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Mathematical Neural Network (MaNN) Models

Part I[#]: Data-driven Soft-models for ozone in air quality[#]

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Dedicated to Malladi Narasimha Sastry (popularly known as M N Sastry), former professor of Nuclear chemistry, Andhra University, on his *sahasra chandra darsanam* (thousand lunar months of life on the lap of mother earth)

ABSTRACT

The quality of environment especially of air and water has a key role on human health. The effect is pronounced on children and vulnerable groups. The efforts of governmental agencies are to forecast and inform the alarming situations of the day in advance. The monitoring, modelling and now short term and long term prediction is pivotal in environmental research. And, passing the skills down to routine maintaining stations are in the direction of avoiding the ill-effects of pollutants. The chemical, biological and meteorological micro processes and their interaction are complex, non-stationary and thus cannot be handled from first principles. Artificial neural networks (ANN), later preferably called neural networks are in fact Mathematical Neural Network Models (MNNM) partially resembling mega biological neural networks. These data driven NNs, a subset of evolutionary models revolutionised the modeling practices in environmental science since late 1990s. The earlier model driven linear/non-linear models are integrated as a priori knowledge in sequential NNs. An increase of 0 to 1.7K and 1.4 to 2.4K of temperature in select US cities is forecasted during the periods 2020-2050 and 2051-2099. This long term forecast paves way in the management and planning of eco-balance. Cause and effect models fail for ozone due to non-linear, dynamic processes occurring in the formation, decomposition and transport of ozone. Tropospheric ozone is modelled by SLP-NN using 13 variables. The prediction of ozone at ground level in UK, Europe, Athens and Dallas and surface level in Austria, UK, Chile and Korea with NNs is more reliable compared to non-linear multiple regression and generalized additive model. The exceedence predictions in Athens as well as rural places in UK are successful experiments. NEUROZONE is an automatic software prediction tool and it is successful in six out of seven incidences of ozone exceedence. The factors for failure of ozone predictive models are described.

Keywords: Air pollution, Ozone exceedence, Human health, Neural network model, Forecast, Nature mimicking algorithms.

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