NOAA Satellite and Information Services
National Environmental Satellite, Data, and Information Service

IMSG
I.M. Systems Group, Inc.

CrIS Cloud Product From VIIRS collocation/Intergration processing

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Outline

- Physical Collocation Method
- LUT based Physical Collocation Method
- Problem and solution
- CrIS Cloud Product
- Conclusion

Physical Collocation Method

- The instrument observation(~ CrIS) is contributed by all the points within the effective field of view (EFOV).
- The physical collocation required the collocated observation and physical variables(~ Collocated VIIRS cloud product) have the same spatial and physical representivity
- The same spatial representivity required the collocated physical variable are from the same coverage area, (Same effective field of view (EFOV).
- The same physical representivity required the contribution weight of the individual point to the collocated physical variable are same.

CrIS/VIIRS Physical Collocation Processing

Data flow:

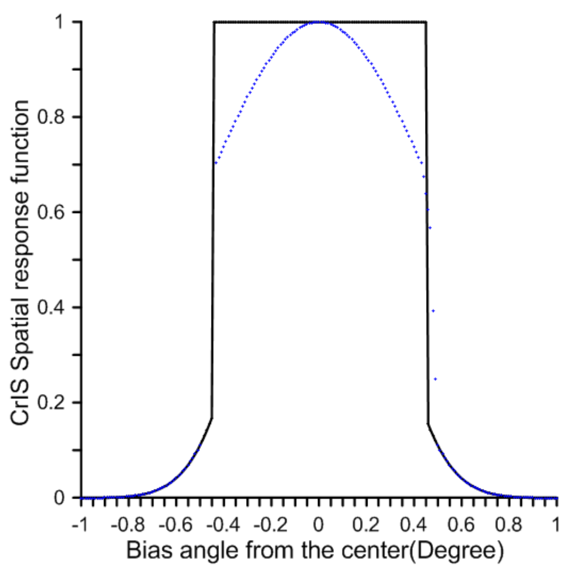
Step 1: The closing points collocation between different instrument is accomplished with observation geo-location information.(spatial Searching algorithms

Step 2: Identify all collocated observations. The closing VIIRS point is mapped to CrIS EFOV spatial response function(SRF) to get the contribution weight of the collocated points. The point with non zero weight will be collocated.(Input : Satellite position and attitude, observation geo-location, EFOV SRF)

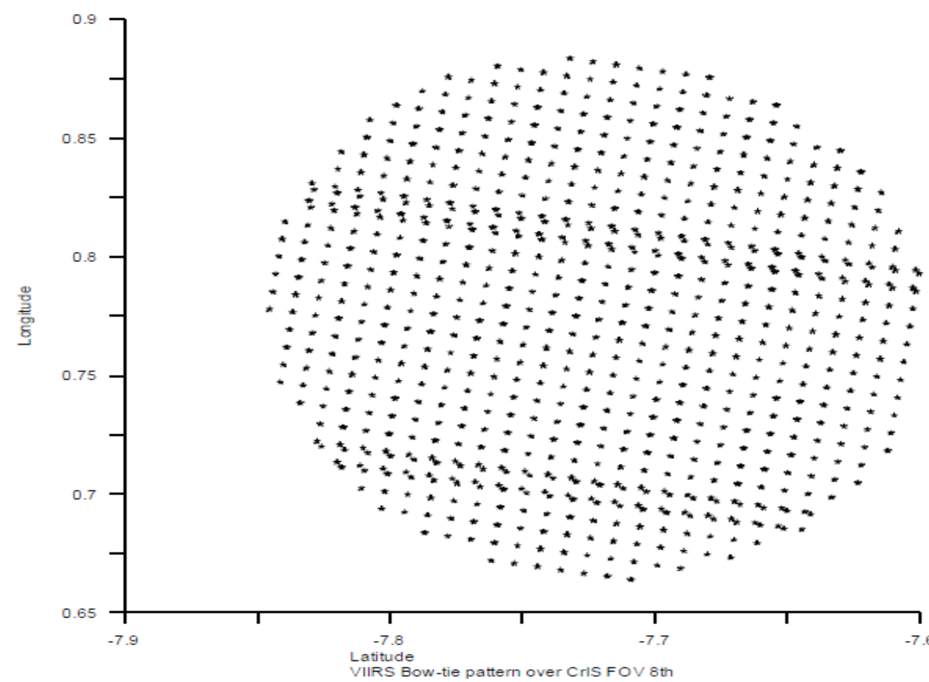
Step 3: Averaging/Integrate the collocated VIIRS point with/without the contribution weight.

Physical Collocation Method

In the CrIS/VIIRS collocation processing, the master instrument (CrIS) EFOV SRF is used to identify all collocated slaver observation(VIIRS) within the EFOV



CrIS EFOV SRF



VIIRS Collocation Colocation

LUT based Physical Collocation Method

Operational Requirement: In JPSS CrIS/VIIRS collocation operational processing, the processing speed is listed as the most critical requirement. The collocation scheme with the look up table(LUT) is selected.

POS: The LUT method significantly speed up the processing by applying the off-line calculated match-up LUT in the integration processing.

Condition: Given the relative position between the collocation observation from different observation system keep "Fixed", a pre-calculated LUT for the collocation can be used in the real time processing.

VIIRS ,CrIS instruments are aboard on the same observation platform and their relative position keep "fixed". LUT based Physical Collocation Method is selected.

The problem introduced by the of relative position variation need to be addressed when the LUT method is selected for collocation processing.

LUT based CrIS/VIIRS Physical Collocation Processing

Data flow:

Step 1: Identify all collocated observations. The collocated VIIRS point is identified with LUT. (Input : off line calculated LUT)

Step 2: Averaging/Integrate the collocated VIIRS point with/without the contribution weight.

POS:

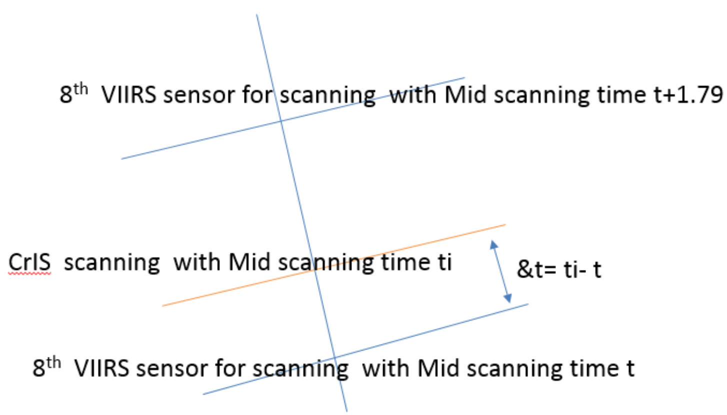
1: No time consuming calculation

2: EFOV SRF is applied

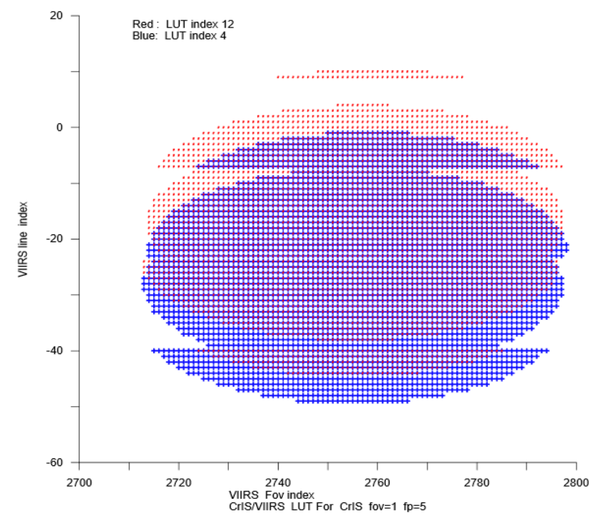
LUT based Physical Collocation Method

The LUTs for the collocation is trained with the real observation navigation data. Multiple tables are trained with the real collocated CrIS/VIIRS data with "different relative position" due to the scan mirror rotate period difference.

The collocation LUTs are trained at 16 even distributed t_{li} time point [0,1.784]. The time intervals is 0.113 second and the surface along track movement is about 0.75km. This is also the spatial resolution of the colocation LUT



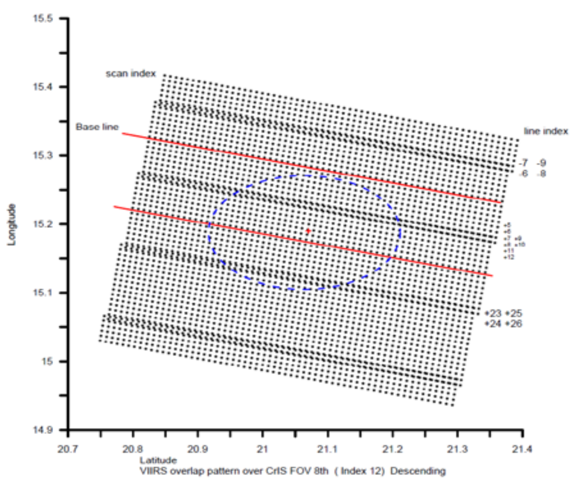
Multiple LUT Trainning

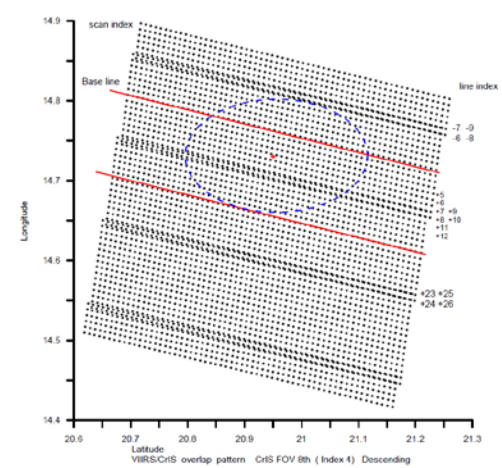


Problem: Fixed Relative position vs Different scan period

In CrIS/VIIRS collocation, The observation time difference in collocation processing should be equal or close enough to the observation time difference of the in collocation LUT training.

The solution is to use multiple LUTs according to the observation time difference. For the CrIS FOV, Multiple LUTs are trained with the overlapped CrIS/VIIRS data set with different time difference.

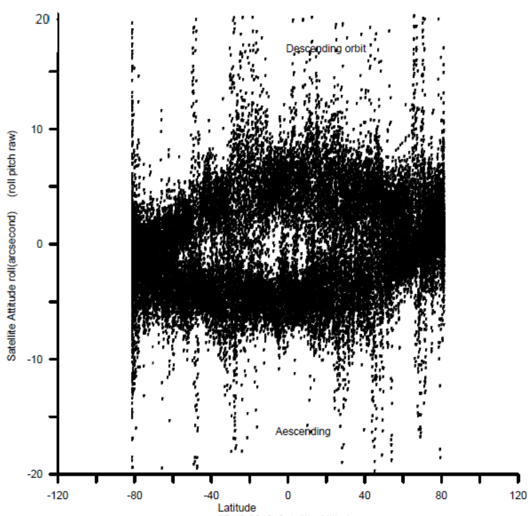




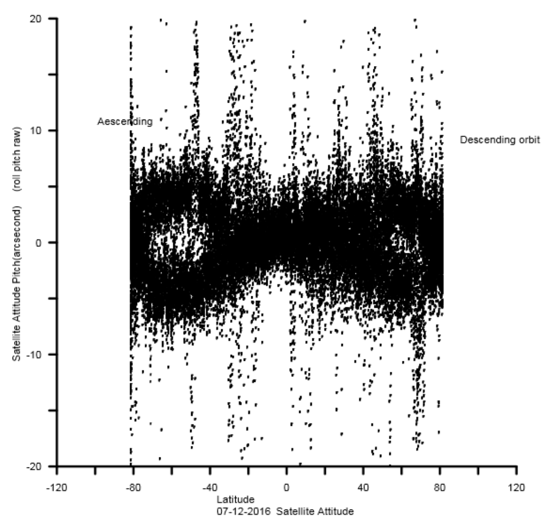
Problem: The relative position variation relating with satellite attitude

Spacecraft with momentum actuators suffer from attitude jitter and high frequency oscillations due to imbalance in the rotors of momentum actuators. Beside the attitude jitter, NPP satellite attitude also has the system variance pattern according to the latitude.

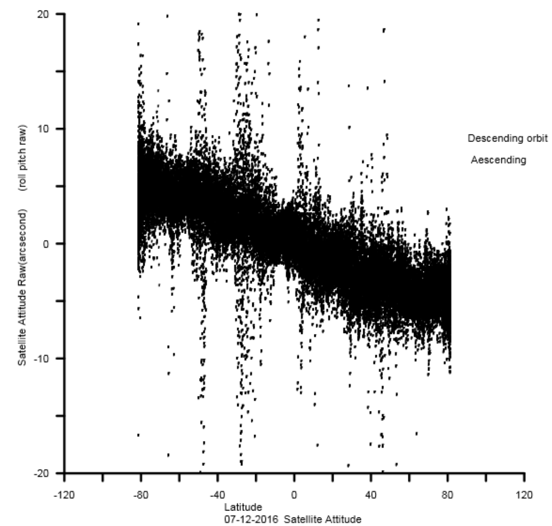
In CrIS/VIIRS collocation, The observation **satellite attitude** in collocation processing should has equal or close enough to the **satellite attitude** of the data used in collocation LUT training.



Roll



Pitch



Raw

Solution: The relative position variation relating with satellite attitude

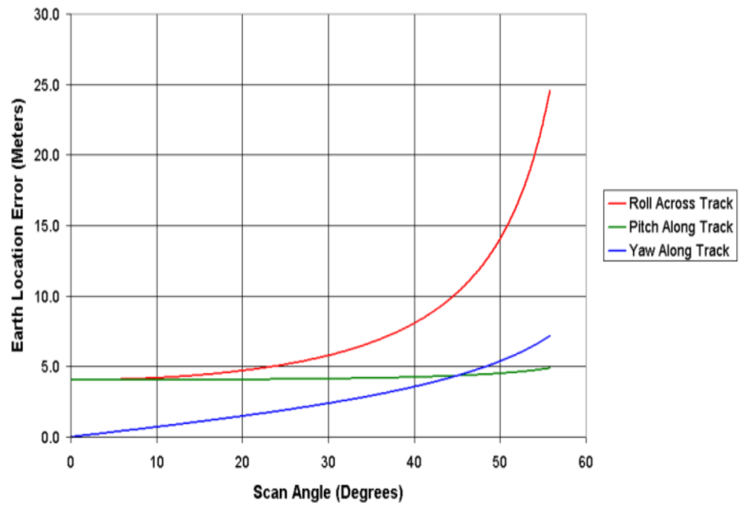
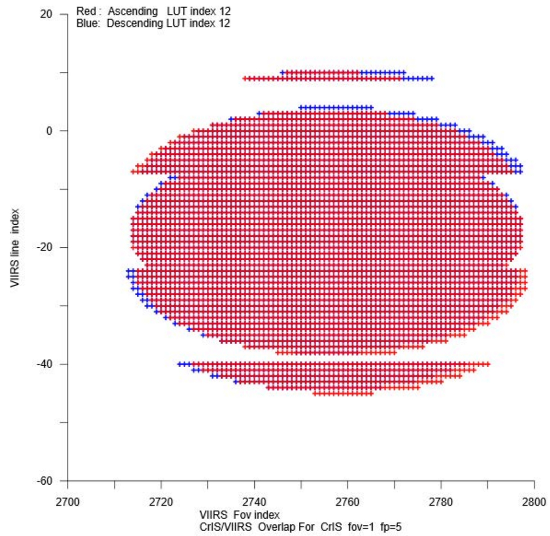


Figure 3.4-5: Earth Location Error (in meters) resulting from Instrument/Platform Pointing Error (in arcseconds) as a Function of Scan Angle



- Basing on the attitude effect and the attitude pattern, In present LUT collocation, the collocation LUT are trained separately for ascending and descend observation. The collocation LUT are trained independently with descending and ascend data covering the equator area.

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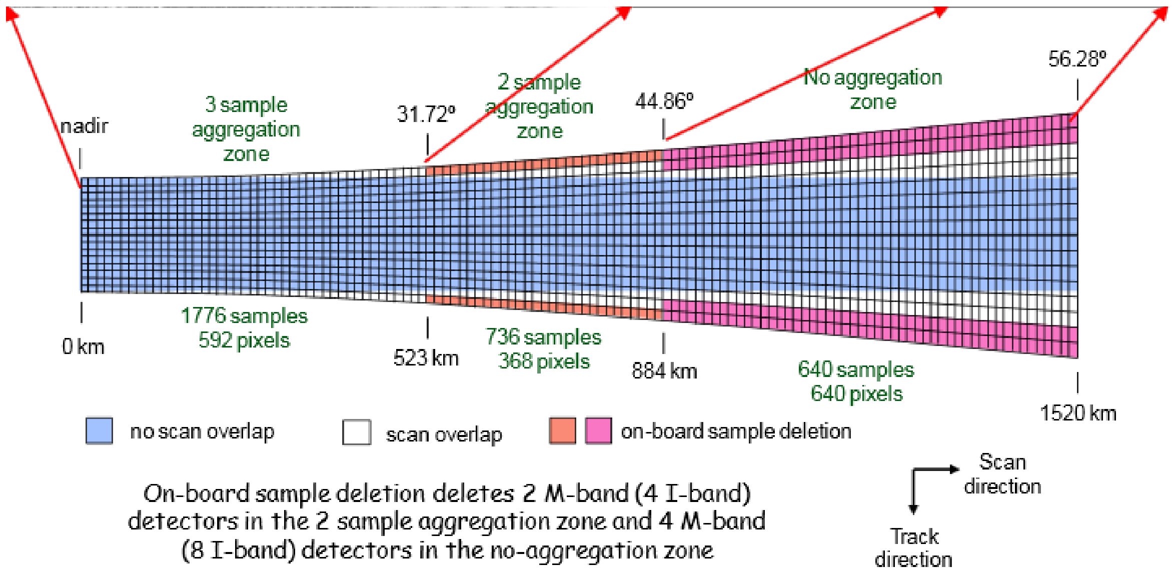
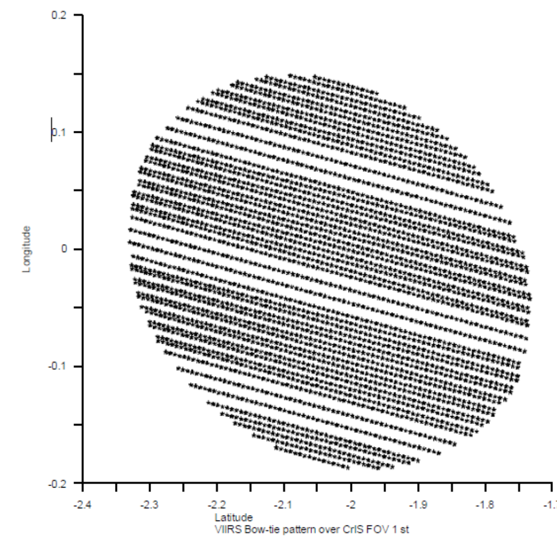
Problem: VIIRS Bowtie Effect





The VIIRS scan-to-scan overlapping lead to the un-uniformly distribution of the collocated VIIRS pixels.

To avoid problem introduced from the un-even slaver observation sampling problem, a two dimension grids G(X,Y) is used to selected the qualified slaver observation from the spatial overlapped VIIRS FOV.

Product

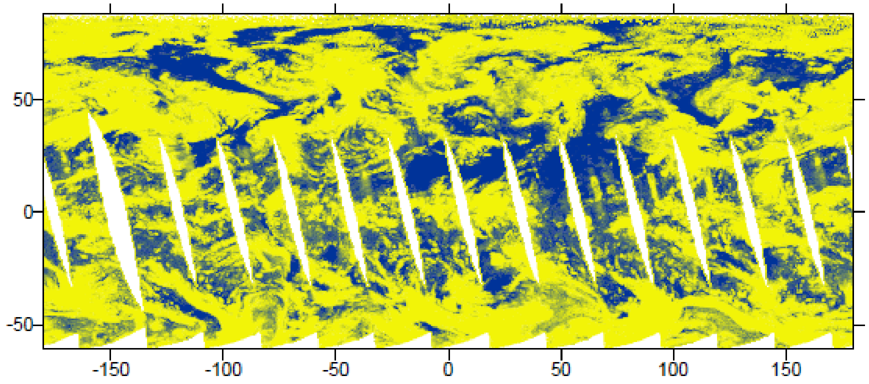
- The CrIS/VIIRS collocation/Integration processing provide CrIS FOV cloud fraction/ cloud top height information.

- CrIS FOV cloud data is generated from the collocated VIIRS cloud product(IDPS IB and EDR; Enterprise cloud product).

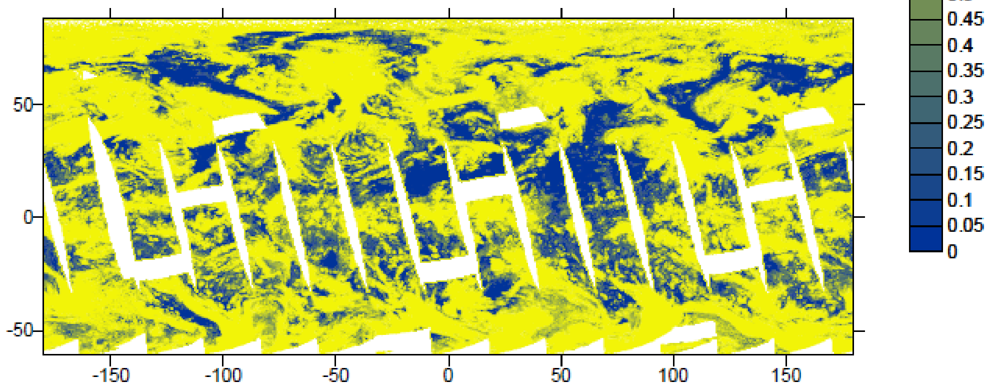
- The operational CrIS/VIIRS collocation processing provide the “real time” cloud input for CrIS retrieval processing. The processing speed is the most important requirement.

- The system transition: From IDPS VIIRS cloud to Enterprise VIIRS product

CrIS cloud fraction comparison in Ascending



CrIS cloud fraction from IDPS VIIRS cloud IB product
04/24/2017



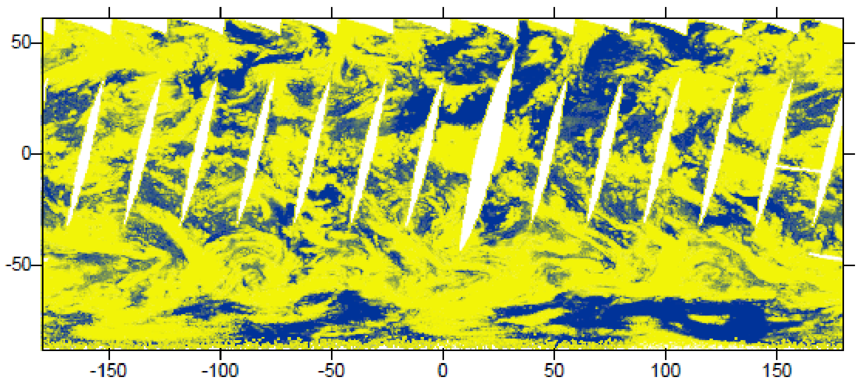
CrIS cloud fraction from Enterprise VIIRS cloud product
04/24/2017

CrIS cloud fraction from Collocated IDPS product

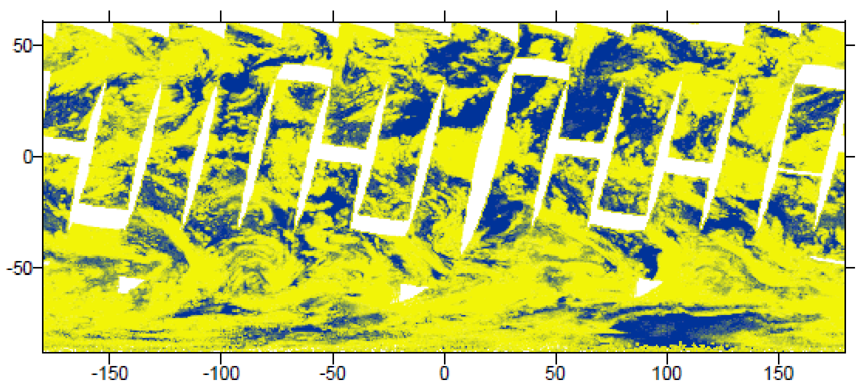
Vs

CrIS cloud fraction from Collocated Enterprise product

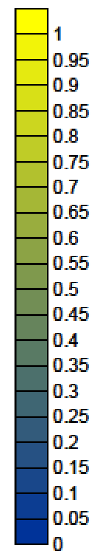
CrIS cloud fraction comparison in Descending



CrIS cloud fraction from IDPS VIIRS cloud IB product
04/24/2017



CrIS cloud fraction from Enterprise VIIRS cloud product
04/24/2017

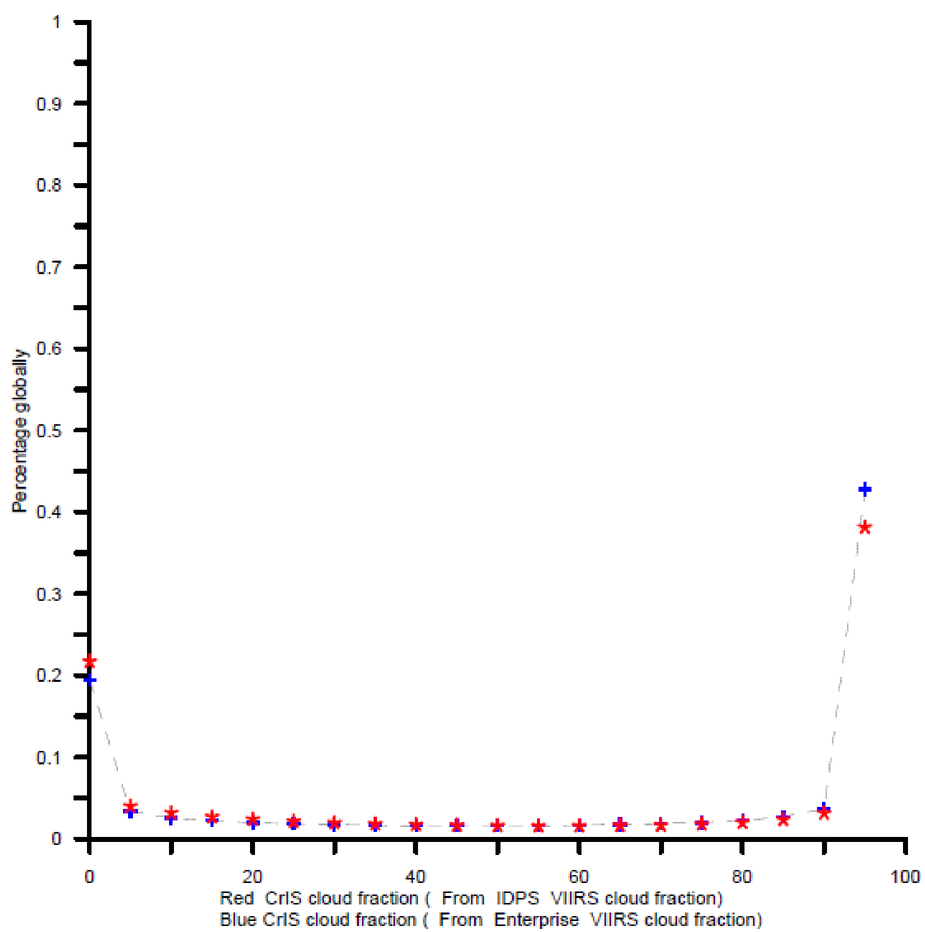


CrIS cloud fraction from Collocated IDPS product

Vs

CrIS cloud fraction from Collocated Enterprise product

CrIS cloud fraction comparison in Descending



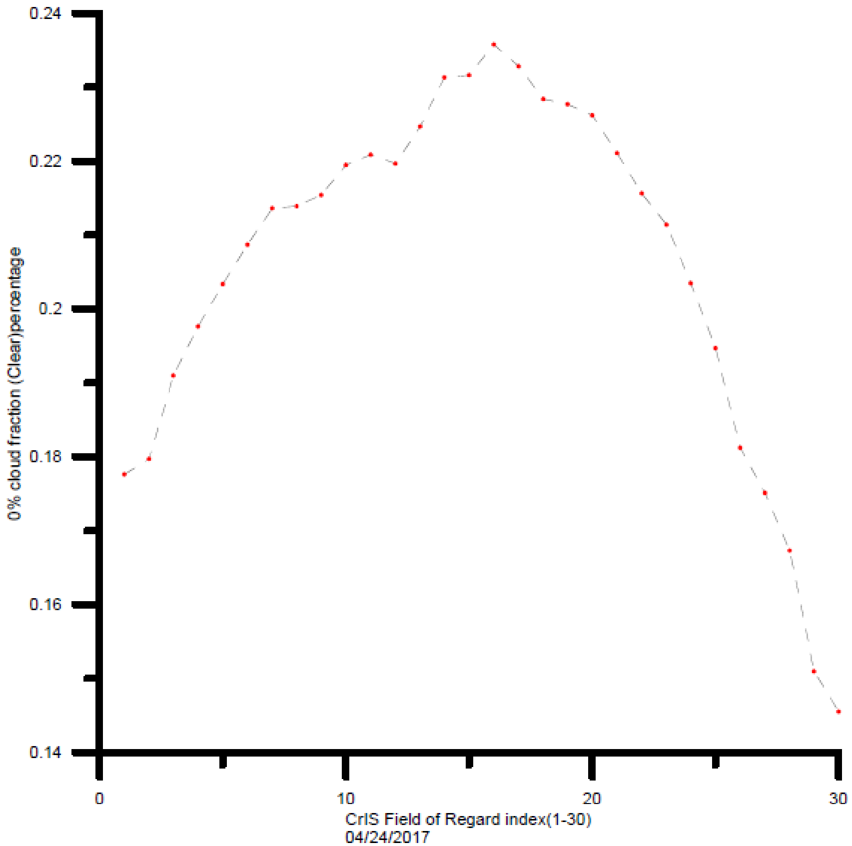
1: The collocated cloud fraction from IDPS and Enterprise are comparable.

2: Both own the double peak pattern

3: There are “more” cloud generated in JRR

There are some samples difference, the conclusion may not be correct. More analyzing are required.

CrIS Cloud Fraction vs Scanning Angle: Clear



The collocated cloud fraction vs Scanning angle.(Enterprise product)

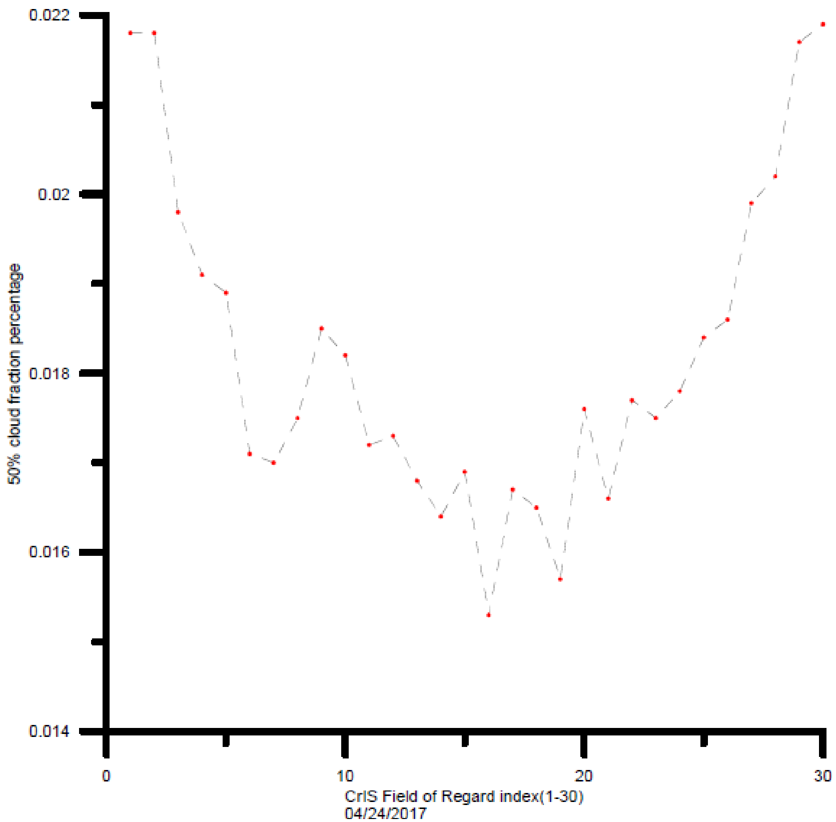
Clear case:

FOV size dependence (scanning angle related)
---symmetric

Scanning angle dependence
---asymmetric

Less clear case for for16-30

CrIS Cloud Fraction vs Scanning Angle: 50% cloud Fraction



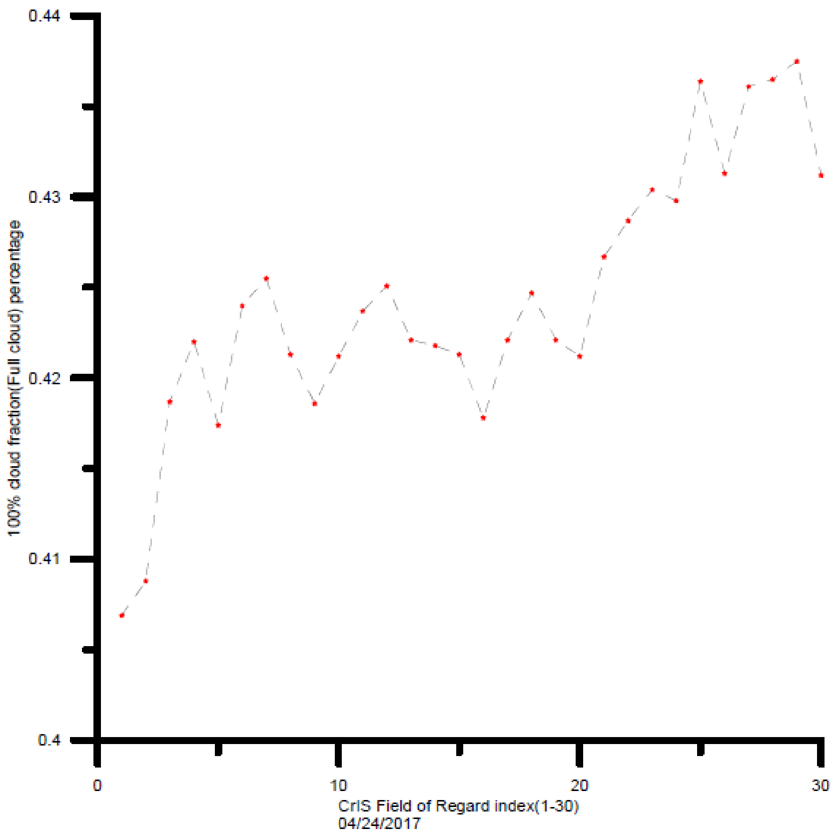
The collocated cloud fraction vs Scanning angle.(Enterprise product)

50% cover case:

FOV size dependence (scanning angle related)
---symmetric

Scanning size dependence for which is normal
---Asymmetric is not significant

CrIS Cloud Fraction vs Scanning Angle: Full cloud



The collocated cloud fraction vs Scanning angle.(Enterprise product)

Full cloud case:

FOV size dependence (scanning angle related) ---symmetric

Scanning size dependence for which is normal ---asymmetric

More cloud for for16-30

Conclusion

The CrIS/VIIRS collocation/Integration processing provide CrIS FOV cloud fraction/ cloud top height information.

CrIS FOV cloud data is generated from the collocated VIIRS cloud product(IDPS IB and EDR; Enterprise cloud product).

The operational CrIS/VIIRS collocation processing provide the "real time" cloud input for CrIS retrieval processing. The processing speed is the most important requirement.