Identifying Ducting Events in GNSS-RO Data: A Comparative Study of Spectral and Time-Series Approaches

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The accuracy of Global Navigation Satellite System (GNSS) Radio Occultation (RO) retrievals is frequently degraded by superrefraction (SR) in the moist lower troposphere, where extreme refractivity gradients produce deep signals and substantial retrieval errors. To address this, we developed a machine learning framework for automated SR detection using FORMOSAT-7/COSMIC-2 data. Two complementary approaches are compared: a convolutional neural network trained to identify SR signatures directly from RO spectrograms, and a time-series model that operates on raw excess phase observations, capturing the signal's temporal phase evolution without any post-processing. Both models are trained and validated against high-resolution radiosonde observations as ground truth, using a strict spatio-temporal collocation window of 300 km and 3 hours. Both architectures achieve approximately 90% detection accuracy; while the spectrogram-based model performs SR detection with high precision, the time-series model offers superior computational efficiency and simpler data handling. Together, these two approaches form a practical toolkit for improving quality control of RO data and ensuring more reliable atmospheric soundings under extreme meteorological conditions.