Detection of Rapidly Developing Cumulus Areas from MTSAT-1R Short-Time Interval Images

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1. Introduction-1

Rapidly Developing Cumulus Areas (RDCA)

MTSAT-1R Rapid Scan observation
- 5-minute interval
- Available in daytime of summer

Example of RDCA (prototype)
- Mainly to capture airmass thunderstorms
- For aviation
- Service will start in 2012
What does MTSAT-1R observe for nowcasting?

**Visible (VIS)**
- Cloud optical thickness

**Infrared**
- Cloud top temperature (10.8μm)
- Water vapor on upper level (6.8μm)
- Solar radiation reflected by cloud (3.8μm)
3. Concept of RDCA

10.8μm BT*: Low
VISR*: High

10.8μm BT: High
VIS: Low

Lift of Cloud top

5 minutes

Roughness in a cluster

* BT: Brightness Temperature  VISR: Reflectance
4. Time sequence of some parameters

12 convective clusters with lightening strokes (9 to 12 July 2011)
## 5. Parameter list on RDCA

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameters</th>
<th>Main objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VISR</td>
<td>To detect optical thick cloud (mainly for <em>Pre-detection)</em></td>
</tr>
<tr>
<td>2</td>
<td>Difference between maximum and minimum of VISR</td>
<td>To detect a roughness in developing cloud</td>
</tr>
<tr>
<td>3</td>
<td>Standard deviation of VISR</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Difference between maximum and minimum of 10.8μm BT</td>
<td>To exclude optically thin cloud (cirrus) (mainly for Pre-detection)</td>
</tr>
<tr>
<td>5</td>
<td>Standard deviation of 10.8μm BT</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Difference between 10.8μm and 12μm BT</td>
<td>To detect the potential to develop</td>
</tr>
<tr>
<td>7</td>
<td>Difference between 6.8μm and 10.8μm BT</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Slope index (relation between 10.8μm BT and effective radius of cloud top estimated from 3.8μm)</td>
<td>To evaluate cloud microphysical structure</td>
</tr>
<tr>
<td>9</td>
<td>Time differential of maximum of VISR</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Time differential of averaged VISR</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Time differential of minimum of 10.8μm BT</td>
<td>To evaluate vertically developing trend of developing cloud</td>
</tr>
<tr>
<td>12</td>
<td>Time differential of averaged 10.8μm BT</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Pinpoint fall down of 10.8μm BT</td>
<td></td>
</tr>
</tbody>
</table>

* Pre-Detection: To extract candidates of cloud

### Non-time-trend parameters
- Diagnostic parameters based on a single image

### Time-trend parameters
- Variance in 5 minutes
- Cloud motion is considered

Motion Vectors
6. Parameter’s sensitivity and index

Parameter value and probability of strokes

- VISR: Minimum-Mean (Par-2)
- 10.8μm BT: Standard deviation (Par-5)
- 10.8μm BT: Time trend of Mean (Par-12)

Logistic regression model

\[ p = \frac{1}{1 + \exp\left(-\left(a_0 + \sum a_i x_i\right)\right)} \]

**X\_i**: Effective parameter values

New Index (Predicted Probability)

Comparison with actual probability

- Actual Probability
- Index (Predicted Probability)
7. Example of RDCA

MTSAT-1R image and probability at 13:20 JST, 11 July 2011

Rain Radar charts

Effective for RDCA

Lightening strokes
8. Summary and issues

- Introduction of detection parameters using MTSAT-1R Visible and Infrared channels.
- Parameters have sensitivity for thunderstorms.
- Index based on detection parameters is effective to capture clouds at early developing stage.

**Issues in the future**

- Introduction of other effective parameters
- Investigation of method to treat parameters
- Consideration of method to validate
- Preparation for next generation satellite
Thank you for your attention.