



Towards Climate-Smart Alpine Forests

Climate Change in Mountainous Areas

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A photograph of a theater stage. The stage is framed by heavy red curtains with gold fringe. The backdrop is a dark blue screen with a pattern of small, glowing white stars. Several bright blue spotlights are directed at the stage floor, creating a hazy, atmospheric effect. The stage floor is a light-colored wood. In the foreground, the backs of several rows of dark red theater seats are visible. The text "Setting the scene...." is written in a large, black, cursive font across the center of the image.

Setting the scene....

Towards Climate-Smart Alpine Forests

Climate change

▲ ... is a reality

▲ 2021:

- new IPCC report (AR6)
- disastrous forest fires in Mediterranean
- record temperatures in US
-

▲ 'Paris' is hardly reachable

▲ adaptation strategies needed ...
and Climate-Smart Alpine
Forests are one possibility



Mountain areas

▲ doubled climate sensitivity

....about 2°C warming realised

▲ fragile ecosystems

▲ massive services to society

→ water towers

→ recreation

→ renewable energy

→ all the **forest services**....

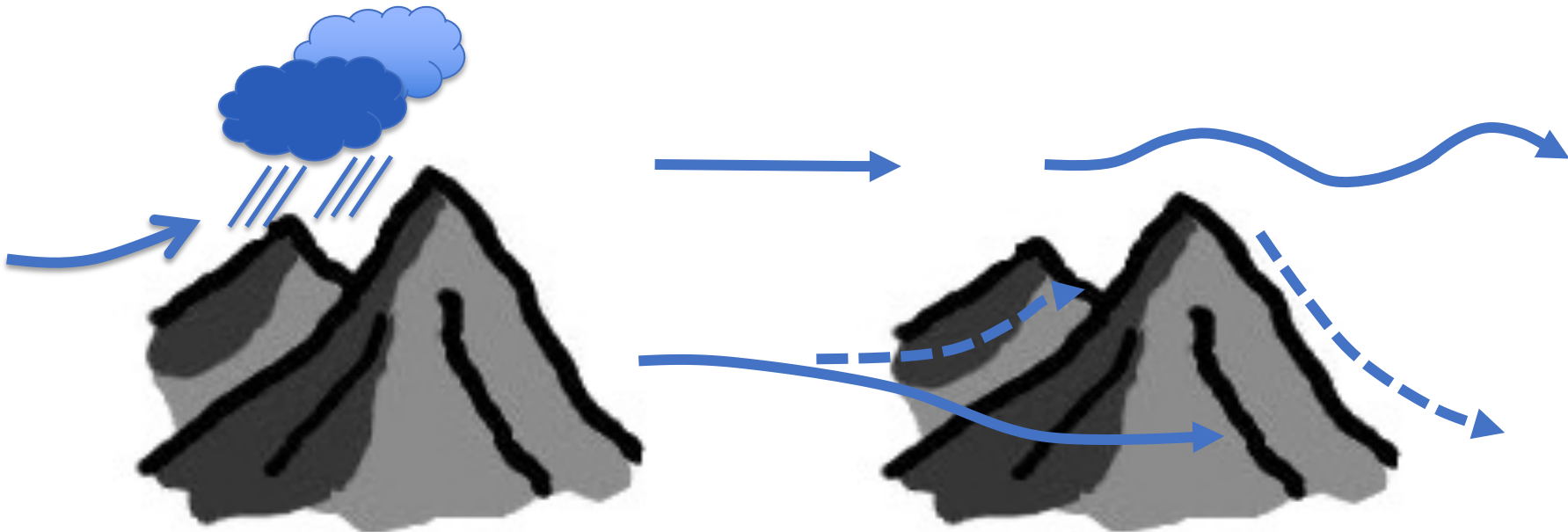
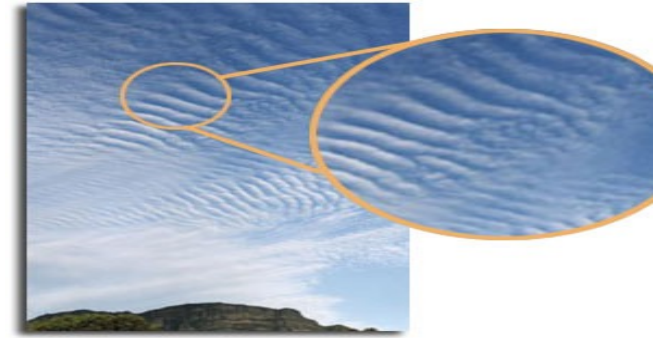


Photo Michael Bruendl, SLF

Mountain Weather and Climate

▲ mountains influence weather and climate

- orographic precipitation
- flow modifications
 - > mountain windstorms
 - > Föhn (Bora, Mistral, Chinook, ...)
- gravity waves, (rotors)



Which climate conditions to be expected?

- Need to measure
 - harsh conditions
 - validate the models
 - sparse data coverage



- For the future:
 - need to model
 - big computers

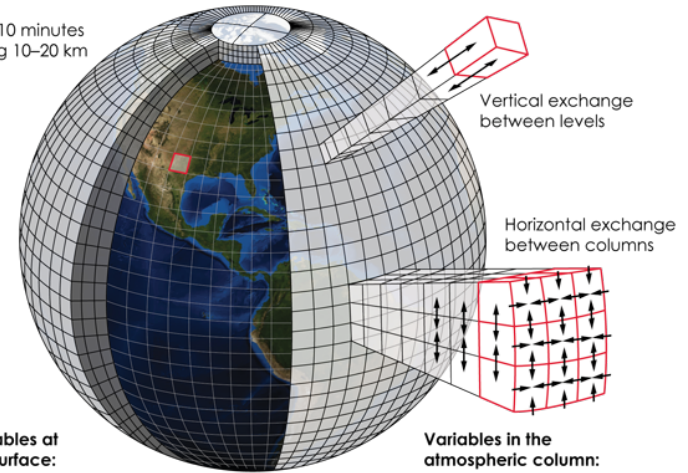


CSCS Piz Daint

Climate modeling

Weather forecast modeling

Timestep 5–10 minutes
Grid spacing 10–20 km



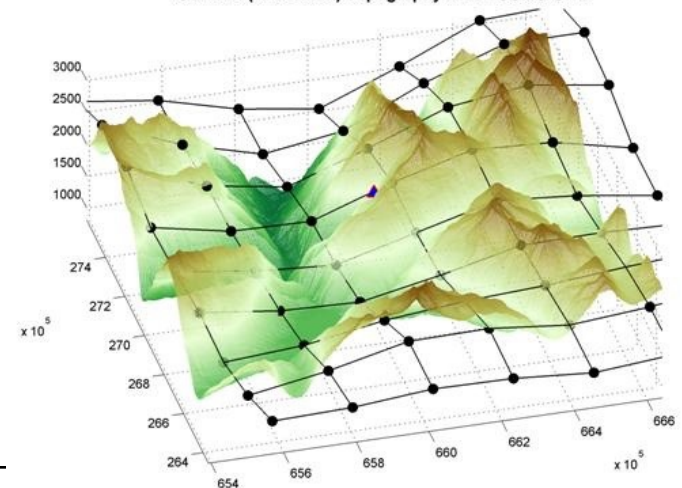
Variables at the surface:

Temperature
Humidity
Pressure
Moisture fluxes
Heat fluxes

Variables in the atmospheric column:

Wind vectors
Humidity
Clouds
Temperature
Height

Guetsch (Andermatt) Topography with COSMO Grid



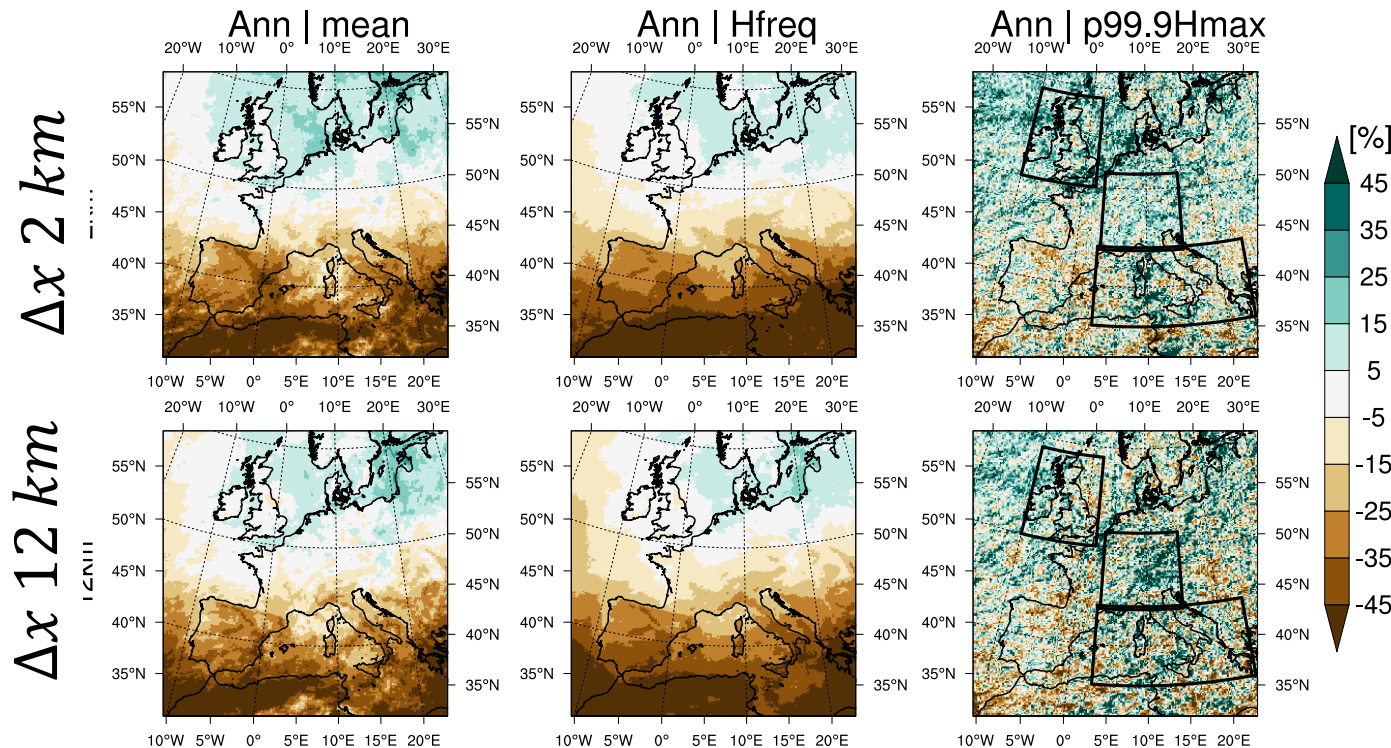
From MeteoSwiss (2009)

- grid on the atmosphere:
 - determine in each grid box:
 - > physical processes
 - > first principles

- In the mountains
 - resolution
 - regional climate:
 - ~10 km grid boxes

Climate projections – annual precipitation

- ‚climate model resolution‘: too coarse for the Alps
 - high-resolution ‚pseudo-global warming‘ experiments



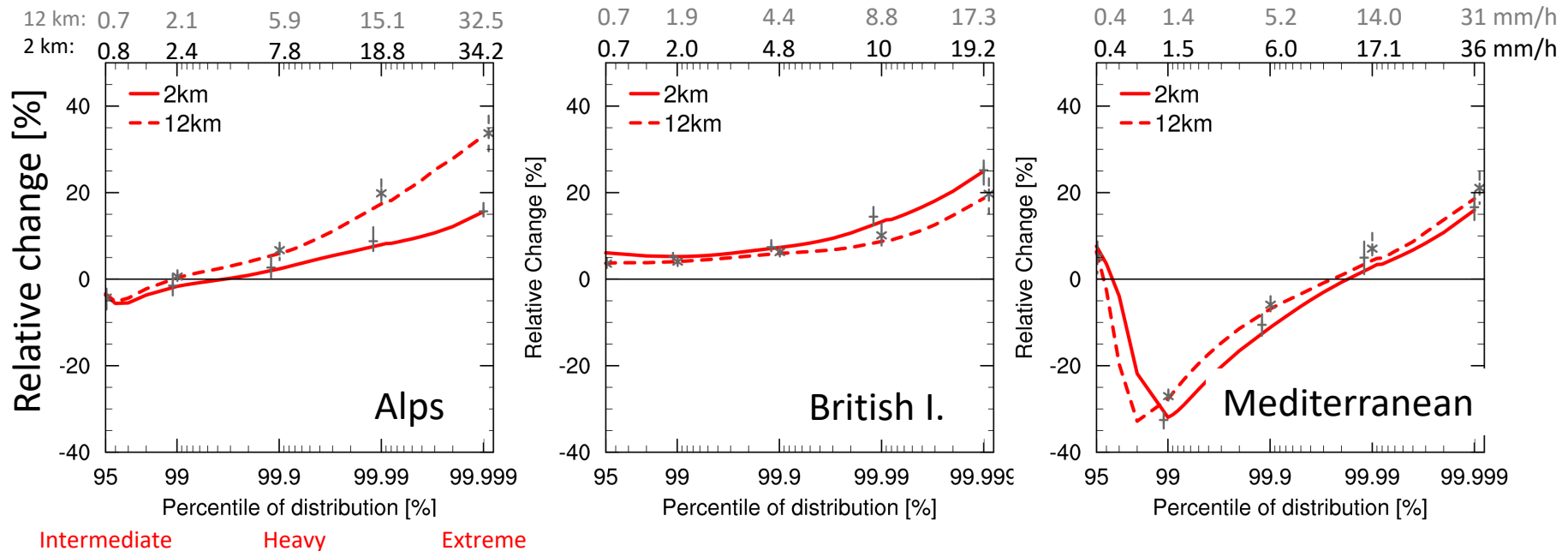
➔ $p99.9 - 99.9^{th}$
percentile of all (wet
& dry) events (0.1%
corresponds to 4
events per 10 years)
of daily maximum
hourly (Hmax)
precipitation

Ban et al (in prep)

Climate projections - reliability

Example: Hourly Precipitation, extremes

Relative changes in the precipitation intensity for different intensity



Ban et al (in prep)

→ largest impact of grid spacing: Alps

Climate projections – needs for the smart forests

- ▲ only temperature and precipitation?
 - what is it that determines forest growth / adaptation?
 - any specific (atmospheric) conditions for pests?
- ▲ Can we reliably get the required information?
 - from the models?
 - more (other) data needed?



We do our best



- Large international research programme on
 - mountain weather and climate
 - **TEAMx**



- Supported by
 - World Climate Research Programme of WMO
 - World Weather Research Programme of WMO
 - climate service providers (Meteorological & Hydrological Services)
 - universities & research institutions
- Better understanding / better models / more data
 - better information for e.g. **Climate-Smart Alpine Forests**

The Scene.....

- ▲ Planning for *Climate-Smart Alpine Forests*
 - requires climate information (projections) where it is most challenging
 - requires information on variables not usually measured (not even modelled)

- ▲ International collaboration is essential
 - TEAMx
 - international programmes (WMO, Copernicus, PRACE, ...)



.... the ,scene is set'
thank you very much for your attention