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Why atmospheric methane surged in 2020?

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Methane (CH₄) levels in the atmosphere increased by 15.1 ± 0.4 ppb in 2020, the highest annual increase from 1984 to 2020, despite a likely decrease in anthropogenic CH₄ emissions during COVID-19 confinements. Here, we used bottom-up and top-down methods to quantify the changes in different sources of CH₄, and in its atmospheric sink due to the hydroxyl radical (OH) in 2020 compared to 2019. Bottom-up methods showed that, globally, total anthropogenic emissions slightly decreased by ~1.2 Tg CH₄ yr⁻¹, fire emissions were lower than in 2019 by ~6.5 Tg CH₄ yr⁻¹, and wetland emissions increased by 6.0 ± 2.3 Tg CH₄ yr⁻¹. In addition to higher wetland emissions in 2020 than 2019 from bottom-up, we found a decrease of 1.6–1.8% in tropospheric OH concentration relative to 2019, mainly due to lower anthropogenic NO_x emissions and associated lower free tropospheric ozone during the confinements. Based on atmospheric CH₄ observations from the surface network, and considering the decrease in OH, using top-down inversions, we infer that global net emissions increased by 6.9 ± 2.1 Tg CH₄ yr⁻¹ in 2020 relative to 2019, while the global CH₄ removal from reaction with OH in the atmosphere decreased in 2020 by 7.5 ± 0.8 Tg CH₄ yr⁻¹. Therefore, we attribute the positive growth rate anomaly of atmospheric CH₄ in 2020 relative to 2019 to lower OH sink (53 ± 10%) and higher natural emissions (47 ± 16%), mostly from wetlands. Warmer and wetter climate conditions in the Northern Hemisphere promoted wetland emissions, but fires decreased in the Southern Hemisphere, compared to the previous year. Our study highlights that northern microbial emissions of CH₄ are highly

sensitive to a warmer and wetter climate and could act as a positive feedback in the future. Our study also hints that the global CH₄ pledge must be implemented by taking into account NO_x emissions trend, whose reduction lengthens the lifetime of atmospheric CH₄.