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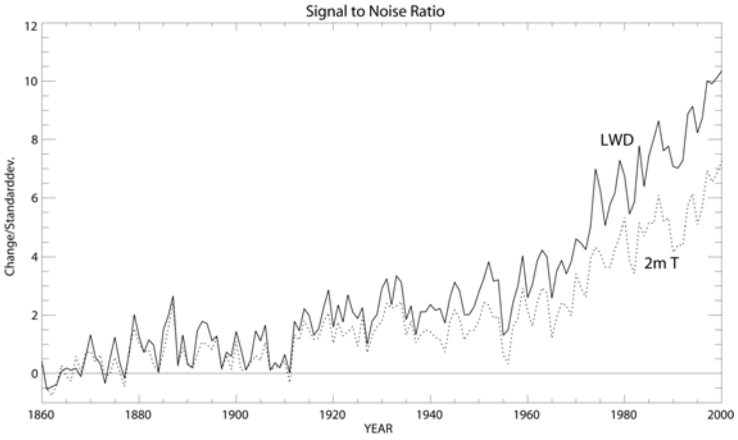
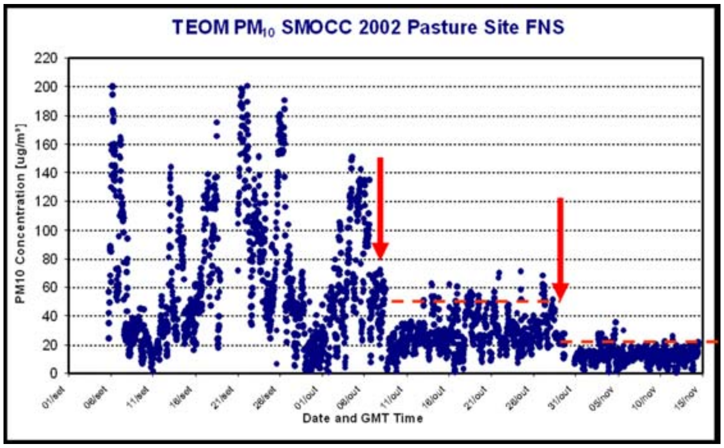
BSRN LONGWAVE DOWNWARD RADIATION MEASUREMENTS SHOW PROMISE FOR GREENHOUSE DETECTION STUDIES



THE SIGNAL OF INCREASING LWD EMERGES FASTER FROM ITS BACKGROUND NOISE THAN THE TEMPERATURE SIGNATURE

Ratio between the GCM-projected global annual mean change signal in a transient GCM experiment (Roeckner et al., 1999) and the interannual variability in terms of standard deviations in an unperturbed control run ("signal-to-noise ratio") for longwave downward radiation (solid line) and surface temperature (dashed line). See article on page 9.

LBA SHOWS IMPACT OF AEROSOLS ON CLOUDS



Evolution of the concentration of aerosols with a diameter less than 10 µm (PM_{10}) measured in central Rondônia in a pasture site during September to November 2002. The ***arrows indicate the first significant rainfall by October 7 and the onset of regular rainfall in the beginning of November.*** *Data from LBA/Smoke Aerosols, Clouds, Rainfall and Climate Perturb Global and Regional Climate (SMOCC) Project. See article on page 4.*

GCSS/ISCCP CLOUD REGIME ANALYSIS POINTS THE WAY FOR GCM MODEL IMPROVEMENT (Page 6)

AEROSOLS IMPACT CLOUDS IN THE AMAZON BASIN

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Physical Properties of Amazonian Aerosol Particles

Most of the Amazon Basin has a well marked yearly cycle of rainfall with a short dry season, a long wet season and short transitions between the dry and the wet seasons. In the dry season and in the transition to the dry season, biomass burning takes place mainly at the southern and eastern sectors of the Amazon Basin and provides a tenfold increase in the background number concentration of aerosols and cloud condensation nuclei (Williams et al., 2002). In the wet season, the main source of aerosols and Cloud Condensation Nuclei (CCN) is the natural emissions of biogenic aerosol particles, including coarse mode primary particles and fine mode particles from the gas-to-particle conversion from volatile organic compounds emissions (Artaxo et al., 2002). The main sources of aerosol particles in the coarse mode in Amazonia are soil dust and natural primary biogenic particles, where in the fine mode, secondary organic biogenic particles and biomass burning smoke predominate.

Recently, Claeys, et al. (2004) have demonstrated the possibility that oxidation products of isoprene could make a fraction of natural wet season aerosol particles in considerable amounts. Roberts, et al. (2002) analyzed the effect of sulfur compounds from decaying organic matter deposited on pre-existing particles, enhancing their capacity to become CCN, showing that the amount of sulfate on the particle was directly related to the activation fraction of the aerosol for a given supersaturation. Andreae, et al. (2004) showed the large impact of pyrogenic particles in cloud properties during the biomass burning season, with large changes in cloud microphysics from natural conditions to heavy biomass burning impacts. Using remote sensing techniques, Koren (2004) demonstrated the suppression of low cloud formation due to biomass burning smoke. Basically, no low clouds were observed with an aerosol optical thickness above 1.5 at 500 nm.

Impacts of Aerosol Particles in the Atmospheric Radiation Budget

One of the important impacts of aerosol particles on the radiation budget is through the absorption and scattering of solar radiation reaching the surface. This is basically a dry season phenomenon due to the very high aerosol loading in the atmosphere when mass concentrations can reach an extremely high 600 µg/m³, with an aerosol optical thickness over 3 at 500 nm. In addition to pyrogenic particles, biogenic and soil dust aerosols must be taken into account when modeling the physical and optical properties of aerosols in forested regions such as the Amazon Basin (Claeys, et al., 2004). The albedo of the surface affects the absorption of short wave radiation by overlying aerosols in the sense that high albedo areas are associated with more absorption and thus have a more pronounced surface negative radiative forcing. Procópio et al. (2004) show that the aerosol radiative forcing in the dry season has different values at the surface, boundary layer, and top of the atmosphere. The average of 7 years of measurements indicates a forcing of -38 watts/m² at the surface, while the forcing in the atmosphere reached +28 watts /m², due to the presence of black carbon aerosol that heats up the atmosphere. The main effect is seen as a cooling of the surface and warming of the boundary layer, which strongly affects the atmospheric stability in low levels. The increased static stability leads to a reduction in turbulence and a negative impact on updraft speed at the cloud base. Since a large scale subsidence inversion is often seen during the dry season, the reduced updraft speed indicates that most cumulus clouds will not evolve into congestus or into cumulonimbus.

Microphysical Impact of Aerosols

During the transition season from dry to wet in 2002, a Large-scale Biosphere Atmosphere Experiment in Amazonia (LBA) intensive field campaign was conducted in the southwest Amazon Basin to measure the impact of aerosols on clouds using an airplane instrumented to measure cloud microphysical properties. Andreae, et al. (2004) describes the first results, which show a well defined shift of the drop size spectra to larger droplets from the cloud base to middle levels in clouds inside the polluted air mass when compared to those in cleaner environments, indicating that larger droplets are suppressed at lower levels in the presence of large number of aerosols due to the competition for the available moisture (see figure on page 20). The absence of larger droplets is an indication of rain suppression in the first stage of cumulus development and an eventual shift from warm rain to rainfall generated through the ice microphysical processes. Williams et al. (2002) noted that in the transition from the dry to wet season, the convective systems in the Amazon had the typical features of continental thunderstorms with plenty of lightning, damaging winds and eventually hail. The triggering of deep convection in a scenario of a cooler surface, enhanced CCN number concentration, and absence of frontal systems, would be possible by either forced uplift over topography or in selected spots with large sensible heat flux, such as in slopes, deforested areas, or bare soil areas In this case, the process of rain formation would have to be through the ice phase, which explains the enhanced lightning in the transition from dry to wet season.

During the wet season, the low number of lightning strikes indicates a more oceanic behavior of convection, although significant intraseasonal variability is observed. The microphysical properties analyzed in data from a surface disdrometer (Tokay, et al. 2002) show that as the low level wind changed from easterlies to westerlies with the approach of frontal boundaries (Rickenback, et al. 2002), the character of rainfall changed with a pronounced decrease in the number of larger droplets at the surface. Carvalho, et al. (2002) showed that during the easterlies the clouds were more isolated and deeper, while these studies indicate that rainfall had larger convective fraction during the easterlies. Aerosol concentration varied accordingly with low concentrations during the westerlies when the systems were larger in area. Silva Dias, et al. (2002) discussed the possible feedback of clouds and aerosols in the wet season, suggesting that the main effect could be in the local recycling of biogenic material during the westerlies and an export of biogenic material during the easterlies through the enhanced vertical transport to upper levels (Freitas et al, 2004).

Large Scale Impact

The fact that the atmospheric large scale environment is dominated by subsidence in the dry season and by large scale moisture convergence during the wet season (Li and Fu, 2004) makes the analysis of the differences in cloud processes a non-trivial task. However, the transition from the dry to wet season shows a suggestive evolution from the surface budget point of view. Li and Fu (2004), through analysis of a composite of the European Center for Medium-range Weather Forecasts (ECMWF) reanalysis over the Amazon Basin during the transition from the dry to wet season, suggest that the transition can be divided into three phases: initiating, developing, and mature. The temporal evolution of the dry season is initially dominated by a gradual increase of local sensible and latent heat fluxes forced by increased solar radiation. The developing phase is dominated by the seasonal transition of the large-scale circulation with the change of the cross-equatorial flow, which becomes northerly and is associated with increase of thunderstorms. The northerly flow increases the net moisture convergence in the area leading to the onset of the wet season in the mature phase. The ECMWF analysis used by these authors does not include the explicit effect of aerosols and, thus, the comparison with observed surface fluxes show some differences in the correct sense, for example, lower values in the observations as compared with the reanalysis. It can be argued that the presence of a dense aerosol layer in the dry season would delay the surface flux increase and thus postpone the onset of the rainy season, but by how much has not yet been determined. The figure at the bottom of page 1 shows the evolution of the concentration of aerosols with a diameter less than 10 µm (PM_{10}) measured in central Rondônia in a pasture site from September to November 2002. The arrows indicate the first significant rainfall by October 7 and the onset of regular rainfall at the beginning of November.

Impact on Precipitation

It is becoming clear that larger aerosol loadings in the atmosphere cause changes in cloud microphysics, with both *in situ* and satellite measurements indicating smaller droplet sizes with increasing aerosol loading and changes in cloud dynamics. However, the final effect on the precipitation rate and amount is still unclear. Several researchers have looked at possible changes in the precipitation rate with large temporal or spatial changes in aerosols, but there is no clear signal on this critical issue. This area needs attention due to possible changes in precipitation rates and amounts. Additionally, the quantitative aspects of the aerosol indirect effects, as well as the semi-indirect effect, is still in its infancy, with potentially significant changes in the global and regional atmospheric radiation balance.

Acknowledgements: This work has been supported by Fundacao de amparo a pesquisa do estado de Sao Paulo, Conselho Nacional de Desenvolvimento Cientifico e Tecnologico, the European Community, the Max Planck Society and the National Aeronautics and Space Administration.

(Continued on page 19)

AEROSOLS IMPACT CLOUDS

(Continued from page 5)

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GEWEX/WCRP MEETINGS CALENDAR

For the complete listing of meetings, see the GEWEX web site (http://www.gewex.org)

3–5 November 2004—IGWCO/GEWEX/UNESCO WORKSHOP ON TRENDS IN GLOBAL WATER CYCLE VARIABLES, Paris, France.

8–10 November 2004—2ND TIGER WORKSHOP, Pretoria, South Africa.

15–18 November 2004—18TH CEOS PLENARY MEETING, Beijing, China.

18 November 2004—11TH (BIS) IGOS PARTNERS MEETING, Beijing, China.

29–30 November 2004—GEO-5, Ottawa, Canada.

1–5 December 2004—9TH GAME INTERNATIONAL SCIENCE PANEL MEETING AND 6TH INTERNATIONAL STUDY CONFERENCE ON GEWEX IN ASIA AND GAME, Kyoto, Japan.

13–17 December 2004—AGU FALL MEETING, San Francisco, California, USA.

9–13 January 2005—85TH AMS ANNUAL MEETING, San Diego, California, USA.

31 January–4 February 2005—GEWEX SCIENTIFIC STEERING GROUP-17 MEETING, Kunming, China.

14–16 February 2005—GEO-6/EARTH OBSERVATION SUMMIT III, Brussels, Belgium.

28 February–4 March 2005—4TH CEOP/IGWCO JOINT MEETINGS, Tokyo, Japan.

14–18 March 2005—26TH SESSION OF THE JOINT SCIENTIFIC COMMITTEE, Guayalquil, Ecuador.

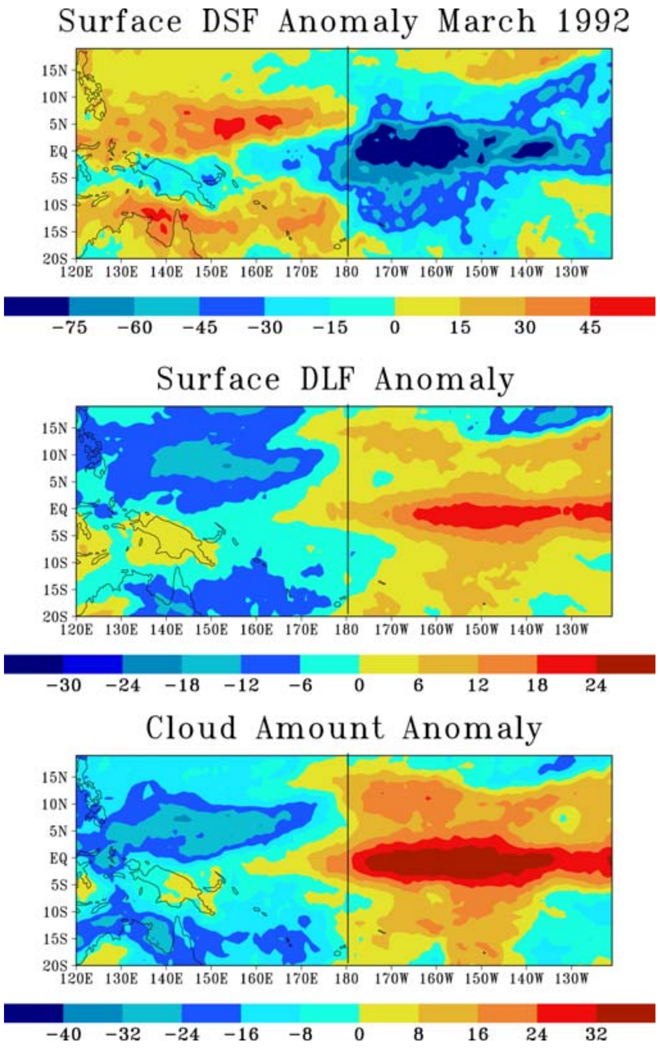
11–15 April 2005—CLIC FIRST SCIENCE CONFERENCE, Beijing, China.

16–20 May 2005—PAN GCSS MEETING ON CLOUDS, CLIMATE AND MODELS, Athens, Greece.

15–17 June 2005—PAN-WCRP MONSOON WORKSHOP, Irvine, California, USA.

20–24 June 2005—5TH INTERNATIONAL SCIENTIFIC CONFERENCE ON THE GLOBAL ENERGY AND WATER CYCLE, Orange County, California, USA.

CLOUDINESS ANOMALIES OF THE 1992 EL NINO AND THEIR EFFECTS ON SURFACE FLUXES


Surface DSF Anomaly March 1992

Surface DLF Anomaly

Cloud Amount Anomaly

Anomalies of downward shortwave flux (DSF), downward longwave flux (DLF), and total cloud amount over the tropical Pacific Ocean for March 1992 El Niño episode. See article on page 10.

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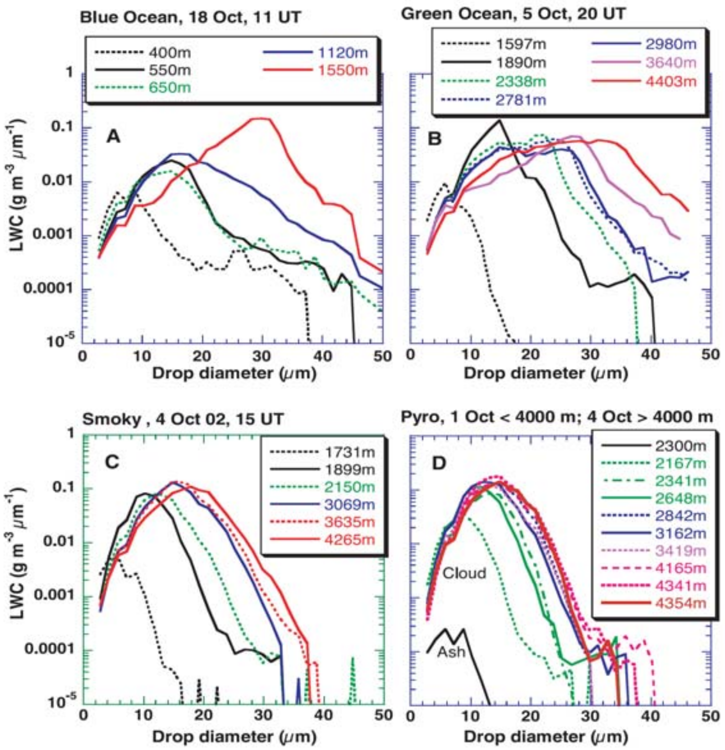
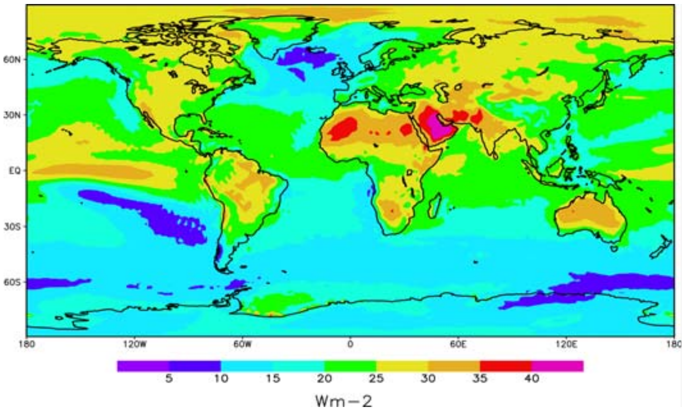
CLOUD DROPLET SPECTRA FOR DIFFERENT HEIGHTS AND FOUR AEROSOL CONDITIONS



Four aerosol conditions in Amazonia: Blue Ocean (oceanic area); Green Ocean (Amazon Basin wet season); Smoky (cloud in light smoke conditions); Pyro (cloud in heavy smoke conditions). See article on page 4.

HOW LONGWAVE DOWNWARD RADIATION MIGHT CHANGE TOWARDS THE END OF THE 21ST CENTURY



Change in downward longwave radiation towards the end of the 21st century under the IPCC SRES A2 scenario, as projected in an experiment with the ECHAM5 T106 GCM (Roeckner et al., 2003). See article on page 9.