Observational constraints on the budget of H_2

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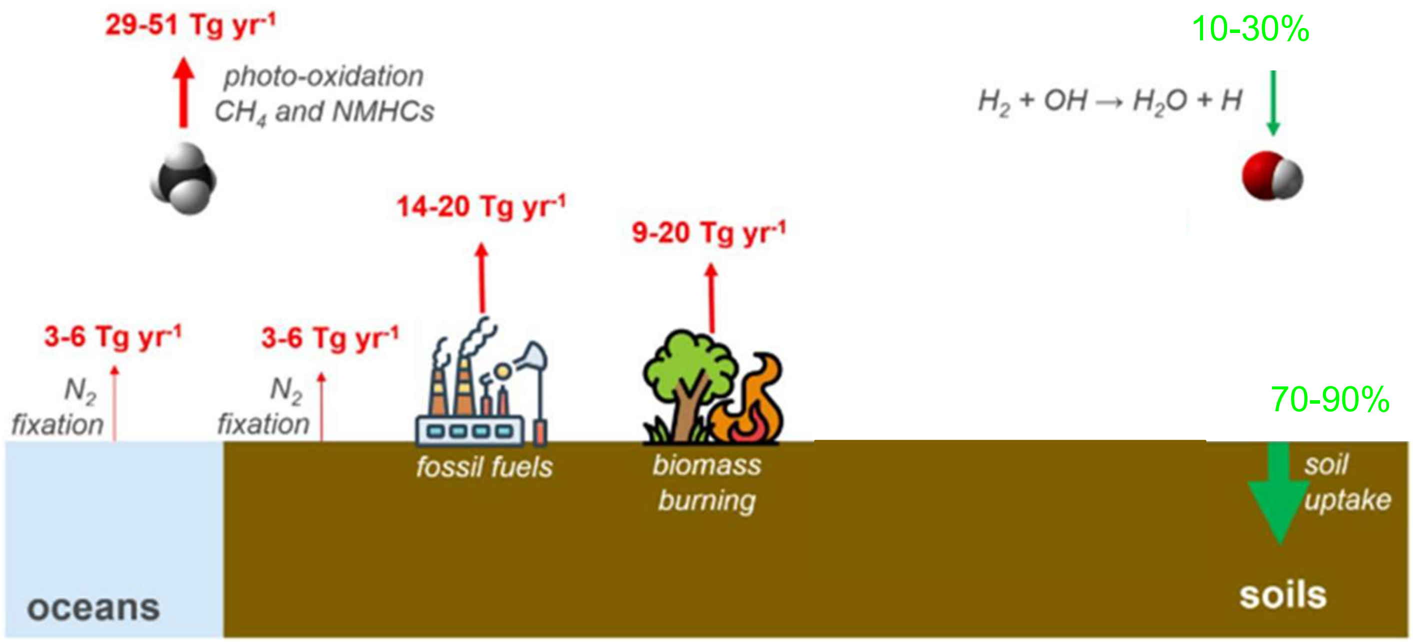
Overview of the H_2 budget (~2010)



Adapted from Arigoni et al. JRC (2022)

H₂ oxidation increase GHGs

Derwent (2001, 2006)

Prather (2010)

Sources and sinks

Schmidt (1974)

Novelli (1999)

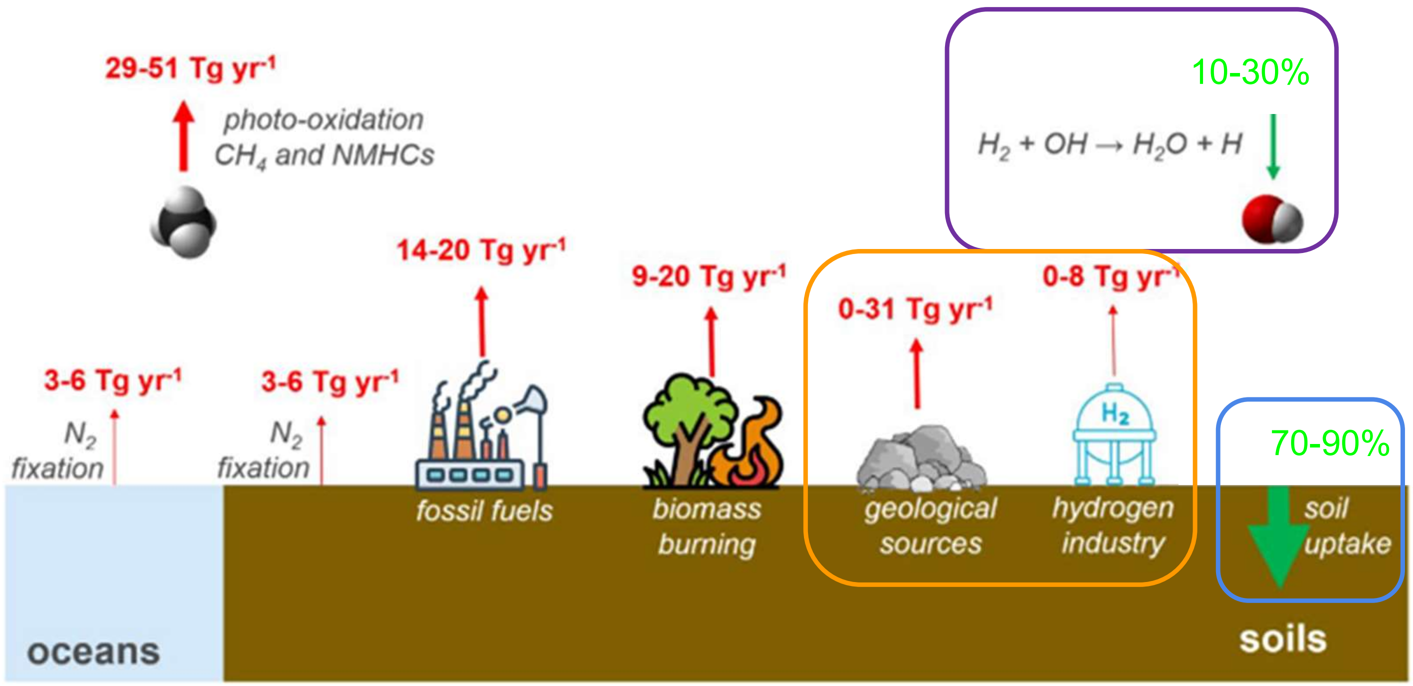
Ehhalt (2009)

Semi-empirical parameterization of vd(H_2)

Smith-Downey (2006/2009)

Ehhalt (2011)

Overview of the H_2 budget (recent developments)



Adapted from Arigoni et al. JRC (2022)

Revised estimate of H_2 GWP

Warwick et al. (2023)

Sand et al. (2023)

Large missing sources

Zgonick (2020)

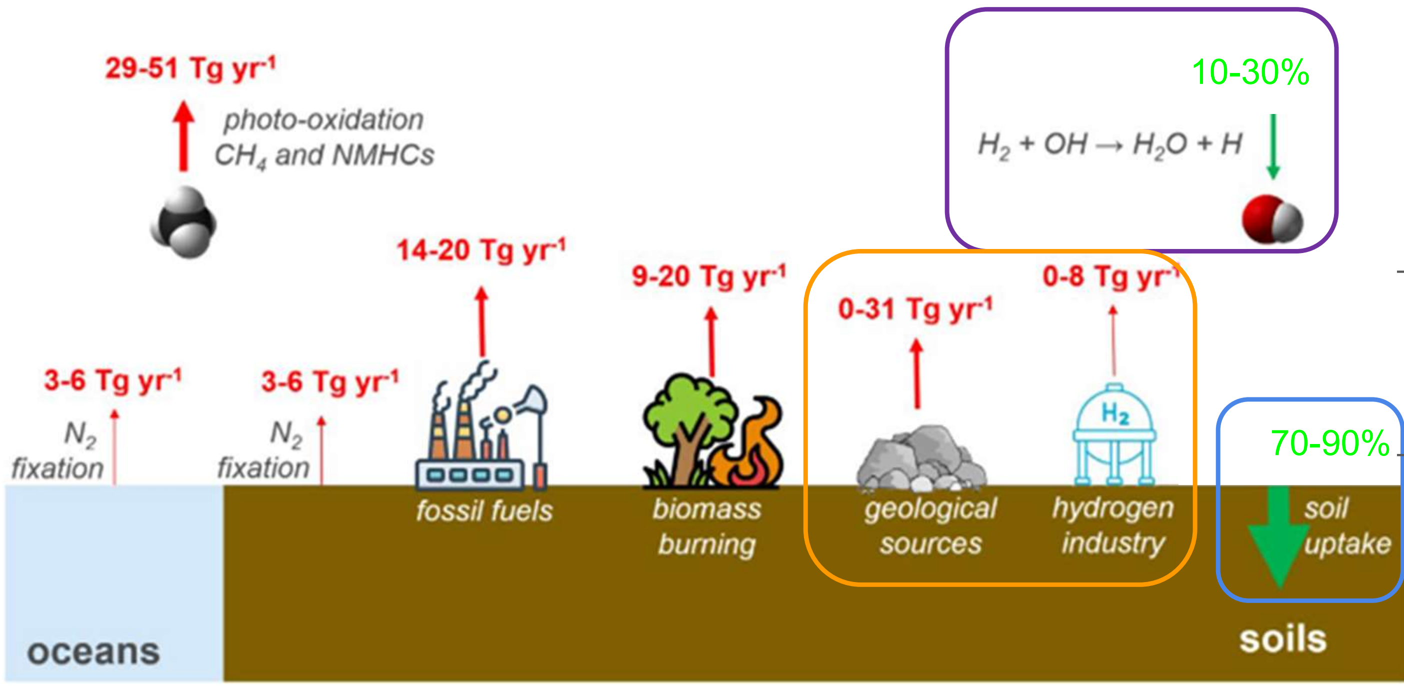
n (2024)

Land sink is driven by HA-HOB

Constant et al (2008, 2011)

Greening et al. (2014, 2015)

Overview of the H_2 budget (recent developments)



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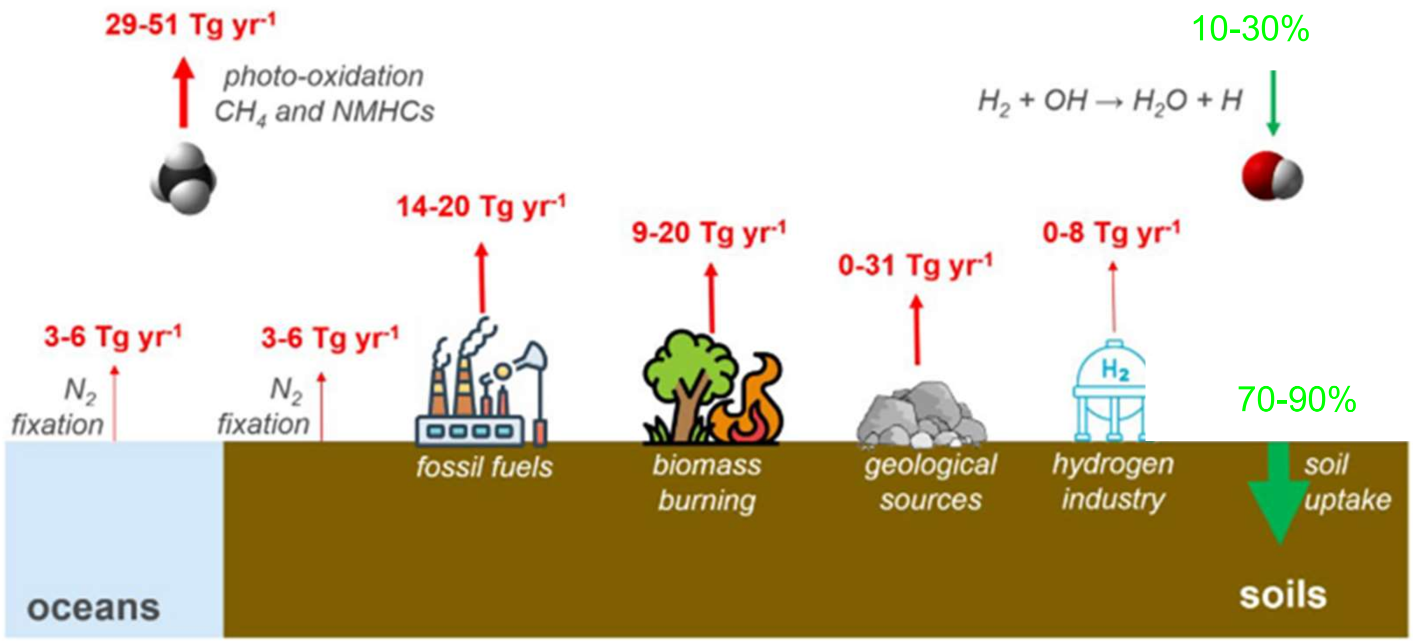
Decrease in observing capabilities

NOAA, isotopes

Overview of the H_2 budget: overarching questions?



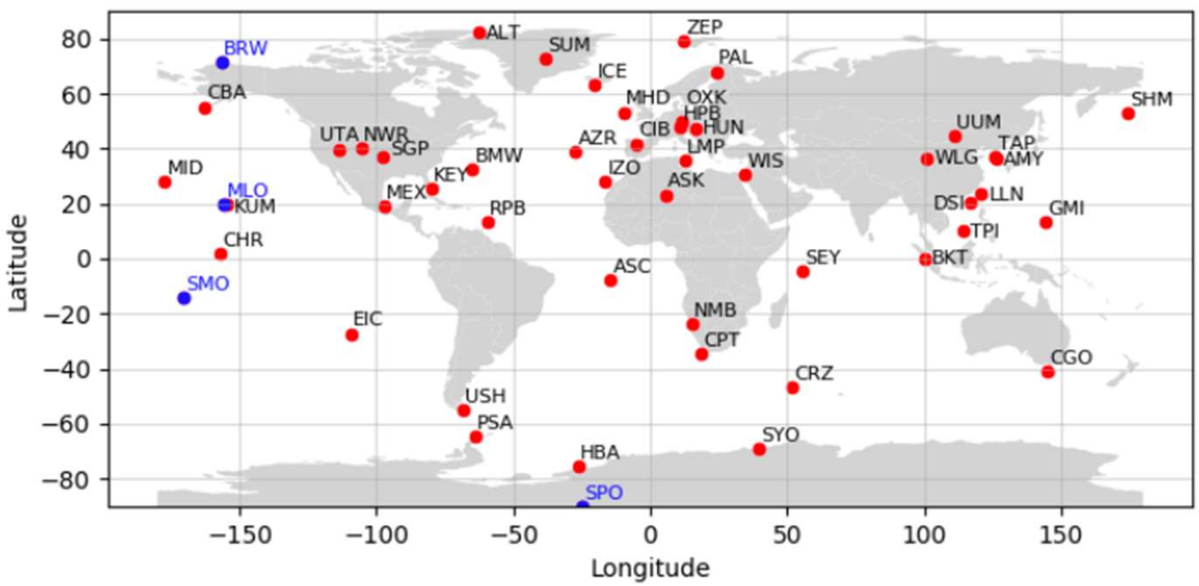
Adapted from Arigoni et al. JRC (2022)

- How much have anthropogenic activities already perturbed H_2 sources?
- What controls H_2 soil sink (and how do we represent it in models)?

Reviving NOAA GML H_2 observations

Global coverage and weekly sampling provides observational constraints on the distribution of H_2 and its changes since 2010

Addresses biases caused by drift in standard and non-linearity in instrument

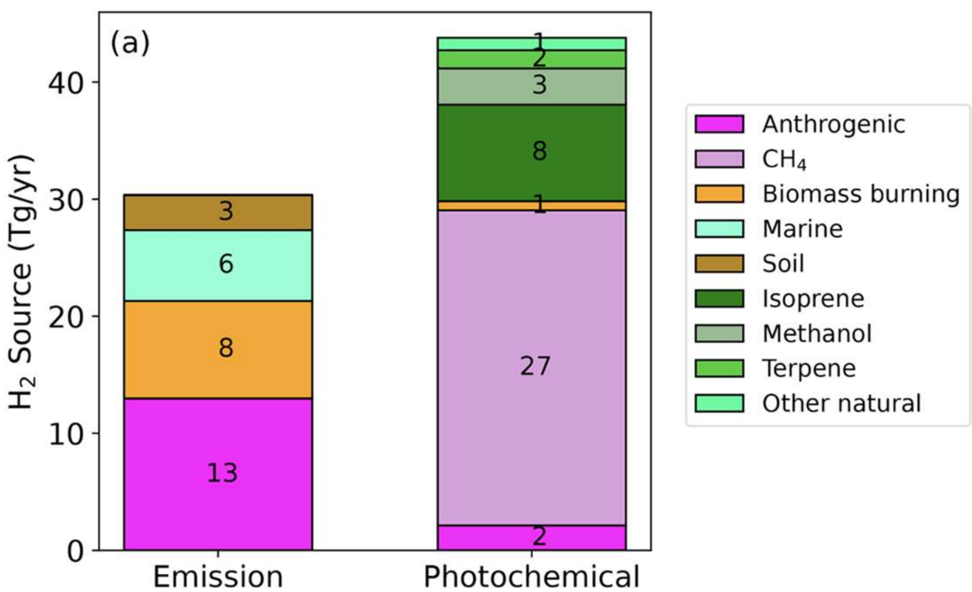


⇢ Public release of NOAA GML flask air H_2 dry air mole fraction for 70 sites [2009-2021]

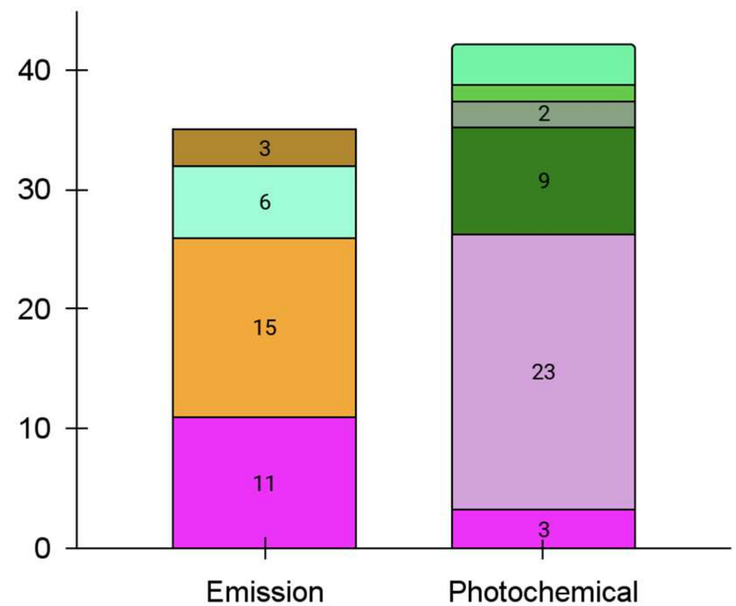
Pétron et al. - AMT (2024)

Evaluation of NOAA GFDL chemistry-climate model

Paulot et al, ACP (2024)

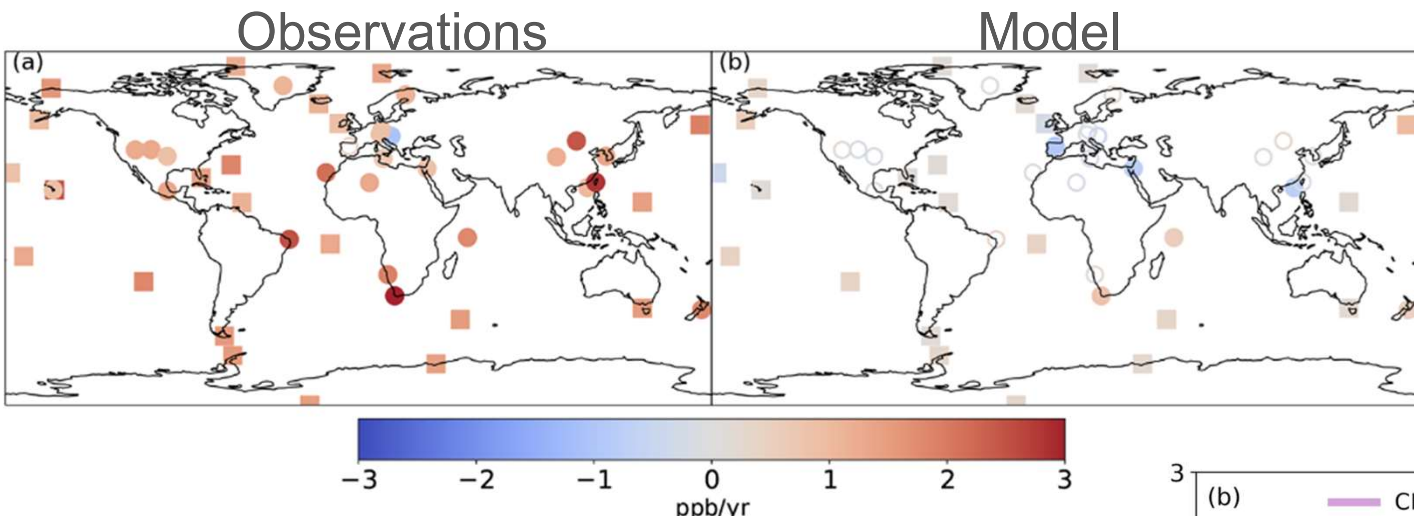


Ehhalt (2009)



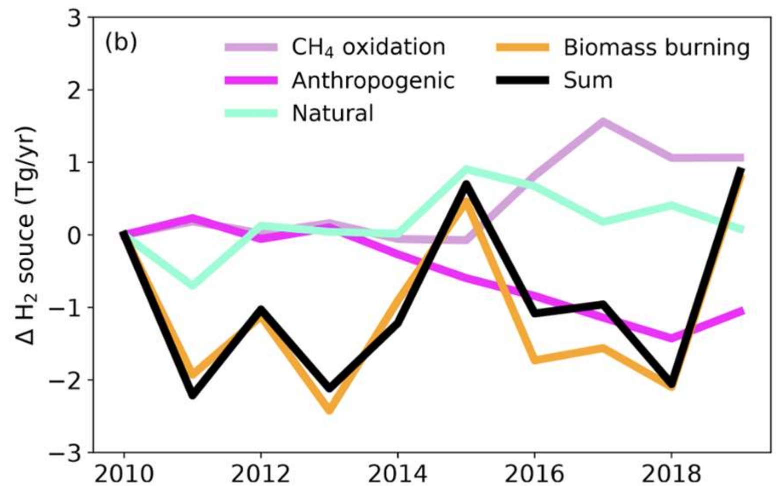
1. Similar to Ehhalt et al. (2009)
    a. Photochemical yield (CH_2O)
    b. Natural emissions
2. Except for biomass burning. GFED5 has 50% higher H_2 emissions than GFED4s
3. Anthropogenic activities account for ~40% of the overall H_2 source

BASE model fails to capture observed increase in H_2 from 2010- 2019



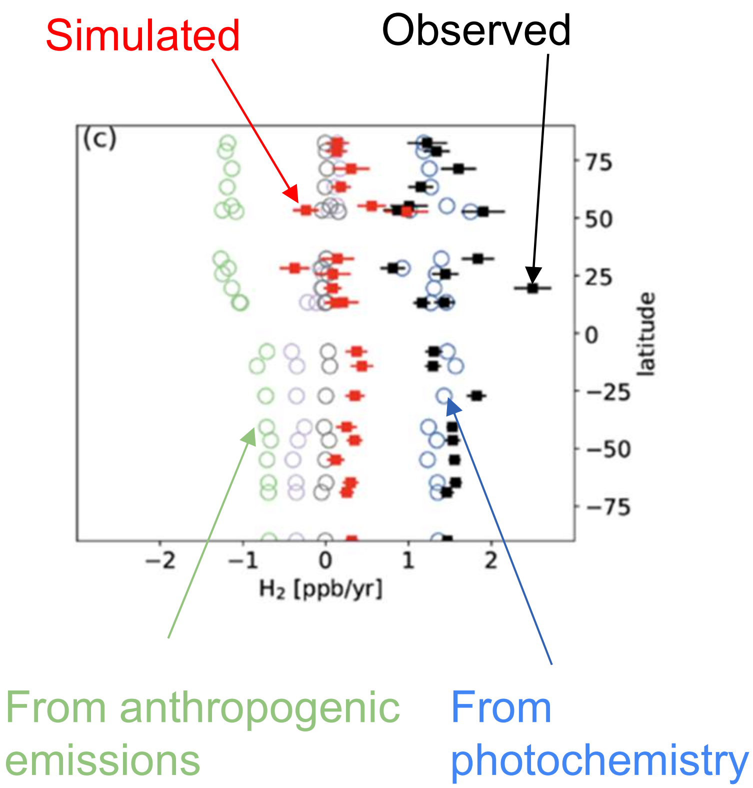
Increase at all sites (see also Derwent (2023) for Mace Head)

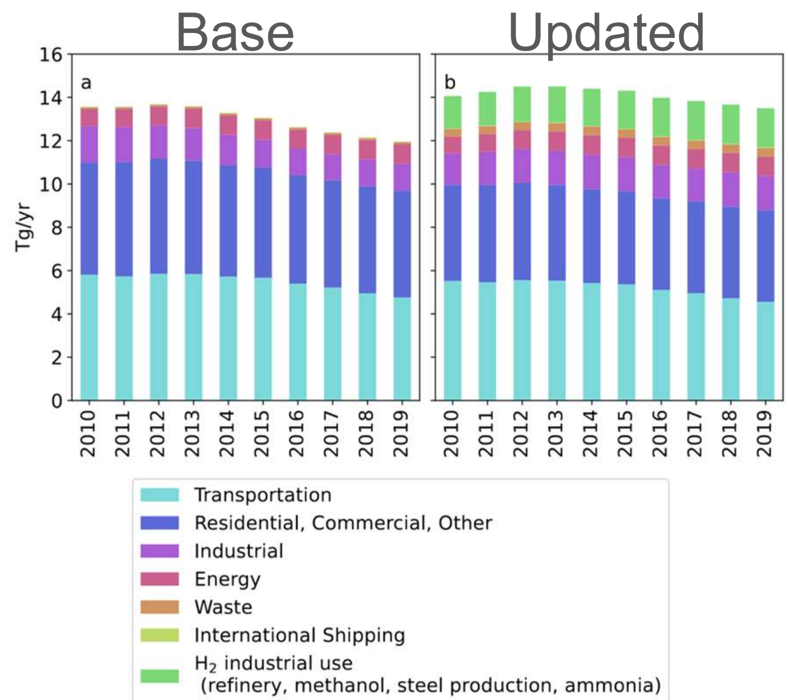
Cancellation between increasing H_2 from CH_4 and decreasing anthropogenic H_2



Anthropogenic emissions may not have declined over the last 10 years

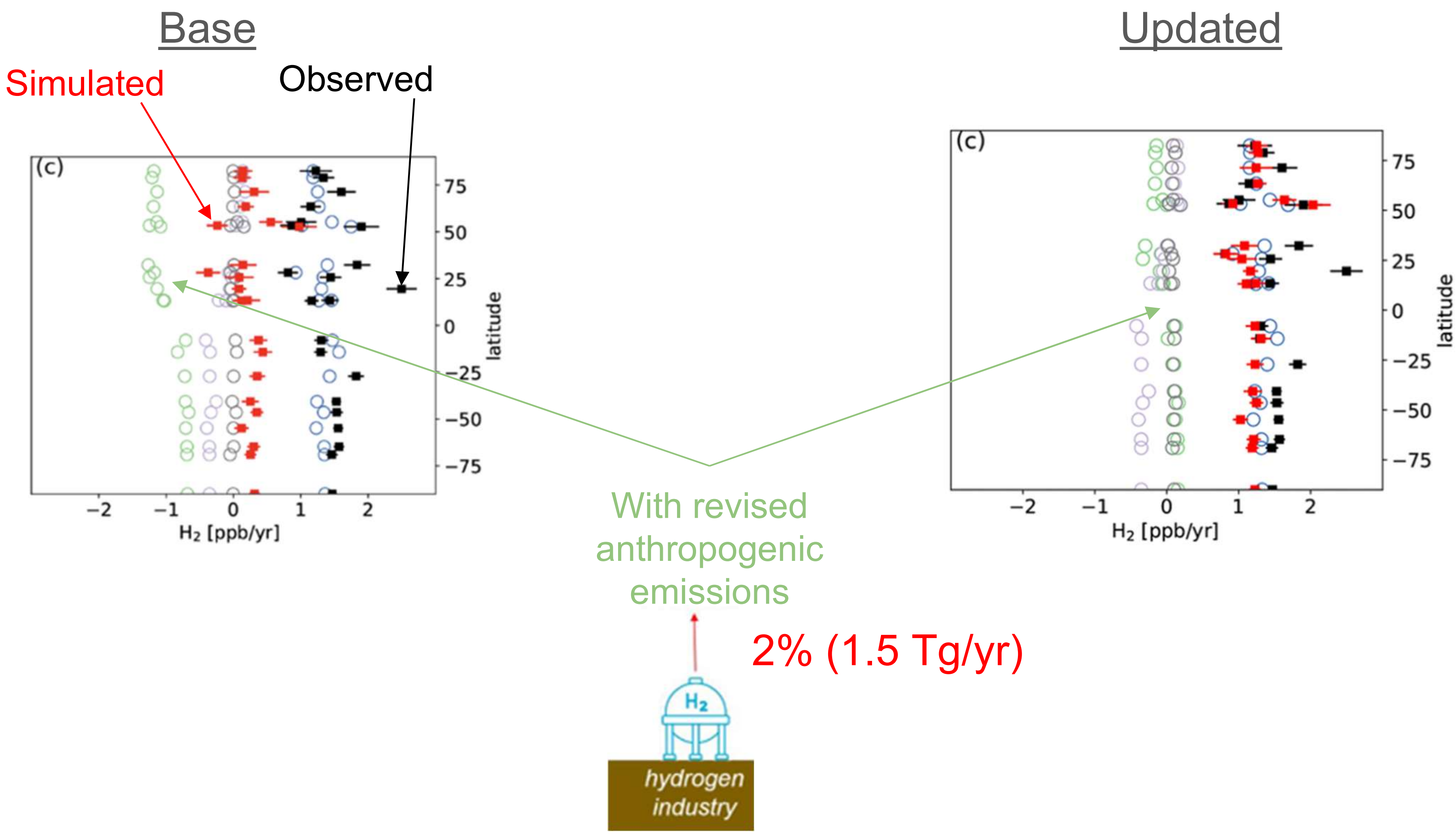
Change in H_2 at background sites





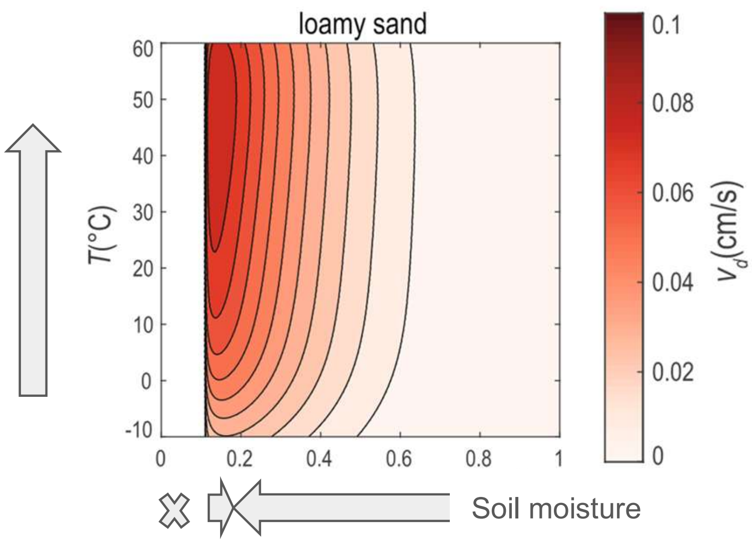
- **Fossil fuel emissions are all estimated from CO:**
  - More comprehensive treatment of fossil fuel sources of H_2 (emission standard, gasoline vs diesel, …)
  - Uncertainty in CO emissions (industry)
- **Release of H_2 from H_2 industrial use (2% - increasing)**

Updated anthropogenic emissions largely eliminate model bias



Can we really assume that the soil H_2 removal rate has remained constant?

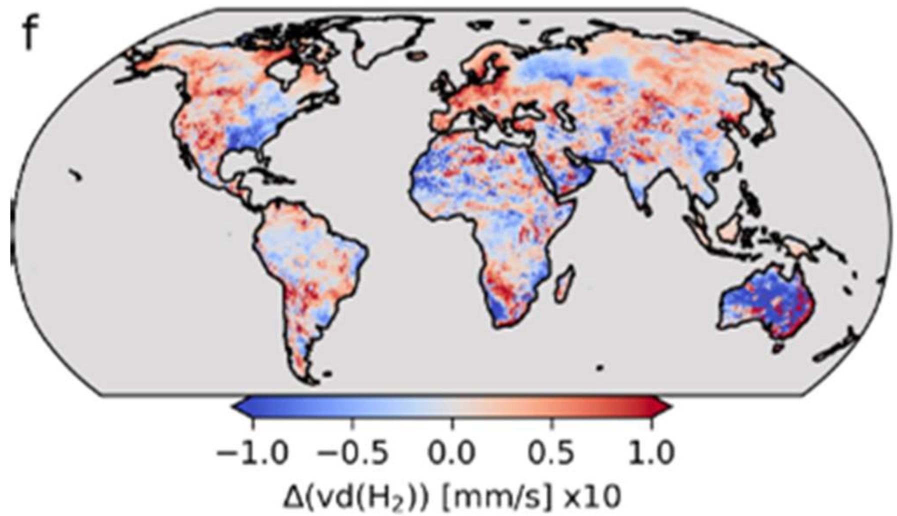
Sensitivity of vd(H_2) to (T,s)



Biology Diffusion

Bertagni et al. (2021)

Simulated change in vd
2010–2019



ow increase
uptake in the Northern Hemisphere

Drier conditions can decrease or increase H_2 uptake in arid regions