CMI Best Paper Award for Postdoctoral Fellows

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"Risk of The Hydrogen Economy for Atmospheric Methane"

Hydrogen (H_2) is a promising candidate for a low- or zero-carbon fuel, but its losses to the atmosphere impact atmospheric chemistry, including positive feedback on the atmospheric concentration of methane (CH_4), the second most important greenhouse gas. Hydrogen increases the atmospheric lifetime of methane and most of the current and near-term future hydrogen production relies on steam methane reforming, which would entail some fugitive methane emissions. In this study, we used a minimalist atmospheric model to assess the response of atmospheric methane to fossil fuel displacement by hydrogen.

Our results show that atmospheric methane may increase or decrease depending on the amount of hydrogen lost to the atmosphere and the methane emissions associated with hydrogen production. We also identified a critical hydrogen emission intensity (HEI) above which there is no benefit in hydrogen adoption for atmospheric methane mitigation. The critical HEI is around 10% for green H_2 and much lower for blue H_2, depending on methane leakage rate. Our findings underscore the importance of addressing hydrogen and methane losses when considering the potential of H_2 as a decarbonization strategy.

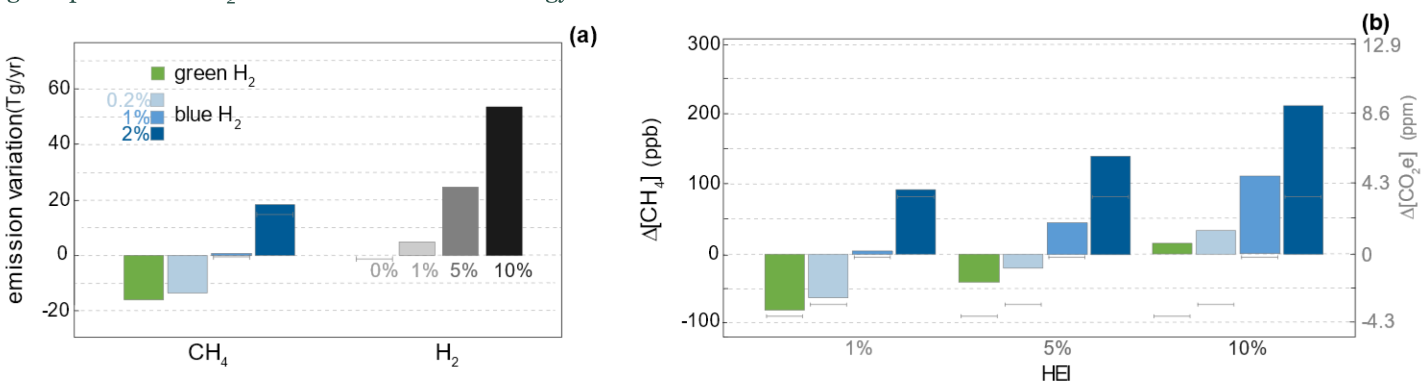

Figure 1 Methane response to increasing H2 production (500 Tg yr⁻¹). **(a)** Changes in H_2 and CH_4 emissions due to green and blue H_2 replacement of fossil fuels. **(b)** Response of CH_4 atmospheric concentration. HEI is the H_2 emission intensity. At HEI=10%, even green hydrogen leads to an increase of atmospheric methane, even though the lower methane emissions. Gray lines mark the case for HEI = 0%. The right axis shows the $\Delta[CO_2e]$ that would produce equivalent radiative forcing to the change in equilibrium CH_4.

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