OCEANOPIA

An improvement of Pacific Decadal Oscillation pattern simulation in Climate models (CMIP5)

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Outline

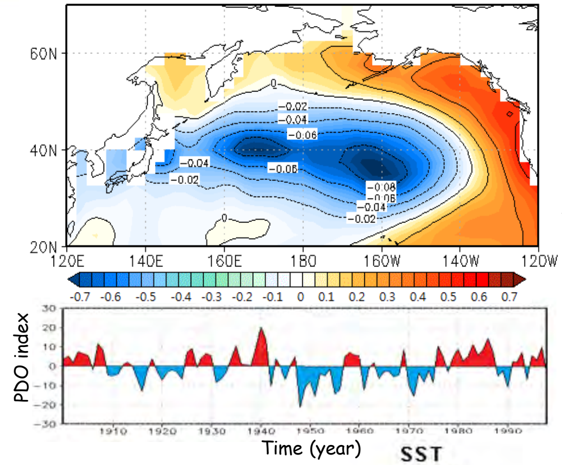
- Background of study
- Motivation and Objectives
- Data and Method
- Result
  - ✓PDO pattern simulation
  - ✓ENSO-PDO teleconnection pattern simulation
- Discussion
- Conclusion and Summary

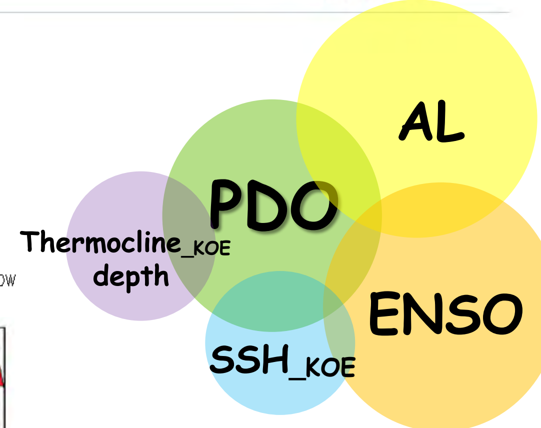
Background study

Pacific Decadal Oscillation (PDO)

: A dominant SST variability on a decadal timescales in the North Pacific

Mantua and Hare 2002





Impacts of PDO on North Pacific

1) Marine ecosystems
2) Oceanic/Atmospheric variability

Mantua 1997

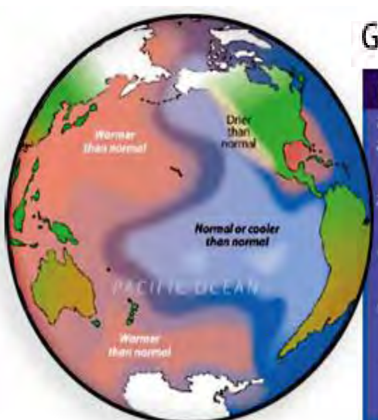
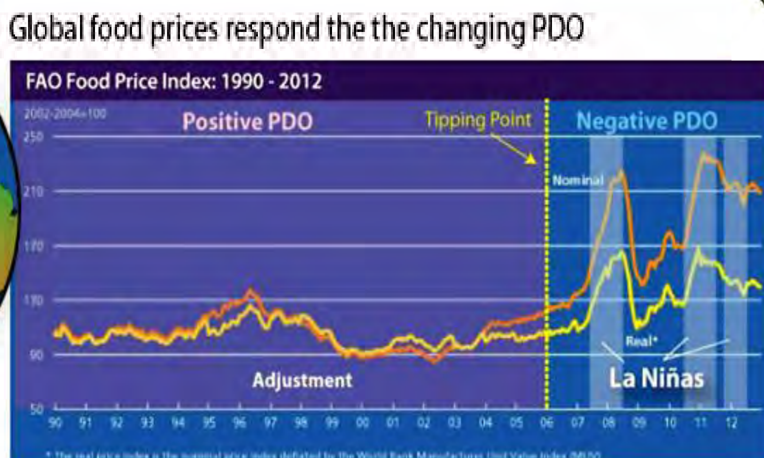
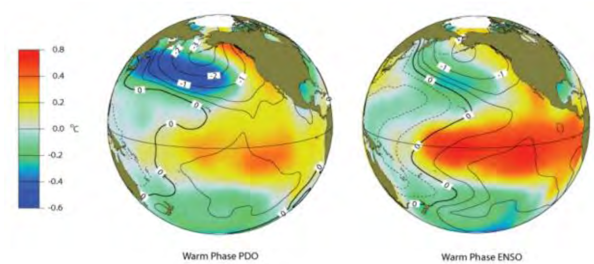


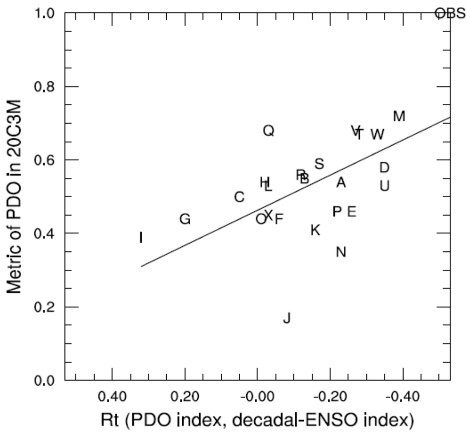
fig. 13 The Negative PDO





<u>Reproducibility of Natural variability in climate models is important to evaluate and improve model performance.</u>

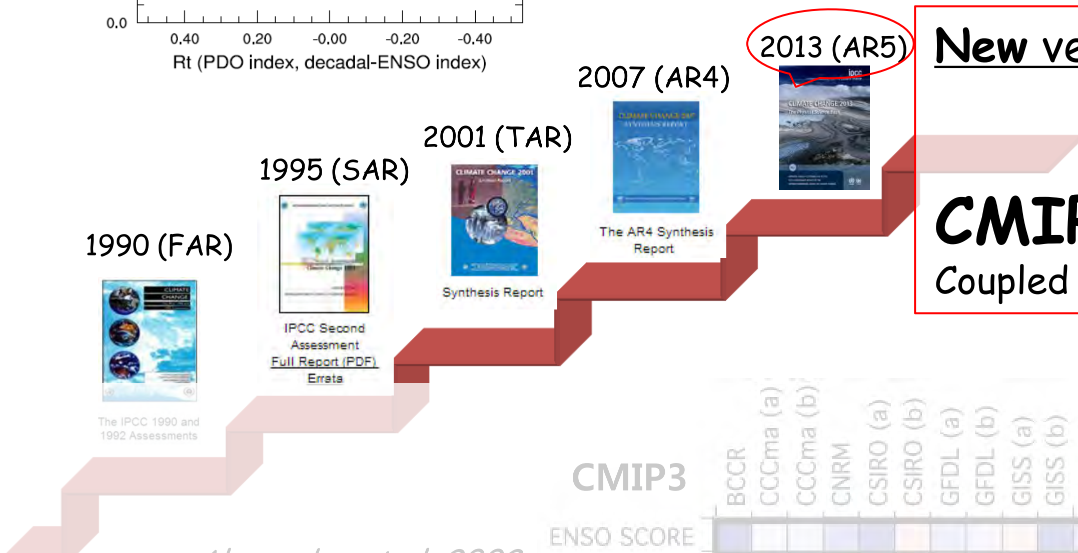
Motivation



Oshima and Tanimoto 2009

" we examine how well patterns of the PDO match between the observations and simulations by calculating a metric of the patterns with CMIP3 models"

→the models with the high PDO metric reproduce the linkage between the central North Pacific and the tropical Pacific.



<u>New versions of</u>
<u>**C**oupled **G**eneral **C**irculation **M**odels</u>

CMIP5 (Global climate models)
Coupled Model intercomparison Project Phases 5

Bellenger et al. 2013

Alexander et al. 2002

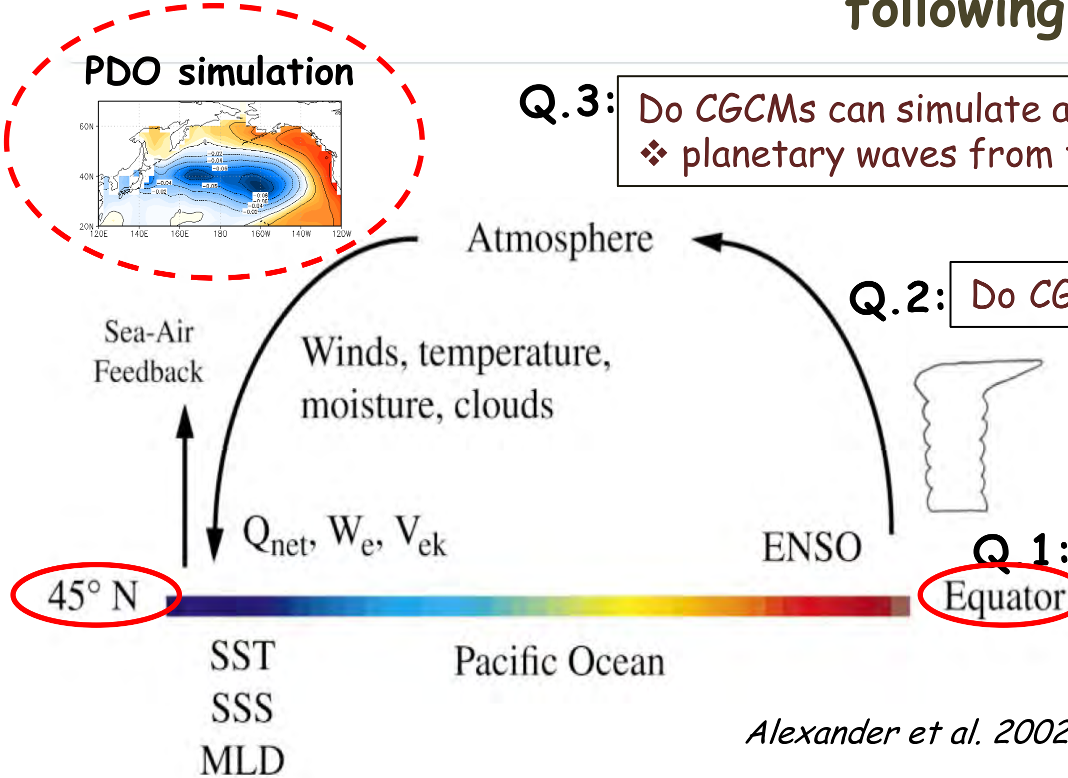
How are the PDO simulations from CMIP3 to CMIP5 ?

To investigate factors affecting the PDO simulation in CGCM, following questions should be answered.

Q.3: Do CGCMs can simulate appropriate ENSO-PDO teleconnection ?
❖ planetary waves from tropics to extratropics : Φ_{500}, $Uwnd_{850}$

Q.2: Do CGCMs can correctly simulate ENSO ?

Q.1: Do CGCMs can simulate tropical convection with the precipitation responding sensitively to tropical SST ?



Alexander et al. 2002

Objectives

1) To evaluate PDO pattern simulations in CMIP3 and CMIP5 CGCMs
: Is it improved in CMIP5?

2) To study the relationship of pattern simulation performance between PDO and ENSO-PDO teleconnection in CGCM

Data and Method

- **Data**

  - CMIP3 20C3M exp. (21 models)
  - CMIP5 Historical exp. (20 models)

- **Assessment Method**

  - Taylor diagram and Regression analysis with data re-gridded on 2.5° x 2.5°

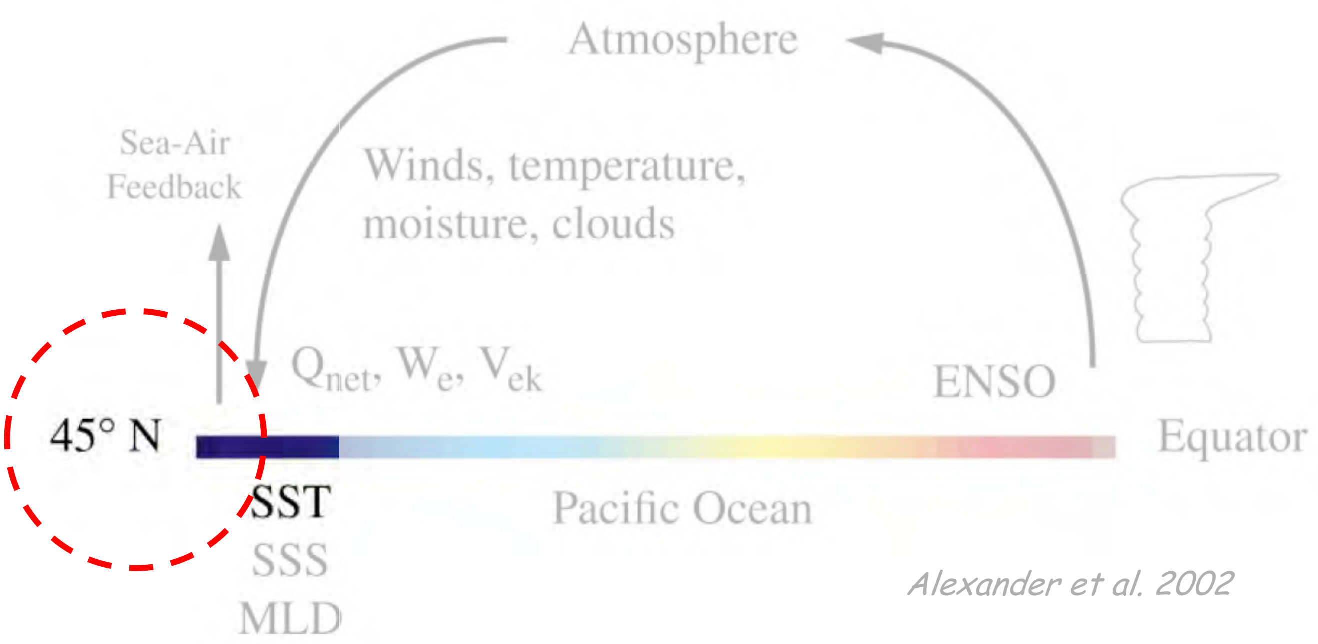
Simulation	Variable	Period	Observational data
PDO and ENSO	SST	1900~1999 (DJF)	ERSST
Precipitation sensitivity to SST (NINO3.4)	Precipitation SST	1979~1999 (DJF)	GPCP
Φ_{500} composite for ENSO	Geopotential height	1948~1999 (DJF)	NCEP & NCAR
U_{850} composite for ENSO	Zonal wind	1949~1999 (DJF)	NCEP & NCAR

Archive	CMIP ID	Contury
CMIP3	BCCR-BCM2.0	Norway
	CCSM3	USA
	CGCM3.1(T47)	Canada
	CGCM3.1(T63)	Canada
	CNRM-CM3	France
	CSIRO-MK3.5	Australia
	ECHAM5/MPI-OM	Germany
	FGOALS-g1.0	China
	GFDL-CM2.0	USA
	GFDL-CM2.1	USA
	GISS-AOM	USA
	GISS-EH	USA
	GISS-ER	USA
	INGV-SXG	Italy
	INM-CM3.0	Russia
	IPSL-CM4	France
	MIROC3.2(hires)	Japan
	MIROC3.2(medres)	Japan
	MRI-CGCM2.3.2	Japan
	PCM	USA
	UKMO-HadCM3	UK
CMIP5	CanESM2	Canada
	CCSM4	USA
	CESM1(CAM5)	USA
	CNRM-CM5	France
	CSIRO-Mk3.6.0	Australia
	GFDL-ESM2M	USA
	GISS-E2-H	USA
	GISS-E2-R	USA
	HadCM3	UK
	HadGEM2-AO	Korea
	HadGEM2-CC	UK
	HadGEM2-ES	UK
	INM-CM4	Russia
	IPSL-CM5A-LR	France
	IPSL-CM5A-MR	France
	MIROC5	Japan
	MPI-ESM-LR	Germany
	MRI-CGCM3	Japan
	NorESM1-M	Norway
	NorESM1-ME	Norway

Result

✓ **Part 1. PDO pattern**

Part 2. ENSO-PDO teleconnection



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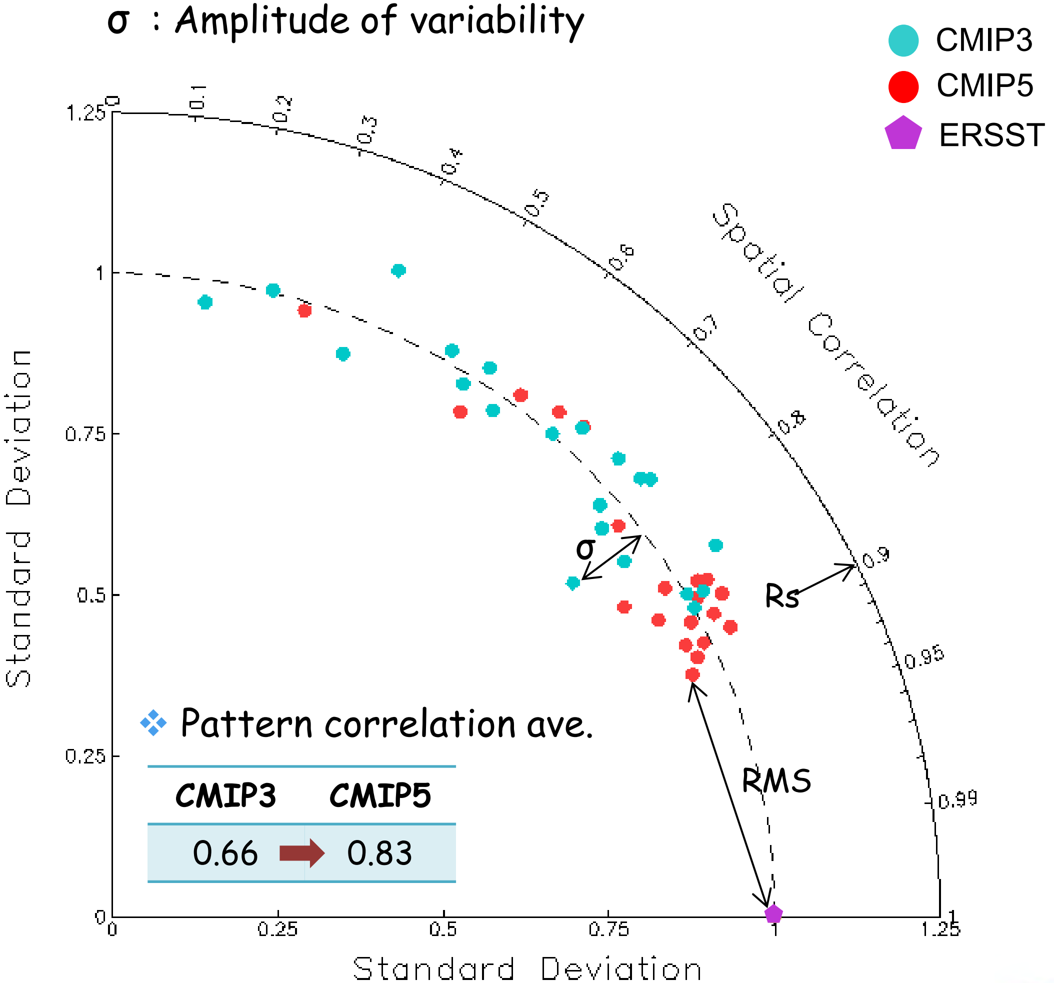
PDO patterns in CMIP3 and CMIP5

MME : Multi-model ensemble mean

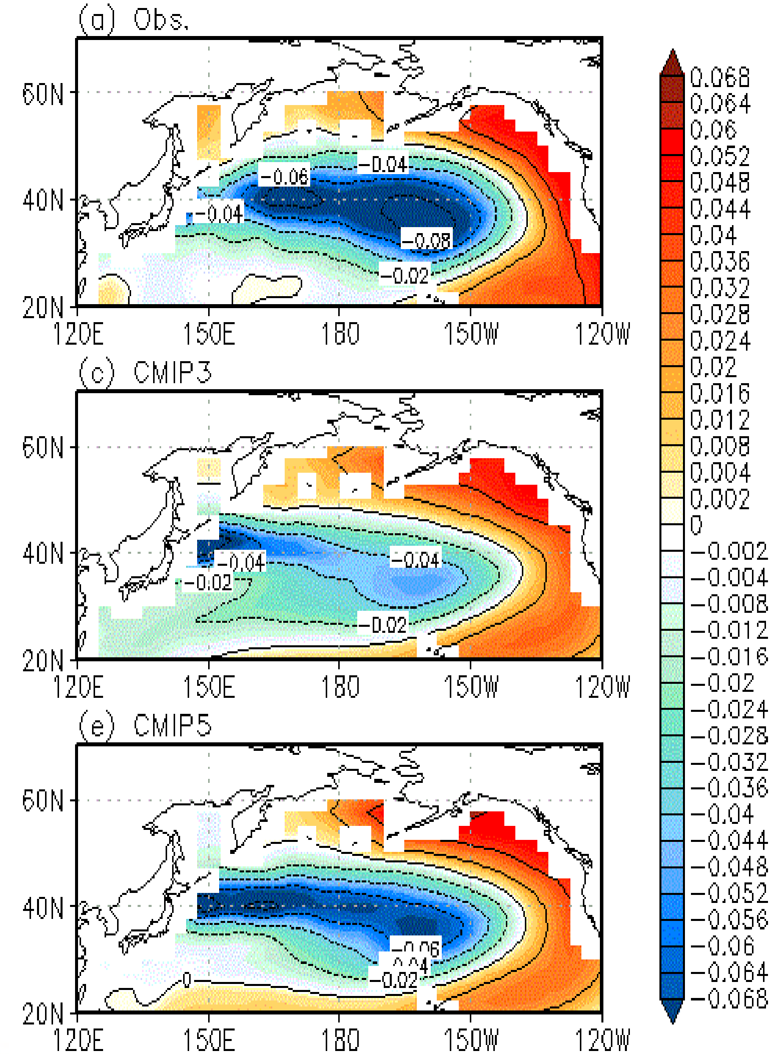
Rs : Spatial correlation coefficient
RMS : Root Mean Square
σ : Amplitude of variability



Pattern correlation ave.

CMIP3	CMIP5
0.66 →	0.83

MME PDO pattern

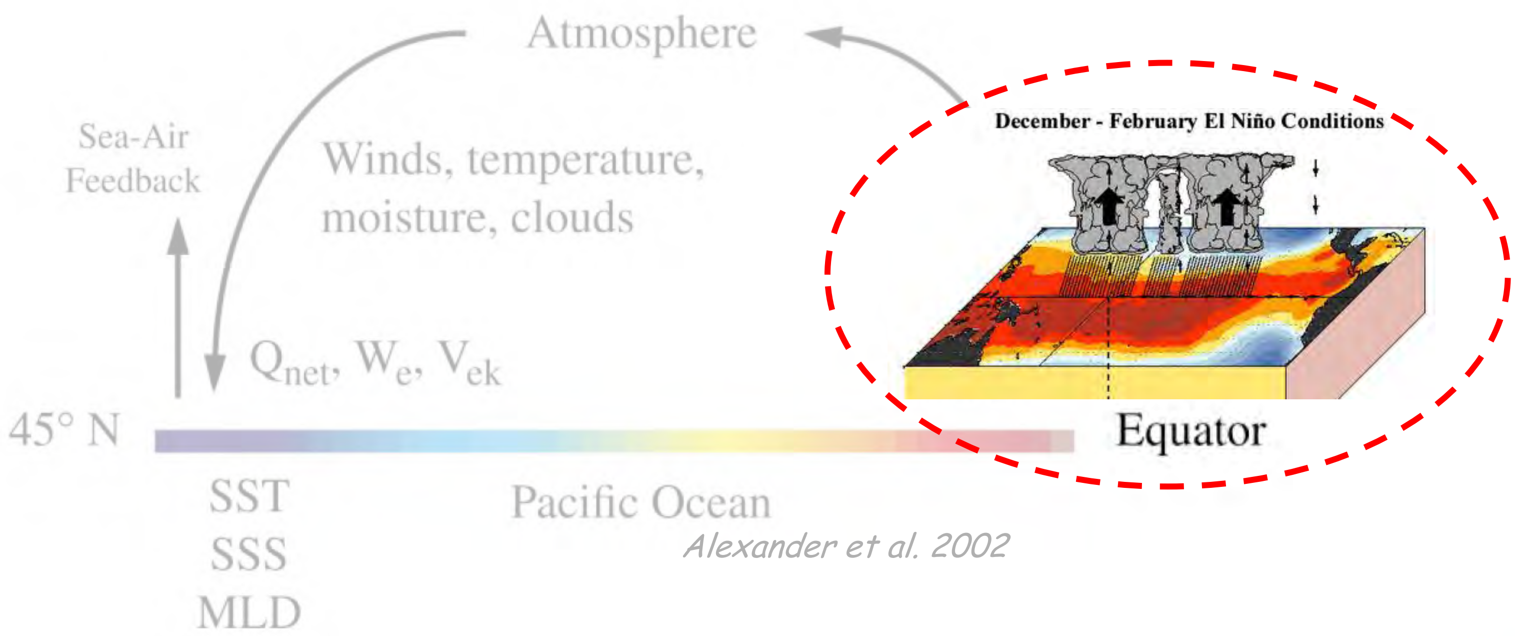


Result

Part 1. PDO pattern

✓ **Part 2. ENSO-PDO teleconnection**

<Precipitation sensitivity to tropical SST>



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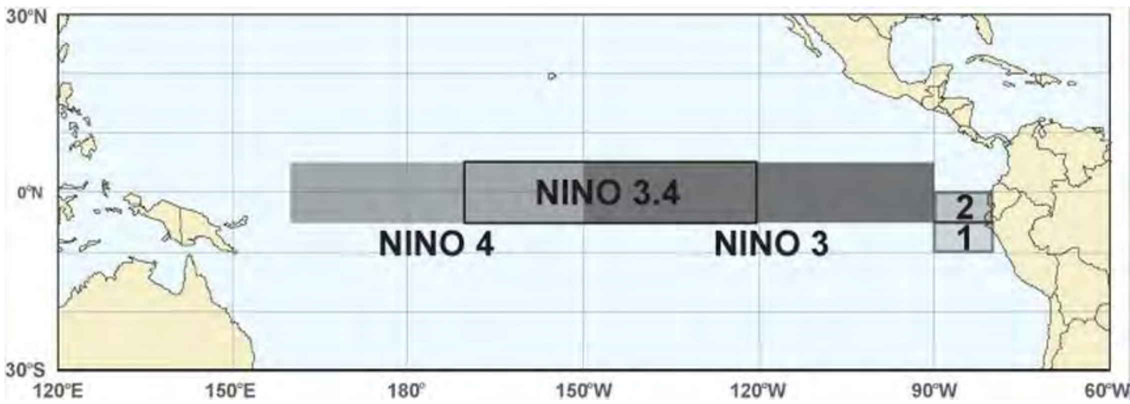
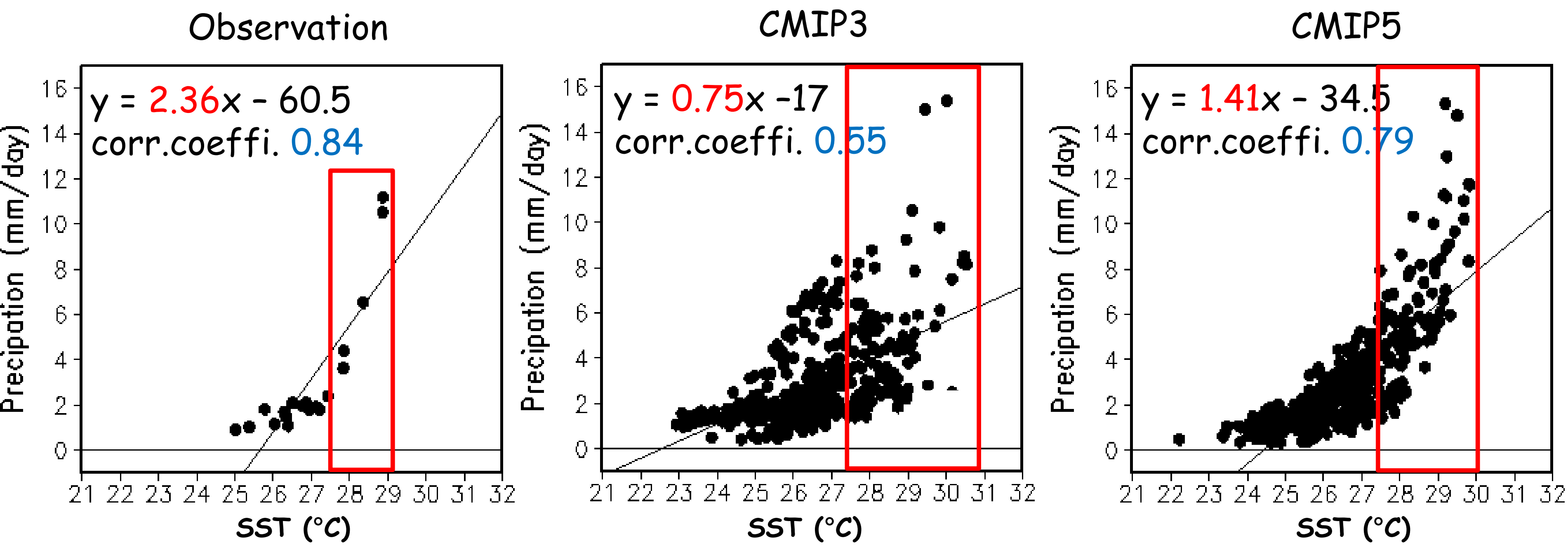
❖Precipitation sensitivity to tropical SST

Q.1: Is the precipitation sensitivity to tropical SST improved ? Yes



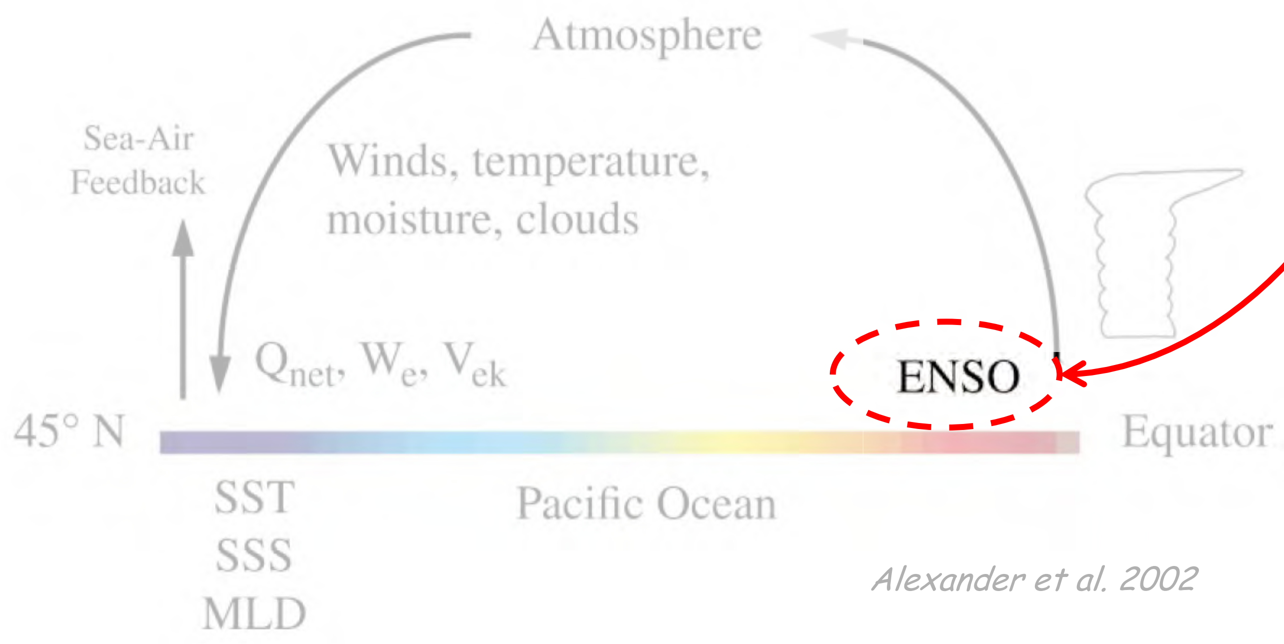


Result

Part 1. PDO pattern

✓ Part 2. ENSO-PDO teleconnection

<Simulated ENSO pattern>



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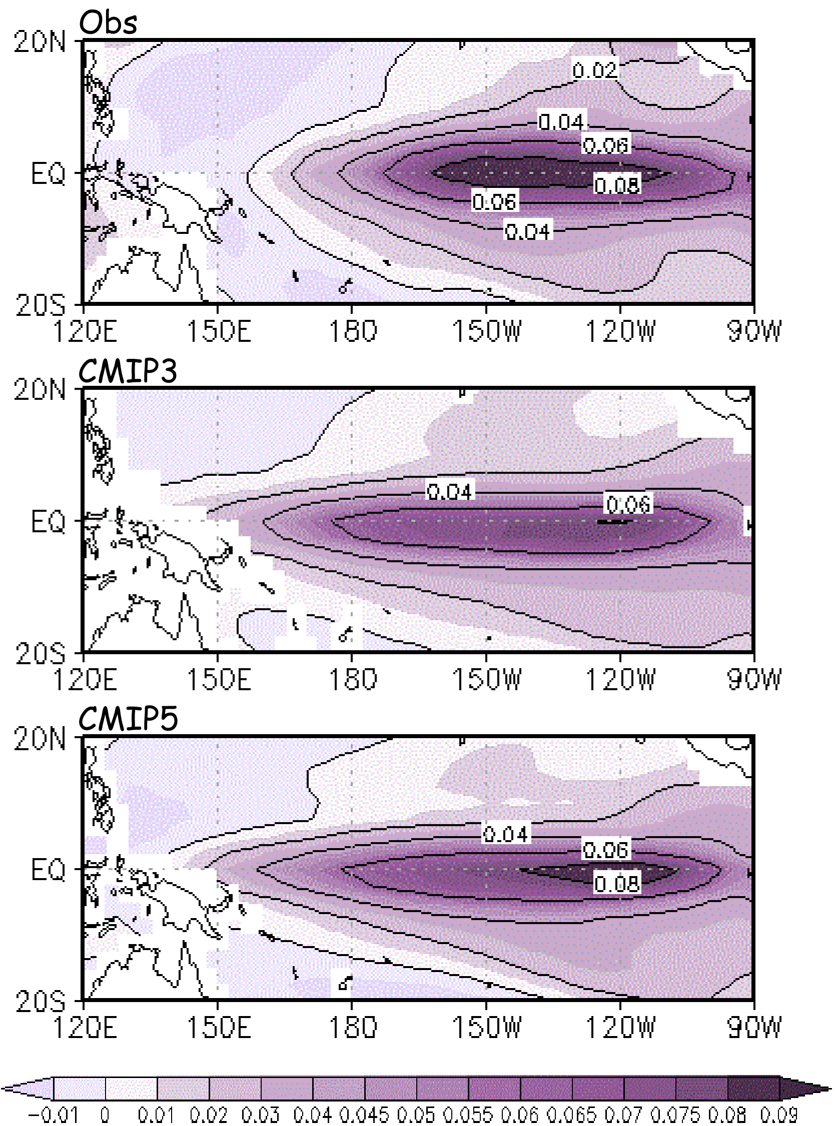
❖ ENSO pattern simulation in CMIP3 and CMIP5

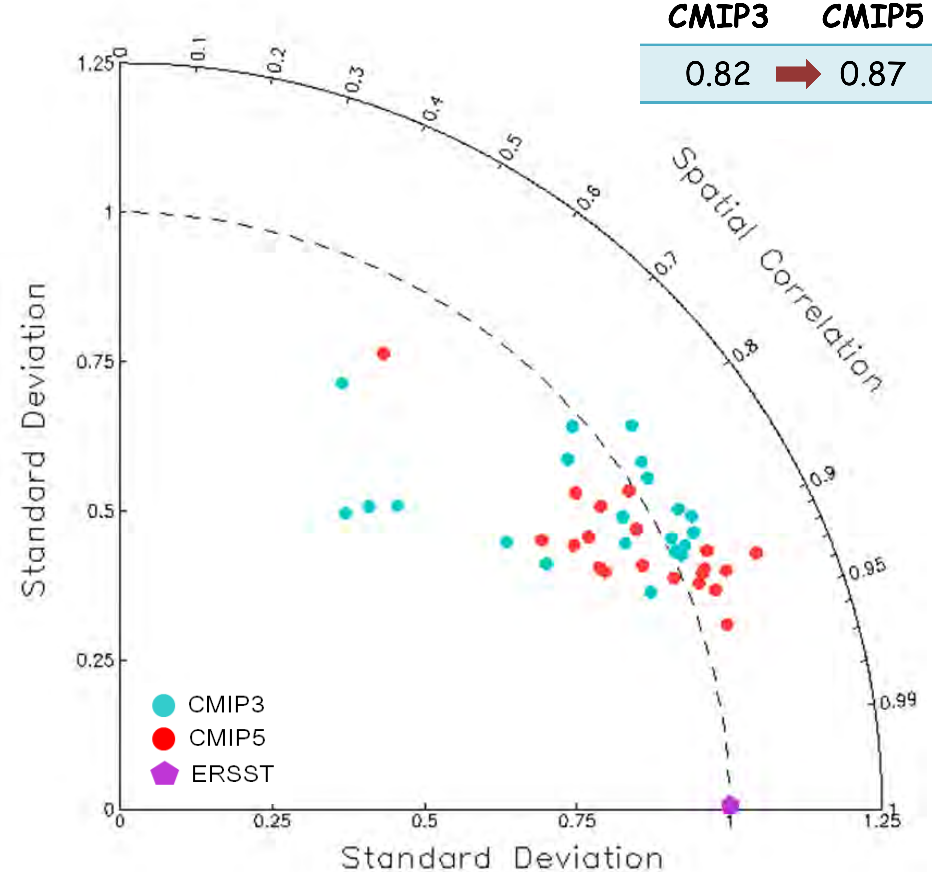
❖ MME ENSO pattern



Q.2: Is simulated ENSO pattern improved ? **Yes**

❖ Pattern correlation ave.

CMIP3		CMIP5
0.82	➡	0.87

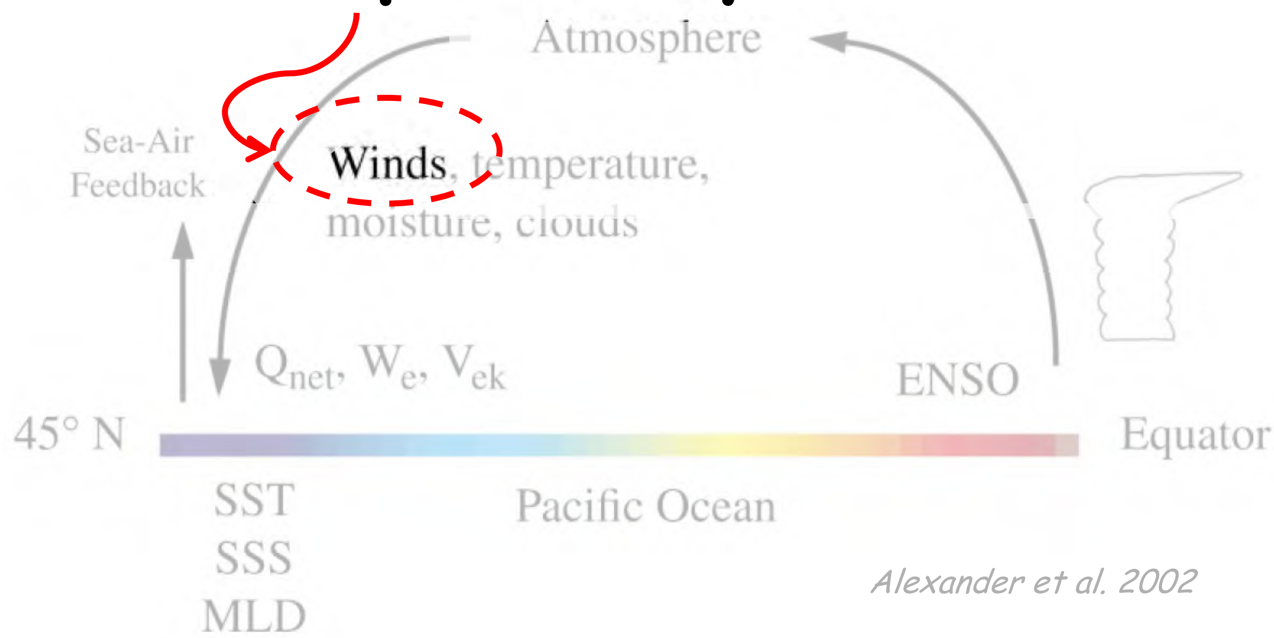


Result

Part 1. PDO pattern

✓ **Part 2. ENSO-PDO teleconnection**

<Simulated planetary waves>



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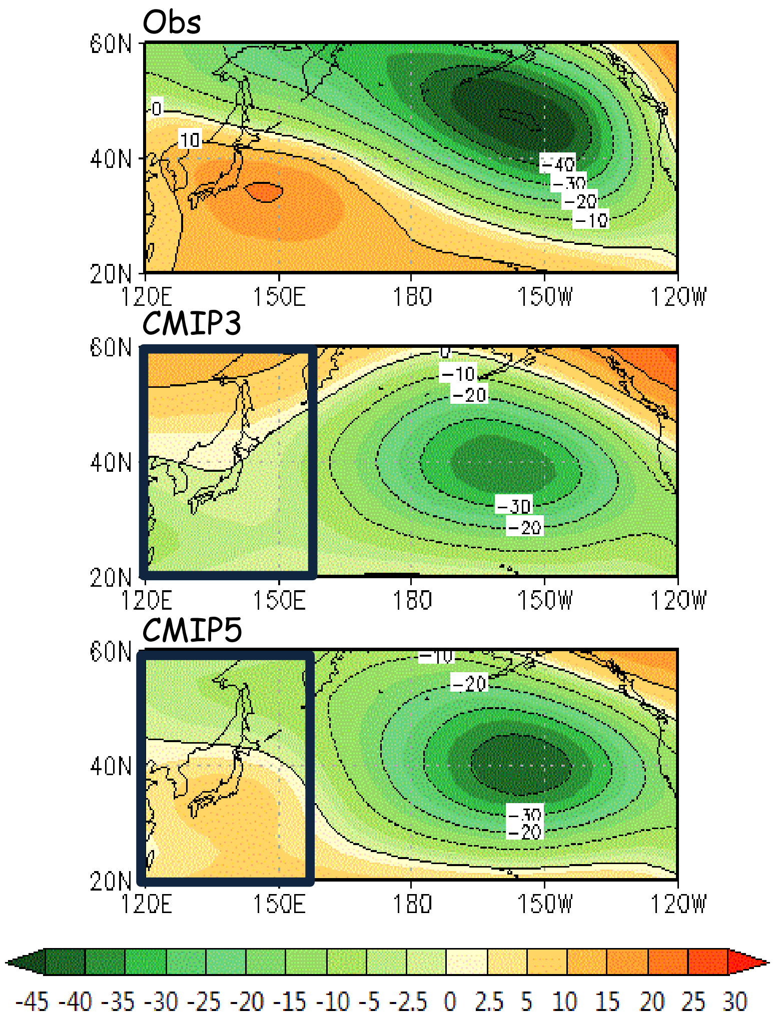
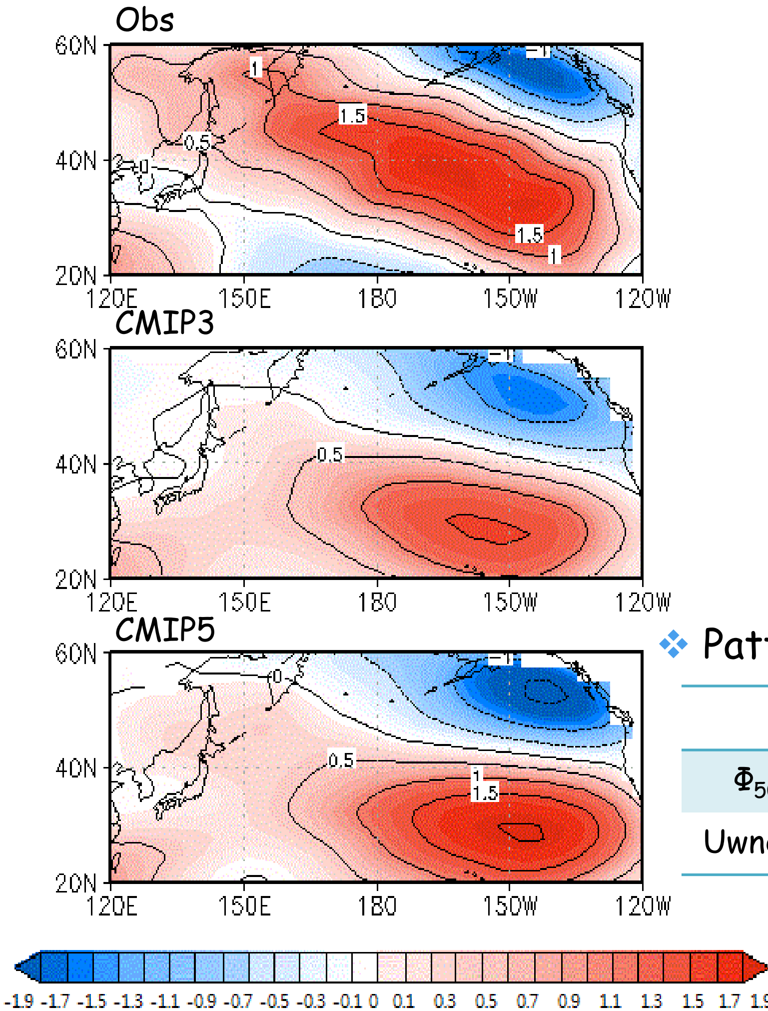
❖Composite ENSO-PDO teleconnections pattern simulation in CMIP3 and CMIP5

Q.3: Is simulated pattern of ENSO-PDO teleconnection improved ? Yes

❖Φ_{500} Comp. for El Nino years



❖$Uwnd_{850}$ Comp. for El Nino years



❖ Pattern correlation ave.

	CMIP3		CMIP5
Φ_{500}	0.47	➡	0.67
$Uwnd_{850}$	0.21	➡	0.57

Discussion

- Pattern correlation ave.

	CMIP3	CMIP5
PDO	0.66 ➡	0.83
Φ_{500} comp.	0.47 ➡	0.67
$Uwnd_{850}$ comp.	0.21 ➡	0.57

Is there relationship of model performances between PDO and ENSO-PDO teleconnections in Climate models?

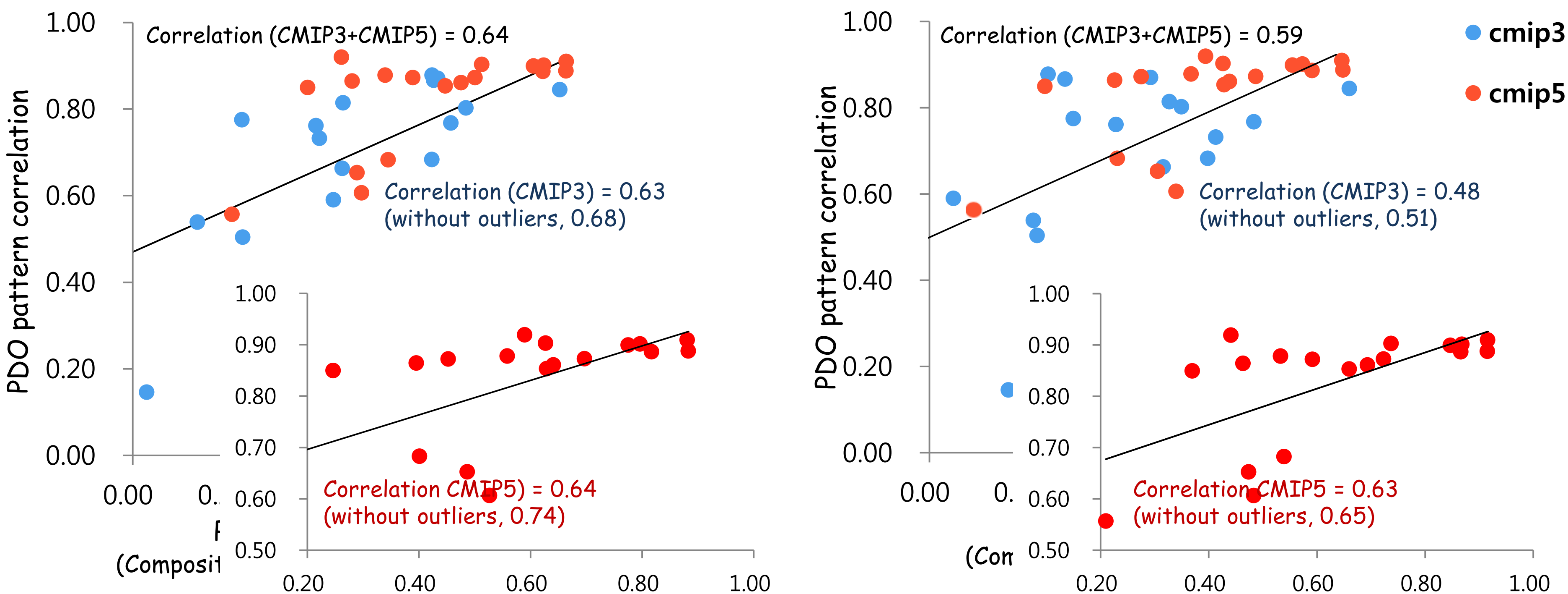
Discussion

❖ Pattern correlation ave.

	CMIP3		CMIP5
PDO	0.66	➡	0.83
Φ_{500} comp.	0.47	➡	0.67
$Uwnd_{850}$ comp.	0.21	➡	0.57

Is there relationship of model performances between PDO and ENSO-PDO teleconnections in Climate models?

Model Performance



Summary and Conclusion

- ✓ An improvement of PDO pattern simulations has been found from CMIP3 to CMIP5.
- ✓ It is considered that this improvement of PDO pattern simulations in CMIP5 is deeply related to the enhanced pattern simulation of ENSO-PDO teleconnections.

KIOST
한국해양과학기술원

Thank you : D