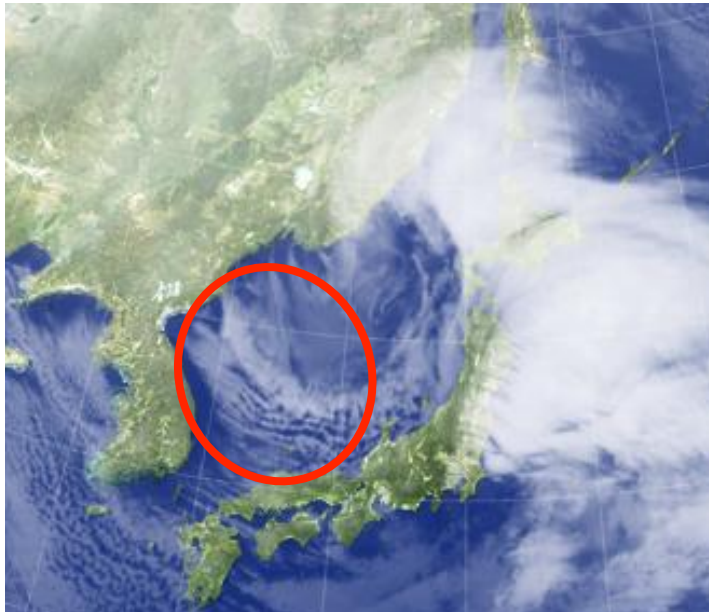
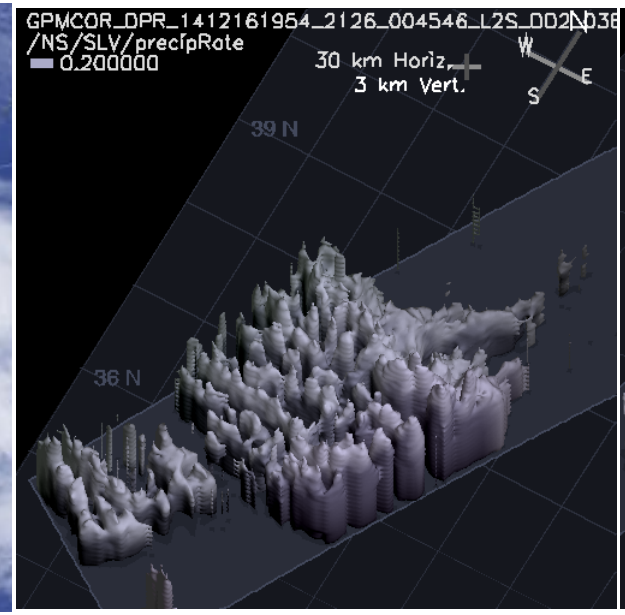
JAXA GPM Science Status

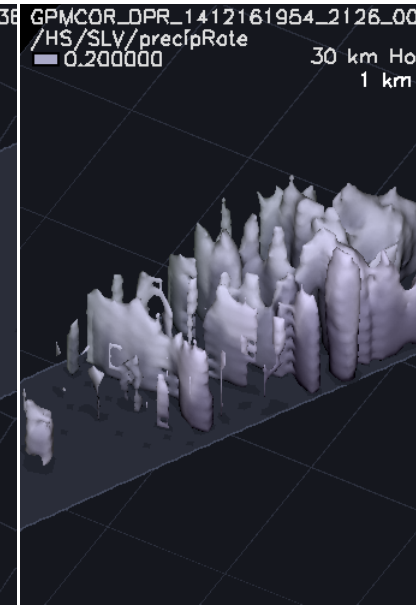
Yukari N. Takayabu
AORI, University of Tokyo
JAXA GPM Project Scientist

ea Polar airmass
gence Zone)

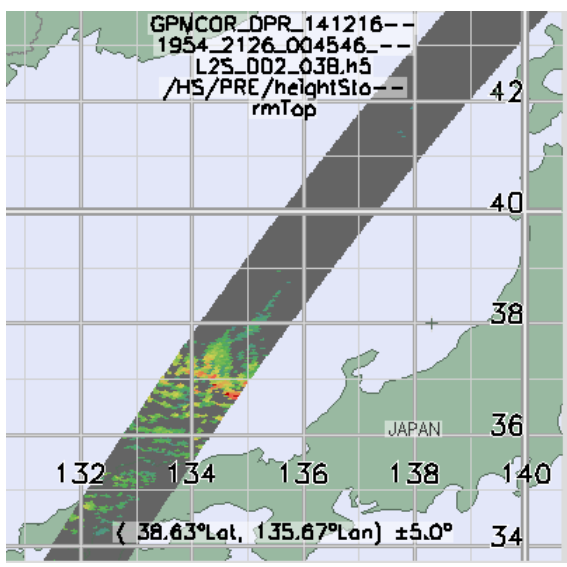
sunaga

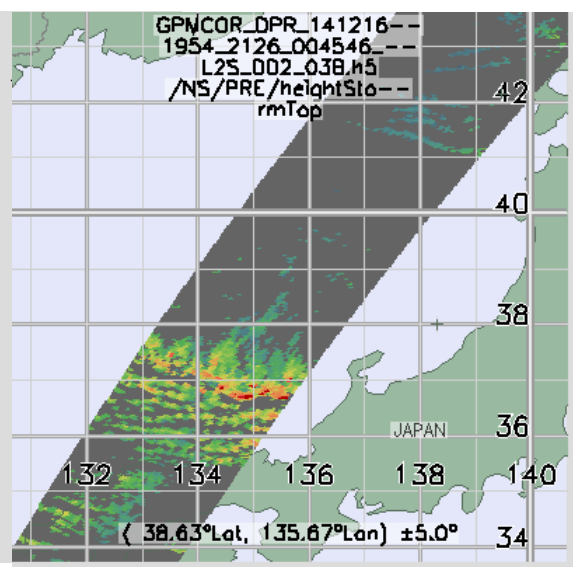


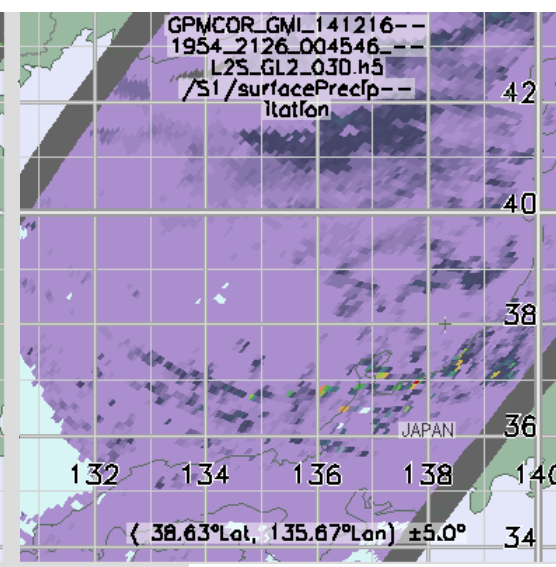




Making use of GPM datasets, the development of snow-clouds in JPCZ is investigated. The most intensive precipitation in this case found at the northern edge of the observed JPCZ.



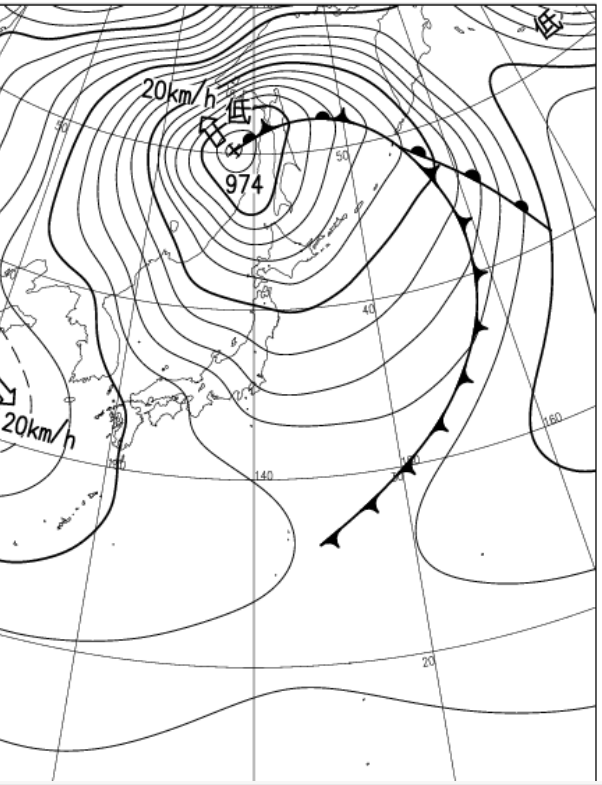


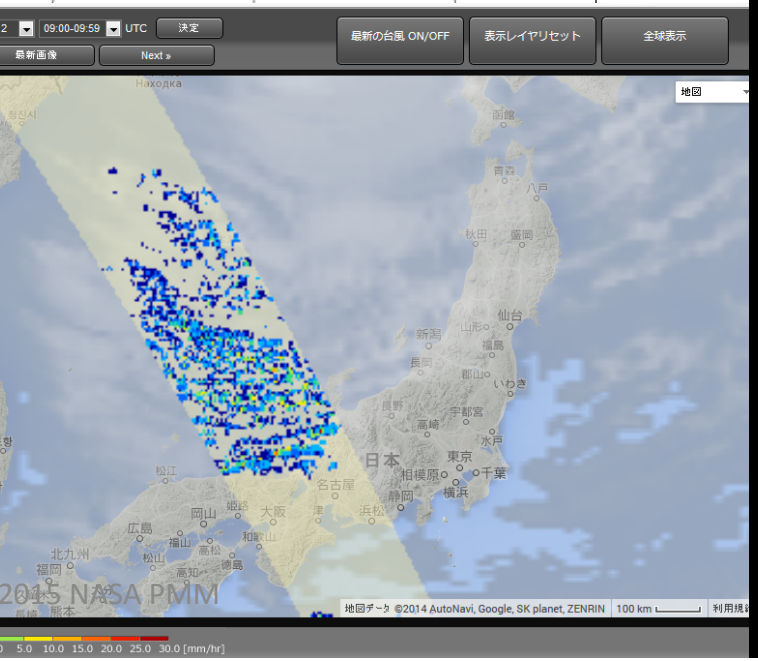


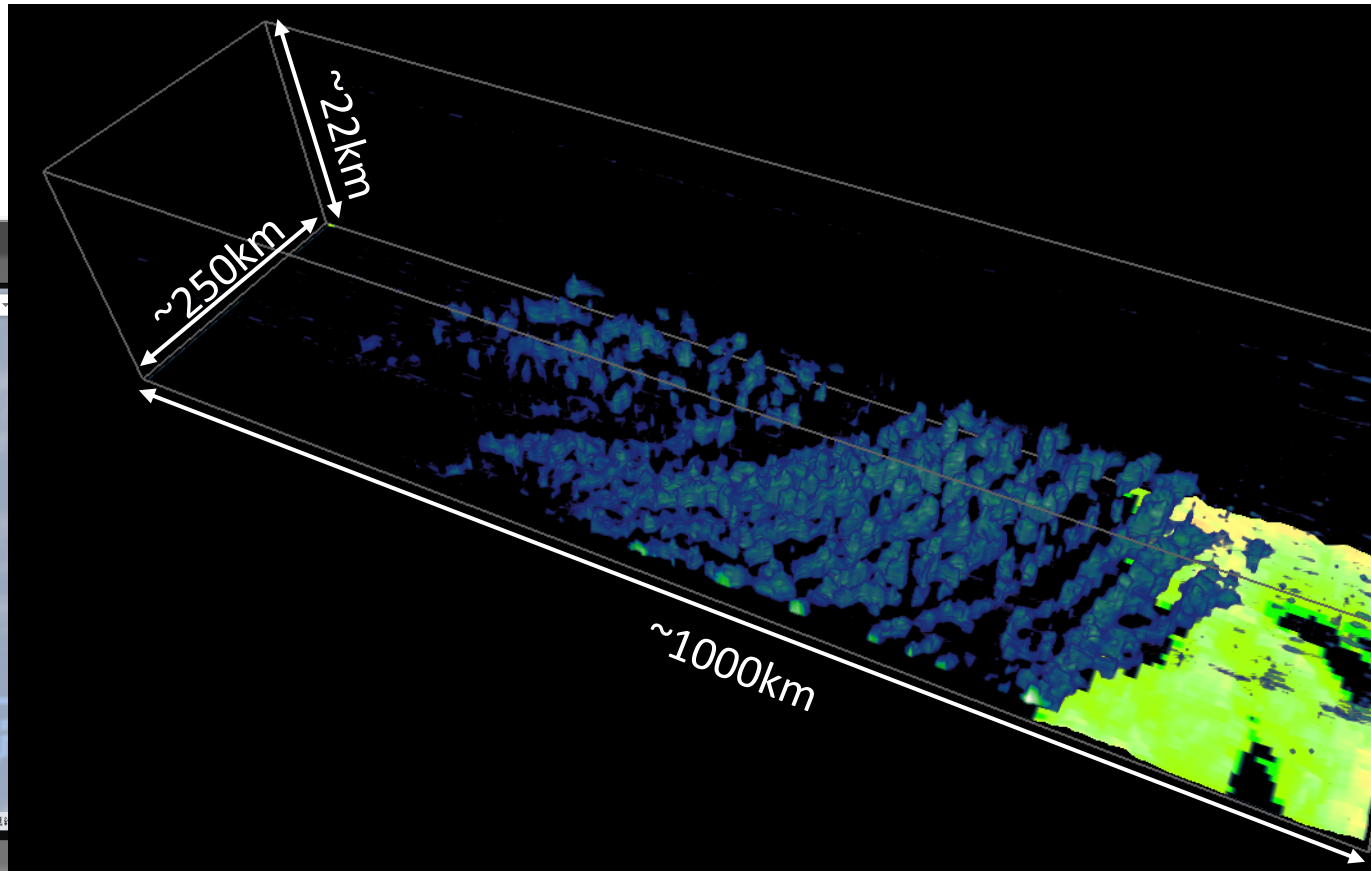
Cold Air Outbreaks Over Warm Water: DPR

2014/12/02 09:55Z

by Takayabu and Hamada

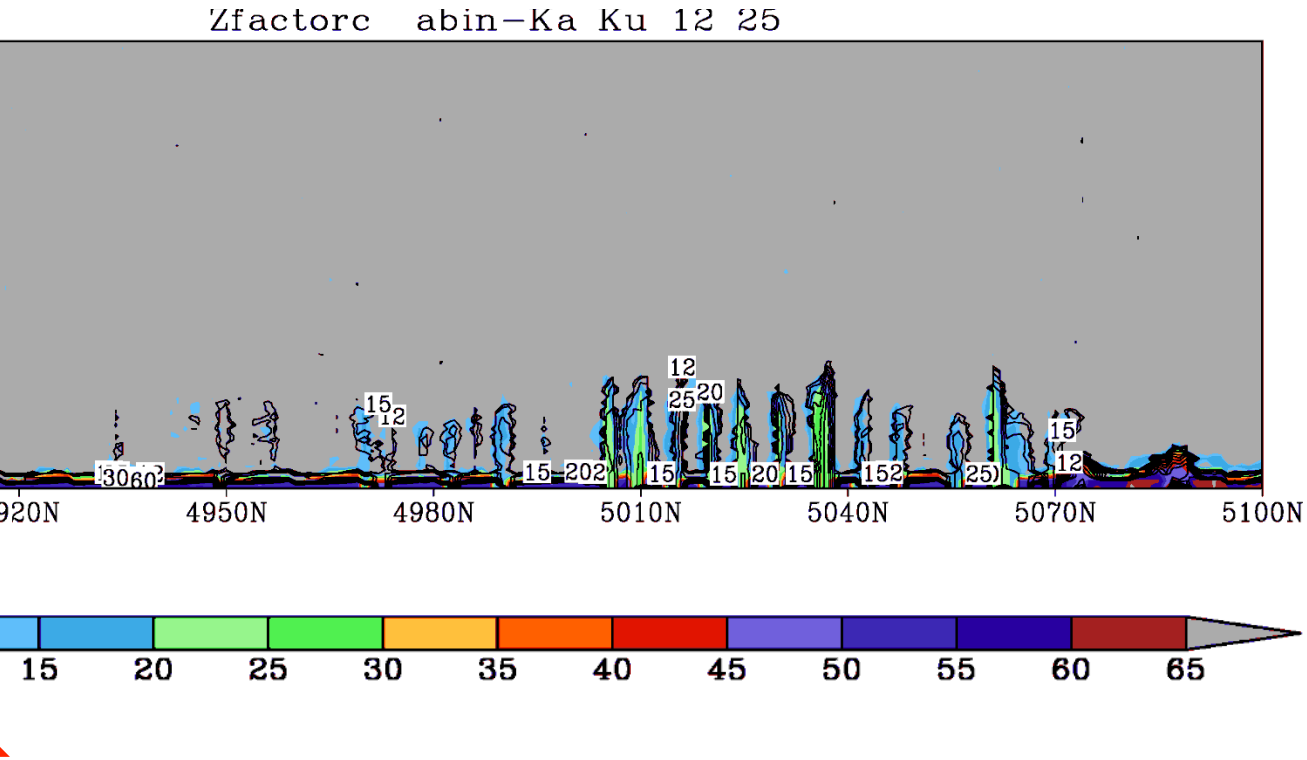


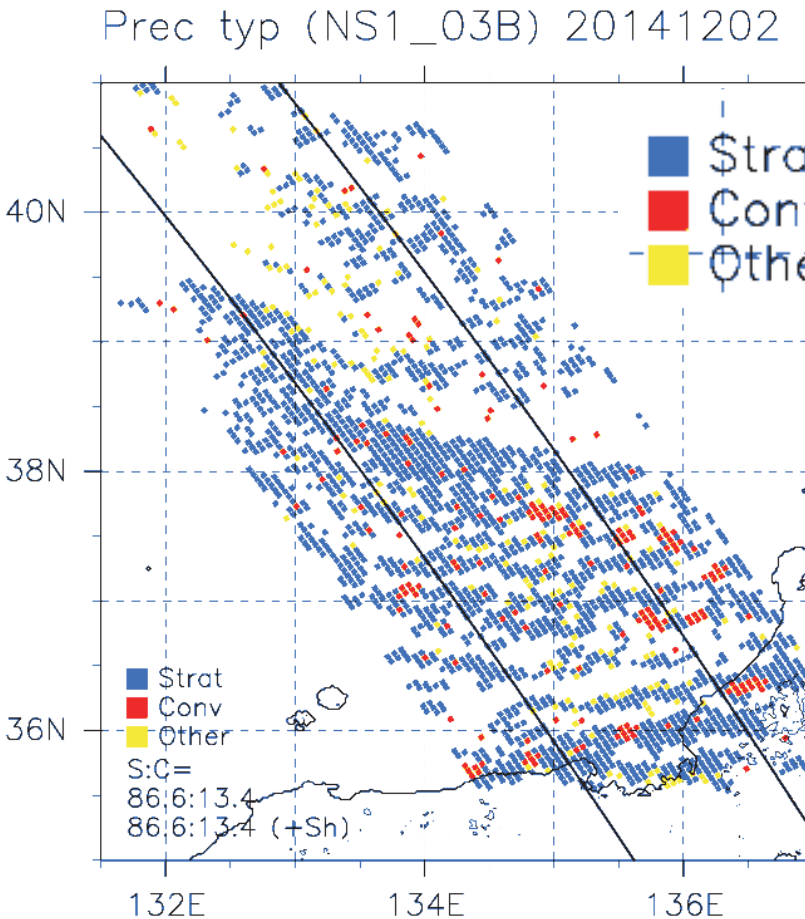




long-track cross section and precipitation type

Corrected Ze at Nadir





s like this, but the precipitation is mostly classified as stratiform wth current V03B.
reported to Dr. Awaka for an examination of the precip. type classification.

COMPARISONS WITH TRMM PR

Vertical Distributions of Precipitation (Hirose 2015)

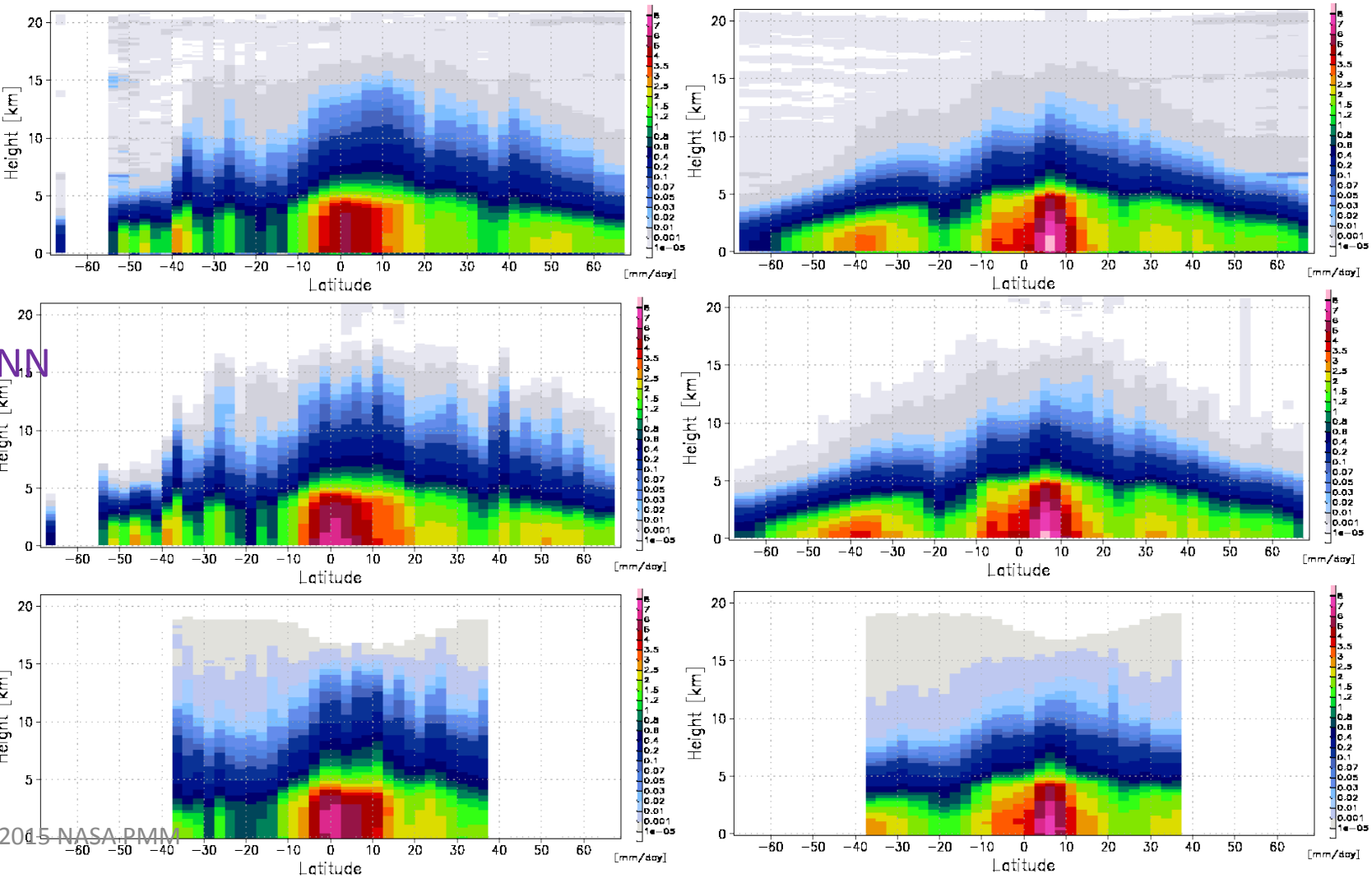
Height Section of Precipitation

NN: Near-nadir data: 6 bins, 22-24th & 26-28th

2014/4-8

Land | Ocean

NN

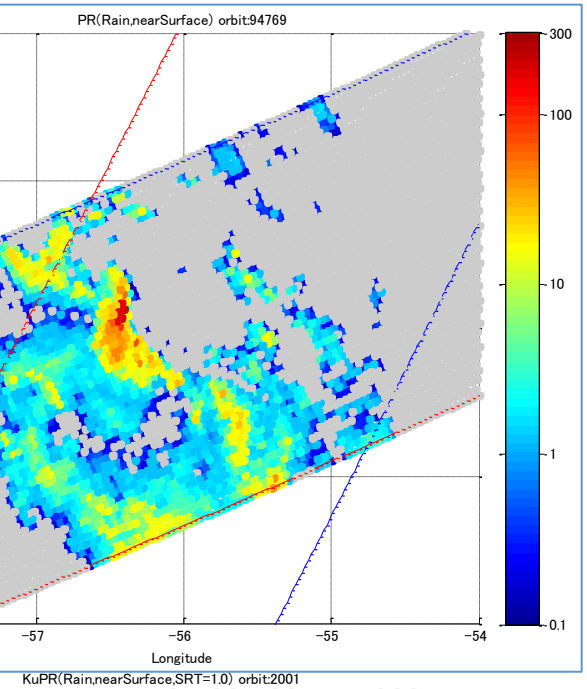


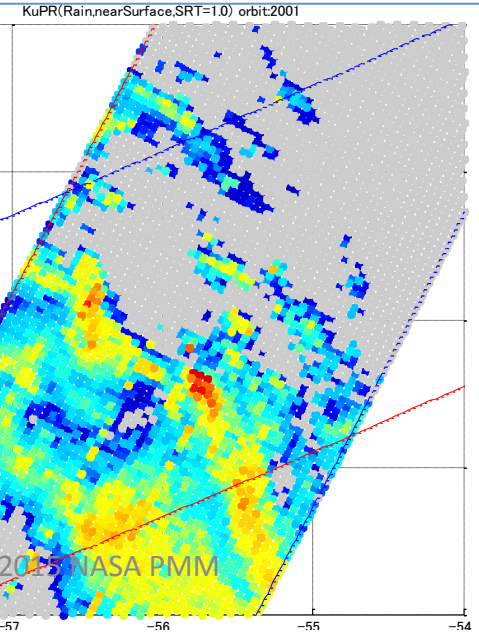
A good correspondence KuPR with TRM near nadir is co in TRMM obser range. At Highe latitudes, short precipitation is obtained very smoothly.

2015 NASA PMM

Matchup Comparisons of GPM Ku vs TRMM PR

(Shimozuma and Seto, IGARSS 2015)





PR's rain rate

Zm → Ze → R

PIA Ze-R

KuPR's rain rate

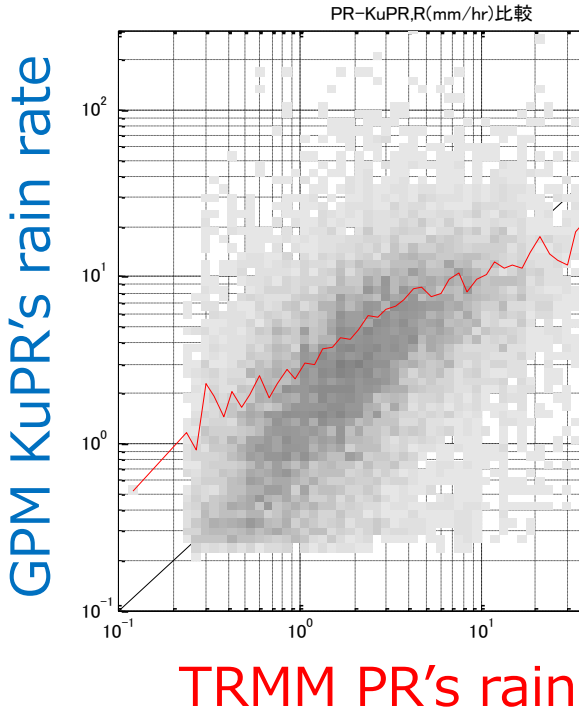
Zm → Ze → R

PIA Ze-R

KuPR's rain rate
Bias (KuPR-PR): 1.581mm/h

KuPR's Ze + PR's Ze-R
Bias (KuPR*-PR): 1.750mm/h

KuPR's Zm + PR's PIA + PR's Ze-R
Bias (KuPR**-PR): 0.428mm/h



- PR and KuPR's estimates are compared for 13 match-up
- KuPR (under development for V04) has a positive bias vs
- The biases in rain rates between PR and KuPR are caused differences in Zm and SRT.

2015 NASA PMM

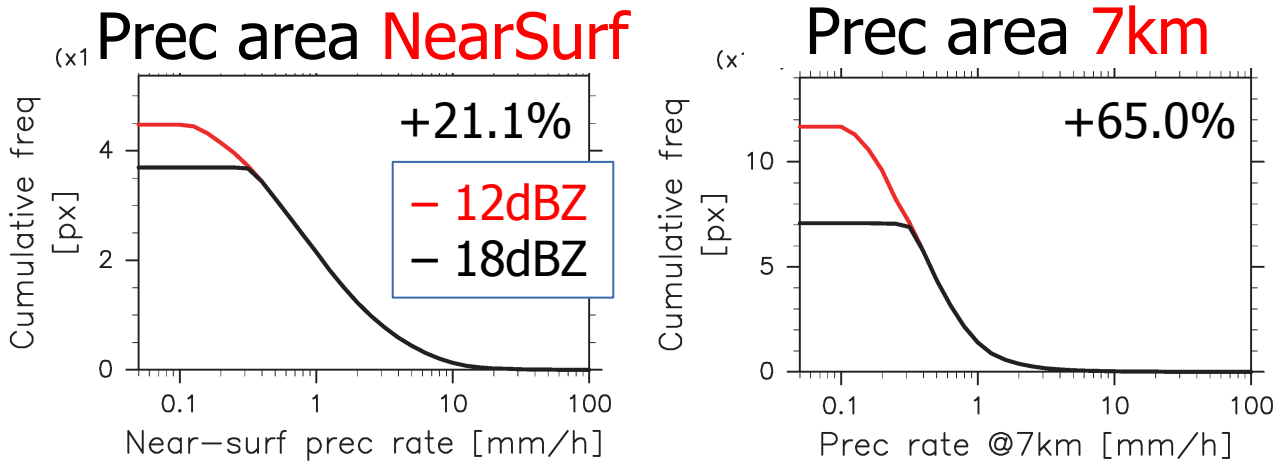
Impacts of Light Precipitation Detection with GPM/DPR

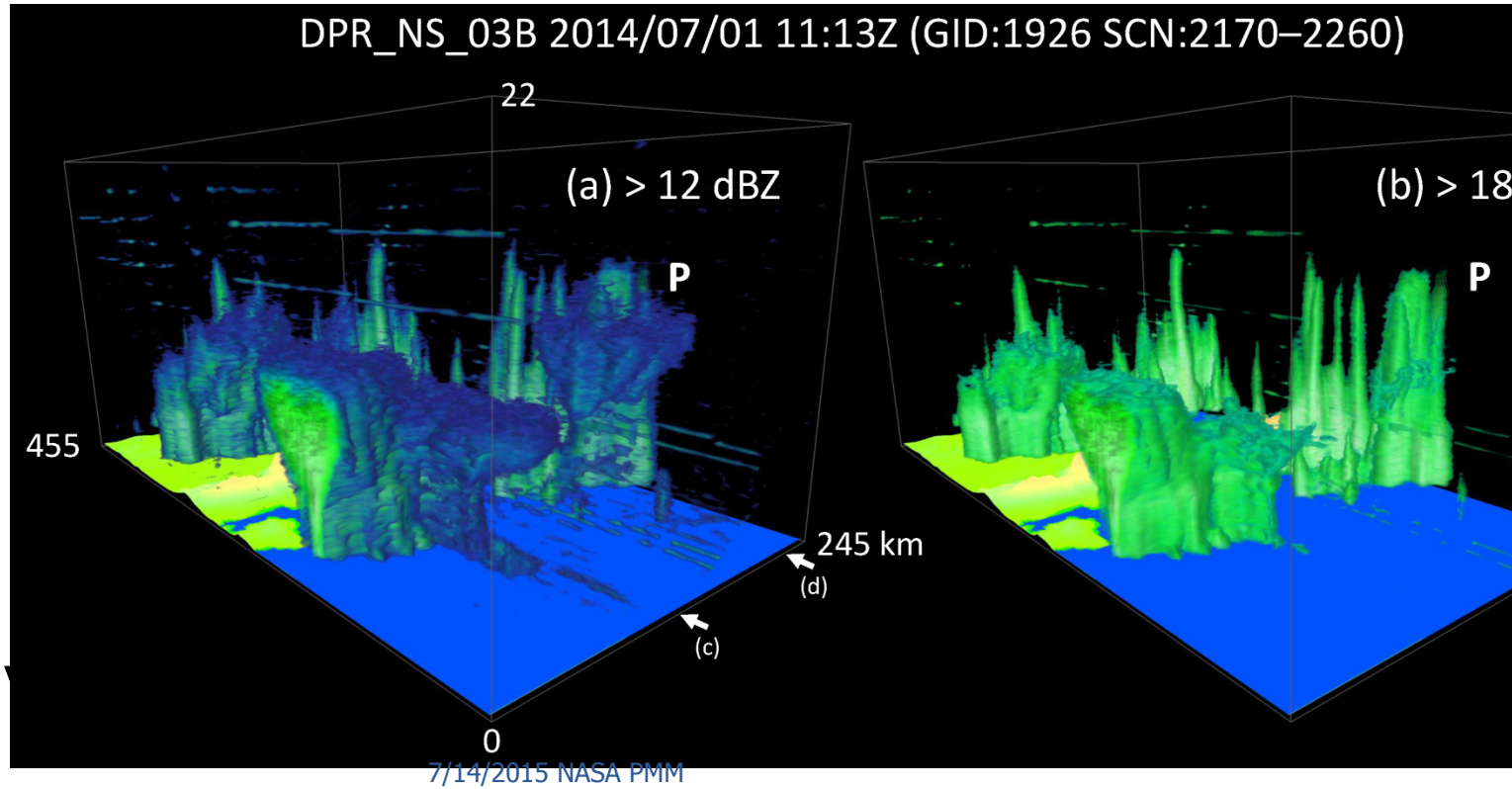
la & Takayabu
tted)

ative Freq. Distribution
cip. Area: Effects of
vity increase from
to 12dBZ(DPR)

2 (4/3–10/3), 40°S–40°N,
21–29

ition to increased
ons of shallow and
recipitation at near
e, detections of anvil
tation are significantl
sed

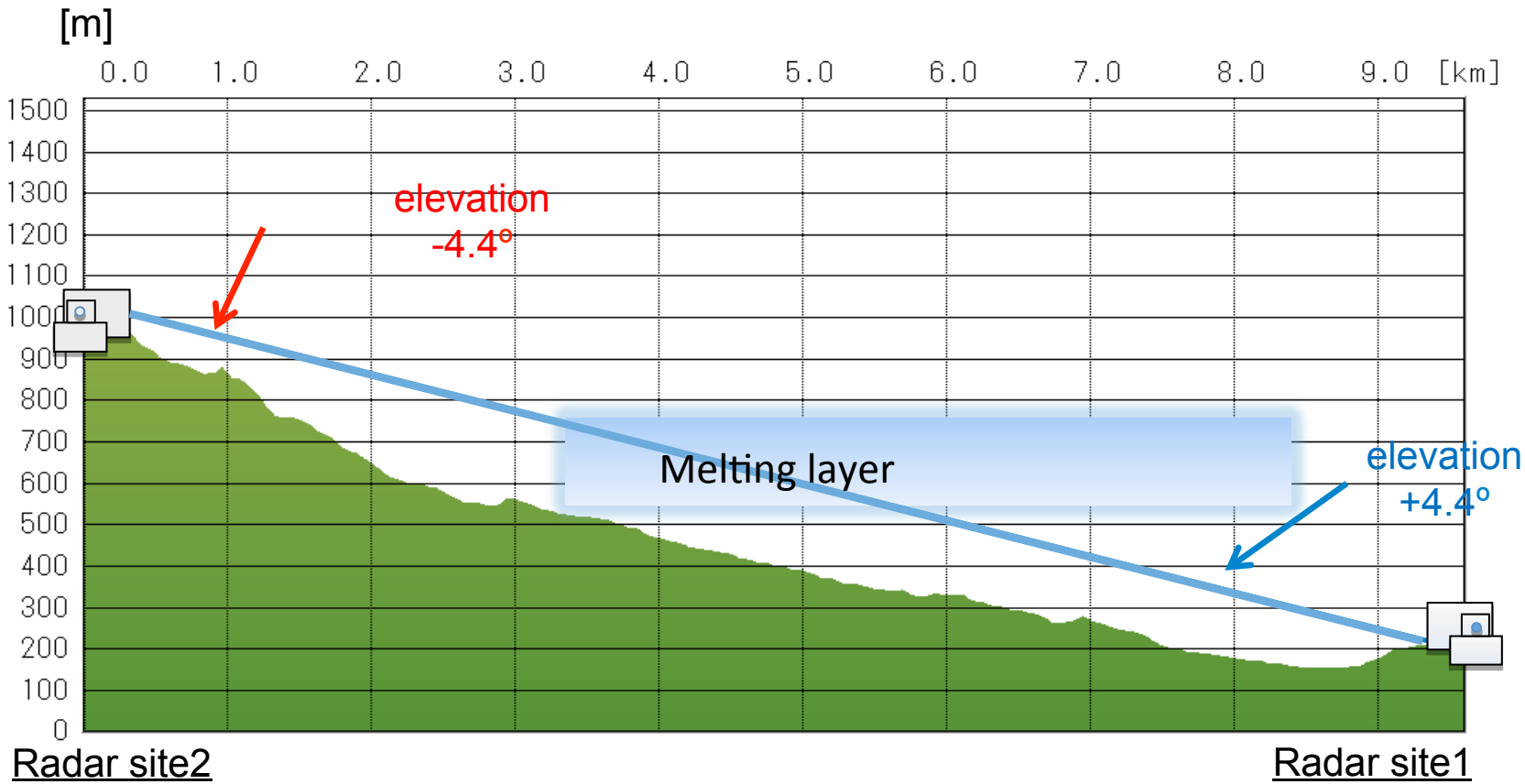




GROUND VALIDATIONS

Dual Ka radar experiment in Mt. Zao

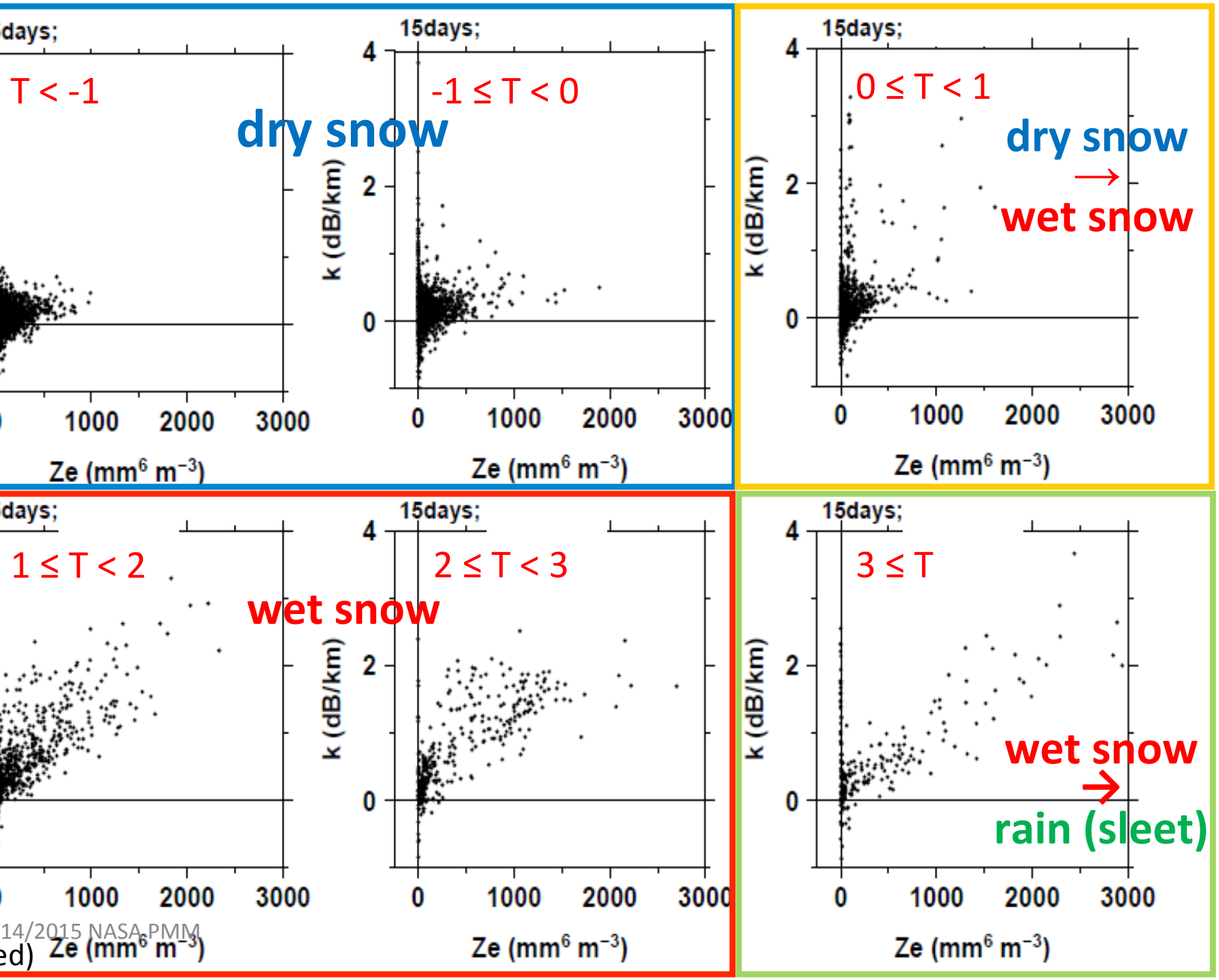
by K. Nakam



configuration of the melting layer measurment at Zao, Yamagata, Japan in Nov. las
(2014). Two Ka-band radars are set facing to each other. By comparing the
ipitation echoes, the specific attenuation k and equivalent radar reflectivity Ze are
nated.

NASA PMM

k-Z_e plots by every 1 ºC for all snow events in Nagaoka

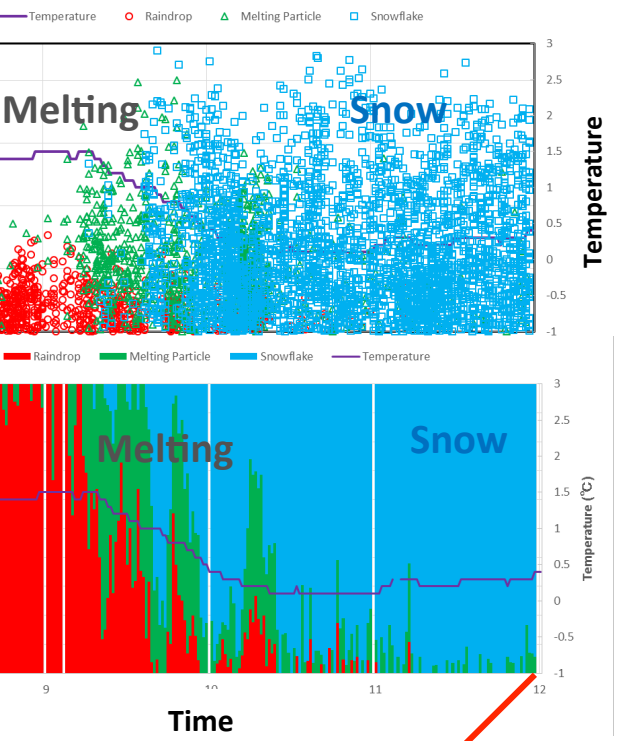


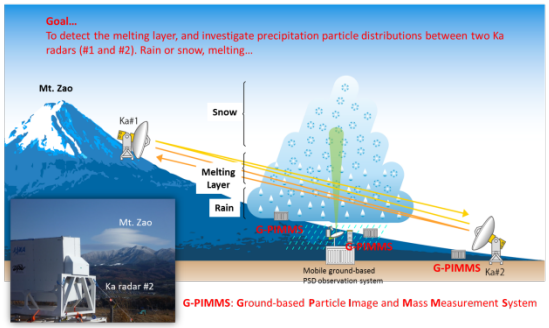
Nishikawa, Nakam
(accepted)

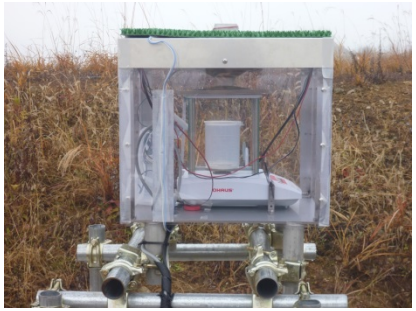
k-Ze relationships
obtained in Nagac
expeiment. It is t
as Zao experimen
with the radar ant
beam is nearly ho
The k-Ze are strat
the ground air
temperature. As t
temperature incre
from below 0C, fir
increases followe
Ze. After melting,
Ze reduce to the
relationship for ra

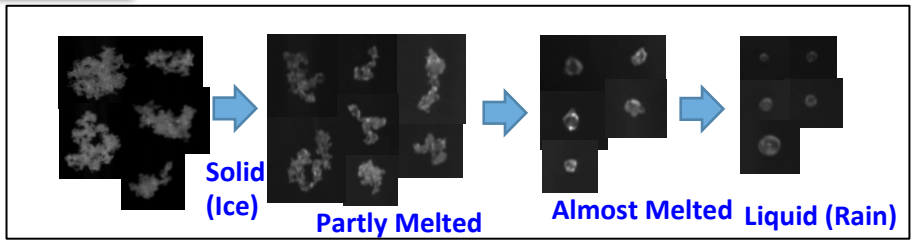
leasurement of Precipitation Particles in Melting Layer using G-PIMMS

ember 26, 2014 @ Zao

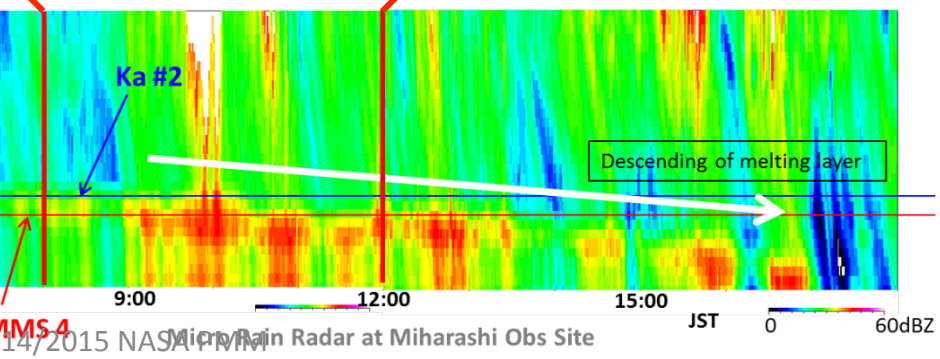


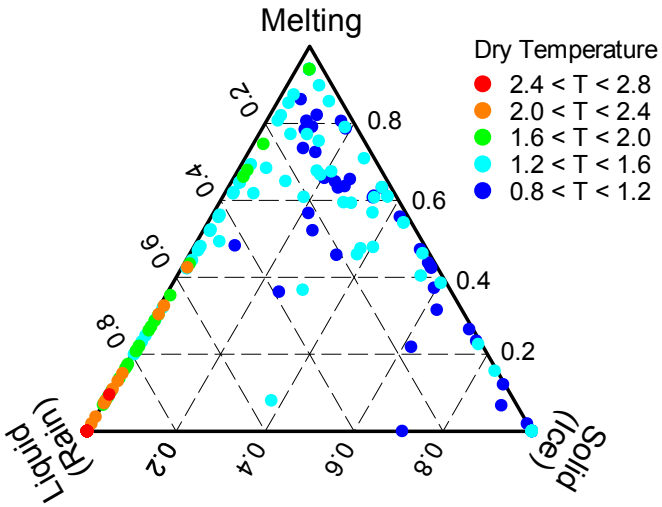






Rain/Snow/melting distinction depending temperature





→Vertical structure of melting layer
→Dry snow or Wet snow?

Ground-based P
Images and Mas
Measurement Sy
(G-PIMMS)

by K. Suz

...consists of two
cameras, an infra
sensor, a strobe
an electronic bal
Interruption of t
infrared beam by
particle triggers t
strobe and the p
image is then cap
by the CCD came

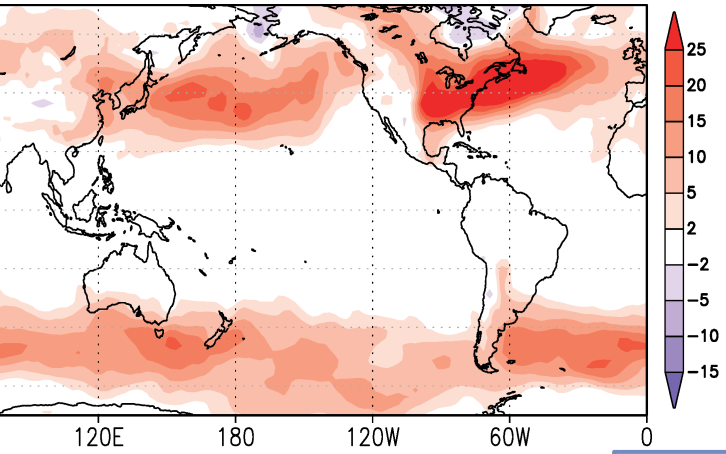
Precipitation par
images obtained
G-PIMMS., which
classified into so
(ice), partly melt
almost melted, a
liquid (rain).

WEATHER REGIME CLASSIFICATION IN HIGHER LATITUDES FOR GPM GSMAP

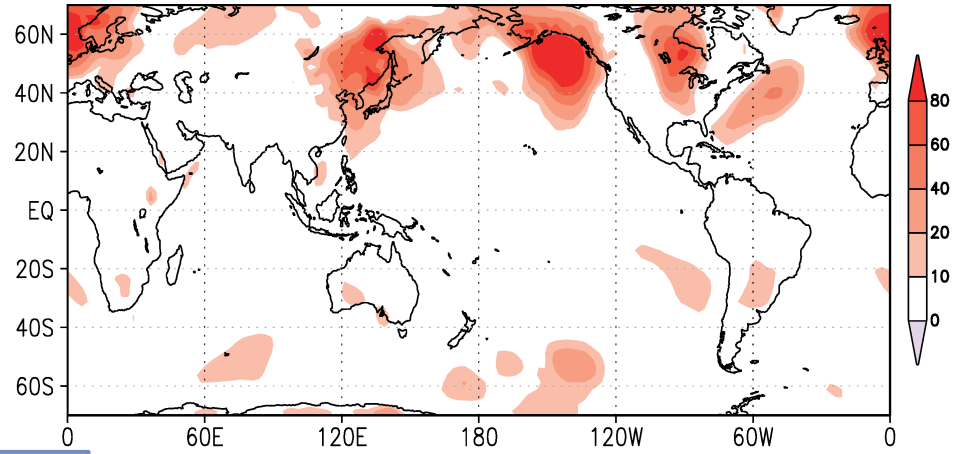
Weather Regime Classification for GPM GSMaP

Hamada, Takayabu,

x $\overline{v'T'}_{850hPa}$ (synopotic<8days)

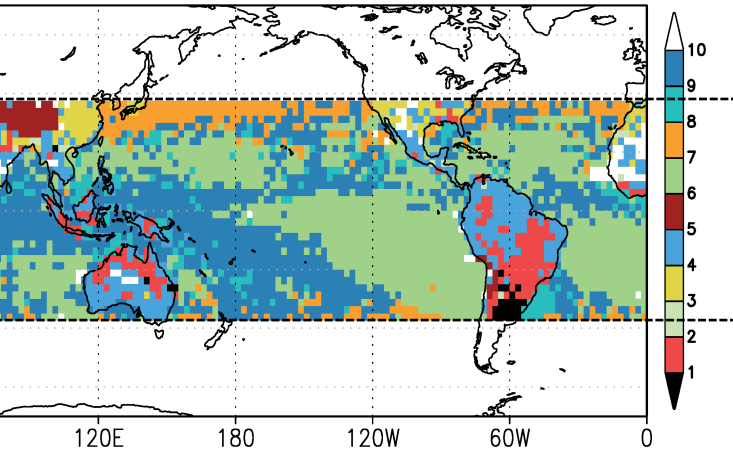


sgn(lat) $\overline{v^*T^*}_{850hPa}$ (stationary>1mo)

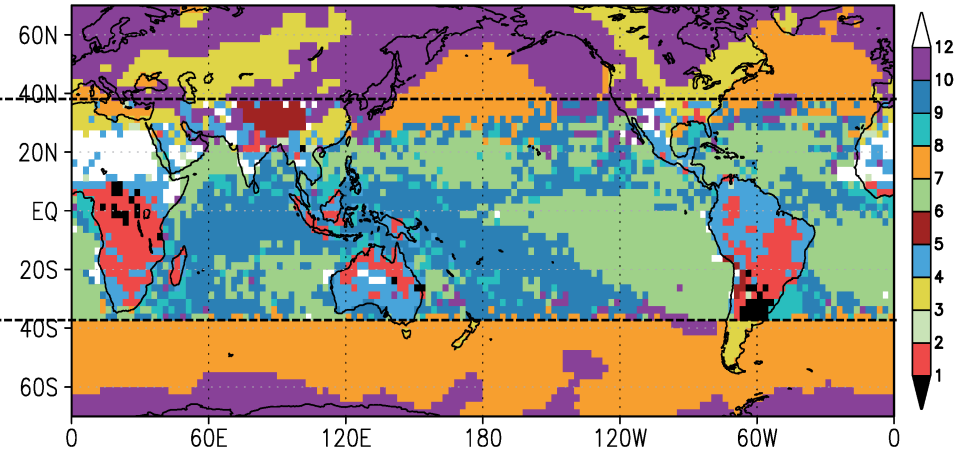


Jan2014

iptation regime (TRMM)



Preciptation regime (GPM)



We utilize the
meteorological

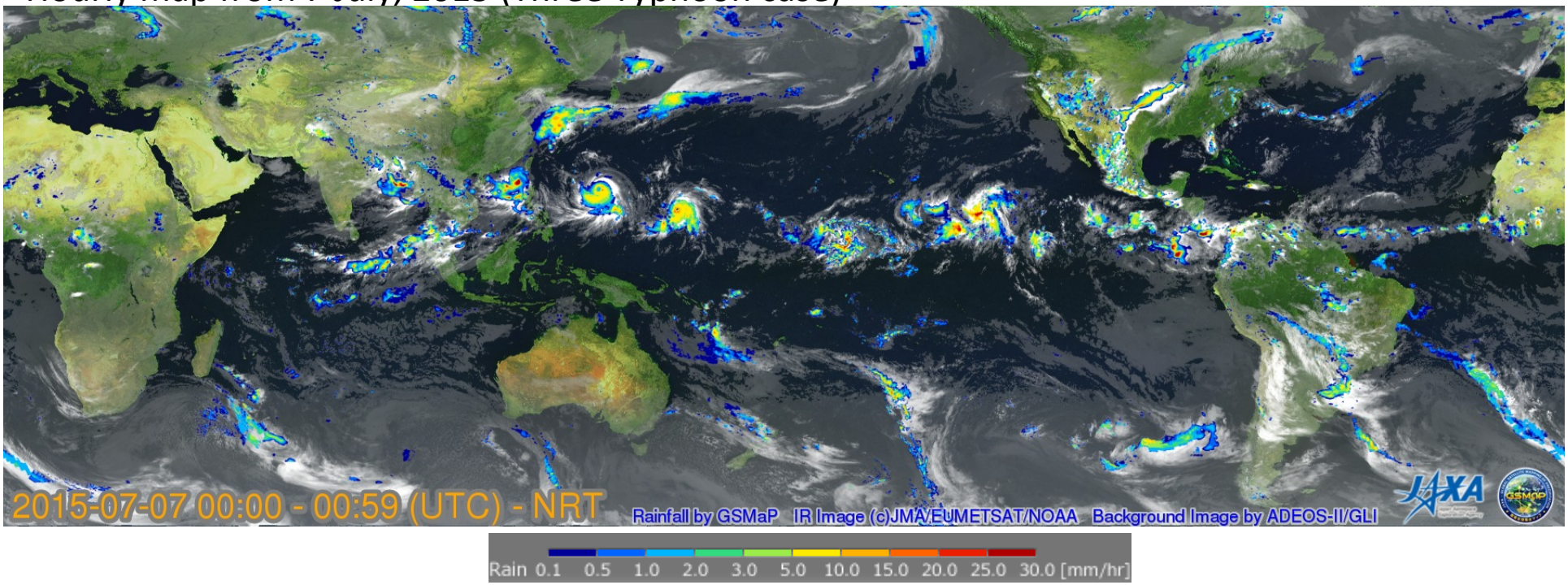
Based on montl
meridional eddy
flux at 850hPa,
TRMM region &
"extratropical re
inside TRMM re

Two regimes ar
defined:
"Transient eddie
"stationary outf
Purple

Global Satellite Mapping of Precipitation (GSMaP)

http://sharaku.eorc.jaxa.jp/GSMaP/

Hourly map from 7 July, 2015 (Three Typhoon case)



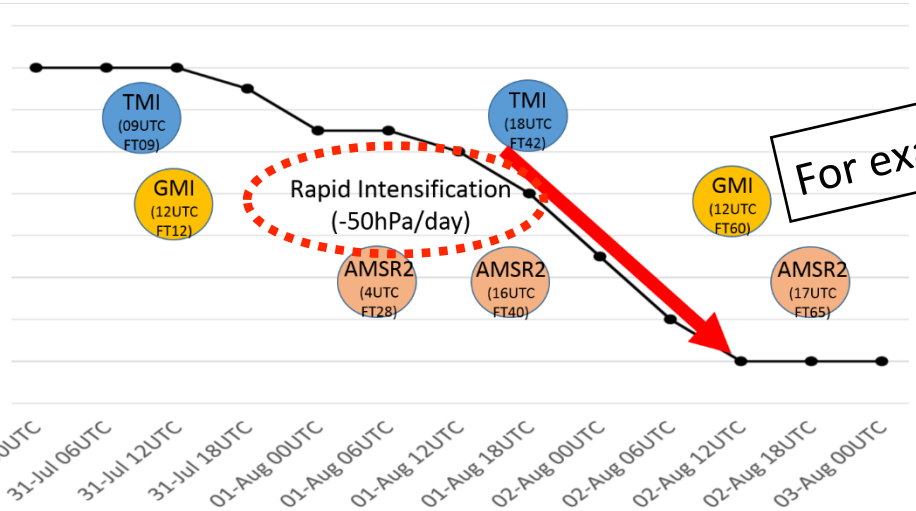
- GSMaP is a blended Microwave-IR product and has been developed in Japan toward the GPM mission.
  - U.S. counterpart is "IMERG"
- Proto-type version has been in operation in JAXA since 2007
  - **"GPM-GSMaP" data were released on Sep. 2014.**
  - GPM-GSMaP data for TRMM period is currently processing as reanalysis version (GSMaP_RNL), and will be distributed soon.

EVALUATIONS OF MODEL PERFORMANCE

Evaluation of Tropical Cyclones Simulated in NWP Models

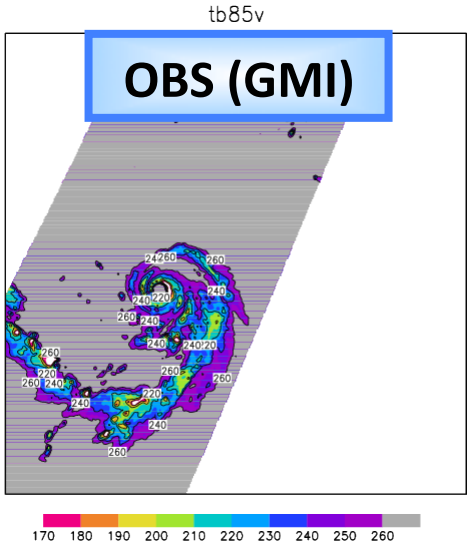
Yamagu
(MRI/JM

bserved Intensity of Typhoon Halong (1411) and Microwave Observations

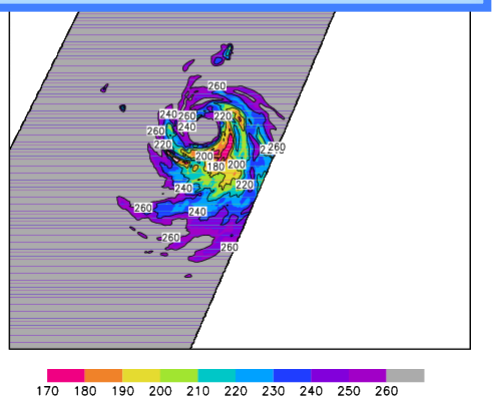


For example

TB85v



Simulated satellite image by JMA/NHM



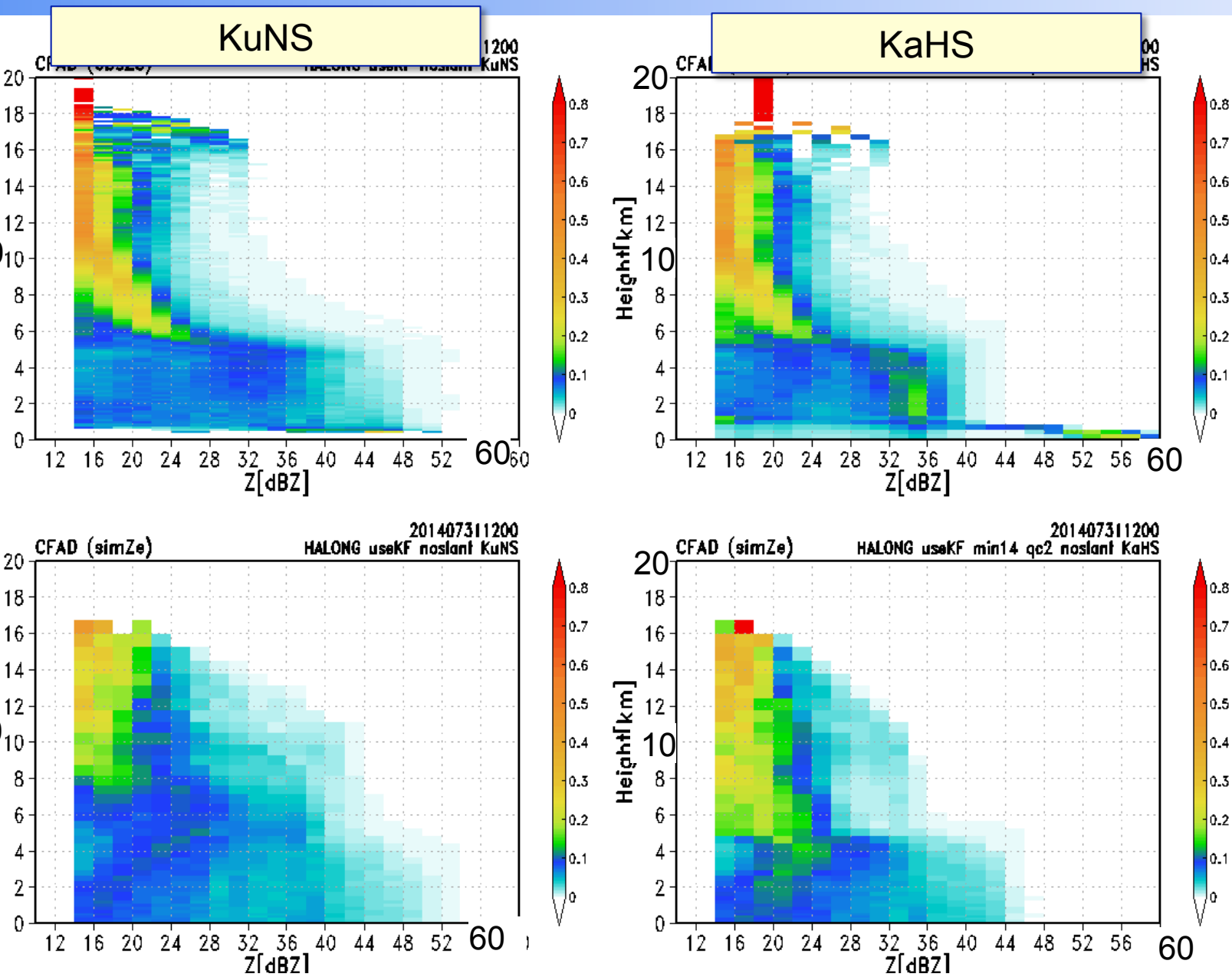
The rainband structure is much weaker in the model.

The area of TB < 200 K is larger in the model while.

The area of 210 < TB < 260 is much larger in the observations.

Radiance space-based evaluation is useful in verifying the structure and precipitation-related variables of tropical cyclones simulated in NWP models.

AD (Contoured Frequency by Altitude Diagram) Okamoto(JMA) (

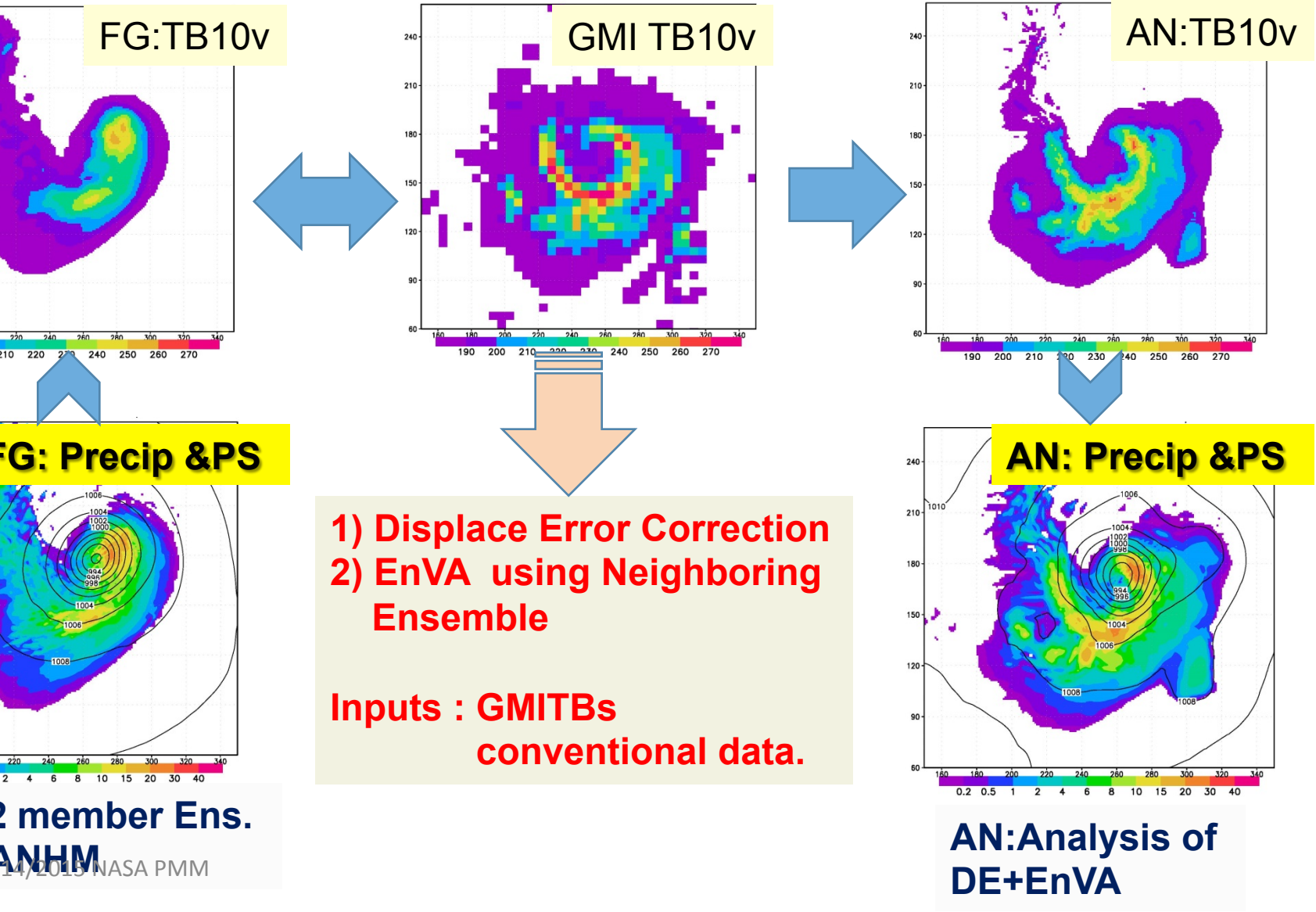


Comparison of GPM
DPR with model sim

JMA-NHM
overestimates Z
ice particles and
unclear bright ba
The Ze overestim
ice is alleviated i
relative to Ku.

ASSIMILATIONS OF GPM PRECIPITATION

nble-based variational assimilation of GMI TBs for on Halong (14/7/31/12UTC) by Aonashi (MRI/JMA)



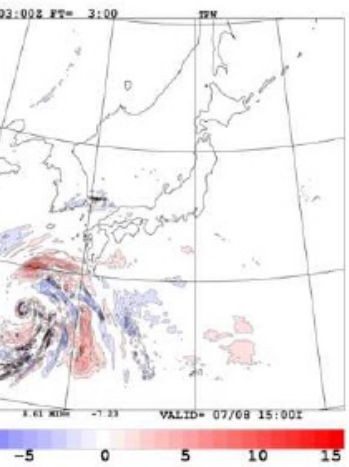
An average of 52-
CRM ensemble fo
starting at 00UTC
utilized as the firs
of EnVA (FG). The
TB10v, TB18v, TB
TB36v, TB89v at
are assimilated wi
DEcorr & EnVA sc

The results (right
show that TBs cal
from the analyzed
variables agreed
the GMI observati
that analysis gave
significant change
precipitation and s
pressure.

GPM/DPR Impact Experiment

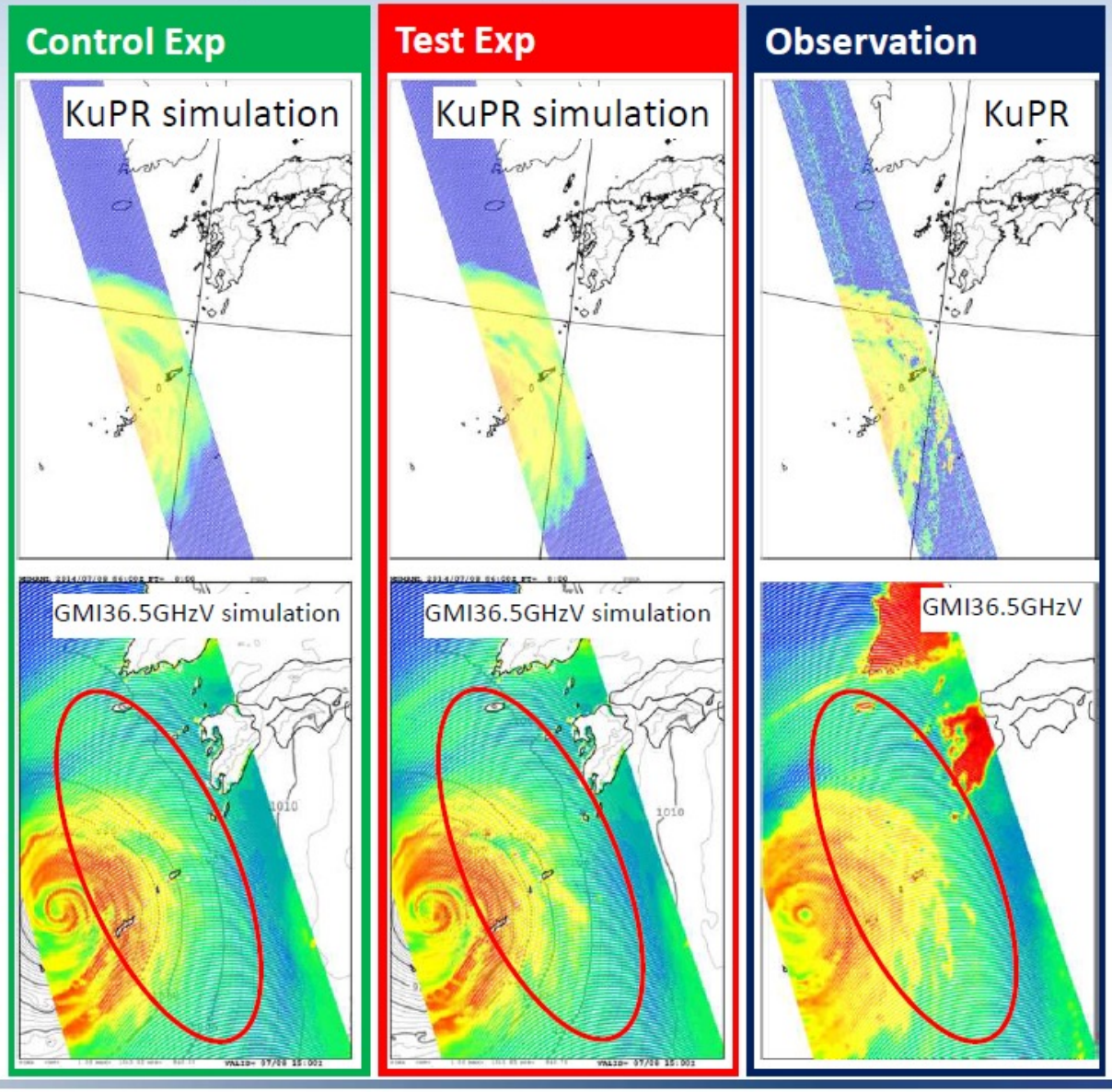
trol Exp:
operational data
tion system using
bservations.

t Exp:
xp with
PR(KuPR, KaPR)



e Water Vapor Difference (Test
t initial time. The increment is
only around the DPR path but
distant place by model
4D-Var.

2014,IPWG7)



Courtesy of Ikuta

JMA is now devel
system to utilize G
DPR in operationa
forecast routine.

A test experiment
assimilate the rela
humidity profiles
from KuPR and Ka

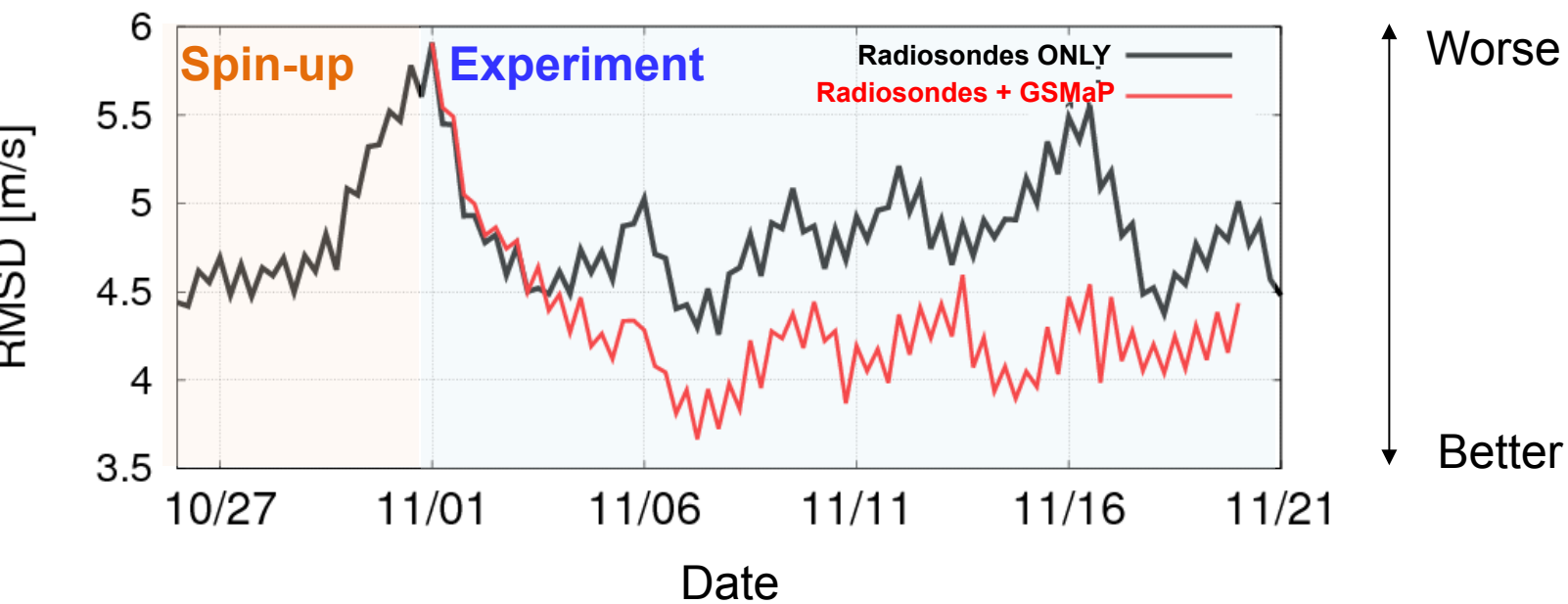
We can confirm a
improvement of t
humidity field by
assimilating DPR
information.

nsemble Assimilation of GSMaP precipitation

prove NICAM-LETKF analysis using satellite-
erived precipitation with Gaussian transformation
ien et al., 2013, 2015)

CAM-LETKF analysis improved by assimilating GSMaP/Gauge

Global RMSD of V-wind [m/s] at 500 hPa (vs. ERA-Int)



By Miyoshi (

Experimental
Assimilation
GSMaP-Gau
precipitation
addition to
radiosonde to
Nonhydrosta
Icosahedral r
with NICAM-
analysis impr
the RMSD of
meridional wi
significantly.

HYDROLOGICAL APPLICATION

iendly display of Indus-IFAS

TA :

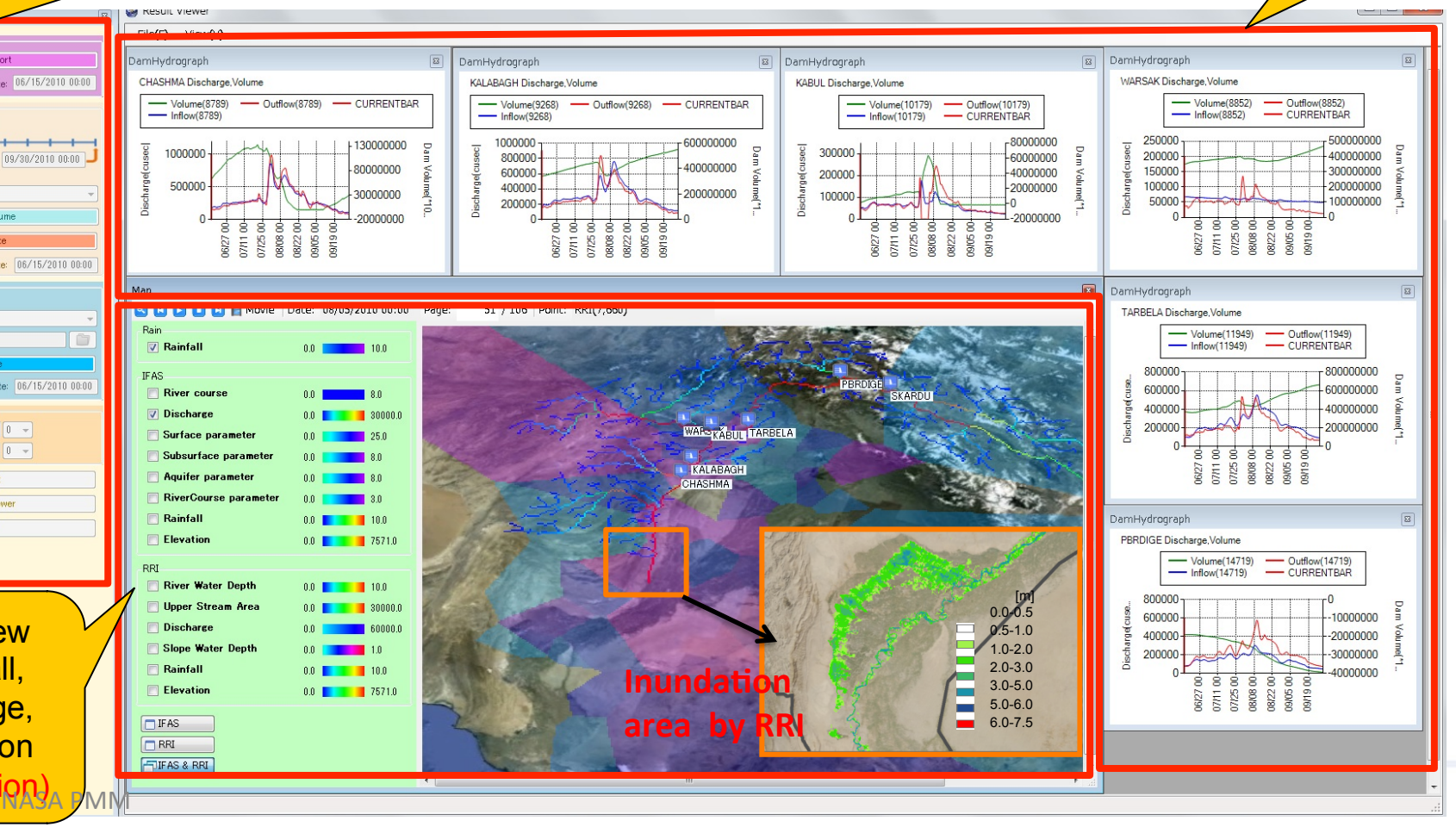
ll data (ground- gauges, GSMaP
recasted)
ime observed discharges

OUTPUT DATA:

- Rainfall distribution maps
- Hydrographs at specified locations
- Inundation extents in mid-low Indus

panel for operation settings

Hydrograph



ew
ll,
ge,
on
ion)

NASA PMM

Courtesy of
(ICHARM)

ICHARM develo
flood forecastin
system with us
friendly display
"Indus-IFAS". I
IFAS has been
for flood foreca
during Monsoo
season at Pakis
Meteorological
Department
operationally s
June in 2014.

Summary

GPM science in JAXA had a very smooth start with ample experiences from the TRMM science.

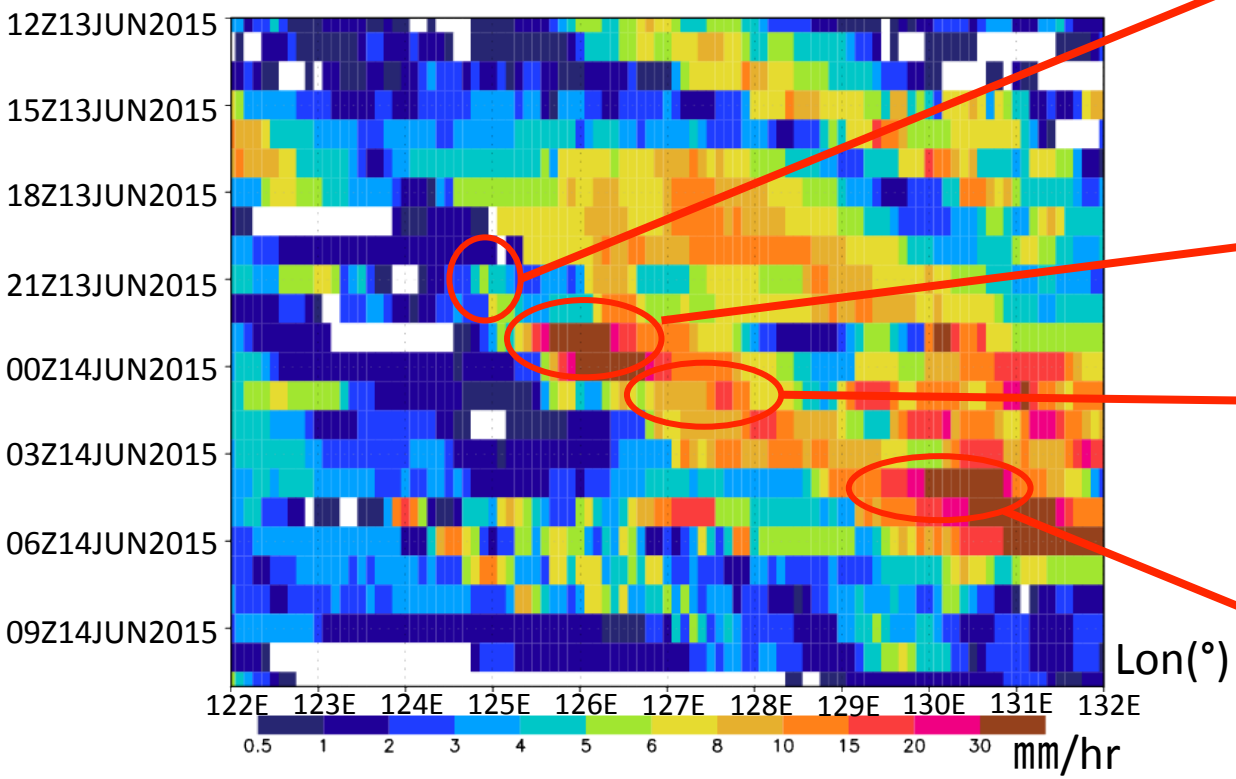
Progresses are found in studies on

- ✓ Learning structures of mid-lat precipitation systems
- ✓ Comparisons with TRMM
- ✓ Ground validations
- ✓ Weather regime classification in higher latitudes
- ✓ Evaluations of Model Performances
- ✓ Assimilation of GPM Precipitation
- ✓ Hydrological Applications

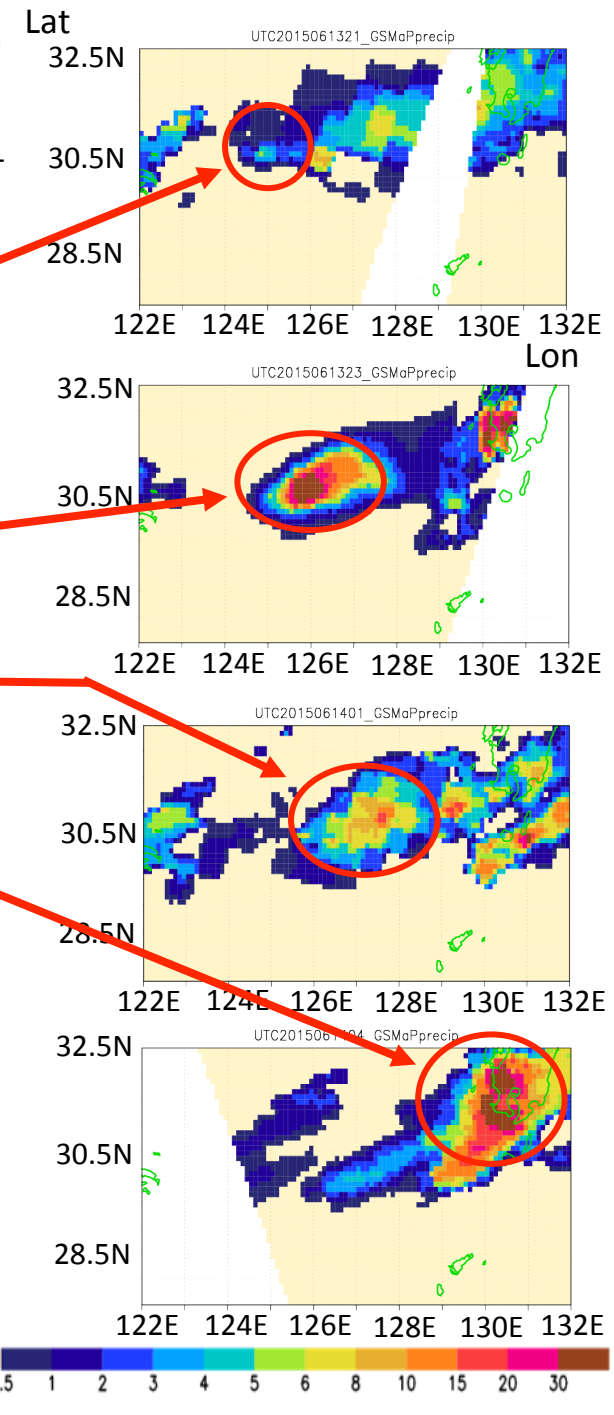
Thank you

Meso-α-scale low pressure in the East China Sea (GSMaP NRT)

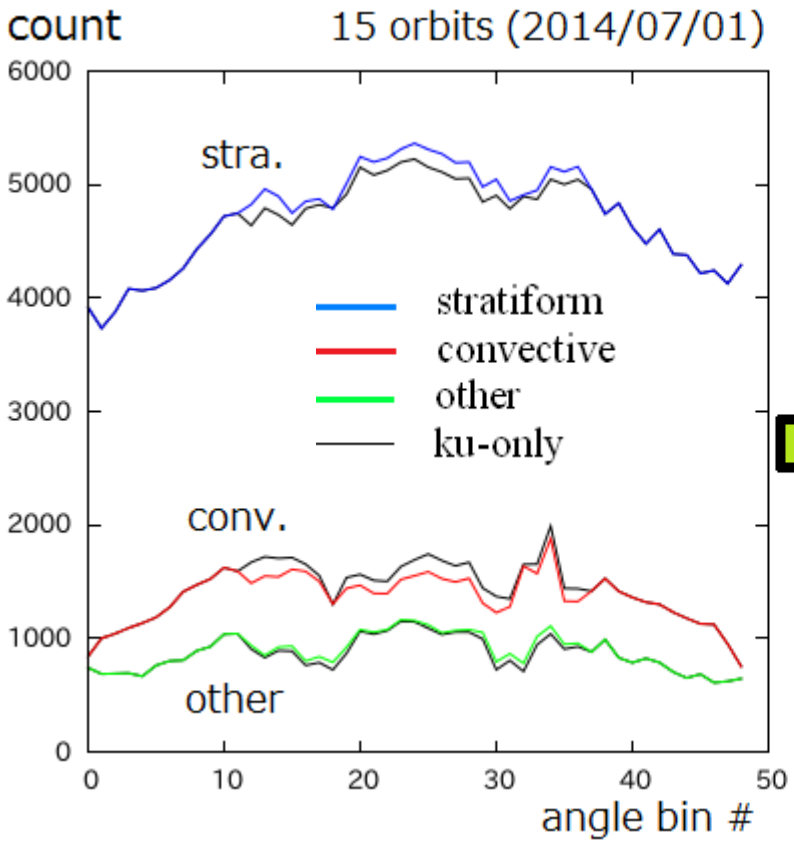
Using GSMaP dataset, we can get full coverage of rain distribution over the East China Sea. This example is an occurrence of small-scale disturbance on the Baiu-front and accompanied cumulus cluster over the ocean with poor ground radar coverage.



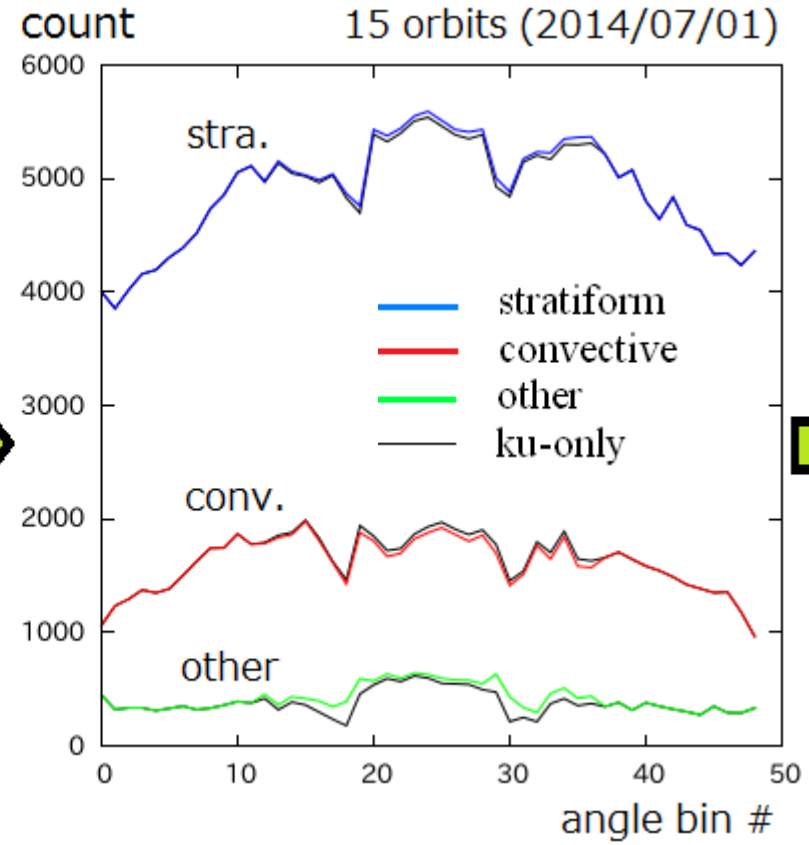
Maximum precipitation between 28.5N-31.5N (GSMaP NRT)



Statistical analysis of the occurrence of meso-α-cale low pressure is now conducted with 15-year GSMaP rainfall record



(a) 03B (current public release data)

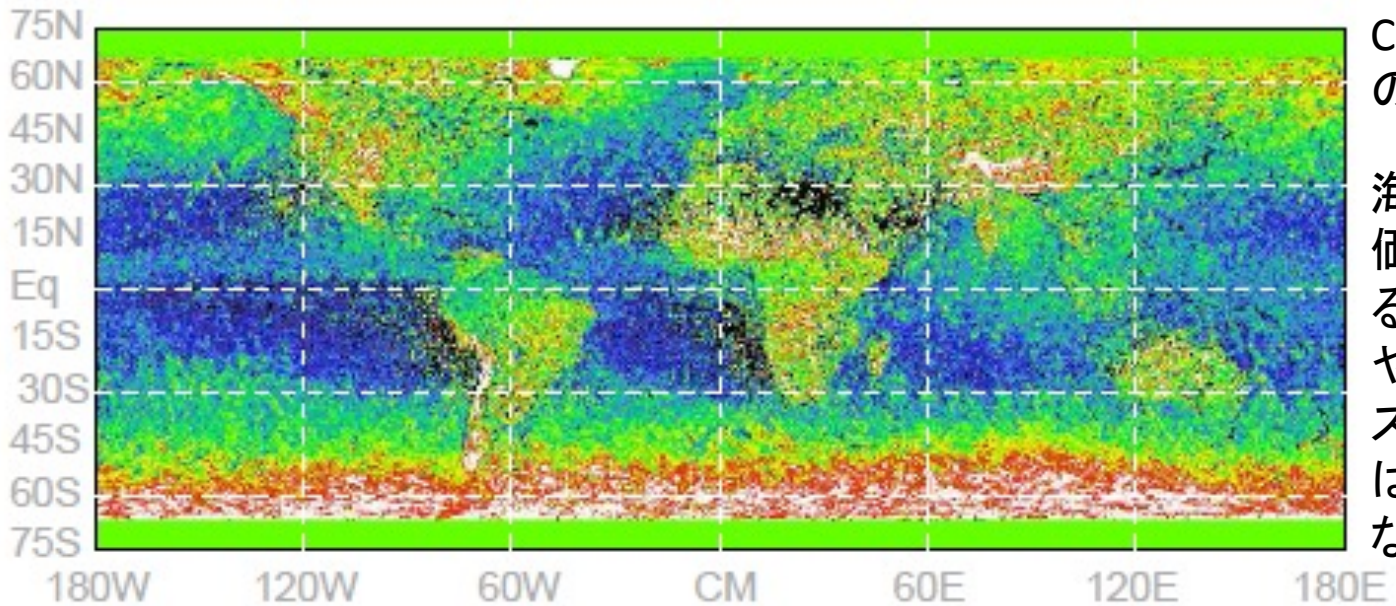


(b) New result using test L1 data (04B)

Levels of L1 03B data will be used in next public release

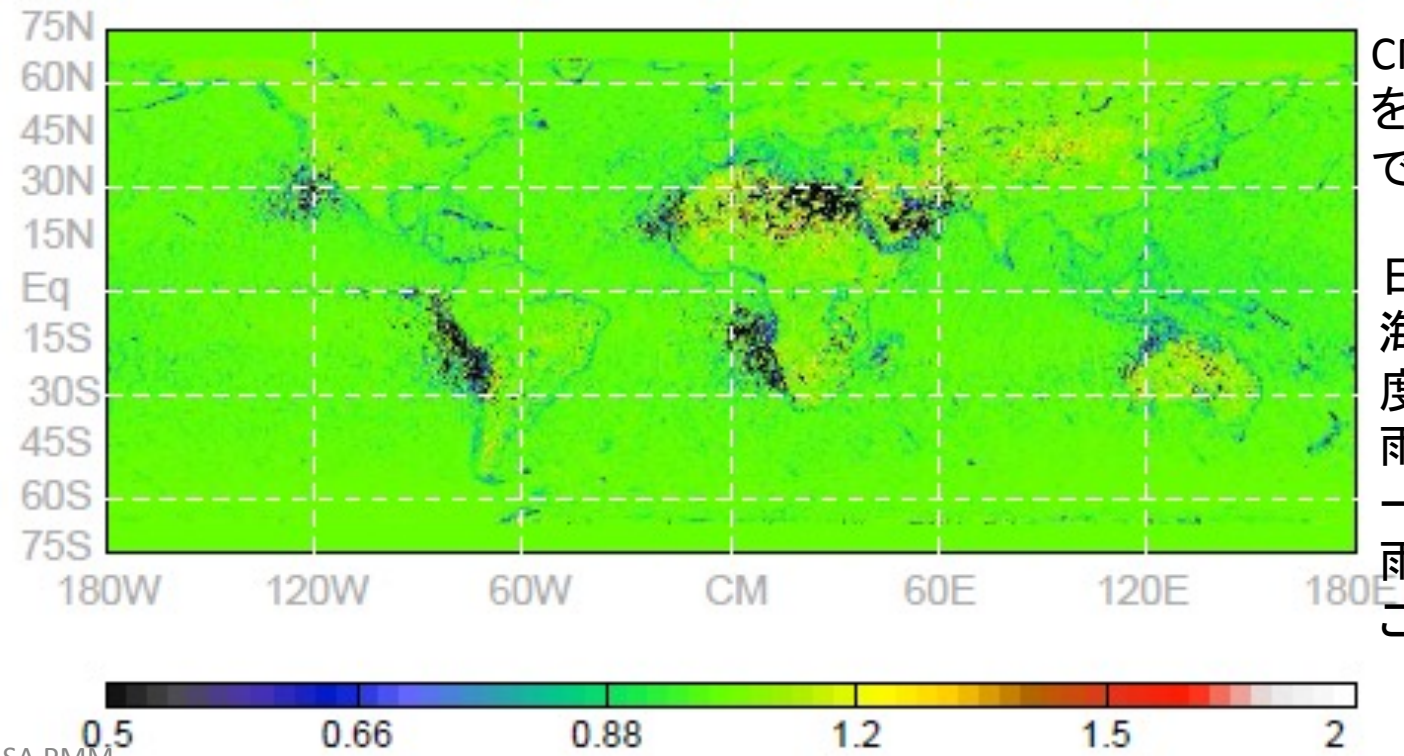
Rain-type count by the dual-frequency CSF module

Appreciable difference between Ku-only rain-type count and the dual-frequency rain-type count observed in the current public data becomes smaller in a new test result which was obtained by using V6.20150516 algorithms. Fig. (b) includes the effect of not only CSF module but also other modules. Fig. (b) was generated using a test 04B L1 data.



CMB-NSの降雨量をKu-NSの降雨量で割った分布

海洋は全体的に過小評価で0.7倍程度となっている。一方、グリーンランドやヒマラヤ山脈、アンデス山脈、南高緯度地域ではファクター2倍程度になっている。



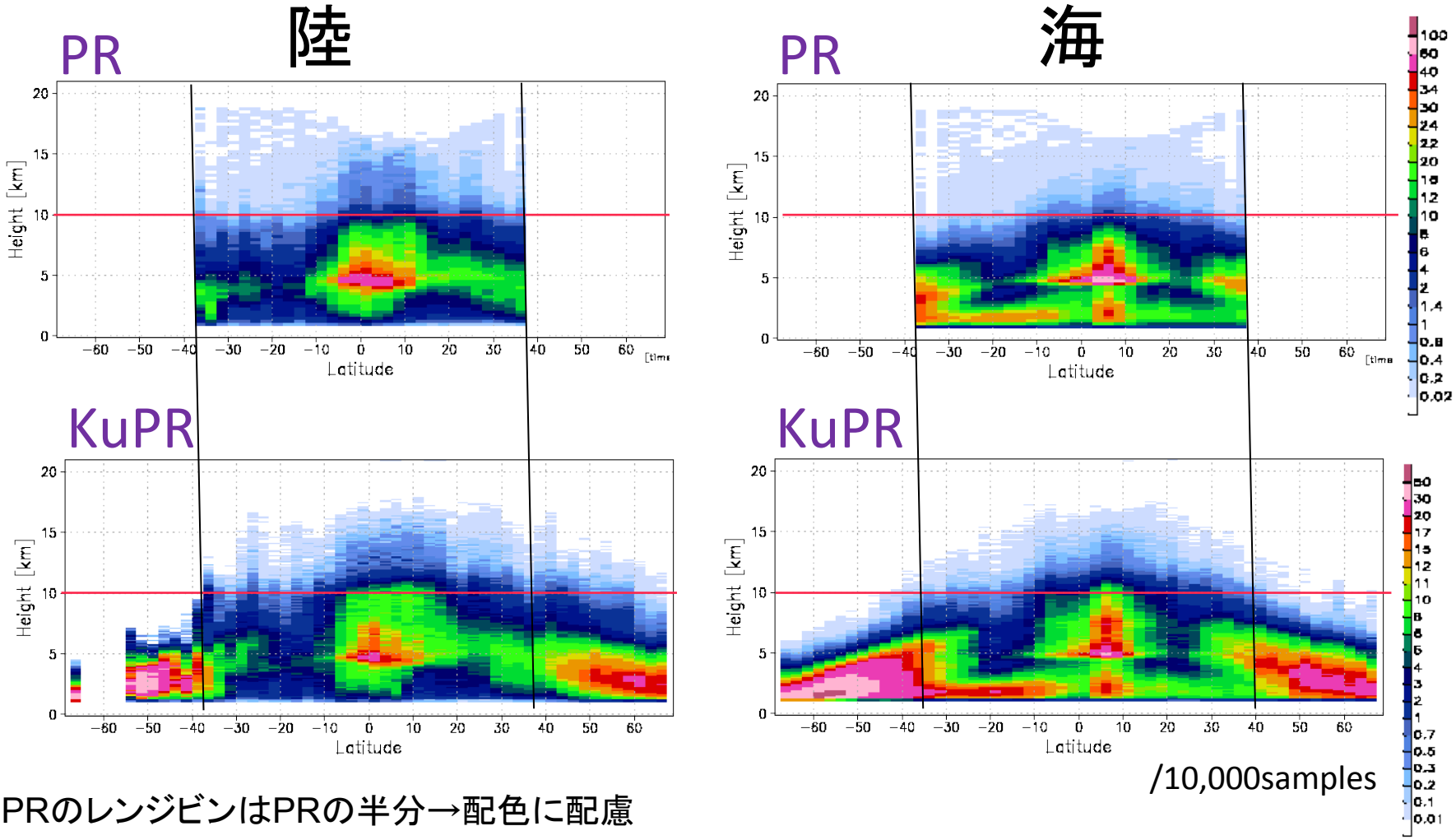
CMB-NSの降雨観測割合をKu-NSの降雨観測割合で割った分布

日本やニュージーランド、海岸線は複合が0.7倍程度で、過小評価、つまり、雨の見逃しとなっている。一方、陸上では過大評価、雨の誤判定となっていることがわかる。

2015 NASA PMM

2014年4月~11月

各緯度の降雨頂出現頻度（/10^{4}samples. 直下付近のみ）　2014/4-8

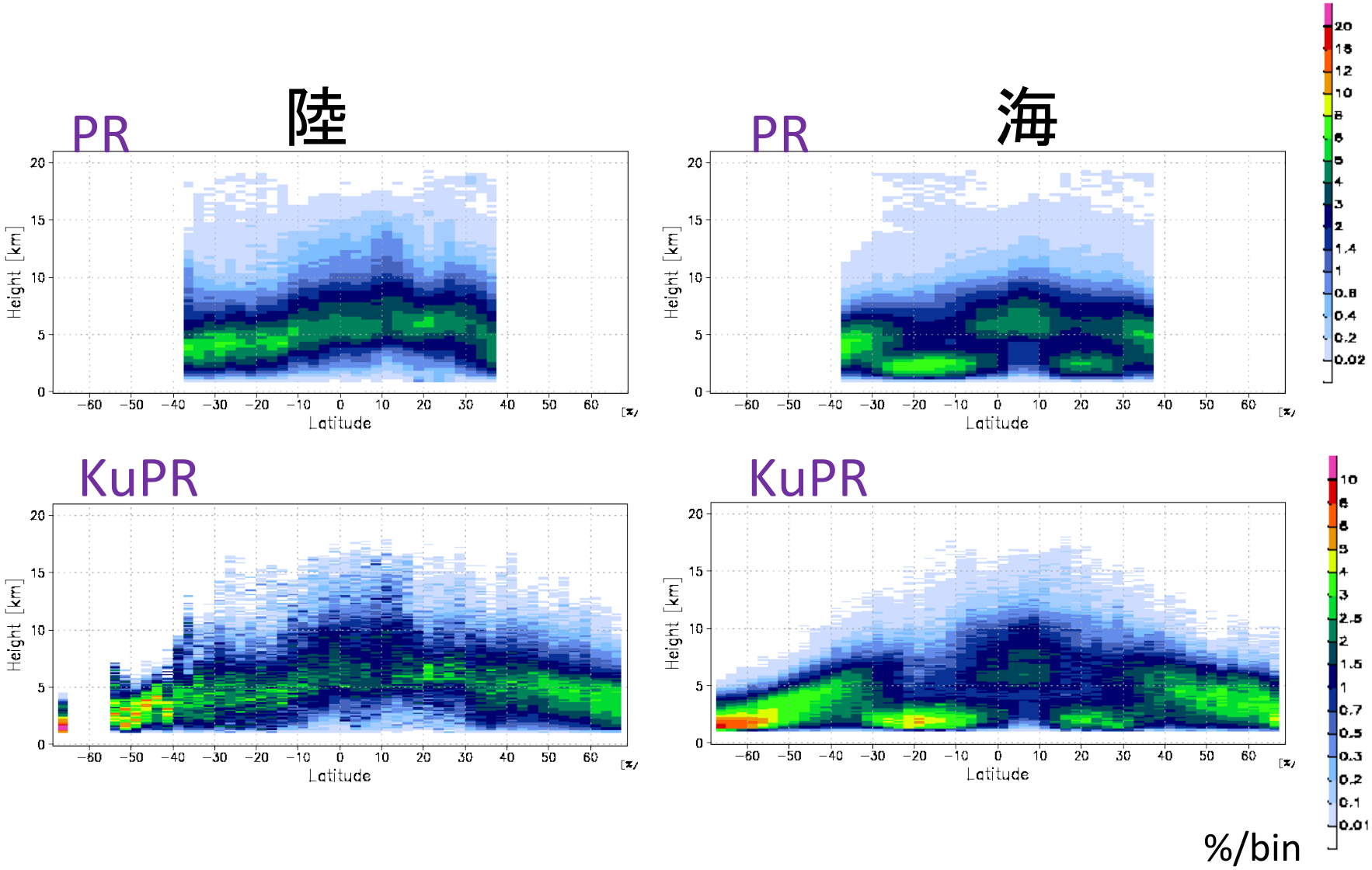


KuPRのレンジビンはPRの半分→配色に配慮

各緯度における総降水量（地表面）に対する降雨頂別の寄与

NNのみ[%/bin]

2014/4-8

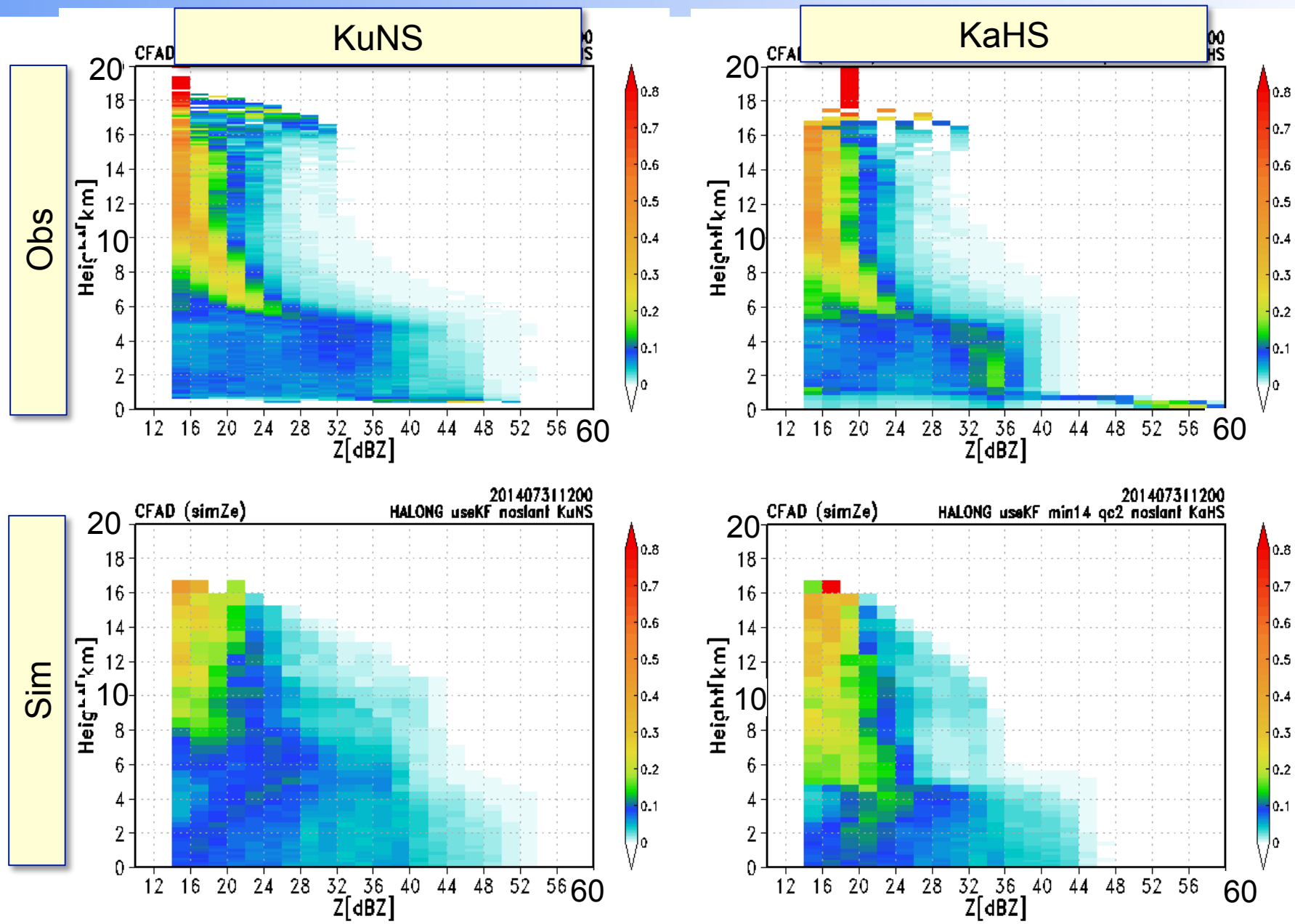


$\Delta H_{PR} = 2*\Delta H_{Ku}$

2枚目の同化のスライドは、GPMではなくTRMMの結果です。

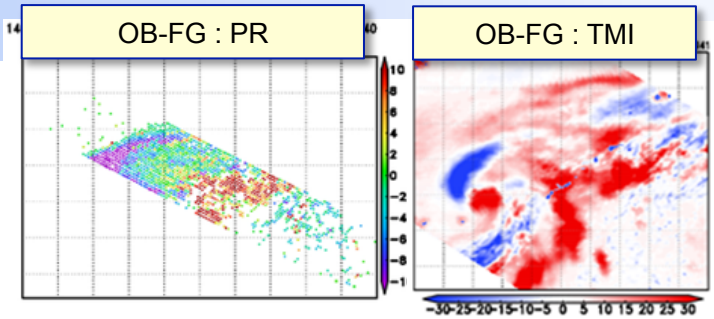
- GPM/DPRの同化は現在、動作確認中であり、間に合いませんでした。すいません。

CFAD (Contoured Frequency by Altitude Diagram)

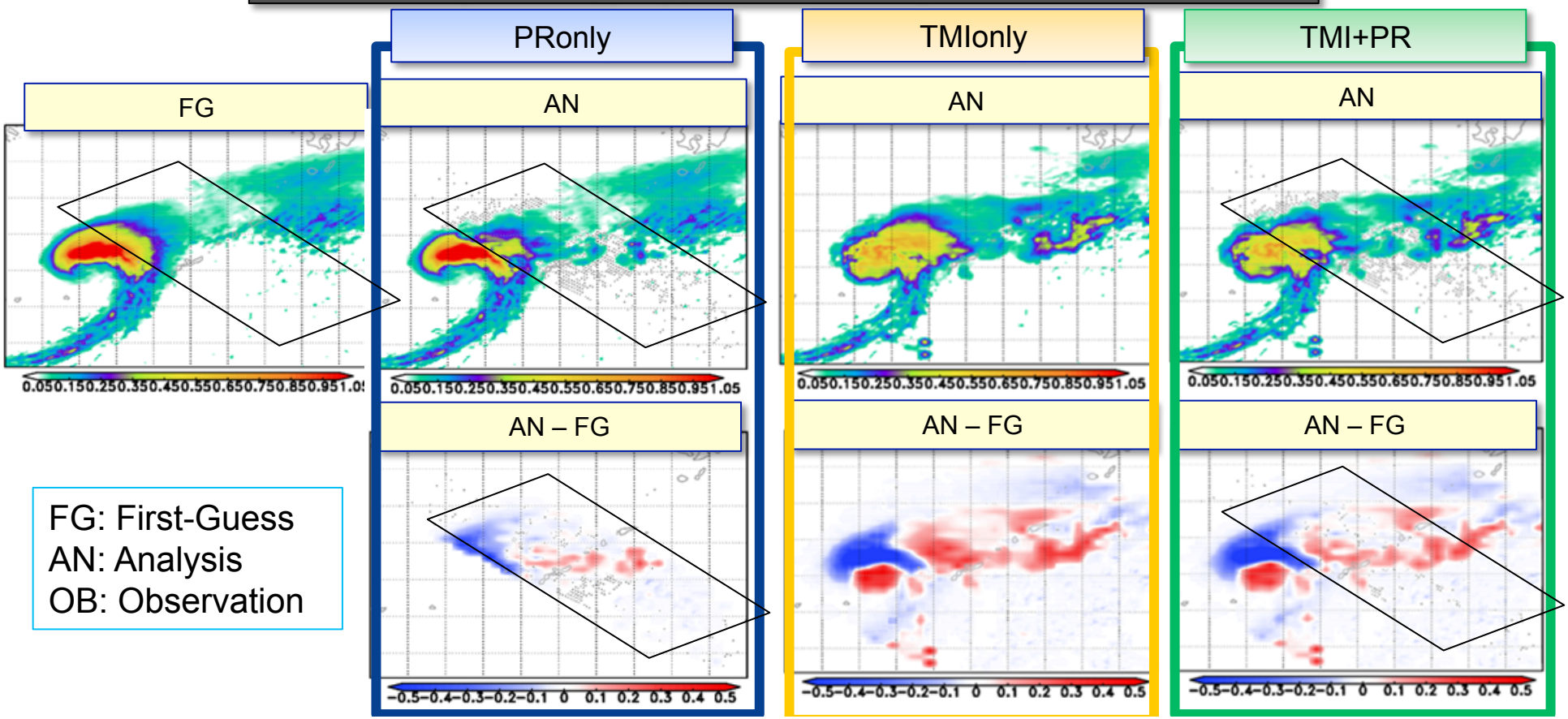


ssimilation of PR and/or TMI

- PRonly : use only PR Ze
- TMIonly : use only TMI radiance
- TMI+PR : use PR (Ze) and TMI(TB)



Rain Mixing Ratio (g/kg) at 2.5km height for AN and AN-FG

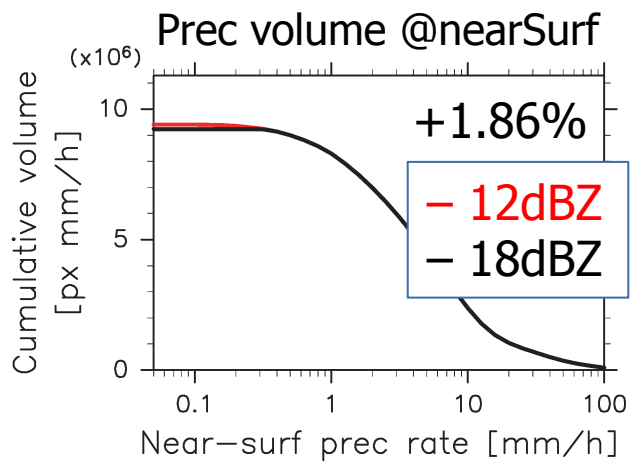


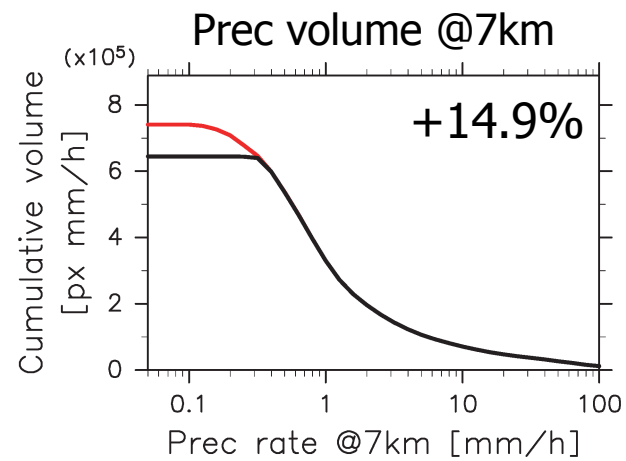
FG: First-Guess
AN: Analysis
OB: Observation

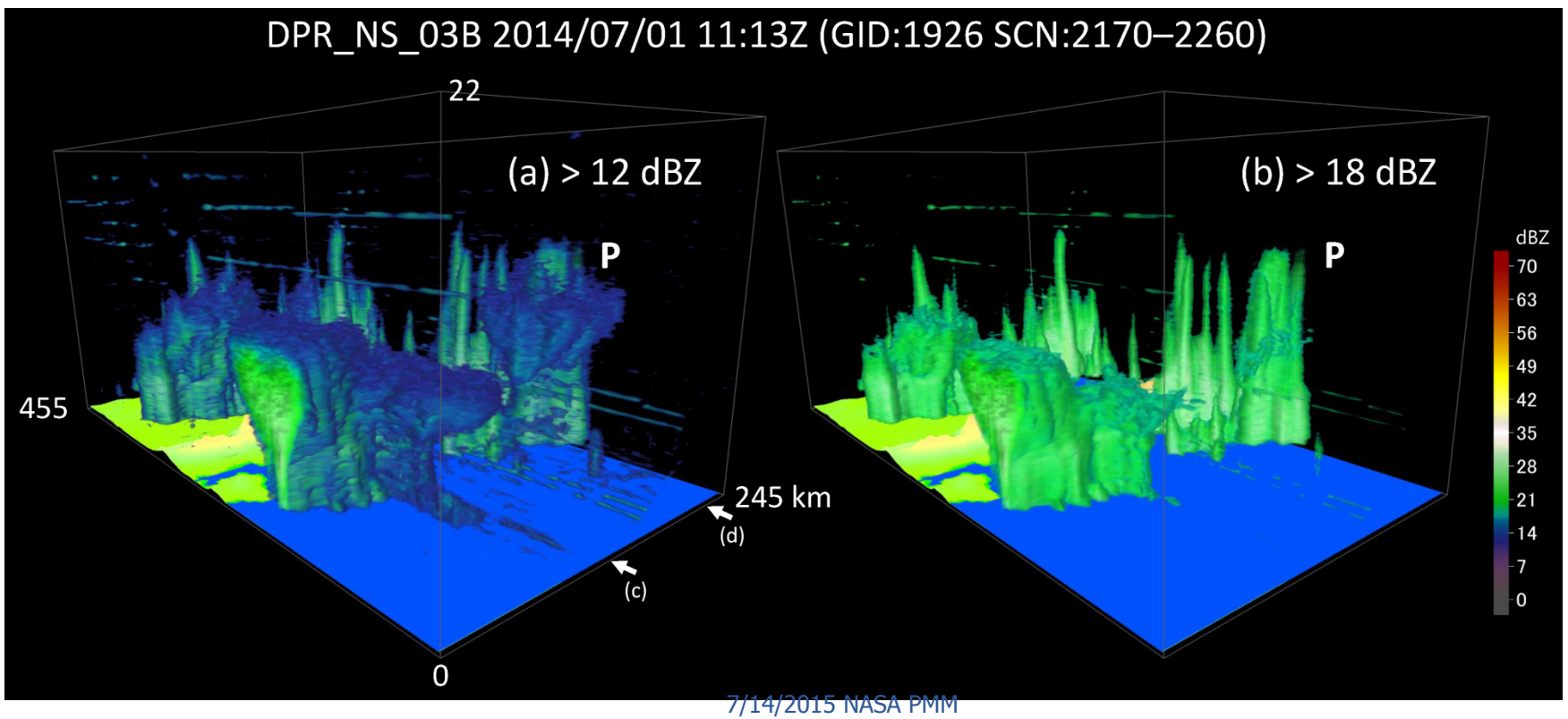
Impacts of Light Precipitation Detection with GPM/DPR

Effects of sensitivity increase (12 vs 18dBZ) at nearSurf and 7km
V03B NS2 (4/3–10/3), 40°S–40°N, anglebin 21–29

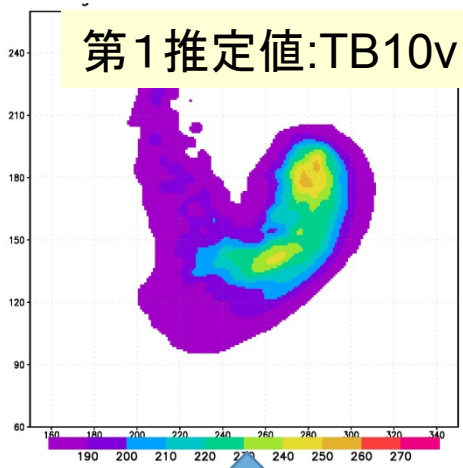
Hamada & Takayabu (submitted)

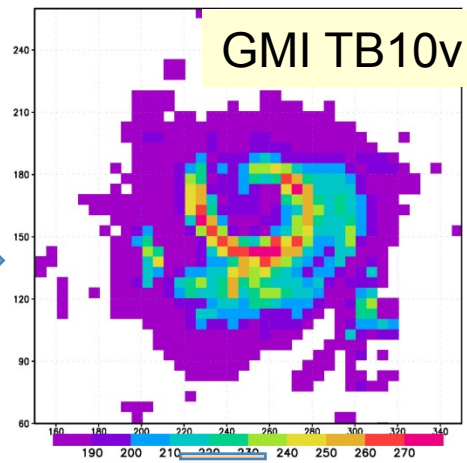


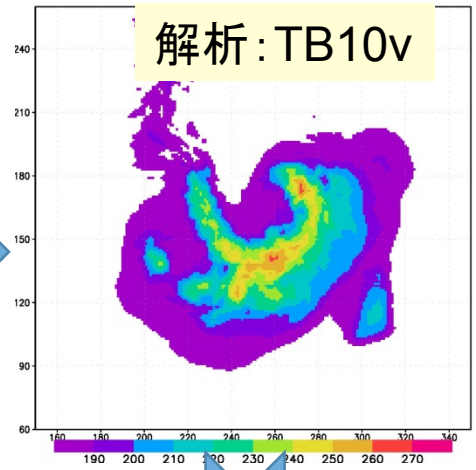




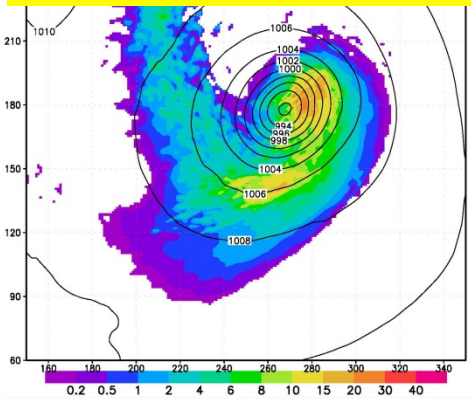
台風1411号事例のGMI輝度温度データ同化実験







第1推定値:降水＋地上気圧

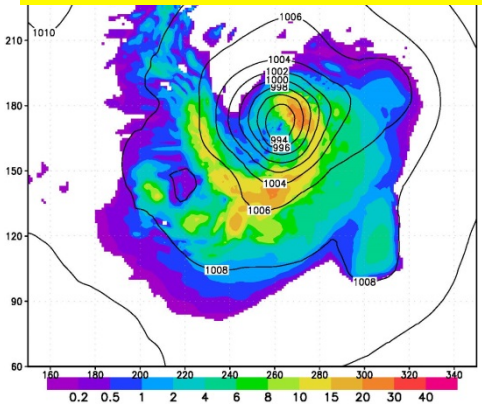


第1推定値:
JMANHM 52メンバーアンサンブル

1) 位置ずれ補正
2)周囲のアンサンブルを用いた
変分同化法(NE+EnVA)

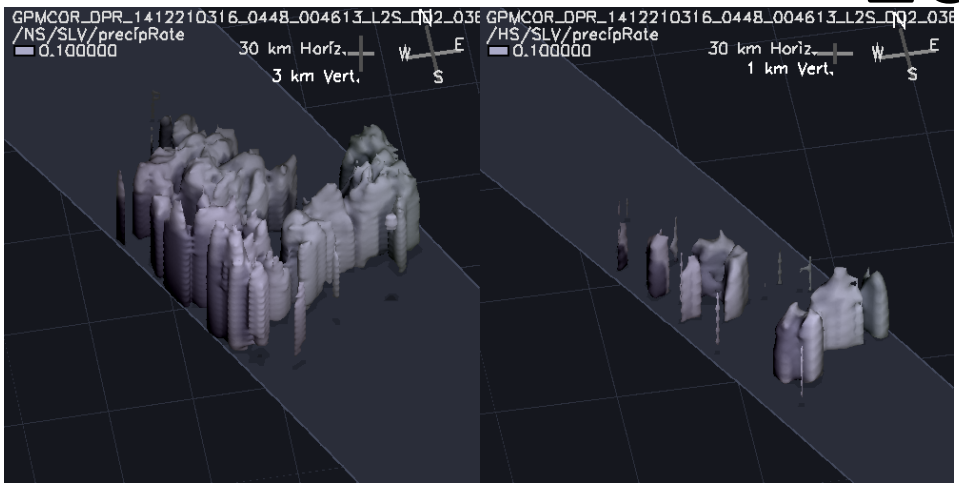
入力：GMI　輝度温度
ルーチン観測データ.

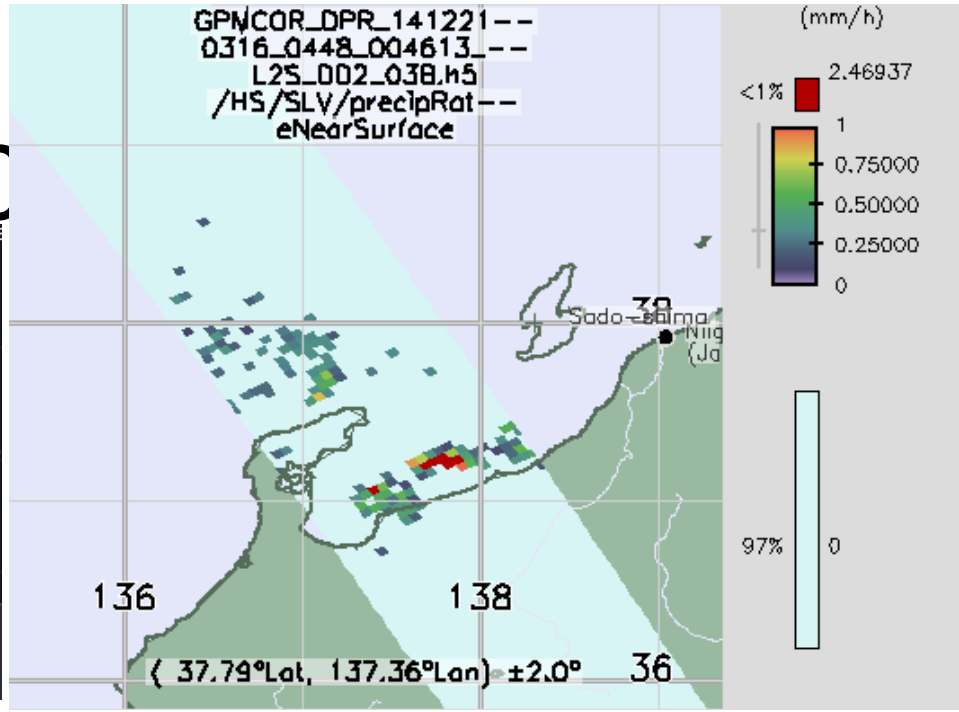
解析:降水＋地上気圧

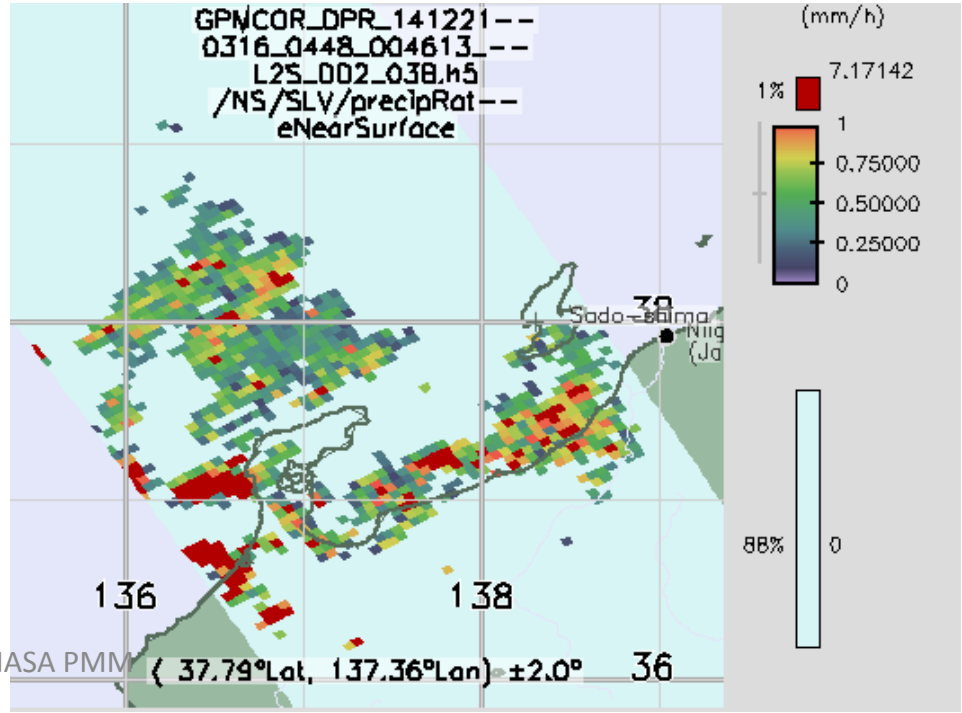


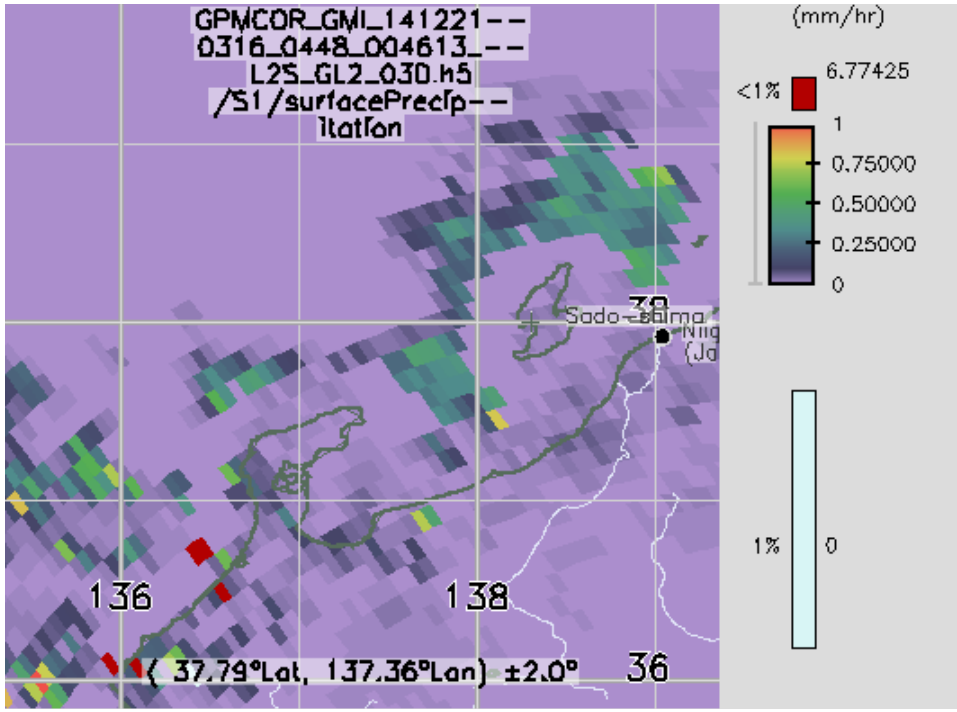
解析:
位置ずれ補正＋NE+EnVA

20

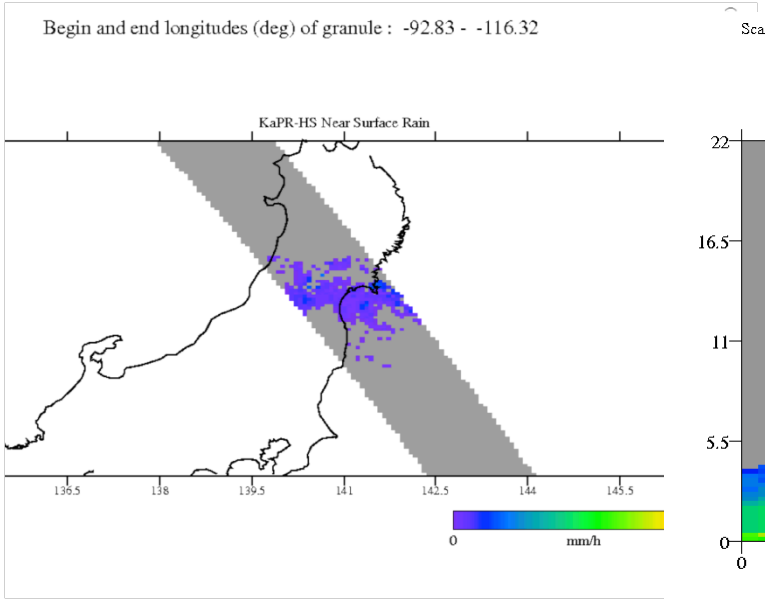

GPMCOR_DPR_1412210316_0448_004613_L2S_002_038
/NS/SLV/precipRate
0.100000
30 km Horiz.
3 km Vert.
GPMCOR_DPR_1412210316_0448_004613_L2S_002_038
/HS/SLV/precipRate
0.100000
30 km Horiz.
1 km Vert.

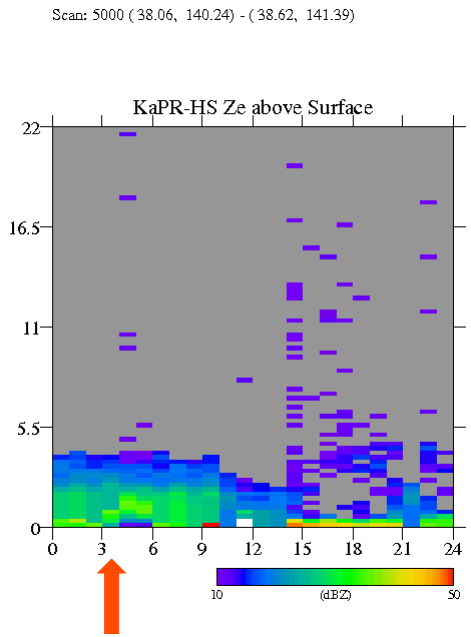

GPMCOR_DPR_141221--
0316_0448_004613_--
L2S_002_038.h5
/HS/SLV/precipRat--
eNearSurface
(mm/h)
<1%
2.46937
1
0.75000
0.50000
0.25000
0
97%
0
136
138
36
(37.79°Lat, 137.36°Lan) ±2.0°

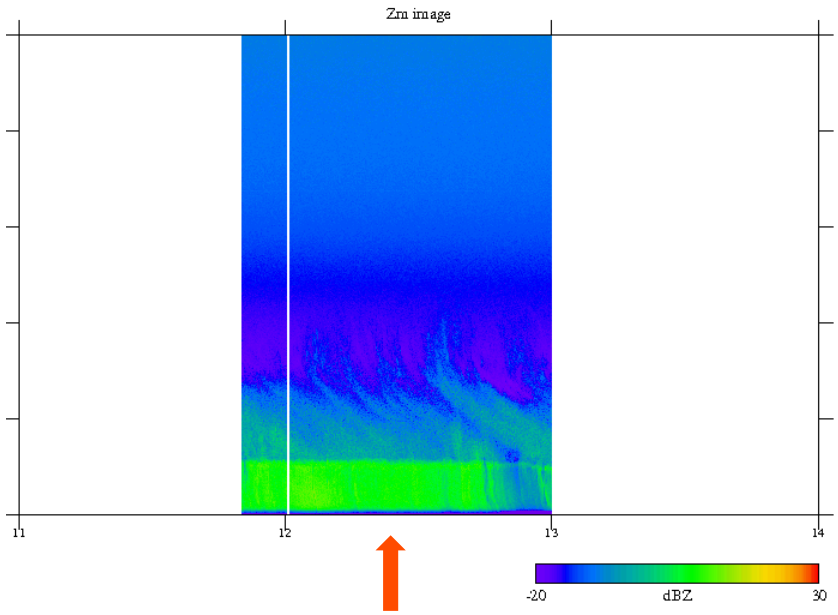

GPMCOR_DPR_141221--
0316_0448_004613_--
L2S_002_038.h5
/NS/SLV/precipRat--
eNearSurface
(mm/h)
1%
7.17142
1
0.75000
0.50000
0.25000
0
88%
0
136
138
36
(37.79°Lat, 137.36°Lan) ±2.0°

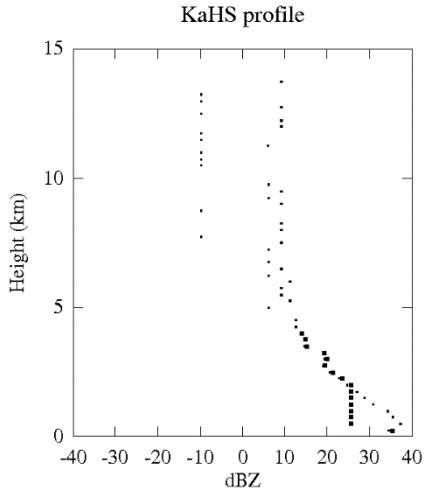

GPMCOR_GMI_141221--
0316_0448_004613_--
L2S_GL2_030.h5
/S1/surfacePrecip--
itation
(mm/hr)
<1%
6.77425
1
0.75000
0.50000
0.25000
0
1%
0
136
138
36
(37.79°Lat, 137.36°Lan) ±2.0°

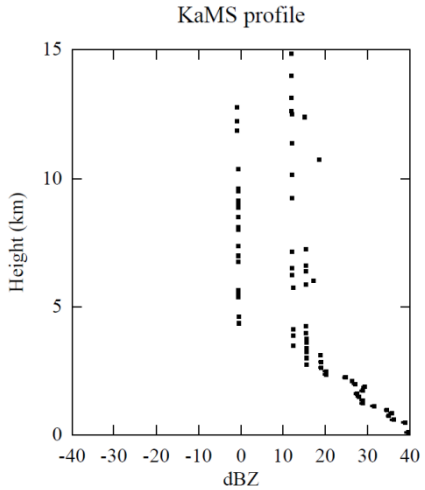
KaPR vs. Ground-based Ka-radar (21 April 2014)

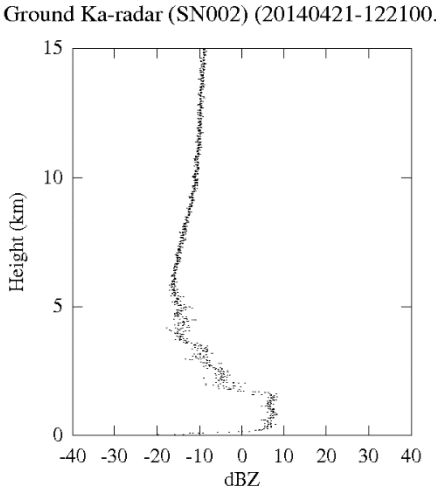












GV Kaneko

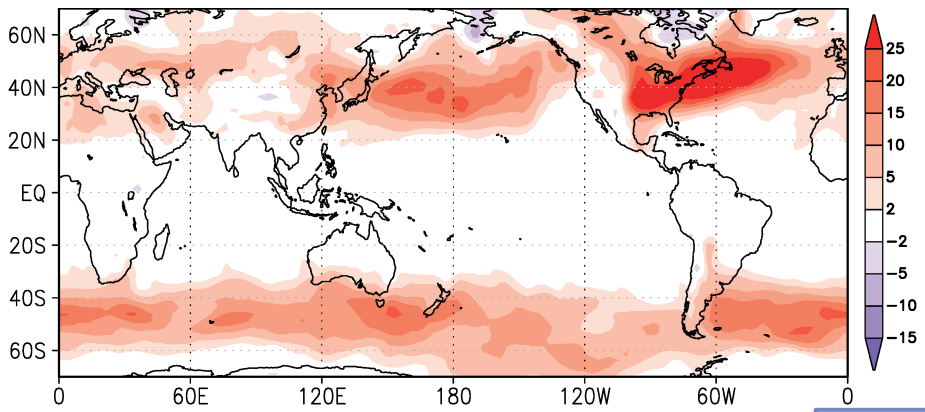
Weather Regime Classification for GPM GSMaP

Using monthly-mean meridional eddy heat flux at 850hPa,

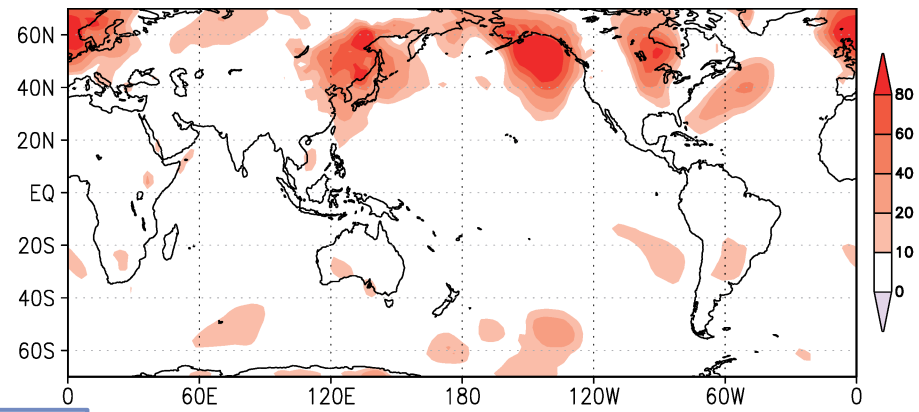
- Classify precip regime <u>outside</u> TRMM region
- Subdivide "extratropical" regime <u>inside</u> TRMM region

Into two regimes: "Extratropical frontal systems" and "Stationary (winter monsoon)"

$\text{sgn(lat)}*\overline{v'T'}_{850hPa}$ (synopotic)

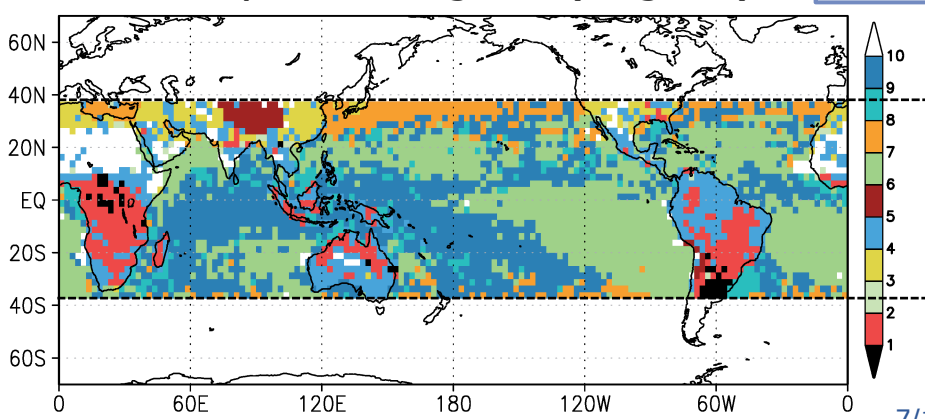


$\text{sgn(lat)}*\overline{v'T'}_{850hPa}$ (stationary)

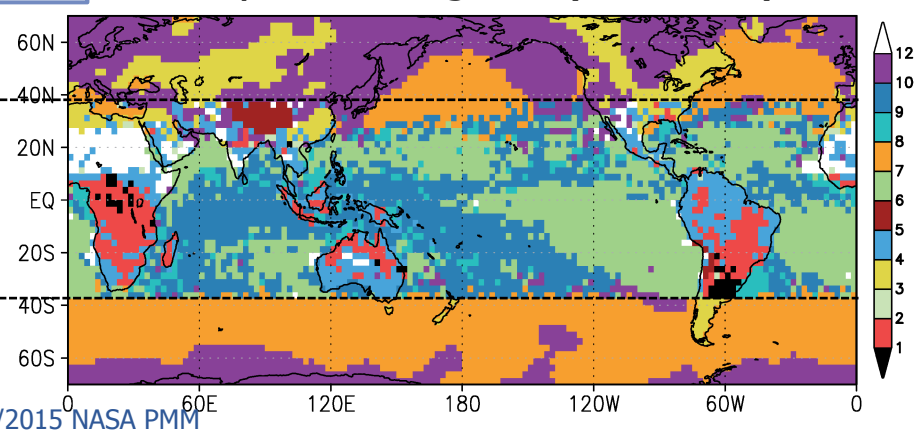


Jan2014

Preciptation regime (original)

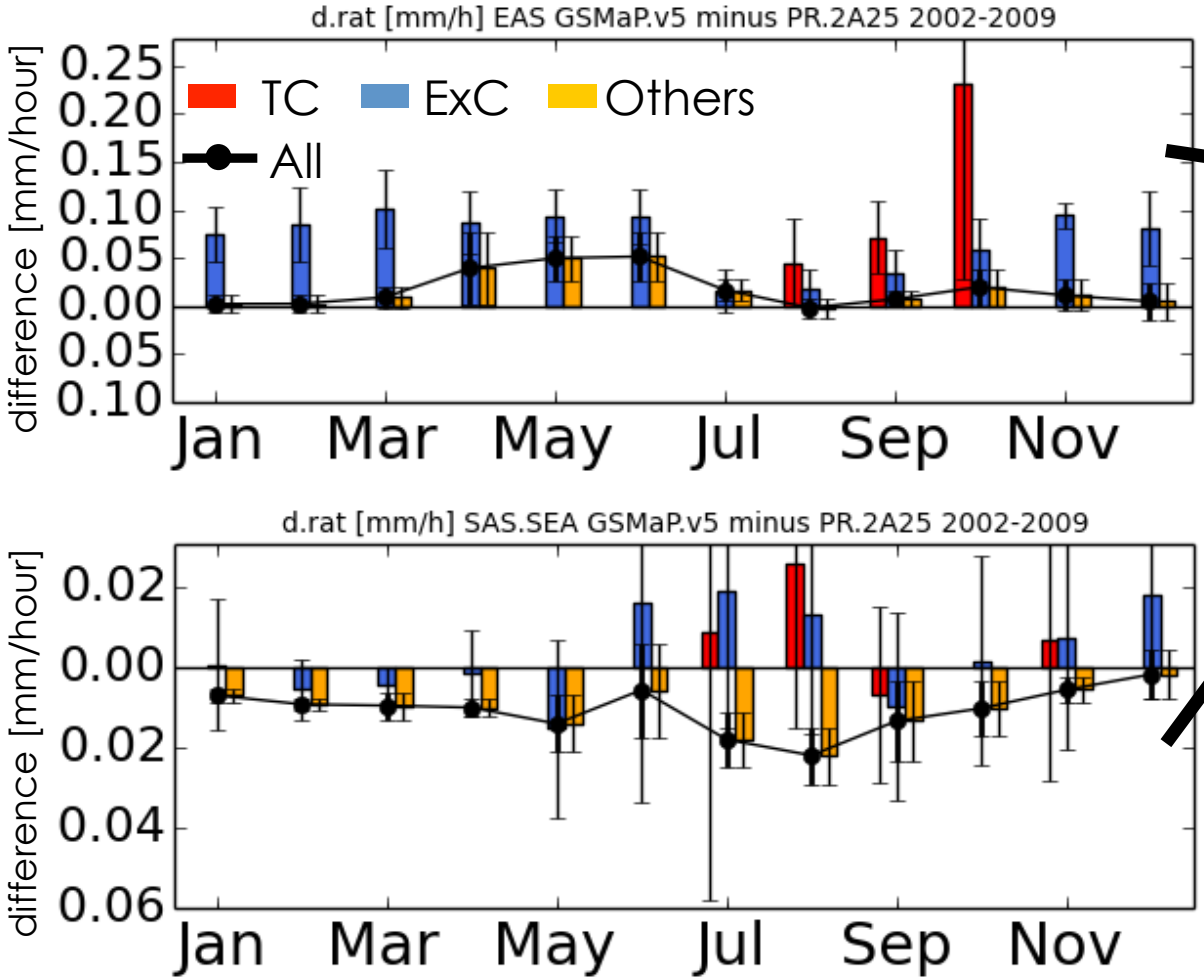


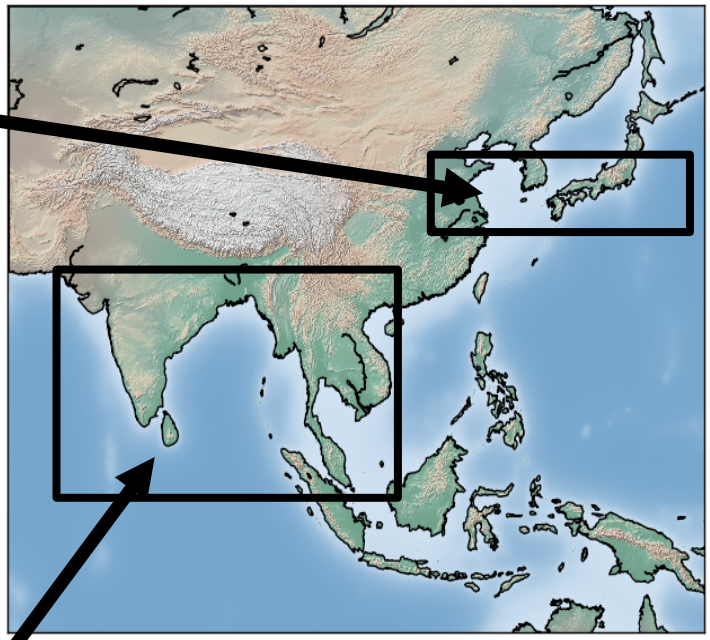
Preciptation regime (modified)



Weather System-wise Intercomparison

(GSMaPv5 – TRMM/PR 2A25v7)

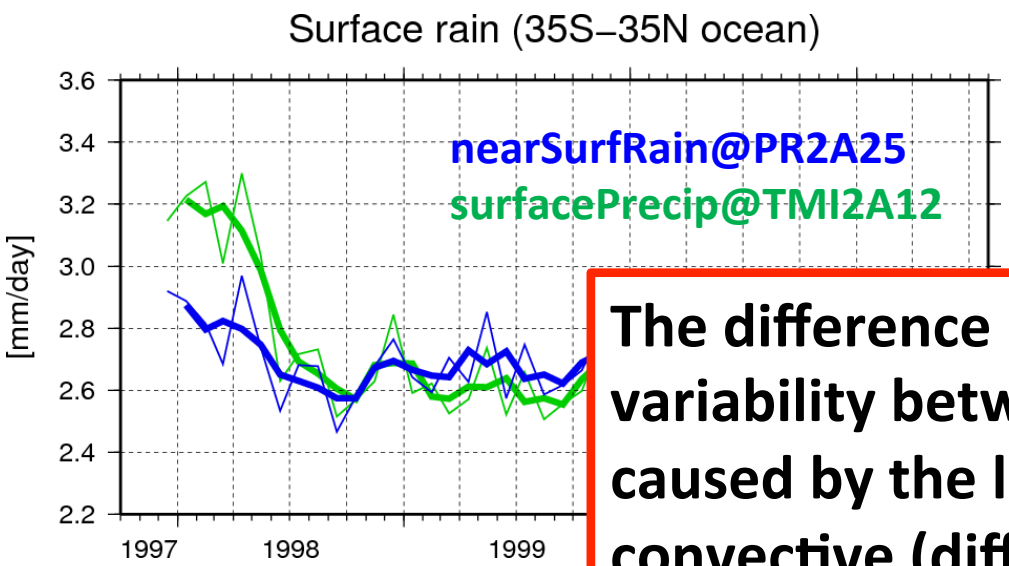




Different biases for …
- ✓ **Different weather systems**
- ✓ **Different seasons**

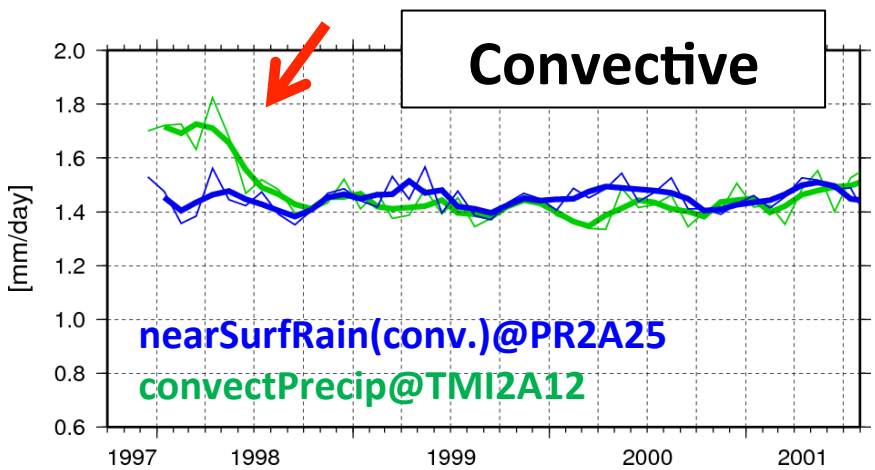
Sensitivities of precipitation measurements among various products varies for background weather systems such as tropical cyclone, extratropical cyclone (center+frontal), and the others.

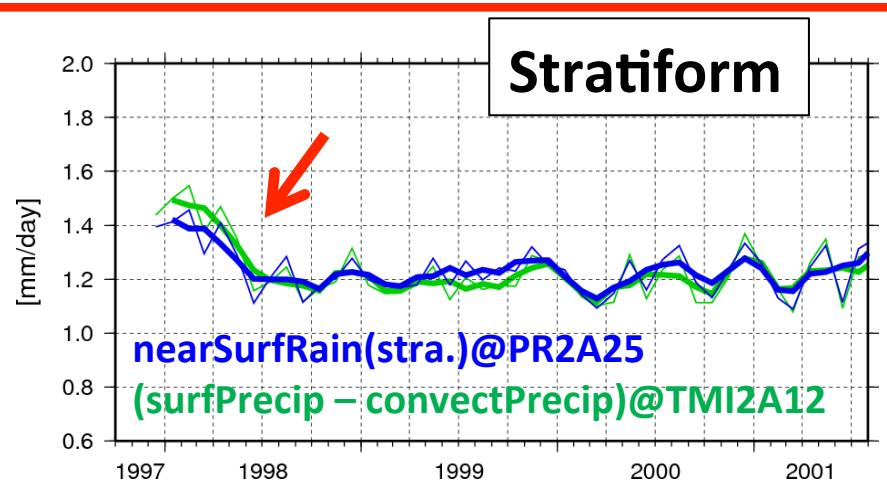
fference in interannual rainfall variability



Solid lines :
monthly average
Thick lines:
3-month running mean

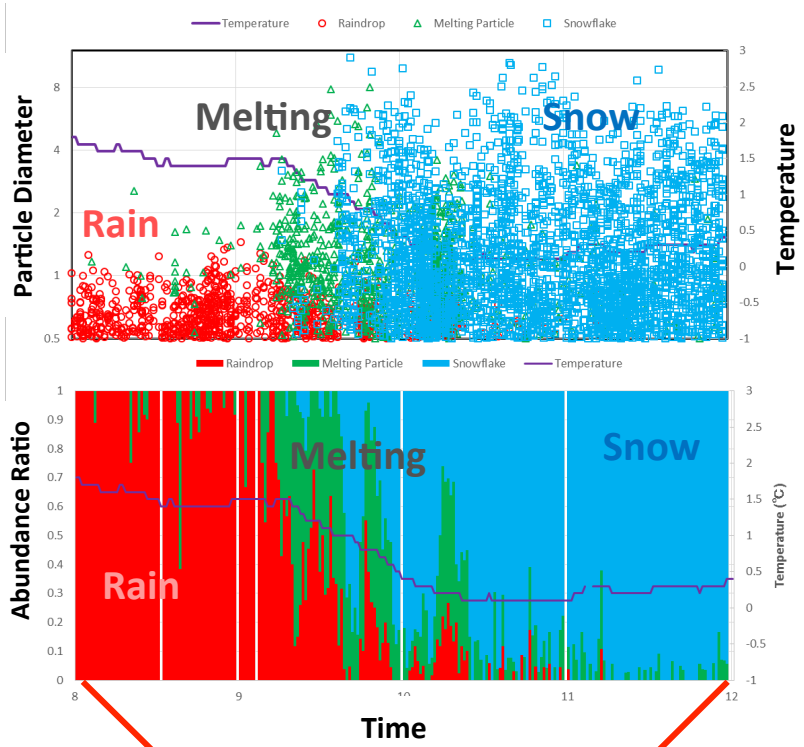
The difference in interannual of rainfall variability between PR and TMI is overall caused by the large discrepancy of convective (difference in stratiform is small).

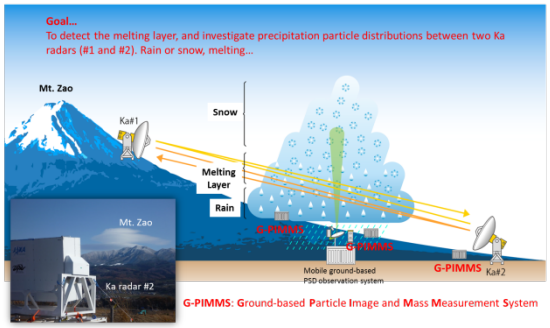


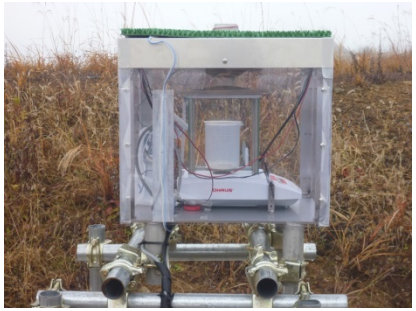


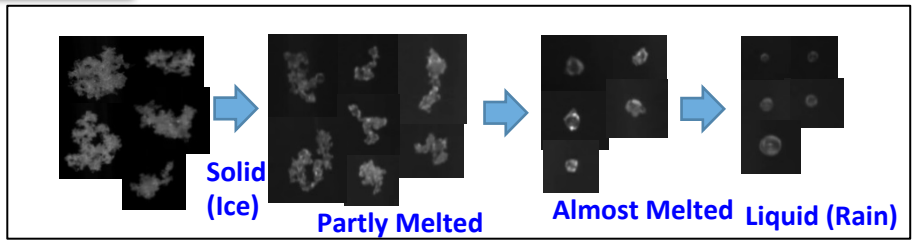
Direct Measurement of Precipitation Particles in Melting Layer using G-PIMMS

Case of November 26, 2014 @ Zao



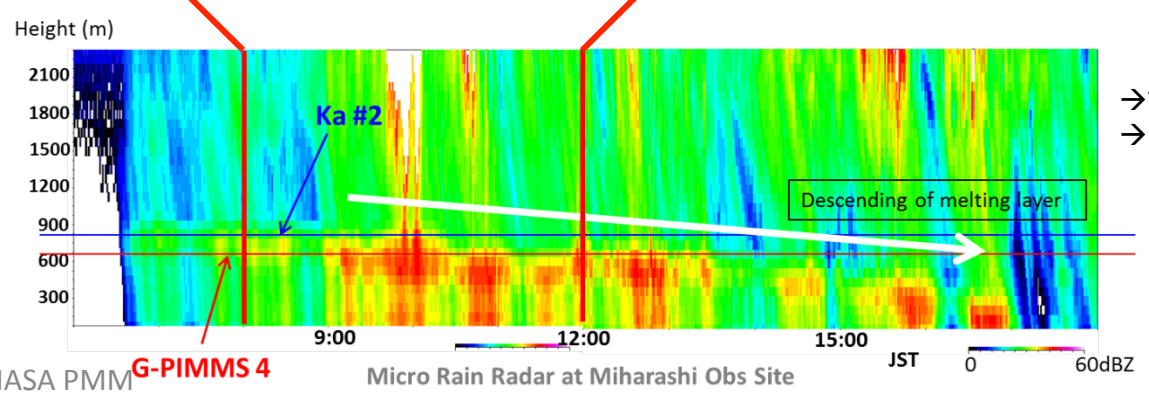






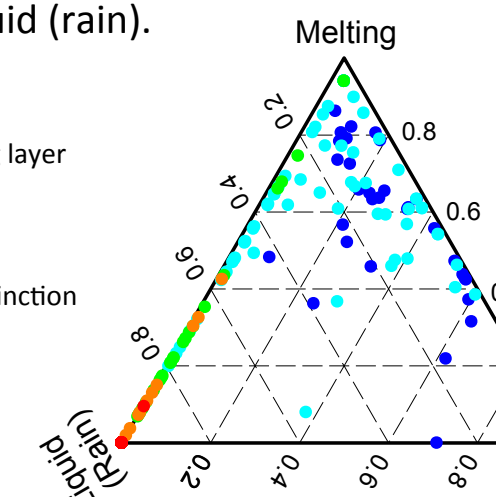
Ground-based Particle Images and Mass Measurement System (G

It consists of two CCD cameras, an infra-red sensor, a strobe and ar balance. Interruption of the infrared beam by a particle triggers the and the particle image is then captured by the CCD camera. Precipi particle images obtained from **G-PIMMS**., which are classified into partly melted, almost melted, and liquid (rain).



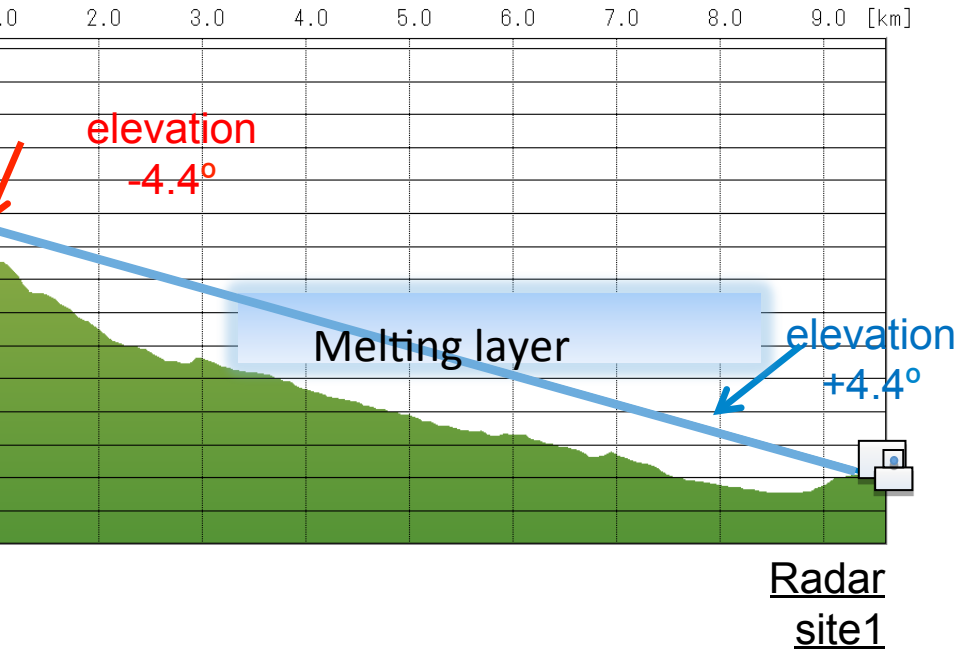
→Vertical structure of melting layer
→Dry snow or Wet snow?

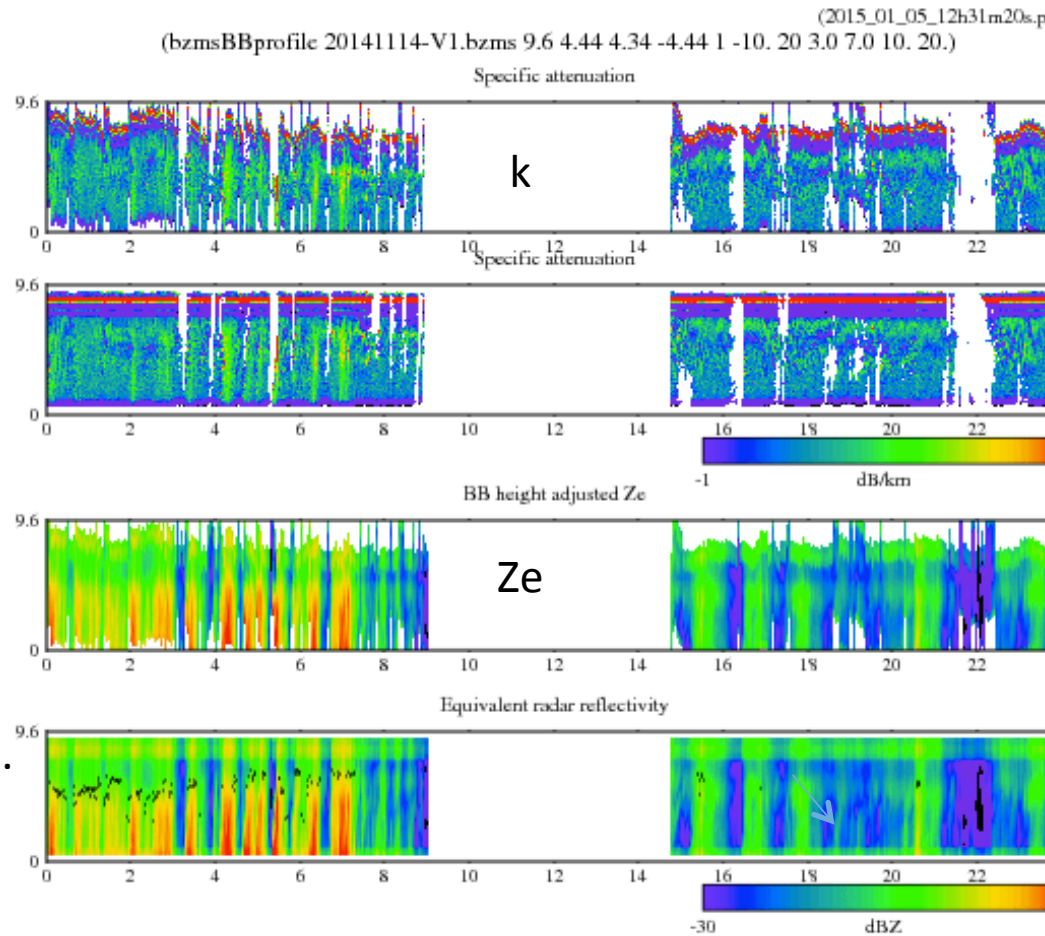
Rain/Snow/melting distinction depending temperature



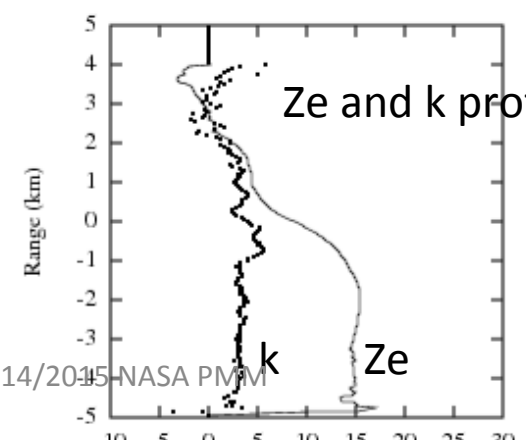
al Ka radar experiment in Mt. Zao

K. Nakamura and Y. Kaneko





Dotted rays are processed.
(14 Nov. 2014)



Ze and k profiles in and around BB