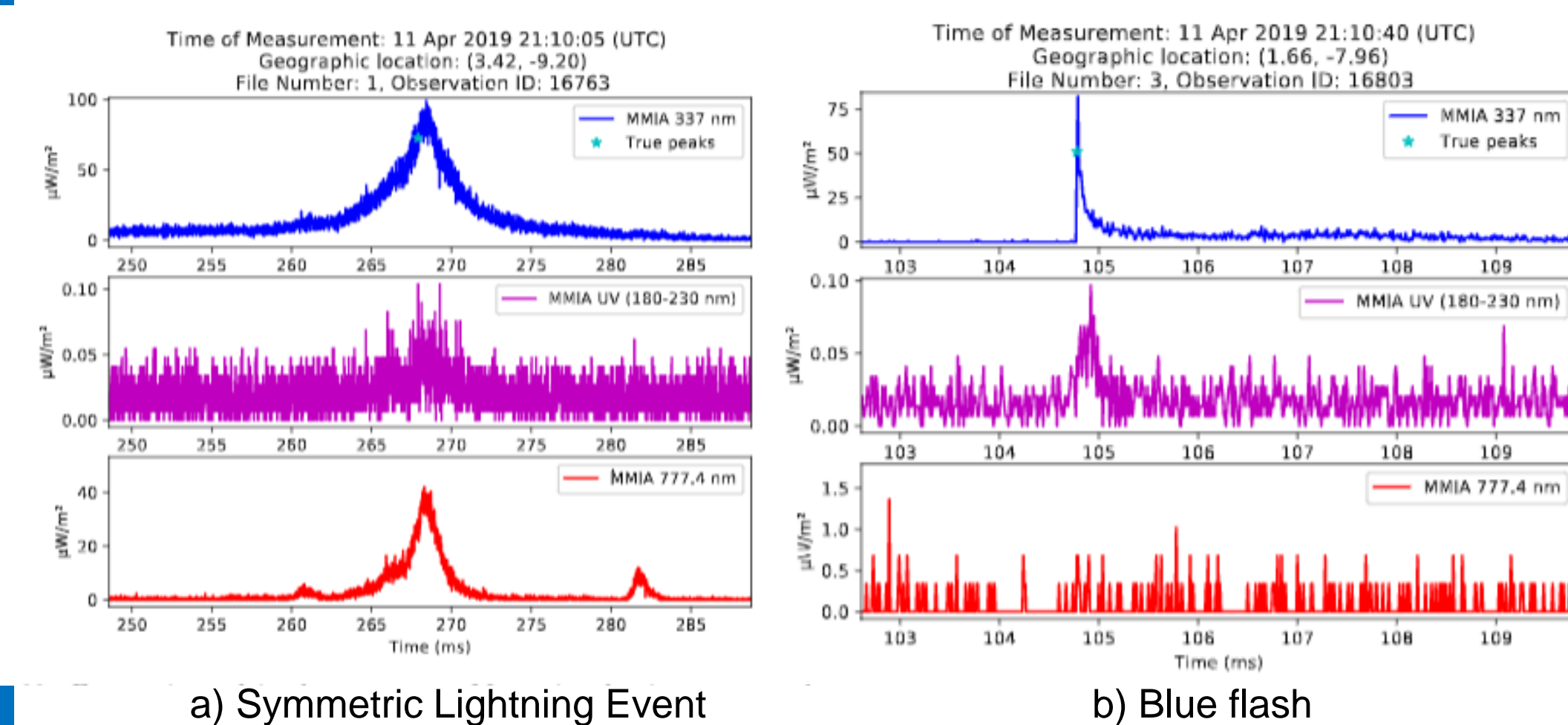


Transient Luminous Event Detection with Unsupervised Convolutional Variational Auto-Encoder

Rasmus Christian Jørgensen – s164044
Søren Christian Winther Engell – s165518

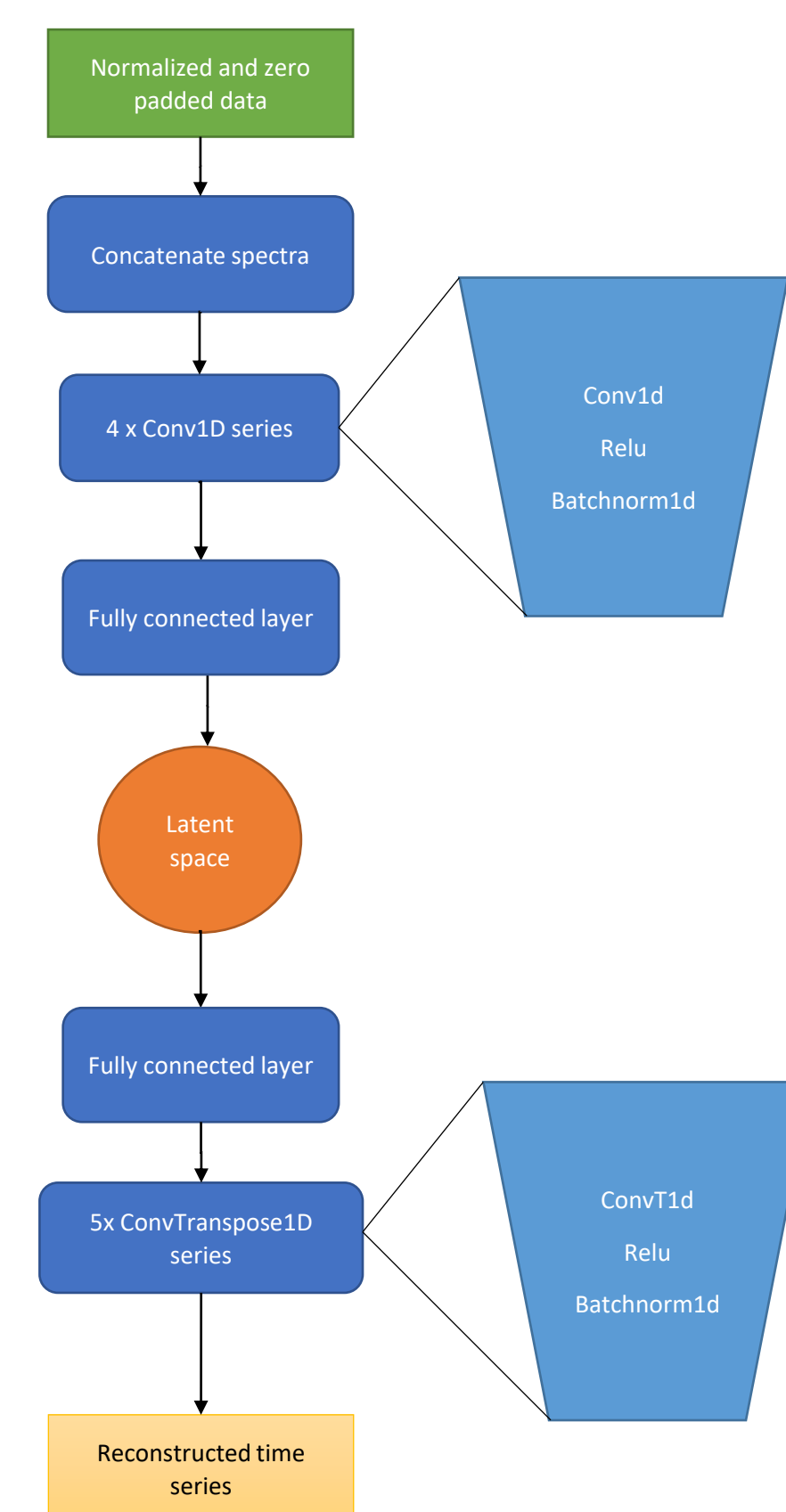
Introduction

Transient Luminous Events (TLEs) cover a range of different kinds of events in the atmosphere, which we currently know very little about. The Atmosphere Space Interaction Monitor (ASIM) is an instrument which measure such events at three different wavelengths; 337 nm (Nitrogen second positive, N₂P₂ emission), 180-230 nm (UV) and 777.4 nm (Atmospheric Oxygen, O)[1]. The signal from the different wavelengths is not well understood for each type of TLE, which means that currently it is a manual process to investigate and interpret the data. This is a slow and tedious process, which would benefit from a more systematic approach. We are fairly certain that each type of TLE has its own distinguishing feature, whether it is the amplitude of the signal, or the form. Below are two examples of events which correlates differently in the spectra.



In order to achieve a more systematic approach, we stack the three spectra utilizing a 1D convolutional structure and applying variational autoencoders to the stacked spectra. The hope is that this will reveal clusters in the latent space of the encoding, which corresponds to different types of TLEs.

Model



Details

Observation model follow a beta distribution:

$$f(x; \alpha, \beta) = \frac{1}{B(\alpha, \beta)} x^{\alpha-1} (1-x)^{\beta-1}$$

The reconstruction loss is given as the log likelihood:

$$\ln \mathcal{L}(\alpha, \beta | X) = \sum_{i=1}^N \ln(\mathcal{L}_i(\alpha, \beta | X_i))$$

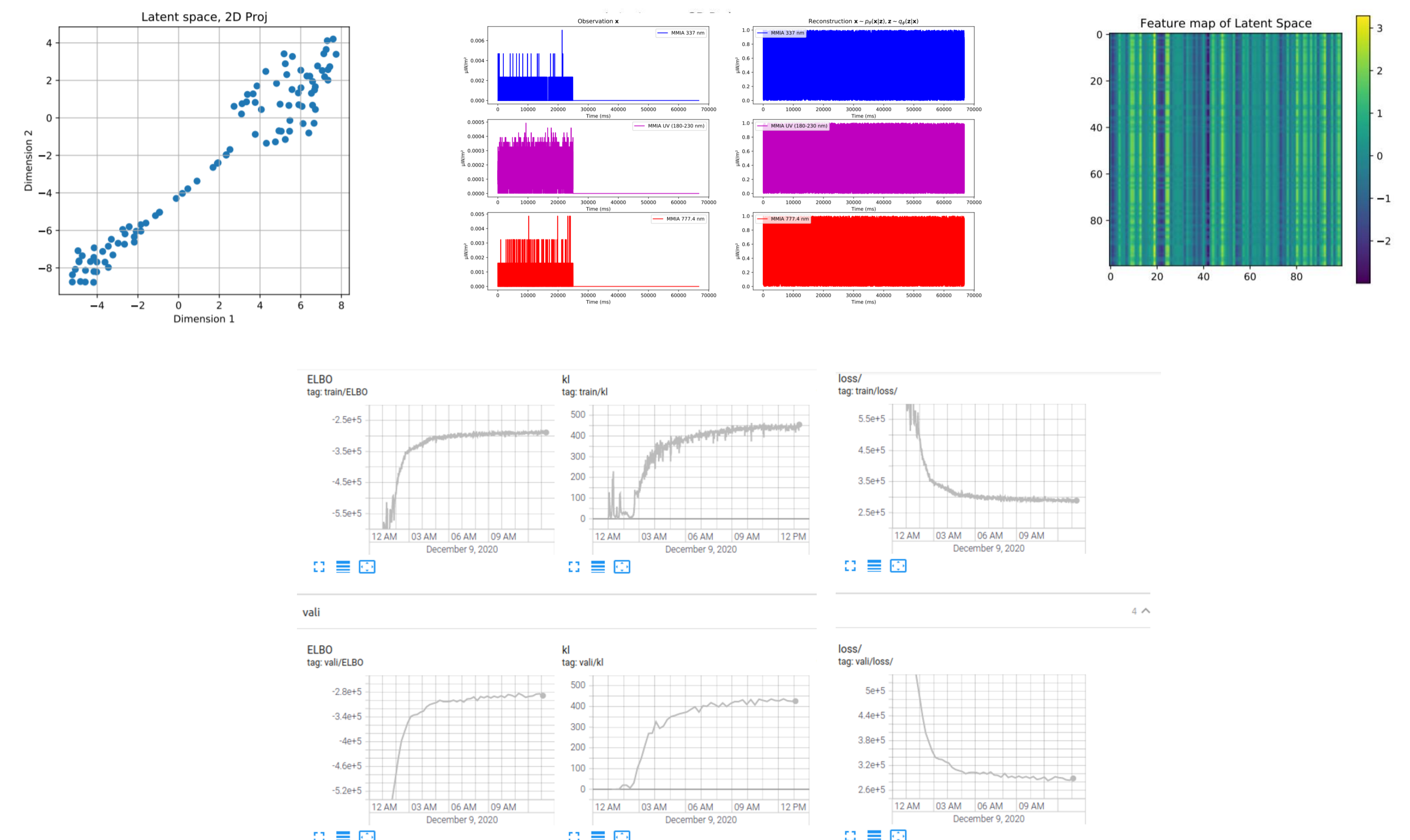
Regularization term:

$$D_{KL} = \sum_{i=1}^n \sigma_i^2 + \mu_i^2 - 2 \log(\sigma_i) - 1$$

The loss is calculated as

$$\text{Loss} = -(\text{Reconstruction error} - D_{KL})$$

Results



References

[1] Neubert, T., Østergaard, N., Reglero, V., Blanc, E., Chanrion, O., Oxborrow, C. A., Orr, A., Tacconi, M., Hartnack, O., & Bhandari, D. D. V. 2019a. The ASIM Mission on the International Space Station. Space Sci Rev.