universität innsbruck

The TEAMx Observational Campaign

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2nd Observational campaigns workshop for better weather forecasts, Reading July 1-3 2026

https://www.teamx-programme.org

….what I want you to know by the end ….

- what is TEAMx ?
- which aspects of NWP will likely profit the most?
- what data is available where can I get it?

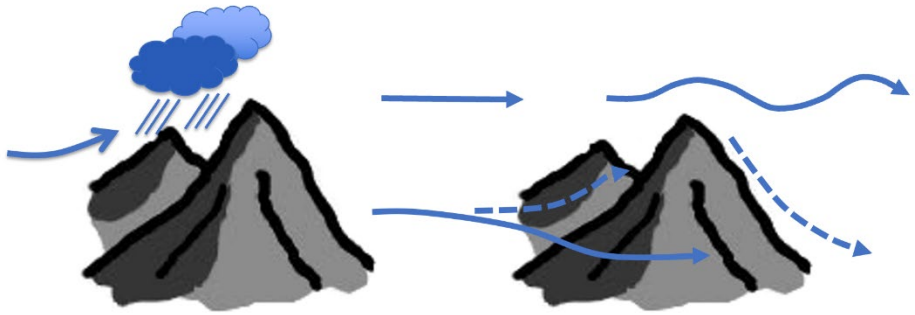
https://www.teamx-programme.org

… Multi-scale Transport and Exchange processes in the Atmosphere over Mountains – programme and experiment

- international research program (~300 individuals, ~45 groups, 13 countries)
- bottom-up financed
- Cross-Cutting Project of GEWEX Hydroclimate Panel
  and
  'Endorsed Project' of WWRP (when they still existed)

- exchange processes for energy, mass and momentum over rough mountainous terrain.

Where's the problem?



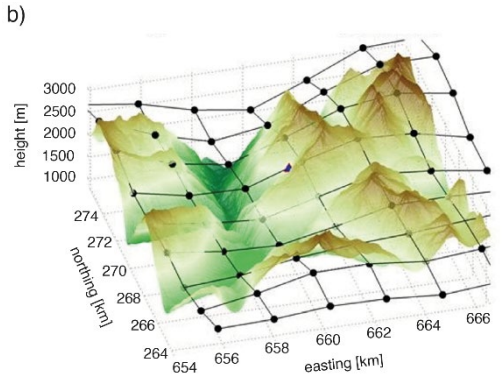
- mountains and mountain ranges modify the flow ….
  …. and trigger 'mountain winds'

- Exchange (over flat terrain) is the task of the Atmospheric Boundary Layer (ABL)
  → ABL parameterization

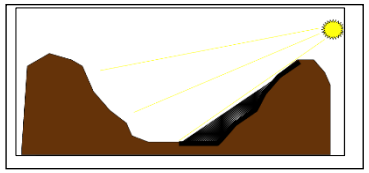
- Over mountains: MoBL
  ⟶ ABL parameterizations ok for MoBL?
  ⟶ sfc exchange parameterization ok for MoBL?
  ⟶ interaction with the (sub)meso-scale flows?

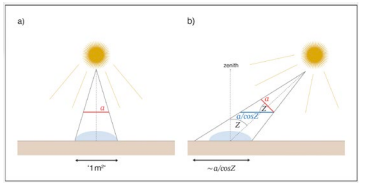
More challenges over mountains

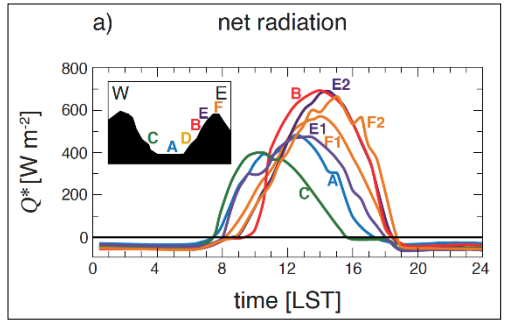
- numerical models require high resolution
  ⟶ expensive
- numerical instabilities over steep terrain
- most physical processes impacted
  [but in the models treated as over flat]
  - ⟶ radiation (shading, angle)
  - ⟶ turbulence
  - ⟶ convection (initiation)
  - ⟶ (surface) energy balance
  - ⟶ sub-mesoscale circulations



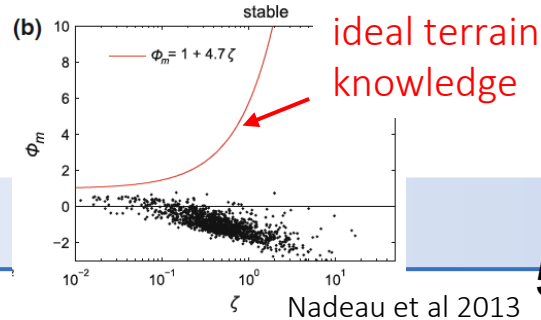
Rotach and Holtslag (2025)





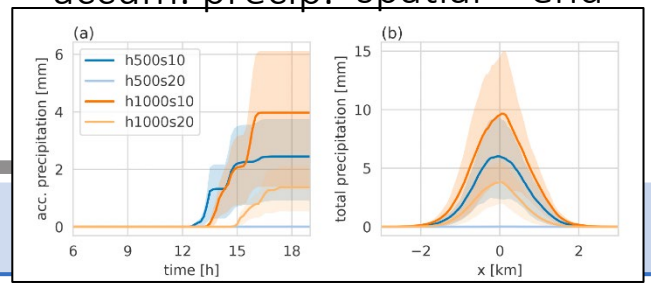


accum. precip. spatial - end



ideal terrain knowledge

Nadeau et al 2013



Göbel et al 2023

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https://www.teamx-programme.org

… Multi-scale Transport and Exchange processes in the Atmosphere over Mountains – programme and experiment

- one of the four pillars: understanding / observing / modeling / applying

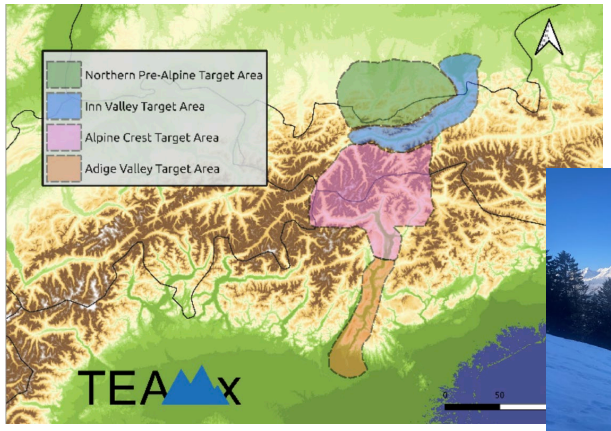
Objective	Primary Focus	Target
Process understanding	Micro- and meso-scale processes within and above the *mountain boundary layer* (MoBL); Interaction between scales.	Quantitative understanding of momentum, energy and mass exchange over mountainous terrain
TEAMx Joint Experiment(s)	Collaborative use of multi-platform instrumentation to sample the spatial heterogeneity of turbulence and mesoscale circulations over and near mountains	Quality-controlled observational data pool, available for process investigation, high-resolution model verification, parameterization development
Improving Weather and Climate Models	*Models right for the right reason*, i.e., identification and reduction of model biases and uncertainties over complex terrain	Weather forecasts and climate simulations over mountains as good as over flat terrain, and less reliant on model output post-processing
Support to Weather and Climate Service Providers	Air pollution, hydrology, climate change scenarios (e.g., elevation-dependent climate change).	Smaller uncertainty of impact models, due to reduced errors in weather and climate information.

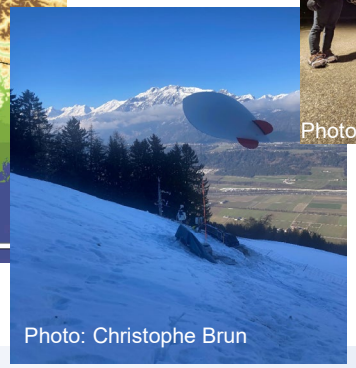
Serafin et al. 2020

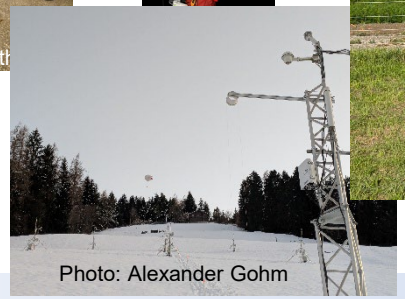
https://www.teamx-programme.org

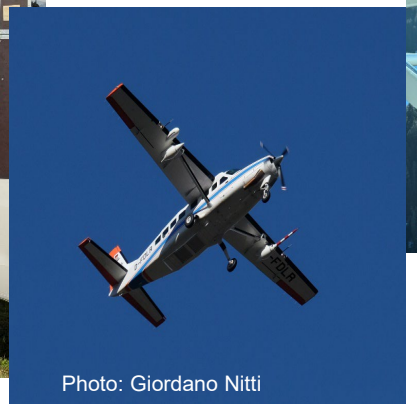
… Multi-scale Transport and Exchange processes in the Atmosphere over Mountains – programme and experiment

- TEAMx Observational Campaign:
  → one-year long observational campaign with two multi-week extended observations periods (EOPs) in winter (Jan/Feb ‘25) and summer (Jun/Jul ‘25)



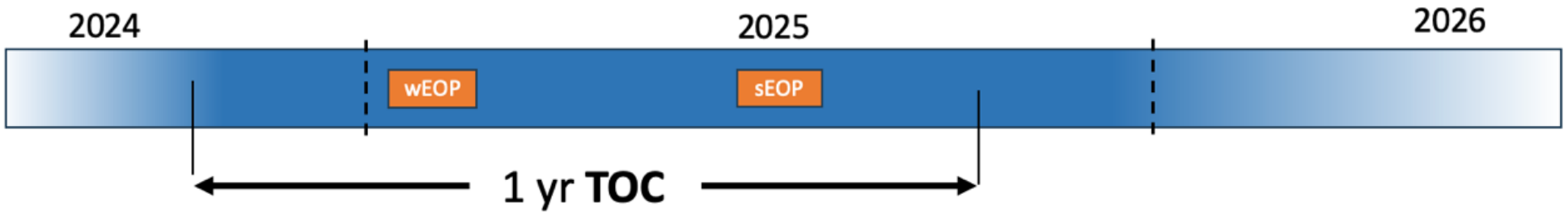






Joint TEAMx Observational Campaign (TOC)

Autumn 2024 - autumn 2025 (EOPs and IOPs):



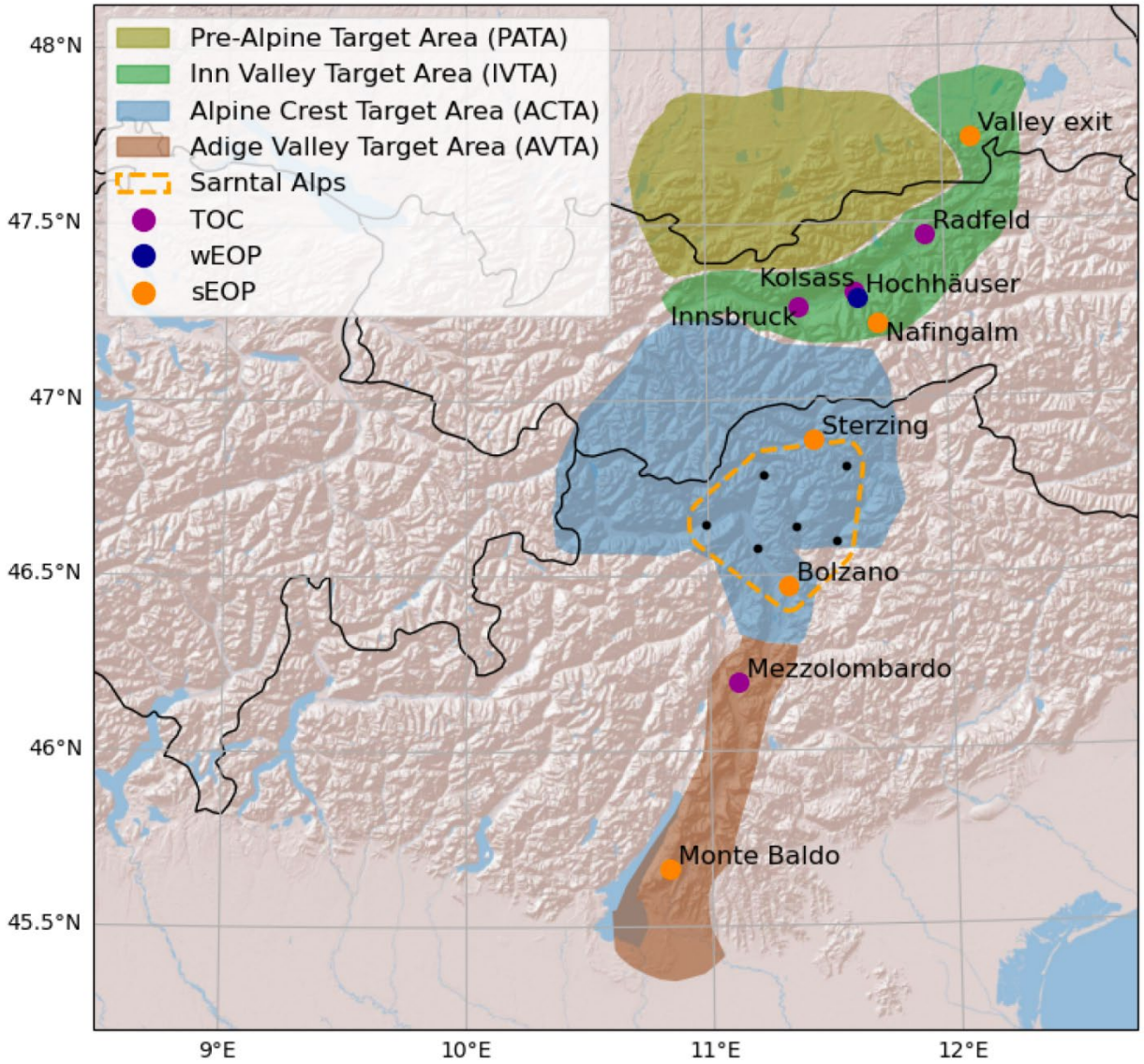
wEOP

Winter EOP (wEOP)
specified dates: Jan 20 2025 – Feb 28 2025

sEOP

Summer EOP (sEOP)
specified dates: June 16 2025 – July 25 2025

Joint TEAMx Observational Campaign (TOC)



Northern Pre-Alpine TA

Inn Valley TA

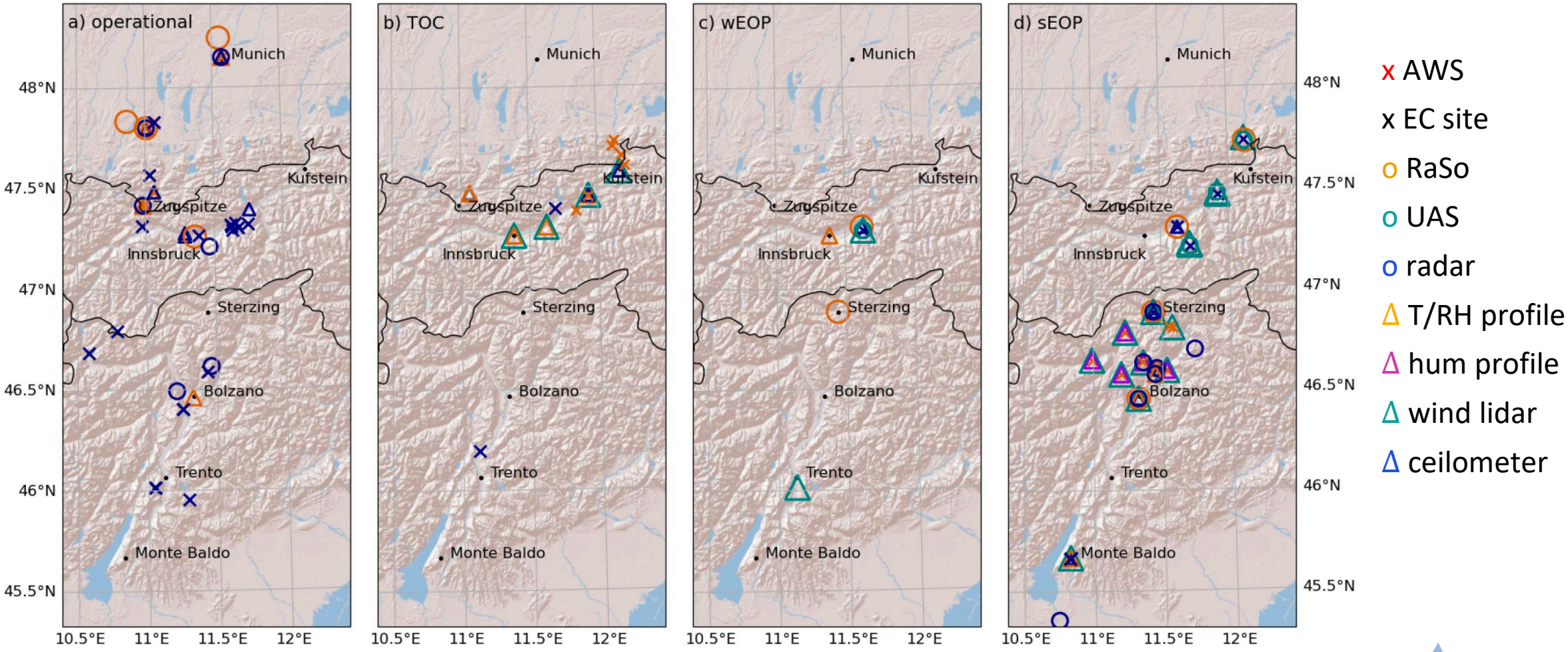
Alpine Crest TA

Adige Valley TA

Lehner et al. (subm JEMS)

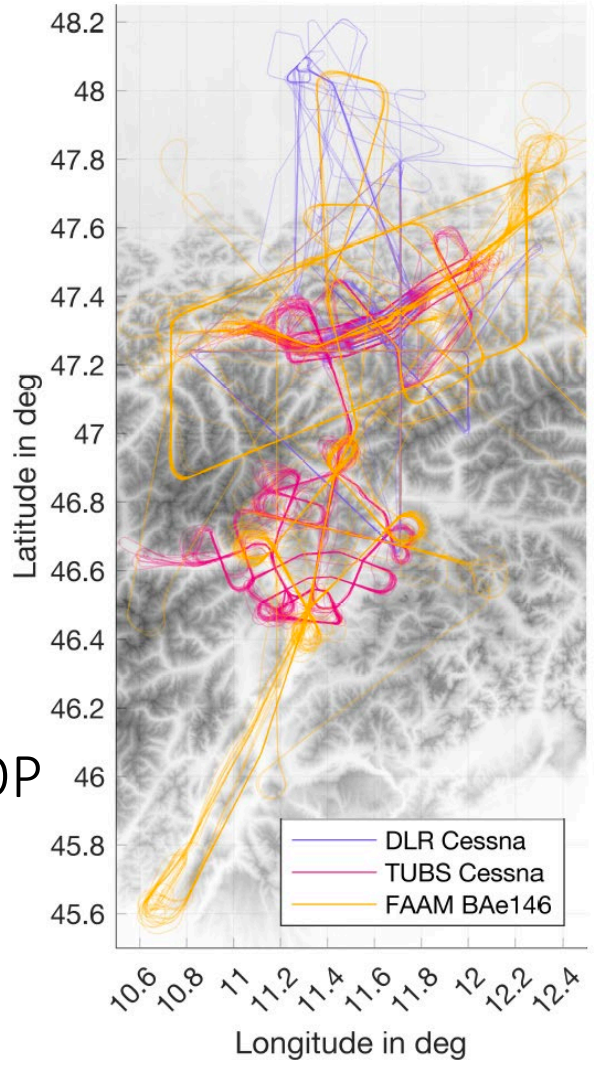
Joint TEAMx Observational Campaign (TOC)

operational | TOC + | wEOP + | sEOP +



Lehner et al (subm JEMS)

IOPs – airborne observations



- Cessna Grand Caravan (DLR): 6+18 flights / 24+74 h: wEOP+sEOP
- Cessna F406 (Techn U Braunschweig): 35 flights / 98 h: sEOP
- FAAM Bae146 (NCAS): 27 flights / 94 h: sEOP
- 3 weeks with all three operating simultaneously (sEOP)

IOPs - UAS

Drones: swarm of drones

- Nafingalm (DLR/UIBK), sEOP
  → 30 multicopters SWUF-3D
  → fixed-height arrays

profiling drones

- Radfeld (U Tüb/UIBK), sEOP
  → 4 MASC-MC
  → ~400 profiles

intercomparison

- KOL (IVTA) sEOP
  → comparison to tower

TOC Overview – IOPs and processes

	wEOP 20 Jan – 28 Feb	sEOP 16 Jun – 25 Jul
Slope winds	6	2
Valley-exit jets	-	2
MoBL – thermal	2	14
MoBL – dynamic	1	1
Convection	-	7
Gravity waves	9	2
Synoptic	-	1
Total	**18**	**24**

+ additional slope-wind observations
+ additional activities after the end of the sEOP

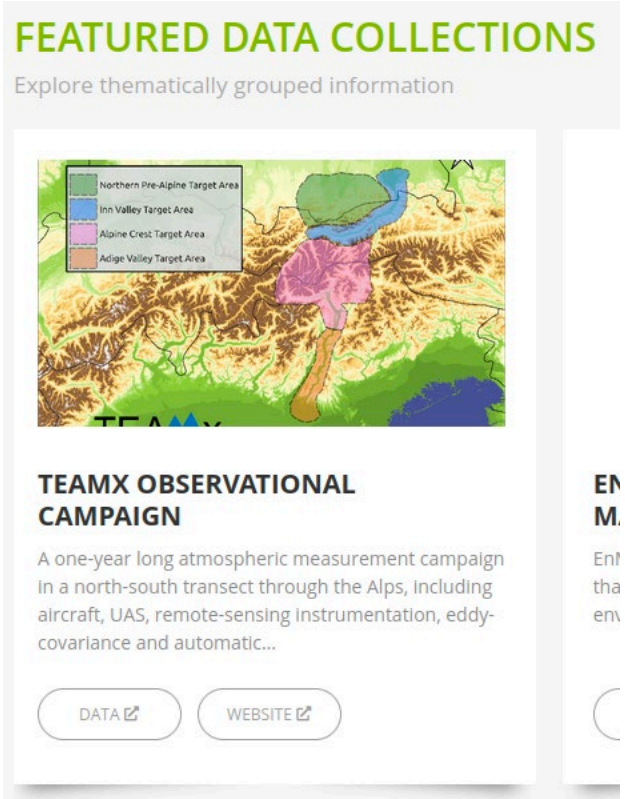
- RaSo, often 3 hrly
  → Kolsass, Sterzing: wIOPs&sIOPs
  → Bolzano: sIPOs
- RaSo 2 /4 times per day
  → IBK airport: wEOP&sEOP
  → Altenstadt: wEOP&sEOP
  → Sterzing: wEOP&sEOP



Data availability

TOC **data** will be

- made publicly available one year after the TOC (Sept 2026)
- published in public repositories (such as zenodo, PANGEA)
  → but also participant's institutional repositories
- access through EARTH Data Portal
  → https://Earth-data.de



Overview paper for Journal of the EMS (Lehner et al.) in review

GREAT (news)

Collaborative project: A **GR**ey-zone **E**nsemble **A**nalysis for **T**EAMx

- Joint proposal recently funded
- **U Vienna (leading)**, UIBK, DWD, KIT, MCH
- - 1 km ensemble (RE)A [ICON-KENDA] for the EOPs (2x 6 weeks)

  - 125 m REA for (selected) IOPs
- ‘optimal atmospheric state’ for the golden days
- impact analysis for massively enhanced observations
- ‘gridded data sets’ available for verification of operational NWP (in 3 years time)


Thank you for
your attention!

Possible field campaign targets

Consensus was achieved that future observational campaigns, or better exploitation of existing datasets, could help to improve the representation of several important processes in ECMWF's Integrated Forecasting System over the coming years:

- **The coupling of the lower atmosphere with the underlying surface**, which is key for the prediction of near-surface weather. Specific issues need to be tackled over land, ocean and snow/sea-ice, e.g. the strength of land–atmosphere coupling, the impact of land heterogeneity on surface fluxes, the partition between latent and sensible heat flux over bare soil and vegetated areas, the thermodynamic coupling over sea ice, the coupling of ocean currents, waves and the atmosphere, and atmosphere–ocean coupling over boundary currents (e.g. the Gulf Stream). Efforts to improve the coupling of the lower atmosphere with the underlying surface would benefit from gathering collocated observations through the atmosphere–surface interface (e.g. in the atmosphere, at the surface, and in the ocean mixed layer/soil/snow) during future observational campaigns as well as from observations along a path across various surfaces ('observational transects'), e.g. across the snow line, from bare soil to vegetated areas, and from flat terrain to mountain ridges.
- **Low-level clouds, in particular maritime stratocumulus and low-level mixed-phase clouds at high latitudes.** As the resolution of global models increases towards resolutions at which deep convection becomes resolved, the need for observational constraints for microphysical processes will increase as these processes will play an increasingly important role.
- **Momentum transport and wind profiles in the boundary layer.** A better representation of boundary-layer winds is key for predictions of near-surface and wind turbine height winds and of heat, momentum and moisture exchange at the interface between the atmosphere, ocean, land and ice. It is also important for the large-scale circulation forecast skill, which crucially depends on surface friction (or drag).
- **Temperature, moisture and trace gases (ozone) in the stratosphere**, for which very few independent observations with high vertical resolution exist.
- **Temporal and spatial variability.** As the resolution of global NWP models increases, it is becoming important to deploy observations with high temporal and spatial frequency to be able to verify the ability of NWP models to represent mesoscale variability in both the atmosphere and the ocean and particularly over boundary currents.

ECMWF Newsletter, 161, 2019