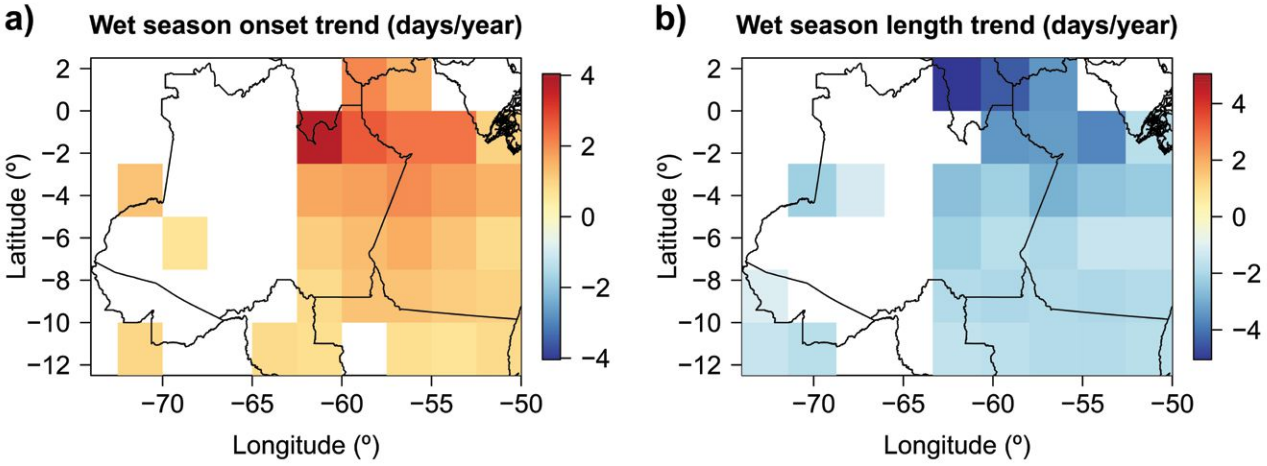
Shortening of the Amazon's Rainy Season Detected Using Satellite Cloudiness Observations

The Amazon rainforest is crucial in regulating the global climate system, recycling water vapor from the Atlantic Ocean, and transporting heat and moisture from the tropics to the subtropics. During the last decades, this region has been experiencing massive deforestation and biomass burning. The tropical rainforest response to natural climate variability and human-induced environmental changes is largely unknown. Recently, 2 severe droughts occurred within a period of only 5 years, evidencing pronounced alterations in the Amazonian rainfall regime. We propose a new methodology to evaluate the onset and length of the Brazilian Amazon rainy season during the last decades using cloudiness observations from geostationary satellites. The advantage of this method is that it does not rely on rain gauges (which are very sparse in the region).

Trend analyses show that cloudiness has consistently reduced regardless of the time of day or location, with more prominent trends of up to −6% per decade in the morning over the central and eastern Amazon. High cloud cover reduction is the major contributor to the decline in total cloud fraction. This decrease in cloudiness reduces the amount of solar radiation reflected back to space, while increasing irradiance at the surface. This local warming alters the surface and lower atmospheric temperature, further affecting cloud development. Previous studies that reported trends on wet and dry season lengths have focused on the southwestern Amazon, a region that has been severely deforested since the 1970s. However, our study shows that the shortening rainy season is more significant over less-deforested areas, such as the northern and central Amazon, where a reduction of up to 4 days per year in the wet season length is observed. This result suggests that large-scale influences on rainfall regimes in the Amazon are likely more relevant than local influences, such as the rate of deforestation.

Our study examined the physical mechanisms that potentially trigger modifications in the variability of the seasonal cycle of convection. The results indicate that the El Niño/Southern Oscillation (ENSO) is related to delayed onsets and earlier demises of the wet season. The North Atlantic tripole and larger areas of the Pacific warm pool are associated with delayed onsets over the western and northern Amazon, respectively. Positive sea surface temperature anomalies in the tropical South Atlantic are linked to delayed demises over the western and central Amazon. Since the interannual variability of the Amazon's rainfall regime is the result of complex, competing physical mechanisms of natural and anthropogenic origin, the reduced cloudiness and shortening of the wet season cannot be completely attributed to these climatic modes. Therefore, further modeling and observational studies are needed. The critical changes in cloud life cycle evidenced in this study potentially impact South America's hydrological cycle and climate, with important implications for the ecosystem and agriculture.—Elisa T. Sena (Escola Paulista de Política, Economia e Negócios-Universidade Federal de São Paulo), M. A. F.



Rainy Season Delay and Shortening. **Spatial distribution of the trends of the Amazon's rainy season onset and duration from 1983 to 2009. The left panel shows a delay in the onset, while the right panel reveals a shortening wet season.**

Silva Dias, L. M. V. Carvalho, and P. L. Silva Dias, "Reduced wet season length detected by satellite retrievals of cloudiness over Brazilian Amazonia: A new methodology," in the 15 December issue of the *Journal of Climate*.

Coherent Turbulence in Hurricane Rita (2005) During an Eyewall Replacement Cycle

The destructive power of hurricanes is unlike anything else on Earth, with the proven capability to significantly damage the U.S. economy, devastate regions, and kill thousands of people even in the modern era. The boundary layer of a hurricane (surface to ~1-km height) is of prime importance for vulnerable coastal communities and for making accurate forecasts of storm intensity that can help mitigate the loss to life and property. Measurements of this intense and dangerous layer are difficult to make and have relied heavily on instruments dropped from aircraft (dropsondes). While valuable sources of wind information, the Lagrangian nature of the dropsonde (not a true vertical profile) with its coarse horizontal resolution significantly hinders the characterization of intense winds in hurricanes and limits our understanding of the storm physics.

New processing and analysis of data from the Imaging Wind and Rain Airborne Profiler (IWRAP) in intense Hurricane Rita (2005) is able to provide the nearly full structure of the turbulent boundary layer at very high resolution, filling a crucial measurement gap. The IWRAP is a downward-pointing, conically-scanning, dual-frequency (C- and Ku-band), dual-polarization, dual-beam airborne radar that measures surface backscatter and volume reflectivity/Doppler velocity from precipitation at 30-m range resolution. The IWRAP scans at 60 revolutions per minute, allowing wind retrievals with ~200-m horizontal and ~30-m vertical grid spacing. The radar has collected data in several high-impact storms from the NOAA WP-3D (P3) aircraft since 2003 and currently operates each hurricane season. Collocation of IWRAP with the Stepped Frequency Microwave Radiometer (SFMR), tail Doppler radar and dropsondes on the P3 aircraft allows a comprehensive characterization of the turbulent, convective, and vortex scales of motion.

The IWRAP measurements and calculations showed that Rita contained thin turbulent features