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Towards evaluating the intensity of convective systems by using GPS radio occultation profiles

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Deep convective systems, also more casually often just called storms, are destructive weather phenomena causing every year many deaths, injuries and damages and accounting for major economic losses in several countries. The number and intensity of such phenomena increased over the last decades in some areas of the globe, including Europe. Damages are mostly caused by strong winds and heavy rain and these parameters are strongly connected to the structure of the storm. Convection over land is usually stronger and deeper than over the ocean and some convective systems, known as supercells, also develop tornadoes through processes which are still mostly unclear. The intensity forecast and monitoring of convective systems is one of the major challenges for meteorology because in-situ measurements during extreme events are too sparse or not reliable and most ongoing satellite missions do not provide suitable time/space coverage.

With this study we propose a new method for detecting the convection intensity in terms of rain rate and surface wind speed by using meteorological surface measurements in combination with atmospheric profiles from Global Positioning System (GPS) radio occultation observations, which are available in essentially all weather conditions and with global coverage. The analysis of models indicated a relationship between the cloud top altitude and the intensity of a storm. We thus use GPS radio occultation bending angle profiles for detecting the storm's cloud top altitude and we correlate this value to the rain rate and wind speed measured by meteorological station networks in two different regions, the WegenerNet climate station network (South-Eastern Styria, Austria) and the Atmospheric Radiation Measurement site (ARM, Southern Great Plains, USA), respectively.

The results show a good correlation between the cloud top altitude and the maximum rain rate in the monitored areas, while this is not found for maximum wind speed. We conclude from this initial study that for land convective systems the cloud top altitude is strongly connected to the rain intensity and that GPS radio occultation observations show encouraging potential to improve the intensity nowcasting and detection of such kind of severe weather phenomena.