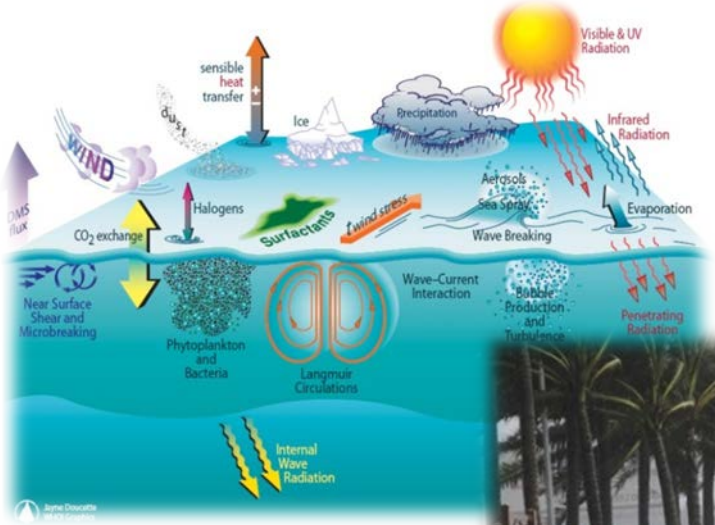
Evaluation of climatological mean surface winds over the Korean Waters simulated by CORDEX regional climate models

Wonkeun Choi[1,2], Ho-Jeong Shin[3], Chan Joo Jang[1,2], Hee seok Jung[1]

[1]Korea Institute of Ocean Science and Technology
[2]University of Science and Technology
[3]Gangneung-Wonju National University

Background

Surface wind over the ocean influences not only climate change through air-sea interactions but coastal erosion through changes in wave height and direction

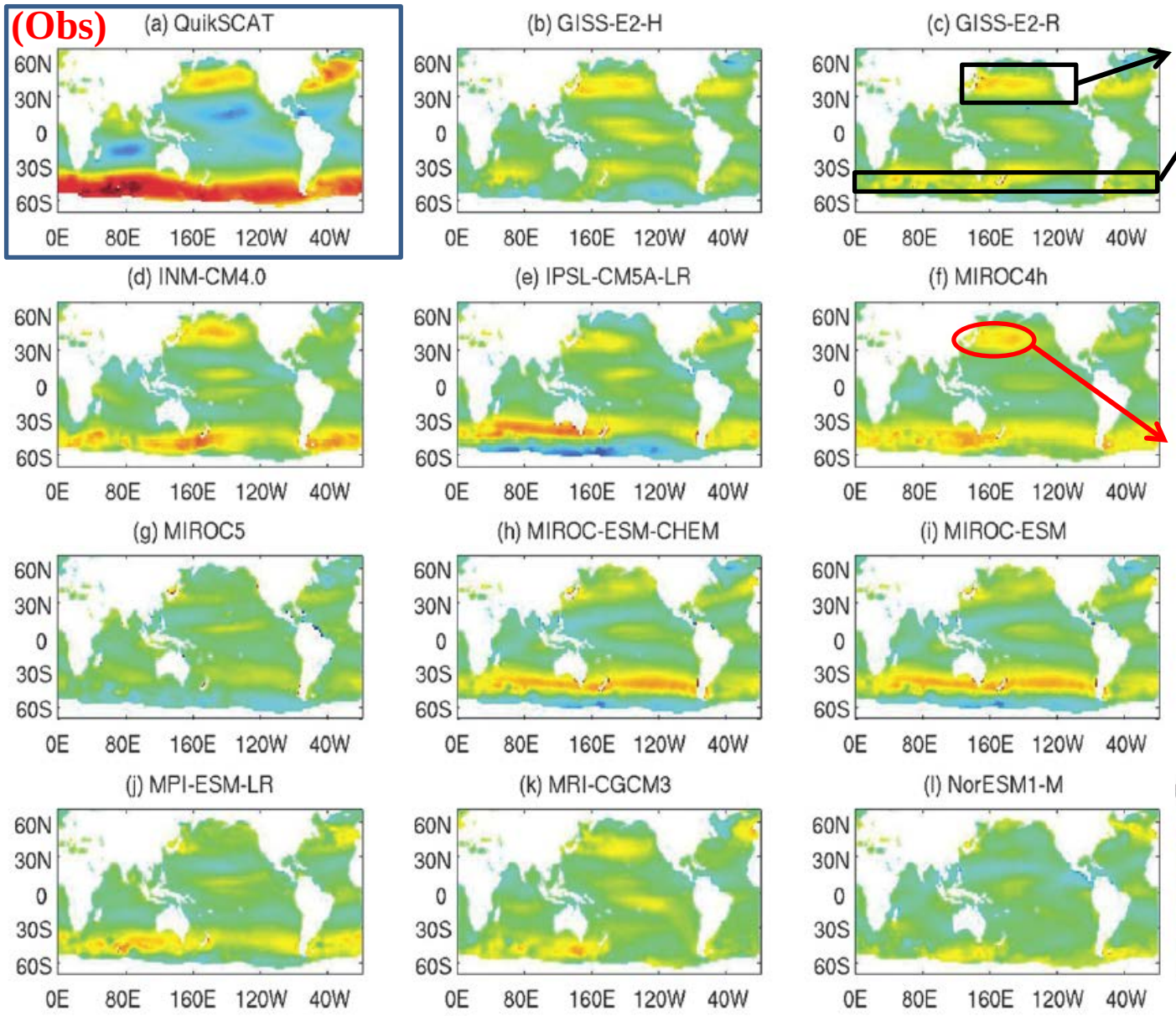


- Mixed layer depth

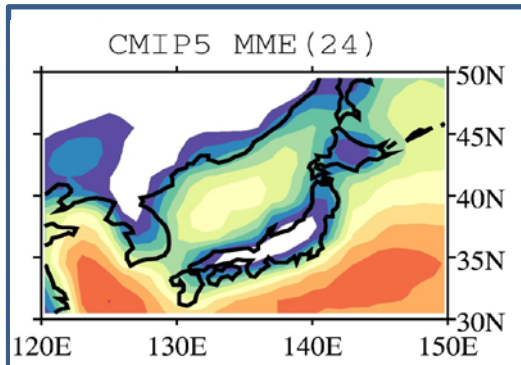
- Coastal erosion

- Ocean wave

Wind stress biases in CMIP5



30°–50°N and 30°–50°S, with CMIP5 being too strong by as much as 55%



CMIP5 models simulate large wind biases over the seas around the Korea.

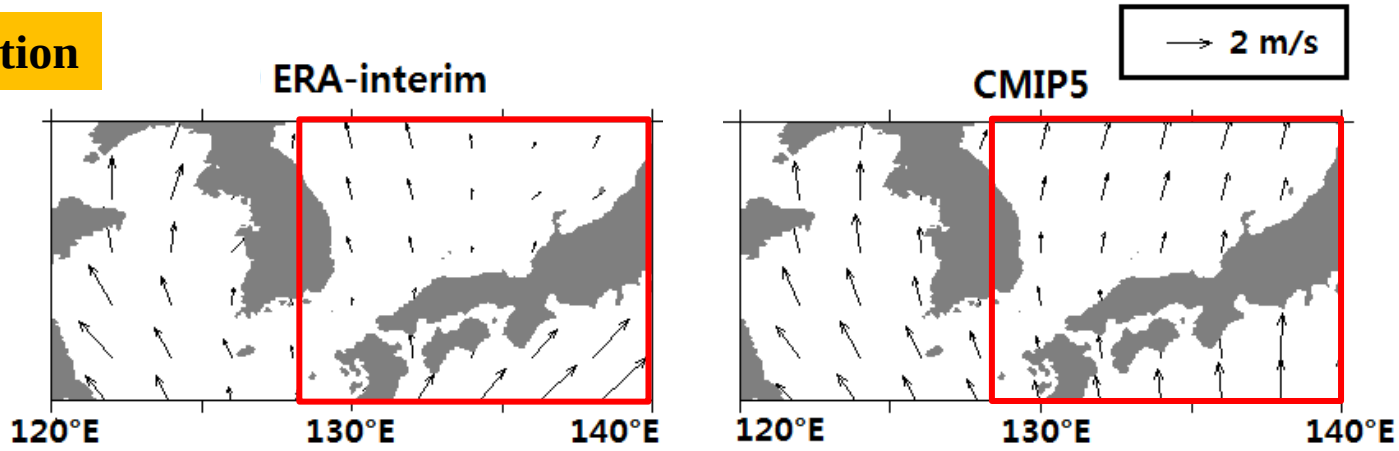
FIG. 4. (a) Annual-mean zonal wind stress (N m^{-2}) from QuikSCAT and (b)–(i) the difference between CMIP5 models and QuikSCAT.

Lee et al (2013)

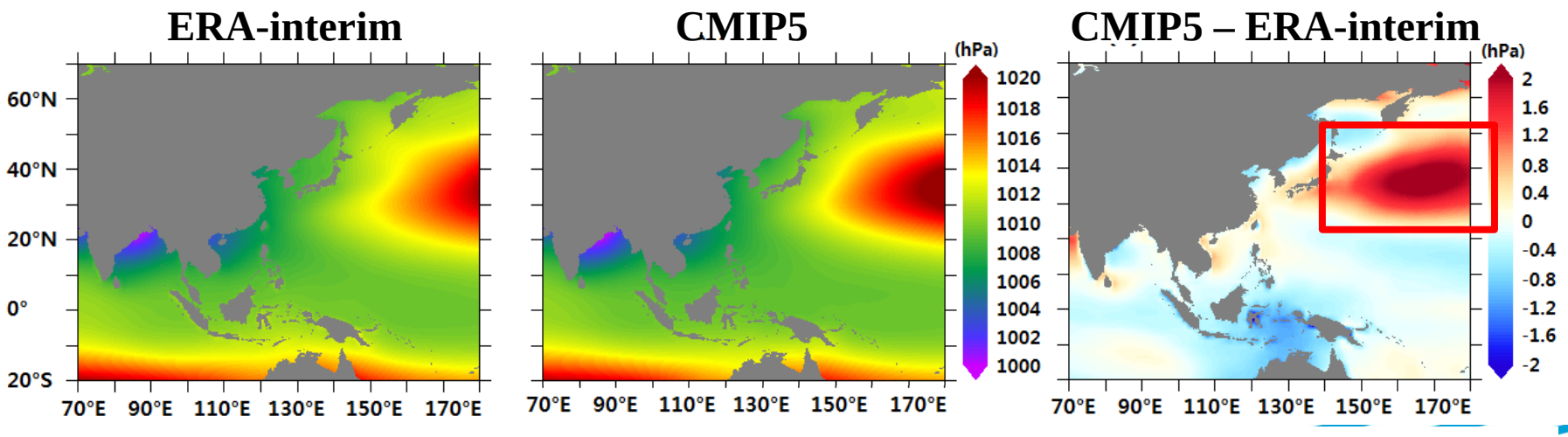
Wind direction & SLP biases in CMIP5 (JJA)

KIOST 한국해양과학기술원

Wind direction



Sea level pressure



CMIP5 models extends the North Pacific high pressure to the west and strong compared to the reanalysis data.

Evaluation of RCM for Korean Waters: limitations

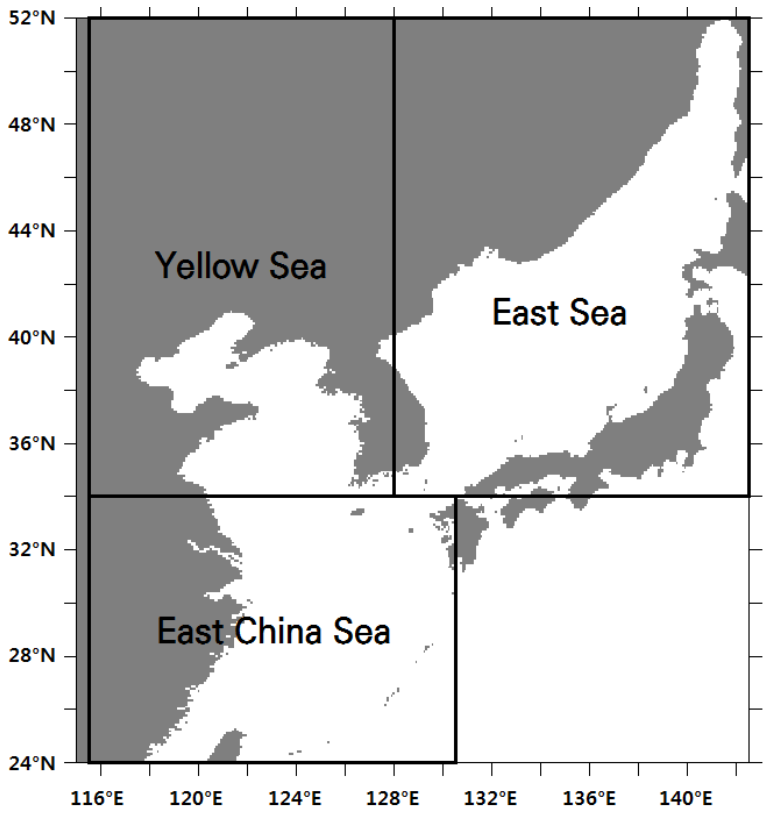
- Most previous studies on the evaluation of regional climate models (RCMs) mainly focused on SST and precipitation. But surface wind biases in RCMs have been relatively poorly known.

- Most of the evaluation of surface wind studies have been done for a short period (within 1 year) and have focused on the surface wind over the land, not over the sea

Purpose

- This study aims to evaluate the surface winds over Korean Waters simulated by CORDEX (Coordinated Regional Climate Downscaling Experiment) regional climate models focusing on common bias among models, as well as inter-model bias.

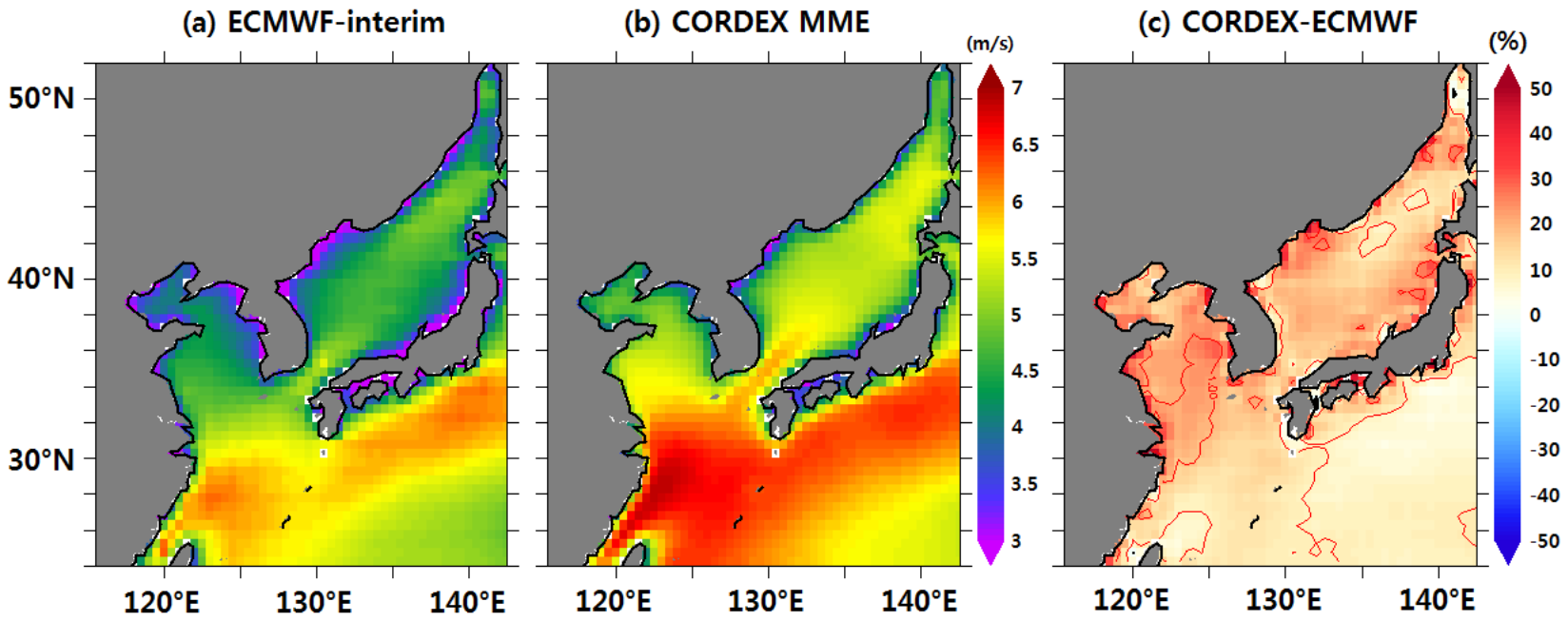
Data



- Evaluation standard : ERA-interim reanalysis data
- Analysis period : 1989-2007 (19 years)
- Land-masked : ETOPO5
- Re-gridded 0.5◦x0.5◦
- Time interval : Daily mean data
- Surface wind at 10m

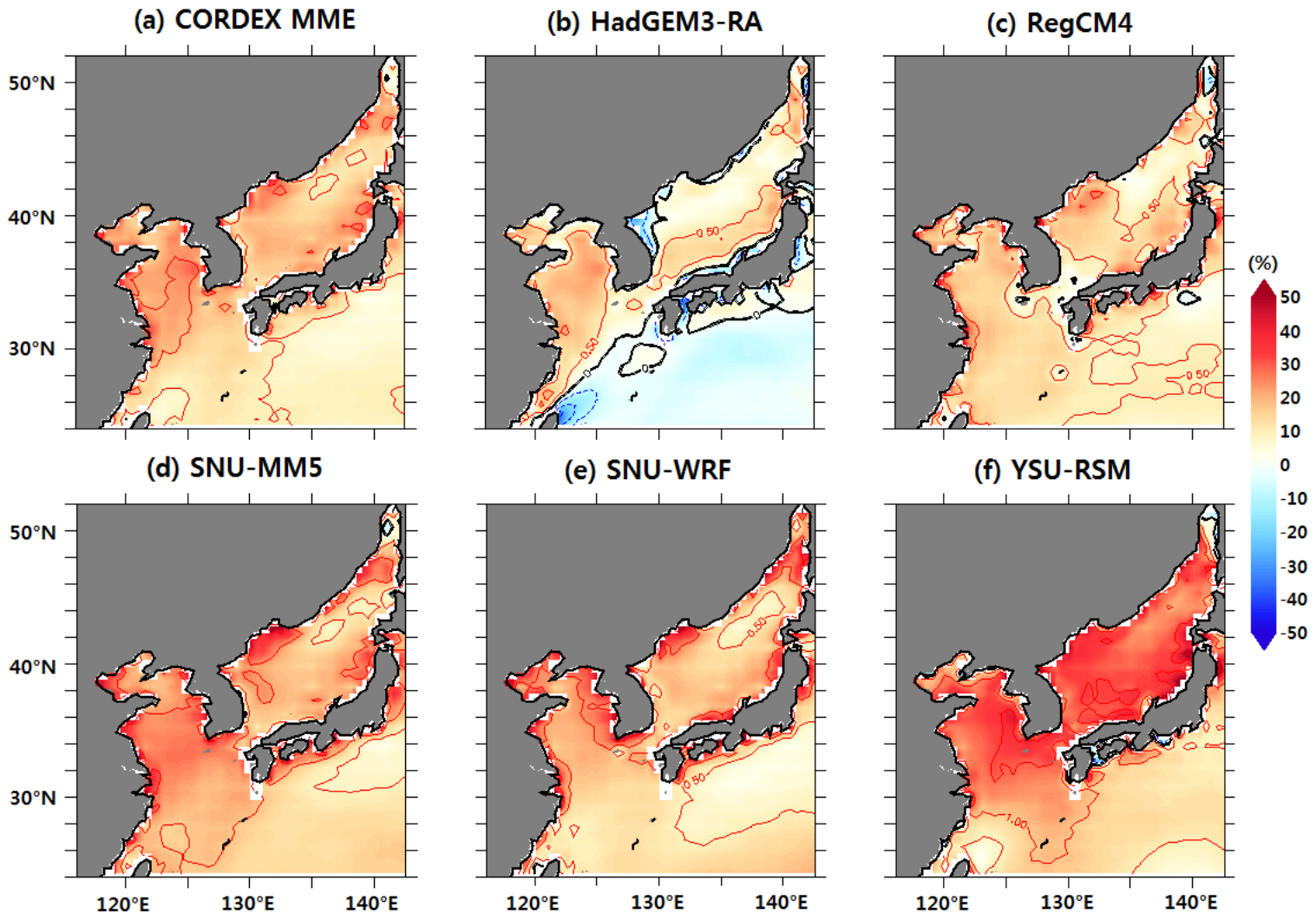
Model	Projection resolution	Spectral nudging	Reference
HadGEM3-RA	0.44 (~50 km)	No	Davies et al. (2005)
RegCM4	50 km	Yes (Storch et al. 2000)	Giorgi et al. (2012)
SNU-MM5	50 km	Yes (Storch et al. 2000)	Cha and Lee et al. (2009)
SNU-WRF	50 km	Yes (Miguez-Macho et al. 2005)	Skamarock et al. (2005)
YSU-RSM	50 km	Yes (Kanamaru and Kanamitsul. 2007)	Hong et al. (2012)

Surface wind speed in summer (JJA)

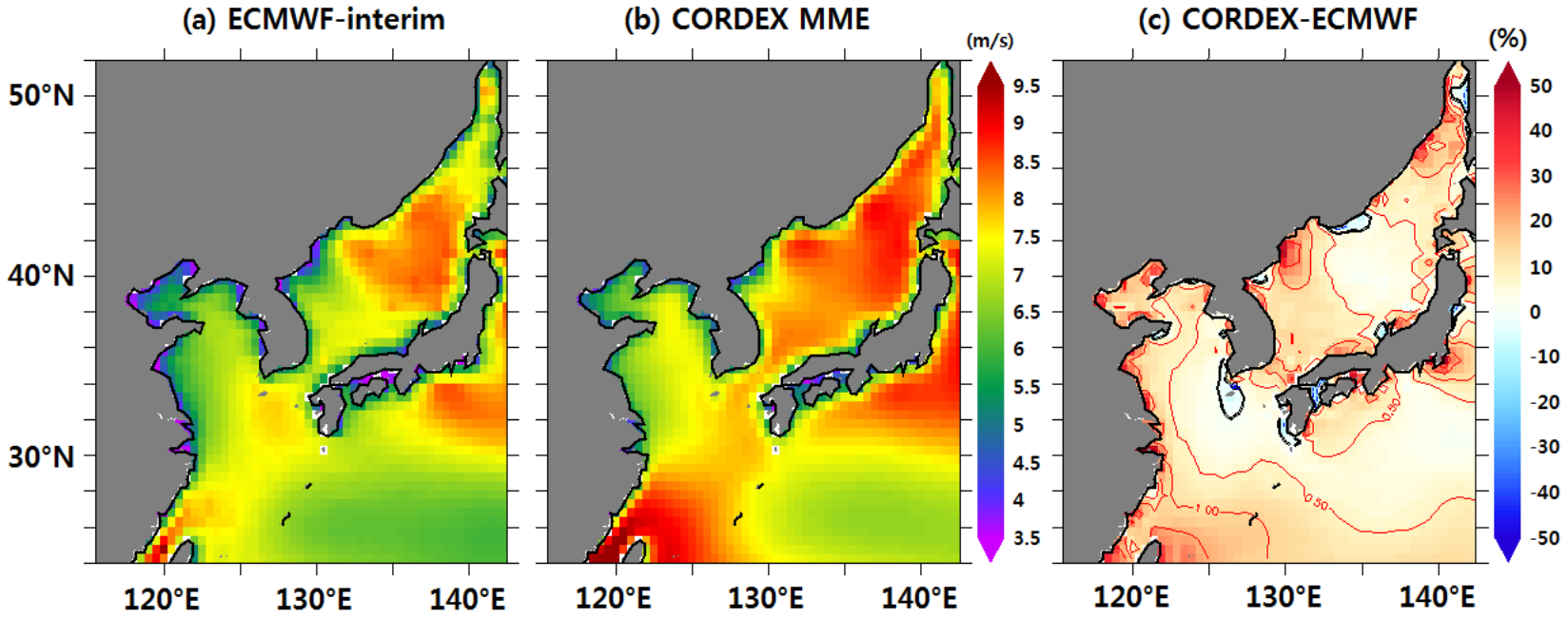


→ Although wind speed spatial pattern is shown similar to reanalysis data (Correlation Coefficient > 0.9), wind speed by CORDEX regional models is overestimated over the most area in summer.

Surface wind speed in summer (JJA)

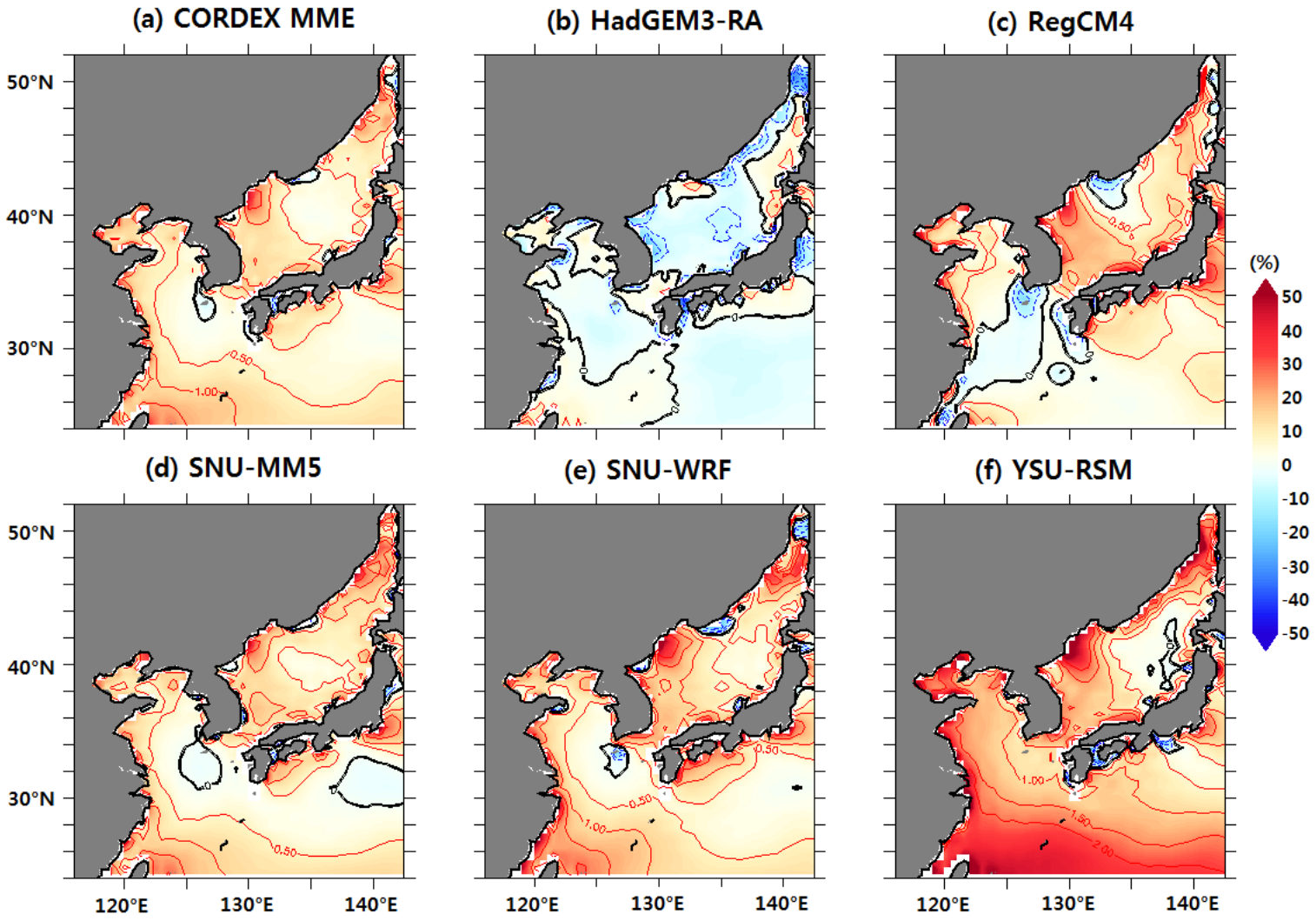


Surface wind speed in winter (DJF)



→ Wind speed by CORDEX is overestimated approximately more than 15% over the most area (Correlation Coefficient > 0.9).

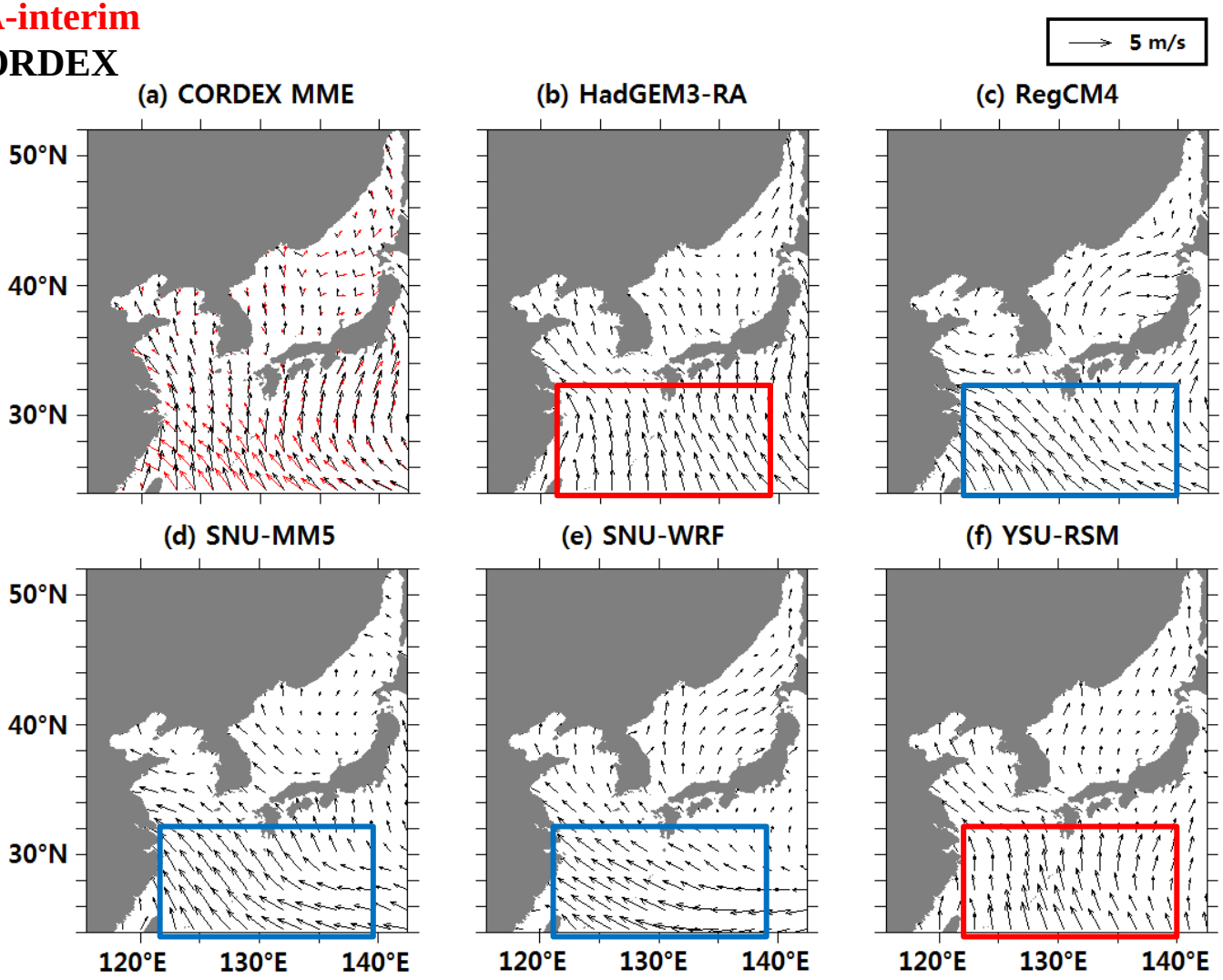
Surface wind speed in winter (DJF)



→ Wind speed by CORDEX with spectral nudging is overestimated over the most area regardless of the season.

Surface wind direction in summer (JJA)

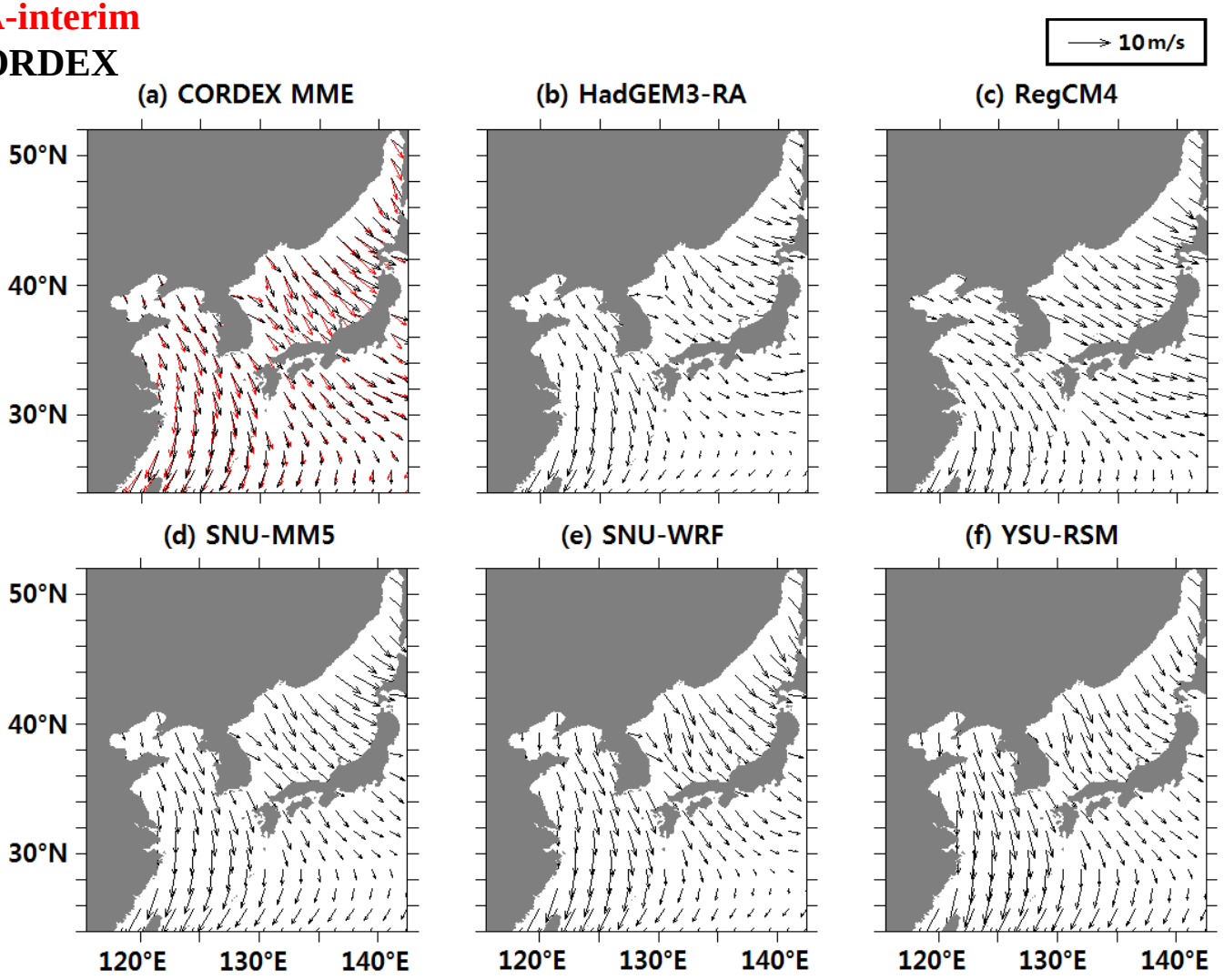
Red : ERA-interim
Black : CORDEX



→ Summer wind direction is different depending on using spectral nudging.

Surface wind direction in winter (DJF)

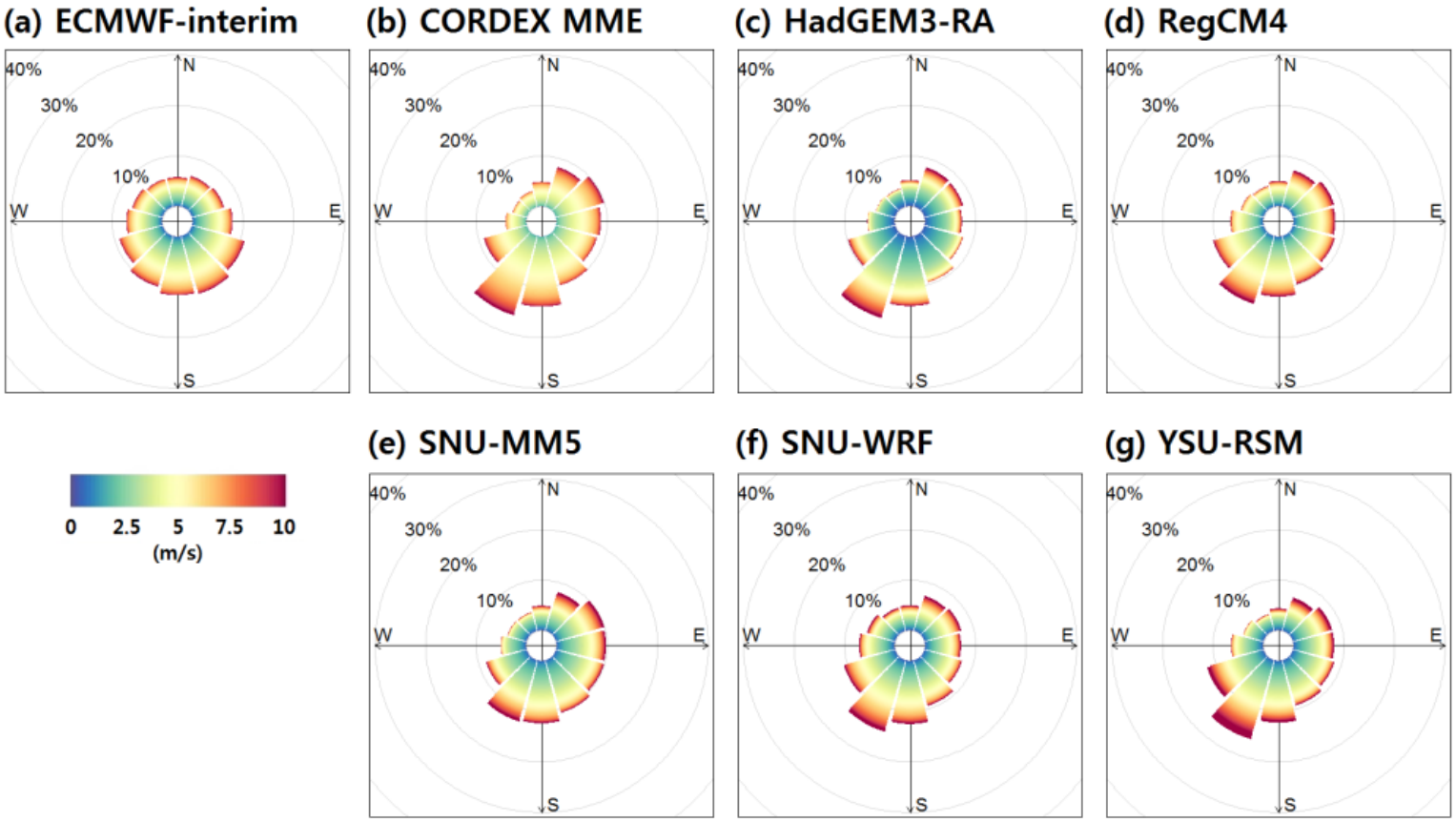
Red : ERA-interim
Black : CORDEX



→ Wind direction by CORDEX is similar to reanalysis data: northwesterly wind

Climatological mean windrose in summer (JJA)

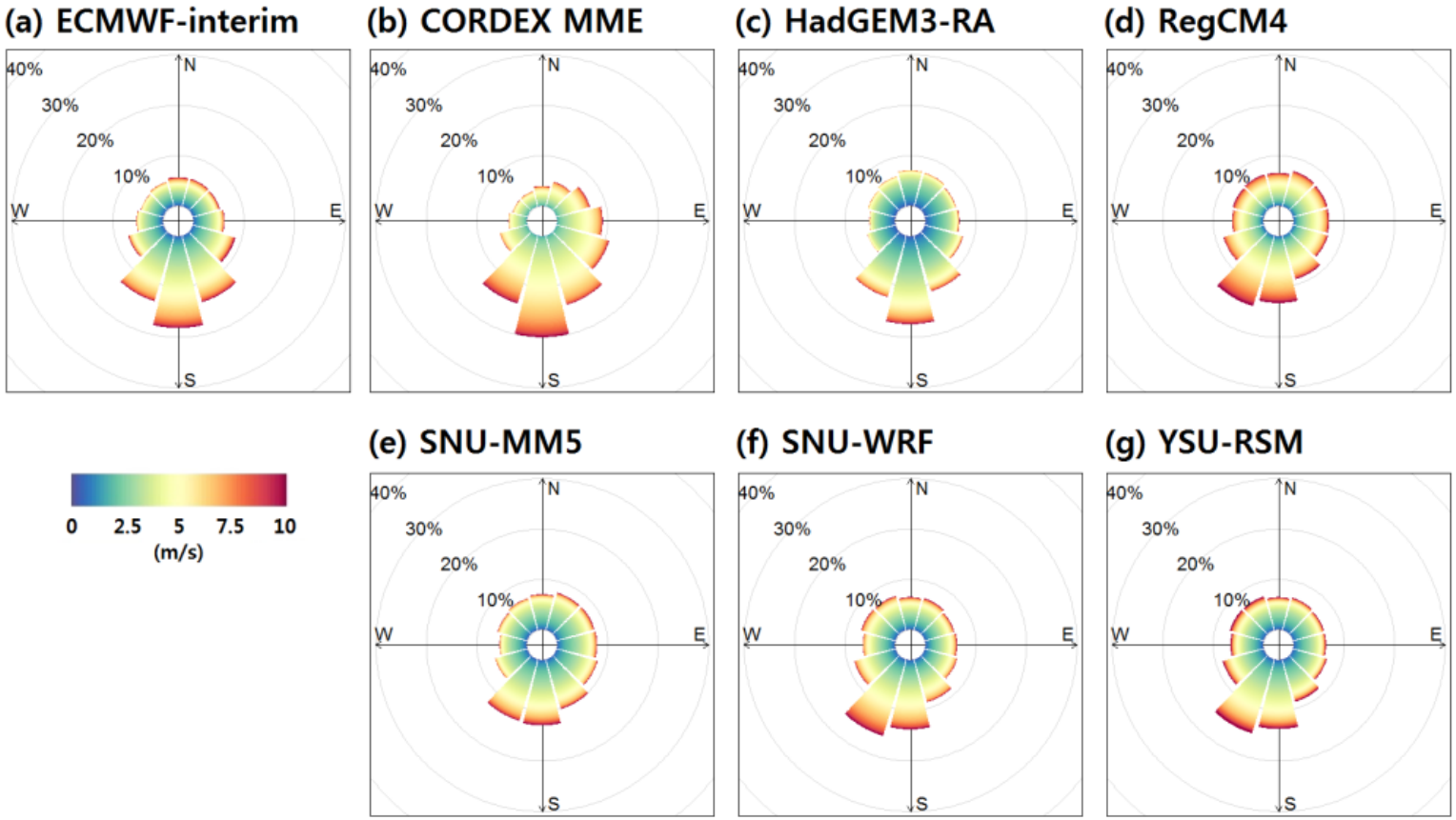
(A) East Sea



CORDEX models often simulates southwesterly winds in the East Sea.

Climatological mean windrose in summer (JJA)

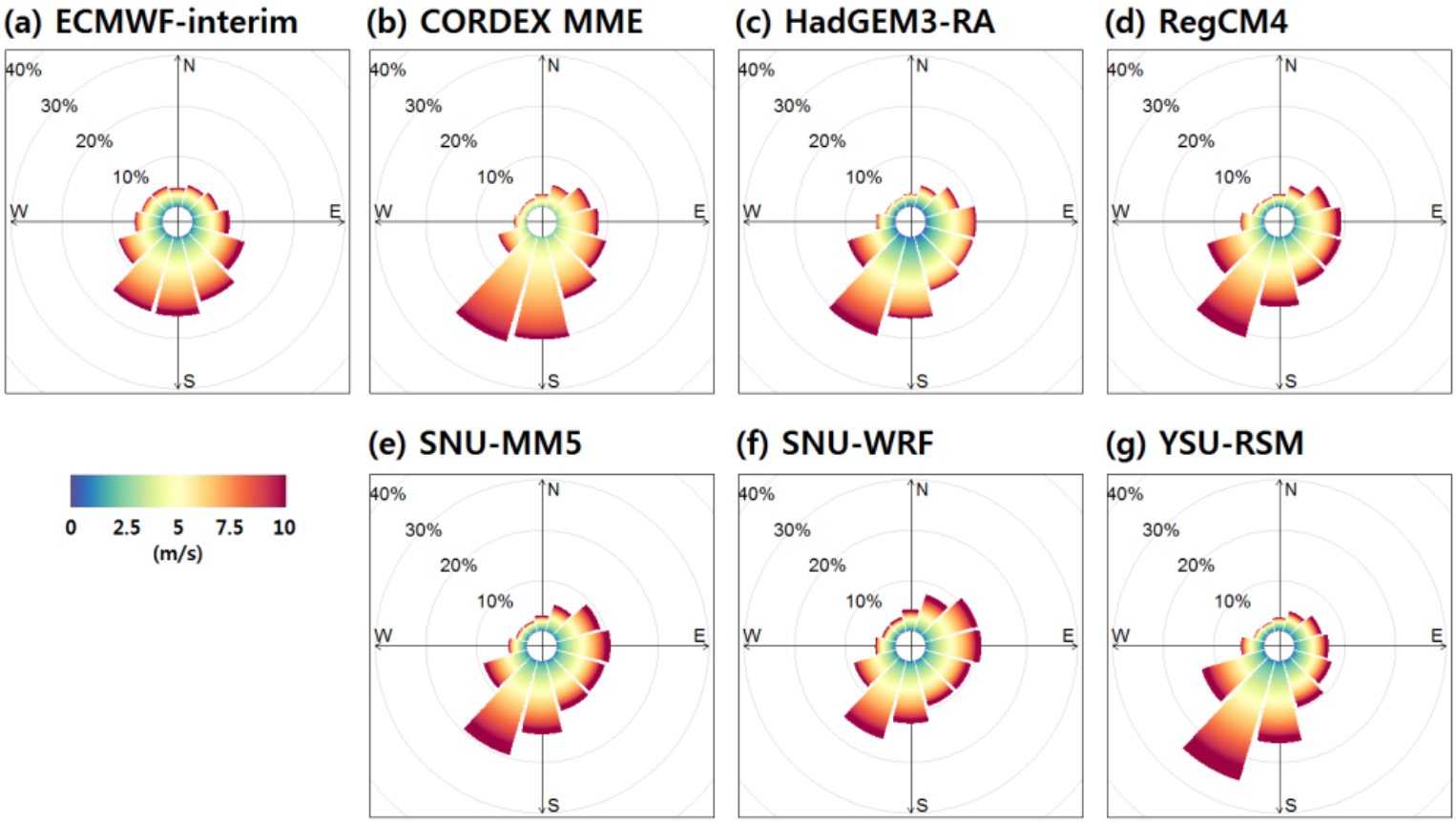
(B) Yellow Sea



CORDEX models simulates slightly southwesterly winds in the Yellow Sea.

Climatological mean windrose in summer (JJA)

(C) East China Sea

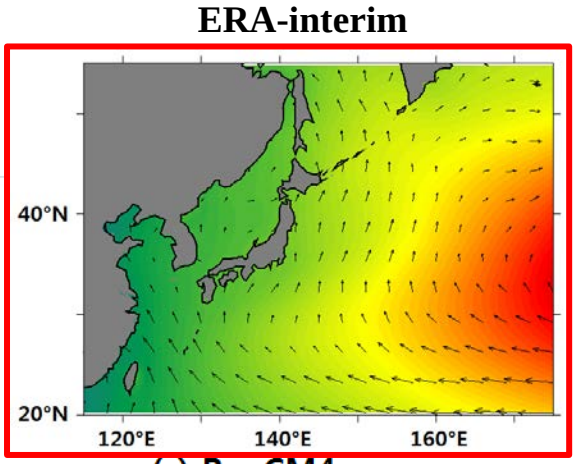


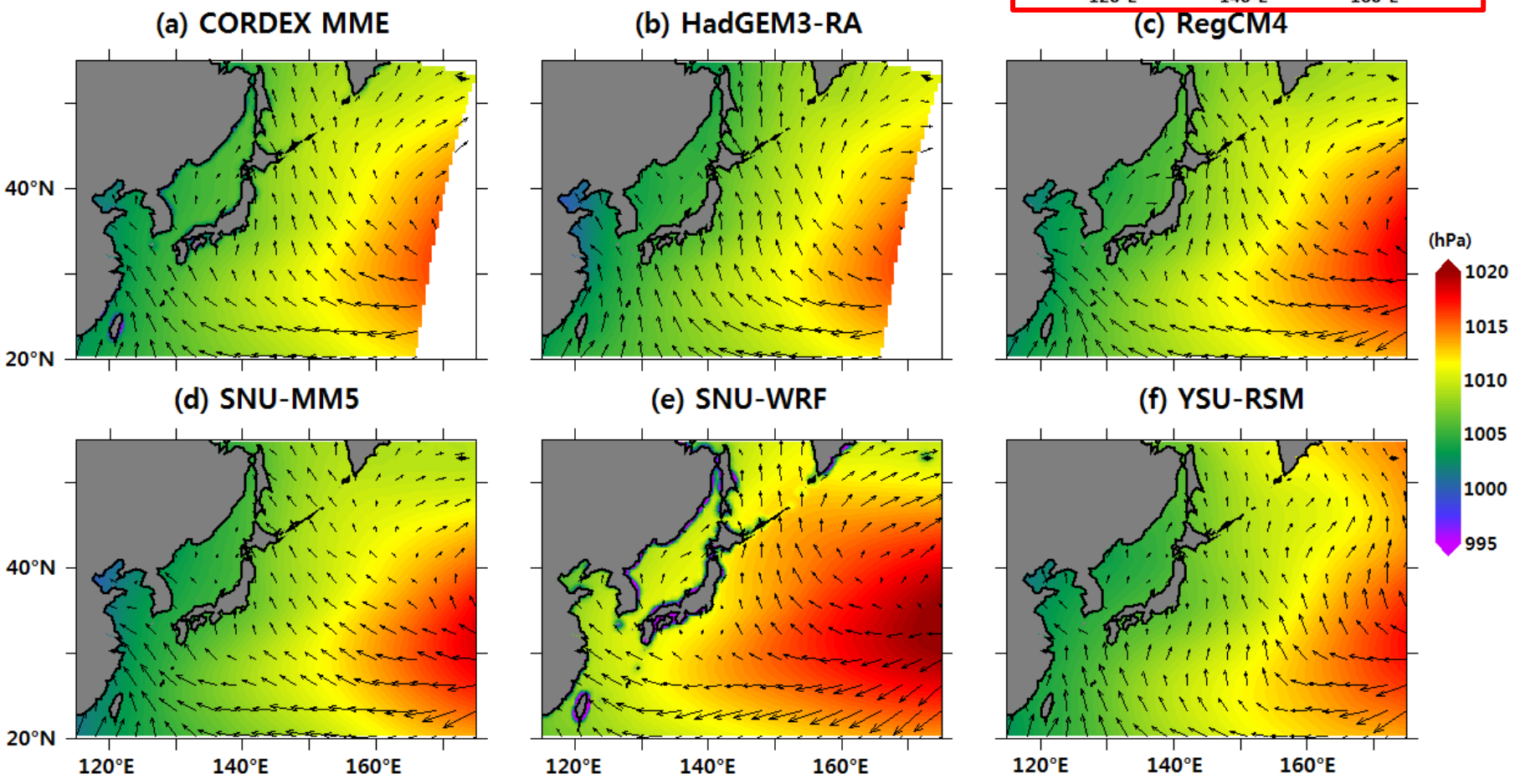
CORDEX models simulates southwesterly winds in the East China Sea.

→ The CORDEX regional model tends to strongly simulate the southwesterly winds in summer

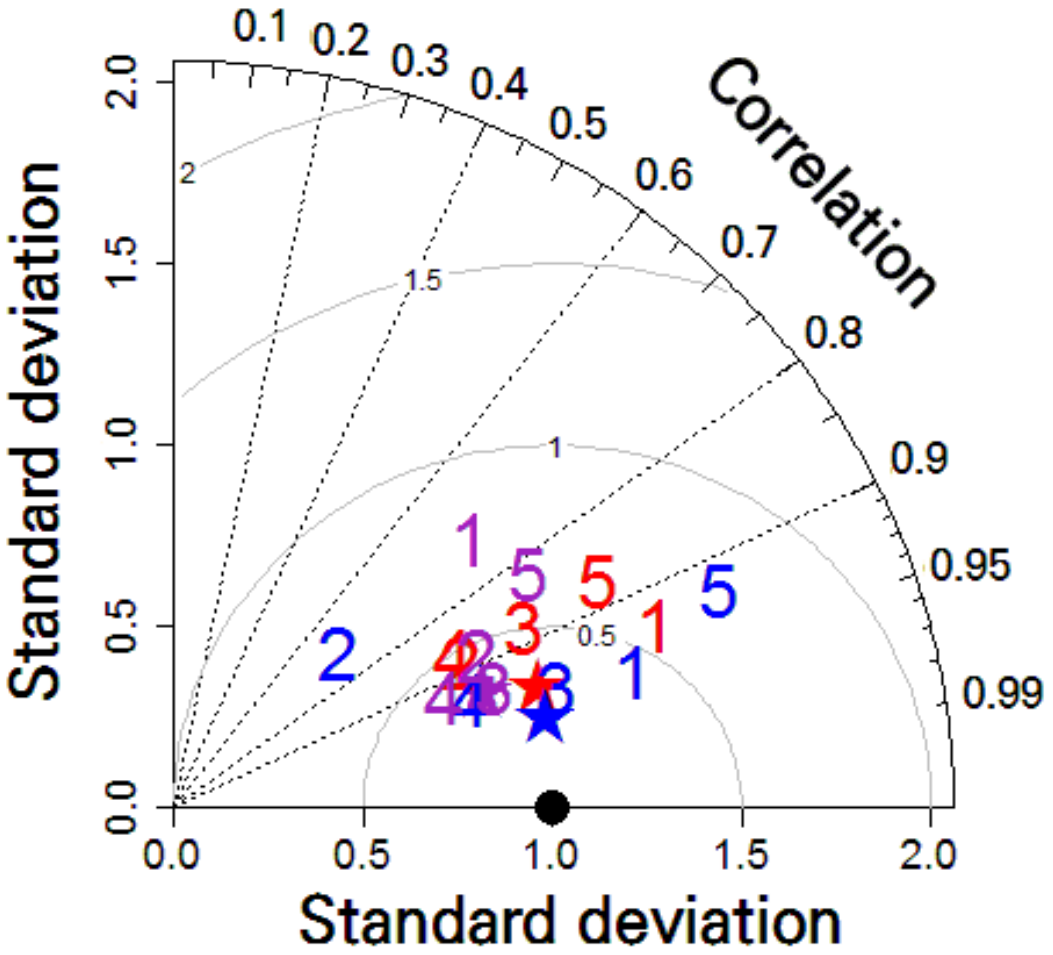
Sea level pressure in summer (JJA)

Reason of southerly wind direction bias by HadGEM3-RA and YSU-RSM is thought that these two models did not simulate sea level pressure pattern correctly





Wind speed: Taylor diagram in summer (JJA)



★ MME
1 HadGEM3-RA → W/O Spectral Nudging
2 RegCM4
3 SNU-MM5
4 SNU-WRF
5 YSU-RSM → Weak SP
East Sea
West Sea
East China Sea

Conclusions

- For Korean waters, the spatial patterns of wind speed in all 5 CORDEX RCMs is similar to reanalysis data. (spatial correlation coefficient > 0.9).
- However, most of the CORDEX RCMs tend to overestimate wind speeds regardless of the season by up to **15** %.
- The RCMs without spectral nudging (SP) or with weak nudging near the surface show biases in wind direction in summer, mainly through westward expansion of NPHP, suggesting importance of SP for summer wind simulation.

KIOST
한국해양과학기술원

Q & A

Thank you