THE SPECTRUM

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Influence of solar flux variations on the wave dynamics of the Earth's thermosphere

(Subir Mandal, Duggirala Pallamraju, and Pradip Suryawanshi)

The Earth's atmosphere hosts waves of different spatial and temporal scales, which play a crucial role in the redistribution of energy and coupling between the various regions. Atmospheric gravity waves (GWs) are one such type of waves, wherein the force of gravity acts as the restoring force. These wave-like fluctuations manifest themselves in the different atmospheric parameters, such as density, pressure, and temperature.

We used the electron density data obtained from digisonde that is in operation from the Thaltej Campus of PRL to study such wave features in the height region of 200 – 300 km. GW characteristics, such as time periods (τ), vertical phase speeds (c_z) and vertical wavelengths (λ_z) have been obtained from this study. The thermosphere is a lethargic medium and takes ~20 days to respond to systematic changes due to external forcing. This time lag has been considered to investigate the effect of solar flux variations on GW activity. Distribution of c_z and the number of GWs that are represented by the number of independent time periods, in the daytime thermosphere show similarity with the variations in the values of the solar flux (figures 1a & b). These similarities indicate a strong influence of solar flux variability on the thermospheric GW activity.

This semblance between the GW activity and solar flux is inferred to be caused by the changes in neutral temperature, which increase during high solar flux. An increase in the neutral temperature causes the thermosphere to expand. Such expansion alters the vertical density distribution of neutral species. These changes are known to modify the background stability condition, which leads to a weakening of wave dissipations. As a result of all these modifications, the vertical wavelength and vertical phase speeds of GWs (and hence the number of GWs) increase with increasing solar flux. Such results on the influence of solar flux on the GWs in the daytime thermosphere provide new insights into the solar-terrestrial coupling in terms of the neutral atmospheric dynamics. doi: https://doi.org/10.1016/j.jastp.2020.105414

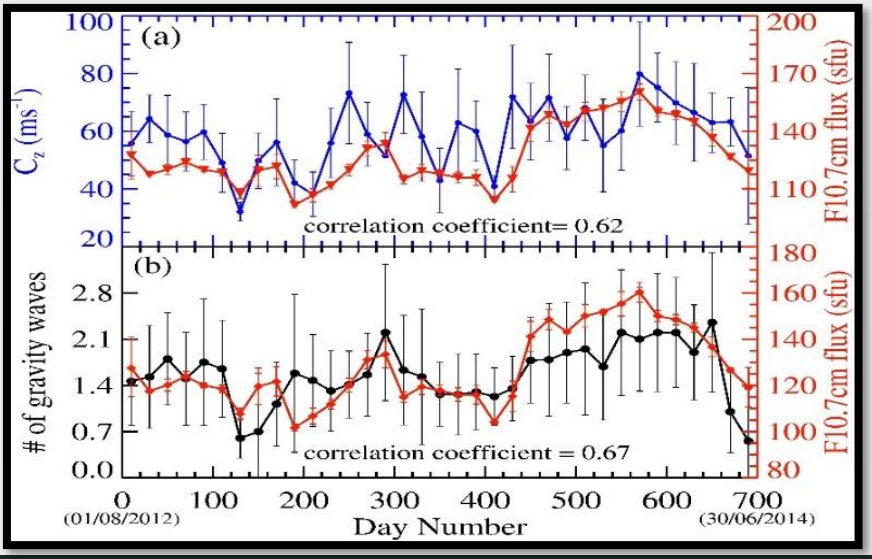


Figure 1: (a) Variation in the 20-day averaged values of vertical phase speeds of GWs (blue-color) and solar flux (red-color) for the period of 01/07/2012 – 30/06/2014. (b) Same as shown in (a) but for number of gravity waves observed in the daytime thermosphere.

The Author

Santosh Vadawale

About Him:

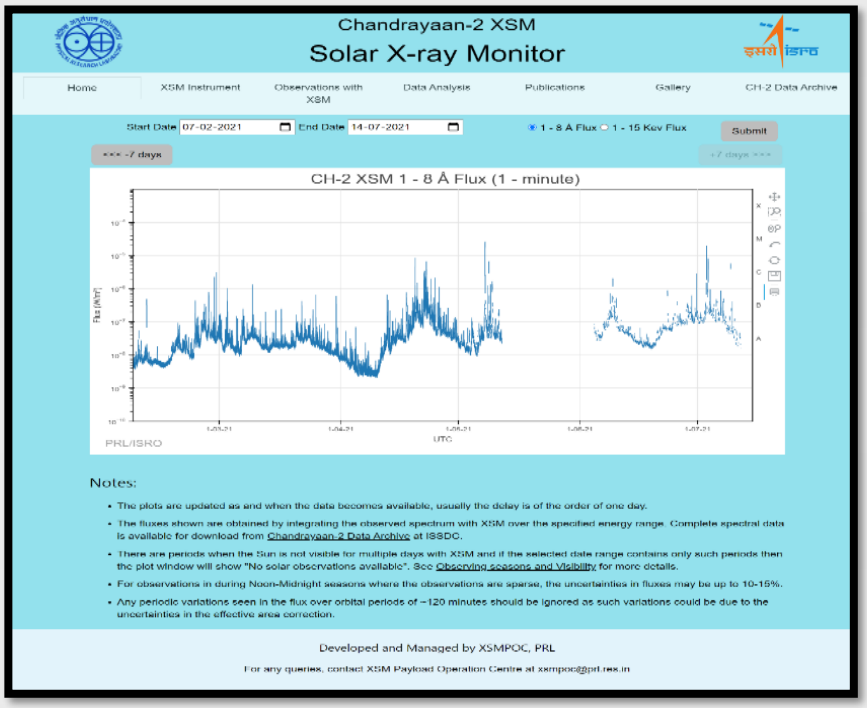
Prof. Santosh Vadawale is a Professor at the Astronomy & Astrophysics Division.

Launch of Solar X-ray Monitor (XSM) website at PRL

The XSM (Solar X-ray Monitor) is one of the eight scientific experiments (payloads) onboard the Chandrayaan-2 Orbiter. It measures the solar X-ray spectrum in the 1 – 15 keV energy range, with the high energy resolution of ~175 eV (@5.9 keV), at every second, whenever the Sun is within the field of view of the XSM. The measurements by XSM provide the solar X-ray flux incident on the Moon, which is required by the CLASS (Chandrayaan-2 Large Area Soft X-ray Spectrometer) payload for determining the elemental composition of the lunar surface.

The XSM is the only solar soft X-ray spectrometer operational at present and has been providing high-sensitivity data on solar X-rays since September 2019. Though XSM measures the X-ray spectra of the Sun as a star, the high energy resolution and the high cadence measurements have great potential to address a variety of problems related to the enigmatic solar corona, and hence, are of great interest for solar physicists. The XSM data is available publicly from the PRADAN portal of the ISSDC (Indian Space Science Data Centre) after a lock-in period of nine months. However, in order to quickly disseminate the basic information on the solar X-ray intensity to the scientific community, the XSM POC (Payload Operation Centre) at PRL has developed a website, which provides an interactive display of the solar X-ray light curves measured by XSM in the energy range of 1 – 15 keV as well as in the standard GOES energy range of 1 – 8 Å. The website also provides similar interactive access to light curves for the past XSM data, starting from 12 September 2019, and basic information on the XSM instrument and observations, publications, as well as the software and documents necessary to analyse the data obtained from the PRADAN portal.

This XSM website at PRL was inaugurated by the Chairman of the PRL Council of Management, Shri A. S. Kiran Kumar, on 8 July 2021 and is now available publicly at https://www.prl.res.in/ch2xsm



Monthly Publications Digest of PRL

1. Main Pal, Neeraj Kumari, P. Kushwaha, K. P. Singh, A. C. Gupta, Sachindra Naik, G. C. Dewangan, P. Tripathi, R. Adhikari, O. Adegoke, H. Nandan, 2021, *Spectro-Timing Analysis of a highly variable narrow-line Seyfert 1 galaxy NGC 4748 with AstroSat and XMM-Newton*, Journal of Astrophysics and Astronomy, 42, 81, Date of Publication: 26/07/2021
2. Tanmoy Chattopadhyay, Soumya Gupta, Vidushi Sharma, Shabnam Iyyani, Ajay Ratheesh, N. P. S. Mithun, E. Aarthy, Sourav Palit, Abhay Kumar, Santosh V. Vadawale, A. R. Rao, Varun Bhalerao, Dipankar Bhattacharya, 2021, *Sub-MeV spectroscopy with AstroSat-CZT imager for gamma ray bursts*, Journal of Astrophysics and Astronomy, 42, 82, Date of Publication: 21/07/2021
3. R. Chatterjee, S. Das, A. Khasnovis, R. Ghosh, Neeraj Kumari, Sachindra Naik, V. M. Larionov, T. S. Grishina, E. N. Kopatskaya, E. G. Larionova, A. A. Nikiforova, D. A. Morozov, S. S. Savchenko, Yu. V. Troitskaya, I. S. Troitsky & A. A. Vasilyev , 2021, *Short-timescale variability of the blazar Mrk 421 from AstroSat and simultaneous multi-wavelength observations,* Journal of Astrophysics and Astronomy, 42, 80, *Date of Publication: 17/07/2021*
4. Ajay Vibhute, Dipankar Bhattacharya, N. P. S. Mithun, V. Bhalerao, A. R. Rao, S. V. Vadawale, 2021, *Imaging calibration of AstroSat Cadmium Zinc Telluride Imager (CZTI),* Journal of Astrophysics and Astronomy, 42, 76, *Date of Publication: 16/07/2021*
5. G. K. Jaisawal, Sachindra Naik, Prahlad Epili, Birendra Chhotaray, Arghajit Jana, P. C. Agrawal, 2021, *AstroSat observations of eclipsing high mass X-ray binary pulsar OAO 1657-415,* Journal of Astrophysics and Astronomy, 42, 72, *Date of Publication: 03/07/2021*
6. Abhay Kumar, Tanmoy Chattopadhyay, Santosh V. Vadawale, A. R. Rao, Soumya Gupta, N. P. S. Mithun, Varun Bhalerao, Dipankar Bhattacharya, 2021, *Exploring sub-MeV sensitivity of AstroSat–CZTI for ON-axis bright sources,* Journal of Astrophysics and Astronomy, 42, 67, *Date of Publication: 03/07/2021*
7. D. Paul, A. R. Rao, A. Ratheesh, N. P. S. Mithun, S. V. Vadawale, A. Vibhute, D. Bhattacharya, P. Pradeep, S. Sreekumar, 2021, *Characterisation of cosmic ray induced noise events in AstroSat-CZT imager,* Journal of Astrophysics and Astronomy, 42, 68, *Date of Publication: 03/07/2021*
8. Abdur Rahman, M. Atif Khan, Arvind Singh, Sanjeev Kumar, 2021, Hydrological characteristics of the Bay of Bengal water column using δ18O during the Indian summer monsoon, Continental Shelf Research, Date of Publication: 30/07/2021
9. P. Ragavan, Sanjeev Kumar, K. Kathiresan, P.M. Mohan, R.S.C. Jayaraj, K. Ravichandaran, T. S. Rana, 2021, *Biomass and vegetation carbon stock in mangrove forests of the Andaman Islands, India,* Hydrobiologia, *Date of Publication: 29/07/2021*
10. Deepika Sahoo, Himanshu Saxena, Sipai Nazirahmed, Sanjeev Kumar, A. K. Sudheer, Ravi Bhushan, Arvind Sahay, and Arvind Singh, 2021, *Role of eddies and N2 fixation in regulating C:N:P proportions in the Bay of Bengal,* Biogeochemistry, doi://10.1007/s10533-021-00833-4, *Date of Publication: 24/07/2021*

Monthly Publications Digest of PRL

11. A. M. Lone, S. Sharma, H. Achyuthan, Anil D Shukla*, R. A. Shah, S. J. Sangode, Fousiya 2021, *Climatic implications of late Holocene loess and intervening paleosols, Southern Zanskar range, northwestern Himalaya,* Physical Geography, Date of Publication: 01/07/2021
12. C. Krishnaprasad, Smitha V. Thampi, Anil Bhardwaj, Tarun K. Pant, R. Satheesh Thampi, 2021, *Ionospheric plasma energization at Mars during the September 2017 ICME event*, Planetary and Space Science, Date of Publication: 02/07/2021
13. N.M., Mishra, S., Gaddamidi, S., Tripathi, N., Vats, P., Rastogi, N., Sahu L.K., Ganguly, D., Kumar, M., Singh, V., Gargava, P., and Tripathi S.N. , 2021, *Real-time quantification and source apportionment of fine particulate matter including organics and elements in Delhi during summertime,* Atmospheric Environment, Date of Publication: 05/07/2021
14. S. Ramachandran, T. A. Rajesh and R. Cherian, 2021, *Black carbon aerosols over source vs. background region: Atmospheric boundary layer influence, potential source regions, and model comparison,* Atmospheric Research, Date of Publication: 01/07/2021
15. John M. Campbell, Giuseppe De Laurentis, R. Keith Ellis, Satyajit Seth, 2021, *The pp → W(→ lν) + γ process at next-to-next-to-leading order,* Journal of High Energy Physics, Date of Publication: 13/07/2021
16. Lucy Budge, John M. Campbell, R. Keith Ellis, Satyajit Seth, 2021, *Analytic results for scalar-mediated Higgs boson production in association with two jets,* Journal of Physics G: Nuclear and Particle Physics, Date of Publication: 08/07/2021
17. Monojit Ghosh, Srubabati Goswami, Ananya Mukherjee, 2021, *Implications of the Dark-LMA solution for neutrino mass matrices* , Nuclear Physics B, Date of Publication: 07/07/2021
18. Rohan Louis, Avijeet Prasad, Christian Beck, Debi Prasad Choudhary, Mehmet S. Yalim, 2021, *Heating of the Shukla, A.K., Lalchandani, V., Bhattu, D., Dave, J.S., Rai, P., Thamban, Solar chromosphere in a sunspot light bridge by electric currents,* Astronomy & Astrophysics Letters, Date of Publication: 13/07/2021
19. Wageesh Mishra, Kunjal Dave, Nandita Srivastava, Luca Teriaca, 2021, *Multipoint remote and in situ observations of interplanetary coronal mass ejection structures during 2011 and associated geomagnetic storms,* Monthly Notices of the Royal Astronomical Society, Volume 506, Issue 1, September 2021, Pages 1186–1197, Date of Publication: 13/07/2021
20. Erika Palmerio, Nariaki V. Nitta, Tamitha Mulligan, Marilena Mierla, Jennifer O'Kane, Ian G. Richardson, Suvadip Sinha, Nandita Srivastava, Stephanie L. Yardley and Andrei N. Zhukov, 2021, *Investigating Remote-Sensing Techniques to Reveal Stealth Coronal Mass Ejections,* Frontiers in Astronomy and Space Science, Date of Publication: 05/07/2021

Visitors @ PRL

- Ms. Ayushi Bhatnagar: Ph.D - INSPIRE Fellow, Banasthali Vidyapeeth is visiting PRL to work with Dr. A.D. Shukla from Geosciences Division. She is here to carry out her doctoral research on the evolution of Western Great Rann of Kachchh.

- Mr. Drona Vatsyayan: PhD Student, Delhi University was visiting PRL. He was working with Prof. Srubabati Goswami from THEPH Division on Explaining the observed Baryon asymmetry of the Universe via leptogenesis.

Superannuation

Shri C.V.R.G. Deekshitulu, Registrar, PRL superannuated on 31st July 2021. PRL family thanks him for his contributions towards the betterment of the Institute and wishes him a happy and healthy superannuated life.

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