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

Manuela Lehner[1], Mathias W Rotach[1]

on behalf of the TEAMx *Coordination and Implementation Group*

Marco Arpagaus[2], Nikolina Ban[1], Sven Kotlarski[2], Peter Knippertz[4], Dan Kirshbaum[5], Stephen Mobbs[6], Alexandre Paci/Didier Ricard[7], Stefano Serafin[9], Helen Ward[1], Christoph Wittmann[10], Günther Zängl[3], Dino Zardi[11]

[1]University of Innsbruck, [2]MeteoSwiss, [3]Deutscher Wetterdienst, [4]Karlsruhe Institute of Technology, [5]McGill University, [6]National Centre of Atmospheric Sciences, [7]Meteo France, [8]ISAC CNR, [9]Univerisity of Vienna, [10]GeoSphere Austria, [11]University of Trento

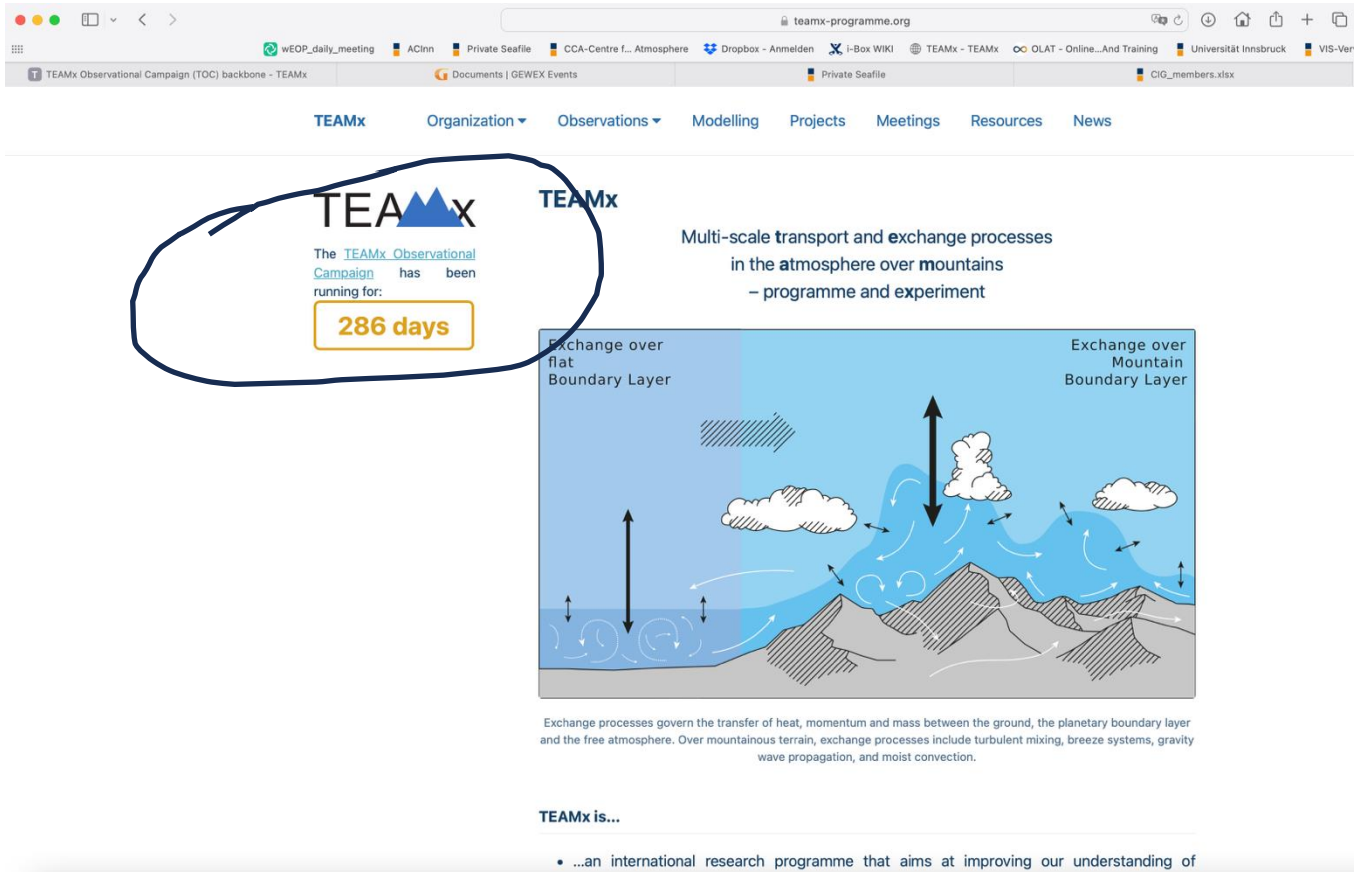
www.teamx-programme.org

What is TEAMx?

Multi-scale Transport and
Exchange Processes in the
Atmosphere over
Mountains
Programme and experiment

- TEAMx is a bottom-up financed research program on weather, climate, and air pollution in mountain areas.
- TEAMx follows in the footsteps of previous international mountain meteorology programs (ALPEX, PYREX, MAP).
- A Programme Coordination Office (PCO) at UIBK is financed through institutional crowd funding.

TEAMx news



….and in particular, the summer EOP is currently ongoing

Objectives, Goals & Accomplishments

Goals for 2024

- preparations for the TEAMx Observational Campaign (TOC), including
- the publication of the TEAMx Numerical Modeling Plan ✓
- the completion of the TEAMx Data Management Plan ✓
- a first version of the Implementation Plan ✓
- organization of the 4th TEAMx Workshop ✓
- the planning of and preparation for all the TOC activities ✓

Further highlights and accomplishments

- 7 new TEAMx projects have started since the beginning of 2024

  → plus 4 TEAMx-UK projects assigned
- 8 TEAMx proposals are currently awaiting funding decisions
- TEAMx Session at EMS Annual Meeting 2024
- first model intercomparison results presented

Further highlights and accomplishments

Model intercomparison studies

- cold pool case study, Piano field campaign

Participating models/groups

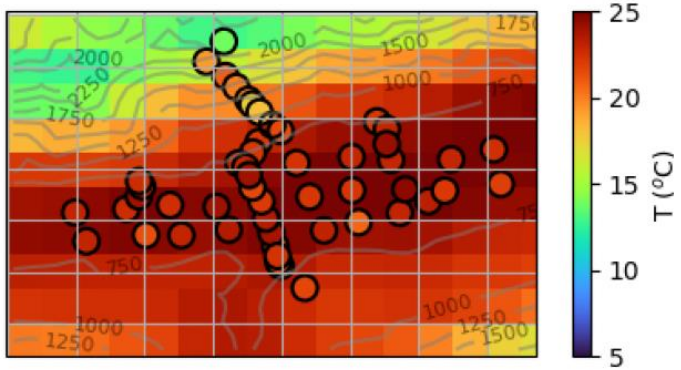
Model	Group	Presentation
AROME	GeoSphere Austria	x
AROME	Météo-France	
ICON	Goethe Universität Frankfurt	x
Meso-NH	Météo-France	
UM	Met Office	x
WRF	University of Innsbruck	x
WRF	Université Grenoble Alpes	

Lehner et al. 2024 (EMS annual meeting)

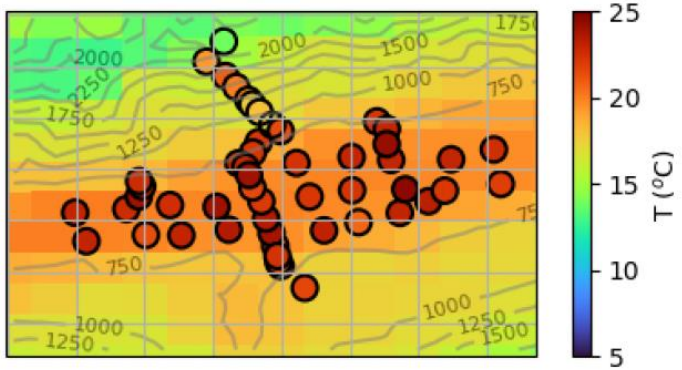
Near-surface temperature field

Afternoon (14 UTC)

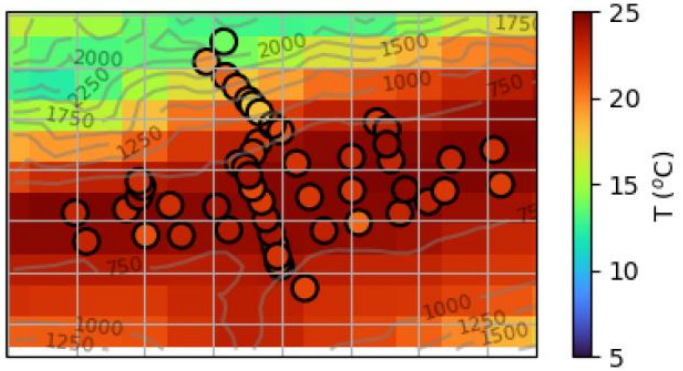
AROME



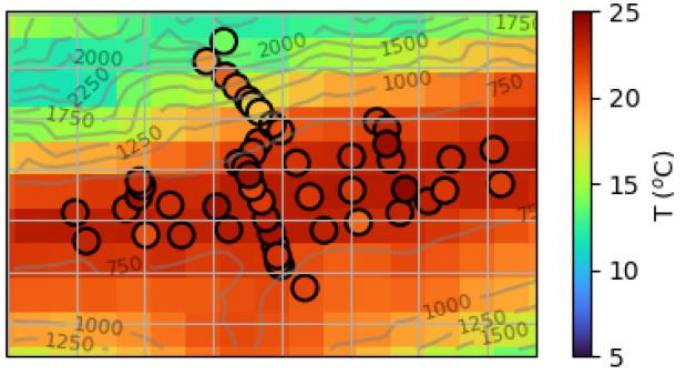
UM



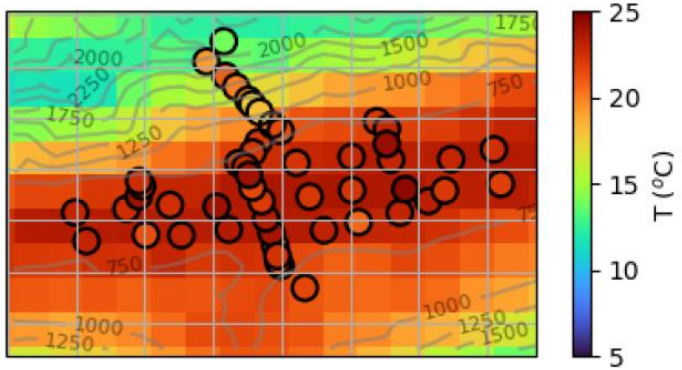
WRF



ICON



ICON-2TE



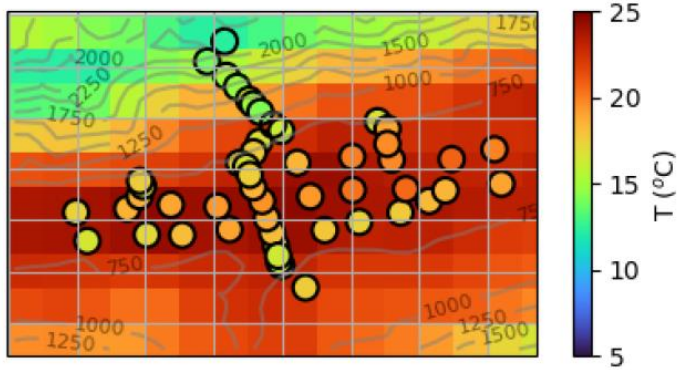
HOBO obs

Models agree with observations before sunset.

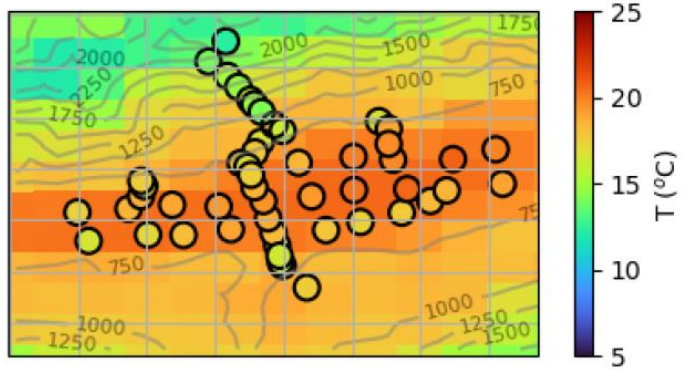
Near-surface temperature field

Evening (16 UTC)

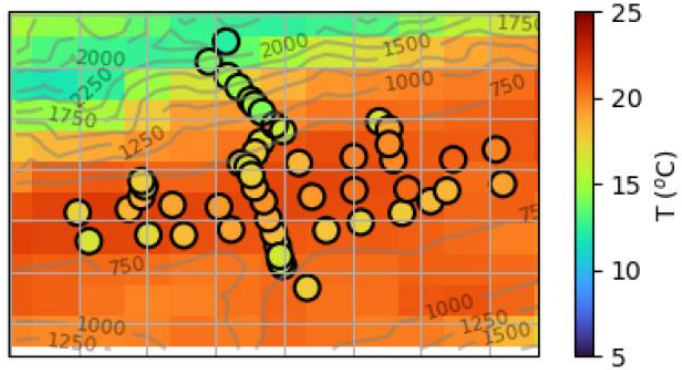
AROME



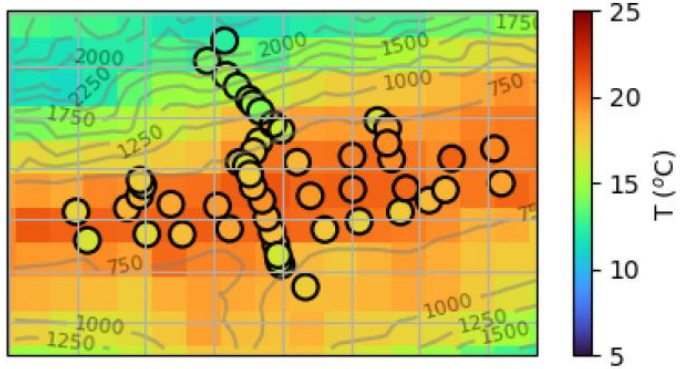
UM



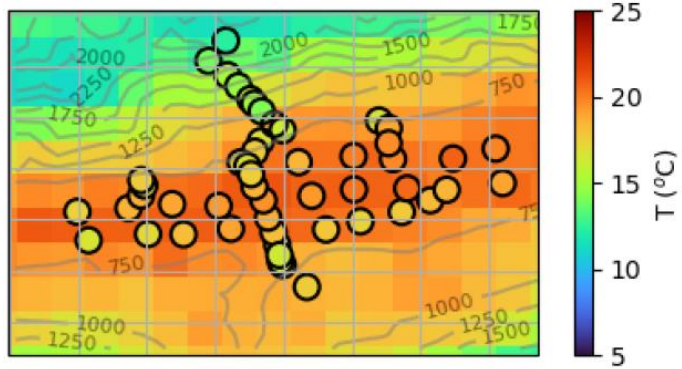
WRF



ICON



ICON-2TE



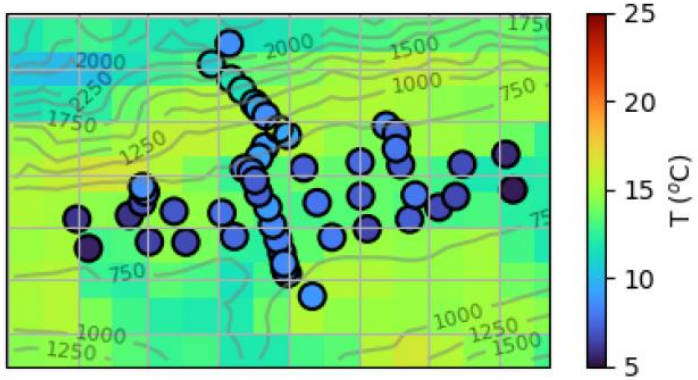
HOBO obs

Evening cooling too weak.

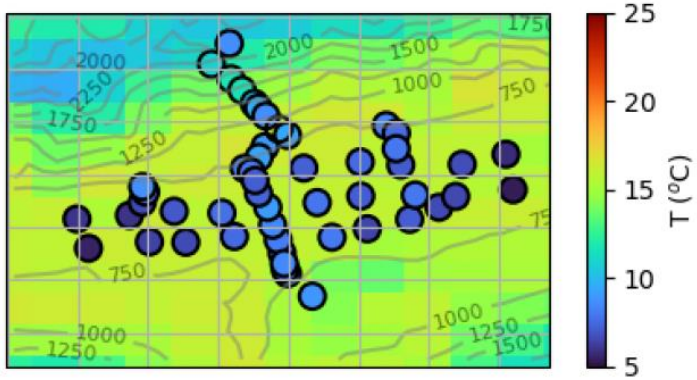
Near-surface temperature field

Early morning (06 UTC)

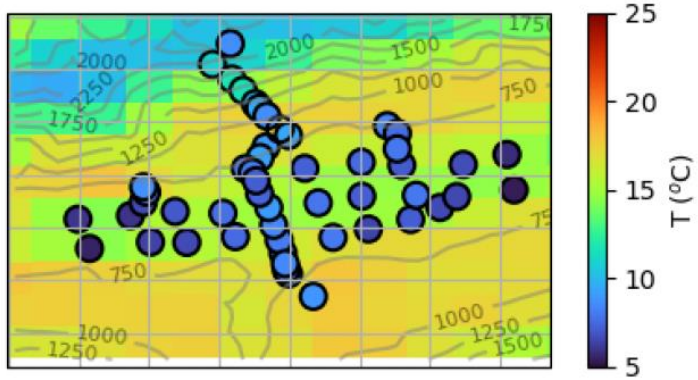
AROME



UM

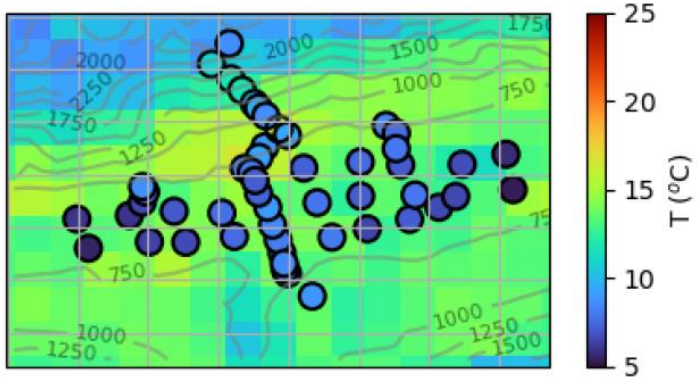


WRF

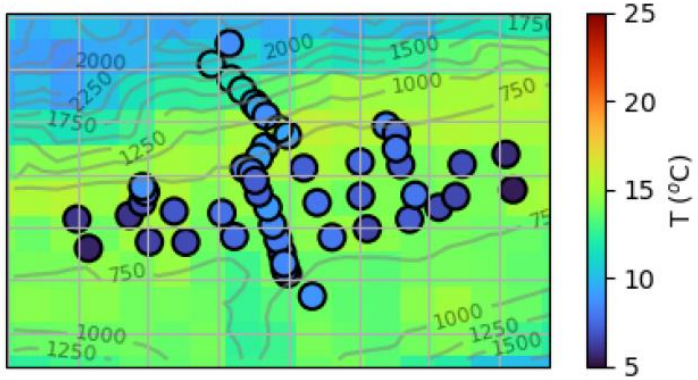


HOBO obs

ICON

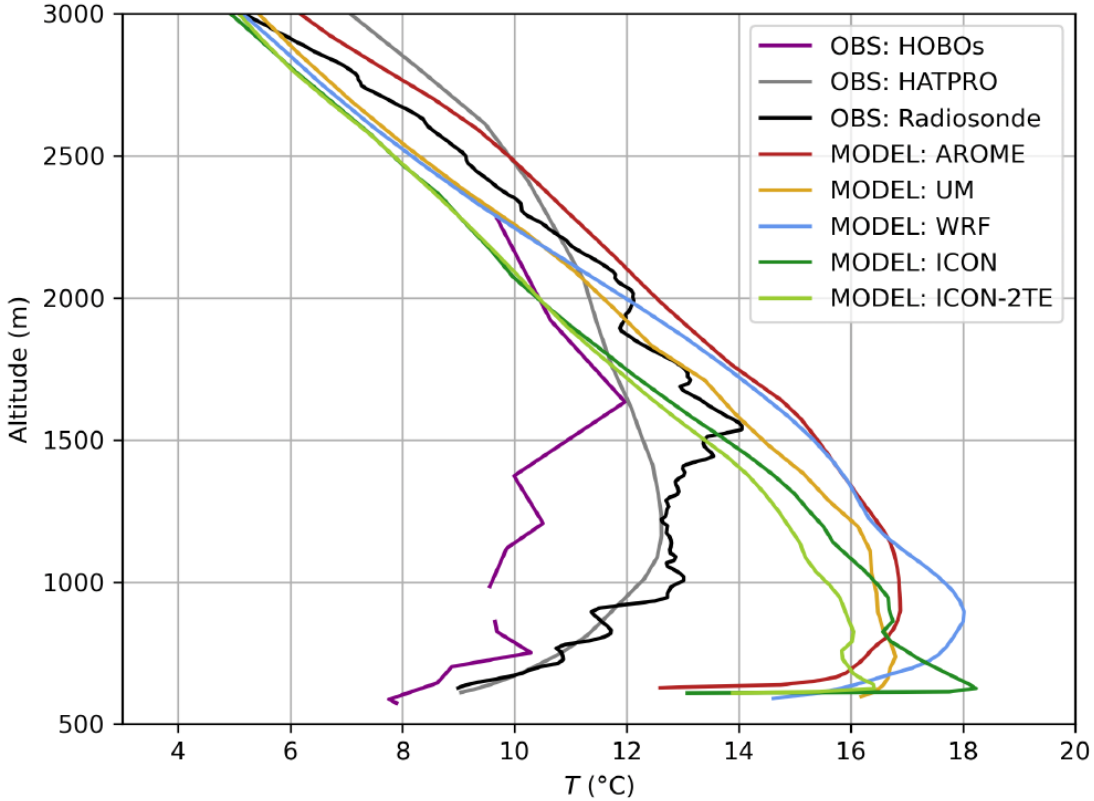


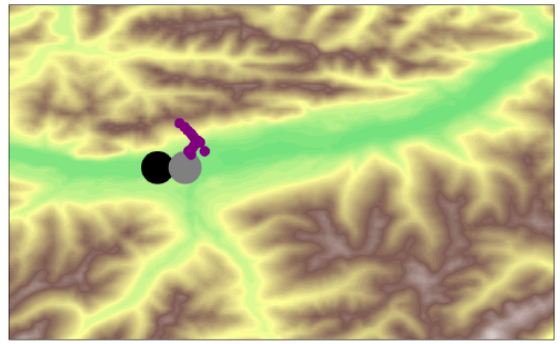
ICON-2TE



All models too warm during nighttime.

Temperature profiles at Innsbruck

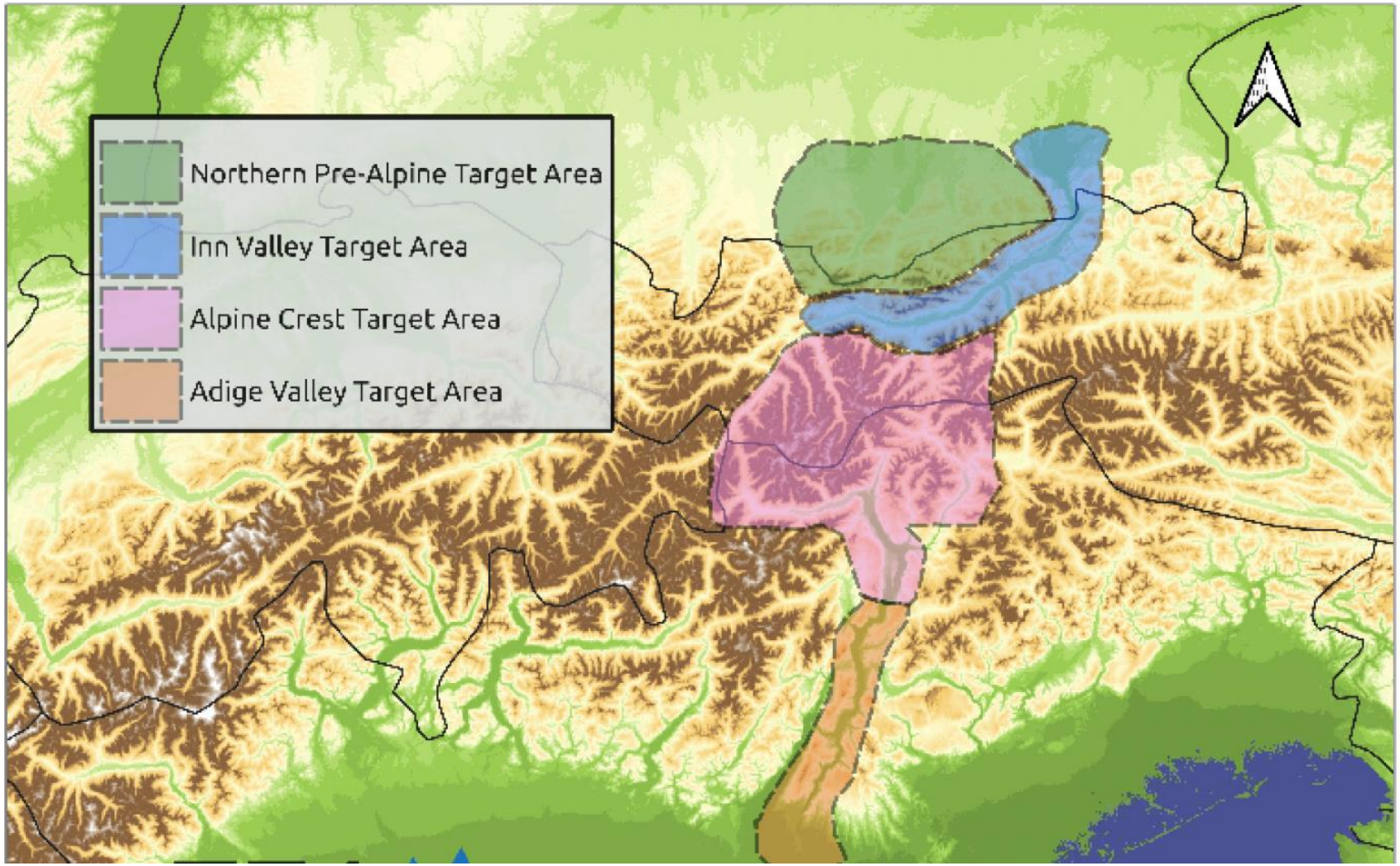




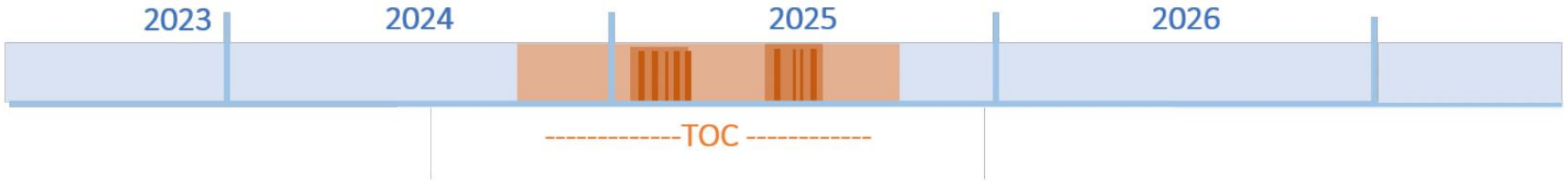
- Continuous (pseudo-)vertical profiles from
  - a microwave T/RH profiler (HATPRO)
  - a line of temperature sensors running up the north valley sidewall (HOBOs)

Move on to actually ongoing TOC…..

TEAMx Observational Campaign (TOC)

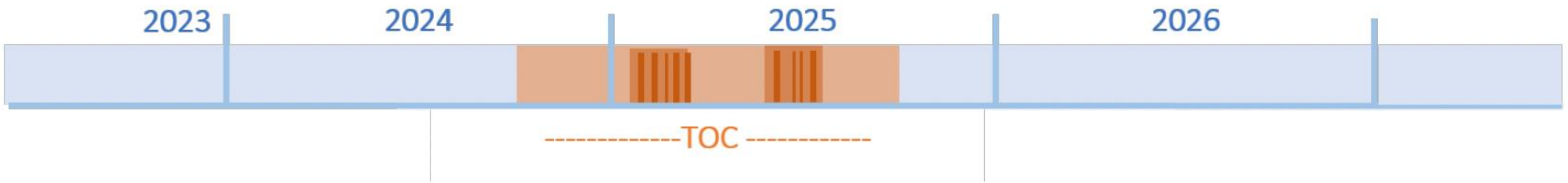


TEAMx Observational Campaign (TOC)



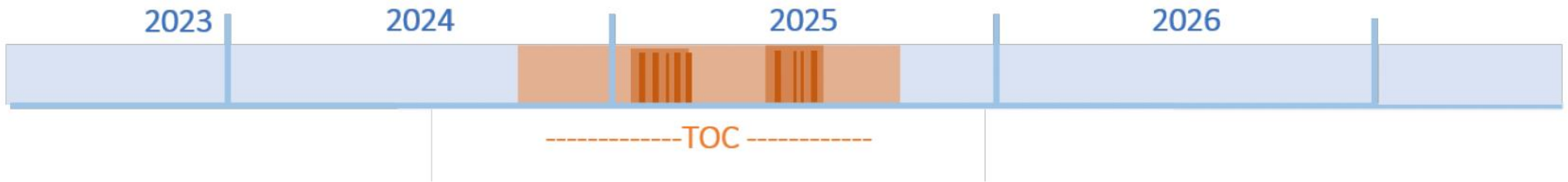
- One-year long TOC

TEAMx Observational Campaign (TOC)



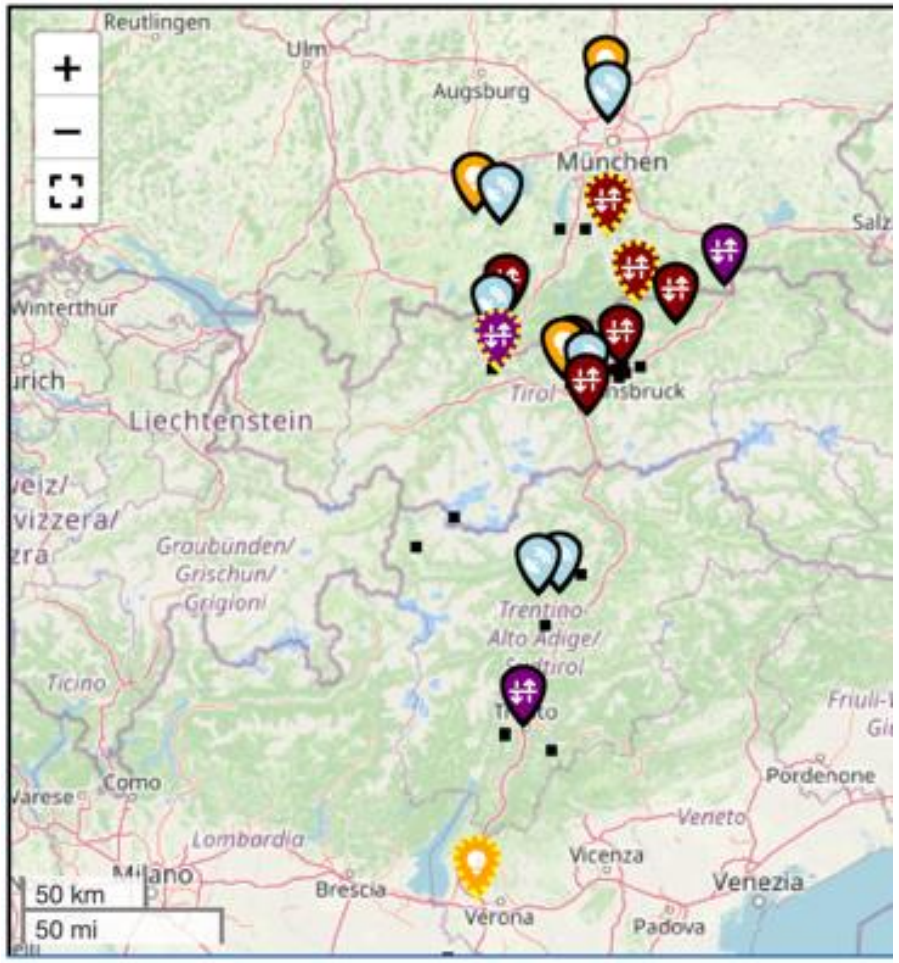
- One-year long TOC
- Winter EOP (wEOP): 20 Jan–28 Feb
- Summer EOP (sEOP): 16 Jun–25 Jul

TEAMx Observational Campaign (TOC)



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

TEAMx Observational Campaign (TOC)



Backbone infrastructure
Winter EOP

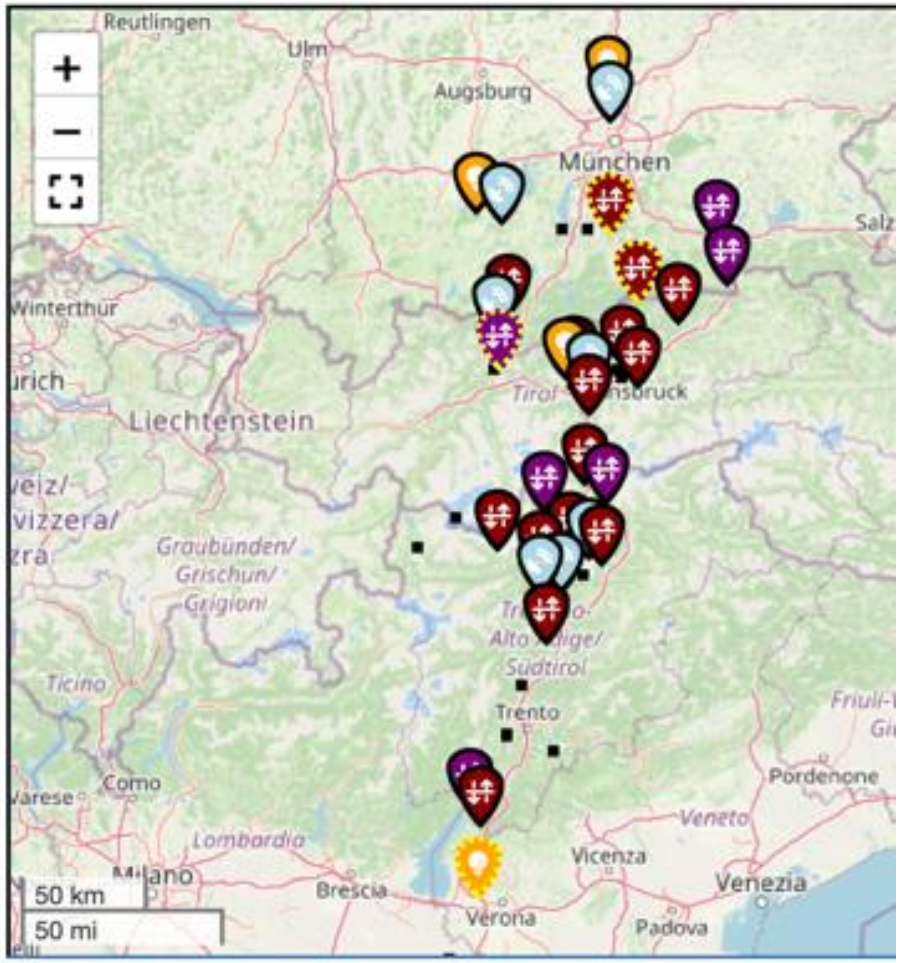
Wind lidar and/or T/RH profiler

Radiosonde

Surface flux site

Gap identified in the backbone infrastructure. Ongoing attempts to attract further research groups to fill these gaps.

TEAMx Observational Campaign (TOC)



Backbone infrastructure
Summer EOP

Wind lidar and/or T/RH profiler

Radiosonde

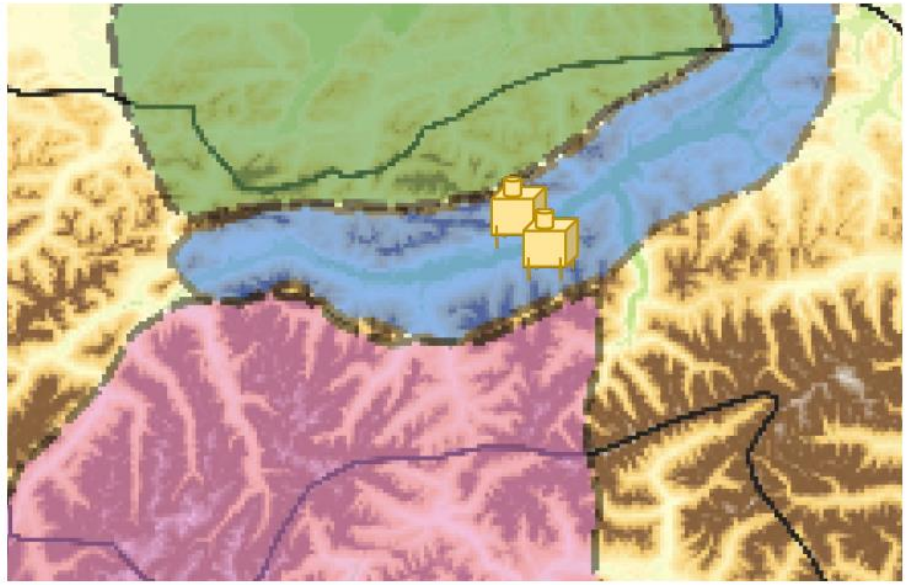
Surface flux site

Gap identified in the backbone infrastructure. Ongoing attempts to attract further research groups to fill these gaps.

Examples wEOP

3 Fog and low stratus

Karlsruhe Low-Cloud Exploratory Platform (KLOCX)



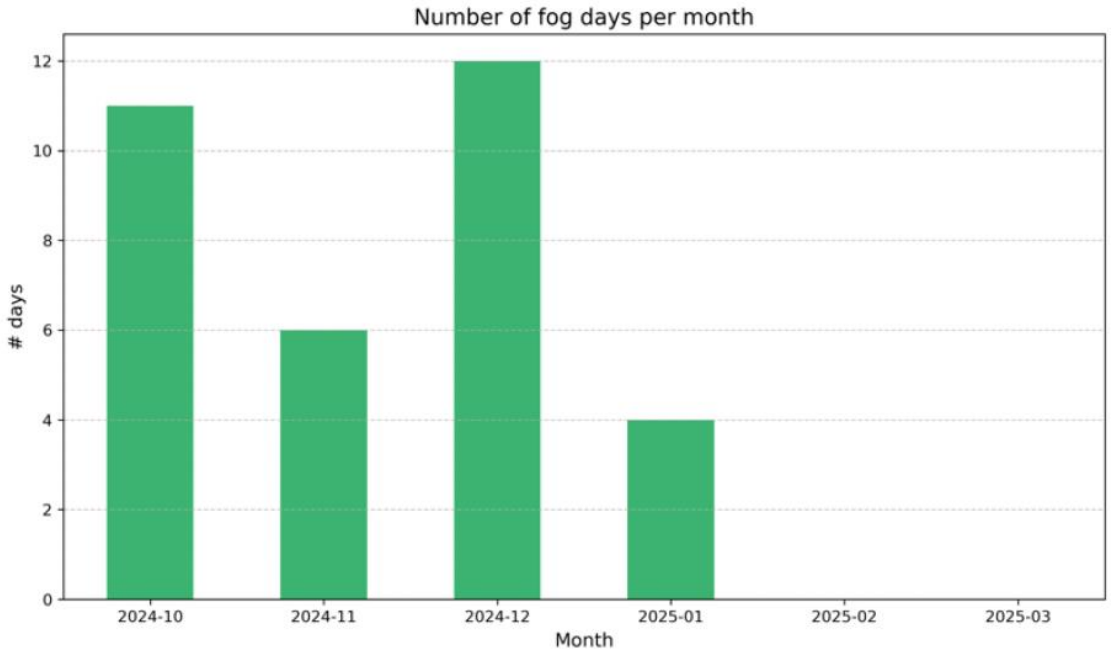
- 25 Sep 2024–31 Mar 2025
- Life-cycle phases of low-level stratiform clouds and fog

Credit: J. Vüllers KIT

TEAMx

Fog and low stratus

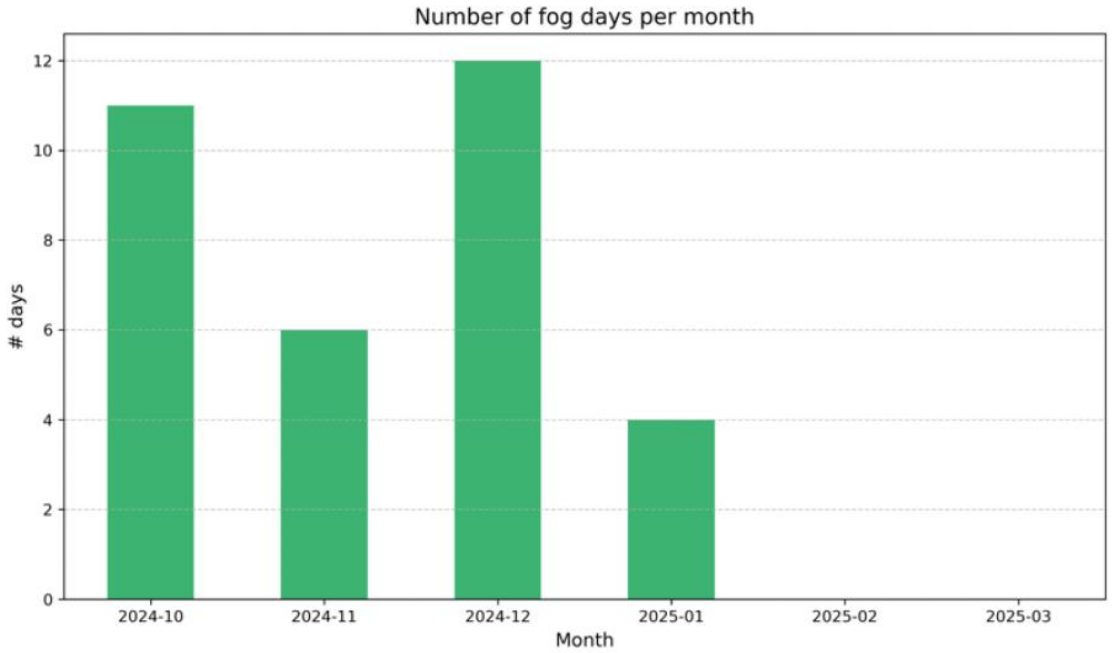
- 33 days with fog (Oct–Jan)



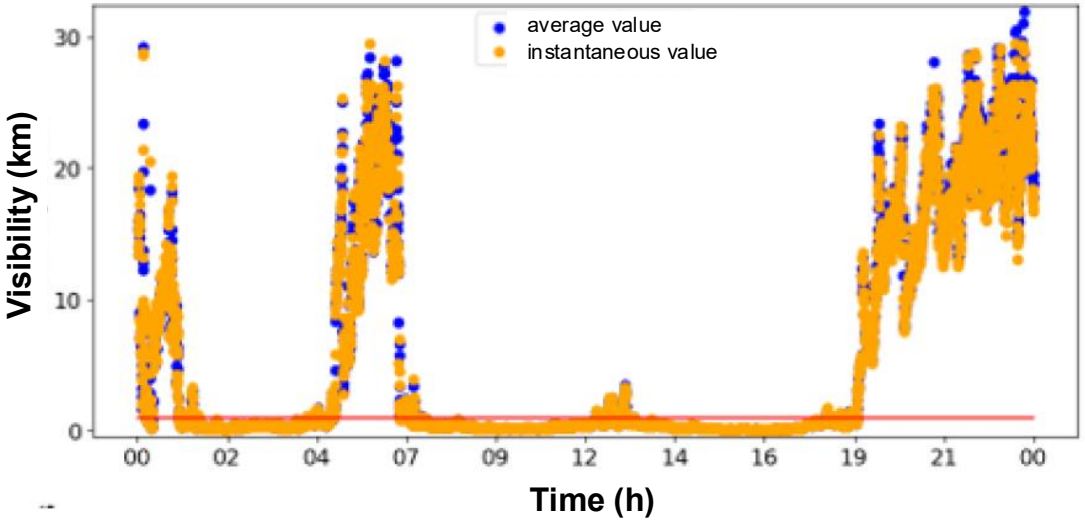
Credit: J. Vüllers KIT

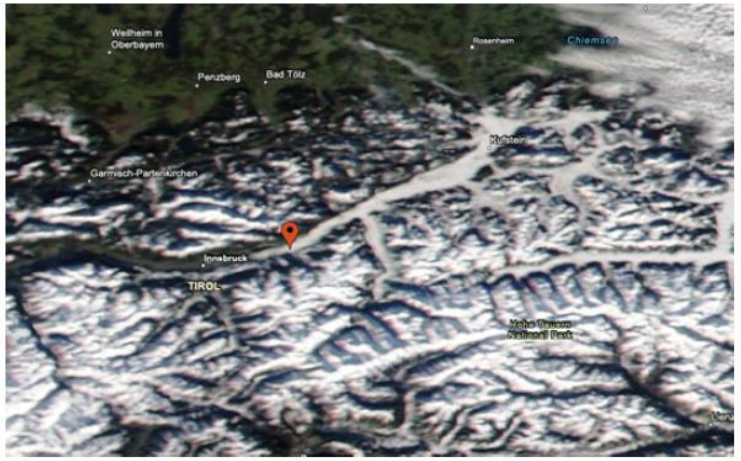
Fog and low stratus

33 days with fog (Oct–Jan)



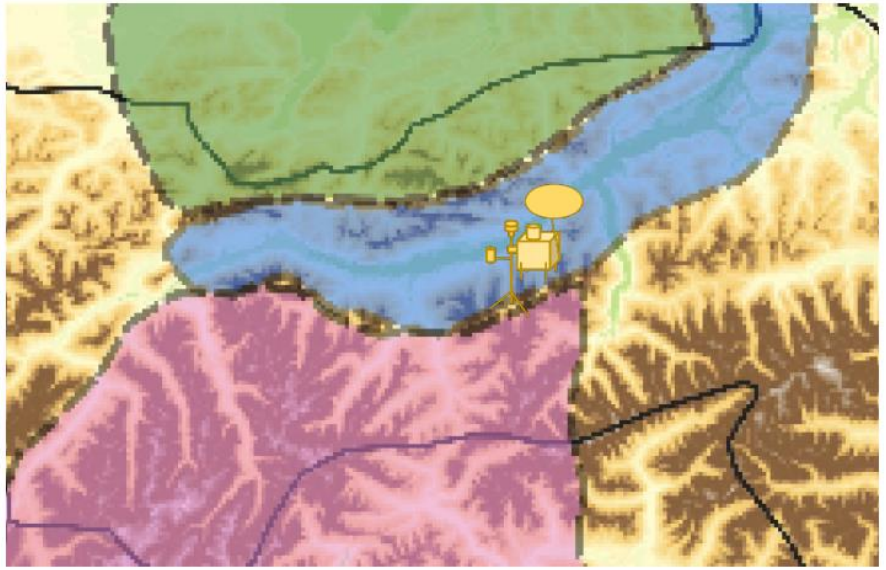
Case study—17 Dec 2024





Credit: J. Vüllers

4 Katabatic winds



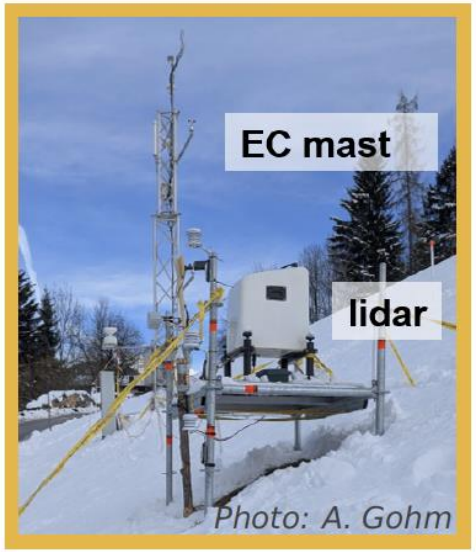
- 3D structure of mean and turbulent properties
- Surface boundary conditions for models over complex terrain
- Wide range of weather conditions (6 katabatic IOPs, multiple foehn episodes)

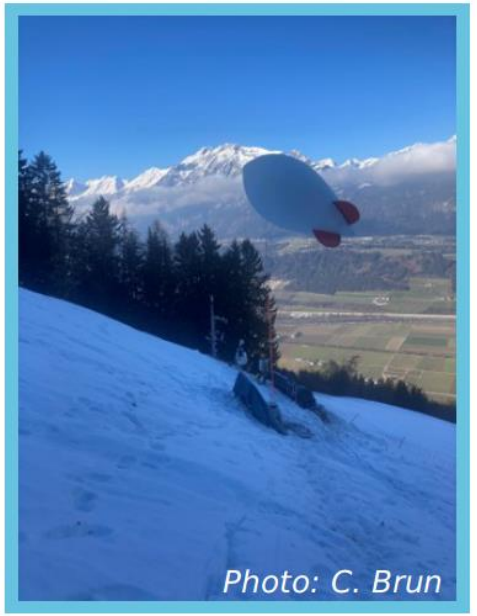
Credit: I. Stiperski, A. Gohm, L. Pfister universität innsbruck *, C. Brun* UGA Université Grenoble Alpes

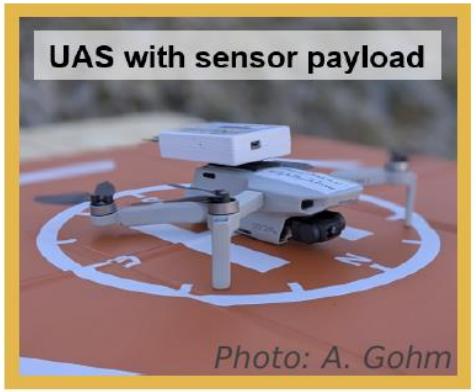
TEAMx

Katabatic winds

Vertical profiles



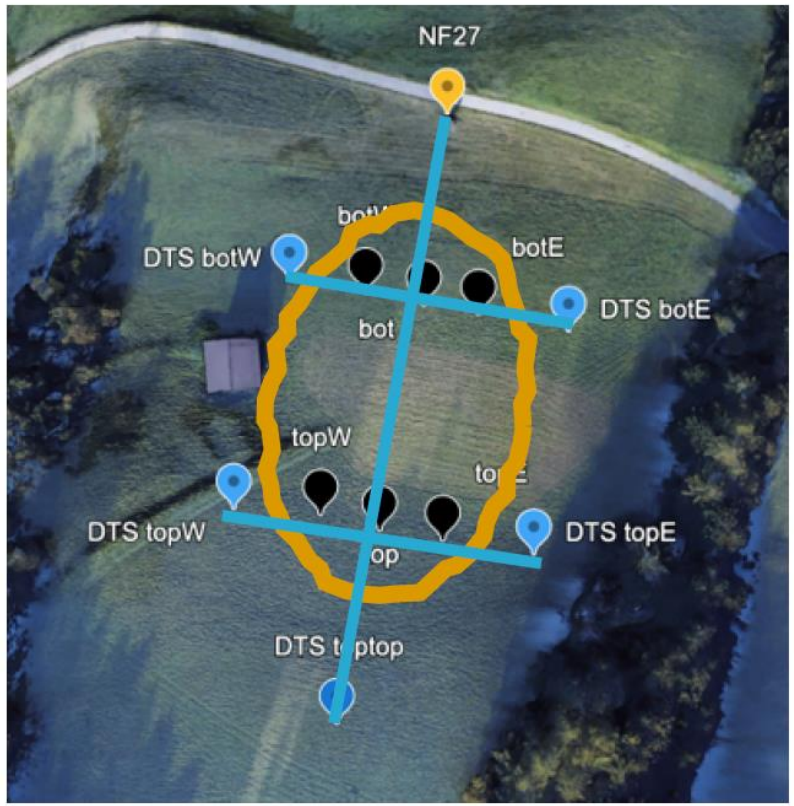




Credit: I. Stiperski, A. Gohm, L. Pfister universität innsbruck *, C. Brun* UGA Université Grenoble Alpes

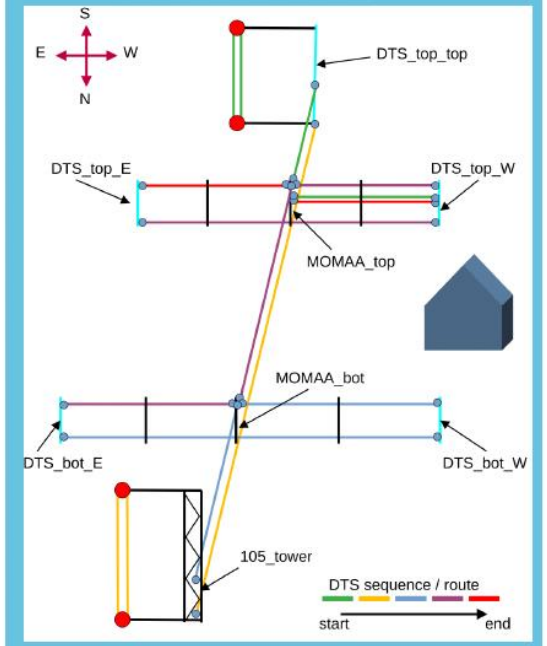
TEAMx

Katabatic winds



Spatial structure

Station network

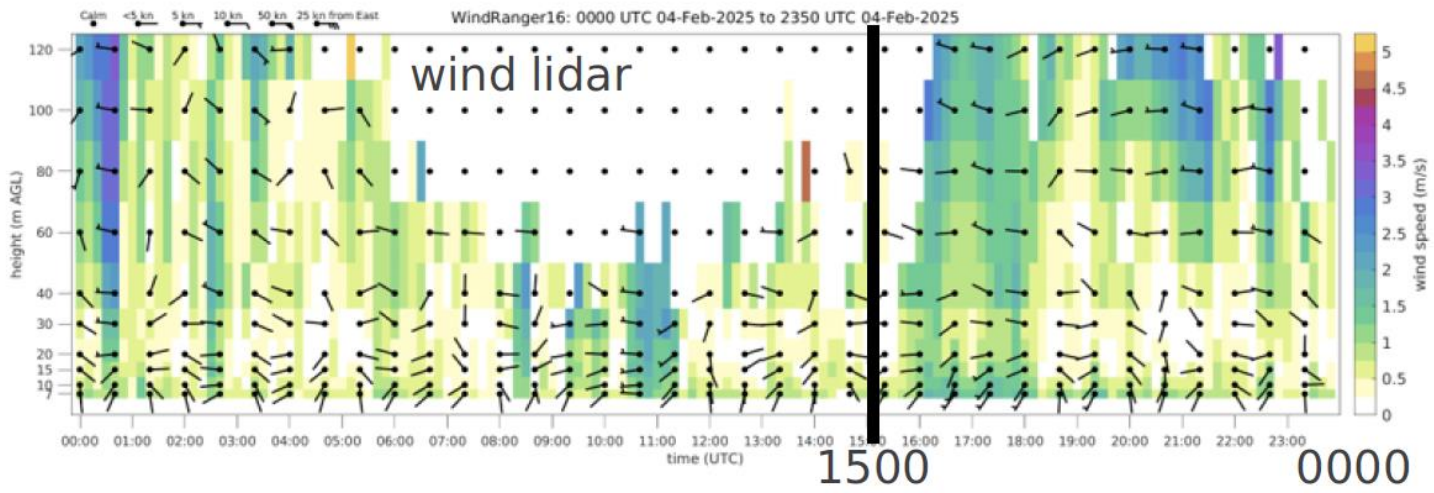


DTS array

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

TEAMx

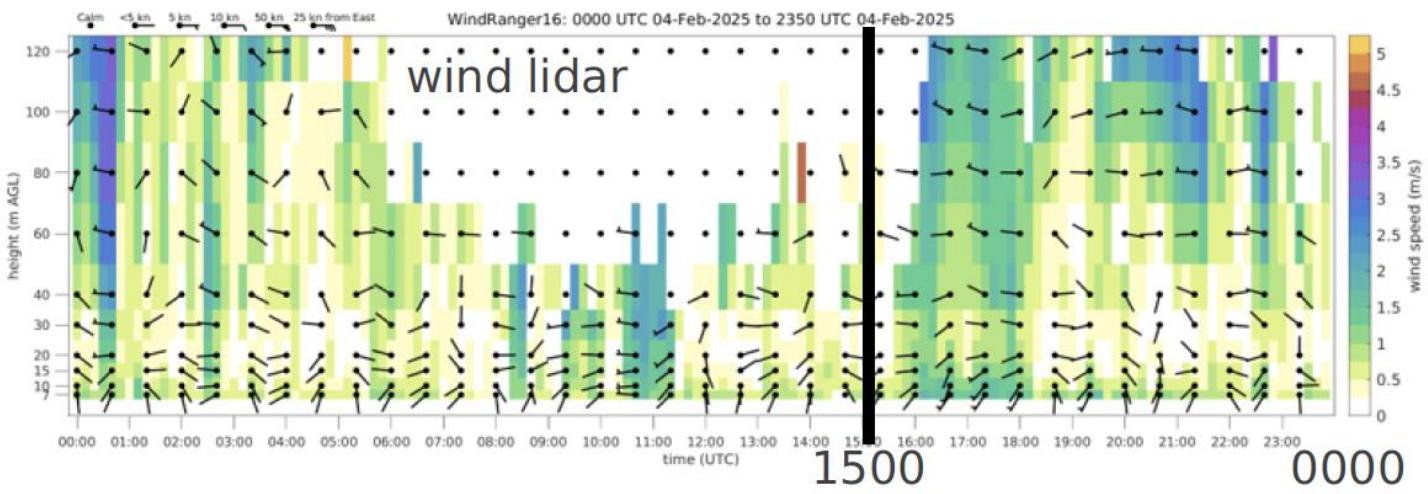
Katabatic winds—Vertical profiles

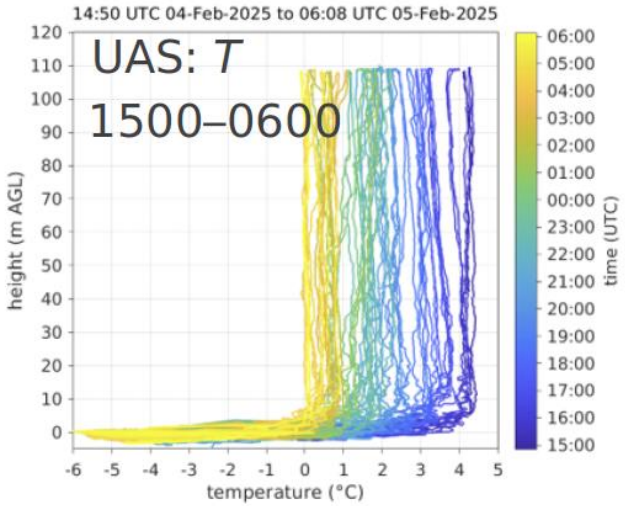


- Shallow katabatic jet: peak < lowest lidar level
- Transition from downslope (S) to down-valley (W) winds

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

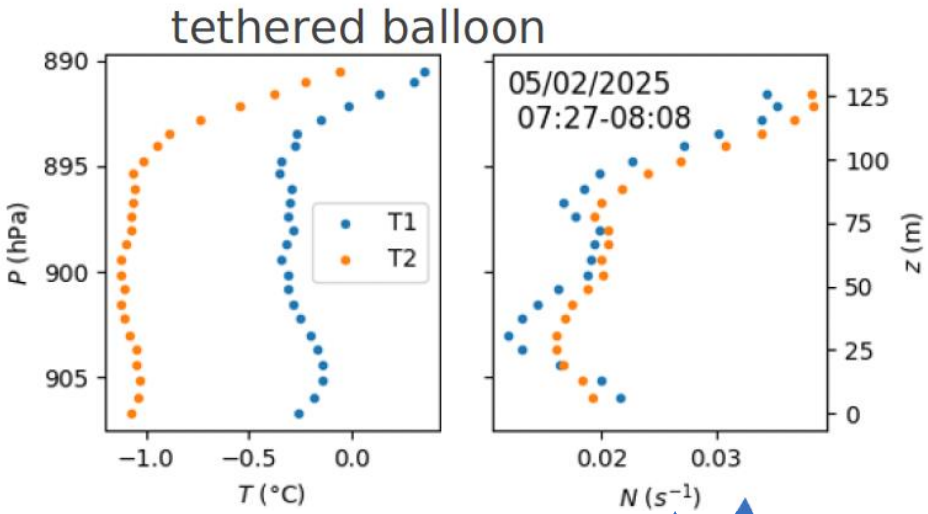
Katabatic winds—Vertical profiles





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

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



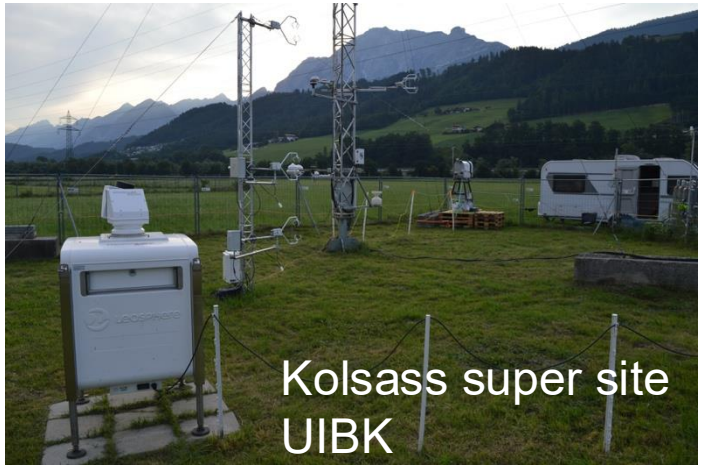
Examples sEOP

- ongoing….

KITcube Bolzano
Alpine Crest TA

Calibration MWRs
KIT – U Cologne
Alpine Crest TA

Deployment DWL
U Bergen, UIBK
Inn Valley TA



Kolsass super site
UIBK
Inn Valley TA

Radfeld
MCH – U Tübingen
Inn Valley TA

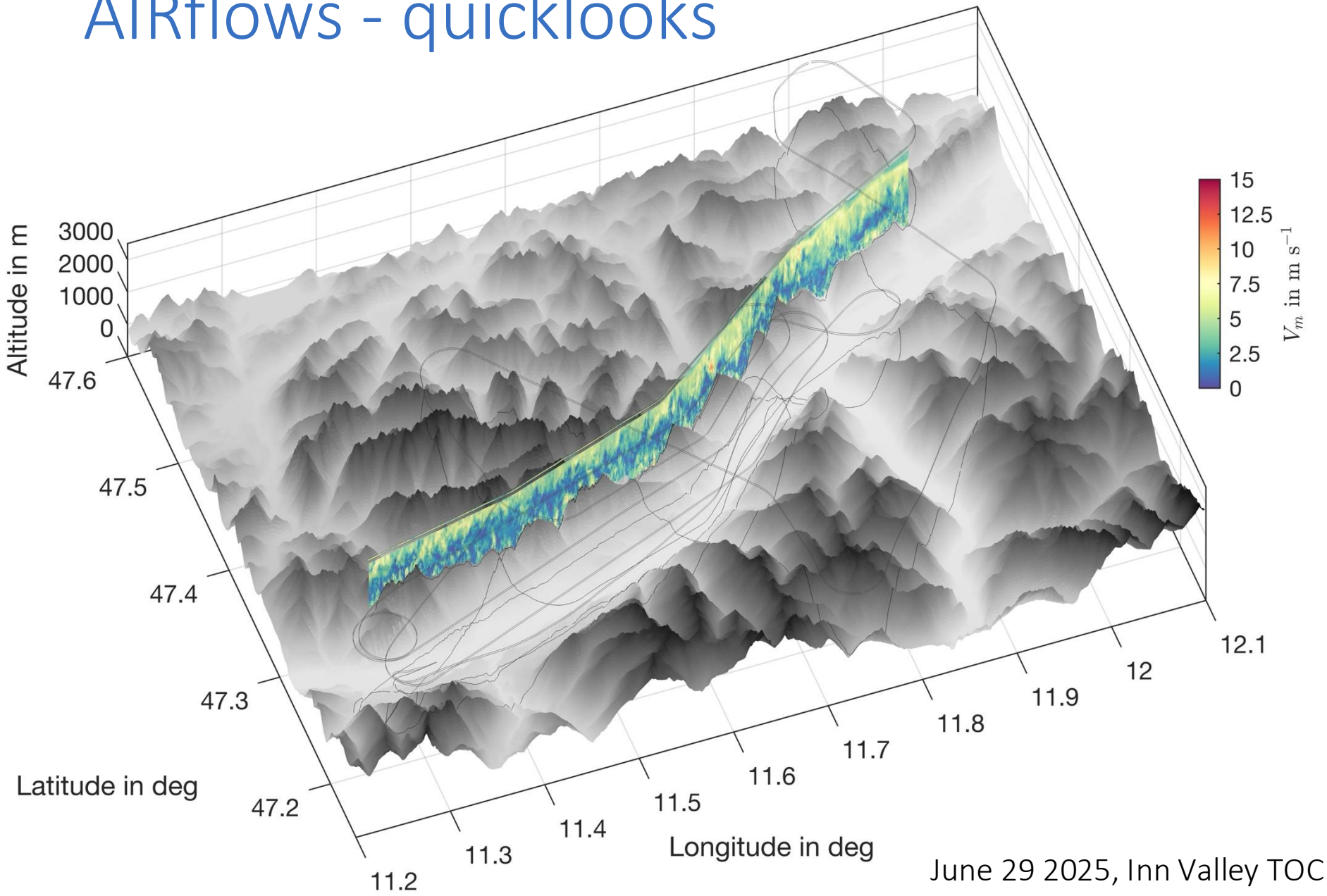
Examples sEOP

- ongoing….
- only show

  AIRflows

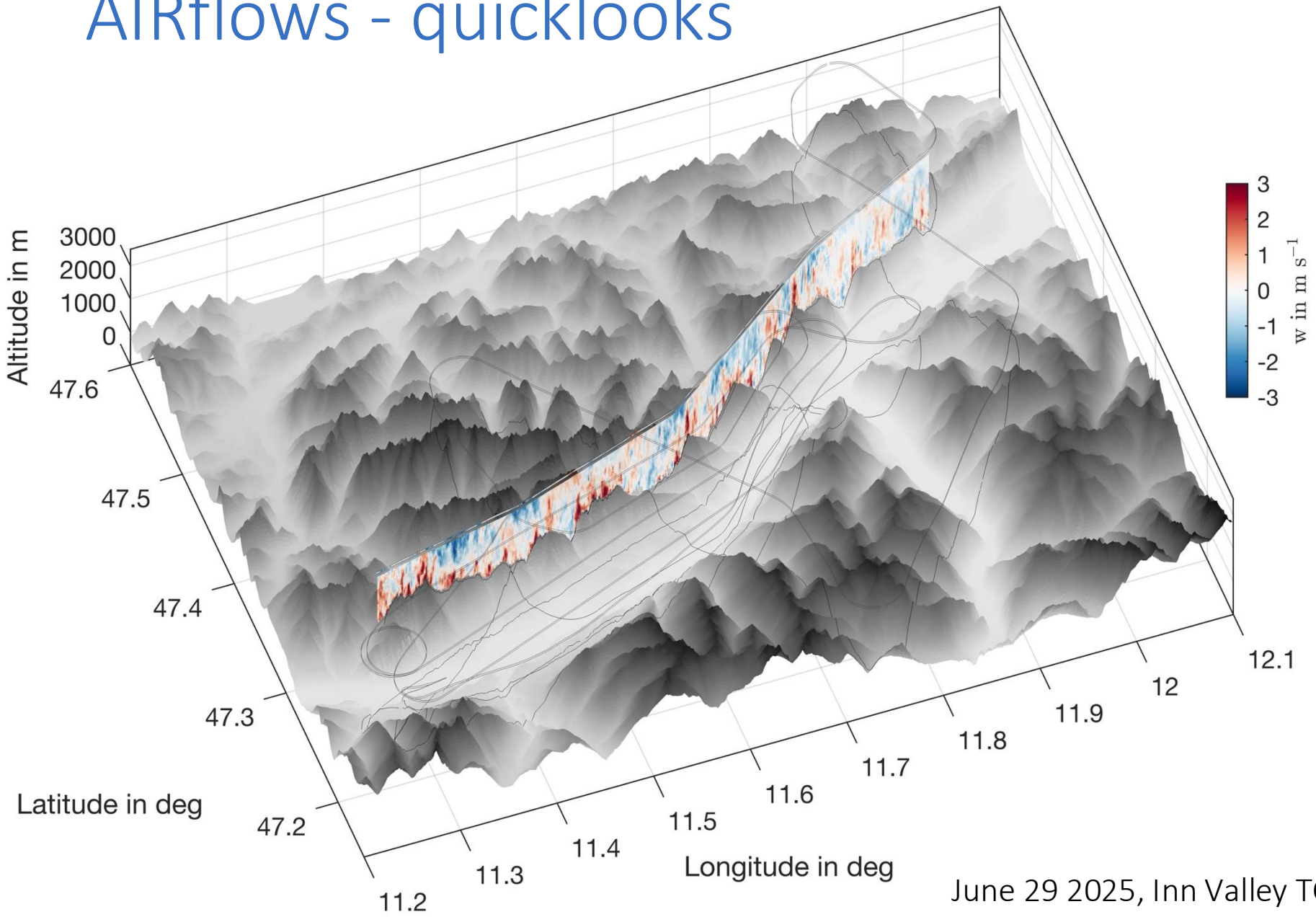
- 5-beam airborne lidar
- on board of D-ILAb Cessna
  Techn. University Braunschweig
- KIT development
  Karlsruhe Institute of Technology

AIRflows - quicklooks



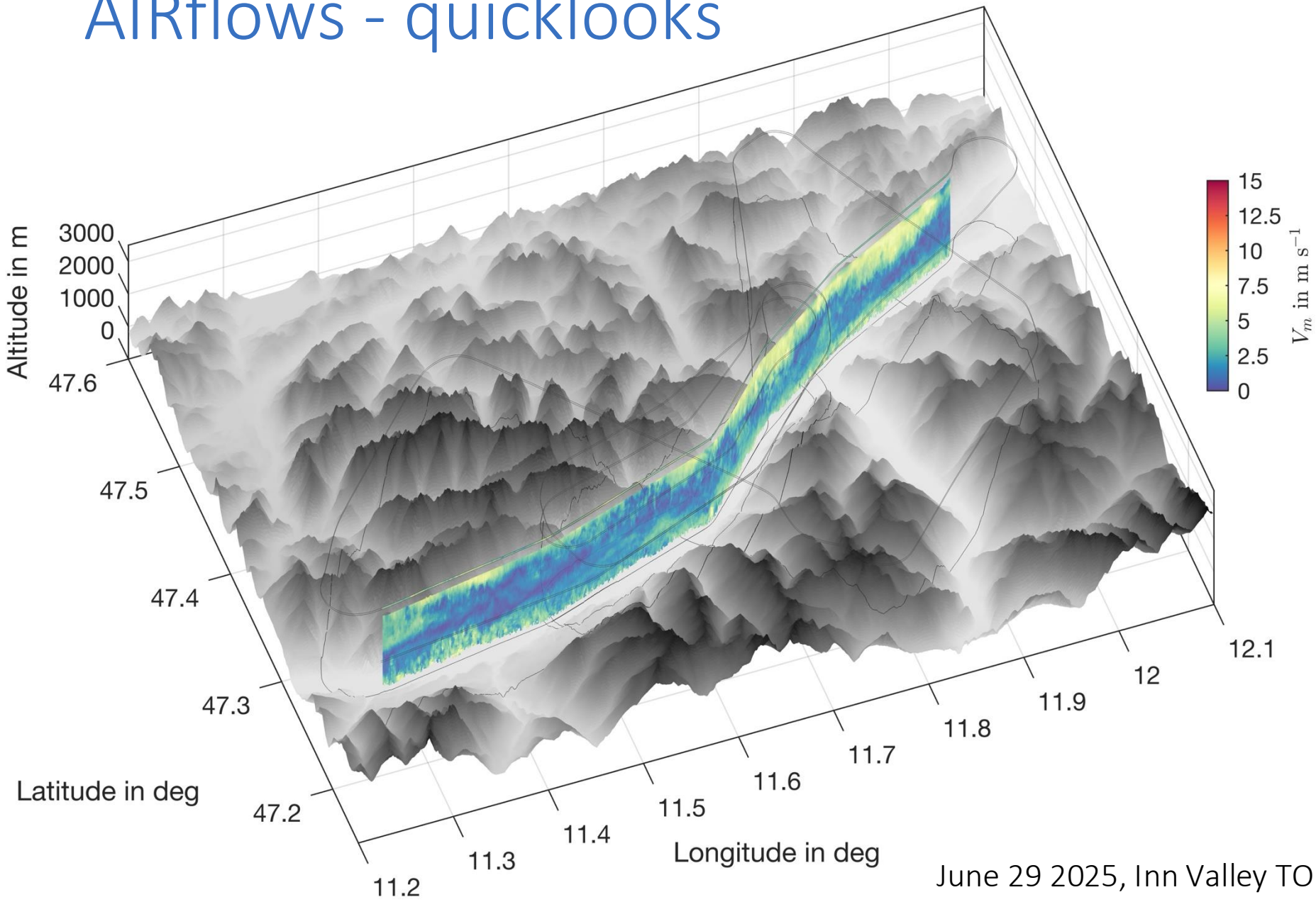
horizontal wind

AIRflows - quicklooks



vertical wind

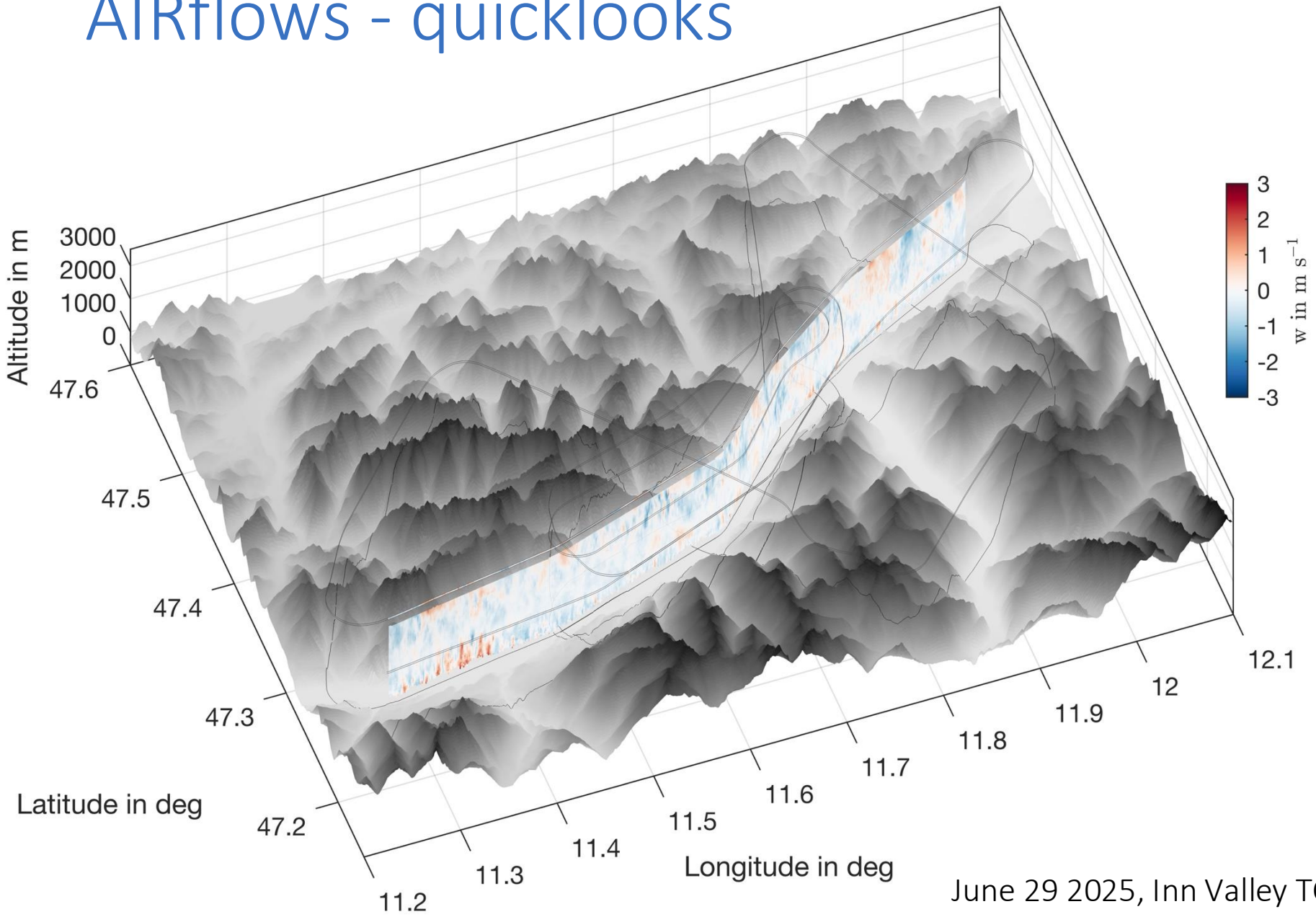
AIRflows - quicklooks



horizontal wind

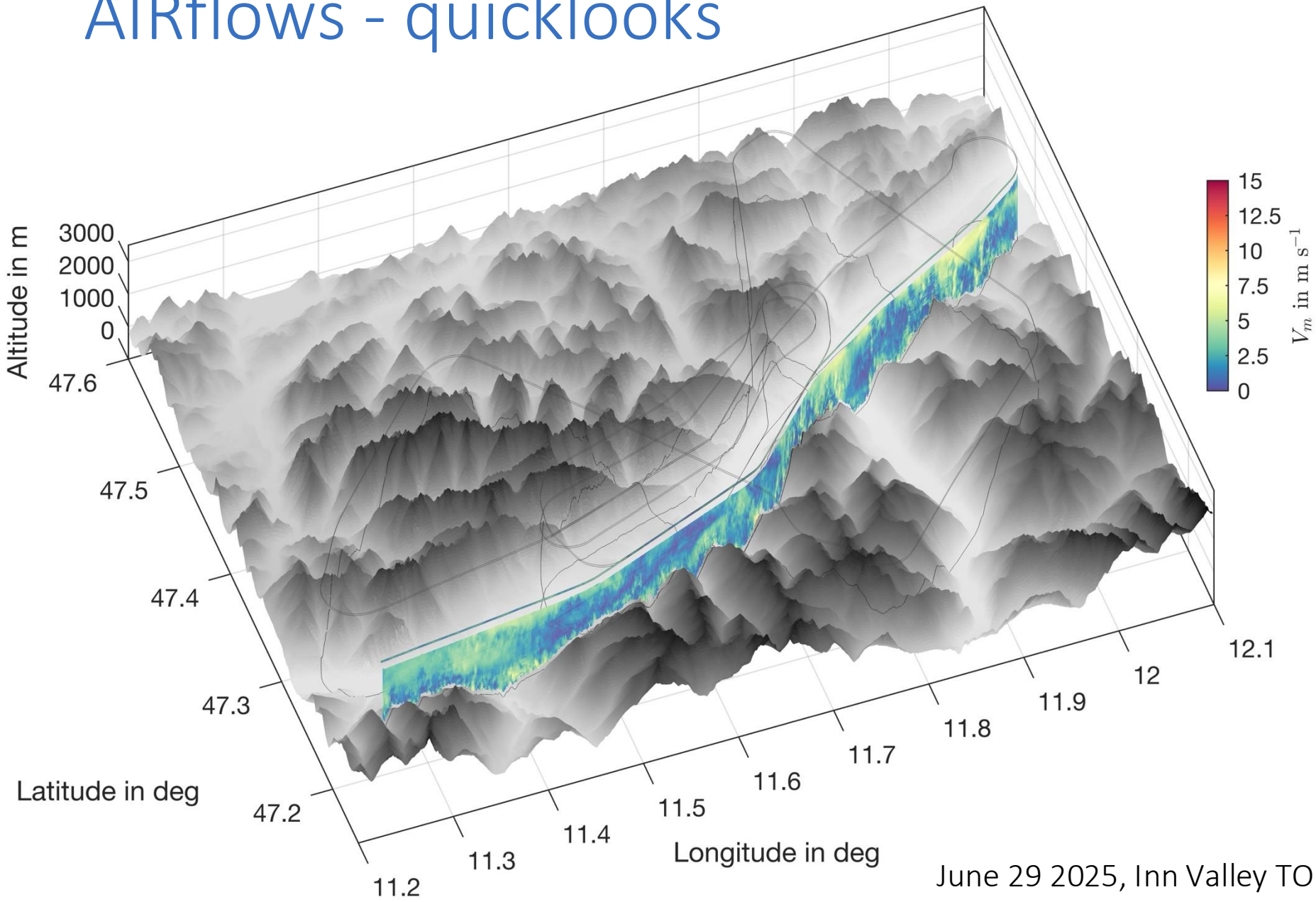
June 29 2025, Inn Valley TOC

AIRflows - quicklooks



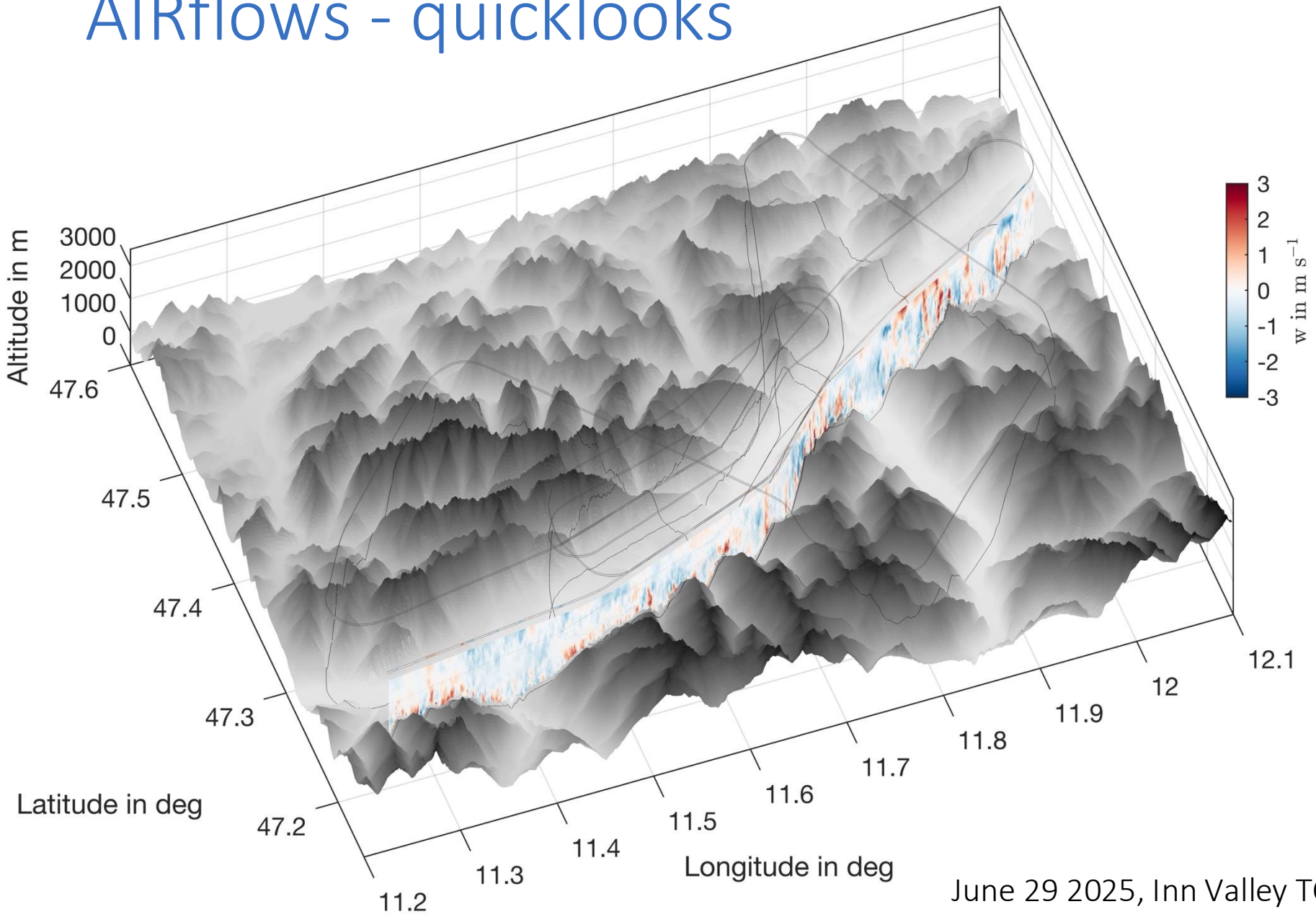
vertical wind

AIRflows - quicklooks



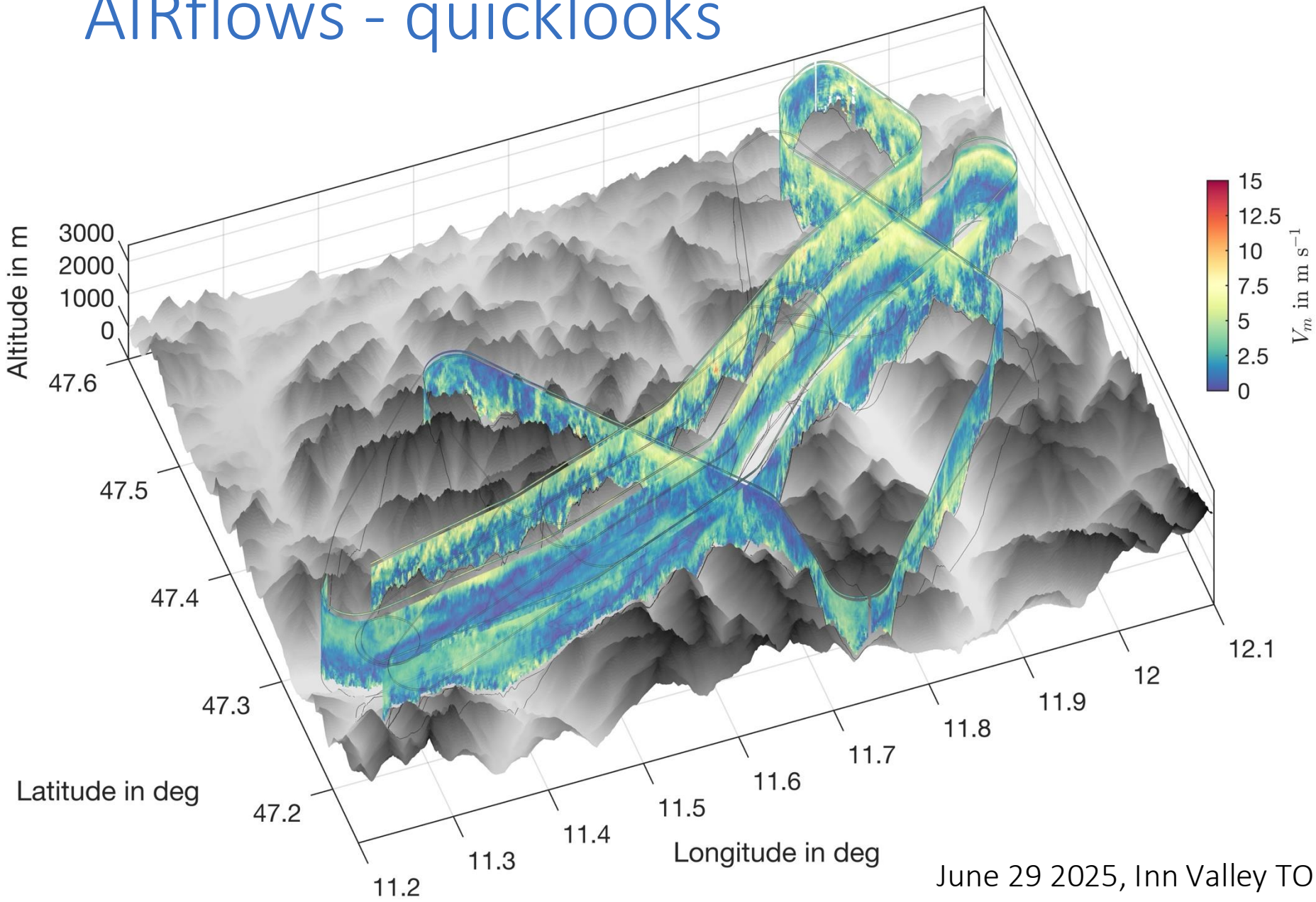
horizontal wind

AIRflows - quicklooks



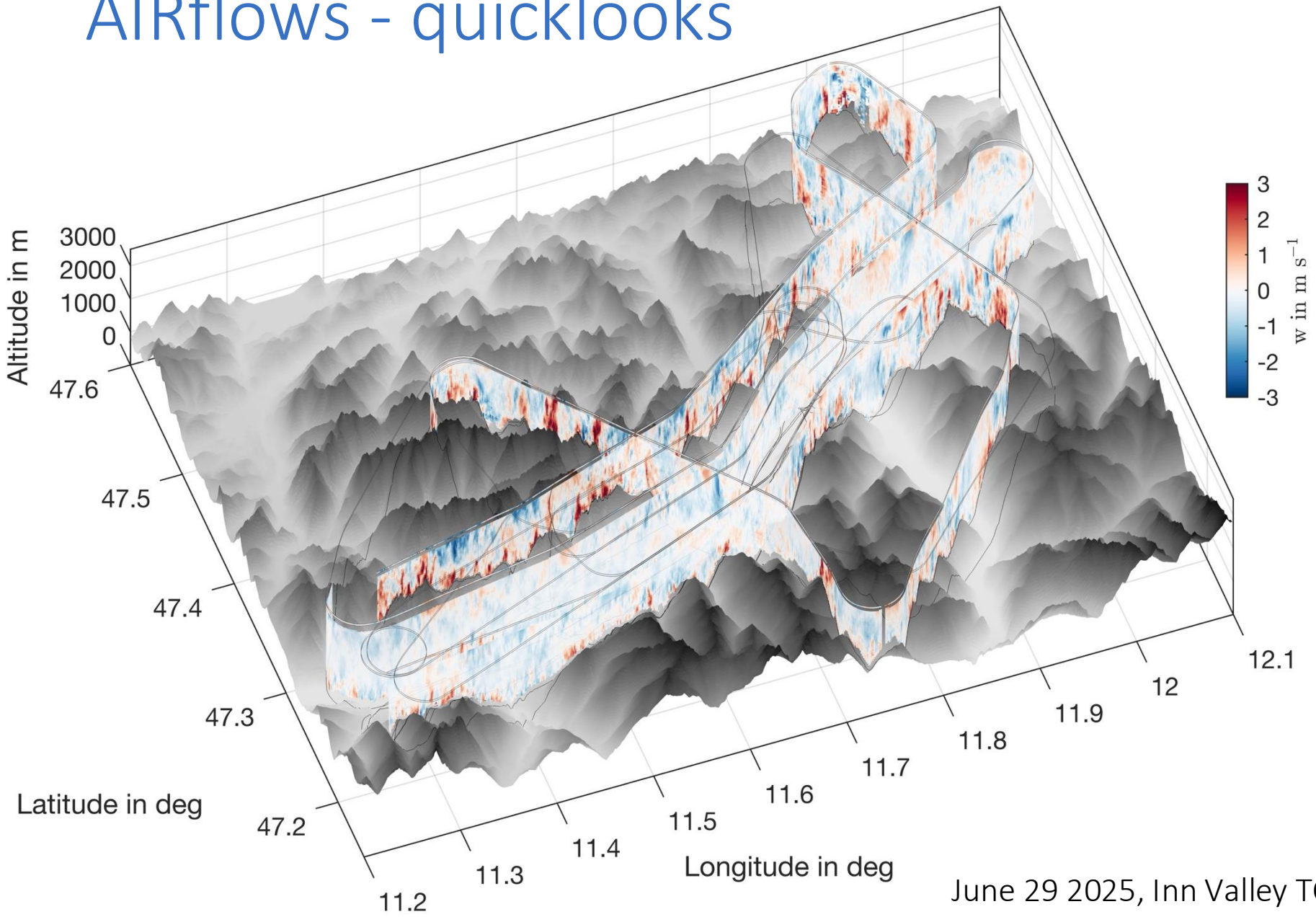
vertical wind

AIRflows - quicklooks



horizontal wind

AIRflows - quicklooks



vertical wind

TEAMx Project report 2024

…. further details in the project report.

TEAMx - Discussion

From the rapporteurs' report:

- 'Expand Beyond the Alpine Region: Given the maturity of the network, it may be time to broaden TEAMx efforts to other mountain regions after the field campaign ends in 2025.'
  —> TEAMx cannot do another observational campaign ….
  —> but joint modeling intercomparison studies (e.g., with a focus on surface-atmosphere exchange) – process studies
  —> we are happy to collaborate
- 'Collaborative outputs or joint proposals (e.g., with other GHP projects or LHAs) could further amplify the network's impact after the field campaign.'
  —> how to get started?