The West African Monsoon water cycle investigated with a ground-based GPS network

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A permanent network of six ground-based GPS receivers was established in five West African countries during the course of the African Monsoon Multidisciplinary Analysis (AMMA) project. Three stations have been in operation since June 2005, and three others since May 2006, and all provide continuous observations at a 30-sec sampling rate. The data are processed operationally with GAMIT software in delayed-mode and are also reprocessed according to improvements of the GAMIT software. One-hourly precipitable water vapour (PWV) estimates have been used in various studies dealing with the atmospheric water cycle.

The operational radiosonde network represents a major source of upper air atmospheric measurements which are assimilated into NWP models. They are also often used for atmospheric process studies of boundary layer dynamics, deep convection and synoptic-scale phenomena, and water budget computations. However, radiosondes suffer from humidity and temperature biases which are detrimental to these studies and negatively impact short-range weather forecasts. Contrary to other regions of the world, GPS data are not assimilated over Africa and therefore represent a unique and valuable source of independent observations for evaluating both radiosonde observations and NWP model products. Results from six co-located GPS – radiosonde comparisons are presented which reveal significant biases with some of the radiosonde sensors used during the AMMA in 2006. The impact of these biases on NWP model analyses is highlighted too, though the models also suffer from other deficiencies.

West Africa is a core region for the development of Mesoscale Convective Systems (MCSs) that are responsible for most of the monsoonal rainfall. Some of them transform into a significant portion of the tropical Atlantic cyclones. Understanding the lifecycle of MCSs, their interactions with the continental surface and the ocean are major objectives of AMMA. Water budgets have been computed at high temporal resolution with the help of GPS PWV estimates which give insight into the strength of the water cycle and the special role of MCSs within the monsoon system. At larger spatial and temporal scale, GPS PWV estimates also reveal short periods of strong moisture advection associated with pulsations of the Saharan Heat-Low, especially before the monsoon onset, and reveal a marked seasonal cycle.