A Study on the Use of Atmospheric Radiation Measurements for the Validation of National Polar-orbiting Operational Environmental Satellite System/Visible/Infrared Imager/Radiometer Suite Cloud Products

E. Wong
Northrop Grumman Space Technology
Los Angeles, California

Introduction

Many Environmental Data Records (EDR) will be produced using the National Polar-orbiting Operational Environmental Satellite System Visible/Infrared Imager/Radiometer Suite (VIIRS) measurements. Among them, the cloud products include the cloud optical thickness, effective particle size, cloud-top pressure, cloud-top height, cloud-top temperature, cloud-base height and finally cloud cover and layers EDRs. Although the cloud phase index and cloud/clear confidence flag are not EDRs, they are required input parameters to produce the cloud EDRs. All EDRs are required to meet the VIIRS System Specification. To assess the uncertainties in these cloud EDRs, we plan to validate their performance primarily with fixed ground site measurements, such as those from the Atmospheric Radiation Measurement (ARM) Program sites, and selectively with airborne measurements.

The VIIRS Cloud retrieval algorithms are executed sequentially due to the data dependency among algorithms. The cloud chain algorithms are: Cloud mask, cloud optical properties, cloud-top parameters, cloud cover and layer and cloud-base height. In particular, based on radiative transfer and microphysical parameterizations, cloud optical properties determines cloud optical thickness, effective particle size and cloud-top temperature by using visible, SWIR and LWIR radiometric measurements. While cloud mask initiates the chain and determines the processing paths, cloud optical properties drives the chain by providing nearly all the cloud optical properties required for subsequent data processing.

Our overall approach to the validation of cloud EDRs includes a qualitative assessment of the VIIRS cloud EDR statistics by comparing with cloud climatologies generated by moderate-resolution imaging spectroradiometer and International Satellite Cloud Climatology Program, and an ensuing longer-term quantitative assessment of the VIIRS EDR performance with ground site (e.g. ARM) lidar, radar, and ceilometer measurements. Limited and selective airborne in-situ measurements, including two-dimensional probes, CAPS, CPI, and replicator will optionally be used to validate the VIIRS cloud

EDRs. Examples of preliminary validation of cloud-top and base heights using moderate-resolution imaging spectroradiometer proxy data and collocated and coincident millimeter wave cloud radar measurements for selected dates at ARM Southern Great Plains site show encouraging results.

A study was conducted to determine the ground site instruments needed for the validation of the cloud EDRs. The study showed that while the uncertainties in cloud-top and base heights from the ground-based lidar and radar measurements are within the System Specification, the cloud optical depth and particle size derived from measurements by different instruments have large uncertainties. In addition, we have estimated that a period of 1-2 years of continuous fixed site measurements are needed to validate the full range of conditions required by the System Specification.