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Temporal Analysis of Large-Scale Winds in Austral Chile

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Austral Chile, characterized by its intricate topography of small islands, channels, and fiords, relies heavily on navigation for local economic activities, security, and societal functions. Wind-related hazards pose a significant safety threat to navigation, with the complex topography exerting a profound influence on local wind patterns. This study undertakes a comprehensive examination of large-scale winds in the region as an initial step toward understanding the intricate dynamics of local wind systems. This study is part of a larger research project that aims to produce a very high-resolution wind forecasting system, based on the downscaling of WRF simulations by using Deep learning techniques (SiVAR-Austral, funded by ANID ID22I10206).

Utilizing 50 years of ERA 5 reanalysis daily wind fields, we employ a self-organizing map (SOM) approach, with four distinct SOMs corresponding to each season, to unveil seasonal wind patterns. Furthermore, a cluster algorithm is applied to establish relationships between these patterns, elucidating the various stages of synoptic conditions associated with different wind patterns. Through an in-depth analysis, we explore the frequencies of these patterns across different decades, providing insights into their temporal evolution.

Our findings reveal the complex interplay between the region's topography and wind patterns, offering a better understanding of the seasonal variations in large-scale winds. The identification of distinct synoptic conditions associated with specific wind patterns enhances our ability to predict and mitigate navigation-related safety threats. Additionally, the temporal evolution of these patterns across decades contributes valuable information for long-term planning and risk assessment. This research lays the foundation for a more robust comprehension of wind dynamics in Austral Chile, with potential applications in enhancing navigation safety protocols and supporting sustainable coastal development.