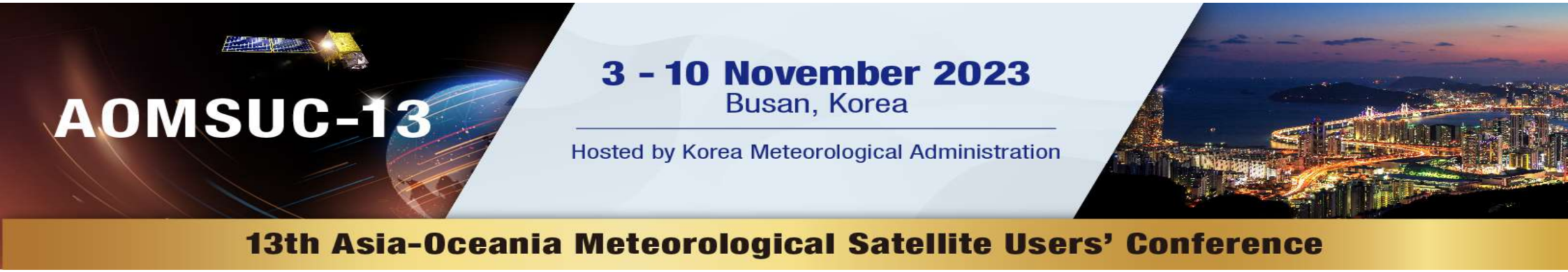

Session 5 : Application for Land Surface and Sea Surface Derived from Satellite Observations (I)

Enhancing Consistency and Long-Term Reliability of Surface Albedo from COMS/MI and GK2A/AMI

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❖ Surface Albedo

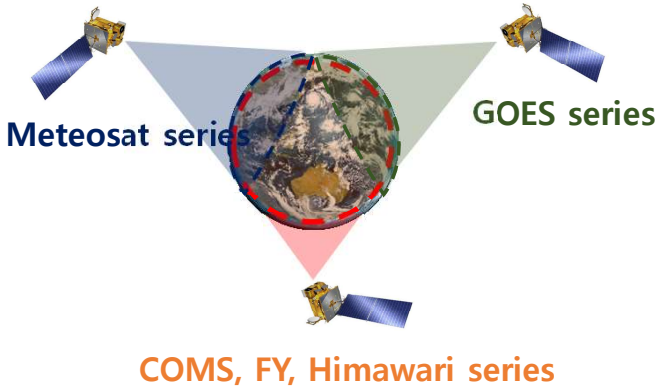
- The ratio of solar energy incident on the surface to the solar energy reflected from the surface
- An important variable to characterize the energy balance in the soil-vegetation-atmosphere system
- Surface albedo, an Essential Climate Variable (ECV) selected by GCOS, is utilized for climate change monitoring and research

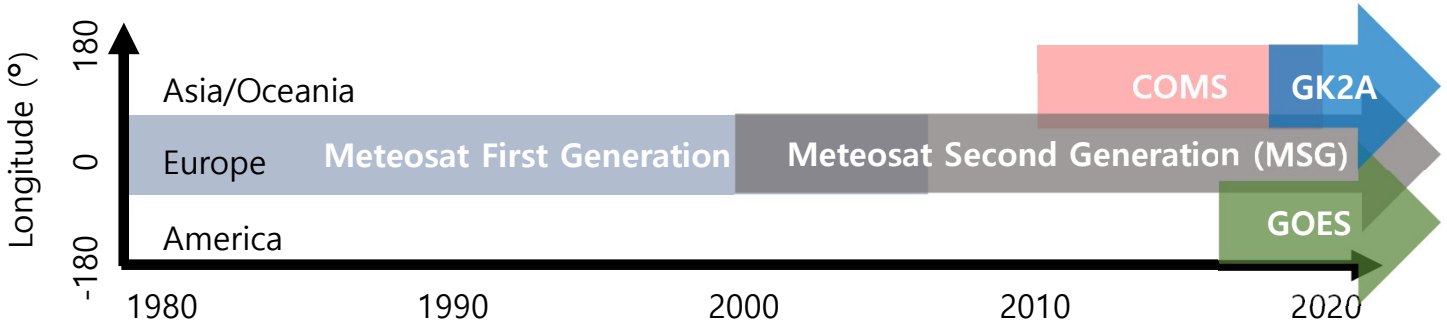
$$Surface\ Albedo = \frac{Solar\ radiation\ reflected\ from\ the\ surface}{Solar\ Radiant\ Incident\ to\ the\ surface}$$

❖ Geostationary Satellite Surface Albedo Retrieval Status

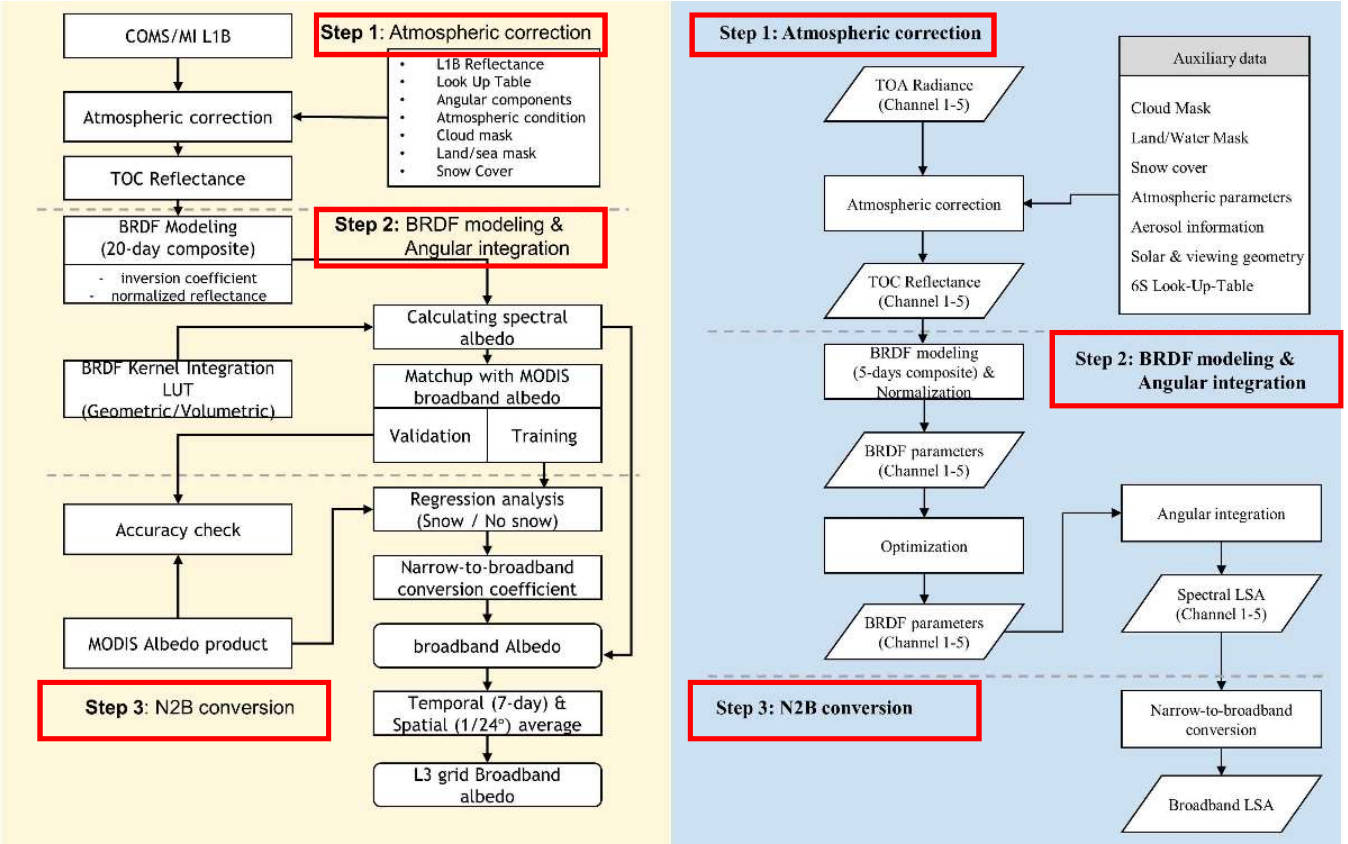
- COMS/MI ~ GK-2A/AMI provide surface albedo products for Asia/Oceania regions

  → COMS/MI ended its mission in March 2020, succeeded by GK-2A/AMI, necessitating consistent product outputs





❖ Comparison of retrieval algorithms between COMS/MI and GK-2A/AMI



→ The steps of the COMS/MI and GK-2A/AMI surface albedo retrieval algorithms are the same, but errors occur between outputs due to differences in input data and auxiliary data.

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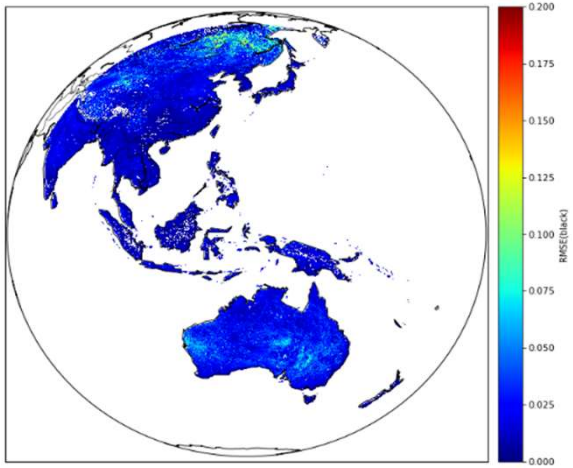
❖ Error comparison of surface albedo between COMS/MI and GK-2A/AMI

- The RMSD appears relatively high in Manchuria, the Tibetan Plateau, and the Australian continent compared to other areas.
- A negative Bias is observed in the Australian continent, while a positive Bias is seen in the northern latitudes.
- In general land type , the values between the two outputs are generally similar..

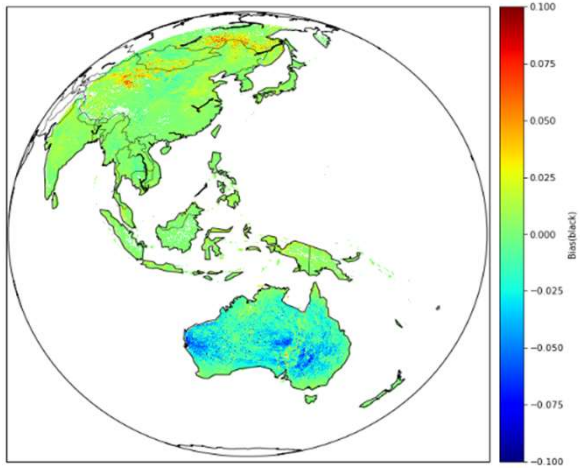
  In snowy regions, the COMS/MI Albedo tends to be greater than the GK-2A/AMI Albedo.

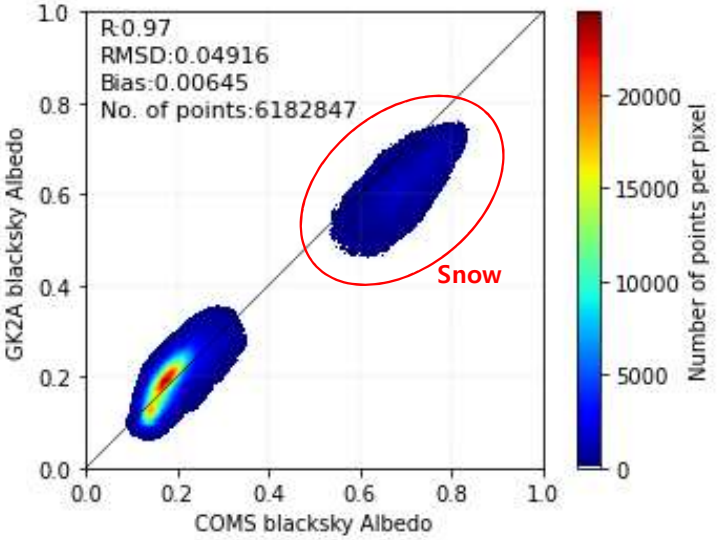
  This is likely due to errors in the COMS/MI's snow and cloud detection data

RMSD



bias





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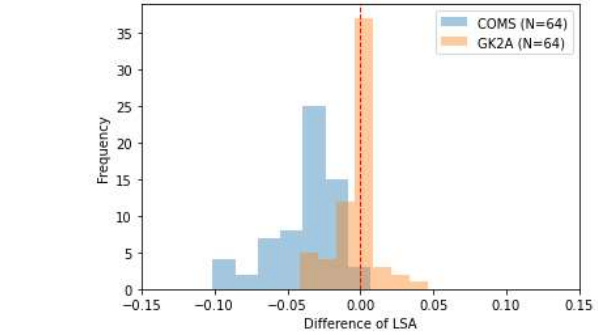
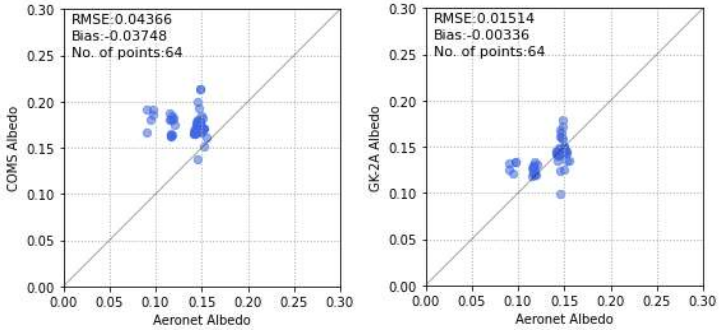
❖ Error comparison of surface albedo between COMS/MI and GK-2A/AMI

- Measurement method : AERONET Version 3 inversion algorithm (2019.07.01 ~ 2020.03.31)
- Temporal and spatial resolution matching : Observation data is used when it is within half a pixel (1 km) based on GK-2A/AMI standards and within one hour of local noon
- The error and values between COMS/MI and the in-situ data appear significantly larger than those of GK-2A/AMI. This is suspected to be due to the difference in reference angles (COMS/MI: Mean SZA, GK-2A/AMI: local noon SZA)

COMS			GK2A		
RMSE	Bias	N	RMSE	Bias	N
0.0436	-0.0374	64	0.0151	-0.0033	64

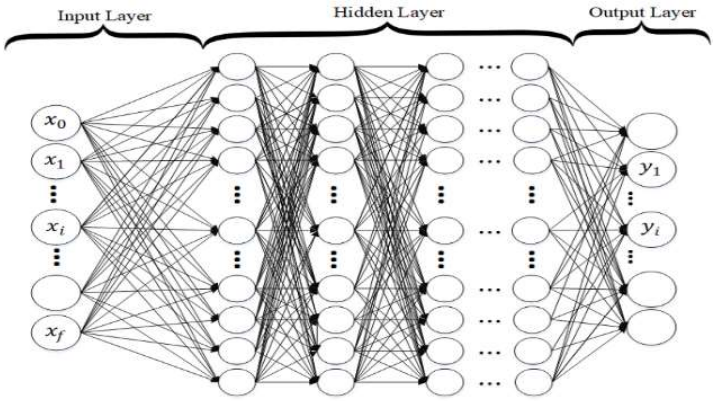
Sites	COMS			GK2A		
	RMSE	Bias	N	RMSE	Bias	N
Bukit_Kototabang	0.0070	0.0070	1	0.0462	0.0462	1
EPA-NCU	0.0177	-0.0177	1	0.0232	0.0232	1
Gangneung_WNU	0.0655	-0.0654	6	0.0064	-0.0053	6
Kuching	0.0038	-0.0023	2	0.0194	0.0193	2
Osaka	0.0479	-0.0476	6	0.0115	-0.0109	6
Pokhara	0.0359	-0.0359	1	0.0215	0.0215	1
Silpakorn_Univ	0.0260	-0.0256	35	0.0039	0.0017	35
Yonsei_University	0.0902	-0.0898	5	0.0357	-0.0353	5



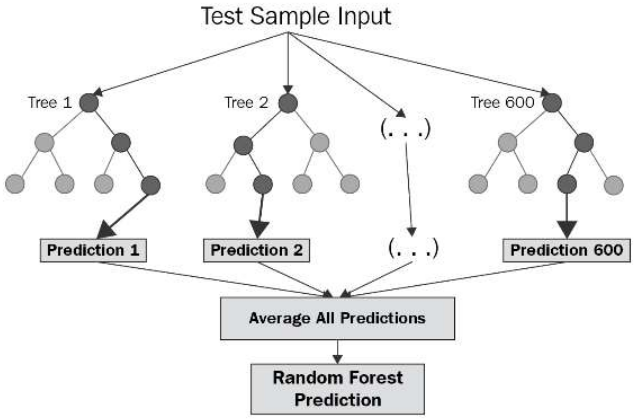


❖ Error Correction approach using machine learning techniques

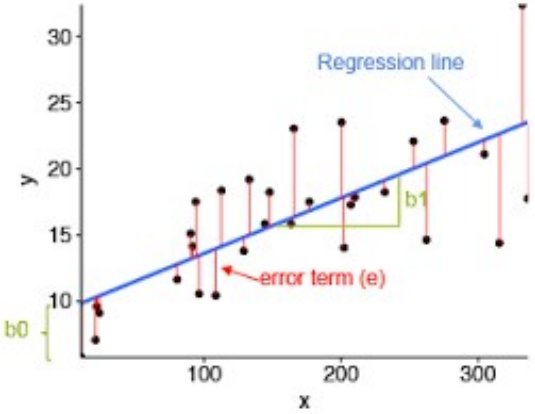
- **DNN:** A Deep Neural Network (DNN) is an artificial neural network composed of an input layer and an output layer with multiple hidden layers in between.
- **Random Forest :** An ensemble model that trains multiple decision tree models and aggregates their results for the final prediction
- **Linear Regression:** A regression analysis technique that models the linear correlation between the dependent variable Y and one or more independent variables X. When based on a single explanatory variable, it's referred to as simple linear regression, and when based on more than one, it's called multiple linear regression.



DNN



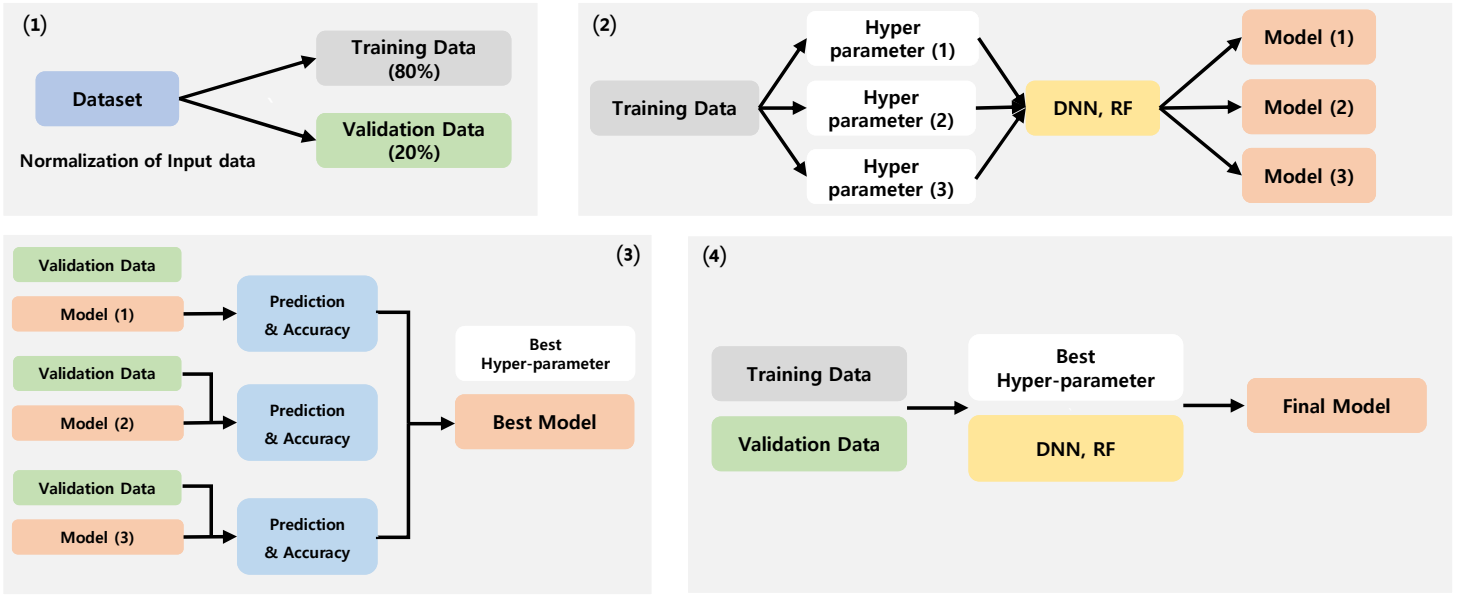
Random Forest



Linear Regression

❖ Hyper-parameter Tuning for machine learning-based optimal model generation

- Input data : COMS/MI surface albedo, SZA, VZA, Latitude, Longitude
- Output data : Corrected COMS/MI surface albedo
- Setting the optimum parameters with Python library GridSearchCV
- RF regressor : N_estimators=10, Max_depth=20, min_samples_leaf=8, min_samples_split=8
- DNN : Hidden layer=5, Hidden node=200, Batch size=256, Activation=Relu



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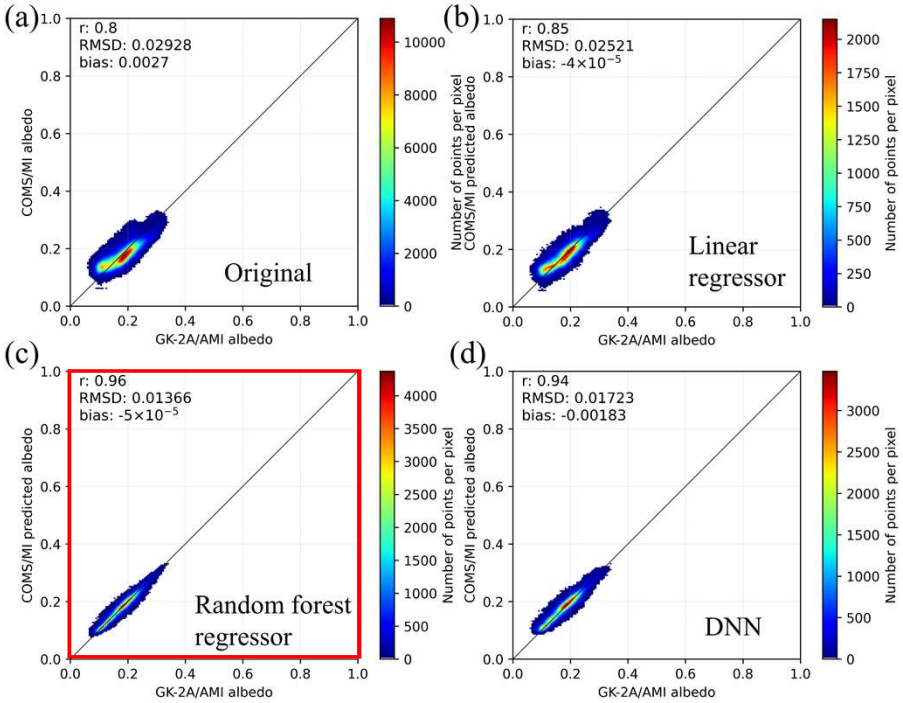
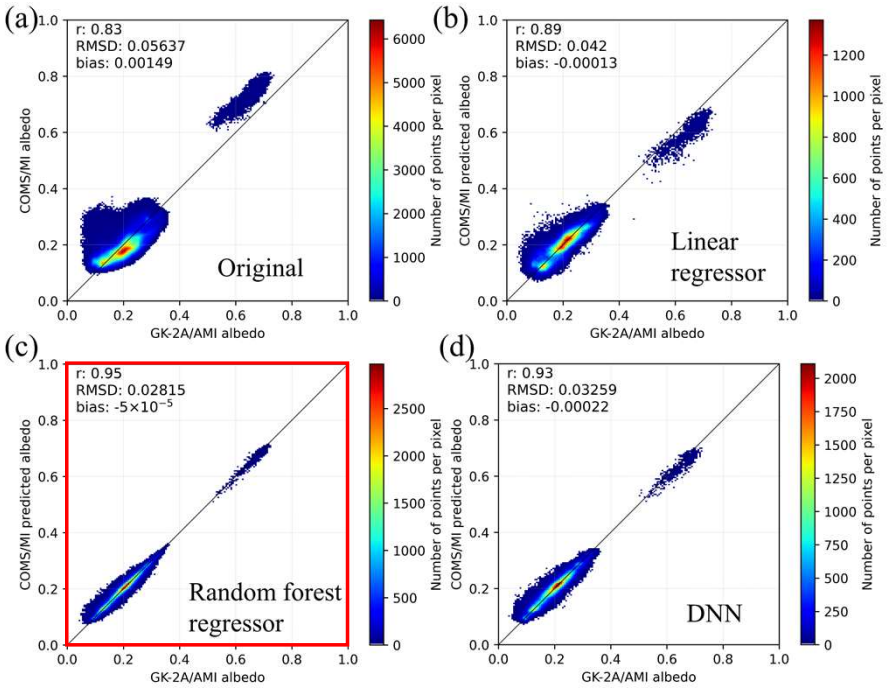
❖ Model performance results and comparisons

- MLR, DNN, and RF regressor models were compared to correct the COMS/MI surface albedo
- The RF regressor model showed the best prediction with RMSD = 0.014 and r = 0.96 for snow-free conditions
- For include snow-covered conditions, RF model had the smallest error with RMSD = 0.028 and the highest correlation coefficient at r = 0.95

[Snow-free condition]

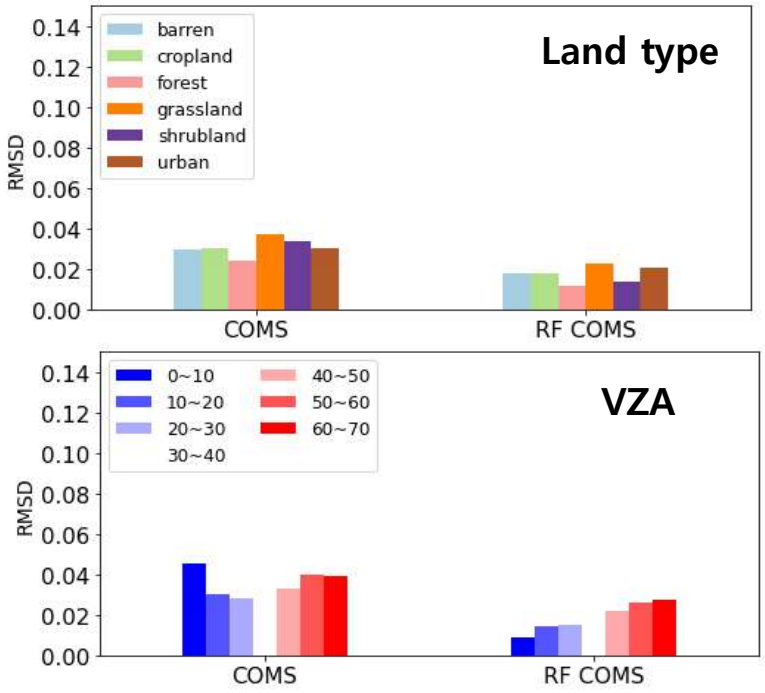


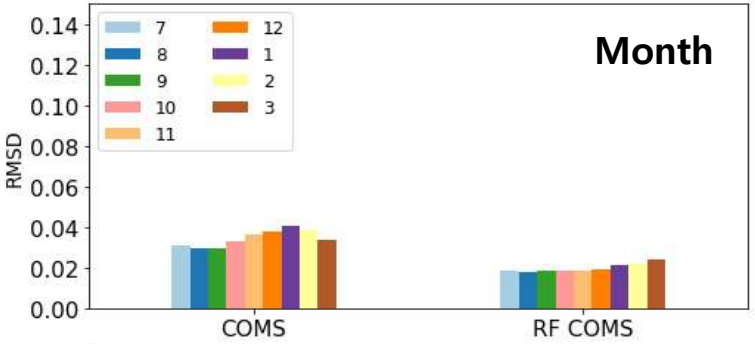
[Include snow-covered condition]

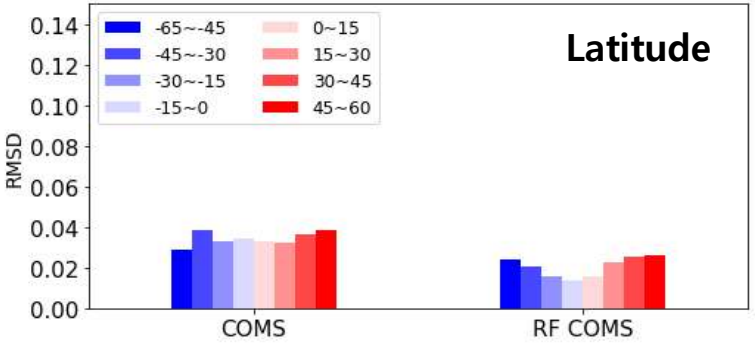


❖ Uncertainty analysis for various conditions over overlapping periods

- RMSD analysis by Landtype: Decreased error observed in all land types.
- Monthly RMSD analysis: Overall decrease in RMSD observed in every month.
- RMSD analysis by VZA (View Zenith Angle): Overall decrease in RMSD, but as VZA increases, a trend of increasing error remains.
- RMSD analysis by Latitude: Overall error decrease and reduction in error near the equator.

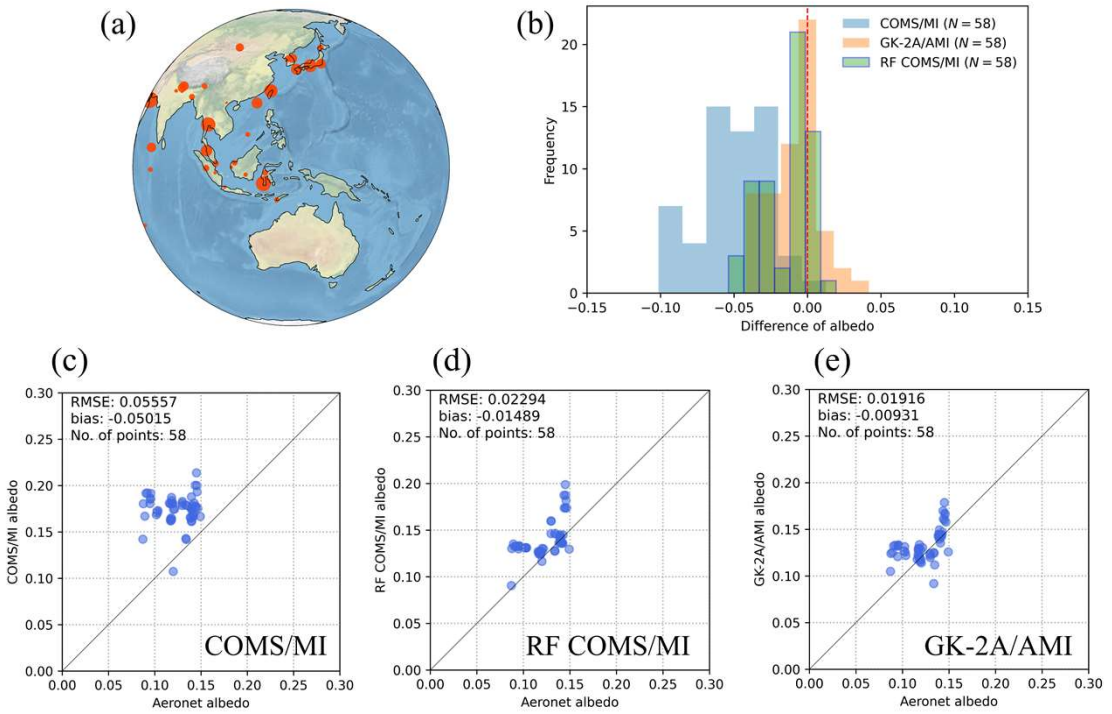






❖ Evaluation of the accuracy and stability of the corrected surface albedo

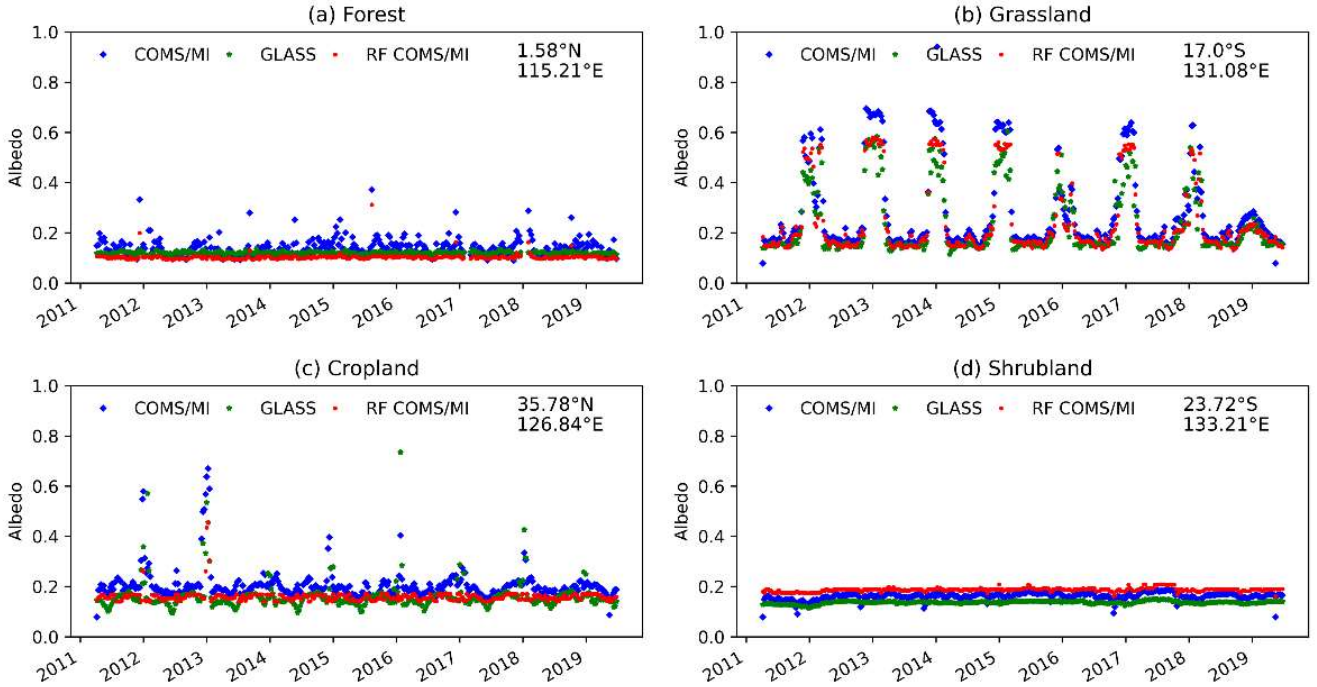
- Validation with ground observation data (AERONET) : The error of RF COMS is lower than that of COMS
- GK-2A exhibits a normal distribution pattern, while RF COMS shows a weak negative distribution pattern. RF COMS improves the negative distribution pattern of COMS
- Compared to COMS, RF COMS has a lower RMSE of 0.0327.



❖ Evaluation of the accuracy and stability of the corrected surface albedo

➢ Temporary Consistency Analysis: Time series of surface albedo by land type (2011.4 ~2019.6)

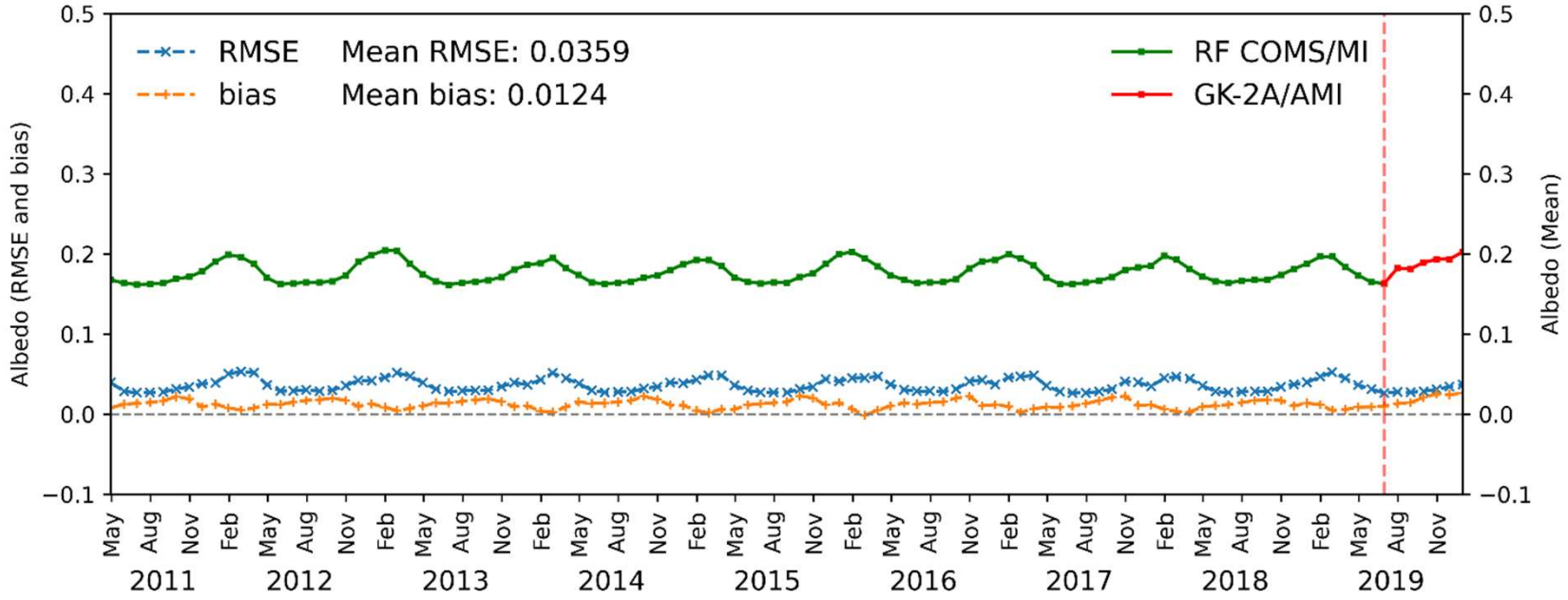
- Forest, cropland : Forest, cropland: The albedo of COMS has significant errors compared to GLASS and RF COMS
- Grassland: Overall higher values in snow-covered areas during winter, RF albedo tends to have less error than COMS albedo
- Shrubland: In the southern hemisphere, the values of RF COMS are relatively high



❖ Evaluation of the accuracy and stability of the corrected surface albedo

➢ Comparison of accuracy with GLASS data and Temporary Consistency (2011.4 ~2019.12)

- Comparison of RMSE with the GLASS data and Temporal Consistency: 2011.4 ~ 2019.12
- Accuracy validation for the against GLASS data : Mean RMSE: 0.0359 / Mean Bias: 0.0124
- Maintaining the trend of error in RF COMS versus GLASS with GK-2A

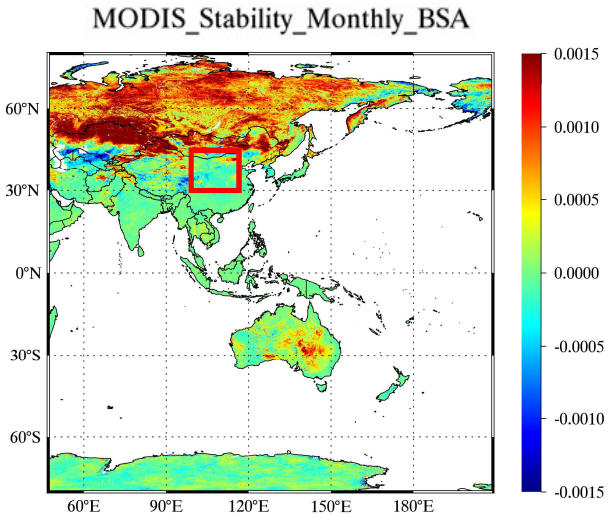


❖ Evaluation of the accuracy and stability of the corrected surface albedo

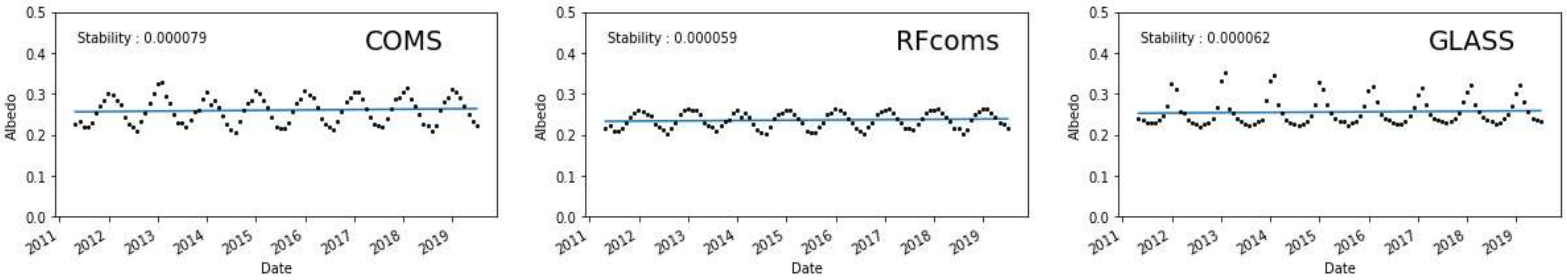
➢ Temporal Stability analysis over the entire period (2011~2019)

- For stability analysis, the target is a temporally homogeneous surface (desert) for evaluation based on MODIS data

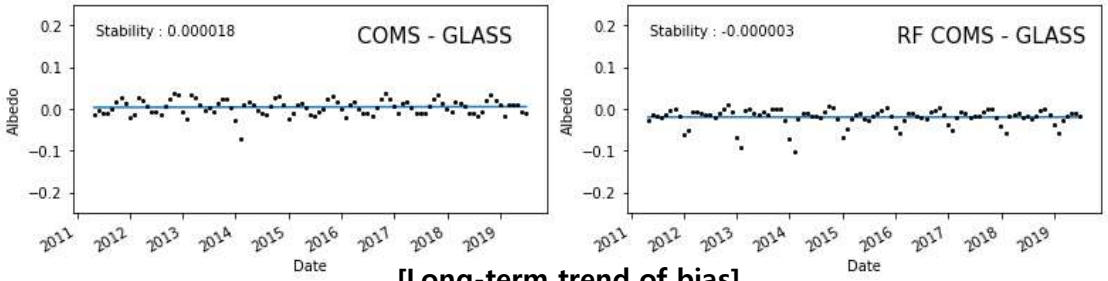
1. Long-term trend of satellite data itself
2. Long-term trend of Bias (reflecting temporal changes in the reference data)



desert area
(lat : 41.662°N , lon : 103.234°E)



[Long-term trend of satellite data itself]

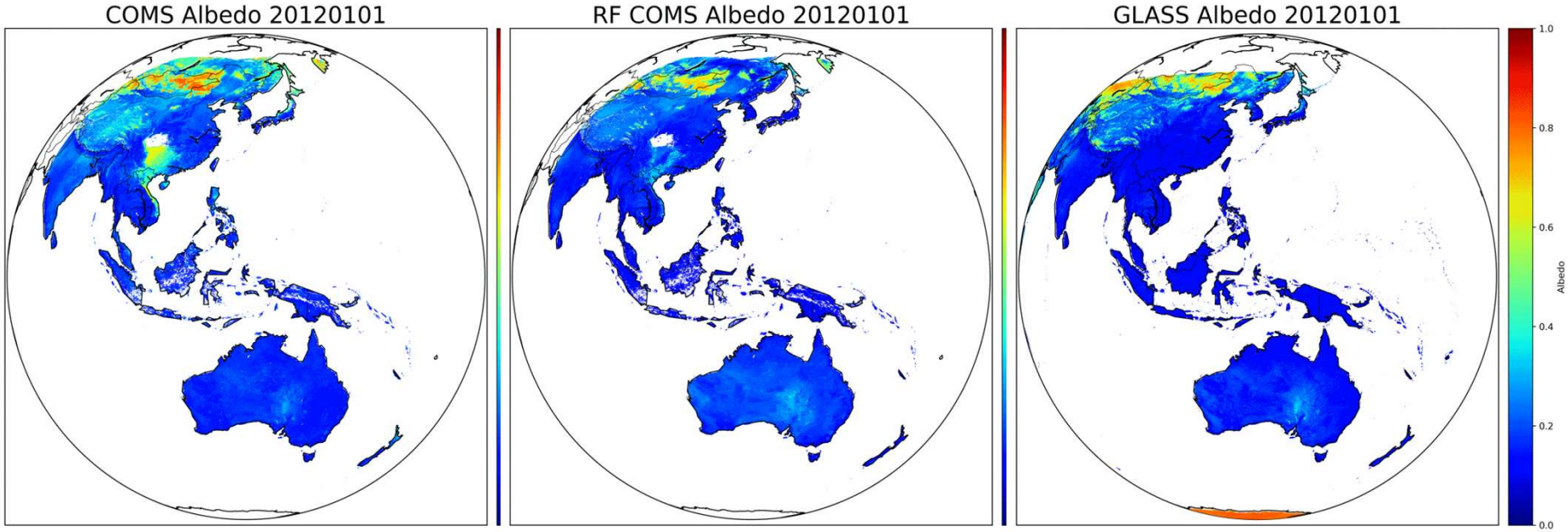


[Long-term trend of bias]

❖ Evaluation of the accuracy and stability of the corrected surface albedo

➢ Temporal & Spatial changes over the entire period (2012~2019)

- The spatial distribution and changes of the corrected COMS/MI albedo appear more similar and stable compared to GLASS



COMS **RF COMS** **GLASS**

Thank you