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The Water Quality Protocol for Model Intercomparisons Under Climate Change Impacts

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Water quality is under threat in many places on Earth. This is associated with impacts of climate change (e.g., droughts, floods) that are integrated with socio-economic developments (e.g., agriculture, urbanization). Computer models have been developed and combine our knowledge and data to quantify water pollution levels, sources of pollution, and impacts of a wide range of pollutants such as salinity, nutrients, pathogens, plastics, and chemicals. These models are diverse in time and space and their modeling approaches. Such diversity offers a great opportunity to compare model results to identify robust pollution hotspots, their sources and explore trends under global change across pollutants, scales, scenarios, and sectors. We take this unique

opportunity and develop a protocol for water quality models within the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) initiative supported by the Process-based models for Climate Impact Attribution Across Sectors (Proclias COST Action). This protocol serves as a guide for water quality modelers on how to harmonize model inputs and outputs and contributes to cross-scale and cross-sectoral assessments of water quality. Within our community, we identified challenges and opportunities for implementing the protocol. One of the challenges is the diversity of water quality models in their approaches, spatial and temporal level of detail, and water quality constituents that the models consider. The other challenge is inconsistencies in data for model inputs that make the data harmonization more difficult. However, opportunities exist for the large water quality modeling community to creatively identify approaches for model intercomparison purposes. This not only facilitates interactions among the modelers but also contributes to the development of novel model intercomparison approaches for the diverse water quality models. During several workshops throughout 2022-2023, the water quality modeling community (largely focused on large-scale) discussed and identified two promising directions for model intercomparisons. The first direction is qualitatively based. It aims largely at the integration of model outputs (e.g., via indicator-based approaches) from various water quality models to identify robust hotspots, sources and trends across pollutants and scenarios. This direction could fit the recently initiated “Fast Track” with the ISIMIP platform for the water quality sector. The second direction is quantitatively based. It aims largely at the intercomparison of model outputs. An example is the comparison of water pollution levels between two or more models for the same pollutant, scenario, scale, climate model, and sector. This requires at least two model simulations for one water quality constituent. This second direction requires more efforts in harmonizing model inputs across models and could serve as a good basis for the ongoing ISIMIP3 model intercomparison purposes across sectors. The first attempts were made to harmonize model inputs in scenario developments for global water quality assessments by the modeling community of the UN-World Water Quality Alliance. This can be the basis for further model harmonization. In EGU, we will discuss promising examples of the two directions and the ways forward. We will draw lessons on the process to develop such a protocol for model intercomparisons to understand climate change impacts on water quality better.