Disentangling the impacts of rising CO_2 and VPD on terrestrial carbon and water cycles

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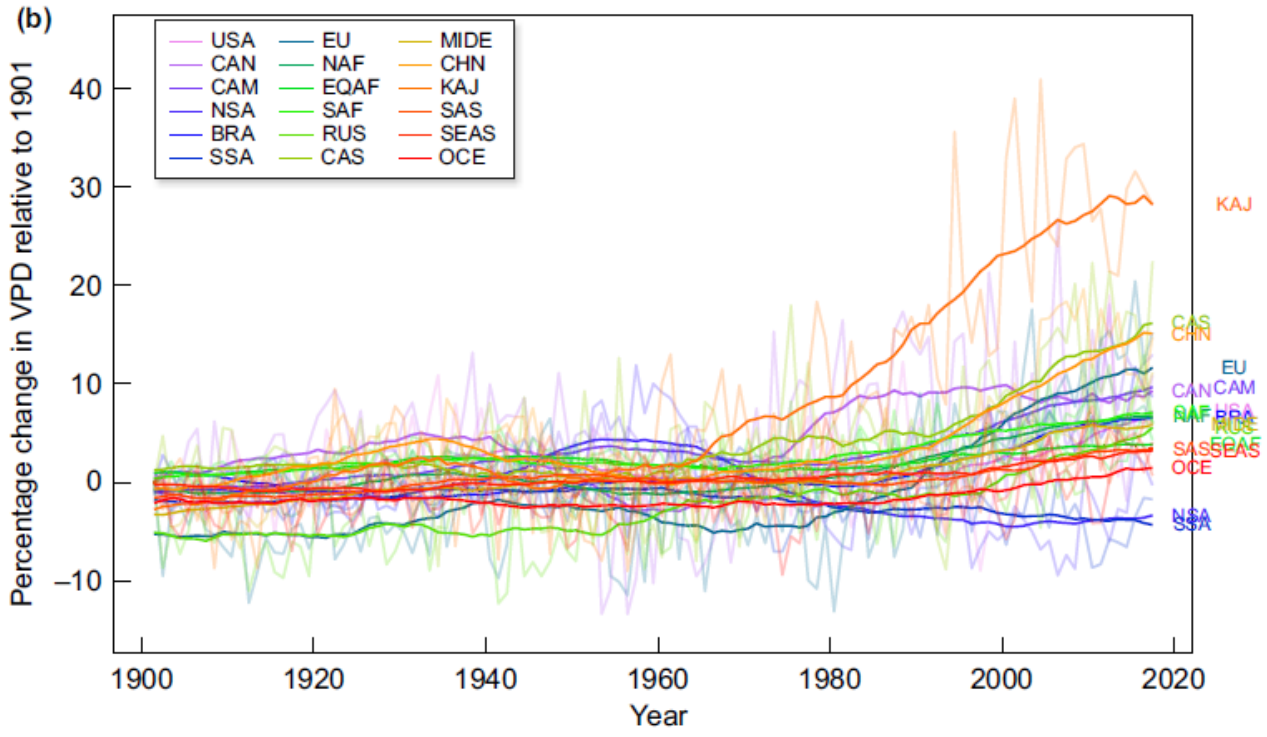
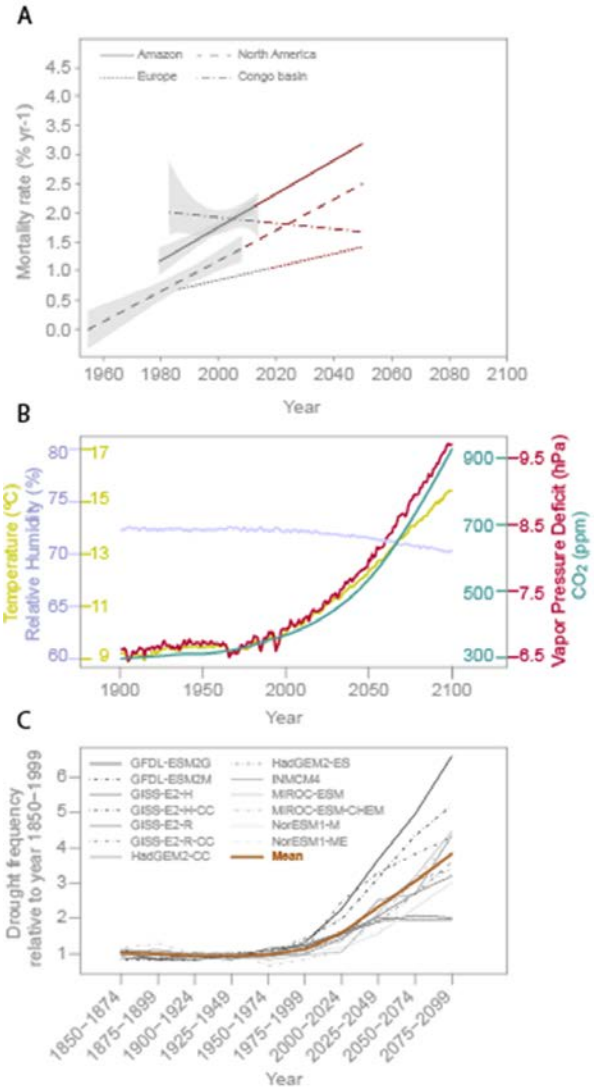


Global VPD trends 1901-2018

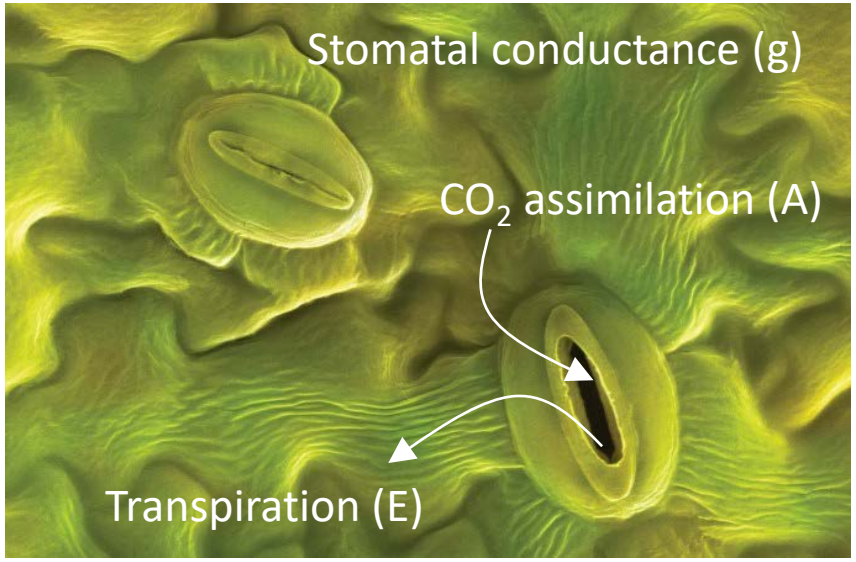
Grossiord et al. 2020

Uncertainty surrounds the net impact of rising CO_2 and VPD on plant WUE, survival, and subsequent ecosystem C and H_2O cycling



Tree mortality, temperature, CO_2, and VPD are rising rapidly and are superimposed upon increasing soil drought.

McDowell et al. in prep



Rising CO_2 and VPD both increase WUE (A/g) but for opposing reasons.

- Rising CO_2 increases A
- Rising VPD decreases g
- Moderated by soil nutrients

Theory, observations, and models diverge on the net impact on WUE, productivity, and mortality

- Model variability
- Real global variability

Future research: experimentally disentangle the impacts and feedbacks of rising CO_2 and VPD from stomata to globe

- **Leaf to plant:** WUE (A/g, A/E) responses to combined drivers?
  - Net impacts on *plant productivity* and *mortality* under drought and non-drought conditions
- **Ecosystem to globe:** Feedbacks on surface energy, carbon, and water budgets?
- What are the most informative, **scalable** traits?
- Methods:
  - empirical and numerical **manipulative** experiments
  - Observations (ground, atmosphere, and remote)

Relationship to white paper

- **Grand challenge**: "How do…ecosystems respond to changes in disturbances and influence regional and global conditions"
  - CO_2, VPD, and drought as drivers of change-feedbacks to global environment

- **Gaps**: "…physiological response to increasing CO_2, surface energy budgets…" *AND* "Impacts of extremes on terrestrial ecosystems"

- **Research goals**: "Evaluate plant physiological and land surface responses to changing atmospheric CO_2, surface energy budgets…" *AND* "Convene…working groups"