



# WORLD CLIMATE RESEARCH PROGRAMME

## Safe Landing Lighthouse

Leads: Steven Sherwood, Gabi Hegerl

Steering Group: Bette Otto-Bliesner, Beth Holland, Hyungjun Kim, Neil Harris, Paulo Nobre, Pierre Friedlingstein, Molly Mitchell, Kevin Reed.



# Purpose

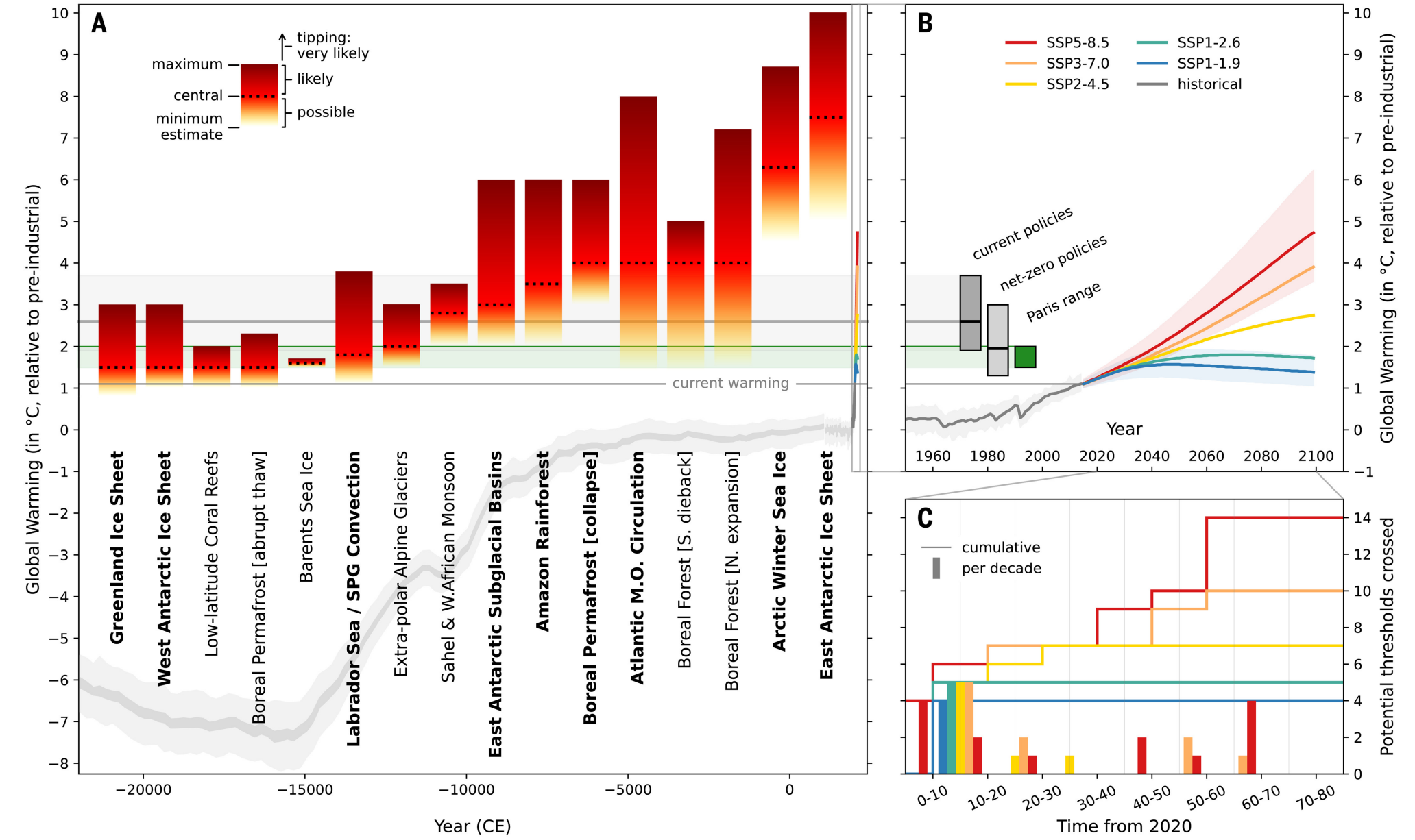
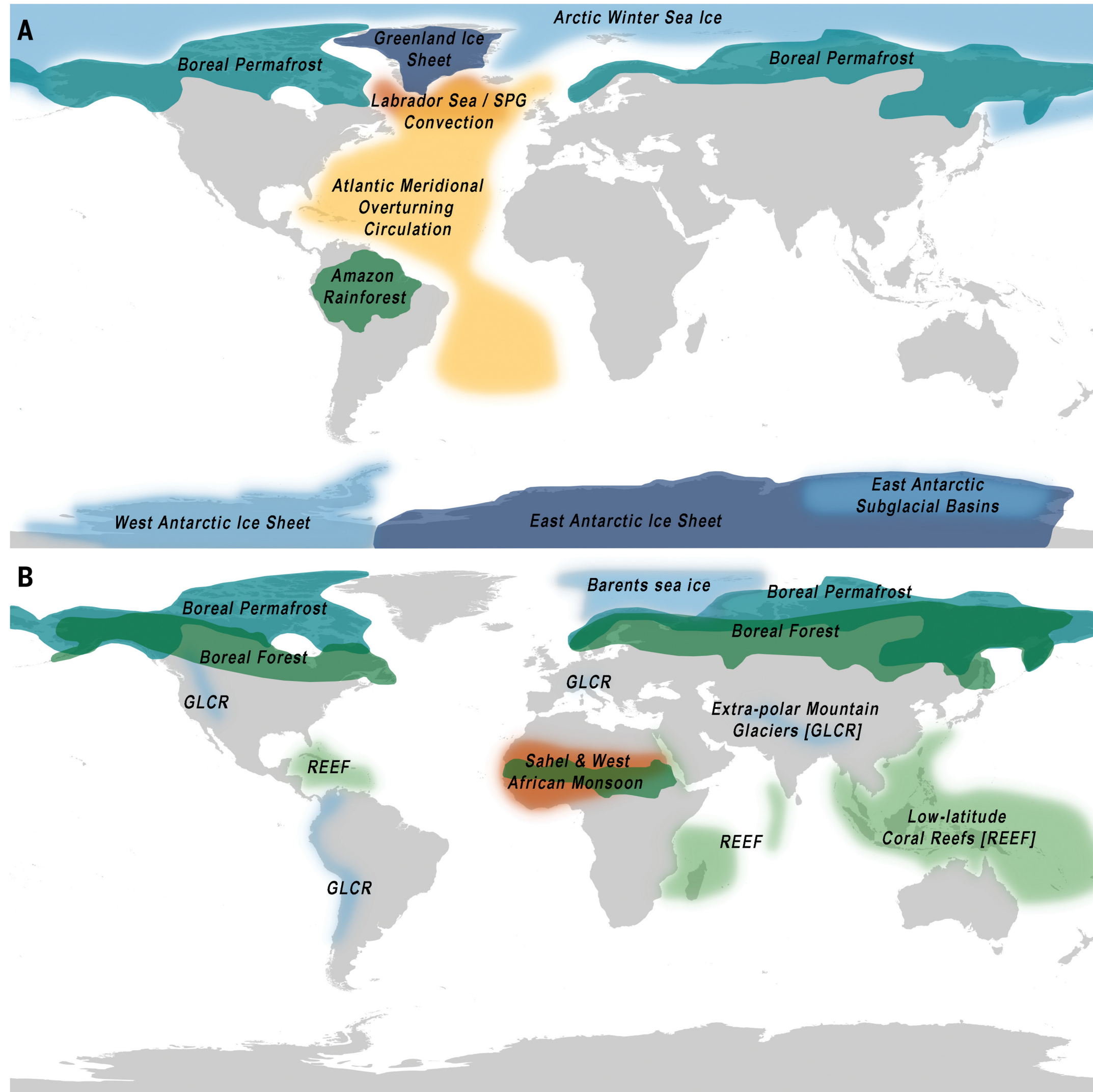
This Lighthouse Activity is an exploration of the routes to climate-safe landing 'spaces' for human and natural systems. It will explore present-to-future pathways for achievement of key Sustainable Development Goals (SDGs). The time scale is multi-decadal to millennial.



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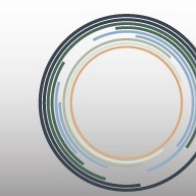
# Assessment of “tipping points” and tipping elements



Armstrong McKay et al. 2022



**AIMES**  
analysis, integration, and modeling of the earth system



**EARTH COMMISSION**  
GLOBAL COMMONS ALLIANCE



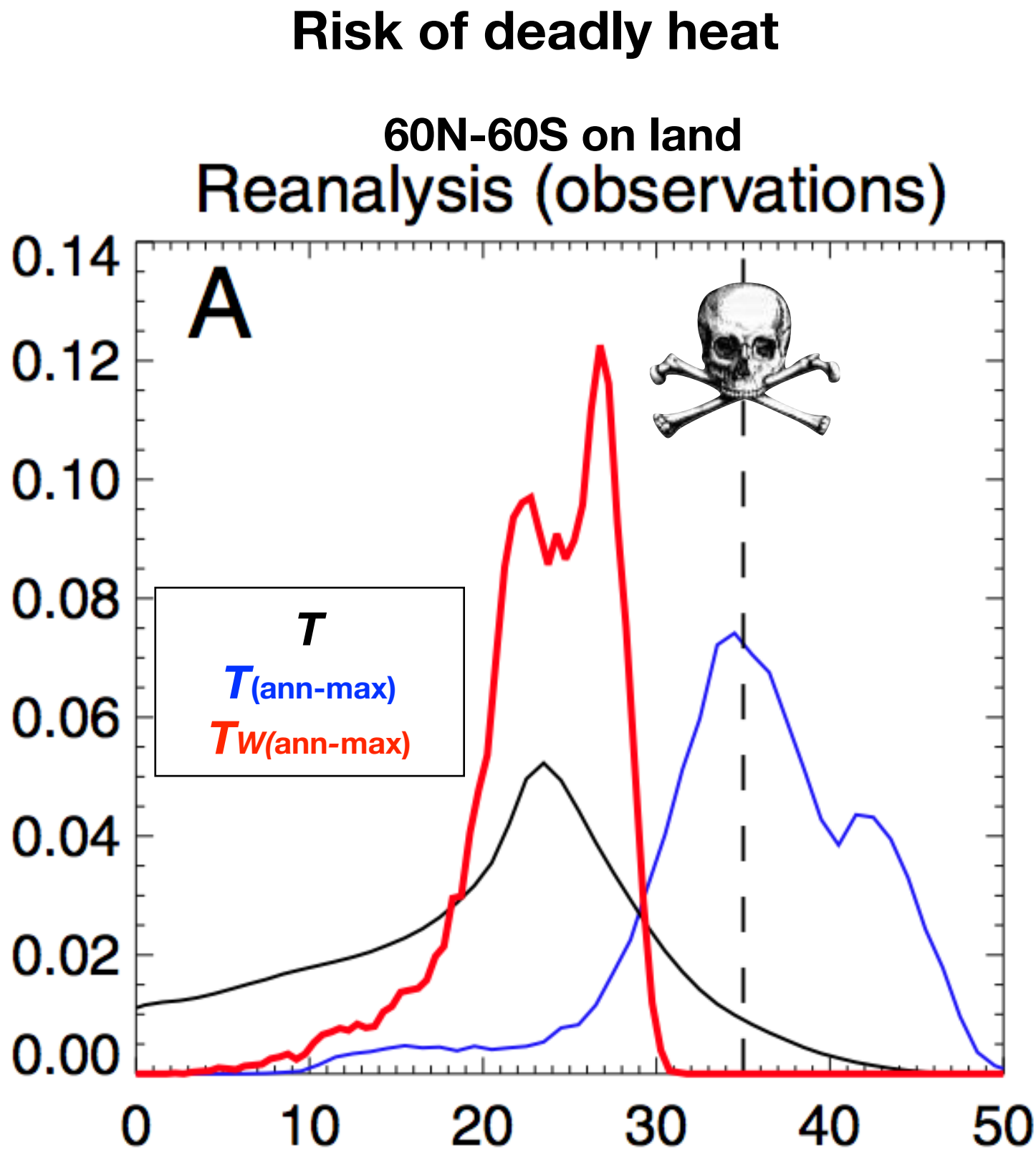
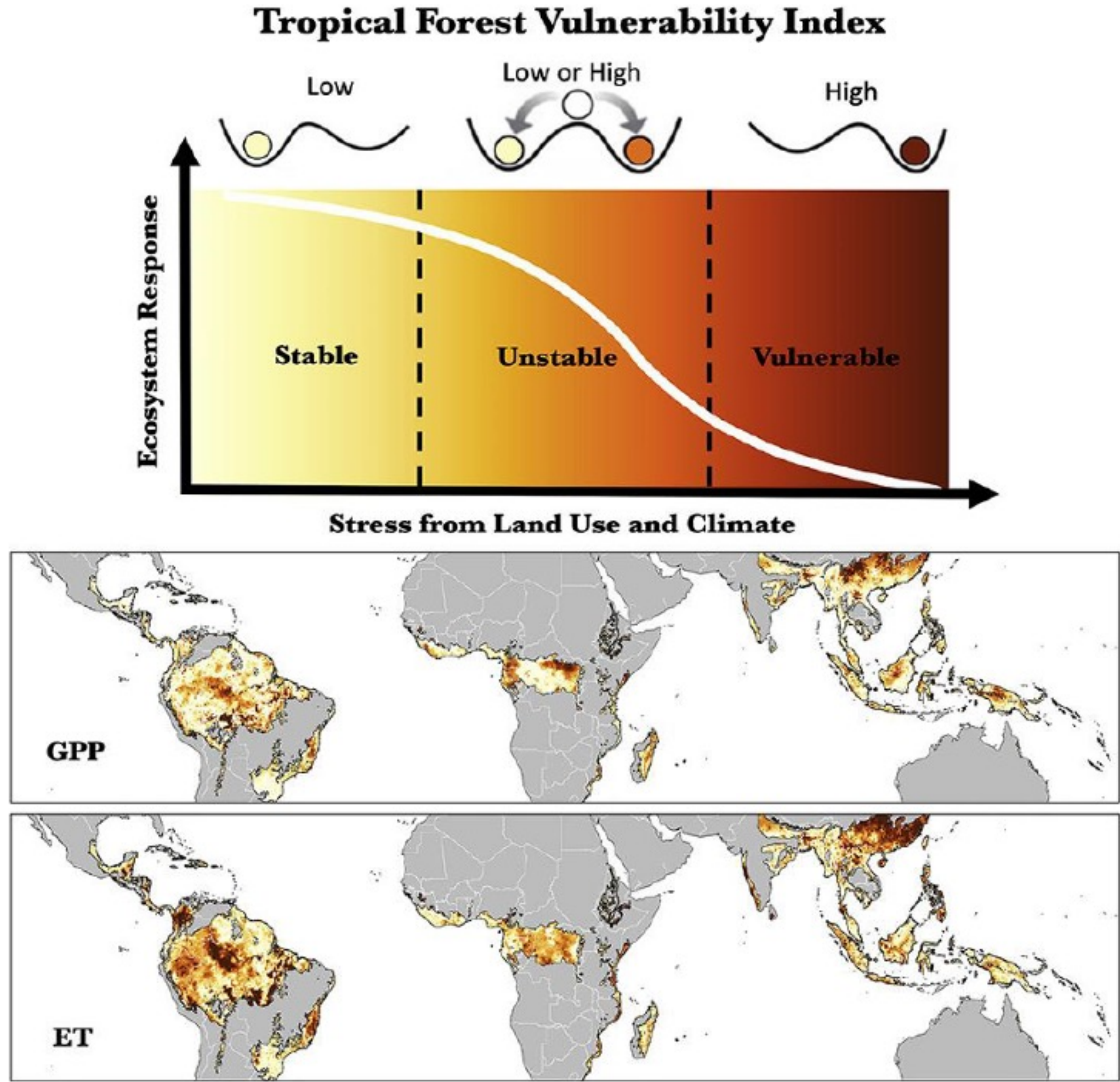
**WCRP**  
World Climate Research Programme

**Tipping Elements, Irreversibility, and Abrupt Change  
in the Earth System**

Discussion Series



# Risks to the biosphere and limits to tolerance



Sherwood and Huber (2010)

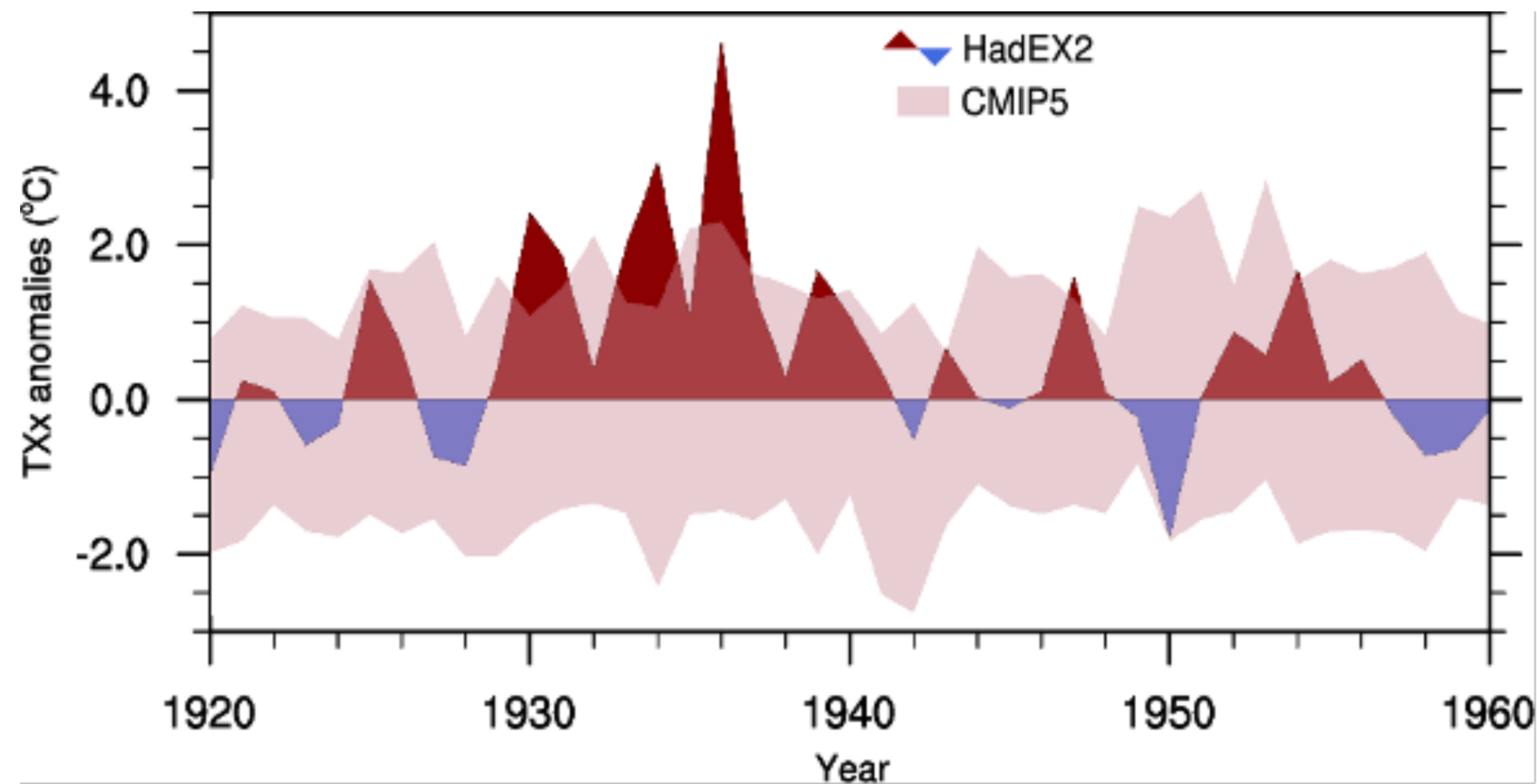
Figure 4. Maps of vulnerability of humid tropical gross primary productivity (GPP) and evapotranspiration (ET).  
Source: Saatchi et al., 2021.

Saatchi et al. (2021)



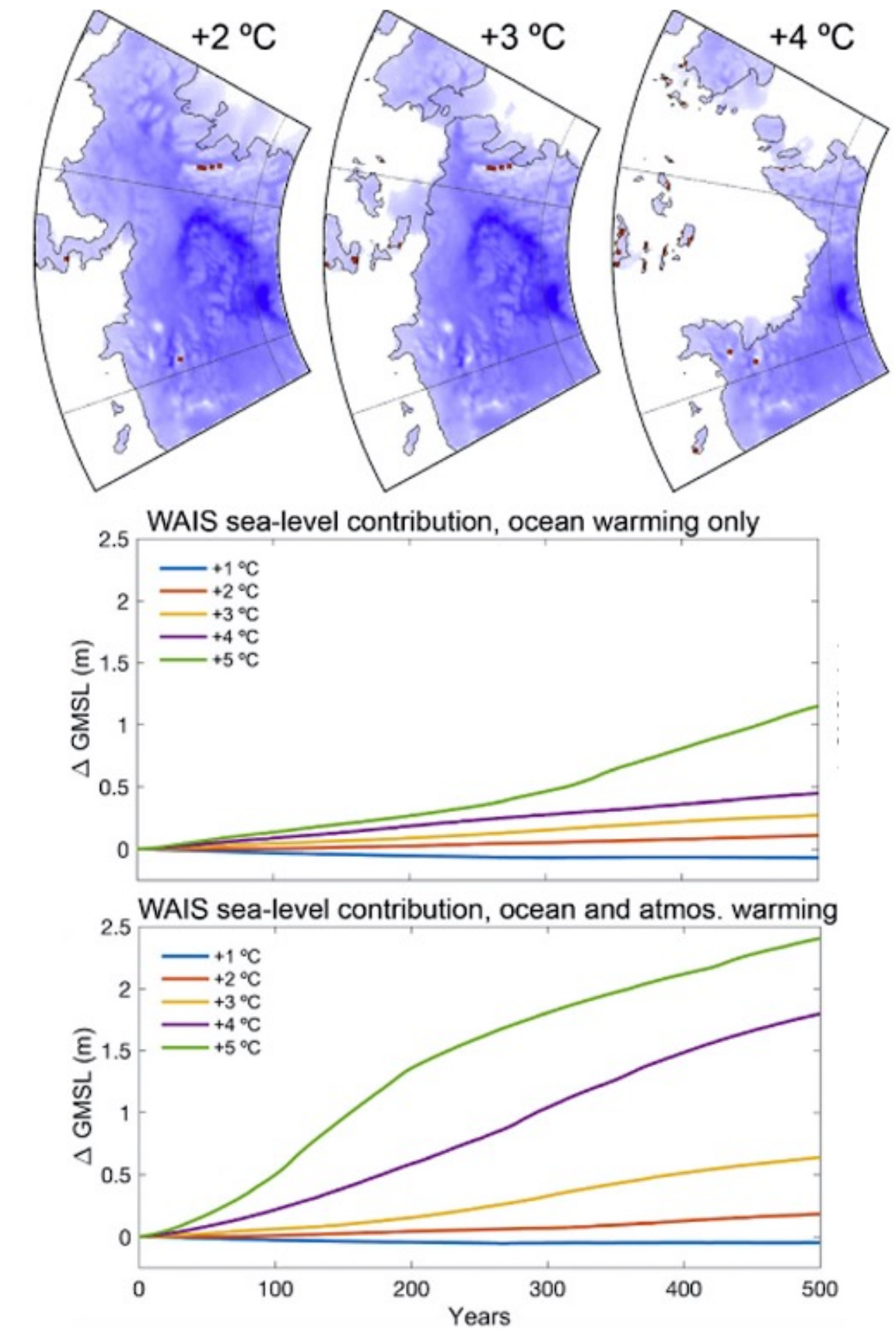
# Current models can miss high-impact extreme events

1. Models miss the Dust Bowl (lack of vegetation coupling)

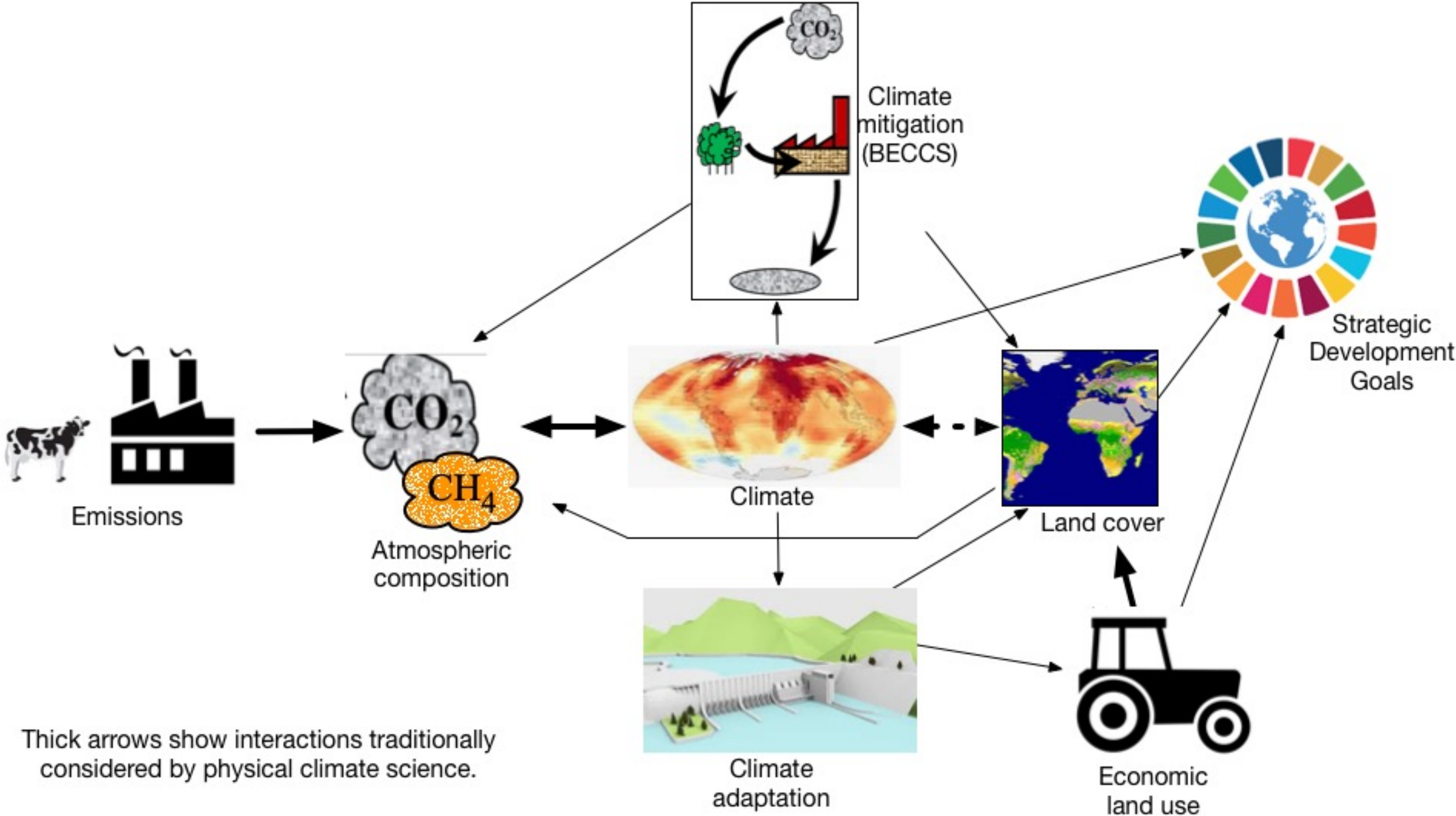


Adapted from Cowan et al. (2020)

2. Coupled model predicts West Antarctic Ice Sheet collapse around +3°C, but not an uncoupled ocean model. (adapted Scambos et al., 2017)



# Strongly interconnected system requires holistic approach



Thick arrows show interactions traditionally considered by physical climate science.



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## Research themes – ongoing work

**Theme 1: Understanding High risk events:** tipping points, large scale high risk events across earth system and earth/human system

**Theme 2: Perturbed Carbon Cycle:** Overshoot scenarios, implications of and risks from negative emission scenarios

**Theme 3: Water Resources:** Focus on Amazon and its teleconnections

**Theme 4: Sea Level Rise:** identifying limits to habitability, engagement with user communities;

**Theme 5: Safe Landing Pathways:** identifying risks on way to mitigated climate => gaming approaches, collaboration with industry

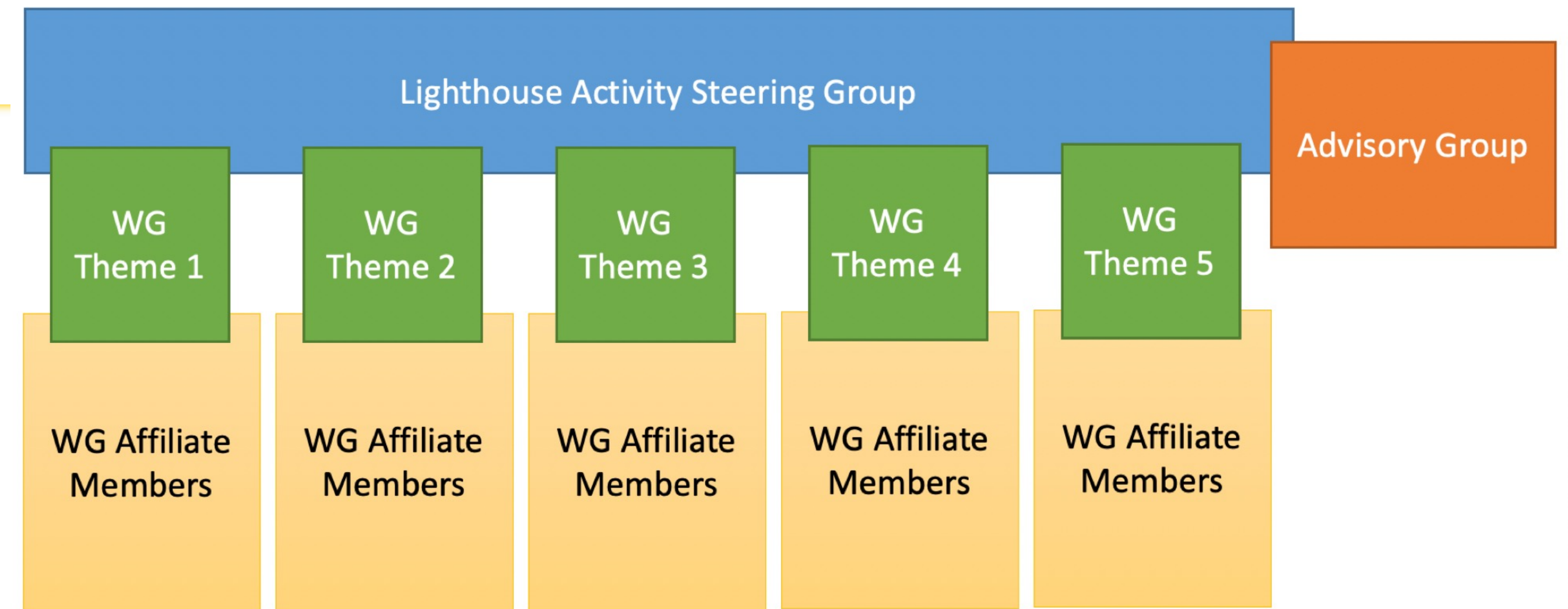


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## Safe Landing Climates: Structure

- First
- Current Working Group members and affiliates are listed at <https://www.wcrp-climate.org/safe-landing-climates>
- Workshop: March 7-9, London



Understanding High-Risk Events	Perturbed Carbon Cycle	Water Resources	Sea Level Rise	Safe Landing Pathways
Bette Otto-Bliesner Gabi Hegerl	Pierre Friedlingstein Neil Harris	Hyungjun Kim Paulo Nobre	Molly Mitchell Elisabeth Holland	Neil Harris Kevin Reed
Hannah Liddy Thomas Lontzek Izidine Pinto Ryan Sriver Laura Suare-Gutierrez	Ana Bastos Jamie Collins Chris Jones Roland Séférian Gyami Shrestha Sophie Szopa	Ramia Al Bakain Cristiano Chiessi Benjamin Keenan Nathalie Philippon Marion Saint-Lu Kazuyoshi Suzuki	Benjamin Hamlington Svetlana Jevrejeva Christopher Little Heiko Goelzer Roshin P. Raj Swapna Panickal	Peter Alexander Marco J. Cabrerizo Felix Donkor Luke Harrington Lisa Miller



## How does the LHA advance the research agenda

- Past 1-2 years: Online discussions, participation in tipping point workshops and co-organization of tipping point webinar series
- Started own webinar series to build base knowledge and connect communities
- White Paper submitted to high impact journal (invited) to highlight issues and gather interest

### London meeting (7-9 March 2023) to develop specific plan

- Near term activities to push research agenda: targeted workshops, new initiatives and climate modelling strategies
- Long term goals and integration of activities in WCRP Core Projects



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## London Workshop: New suggested activities (in development)

**CMIP7: Understanding High risk events** (Lead High Risk): Promote highly-coupled model runs in CMIP7; new scenarios to represent different pathways (e.g. overshoot scenarios with strong but late mitigation and CDR); evaluate tipping impacts. Proposals to ScenarioMIP, ZECMIP; Work with MIPs or propose new HighRiskMIP.

**Gaming and decisions/scenario exploration** (Lead Pathways): develop scenarios that are more relevant outside the climate sphere. (Pathways WG). Workshops, including one on gaming approaches to identify climate risk

**Water variability impacts** (Lead: Water): resilience of water-use sectors, valuation and optimal allocation of water, 'green finance' in various future scenarios of (greater) water variability. (Water WG). Planning Workshop.



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## Planned activities

**Signposts for sea level rise** (lead: Sea level). Identify indicators of change and their implications for the future, integrate with communication strategies. Webinar then maybe workshop/white paper

**High-risk cascading shocks** (lead: High Risk WG; w Carbon; Laura/Gabi on severe events leading to cascading impacts, including on the carbon cycle; e.g. multiyear drought, heat waves. (High Risk WG, w/Carbon WG). Webinars 2023; AGU 2023 session proposal Workshop (2024) interdisciplinary, start of continuing activity / task force

**Is EPESC interested to join this activity (heat/drought theme)?**



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## Planned activities

**Connecting across the IAM-GCM-impact hierarchy** (High Risk, Pathways). Discover unexpected climate hazards possible in a fully coupled system, two-way flow of information across hierarchy, error framing. Workshop involving ESMO/AIMES if interested?

**TCRE Assessment.** Assess the pdf of TCRE using approach similar to Sherwood et al. (2020) for ECS. (Carbon WG)



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