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With the support of the
Erasmus+ Programme
of the European Union

INTERNATIONAL CONFERENCE ON CLIMATE JUSTICE – 27th October

Anthropogenic CO_2 emissions and climate change: the state of art and future scenarios

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ICOS Integrated Carbon Observation System

www.climate-justice.earth

ICEA

GIScience

STeDe Sustainable Territorial Development

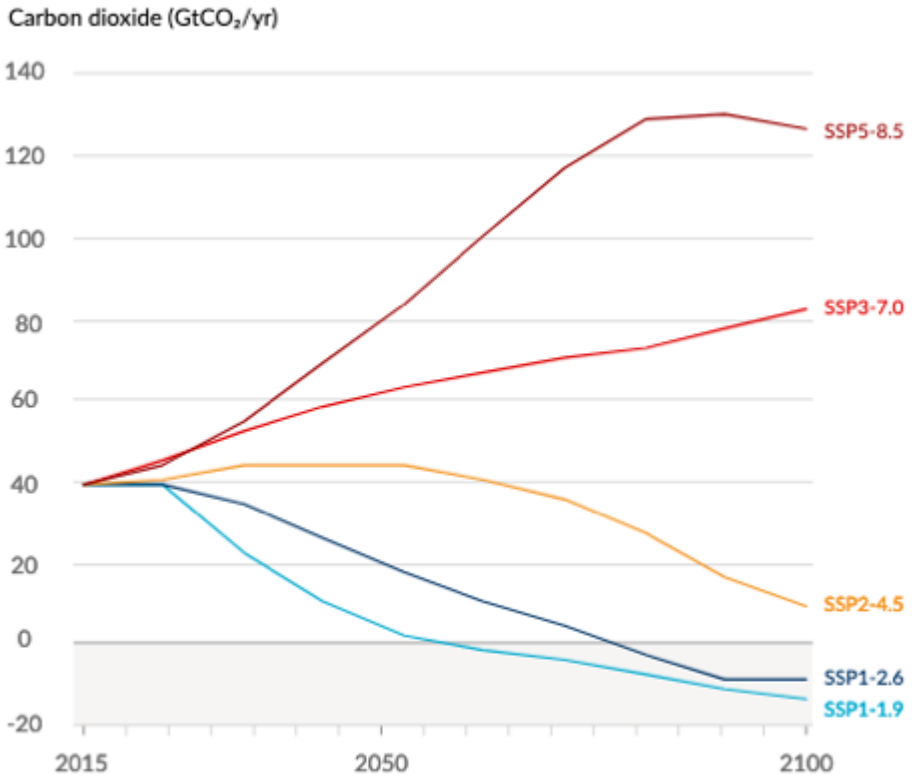
Associazione GISHub

Future emission scenarios

Future annual emissions of CO_2 across 5 scenarios

Major uncertainties:

- Model uncertainty
- Relation between temperature and emissions uncertain after hitting zero emissions
- Uncertain trends in the natural carbon cycle
- Possible feedbacks



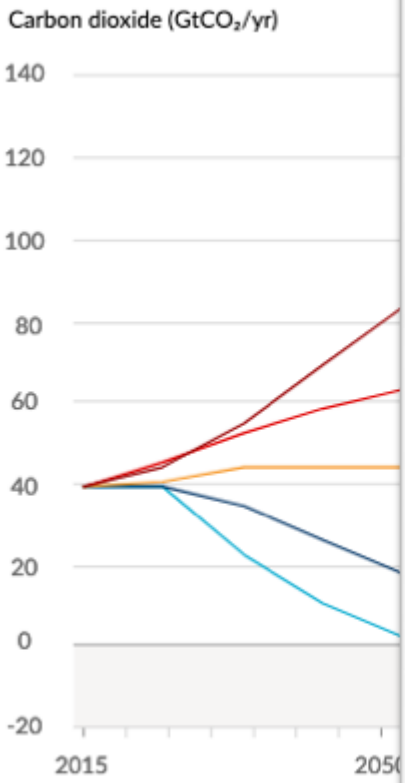
IPCC, 2021

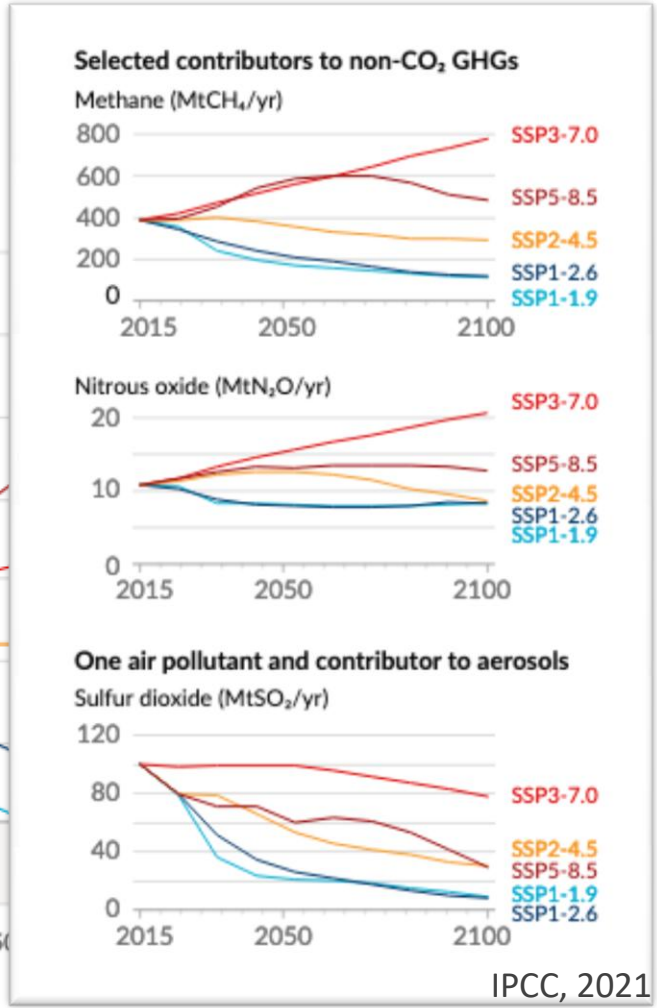
Future emission scenarios

Future annual emissions of CO_2 across 5 scenarios

Major uncertainties:

- Model uncertainty
- Relation between temperature and emissions uncertain after hitting zero emissions
- Uncertain trends in the natural carbon cycle
- Possible feedbacks
- Contribution of non-CO_2 greenhouse gases

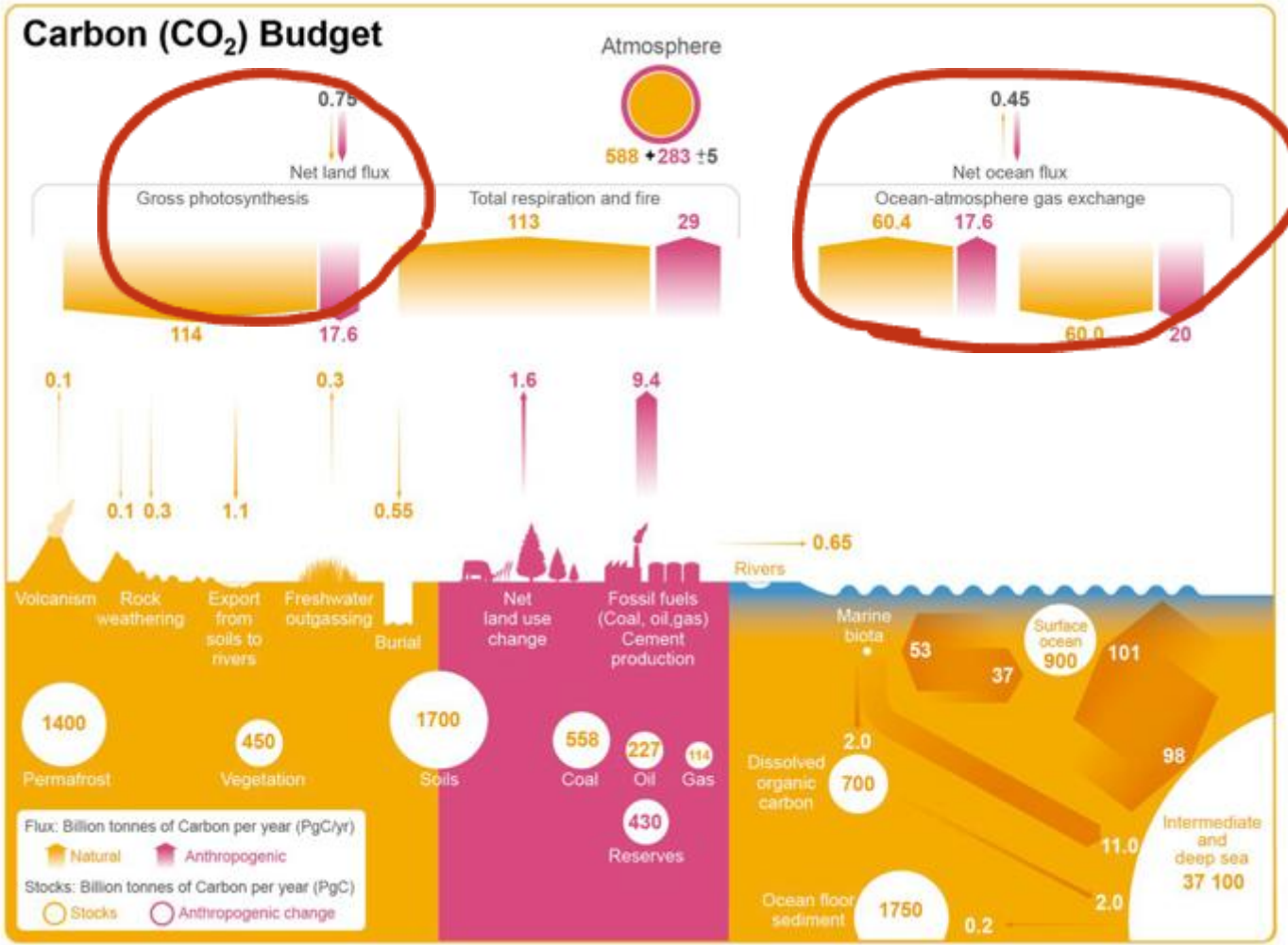




IPCC, 2021

The global carbon cycle

Small anthropogenic pertubation compared to the natural signal



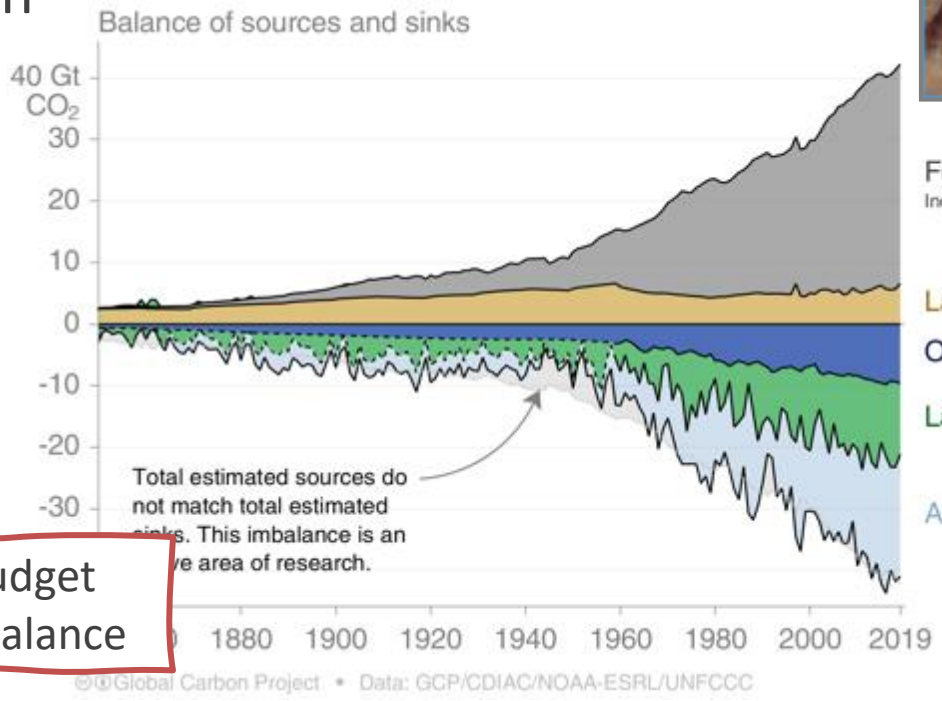
IPCC, 2021

Understanding the global carbon cycle

What is happening to the CO_2 we emit to the atmosphere?

Understanding the global carbon cycle

Temporal evolution in the past

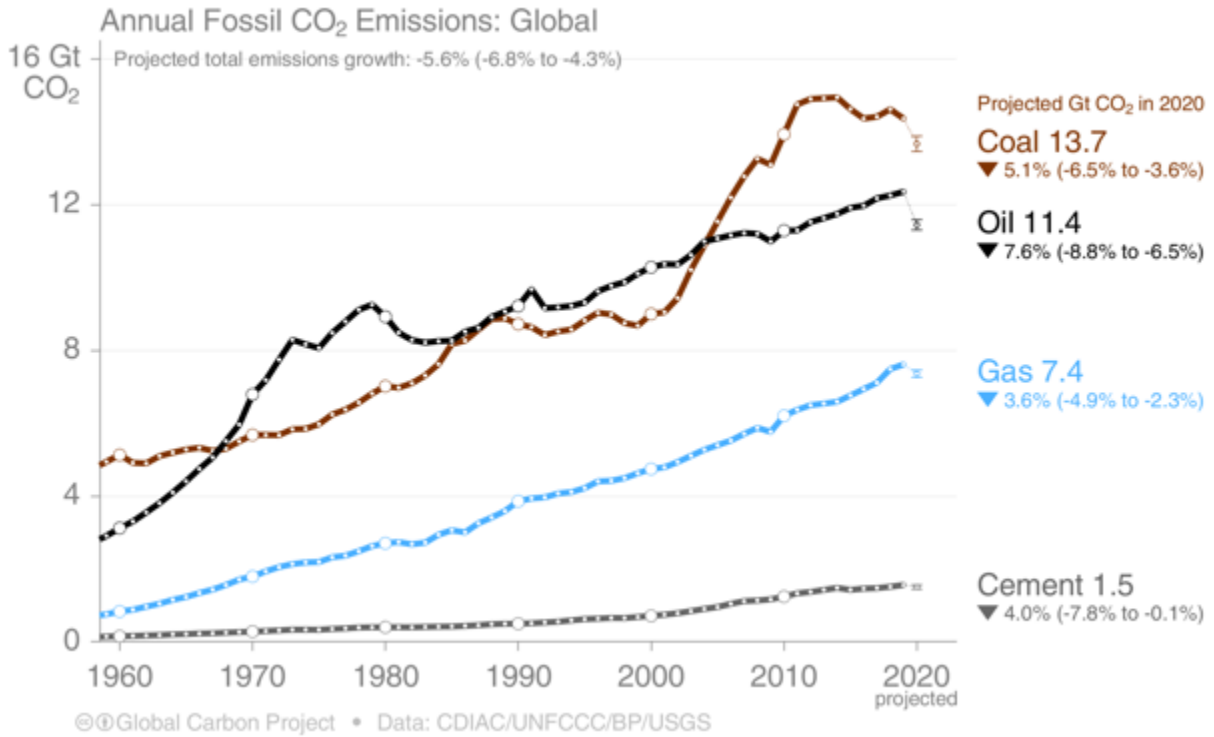


Budget imbalance

Source: Friedlingstein et al 2020; Global Carbon Budget 2020

Understanding the global carbon cycle

Distrubution over different sources of fossil fuel emissions



Source: CDIAC; Friedlingstein et al 2020; Global Carbon Budget 2020

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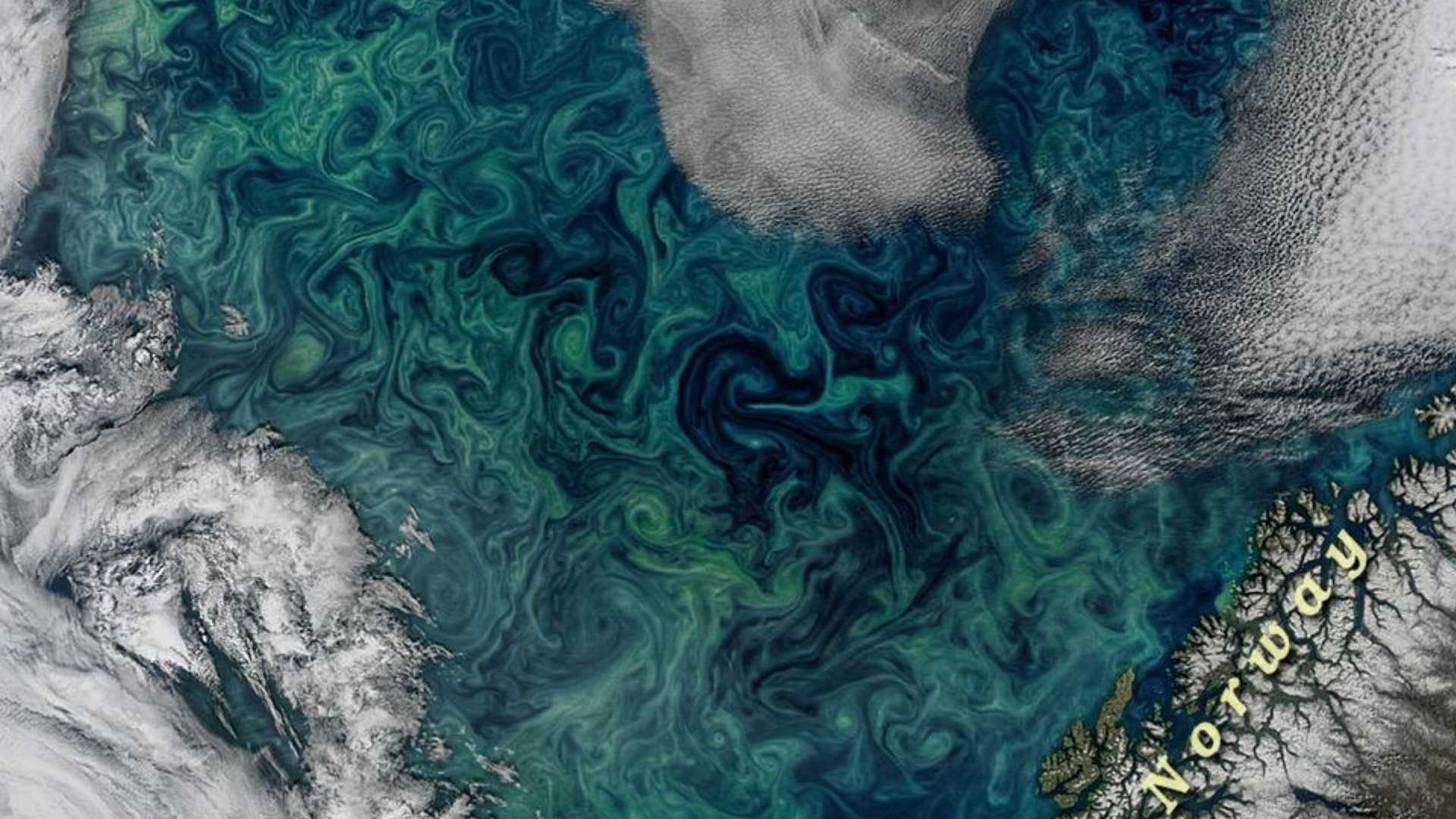
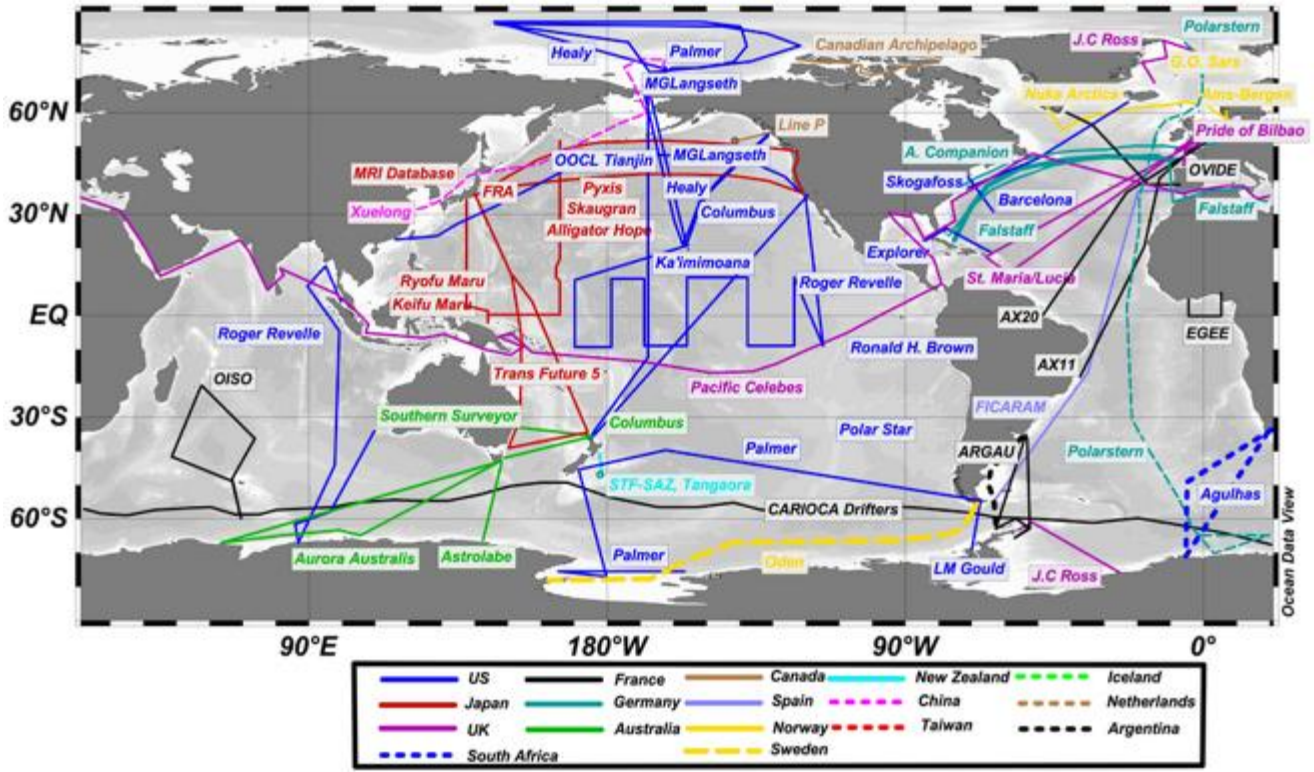
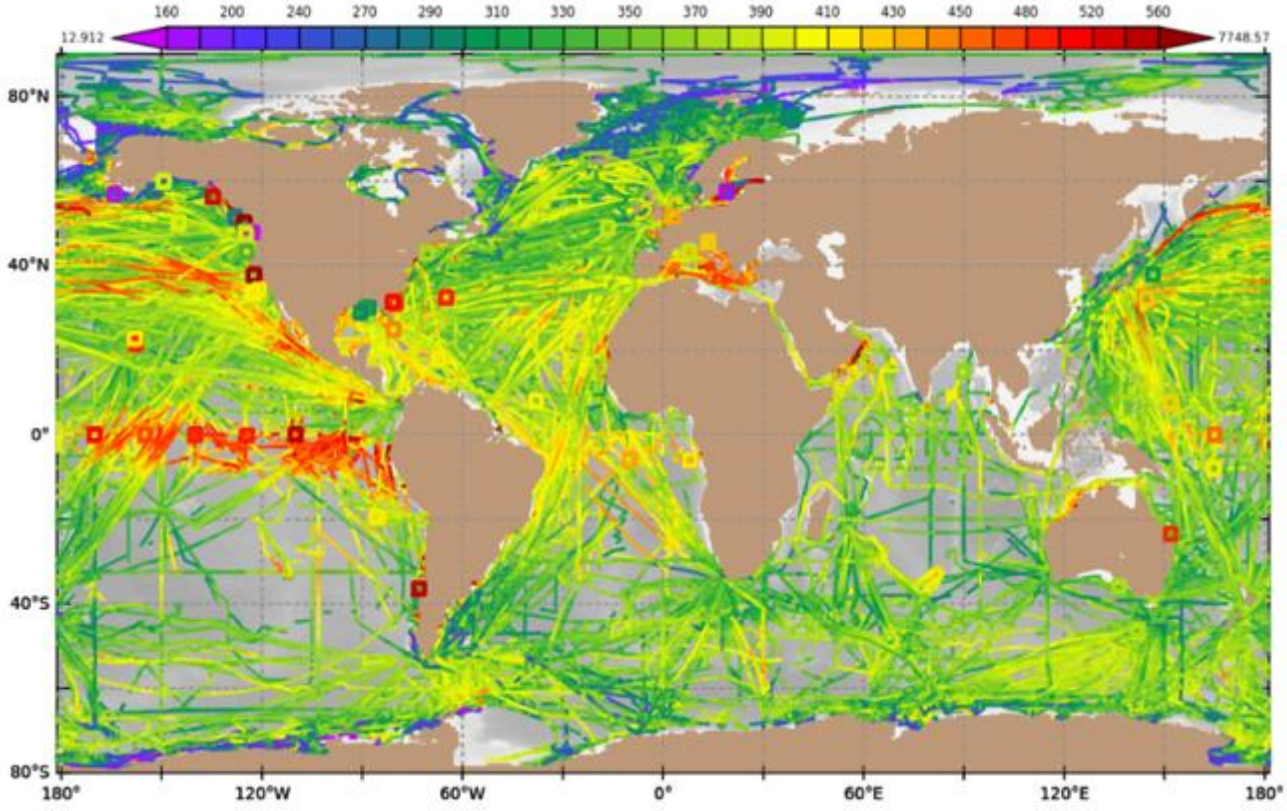

Norway

Global Network for marine CO_2 observations



Global data Collection

- Annualy updated
- 30.6 million quality controlled in situ surface ocean pCO_2 measurements
- Data collection has continued during the pandemic, albeit at a reduced rate



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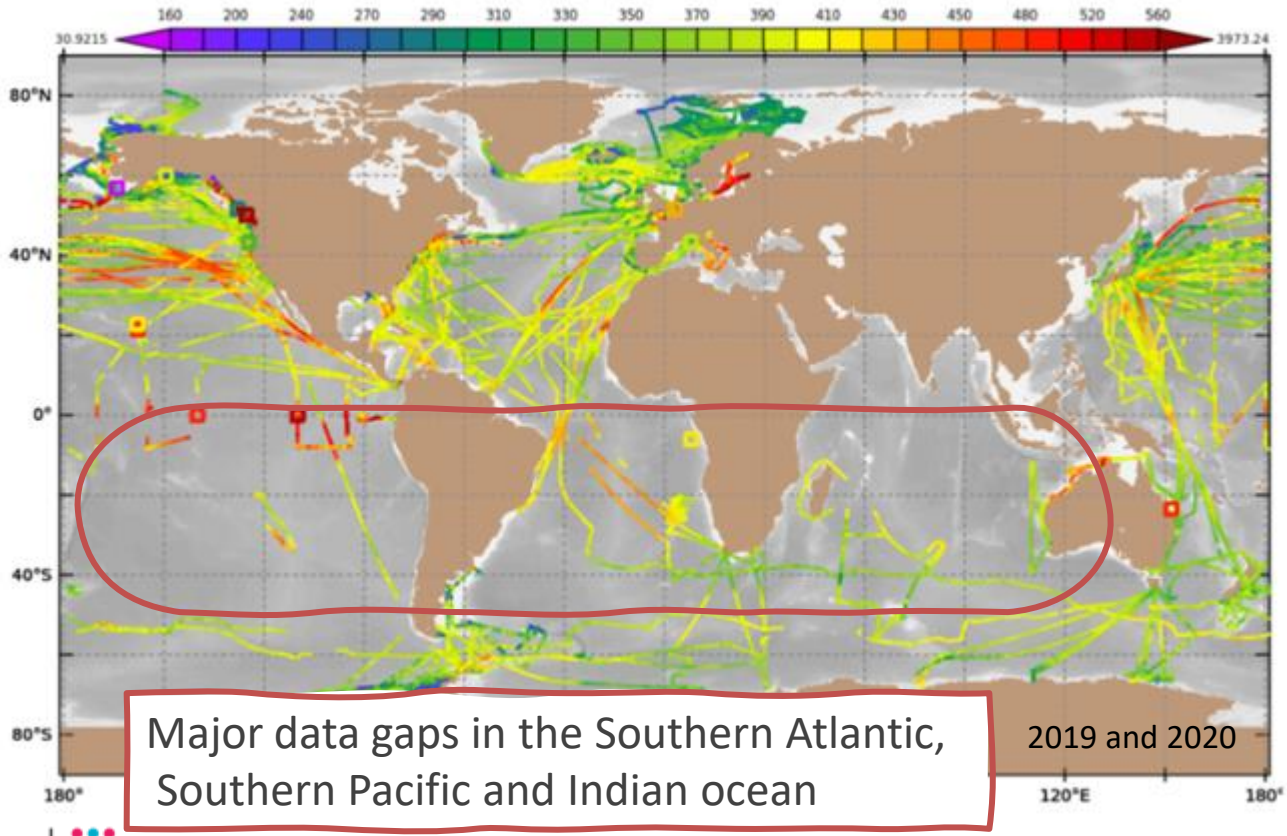

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The value chain of ocean CO_2 measurements

ICOS INTEGRATED CARBON OBSERVATION SYSTEM

SOCONET - SURFACE OCEAN CO2 OBSERVING NETWORK -

Guidi et al. (2020) Big Data in Marine Science. EMB Future Science Brief 6, doi:10.5281/zenodo.3755793

D. Bakker

There is still significant uncertainty related to the global carbon cycle.
- especially related to the mitigation scenarios

The oceans play a major role in taking up CO_2 from the atmosphere.

Is it important to understand how the oceans change with increasing CO_2 concentrations.

- Which effect will ocean acidification and increasing CO_2 content have on the marine ecosystems?
- How much CO_2 will the ocean take up in the future?

We cannot understand the effect of emission reduction measures without understanding the uptake and distribution of carbon in the ocean !

We need a good, global network for CO_2 observations !

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Do you have any questions?
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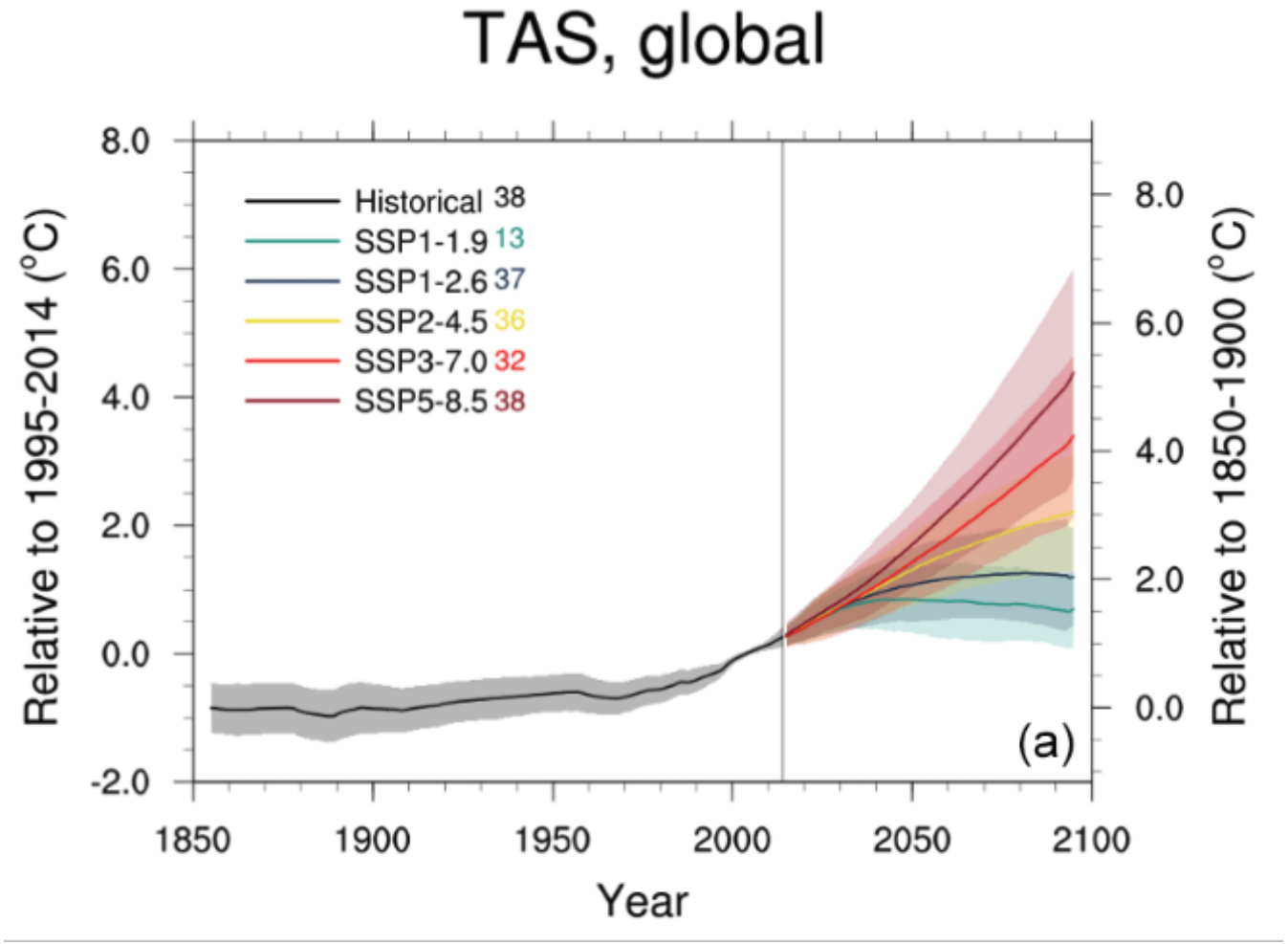
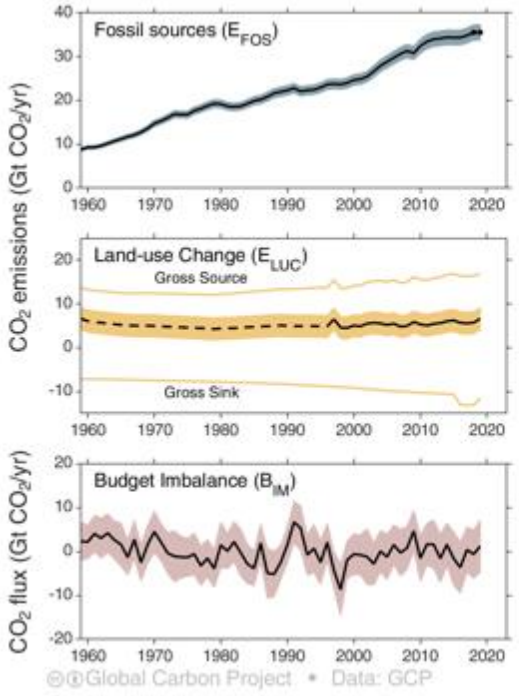


Tebaldi et al. 2021

Changes in the budget over time

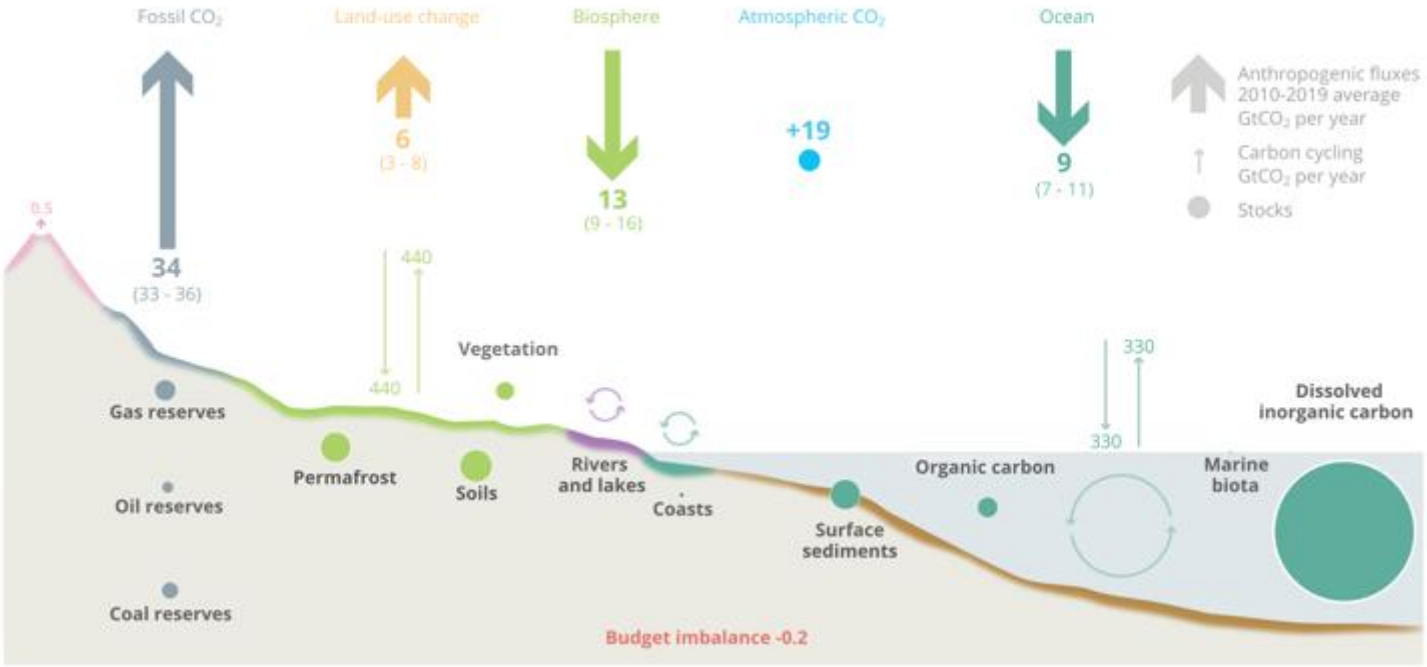
The sinks have continued to grow with increasing emissions, but climate change will affect carbon cycle processes in a way that will exacerbate the increase of CO_2 in the atmosphere



The budget imbalance is the total emissions minus the estimated growth in the atmosphere, land and ocean.
It reflects the limits of our understanding of the carbon cycle.
Source: Friedlingstein et al 2020; Global Carbon Budget 2020

Anthropogenic perturbation of the global carbon cycle

Perturbation of the global carbon cycle caused by anthropogenic activities, averaged globally for the decade 2010–2019 ($GtCO_2$/yr)



The budget imbalance is the difference between the estimated emissions and sinks.

Source: CDIAC; NOAA-ESRL; Friedlingstein et al 2020; Ciais et al. 2013; Global Carbon Budget 2020

Fate of anthropogenic CO_2 emissions (2010–2019)

Sources = Sinks

34.4 $GtCO_2$/yr

86%

14%

5.7 $GtCO_2$/yr

18.6 $GtCO_2$/yr

46%

31%

12.5 $GtCO_2$/yr

23%

9.2 $GtCO_2$/yr

Budget Imbalance:
(the difference between estimated sources & sinks)

0.4%

0.2 $GtCO_2$/yr

Source: Friedlingstein et al 2020; Global Carbon Budget 2020

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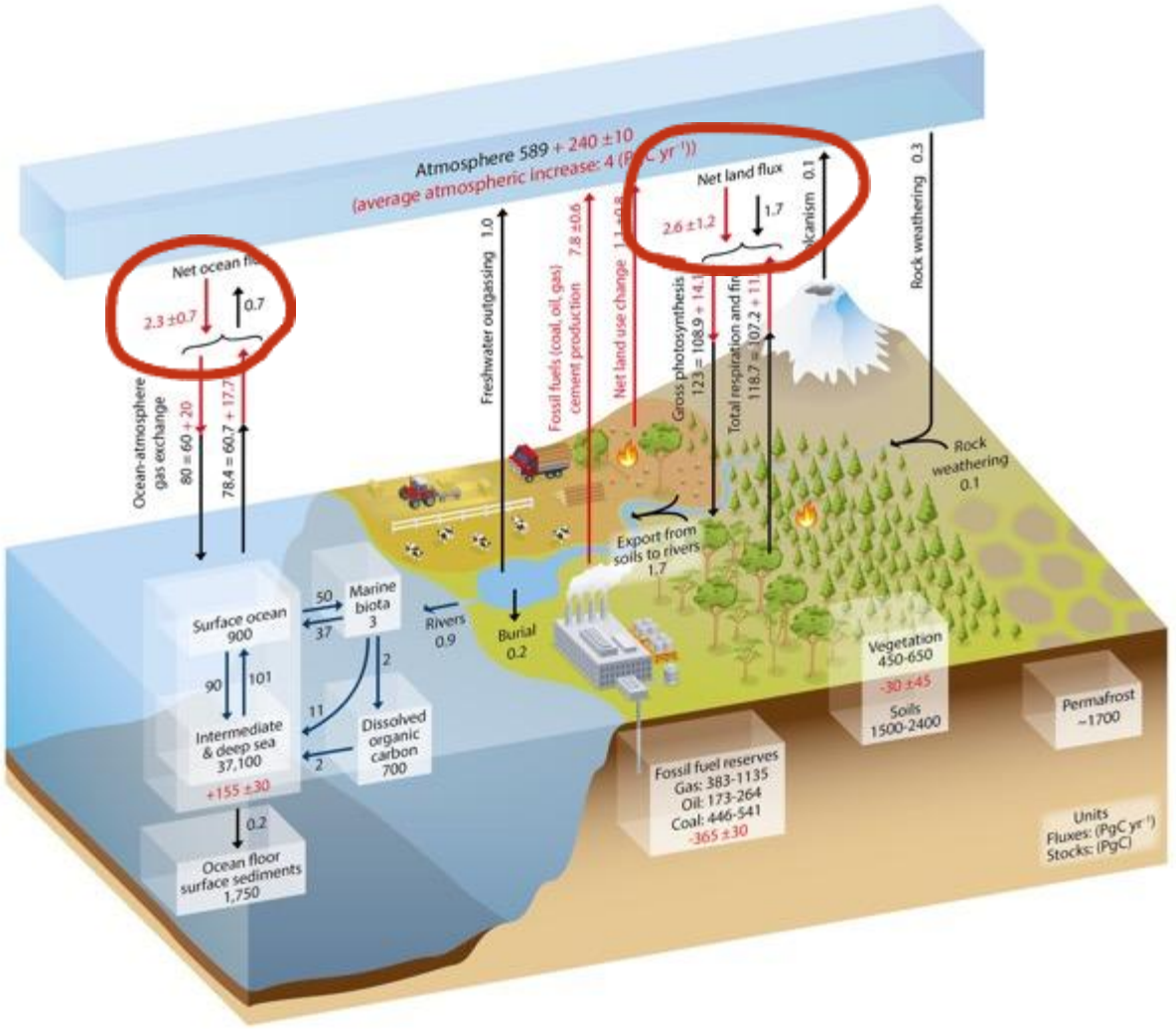

Geophysical Research Letters

RESEARCH LETTER
10.1029/2018GL080554

Wintertime fCO_2 Variability in the Subpolar North Atlantic Since 2004

Key Points:
- Subpolar North Atlantic winter surface ocean fCO_2 growth rates track the atmospheric CO_2 growth rate between 2004 and 2017
- DIC-driven fCO_2 changes are twice as large as expected from atmospheric trends in fCO_2, a result of substantial surface cooling

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