GEMS Cloud Algorithm: Update and Ongoing Progress

Aug 30th, 2024

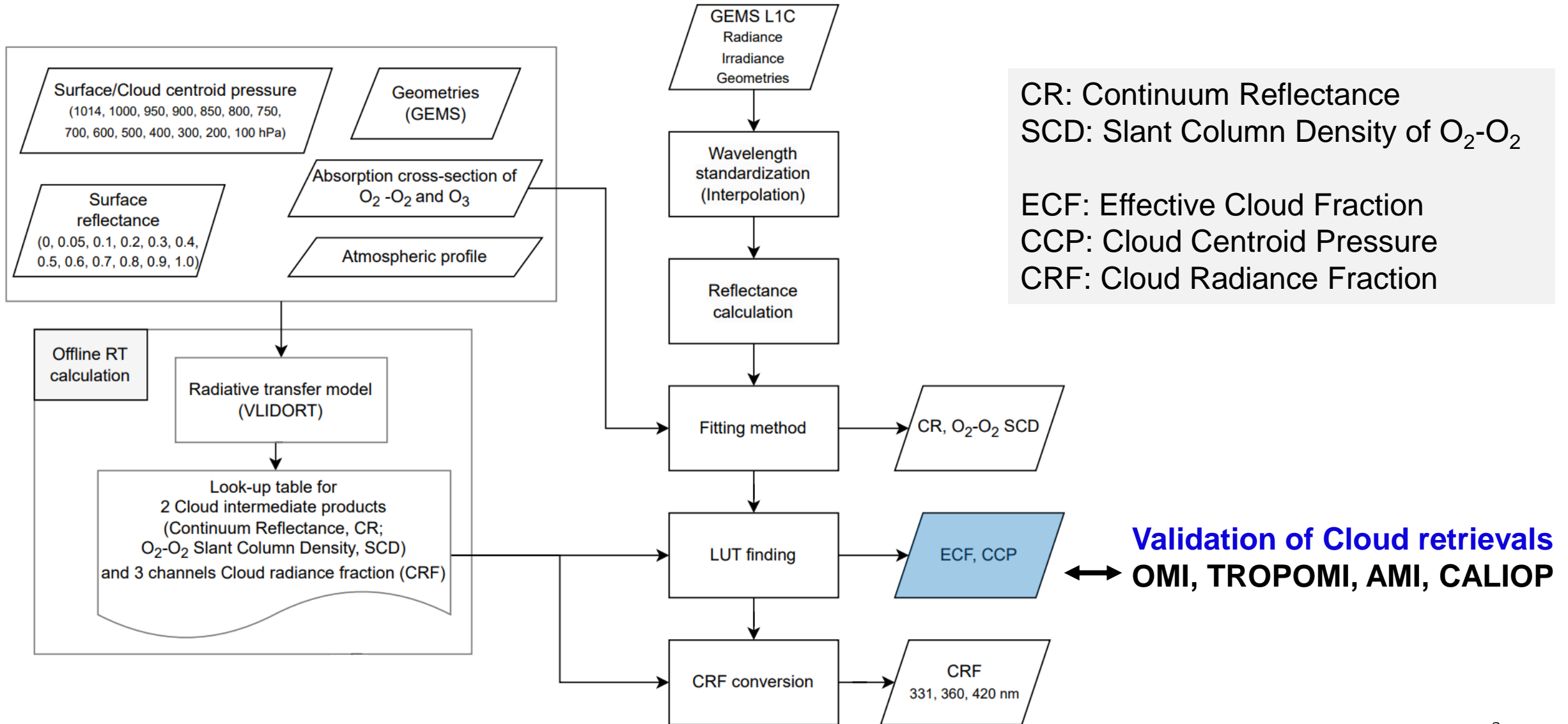Gyuyeon Kim, Minjeong Cho, Bo-ram Kim, and Yong-Sang Choi
Ewha Womans University

CONTENTS

I. Overview of GEMS cloud algorithm

CR: Continuum Reflectance
SCD: Slant Column Density of O_2-O_2

ECF: Effective Cloud Fraction
CCP: Cloud Centroid Pressure
CRF: Cloud Radiance Fraction

Validation of Cloud retrievals
OMI, TROPOMI, AMI, CALIOP

II. Update of GEMS cloud version 3

| Issue	CLD V2	CLD V3
Replacement of surface reflectance data	OMI SFC at 477 nm	GEMS SFC at 463 nm, OMI SFC at 463 nm
Updated Look-Up Table (LUT)	-	Updated
Overestimation of ECF	-	Updated LUT interpolation method
Striped-pattern in CCP validation	-	
Clear sky value of CCP	Clear sky = 1,013 hPa	Clear sky is replaced by L1C surface pressure
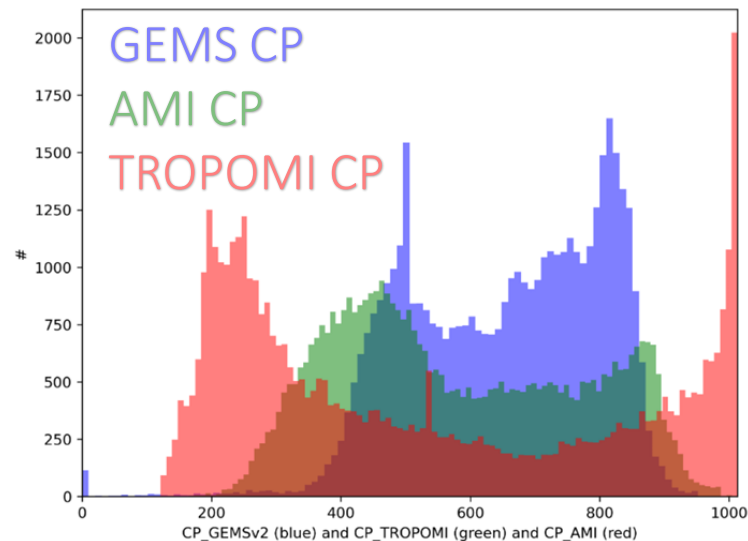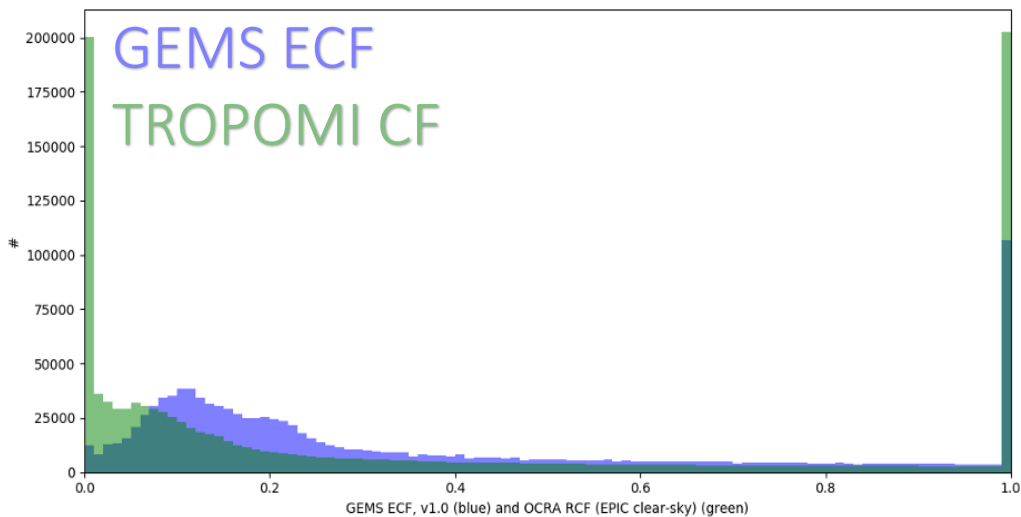
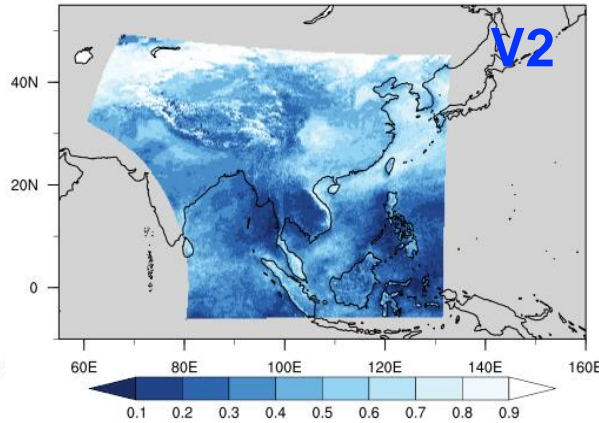

Source: PEGASOS Report (DLR)

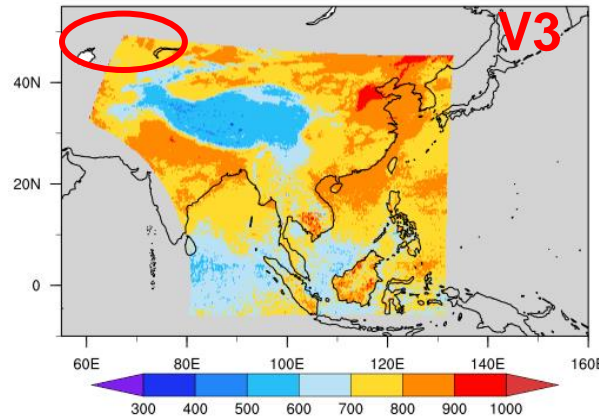## ▪ Monthly mean cloud retrieval

2023.12.01-31 0445 UTC
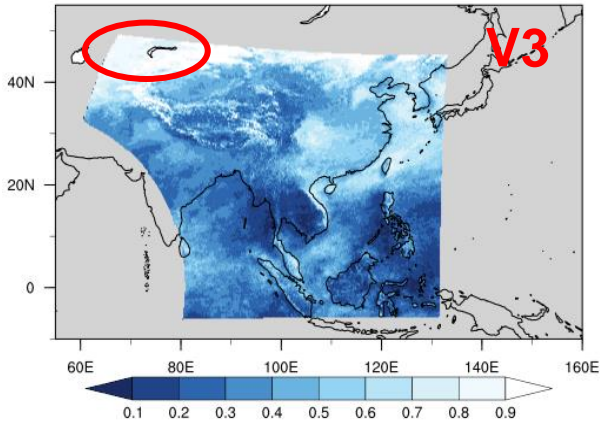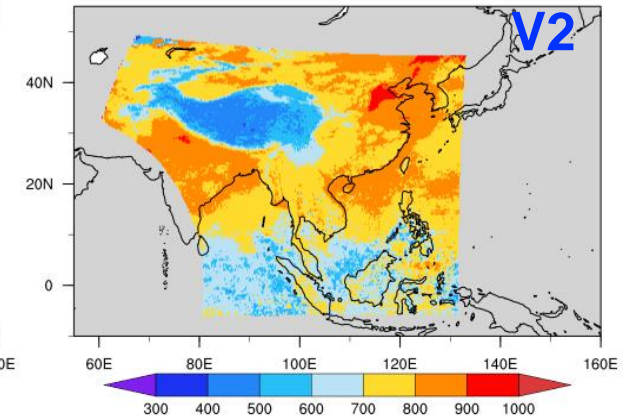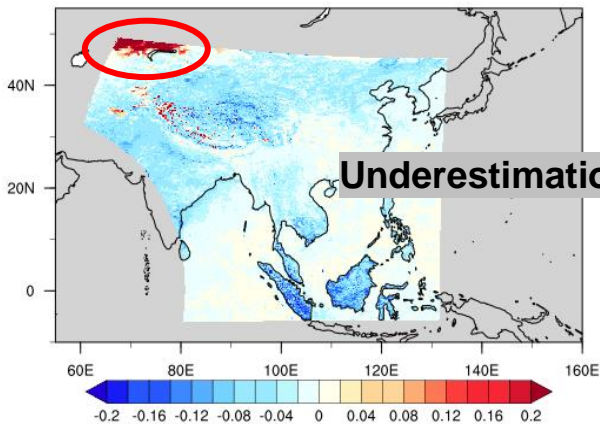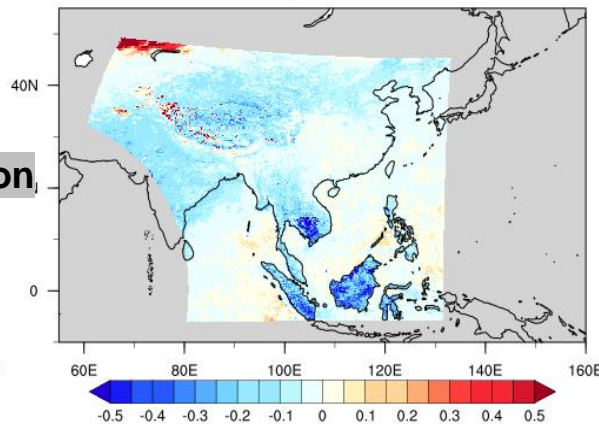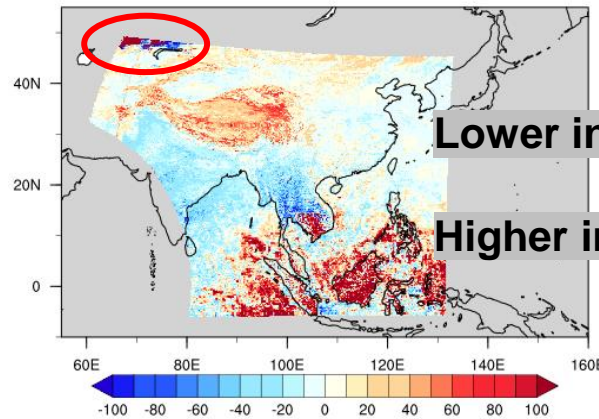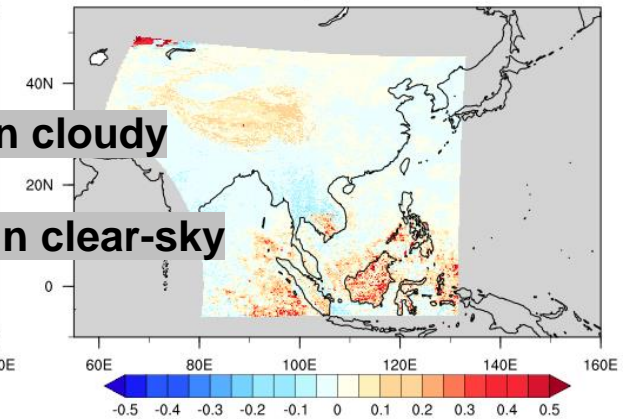
2023.12

V2 INPUT: OMI monthly reflectivity 477 nm

V3 INPUT: GEMS SFC 463 nm

TerrainReflectivity (unitless)

0.0   0.2   0.3   0.5   0.6   0.8

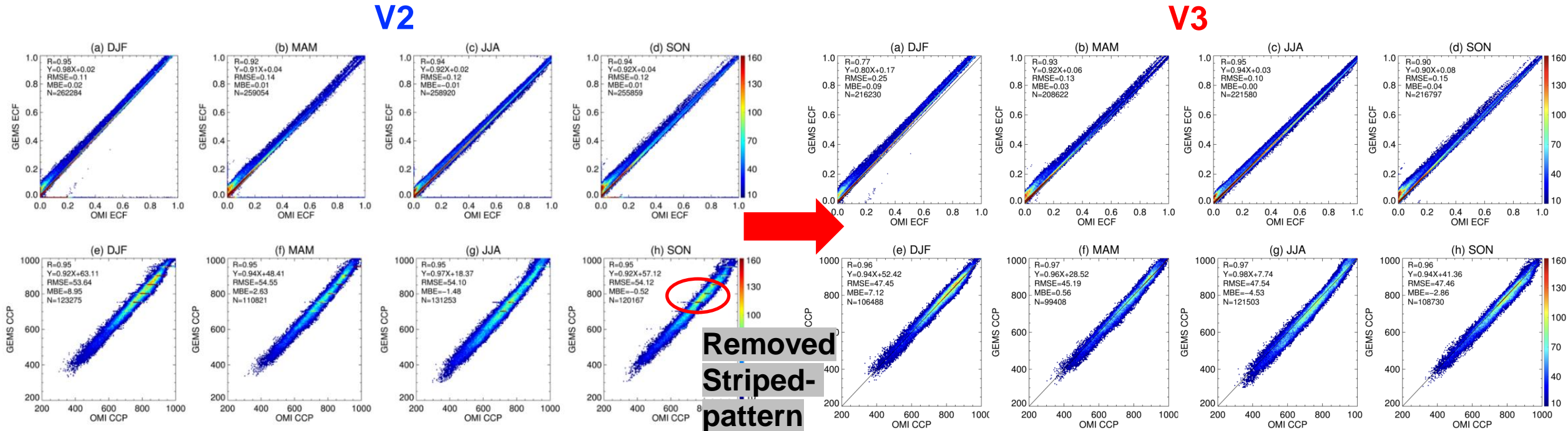TerrainReflectivity (unitless)

0.0   0.2   0.4   0.6   0.8   1.0
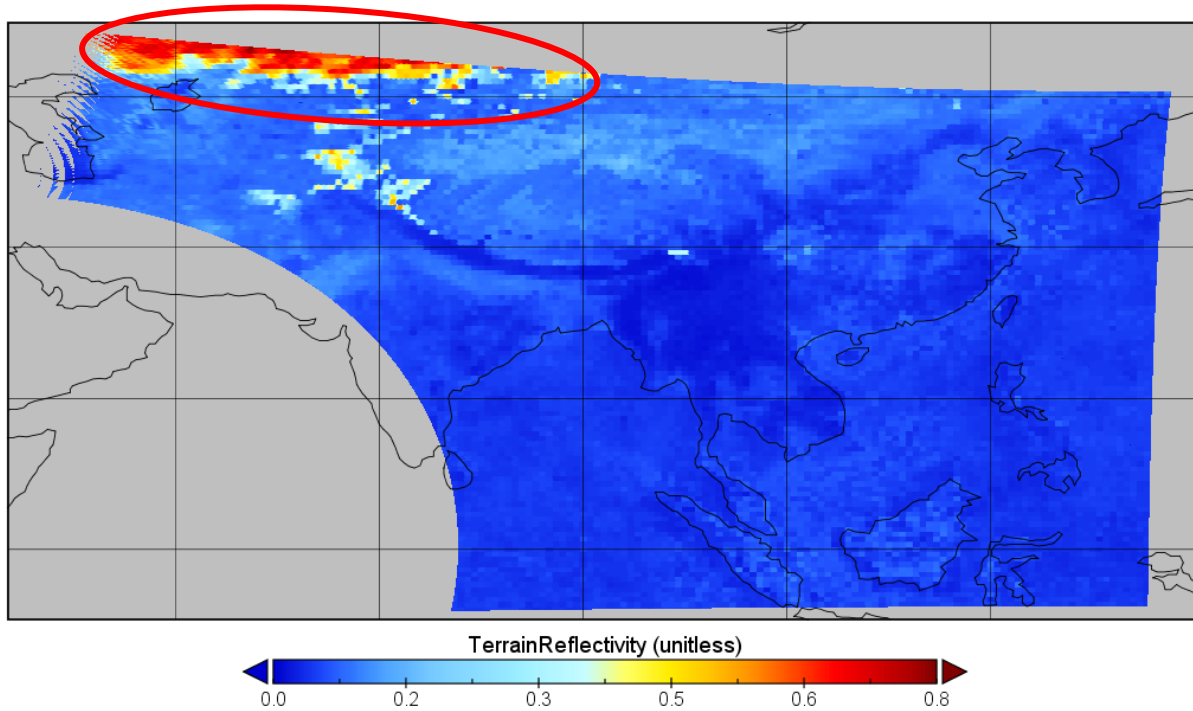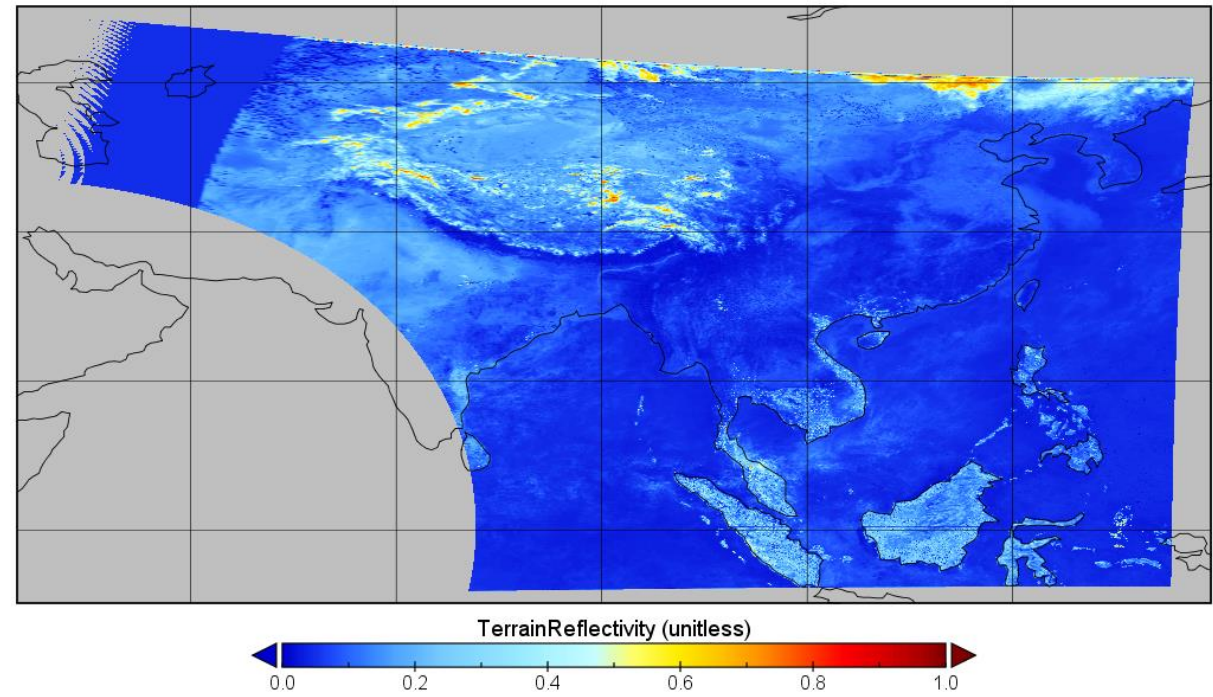
- The difference in cloud retrievals is **due to the variation in surface albedo** used as input data.

II. Update of GEMS cloud version 3

- **Update of look-up table and interpolation method**

- **(V2) Using extrapolation method** when the input conditions didn't satisfy the nodal point of LUT.
- **(V3)** ECF value is set to **either 0 or 1**.
    - ✓ [ECF] R: 0.01 ↑   y-slope: 0.01 ↑   RMSE: 0.01-0.02 ↓ (excluding DJF)
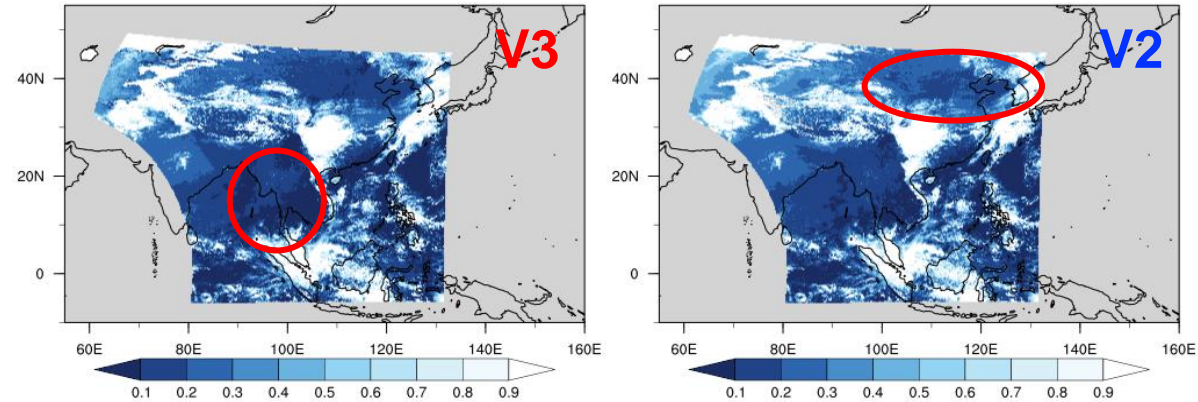   - ✓ [CCP] R: 0.01-0.02 ↑   y-slope: 0.02 ↑   RMSE: 7 hPa ↓

■ **ECF result**

2023.03.01. 0445 UTC

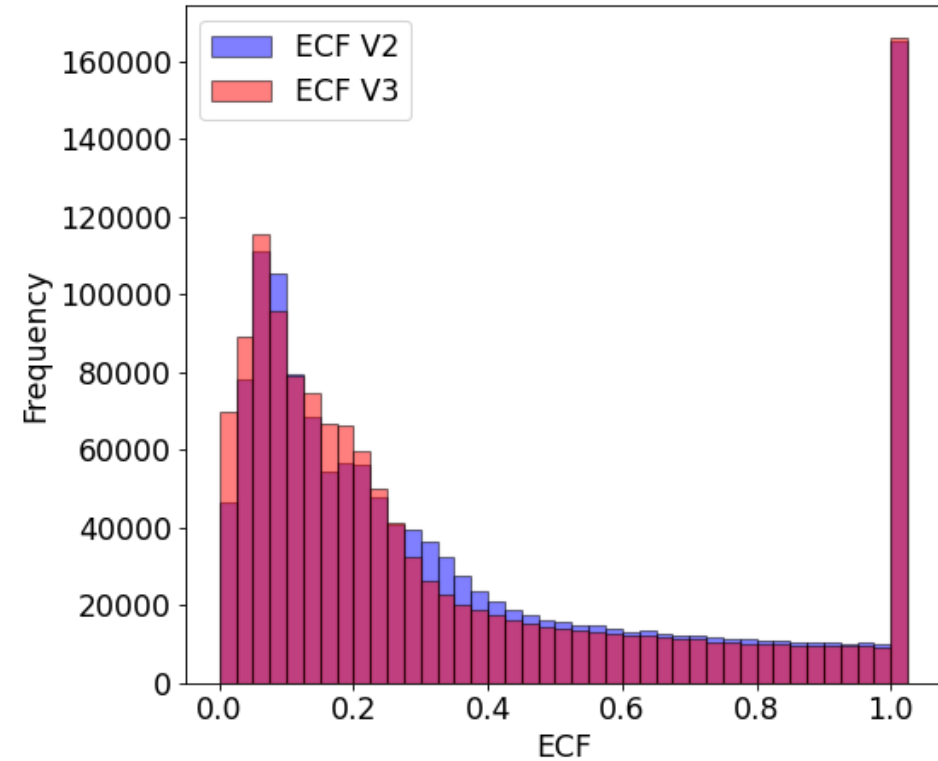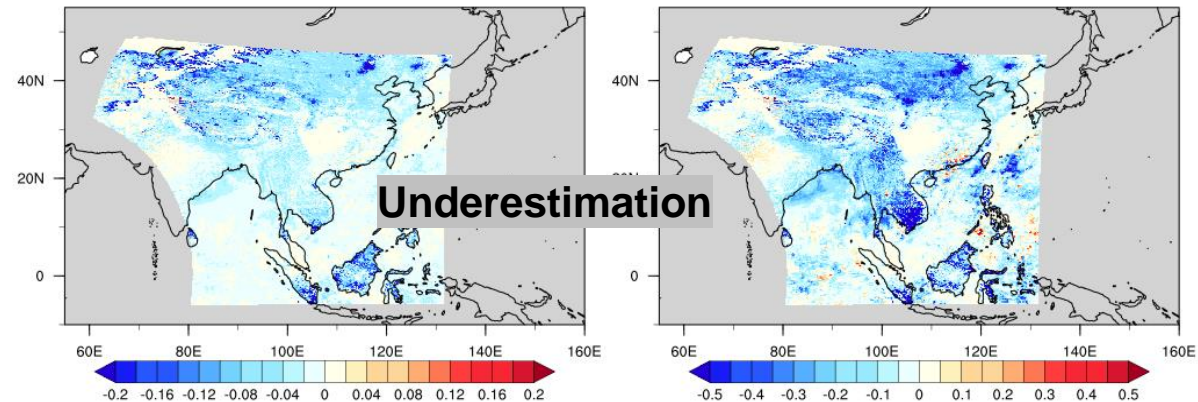(a) GEMS ECF: V3   **V3**

(b) GEMS ECF: V2   **V2**

a-b

(a-b)/b

Underestimation

- Discontinuity over Northeastern China was eliminated by using GEMS SFC data.
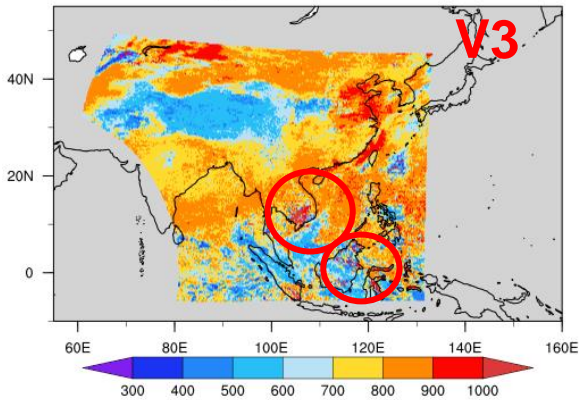- V3 reduces the overestimation of ECF in clear-sky pixels.

GEMS

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■ CCP result

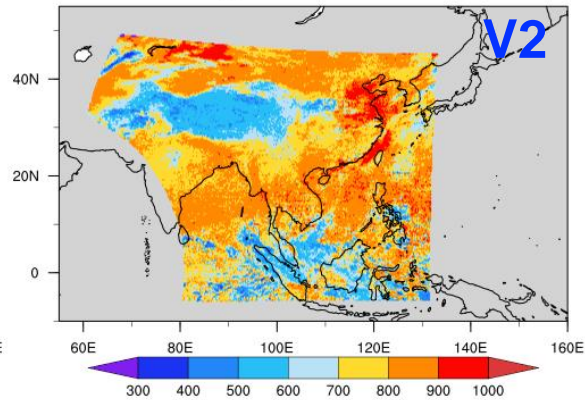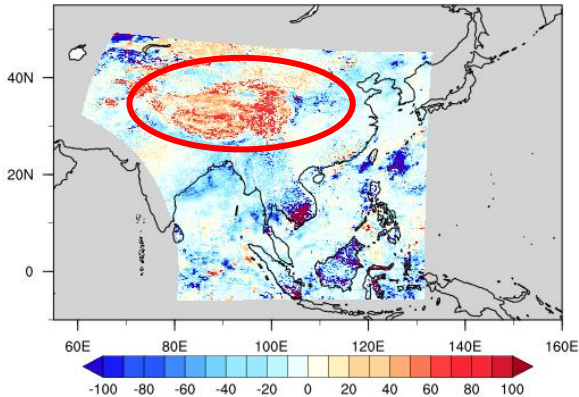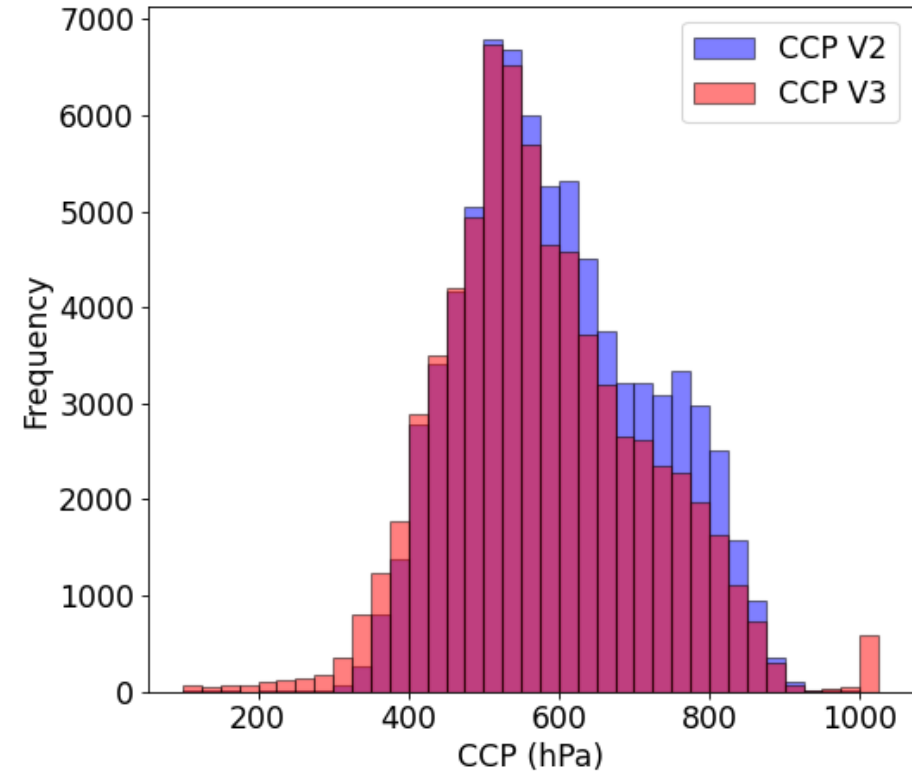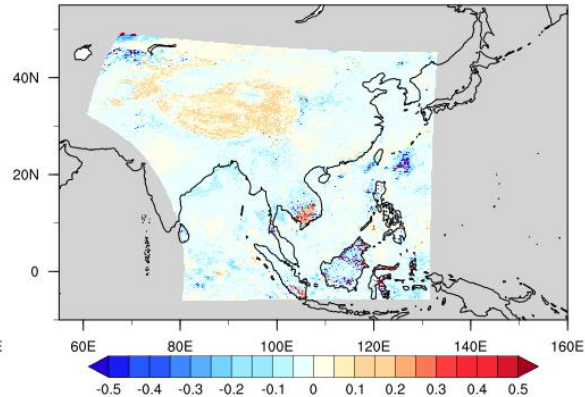2023.03.01. 0445 UTC

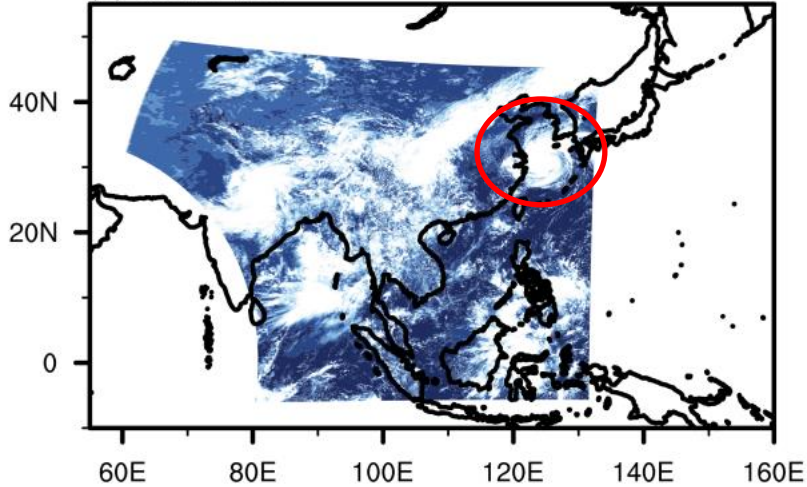- V3 generally retrieves higher altitudes than V2, while clear-sky pixels are retrieved at lower altitudes.
- V3 retreive higher and lower values compared to V2.

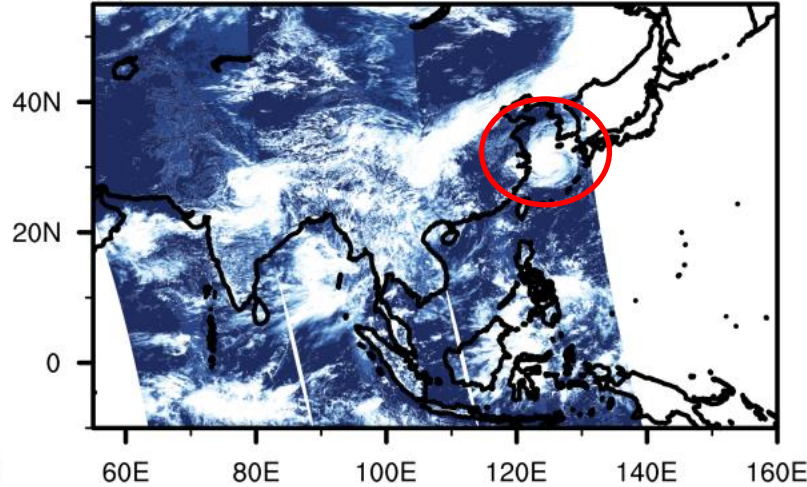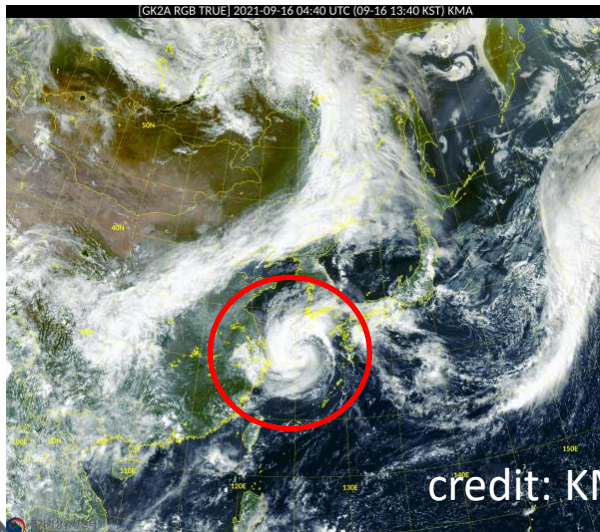# III. Scene analysis of GEMS cloud

- **Typhoon case (Sep 16th, 2021)**
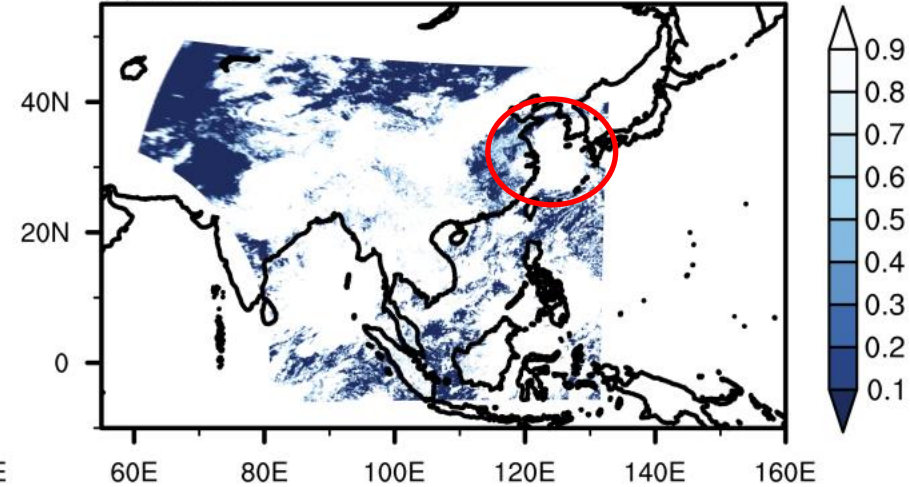
Kim et al. 2024, AMT

- The cloud detection results from GEMS and TROPOMI were similar.
- AMI showed a quantitative difference due to its different physical meaning compared to GEMS.

(a) GEMS CCP

(b) TROPOMI CCP

(c) AMI CTP

(d) Vertical CALIOP

GEMS CCH & TROPOMI CH & AMI CTH & CALIOP CLD & CALIOP AERO
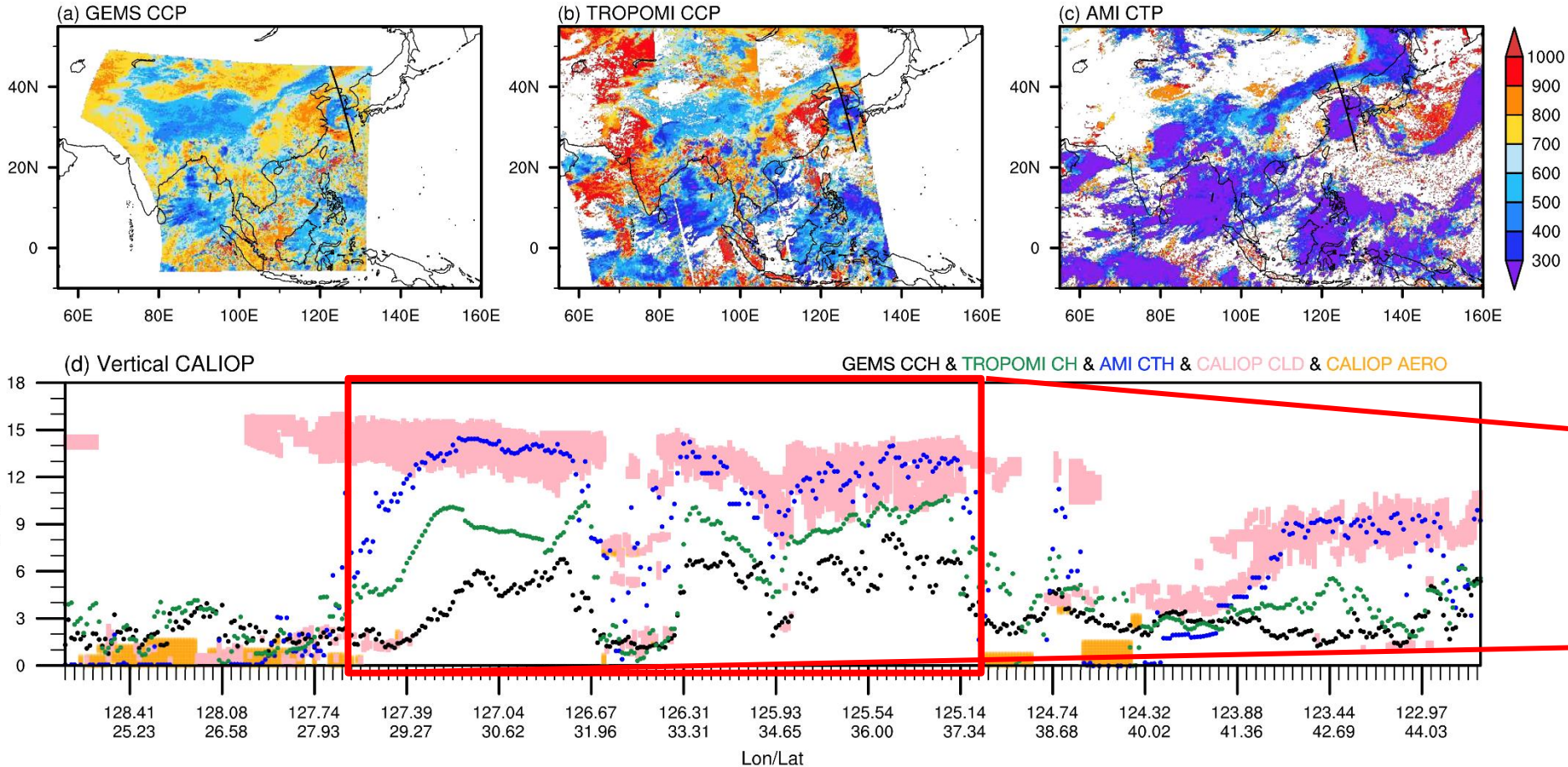
Typhoon case
(Sep 16th, 2021)
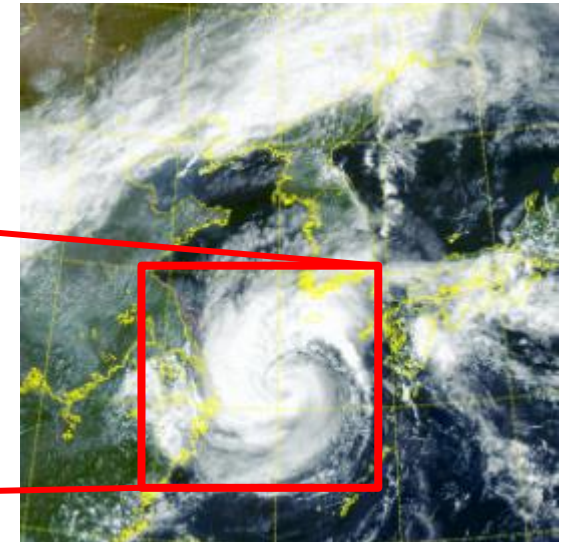
Kim et al. 2024, AMT

- The spatial pattern of overall cloud output in the typhoon region is similar.
- GEMS shows lower cloud heights compared to TROPOMI and AMI.

- **Cloud effect on trace gas retrieval**

- Cloud retrieval values can vary significantly with the solar zenith angle (SZA).
  - ✓ SZA > 60: ECF deviation of 30%

    CCP deviation of 10%
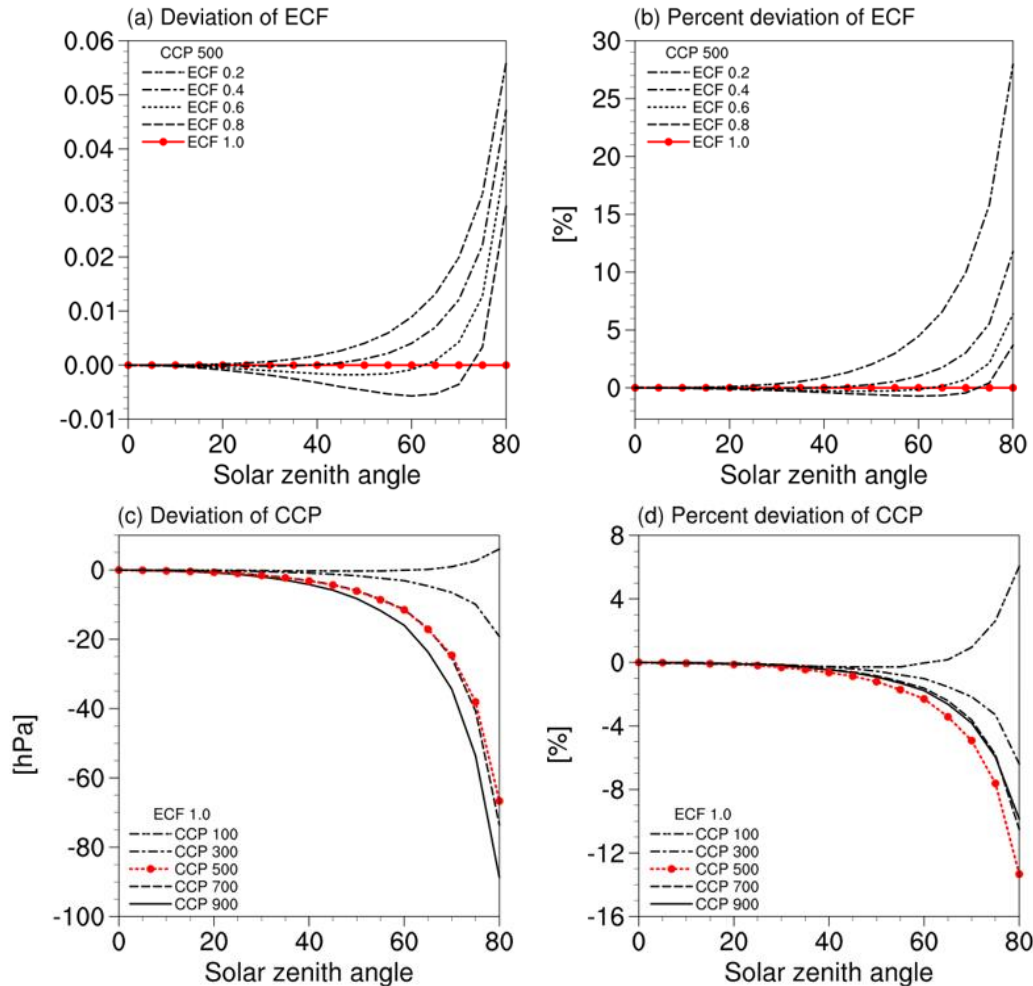
- Collaboration is needed for an impact study on cloud retrievals by time and region for trace gases such as O_3, NO_2, SO_2, HCHO, etc.

- We intend to identify issue for future improvement in GEMS CLD.

Kim et al. 2021, IJRS

IV. Ongoing issue

- **Improving the utilization of GEMS Data**

  Project launched to strengthen women's resilience to heat stress in Asia and the Pacific

  - Project name: Strengthening Women's Resilience to Heat Stress in Asia and the Pacific - Gender-responsive Heat Early Warning Systems Development Expert (Firm)
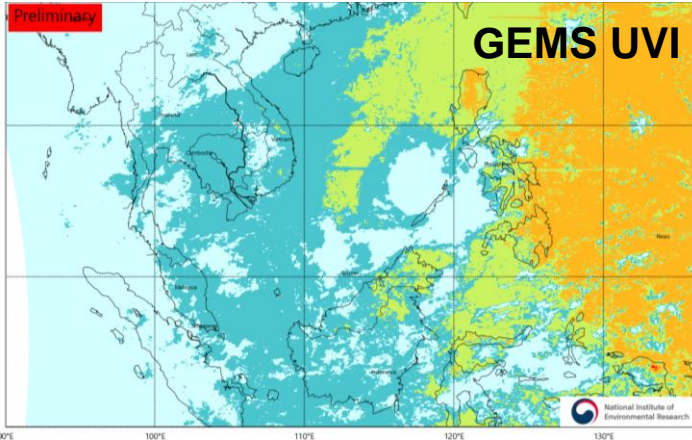 - Project period: 2024.8.26-2026.5. (18m)

Summary

- **Improved the overall performance of GEMS cloud retrievals in V3.0**
  - ✓ ECF discontinuity area is improved.
  - ✓ We reduce the overestimation of ECF in clear-sky pixels.
  - ✓ The Lower-level CCP retrieval is improved.

Kim et al. 2021 (IJRS)

- **Performance validation of GEMS CLD algorithm through OMI, TROPOMI, AMI, and CALIOP**
  - ✓ The GEMS cloud retrievals showed good agreement with other satellite-based cloud retrievals.

Kim et al. 2024 (AMT)

- **Need for international cooperation in utilizing cloud data**
  - ✓ We need a discussion of improvements for GEMS CLD V4.
  - ✓ Analysis of the impact of cloud data on trace gases is needed.