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Scheduling satellite imagery acquisition for sequential assimilation of water level observation into flood modelling

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Satellite-based imagery has proved useful for obtaining information on water levels in flood events. Microwave frequencies are generally more useful for flood detection than visible-band sensors because of its all-weather day-night capability. Specifically, the future SWOT mission, with Ka-band interferometry, will be able to provide direct Water Level Observations (WLOs), and current and future Synthetic Aperture Radar (SAR) sensors can provide information of flood extent, which, when intersected with a Digital Elevation Model (DEM) of the floodplain, provides indirect WLOs. By either means, satellite-based WLOs can be assimilated into a hydrodynamic model to decrease forecast uncertainty and further to estimate river discharge into the flooded domain. Operational scenarios can even make a combined use of imagery from different uncoordinated missions to sequentially estimate river discharge. Thus, with an increasing number of operational satellites with WLO capability, information on the relationship between satellite first visit, revisit times, and forecast performance is required to optimise the operational scheduling of satellite imagery. By using an Ensemble Transform Kalman Filter (ETKF) and a synthetic analysis with the 2D hydrodynamic model LISFLOOD-FP based on a real flooding case affecting an urban area (summer 2007, Tewkesbury, Southwest UK), we evaluate the sensitivity of the forecast performance to visit parameters. As an example, we use different scenarios of revisit times and observational errors expected from the current COSMO-Skymed (CSK) constellation, with X-band SAR. We emulate a generic hydrologic-hydrodynamic modelling cascade by imposing a bias and spatiotemporal correlations to the inflow error ensemble into the hydrodynamic domain. First, in agreement with previous research, estimation and correction for this bias leads to a clear improvement in keeping the forecast on track. Second, imagery obtained early in the flood is shown to have a large influence on forecast statistics. Revisit interval is most influential for early observations. The results are promising for the future of remote sensing-based water level observations for real-time flood forecasting in complex scenarios.