## Source and variability of formaldehyde (HCHO) at northern high latitude: an integrated satellite, ground/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 background column at Fairbanks in 2018 and 2019 summer. X-axis is surface air temperature from MERRA-2 dataset, Y-axis is HCHO vertical column. Red dots are GEOS-Chem dVCD<sub>GC</sub> from fire-free simulations, gray dots are GEOS-Chem background HCHO

30 VCD<sub>0,GC</sub>, blue dots are MAX-DOAS VCD<sub>MD</sub>.

HCHO vertical profile, Fairbanks local noon



Figure S3/Monthly HCHO vertical profiles at Fairbanks in 2018 and 2019 summer. Thick curves are

HCHO vertical profile a priori in TROPOMI TROPOMI HCHO product, provided by TM5-MP model.

35 Dashed curves are HCHO vertical profiles from GEOS-Chem simulations.



## Figure S4/ GEOS-Chem monthly differential HCHO vertical profiles at Fairbanks in 2018 and 2019

summer. Thick curves are wildfire related HCHO vertical profiles; dashed curves are biogenic

40 *emission related HCHO vertical profiles.* 



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



Figure S6/ MEGAN v2.1 estimated monthly biogenic isoprene and monoterpenes emission in 2018





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

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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>



Figure S9/Difference between TROPOMI HCHO dVCD<sub>SAT,new</sub> and GEOS-Chem HCHO dVCD<sub>GC</sub> in

Alaska in 2018 and 2019 summer.

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

Glossary

Name	
VOC	Volatile organic compound
NMVOC	Non-methane volatile organic compound
BVOC	Biogenic volatile organic compound
нсно	Formaldehyde

ISOP	Isoprene
	isoprene
TROPOMI	TROPOspheric Monitoring Instrument
MAX-DOAS	Multi-AXis Differential Optical Absorption Spectroscopy
GC	GEOS-Chem
ATom	Atmospheric Tomography mission
SAT	Satellite (here TROPOMI especially)
L2	Level-2 product
VCD	Vertical column density
SCD	Slant column density
AMF	Air mass factor
dVCD	Differential vertical column density
dSCD	Differential slant column density
VCD <sub>GC</sub>	GEOS-Chem simulated HCHO vertical column density, with wildfire and biogenic
or VCD <sub>GC,Ctrl</sub>	emission impact
<i>VCD</i> <sub>0,GC</sub> or <i>VCD</i> <sub>GC,BG</sub>	HCHO vertical column density calculated from the "Background" simulation
VCD <sub>GC,NB</sub>	HCHO vertical column density calculated from the "No biogenic emission" simulation
VCD <sub>GC,NF</sub>	HCHO vertical column density calculated from the "No Wildfire" 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,
	$dVCD_{GC,Bio} = VCD_{GC,NF} - VCD_{GC,BG}$
TFS	Toolik Field Station (68.38°N, 149.36°W)
115	10011x 11clu Statioli (08.38 19, 149.30 W)