

GPS Performance in the Quantification of Integrated Water Vapor in Amazonian Regions

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ABSTRACT

LBA, acronym of Large Scale Biosphere-Atmosphere Experiment in Amazonia, is an international initiative of research carried out under the leadership of Brazil. LBA will provide subsidies to understand the climatological, ecological, biogeochemical, and hydrological functioning of Amazonia, the impact of land use change in the Amazonia forest on these functions and interactions between Amazonia and the Earth system. An experiment with intensive atmosphere physical and chemical information collection in 2002 was accomplished during the transition from the dry to wet season to contribute with the LBA objectives. This experiment is denominated RACCI (Radiation, Cloud, and Climate Interactions in the Amazon during the DRY-TO-WET Transition Season). RACCI was carried out in several cities from Rondônia State, Brazil where is quite advanced the clearing of forest for agriculture and cattle raising. The RACCI main aim is to understand the physical processes that control the transition station in the Amazonia Southwest area and the regional effects of aerosols generated from biomass burning, which is a quite common practice in that area in the finish of dry station.

The IWV (Integrated Water Vapor) quantification from GPS was using in this experiment to supplying subsidies to evaluate the aerosols influence in the associated processes modifications to seasonality of IWV.

The IWV estimates with high temporal resolution allow to monitor the atmospheric water vapor flow and to study of the IWV daily cycle in the dry and wet periods and during the transition season.

The Amazonia areas are characterized by large space-time variability in the humidity fields due to the intense convective process in those areas associated to the great humidity potential generated by high temperatures. Those areas are the most humid of the planet, where IWV average values are in the order of 50 kg m⁻². As the IWV quantification using GPS has not been explored in these areas, the objective this work is to evaluate the GPS performance in those circumstances when comparing with other present techniques in the experiment RACCI.

GPS Data in the RACCI/LBA campaign

The GPS data for the IWV quantification in the RACCI/LBA campaign was collected using one ASHTECH receiver, ZXII model and two TOPCON, LEGACY model. These receivers were installed in three RACCI sites, which form an equilateral triangle with side of approximately 300 km, in order to provide the IWV flow analysis. These sites are located at Ouro Preto do Oeste county, (ABRA station), Porto Velho airport (PTVE station) and at Guajará Mirim county (GJMI station) in Rondônia State, Brazil. In these stations were carried out radiosondes launchings and meteorological data collection. The number of radiosonde launched was 133 in ABRA, 105 in GJMI and 96 in PTVE. In ABRA was also installed an AERONET (AERosol RObotic NETwork) CIMEL radiometer which provided IWV values several times during the day. The radiosondes, as well as the radiometer, were used in the performance analysis of the IWV values estimated from GPS. There are also IWV values generated by humidity sounding satellites that will also be compared against IWV values from GPS. These humidity sounding satellite are NOAA-14, NOAA-16 and AQUA.

Preliminary results

The zenithal tropospheric delays were obtained when GPS data were processed in the GOA-II software using the pos-processed precise point positioning method. These delays were converted to IWV values using tropospheric mean temperature values from a Brazilian model. This model was developed using 90,000 radiosondes launched in Brazilian territory. The GPS data processing near real time is been carried out using IGS (International GPS Service) ultra-rapid ephemerides. The radiosonde IWV values were compared against IWV values from pos-processed GPS data. The RMS values were 3.5 kg m^{-2} (7.1%) in ABRA station, 3.3 kg m^{-2} (6.5%) in GJMI station and 2.4 kg m^{-2} (4.8%) in PTVE station. The bias values generated in that comparison were 2.5 kg m^{-2} in ABRA, 2.3 kg m^{-2} in GJMI and 0.9 kg m^{-2} in PTVE. When the GPS IWV values were compared against those supplied by the radiometer, the RMS resultant was 2.7 kg m^{-2} (5.4%) and the bias of -2.15 kg m^{-2} , contrarily of the previous results.

Conclusions

The bias values indicate that the IWV values from GPS tend to be larger than the radiosondes values and smaller than the radiometer values. On the other hand, IWV values from GPS are very close of the average values supplied by radiosondes and radiometer. Due to the great amount of atmospheric water vapor existent in this region, the results obtained in the experiment in percentile terms are quite better than those found in the literature, which are around of 10%. In the continuity of this research, comparisons will be carried out using IWV values generated by humidity sounding satellites.

The IWV estimates from GPS obtained during the RACCI/LBA campaign are appropriated to analyze the impact of the assimilation of this information in the Numerical Weather Prediction (NWP) models in Brazil. In this experiment was installed an automatic pluviometer network that will contribute with the analysis of the obtained results. This pluviometer network will supply the amount and the real location of rains occurrence during the experiment.

The application of GPS for IWV quantification in Brazil is very promising. On one side, the Brazilian extensive geographical area has great deficiency in the meteorological database. On the other hand, it is available the Brazilian Network for Continuous Monitoring of GPS (RBMC) which must have great potentiality for the spatial and temporal monitoring of the atmospheric water vapor. The results presented in this work may contribute with the use of RBMC data application in the atmospheric water vapor determination and its assimilation in the NWP models. In that way, the deficiency of IWV information collection in Brazil will be minimized and consequently the meteorological forecasts quality may improve.

The most relevant result of this article is that so far, the evaluation of the GPS performance in the IWV quantification were carried out at regions where the IWV medium values was around of 25 kg m^{-2} . Therefore, this work can bring significant contribution in the evaluation of this technique in the presence of great amount of atmospheric water vapor; as it was the case of the Amazonian regions, where the experiment was carried out.