

Himawari-8 SST by JAXA

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(1) JAXA, Earth Observation Research Center (EORC), (2) JAMSTEC

Topics

- } Product outline

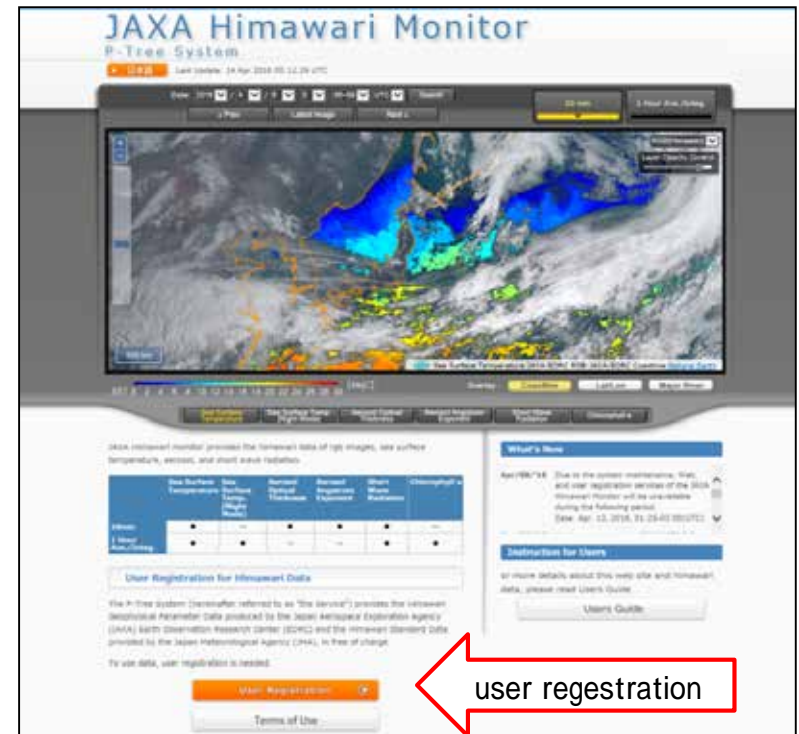
- } Quality and issues

- } Other related activities

- } Summary

Himawari Monitor and SST product

- } Himawari Monitor
- } Himawari-8 SST product
 - } Normal mode SST:
 - } Snap shot (every 10 min)
 - } Hourly composite
 - } Night mode SST:
 - } Hourly composite
- } Current Version : 1.1
- } Product is free to regestered users



<http://www.eorc.jaxa.jp/ptree/index.html>

Algorithms and data

} SST calculation

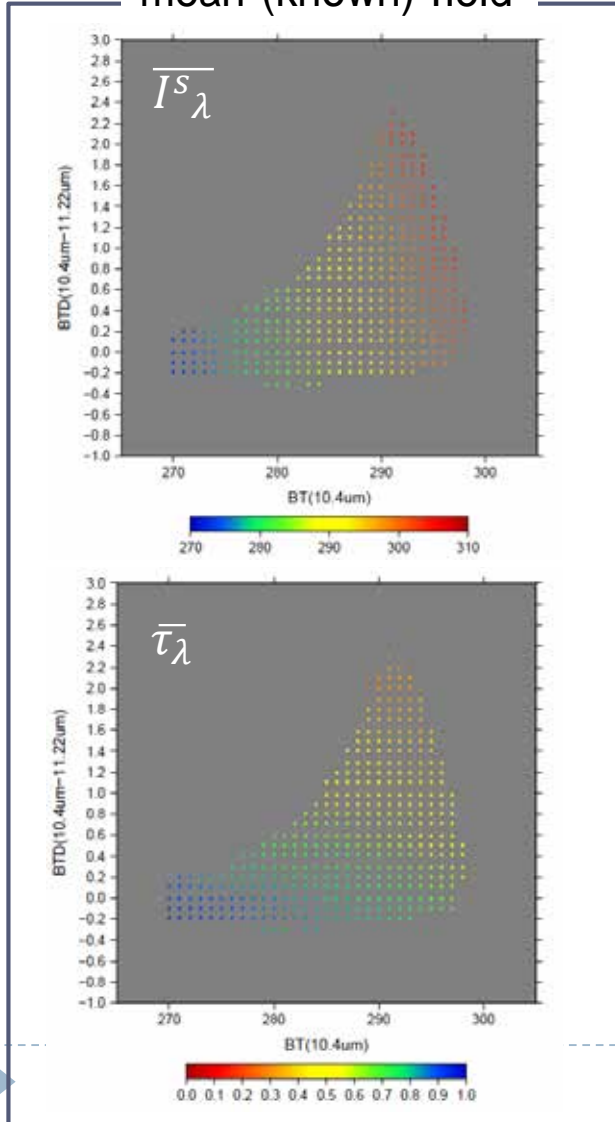
- } quasi-physical algorithm
- } skin SST
- } normal mode : 10.4, 11.2, and 8.6 um bands
- } night mode : 10.4, 11.2, and 3.9 um bands
- } NWP data : **no**
- } SST analysis : **no**

} Cloud screening

- } Bayesian
- } IR data : 10.4, 12.4 um, and 3.9 um (3.9 um : only during daytime)
- } NWP data : **no**
- } SST analysis : provided by JMA
- } PDF : statistically generated
- } Mask : Cloud probability > 0.4

Parameterization of radiative transfer

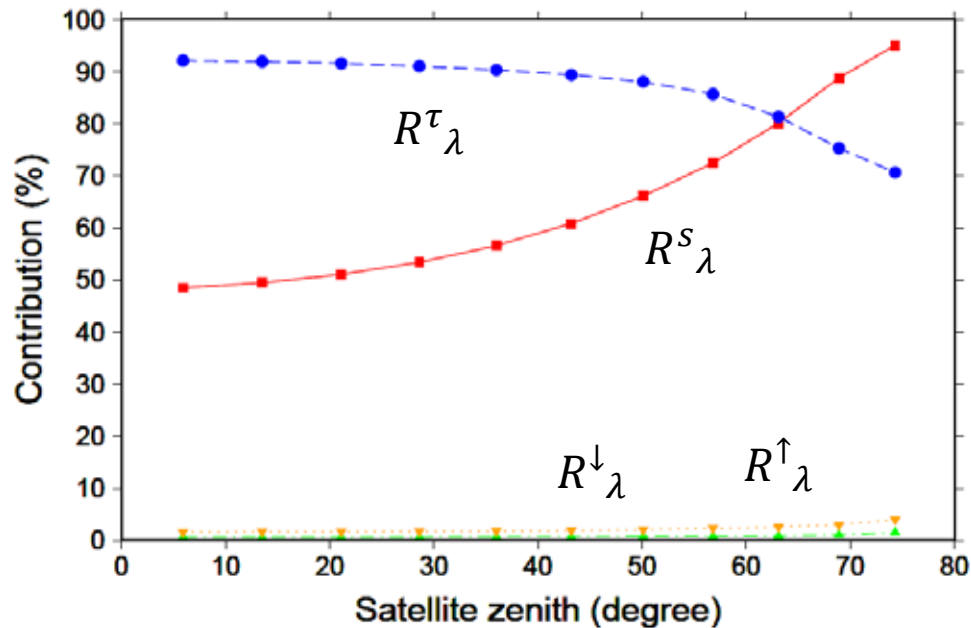
mean (known) field



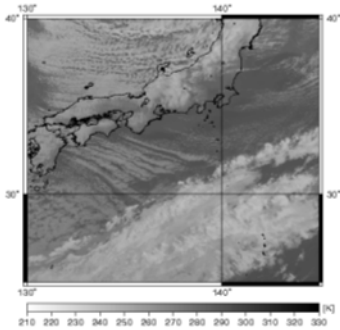
$$\begin{aligned} \overline{I}_\lambda + \Delta I_\lambda = & \varepsilon_\lambda (\overline{I}_\lambda^s + \Delta I_\lambda^s) (\overline{\tau}_\lambda + \Delta \tau_\lambda) + \\ & (1 - \varepsilon_\lambda) (\overline{I}_\lambda^\downarrow + \Delta I_\lambda^\downarrow) (\overline{\tau}_\lambda + \Delta \tau_\lambda) + \\ & (\overline{I}_\lambda^\uparrow + \Delta I_\lambda^\uparrow). \end{aligned}$$

Parameterized radiative transfer equation

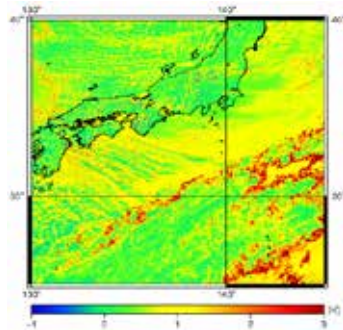
$$\begin{pmatrix} \Delta I_{\lambda_0} \\ \Delta I_{\lambda_0}^s \\ \Delta \tau_{\lambda_0} \\ \Delta I_{\lambda_0}^\uparrow \\ \Delta I_{\lambda_0}^\downarrow \end{pmatrix} \approx \begin{pmatrix} 1 & & & & \\ a_{21} & 1 & & & \\ a_{31} & a_{32} & 1 & & \\ a_{41} & a_{42} & a_{43} & 1 & \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{pmatrix} \begin{pmatrix} \Delta I_{\lambda_0} \\ R_{\lambda_0}^s \\ R_{\lambda_0}^\tau \\ R_{\lambda_0}^\downarrow \\ R_{\lambda_0}^\uparrow \end{pmatrix}$$



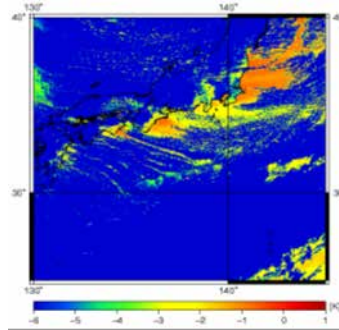
Cloud probability calculation (Bayesian)



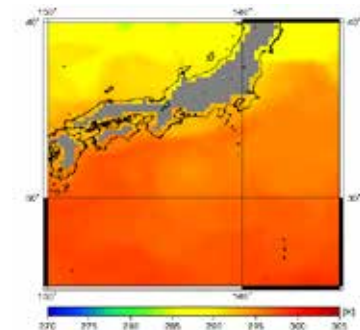
Brightness Temperature (BT)
(10.7 um)



BT Difference
(10.7 - 12.0 um)



BT Difference
(10.8 - 3.7 um)
only daytime



Daily SST Analysis
(MGDSST by JMA)

empirical PDFs

$$P(y_i|x) = \frac{P(x|y_i)P(y_i)}{P(x)}$$

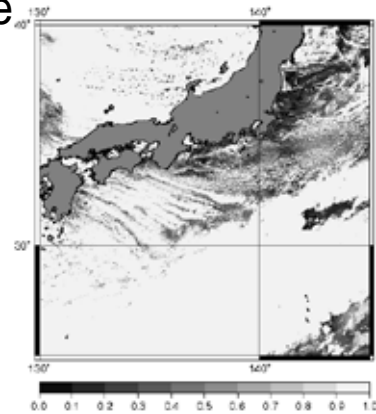
Bayesian inference method

$$P(x|y_i) = \frac{e^{-\{\frac{1}{2}(\mathbf{x}-\mathbf{x}_0|_{y_i})^t(\mathbf{B}|_{y_i}+\mathbf{E})^{-1}\}(\mathbf{x}-\mathbf{x}_0|_{y_i})}}{\sqrt{|2\pi(\mathbf{B}|_{y_i}+\mathbf{E})|}}$$

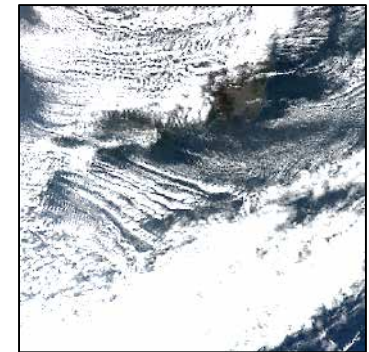
$$P(x) = \sum_i P(x|y_i)P(y_i)$$

$$P(y_i) = \frac{N|_{y_i}}{N}$$

PDF



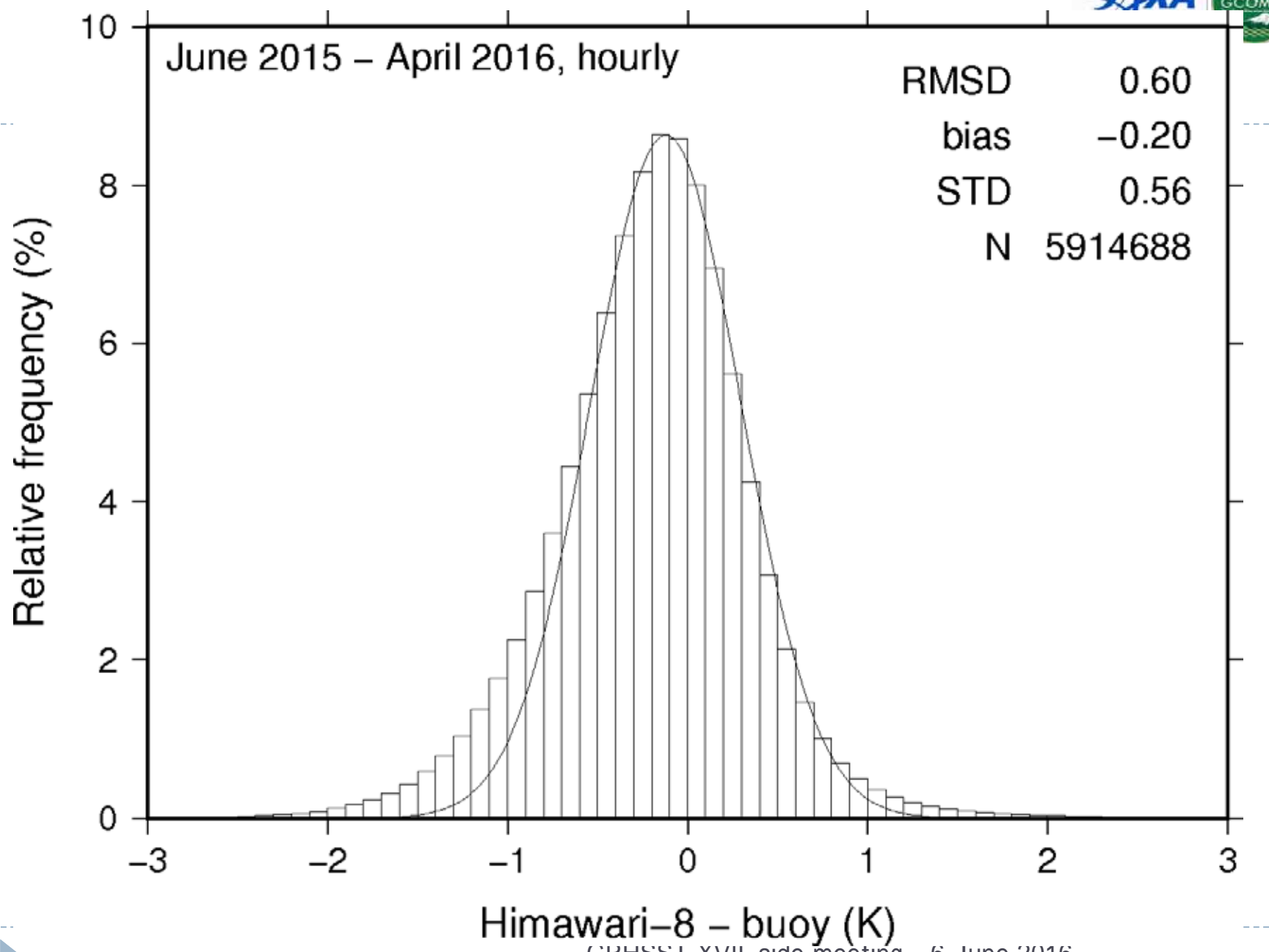
Cloud probability



Specifications of SST product

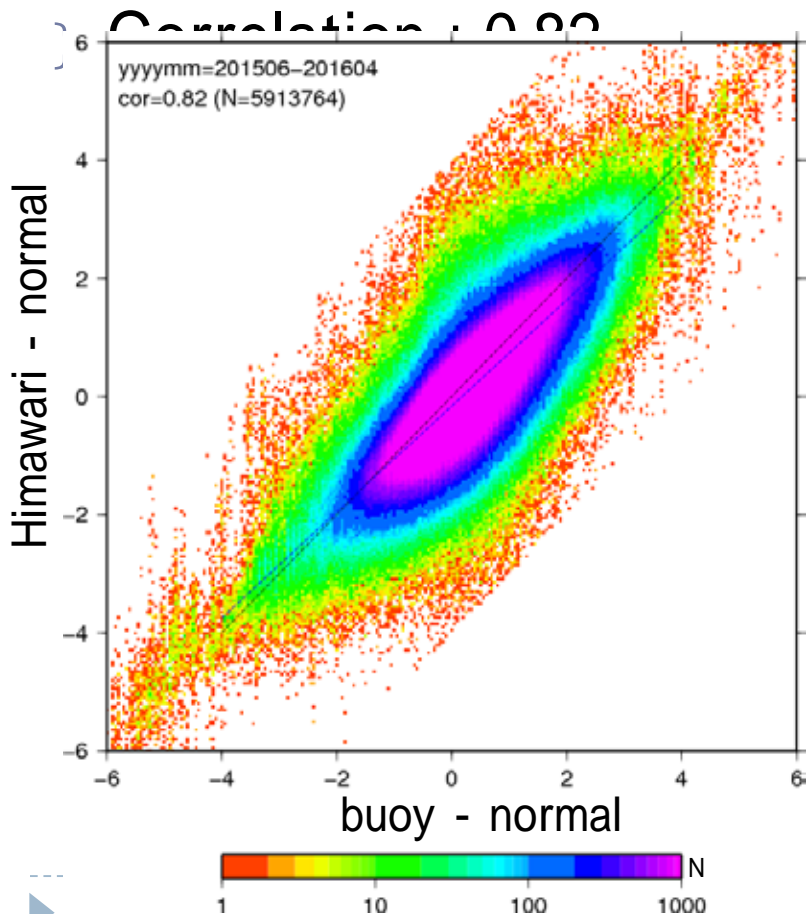
- } Data type : Grided (latitude-longitude) data
- } Area coverage : 80E-160W, 60N-60S
- } Spatial Resolution : 0.02 x 0.02 degrees
- } Array size : 6001 x 6001
- } File format : NetCDF (GDS 2.0*)
- } File size : 17 MB/file
- } Latency : 1 hour

* GDS: GHRSSST Data Specification



Anomaly correlation

} Normal : Cobe SST normal (in-situ based normal by JMA)

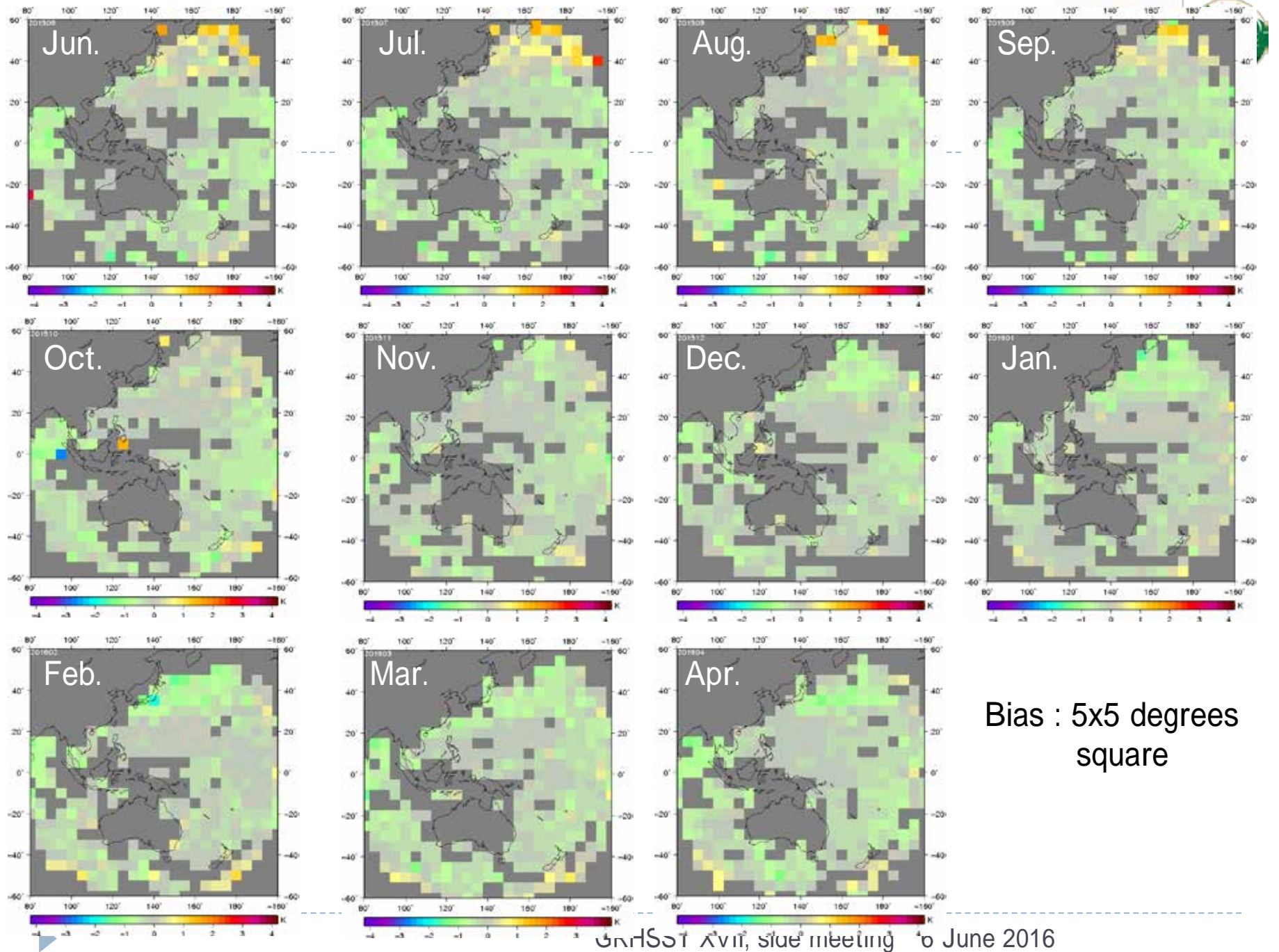


Anomaly correlations (2015.06-12)

MM	06	07	08	09	10	11	12
Corr	0.82	0.82	0.80	0.83	0.85	0.82	0.82

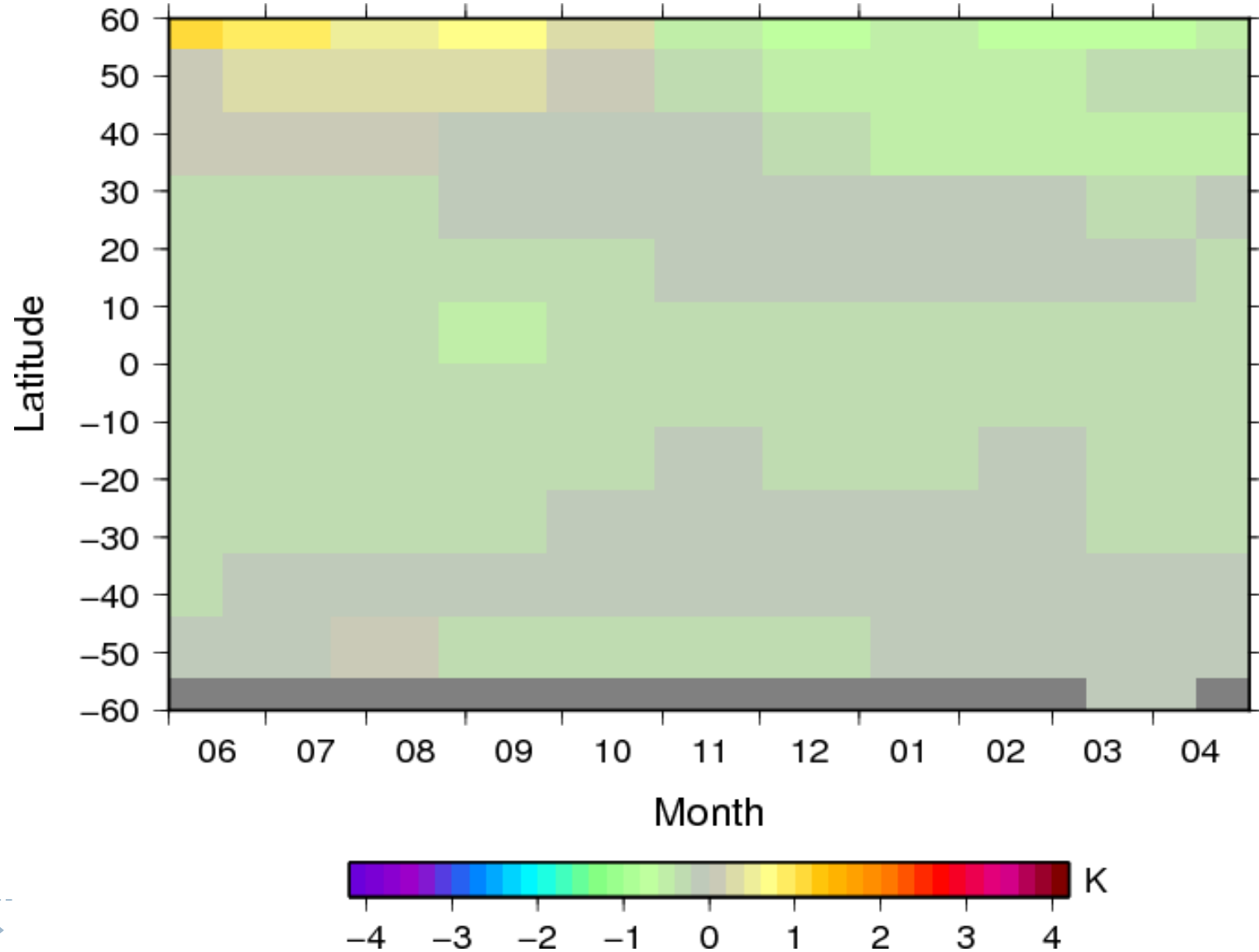
Anomaly correlations (2016.01-04)

MM	01	02	03	04
Corr	0.78	0.79	0.83	0.83



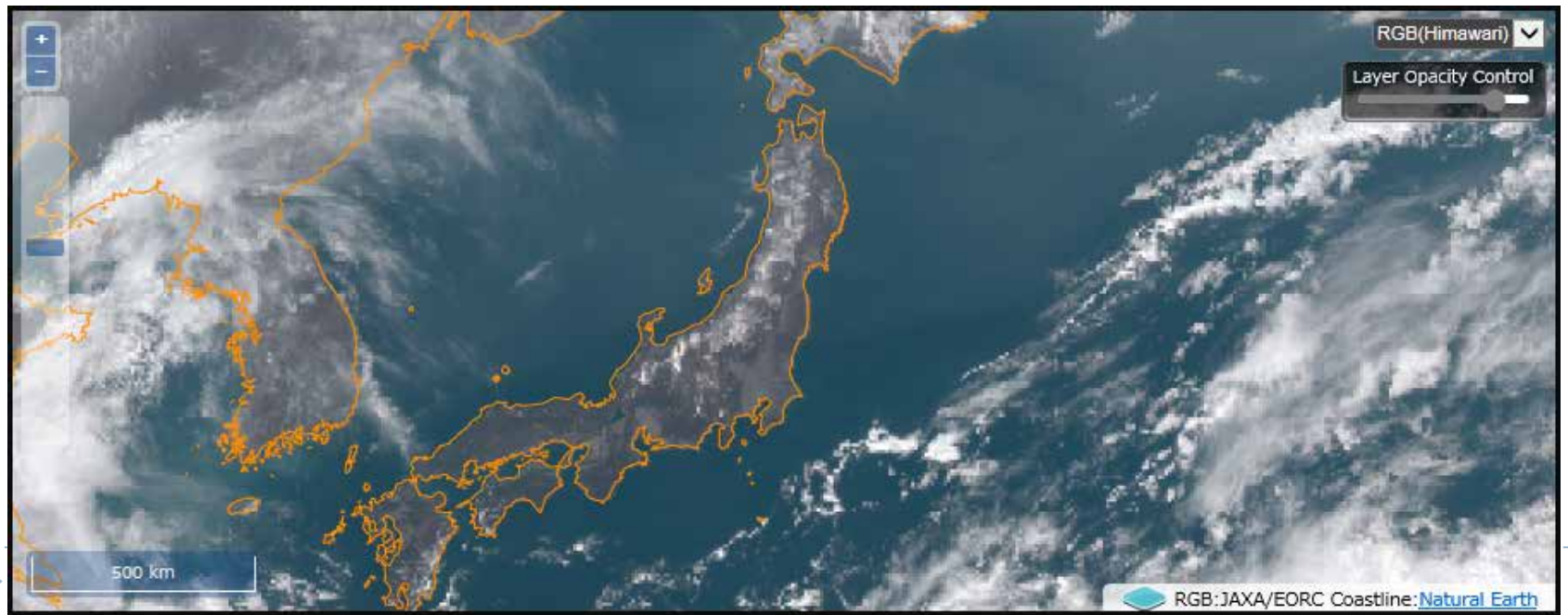
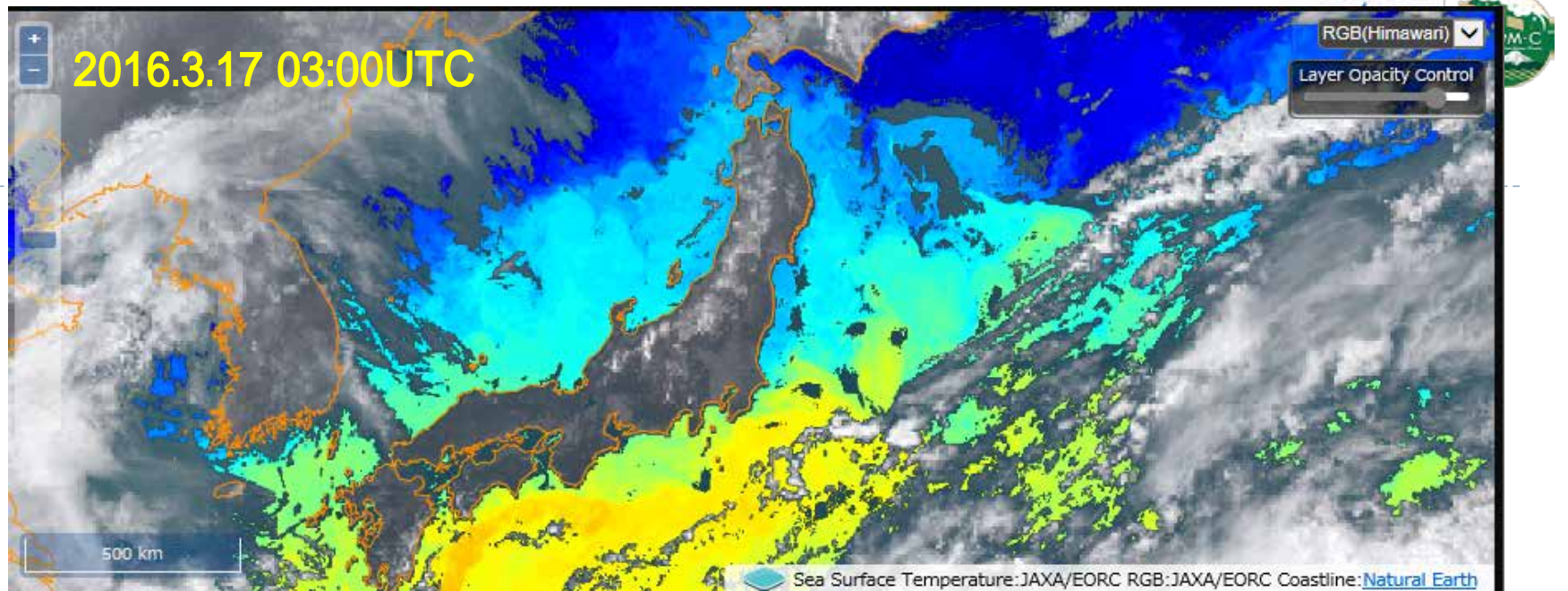
Bias : 5x5 degrees square

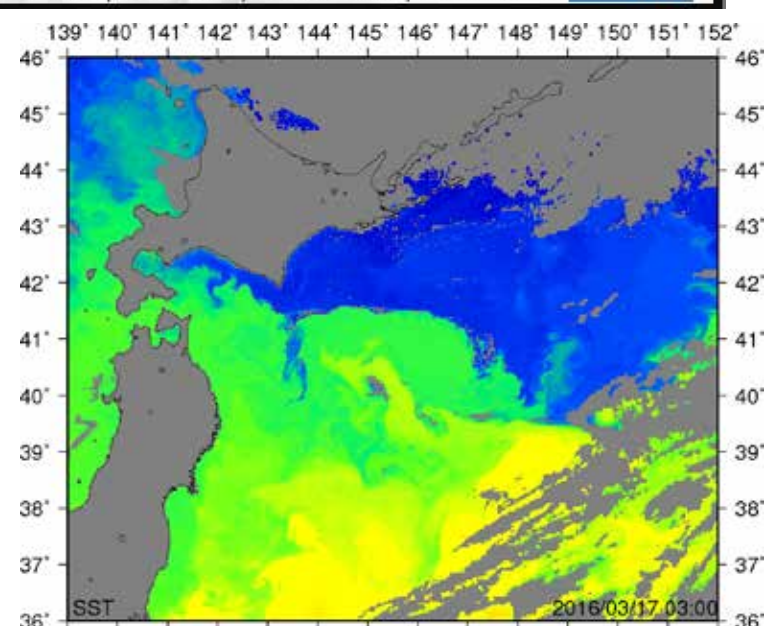
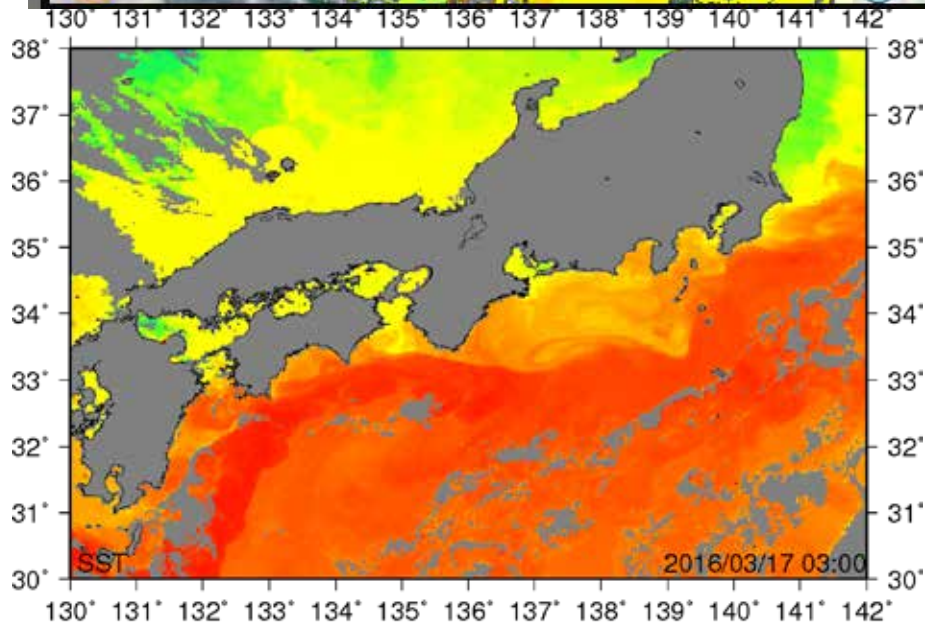
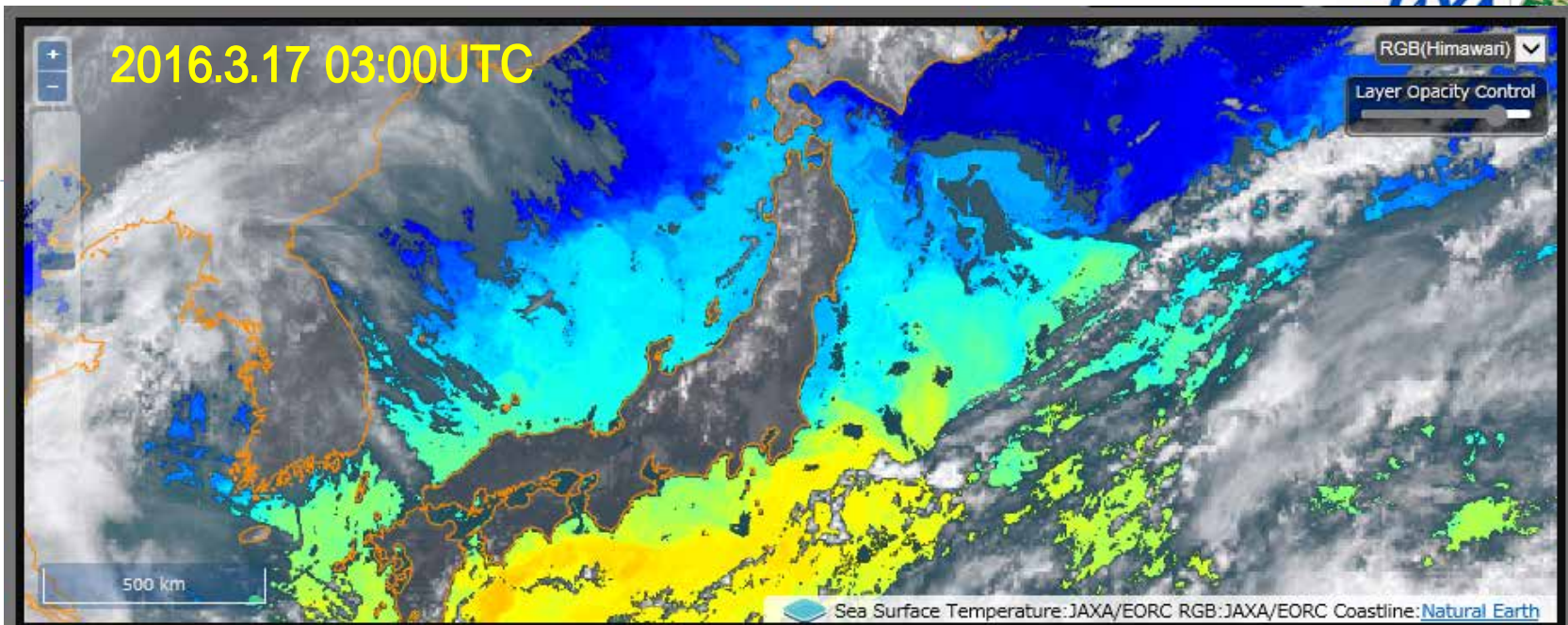
Seasonal variation of latitudinal biases



Issues

- } Seasonal biases in the north Pacific
- } Cloud mask over detection (**will be improved soon**)
- } Consistency with other satellite SSTs





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- } Cloud mask over detection (**will be improved soon**)
- } Consistency with other satellite SSTs

Other related activities

- } Update of the L1 processing algorithm by JMA (9 Mar. 2016)

- } Himawari-8 SST data assimilation at JAMSTEC*
(Poster: Dynamic interpolation of HIMAWARI-8 SST, T. Hihara, et. al.)

* JAMSTEC : **J**apan **A**gency for **M**arine-earth **S**cience and **T**EChnorogy

Processing algorithm update by JMA (9 March)



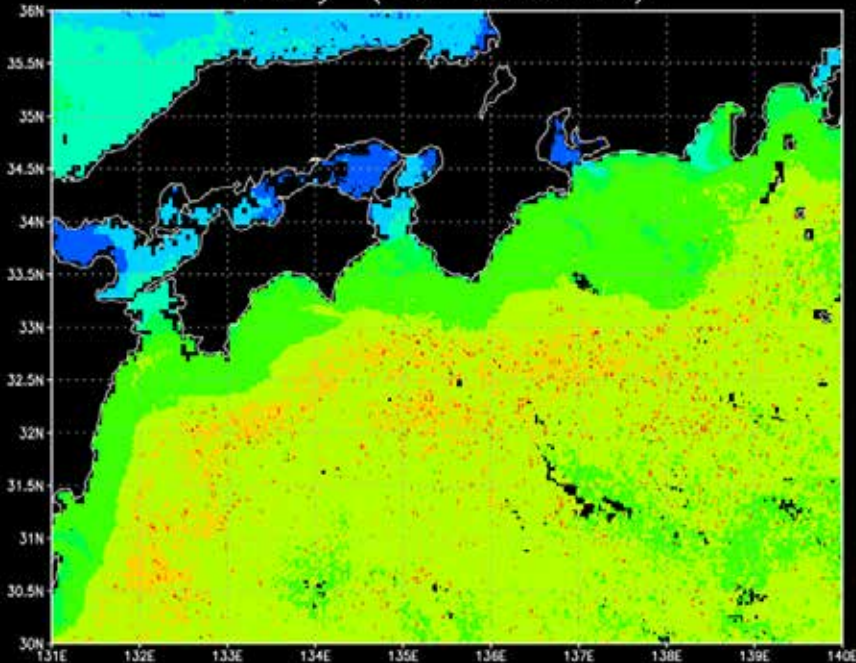
- } Implementation of coherent noise reduction processing
- } Improvement of band-to-band co-registration processing for infrared bands
- } Improvement of resampling processing
- } Bug fix for HSD header information

(http://www.data.jma.go.jp/mscweb/en/operation8/eventlog/20160309_himawari-8_event_en.pdf)

Impact of the update

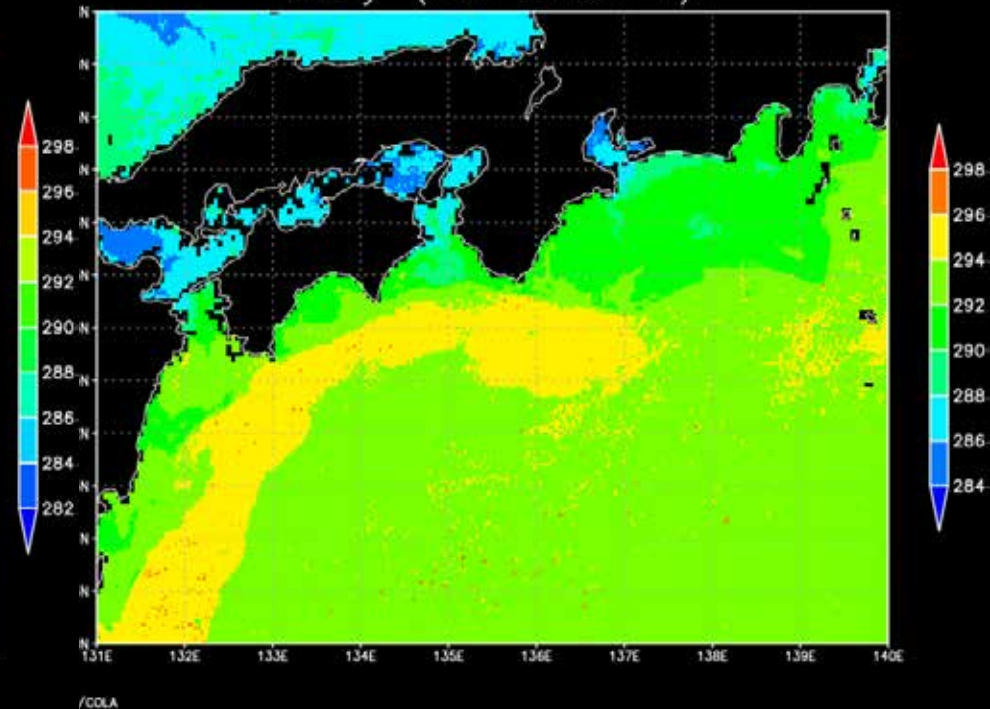
Daily SST composites retrieved by keeping maximum

daily (2016.03.02)



2016.3.2 (before the update)

daily (2016.03.17)



2016.3.17 (after the update)

Unnatural high SSTs (left) have been highly improved (right) by the update.

Title: Dynamic interpolation of HIMAWARI-8 SST

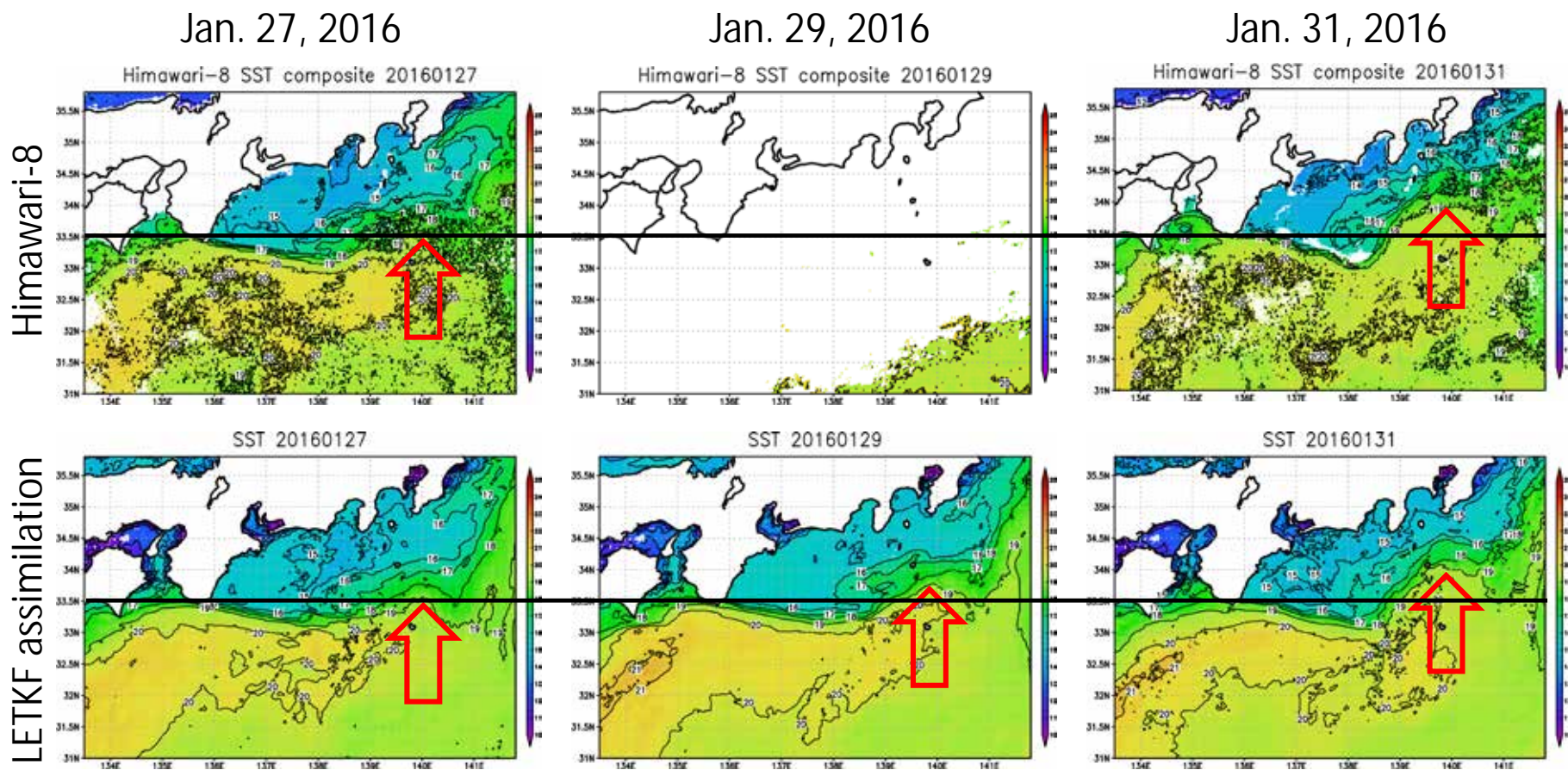
Tsutomu Hihara, Poster No.: 15



We constructed a data assimilation system using the ensemble Kalman filter combined with an ocean model. In this system, Himawari-8 SST data provided by JAXA are assimilated.

Assimilation method: Local Ensemble transformation Kalman filter algorithm (LETKF)

Analysis Area: South of Japan (128-142°E, 28-36°N) **Horizontal resolution:** 1/36°



Summary

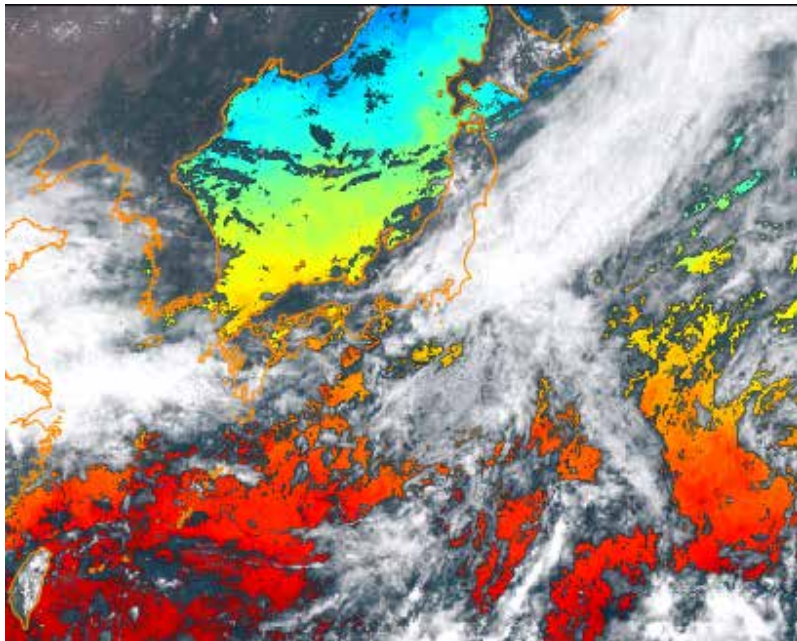
- } JAXA opened Himawari Monitor last August and released the Himawari-8 SST product on the web-site.
- } Quasi-physical algorithm and the cloud algorithm based on Bayesian is used for the Himawari-8 SST product.
- } Comparison shows a good agreement between buoy data and Himawari-8 SST.
- } Seasonal biases are found in the north Pacific.
- } Over cloud detection will be improved in the next update.
- } The update of the L1 processing likely made a positive impact on the SST product.
- } Dynamic ocean model of JAMSTEC has been improved by the assimilation of Himawari-8 SST.

Thank you

Back ups

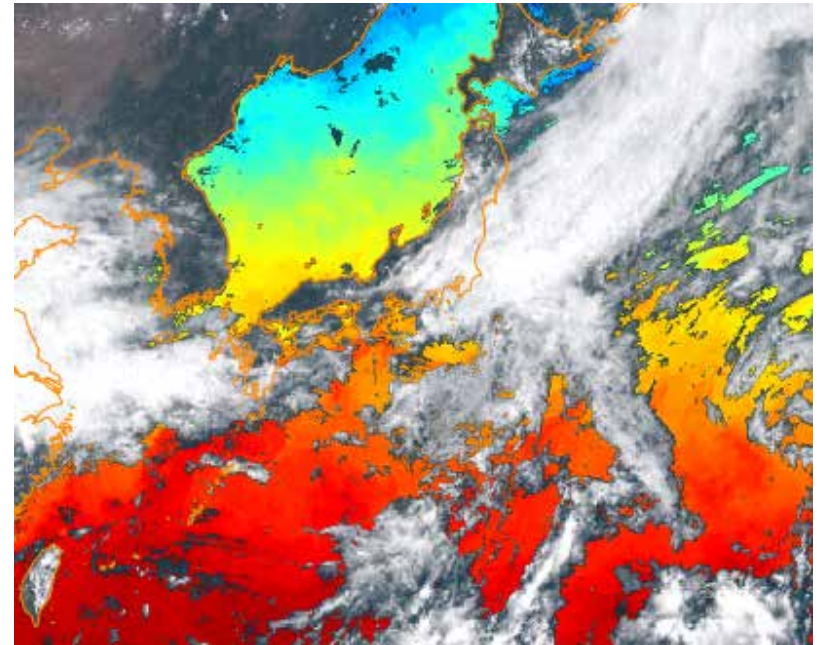
Snap shot and hourly composite

Snap shot



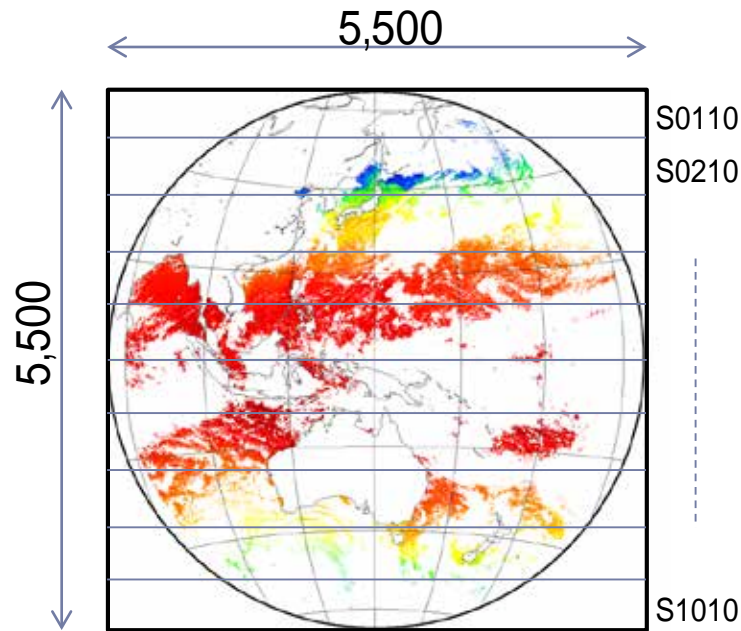
25 May 2016 04:00 UTC

Hourly composite

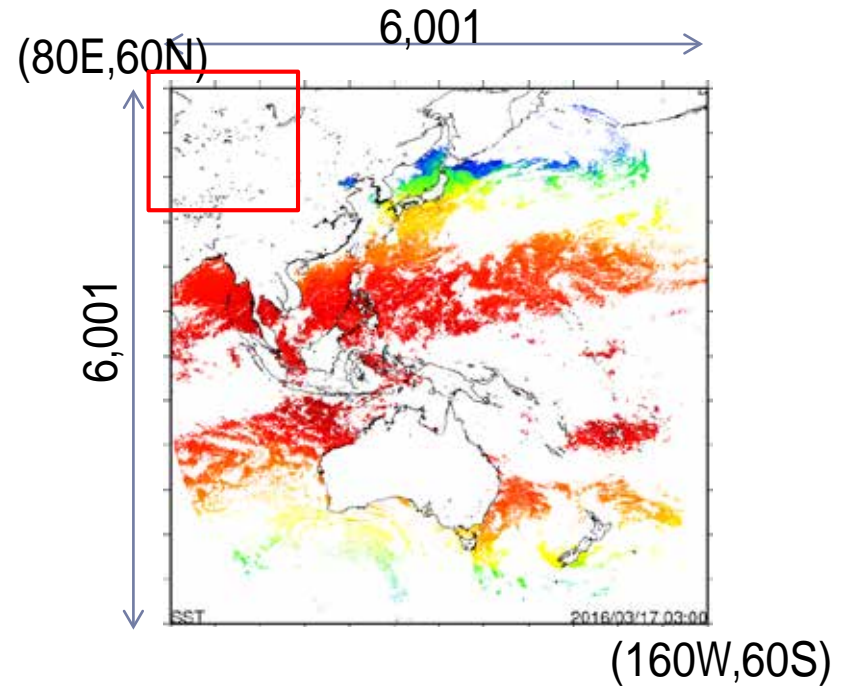


25 May 2016 04:00-04:50 UTC

Location on the map

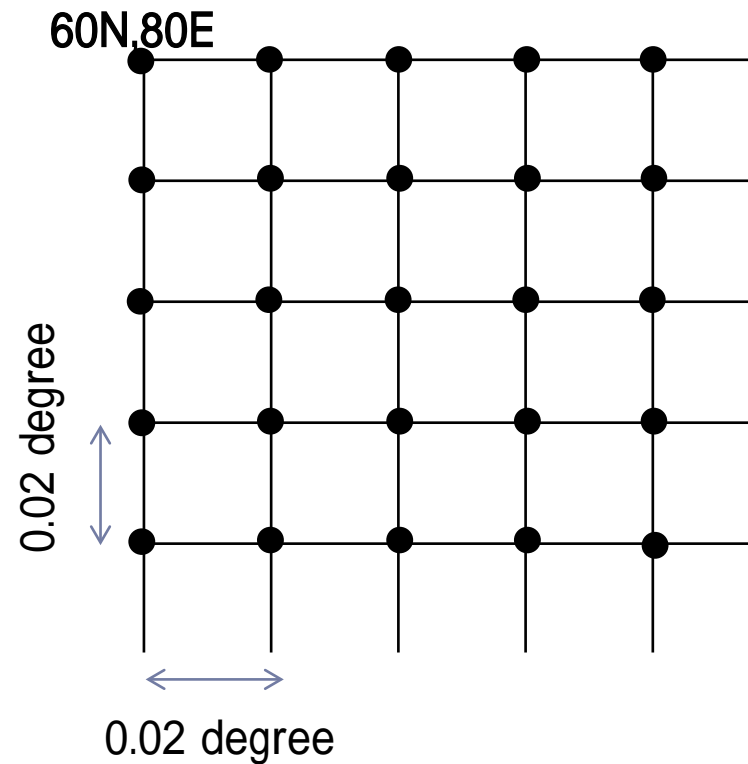


Himawari Standard (HISD by JMA)



Himawari-8 SST (JAXA)

Location on the map (enlarged view)



Quality level (GDS2.0)

QL	description	remarks
5	best	Cloud Probability < 0.3
4	acceptable	0.3 < Cloud Probability < 0.4
3	low quality	not used
2	worst quality	not used
1	bad data	not used
0	no data	Cloud Probability > 0.4, land, ...

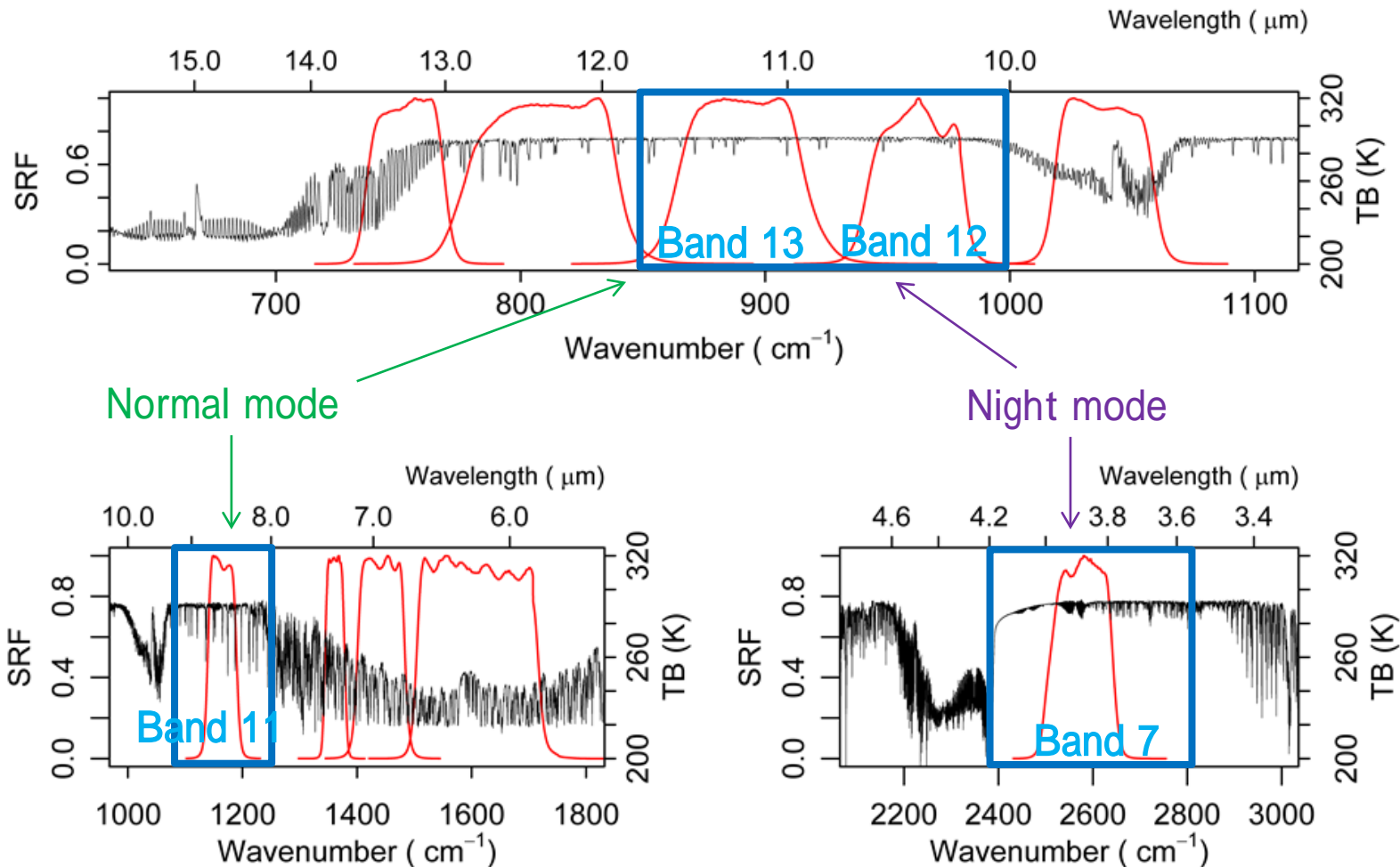
We assume ...

QL 5 : Quantitative use

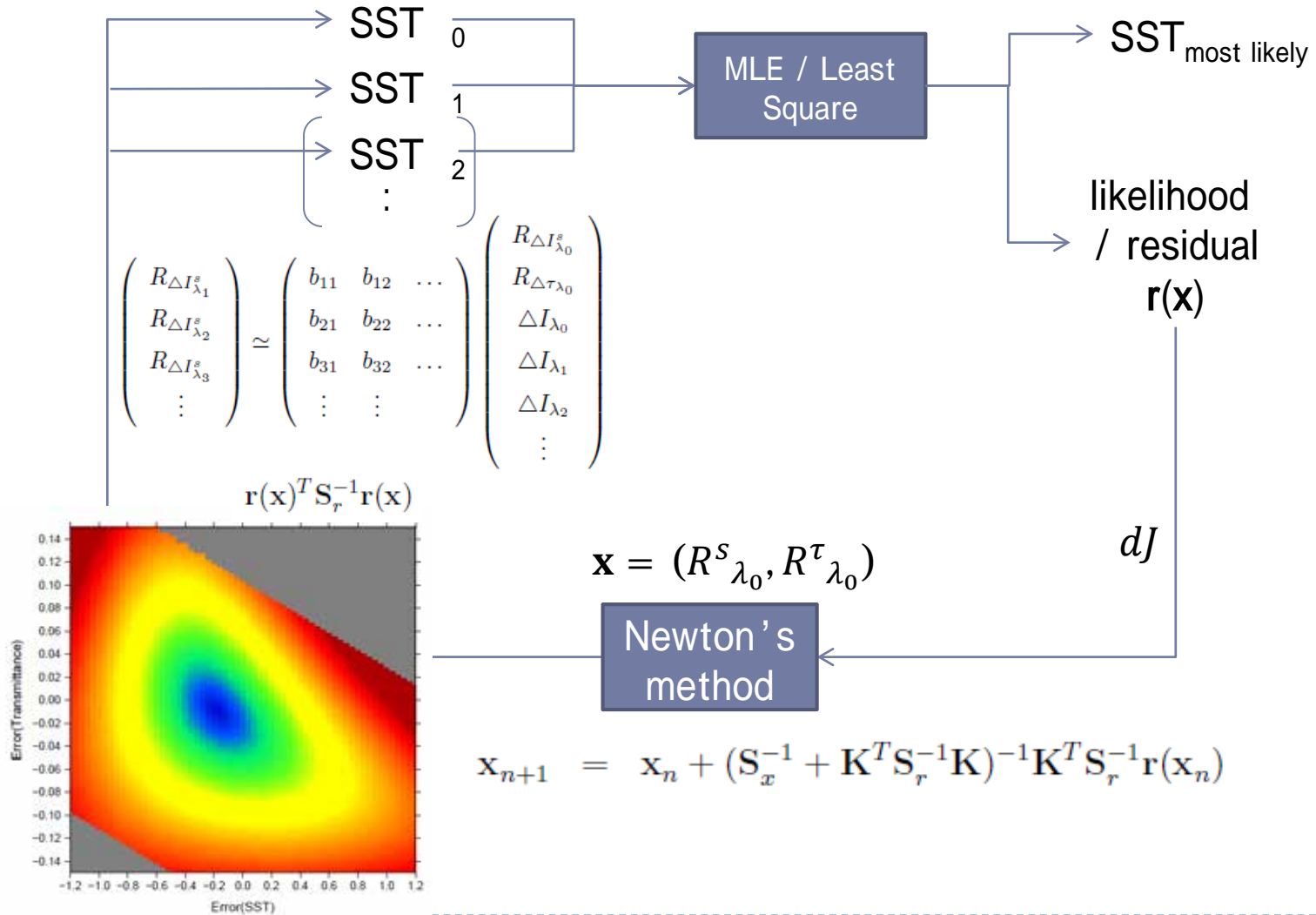
QL >=4 : Qualitative use

IR data used for SST

SRFs of Himawari-8/AHI Infrared Bands (September 2013) (JMA/MSC)



SST algorithm



Validation

} Himawari-8 SST

} SST : normal mode (split+8.6)

} QL : best (Cloud Probability < 0.3)

} Period : June 2015 – April 2016, observed on the hour (00-23:00)

} In-situ data

} BUOY (drifter and moored) from NOAA iQuam

} Match-up data set

} Within 3km and 3 hours

} N : 5,911,102

Match-up data

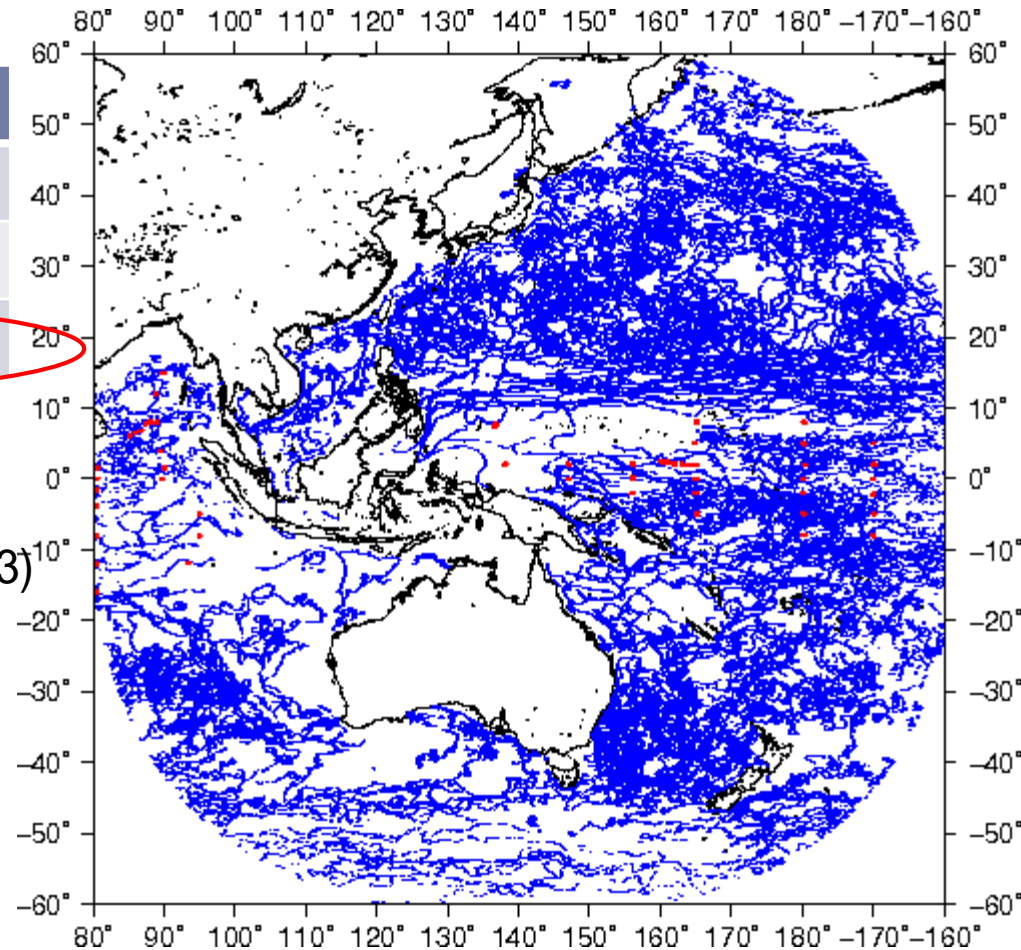
Match-up	N	% (*)
ALL	14,282,174	100
$P_{\text{cloud}} < 0.4$	6,585,308	46
$P_{\text{cloud}} < 0.3$	5,911,102	41

* Different from clear percentage

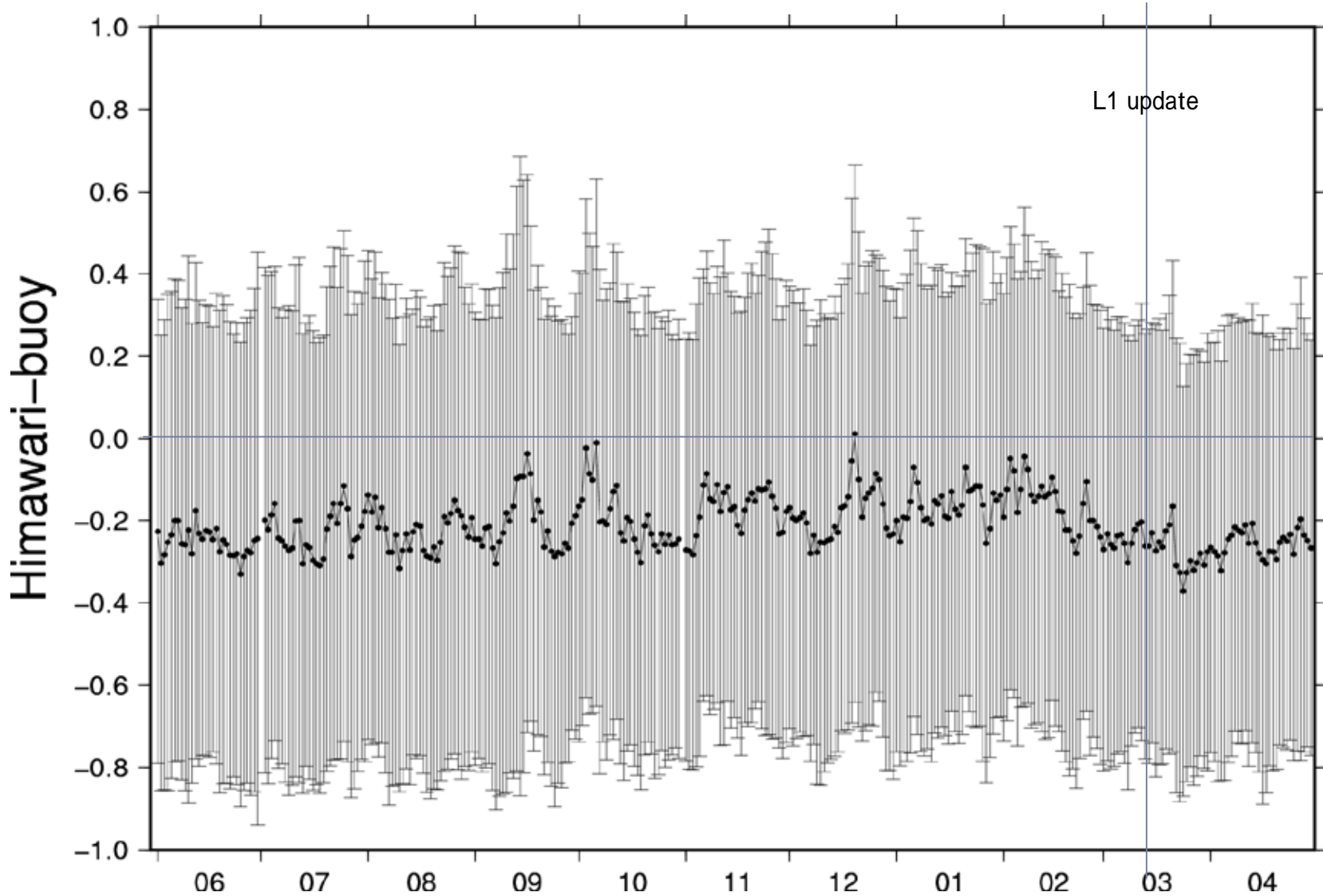
Location of match-up data ($P_{\text{cloud}} < 0.3$)

Blue : drifting buoy

Red : moored buoy

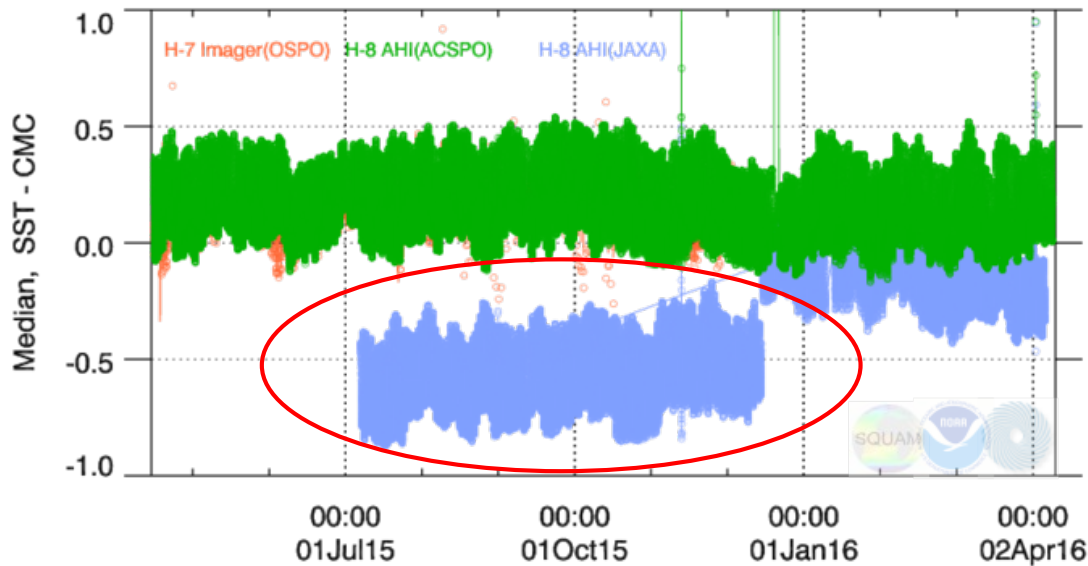


Bias and standard deviations

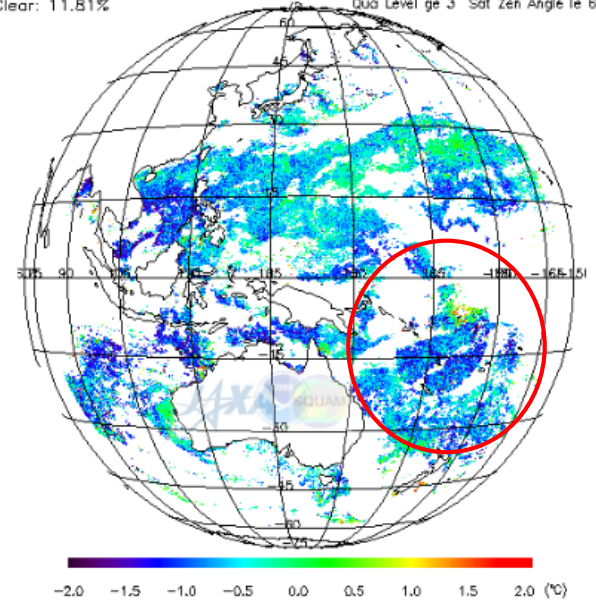


Ver. 1.1 (14 Dec. 2015)

- } Improved :
 - } High negative bias
 - } Unnatural circular pattern



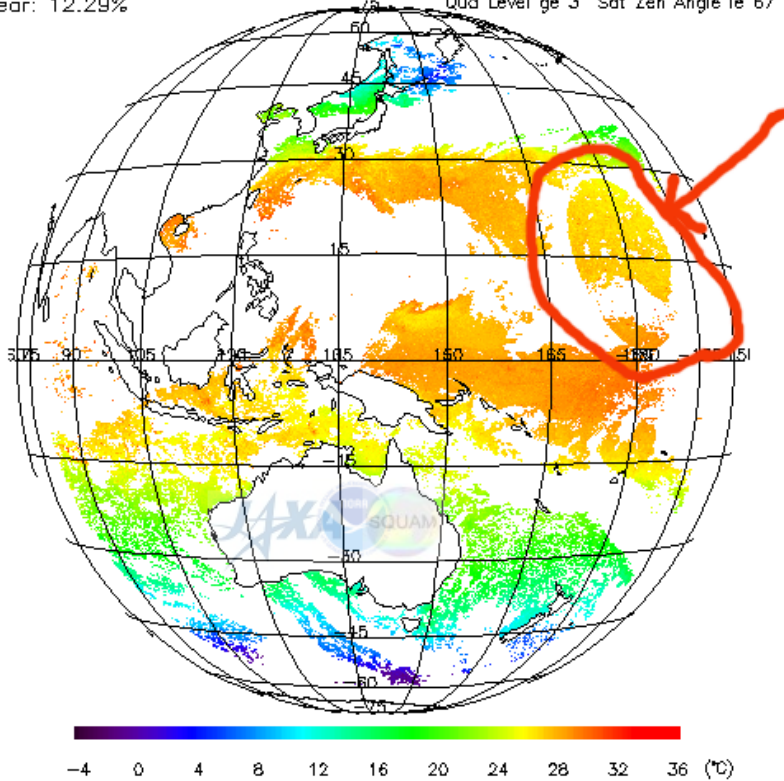
Himawari-8 AHI (JAXA)-CMC, v1.0-v02.0-fv01.0,201512012210
Clear: 11.81% Qua Level ge 3 Sat Zen Angle le 67



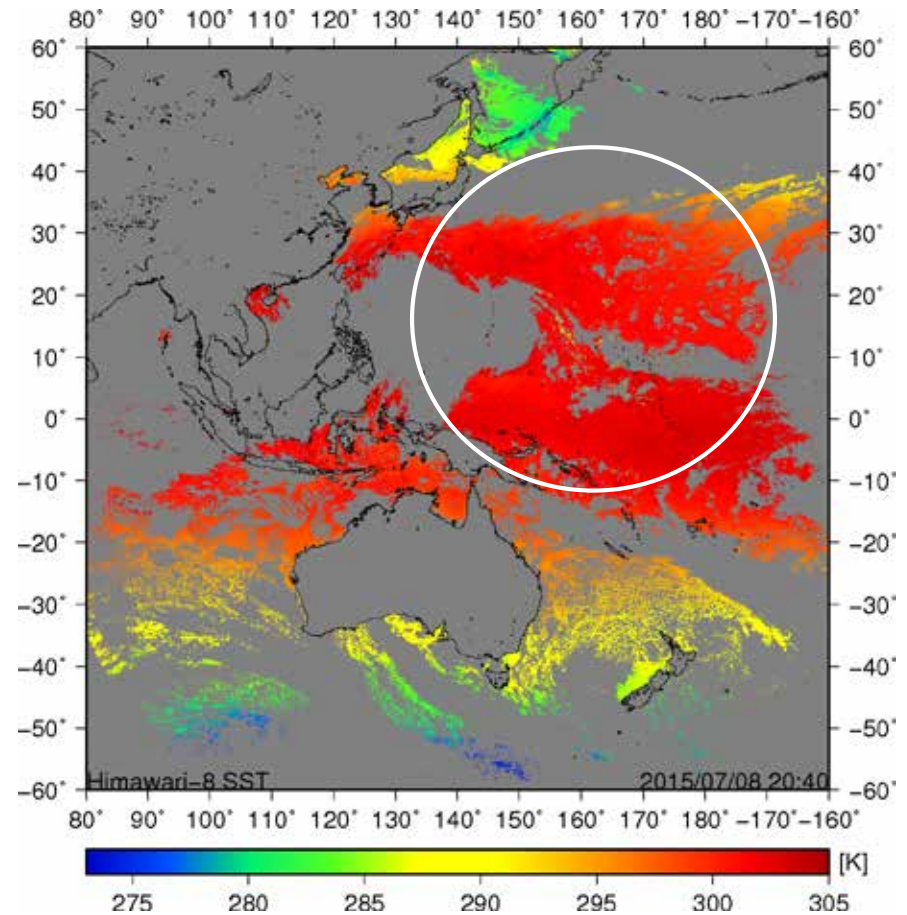
NOAA SQUAM (<http://www.star.nesdis.noaa.gov/sod/sst/squam/GEO/#>)

Cloud Mask issue around sun-glint

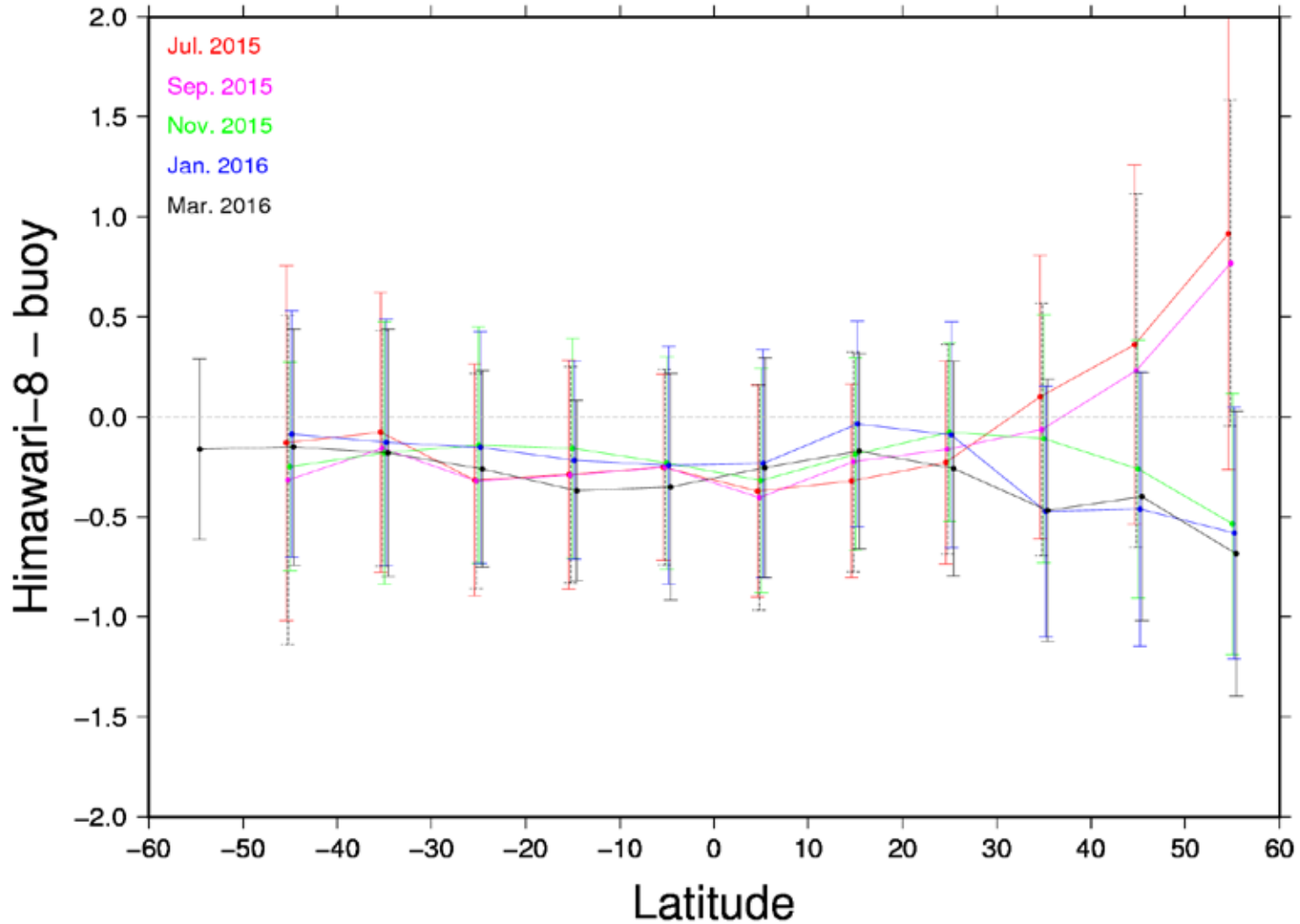
Skin SST, Himawari-8 AHI (JAXA), v1.0-v02.0-fv01.0, 201507082040
 Clear: 12.29%
 Qua Level ge 3 Sat Zen Angle le 67



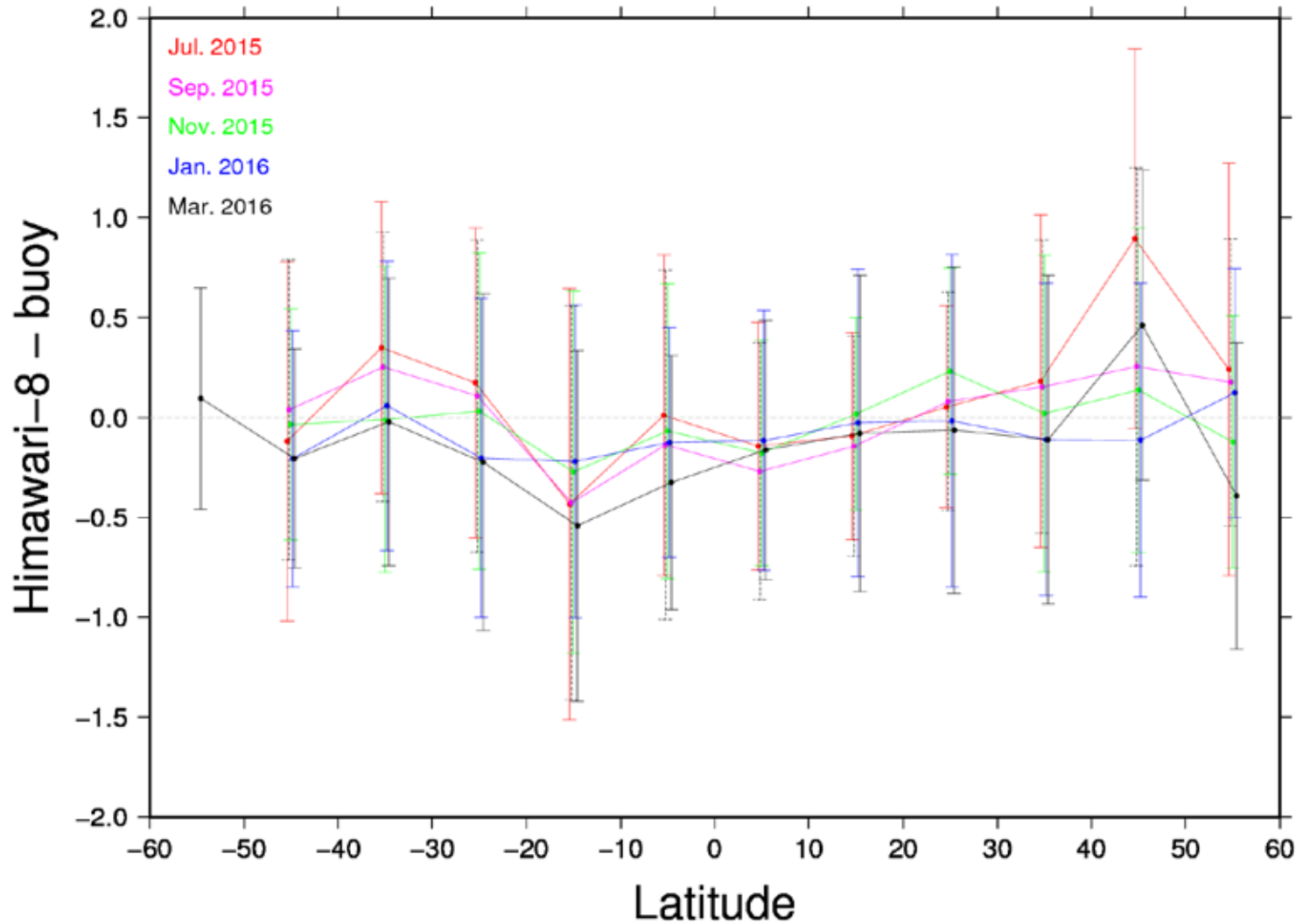
by NOAA SQUAM



Dependency (latitude)



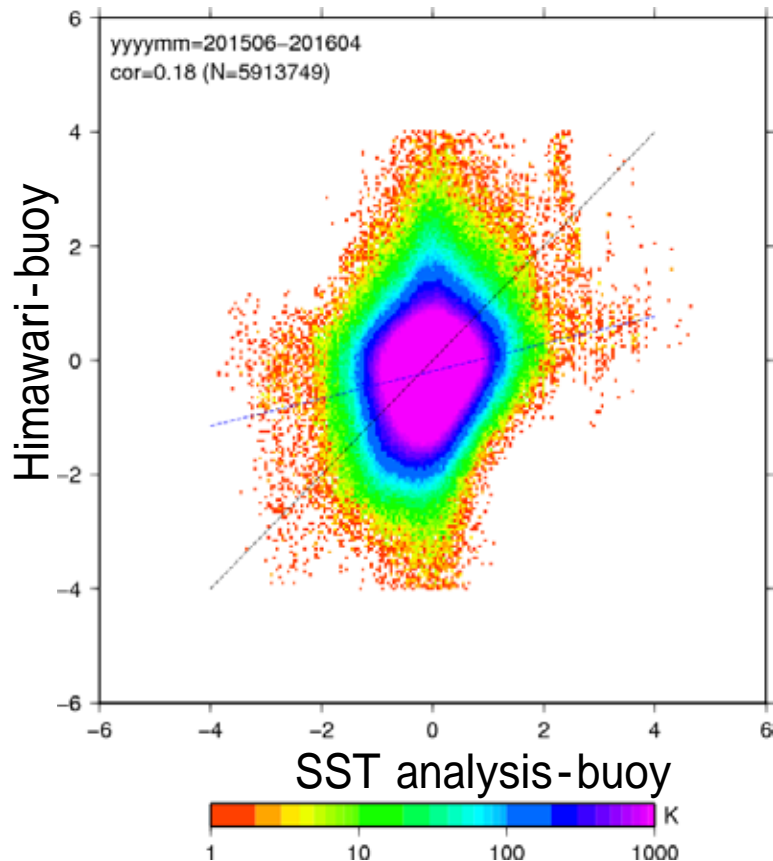
NLSST



► $T_s = a_0 + a_1 T_{B10} + a_2 (T_{B10} - T_{B11}) (T_s^0 - 273.15) + a_3 (T_{B10} - T_{B11}) (\sec\theta - 1)$ (B. Petrenko et al., 2011)

Dependency (analysis)

- } SST analysis : MGDSST (JMA)
- } Correlation : 0.18



Error correlations (2015.06-12)

MM	06	07	08	09	10	11	12
Corr	0.23	0.12	0.16	0.20	0.18	0.18	0.17

Error correlations (2016.01-04)

MM	01	02	03	04
Corr	0.19	0.16	0.21	0.19