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TID measurement using oblique transmissions of HF pulses

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The Traveling Ionospheric Disturbance (TID), a wave-like signature of moving plasma density modulation in the ionosphere, is widely acknowledged for its utility in backtracking the anomalous events responsible for the TID generation, and as a major inconvenience to high-frequency (HF) operational systems because of its deleterious impact on the accuracy of navigation and geolocation. The pilot project "Net-TIDE" for the real-time detection and evaluation of TIDs began its operation in 2016 based on the remote-sensing data from synchronized, network-coordinated HF sounding between pairs of DPS4D ionosondes at five participating observatories in Europe. Measurement of all signal properties (Doppler frequency, angle of arrival, and time-of-flight from transmitter to receiver) proved to be instrumental in detecting the TID and deducing the TID parameters: amplitude, wavelength, phase velocity, and direction of propagation. Processing of the measured HF signal data required a specialized signal processing technique that is capable of consistently extracting different signals that have propagated along different ionospheric paths. The multi-path signal environment proved to be the greatest challenge for the reliable TID specification by Net-TIDE, demanding the development of an intelligent system for "signal tracking". The intelligent system is based on a neural network model of a pre-attentive vision capable of extracting continuous signal tracks from the multi-path signal ensemble. Specific examples of the Net-TIDE algorithm suite operation and its suitability for a fully automated TID warning service are discussed.