Session: C2 Poster: T136B

Multiannual variations of the South American Monsoon System

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The South American Monsoon System (SAMS) is the most important climatic feature that affects millions of people in South America. SAMS is characterized by pronounced seasonality in rainfall along with a seasonal reversal of the large-scale circulation when annual mean is removed. Other important features of SAMS during the wet season are the South Atlantic convergence zone (SACZ), an upper level anticyclone (the Bolivian High), an upper level trough (the Northeast Trough) and a low level thermal low (the Chaco Low). Regional and remote factors influence the life cycle of SAMS on a broad range of time-scales. Examples of regional factors affecting SAMS are complex terrain such as the Andes and the Brazilian high plain, land use changes, biosphere-atmosphere and soil-atmosphere interactions. Remote factors affecting SAMS have been associated with the Atlantic and Pacific sea surface temperatures patterns, and tropical and extratropical modes such as the North Atlantic Oscillation, the Madden-Julian Oscillation, the Southern Annular Mode among others. The onset of intense convective activity and heavy precipitation over most of the Amazon, central and southeastern Brazil in the present climate is between October and November; it peaks in the austral summer (December-February). The end of the rainy season over central and southeastern Brazil is between the end of March and mid-April as intense precipitation gradually migrates from the south Amazon and central Brazil toward the equator. However, recent studies using NCEP/NCAR reanalysis (1948-2010) and several distinct precipitation datasets have shown evidence that SAMS' duration and amplitude have increased in the last 62 years. Combined Empirical Orthogonal Functions (CEOF) of circulation, temperature, specific moisture and precipitation is used as a metric to represent variations in SAMS. The observed changes in SAMS are related to increase (decrease) of moisture transport and precipitation over central and eastern Brazil (northern South America). Moreover, there is evidence that due to the equatorward geographical extent of South America, warming in recent decades has been more pronounced in the lower troposphere of tropical regions compared with the subtropics, with large rates of temperature increase over high elevations such as the Bolivian Andes and the Brazilian high plains. These changes have affected the temperature gradient between the South Atlantic and the continent resulting in intensified easterly moisture transport over eastern and central Brazil and weakened easterly transport over Northern South America. Here we investigate variations in SAMS' amplitude, onset and demise in the available CMIP5 coupled climate models using the same metric described above. We compare the historical and pre-industrial simulations with the objective to identify the role of greenhouse gases and radiative forcings in the observed variability of SAMS.