For any scientific activity concerning climate variability, atmospheric dynamics of any layer up to the thermosphere and above has to be taken into account, since there exists a number of processes that couple different regions of the atmosphere. These processes are relevant for any description of the atmospheric system and thus their knowledge is necessary for climate description and climate change signal detection, for instance. One of these coupling processes is through the propagation of gravity waves that can be registered best in the mesospheric heights due to the large wave amplitudes there. The global atmospheric community is now interested in the vertical coupling of the different regions of the Earth's atmosphere and hence the programs like Climate and Weather of Sun Earth System (CAWSES) are being realized.

Gravity waves play a crucial role in coupling different regions of the Earth's atmosphere. Mainly generated in the lower atmosphere, gravity waves propagate upwards, with wave amplitudes increasing with height owing to conservation of momentum. At higher altitudes they get dissipated by various processes and thus contribute significantly to the momentum and energy budget of the middle and upper atmosphere. Divergence/convergence of the momentum fluxes carried by the gravity waves accelerate/decelerate the mean flow which in turn is partly responsible for the generation and maintenance of Quasi Biennial Oscillation (QBO) and Semi Annual Oscillation (SAO), which are the characteristic features of the equatorial middle atmospheric region. Once the contribution of gravity waves is quantified, it will be very helpful to parameterize these waves in the general circulation models, which are otherwise posing a great challenge to the scientific community. The difficulty in parameterising these waves arises as its source mechanism and propagation characteristics exhibit a wide range of variability in both spatial and temporal scales. In this regard, a very ambitious five year long national program known as 'ISRO's Middle Atmosphere Dynamics Program (MIDAS 2002-2007)' had been launched by Space Physics Laboratory (SPL) of Vikram Sarabhai Space Centre (VSSC), Trivandrum to explore the various aspects of middle atmospheric dynamics. One of the major objectives
of the MIDAS program is to divulge the salient characteristics of gravity waves, their climatology, their role in the generation and maintenance of QBO/SAO and coupling between various layers in the low latitude middle atmospheric region using ground-based remote sensing techniques like lidar and radars and in-situ observations such as balloon and rocket soundings. The present work is the first of its kind to delineate the propagation characteristics of gravity waves, their relation with source mechanisms and their forcing towards the generation of QBO and SAO in the stratopause and mesopause regions. The wind and temperature data in the middle atmospheric region collected from two low latitude Indian stations Trivandrum and Gadanki under MIDAS program have been used for the present study.

The results of these investigations presented in this thesis comprise of seven chapters. A brief introduction to the dynamics of equatorial and low latitude middle atmosphere is given in Chapter 1. Various probing techniques of the atmosphere which includes Rayleigh Lidar and MST Radar at National Atmospheric Research Laboratory, Gadanki and All-SKY SKiYMET Meteor wind radar along with High Altitude Balloon (HAB) and RH-200 rocket soundings at Trivandrum have been used effectively to achieve the aforementioned objectives. The details of experimental techniques and data analysis are discussed in Chapter 2. The results of the important investigations are discussed in Chapters 3-6. In Chapter 7, the major findings are summarized along with possible directions for further studies.
LIST OF SCIENTIFIC PUBLICATIONS


10. Kumar, K. K., C. Vineeth, T. Maria Antonita, T. K. Pant, and R Sridharan, Determination of day-time OH emission heights using simultaneous meteor radar, day-glow photometer and TIMED/SABER observations over Thumba (8.5°N, 77.2°E) (communicated to *Geophys. Res. Lett.*,).

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1. Ramkumar, G., T. Maria Antonita, Y. B. Kumar, D N. Rao and S K Dhaka,
   Seasonal variations in the gravity wave activity as observed from ISRO’s MIDAS (2002-2007) programme

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2. Maria Antonita, T., G. Ramkumar, S. V. Thampi, C. V. Devasia, The characteristics of the mean zonal winds observed from SKiYMET Meteor Wind Radar at Trivandrum during CEJ and non CEJ days

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4. Deepa, V., G. Ramkumar, T. Maria Antonita, K. K. Kumar, and M. N. Sasi, Tidal oscillations in the MLT region over Trivandrum (8°N, 77°E)- results from SKiYMET Meteor Radar Observations

5. Kumar, K. K., V. Deepa, T. Maria Antonita, and G. Ramkumar, Meteor radar observations of solar tides and planetary waves interaction in the MLT region

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6. Maria Antonita, T., G. Ramkumar, K. S. Appu, K. V. S. Namboodiri, M. Satya Narayana, Y. B. Kumar, D. N. Rao, Anandan and H. V. Kumar, Rayleigh Lidar observation of gravity wave variability in the middle atmosphere: Preliminary results from MIDAS

7. Deepa, V., G. Ramkumar, T. Maria Antonita, and K. K. Kumar, Vertical propagation characteristics of tides over Trivandrum (8°N, 77°E) in the mesospheric and lower thermospheric region

and their variability- Results from ISRO’s Middle Atmospheric Dynamics programme (MIDAS)

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9. **Maria Antonita, T.,** G. Ramkumar, Y. B. Kumar, D. N. Rao, Seasonal variation in the gravity wave momentum flux using Temperature data from Rayleigh Lidar

10. **Maria Antonita, T.,** G. Ramkumar, Y. B. Kumar, D. N. Rao, Gravity wave variability in the middle atmosphere: An observational evidence for lower and middle atmosphere coupling


11. **Maria Antonita, T.,** G. Ramkumar, Y. B. Kumar, D. N. Rao, Lidar observation of gravity wave characteristics in the tropical middle atmosphere

12. **Maria Antonita, T.,** G. Ramkumar, Y. B. Kumar, D. N. Rao, Seasonal variation in the gravity wave momentum flux using Temperature data from Rayleigh lidar

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13. **Maria Antonita, T.,** and G. Ramkumar, Momentum fluxes of Gravity waves in the MLT region using SKiYMET Meteor Wind Radar at Trivandrum (8.5°N, 77°E), India

14. **Maria Antonita, T.,** G. Ramkumar, Y. B. Kumar, and D. N. Rao, Momentum fluxes of gravity waves and their role in Stratospheric Semi annual Oscillation

15. **Maria Antonita, T.,** G. Ramkumar, Y. B. Kumar, H. V. Kumar and D. N. Rao, Gravity wave variability in the middle atmosphere: An observational evidence for lower and middle atmosphere coupling using MST radar and Lidar

16. Ramkumar, G., **T. Maria Antonita,** V. Deepa, Y. B. Kumar, K. V. S. Nambhooodiri, D. Swain, K. K. Kumar, and D. N. Rao, Long period oscillations in the equatorial middle atmosphere from temperature/wind measurements using balloons, rockets, lidar and radar at Gadanki (13.5°N, 79.2°E) and TERLS (8.5°N, 77°E)

17. Kumar, K. K., and **T. Maria Antonita,** Meteor radar observations of gravity wave activity in the Mesosphere Lower Thermosphere (MLT) region over Thumba (8.5°N, 77°E)
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18. **Maria Antonita, T.**, G. Ramkumar, K. K. Kumar and V. Deepa, Gravity wave momentum fluxes in the middle atmospheric region (30-100km) and their role in driving the SSAO/MSAO

19. Kumar, K. K., and **T. Maria Antonita**, Meteor radar observations of short-term tidal variabilities in the low-latitude Mesosphere-Lower Thermosphere: Implication of non-linear wave-wave interactions

20. Ramkumar, G., K. V. S. Namboodhiri, D. Swain, Sunil Kumar, **T. Maria Antonita** and Y. B. Kumar, Dynamical coupling processes in the equatorial middle atmosphere- Results from ISRO MIDAS program

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21. **Maria Antonita, T.**, G. Ramkumar, K. K. Kumar and V. Deepa, Gravity wave momentum fluxes in the MLT region and their contribution towards the generation of Mesospheric Semiannual Oscillation: A quantitative study using SKiYMET Meteor Radar observations at Trivandrum (8.5°N, 78°E)

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26. Ramkumar, G., S. B. Veena, **T. Maria Antonita**, K. V. S. Namboodiri Characteristics of Planetary waves in the middle atmospheric region: Results from MIDAS campaigns

27. Deepa, V., G. Ramkumar, **T. Maria Antonita**, and K. K. Kumar, SKiYMET Radar Observations of tidal amplitudes over a low latitude station Trivandrum (8.5°N, 77°E): Interannual variability and the effect of background wind on diurnal tidal amplitudes