

# Three-dimensional behaviors of atmospheric CO<sub>2</sub> revealed by the CONTRAIL project



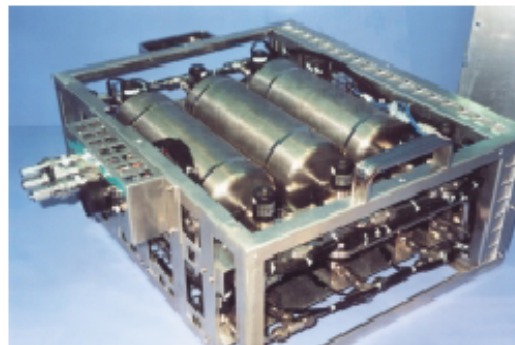
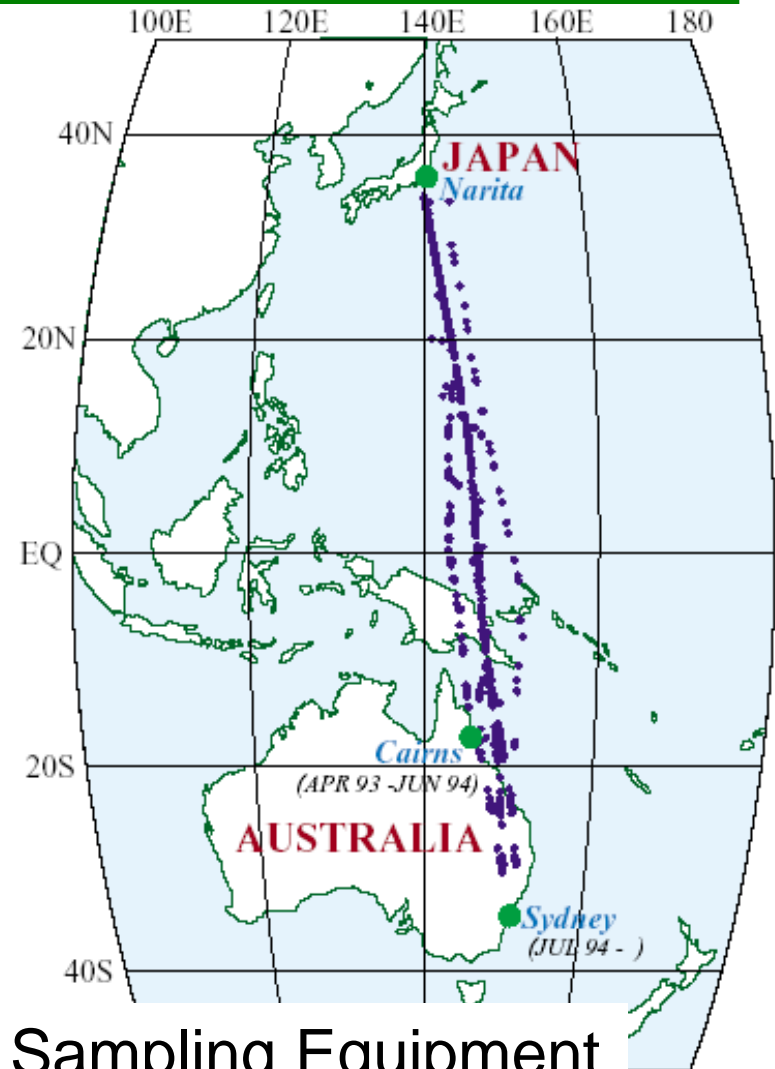
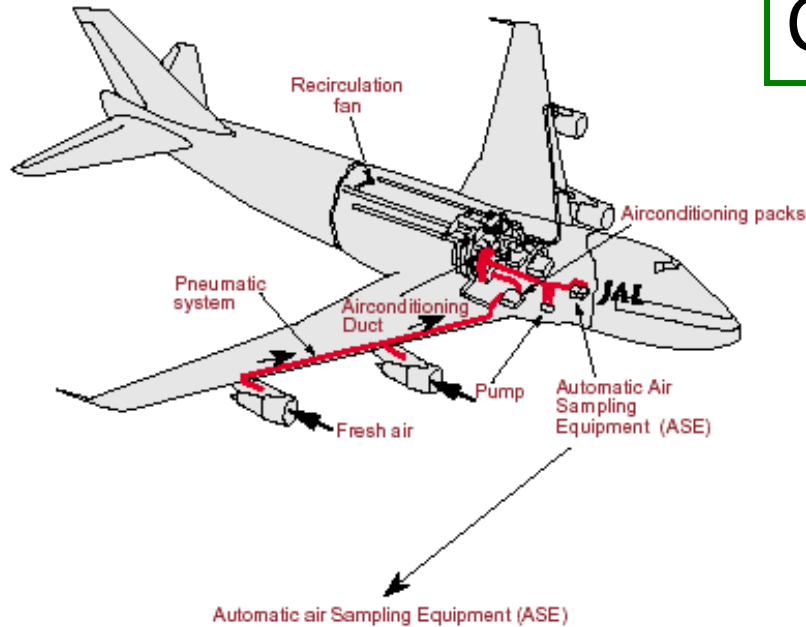
T. Machida<sup>1</sup>, H. Matsueda<sup>2</sup>, Y. Sawa<sup>2</sup>,  
Y. Niwa<sup>2</sup> and T. Shirai<sup>1</sup>

1. NIES, 2. MRI



# Old JAL Project (MRI, JAL, JAL F)

1993-2005, Twice/month  
CO<sub>2</sub>, CH<sub>4</sub>, CO



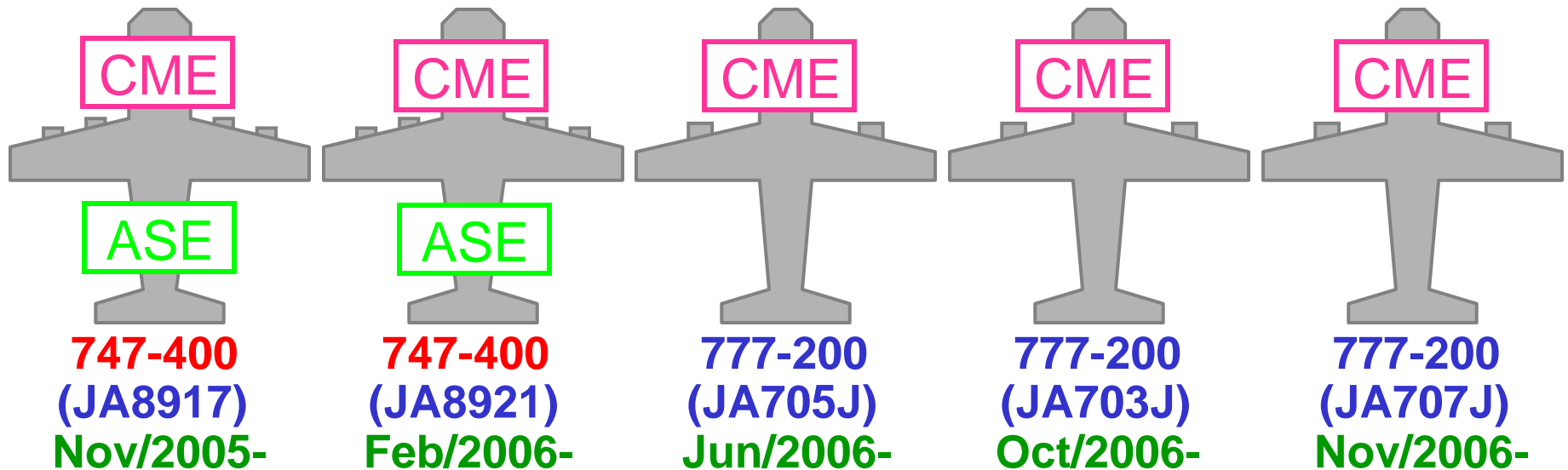
ASE: Automatic Air Sampling Equipment

# CONTRAIL Project since 2005



CME: Continuous CO<sub>2</sub> Measuring Equipment

new ASE: (CO<sub>2</sub>, CH<sub>4</sub>, CO, N<sub>2</sub>O, SF<sub>6</sub>, H<sub>2</sub>, isotopes)



# Six 777-200ER aircraft by JAL

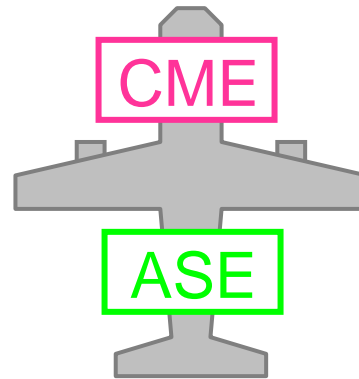


Forward Cargo Room

Aft Cargo Room

CME

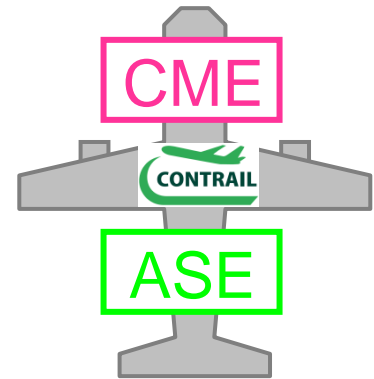
ASE



777-200  
(JA705J)  
Jun/2006-



777-200  
(JA703J)  
Oct/2006-



777-200  
(JA707J)  
Nov/2006-



777-200  
(JA708J)  
Jun/2012-



777-200  
(JA709J)  
Sep/2012-

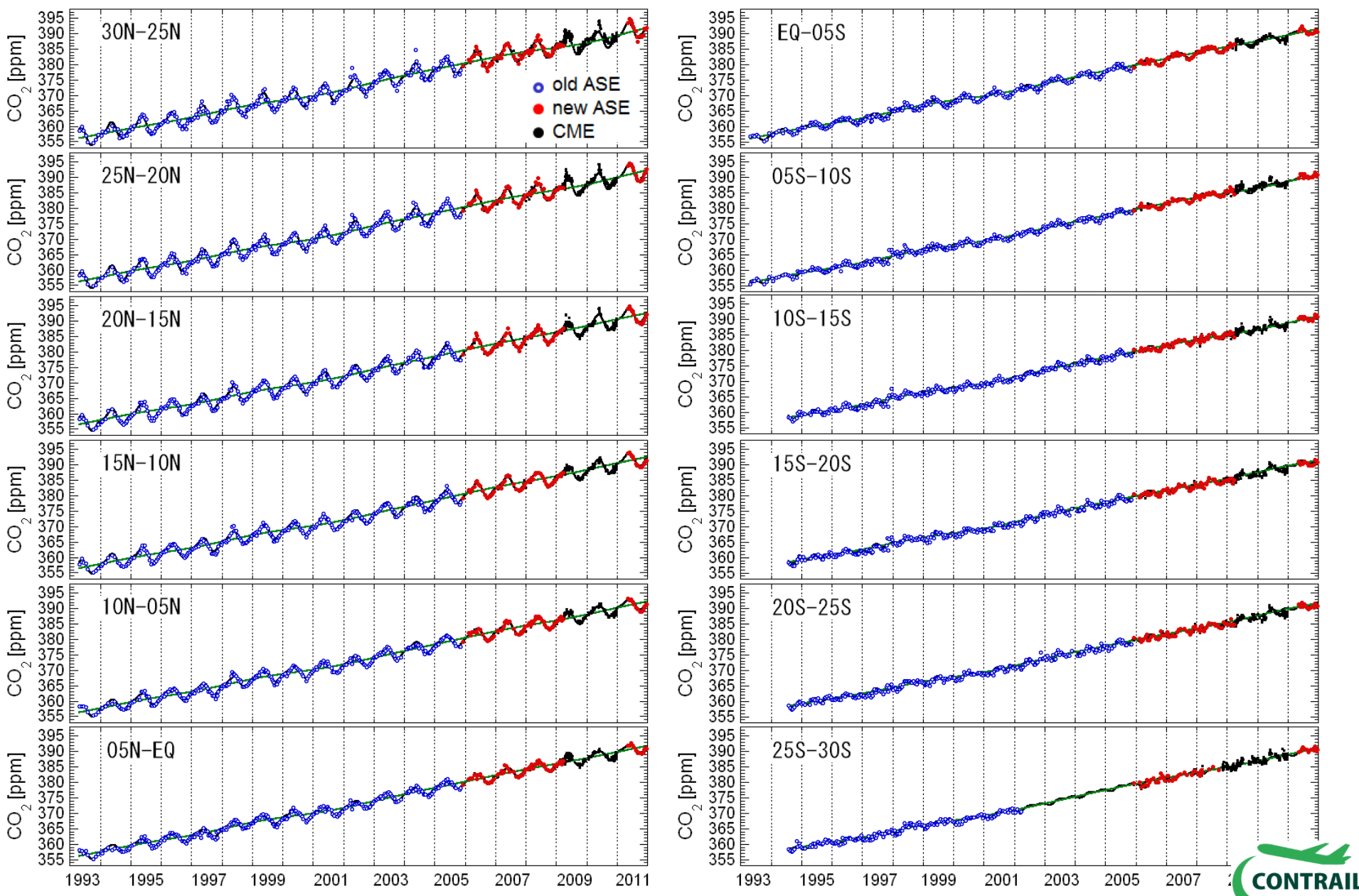


777-200  
(JA702J)  
Mar/2013-





# Time series of CO<sub>2</sub> from 30N to 30S

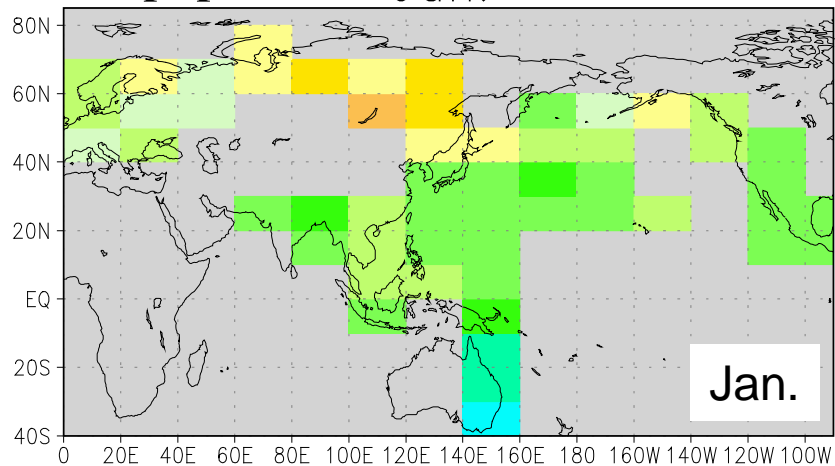




# Seasonal changes in CO<sub>2</sub> ref=2008 distributions

(8km-tropopause)

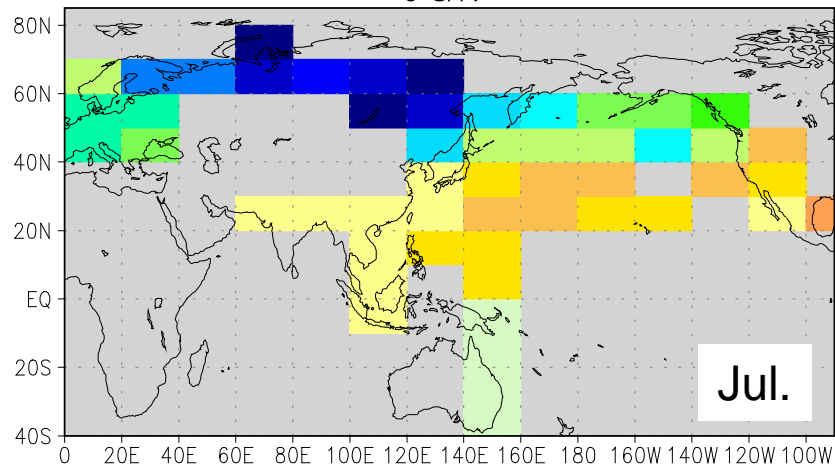
Jan.



Jan.

CO<sub>2</sub> (ppm)  
380 381 382 383 384 385 386 387 388 389

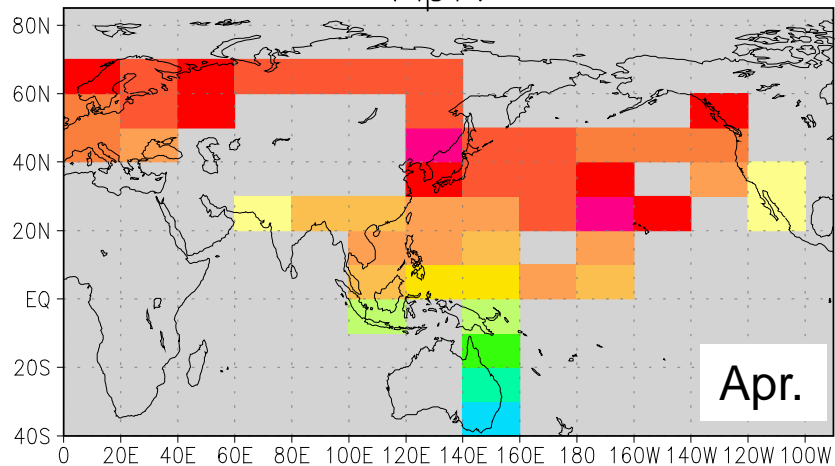
Jul.



Jul.

CO<sub>2</sub> (ppm)  
380 381 382 383 384 385 386 387 388 389

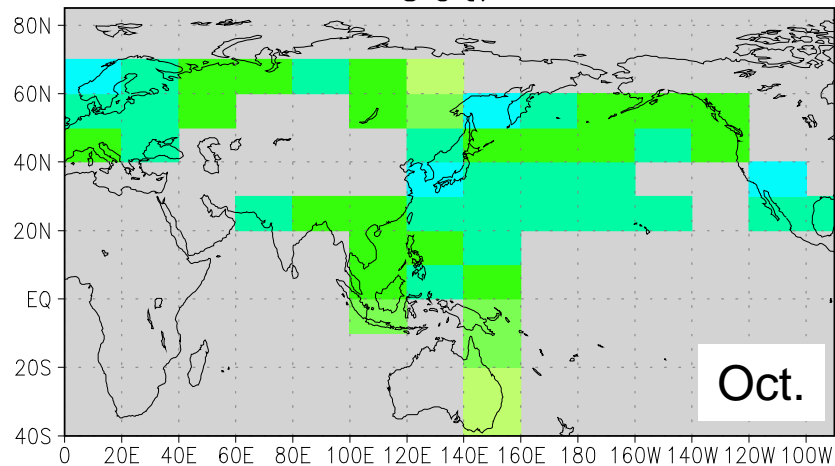
Apr.



Apr.

CO<sub>2</sub> (ppm)  
380 381 382 383 384 385 386 387 388 389

Oct.



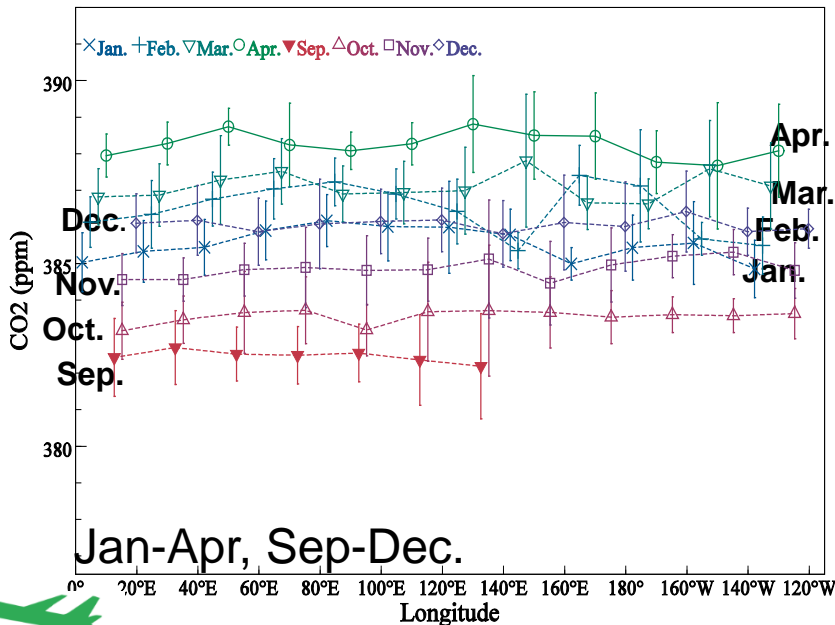
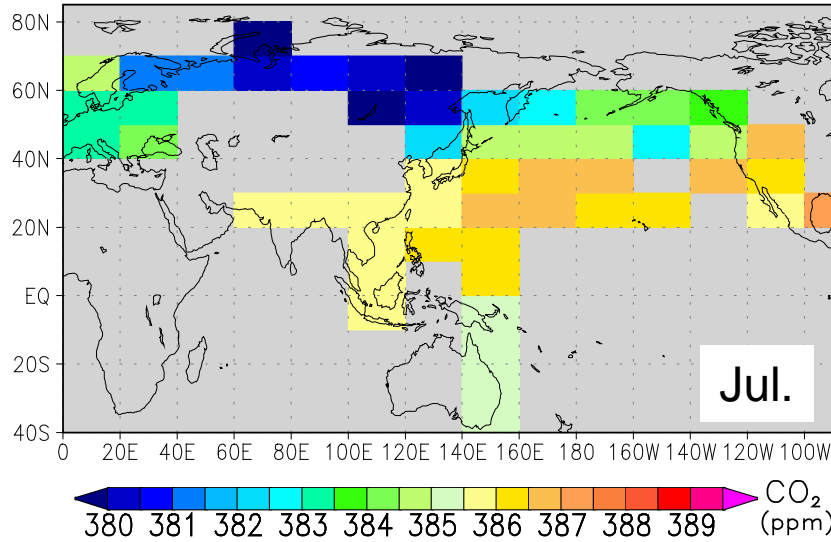
Oct.

CO<sub>2</sub> (ppm)  
380 381 382 383 384 385 386 387 388 389

# Low CO<sub>2</sub> over the Eurasia in summer

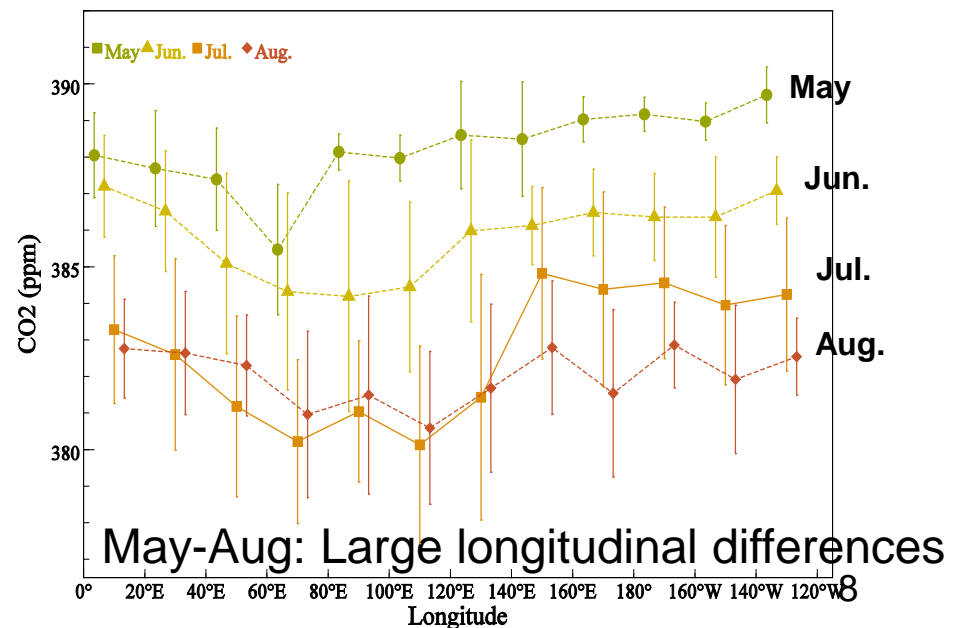
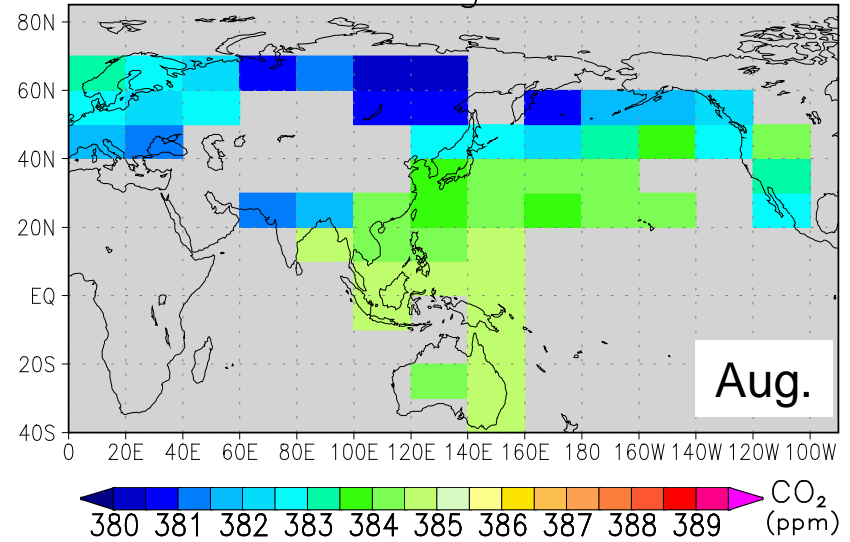
(8km-tropopause)

Jul.



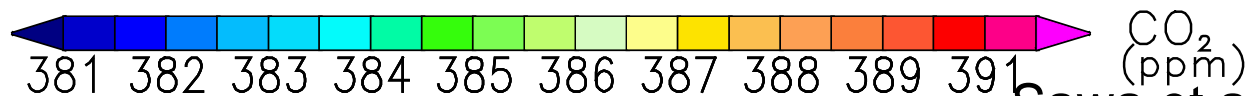
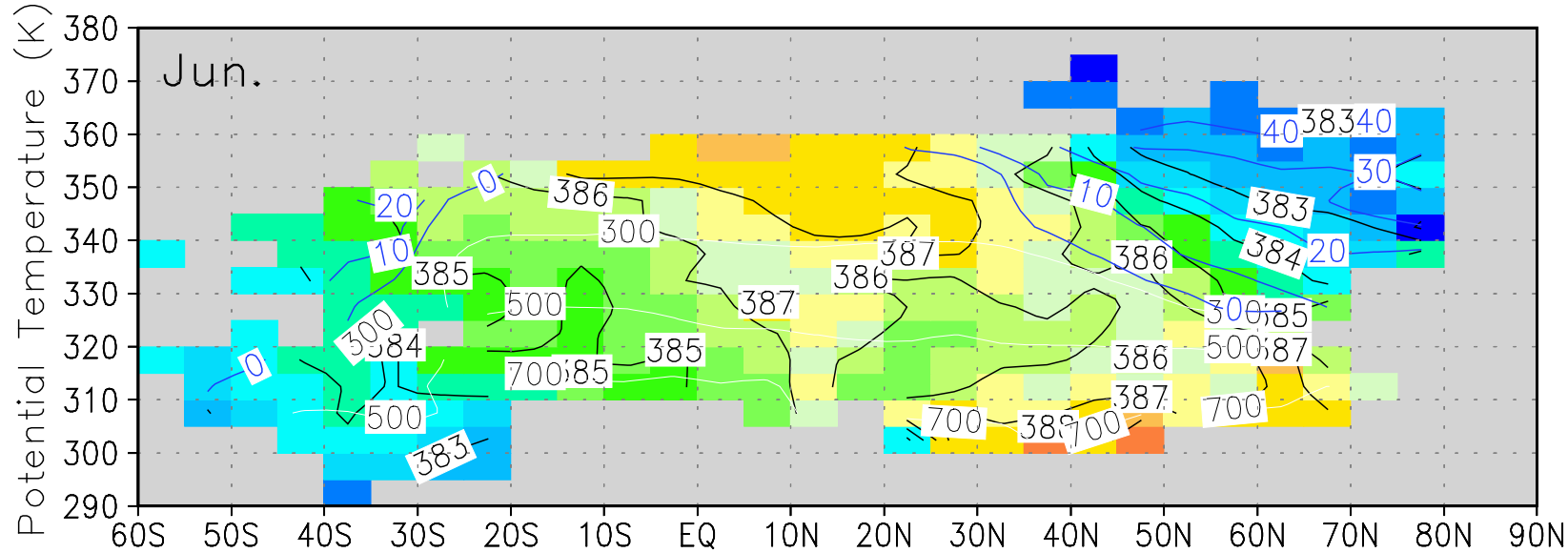
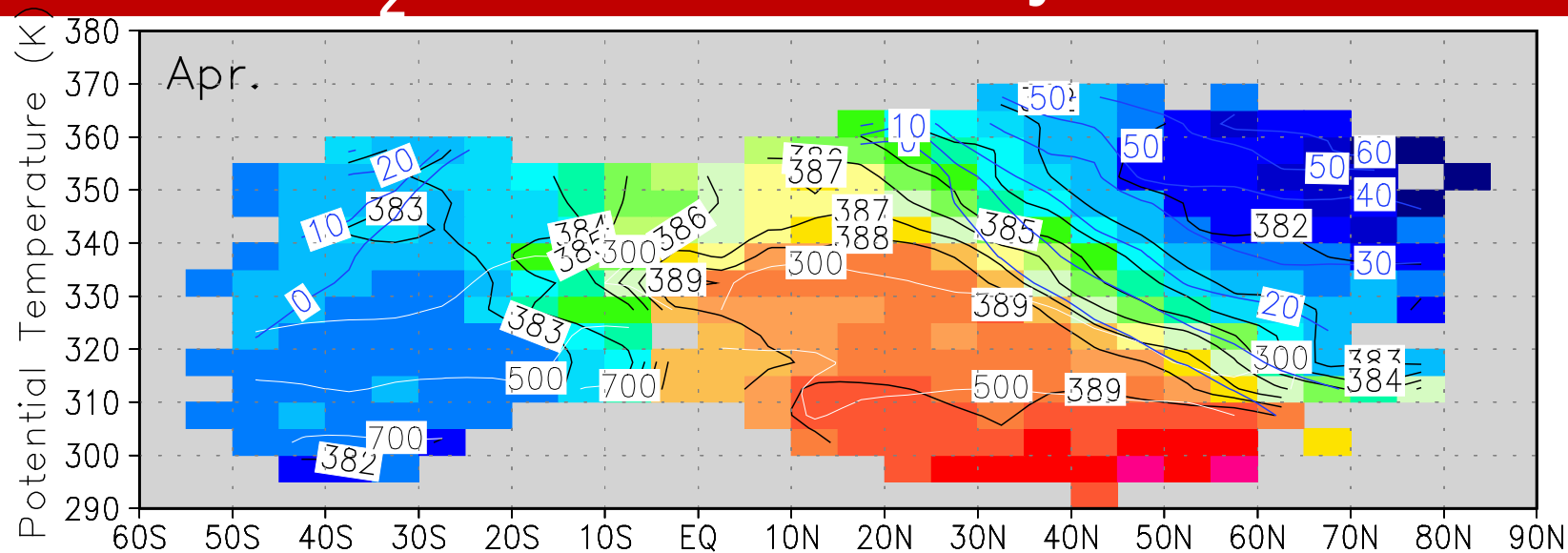
(Sawa et al., 2012, JGR)

Aug.



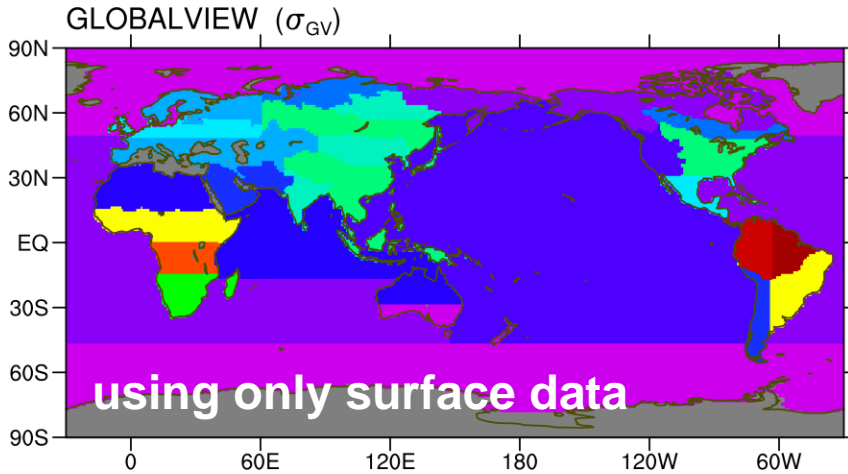


# CO<sub>2</sub> cross section by CME data

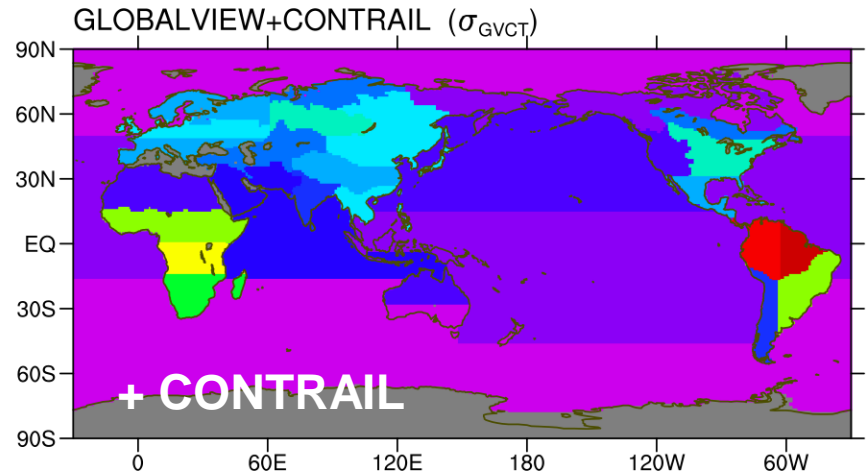


# CONTRAIL has large impacts on the flux estimate

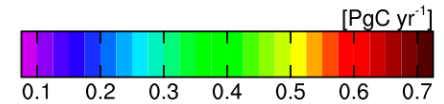
(a) Estimated Flux Error



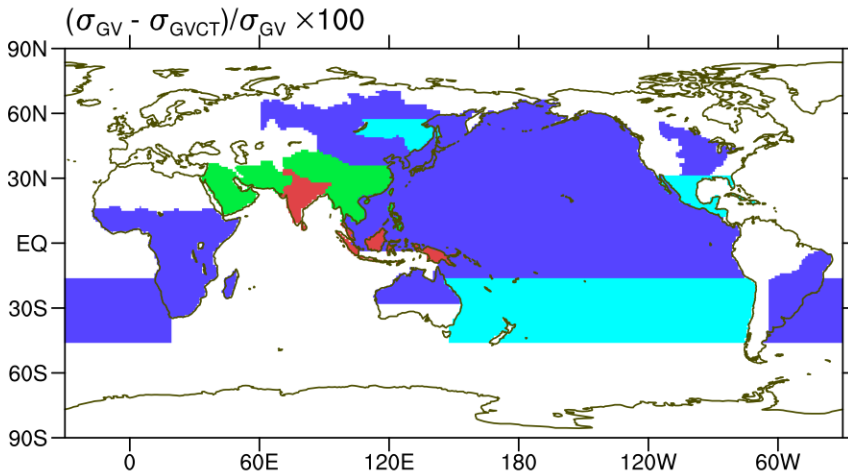
(b) Estimated Flux Error



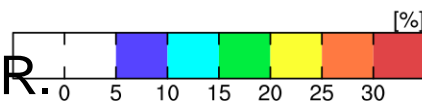
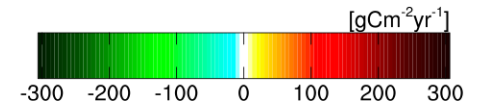
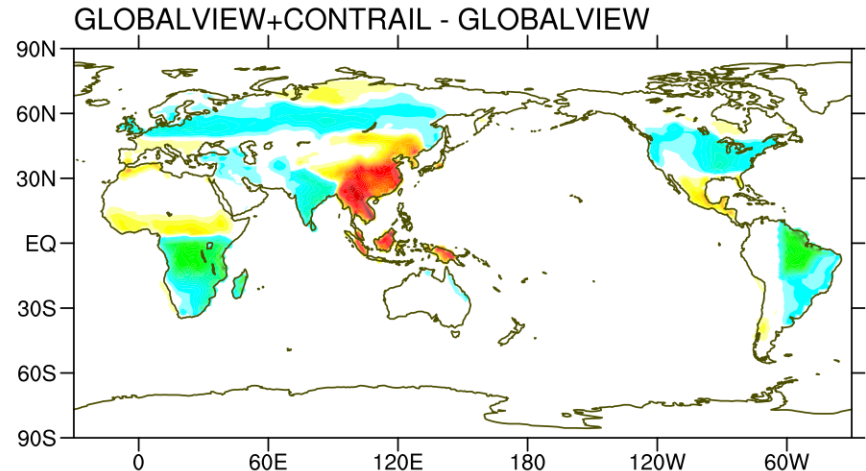
Three-year mean for 2006–2008



(c) Error Reduction Rate



(d) Difference of Estimated CO<sub>2</sub> Fluxes

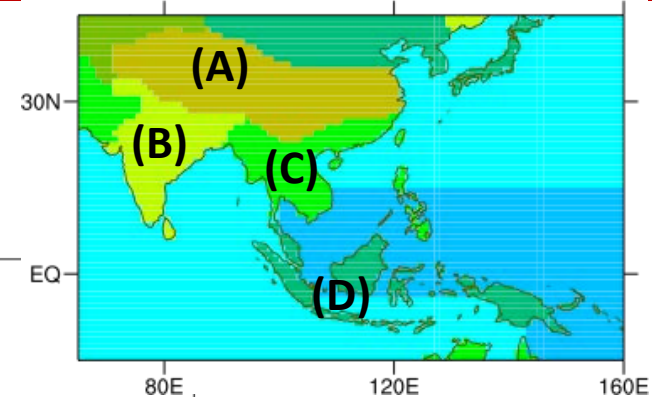
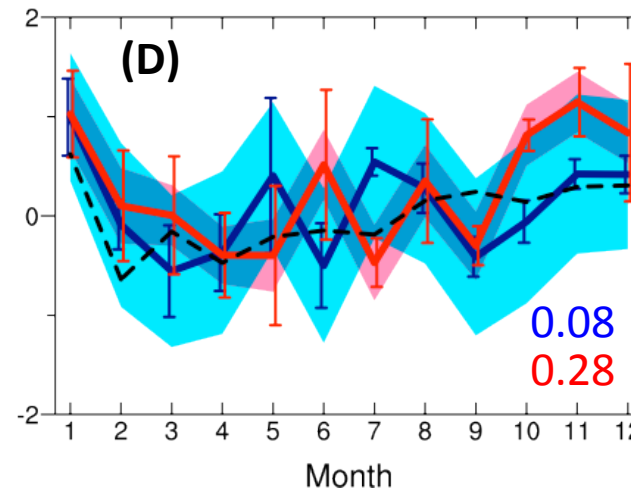
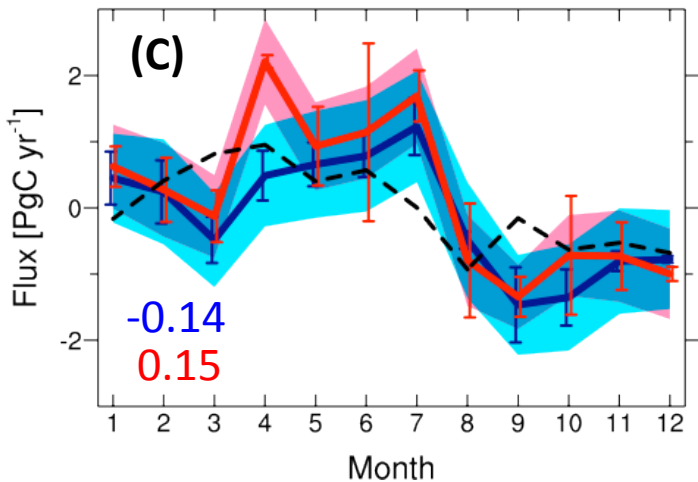
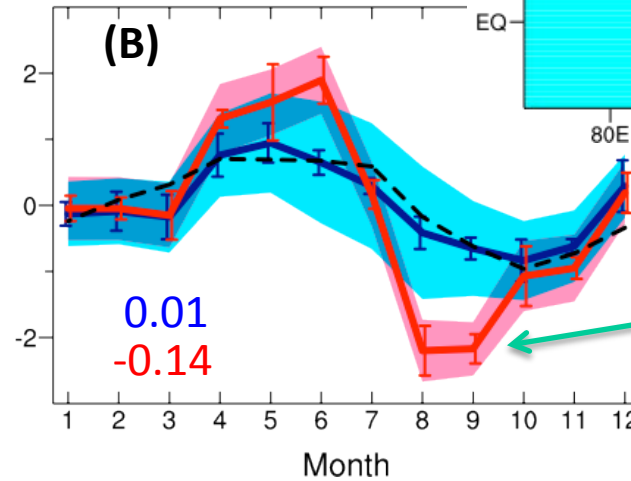
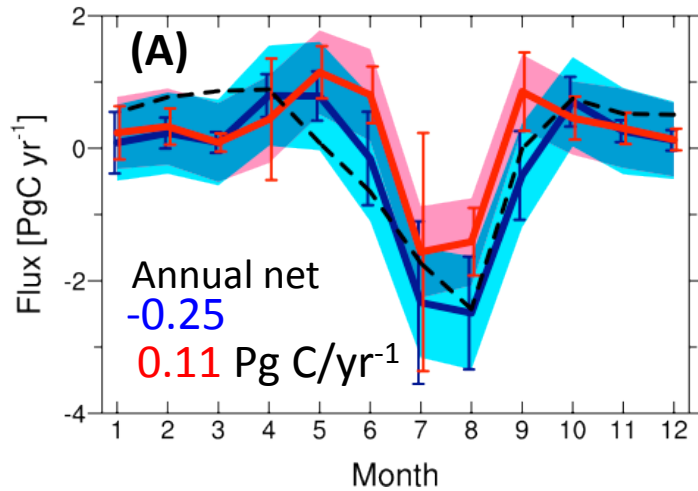


# How were inversion fluxes changed by CONTRAIL?

Mean seasonal flux for 2006–2008

inverted by surface data

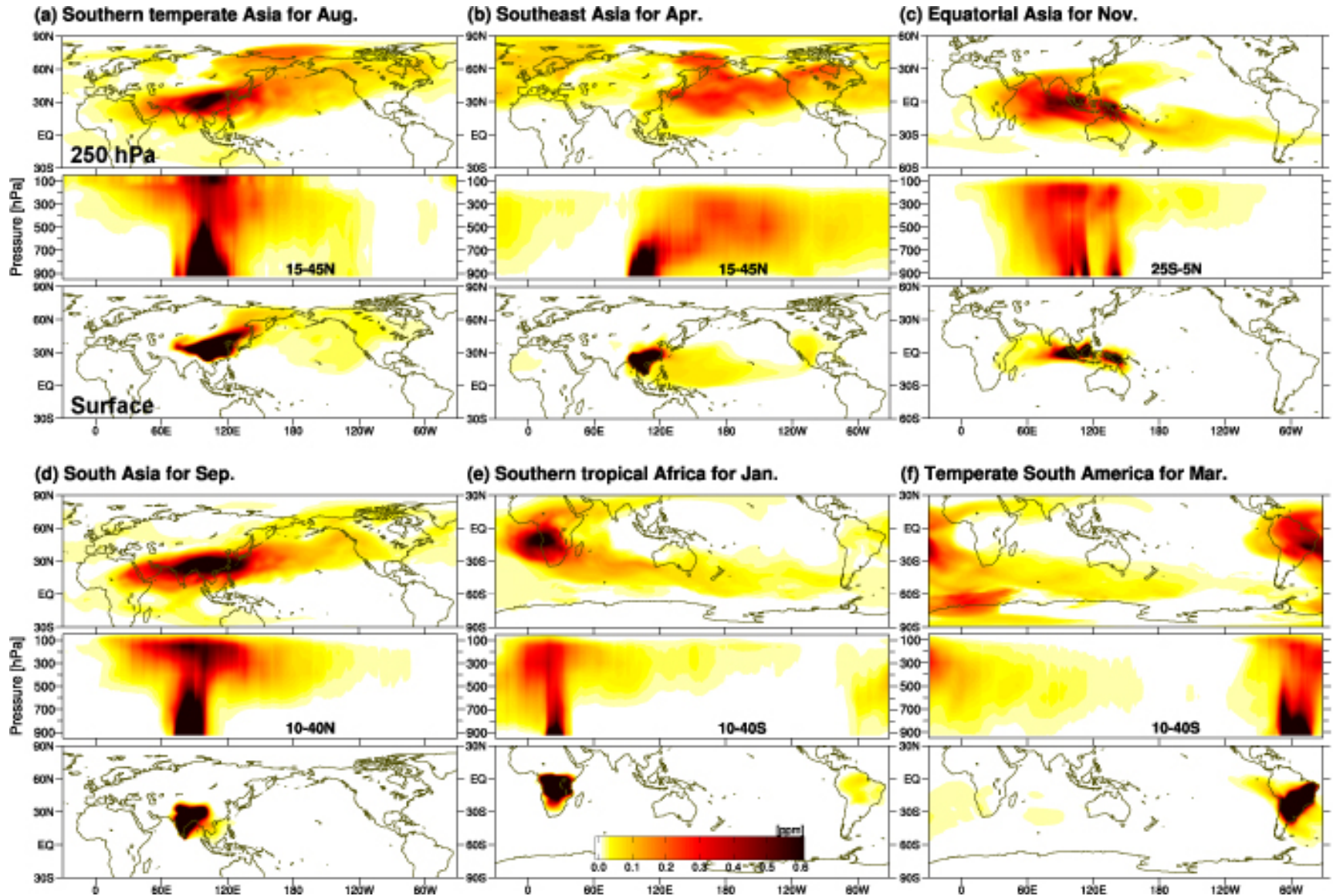
inverted by surface + CONTRAIL data



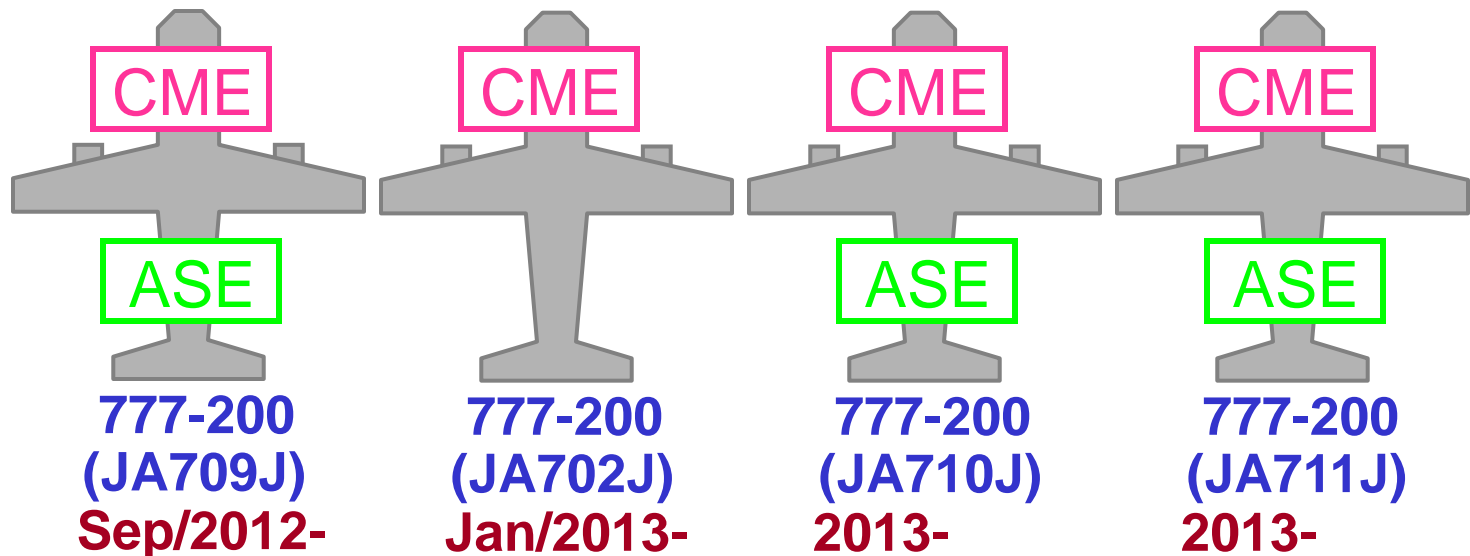
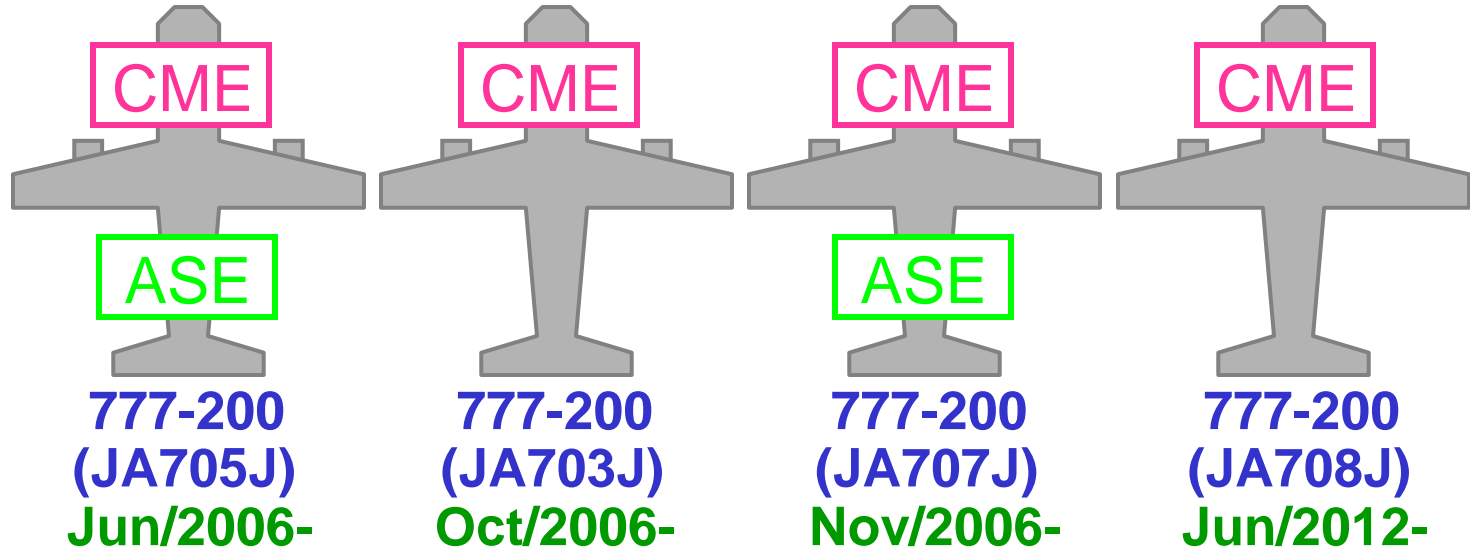
consistent with  
Patra et al. (2011)

--- CASA (prior flux)  
estimated flux error  
| std. for 2006-2008

# Mean tracer distribution by NICAM model



# Other two 777-200ER will be modified





# CONTRAIL web page

- Home
- What is CONTRAIL?
- ASE
- CME
- Data protocol
- Publications
- Press
- Topics
- Members
- Photo gallery
- Link



CONTRAIL Group



JAPAN AIRLINES



JAL FOUNDATION

[www.cger.nies.go.jp/contrail/](http://www.cger.nies.go.jp/contrail/)

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

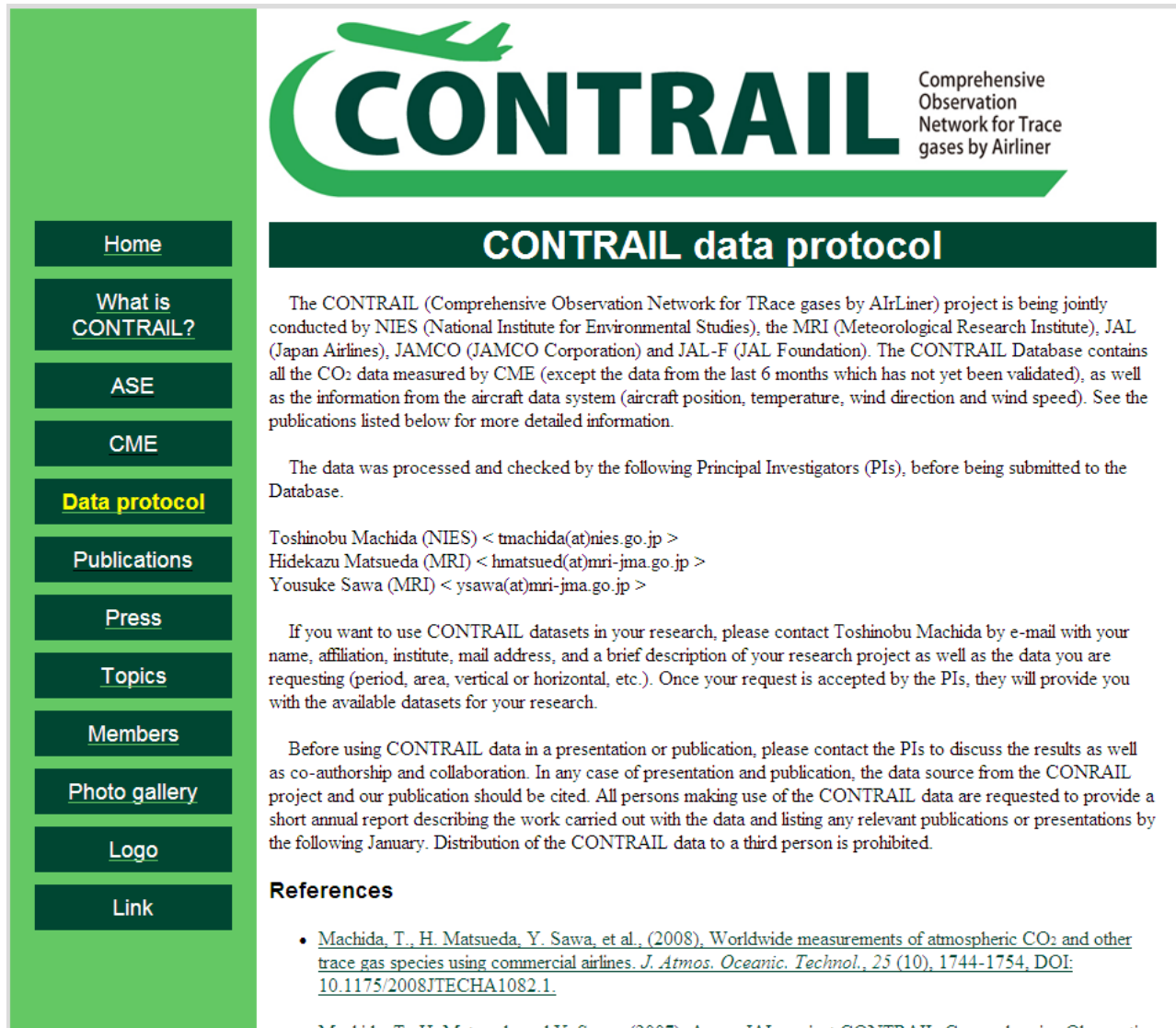


Thank you.





# CONTRAIL data can be used.



The screenshot shows the CONTRAIL website interface. On the left is a green sidebar with navigation buttons: Home, What is CONTRAIL?, ASE, CME, Data protocol (highlighted in yellow), Publications, Press, Topics, Members, Photo gallery, Logo, and Link. The main content area features the CONTRAIL logo (a green stylized airplane) and the text 'Comprehensive Observation Network for Trace gases by Airliner'. Below the logo is a dark green header for 'CONTRAIL data protocol'. The main text describes the project as a joint effort by NIES, MRI, JAL, JAMCO, and JAL-F, detailing the data collected (CO<sub>2</sub> and aircraft parameters) and listing the Principal Investigators (Toshinobu Machida, Hidekazu Matsueda, and Yousuke Sawa) with their contact information. It also provides instructions on how to request data and a warning about citation and distribution. A 'References' section lists a 2008 paper by Machida et al. and a 2007 paper by Machida et al.

**CONTRAIL** Comprehensive Observation Network for Trace gases by Airliner

## CONTRAIL data protocol

The CONTRAIL (Comprehensive Observation Network for TRace gases by AirLiner) project is being jointly conducted by NIES (National Institute for Environmental Studies), the MRI (Meteorological Research Institute), JAL (Japan Airlines), JAMCO (JAMCO Corporation) and JAL-F (JAL Foundation). The CONTRAIL Database contains all the CO<sub>2</sub> data measured by CME (except the data from the last 6 months which has not yet been validated), as well as the information from the aircraft data system (aircraft position, temperature, wind direction and wind speed). See the publications listed below for more detailed information.

The data was processed and checked by the following Principal Investigators (PIs), before being submitted to the Database.

Toshinobu Machida (NIES) < [tmachida\(at\)nies.go.jp](mailto:tmachida@nies.go.jp) >  
Hidekazu Matsueda (MRI) < [hmatsued\(at\)mri-jma.go.jp](mailto:hmatsued(at)mri-jma.go.jp) >  
Yousuke Sawa (MRI) < [ysawa\(at\)mri-jma.go.jp](mailto:ysawa(at)mri-jma.go.jp) >

If you want to use CONTRAIL datasets in your research, please contact Toshinobu Machida by e-mail with your name, affiliation, institute, mail address, and a brief description of your research project as well as the data you are requesting (period, area, vertical or horizontal, etc.). Once your request is accepted by the PIs, they will provide you with the available datasets for your research.

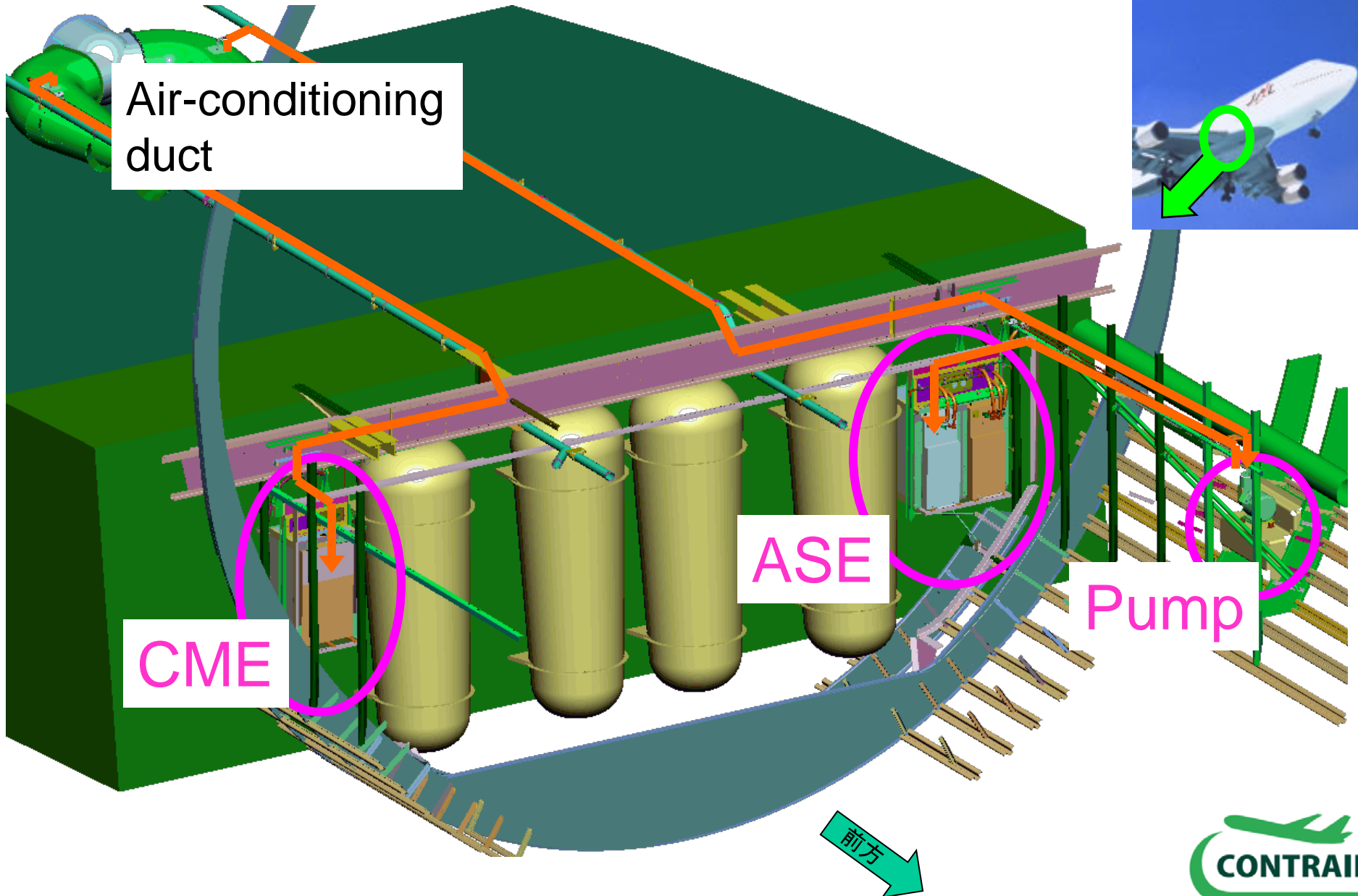
Before using CONTRAIL data in a presentation or publication, please contact the PIs to discuss the results as well as co-authorship and collaboration. In any case of presentation and publication, the data source from the CONTRAIL project and our publication should be cited. All persons making use of the CONTRAIL data are requested to provide a short annual report describing the work carried out with the data and listing any relevant publications or presentations by the following January. Distribution of the CONTRAIL data to a third person is prohibited.

### References

- [Machida, T., H. Matsueda, Y. Sawa, et al., \(2008\), Worldwide measurements of atmospheric CO<sub>2</sub> and other trace gas species using commercial airlines. \*J. Atmos. Oceanic. Technol.\*, 25 \(10\), 1744-1754, DOI: 10.1175/2008JTECHA1082.1](#)
- [Machida, T., H. Matsueda and Y. Sawa, \(2007\), A new JAL project CONTRAIL, Comprehensive Observation](#)

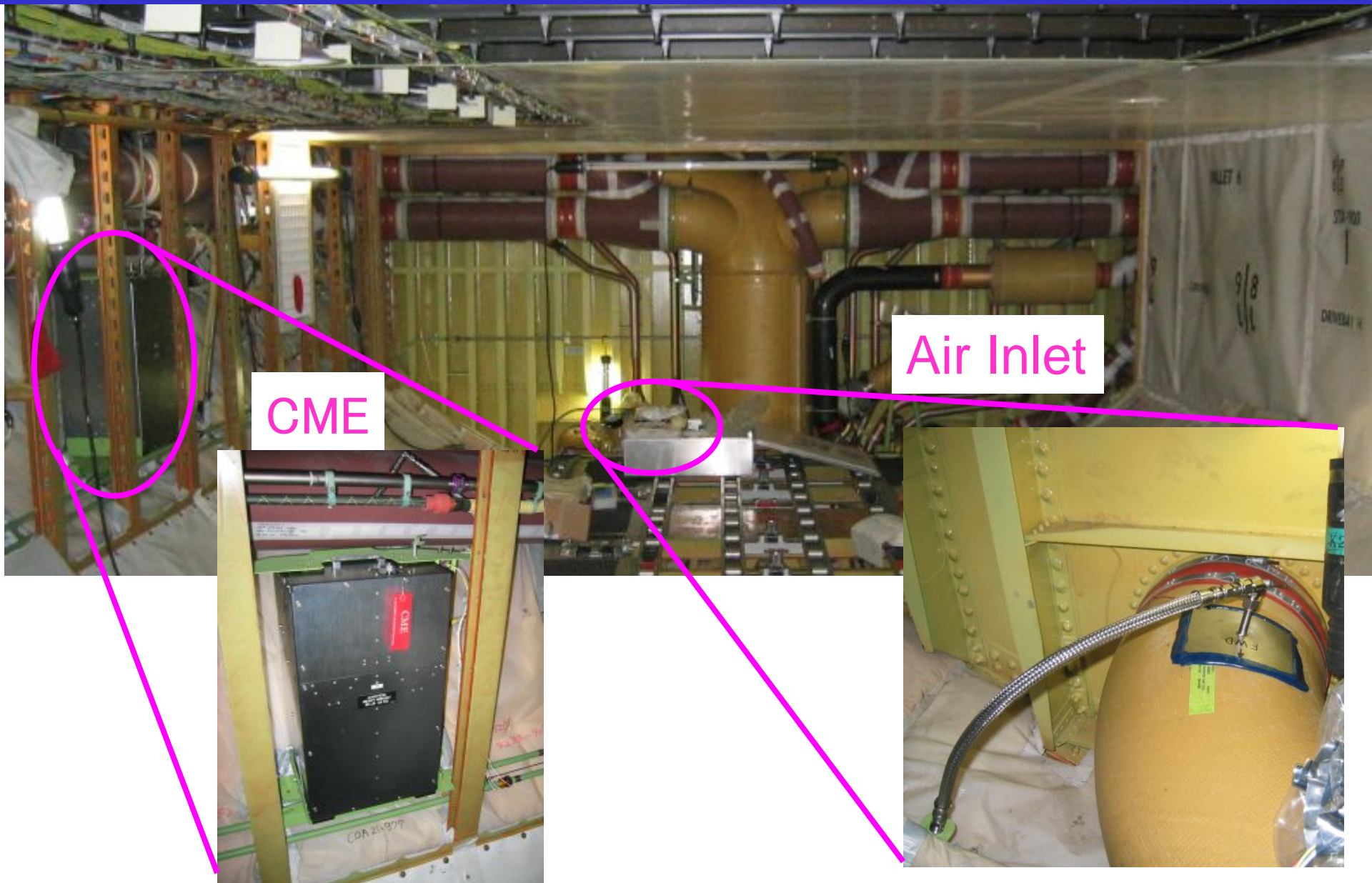
[www.cger.nies.go.jp/contrail/protocol.html](http://www.cger.nies.go.jp/contrail/protocol.html)

# Installation for 747-400





# CME in Forward-Cargo of 777-200



# ASE in Aft-Cargo of 777-200



# CME data are agree with ASE

Dec 08, 2005

