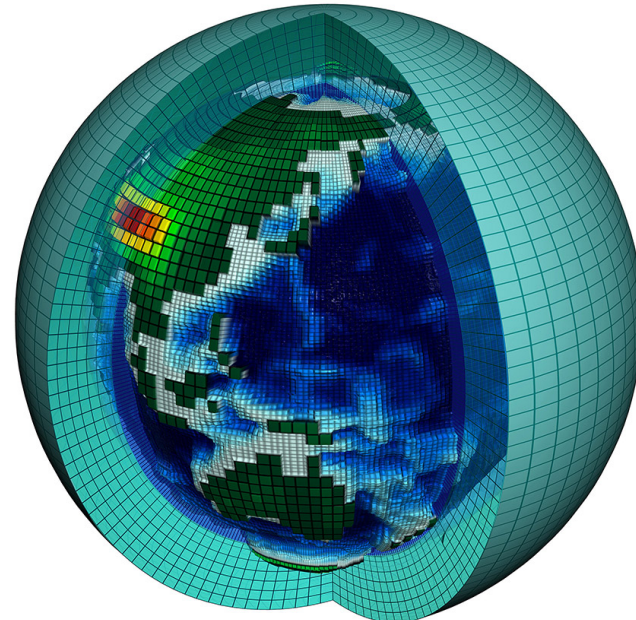


The Norwegian Earth System Model (NorESM): Addressing global climate challenges

Jerry Tjiputra

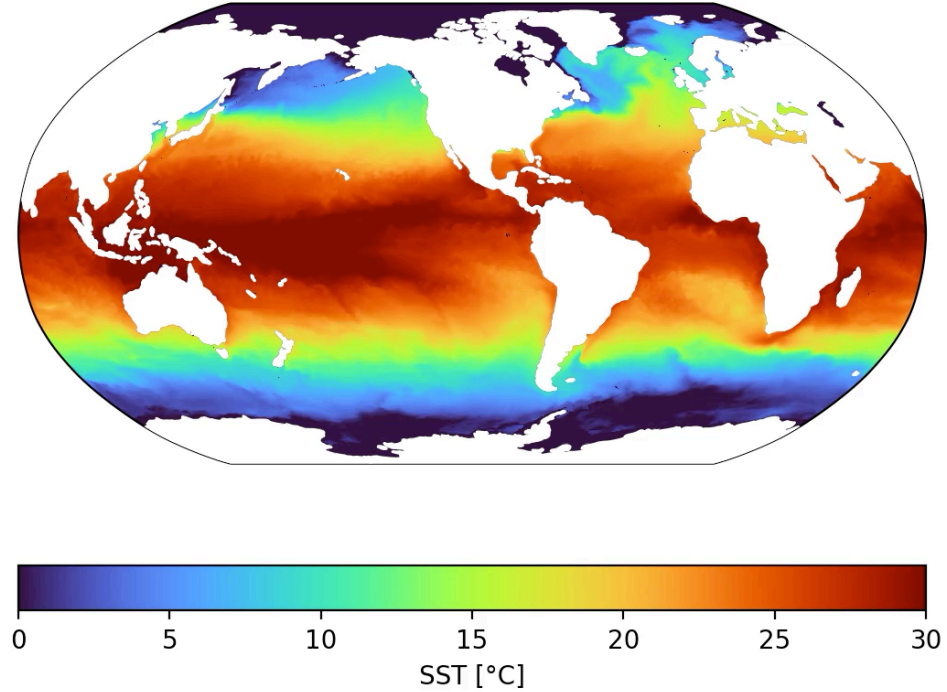


Introduction



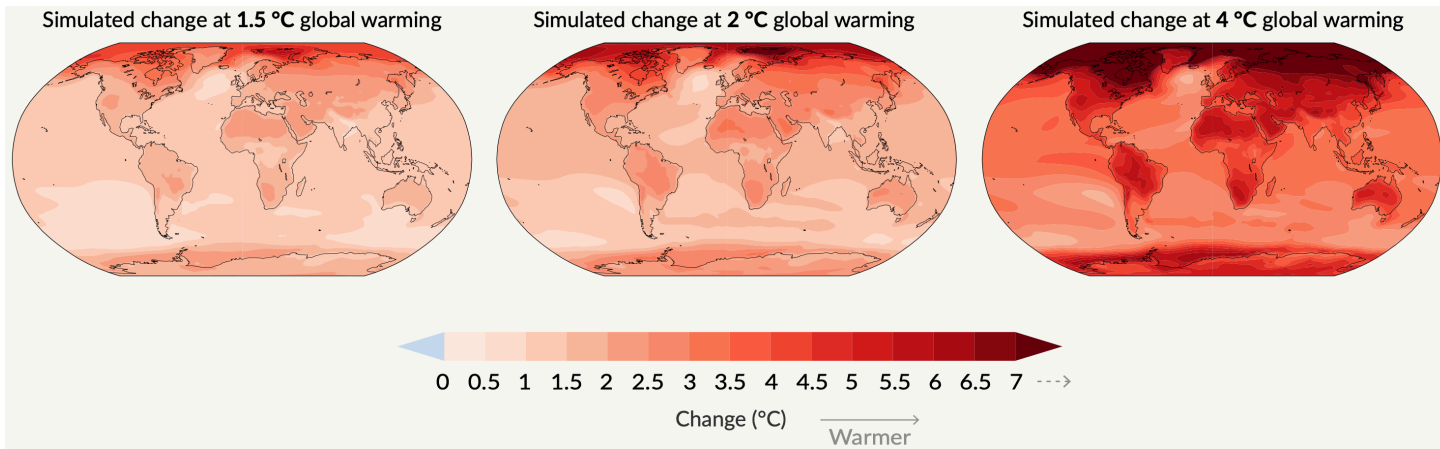
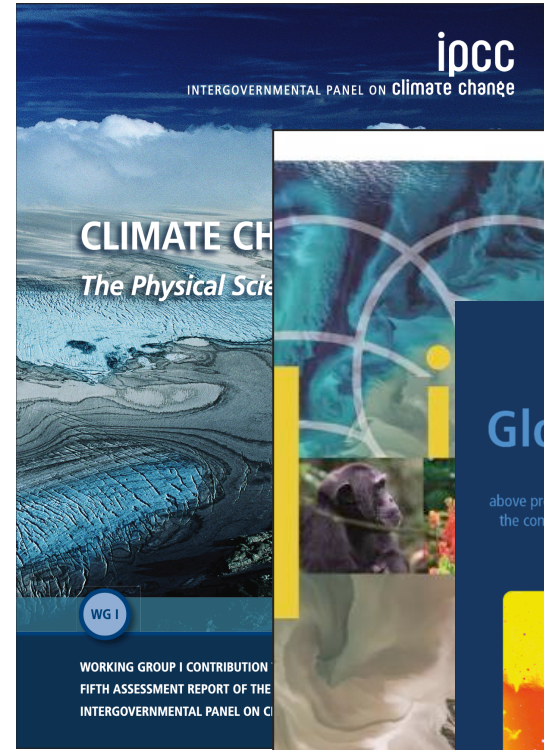
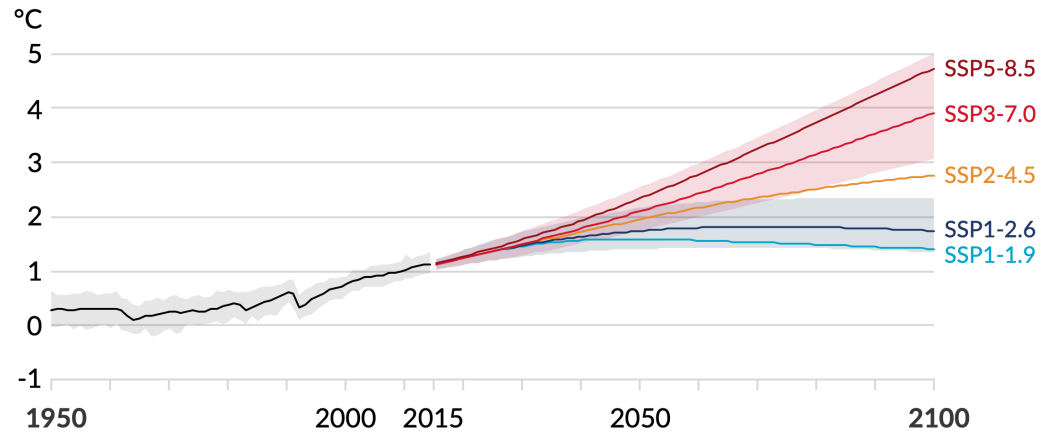
Schematic from JAMSTEC

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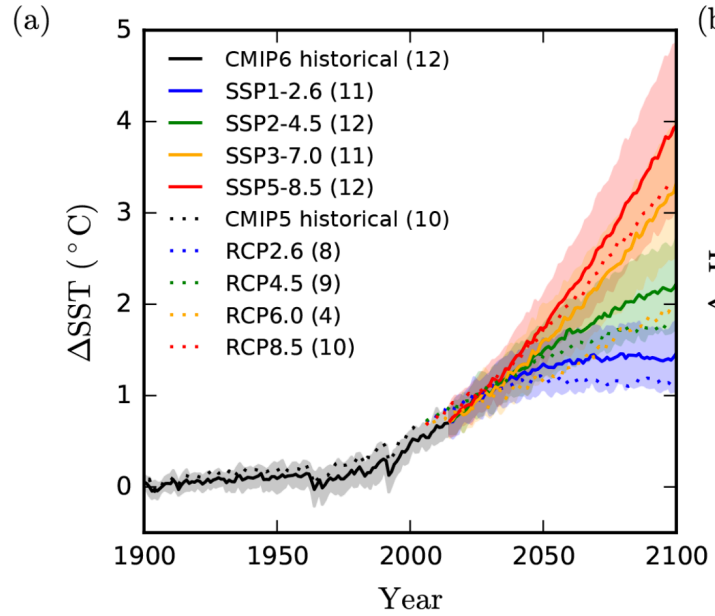


Contributions to international synthesis report

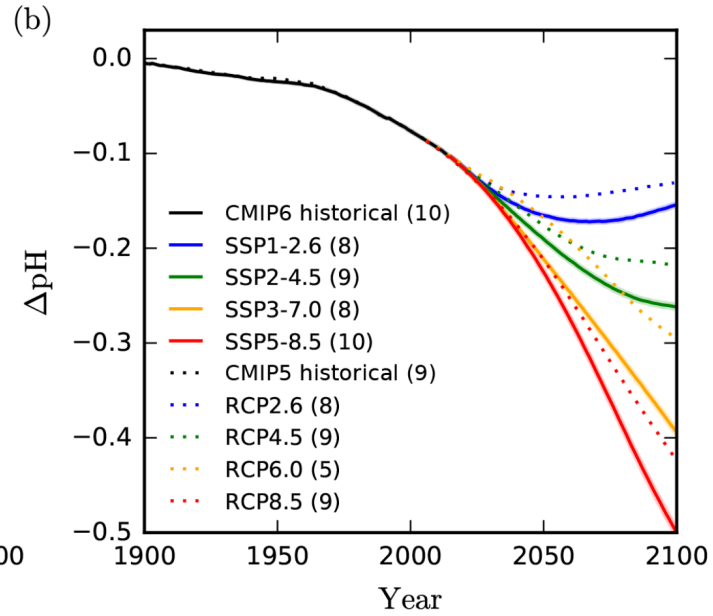
a) Global surface temperature change relative to 1850-1900



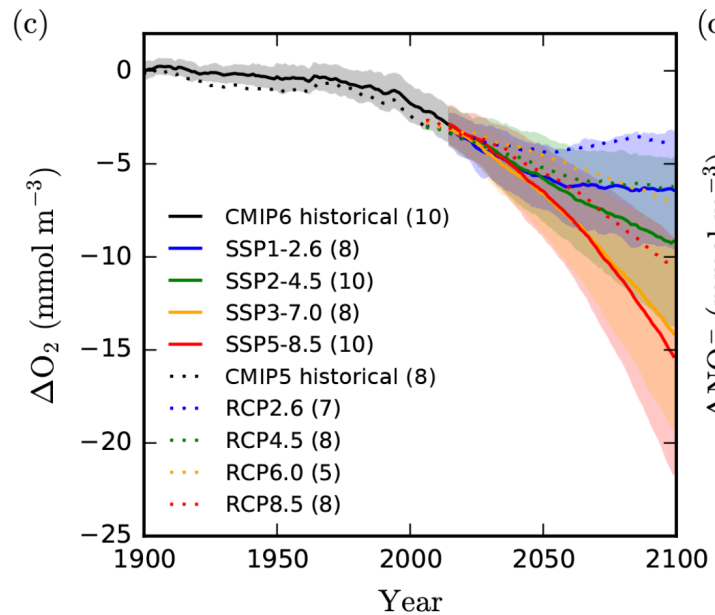
Surface ocean temperature



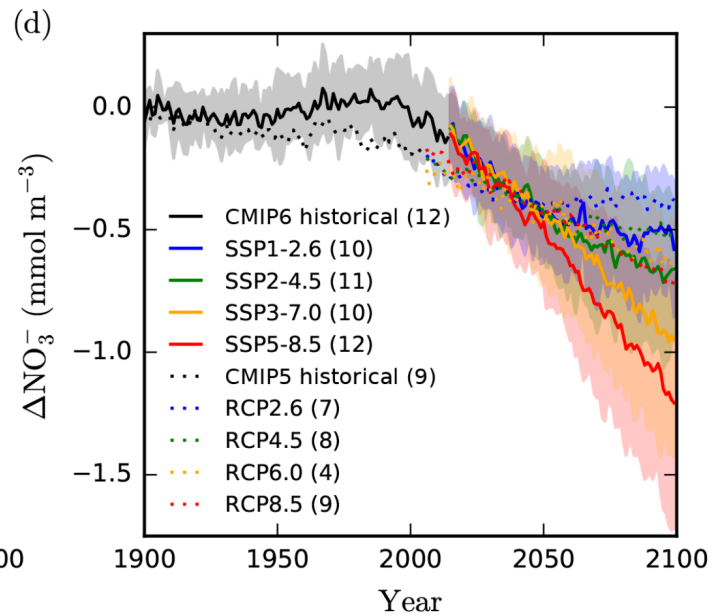
Surface ocean pH



Ocean oxygen content



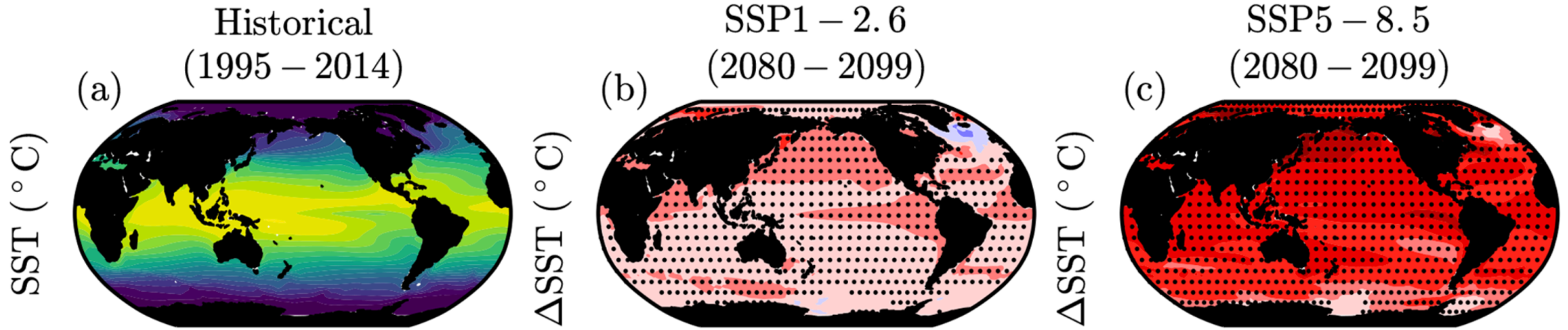
Surface ocean nutrient



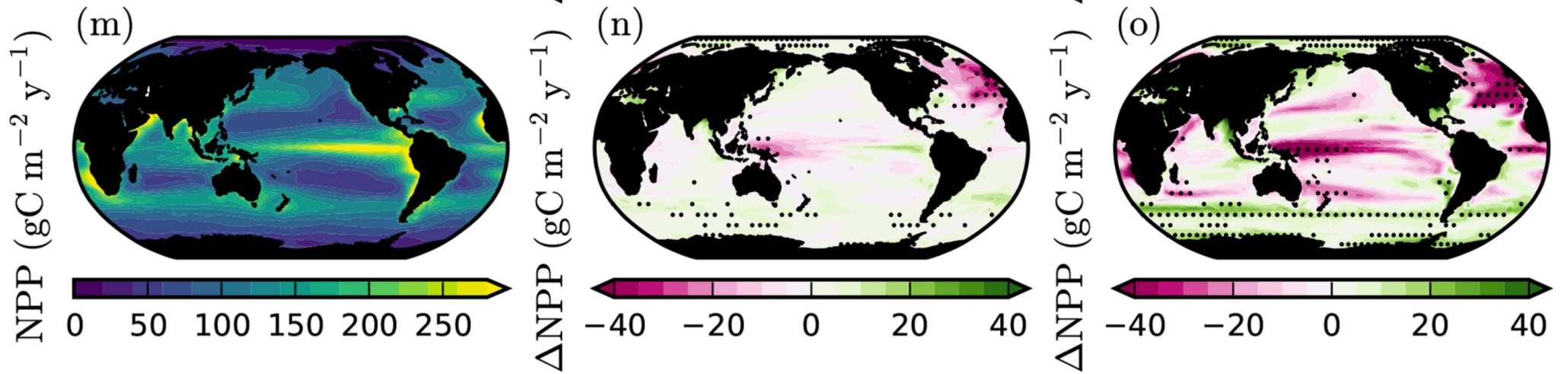
Kwiatkowski et al. (2021)



Ocean temperature



Ocean productivity



Kwiatkowski et al. (2021)



Did the Drop in COVID-Related Emissions Affect the Climate?

Global emissions dropped markedly in 2020, due in large part to lockdowns that slowed economic and social activity, but the climate likely won't be noticeably affected.

By Kate Wheeling 4 May 2021



COVID-19 lockdowns in cities across the United States kept cars off the road, as seen here in Portland, Ore., which contributed to a drop in global emissions. Credit: Mattsjc, CC BY-SA 4.0

Geophysical Research Letters

RESEARCH LETTER

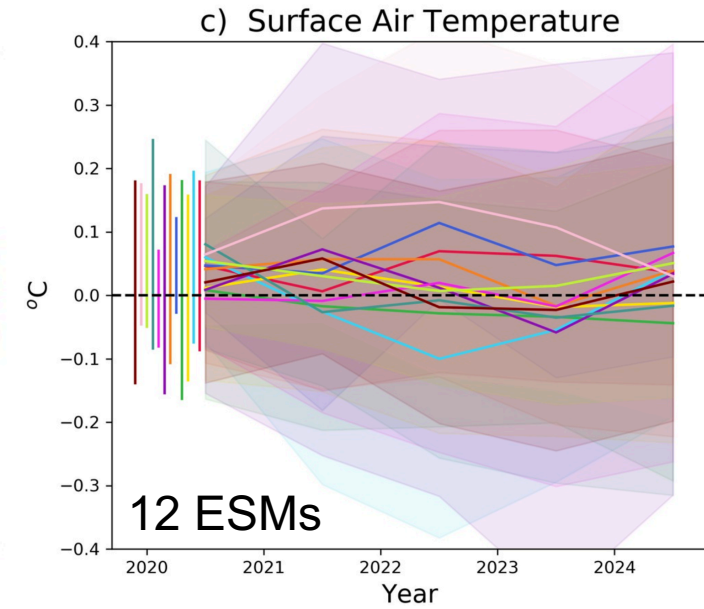
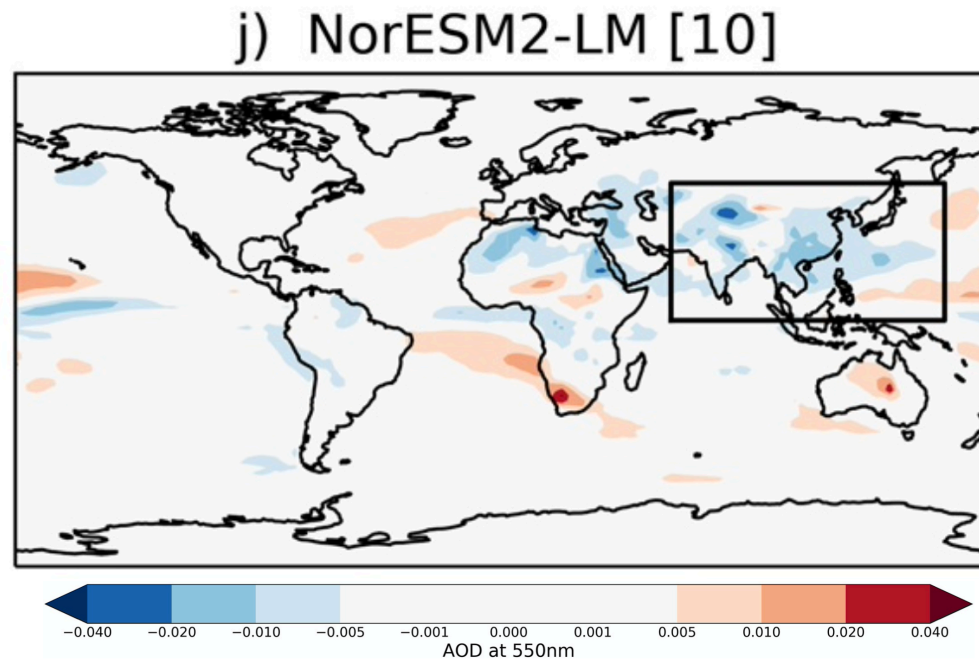
10.1029/2020GL091883

Key Points:

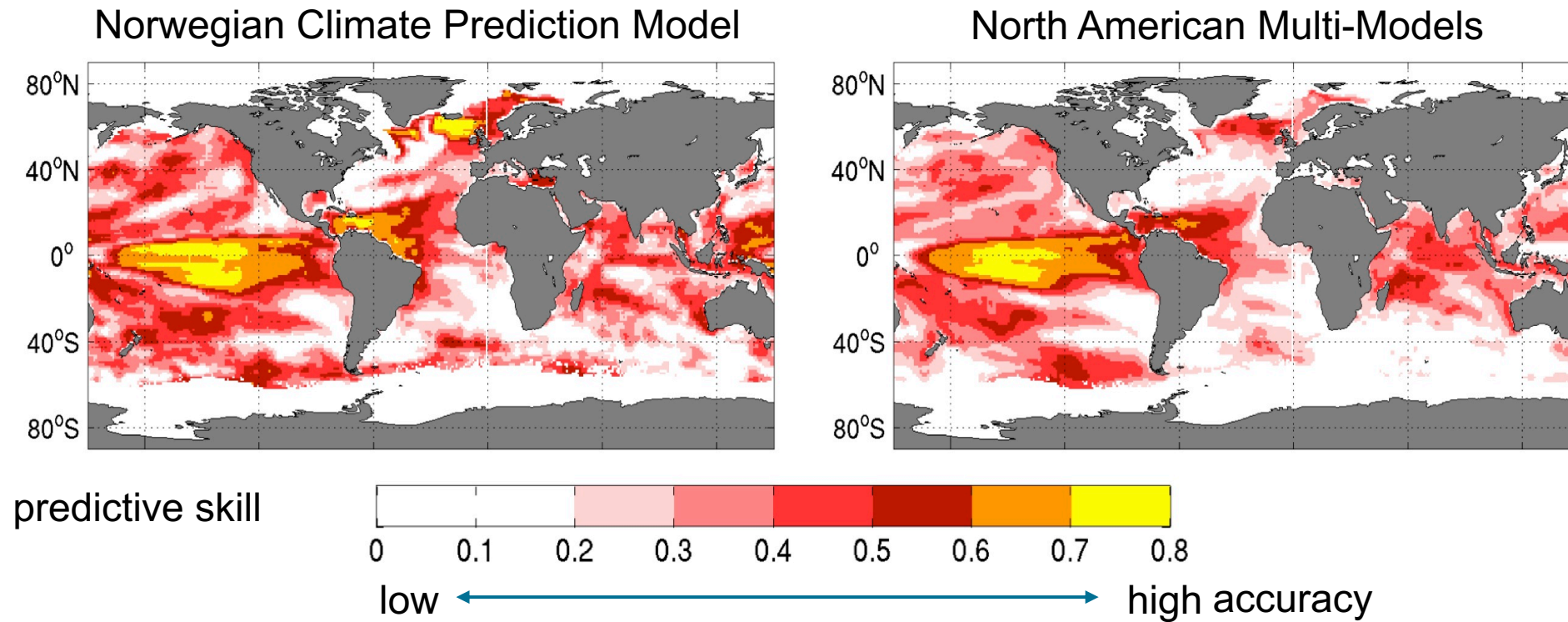
- Lockdown restrictions during COVID-19 have reduced emissions of aerosols and greenhouse gases
- 12 CMIP6 Earth system models have performed coordinated experiments to assess the impact of this on climate
- Aerosol amounts are reduced over southern and eastern Asia but there is no detectable change in annually averaged temperature or

The Climate Response to Emissions Reductions Due to COVID-19: Initial Results From CovidMIP

Chris D. Jones¹, Jonathan E. Hickman², Steven T. Rumbold³, Jeremy Walton¹, Robin D. Lamboll⁴, Ragnhild B. Skeie⁵, Stephanie Fiedler^{6,7}, Piers M. Forster⁸, Joeri Rogelj^{4,9}, Manabu Abe¹⁰, Michael Botzet¹¹, Katherine Calvin^{12,13}, Christophe Cassou¹⁴, Jason N.S. Cole¹⁵, Paolo Davini¹⁶, Makoto Deushi¹⁷, Martin Dix¹⁸, John C. Fyfe¹⁵, Nathan P. Gillett¹⁵, Tatiana Ilyina¹¹, Michio Kawamiya¹⁰, Maxwell Kelley^{19,2}, Slava Kharin¹⁵, Tsuyoshi Koshiro¹⁷, Hongmei Li¹¹, Chloe Mackallah¹⁸, Wolfgang A. Müller¹¹, Pierre Nabat²⁰, Twan van Noije²¹, Paul Nolan^{22,23}, Rumi Ohgaito¹⁰, Dirk Olivie²⁴, Naga Oshima¹⁷, Jose Parodi²⁵, Thomas J. Reerink²¹, Lili Ren²⁶, Anastasia Romanou¹, Roland Séférian²⁰, Yongming Tang¹, Claudia Timmreck¹¹, Jerry Tjiputra²⁷

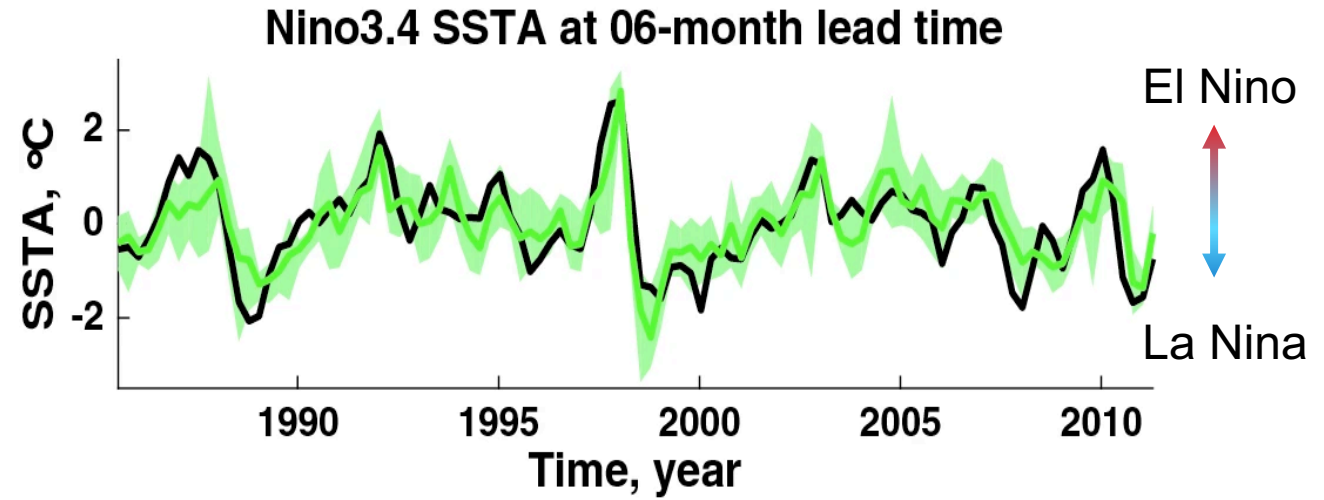
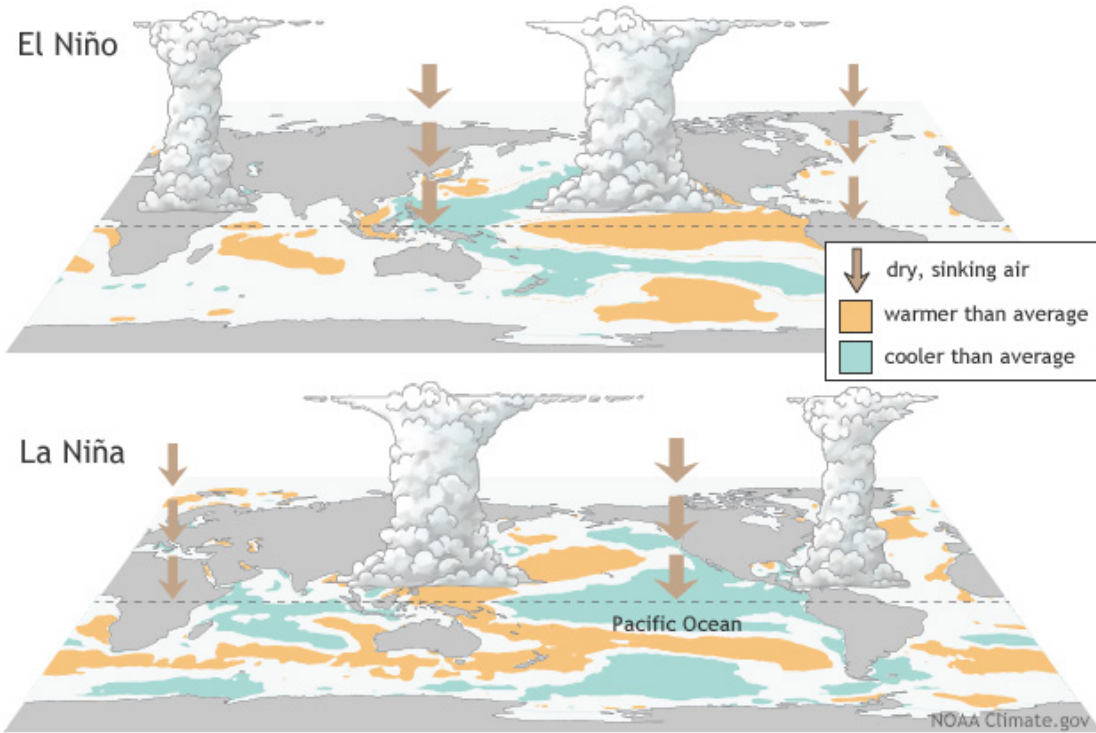


Seasonal prediction of sea surface temperature at six months prior



Wang et al. 2019

State-of-the-art prediction skills



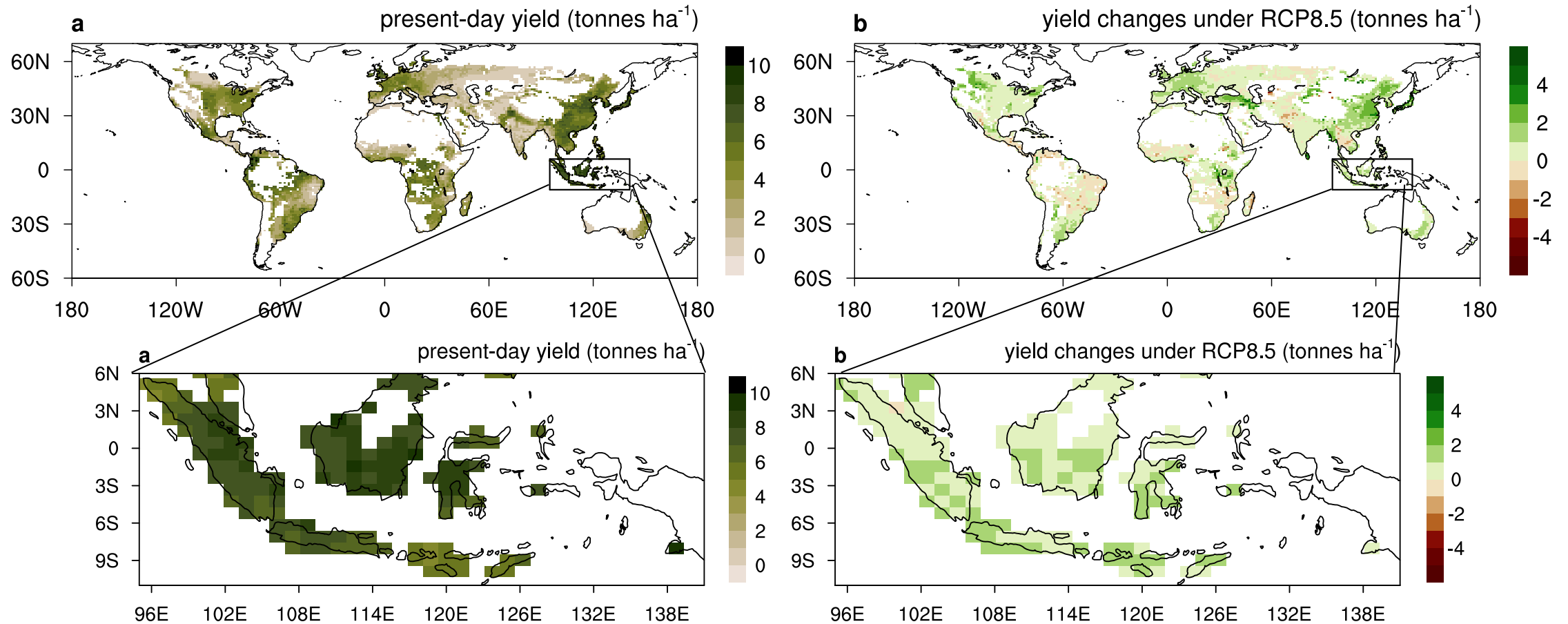


Solar geoengineering can alleviate climate change pressures on crop yields

Yuanchao Fan^{1,2}, Jerry Tjiputra¹, Helene Muri³, Danica Lombardozi⁴, Chang-Eui Park⁵, Shengjun Wu⁶ and David Keith^{7,8}

Solar geoengineering (SG) and CO₂ emissions reduction can each alleviate anthropogenic climate change, but their impacts on food security are not yet fully understood. Using an advanced crop model within an Earth system model, we analysed the yield responses of six major crops to three SG technologies (SGs) and emissions reduction when they provide roughly the same reduction in radiative forcing and assume the same land use. We found sharply distinct yield responses to changes in radiation, moisture and CO₂, but comparable significant cooling benefits for crop yields by all four methods. Overall, global yields increase -10% under the three SGs and decrease 5% under emissions reduction, the latter primarily due to reduced CO₂ fertilization, relative to business as usual by the late twenty-first century. Relative humidity dominates the hydrological effect on yields of rainfed crops, with little contribution from precipitation. The net insolation effect is negligible across all SGs, contrary to previous findings.

Crop production

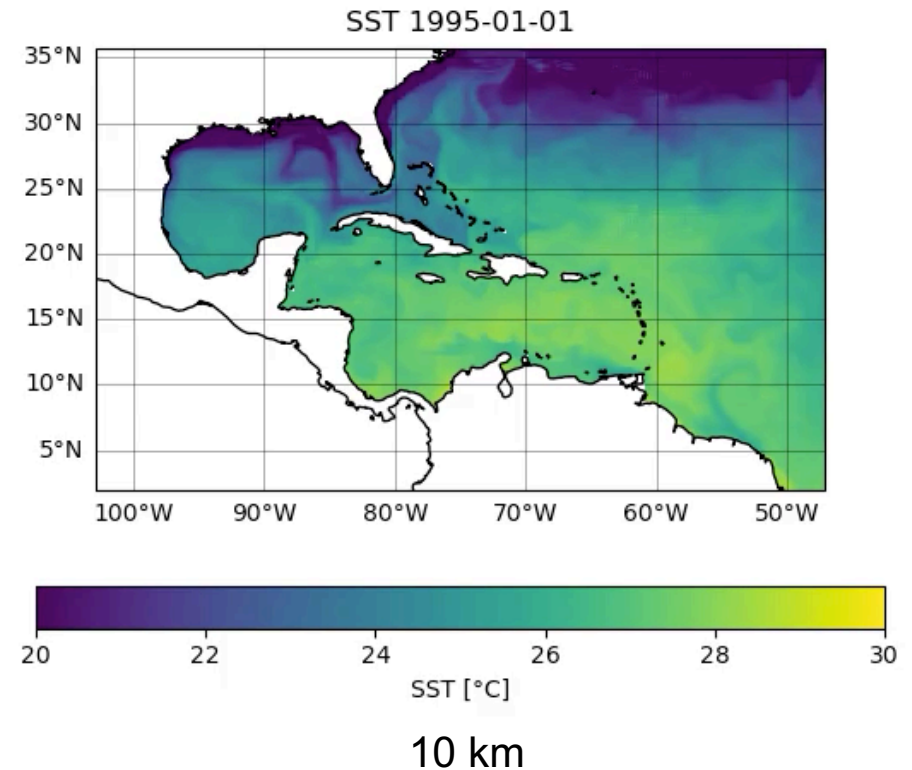
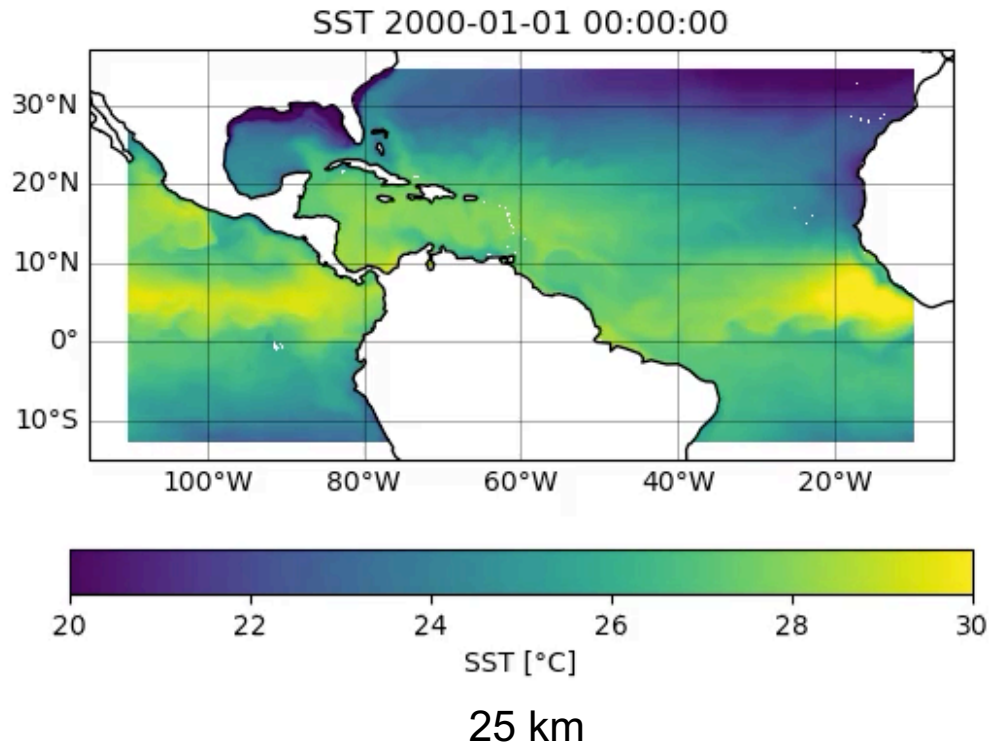




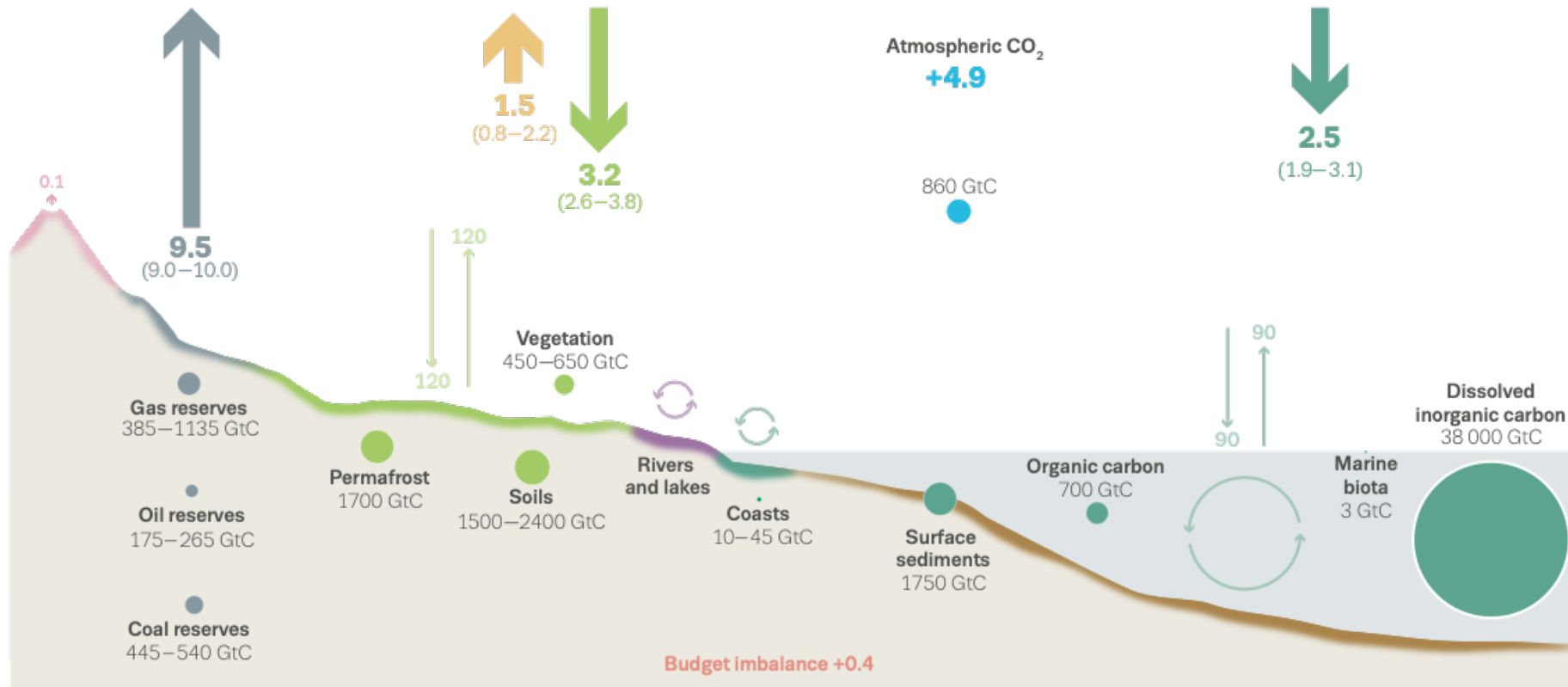
REEF-FUTURE

The future of reef services in the Anthropocene









- › Determine changes in reef services: from biomass production providing livelihoods to cultural value that sustains tourism, and nutritional value insuring food security.



The global carbon cycle



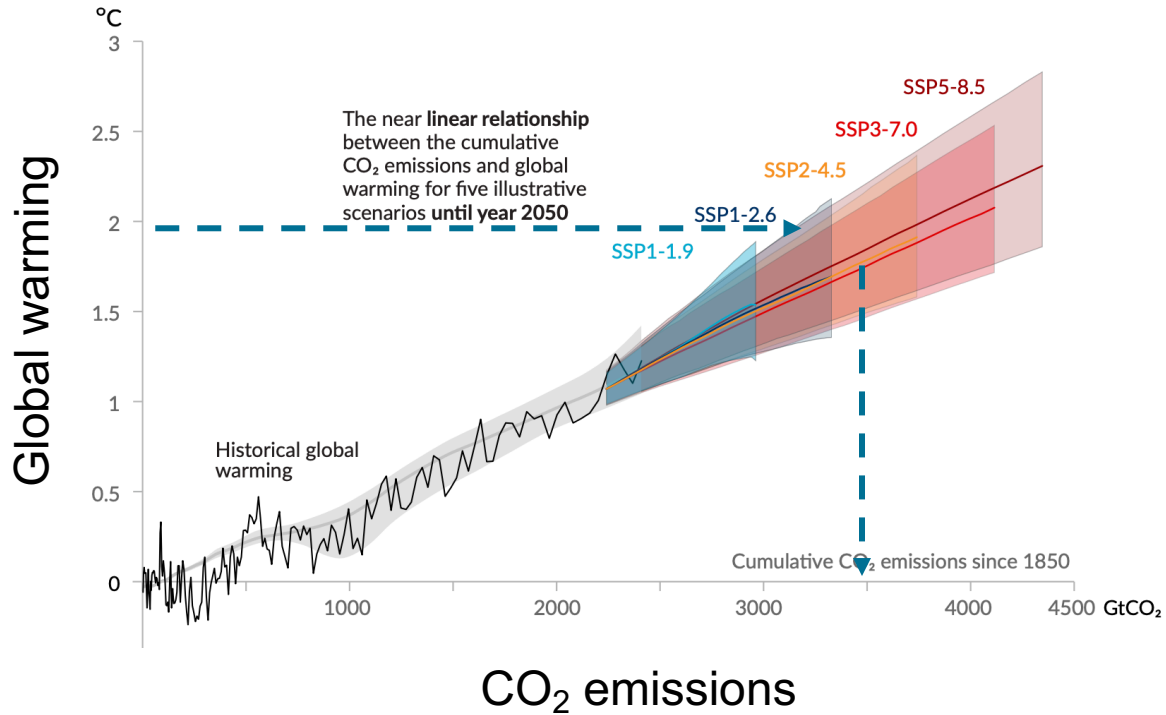
Anthropogenic fluxes 2009–2018 average GtC per year

-  Fossil CO₂ E_{FF}
-  Land use change E_{LUC}
-  Atmospheric increase G_{ATM}
-  Carbon cycling GtC per year
-  Land uptake S_{LAND}
-  Ocean uptake S_{OCEAN}
-  Budget imbalance B_{IM}
-  Stocks GtC

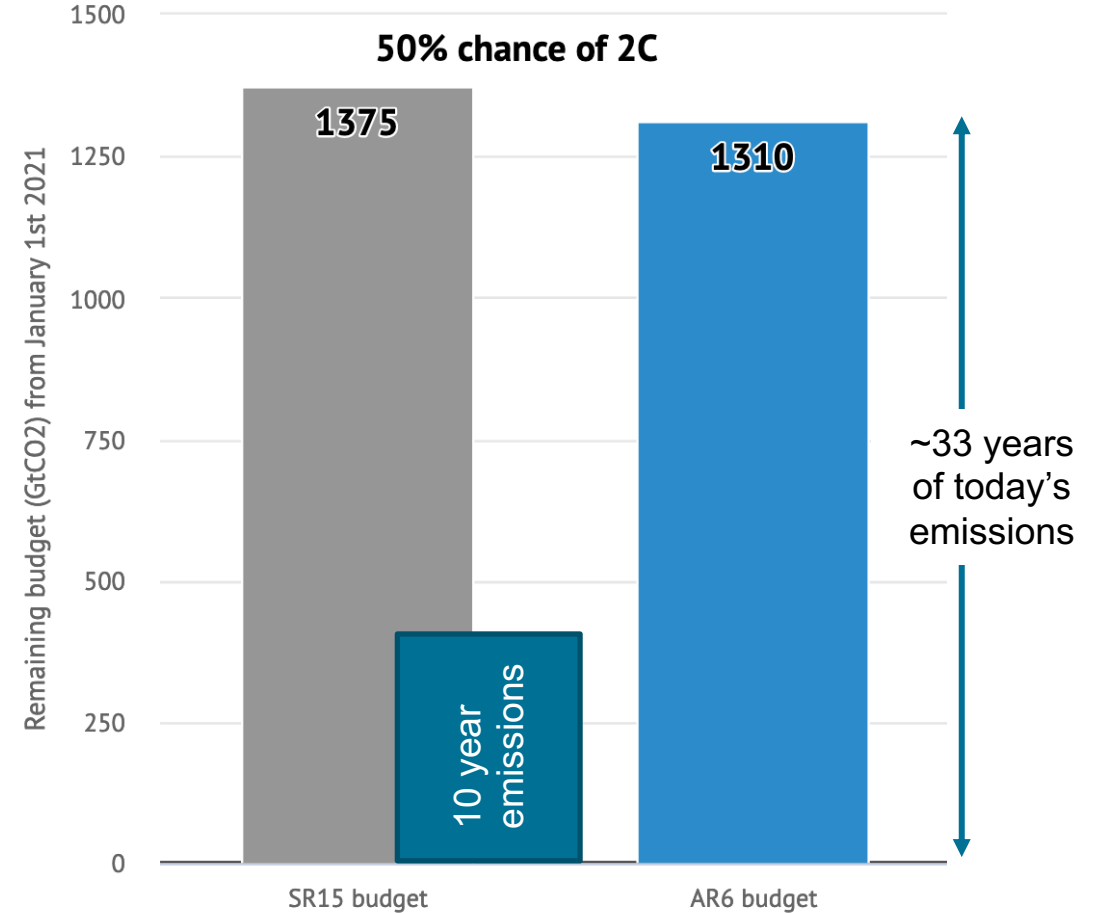
Friedlingstein et al. (2019)

Every tonne of CO₂ emissions adds to global warming

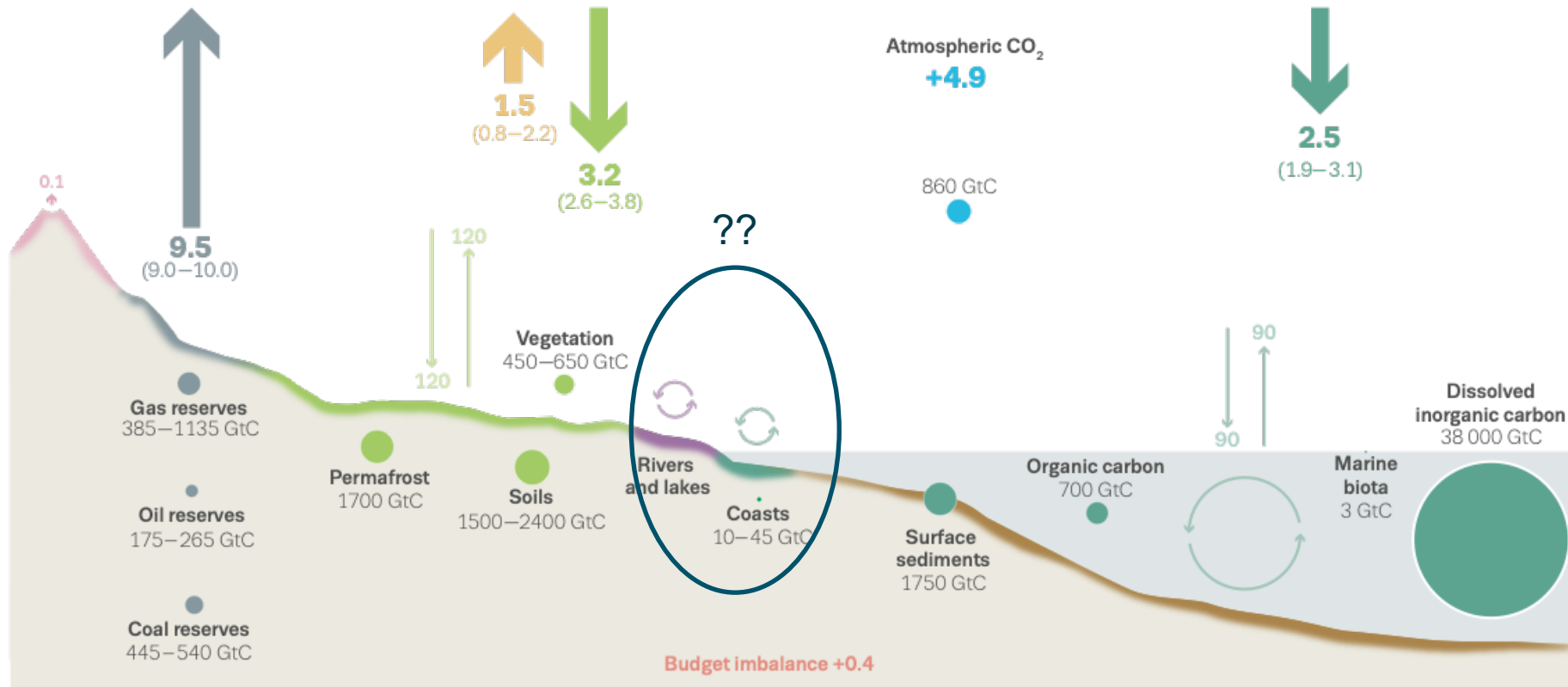
Global surface temperature increase since 1850-1900 (°C) as a function of cumulative CO₂ emissions (GtCO₂)











Comparing SR15 and AR6 carbon budgets for a 50% chance of 2C



The global carbon cycle

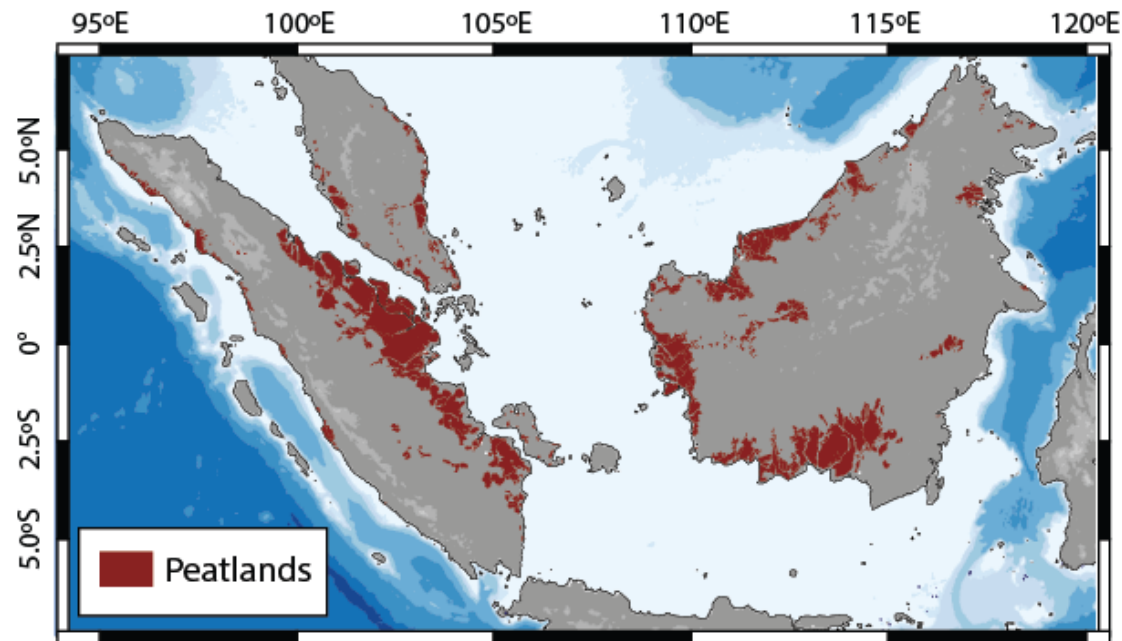


Anthropogenic fluxes 2009–2018 average GtC per year

-  Fossil CO₂ E_{FF}
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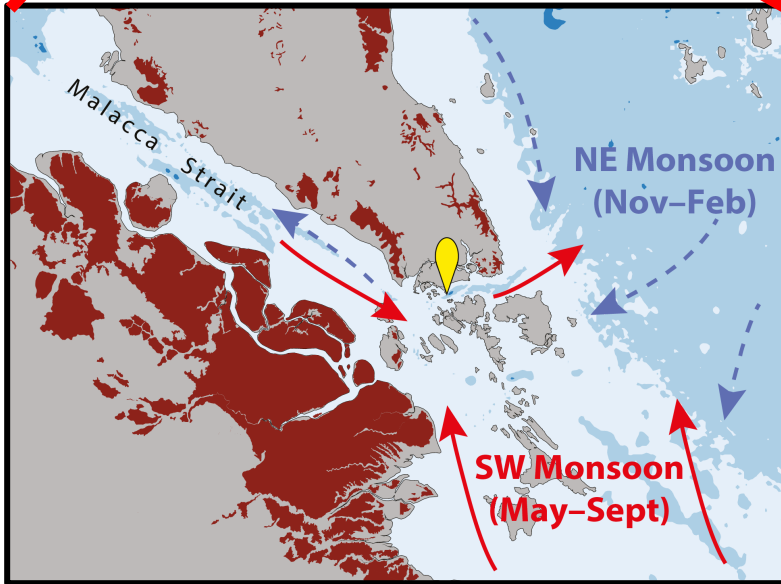
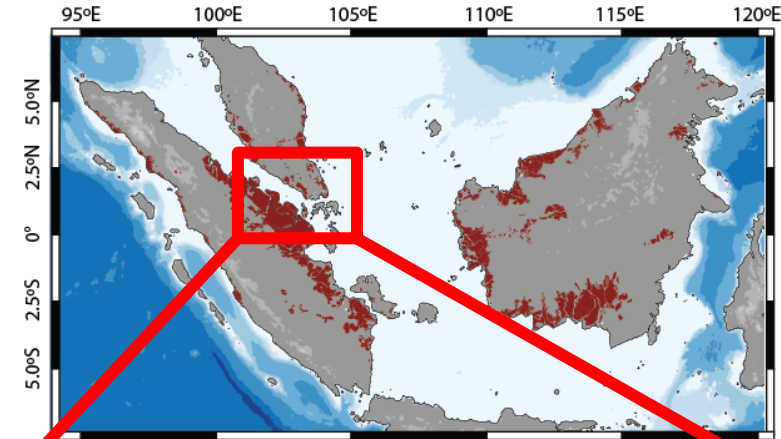
Friedlingstein et al. (2019)

SE Asia: A key hotspot for land-ocean carbon flux



- › ~60% of tropical peatland carbon is in SE Asia
- › “Blackwater” rivers from peatlands carry ~10% of global land–ocean flux of dissolved organic carbon





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Alan Koropitan
(Bogor Agr. Uni.)



A'an Wahyudi
(BRIN)



Patrick Martin
(NTU Singapore)



Richard Sanders
(NORCE)



Hanif Budiprayitno
(BRIN)



Moritz Müller
(Swinburne, Kuching)



Bernhard Mayer
(Uni. Hamburg)



Thank you.

Contact: Jerry.Tjiputra@norceresearch.no