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Spatio-Temporal LSTM Forecasting of Ozone Secondary Events

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Given the dynamics of the atmosphere, the ozone hole is accompanied by episodes of exchange between the polar vortex and the mid-latitudes and the tropics (Bencherif et al., 2007). During these events, the polar vortex is deformed and ozone-poor polar air-masses move towards the tropics. We call these episodes of isentropic exchanges “Ozone Secondary Effects” (OSE), and several events have been observed during the last decade. For example, an event observed on October 14, 2012 reached the south of Brazil (Peres et al., 2017), causing 13.7% reduction in the total columns of ozone. Recently, Bresciani et al. (2018) reported on a major OSE event (23% reduction in TCO) and its influence in southern Brazil and Uruguay that occurred in October 2016. Such OSE episodes may last up to 3 weeks, causing a potential increasing in the UV radiation levels leading to public health issues as well as impacts on the fauna and flora, with notable risks for the biodiversity and the agriculture.

In the present study, we investigate the use of Long Short-Term Memory recurrent neural networks to forecast OSE events, more specifically the Causal LSTM model proposed by Wang et al. (2018), which has been successfully applied to the analysis of video images. In our study, however, the input data is composed by historical data for the total column of ozone (TCO), obtained by satellites. We aim at using the resulting forecasts to detect, monitor and classify OSE events by isentropic levels, latitudinal bands and geographical areas. We believe that these results can be integrated into a weather forecast workflow to improve the accuracy of existing models.

Further experiments include the conjoint analysis of other atmospheric markers such as the potential vorticity (PV). Together with auxiliary parameters such as cloud fraction, aerosol optical depth, nebulosity and altitude, these forecasts could be used to produce realistic UV-Index estimations.

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