Cirrus cloud observed from Himawar-8
T. Inoue, H. Ishimoto, M. Hayashi, Y. Hagihara

Cirrus cloud and BTD (Brightness Temperature Difference) of AHI (Advanced Himawari Imager)
Evolution of deep convection and BTD

Cirrus cloud optical parameters derived from OCA (Optimal Cloud Analysis)
Diurnal variation of cirrus cloud in OCA
Thin and high cloud represented by NICAM and OCA
Simulated BTD for AHI

T10-T12 indicates larger BTD

Cirrus at 12km height
Standard Atmosphere
Tropics
EFR 30µm
TAU 0.1-10

Ishimoto (2012)

Voronoi Aggregate

Solid column
Simulated BTD for AHI

T86-T12 indicates larger BTD as well
BTD and VIS,IR Images

T10-T12

T10-T11
BTD Images

T10-T12

T10-T11

T11-T12

T86-T12
RGB Composite and CALIOP

R:IR  G:T10-T12  B:T86-T12

(After CALIPSO WEB SITE)
BTD and CALIOP
BTD for CALIOP signal seen at higher than 8km

T10-T12 indicates larger BTD even for 280K<
Evolution of Deep Convection and BTD

Developing stage: T86-T12 is small. Decaying stage: T86-T12 becomes larger for cloud colder than 253K.

00 UTC 0727,2016
02 UTC 0727,2016
04 UTC 0727,2016
06 UTC 0727,2016
Himawari-8 Optimal Cloud Analysis (OCA)

**Inputs of OCA**
- Himawari-8 Satellite Imageries for all bands
- JMA Cloud Mask product for Himawari-8
- Surface radiative properties from MODIS products
  - Surface Reflectivity
  - Surface Emissivity
- JMA Operational NWP model data
- Cloud Radiative properties LUTs computed by DISORT
  - Water Cloud
  - Ice Cloud

**Outputs of OCA**
- Cloud Optical Thickness
- Cloud Effective Radius
- Cloud Phase
- Cloud Top Pressure
- Surface Temperature

Hayashi is developing the OCA Collaborating with EUMETSAT

Based on Watts et al. (1998), EUMETSAT (2011)

Ice crystal shape is assumed as Voronoi aggregate. Its single scattering properties are computed at MRI/JMA (Ishimoto et al. 2012, JQSRT, 113)
# Bands of AHI

## Himawari-8/-9 Imager bands (AHI)

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<th>Himawari-8/9</th>
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- **OCA VIS+IR**
- **OCA IR**
Analysis Area: 20S-40N: 115E-170W Period: July 2016, hourly
Difference between VIS+IR and IR (COD)

Difference is larger for thicker cloud
OCA (CTP)

Shallow cloud is not good in IR version

VIS+IR

IR
Diurnal Variation of High Cloud

Afternoon Peak for cirrus
Early morning peak for DC

Cirrus Number

Cirrus COD

High Cloud

Cirrus COD
Diurnal Variation of High Cloud

Effective Radius Peak of Cirrus is afternoon
Eddective radius Peak of DC is noon

COD-REF-Number
Vertical Profile of Thin Cloud

NICAM Cloud on ISCCP diagram

(a) annual mean 1984–2003 (tropical)

Cloud Top Pressure [hPa]

Cloud Optical Depth

Visible Cloud Fraction: 59.38 %

ISCCP v.s. NICAM tropical

Cloud Top Pressure [hPa]

ISCCP 1984–2003 tau > 1.3
ISCCP 1984–2003 tau > 0.3
NICAM amip 3day tau > 1.3
NICAM amip 3day tau > 0.3

Number of Pixel

(20S-30N:115E-170W, July 2016)
Both T10-T12 and T86-T12 are good indicators for detecting cirrus cloud.

Life stage of deep convection can be identified by T86-T12.

Diurnal variation of cirrus cloud is shown in OCA.

Diurnal variation of COD and REF of cirrus is shown in OCA.

Optically thin high cloud is less in OCA than NICAM simulation.
Thank you for your patience.

Goal is a long way to go.
ISCCP CLOUD CLASSIFICATION

CLOUD TOP PRESSURE (MB)

CLOUD OPTICAL THICKNESS

- CIRRUS
- CIRROSTRATUS
- DEEP CONVECTION
- HIGH

- ALTOCUMULUS
- ALTOSTRATUS
- NIMBOSTRATUS
- MIDDLE

- CUMULUS
- STRATOCUMULUS
- STRATUS
- LOW

0 1.3 3.6 9.4 23 60 379
RGB Composite and CALIOP
Characteristics of Deep Convection in terms of Lifecycle

Rainfall rate is higher at developing stage.