Recent Trends in Amazon Climate and Greenhouse Gas Budgets

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Contributions from
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Amazon Basin

$6 \times 10^6 \text{ km}^2$ - 25 times UK area
20% of global biomass
30% of biodiversity
20% of global river discharge to oceans
Deforestation

Forest loss 2008-2014 (km²/100km²)

Courtesy M. Kalamandeen & D. Galbraith
Climate trends - Temperature

INMET conventional stations – wgtd inversely w station density

Max monthly Temp (°C)


Year

19  20  21  22  23

Min monthly Temp (°C)


Year

INMET Climate Station network

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INMET Climate Station network
Climate trends - Precipitation

INMET conventional stations – weighted inversely with station density
Acceleration of Walker circulation

Caused by contrast in Eastern tropical Pacific – tropical Atlantic sea surface temperature trend

Important element: rapid tropical Atlantic warming
Recent Walker Circulation strengthening and Amazon precipitation

W Pacific Trade Winds (160 E -180 E) and Rio Negro wet season discharge

Courtesy Jonathan Barichivich
Increase in Agulhas leakage due to poleward shift of Southern Hemisphere westerlies

A. Biastoch¹, C. W. Böning¹, F. U. Schwarzkopf¹ & J. R. E. Lutjeharms²

Response of Agulhas leakage. Here we present the results of a high-resolution ocean general circulation model⁷,⁸ to show that the transport of Indian Ocean waters into the South Atlantic via the Agulhas leakage has increased during the past decades in response to the change in wind forcing. The increased leakage has contri-
Altogether Climate becomes hotter and more variable – more severe floods and dry anomalies.
Tropical South American trends in Greenhouse Gas budgets
Aircraft-based Greenhouse gas sampling
CH$_4$ mixing ratio profile – Pantanal March 9, 2017
Greenhouse gas flux estimation using back-trajectory based column budget approach

\[ F_{CO_2} \approx \frac{\int_{z=0}^{4 \text{ km}} (CO_{2}^{\text{site}} - CO_{2}^{\text{backgrd}}) \, dz}{t_{\text{Santa Rem}} - t_{\text{coast}}} \]
Inter-annual variation carbon flux estimates in upwind region of sites – dry and wet season
Carbon fluxes upwind Rio Branco
Relation of fluxes with temperature and precipitation anomalies

0.8 ± 0.1 gC.m⁻².day⁻¹/°C
Some results about Methane
Law Dome (ice core) and Mauna Loa (in situ) $\text{CH}_4$
Annual mean Atmospheric $^{13}$CH$_4$ (INSTAAR, Boulder)
Wetlands - tropical South America

seasonally flooded savannahs
seasonally flooded river floodplains: varzeas and iguapos
major peat-lands

from Hamilton et al. 2004
Methane fluxes upwind of Rio Branco
2437 individual Amazonian floodplain tree stems from across 13 locations spanning the central Amazon basin
Combining top-down Amazon CH$_4$ balance agrees well with bottom-up estimate if emission pathway via trees is taken into account. Total CH$_4$ emissions are larger than previous estimates (~25 % of global wetland emissions).
Summary

Amazon getting hotter and climate more variable – remarkable increase in severe floods – linked to contrast in tropical Pacific – Atlantic SST trends

Top-down estimates suggest for Carbon
- clear seasonality – carbon uptake during wet season carbon release during dry season
- seems to be a tendency towards lesser net uptake
- temperature and precipitation seem to be both important

Top-down estimates suggest for Methane
- Clear seasonality lagging precipitation
- Upward revision of Amazon balance in very good agreement with emission pathways discovered and quantified by Vince Gauci and Sunitha Pangala