

Mechanisms of Changes in Marine Fog in CMIP5 Multi-Model Simulations

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Purpose

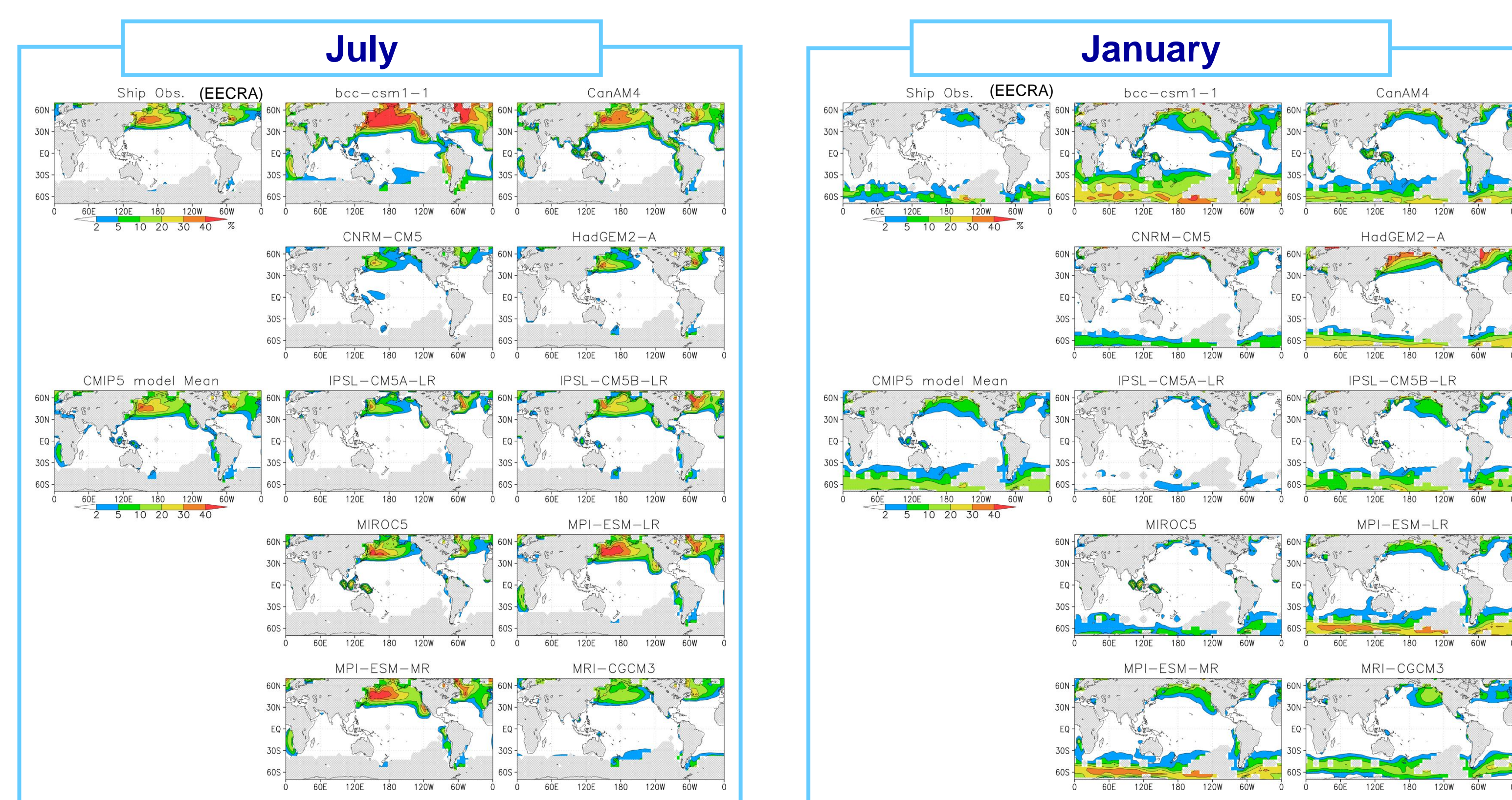
Reveal the followings:

- How well do the CMIP5 multi-models reproduce marine fog?
- How does marine fog change under different climates in CMIP5 simulations?
 - Under warmer SST climates
 - Under an increased CO₂ climate (without changes in SST)
- What is the mechanism of the marine fog changes?

Data

- 10 CMIP5 multi-model data
- Experiments:
 - amip observed SST is given
 - amip4K 4K SST increase (uniform)
 - amipFuture 4K SST increase (patterned)
 - amip4xCO₂ CO₂ is increased under fixed SST
- Period: 31 years (1979–2009)
- Monthly average data
 - Model level data:
 - Definition of fog: cloud at the lowest model level
 - 2D (SLP, 1000hPa wind), 3D p-level data (T, q)

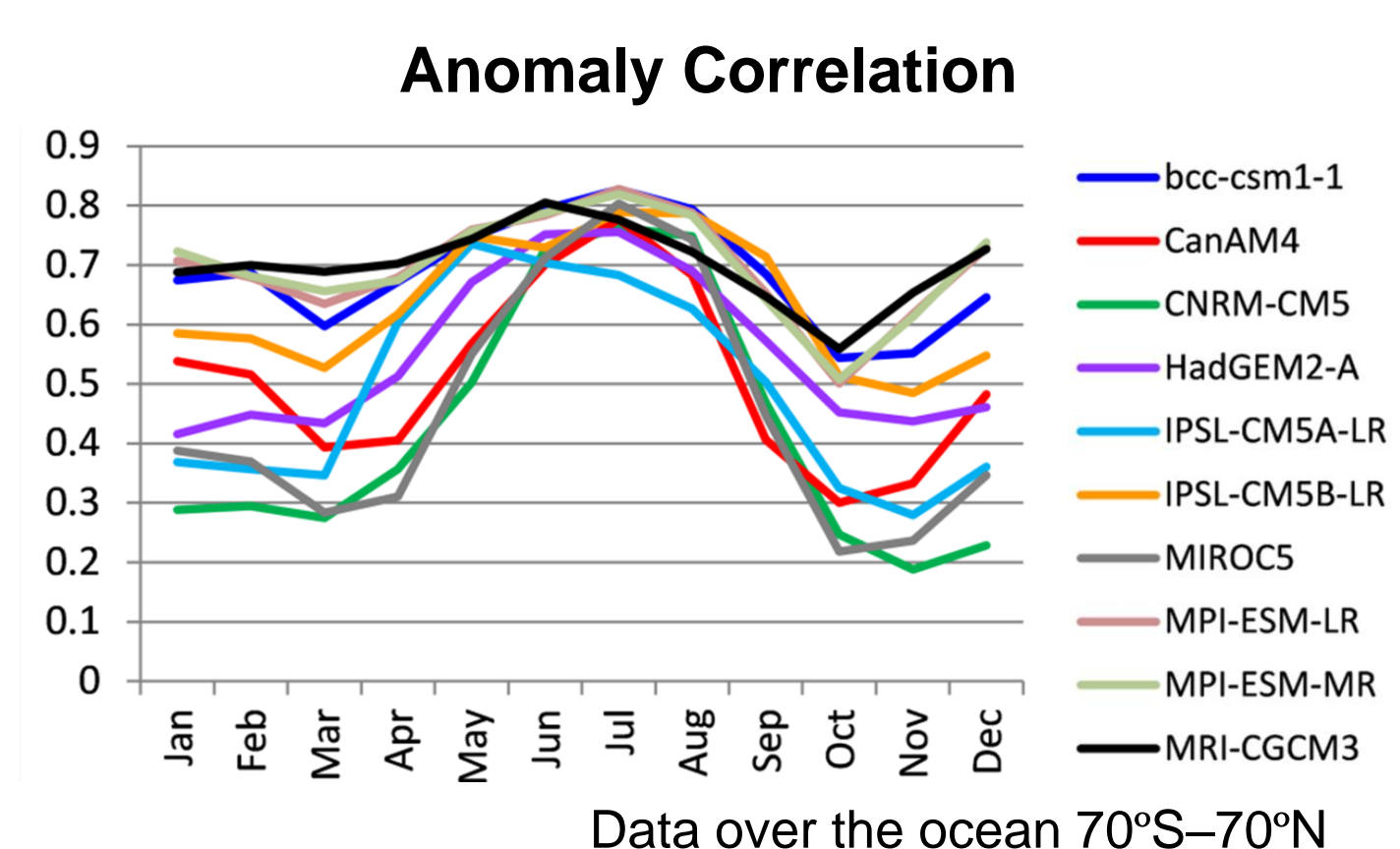
Simulated Fog in CMIP5 models



Represented well in July for the North Pacific!

Represented poorly in January...

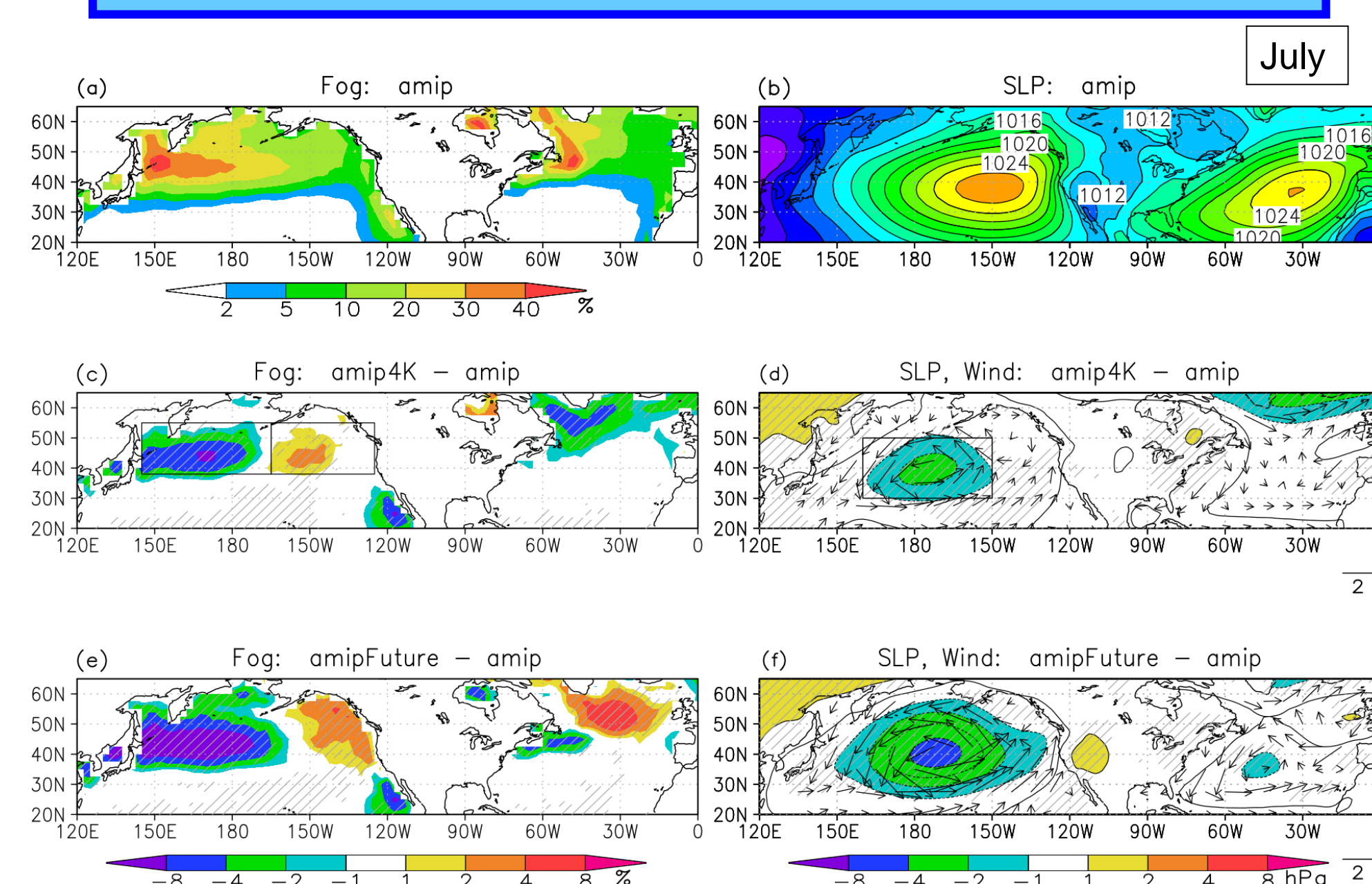
Score



(boreal) summer: Score is high for all models
(boreal) winter: Score is low and extremely low in some models

Discuss fog changes for July in the NH.

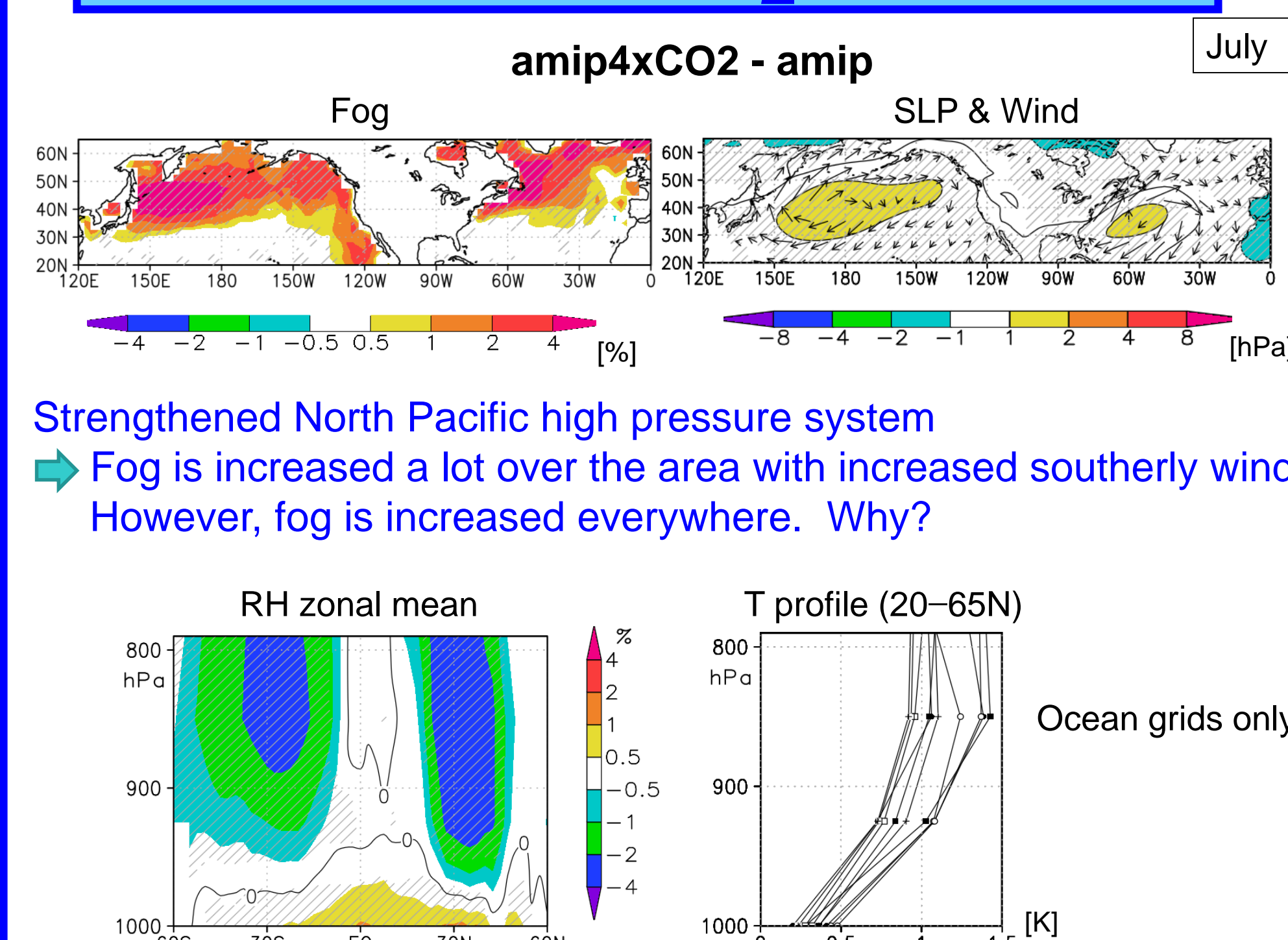
Increased SST Climate



Increased SST
➔ Weakened North Pacific high pressure system

Western N. Pac. : Weaker southerly wind -> Less advection fog
Eastern N. Pac. : Stronger southerly wind -> More advection fog

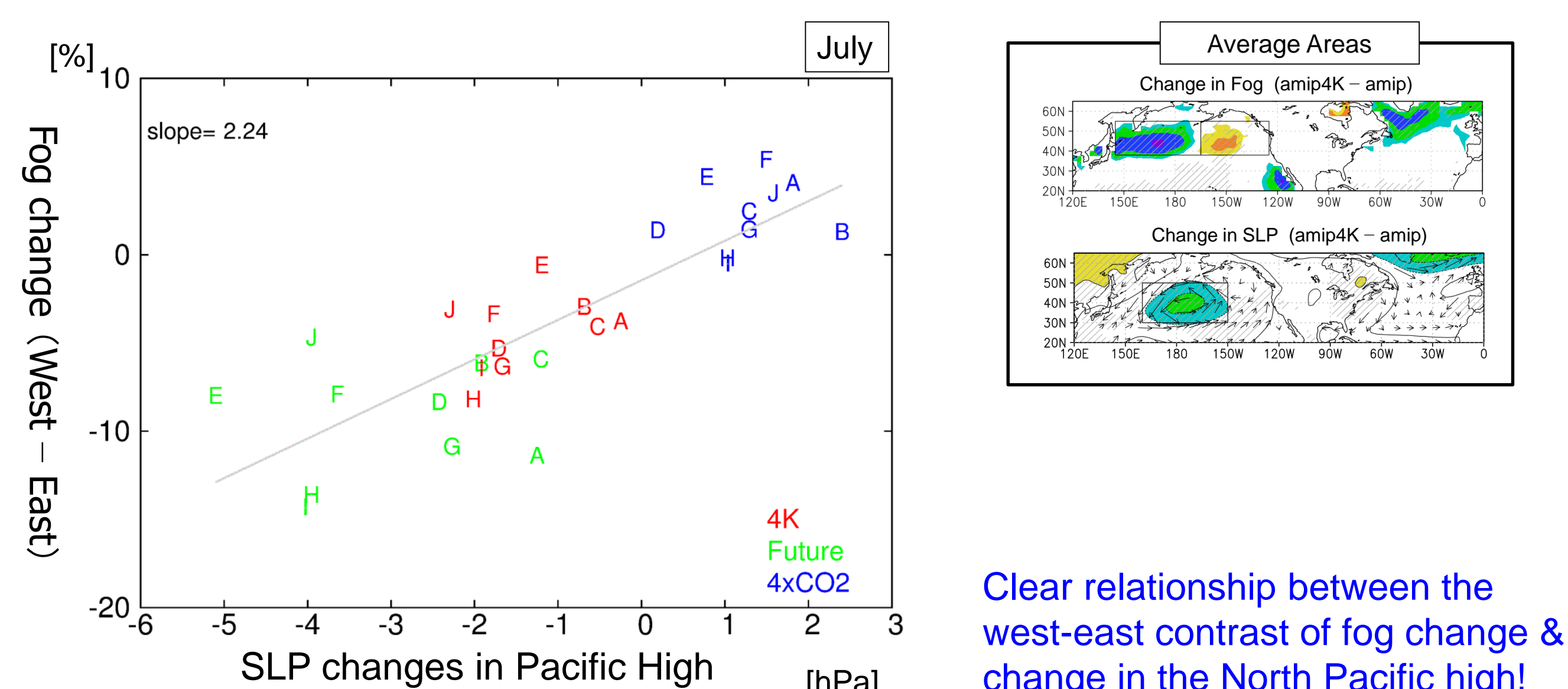
Increased CO₂ Climate



Strengthened North Pacific high pressure system
➔ Fog is increased a lot over the area with increased southerly wind. However, fog is increased everywhere. Why?

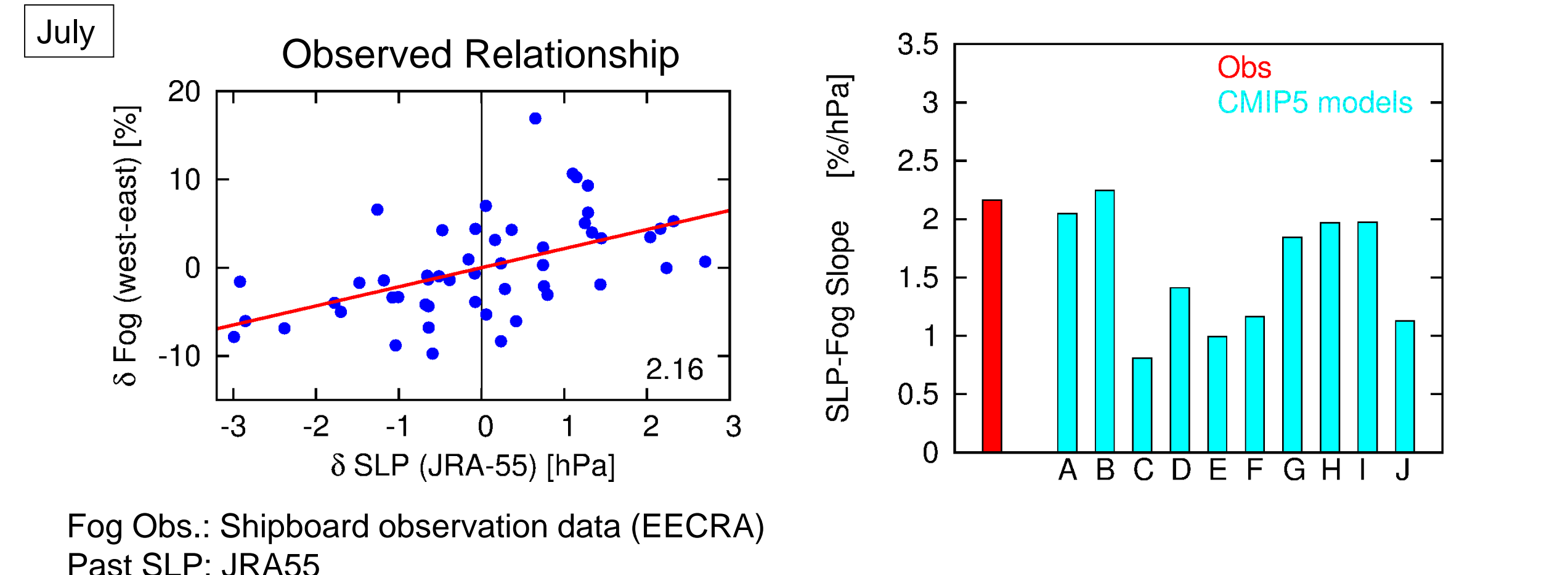
When only CO₂ is increased without changes in SST, ABL becomes more stable.
-> RH near the surface is increased. (Kamae et al. 2015)

SLP & Fog Change Relationship



Clear relationship between the west-east contrast of fog change & change in the North Pacific high!

SLP & Fog Interannual Variations



Fog Obs.: Shipboard observation data (EECRA)
Past SLP: JRA55

The observed slope for interannual variation is close to the simulated slope for climate change.

CMIP5 models roughly reproduce the relationship for interannual variations.

Summary

(Kawai et al. 2018)

- There is a large variety in representation of marine fog in CMIP5 models.
- Marine fog is well represented in CMIP5 models over the North Pacific in boreal summer, but not in boreal winter.
- Changes in marine fog in CMIP5 models correspond to changes in sea level pressure patterns.
 - Fog increase (decrease) for the region of strengthened (weakened) southerly wind.
 - Consistent with MRI-CGCM3 results in Kawai et al. (2016).
- Only CO₂ increased experiment shows the increase in marine fog especially for strengthened southerly wind areas. But also in weakened areas. (Main cause: Stabilization of ABL. (Kamae et al. 2015))
- There is a clear relationship between the changes in the North Pacific high pressure system & west-east contrast of fog change.

Acknowledgements

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References

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