

# MEETINGS

## The Rapidly Changing Greenhouse Gas Budget of Asia

*International Workshop on Asian Greenhouse Gases Budgets; Ahmedabad, India, 27–29 September 2011*

PAGE 237

An international workshop assessed the availability of data and modeling capability to work toward the establishment of the greenhouse gas (GHG) budget for South and Southeast Asia. The workshop was organized with support from the Asia-Pacific Network (APN) and the Indian Space Research Organisation Geosphere-Biosphere Programme at the Physical Research Laboratory, in Ahmedabad, India. The effort is based on the synthesis and reconciliation of top-down (atmospheric observations and inverse models) and bottom-up estimates (ground-based flux observations and terrestrial models). While inverse estimates provide a regional net GHG balance, bottom-up estimates provide the necessary process attribution to shed light into future dynamics and the components of the balance that can be managed by human activity.

The workshop included discussion of concentration measurements and top-down modeling. Michel Ramonet (Laboratoire des Sciences du Climat et l'Environnement) highlighted the needs for high-quality measurements, which are set at an accuracy of 0.1 part per million, 2 parts per billion, and 0.1 part per billion for carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O), respectively, for the upcoming Integrated

Carbon Observation System project. Prabir Patra (Japan Agency for Marine-Earth Sciences and Technology Center) set a target for CO<sub>2</sub> flux estimation uncertainty for the South and Southeast Asia regions at 0.2 petagram of carbon per year within the time span of the APN project of 3 years by utilizing in situ and remote sensing observations in atmospheric CO<sub>2</sub> inverse modeling. While the South Asia region has apparently acted as the net sink of CO<sub>2</sub> at a rate of  $0.3 \pm 0.3$  petagram of carbon per year during 2007–2008, most parts of the Asian region behave as a significant source of CH<sub>4</sub> and N<sub>2</sub>O (K. Ishijima, Japan Agency for Marine-Earth Sciences and Technology Center). Ozone concentration over India increased at a linear rate of approximately 1.4% per year in the 1950s and 1990s, which could affect crop yields (S. Lal, Physical Research Laboratory).

The needs for further top-down works identified by the workshop participants were (1) expansion of the atmospheric observation network and compliance with international standards and data accessibility, (2) molecular and isotopic analyses of GHGs, and (3) a concerted effort to develop inverse modeling systems for effective use of in situ and remote sensing data streams.

Participants also discussed bottom-up observations and modeling. A growing role

of eddy covariance flux towers is expected particularly in India because a new network is being deployed through the National Carbon Project (R. Nayak, National Remote Sensing Center, and N. R. Patel, Indian Institute of Remote Sensing). New estimates of CH<sub>4</sub> emissions from Indian rice paddy fields are 3.4 teragrams per year, and from livestock are 11.7 teragrams per year (K. R. Manjunath, Space Applications Centre). The transport of terrestrial carbon to estuaries (33 teragrams per year) and emissions from coastal oceans (6.4 teragrams per year; V. V. S. S. Sarma, National Institute of Oceanography) was described. The concept of ocean acidification was also discussed in the context of rapidly changing emission scenarios (M. M. Sarin, Physical Research Laboratory).

The needs for further bottom-up works identified by participants were (1) explicit representation of crops in terrestrial modeling, given the predominant role of agriculture in the region; (2) better constraints of emissions from wetlands, particularly for Southeast Asia, where extensive tropical peatlands exist; and (3) a region-wide effort on riverine carbon transport to coastal oceans.

Involvement in this activity is sought; to become involved, please contact [prabir@jamstec.go.jp](mailto:prabir@jamstec.go.jp) or [pep.canadell@csiro.au](mailto:pep.canadell@csiro.au) or visit <http://www.globalcarbonproject.org/reccap>.

More details on the workshop are available in the online supplement to this meeting report ([http://www.agu.org/journals/eo/v093/i025/2012EO250006/2012EO250006\\_suppl.pdf](http://www.agu.org/journals/eo/v093/i025/2012EO250006/2012EO250006_suppl.pdf)).

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