DELAWARE Data Science SYMPOSIUM NOV 17, 2021

A Bayesian Approach to Identifying Uncertainties in Atmospheric Modelling on Ground-Based Hyperspectral Imaging

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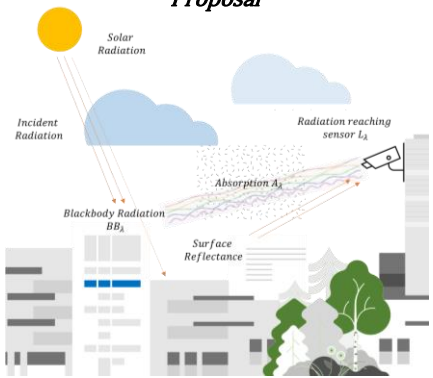
Introduction

- The estimation of **covariances** and **uncertainties** of atmospheric parameters contributes to a better approach to analyse the composition, sources, and patterns of emissions.
- Accurate and consistent methodologies that enable the **characterization of emissions** are necessary for promoting **climate change compliance** through **targeted policies**.

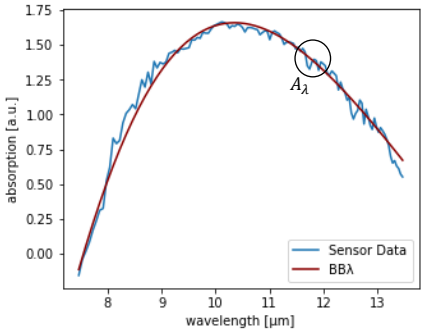
Proposal



$$L_\lambda(T_0, T, p, l, cM_i) = a_0 + a_1 BB_\lambda(T_0)[1 - A_\lambda(T, p, l, cM_i)]$$

Methodology

Proof of Concept! → **Synthetic Data**



Long-Wave Infrared (**LWIR**) Hyperspectral Imaging

Pixels: 128 channels
Wavelength range: 7.6 - 13.2 μm

Inverse Atmospheric Modelling through:

- HITRAN Application Programming Interface (**HAPI**[1]) with optimizations.
- Markov Chain Monte Carlo (**MCMC**[2]).

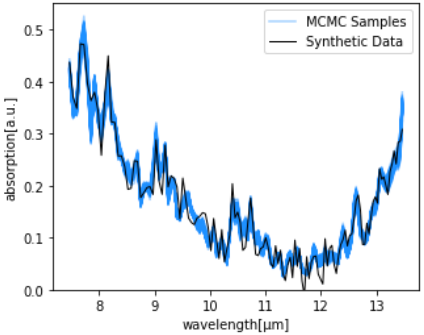
Instrument Noise

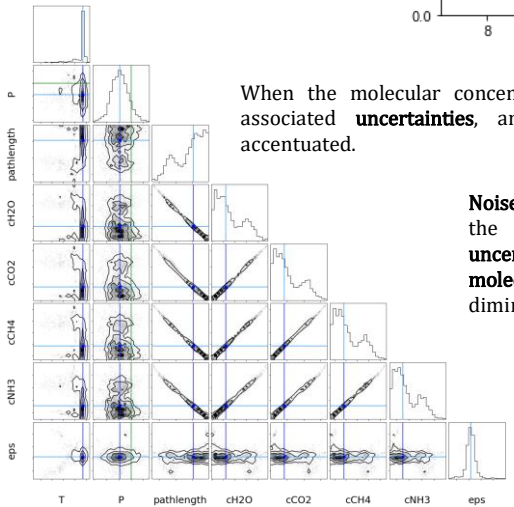
Influence of H_2O

Molecules concentrations increased over noise amplitude

Results and Discussion

Posterior distributions and **uncertainties** of atmospheric parameters: H_2O absorption has a significant correlation with the other tested molecules that have smaller absorption and concentrations (CO_2, CH_4, NH_3).





When the molecular concentrations increase, so do the associated **uncertainties**, and existing **covariances** are accentuated.

Noise does not cause any changes in the model trends, although **uncertainties** do become larger and **molecules absorption features** diminish.

Developed a successful **framework** capable of identifying the **concentrations of gases** in the atmosphere.

[1] Kochanov, Roman V., et al. "HITRAN Application Programming Interface (HAPI): A comprehensive approach to working with spectroscopic data." *Journal of Quantitative Spectroscopy and Radiative Transfer* 177 (2016): 15-30.

[2] Hastings, W. K. (1970). Monte Carlo sampling methods using Markov chains and their applications.