Application of AIRS Sounding Products for Trend Analysis of Temperature, Water Vapor, Ozone, Methane and Carbon-Monoxide over India

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In the present study, atmospheric infrared sounder (AIRS) sounding products of temperature, water vapor, ozone, methane and carbon-monoxide have been utilized to study the trends over Indian region for a decade from 2003 to 2012. Temperature, water vapor and ozone were available in profiles, however, methane and carbon-monoxide were available as total column. Hence, the trends of temperature, water vapor and ozone were studied in various atmospheric layers in addition to total column for water vapor, ozone, methane and carbon-monoxide. Annual averages of all parameters were estimated from daily data. Also, the spatial average was taken over Indian region. As the data was found to be not normally distributed, non-parametric Mann-Kendall test was applied to check for trend and Sen's slope estimate was used to find the rate of the change of parameter per year, if a trend was observed. The temperature values were averaged in four atmospheric layers viz. surface-850 hPa, 850-500 hPa, 500-100 hPa and 100-50 hPa, for trend studies. The water vapor and ozone were considered as layer integrated amount. Water vapor trend was seen in first three layers out of fours layers mentioned above and ozone trend was estimated in 50-1 hPa atmospheric layer in addition to earlier fours layers. It was observed that the layer average temperature (LAT) in surface to 850hPa layer has significant increasing trend over India and the rate of increase is 0.04 ˚K/year. No statistically significant trend was seen for LAT in 850-500 hPa and 500-100 hPa atmospheric layers. However, LAT in 100-50 hPa has significant decreasing trend with a rate of 0.07 ˚K/year. Layer integrated water vapor (LIWV) didn't show any significant trend in any of the atmospheric layers considered, however, total column water vapor (TWV) was found to have increasing trend at a rate of 0.24 kg/m^2/year. For ozone trends, it has been observed that the layer integrated ozone (LIOZ) had no statistically significant trend in surface-850 hPa, 850-500 hPa, 500-100 hPa and 50-1 hPa, however, a significant trend was seen for LIOZ in 100-50 hPa layer with a decrease rate of 0.1 DU/year. Total column ozone didn't show significant trend over India. A statistically significant trend was seen for total column methane and rate of increase was estimated to be 1.4E+17 molecules/cm^2/year, however, no trend was observed for total column carbon-monoxide. So, the temperature has been found to have increasing trend in lower troposphere and decreasing trend in lower stratosphere. Also, the ozone has shown decreasing trend in lower stratosphere which is one of the important reason of decreasing trend of temperature there.

Keywords: AIRS, trend analysis, Mann-Kendall, temperature, water vapor