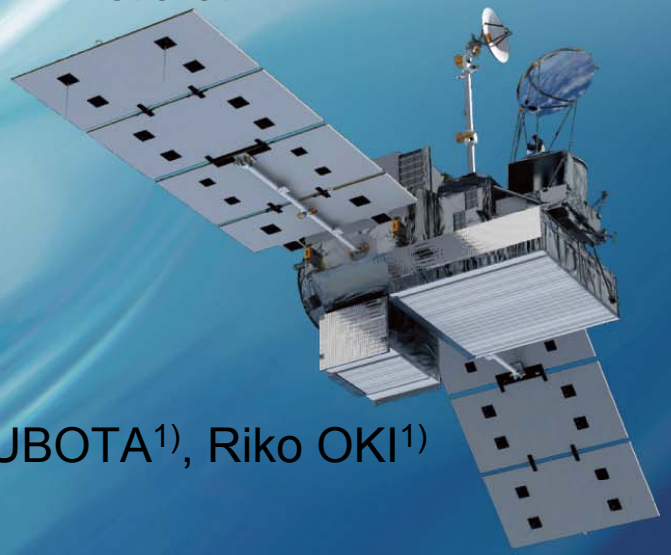
Scan Pattern Change Test Operations of The Dual-frequency Precipitation Radar on The Global Precipitation Measurement Core Spacecraft



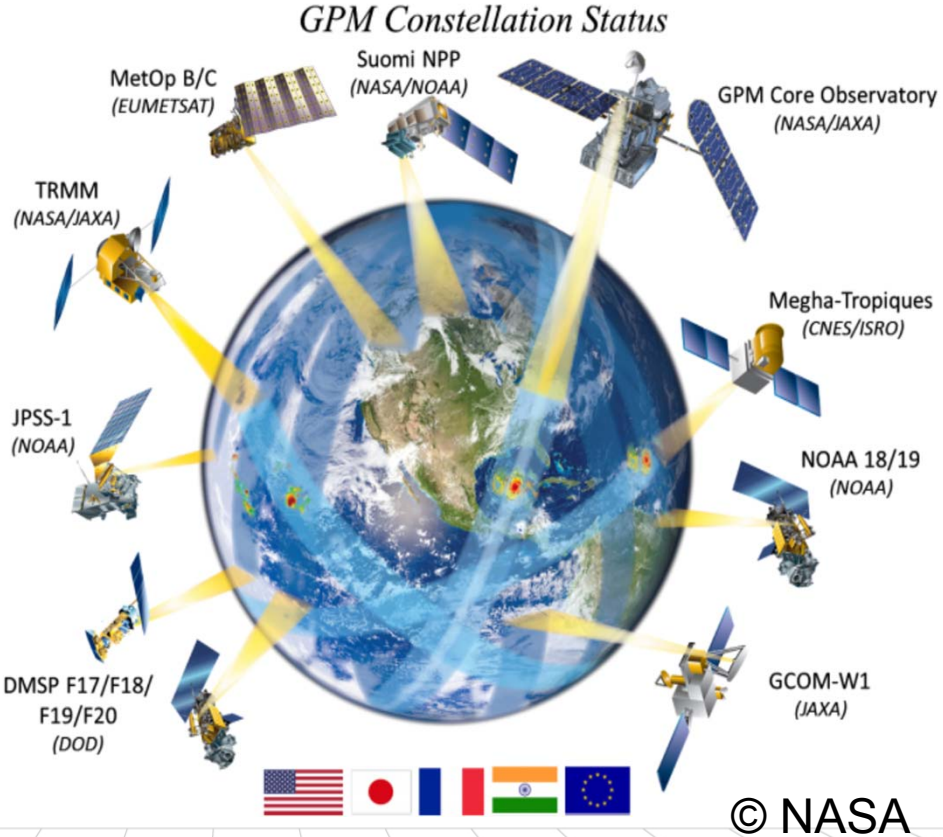
Kinji FURUKAWA[1)], Kosuke YAMAMOTO[1)], Takuji KUBOTA[1)], Riko OKI[1)] and Toshio IGUCHI[2)]

1) Japan Aerospace Exploration Agency
2) National Institute of Information and Communications Technology

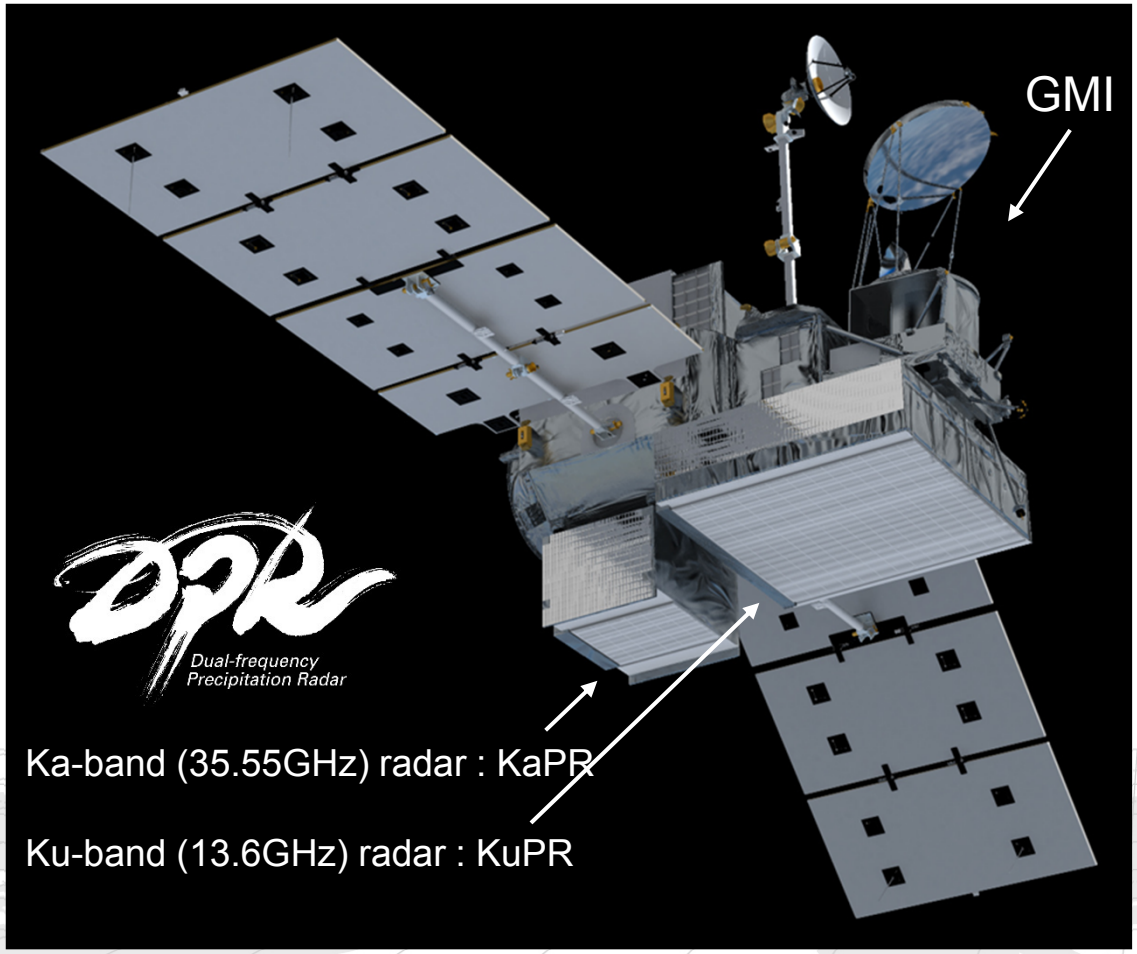
Concept of GPM

- To establish accurate and frequent global precipitation observation system, Global Precipitation Measurement (GPM) consists of GPM core observatory and constellation satellites.

- The GPM Core Observatory carries an advanced radar/radiometer system and serves as a reference standard to unify precipitation measurements from constellation satellites.



Overview of GPM Core Observatory



Altitude: 407km
Inclination: 65 deg
Orbit: Non-sun-synchronous circular orbit

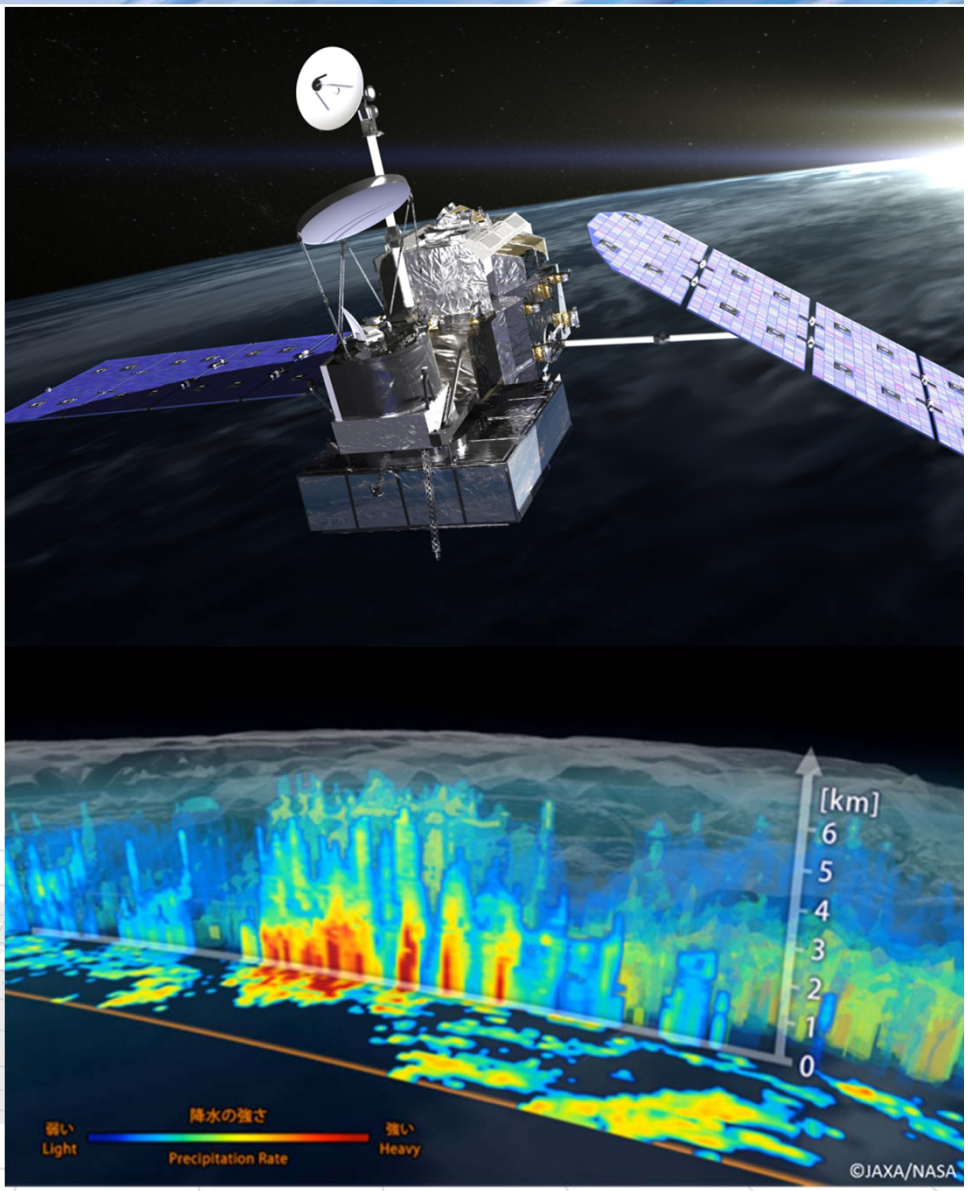
Launcher:H2A (JAXA/MHI)

Objectives of DPR

- Three-dimensional observation of precipitation
- High sensitivity measurement of light rainfall and heavy snowfall in high latitude
- Accurate estimation of rainfall rate by combining the Ku- and Ka-band radar data
- DPR data improve estimation accuracy of MWR estimated precipitation.

Orbital Operations

- GPM Core Observatory was launched from the Tanegashima Space Center, JAXA on Feb. 28, 2014 (Japan Time).
- DPR completed its prime mission phase in May 2017 and moved to extended mission phase.
- JAXA is continuing DPR data monitoring and confirming that DPR function and performance are kept on orbit in the extended mission phase.



Overview of the Test Operations

- Scan pattern change test operation has been conducted 2 times and successfully done.

✓ **<u>September 26th -29th in 2017</u>**

- Wide swath test (Sep, 26th to 27th)
- KaPR HS outer swath test (Sep, 27th to 28th)

✓ **<u>February 20th -22nd in 2018</u>**

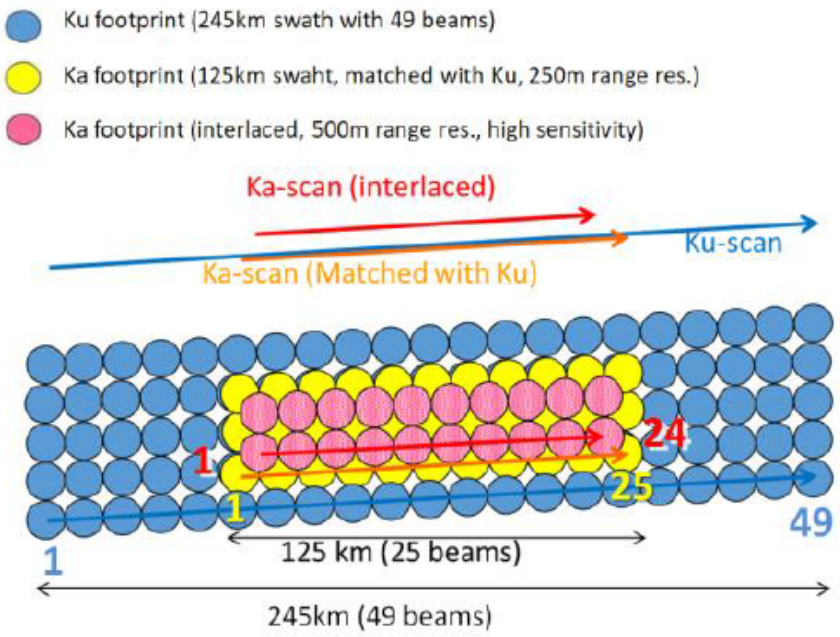
- KaPR HS outer swath test (Feb, 20th to 21st)

✓ **<u>May 21st in 2018</u>**

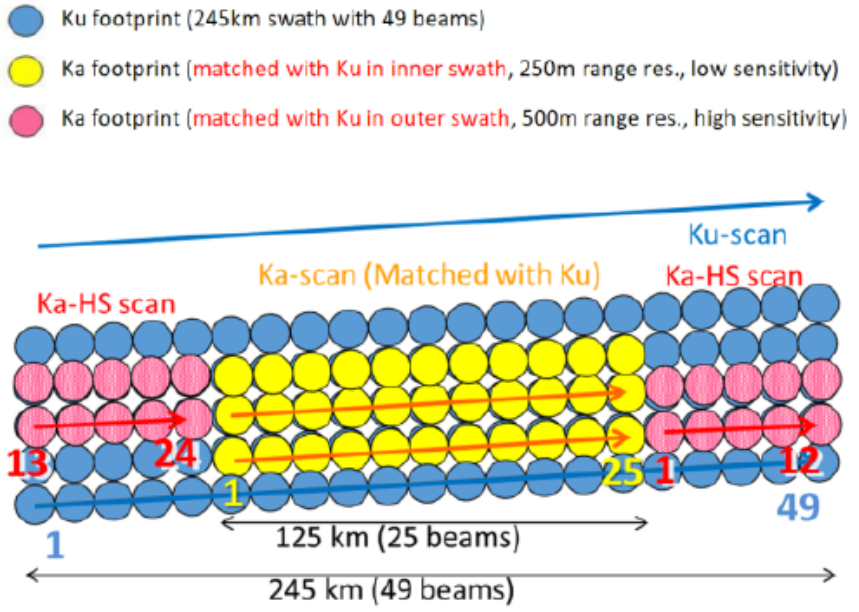
- KaPR HS Outer Swath Observation Start

KaPR Scan Pattern Change

before



after

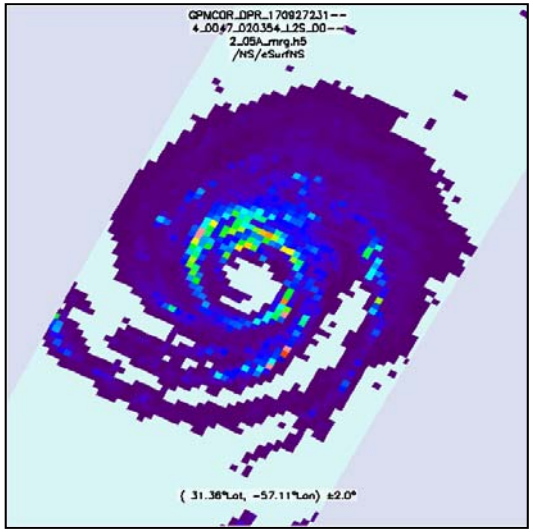


- <u>KaPR-HS's scan pattern was changed.</u>
  → Dual-frequency technique can be applied in a full swath.

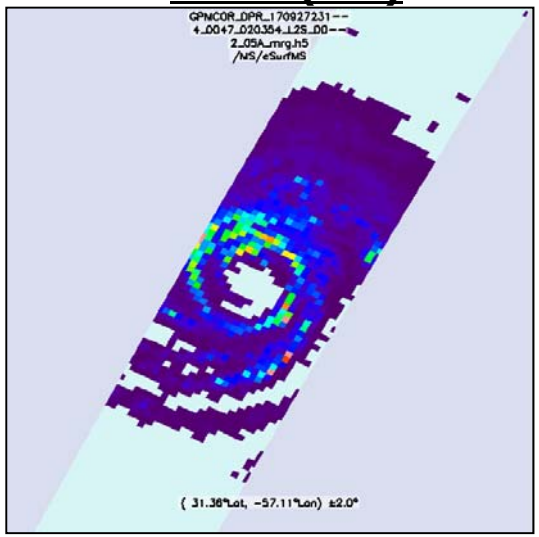
Experiments results

DPR L2 : precipRateESurface ***The current L2 algorithm is still in development phase.***

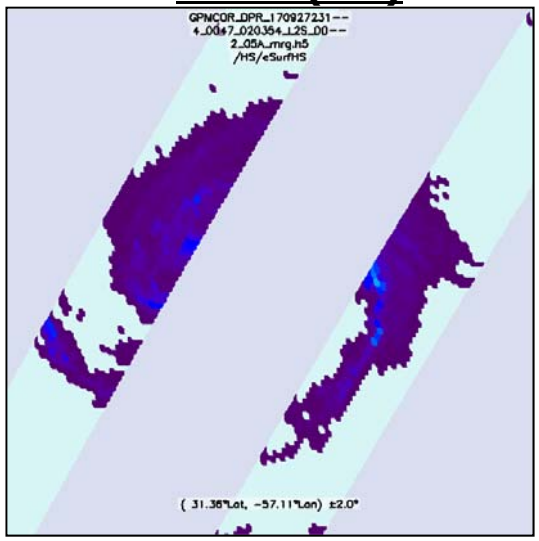
KuPR



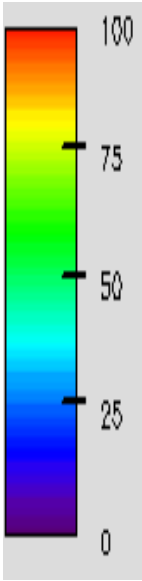
KaPR(MS)



KaPR(HS)

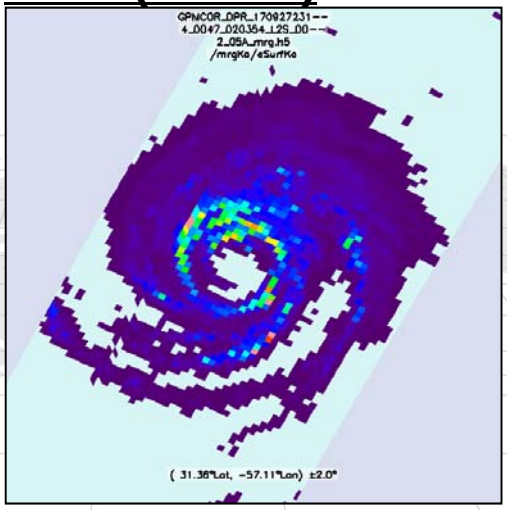


[mm/h]



Sep 27th 2017
Hurricane LEE

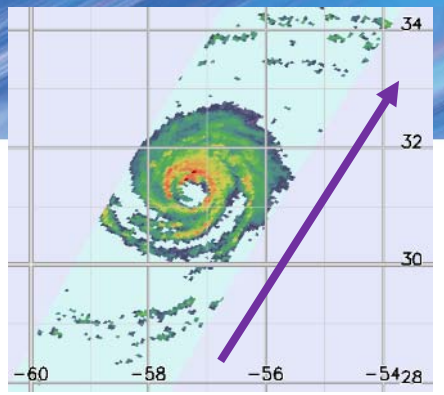
KaPR(MS/HS)

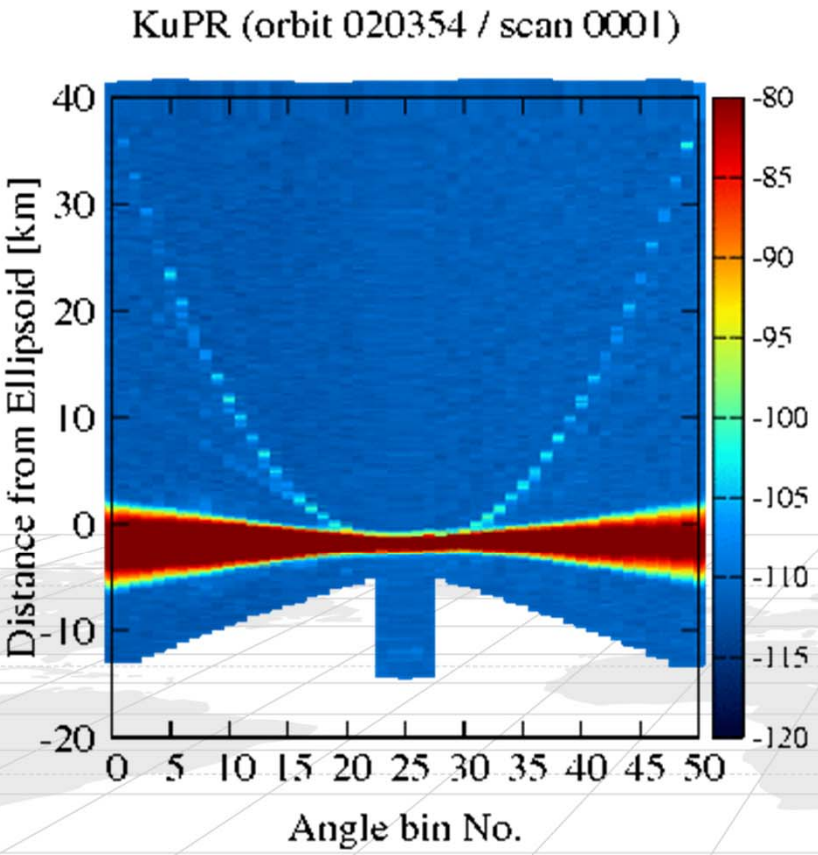


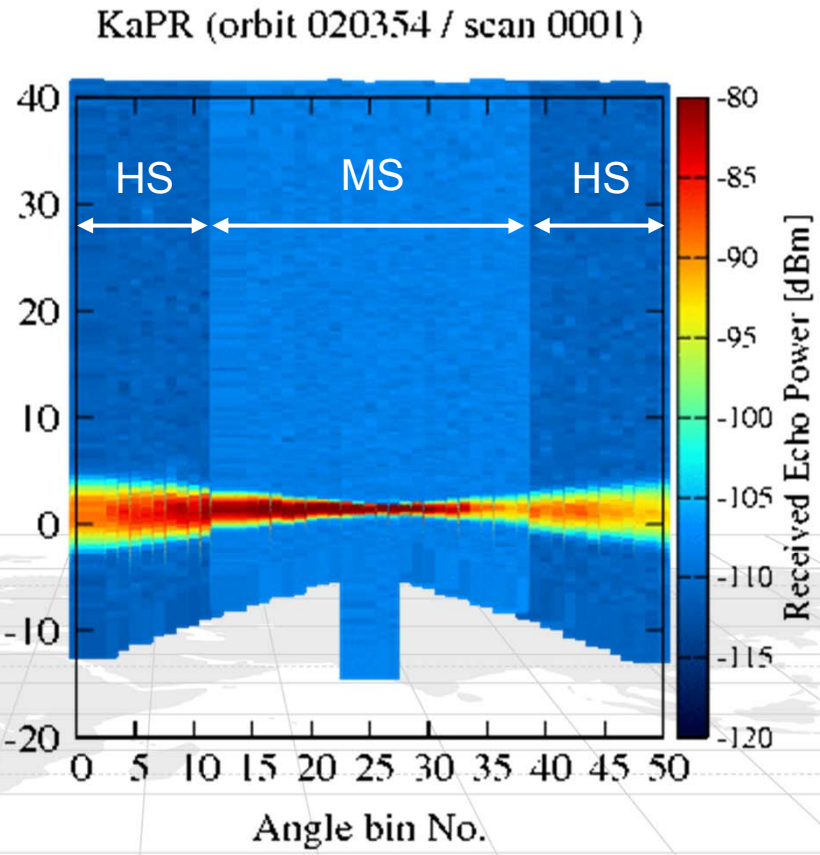
Dual-frequency technique
will be applied in a full swath.

Experiments results

- JAXA confirmed DPR is working as expected.



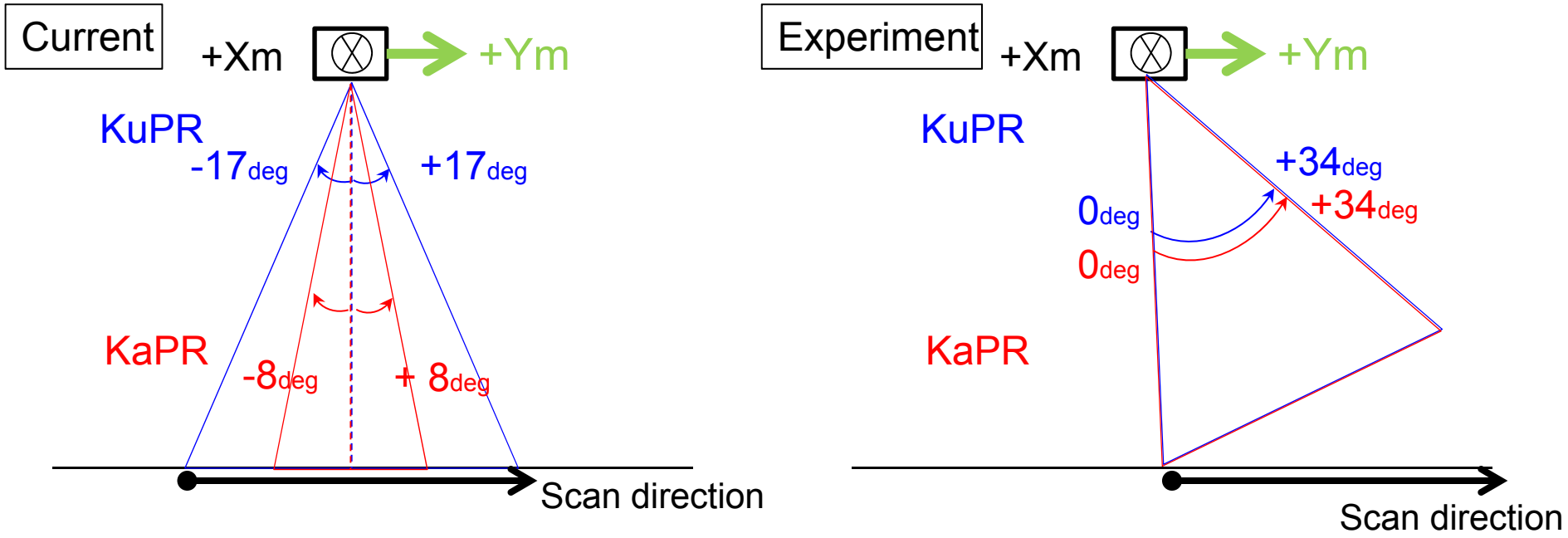




Brief summary for KaHS outer scan pattern

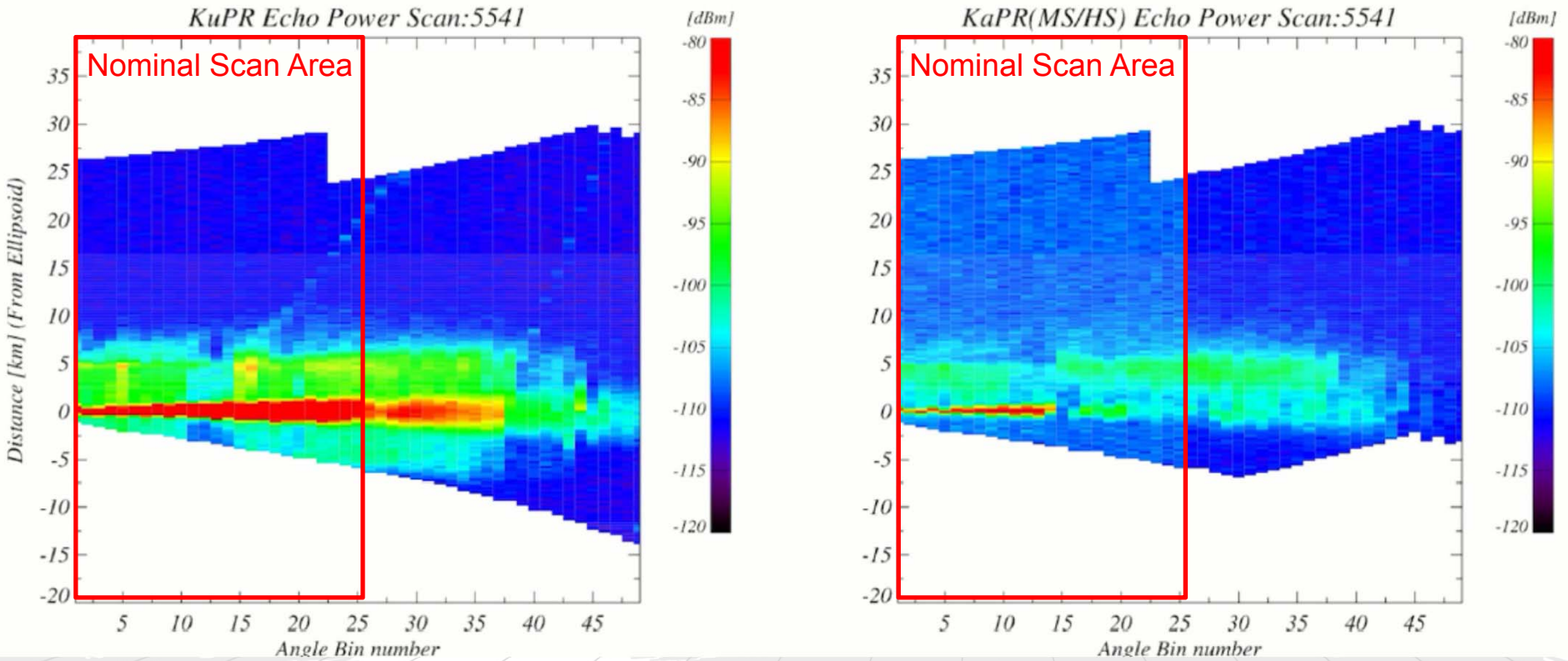
- Advantages
  - By the change of the KaHS scan pattern, the dual-frequency technique can be applied in a full swath.
- Remaining issues
  - There is a possible discontinuity of signals between the MS and the HS at the boundary.
    - Due to differences of sensitivities (18dBZ vs 12dBZ) , in addition to vertical resolutions (250m vs 500m).
    - Actually, higher sensitivity in the HS will be able to cause the discontinuity of the precipitation pattern in the Ka full scan.
  - We need to take these into a consideration in the format change and the L2 algorithm development.

Wide swath experiment (KuPR and KaPR)



- Scan patterns were changed both KuPR and KaPR.
  → Toward a future radar development.
  (These scan patterns are NOT applied in future DPR nominal observation.)

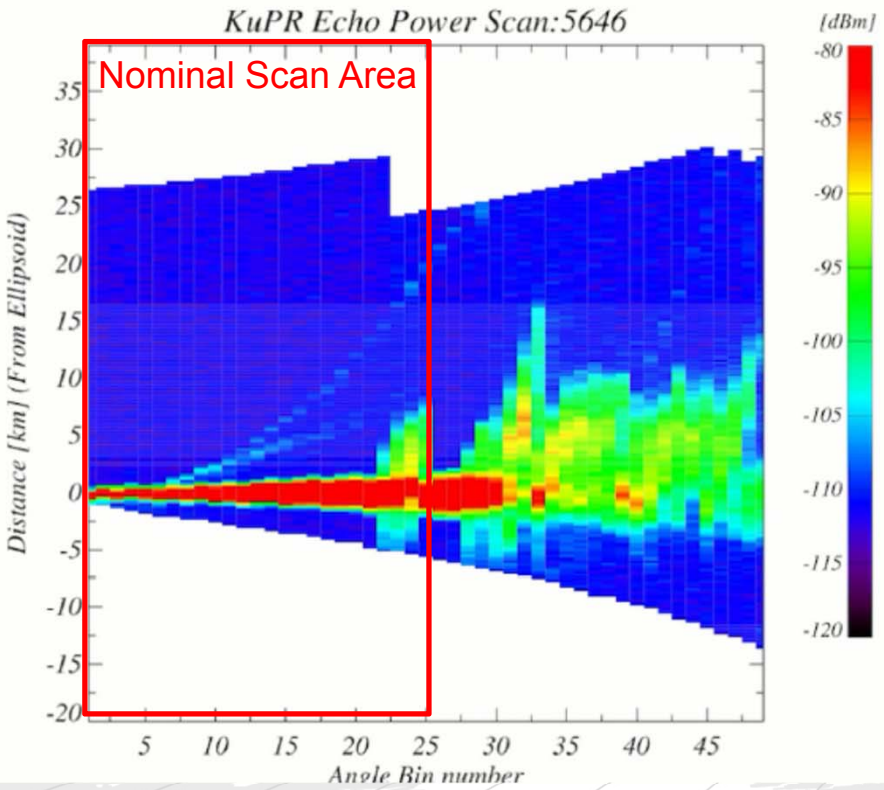
Experiment Results

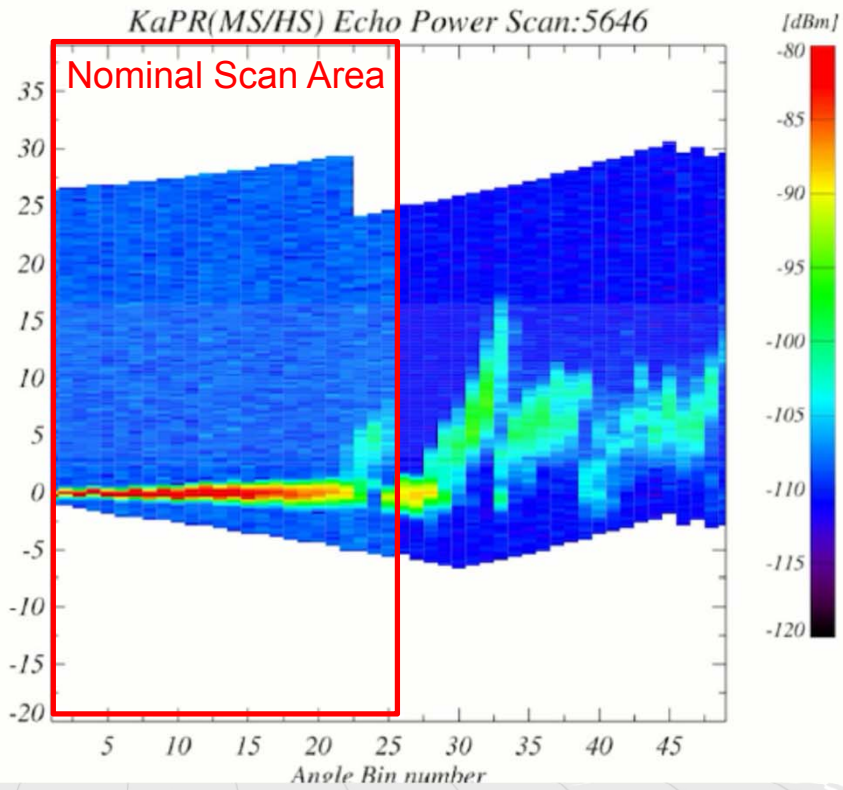


＜Stratiform precipitation case＞

＊Both KuPR and KaPR could observe precipitation in wide swath area (17 to 34 deg.)

Experiment Results

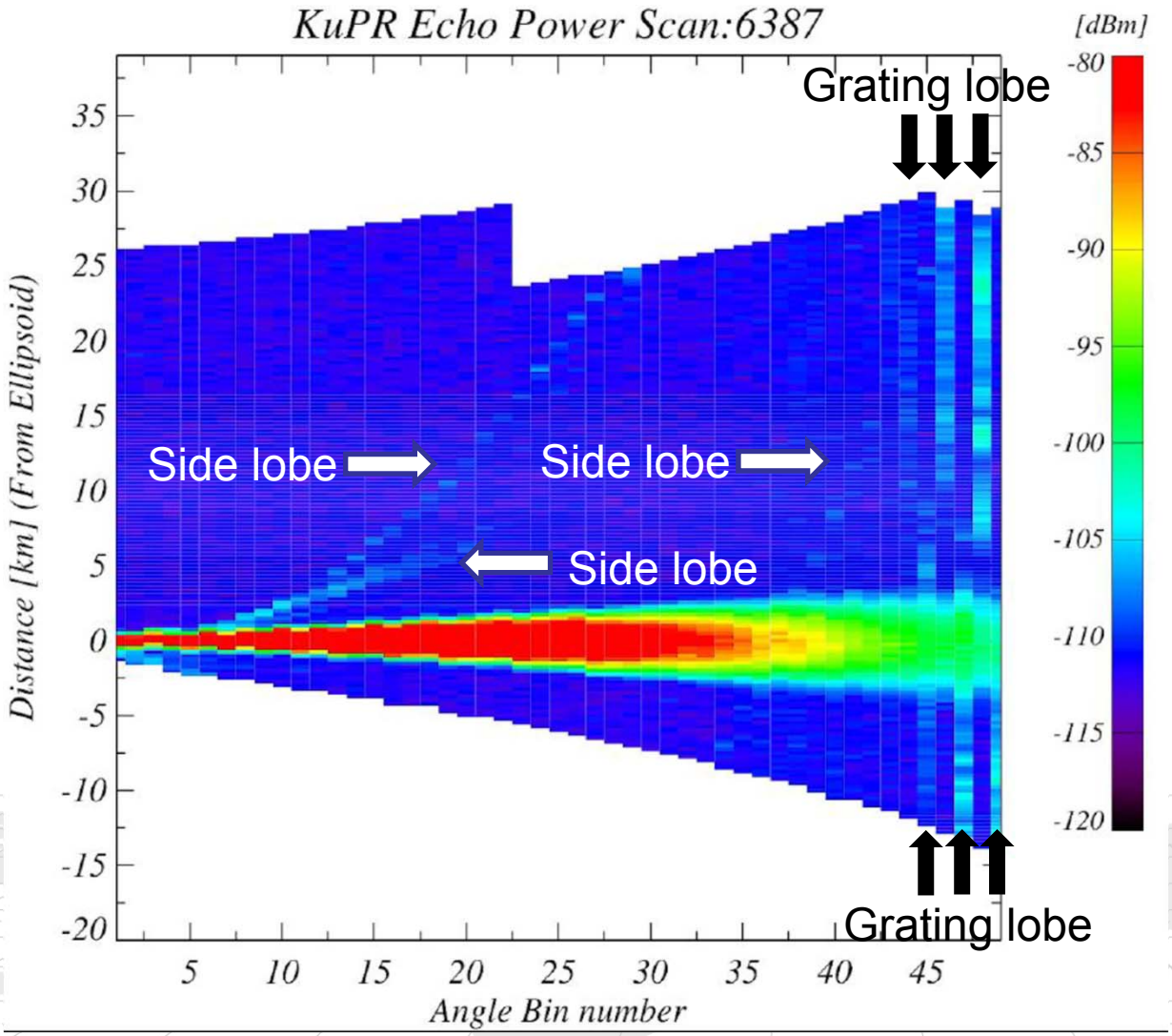




＜Convective precipitation case＞

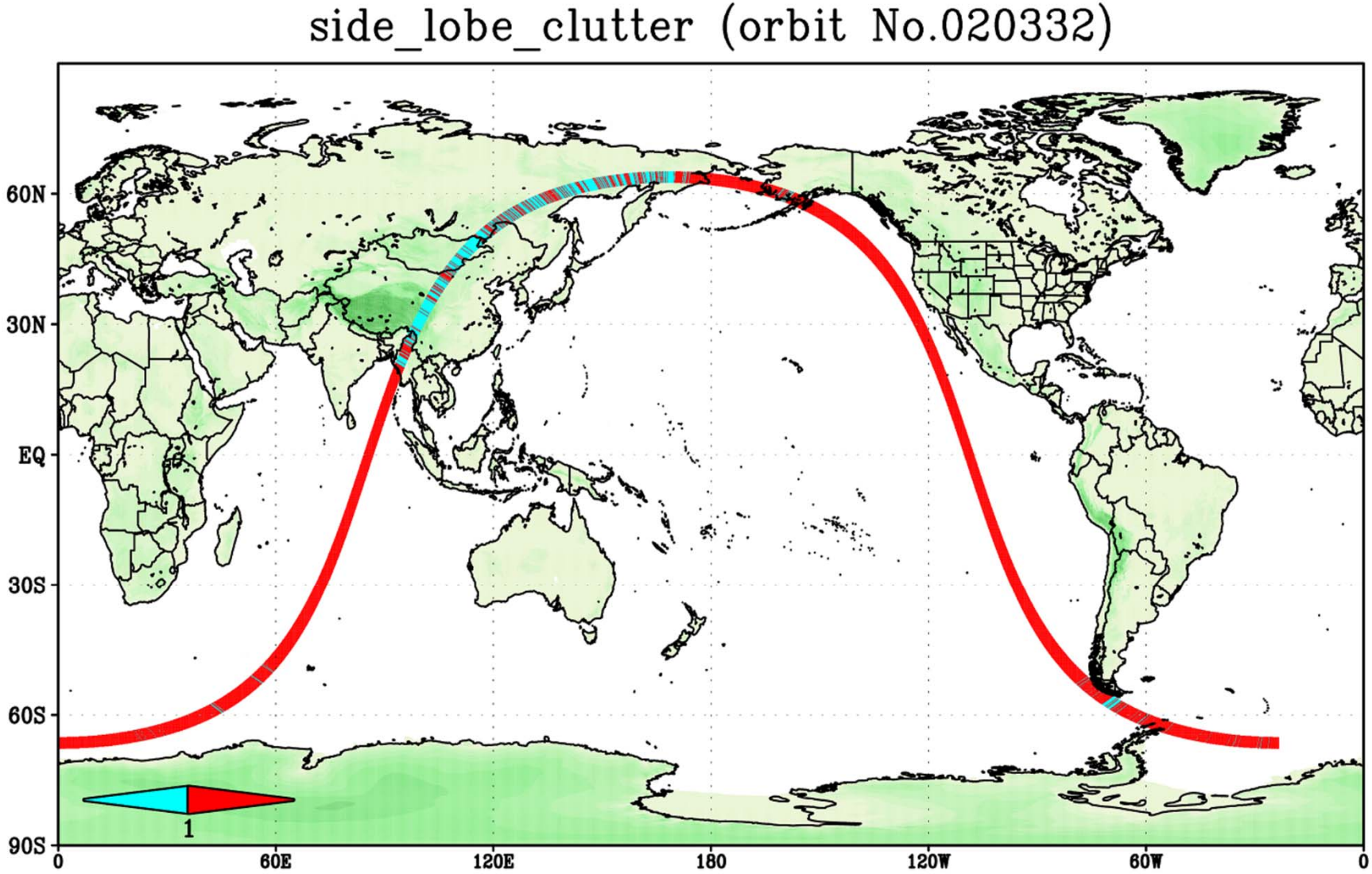
＊Both KuPR and KaPR could observe precipitation in wide swath area (17 to 34 deg.). There are obvious attenuation was found for KaPR.

Experiment Results



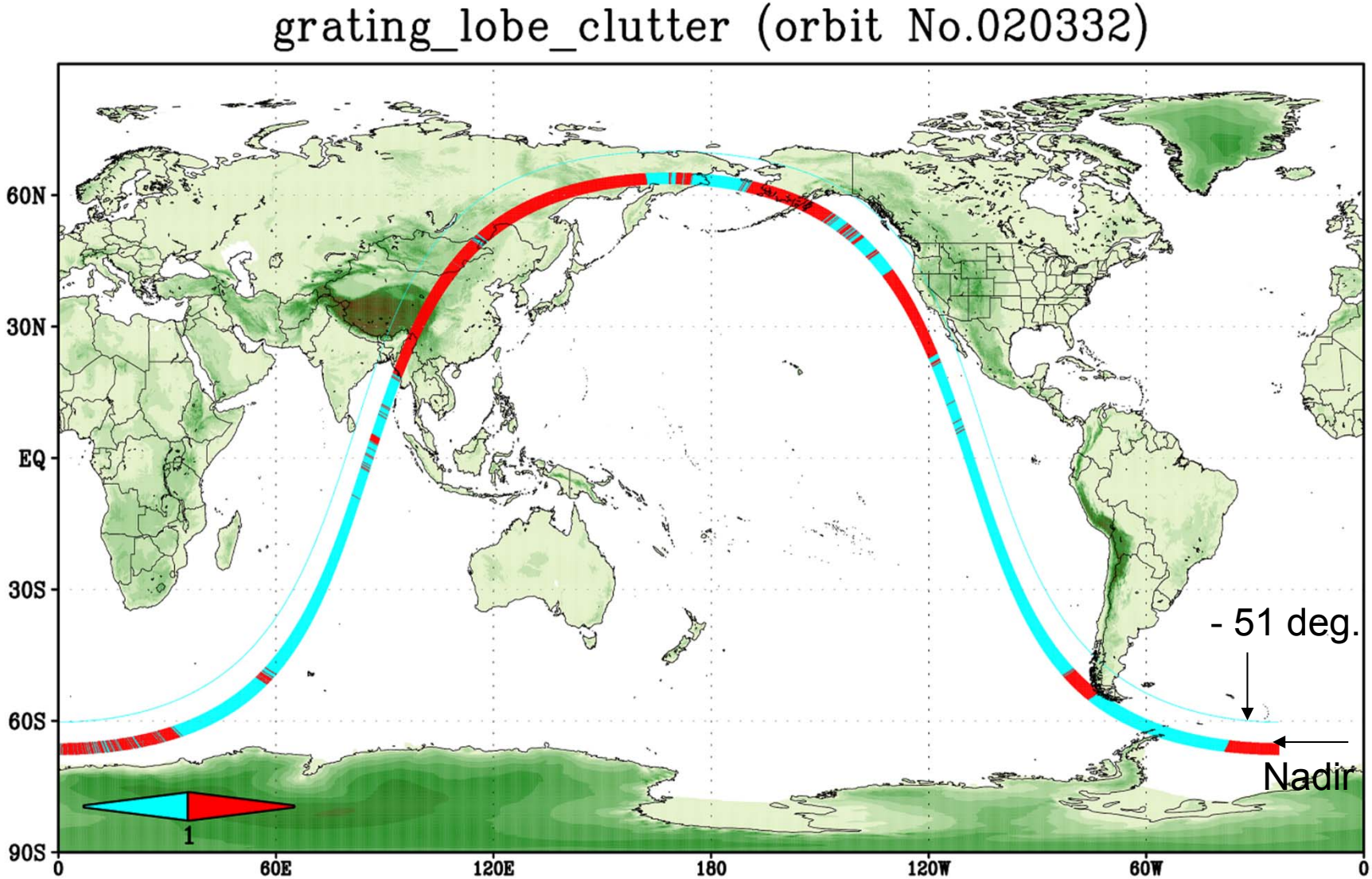
∗ There are obvious side lobe effects and grating lobe effects in some scans.

Experiment Results



∗ Most of side lobe effects are seen over sea area.

Experiment Results



∗ Most of grating lobe effects at 33.37 deg. are seen where – 51 deg. angle is over land and Screaming Sixties.

Summary

- Ka scan pattern change test operation has been conducted 2 times and successfully done. KaPR HS Outer Swath Observation Start on May 21ST 2018. JAXA confirmed DPR is working as expected.

- By the change of the KaHS scan pattern, the dual-frequency technique can be applied in a full swath. There is a possible discontinuity of signals between the MS and the HS at the boundary. We need to take these into a consideration in the format change and the L2 algorithm development.

- Wide swath experiment were conduced toward a future radar development. We confirmed that KuPR and KaPR can observe precipitation from 0 to 34 deg. scan angle. There are obvious side lobe and grating lobe effects in some scans. We need to consider these results to design future wide swath precipitation radar.