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

OMI HCHO, 2006-2008 JJA average

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Relating HCHO columns to VOCs emissions

In absence of horizontal wind, mass balance for HCHO column $\Omega_{\text{HCHO}}$:

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

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

HCHO is mainly sensitive to isoprene emission with smearing $\sim 10$-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 HCHO (molec./cm²)

OMI HCHO (molec./cm²)

\( R^2 = 0.82, \quad p < 0.001 \)

1:1 line

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

Detection of anthropogenic VOCs from space: Houston area

Even in Houston, high anthropogenic VOC 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?

OMI HCHO SCD
+ Emission activity factor of T

HCHO = \exp(0.15 \times T - 9.07)

R^2 = 0.75

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

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

R² between anomalies in growing seasons

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<thead>
<tr>
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<th>GOME HCHO</th>
<th>GOME-2 HCHO</th>
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<tr>
<td>PDSI</td>
<td>0.40</td>
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<td>T</td>
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PDSI data from Dai et al., [2004]
Thank you!
HCHO Retrievals

Tropospheric Emission Monitoring Internet Service,

[De Smedt et al., 2008, 2012]

Vertical Column Density

Slant Column Density

Harvard CFA, Chance & Nowlan

GOME

SCIAMACHY

GOME-2

OMI

OMI Row Anomaly
Background Correction

OMI 2006-2008, JJA, SCD without BC

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

A 4\textsuperscript{th} order polynomial

Kim \textit{et al.}, 2011; Marais \textit{et al.}, 2012