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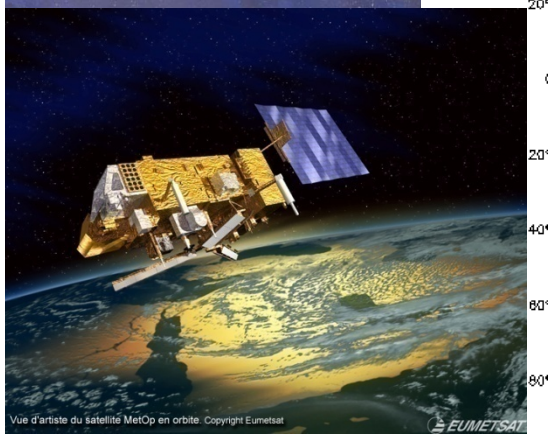
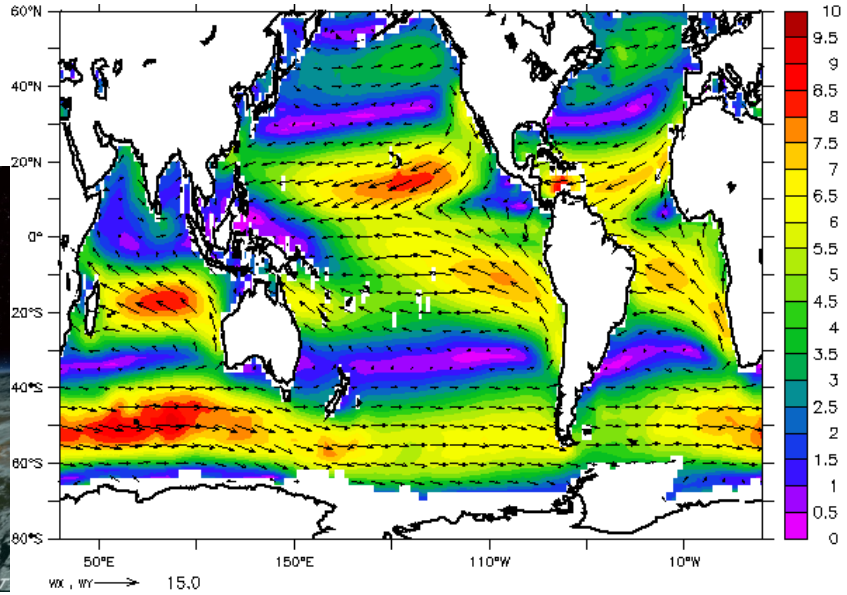
May 6, 2013

Detection of the Weakening Westerly Winds in the North Pacific Ocean using Satellite-derived Wind Data Set/J-OFURO in Recent Decade

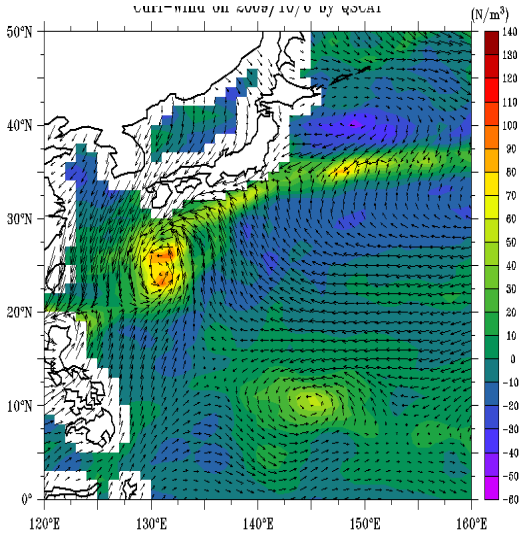
Kunio Kutsuwada, Suguru Kameda and Koh Kamemura
(Tokai University, Japan)



【Surface Wind Vector Field】



【Curl of Wind Field】



Our Data Server for the Satellite-derived Surface Flux Products in J-OFURO
Japanese - Ocean Flux Data Sets with Use of Remote-Sensing Observations

Gridded Product of Surface Wind/Wind-stress Field
using Satellite Scatterometer Data

Parameter : Surface Wind / Wind-stress Vectors

Region : World Ocean (60ºN-80ºS, 0ºE - 0ºW)

Spatial Resolution : 1º x 1º grid

J-OFURO : surface flux data ***http://dtsv.scc.u-tokai.ac.jp/j-ofuro/***

Time Resolution : Daily

Period: **Aug. 1999 - Oct. 2009 Qscat/SeaWinds (Ver.2)**

Apr. 2009 - Dec. 2012 MeTOP/Ascat

Updating Ascat Data

Constructing QSCAT V3 Data

Outline

Introduction of (*QSCAT/J-OFURO*)
Gridded products of surface parameters over global ocean derived by satellite data
Validation & inter-comparison with other products

Background of this study about climatec change of Wind Field

Results
Evidence of Weakening Westerly Winds in the North Pacific

Summary

Extension of our analysis using *ASCAT* data

Validation by Comparison with In-situ Measurements

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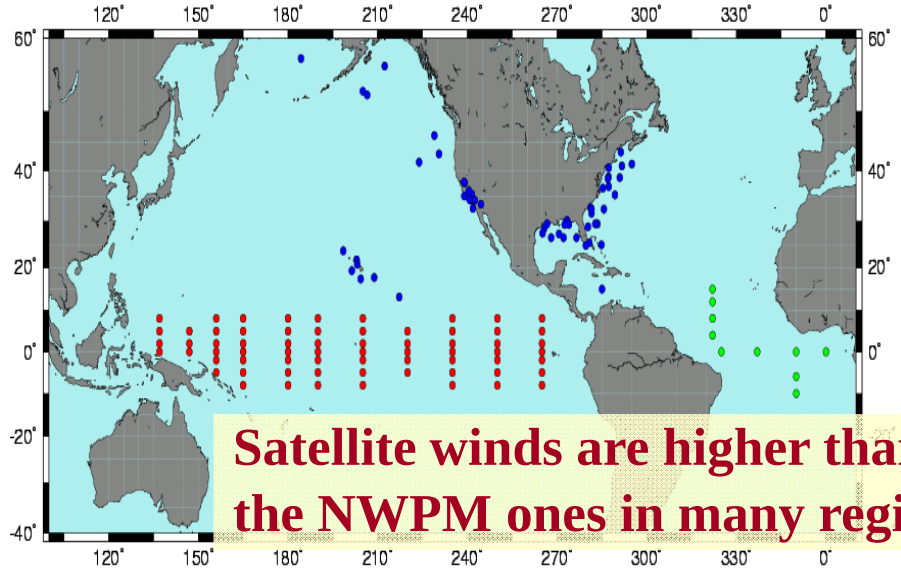
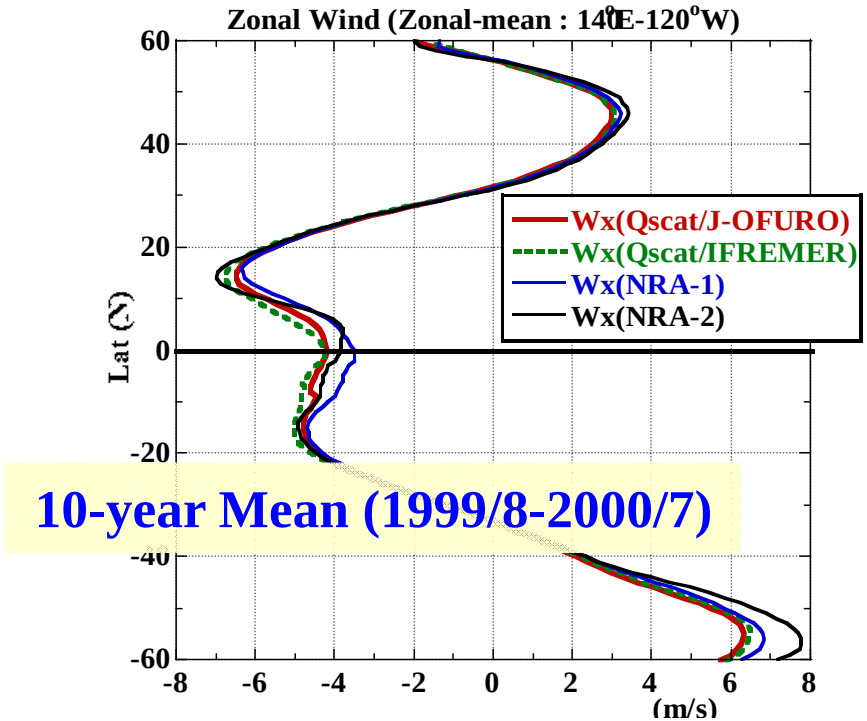


Satellite winds are higher than the NWPM ones in many regions.

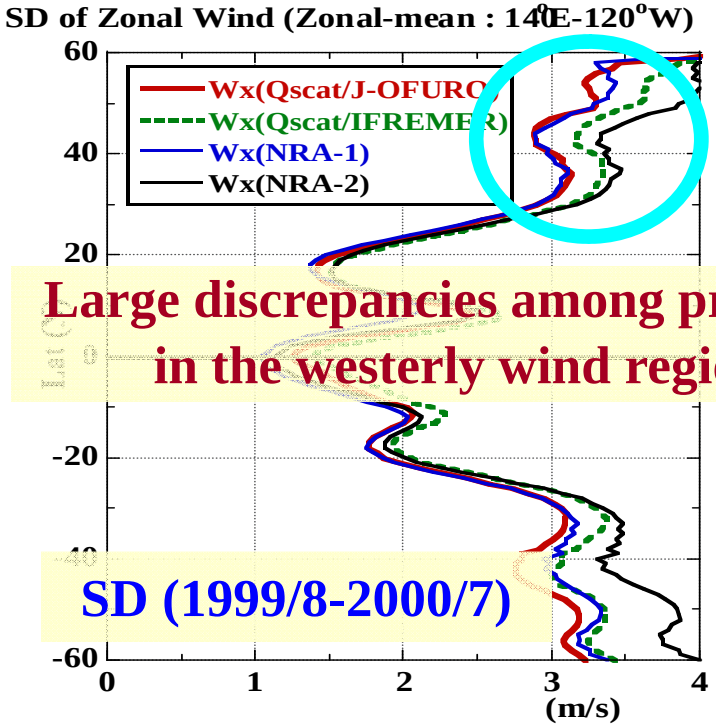
Correlation

RMSD		All	Extension	West	Trop. Pac. Cent-East	Mid-Pac.	East Pac.	Atlantic West	Tropical Atlantic
			KEO	TRAITON	TAO	NDBC	NDBC	NDBC	PIRATA
Zonal wind	J-OFURO	0.907	0.907	0.929	0.912	0.934	0.879	0.909	0.881
	IFREMER	0.863	0.941	0.860	0.860	0.930	0.857	0.886	0.801
	NRA1	0.773	0.740	0.851	0.742	0.833	0.745	0.844	0.693
	NRA2	0.818	0.926	0.896	0.776	0.890	0.790	0.918	0.714
Meridional wind	J-OFURO	0.898	0.884	0.879	0.896	0.861	0.923	0.916	0.871
	IFREMER	0.896	0.934	0.852	0.895	0.874	0.928	0.919	0.863
	NRA1	0.735	0.744	0.780	0.661	0.723	0.831	0.865	0.631
	NRA2	0.766	0.935	0.807	0.665	0.777	0.910	0.927	0.640

Intercomparison among different Gridded Products



10-year Mean (1999/8-2000/7)



Large discrepancies among products in the westerly wind region

SD (1999/8-2000/7)

Our Flux Products

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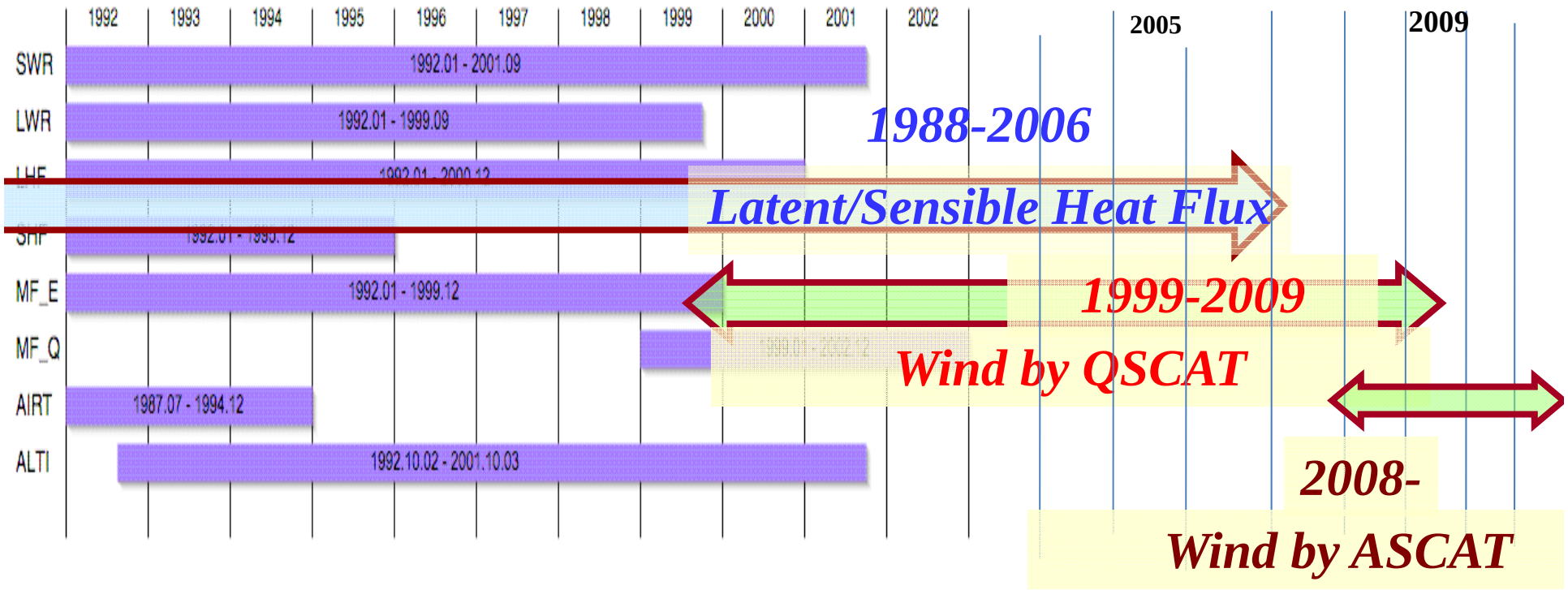
Period of Available Data Set



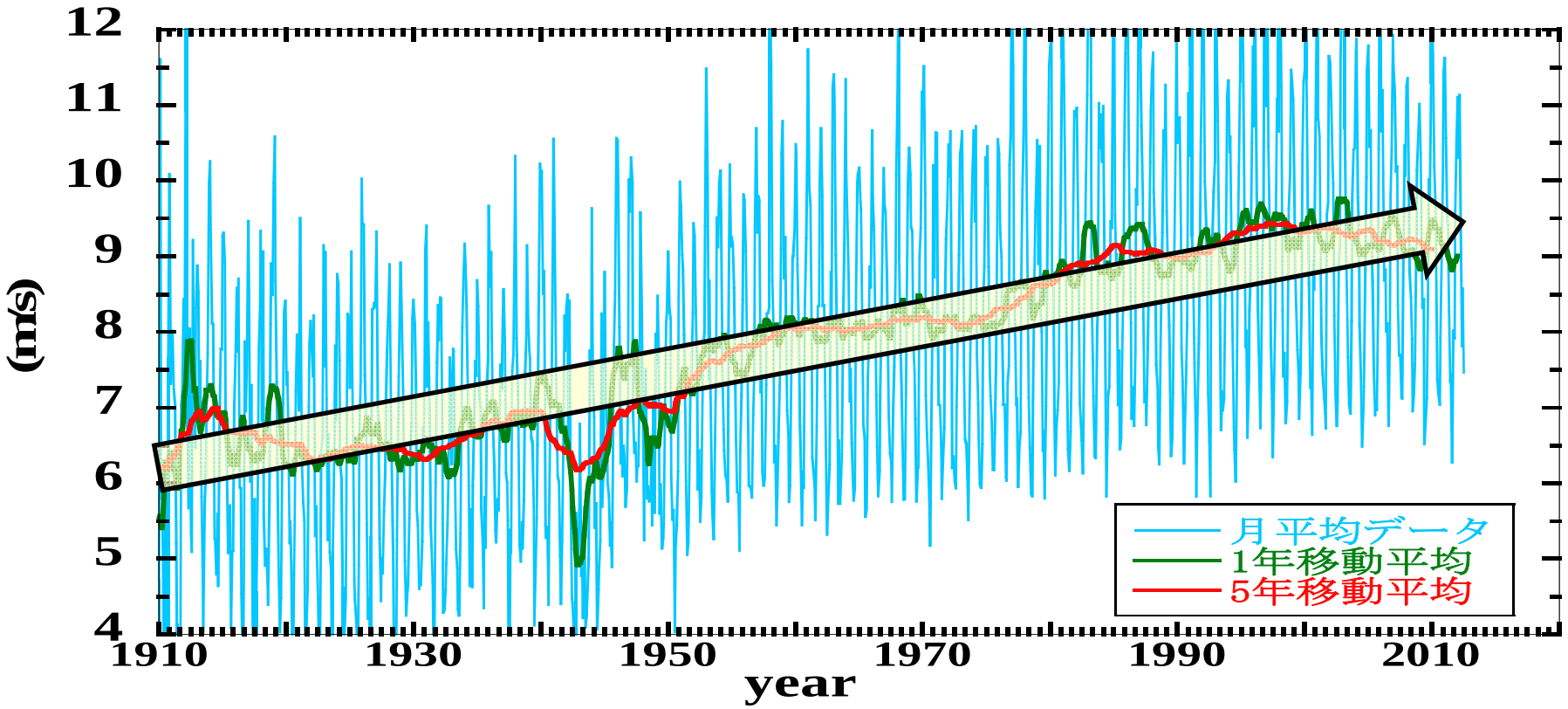
LHF : Latent Heat Flux
SHF : Sensible Heat Flux

MF_Q : Momentum Flux (Qscat)

Previous Study focusing on Climatec Wind Changes

Yang et al (2011) : Global Trends in Wind Speed and Wave Height
Satellite altimeter data : Increasing trend in wind speed and wave height (1985 - 2008)

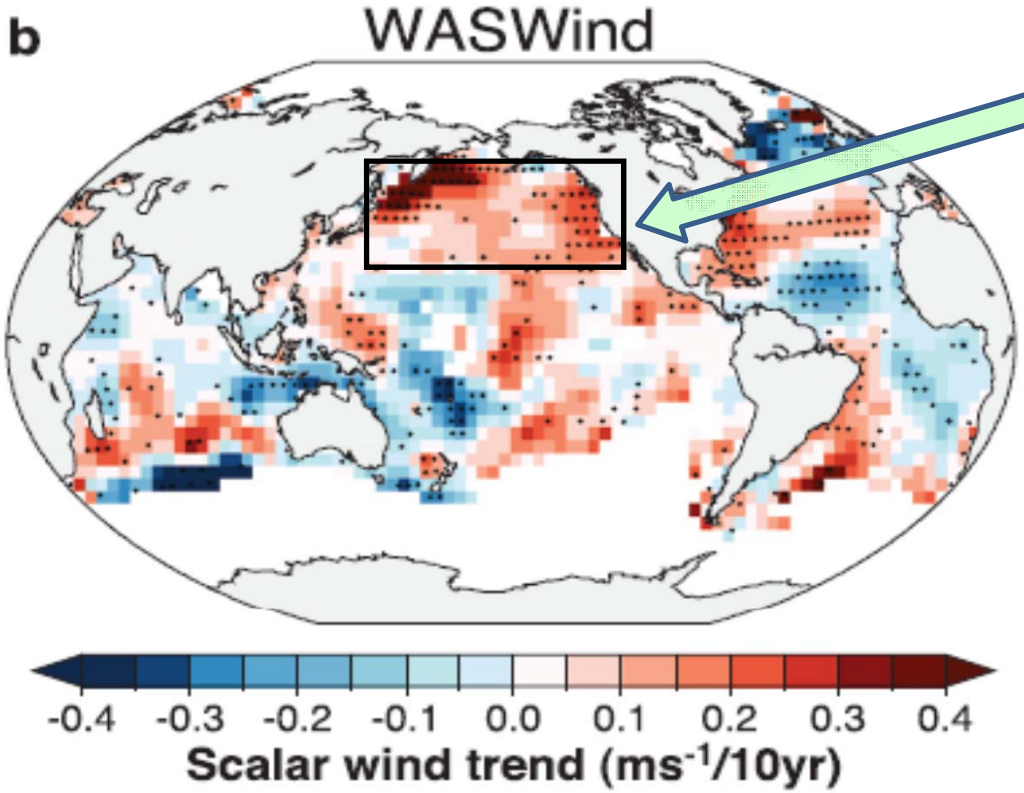
Merrifield and Maltrud (2011): Regional sea level trends
due to a Pacific trade wind intensification (2000 - 2008)



Evidences of increasing wind speed in may regions
→ investigate long-term signals in the North Pacific using new record

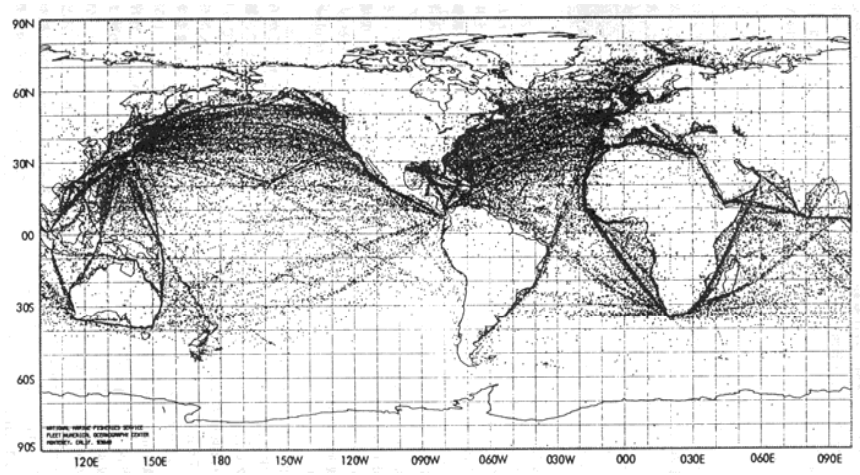
Previous Study focusing on Long-term Wind Changes

Wave- and Anemometer-Based Sea Surface Wind (WASWind)
for Climate Change Analysis (Tokinaga and Xie, 2011)
Correction for error soureces due to ship measurements
→ revaluate long-term changes in wind speed



July 1987 to August 2006

Increasing wind speed in the North Pacific



Reliability depend on shipping routes

J-OFURO Westerly Wind region of the North Pacific

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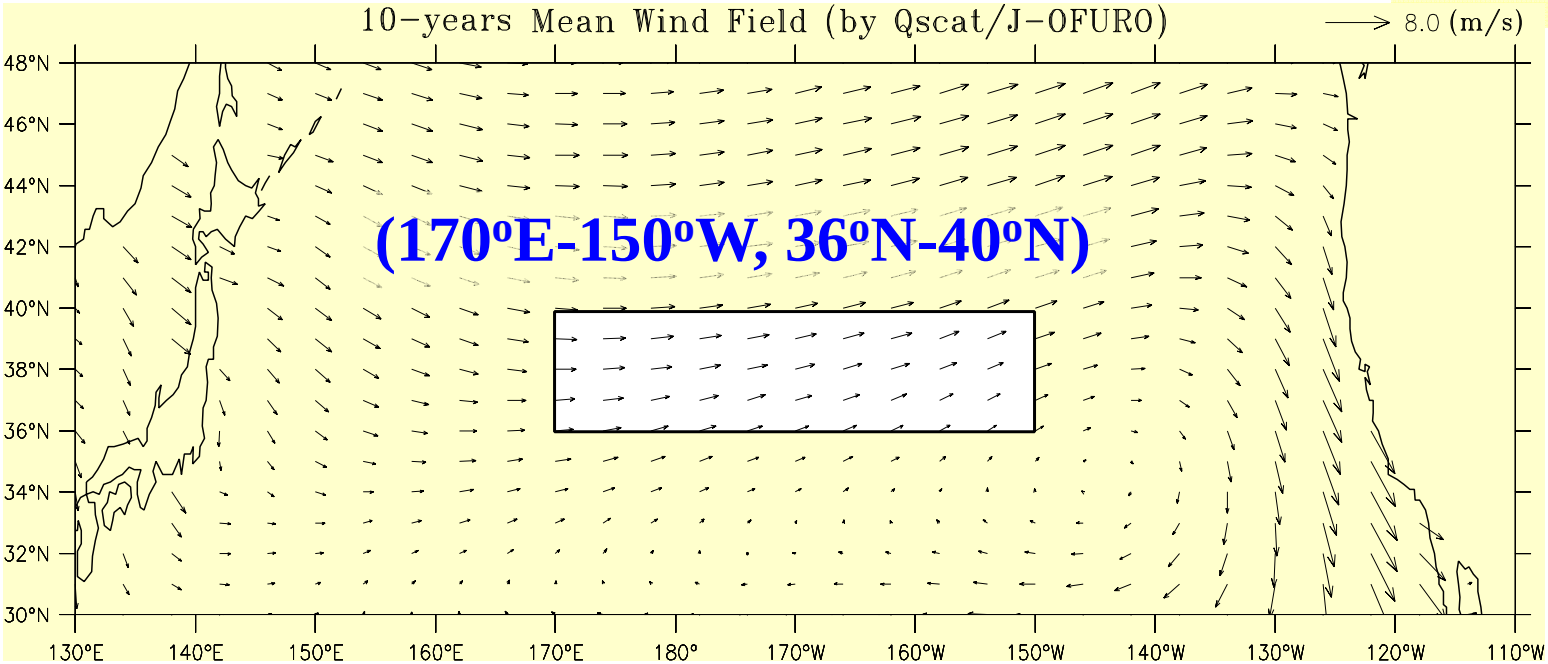
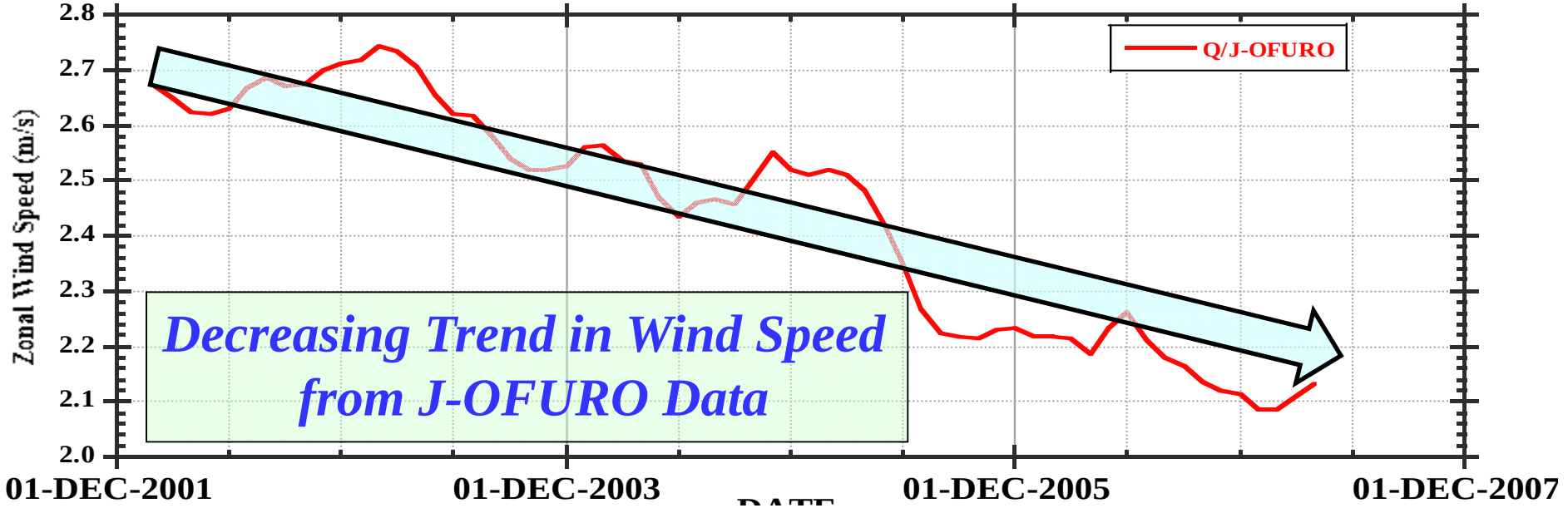


Time series (5-yr RM) of Zonal Wind in the Westerly Wind Region



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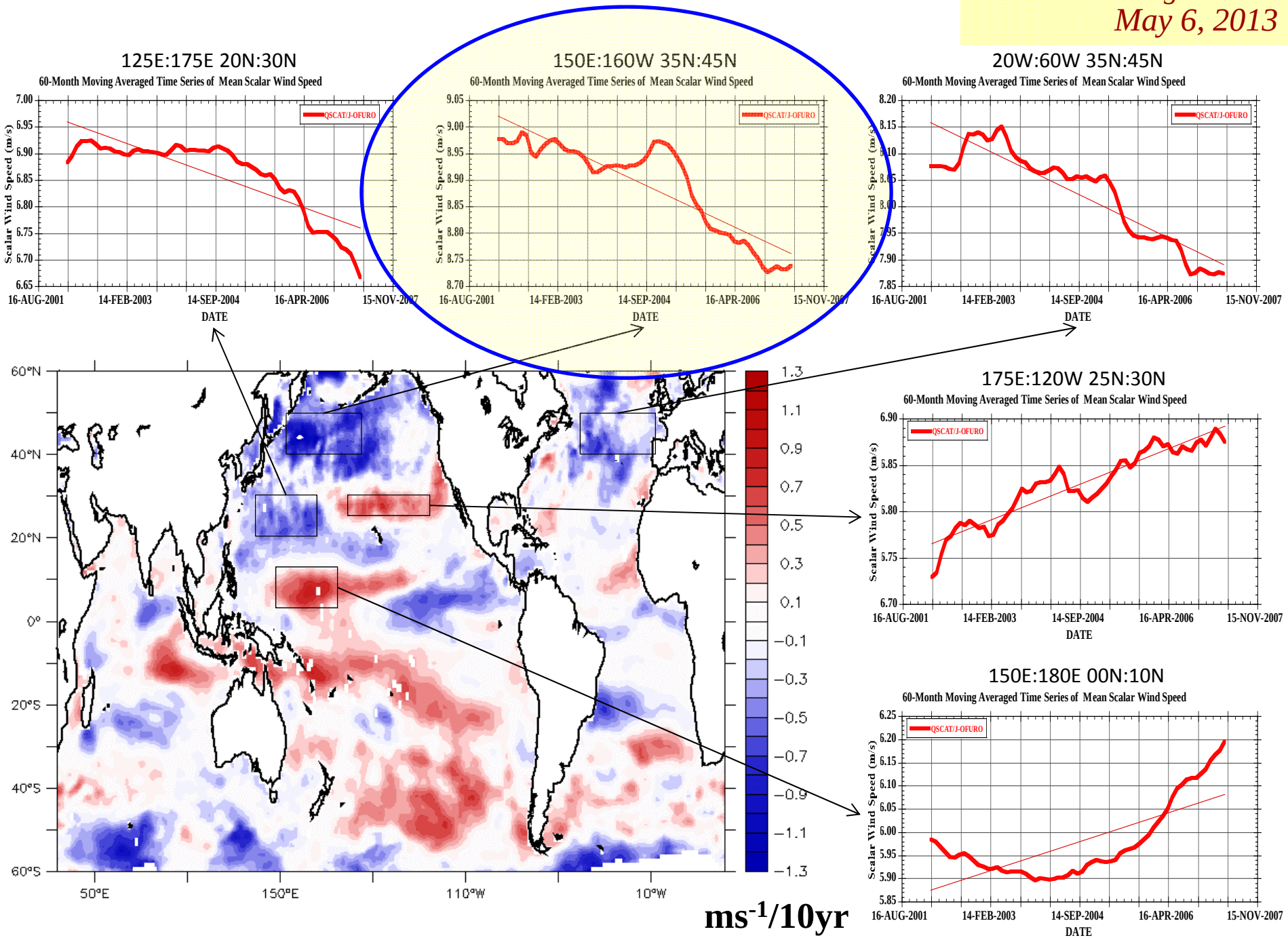
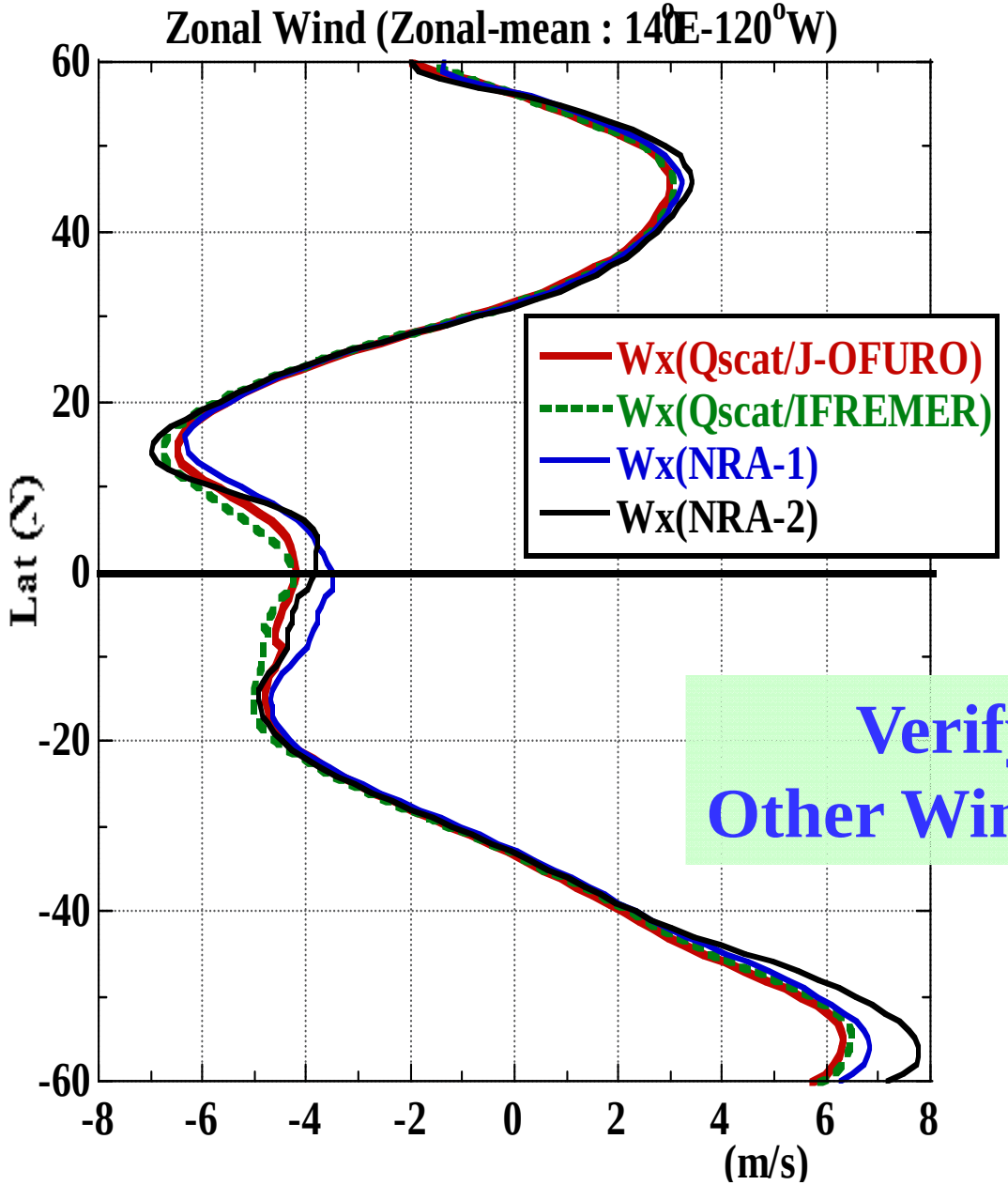
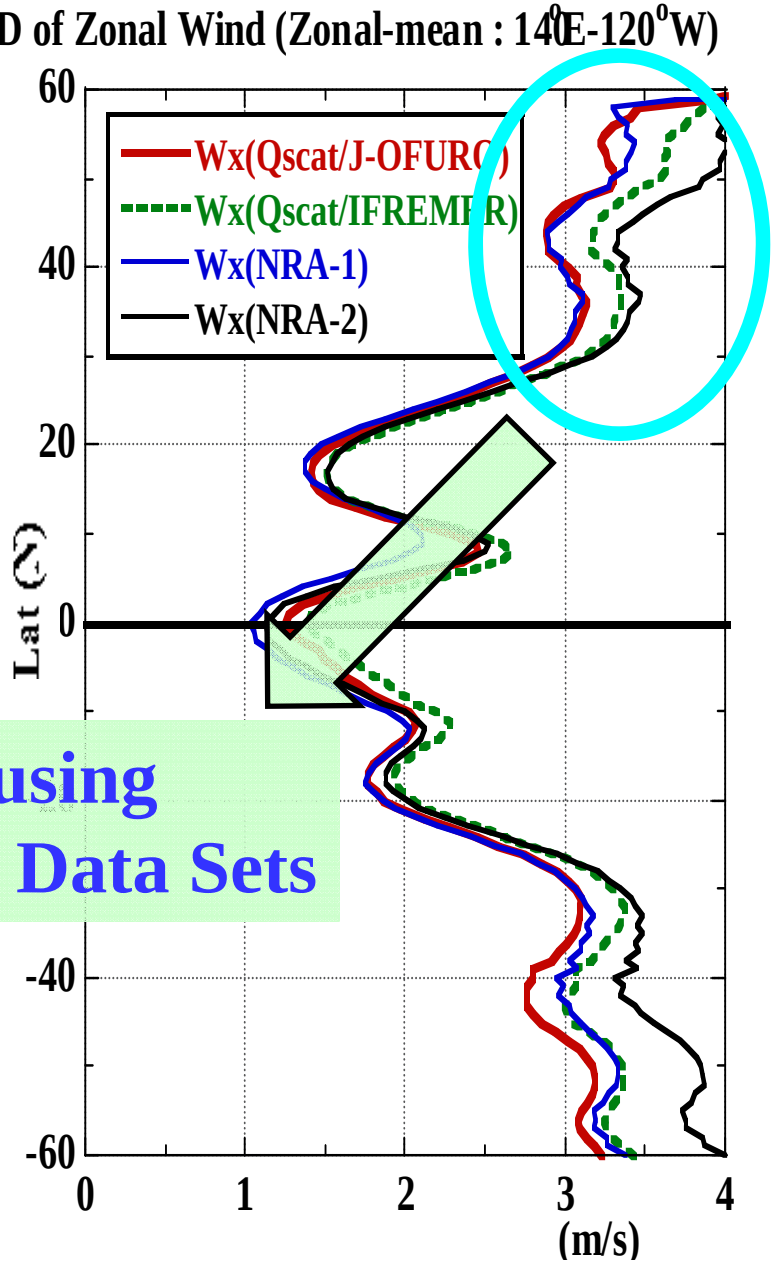


Intercomparison among different Gridded Products
10-year Mean (1999/8-2000/7) & SD





Verify using
Other Wind Data Sets

Date Sets used in This Study

Satellite Wind

QSCAT/J-OFURO V2 (1999/8 ~ 2009/10, monthly, $1^{o} \times 1^{o}$)

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

Ship-measured Wind

ICOADS (1800/1 ~ current, monthly,$1^{o} \times 1^{o}$)

http://icoads.noaa.gov/products.html

WASwind (1950/1 ~ 2009/12, monthly,$4^{o} \times 4^{o}$)

http://iprc.soest.hawaii.edu/users/tokinaga/waswind.html

Numerical Model Winds

NCEP -1 (1948/1 ~ current, monthly, Gaussian grid)

http://database.rish.kyoto-u.ac.jp/arch/ncep/data/ncep.reanalysis.derived/

NCEP -2 (1979/1 ~ current, monthly, Gaussian grid)

http://database.rish.kyoto-u.ac.jp/arch/ncep/data/ncep.reanalysis2.derived/

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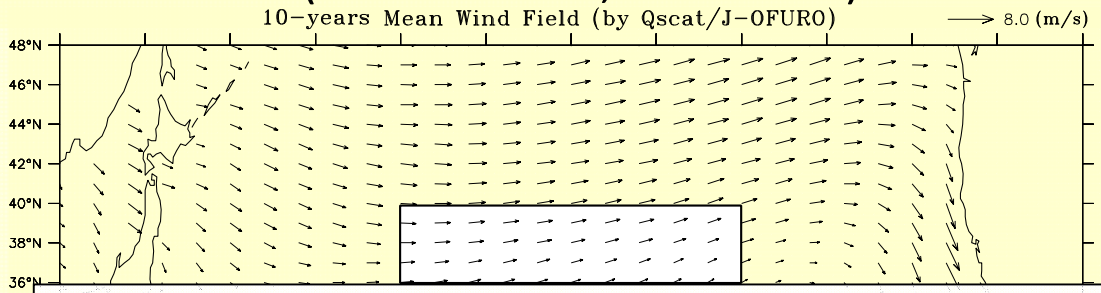
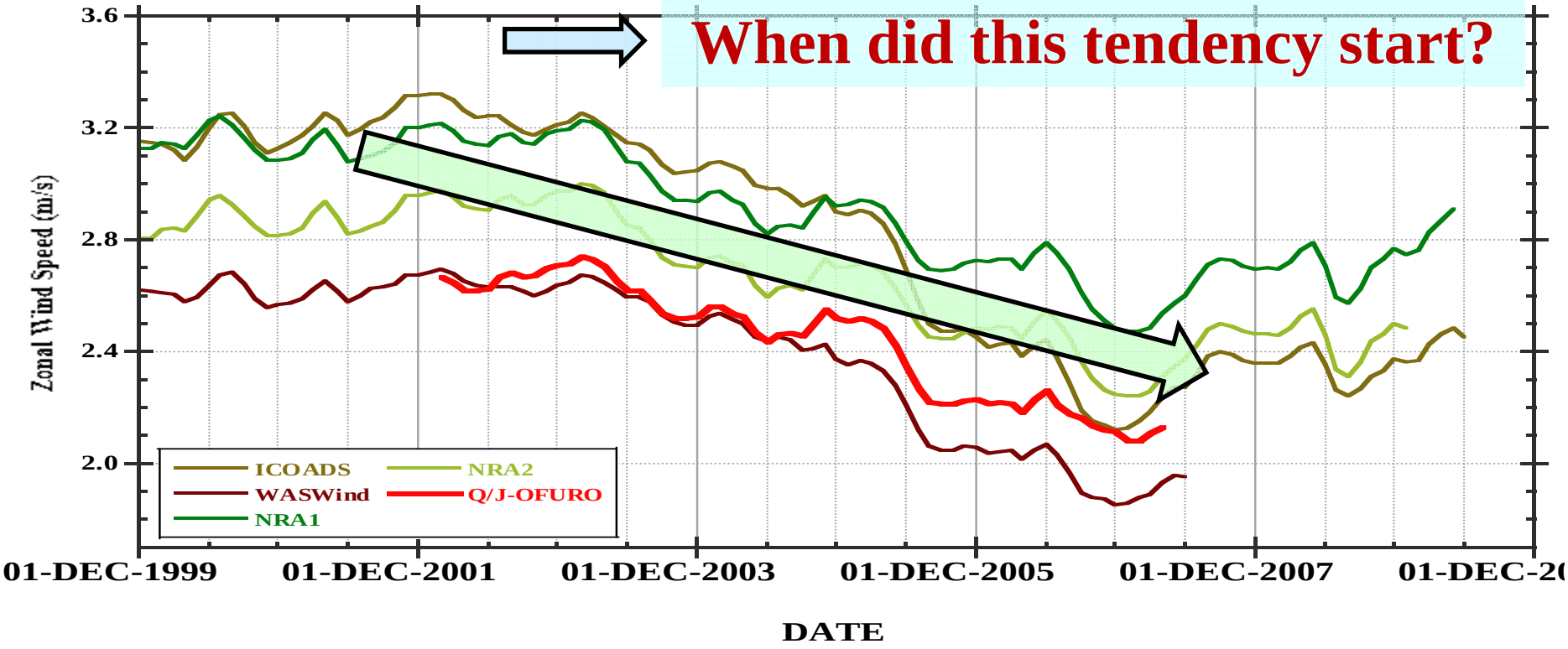
(170°E-150°W,36°N-40°N)



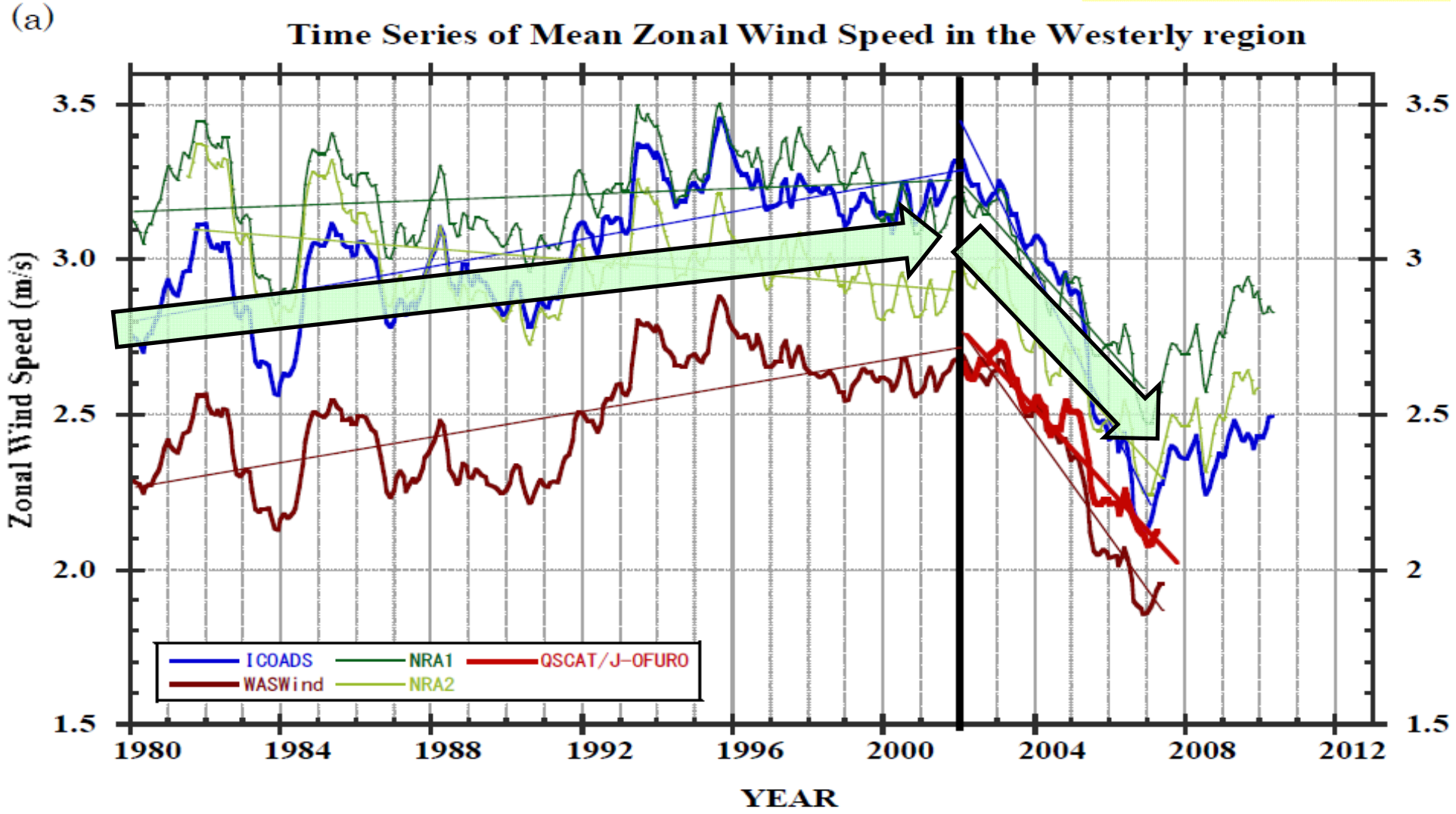
Even if there are, more or less, discrepancies among wind data sets, we can find tendencies of weakening westerly winds since the beginning of 2000s.

60-Month Moving Averaged Time Series of Mean Zonal Wind Speed of Westerline region

When did this tendency start?

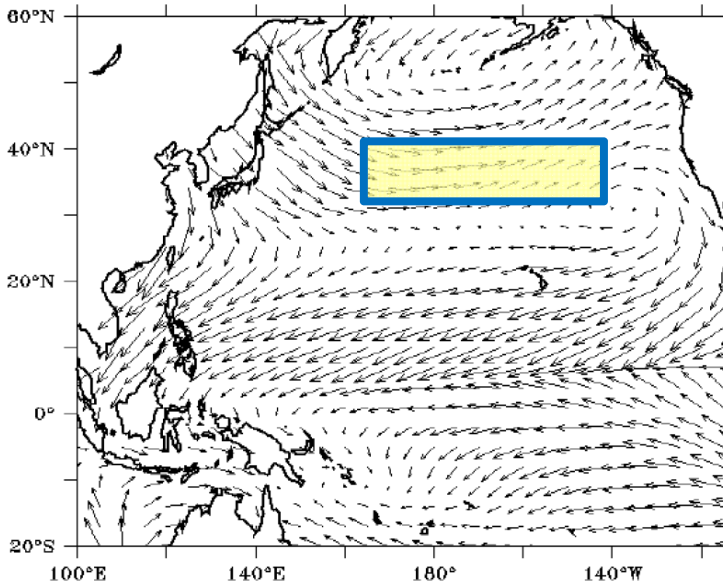


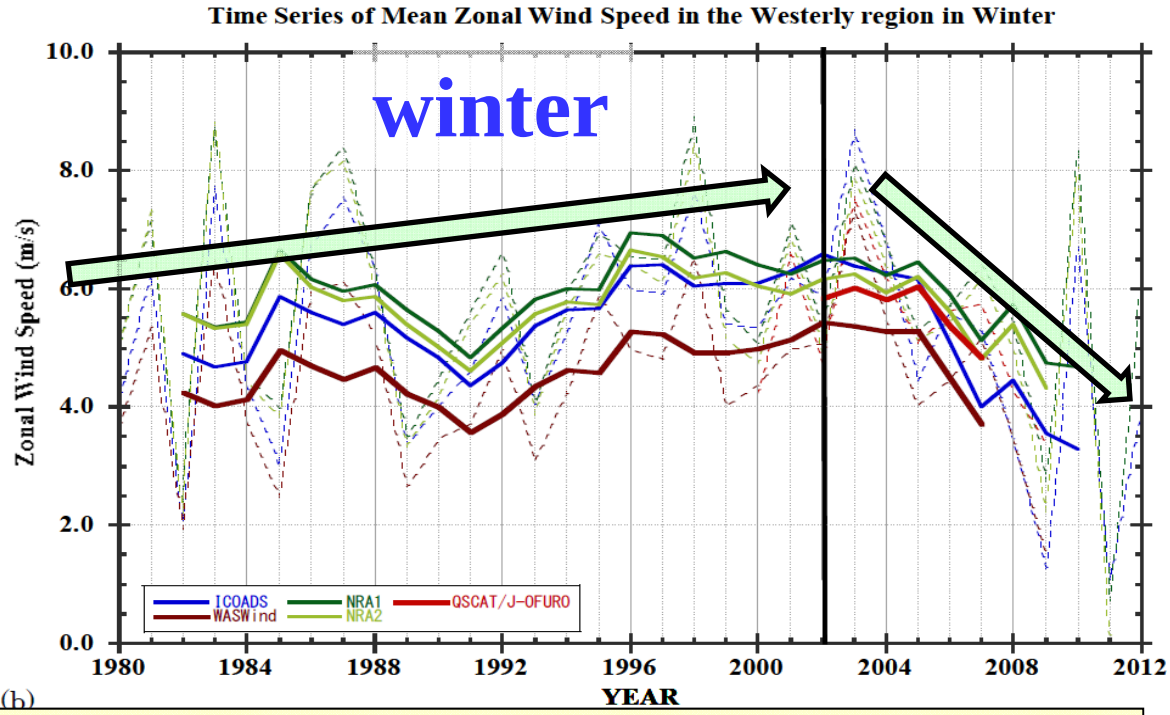
Time series (5-yr RM) of Zonal Wind in the Westerly Wind Region



All the time series have tendencies of increasing wind speed before the beginning of 2000s, and subsequently decreasing.

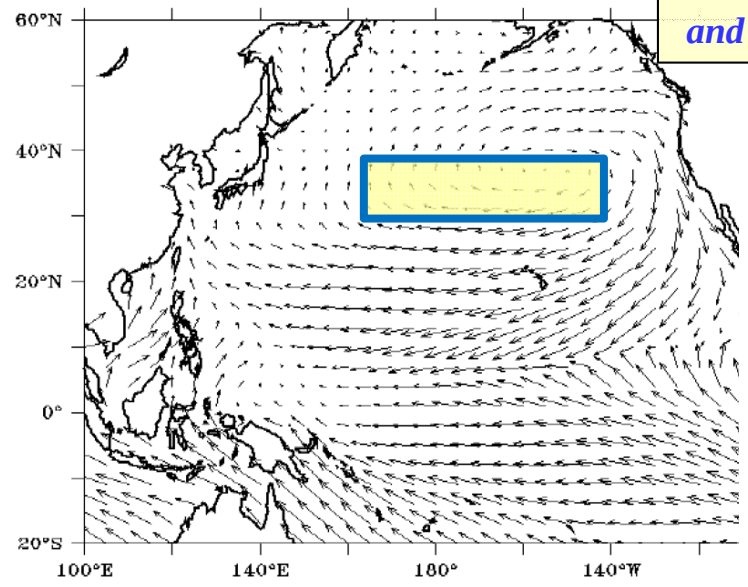
Winter (January)



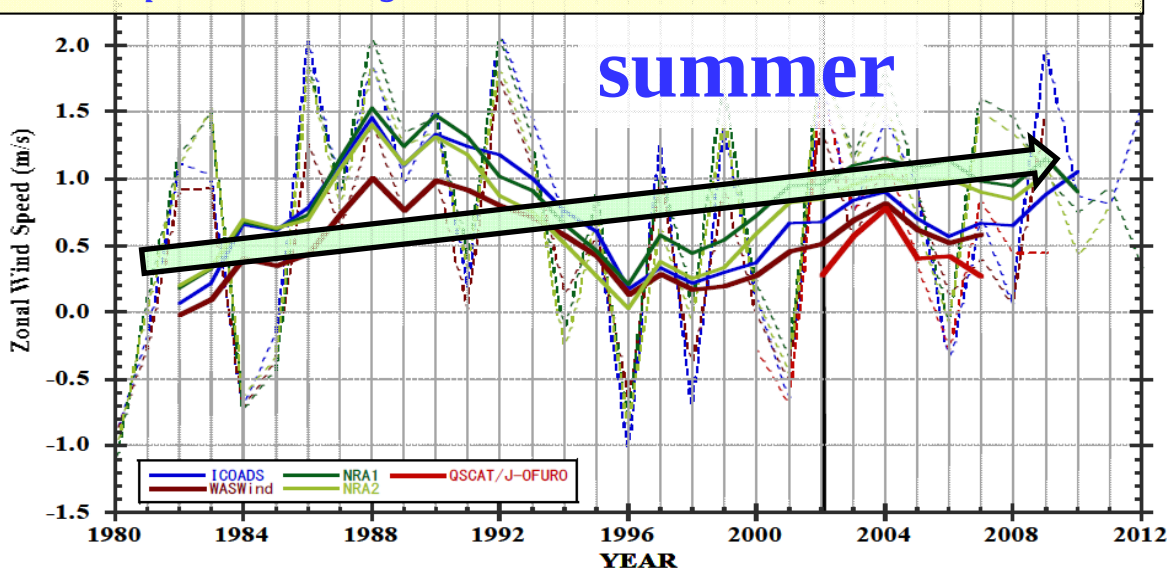


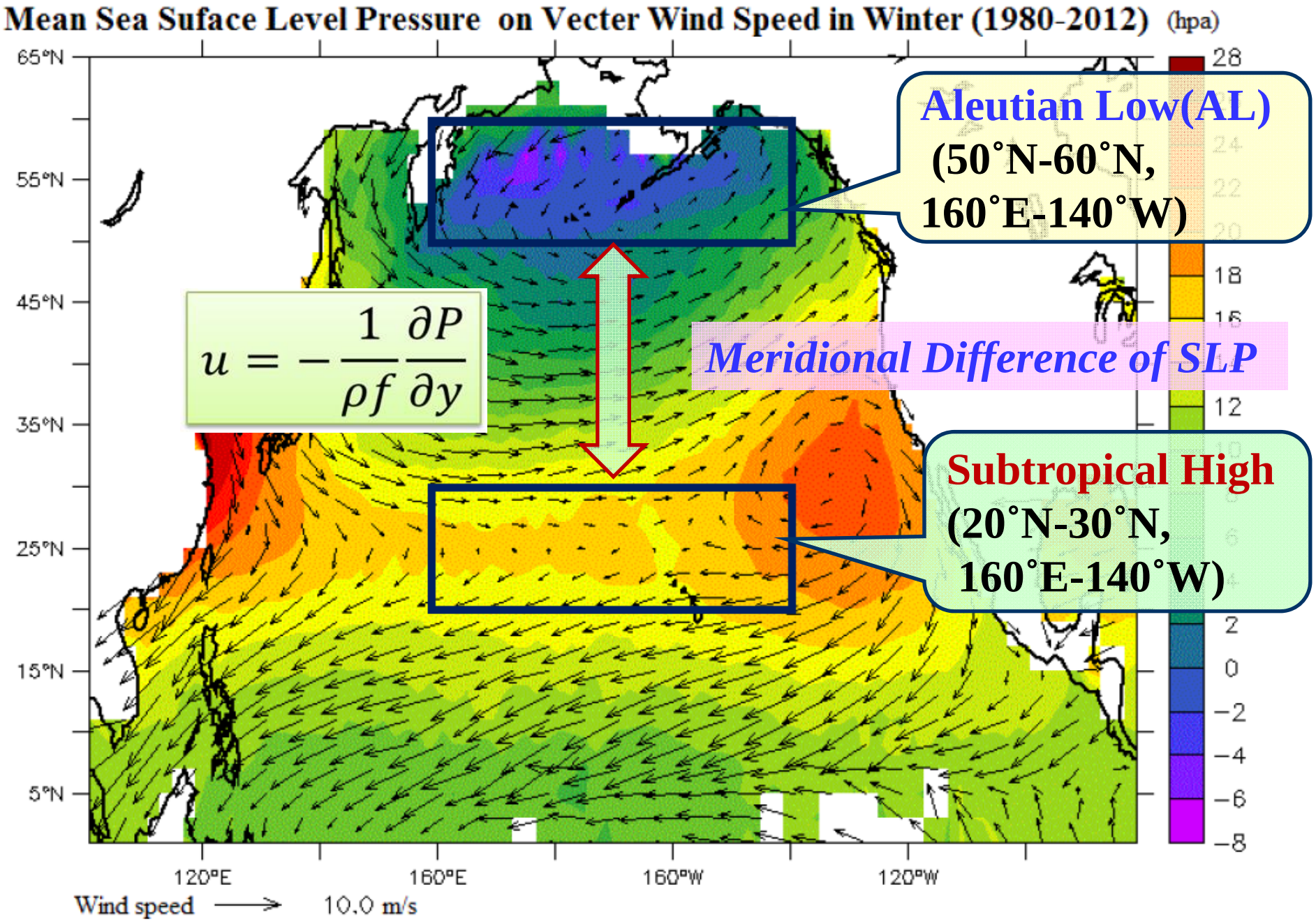
(b)

Summer (July)



Tendencies of increasing wind speed before the beginning of 2000s and its subsequent decreasing are dominant in winter rather than in summer.




Mean Sea Suface Level Pressure on Vecter Wind Speed in Winter (1980-2012) (hpa)
65°N
55°N
45°N
35°N
25°N
15°N
5°N
120°E
160°E
160°W
120°W
28
18
12
2
0
−2
−4
−6
−8
Wind speed
10.0 m/s
Aleutian Low(AL)
(50˚N-60˚N,
160˚E-140˚W)
$u = -\frac{1}{\rho f}\frac{\partial P}{\partial y}$
Meridional Difference of SLP
Subtropical High
(20˚N-30˚N,
160˚E-140˚W)

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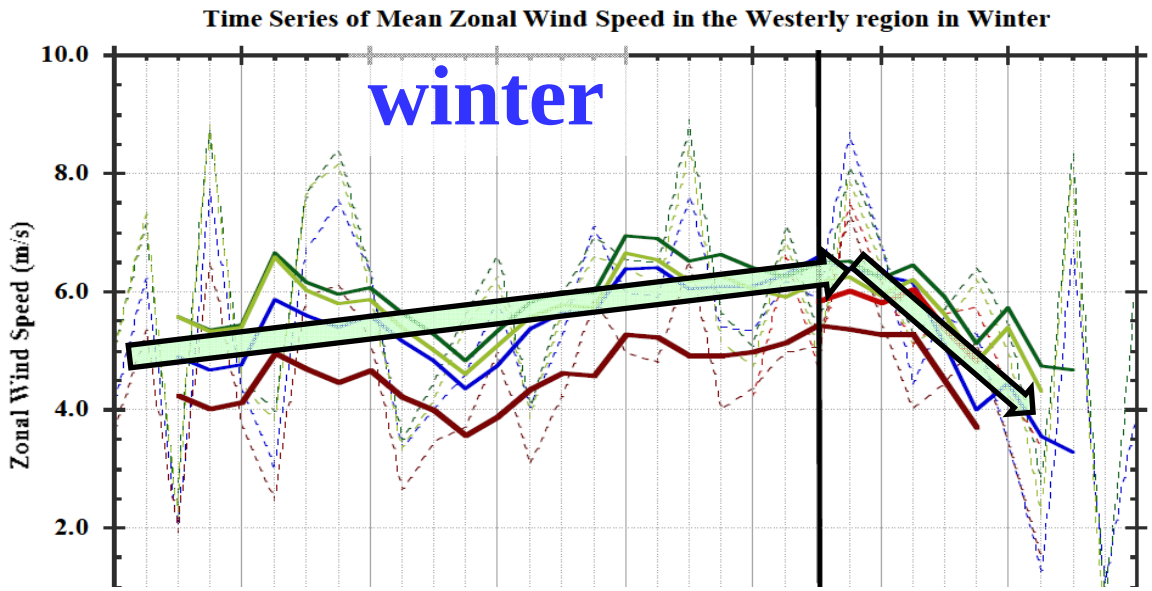
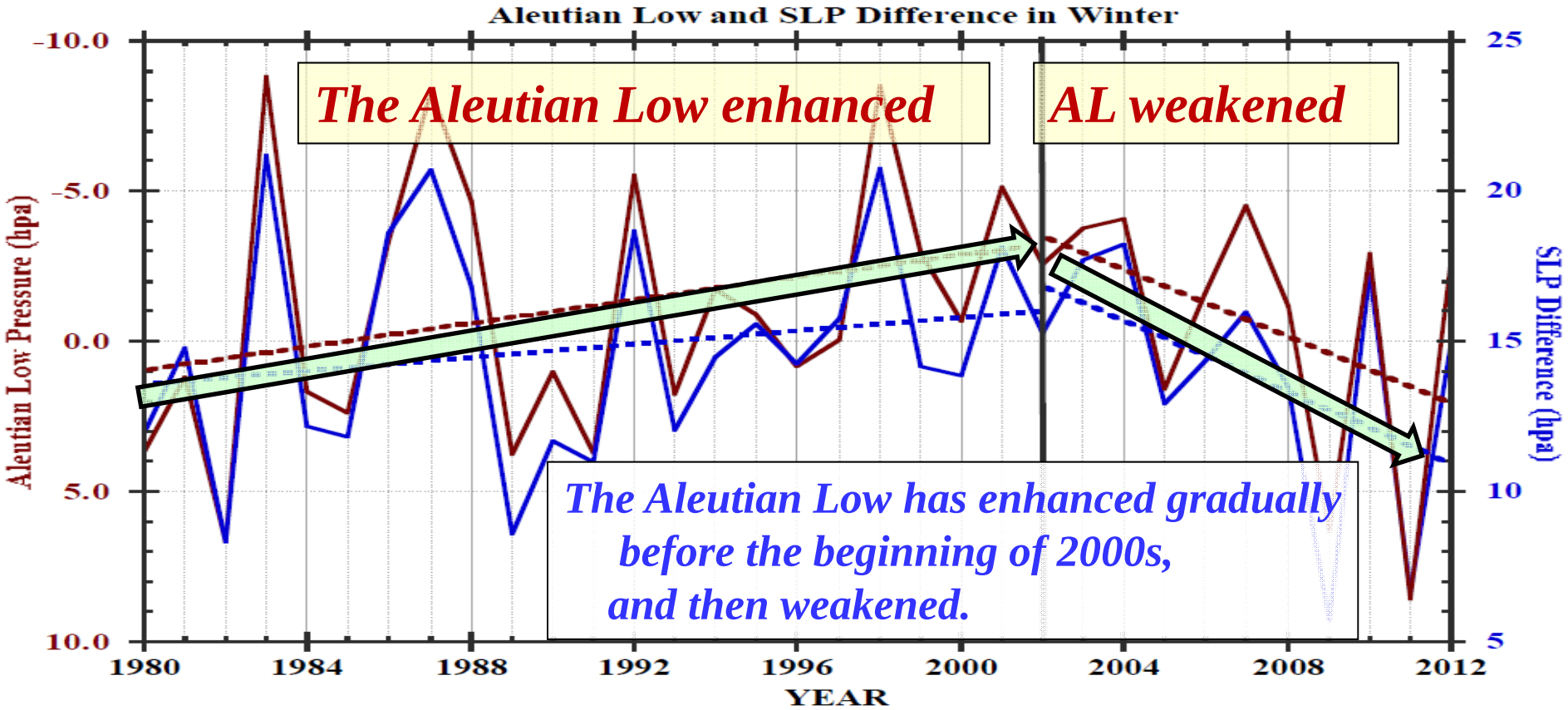


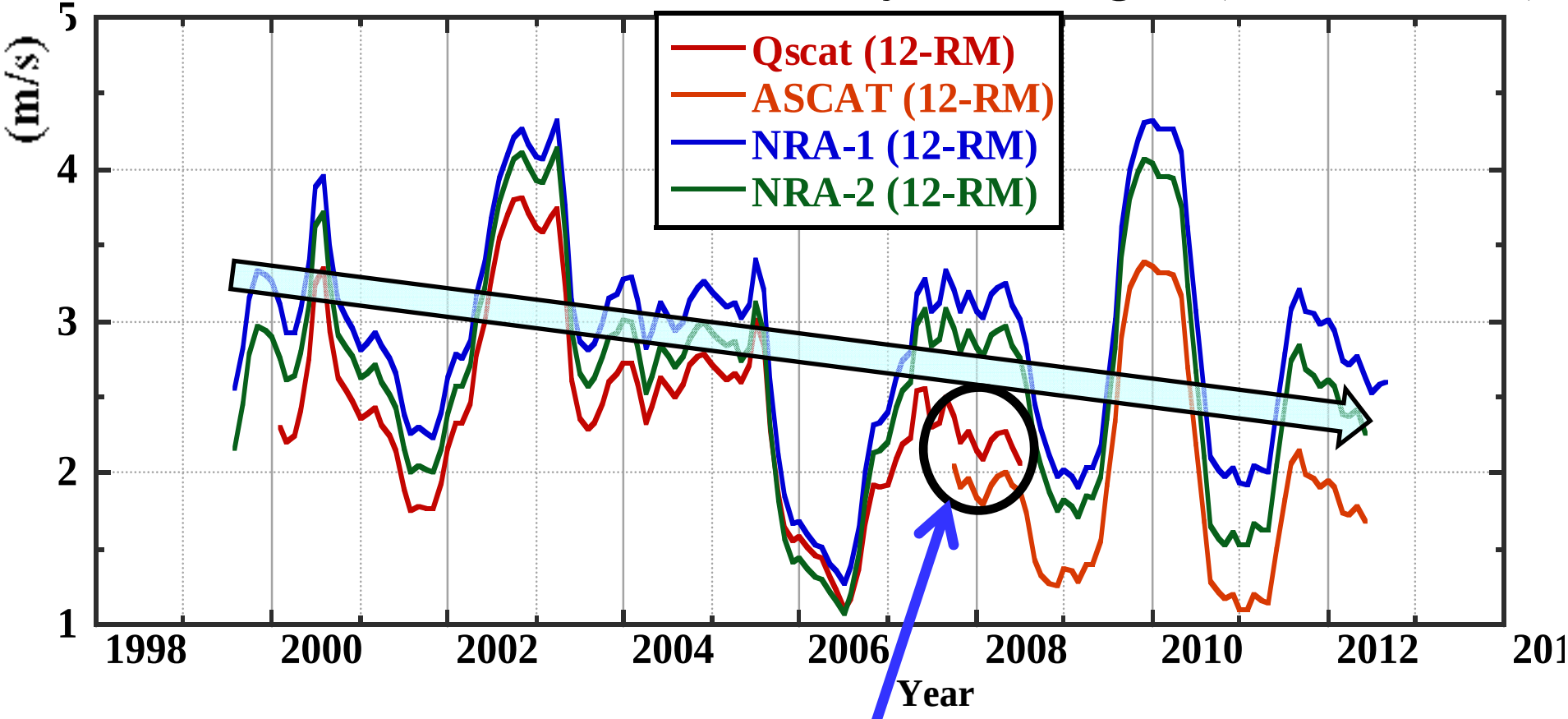


Summary

1. **Time series of our QSCAT/J-OFURO product has revealed an evidence of weakening westerly wind in the beginning of 2000s, which is not consistent with the results in many previous studies.**
2. **Similar features are found also in the time series of other wind products, even if there are, more or less, discrepancies among them.**
3. **Long-term time series suggest long-term changes characterized by a shift from positive trend (strengthening) in 1980s-90s to negative trend (weakening) in 2000s in this region.**
4. **These features seem to be governed by the strength of the Aluetian Low.**

Extension of
time series by new product constructed by ASCAT data

Time Series of Zonal Wind in Westerly Wind Region (12-month RM)



It seems that there are some discrepancies between the Qscat and Ascat products.

Continuously Construction of Gridded Products of Surface Wind Vectors by Scatterometer Data

Thank you for your attention!