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Subject: Summary Report of the APMEX campaign

Dear Colleagues,

The APMEX campaign completed its aircraft campaign on Nov 10<sup>th</sup> and its special observations at the surface today. I am writing this report before packing up to leave Hanimaadhoo tomorrow morning. From now on, only routine observations will be conducted at the ABC observatories. Three of my Scripps colleagues, Drs. Corrigan, Kim, and Ramana will be here until Nov 15<sup>th</sup> training Maldivian personnel to run the observatory.

### Highlights of the Campaign

- Successful initiation and operation of the ABC-Super Observatory
- Black carbon (BC) measurements by five independent techniques including single-particle, cavity ring-down, filters, aethalometers and radiometric techniques
- Twelve flight days of Dornier aircraft data that sampled air masses from almost all regions of Asia, including data on BC and aerosol indirect effects.
- Continuous observations of direct solar radiation by Kipp-Zonen and Eppley-Pyrheliometers to estimate the uncertainties in global dimming studies;
- Determination of ABC-induced dimming by five independent radiometers and spectrometers to define its spectral nature.
- Validation of aerosol-chemical transport models, including validation of recent BC emission estimates by ABC scientists.

I am indebted to Mr. Hung Nguyen of Scripps, Mr. Abdullahi Majeed and Mr. Amjad Abdullah of the Maldivian Ministry of Environment and Construction, and Mr. Ahmed Intikab of Island Aviation for making this campaign a success. In a campaign such as this it is difficult, if not impossible, to single out any group, but I am truly impressed with the enormous cooperation and team spirit shown by Island Aviation, including their pilots, engineers and ground staff. I also wish to thank our most gracious hosts at Hanimadhoo Village and the ever smiling and helpful Village Chief. Our campaign coincided exactly with the one-month Ramadan period and we stressed all of their resources to the limit. I am also grateful for the immense help of my team at Scripps. The campaign was successful and a summary of the major accomplishments are given below. Of course, my deep gratitude goes to NOAA for funding the observatory and some of the campaign and to NSF and The Vetlesen Foundation for funding portions of the campaign and the modeling studies.

## Capacity Building in South Asia

- A 10-day South Asian training program, co-chaired by Drs. Jayaraman and Ramanathan, was completed and participants from many regions of South Asia and Southeast Asia were given lectures by Drs. Crutzen, Jayaraman, Kim, Nakajima, Ramanathan and Yoon. In addition, they obtained hands-on training in running the observatory instruments from Drs. Corrigan, Kim and Ramana. The students collected data from the observatory, analyzed the results and presented their paper as requirements for completing the program. Dr. Jayaraman of the Physical Research Laboratory, India, organized the training program.
- Maldivian personnel received hands-on training in running the instruments and the scientific objectives of the observations.
- Discussions have been initiated with the Maldivian government to expand the observatory into an early warning system for climate and environmental changes for the Maldives and the Indian Ocean region.

## Observations and ABC-Related Research

### Objectives

Surface and aircraft observations were collected to accomplish the following ABC objectives:

- Understanding the long range transport of black carbon
- Understanding how ABCs fill the North Indian Ocean as the ITCZ retreats from the North to the South Indian Ocean
- Examining the link between aerosols and cloud microphysics to compare the indirect effect during the post-monsoon with that observed during INDOEX
- Validation of regional aerosol-chemical-transport models.

### Specific Details

#### I. Surface-Based Observations

Aerosol and radiation observations were conducted at: Hanimadhoo and Gan Islands, Maldives; Kanpur, India; Colombo, Sri Lanka; Katmandu, Nepal; and Sri Samrong, Thailand. The following nations and institutions participated in the experiment:

- Observations in the Maldives: Hanimadhoo and Gan
  - USA: Scripps Institution of Oceanography, University of California, San Diego (UCSD); University of Wisconsin; University of Miami; NASA-Ames; and NASA-Goddard
  - Sweden: U. of Stockholm
- Observations in India
  - India: Indian Institute of Technology at Kanpur
  - USA: Scripps Institution of Oceanography, UCSD; and NASA-Goddard
- Observations in Sri Lanka:
  - Sri Lanka: Meteorological Department at Colombo
  - USA: Scripps Institution of Oceanography, UCSD

- Observations in Nepal
  - Nepal: ICIMOD at Katmandu
  - USA: Scripps Institution of Oceanography, UCSD
- Observations in Thailand
  - Thailand: Chulankong University, Bangkok

## II. Aircraft Observations

The objectives of the aircraft program were:

- to collect data on the indirect effect of aerosols
- to examine the vertical distribution of aerosols and infer modes of long range transport
- to examine the vertical distribution of BC.

Between October 15<sup>th</sup> and November 10<sup>th</sup>, 65 hours of aerosol and cloud microphysical data were collected from Island Aviation Dornier aircraft instrumented by the University of Miami and Scripps Institution of Oceanography. We were remarkably successful with this limited time to sample air masses coming not only from South and Southeast Asia, but also from East Asia.

## III. Instrument Intercomparison and Validation

The major new attempt of this step was to compare BC measured by a single particle instrument (ATOMFS), cavity ring down instrument, filter based measurement, and the standard aethalometers. In addition, we had simultaneous measurements of solar fluxes by Kipp-Zonen (used in European data sets) with Eppley Pyranometers (used in US data sets). This step will enable to us to understand the uncertainties in Global Dimming measurements.

## IV. Model Intercomparison and Validation

Regional chemical-transport models from the University of Iowa and MPI-Mainz were included in the study. Both models conducted real time simulations of aerosols and gases. The data collected on aerosol optical depths, aerosol chemistry, BC, and vertical distribution of aerosols will be used to validate the models.

## V. Black Carbon and Sulfate Emissions from South Asia

In preparation for the campaign, new state-by-state emission estimates of BC and sulfates were made through collaboration between TERI (India) and Scripps (La Jolla). This data will be used in the University of Iowa regional model to determine if it improves the comparison with observed data.

Respectfully submitted by



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