1. Title Slide

Advancing Nighttime VIIRS Cloud Products
with the Day/Night Band

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Topics: Cloud , JPSS Day night band

JPSS Risk reduction

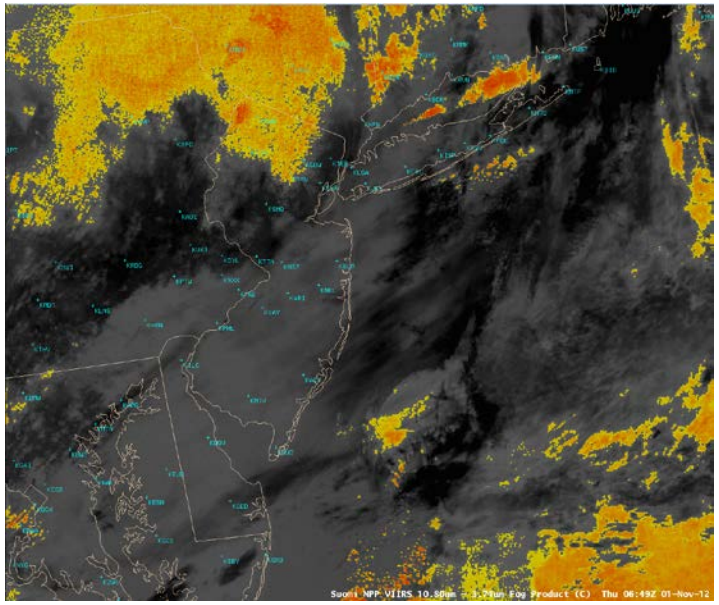
2. Introduction

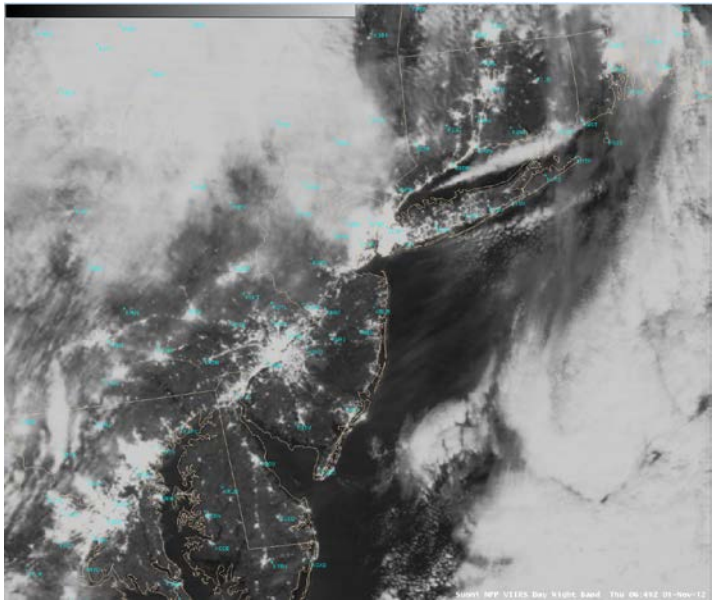
- The **Day/Night band** (DNB) of VIIRS is capable to measure moon light reflectance sensitive enough for cloud property retrievals.
- The project aims to improve cloud detection and properties retrieval during nighttime.
- **Cloud detection:** Will be particularly valuable for low-level cloud detection over dark backgrounds where reflectance provides contrast. This is often missed with existing cloud masks.
- **Cloud properties:** Satellite-based nighttime observation of optical properties (Cloud optical thickness, particle size and water path) of clouds were not possible till the launch of NPP. The new retrieval will help to close the nighttime gap of cloud properties observations.

3. Methodology/Expected Outcomes

- VIIRS DNB radiance together with a moon phase model can be calibrated into **lunar reflectance** for the visible spectrum (Miller and Turner, 2010).
- Implementation of the new retrievals in **CLAVR-x** retrieval scheme. The output are intended to be part of PATMOS-x cloud climatology.
- Adaption of ***DCOMP*** (Walther and Heidinger, 2012) to nighttime retrieval based on lunar reflectance by combining DNB reflectance with 3.9 channel emissivity.
- Improvement of existing nighttime cloud mask by using contrast parameter and radiance measurement in post-processing of the existing CLAVR-x cloud mask.

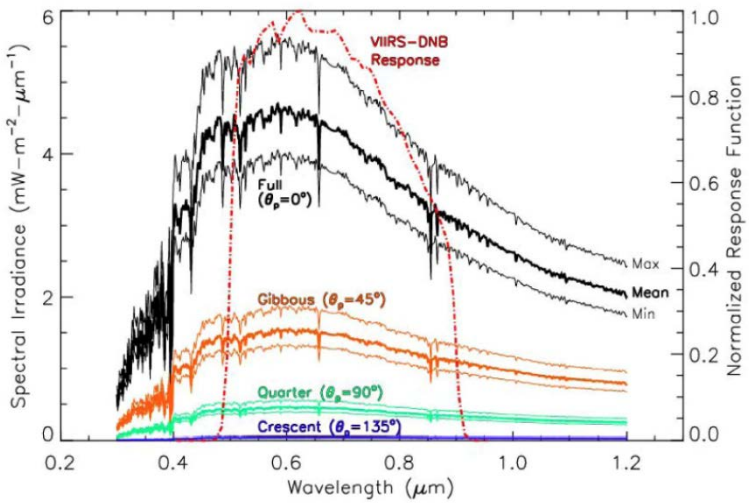
4. Results (I)

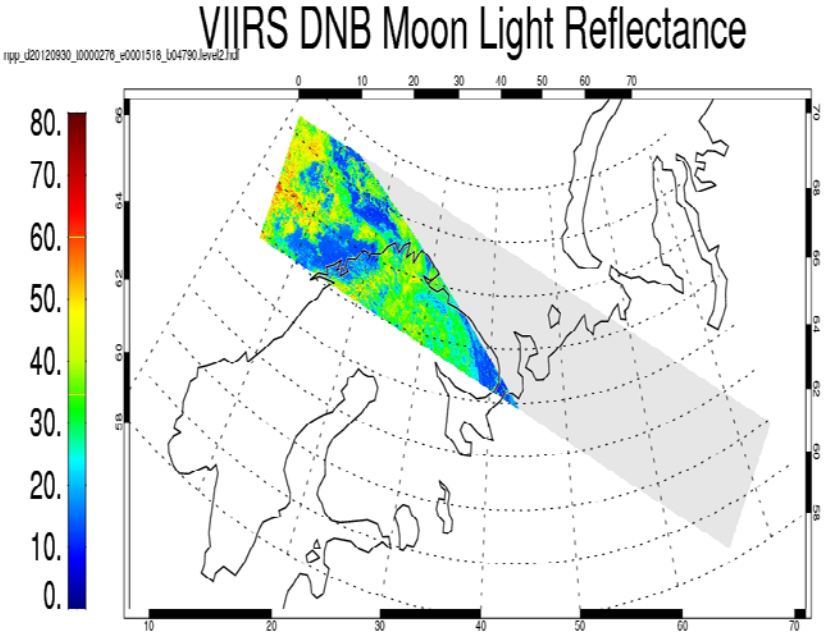




Cloud mask: Images show an example how DNB can improve cloud detection. Left image shows difference M12 (3.75um) – M15 (11um) brightness temperature, one cloud test in the current cloud mask. Water clouds appear yellow and red. Right image shows VIIRS DNB, where water clouds are very bright. It can be seen that DNB will detect low-level clouds those are missed in IR.

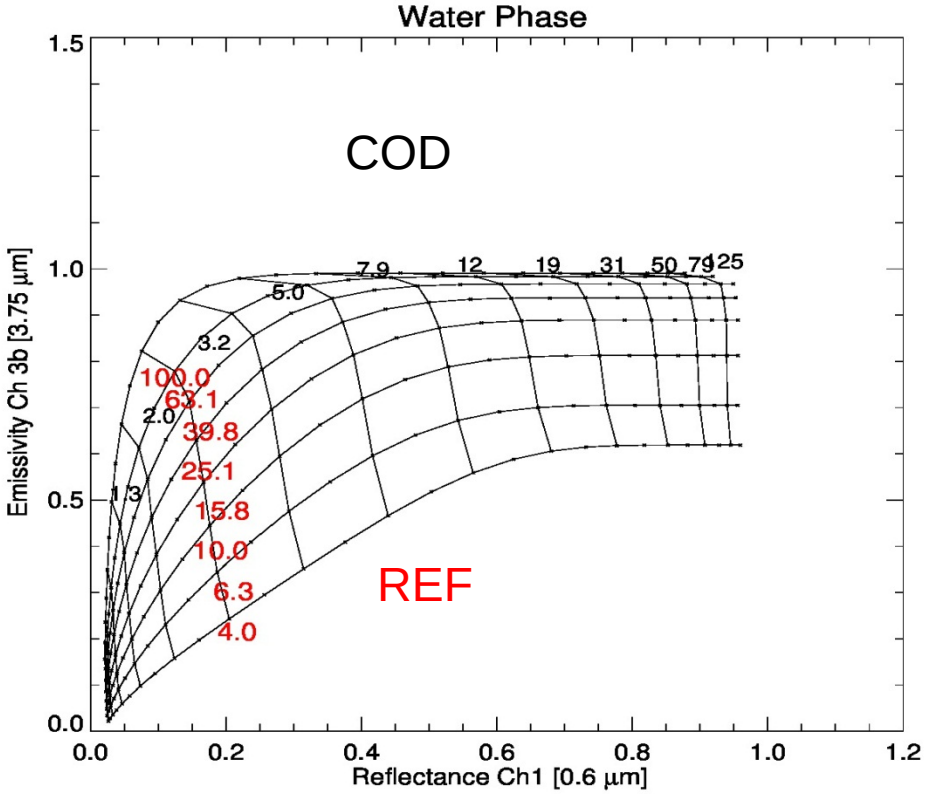
4. Results (II)





Lunar reflectance: Computation of lunar reflectance is not an easy task. The retrieval model has to consider lunar phase angle, phase function, non-homogenous lunar surface albedo, and varying sun-earth and moon-earth distance. Left image shows lunar spectral irradiance for selected lunar phase angles together with DNB spectral response function (Miller and Turner 2010). Right image shows the moon light reflectance as an output of CLAVR-x.

4. Results (III)



DNB- COMP: The Day/night band cloud optical microphysical properties retrieval is based on bi-spectral measurement of visible lunar reflectance and emissivity in channel M12 (3.75 um). Image shows the forward model computed by a radiative transfer model. It can be seen that retrieval information content is sufficient.

5. Possible Path to Operations

- **CLAVR-x** is an existing radiance calibration and cloud property retrieval set. **CLAVR-x** supports several field experiments (e.g. TC-3) on a quasi operational basis.
- CLAVR-x and PATMOS-x build a NCDC cloud climatology data set.
- Many of the CLAVR-x algorithms are also part of the NOAA AWG retrieval **FRAMEWORK**, which was developed for GOES-ABI. DCOMP and the cloud mask are the official GOES-ABI algorithms and will build the operational ABI retrieval. The new retrievals may be implemented in this system.
- The results of this project will benefit of these already existing structures from development to operations.

6. Future Plans

- This project started in summer 2012 and is still in the first year.
- Possible other ideas:
- Urban light build a disturbing signal and has to be corrected or masked for the retrievals. Initial development will focus on “good” areas without massive light. We will investigate if and how we can use city light cloud-free radiance maps to correct the impact.
- We also see a chance to **exploit city lights** for cloud detection at **new moon phase** where lunar radiance is not present by help of textural analysis. In DNB images can be seen, that clouds leads to **blurred texture** during new moon over cities.
- With JPSS satellite series we will be able to start to extend cloud climatology to nighttime. It will be the first time where we have a full **diurnal cycle** of optical properties and water path. This can be also used for **precipitation estimates**, which will be particular valuable for areas with long periods without sufficient daylight, such as for Alaska in winter.

7. Publication List

- References

Heidinger, A K., A T. Evan, M. J. Foster, A. Walther, 2012: A Naive Bayesian Cloud-Detection Scheme Derived from CALIPSO and Applied within PATMOS-x. *J. Appl. Meteor. Climatol.*, **51**, 1129–1144.

Miller, S. D., and R. E. Turner: A dynamic lunar spectral irradiance dataset for NPOESS/VIIRS Day/Night Band nighttime environmental applications, IEEE /TGRS, 47, 2316-2329.

Walther, A, A K. Heidinger, 2012: Implementation of the Daytime Cloud Optical and Microphysical Properties Algorithm (DCOMP) in PATMOS-x. *J. Appl. Meteor. Climatol.*, **51**, 1371–1390.

- Project Publications

Project proposal: Miller, Heidinger and Walther, 2012: Advancing Nighttime VIIRS Cloud Products with the Day/Night Band