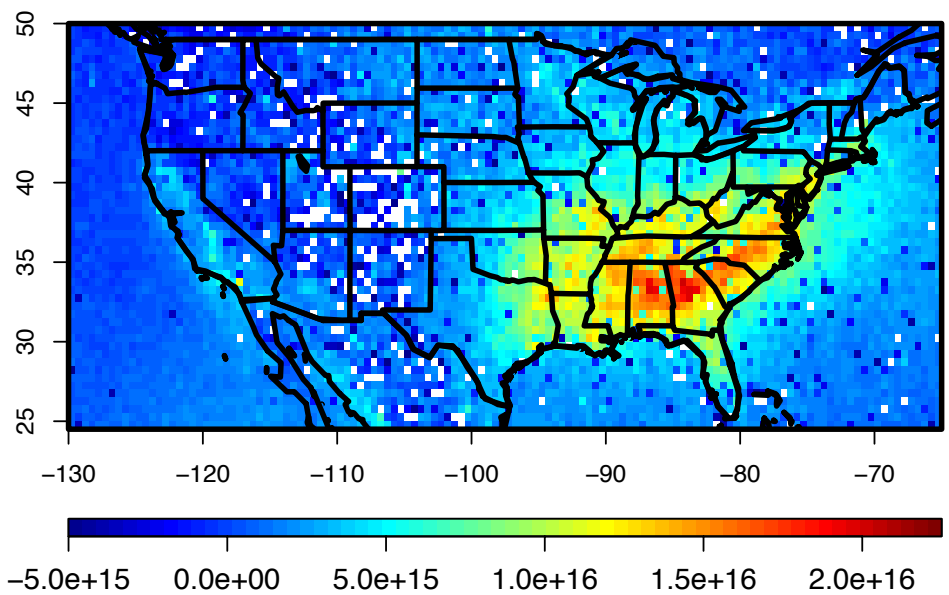
Variability of HCHO over the United States: Implications for VOCs Emissions

OMI HCHO, 2006-2008 JJA average



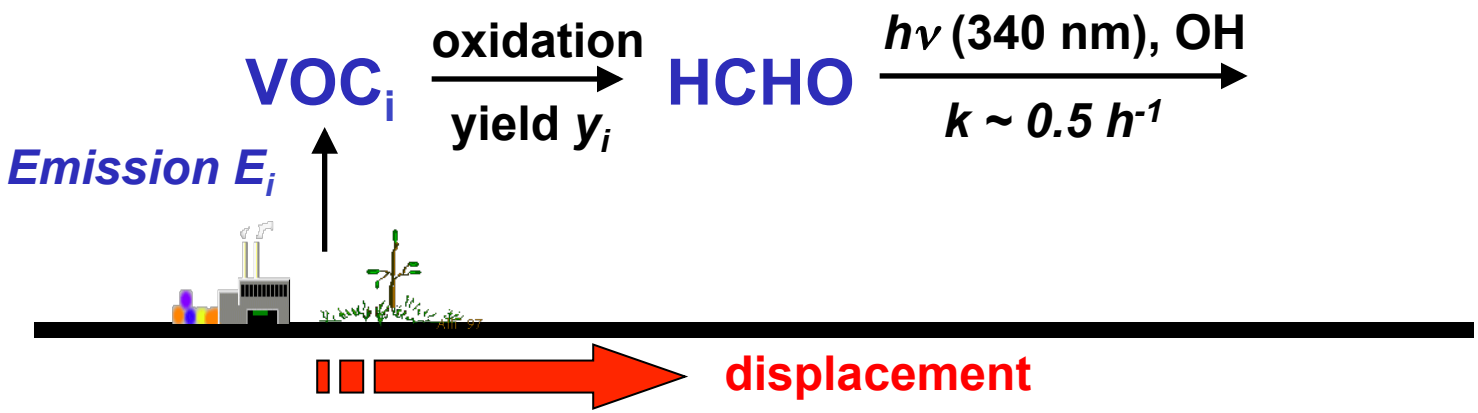
Lei Zhu, Loretta Mickley, Daniel Jacob, Kelly Chance, Dan Cohan, Isabelle De Smedt, Yang Chen, Eloïse Marais, Barry Lefer, James Flynn, Caroline Nowlan

June 4th, 2013

AQAST5

Thanks to: Tiger Team and Investigator Project Funding

Relating HCHO columns to VOCs emissions

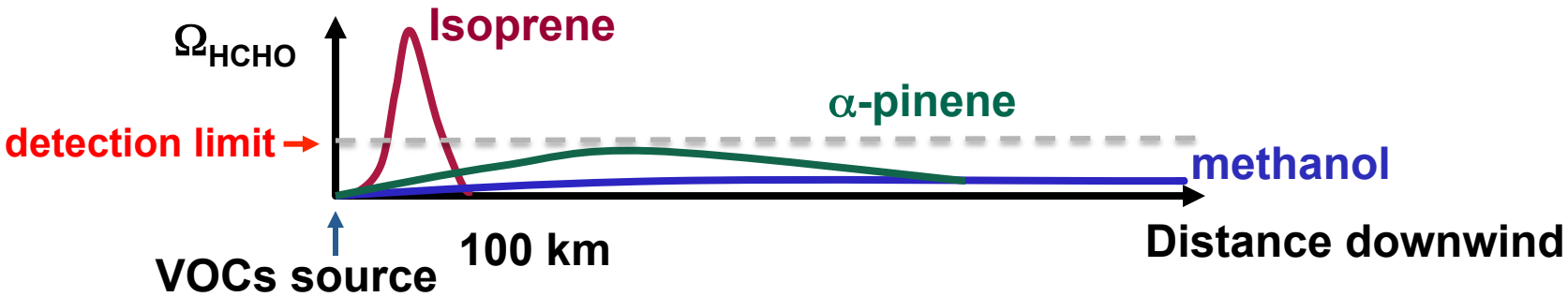


In absence of horizontal wind, mass balance for HCHO column Ω_{HCHO}:

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

Local linear relationship between HCHO column and *E*

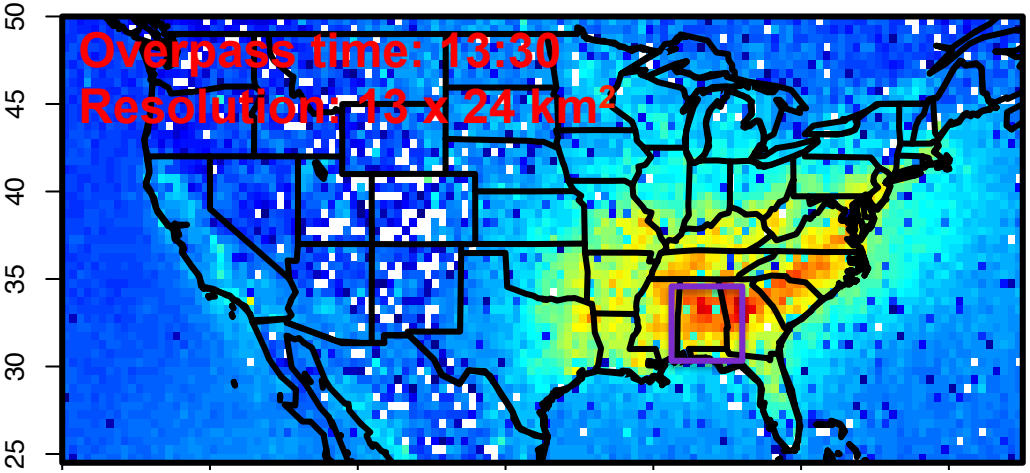
but wind smears this relationship depending on VOC lifetime wrt HCHO production:



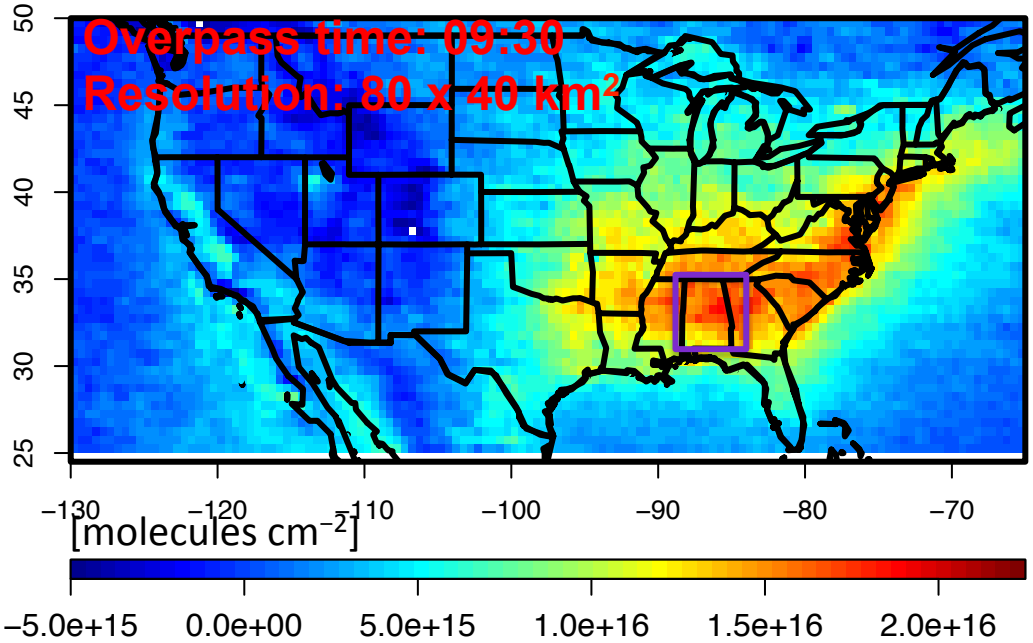
HCHO is mainly sensitive to isoprene emission with smearing ~ 10-100 km

OMI is failing for HCHO, but GOME-2 provides continuity

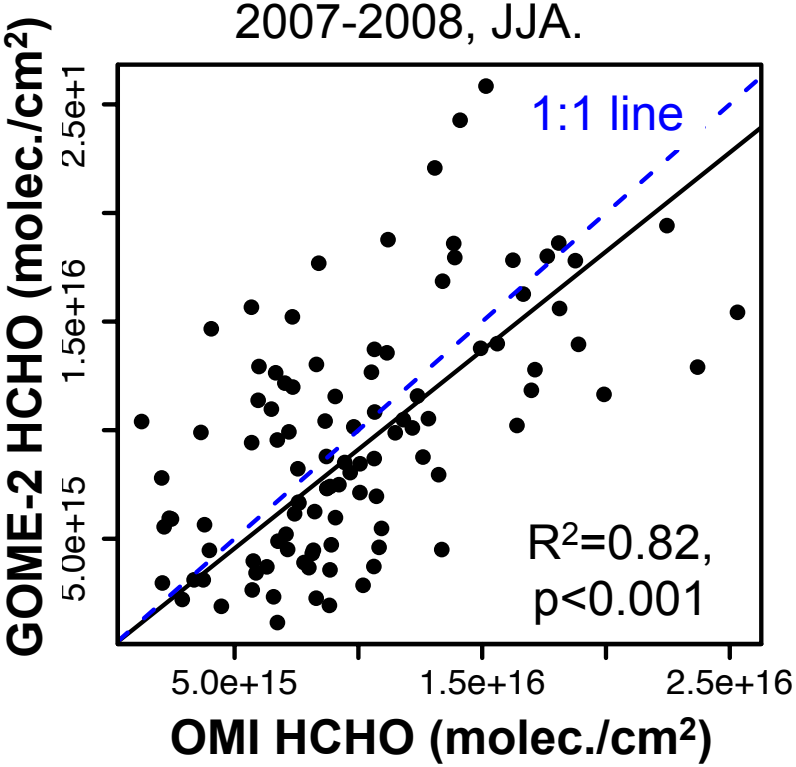
OMI, 2006-2008 JJA average



GOME-2, 2007-2009 JJA average



Daily HCHO over the SE. U.S. 2007-2008, JJA.

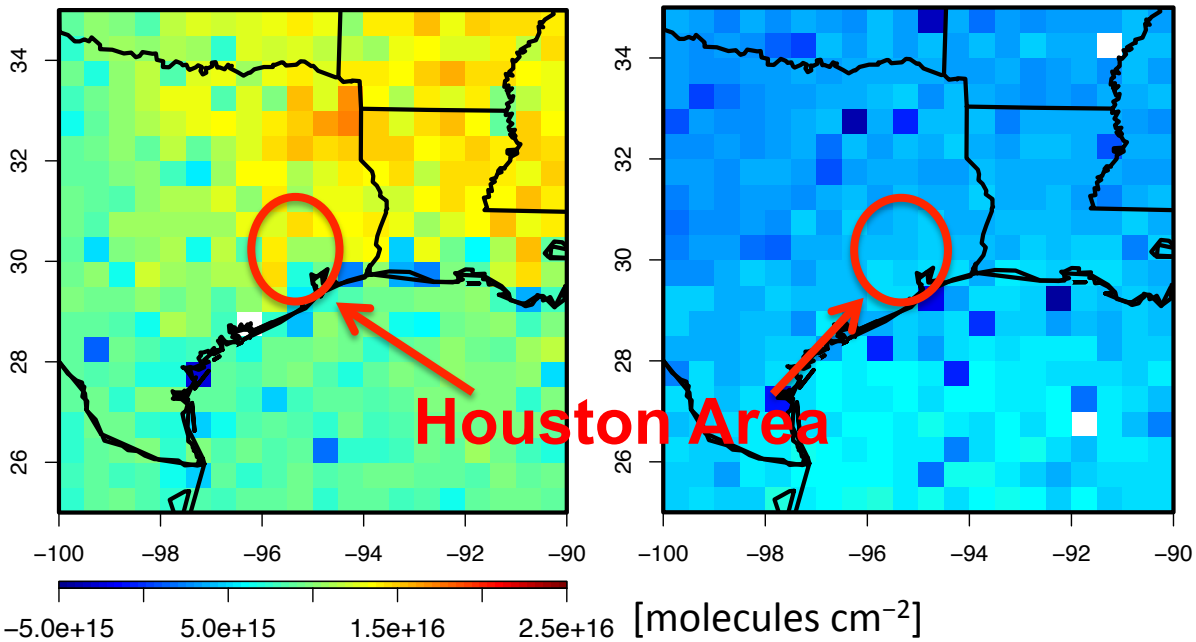


GOME-2 can provide the data continuity of HCHO after the degradation of OMI since 2008.

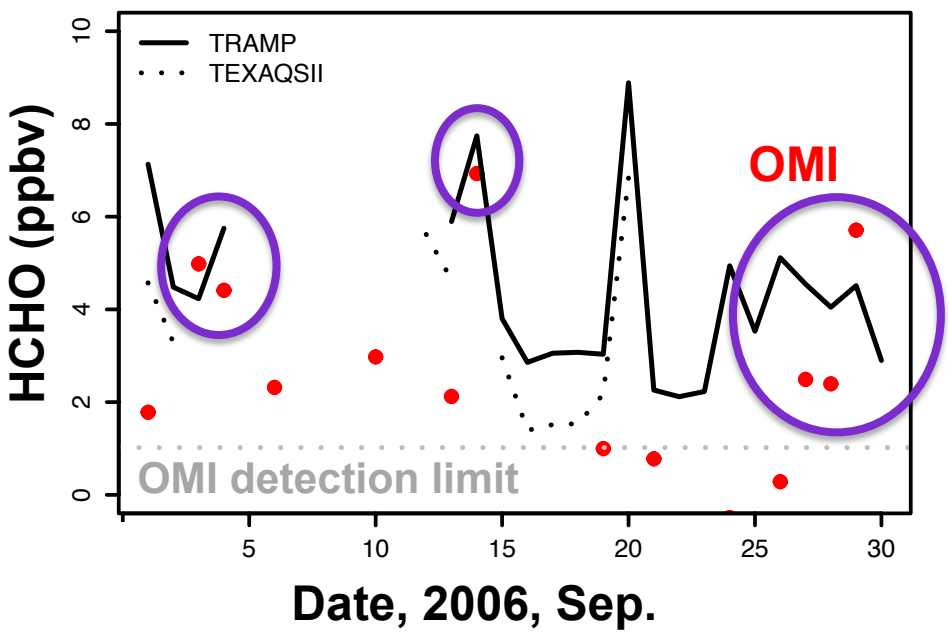
Beyond GOME-2: TROPOMI (2015) and TEMPO (2019)

Detection of anthropogenic VOCs from space: Houston area

OMI HCHO columns, 2005-2008 **JJA** average

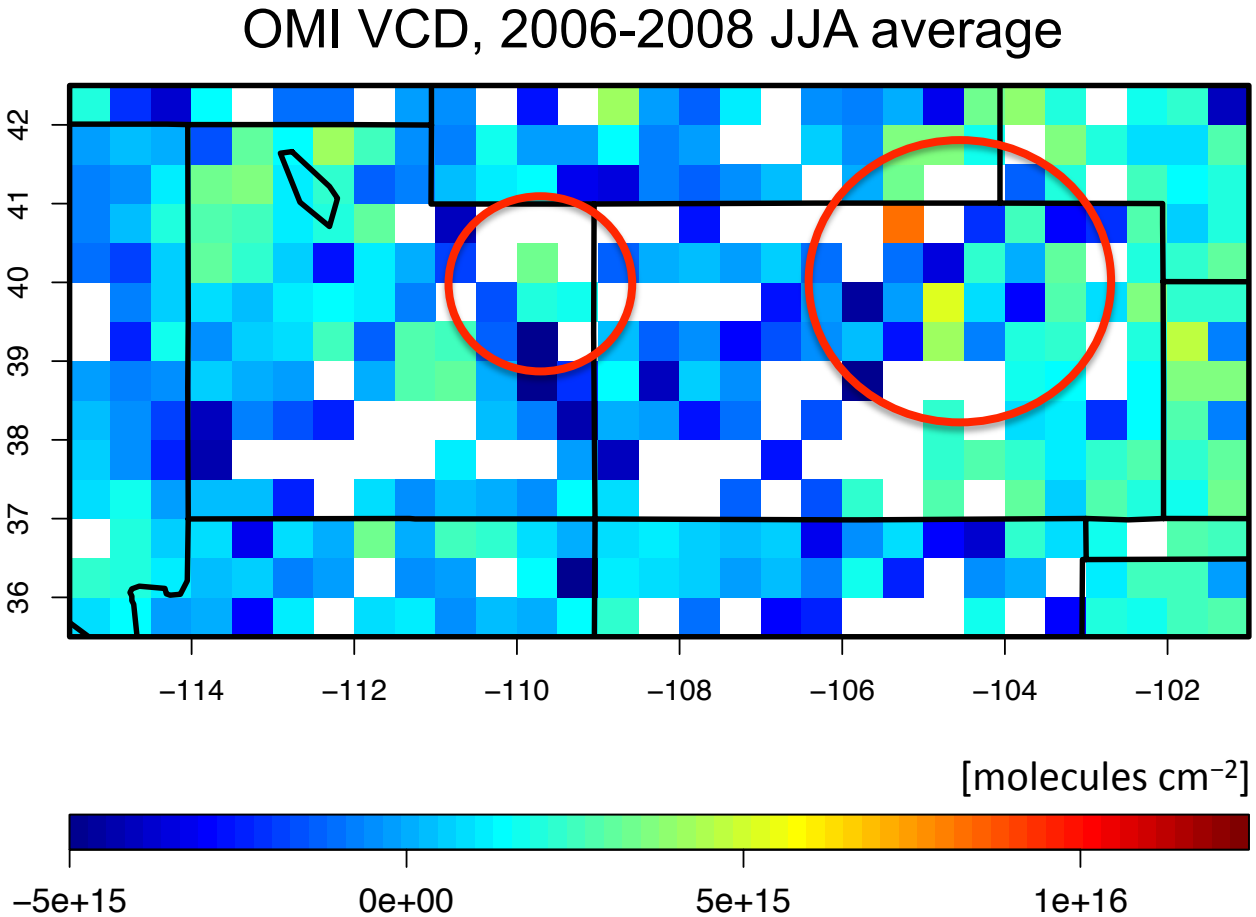


OMI HCHO columns, 2005-2008 **DJF** average



Even in Houston, high anthropogenic VOCs emissions are only marginally detectable – not reactive enough?

Searching for HCHO signals from oil/gas operations in western US



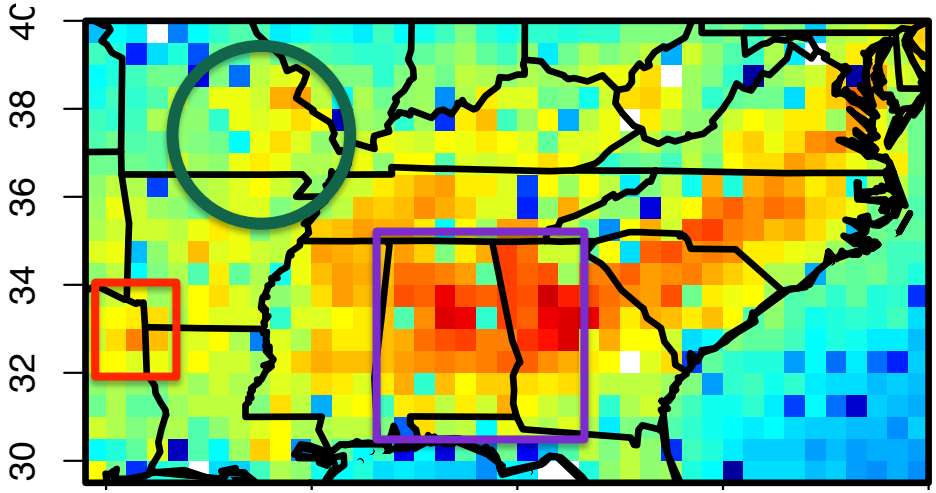
Difficulties in detecting/searching known anthropogenic VOCs sources due to:

(a) long life time, thus long smearing length, of anthro. VOCs

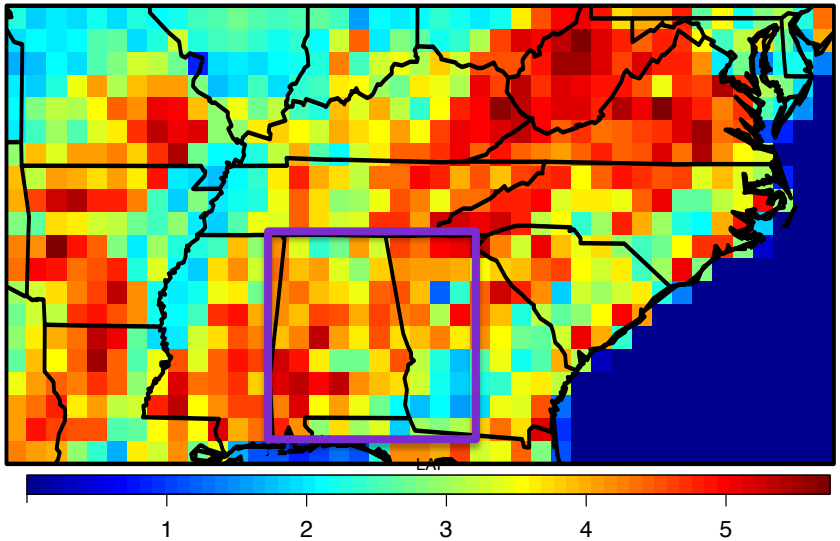
(b) noise associated with the retrievals.

HCHO as a proxy of isoprene emission

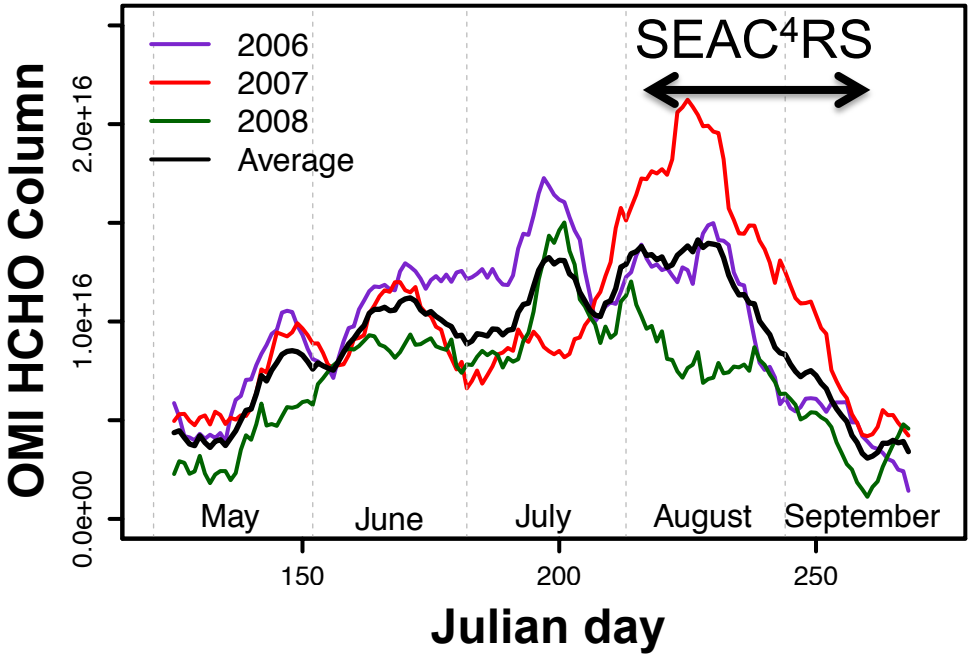
OMI HCHO, 2006-2008 JJA average



MODIS LAI, 2006-2008 JJA average



Daily OMI Column, 2006-2008 JJA, SE. U.S.



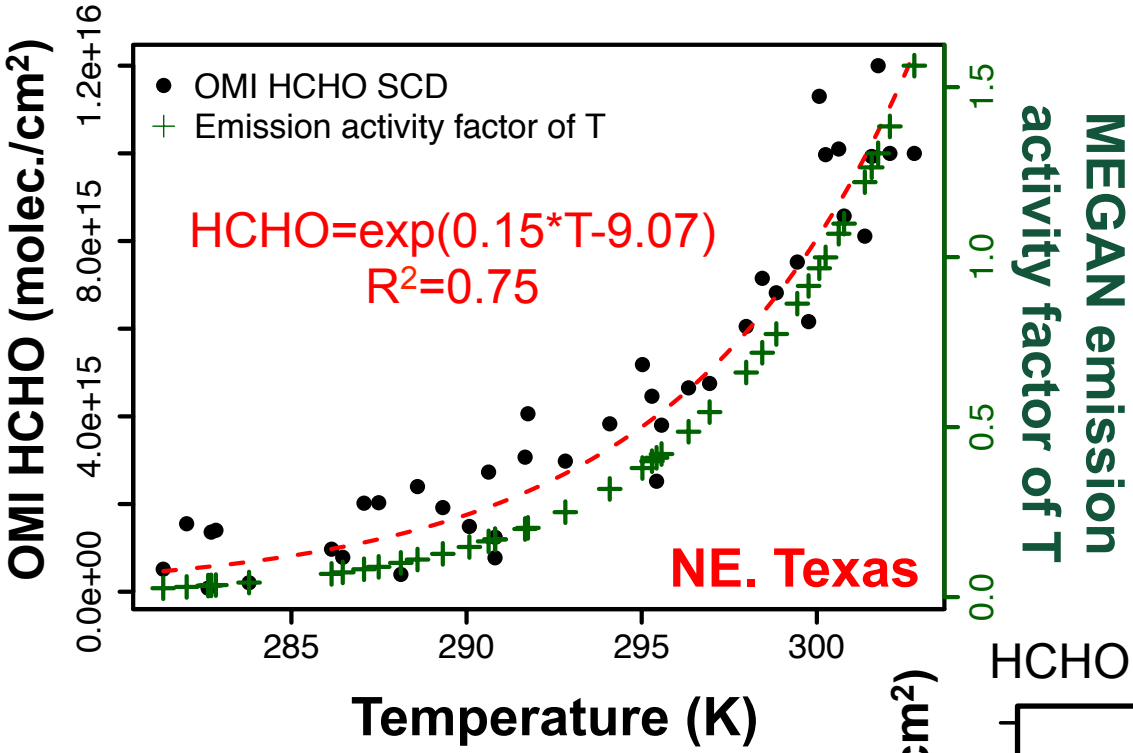
Main features of spatial distribution:

(a) Hot spots over the **SE. U.S.**

(b) HCHO over **Ozark "isoprene volcano"** is not very high.

Short-term variability of HCHO is due to seasonality of isoprene emissions.

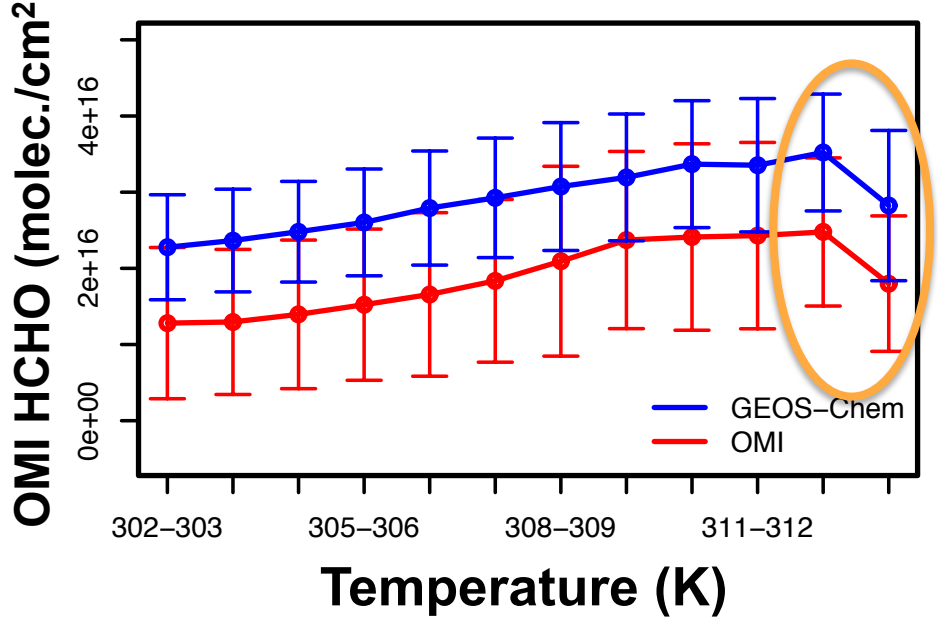
Temperature dependence of isoprene emission: how good are current models?



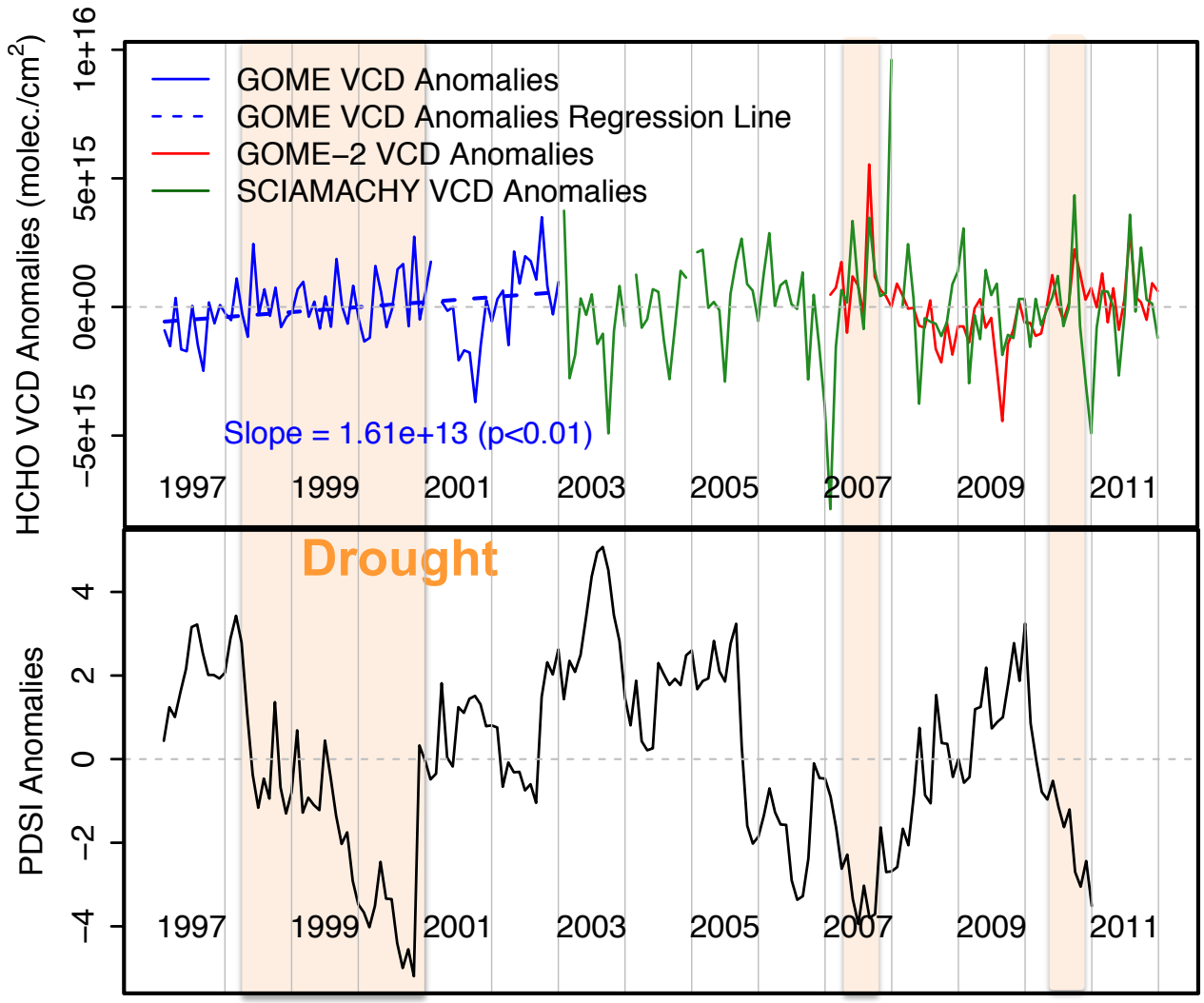
HCHO column shows a robust exponential T dependence of isoprene emission.

However, a turn-over of isoprene emission occurs around 313 K.

HCHO vs. T controlled for soil moisture



Long-term trend of HCHO over the southeast U.S.



Monthly HCHO VCD and PDSI
(Palmer Drought Severity Index)

PDSI data from Dai et al., [2004]

A increasing HCHO trend 1997-2002 is associated with an increasing drought conditions.

Isoprene emission increases during drought. **Why? Temperature?**

For long term IAV of isoprene, **other factors** (e.g., soil moisture, land use change) may become important.

R^2 between anomalies in growing seasons

	GOME HCHO	GOME-2 HCHO
PDSI	0.40	0.47
T	0.16	0.36

Thank you!

HCHO Retrievals

Tropospheric Emission Monitoring Internet Service,

TEMIS

[De Smedt *et al.*, 2008, 2012]

GOME

SCIAMACHY

GOME-2

97 98 99 00 01 02 03 04 05 06 07 08 09 10 11

Vertical Column Density

Slant Column Density

CfA

Harvard CFA, Chance & Nowlan

GOME-2

OMI

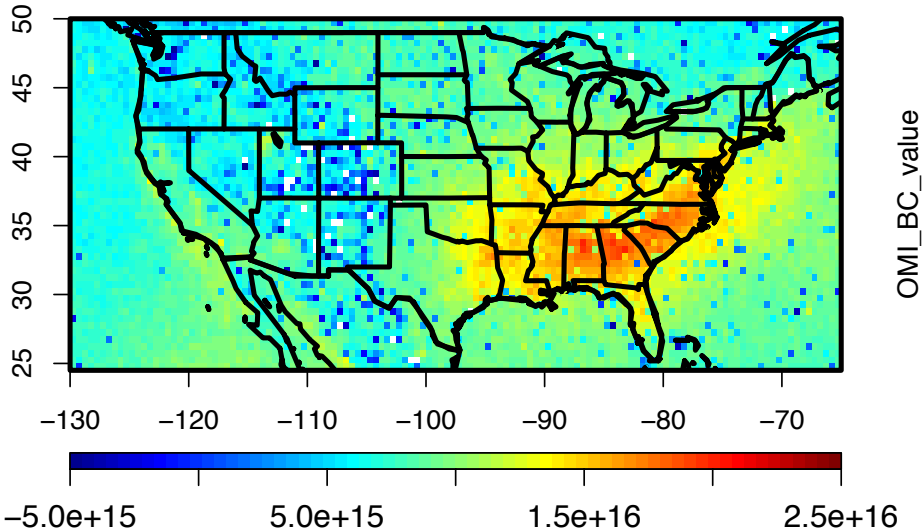
GOME-2

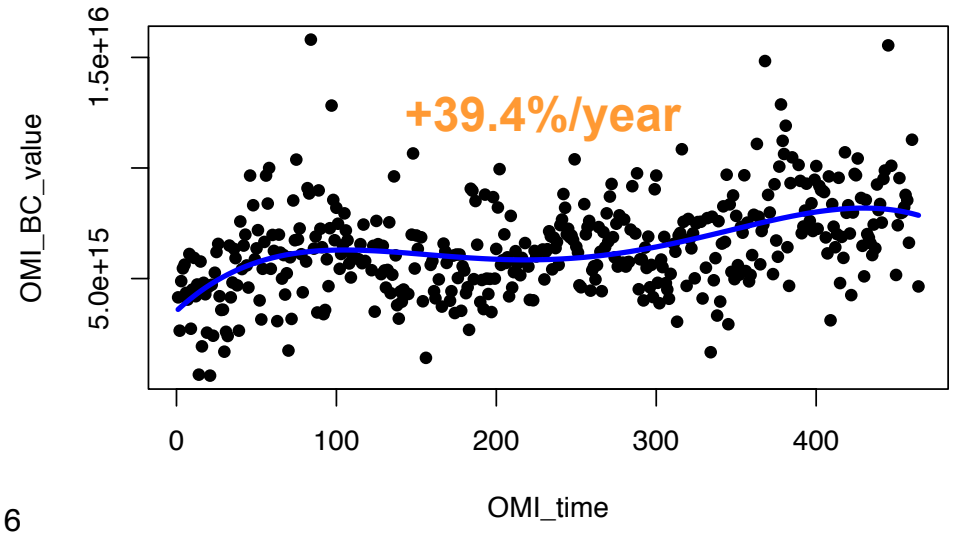
OMI

OMI Row Anomaly

Background Correction

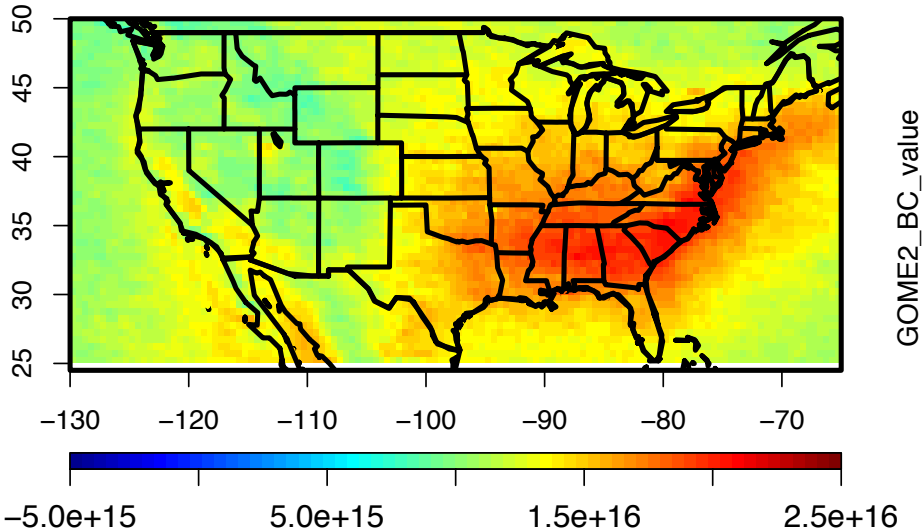
OMI 2006-2008, JJA, SCD without BC

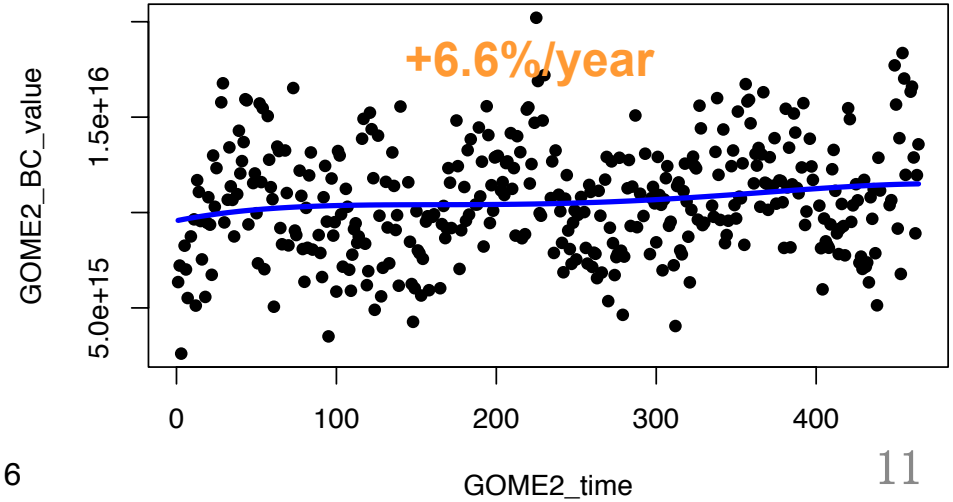




GOME-2 2007-2009, JJA, SCD without BC

A 4th order polynomial





Kim *et al.*, 2011; Marais *et al.*, 2012