Summer noontime h_mF_2 long-term trends inferred from f_oF_1 and f_oF_2 ionosonde observations in Europe

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Long-term hmF2 trends may serve as an indicator of the thermosphere cooling due to the CO_2 concentration increase in the Earth's atmosphere. Unfortunately required long-term reliable hmF2 observations are absent. A new method has been proposed to solve this problem using available monthly median foF1 and foF2 ground-based ionosonde observations. Such manually scaled observations are available on European stations for a period of 5 solar cycles. Summer (June) daytime foF1 observations are used to retrieve: exospheric temperature Tex, neutral composition ([O], [O_2], [N_2]) and the total solar EUV flux with λ<1050Å. Fitting with vertical plasma drift W (the only unknown parameter) calculated foF2 to the observed one the height of F2-layer maximum, hmF2 may be found. Such calculations have been done using Sodankylä and Juliusruh foF1 and foF2 observations for the (1958-2017) period. Two methods were used to remove solar and geomagnetic activity effects from the retrieved hmF2 long-term variations: i) by a normalization with the Shubin hmF2 monthly median model and b) using a regression with an $index = F_{10.7}^{\alpha} + Ap^{\beta}$, where α and β are fitted parameters. Both methods give negative statistically significant (at 99% confidence level) trends hmF2 but with different magnitudes: ~ 0.7% per decade at Juliusruh and ~ 2% per decade at Sodankylä. Over four decades (the period of cooling due to the CO_2 concentration increase) this gives a decrease in hmF2 of ~ 8 km at Juliusruh and ~ 25 km at Sodankylä. Both estimates are larger than expected under a 20% increase in the CO_2 abundance. Possible mechanisms are discussed.