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Integration of routine and high-frequency data to improve 3-D water quality model predictions

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The challenges of supporting short- and long-term water quality management decisions in aquatic systems require a holistic view of their internal response to external stressors. Whilst regular monitoring programs of water quality with weekly or longer time intervals allows for tracking trends in water quality and an understanding of the system evolution over extended periods of time, high frequency monitoring data offers potential to improve our knowledge of the finer-scale hydrodynamic and biogeochemical processes (e.g. mixing, diel metabolism). Such data also offers great potential to assist in the calibration and testing of water quality models targeting hypoxia and harmful algal bloom issues, but as yet their remains challenges in the uptake of sensor data into model prediction workflows. Here we report an approach to the integration of models and observations for the Swan-Canning system, a eutrophic urban estuary in Western Australia, under threat from nutrient enrichment and changing hydrology. Initially, modelling to facilitate hypoxia management and nutrient budgeting was supported by a long-term monitoring strategy, which together highlighted changes brought about by a notable drying climate trend. A real-time water quality system, SCEVO (Swan-Canning Estuary Virtual Observatory), was subsequently developed to support decision-making and streamline prediction workflows. The real-time system uses the validated 3D finite volume water quality model (TUFLOW-FV–AED2), and integrates a data management system, weather model (WRF), and a coastal model (ROMS), to generate a hindcast and a daily 5-day forecast of water quality conditions online. A conceptual framework is outlined for how sensor data is able to be used for supporting the model predictions. First, due to the often patchy and time-lagged nature of nutrient monitoring, the application of machine-learning methods has been introduced to exploit available sensor data for prediction of boundary condition inputs (e.g. inflowing nutrient loads) required to run the model. Secondly, high-frequency oxygen data is being used to identify local drivers of productivity, which is assisting in how the model configuration captures the diel-scale sensitivity of metabolism to light, flow and benthic activity. Looking forward, an *in situ* sensor platform is under development in the centre of the Swan River that will report high-frequency changes in key water quality parameters including chl-a, salinity, oxygen, temperature, PAR, fDOM and pCO2. It is envisaged that the new data streams will support further connections between data-driven and process-based model approaches, and ultimately lead to more “process—inspired” calibration opportunities of the model system.

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Poster Session Abstract Book

GLEON 20
Rottnest Island, WA, Australia
3 - 7 Dec 2018

Hosted by the University of Western Australia
and the University of Adelaide

Last updated 2018-11-24