LPICEA | Lab of Plant Interactions: Climate, Ecosystem & Atmosphere

Department of Earth System Science | Tsinghua University

EGU General Assembly 2022

Optimality principles explaining divergent responses of alpine vegetation to environmental change

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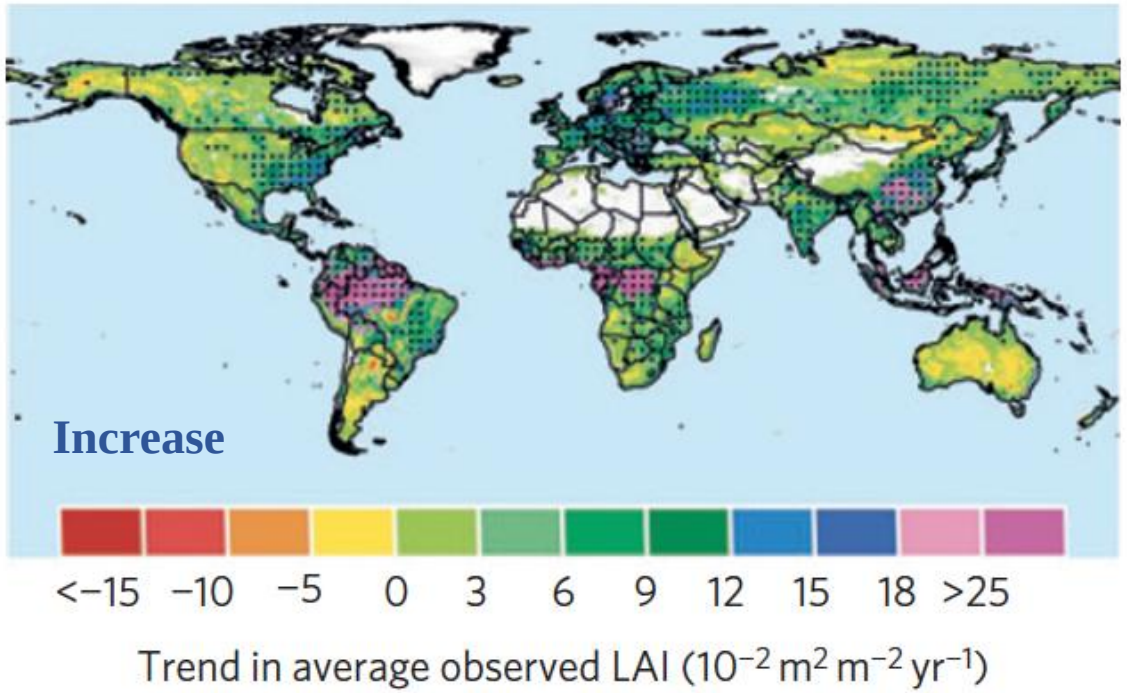
EGU European Geosciences Union

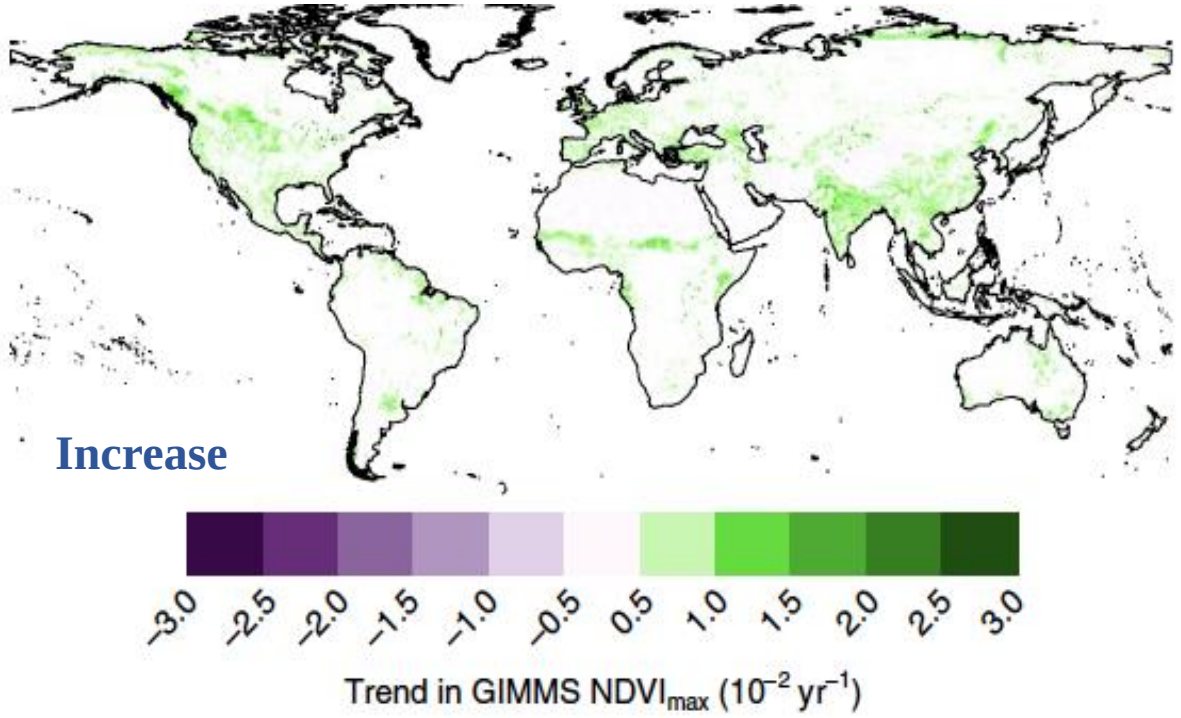
A global increase in vegetation cover

- **Greening of the earth**



(Zhu et al., Nature Climate Change 2016)

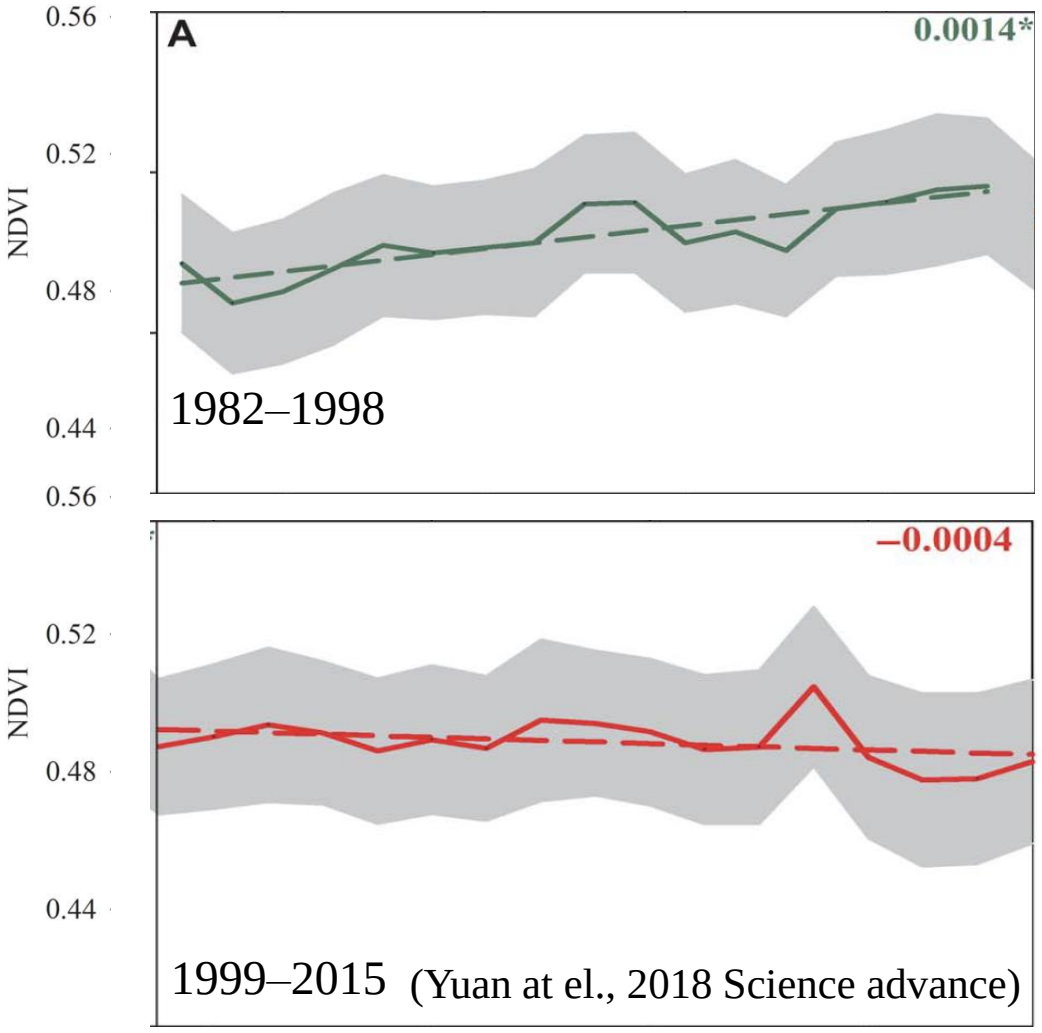
- **Enhancement of vegetation peak growth**



(Huang et al., Nature Ecology & Evolution 2018)

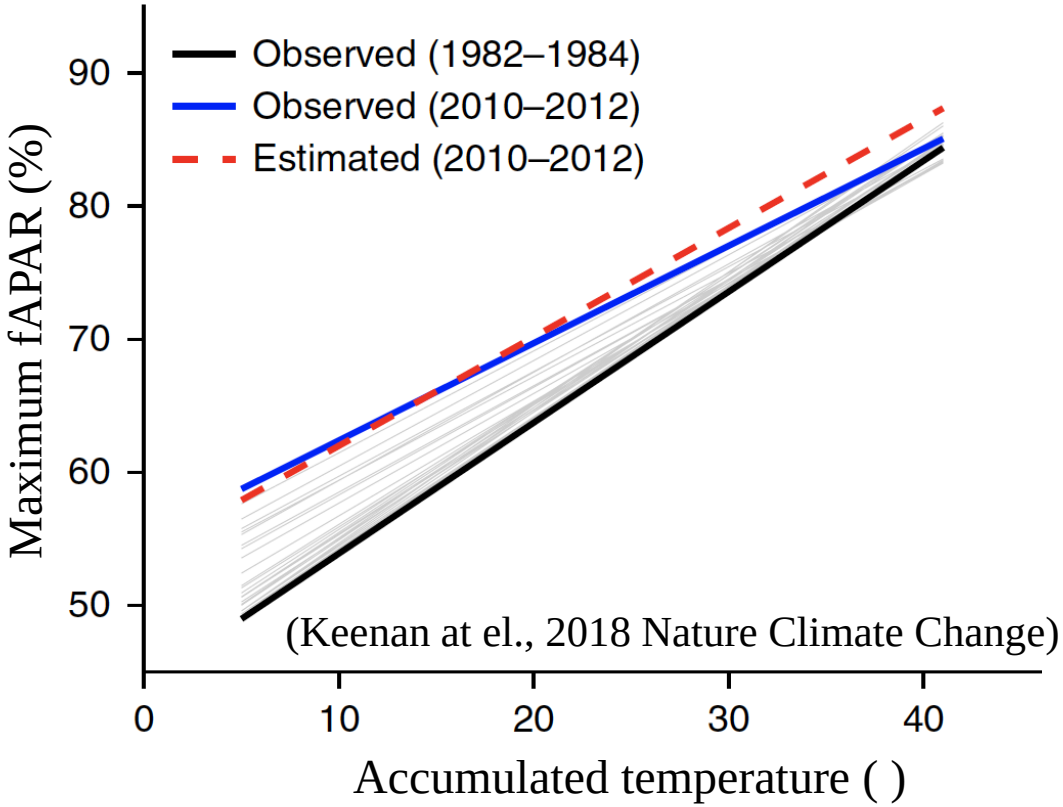
Slowdown of greening trend

Stalled greening trend after late 1990s



(Yuan at el., 2018 Science advance)

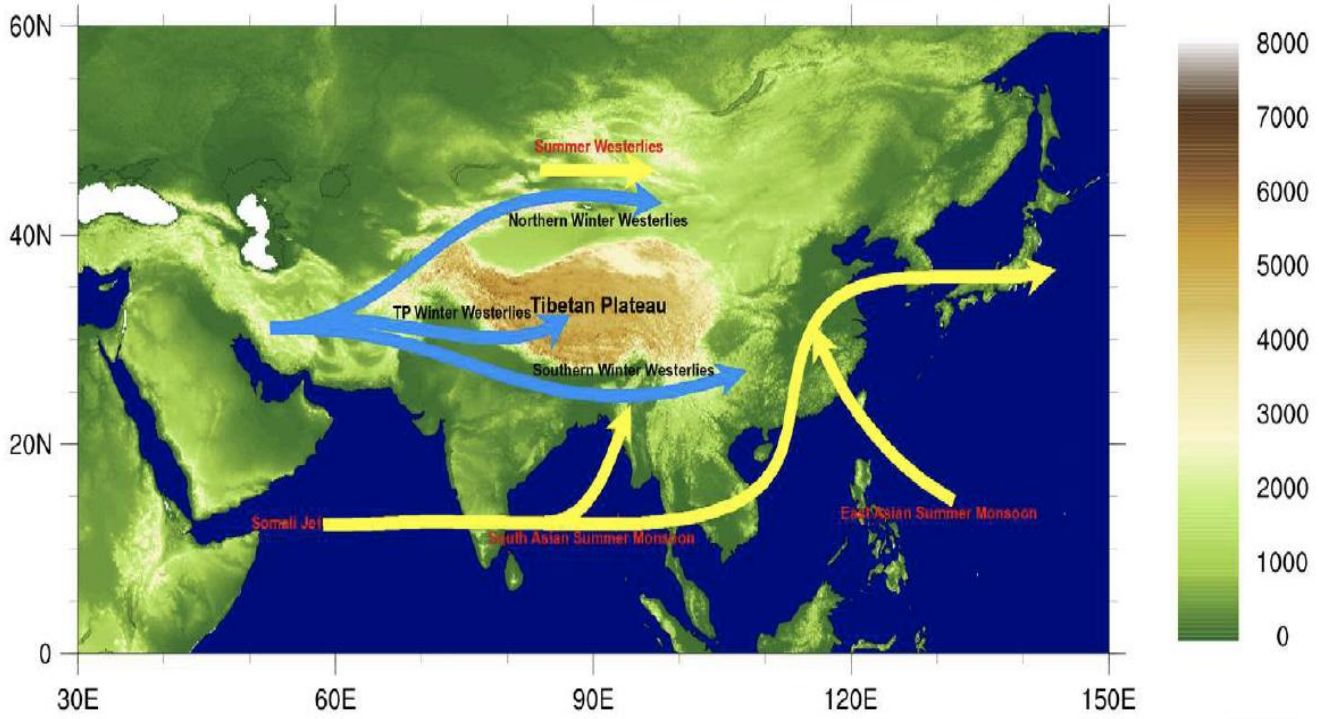
Declined vegetation to temperature response



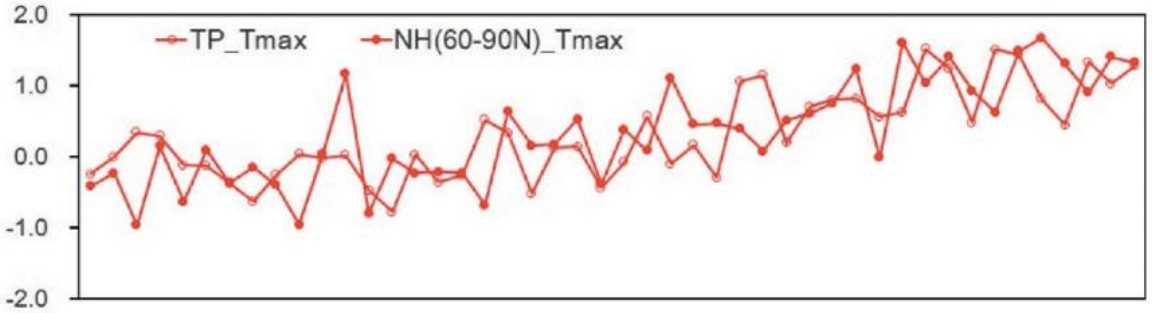
(Keenan at el., 2018 Nature Climate Change)

Question | Why the relationship between vegetation and climate changes has weakened?

Rapid warming on the Tibetan Plateau



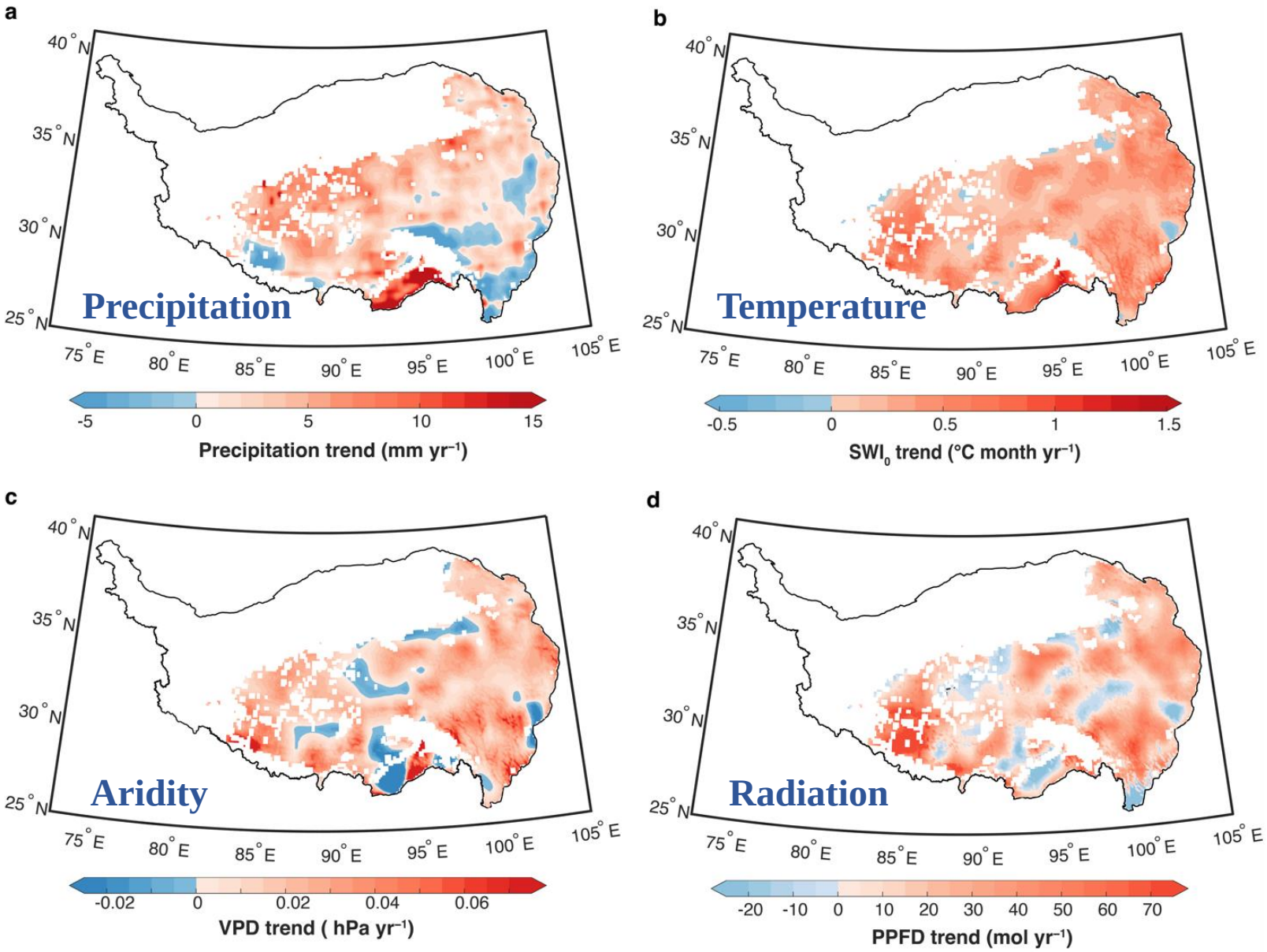
(Yang et al., Global and Planetary Change 2016)



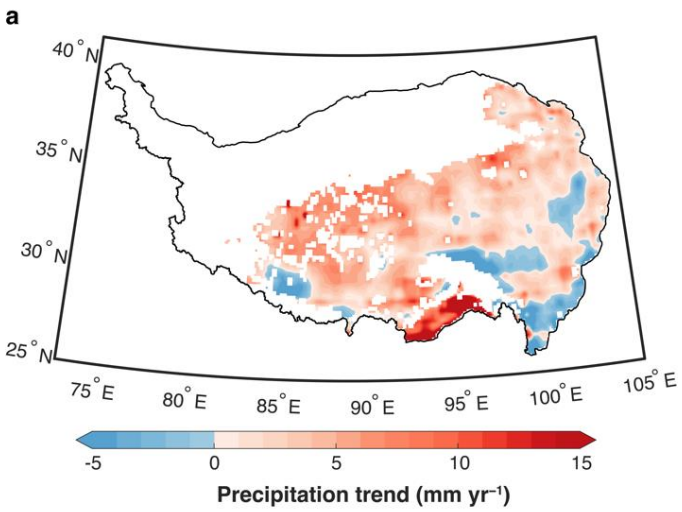
(Yao et al., Bulletin of the American Meteorological Society 2019)

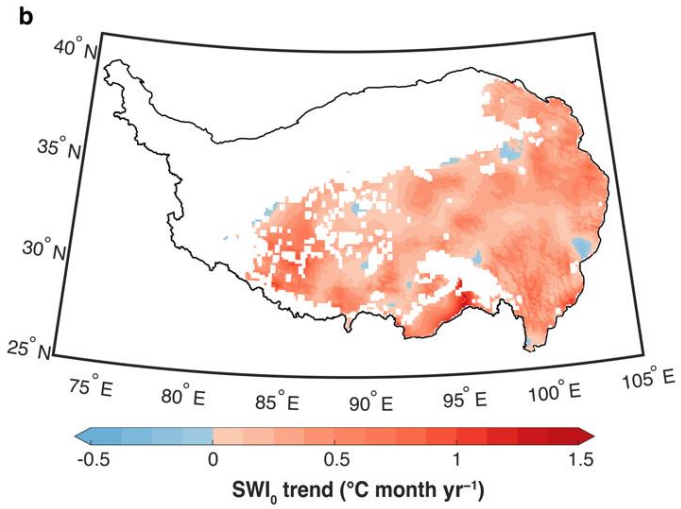
- **Comparable warming rate of the Arctic**
- **Sensitive, ecologically fragile and highly representative**
- **Limited understanding of how alpine ecosystems adapt to climate change**

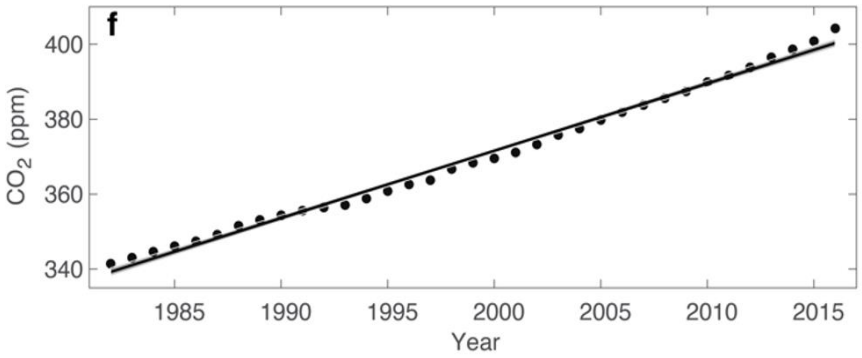
Similar climate trends on the Tibetan Plateau

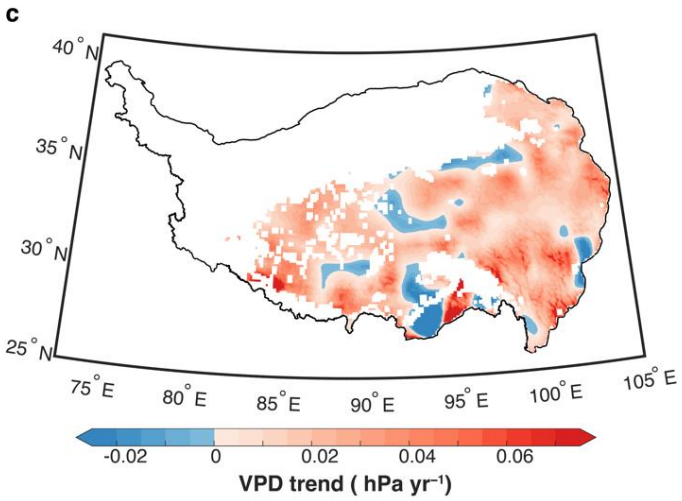


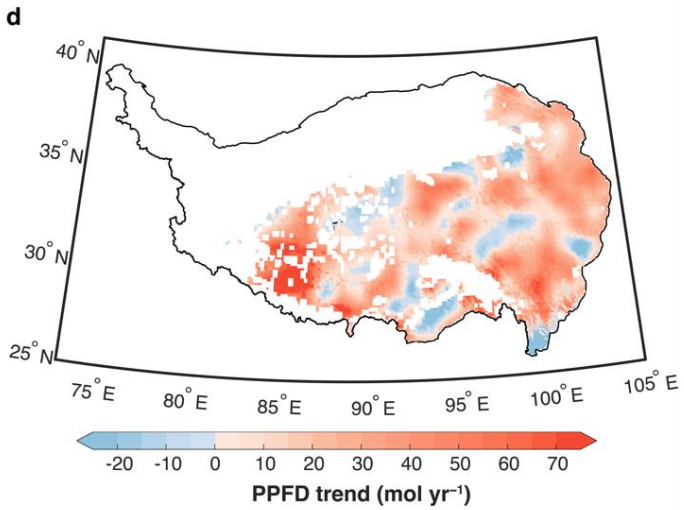
Divergent responses of vegetation growth

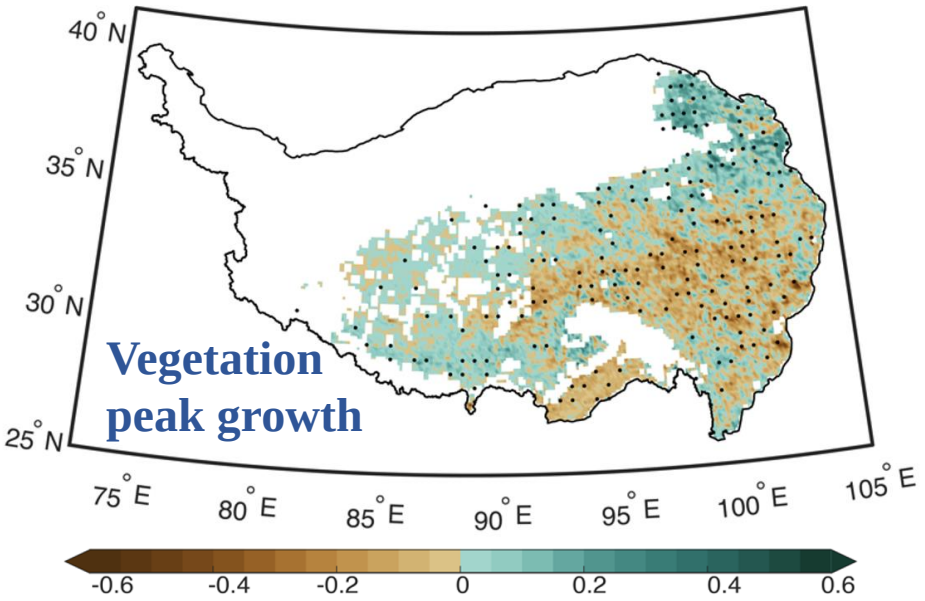






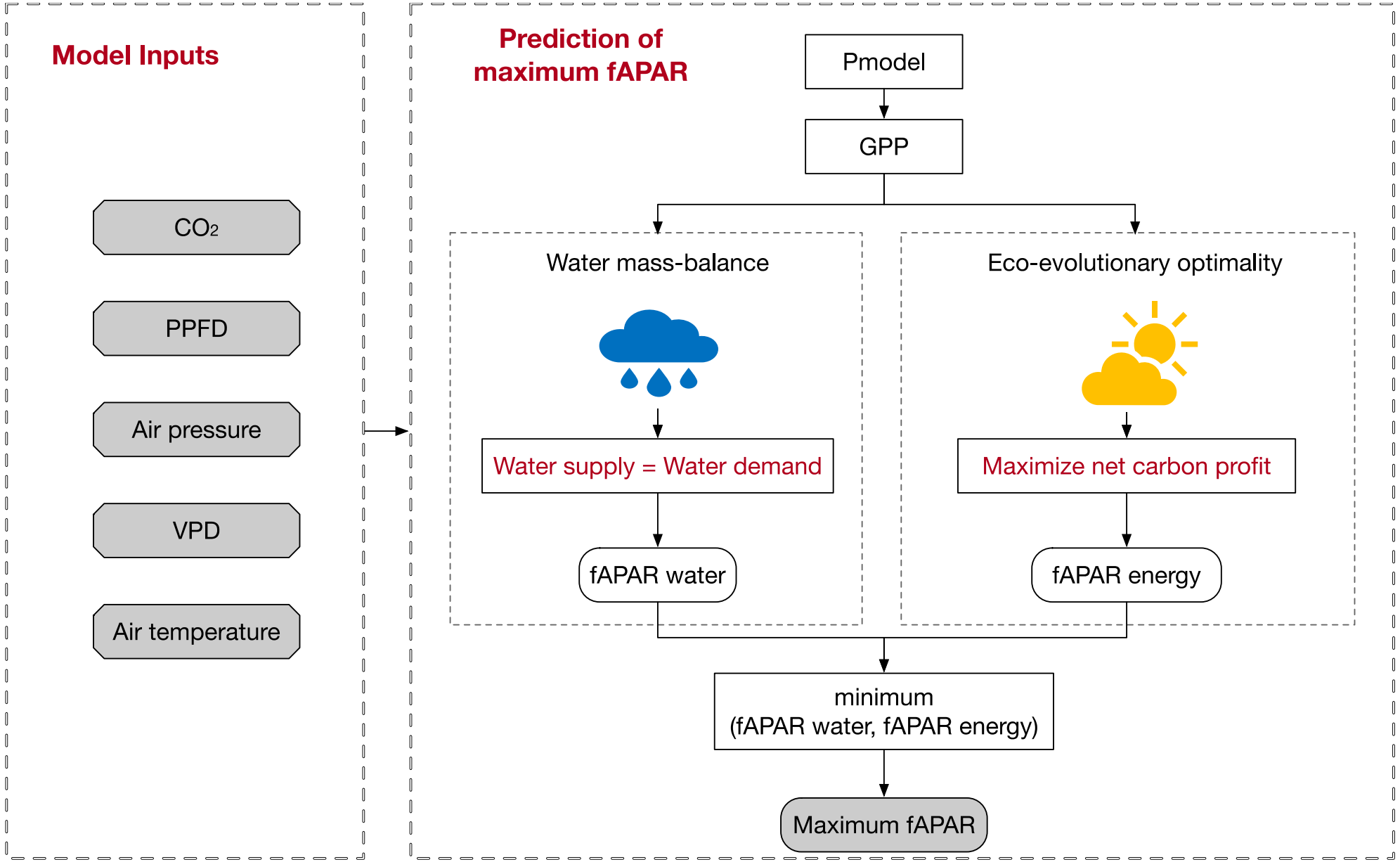




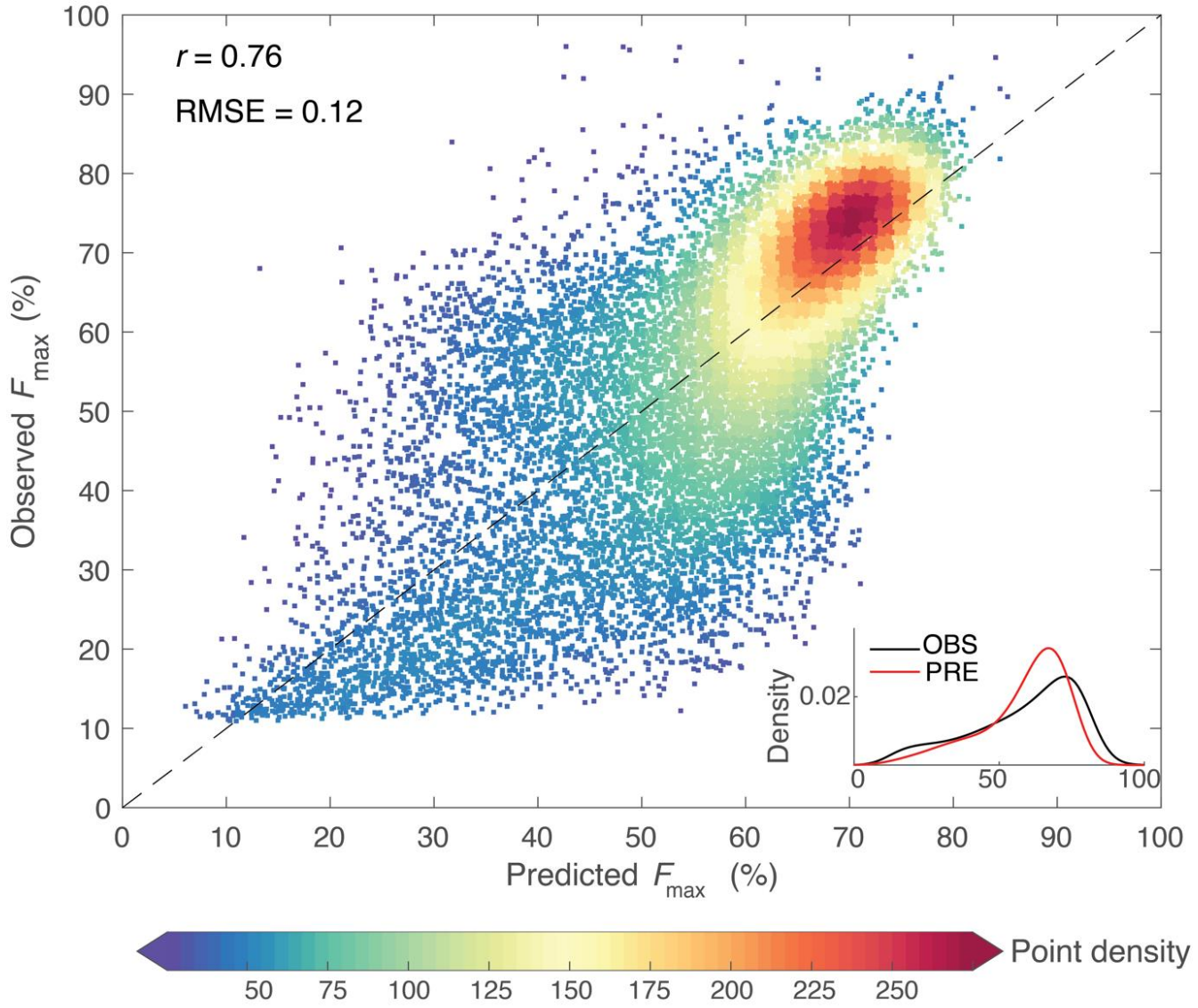


➢ **Question | Why does similar climate change lead to divergent responses of vegetation growth?**

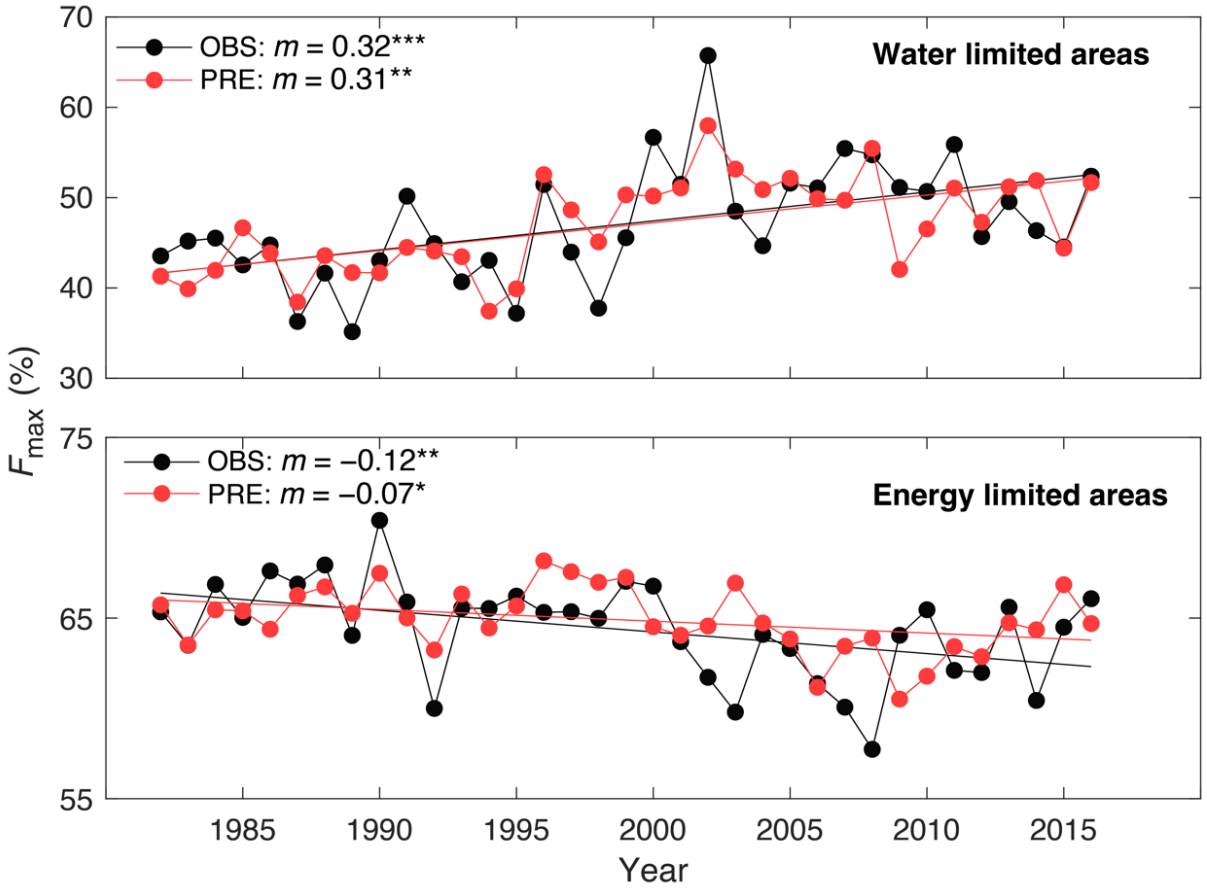
Prediction of peak vegetation growth

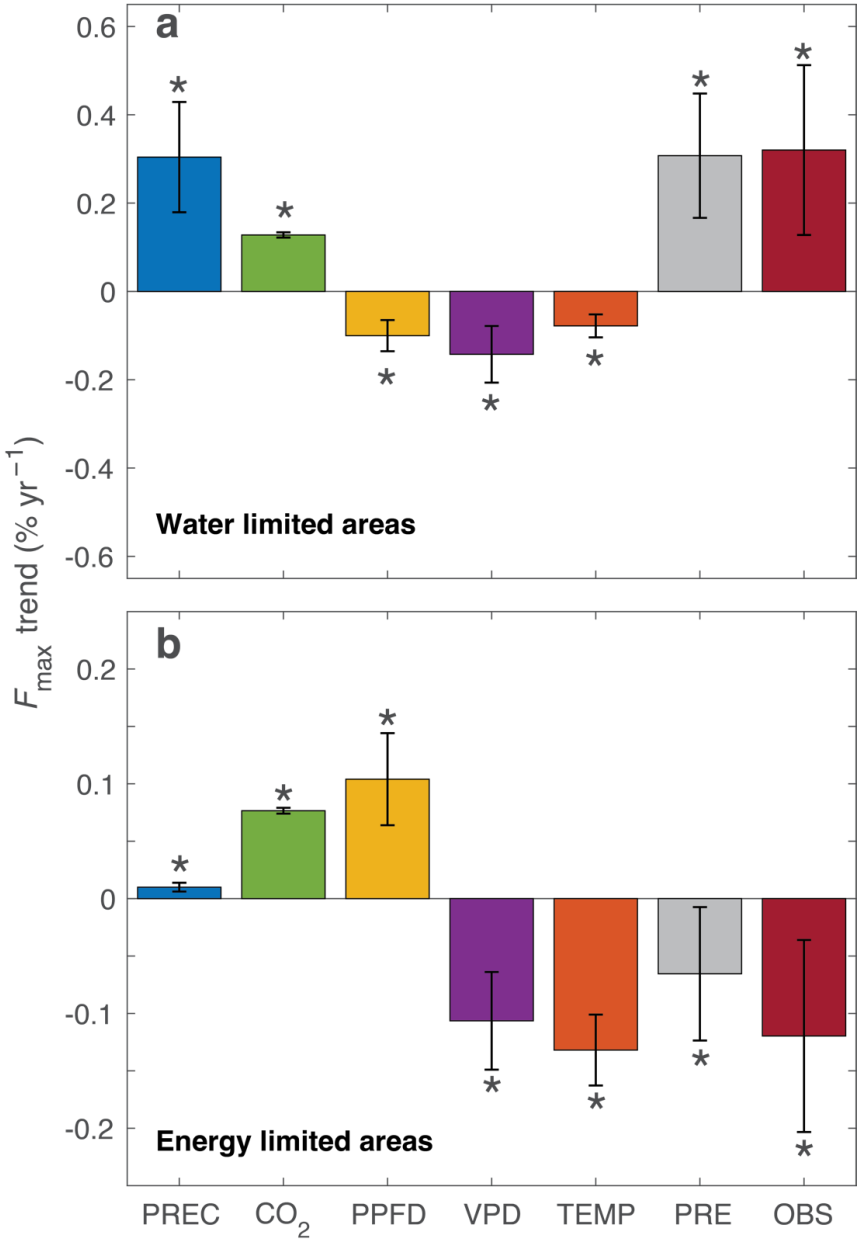


Model validation



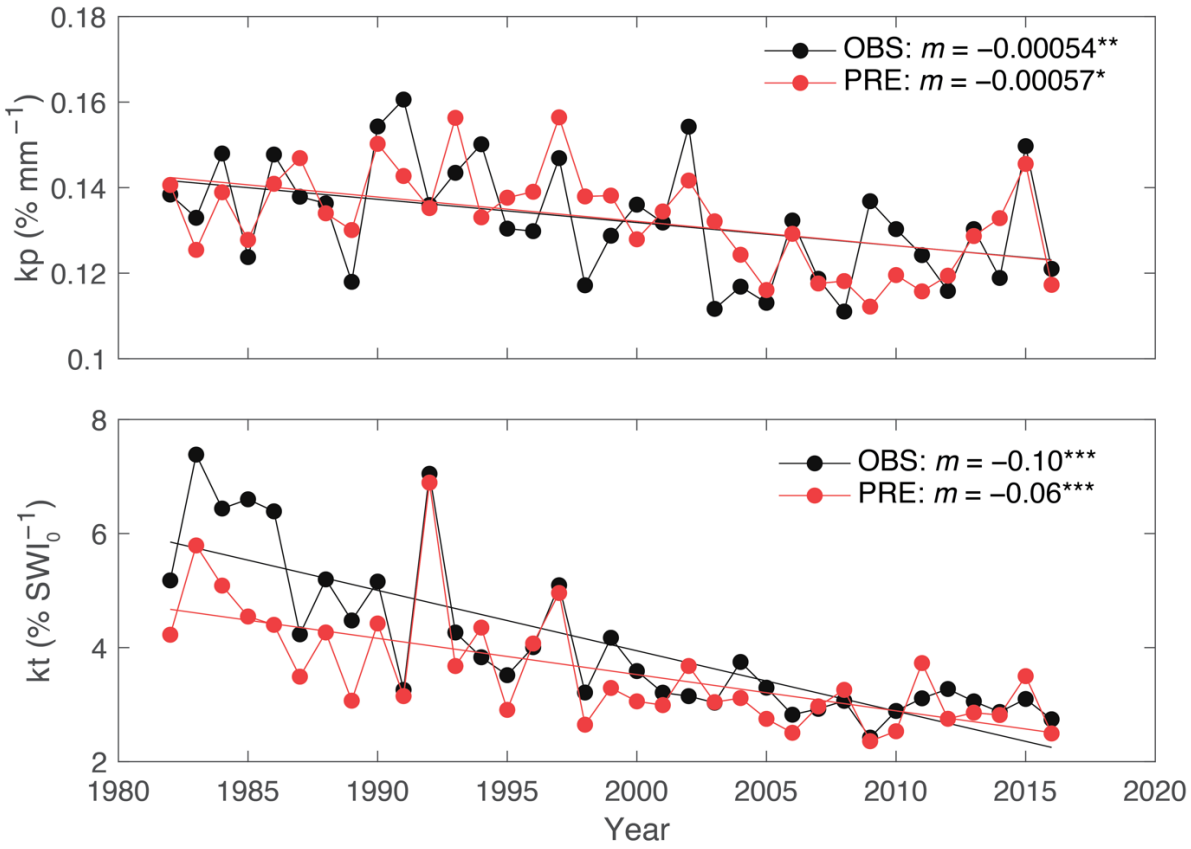
Divergent responses of alpine vegetation



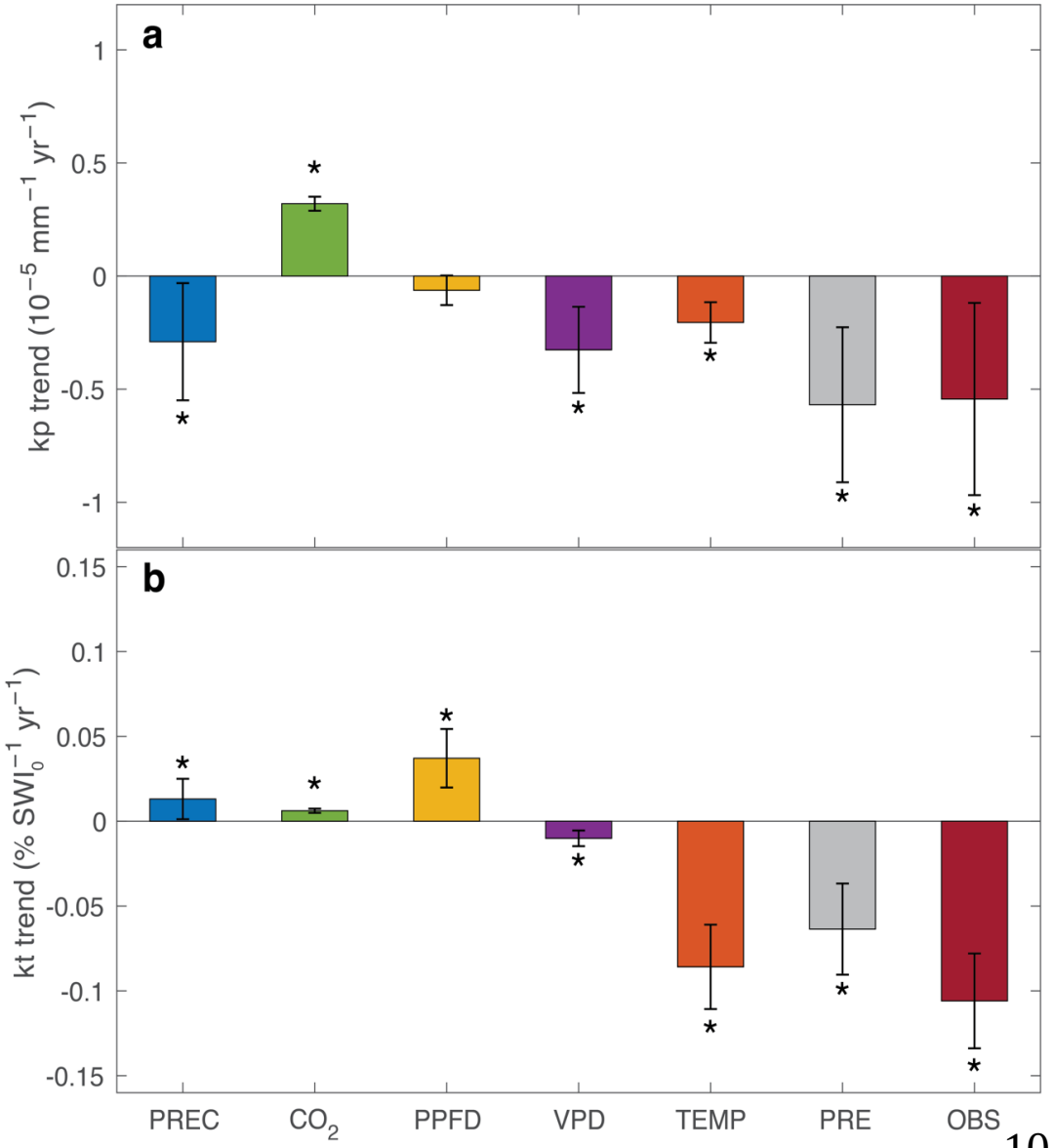


- CO_2 have tended to increase vegetation cover in both energy and water-limited regions
- Changes in radiation, temperature and atmospheric aridity have impacted these regions differently

Decreased environmental sensitivities



- Increased precipitation and atmospheric aridity lead to reduced precipitation sensitivity
- Warming has weakened the sensitivity of vegetation to temperature increases



Take-home messages

1. Although climate trends are **similar**, there is a **greening** trend in drier regions and a **browning** trend in wetter regions
2. These **divergent** responses can be explained using a model that invokes the limitation **water** or **energy**
3. The relationship between vegetation cover and climate has **weakened** over the past three decades
4. Our study demonstrates the potential of **eco-evolutionary optimality** approaches

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Thank you!

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Imperial College London

MACQUARIE University

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