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Supplement of

Observing atmospheric formaldehyde (HCHO) from space: validation and intercomparison of six retrievals from four satellites (OMI, GOME2A, GOME2B, OMPS) with SEAC^{4}RS aircraft observations over the southeast US

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Table S1 Summary of different HCHO retrievals validated and intercompared in this work

	OMI-SAO (V003)	OMI-BIRA	GOME2A-BIRA (V14)	GOME2B-BIRA (V14)	OMPS-SAO	OMPS-PCA
Fitting window (nm)	328.5–356.5	328.5–346.0	328.5–346.0	328.5–346.0	327.7–356.0	328.5–356.5
Spectral resolution (nm, at 340 nm)	0.42	0.42	0.27	0.28	~1	~1
Fitted species	O_3, NO_2, BrO, O_2-O_2, Ring	O_3, NO_2, BrO, O_2-O_2, Ring	O_3, NO_2, BrO, O_2-O_2, Ring	O_3, NO_2, BrO, O_2-O_2, Ring	O_3, NO_2, BrO, O_2-O_2, Ring	BrO (O_3, Ring, NO_2 features are from principal components)
HCHO cross-section	Chance and Orphal [2011], 300K	Meller and Moortgat [2000], 298K	Meller and Moortgat [2000], 298K	Meller and Moortgat [2000], 298K	Chance and Orphal [2011], 300K	-
Closure polynomial	3rd order	5th order	5th order	5th order	3rd order	-
Underdamping correction	Yes	No	No	No	Yes	-
Additional fit parameters	Residual common mode spectrum	Non-linear O_3 absorption effect	Non-linear O_3 absorption effect; Polarisation cross-section	Non-linear O_3 absorption effect; Polarisation cross-section	Residual common mode spectrum	Principal components derived from radiances
Cloud product used	OMI O4 cloud product, Acarreta et al. [2004]	OMI O4 cloud product, Stammes et al. [2008].	GOME-2 O2 A-band Frescov6 product, Wang et al. [2008]	GOME-2 O2 A-band Frescov6 product, Wang et al. [2008]	OMPS cloud product, Vasilkov et al. [2014]	OMPS cloud product, Vasilkov et al. [2014]
Vertical layers of the CTM	47	40	40	40	47	72
Horizontal resolutions of the CTM	$2^o \times 2.5^o$	$2^o \times 2.5^o$	$2^o \times 2.5^o$	$2^o \times 2.5^o$	$2^o \times 2.5^o$	$2^o \times 2.5^o$
A prior HCHO profiles	1300 to 1400 Monthly average in 2007	Sampled at the satellite overpass times	Sampled at the satellite overpass times	Sampled at the satellite overpass times	1300 to 1400 Monthly average in 2007	Monthly average, 2005–2007
Resolution of scattering weight grids	$2^o \times 2.5^o$	Interpolated for each satellite pixel (surface	Interpolated for each satellite pixel (surface	Interpolated for each satellite pixel (surface	$2^o \times 2.5^o$	$2^o \times 2.5^o$

		albedo, surface altitude, observation angles)	albedo, surface altitude, observation angles)	albedo, surface altitude, observation angles)		
Terrain corrections	Yes	Yes, based on Zhou et al. [2009]	Yes	Yes	Yes	Yes
Treatment of aerosols	No	No	No	No	No	No
Reference sector correction[a]	Pixel-by-pixel correction	Modelled by a polynomial	Modelled by a polynomial	Modelled by a polynomial	Pixel-by-pixel correction	Model climatology

[a] SAO retrievals applied the "pixel-by-pixel correction" method, which accounts for the difference between retrieved and GEOS-Chem modelled slant columns over the remote Pacific Ocean. For BIRA retrievals, the reference sector correction refers to the latitudinal dependency (modelled by a polynomial) of the HCHO slant columns in the reference sector. For OMPS PCA retrievals, the latitude-dependent GMI monthly climatology HCHO column amount over the remote Pacific is added to all pixels, without pixel-specific correction.

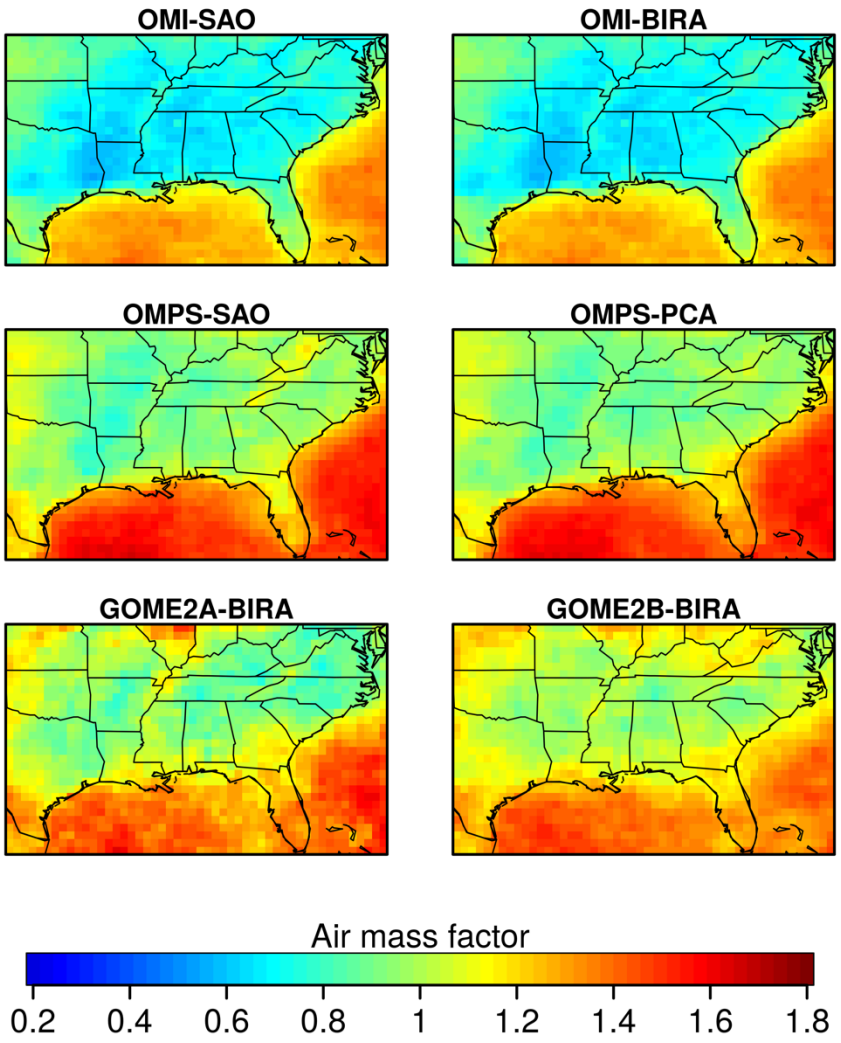

Figure S1. GEOS-Chem based air mass factors (AMF) over the Southeast US averaged over the SEAC^{4}RS period (5 August–25 September 2013). Each panel shows the AMF computed using GEOS-Chem HCHO shape factors with scattering weights from the six retrievals (Table 1). For each retrieval, GEOS-Chem shape factors are sampled under its schedule, and filtered by its quality flags and cloud conditions.

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