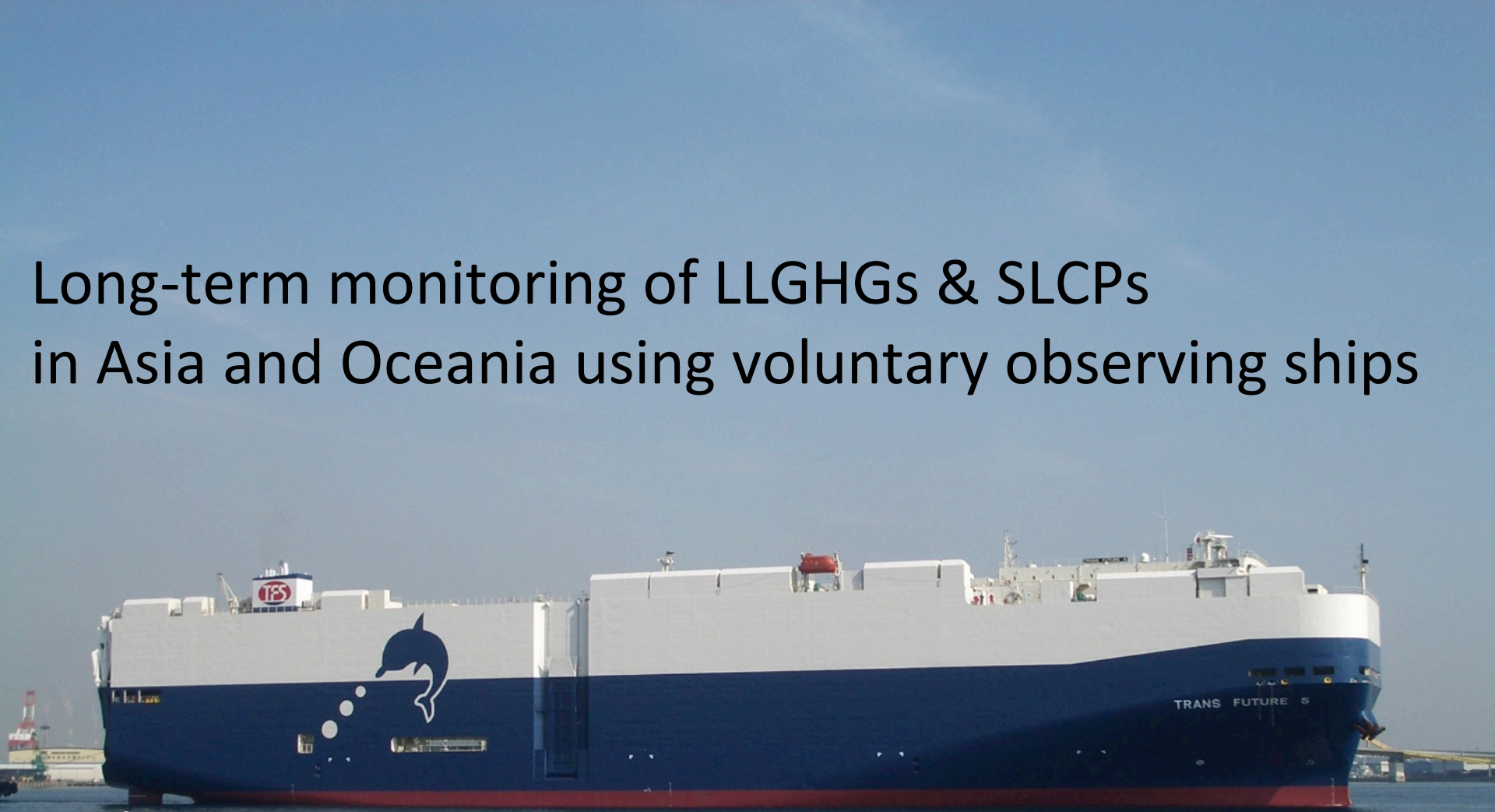
Long-term monitoring of LLGHGs & SLCPs in Asia and Oceania using voluntary observing ships



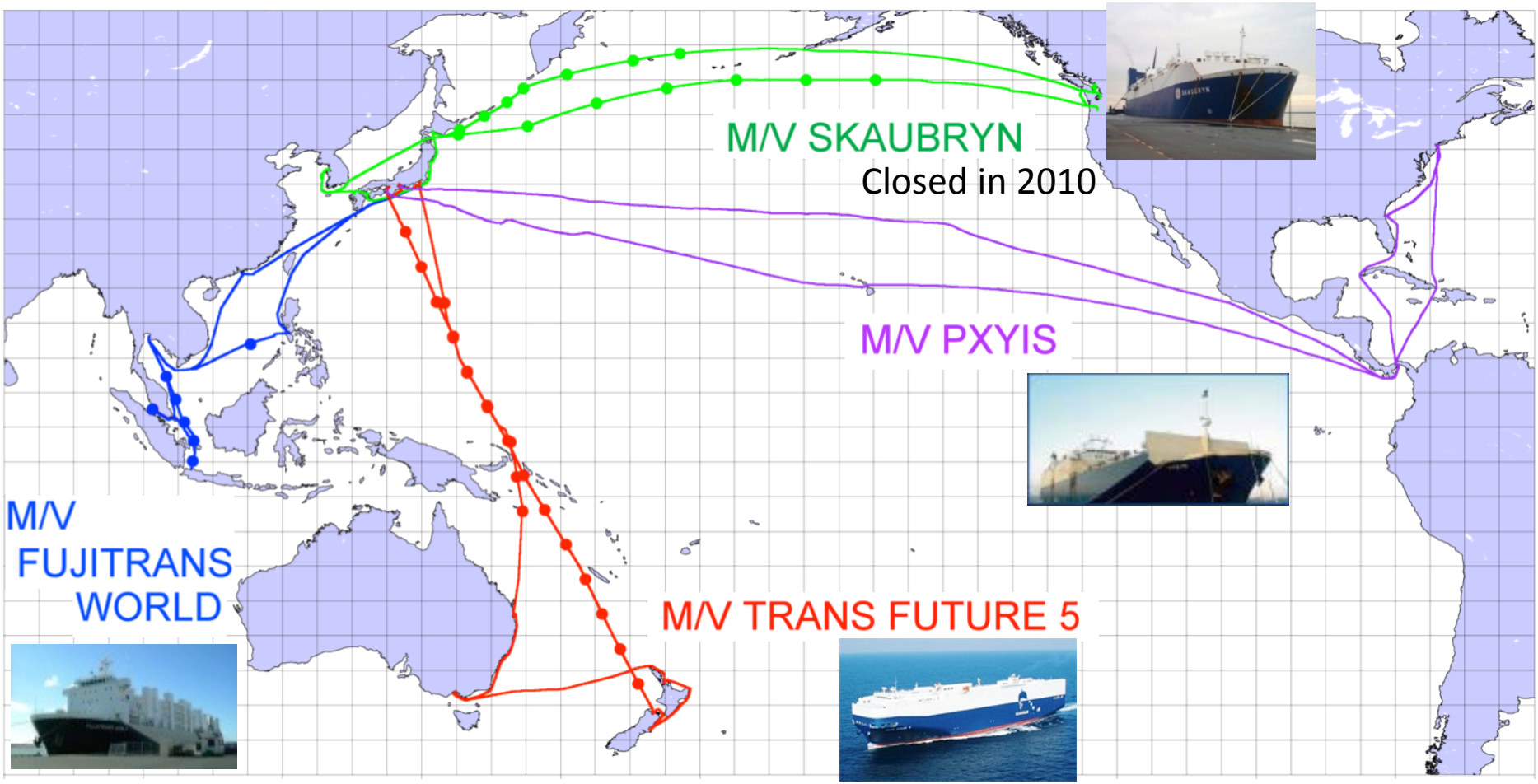
Hiroshi Tanimoto

National Institute for Environmental Studies, Japan

with contributions from

H. Nara, F. Kondo, H. Mukai, Y. Nojiri, Y. Tohjima, T. Machida, S. Hashimoto

NIES – VOS program started in 1995 for pCO_2 (Y. Nojiri)

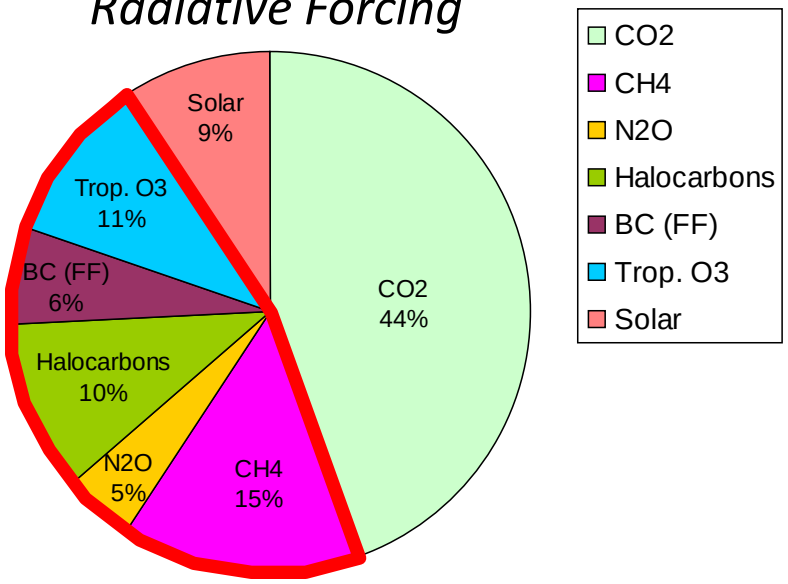


- Four commercial cargoships over the Pacific Ocean
  - Japan – the United States (west coast & east coast)
  - Japan – Australia/New Zealand, Japan – Southeast Asia

Focus on Asia & Oceania: New project since 2005

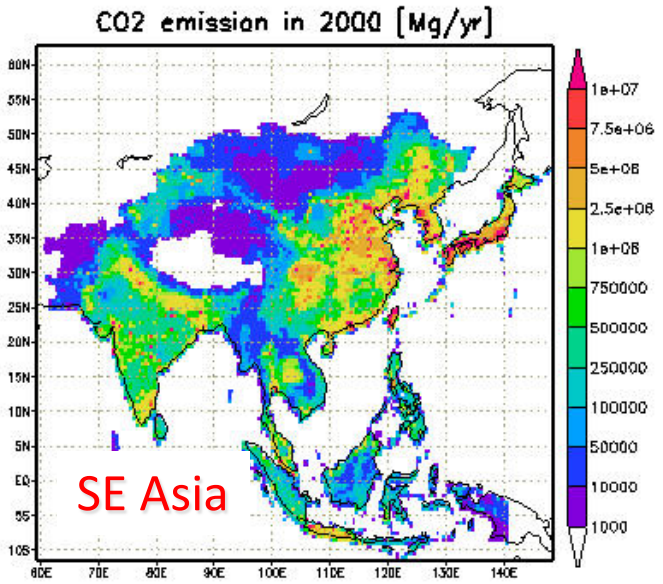
- Rapidly developing economy & severe biomass burning in Asia
- Long-term, comprehensive monitoring of non-CO_2 trace atmospheric constituents – greenhouse gases and aerosols
  - CH_4, N_2O, halocarbons (HFC, PFC, SF_6) (long-lived greenhouse gases, LLGHGs)
  - Tropospheric O_3, BC (short-lived air pollutants, SLCPs)
  - CO, CO_2 (references for emissions ratios)

Radiative Forcing



Σnon-CO_2 ~ CO_2

Emissions Inventory



Focus on Asia & Oceania: Combining two routes

Japan – Southeast Asia

regionally polluted air

(more info. on emission sources)

Japan – Australia / New Zealand

background clean air (reference data)

Air sampling at M/V *Fuji-transworld*

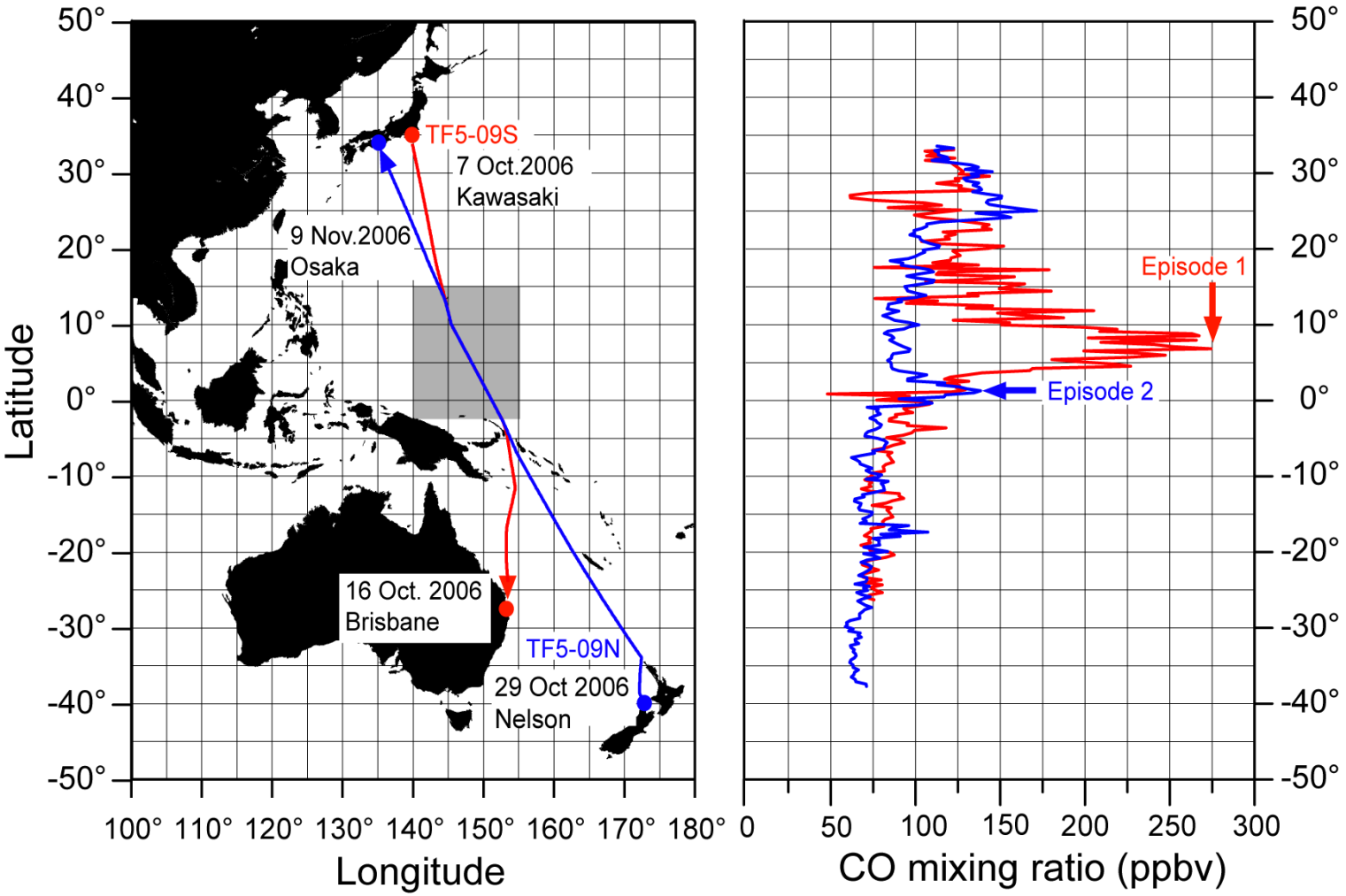
Air intake for long-lived species

Air intake for reactive species

Observation room

M/V TF5 detected high-CO plumes

Nara et al., Environ. Chem., 2011

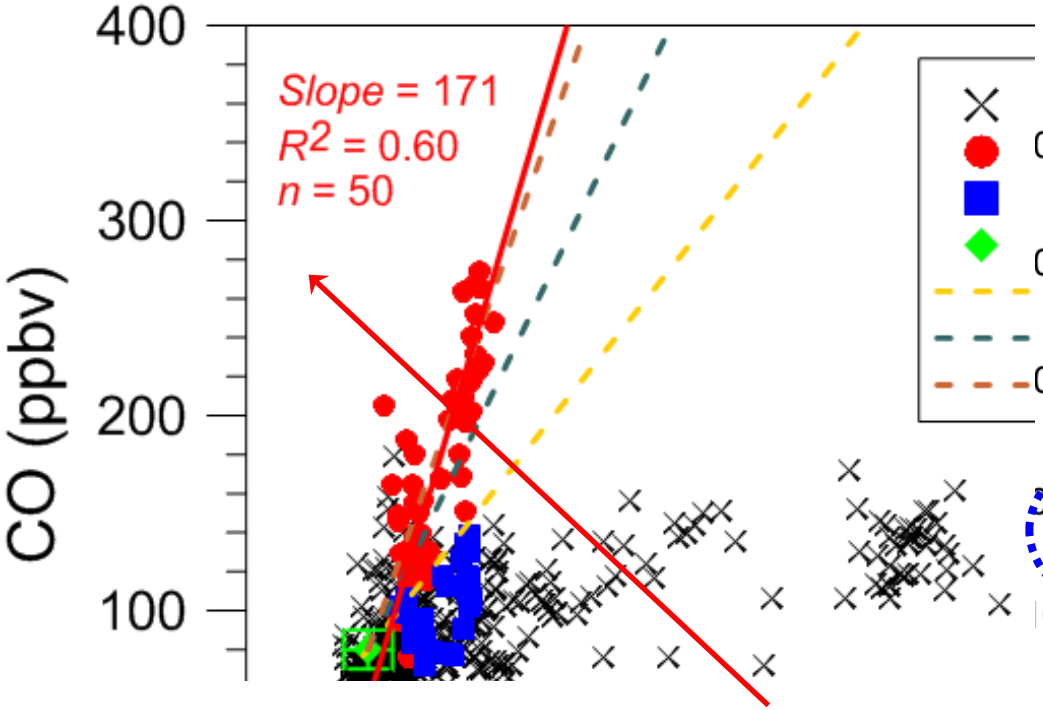


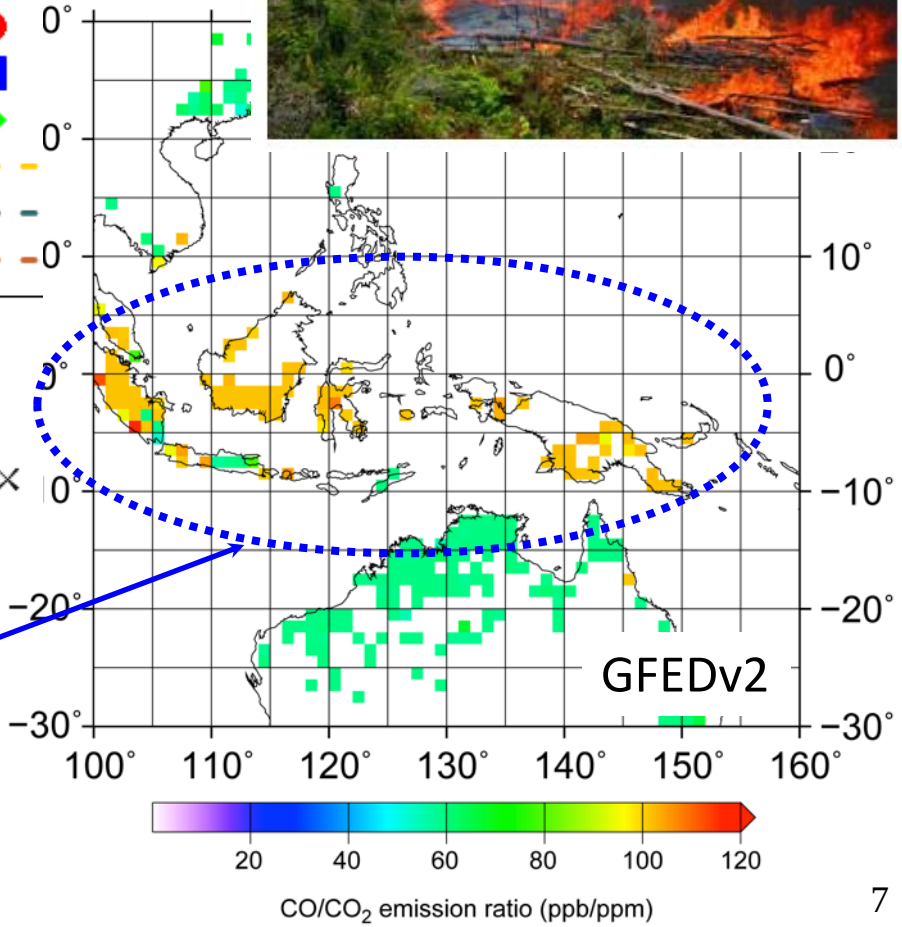
- Abnormally high CO in October 2006 (El Nino) over the tropical Pacific Ocean

CO-vs-CO_2 correlation in BB plumes

Indonesian peatland: 143, 194-279
Tropical forest: 103 (+/-21)
Savanna & glassland: 63 (+/-20)

Nara et al., Environ. Chem., 2011

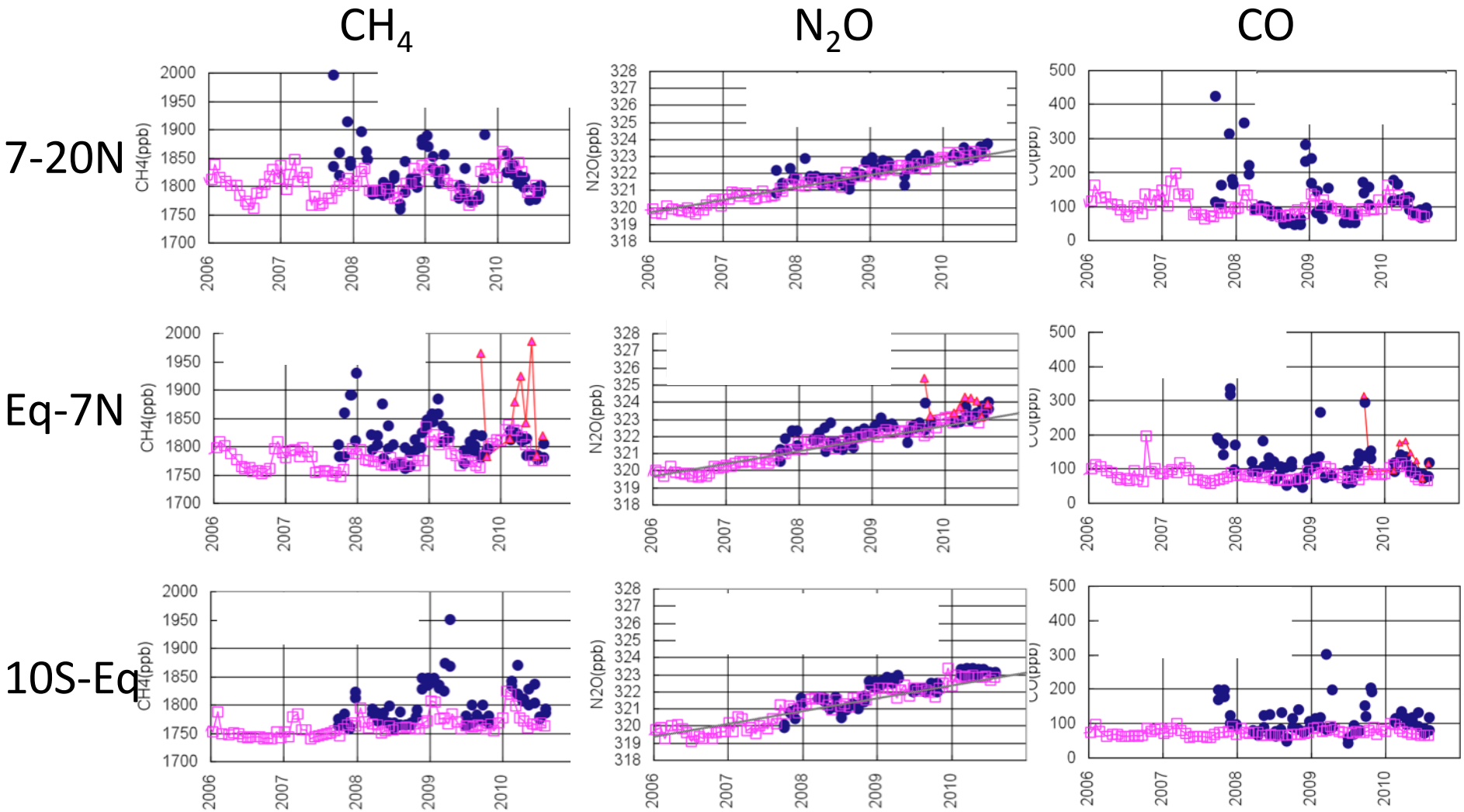




- Observed CO/CO_2 ratio (171 ppb/ppm) is higher than in GFEDv2 (~110 ppb/ppm)
- Uncertainty in CO emissions by GFEDv2 in Southeast Asia associated with emission factors of peatland fires

Variations of CH_4, N_2O, & CO (Flasks)

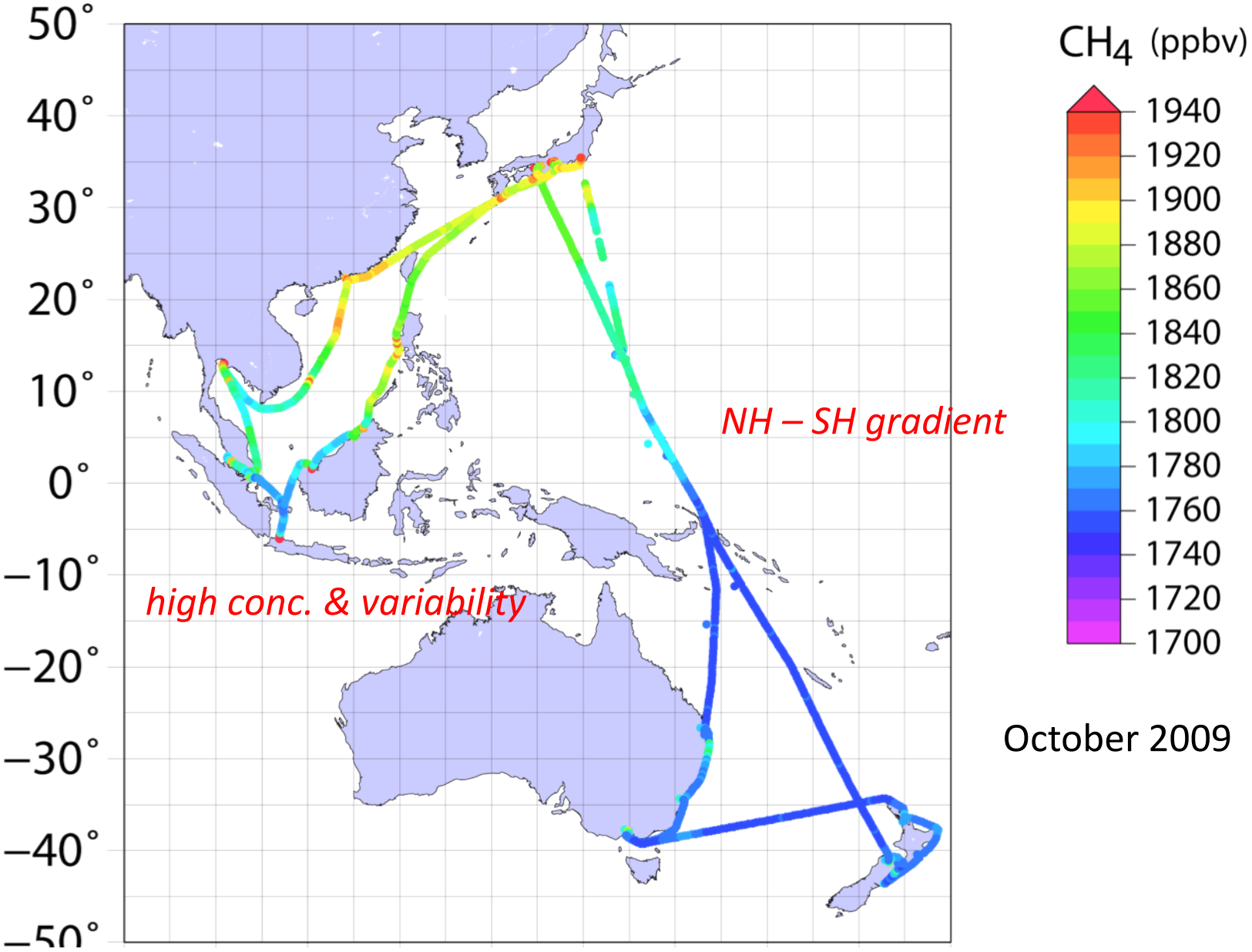
Western Pacific
Southeast Asia



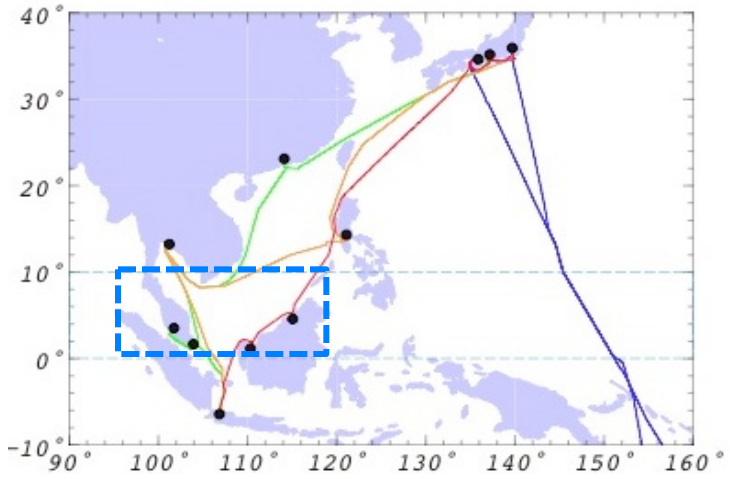
- CH_4 is high in winter due to continental outflow
- High-events coincident with N_2O and CO; extra-sources like BB?

H. Mukai

Continuous CH_4 with Picarro CRDS

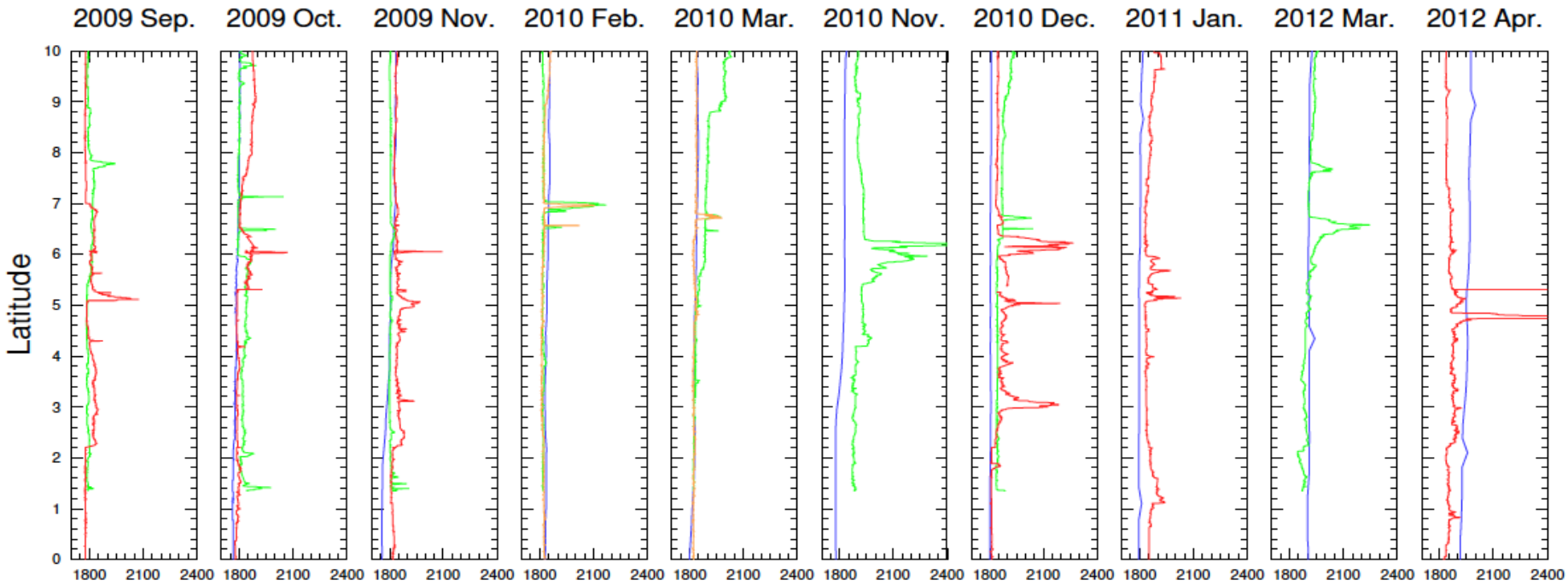


Variability of CH_4 in Southeast Asia



Hideki Nara et al., in preparation
To be presented at GGMT 2013

- CH_4 peaks in northern tropical area
  - East coast of Malay Peninsula: 5.5 - 8° N
  - West coast of Borneo Island: 4.5 - 7° N

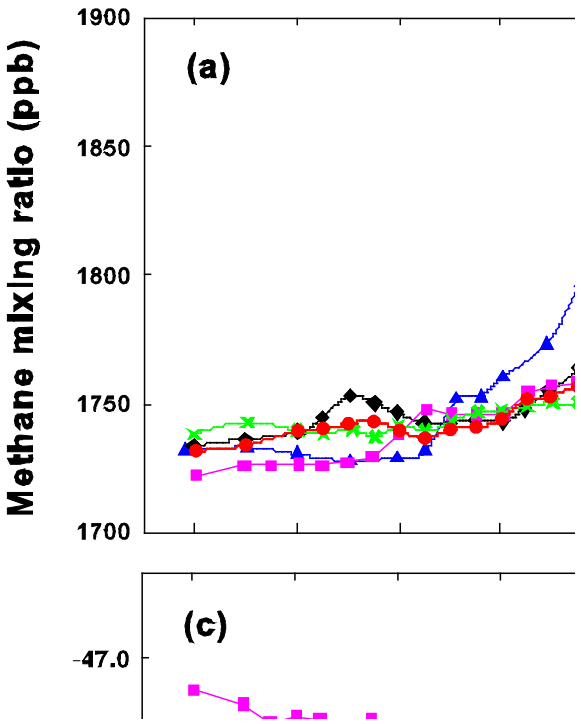


1 min-mean CH_4 latitudinal distribution (ppb)

Samplings by NIWA

- Established by Dr Yukihiro Nojiri (NIES) & Dr Dave Lowe (NIWA) in 2004
- Species of interest
  - CH_4 & stable carbon isotopic composition
  - CO & its isotopic composition
  - Manual collection of clean air by Tony Bromley or Ross Martin

	04	05	06	07	08	09	10	11	12	13
Jan				X						
Feb										
Mar									X	X
Apr										
May	X	X	X		X					
Jun				X					X	
Jul										
Aug			X							
Sep					X					
Oct										
Nov										
Dec	X	X				X		X		



Bromley et al., JGR, 2012

NOAA-GCOS flasks

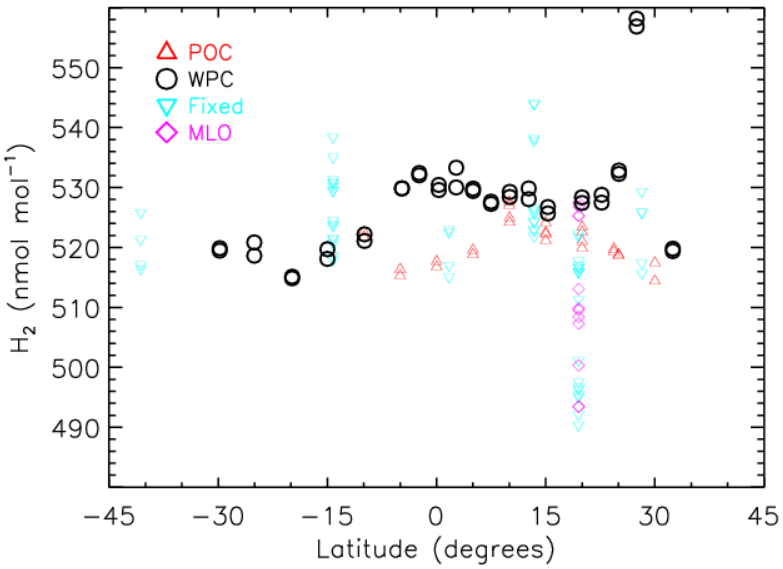
PI: Howard Diamond, US GCOS, NOAA
PI: Ed Dlugokencky, NOAA CMDL

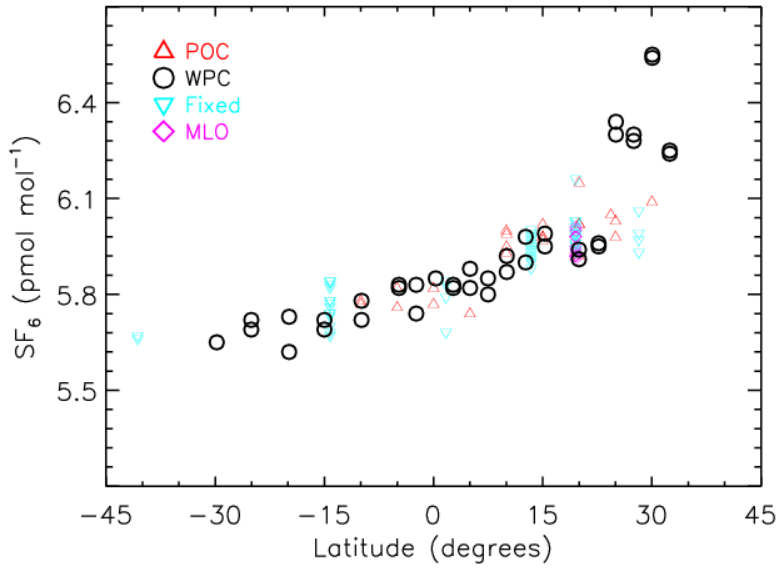
- Measurement of essential climatic variables, & components of GAW across Western Pacific

- Location proving valuable for examination of inter-hemispheric trace-gas mixing & meteorological influence on trace gas & aerosol transport and distribution, relatively uncontaminated by local sources

- Provides essential direct comparison for NIWA (same airline, same pump, different lab)

- Species:
CO_2, N_2O, SF_6, CH_4, H_2, CO, 13-CO_2, CO_2-18
[World Data Centre for Greenhouse Gases]





Courtesy: Tony Bromley, Gordon Brailsford (NIWA)

Summary & acknowledgments

- NIES VOS Program started in 1995, focusing on CO_2 (air and seawater)
- It has expanded to non-CO_2 long- and short-lived trace gas and aerosols
  - Long-term records of LLGHGs (CH_4, N_2O, CO, halocarbons, etc) based on flask sampling
- Challenges toward continuous measurements onboard ships
  - QA/QC activity for CO based on flask and in situ measurements (Nara et al. AMT 2011)
  - Picarro CRDS successfully installed for CO_2 & CH_4 (Nara et al. AMT 2012)
  - Ongoing effort to measure SLCP (O_3, Black Carbon) onboard ships
- Biomass burning event in southeast Asia
  - Importance of peat burning in Southeast Asia (Nara et al. Environ Chem 2011)
  - Feedback to emission inventory (GFED) in this region

- Great thanks to:
  - Toyofuji Shipping Co. & Kagoshima Shipping Co. – offer of cargo ships
  - S. Kariya & T. Yamada (Global Environmental Forum) – technical support
  - Ministry of the Environment, Japan – core funding