

**Dr. Bhishma Tyagi**

Associate Professor

Department of Earth and Atmospheric Sciences

National Institute of Technology Rourkela

E-Mail: tyagib@nitrkl.ac.in

**Research Interests**

- Air Quality
- Boundary Layer Meteorology
- Atmospheric Physics
- Atmosphere-Biosphere Interactions

**Qualifications**

| <b><u>Examination</u></b> | <b><u>Subjects</u></b>                 | <b><u>College/Department</u></b>                               | <b><u>Board/University</u></b>                         | <b><u>Year of Completion</u></b> |
|---------------------------|--|--|--|----------------------------------|
| <b>Ph.D.</b>              | Meteorology/<br>Atmospheric<br>Physics | Centre for Oceans,<br>Rivers, Atmosphere, and<br>Land Sciences | Indian Institute of<br>Technology,<br>Kharagpur, India | 2012                             |
| <b>M.Tech.</b>            | Atmospheric<br>Science                 | Department of<br>Atmospheric & Space<br>Science                | University of Pune,<br>Pune, India                     | 2007                             |
| <b>M.Sc.</b>              | Physics                                | M.S.College,<br>Saharanpur                                     | C.C.S.University,<br>Meerut, India                     | 2005                             |

**Research Experience**

**July 2015 - Present:** Assistant Professor at Department of Earth and Atmospheric Science, National Institute of Technology Rourkela, India.

**September 2014 – July 2015:** Scientist at National Research Council (CNR-ISAFoM), Naples, Italy.

**July 2012 – April 2014:** Post Doctoral Candidate at Department of Meteorology (MISU), Bert Bolin Centre for Climate Research, Stockholm University, Stockholm, Sweden.

**April 2012 – July 2012:** Research Assistant at Department of Meteorology (MISU), Bert Bolin Centre for Climate Research, Stockholm University, Stockholm, Sweden.

**July 2007 – April 2012:** PhD Candidate at Centre for Oceans, Rivers, Atmosphere, and Land Sciences (CORAL), Indian Institute of Technology, Kharagpur, India.

**July 2006 - June 2007:** M.Tech. Second year Project Student at Physical Meteorology and Aerology Division, Indian Institute of Tropical Meteorology (IITM), Pune, India.

**Teaching Experience**

**August 2015 – Present:** Teaching Masters Student's course on "Introductory Atmospheric Dynamics", "Advanced Atmospheric Dynamics", "Boundary Layer Meteorology", "Air Pollution" and "Atmospheric Instrumentation Laboratory" at Department of Earth and Atmospheric Science, National Institute of Technology Rourkela, India.

### **Peer Reviewed Publications**

1. Hari, M., Sahu, R.K., **Tyagi, B.**, Kaushik, R., 2021. Reviewing the Crop Residual Burning and Aerosol Variations during the COVID-19 Pandemic Hit Year 2020 over North India. *Pollutants*, 1(3), pp. 127-140
2. Sahu, S.K., Mangaraj, P., Beig, G., **Tyagi, B.**, Tikle, S. and Vinoj, V., 2021. Establishing a link between fine particulate matter (PM<sub>2.5</sub>) zones and COVID-19 over India based on anthropogenic emission sources and air quality data. *Urban Climate*, 38, p.100883.
3. Hari, M. and **Tyagi, B.**, 2021. Investigating Indian summer heatwaves for 2017–2019 using reanalysis datasets. *Acta Geophysica*, pp.1-18.
4. Sahu, S.K., Mangaraj, P., Beig, G., Samal, A., Dash, S. and **Tyagi, B.**, 2021. Quantifying the High Resolution Seasonal Emission of Air Pollutants from Crop Residue Burning in India. *Environmental Pollution*, 286, p.117165.
5. **Tyagi, B.**, Choudhury, G., Vissa, N.K., Singh, J. and Tesche, M., 2021. Changing Air Pollution Scenario During COVID-19: Redefining the Hotspot Regions over India. *Environmental Pollution*, 271, p.116354.
6. Singh, J. and **Tyagi, B.**, 2021. Transformation of Air Quality over a Coastal Tropical Station Chennai during COVID-19 Lockdown in India. *Aerosol and Air Quality Research*, 21, 200490, <https://doi.org/10.4209/aaqr.200490>.
7. Hari, M., **Tyagi, B.**, Huddar, M.S.K. and Harish, A., 2021. Satellite-based regional-scale evapotranspiration estimation mapping of the rice bowl of Tamil Nadu: A little water to spare. *Irrigation and Drainage*, online published, <https://doi.org/10.1002/ird.2553>.
8. Gogikar, P., Tripathy, M.R., Rajagopal, M., Paul, K.K. and **Tyagi, B.**, 2021. PM 2.5 estimation using multiple linear regression approach over industrial and non-industrial stations of India. *Journal of Ambient Intelligence and Humanized Computing*, 12, pp. 2975-2991
9. Choudhury, G., **Tyagi, B.**, Vissa, N.K., Singh, J., Sarangi, C., Tripathi, S.N. and Tesche, M., 2020. Aerosol-enhanced high precipitation events near the Himalayan foothills. *Atmospheric Chemistry and Physics*, 20(23), pp.15389-15399.
10. Sahu, S.K., **Tyagi, B.**, Beig, G., Mangaraj, P., Pradhan, C., Khuntia, S. and Singh, V., 2020. Significant change in air quality parameters during the year 2020 over 1st smart city of India: Bhubaneswar. *SN applied sciences*, 2(12), pp.1-8.
11. Sahu, R.K., Dadich, J., **Tyagi, B.** and Vissa, N.K., 2020. Trends of thermodynamic indices thresholds over two tropical stations of north-east India during pre-monsoon thunderstorms. *Journal of Atmospheric and Solar-Terrestrial Physics*, 211, 105472.
12. Samanta, S., **Tyagi, B.**, Vissa, N.K. and Sahu, R.K., 2020. A new thermodynamic index for thunderstorm detection based on cloud base height and equivalent potential temperature. *Journal of Atmospheric and Solar-Terrestrial Physics*, 207, 105367, 1-6.
13. Sahu, R.K., Dadich, J., **Tyagi, B.**, Vissa, N.K. and Singh, J., 2020. Evaluating the impact of climate change in threshold values of thermodynamic indices during pre-monsoon thunderstorm season over Eastern India. *Natural Hazards*, 102, 1541-1569, 1-29.
14. **Tyagi, B.**, Singh, J. and Beig, G., 2020. Seasonal progression of surface Ozone and NOx concentrations over three tropical stations in North-East India. *Environmental Pollution*, 258, 113662, DOI: 10.1016/j.envpol.2019.113662
15. Choudhury, G., **Tyagi, B.**, Singh, J., Sarangi, C. and Tripathi, S.N., 2019. Aerosol-orography-precipitation—A critical assessment, *Atmospheric Environment*, 214(116831), 1-19.
16. Singh, K.S., **Tyagi, B.**, Verma, V.K., Maity, S., 2019. Assessing the performance evaluation of different convective parameterization schemes in simulating the intensity of severe cyclonic storms over the Bay of Bengal region, *Meteorological Applications*, 26(4), 597-609, DOI: 10.1002/met.1787

17. **Tyagi, B.** and Satyanarayana, A.N.V., Assessment of difference in the atmospheric surface layer turbulence characteristics during thunderstorm and clear weather days over a tropical station, *SN Applied Science*, 1(8), 909, 1-9.
18. Sahu, S.K., **Tyagi, B.**, Pradhan, C. and Beig, G., 2019. Evaluating the variability, transport and periodicity of particulate matter over smart city Bhubaneswar, a tropical coastal station of eastern India. *SN Applied Sciences*, 1(5), 383.
19. Panda, D., Senapati, B., **Tyagi, B.** and Kundu, B., 2019. Effects of Rayleigh-Taylor instability and Ionospheric plasma bubbles on the Global Navigation Satellite System signal. *Journal of Asian Earth Sciences*, 170, 225-233, DOI: <https://doi.org/10.1016/j.jseaes.2018.11.006>
20. Singh, K.S. and **Tyagi, B.**, 2019. Impact of data assimilation and air-sea interaction parameterization schemes for prediction of Bay of Bengal cyclone Phailin, *Meteorological Applications*, 26(1), 36-48, DOI: 10.1002/met.1734
21. Gogikar, P., **Tyagi, B.**, Gorai, A.K., 2019. Seasonal Prediction of Particulate Matter over the Steel City of India using Neural Network models, *Modeling Earth Systems and Environment*, 5(1), 227-243, DOI: <https://doi.org/10.1007/s40808-018-0530-1>
22. Singh, J., Noh, Y.J., Agrawal, S., **Tyagi, B.**, 2019. Dust Detection and Aerosol Properties over Arabian Sea Using MODIS Data, *Earth Systems and Environment*, 3(1), 139-152, DOI: <https://doi.org/10.1007/s41748-018-0079-1>
23. Gogikar, P., **Tyagi, B.**, Padhan, R.R., Mahaling, M., 2018. Particulate Matter Assessment Using In-Situ Observations from 2009 to 2014 over an Industrial Region of Eastern India, *Earth Systems and Environment*, 2 (2), 305-322, DOI: 10.1007/s41748-018-0072-8
24. **Tyagi, B.**, Magliulo, V., Finardi, S., Gasbarra, D., Carlucci, P., Toscano, P., Zaldei, A., Riccio, A., Calori, G., D' Allura, A., Gioli, B., 2018. Performance Analysis of Planetary Boundary Layer Parameterization Schemes in WRF Modeling Set Up over Southern Italy, *Atmosphere*, 9(7), 272, 1-22
25. Singh, J., **Tyagi, B.**, Ntsangwane, L., and Botai, J., 2017. Analysis of Aggregated Solar PV Output in South Africa, *Journal of Clean Energy Technologies*, 5(5), 378-382
26. Kundu, B., Vissa, N.K., Panda, D., Jha, B., Asaithambi, R., **Tyagi, B.**, Mukherjee, S., 2017. Influence of a meteorological cycle in mid-crustal seismicity of the Nepal Himalaya, *Journal of Asian Earth Sciences*, 146, 317–325
27. Gogikar, P., and **Tyagi, B.**, 2016. Assessment of particulate matter variation during 2011–2015 over a tropical station Agra, India, *Atmospheric Environment*, 147, 11-21.
28. Madala, S., Satyanarayana, A.N.V., Srinivas, C.V., and **Tyagi, B.**, 2016. Performance Evaluation of PBL Schemes of WRF-ARW Model in the Simulating Thermo-Dynamical Structure of Pre-monsoon convective Episodes over Kharagpur using STORM Data Sets, *Pure and Applied Geophysics*, 173 (5), 1803-1807.
29. **Tyagi, B.**, and Satyanarayana, A.N.V., 2015. Delineation of surface energy exchanges variation during thunderstorm and non-thunderstorm days during pre-monsoon season, *Journal of Atmospheric and Solar Terrestrial Physics*, 122, 138-144.
30. **Tyagi, B.**, Satyanarayana, A.N.V., 2014. Coherent structures contribution to fluxes of momentum and heat during stable conditions for pre monsoon thunderstorm season, *Agriculture and Forest Meteorology*, 186, 43-47.
31. **Tyagi, B.**, Satyanarayana, A.N.V., 2014. Coherent Structures contributions in fluxes of momentum and heat at two tropical stations during pre-Monsoon Thunderstorm season, *International Journal of Climatology*, 34(5), 1575-1584, DOI: 10.1002/joc.3785.
32. **Tyagi, B.**, Satyanarayana, A.N.V., Rajvanshi, R.K., Mandal, M., 2014. Surface Energy Exchanges during pre-Monsoon Thunderstorm Activity over a tropical Station Kharagpur, *Pure and Applied Geophysics*, 171(7), 1445-1459, DOI 10.1007/s00024-013-0682-x.
33. Singh, J. and **Tyagi, B.**, 2014. Investigating Lunar Phase Impact on Natural Disasters over India, *Advances in Research*, 2 (12), 926-934.

34. **Tyagi, B.**, Satyanarayana, A.N.V., 2013. Assessment of Turbulent kinetic energy budget and boundary layer characteristics during pre-monsoon thunderstorm season over Ranchi, Asia Pacific Journal of Atmospheric Science, 49(5), 587-601, DOI:10.1007/s13143-013-0052-8
35. **Tyagi, B.**, and Satyanarayana, A.N.V., 2013. An observational study of Turbulent Kinetic Energy budget parameters during Pre-monsoon thunderstorms over a tropical station of Gangetic West Bengal, ISRN Meteorology, Volume 2013, Article ID 972942, 11 pages <http://dx.doi.org/10.1155/2013/972942>.
36. **Tyagi, B.**, Satyanarayana, A.N.V., and Naresh Krishna, V., 2013. Thermodynamical structure of atmosphere during pre-monsoon thunderstorm season over Kharagpur as revealed by STORM data, Pure and Applied Geophysics, 170(4), 675-687, DOI: 10.1007/s00024-012-0566-5
37. Madala, S., Satyanarayana, A.N.V., and **Tyagi, B.**, 2013. Performance Evaluation of Convective Parameterization Schemes of WRF-ARW Model in the Simulation of Pre-monsoon Thunderstorm Events over Kharagpur using STORM Data Sets, International Journal of Computer Applications, 71(15), 43-50.
38. **Tyagi, B.**, Satyanarayana, A.N.V., Kumar, M., and Mahanti, N.C., 2012. Surface energy and radiation budget over a tropical station: An Observational study, Asia-Pacific Journal of Atmospheric Science, 48(4), 411-421, DOI: 10.1007/s13143-012-0037-z
39. **Tyagi, B.**, Naresh Krishna, V., Satyanarayana, A.N.V., 2011. Skill of Thermodynamic indices for forecasting pre-monsoon thunderstorms over Kolkata during STORM pilot phase 2006-2008, Natural Hazards, 56(3), 681-698, DOI: 10.1007/s11069-010-9582-x
40. **Tyagi, B.**, Satyanarayana, A.N.V., 2010. Modeling of Soil Surface Temperature and Heat Flux during Pre-monsoon season at two Tropical Stations, Journal of Atmospheric and Solar–Terrestrial Physics, 72 (2-3), 224-233, DOI:10.1016/j.jastp.2009.11.015
41. Ghude, Sachin D.; Jain, S.L.; Beig, G.; Arya, B.C.; Ahamed, Y.N; Kumar, Arun; **Tyagi, B.**, 2008. Ozone in Ambient air at Tropical mega city, Delhi: Characteristics, trends and cumulative ozone exposure indices, Journal of Atmospheric Chemistry, 60(3), 237-252, DOI 10.1007/s10874-009-9119-4.
42. Beig, G., Ghude, S.D., Polade, S. and **Tyagi, B.**, 2008. Threshold exceedances and cumulative ozone exposure indices at tropical suburban site, Geophysical Research Letters, 35, L02802, 1-5, DOI: 10.1029/2007GL031434.

#### **Book Chapter**

1. Gogikar, P., and **Tyagi, B.**, 2017. Air Quality Assessment over Mining area of Chandrapur during 2012-2016, Sustainable Mining Practices (book published by Narosa Publication, India), Gorai, A.K., Nimaje, D.S. (Ed.), ISBN: 978-81-8487-604-8, 260 pp.

#### **Presentations at International Conferences**

1. Gogikar, P., **Tyagi, B.**, 2019. Assessment of Source Areas and Prediction of Particulate Matter using Neural Networks over Heritage and Steel Cities of India. European Geoscience Union General Assembly 2019, 07-12 April 2019, Vienna, Austria
2. Choudhury, G., **Tyagi, B.**, Singh, J., Sahu, R.K., 2019. Understanding the aerosol variability associated with extreme rainfall events over foothills of Himalayan region. International conference on Climate Change Impacts, Vulnerabilities, and Adaption: Emphasis on India and Neighbourhood (CCIVA), Indian Institute of Technology Kharagpur, India, 26 February - 02 March, 2019.
3. Sahu, R.K., Dadich, J., **Tyagi, B.**, Singh, J., 2019. Thermodynamic indices variability in relation to pre-monsoon thunderstorms over north-eastern India. International conference on Climate Change Impacts, Vulnerabilities, and Adaption: Emphasis on India and Neighbourhood (CCIVA), Indian Institute of Technology Kharagpur, India, 26 February - 02 March, 2019.

4. Gogikar, P., **Tyagi, B.**, 2018. Prediction of Particulate Matter over Agra: A Neural Network Approach and Performance Evaluation. International Symposium on Atmospheric Pollution: Science, Technology, Innovation & Compliance (ATMOP-STIC 2018), 07-11 August 2018, National Institute of Technology Calicut, Calicut, India
5. Gogikar, P., **Tyagi, B.**, 2017. Spatial and temporal variation of RSPM and SPM over an industrial site. International Tropical Meteorological Symposium on Advancements in Space-Based Earth Observations and Services for Weather and Climate (INTROMET 2017), 07-10 November 2017, Ahmadabad, India.
6. Singh, J., **Tyagi, B.**, Ntsangwane, L., and Botai, J., 2016. Analysis of Aggregated Solar PV Output in South Africa. 3rd Journal Conference on Clean Energy Technologies, 09-11 September 2016, Hong Kong.
7. **Tyagi, B.**, Agrillo, G., Farmulari, D., Magliulo, V., Riccio, A., Gioli, B., Gasbarra, D., Shindler, L., Carlucci, P., Toscano, P., Zaldei, A., 2015. Use of Back-trajectory Analysis with Aircraft Measurements to Study Trans-Boundary Advection of Particulate Matter in Southern Italy. European Aerosol Conference (EAC 2015), 06-11 September 2015, Milan, Italy.
8. Agrillo, G., Carlucci, P., Tommasi, P. Di, Esposito, A., Farmulari, D., Gioli, B., Gasbarra, D., Riccio, A., Russo, I., Shindler, L., Tirimberio, G., **Tyagi, B.**, Toscano, P., Vuolo, R., Zaldei, A., Magliulo, V., 2015. AriaSaNa – Regional Observatory of Air Quality of Campania (Southern Italy). European Aerosol Conference (EAC 2015), 06-11 September 2015, Milan, Italy.
9. Farmulari, D., Tirimberio, T., Russo, I., Vuolo, R., Esposito, A., Agrillo, G., **Tyagi, B.**, Mazzarella, A., Viola, R., Scafetta, N., Gioli, B., Magliulo, E., Riccio, A., Zaldei, A., Toscano, P., 2015. Intensive Measurement of PM above the city of Naples. European Aerosol Conference (EAC 2015), 06-11 September 2015, Milan, Italy.
10. **Tyagi, B.**, Gasbarra, D., Agrillo, G., Magliulo, V., Gioli, B., Riccio, A., Finardi, S., Carlucci, P., Shindler, L., Toscano, P., Zaldei, A., Esposito, A., 2015. Aircraft measurements and WRF-FARM modeling of Ozone and Particulate Matter in the city of Naples-Caserta. ICUC9 - 9<sup>th</sup> International Conference on Urban Climate jointly with 12<sup>th</sup> Symposium on the Urban Environment, 20-24 July 2015, Toulouse, France
11. Singh, J., Noh, Y.J., Agrawal, S. and **Tyagi, B.**, 2013. Dust Detection and its radiative forcing over Arabian Sea using MODIS data and SBDART. COSPAR Symposium, 11-15 November 2013, Bangkok, Thailand.
12. Singh, J., **Tyagi, B.**, Kumar, M., and Satyanarayana, A.N.V., 2013. A study of atmospheric conditions during thunderstorm events over the Eastern part of India using satellite and in situ observations. COSPAR Symposium, 11-15 November 2013, Bangkok, Thailand.
13. Satyanarayana, A.N.V., **Tyagi, B.**, 2011. Turbulent Energy transport in the atmospheric boundary layer and its thermodynamical structure during different epochs of thunderstorm events over Kharagpur as revealed by STORM Field Experiments, International Scientific Workshop on Results and Review on SAARC STORM Field Experiments in Kathmandu, Nepal, 21-23 December 2011
14. **Tyagi, B.**, Satyanarayana, A.N.V., Mandal, M., Kumar, M., Mahanti, N.C., 2011. Land surface-atmosphere energy exchanges during pre-monsoon thunderstorm activity over barren and agriculture field sites at two tropical stations, EGU General Assembly 2011, Vienna, Austria, 03-08 April 2011
15. Satyanarayana, A.N.V., **Tyagi, B.**, Vissa, N.K., 2010. Thermodynamical structure of atmospheric boundary layer over Kharagpur during the events of thunderstorm activity as revealed by STORM Pilot campaigns, Proceedings of International Conference on Geophysical Sciences – Energy, Climate Change and Evolution of Human Society (ICON-GSECESS2010), Department of Geophysics, Banaras Hindu University, India, Abstract No: ICONGSECCES2010/ Met-204, 21-23 December, 2010

16. **Tyagi, B.,** Satyanarayana, A.N.V., Mandal, M., 2008. Estimation of Soil Heat Flux and Soil Surface Temperature and their relation to variation in the convective activity during Pre-Monsoon Thunderstorm Activity in 2007- A Case Study, International Workshop on the “Frontiers of Atmospheric Physics and Technology”, Yogi Vemana University, Kadapa, India, 20-22 February, 2008
17. Rajvanshi, R.K., Satyanarayana, A.N.V., **Tyagi, B.,** Mandal, M., 2008. Variation of turbulent transportation of surface energy fluxes during pre-monsoon thunderstorm activity over Kharagpur, International Workshop on the “Frontiers of Atmospheric Physics and Technology”, Yogi Vemana University, Kadapa, India, 20-22 February, 2008

#### **Presentations at National Conferences (India)**

1. Hari, M., **Tyagi, B.,** 2020. Analysing Indian Summer Heatwaves for 2017–2019 using Reanalysis Datasets, National Conference on Coastal Ocean-Atmosphere Science & Technology (COAST 2020) 28th February – 01st March, 2020 Berhampur University, India.
2. Sahu, R.K., **Tyagi, B.,** Vissa, N.K., Singh, J., 2020, Spatial variation of thermodynamic indices in pre-monsoon thunderstorm season over Assam, India, National Conference on Coastal Ocean-Atmosphere Science & Technology (COAST 2020) 28th February – 01st March, 2020 Berhampur University, India.
3. Paul, O., **Tyagi, B.,** 2020, Time Series Analysis and Forecasting of Ambient Quality in NCR Region using Statistical Models, National Conference on Coastal Ocean-Atmosphere Science & Technology (COAST 2020) 28th February – 01st March, 2020 Berhampur University, India.
4. Sahu, R.K., Dadich, J., **Tyagi, B.,** 2018. Understanding the thermodynamic variability in relation to pre-monsoon thunderstorms over a tropical coastal station Bhubaneswar. National Symposium on Understanding Weather and Climate Variability: Research for Society, TROPMET 2018, Banaras Hindu University, Varanasi, India, 24 - 27 October, 2018.
5. Gogikar, P., and **Tyagi, B.,** 2018. Assessment of Particulate Matter Variation over World Heritage Site and Steel City of India. Aerosol Impacts: Human Health to Climate Change, IASTA-2018, Indian Institute of Technology Delhi, 26-28 November 2018.
6. Gogikar, P., and **Tyagi, B.,** 2016. Air Quality Assessment over Mining area of Chandrapur during 2012-2016, National Conference on Sustainable Mining Practices, National Institute of Technology Rourkela, 2-3 December, 2016
7. **Tyagi, B.,** Satyanarayana, A.N.V., Kumar, M., Mahanti, N.C., 2011. Characteristics of Turbulent Kinetic Energy and surface meteorological variables during Pre-Monsoon Thunderstorm Activity over Ranchi, National Conference on Mathematical and Statistical Modeling in Innovative areas, Birla Institute of Technology, Ranchi, 19-20 October, 2011
8. **Tyagi, B.,** Satyanarayana, A.N.V., Kumar, M., Mahanti, N.C., 2010. Variation of atmospheric surface layer processes during thunderstorm and non-thunderstorm over Ranchi - A case study, National Conference TROPMET 2010: Advances in Weather and Climate Services, Kolkata, 19-21 May, 2010
9. Satyanarayana, A.N.V., **Tyagi, B.,** Vissa, N.K., 2010. Vertical Thermodynamical structure of atmosphere during active and weak phases of summer monsoon over Kharagpur as revealed by CTCZ Pilot Campaign 2009: Observational Study, Workshop on Continental Tropical Convergence Zone (CTCZ)-Pilot: Initial Results, Indian Institute of Tropical Meteorology, Pune, Pune, 29-30 April 2010
10. Rajvanshi, R.K., Satyanarayana, A.N.V., **Tyagi, B.,** Mandal, M., 2008. Variation of surface energy balance parameters over Kharagpur during 2007 pre-monsoon thunderstorm activity, 15th National Space Science Symposium (NSSS-2008), Radio Astronomy Centre (NCRA-TIFR), Udhagamandalam (Ooty), 26-29 February, 2008
11. **Tyagi, B.,** Satyanarayana, A.N.V., Mandal, M., 2008. Estimation of Soil Heat Flux and analysis of sub-soil Surface Temperature at Kharagpur during Pre-Monsoon Thunderstorm season, 15th National Space Science Symposium (NSSS-2008), Radio Astronomy Centre (NCRA-TIFR), Udhagamandalam (Ooty), 26-29 February, 2008