



Long-Term Variability of 50 Years Standard Phase Height measurements over Europe

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Phase height measurements of low frequency radio waves are used to study the long-term variability of the mesosphere (D layer, about 80 km altitude) over Europe. The concept of standard phase heights (SPH) guarantees the continuity of the series in the case of slight frequency changes. Since February 1959, that means over 50 years, field strength measurements of the broadcasting station, Allouis (Central France), have been maintained at Kühlungsborn (54° N, 12° E, Mecklenburg, Northern Germany). A homogenized daily series was generated with a loss rate of about 2 %.

The mean annual cycle of SPH-series shows a negative winter anomaly as known due to enhanced downward transport of NO and subsequent photo-ionization. The SPH-series are partially anti-correlated to the solar cycle because stronger photo-ionization is linked with higher number of electrons, which reduces the SPH. Further the statistical analysis of the SPH-series shows a significant overall trend with a decrease of 114 m per decade induced by a shrinking stratosphere due to global warming but with strong intra-decadal variability in winter.

Stratospheric influences of ENSO-like and QBO-like oscillations on mesospheric SPHs have been shown for solar minimum phases. Especially in winter the SPH changes are linked with change of the residual circulation indicated by the Eliassen-Palm flux divergence. This induces changes of vertical NO transport, and the subsequent NO photo-ionization. Furthermore we show that during phases of solar maximum nonlinearity and solar feedback processes seem to be an important factor for changes of SPH-oscillation phase.