Characteristics of atmospheric greenhouse gases over Asia-Pacific region observed by CONTRAIL aircraft project

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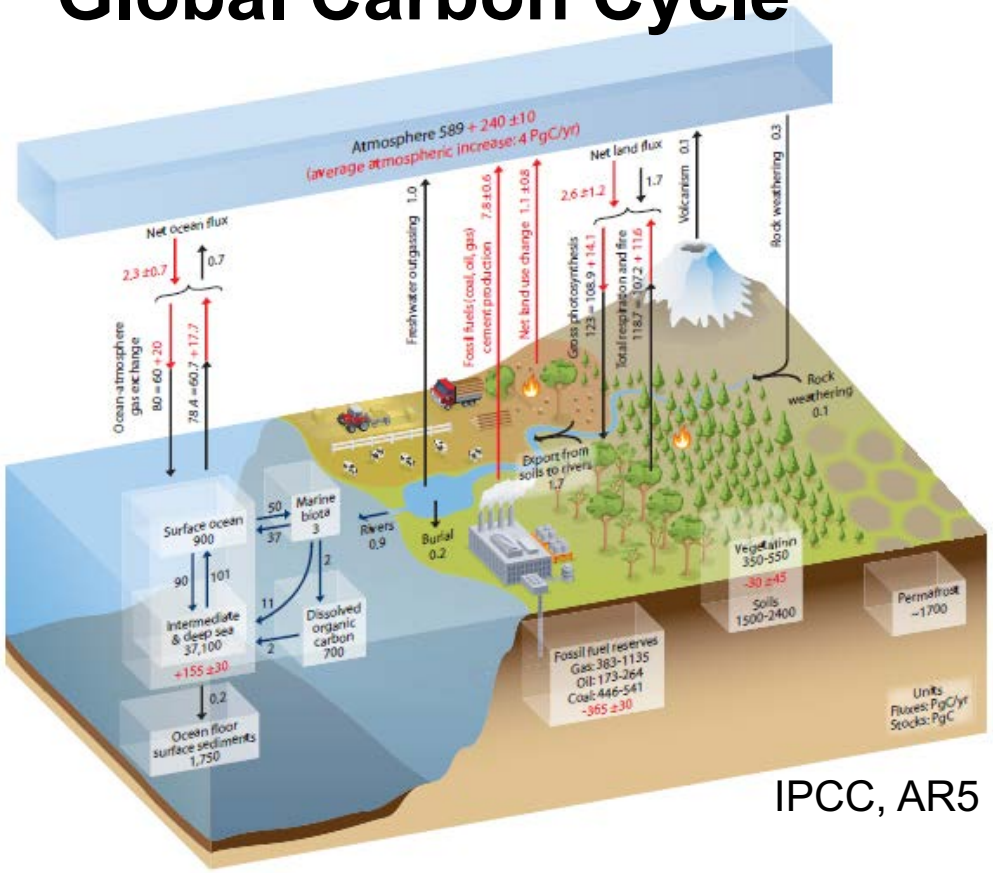
CONTRAIL

Background

Paris Agreement, 2015

Global Carbon Cycle



IPCC, AR5

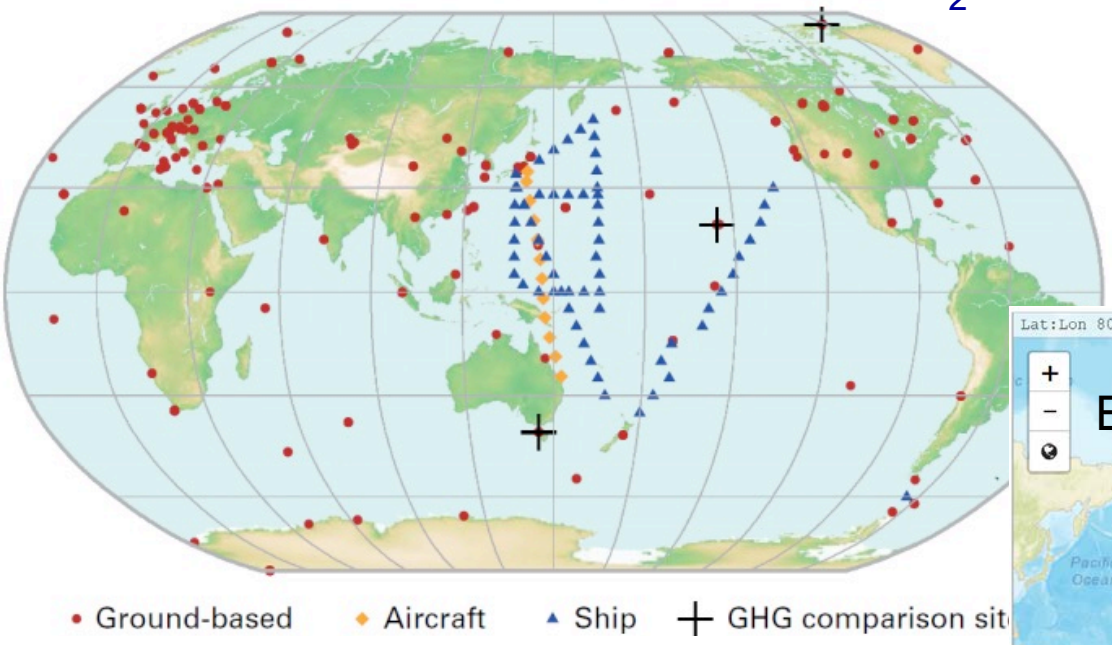
- Mitigation
- Adaptation

for global warming

Background

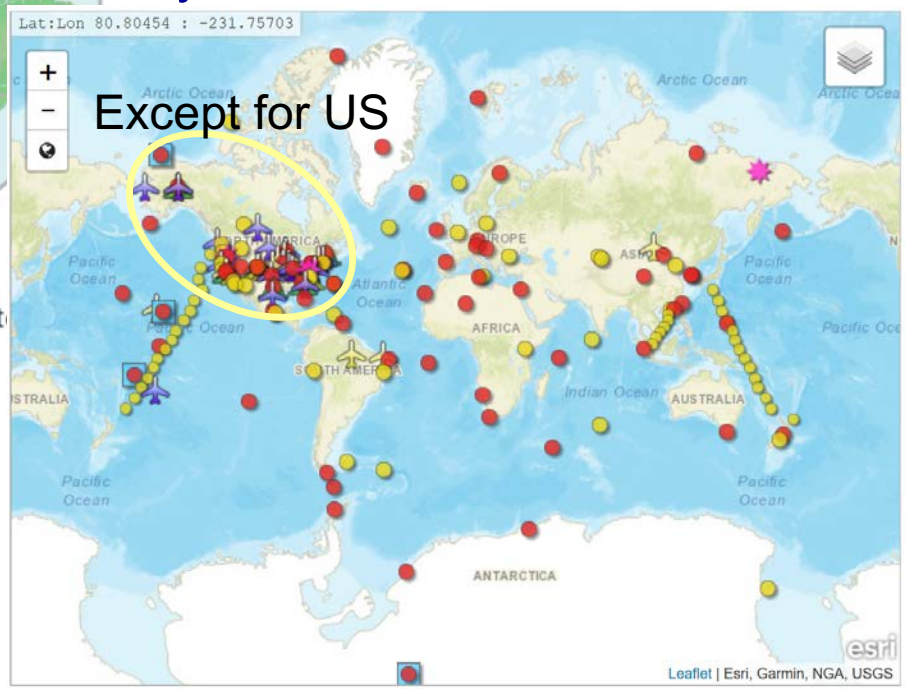
Most of the observation sites are on earth's surface

WMO/GAW Global network for CO_2



WMO GHG Bulletin No.13, 2017

GHG reference network site
By NOAA/ESRL



https://www.esrl.noaa.gov/gmd/ccgg/ggrn.php

Obs. in upper air was limited.
→cost for aircraft charter

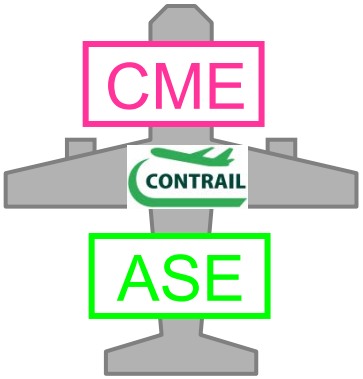
CONTRAIL Project since 2005

CME:
Continuous CO_2 Measuring Equipment

ASE: Automatic Air Sampling Equipment, for CO_2, CH_4, CO, N_2O, SF_6, H_2, isotopes

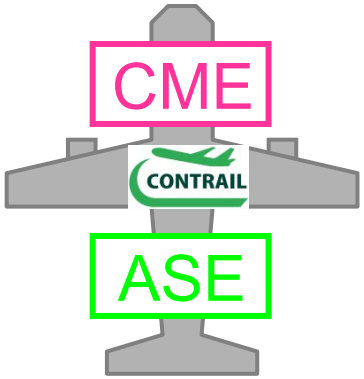
Machida et al. JTECH-A (2008)

Eight 777-200ER and two 777-300ER by JAL



777-200ER
(JA705J)
Jun/2006-

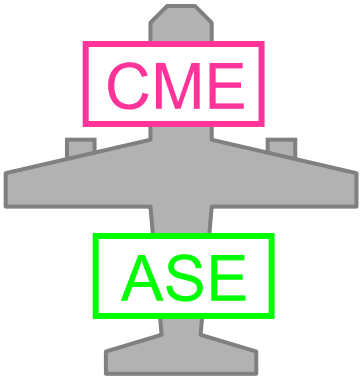
777-200ER
(JA703J)
Oct/2006-



777-200ER
(JA707J)
Nov/2006-

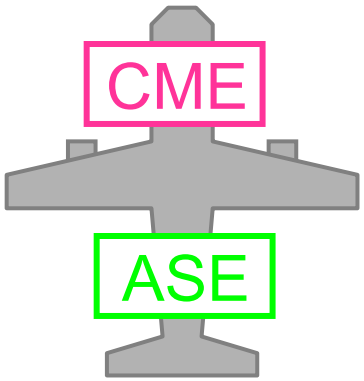
777-200ER
(JA708J)
Jun/2012-

777-300ER
(JA734J)
Feb/2015-

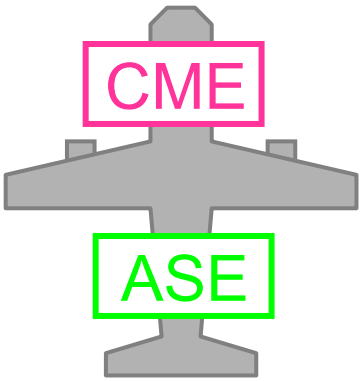


777-200ER
(JA709J)
Sep/2012-

777-200ER
(JA702J)
Mar/2013-



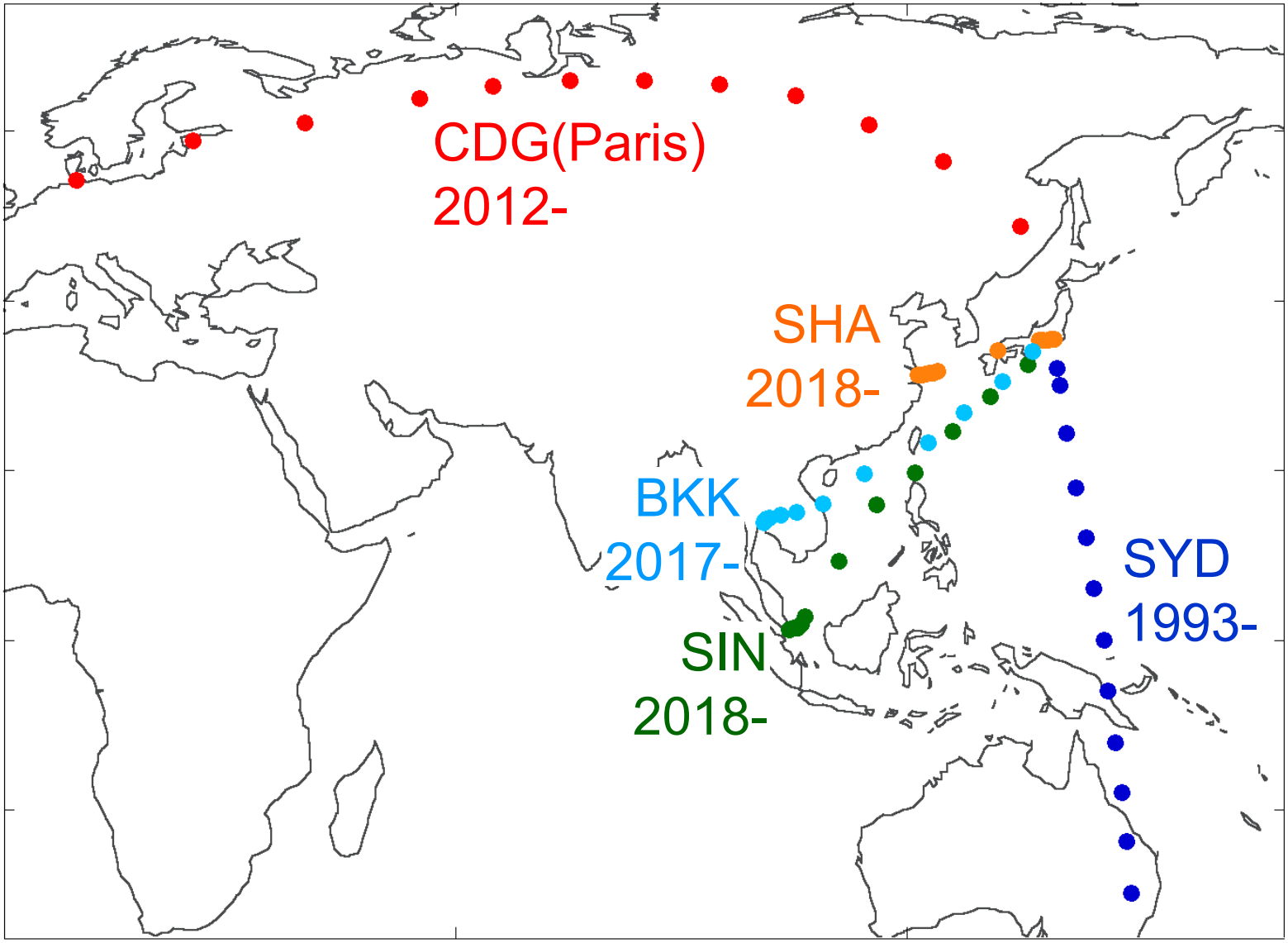
777-200ER
(JA710J)
Jul/2013-



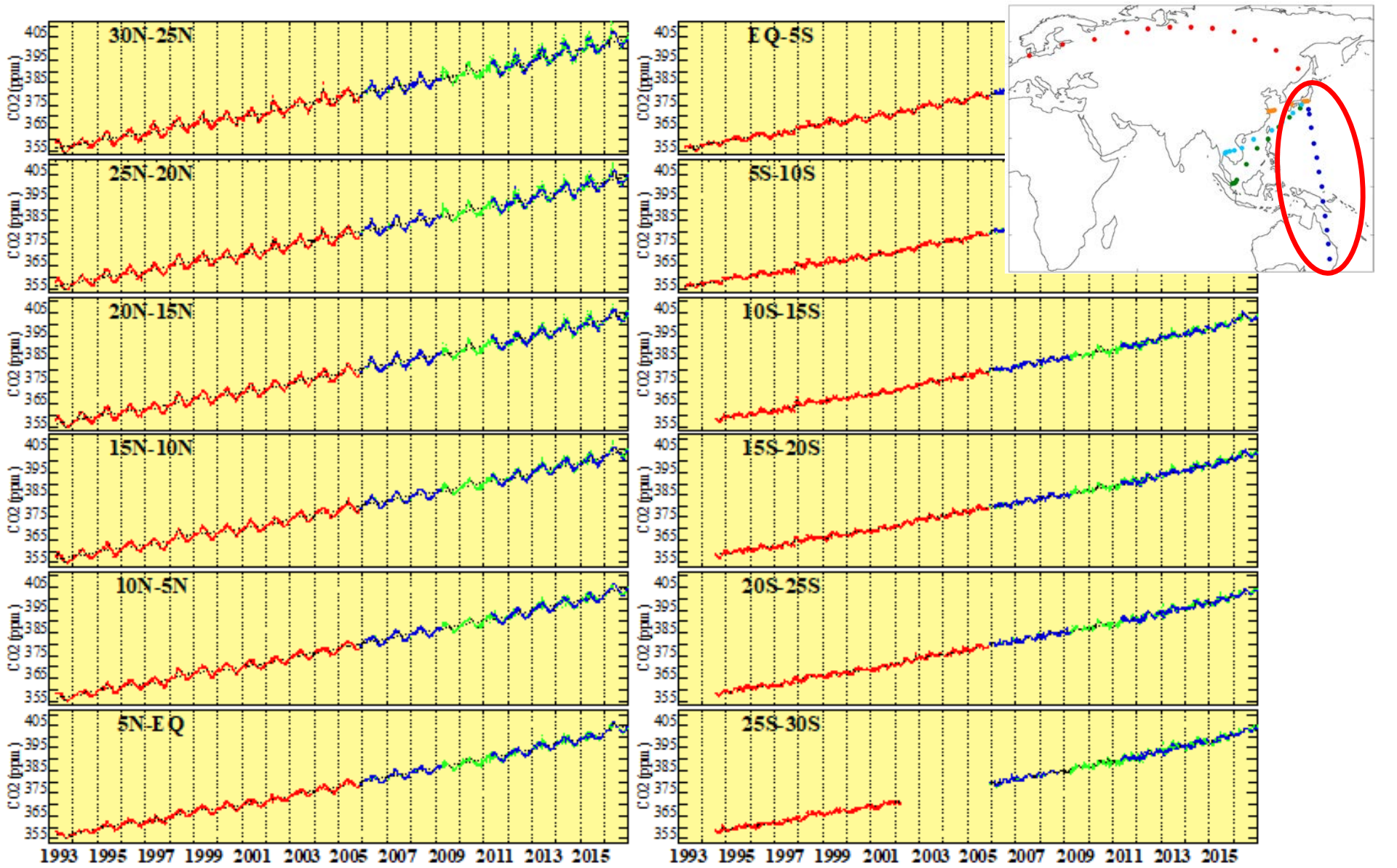
777-200ER
(JA711J)
Aug/2013-

777-300ER
(JA733J)
Feb/2016-

ASE whole air sampling

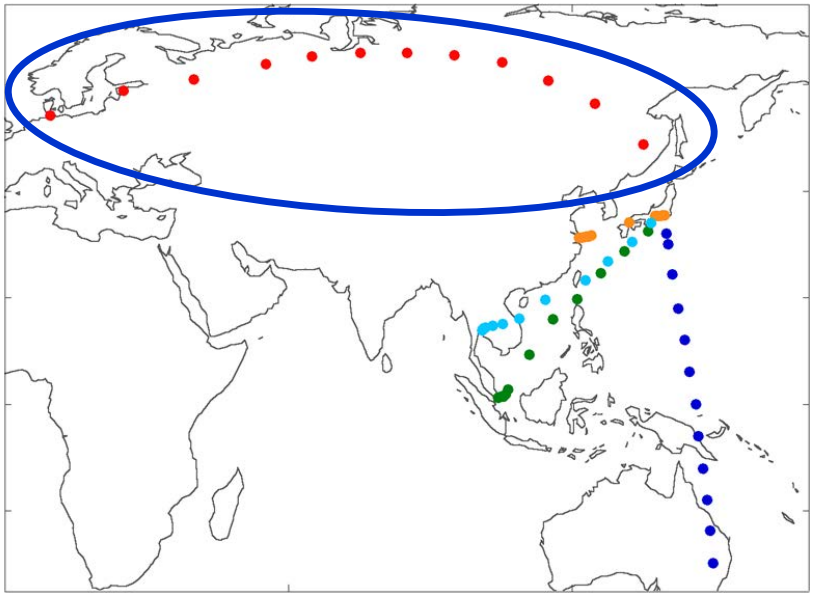


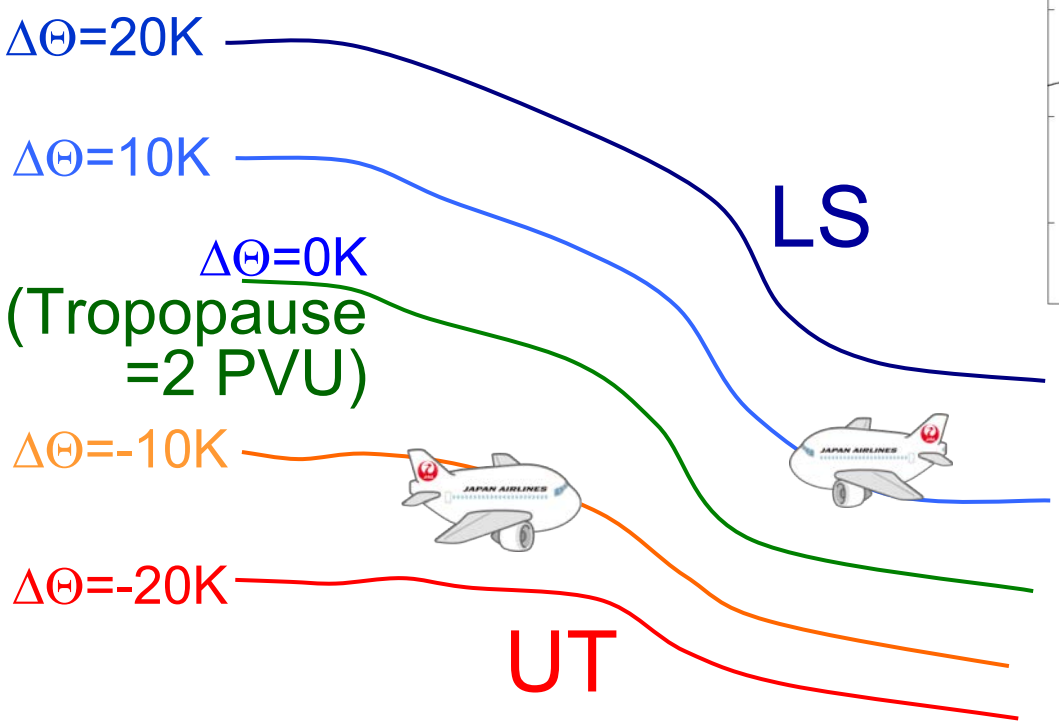
Time series of CO_2 in UT from 30N to 30S



Matsueda et al. GRL (2015)

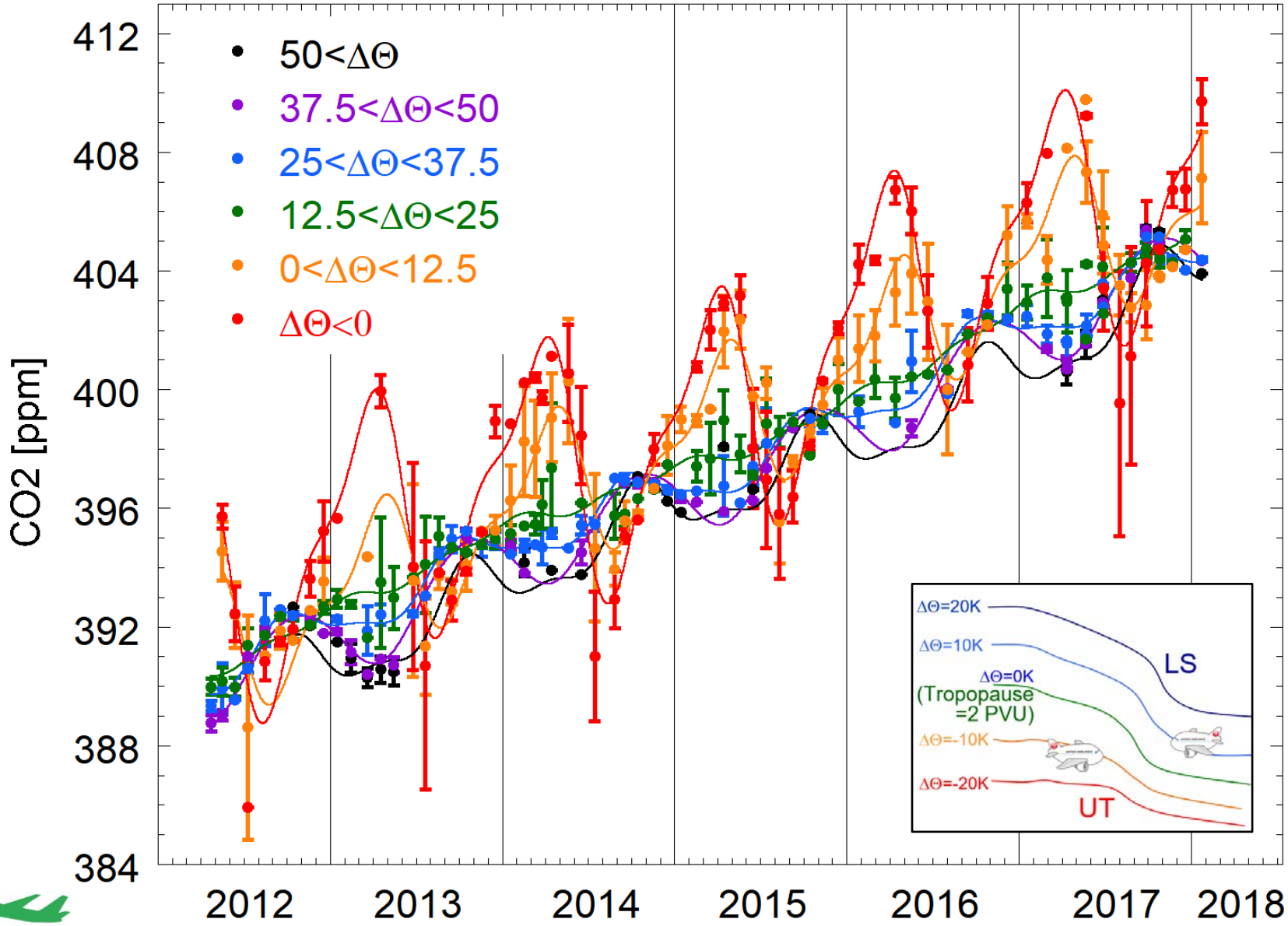
Upper Troposphere (UT) and Lower Stratosphere (LS)





Low Latitude ⟷ High Latitude

Time series of CO_2 in UT/LS

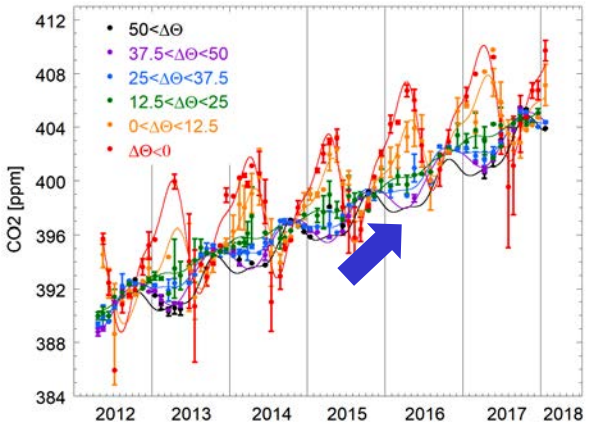


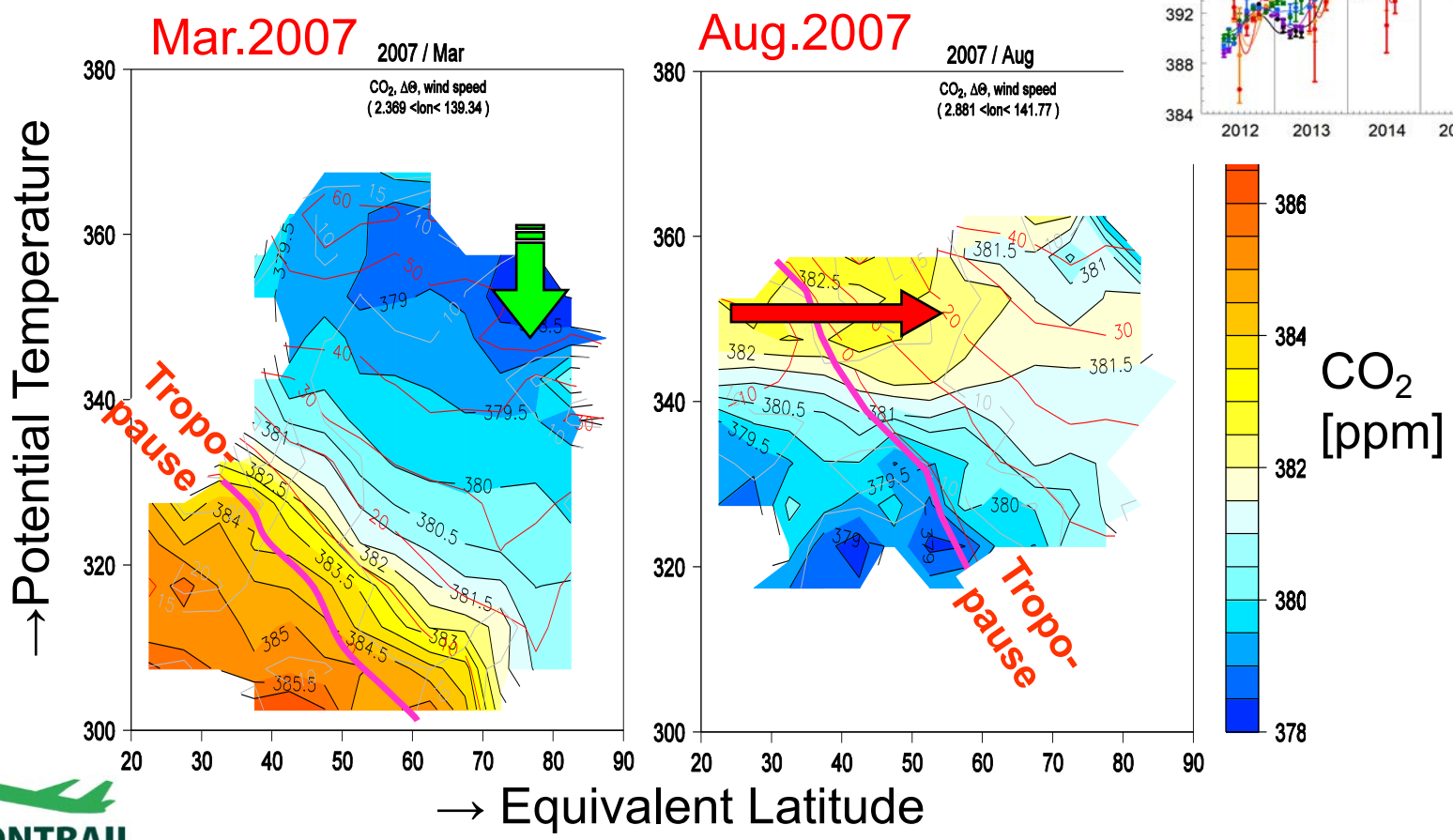
CONTRAIL

Sawa et al. GRL (2015)

CO_2 distributions on in UT/LS

- Seasonal variation of CO_2 in LS is controlled by air intrusion in summer.

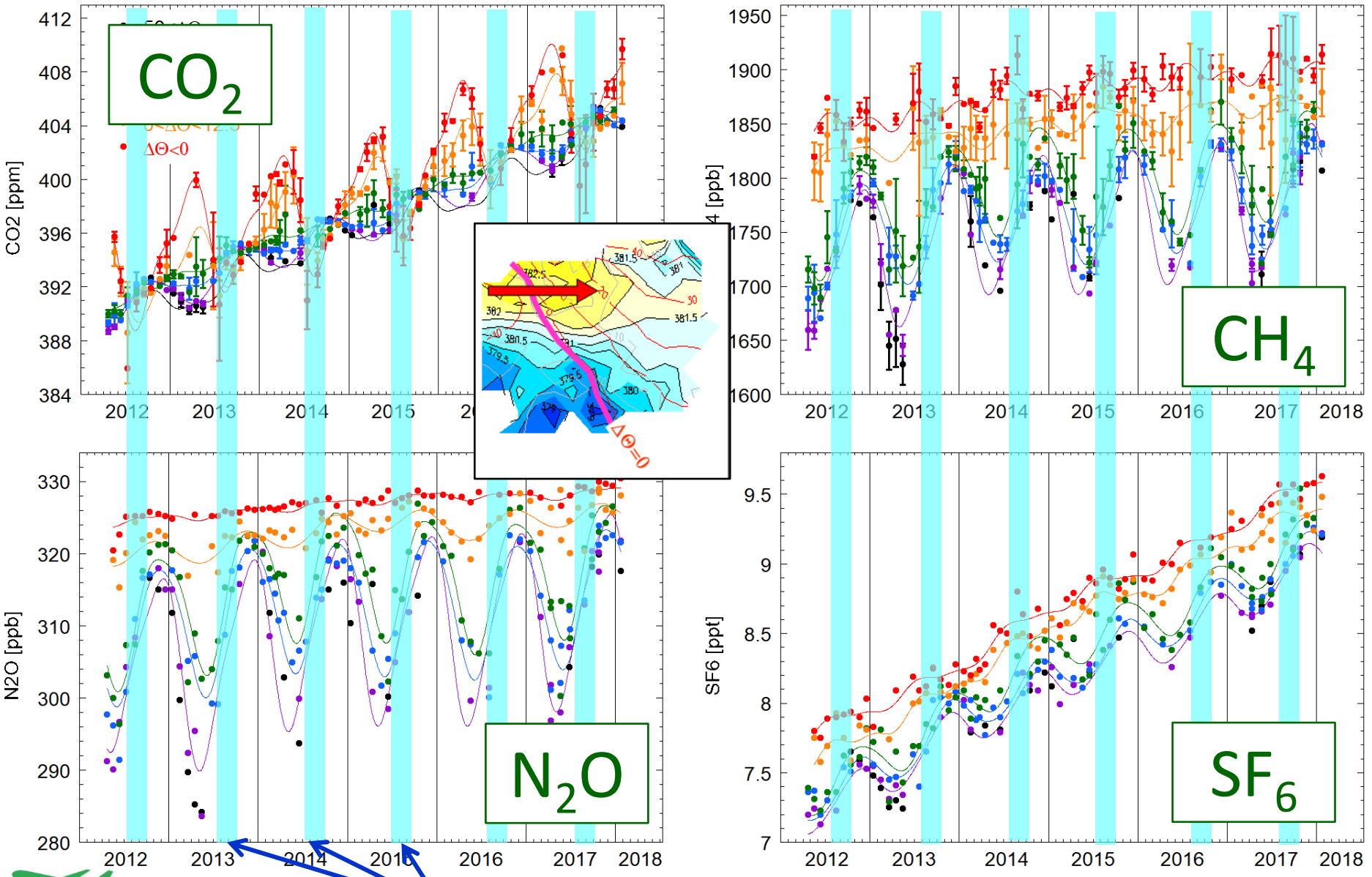




CONTRAIL

Sawa et al. JGR (2008)

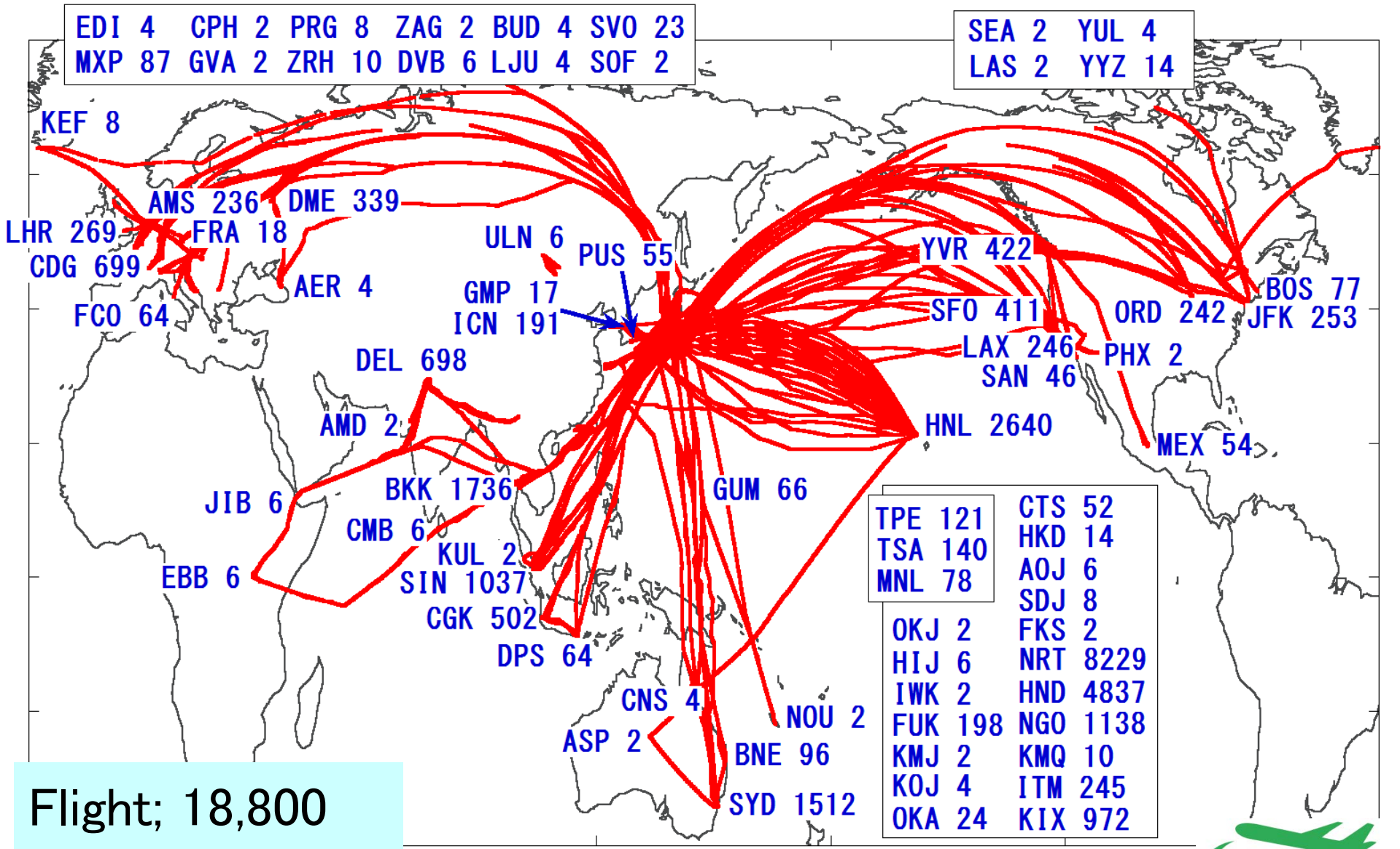
CO_2, CH_4, N_2O and SF_6 in UT/LS



CONTRAIL

Sawa et al. GRL (2015)

Observation area and frequency of CME



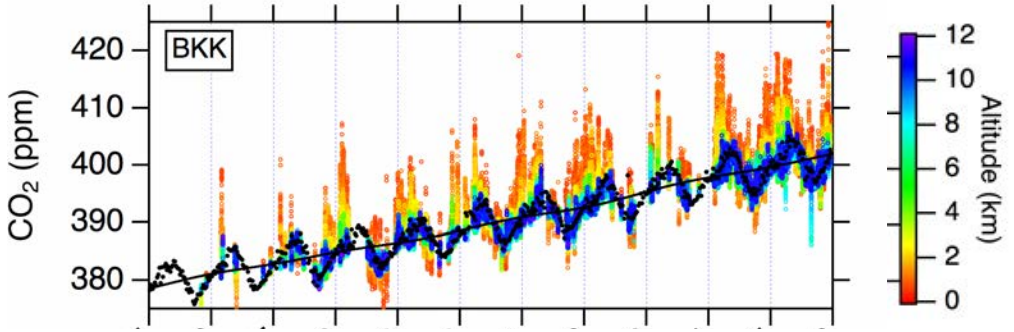
Flight; 18,800

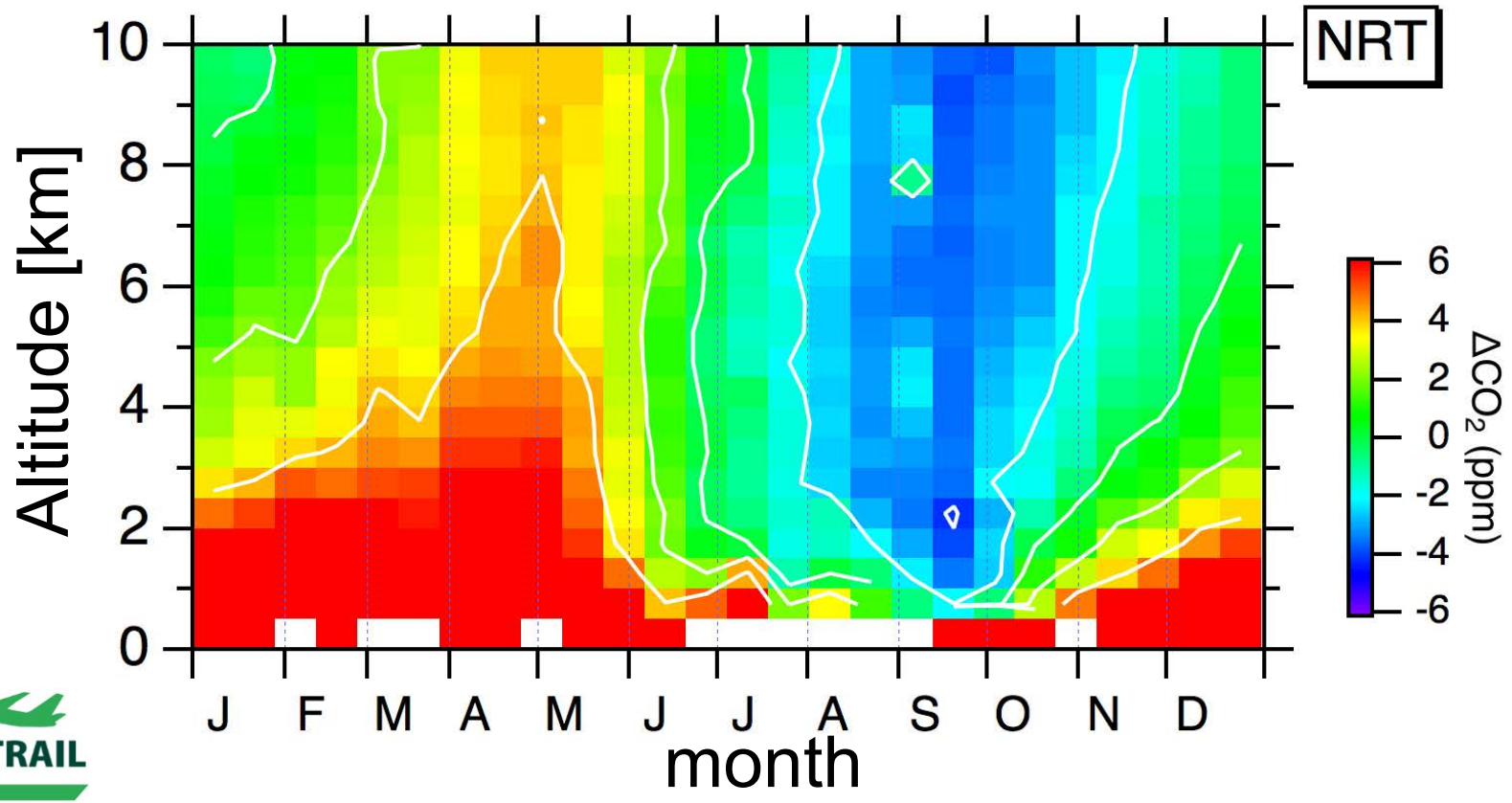
Profile; 29,700

CONTRAIL

Seasonal variation of vertical CO_2 over Narita, Japan

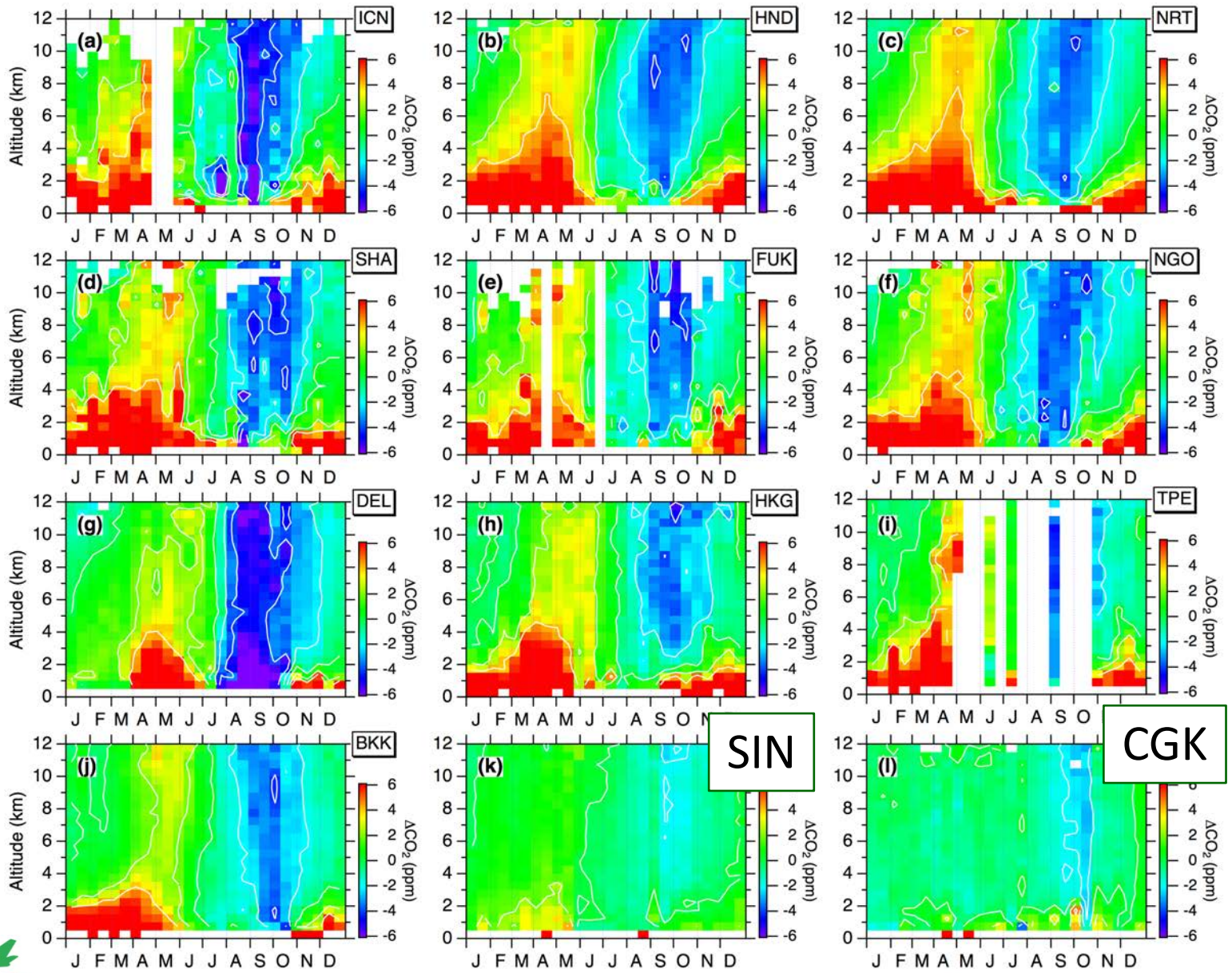
ΔCO_2=(obs. CO_2) – (CO_2 trend at Mauna Loa)





CONTRAIL

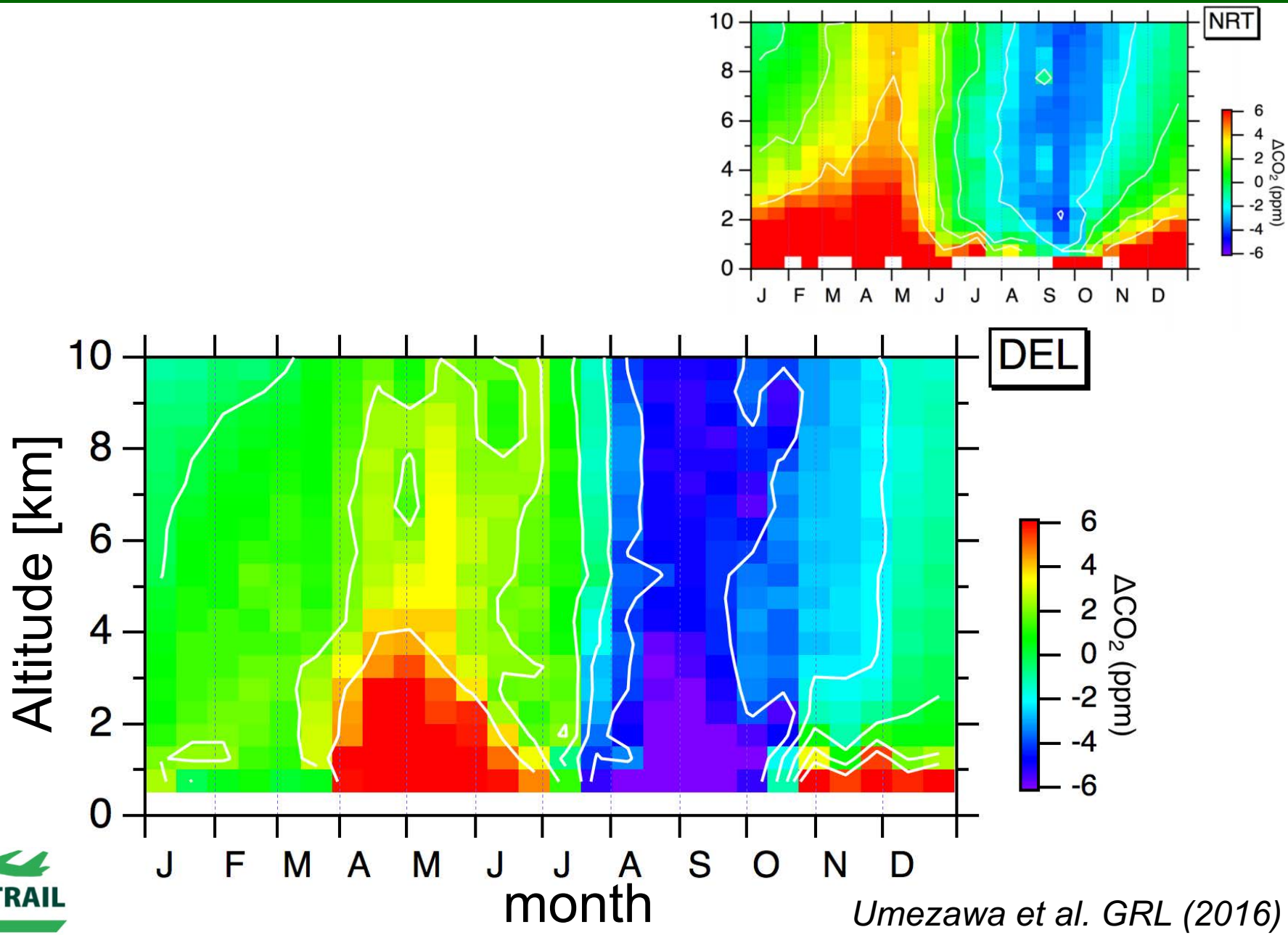
Vertical profiles over the cities in Asia-Pacific region



CONTRAIL

Umezawa et al. ACP (2018)

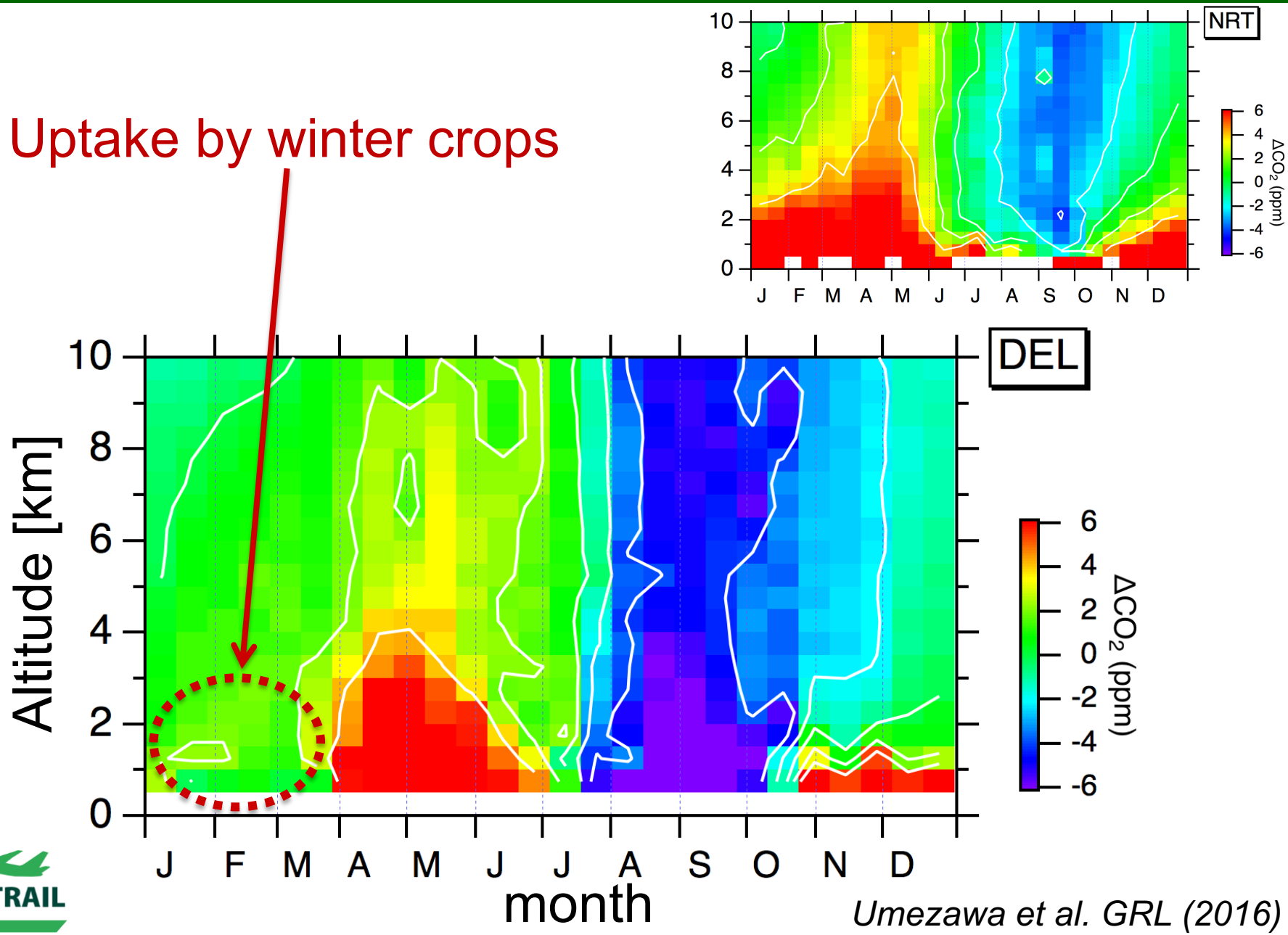
Seasonal variation of vertical CO_2 over Delhi, India



CONTRAIL

Umezawa et al. GRL (2016)

Seasonal variation of vertical CO_2 over Delhi, India

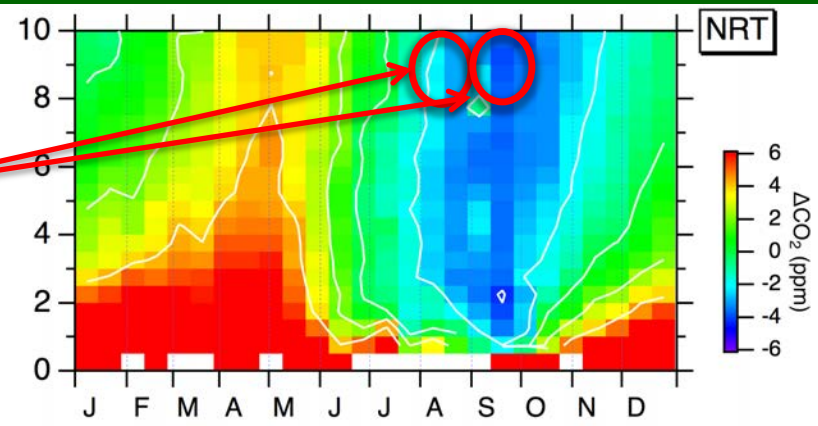


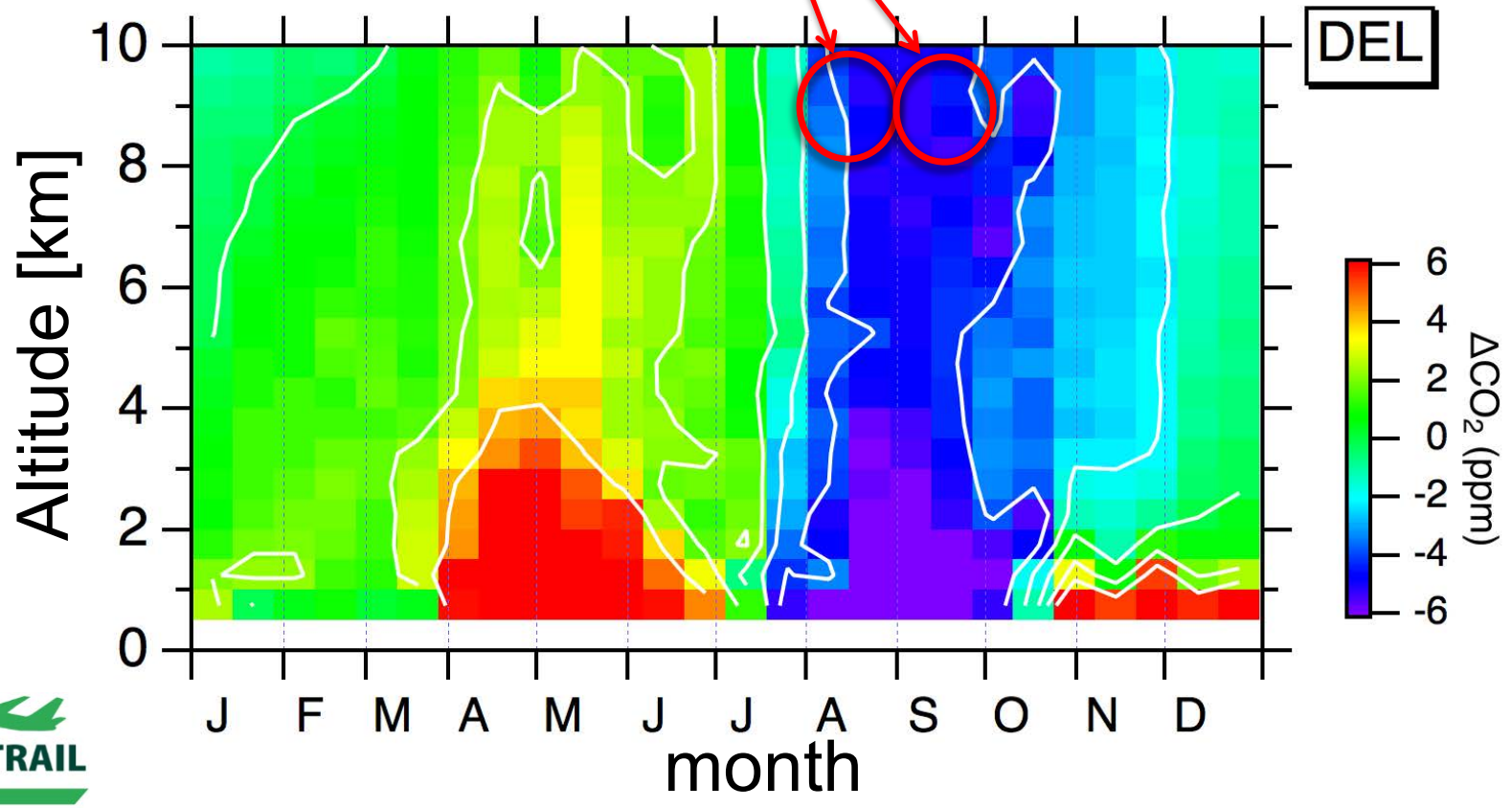
CONTRAIL

Umezawa et al. GRL (2016)

Focusing on Upper Troposphere

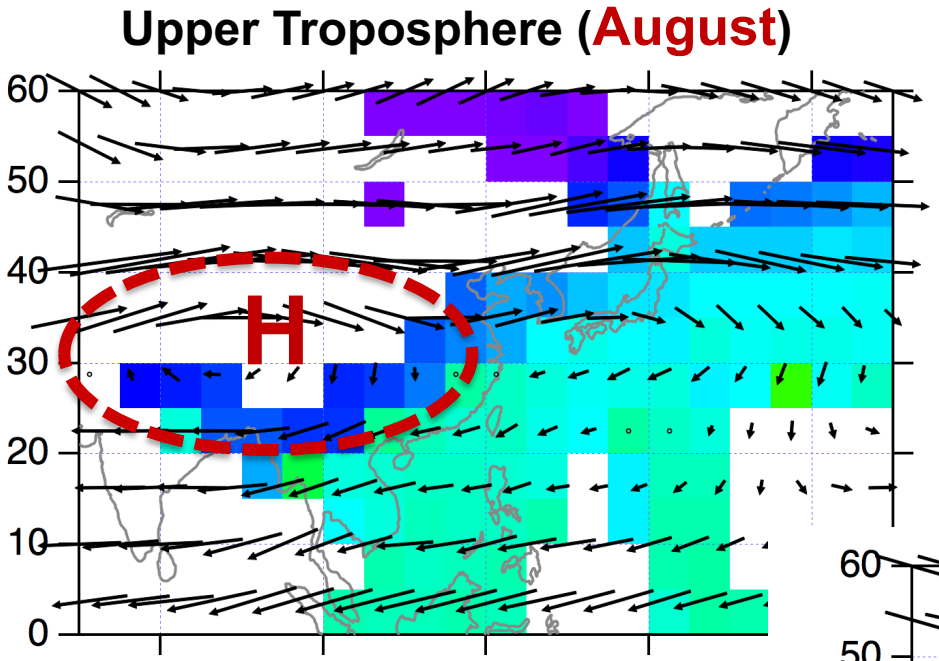
Upper Troposphere (> 8km)
in August and September



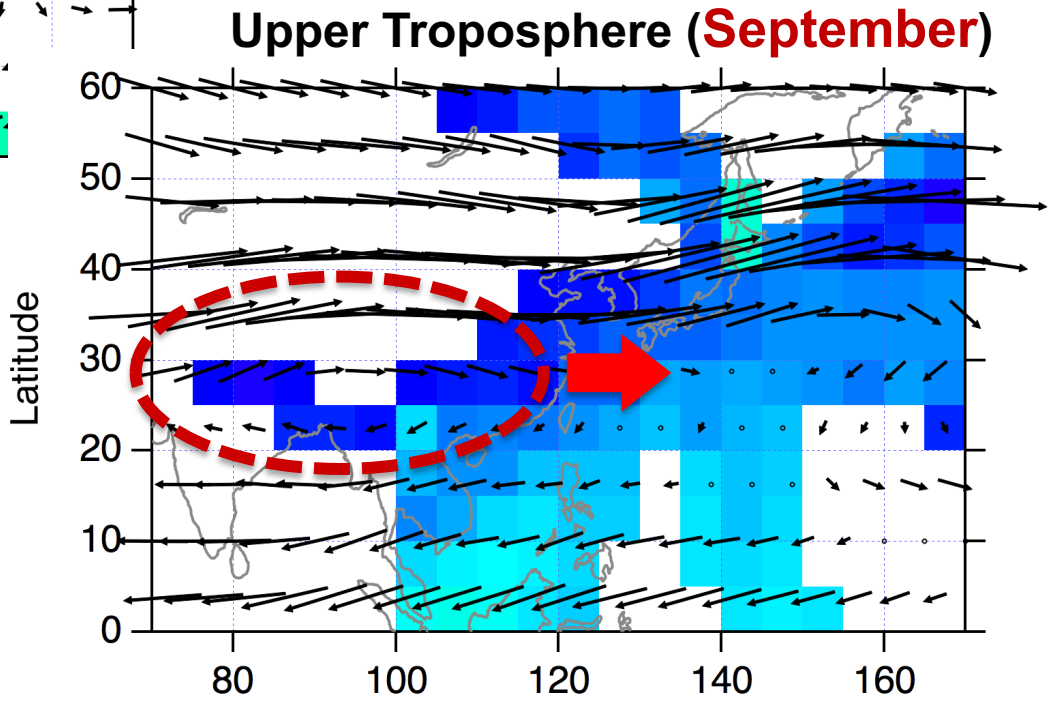


CONTRAIL

CO_2 in upper troposphere over Asia-Pacific region



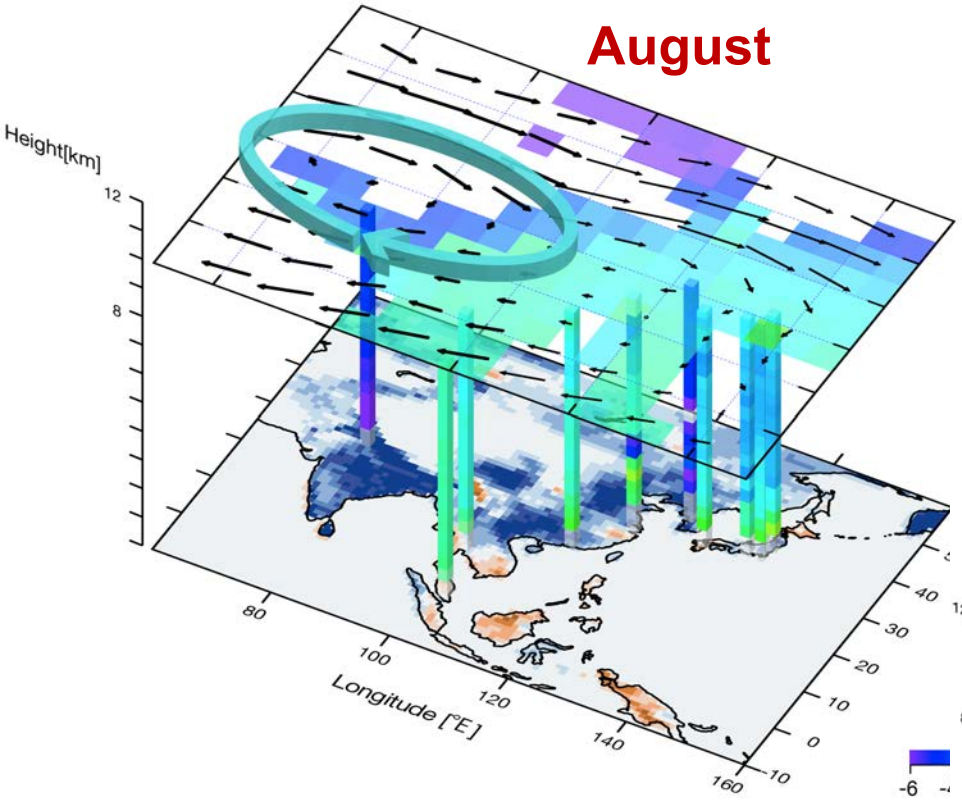
Ground signal is trapped in monsoon anticyclone in August



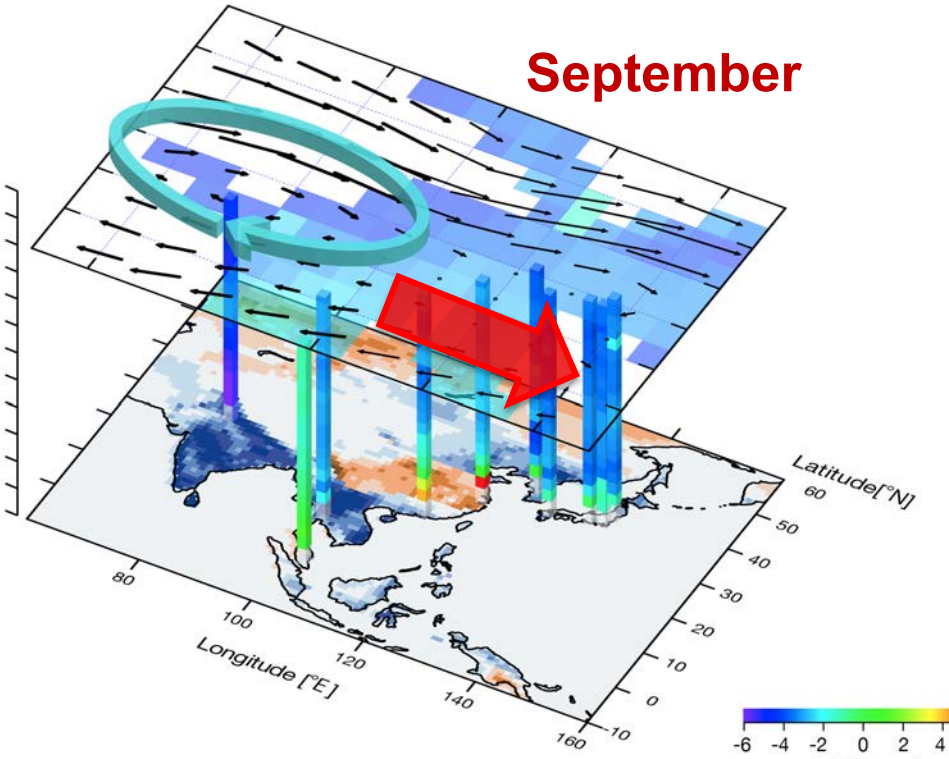
Ground signal spreads to Pacific region in September

Umezawa et al. ACP (2018)

3-D distrubutions of CO_2 over Asia-Pacific region



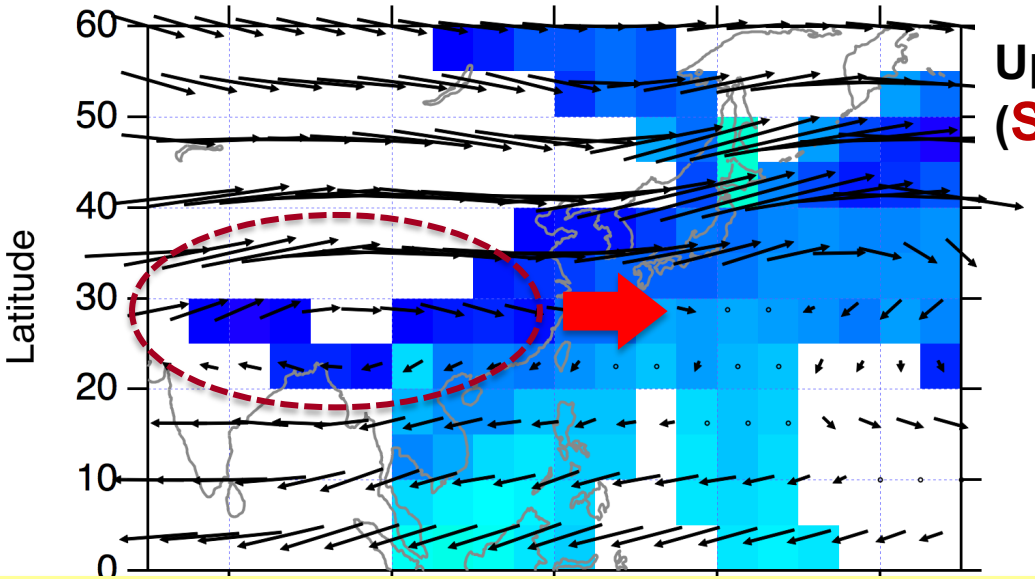
Ground signal is trapped in monsoon anticyclone in August



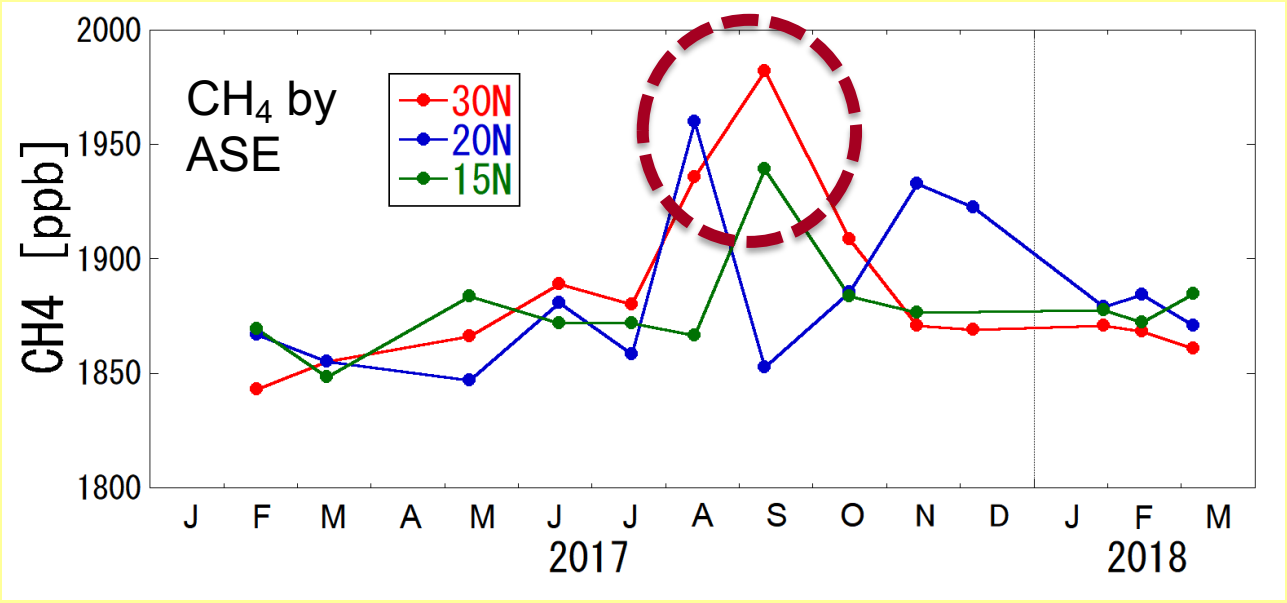
Ground signal spreads to Pacific region in September

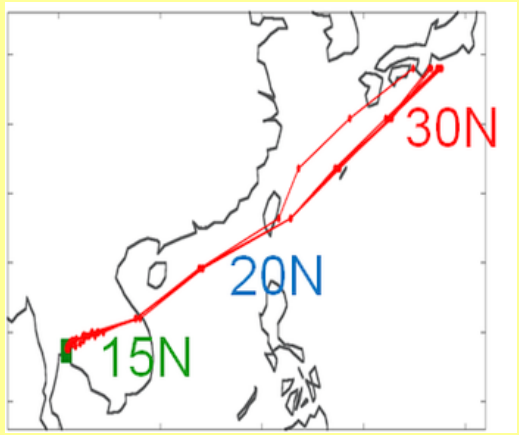
Umezawa et al. ACP (2018)

High CH_4 in UT in summer

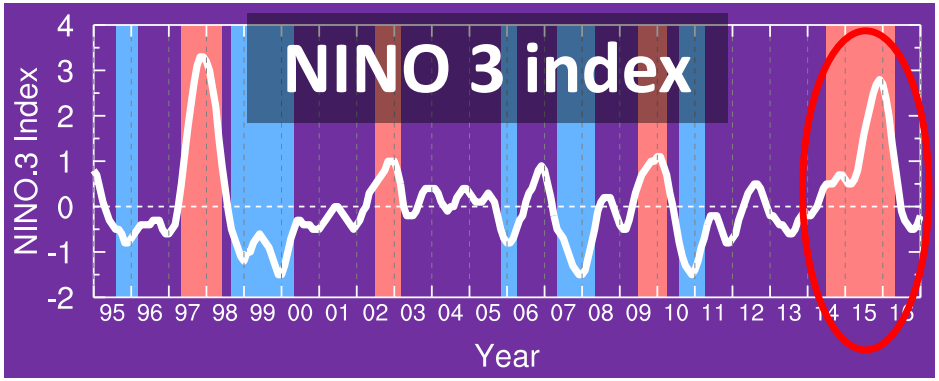


Upper Troposphere
(September)

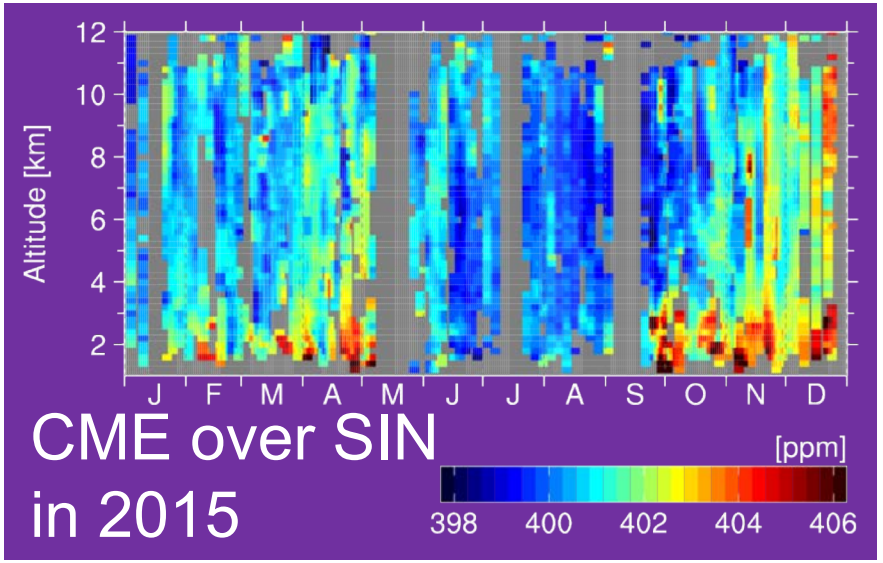




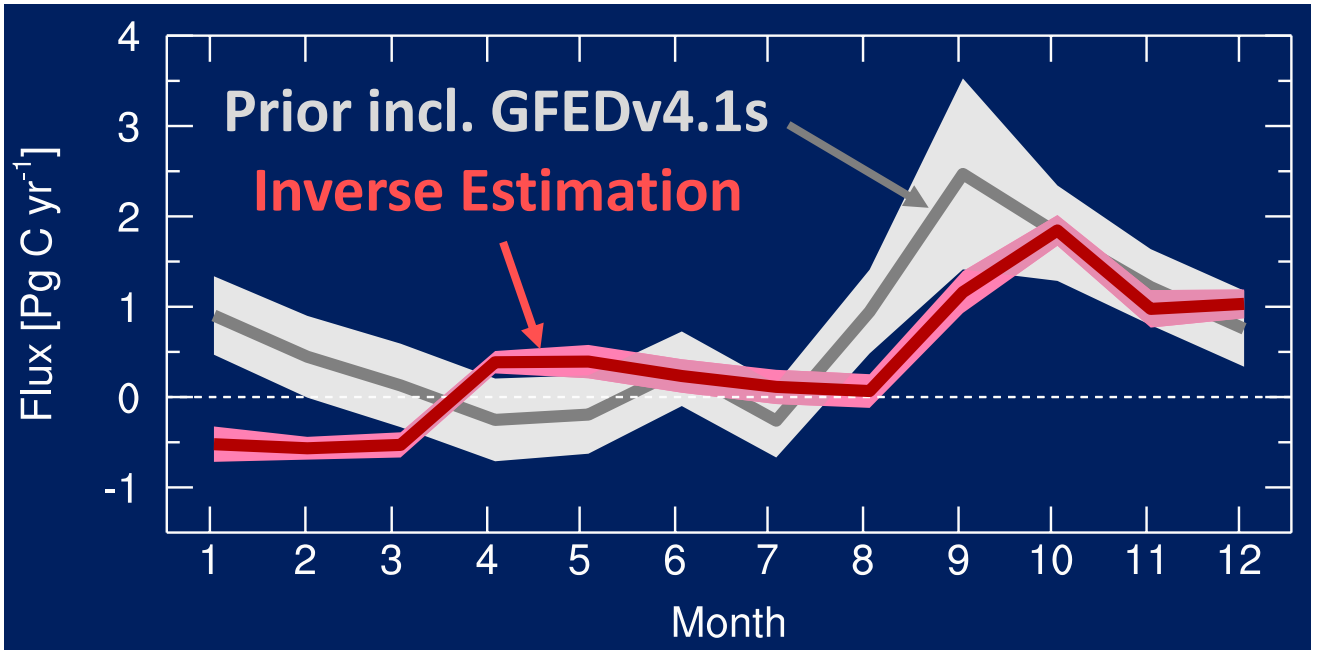
Estimation of CO_2 flux by Inverse model



Big El Nino in 2015
A lot of fire in SE Asia

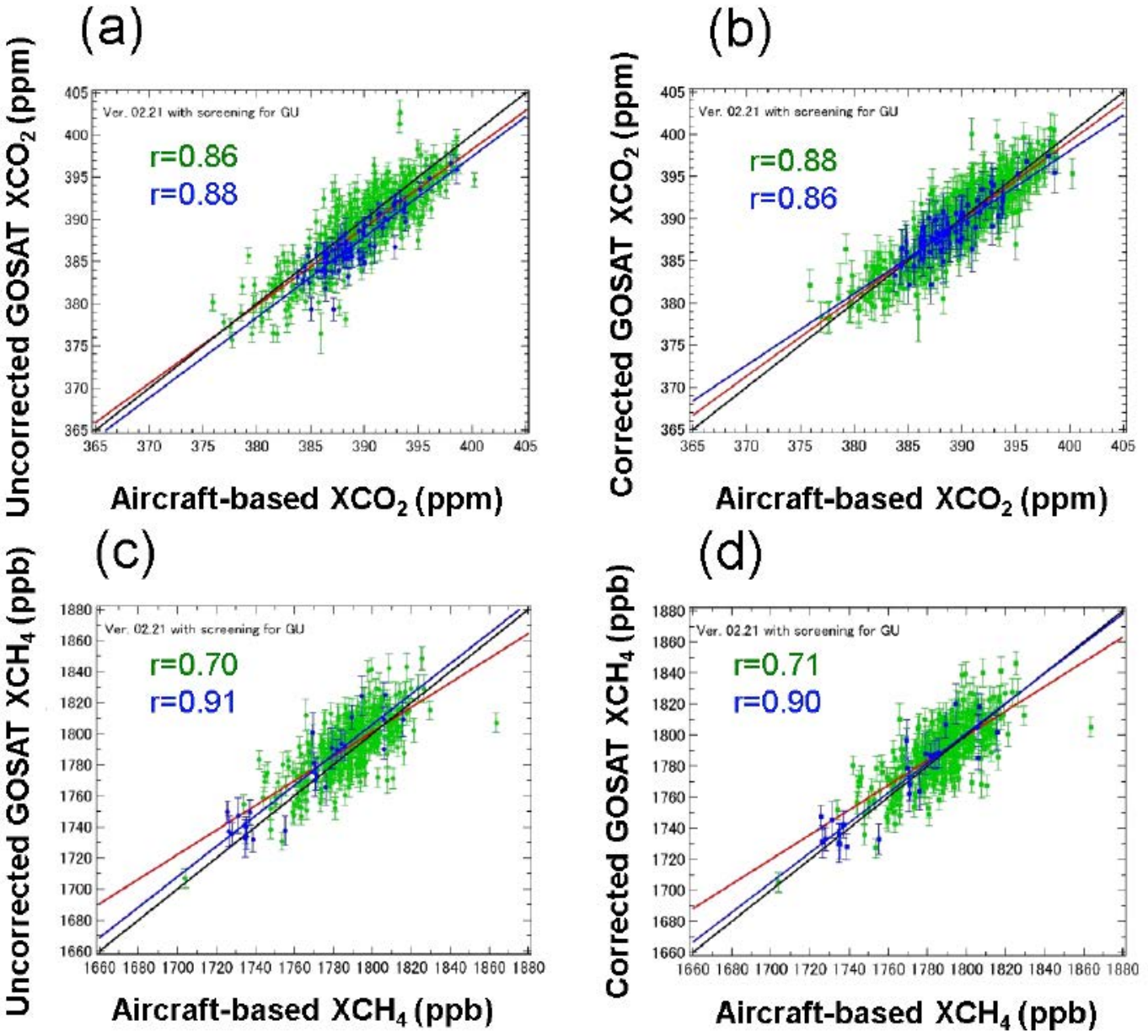


Much less emission than GFED



Niwa et al., in prep.

Validation for GOSAT XCO_2 and XCH_4



Inoue et al., 2016

Summary

- Long-term CO_2 record between 30N and 30S in UT
- Unique seasonal variation of CO_2, CH_4, N_2O and SF_6 in LS
  → controlled by air exchange in UT/LS
- Seasonality in vertical CO_2 over the cities in Asia-Pacific region
- Winter crop absorb substantial CO_2 around northern India
- Monsoon anticyclone accumulate ground signal in August
  →Such signal spreads to Pacific region in Sep.
  →consistent to CH_4 in UT
- Much less CO_2 emission from SE Asia in 2015
- CONTRAIL data are available. CONTRAIL NIES

Thank you.

Please consider to use JAL
for your next travel to Japan.