Analysis of deep convective clouds (DCC) for near infrared channels

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Introduction

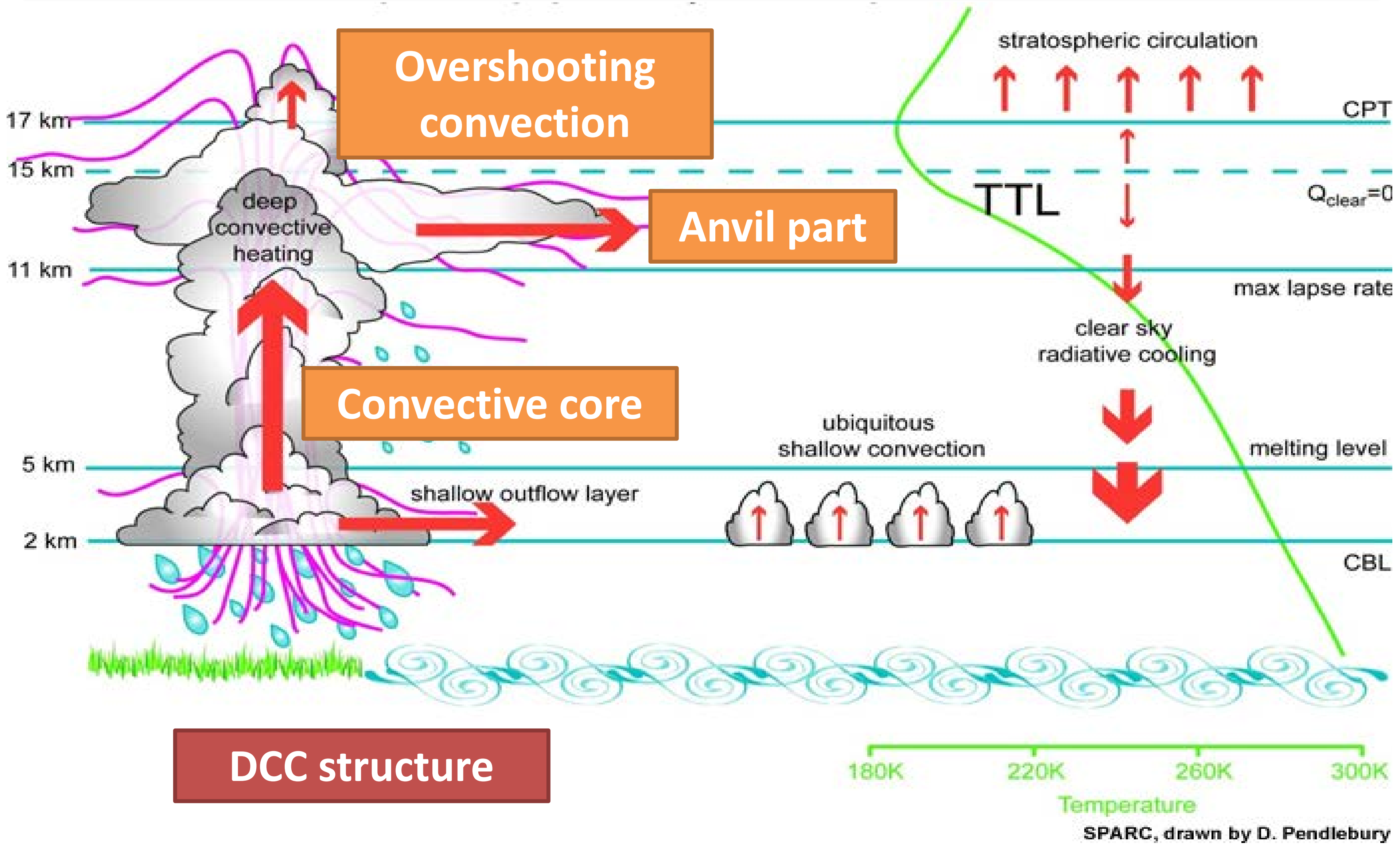
- ❑ Deep convective clouds (DCCs) are extremely bright and cold and can be assumed nearly a Lambertian reflectance and provided a constant monthly mean albedo. So they are used as calibration targets for a calibration technique.

- ❑ In previous studies, the existence of bi-modal patterns at near/shortwave IR channels in reflectance histograms causes large uncertainties for long-term trending of calibration accuracy (Wu et al. 2013 and Yu and Wu 2016).

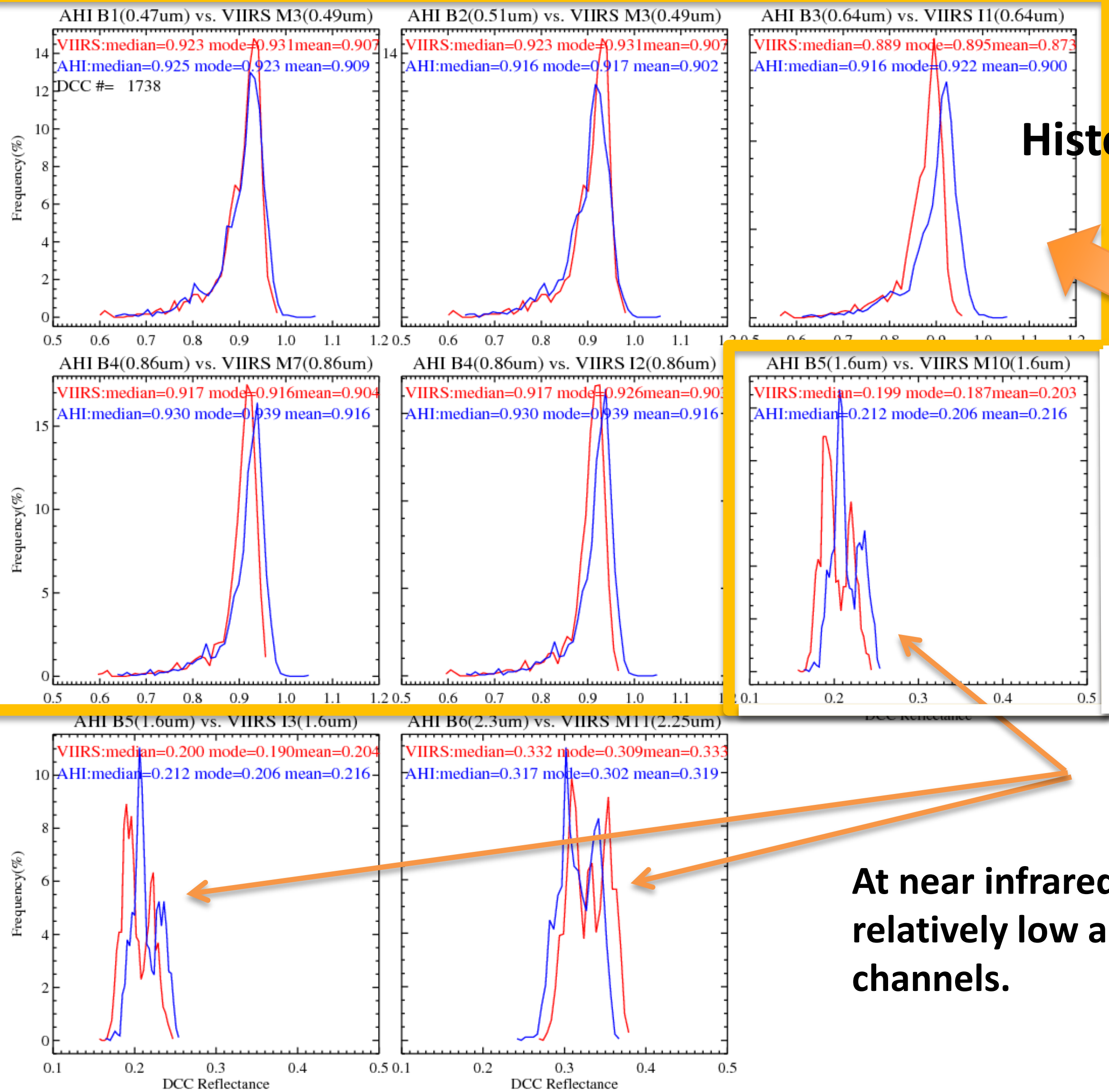
- ❑ DCC work can provide a unique opportunity to develop, test and examine the calibration/validation tools for the Advanced Baseline Imager (ABI).

- ❑ This work supports the development of the ABI L1b Post-Launch Product Test.

Introduction



Introduction



Histograms of the DCC reflectances (from Yu and Wu 2016)

DCCs show single mode and high reflectance at the bands with wavelength less than 1 µm.

At near infrared channels (NIR), reflectance is relatively low and bi-modal patterns at near IR channels.

Introduction

1. Objective: To reduce DCC reflectance uncertainty at NIR channels in identifying DCC pixels using VIIRS and GEO-LEO inter-calibration techniques
2. Strategy

- Use of VIIRS Level2 product to look at cloud properties identified DCCs by Level 1b data
- Comparison two results from different methods in identifying DCCs, can we estimate reflectance threshold value for NIR channels?
- Select a convective core part from DCC structure by identifying overshooting part

3. Brief background

There are four methods to identify cold clouds near the tropopause.

a) Using a fixed brightness temperature threshold (e.g., T_{b11} < 205 or 210 K)

b) Using a threshold relative to the monthly tropopause temperature ($T_{b11} < T_{tropo}$)

c) Using a threshold based on the difference between a surface channel and a sounding channel (difference between $T_{b6.7}$ and T_{b11}).

d) Using tri-spectral IR technique that used bands at 8.5, 11, and 12 µm

Method & data

Data:

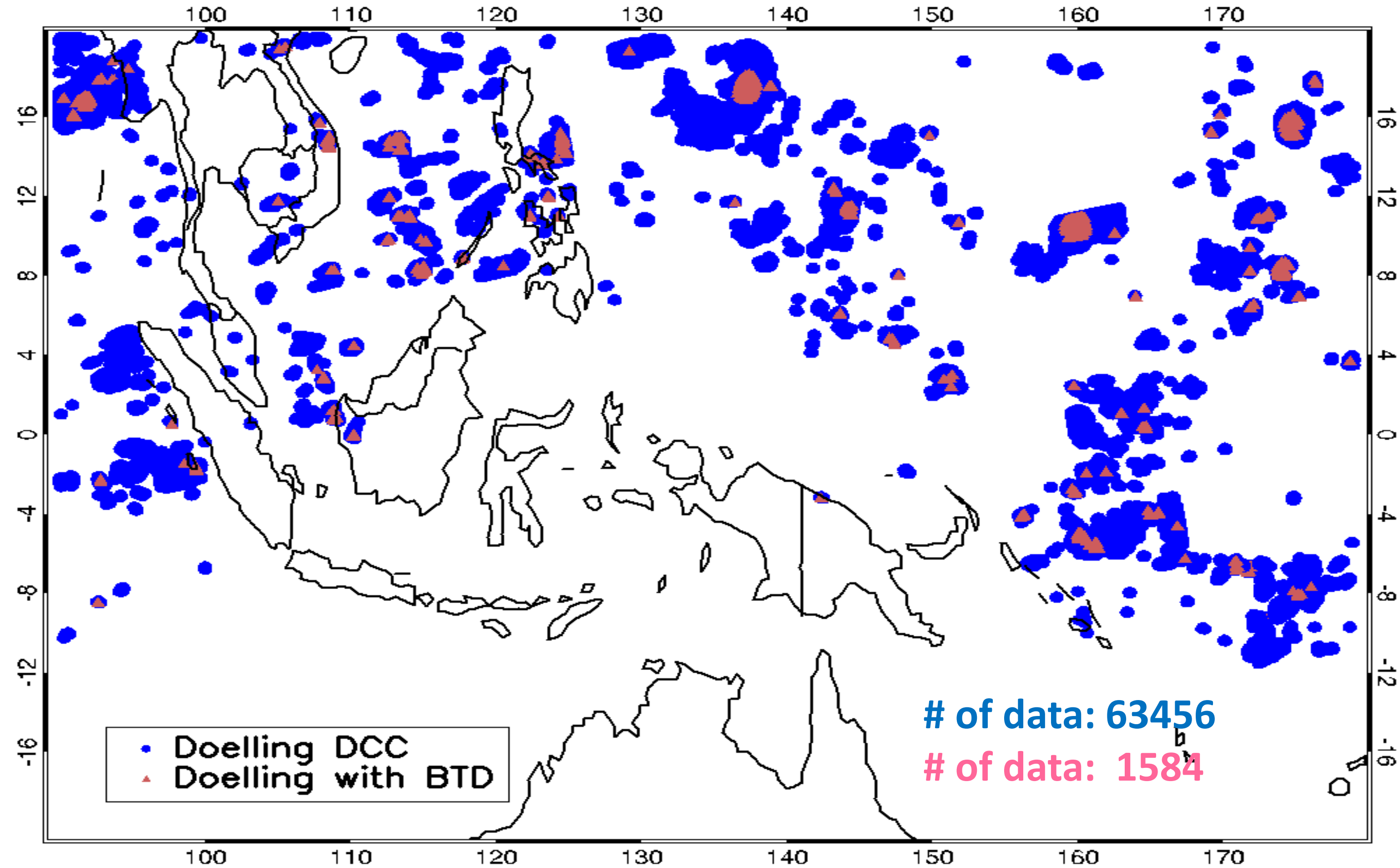
1. VIIRS Level 1b data and Level 2 cloud product (July, 2015)
2. Collocated VIIRS and AHI data (July and August, 2015)

Doelling et al. (2004)	Ackerman et al. (1996)
Latitude < ± 20 ° SZA < 40° VZA < 40° Tb at Mband 15 (10.76 μm) < 205 K STD at Mband 15 < 1 K STD at Iband 1 (0.64 μm) < 3 %	IR window channel BT differences between 11 and 12 μm
DCC	**Overshooting part**

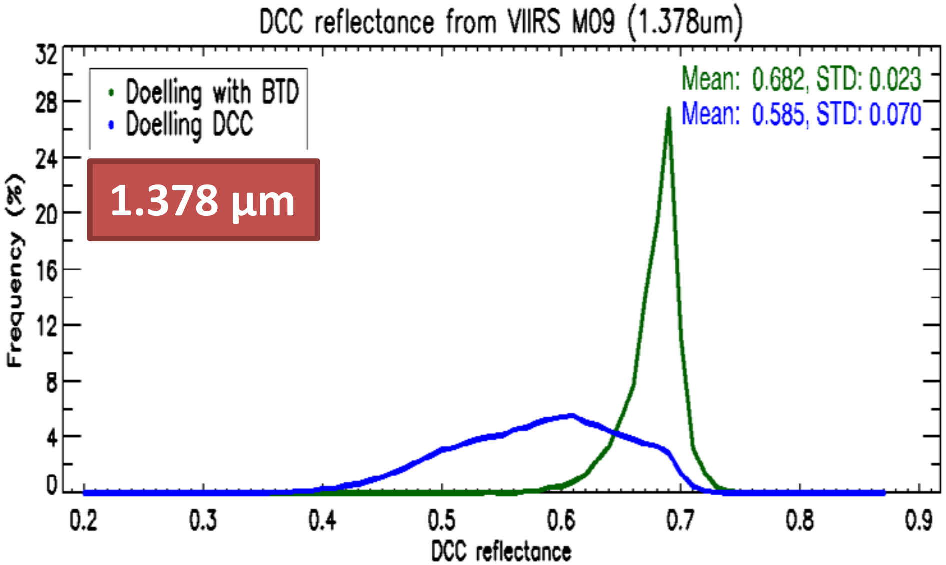
We defined DCCs by combining Doelling method and positive BTD values (BT12 -BT11 μm).

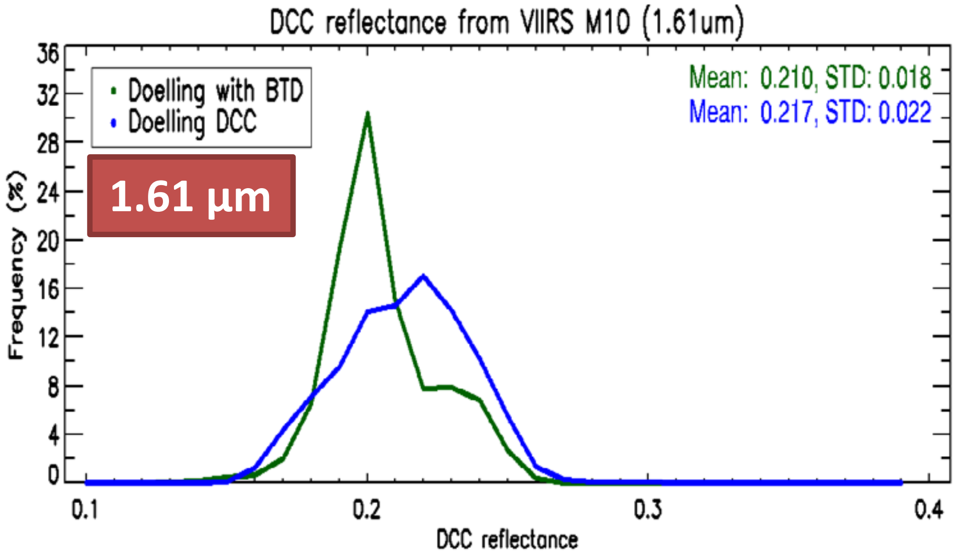
Results: VIIRS

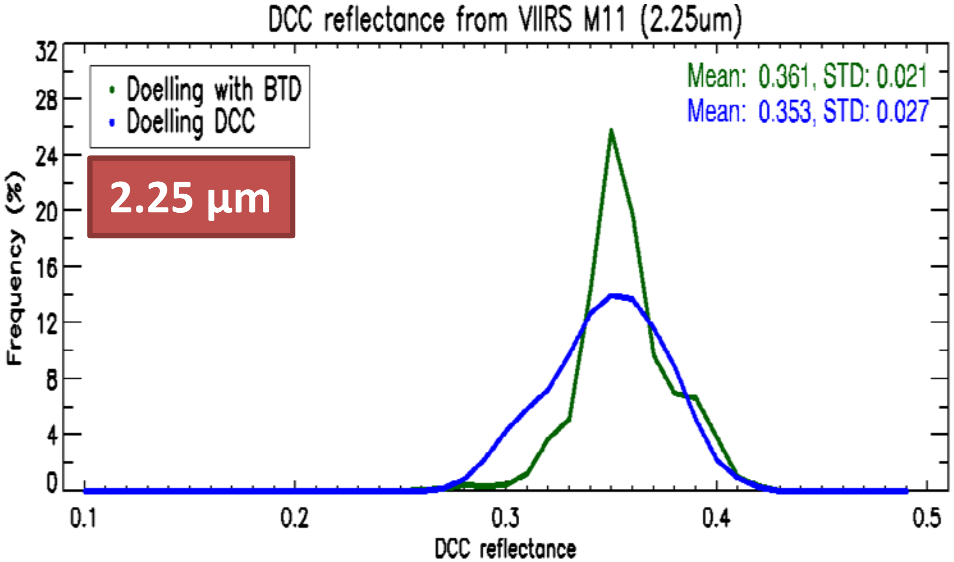
Distribution of DCCs identified by the two methods from VIIRS in July, 2015



Results: VIIRS



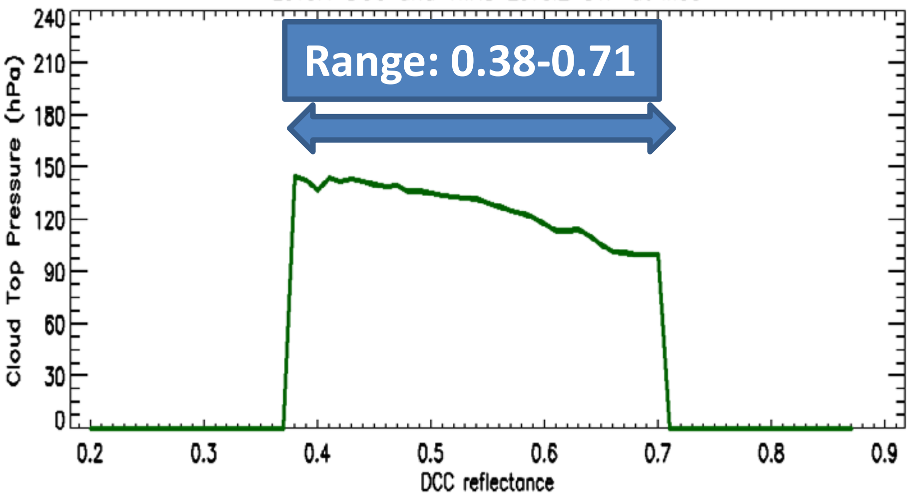


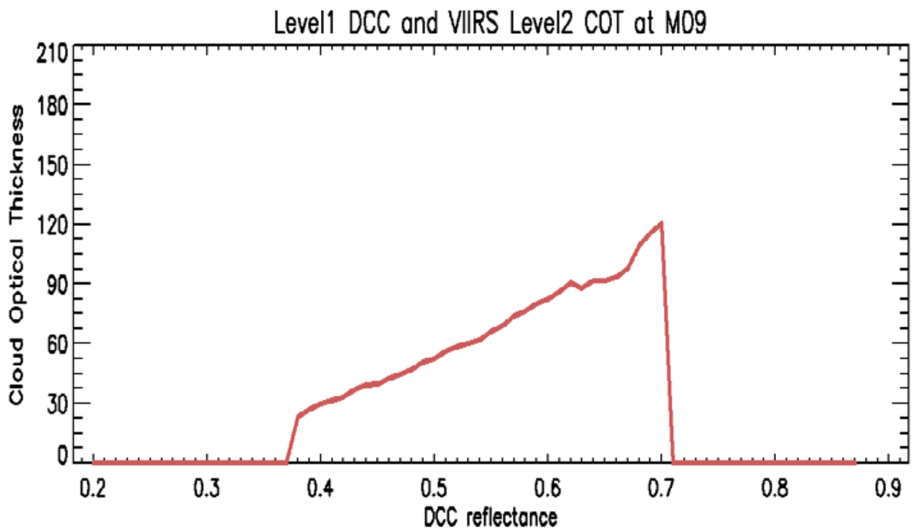


Frequencies of the DCC reflectance at near IR from the two methods

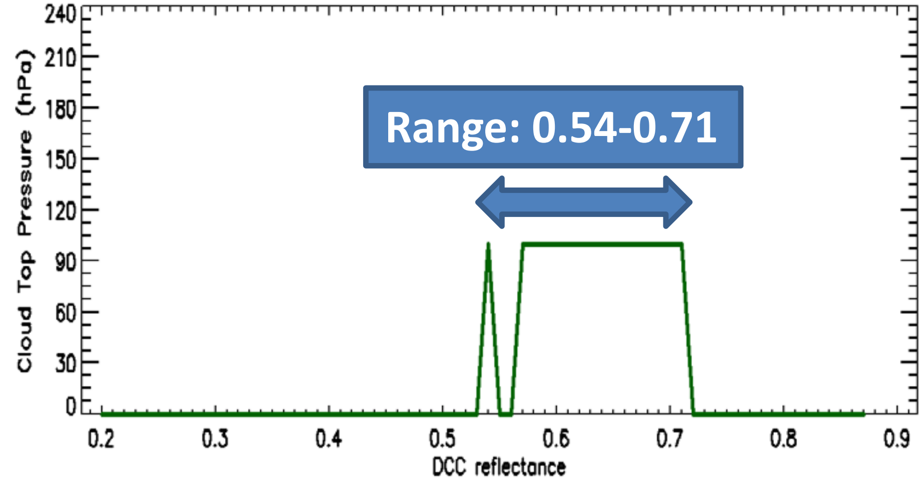
Results: 1.378 µm

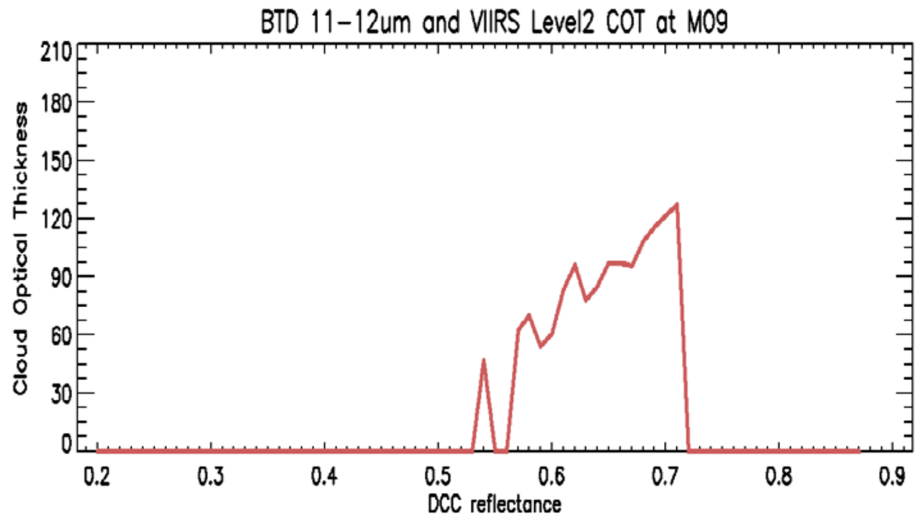
Doelling





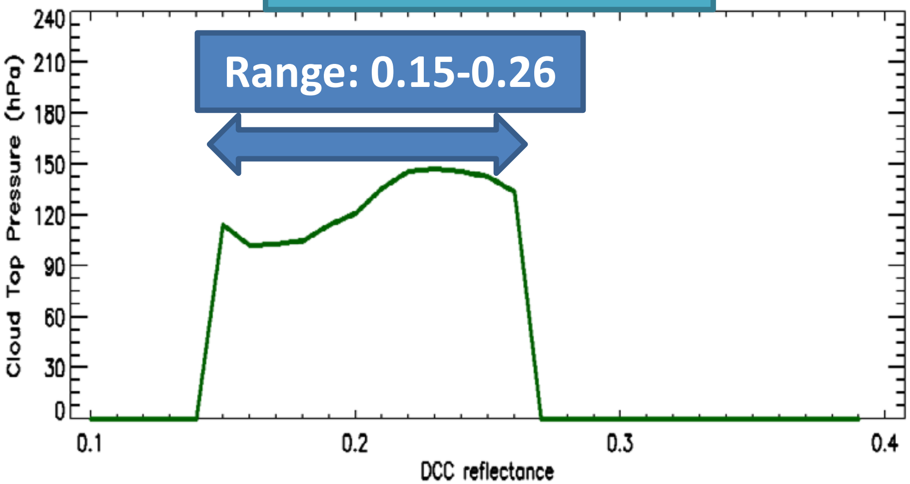
Doelling with BTD

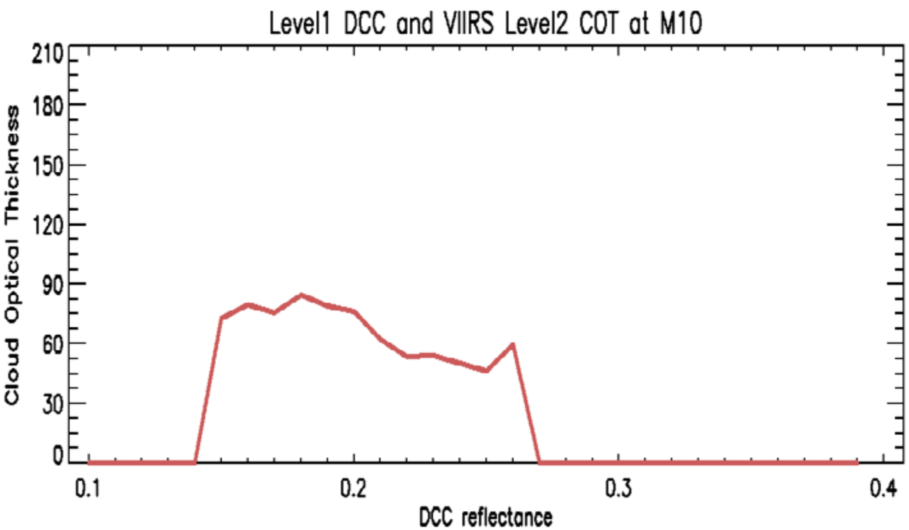




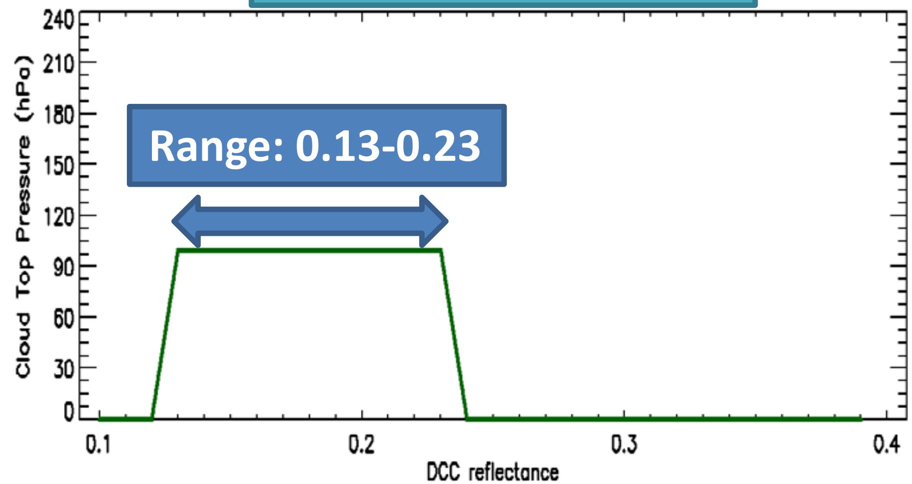
Results: 1.61 µm

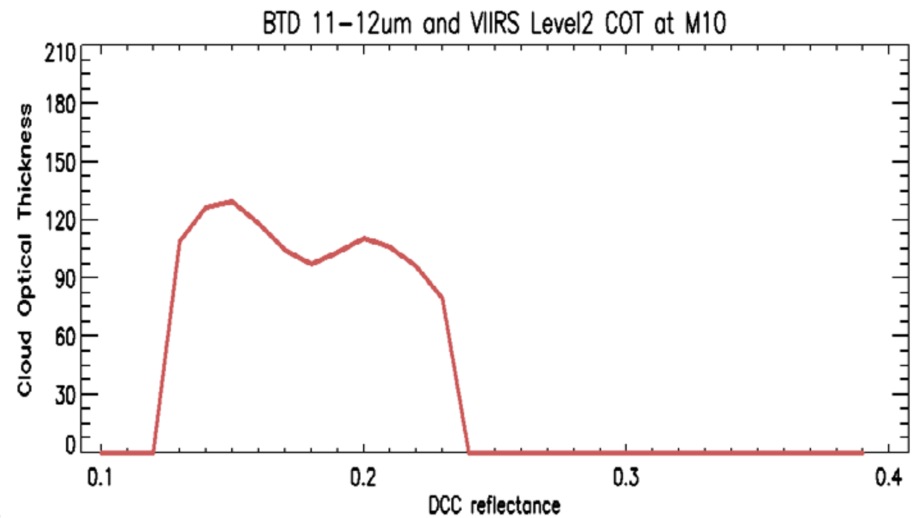
Doelling





Doelling with BTD





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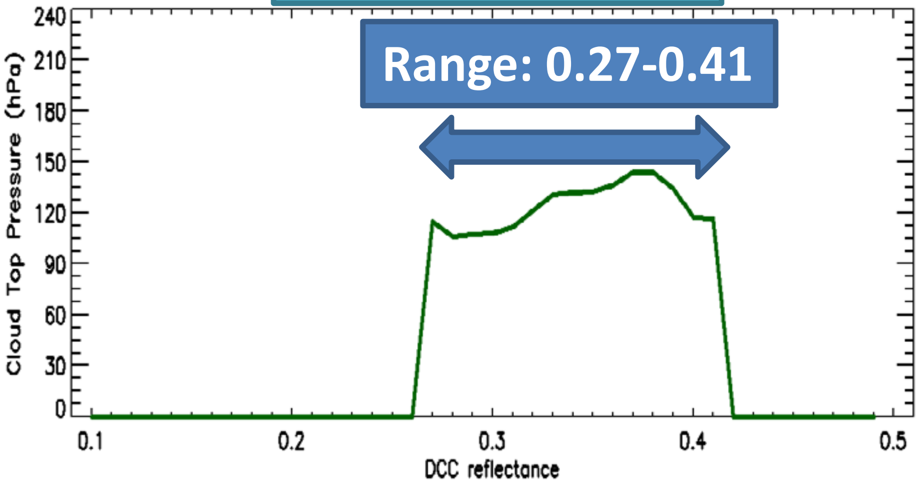
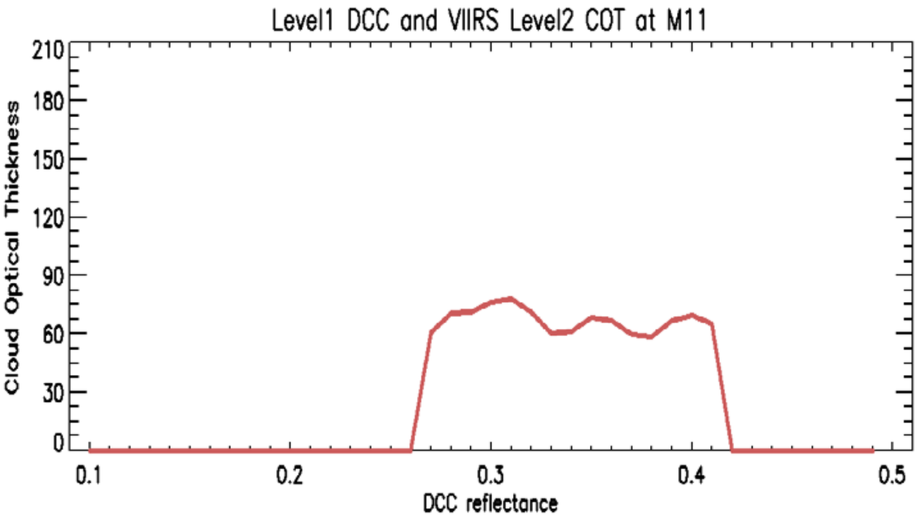
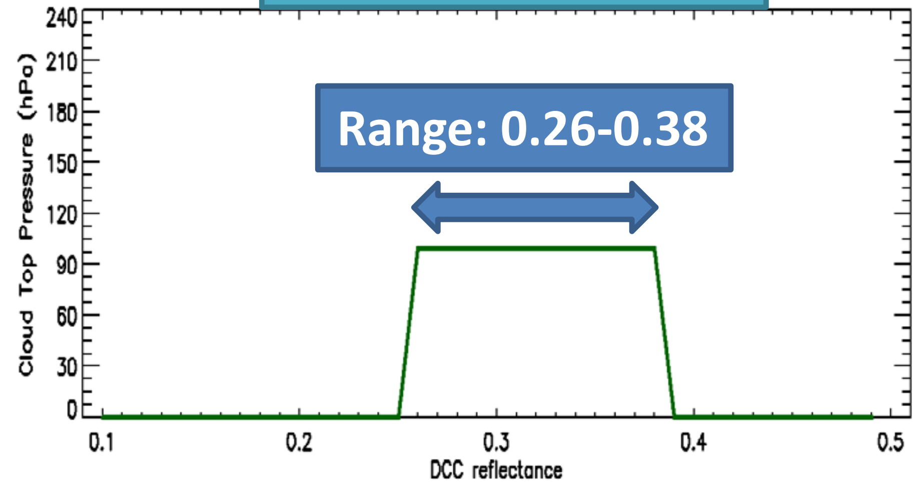
Results: 2.25 µm

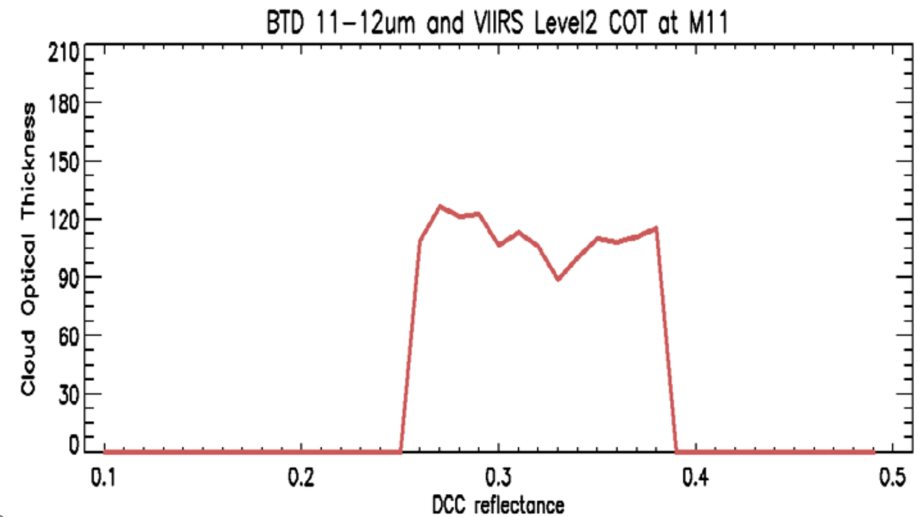
Doelling





Doelling with BTD

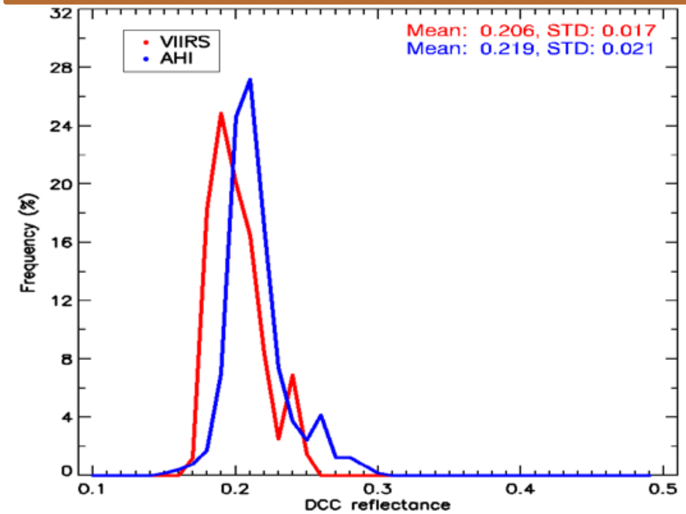


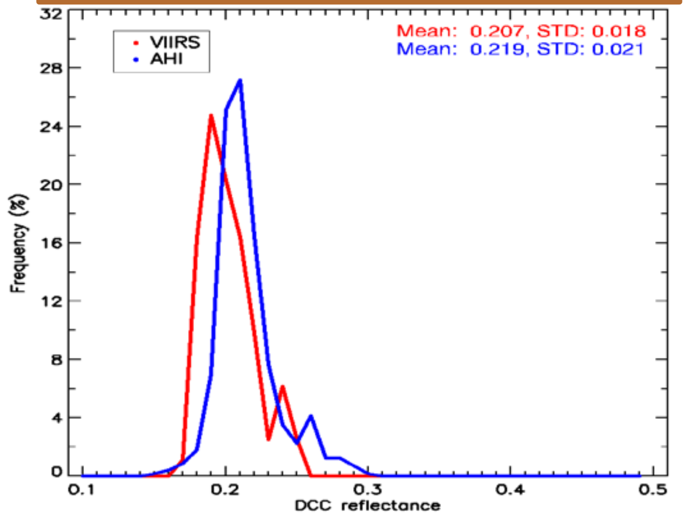


Results: GEO-LEO

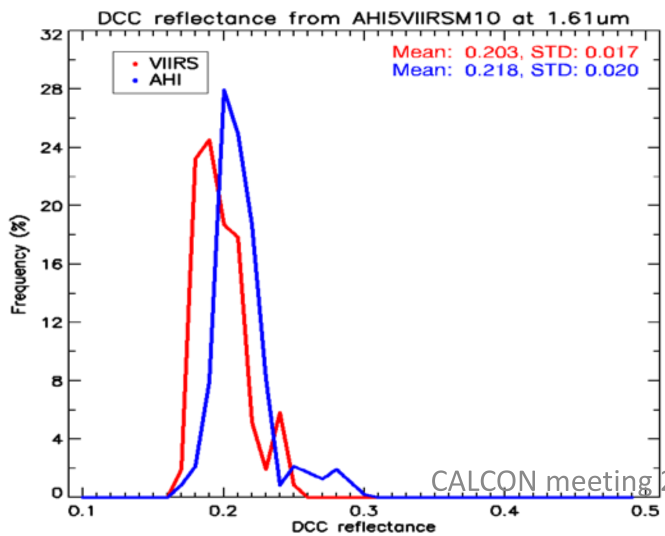
AHI 5 vs VIIRS M10 at 1.61µm | **AHI 5 vs VIIRS I3 at 1.61µm**

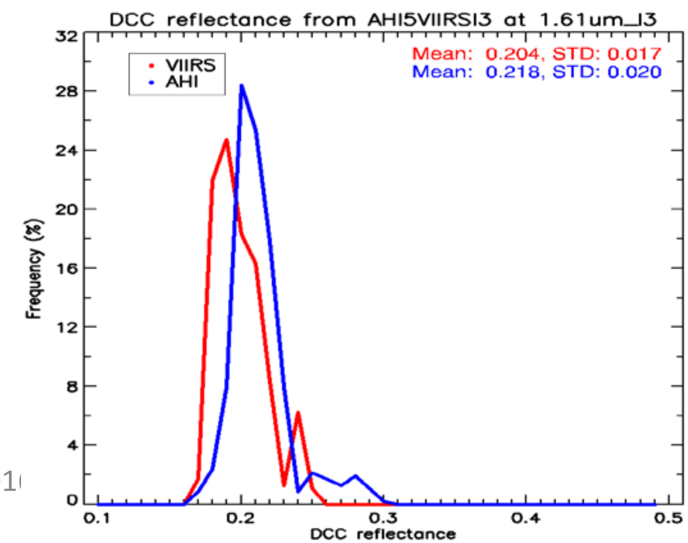
Doelling





Doelling with BTD

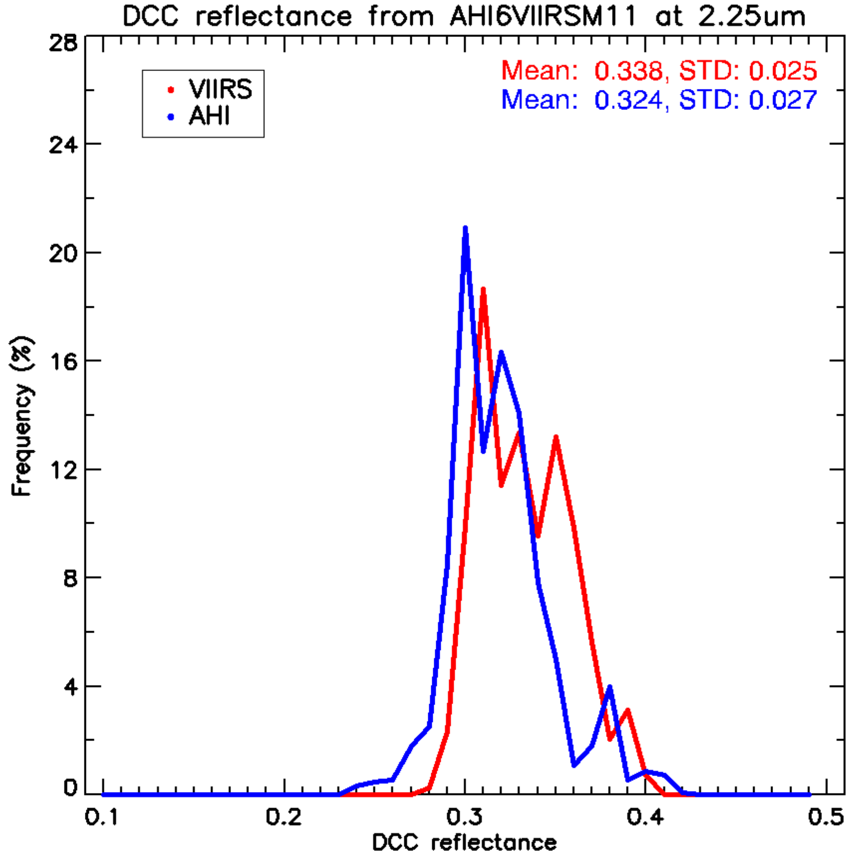




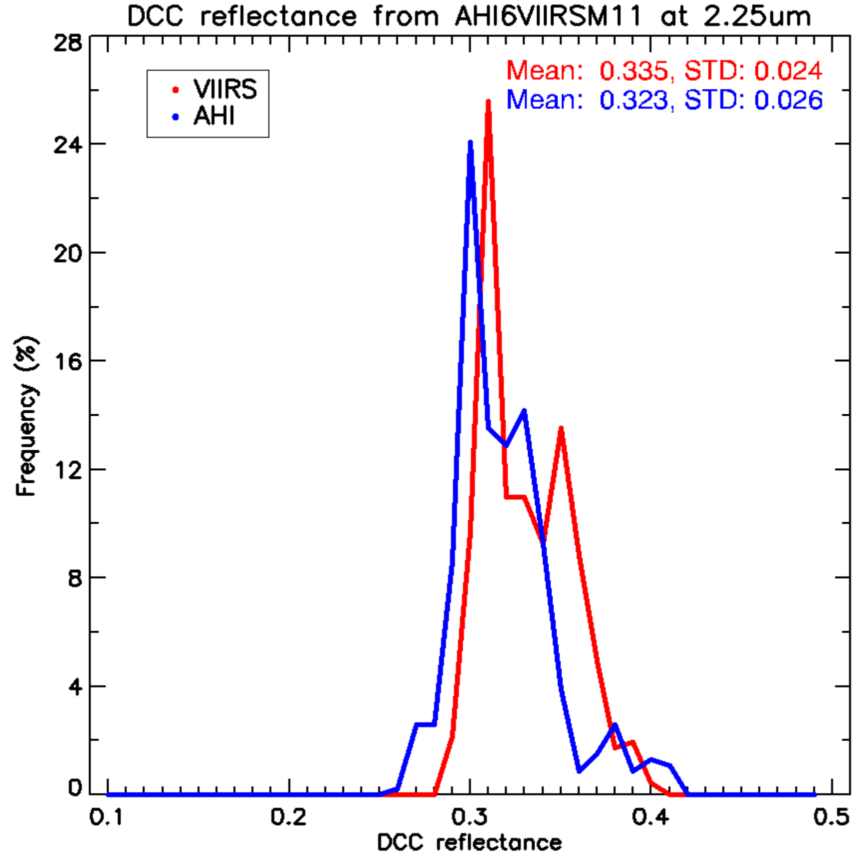
Results: GEO-LEO

AHI 6 vs VIIRS M11 at 2.25µm

Doelling



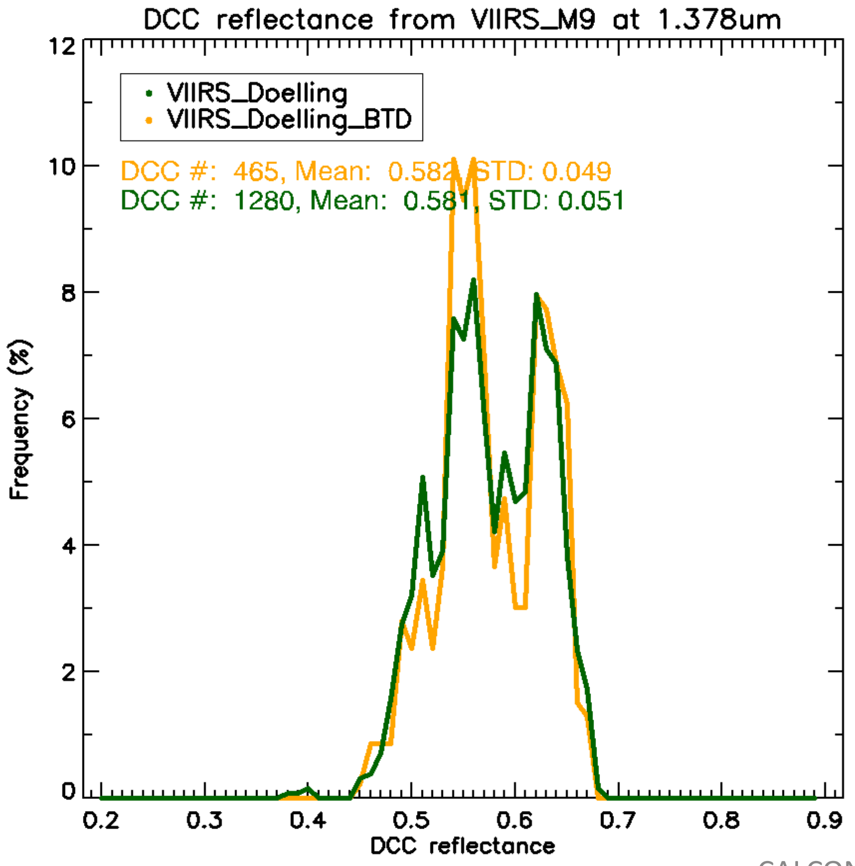
Doelling with BTD



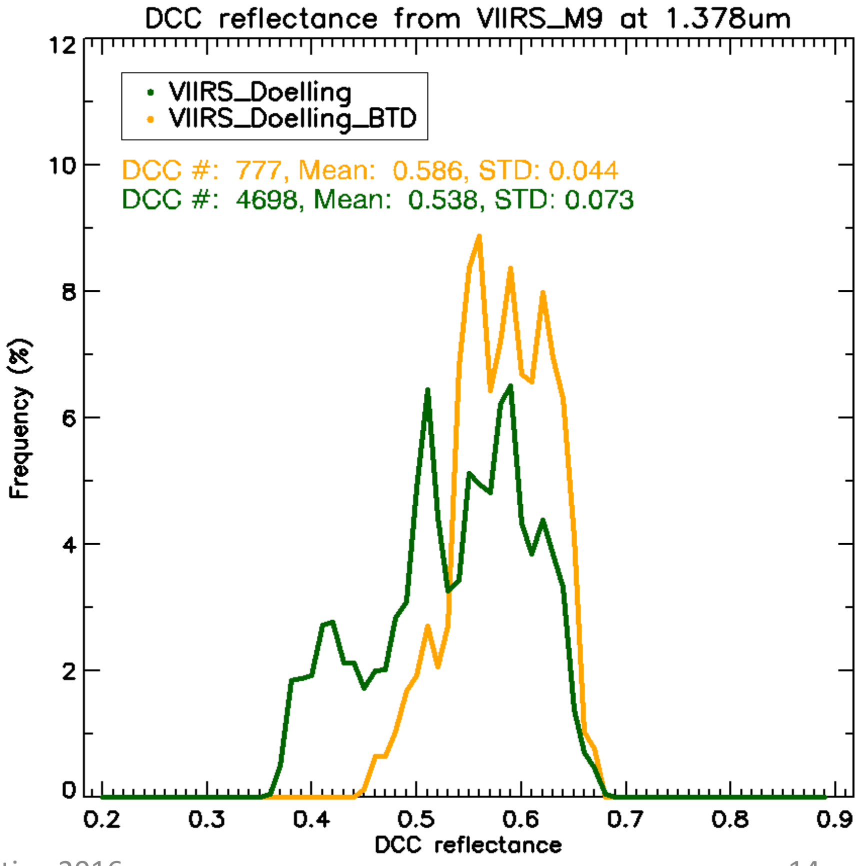
Results: GEO-LEO

VIIRS M9 at 1.378µm, AHI does not have this channel.

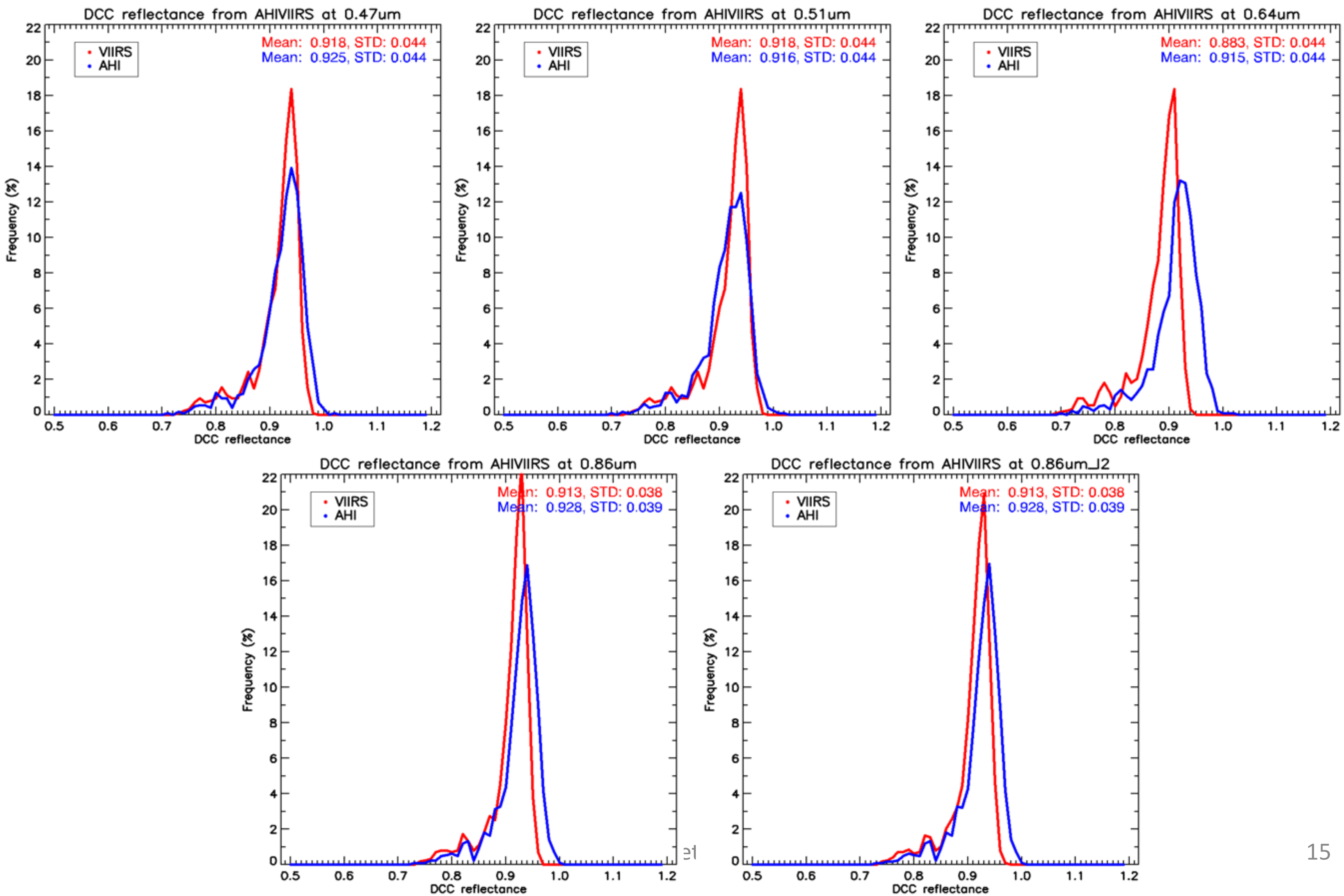
July to August



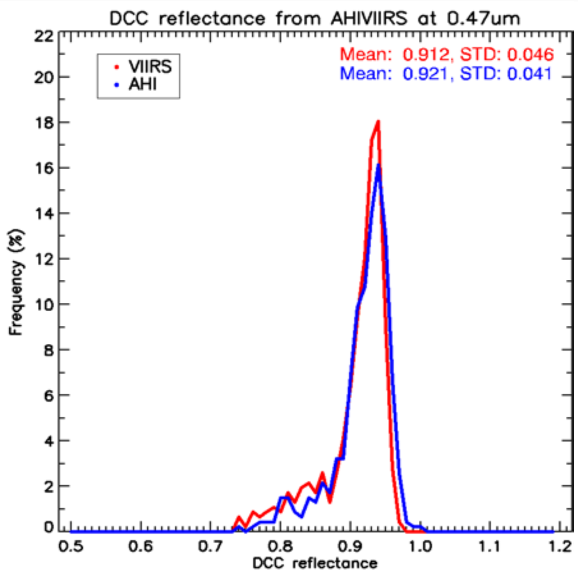
July to October

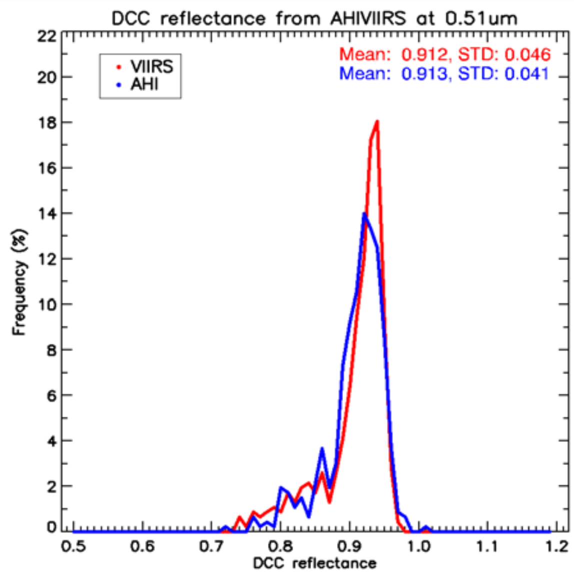


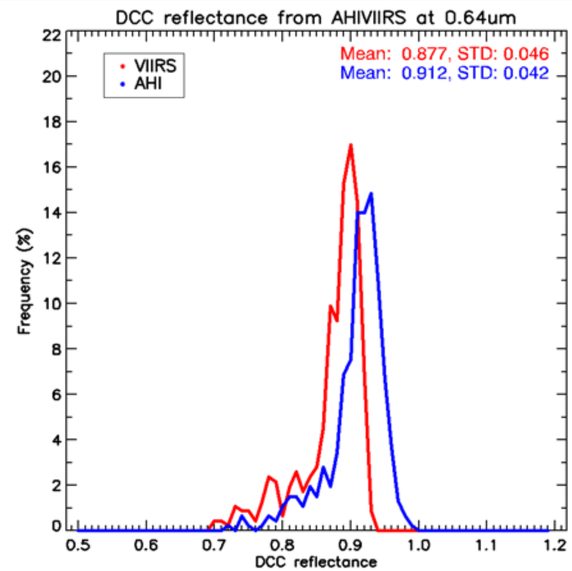
Results: VIS (ori)

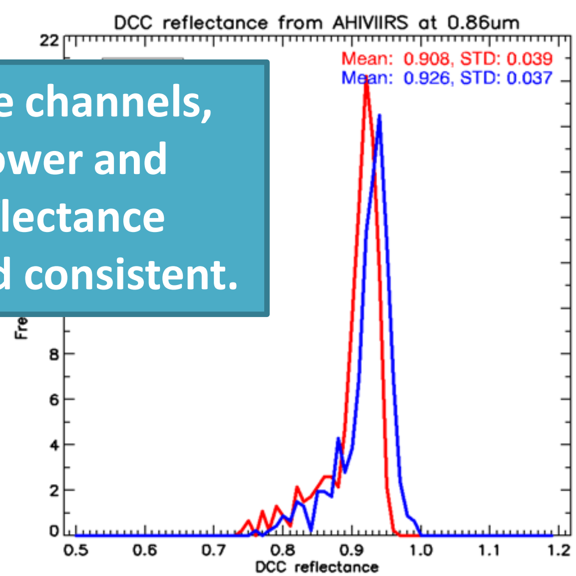


Results: VIS (new)

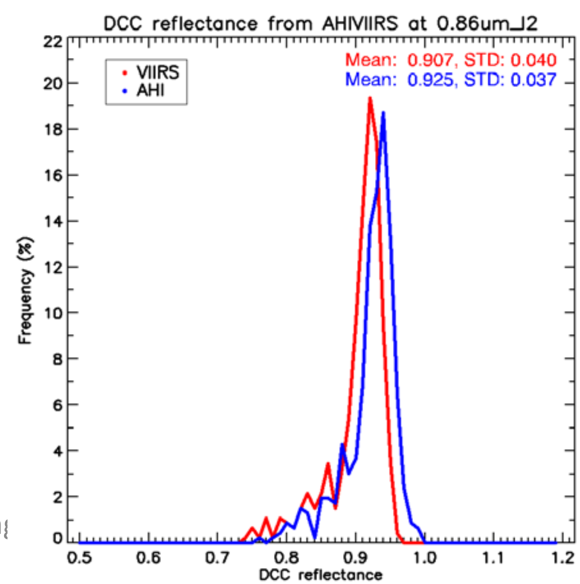








For AHI all visible channels, STD values get lower and histogram of reflectance shows stable and consistent.



Results

Reflectance values between the two methods using VIIRS data

	M09 (1.378µm)		M10 (1.61µm)		M11 (2.25µm)	
	Ori	New	Ori	New	Ori	New
Standard devi.	0.07003	0.02300	0.02271	0.01895	0.02779	0.02170
mean	0.5851	0.6823	0.2170	0.2102	0.3533	0.3615
mode	0.61	0.69	0.22	0.2	0.35	0.35

Reflectance values between the two methods using the collocated data

	M09 (1.378µm)		M10 (1.61µm)		M11 (2.25µm)	
	Ori	New	Ori	New	Ori	New
Standard devi.	0.051 (0.073)	0.049 (0.044)	0.021	0.020	0.027	0.026
mean	0.581 (0.538)	0.582 (0.586)	0.219	0.218	0. 324	0.323
mode	0.61	0.69	0.22	0.2	0.35	0.35

Summary

1. Two results; DCCs identified from Doelling method using Level1b data and Doelling with BTD method are within the DCCs captured by Level2 cloud product.
2. Doelling with BTD method shows some improvements at all three SWIR bands for both VIIRS and the collocated data than only Doelling method.
3. At 1.378 µm, Doelling with BTD method has larger reflectance values than those from original method using VIIRS. At 1.61 and 2.25 µm, mean reflectance and STD get smaller using Doelling with BTD method.
4. In AHI data, the results of Doelling with BTD method have consistent single mode of reflectance and lower standard deviation values at all visible channels compared the only Doelling method.