VIIRS Radiance Cluster Analysis under CrIS Field of Views

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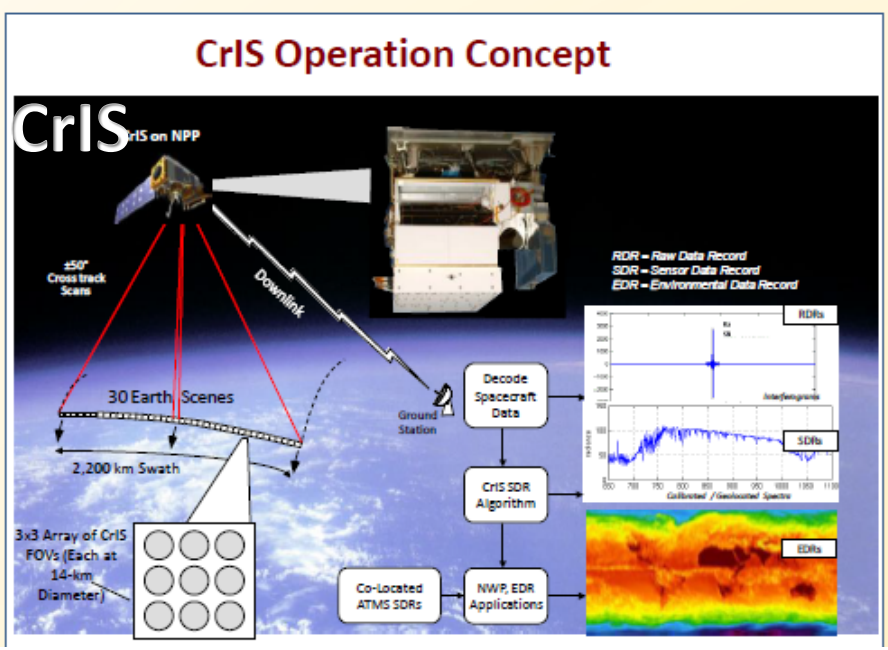
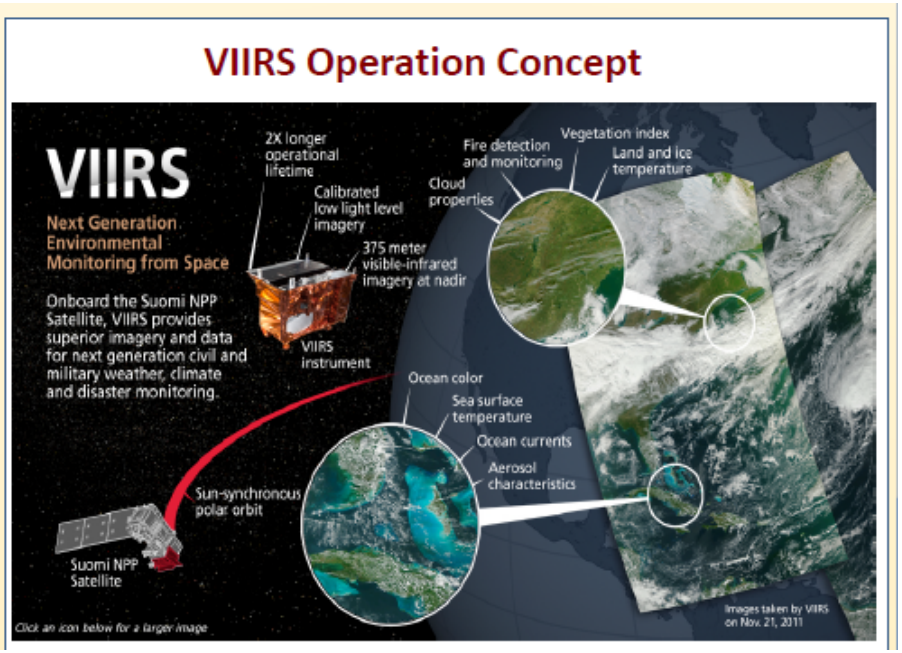
Acknowledgment CrIS SDR Team

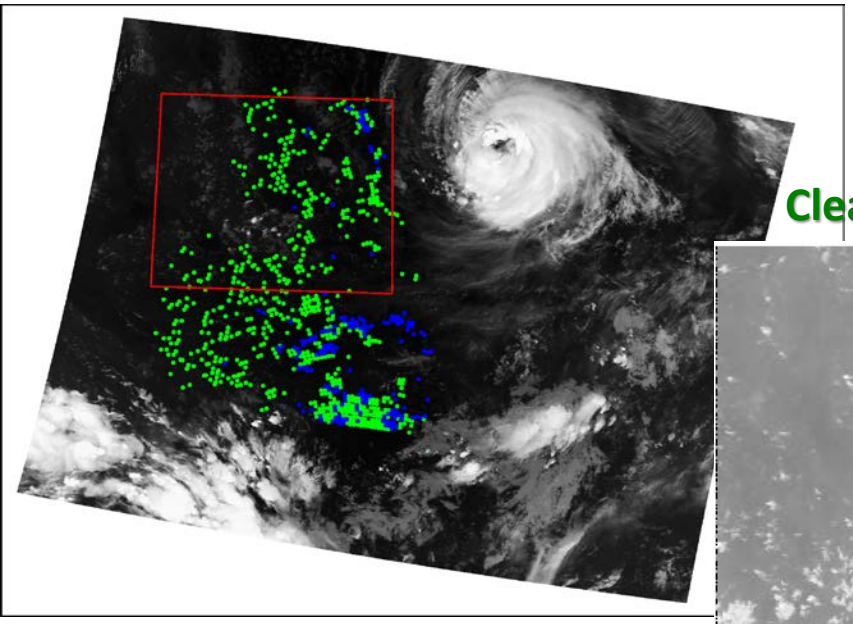
Sounder vs. Imager





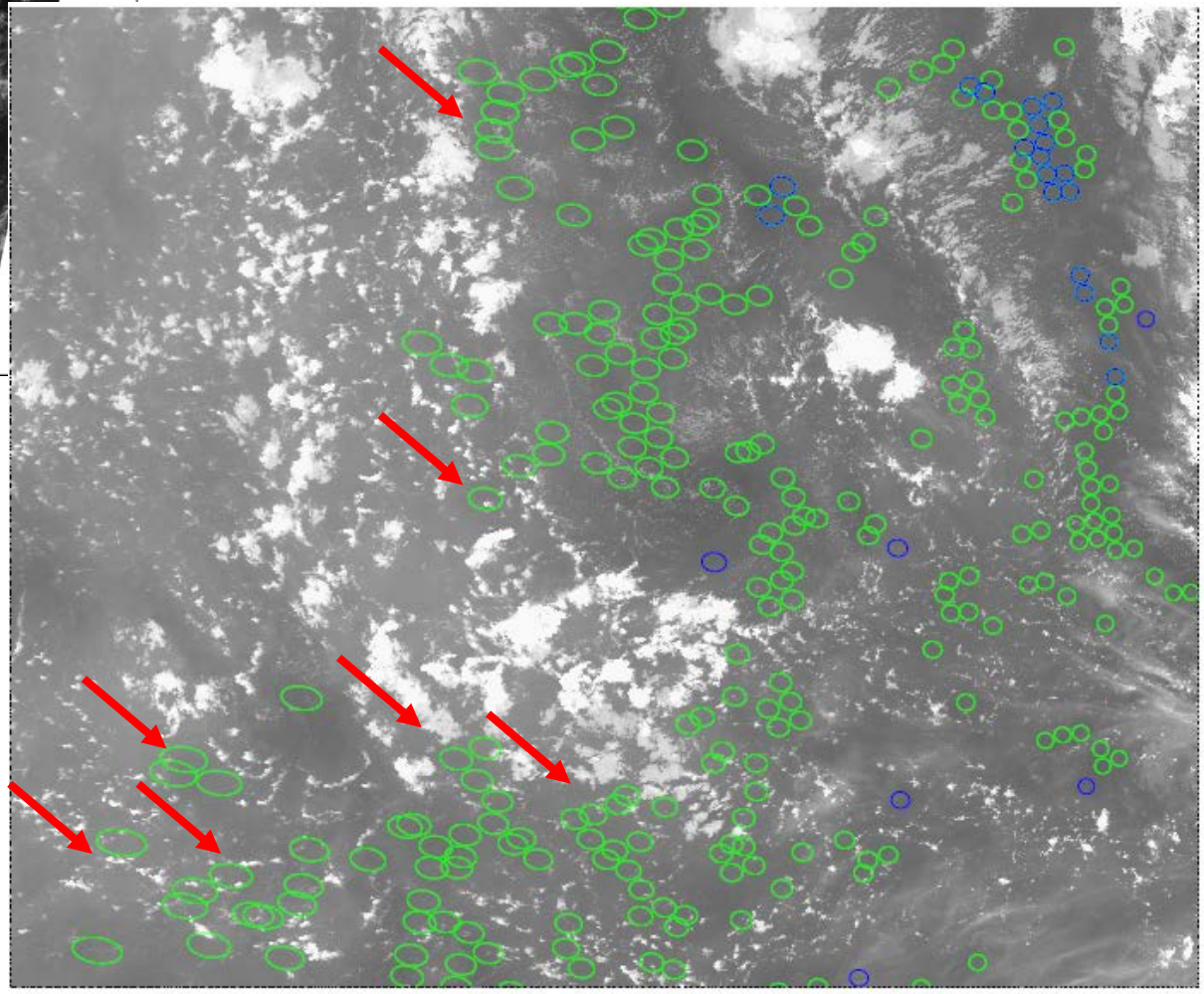
	CrIS (Sounder)	VIIRS (Imager)
Purpose	Atmospheric vertical profiles NWP data assimilation	Spatial images (land, cloud, aerosol, ocean …)
Channels	1305 (normal) or 2211 (full)	16 M-Bands, 5 I-Bands, 1 DNB
Spatial Resolution (nadir)	14.0 km	375m, or 750m
Spectral Range	IR	IR, VIS

Benefits of Combining VIIRS with CrIS



NWP data assimilation of IR sounder observations still relies on cloud-free observations.

Clear sky indicated by NWP method



Cloud contamination data are one of major errors for NWP data assimilation.

Collocated high-spatial resolution VIIRS radiances or products can provide sub-pixel information for CrIS.

Outline

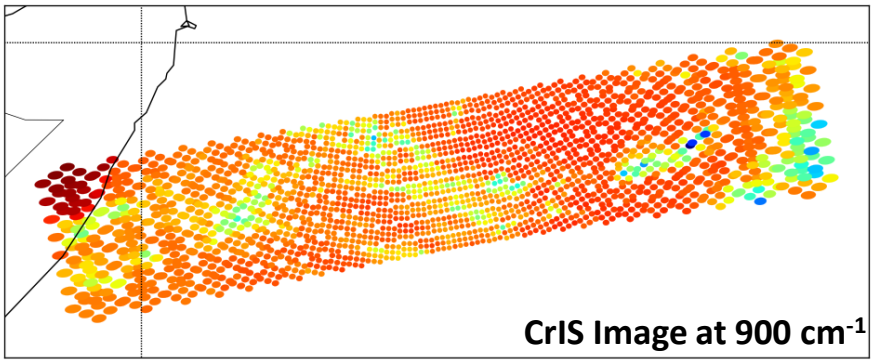
- CrIS and VIIRS are two independent instruments, though on the same platform
  - Not like IASI and AVHRR on MetOp
  - No alignment requirements
  - Separate geolocation fields

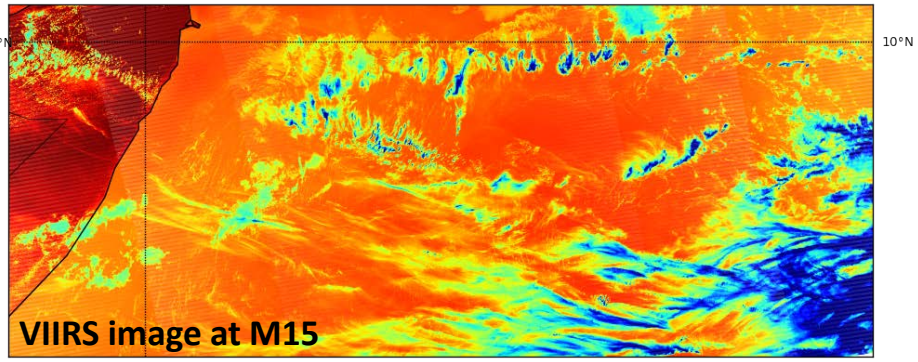
- Fast and accurate collocation algorithm is needed for operational use.
  - Wang, L., D. A. Tremblay, B. Zhang, and Y. Han, 2016: Fast and Accurate Collocation of the Visible Infrared Imaging Radiometer Suite Measurements and Cross-track Infrared Sounder Measurements. Remote Sensing, 8, 76; doi:10.3390/rs8010076.

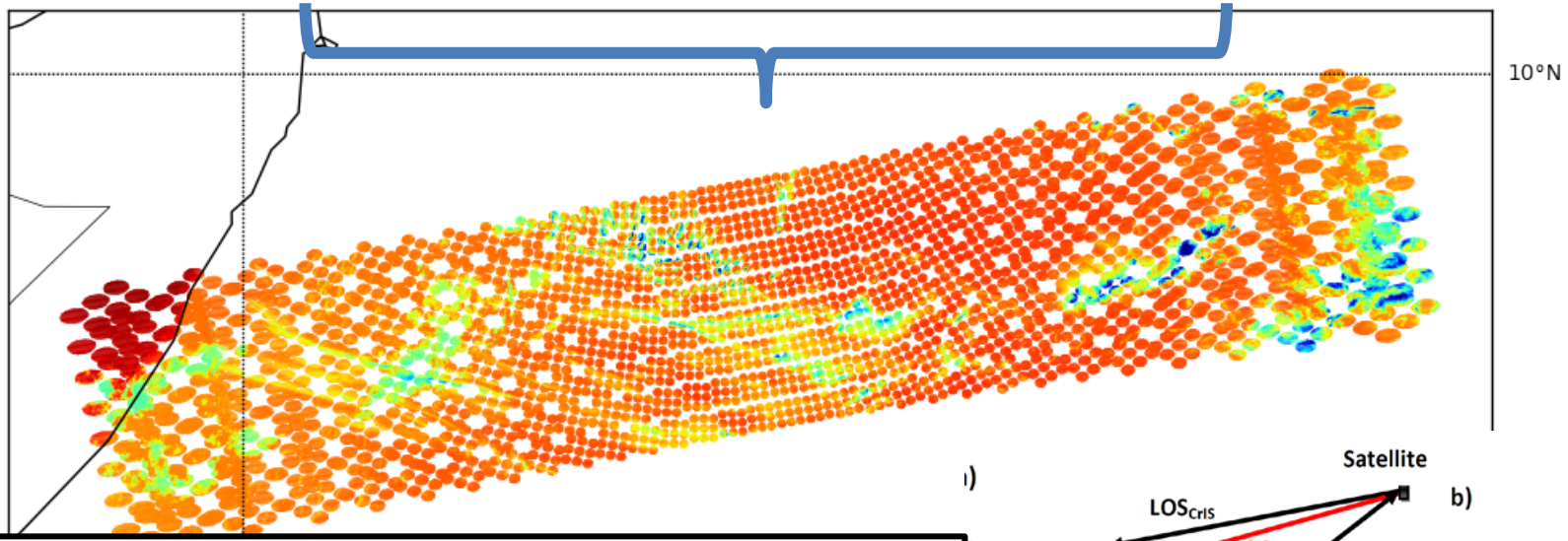
- Are CrIS and VIIRS align together? If not, collocated products can introduce errors and uncertainties, making applications even worse.
  - Wang, L., D. A. Tremblay, Y. Han, M. Esplin, D. E. Hagan, J. Predina, L. Suwinski, X. Jin, and Y. Chen, 2013: Geolocation assessment for CrIS sensor data records, Journal of Geophysical Research, 118, doi:10.1002/2013JD020376.
  - Wang, L., D. A. Tremblay, B. Zhang, and Y. Han, 2016: Improved scheme for Cross-track Infrared Sounder geolocation assessment and optimization. Journal of Geophysical Research - Atmosphere (Accepted upon revision).

- Application: VIIRS Radiance Cluster analysis under CrIS FOVs
  - Wang, L., Y. Chen, and, Y. Han, 2016: Impacts of Field of View Configuration of Crosstrack Infrared Sounder on Clear Sky Observations, Applied Optics, 55, 7113-7119, doi:10.1364/AO.55.007113.
  - Wang, L., Y. Chen, and, Y. Han, 2016: VIIRS radiance cluster analysis within CrIS Field of Views, Optical Express (prepared).

Collocating VIIRS pixels within CrIS FOVs

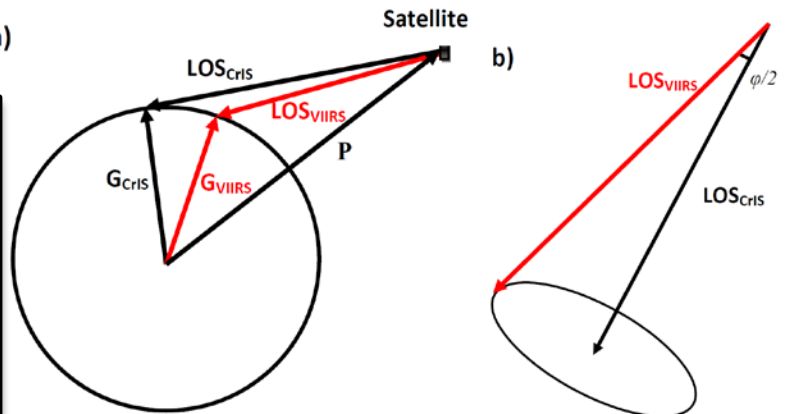




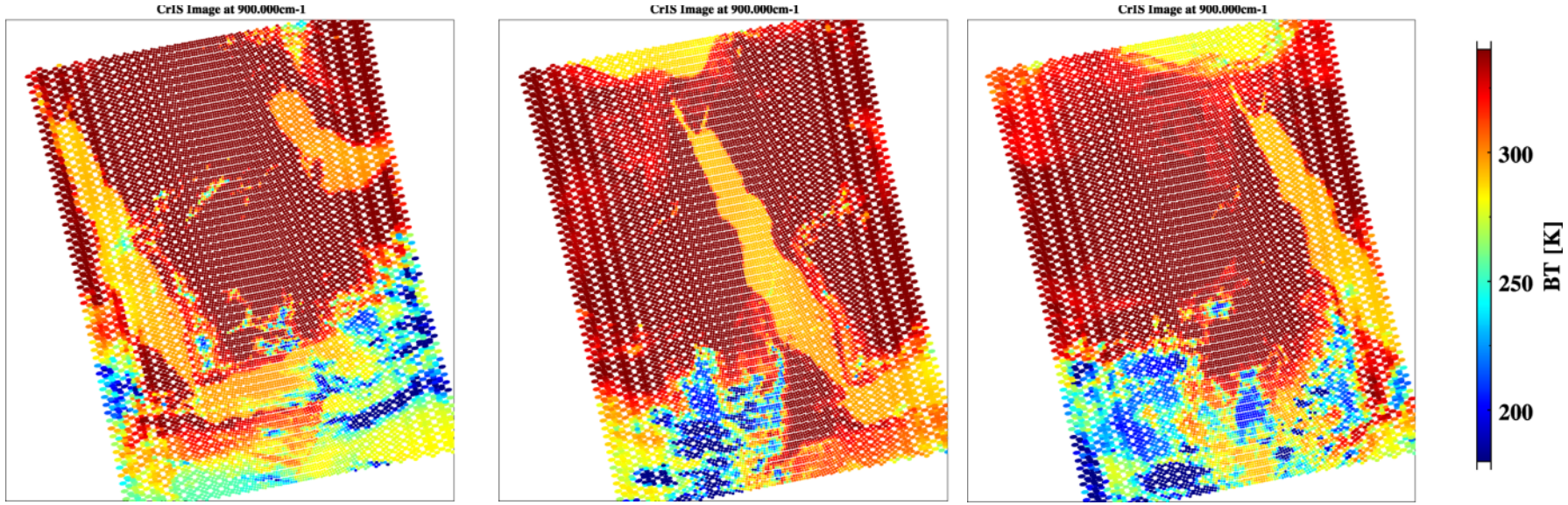


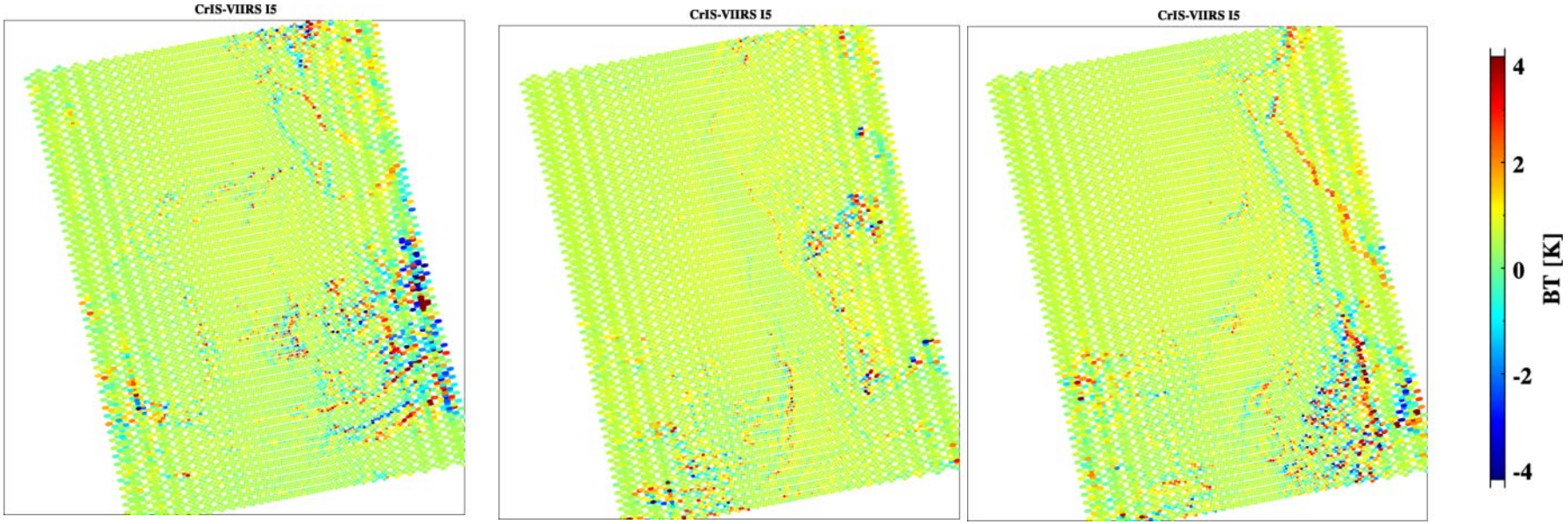
It is better to collocate CrIS and VIIRS in space instead of on the Earth Surface;

If we can retrieve line-of-sight vector of CrIS and VIIRS , the collocation of VIIRS and CrIS can be simplified as examining the angles between two vectors.

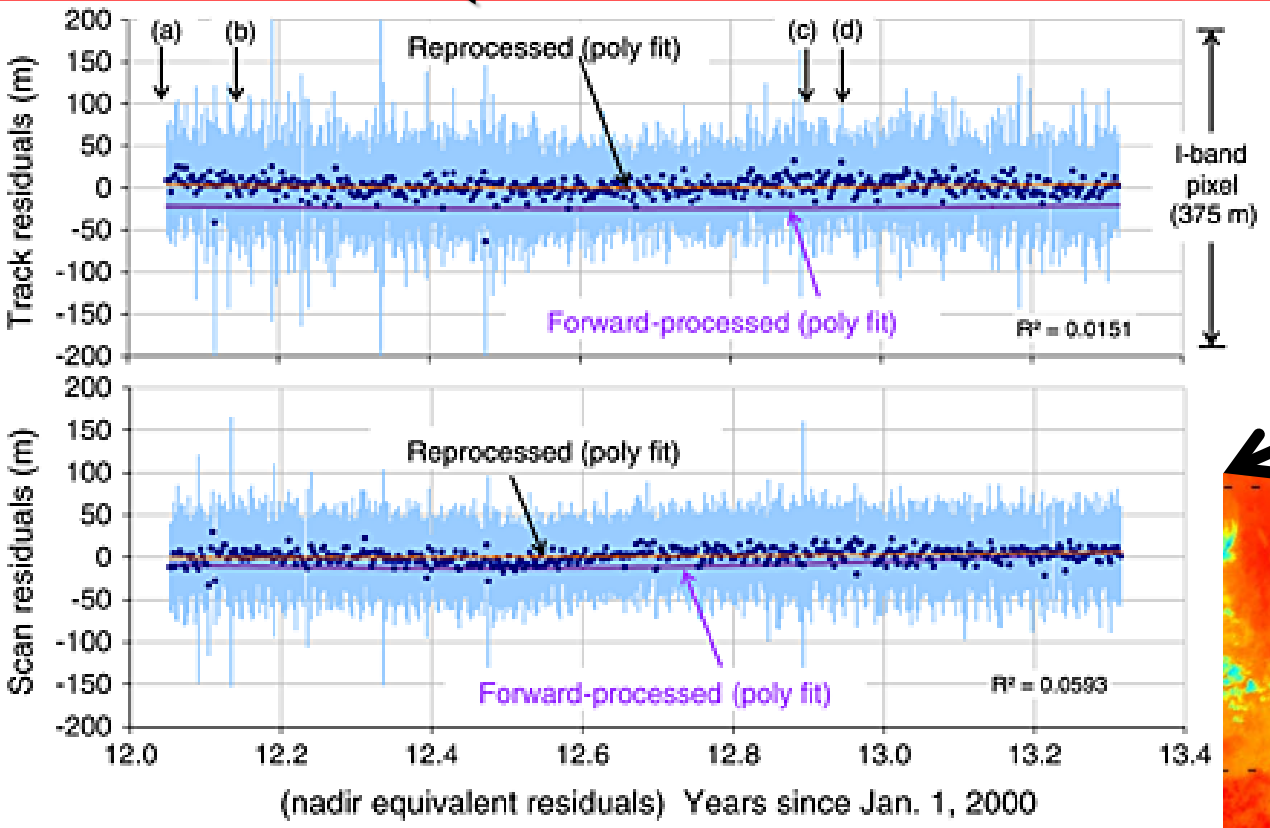


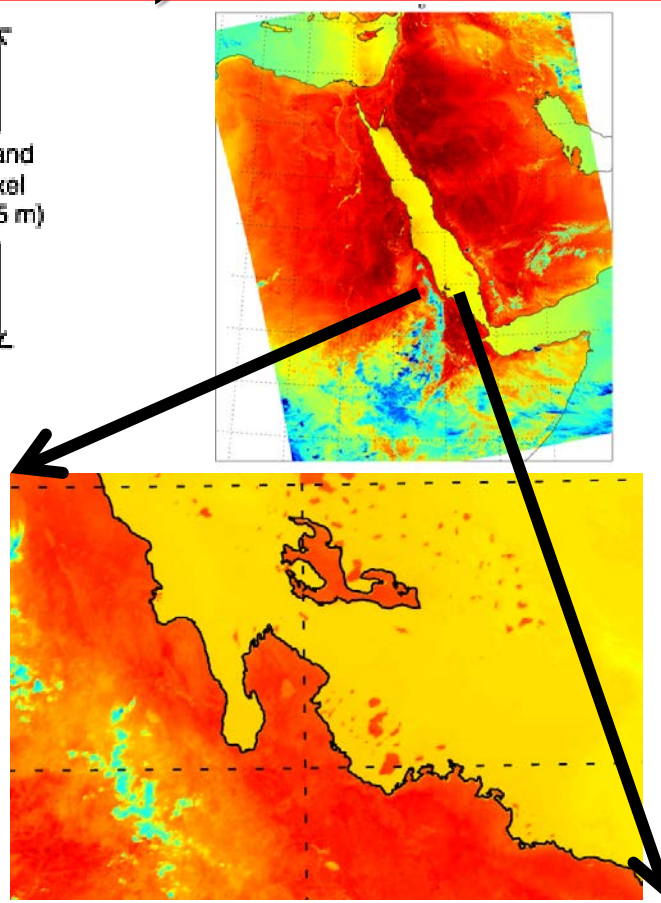
Misalignment between CrIS and VIIRS at the end of scan





VIIRS Geolocation Very Accurate ! (I5 band: 375m resolution)





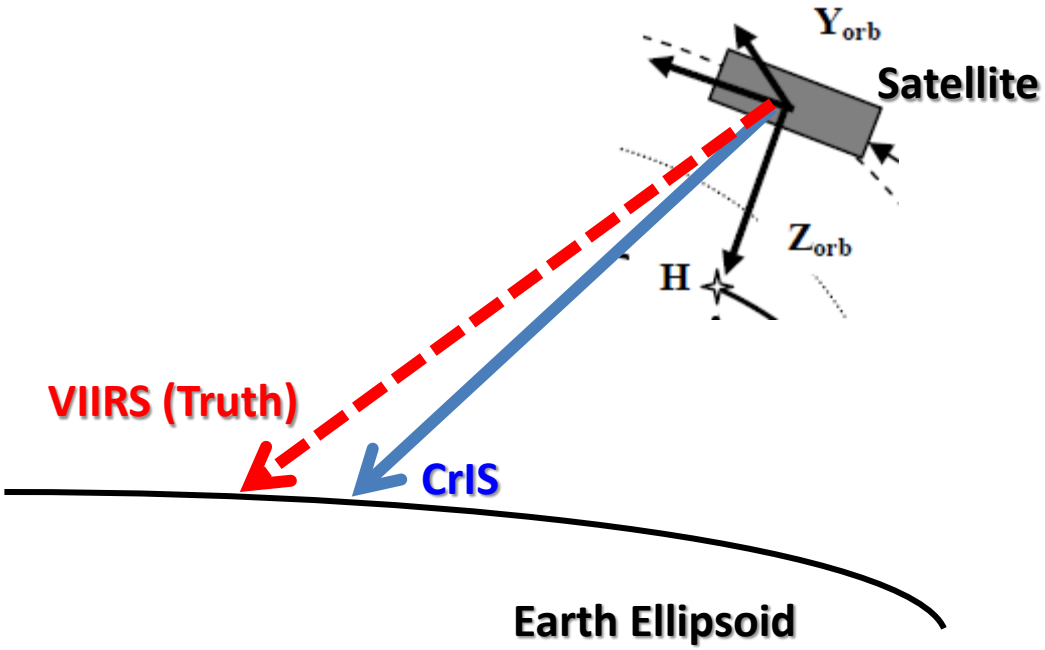
from Wolf et al. 2013

Table 2. VIIRS Geolocation Accuracy

Residuals	First Update	Second Update
	23 February 2012	18 April 2013
Track mean	**–24 m, –7%**	**2 m, 1%**
Scan mean	**–8 m, –2%**	**2 m, 1%**
Track RMSE	**75 m, 20%**	**70 m, 19%**
Scan RMSE	**62 m, 17%**	**60 m, 16%**

Aligning CrIS with VIIRS

- The misalignment between CrIS and VIIRS can be caused by the CrIS geolocation error.
- Can we use VIIRS as a reference to check CrIS geolocation accuracy?
- The purpose is to identify the error characteristics of CrIS LOS pointing vector by comparing them with the truth.
- Furthermore, if the systematic errors are found, a new set of co-alignment parameters should be retrieved based on assessment results to improve the geolocation accuracy.



Overview of NPP/JPSS Geolocation Algorithms

CrIS (or other instrument)

Coordinate transformation

- Interferometer
- SSM
- Sensor Isolation system
- Spacecraft

JPSS or any satellite

COMMON GEO

- Spacecraft
- Orbital
- ECI
- ECEF(ECR)
- Geodetic

Function call to common geo:
ellipIntersect(outPt,inst2SC,exitVec, dlat,lon,satazm,satzen,range)

feedback

GEOLOCATION ASSESSMENT

- •GCP/Maps/Ground truth
- • the other instrument measurements with enough geolocation accuracy
- • Comparing the truth and CrIS Geo fields

Geolocate each FOV

ADCS

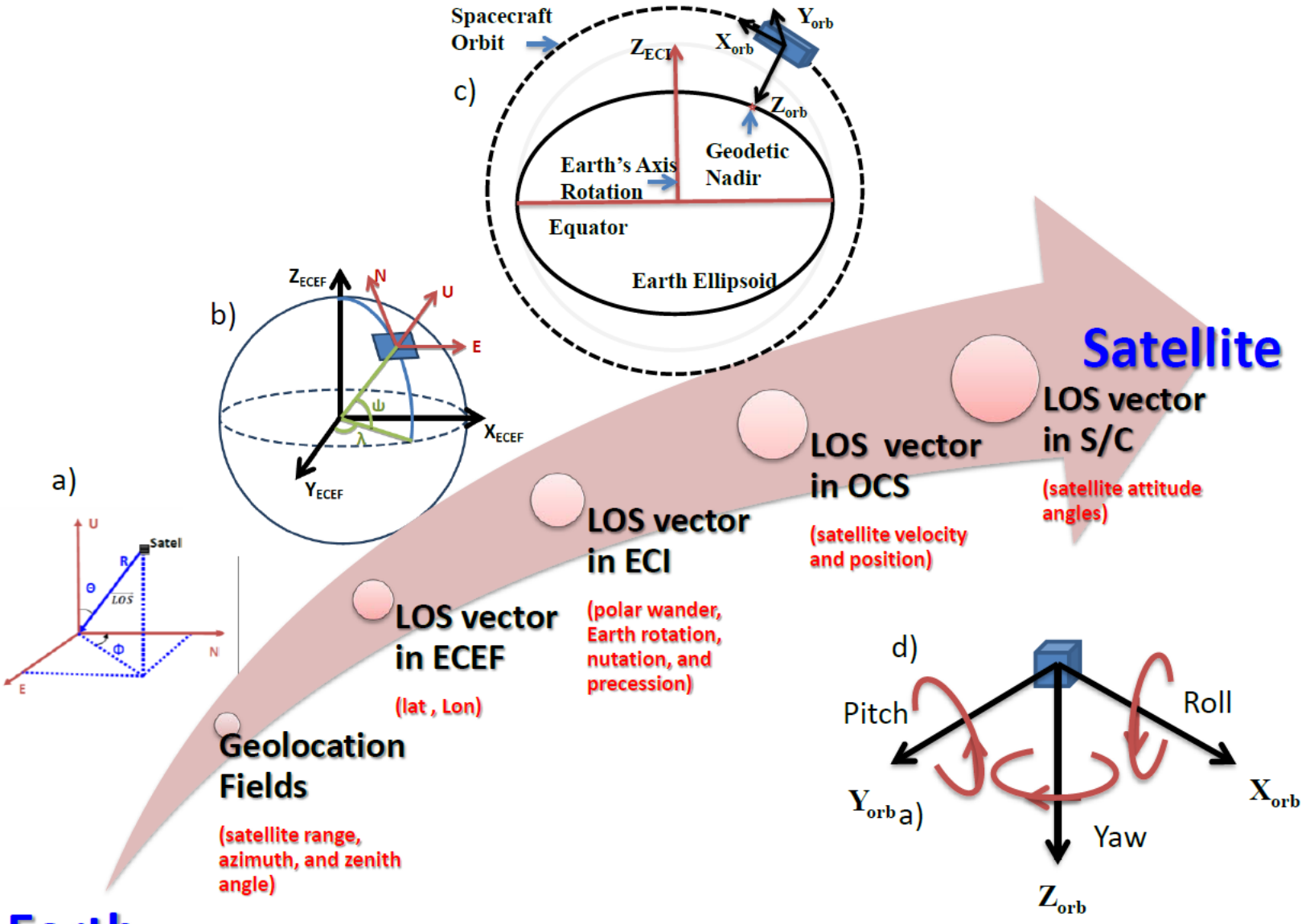
Pos/Vel/Quaternion (RPY)

Attitude Determination & Control System (ADCS)

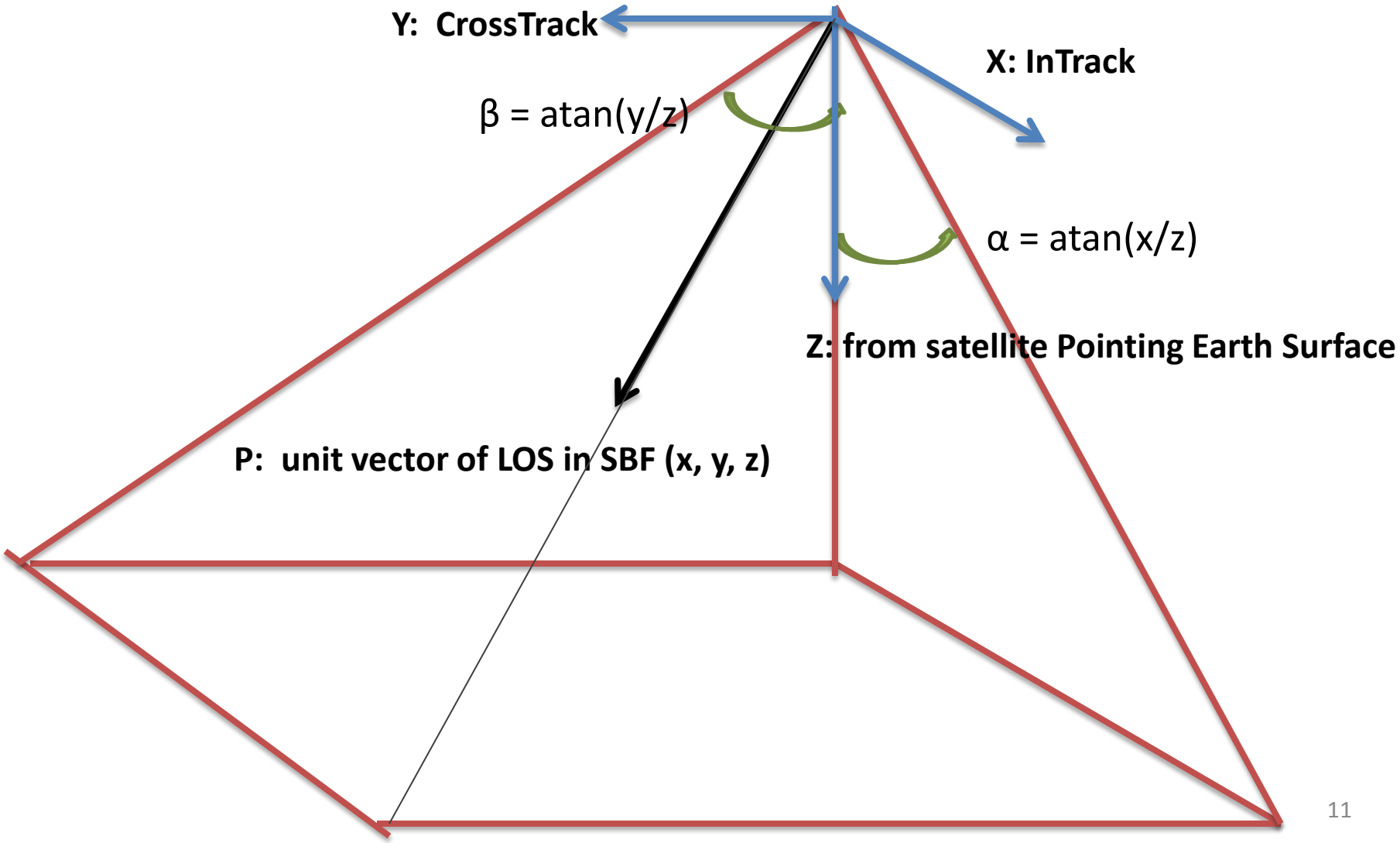
SGP4

Modified from C. Cao

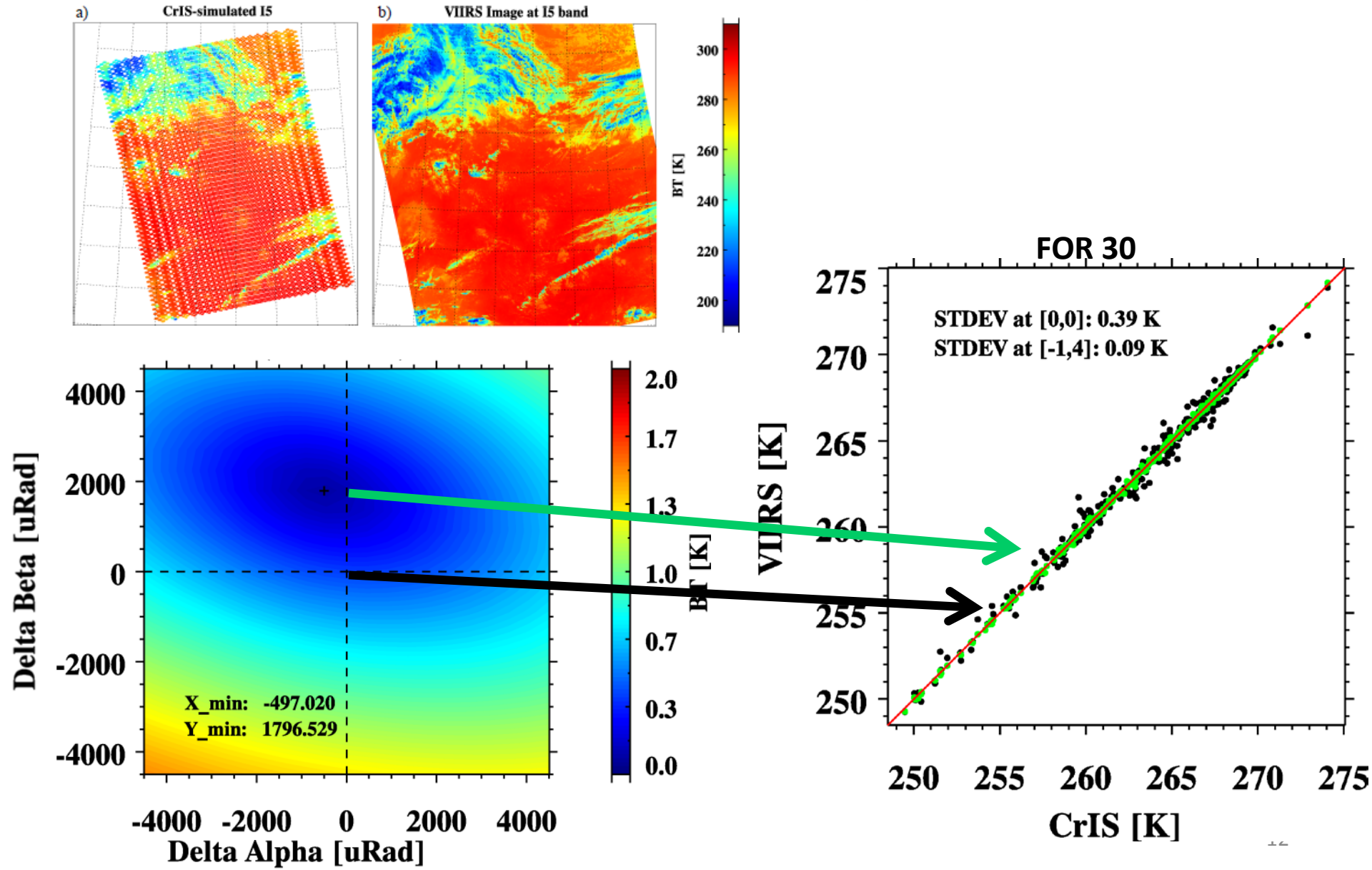
Inverse Geolocation Computation



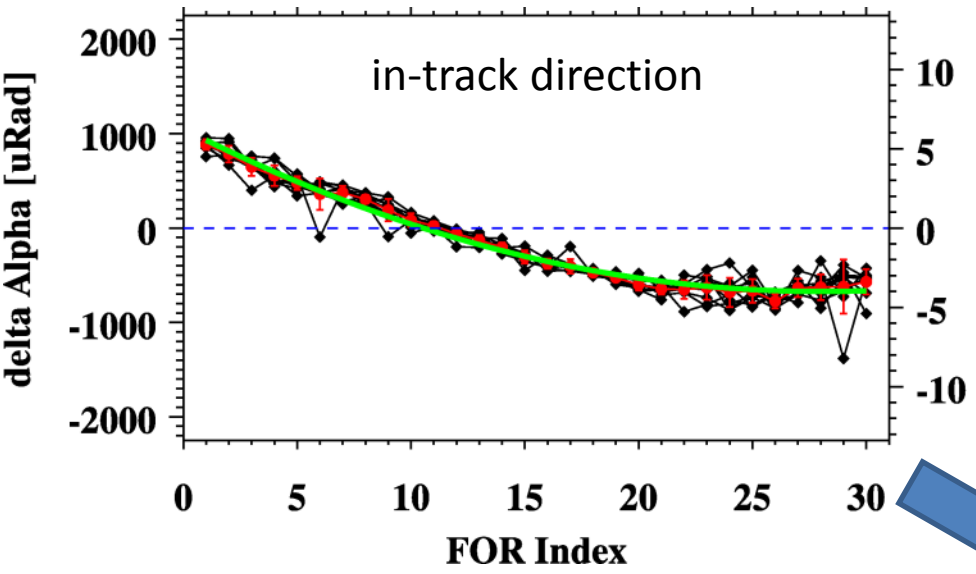
Defining α and β angles of CrIS LOS vector in Spacecraft Coordinate

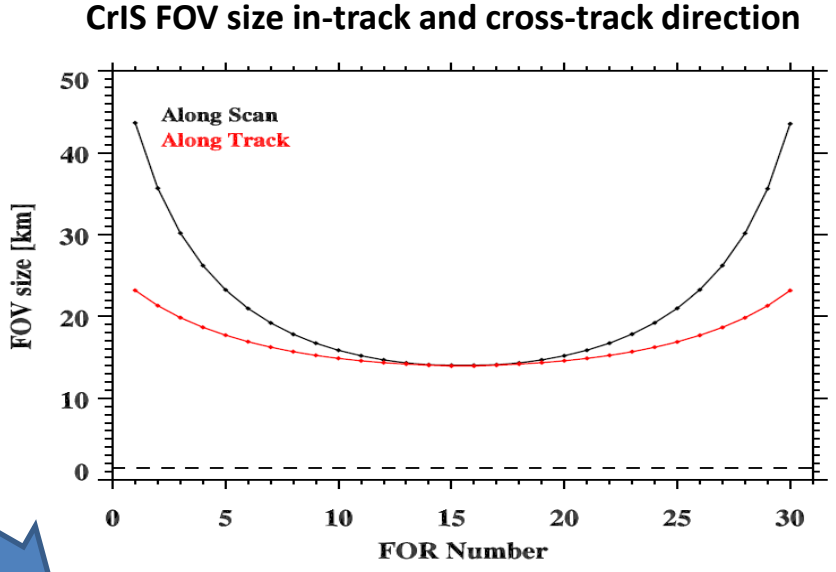


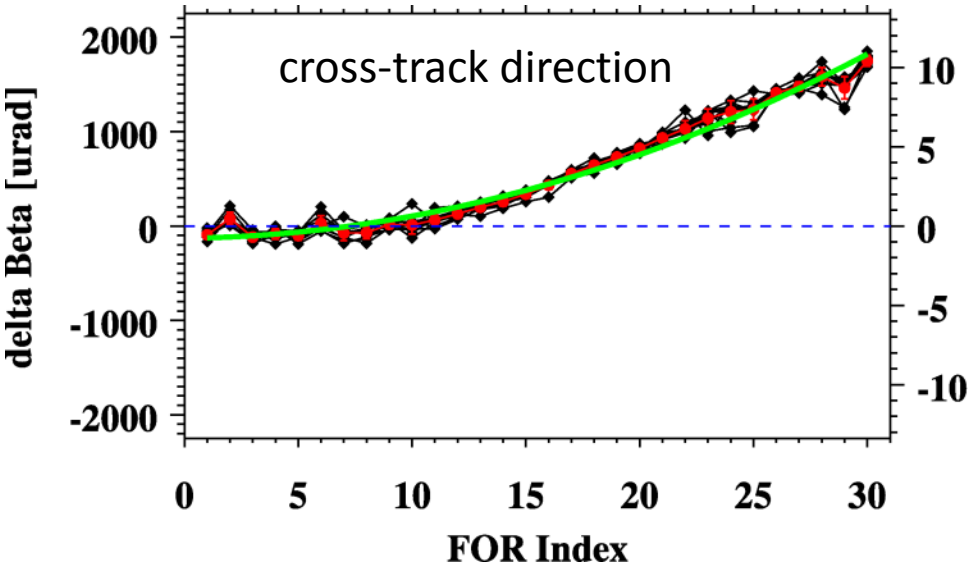
Using VIIRS to find best collocation position

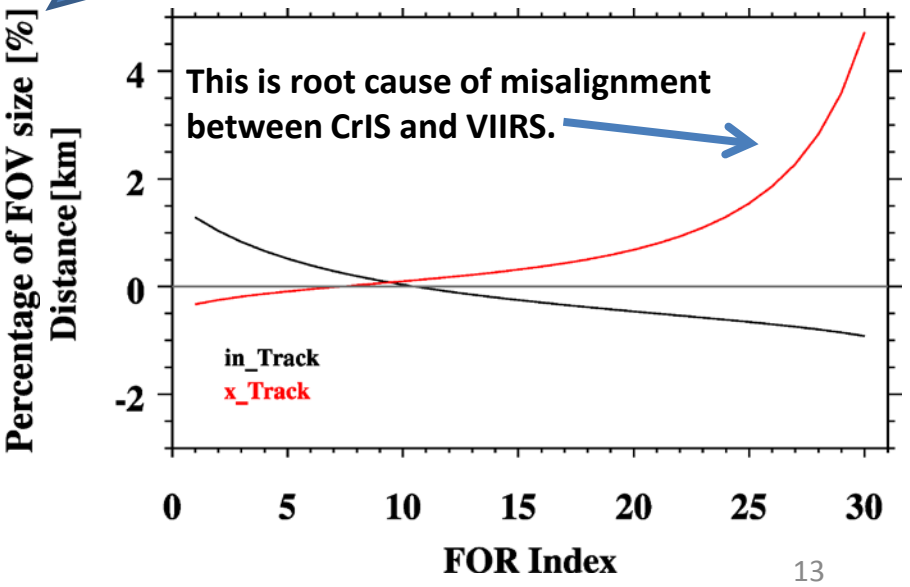


IDPS Data Geolocation Performance









New Geometric Parameters

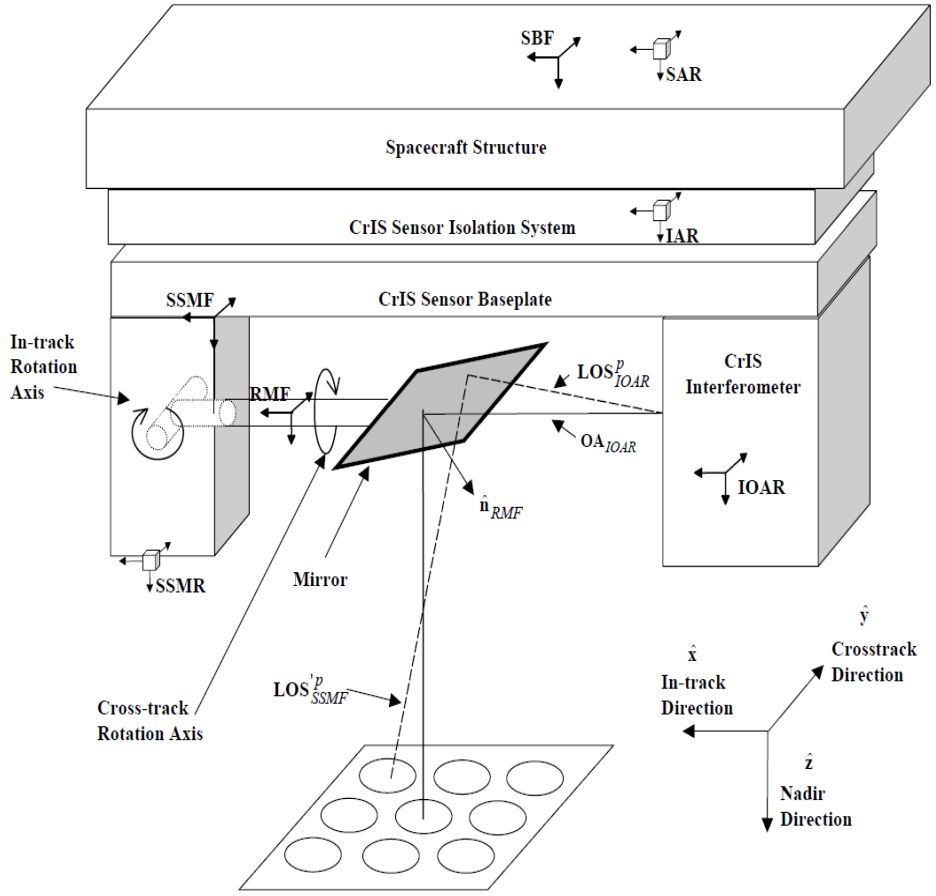


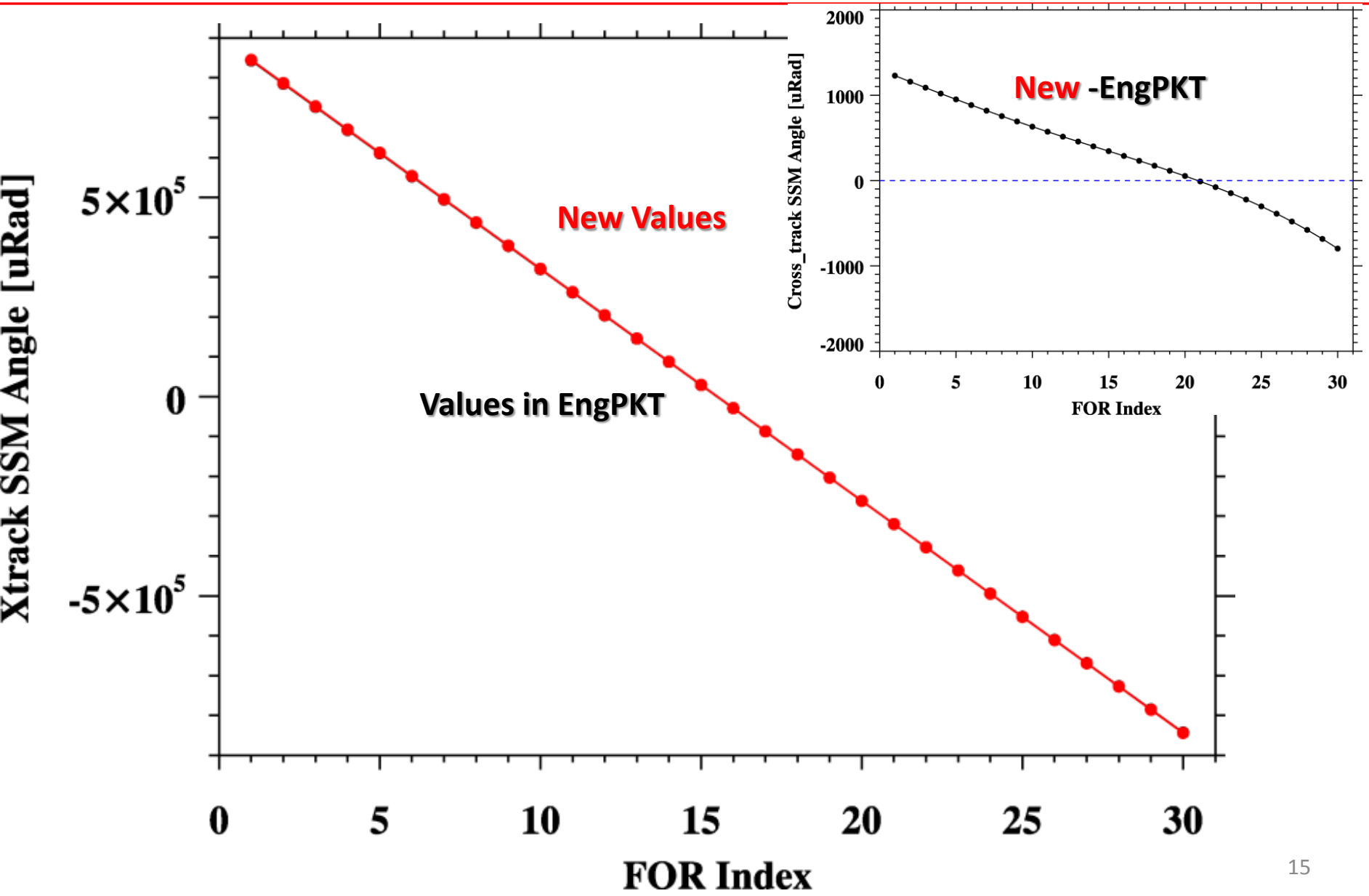
Figure 48: Sensor Algorithm Level Coordinate Systems

Given the assessment results with 60 angles, the best strategy is to retrieve 60 scan mirror rotation angles.

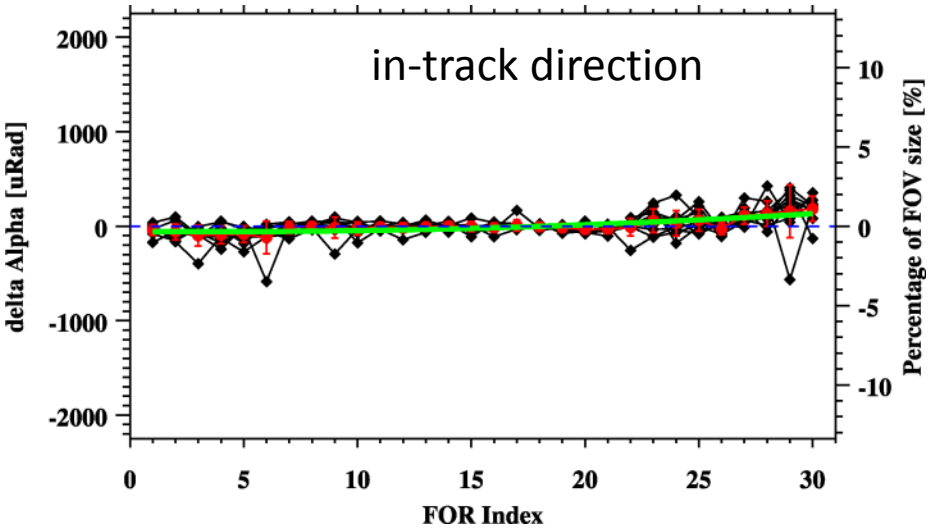
SDR Algorithm Process

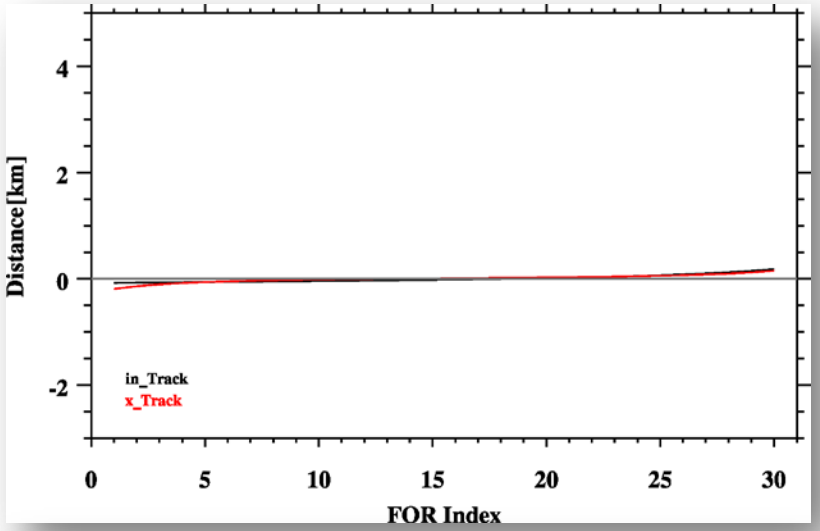
1) LOS in IOAR coordinate = ILS parameters (3x3)
2) Convert from IOAR to SSMF coordinate **(2 angles)**
3) Compute normal to SSM mirror in SSMF (30 Scan Pos) **(60 angles)**
4) Apply SSM mirror rotation to get LOS in SSMF coordinate
5) Convert from SSMF to SSMR coordinate **(3 angles)**
6) Convert from SSMR to IAR coordinate **(3 angles)**
7) Convert from IAR to SAR **(3 angles)**
8) From SAR=> SBF coordinate **(0 angels)**
9) From SBF=> Spacecraft **(3 angles)**

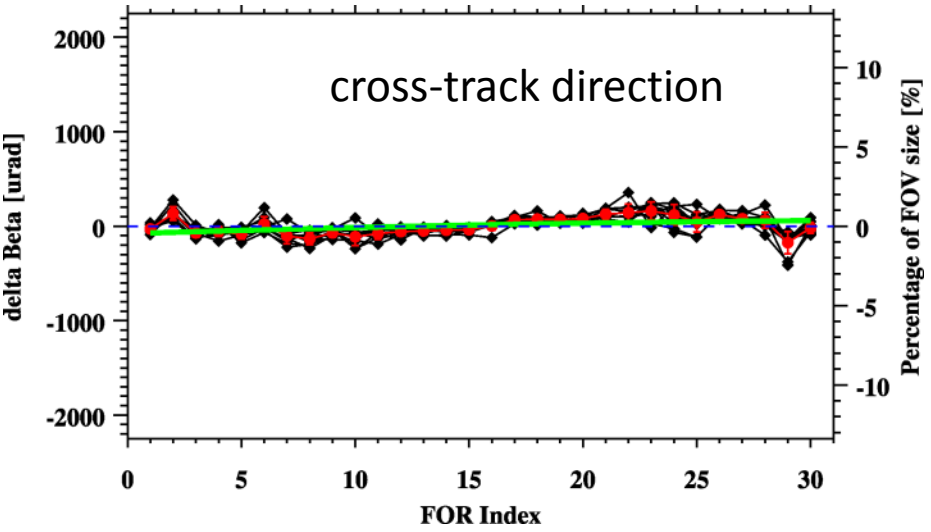
Retrieved SSMF Cross-track Angles

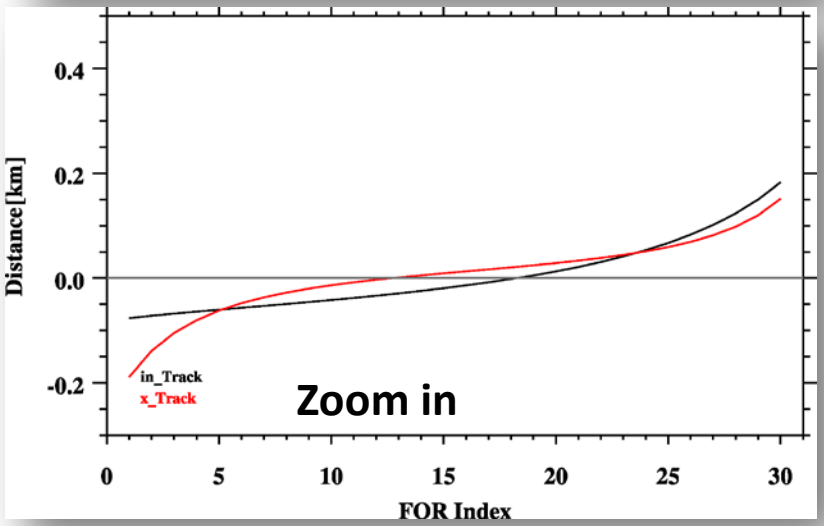


Geolocation Performance (New Parameters)

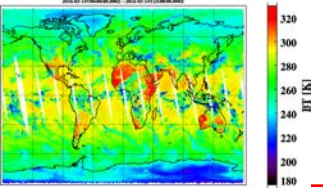


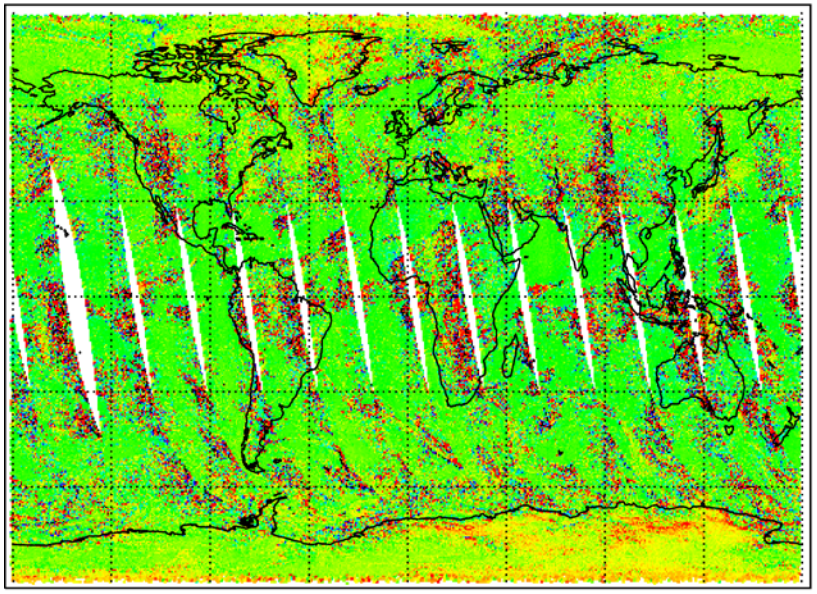


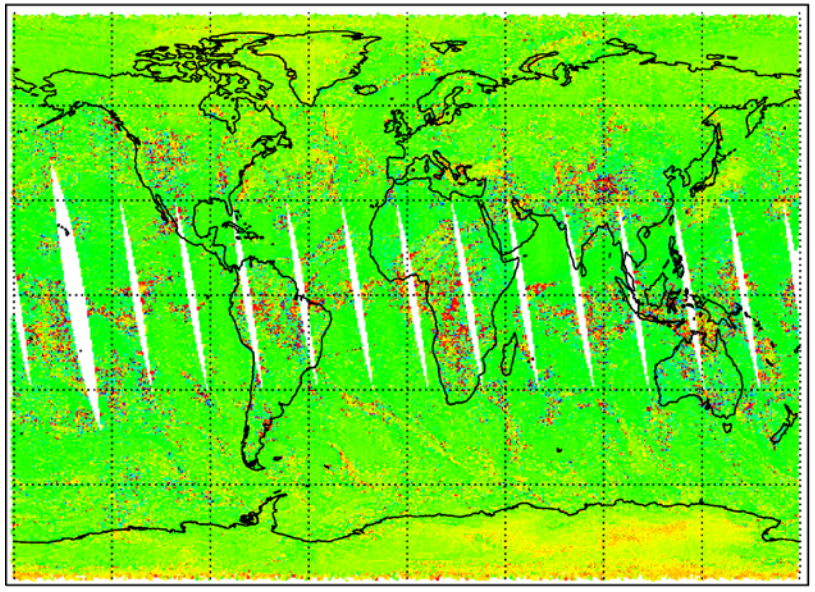


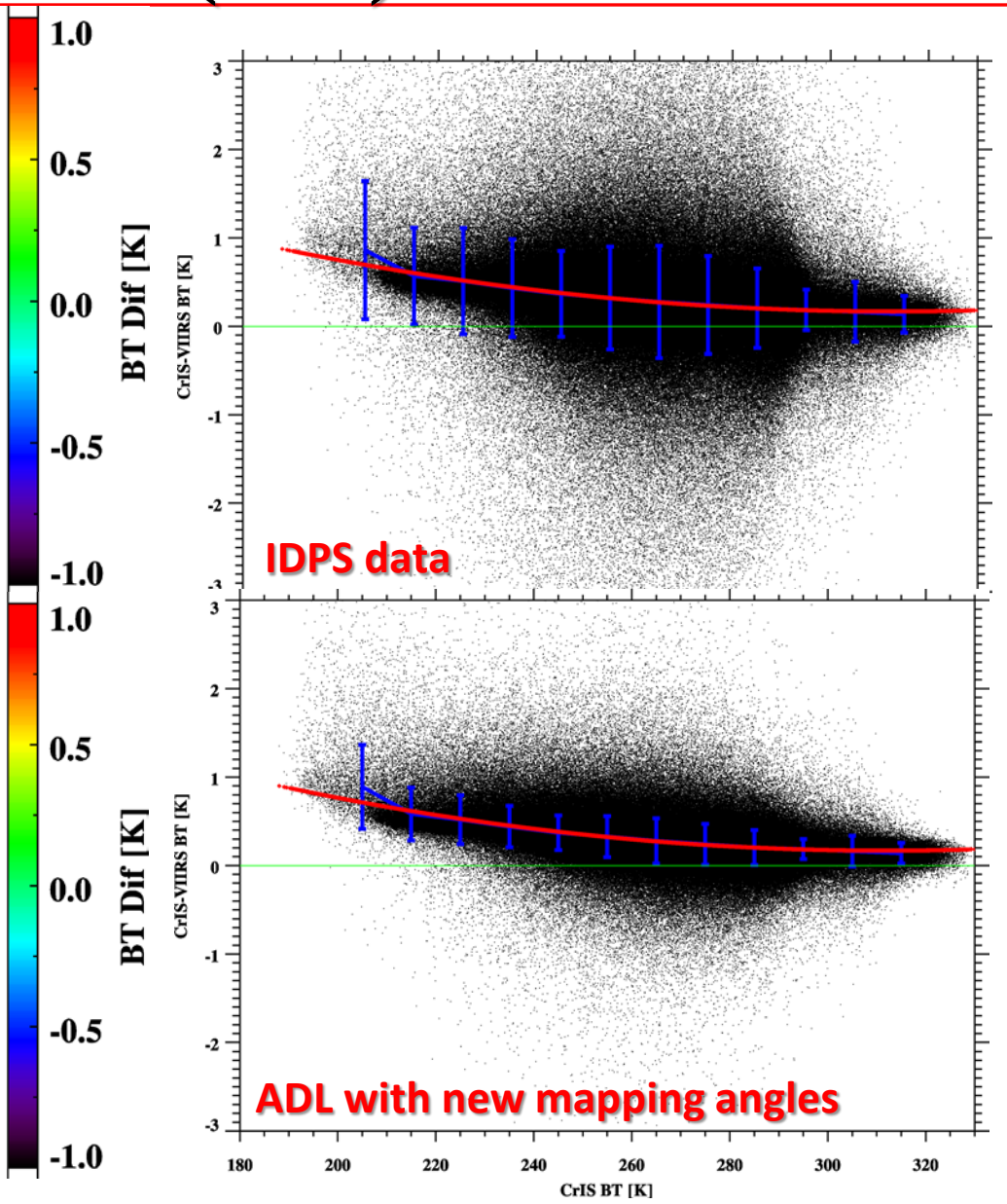


Effects of Geolocation Updates
CrIS-VIIRS (M15)

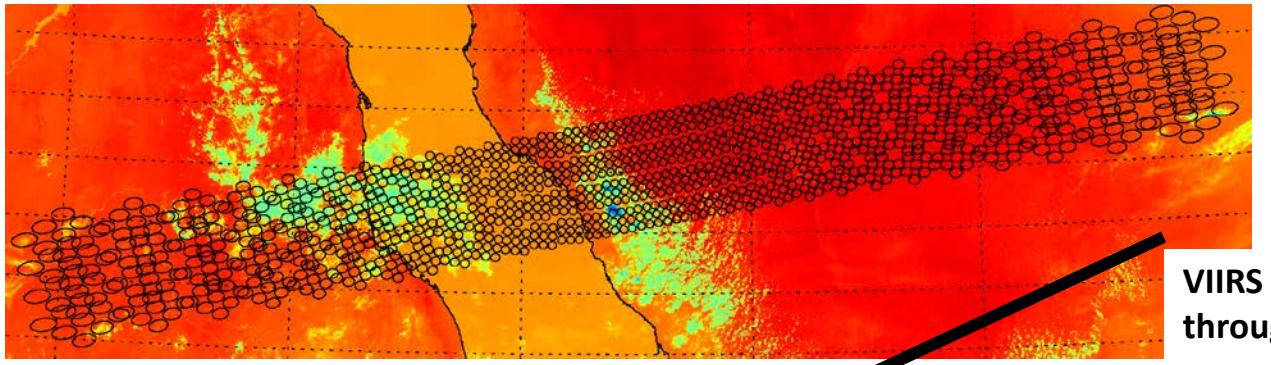




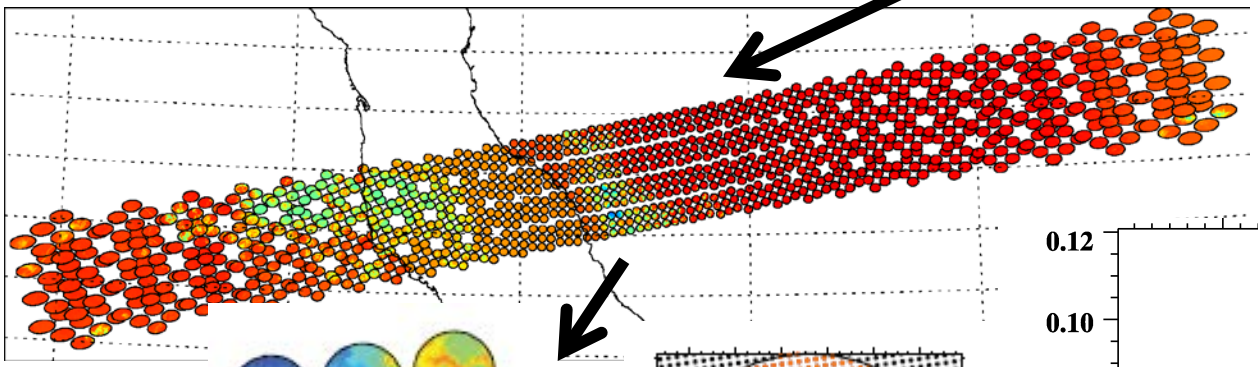


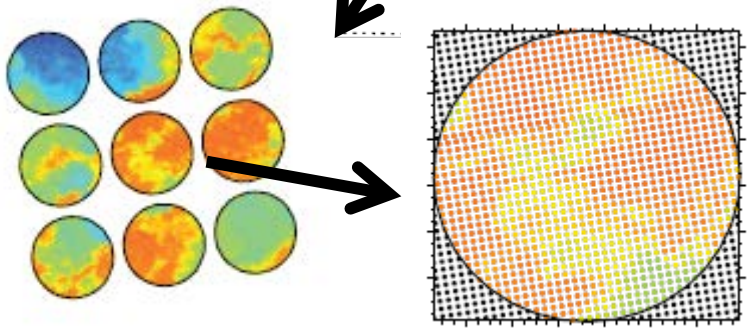


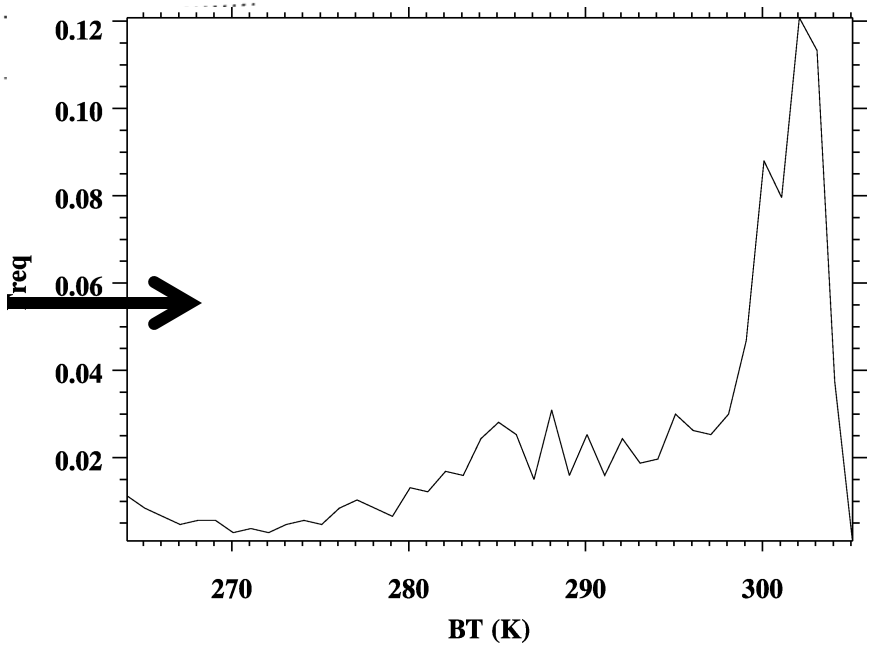
VIIRS Radiance Cluster Analysis within CrIS FOVs



VIIRS can be collocated within CrIS footprint through fast collocation method



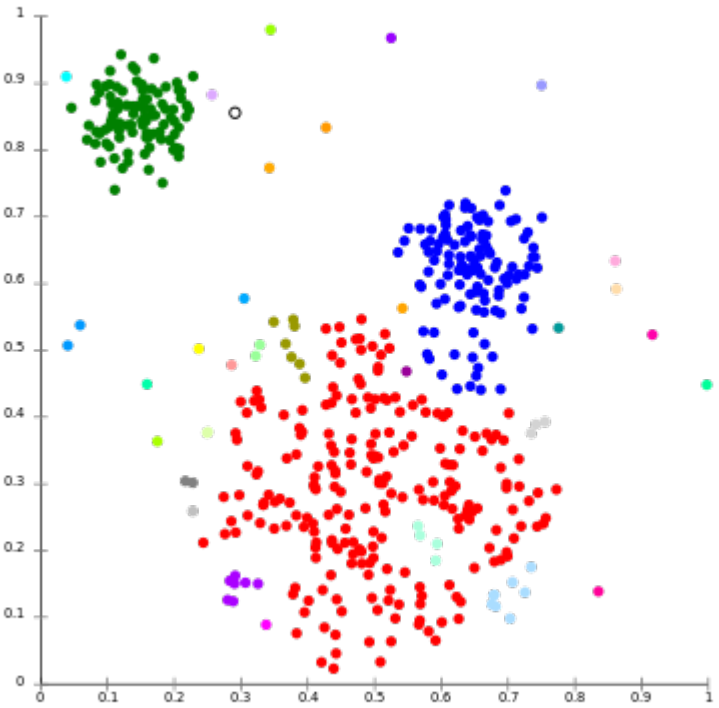




The collocated VIIRS pixels are then separated into several classes based on cluster analysis; for each class, the fraction of CrIS FOV coverage, mean radiance value, standard deviation are provided.

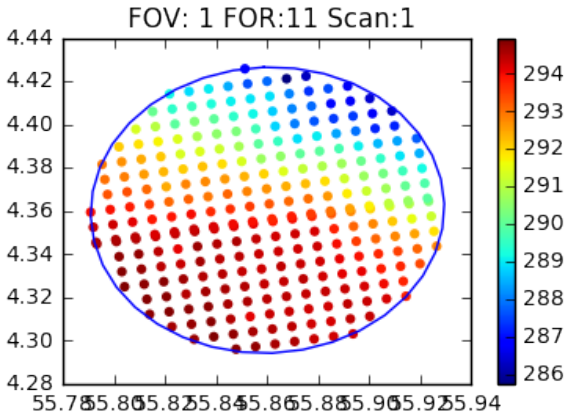
Cluster Analysis

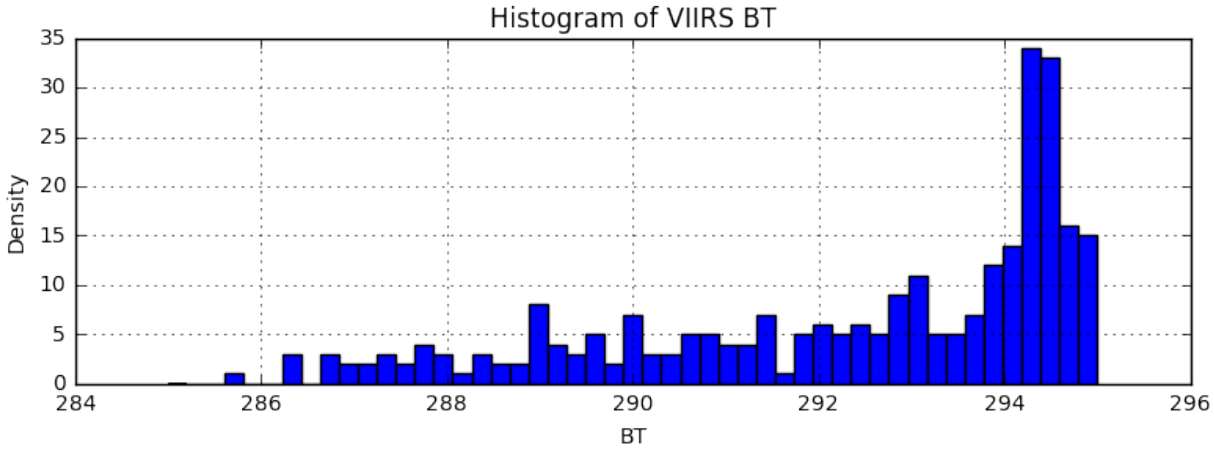
Cluster analysis or **clustering** is the task of grouping a set of objects in such a way that objects in the same group (called a **cluster**) are more similar (in some sense or another) to each other than to those in other groups (**clusters**).

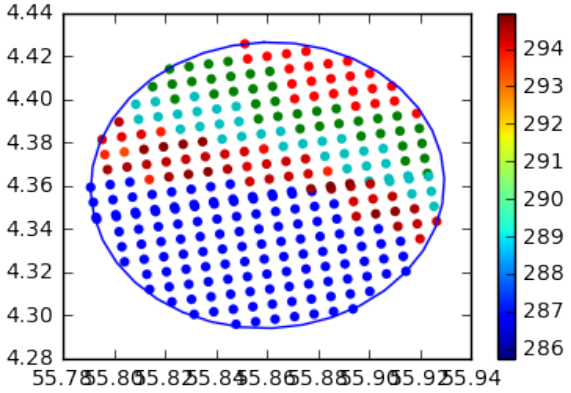


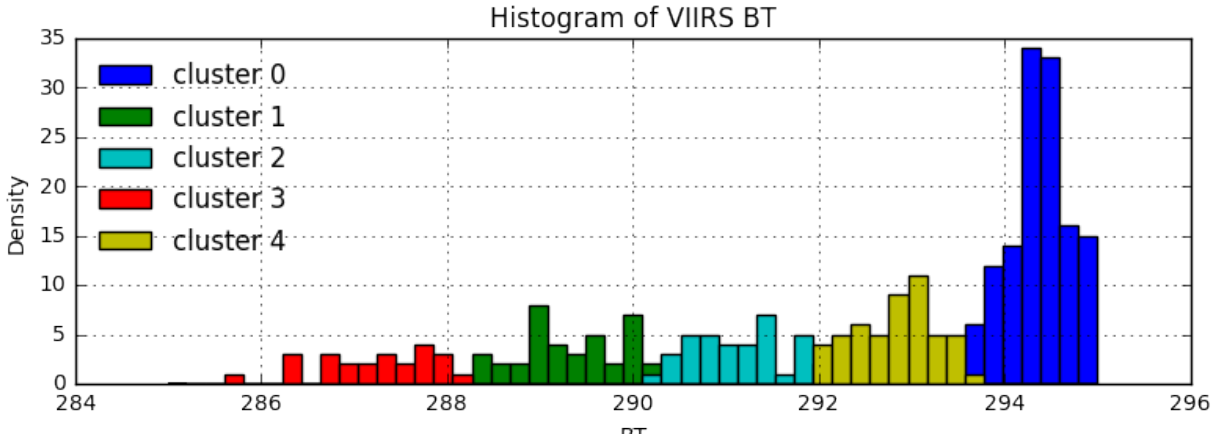
The implementation of **VIIRS radiance cluster analysis** under CrIS FOVs will facilitate the following applications, 1) accurate determination of heterogeneous degree of the CrIS FOVs, 2) fast selection of clear situation.

Cluster Analysis (I)



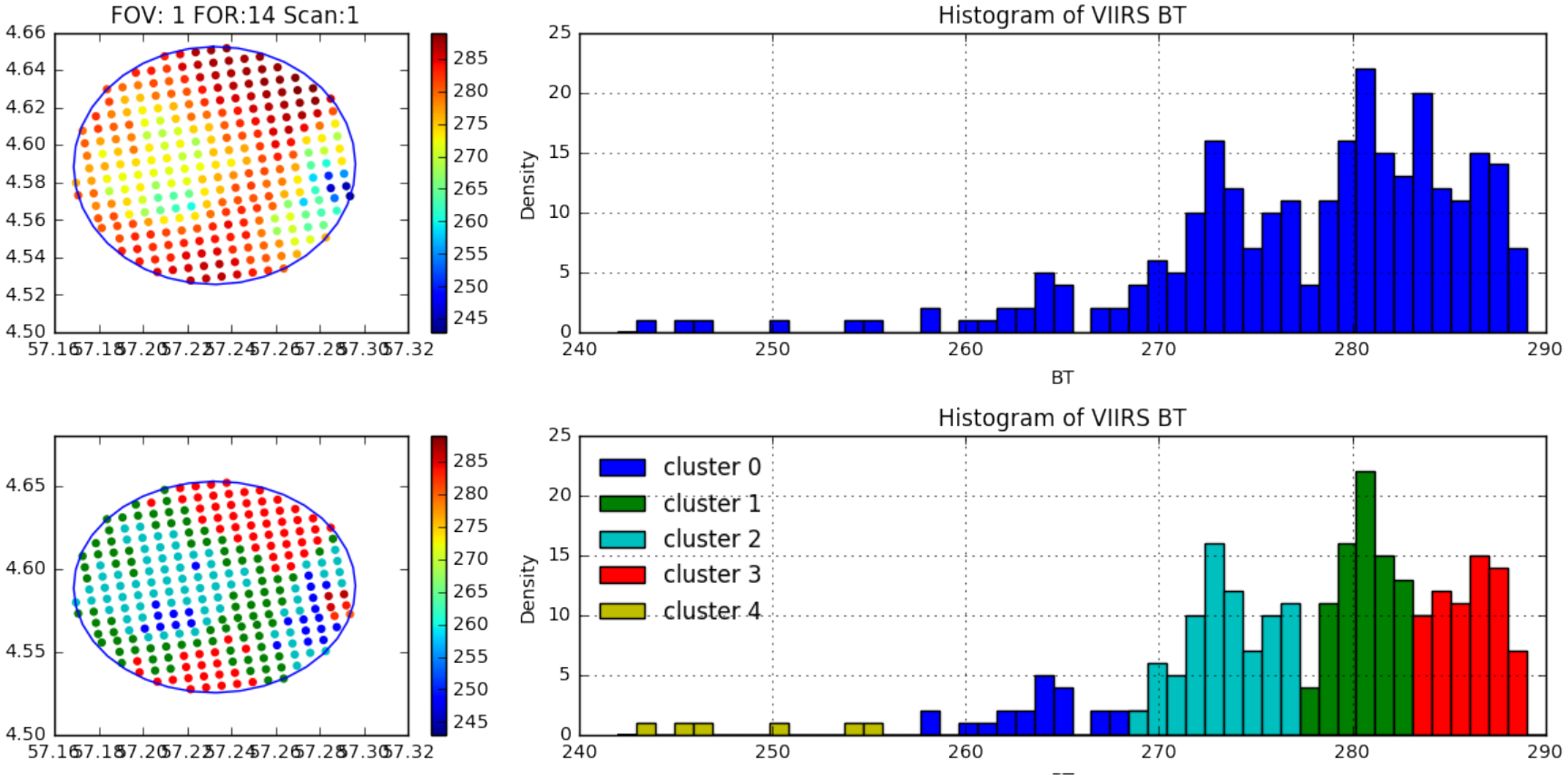






Partial cloud coverage

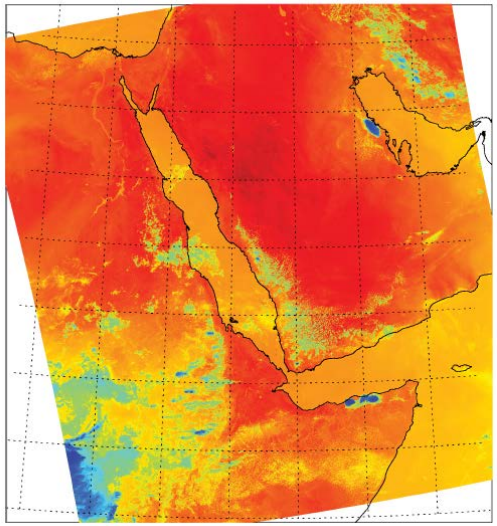
Cluster Analysis (II)

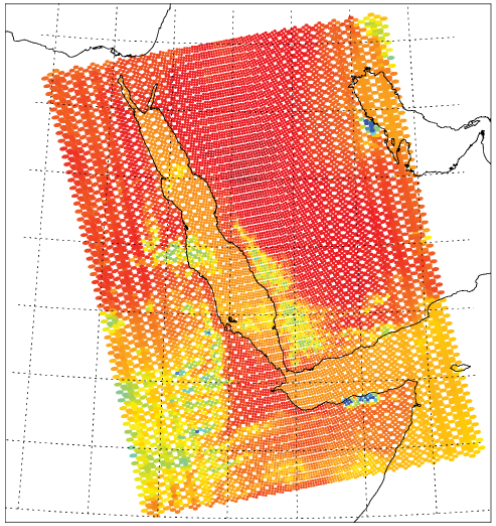


Broken cloud case

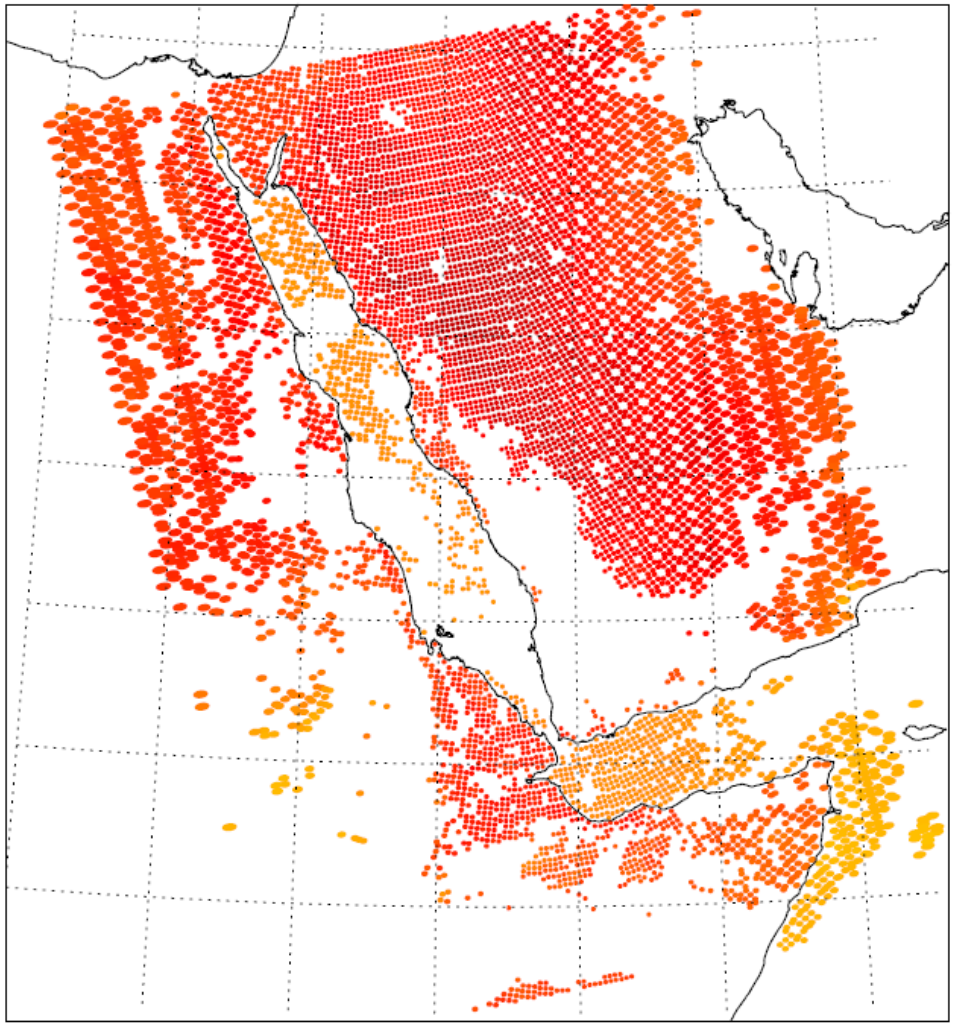
Clear Sky Detection

VIIRS Image at I5 band





CrIS Clear Sky Pixels



Conclusion

- Fast and accurate collocation method of CrIS and VIIRS has been developed, which is suitable for operational use.

- CrIS geolocation has been adjusted to better align with VIIRS.

- VIIRS radiance cluster analysis shows some potentials for data assimilation and geophysical parameter retrievals.

QUESTIONS?

Flowchart for VIIRS-CrIS Alignment Check