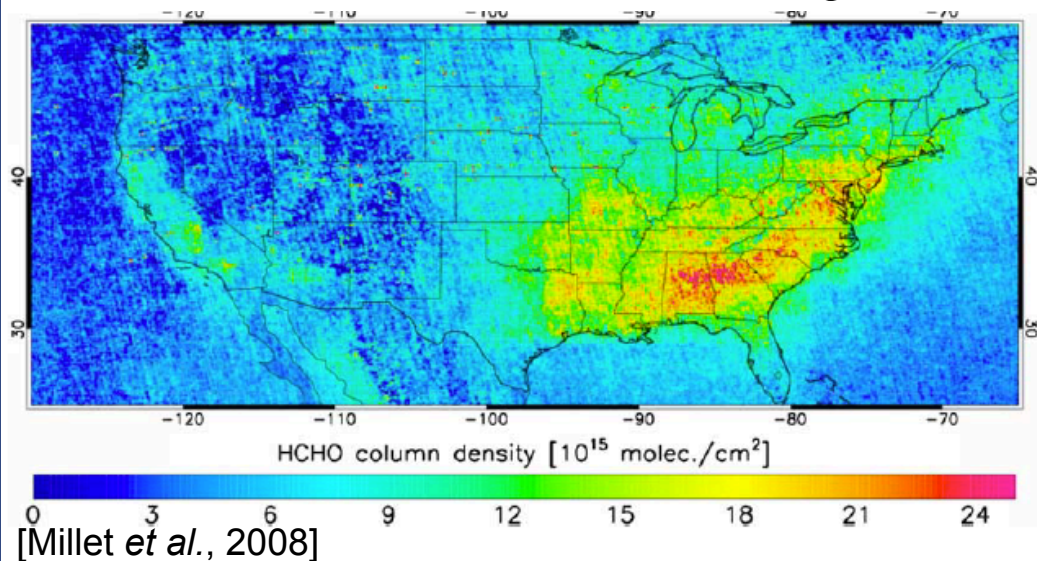


Anthropogenic emissions of highly reactive VOCs (HRVOCs) inferred from oversampling of OMI formaldehyde (HCHO) columns

And its application to Houston-Galveston-Brazoria (HGB) area

OMI HCHO 2006 JJA average



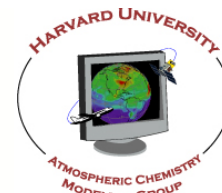
Lei Zhu¹, Daniel Jacob¹,
Loretta Mickley¹, Yasuko
Yoshida², Bryan Duncan²,
Eloïse Marais³, Kelly
Chance⁴

01/15/2014

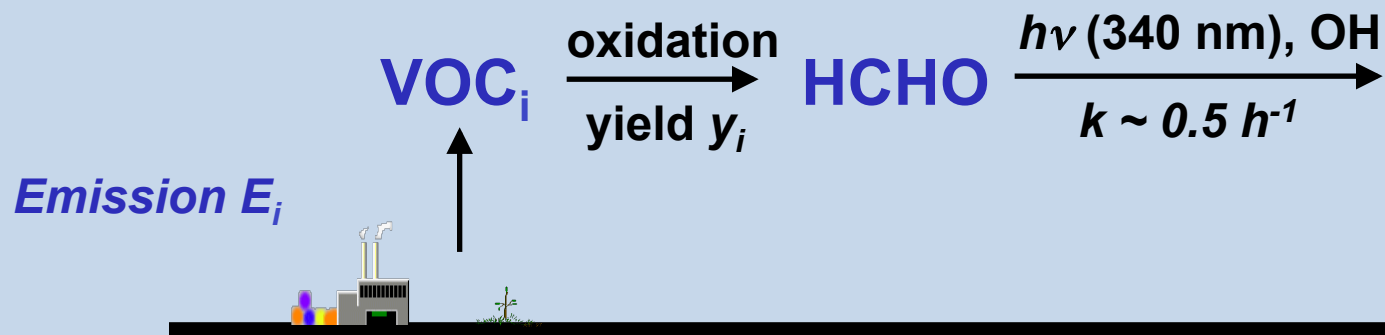
AQAST6

¹Harvard School of Engineering and Applied Sciences;

²Atmospheric Chemistry and Dynamics Laboratory, NASA Goddard Space Flight Center; ³Harvard Department of Earth and Planetary Sciences; ⁴Harvard-Smithsonian Center for Astrophysics



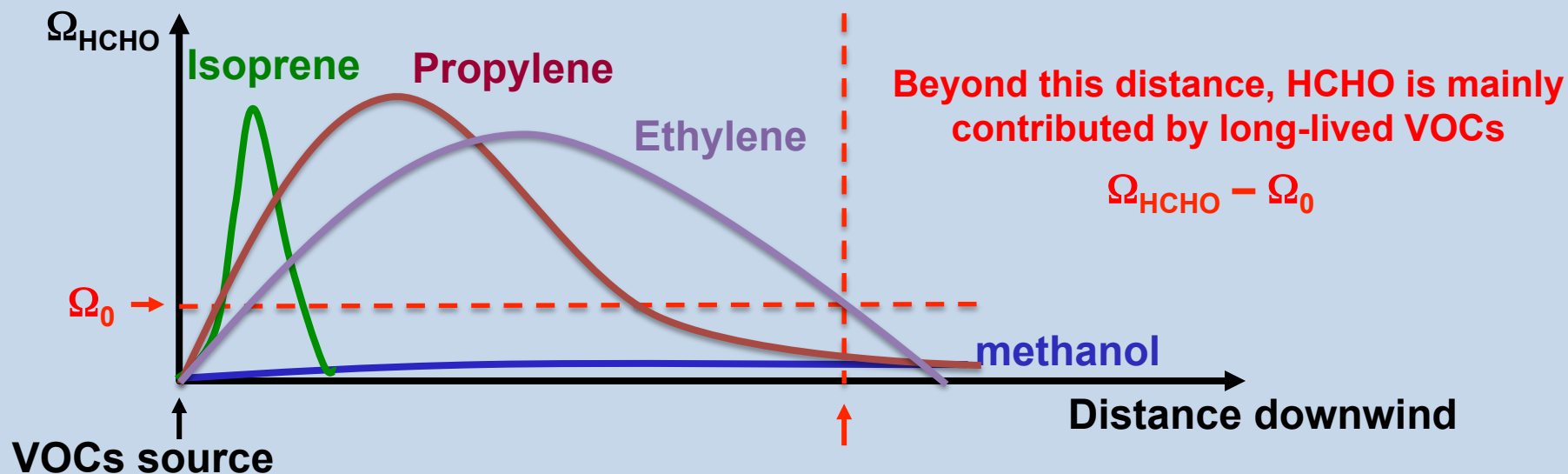
Relating HCHO columns to HRVOCs



In absence of horizontal wind, mass balance for HCHO column Ω_{HCHO} :

$$\Omega_{\text{HCHO}} = \frac{\sum_i y_i E_i}{k}$$

but wind smears this relationship

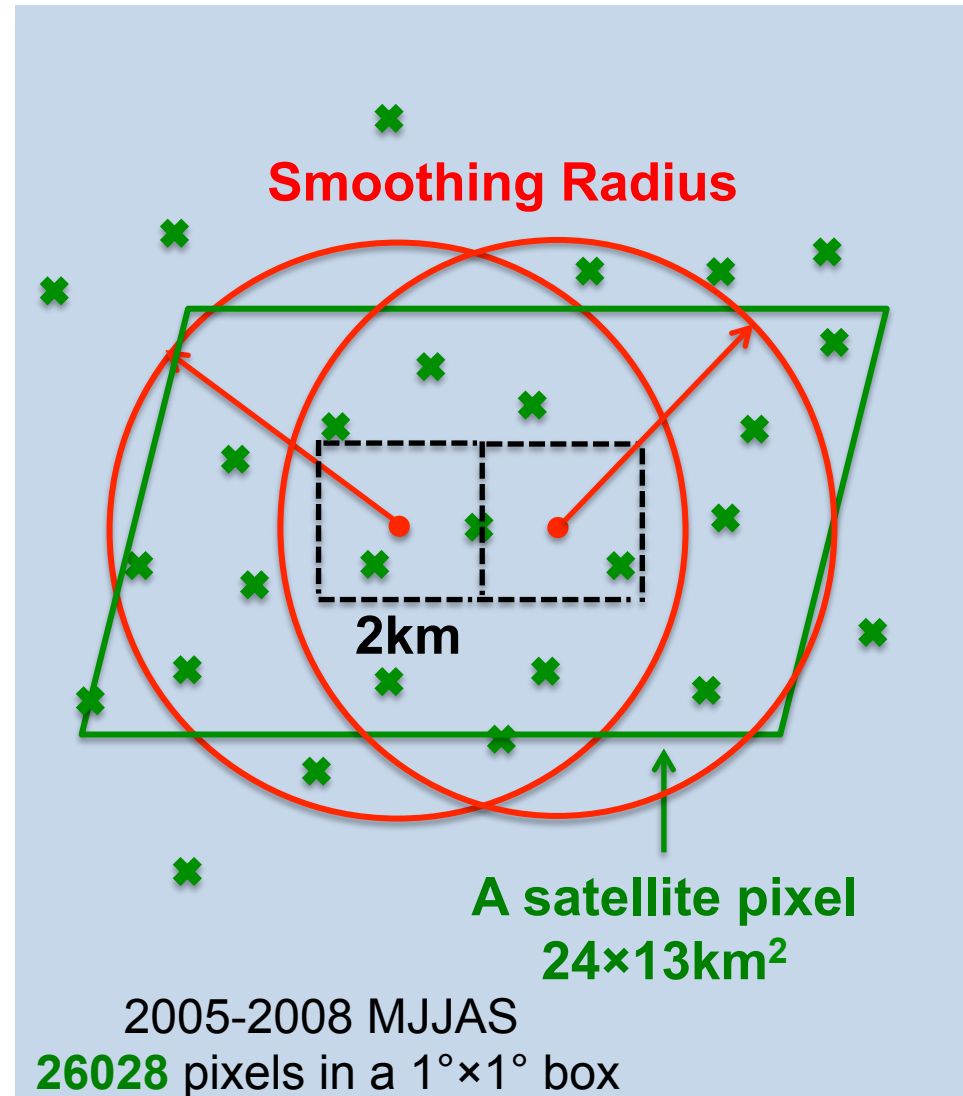


Oversampling approach to detect point sources

- Oversampling: temporal averaging of the satellite data on a spatial grid **much finer** than the pixel resolution of the instrument
- Takes advantage of the spatial offset and changing geometry of the satellite pixels from day to day
- **Trades** temporal for spatial resolution
- Achieves higher signal-to-noise ratio data

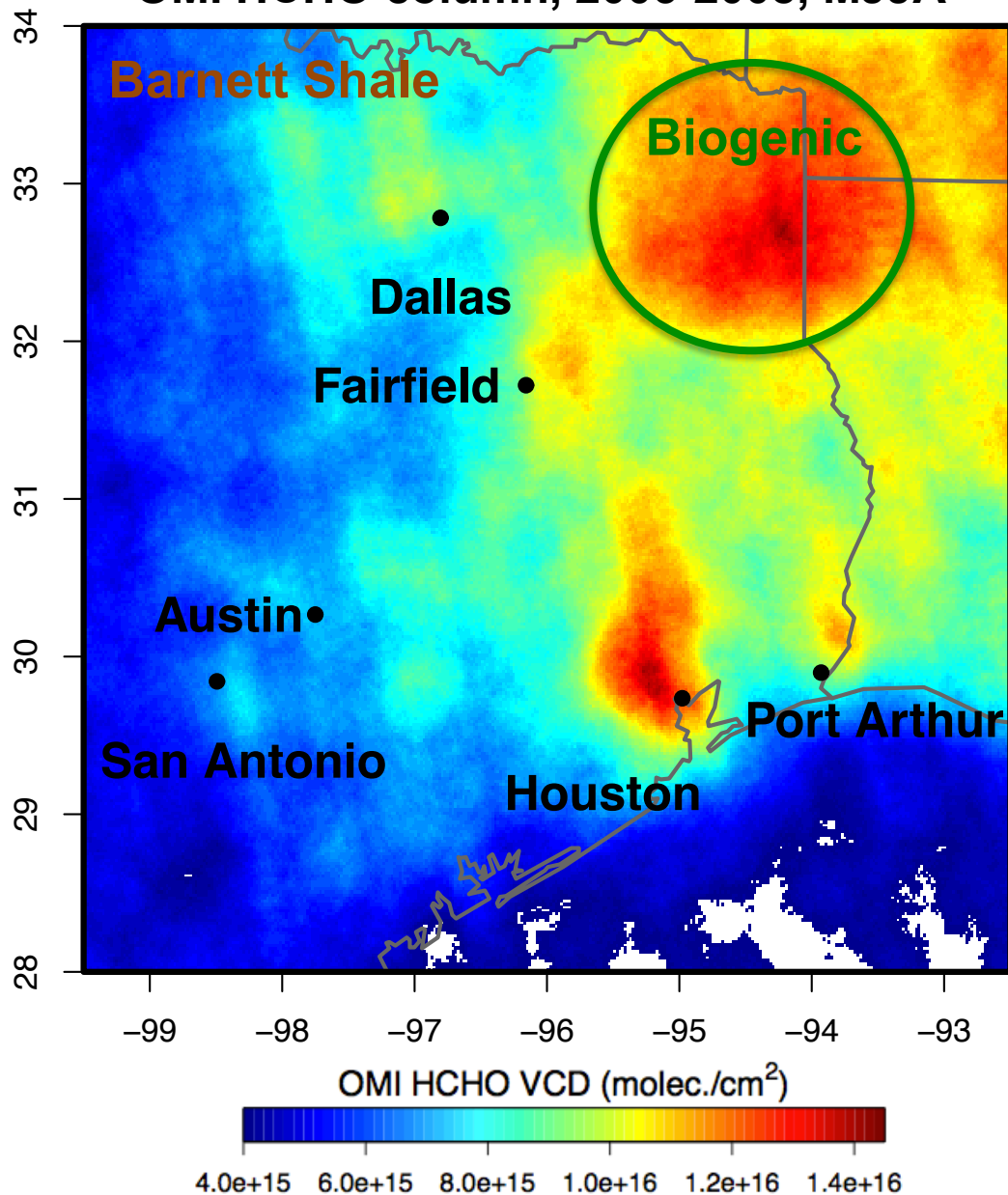
Optimize smoothing radius:

- Too fine (12 km): Increase noise
- Too coarse (36 km): Lose spatial features

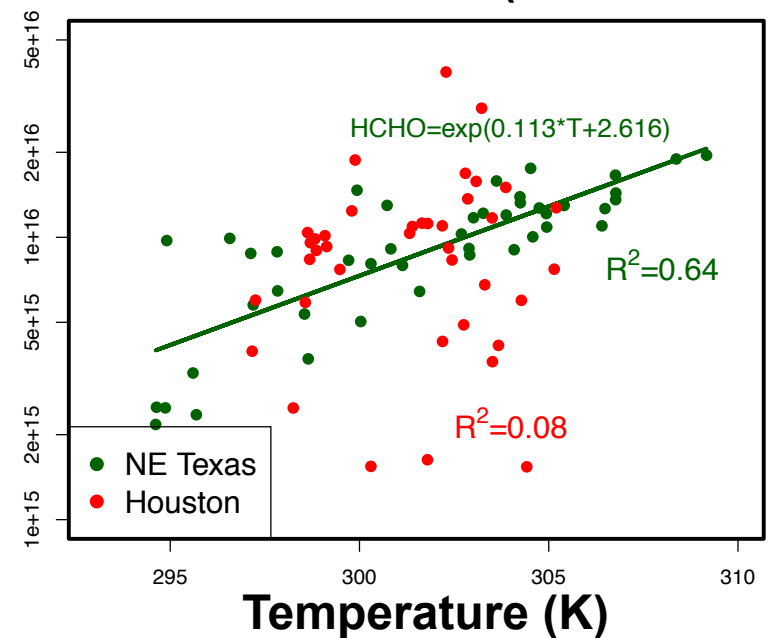


Results: Oversampling of OMI HCHO pixels

OMI HCHO column, 2005-2008, MJJA

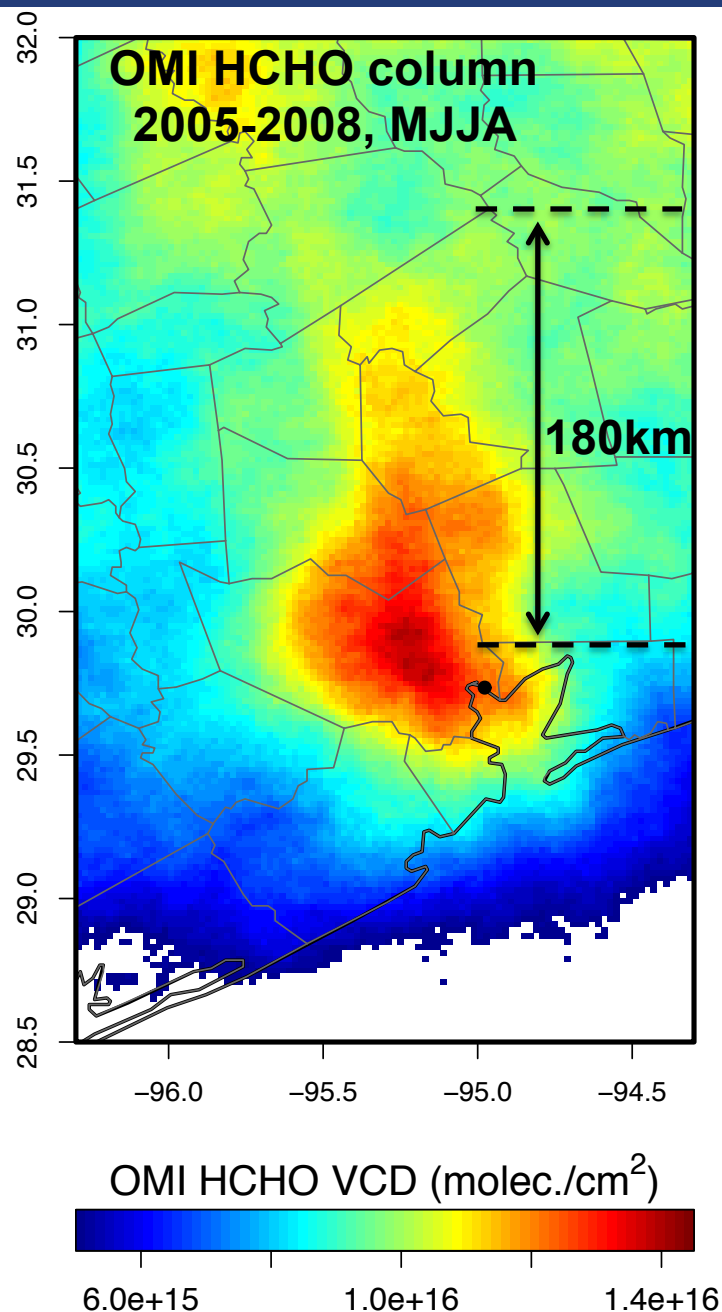


OMI HCHO column (molec./cm²)



Oversampling approach enables detection of anthropogenic HRVOCs from point/urban sources and gas operations.

Reactivity-weighted HRVOCs emissions in HGB area based on top-down approach



Integration of HCHO columns over HGB

HCHO VCD

$$E_{HRVOCs}^{Top-down} = k \iint (\Omega - \Omega_0) dA$$

HCHO loss rate

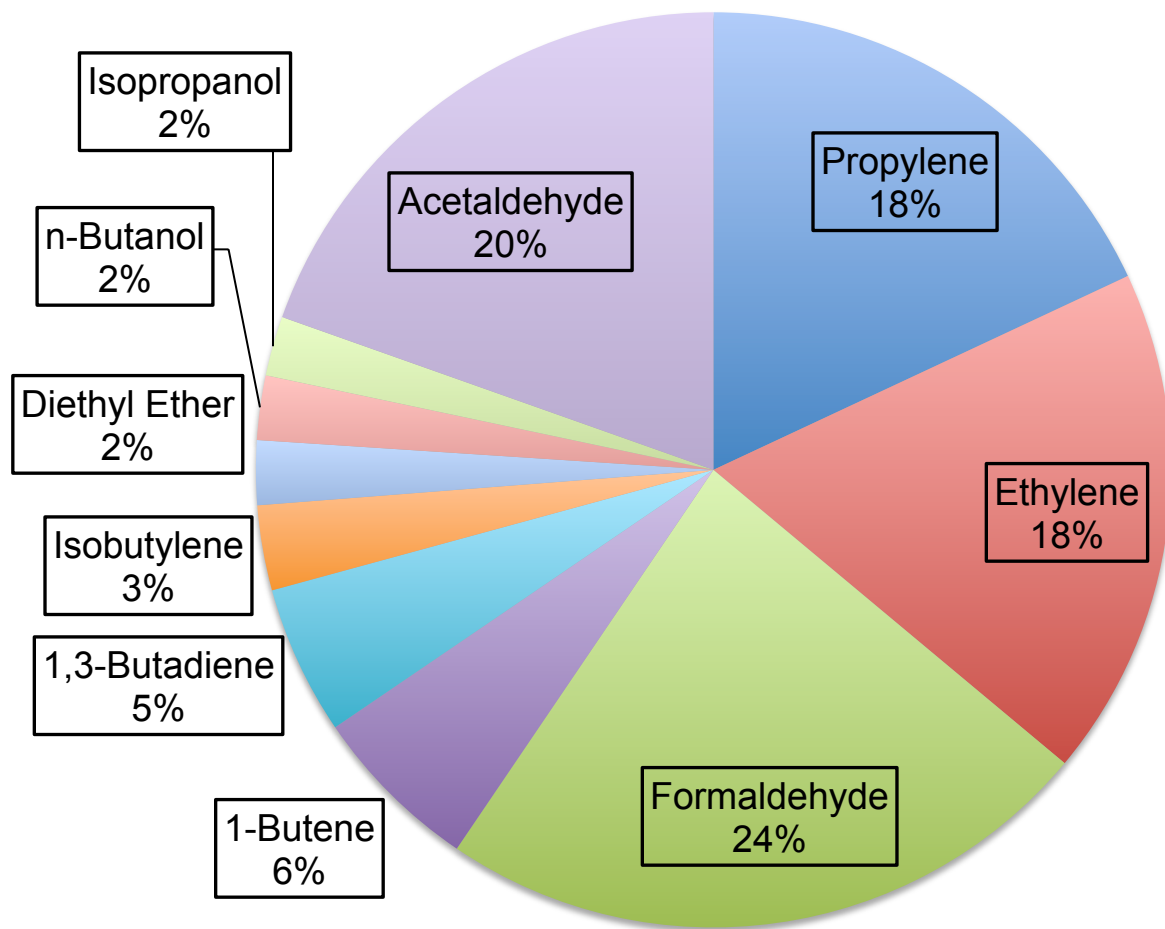
HCHO VCD from long-lived VOCs

Reactivity-weighted HRVOCs in HGB

Top-down constraint: **13.7±5.2 Gg C/year**
NEI08 estimation: **4.5 Gg C/year**

Parrish *et al.* [2012]: **25.2±1.1 Gg C/year**

HRVOCs emissions and secondary HCHO in HGB area



10 HRVOCs emissions from NEI08
Total=9.1 Gg C/year

Understanding relative contribution of secondary play an important role in developing ozone control strategies

Secondary HCHO contribution near Houston:

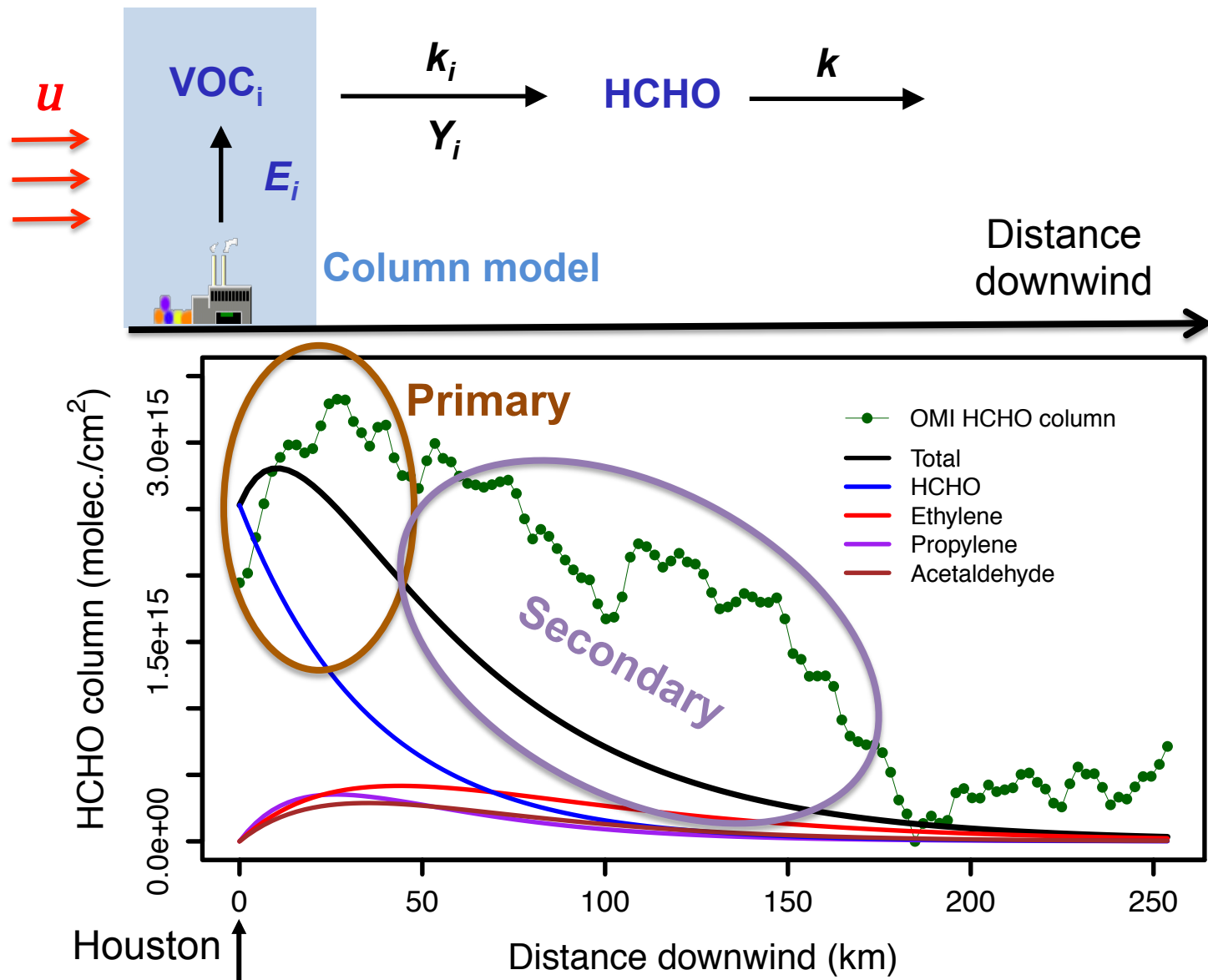
24±17%,
Rappenglück, *et al.*, [2010]

36%,
Guven and Olaguer [2011]

63%,
Friedfeld *et al.*, [2002]

92%,
Parrish *et al.*, [2012]

Distinguish primary and secondary HCHO based on plume structure



NEI08 underestimates secondary HCHO by 3~6 times

Take home messages

Oversampling of OMI HCHO columns provides a **new** solution to the long-standing problem of detecting and quantifying anthropogenic HRVOCs emissions from space

Top-down constraint shows reactivity-weighted HRVOCs emission in HGB is 13.7 ± 5.2 Gg C/year, **3.0 ± 1.2** times higher than that estimated using NEI08

AQ managers:
Are there any specific areas or periods that you would want me to look at?

HCHO columns can go as fine as **0.02 degree (~2 km)!**

2005-2008, available
2008-now, processing

Other urban areas?
VOCs point sources regions?
Gas/oil fields?
Trends?

Thank you!