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EDITORIAL

The 12th International Workshop on Modeling the Ocean (IWMO 2022) in Ann Arbor, Michigan, USA on June 28–July 1, 2022

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The 12th International Workshop on Modeling the Ocean (IWMO 2022) was hosted by the Cooperative Institute for Great Lakes Research (CIGLR) and NOAA Great Lakes Environmental Research Laboratory (GLERL). The meeting was held on the campus of the University of Michigan, Ann Arbor, Michigan, USA, on June 28-July 1, 2022.

The IWMO meetings are aimed at bringing together scientists from different countries and encouraging international research collaborations on topics of ocean modeling, ocean prediction and data analysis. The IWMO founded and started in 2009 (Oey et al. 2010) and was held so far in some 10 different countries. However, only once before it was held in the USA (IWMO 2010 in Norfolk, Virginia; Ezer et al. 2011). The 12th IWMO 2022 was unique and challenging, as the first meeting after a 3-year long halt due to the COVID pandemic, following the 11th IWMO 2019 meeting held in Wuxi, China (Ezer et al. 2021).

Ann Arbor is a college town around the meandering Huron River residing the University of Michigan (established in 1817), with a population of around 120,000 including about 50,000 students. Michigan has distinct four seasons with beautiful autumn red leaves scenic, but long winters with ice covered lakes and typical Mid-West weather. The Great Lakes provide a platform for cutting-edge research in modeling and prediction of lake hydrodynamics, lake ice, special weather events, and climate change components that include the atmosphere, cryosphere (ice), hydrosphere (lake hydrodynamics), biosphere (lake ecosystem), and land process; all these components closely interact with human dimensions and affect the large population around the Great Lakes. Therefore, several presentations addressed lake research in the region.

With the pandemic still not completely over in 2022, due to travel restrictions the meeting employed a hybrid format with both, in-person and online virtual presentations; masks were required for all in-person participants. Attendance includes 66 scientists and graduate students (31 in-person and 35 online) from 12 different countries around the world (Fig. 1).

The meeting was opened with welcome greetings and remarks from Deborah Lee and Jesse Feyen, the director and deputy director of GLERL, and Gregory Dick, the director of CIGLR, flowing by scientific presentations in 10 sessions:

1. Modeling Waves, Currents, Ice and Their Interactions in Coastal and Shelf Seas
2. Circulation and Dynamics Modeling
3. Great Lakes System Modeling and Forecasting
4. Outstanding Young Scientist Awards (OYSA) Presentations
5. Data Assimilation and Ocean Forecast Systems
6. Multi-Scale Ocean & Atmospheric Processes
7. Modeling and Prediction of Extreme Marine Events
8. Coupled Physical-Biological Ocean Models
9. Simulation of Internal Waves, Tides, Turbulence and Mixing
10. Numerical Techniques and Approaches in Ocean Modeling

Continuing with the IWMO tradition of encouraging the participation of young scientists, we had 11 graduate

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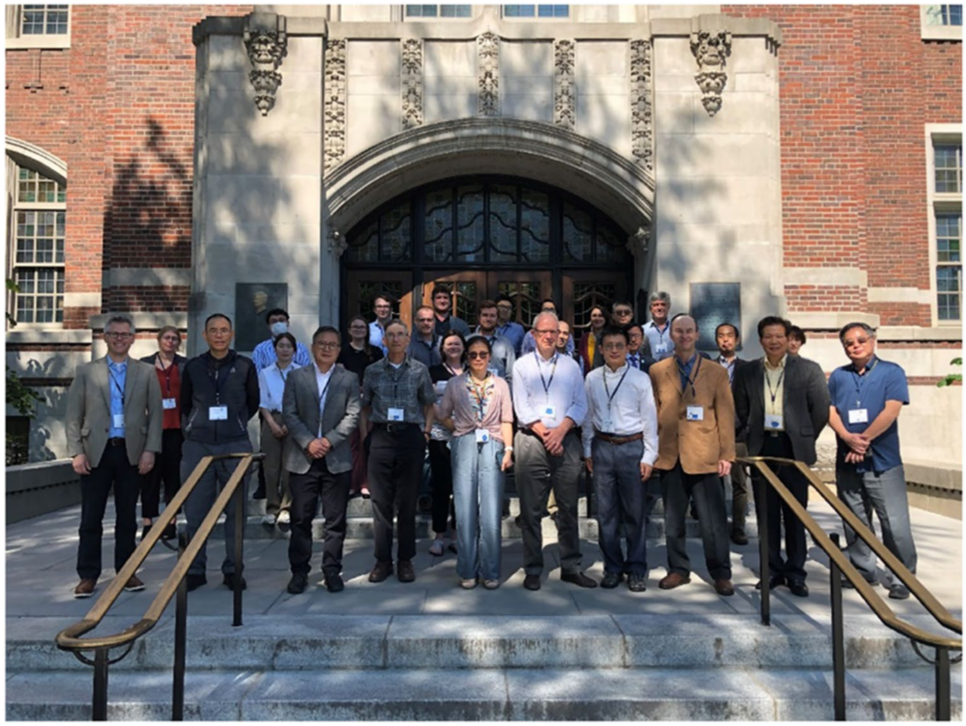

Fig. 1 The 2022 IWMO group photo for in-person participants in front of Michigan Union Hall at the University of Michigan central campus

students and postdocs presenting their research and competing for the Outstanding Young Scientist Award (OYSA).

This topical collection of papers in Ocean Dynamics includes 11 peer-reviewed papers from participants of IWMO 2022. The papers went through rigorous reviews from both IWMO members and external experts. Below are brief summaries of the IWMO 2022 papers (alphabetically ordered):

Cannon et al. (2023) employed a modified FVCOM-CICE model to simulate all five Great Lakes' hydrodynamics driven by NARR (North America Regional Reanalysis). The modified numerical time integration (leapfrog) scheme possesses neutral inertial stability and allows the 42-year simulation without any data assimilation.

Chang et al. (2023) presents a coupled river-ocean model to accurately capture real-time river runoff caused by a heavy rainfall event in Japan, showing how real-time river discharge data can improve the modeling results.

Ezer (2023) investigates the major factors contributing to sea-level rise (SLR) and variability in Chesapeake Bay during 1975–2021. Factors include local seasonal cycles due to annual and semi-annual tides and remote factors such as the North Atlantic Oscillation (NAO). The study found large sea level variations within the bay, and on long-time scale the sea level in the north and south of the bay are at opposite phase. Sea level prediction up to 2100 demonstrates the difficulty of predicting long-term SLR in bays.

Fan and Du (2023) analyzed hourly sea-level data from 699 worldwide tide gauges and 72 representative tide gauges in the Northwest Pacific between 1960 and 2013 to study the extreme sea level (ESL) variability. It was found that the combined effect of water-level discrepancy, sea-level variability, high tide level and wind are major contributors.

Gramcianinov et al. (2023) investigate the extreme wave climate trends in the southwestern South Atlantic using traditional and storm-based approaches to determine potential coastal impacts. It was found that extreme wave events are being modified by storm track changes as consequence of Hadley cell expansion.

Liao et al. (2023) investigate the forecasting of marine debris by forcing a state-of-the-art particle-tracking model with operational oceanic and atmospheric models and compares simulations with the spotted debris from an actual maritime container spill in the south-eastern Australia water. The study evaluates different factors that affect the model such as Stokes drift and dispersion parameterizations.

Titze et al. (2023) tested a flood forecasting modeling system consists of a hydrodynamic model built on FVCOM with one-way coupling to a WAVEWATCH III wave model. The National Water Model stream network was expanded to include the entire Lake Champlain-Richelieu River (LCRR) domain and is used to inform river inflows into the system. Simulations of significant wave heights and water levels were compared well with observations.

Wang et al (2023) demonstrated that FVCOM default time integration schemes are unstable in the inertial mode, thus the model required too large viscosity, which smooths physical features such as vertical stratification, fronts, and mesoscale eddies. The study also showed that the Euler forward scheme with a 1st-order truncation error used in FVCOM introduces unrealistic computational (biharmonic) viscosity, making FVCOM too dissipative for temperature and salinity. Another numerical option was introduced in this study, using a 2nd order accuracy leapfrog scheme, which has a neutral inertial stability and no computational viscosity. The comparison between the two schemes was conducted in all five Great Lakes to show the significant improvement using the leapfrog scheme.

Yang et al. (2023) shows the non-linear tide-surge interactions (NTSIs) over the eastern Canadian shelf (ECS) during two extreme weather events, using the Regional Ocean Modeling System (ROMS). It is found that the non-linear friction and advection are the dominant factors in the NTSIs during the two storms.

Zhang et al. (2023a) implemented the ATLANTIS fisheries model with one-way coupling to 3-D FVCOM (see Cannon et al. 2023, this issue) in Lake Michigan. This is the first trial applying Atlantis to freshwater lake. The model reproduces both lower (food web) and upper (fisheries) trophic level ecosystems in a 3-D manner. The coupled FVCOM-CICE-Atlantis model is the framework of the Great Lakes Earth System Model that will be used to hindcast the past and present conditions and future changes of the ecosystem in response to climate change.

Zhang et al. (2023b) implemented an ice model into the Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM) and applied the coupled model to Lake Superior. The unstructured fine model grid allows simulations of ice fields at scales as small as ~ 1 m. This new model will provide another coupled ice-ocean model to the coastal community in addition to the existing coupled ice-ocean models.

In summary, the 2022 IWMO was successfully held during the end of the pandemic at the University of Michigan Ann Arbor campus. We implemented a hybrid meeting (in-person and virtual presentations) and a strict COVID protocol and achieved no incident for the in-person attendees. The following meeting (IWMO-2023, held in Hamburg, Germany) returned to a standard all in-person meeting. It is noted that about half of the papers in this IWMO-2022 Topical Collection focus on the Great Lakes system modeling, indicating that great efforts and progress have been made on the development of the Great Lakes system modeling in recent years.

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Data availability No data are involved in this manuscript.

Declarations

The paper has not been submitted or under consideration for any other publication.

Conflict of interest The authors declare no conflict of interest.

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