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

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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

Input Module

PRE (Preparation) Module

VER (Vertical Profile) Module

CSF (Classification) Module

DSD Module

SRT Module

SLV (Solver) Module

Output Module

Ku algorithm
Ka algorithm
DPR algorithm

These have similar module structures.
Input/Output (GPM DPR L2)

Ku only

L1 Ku out

L2 Ku algorithm

L2 Ku out

STD
TMP (L1 info.)
ENV

Ka only

L1 Ka out

L2 Ka algorithm

L2 Ka out

STD
TMP (L1 info.)
ENV

DPR

L2 Ku out

STD
TMP (L1 info.)
ENV

L2 Ka out

STD
TMP (L1 info.)
ENV

L2 DPR out

STD
TMP
ENV
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,

\[ \text{DFRm} = Z_{m(Ku)} - Z_{m(Ka)} \]

- **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.

![Diagram with decision tree and flowchart]

- Yes
  - Pair exist?
    - Yes
      - Calculate DFRm slope between the bin with DFRm (min) value and 1st clutter free bin
      - \[ V_2 = \text{abs} \left( \text{mean} \left( DFR_m \text{ (slope)} \right) \right) \]
    - No
      - Convective

- No
  - V3>C2: Stratiform
  - V3<C1: Convective
  - C1<=V3<=C2: Transition

Detection of BB

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.

DPR
(In collaboration with Colorado State Univ.)

DFRm method
(a kind of V-method)
Detection of BB.
Type: stra., conv., transition.

H-method
Type: stra., conv., other.

Unified Rain type
Stratiform, Convective, 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

Some other information

Shallow rain
BB (for Ku-only, Ka-only, and outer swath of dpr)

H rain type

V rain type

DFRm BB (=0 for Ku-only and Ka-only)

DFRm rain type (=0 for Ku only and ka-only)
=1: stratiform, 2: convective, 4: transition, 9: DFRm skipped

Main rain type
=1: stratiform, 2: convective, 3: other
Current rain type numbering (tentative)

**DPR inner swath, for example**

<table>
<thead>
<tr>
<th>Stratiform</th>
<th>Convective</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>11B0H0xy</td>
<td>2100H0xy</td>
<td>340030xy</td>
</tr>
<tr>
<td>14B01000</td>
<td>2110H00y</td>
<td>390030xy</td>
</tr>
<tr>
<td>19001000</td>
<td>2200H0xy</td>
<td>390330xy</td>
</tr>
<tr>
<td>19011000</td>
<td>2210H00y</td>
<td></td>
</tr>
<tr>
<td>19013000</td>
<td>2400H0xy</td>
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<tr>
<td>19031000</td>
<td>2410H00y</td>
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<tr>
<td></td>
<td>290020xy</td>
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<tr>
<td></td>
<td>2901H0xy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2902H0xy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>290310xy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>290320xy</td>
<td></td>
</tr>
</tbody>
</table>

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

- 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

1xxxxxxx  stratiform
2xxxxxxx  convective
3xxxxxxx  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
TRMM 2A23 V7  Orbit No. 76176
Ku only (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
- Rain no-rain
- Land surface type
- Sigma 0

binClutterFreeBottom
Mainlobe clutter code in PRE module

DEM: SRTM30

76176 orbit
Ku: before update

A

B
Ku: after update (Dec. 2013)
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.
Month relative to the launch of TRMM


Stratiform

Boost
Aug. 2001

Switched to B side
May-June 2009

Convective

Other

Month relative to the launch of TRMM
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.