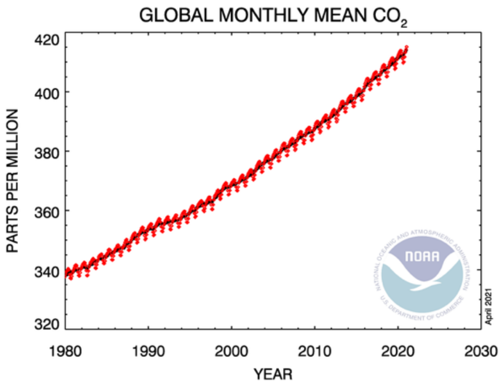
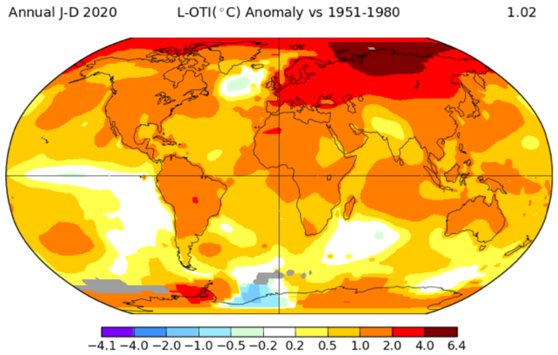
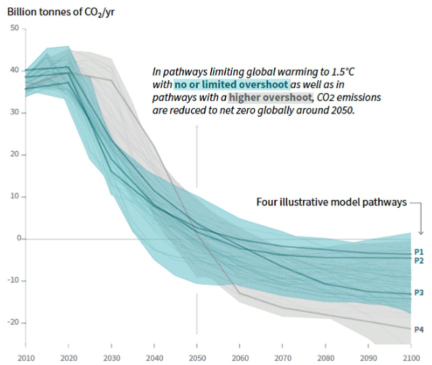






Forest Dynamics in the Anthropocene:

Reconciling Satellite and Model-Based Estimates of Forest Carbon Mitigation Potentials

Anders Ahlström, Peter Cox, Rosie Fisher, Lara Kueppers, and Ben Poulter
AGCI: James Arnott, Martin Bonzi, Emily Jack-Scott

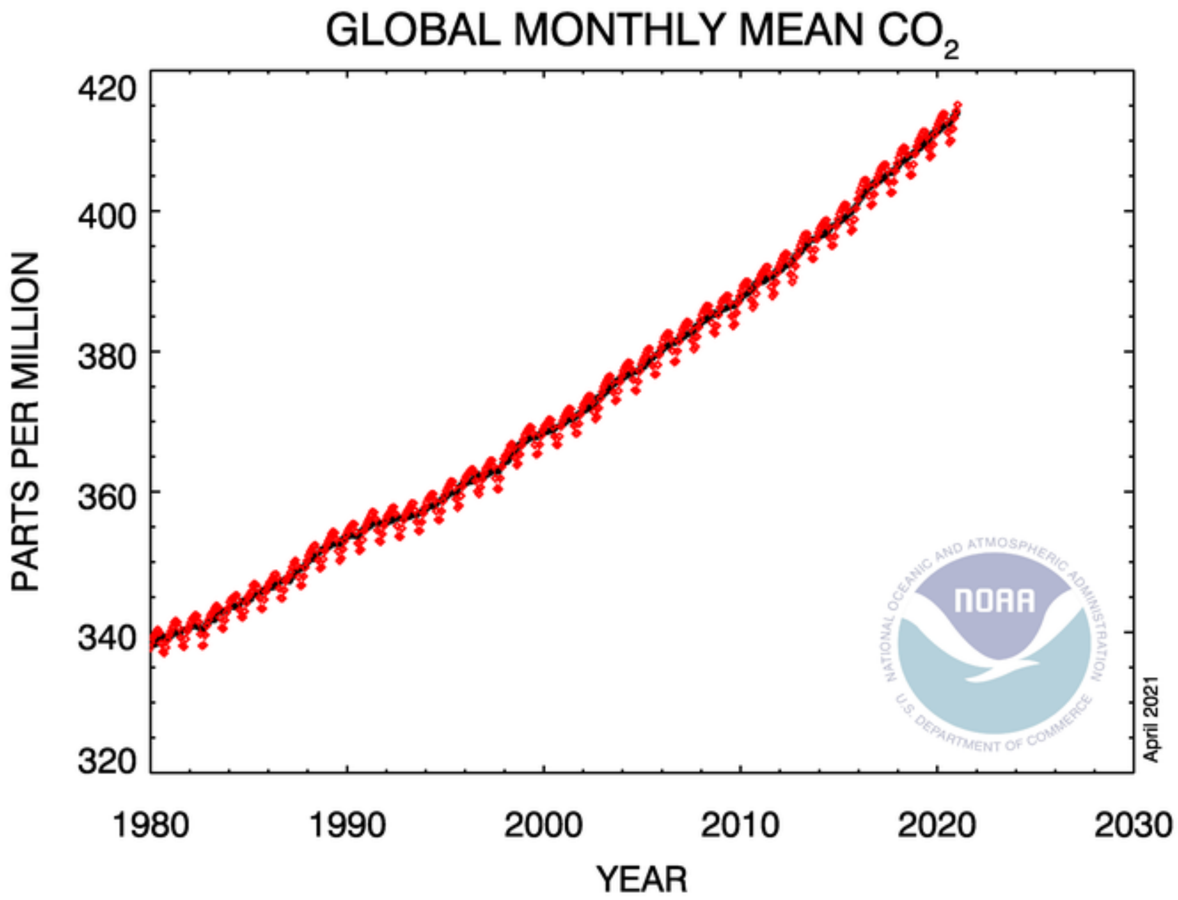
AGCI April 13-15, 2021

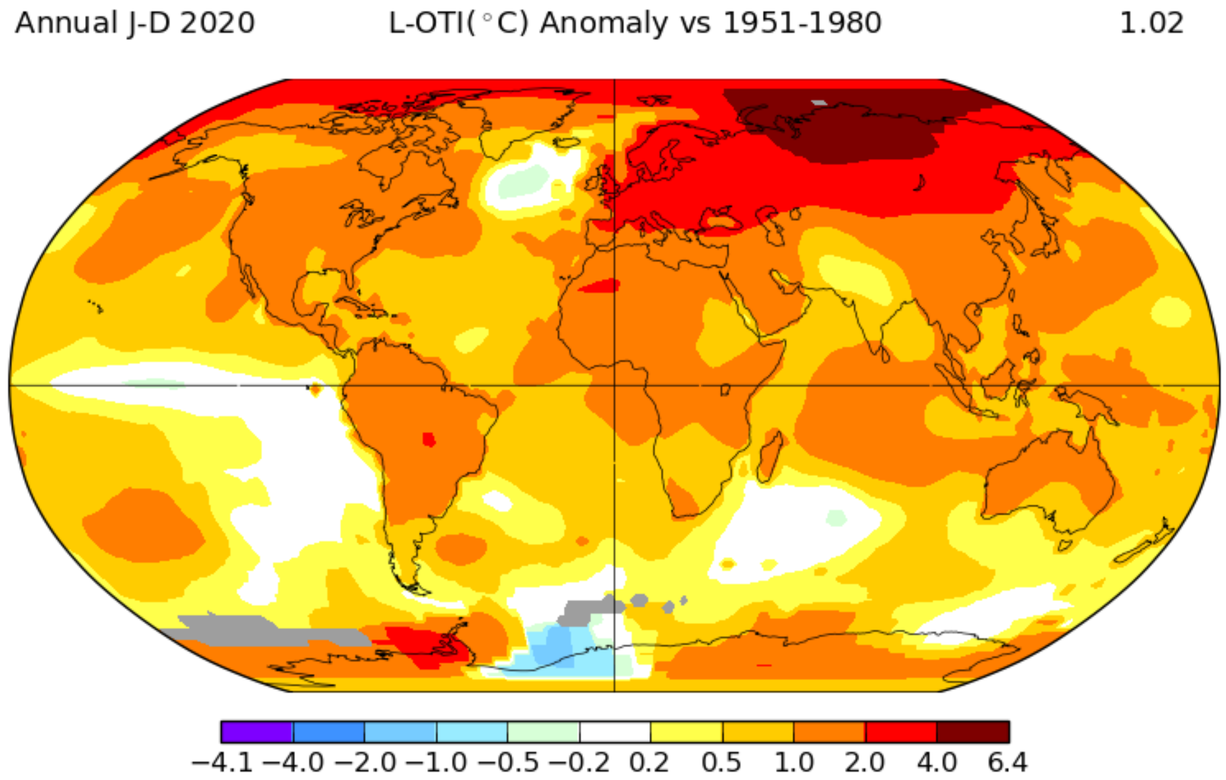
Thanks for joining the AGCI workshop:

Goals:

1. How much carbon can forests remove from atmosphere?
2. Why is the range of estimates so large?
3. What can be done to understand uncertainties and to better inform policy?

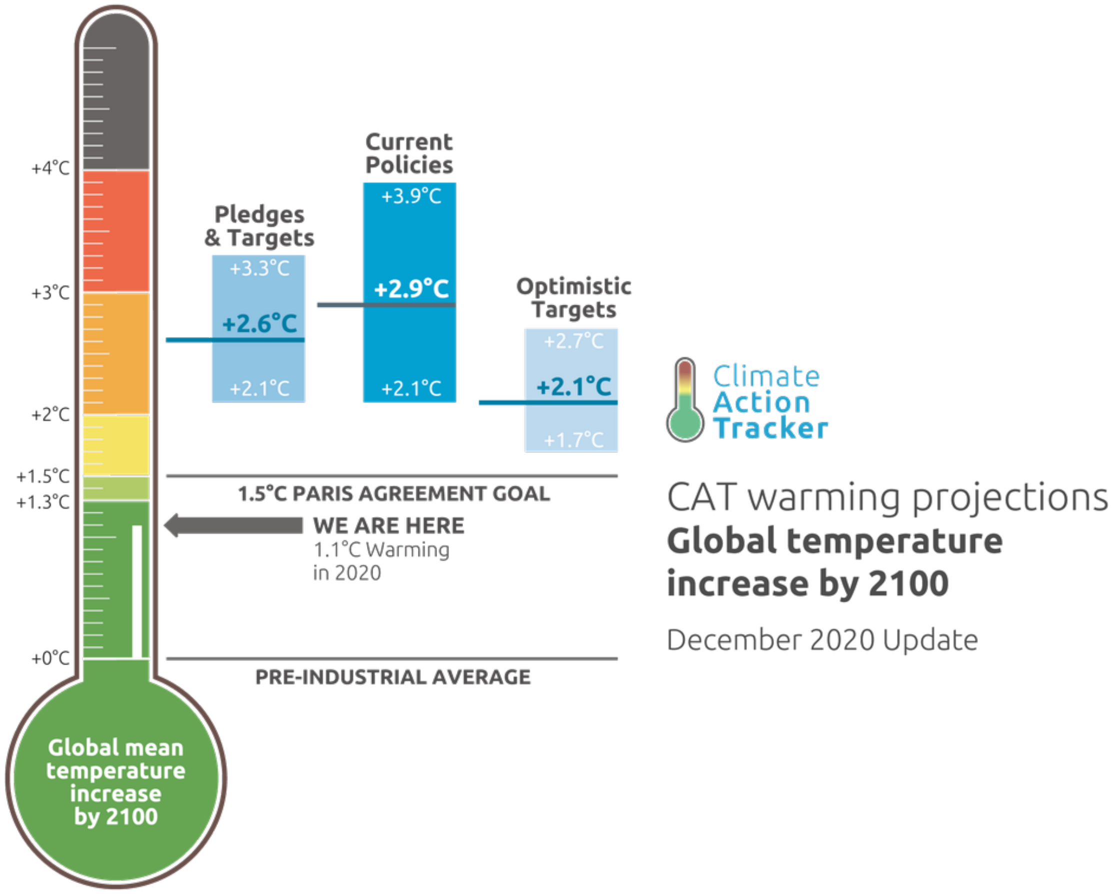
Setting the stage: Need for GHG attribution and climate impact studies

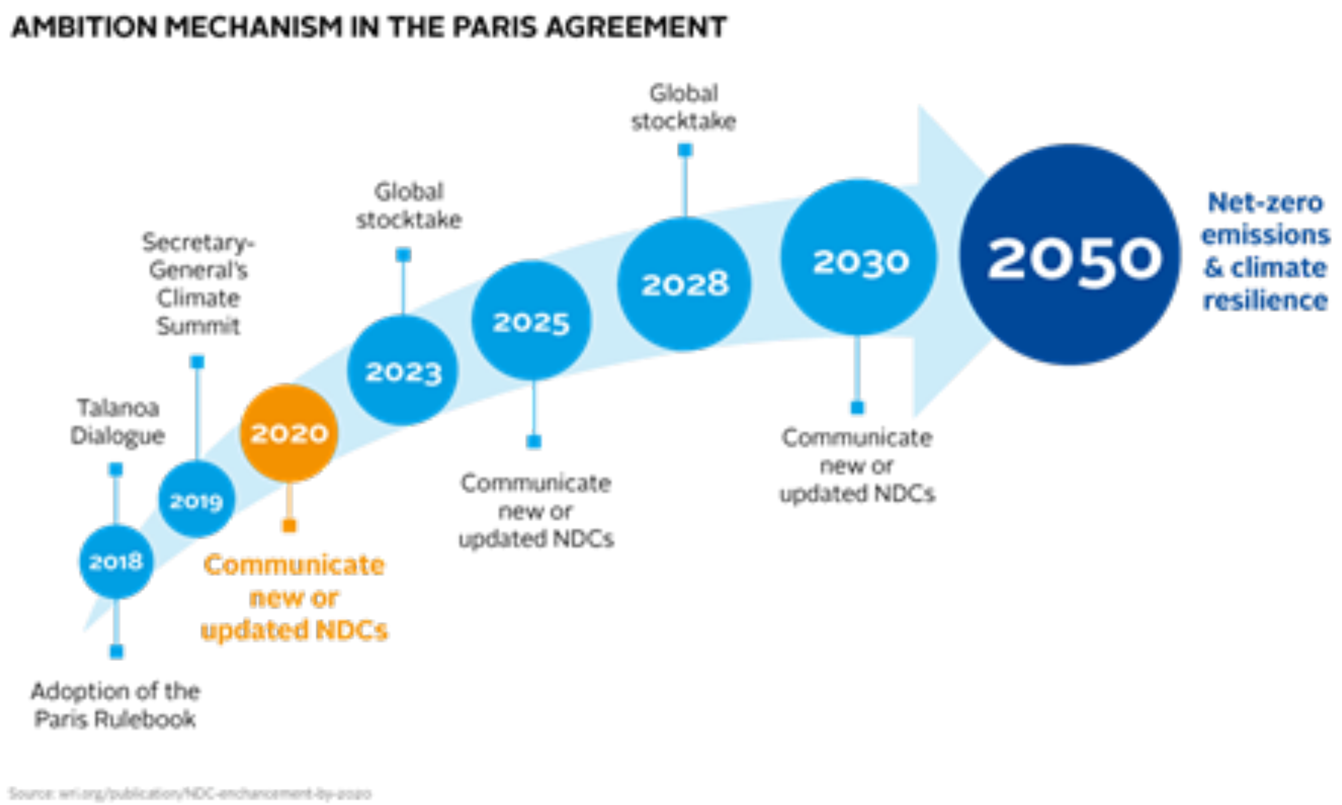




GISSTEMP

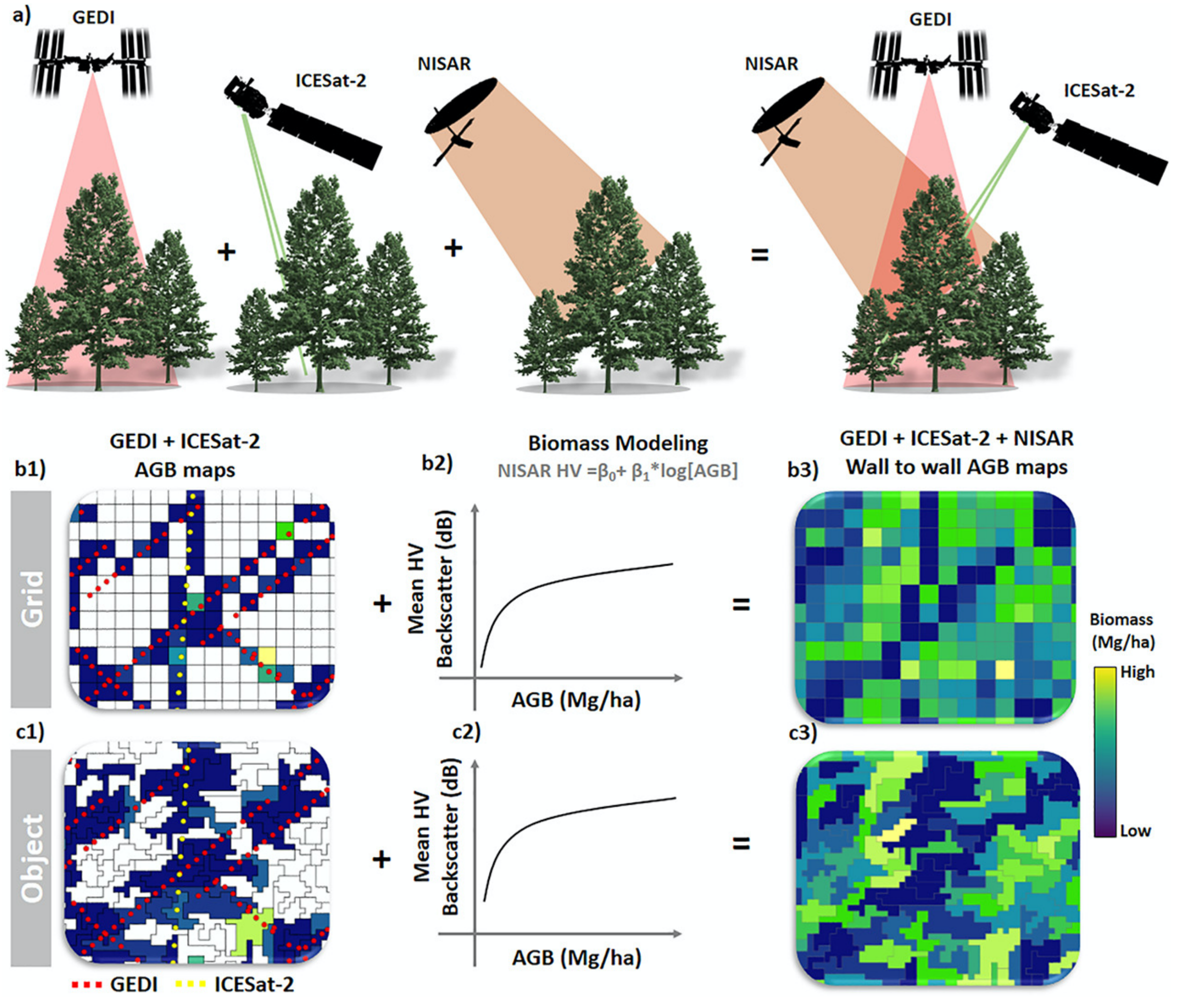
Setting the stage: Increasing pace for science to inform climate policy

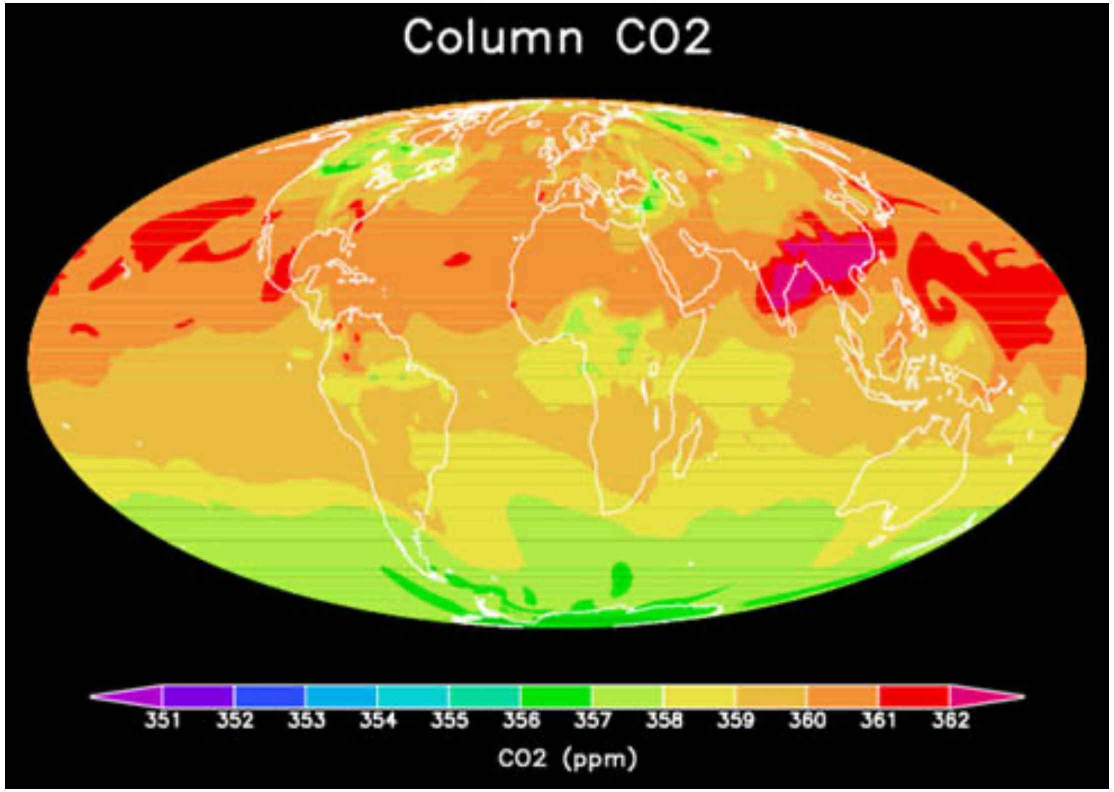




Setting the stage: New era in monitoring the Earth system: continuity, high-resolution, 3-dimensions, GHGs…

Setting the stage: New era in monitoring the Earth system: continuity, high-resolution, 3-dimensions, GHGs…



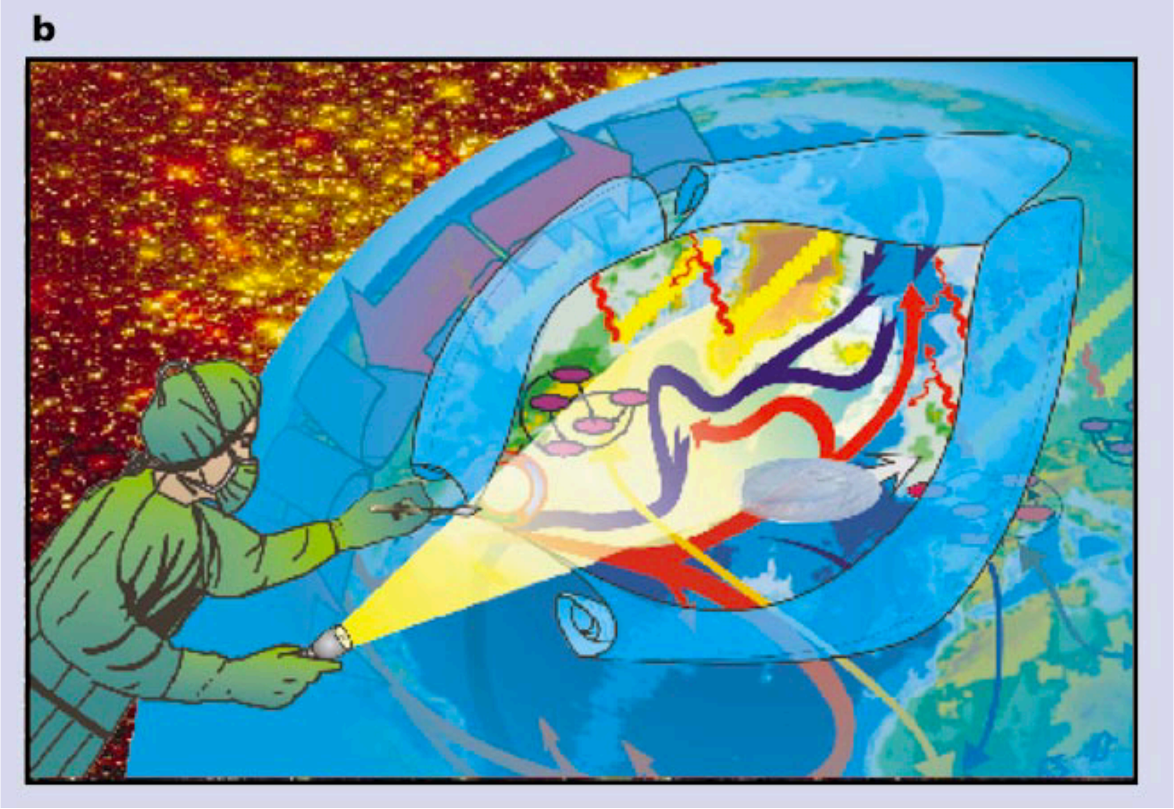


Silva et al., 2021

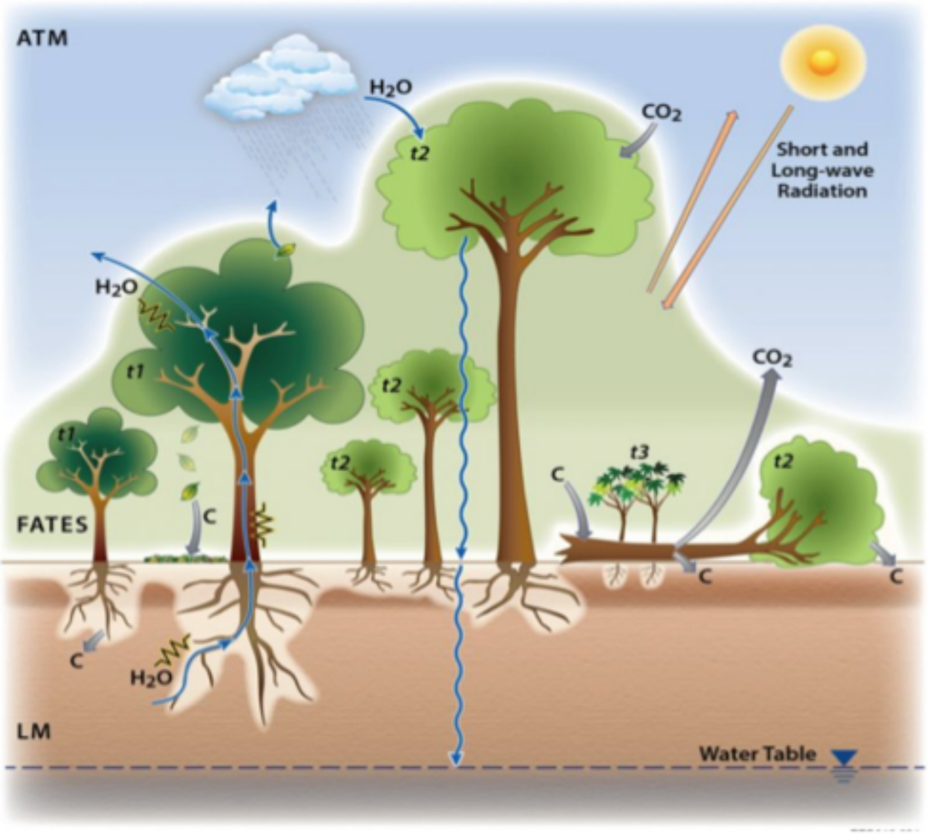
Has the second Copernican revolution arrived?

‘Earth system’ analysis
and the second Copernican revolution

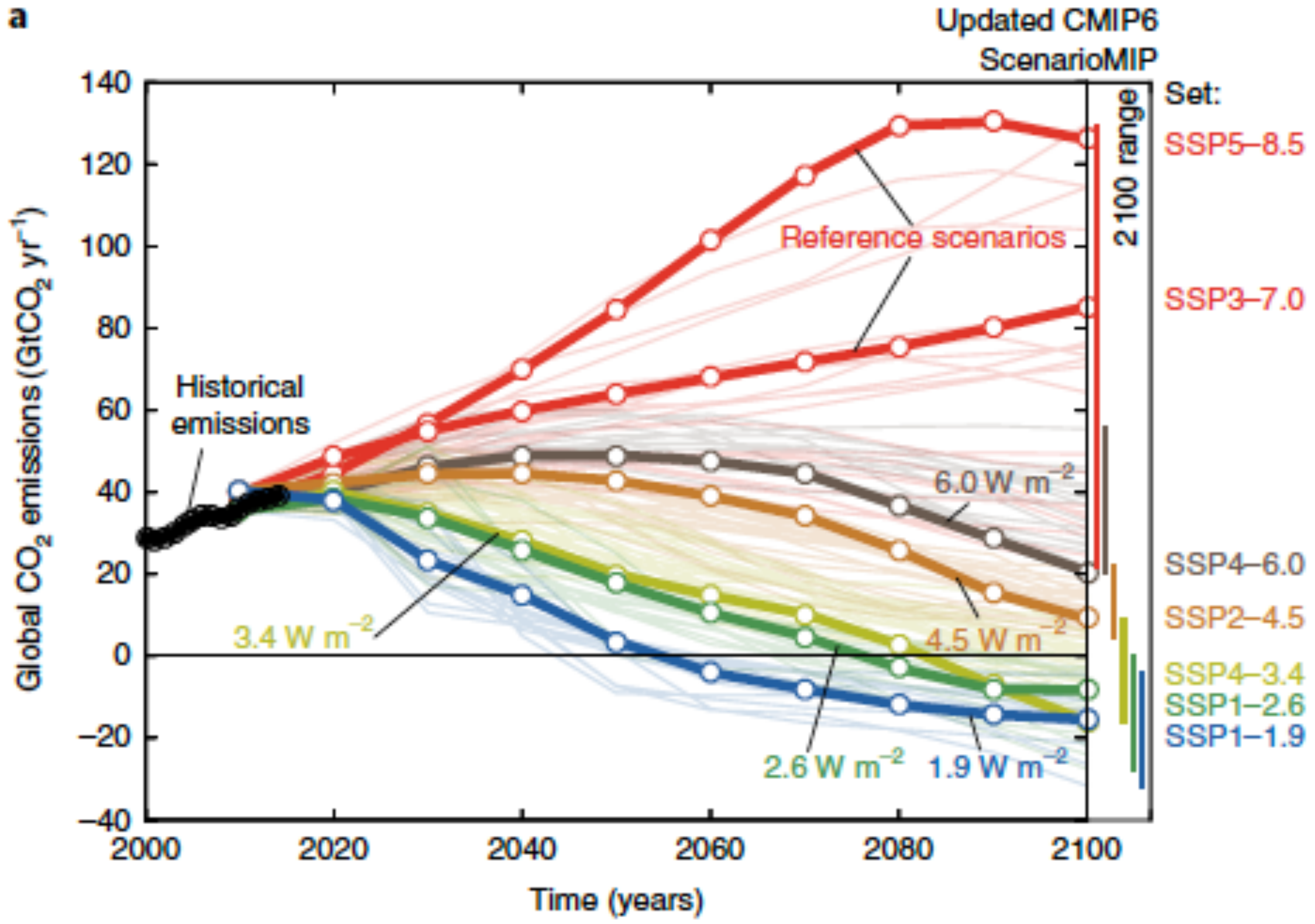
H. J. Schellnhuber



e.g., new land-surface models with demography (ED, FATES, ORCHIDEE-CAN)

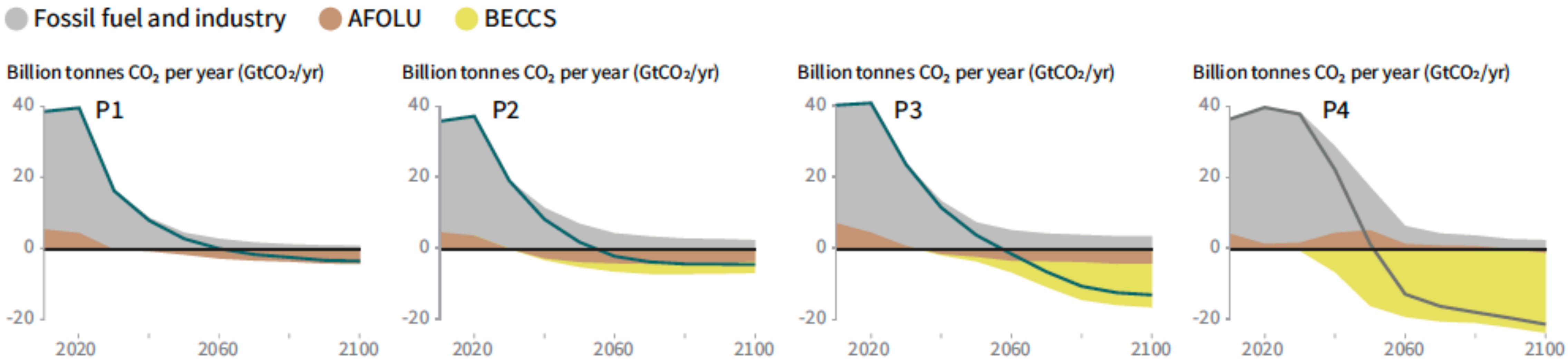


Applying measurements and models to inform climate mitigation



Rogelj et al., 2018

Applying measurements and models to inform climate mitigation



P1: A scenario in which social, business and technological innovations result in lower energy demand up to 2050 while living standards rise, especially in the global South. A downsized energy system enables rapid decarbonization of energy supply. Afforestation is the only CDR option considered; neither fossil fuels with CCS nor BECCS are used.

P2: A scenario with a broad focus on sustainability including energy intensity, human development, economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption patterns, low-carbon technology innovation, and well-managed land systems with limited societal acceptability for BECCS.

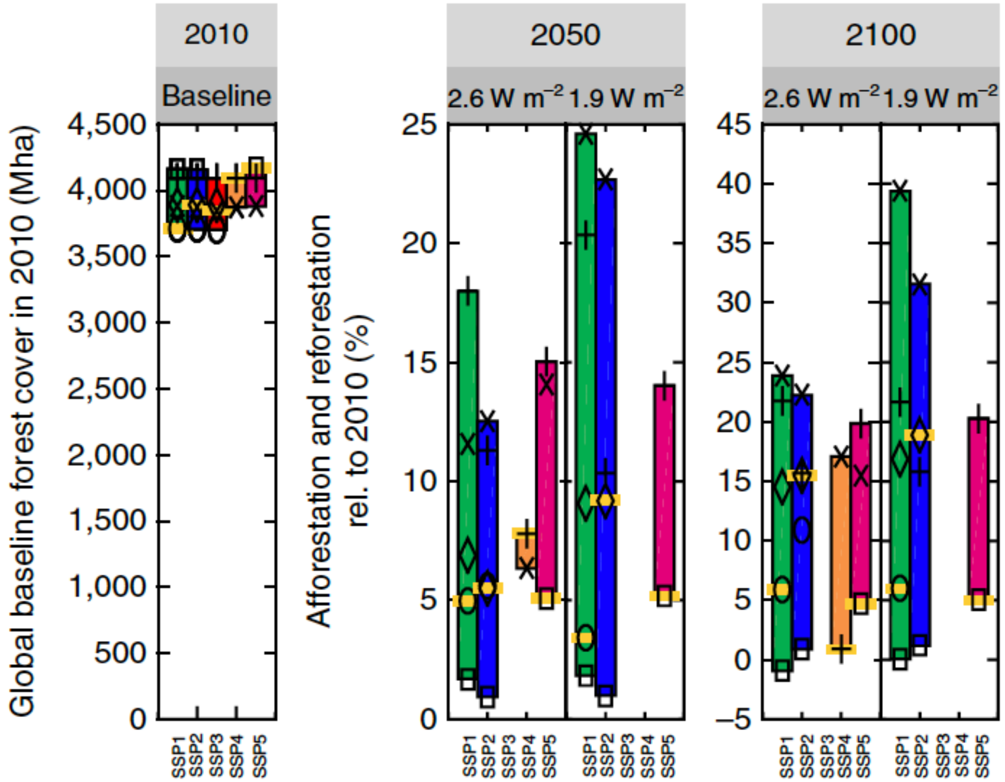
P3: A middle-of-the-road scenario in which societal as well as technological development follows historical patterns. Emissions reductions are mainly achieved by changing the way in which energy and products are produced, and to a lesser degree by reductions in demand.

P4: A resource- and energy-intensive scenario in which economic growth and globalization lead to widespread adoption of greenhouse-gas-intensive lifestyles, including high demand for transportation fuels and livestock products. Emissions reductions are mainly achieved through technological means, making strong use of CDR through the deployment of BECCS.

IPCC SRCCL 2019

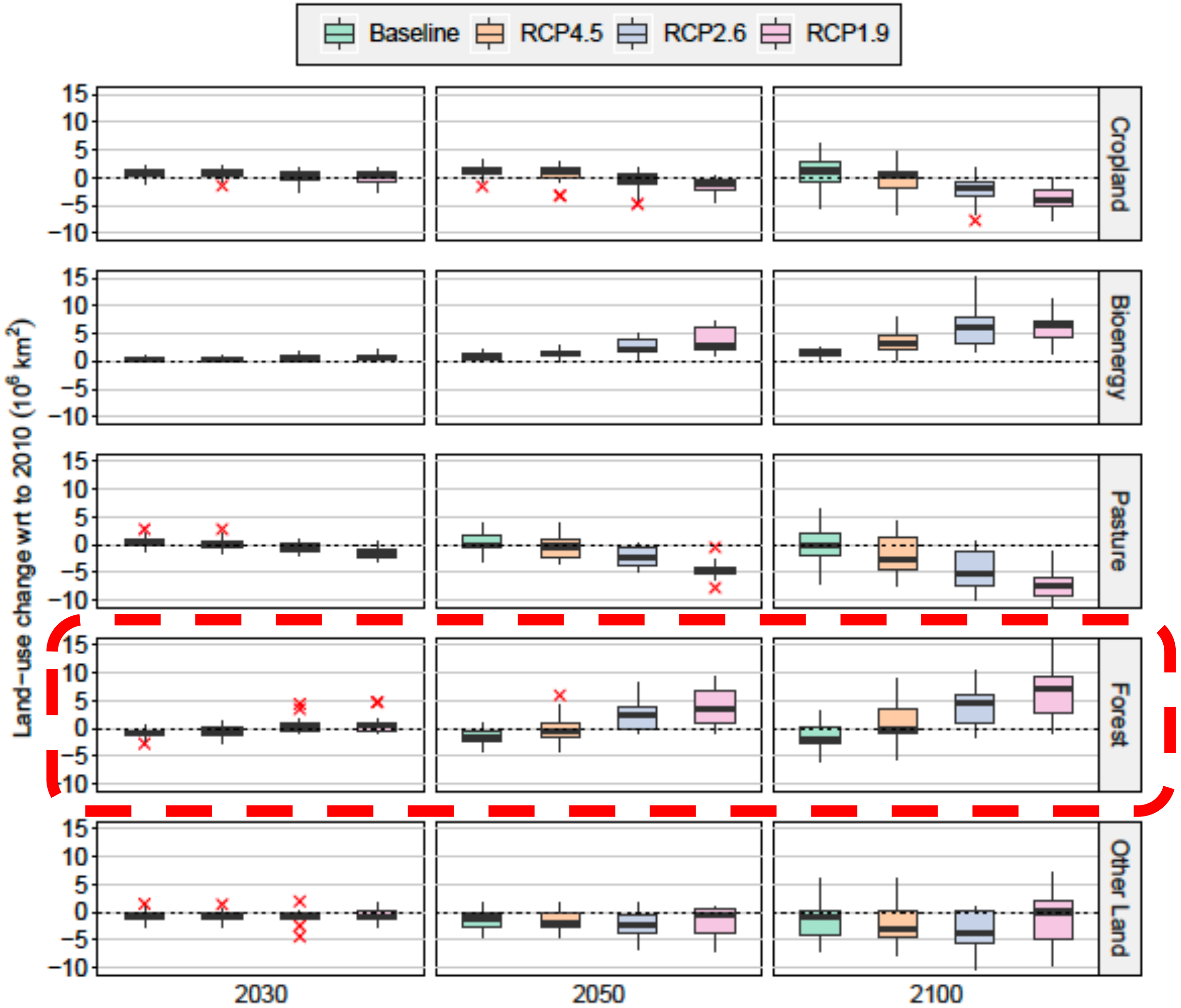
Applying measurements and models to inform climate mitigation

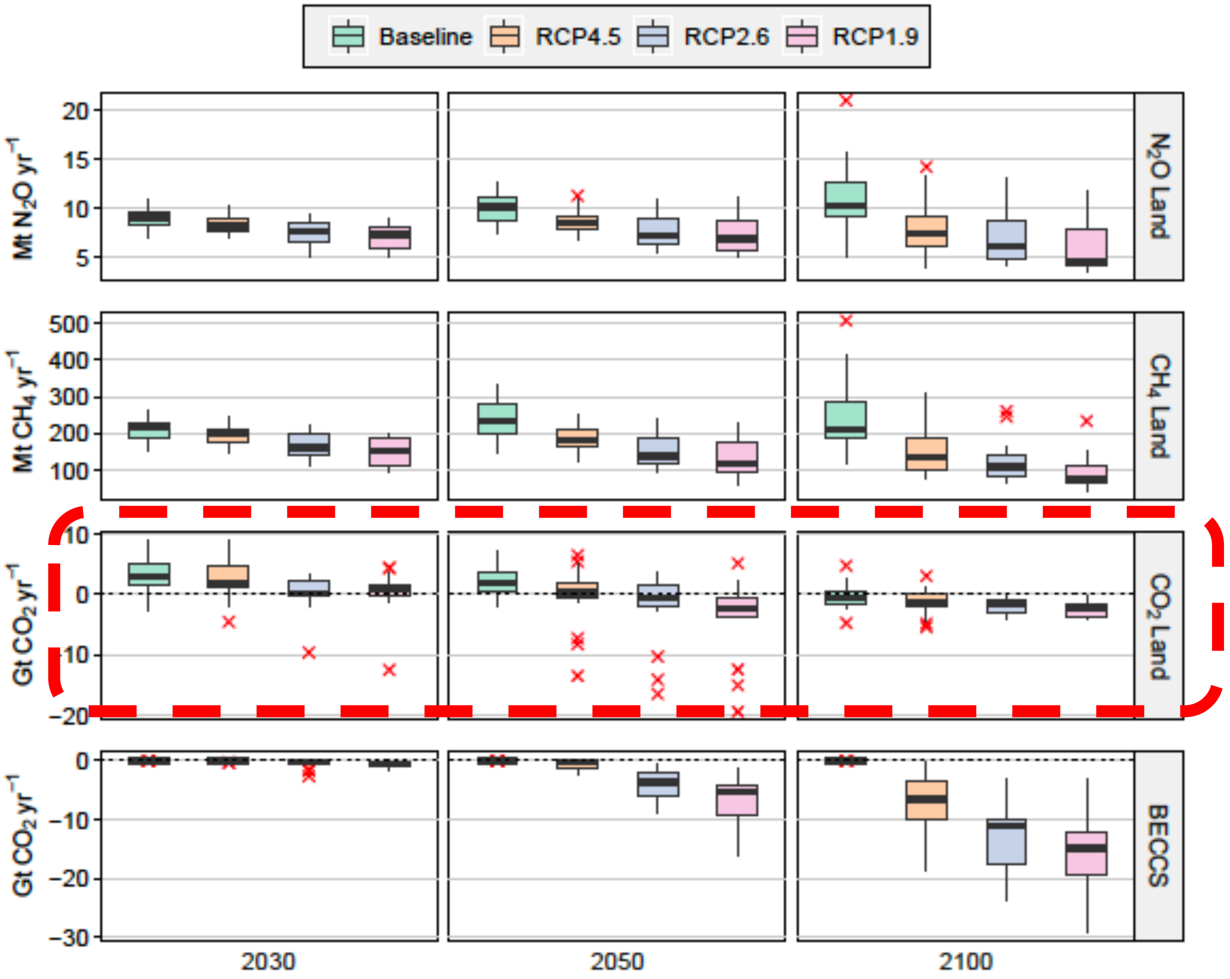
- **RCP1.9 : limits cumulative emissions to -175 to 475 $GtCO_2$**
  - Would increase forest area by 24% (SSP1), 2-18% (SSP2), 0-16% (SSP5) – up to 7200 Mha by 2100
  - Cumulative re/afforestation of 128 $GtCO_2$ ‘low residual’, 117 $GtCO_2$ ‘increased ambition’, 428 $GtCO_2$ ‘early CDR’
    - Forest removal rate of 1.3 to 2.4 $GtCO_2$ yr^{-1}



IPCC SRCCL 2019

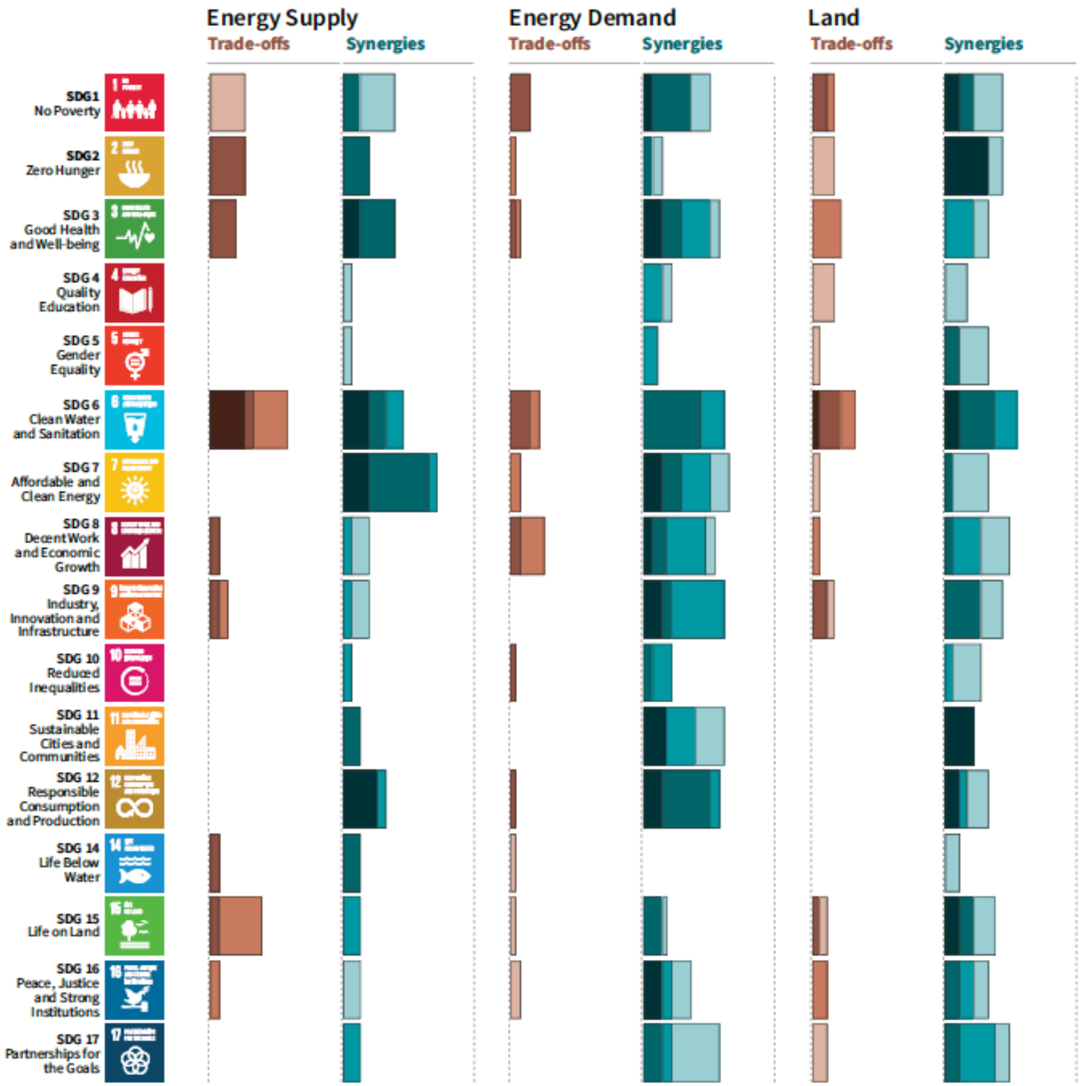
Applying measurements and models to inform climate mitigation





IPCC SRCCL 2019

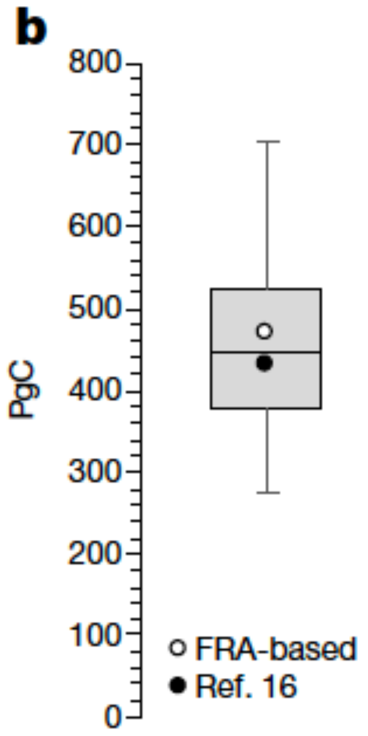
Natural Climate Solutions come at a cost – with trade-offs on almost all SDGs



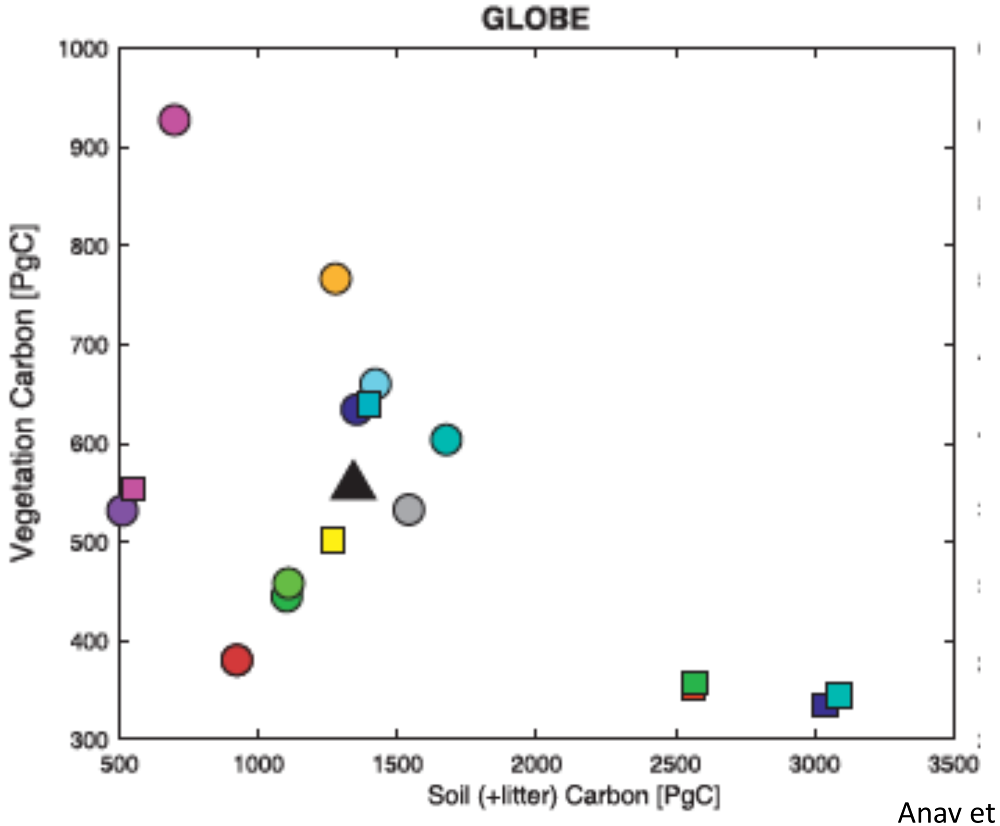
IPCC SRCCL 2019

Putting science to practice – current forest biomass estimates vary by 50%

- Current global biomass estimates range from 380 to 536 PgC
- For CMIP5 models; vegetation carbon range from 360 to 684 PgC
- Potential biomass planet could support, 770-1100 PgC (Erb et al., 2107)

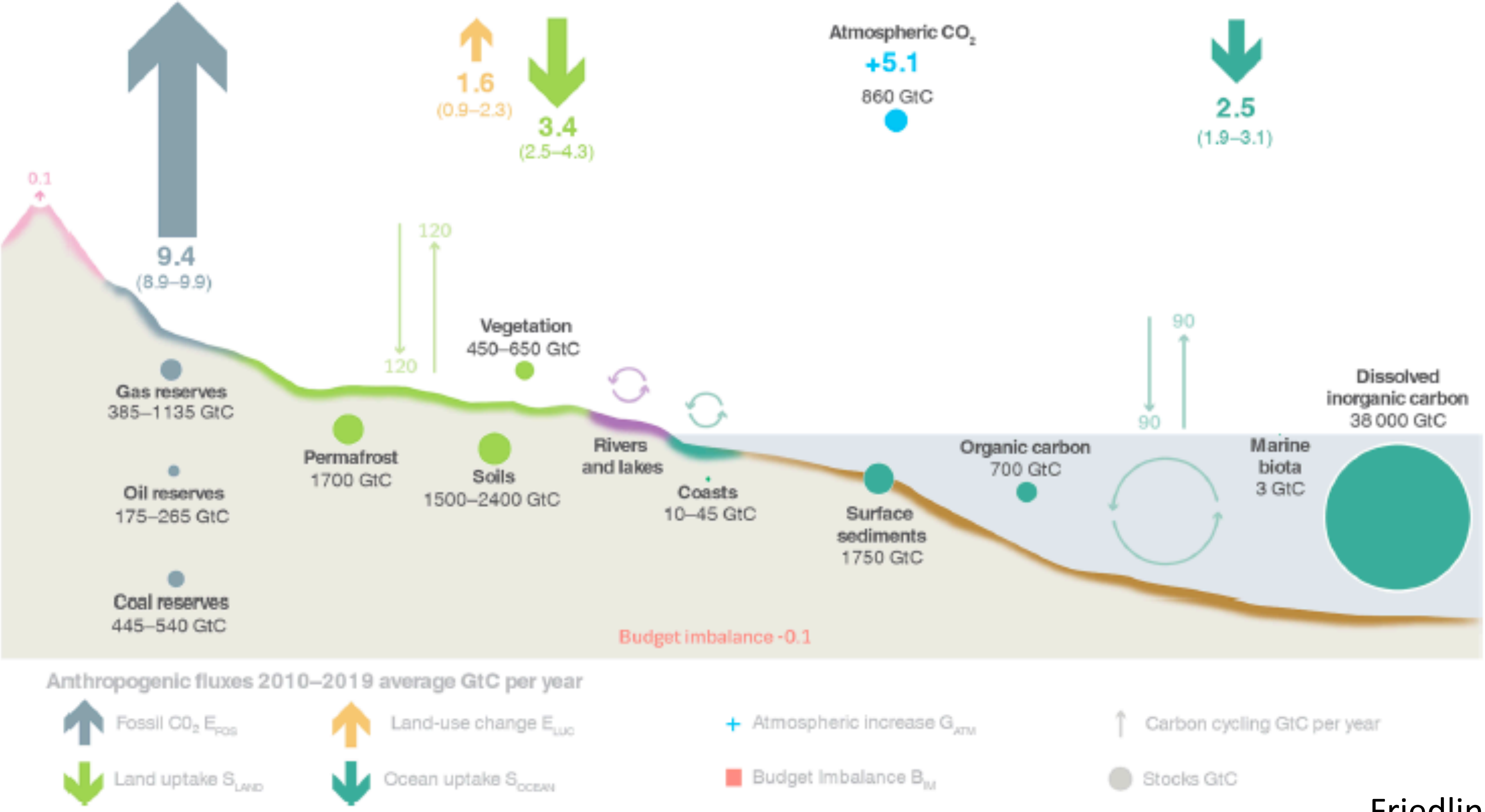


Erb et al., 2017



Anav et al., 2013

Each year, terrestrial ecosystems remove ~30% of CO_2 emissions (12.5±3.3 $GtCO_2\ yr^{-1}$)



Friedlingstein et al., 2020

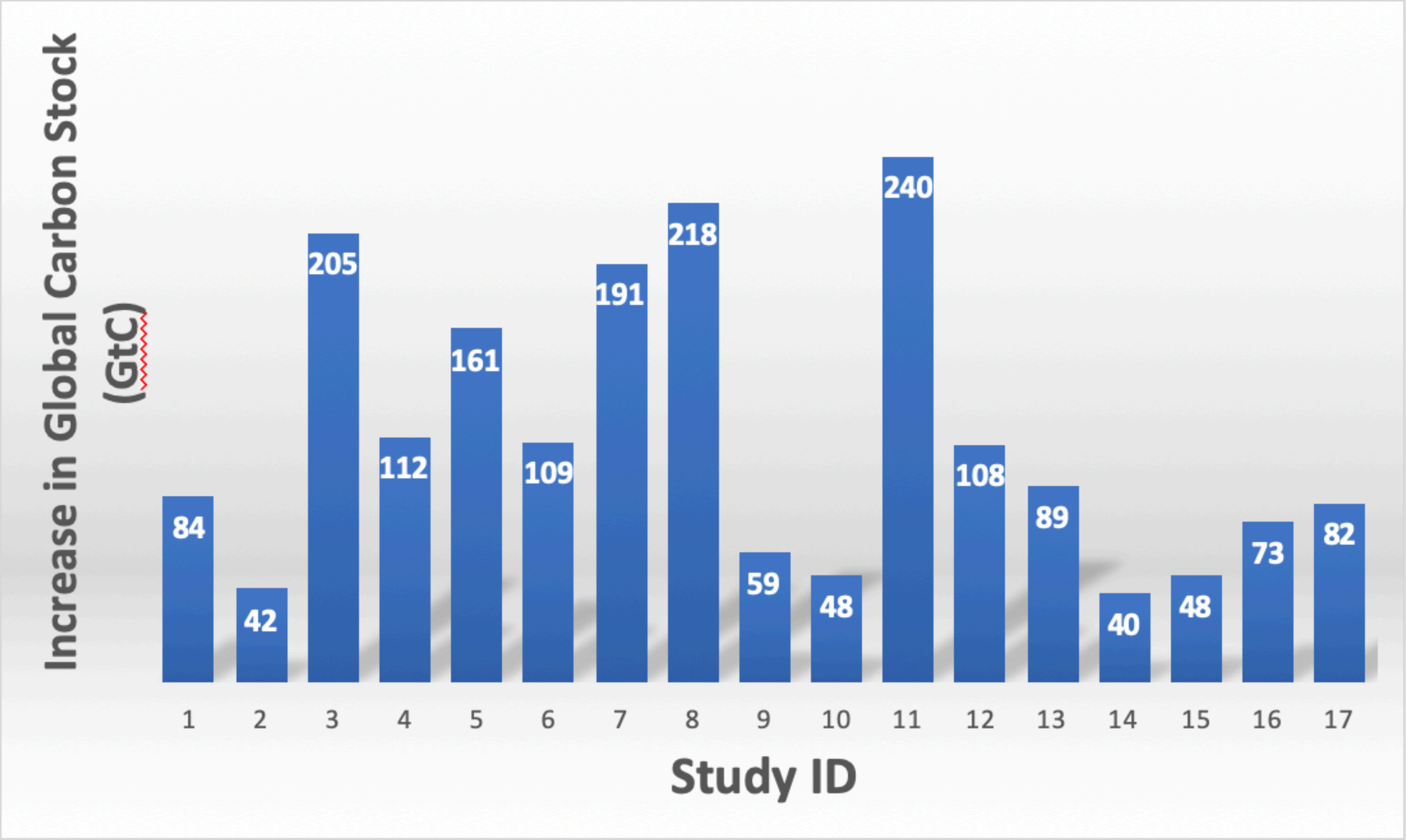
Historic CO_2 emissions from land-use change on order of 255±70 GtC or 935±256 $GtCO_2$

- Land-use change emissions are responsible for 36% of CO_2 to atmosphere since 1750

	1750–2019	1850–2014	1959–2019	1850–2019	1850–2020[a]
Emissions					
Fossil CO_2 emissions (E_{FOS})	445 ± 20	395 ± 20	365 ± 20	445 ± 20	455 ± 20
Land-use change CO_2 emissions (E_{LUC})	255 ± 70[b]	200 ± 60[c]	85 ± 45[d]	210 ± 60[c]	210 ± 60
Total emissions	700 ± 75	595 ± 65	450 ± 50	650 ± 65	665 ± 65
Partitioning					
Growth rate in atmospheric CO_2 concentration (G_{ATM})	285 ± 5	235 ± 5	205 ± 5	265 ± 5	270 ± 5
Ocean sink (S_{OCEAN})[e]	170 ± 20	145 ± 20	105 ± 20	160 ± 20	165 ± 20
Terrestrial sink (S_{LAND})	230 ± 60	195 ± 50	145 ± 35	210 ± 55	215 ± 55
Budget imbalance					
$B_{IM} = E_{FOS} + E_{LUC} - (G_{ATM} + S_{OCEAN} + S_{LAND})$	20	20	0	20	20

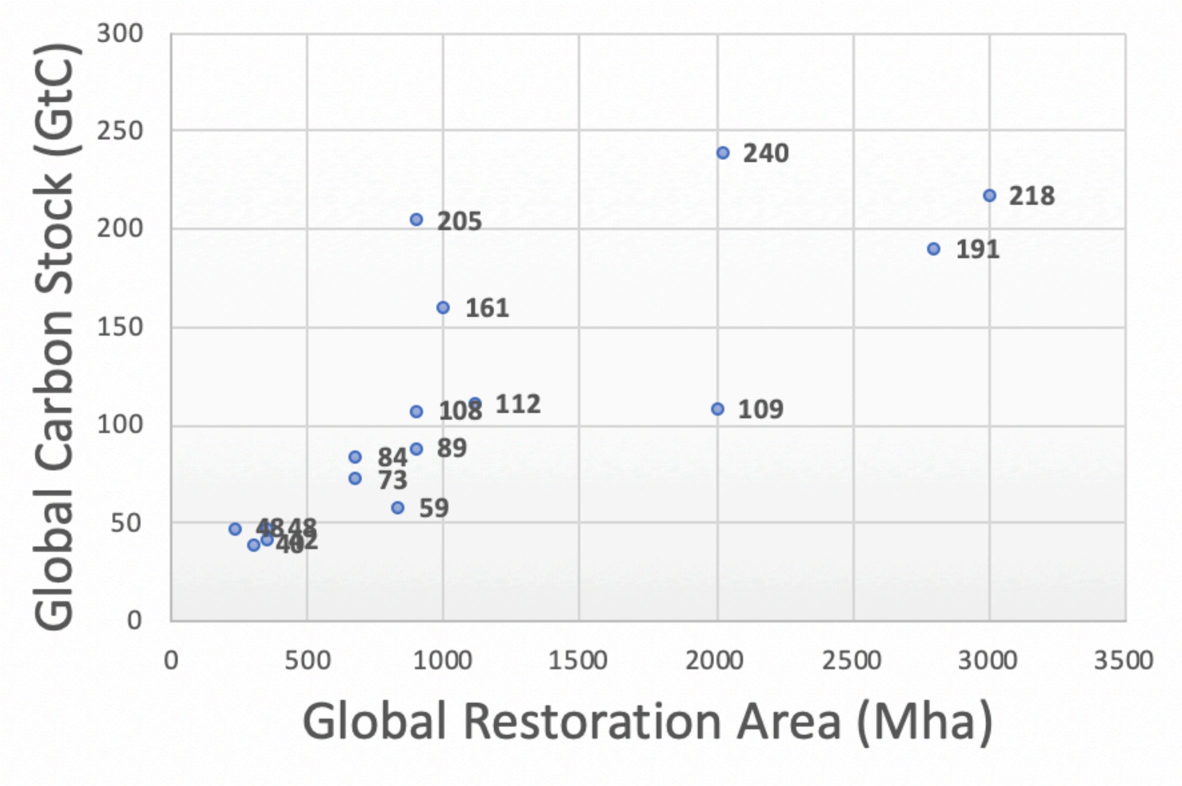
Friedlingstein et al., 2020

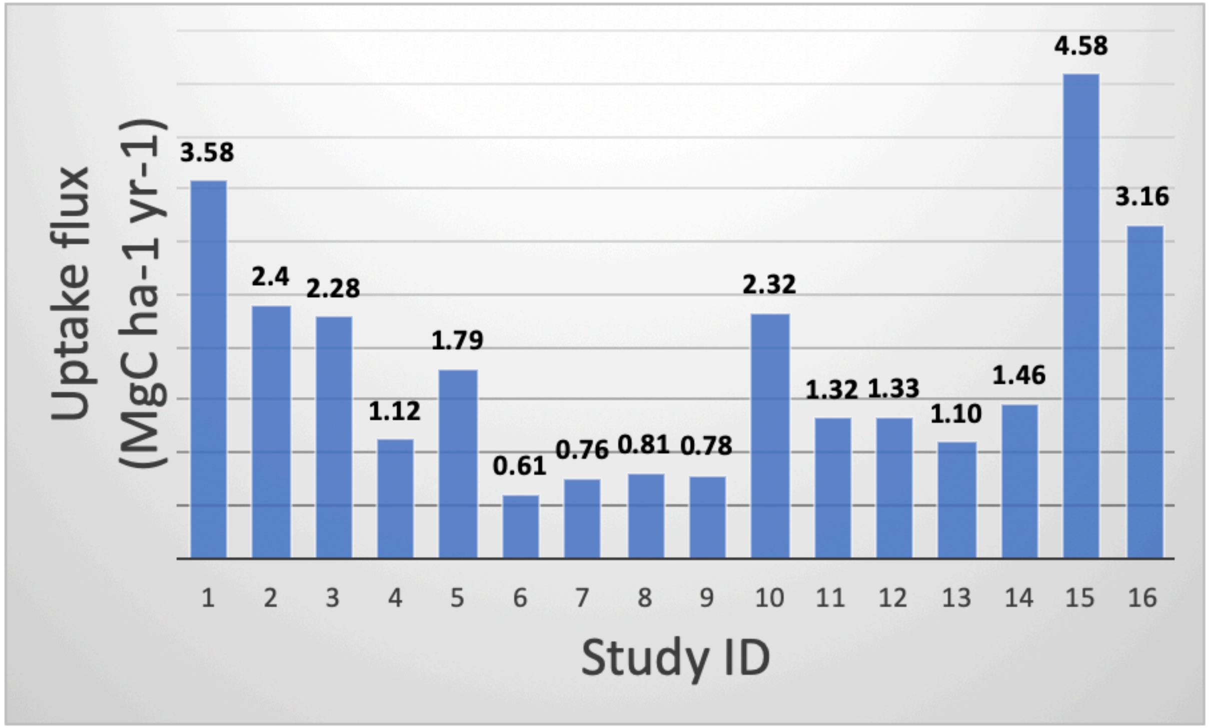
Reforestation and afforestation estimated to increase biomass by 40 to 240 PgC by 2100



Griscom (2017), Lewis (2019), Bastin (2019), Doelman (2020), Calvin (2014), Humpenoder (2014), Fricko (2017), Sathaye (2006), Arora (2011), Lewis (2019), Veldman (2019), Cook-Patton (2019), Strassburg (2020) & more

Goal of workshop to understand why: methodology, prioritization, time frames, etc.





Goal of workshop is to highlight 'best practices' for Natural Carbon Solutions…

RESEARCH | REPORT

RESTORATION ECOLOGY

The global tree restoration potential

Jean-Francois Bastin[1]*, Yelena Finegold[2], Claude Garcia[3,4], Danilo Mollic
Marcelo Rezende[2], Devin Routh[1], Constantin M. Zohner[1], Thomas W. Crov

The restoration of trees remains among the most effective strategies for clim
mitigation. We mapped the global potential tree coverage to show that 4.4 b
of canopy cover could exist under the current climate. Excluding existing tr
agricultural and urban areas, we found that there is room for an extra 0.9 b
of canopy cover, which could store 205 gigatonnes of carbon in areas that wo
support woodlands and forests. This highlights global tree restoration as our r
climate change solution to date. However, climate change will alter this poten
coverage. We estimate that if we cannot deviate from the current trajectory, tl
potential canopy cover may shrink by ~223 million hectares by 2050, with the
of losses occurring in the tropics. Our results highlight the opportunity of clim
mitigation through global tree restoration but also the urgent need for action.

Science

TECHNICAL COMMENTS

Cite as: S. L. Lewis *et al.*, *Science* 10.1126/science.aaz0388 (2019).

Comment on "The global tree restoration potential"

Simon L. Lewis[1,2]*, Edward T. A. Mitchard[3], Colin Prentice[4], Mark Maslin[1], Ben Poulter[5]

[1]Department of Geography, University College London, London WC1E 6BT, UK. [2]School of Geography, University of Leeds, Leeds LS2 9JT, UK. [3]School of GeoSciences, University of Edinburgh, Edinburgh EH9 3FF, UK. [4]Department of Life Science, Imperial College, Ascot, Berks SL5 7PY, UK. [5]NASA Goddard Space Flight Center, Greenbelt, MD, USA.

*Corresponding author. Email: s.l.lewis@leeds.ac.uk

Bastin *et al.* (Reports, 5 July 2019, p. 76) state that the restoration potential of new forests globally is 205 gigatonnes of carbon, conclude that "global tree restoration is our most effective climate change solution to date," and state that climate change will drive the loss of 450 million hectares of existing tropical forest by 2050. He

Science

Comment on "The global tree restoration pote

Alan Grainger[1]*, Louis R. Iverson[2], Gregg H. Marland[3], Anantha Prasad[2]

[1]School of Geography, University of Leeds, Leeds LS2 9JT, UK. [2]U.S. Forest Service, Northern Research Station and Northern I Science, Delaware, OH 43015, USA. [3]De

*Corresponding author. Email: a.grai

Bastin *et al.* (Reports, 5 Ju
mitigation during the 198
technically suitable for ex
of actually available land a

Received: 25 September 2020 | Revised: 24 December 2020 | Accepted: 27 December 2020

DOI: 10.1111/gcb.15513

GCB REVIEWS

Global Change Biology WILEY

Getting the message right on nature-based solutions to climate change

Nathalie Seddon[1] | Alison Smith[1,2] | Pete Smith[3] | Isabel Key[1] | Alexandre Chausson[1] | Cécile Girardin[1,2] | Jo House[4] | Shilpi Srivastava[5] | Beth Turner[1,6]

Science

EMBARGOED UNTIL 2:00PM US ET, THURSDAY 17 OCTOBE

Comment on "The global tree restoration potential"

Pierre Friedlingstein[1]*, Myles Allen[2], Josep G. Canadell[3], Glen P. Peters[4], Sonia I. Seneviratne[5]

[1]College of Engineering, Mathematics and Physical Sciences, University of Exeter, Exeter EX4 4QE, UK. [2]Department of Physics, University of Oxford, Oxford OX1 3PJ, UK. [3]Global Carbon Project, CSIRO Oceans and Atmosphere, Canberra, ACT 2601, Australia. [4]CICERO Center for International Climate Research, Oslo 0349, Norway. [5]Institute for Atmospheric and Climate Science, ETH Zurich, 8092 Zurich, Switzerland.

*Corresponding author. Email: p.friedlingstein@exeter.ac.uk

Bastin *et al.* (Reports, 5 July 2019, p. 76) claim that global tree restoration is the most effective climate change solution to date, with a reported carbon storage potential of 205 gigatonnes of carbon. However, this estimate and its implications for climate mitigation are inconsistent with the dynamics of the global carbon cycle and its response to anthropogenic carbon dioxide emissions.

Science

Comment on "The global tree restoration potential"

Joseph W. Veldman[1,2]*, Julie C. Aleman[1,3], Swanni T. Alvarado[4,5], T. Michael Anderson[6], Sally Archibald[7], William J. Bond[8], Thomas W. Boutton[1], Nina Buchmann[9], Elise Buisson[10], Josep G. Canadell[11], Michele de Sá Dechoum[12], Milton H. Diaz-Toribio[13], Giselda Durigan[14], John J. Ewel[13], G. Wilson Fernandes[15], Alessandra Fidelis[16], Forrest Fleischman[17], Stephen P. Good[18], Daniel M. Griffith[19], Julia-Maria Hermann[20], William A. Hoffmann[21], Soizig Le Stradic[22], Caroline E. R. Lehmann[23,24], Gregory Mahy[25], Ashish N. Nerlekar[1], Jesse B. Nippert[26], Reed F. Noss[27], Colin P. Osborne[28], Gerhard E. Overbeck[29], Catherine L. Parr[7,30,31], Juli G. Pausas[32], R. Toby Pennington[23,33], Michael P. Perring[34,35], Francis E. Putz[13], Jayashree Ratnam[36], Mahesh Sankaran[37,38], Isabel B. Schmidt[39], Christine B. Schmitt[40,41], Fernando A. O. Silveira[42], A. Carla Staver[43], Nicola Stevens[44], Christopher J. Still[45], Caroline A. E. Strömberg[46], Vicky M. Temperton[47], J. Morgan Varner[48], Nicholas P. Zaloumis[49]

Goal of workshop is to highlight ‘best practices’ for Natural Carbon Solutions…

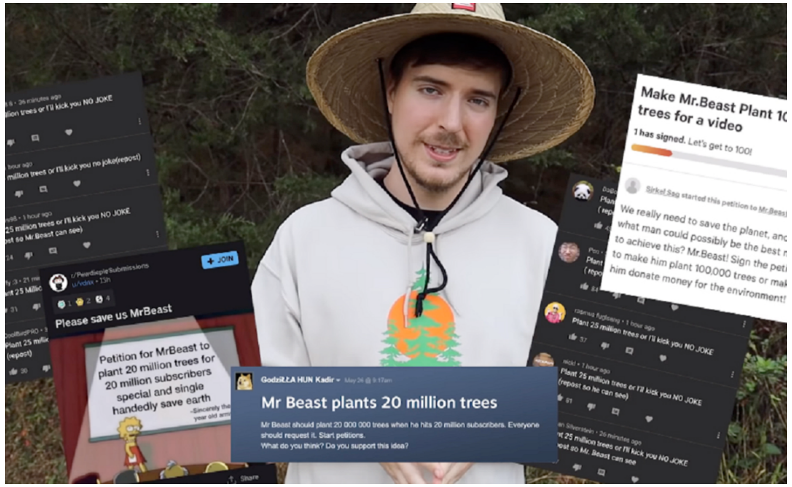
Goal of workshop is to better inform public interest in forests as a climate mitigation option

TRILLION TREES

WCS

WWF

BirdLife INTERNATIONAL

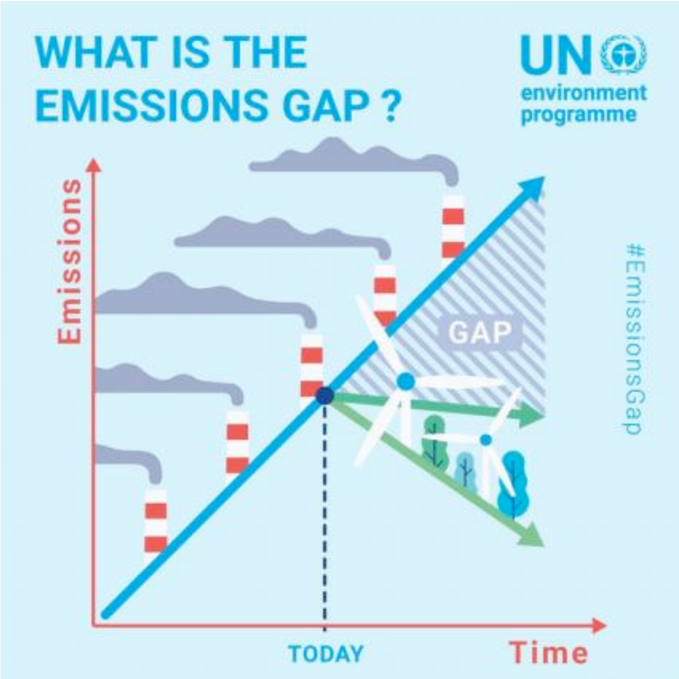


PLANT FOR THE PLANET

UN environment

Goal of workshop is to better inform public and private policies and CDR scenario development

- & synergies w Bonn Challenge (2011), African Forest Landscape Restoration Initiative, New York Declaration on Forests (2014)



Format of workshop to highlight advances in Earth science and modeling to inform forest CDR

<u>Plenary presentations on:</u>

1) Range of forest carbon potentials
2) Why the range of uncertainties
3) Best practices for reducing uncertainties

<u>Breakout groups – driving questions</u>

- How believable is the range of carbon sequestration estimates for climate mitigation?
- What appear to be the main sources of uncertainties driving the range of uncertainty?
- Are the uncertainties related to our scientific understanding or scenario assumptions?
- What are barriers to getting to reliable/best estimates?
- What ‘best practices’ should guide natural climate solutions going forward?

<u>Outcome of workshop</u>

- New networks and perspectives for COP26
- Perspectives paper