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

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University of Innsbruck

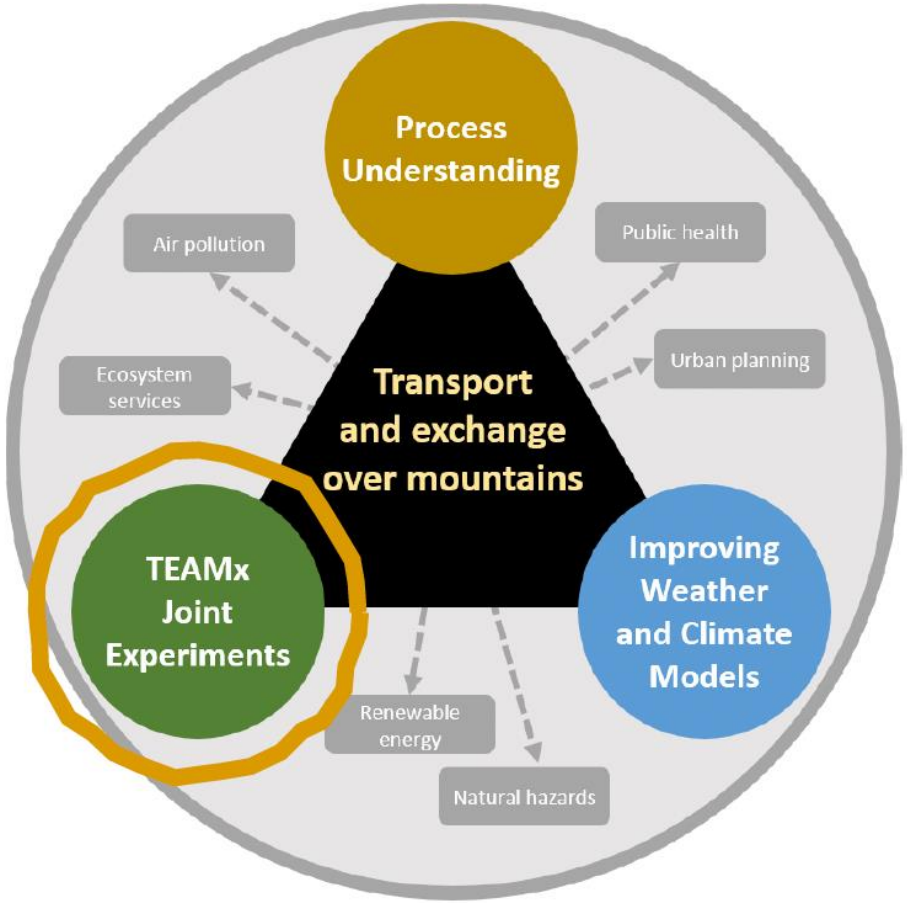
GLORI Workshop, 14-16 May 2025, Bologna

Outline

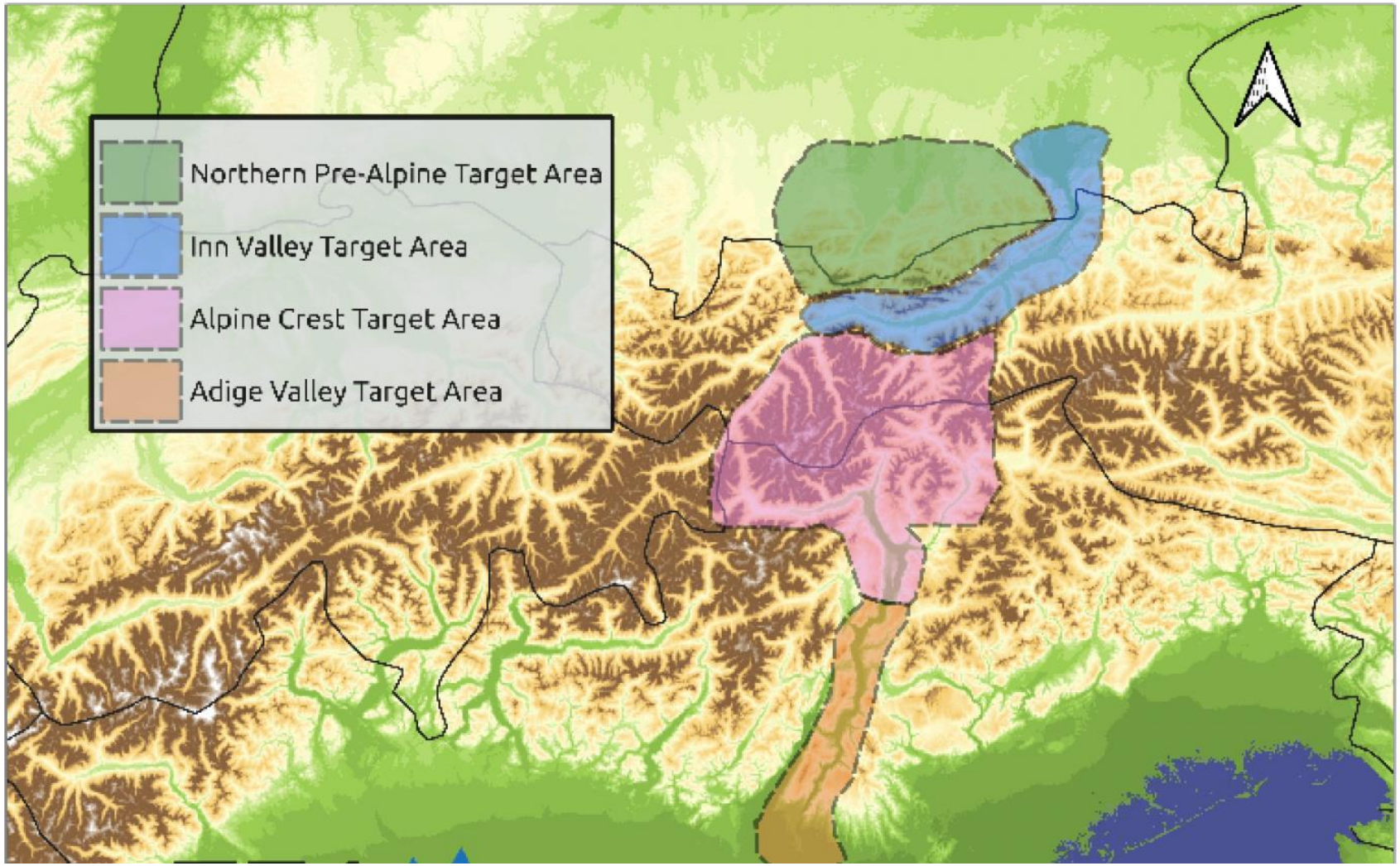
- TEAMx Observational Campaign
- some highlights from the winter EOP
- dedicated forecasts

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 Observational Campaign (TOC)



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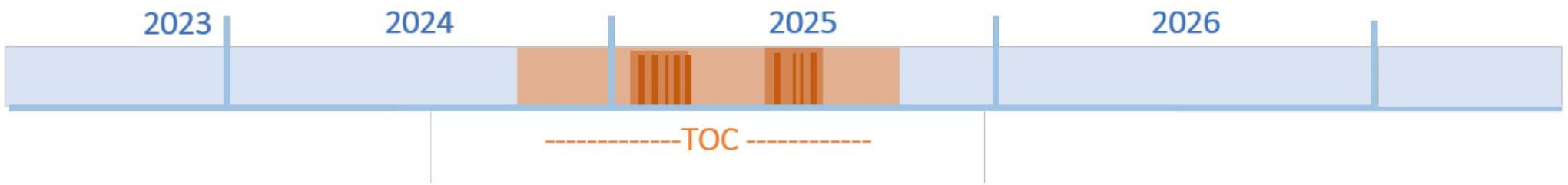

- One-year long TOC

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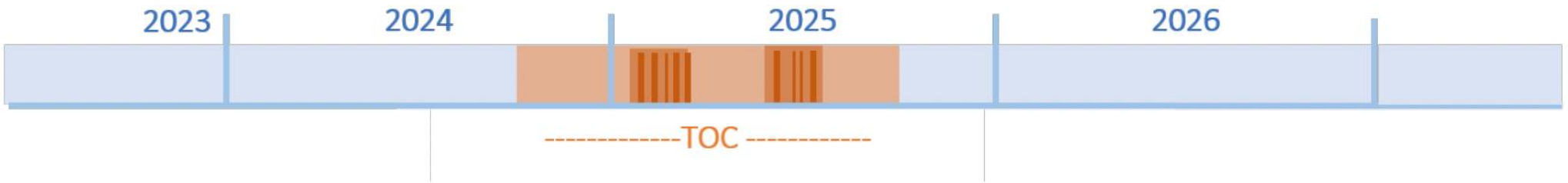

- One-year long TOC
- Winter EOP (wEOP): 20 Jan–28 Feb
- Summer EOP (sEOP): 16 Jun–25 Jul

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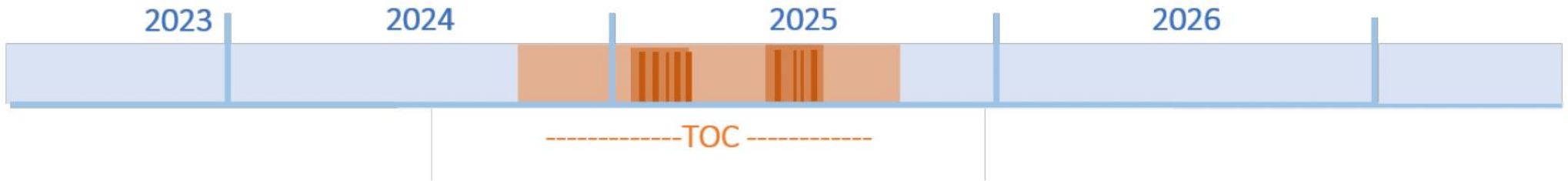

- One-year long TOC
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Photo: G. Nitti


Photo: P. Berthelemy

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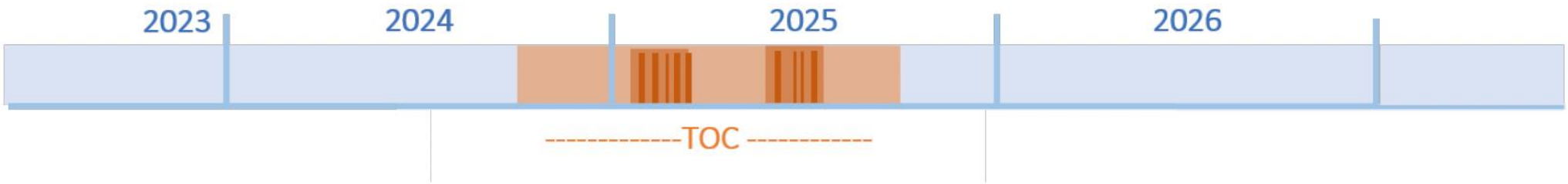

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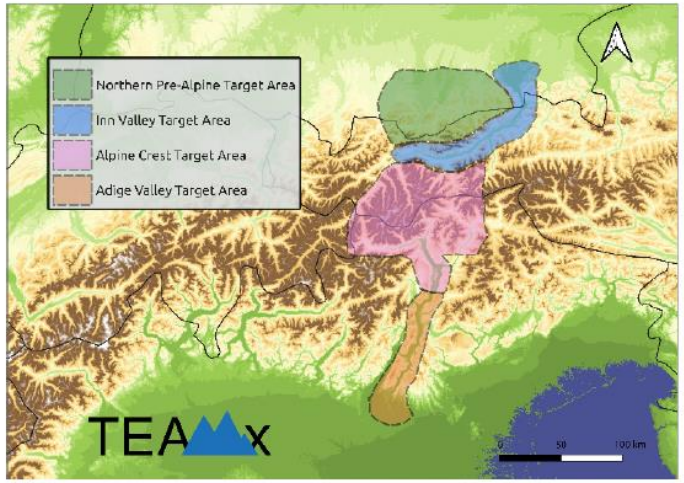
TEAMx winter EOP (wEOP)



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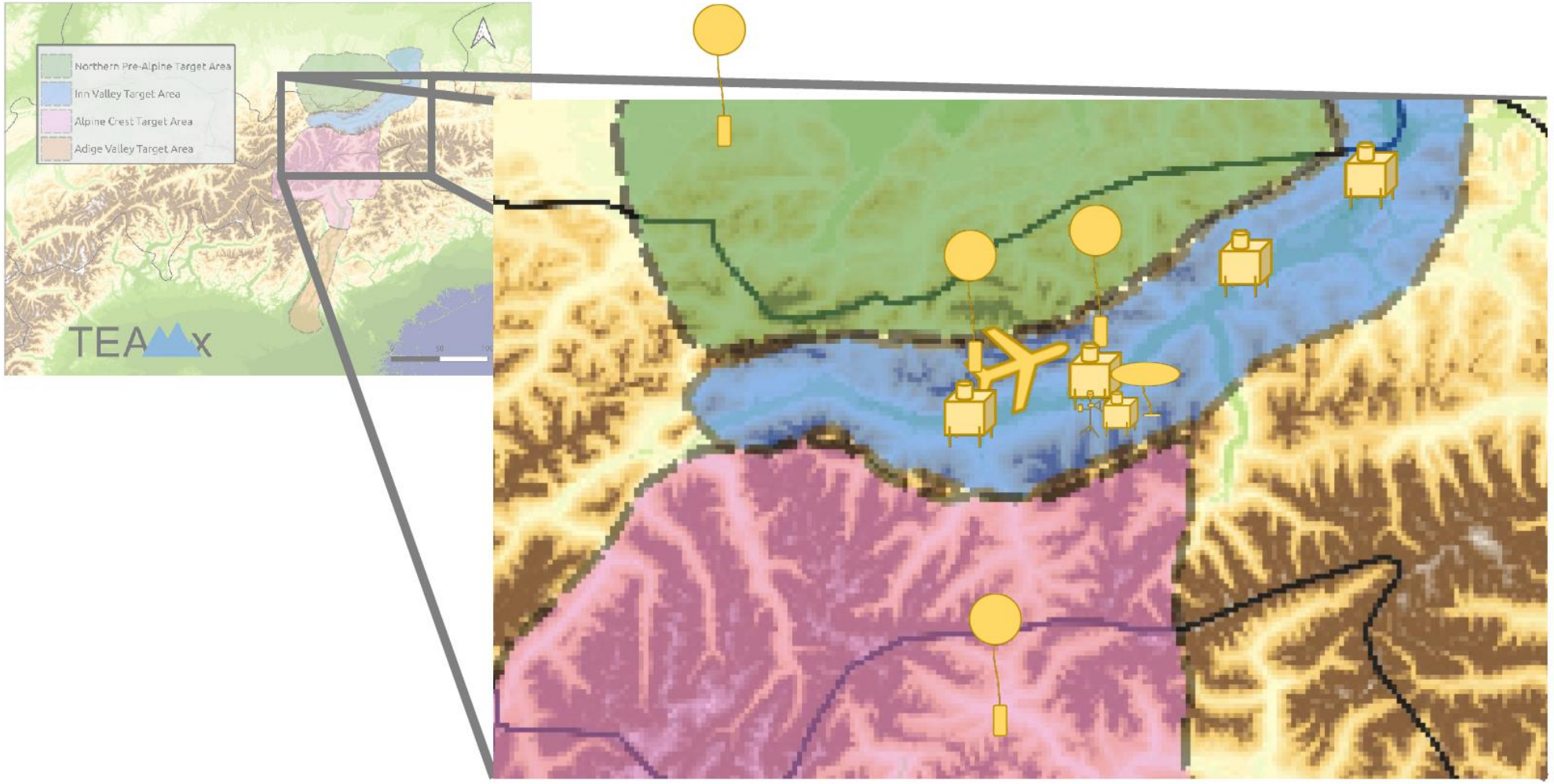
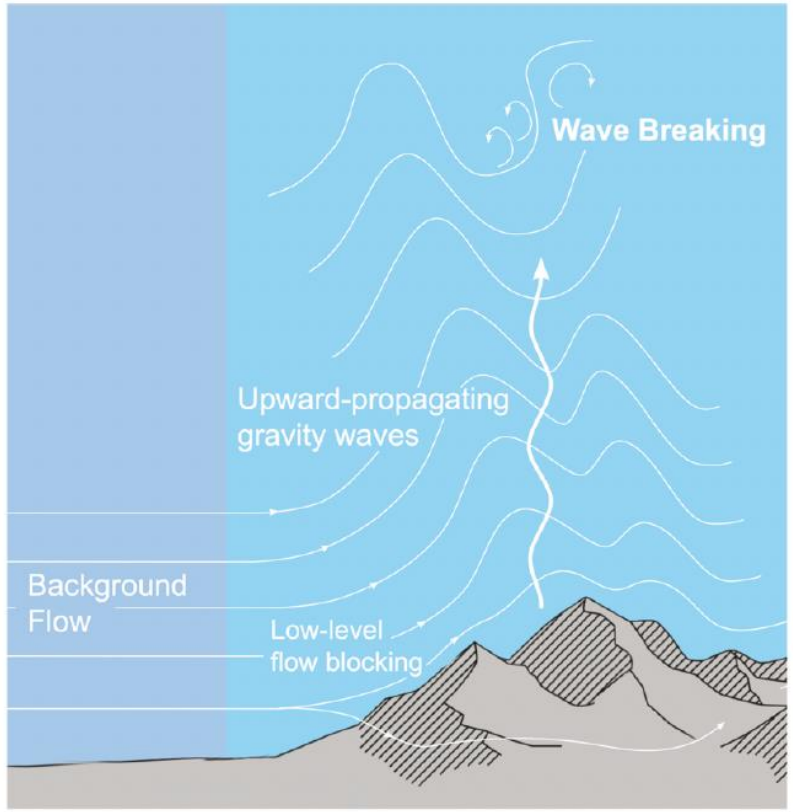
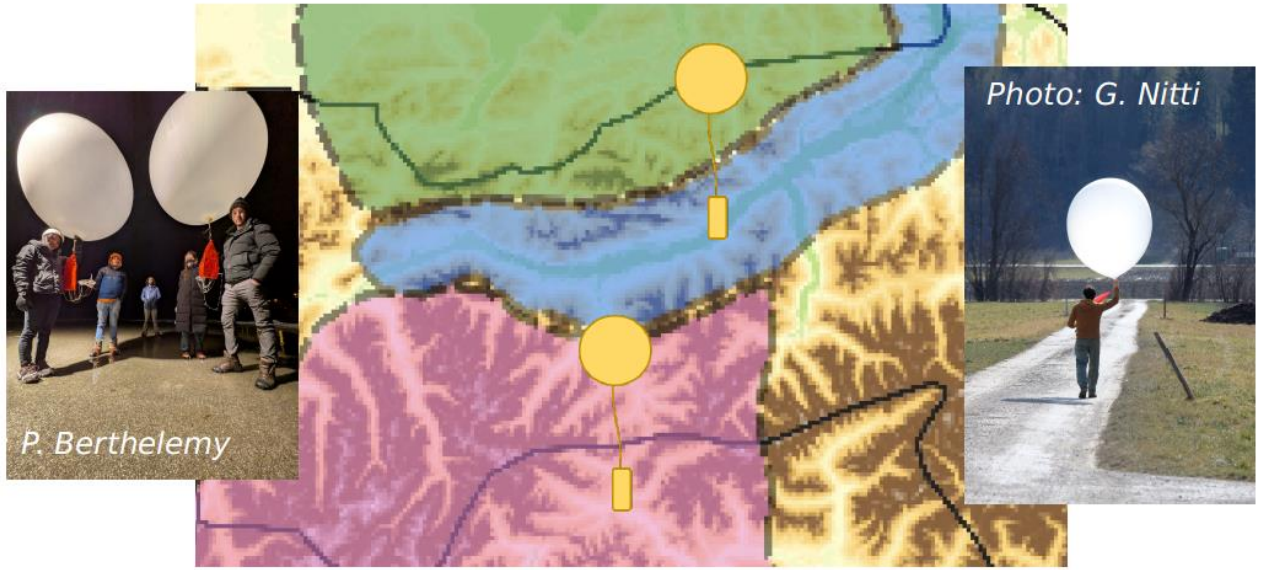


1 Gravity waves

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

2 MoBL structure

- Winter valley atmosphere
- Turbulence anisotropy

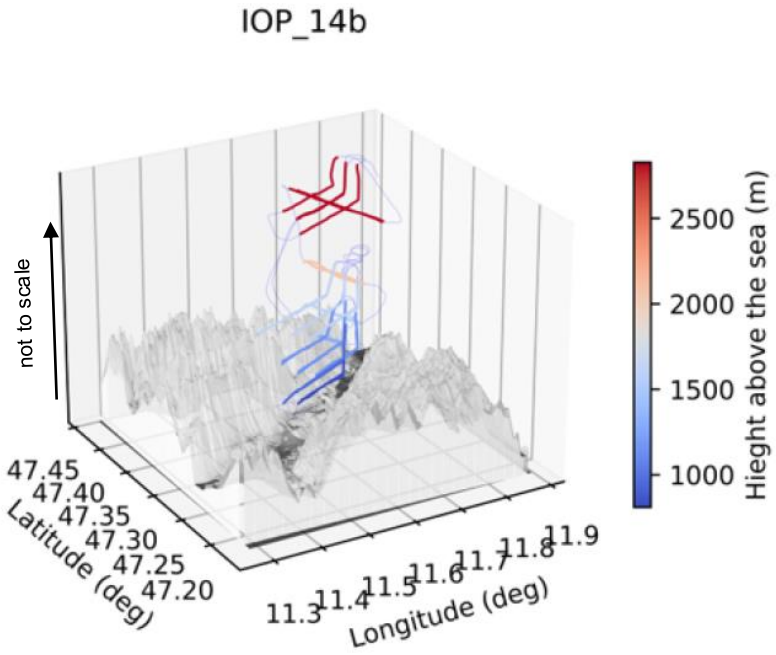
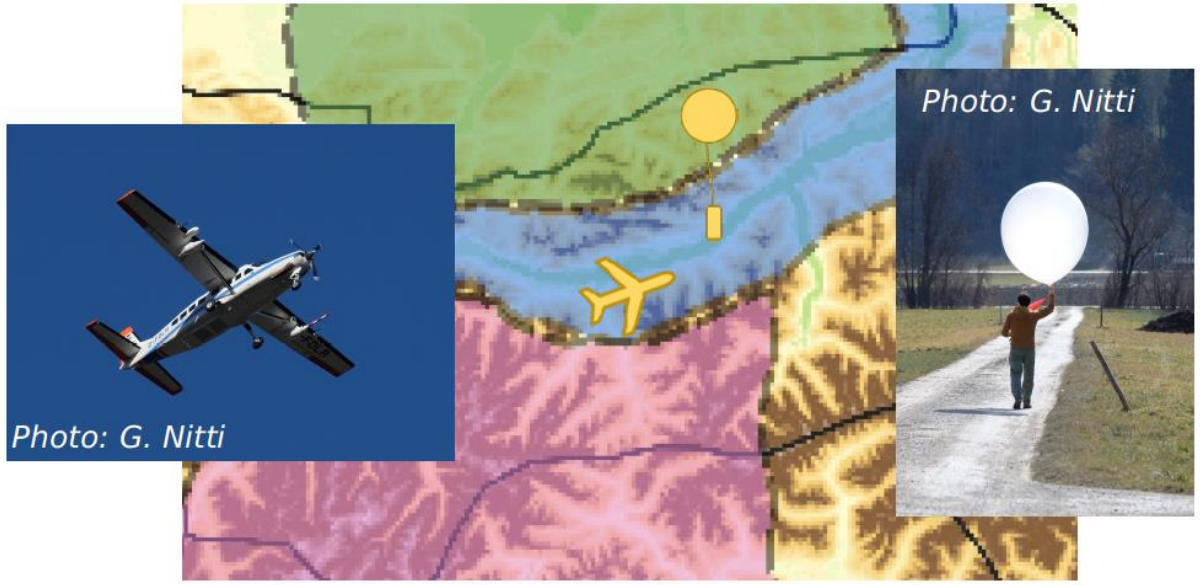


Figure courtesy: Q. Berthier



3 flight days (6 flights)

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

Credit: M. Rotach

universität innsbruck

MoBL structure

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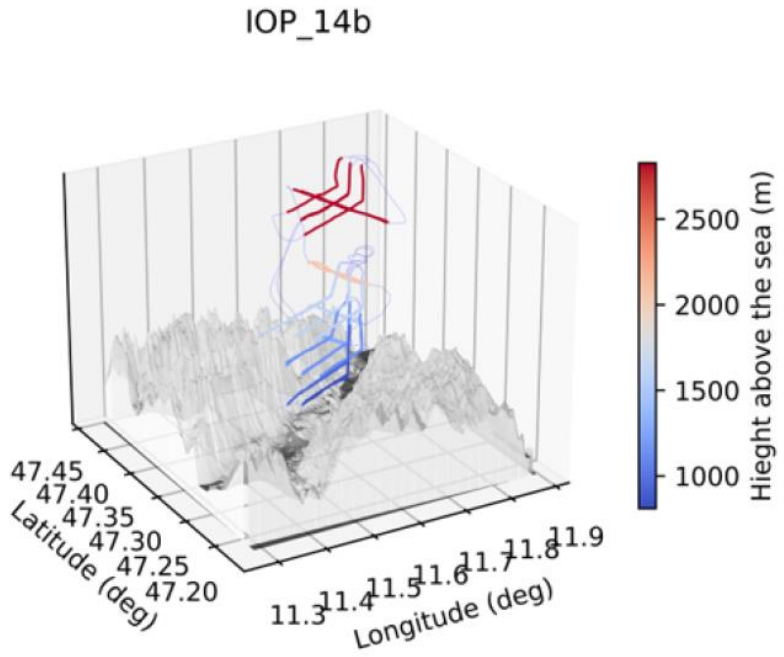
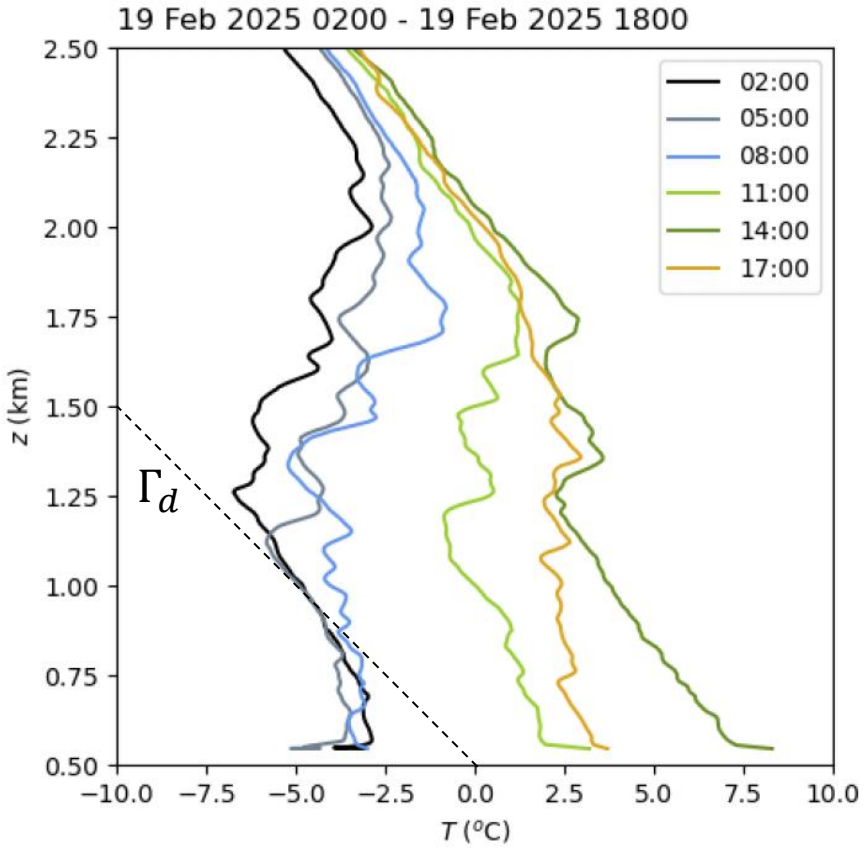


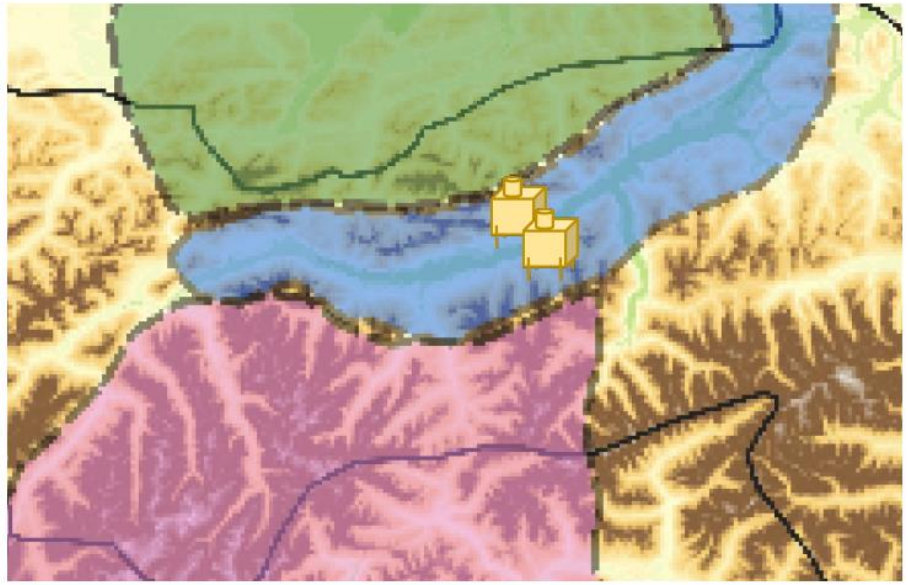
Figure courtesy: Q. Berthier

3-h radiosoundings



3 Fog and low stratus

Karlsruhe Low-Cloud Exploratory Platform (KLOCX)



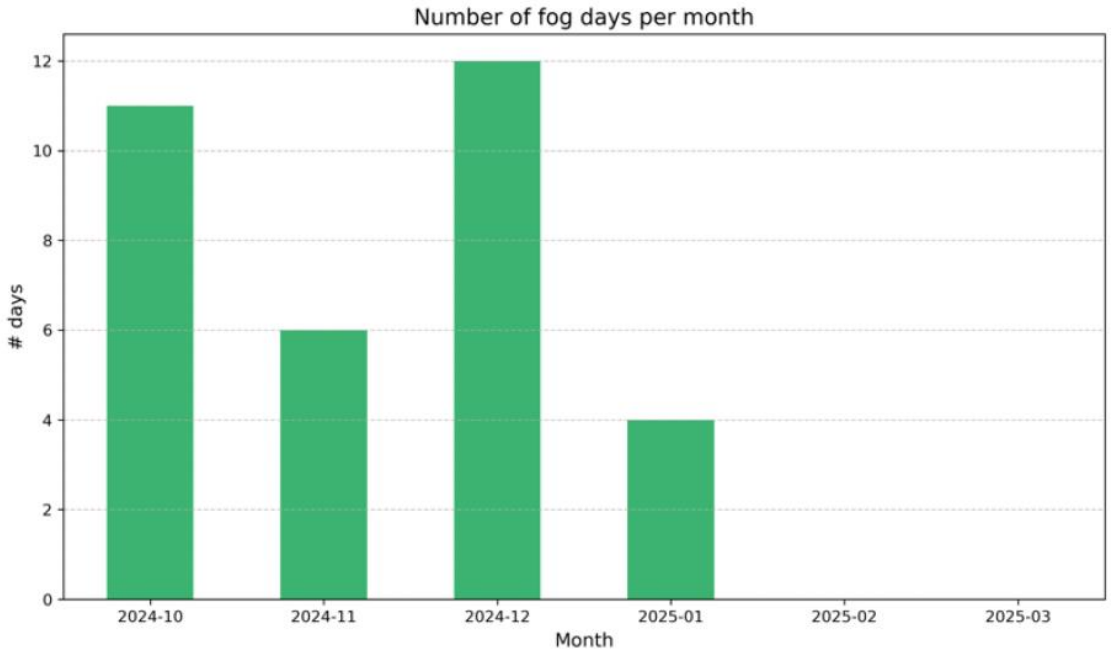
- 25 Sep 2024–31 Mar 2025
- Life-cycle phases of low-level stratiform clouds and fog

Credit: J. Vüllers KIT

TEAMx

Fog and low stratus

- 33 days with fog (Oct–Jan)



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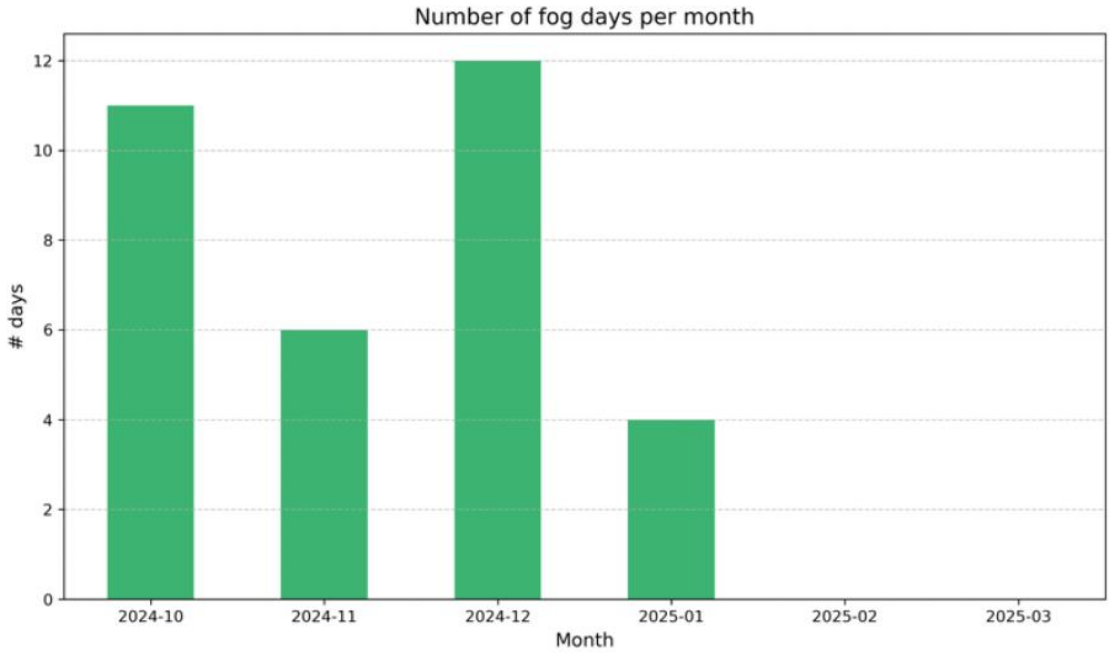
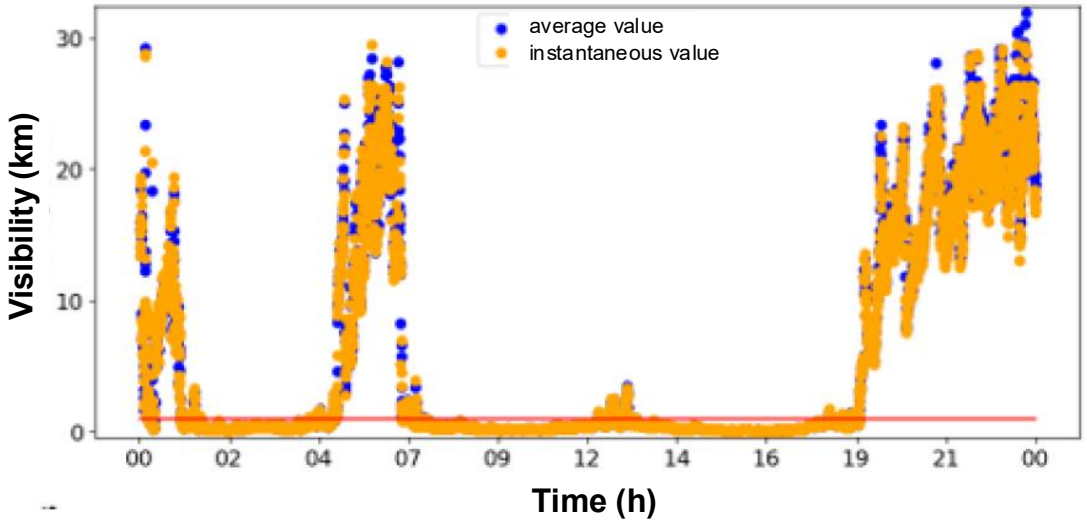
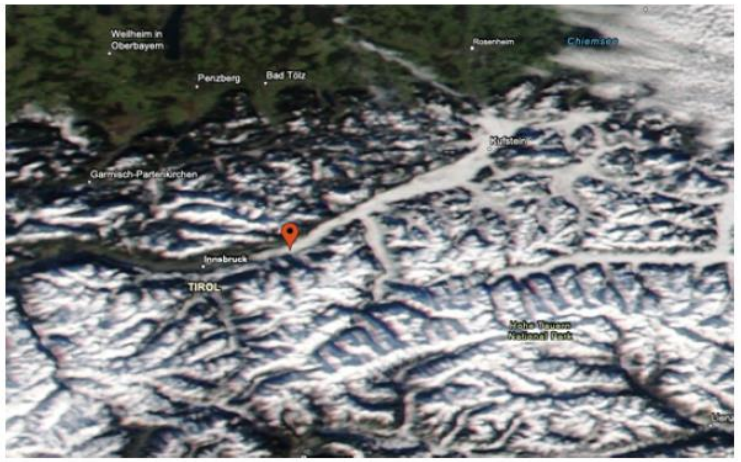


Case study—17 Dec 2024





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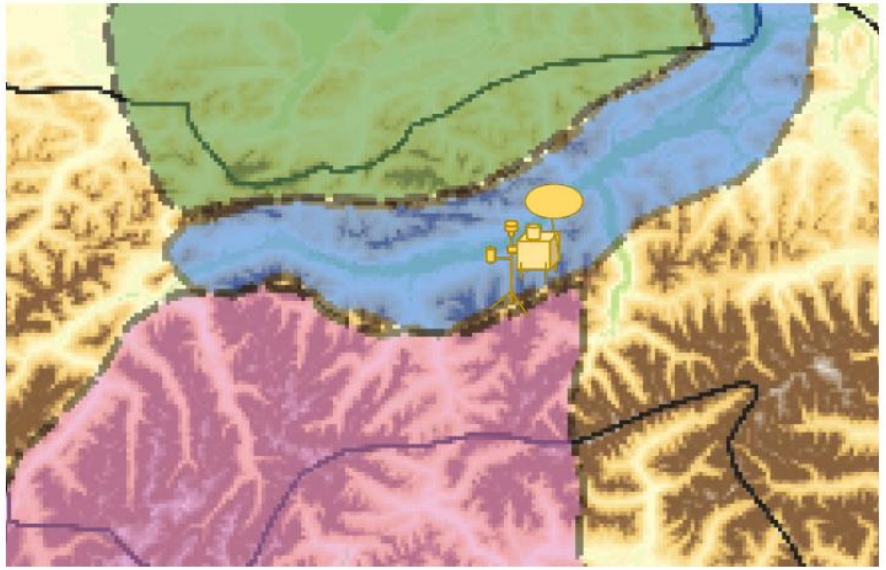
4 Katabatic winds



- 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 universität innsbruck *, C. Brun* UGA Université Grenoble Alpes

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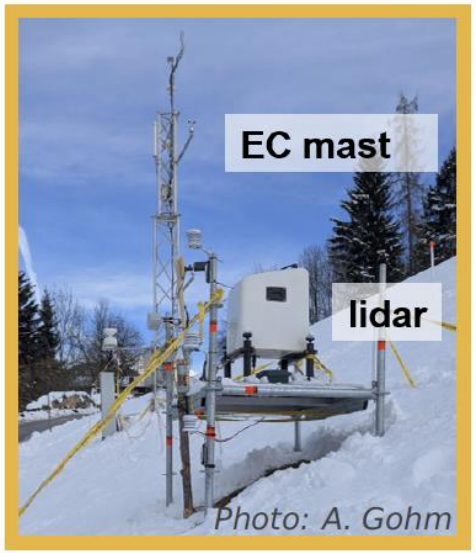
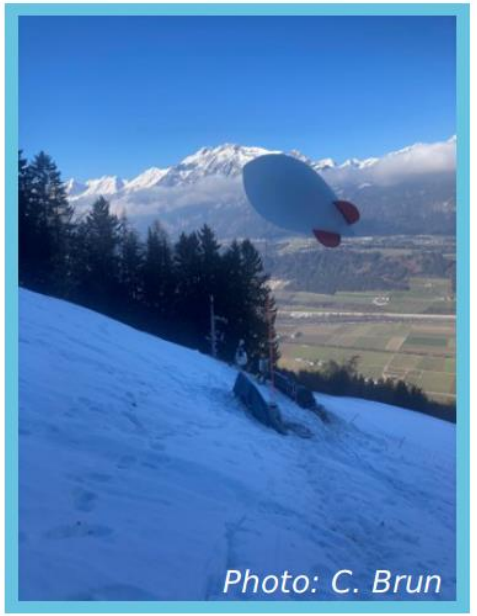
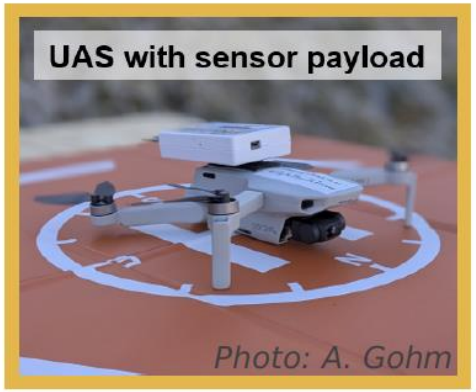
Katabatic winds

Vertical profiles







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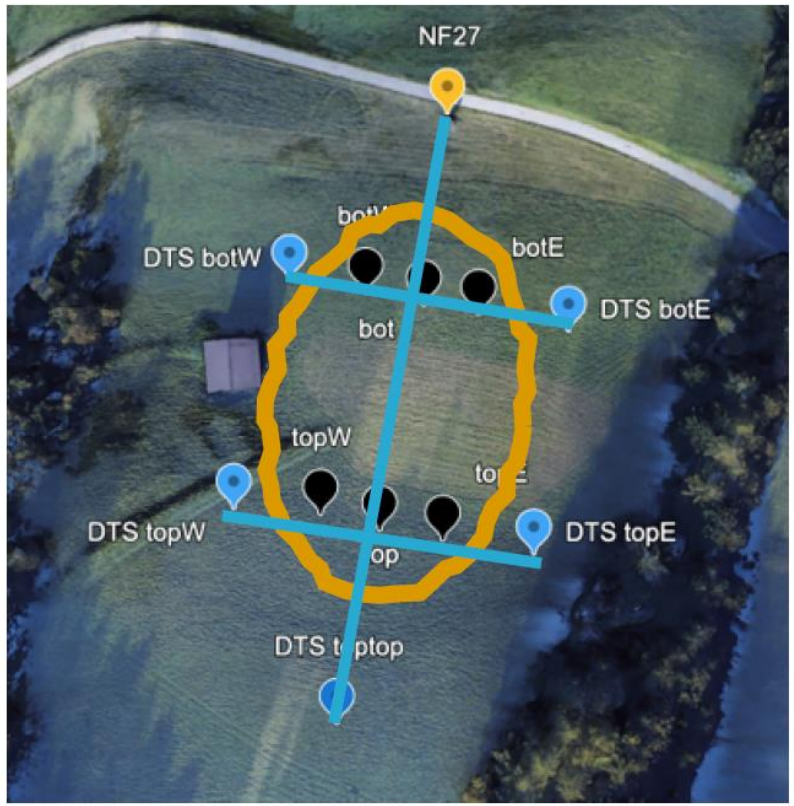
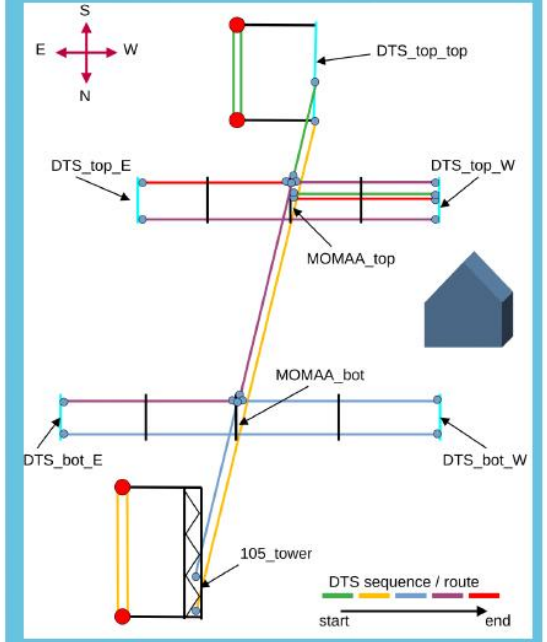


Spatial structure

Station network



DTS array

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

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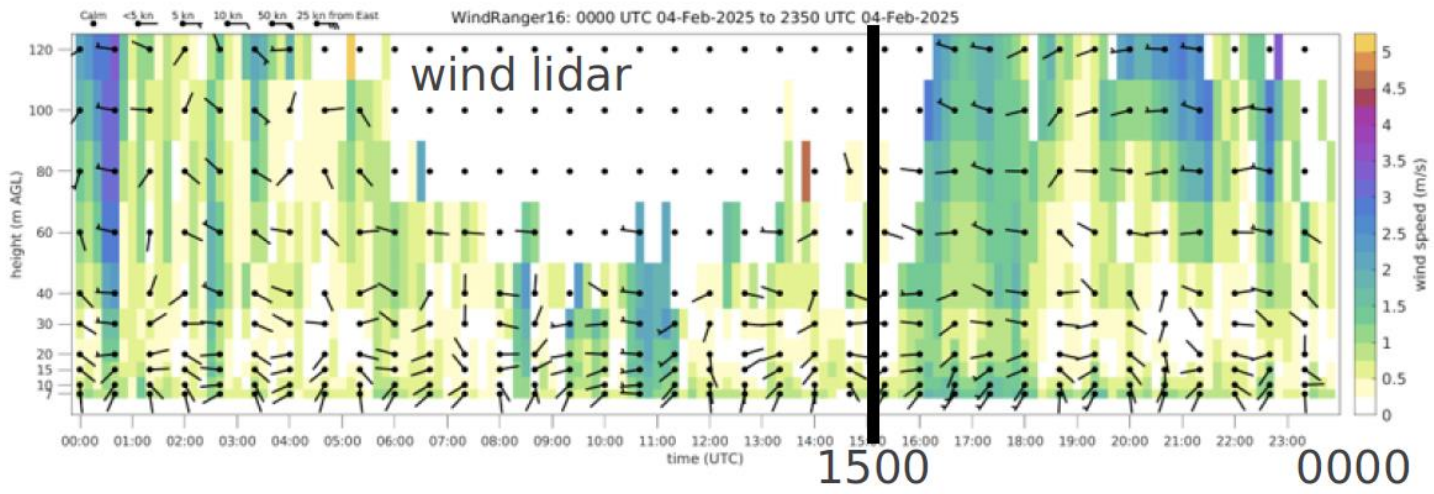
Katabatic winds—Vertical profiles



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

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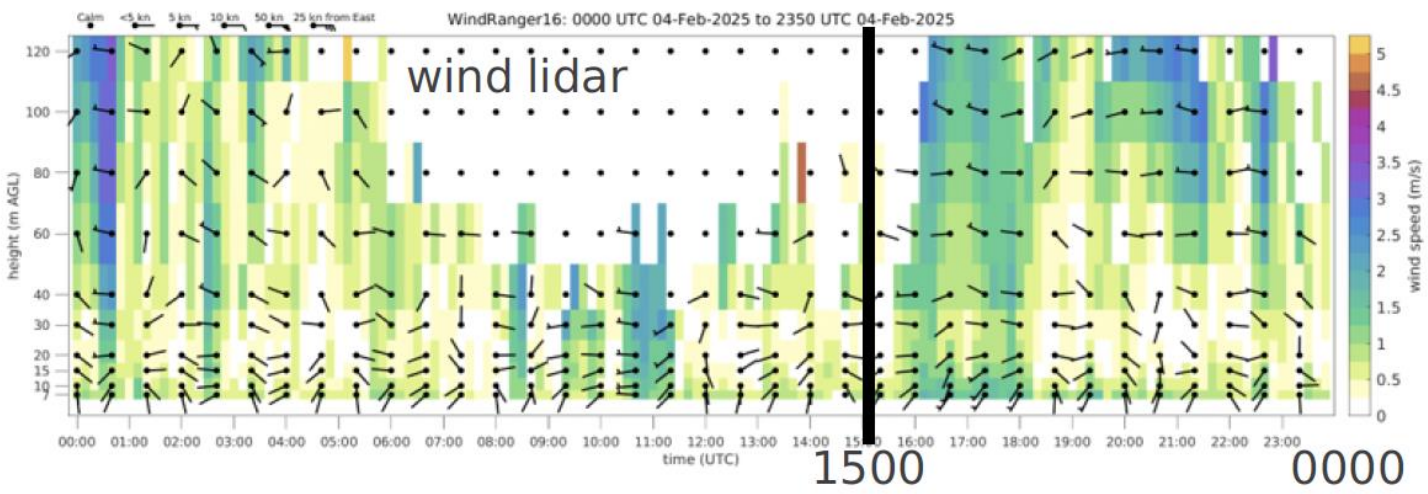
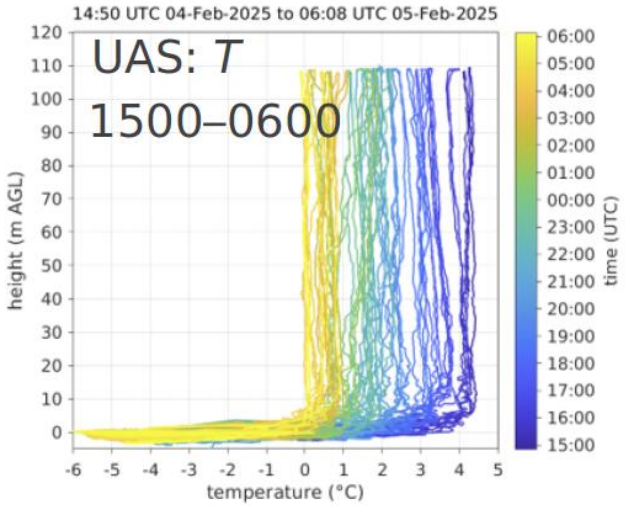
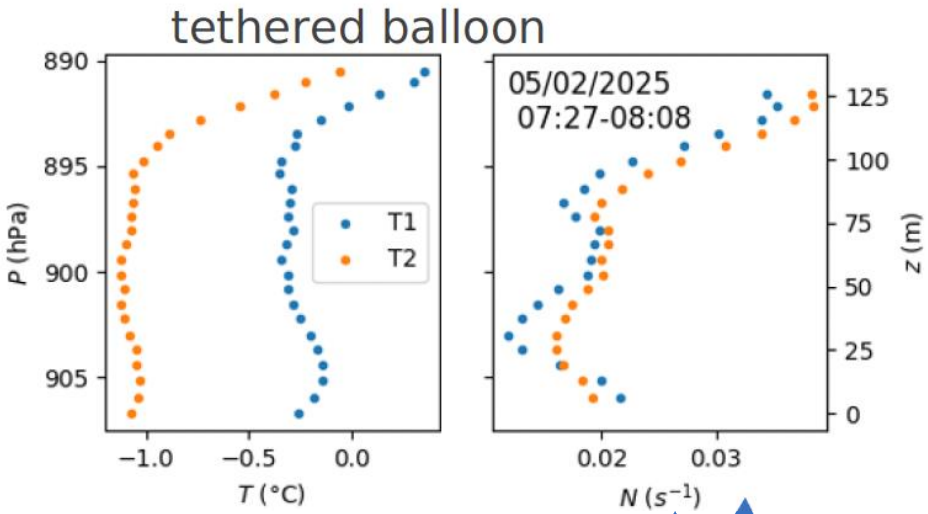
Katabatic winds—Vertical profiles





- Shallow katabatic jet: peak < lowest lidar level
- Transition from downslope (S) to down-valley (W) winds
- Shallow temperature inversion: 5–10 m

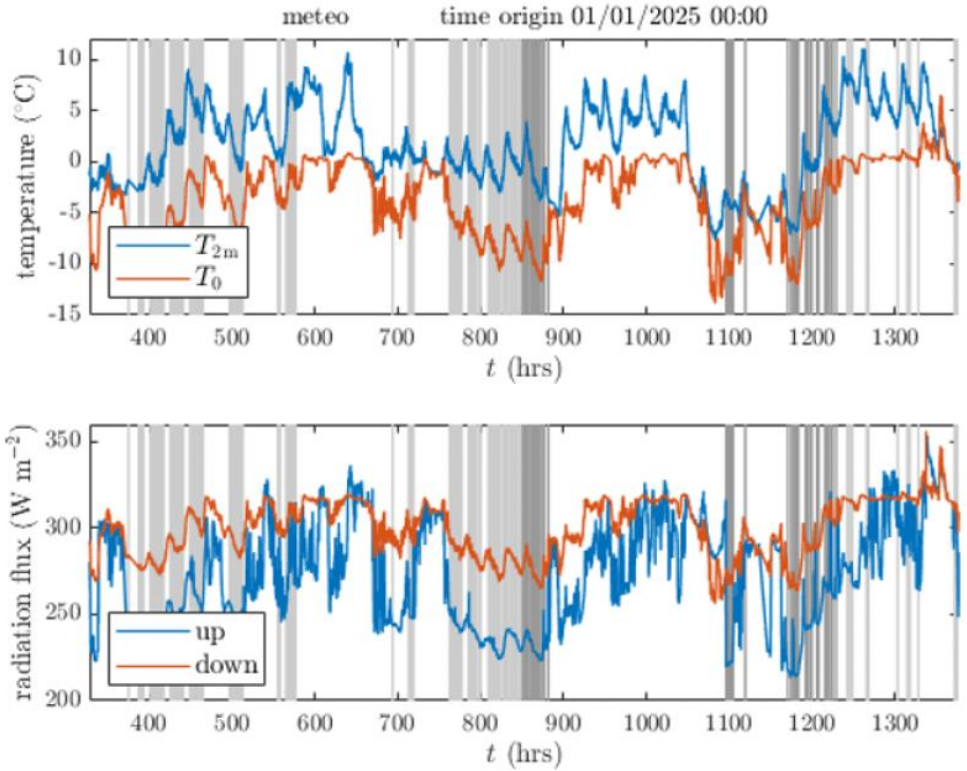
Credit: A. Gohm, C. Brun, L. Pfister



Katabatic winds

Radiative flux divergence:

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



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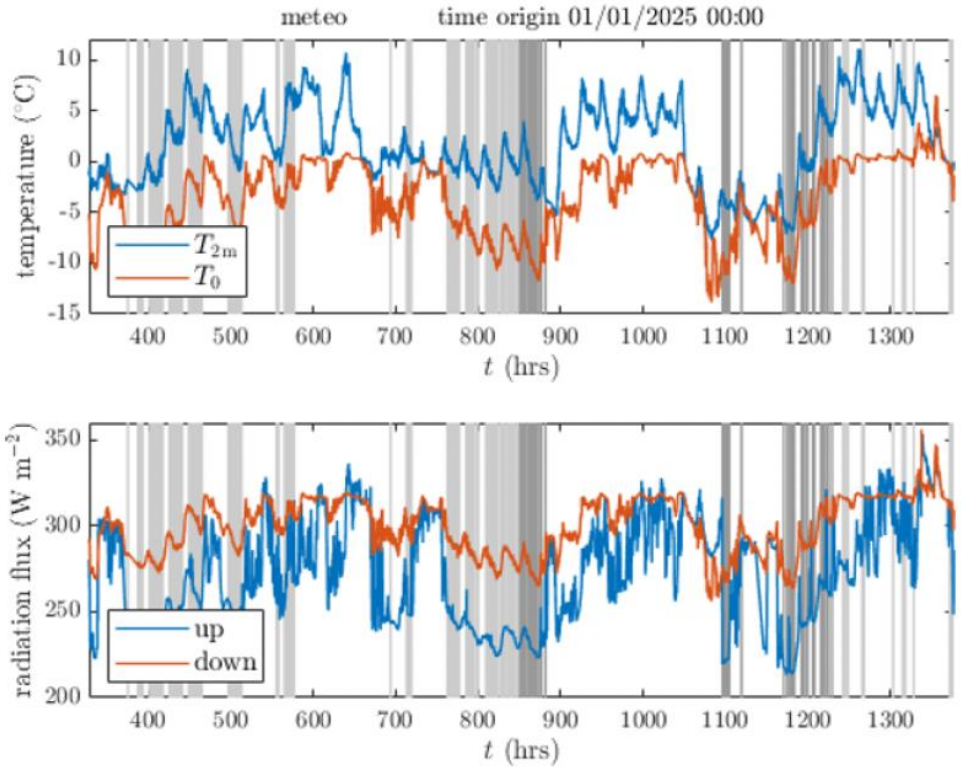

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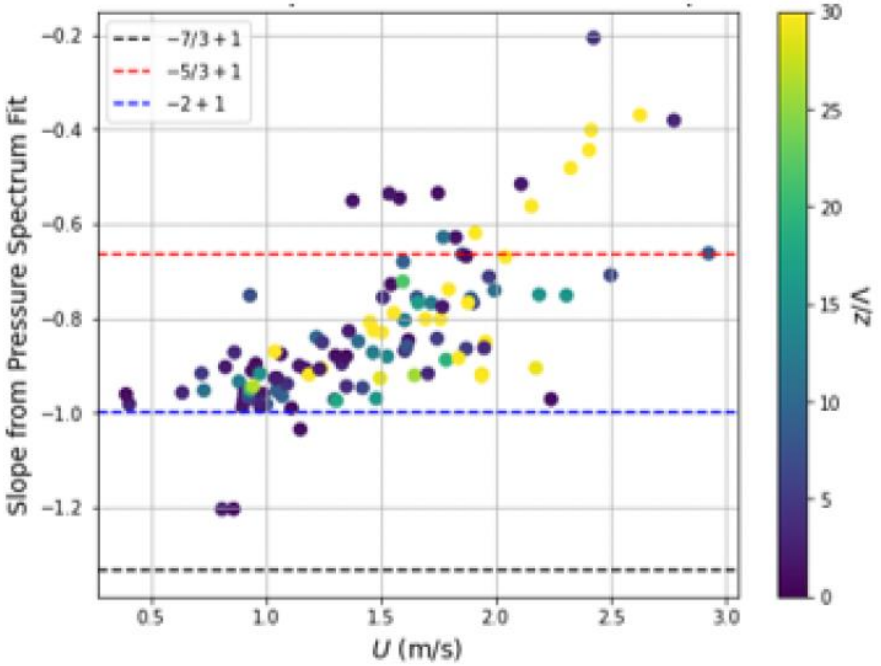
Pressure spectra: spectral slope is a function of wind speed for non-katabatic conditions



IOP	Length	Type	Flights	Raso KOL	Raso STZ	Teth. Ball.	UAS
IOP1	13 h	KAT		4 snds		4 profs	25 profs
IOP2	15 h	GW		6 snds	2 x 4 snds		
IOP3	21 h	GW			2 x 8 snds		
IOP4	12 h	KAT		5 snds		4 profs	18 profs
IOP5	15 h	GW			6 snds		
IOP6	15 h	KAT		6 snds		3 profs	
IOP7	12 h	GW			2 x 5 snds		
IOP8	16 h	KAT				8 profs	13 profs
IOP9	45 h	KAT		16 snds		16 profs	31 profs
IOP10	24 h	GW		5 snds	2 x 9 snds		
IOP11	15 h	GW		5 snds	2 x 5 snds + 1 snd		
IOP12	9 h	GW		5 snds	2 x 5 snds		
IOP13	15 h	KAT		6 snds		5 profs	15 profs
IOP14	12 h	MoBL – therm	2 x 4 h	5 snds	3 snds		
IOP15	12 h	MoBL – therm	2 x 4 h	5 snds	3 snds		
IOP16	12 h	MoBL – dyn	2 x 4 h	5 snds	3 snds		
IOP17	6 h	GW		3 snds	2 x 3 snds		
IOP18	9 h	GW		4 snds	2 x 4 snds		

High-resolution NWP forecasts

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

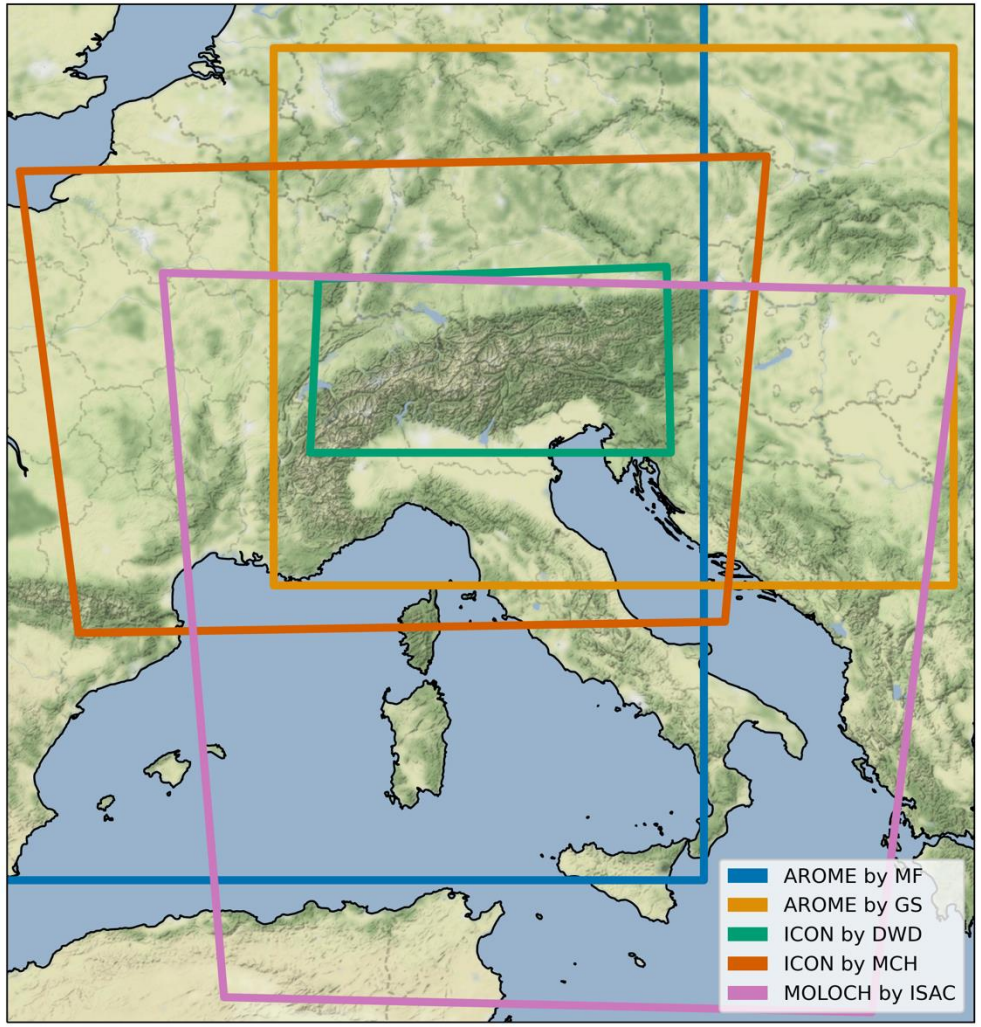
Low-level clouds in the Inn Valley

Wind speed across the Alps (S-N)

TEAMx NWP forecast runs

- Several European weather services have offered TEAMx forecast runs
  - DWD 0.5-km ICON run is visualized semi-operationally and available to the TEAMx community
  - Météo-France and Met Office have delivered first runs → visualization in progress
  - Met Office have also created a webportal for their run (accessible to the TEAMx community)
- UIBK weather portal made accessible to the TEAMx community
- High-resolution runs accessible on a public server
  - Simple website for better navigation in preparation

High-resolution NWP forecasts



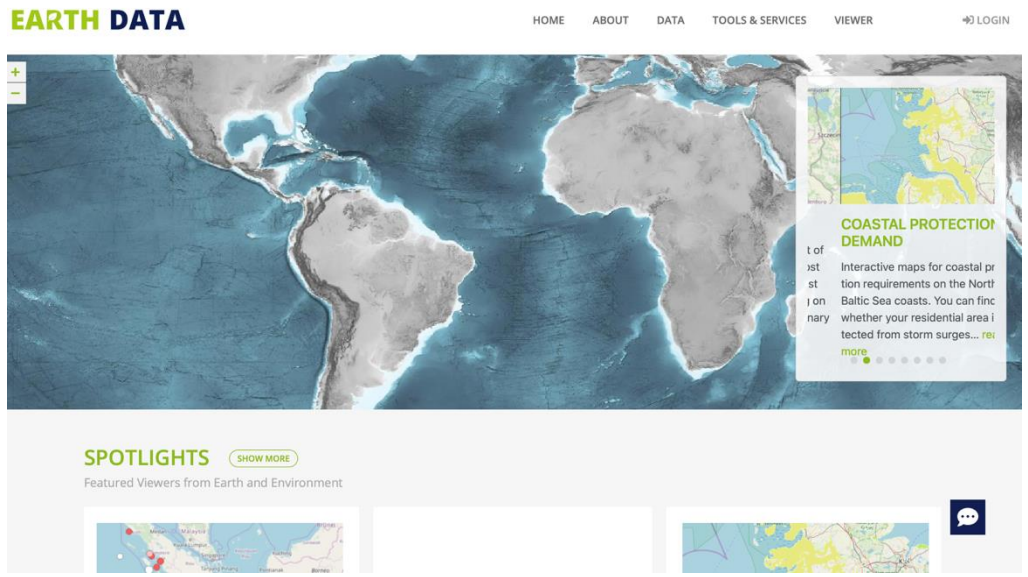
Data availability

- TEAMx data agreement

  → one year embargo after end of corresponding EOP

  → to protect PhD students

- data will be accessible via Earth Portal (earth-data.de)



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  - → to protect PhD students
- data will be accessible via Earth Portal (earth-data.de)
- PIs will ‘be happy’ to share data
  - → private exchange
  - → if it is for other purpose than ‘theirs’
  - → teamx-pco@uibk.ac.at

Thank you for your attention