Investigation of offshore wind energy resource using AMSR2-derived wind speed and sea surface temperature products
- Estimation of offshore wind energy resource -

Katsutoshi Kozai, Teruo Ohsawa, Tsuguhiro Morita
(Kobe University Graduate School of Maritime Sciences)

GCOM-W1 PI Workshop, Jan.17, 2014, Tokyo, Japan

Contents

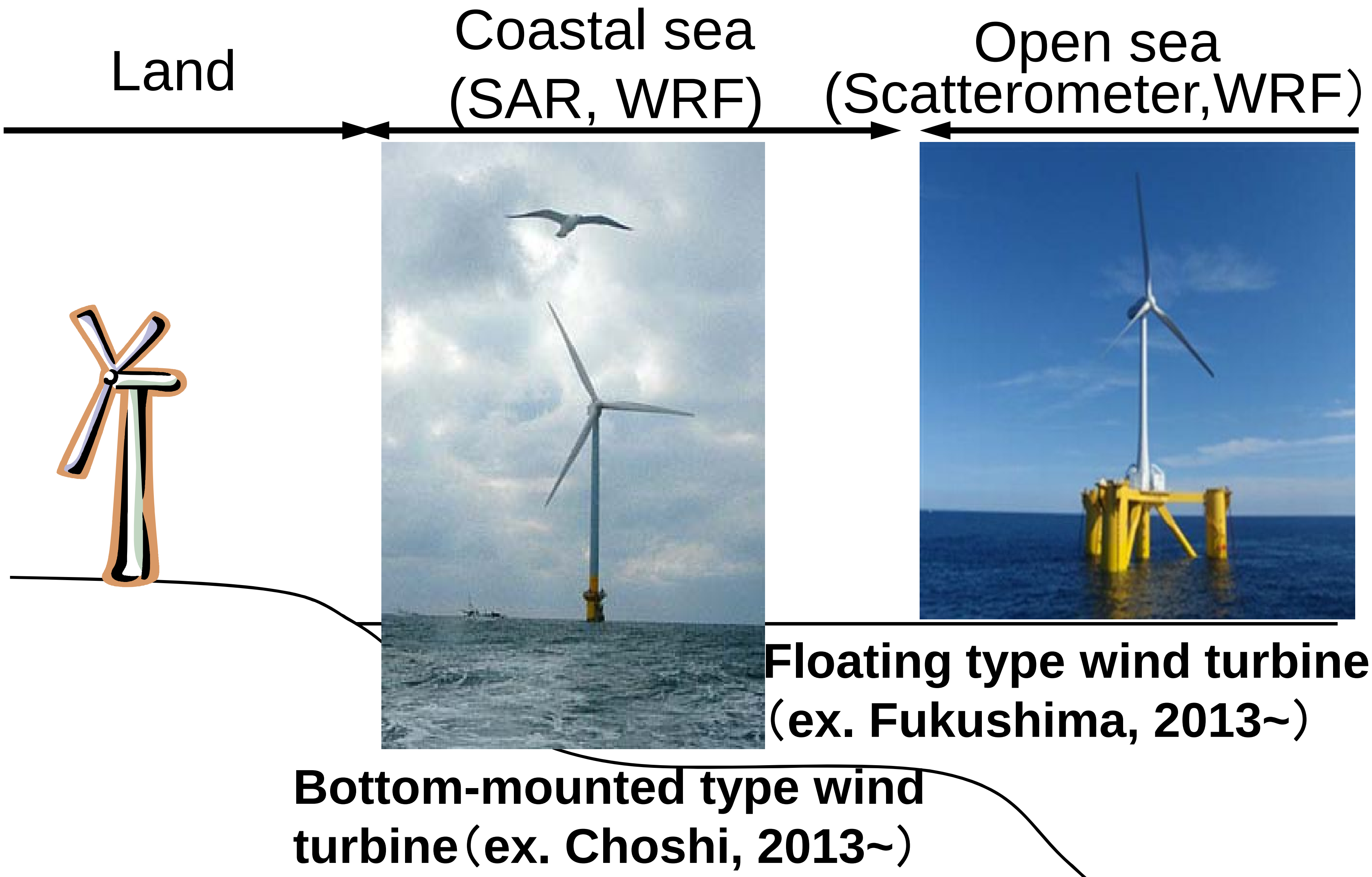
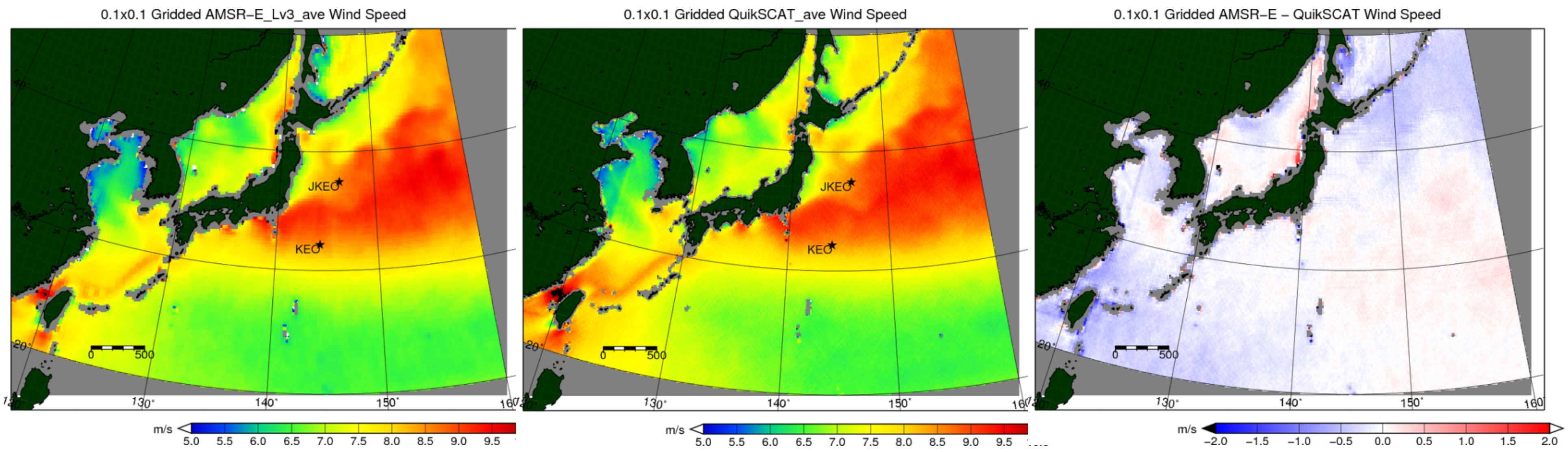


Fig.1 Classification of offshore wind evaluation method based on coastal and open seas.

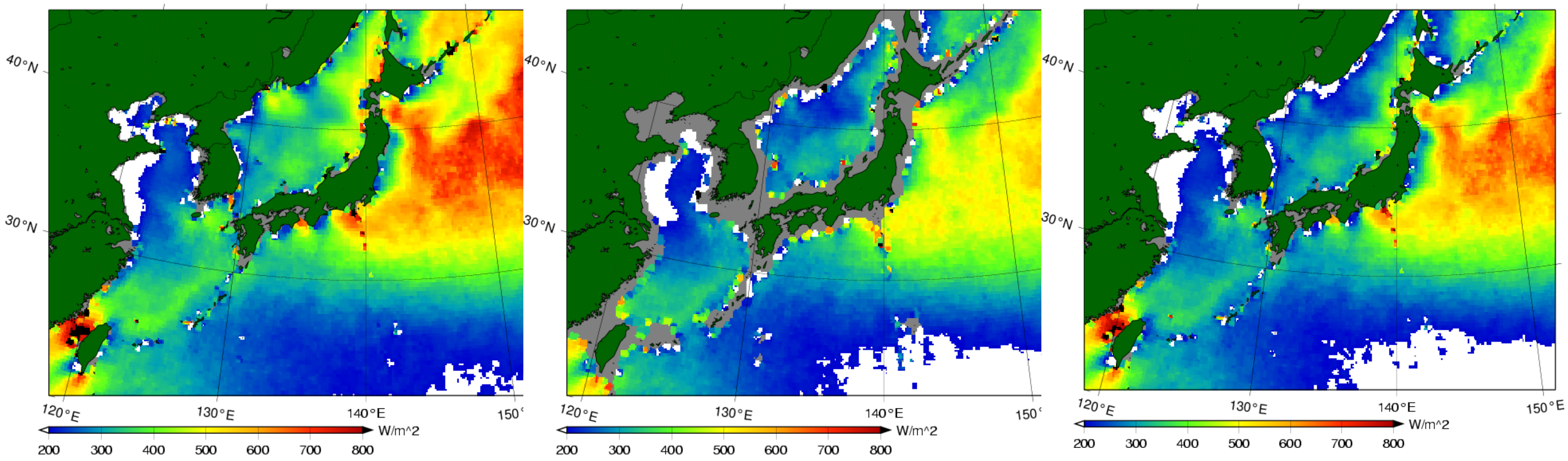
2012



AMSR-E **SeaWinds** **AMSR-E minus SeaWinds**

Fig.2 Comparison between AMSR-E and SeaWinds (2003-2008mean, 10m height)

2013



(a) AMSR-E derived Weibull energy density

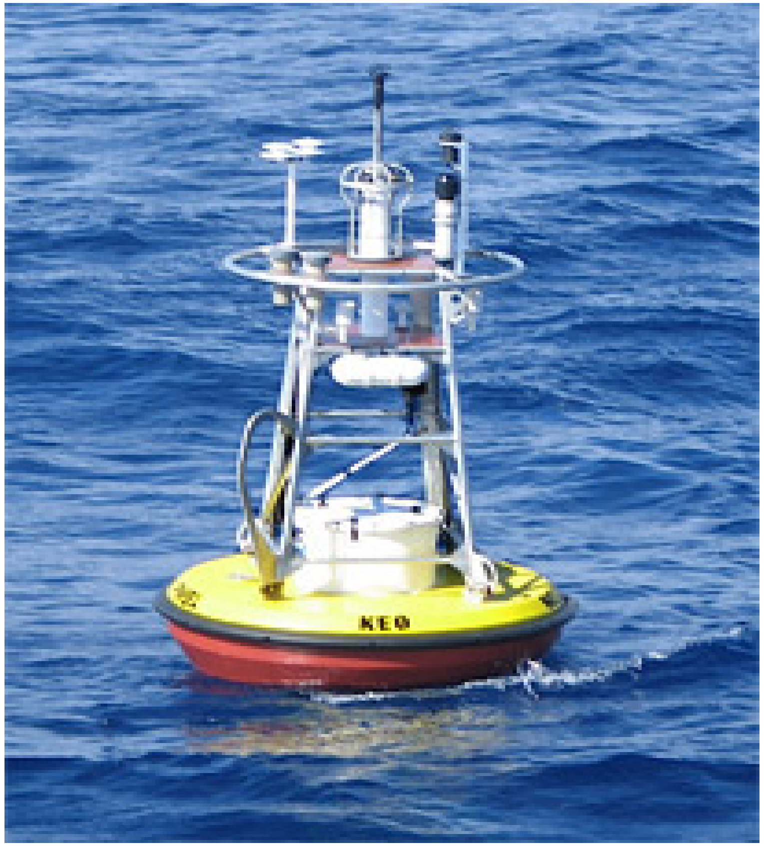
(b) AMSR-E SDW (AMSR-E SST) derived Weibull energy density

(c) AMSR-E SDW (NGSST) derived Weibull energy density

Fig.3 Comparison of AMSR-E derived Weibull energy density with and without consideration of atmospheric stability (10m height, AMSR-E SST and NGSST)

Purpose

1. To develop evaluation methods for offshore wind energy resources using AMSR-E and SeaWinds (2012)
2. To investigate the atmospheric stability effect on wind energy resources using AMSR-E SST and NGSST products (2013)
3. To develop evaluation methods for offshore wind energy resources using AMSR-E , AMSR2 derived wind speed (2014)



KEO buoy (Measurement height 4m, http://www.pmel.noaa.gov/keo/)

JKEO buoy (Measurement height 4m,http://www.jamstec.go.jp/iorgc/ocorp/ktsfg/data/jkeo/

Wind speed at KEO,JKEO buoys at 4m → Equivalent Neutral Wind speed at 10m → Stability dependent Wind speed at 10m

LKB code (Tang and Liu, 1996)

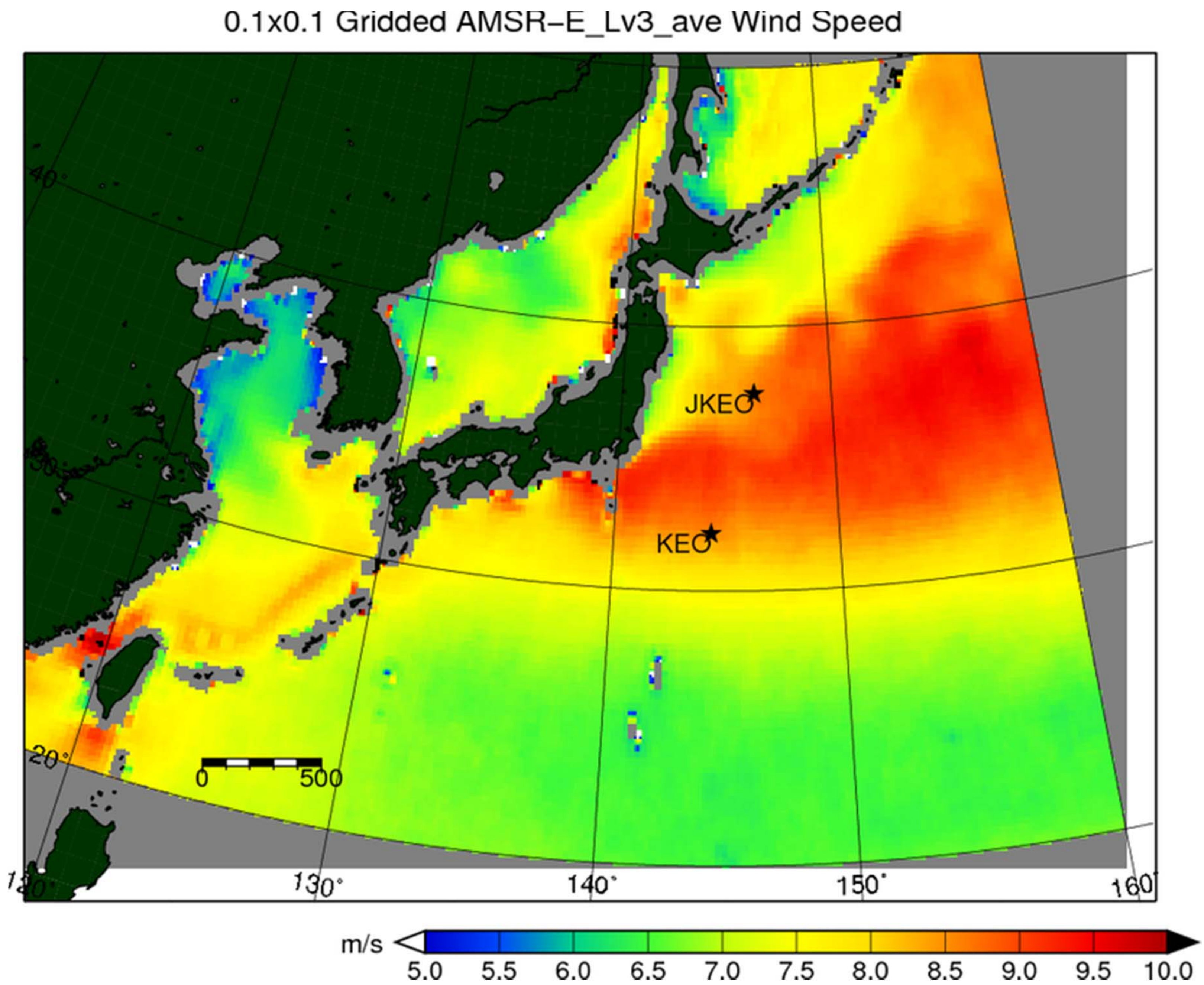


Fig.4 Location of KEO and JKEO

Table 1 Configuration of WRF

Period	2009/4/11-2011/4/10
Input data	JMA Meso Analysis(every 3hours 、 5km×5km)
	OSTIA SST(every 24hours、 0.05°×0.05°)
Area	10km×10km、 350×280 grid
Vertical grid	21 layers
FDDA	Effective
Physics configuration	Dudhia shortwave scheme
	RRTM longwave scheme
	Eta micorophysics scheme
	Betts-Miller-Janjic scheme
	Mellor-Yamada-Janjic scheme
	unified Noah land-surface model

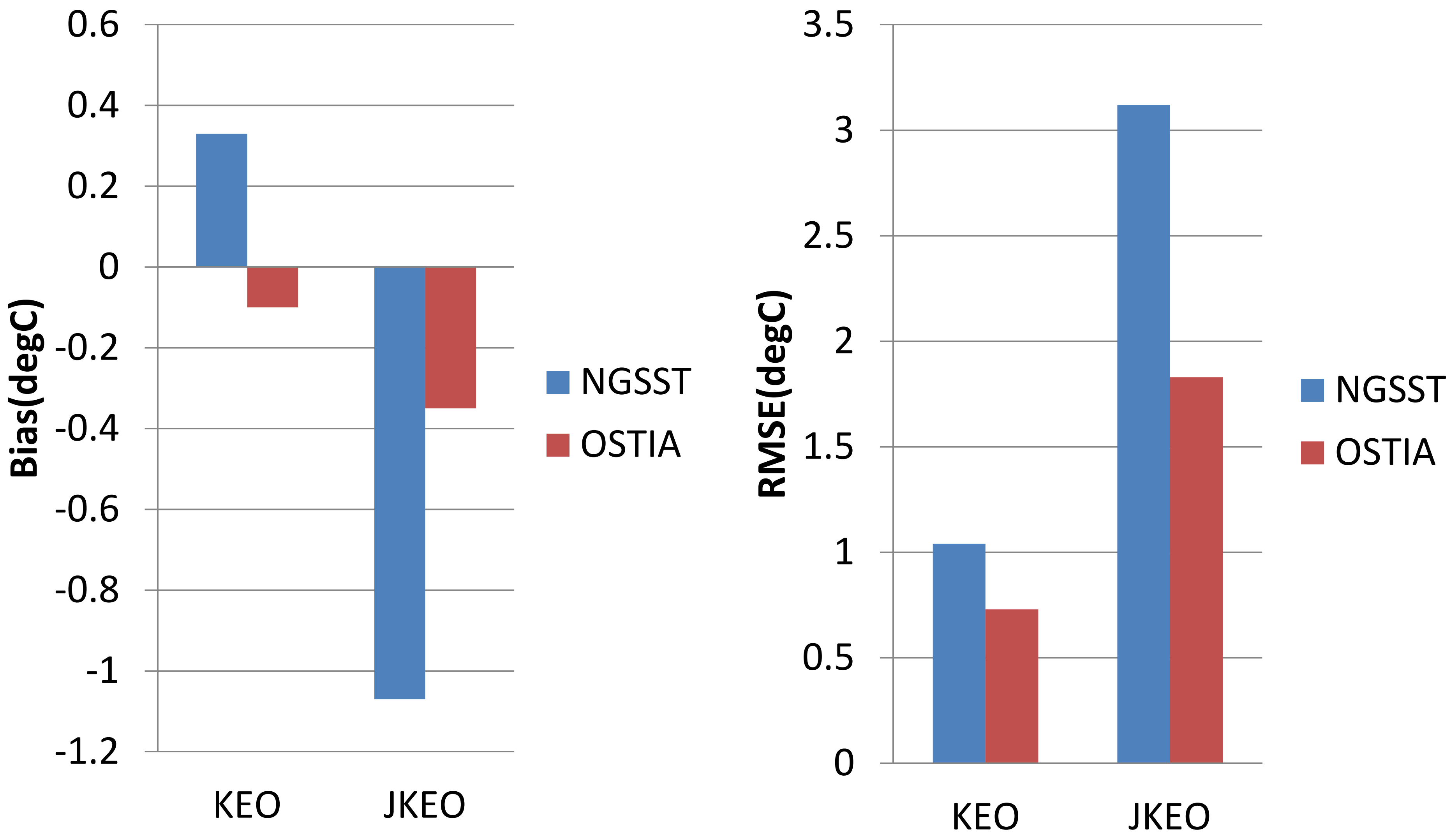
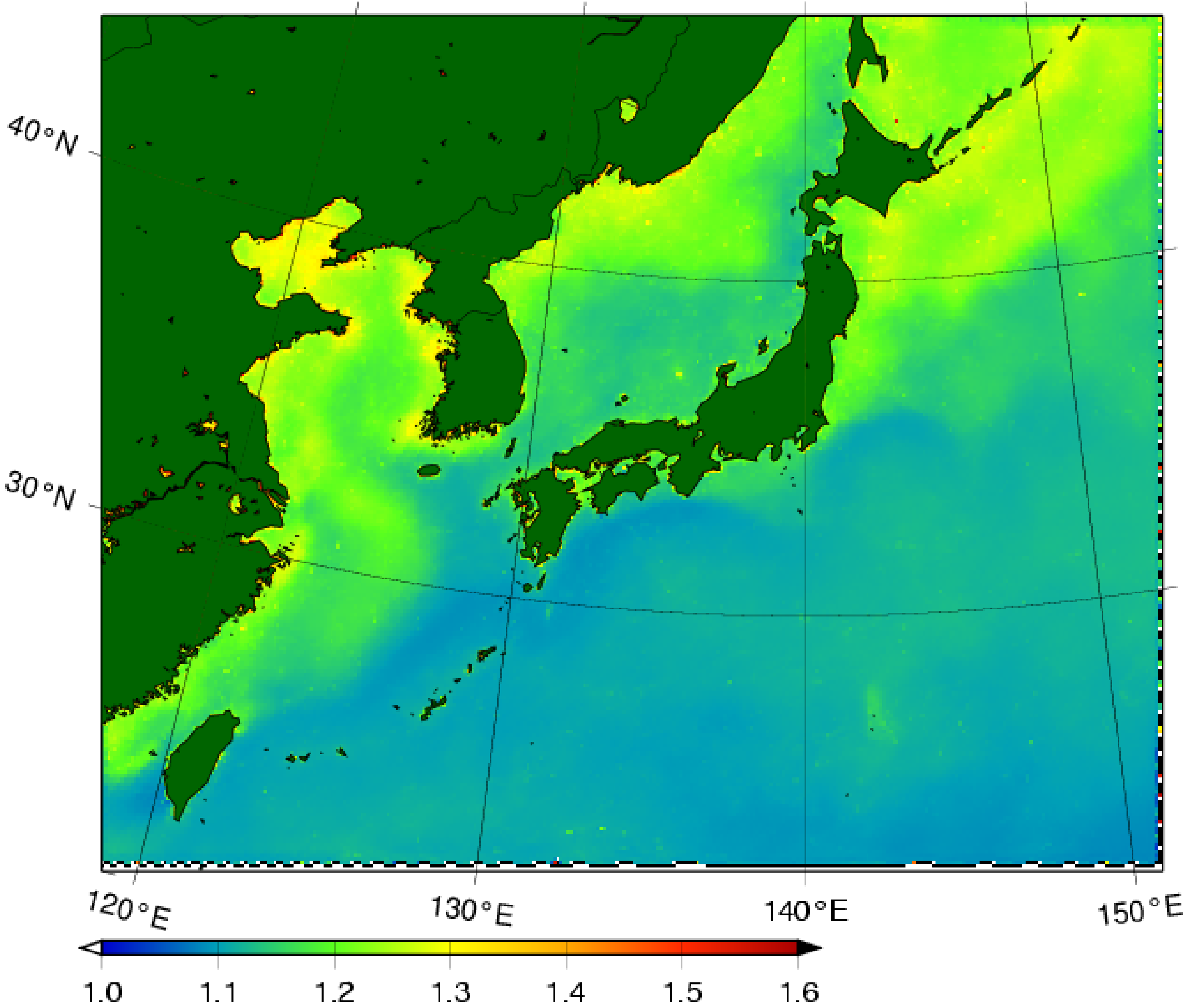


Fig.5 Validation results of NGSST and OSTIA against KEO and JKEO (2007-08)



80m wind speed = 10m wind speed x ratio (80/10m wind speed)

Fig.6 Wind speed ratio between 10 and 80m height derived from WRF.

Statistical models based on Weibull parameter

Weibull probability density function

$$f(v) = \frac{k}{A}\left(\frac{v}{A}\right)^{k-1} Exp\left(-\left(\frac{v}{A}\right)^{k}\right)$$

where v:wind speed, k: shape, A: scale

Weibull mean wind speed

$$V_m = \int_0^\infty v f(v) dv \Rightarrow V_m = A\Gamma(1+\frac{1}{k})$$

Γ : Gamma function

Available energy density (W/m²)

$$P_v = \frac{1}{2}\rho_a v^3$$

Available energy density for all wind speed (W/m²)

$$E_d = \int_0^\infty P_v f(v) dv \Rightarrow E_d = \frac{\rho_a A^3}{2}\Gamma(1+\frac{3}{k})$$

Table 2 Study period of in situ, mesoscale model and satellites

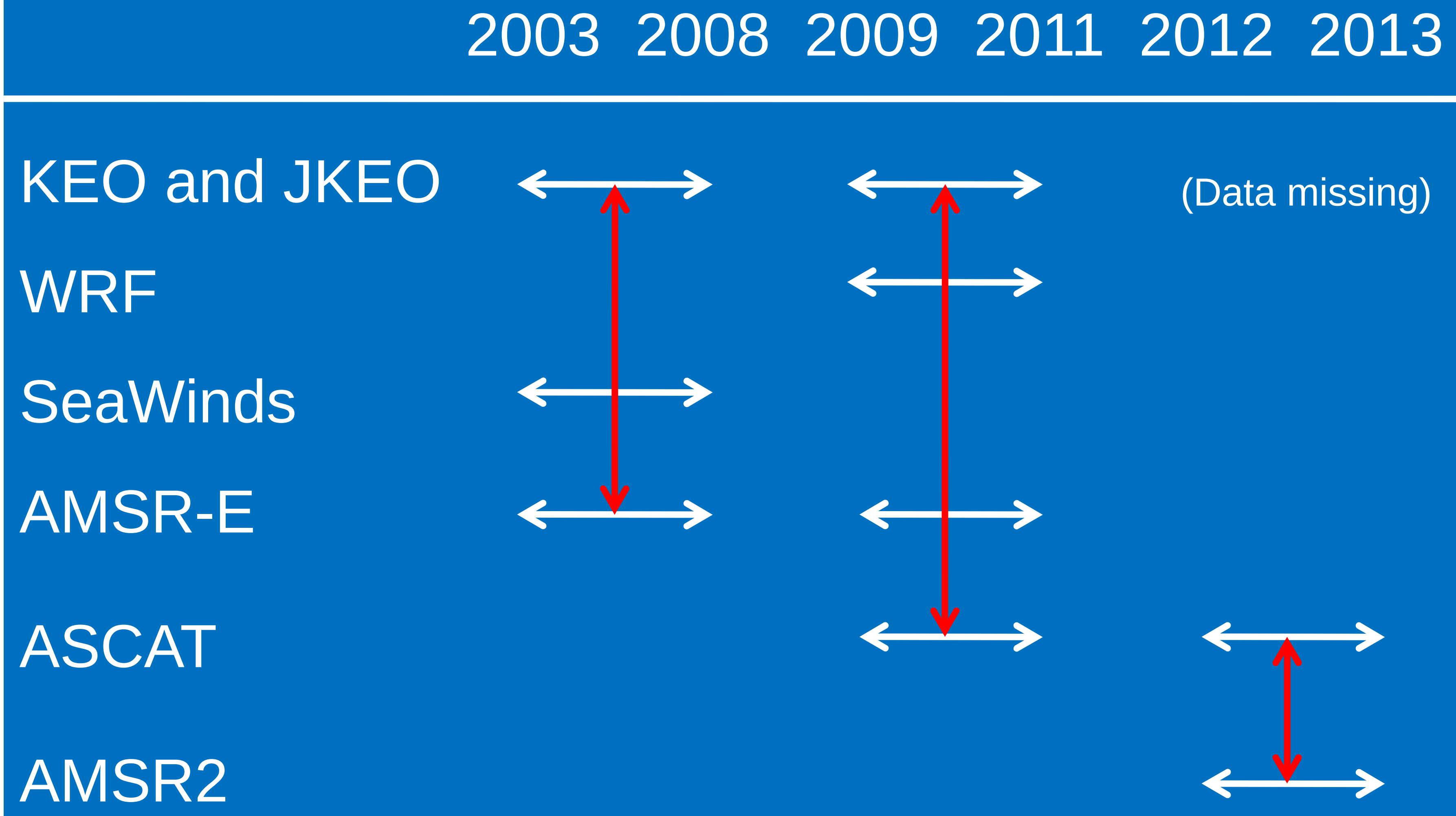
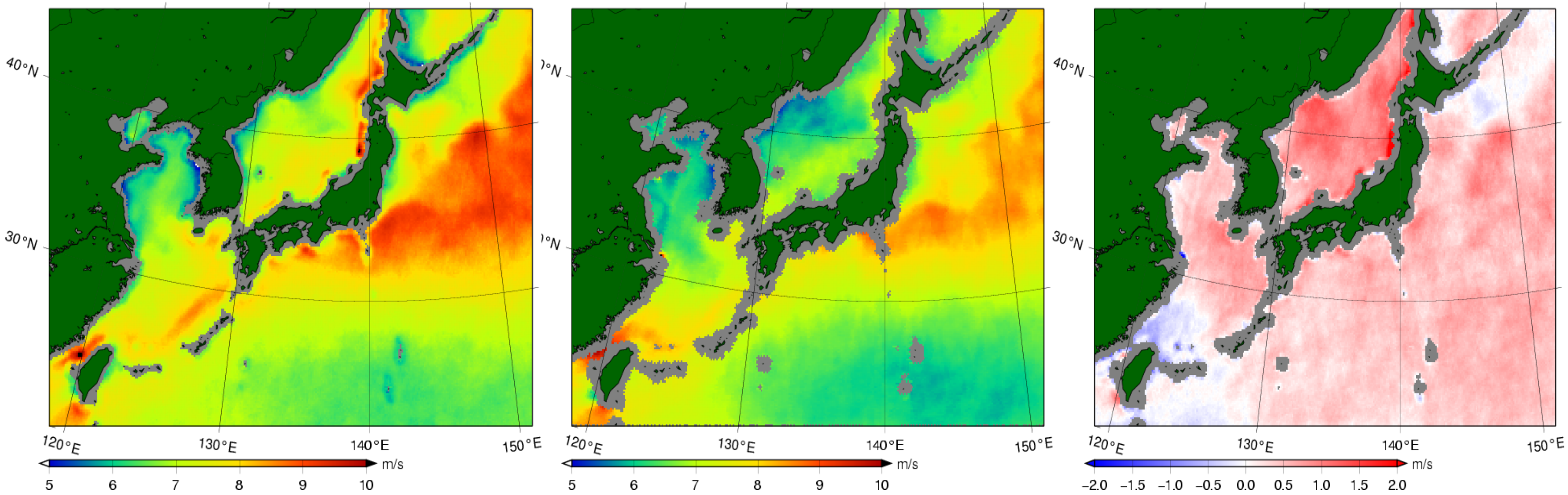


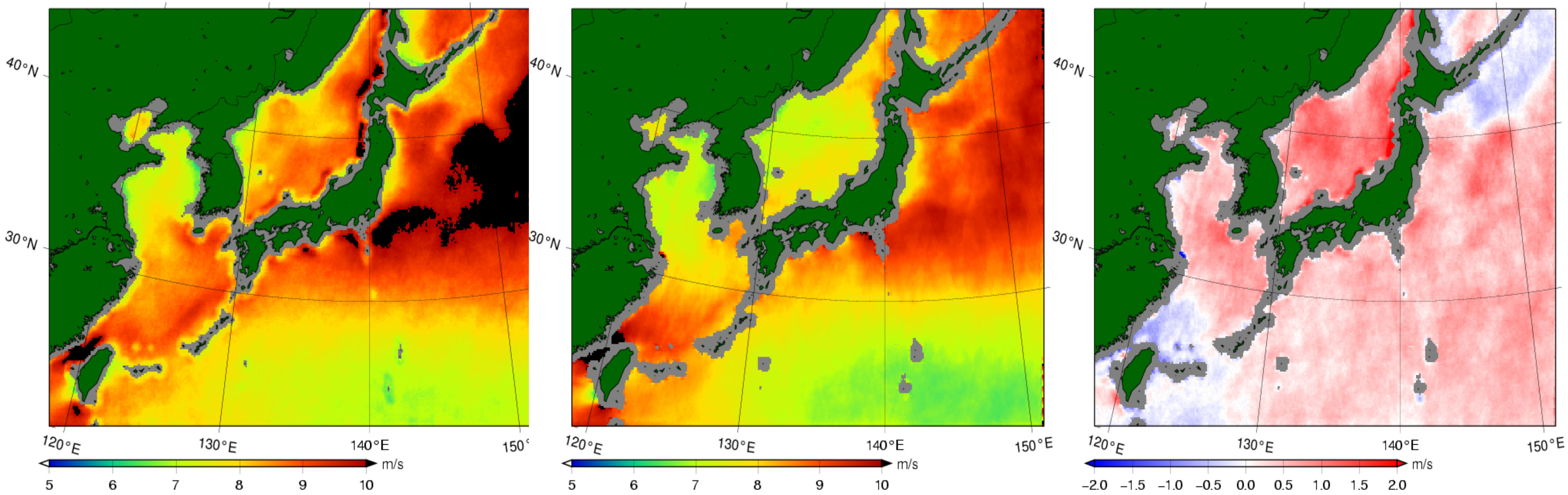
Table 3 Satellite-derived wind speed estimates and statistics

	10m Wind speed	10m Energy density	80m Wind speed	80m Energy density
AMSR-E	○ 2009-11	○ 2009-11	○ 2009-11	○ 2009-11
AMSR2	○ 2012-13	○ 2012-13	×	×
ASCAT	○ 2009-11 2012-13	○ 2009-11 2012-13	○ 2009-11	○ 2009-11



AMSR-E **ASCAT** **AMSR-E minus ASCAT**

Fig.7 Comparison between AMSR-E and ASCAT derived wind speed(2009/04/11 - 2011/04/10 mean, 10m height)



AMSR-E **ASCAT** **AMSR-E minus ASCAT**

Fig.8 Comparison between AMSR-E and ASCAT derived wind speed (2009/04/11 - 2011/04/10 mean, 80m height)

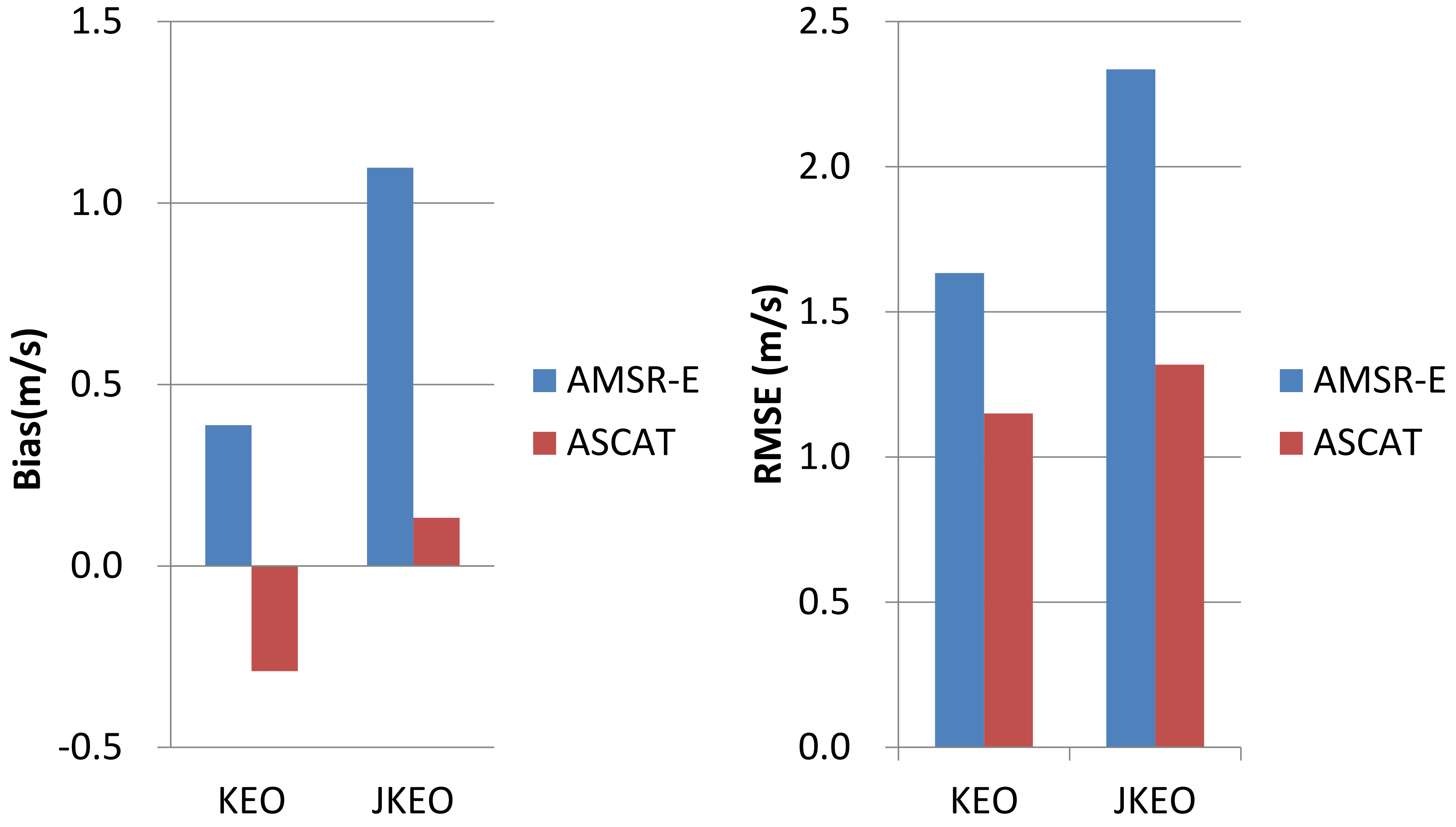
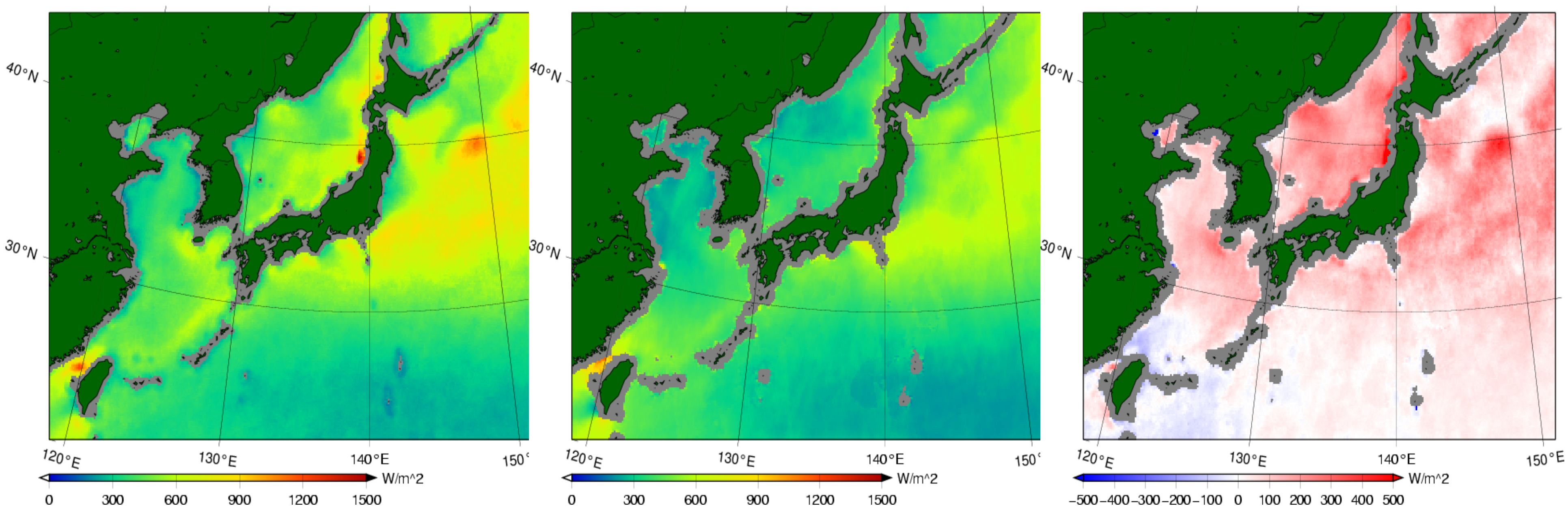
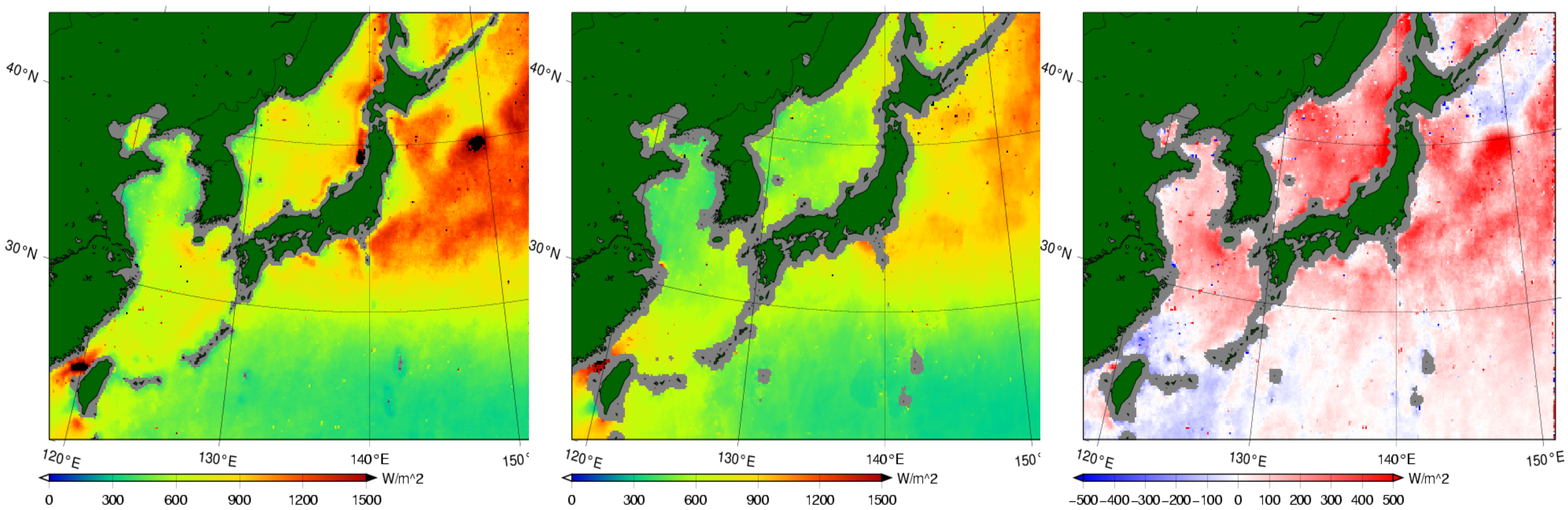


Fig.9 Validation results of AMSR-E and ASCAT against KEO and JKEO (10m height, 2009-11)



AMSR-E **ASCAT** **AMSR-E minus ASCAT**

Fig.10 Comparison between AMSR-E and ASCAT derived mean energy density (2009/04/11 - 2011/04/10 mean, 10m height)

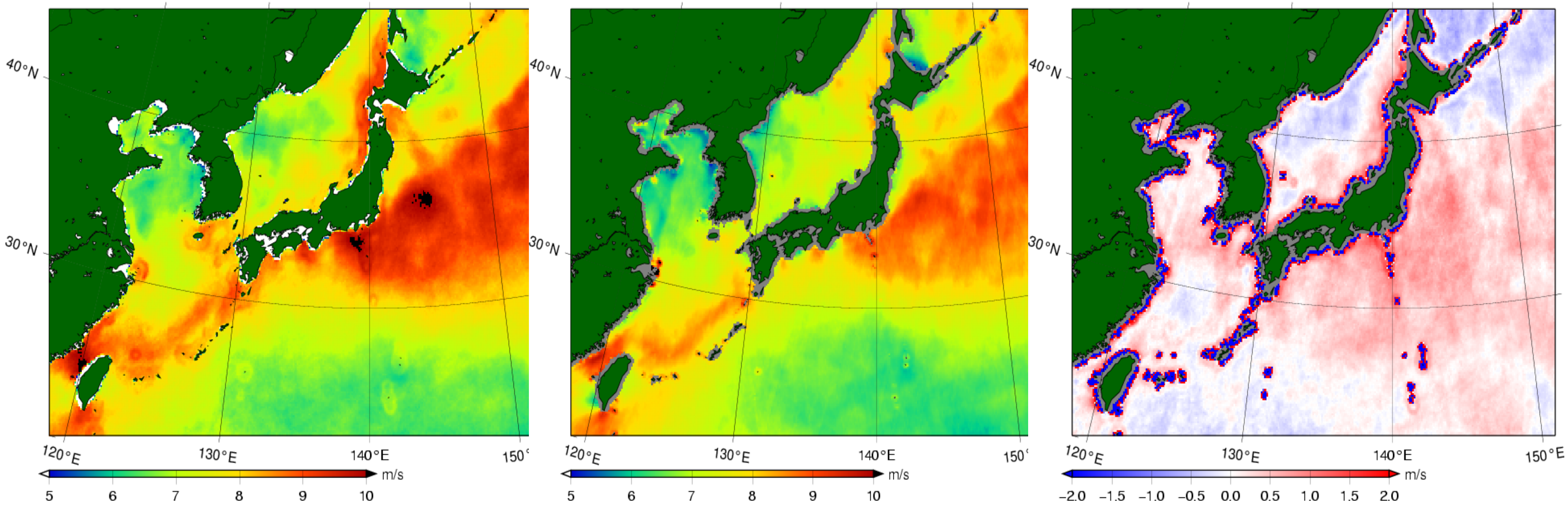


AMSR-E

ASCAT

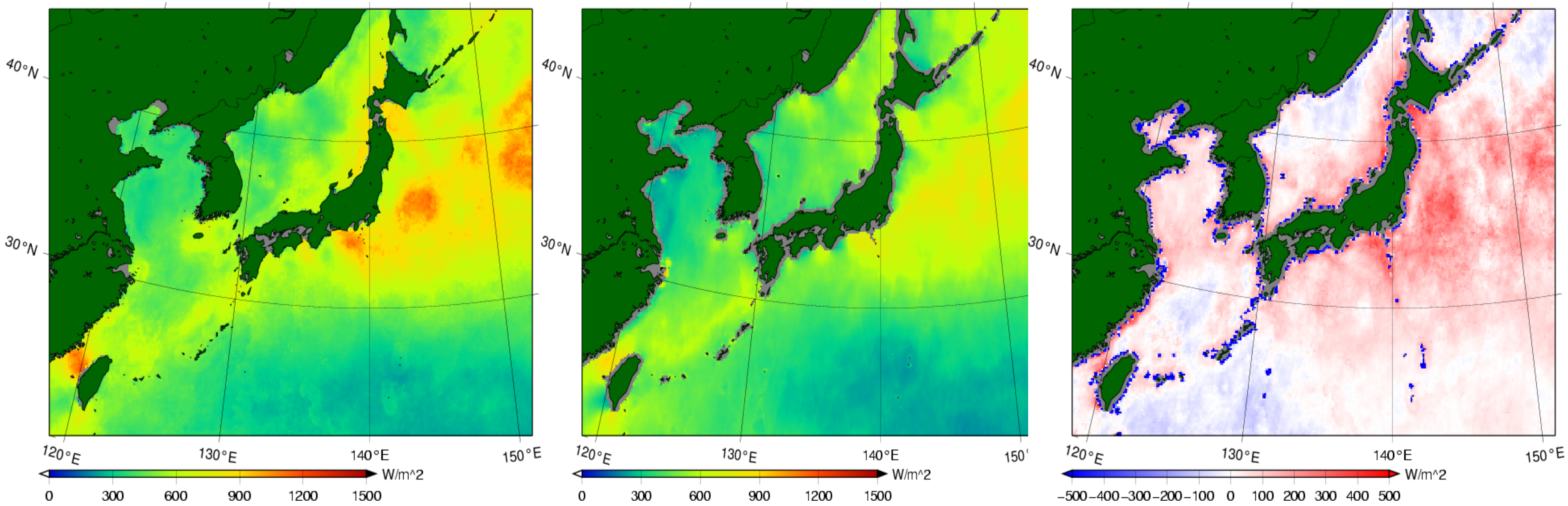
AMSR-E minus ASCAT

Fig.11 Comparison between AMSR-E and ASCAT derived mean energy density (2009/04/11 - 2011/04/10 mean, 80m height)



AMSR2 **ASCAT** **AMSR2 minus ASCAT**

Fig.12 Comparison between AMSR2 and ASCAT derived wind speed(2012/07/03 - 2013/07/02 mean, 10m height)



AMSR2 **ASCAT** **AMSR2 minus ASCAT**

Fig.13 Comparison between AMSR2 and ASCAT derived mean energy density (2012/07/03 - 2013/07/02 mean, 10m height)

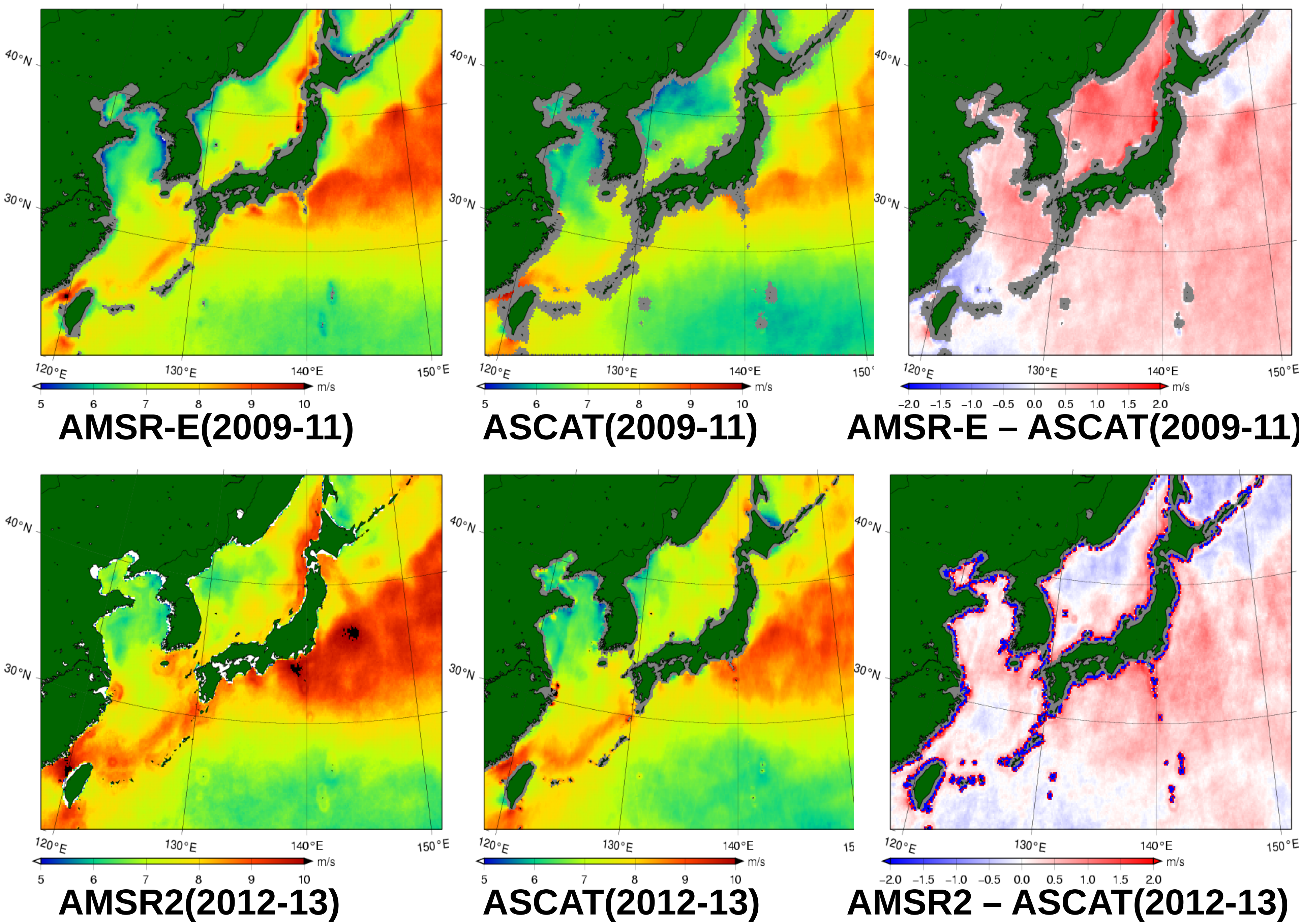


Fig.14 Comparison of AMSR-E and AMSR2-derived wind speed at 10m height

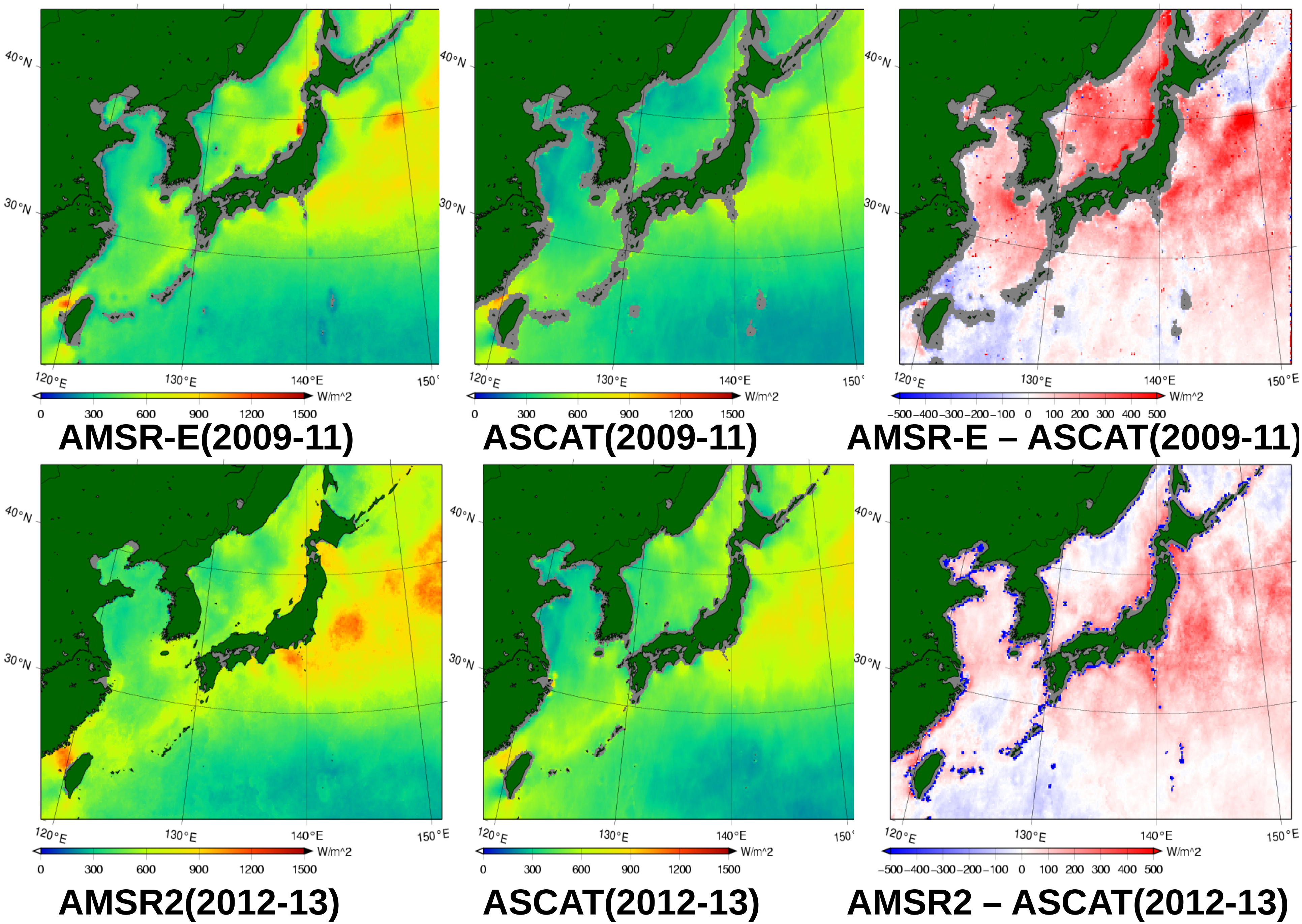


Fig.15 Comparison of AMSR-E and AMSR2-derived energy density at 10m height

Summary

(1) Comparison of wind resource maps shows mean wind speed difference between AMSR-E and SeaWinds are mostly within ±0.5m/s.(2012)

(2) Weibull energy density with consideration of atmospheric stability using AMSR-E SST and NGSST is close to the one derived from JKEO buoy.(2013)

(3) Validation results indicate that bias and RMSE of AMSR-E wind speeds are higher than those of ASCAT. Wind speed differences of AMSR2 and ASCAT are getting smaller than those of AMSR-E and ASCAT. (2014)

Acknowledgements

AMSR-E , AMSR2 wind speed products (Level 2,3) were provided by EORC, JAXA. Wind speed and direction, air and sea surface temperature, relative humidity data at the KEO and JKEO buoys were provided by Pacific Marine Environmental Laboratory, NOAA and Japan Agency for Marine-Earth Science and Technology respectively. This study is supported by a Grant-in-Aid for Scientific Research (B) 22360379 from the Ministry of Education, Science, Sport and Culture, Japan.