Current status of Korean Met/Env Sat programs

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Korean Met/Env Satellite Programs

GK-1: COMS - first multi-purpose geostationary satellite for Korea in Meteorology, Ocean and Communication (launched in 2010)

GK-2A: Meteorological Satellite (to be launched in 2018)
GK-2B: GEMS/GOCI (to be launched in 2019)

Development of Korean Meteorological LEO satellite

COMS

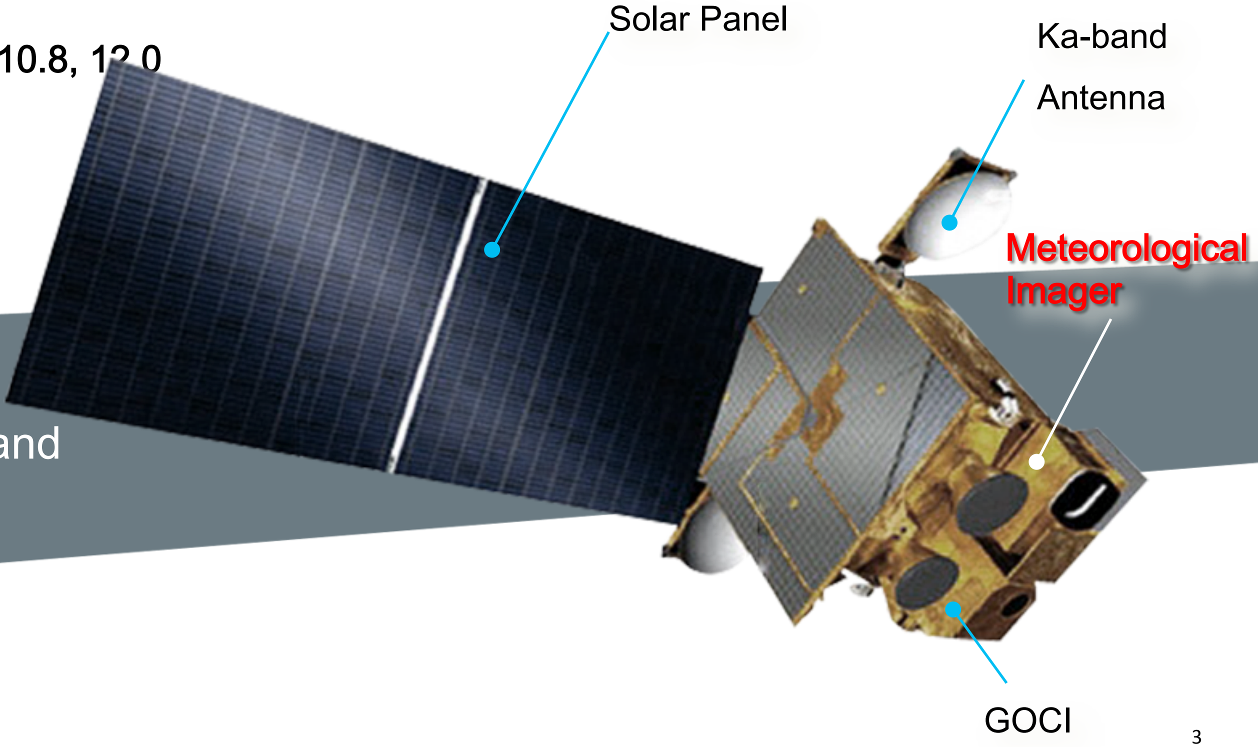
COMS(GK-1) is the first multi-purpose geostationary satellite for Korea in the application of Meteorology, Ocean and Communication

Meteorological Mission : Continuous Observation to support weather forecasting
and early detection of severe weather phenomena

Launched: June 27, 2010

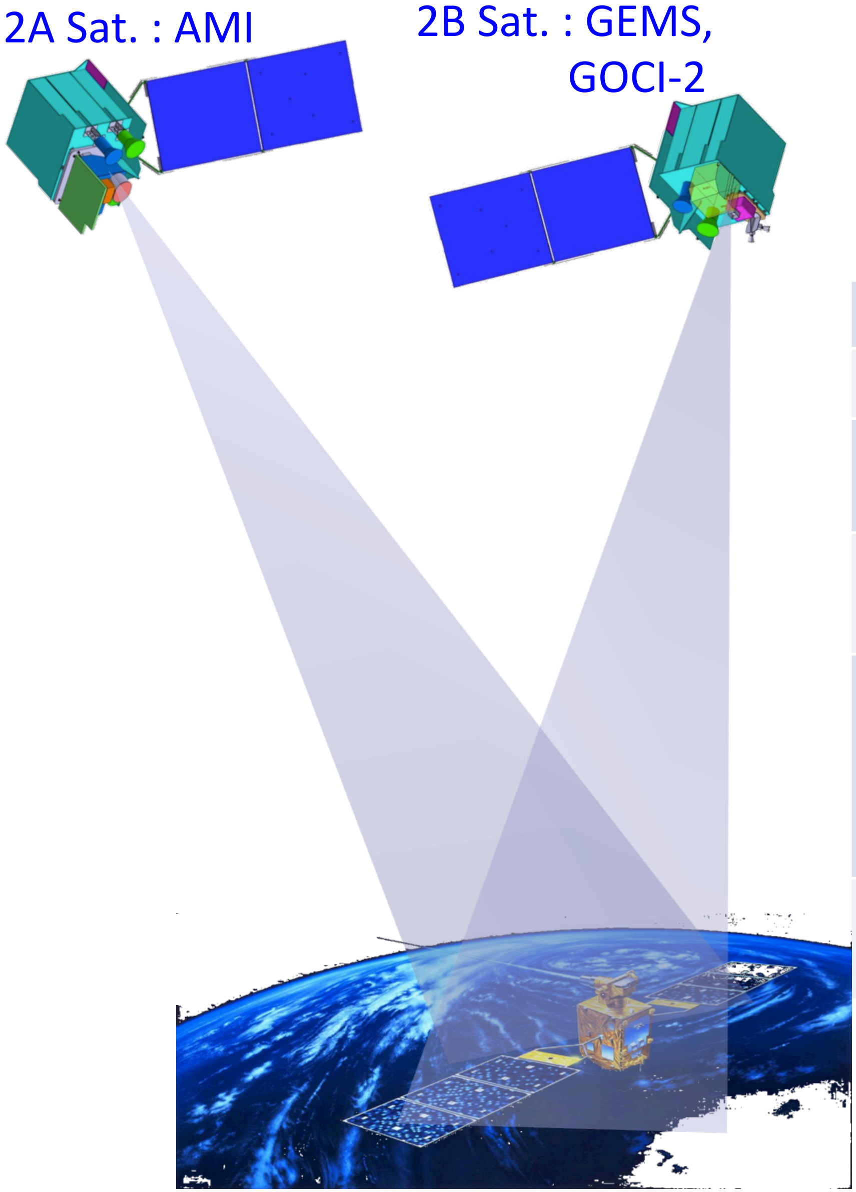
Orbit : 128.2°E

Channels: 0.67, 3.7, 6.7, 10.8, 12.0



Communication, Ocean and Meteorological Satellite

GEO-KOMPSAT 2



- Launch
  2A: May 2018 , 2B: Mar 2019

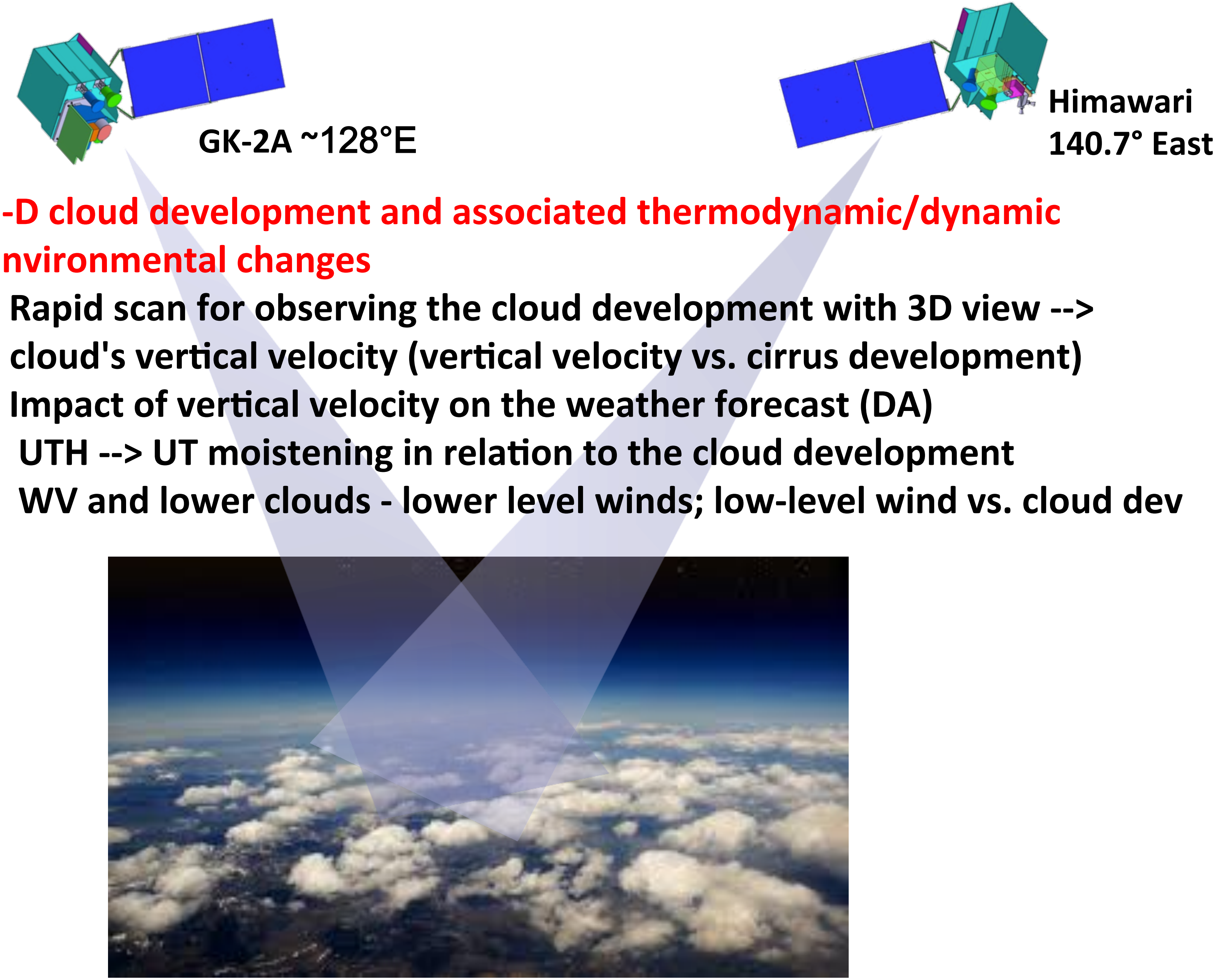
Specification

	2A	2B	
Payload	AMI	GOCI-2	GEMS
Lifetime	10 years		
Channels	16	13	1000
Wavelength range	0.4 - 13 μm	375 - 860 nm	300-500 nm
Spatial resolution	0.5 / 1 km (Vis) 2 km (IR)	250 m@ eq 1 km (FD)	7 x 8 km^2 @ Seoul 3.5x8 km^2 (aerosol)
Temporal resolution	10 min (FD)	1 hour (1 FD/day)	1 hour

GEO-KOMPSAT-2A AMI (Advanced Meteorological Imager)

- Multi-channel capacity: 16 channels
- Temporal resolution: within 10 minutes for Full Disk observation
- Flexibility for the regional area selection and scheduling
- Lifetime of meteorological mission: 10 years

Bands		Center Wavelength		Band Width (Max, um)	Resolution (km)	GOES-R (ABI)	Himawari-8 (AHI)
		Min(um)	Max(um)				
VNIR	VIS0.4	0.431	0.479	0.075	1	0.47	0.46
	VIS0.5	0.5025	0.5175	0.0625	1		0.51
	VIS0.6	0.625	0.66	0.125	0.5	0.64	0.64
	VIS0.8	0.8495	0.8705	0.0875	1	0.865	0.86
	NIR1.3	1.373	1.383	0.03	2	1.378	
	NIR1.6	1.601	1.619	0.075	2	1.61	1.6
	NIR2.2				2	3.35	2.3
MWIR	IR3.8	3.74	3.96	0.5	2	3.90	3.9
	IR6.3	6.061	6.425	1.038	2	6.185	6.2
	IR6.9	6.89	7.01	0.5	2	6.95	7.0
	IR7.3	7.258	7.433	0.688	2	7.34	7.3
	IR8.7	8.44	8.76	0.5	2	8.50	8.6
LWIR	IR9.6	9.543	9.717	0.475	2	9.61	9.6
	IR10.5	10.25	10.61	0.875	2	10.35	10.4
	IR11.2	11.08	11.32	1.0	2	11.2	11.2
	IR12.3	12.15	12.45	1.25	2	12.3	12.3
	IR13.3	13.21	13.39	0.75	2	13.3	13.3



3-D cloud development and associated thermodynamic/dynamic environmental changes

- Rapid scan for observing the cloud development with 3D view --> cloud's vertical velocity (vertical velocity vs. cirrus development)
- Impact of vertical velocity on the weather forecast (DA)
- UTH --> UT moistening in relation to the cloud development
- WV and lower clouds - lower level winds; low-level wind vs. cloud dev

LEO Satellite development (Plan)

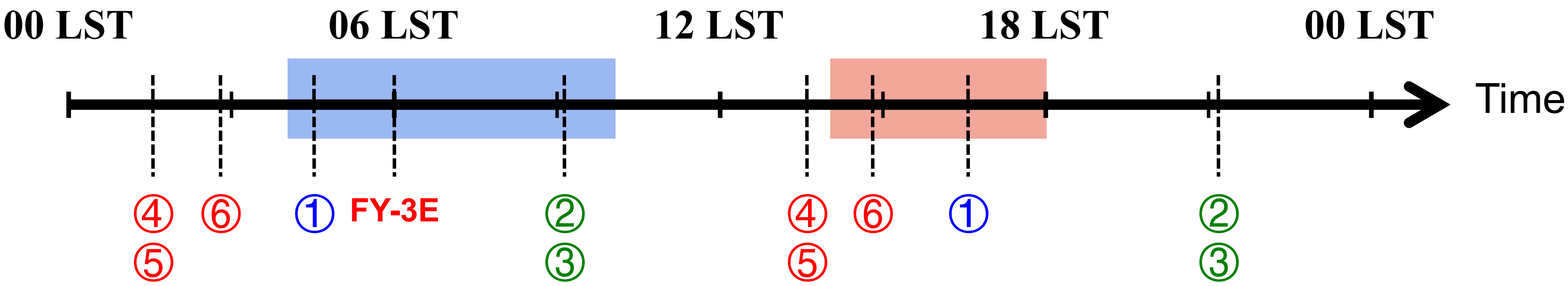
- **Long-term LEO satellite development Plans** was approved by National Space Development Committee(‘14.2) : 12 LEO satellites development(’14~’25)
  - KMA LEO satellite launching : 2022

- **2015 : Surveying potential meteorological payloads(ATMS, CrIS, GPM)**
  : Research on economical and social benefits
  : impact studies on NWP (orbit and sensor elimination tests using operational model, UM512)

- **2016 : Feasibility test request** for KMA LEO satellite development budget

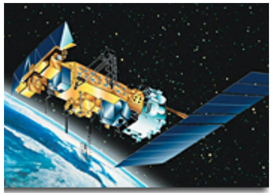
- **Goal : Project kick-off no later than 2018, targeting to launch in 2023.**

Eq-crossing times of polar satellites



✓ **Early morning (EM) satellites**

① **NOAA-15 AMSU-A/B (MW)**



✓ **Morning (M) satellites**

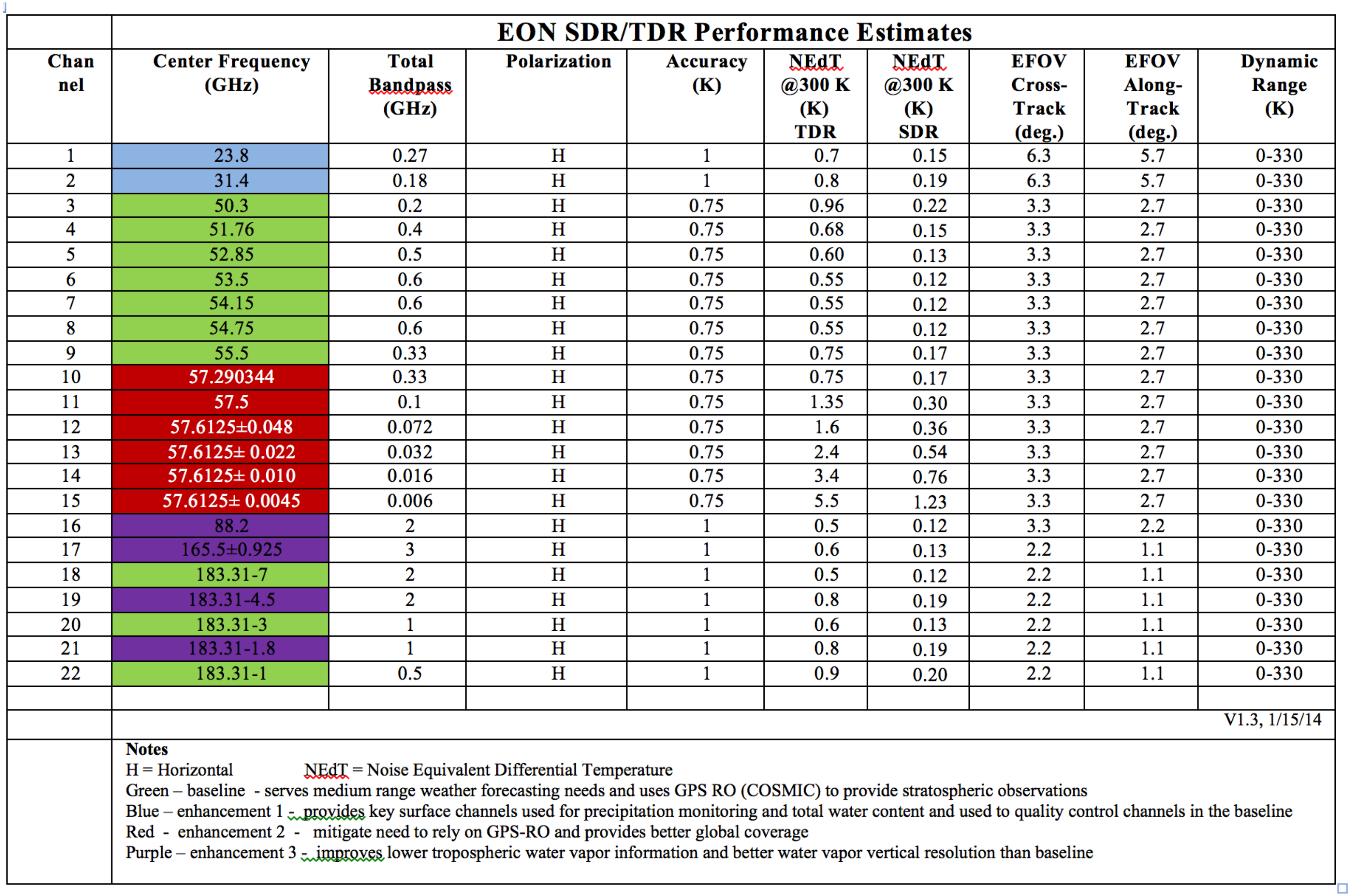
② **Metop-A AMSU-A/MHS (MW)**
③ **Metop-A IASI (IR)**

✓ **Afternoon (A) satellites**

④ **Aqua AIRS (IR)**
⑤ **NOAA-19 AMSU-A/MHS (MW)**
⑥ **NOAA-18 AMSU-A/MHS (MW)**

Korean Polar Sat will likely have dawn/dusk crossing time

Microwave Channel Priority from NWS



EON SDR/TDR Performance Estimates

Channel	Center Frequency (GHz)	Total Bandpass (GHz)	Polarization	Accuracy (K)	NEdT @300 K (K) TDR	NEdT @300 K (K) SDR	EFOV Cross-Track (deg.)	EFOV Along-Track (deg.)	Dynamic Range (K)
1	🟦 23.8	0.27	H	1	0.7	0.15	6.3	5.7	0-330
2	🟦 31.4	0.18	H	1	0.8	0.19	6.3	5.7	0-330
3	🟩 50.3	0.2	H	0.75	0.96	0.22	3.3	2.7	0-330
4	🟩 51.76	0.4	H	0.75	0.68	0.15	3.3	2.7	0-330
5	🟩 52.85	0.5	H	0.75	0.60	0.13	3.3	2.7	0-330
6	🟩 53.5	0.6	H	0.75	0.55	0.12	3.3	2.7	0-330
7	🟩 54.15	0.6	H	0.75	0.55	0.12	3.3	2.7	0-330
8	🟩 54.75	0.6	H	0.75	0.55	0.12	3.3	2.7	0-330
9	🟩 55.5	0.33	H	0.75	0.75	0.17	3.3	2.7	0-330
10	🟥 57.290344	0.33	H	0.75	0.75	0.17	3.3	2.7	0-330
11	🟥 57.5	0.1	H	0.75	1.35	0.30	3.3	2.7	0-330
12	🟥 57.6125±0.048	0.072	H	0.75	1.6	0.36	3.3	2.7	0-330
13	🟥 57.6125± 0.022	0.032	H	0.75	2.4	0.54	3.3	2.7	0-330
14	🟥 57.6125± 0.010	0.016	H	0.75	3.4	0.76	3.3	2.7	0-330
15	🟥 57.6125± 0.0045	0.006	H	0.75	5.5	1.23	3.3	2.7	0-330
16	🟪 88.2	2	H	1	0.5	0.12	3.3	2.2	0-330
17	🟪 165.5±0.925	3	H	1	0.6	0.13	2.2	1.1	0-330
18	🟩 183.31-7	2	H	1	0.5	0.12	2.2	1.1	0-330
19	🟪 183.31-4.5	2	H	1	0.8	0.19	2.2	1.1	0-330
20	🟩 183.31-3	1	H	1	0.6	0.13	2.2	1.1	0-330
21	🟪 183.31-1.8	1	H	1	0.8	0.19	2.2	1.1	0-330
22	🟩 183.31-1	0.5	H	1	0.9	0.20	2.2	1.1	0-330

V1.3, 1/15/14

Notes

H = Horizontal NEdT = Noise Equivalent Differential Temperature

Green – baseline - serves medium range weather forecasting needs and uses GPS RO (COSMIC) to provide stratospheric observations

Blue – enhancement 1 - provides key surface channels used for precipitation monitoring and total water content and used to quality control channels in the baseline

Red - enhancement 2 - mitigate need to rely on GPS-RO and provides better global coverage

Purple – enhancement 3 - improves lower tropospheric water vapor information and better water vapor vertical resolution than baseline

T, q sounding chs (near 60 GHz, 183 GHz), and 19, 22, 37, 89 GHz chs

Platform will have a weight of ~500 kg.

Instrument carrying the baseline channels may be around 100 kg
: Sounding channels
60 GHz O2 channels for temperature
183 GHz H2O channels for water vapor
: Window channels and weak H2O absorption channels
19, 22, 37, 89 GHz channels

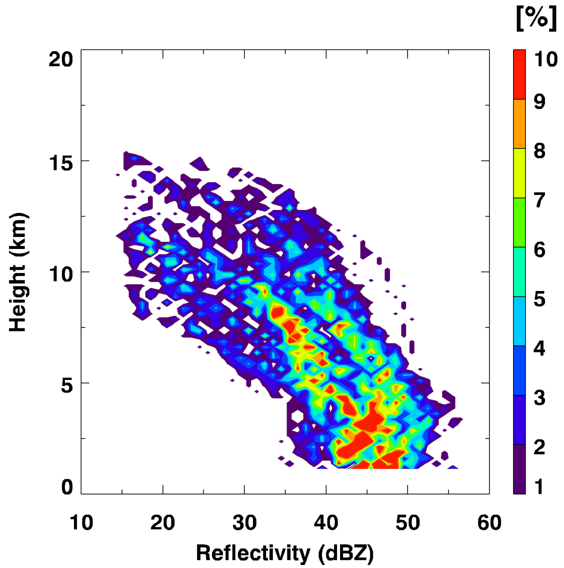
Thus, about ~50 kg space may be available.

It should be much beneficial to carry a small precipitation radar within 50 kg because it can become an important satellite for the GPM constellation;
it can provide a possible GPM calibration board particularly if the GPM core satellite has problems beyond 2024 or so. (GPM Core Sat was launched on February 28, 2014)

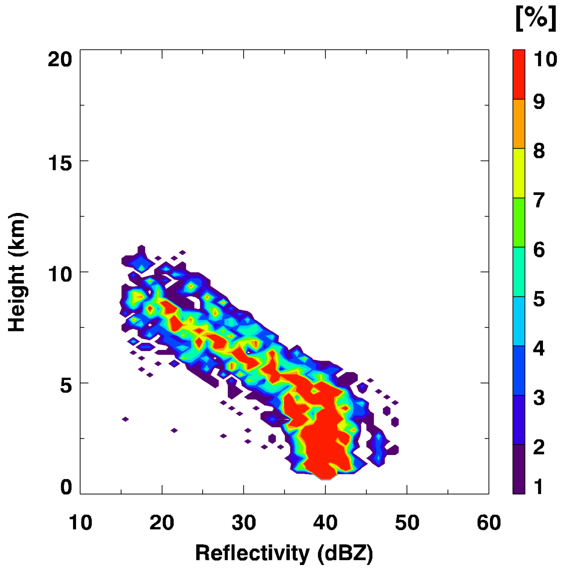
Warm-type heavy precipitation, diurnal variation in particular focusing on the rainfall in the early morning.

TRMM PR Ze CFADs (RR > 10 mm h^{-1})

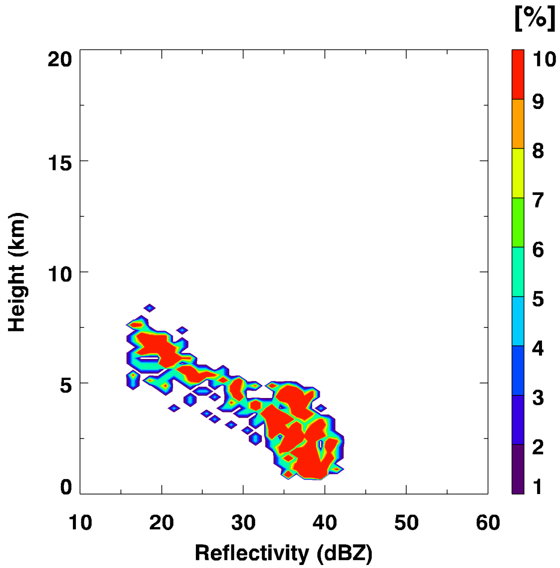
China
23 Aug. 2002

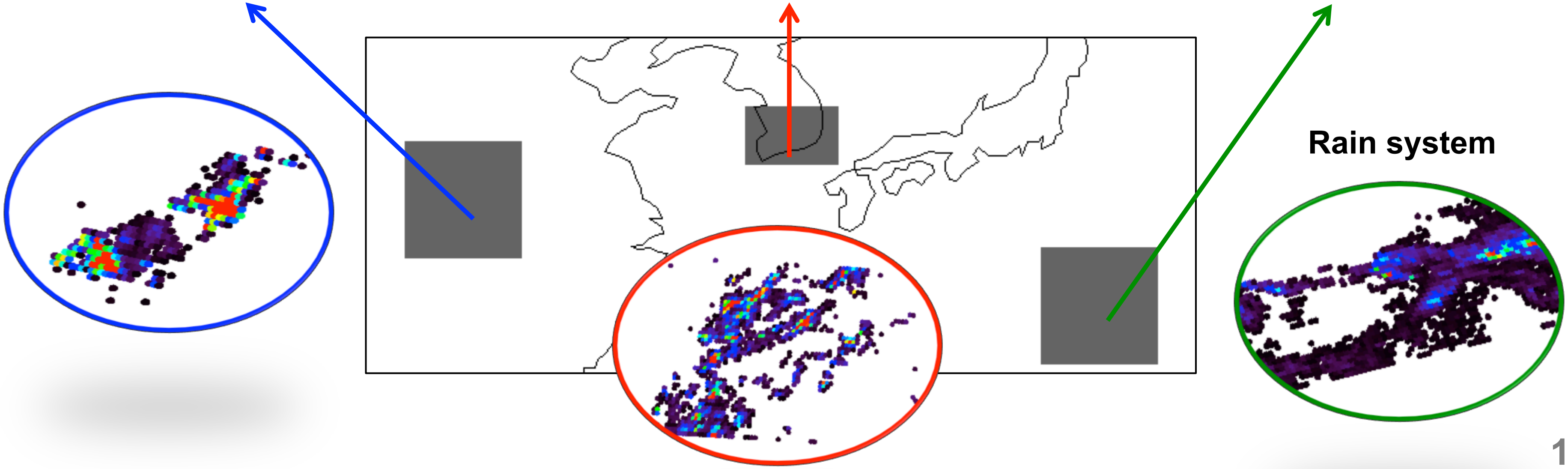


Korea
6 Aug. 2002

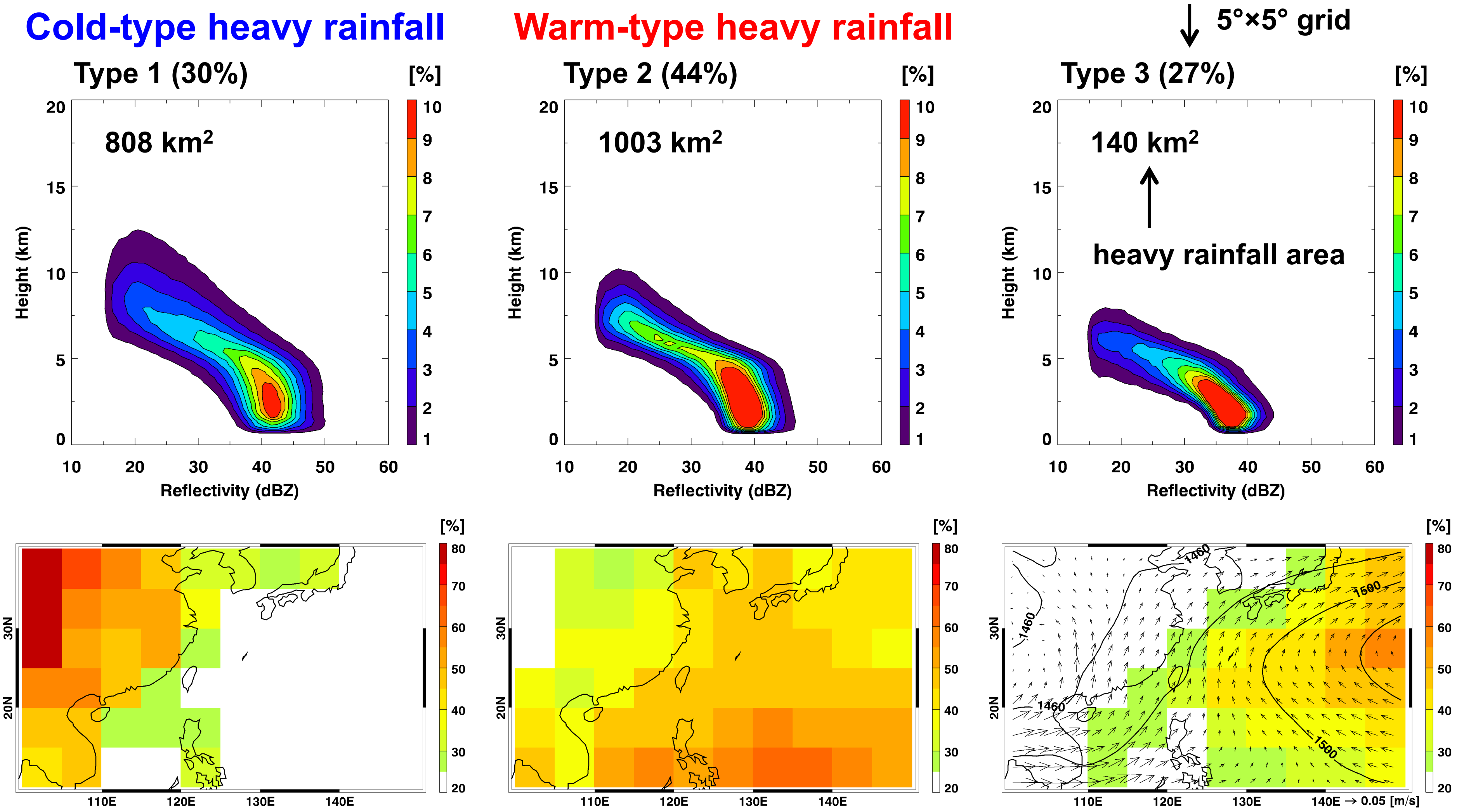


North Pacific high
1 Jun. 2002





K-means Clustering Analysis of TRMM PR Ze over East Asia (RR > 10 mm hr^{-1}) JJA 2002-2011



Cold-type heavy rainfall

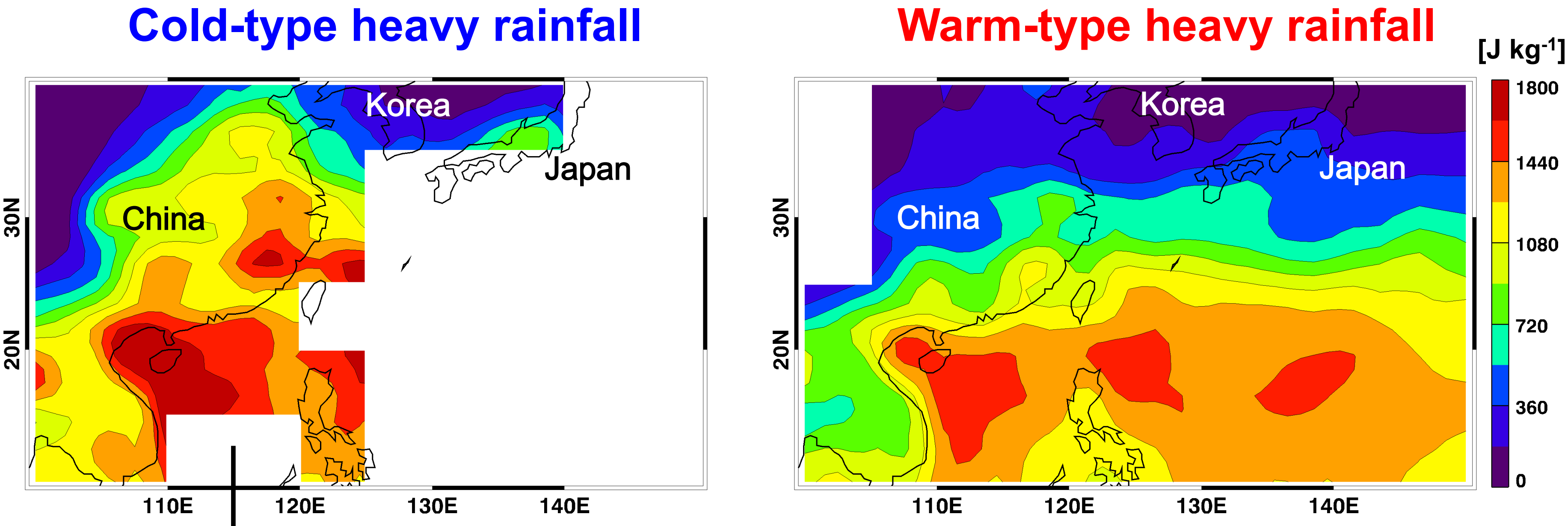
Warm-type heavy rainfall

↓ 5°×5° grid

Solid Line: $Z_{850\ hPa}$, Arrow: $qV_{850\ hPa}$, Color: Occurrence frequency

Convective Available Potential Energy (CAPE)

JJA 2002–2011
ERA-Interim



Cold-type heavy rainfall

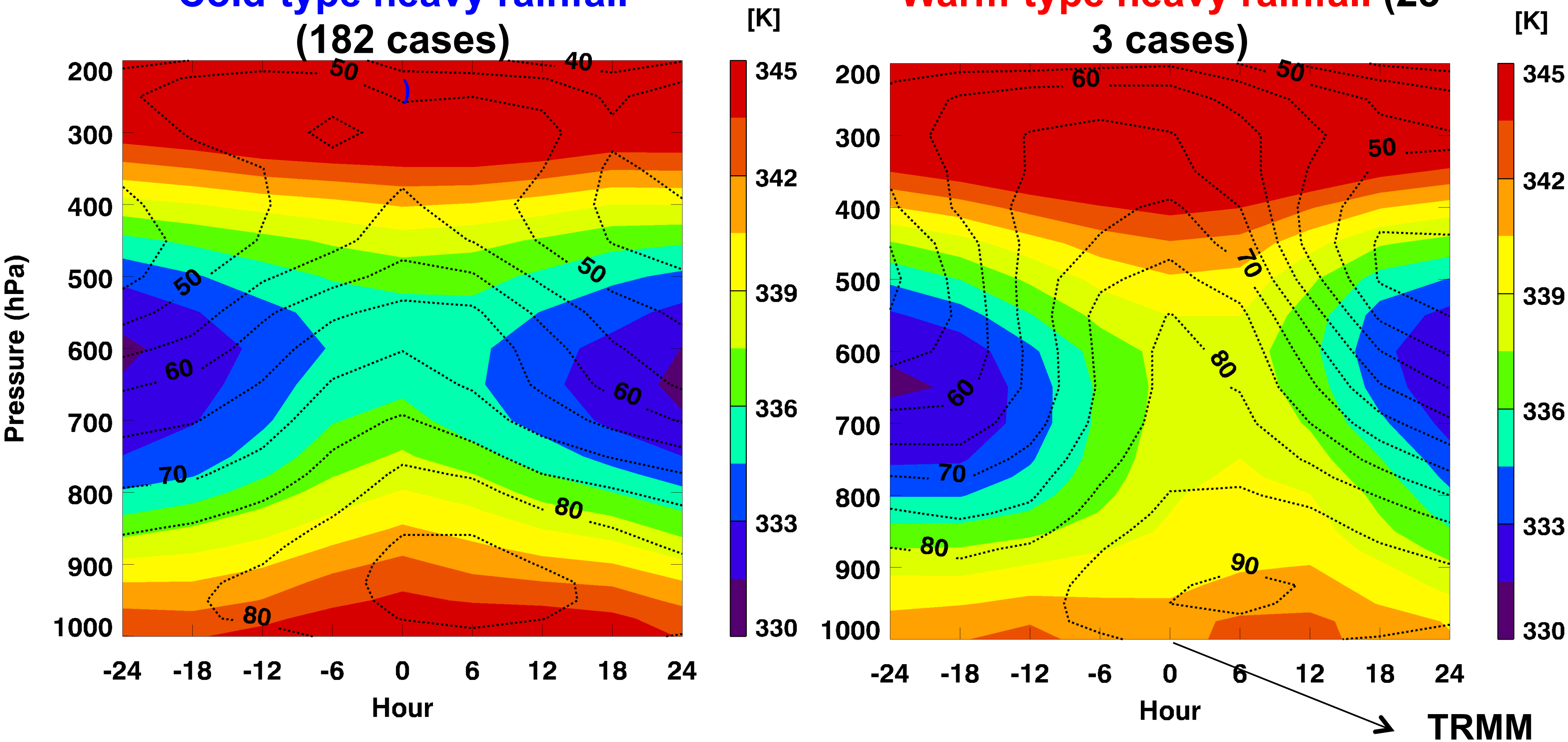
Warm-type heavy rainfall

N (TRMM PR rain rate > 10 mm h^{-1}) < 10000 pixels

Temporal evolution of θ_e (z), RH (z)

Cold-type heavy rainfall (182 cases)

Warm-type heavy rainfall (233 cases)



TRMM visit time

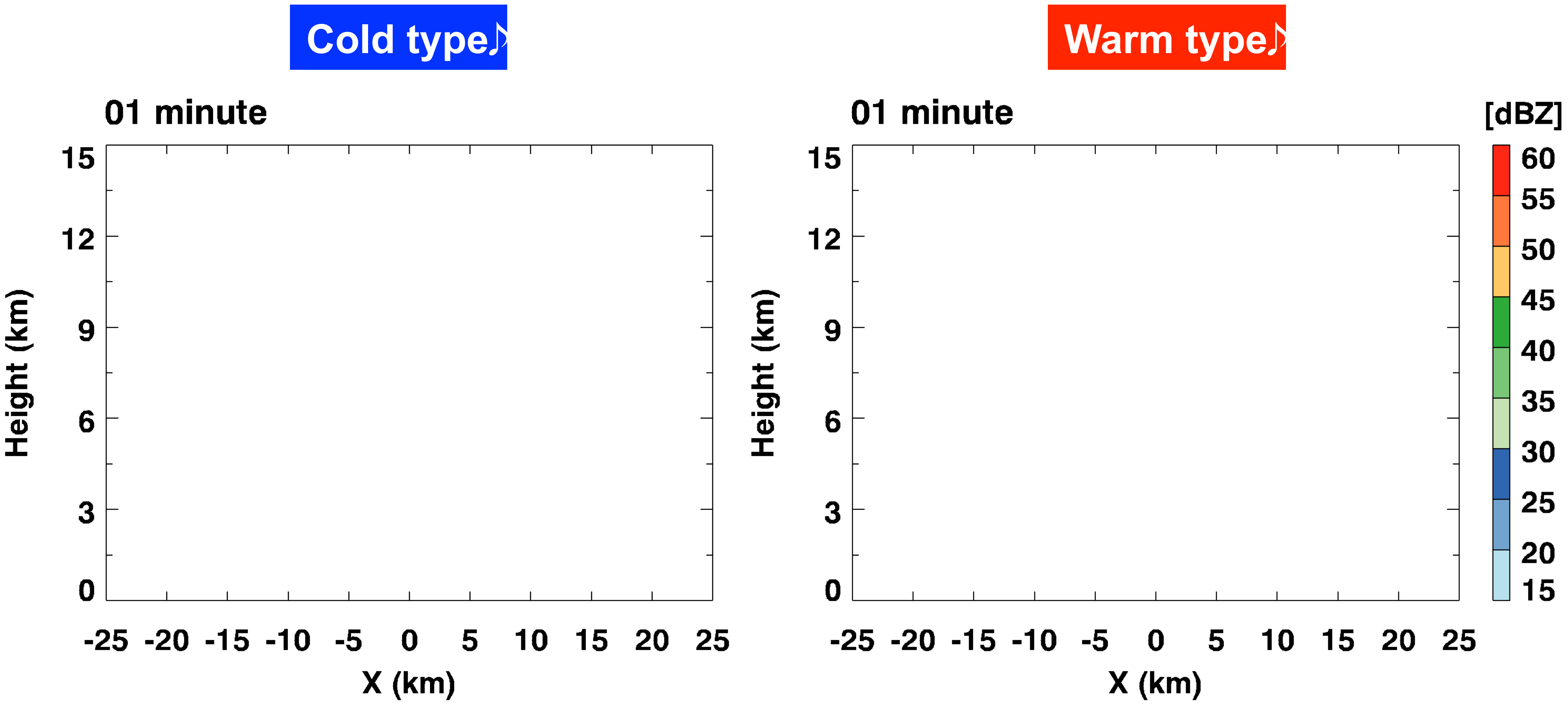
Convective instability

Moist adiabatically near neutral

Color: θ_e (K), Dotted line: RH (%)

Storm Evolution

Radar Reflectivity (Color) & Vertical Velocity (Contour)



Initial condition: a warm bubble with 4-km in radius and maximum 3 K perturbation

Reflectivity (D_{rain} vs. N_{rain})

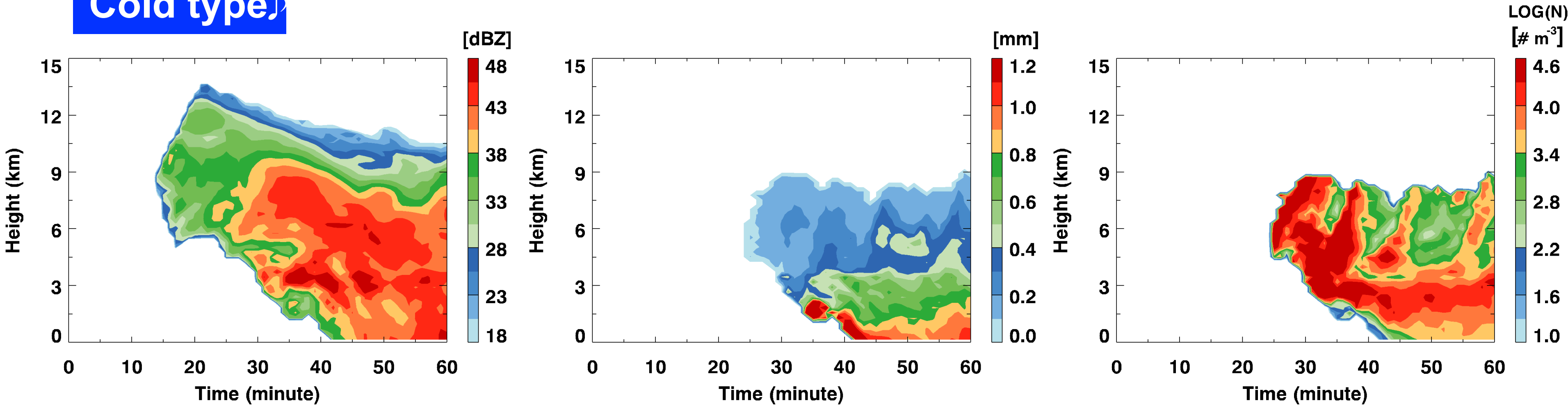
$$Z=\int_0^{\infty} N(d) D^6 \, dD$$

Radar reflectivity (Z)

Diameter$_{rain}$

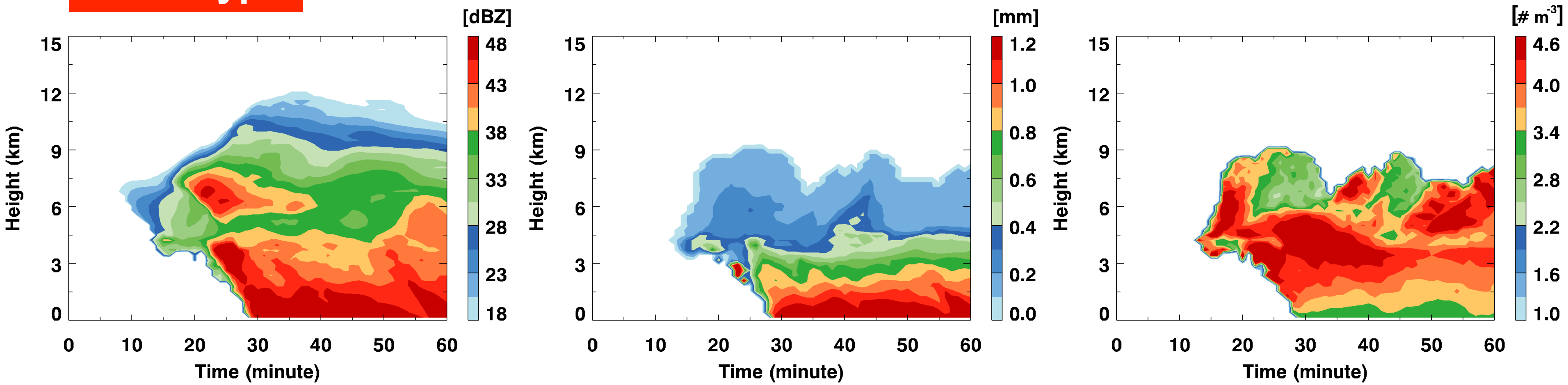
Number concentration$_{rain}$

Cold type

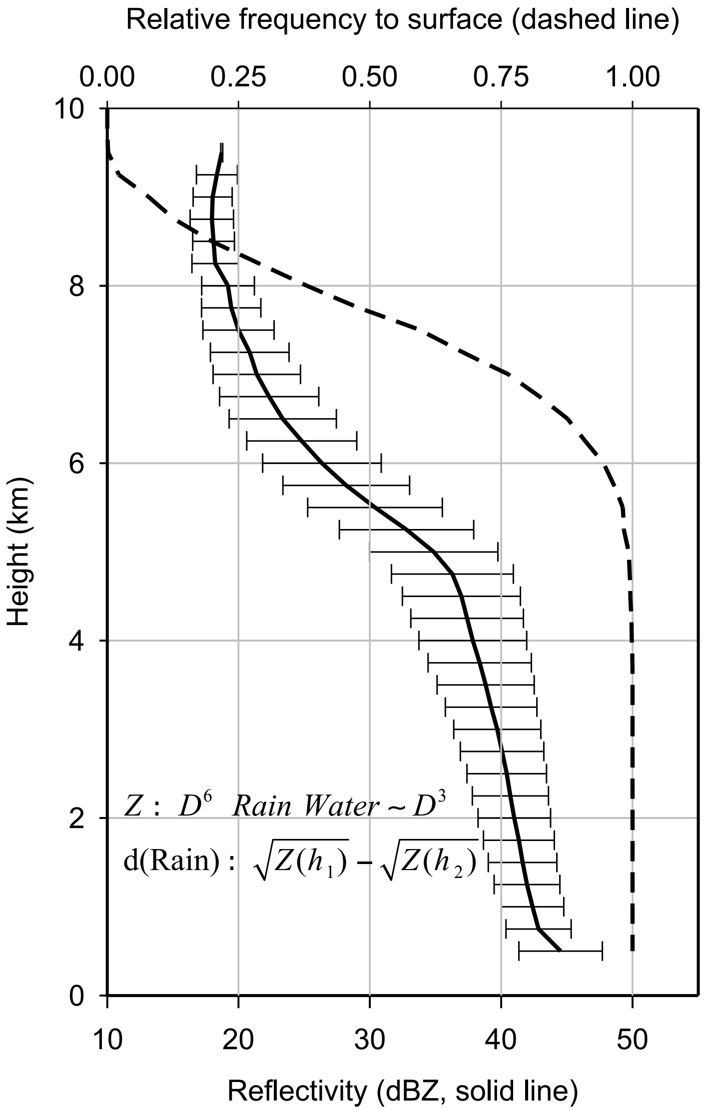


Warm type

Strong collision-coalescence process

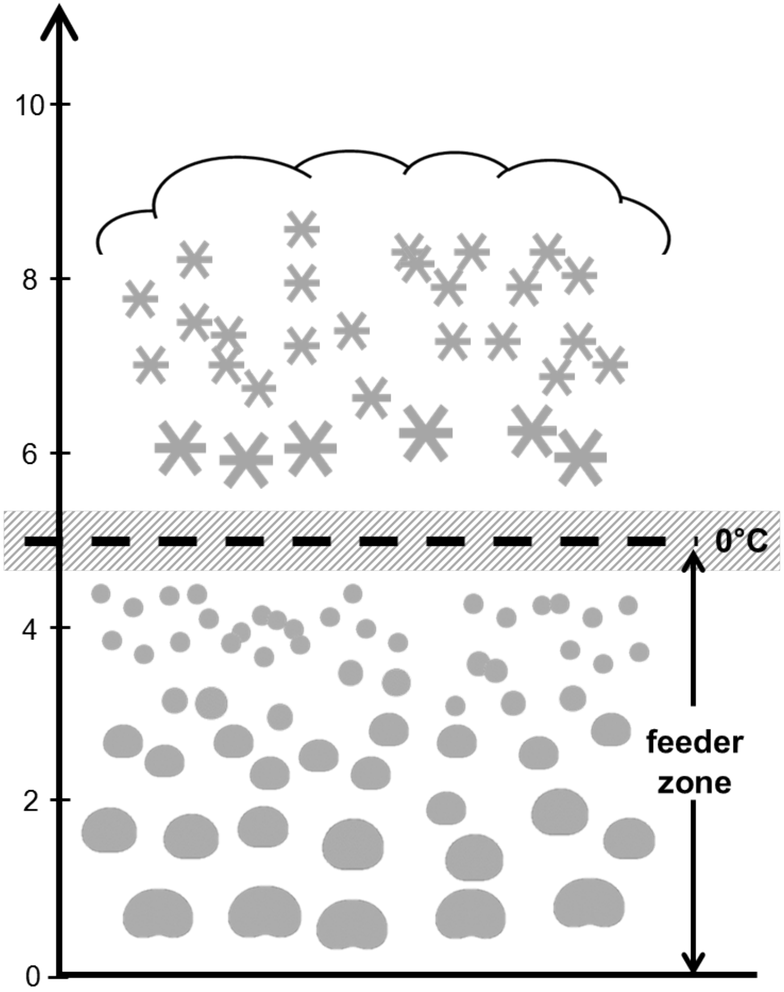


Warm-type heavy rainfall
TRMM mean PR reflectivity for 20 < RR_{PR} < 40 mm/hr



$Z : D^6 \quad \text{Rain Water} \sim D^3$

$\mathrm{d(Rain)} : \sqrt{Z(h_1)} - \sqrt{Z(h_2)}$



Sohn et al. (2013, MWR)

- If there is strong water vapor convergence onto the very humid area, then immediate condensation is possible,
- But, released latent heat may not be used for inducing the updraft motion (because of moist adiabatically in near neutral condition), and it is why the storm height does not grow deeper as for the cold type. Little lightening and thunders are found because less ice crystals in the upper layer.
- When rain drop falls below the melting layer, there should be abundant cloud liquid water which can help to grow rain drop quickly. Longer precipitation spell which cause severe flood.
- This concept is very much applicable to orographic ran, and rain associated with water vapor river.

Consequences in the global water budget

- How much we loose the global mean precip, because of that.
- MW-based rain algorithm based on the scattering signature cannot do much because less ice crystals which cannot give much of scattering signatures. Over the ocean, it does better because it uses the emission algorithm. But we do not know how the MW radiometer can measure signatures of the warm-type rain because the algorithm itself relies on the drop size distribution.
- For the radar, it often misses because it is located in higher altitude and aims higher to avoid the topography influences. In addition, there is the earth's curvature effect. In any circumstance, significant underestimate is expected.
- How about prediction?