SIXTH ASSESSMENT REPORT
Working Group I – The Physical Science Basis

ipcc
INTERGOVERNMENTAL PANEL ON Climate change

WMO UNEP

How does the IPCC AR6 WGI report address carbon dioxide removal?

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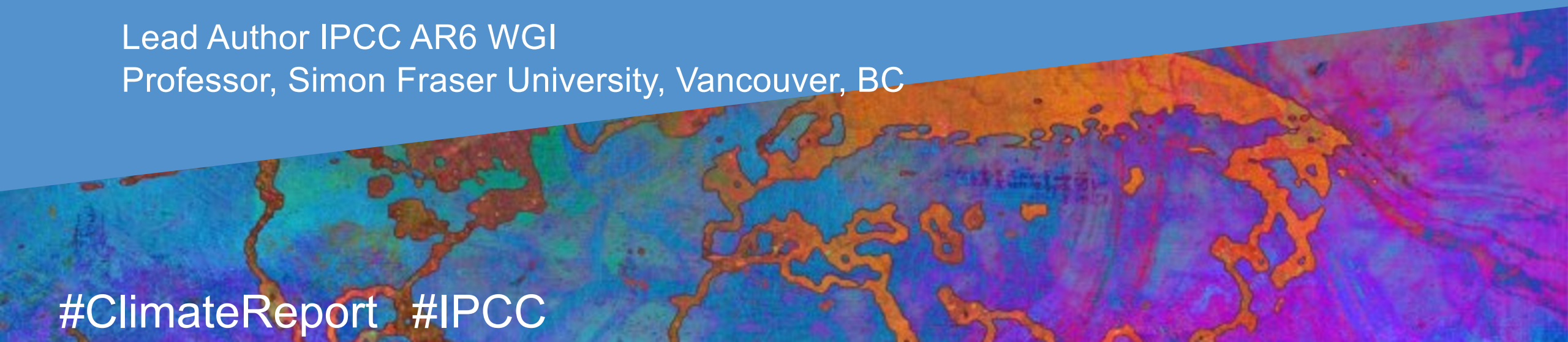

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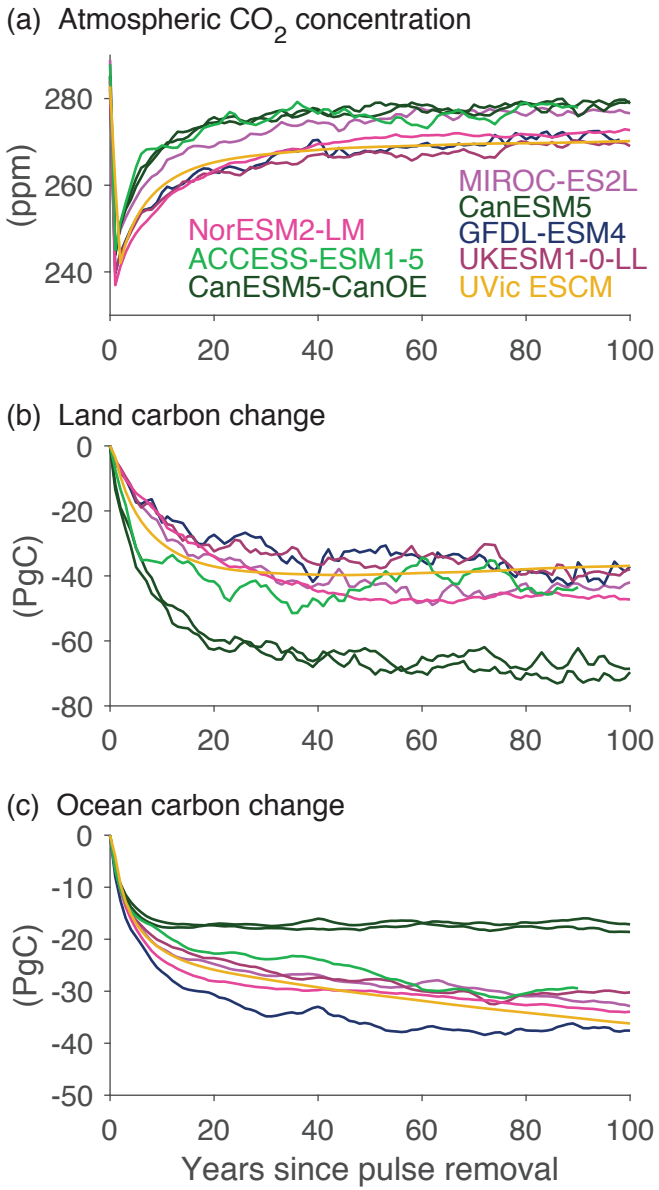
CDR Assessment in WGI AR6 Report

- Chapter 4: Future global climate: scenario-based projections and near-term information
  - Climate response to CDR
  - Termination effects of CDR
- Chapter 5: Global Carbon and other Biogeochemical Cycles and Feedbacks
  - Carbon cycle response to CDR
  - Effectiveness of CDR at drawing down atmospheric CO_2
  - Asymmetry in the carbon cycle and temperature response to CO_2 emissions and removals
  - Effects of specific CDR methods on climate and biogeochemical cycles

Carbon Cycle Response to CDR: Rebound effect

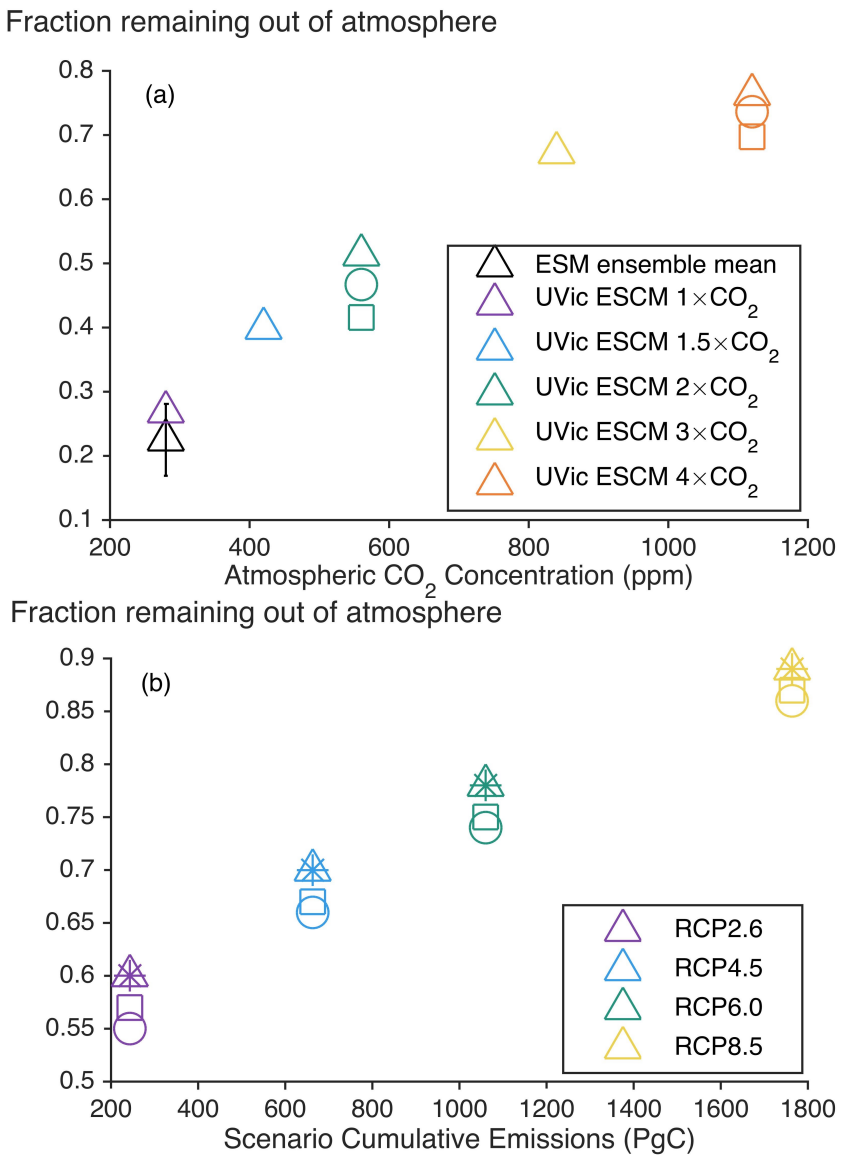


- 100 GtC (367 $GtCO_2$) removed from pre-industrial state
- Atmospheric CO_2 declines rapidly after removal, rebounds within years of removal
- Rebound due to loss of CO_2 from land, ocean reservoirs

➢ Only a fraction of CO_2 removed remains out of atmosphere

IPCC WGI AR6 Figure 5.32

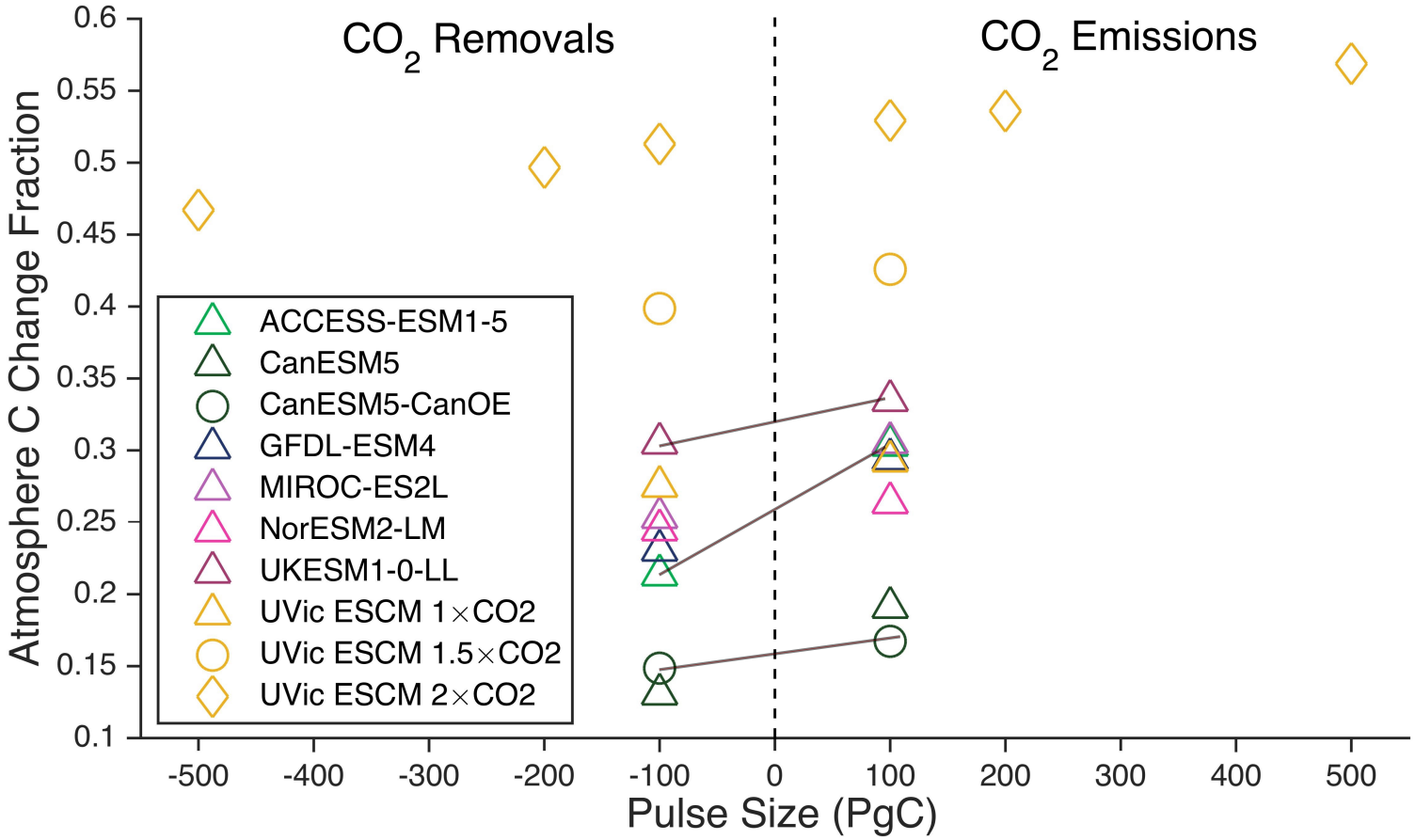
How much CO_2 remains out of the atmosphere after removal?



- Fraction of CO_2 removed remaining out of atmosphere measure of CDR effectiveness
- Fraction remaining out of atmosphere *is not constant*; it decreases with decreasing atmospheric CO_2 and decreases slightly with increasing amount of removal

IPCC WGI AR6 Figure 5.34

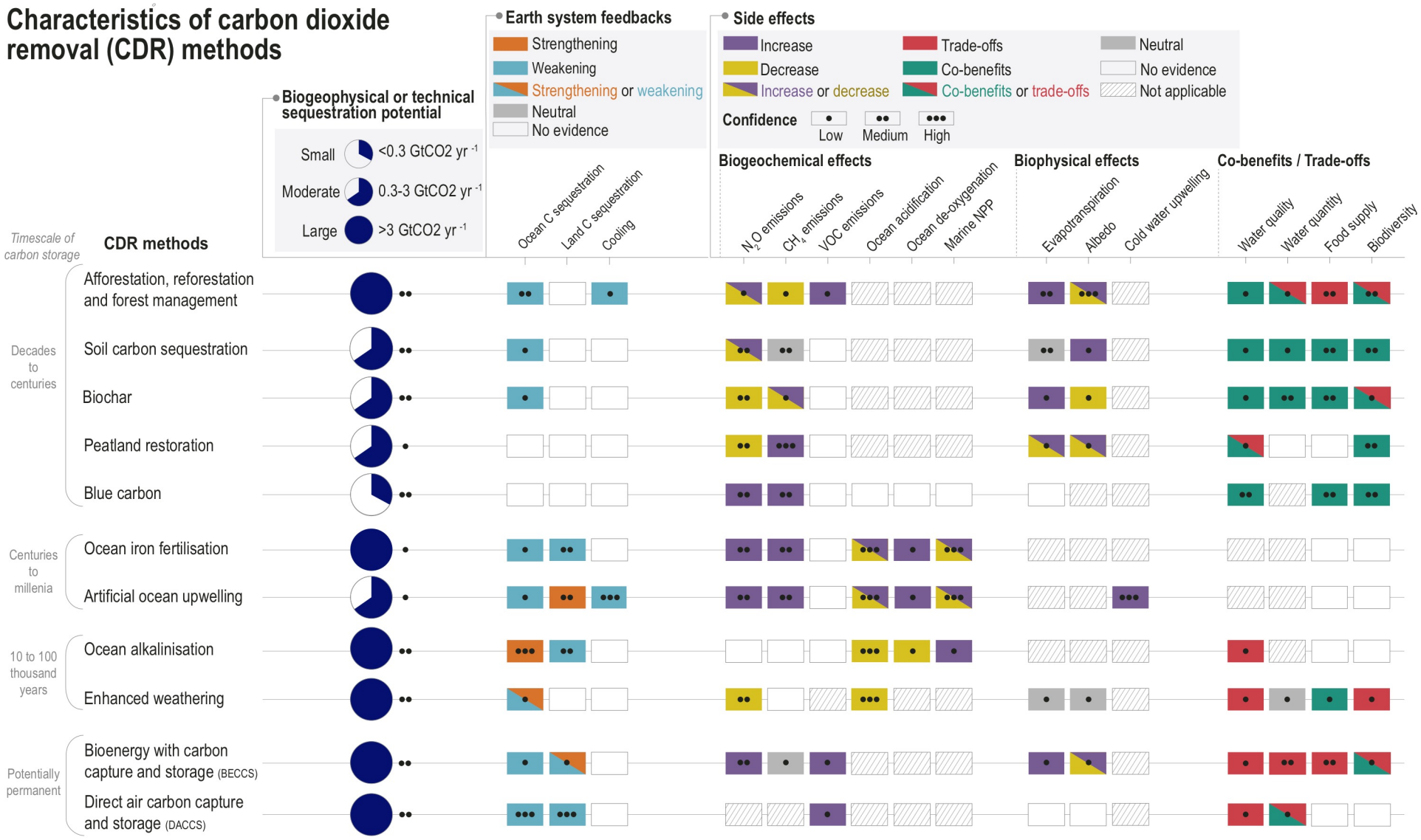
Asymmetry in carbon cycle response to CO_2 emissions and removals



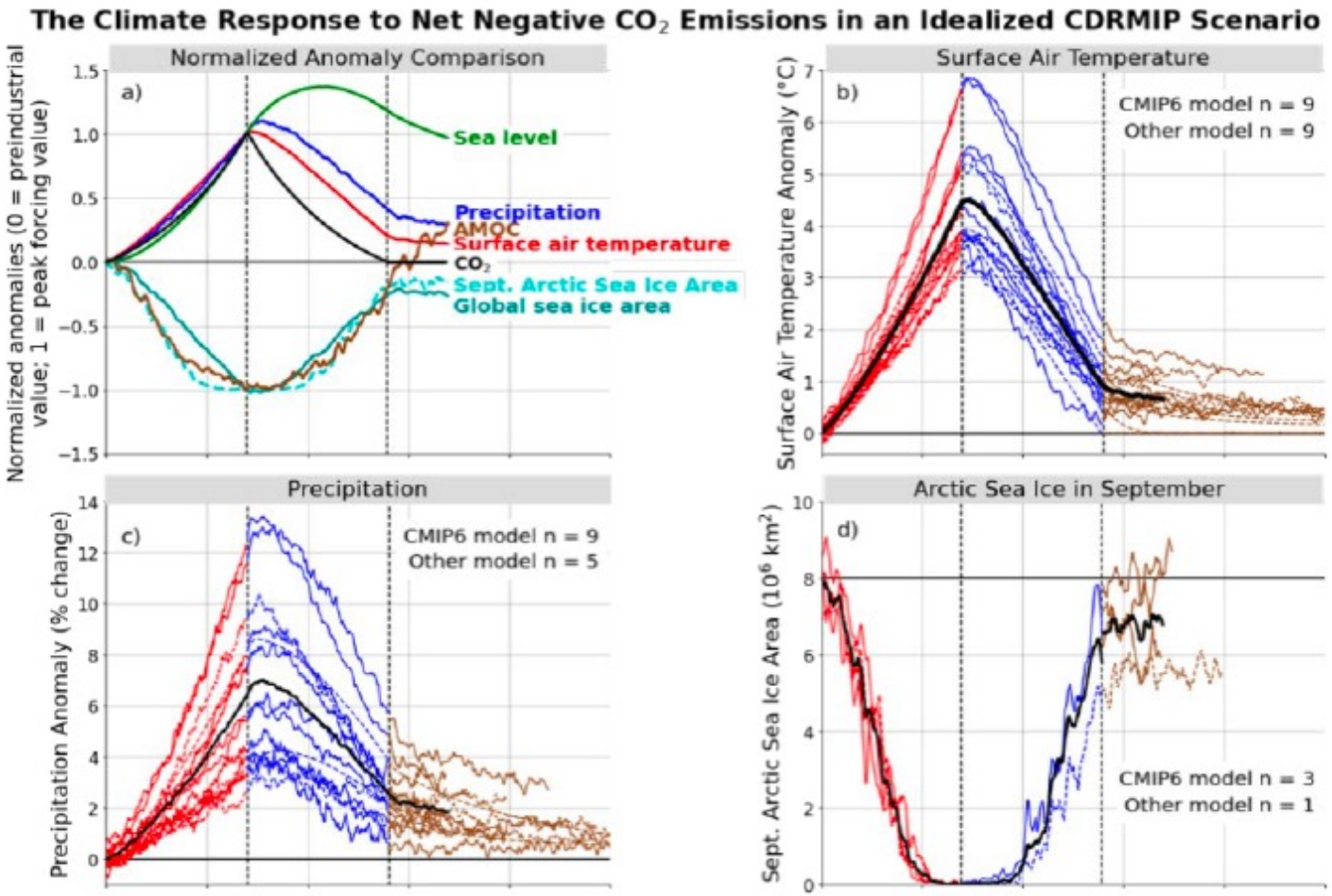
- Fraction of CO_2 emission remaining in atmosphere larger than fraction of CO_2 removal remaining out
- Asymmetry 2-9%

IPCC WGI AR6 Figure 5.35

Biophysical and biogeochemical effects of CDR methods



Delayed climate response to net negative CO_2 emissions



- Changes in key climate variables lag behind decline in atmospheric CO_2 induced by net negative CO_2 emissions

IPCC WGI AR6 Figure 4.37

Conclusions

- CDR results in a drop in atmospheric CO_2
- CO_2 removed from atmosphere partly replaced by CO_2 from land, ocean
- Effectiveness of CDR at drawing down CO_2 decreases with decreasing atmospheric CO_2 concentration and increasing amount of removal
- Asymmetry in the carbon cycle response to CO_2 emissions and removals
  → Offsetting a CO_2 emission with an equivalent CO_2 removal could result in a different climate than avoiding the CO_2 emission
- Most CDR methods have biophysical and/or biogeochemical effects that could either amplify or reduce the climate benefit of CO_2 sequestration