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.

Methodology

Long-Wave Infrared (LWIR) Hyperspectral Imaging
- HITRAN Application Programming Interface (HAPI) with optimizations.
- Markov Chain Monte Carlo (MCMC).

Inverse Atmospheric Modelling through:
- HITRAN Application Programming Interface (HAPI) with optimizations.
- Markov Chain Monte Carlo (MCMC).

Results and Discussion

Posterior distributions and uncertainties of atmospheric parameters: H₂O absorption has a significant correlation with the other tested molecules that have smaller absorption and concentrations (CO₂, CH₄, NH₃).

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.

Proof of Concept! → Synthetic Data

Instrument Noise

Molecules concentrations increased over noise amplitude

L₄(T₀, T, p, l, cMᵢ) = a₀ + a₁BB₄(T₀)[1 − A₄(T, p, l, cMᵢ)]