

## CERTIFICATE

*This is to certify that the thesis entitled **Stratosphere Troposphere Interactions associated with the Dynamical Processes in the Atmosphere** is a bonafide record of research work done by **Mr. V. Sathiyamoorthy** in the Department of Atmospheric Sciences, Cochin University of Science and Technology. He carried out the study reported in this thesis, independently under my supervision. I also certify that the subject matter of the thesis has not formed the basis for the award of any Degree or Diploma of any University or Institution.*

*Certified that **Mr. V. Sathiyamoorthy** has passed the Ph.D qualifying examination conducted by the Cochin University of Science and Technology in September 1999.*

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## Preface

The lowest two layers of the atmosphere namely the stratosphere and the troposphere have entirely distinct structure, composition, dynamics, etc. Atmospheric trace constituents like ozone, CFCs, Methane, etc have their source regions in one of these regions and sinks in the other. The transport and mixing of mass and chemical species between stratosphere and troposphere, also known as stratosphere-troposphere exchanges, affect climate in numerous ways; eg. the impact of aircraft emissions on the ozone layer, the vertical structure of greenhouse gas distributions in the upper troposphere/lower stratosphere and midlatitude ozone depletion.

The aim of the present study is to understand the biennial scale stratosphere-troposphere interactions over India, and synoptic to interannual timescale meridional stratosphere-troposphere exchanges caused by upper tropospheric/lower stratospheric longwaves using NCEP/NCAR reanalysis data and satellite measured total ozone data.

The doctoral thesis consists of 7 chapters. In chapter 1, elaborate introduction on the dynamical processes in the lower and middle atmosphere is given. In addition, role of ozone as the tracer of atmospheric motion in upper troposphere/lower stratosphere, its production, destruction, transportation mechanisms are presented. Based on published works in various scientific journals, books and reports a review on the literature is given chapter-2. Details regarding the data, their accuracy, limitations, etc are described in chapter-3.

Nature of the biennial scale stratosphere-troposphere interactions over Thumba, a near-equatorial station is studied using radiosonde measured temperature and wind data and is presented in chapter-4. Tropospheric temperature over this station shows a significant biennial variability. Marked differences in amplitude and phase of QBO and TBO are noticed between the decades 1971-81 and 1982-92. The decadal change in phase coherence between TBO and QBO in temperature suggests that they are different phenomena. The strong relation existing between the phase of TBO and Indian summer monsoon activity suggest that the observed biennial variability in the tropospheric temperature over Thumba, may be due to the monsoon-ocean-atmosphere interactions taking place over Indian Ocean in biennial timescale.

In chapter-5, the interannual timescale stratosphere-troposphere ozone exchanges caused by the newly documented Asia Pacific Wave (APW) is presented in detail. This wave is present between 70 hPa and 500 hPa levels in May and the following summer and autumn seasons and couples the stratosphere and troposphere directly. This wave shows a phase shift of 20° longitudes between extreme Indian summer monsoon rainfall years. The large amplitude portion of this wave is situated in the tropopause break region and found to exchange ozone-rich extratropical lower stratospheric air and ozone-poor tropical upper tropospheric air. The ozone exchanges caused by APW is illustrated using the gridded global TOMS total ozone data.

Chapter-6 deals with synoptic scale stratosphere-troposphere ozone exchanges caused by upper tropospheric/lower stratospheric longwaves in winter and summer seasons. The winter time Upper Tropospheric Troughs

(UTT) and the ridges following and preceding it occasionally penetrate deep into South Asia and generates synoptic scale total ozone anomalies (TOA) as mentioned above. Values of positive and negative TOA reached upto 25-30% during this condition over Asia. In summer season, Upper Tropospheric Blocking High and Trough (UTBHT) situation develops over Asia during break periods in Indian summer monsoon. This situation persists for a few days to a few weeks and generates negative and positive TOA over Asia. The negative TOA reached even 50% less than the long-term mean in some areas over Asia and generated a sort of *ozone mini-hole* like situation.

The summary and conclusions of the research work carried out in the thesis is presented in the last chapter, chapter-7. References are listed at the end of the thesis in alphabetical order.