Quantifying Projected Changes in Carbon Cycle Extremes and Attribution to Climate Drivers

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Science Summary

Objective: To investigate the impact of LULCC on extreme anomalies in terrestrial photosynthetic activity (GPP) under business-as-usual CO_2 emission scenario from 1850 through 2300.

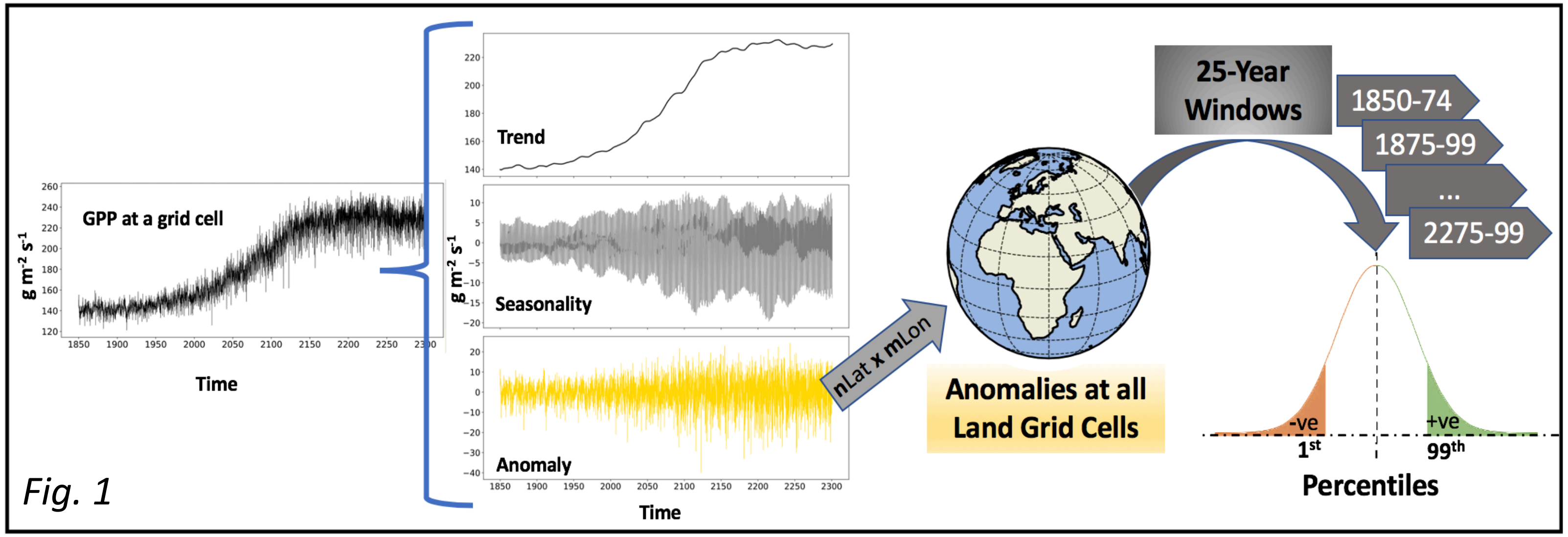

Fig. 1

Carbon Extremes are typically short duration and intense events associated with large gains or losses in carbon uptake.

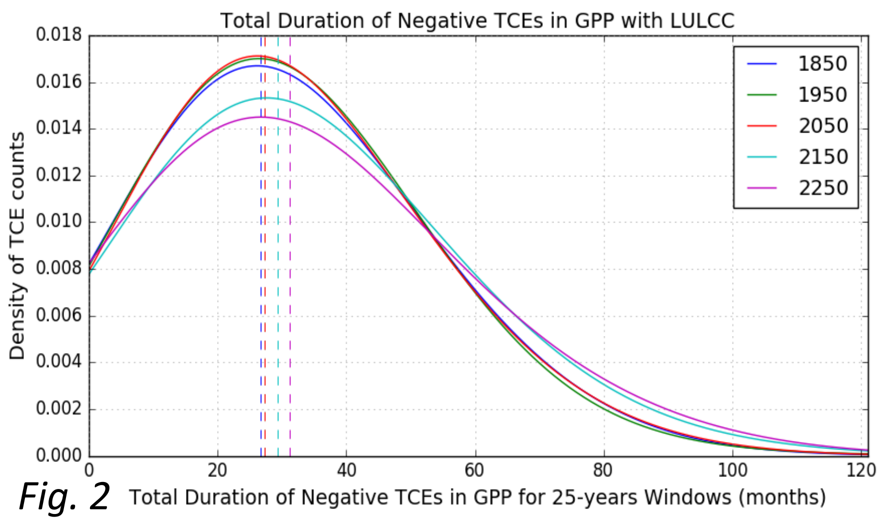

Fig. 2

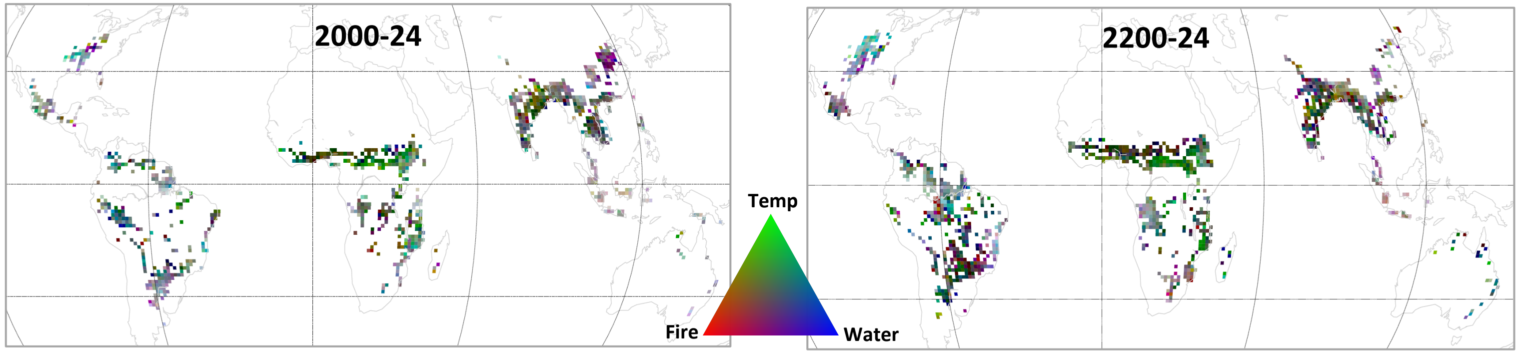

Fig. 3 **Compound climate drivers**

Data:

- CESM1(BGC) model simulations, with and without LULCC from 1850 to 2300.
- Simulations forced with historical, RCP 8.5 and ECP 8.5 CO_2 trajectory.

Results:

- LULCC will increase the intensity, duration, and frequency of losses in photosynthetic activity.
- Soil moisture is a dominant climate driver.
- Compound effect of Fire, Temperature, and Water (Soil moisture) drive majority of carbon extremes.

Future Research

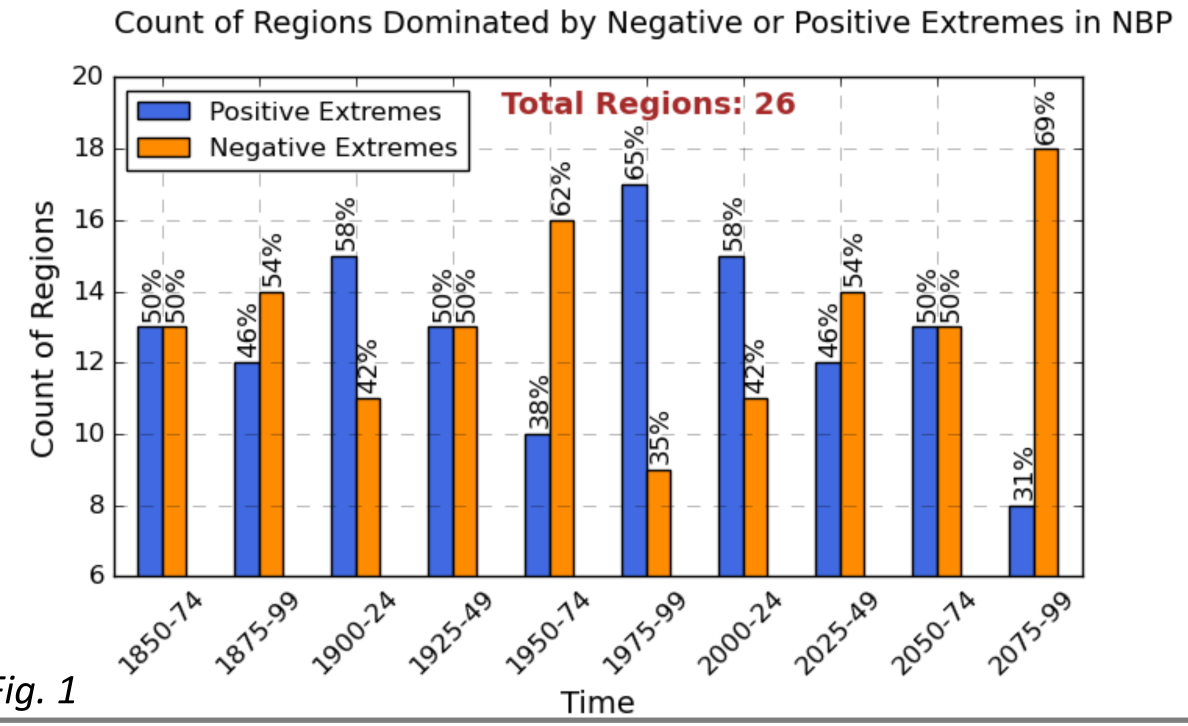

Fig. 1

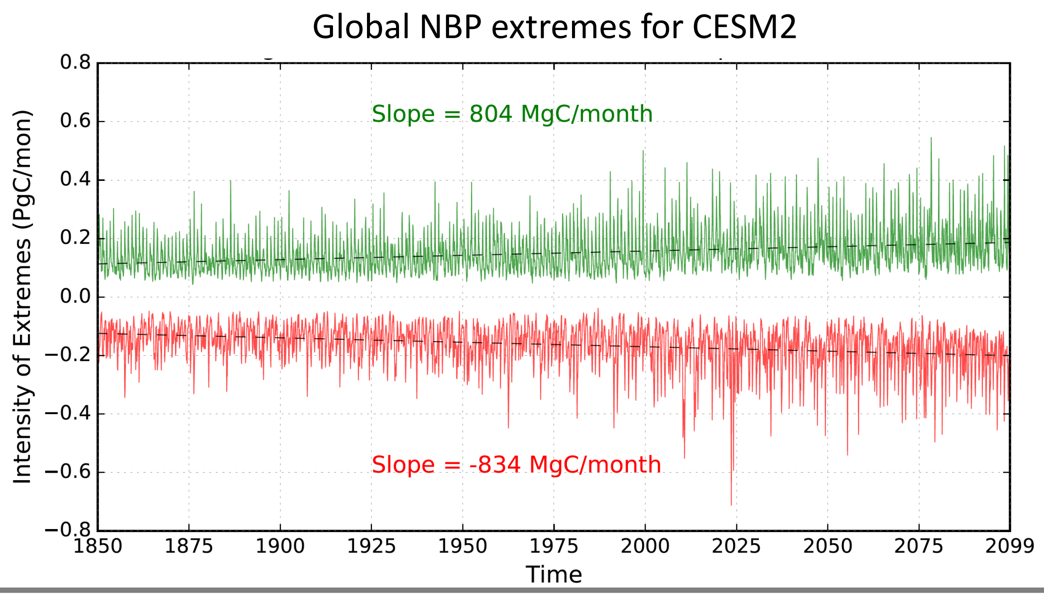

Fig. 2

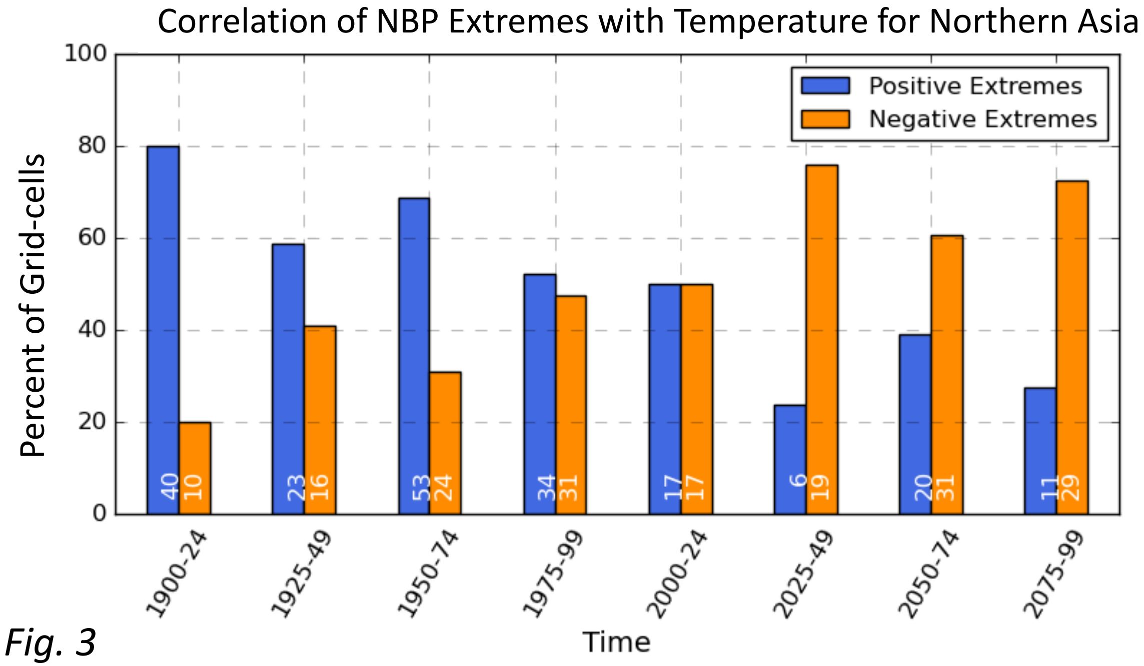

Fig. 3

Preliminary Results:

- Study of NBP extremes in CMIP6 models
  - In CESM2, we found larger intensity and frequency of extremes associated with losses in carbon uptake than gains.
- Contrasting patterns of temperature – carbon cycle feedback
  - Toward the end of the 21st century, an increasing number of grid cells with negative temperature-carbon correlations in the higher latitudes could result in loss of land sink in summers.

We will investigate the concurrency of climate and carbon extremes.

Relation to White paper

- Compound effect of climate drivers
  - Interactive effect of anomalous climate drivers is larger than the additive effect of individual climate drivers.
- Time scale and buffer response
  - We investigated the short, time continuous and spatio-temporal continuous extremes in carbon cycle.
  - Attribution with lagged response of climate drivers on carbon cycle extremes show that magnitude of correlation coefficients and significance value weakens with increasing lags.
- Impact of LULCC
  - Relative to the total changes in GPP due to LULCC, the magnitude of negative GPP extremes increased from 6.9% (1850 – 2100) to 10% (2101 – 2300).
- High Latitudinal Biogeochemistry
  - The increasing number of the grid cells in Northern Asia in CESM2 show negative temperature-carbon cycle correlation.