Mapping Satellite Observations of Atmospheric Latent Heating from Passive Microwave Sensors

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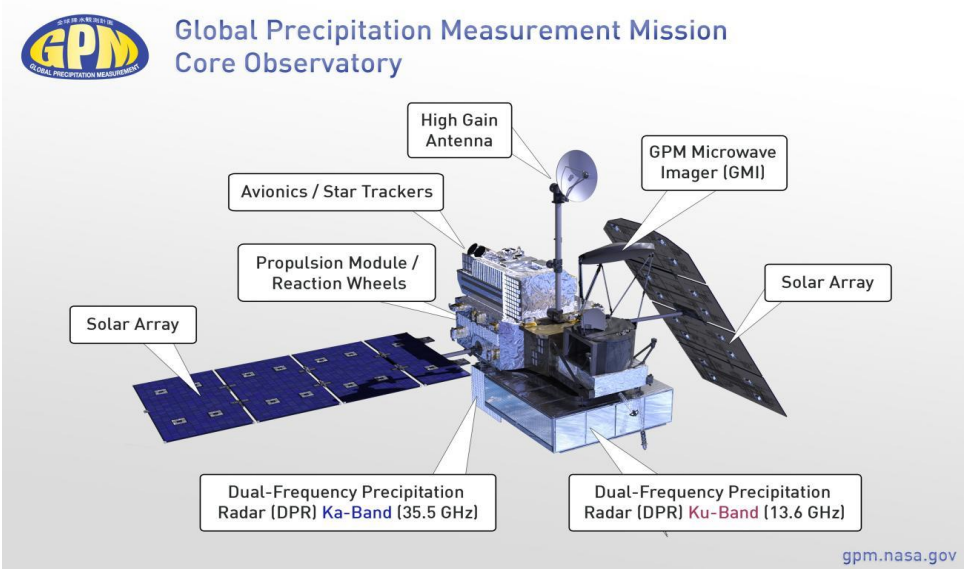
Problem statement

- Dual-Frequency Precipitation Radar on GPM satellite mission (~ $1B) provides accurate latent heating retrievals at different levels of atmosphere but is expensive.
- Replacing or complementing radar retrievals with Microwave Imager ML estimates would reduce the cost and extend the coverage.

Objective

- Learn a mapping from 13 microwave brightness temperature channels (*features*) to predict 28-level latent-heating profile (*target*).



Credit- gpm.nasa.gov

Collocations of Radar (target) & Radiometer (features) data observed in 2015, 2016, 2017

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Limit the problem to **ocean only** and quality control to keep only valid retrievals.

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Shard the data into 1000 100MB binary files for efficient GPU training.

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Train **Fully Connected Neural Network** (PyTorch) with standardization & sampling.

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Test the model on unseen data

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Visualize and **analyze** the results

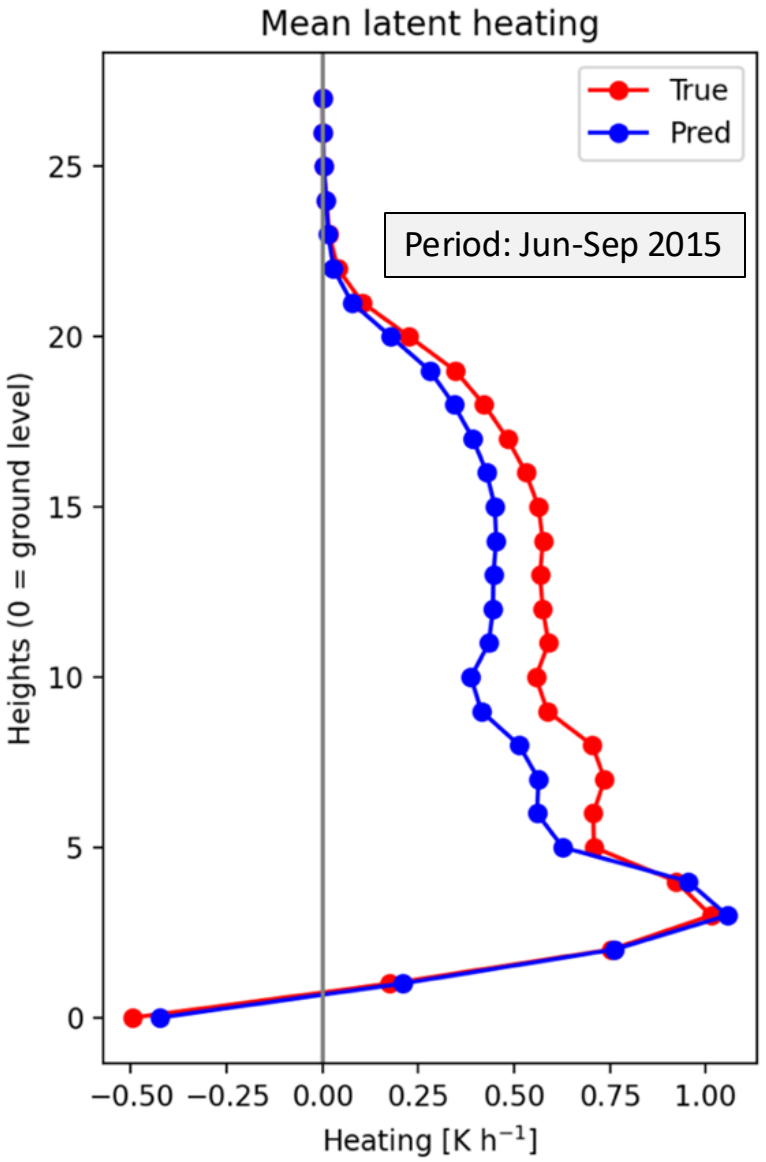
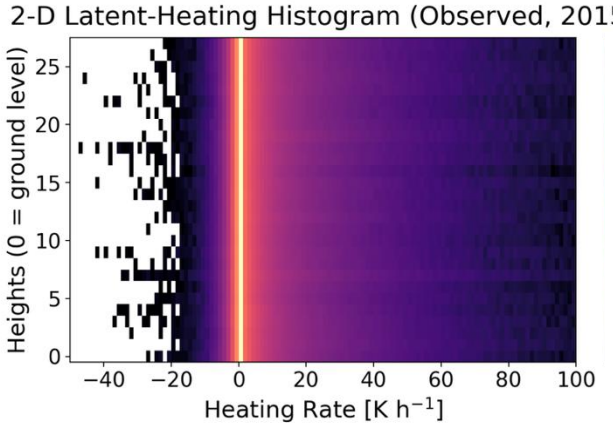
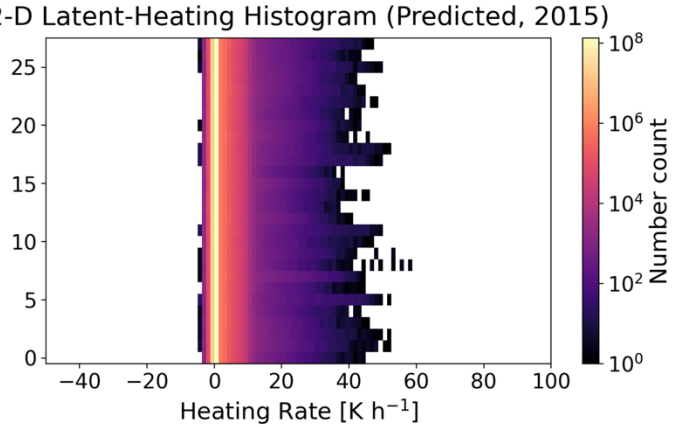


Figure 4 - Mean Latent Heat Profile for cloudy skies over ocean

Key Findings

- Captures vertical LH pattern and direction of the low-level spike.
- Tends to slightly underpredict the mean latent heating at upper levels.
- Predicted distribution matches zero-heavy skew but misses rare high-heating events.





Conclusion and Future Work

- Our ML model, trained on GMI brightness temperatures, successfully reproduces the shape of the vertical structure of latent heating, pointing to a viable, low-cost complement to radar retrievals.
- In the future, we aim to balance the data in a more strategic way
- Model hyperparameter tuning + explore CNNs and U-Nets
- Expand beyond oceans; stratify by region & season