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DATA DRIVEN IONOSPHERIC MODELING IN RELATION TO SPACE WEATHER: Percent Cloud Coverage

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Since 1990, a small group at METU has been developing data driven models in order to forecast some critical system parameters related with the near-Earth space processes. The background on the subject supports new achievements, which contributed the COST 724 activities, which will contribute to the new ES0803 activities. This work mentions one of the outstanding contributions, namely forecasting of meteorological parameters by considering the probable influence of cosmic rays (CR) and sunspot numbers (SSN). The data-driven method is generic and applicable to many Near-Earth Space processes including ionospheric/plasmaspheric interactions. It is believed that the EURIPOS initiative would be useful in supplying wide range reliable data to the models developed.

Quantification of physical mechanisms, which causally link Space Weather to the Earth's Weather, has been a challenging task. In this basis, the percent cloud coverage (%CC) and cloud top temperatures (CTT) were forecast one month ahead of time between geographic coordinates of (22.5˚N; 57.5˚N); and (7.5˚W; 47.5˚E) at 96 grid locations and covering the years of 1983 to 2000 using the Middle East Technical University Fuzzy Neural Network Model (METU-FNN-M) [Tulunay, 2008]. The Near Earth Space variability at several different time scales arises from a number of separate factors and the physics of the variations cannot be modeled due to the lack of current information about the parameters of several natural processes. CR are shielded by the magnetosphere to a certain extent, but they can modulate the low level cloud cover.

METU-FNN-M was developed, trained and applied for forecasting the %CC and CTT, by considering the history of those meteorological variables; Cloud Optical Depth (COD); the Ionization (I) value that is formulized and computed by using CR data and CTT; SSN; temporal variables; and defuzified cloudiness. The temporal and spatial variables and the cut off rigidity are used to compute the defuzified cloudiness. The forecast %CC and CTT values at uniformly spaced grids over the region of interest are used for mapping by Bezier surfaces. The major advantage of the fuzzy model is that it uses its inputs and the expert knowledge in coordination.

Long-term cloud analysis was performed on a region having differences in terms of atmospheric activity, in order to show the generalization capability. Global and local parameters of the process were considered. Both CR Flux and SSN reflect the influence of Space Weather on general planetary situation; but other parameters in the inputs of the model reflect local situation. Error and correlation analysis on the forecast and observed parameters were performed. The correlations between the forecast and observed parameters are very promising.

The model contributes to the dependence of the cloud formation process on CR Fluxes. The one-month in advance forecast values of the model can also be used as inputs to other models, which forecast some other local or global parameters in order to further test the hypothesis on possible link(s) between Space Weather and the Earth's Weather.

The model based, theoretical and numerical works mentioned are promising and have potential for future research and developments.

References

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