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Flood detection using Gravity Recovery and Climate Experiment (GRACE) terrestrial water storage and extreme precipitation data

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In Figure S1, we took a GRACE grid in China as an example to show that high frequency signals may loss some useful information and this was the reason why we considered flood potential index as a supplement to missed flood events by high frequency signals. We obtained the high-frequency signals and analysed the DFO flood event covering this grid. The unrecognizable flood of GRACE high-frequency signals was due to the fact that AR interpolation was used in GRACE TWS and it introduces white noise. This white noise will be filtered out in the subsequent GESD test method, resulting in the loss of useful signals (red rectangular boxes). The other reason of unrecognition was that GRACE TWS itself was not able to identify the flood event (blue rectangular boxes).

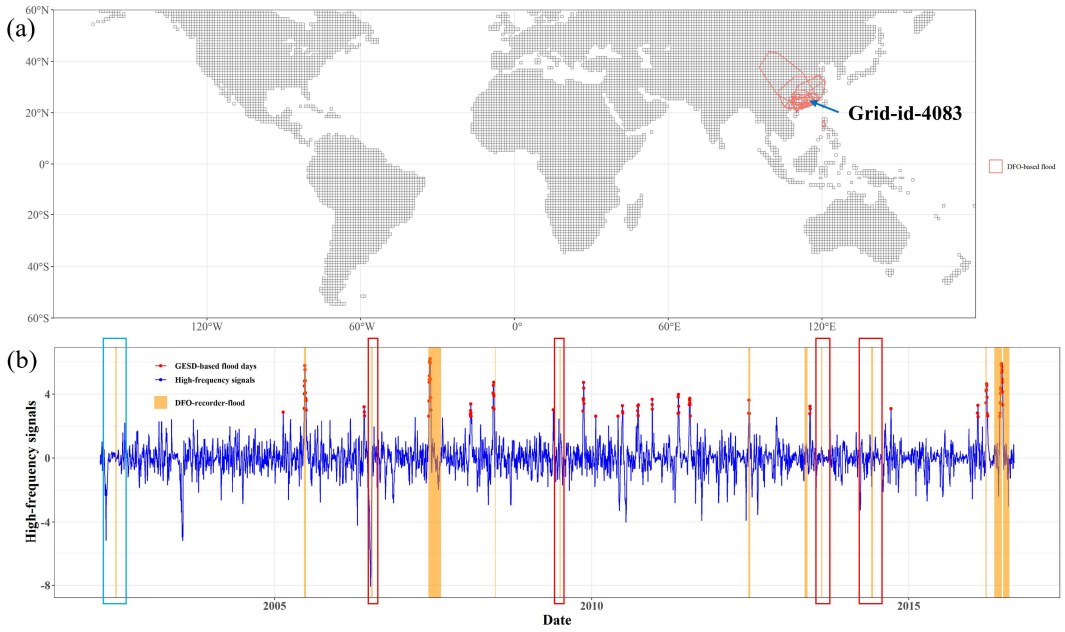

Figure S1 The high-frequency signal of GRACE-id-4803 grid and flood detection. Red rectangular boxes indicate unrecognized floods due to GRACE high-frequency signals, and blue rectangular boxes indicate unrecognized floods due to GRACE missing months.

We also considered the reliability of the GESD test. The method effectively extracted the important anomalous peaks (i.e., the pre-extracted flood days) and the extracted flood days for each spatial grid were stable and did not increase with the increase of the preset up bound in our study. As shown in Figure S2, the histogram distribution of the pre-extracted global flood days for each spatial grids was concentrated around 200 days, not more than 500 days. It was not more than 200 flood events after converted from flood days to flood events. The order of magnitude was consistent with the number of historical flood events (shown in results section). The advantages of the GESD test method and good performance on the flood days extraction laid a solid method foundation for subsequent analysis in this study.

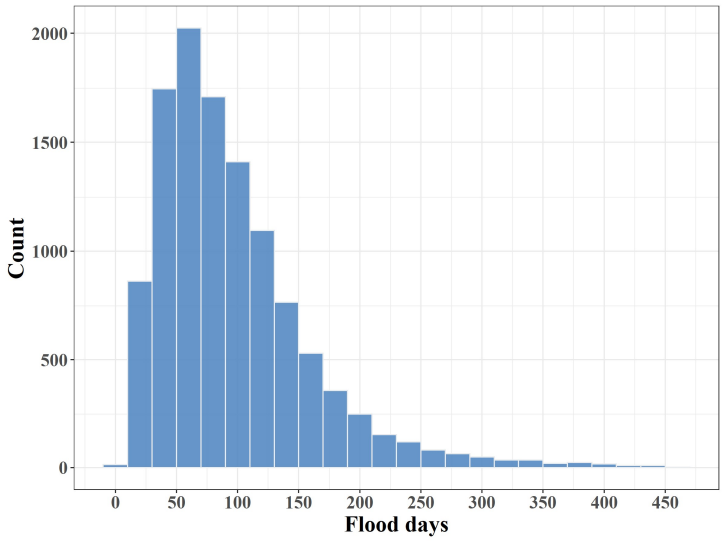

Figure S2 The histogram of pre-selected flood days based on high-frequency signals of TWS using GESD test method.

Figure S3 showed an example that flood potential index was able to supplement some flood events not identified by GRACE high-frequency signals. Red rectangular boxes indicated floods detected by FPI but not detected by high-frequency signals.

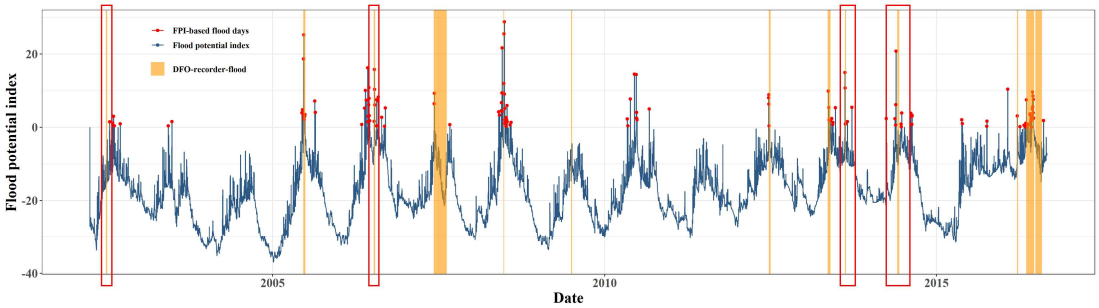

Figure S3 Flood potential index supplemented floods unrecognized by GRACE TWS high-frequency signals (red rectangular boxes).

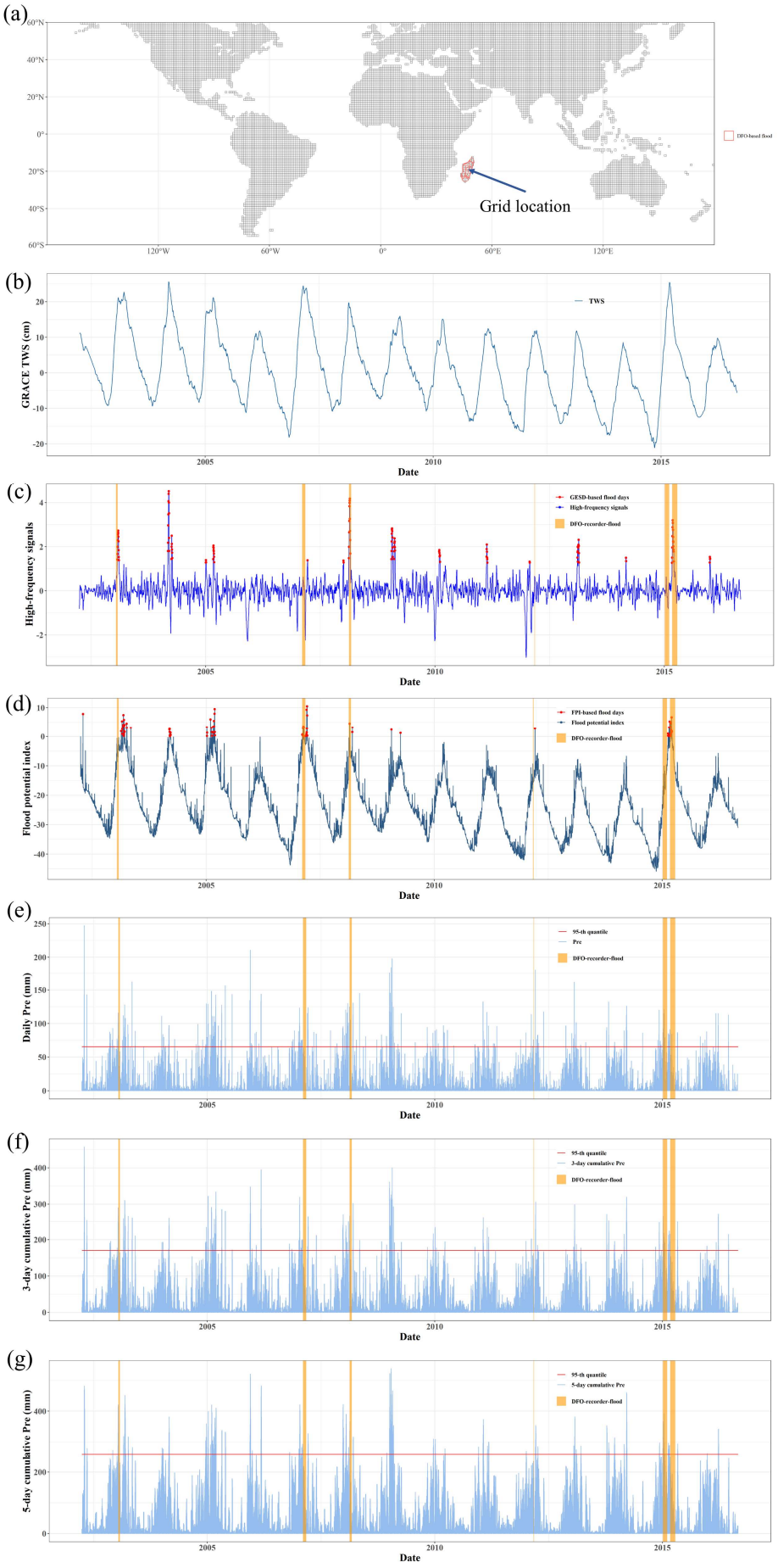

Figure S4 Schematic diagram of the intermediate variable time series processing for flood extraction based on GRACE and extreme precipitation for a randomly selected grid from Apr. 1st, 2002 to Aug. 31st, 2016. (a) randomly selected grid for flood detection; (b) GRACE TWS times series; (c) high-frequency signals time series derived from GRACE and flood days extraction

based on GESD; (d) flood days extraction based on flood potential index time series; (e) daily precipitation time series and extreme precipitation days based on 95-th quantile; (f) 3-day cumulative precipitation time series and extreme precipitation days based on 95-th quantile; (g) 5-day cumulative precipitation time series and extreme precipitation days based on 95-th quantile.