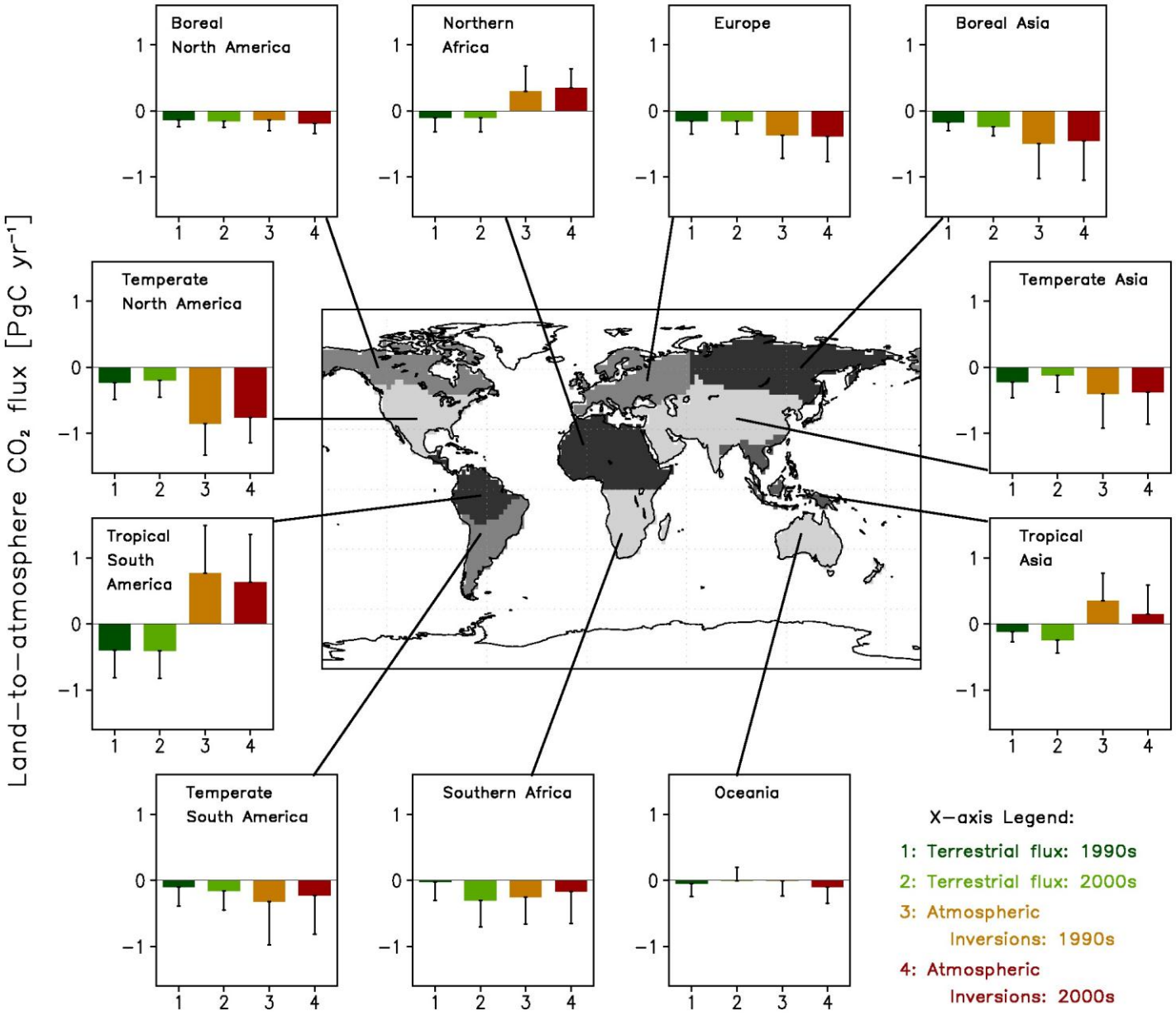
Upcoming synthesis of "Asian Greenhouse Gases Budget"

Prabir K. Patra
on behalf of the APN project participants and supporting institutions

At
Korea Research Institute of Standards and Science
Daejeong, 20-22 October 2014

Department of
Environmental
Geochemical
Cycle Research

Synthesis of Land fluxes from TDIs and DGVMs

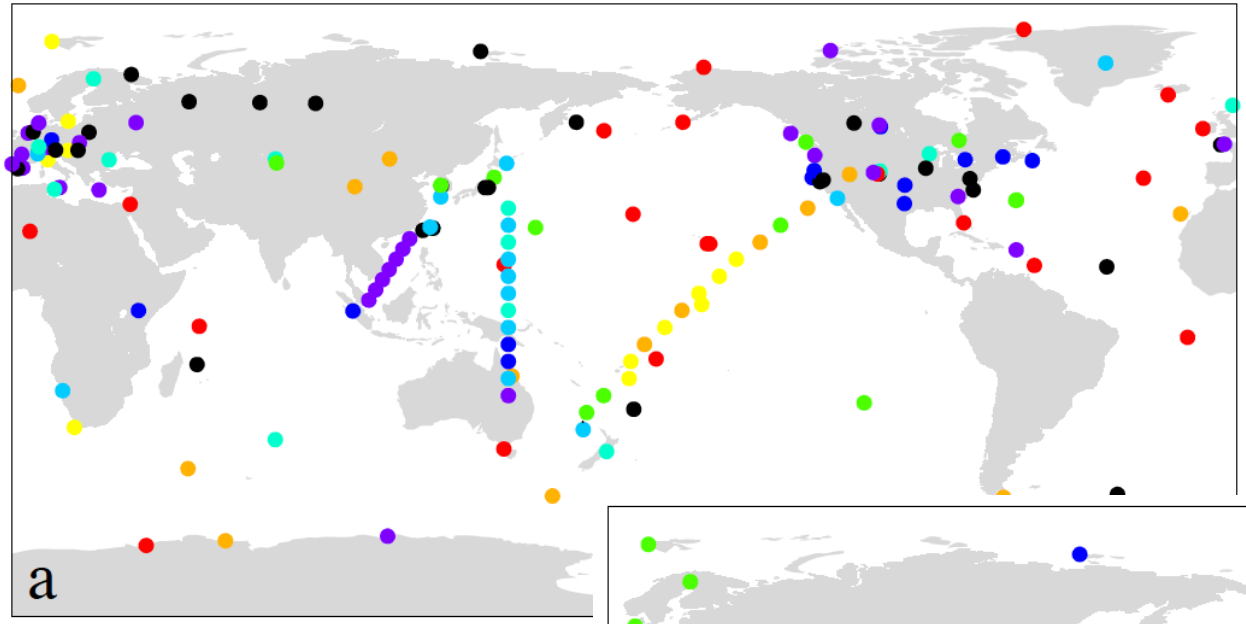


Unfair to compare inversion fluxes (include all CO_2 component) with the DGVMs (dynamic vegetation models)

Why is the Asia (temperate and boreal) regions so large?

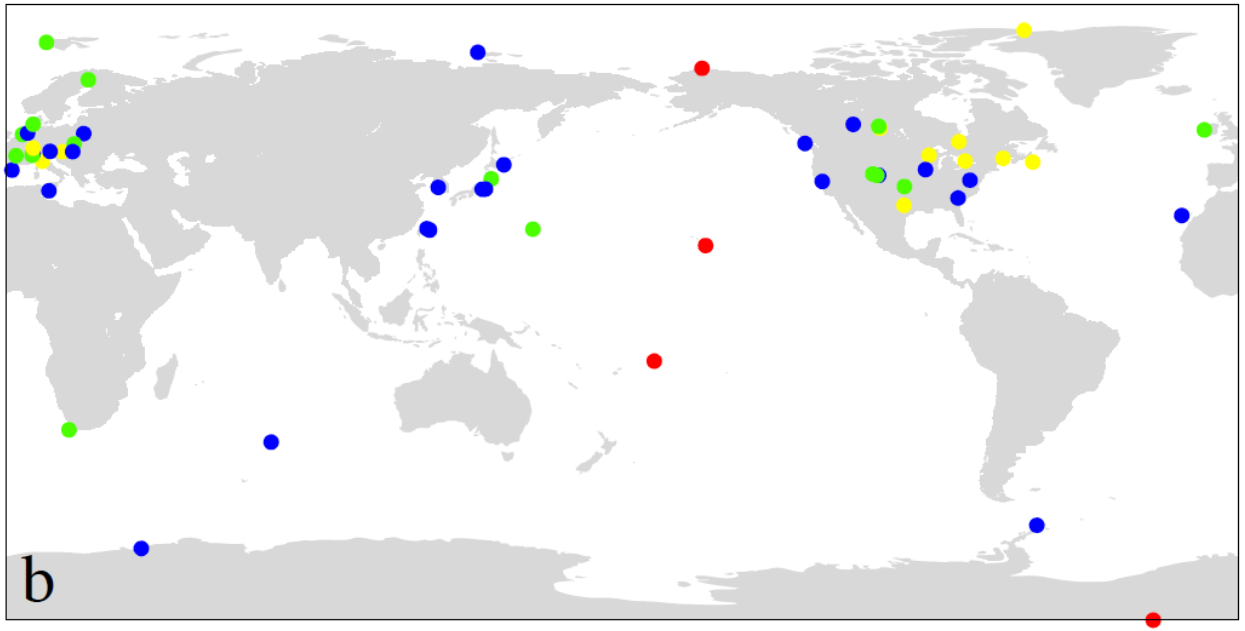
Figure 6.15, IPCC-AR5-WG1, analysis by P. Patra

Lack of observational data (CO_2)



Maximum number of sites (used in any inversion)

~~black: 1, purple: 2~~, dark blue: 3, light blue: 4, cyan: 5–6, green: 7–8, yellow: 9, orange: 10, red: 11

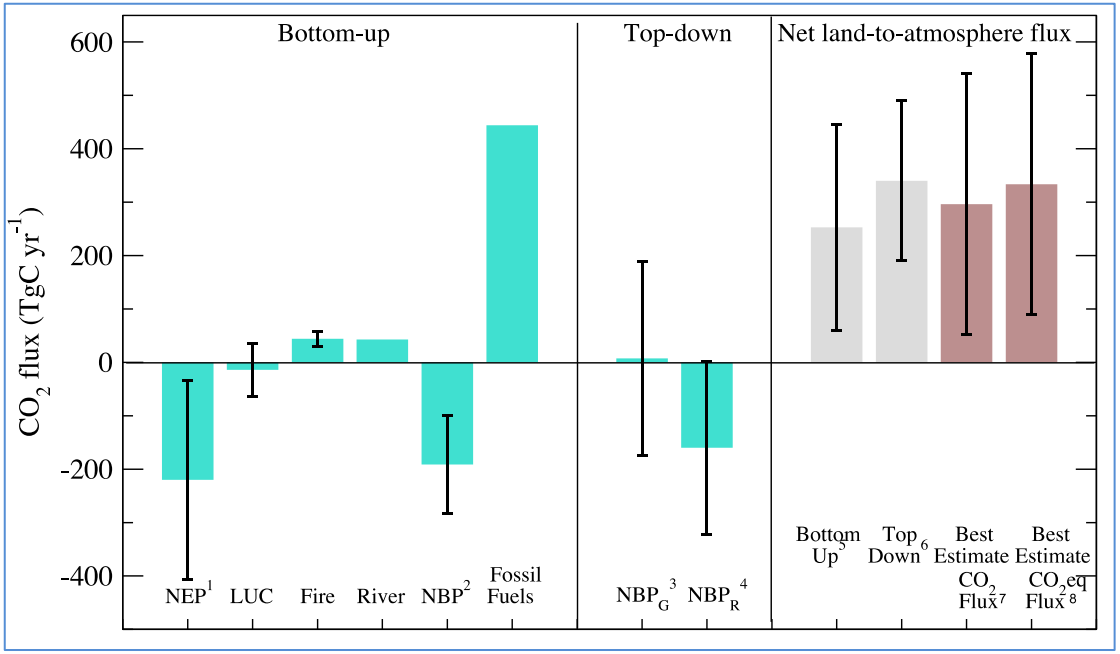


In situ measurement sites (used by upto 4 inversions)

1 (blue), 2 (green), 3 (yellow), 4 (red)

RECCAP: Budget equations

The South Asian Carbon Budget: *Patra et al.* 2013



Equations based on *Harverd et al.* 2013

A carbon budget for a land region can be expressed by equating the change in territorial storage of carbon C_T per unit time t with the net flux of carbon into the land surface:

$$-dC_T/dt = -dC_B/dt - dC_{FF}/dt - dC_{HWP}/dt \quad -dCH_4/dt \quad -dC_{BC}/dt \quad -dCO/dt$$

$$= (F_{NPP} + F_{RH} + F_{Fire} + F_{LUC} + F_{Transport} + F_{Harvest}) + F_{FF} + F_{FF,Export} - dC_{HWP}/dt$$

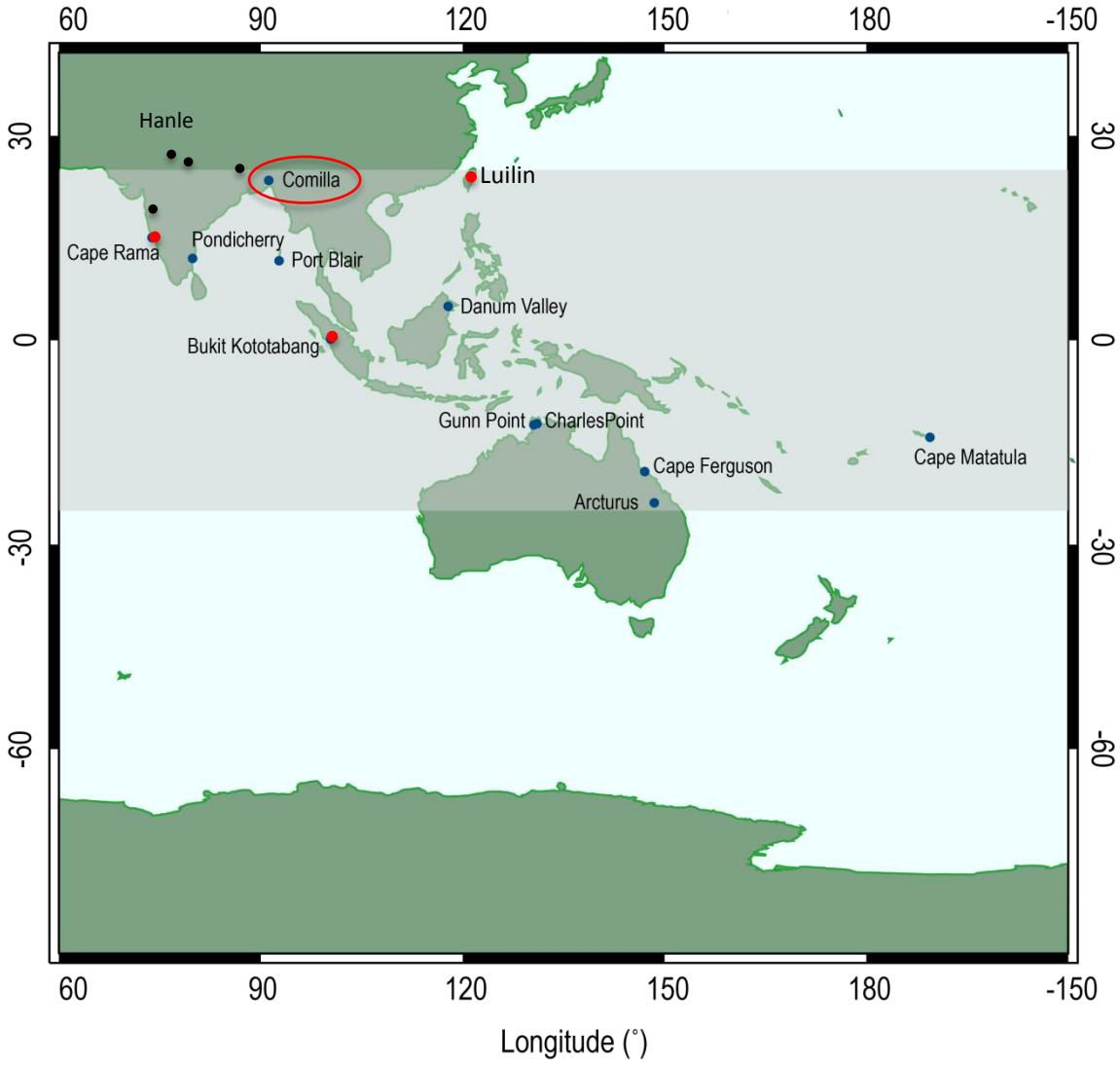
Here, C_B , C_{FF} and C_{HWP} are C stocks in the biospheric, fossil fuel and harvested wood product (HWP) pools, respectively.

The net land-to-atmosphere C flux (F_{LAE}):

$F_{LAE} = F_{NPP} + F_{RH} + F_{Fire} + F_{LUC} + F_{FF} + F^{Consump}_{Harvest} - dC_{HWP}/dt$,

$F^{Consump}_{Harvest}$ is the component of the harvest flux that is consumed within the land region.

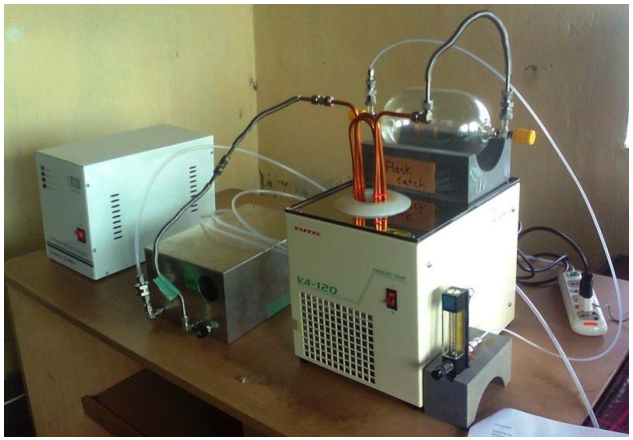
Tropical Asia-Australian Regional Network



Thanks to AP-GAW and the data providers (Cape Rama, Luilin and Bukit sites)

Modified rom Marcel van der Schoot

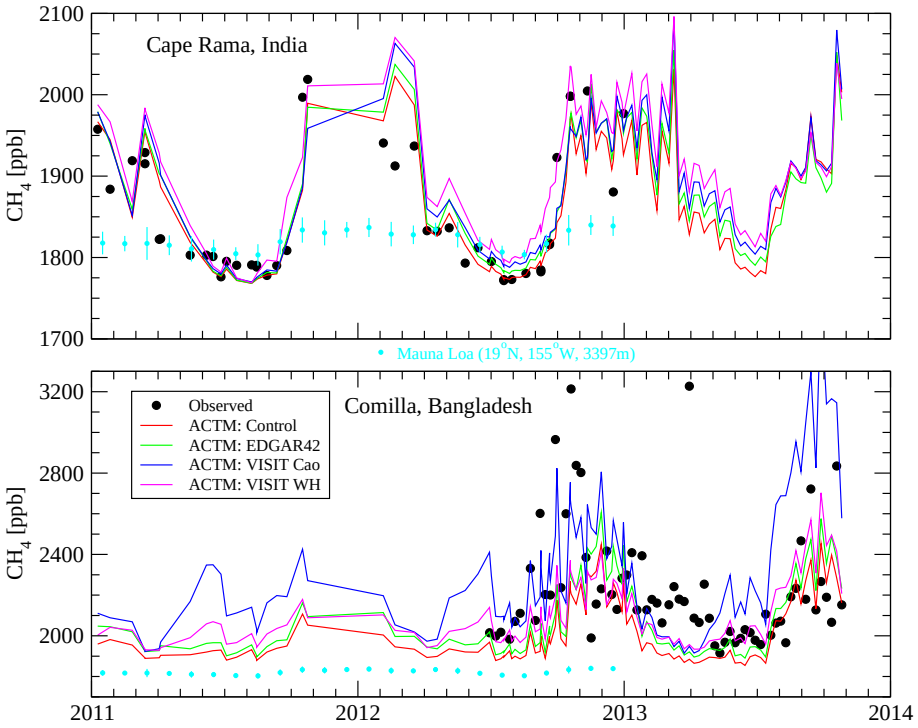
JAMSTEC established site in collaboration with Dhaka Univ/NIES

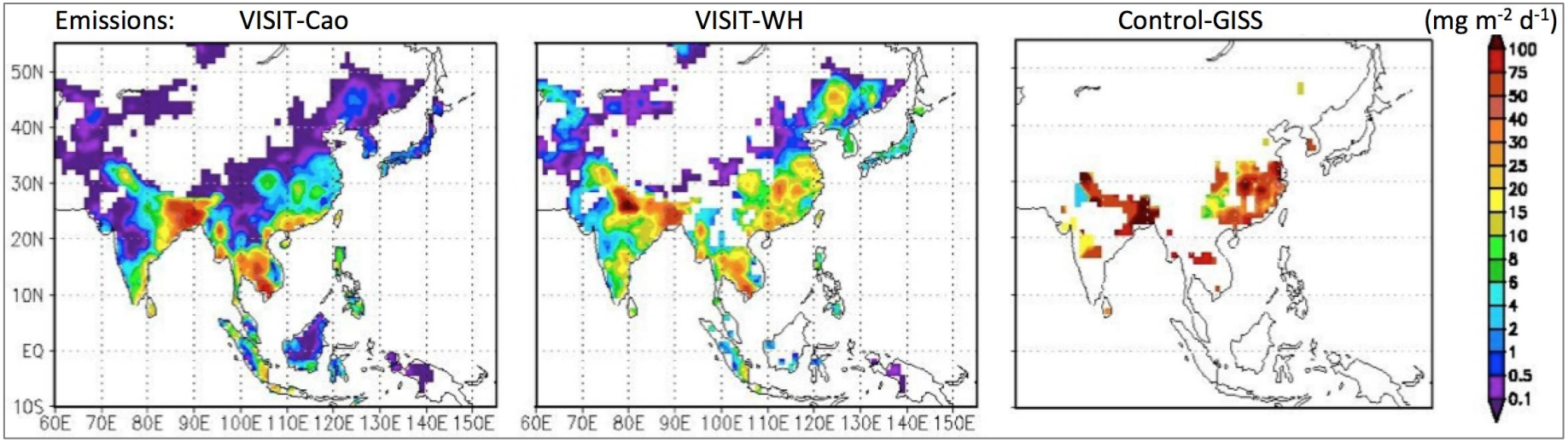


Comilla (23.45^{o}N, 91.20^{o}E),
Observatory of Bangladesh Meteorol. Dept.

CH_4 in Bangladesh and India – ACTM/VISIT sensitivity

Cape Rama data source: CSIRO MAR/WDCGG; Bhattacharya et al., Curr. Sci., 2009
Mauna Loa data source: ftp://aftp.cmdl.noaa.gov/data/trace_gases/ch4/flask/surface/





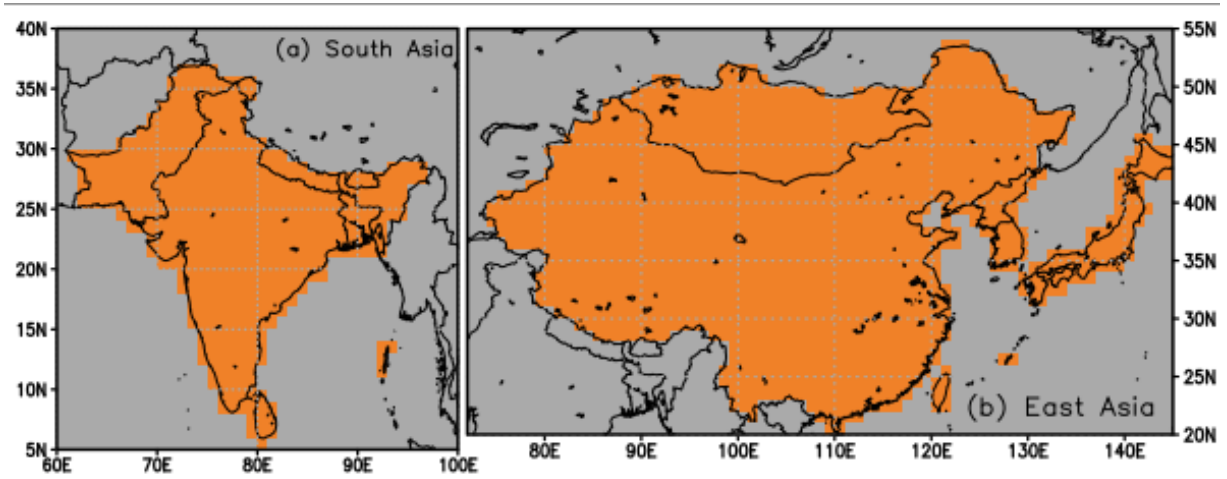
3rd APN* workshop on Asian GHG budget (8-10 April 2014, JAMSTEC)

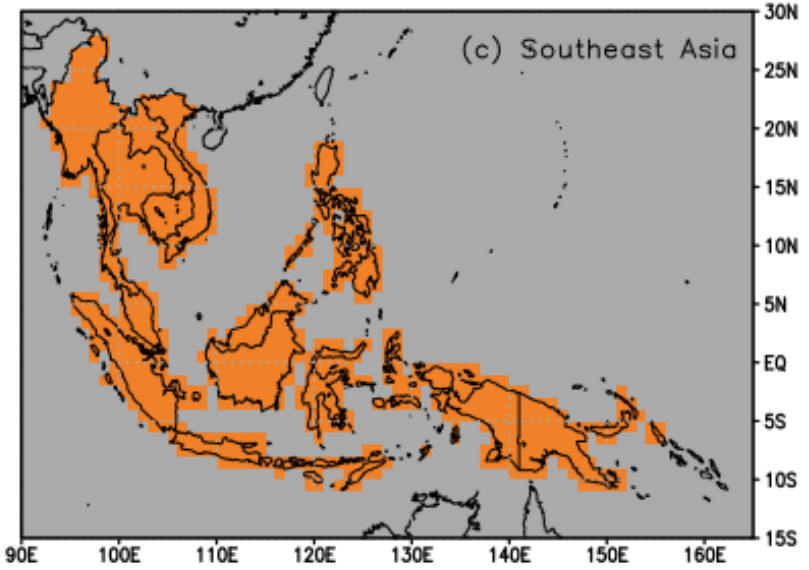
discussion subgroups:

- Atmosphere (top-down/inventory) subgroup
  – CO_2, CH_4, N_2O, CO, BC
- Terrestrial subgroup – CO_2, CH_4 and N_2O
- Riverine export and coastal ocean

*APN: Asia Pacific Network

Project: Greenhouse gas budgets of South and Southeast Asia (ARCP2013-01CMY-Patra/Canadell)





Objective

To develop a grand synthesis of the net GHG (CO_2, CH_4, N_2O, black carbon and carbon monoxide) balance of Asia, excluding Siberia, using bottom-up and top-down constraints and estimates covering the 2000-2012 period.

Atmosphere sub-group

R. L. Thompson, M. Ramonet, P. K. Patra,
T. Saeki, K. Ishijima, S. Maksyutov, Y. Niwa, S. Gonzi, K. Yumimoto
M. Montean, J. Kurokawa, S. Tao,
H. Mukai, S. Nomura, K. Ahmed

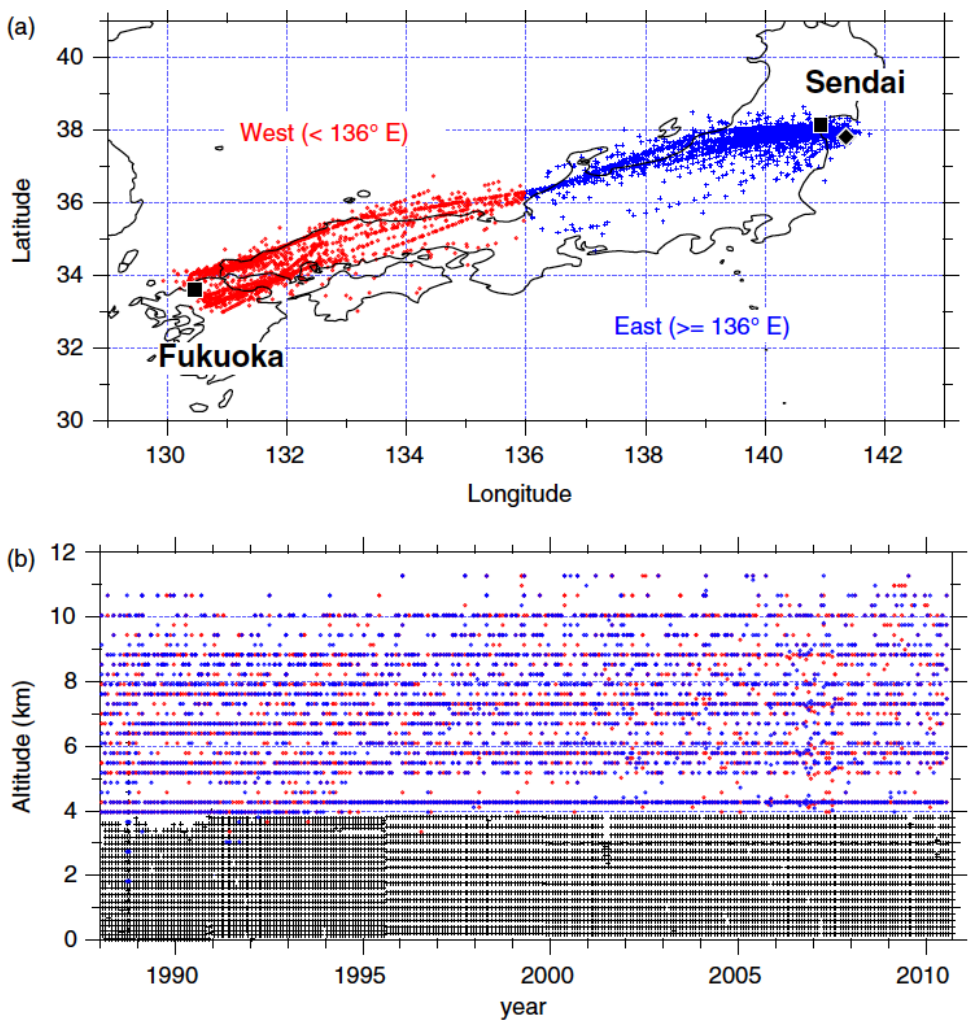
Top-down constraints – existing & new observations (list incomplete)

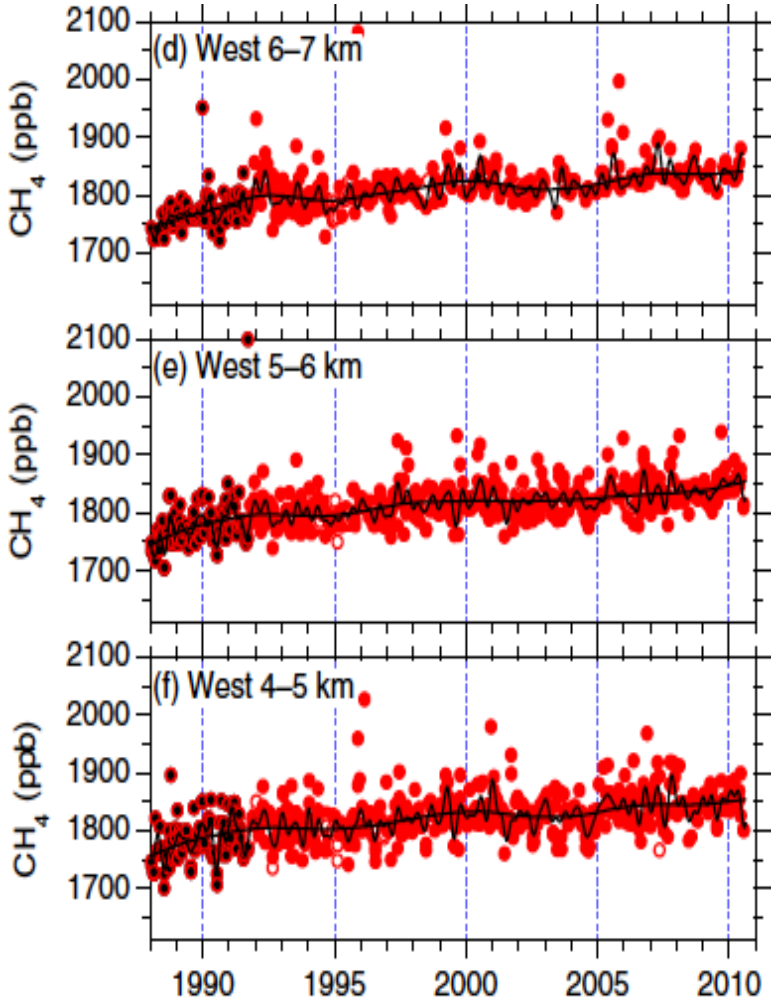
- Long-term record inversions (focus 2000-2012)
  - NOAA CCGG flask network
  - AGAGE in-situ network
  - CSIRO
  - JMA
  - NIES
- Short-term new observation inversions (focus 2010-2012)
  - GOSAT (CO_2, CH_4)
  - CONTRAIL ASE (CO_2, CH_4, N_2O, CO)
  - Tohoku Univ. aircraft and ships (CO_2, CH_4, N_2O, CO)
  - RAMCES ground-based sites (CO_2, CH_4, N_2O)
  - NIES flask sampling network (CO_2, CH_4, N_2O, CO)
  - CSIRO flasks (CO_2, CH_4, N_2O, CO)
  - JMA flights (CO_2, CH_4, N_2O, CO)

Attempt to collect atmospheric data (June 2014)

Name	Institute	Data
Ed Dlugokencky	ESRL/NOAA, USA	NOAA Flask
Mukai-san	NIES, Tsukuba, Japan	NIES flasks
Tohjima-san	NIES, Tsukuba, Japan	CH_4, N_2O, CO continuous
Nakazawa-san, Morimoto-san	Tohoku University	Ship and aircraft
Fukuyama-san	JMA, Japan	JMA flights and stations
Machida-san & Matsueda-san	MRI and NIES	CONTRAIL
M. Ramonet	LSCE, Saclay, France	RAMCES network
M. Van der Shoot	CSIRO, Aspendale, Australia	CSIRO network
Lingxi Zhou	CAMS, China	China network
I. Morino	NIES, Tsukuba, Japan	FTIR Japan (3 sites??)
Anita Ganesan	Bristol/AGAGE	CH_4, SF_6…
Yogesh Tiwari	IITM, Pune	CO_2, CH_4
N.-H. Lin/C.-F. Ou-Yang	NCU, Taiwan	Flask & Continuous data

Tohoku University database – aircraft example





Umezawa et al., Tellus, 2014

Top-down constraints – expected models

	CO_2	CH_4	N_2O	CO	Black Carbon
TM5[1]	✔✔	✔✔	✔	✔✔	
TM3[2]	✔✔		✔		
GeosChem[3]	✔✔	✔			
LMDZ-PYVAR[4]	✔✔	✔✔	✔	✔	✔[12]
ACTM[5]	✔✔	✔✔	✔✔		
NIES-TM[6]	✔✔	✔✔			
NICAM-TM[7]	✔✔				
FLEXINVERT[8]		✔✔			
GeosChem[9]				✔✔	
CHASER[10]				✔✔	
MOZART[11]			✔✔		

1. WUR, JRC, NOAA
2. MPI-BGC
3. Univ. of Edinburgh
4. LSCE and NILU (N2O)
5. JAMSTEC
6. NIES
7. MRI JMA
8. NILU
9. MRI/U. Toronto
10. JAMSTEC
11. Emory Univ.
12. Univ. Chile

✔: Longterm, 2000-2012

✔: focussed, 2010-2012

Analysis plan for top-down constraints

We already have a Protocol Ready
(*Chevallier* et al., Greenhouse Gas inversion inter-comparison protocol for Asia)

Terrestrial sub-group - Carbon

B. Poulter (Montana State Univ.), S. Piao (Peking Univ.), K. Ichii (JAMSTEC), A Ito (NIES), L. Nieradzik, P. Canadell (CSIRO), A. Baccini (WHRC), et al.

Terrestrial sub-group – CH_4

(tied with GCP activity)

B. Poulter (Montana State University, USA),

A. Ito (National Institute for Environmental Studies, Japan),

H. Tian (Auburn University, USA) et al.

Terrestrial sub-group – N_2O

NMIP - Global and regional N_2O model Inter-comparison Project

Hanqin Tian (Auburn University, USA)
Eri Saikawa (Emory University, USA)
Xu-Ri (Chinese Academy of Sciences)
Akihiko Ito (NIES, Japan)

Riverine export and coastal ocean

N.-H. Oh (Seoul National Univ.),

H.-K. Lui and C.-T. Chen (National Sun Yat-sen University)

Ongoing developments in ACTM

Species name	Model resolution	Purpose	Emission scenarios	References
CO_2	T42 L32	Carbon cycle	Inversion, CASA-mon/3hr, Takahashi, EDGAR/CDIAC	Patra et al., ACP,2011a Miyazaki et al., JGR, 2012
O_2/N_2	T42 L32	Carbon cycle	Blaine/Keeling, Gloor/Gruber	Ishidoya et al., Tellus, 2012
CH_4	T42/T106 L67	Chemistry and emission	EDGAR, GISS, VISIT, REAS	Patra et al., ACP, 2011b
N_2O	T42 L67	Chemistry and emission	EDGAR4.2, Boumann, Nevison	Ishijima et al., JGR,2010
CFC-11/12	T42 L67	Emission mitigation	GEIA, UNEP, Growth fitted	Patra et al.
Halon-1211/1301	T42 L67	Emission mitigation	GEIA, UNEP, Growth rate fitted	Patra et al.
HCFC-22/141b	T42 L67	Emission mitigation	EDGAR, UNEP, Growth rate fitted	Xiang et al., PNAS, rev.
HFC-134a	T42 L67	OH reactivity, Emission	EDGAR4.2	Xiang et al., PNAS, rev.
CH_3CCl_3	T42 L67	OH reactivity; TransCom-CH_4	Krol, UNEP	Patra et al., Nature, 2014
$CH_2Br_2/CHBr_3/CH_3I$	T42 L67	Bromine/Iodine in stratosphere/VSLS	Odornez et al., Liang et al., Ziska et al.	Hossaini et al., in prep.
$SF_6/^{222}Rn$	T42/T106 L32	Model transport	EDGAR4.2, Jacob et al.	Patra et al., ACP, 2011b
CH_3SCH_3	T42 L32	Oceanic emission	Lana et al., Stegmeir et al.	In testing
NH-VOCs	T42 L32	Carbon cycle	exploring	Planned