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

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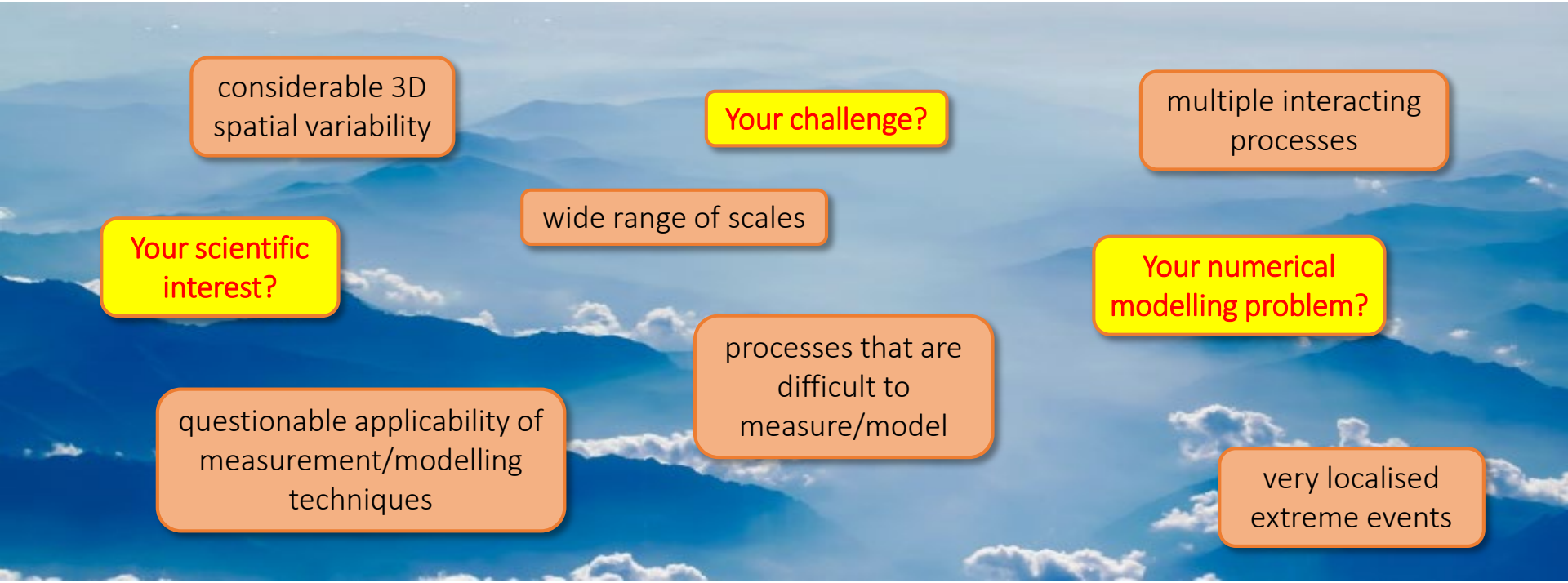
Complex terrain brings many challenges

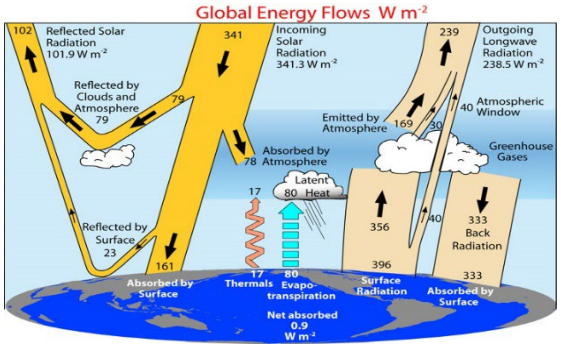


TEAMx is about … exchange processes over mountains

Momentum

- orographic blocking
- gravity wave breaking
- orographic drag parametri-sations in general circulation models

Heat

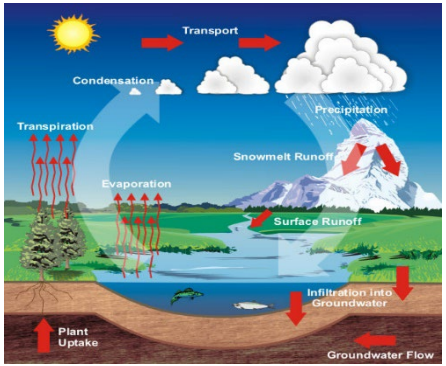


https://scied.ucar.edu/longcontent/energy-budget

- thermally driven flows
- cold air pooling
- interaction meso- ↔ local scales

TEAMx is about … exchange processes over mountains

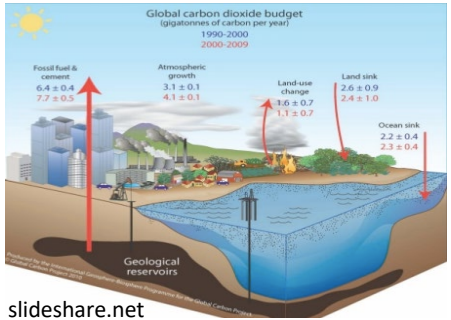
Mass: Water



http://www.algebralab.org/practice/practice.aspxfile=Reading_WaterCycle.xml

- orographic precipitation
- triggering of convective precipitation
- "water towers" for the surrounding plains

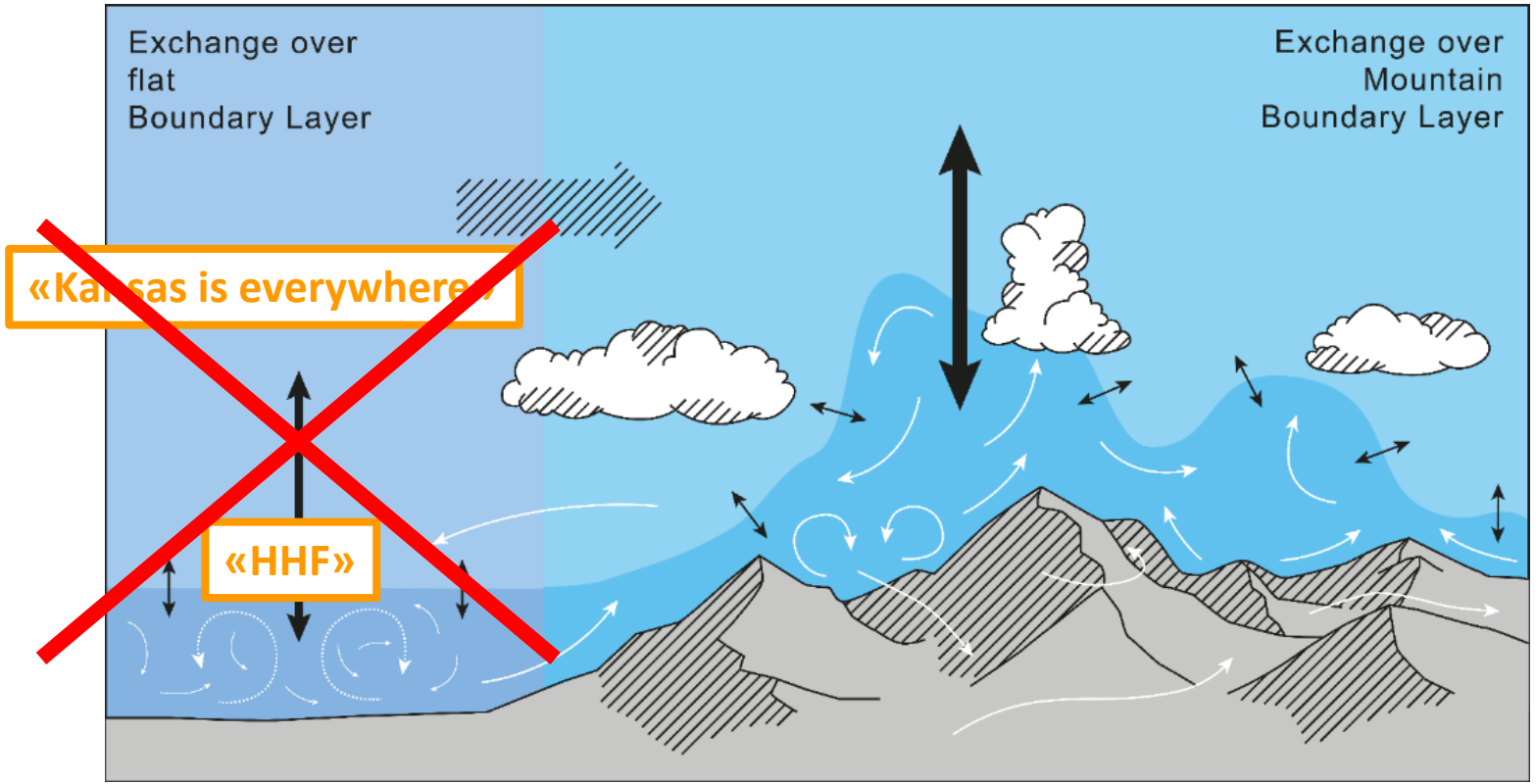
Mass: CO_2



slideshare.net

- global (regional) budgets most uncertain over land
- poorly represented exchange over orography may be one reason for 'missing sink'

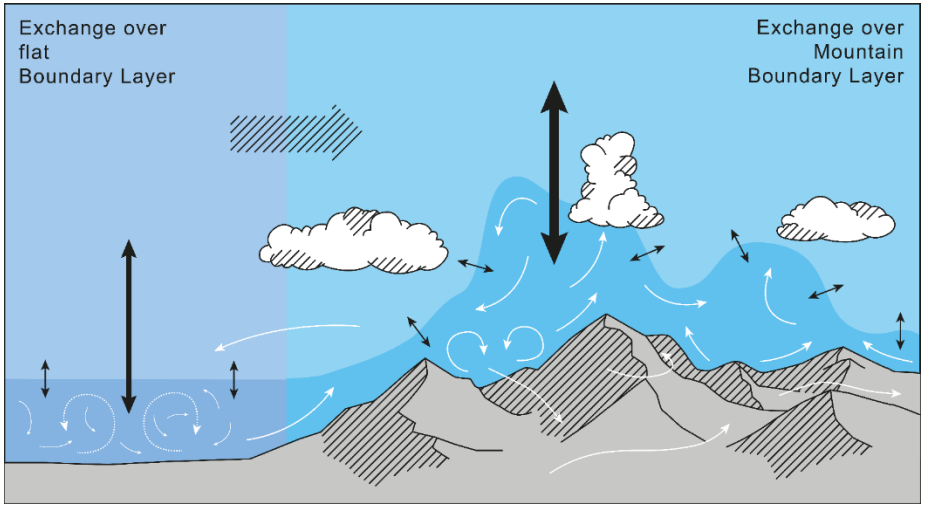
The Mountain Boundary Layer (MoBL)



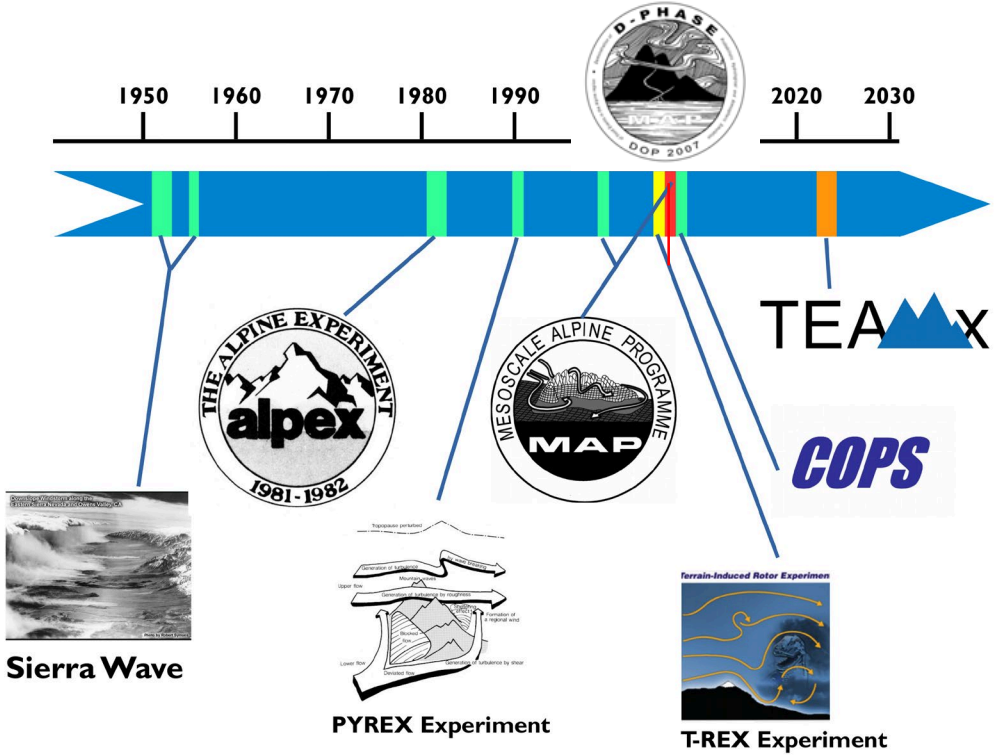
The Mountain Boundary Layer (MoBL)

- Traditionally: earth-atmosphere exchange through the Atmospheric Boundary Layer
- vertical, only

- Over mountains: interaction with mesoscale flows
  - thermally driven
  - dynamically forced
- 3-dimensional: **Mountain Boundary Layer (MoBL)**
- spatially (very) heterogeneous



Major experiments in mountain meteorology



TEAMx technological drivers

Observational advances w.r.t. historical campaigns:

- Remote sensing: ground based (radar, lidar, boundary-layer profiling) and satellite-based (resolution, parameters retrieved).
- Airborne sampling and remote sensing.

Model advances:

- Steadily increasing resolution.
- High resolution implies challenges in model initialisation, parameterization of sub-grid scale physical processes, model evaluation.

TEAMx Science Plan

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.

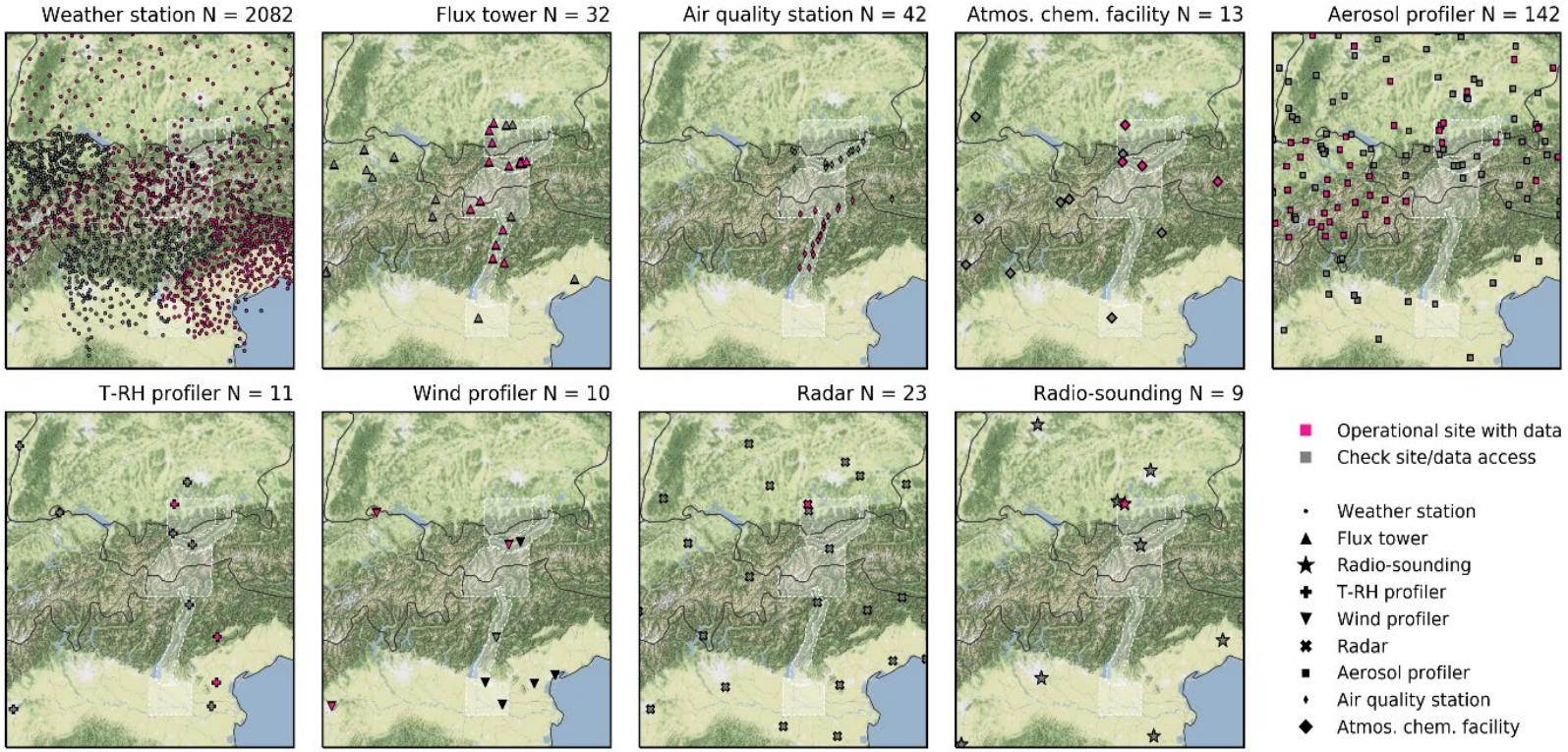
TEAMx Observational Campaign (TOC) in 2024-2025

Coordinated field campaign from Spring 2024 to Spring 2025, including two Extended Observational Periods (EOPs)
→ one in summer, one in winter

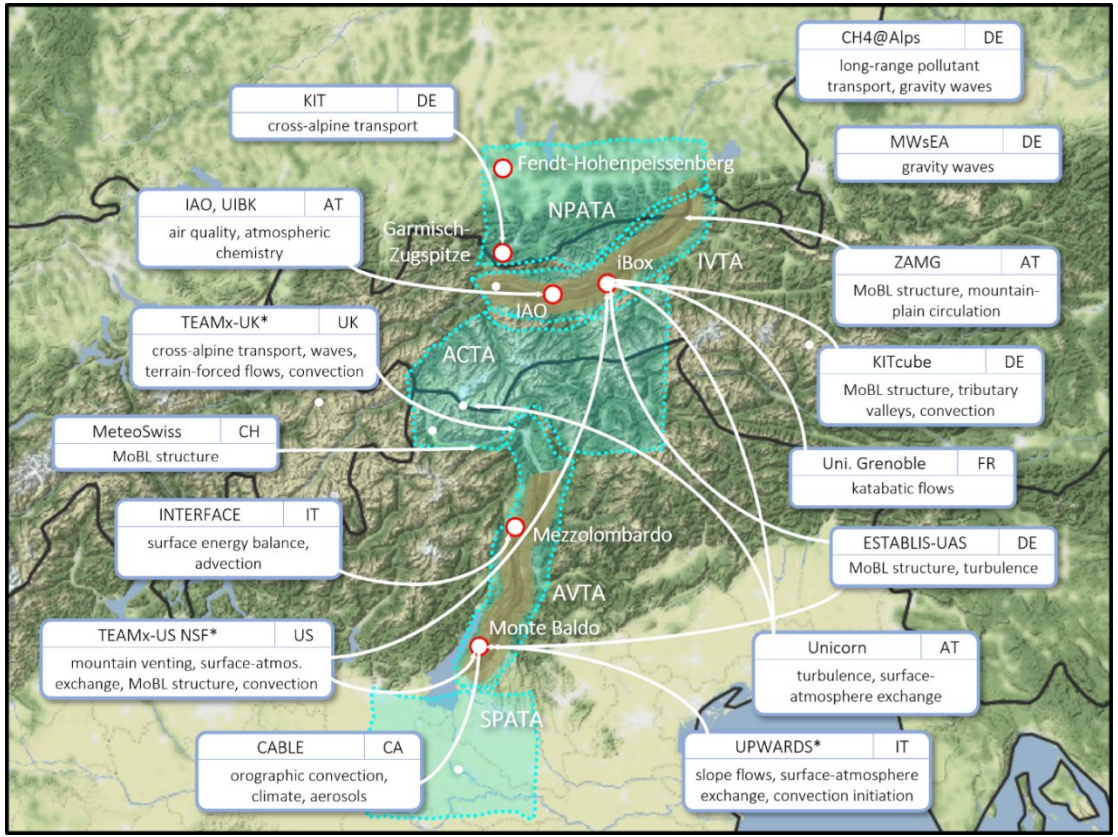
Focus: **European Alps**

Specialized instrumentation to be assembled: eddy covariance stations, wind/T/RH profilers, ceilometers, weather radars, atmospheric chemistry, research aircraft, …

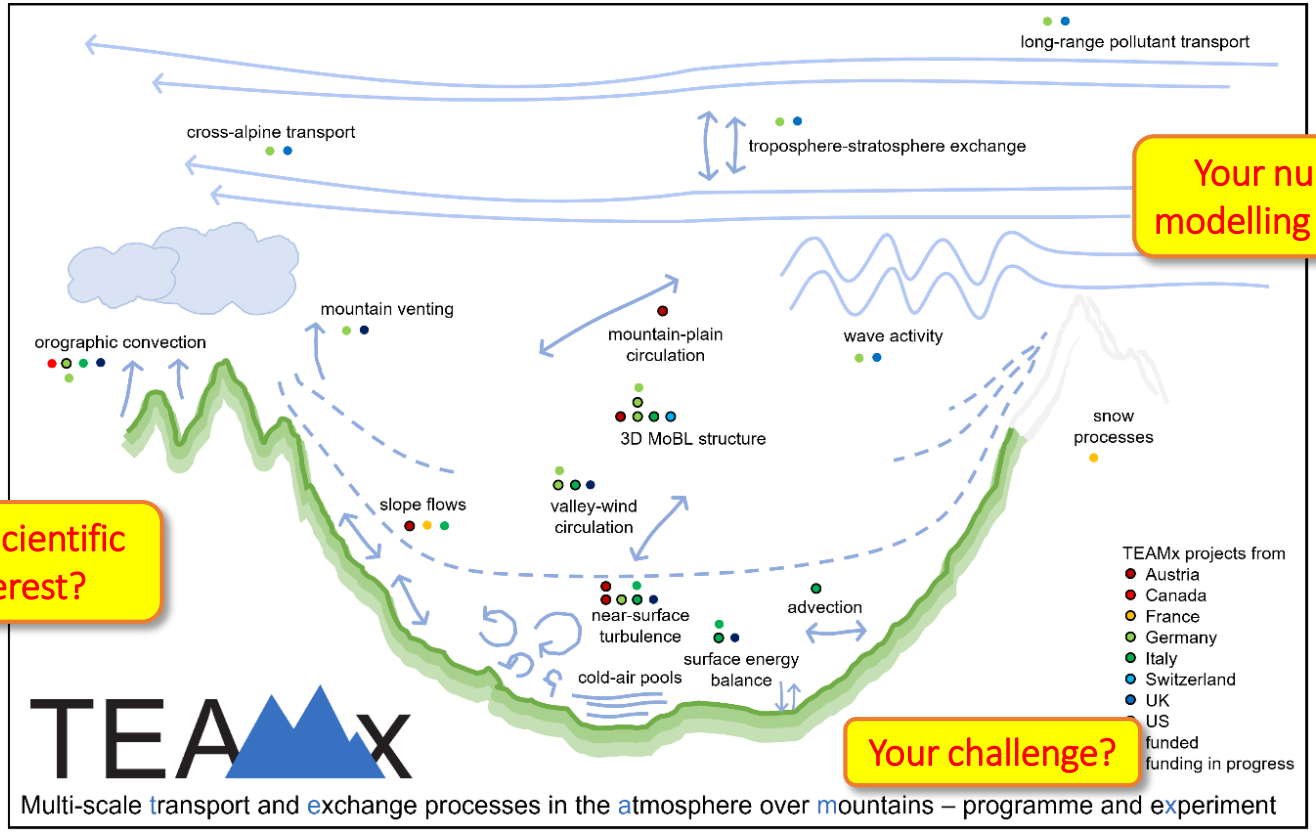
TOC: Existing observational infrastructure



TOC: Additional observational infrastructure



TOC: Sketch of various processes that will be studied within TEAMx



Bottom-up: Working Groups and Committees

Working group on *Atmospheric Chemistry*

Investigating atmospheric transport and atmospheric chemistry in mountainous terrain
Leaders: Martin Graus (University of Innsbruck) and Marcus Hirtl (ZAMG)

Working group on *Mountain Boundary Layer*

High-resolution modelling experiments, development of an observati… the MoBL
Leaders: Sebastian Hoch (University of Utah), Manuela Lehner (Universi…
Vienna)

Working group on *Mountain Climate*

Improving understanding and modelling of the processes by wh… …apin… …mates
Leaders: Nikolina Ban (University of Innsbruck) and Sven Kotlarski (Met… Swiss)

Working group on *Orographic Convection*

Studies of convective triggering due to mechanical and thermal orographic forcing
Leaders: Daniel Kirshbaum (McGill University) and M. Marcello Miglietta (ISAC-CNR)

Working group on *Surface-Atmosphere Exchange*

Investigating the transport and exchange of momentum, mass and energy between the Earth's surface and the atmosphere in mountainous terrain
Leaders: Helen Ward (University of Innsbruck) and Lorenzo Giovannini (University of Trento)

Working group on *Waves and Dynamics*

Improving understanding of mountain wave related processes across multiple scales and their relevance for turbulent transport
Leaders: Andrew Elvidge (University of East Anglia) and Annelize van Niekerk (Met Office)

*Responsible for **coordinating scientific research**.*

Com…mittees

…e TEAMx Observational Campaign
Leaders: Mathias Rotach (University of Innsbruck)

***N…erical Modelling* Committee**

Respons…le for coordinating TEAMx modelling experiments
Leaders: St…ano Serafin (University of Vienna) and Jürg Schmidli (Goethe University Frankfurt)

*Responsible for **coordinating and leading the design of strategically important matters**, i.e., the main field campaign and modelling experiments.*

More information

- TEAMx Website: http://www.teamx-programme.org/
- White Paper and other publications (e.g., BAMS Essay, Atmosphere Special Issue)
- Memorandum of Understanding (MoU; currently signed by 30 institutions)
- Organisation
- and much more …

TEAMx

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

Strategic goals for COSMO & its members

- Improve ICON (-LAM)!
- Make sure ICON profits maximally from TEAMx results and know-how!

- Try to establish ICON as «TEAMx working horse» and primary R&D tool.
- Provision of a 500m mesh-size ICON-Version during the TEAMx Observational Campaign as forcasting tool during the EOPs and as primary planning tool for the IOPs (→ GLORI Alpine Twin).