Performance Assessment of the SNPP VIIRS Cloud Properties Products

Eric Wong, Northrop Grumman Aerospace System, Andrew Heidinger, NOAA, Robert Holz, Min Oo, Andi Walther, UW/CIMSS, Steve Miller, Colorado St. Univ., Steve Ou, Univ. Cal., Los Angeles

Introduction

SNPP cloud properties products include day and night time cloud optical thickness (COT), effective particle size (EPS), cloud top height (CTH), pressure and temperature, cloud cover layers and cloud base height. At the present the cloud properties products (not including Cloud Mask) were approved for Beta Maturity in July 2013 and were recommended by the review panel for Provisional Maturity in January 2014. The significant algorithm changes at and after Beta are: the adoption of a new set of daytime cloud reflectance look-up-table (equivalent to MODIS Collection 5 models), the implementation of the Marine Layer Cloud logic, replacement with more accurate parameterization equations of LWP for water clouds and the ratio of extinction coefficient of M14 and M18 band for the ice clouds.
Performance assessments were performed using pixel-level SNPP Intermediate Products and comparisons were made with MODIS, NOAA PATMOS-X, Calipso Lidar and CloudSat products. For nighttime EPS validation we have used Calipso IIR products for ice clouds.

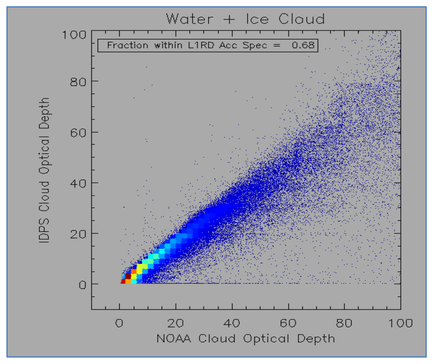
Goal

In this presentation we shall show quantitatively the SNPP VIIRS Cloud Properties EDR performance at Provisional State, along with the issues identified above. Specifically we shall show the following:

- Day and Night COP Performance
- Cloud Top Height Performance
- Ice Cloud Top Height Performance Enhancement
- CBH Performance

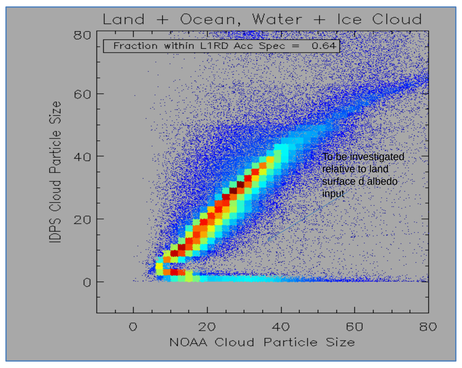
Comparison of SNPP Day time Cloud Optical Thickness

- Good correlation of SNPP with NOAA. 68% of SNPP within L1RD spec relative to NOAA



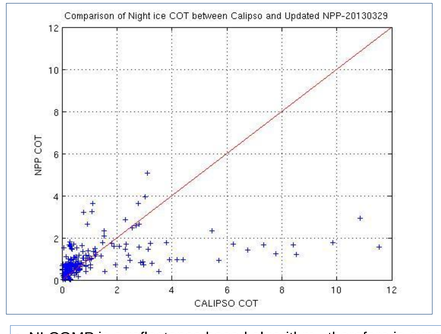
Comparison of SNPP Day time Cloud Effective Size

– Good correlation of SNPP with NOAA. 64% of SNPP within L1RD spec relative to NOAA



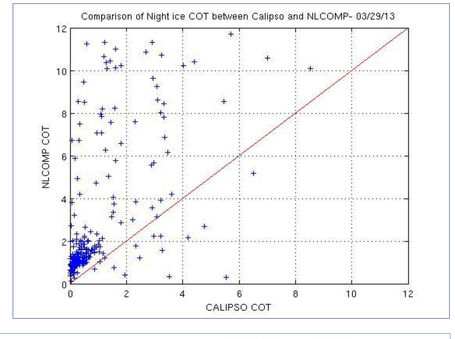
Comparison of SNPP Night time Cloud Optical Thickness with CALIPSO

- in the valid Calipso COT range SNPP correlates well with Calipso



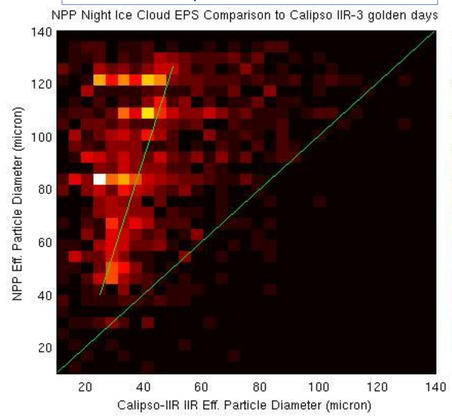
Comparison of NOAA Lunar Night Lunar Cloud Optical Thickness with CALIPSO

- in the valid Calipso COT range NLCOMP correlates with Calipso with a high bias



- NLCOMP is a reflectance based algorithm, therefore is expected to be qualitatively similar to MODIS and SNPP day algorithm.
- Direct comparison between SNPP night and NLCOMP shows good COT correlation indicating good accuracy in SNNP night ice COT relative to day products.

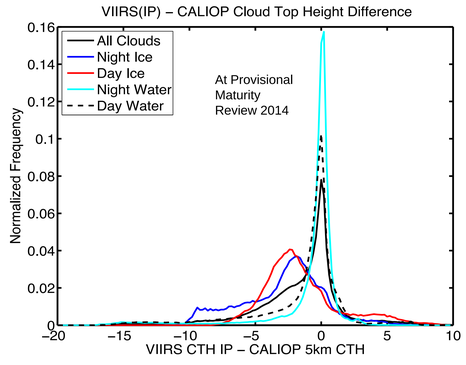
Comparison of SNPP Night time Ice Cloud Effective Particle Diameter with CALIPSO IIR product



- SNPP EPS correlates approximately with CALIPSO IIR retrievals and is a factor of 2 larger
- Ganier et al "Retrieval of Cirrus Cloud Properties from combined IIR, Lidar and WFC observations" indicates IIR global ice cloud EPS distribution is ~ 30-40% lower than MODIS day ice cloud EPS.
- This suggests that values of SNPP night ice cloud EPS and MODIS day EPS to be comparable

Comparison of SNPP Cloud Top Height

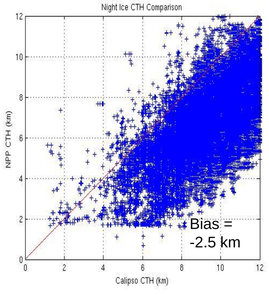
– global evaluation with CALIPSO



- 4 months of collocated CALIOP (lidar) comparisons with the VIIRS IP CTH product
- 20 minute maximum time separation
- Poles (>60deg lat) excluded.
- Results show positive bias for water clouds seen at Beta has been largely removed.
- Updated ice cloud CTH product will show reduced low bias when new k-ratio update is operationalized
- Ice cloud low bias will be further investigated with focus on clear sky radiances and surface emissivity

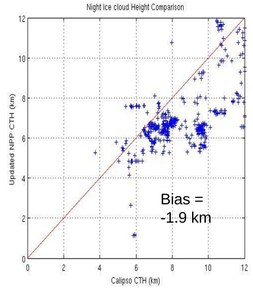
Comparison of Baseline day ice CTH with CALIPSO

- collocated dataset in Oct-Nov 2012



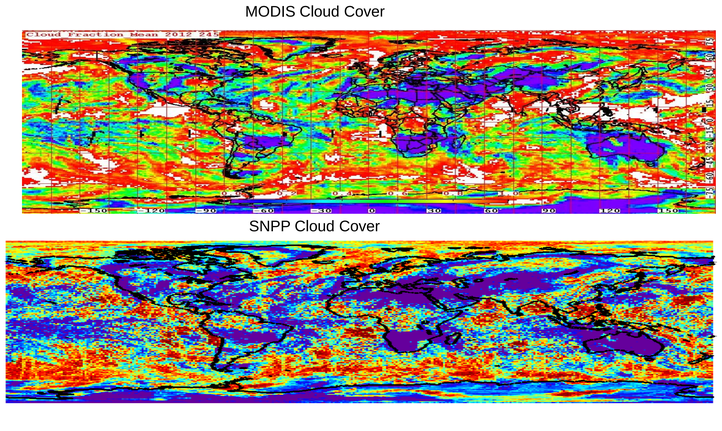
Comparison of k-ratio updated Baseline with CALIPSO

- collocated dataset in March 2013



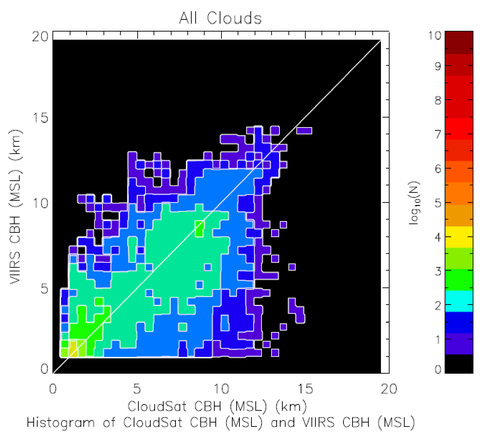
- The ice cloud k-ratio defined as the extinction coefficient ratio between M14 and M16 is used in determining CTH
- k-ratio is updated using either radiative transfer calculations of ice cloud models of Pang (2004) or from CALIPSO IIR product
- With updated k-ratio low bias error reduced significantly for mid-level cloud, however low bias remains for high ice cloud

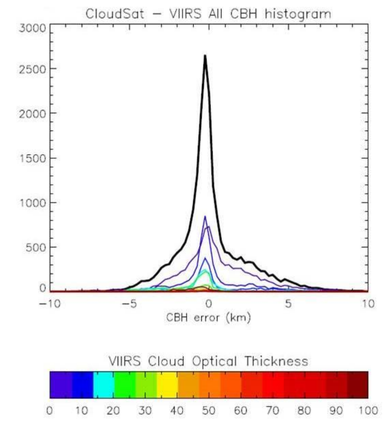
Qualitative Comparison of SNPP Global Cloud Cover Distribution with MODIS



Comparison of SNPP Cloud Base Height with CloudSat Base Height

- focus on pixels of which CTH are within System Requirement





- CTH accuracy controls CBH performance.
- CBH uncertainty (RMS error) = 2.1 km.
- Reduce low bias CTH error will reduce CBH error.
- Assess sensitivity of LWC on cloud thickness with different water cloud types.

Conclusions

- SNPP VIIRS cloud properties are currently at Provisional Maturity status
- SNPP day COT and EPS compare well with NOAA cloud products with some undesirable artifacts. The artifacts of which shown in SNPP ice EPS retrievals are being investigated with focus on differences in surface albedo input.
- Validating IR based night time COT/EPS is difficult due to a lack of "truth" data. However, relative to the CALIPSO within the valid range of Calispo COT SNPP shows good correlations.
- SNPP ice cloud top height shows a low bias however the k-ratio update will reduce the bias.
- The low bias probably will remain for high clouds and is being investigated with focus on clear sky radiances accuracies and land surface emissivity.
- SNPP global cloud cover distribution is qualitatively similar to that of MODIS
- The SNPP CBH shows reasonably good accuracy when CTH meets Spec. requirement. We expect CBH performance to improve when the low bias seen in CTH is corrected .