AI-driven nowcasting of sea-surface currents estimated by HF Radar

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Obtaining accurate forecasts of sea currents is a problem of paramount importance in many respects ranging from coastal management to civil protection activities. Short-term forecasts, the so-called nowcasting, are also useful because of their role to reduce the impact of natural disasters and other hazards on the population, thus, ultimately, saving lives. Our focus here is to propose a new data-driven AI-based strategy to predict sea-surface currents (direction and magnitude) for a time-horizon of six hours (hourly frequency). Our nowcasting strategy is based on HF-radar observations, collected from CNR in the Ligurian sea from 2018 to 2022. The AI architecture uses convolutional (CNN) and Bidirectional convolutional LSTM (ConvLSTM) modules inserted in an Variational Encoding – Forecasting (VEF) architecture. The convolutional and recurrent layers are stacked repeatedly in the encoding and forecasting part of the model. The encoding network analyses spatiotemporal patterns of past data to generate a latent space that corresponds to the parameters of a variational distribution. The forecasting network uses latent vectors of the encoding network to forecast future sea currents. In order to train the model, the input is made by sequence of regular grids of 2 km X 2 km, with 16 cells per side, where in each cell u and v components of the sea current velocity are stored, with hourly frequency. Then, the objective is to forecast a new sequence, with hourly frequency, of the u and v components of the sea current up to six hours. The predicted current fields have been compared with the ground truth in terms of statistical indices, such as Normalized Root Mean Square (NRMSE) and Pearson correlation coefficient, by looking at the u and v velocity components, vorticity, divergence, and strain rate tensor. In order to train the AI model, we used data from 2018 to 2021, and the test is performed on the whole 2022. The results are promising, and have been compared with predictions from a base model, such as the persistence and an Encoding – Forecasting architecture, also known as UNet, showing skill scores of the statistical indices considered up to 25%.