FVCOM Implementation and Validation in the USVI and Eastern PR

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Introduction

The Finite Volume Community Ocean Model (FVCOM) developed by Dr. Chen et. al has been implemented in PRVI by CARICOOS (Fig 1) and it has been validated to be a reliable and indispensable 3D ocean modeling tool. Compared to other ocean models (like HYCOM, SWAN, et al.) built in a structured grid, FVCOM employing triangular elements can provide an accurate geometric representation of complex coastlines. a variable spatial resolution of 80-3000 m was applied (Fig. 3) in PRVI where the grid gets finer towards the coast. FVCOM solves the governing equations on Cartesian or spherical coordinates in integral form by computing fluxes between non-overlapping horizontal triangular control volumes (Chen, et. al, 2013). This finite-volume approach combines the best features of the finite-element methods for geometric flexibility and finite- difference methods for code simplicity and numerical efficiency.

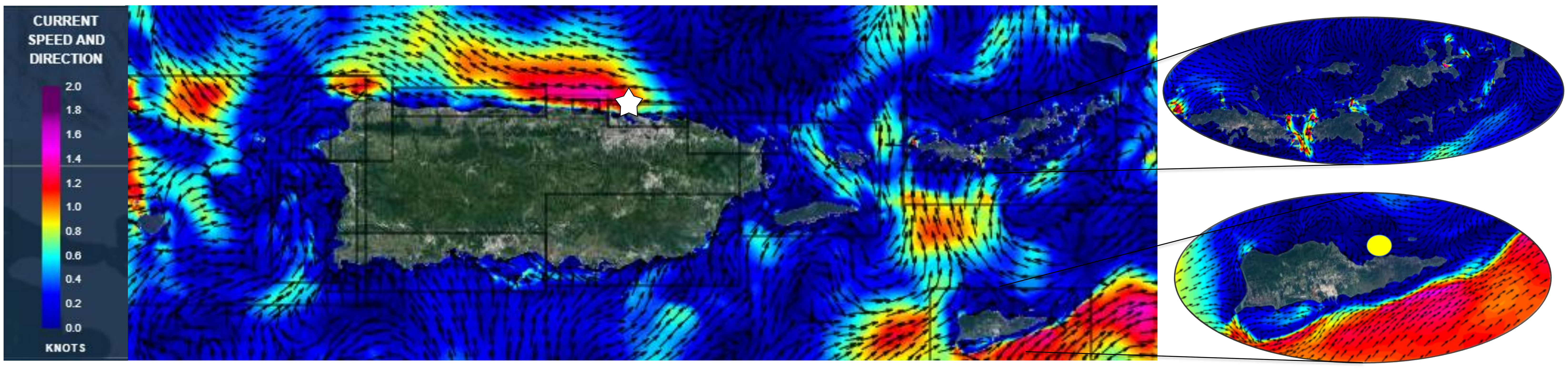


Fig. 1. FVCOM was implemented in the PRVI domain providing an accurate geometric representation of complex coastlines.

Model Setup

Basic model set-up is comprised of grid, bathymetry, boundary conditions, surface forcing and initial conditions.

- *Unstructured grids*: SMS
- *Coastline*: NOAA GEODAS
- *Bathymetry*: NGDC database
- *Surface forcing*: the interpolation of 2km and 6km WRF NMM (Fig. 3).
- *Boundary tide forcing*: TMD
- *Baroclinic forcing and initial condition*: Global RTOFS

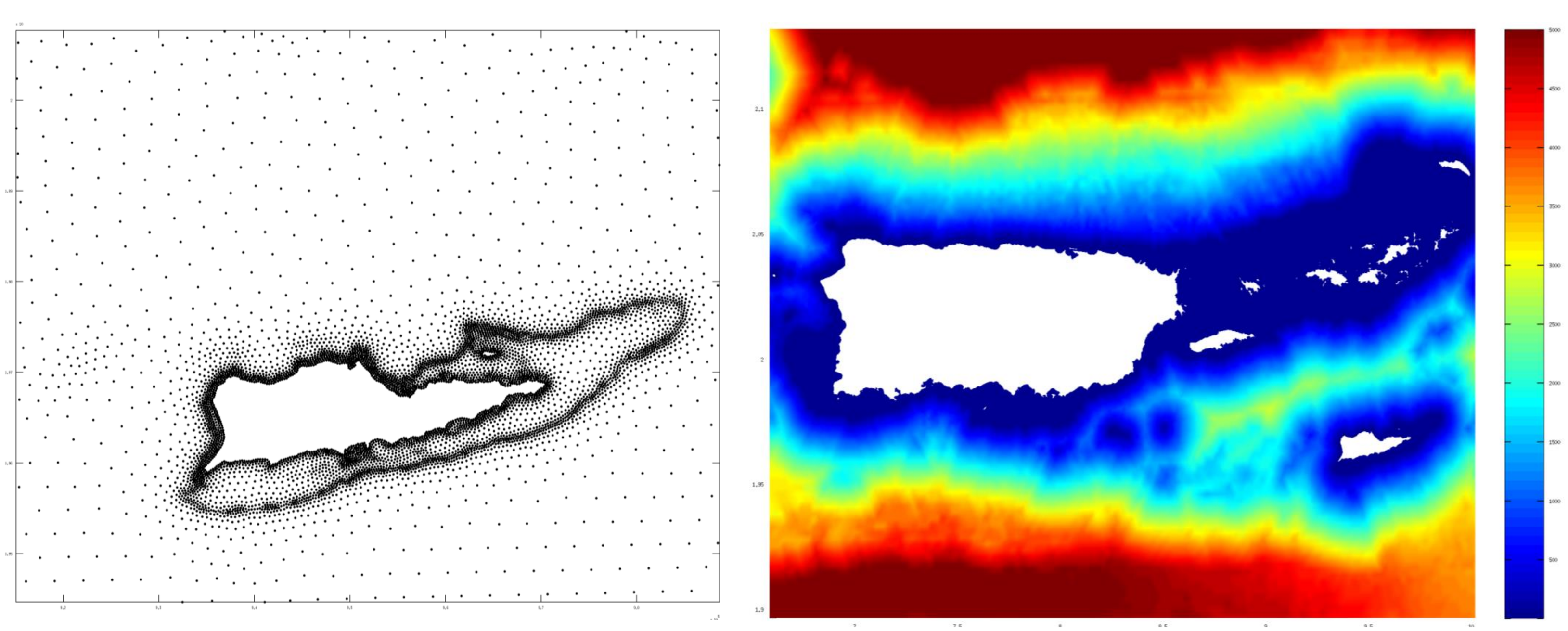


Fig. 2. The complex coastline (St. Croix) and accurate bathymetry fields represented by unstructured grids applied in FVCOM simulation.

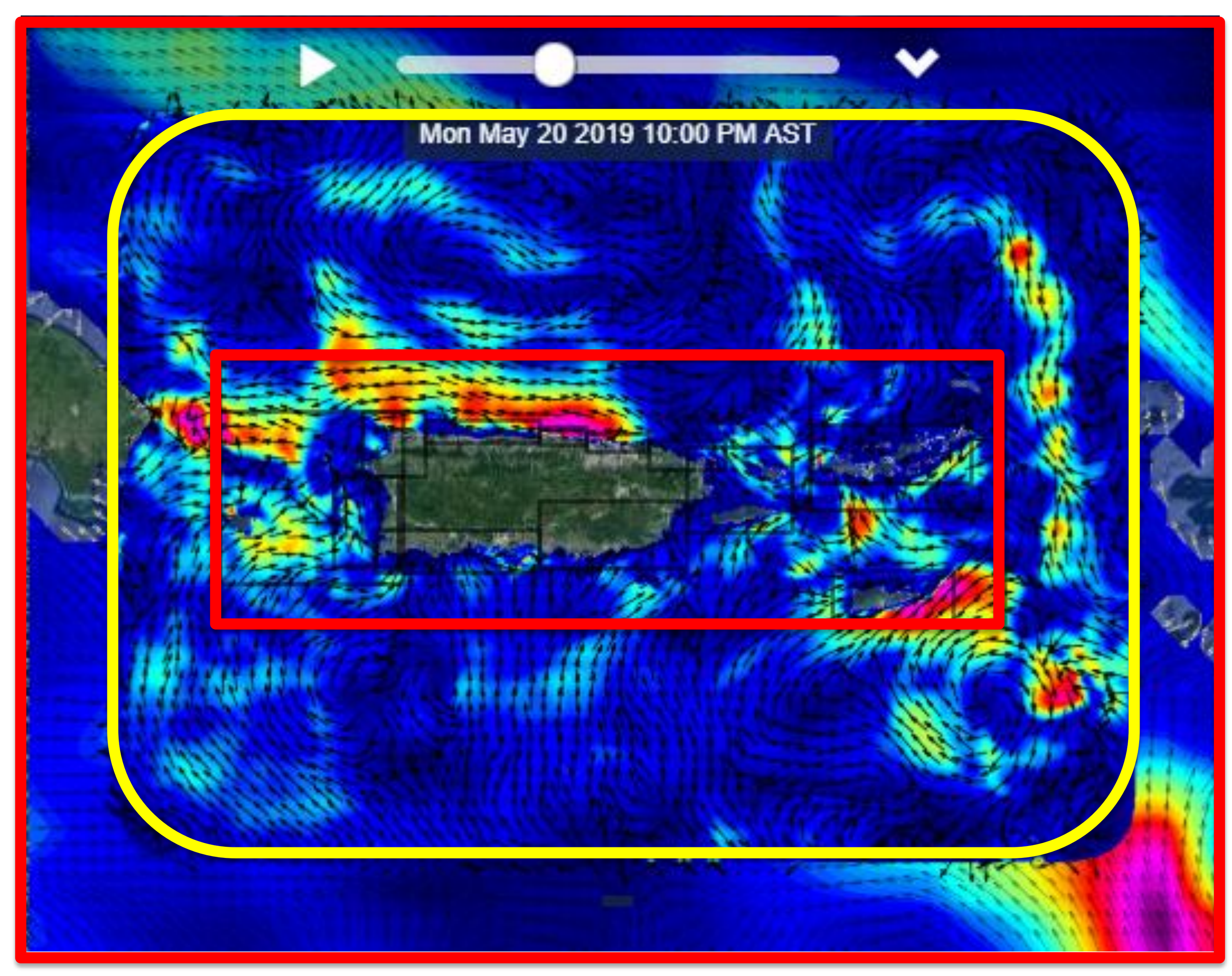
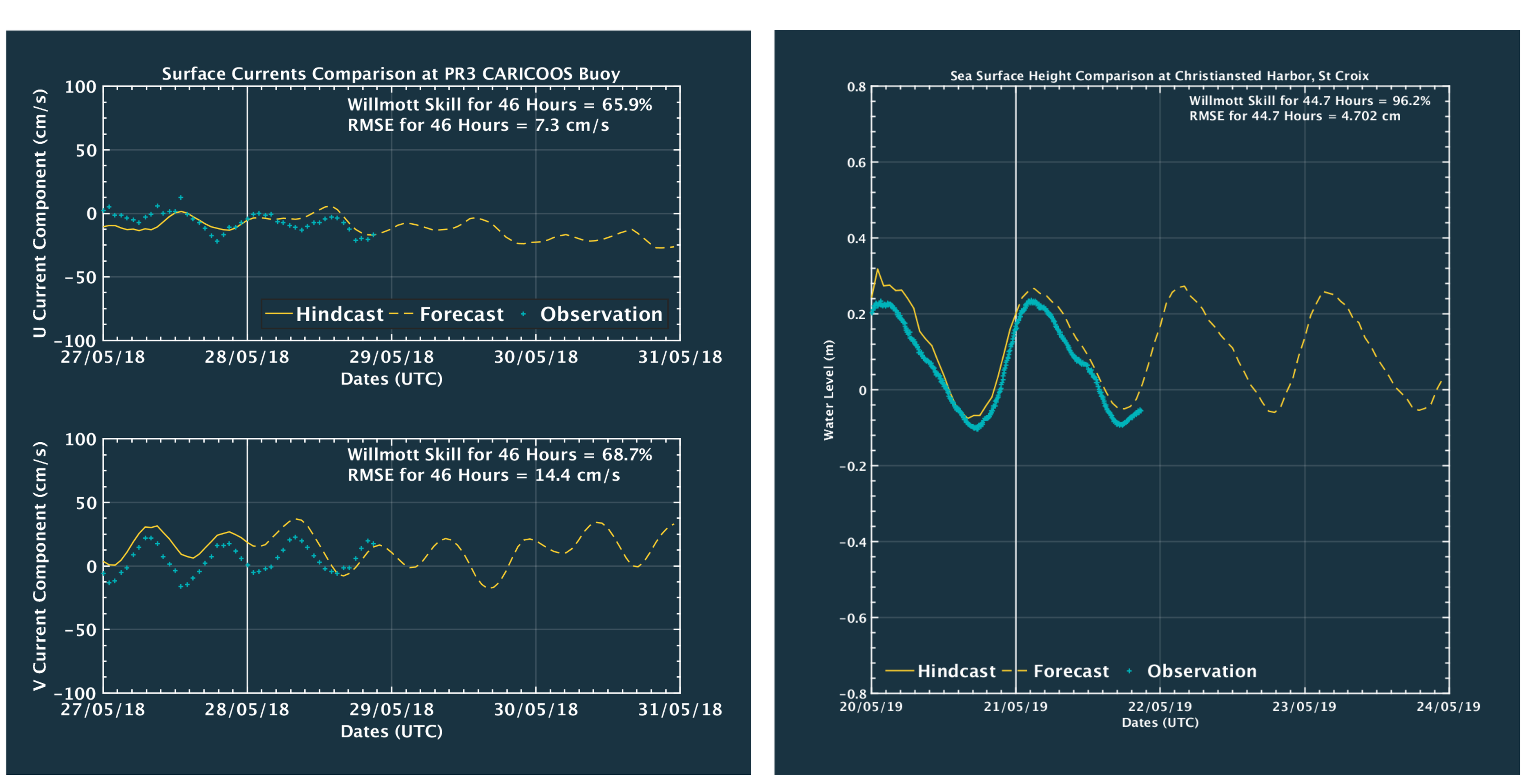


Fig. 3 The forecast current speed simulated by FVCOM (unstructured) and AMSEAS (structured) in PRVI. The close area within the yellow round-cornered rectangle represents FVCOM implementation domain while the inner and outer red rectangle represent the WRF model boundary with spatial resolutions of 2 and 6 km, respectively.

Model Validation



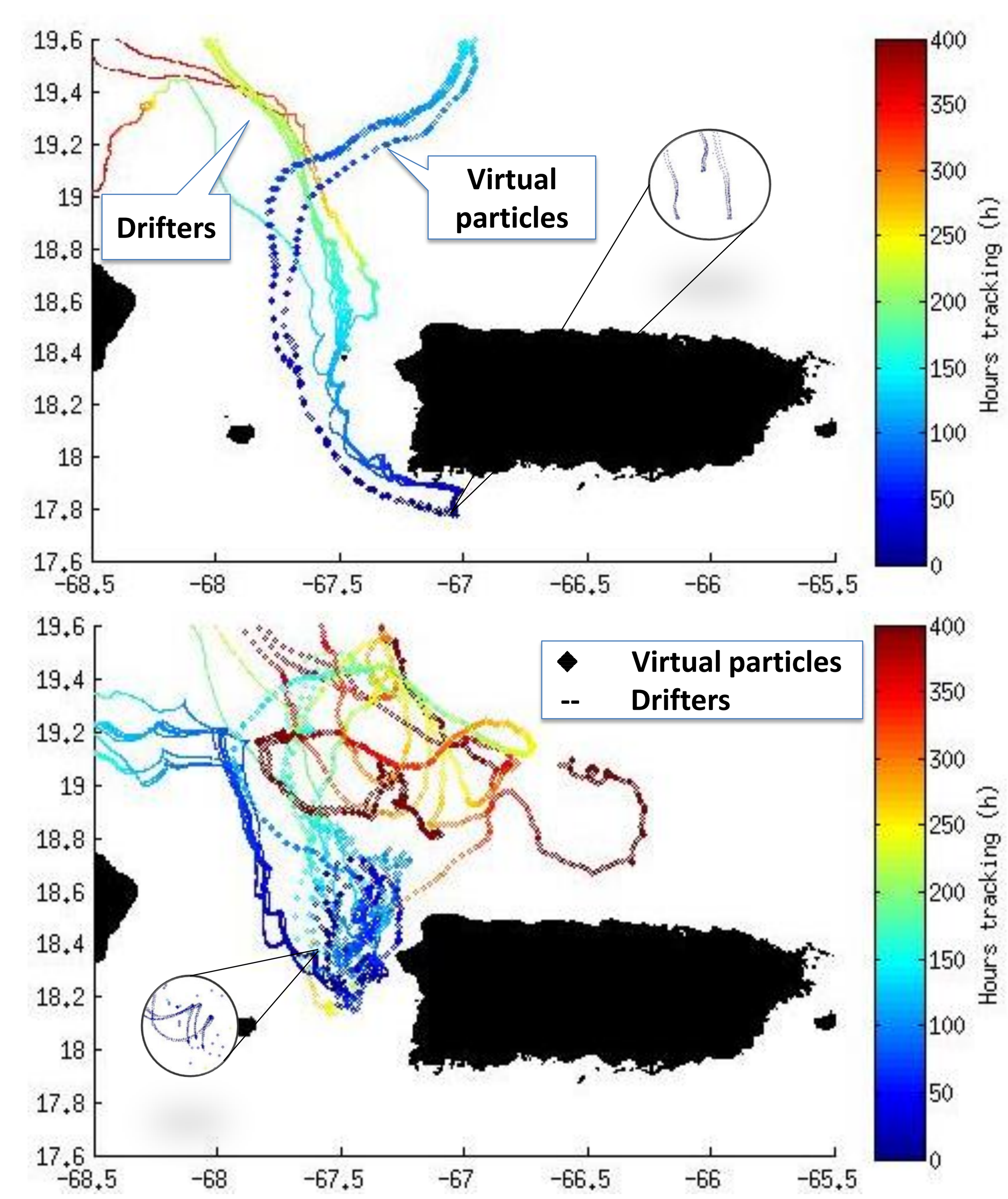


Fig. 4. The two panels above show the hindcasts and forecasts from FVCOM compared to the observations at Vieques Buoy (white asterisk in fig. 1), Christiansted Harbor Tide Gage (yellow circle in fig. 1). In addition, the satellite-based surface drifters were used to validate FVCOM (right two panels). A total of 20 floating drifters were released at southwestern PR on April 26, 2017. Meanwhile 20 virtual particles released at the same locations were simulated by the proposed PTM. The trajectories of drifters and PTM particles were indicated by solid line and circles, respectively.

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