

# Using UKESM1 to model the climate response to reductions in emissions caused by COVID-19

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# Background

- The COVID-19 pandemic has caused
  - restrictions in travel & other activities
  - reductions in greenhouse gases, ozone & aerosol precursors
- Will this affect Earth's future climate?
  - run climate simulations to find out



# Emission reduction scenarios

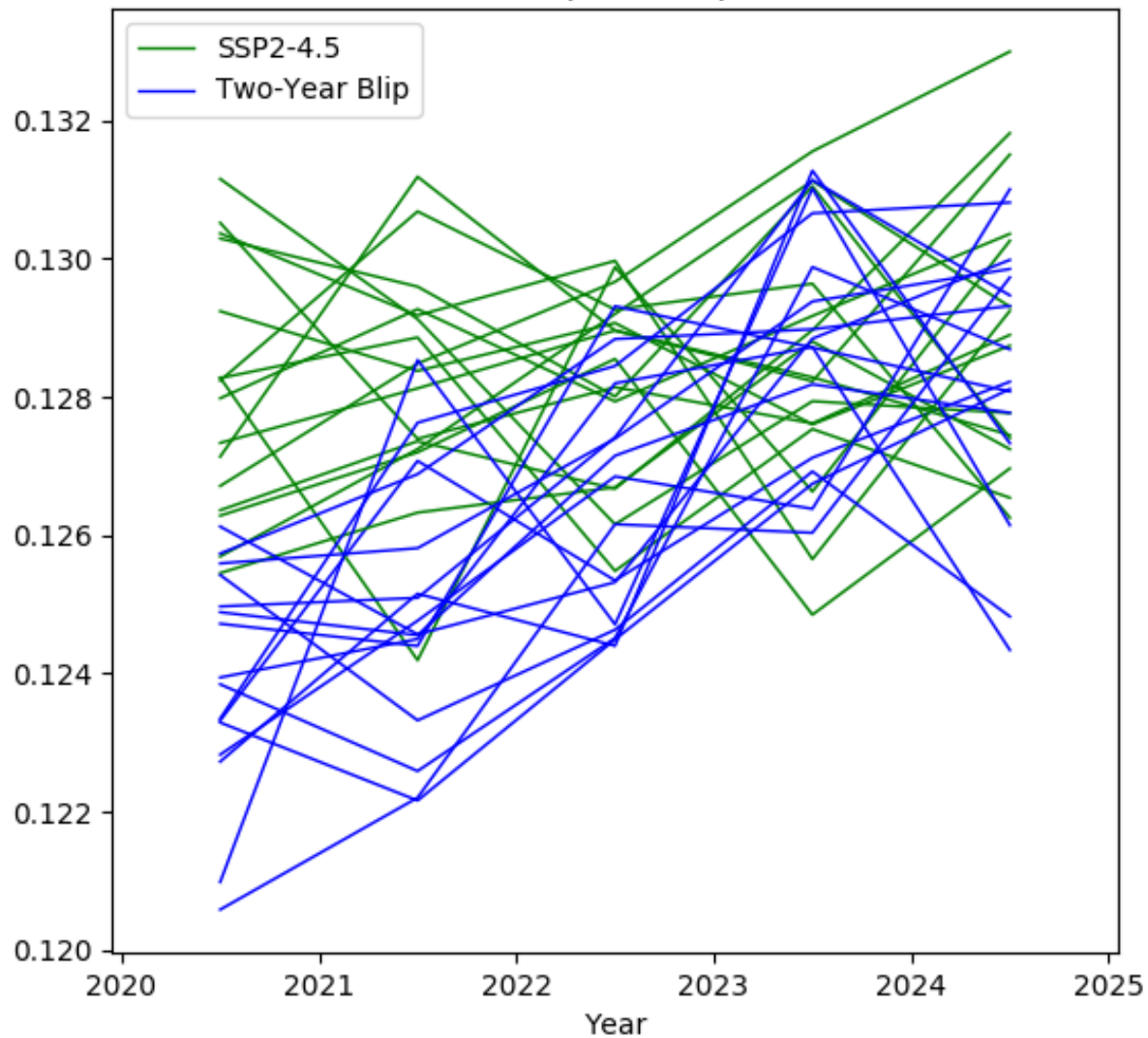
- 2020 emissions reductions determined by
  - bottom-up estimates (from sector activity data)
  - top-down analysis (from atmospheric observations)
- Used to develop 2020+ scenarios, inc. *Two-Year Blip*:
  - emissions reduced in Jan-Mar 2020
    - 35% (NO<sub>x</sub>), 5% (CO<sub>2</sub>), 5% (CH<sub>4</sub>)
  - stay constant till Jan 2022
    - then return to pre-2020 levels
- Forcings and modelling protocol created

# Experiment protocol

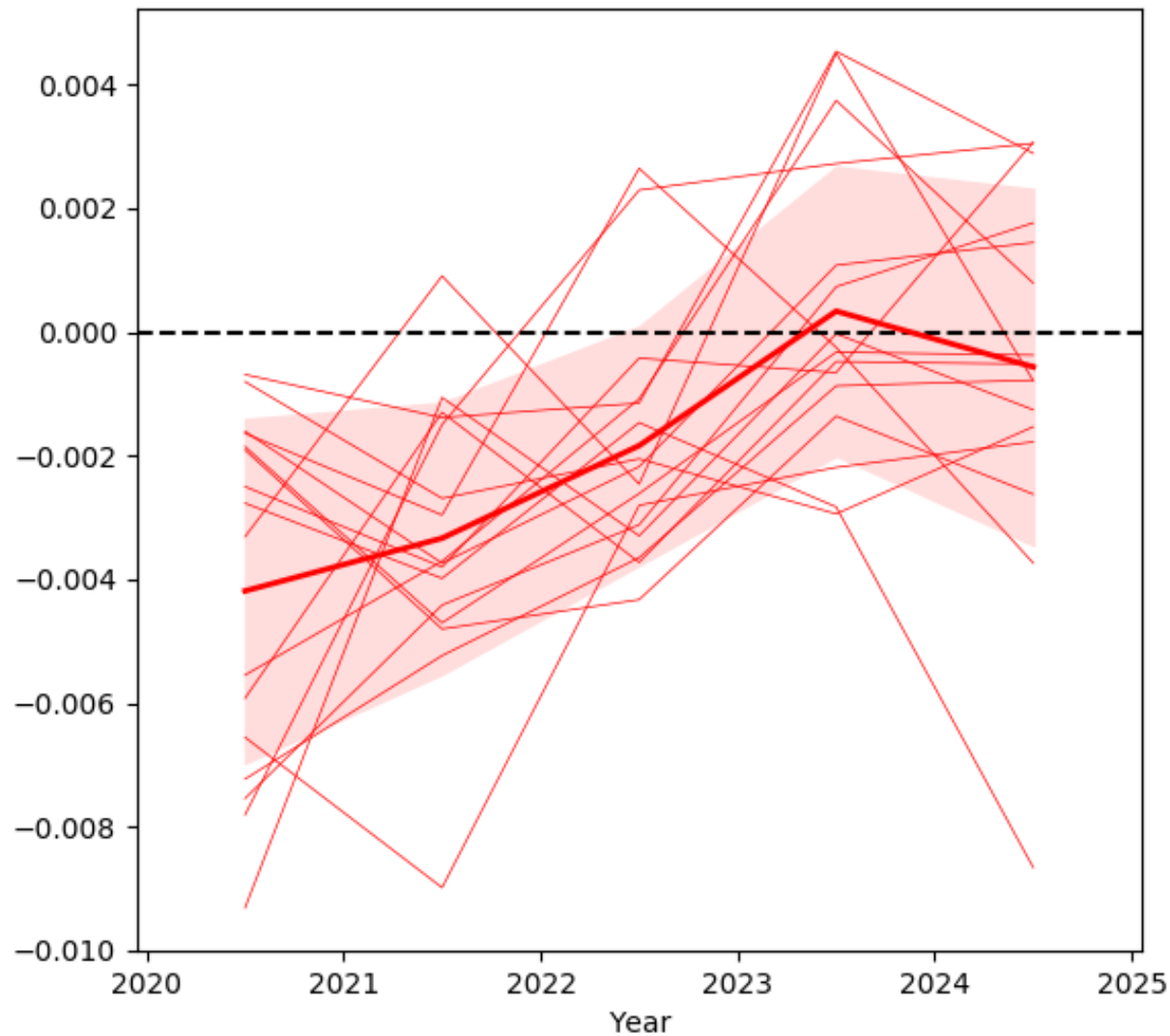
- Use SSP2-4.5 scenario as baseline
- Two-Year Blip forcings applied at start of 2020
  - runs go up to 2050
  - difference in results from baseline shows effect
- Large ensemble needed
  - because effect is likely to be small
  - For UKESM1, SSP2-4.5 ensemble had 5 members
    - but historical has 16, so added 11 more members to SSP2-4.5
- All UKESM1 runs are concentration-driven

# Results from UKESM1

Global Aerosol Optical Depth at 550nm



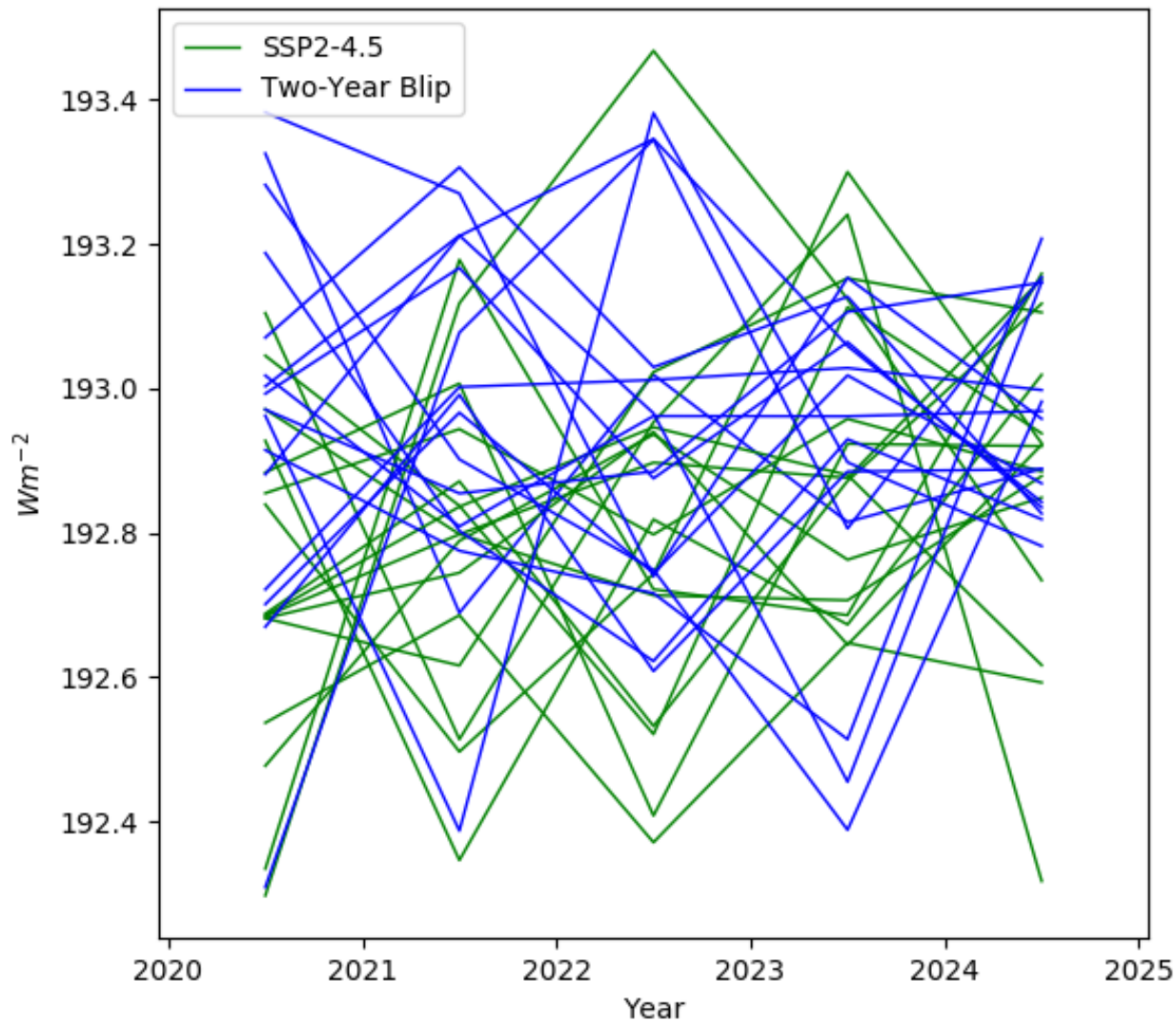
Difference



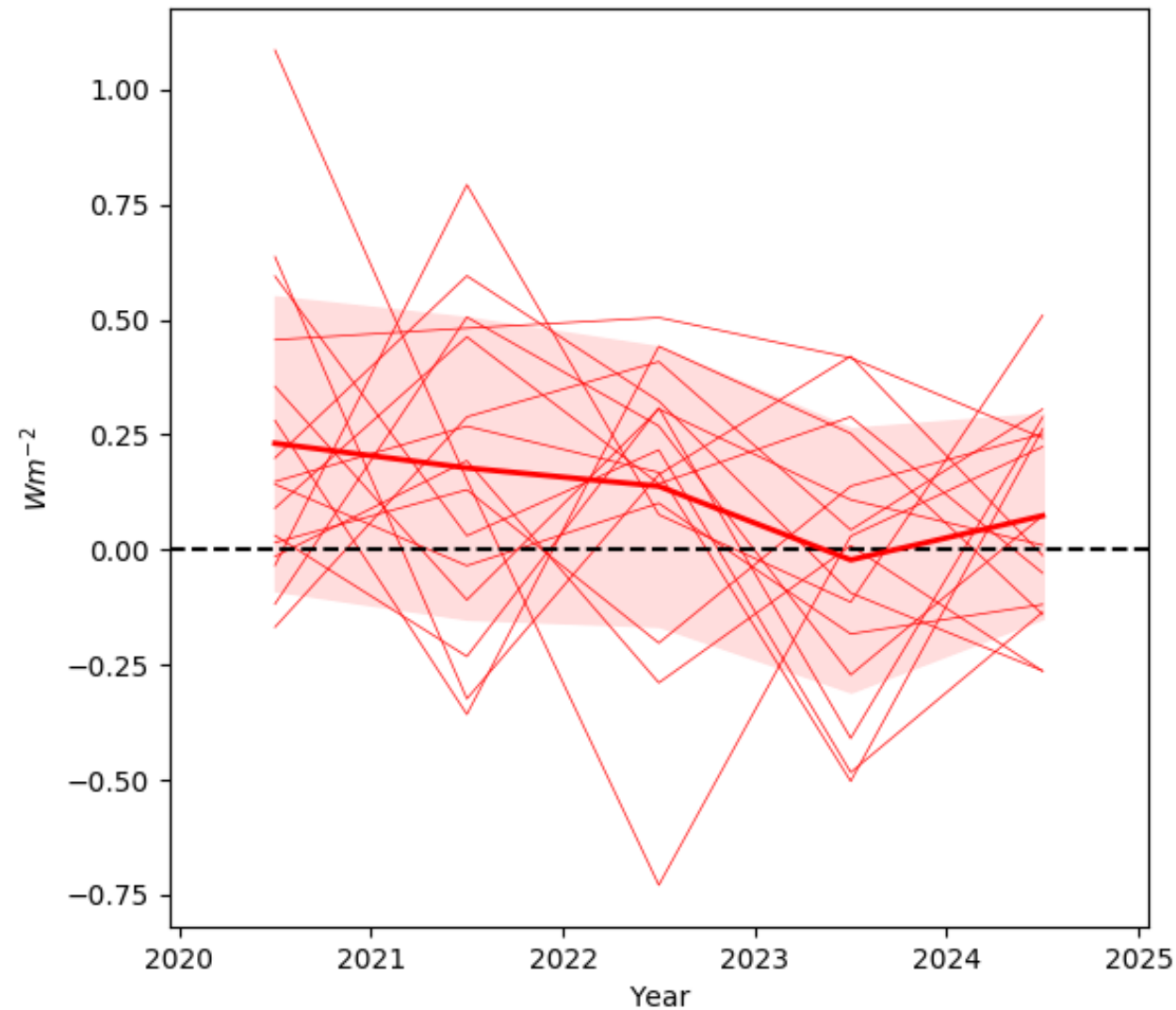


# Results from UKESM1

Downward SW radiation at surface

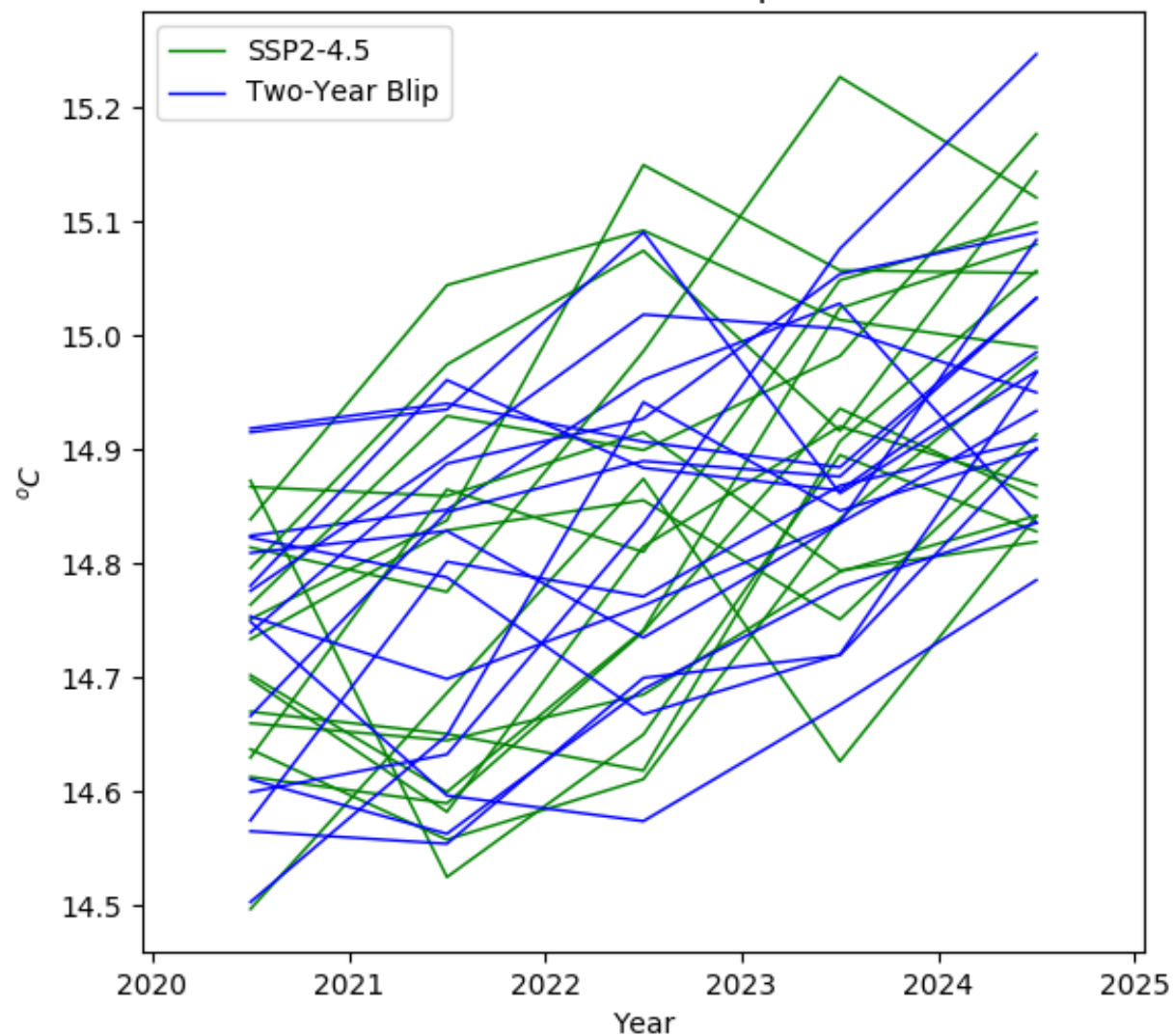


Difference

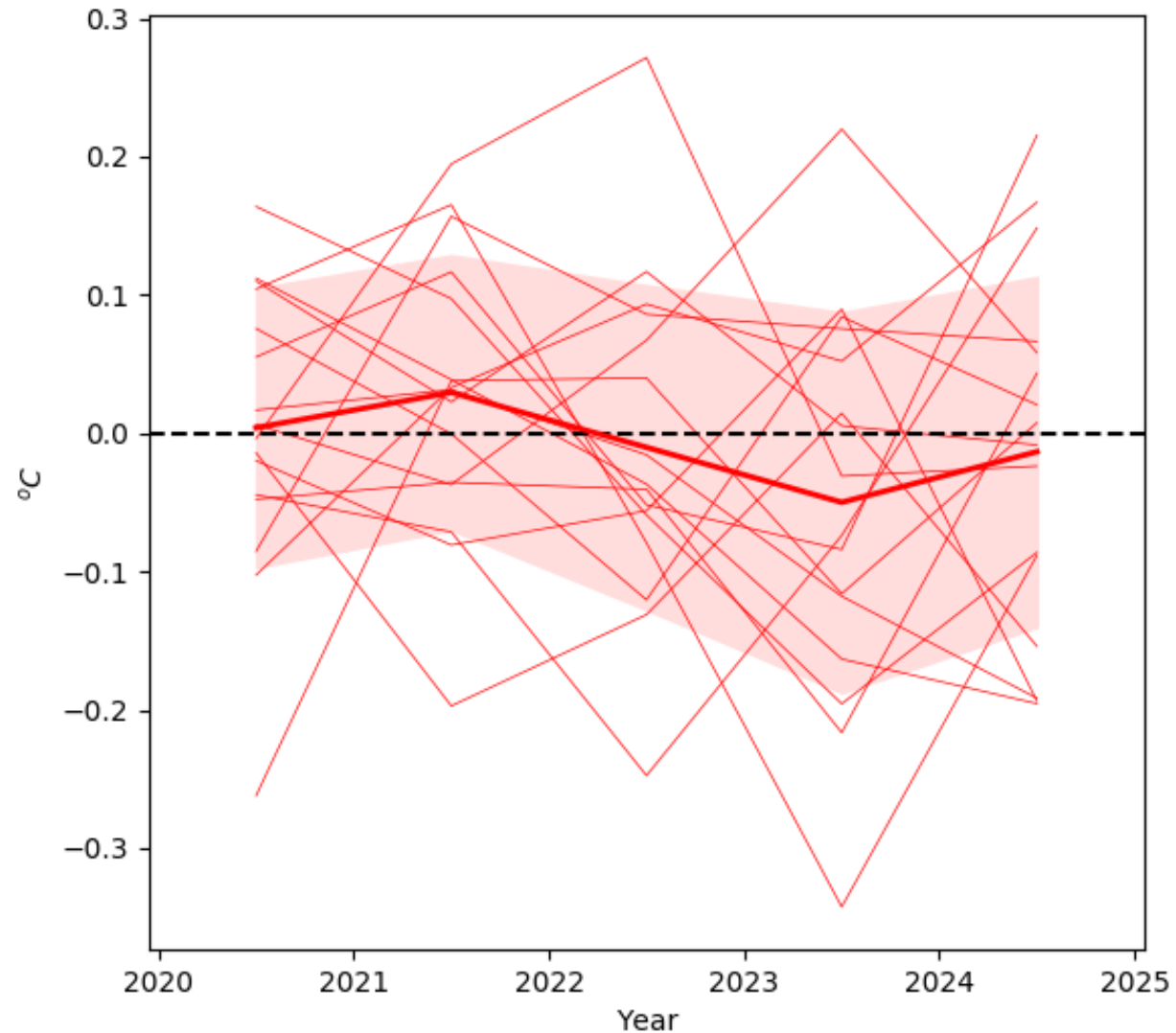


# Results from UKESM1

Global surface air temperature

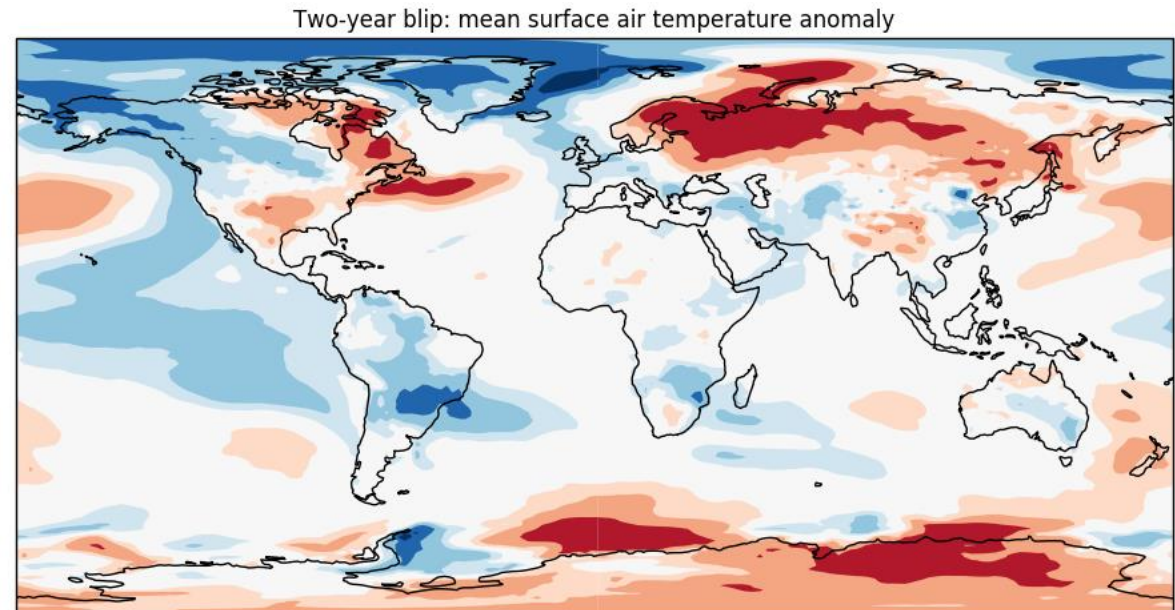


Difference



# Results from UKESM1

- Initial reduction in AOD
  - becoming insignificant after two years
- Initial (smaller) increase in amount of solar radiation
  - becoming insignificant after two years
- No significant change in surface air temperature
  - 2020-4 average shows
    - +0.25 °C: Russia & Antarctica
    - - 0.25 °C: Arctic

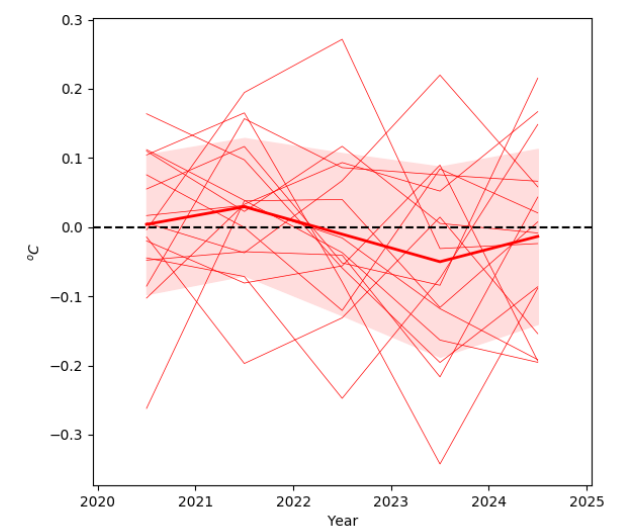
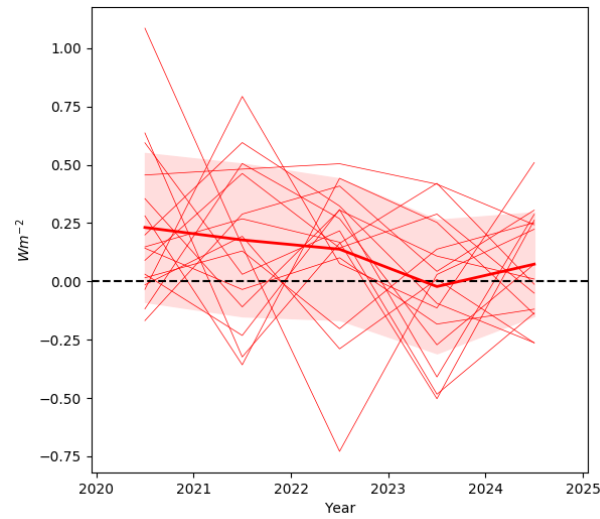
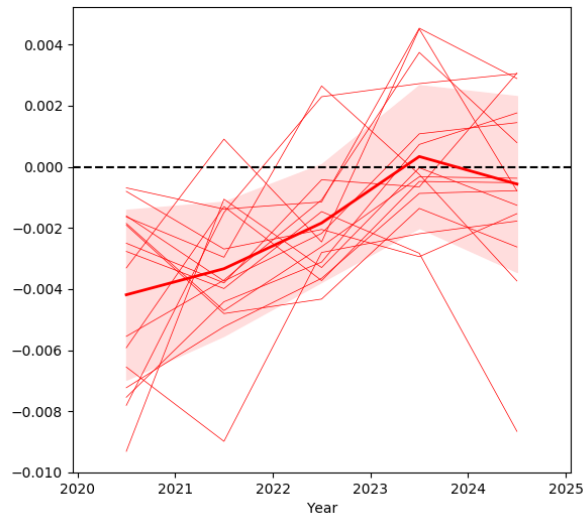
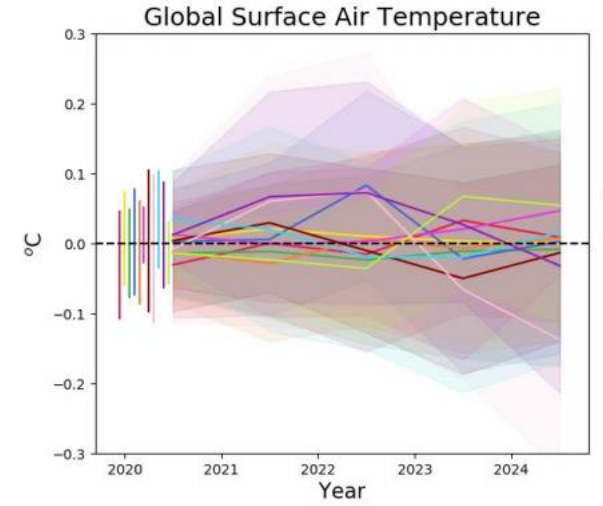
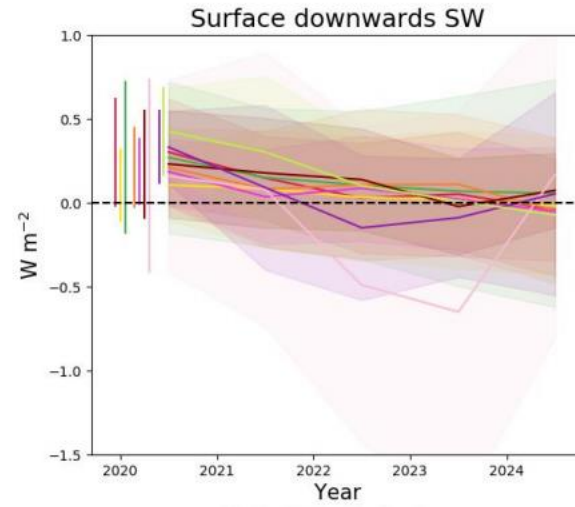
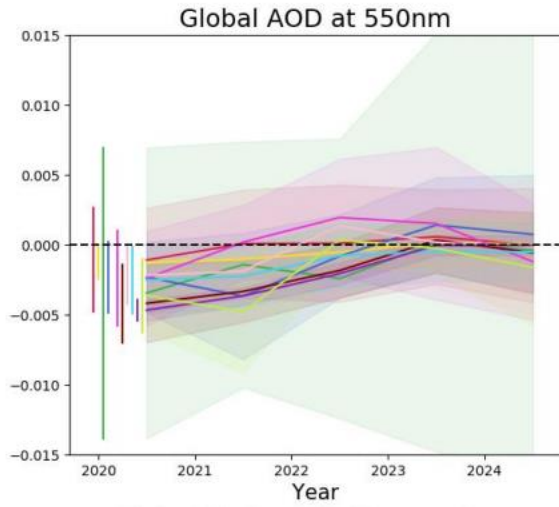




# UKESM1 in CovidMIP

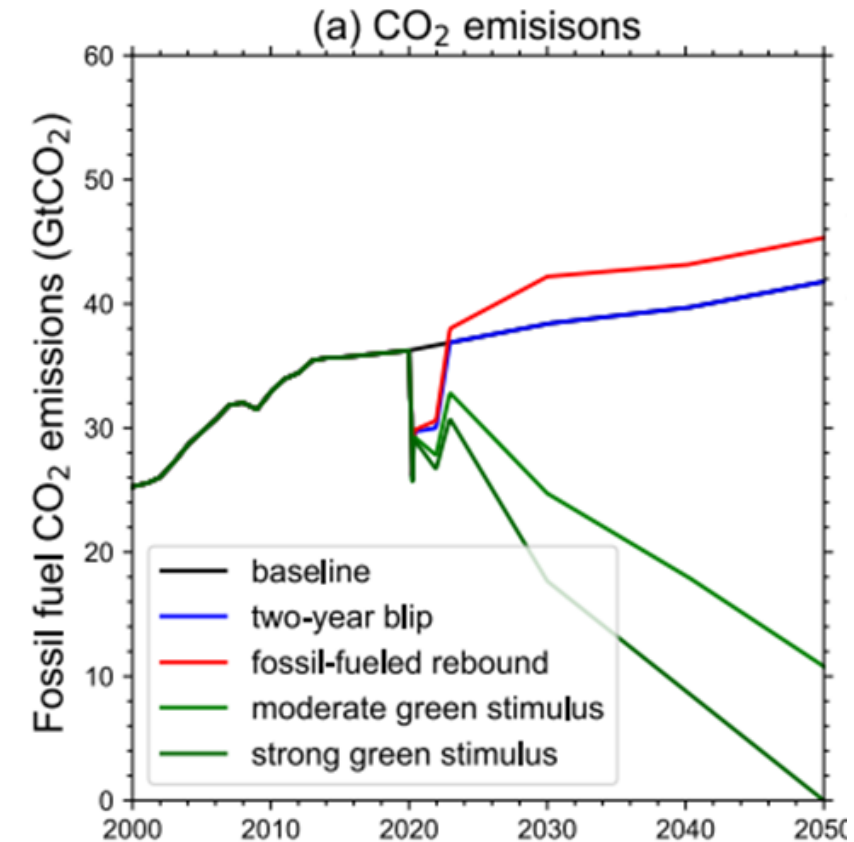
- 12 models (inc. UKESM1) running 300+ simulations
  - in multiple initial-condition ensembles
- Results for UKESM1 consistent with other models

# UKESM1 in CovidMIP



# Further work

- Initial focus on short-term (2020-24)
  - full experiments go up to 2050
- Other scenarios have been run
  - reflecting investment in
    - fossil fuel-based energy, or
    - environmentally-friendly technology
      - at a moderate or strong level
- All UKESM1 results are on ESGF
  - and for some other models too



# Conclusions

- Pandemic: an opportunity to study climate change
- Early results show no impact on global climate
  - from Two-Year Blip scenario
- Further analysis ongoing / proposed
  - fixed SST runs to quantify ERF due to emissions reductions
  - local effects: changes in extremes or atmosphere circulation?
- Analysis of other scenarios
  - fossil-fuel recovery / moderate- / strong-green stimulus
  - Four-Year Blip??

# More details

- “Using UKESM1 to Model the Climate Response to Reductions in Emissions caused by COVID-19”
  - J. Walton, S. Rumbold, Y. Tang, C. Jones
  - UKESM1 Newsletter No. 12, January 2021
  - <https://ukesm.ac.uk/portfolio-item/using-ukesm1-to-model-the-climate-response-to-reductions-in-emissions-caused-by-covid-19>
- “The Climate Response to Emissions Reductions due to COVID-19: Initial Results from CovidMIP”
  - C.D. Jones, J.E. Hickman, S.T. Rumbold, J. Walton, R.D. Lamboll *et al*
  - Geophysical Research Letters, 10 March 2021
  - <https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2020GL091883>