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Long-term variations and trends in the E and sporadic E layer over Juliusruh (54° N), Europe

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Sporadic E (Es) is a thin layer of metallic ion plasma that forms in the E region of the Earth's ionosphere, mostly between 90 and 125 km. It can affect the radio frequencies in the HF range of up to 30 MHz. In the mid-latitudes, the wind shear mechanism causes the formation of the Es layers. In general, solar forcing primarily controls changes in the E layer. On the other hand, the formation of the mid-latitude Es layer is driven by the wind shear associated with lower atmosphere originated wave activities. Since the formation of the Es layer is caused by the lower atmospheric forcing, it can be used as a tracer to estimate the lower atmospheric impact on the upper mesosphere and lower thermosphere (UMLT). Therefore, the study of the long-term changes and trends (if any) in the E and Es layers will throw some light on the effect of the lower atmosphere and solar forcing on the UMLT region.

In the present study, we investigate the long-term variation and trends in the E region, using sixty-three years of continuous ionosonde observations over Juliusruh (54.6° N 13.4° E), Europe. Before the trend analysis, predominant long-term variations are estimated using the Lomb-Scargle periodogram analysis. We found that the annual and solar cycle oscillations are strongly present in both foE and foEs. In addition, a weak semi-annual oscillation is also noted in the foE. Furthermore, the model time series data of foE and foEs is created using the period and amplitude of the predominant oscillations. Then, the residual value of foE and foEs is calculated by subtracting the model values from the observation. By using the least square fit analysis, the trend is estimated. Interestingly, weak negative trends in the foE and foEs are found. The plausible causative mechanism for the observed trends will be detailed in the presentation.