Formaldehyde Trend Analysis from Satellite Observations and Ground Measurements

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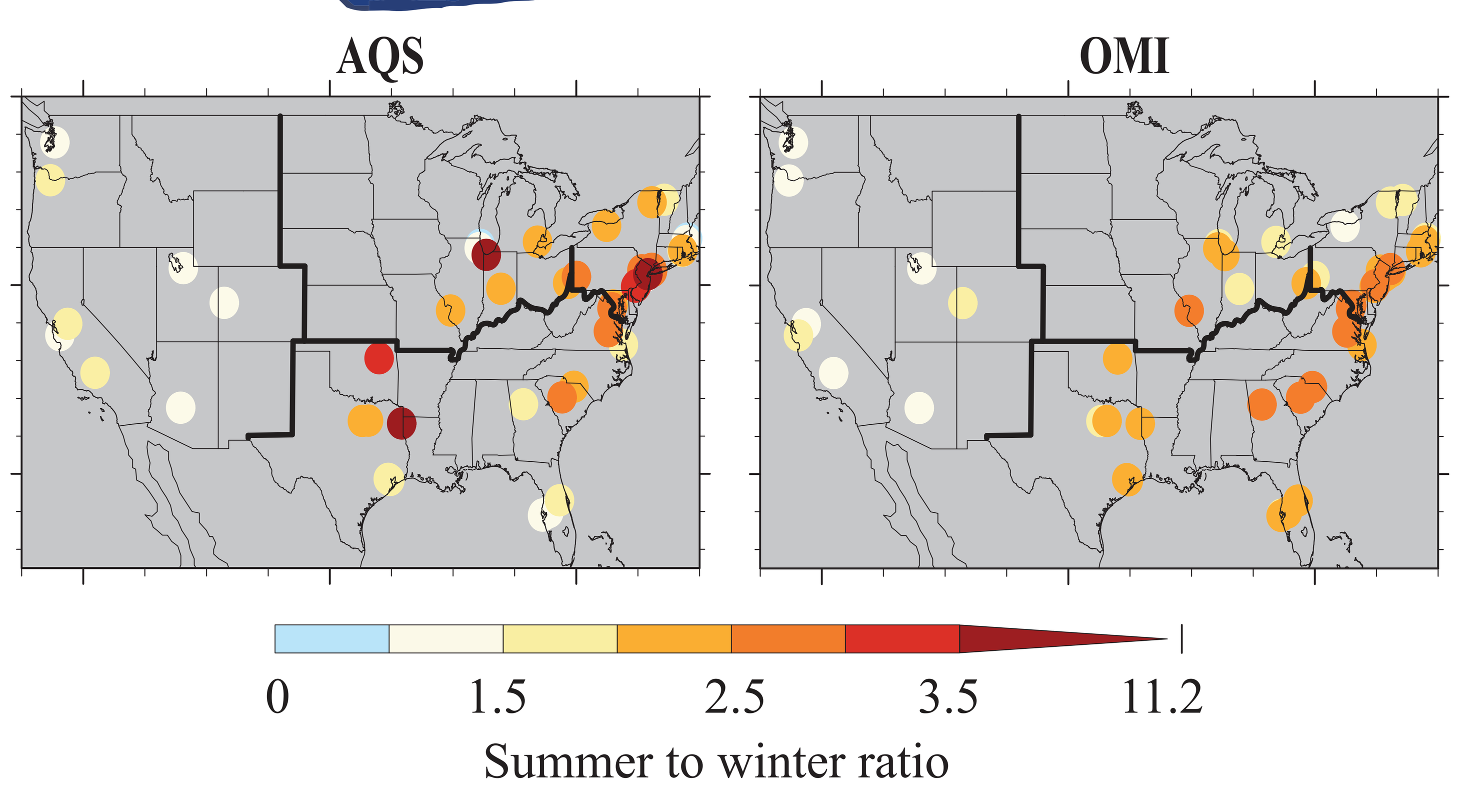
Introduction

Formaldehyde (HCHO) is a carcinogen and mutagen that has been categorized by U.S. Environmental Protection Agency (EPA) as one of the 187 Hazardous Air Pollutants (HAPs). HCHO on continents is mostly secondary, formed by oxidation of non-methane volatile organic compounds (VOCs). Among anthropogenic VOCs, fuelwood production, utilizations of gasoline and biomass burning are major emission sources. The dominant biogenic VOC is isoprene, which comes from vegetation that reacts with the hydroxyl radical (OH).

Measurements of HCHO include *in situ* and remote sensing. Chromatography is commonly used for ground monitors managed by EPA. Current satellite instruments that detect HCHO include Ozone Monitoring Instrument (OMI), Ozone Mapping and Profiler Suite (OMPS) and Global Ozone Monitoring Experiment-2 (GOME-2).

Observations of HCHO advance understanding of atmospheric chemistry, and they support air quality management to protect public health. Combined with satellite-derived NO_2, HCHO has also been used to support assessment of ozone production regime and used in decision-making contexts.

Seasonal Variability

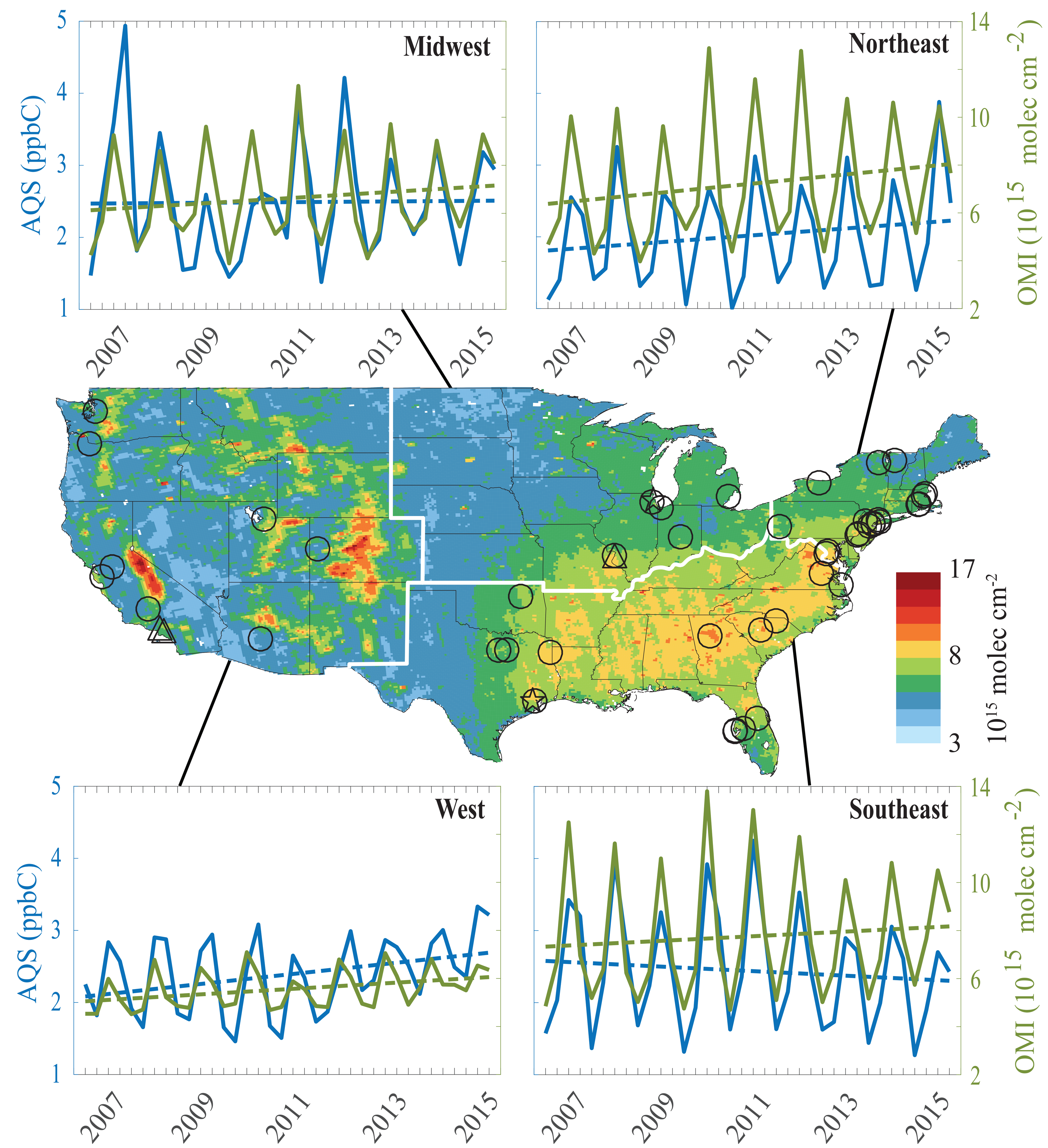


2007-2015 average seasonal variability, defined as summer to winter ratio. **Both OMI and AQS indicate low HCHO seasonal variability in West U.S. and high variability in the Northeast.**

Data & Methods

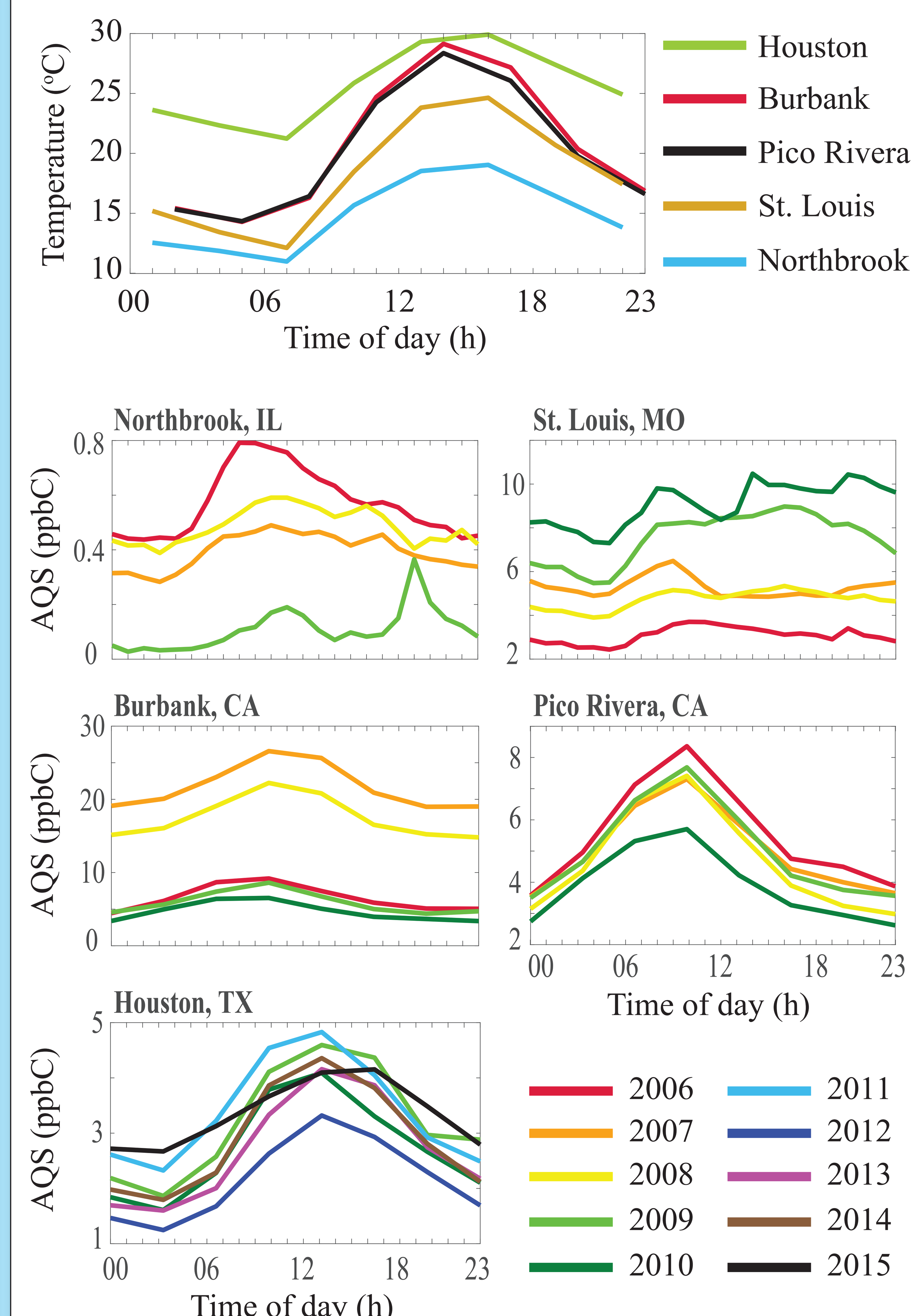
	Data Source	Analysis	Spatial Coverage
Satellite HCHO	OMI	Seasonal Inter-annual	Oversampled to 12 × 12 km^2
Ground HCHO	EPA AQS	Diurnal Seasonal Inter-annual	48 daily sites 5 hourly sites
Temperature	NARR	Diurnal Seasonal	Resolution of 32 × 32 km^2
Emissions	EPA NEI	Inter-annual	County level State level

Inter-annual Trends



Map in the middle shows 2007-2015 average OMI HCHO, with AQS stations labeled in black markers. During this time range, there were 337 ground stations that measure HCHO, but only 48 of those have at least 12 samplings in a season continuously, and only 5 sites have > 10 % available diurnal measurements. **Compared by seasonal average trends both from AQS and OMI, HCHO was observed to increase in all four regions, but with a decrease in the Southeast from AQS.**

Diurnal Cycles



Top figure indicates 2007-2015 average temperature from NARR at 3-hour intervals at 5 diurnal AQS sites. Figures after temperature are HCHO diurnal average in July, August and September. **Warmer temperature is associated with sharper mid-day peaks and higher concentrations of HCHO.**

Main Findings

- Satellite retrievals of HCHO can complement the limited network of ground-based monitors.
- On a regional average basis, OMI and AQS show similar inter-annual trends and seasonal variability of HCHO.
- Both OMI and AQS show a higher end of seasonal change in HCHO in the Eastern U.S. and lower in the Western U.S.

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