A coordinated effort to investigate Transport and Exchange Processes in the Atmosphere over Mountains-Experiment (TEAMx)

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Mountain Weather and Climate

- traditionally: impact of mountains on weather
  → orographic precipitation
  → gravity waves, ~ breaking
  → blocking, Föhn, Bora & co
  → dynamic features

- Alpex, Pyrex, MAP, MATERHORN, ....

Recent developments (since MAP):
- climate change additionally in the focus
  → requires models able to (also) realistically reproduce mountain climate (impact modeling)
- model resolution ↑ - but not (?) corresponding physics
- new observational possibilities
  → commercial Doppler wind lidars, satellites
Mountain Weather → Climate

- **weather (traditional):** mountain → atmosphere perspective → how does ‘the mountain’ modify the precipitation regime → how does ‘the mountain’ trigger downslope wind storms → surface characteristics of $\mathcal{O}(100 \text{ km})$

![Diagram showing orographic precipitation and wind patterns around a mountain.](http://kbkb-wx.blogspot.co.at/2014/04/orographic-precipitation.html)

Steinacker et al. (2005)
Mountain Weather → Climate

- **climate** (and climate change)
  → treats the same atmosphere...
  → requires impact modeling
  → need: (e.g.) *the right temperature* at mountain surface (not only the mtn. sfc. temperature that yields the ‘right precipitation’)

- Mountain (surface) ↔ atmosphere perspective
- how does ‘the mountain’ influence the atmosphere?
- what near-surface atmosphere is produced close to the mountain?
  → impact modeling
Mountain Weather → Climate

- climate/atmosphere system:
  → ‘mountain’ is part of the surface
  → character of the surface

- character of the surface
  → determines the exchange between the atmosphere and the earth
  → coupling of the atmosphere with the surface

Exchange processes in the Atmosphere over Mountains

http://www.panoramio.com/photo/1724212
Mountain ↔ Atmosphere perspective

- Exchange
  → heat, mass and momentum *at the surface*

- traditionally: this is the role of the *boundary layer*
  → transport to the ground / away from the ground

- over mountainous surface
  → interaction with meso-scale mountain flows

→ ‘Mountain Boundary Layer’

Rotach et al. 2015
Mountain Boundary Layer (Lehner & Rotach 2018)

unstable stratification (daytime)

stable stratification (nighttime)
A new international initiative

TEAMx

Transport and Exchange processes in the Atmosphere over Mountainous terrain - programme and eXperiment

- discussion started: after ICAM-2015
- meetings aside conferences
- Coordination and Implementation Group established (9/2017)
- White Paper in preparation, special issue ‘Atmosphere’
- Program Office: @UIBK (‘crowd funded’)
  → coordination;
  → int. embedding – WWRP, WCRP;
  → joint projects (H2020, ...);
topics:
- BLs in complex terrain
- thermally driven flows
- dynamic transport (waves, breaking, ...)
- convection & orography
- impact on orogr. precip.
- stable BLs
- pollutant transport and dispersion
→ and their interactions
methods:
- numerical modeling → NWP (km scale, LES)
- regional climate → processes and parameterizations
- observations → turbulent exchange → Lidar, scintillometer → obs strategies

goal:
→ coordinated experiment
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Research questions

→ how does mountainous terrain impact exchange to the free atmosphere of energy, mass and momentum? (which processes, interaction, abundance, ...)

→ do we understand the relevant processes quantitatively?

→ are current models (regional climate, NWP) able to adequately reproduce these processes?

→ do we need a sgs-parameterization (as for gravity wave drag) for \(\mathcal{O}(10 \text{ km})\) grid spacing models?

→ how does mountainous terrain affect air quality?
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partners (so far...):

• University of Innsbruck
• University of Leeds (NCAS)
• Karlsruhe Institute of Technology (KIT)
• Mc Gill University
• University of Trento
• University of Virginia

• MeteoSwiss
• Meteo France (CNRS)
• NCAR
• ZAMG

Additional partners with innovative ideas and commitment (very) welcome!
White paper – Atmosphere Special Issue

“Atmospheric Processes over Complex Terrain”

• Lehner and Rotach (2018): Current Challenges in Understanding and Predicting Transport and Exchange in the Atmosphere over Mountainous Terrain
• Serafin et al. (2018): Exchange Processes in the Atmospheric Boundary Layer Over Mountainous Terrain
• Vosper et al. (2018): Current Challenges in Orographic Flow Dynamics: Turbulent Exchange Due to Low-Level Gravity-Wave Processes
• Kirschbaum et al. (2018): Moist orographic convection: Physical mechanisms and links to surface-exchange processes
• Emais et al. (2018): High-resolution observation of transport and exchange processes in mountainous terrain
• De Wekker et al. (2018): Meteorological Applications Benefiting from an Improved Understanding of Atmospheric Exchange Processes over Mountains
• Hacker et al. (2018): Challenges and Opportunities for Data Assimilation in Mountainous Environments
• Chow et al. (2018): Crossing multiple gray zones in the transition from mesoscale to microscale simulation over complex terrain
Thank you for your attention!

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- Memorandum of Understanding
  → states importance of topic
  → signatories concur with general ‘need for action’
  → founding members (Partner list A) sign it
  → as many supporting institutions as possible (Partner list B) sign as well (ICAM ‘countries’ / institutions, AMS MM Committee, GEWEX, individual institutions, departments, ..)

- Support of TEAMx-seed (program office @UIBK)
  → bilateral contracts
  → tasks / deliverables specified
  → two years (‘seed’)