Abstract

The clear-sky greenhouse effect is the difference between the infrared radiation emitted by the earth and infrared radiation reached at the top of atmosphere, due to different greenhouse gases present in the atmosphere Water vapor is the major greenhouse gas present in the atmosphere The clear-sky greenhouse effect plays an important role in the modulation of the climate in the tropics

In this thesis an analytical expression has been derived for the clear-sky greenhouse effect as a function of precipitable water vapor, water vapor scale height and temperature lapse rate The clear-sky greenhouse effect obtained from analytical model is well in agreement with ERBE data sets as well as NCEP Reanalysis There were a few regions where the discrepancy was more than 5% In these regions it was noticed that the vertical structure of water vapor was quite different from that assumed in the analytical model Hence a radiative transfer SBDART model was used to explore the role of water vapor in the clear-sky greenhouse effect. We validated the SBDART model with METEOSAT-5 satellite observations for clear-sky pixels and observed that the difference between brightness temperature was less than 1 K in the $(10.5 - 12.5\mu m)$ window channel, Hence this model was considered to be appropriate for explaining the role of water vapor in the clear-sky greenhouse effect.

We compared the clear-sky greenhouse effect obtained from NCEP Reanalysis and BOBMEX with SBDART model and found that error in clear-sky greenhouse effect in NCEP is mainly due to error in the precipitable water vapor. We considered next the cases with same precipitable water vapor but different vertical structure of water vapor by creating density smoothened profiles. It was observed that in the lower troposphere even when there was a difference in water vapor structure, it showed hardly any impact on upward infrared fluxes. But in upper troposphere the difference between water vapor structure showed a large impact on the upward infrared fluxes The previous studies attributed this to the complex water vapor rotation and vibration-rotation bands. But in this study we proposed a simple mechanism showing why upper troposphere is more sensitive than lower troposphere with the help of radiative transfer model We used a simple analytical model to unravel the impact of total water vapor, water vapor scale height and temperature lapse rate on the clear-sky greenhouse effect We used a complex radiation code and radiosonde data to highlight the impact played by upper troposphere water vapor in the clear-sky greenhouse effect.