

## **A&M Data: Processing and Modeling in Real Time**

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Atmospheric modeling requires usage of accurate radiative and collisional A&M data, both experimental and theoretical (Griem et al. 1962; Albert et al. 2020, Marinkovic et al. 2017a,b). From technological perspective, this often means heterogeneous e-ecosystem, consisting of different datasets and formats and various programming frameworks synchronized to work together, such as in Virtual Observatory (ivoa.net) or VAMDC (vamdc.org) project efforts. Understanding atmospheric processes is not only of pure scientific importance but for prevention of signal disturbances and infrastructure failures.

Our aim was to determine properties of the atmosphere i.e. lower ionosphere plasma in real time in order to establish a platform which can issue electronic alerts in a timely manner as well as show ongoing analytical overview of atmospheric properties (chemistry and physics). Moreover, it would enable real time modeling incorporating methods already introduced in flarED (Srećkovic et al. 2021a,b).

We selected data obtained from BLG ionospheric VLF (Very Low Frequency) station, and GOES satellite. For the initial development phase, we staged the data to behave as it would in a real-time scenario, by transforming input MATLAB data into a simulated stream of time series data. The analysis of VLF data was carried out simultaneously with the examination of the correlative solar X-ray fluxes collected from GOES satellite. Every data object obtained from these instruments can be regarded as an event, similar to a stock tick at the stock exchange. Correlation of some of these events leads to recognition of the events of higher order, and at the same time various kind of running statistics and analytics can be applied over the data. We used Esper, an open-source event-processing technology for the back-end.

We made a pre-alpha version of cep4vlf (Complex Event Processing for Very Low Frequency), which stages historical data in a real-time scenario. All work is available on GitHub (<https://github.com/sambolino/cep4vlf>). Purpose of cep4vlf is to enable automatic, real time detection of SID events, like flares, GRB's, lightning, etc. which can affect chemistry and physics of ionosphere. Moreover, it will enable real time modeling incorporating methods already introduced in flarED (<https://github.com/sambolino/flared>).

## References

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