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Development/Improvement of GPM DPR L2 rain type classification module and maintenance/improvement of TRMM PR rain type classification algorithm

Jun Awaka
Tokai University, Sapporo Campus

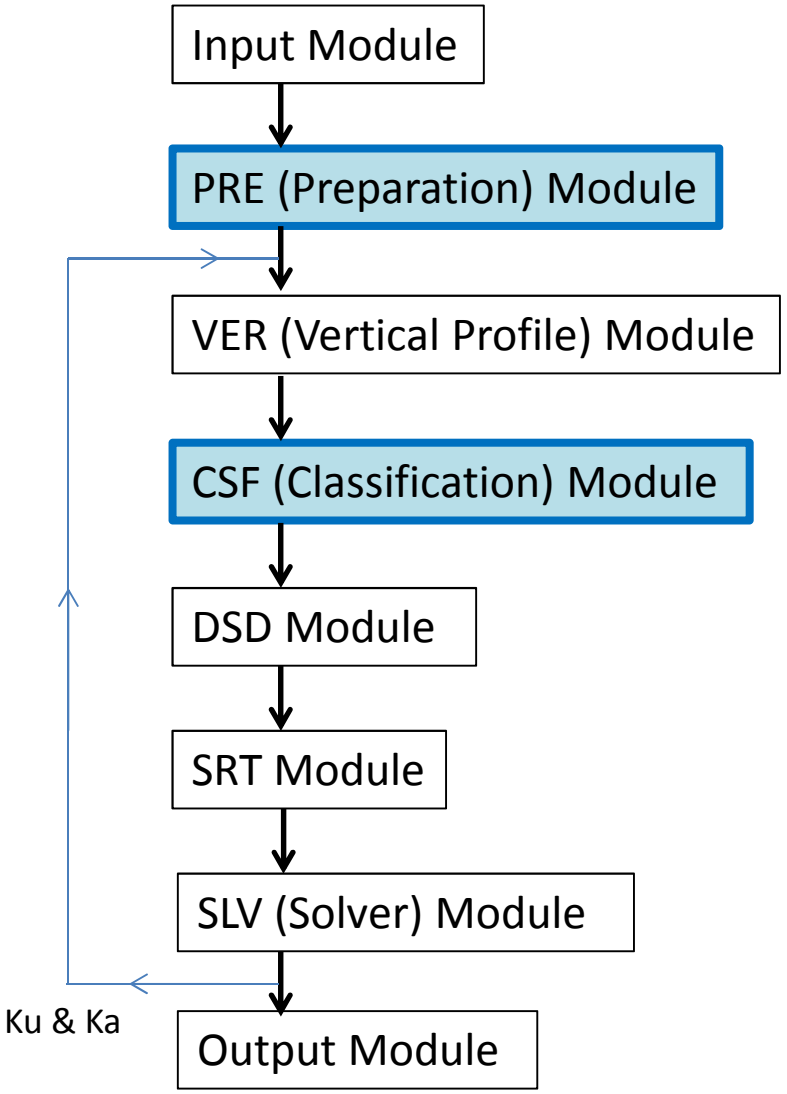
GPM DPR L2 algorithm

- Rain type classification (CSF) module
  (which includes BB detection)
- Clutter routine in preparation (PRE) module

TRMM PR algorithm

- Rain type classification algorithm 2A23
  (which includes BB detection)
- Clutter routine in 1B21

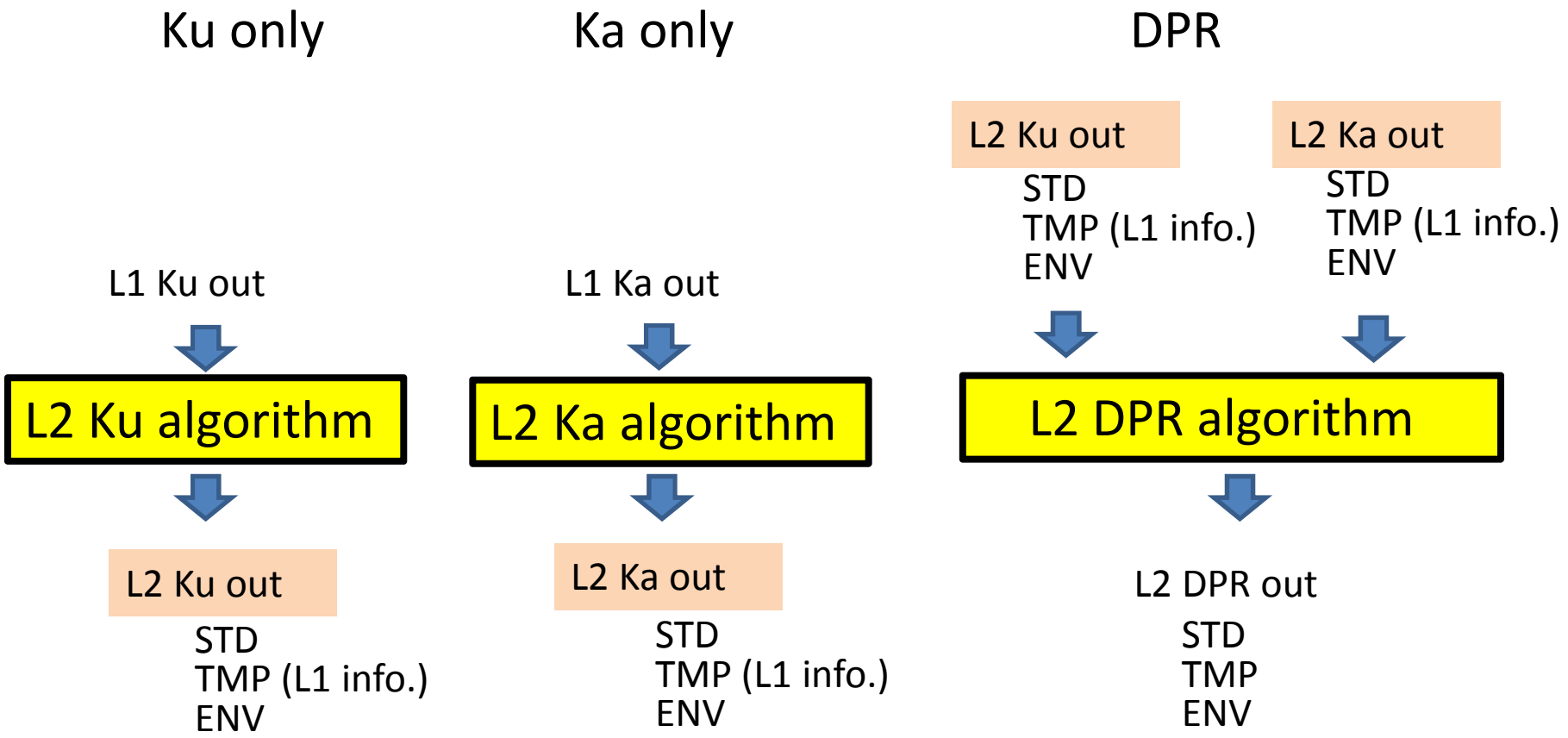
GPM DPR L2 algorithm



Ku algorithm
Ka algorithm
DPR algorithm

These have similar module structures.

Input/Output (GPM DPR L2)



CSF module

- Detection of BB
- Classification of rain type
- Detection of shallow rain

All of these examine texture of data to some extent.

Each CSF module (Ku, Ka, and dpr) outputs three major rain types :

- Stratiform,
- Convective,
- Other.

CSF module

Ku and Ka

V-method

H-method

DPR

DFRm method (a kind of V-method)

(DFRm: measured Dual-Frequency Ratio)

H-method

DPR processing uses

DFRm method

(DFRm: measured Dual-Frequency Ratio)

A kind of V-method.

Proposed by Prof. V. Chandra and Dr. M. Le.

In term of dB,

$$DFRm = Zm(Ku) - Zm(Ka)$$

- Rain type Classification
  - stratiform
  - convective
  - transition
  - DFRm not applicable (e.g., in the case of snow only)
- Detection of BB

- **Find all local DFRm max values within rough melting layer height window;**
- **Find all local DFRm min values within rough melting layer height window;**
- **Select an adjacent DFRm [max min] pair with the largest value difference (max-min). DFRm max value is at higher altitude, DFRm min value is at lower altitude.**

Pair exist? — **No** → **Convective**

Yes

Calculate DFRm slope between the bin with DFRm (min) value and 1st clutter free bin

$$V2 = abs(mean(DFR_m(slope))$$

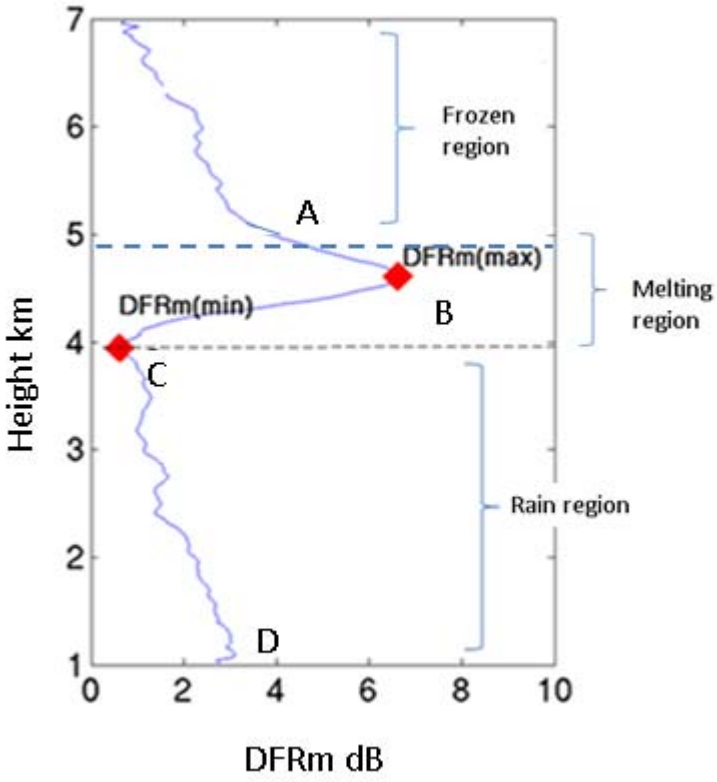
Calculate

$$V1 = \frac{DFR_m(max) - DFR_m(min)}{DFR_m(max) + DFR_m(min)}$$

Calculate $V3 = V1/V2$

V3>C2 : Stratiform
V3<C1 : Convective
C1<=V3<=C2: Transition

Detection of BB



Schematic plot of DFRm profile with key point A, B, C and D. Point A: slope of DFRm has maximum. Point B: maximum of DFRm. Point C: local minimum of DFRm. Point D: DFRm value near surface.

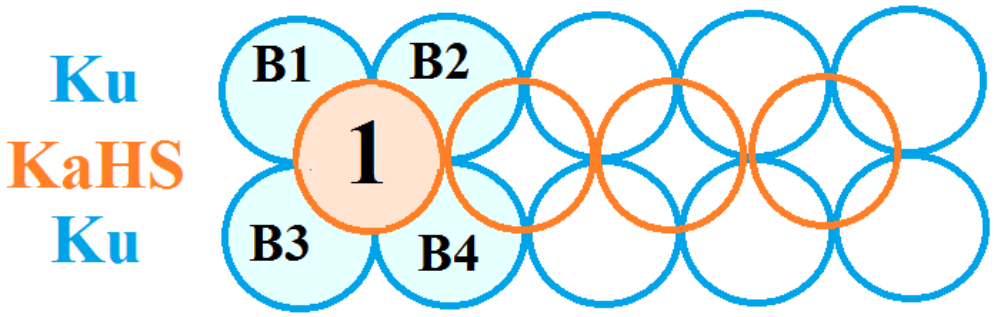
C1=0.112; C2=0.205. These thresholds might be adjusted after more analysis is done.

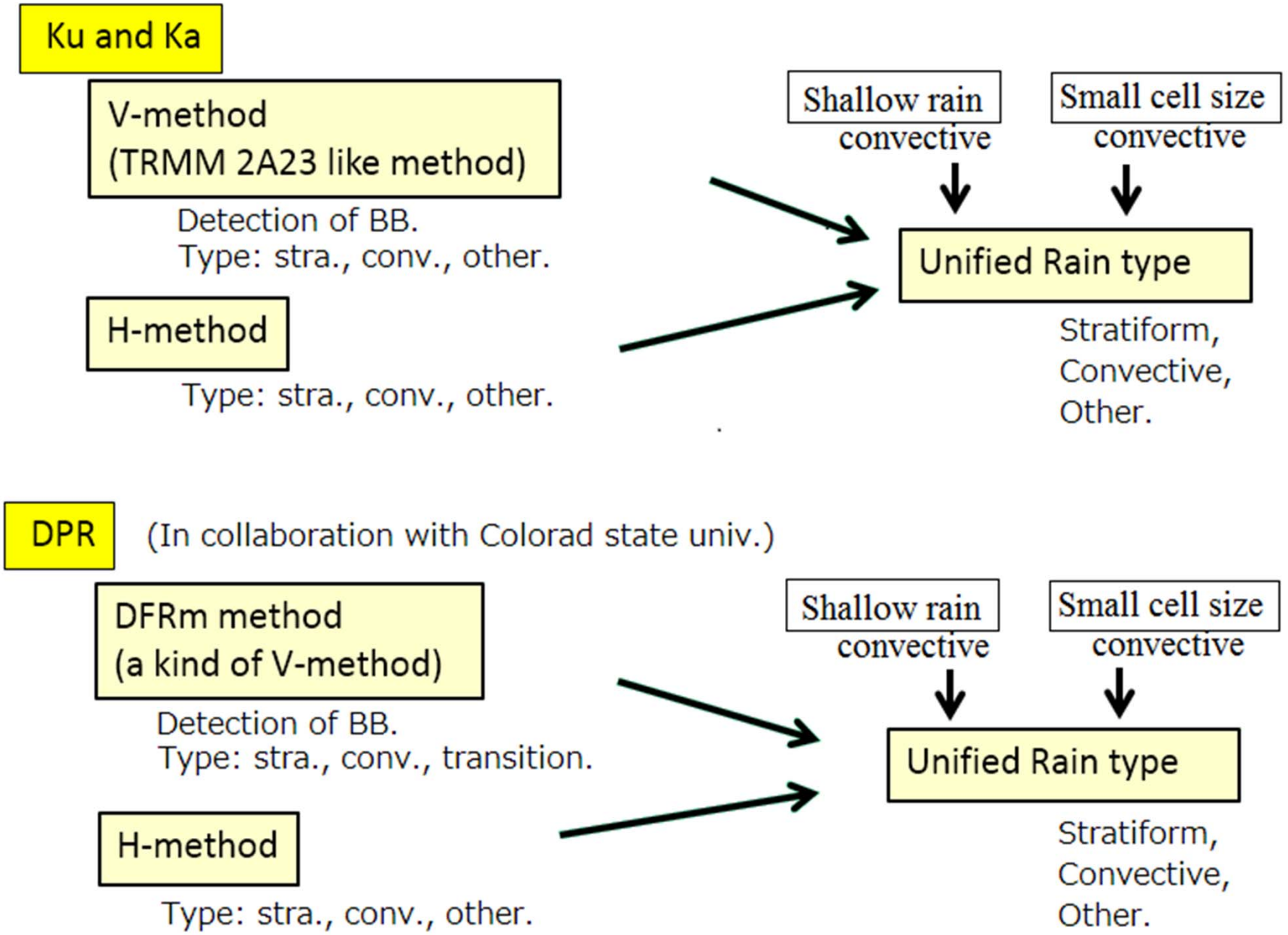
(From Prof. Chandra's materials on DFRm)

DFRm method is also used for HS data

Corresponding Ku data is the average of Ku power in pixels B1,B2, B3, & B4.

Effect of bias has been examined by Dr. Minda Le, CSU.

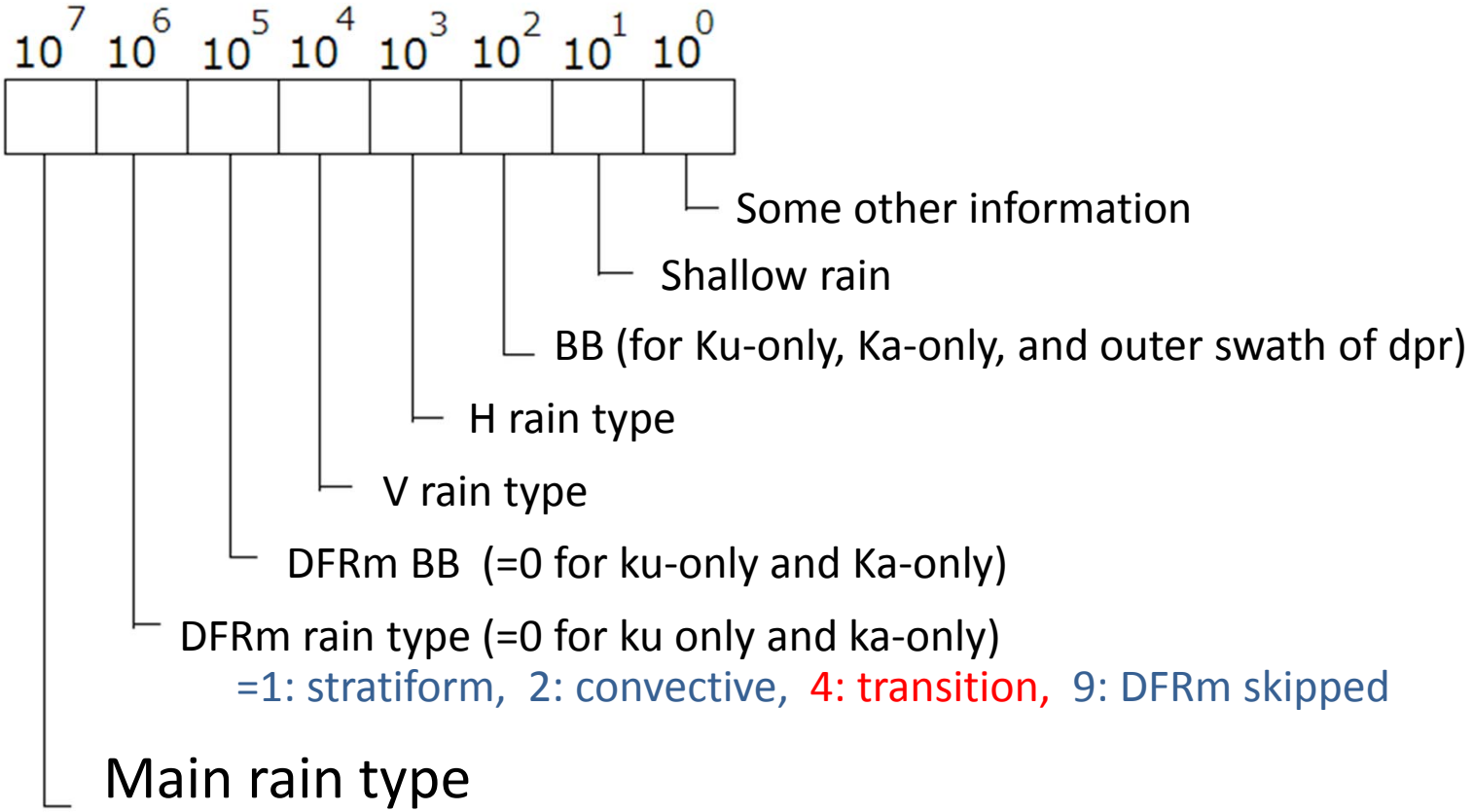



Ku and Ka
V-method
(TRMM 2A23 like method)
Detection of BB.
Type: stra., conv., other.
H-method
Type: stra., conv., other.
Shallow rain
convective
Small cell size
convective
Unified Rain type
Stratiform,
Convective,
Other.
DPR
(In collaboration with Colorad state univ.)
DFRm method
(a kind of V-method)
Detection of BB.
Type: stra., conv., transition.
H-method
Type: stra., conv., other.
Shallow rain
convective
Small cell size
convective
Unified Rain type
Stratiform,
Convective,
Other.

Rain type numbering (GPM DPR-L2)

TRMM 2A23
3 digit

GPM DPR-L2
8 digit



Current rain type numbering (tentative)

DPR inner swath, for example

Stratiform

- 11B0H0xy
- 14B01000
- 19001000
- 19011000
- 19013000
- 19031000

Convective

- 2100H0xy
- 2110H00y
- 2200H0xy
- 2210H00y
- 2400H0xy
- 2410H00y
- 290020xy
- 2901H0xy
- 2902H0xy
- 290310xy
- 290320xy

Other

- 340030xy
- 390030xy
- 390330xy

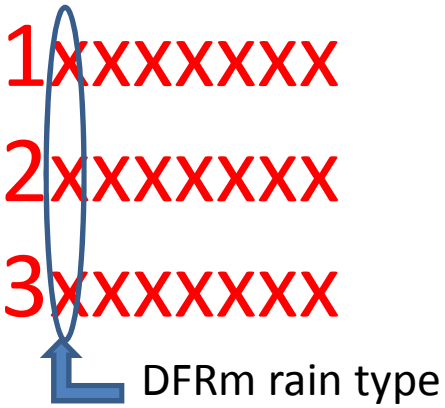
B = 0: BB not detected by DFRm method,
1: BB detected by DFRm methd.

H = 1: stratiform by H-method,
2: convective by H-method,
3: other by H-method.

x = 0: No shallow rain,
1: Shallow isolated,
3: Shallow non-isolated.

y = 0: No small size cell,
1: Single cell,
2: Small size cell consisting of two adjacent pixels.

Main rain type



stratiform

convective

other --- cloud only or noise

DFRm rain type takes the following 4 values:

1: stratiform,

2: convective,

4: transition,

9: DFRm method not applicable.

When DFRm rain type is 4 or 9, the main rain type is again stratiform, convective or other.

TRMM 2A23 V7

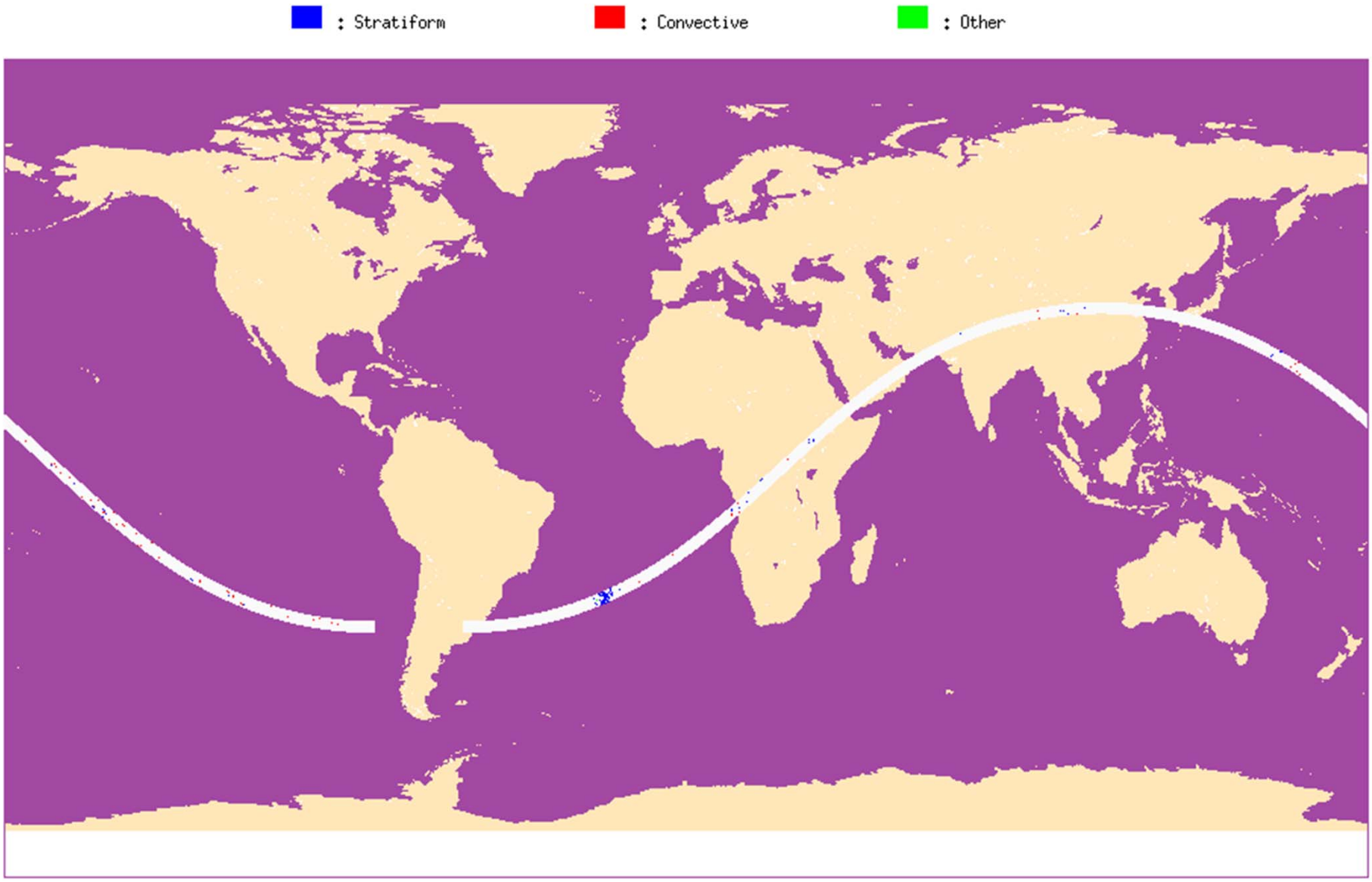
Shallow isolated – convective

Shallow non-isolated – convective or stratiform

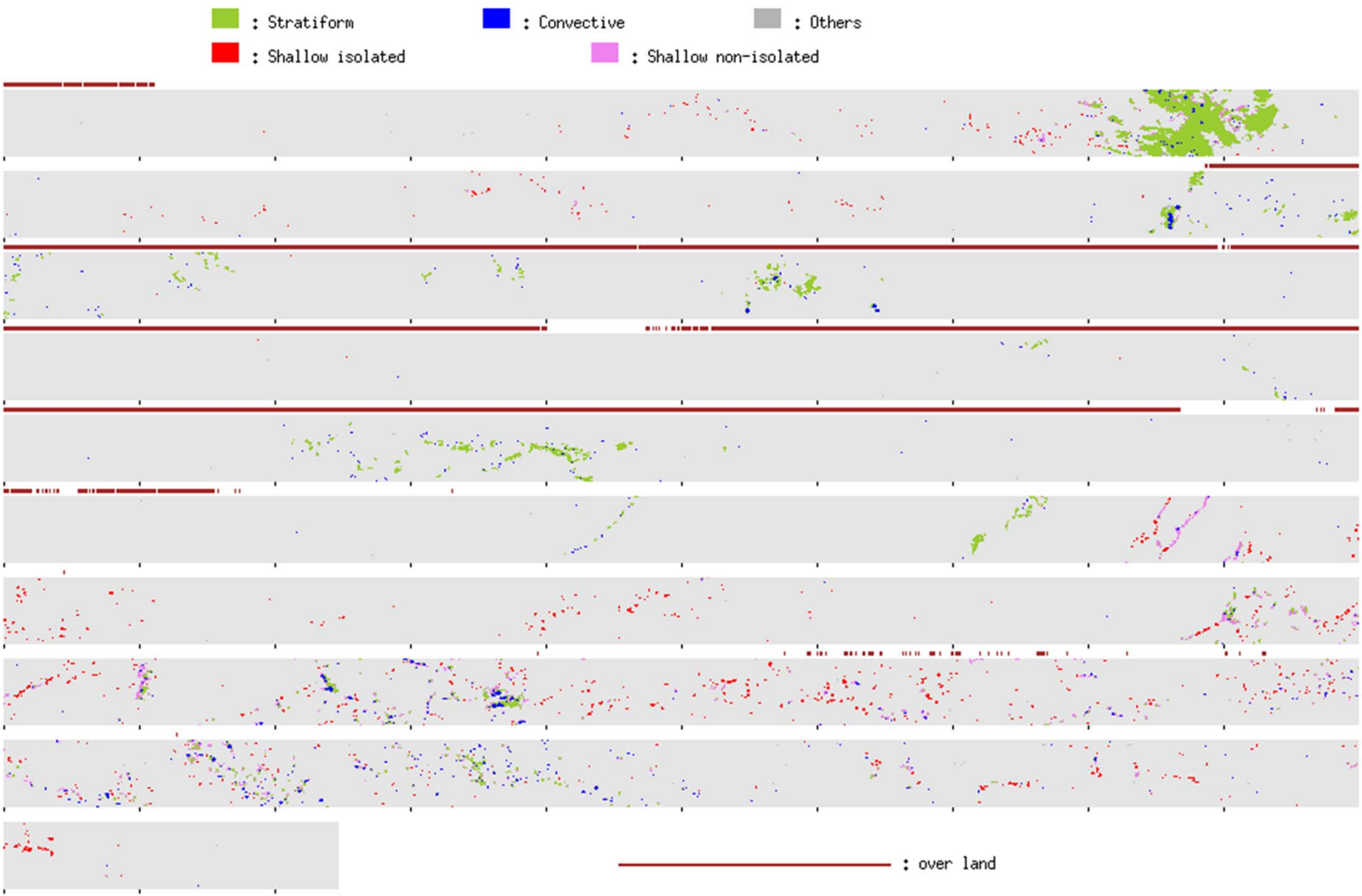
DPR L2

Shallow isolated – convective

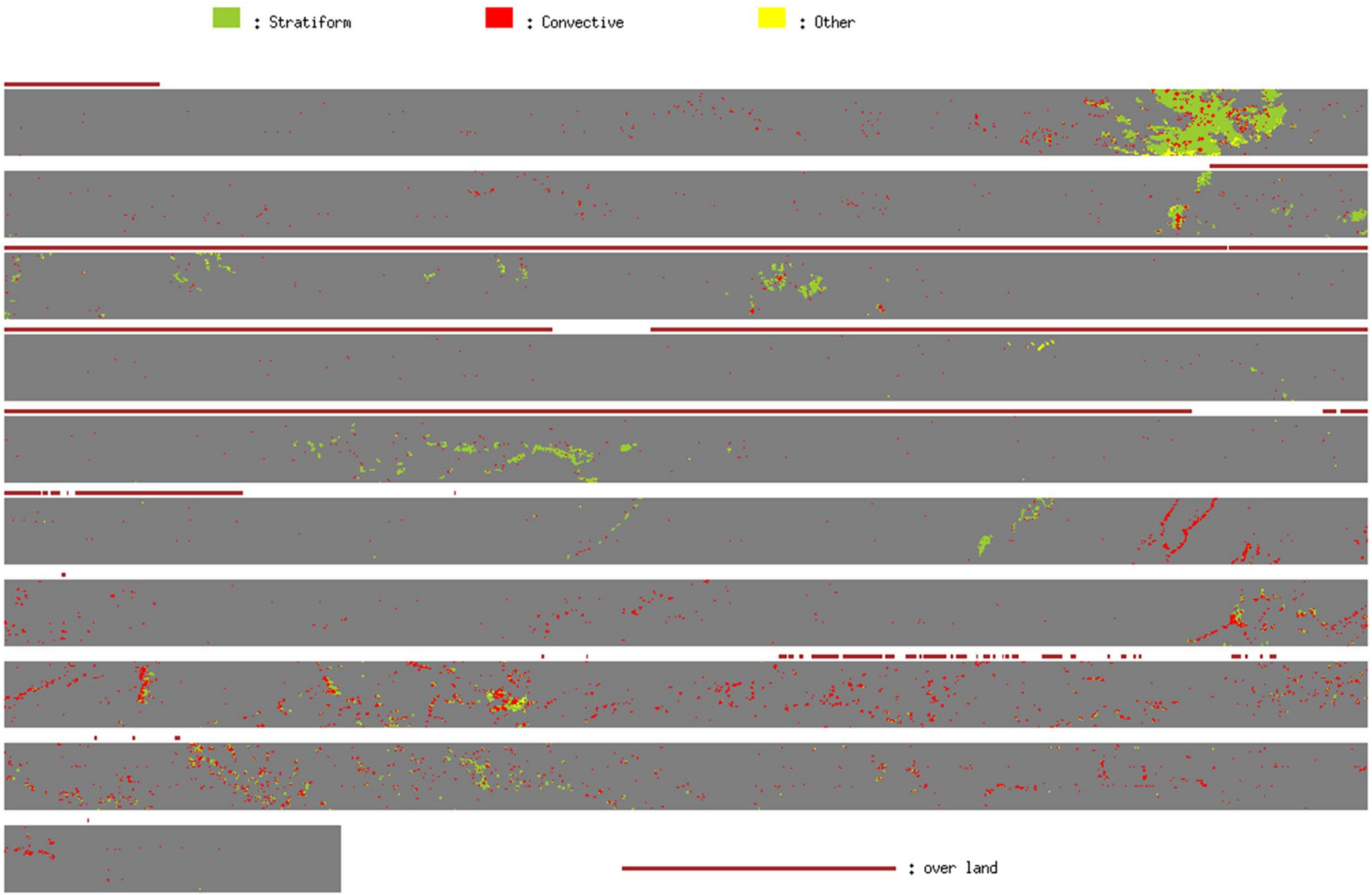
Shallow non-isolated – convective



2A23 V7 Orbit No. 76176



TRMM 2A23 V7 Orbit No. 76176



Ku only (Synthetic data) Orbit No. 76176

DPR inner swath (Synthetic data) Orbit No. 76176

Advantage of DPR

CSF

- Detection of strong convective becomes easy
  - Strong ATT can be observed at Ka data.
- Decrease false detection of BB
  - We can distinguish between real BB peak and false BB peak, the latter of which occurs due to a large ATT.
- Detection of shallow rain becomes reliable
  - Storm top becomes reliable by the use of Ku and Ka data.

PRE

- Can improve determination of clutterFreeBottom

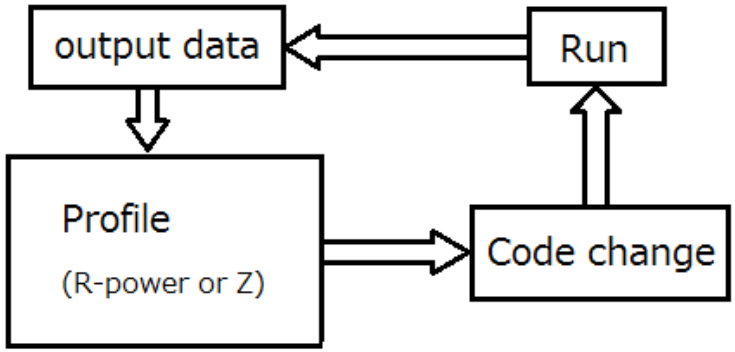
PRE module

- Surface peak
- Mainlobe clutter
- Sidelobe clutter

binClutterFreeBottom

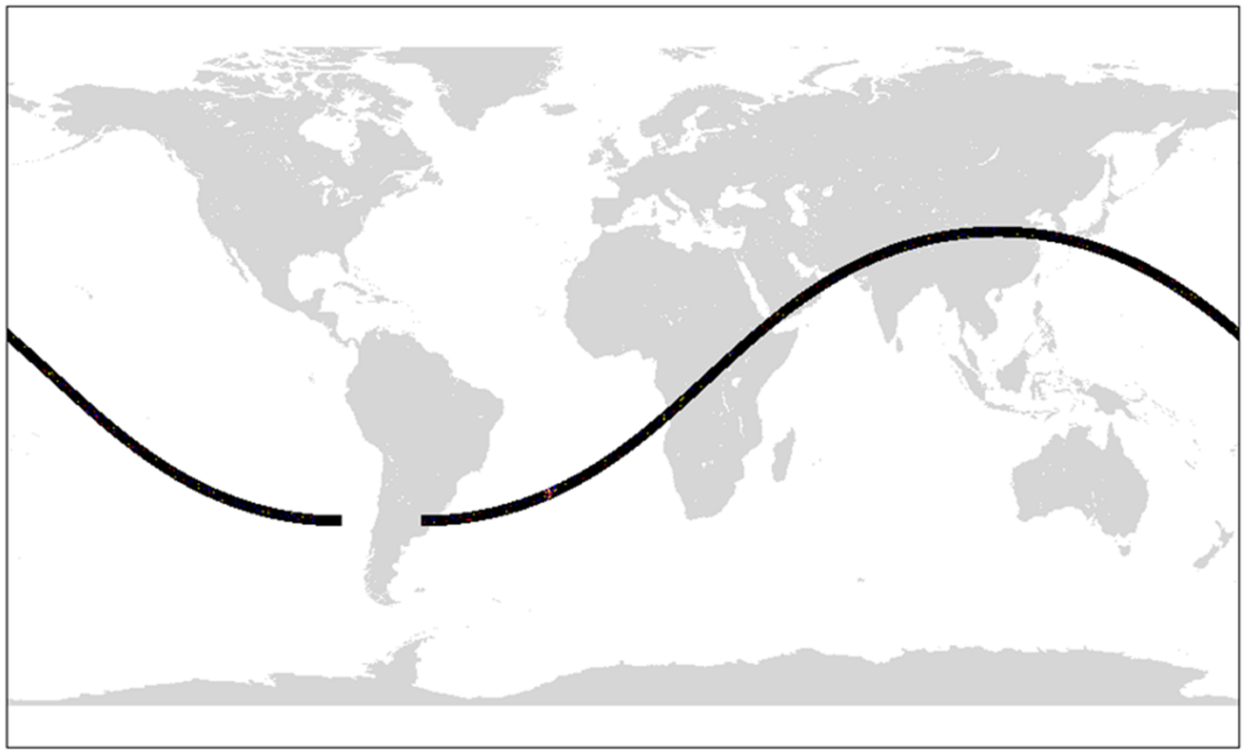
- Rain no-rain
- Land surface type
- Sigma 0

Mainlobe clutter code in PRE module

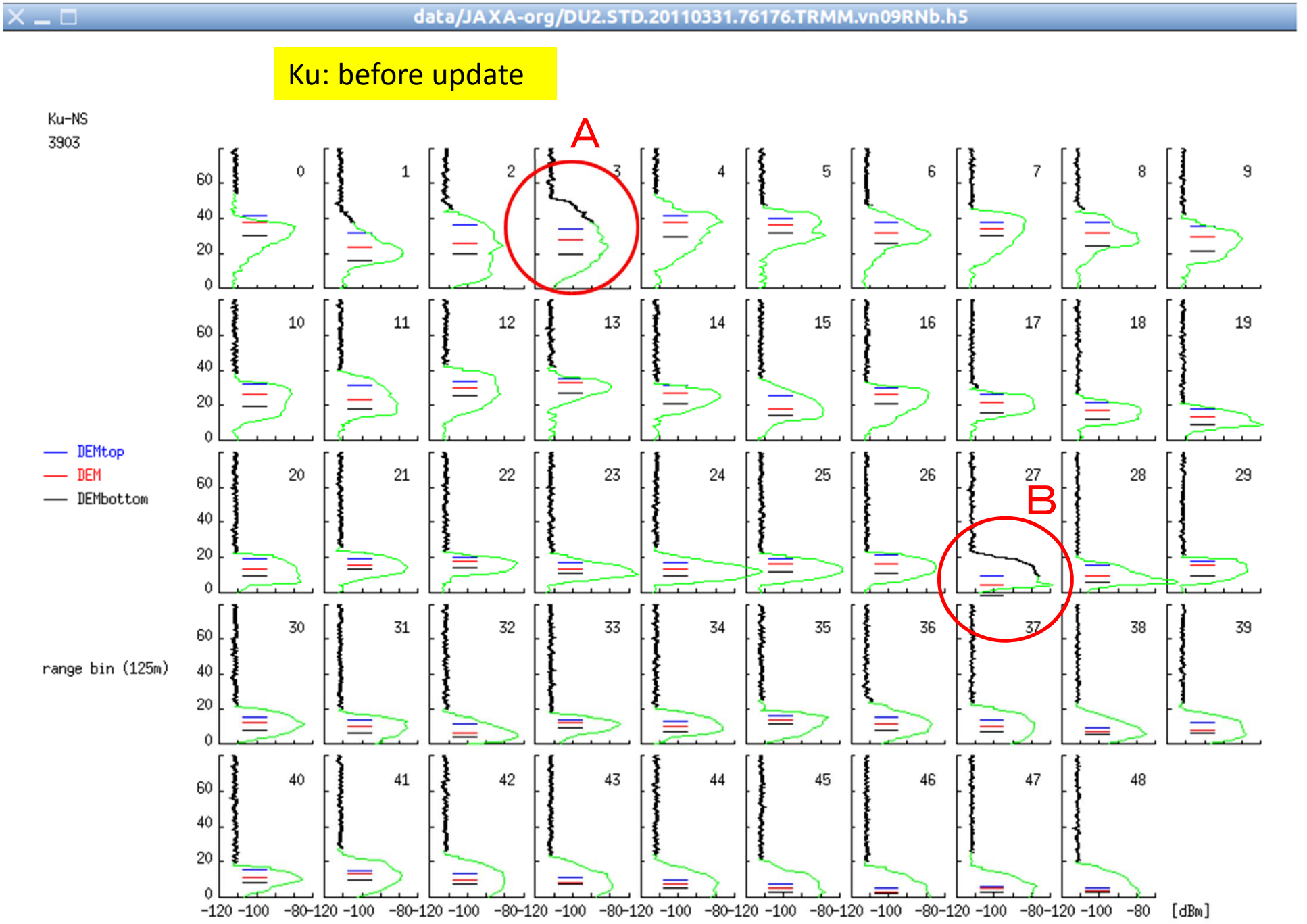


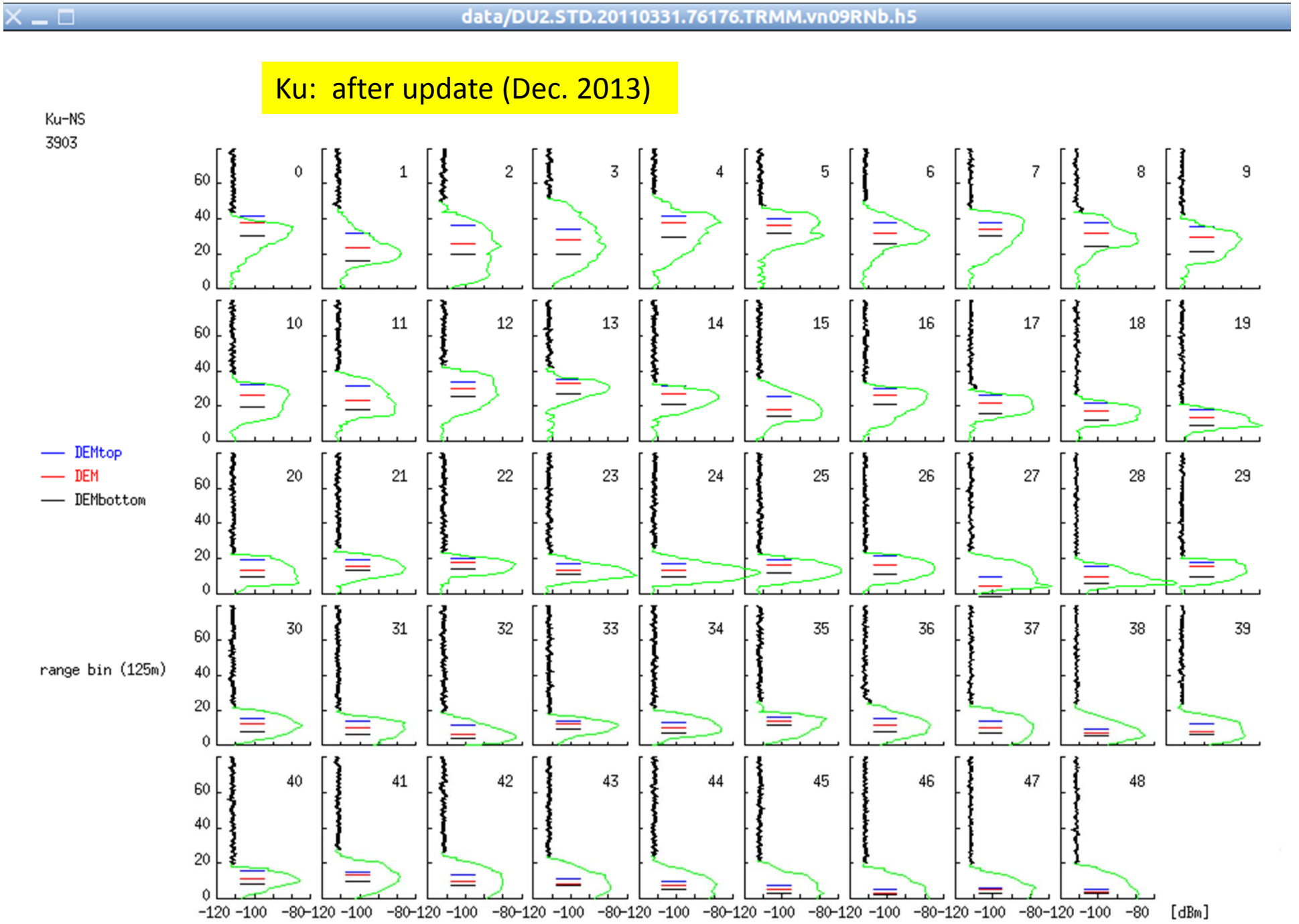
DEM:

SRTM30



76176 orbit


data/JAXA-org/DU2.STD.20110331.76176.TRMM.vn09RNb.h5
Ku: before update
Ku-NS
3903
A
B
DEMtop
DEM
DEMbottom
range bin (125m)
0 1 2 3 4 5 6 7 8 9
10 11 12 13 14 15 16 17 18 19
20 21 22 23 24 25 26 27 28 29
30 31 32 33 34 35 36 37 38 39
40 41 42 43 44 45 46 47 48
0 20 40 60
-120 -100 -80 [dBm]


data/DU2.STD.20110331.76176.TRMM.vn09RNb.h5
Ku: after update (Dec. 2013)
Ku-NS
3903
DEMtop
DEM
DEMbottom
range bin (125m)
0 1 2 3 4 5 6 7 8 9
10 11 12 13 14 15 16 17 18 19
20 21 22 23 24 25 26 27 28 29
30 31 32 33 34 35 36 37 38 39
40 41 42 43 44 45 46 47 48
0 20 40 60
-120 -100 -80
[dBm]

Mainlobe clutter code in PRE module

Current Status (December code)

Bad judgment for Ku data is decreased greatly.

Outer swath: bug – fixed.

Bad DEM case is rectified by examining the surrounding data.

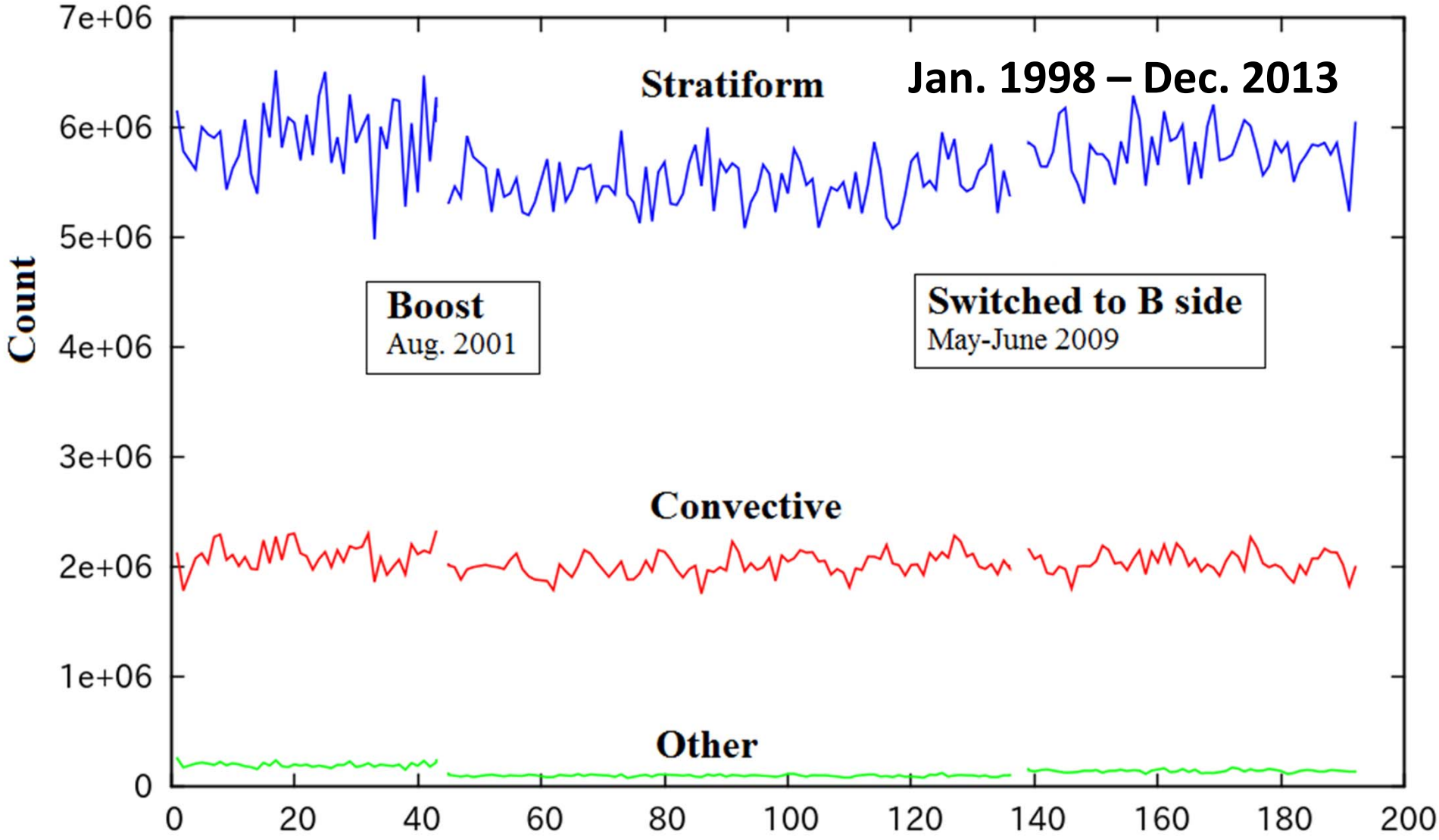
Bad judgment for Ka data is also decreased to a large extent.

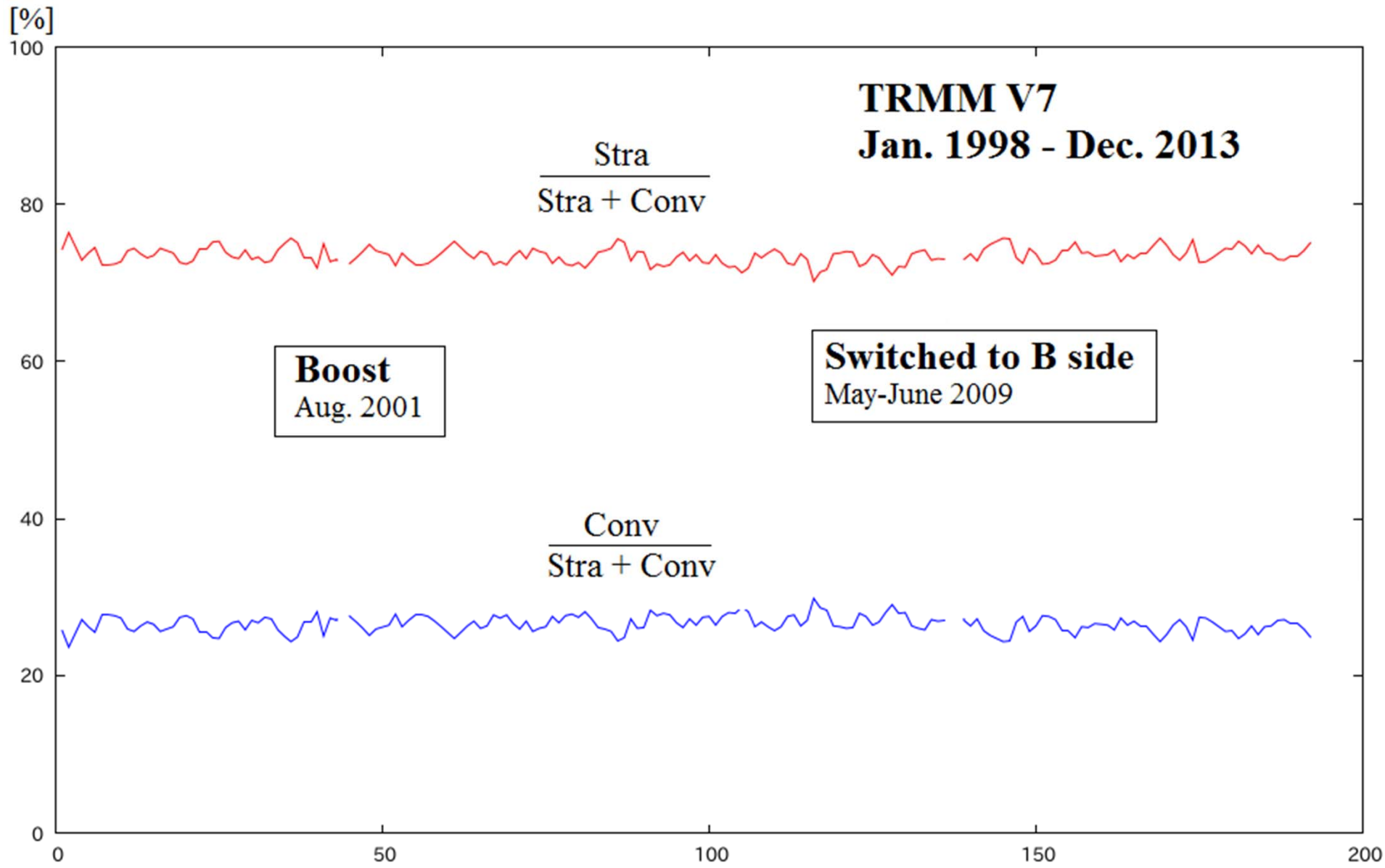
Handling of large ATT case was inappropriate – fixed.

However, further improvement is needed.

TRMM PR algorithm

Maintenance of rain type classification algorithm 2A23 has been made using a monthly statistics prepared by EORC.


Stratiform
Jan. 1998 – Dec. 2013
Boost
Aug. 2001
Switched to B side
May-June 2009
Convective
Other
Count
7e+06
6e+06
5e+06
4e+06
3e+06
2e+06
1e+06
0
0
20
40
60
80
100
120
140
160
180
200
Month relative to the launch of TRMM


[%]
100
80
60
40
20
0
0
50
100
150
200
TRMM V7
Jan. 1998 - Dec. 2013
Stra
Stra + Conv
Boost
Aug. 2001
Switched to B side
May-June 2009
Conv
Stra + Conv
Month relative to the launch of TRMM

- Parameter tuning and necessary change of code will be made using actual data after the launch of GPM.
- Maintenance of TRMM 2A23 is to be continued.