Chirp-Based Pulse Compression for Duty Cycle Optimization in SOPHy X-Band Weather Radar

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Abstract

The *Scanning-system for Observation of Peruvian Hydrometeorological Events* (SOPHy) weather radar, developed by the Instituto Geofísico del Perú (IGP), is a dual-polarization *software-defined radio* (SDR) system operating in the X band with a range of 60 km and resolution of 60 m. Its transmission technology is primarily based on solid-state amplifiers. Due to their low output power (200 W), pulse compression techniques are necessary to achieve adequate sensitivity without decreasing range resolution. The initially employed phase-coding technique prevented the amplifier from operating at maximum efficiency, achieving only 4% of the available *duty cycle*. To overcome this limitation, a pulse compression technique based on *chirp* waveforms is developed and evaluated, enabling more efficient use of the transmitted power and achieving a *duty cycle* of 12%. The results demonstrate an increase in the average *signal-to-noise ratio* (SNR) of 13.87 dB, a reduction of the blind range by 151 m, and an increase in the unambiguous Doppler velocity to ±20 m/s. Consequently, these improvements in the *duty cycle* will strengthen the detection capabilities of the high-resolution SOPHy radar system and make a significant contribution to the observation and study of atmospheric phenomena in Peru.

Keywords: weather radar, pulse compression, *chirp* signal, *duty cycle*