



## Supplement of

## Source and variability of formaldehyde (HCHO) at northern high latitudes: an integrated satellite, aircraft, and model study

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Figure S1. Major plant functional type (PFT) fraction maps in Alaska, from CLM4 simulation.

Spatial resolution is 0.25°×0.3125°.



Figure S2. Temperature dependence of  $dVCD_{GC,Bio}$  and  $VCD_{0,GC}$  at Fairbanks in 2018 and 2019 summer. X-axis is surface air temperature from MERRA-2 dataset, Y-axis is GEOS-Chem HCHO vertical columns (background columns or biogenic emission related HCHO dVCD). Red dots are GEOS-Chem  $dVCD_{GC,Bio}$ , gray dots are GEOS-Chem background HCHO  $VCD_{0,GC}$ .

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*Figure S3. Monthly HCHO vertical profiles at Fairbanks in summer 2018 and summer 2019. Thick curves are HCHO vertical profile a priori in TROPOMI HCHO product, provided by TM5-MP model. Dashed curves are HCHO vertical profiles from GEOS-Chem simulations.* 



Figure S4. GEOS-Chem monthly differential HCHO vertical profiles at Fairbanks in summer 2018 and summer 2019. Thick curves are wildfire related HCHO vertical profiles; dashed curves are biogenic emission related HCHO vertical profiles.

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Figure S5. Alaska GFED4.1s monthly wildfire dry mass emission in summer 2018 and 2019.



## summer 2018.



## Figure S7. Monthly averaged air mass factors in Alaska summer in 2018 (left) and 2019 (right). The

30 first row is AMF<sub>GC</sub> based on GEOS-Chem HCHO vertical profiles; the second row is AMF<sub>SAT</sub> from TROPOMI HCHO product, based on TM5-MP HCHO a priori. The third row is the difference between AMF<sub>GC</sub> and AMF<sub>SAT</sub>.



(c) 2019 (GEOS-Chem - TROPOMI Background)

35 Figure S8. Monthly averaged background HCHO VCD<sub>0</sub> in Alaska summer in 2018 (left) and 2019 (right). The first row is VCD<sub>0,GC</sub> provided by GEOS-Chem; the second row VCD<sub>0,SAT</sub> from TROPOMI HCHO product, based on TM5-MP model. The third row is the difference between VCD<sub>0,GC</sub> and VCD<sub>0,SAT</sub>



40 Figure S9. Difference between reprocessed TROPOMI HCHO dVCD<sub>SAT,GC</sub> and GEOS-Chem HCHO dVCD<sub>GC</sub> in Alaska in summer 2018 and 2019.



Figure S10. Difference between the reprocessed TROPOMI HCHO VCD<sub>SAT,GC</sub> and original TROPOMI HCHO VCD<sub>SAT</sub> from the S5P operational product, in Alaska in summer 2018 and 2019.

Glossary

Volatile organic compound
Non-methane volatile organic compound
Biogenic volatile organic compound
Formaldabuda
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ISOP	Isoprene
TROPOMI	TROPOspheric Monitoring Instrument
GC	GEOS-Chem
ATom	Atmospheric Tomography mission
SAT	Satellite (here TROPOMI specifically)
L2	Level-2 product
VCD	Vertical column density
SCD	Slant column density
AMF	Air mass factor
AMF <sub>SAT</sub>	Air mass factor in S5P HCHO L2 operational product
AMFGC	Air mass factor based on GEOS-Chem vertical profile a priori
dVCD	Differential vertical column density
dSCD	Differential slant column density
VCD <sub>SAT</sub>	TROPOMI HCHO VCD from S5P HCHO L2 operational product
VCD <sub>SAT,GC</sub>	Reprocessed TROPOMI HCHO VCD
VCD <sub>GC</sub>	GEOS-Chem simulated HCHO vertical column density, with wildfire and biogenic emission impact

VCD <sub>0,GC</sub>	HCHO vertical column density calculated from the "Background" simulation
dVCD <sub>GC</sub>	GEOS-Chem simulated HCHO vertical column density, with wildfire and biogenic
	emission impact
dVCD <sub>GC,Fire</sub>	GEOS-Chem simulated wildfire induced HCHO dVCD,
	$dVCD_{GC,Fire} = VCD_{GC,NB} - VCD_{GC,BG}$
dVCD <sub>GC,Bio</sub>	GEOS-Chem simulated biogenic emission induced HCHO dVCD,
	$dVCD_{GC,Bio} = VCD_{GC,NF} - VCD_{GC,BG}$