ABSTRACT

Coronal Holes (CHs) are the major source of origin of the fast solar wind, which is its most geo-effective component. Identifying the coronal hole configuration and the large-scale structures of the solar corona enables prediction of the solar wind at 1 AU, thus allowing validation of solar wind models in reference to 1 AU observations. In this work, we contribute to the WindTRUST project, which aims to fill the gaps in France's ability to predict and protect against the most intense solar events, and we are dedicated to improving numerical simulations of the Sun-Earth system and its interaction with the Parker spiral. We focus on developing a solar wind model validation pipeline based on coronal hole EUV observations. Specifically, we use SDO/AIA images for *193Å* and composite images *(171Å, 193Å, & 211Å)*, under different solar conditions within solar cycle 24. CHs are detected by identifying the darker regions, which correspond to the low-density and low-temperature regions of the solar corona. Therefore, based on the intensities in the EUV wavelengths, the threshold value corresponding to the segmentation of CH regions requires optimization.

Based on CH contour observations, we develop a machine learning algorithm to determine the optimized threshold value for a fixed time within solar cycle 24. To this end, we use the *EZSEG* algorithm and the *opencv-python* library to trace the CH contours, and the optimized threshold values are identified by matching the observed CH area on the solar disk at that time with the CH contour area detected using these two methods. The machine learning algorithm is trained using solar indices data and data from large-scale events such as solar flares and Coronal Mass Ejections during solar cycle 24. Once we identify the optimized threshold values for the CH contours in the SDO/AIA images, we validate them using a diagnostic test with the CH contours produced from the Potential Field Source Surface (PFSS) model (non-MHD) and the WindPredict (WP) model (Polytropic and Alfvén Wave) (MHD). Subsequently, we repeat the above systemic procedure to develop a comprehensive automatic validation tool, extending it to include solar cycles 23 and 25 using SoHO, STEREO, and SolO EUV images of the solar corona. Finally, we couple the machine learning model and the validation pipeline to develop an automation tool for solar wind predictions at 1 AU.