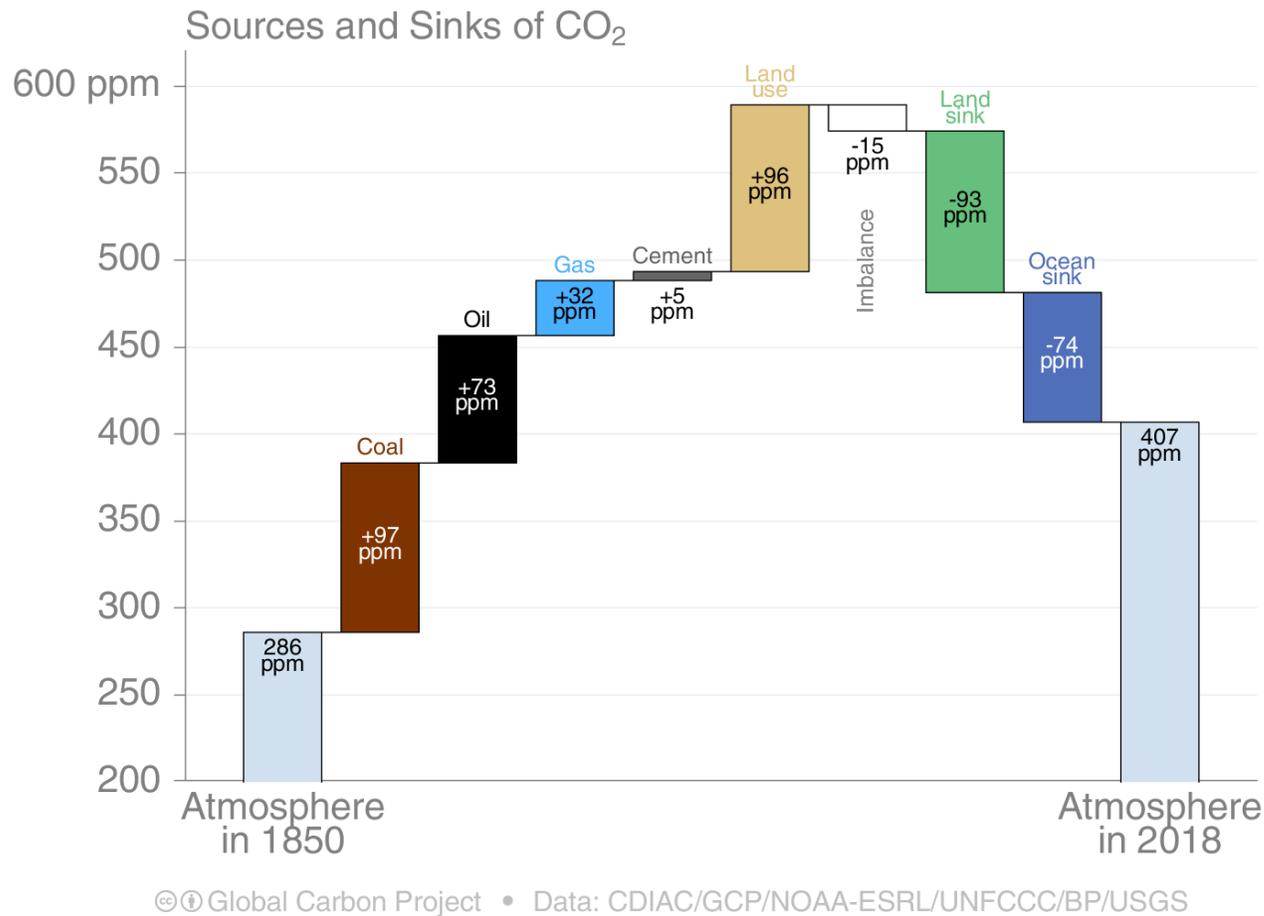




## What TeamX can do for mountain ecology

Georg Wohlfahrt, University of Innsbruck, Department of Ecology

# A primer on land-atmosphere feedbacks



- Negative feedback from land and ocean sink is reducing greenhouse effect and slowing down global warming.

The Global Carbon Project (2019)

In order to accurately reproduce land-atmosphere feedbacks models need to (i) represent the underlying processes and (ii) be informed by appropriate data, BUT ...

## THE WORLD IS NOT FLAT

### Implications for the Global Carbon Balance

BY MATHIAS W. ROTACH, GEORG WOHLFAHRT, ARMIN HANSEL,  
MATTHIAS REIF, JOHANNES WAGNER, AND ALEXANDER GOHM

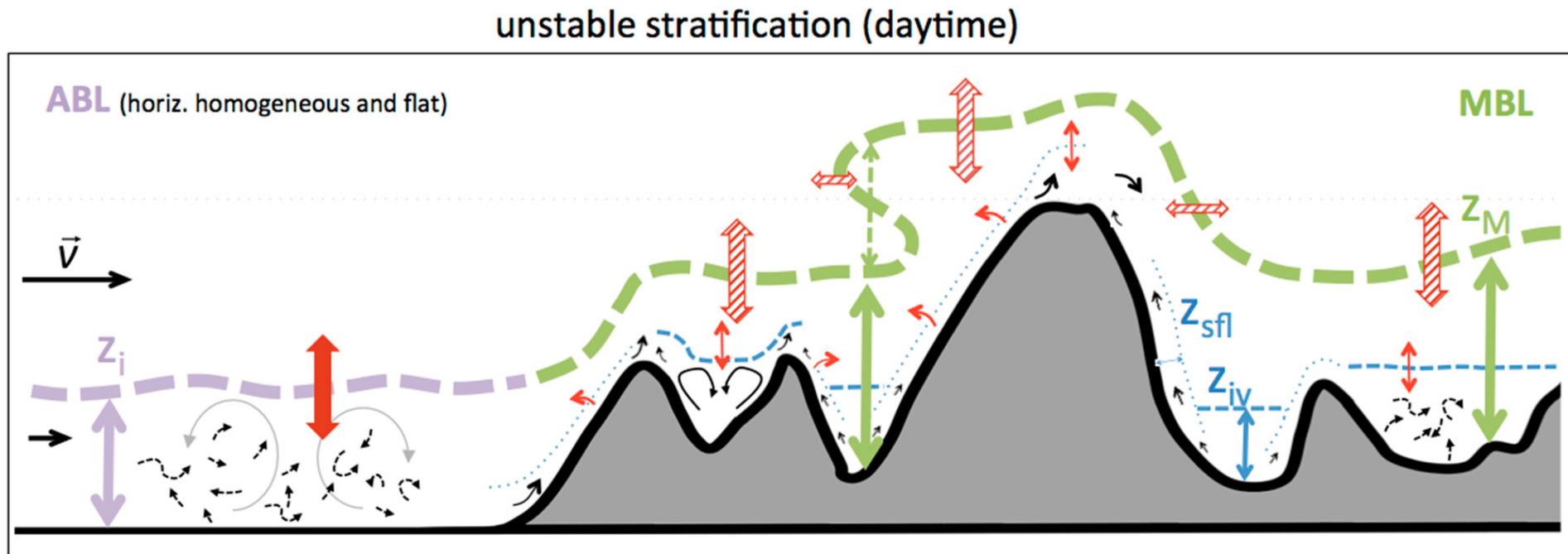
The incorporation of mesoscale circulations would increase the accuracy of global (or regional) atmospheric carbon budget models—  
A finding that calls for more much-needed research.

**A**nthropogenic activities, such as combustion of fossil fuels plus cement production and land use changes, result in large CO<sub>2</sub> emissions into Earth's atmosphere. The corresponding CO<sub>2</sub> emission values for the year 2011 are  $9.5 \pm 0.5$  and  $0.9 \pm 0.5$  PgC yr<sup>-1</sup>, respectively (Le Quéré et al. 2013). About half of the manmade CO<sub>2</sub> remaining

Whether oceans and land ecosystems will continue to substantially take up CO<sub>2</sub>, without which warming would proceed at double speed (Raupach 2011), is the topic of controversial discussions (Le Quéré 2010; Ballantyne et al. 2012). Current estimates of the terrestrial and oceanic sinks are associated with considerable uncertainties [35% and 20%, respec-

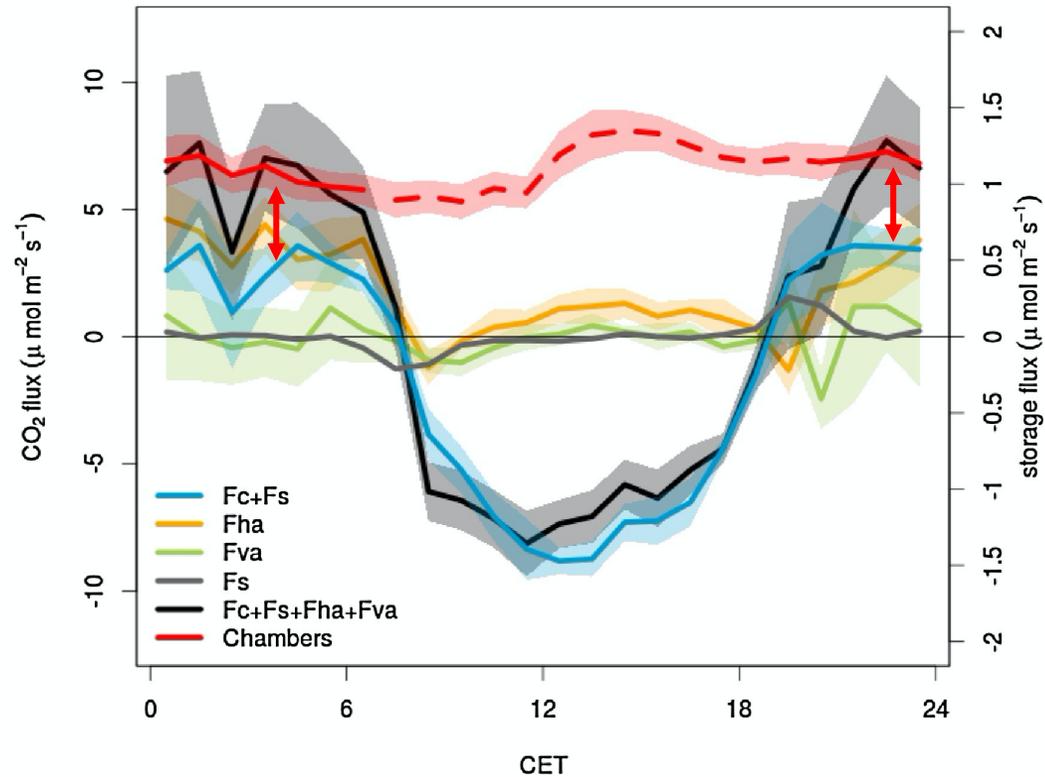
Rotach et al. (2014)

In order to accurately reproduce land-atmosphere feedbacks models need to (i) represent the underlying processes ...

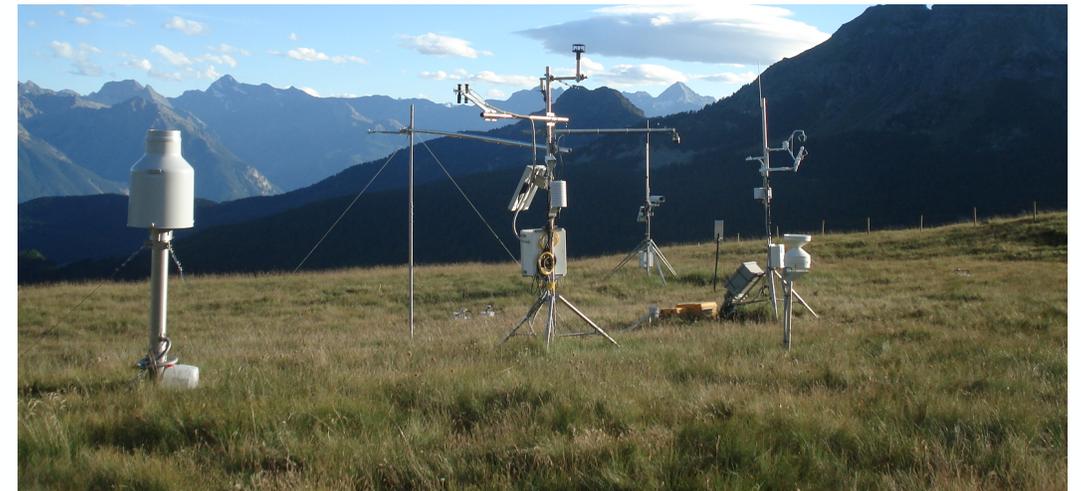


Lehner & Rotach (2018)

In order to accurately reproduce land-atmosphere feedbacks models need to (i) represent the underlying processes ...

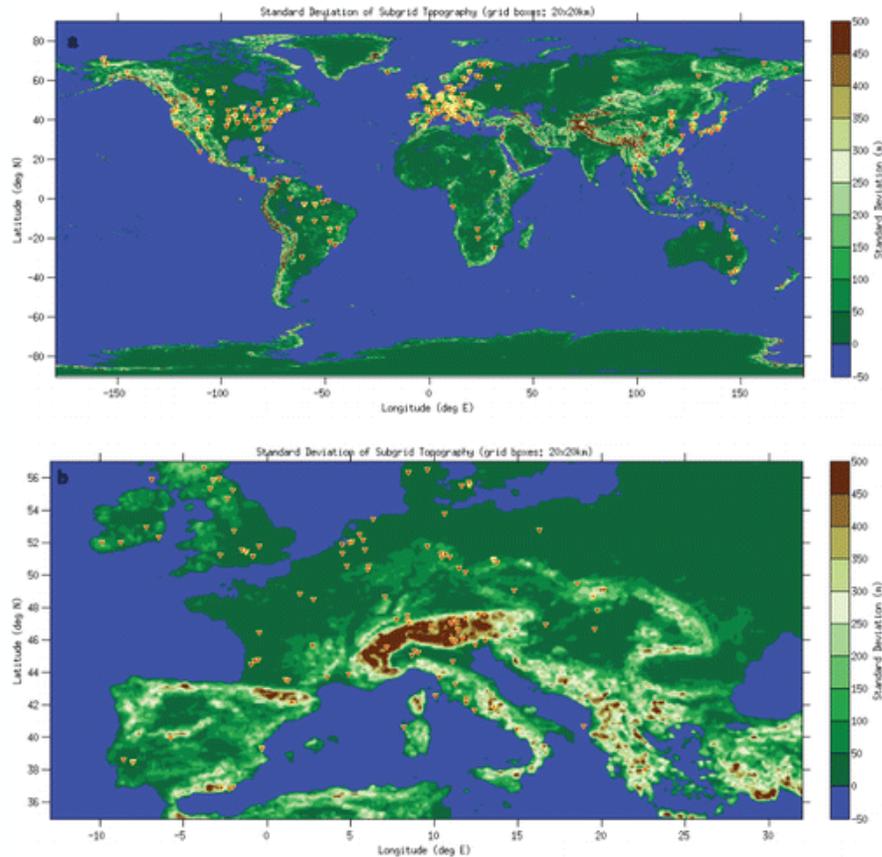


Year	NEE	NEE <sub>lr</sub>	NEE <sub>ow</sub>	NEE <sub>lr50</sub>	NEE <sub>REF</sub>	R <sub>max</sub>	NEE <sub>Fmod</sub>
2010	-58	-58	-34	2 (41)	15 (41)	81	92.5
2011	-236	-234	-191	-156 (73)	-151 (73)	-60	-51
2012	-23	-19	-1	47 (48)	54 (48)	145	147
2014	-116	-119	-80	-57 (69)	-48 (69)	74	112
Average	-108	-107	-76	-40 (58)	-32 (58)	80	75



Galvagno et al. (2017)

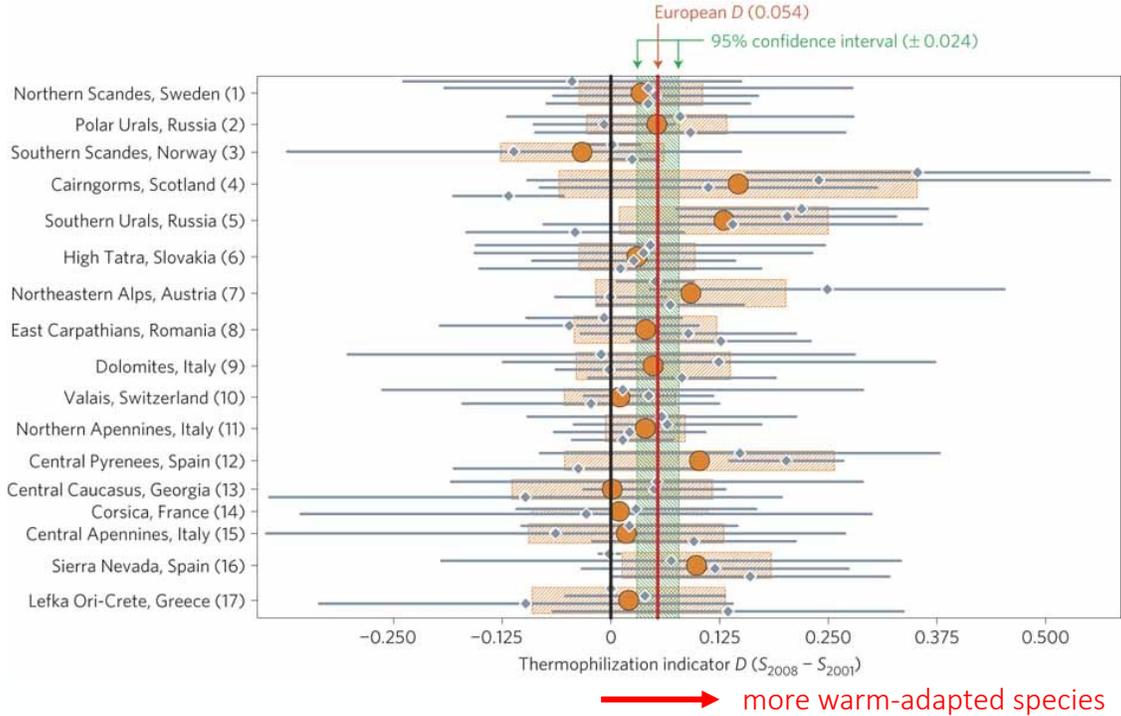
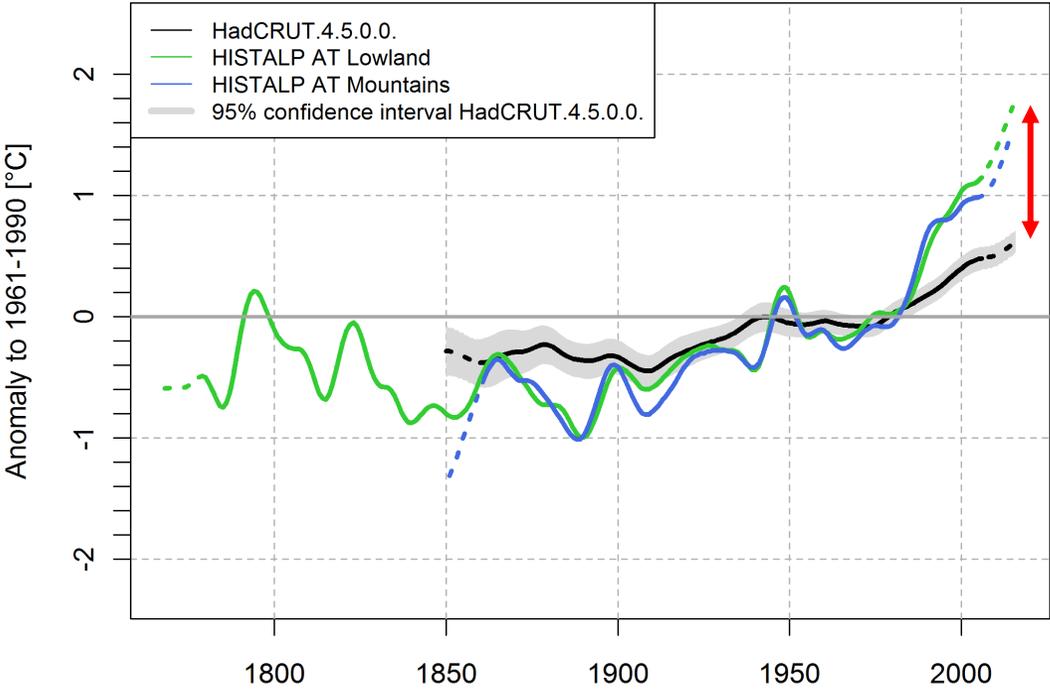
In order to accurately reproduce land-atmosphere feedbacks models need to (i) represent the underlying processes and (ii) be informed by appropriate data



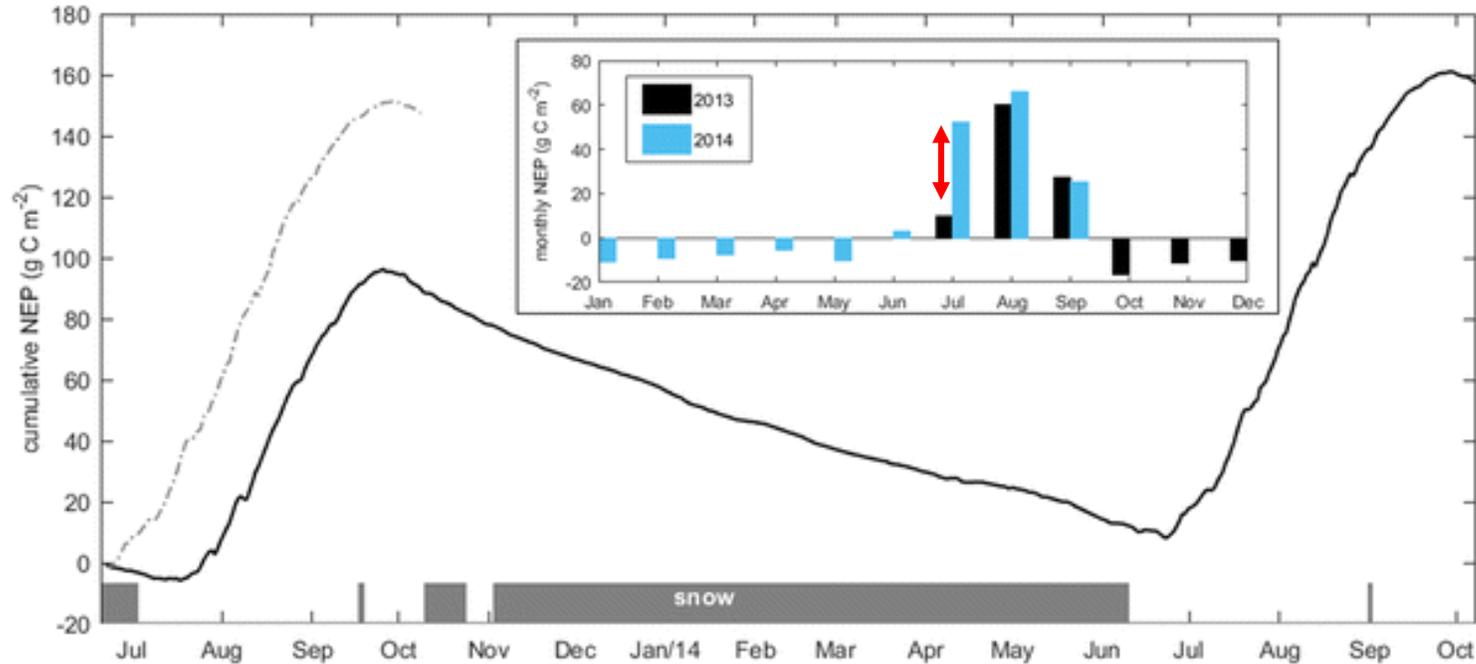
- Compared to their aerial extent, flux measurements in mountainous topography are underrepresented.

Rotach et al. (2013)

# At the same time, many mountain regions are experiencing rapid changes in climate ...



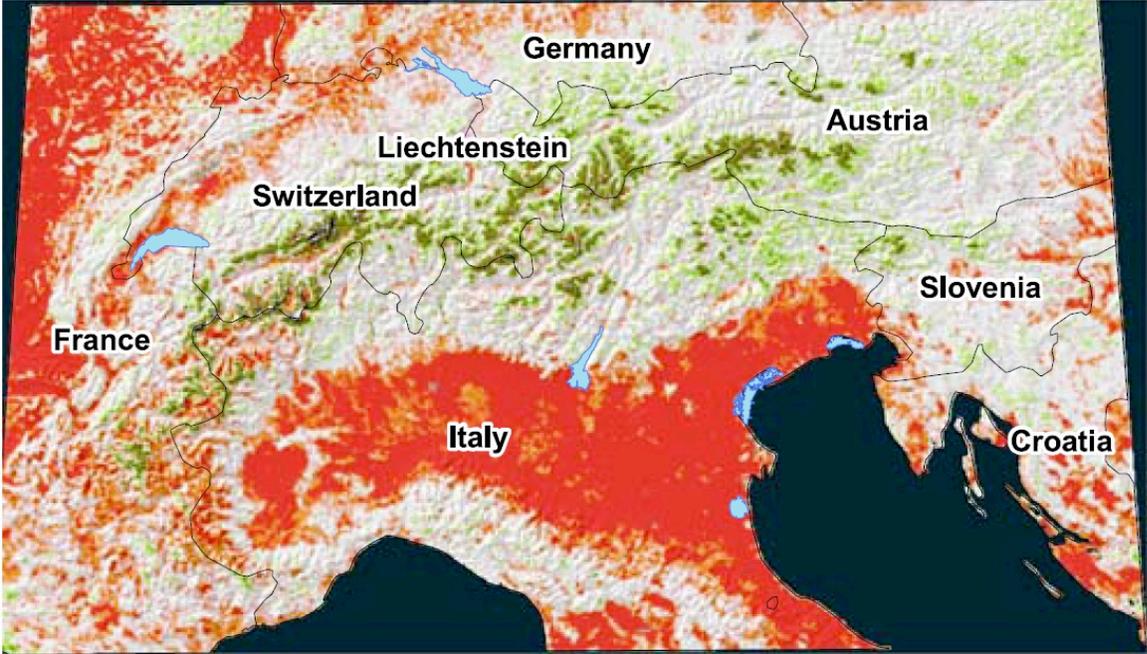
At the same time, many mountain regions are experiencing rapid changes in climate ...



- Earlier snow melt causes increase in carbon uptake.

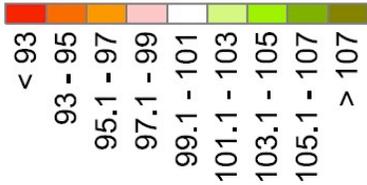
Scholz et al. (2018)

At the same time, many mountain regions are experiencing rapid changes in climate ...



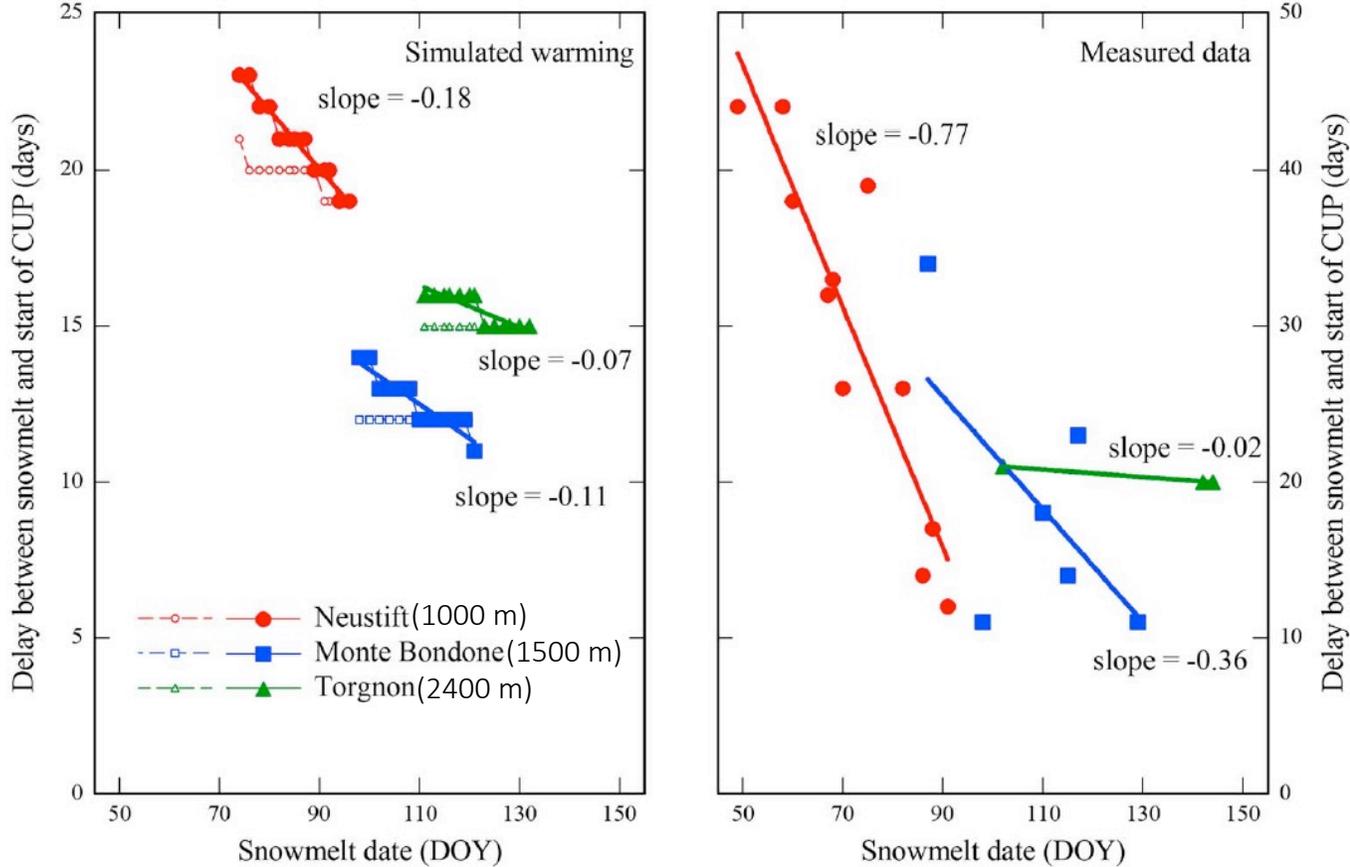
Summer 2003

MODIS Summer FPAR relative to mean (%)



Jolly et al. (2005)

At the same time, many mountain regions are experiencing rapid changes in climate ...



- Earlier snow melt causes a lengthening of the time required by grassland to become carbon sink.
- This effect is more pronounced at lower elevations, where snow melt occurs earlier in the season with shorter days.

Wohlfahrt et al. (2013)

# At the same time, many mountain regions are experiencing rapid changes in climate and land use

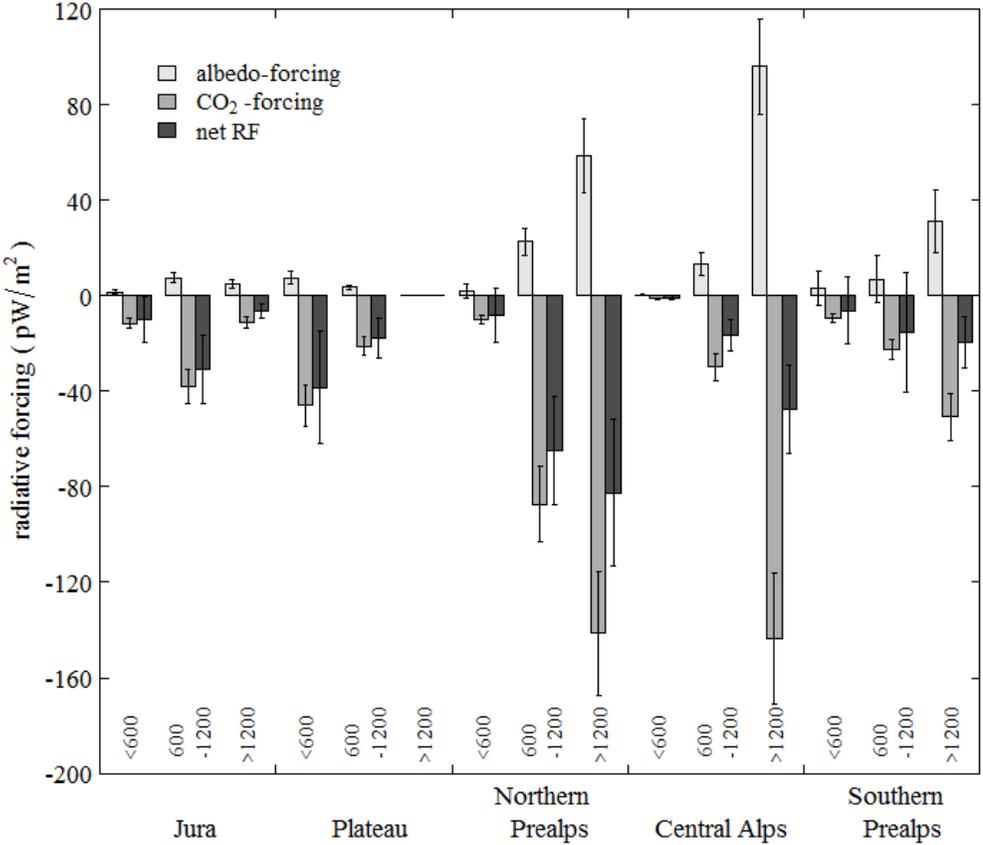
1905



2010

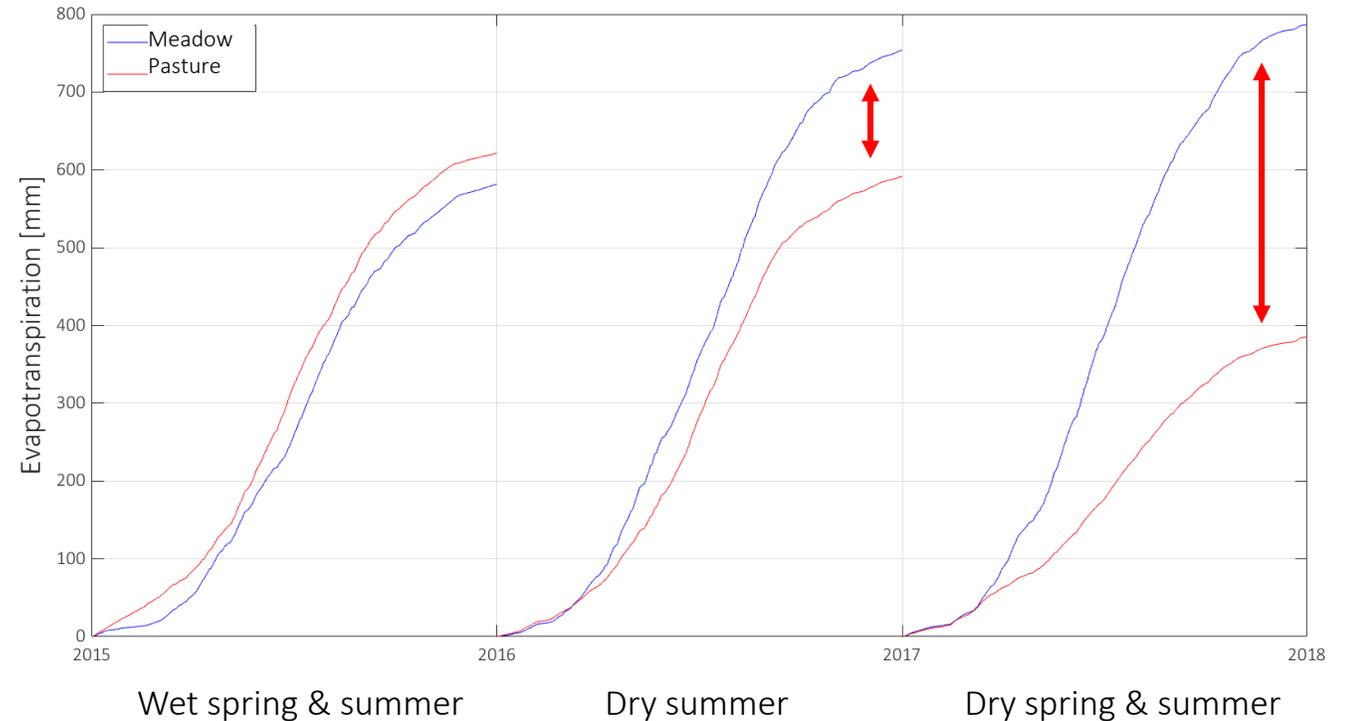
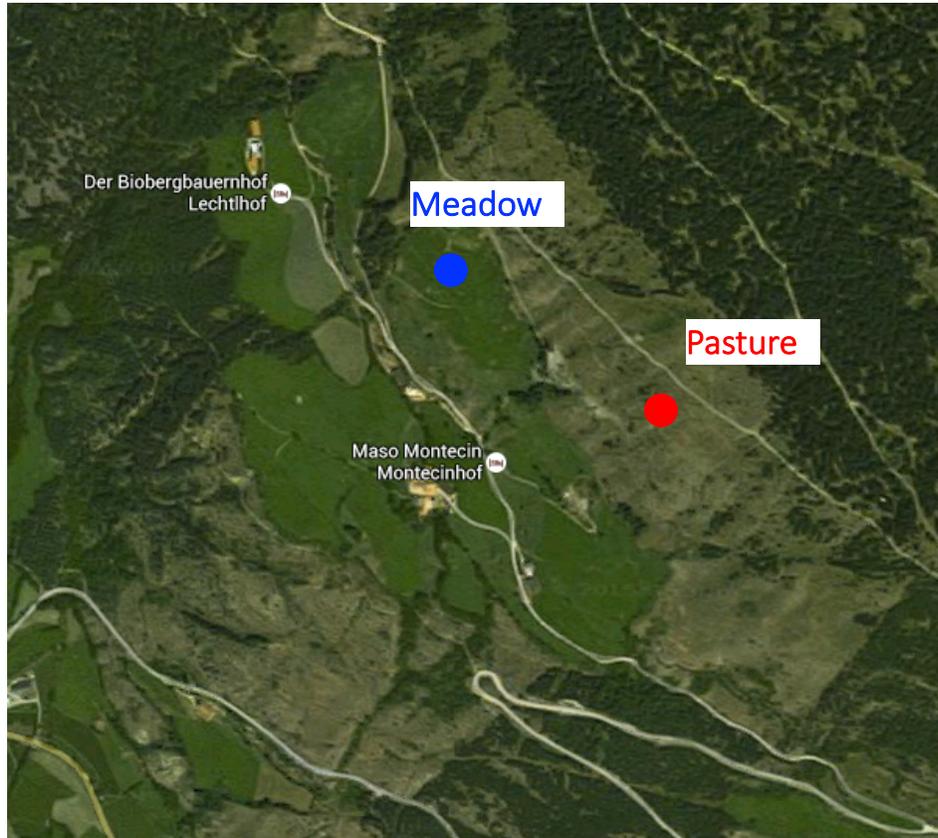


Pictures courtesy Erich Tasser



Schwab et al. (2015)

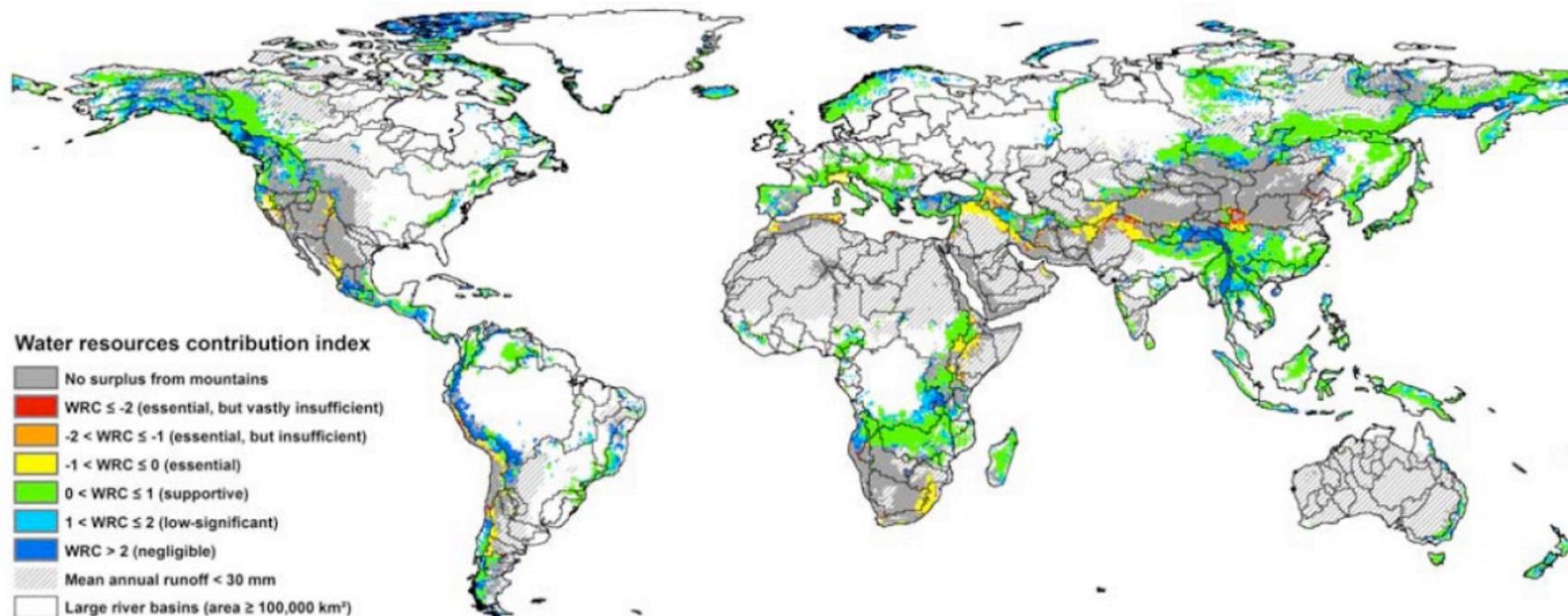
At the same time, many mountain regions are experiencing rapid changes in climate and land use



Willeit et al. (in prep.)

At the same time, many mountain regions are experiencing rapid changes in climate and land use

$$\text{PPT} - \text{ET} \approx \text{Runoff}$$



Viviroli et al. (2007)

# What TeamX can do for mountain ecology

- Mountain ecosystems are undergoing rapid changes in climate, often in combination with land use.
- Changes in ecosystem structure and function result in both positive and negative feedbacks to climate.
- Effects not confined to mountain areas (e.g. water towers).

TeamX can help to better understand the underlying processes by

- advancing the theory that underlies the measurement and modelling of the land-atmosphere exchange in complex mountainous topography,
- improving data availability and
- pointing the spotlight to mountain areas.

