i-Box: Studying Boundary Layers in Complex Terrain

Institute for Meteorology and Geophysics

Ivana Stiperski, Mathias W Rotach

universität innsbruck

INTRODUCTION

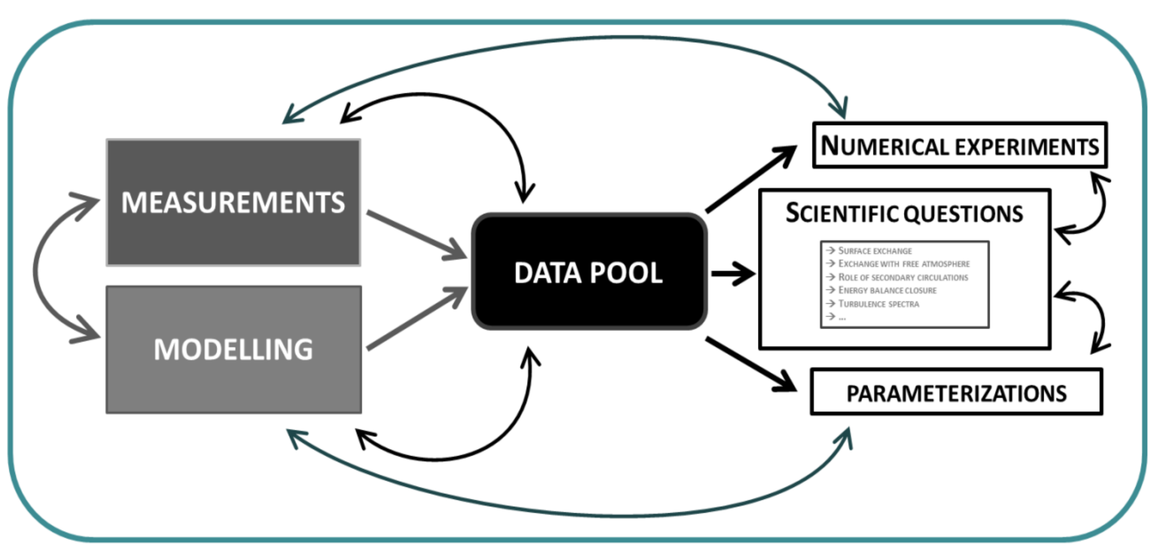
- **Turbulent exchange processes** within the PBL are the main **mechanism of transport** of heat, momentum and matter between the surface (i.e. Biosphere, Cryosphere, Hydrosphere) and the atmosphere
- They impact the atmosphere on **all scales**, from daily cycles of the near surface variables to the lifetime of synoptic systems and climate
- In **complex terrain** the turbulent characteristics still remain **poorly understood** and therefore **inadequately parameterized** within the climate and weather prediction models. Up to date, parameterizations of turbulent exchange between rely heavily on **scaling relations** originally obtained over **flat and homogeneous terrain**
- Given that 24% of the earth surface is covered by terrain complexities, understanding PBL in complex terrain and finding **appropriate scaling** relations is crucial for correct simulations of present and future climate

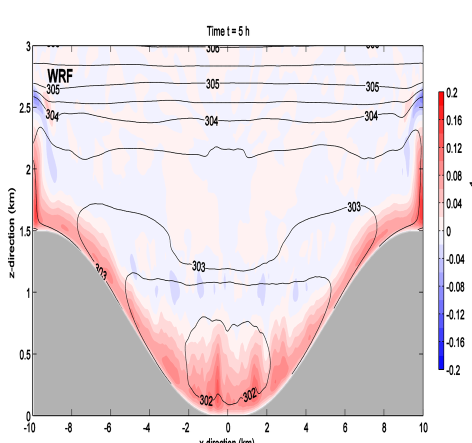
i-Box approach

i-Box (short for Innsbruck Box) is a **TEST BED** for studying boundary layer processes in complex terrain

It represents an **INTEGRATED APPROACH** combining:

- long-term **reference turbulence measurements** (turbulence towers + remote sensing: T/RH profiler, scintillometer, lidar, radio-soundings)
- high-resolution **numerical modelling** (virtual i-Box)



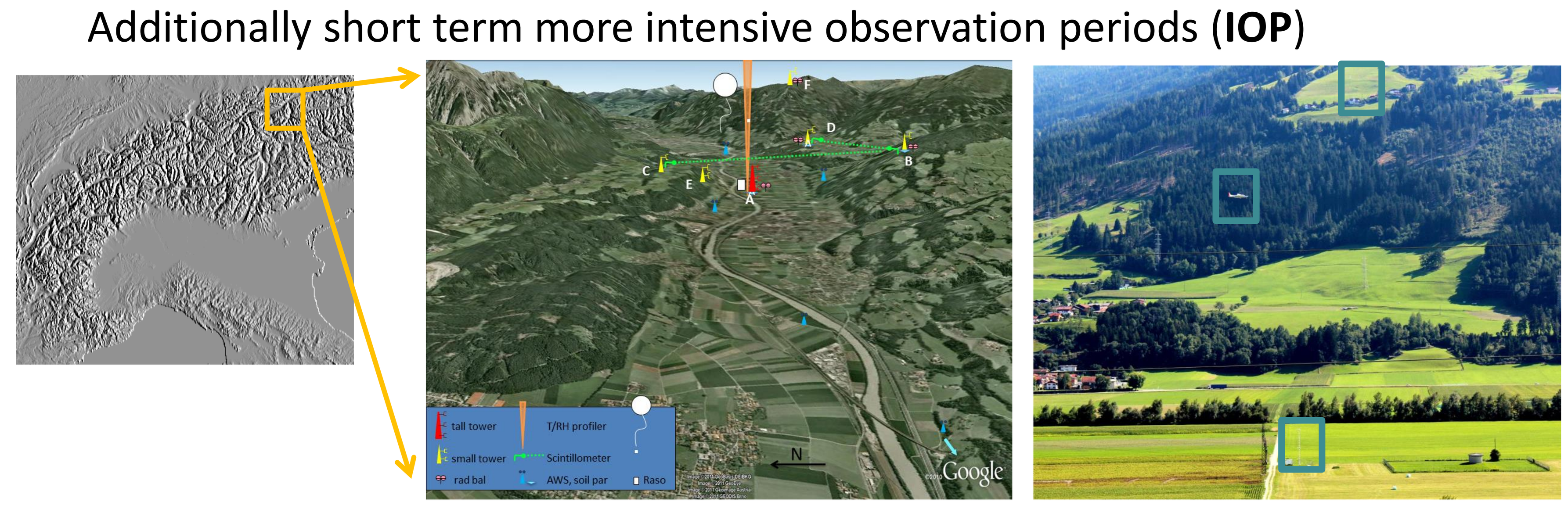


i-Box measurements

Performed in a **3D** volume: studying turbulence throughout the PBL

Long-term (> 4 years) to obtain substantial statistics

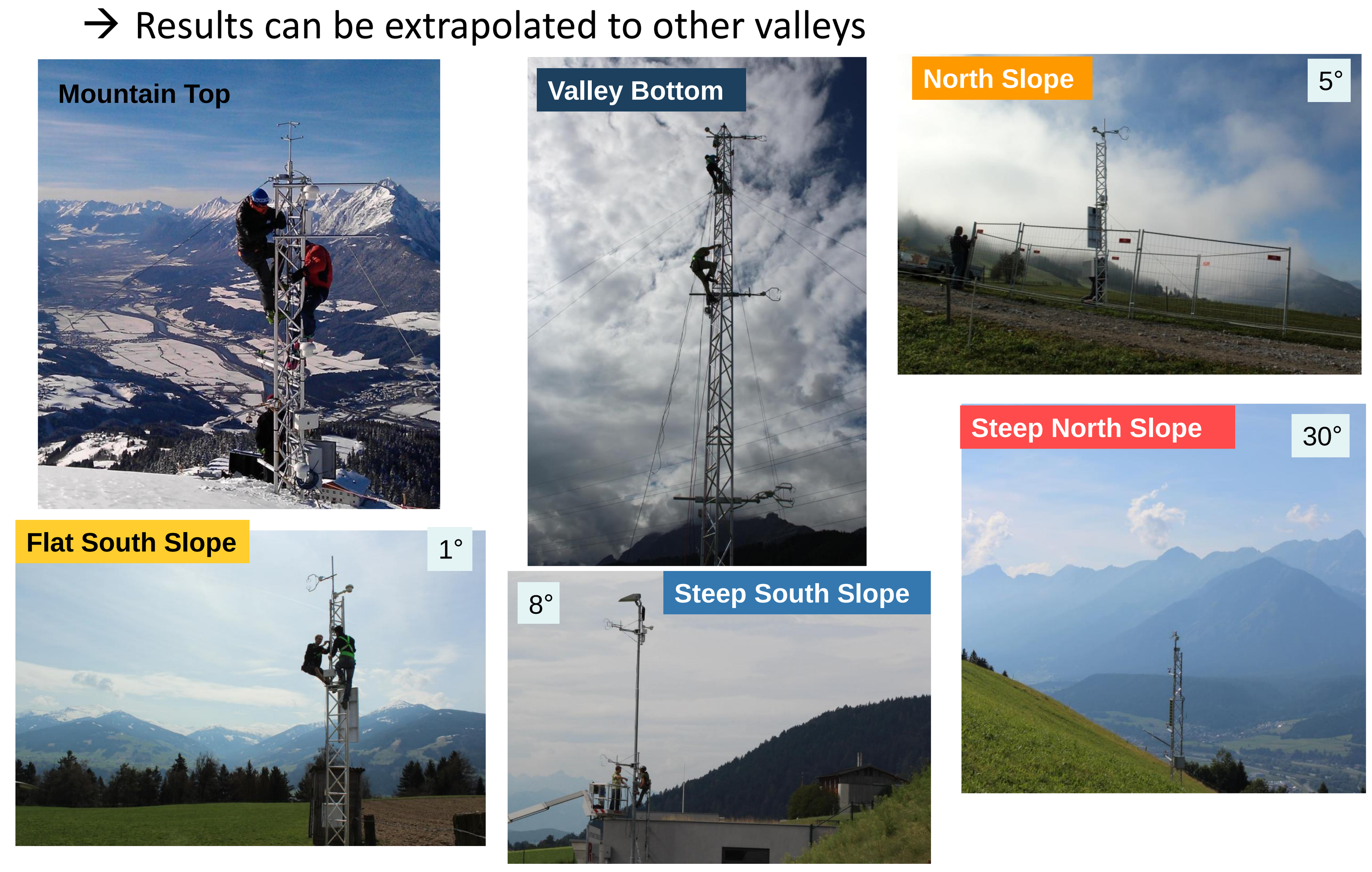
Additionally short term more intensive observation periods (**IOP**)



Observation sites are **characteristic** for different topographic features:

→ valley bottom, N and S facing steep and gentle slopes, mountain top

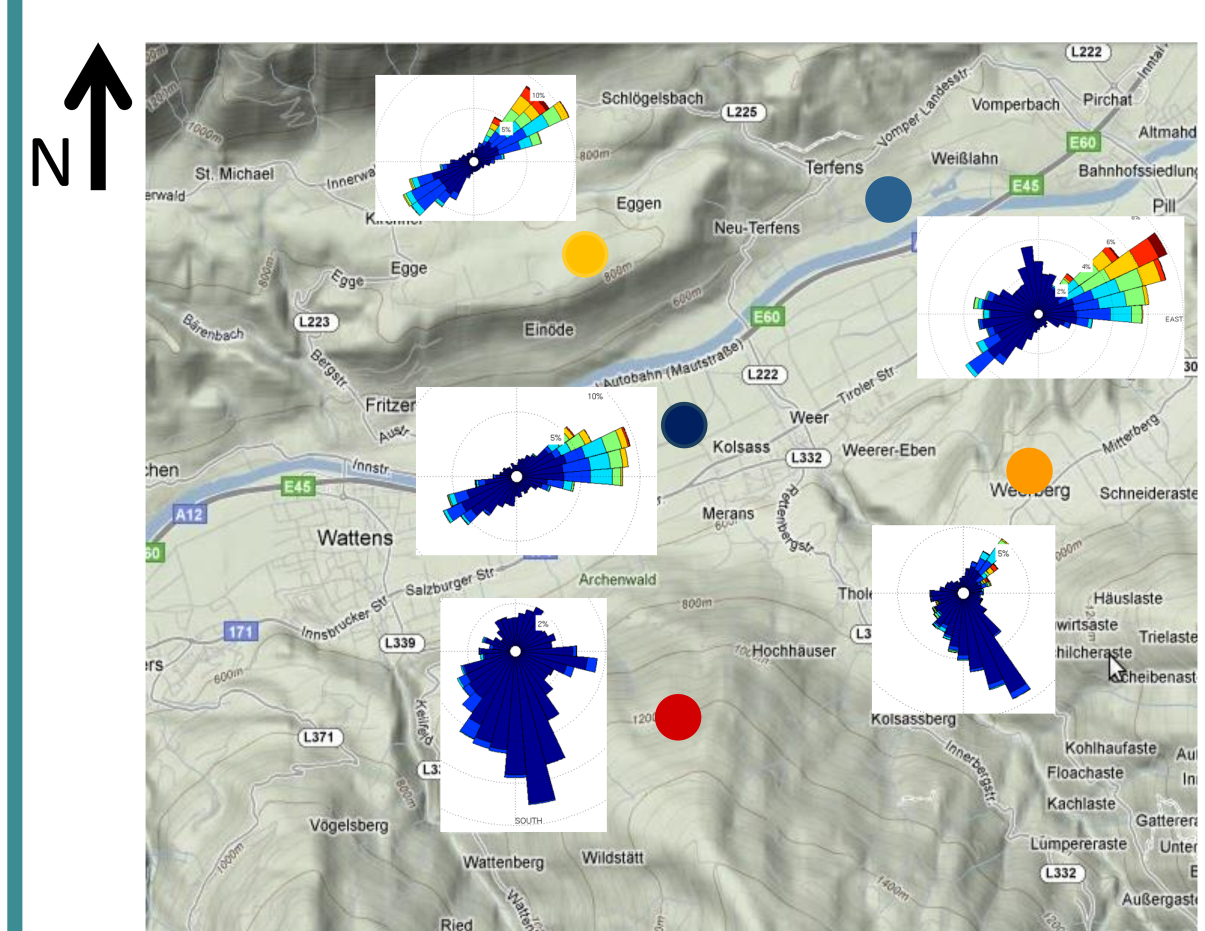
→ Results can be extrapolated to other valleys

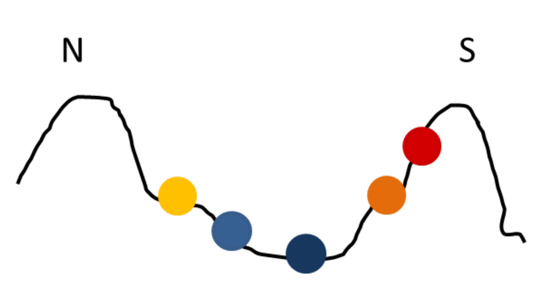


Spatial variability of exchange processes in an Alpine Valley

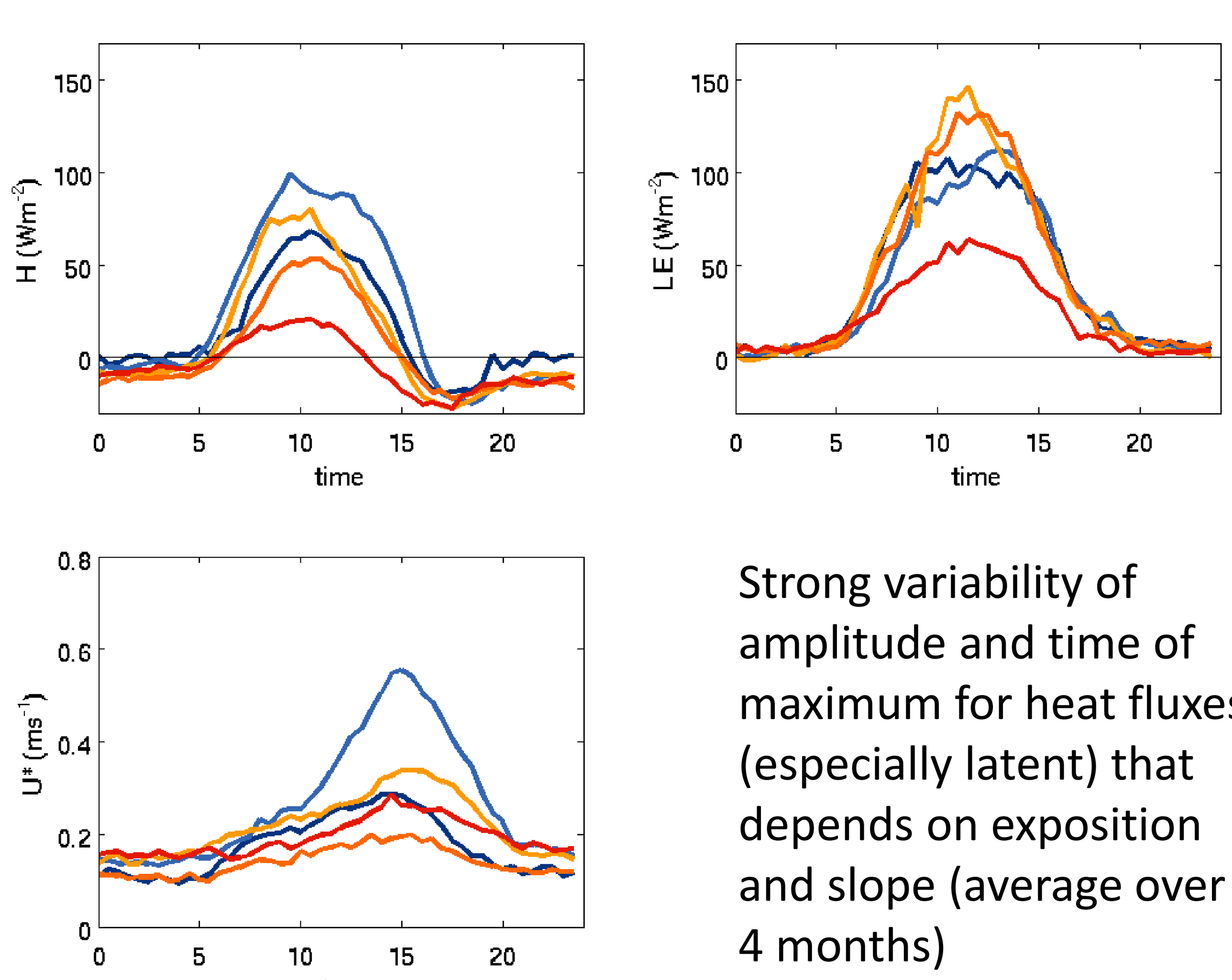
Measurements from 5 stations over a period of over 6 months are used to study the variability of surface fluxes and scaling relations in complex terrain

General characteristics of near surface atmosphere





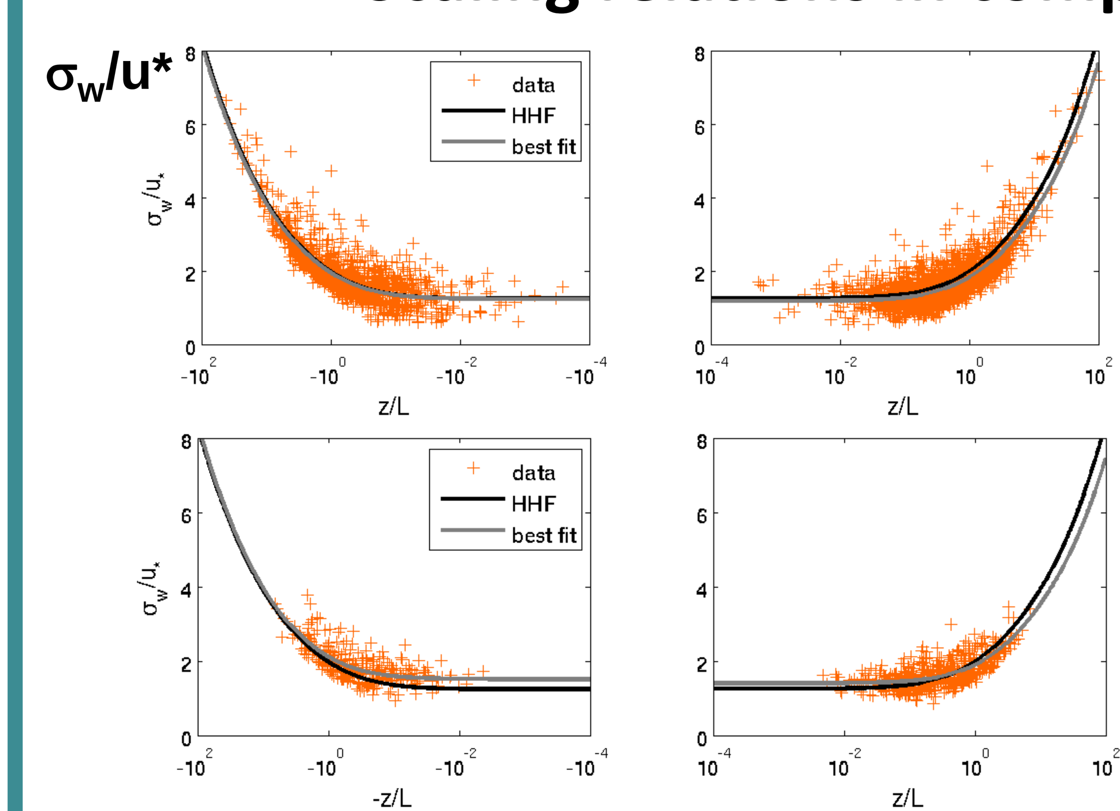
Slope stations facing N have predominantly **slope** wind systems (downslope), while flat stations and those facing S experience **valley** winds



Strong variability of amplitude and time of maximum for heat fluxes (especially latent) that depends on exposition and slope (average over 4 months)

Contact: ivana.stiperski@uibk.ac.at

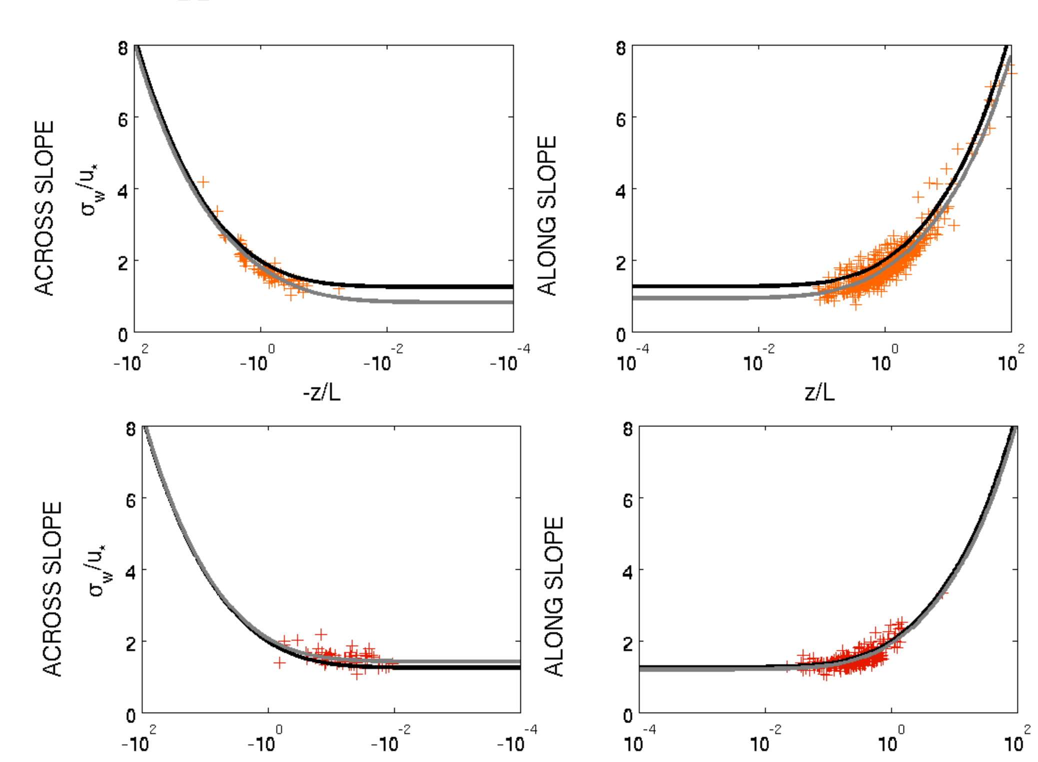
Scaling relations in complex terrain



Results strongly depend on appropriate data analysis:

- Reducing the scatter
- Quality data show **higher variance** than over flat terrain

Scaling relations for σ_w/u_* appear to correspond relatively well to the data but certain **wind directions** and **slope angles** show much worse agreement



Scaling relations for σ_T/θ_* show a **larger deviation**, especially for slope flows suggesting difference in the **heat transport** and existence of **processes** not accounted for