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Supplement of

Northern hemispheric atmospheric ethane trends in the upper troposphere and lower stratosphere (2006–2016) with reference to methane and propane

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Table S1. Geographical definition.

Definition	Latitude	Longitude
NAM (North America)	30~65°N	60~125°W
ASI (Asia)	15~50°N	60~140°E
EUR (Europe)	40~55°N	10°W~30°E
RNH (Rest of Northern Hemisphere)	All regions excluding NAM, ASI, EUR	

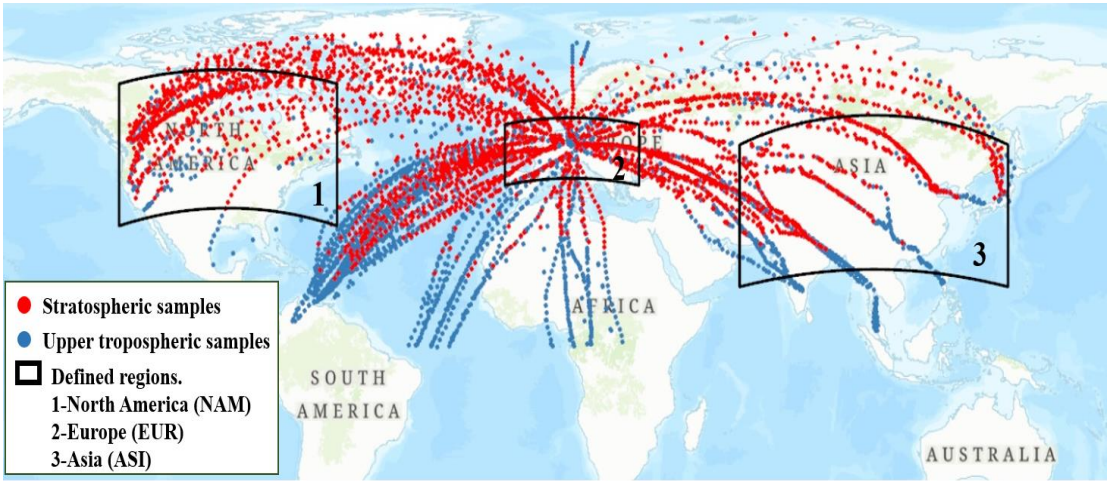

Figure S1. Geographical locations of aircraft samples (distinguished as upper tropospheric samples and stratospheric samples) and spatial segregation. Samples collected in the Northern Hemisphere outside the black boxes are defined as RNH samples.

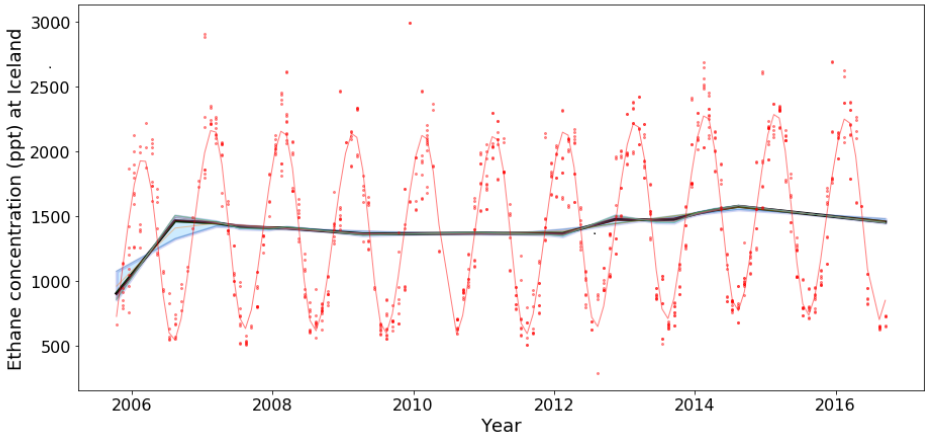

Figure S2. Ethane seasonality and trend at Iceland estimated by “Prophet” algorithm, light blue shadow indicates uncertainty from trend fittings.

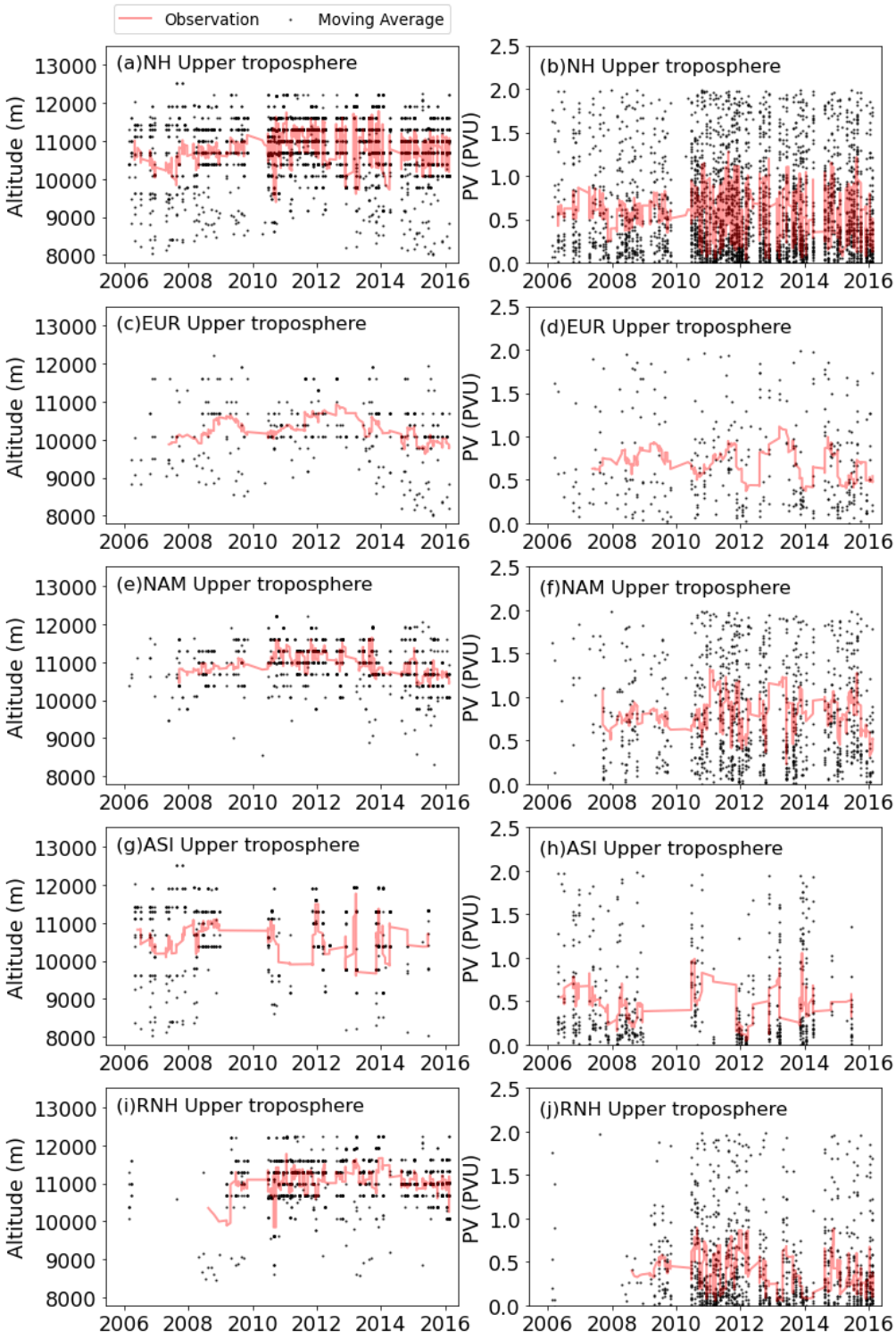

Figure S3. Altitude and PV of the upper tropospheric samples collected over the whole NH, EUR, NAM, ASI and RNH.

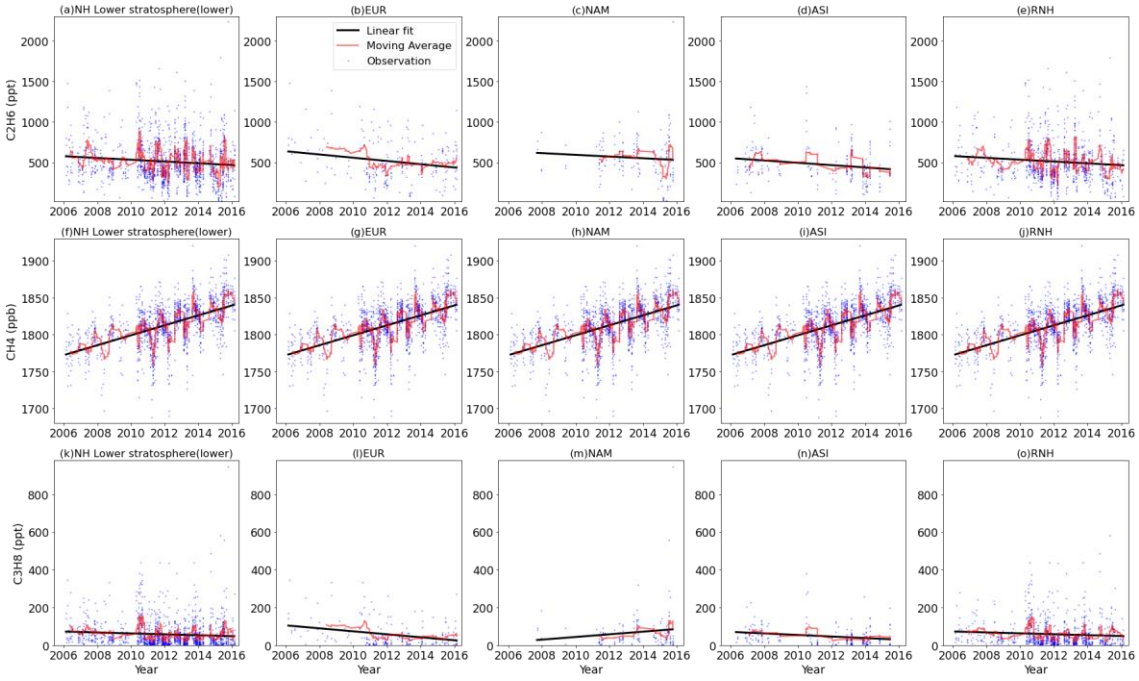

Figure S4. The lower part of the lower stratospheric ethane, methane and propane mole fractions from observations and linear trends over five regions (whole NH, EUR, NAM, ASI, and RNH).

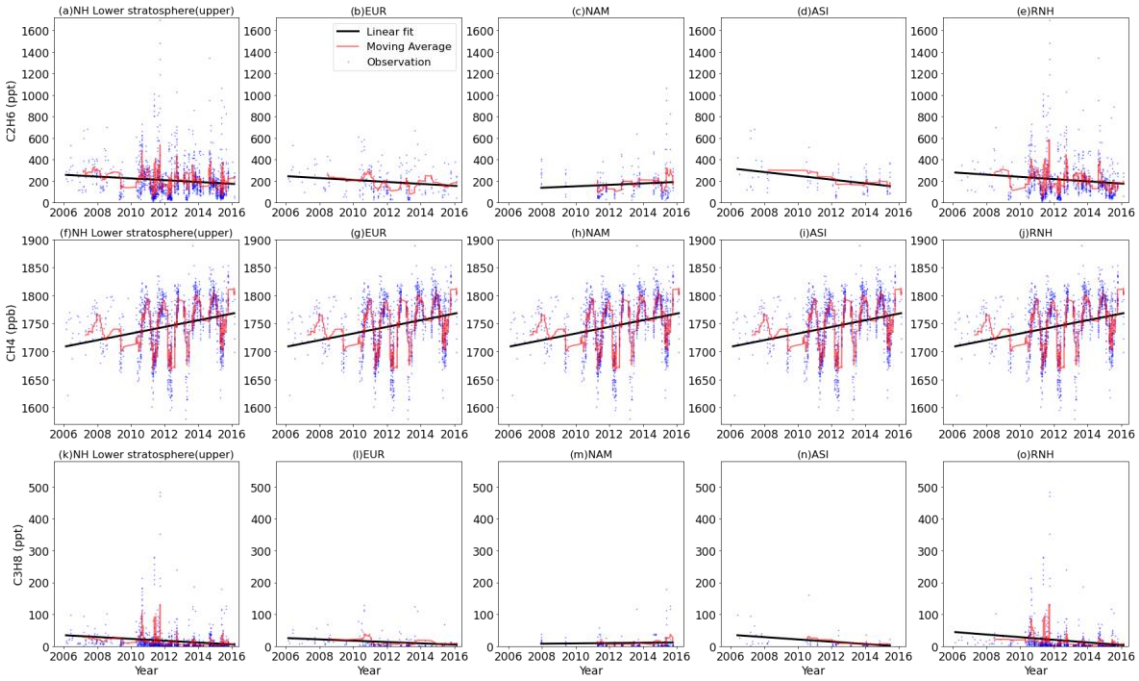

Figure S5. The upper part of the lower stratospheric ethane, methane and propane mole fractions from observations and linear trends over five regions (whole NH, EUR, NAM, ASI, and RNH).

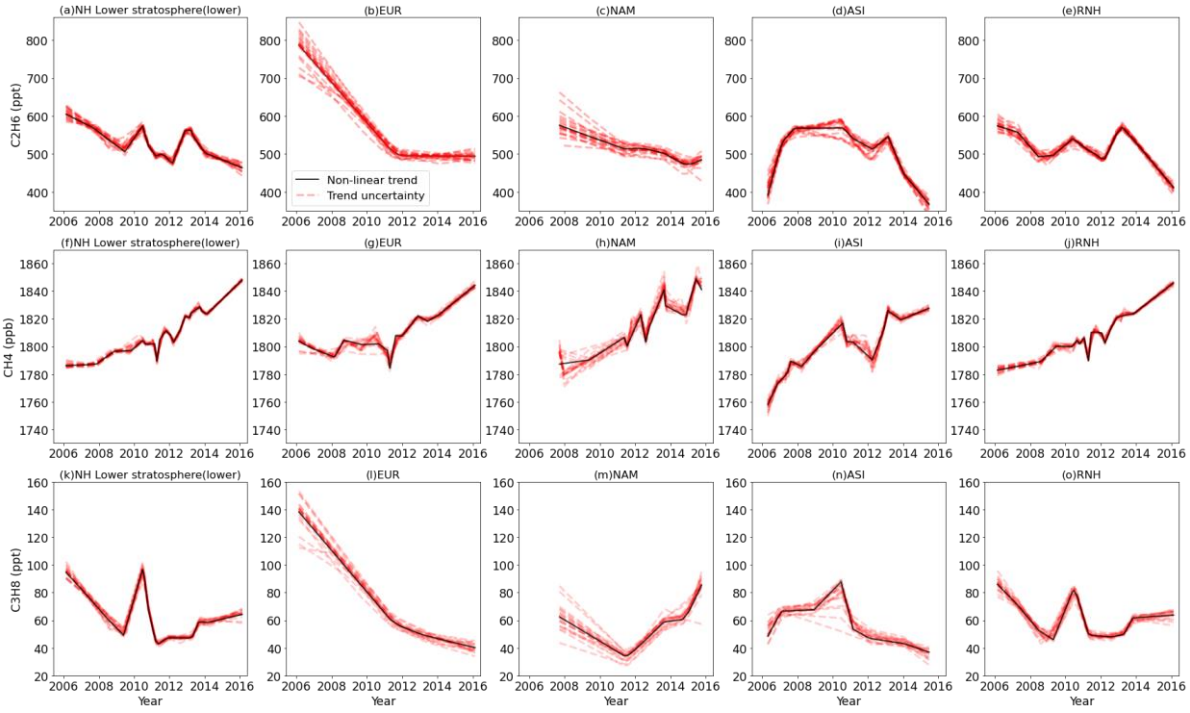

Figure S6. Non-linear trends of the lower part of the lower stratospheric ethane, methane and propane over five regions (whole NH, EUR, NAM, ASI, and RNH).

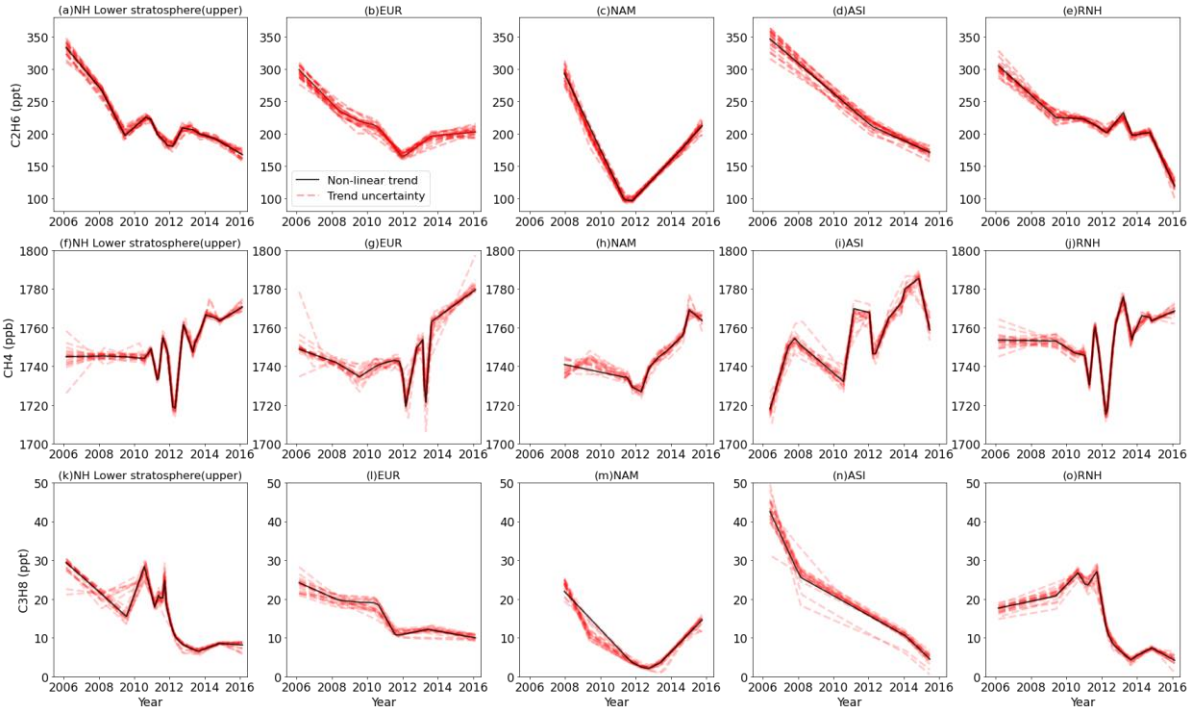

Figure S7. Non-linear trends of the upper part of the lower stratospheric ethane, methane and propane over five regions (whole NH, EUR, NAM, ASI, and RNH).

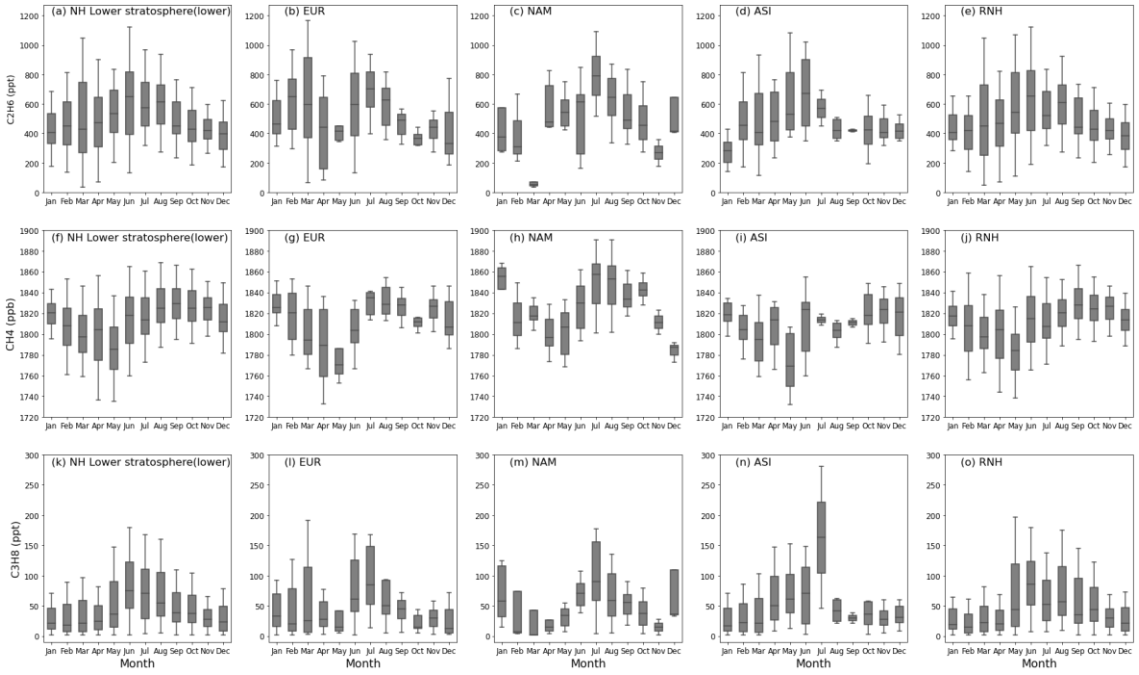

Figure S8. Monthly variations of the lower part of the lower stratospheric ethane, methane and propane (2006-2016) over five regions (whole NH, EUR, NAM, ASI and RNH). The boxes represent 25%-75% of the observed mole fractions, the horizontal lines in the boxes indicate the medians. The whiskers represent the 10%-90% range of all the observed mole fractions.

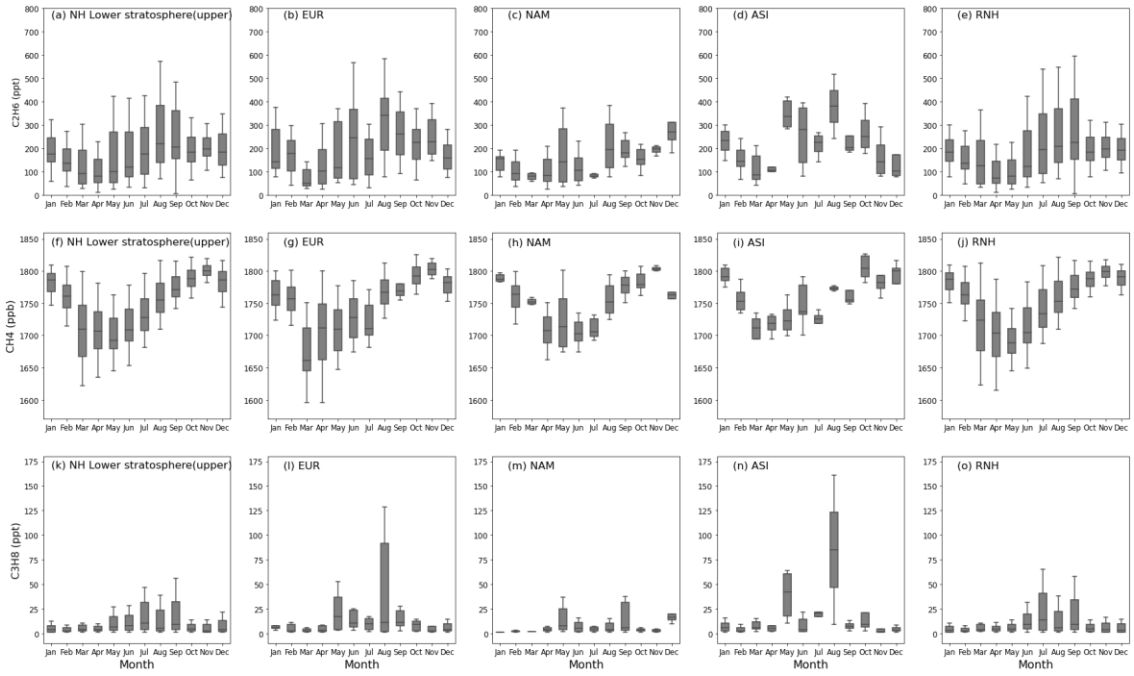

Figure S9. Monthly variations of the upper part of the lower stratospheric ethane, methane and propane (2006-2016) over five regions (whole NH, EUR, NAM, ASI and RNH). The boxes represent 25%-75% of the observed mole fractions, the horizontal lines in the boxes indicate the medians. The whiskers represent the 10%-90% range of all the observed mole fractions.

Table S2. Linear trends of ethane, methane and propane for 2006-2016 excluding 2009 and 2010 data.

	Linear trend (2006-2016 excluding 2009 and 2010)		
	C_2H_6(%/yr)	CH_4(%/yr)	C_3H_8(%/yr)
(a)Upper troposphere (Altitude ≥8000m, PV<2)			
Whole NH	-2.24	0.33	-0.78
EUR	-1.33	0.37	2.07
NAM	-2.33	0.36	0.9
ASI	-1.17	0.29	0.33
RNH	-5.19	0.33	-14.73
(b)Lower stratosphere (PV≥2)			
Whole NH	-3.27	0.26	-4.91
EUR	-1.61	0.37	-5.42
NAM	2.28	0.51	11.87
ASI	-4.55	0.24	-7.55
RNH	-4.33	0.22	-6.7
(c)Lower stratosphere (lower part; 2≤PV<6)			
Whole NH	-1.69	0.38	-2.42
EUR	-2.89	0.33	-7.2
NAM	-1.95	0.5	15.05
ASI	-3.25	0.31	-7.11
RNH	-2.04	0.38	-3.24
(d)Lower stratosphere (upper part; PV≥6)			
Whole NH	-2.99	0.34	-10.21
EUR	-3.53	0.22	-9.33
NAM	3.27	0.37	3.46
ASI	-5.83	0.25	-12.84
RNH	-4.01	0.39	-24.84

Code in Python for trend analysis

```
import datetime

from fbprophet import Prophet

from fbprophet.plot import seasonality_plot_df

#before proceeding, please set the column “DateTime (UTC)” as “ds”, “C2H6_CARIBIC” as “y”

df = pd.read_excel('Data.xlsx')

df['ds']= pd.to_datetime(df['ds'])

m = Prophet(daily_seasonality=False, weekly_seasonality=False, yearly_seasonality=2,
seasonality_mode='additive', changepoint_prior_scale=0.5, interval_width=0.95)

m.fit(df)
```