NASA Progress Report: NASA Award Number, NNX11AL95G, entitled, EVALUATION OF VIIRS CLOUD EDRS AND EXTENDING MODIS CLOUD DATA RECORDS INTO THE NPP TIMEFRAME

This is the progress report for grant NNX11AL95G. The proposal is a joint UW Madison and NASA Goddard project. This report presents the accomplishments at UW Madison. This is the first year of funding with the VIIRS launch at the end of October 2011. Our focus for this year has been an initial evaluation of the contractor cloud Algorithms including the optical property look up table quality assessment, and building the infrastructure to develop joint MODIS/VIIRS cloud retrievals to facilitate our assessments of the VIIRS cloud products. Highlights and initial results of this work are presented as part of this report.

Initial cloud property evaluation

The VIIRS retrievals are produced at both the pixel level (Intermediate Product) and then aggregated into lower resolution Environmental Data Records (EDRs). For Clouds It is the EDRs that are archived at CLASS. As will be discussed the aggregation process is complex leading to challenges in evaluated and using the EDR's for climate applications. For MODIS, all products are generated from Level 1b radiances and most closely resemble the VIIRS IPs. For this reason our initial evaluation is focused on the IP level products. Although they are not part of the CLASS archive, the Atmospheric PEATE is storing all cloud IPs produced by the IDPS allowing for long term evaluation using IPs.

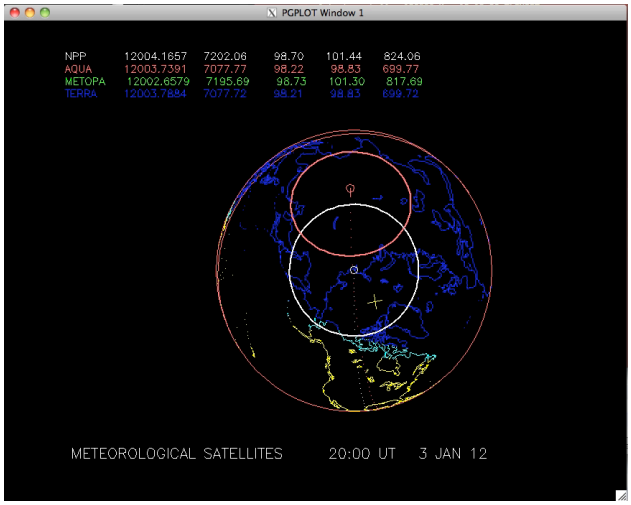

Figure 1: The Aqua and NPP orbits are presented with NPP as white and Aqua as red. The circles represent the viewable area of each satalite.

Our primary evaluation observations for cloud products are MODIS Aqua, CALIOP, and CloudSat that fly in the A-train 1:30 pm orbit. NPP (VIIRS) is also in a 1:30 pm orbit but orbits at a higher altitude and as a result has a slightly different orbital period compared to the A-train. These orbital characteristics provide coincident (space and time) observations every three days which lasts for multiple orbits providing high quality comparison statistics. An example of the Aqua and NPP orbits are presented in Figure 1.

Cloud Top Height/Pressure

The cloud top height/pressure retrieval for VIIRS is actually a combination of three retrieval approaches with significant differences between day and night time retrievals. For daytime CTH the VIIRS algorithm uses a combination of

visible and IR channels and precompiled look tables to simultaneously solve for cloud top temperature, optical depth and effective radius. The cloud top temperature is then converted to cloud top height using a model profile. The night time cloud top height is retrieved using two aprouches. For ice clouds a water vapor corrected IR brightness temperature (10.6 um) converted to a cloud top height and for water clouds using an IR fast model and iterating to find the best closure with the measured IR radiance. Because of the complex logic and multiple retrieval methods the evaluation of the cloud top properties including

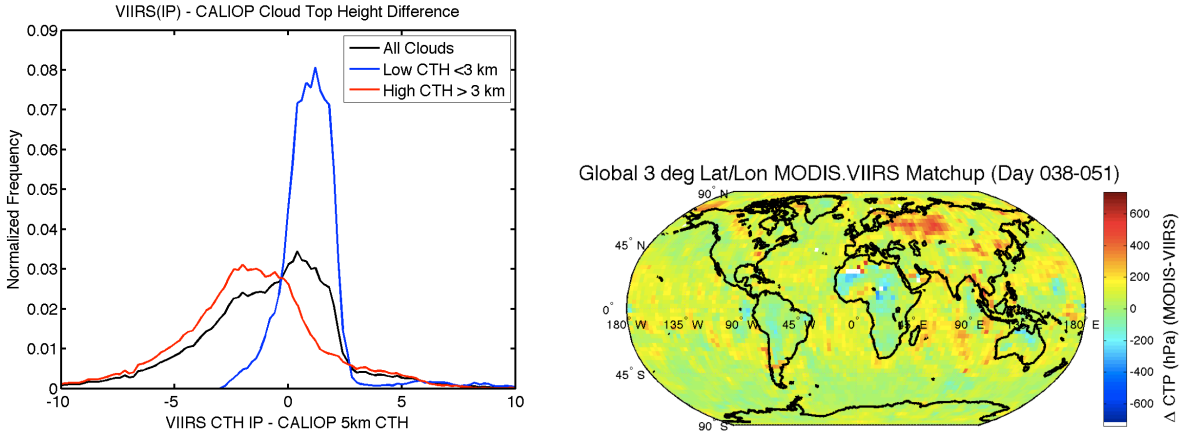

Figure 2: Collocated differences between VIIRS and CALIOP cloud top heights for coincident observations between Feb 9th – April 3rd 2012 are presented in the left figure. The results are separated by the CALIOP cloud top height. The right figure presents the global collocated differences of cloud top pressure between MODIS and VIIRS using a 3 deg grid.

cloud top height needs to be separated by retrieval methods. In comparison the MODIS cloud top height retrieval uses only IR channels including CO2 channels that are not available on VIIRS and does not have the potential day/night differences compared to VIIRS.

CALIOP and MODIS provide the primary source of evaluation observations in this report. The VIIRS cooler was operational starting on Jan 18th 2012. For this document we have focused our comparisons on data collocated between Feb – April of 2012. Figure 2 presents global results of the Atmospheric PEATE collocated CALIPSO, MODIS, and VIIRS cloud products for combined day and night observations. The CALIOP comparison is presented in the left plot in Figure 2. CALIOP provides an independent retrieval of cloud top height with very high sensitivity optically thin clouds and accurate vertical characterization of the clouds vertical extent. When compared to passive retrievals CALIOP provides an excellent well characterized reference for investigating VIIRS retrieval sensitivities and biases. The MODIS comparison provides a well characterized passive cloud height retrieval and allows for evaluation of the continuity of the EOS recorded into the NPP/JPSS time frame.

To summarize our initial findings, the VIIRS retrieval has significant cloud top height biases for both low and high clouds. For low clouds VIIRS is biased 2 -3 km high relative to CALIOP with VIIRS rarely detecting cloud below 2 km. As CALIOP provides a much more sensitive measurement of cloud top height the over estimation of the VIIRS cloud top height is indicative of an algorithm deficiency.. This bias is also found in the global MODIS/VIIRS comparison in Figure 2 with VIIRS systematically over estimating the cloud top height in areas of marine stratus. Investigation of the VIIRS algorithm is needed to identify the cause of this bias. For high clouds, VIIRS significantly underestimates the cloud top height relative to both MODIS and CALIOP. Being a passive observation it is expected that VIIRS will underestimate the cloud top height when compared to CALIOP however the mode of the cloud height difference histogram in Figure 2 is approximate -2.5 km with many FOV underestimated by over 10 km relative to CALIOP. Comparison between MODIS and alternative CTH algorithms are on going to better assess optimal performance of the VIIRS for retrieving CTH.