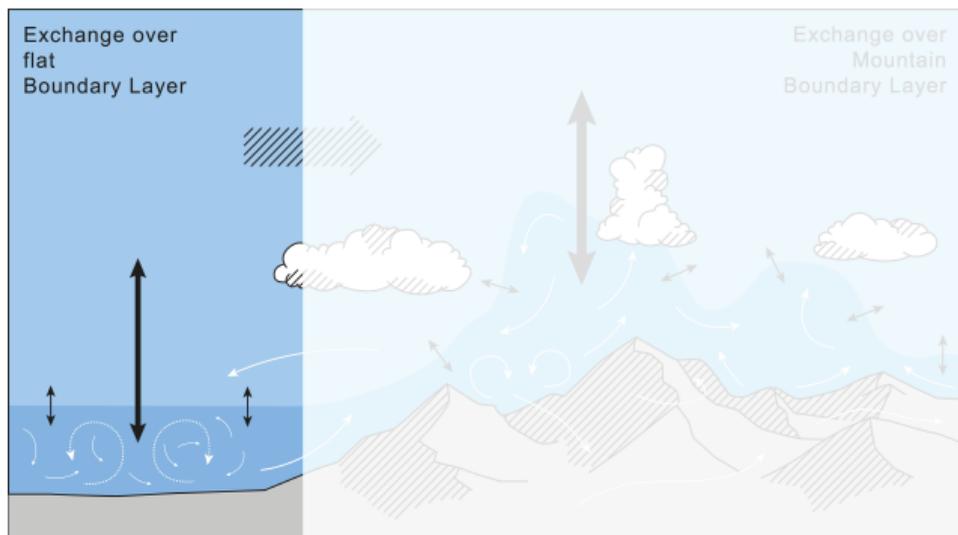
Multi-scale transport and exchange processes in the atmosphere over mountains—programme and experiment

... 42 signatories of the Memorandum of Understanding

... endorsed by 

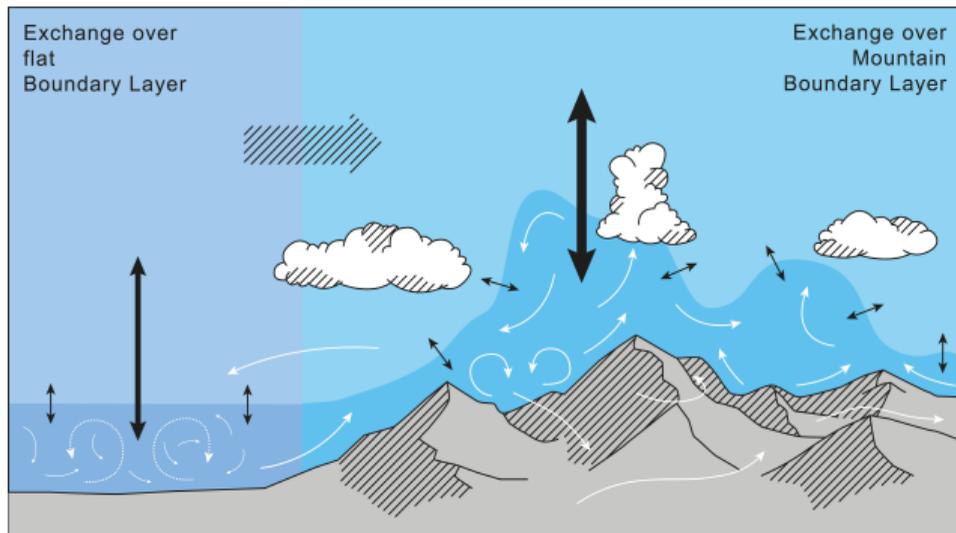
... a cross-cutting project of the  Hydroclimate Panel

Mountain Boundary Layer (MoBL)



- ▲ Horizontally homogeneous conditions
- ▲ Exchange due to vertical turbulent transport
- ▲ Turbulence parameterizations based on observations for flat and homogeneous terrain

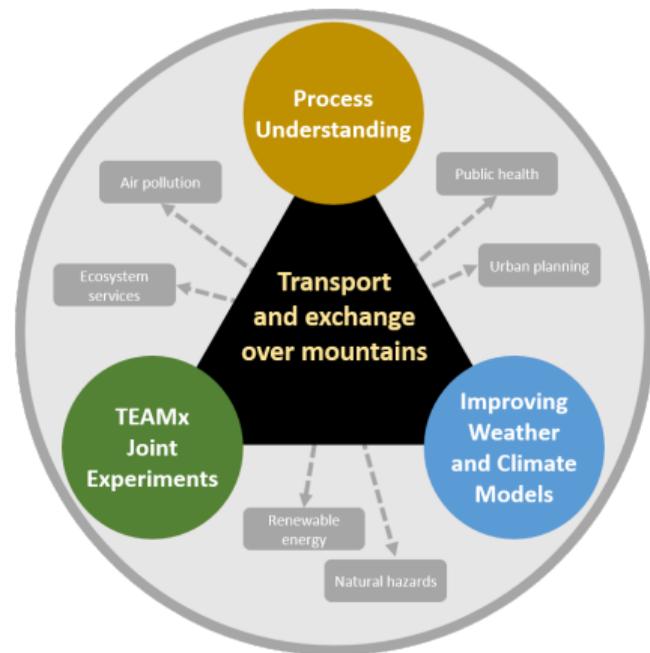
Mountain Boundary Layer (MoBL)



- ▲ Wide range of scales
- ▲ Process interact
- ▲ 3D spatial variability
- ▲ Processes that are difficult to measure/model
- ▲ Questionable applicability of measurement/modeling techniques

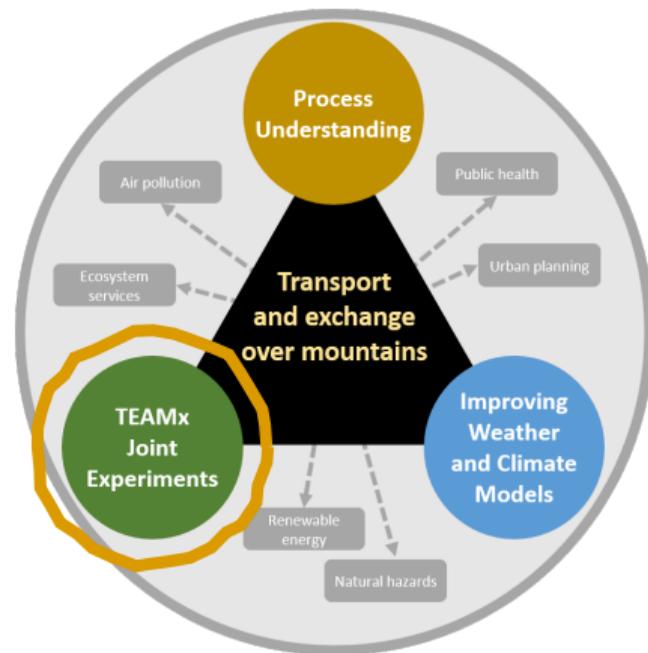
TEAMx Goals

- ▲ Improving our understanding of transport and exchange processes between the surface and the atmosphere and within the atmosphere
- ▲ Evaluating and improving weather and climate models over complex terrain
- ▲ Collecting a unique dataset to study the transport and exchange processes
- ▲ Reducing errors in impact models

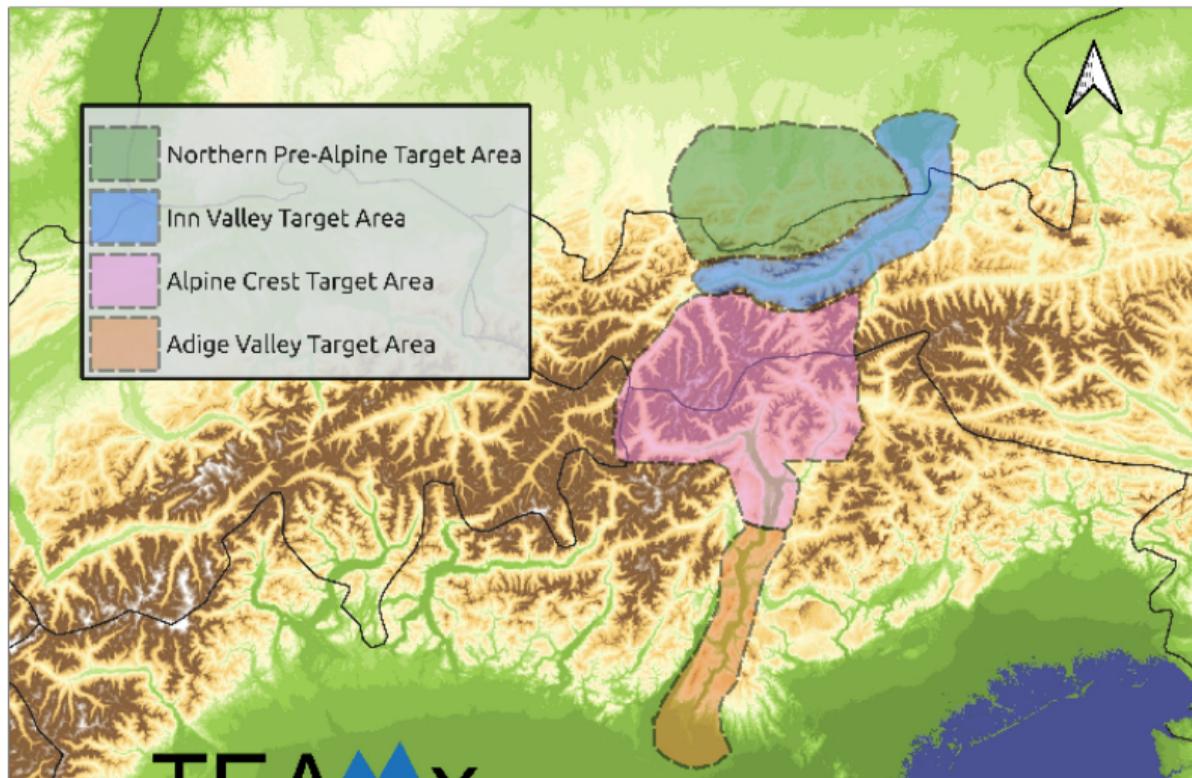


TEAMx Goals

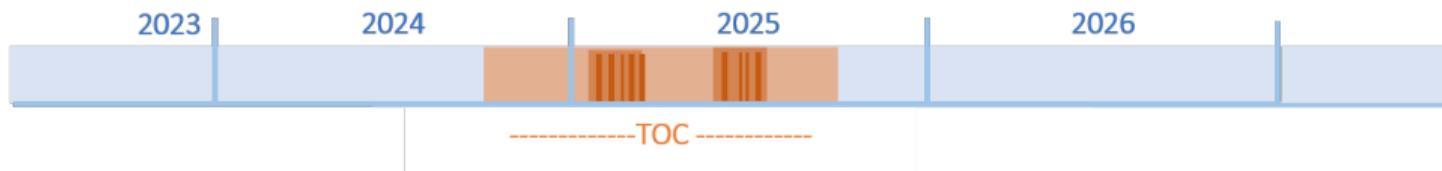
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TEAMx Observational Campaign (TOC)



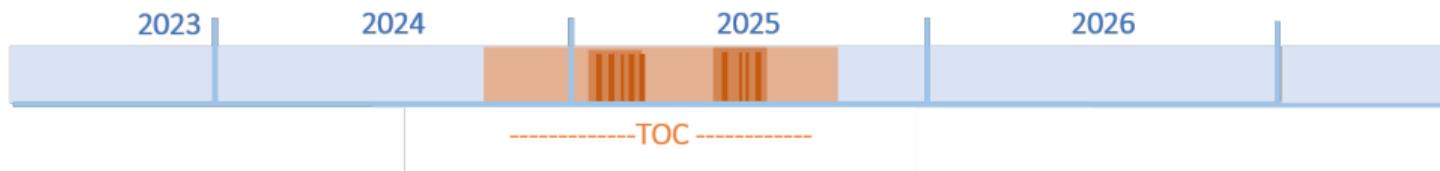
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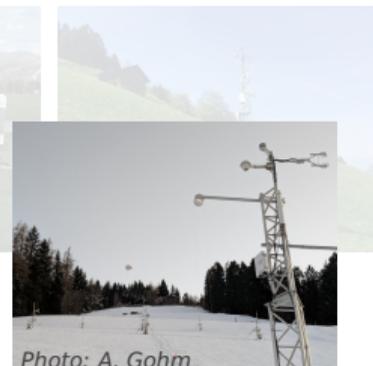
▲ One-year long TOC



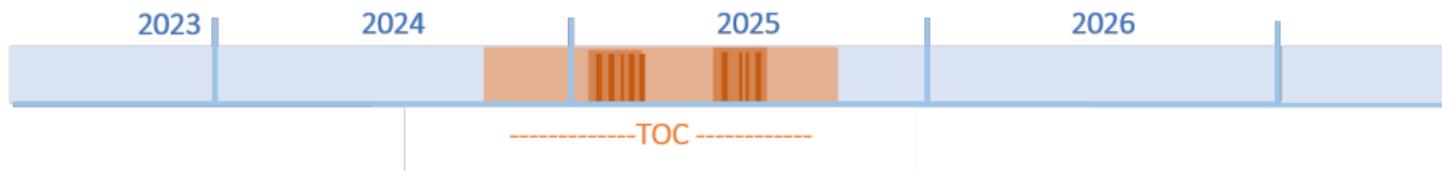
TEAMx Observational Campaign (TOC)



- ▲ One-year long TOC
- ▲ Winter EOP (wEOP): 20 Jan–28 Feb
- ▲ Summer EOP (sEOP): 16 Jun–25 Jul



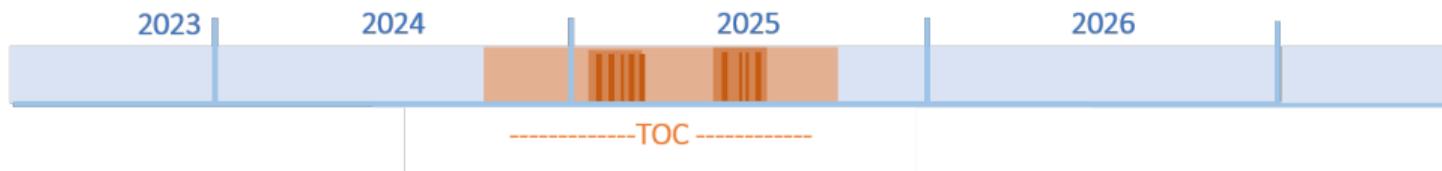
TEAMx Observational Campaign (TOC)



- ▲ One-year long TOC
- ▲ Winter EOP (wEOP): 20 Jan–28 Feb
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- ▲ IOPs targeting specific weather conditions



TEAMx Observational Campaign (TOC)



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Photo: G. Nitti

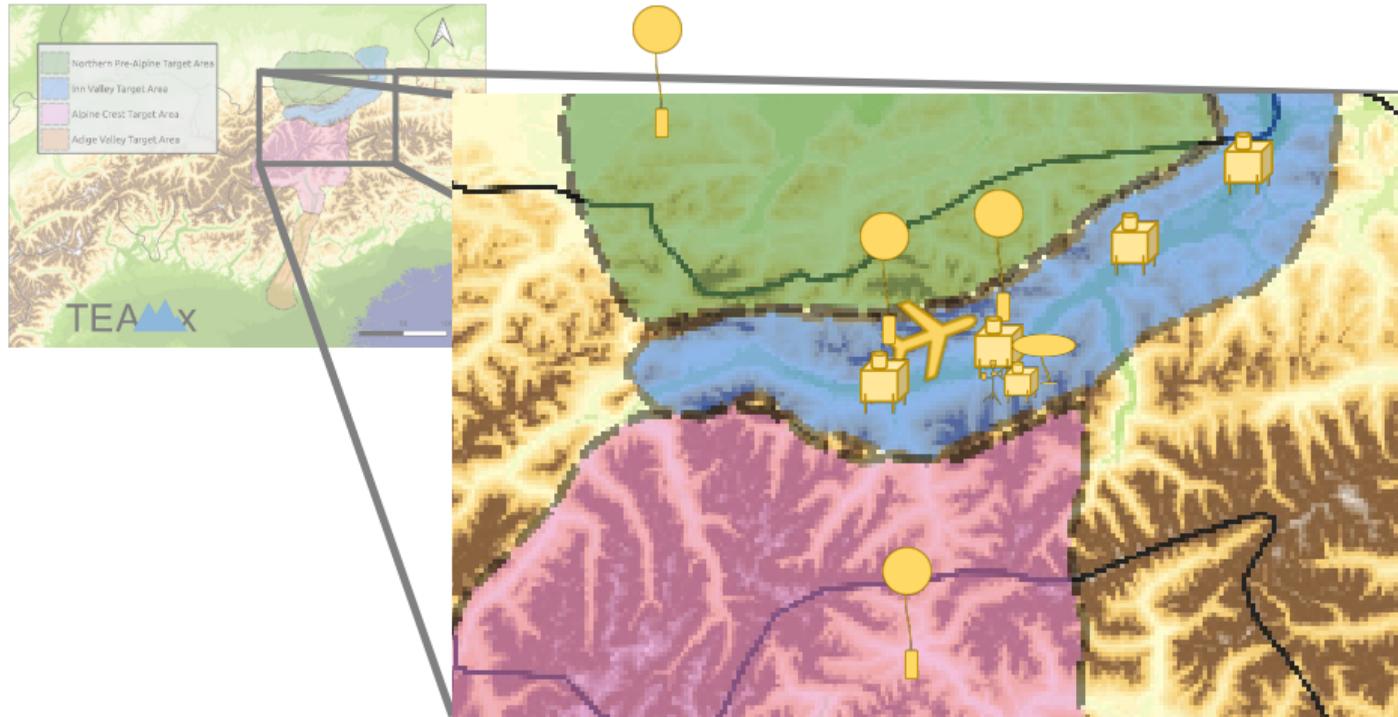


Photo: P. Berthelemy

TEAMx winter EOP (wEOP)

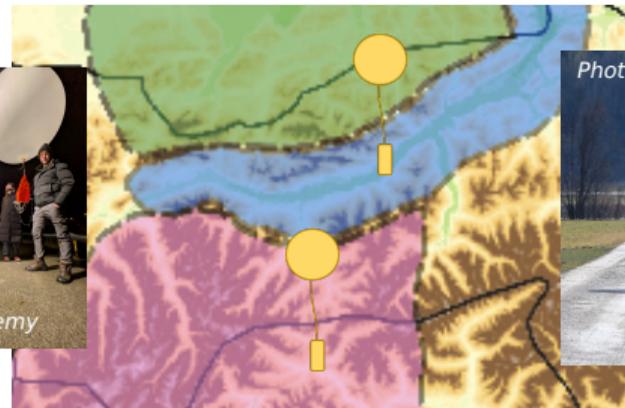
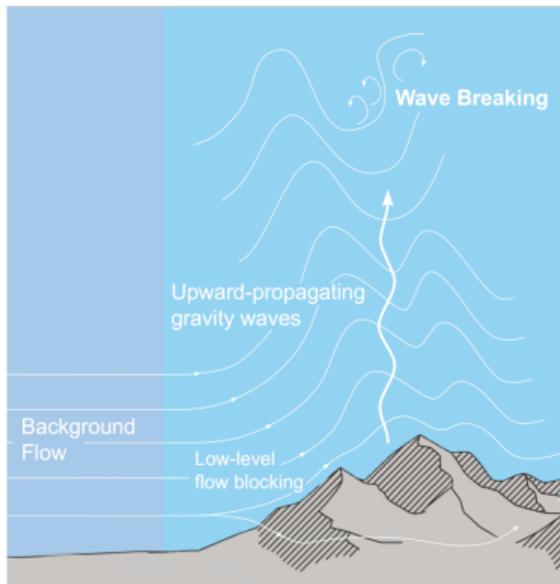


TEAMx winter EOP (wEOP)



Gravity waves

TEAMx-FLOW



- ▲ Improve process understanding (especially gravity-wave drag)
- ▲ Improve understanding of how drag is resolved and parameterised in NWP and climate models at all scales

Credit: A. Orr  British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

TEAMx

MoBL structure

- ▲ Winter valley atmosphere
- ▲ Turbulence anisotropy

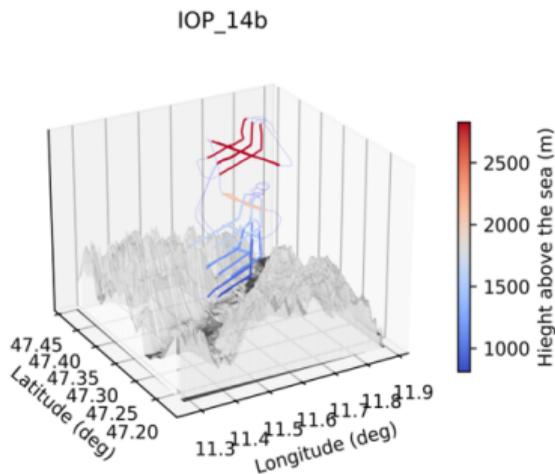


Figure courtesy: Q. Berthier



3 flight days (6 flights)

- ▲ thermally driven (2 d)
- ▲ dynamically forced (1 d)

Credit: M. Rotach  universität
innsbruck

MoBL structure

▲ Winter valley atmosphere

▲ Turbulence anisotropy

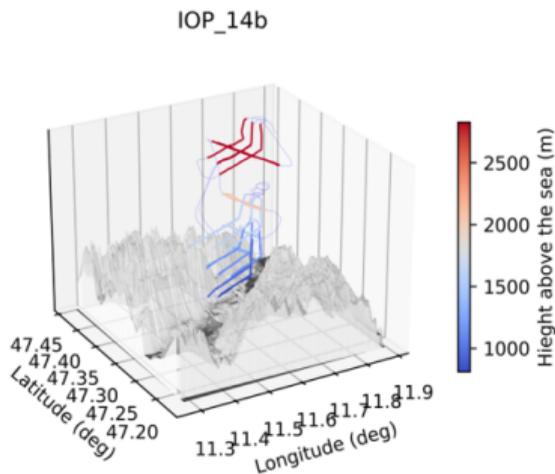
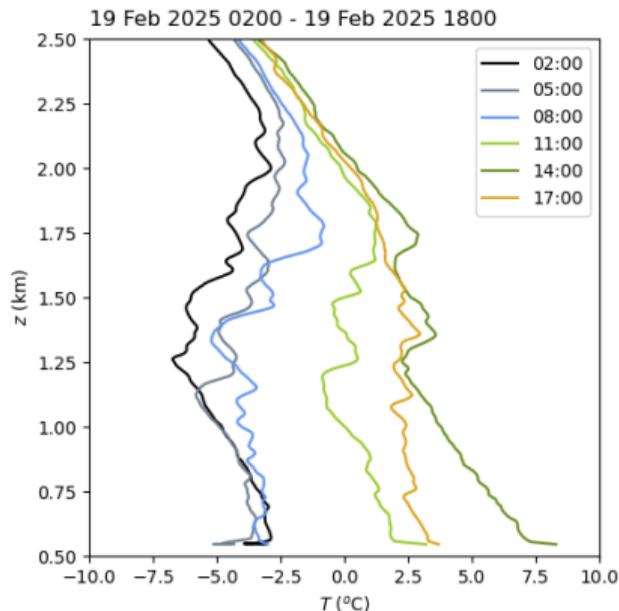


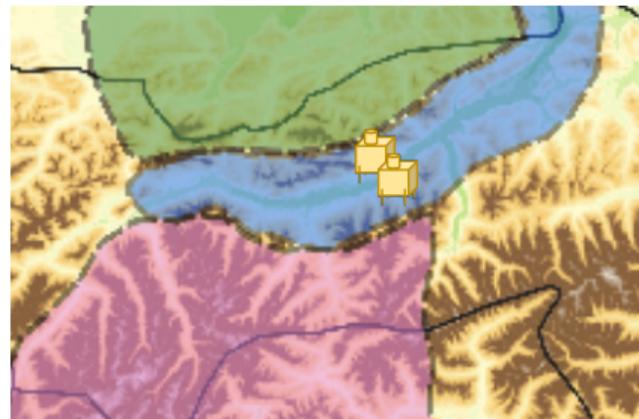
Figure courtesy: Q. Berthier

3-h radiosoundings



Fog and low stratus

Karlsruhe Low-Cloud Exploratory Platform (KLOCX)

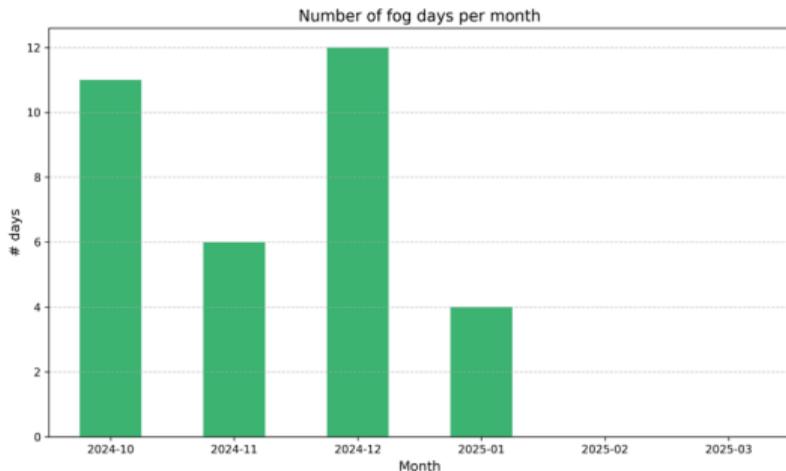


- ▲ 25 Sep 2024–31 Mar 2025
- ▲ Life-cycle phases of low-level stratiform clouds and fog

Credit: J. Vüllers 

Fog and low stratus

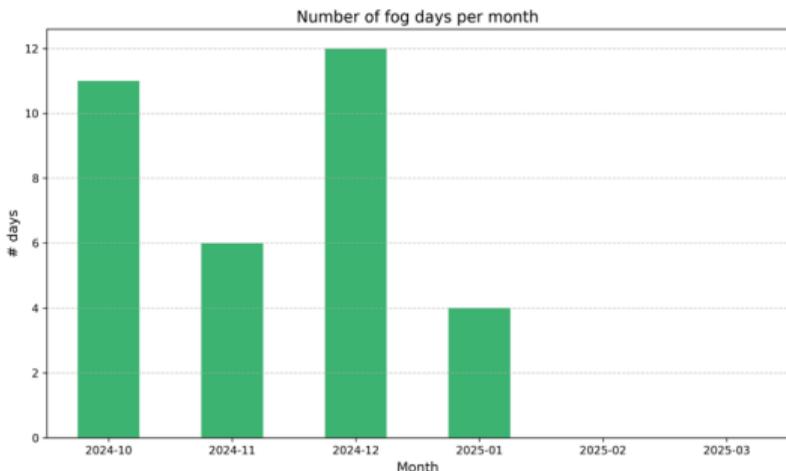
▲ 33 days with fog (Oct–Jan)



Credit: J. Vüllers  KIT
Karlsruhe Institute of Technology

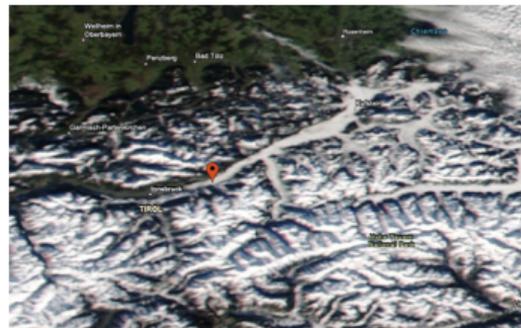
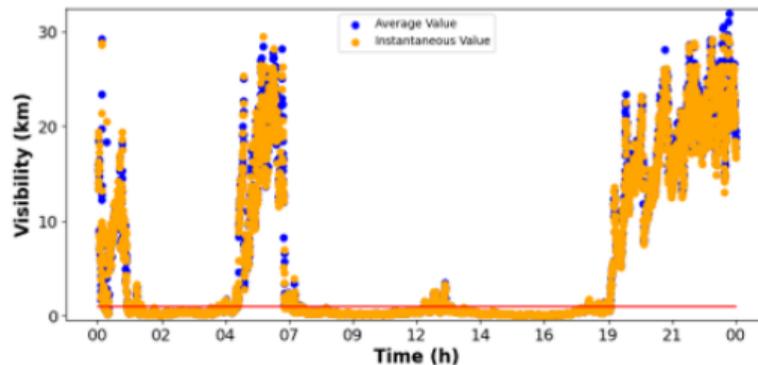
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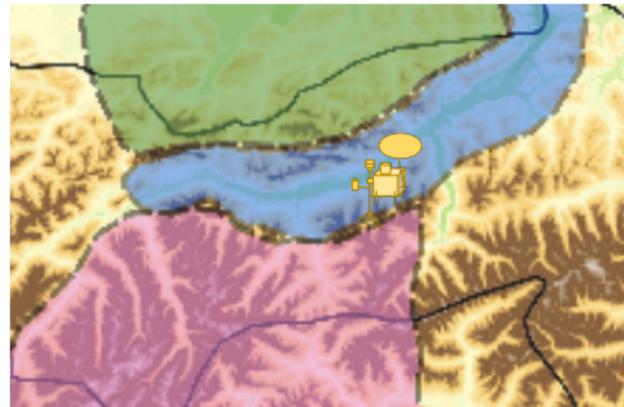
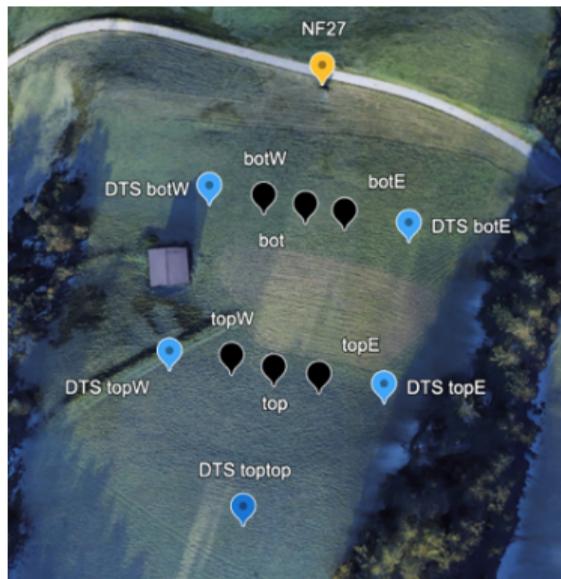


Credit: J. Vüllers 

Case study—17 Dec 2024



Katabatic winds



- ▲ 3D structure of mean and turbulent properties
- ▲ Surface boundary conditions for models over complex terrain
- ▲ Wide range of weather conditions (6 katabatic IOPs, multiple foehn episodes)

Credit: I. Stiperski, A. Gohm, L. Pfister  , C. Brun 

Katabatic winds

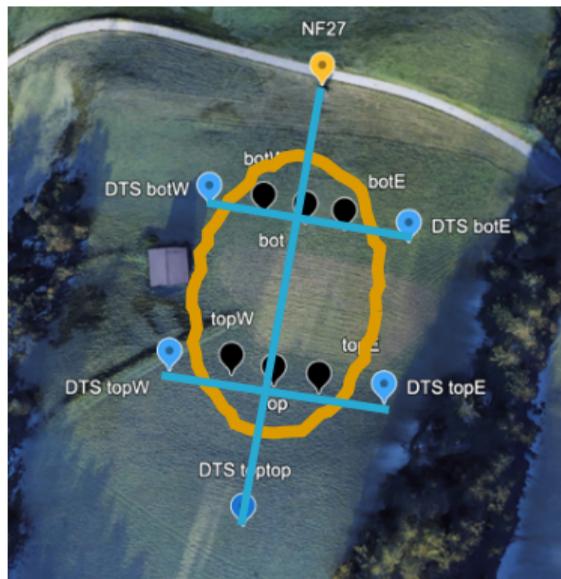


Vertical profiles

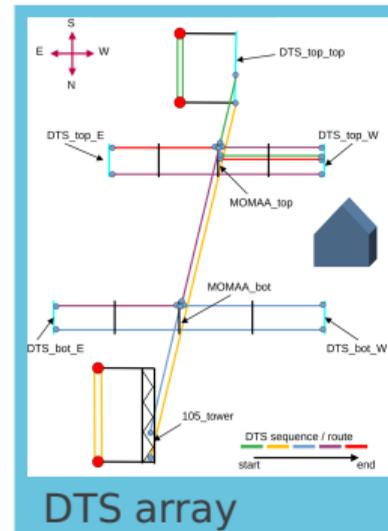


Credit: I. Stiperski, A. Gohm, L. Pfister  universität innsbruck, C. Brun  UGA Université Grenoble Alpes

Katabatic winds



Spatial structure

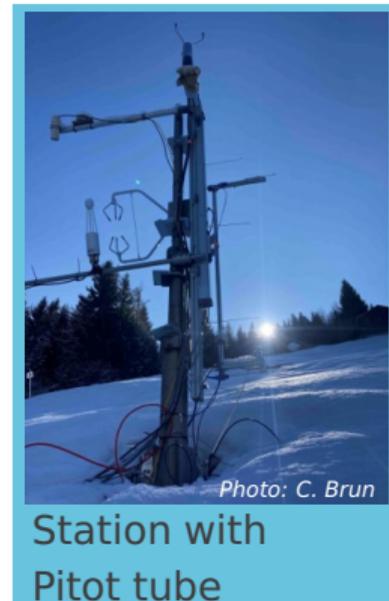
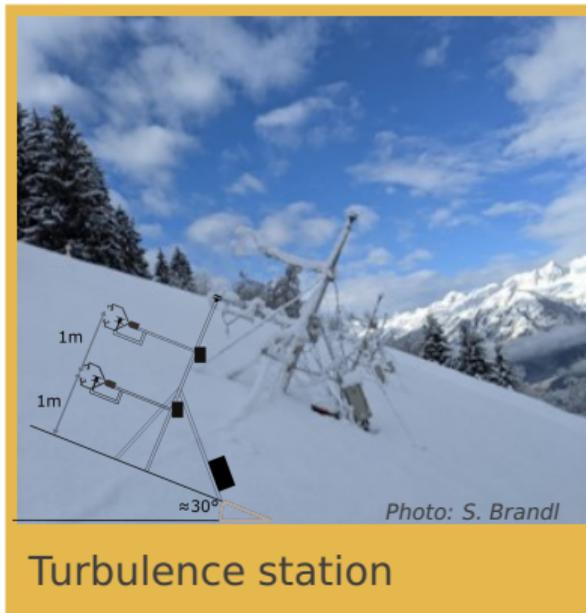


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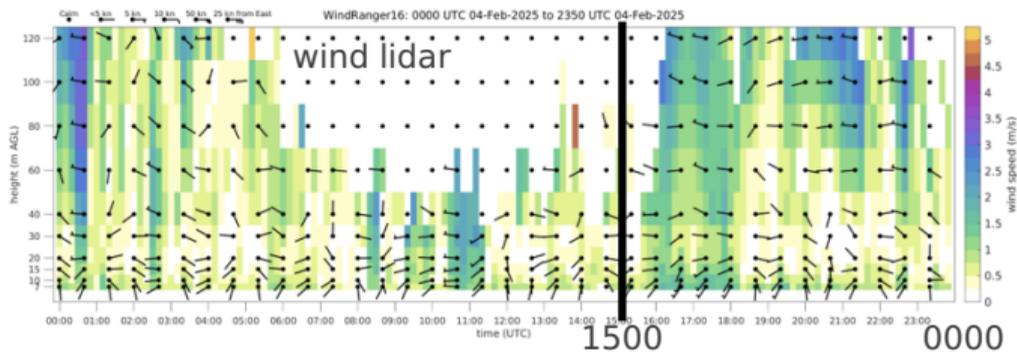


Turbulence



Credit: I. Stiperski, A. Gohm, L. Pfister , C. Brun 

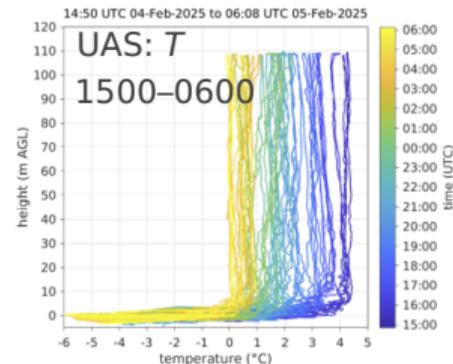
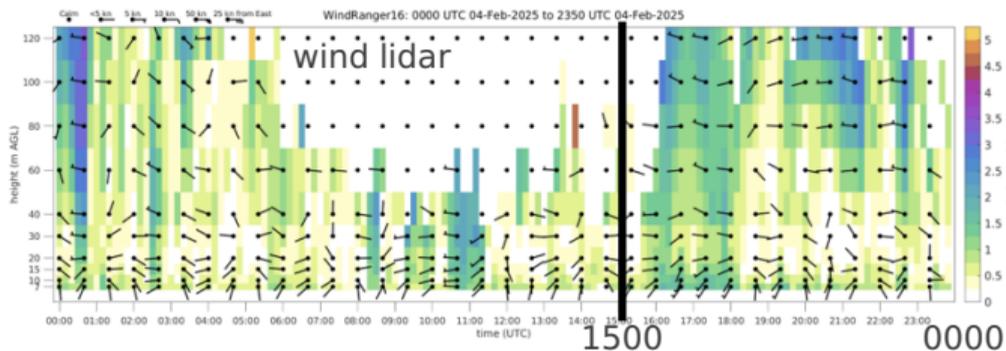
Katabatic winds—Vertical profiles



- ▲ Shallow katabatic jet: peak < lowest lidar level
- ▲ Transition from downslope (S) to down-valley (W) winds

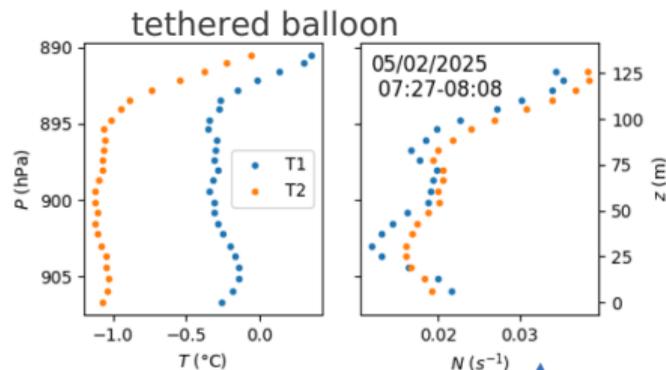
Credit: A. Gohm, C. Brun, L. Pfister

Katabatic winds—Vertical profiles

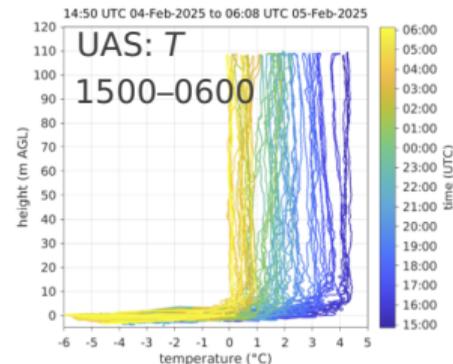
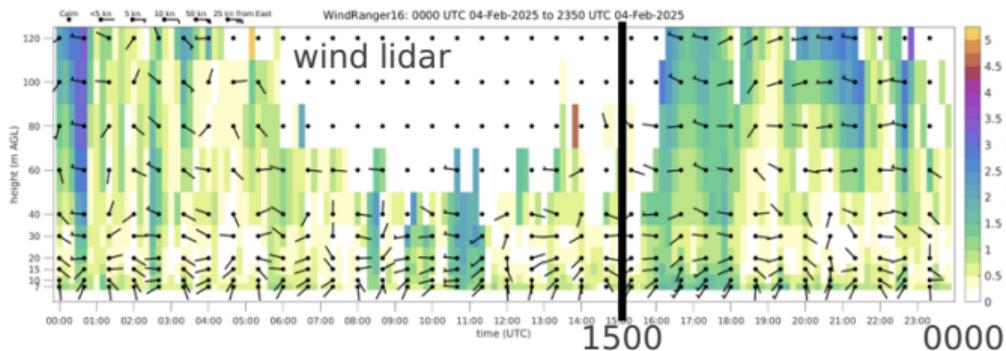


- ▲ Shallow katabatic jet: peak < lowest lidar level
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- ▲ Shallow temperature inversion: 5–10 m

Credit: A. Gohm, C. Brun, L. Pfister

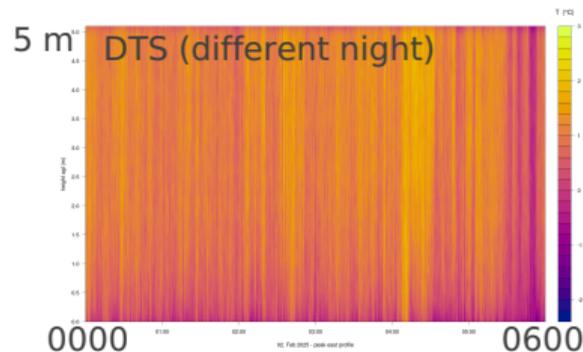


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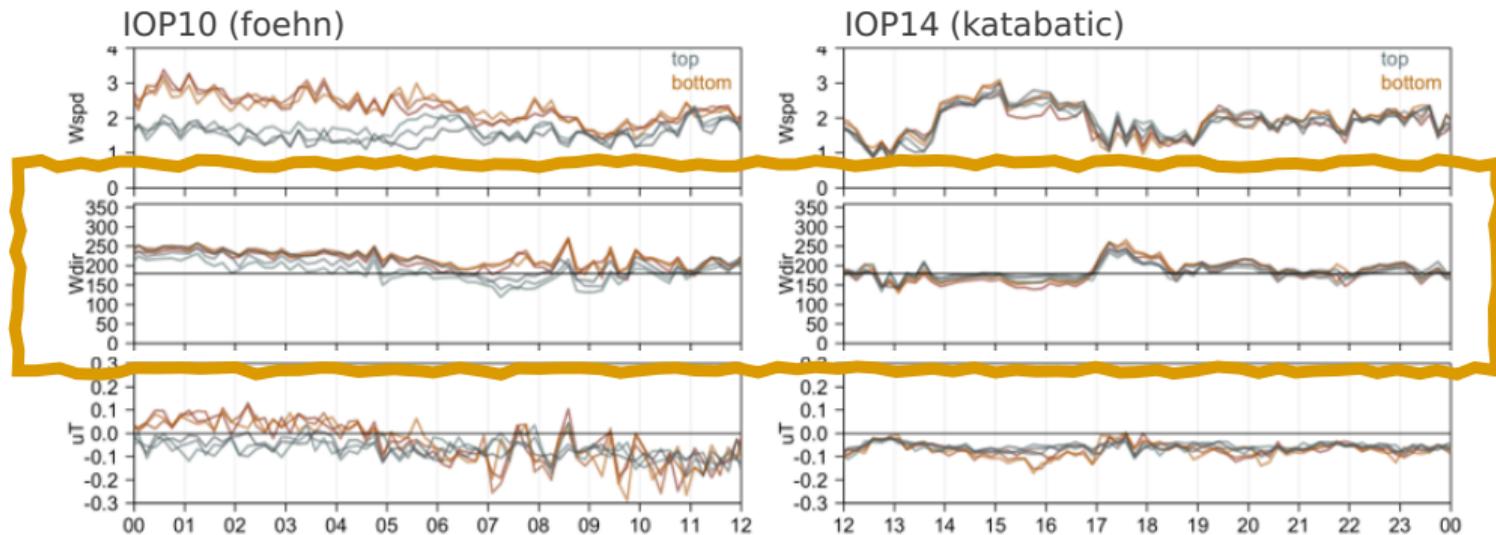


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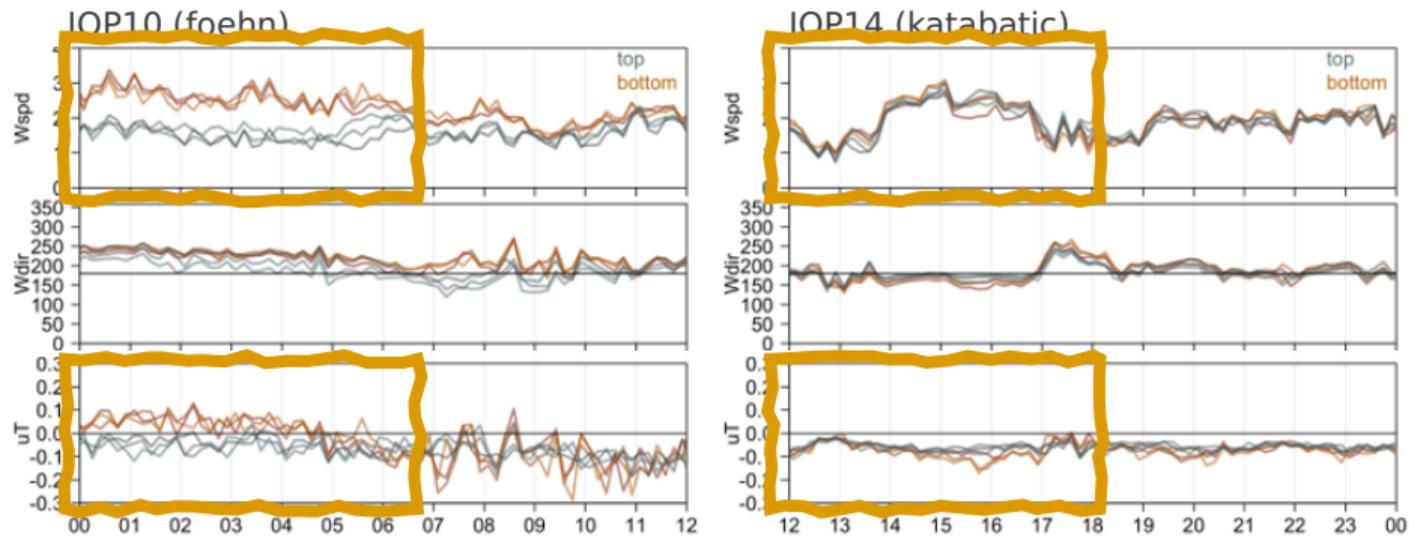
Katabatic winds—foehn influence



▲ Southerly flow during both katabatic flow and foehn

Credit: I. Stiperski

Katabatic winds—foehn influence



▲ Katabatic flow: jet < 1 m

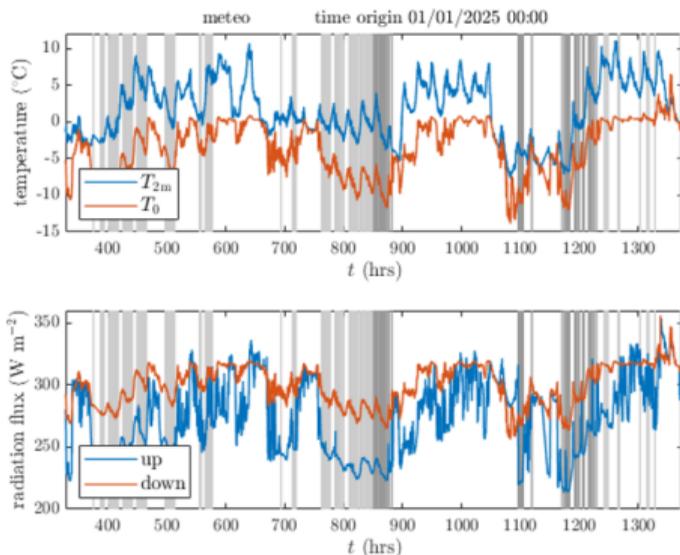
▲ Foehn: jet < 1 m at top transect; jet > 1 m and stronger winds at bottom transect

Credit: I. Stiperski

Katabatic winds

Radiative flux divergence:

$$LW_{up} - LW_{down} = -60 \text{ W m}^{-2}$$

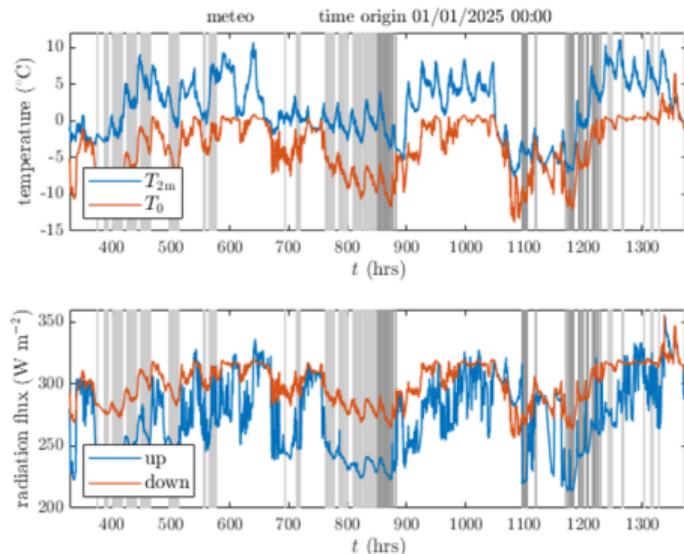


Credit: C. Brun, I. Stiperski

Katabatic winds

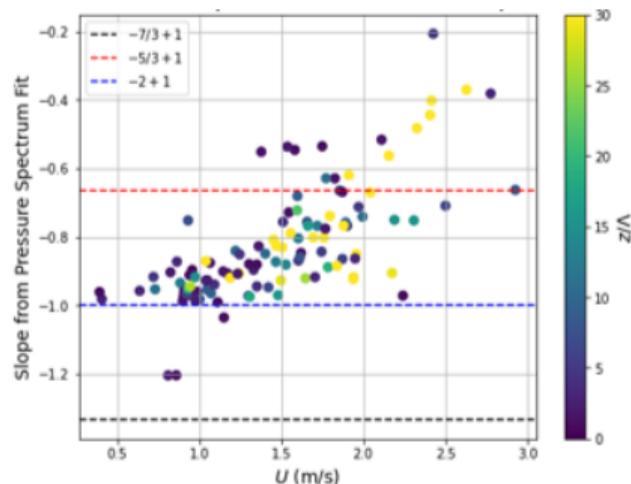
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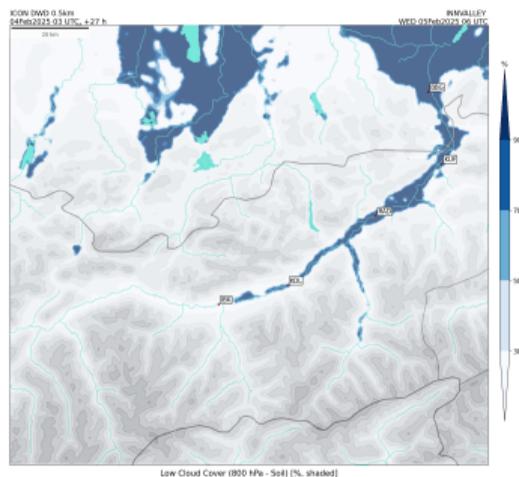
Credit: C. Brun, I. Stiperski

Pressure spectra: spectral slope is a function of wind speed for non-katabatic conditions

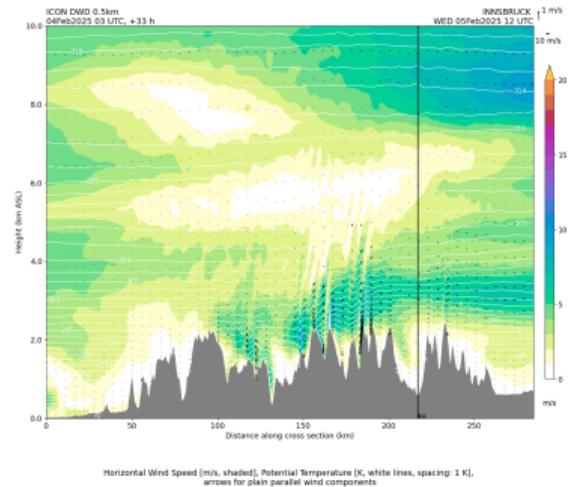


High-resolution NWP forecasts

- High-resolution forecast runs from multiple European weather services
- 500-m DWD ICON runs

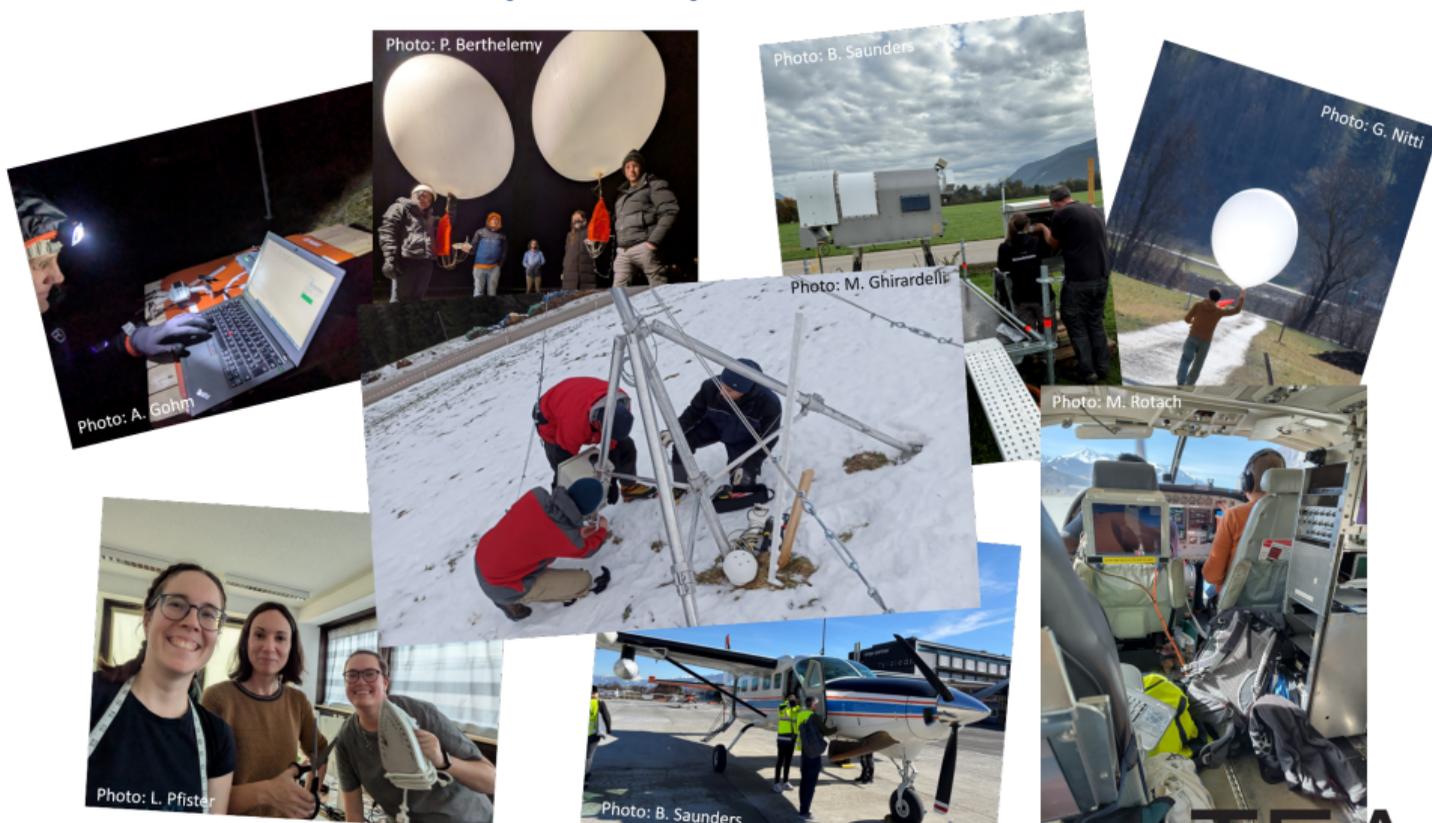


Low-level clouds in the Inn Valley



Wind speed across the Alps (S-N)

Thanks to all the participants!



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TEAMx Multi-scale transport and exchange processes in the atmosphere over mountains—programme and experiment

Web: www.teamx-programme.org

Contact: teamx-pco@uibk.ac.at

TEAMx winter EOP



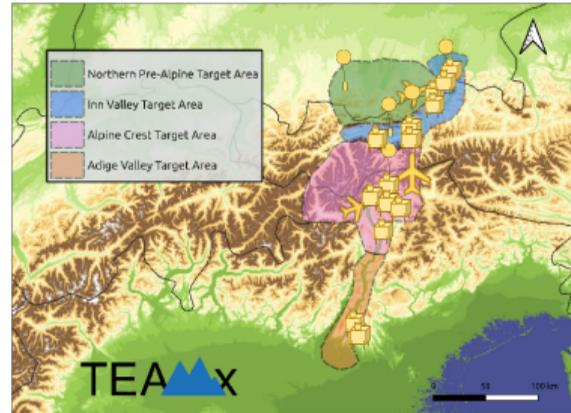
- ▲ 3D structure of gravity waves
- ▲ 3D structure of the wintertime MoBL
- ▲ Life cycle of fog and low-level stratiform clouds
- ▲ Mean and turbulent characteristics of katabatic winds over a snow-covered slope

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Outlook—summer EOP



- Aircraft
- Radiosondes
- Fleets of UAS
- Wind lidars
- T/RH lidars
- T/RH profilers
- Radars
- EC stations
- ...

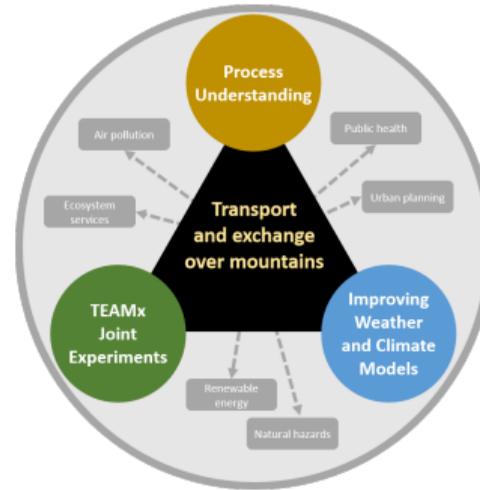
- ▲ 3D structure of gravity waves
- ▲ 3D structure of the MoBL at different scales
- ▲ Development of orographic convection
- ▲ Mean and turbulent structure of slope winds

TEAMX Multi-scale transport and exchange processes in the atmosphere over mountains—programme and experiment

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Outlook—beyond the TOC



▲ Observational data for process analysis and for model evaluation and development