The 17th Integrated Workshop TRCG Special Session
(29.~30. November, 2022)

New trial for real time visualization of three-dimensional structure from GK2A of 11th typhoon 'Hinnamnor' in 2022

Dr. Eun Jeong CHA
Korea Meteorological Administration, Republic of Korea
Vice chair TRCG, Typhoon Committee

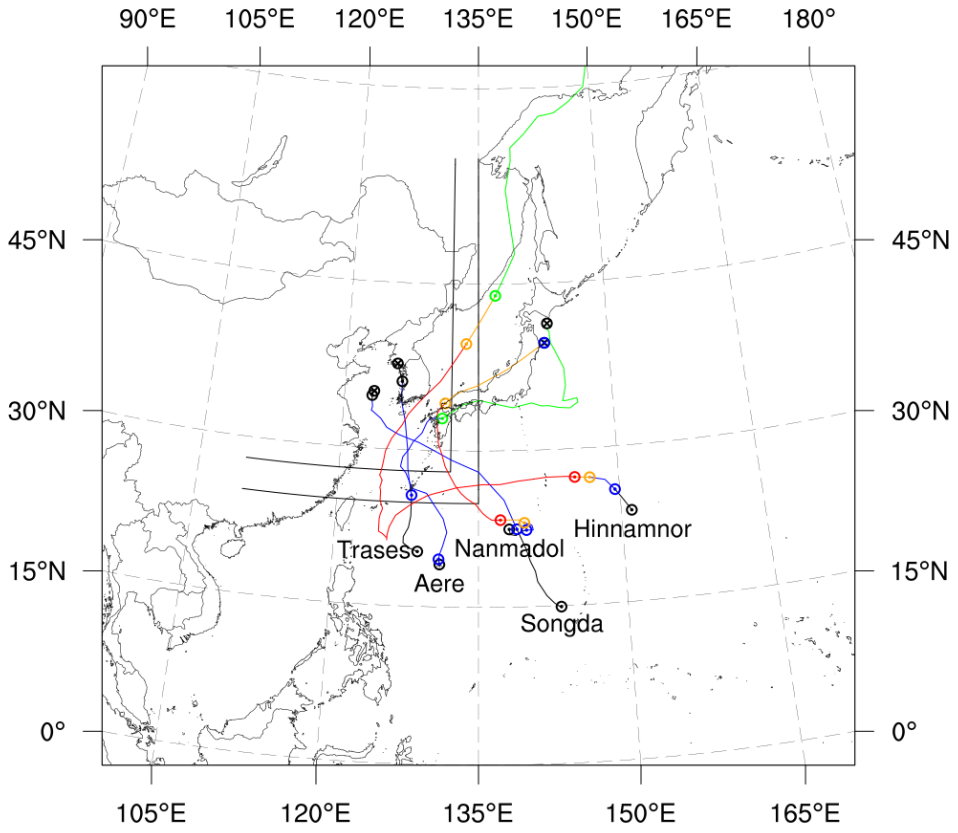
Dr. Dong Hun KIM
Artificial Intelligence Convergence Research Center,
Inha University, Republic of Korea

1. Content

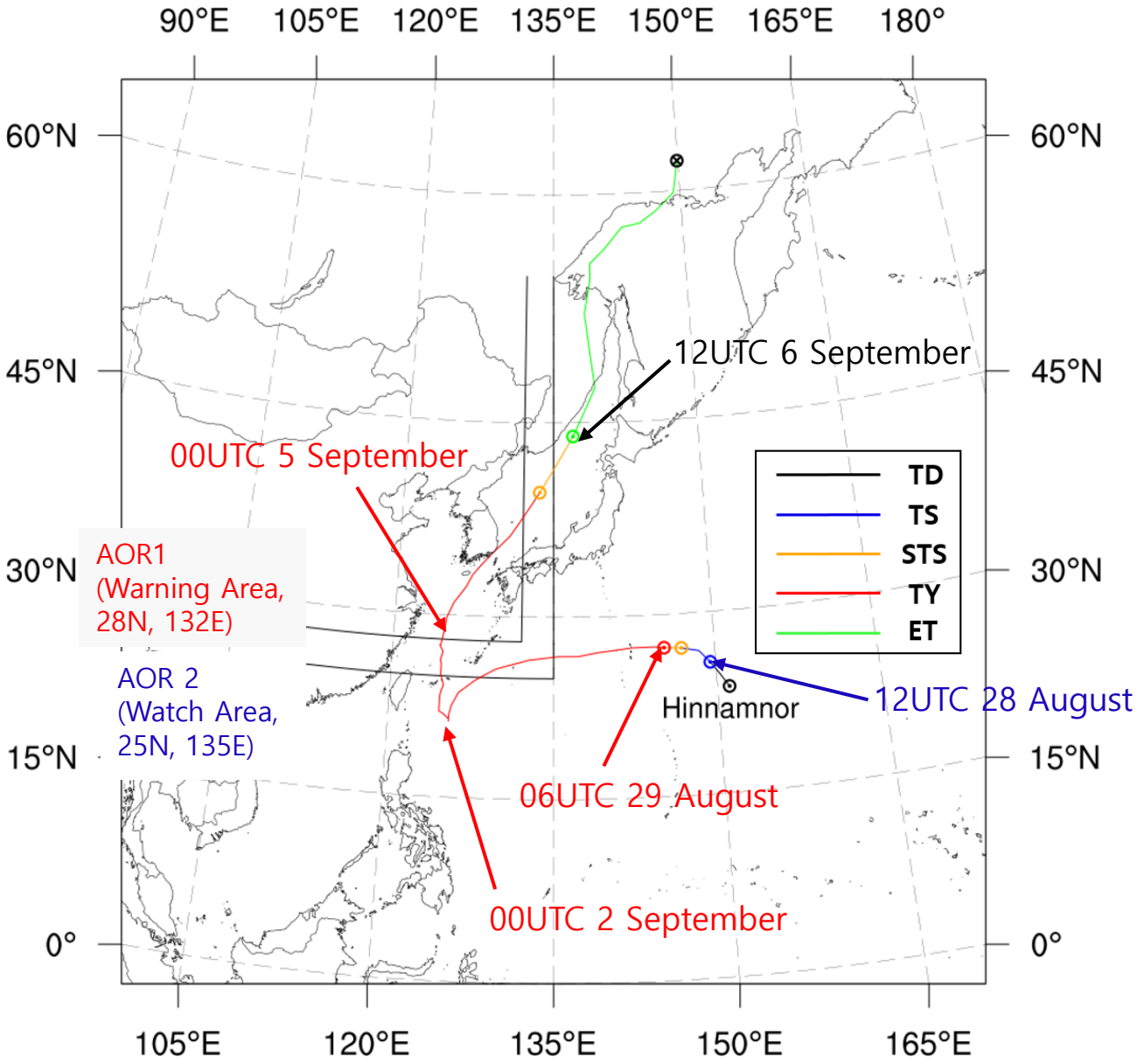
1. Super strong typhoon ‘Hinnamnor’ in 2022
2. Motivation and Purpose
3. Introduction of Scientific Data visualization
4. Example of visualization : Typhoon, wave current
5. Summary and further work
   and application for operational forecast

1. Super strong(>54m/s) typhoon ‘Hinnamnor’ in 2022

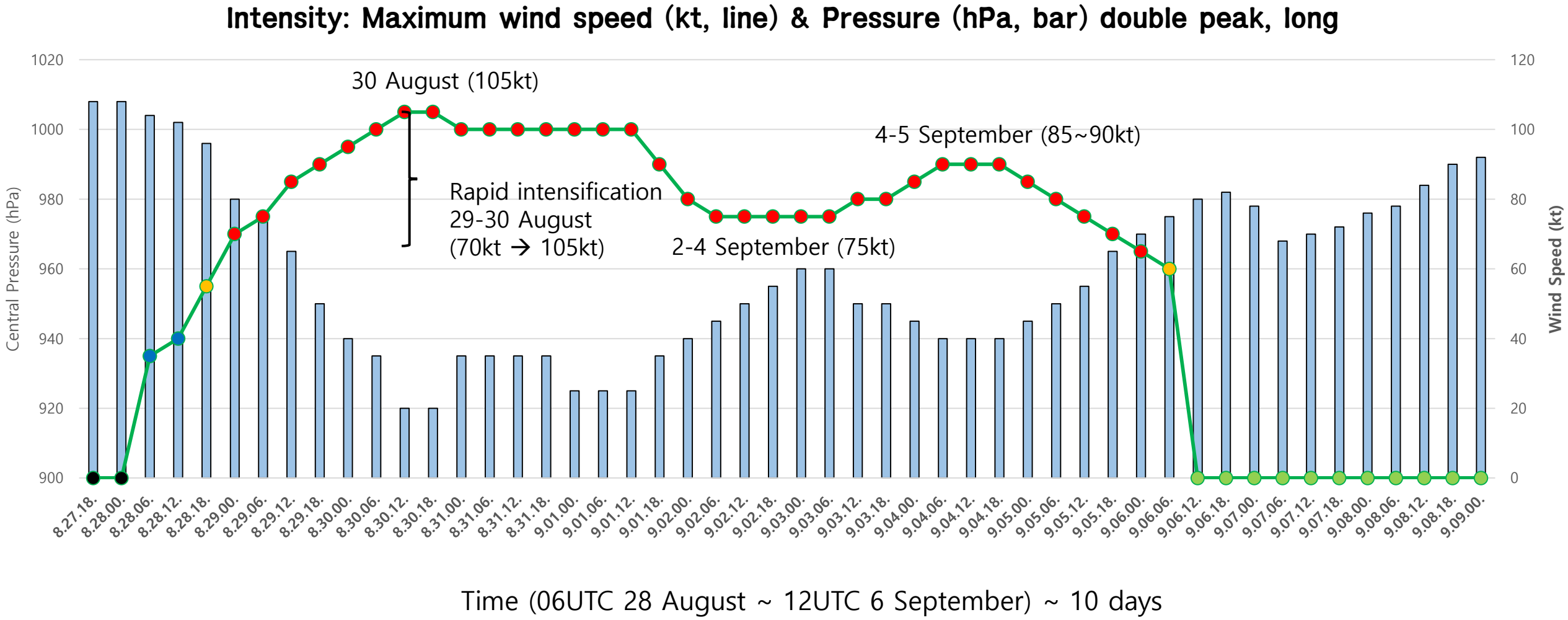
5 impact typhoon track and intensity



** AOR : Area of Responsibility*



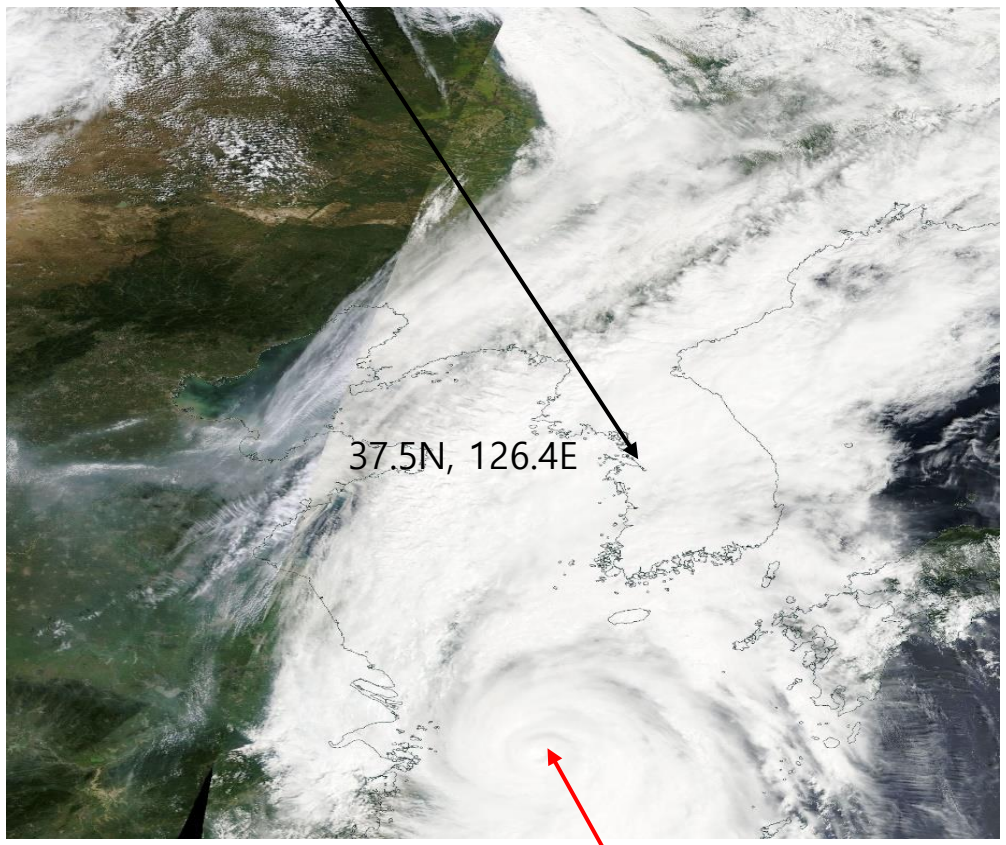
JMA best track



Time (06UTC 28 August ~ 12UTC 6 September) ~ 10 days

Wind distribution(KMA)

Wind Lidar(Supersite, Incheon International Airport), (5 September 2022)

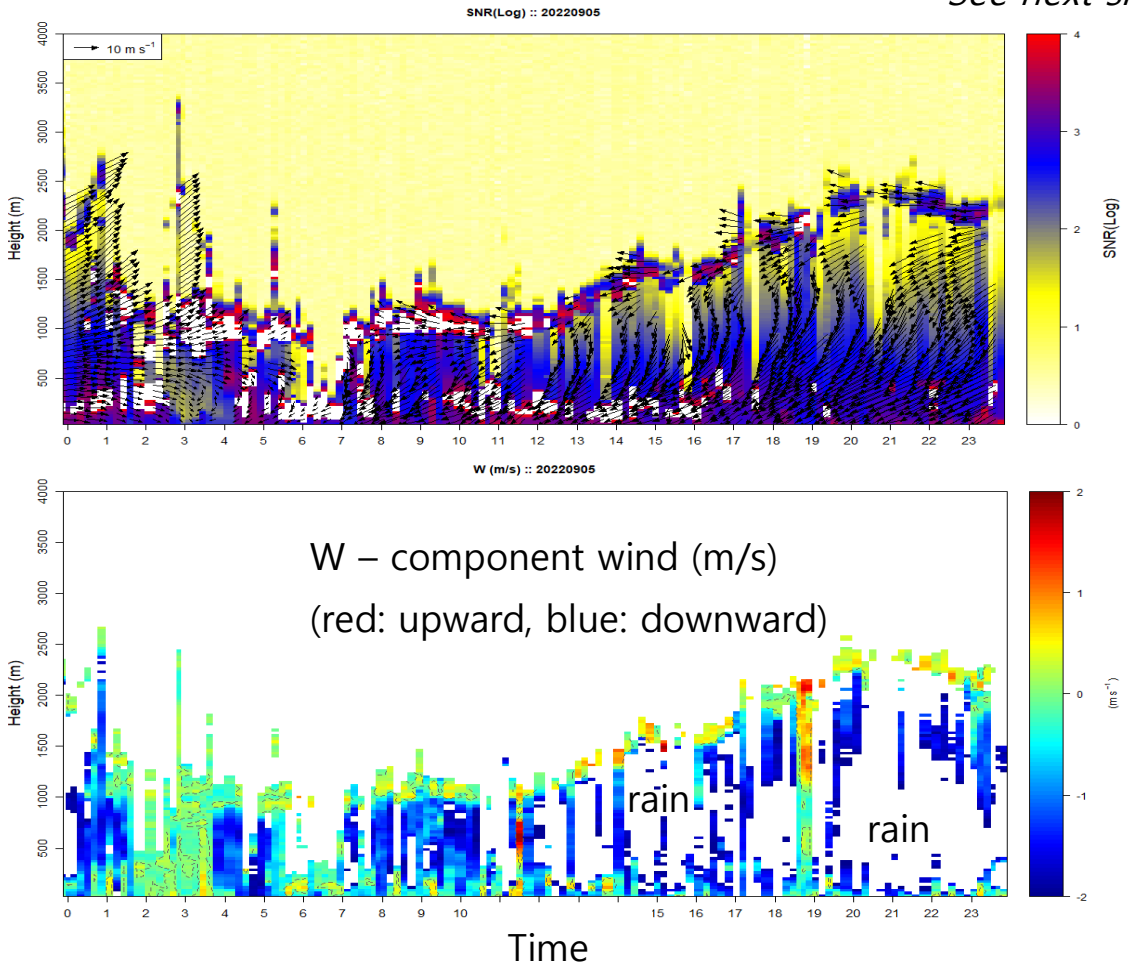


Typhoon ‘Hinnamnor’

00UTC 5 September
29.8N, 124.9E
930 hPa, 50m/s
wind radii 430 km

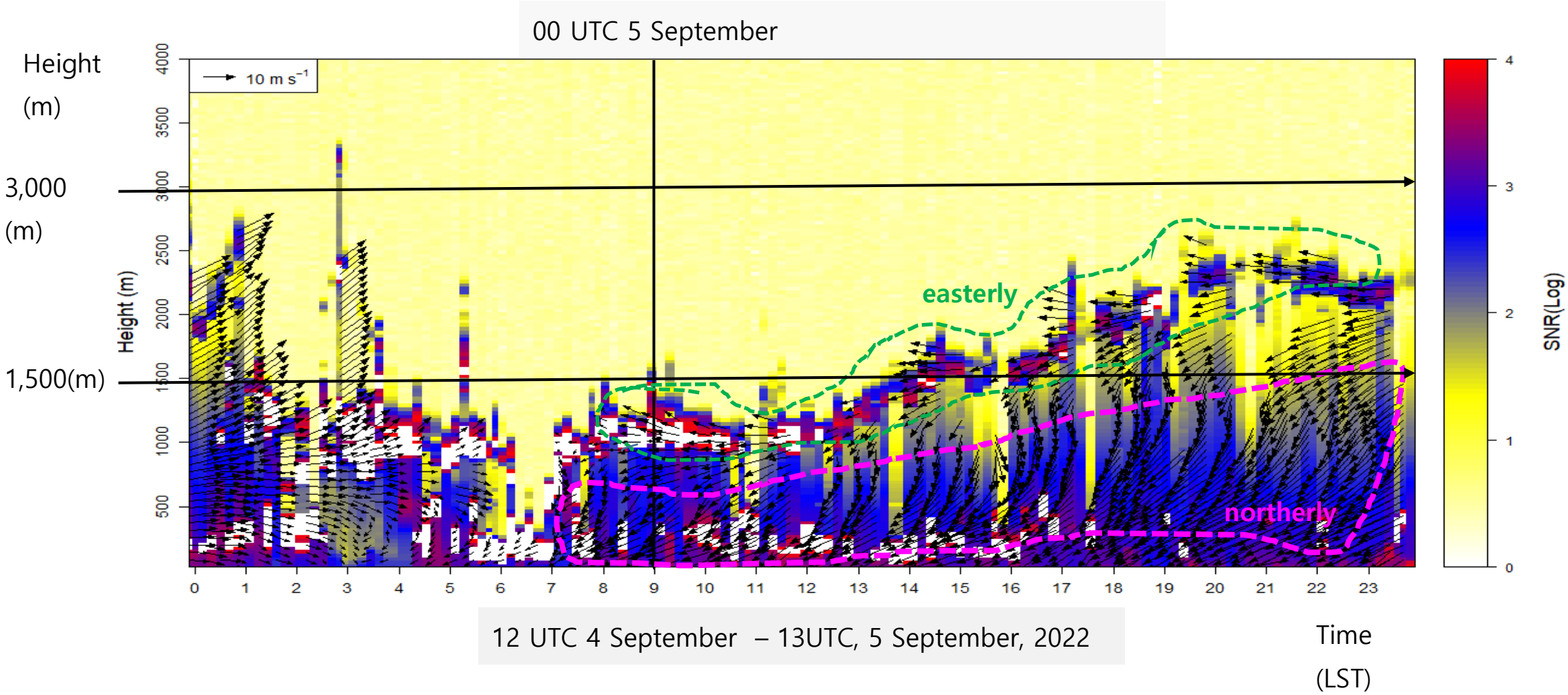
Wind vector (m/s) & SNR

See next slide



12 UTC 4 September – 13UTC, 5 September, 2022

Wind Lidar (Supersite, Incheon International Airport) KMA, (5 September 2022)



✓ Thick cloud layer: 1000m ~ 2500m
✓ Barotropic structure: Veering with height (below cloud: northerly, above cloud: easterly)

2. Motivation and Purpose

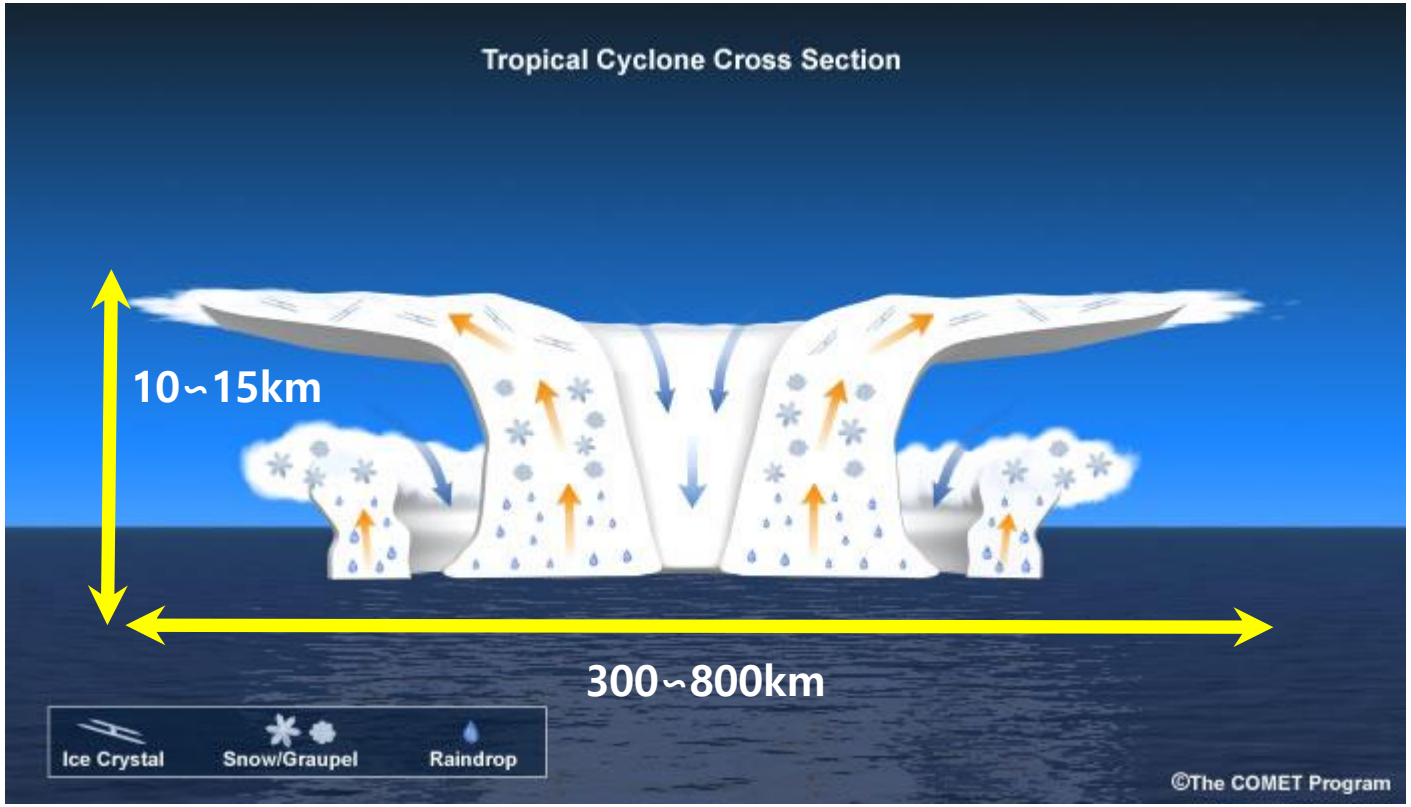
(1) Geostationary satellite
    Limitation of 3D structure
Polar-orbit satellite
    Limitation of time, non-regular observational schedule

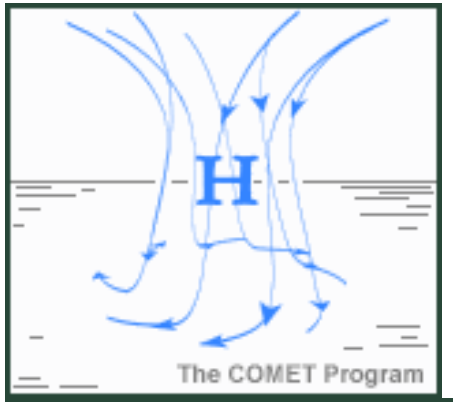
(2) Apply Algorithm to produce cloud thickness
    3D based on GK2A

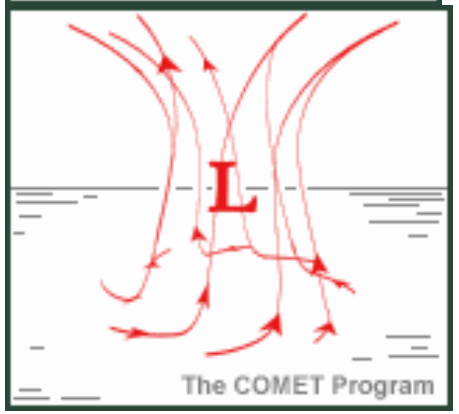
(3) Visualization of 3D structure of Typhoon

Conceptual model of TC and water phase(ice crystal, snow/graupel, raindrop)

vertical scale: 10~15km, up and down circulation
horizontal scale: 300~800km, cyclonic circulation



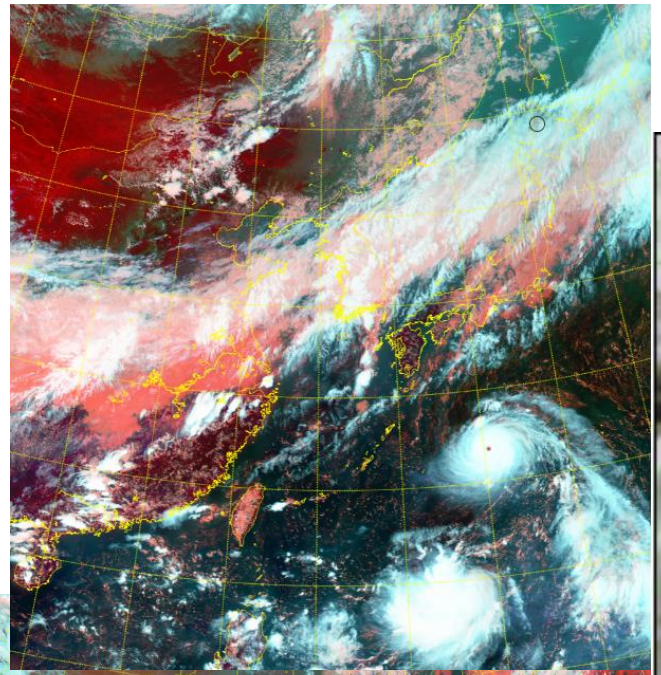




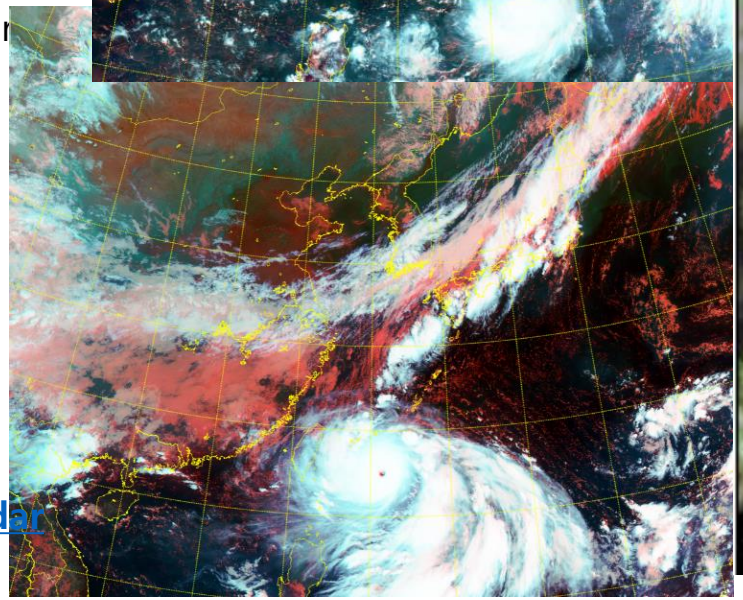
However, in real world, …

Horizontal structure (GK2A)

GK2A, enhanced IR
Typhoon 'Hinnamnor'
(06 UTC, 30. August, 2022)



GK2A, enhanced IR
Typhoon 'Hinnamnor'
(00 UTC, 1. September 2022)

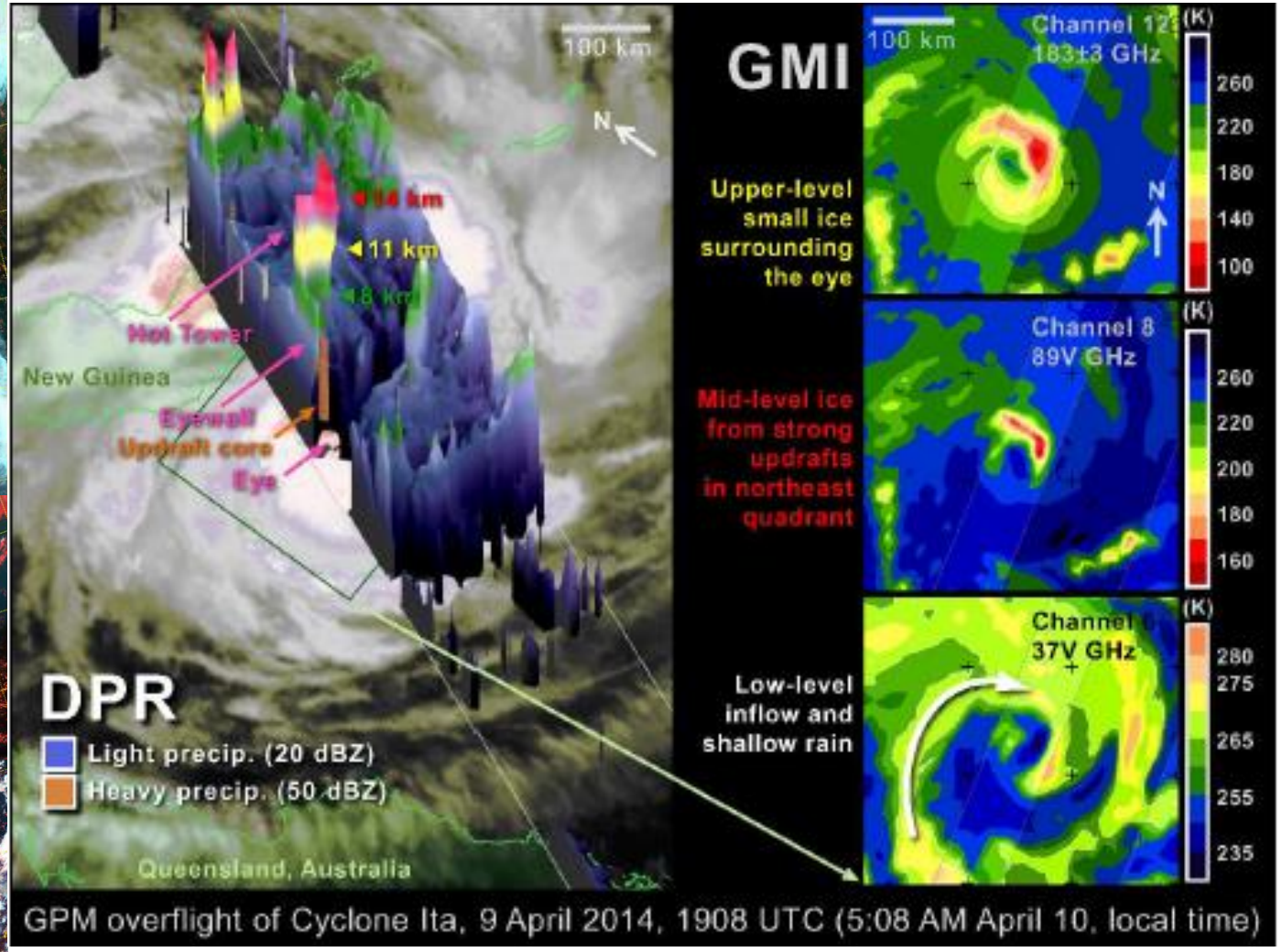


Dual-frequency Precipitation Radar (DPR)

Cross section of vertical & horizontal structure (Low-Mid-Upper level)

2014 Ita, GPM, JAXA/NASA, ~14km, hot tower (mature stage)
(Eye, Eyewall, Hot Tower, Updraft core, Low- Mid-Upper level rain and ice)

GPM Microwave Imager



GPM overflight of Cyclone Ita, 9 April 2014, 1908 UTC (5:08 AM April 10, local time)

3. Introduction of Scientific Data Visualization

What is Blender?

Blender is:

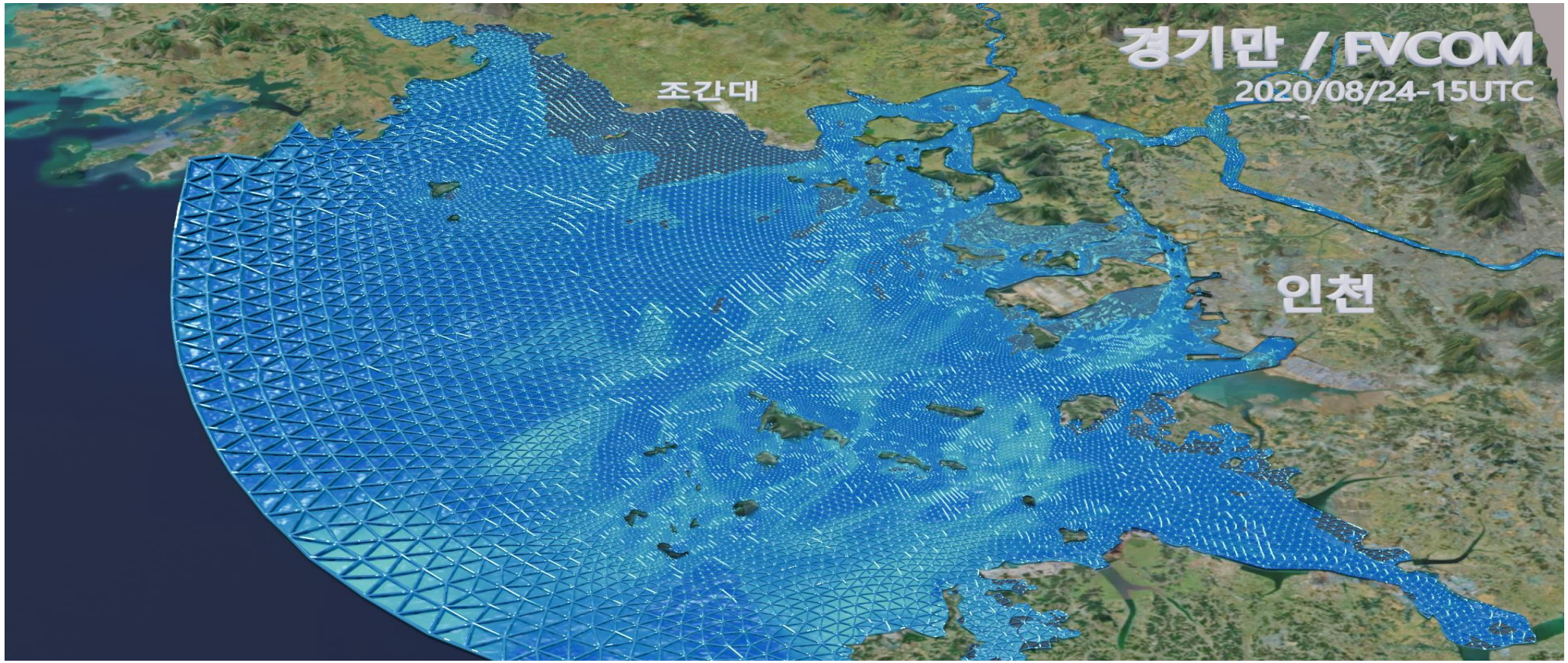
- 3D graphics software for modeling, animation, and visualization
- Open-source
- A real-time 3D viewer and GUI
- A Python scriptable interface for loading data

http://www.blender.org

Rendering Engines

- Blender (included)
- Cycles (included)
- Yafaray
  (open source ray tracing engine, http://www.yafaray.org/)
- Luxrender (http://www.luxrender.net/en_GB/index)
- Octane (http://render.otoy.com/)
- Renderman (http://renderman.pixar.com/view/renderman)

[Example] Wave current (near Incheon Port)



Anim: HighRes

Cloud-Base Height Estimation from VIIRS. Part I: Operational Algorithm Validation against *CloudSat*

CURTIS J. SEAMAN, YOO-JEONG NOH, AND STEVEN D. MILLER

Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, Colorado

ANDREW K. HEIDINGER

NOAA/NESDIS/Center for Satellite Applications and Research/Advanced Satellite Products Branch, Madison, Wisconsin

DANIEL T. LINDSEY

NOAA/NESDIS/Center for Satellite Applications and Research/Regional and Mesoscale Meteorology Branch, Fort Collins, Colorado

(Manuscript received 31 May 2016, in final form 14 October 2016)

ABSTRACT

The operational VIIRS cloud-base height (CBH) product from the *Suomi–National Polar-Orbiting Partnership* (*SNPP*) satellite is compared against observations of CBH from the cloud profiling radar (CPR) on board *CloudSat*. Because of the orbits of *SNPP* and *CloudSat*, these instruments provide nearly simultaneous observations of the same locations on Earth for a ~4.5-h period every 2–3 days. The methodology by which VIIRS and *CloudSat* observations are spatially and temporally matched is outlined. Based on four 1-month evaluation periods representing each season from June 2014 to April 2015, statistics related to the VIIRS CBH retrieval performance have been collected. Results indicate that when compared against *CloudSat*, the VIIRS CBH retrieval does not meet the error specifications set by the Joint Polar Satellite System (JPSS) program, with a root-mean-square error (RMSE) of 3.7 km for all clouds globally. More than half of all matching VIIRS pixels and *CloudSat* profiles have CBH errors exceeding the 2-km error requirement. Underscoring the significance of these statistics, it is shown that a simple estimate based on a constant cloud geometric thickness of 2 km outperforms the current operational CBH algorithm. It was found that the performance of the CBH product is impacted by the accuracy of upstream retrievals [primarily cloud-top height (CTH)] and the a priori information used by the CBH retrieval algorithm. However, even when CTH errors were small, CBH errors still exceed the JPSS program error specifications with an RMSE of 2.3 km.

JOURNAL OF ATMOSPHERIC AND OCEANIC TECHNOLOGY

4. Example of visualization: Typhoon ‘Hinnamnor’

* Cloud - Height, Thickness, Type (GK2A, KMA)

CBH with GK2A data

$$LWP = \int_{z=0}^{\infty} \rho_{air} r_L dz'$$

LWP is the sum of the fluid content of the atmosphere as a concept to describe the radiative transfer process

- CBH estimation using Liquid/Ice Water Path & Liquid/Ice Water Content
- CIRA method(Seaman et al. (2017) based on Suomi-NPP/VIIRS → Apply to GK2A data

water phase

$$LWP = \frac{2}{3} \rho_{liq} \tau r_e$$

$$CGTP = Min(\frac{LWP}{LWC}, 15)$$

Cloud type	LWC ($g m^{-3}$)
Altocumulus/altostratus	0.455
Cirrus	0.01
Cirrocumulus	0.01
Cumulus	0.580
Cumulonimbus/nimbostratus	0.01
Stratus	0.293

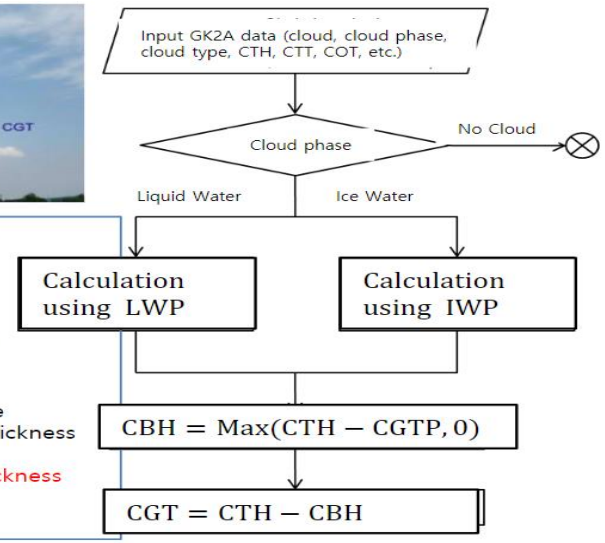
ice phase

$$IWP = \frac{COT}{-0.006656 + \frac{3.686}{D_e}}$$

$$D_e = 326.3 + 12.42\,CTT + 0.197\,CTT^2 + 0.0012\,CTT^3$$

$$CGTP = Min(\frac{IWP}{0.1}, 15)$$

ρ_{liq} : density of liquid water
τ: cloud optical thickness
r_e : effective radius(liquid)
D_e: effective radius(ice)
LWP: Liquid Water Path
LWC: Liquid Water Content
IWP: Ice Water path
IWC: Ice Water Content
CTT: Cloud Top Temperature
CGTP: Cloud Geometrical Thickness Parameter
CGT: Cloud Geometrical Thickness
CTH: Cloud Top Height
CBH: Cloud Base Height



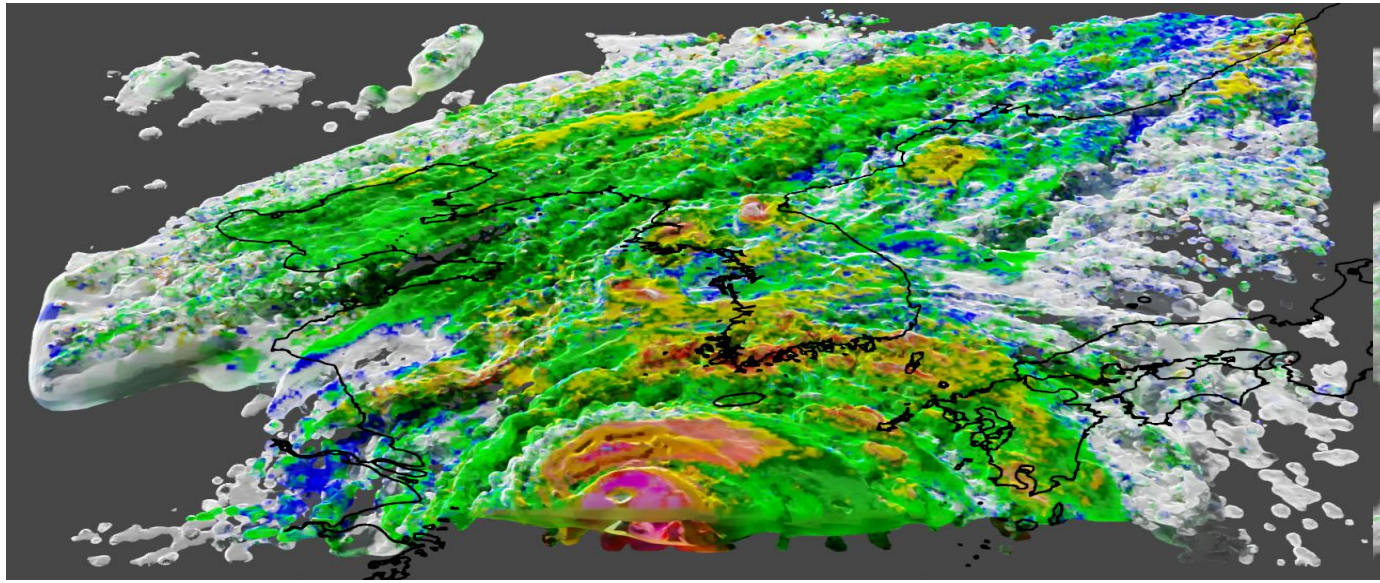
Flow chart

$CBH = Max(CTH - CGTP, 0)$
(cloud base height)

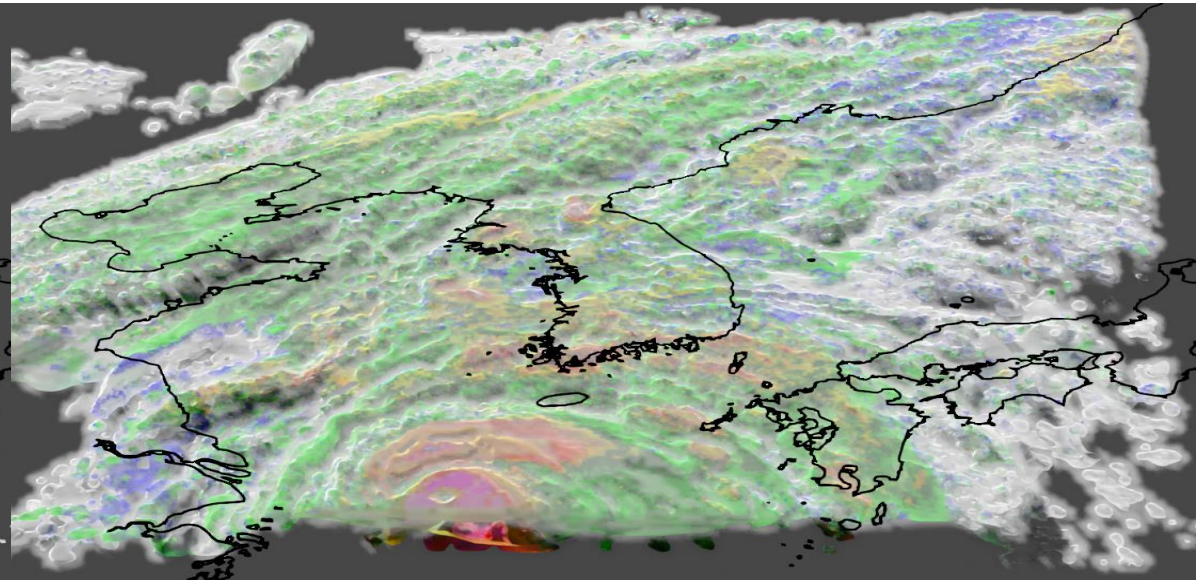
$CGT = CTH - CBH$
(Cloud Geometrical thickness)

Super strong typhoon ‘Hinnamnor’ in 2022

00 – 06 UTC 5 September(Cloud and precipitation intensity)



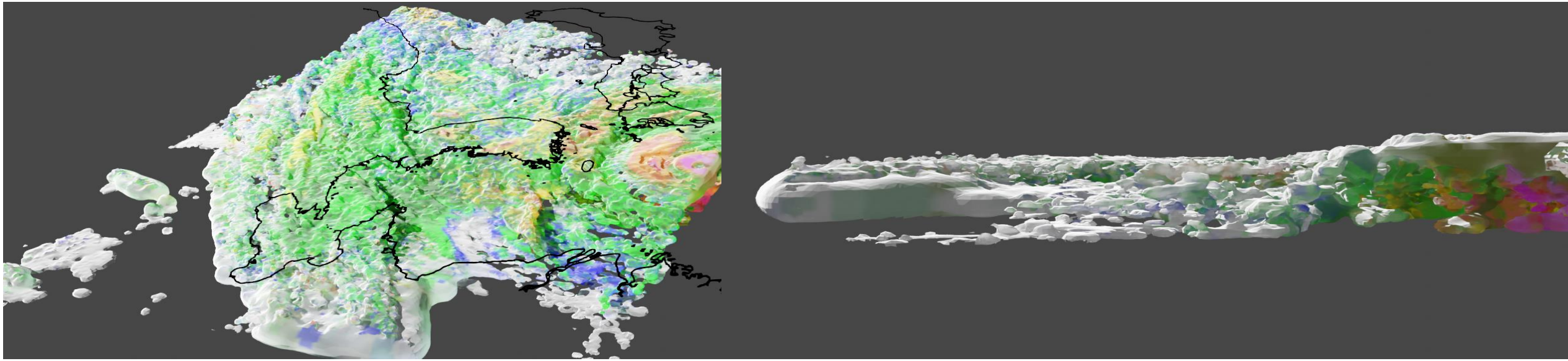
Anim: click HighRes



Anim: click HighRes

Super strong typhoon ‘Hinnamnor’ in 2022

00 – 06 UTC 5 September(Cloud and precipitation intensity)

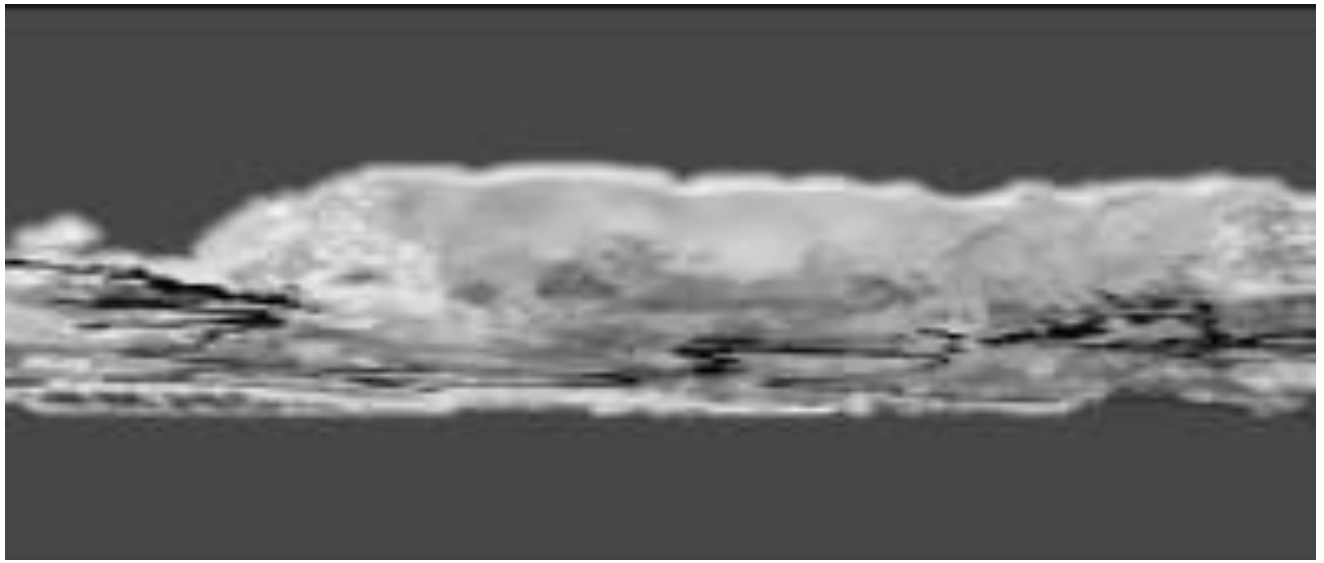


Anim: click HighRes

Anim: click HighRes

Super strong typhoon ‘Hinnamnor’ in 2022

00 – 06 UTC 5 September(Cloud and precipitation intensity)



Anim: click HighRes

5. Summary and further work and application for operational forecast

1. Case study and preliminary test for operational use

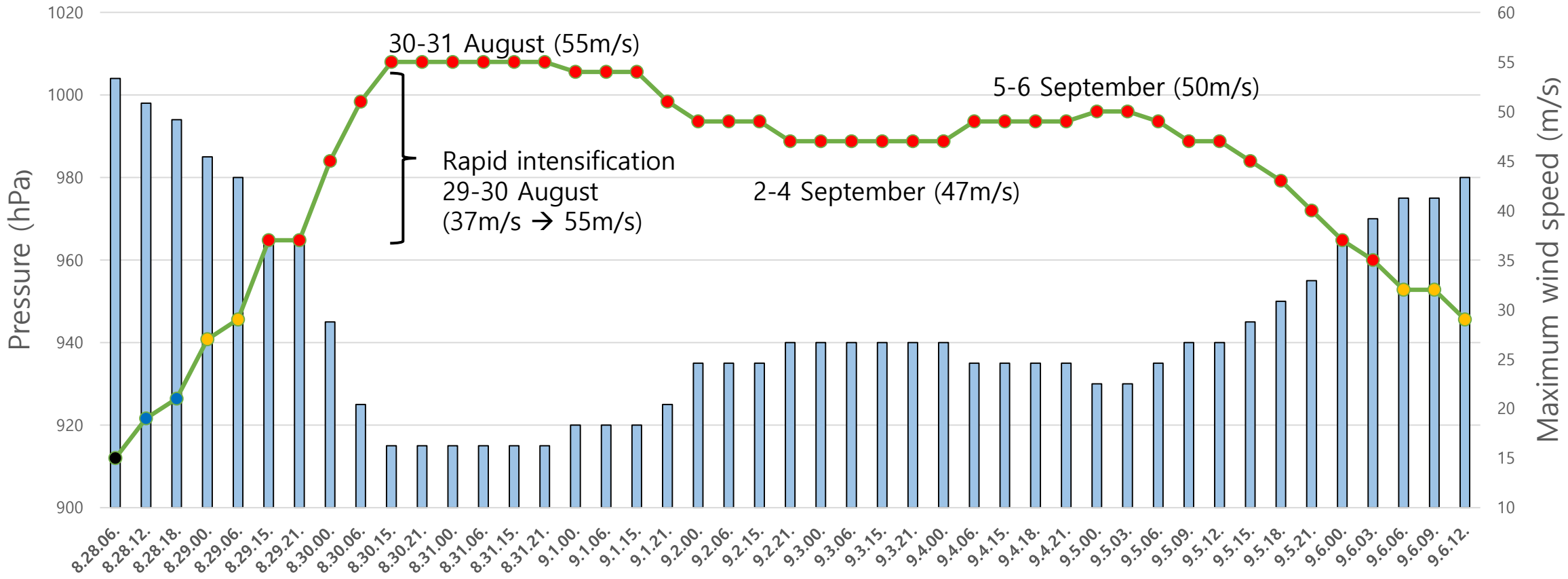
2. Verification ground base data sets
   & improvement of Algorithm,
   share and transfer to member country
   (if any request)

Discussion

Dr. Eun Jeong CHA
Korea Meteorological Administration
Vice Chair, TRCG, Typhoon Committee

KMA operational analysis

Intensity: Maximum wind speed (m/s) & Pressure (hPa) double peak, long



Time (06UTC 28 August ~ 12UTC 6 September) ~ 10 days

** To be confirmed by Best Track*