Remote sensing observations from space have become an essential part of National Aeronautics and Space Administration's (NASA) and the National Oceanic and Atmospheric Administration's (NOAA) Earth science satellite missions for providing operational weather prediction and observational environmental data for scientific research to understand the role of ocean, atmosphere, land and ice in the evolution of the climate change of the Earth. For the microwave portion of the electromagnetic spectrum, today most space-faring nations operate dozens of collaborative satellite missions, with passive microwave sensors. These instruments are used to provide the international science community a multi-decadal time series of environmental measurements of atmosphere, ocean and land upon which scientists will develop climate models to predict future changes in the Earth's climate. From a remote sensing technology perspective, the overriding issue is how to remove instrumental effects from the weak climate signals to allow scientists to reliably forecast the impact of climate change on human habitability into the future for hundreds to thousands of years. Thus, the ability to perform radiometric calibrations is crucial to providing reliable climate data records. Therefore, this dissertation is an examination of the radiometric calibration issues for the purpose of developing improved on-orbit calibration techniques that can be used under a variety of operating scenarios with many instrument configurations.

In this study of climate and global water cycle precipitation is a major factor, it is not homogenous and in changes with time, so retrieval of the precipitation is a challenging task. Global Precipitation Measurement (GPM) mission is an international effort to measure the precipitation globally with high precision every three hours. GPM mission is consists of nine satellites, provided by partnership of United States, Japan, India and Europe. In order to have a consistent measurements, we need to reduce errors in global rainfall estimates associated with temporal/spatial sampling by using a constellation of satellites. The goal is to remove all the instrumental effects, and perform periodic, on orbit radiometric calibrations in the constellation.

Inter-calibration of microwave channels using the GPM Microwave Imager (GMI) is a challenging task. In GPM constellation we have a combination of different sensors, the goal is to make a consistent measurement between all the sensors in this constellation. In this dissertation, the main focus is on calibration of high frequency channels in the GPM constellation. In the next generations of rain retrievals algorithms which are more precise, the importance of higher frequencies are increasing. Inter-calibration channels with low frequencies have been done successfully over years, but the calibration of high frequencies channels is more challenging. For these channels, we have combination of different type of instruments, also the atmospheric models and surface emissivity's models are working in different ways in high frequencies, which makes the calibration of these channels more challenging. The objective of this dissertation is to develop a robust Inter-satellite calibration algorithm for determining biases between high frequency channels within the GPM constellation.

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