4th Cloud Retrieval Evaluation Workshop, Grainau, Germany

South Korea's geostationary satellite cloud retrievals: current status and plans for GK-2A in 2017

2014. 3. 4.

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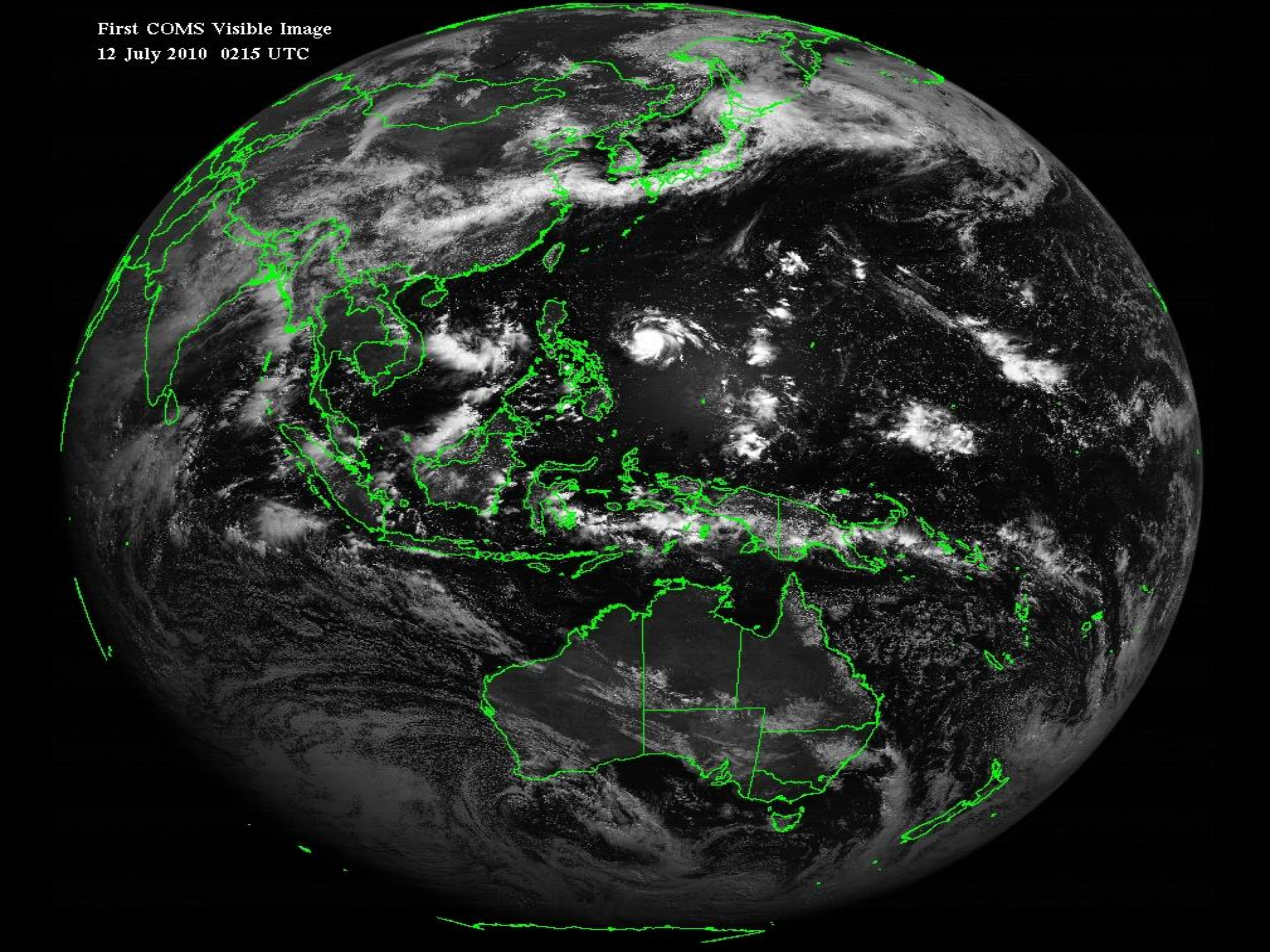
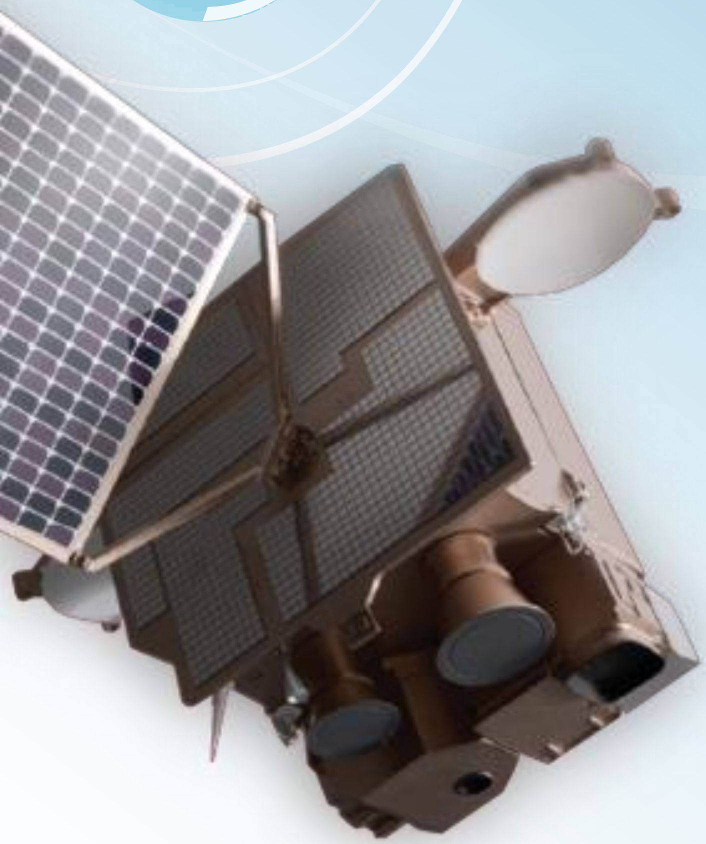
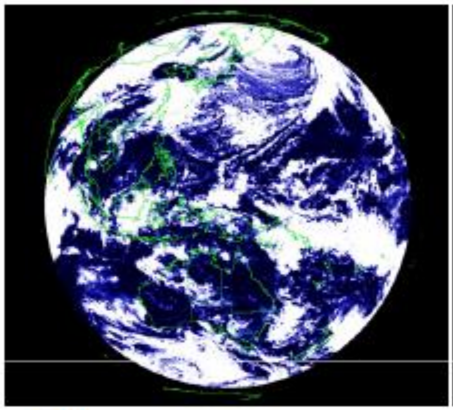

First COMS Visible Image
12 July 2010 0215 UTC



Current status of COMS cloud products (2010-)

Sample Images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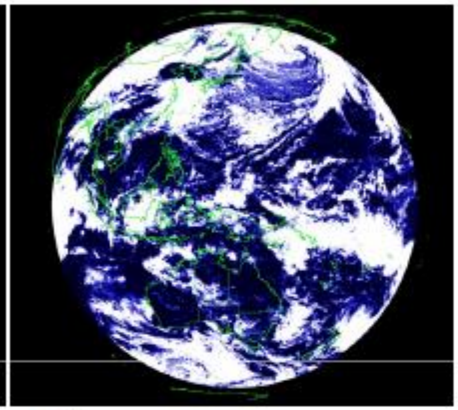
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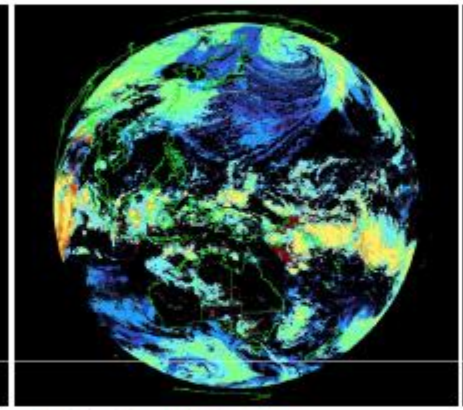
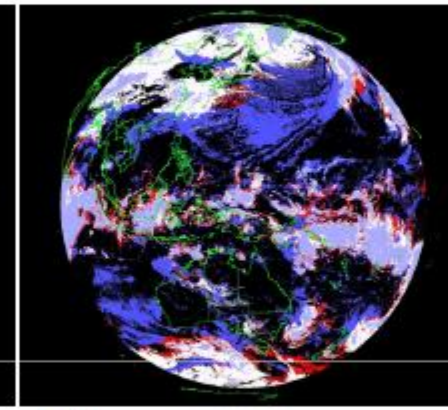

CT_Seviri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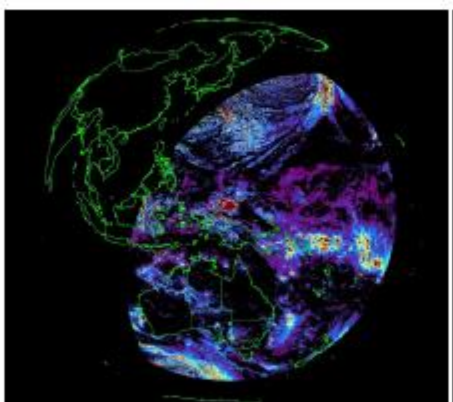
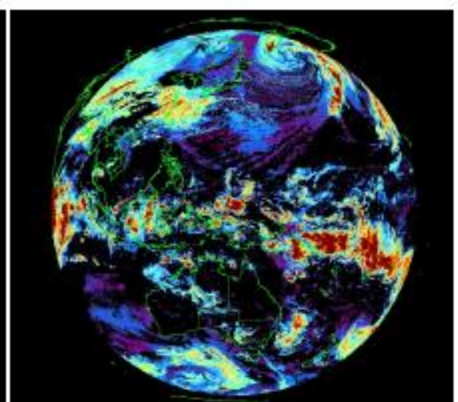
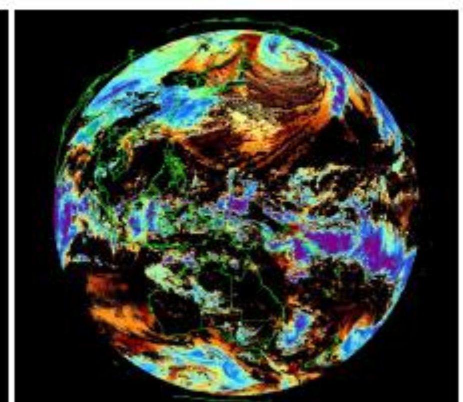
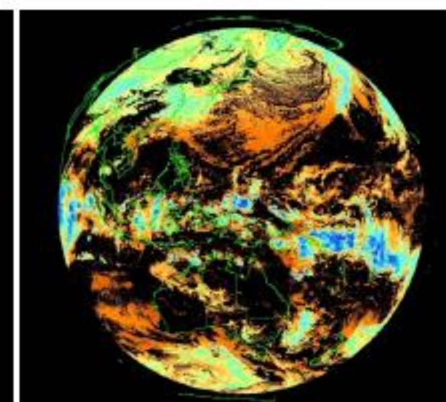

COT


CTH


CTP


CTT

Algorithms and theoretical bases

Products	Retrieval Methods	References
Cloud mask	Single- or bi-spectral threshold tests	Ackerman et al. 1998
Cloud type	1. Single- or bi-spectral threshold tests, texture tests 2. CTTH-COT combination (ISCCP)	Derrien and Le Gleau 2005 Rossowand Schiffer 1999
Cloud fraction	Area average of pixel group	MODIS ATBD, Oh et al. 2006
Cloud phase	IR trispectral algorithm (6.7,11,12) (Absorptivity of ice and water)	Strabala et al. 1994, Baum et al. 2000 Key and Intrieri 2000, Knap et al. 2002 Acarreta et al. 2004, Kokhanovsky 2006 Choi et al. 2007 IJRS, Choi and Ho 2009 IJRS
Cloud optical thickness	Sun reflectance method (cloud-reflected intensity depends on phase) (0.6,3.7)	Ou et al. 1993, Platnick and Valero 1995 Nakajima and Nakajima 1995 King et al. 1997 Choi et al. 2007 IJRS, Choi and Ho 2009 IJRS
effective particle radius	Sun reflectance method (cloud-reflected intensity depends on phase) (0.6, 3.7)	
Cloud top temperature and pressure	1. IR window channel estimate 2. Radiance ratioing method (6.7, 11)	Smith and Platt 1978 Menzel et al. 1983, Schmetz et al. 1993 Choi et al. 2007 IJRS, Choi and Ho 2009 IJRS

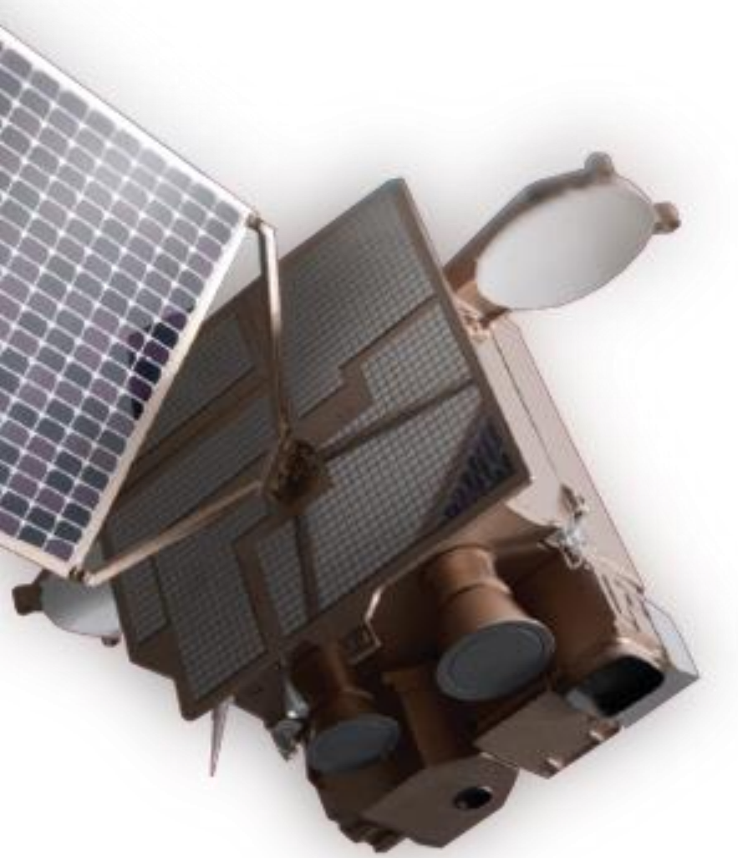
Products validation results

(for more details, see the poster "Inter-comparison of cloud parameters between COMS and MODIS" by Haklim Choi et al.)

CTP (2011)	4	5	6	7	8	9	10	11	12
Number	506,857	502,008	1,209,370	921,060	783,201	710,904	784,909	1,128,555	361,295
R	0.79	0.79	0.84	0.91	0.96	0.94	0.90	0.83	-
CTP (2012)	1	2	3	4	5	6	7	8	
Number	262,406	2,463,000	2,070,112	698,029	1,648,162	1,928,098	777,082	-	
R	-	-	-	-	0.81	0.86	0.94	0.94	

COT (2011)	4	5	6	7	8	9	10	11	12
Number			7,186,928	5,120,114	5,655,369	5,680,796	4,755,212	4,896,736	967,176
R			0.07	0.09	0.09	0.09	0.10	0.09	-
COT (2012)	1	2	3	4	5	6	7	8	
Number	661,720	7,418,602	9,939,544	3,089,647	8,553,424	8,513,975	4,843,645	-	
R	-	-	-	-	0.76	0.85	0.83	0.82	

CF (2011)	4	5	6	7	8	9	10	11	12
Number	32,106,895	-	101,514,547	68,406,931	67,821,246	68,693,589	57,481,217	74,201,714	16,866,578
R	0.90	0.94	1.00	1.00	1.00	1.00	1.00	1.00	-
CF (2012)	1	2	3	4	5	6	7	8	
Number	9,185,198	89,659,779	104,963,490	35,187,443	106,633,644	105,626,985	65,452,771	-	
R	-	-	-	-	1.00	1.00	1.00	1.00	



GEO-KOMPSAT-2A (2018-)

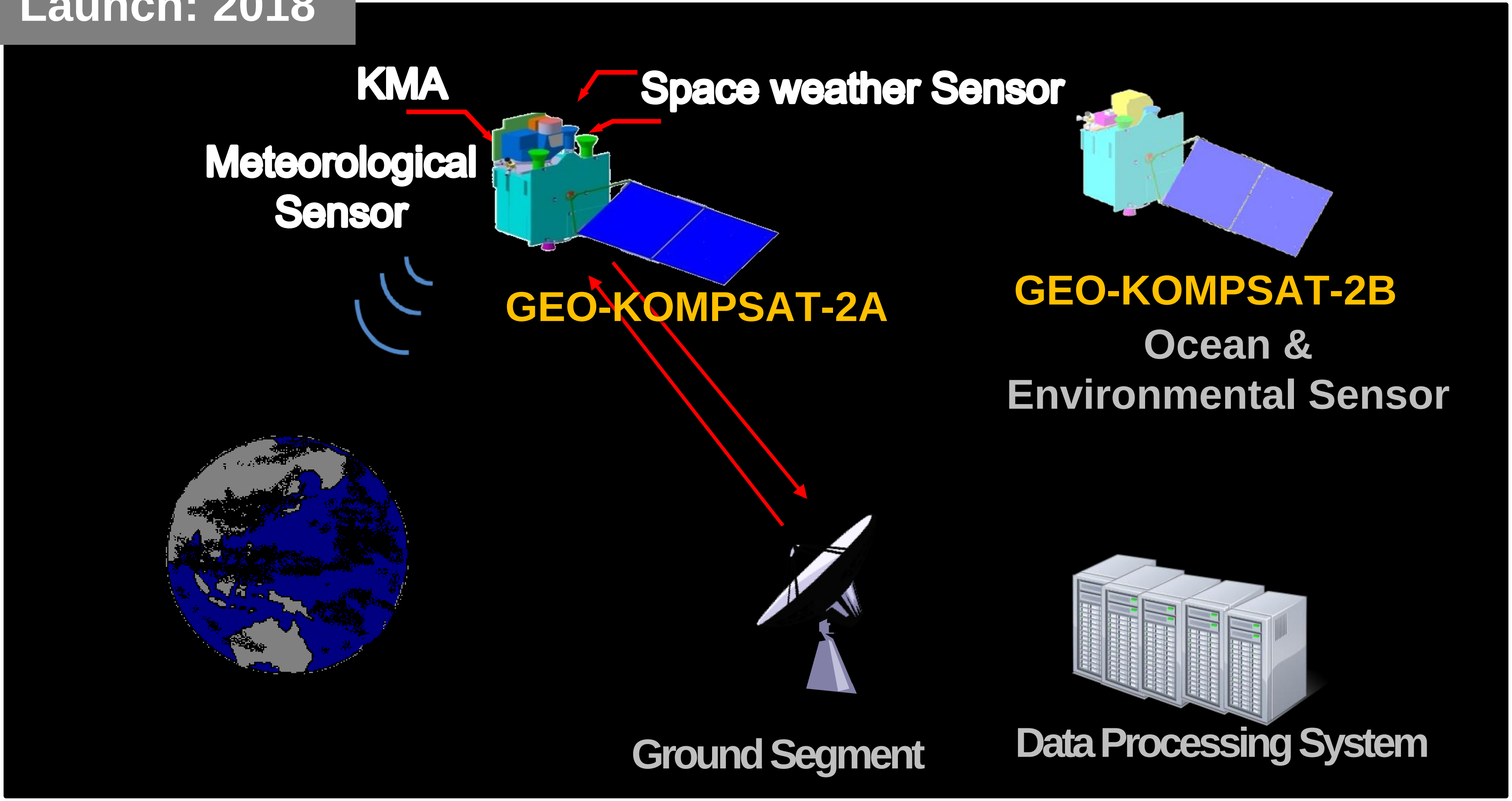
Development of GEO-KOMPSAT-2A

- Object
  - ✓ Obtaining a geostationary meteorological satellite for continuous monitoring of meteorological phenomena
  - ✓ Development of follow-on satellite for succession of COMS mission
- Mission
  - ✓ Continuing the COMS Meteorological Mission
  - ✓ Improving the Severe Weather Monitoring
    - Higher frequency of observation
    - Retrieving the atmospheric structure (pseudo-sounding)
  - ✓ Improving the support of the NWP model
    - Efficient data assimilation system
  - ✓ Intensifying the environment & climate monitoring
    - Various surface information retrieval
    - Air pollution monitoring
    - Establishing long-term observation data

GEO-KOMPSAT-2 Program

→ One for the next generation Meteorological Imager
→ The other for the Ocean and Atmospheric Trace Gas monitoring

Launch: 2018



GEO-KOMPSAT-2A Payload

❖ **Meteorological payload**

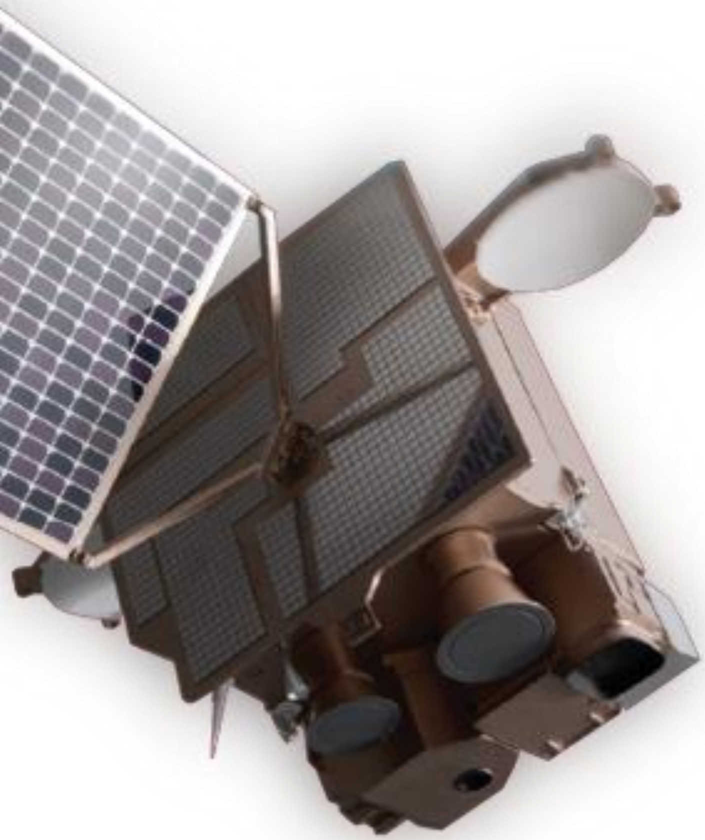
	GEO-KOMPSAT-2A	COMS
Channels	16	5
Spatial Resolution (km)	0.5, 1 (VIS), 2 (IR)	1 (VIS), 4 (IR)
Temporal Resolution (min)	10 (Full Disk)	25 (Full Disk)
Data Rate (Mbps)	~70	2.6
Life time (years)	10	7
Main Purpose of use	Weather Forecasting + NWP + CM	Weather Forecasting

The Channels of GEO-KOMPSAT-2A

Band No.	Band Name	Resolution (km)	Dynamic Range	Radiometric Accuracy
1	VIS0.4	1	0-720 W/m²/sr/um	5%
2	VIS0.5	1	0-710 W/m²/sr/um	5%
3	VIS0.6	0.5	0-620 W/m²/sr/um	5%
4	VIS0.8	1	0-320 W/m²/sr/um	5%
5	NIR1.3	2	0-114 W/m²/sr/um	5%
6	NIR1.6	2	0-77 W/m²/sr/um	5%
7	IR3.8	2	0-400 K	1 K
8	IR6.3	2	0-300 K	1 K(☝)
9	IR6.9	2	0-300 K	1 K
10	IR7.3	2	0-320 K	1 K(☝)
11	IR8.7	2	0-330 K	1 K
12	IR9.6	2	0-300 K	1 K
13	IR10.5	2	0-330 K	1 K
14	IR11.2	2	0-330 K	1 K
15	IR12.3	2	0-330 K	1 K
16	IR13.3	2	0-305 K	1 K

COMS
5 channels
(2010-)

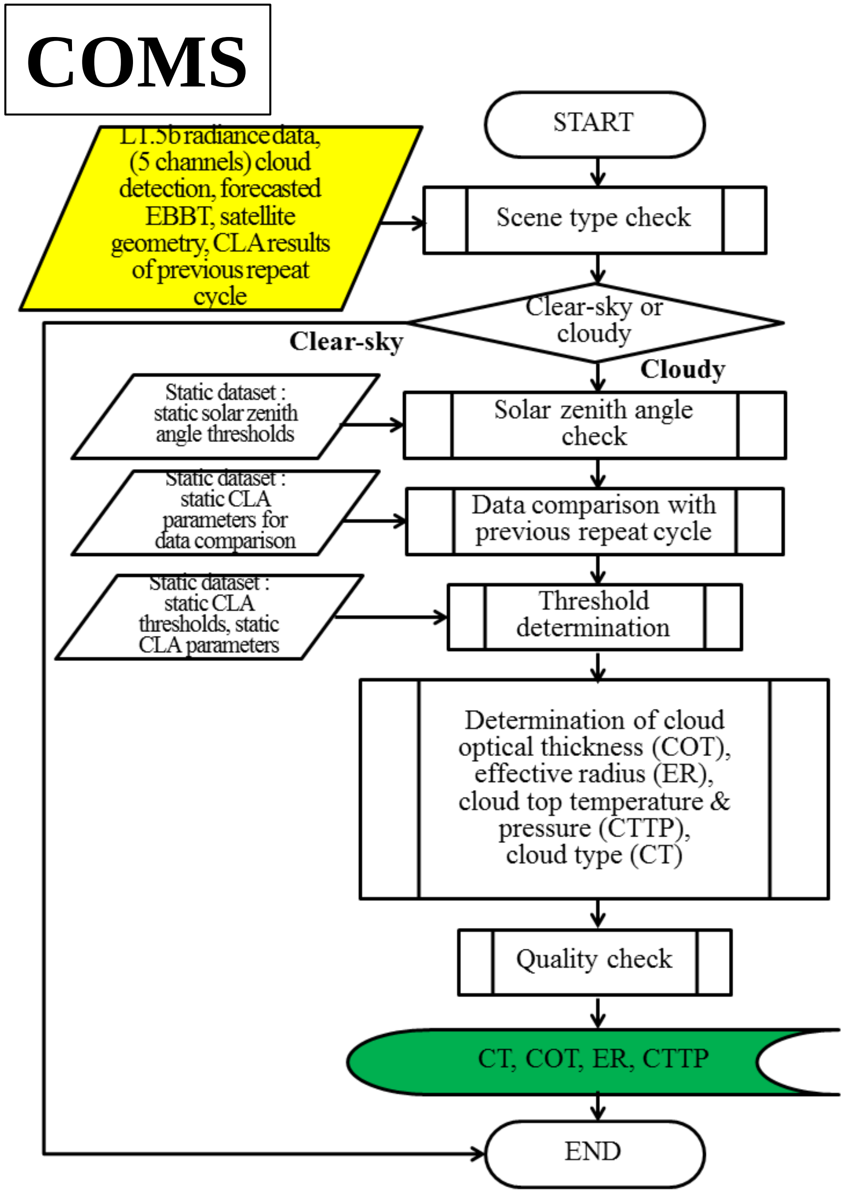
calibration accuracy at max temperature ≤ 300K

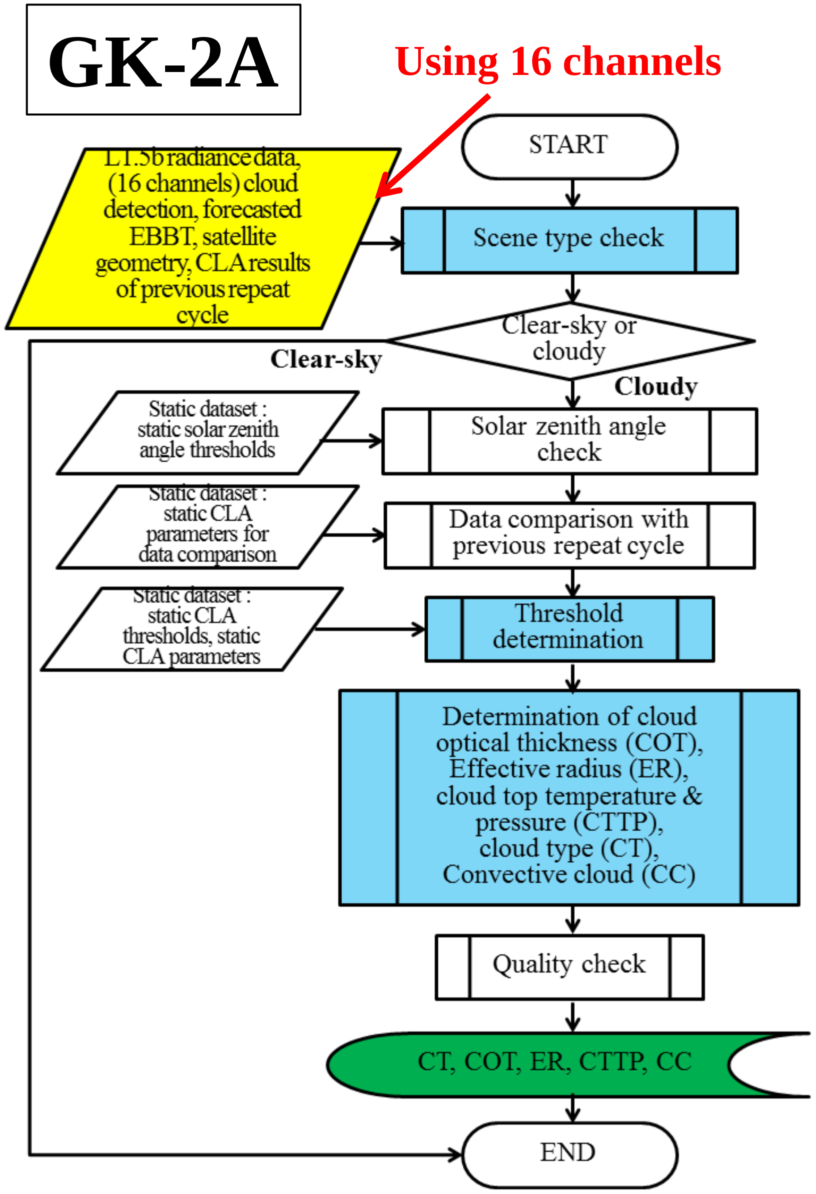


Plans for GK-2A cloud products

Expected algorithms and changes from COMS

Cloud Analysis

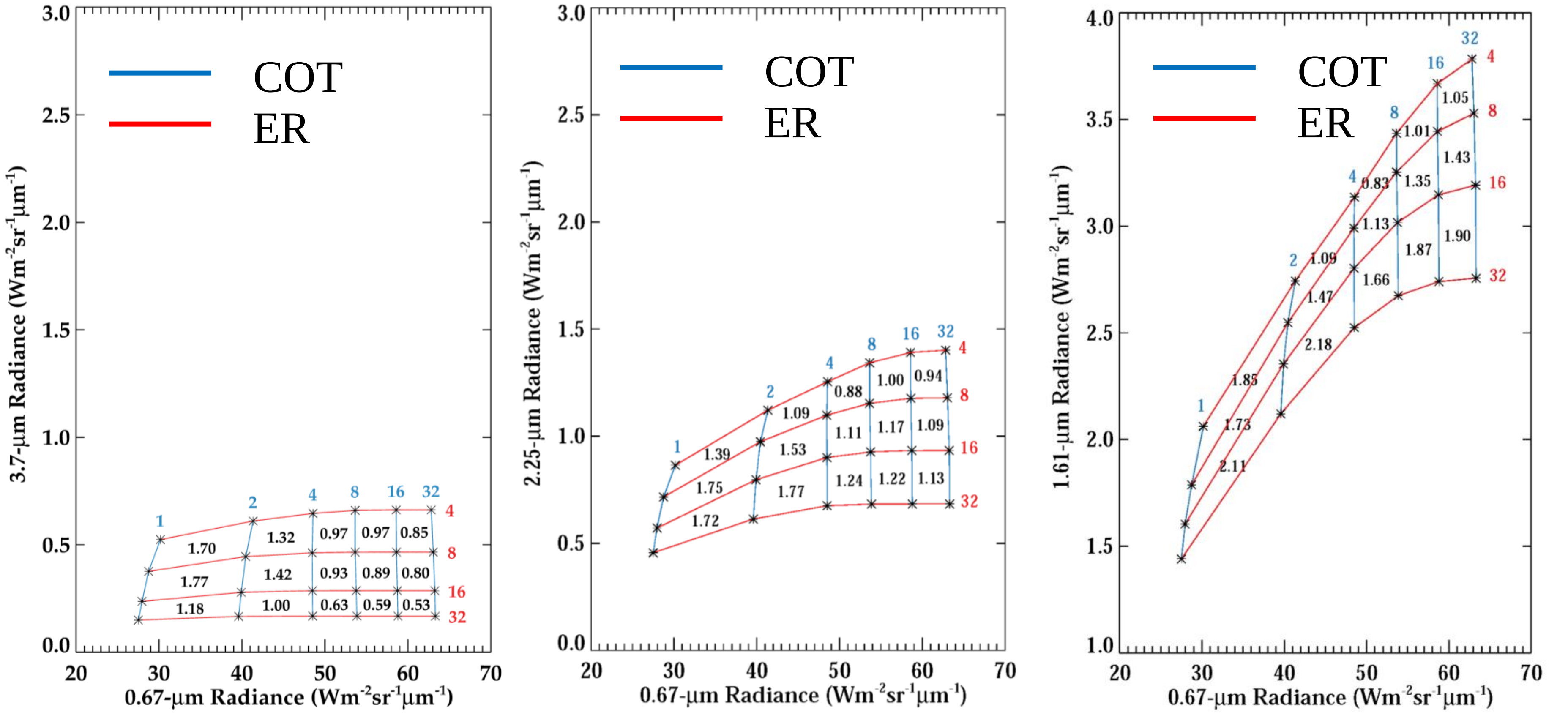




Ongoing studies for algorithm design

STREAMER Tests for cloud optical thickness (COT)& effective radius (ER) retrieval during daytime using three channels (3.7,2.25,1.61-μm)

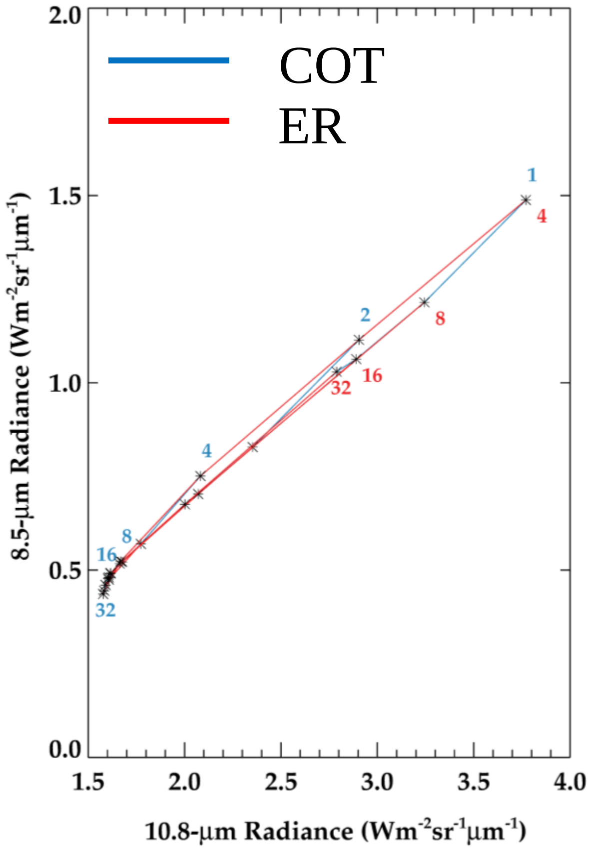
$$\theta(solar\ zenith\ angle) = 60°, \theta_0(satellite\ zenith\ angle) = 60°, \varphi(relative\ azimuth\ angle) = 0°$$

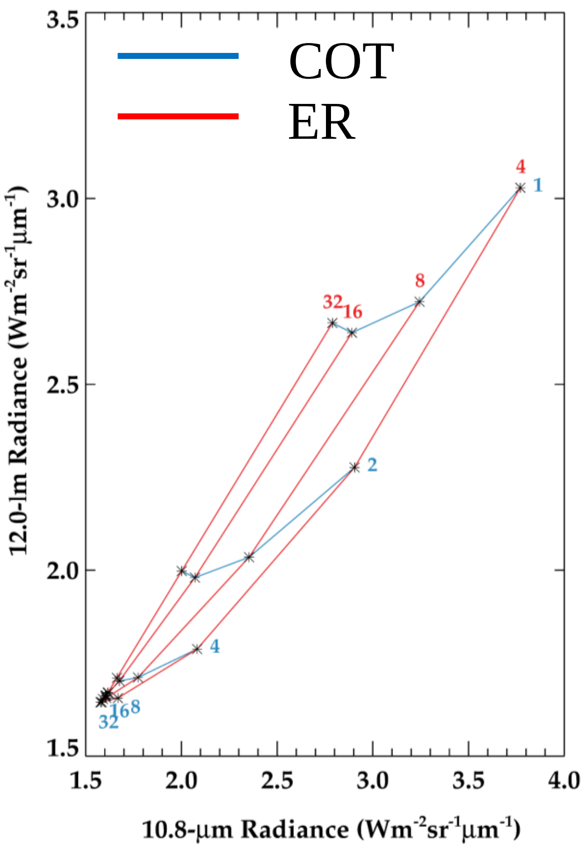


Ongoing studies for algorithm design

STREAMER Tests for cloud optical thickness (COT)& effective radius (ER) retrieval during nighttime using three channels (10.8,8.5,12.0-μm)

$\theta(solar\ zenith\ angle) = 60°, \theta_0(satellite\ zenith\ angle) = 60°, \varphi(relative\ azimuth\ angle) = 0°$





Ongoing studies for algorithm design

STREAMER Tests for cloud top property (CTP) at tropics/mid-latitude /arctic regions in summer using three channels (3.7,9.6,13.3-μm)

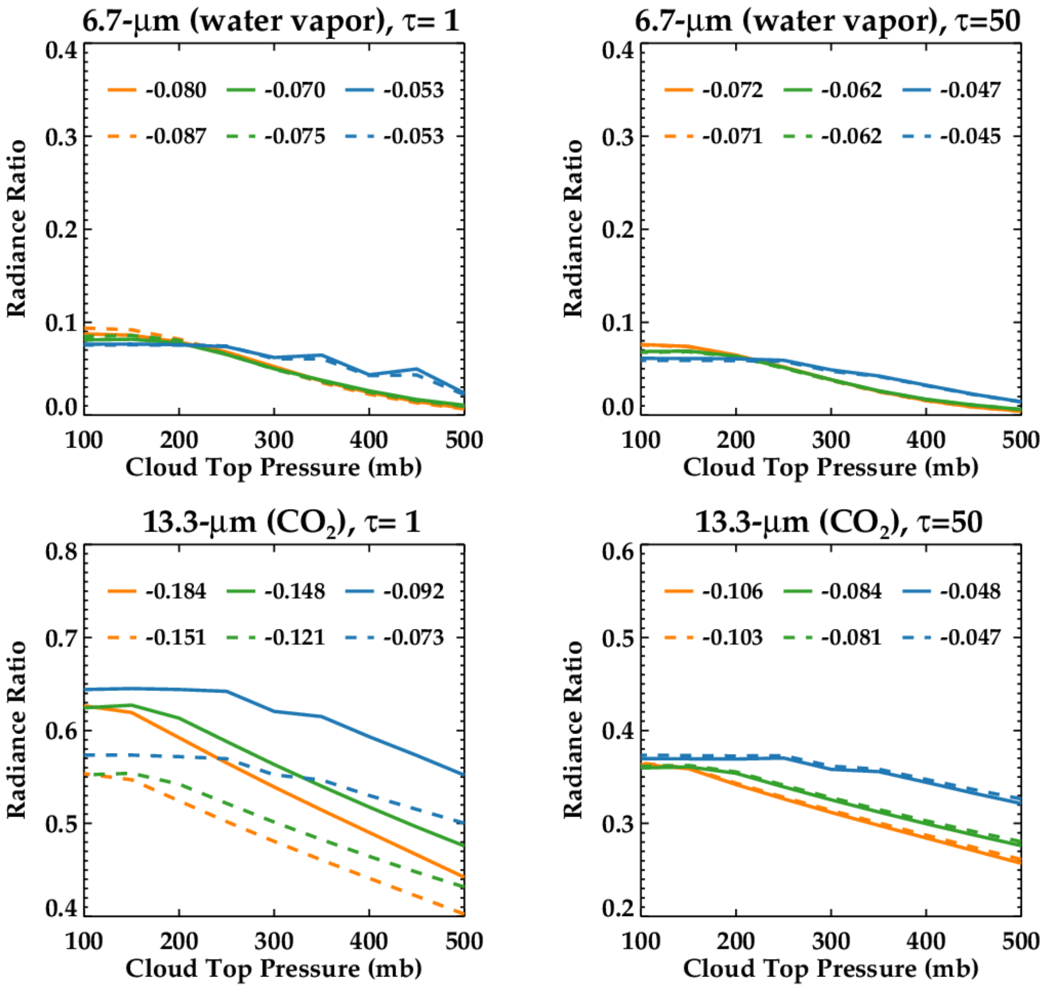
— Tropics
— Mid-latitude
— Arctic

Radiance ratio
for CO_2 slicing method

$$\frac{L_1^{obs} - L_1^{clr}}{L_2^{obs} - L_2^{clr}} = \frac{\int_{p_g}^{p_c} t_1(p,0)\frac{\partial B_1(p)}{\partial p}dp}{\int_{p_g}^{p_c} t_2(p,0)\frac{\partial B_2(p)}{\partial p}dp}$$

Radiance ratio
for COMS algorithm

$$\frac{L_{10.8}^{obs} - L_{10.8}^{clr}}{L_{6.7}^{obs} - L_{6.7}^{clr}} = \frac{B_{10.8}[T(p_c)] - L_{10.8}^{clr}}{\int_{p_g}^{p_c} t_{6.7}(p,0)\frac{\partial B_{6.7}(p)}{\partial p}dp}$$



— water
-- ice

Summary

Products	Current retrieval methods for MI/COMS	Direction of Development for AMI/GK-2A
Cloud mask	Single- or bi-spectral threshold tests with 5 channels	Use all 16 channels, optimization
Cloud phase	IR trispectral algorithm (Absorptivity of ice and water)	Replace 6.7 µm with 8.7 µm channel, optimization
Cloud optical thickness & effective radius	Sun reflectance method (cloud-reflected intensity depends on phase) with 0.6 and 3.7 µm	Replace 3.7 µm by 1.6, or 2.2 µm channels, optimization, Only daytime
Cloud top temperature and pressure	1. IR window channel estimate 2. Radiance ratioing method	Replace 6.7 µm with 13.3 µm channel for radiance ratioing, optimization
Cloud type	1. Single- or bi-spectral threshold tests, texture tests 2. CTTH-COT combination (ISCCP)	SEVIRI cloud type algorithm via the collaboration with NWC SAF, No ISCCP cloud type retrieved
Cloud fraction	Averaging, hemispheric projection	-
Convective cloud	-	Threshold techniques with CTT

이화여자대학교
EWHA WOMANS UNIVERSITY

Thank You!

We welcome your cooperation, and hope to contribute CREW

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Baseline cloud products

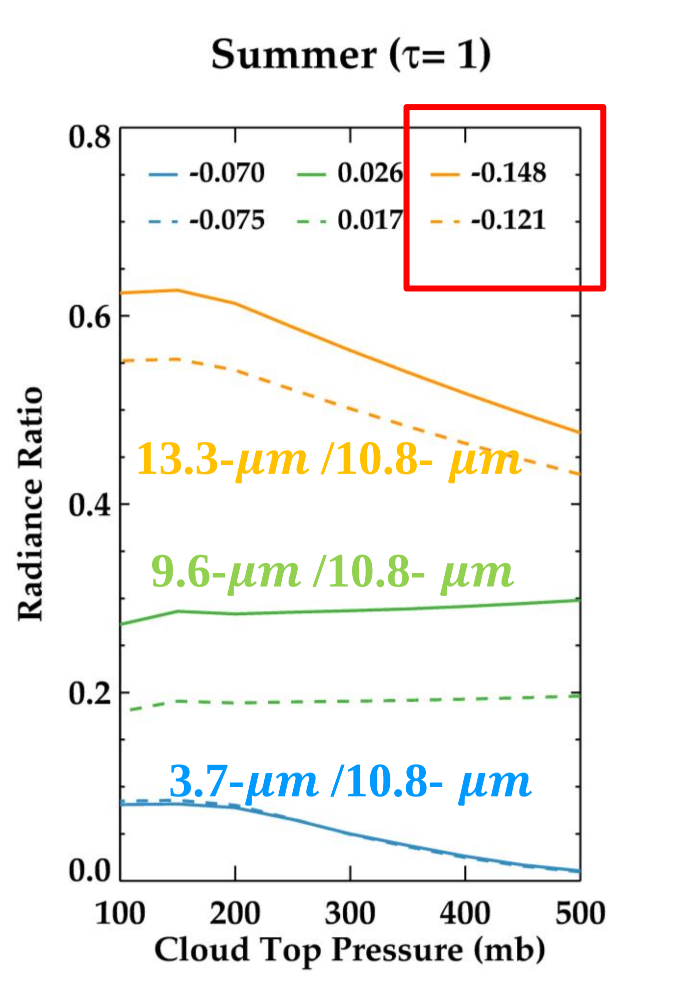
- Cloud mask
  - Existence and nonexistence of cloud with probability
- Cloud type
  - Cloud classification by optical thickness, top height, and textures
- Cloud fraction
  - Cloudiness in %
- Cloud phase
  - Thermodynamic cloud phase: Ice, liquid, and mixed phase
- Cloud optical thickness and effective radius
  - COT: A measure of cloud transparency, $-\log(I / I_0)$
  - ER: A weighted mean of the size distribution of cloud droplets. the ratio of the 3^{rd} to 2^{nd} moment of a droplet size distribution.
- Cloud top temperature/pressure/height
  - Cloud-top temperature (in K), pressure in (hPa), height (m)

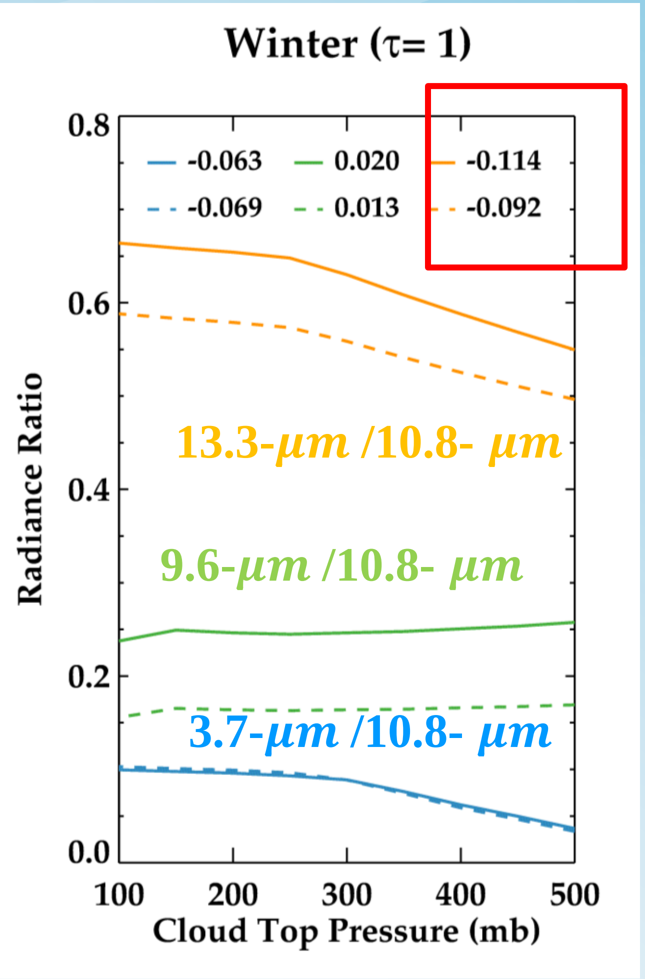
References

- Oh, H.-R., Y.-S. Choi, C.-H. Ho, and M.-H. Ahn (2006), Development of sky cover retrieval algorithm for the Communication, Ocean and Meteorological Satellite (COMS) imagery, *Journal of the Korean Meteorological Society*, 42, 389–396.
- Choi, Y.-S., C.-H. Ho, M.-H. Ahn, and Y.-M. Kim (2007), An exploratory study of cloud remote sensing capabilities of the Communication, Ocean and Meteorological Satellite (COMS) imagery, *International Journal of Remote Sensing*, 28, 4715–4732.
- Choi, Y.-S., and C.-H. Ho (2009), Validation of the cloud property retrievals from the MTSAT-1R imagery using MODIS observations, *International Journal of Remote Sensing*, 30, 5935–5958.

Ongoing studies for algorithm design

STREAMER Tests for cloud top property (CTP) at mid-latitude using three channels (3.7/9.6/13.3-μm)



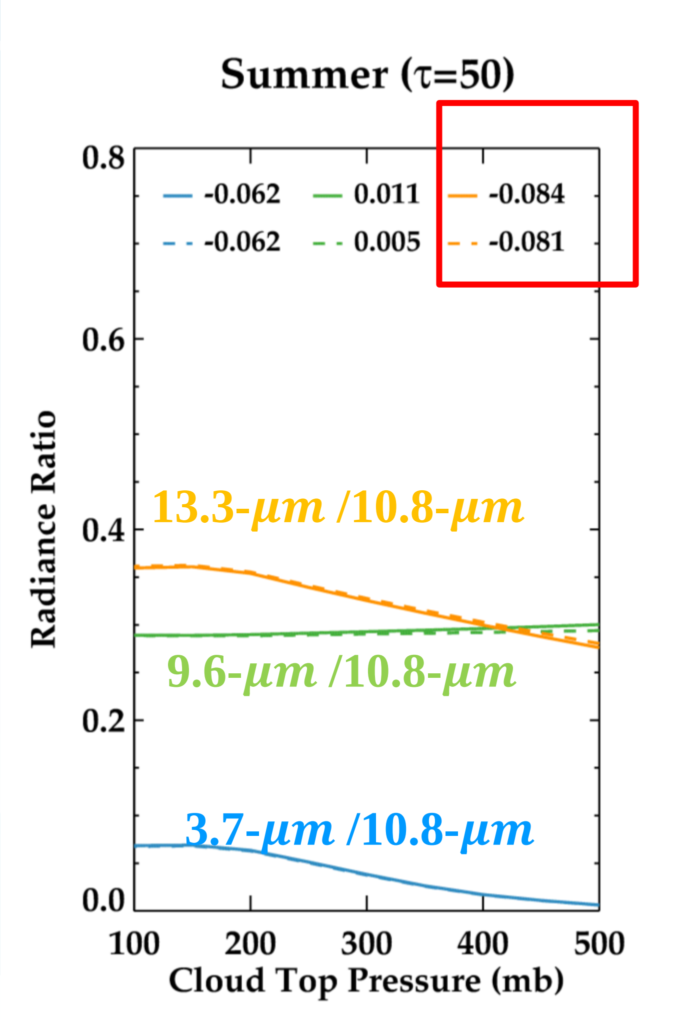


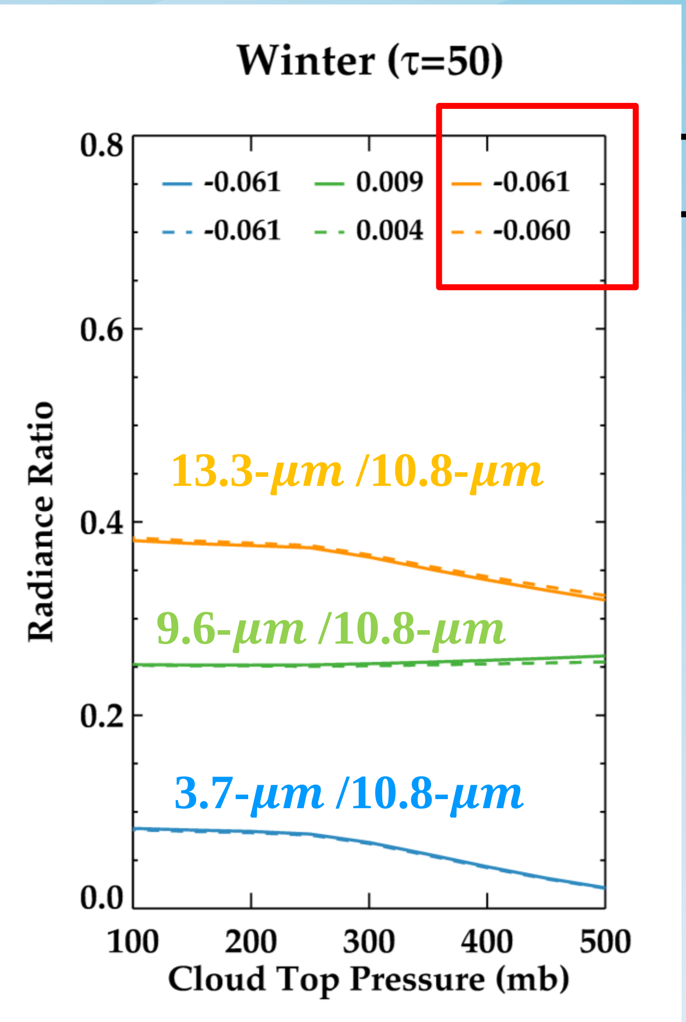
— water

- - ice

Ongoing studies for algorithm design

STREAMER Tests for cloud top property (CTP) at mid-latitude using three channels (3.7/9.6/13.3-μm)



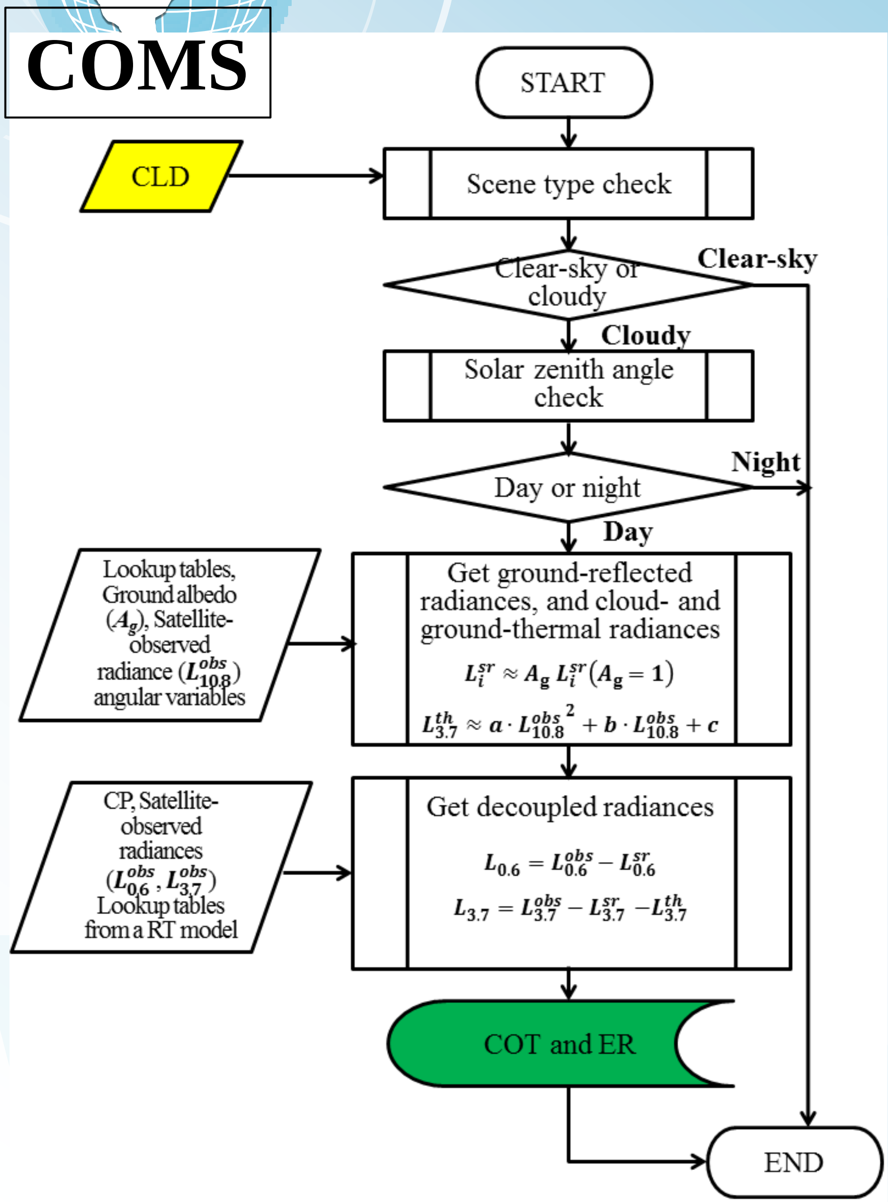


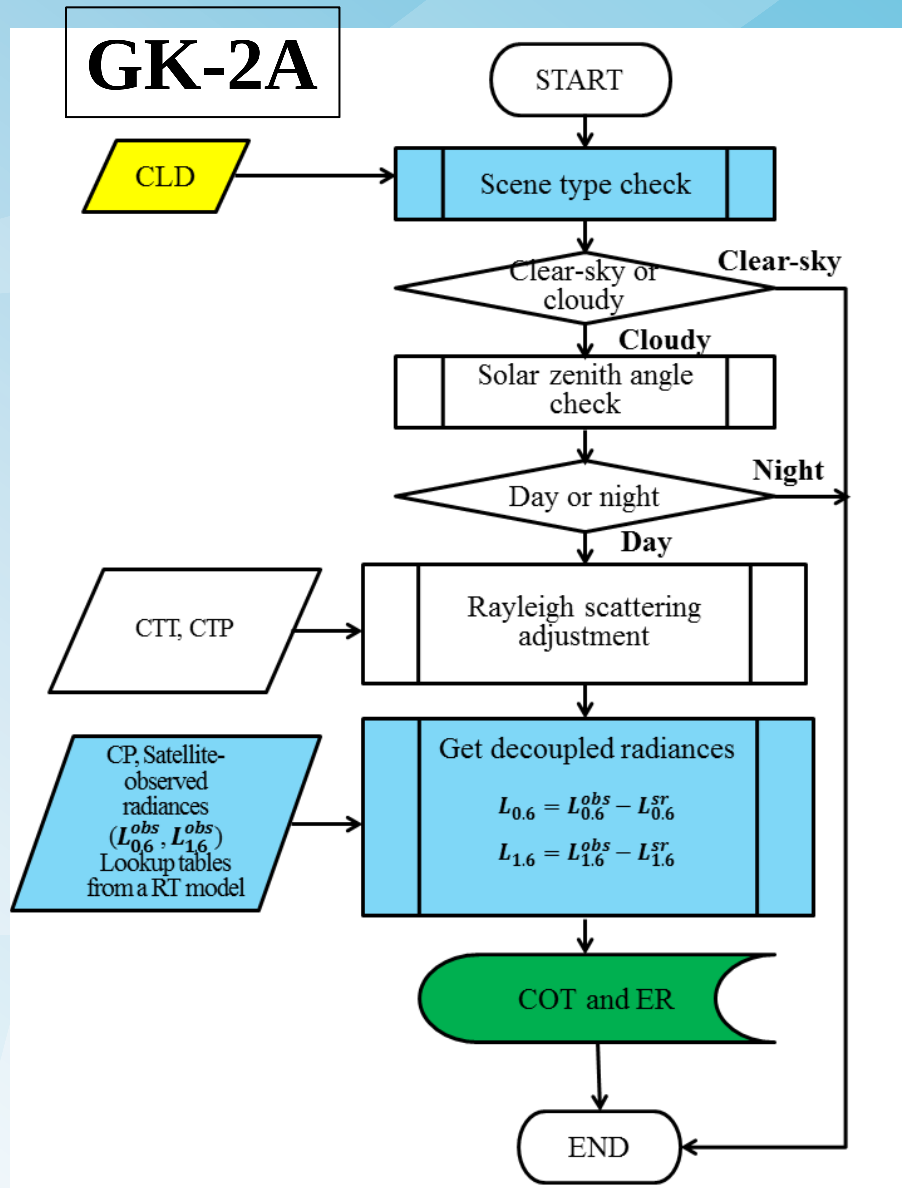
— water

- - ice

Expected algorithms and changes from COMS

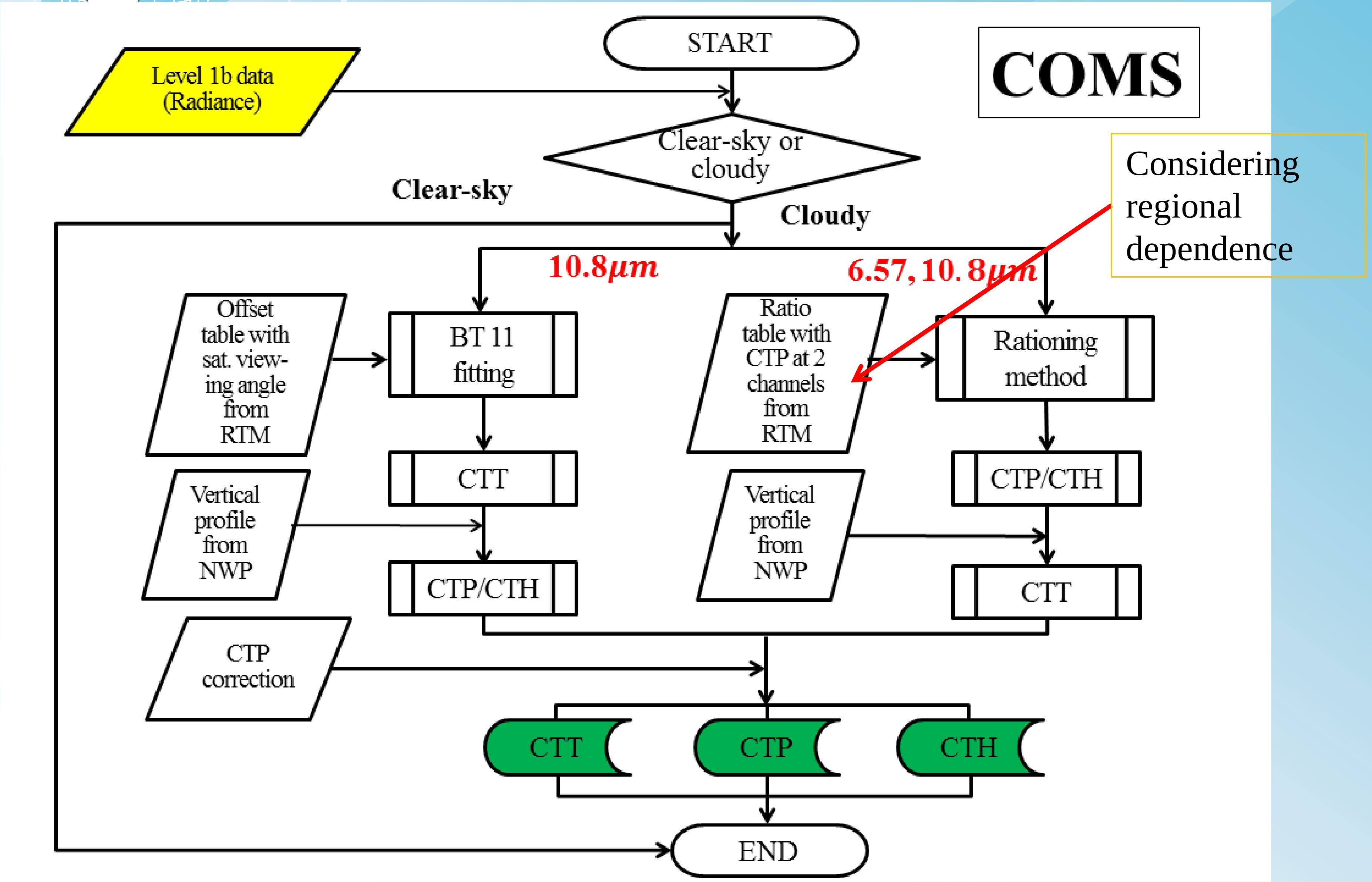
Cloud Optical Thickness (COT) and Effective Radius (ER)





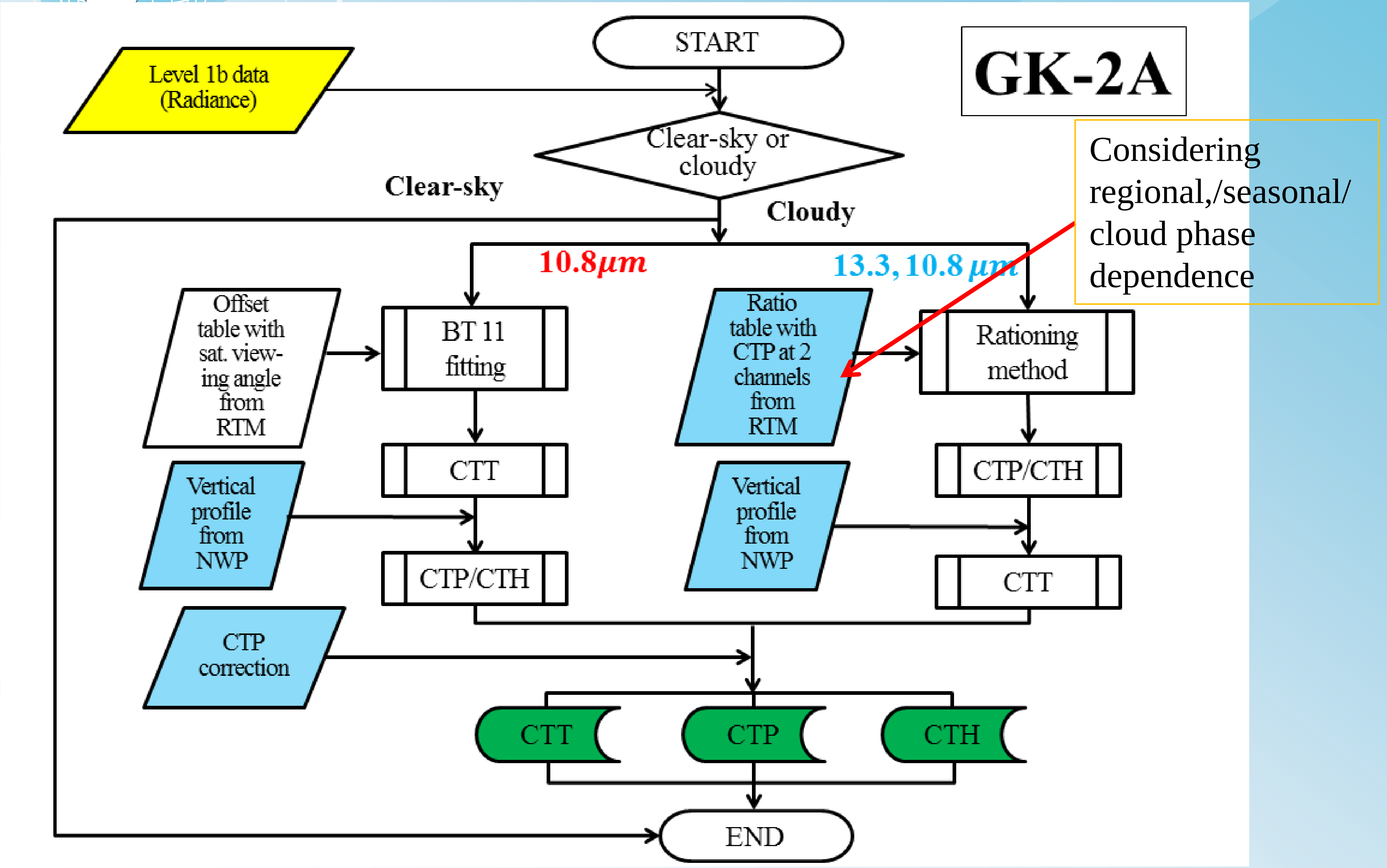
Expected algorithms and changes from COMS

Cloud Top Temperature/Pressure/Height (CTT,CTP,CTH)



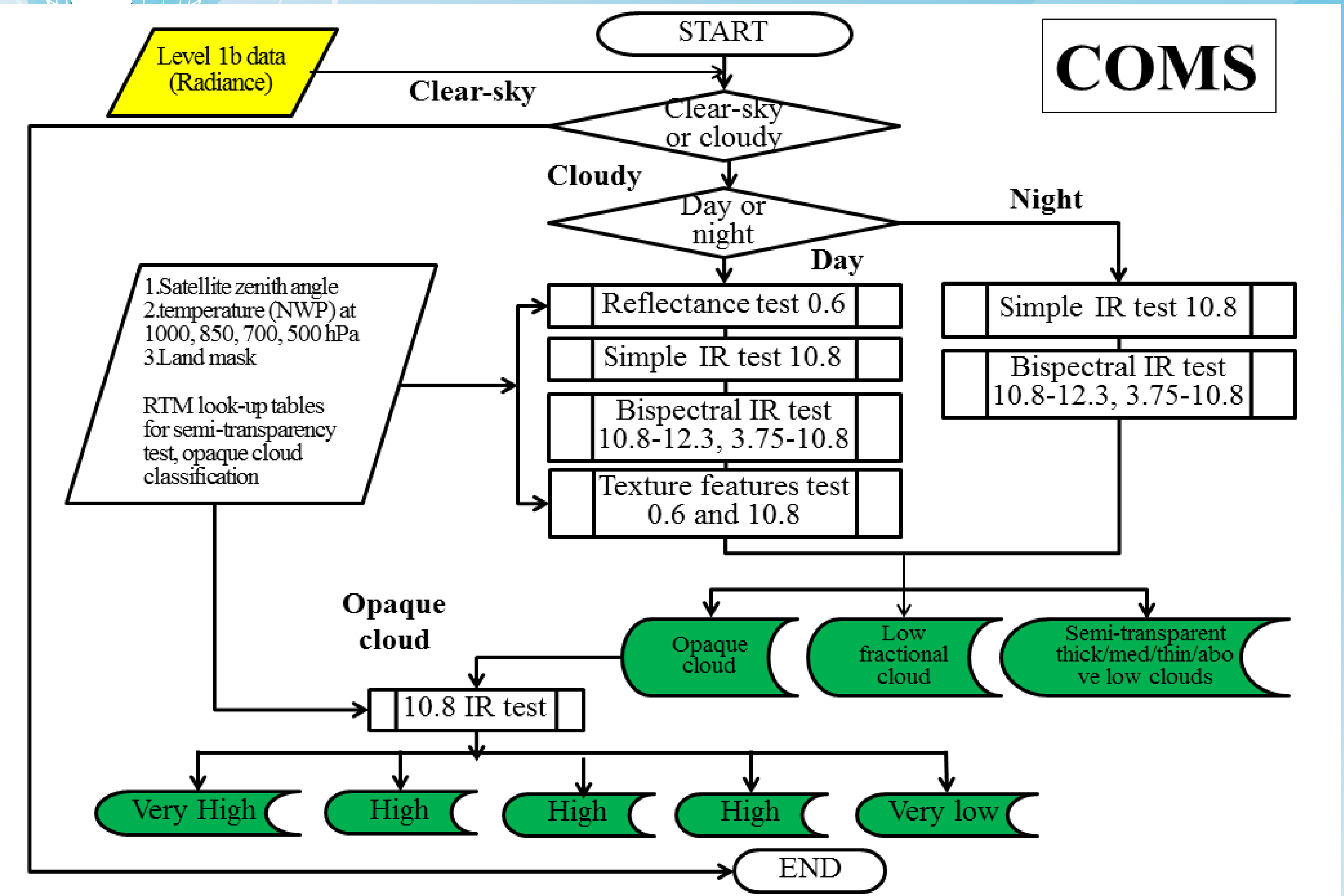
Expected algorithms and changes from COMS

Cloud Top Temperature/Pressure/Height (CTT,CTP,CTH)



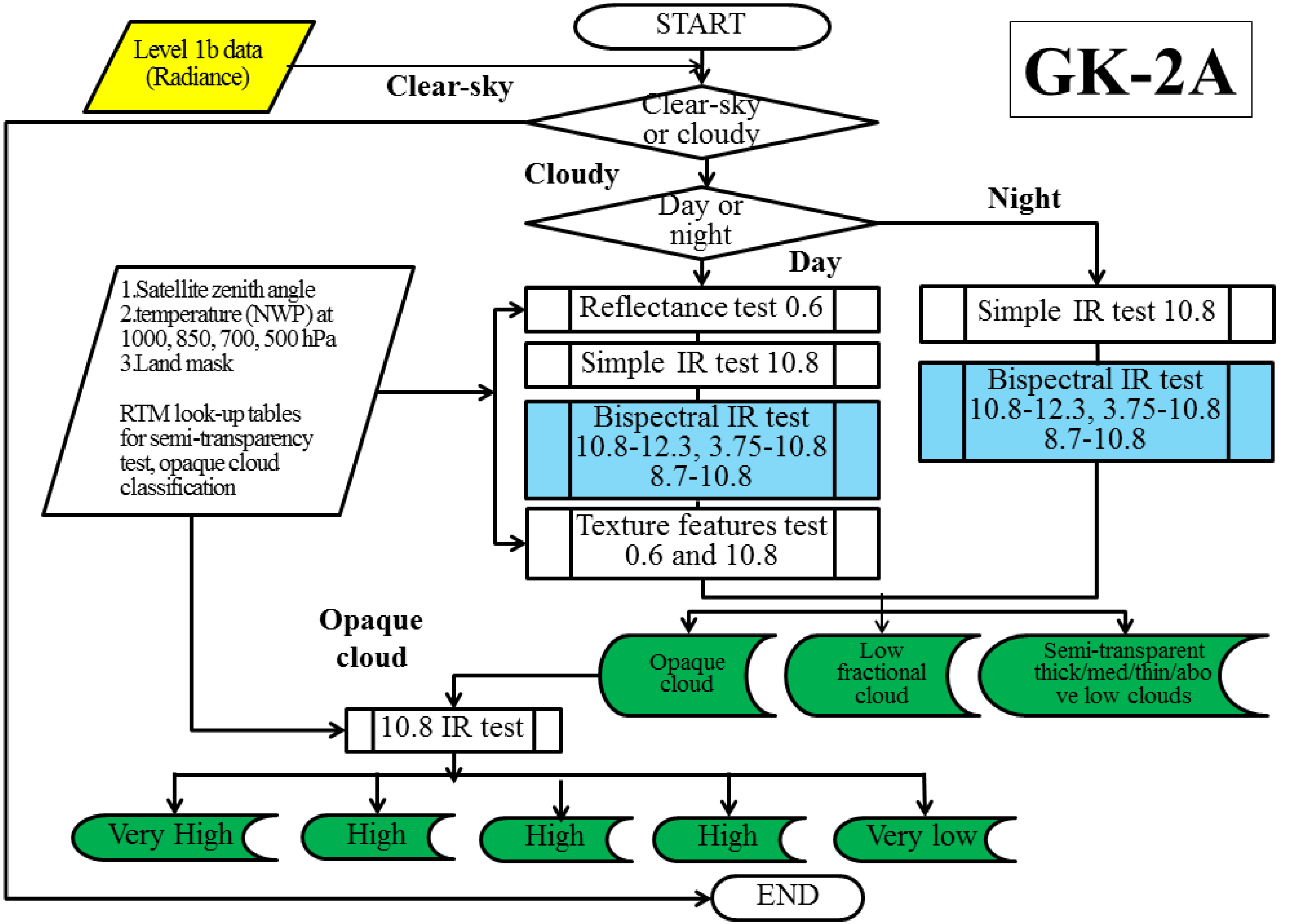
Expected algorithms and changes from COMS

Cloud Type (CT)



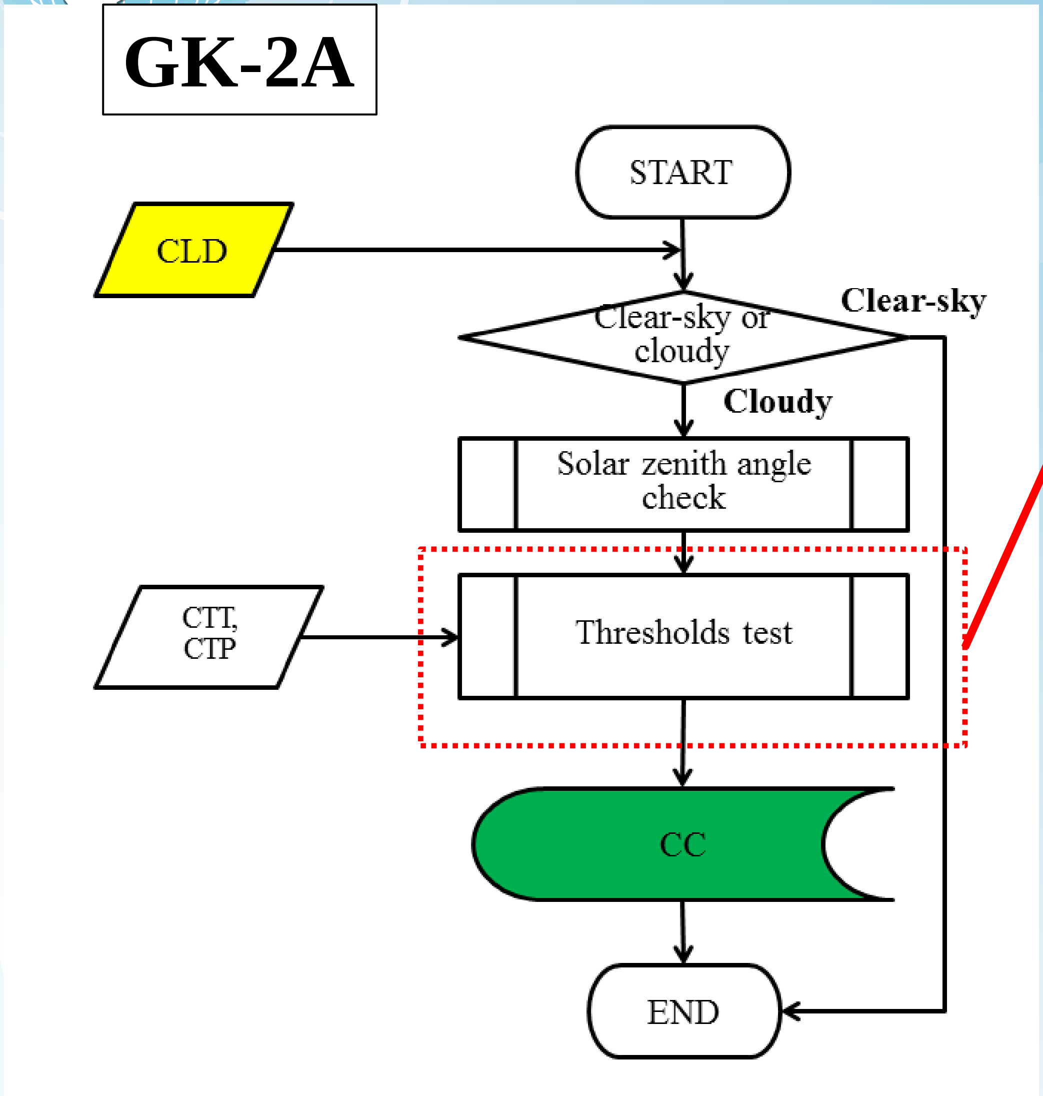
Expected algorithms and changes from COMS

Cloud Type (CT)



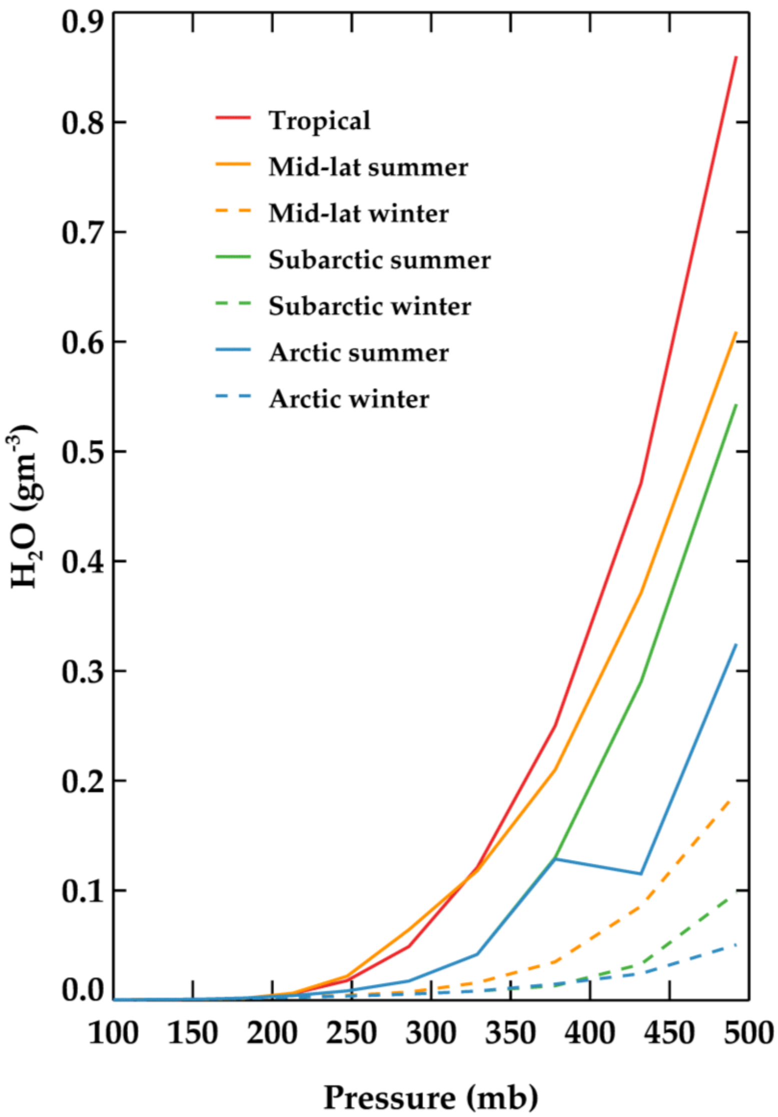
Expected algorithms and changes from COMS

Convective Cloud (CC)

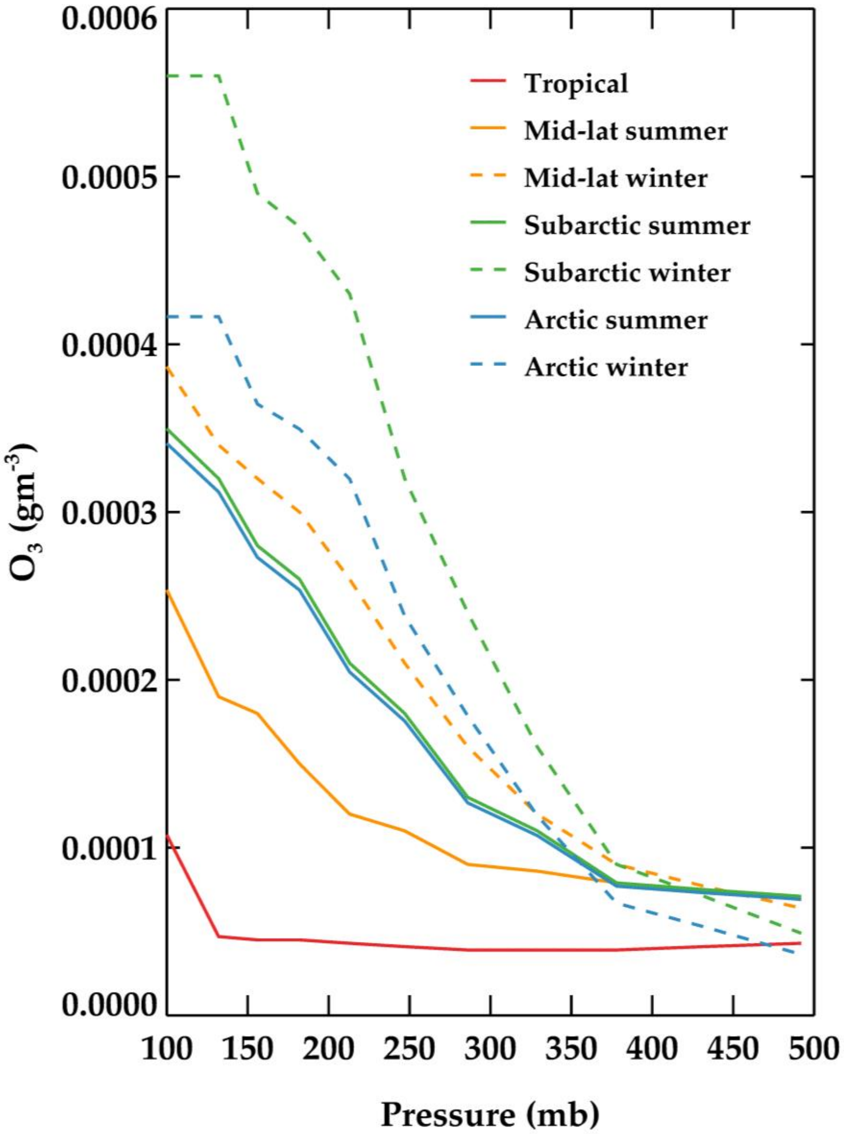


Several thresholds of CTT
−65°C : Hall & Harr, 1999
−58°C : Fu et al, 1990
−43°C : Hendon & woodbery, 1993
−40°C : Liu et al, 1995

Supplement

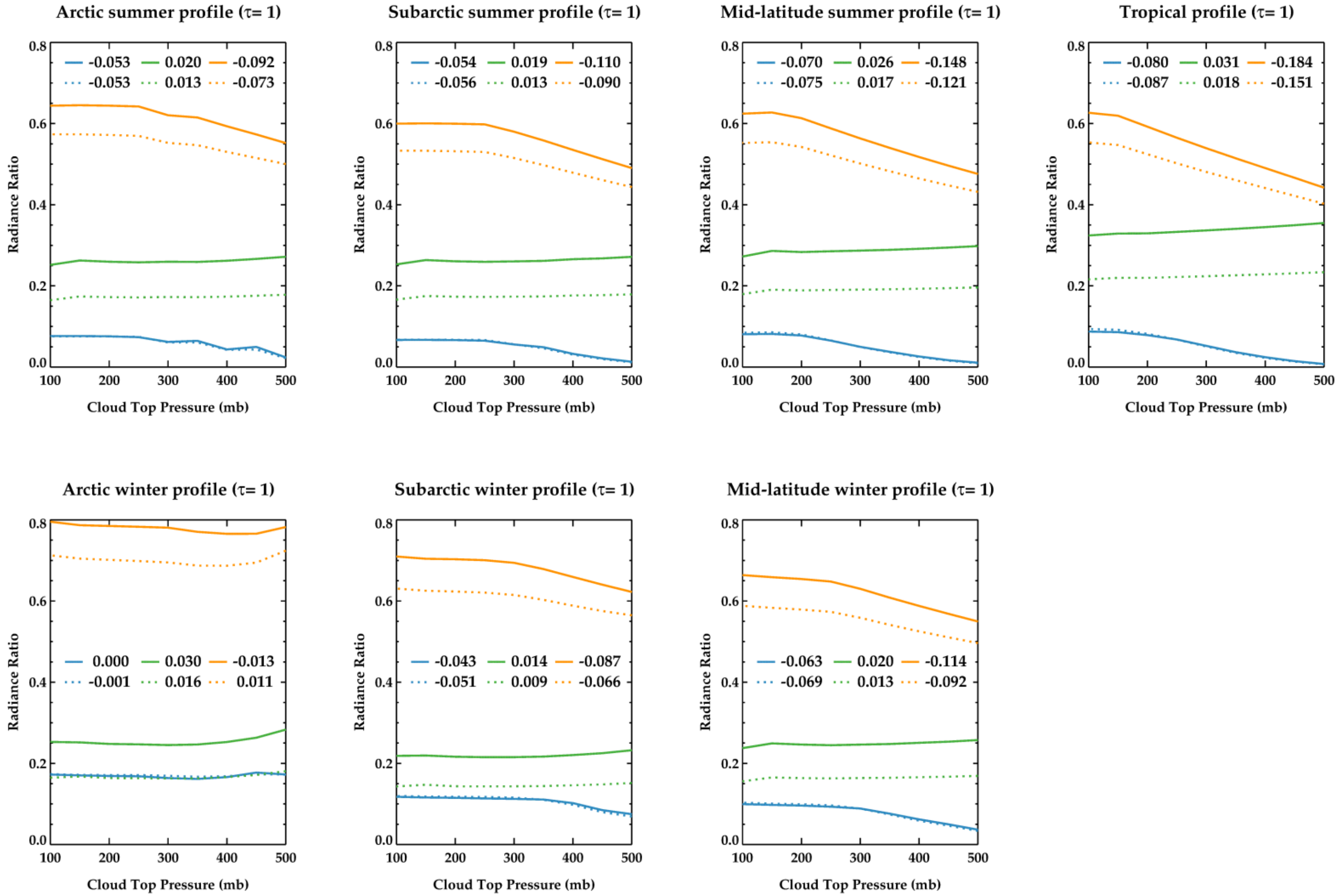


0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
100
150
200
250
300
350
400
450
500
Pressure (mb)
H2O (gm-3)
Tropical
Mid-lat summer
Mid-lat winter
Subarctic summer
Subarctic winter
Arctic summer
Arctic winter

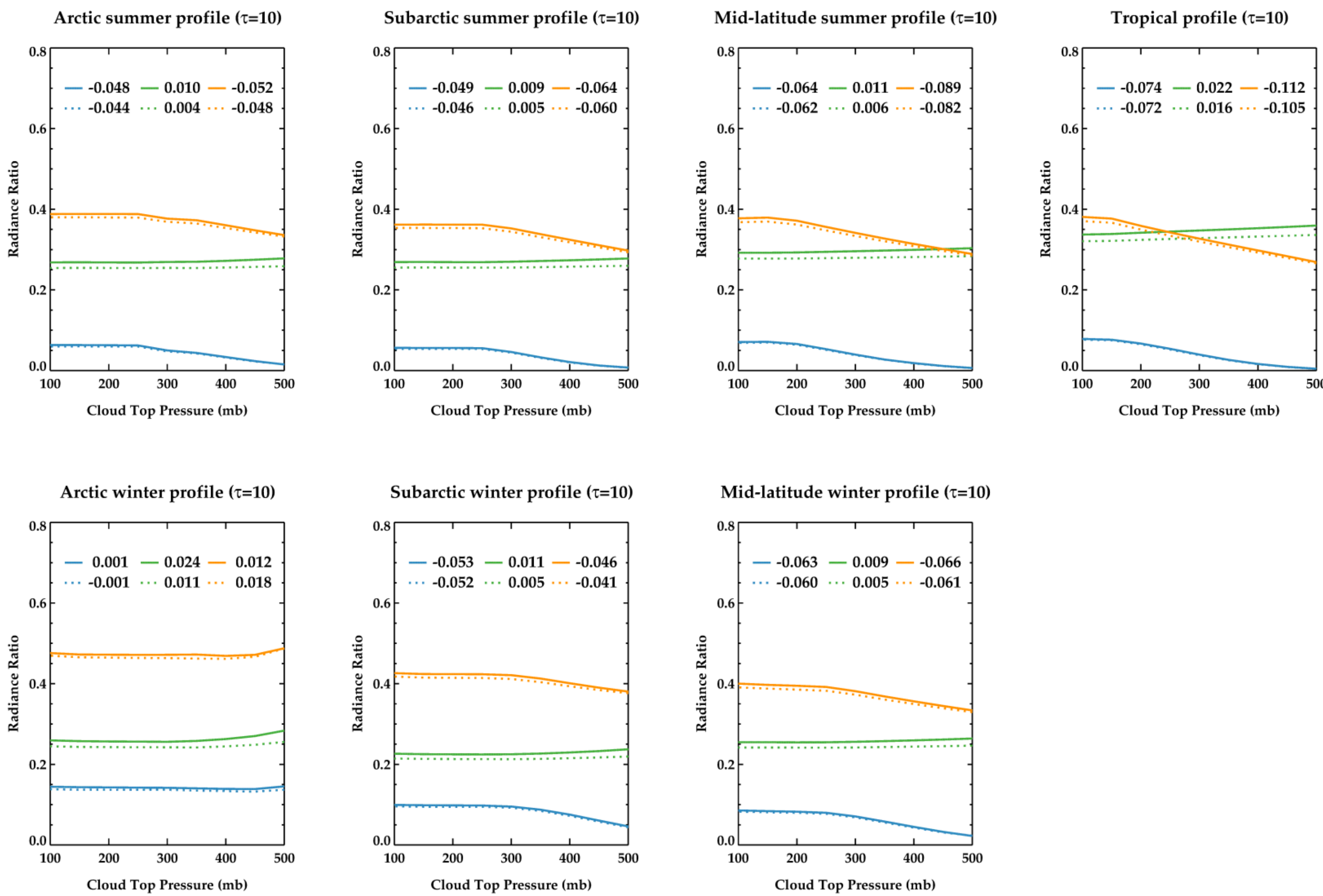


0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
100
150
200
250
300
350
400
450
500
Pressure (mb)
O3 (gm-3)
Tropical
Mid-lat summer
Mid-lat winter
Subarctic summer
Subarctic winter
Arctic summer
Arctic winter

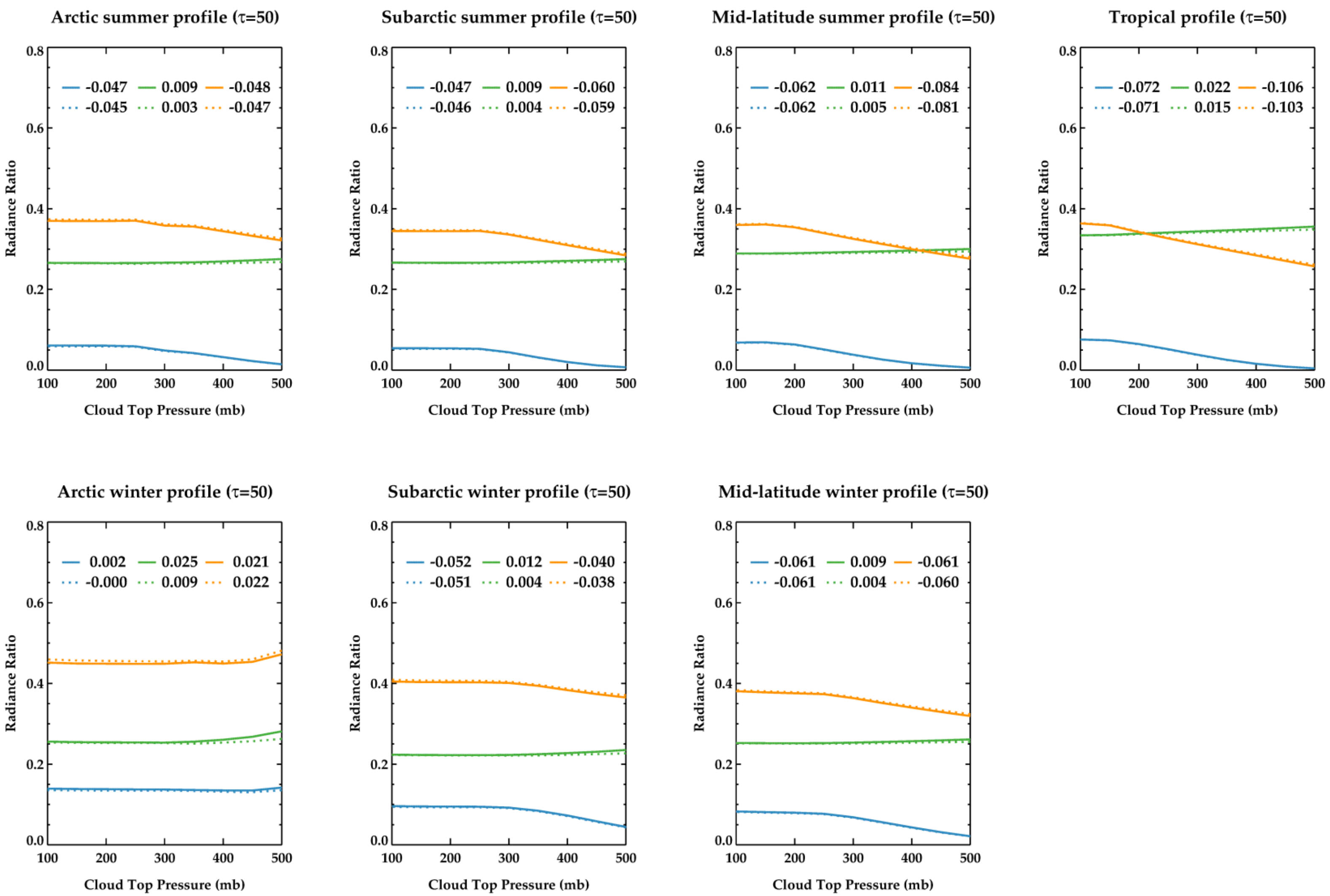
Supplement


Arctic summer profile (τ= 1)
-0.053 0.020 -0.092
-0.053 0.013 -0.073
Subarctic summer profile (τ= 1)
-0.054 0.019 -0.110
-0.056 0.013 -0.090
Mid-latitude summer profile (τ= 1)
-0.070 0.026 -0.148
-0.075 0.017 -0.121
Tropical profile (τ= 1)
-0.080 0.031 -0.184
-0.087 0.018 -0.151
Arctic winter profile (τ= 1)
0.000 0.030 -0.013
-0.001 0.016 0.011
Subarctic winter profile (τ= 1)
-0.043 0.014 -0.087
-0.051 0.009 -0.066
Mid-latitude winter profile (τ= 1)
-0.063 0.020 -0.114
-0.069 0.013 -0.092
Radiance Ratio
Cloud Top Pressure (mb)
0.0
0.2
0.4
0.6
0.8
100
200
300
400
500

Supplement


Arctic summer profile (τ=10)
-0.048 0.010 -0.052
-0.044 0.004 -0.048
Subarctic summer profile (τ=10)
-0.049 0.009 -0.064
-0.046 0.005 -0.060
Mid-latitude summer profile (τ=10)
-0.064 0.011 -0.089
-0.062 0.006 -0.082
Tropical profile (τ=10)
-0.074 0.022 -0.112
-0.072 0.016 -0.105
Arctic winter profile (τ=10)
0.001 0.024 0.012
-0.001 0.011 0.018
Subarctic winter profile (τ=10)
-0.053 0.011 -0.046
-0.052 0.005 -0.041
Mid-latitude winter profile (τ=10)
-0.063 0.009 -0.066
-0.060 0.005 -0.061
Radiance Ratio
0.0
0.2
0.4
0.6
0.8
Cloud Top Pressure (mb)
100
200
300
400
500

Supplement


Arctic summer profile (τ=50)
-0.047 0.009 -0.048
-0.045 0.003 -0.047
Subarctic summer profile (τ=50)
-0.047 0.009 -0.060
-0.046 0.004 -0.059
Mid-latitude summer profile (τ=50)
-0.062 0.011 -0.084
-0.062 0.005 -0.081
Tropical profile (τ=50)
-0.072 0.022 -0.106
-0.071 0.015 -0.103
Arctic winter profile (τ=50)
0.002 0.025 0.021
-0.000 0.009 0.022
Subarctic winter profile (τ=50)
-0.052 0.012 -0.040
-0.051 0.004 -0.038
Mid-latitude winter profile (τ=50)
-0.061 0.009 -0.061
-0.061 0.004 -0.060
Radiance Ratio
0.0
0.2
0.4
0.6
0.8
Cloud Top Pressure (mb)
100
200
300
400
500