Using a Machine Learning Method to Explore Hyperspectral Infrared Satellite Observations

Kavi (Kongkun) Chen
Mentors: Likun Wang

cisess
Cooperative Institute for Satellite Earth System Studies

Problem

- Hyperspectral satellites generate massive amount of high dimensional data among hundreds of bands, many of which are highly correlated
- Physical retrieval algorithms are often ill-conditioned and require heavy background knowledge to produce a reliable result.

Background

- Regression Problem.
- Data collected from CrIS Instrument (from hyperspectral satellites).
- Neural Networks (NN) Models
  - $\sum_i W_i X_i + b$
- Deep Learning (Residual Network i.e. ResNet)
  - $y = F(x) + x$

Figure(s)

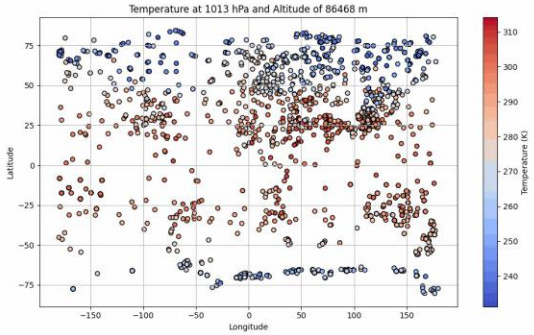

Fig 1. Global Temperature Across 43 Atmospheric Layer.

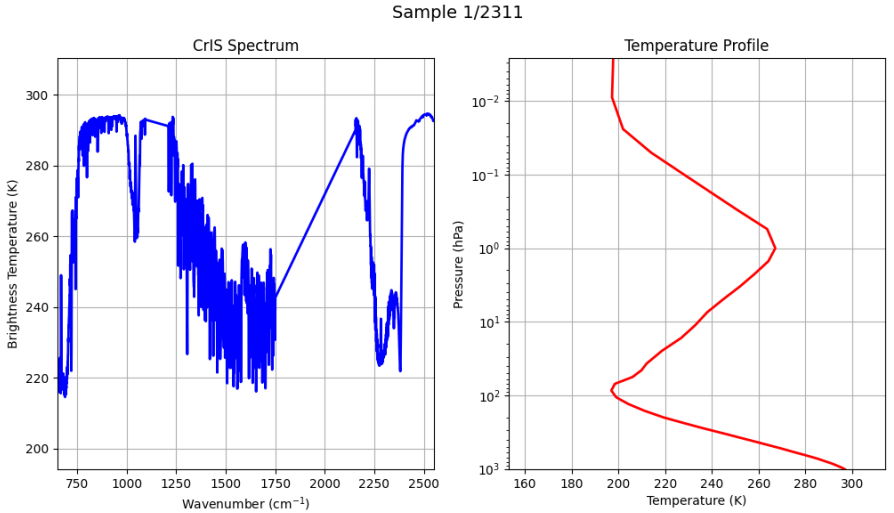

Fig 2. CrIS Spectrum input and Temperature output Relationships.

Using a Machine Learning Method to Explore Hyperspectral Infrared Satellite Observations

Kavi (Kongkun) Chen
Mentors: Likun Wang

cisess
Cooperative Institute for Satellite Earth System Studies

Objectives

- Using Machine Learning Model to Predict Temperatures among atmospheric layers.
  - ANN Model
  - CNN Model
  - ResNet Model
    - For deep learning
  - Define a custom loss function
    - Loss = MAE + 0.5 * Gradient Loss

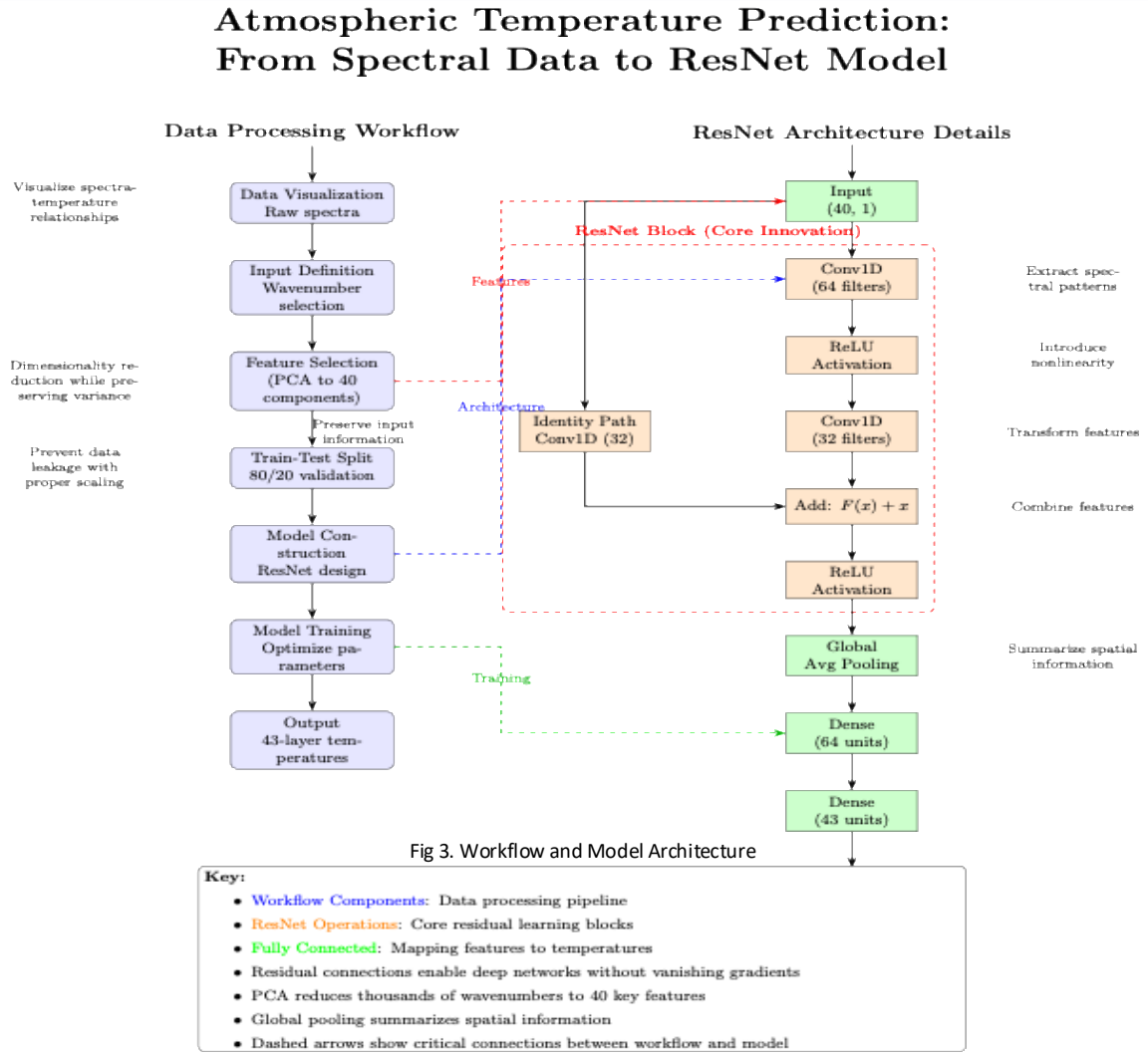

Fig 3. Workflow and Model Architecture

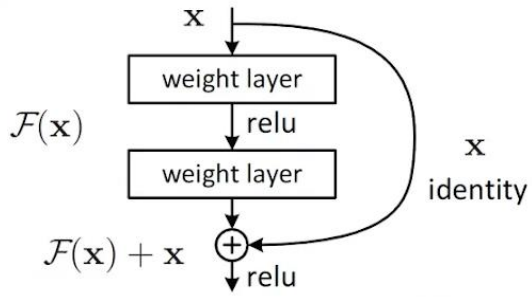

Fig 4. Simple ResNet Plot

Using a Machine Learning Method to Explore Hyperspectral Infrared Satellite Observations

Kavi (Kongkun) Chen
Mentors: Likun Wang

cisess
Cooperative Institute for Satellite Earth System Studies

Results

- ResNet Model trained to predict temperature across atmospheric layers.
- The Model observed local structure of that was hidden in the data.
- The model resulted in high standard deviation in local structures.

Future

- Continue Adding more ResNet Blocks into the model for deep learning.
- Decrease the standard deviation value around local structures.

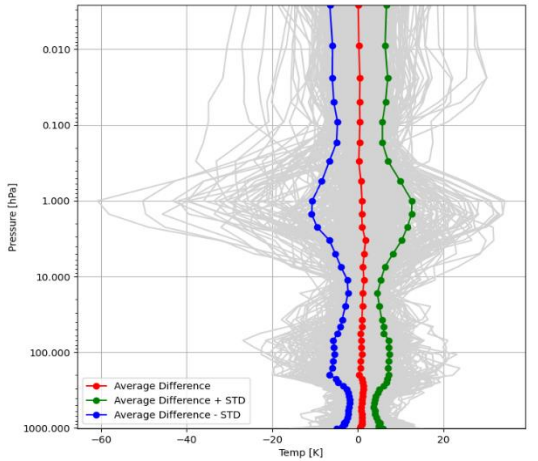

Fig.5 Residual Analysis between predicted value and actual targeted value.

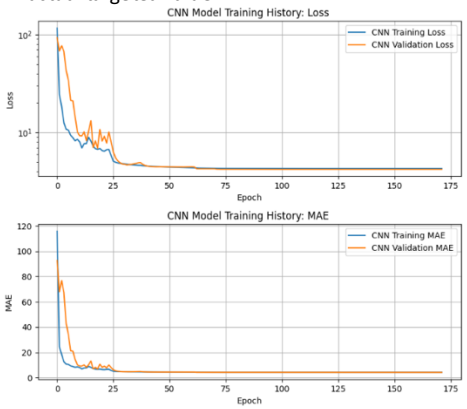

Fig. 6 Training Loss History

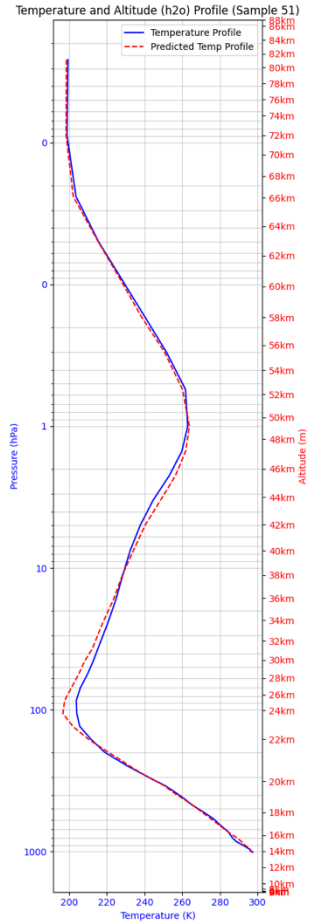

Fig 7. Prediction vs. Truth Plot