Lidar Studies of Middle Atmospheric Density and Temperature Structures over Mount Abu

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Ph. D. Thesis
April 2009

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A thesis submitted to

Gujarat University

for the degree of

Doctor of Philosophy in Physics

By

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April 2009

CERTIFICATE

I hereby declare that the work presented in this thesis is original and and done by me. It has not formed the basis for the award of any degree or diploma by any University or Institution.

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Dedicated

to

Mataji-Pitaji and Arti-Aanshi-Ansh

Contents

Acknowledgements

I am grateful to my thesis advisor Prof. Shyam Lal for his invaluable guidance, support and encouragement. He has been a wonderful thesis mentor and navigator throughout this scientific journey

I am indebted to Prof. Harish Chandra for inducing research aptitude in me since my joining PRL. I am greatly benefited by his vast knowledge, cool, cordial and very affectionate nature. He is not just an advisor, he is a fatherly figure who loves and cares for me from the bottom of his heart.

Help and support received from Dr. Y. B Acharya and Prof. A. Jayaraman in the field of lidar was invaluable This journey of research wouldn't have been so rewarding and wonderful for me without their encouragement, inspiration and guidance. I am indebted to Acharyaji for the help and support I received from him throughout the period, for instruments, field campaigns and during thesis writing Over and above, the concern and affection showered by him, kept me going and motivated throughout this scientific journey.

Prof. H. S. S. Sinha has always been with me during my ups and downs in the field of research. His wonderful organizational skills left a deep impression on me His pleasing personalty, timely suggestions and valuable guidance helped me immensely. Scientific and technical discussions with Mr. R. N. Misra were very fruitful and are acknowledged.

I am grateful to our collaborators Prof Hassan Bencherif (Reunion, France) and Dr. V. Sivakumar (CSIR, South Africa) for thought provoking scientific discussions, suggestions and support during the course of this work Few results in the present study are the outcome of our fruitful scientific collaborative works. Thanks are due to Prof Philippe Keckhut (CNRS, France), and Prof I S. McDermid (USA) for suggestions and providing OHP and Mauna Loa Rayleigh lidar data.

I thank the scientific and technical team members of the HALOE (onboard UARS) and TOMS. HALOE data used in this study were acquired as part of the NASA's Earth-Sun System Division and archived and distributed by the Goddard Earth Sciences (GES) Data and Information Services

Center (DISC) Distributed Active Archive Center (DAAC). Thanks are also due to NOAA-CIRES Climate Diagnostic Center, USA for providing NCEP reanalysis data and Ozone Processing Team of NASA/Goddard Space Flight Center, USA for TOMS ozone data used in this study Team members of ERA-40 data sets are also duly acknowledged.

I am thankful to Dr. David Hooper (Rutherford Appleton Laboratory, UK) for his valuable suggestions and support during initial phase of my research career and for the excellent hospitality during my visit to Oxford.

I am extremely thankful to Prof. R. Sridharan and Prof K N. Iyer for their inspiration, thought provoking scientific discussions and helping me at various levels of my scientific research

I am thankful to former directors of NARL, Prof. P. B. Rao, Prof. A. R. Jain and Prof. D Narayana Rao for their concern, support and encouragement. Thanks are due to Drs. Anandan, Patra, Sarma, Srinivasulu and Bhavanikumar for help during our MST radar/lidar observational campaigns at NARL, Gadanki.

Help and support received from Uma-Sanat Das and family can not be expressed in words. They were always with me during my ups and downs on professional and personal fronts and supported me immensely during this long journey of research. Their suggestions at various stages, really helped me in shaping my thesis. It would have been extremely difficult to sail through without their pleasant company, unconditional support and open discussions on various fronts. I am highly indebted to them, cute Adi and their family.

I am grateful to Prof. Hari Om Vats and his family for unconditional, perineal support and blessings on professional and personal fronts. Since my joining PRL they provided me home away from home and are local guardians for me and my family. Rawat ji, Baliyan ji and their families gave me full strength for carrying out my research work.

I am indebted to PRL's lidar group members (Prof. Harish Chandra, Prof. A. Jayaraman, Dr. Y. B. Acharya and Mr. J. T. Vinchi) for providing me full fledged support and encouragement during lidar observations at Gurushikhar, Mt. Abu.

I am thankful to Dr. G. D. Vyas for teaching me various experimental techniques during my initial phase of research at PRL His calm and composed personality had a deep impact on me.

I am thankful to Prof. Panigrahi, Dr. Rangarajan (Raghu) and Dr Bhas Bapat for their valuable help and suggestions on various fronts and encouragement during this study.

I am grateful to the faculty members of SPA-SC division, Profs. R Sekar, S P Gupta, S. A Haider, K P Subramniam, D. Pallam Raju, S Ramchandran, Drs Bhas Bapat, Varun Sheel, D. Chakrabarty, Mr. S. B. Banerjee, M. B. Dadhania, Narain Dutt, A. P Gohil, R Narayanan, S. Venkatramani, K S. Modh, T. A Rajesh, R P Singh (Jr.), I A. Prajapati and staff memebers Mrs. Manishaben, Ms. Rannaben, Sunilbhai, Pillai (P.K.)and Nathuram Bhai for their full support and cooperation during course of this work. The presence of our division PDFs and research scholars; Uma, Sanat, Bhavesh, Ramya, Amit, Kushwaha, Sumanto, Suchita, Sumita, Arvind, Iman, Chinmaya, Amrendra made my long working hours lively Thanks are due to Mt. Abu observatory staff

members (Rajeshbhai, Mathurji, Kothariji, Purohitji, Jainji, Padamji, Patwalji, Narayanji) for their cooperation, help and logistic support during lidar observations at Mt Abu.

Thanks are due to former PRL director Prof. G. S Agarwal and dean Prof. V. B. Sheorey for allowing me to pursue my doctoral work at PRL. My sincere thanks to Prof J N Goswami, Director, PRL, Prof. A K Singhvi, Dean, PRL for their valuable scientific support, inspiration and encouragement. I am grateful to Prof Utpal Sarkar, Chairman, Academic committee and members for critically reviewing my research work, and for their useful suggestions and support. I am thankful to Profs. S. Krishnaswami, A. C. Das, Vijay Kumar, N Bhandari, R. G Rastogi, P. N. Shukla, D. P Dewangan, U. C. Joshi, B G Anand Rao, N. M. Ashok, T. Chandrasekar, R. Ramesh, M M. Sarin, S. V. S Murthy, A. Ambastha, V K B Kota, A. S Joshipura, S. Rindani and Dr. P. Sharma for their concern and support.

I am thankful to Mrs Nishtha Anilkumar for her concern and encouragement along with all staff members of PRL's library for promptly providing me various research articles, books and journals. I acknowledge the timely, generous help provided by Ubale ji and his workshop team, Sanjay Bhai and others in CMD, purchase, stores, accounts and administration during commissioning and functioning of PRL's lidar laboratory at Mt. Abu. I am thankful to Mr. Dholakiaji, Jigar Bhai and all staff members for computational and help in printing of thesis. Thanks to Sudheendranathan bhai and Pillai bhai (N.R.) for help on various administrative works and their concern for my timely completion of thesis.

My special thanks to Mohanty-Srubabati, Hiranmaya-Amrita, Jerry, Nanditaji (USO), Shantanam, Angom, R. P. Singh (Sr.), J. Banerjee and Sunil Singh for their help and cheerful support at PRL

I am thankful to my friends Dipu, Ravi (Bhushan), Navinji, Jyoti, Anil, Deshpande, Alok, Vinay, Kuljeet (Jitti), Subrata, Panda, Brajesh (USO), Vikas, Nirvikar, Tarun(Pant), Prashanta (Daddu), Manish (Naja), Patra (PK), Duli, Lokesh, Sudheer (Vempatik), Kaushik, Sankar, Anil (Pattu), Sunish, Rajneesh, Aalam, Shikha, Shushma, Duli, Neeraj, Prasanta, Santosh, Vachaspati, Sanjeev, Ganguly, Rishi, Yogesh, Gowda, Bindu, Subimal, Satya, Shreyas, Sasadhar, Antra, Vandana and many others. I am indebted to one of the best friends, Dr. P. K. Rajesh for his support on professional and personal fronts throughout my stay in Ahmedabad and he provided unconditional help whenever I needed it. His wife's (Gere) concern and affection to me and my family is duely acknowledged.

My special thanks to Sahrad Bhai, Swaroopda, Awasthiji (IPR), Harsih Gadhavi, Manishaben, Bhartiben and their families for their help and support,

I am thankful to Mrs. Paulineben, Preetiben, Parulben, Vijayaben, Nishthaben, Leelaben, Umaben (Desai), Nandiniben, Ms Jayashree, Meeraben and Shantaben for being very affectionate and helping me directly or indirectly.

My thanks are due to family members of Profs Harish Chandra, Shyam Lal, Acharya, Sinha, Raghu, Jerry and Mohanty for their concern and affection to me and my family.

Dipu-Amrita-Aayusi, Anil-Dipti-Sivangi, Sashi-Abhi-Gayatri, Ramakant-Kirti-Purva-Pujan de-

serve special thanks for providing very cheerful, lively and showering affection to me and my family.

I am thankful to my shcool/college/university teachers, Shri B. R. Verma, K. N Tirpathi, Prof. V D Gupta, Drs. Poonam Tondon, Shantanu Rastogi and Alka Mishra and friends: Pankaj, Amit, Anupam, Dinesh, Rajaram for encouragement and pleasant company during those days

I am out of words to express my gratitude toward my **Mataji and Pitaji** Without their constant blessing, inspiring words, research wouldn't have been possible for me. I am wordless to acknowledge love, affection support from my Brothers : Raj Kumar, Vinay and Arun Bhaiya; Bhabhies· Rashmi, Geeta and Aruna Bhabhi Since I joined PRL, Rajkumar Bhaiya and Rashmi Bhabhi never let me feel that I am away from home. They always supported me during high or low moments of this journey. I am thankful to my sisters. Rani, Shashi and Beena didi for their constant support. Innocent smiles of my nieces. Shobha, Sonika, Monika, Akrati (Teenu), Shivi and nephew Aabhas (Chintu) has been a real source of inspiration for me. Playing with them was like recharging battery I am thankful to my in-laws· Mummy-Papaji, sister and brother in-laws. Ashadi+Bhuvaneshji and Neerudi+Shalaishji for help and providmg cheerful company on various occasions.

Last but not least, silent, unconditional love, support and patience of my wife **Arti** were the biggest strength for me, throughout the course of this thesis work. Smiles of my daughter **Aanshi** and son **Ansh** were rejuvenating my energies everyday. I have deprived them of many things as I could not give them sufficient time; my apologies and I promise to spend more quality time with them

Som Sharma

Preface

Lidar is one of the important remote sensing instruments to monitor the structure and dynamics of the atmosphere. A wide range of studies have been carried out on the middle atmospheric structure and dynamics, mostly at mid- and high-latitudes and a few at low-latitudes using various types of Lidars. However, there are very few studies over sub-tropical latitudes (between 20°N to 30°N). Studies in sub-tropical regions are crucial as they bridge the gap between low and mid latitudes and have an imprint of the processes associated with low- and/or mid-latitudes. This thesis presents a comprehensive study of the thermal structure of the upper stratosphere and the mesosphere (30-75 km) over a sub-tropical location, Gurushikhar, Mount Abu (24.5°N, 72.7°E, ~1.7 km above MSL), (henceforth referred to as Mt. Abu) using Rayleigh lidar measurements for approximately 400 nights from 1997 to 2007. The thesis is structured in the following way.

Chapter 1 presents an introduction to the structure and dynamics of the Earth's atmosphere with emphasis on the middle atmospheric processes.

Chapter 2 describes techniques of the atmospheric probing, a brief summary of the scattering and extinction of the light in the atmosphere, the lidar technique, PRL's Nd-YAG laser based Rayleigh lidar system and the method used for lidar data analysis. A brief description of errors in the measurements is also given. An account of other data sets (Satellites, NCEP and ERA-40) which are used in char-

acterizing the observed temperature structure are also described.

Chapter 3 presents results of the temperature structure in the height range of 30 to 75 km over Mt. Abu obtained using PRL's Rayleigh lidar. Aspects of the temperature structure presented include the day-to-day, seasonal, annual and stratopause variability over Mt. Abu. The climatological mean temperature is estimated and discussed. A possible association between ozone and the stratospheric temperature is also studied.

A comparative study of the thermal structure is presented in Chapter 4. The lidar observed temperatures are compared with CIRA-86, MSISE-90 and an Indian low-latitude model. Results are also compared with similar observations at three different locations in the northern hemispheres, viz., Gadanki (13.5°N, 79.2°E), Mauna Loa (19.5°N, 156°W), Observatoire de Haute Provence (OHP) (44°N, 6°E) and a southern hemispheric station, Reunion Island (20.8°S; 55.5°E), to examine hemispheric anomaly, if any, in the sub-tropics. Temperature structures over Mt. Abu are also compared with HALOE (onboard UARS) observed temperatures.

Chapter 5 deals with the event-based studies of some of the interesting geophysical phenomena in the stratosphere and the mesosphere viz., double stratopause, mesospheric temperature inversion, and stratospheric sudden warming. Various characteristics of these and associated operative processes are described through a few case studies. In addition, a detailed statistical study is also carried out. The observed characteristics are compared with the low- and mid-latitudes and discussed in the light of the current understanding of the source mechanisms.

Chapter 6 describes a brief study of the long term temperature trends over Mt. Abu using about 11 years of the Rayleigh lidar data. In view of the increasing anthropogenic activities and their consequent impact on various middle atmospheric geophysical processes, an effort has been made to delineate possible causes for observed temperature trends over Mt. Abu.

Chapter 7, which is the last chapter of the thesis summarizes the results obtained and presents prospects of possible future work on related themes.

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12. **Sharma, Som** "Imprint of Greenhouse cooling in Lidar observed stratospheric thermal structure over a sub-tropical station Mount Abu (24.5°N, 72.7°E, MSL height 1.7 Km), at University of Bresia, September 2008, Bresia, Italy. (Invited)