Non uniform beam filling features obtained from dense sampling experiment during the TRMM end of mission operation

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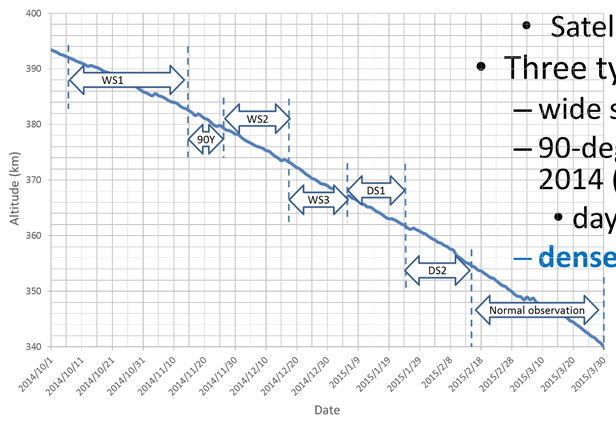
Introduction: TRMM end of mission (EOM) Experiment

Experimental schedule and satellite altitude

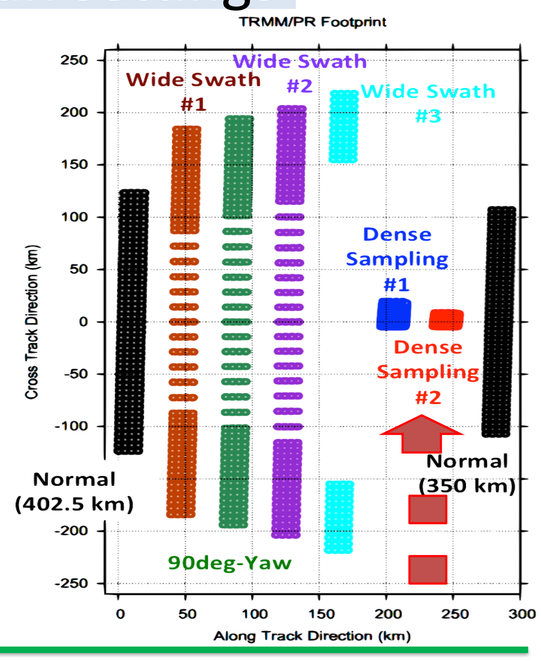
Nominal altitude before descending: 402.5 km



- TRMM EOM Experiment: October 2014-February 2015
  - Satellite was descending and not suitable for nominal operation
- Three types of experiments for PR
  - wide swath (WS1, 2, and 3) --- Nov. to Dec., 2014 (1.5 mo.)
  - 90-degree yaw maneuver (90Y) --- 11 days, from Nov. 15 to 25, 2014 (Total 880 minutes of data).
    - day side of the orbit and the US day time only: 80 min./day
  - **dense sampling (DS1 and 2) --- Jan. 5 to Feb. 12, 2015**

Cross-track scan settings

- 49 angle bins for one scan (angle bin #25 = nadir)
- fixed onboard sampling range (50 km window)
- successive 35 km range cannot be observed data are downlinked
- Full depth of rain data

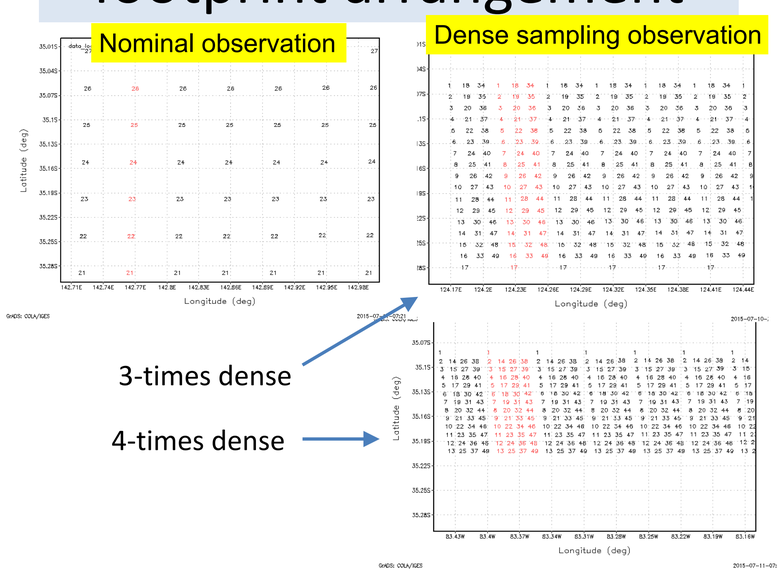


Dense sampling experiment: Spatial over sampling (x3 or x4)

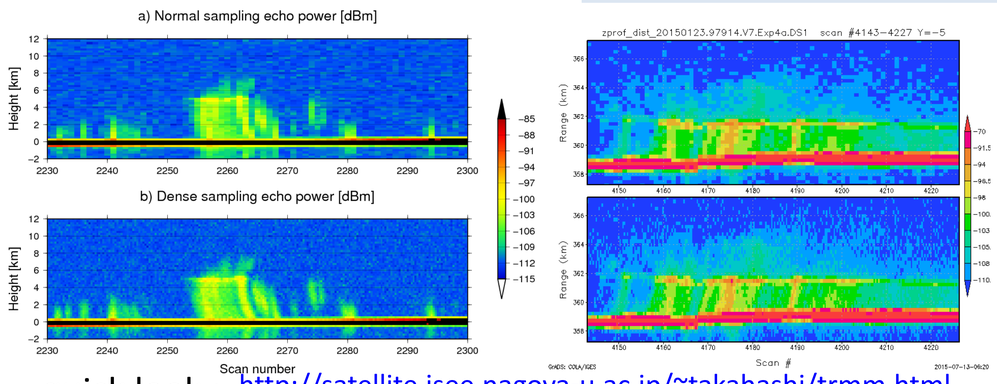
purpose

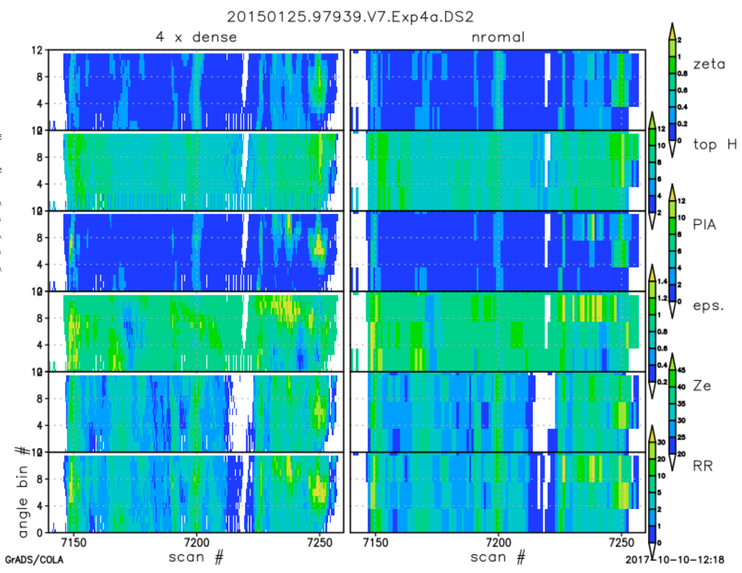
- **To evaluate the high spatial resolution observation by the over sampling.**
- To evaluate the rain retrieval algorithm by comparing the short distance rays.

footprint arrangement



example of dense sampling





quick look : http://satellite.isee.nagoya-u.ac.jp/~takahashi/trmm.html
(ID: trmmeom PW: 2014-2015)

These comparison give impression of that the oversampling can replace high resolution observation. The question is quantitative retrieval is available or not ? Issue of non-uniform beam filling (NUBF) effect.

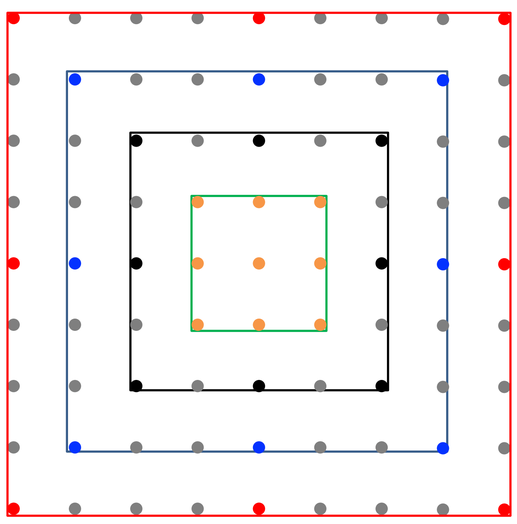
NUBF effect: Preliminary study

Preliminary study of NUBF effect

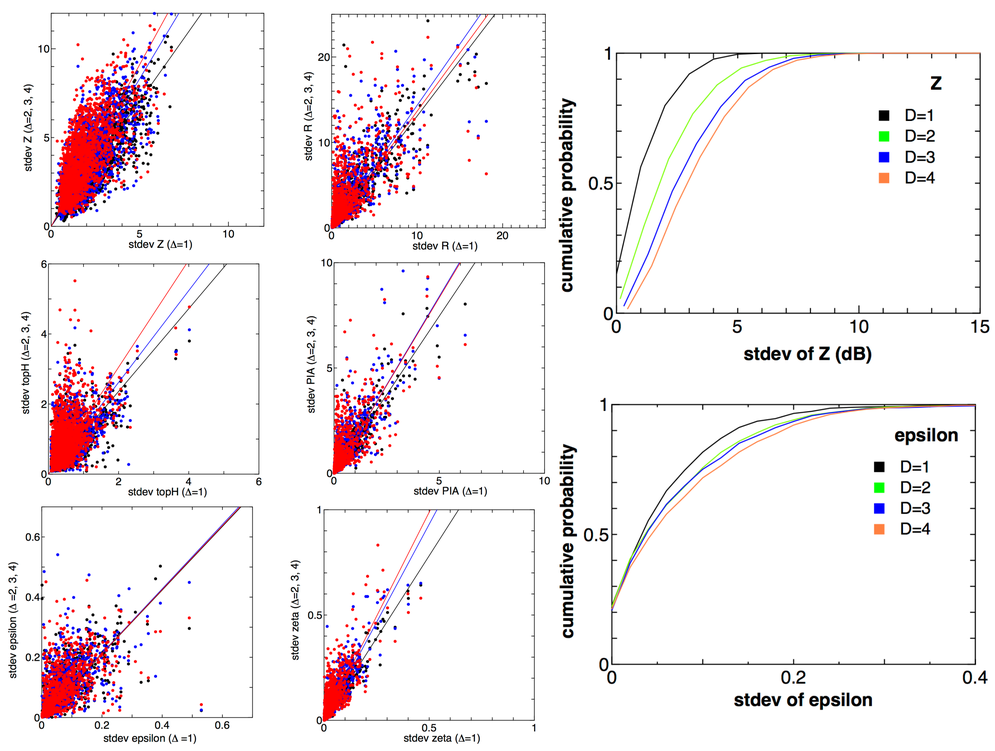
- **To see the fundamental characteristics of NUBF parameter**
- assumption: DS data may represent the high resolution data
- preliminary study: comparison of dense sampling and normal sampling

- standard deviation of adjacent 9 footprints
  - R, Ze, echo top, PIA, zeta, and epsilon
- correlation of profiles
  - R and Ze

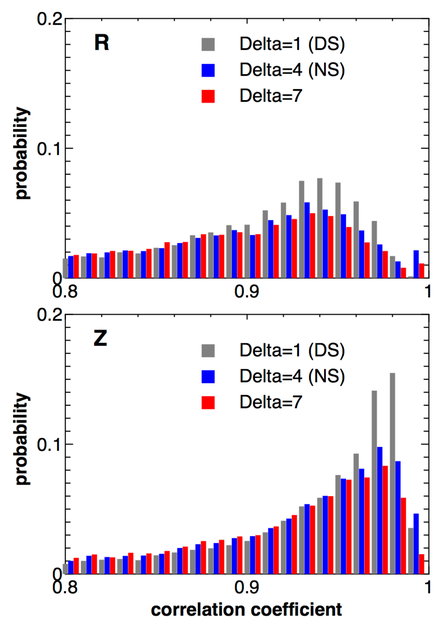
red circles + center : normal obs. (Δ or D = 4)
green + center : 4 times dense sampling (Δ or D = 1)
black + center : 2 times dense sampling (Δ or D = 2)
blue + center : 1.5 times dense sampling (Δ or D = 3)



comparison of standard deviation 9 adjacent footprints for various resolution

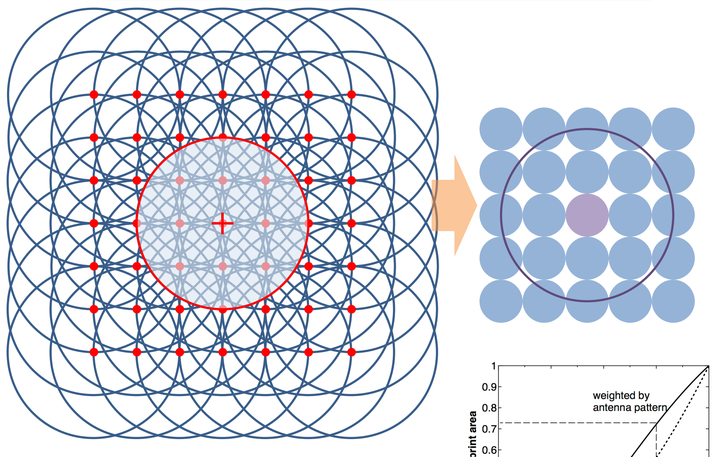


correlation of profiles between adjacent rays



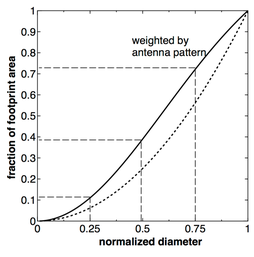
retrieval of fine scale structure

toward the goal



Goal : retrieve the fine scale observations.

- ✓ How the fine scale observation area contribute the nominal observation
- ✓ If NUBF effect is known, is it possible to retrieve?

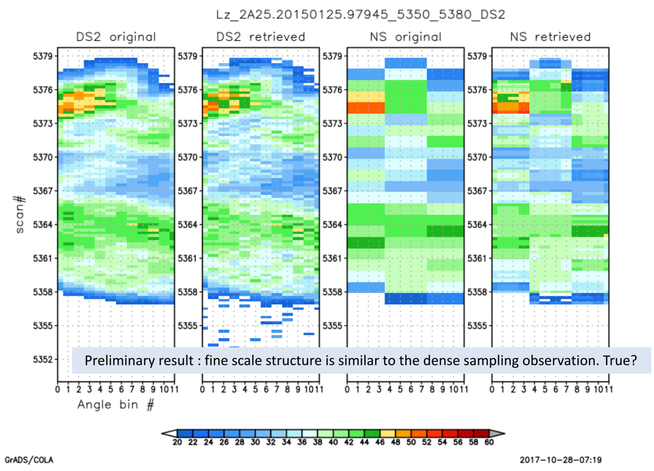


short discussion

R	$\int_{area} N(D)D^{3.67}ds$	Target to retrieve
Z	$\int_{area} N(D)D^{6}wgt(s)ds$	6th power moment of D, weighted by antenna pattern
PIA	$\int_{z=0}^{z=top}\int_{area} N(D)D^{3}wgt(s)dsdz$	• close to the R, but weighted by antenna pattern. • slant incident angle data can give the NUBF information.
zeta	~PIA	depends on the Z and attenuation.
epsilon	PIA(obs)/PIA(zeta)	if the DSD model (not DSD itself) is constant locally, this value keep constant.
echo top H	~Z	larger beam causes the unexpected echo existence.

If the fine scale (4 x dense observation = 1.25 km resolution) is the truth, normal observation is re-sampling of 5 km area and weighted antenna pattern.

True scale observation may be retrieved from dense sampling data.
Fourier transformation with Gaussian filter.
PIA data were tried to retrieve.



Preliminary result : fine scale structure is similar to the dense sampling observation. True?