中国科学院青藏高原研究所
Institute of Tibetan Plateau Research
Chinese Academy of Sciences

青藏高原地球系统与资源环境重点实验室
Key Laboratory of Tibetan Plateau Earth System, Environment and Resources

TPDC

Wetland methane feedback over the last decades

张臻
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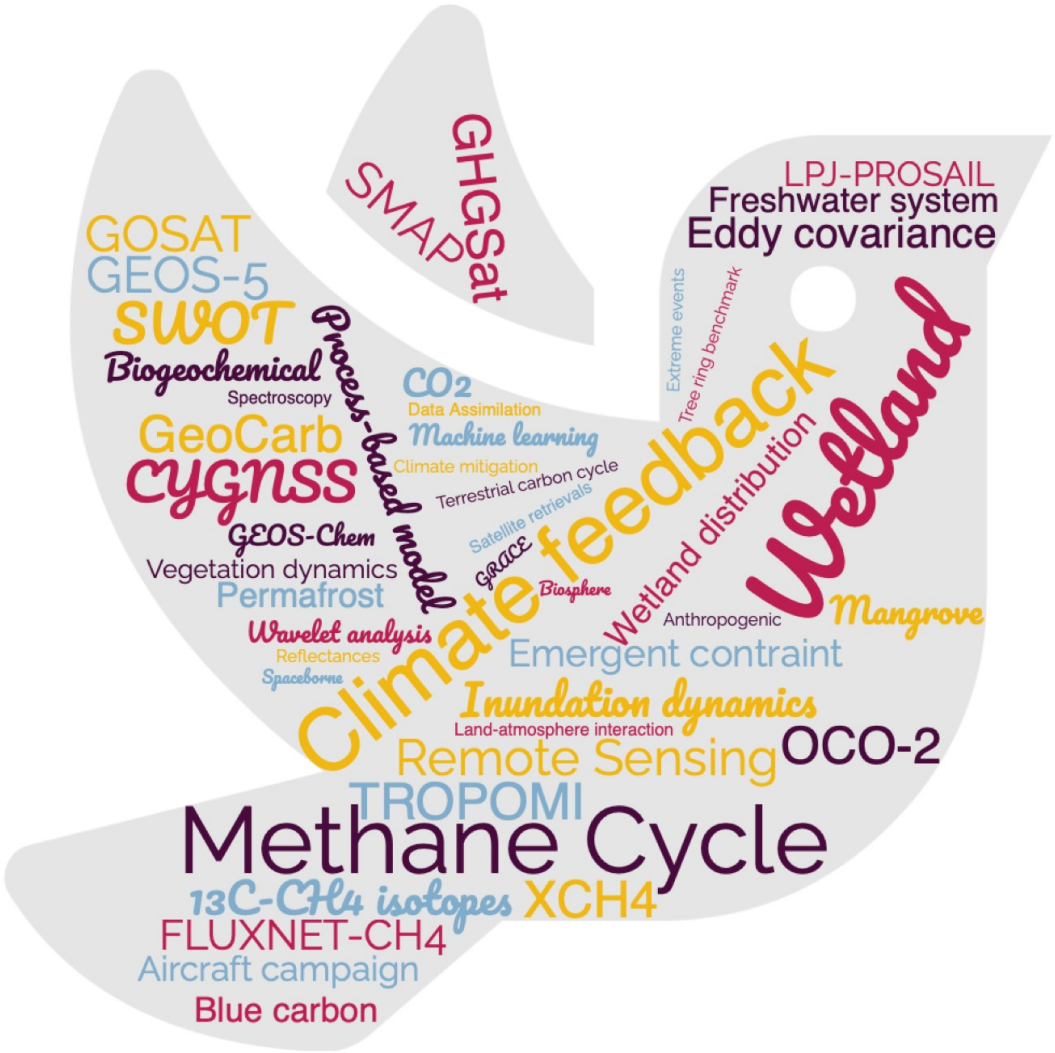
July. 18. 2024

My Research WordCloud:



UNIVERSITY OF MARYLAND 18 56

NASA

WSL

GLOBAL CARBON project

IAC ETH

Environmental Defense Fund

GMAO
Global Modeling & Assimilation Office

GORDON AND BETTY MOORE FOUNDATION

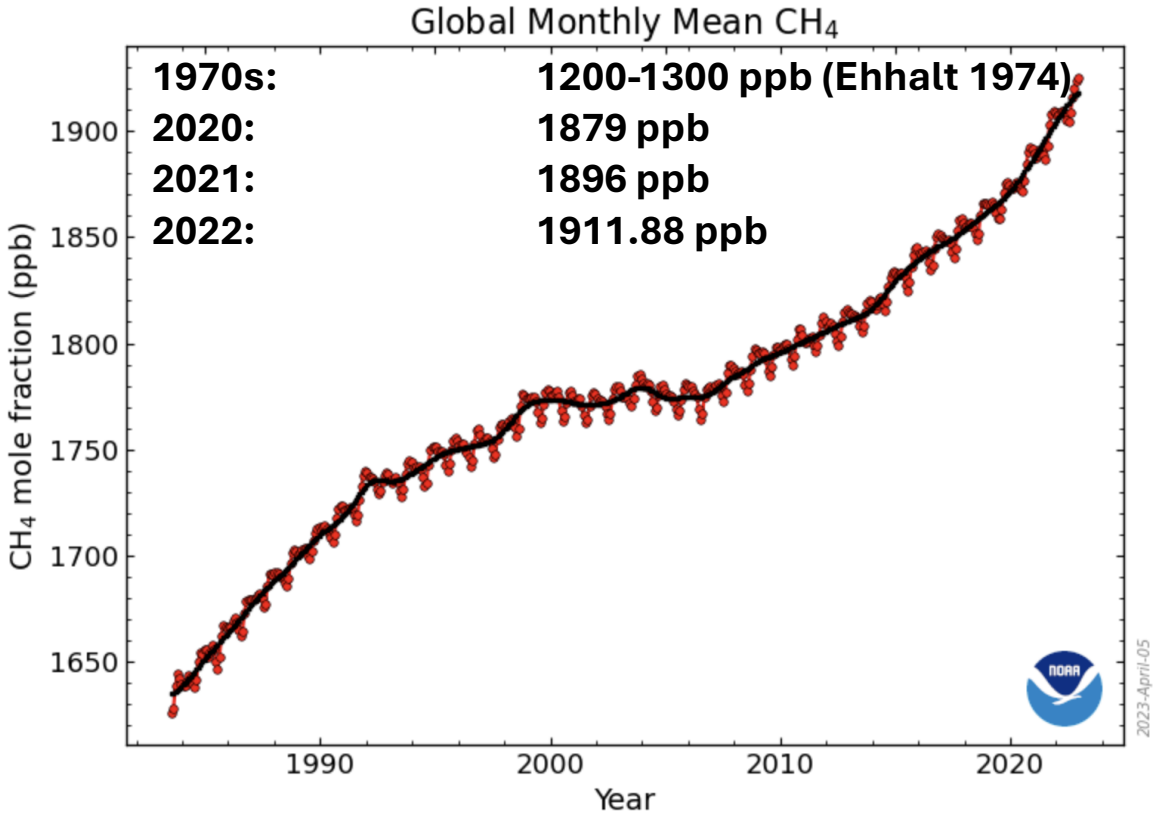
USGS
science for a changing world

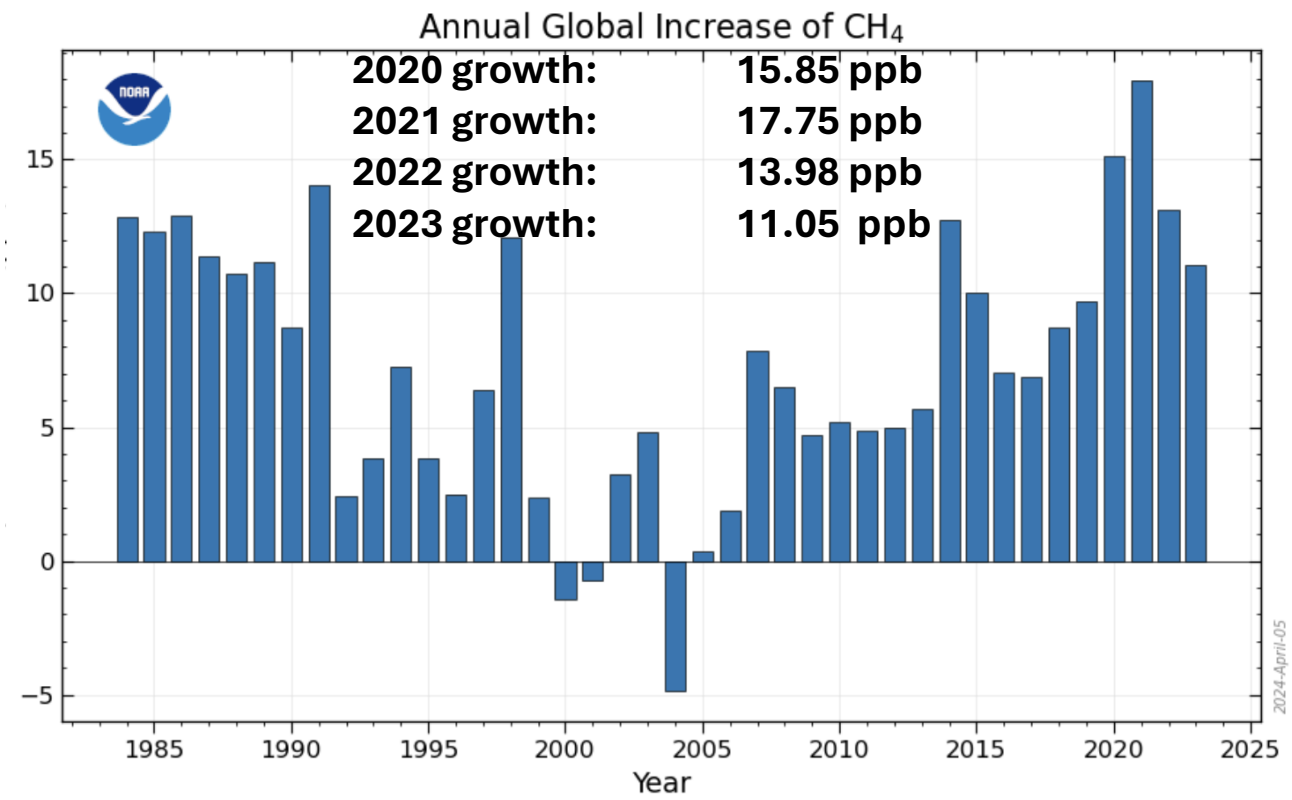
Woodwell Climate Research Center

Powell Center

Methane is fascinatingly difficult to study

- Methane is a greenhouse gas 82x (GWP-20) more potent than CO_2 (29x, GWP-100)
- The short lifetime, 11.8 years, provides several opportunities for mitigation





NOAA ESRL, 2023

Wetland-methane feedback is the major driver of rising methane concentration during paleoclimate events

Article

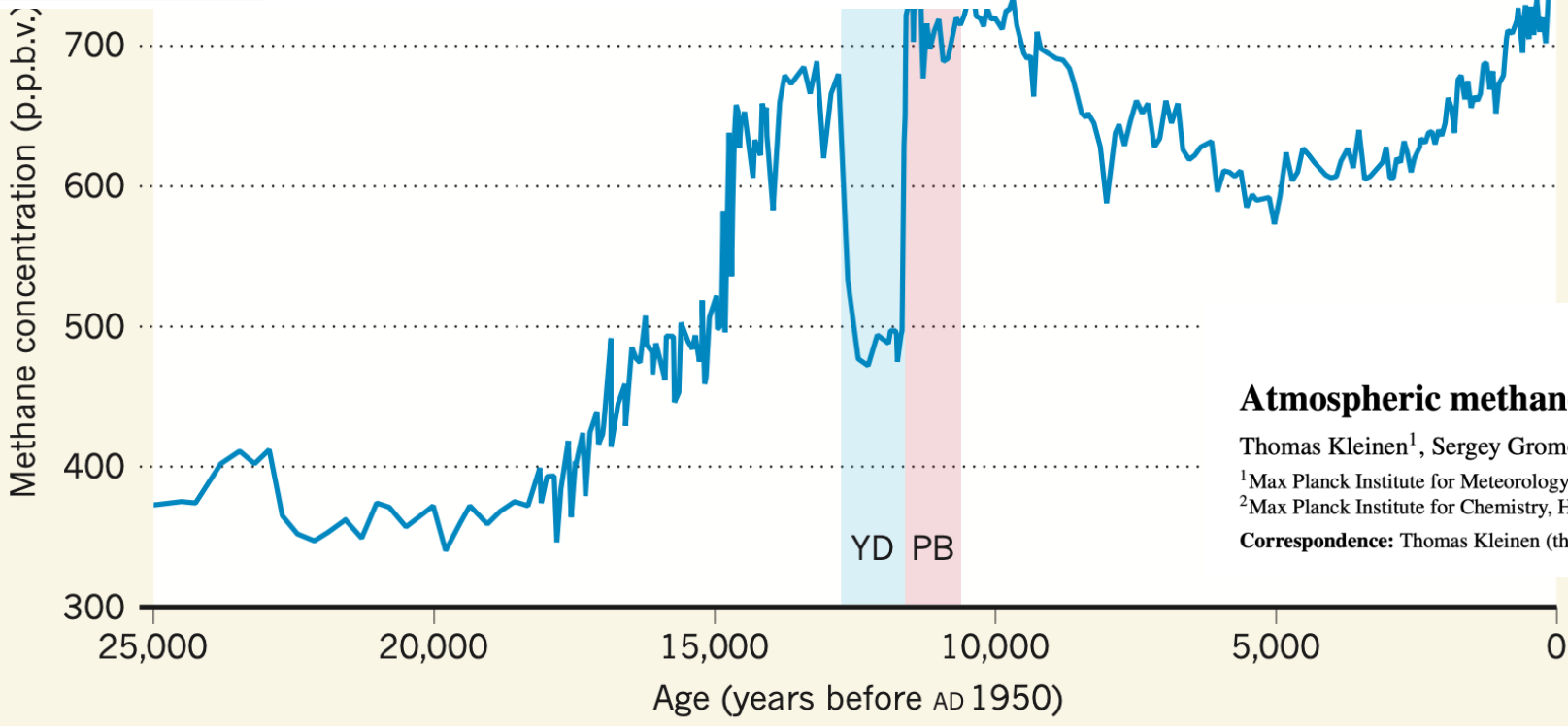
Extensive global wetland loss over the past three centuries

https://doi.org/10.1038/s41586-022-05572-6
Received: 18 January 2022
Accepted: 17 November 2022
Published online: 8 February 2023

Etienne Fluet-Chouinard[1,2,27], Benjamin D. Stocker[3,4,5,6], Zhen Zhang[7], Avni Malhotra[1], Joe R. Melton[8], Benjamin Poulter[9], Jed O. Kaplan[10], Kees Klein Goldewijk[11], Stefan Siebert[12,13], Tatiana Minayeva[14], Gustaf Hugelius[1,15,16], Hans Joosten[17,18], Alexandra Barthelmes[17,18], Catherine Prigent[19,20], Filipe Aires[19,20], Alison M. Hoyt[1], Nick Davidson[21,22], C. Max Finlayson[22,23], Bernhard Lehner[24], Robert B. Jackson[1,25] & Peter B. McIntyre[2,26]

Minimal geological methane emissions during the Younger Dryas–Preboreal abrupt warming event

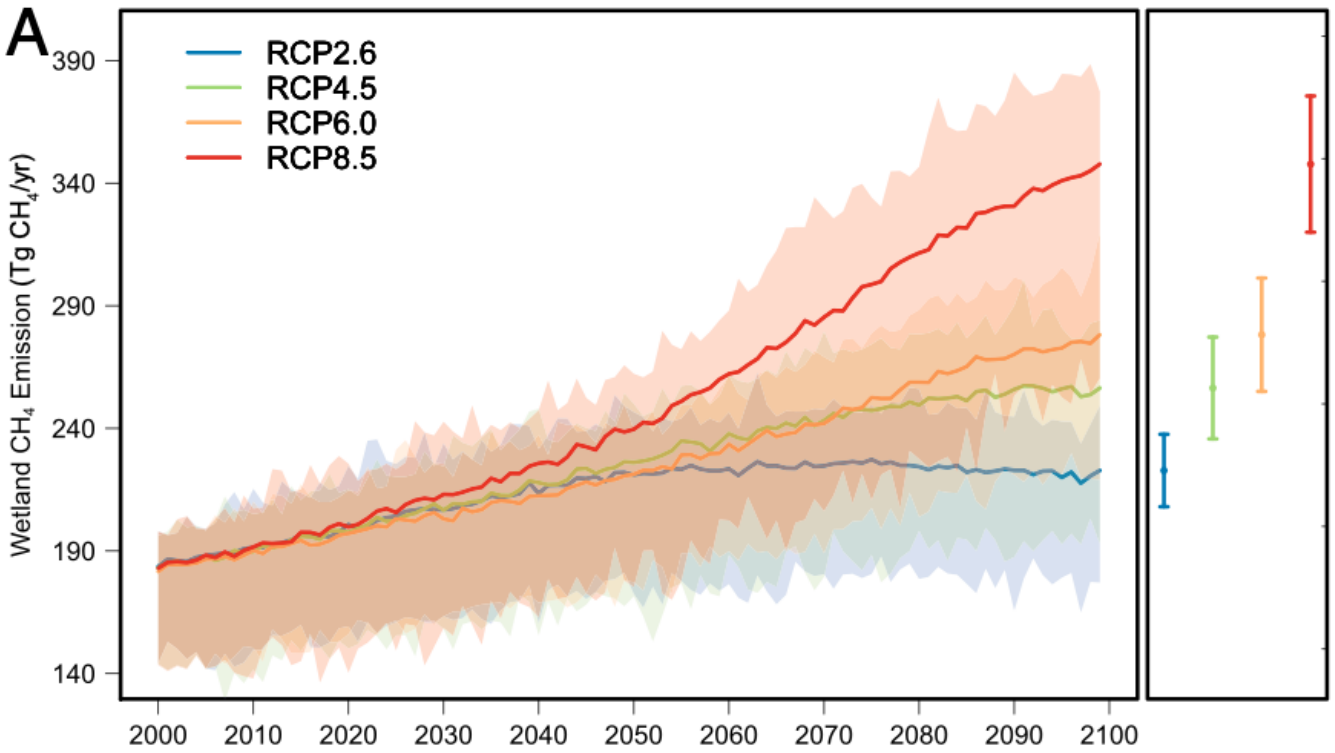
Vasilii V. Petrenko[1], Andrew M. Smith[2], Hinrich Schaefer[3], Katja Riedel[3], Edward Brook[4], Daniel Baggenstos[5,6], Christina Harth[5], Quan Hua[2], Christo Buizert[4], Adrian Schilt[4], Xavier Fain[7], Logan Mitchell[4,8], Thomas Bauska[4,9], Anais Orsi[5,10], Ray F. Weiss[5] & Jeffrey P. Severinghaus[5]



Atmospheric methane since the LGM was driven by wetland sources

Thomas Kleinen[1], Sergey Gromov[2], Benedikt Steil[2], and Victor Brovkin[1]
[1]Max Planck Institute for Meteorology, Bundesstr. 53, 20146 Hamburg, Germany
[2]Max Planck Institute for Chemistry, Hahn-Meitner-Weg 1, 55128 Mainz, Germany
Correspondence: Thomas Kleinen (thomas.kleinen@mpimet.mpg.de)

Future projections of wetland-methane feedback



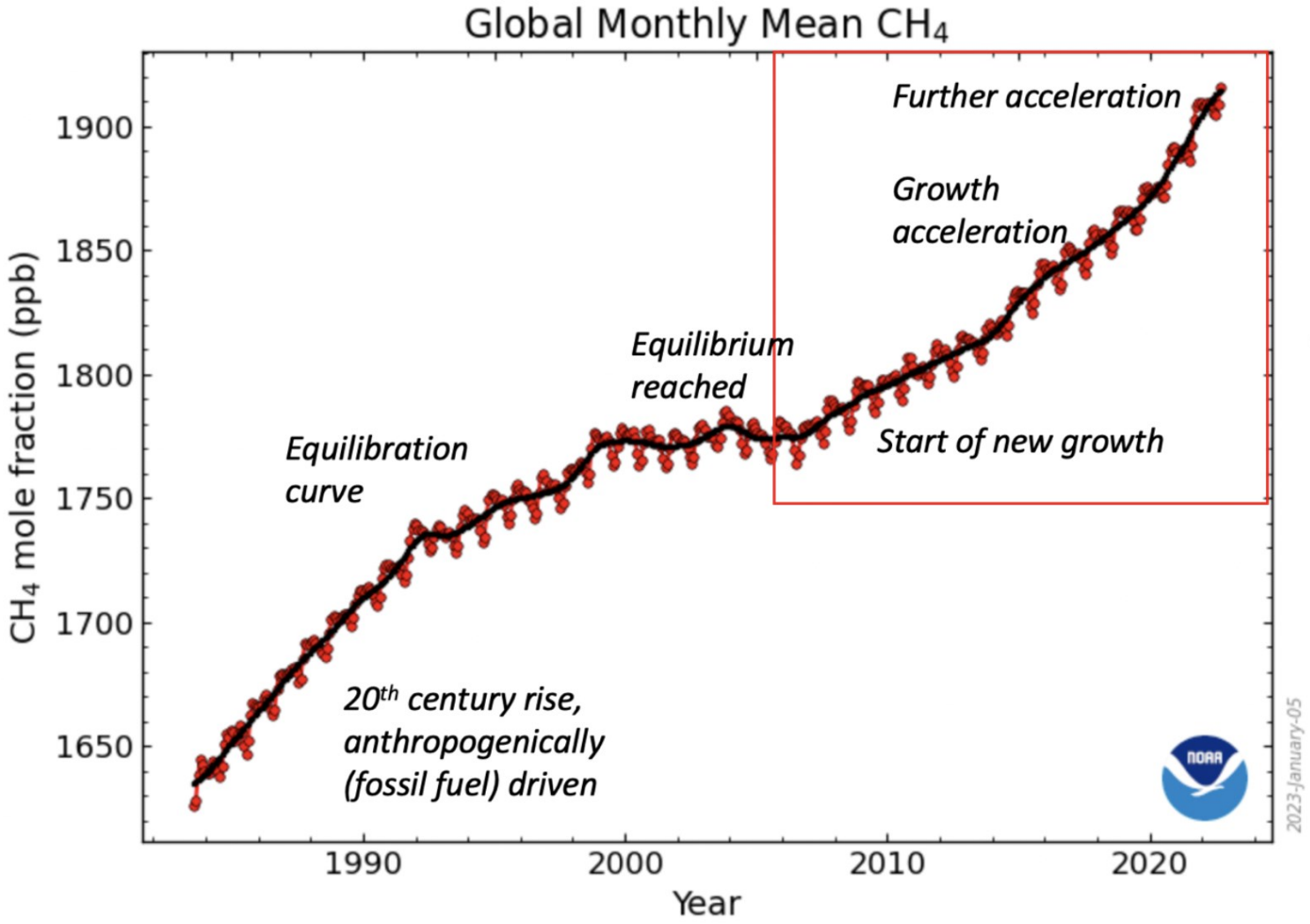
PNAS

Emerging role of wetland methane emissions in driving 21st century climate change

Zhen Zhang[a,b,c,1], Niklaus E. Zimmermann[a,d], Andrea Stenke[d], Xin Li[c,e], Elke L. Hodson[f], Gaofeng Zhu[g], Chunlin Huang[c], and Benjamin Poulter[c,h]

[a]Dynamic Macroecology, Swiss Federal Research Institute WSL, Birmensdorf 8903, Switzerland; [b]Institute on Ecosystems and Department of Ecology, Montana State University, Bozeman, MT 59717; [c]Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences, Lanzhou 730000, China; [d]Department of Environmental System Science, ETH Zürich, Zürich 8092, Switzerland; [e]CAS Center for Excellence in Tibetan Plateau Earth Sciences, Chinese Academy of Sciences, Beijing 100101, China; [f]Office of Energy Policy and Systems Analysis, US Department of Energy, Washington, DC 20585; [g]Key Laboratory of Western China's Environmental Systems, Lanzhou University, Lanzhou 730000, China; and [h]Biospheric Sciences Laboratory, NASA Goddard Space Flight Center, Greenbelt, MD 20770

Signal of emerging wetland feedback to climate change?



The rise of atmospheric CH_4 growth rate for the last three decades is mainly driven by anthropogenic sources

RESEARCH ARTICLE

National Science Review
9: nwab200, 2022
https://doi.org/10.1093/nsr/nwab200
Advance access publication 11 November 2021

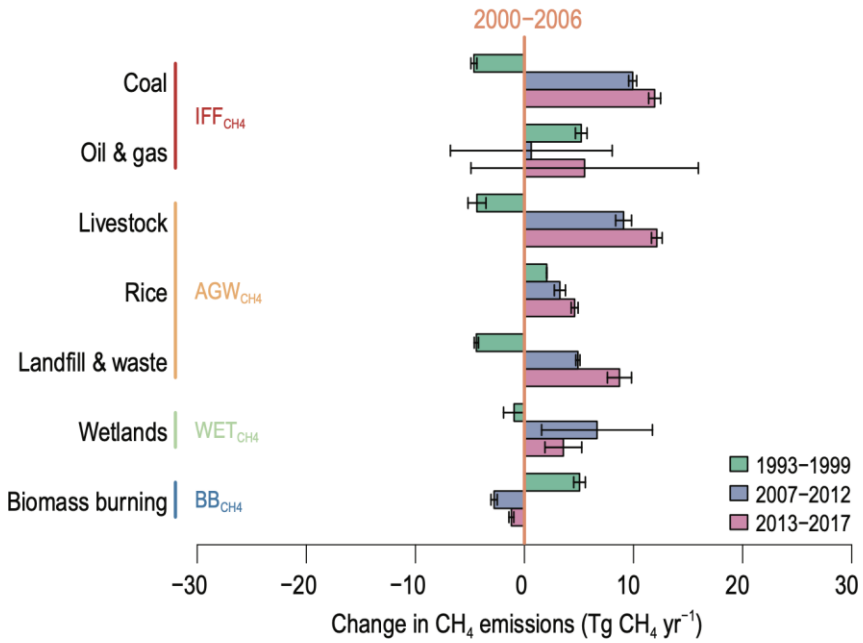
EARTH SCIENCES

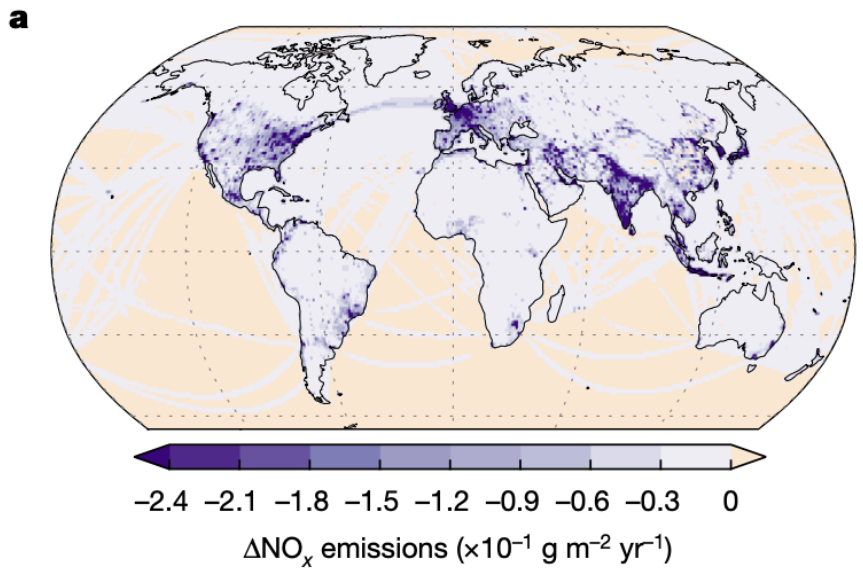
Anthropogenic emission is the main contributor to the rise of atmospheric methane during 1993–2017

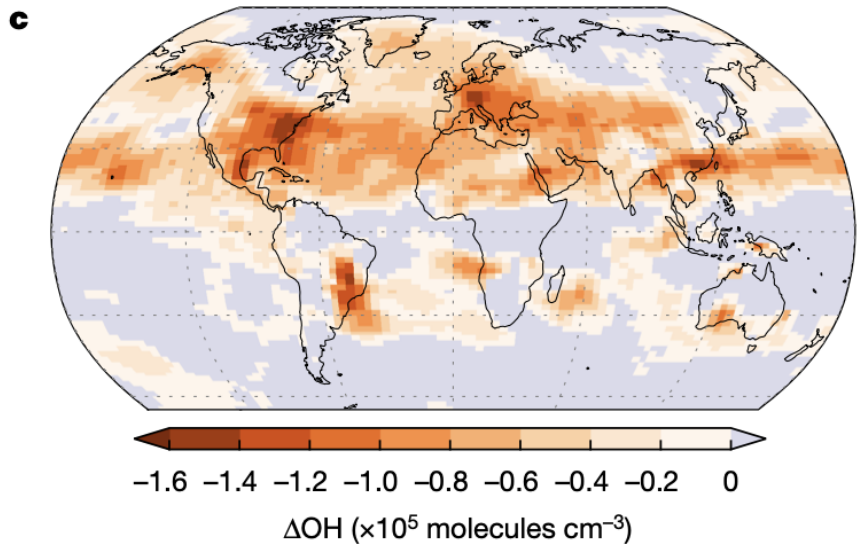
Zhen Zhang (张臻)[1,*], Benjamin Poulter[2], Sara Knox[3], Ann Stavert[4], Gavin McNicol[5], Etienne Fluet-Chouinard[6], Aryeh Feinberg[7], Yuanhong Zhao (赵园红)[8], Philippe Bousquet[9], Josep G. Canadell[4], Anita Ganesan[10], Gustaf Hugelius[11], George Hurtt[1], Robert B. Jackson[6,12], Prabir K. Patra[13], Marielle Saunois[9], Lena Höglund-Isaksson[14], Chunlin Huang (黄春林)[15], Abhishek Chatterjee[16,17] and Xin Li (李新)[18]

[1]Department of Geographical Sciences, University of Maryland, College Park, MD 20742, USA; [2]Biospheric Sciences Laboratory, NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA; [3]Department of Geography, University of British Columbia, Vancouver V6T 1Z2, Canada; [4]Global Carbon

- Atmospheric CH_4 box model in forward and inverse mode
- Comprehensive ^{13}C-CH_4 isotopes database
- Thousands of emissions scenarios that cover prevailing CH_4 hypothesis.







Article

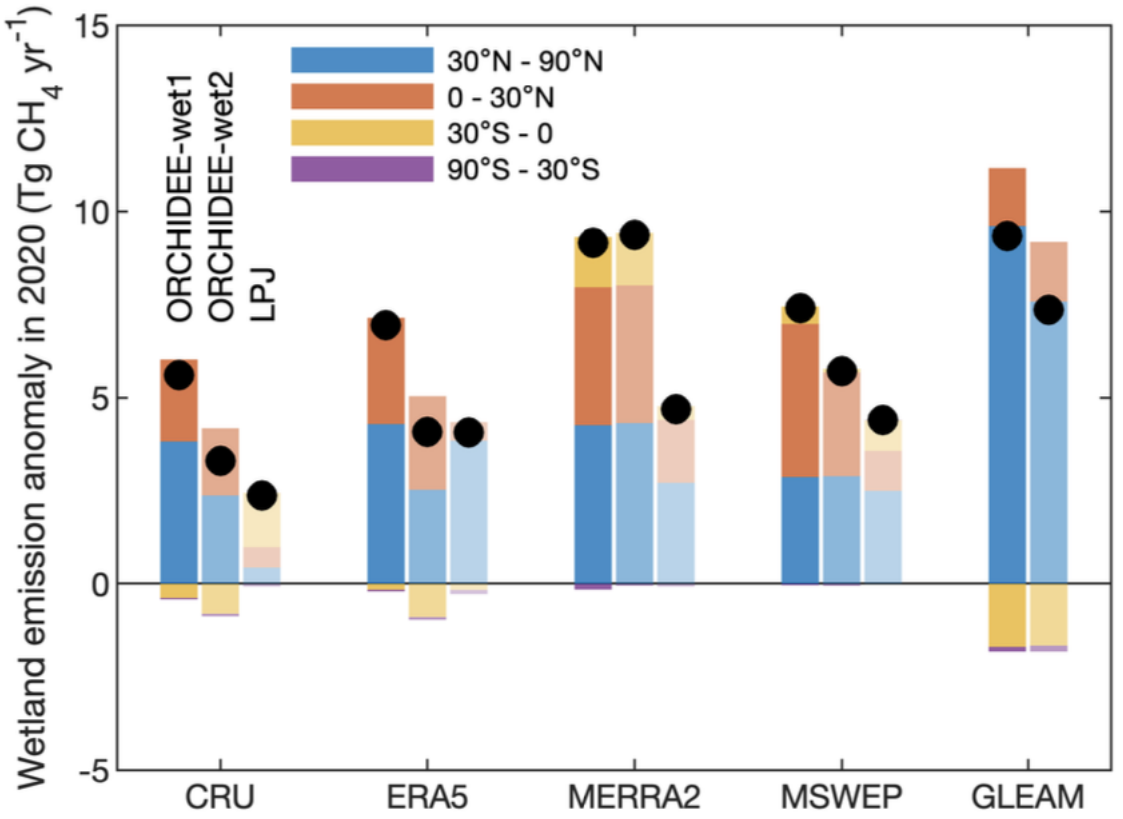
Wetland emission and atmospheric sink changes explain methane growth in 2020

https://doi.org/10.1038/s41586-022-05447-w

Received: 25 January 2022

Accepted: 14 October 2022

Shushi Peng[1,2,3]✉, Xin Lin[4]✉, Rona L. Thompson[5], Yi Xi[1,2], Gang Liu[1,2], Didier Hauglustaine[4], Xin Lan[6,7], Benjamin Poulter[8], Michel Ramonet[4], Marielle Saunois[4], Yi Yin[9], Zhen Zhang[10], Bo Zheng[11,12] & Philippe Ciais[1,2,4,13]



Model results support enhancing wetland CH_4 feedback (1)

Brief Communication

https://doi.org/10.1038/s41558-023-01629-

Recent intensification of wetland methane feedback

Received: 7 September 2022

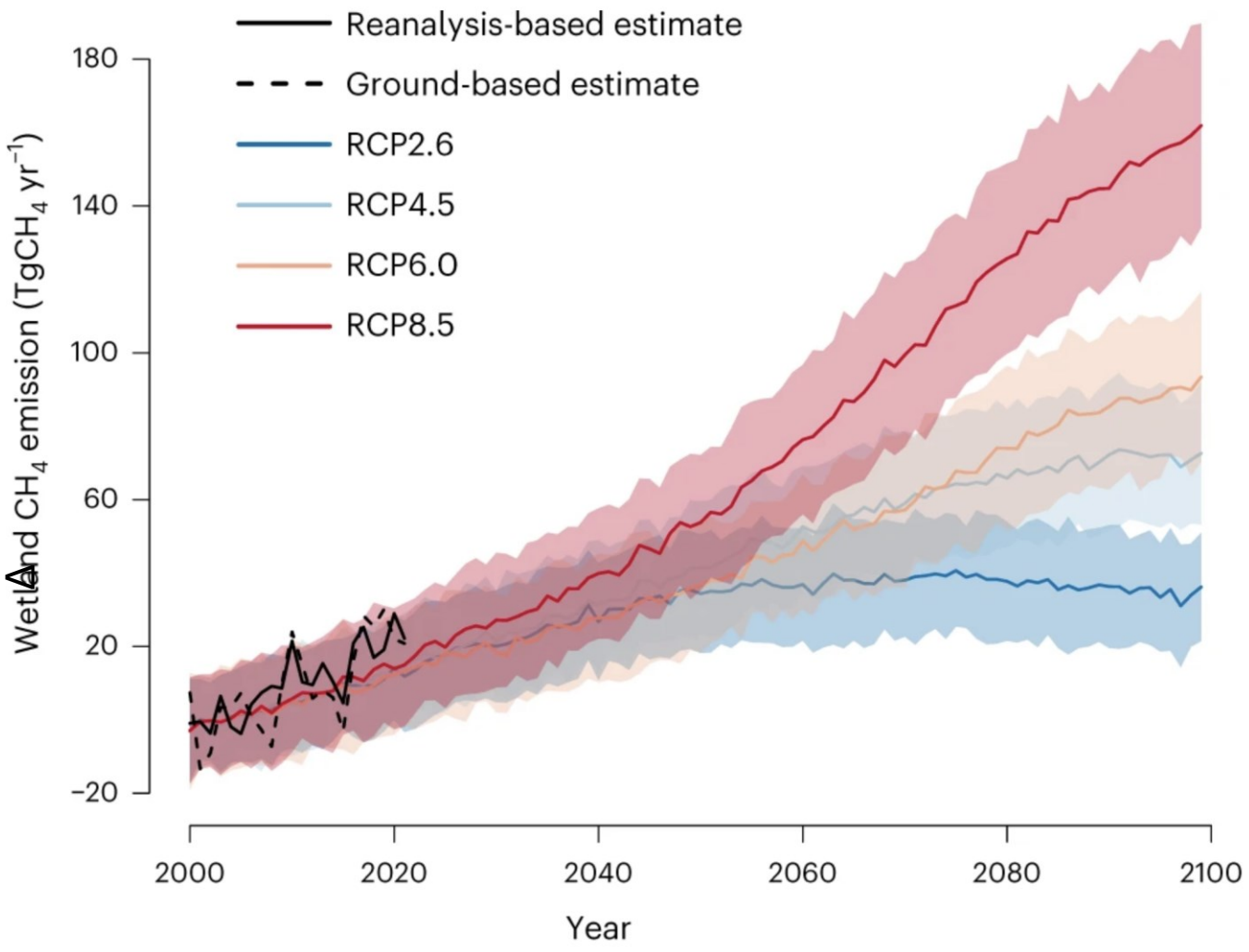
Accepted: 10 February 2023

Published online: 20 March 2023

Check for updates

Zhen Zhang[1,2], Benjamin Poulter[3], Andrew F. Feldman[3,4], Qing Ying[2], Philippe Ciais[5], Shushi Peng[6] & Xin Li[1]

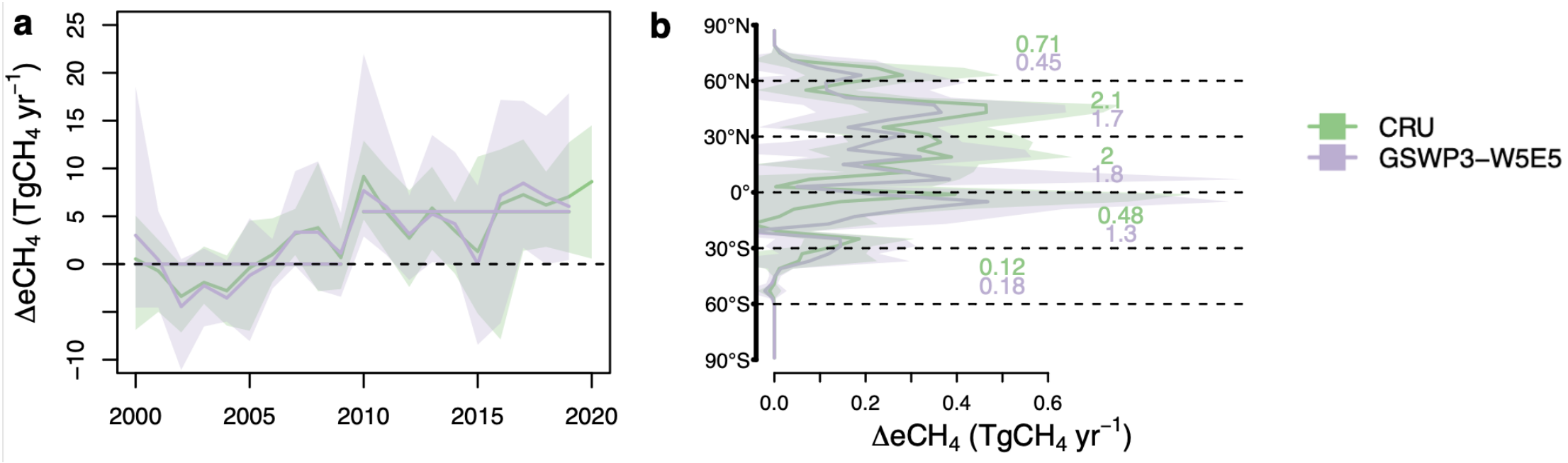
The positive response of wetland methane (CH_4) emissions to climate change is an important yet uncertain Earth-system feedback that amplifies atmospheric CH_4 concentrations. Here, using a wetland model, we report intensified wetland CH_4 emissions during 2000–2021, corresponding with 2020 and 2021 being exceptional years of growth. Our results highlight the need for sustained monitoring and observations of global wetland CH_4 fluxes to document emerging trends, variability and underlying drivers.



Model results support enhancing wetland CH_4 feedback (2)

Time series of wetland CH_4 anomaly

Latitudinal change



Ensemble estimates of global wetland methane emissions over 2000-2020

Zhen Zhang[1], Benjamin Poulter[2], Joe R. Melton[3], William J. Riley[4], George H. Allen[5], David J. Beerling[6], Philippe Bousquet[7], Josep G Canadell[8], Etienne Fluet-Chouinard[9], Philippe Ciais[7], Nicola Gedney[10], Peter O. Hopcroft[11], Akihiko Ito[12], Robert B. Jackson[13], Atul K. Jain[14], Katherine Jensen[15], Fortunat Joos[16], Thomas Kleinen[17], Sara Knox[18,19], Tingting Li[20], Xin Li[1], Xiangyu Liu[21], Kyle McDonald[15], Gavin McNicol[22], Paul A. Miller[23], Jurek Müller[16], Prabir K. Patra[24,25], Changhui Peng[26], Shushi Peng[27], Zhangcai Qin[28], Ryan M. Riggs[29], Marielle Saunois[7], Qing Sun[16], Hanqin Tian[30], Xiaoming Xu[14], Yuanzhi Yao[31], Xi Yi[27], Wenxin Zhang[22], Qing Zhu[4], Qiuan Zhu[32], Qianlai Zhuang[21]

Using measurements to inform CH_4 studies

FLUXNET-CH_4 SYNTHESIS ACTIVITY

Objectives, Observations, and Future Directions

Sara H. Knox, Robert B. Jackson, Benjamin Poulter, Gavin McNicol, Etienne Fluet-Chouinard, Zhen Zhang, Gustaf Hugelius, Philippe Bousquet, Josep G. Canadell, Marielle Saunois, Dario Papale, Housen Chu, Trevor F. Keenan, Dennis Baldocchi, Margaret S. Torn, Ivan Mammarella, Carlo Trotta, Mika Aurela, Gil Bohrer

https://doi.org/10.5194/essd-13-3607-2021

Article | Assets | Peer review | Metrics | Related articles

Data description paper | 29 Jul 2021

FLUXNET-CH_4: a global, multi-ecosystem dataset and analysis of methane seasonality from freshwater wetlands

JGR Biogeosciences

RESEARCH ARTICLE
10.1029/2022JG007259

Key Points:

- Significant model-observation disagreements were found at multi-day and weekly time scales (<15 days)
- Models captured variability at monthly and seasonal time (42–142 days) scales for boreal and Arctic tundra sites but not for temperate and tropical sites
- The model errors show that biases at multi-day time scales may contribute to persistent systematic biases on longer time scales

Supporting Information:

Supporting Information may be found in the online version of this article.

Characterizing Performance of Freshwater Wetland Methane Models Across Time Scales at FLUXNET-CH_4 Sites Using Wavelet Analyses

Zhen Zhang[1,2], Sheel Bansal[3], Kuang-Yu Chang[4], Etienne Fluet-Chouinard[5], Kyle Delwiche[6], Mathias Goeckede[7], Adrian Gustafson[8], Sara Knox[9], Antti Leppänen[10], Licheng Liu[11], Jinxun Liu[12], Avni Malhotra[13], Tiina Markkanen[10], Gavin McNicol[14], Joe R. Melton[15], Paul A. Miller[8], Changhui Peng[16], Maarit Raivonen[10], William J. Riley[4], Oliver Sonnentag[17], Tuula Aalto[10], Rodrigo Vargas[18], Wenxin Zhang[8], Qing Zhu[4], Qiuan Zhu[19], Qianlai Zhuang[11], Lisamarie Windham-Myers[20], Robert B. Jackson[21], and Benjamin Poulter[22]

[1]National Tibetan Plateau Data Center (TPDC), State Key Laboratory of Tibetan Plateau Earth System, Environment and Resource (TPESER), Institute of Tibetan Plateau Research, Chinese Academy of Sciences, Beijing, China, [2]Earth System Science Interdisciplinary Center, University of Maryland, College Park, MD, USA, [3]Northern Prairie Wildlife Research Center, U.S. Geological Survey, Jamestown, ND, USA, [4]Climate and Ecosystem Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA, USA, [5]Institute for Atmospheric and Climate Science, ETH Zurich, Zurich, Switzerland, [6]Department of Environmental Science, Policy, and Management, University of California, Berkeley, Berkeley, CA, USA, [7]Department of Biogeochemical Signals, Max Planck Institute for Biogeochemistry, Jena, Germany, [8]Department of Physical

Knowledge-informed CH_4 ML Model WetCH$_4$

Variable type	Name	Description	Unit	Data source	Spatial resolution	Temporal resolution
Reanalysis	tas	surface air temperature	° C	MERRA2	0.625°×0.5°	1 hourly
Reanalysis	pa	surface air pressure	Kpa	MERRA2	0.625°×0.5°	1 hourly
Reanalysis	le	latent heat	W m^{-2}	MERRA2	0.625°×0.5°	1 hourly
Reanalysis	h	sensible heat	W m^{-2}	MERRA2	0.625°×0.5°	1 hourly
Reanalysis	rsdl	downward-incoming longwave radiation	W m^{-2}	MERRA2	0.625°×0.5°	1 hourly
Reanalysis	rsds	downward-incoming shortwave radiation	W m^{-2}	MERRA2	0.625°×0.5°	1 hourly
Reanalysis	spfh	surface specific humidity	unitless	MERRA2	0.625°×0.5°	1 hourly
Reanalysis	ts1	soil temperature	° C	MERRA2	0.625°×0.5°	1 hourly
Reanalysis	ts2	soil temperature	° C	MERRA2	0.625°×0.5°	1 hourly
Reanalysis	ts3	soil temperature	° C	MERRA2	0.625°×0.5°	1 hourly
Remote Sensing	sm_s_wetness	surface soil wetness	unitless	SPL4SMGP.007	9 km	3 hourly
Remote Sensing	sm_r_wetness	rootzone soil wetness	unitless	SPL4SMGP.007	9 km	3 hourly
Remote Sensing	sm_p_wetness	profile soil wetness	unitless	SPL4SMGP.007	9 km	3 hourly
Remote Sensing	nbar1	red band	unitless	MCD43A4v061	500 m	daily
Remote Sensing	nbar2	near infrared 1 band	unitless	MCD43A4v061	500 m	daily
Remote Sensing	nbar3	blue	unitless	MCD43A4v061	500 m	daily
Remote Sensing	nbar4	green	unitless	MCD43A4v061	500 m	daily
Remote Sensing	nbar5	near infrared 2 band	unitless	MCD43A4v061	500 m	daily
Remote Sensing	nbar6	shortwave infrared 1 band	unitless	MCD43A4v061	500m	daily
Remote Sensing	nbar7	shortwave infrared 2 band	unitless	MCD43A4v061	500 m	daily
Remote Sensing	dem	altitude	m	MERIT-DEM	90 m	static
Remote Sensing	slope	terrain slope	radian	Geomorpho90m	90 m	static
Remote Sensing	spi	stream power index	unitless	Geomorpho90m	90 m	static
Remote Sensing	cti	compound topographic index	unitless	Geomorpho90m	90 m	static

(Ying et al., 2024)

Key Messages

- Anthropogenic emissions are the dominant driver to the rise of growth rate during the last decades.
- Strong evidence suggest ongoing wetland-methane feedbacks.
- Wetland methane feedback is likely playing an important role in the record high growth rate of atmospheric for 2020-2022.

We are recruiting and seeking collaborations!
Welcome to contact me!

Email: Zhen Zhang (zhenzhang@itpcas.ac.cn)

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