Satellite bias estimation by independent inverse analysis

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1. Background

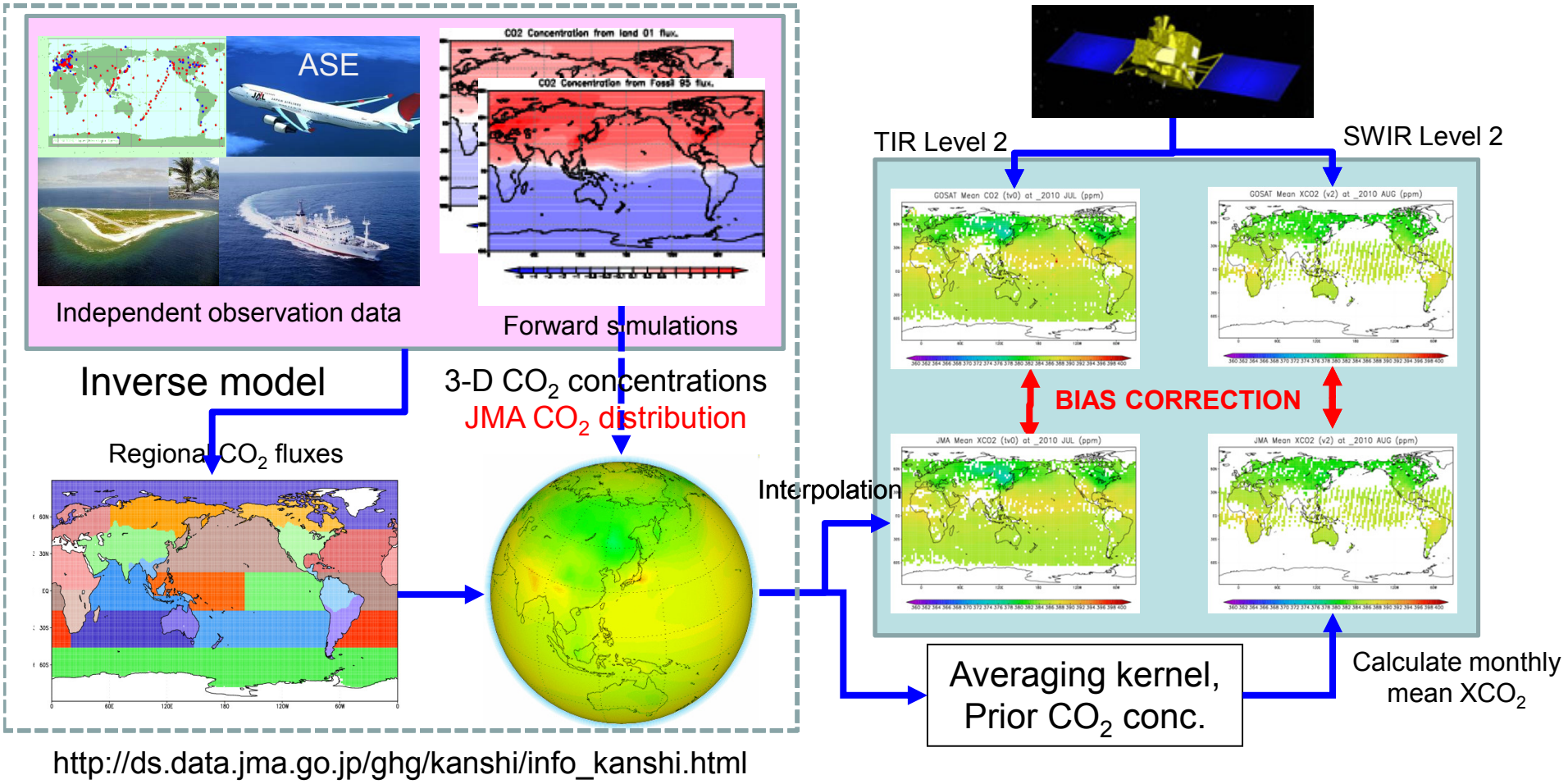
- The merits of satellite data in carbon cycle analysis include their large spatial coverage and relatively large space representativeness comparing with in-situ observations.

- However, there are non-trivial points that need to be reconsidered in satellite data. An important issue is bias, which may change with time and space. In 2012, New data were released to public (TIR V0.01 and SWIR V2.X).

- To make use of satellite data (GOSAT, AIRS, OCO-2, CarbonSat, TANSAT, …) in carbon cycle analysis, bias estimation and correction (horizontal and temporal) is one of the important issue.

- We evaluated bias of GOSAT SWIR NIES Ver. 2.X and ACOS SWIR B2.9 data and TIR NIES Ver. 0.01 data using independent inverse model analysis

2-1. Concept of our bias estimation system



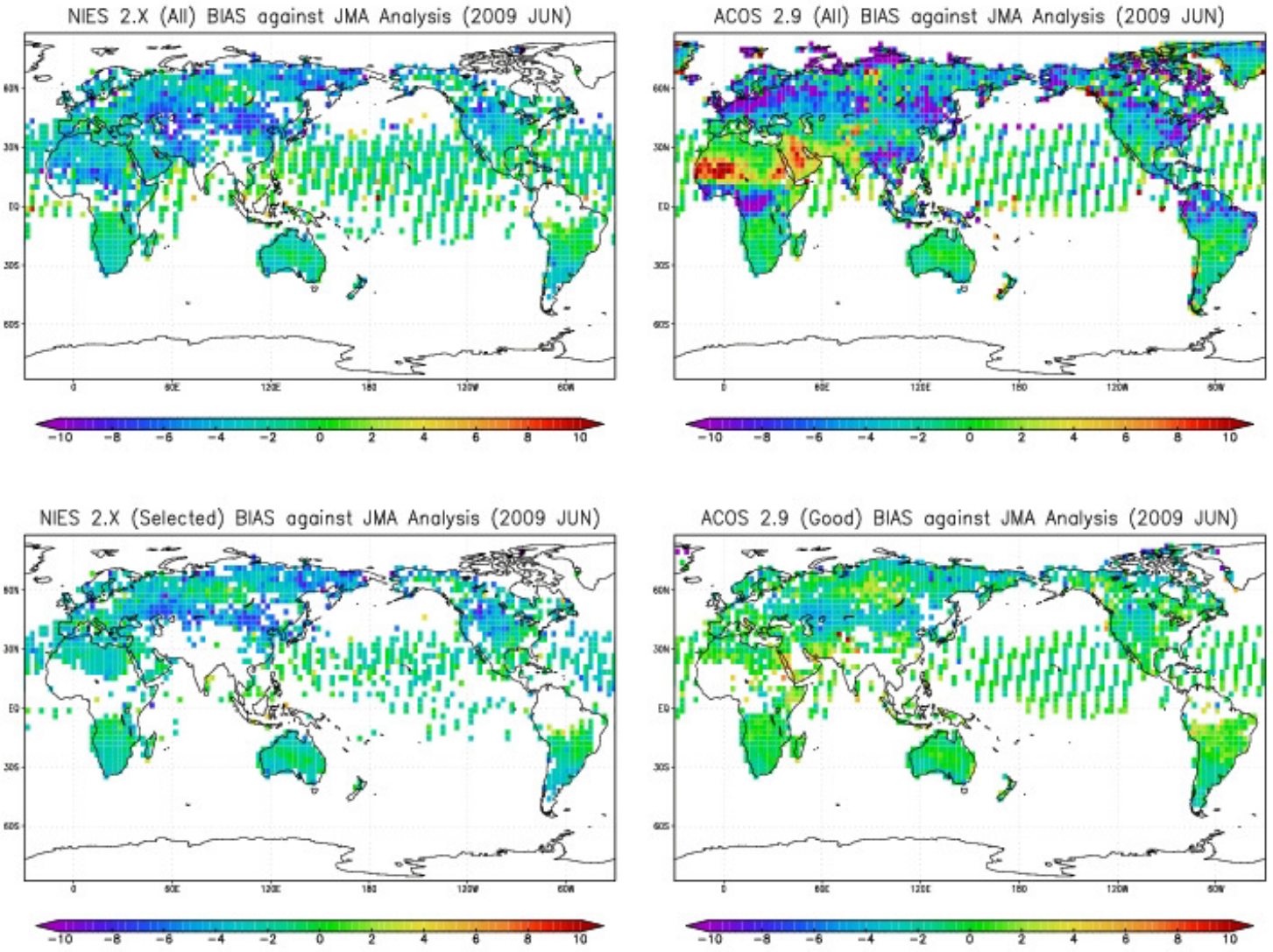
http://ds.data.jma.go.jp/ghg/kanshi/info_kanshi.html

Important features

1. Bias correction with completely independent data (observations and model)
2. We could obtain bias data in all grid point of satellite observation
3. Precision of JMA CO_2 analysis is almost 1ppm in southern hemisphere and free troposphere comparing with independent observation.

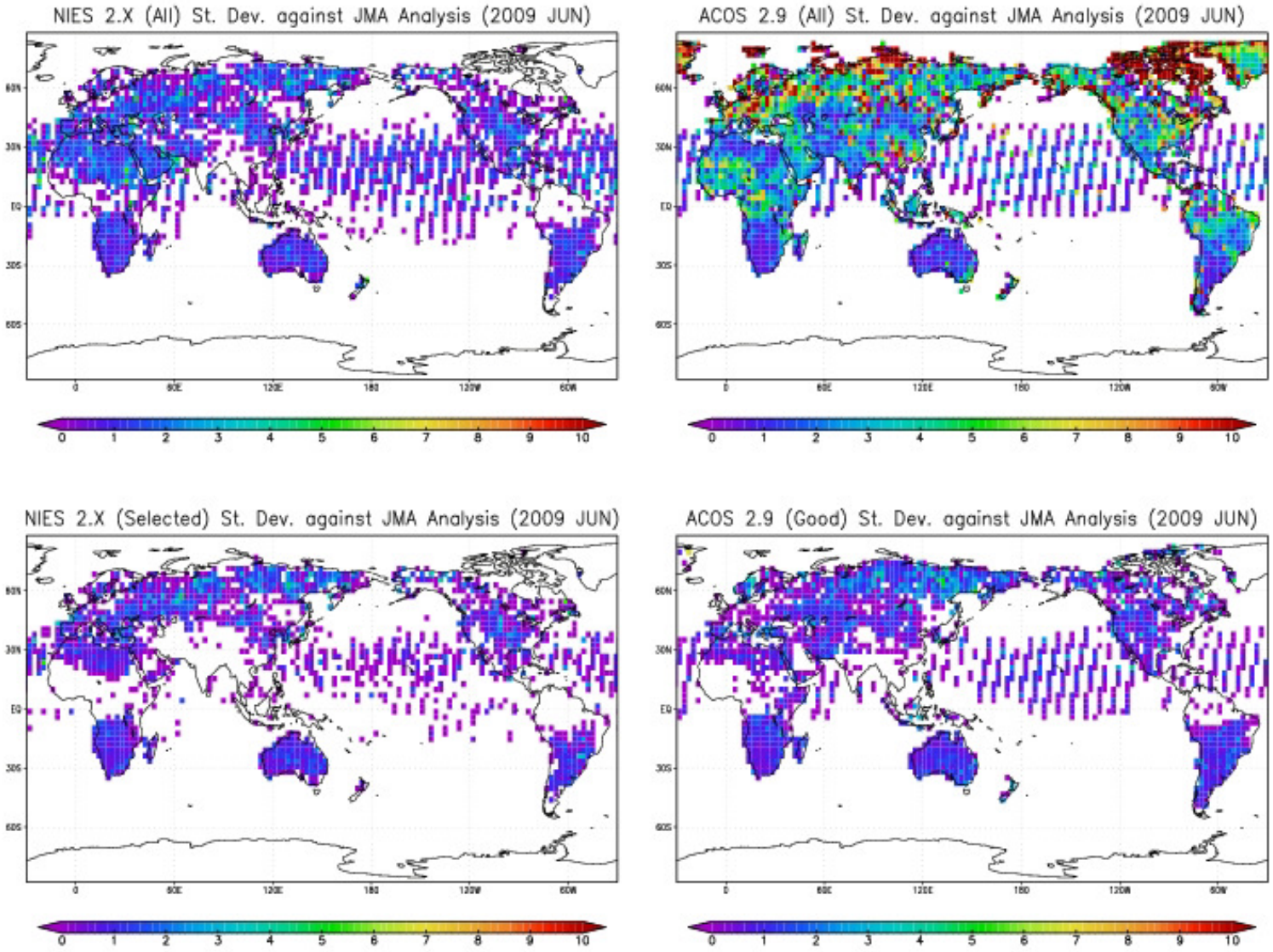
3-1. SWIR results

3-1-1. SWIR BAIS (NIES 2.X and ACOS B2.9)



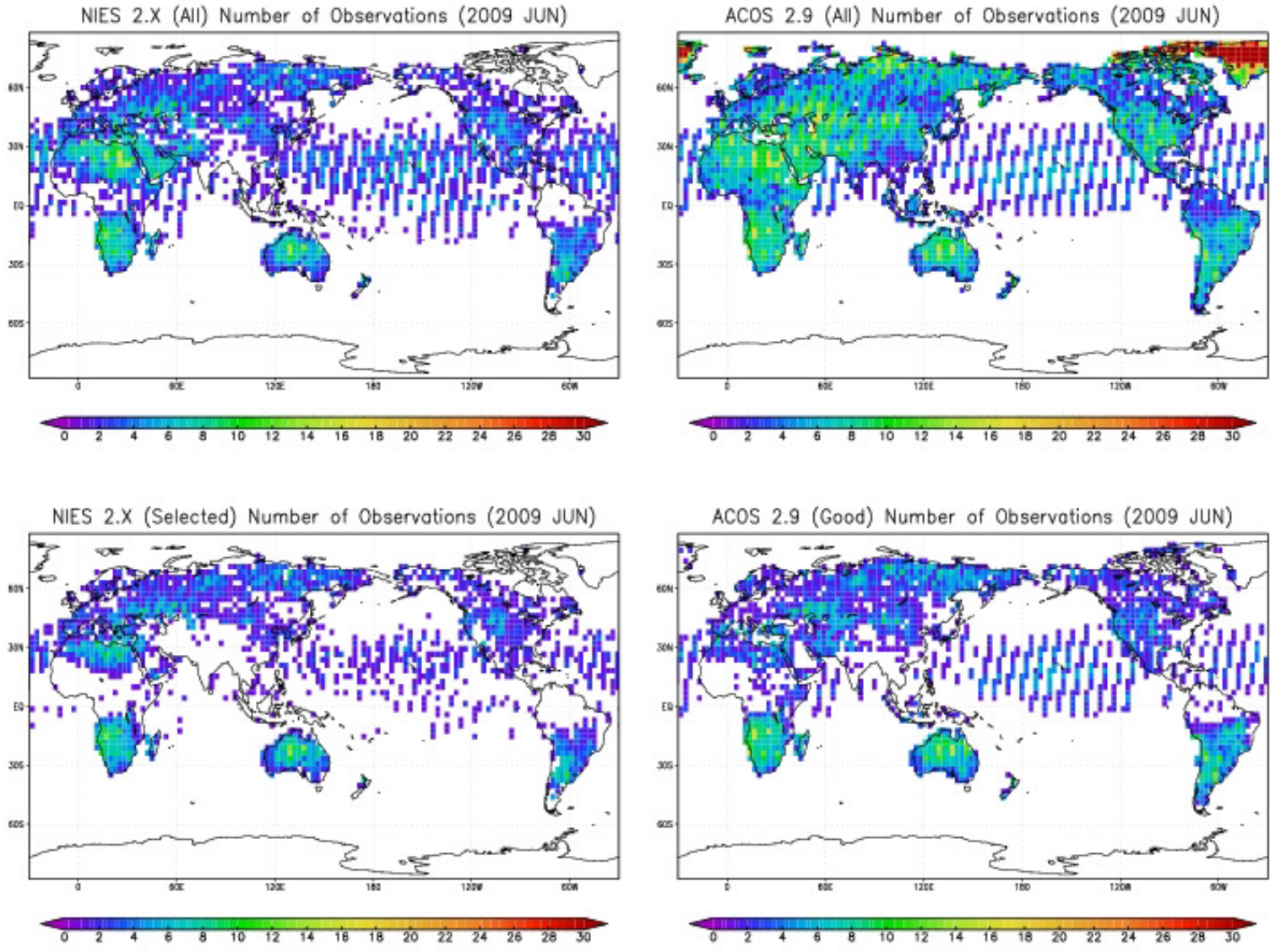
Comparing with independent analysis, bias of NIES Ver. 2.X and ACOS Ver. 2.9 data were smaller than NIES Ver. 1.X data. Bias features were different with each other.

3-1-2. SWIR Standard Deviation



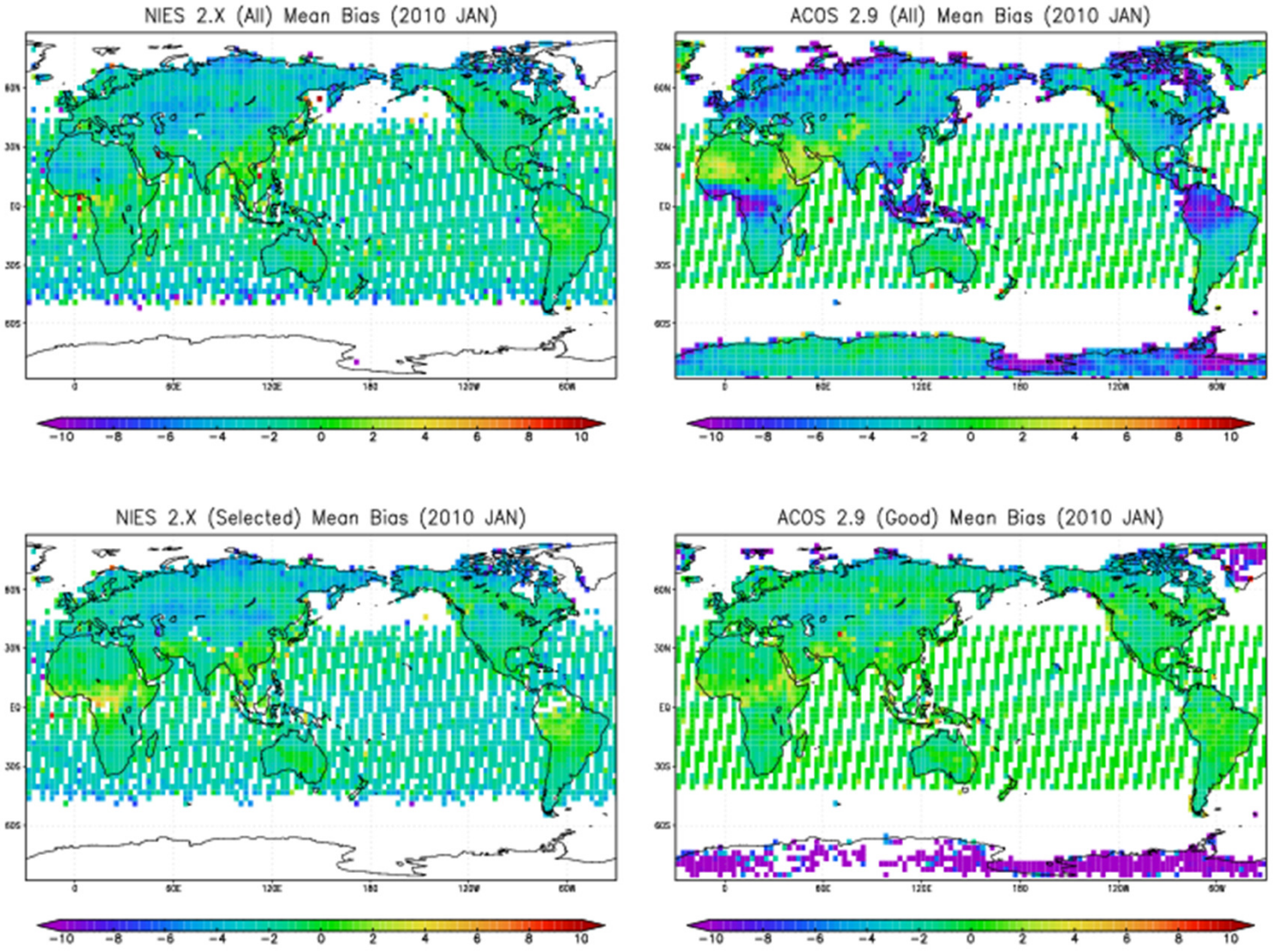
Comparing with independent analysis, standard deviation of NIES data were smaller than ACOS data. Generally, standard deviation were larger in land.

3-1-3. SWIR Number of observation



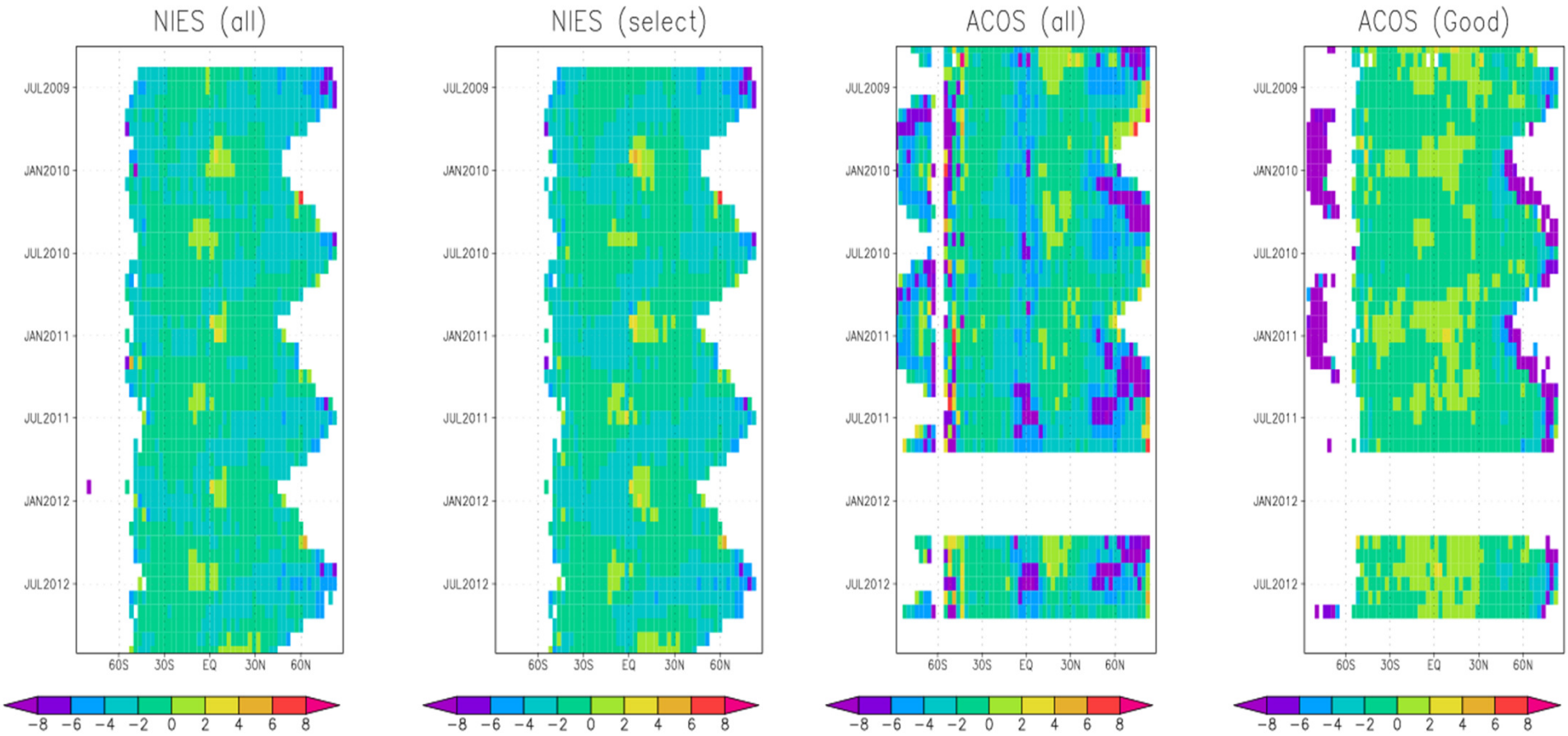
Number of observation were larger in land than ocean. When we adopted data selection, number of observation in tropical land area was significantly reduced.

3-1-4. SWIR Averaged BIAS (spatial distribution)



Averaged bias were almost -2ppm in selected NIES and ACOS data. We can see relatively large bias in high latitude and middle Asia region.

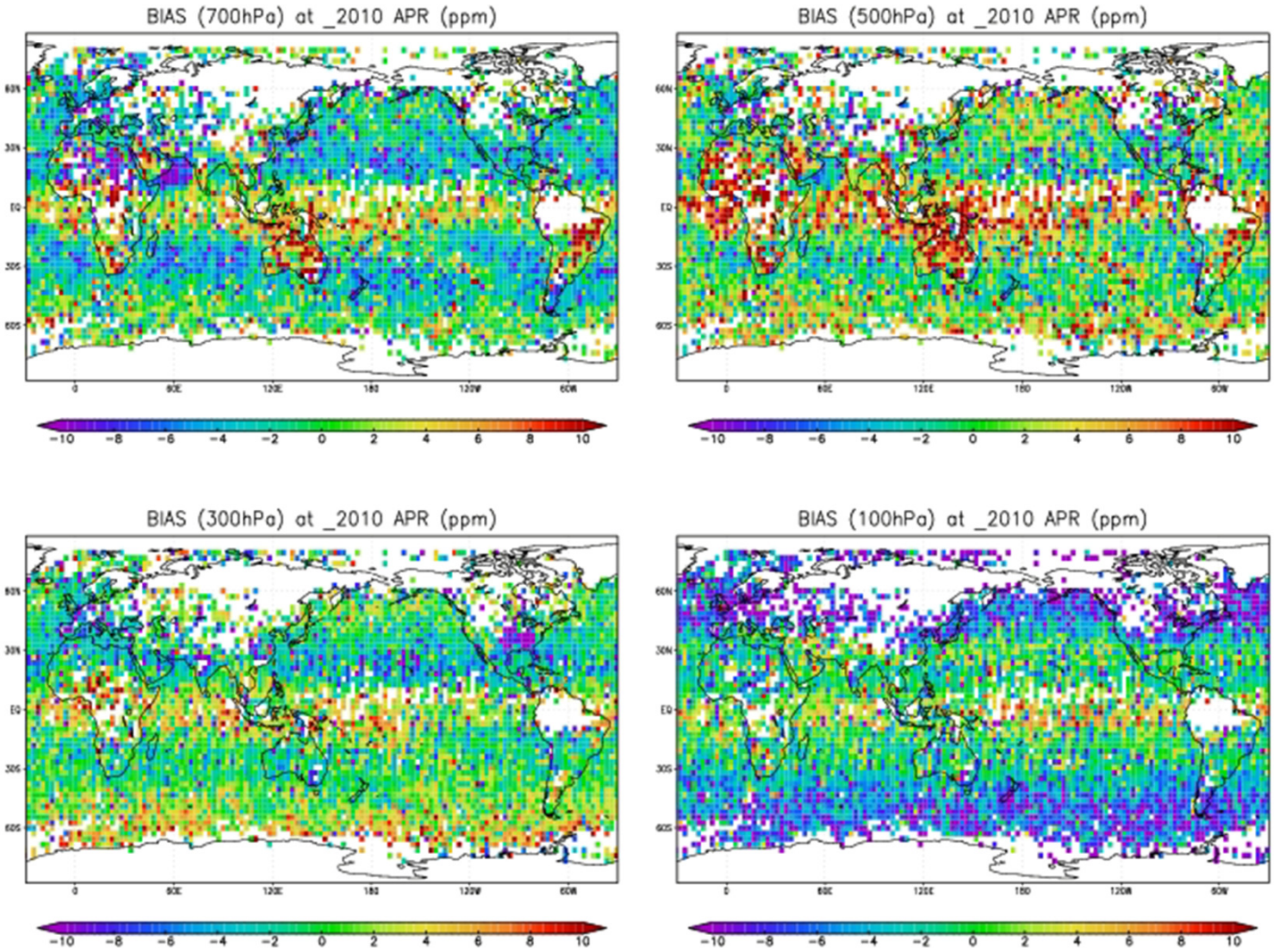
3-1-5. SWIR Averaged bias (latitudinal and temporal)



GOSAT SWIR Bias were large in high latitude area (especially ACOS data).
In tropical area, bias pattern showed some seasonality in both NIES and ACOS data.
When we used all ACOS data, there were large negative bias in tropical land area.

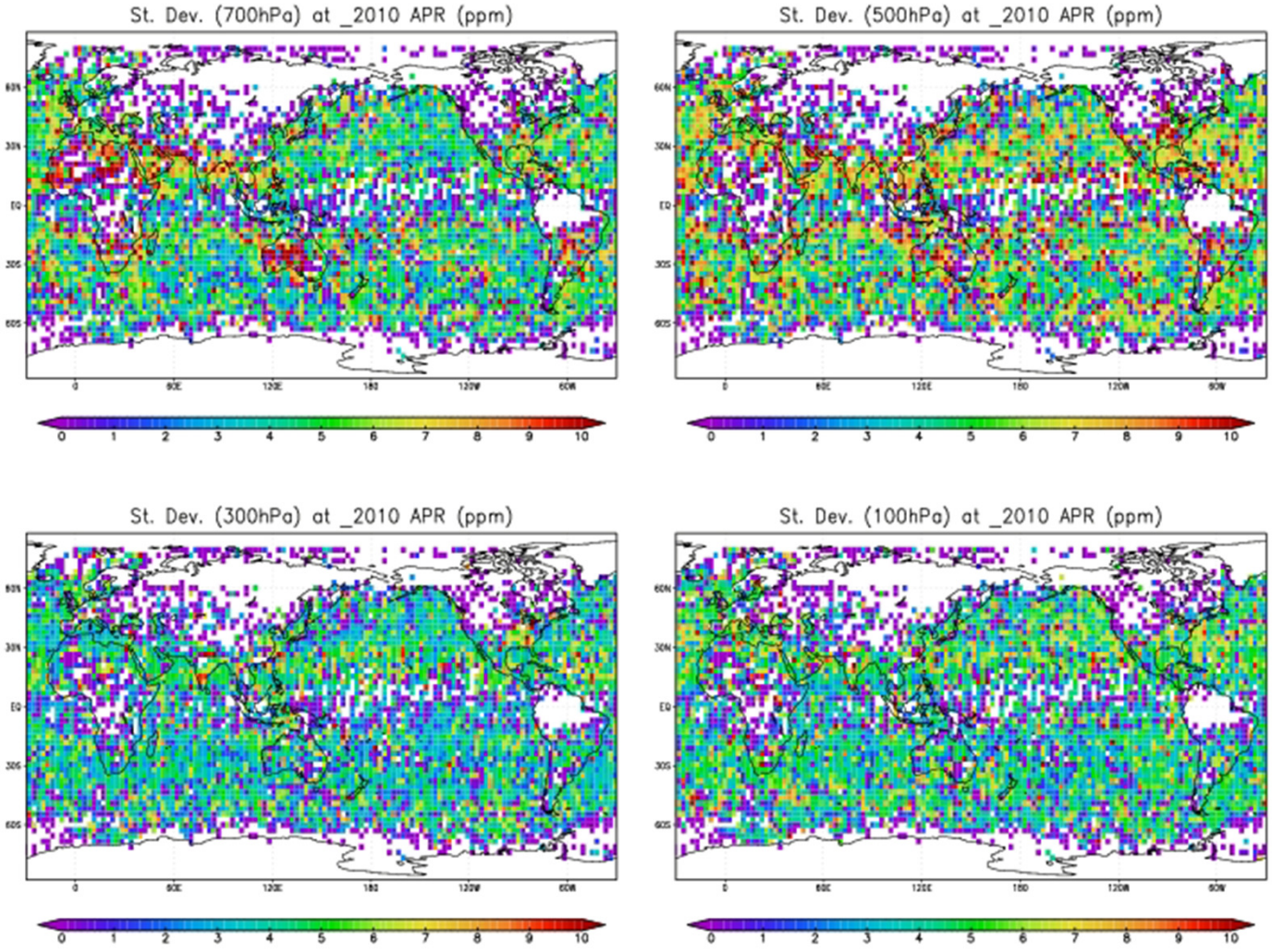
3-2. TIR results

3-2-1. TIR BAIS (NIES 0.01)



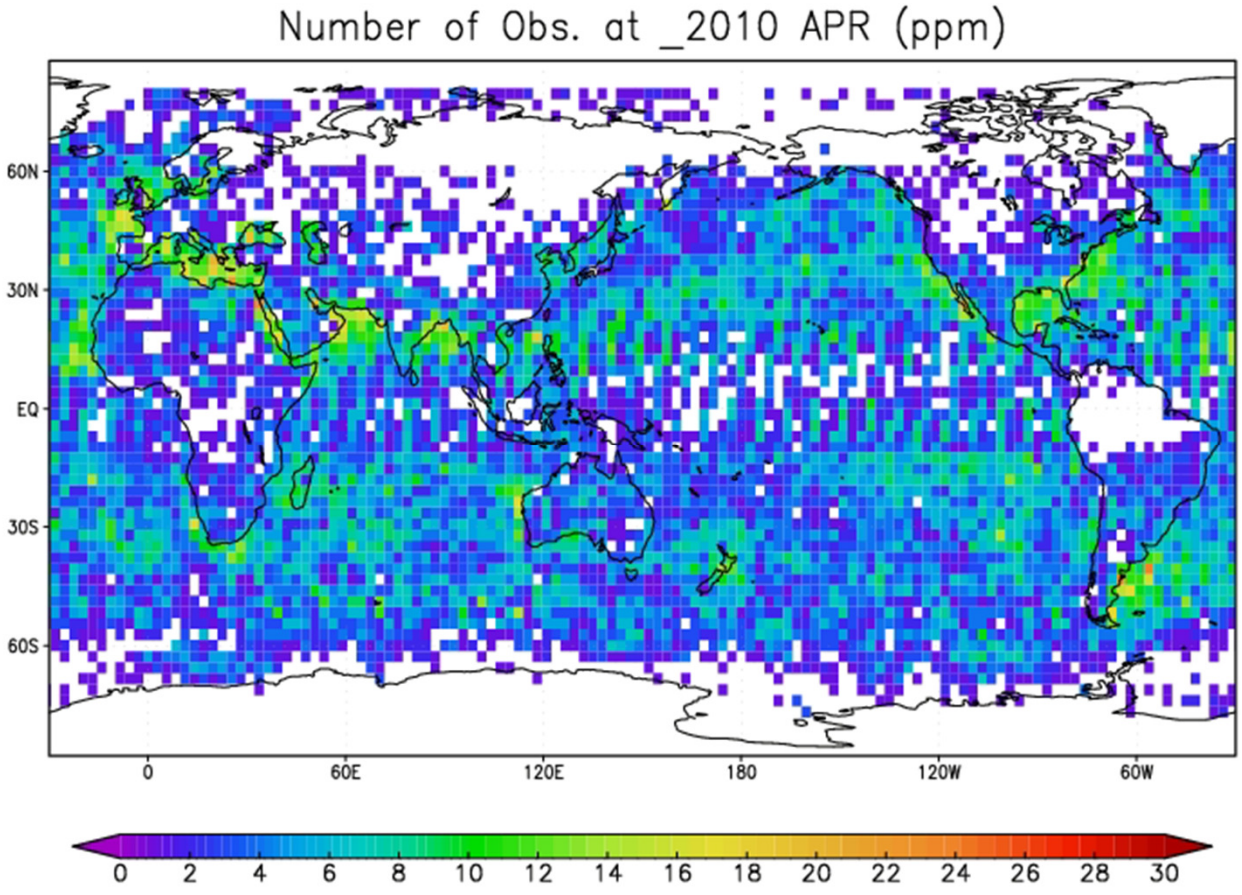
Comparing with independent analysis, NIES TIR Ver. 0.01 data showed large bias in tropical area almost all vertical levels.

3-2-2. TIR Stand deviation (NIES 0.01)



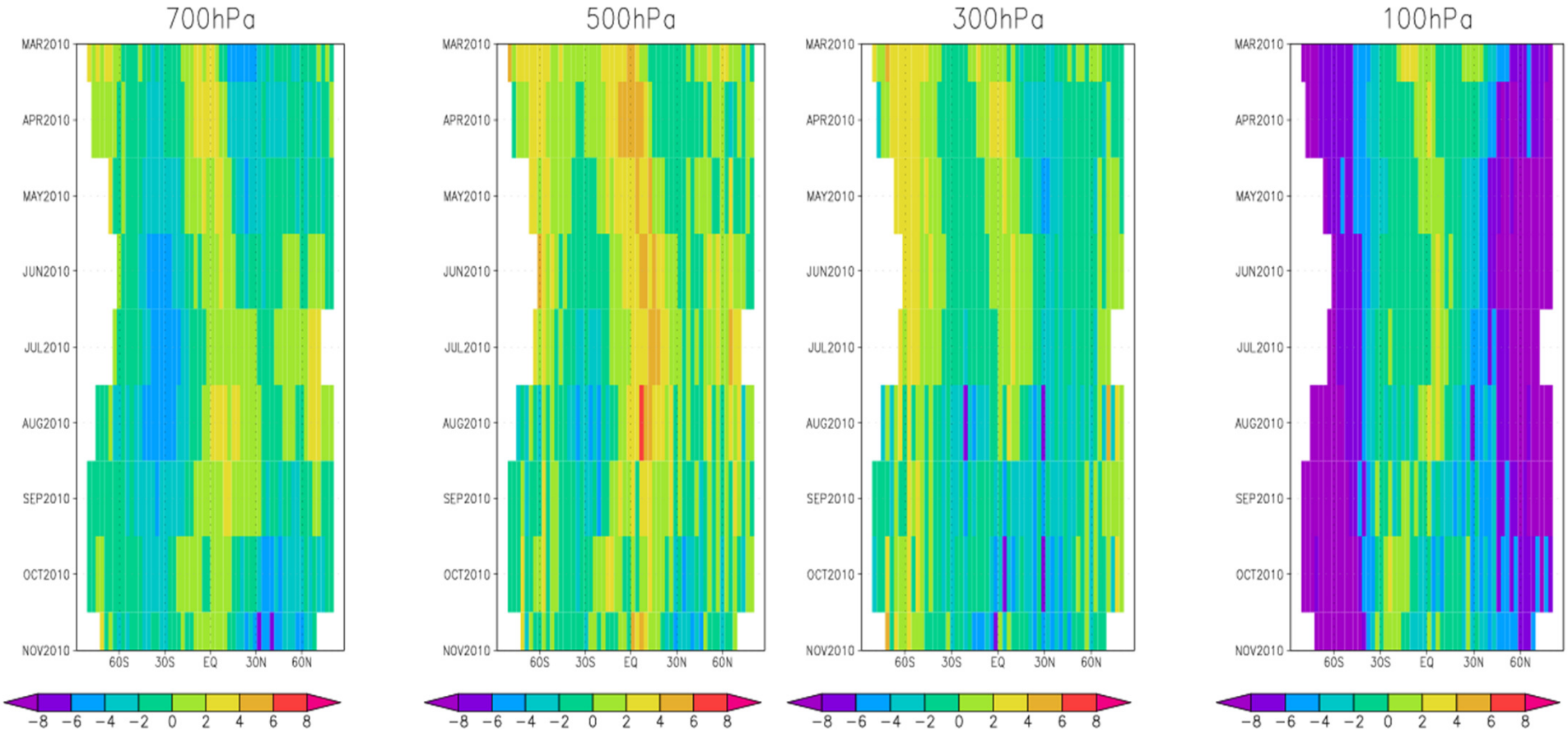
Comparing with independent analysis, standard deviation of NIES TIR Ver. 0.01 data showed larger standard deviation than SWIR data (NIES and ACOS).

3-2-3. TIR number of observations (NIES 0.01)



TIR data covered larger land and ocean area than SWIR data (especially ocean and high latitude area).

3-1-4. TIR Averaged bias (latitudinal and temporal)



TIR Bias were large in high latitude area and tropical area and position of bias peak area showed some seasonality.
As the precision of JMA analysis at 100hPa were not good enough, we could not mention about TIR 100hPa bias in boreal area.

3-3. Statistically summary

Type	Data source	Bias (ppm)	St. Dev. (ppm)
SWIR	NIES 2.X (All)	-1.8	1.7
SWIR	NIES 2.X (Selected)	-1.8	1.3
SWIR	ACOS B2.9 (All)	-2.3	3.2
SWIR	ACOS B2.9 (Good)	-0.9	1.4
TIR	NIES 0.01 (700hPa)	-0.9	3.3
TIR	NIES 0.01 (500hPa)	0.7	3.8
TIR	NIES 0.01 (300hPa)	-0.8	2.8

When we used quality flag or level, we could reduce standard deviation of SWIR data comparing with all data cases. The bias of ACOS B2.9 were also significantly reduced.

TIR data showed small bias. However, standard deviation are larger than SWIR selected data.

Our SWIR validation results were almost consistent with other validation studies.

4−1. Summary and conclusions

We constructed satellite bias estimation system making use of independent analysis (JMA CO_2 distribution).

Our results suggested that current GOSAT SWIR (NIES V2.X and ACOS B2.9) data showed smaller XCO_2 bias and standard deviation than NIES V1.X. When we adopted quality flag, we could obtain less scattered dataset.

Current GOSAT TIR (NIES V 0.01) showed small bias and large data coverage, but showed high concentration bias in tropical area. Their standard deviation were large (about 3ppm).

To make use of satellite data in inverse model or data assimilation, we should carefully estimate their bias and remove them with considering their spatial and temporal variations. Comparing with independent analysis could be one option.

4-2. Acknowledgement

GOSAT data were provided from GOSAT Research Announcement office. ACOS Ver. 2.9 data were provided from the Goddard Earth Sciences (GES) Data and Information Services Center (DISC).

CONTRAIL data were provided from PIs of the CONTRAIL project.

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Thank you very much for your attention!