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GEMS Cloud Algorithm : Current Status

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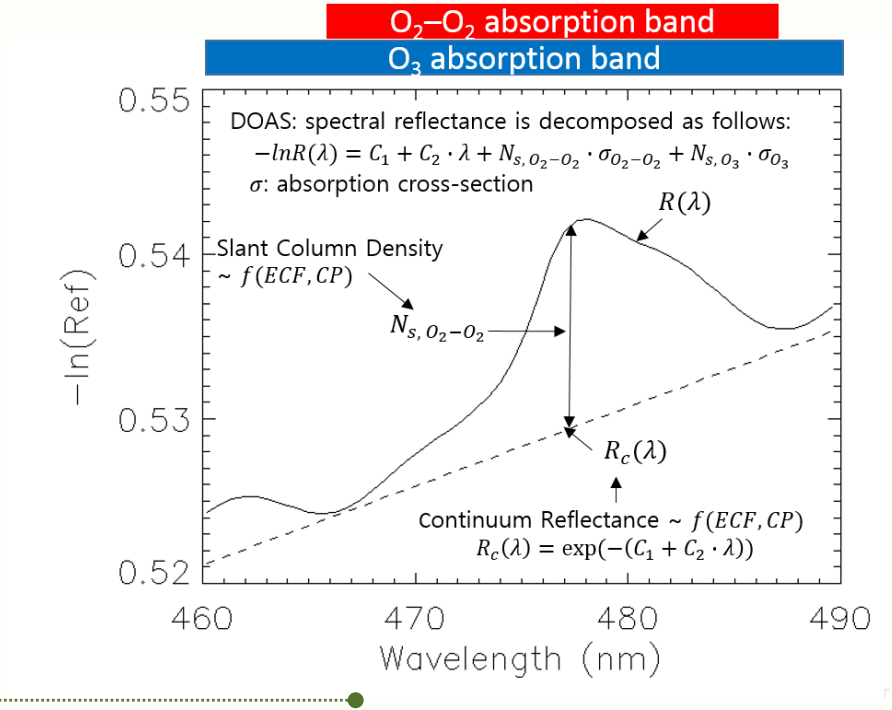
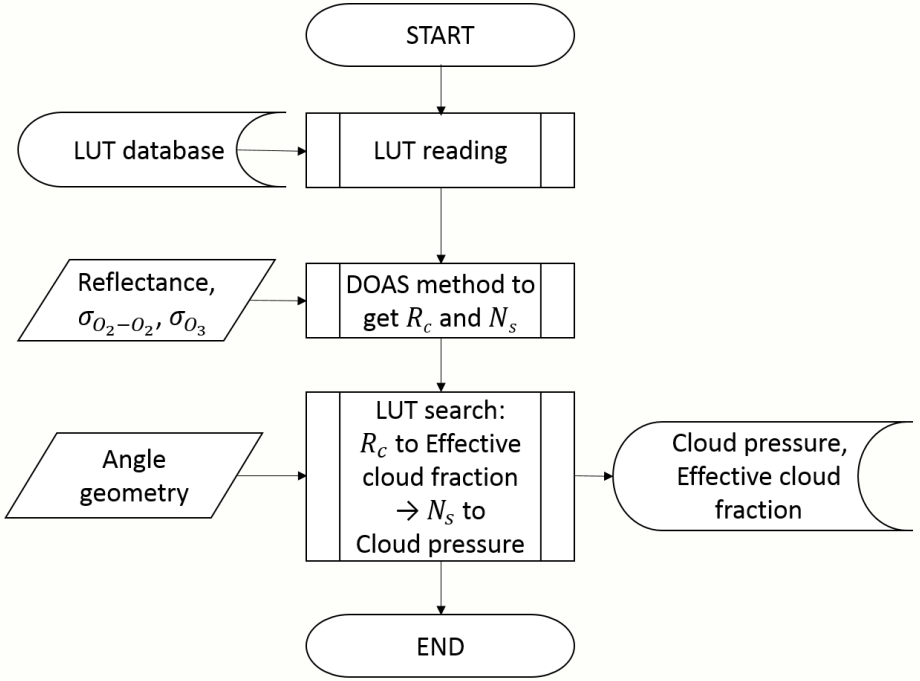
Previous GEMS Cloud Algorithm





ECF: Effective Cloud Fraction
CP: Cloud Pressure

Previous Validation Results
(ECF, every 1st day of each month, 2004)

Month	Slope	Y-intercept	Correlation	RMSE
GOAL	0.7-2.0	Close to '0'	0.45	0.5-0.7
JAN	0.54	0.30	0.48	0.38
FEB	0.62	0.23	0.58	0.33
MAR	0.60	0.20	0.58	0.33
APR	0.66	0.14	0.66	0.28
MAY	0.80	0.07	0.76	0.26
JUN	0.83	0.03	0.80	0.24
JUL	0.83	0.00	0.84	0.20
AUG	0.80	0.00	0.84	0.20
SEP	0.81	0.02	0.82	0.20
OCT	0.77	0.07	0.74	0.26
NOV	0.63	0.20	0.57	0.35
DEC	0.65	0.22	0.57	0.36
2007	0.54	0.30	0.49	0.38

Previous Validation Results
(CP, every 1st day of each month, 2004)

Month	Slope	Y-intercept	Correlation	RMSE
GOAL	0.7-2.0	Close to '0'	0.45	200-300
JAN	0.95	-18.3	0.69	210
FEB	0.91	-4.5	0.66	220
MAR	0.91	-31.2	0.59	260
APR	0.94	-40.5	0.61	240
MAY	0.75	-78.7	0.63	270
JUN	1.02	-131.2	0.69	250
JUL	0.83	-25.6	0.61	280
AUG	0.96	-97.5	0.70	240
SEP	0.79	17.0	0.56	270
OCT	0.77	48.9	0.55	280
NOV	0.85	16.8	0.60	260
DEC	0.82	25.3	0.51	280
2007	0.96	-24.1	0.70	210

Limitations
In the Previous Cloud Algorithm

PROBLEM *1*

Too many cases such as very high/low cloud pressure, surface albedo, etc. are not covered by LUT.

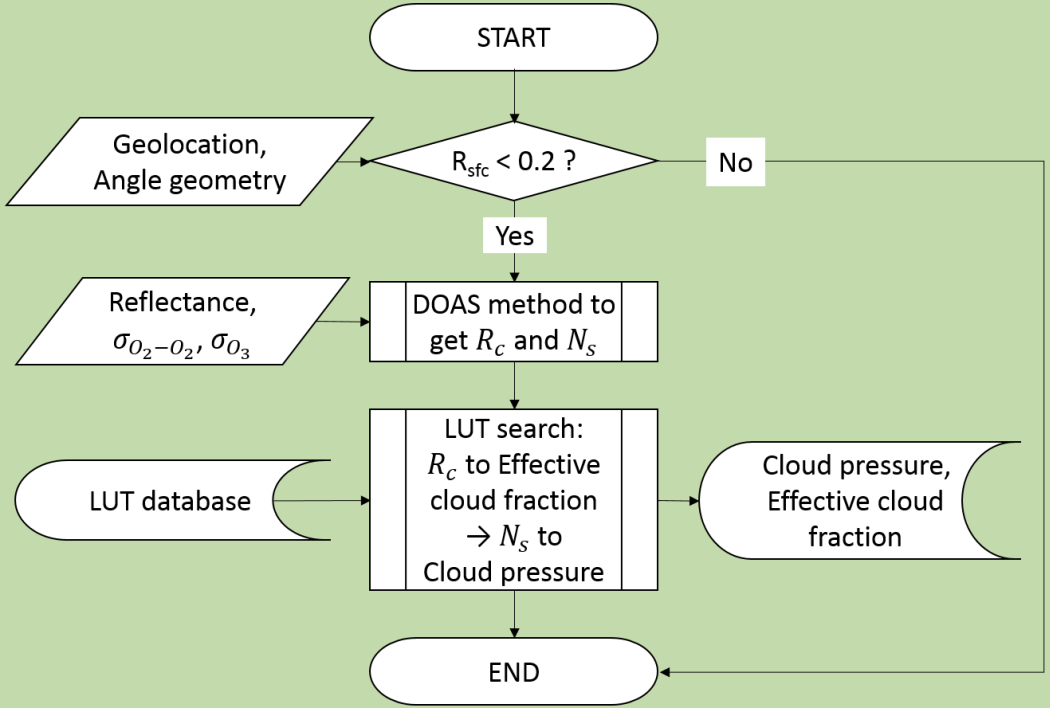
PROBLEM *2*

Various surface conditions are not considered (e.g. reflectivity and pressure).

PROBLEM *3*

The validation results show strong seasonality of the retrieval performance.

Current GEMS Cloud Algorithm



SOLUTION *1*

Retrieving the cloud products to be the same as the boundary of LUT parameters.

SOLUTION *2*

Considering the surface reflectivity and pressure.

SOLUTION *3*

The retrieval accuracy is solved by the solution 1 and 2.

Additionally, the improved current cloud retrieval algorithm works for the dark surface only (R_{sfc} < 0.2).

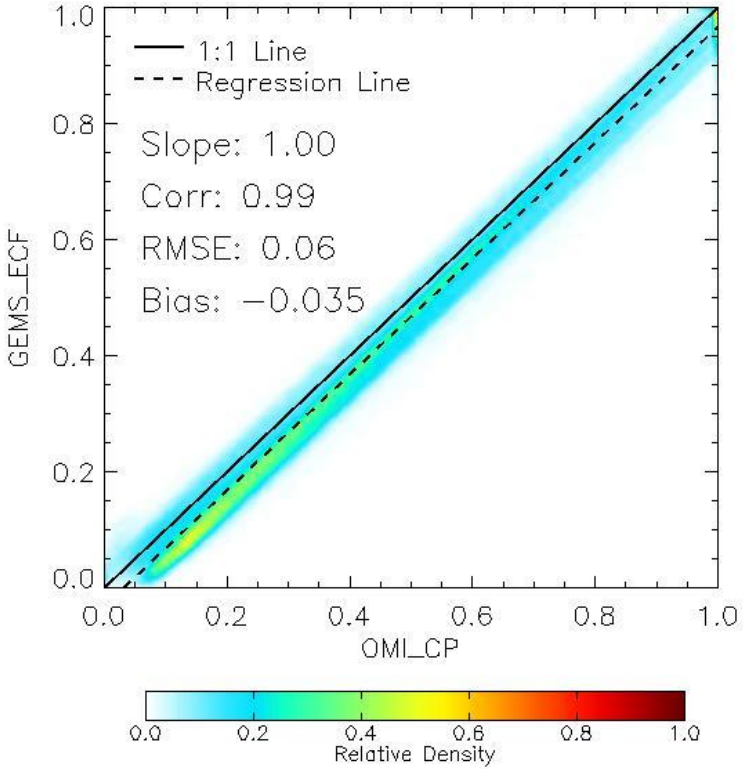
Current Validation Results
(ECF, every 1st day of each month, 2004)

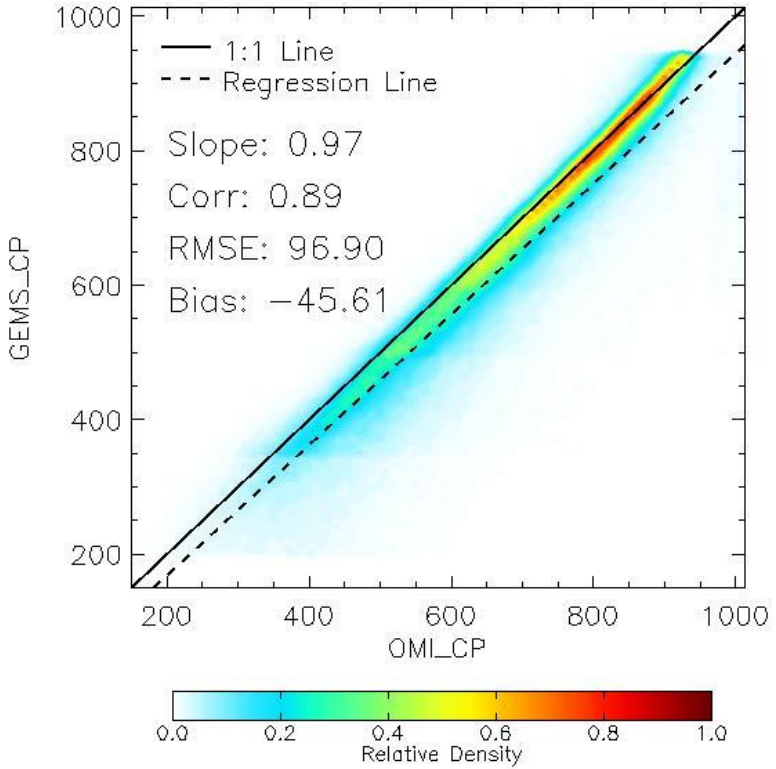
Month	Slope	Y-intercept	Correlation	RMSE
GOAL	**0.7-2.0**	**Close to '0'**	**0.45**	**0.5-0.7**
JAN	1.01	-0.01	0.99	0.03
FEB	1.03	-0.03	1.00	0.03
MAR	1.01	-0.02	0.99	0.04
APR	0.99	-0.04	0.98	0.07
MAY	1.01	-0.05	0.99	0.06
JUN	0.98	-0.05	0.98	0.08
JUL	0.98	-0.05	0.98	0.08
AUG	0.98	-0.06	0.98	0.09
SEP	0.98	-0.04	0.99	0.07
OCT	1.00	-0.04	0.99	0.05
NOV	1.01	-0.02	0.99	0.04
DEC	0.99	-0.01	0.99	0.03
2007	**1.00**	**-0.03**	**0.99**	**0.06**

Current Validation Results
(CP, every 1st day of each month, 2004)

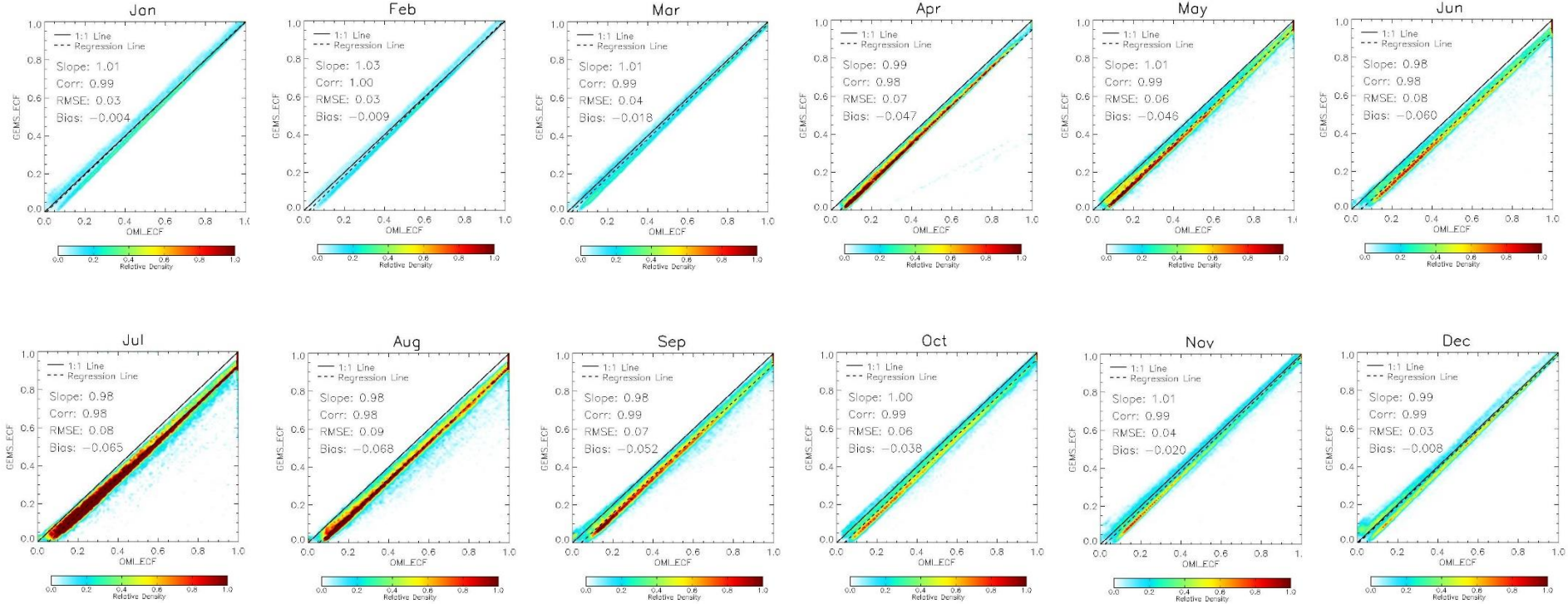
Month	Slope	Y-intercept	Correlation	RMSE
GOAL	0.7-2.0	Close to '0'	0.45	200-300
JAN	0.96	5.0	0.93	75
FEB	1.01	-28.4	0.94	70
MAR	0.99	-31.9	0.90	90
APR	1.06	-86.0	0.90	85
MAY	0.98	-41.8	0.88	105
JUN	1.06	-88.6	0.91	90
JUL	0.97	-51.4	0.87	110
AUG	0.99	-54.0	0.87	105
SEP	0.98	-41.3	0.85	110
OCT	0.90	17.6	0.87	105
NOV	0.94	5.8	0.91	85
DEC	0.87	42.4	0.83	115
2007	**0.97**	**-27.4**	**0.89**	**95**

Current Validation Results
(total of every 1st day of each month, 2004)

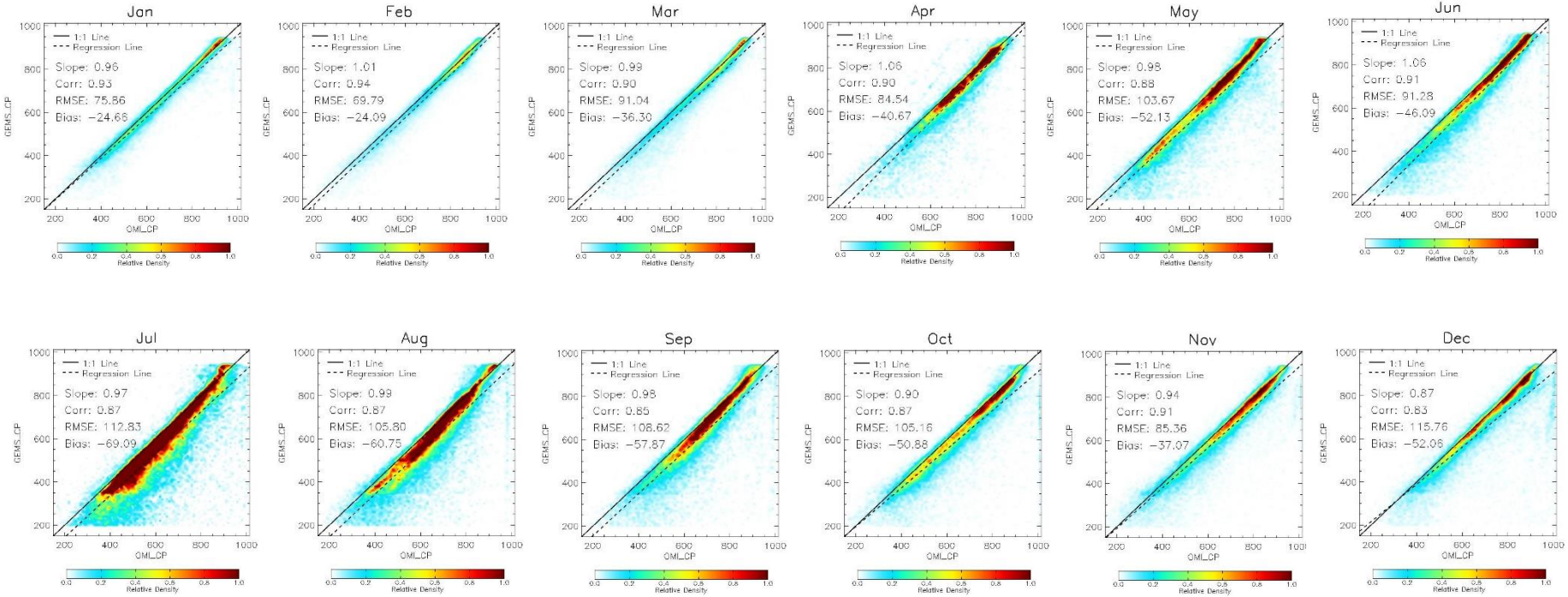




Current Validation Results
(ECF, every 1st day of each month, 2004)



Current Validation Results
(CP, every 1st day of each month, 2004)



Limitations of the Current Version

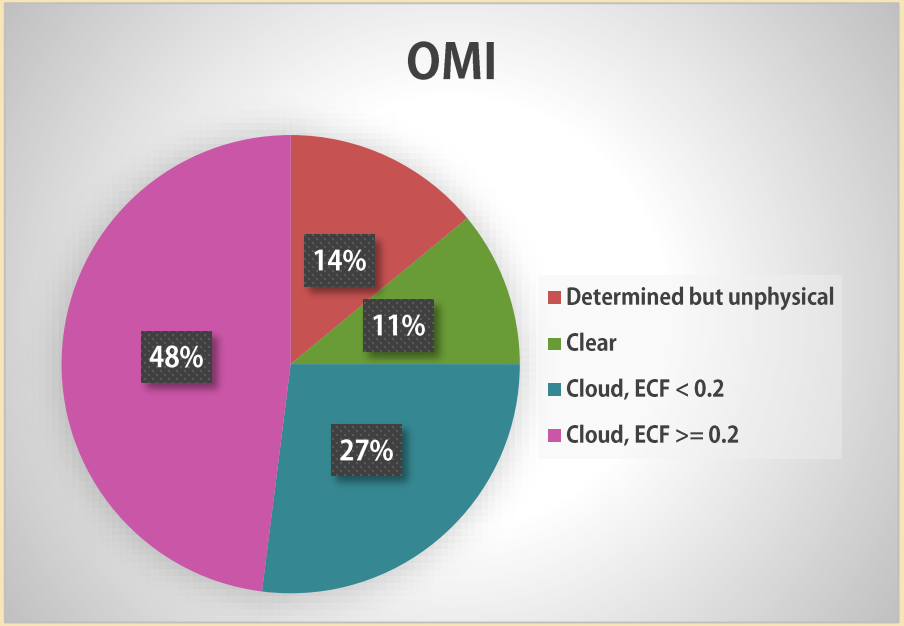
The current version of LUT is built on the surface reflectivity over 0.05. We expect that more pixels would be retrieved as clouds if LUT is expanded to lower surface reflectivity ($0 < R_{sfc} < 0.05$).

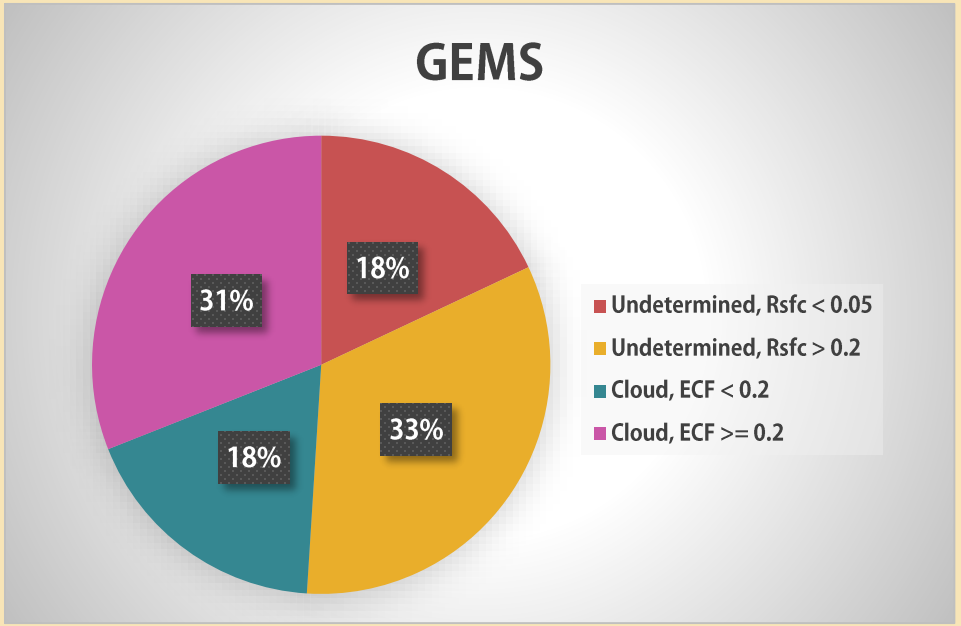
The algorithm operates for the dark surface only ($R_{sfc} > 0.2$).

For high scattering angles (SZA; Solar Zenith Angle + VZA; Viewing Zenith Angle > 150 °), the SCD is less sensitive to cloud pressure.

GCA Retrieve Less Cloud

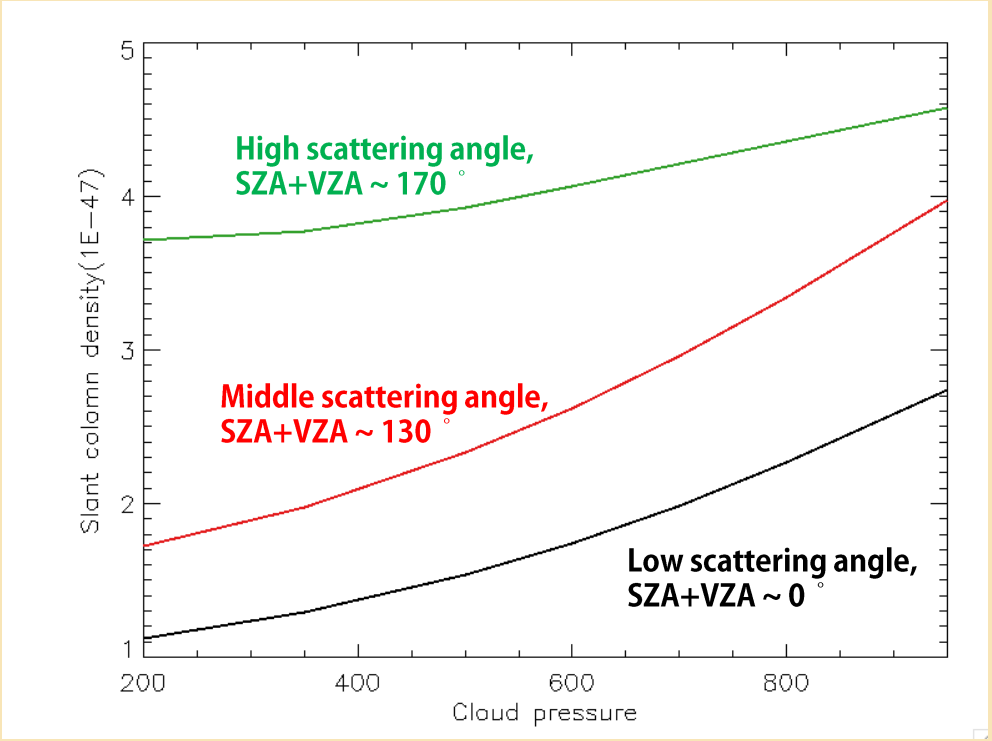
Most of the pixels in GCA process are treated as unavailable pixels based on each surface reflectivity condition.



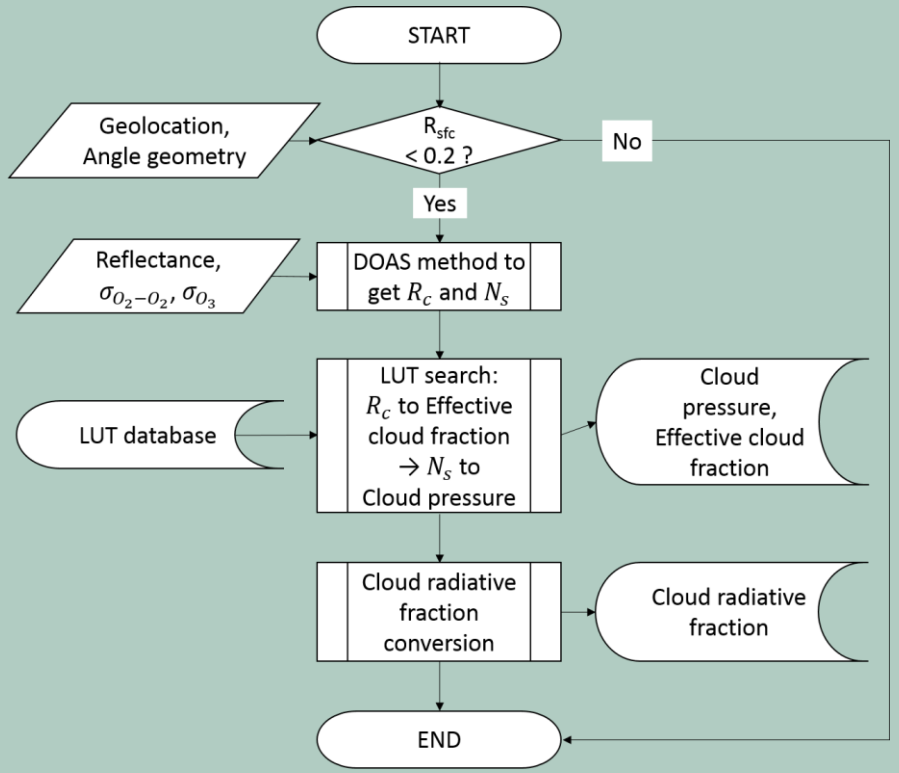


Less Sensitivity in High Scattering Angle Condition

- The sensitivity of SCD to the cloud pressure increases prominently when the sum of scattering angle is less than 150°.
- Namely, if the sum of scattering angle is larger than 150°, the SCD is insensitive to cloud pressure.



Future GEMS Cloud Algorithm



- Expanding LUT coverage especially for extremely low surface reflectivity.
- Adding the cloud radiative fraction (f_r):
  the ratio of reflected cloud radiance to measured radiance.

It makes easy to use cloud products as an input for other trace gas algorithms.

$$f_r = \frac{I_{cld}}{I_m} = ECF \times \frac{I^*_{cld}}{I_m}$$

I_m : measured radiance
I_{cld} : reflected cloud radiance
ECF : effective cloud fraction, wavelength independent
I^*_{cld} : cloud radiance with Lambertian surface albedo of 0.8

THANK YOU

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