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Why atmospheric methane surged in 2020?

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Methane (CH_4) 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 CH_4 emissions during COVID-19 confinements. Here, we used bottom-up and top-down methods to quantify the changes in different sources of CH_4, 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 CH_4 yr^{-1}, fire emissions were lower than in 2019 by ~6.5 Tg CH_4 yr^{-1}, and wetland emissions increased by 6.0 ± 2.3 Tg CH_4 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 CH_4 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 CH_4 yr^{-1} in 2020 relative to 2019, while the global CH_4 removal from reaction with OH in the atmosphere decreased in 2020 by 7.5 ± 0.8 Tg CH_4 yr^{-1}. Therefore, we attribute the positive growth rate anomaly of atmospheric CH_4 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 CH_4 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 CH_4 pledge must be implemented by taking into account NO_x emissions trend, whose reduction lengthens the lifetime of atmospheric CH_4.