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The Central European droughts of 2018 and 2019 observed with GRACE-Follow-On

Eva Boergens¹, Andreas Güntner², Henryk Dobslaw¹, and Christoph Dahle³

¹Deutsches GeoForschungsZentrum Potsdam, Sec. 1.3 Earth System Modelling, Potsdam, Germany (boergens@gfz-potsdam.de)

²Deutsches GeoForschungsZentrum Potsdam, Sec. 4.4 Hydrology, Potsdam, Germany

³Deutsches GeoForschungsZentrum Potsdam, Sec. 1.2 Global Geomonitoring and Gravity Field, Potsdam, Germany

In this study we investigate the ability of GRACE-FO (Gravity Recovery and Climate Experiment Follow-On) to quantify the two consecutive summer droughts of 2018 and 2019 in Central Europe. The GRACE-FO mission was launched in May 2018 as the successor of GRACE (2002-2017) and thus, allows us to relate the droughts of the last two years to former droughts in 2003 and 2015.

The water mass deficit in 2018 was 90 ± 18.5 Gt and in 2019 even 116 ± 18 Gt compared to the long term climatology. These deficits are 60% and 76% of the annual mean variations which is so severe that a fast recovery of the water storage cannot be expected within one year. The drought of summer 2019 was more severe than the European-wide drought of 2003 with a water deficit of 85 ± 16 Gt and had the largest water deficit in the whole GRACE and GRACE-FO time span.

GRACE-FO total water storage data also allows the analysis of the spatio-temporal drought patterns. The largest water mass deficit in 2018 was detected in October and centred in South-Western Germany and neighbouring countries. However, the exact onset of the 2018 drought is not determinable due to missing data between July and October. The drought 2019 reached its largest deficit in July and was more evenly spread across Central Europe than the 2018 drought.

From the GRACE and GRACE-FO mass anomalies, we derive a drought index which is compared to an external soil-moisture drought index. Over the whole time series between 2002 and 2019 both indices show a high congruence. However, as the two indices do not describe the same hydrological compartments a time lag and a memory effect of TWS relative to soil-moisture is visible in the comparison.

Overall, the presented study proves the successful continuation of GRACE with GRACE-FO and thus the reliability of the observed Central European summer drought of 2019 as the most extreme water scarcity event since 2002.