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Interpreting changes in atmospheric methane using satellite and isotopic ratio measurements

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Methane is a potent greenhouse gas with concentrations that are rising in the atmosphere in unexpected ways. Because of its radiative efficiency and because its lifetime in the atmosphere is only around a decade, reducing atmospheric methane concentration is a major component of most pathways designed to meet climate targets. Over the past two decades, observations indicate that there have been substantial changes in the emissions and removal of methane. Yet, years later, we still do not definitively know why methane concentrations plateaued in the 2000s, increased globally after 2007 and then continued to increase at an even faster rate after 2014. This limited understanding impacts our ability to carry out targeted emissions reductions. Here, I discuss two areas of my work in addressing gaps in our knowledge. First, I discuss how high-resolution modeling can extract information from satellite data to quantify long-term changes in emissions and the underlying drivers of these changes. I show that Brazil is a unique example where major sources such as wetlands and cattle are geographically distinct and thus satellite data can be used to examine changes from particular processes. I show how in the absence of this separation, which is the case for many other parts of world, additional information such as isotopic ratios can be used to contribute to the partitioning of methane emissions into underlying sources. I also discuss the limitations in current capability to effectively use isotopic ratio measurements. I show how field experiments and simple models can be used to derive global distributions in the isotopic signatures of major sources such as wetlands, providing more consistency against observations. I discuss how incorrect assumptions about source signature distributions have a major impact on our ability to interpret atmospheric isotopic ratio measurements and that this may be one reason why we have not been able to conclusively interpret the recent atmospheric methane record.