

# Satellite-derived Surface Heat Flux Dataset of Japanese Ocean Flux Using Remote Sensing Observations (J-OFURO)

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# Satellite-derived Surface Heat Flux Data Set of J-OFURO

## Outline

Overview of J-OFURO2

Use of multi-satellite data

Validation with JKEO/KEO sites

Meso-scale air-sea heat flux

Future works toward J-OFURO3

Summary

# Overview of J-OFURO2

## Basic Features

- Daily and monthly mean, 1988-2007 (2002-2007)
- Global (60s-60n), 1 x 1 deg. grid (0.25 x 0.25 deg.)
- COARE 3.0
- Use of Multi-satellite data
- Available variables

Latent and sensible heat fluxes,  
Wind speed, Surface saturated specific humidity,  
Surface Air Specific Humidity

Net heat flux

Net shortwave radiation (ISCCP)

Downward (ISCCP) + Upward longwave radiation

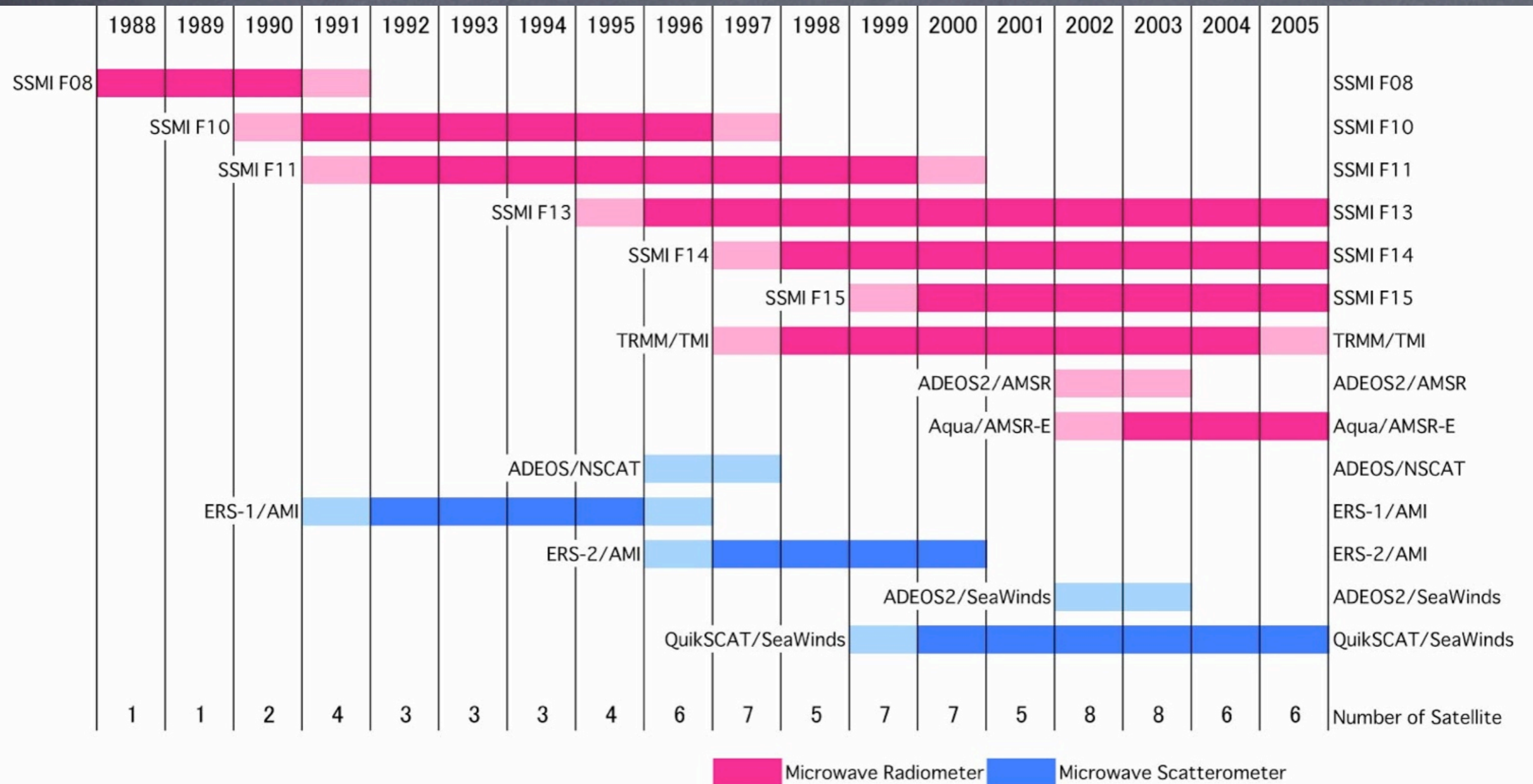
# Overview of J-OFURO2

## Differences between J-OFURO1 and 2

	J-OFURO1	J-OFURO2
Availability	1992-2000 3 days mean	1988-2007 daily mean
Bulk Method	Kondo (1975)	COARE 3.0
Satellite	Single	Multi

# Use of Multi-satellite data

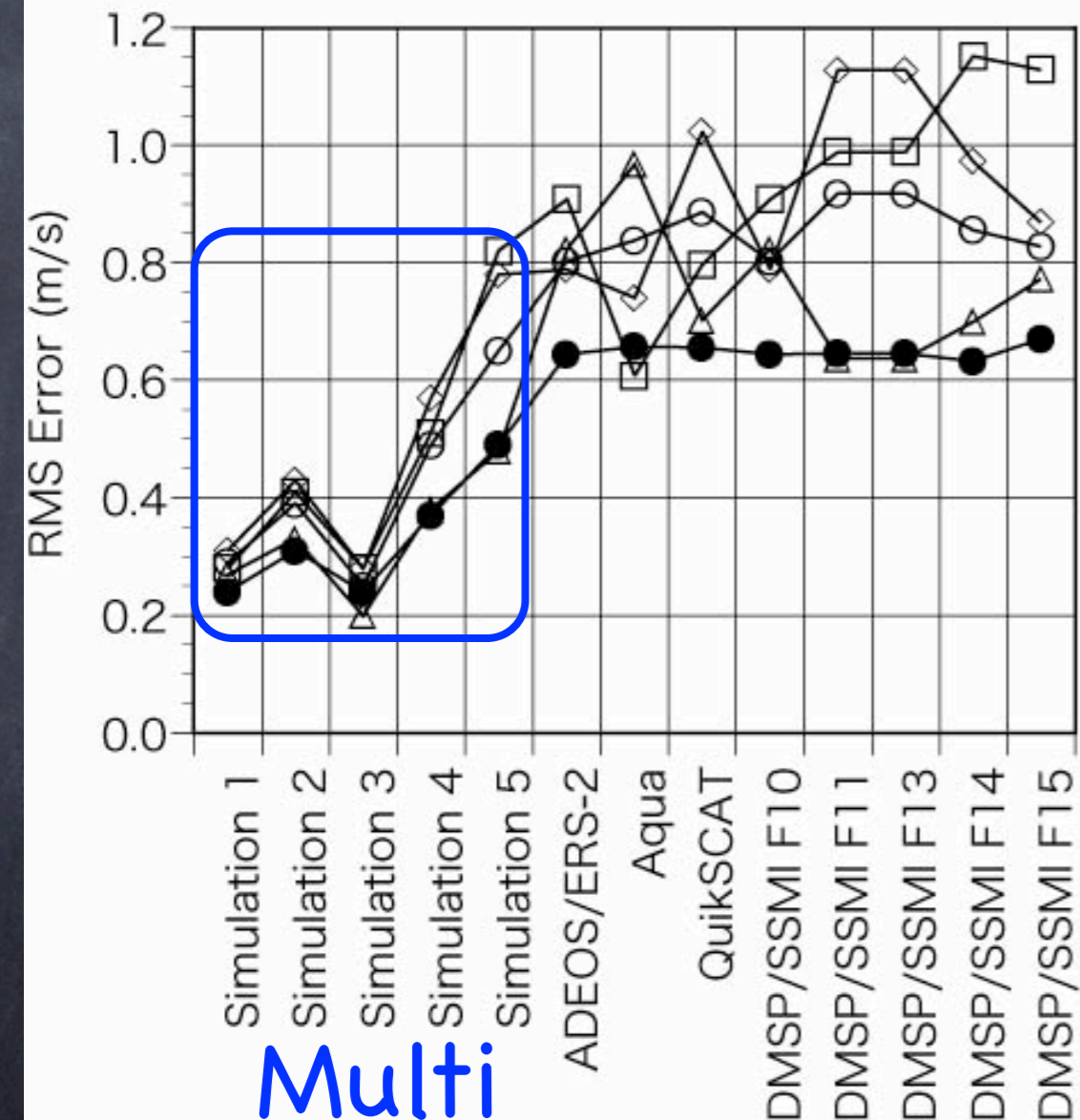
## Availability of Microwave Radiometer and Scatterometer



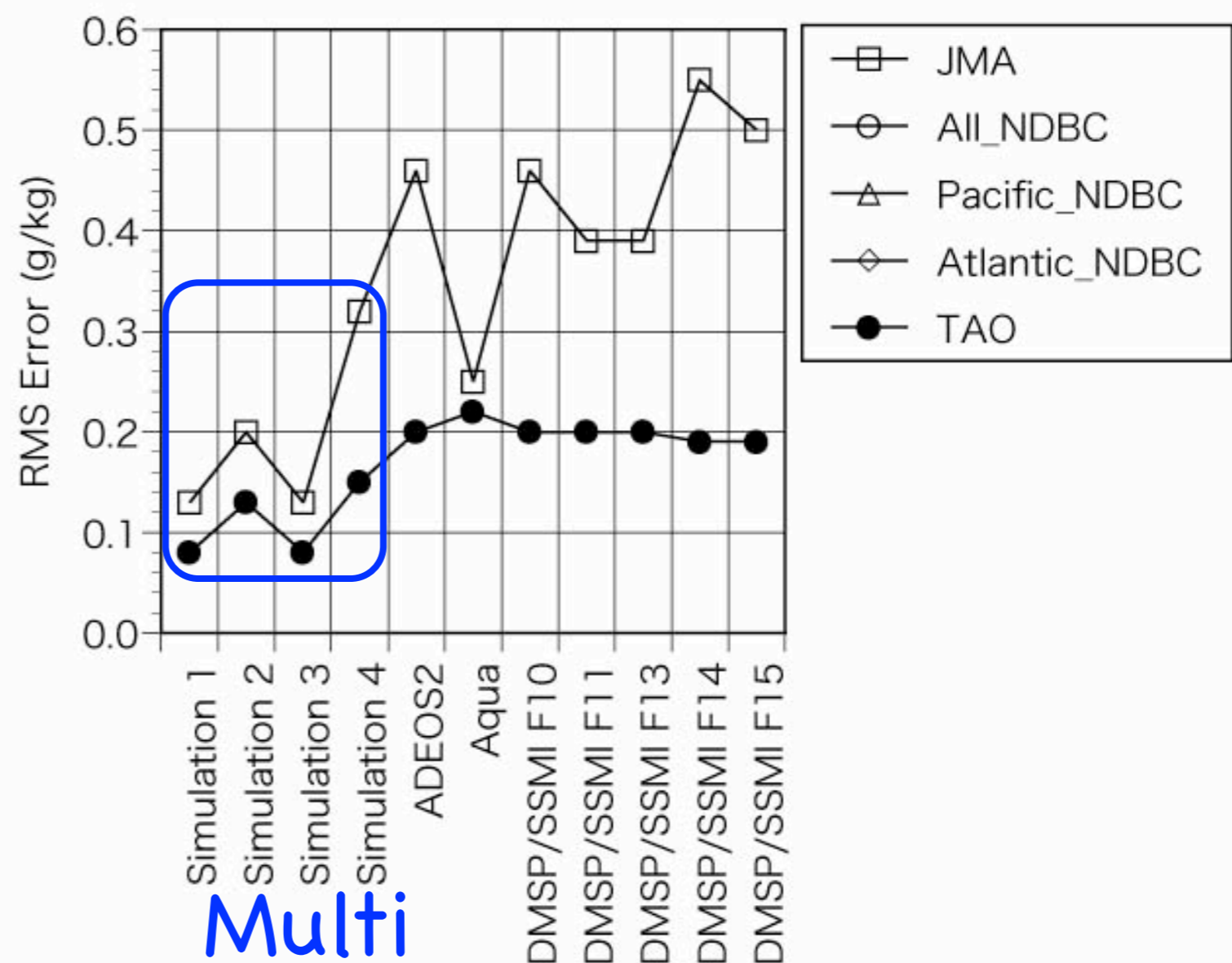
# Use of Multi-satellite data

Sampling simulation for wind speed and surface air specific Humidity

(a) Wind speed



(b) Surface air specific humidity



# Use of Multi-satellite data

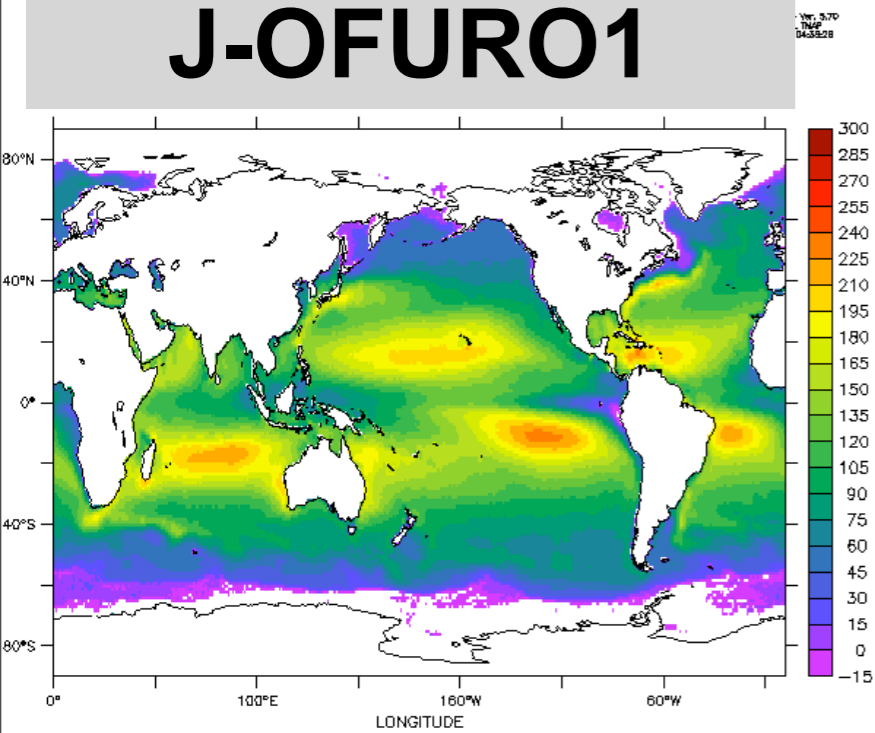
## Data Sources

	J-OFURO01	J-OFURO02
Surface Wind Speed	SSMI (F10 and F13)	SSMIs (F08-F15) ERS1/2, QuikSCAT, AMSR-E, TMI
Surface Air Specific Humidity		All SSMIs (F08-F15)
SST	Reynolds SST	MGDSST AVHRR, AMSR-E (by JMA)
Surface Air Temperature	Bowen ratio	NRA2

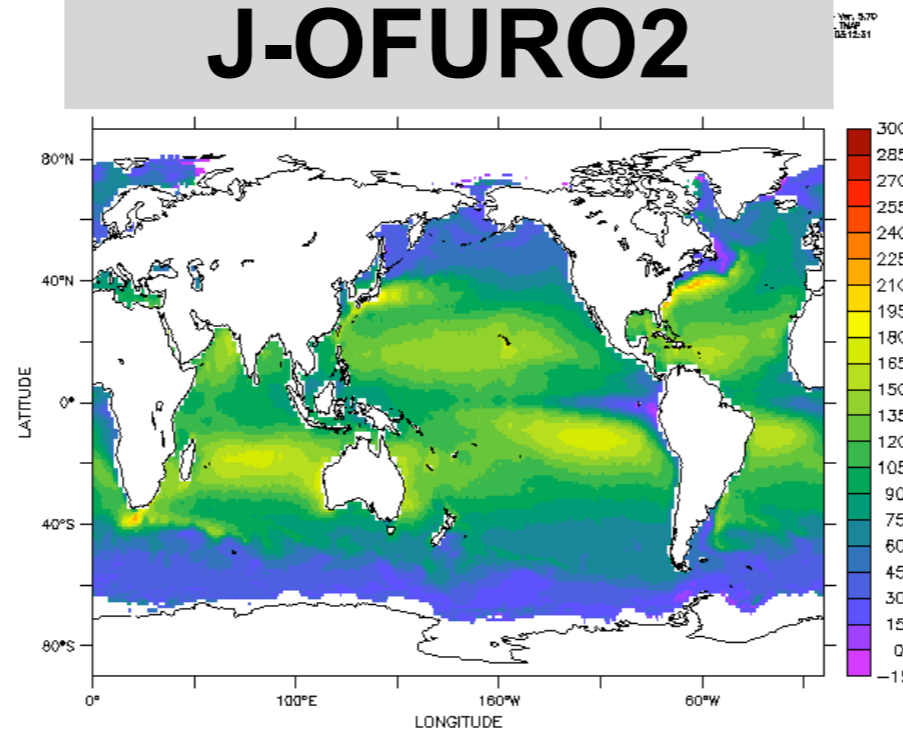
# Comparison of global mean fields

## Mean Fields of LHF (1992-2000)

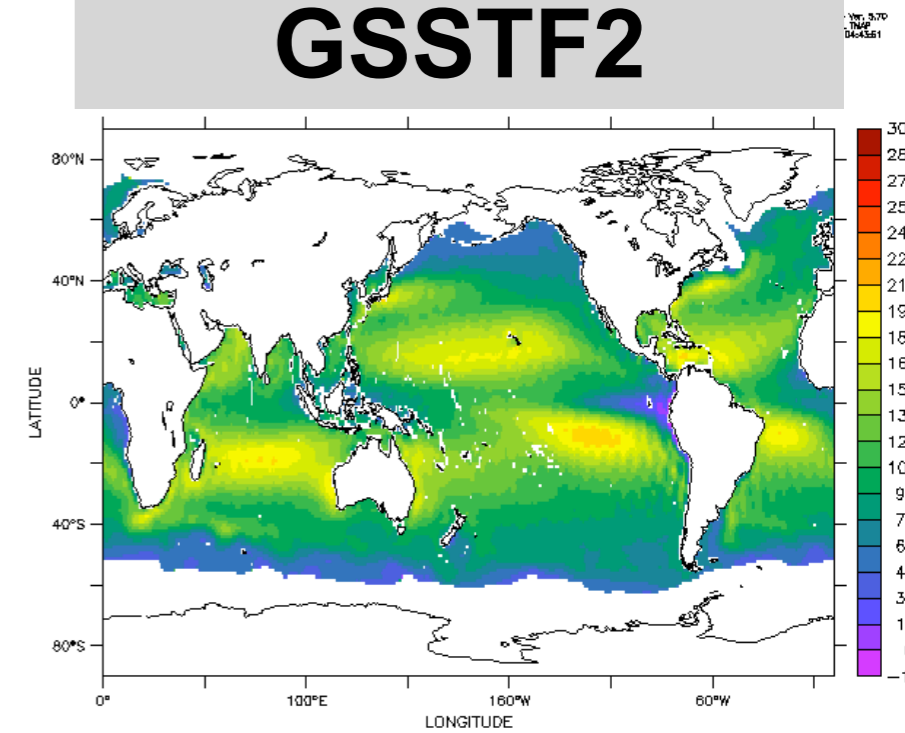
### J-OFURO1



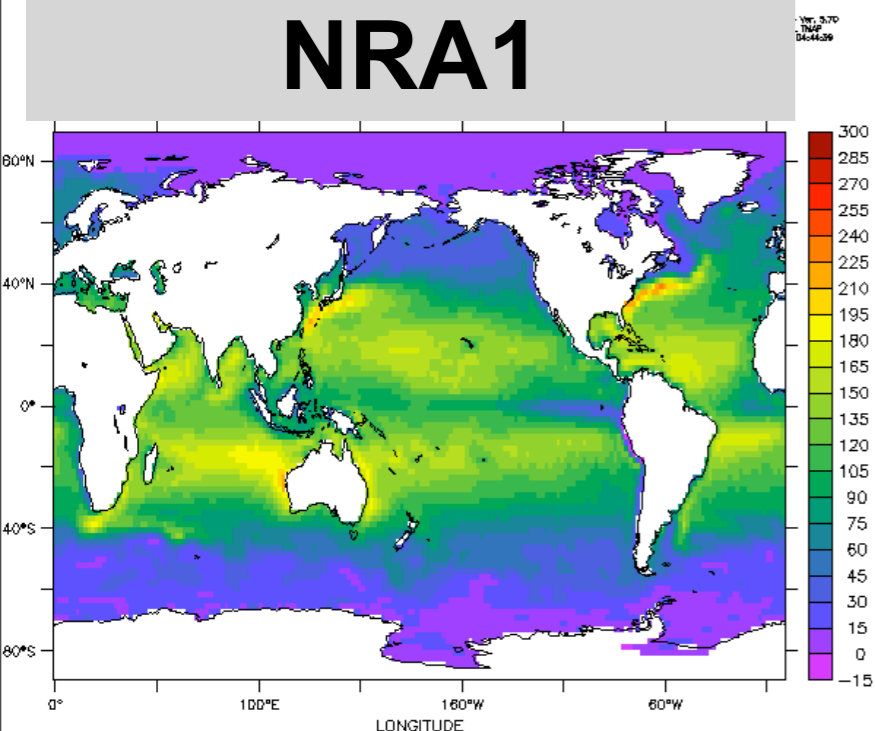
### J-OFURO2



### GSSTF2

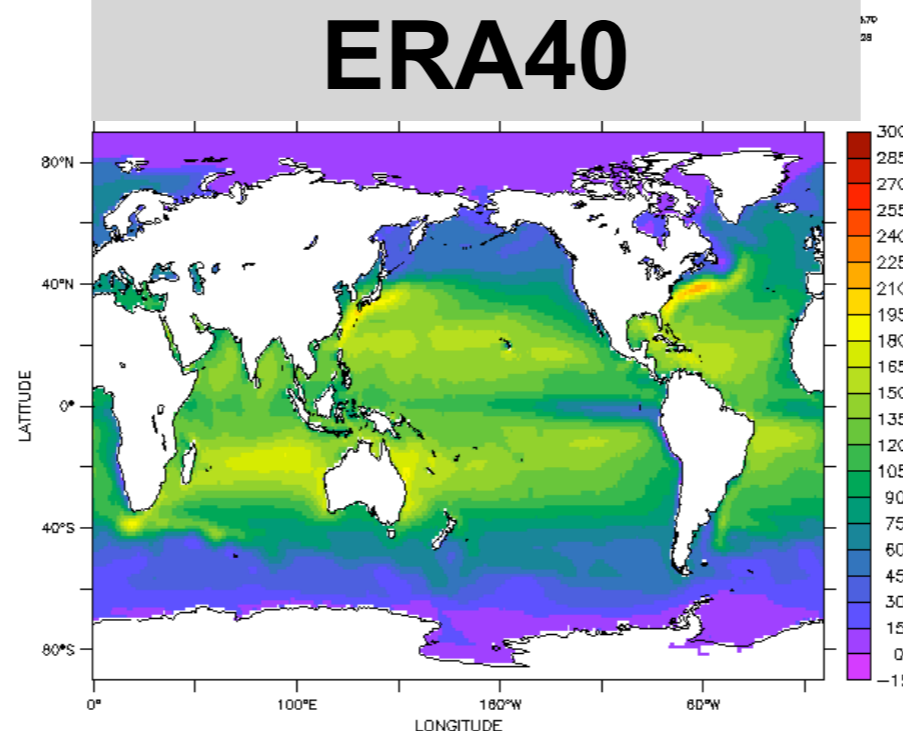


### NRA1



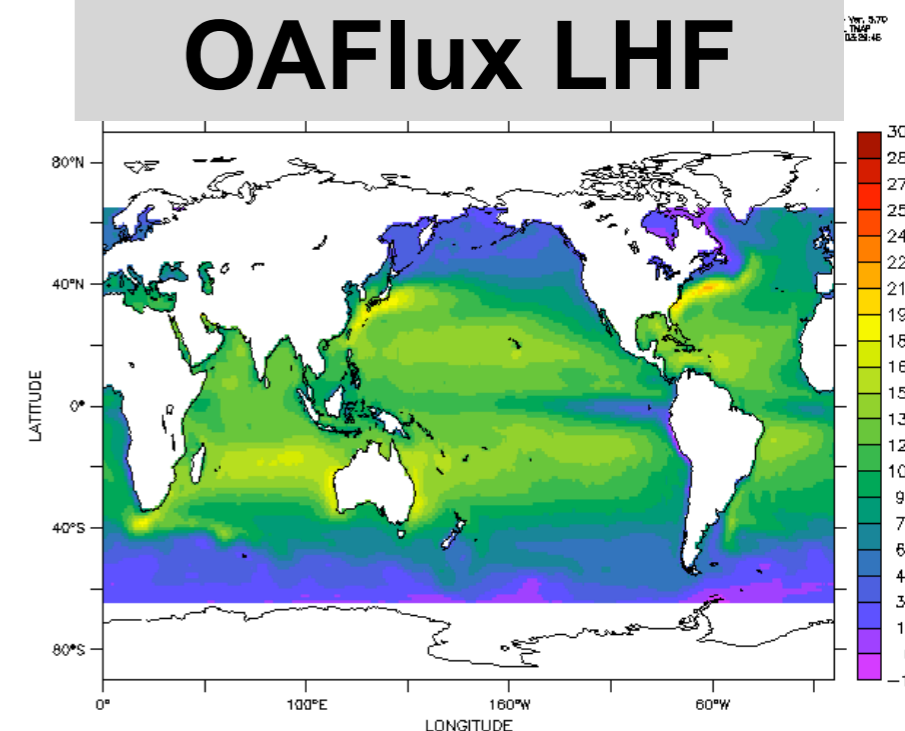
NRA1 Latent Heat Flux (W/m<sup>2</sup>)(T=18-DEC-1991 12:00:16-DEC-1992 00:00)

### ERA40



ERA40 Latent Heat Flux (W/m<sup>2</sup>)

### OAFIux LHF



Latent Heat Flux (W/m<sup>2</sup>)(regrid: on T@ASN)



# Validation Results

## KEO and JKEO buoys

Surface Fluxes, Upper Ocean Temperature and Salinity

### KEO buoy

NOAA/PMEL

32N, 145E

16-Jun-2004- Present

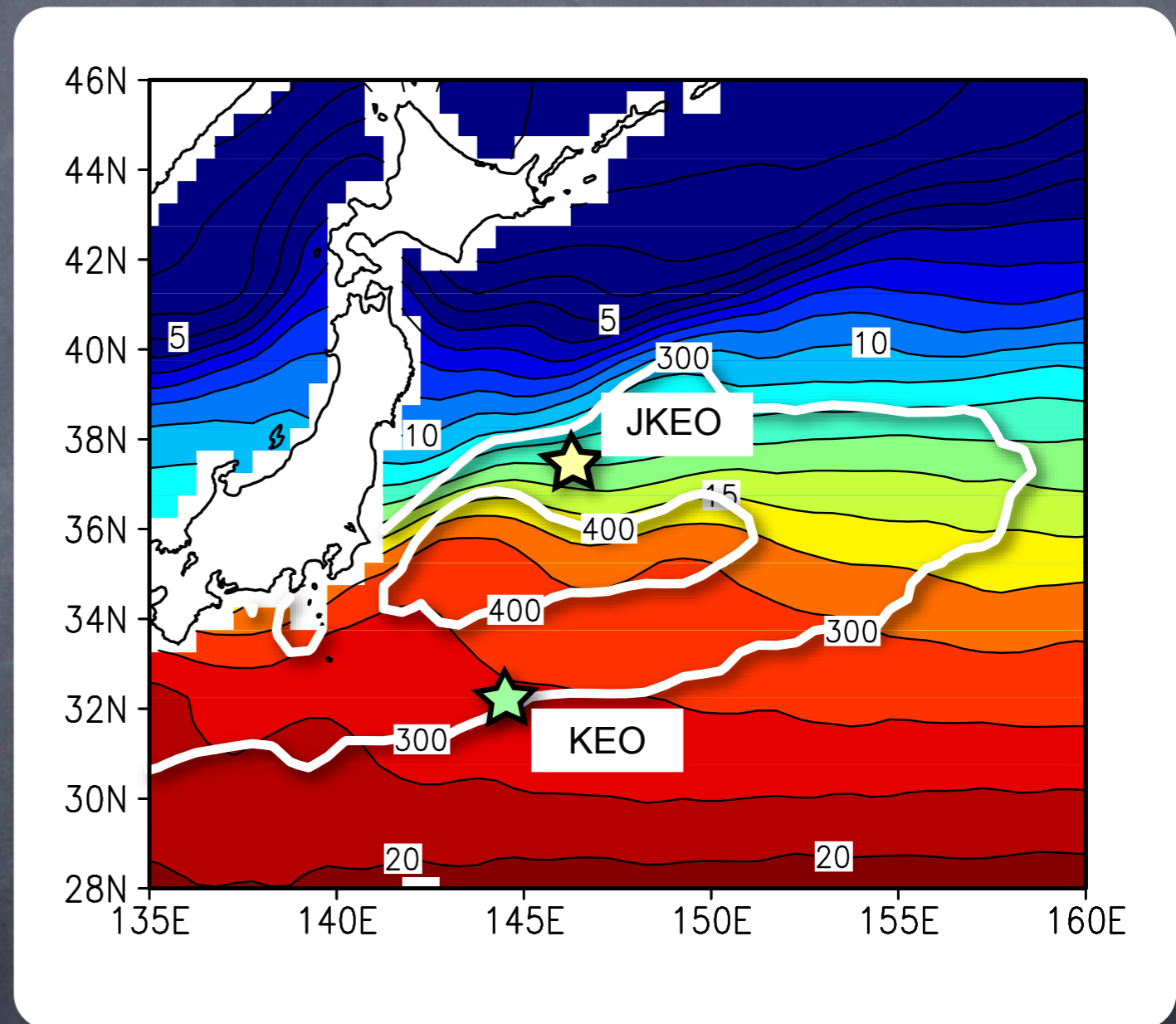
### JKEO buoy

JAMSTEC/IORG

NOAA/PMEL

38N, 146E

deployed on 18-Feb-2007



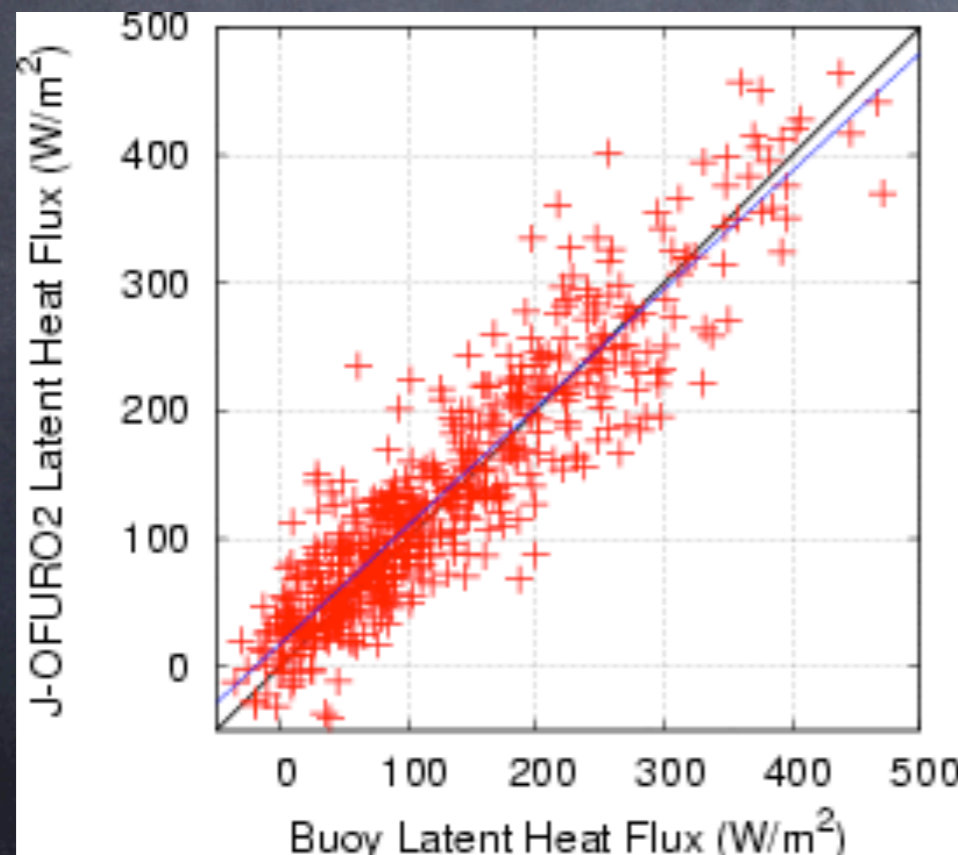
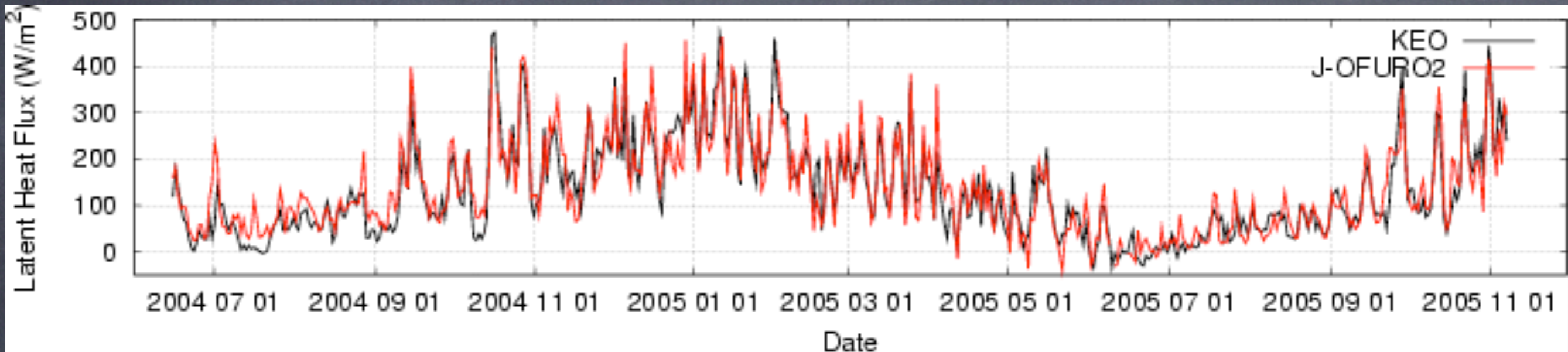
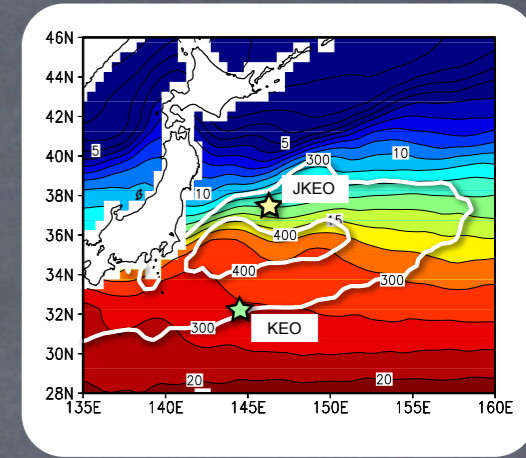
<http://www.jamstec.go.jp/iorgc/ocorp/ktsfg/data/jkeo/>

# Validation Results

Tomita et al. (2010, JGR)

KEO and JKEO buoys

Latent Heat Flux, Jun 2004 - Nov 2005, daily mean



Statistics	
Bias *	6.91 W/m <sup>2</sup>
RMS	41.73 W/m <sup>2</sup>
Corr.	0.92

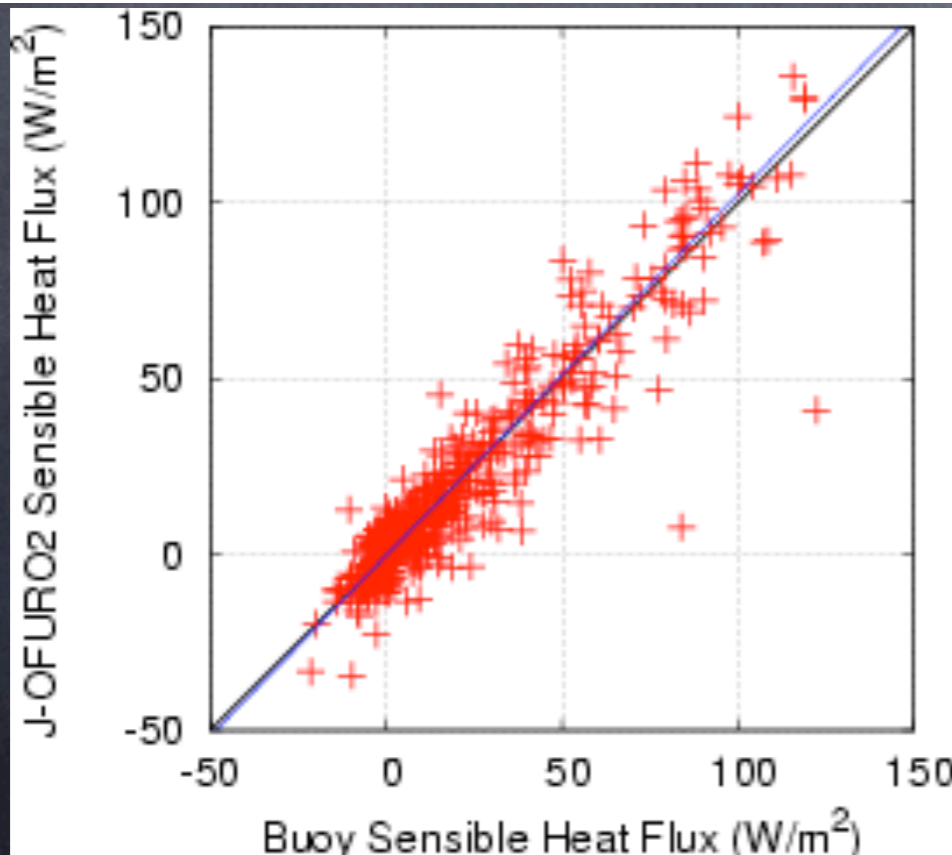
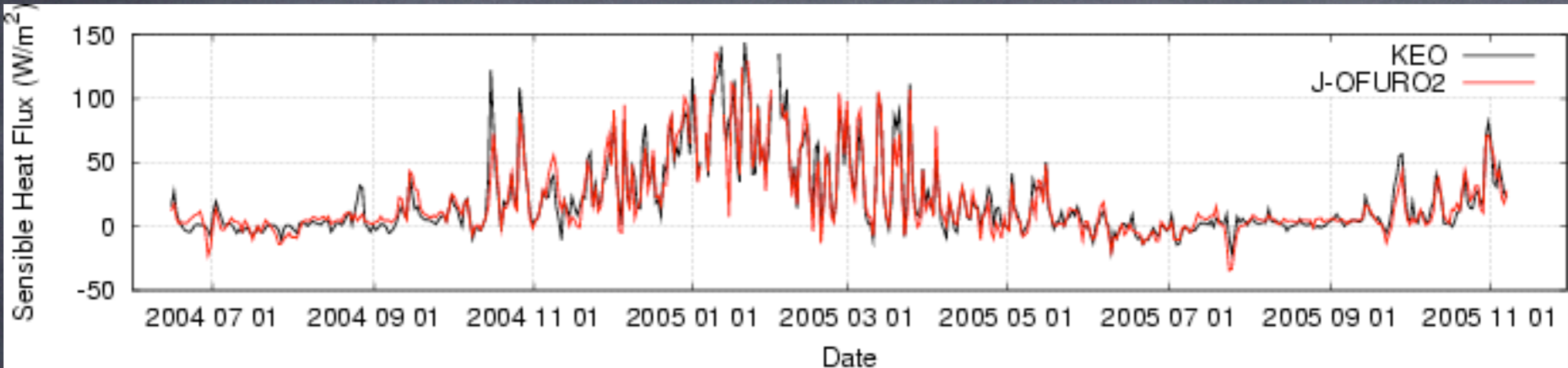
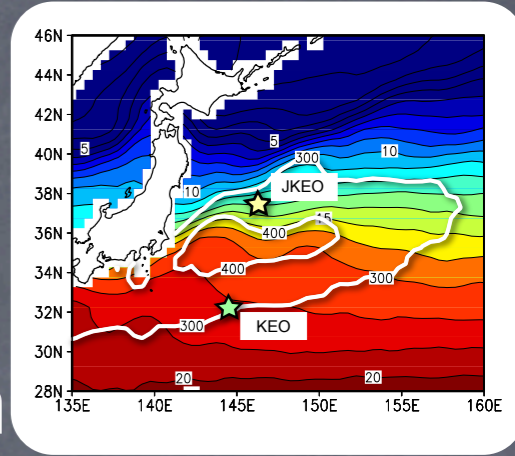
\*Bias (J-OFURO2 - KEO Buoy)

# Validation Results

Tomita et al. (2010, JGR)

KEO and JKEO buoys

Sensible Heat Flux, Jun 2004 - Nov 2005, daily mean



Statistics	
Bias *	0.23 W/m <sup>2</sup>
RMS	10.81 W/m <sup>2</sup>
Corr.	0.95

\*Bias (J-OFURO2 - KEO Buoy)

# Validation Results

Tomita et al. (2010, JGR)

KEO and JKEO buoys

Cross inter-comparison with other global products

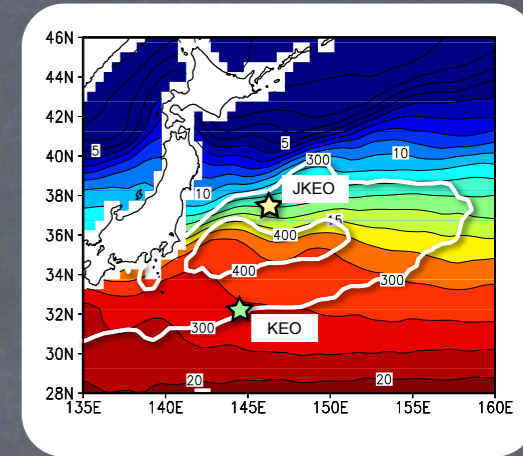


Table 10. Statistics for comparison #5

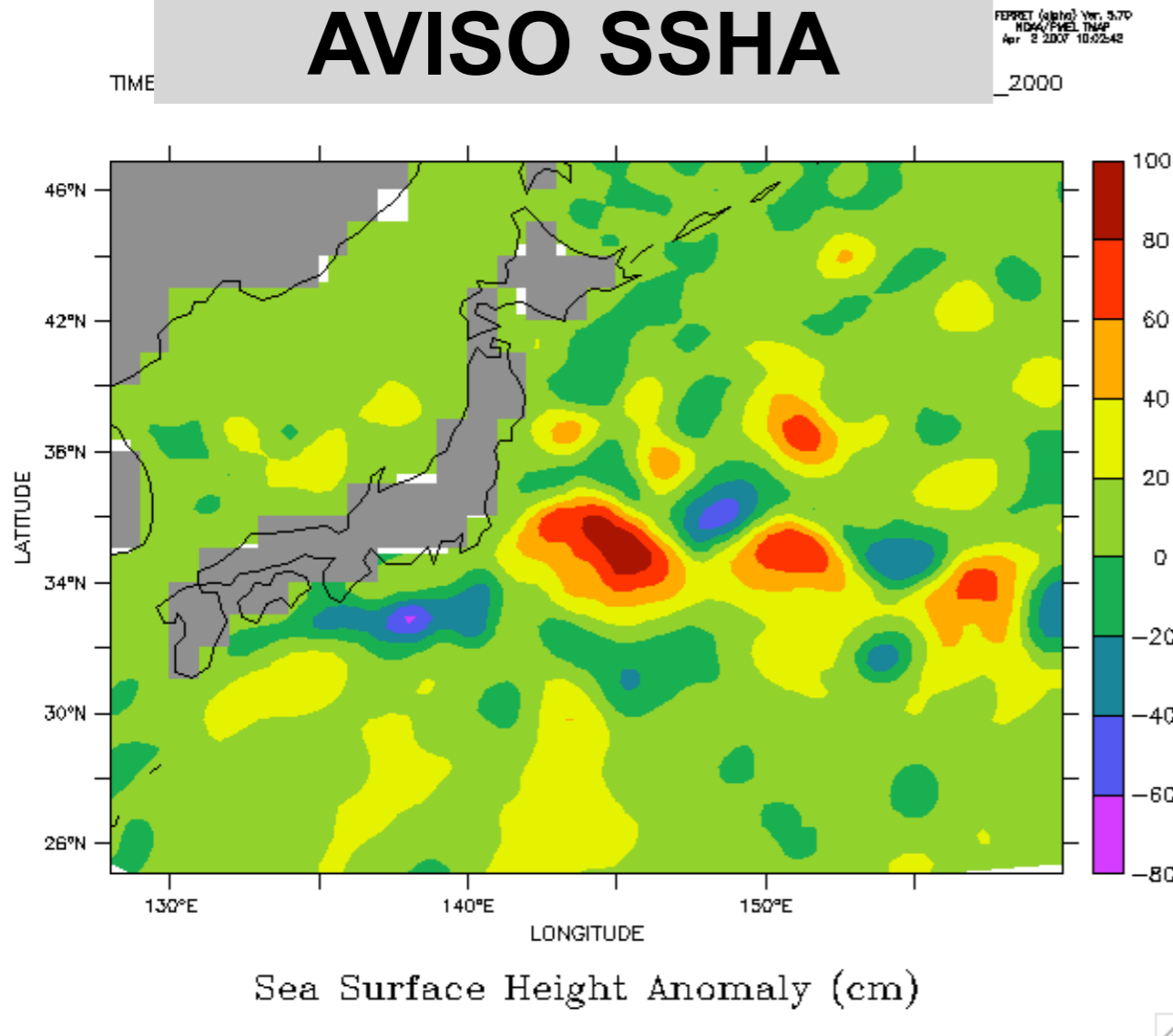
Flux	Global product name	All			Winter (DJF)			Summer (JJA)		
		Bias	RMS	Corr.	Bias	RMS	Corr.	Bias	RMS	Corr.
LHF	J-OFURO2	3.12	40.36	0.92	-4.16	51.16	0.86	10.27	30.44	0.76
	HOAPS3	9.03	48.50	0.88	-12.35	54.37	0.84	27.97	38.18	0.69
	NRA1	26.42	47.01	0.91	36.05	48.42	0.90	29.37	45.24	0.63
	NRA2	43.77	58.47	0.91	80.91	65.55	0.90	39.14	52.51	0.60
	OAFLUX	15.61	36.88	0.94	35.47	47.73	0.89	16.68	28.93	0.72
SHF	J-OFURO2	-3.91	11.03	0.94	-3.00	16.39	0.94	-2.45	7.20	0.68
	HOAPS3	-2.34	16.01	0.86	-14.44	24.97	0.77	-0.26	7.59	0.61
	NRA1	3.91	16.64	0.93	16.48	21.51	0.93	-3.20	10.17	0.73
	NRA2	1.87	19.54	0.93	19.84	25.75	0.94	-5.63	11.52	0.76
	OAFLUX	3.06	12.57	0.95	14.18	18.26	0.93	-3.19	6.64	0.70

# Meso-scale air-sea heat flux

Example: November 2000

Kuroshio/Kuroshio Extension Region

## AVISO SSHA

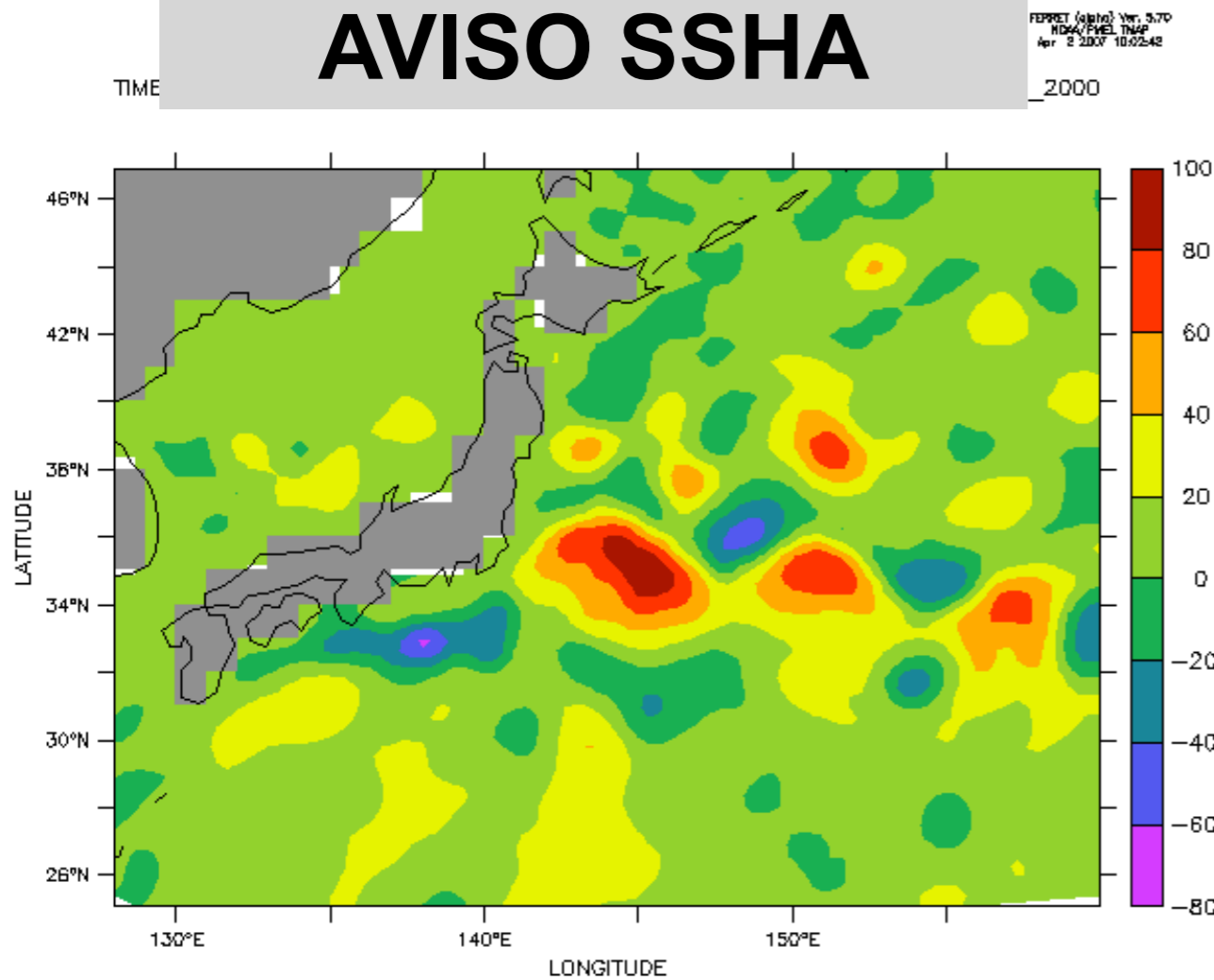


# Meso-scale air-sea heat flux

Example: November 2000

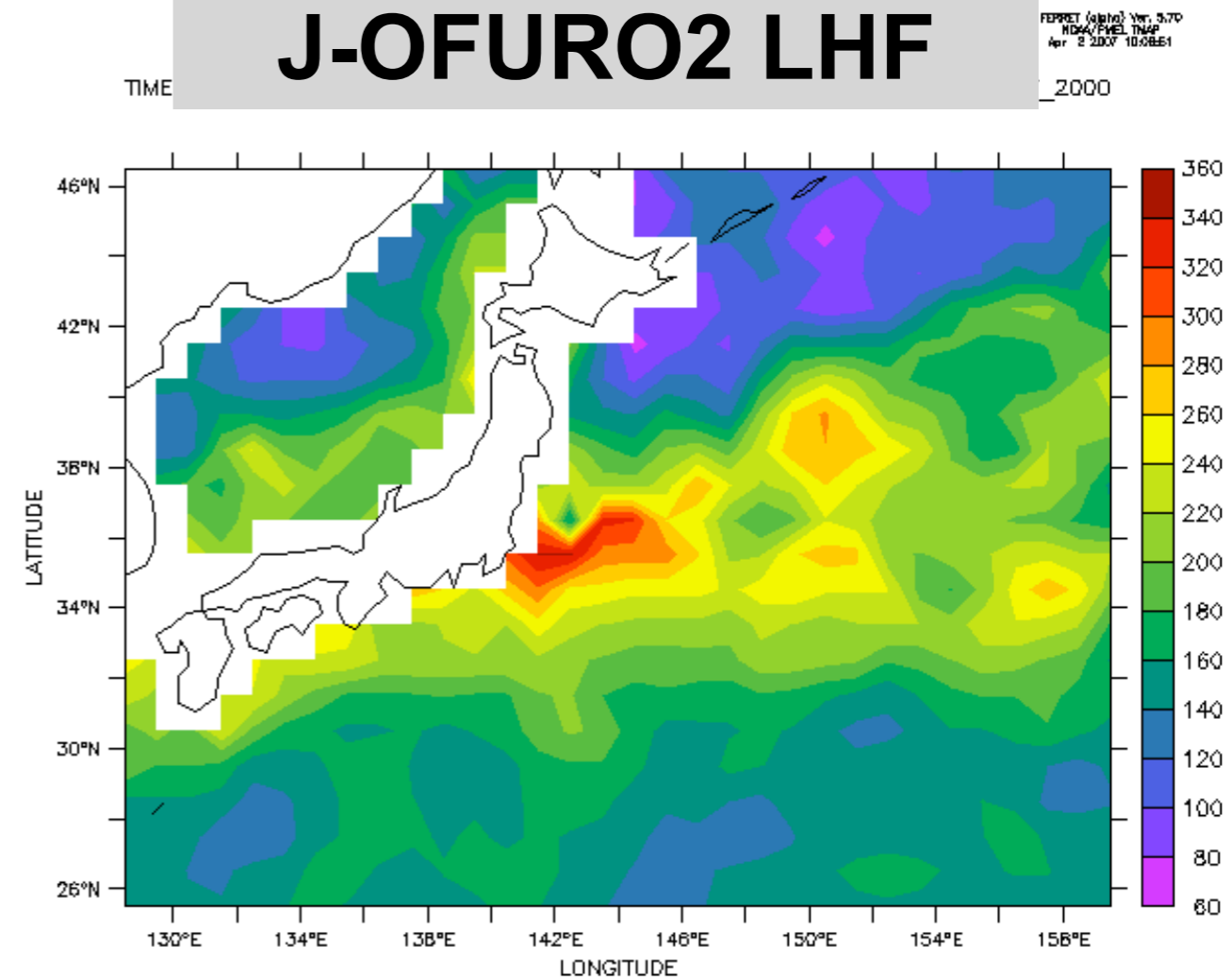
Kuroshio/Kuroshio Extension Region

## AVISO SSHA



Sea Surface Height Anomaly (cm)

## J-OFURO2 LHF



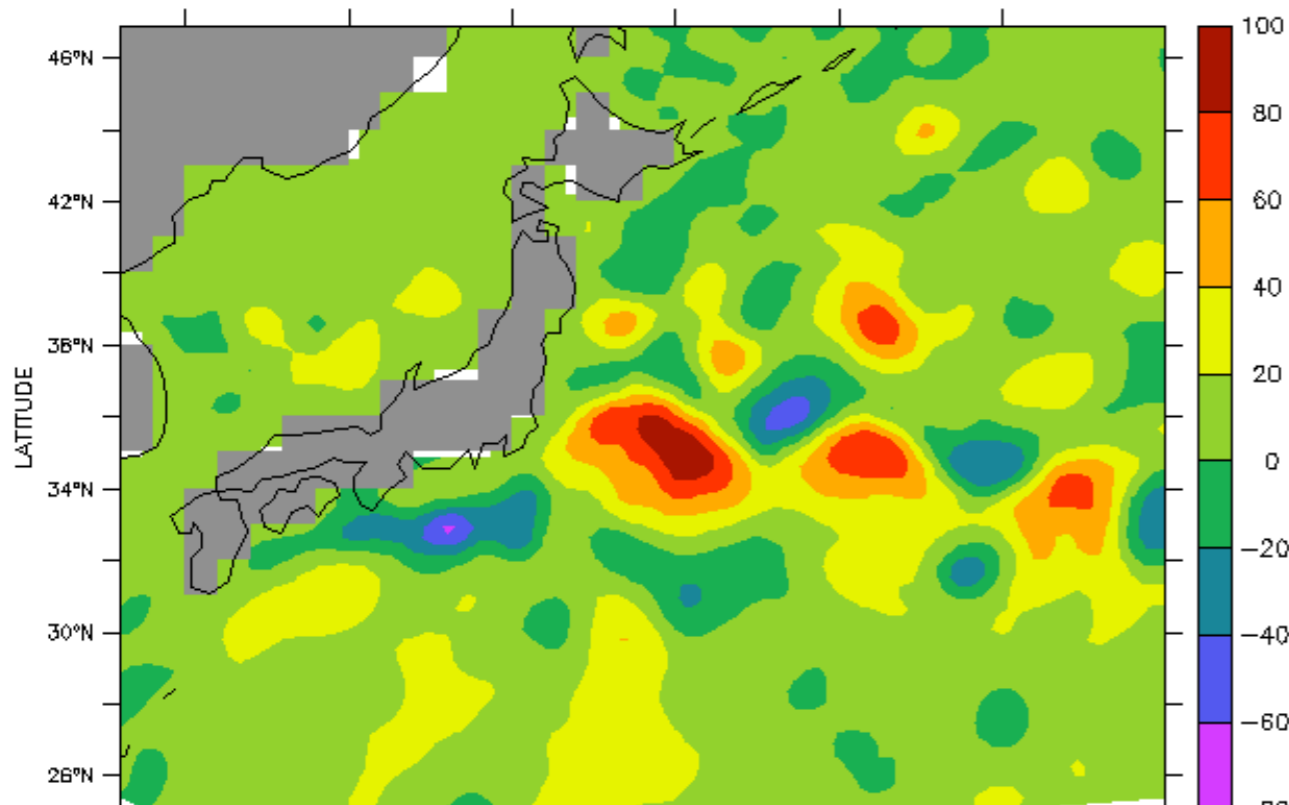
J-OFURO2 LHF Monthly ( $W/m^2$ )

# AVISO SSHA

FEPRF (alpha) Ver. 5.7D  
NDAA/PVEL TNAP  
Apr 2 2007 10:02:42

TIME : 28-

iso\_tp\_2000

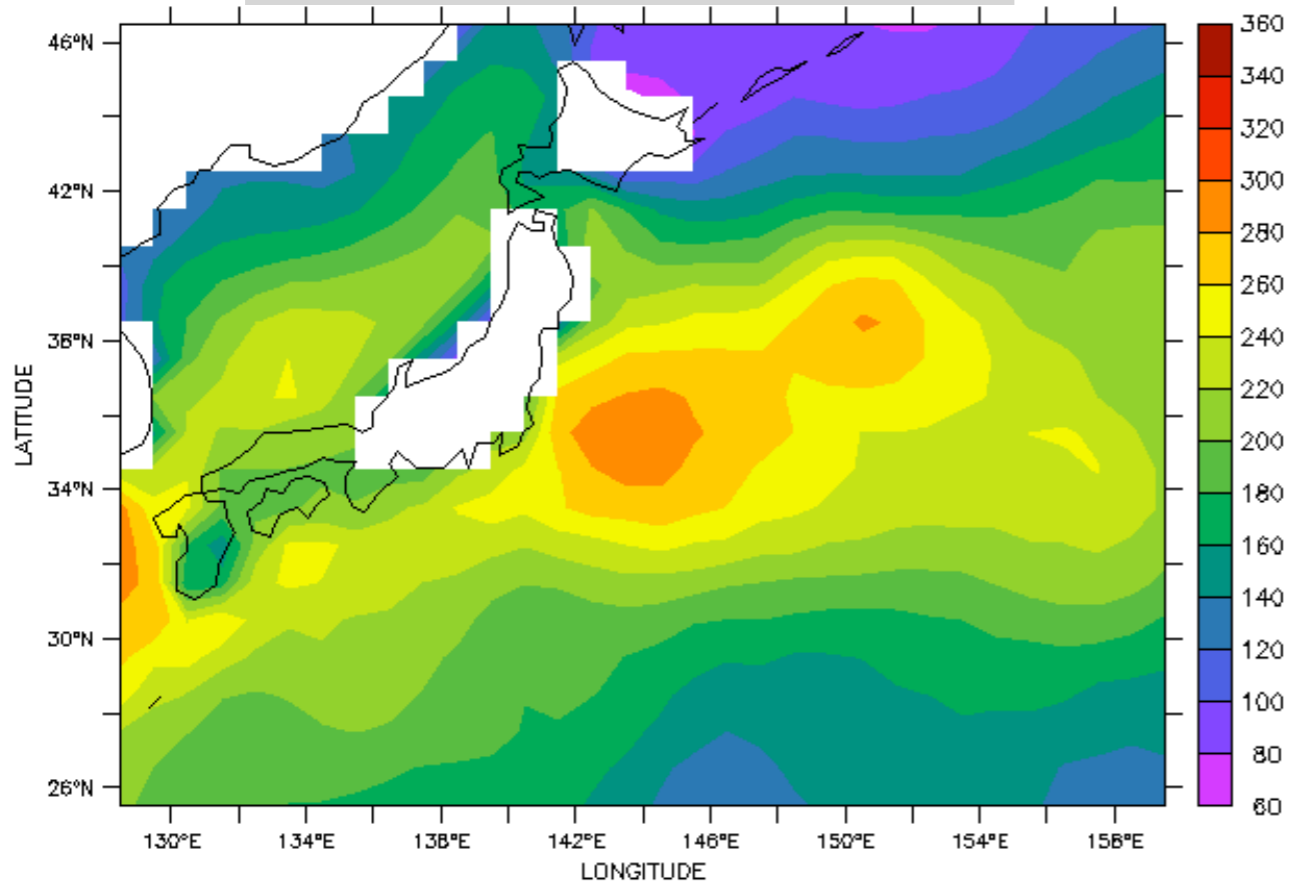


FEPRF (alpha) Ver. 5.7D  
NDAA/PVEL TNAP  
Apr 2 2007 10:22:03

# OAFIux LHF

TIME : 01-

INTHLY\_2000

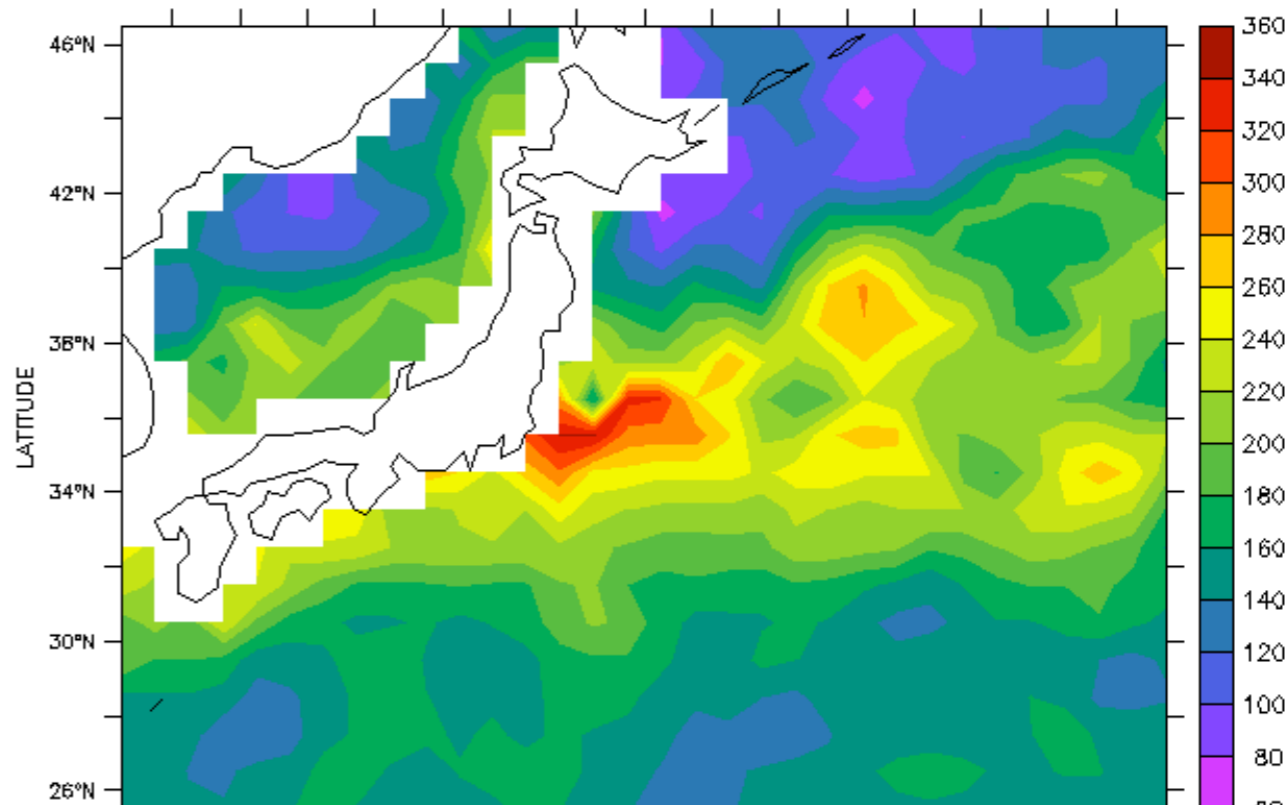


FEPRF (alpha) Ver. 5.7D  
NDAA/PVEL TNAP  
Apr 2 2007 10:02:51

# J-OFURO2 LHF

TIME : 01-

INTHLY\_2000

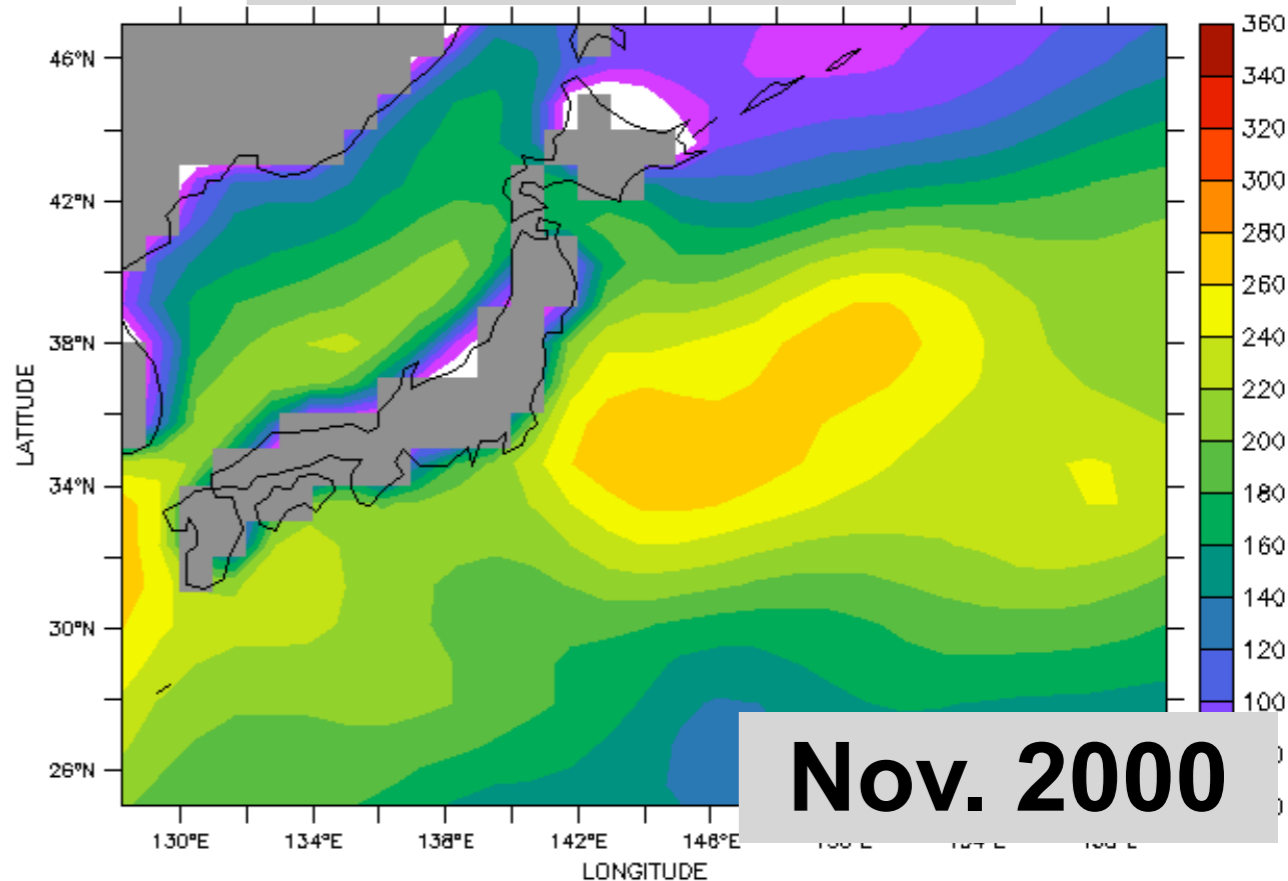


FEPRF (alpha) Ver. 5.7D  
NDAA/PVEL TNAP  
Apr 3 2007 18:02:06

# ERA40 LHF

TIME : 01-

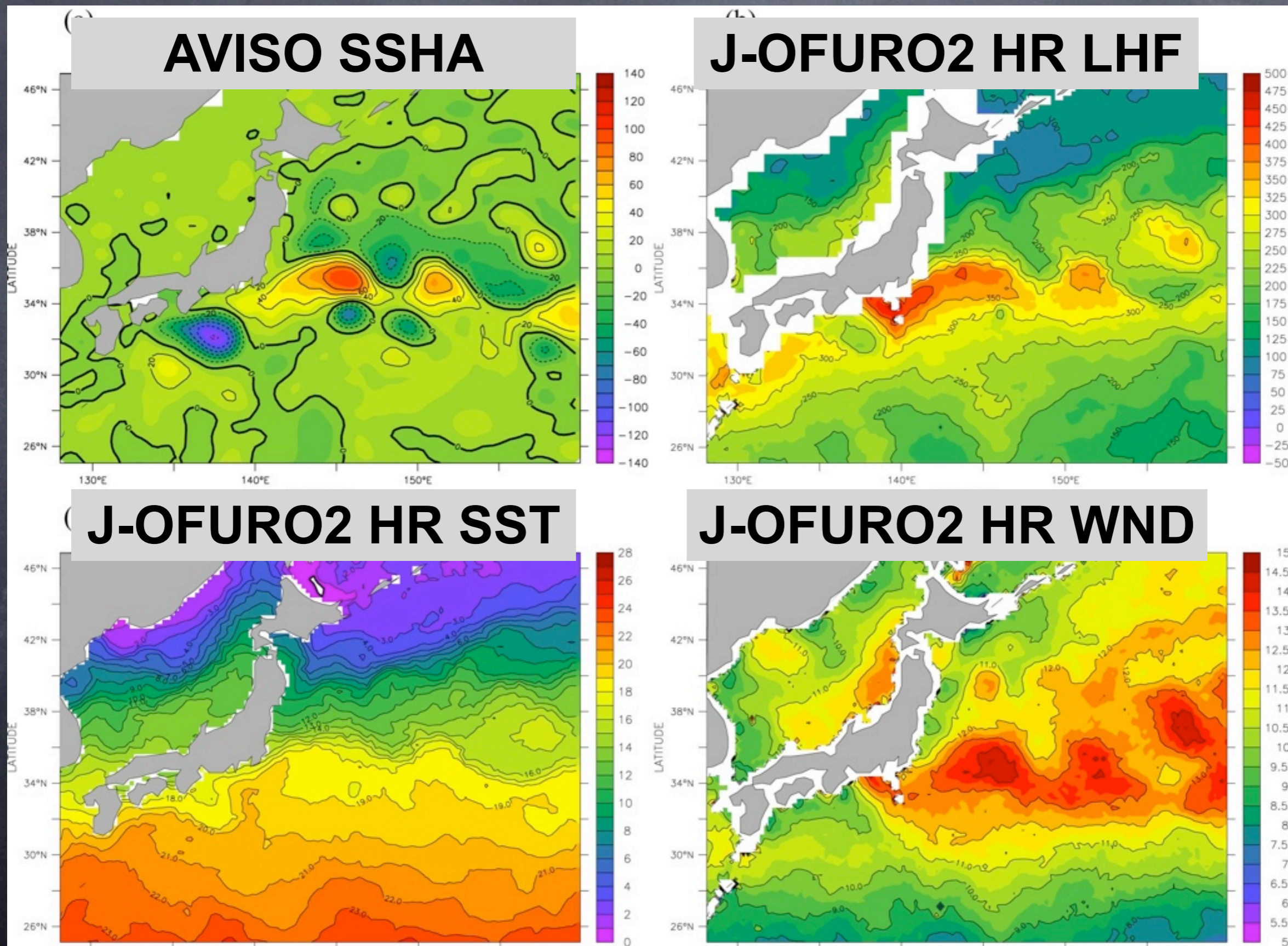
INTHLY\_2000



Nov. 2000

# Meso-scale air-sea heat flux

Example of **High-Resolution**: January 2005





# SUMMARY

- New satellite-derived heat flux data set was constructed as J-OFURO2.
- Overall feature of J-OFURO2 turbulent heat flux data is consistent with other global product and well agree with KEO buoy observation.
- Use of multi-satellite data improves accuracy of surface turbulent heat fluxes.
- In particular, use of multi-satellite data for wind speed and SST contributes to represent fine structure of heat fluxes over the Kuroshio/Oyashio Extension region.

# Future works toward J-OFURO3

## Current issues in J-OFURO2

**Accuracy:** not enough, need development of new Qa

1) using multi-satellite (SSM/I, AMSR-E, TMI ...)

2) taking account of atmospheric profiles

**High-latitude/cold regions:**

**Coastal regions:** land contamination, adopting CSF?

**Air temperature:** using NRA2, need high-resolution

**Radiative flux:** using ISCCP FD, need high-resolution

**Wind direction:** not available

**Precipitation and freshwater flux:** not available

**Near-real time data providing:** no

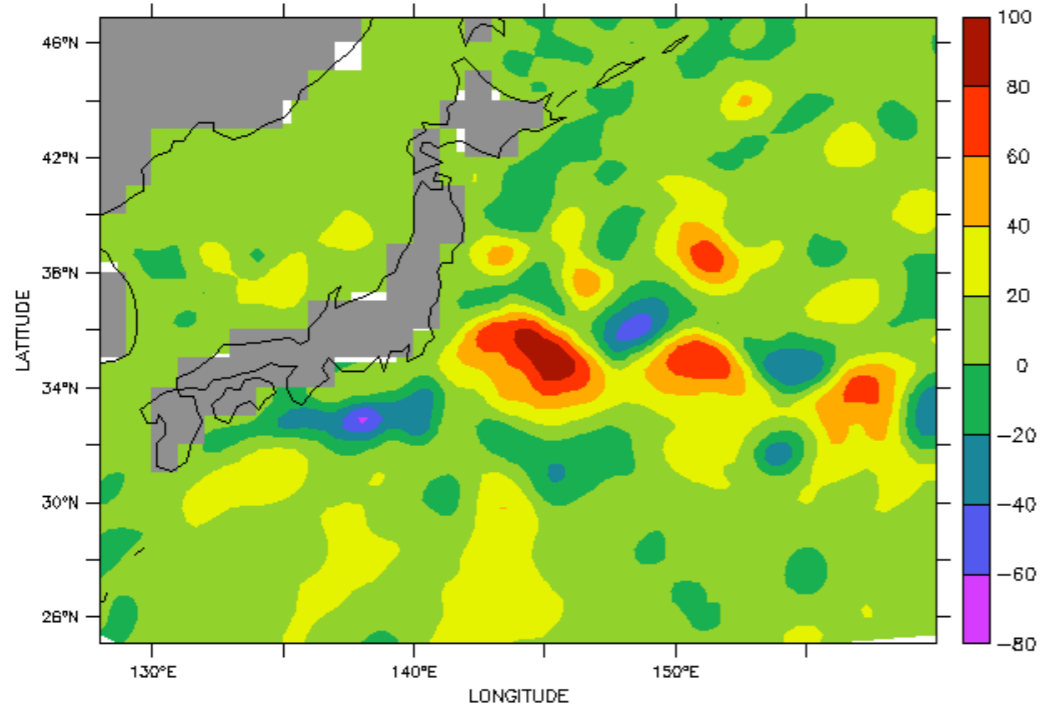
# J-OFURO Version 2 Surface Heat Flux Data

<http://dtsv.scc.u-tokai.ac.jp/j-ofuro>

<ftp://dtsv.scc.u-tokai.ac.jp>

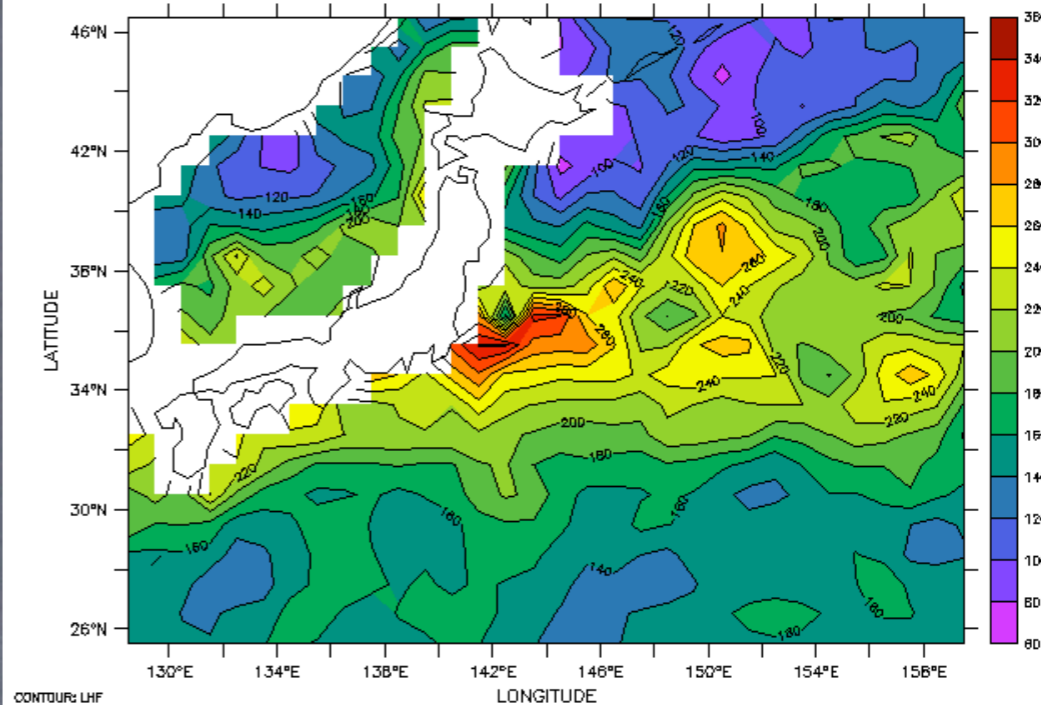
# Appendix

TIME : 28-OCT-2000 12:00 to 02-DEC-2000 12:00 (average) DATA SET: ssha\_avis0\_tp\_2000



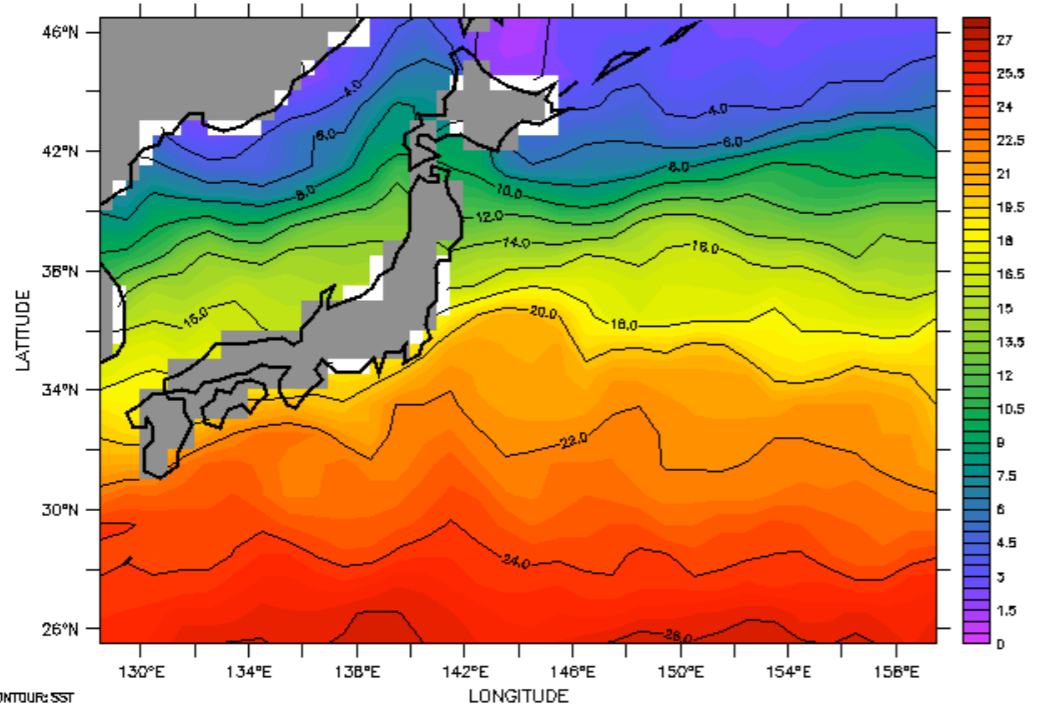
Sea Surface Height Anomaly (cm)

TIME : 01-NOV-2000 00:00 DATA SET: J-OFURO2\_LHF\_ID001\_MONTHLY\_1988-2005



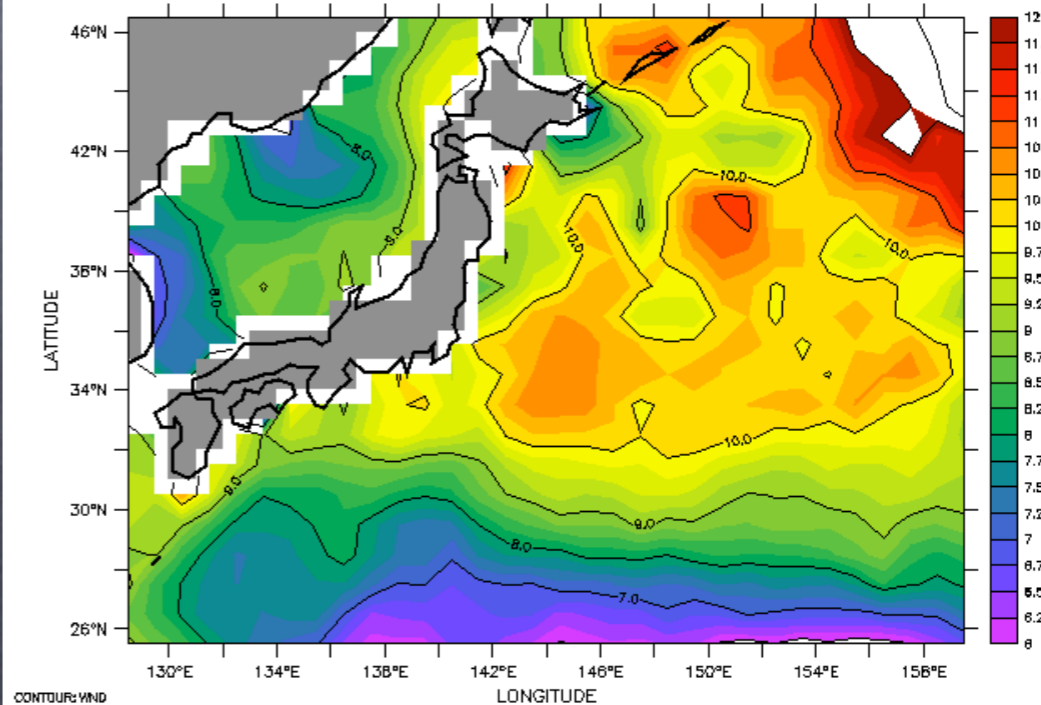
J-OFURO2 LHF Monthly (W/m<sup>2</sup>)

TIME : 01-DEC-2000 00:00 DATA SET: J-OFURO2\_SST\_ID001\_MONTHLY\_2000



J-OFURO2 SST Monthly (degC)

TIME : 01-NOV-2000 00:00 DATA SET: J-OFURO2\_WND\_ID001\_MONTHLY\_2000



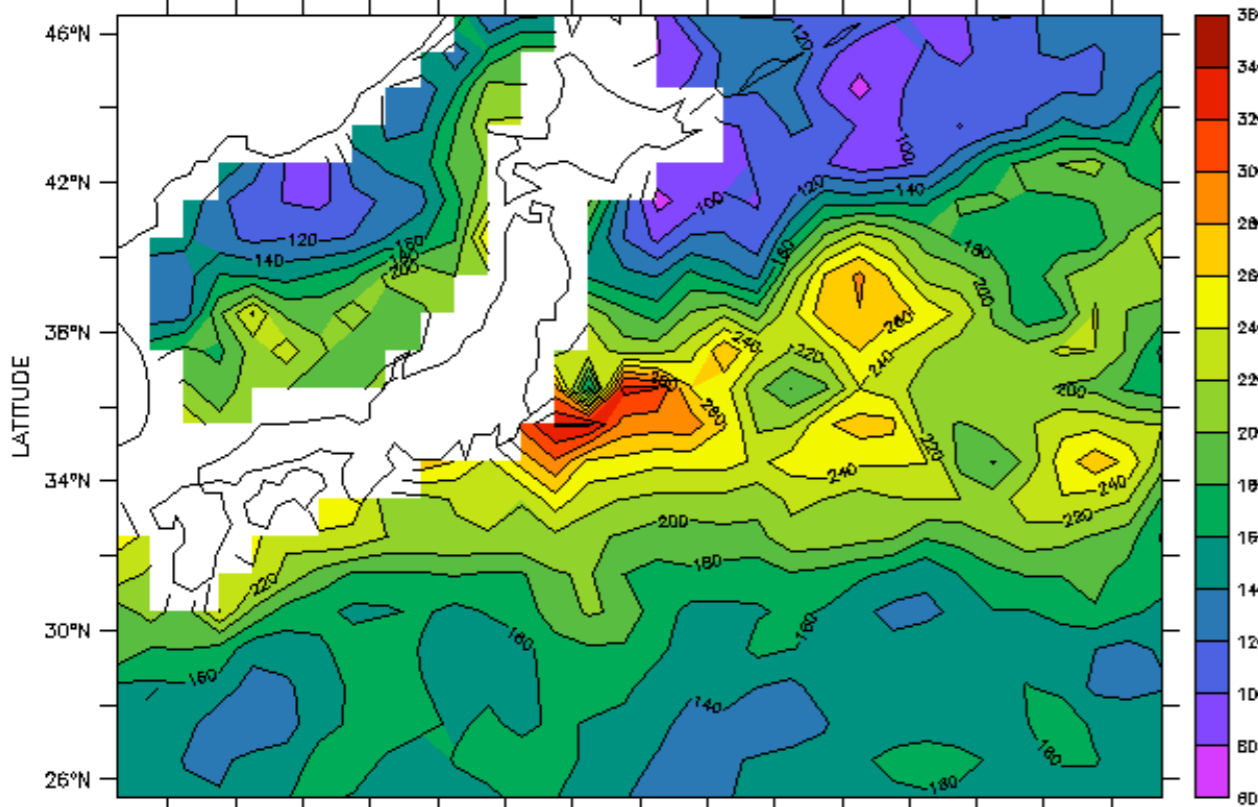
J-OFURO2 WND Monthly (m/s)

TIME : 01

# J-OFURO2 LHF

1988-2005

FERRET Ver. 5.30  
MDS4/PVCL TNAP  
Apr 3 2007 02:18:24

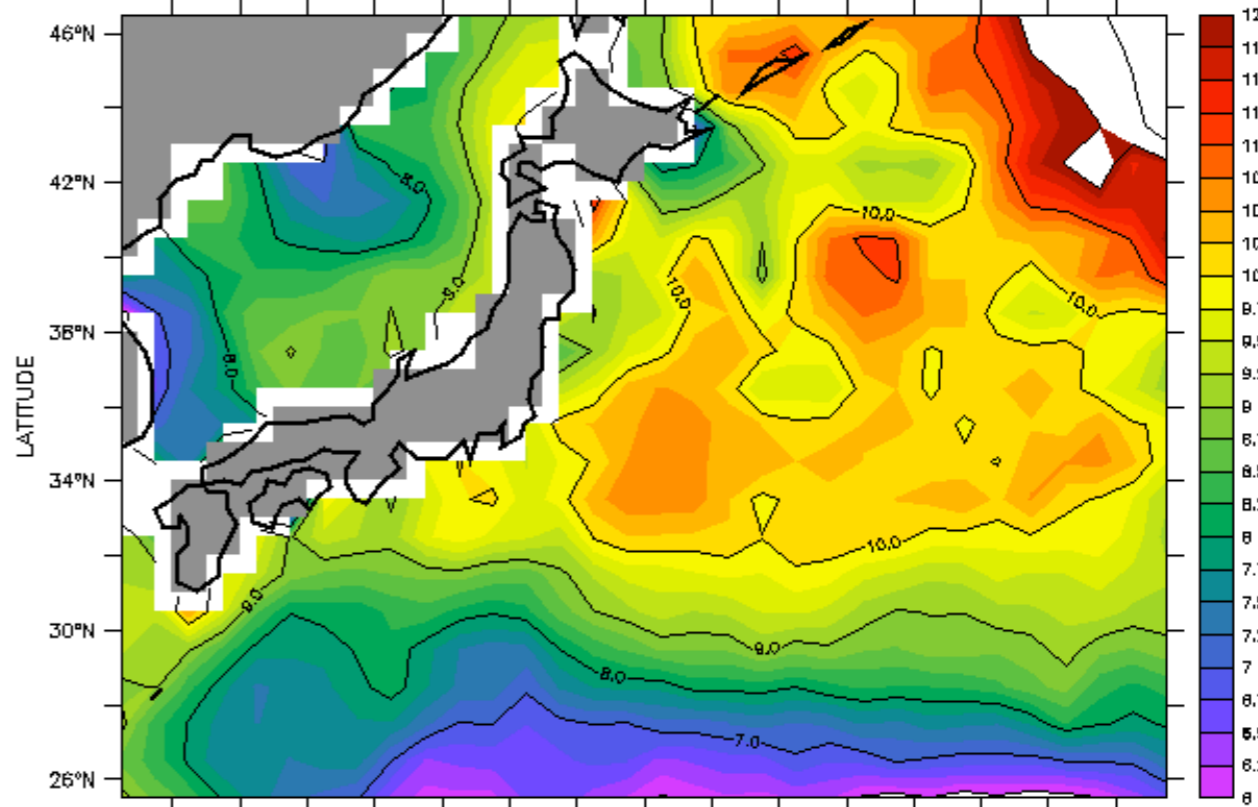


TIME : 01

# J-OFURO2 W

INTHLY\_2000

FERRET Ver. 5.30  
MDS4/PVCL TNAP  
Apr 3 2007 02:20:11

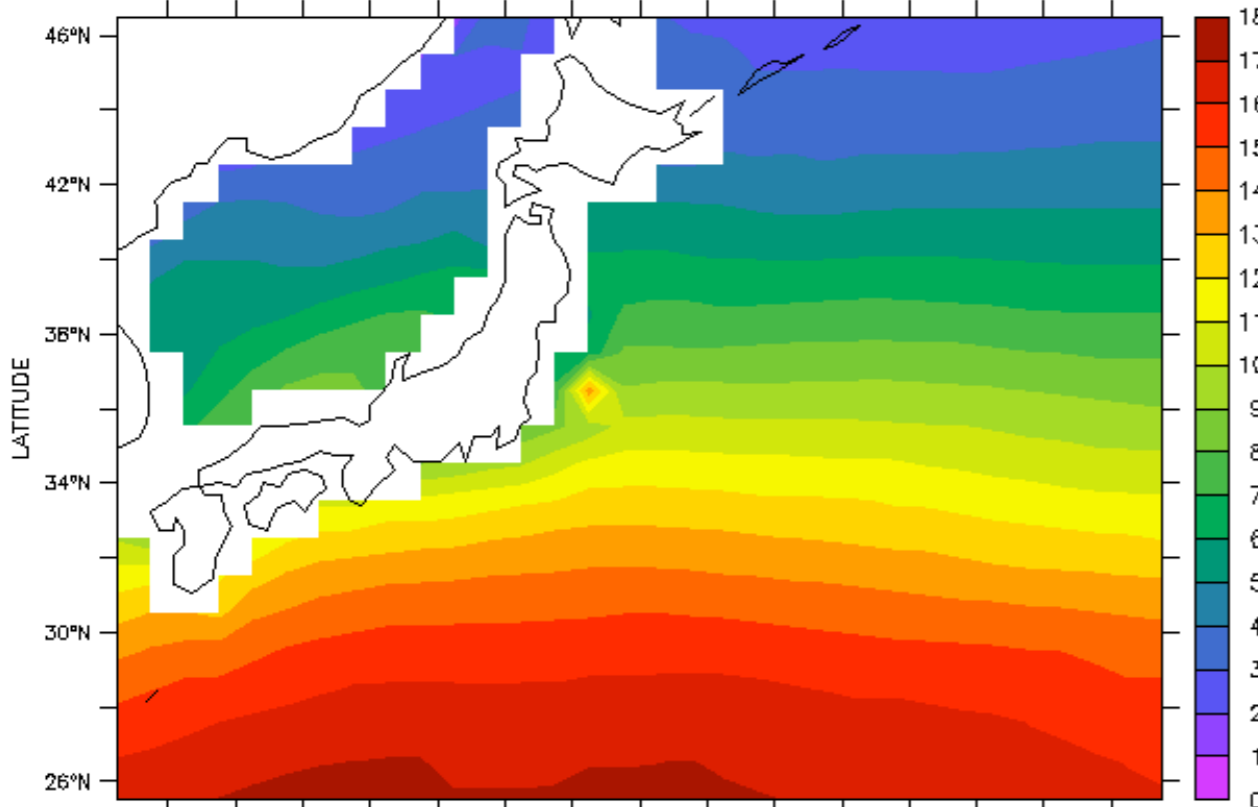


TIME : 01

# J-OFURO2 Qa

INTHLY\_2000

FERRET (alpha) Ver. 5.70  
MDS4/PVCL TNAP  
Apr 3 2007 16:26:15

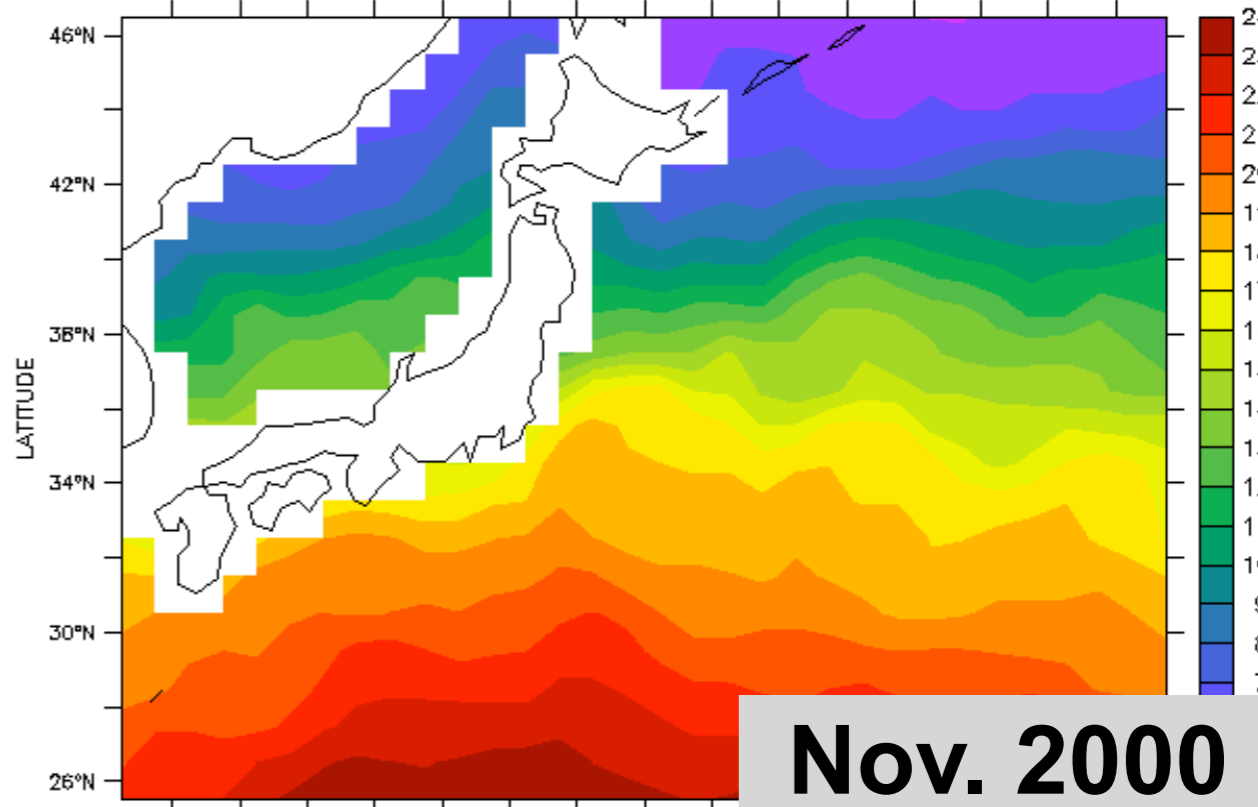


TIME : 01

# J-OFURO2 Qs

INTHLY\_2000

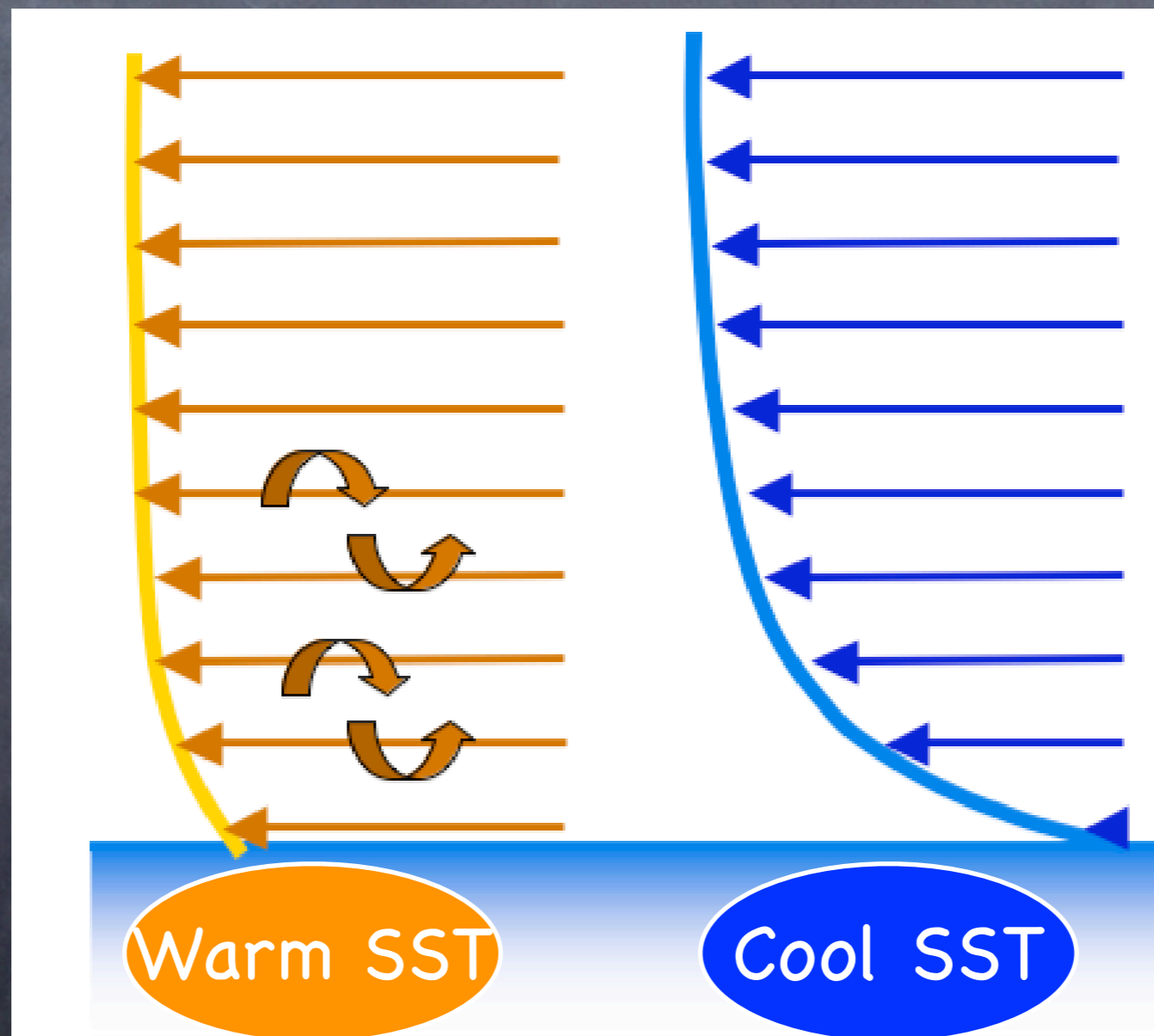
FERRET (alpha) Ver. 5.70  
MDS4/PVCL TNAP  
Apr 3 2007 16:29:00

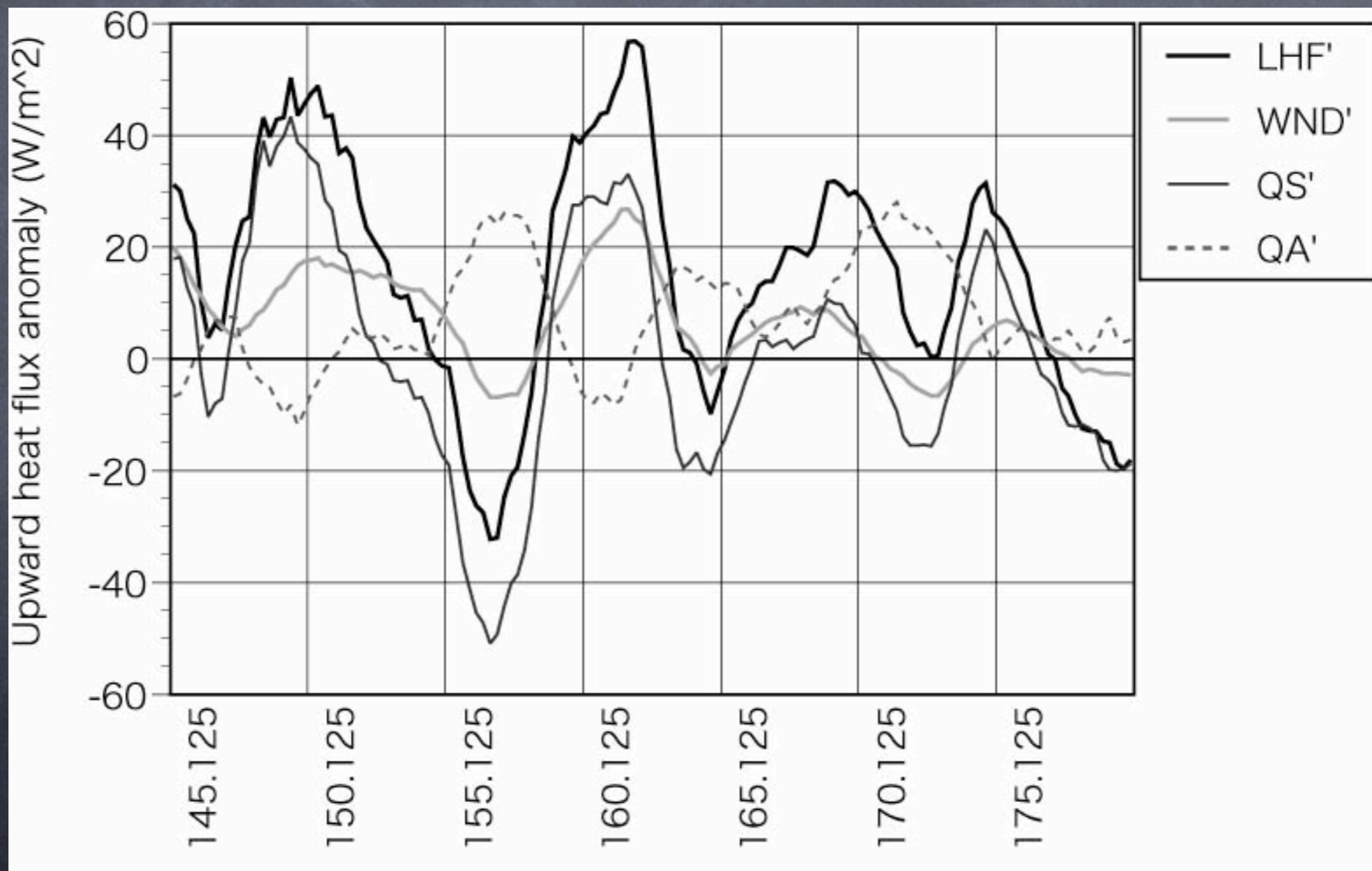


**Nov. 2000**

# SST anomaly and its effect on surface wind

Vertical momentum mixing  
(Wallace et al., 1989)



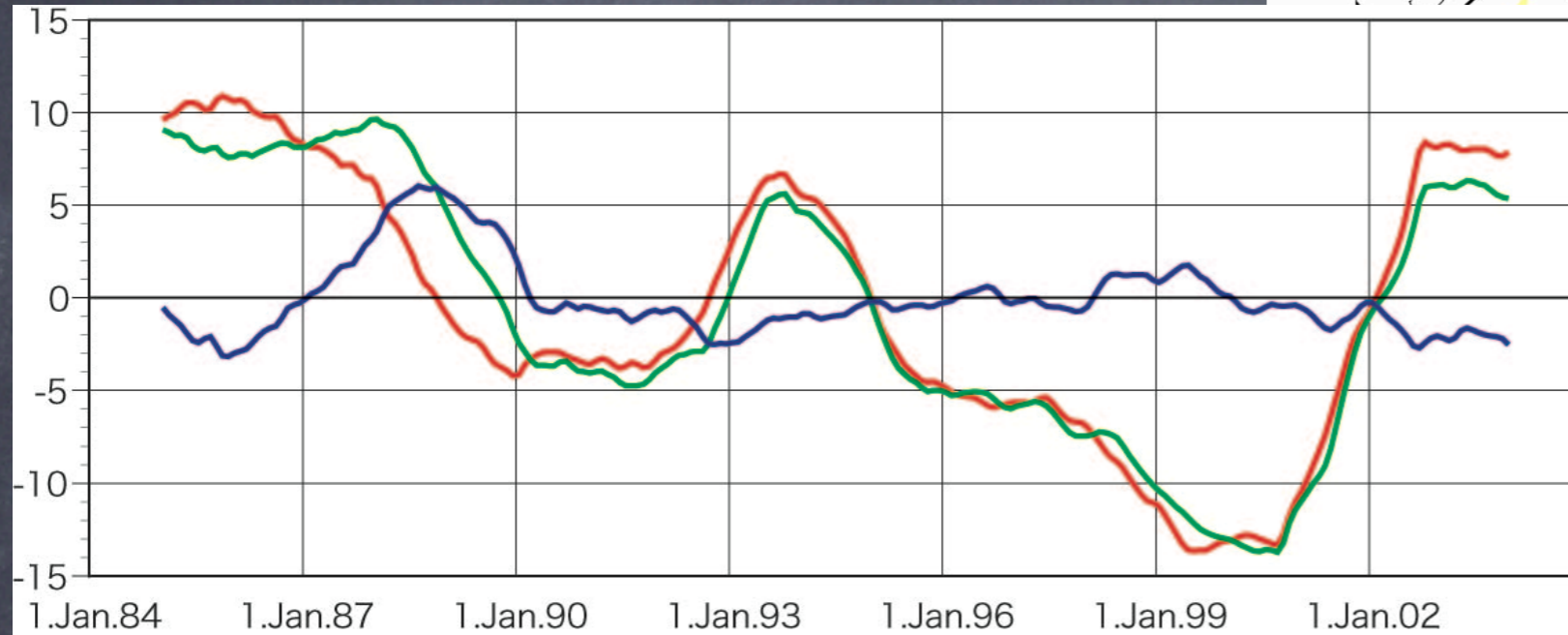
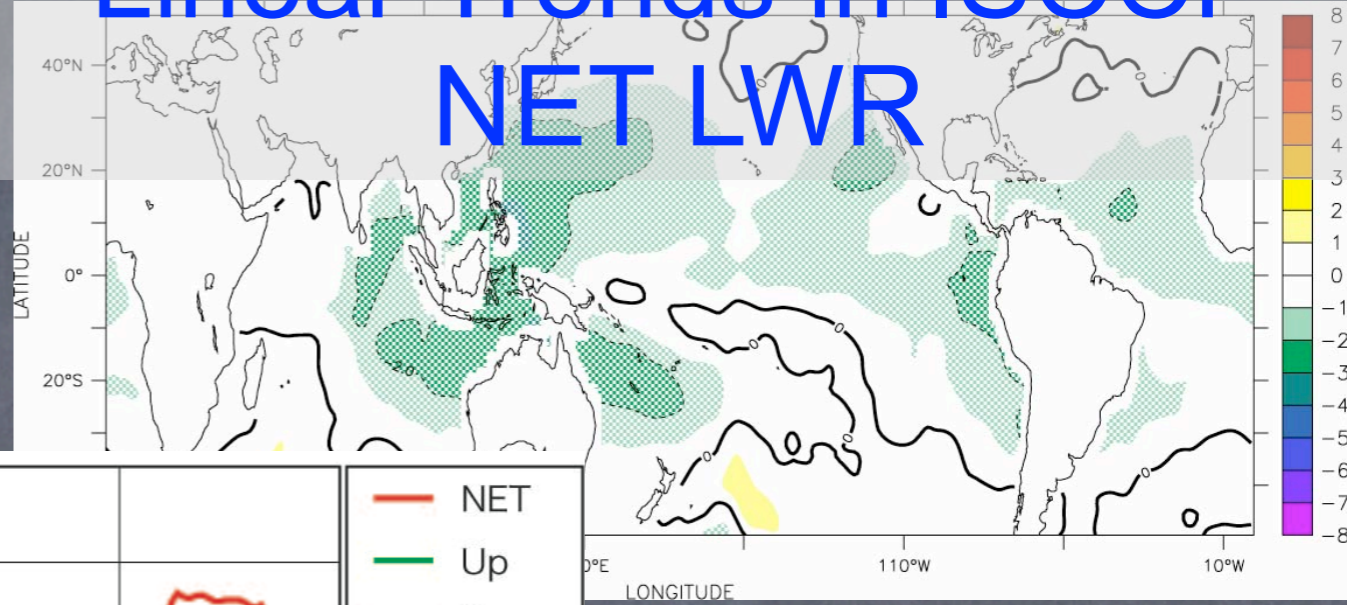




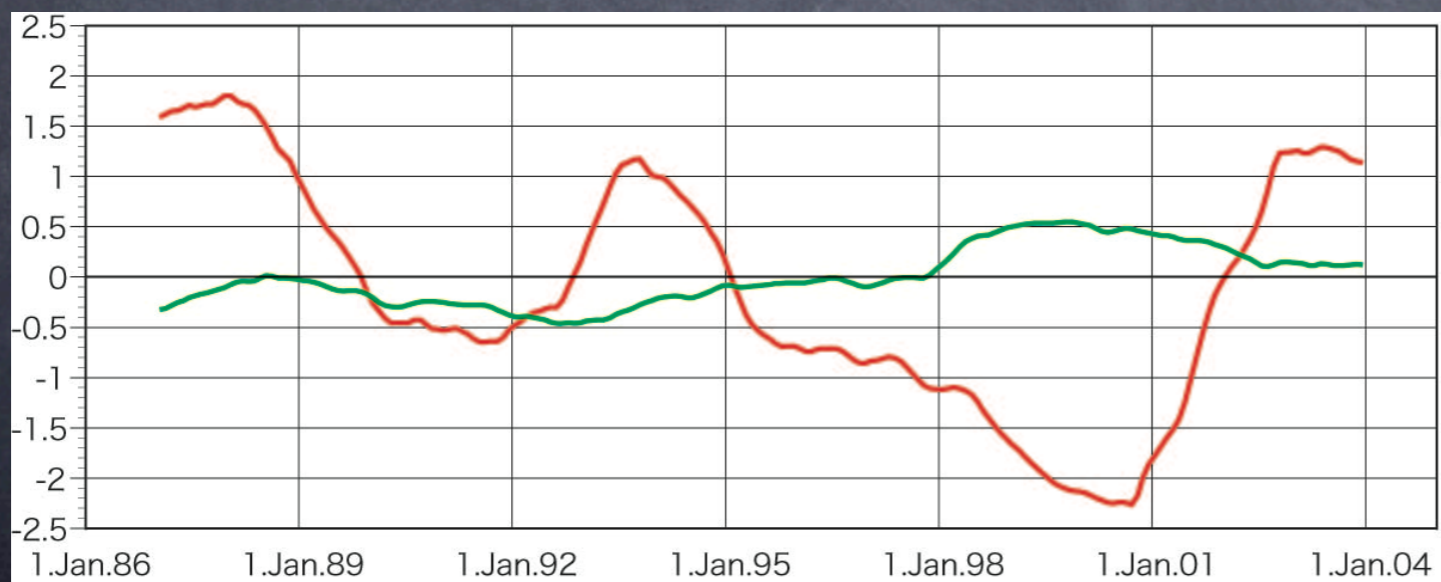


# Modification of ISCCP Upward LWR

# Linear Trends in ISCCP NET LWR



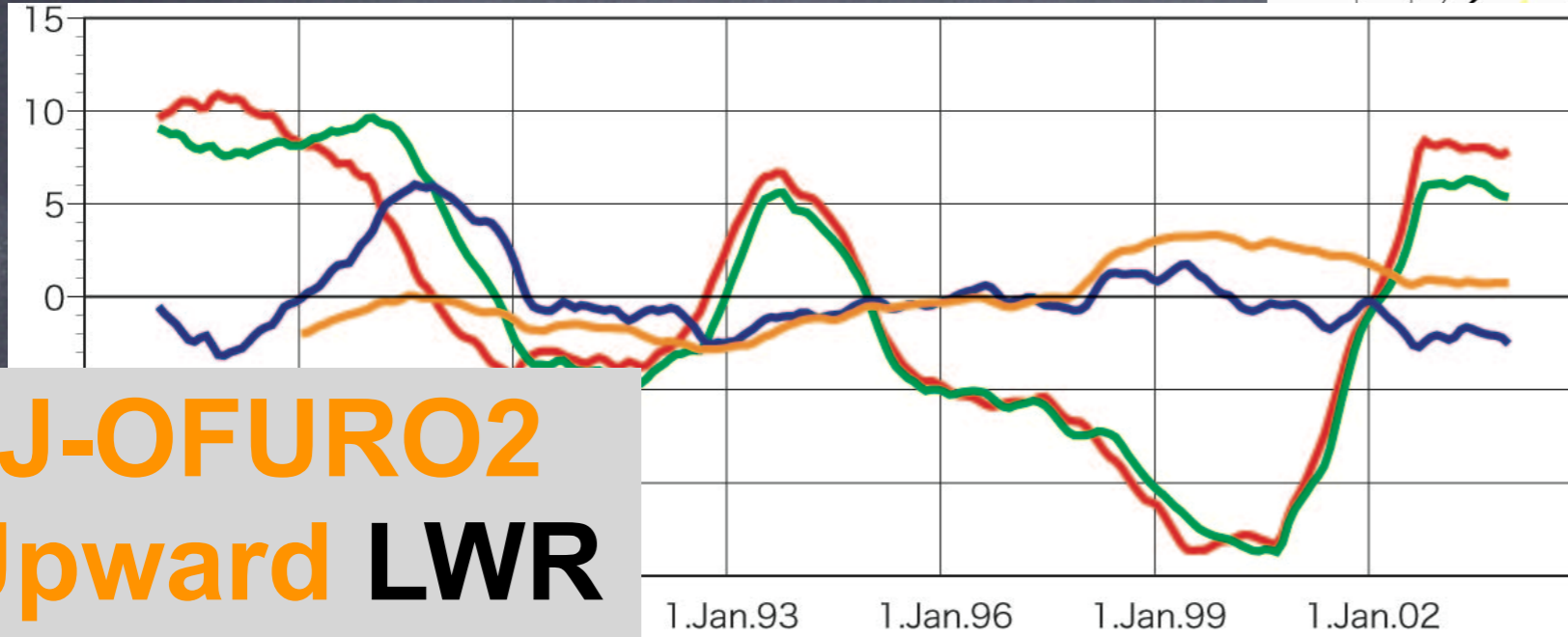
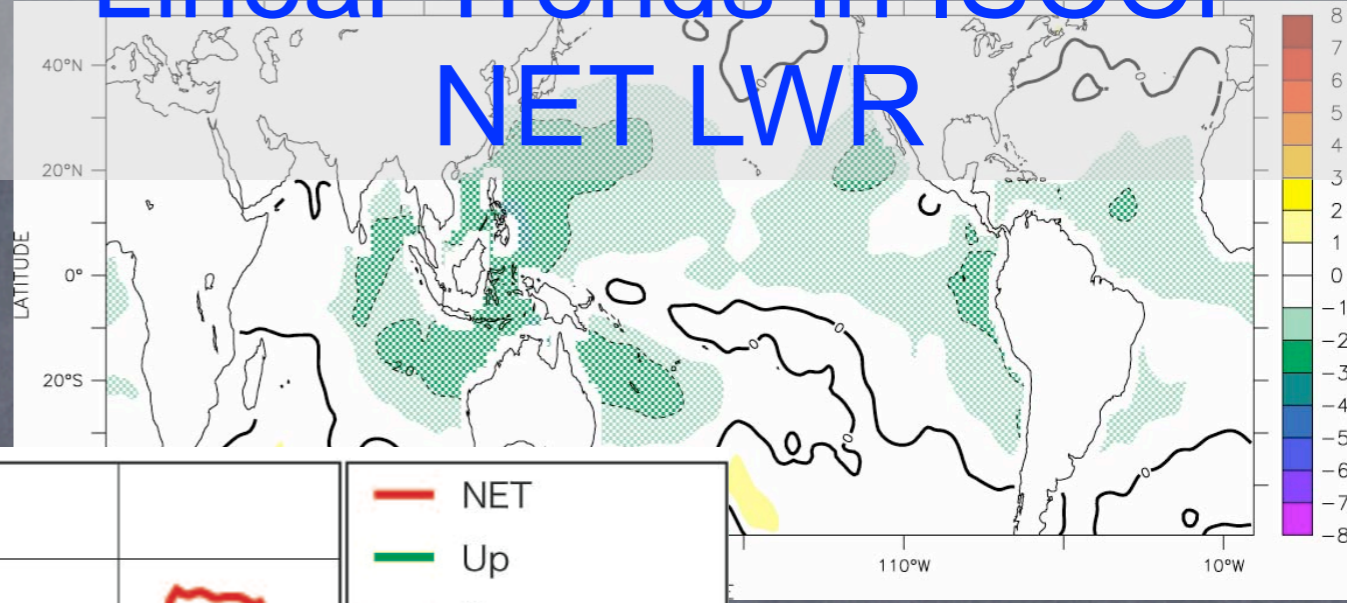
**Net, Upward,  
Downward  
LWR  
(anomaly)**



**ISCCP SST  
MGDSST  
(anomaly)**

# Modification of ISCCP Upward LWR

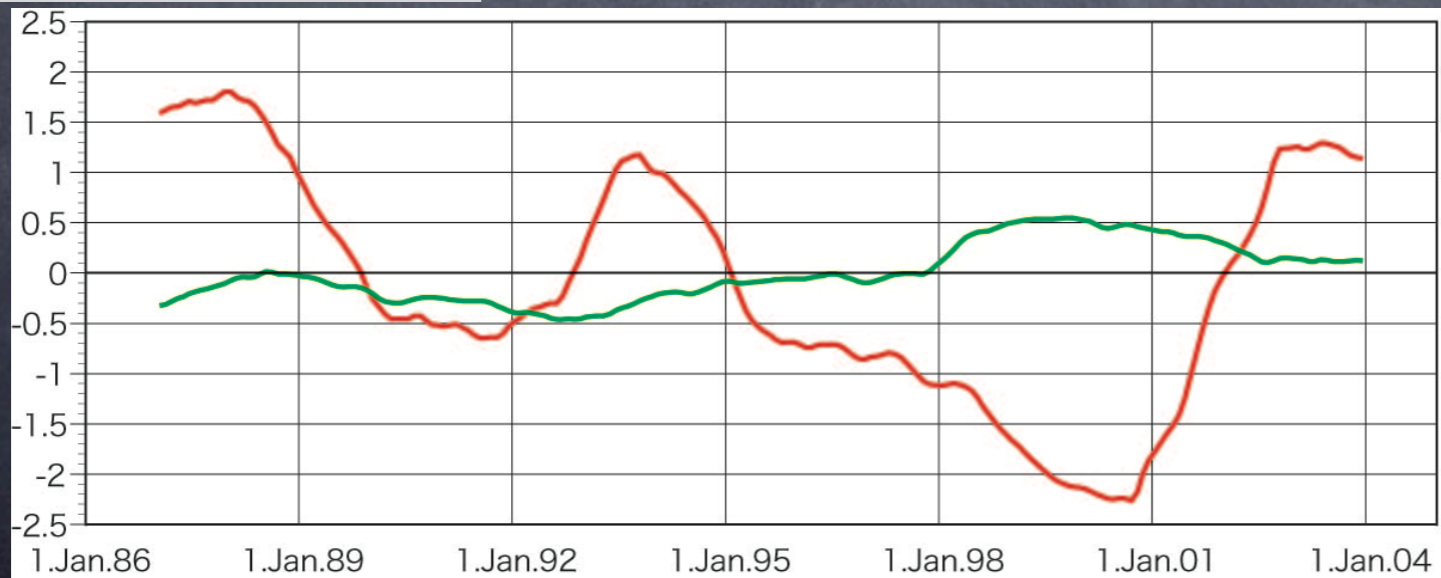
# Linear Trends in ISCCP NET LWR



NET  
Up

**Net, Upward,  
Downward  
LWR  
(anomaly)**

**J-OFURO2  
Upward LWR  
(anomaly)**



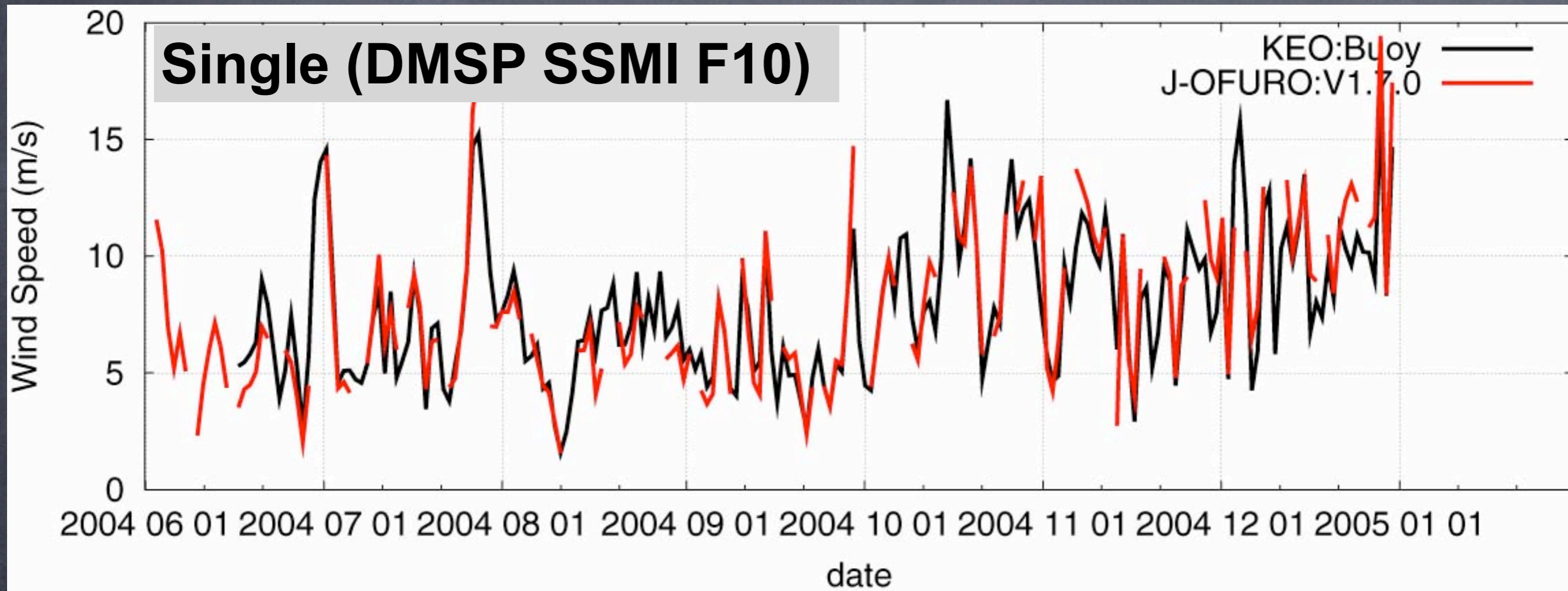
ISCCP  
MGDSST

**ISCCP SST  
MGDSST  
(anomaly)**



# Comparison Results

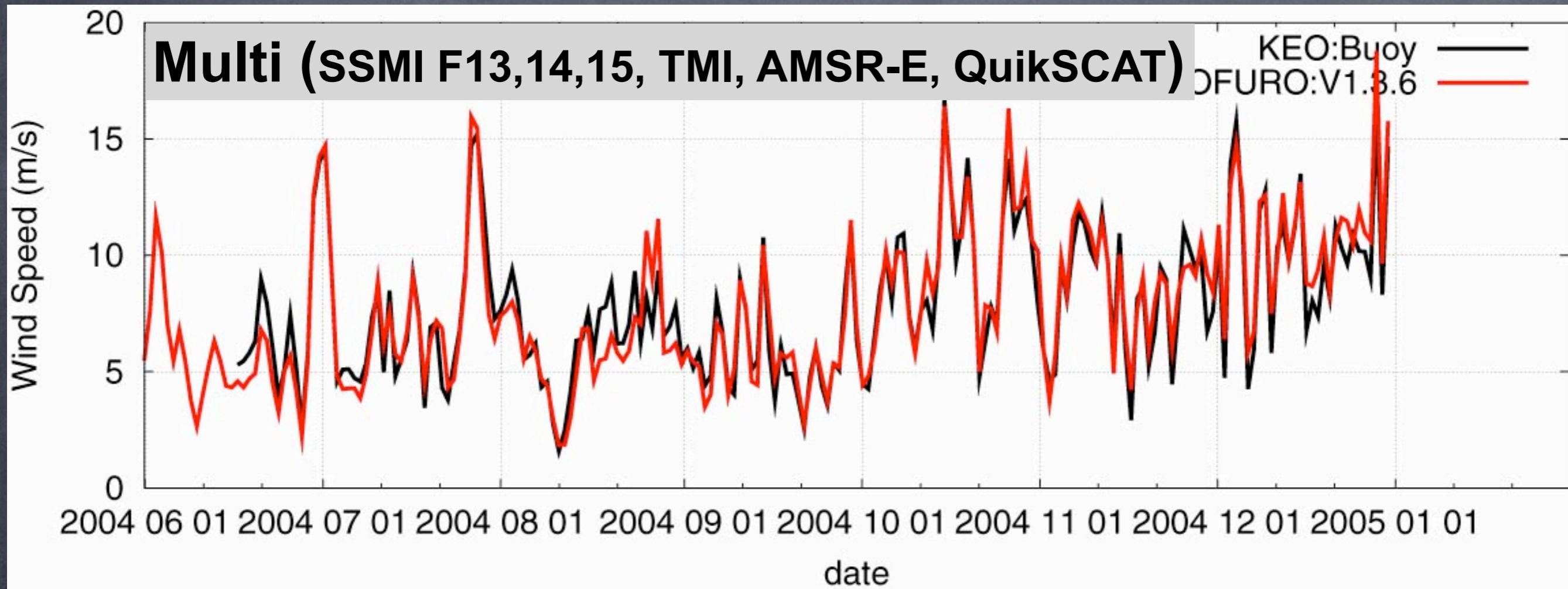
KEO and JKEO buoys - Impact of using multi-satellite -



J-OFURO1 vs KEO Buoy  
Wind Speed

# Comparison Results

KEO and JKEO buoys - Impact of using multi-satellite -



J-OFURO2 vs KEO Buoy  
Wind Speed