Assessing the State Dependency of Infrared Satellite Precipitation Retrieval Errors

The sensing and prediction of precipitation remains at the forefront of weather forecasting, building upon centuries of measurement and study. While in-situ and ground-based methodologies such as rain gauges and weather radars provide the best assessments of precipitation, they are prone to sampling issues and coverage gaps both over challenging terrain and in developing areas of the world. As a result, the use of remote sensing methodologies, namely satellites, have allowed for the expansion of precipitation measurement to encompass nearly the entire Earth. However, unlike rain gauges, satellites are incapable of directly sensing precipitation; rather, they must infer it from the spectral information that can be captured from space through a mathematical framework known as a retrieval.

While satellite precipitation retrievals are a boon to the meteorological community due to their ability to fill in these coverage gaps, their indirect nature inevitably gives rise to errors in the measurements themselves. Furthermore, these errors have historically been specific to their training area and are not directly comparable to the errors in other areas. Therefore, this thesis aims to begin disentangling these errors into more generalizable metrics through known information about the measurements themselves and the environmental state being observed. To do this, a neural-network style retrieval algorithm was developed using infrared and lightning data from the Geostationary Operational Environmental Satellite – 16 (GOES-16) to create a validation statistics study. The error from this retrieval, selected to be its bias statistic, was then analyzed both in the context of the satellite data and ancillary meteorological data. From these analyses, it was shown that an understanding of the satellite data allows for limited reproducibility of the retrieval bias tendencies across multiple areas of study, and that ancillary environmental information can shed additional light on how these errors are influenced by the underlying meteorological state. Though this thesis does not create an exact, quantitative methodology for such an assessment, it does provide a direction in which a framework can be established to predict precipitation uncertainties for a more global perspective.