Documentation of atmospheric constants over Niamey, Niger: a theoretical aid for measuring instruments

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ABSTRACT

The frequent failures of ground measuring devices, e.g. radiosondes, weather stations, in developing regions is worrisome. From the literature, established projects such as the Aerosol Robotic Network (AERONET) and the African Monsoon Multidisciplinary Analyses (AMMA) are burdened by the same challenge. At the moment, the AERONET and AMMA databases show a large volume of data loss. With only about 47% of data available to scientists, it is evident that accurate nowcasts or forecasts cannot be guaranteed. It is proposed that the challenge is not measuring device design error but systemic, i.e. the configuration of accurate calibration constants in the compact flash card of the devices. The calibration constants of most radiosonde or weather stations are not compatible with the atmospheric conditions of the West African climate. A dispersion model was developed to incorporate salient mathematical representations such as the unified number. The unified number was derived to describe the turbulence of aerosol transport in the frictional layer of the lower atmosphere. A 14 year dataset from the Multi-angle Imaging SpectroRadiometer was tested using the dispersion model. A yearly estimation of the atmospheric constants over Niamey using the model was obtained with about 87.5% accuracy. This further revealed that the average atmospheric constants for Niamey, Niger, are $a_1 = 0.77975$ and $a_2 = 0.693021$ and the tuning constants are $n_1 = 0.140187$ and $n_2 = 0.759236$. Also, the yearly atmospheric constants confirmed that the lower atmosphere of Niamey is very dynamic. Hence, it is recommended that radiosonde and weather station manufacturers should constantly review the atmospheric constants over a geographical location to enable about 80% data retrieval.