19th International GHRSST Science Team Meeting

Ensemble SST and Air-Sea Flux Estimation

Hiroyuki TOMITA

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Introduction: SST and air-sea flux

Key parameter to estimate air-sea flux

Many kinds of global SST products

Table. SST products used in satellite-base air-sea flux data set

Flux product	**GSSTF3**	**HOAPS3**	**IFREMER V3**	**J-OFURO2**
Reference	Shie et. 2009	Anderson et al. 2010	Bentamy et al. 2013	Tomita et al. 2010
SST product	AMSR-E and TMI	NODC/RSMAS Pathfinder SST	NCDC analysis	JMA MGDSST

Introduction: SST and air-sea flux

Key parameter to estimate air-sea flux

Many kinds of global SST products

Difficult issue to decide which SST product is suitable for air-set flux estimation.

Unknown influence on air-sea flux estimation when using different SST products

——> Ensemble of multi global SST products

Contents

Project overview

J-OFURO

Japanese Ocean Flux Data Sets with Use of Remote Sensing Observations

Objective

Accurate estimation of ice-free global air-sea flux for better understanding air-sea interaction.

Project Leader

Hiroyuki Tomita (ISEE, Nagoya Univ.)

Project overview

J-OFURO

J-OFURO1

2000

Kubota et al. 2002

J-OFURO2

2008

Tomita et al. 2010

J-OFURO3

2016

Tomita et al. 2018 (submitted)

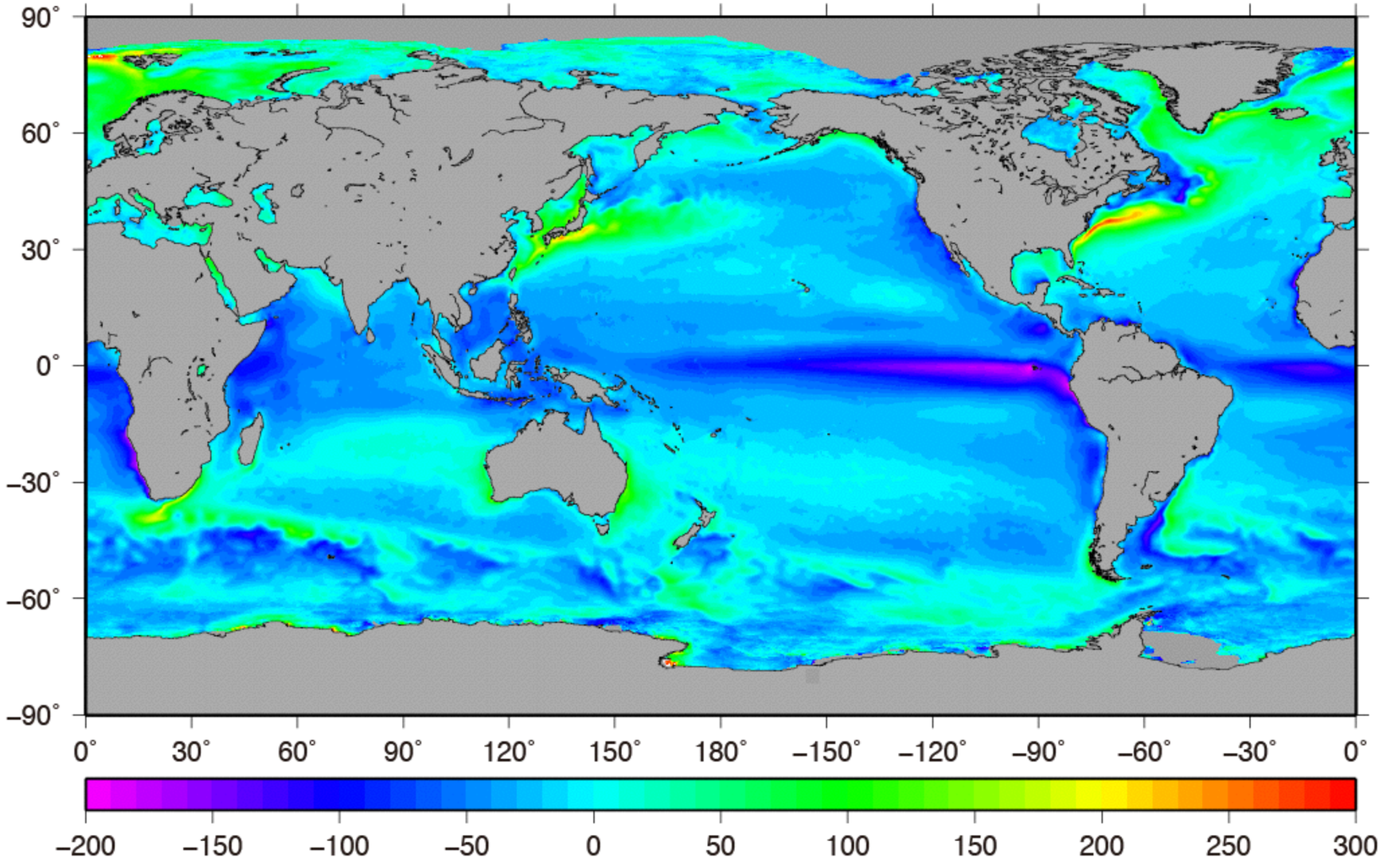
Fluxes

- heat
  - turbulent (latent and sensible heat fluxes)
  - radiation <— CERES, ISCCP
- momentum
- freshwater
  - evaporation
  - precipitation <— GPCP, GSMap

Satellite-derived air-sea heat flux

J-OFURO

2002-2013 (12 years), NHF: net heat flux [W/m²]



J-OFURO3 overview

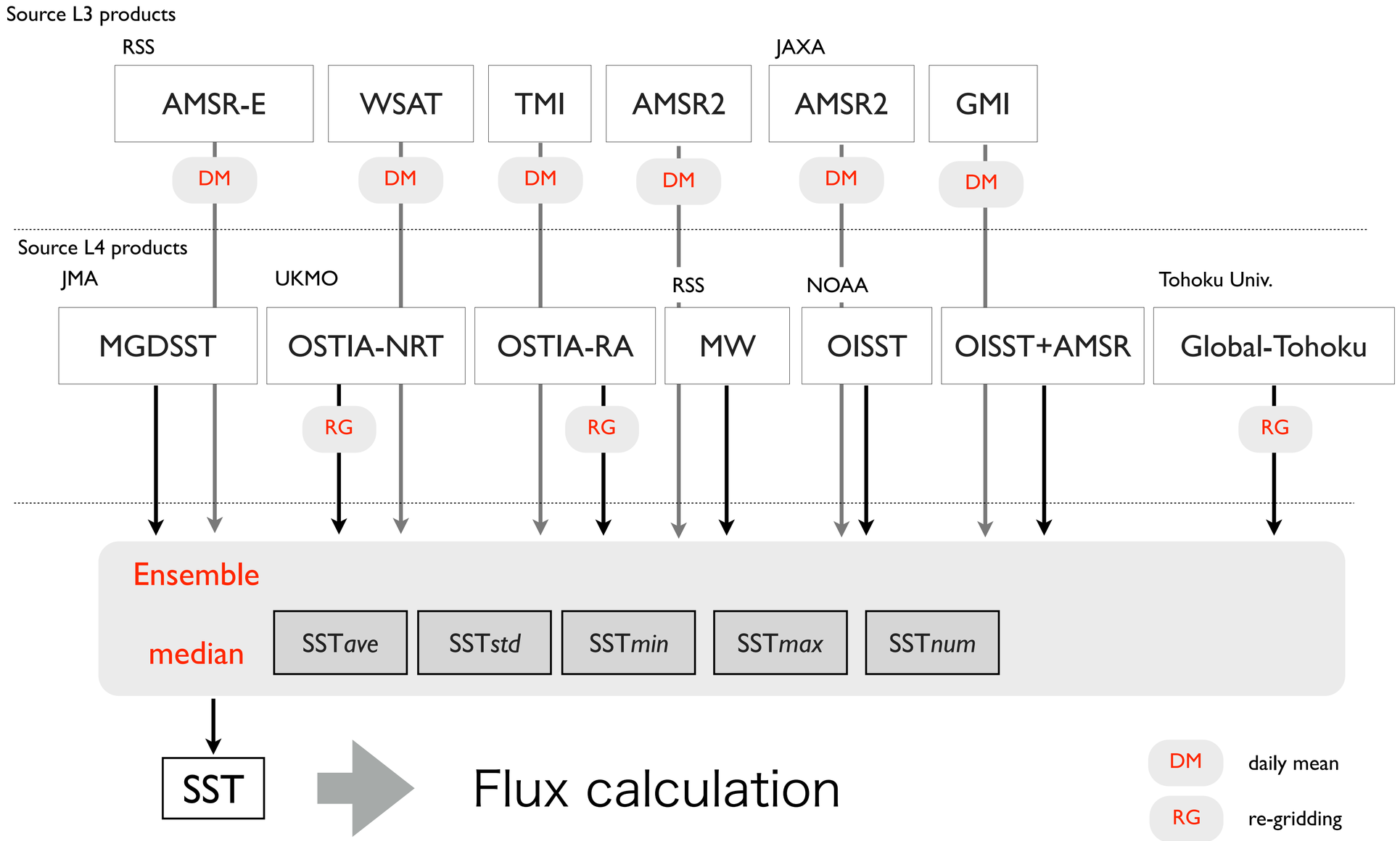
	J-OFURO1	J-OFURO2	J-OFURO3
Period	1992-1993	1988-2008	1988-2013
Temporal average	monthly	daily	daily
Spatial grid size	1.0 deg.	1.0 deg.	0.25 deg.
Flux calculation	Kondo	COARE 3.0	COARE 3.0
SST	Reynolds SST	MGDSST	Ensemble median of multiple global SST products
Humidity	Schlussel et al. 1995 single SSMI	Schlussel et al. 1995 SSMIs	New algorithm Tomita et al. 2018 SSMIs, SSMIS TMI, AMSR-E, AMSR2
Wind speed	singel SSMI	SSMIs, AMSR-E, TMI, ERS-1/2, QuikScat	SSMIs, SSMIS, AMSR-E, AMSR2, TMI, WindSAT, ERS-1/2, QuikSCAT, ASCAT-A/B, OSCAT
Air temperature	Kubota and Mitsumori	NCEP/DOE reanalysis 2	NCEP/DOE reanalysis 2

J-OFURO3 EMSST source products

GHRSST

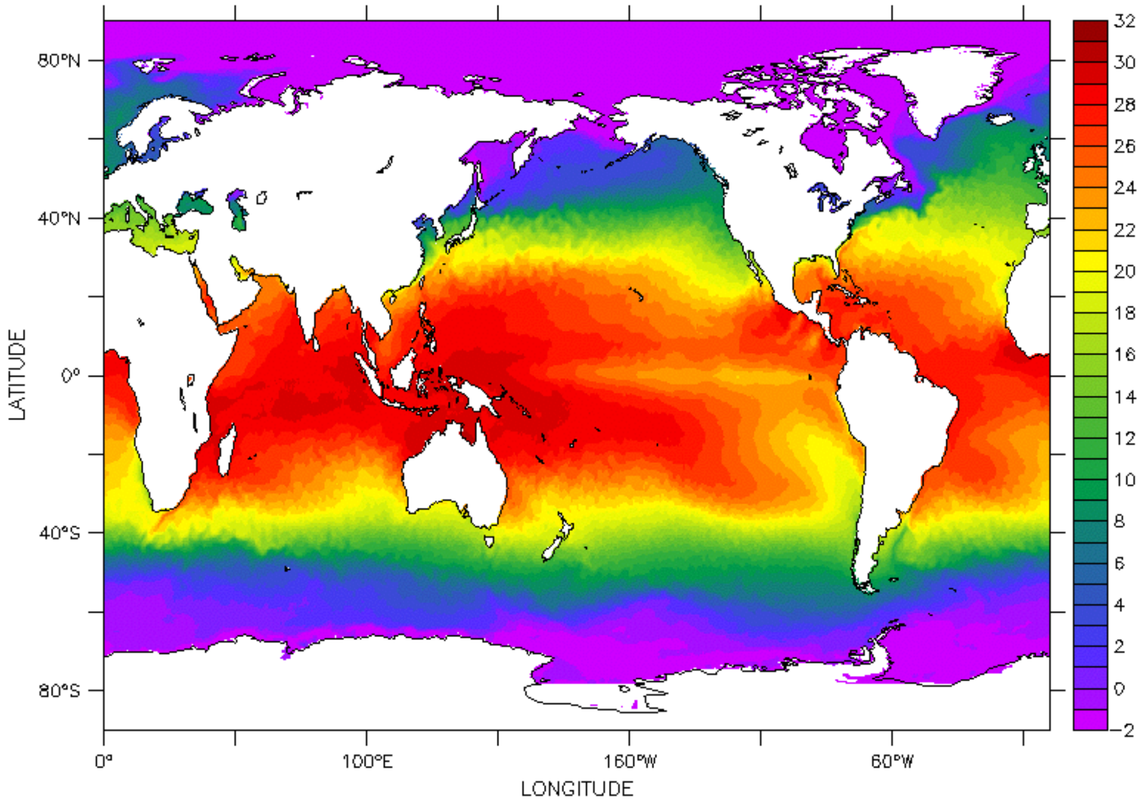
Product name	Provider	Level	Grid size	Depth
AMSR-E	RSS	L3	0.25°	sub-skin
TMI	RSS	L3	0.25°	sub-skin
AMSR2	RSS	L3	0.25°	sub-skin
AMSR2	JAXA	L3	0.25°	sub-skin
WindSat	RSS	L3	0.25°	sub-skin
OISST	NOAA	L4	0.25°	depth
OISST (+AMSR2)	NOAA	L4	0.25°	depth
MGDSST	JMA	L4	0.25°	depth
MW OI SST	RSS	L4	0.25°	foundation
OSTIA	UKMO	L4	0.05°	foundation
OSTIA-RA	UKMO	L4	0.05°	foundation
Global Tohoku	Tohoku Univ.	L4	0.01°	foundation

J-OFURO3 EMSST calculation and data flow

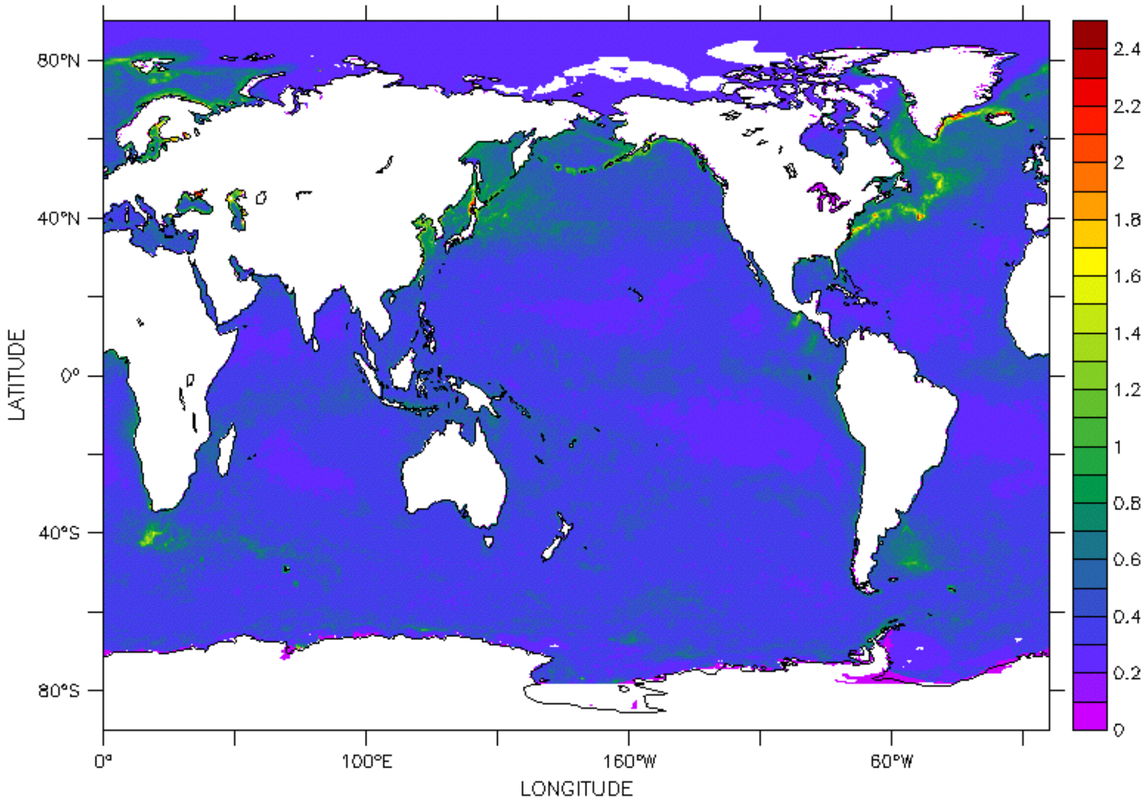


J-OFURO3 EMSST example (2008, January mean)

ensemble median



ensemble spread (standard deviation)

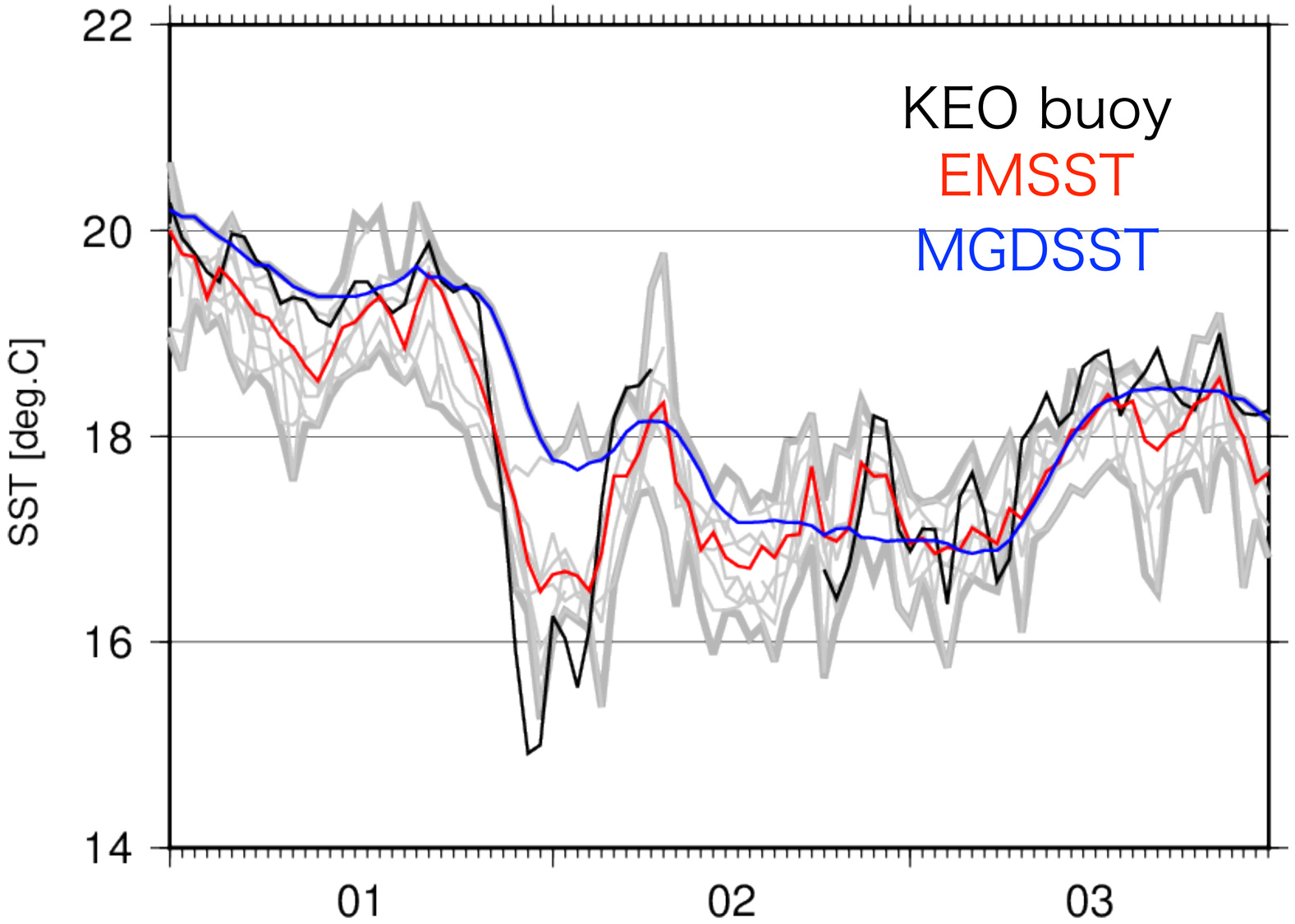


Global average of the spread: 0.45 K

for 1988-2015

SST at the KEO buoy (32N, 146.5E)

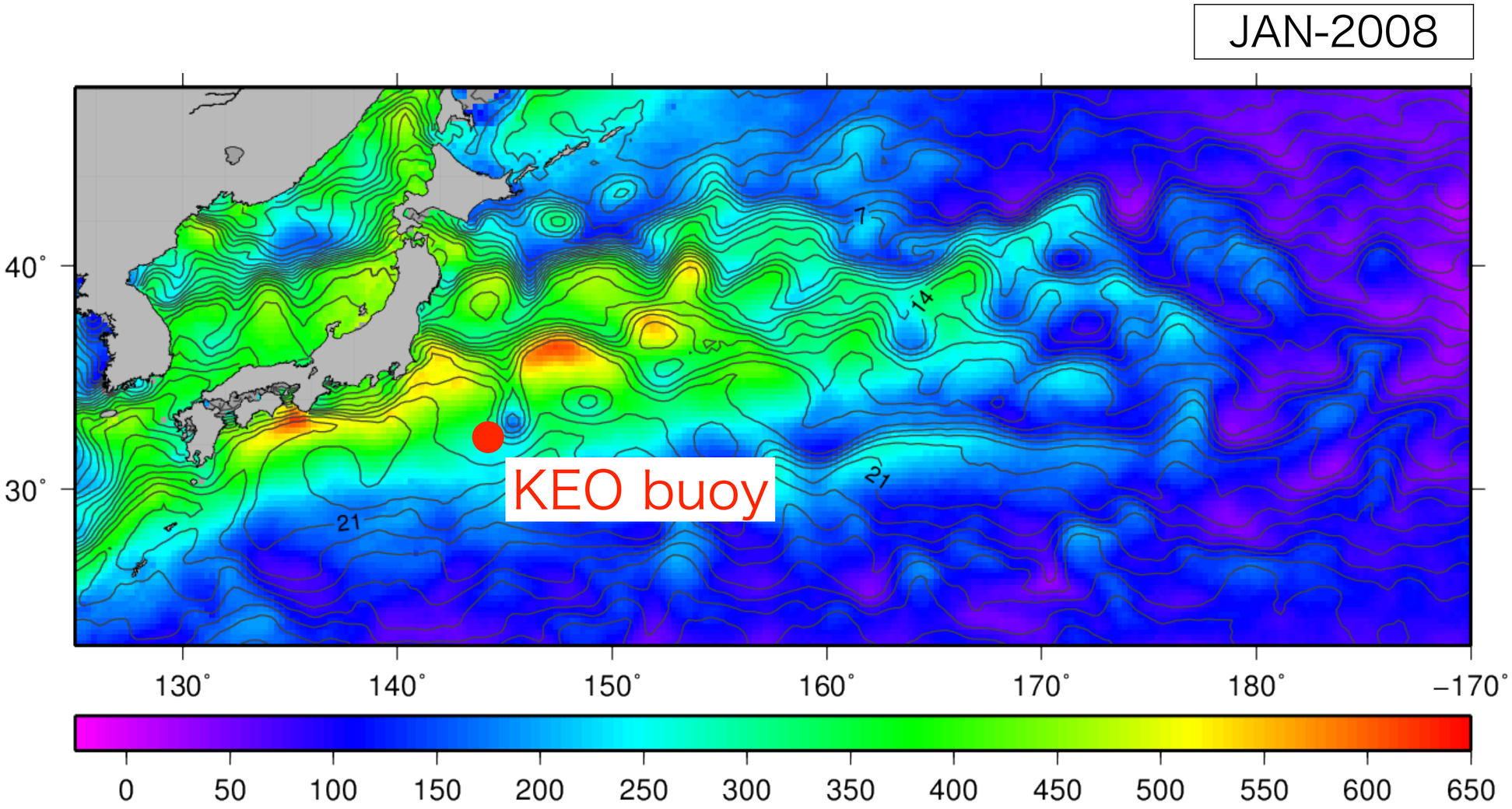
Daily time series of SST during January–March, 2008



MONTHLY mean features over Kuroshio/Oyashio region

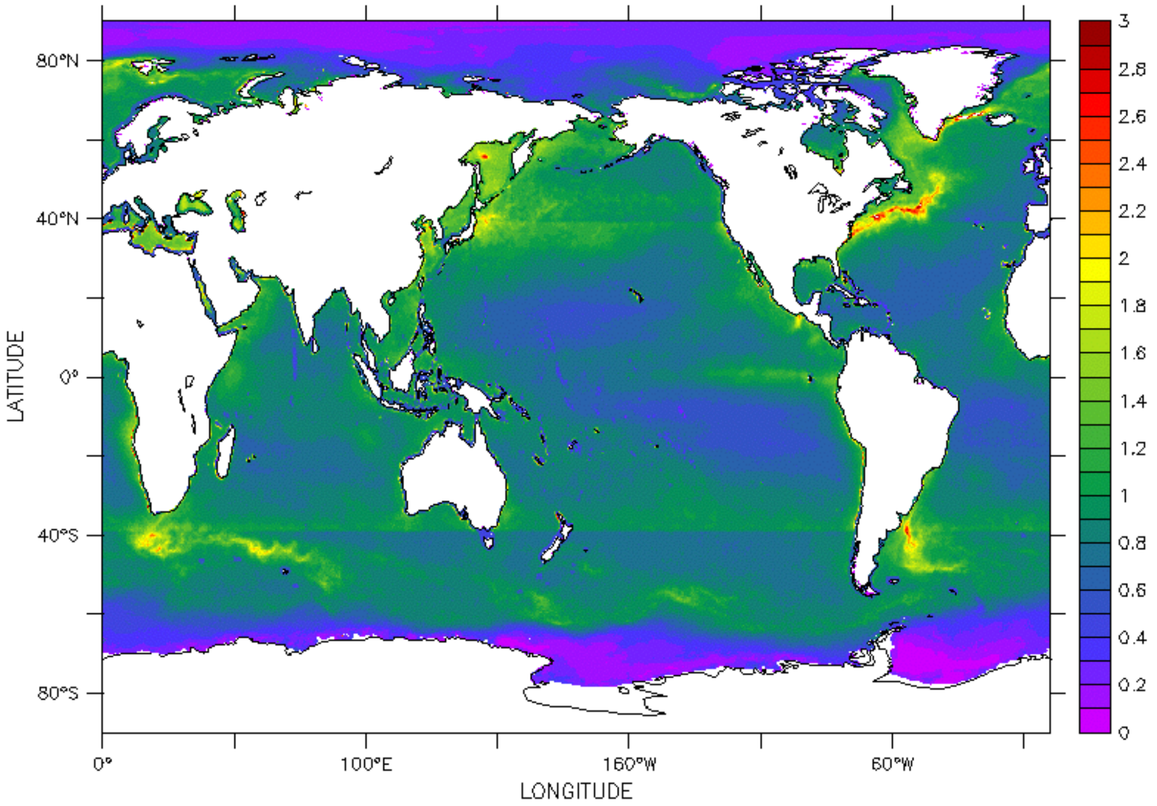
J-OFURO3 Net Heat Flux (color, net heat flux) [W/m^2]

ensemble median SST (contour) [deg.C]

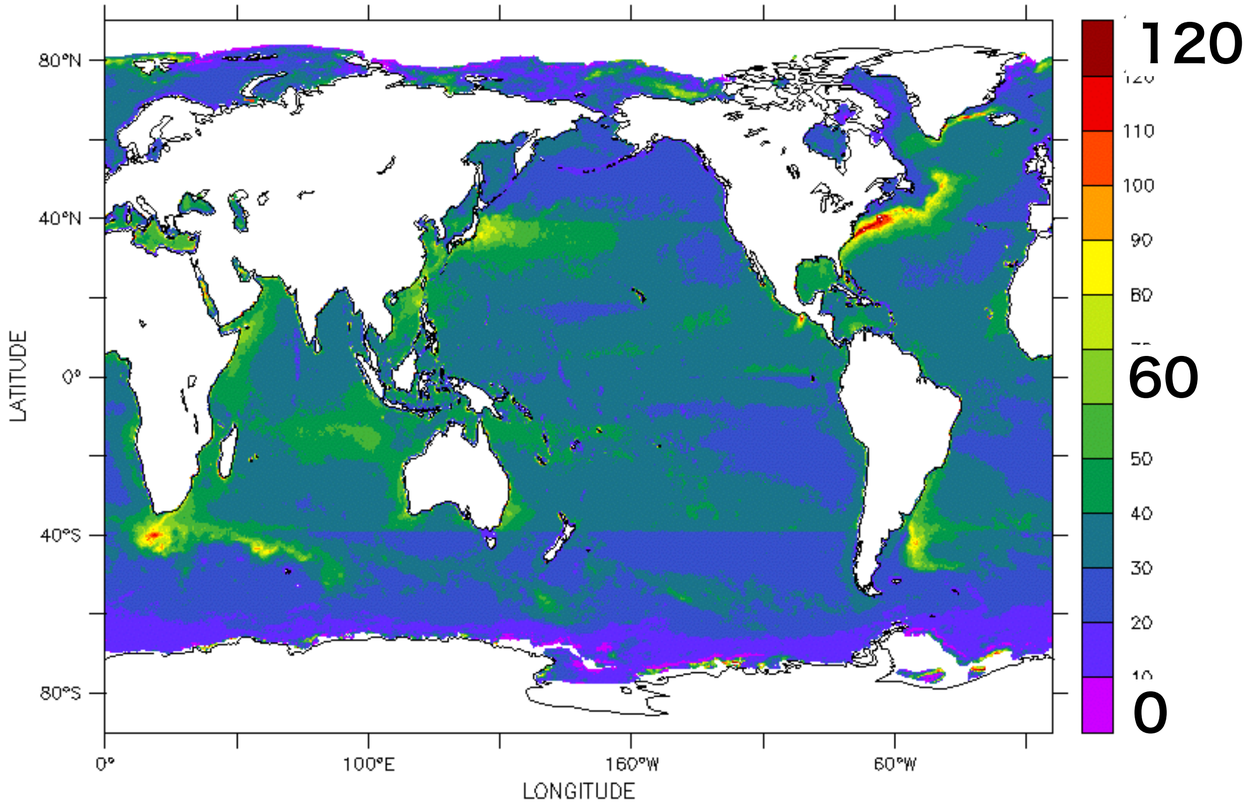


J-OFURO3 SST impact on turbulent heat flux

SST ensemble Max minus Min (K)



Flux diff (W m^{-2})

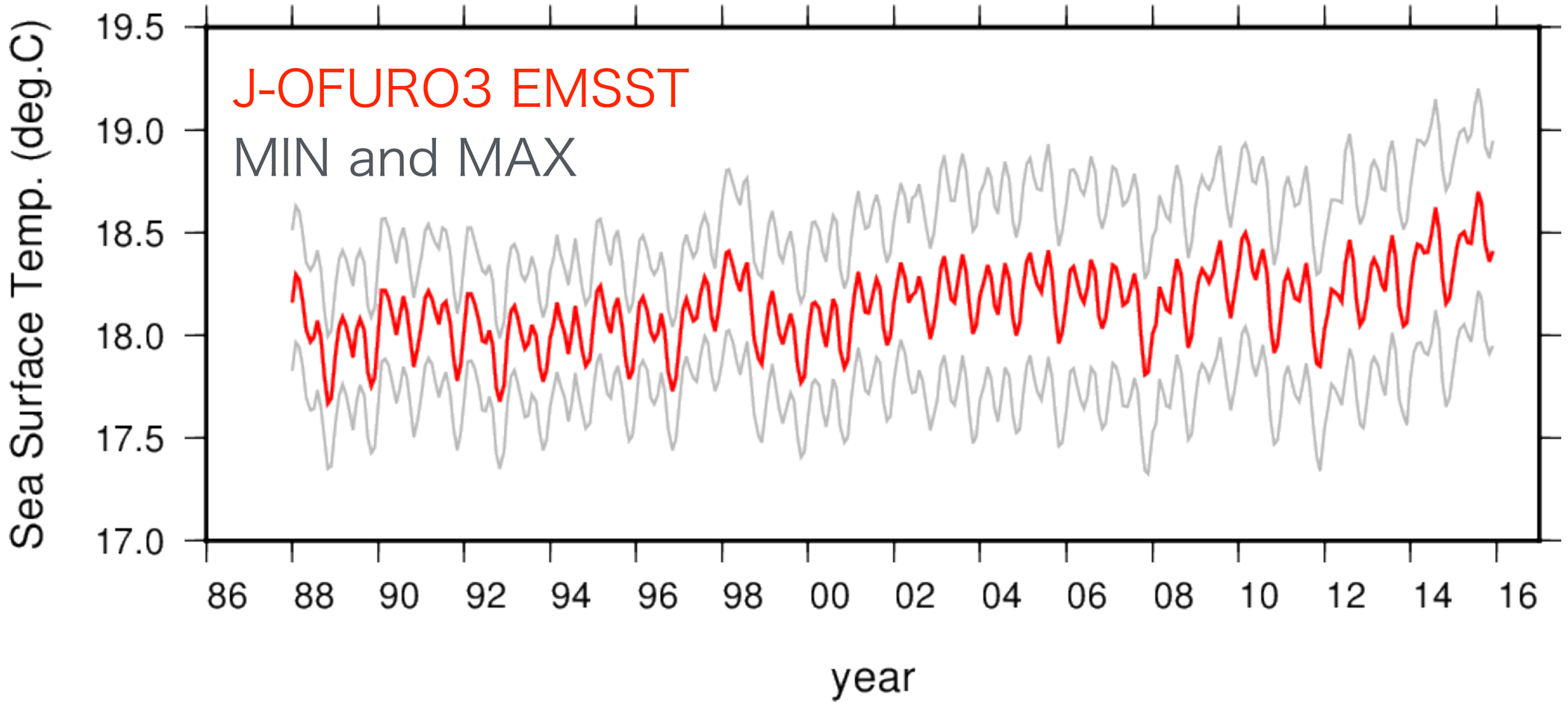


Largest flux differences: ≈ 120 W/m^2

in the WBC regions

Global mean SST

Monthly time series of SST during 1988–2015



Summary

Ensemble SST from multi global products was adopted for global satellite-base air-sea heat flux estimation

Median and spread were calculated form 12 kinds of ensemble members. Averaged spread is about 0.45 K.

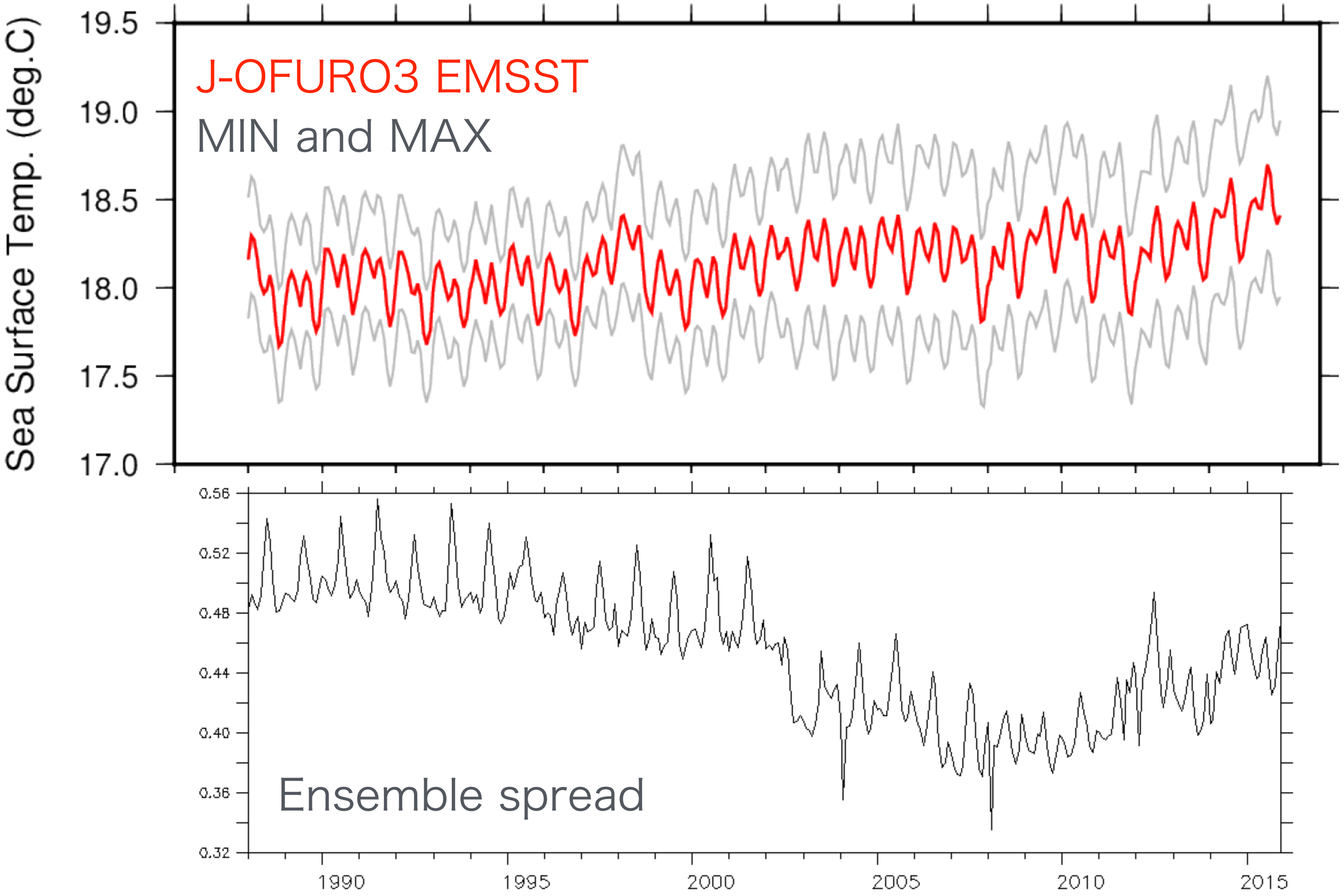
The impact of selection of SST product on air-sea flux estimation is quite large, with a maximum difference of 120 W/m^2 in WBC regions

OPEN DATA

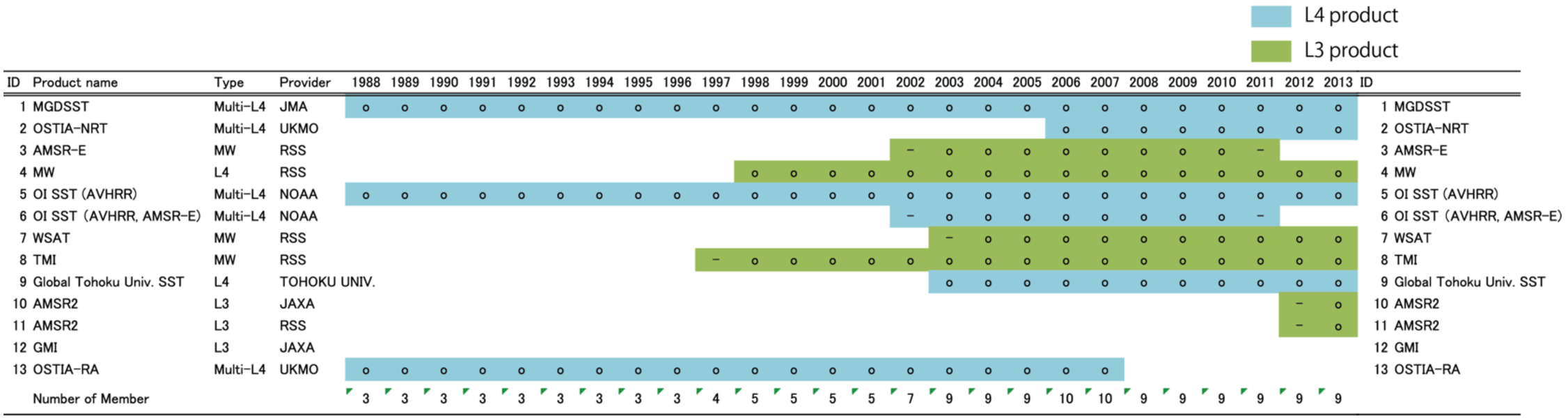
https://j-ofuro.scc.u-tokai.ac.jp

or search J-OFURO3

J-OFURO


J-OFURO3 EMSST
MIN and MAX
Sea Surface Temp. (deg.C)
19.5
19.0
18.5
18.0
17.5
17.0
Ensemble spread
0.56
0.52
0.48
0.44
0.40
0.36
0.32
1990
1995
2000
2005
2010
2015

J-OFURO3 EMSST



ID	Product name	Type	Provider	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	ID
1	MGDSST	Multi-L4	JMA	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	1 MGDSST
2	OSTIA-NRT	Multi-L4	UKMO																			o	o	o	o	o	o	o	o	2 OSTIA-NRT
3	AMSR-E	MW	RSS															–	o	o	o	o	o	o	o	o	–			3 AMSR-E
4	MW	L4	RSS											o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	4 MW
5	OI SST (AVHRR)	Multi-L4	NOAA	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	5 OI SST (AVHRR)
6	OI SST (AVHRR, AMSR-E)	Multi-L4	NOAA															–	o	o	o	o	o	o	o	o	–			6 OI SST (AVHRR, AMSR-E)
7	WSAT	MW	RSS																–	o	o	o	o	o	o	o	o	o	o	7 WSAT
8	TMI	MW	RSS										–	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	8 TMI
9	Global Tohoku Univ. SST	L4	TOHOKU UNIV.																o	o	o	o	o	o	o	o	o	o	o	9 Global Tohoku Univ. SST
10	AMSR2	L3	JAXA																									–	o	10 AMSR2
11	AMSR2	L3	RSS																									–	o	11 AMSR2
12	GMI	L3	JAXA																											12 GMI
13	OSTIA-RA	Multi-L4	UKMO	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o							13 OSTIA-RA
	Number of Member			3	3	3	3	3	3	3	3	3	4	5	5	5	5	7	9	9	9	10	10	9	9	9	9	9	9	

1988 2000 2013

poor

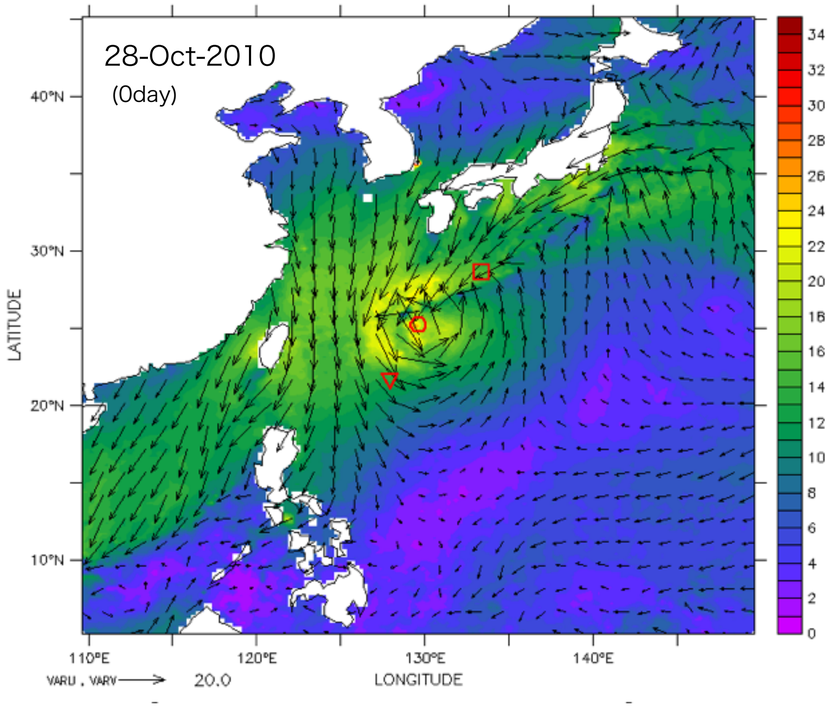
only 3 products
no MW satellite

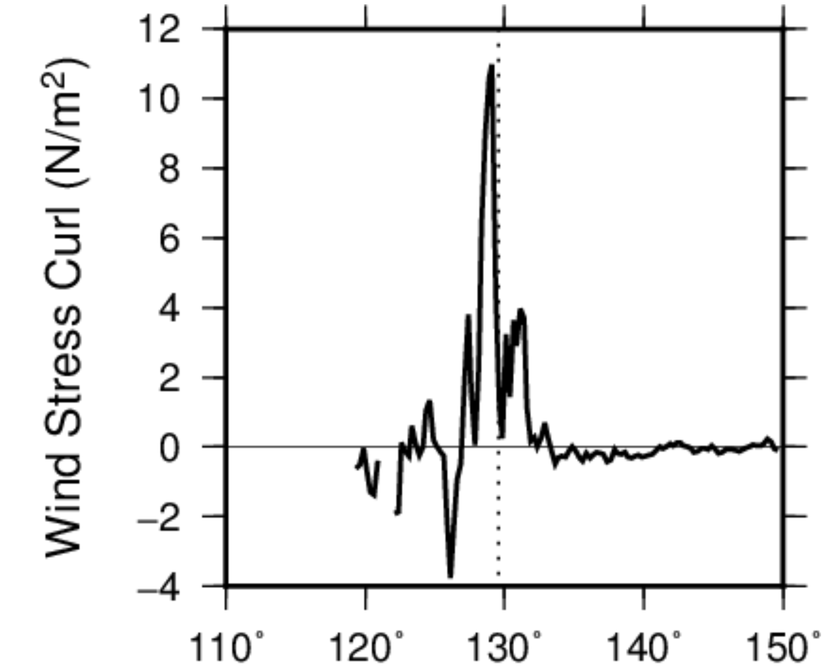
rich

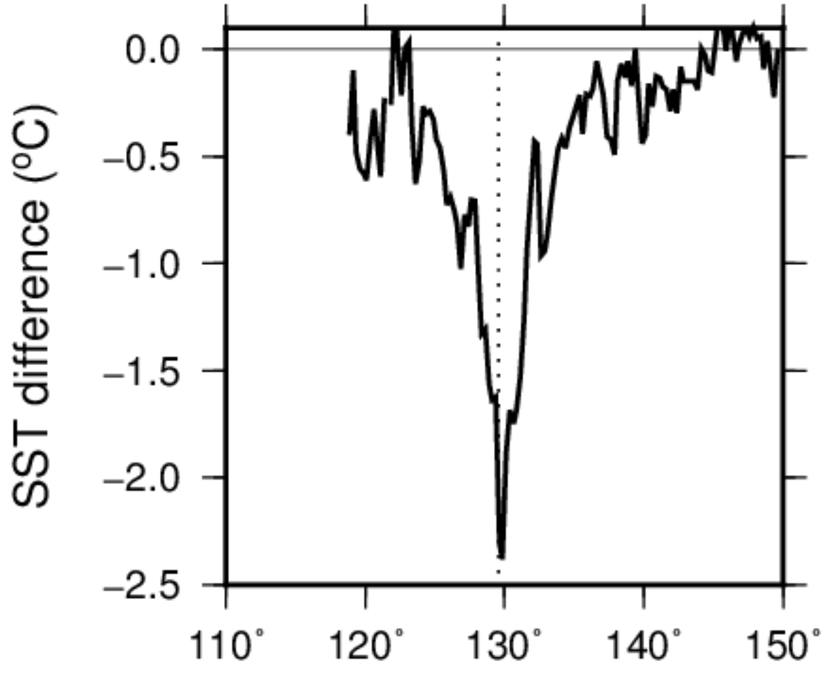
7–10 products
multi MW satellites

Tropical Cyclone

Megi, 2010

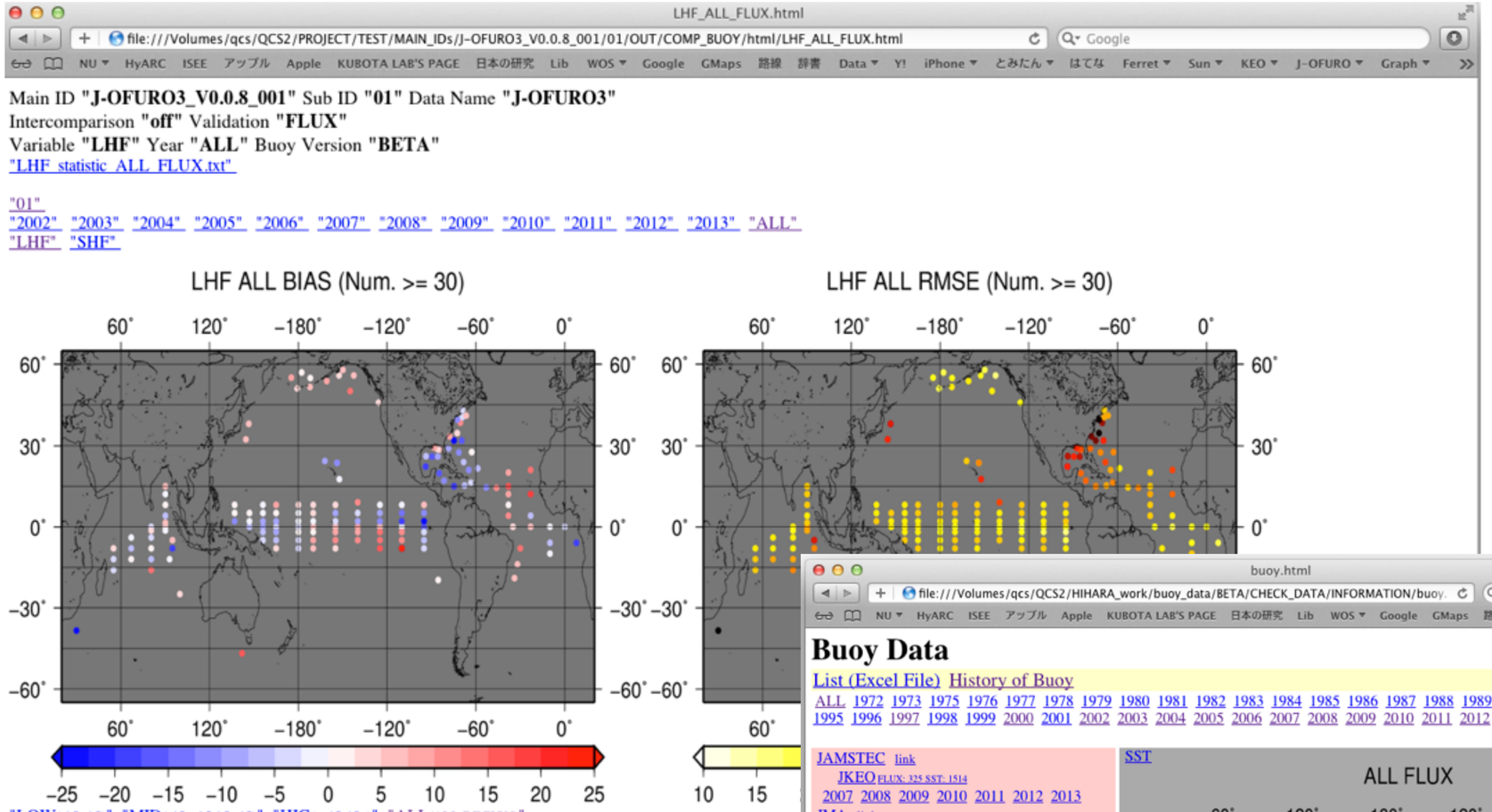




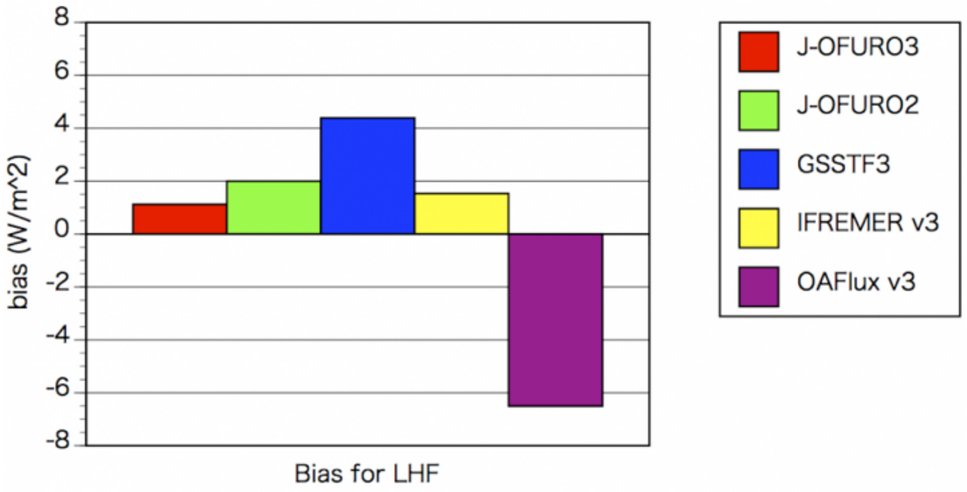


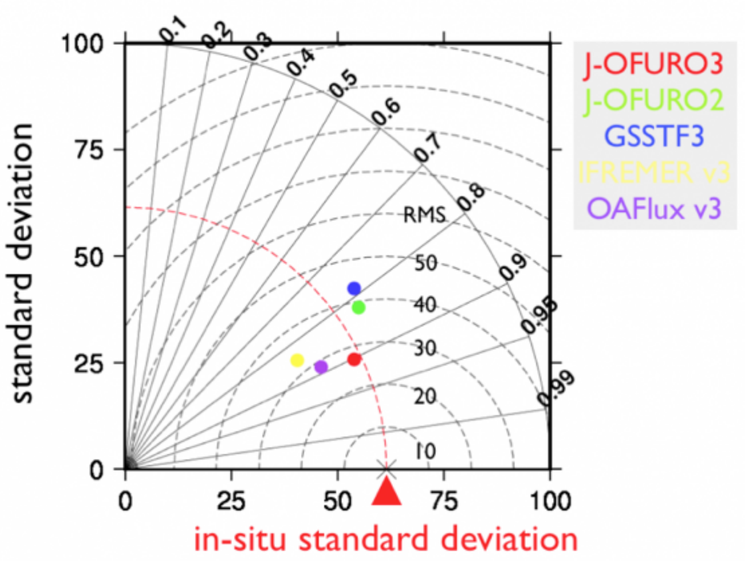
Validation and Inter-comparison

Quality Check System



Validation and Inter-comparison





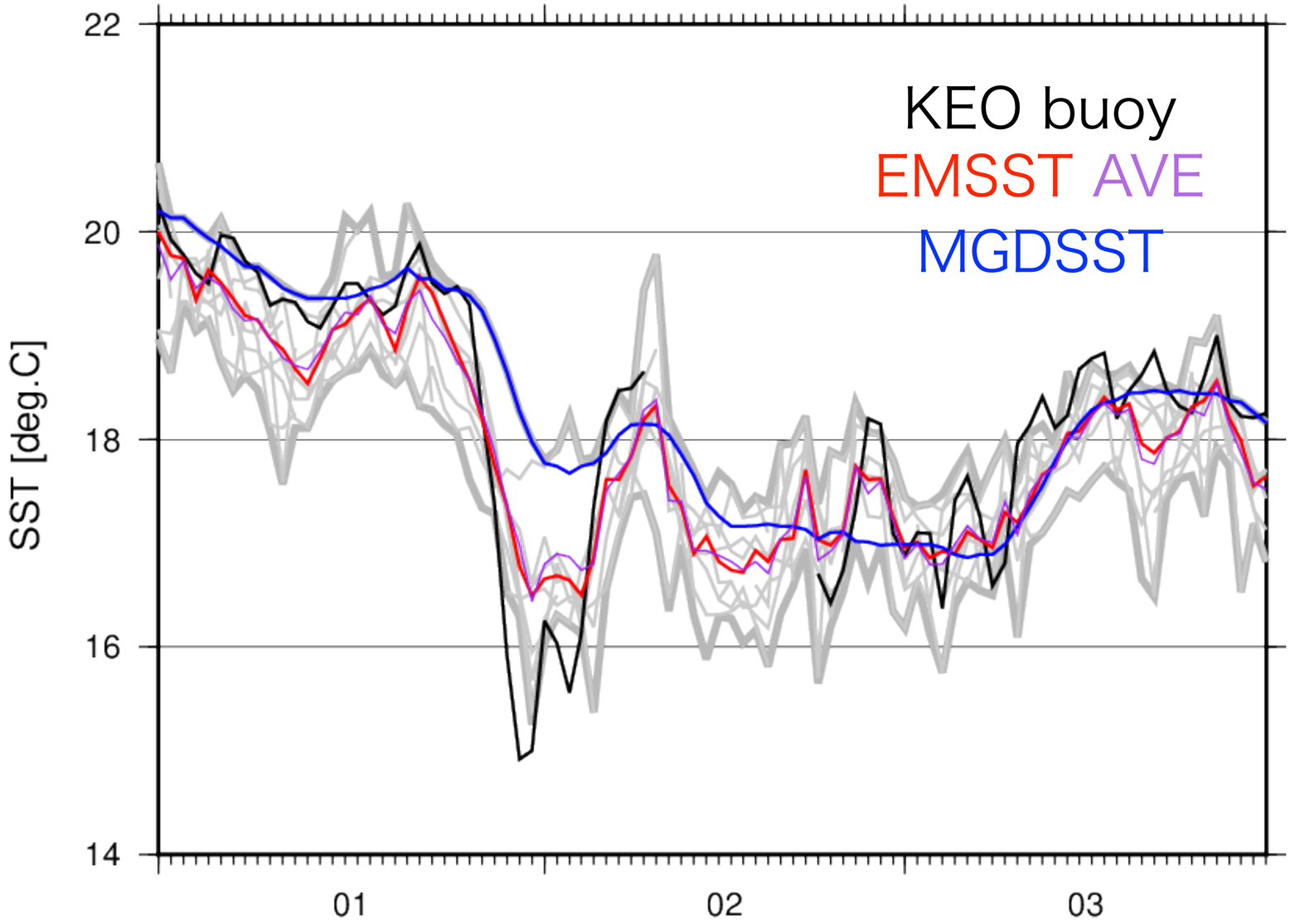
dataset name	type	spatial grid size	version
J-OFURO3	satellite	0.25deg.	V1.0
J-OFURO2	satellite	0.25deg.	HF004
GSSTF3	satellite	0.25deg.	v3
IFREMER	satellite	0.25deg.	v3
OAFlux	satellite+reanalysis	1.0deg.	v3

Validation of J-OFURO3 EMSST using global buoys

	Low-latitude	Mid-latitude	High-latitude
Bias [K]	-0.06	-0.1	0.06
RMS [K]	0.16	0.25	0.42
Correlation	0.92	0.98	0.98
Number of buoys	55	28	10

SST at the KEO buoy (32N, 146.5E)

Daily time series of SST during January–March, 2008



J-OFURO3 EMSST

Table 3.1: List of source products for ensemble median SST in J-OFURO3

ID	Product name	Provider	Original spatial grid size (deg.)	Level	SST type	Data period	Version	Used in V1.0
1	MGDSST	JMA (NEAR-GOOS)	0.25	L4	depth	-2015	-	o
2	OSTIA-NRT	UKMO	0.05	L4	foundation	2006.04.01-current	V1	o
3	AMSR-E	RSS	0.25	L3	sub-skin	-2011.10.04	V7	o
4	MW	RSS	0.25	L4	foundation	2002-current	V4	o
5	OISST	NOAA	0.25	L4	depth	-current	-	o
6	OISST + AMSR	NOAA	0.25	L4	depth	—2011.10.04	-	o
7	WindSAT	RSS	0.25	L3	sub-skin	2002-current	V7.0.1	o
8	TMI	RSS	0.25	L3	sub-skin	1997-2014	V7.1	o
9	Global_Tohoku_SST	TOHOKU UNIV.	0.1	L4	foundation	2003-2014	V7.0.3	o
10	AMSR2	JAXA	0.25	L3	sub-skin	2012.07-current	V2.1	o
11	AMSR2	RSS	0.25	L3	sub-skin	2012.07-current	V7.2	o
12	GMI	JAXA	0.25	L3	sub-skin	2014-current	V1.0	-
13	OSTIA-RA	UKMO	0.05	L4	foundation	-2007	-	o