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An ensemble-based approach to map floods globally using Sentinel-1 data: The Global Flood Monitoring system of the Copernicus Emergency Management Service

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It is expected that climate change – combined with a growing global population in ill-planned flood-prone coastal and riverine areas – will increase the destructive potential of river floods. Central to inundation risk mitigation are the acquisition and processing of high resolution and high frequency information on river discharge response to precipitation. To address this pressing societal need, we introduce a global scale satellite Earth Observation-based flood mapping and forecasting service – capitalizing on the quasi-continuous data stream generated by the radar onboard the Sentinel-1 satellite. Radar signals emitted from satellites are a very powerful tool for assessing flood extents – capable of 'seeing' through cloud covers and covering almost instantaneously thousands of square kilometers. In order to rapidly translate the large volume of SAR data into floodwater maps and value adding services, the European Commission's Joint Research Centre (JRC) recently added Global Flood Monitoring (GFM) products based on Sentinel-1 as a new component to its Copernicus Emergency Management Service (CEMS). The GFM products are obtained by processing all incoming Sentinel-1 SAR images within 8 hours after data acquisition. To reach a high degree of automation, the system takes advantage of the constantly updated 20 m Sentinel-1 data cube made available by the Earth Observation Data Centre (EODC) facilities. It is requisite that the Sentinel-1 based retrieval algorithm, as one of the core components of GFM, is both efficient and robust. Moreover, it is designed to balance two objectives: to detect water at high accuracy (i.e. permanent and seasonal water bodies, and floodwater), while minimizing the identification of false alarms due to water-look-alikes surfaces that can be confused with floodwater. To enhance the robustness of the system, an ensemble-based mapping algorithm is implemented, which combines three independent floodwater mapping algorithms driven by different approaches. 1) LIST's algorithm that requires three main inputs: the most recent SAR scene to be processed, a previously recorded overlapping SAR scene acquired from the same orbit and the corresponding previously computed flood extent map. The change detection algorithm maps all increases and decreases of floodwater extent and makes use of this information to regularly update the flood extent maps. 2) DLR's algorithm requires one scene as the main input and further exploits three ancillary raster datasets: i.e. a digital elevation model (DEM), areas not prone to flooding and a reference water map. 3) TU Wien's algorithm requires three input data sets: i.e. the SAR scene to be processed, a projected local incidence layer,

and the corresponding parameters of a previously calibrated multitemporal harmonic model. The final floodwater map is obtained by integrating the results of the three independently developed algorithms. Pixelwise flood classifications are based on majority voting, such that at least two algorithms are in agreement. The algorithm is currently being extensively tested for different regions all over the world. A first quantitative evaluation shows encouraging results in relation to the accuracy for delineating the evolution of water bodies and further improvements to increase the accuracy of the GFM product is ongoing.

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