Enhancing Tidal Energy Forecasting Using Hybrid Online Machine Learning

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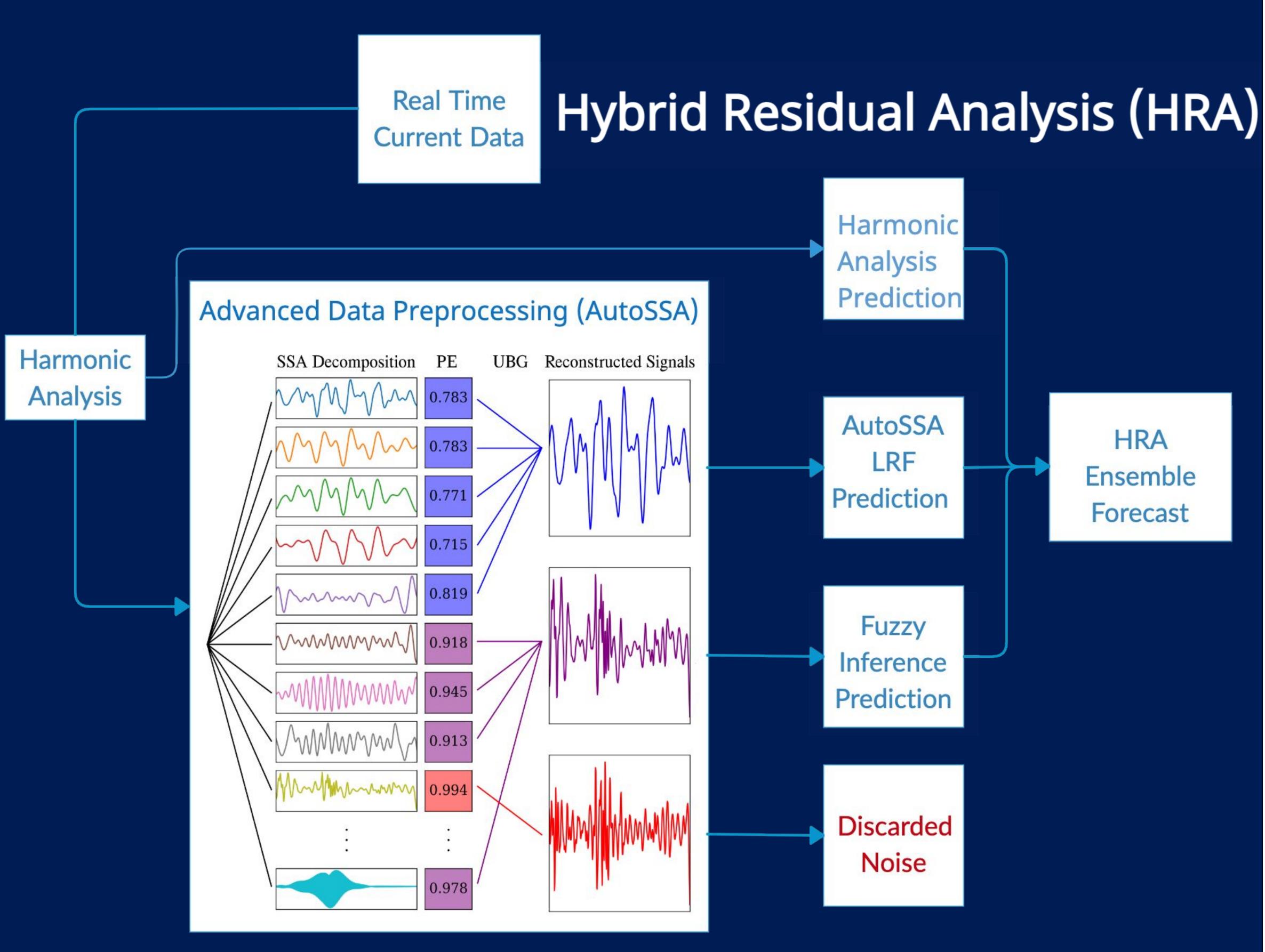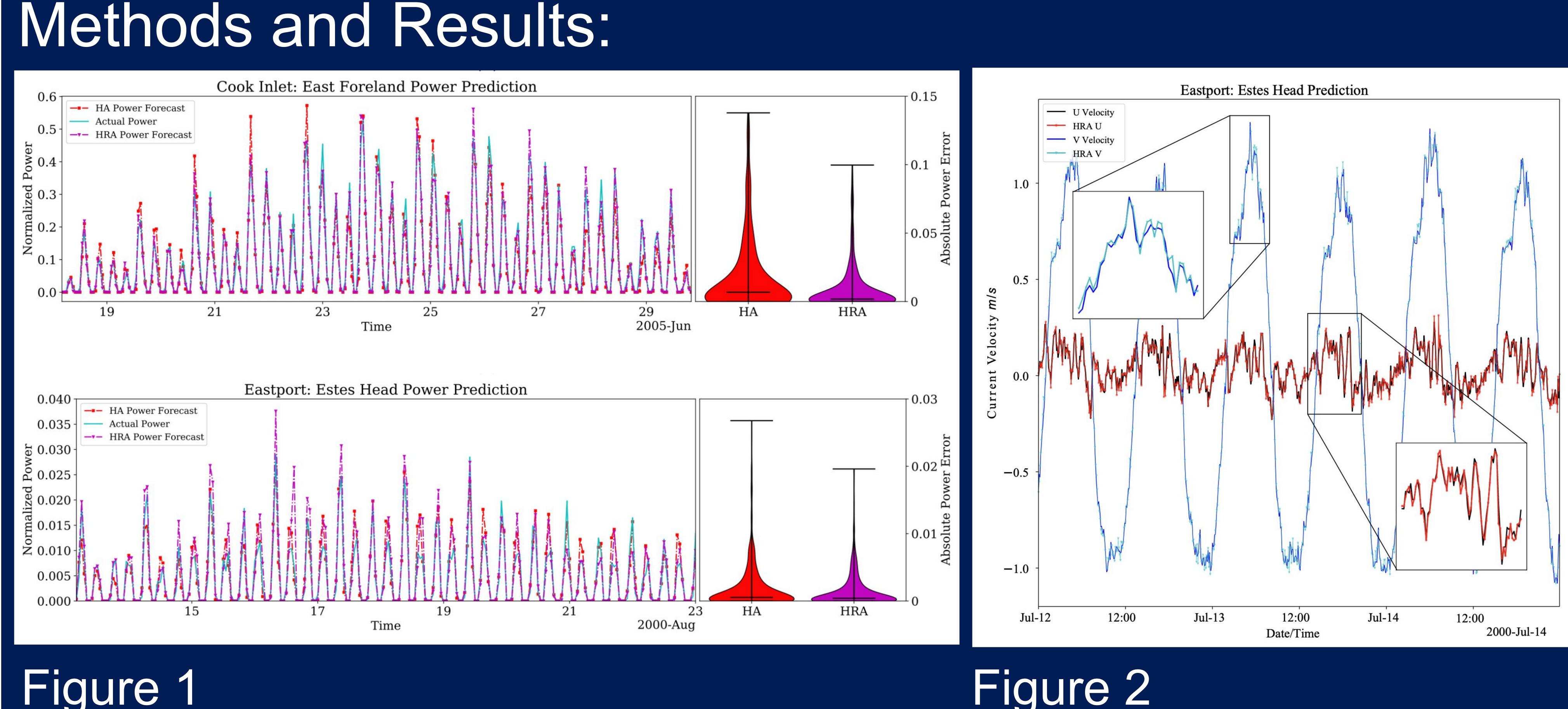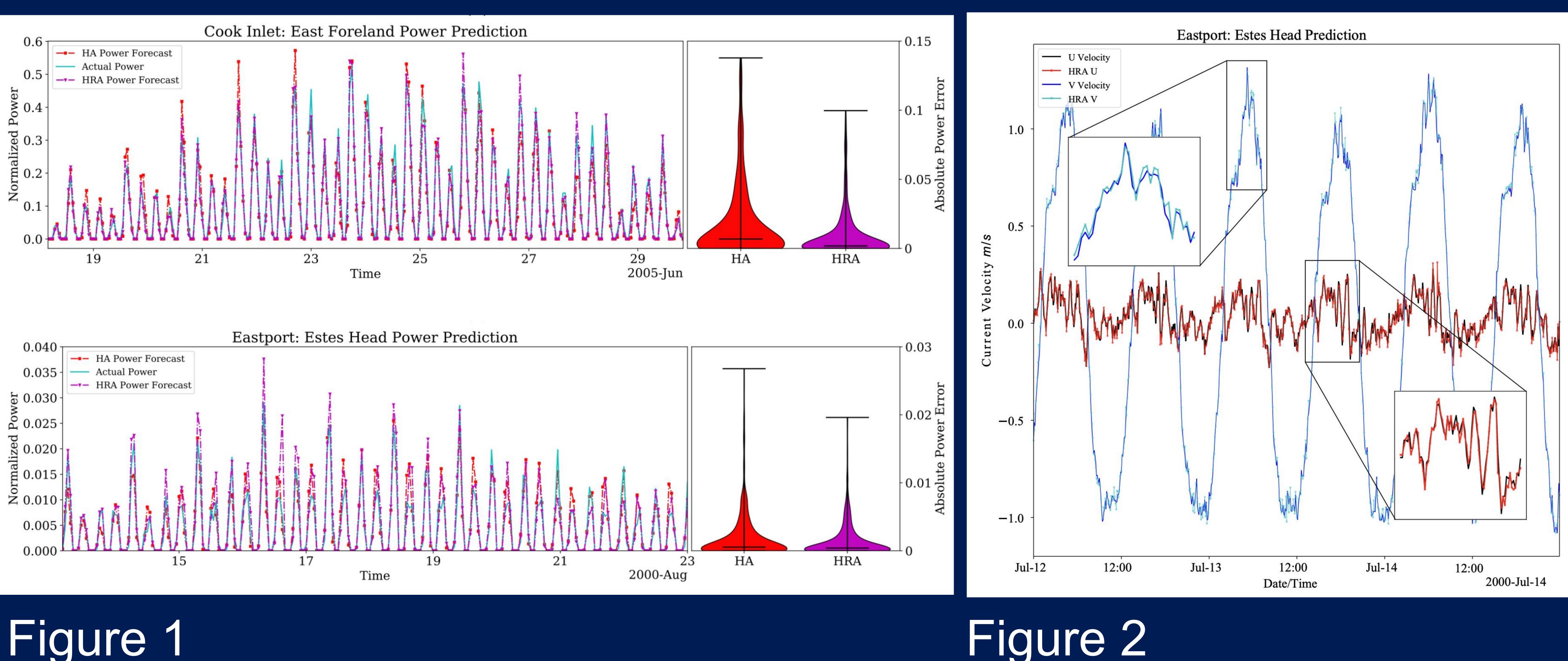## Context:

- Accurate short-term (real-time to 1-hour) power forecasts are critical to facilitate the economical implementation of tidal energy systems.

- Stochasticity and nonlinearity introduced by turbulence, waves, bathymetric interactions, and meteorological forcing make short-term forecasting of fast moving currents a difficult task.

- Hybrid Online methods combine the reliability of "physics-based" methods with the improved localization and generalization capabilities of Machine Learning.

Hybrid Residual Analysis (HRA)

Methods and Results:

Figure 1

Figure 2

Figure 1: 15 days of 1-hour Online Power Forecasts for Cook Inlet, AK and Eastport, ME.

Figure 2: 3 days of 6 Minute Online forecasts for Eastport, ME.

Outcomes and Applications:

- We present the first Online prediction model for tidal currents.

- The experimental results verify the HRA method's viability for both 6-minute and 1-hour online tidal current forecasting. The method is robust to non-linearity and non-stationarity and has been shown to work across a diverse set of sites.

- The proposed model realizes accurate online predictions for both tidal currents and the resultant power generation and can therefore be used to augment the forecasting schemes at existing tidal energy sites.

- Online schemes can significantly improve short-term forecasting accuracy for renewable energies.

- HRA based methods can be combined with alternative ML methods depending on the data and forecast horizon.