Monitoring of atmospheric GHGs by commercial airliner, CONTRAIL

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1. NIES, 2. MRI

CONTRAIL

Two Equipmet onboard Boeing 777

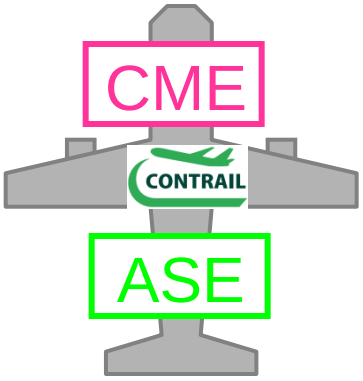
CME:
Continuous CO_2
Measuring Equipment

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

CONTRAIL

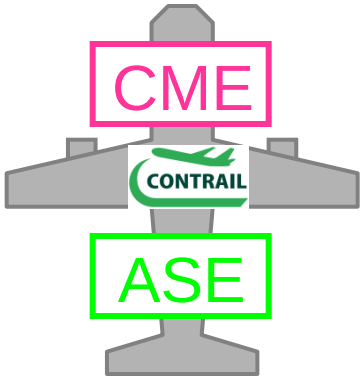
Machida et al. JTEC (2008)

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



777-200ER
(JA705J)
Jun/2006-

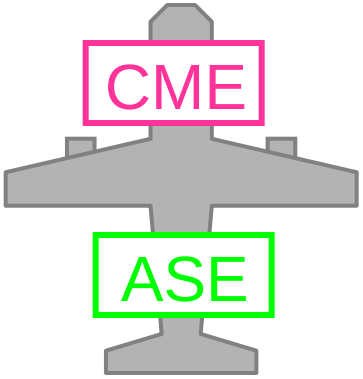
777-200ER
(JA703J)
Oct/2006-



777-200ER
(JA707J)
Nov/2006-

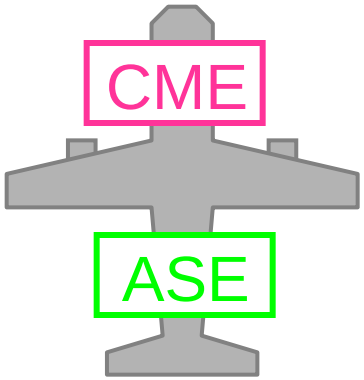
777-200ER
(JA708J)
Jun/2012-

777-300ER
(JA734J)
Feb/2015-

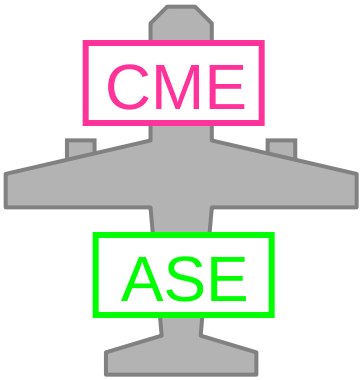


777-200ER
(JA709J)
Sep/2012-

777-200ER
(JA702J)
Mar/2013-



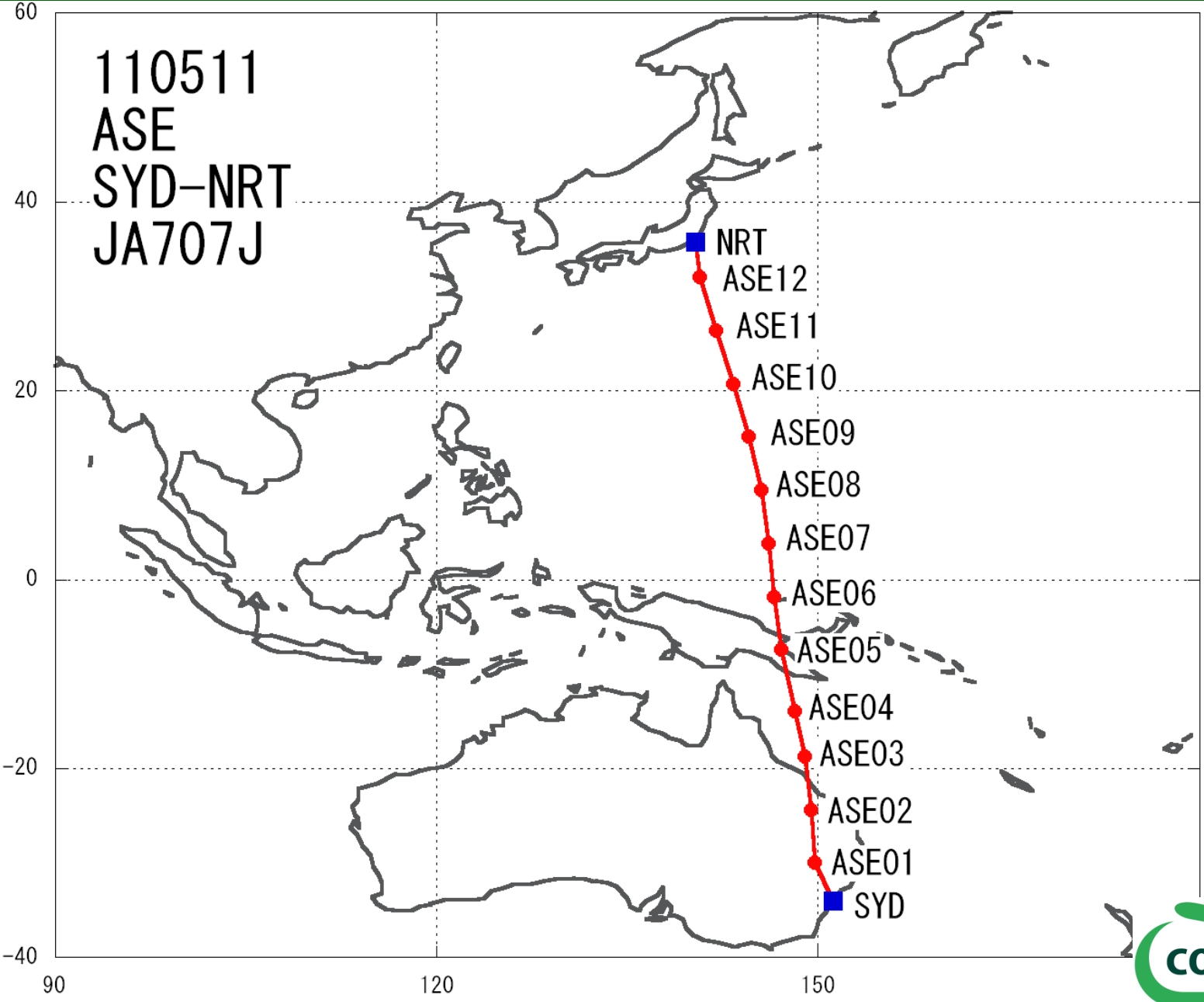
777-200ER
(JA710J)
Jul/2013-



777-200ER
(JA711J)
Aug/2013-

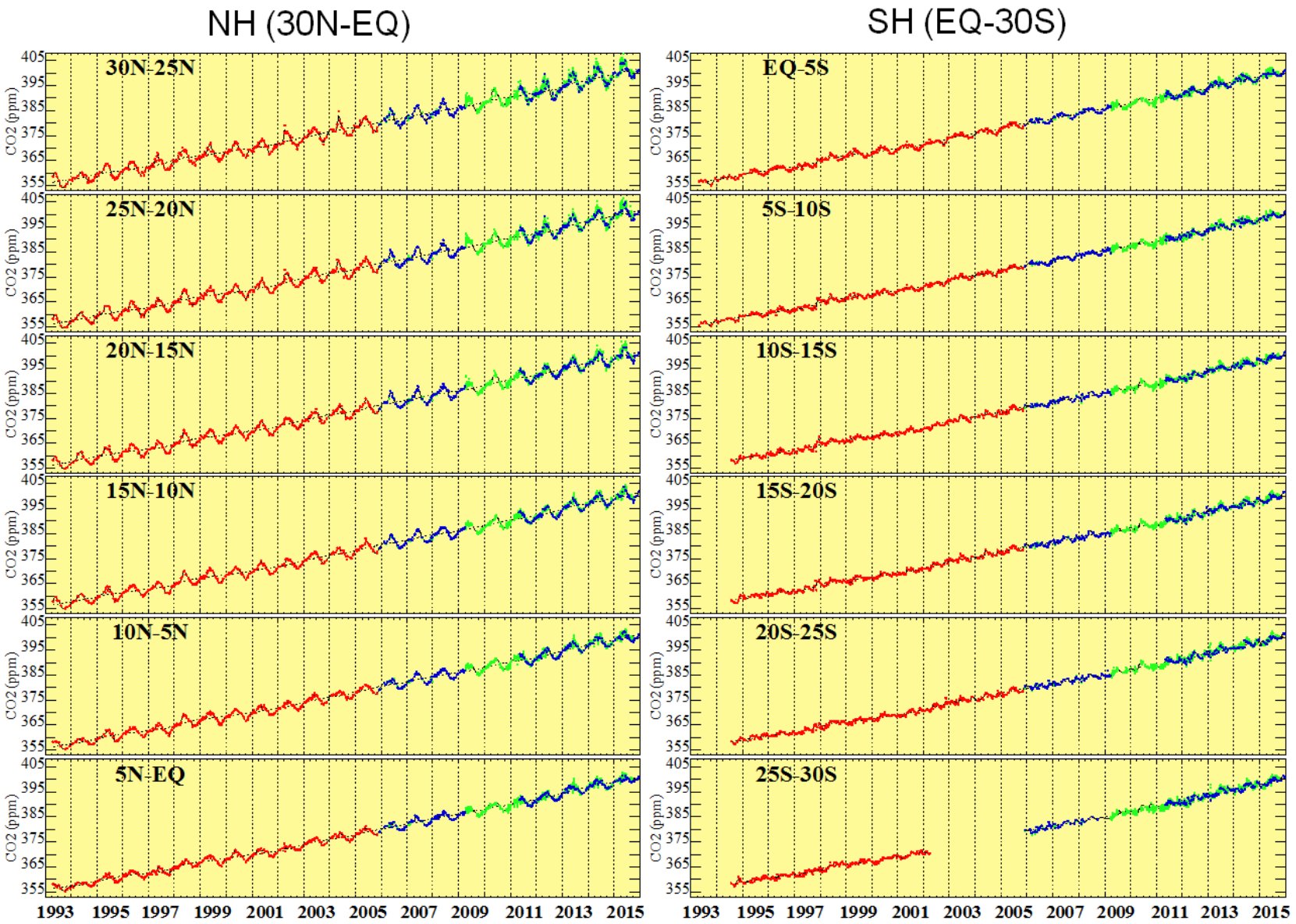
777-300ER
(JA733J)
Feb/2016-

Sampling locations of ASE



CONTRAIL

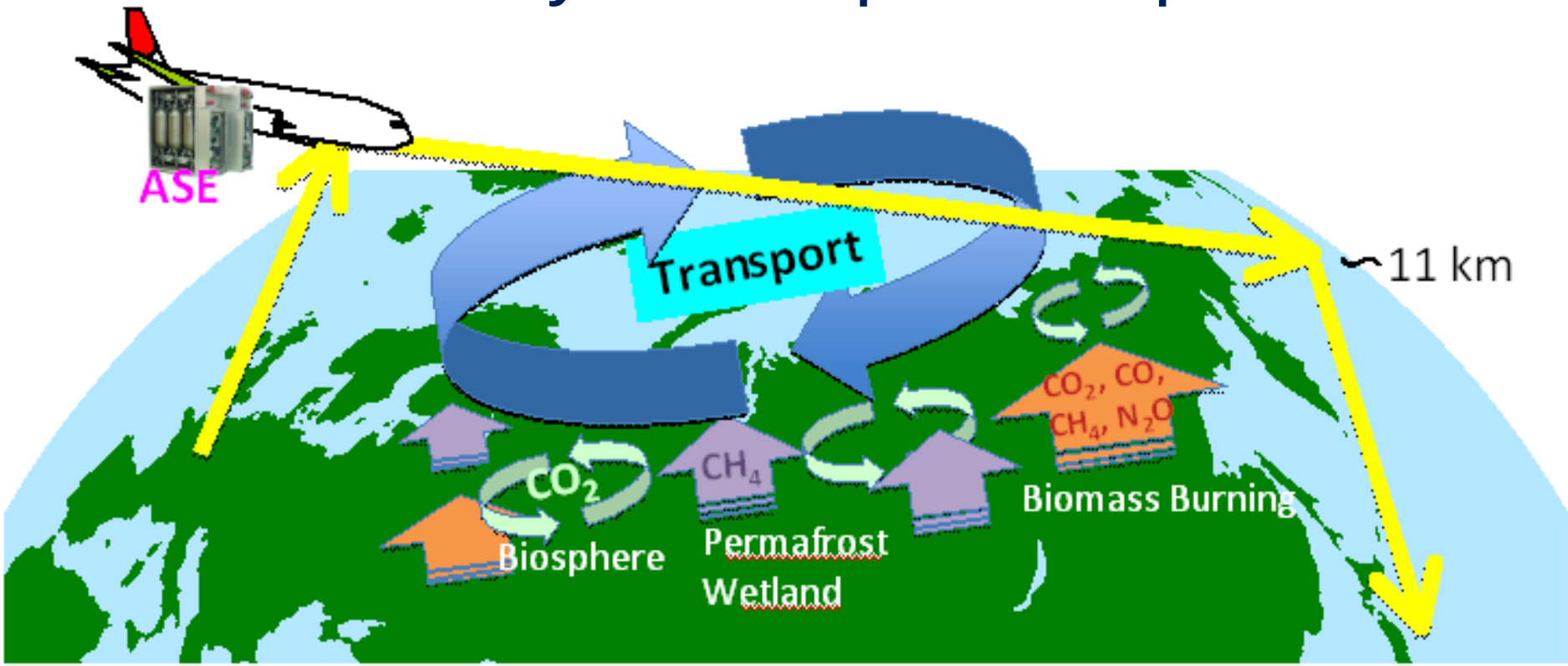
Time series of CO_2 in UT from 30N to 30S



Matsueda et al. GRL (2015)

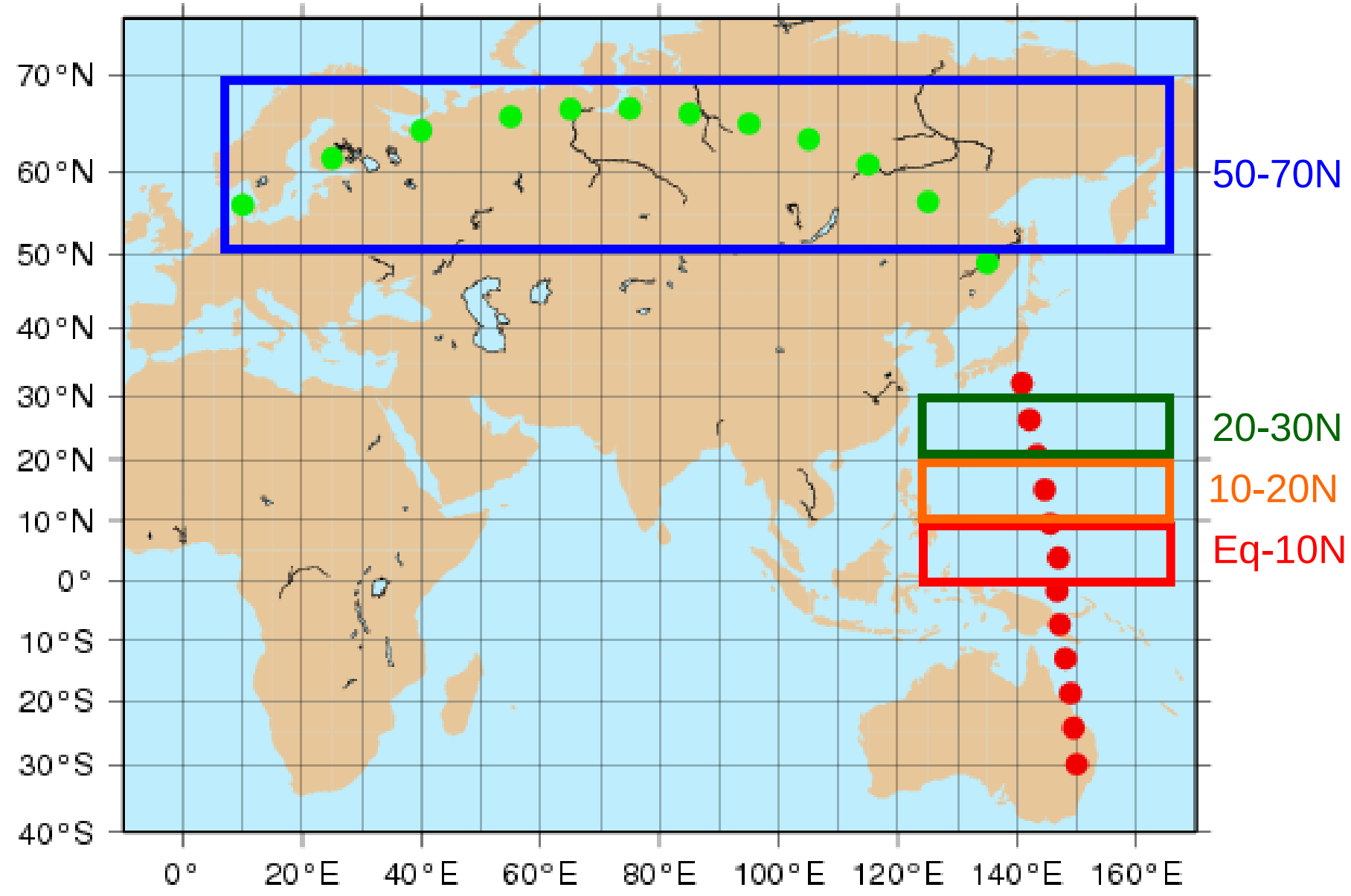
Air Sampling between Europe and Japan

by ASE Apr/2012-Mar/2014
by MSE Apr/2014-present



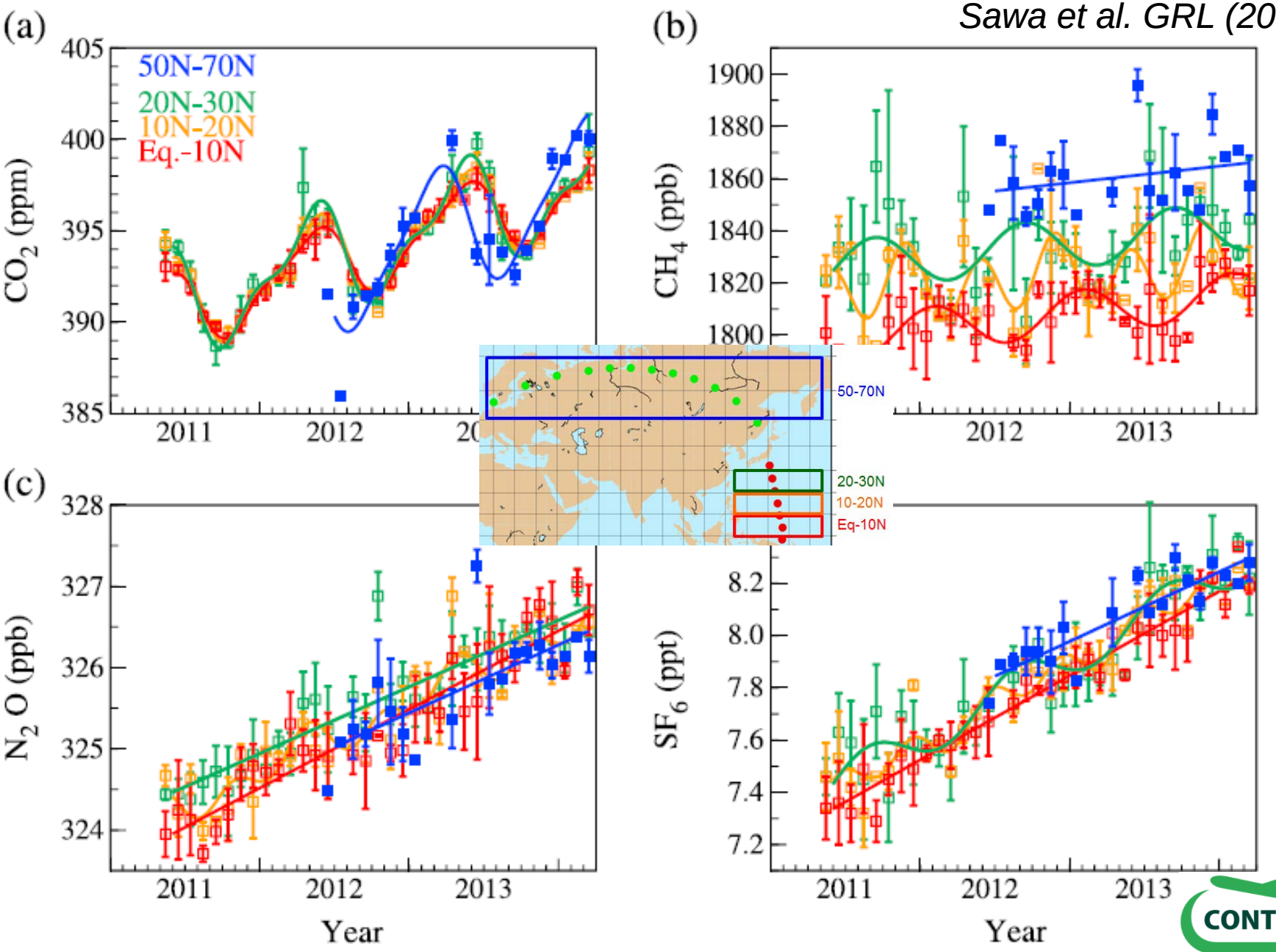
2012 : GRENE observational plan for atmospheric greenhouse gases (NIES, MRI, NiPR, AIST, Tohoku

CONTRAIL


70°N
60°N
50°N
40°N
30°N
20°N
10°N
0°
10°S
20°S
30°S
40°S
0°
20°E
40°E
60°E
80°E
100°E
120°E
140°E
160°E
50-70N
20-30N
10-20N
Eq-10N

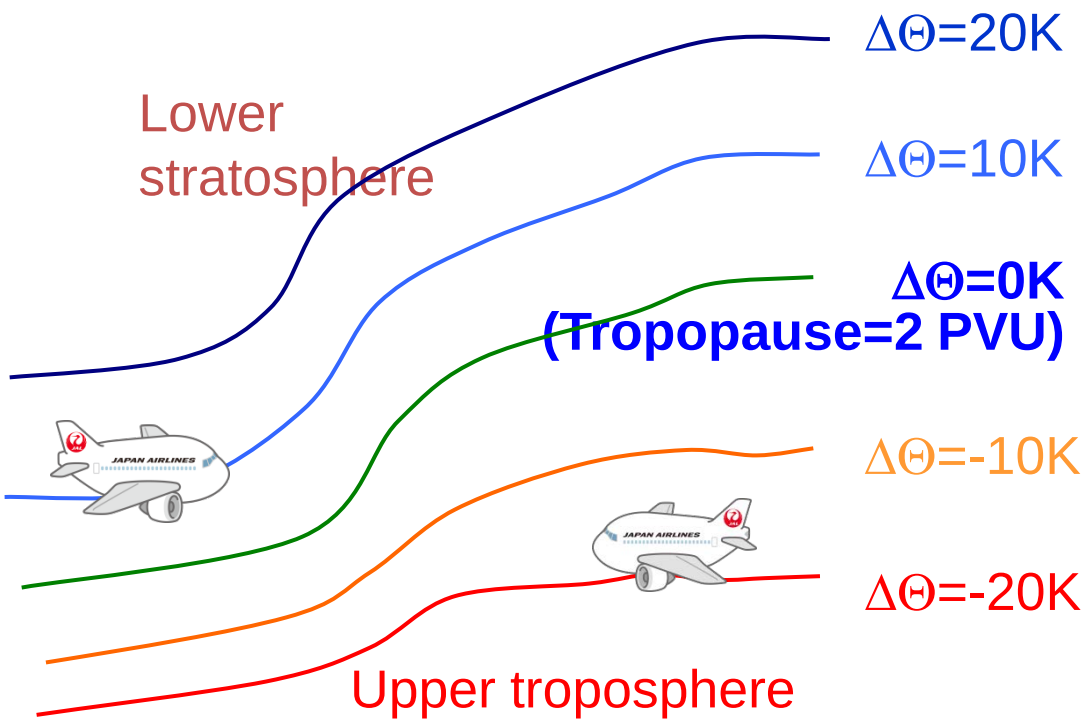
Time series in UT between Eq. and 70N

Sawa et al. GRL (2015)



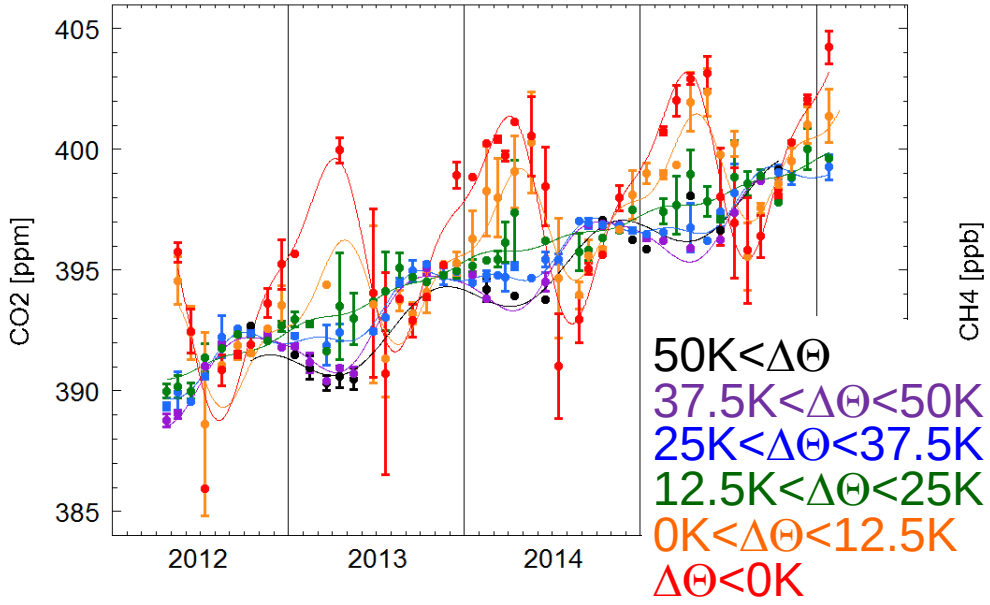
CONTRAIL

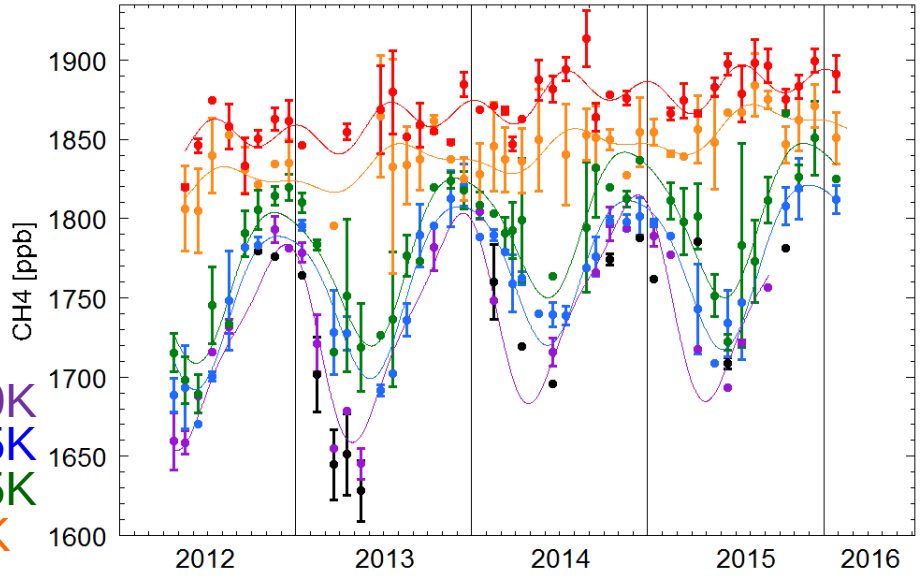
Upper Troposphere (UT) and Lower Stratosphere (LS)

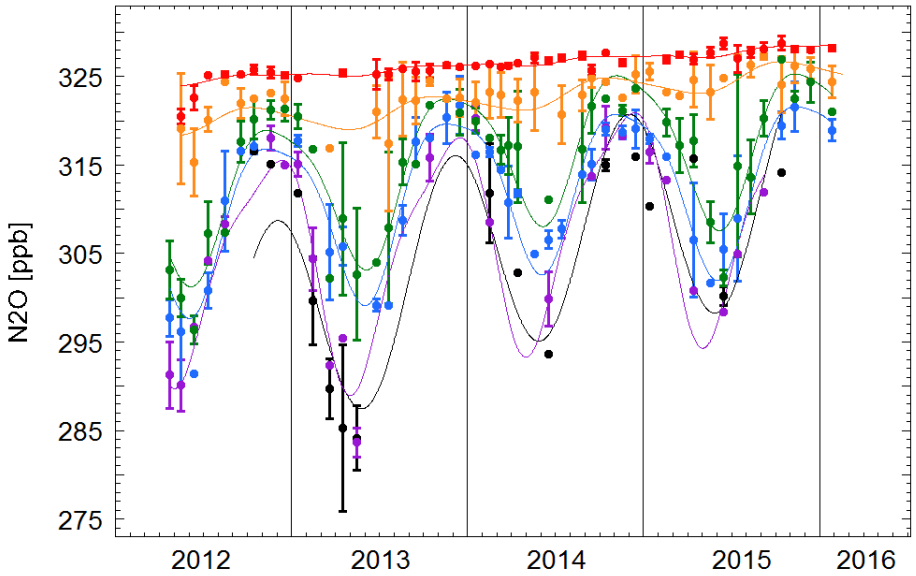


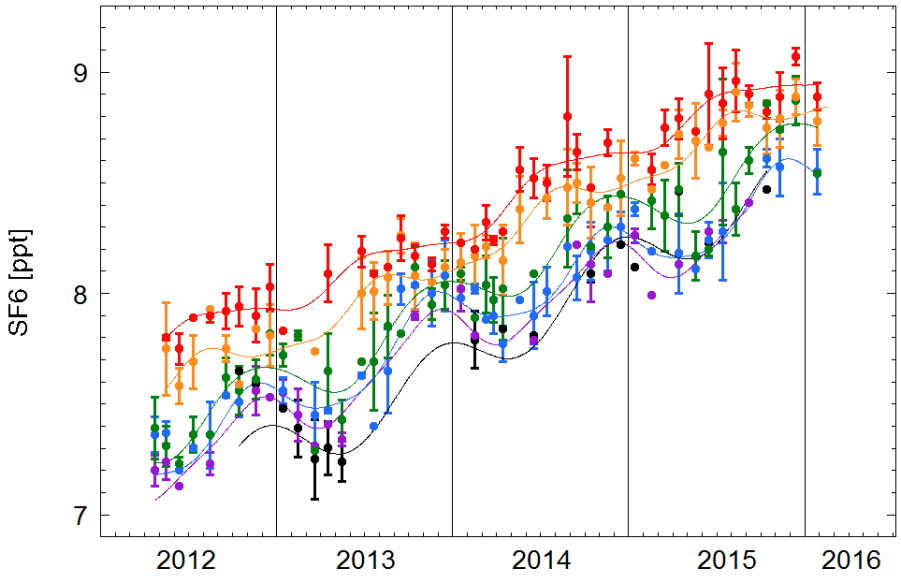
Higher Latitude ⟷ Lower Latitude

Time series in UT and LS





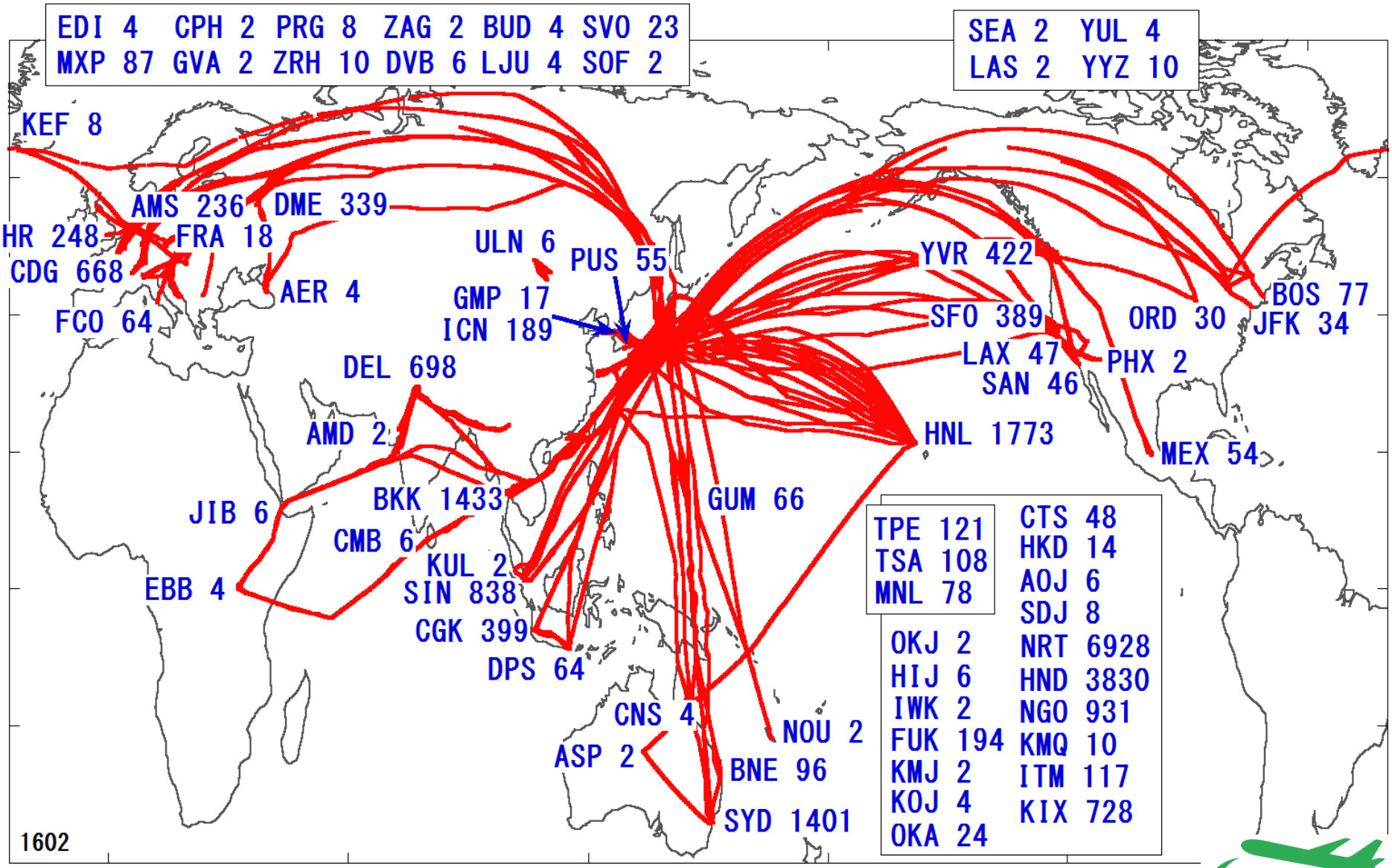




CONTRAIL

Sawa et al. GRL (2015)

Observation area and frequency of CME

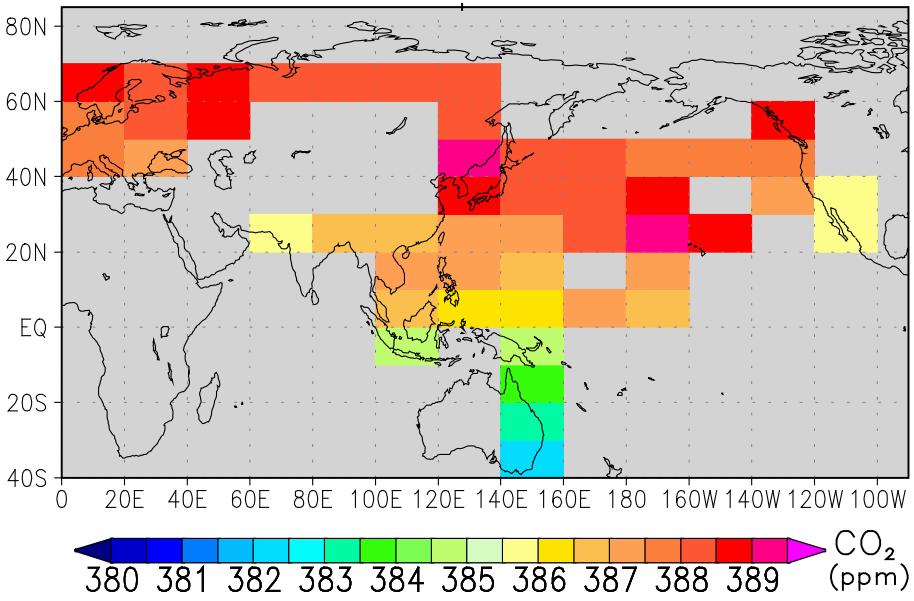


CONTRAIL

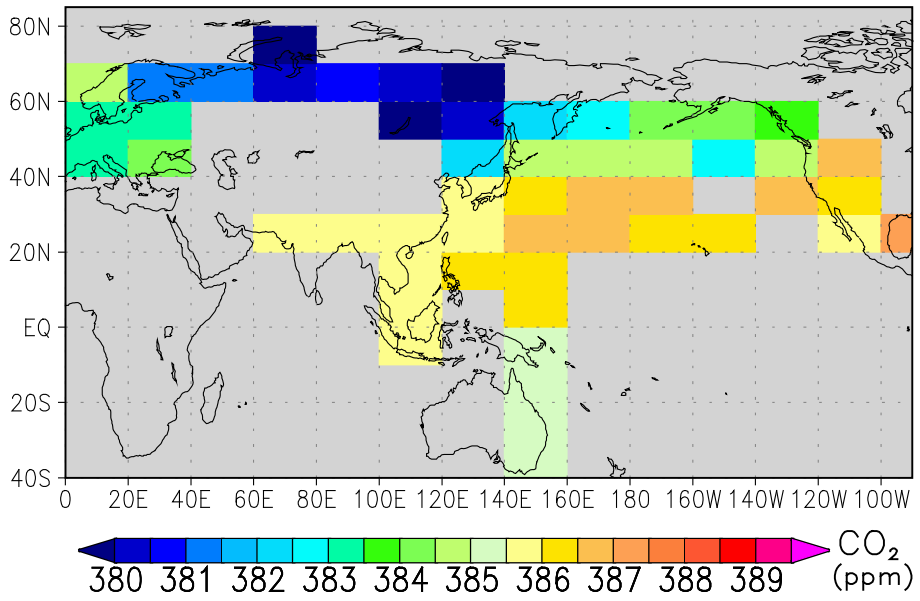
Distribution of CO_2 in Upper Troposphere

8 km < h < Tropopause

Apr.

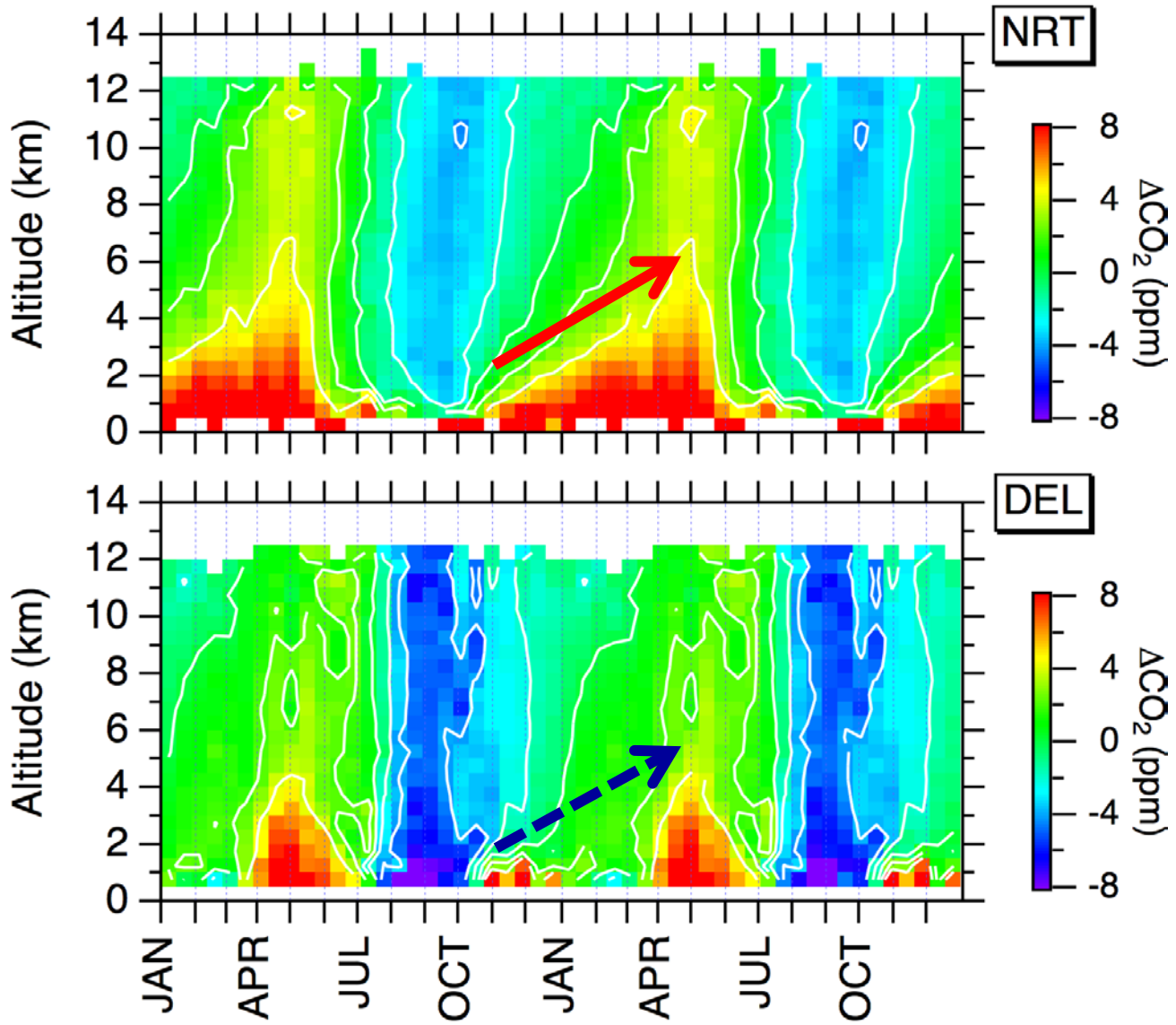


Jul.



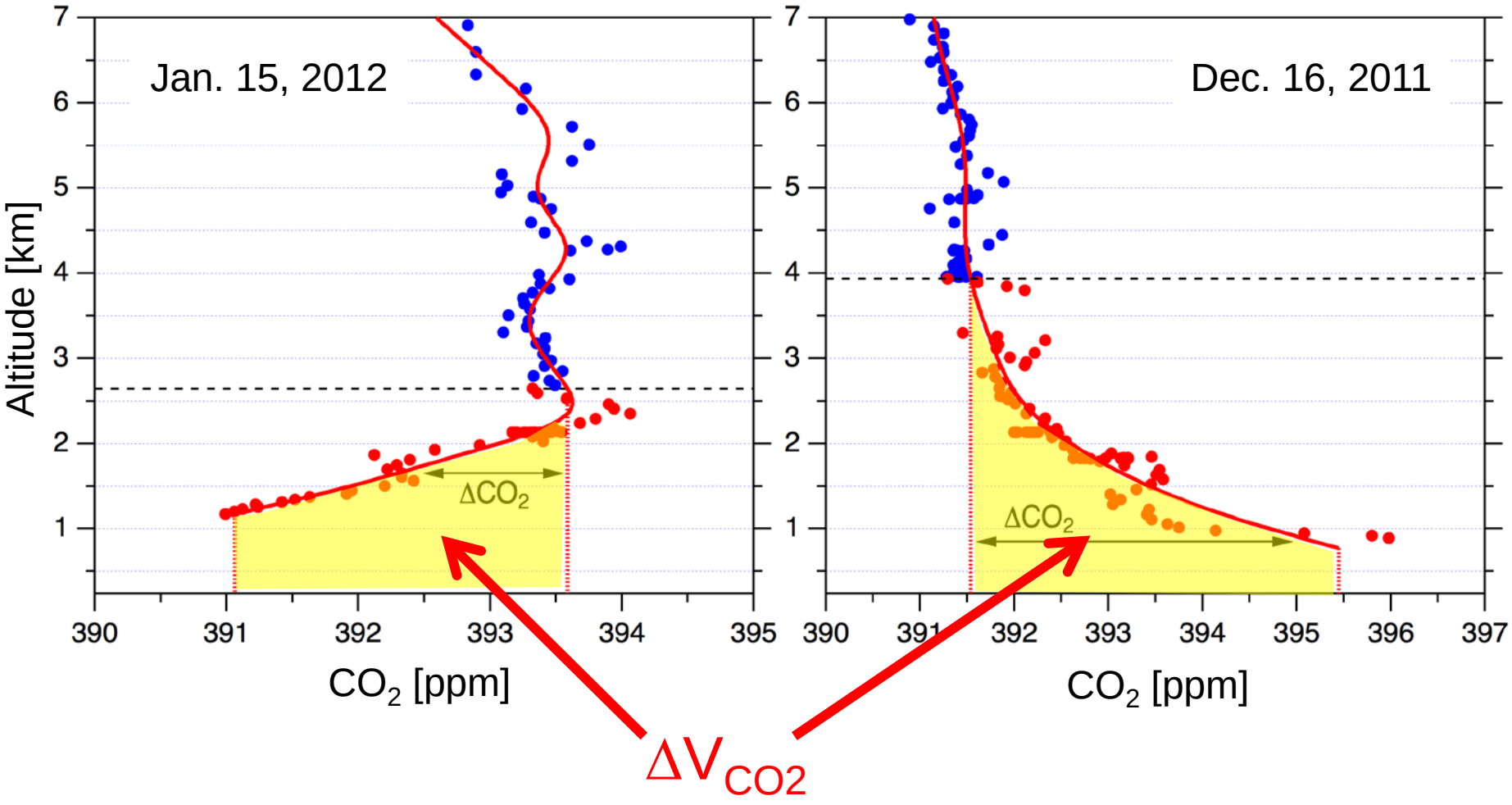
Sawa et al. JGR (2012)

Vertical profiles of CO_2 over Narita, Japan and Delhi, India



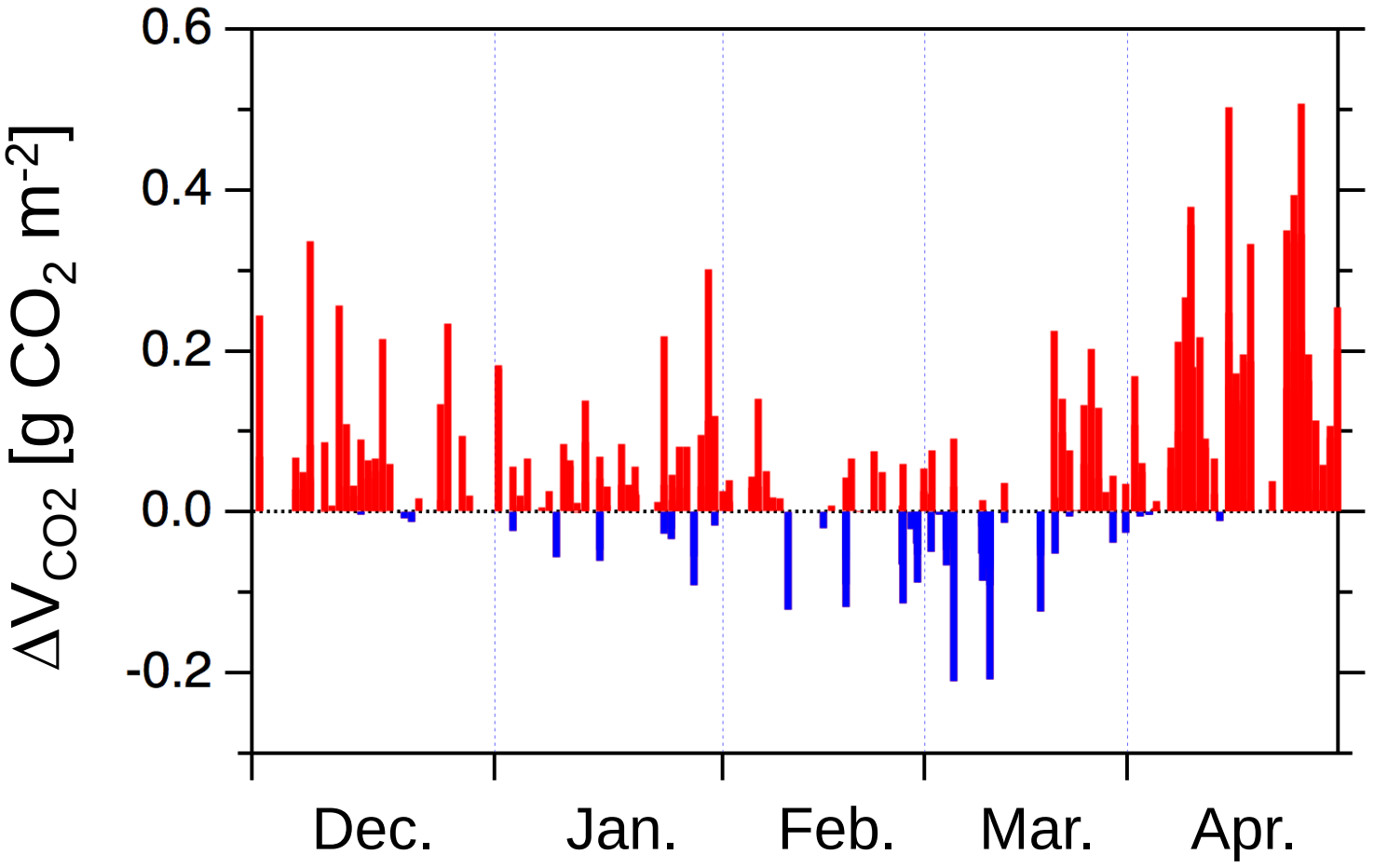
Umezawa et al. GRL (2016)

Cumulative CO_2 column abundance (ΔV_{CO2})



Umezawa et al. GRL (2016)

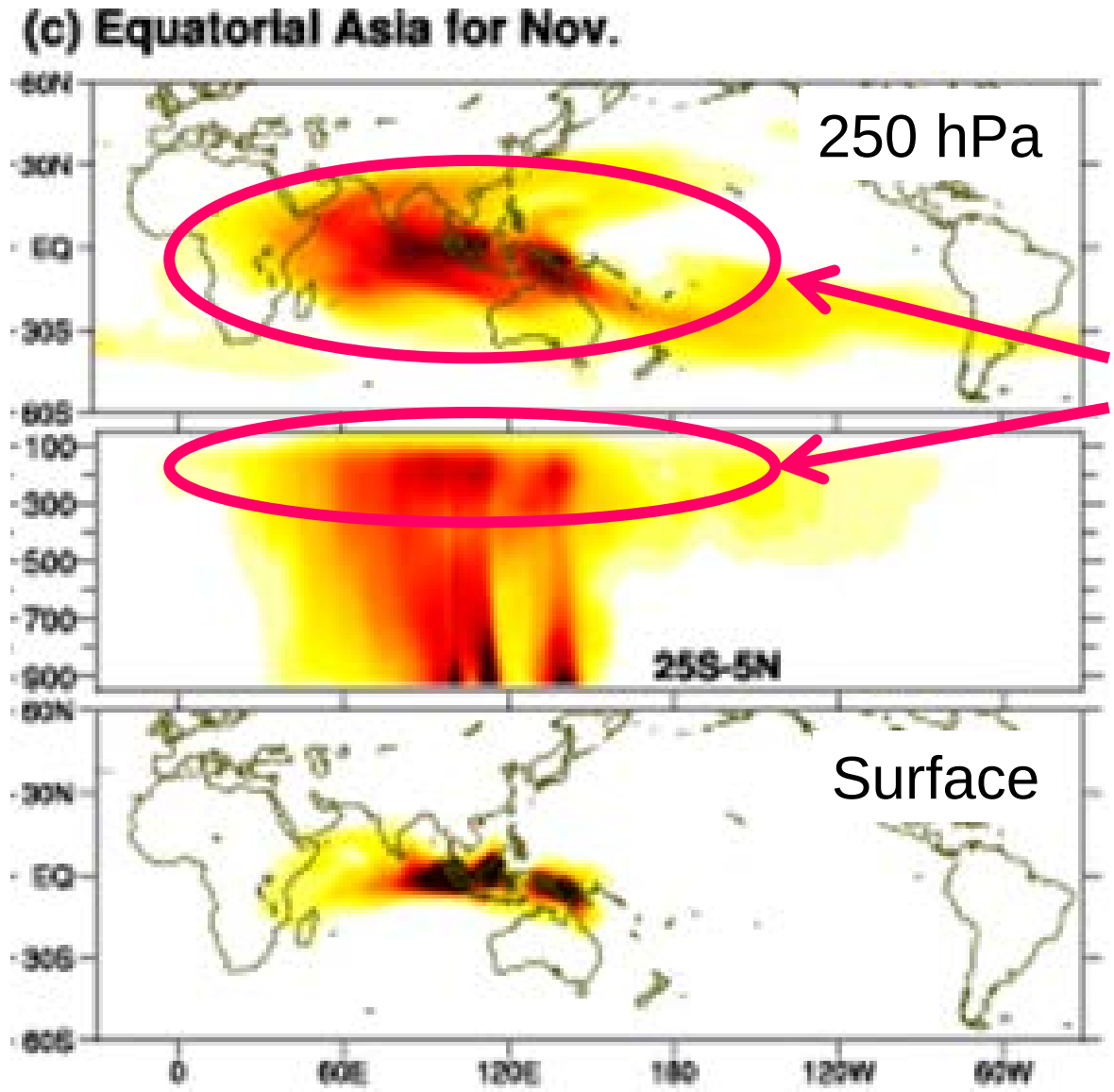
Seasonal change in ΔV_{CO2}



Winter crop CO2 uptake (mainly by wheat)
→Substantial impact of agriculture for carbon cycle

Umezawa et al. GRL (2016)

Footprint calculated by NICAM transport model



The data by aircraft have information of surface fluxes.

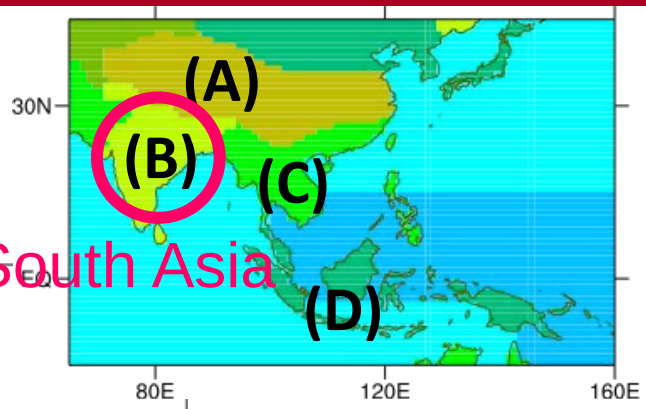
Niwa et al. JGR, 2012

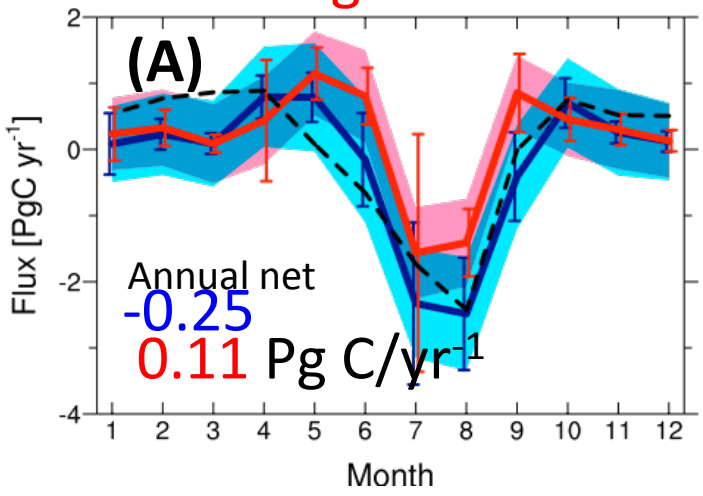
CO_2 flux estimated by inverse model

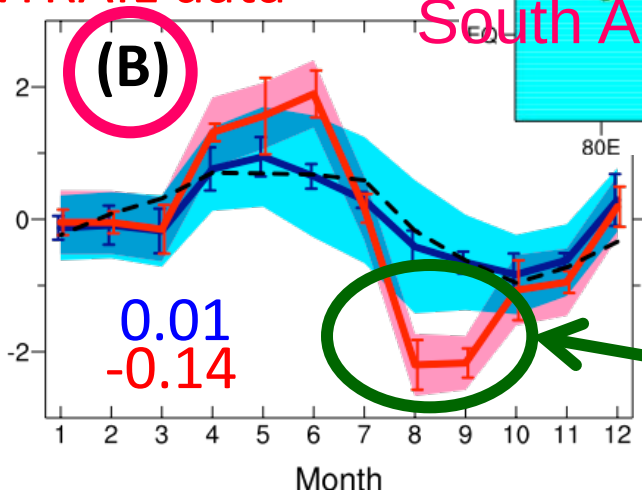
Mean seasonal flux for 2006–2008

using only surface observation

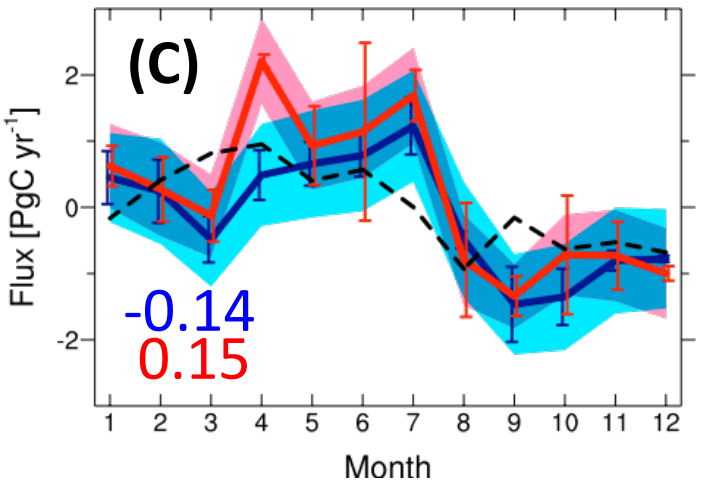
using surface + CONTRAIL data

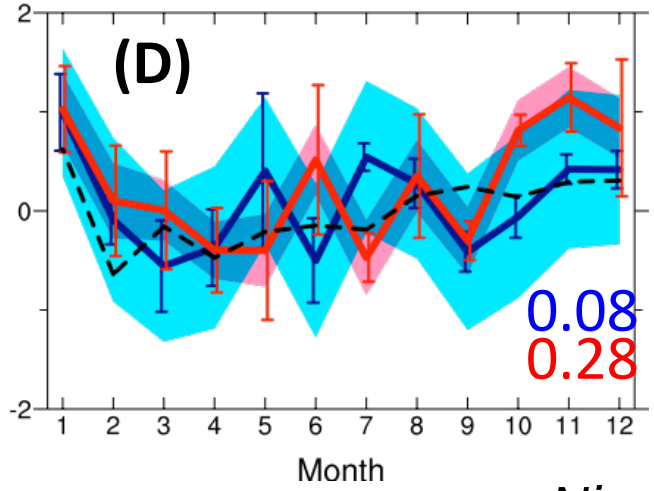






CO2 uptake in Aug. & Sep.





CASA (prior flux)

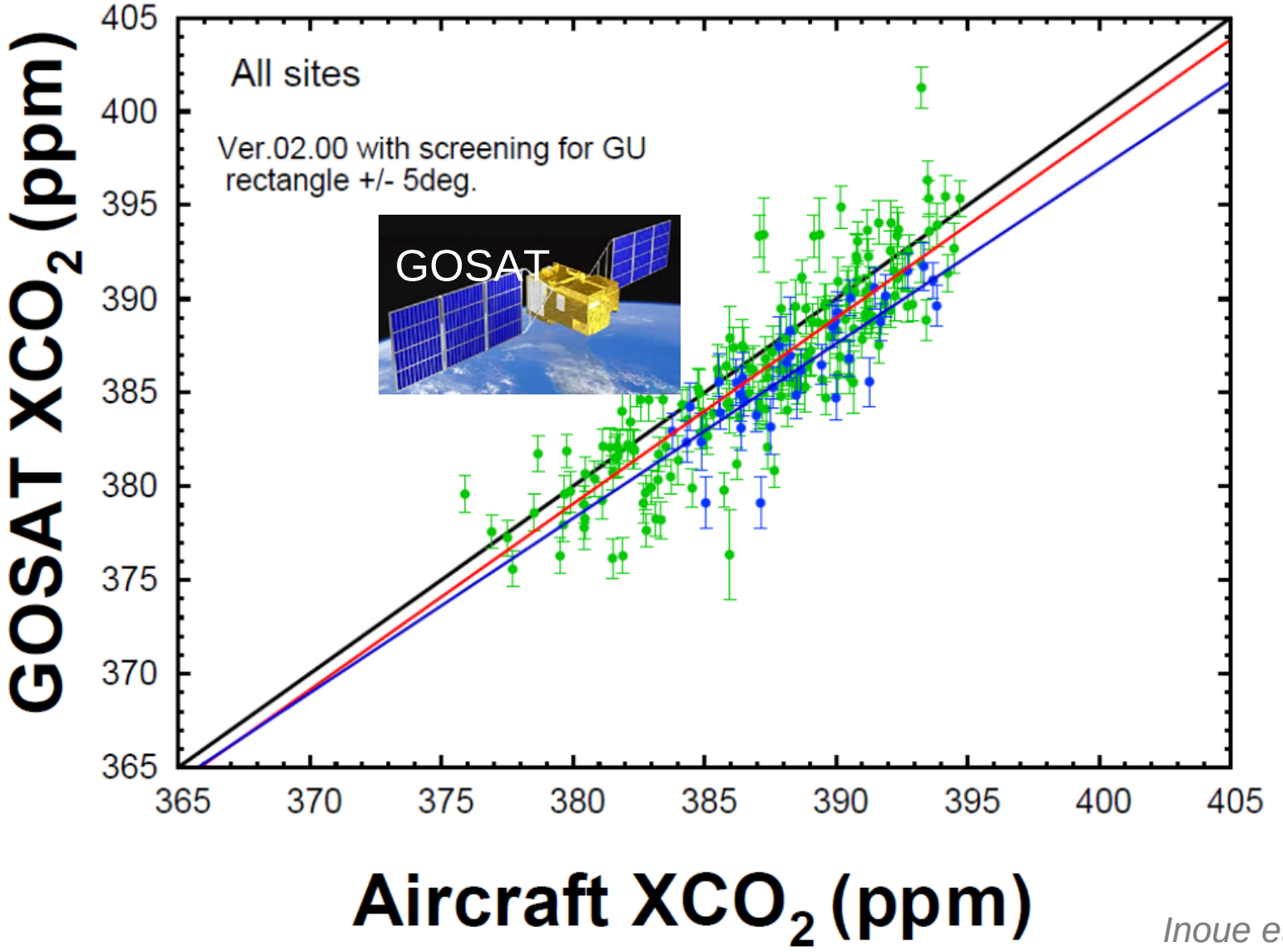
estimated flux error

std. for 2006-2008

Niwa et al. 2012, JGR.

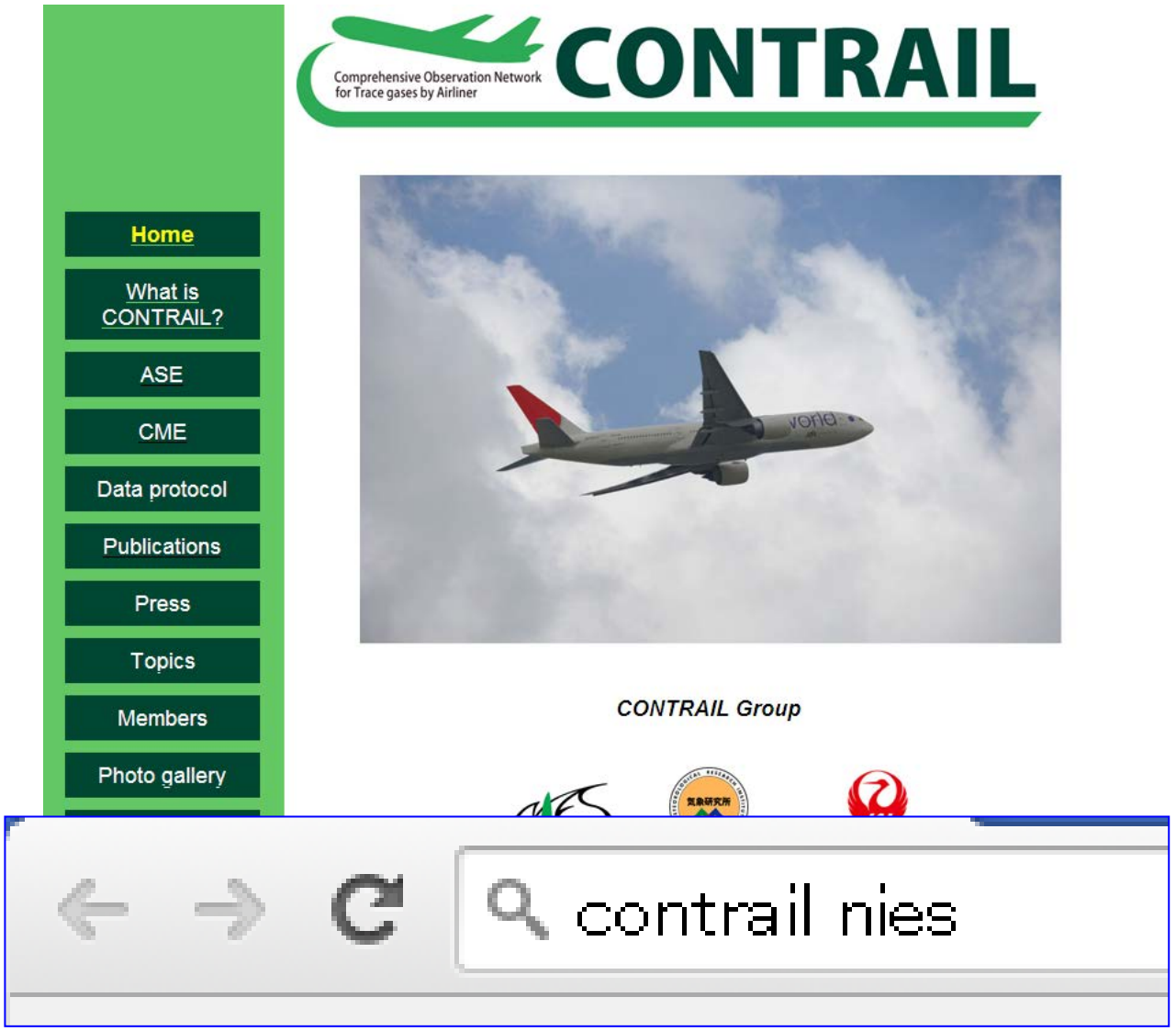
Validation for satellite observation

±5 deg., the same day



Inoue et al. (2013)

CONTRAIL web page



www.cger.nies.go.jp/contrail/

Summary

- CONTRAIL provides great number of GHG data in upper air.
- Long record of CO_2 over Pacific
- Seasonality of GHGs in UT/LS
- Winter crop CO_2 uptake in Delhi region
- Aircraft data constrain CO2 fluxes especially in Asia

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

Thank you.