

Phase synchronization between tropospheric radio refractivity and rainfall amount in a tropical region

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Abstract

This study investigated linear and nonlinear relationship between the amount of rainfall and radio refractivity in a tropical country, Nigeria using forty seven locations scattered across the country. Correlation and Phase synchronization measures were used for the linear and nonlinear relationship respectively. Weak correlation and phase synchronization was observed between seasonal mean rainfall amount and radio refractivity while strong phase synchronization was found for the detrended data suggesting similar underlying dynamics between rainfall amount and radio refractivity. Causation between rainfall and radio refractivity in a tropical location was studied using Granger causality test. In most of the Southern locations, rainfall was found to Granger cause radio refractivity. Furthermore, it was observed that there is strong correlation between mean rainfall amount and the phase synchronization index over Nigeria. Coupling between rainfall and radio refractivity has been found to be due to water vapour in the atmosphere. Frequency planning and budgeting for microwave propagation during periods of high rainfall should take into consideration this nonlinear relationship.

Keywords: Phase synchronization, Radio refractivity, Precipitation, Recurrence plot, RQA, Climate

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