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Constraining U.S. Sulfuryl Fluoride Emissions With Atmospheric Measurements and a Geostatistical Inverse Model

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The mean abundance of sulfuryl fluoride (SO₂F₂) in the global atmosphere has been increasing since at least the 1970s, with ambient air mole fractions exceeding 2.5 parts per trillion (ppt) today. SO₂F₂ is a synthetic pesticide and a potent greenhouse gas (GHG) used for fumigation - predominantly of wooden structures, and increasingly for agricultural and commodity products as well. Worldwide use of SO₂F₂ has surged since the use of methyl bromide (CH₃Br) for fumigation was largely phased out under the Montreal Protocol. Recent atmospheric measurements and modeling work from the Advanced Global Atmospheric Gases Experiment (AGAGE) indicates that global emissions of SO₂F₂ have reached a historic high in recent years at roughly 3.0 Gg SO₂F₂ yr⁻¹. However, under the current UNFCCC emissions reporting guidelines, countries are not required to report their emissions of SO₂F₂, and thus SO₂F₂ is not included in most national GHG emissions inventories, leading to a scarcity of information on the global distribution and magnitude of SO₂F₂ emissions. In the U.S., California is the only state that keeps a public record of statewide SO₂F₂ use, despite the gas being used for termite fumigation in other warm-climate coastal states such as Florida. To fill this information gap, we use flask-sample measurements of SO₂F₂ from the NOAA Global Greenhouse Gas Reference Network (GGGRN) and a geostatistical inverse model (GIM) to provide a measurement-based top-down constraint on the magnitude and spatial distribution of SO₂F₂ emissions across the continental U.S. We find that California emits the vast majority (>90%) of U.S. SO₂F₂ emissions, with the largest emissions coming from the California South Coast (Los Angeles, Orange, and San Diego Counties), and the second largest from the San Francisco Bay Area. Outside of California, SO₂F₂ emissions are rarely detected by the NOAA GGGRN. However, despite California's oversized contribution to U.S. SO₂F₂ emissions, a significantly large fraction (>50%) of the 3.0 Gg yr⁻¹ global emissions budget is still emitted elsewhere. We will present insights gained from the NOAA GGGRN measurements and our inverse modeling work, including a case study on California's SO₂F₂ emissions and reconciliation with California state SO₂F₂ usage records.

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