문서번호 APCC-출장-17-0070(2017-01-22)

| 결재 | 선임연구원 | 팀장 | 부서장 | 부서장 |
|---|---|---|---|---|
| | 01/20 함수련 | 01/20 김선태 | 01/20 유진호 | 대결 01/22 김형진 |
| 협조 | | | | |
| | | | | |

# TRAVEL REPORT FORM
# 출장보고서

## I. **Reporter** 보고자

| Department 소속 | Position 직위(직급) | Name 성명 | Travel Date 날짜 | Note 비고 |
|---|---|---|---|---|
| 기후연구팀 | 선임연구원 | 함수련 | 1/15~18 | 초청발표 (주최측 여비전액지원) |

## II. **Major Activities** 주요업무 수행내용

1. Main Contents and Activities 주요내용 및 활동

- 일본 동경대학교에서 주최한 1st Joint Workshop for Regional climate projection, Next general land surface model development, and model application and implementation에 초청받아 APCC 소개 및 SCoPS의 구축 현황 및 성능검증에 대한 발표를 진행
- 일정/장소: 2017.1.16.~2017.1.17. (2일) / 일본 홋카이도 삿포로, jozankei, Morinouta Hotel
- 발표제목: Assessment of seasonal prediction skill of new APCC in-house model

2. Relevance to APEC Climate Center's Activities 결론 및 소감

- 동경대에서는 최근 5년동안 SOUSEI 프로젝트를 통해 multi-GCM/multi-RCM을 통한 모델의 불확실성에 대한 연구, 태풍 및 홍수를 비롯한 극한기후모의, 지면모델 개발 및 모델 개선 등에 대한 연구를 진행하여 왔다. 프로젝트에 관련되어 있는 기관인 홋카이도 대학교, 요코하마 대학교, 동경대학교 수문연구실 및 모델링 연구실 교수 및 연구원 23명이 참석하여 각 기관의 연구주제들을 발표하고 향후 계획들을 논의하였음.
- 초청강연으로 SCoPS의 예측성능 및 APCC 소개에 대한 발표를 하였으며, 계절예측에 대한 기본 개념을 설명하고 계절예측자료가 표출되는 APCC 웹페이지를 소개함.
- 특히 동경대학교 수문연구실에서는 동경대학교에서 개발된 지면모델인 MATSIRO와 수문모델인 CaMa-Flood을 결합하여 전지구 모델에 적용하여 많은 연구를 진행하고 있어 향후 SCoPS의 지면모델과 관련된 에러의 코멘트를 구할수 있을 것으로 판단됨. 또한 필요시 MATSIRO 및 CaMa-Flood의 소스코드를 제공할 수 있다는 정보를 확인함.

## III. **References** 참고사항

(with attachment of any information or report in case of attendance of conferences,

workshops and meetings) 학술대회, 워크숍, 회의 등 참석 시 관련 정보 및 문서 첨부
발표자료 (첨부)

1. Presented and Collected Materials 주요 수집자료
   워크샵 프로그램 (첨부)
2. Suggestions and Remarks 건의사항

# Assessment of seasonal prediction skill of new APCC in-house model

**Suryun Ham**

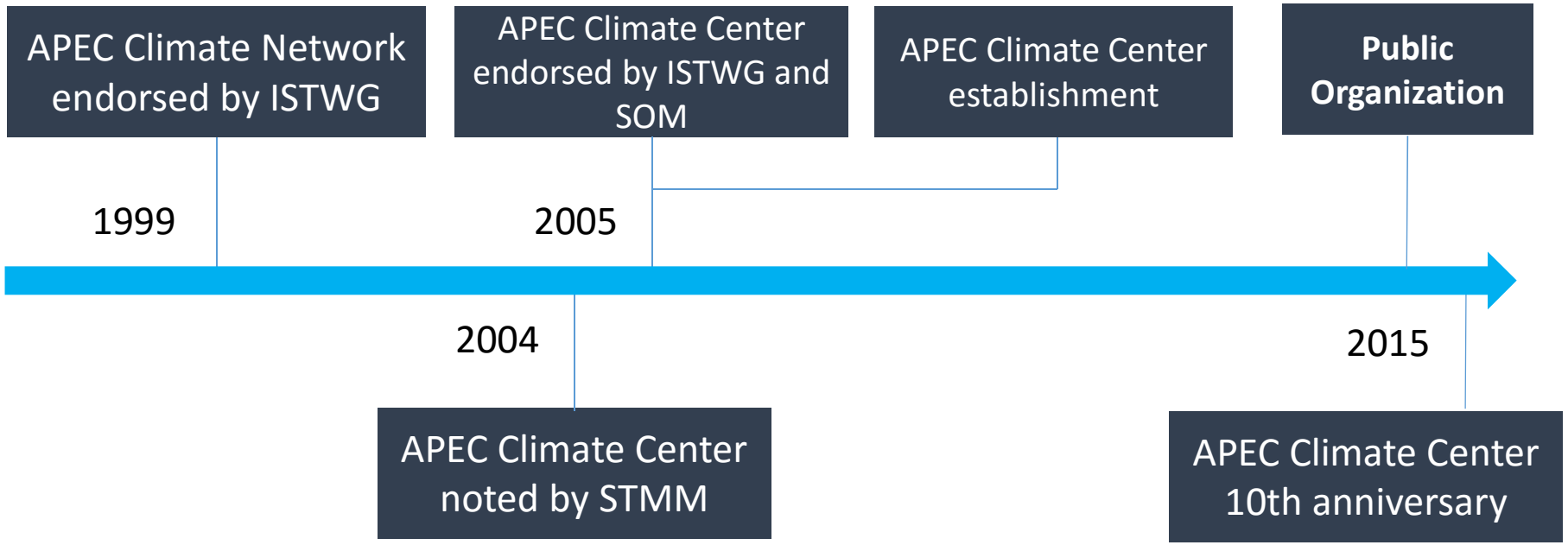
Climate Research Team
APEC Climate Center

Co-Workers: Dr. Seon Tae Kim, Dr. Hae-In Jeong, Dr. SuChul Kang, and Ms. A-Young Lim

APCC APEC CLIMATE CENTER


# Background of the APEC Climate Center (APCC)

# History of the APEC Climate Center (APCC)




**2005 SOM 1 for the 17th APEC Ministerial Meeting Summary Report**

41. SOM concluded that this was an important decision made by the ISTWG and endorsed the establishment of the APCC.

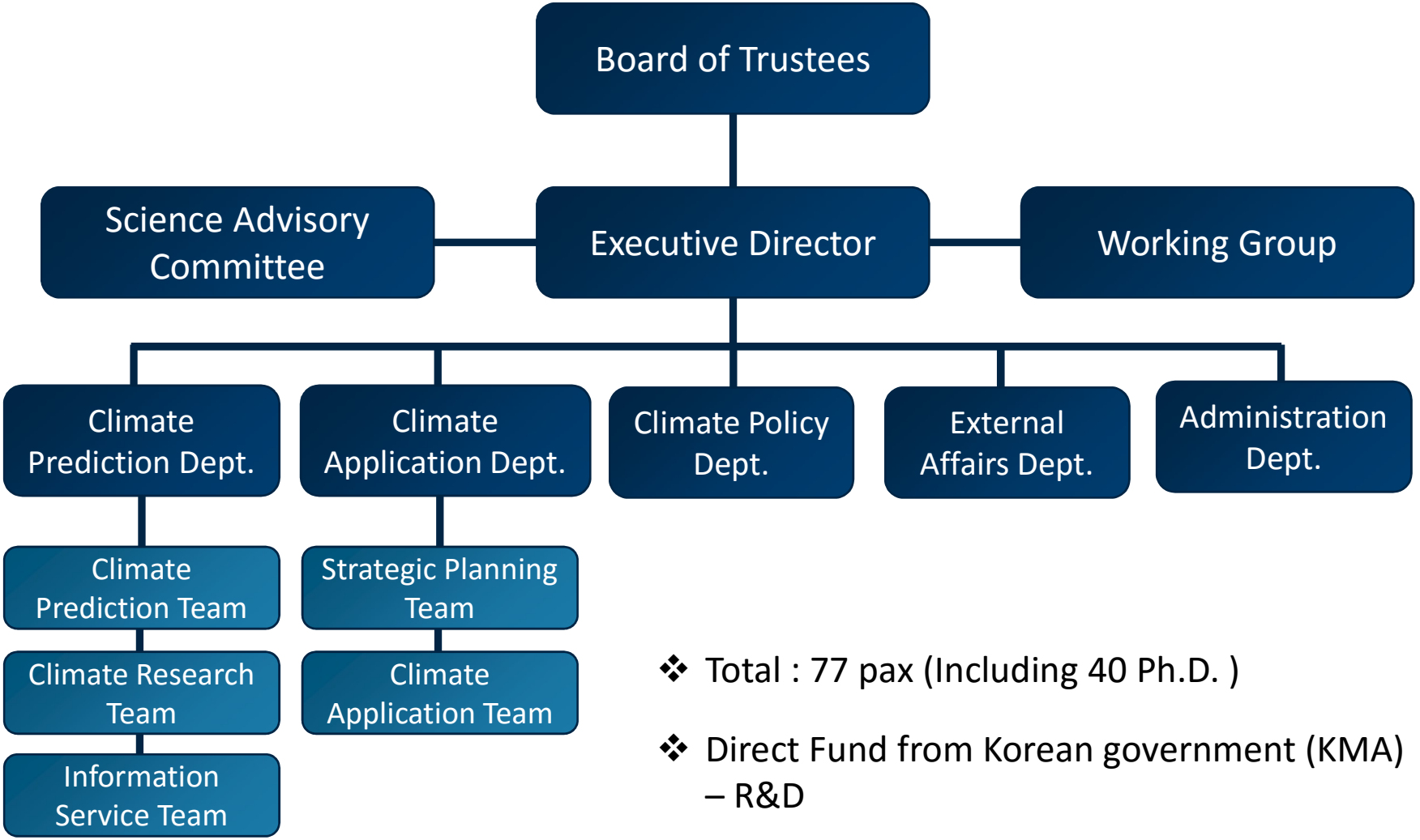
# Functions of the APEC Climate Center

from 2005/SOM1/003rev1

## Functions

- **Developing a value-added reliable real-time climate prediction system**, through a state-of-the-art multi-model climate prediction system utilizing model predictions from member economies
- **Acting as a center for climate data** and related information with open access to member economies
- **Helping build the capacity of member economies** in producing and using reliable climate predictions
- Developing improved methods of utilizing socio-economic innovation to mitigate and adapt to climate fluctuations and change and guide member economies towards optimum **utilization of APCC climate prediction information**
- **Coordinating research** toward the development of an APEC integrated **climate-environment-socio-economic system** model (ultimate and long-term scope)

# Structure of the APEC Climate Center




- Total : 77 pax (Including 40 Ph.D. )
- Direct Fund from Korean government (KMA) – R&D

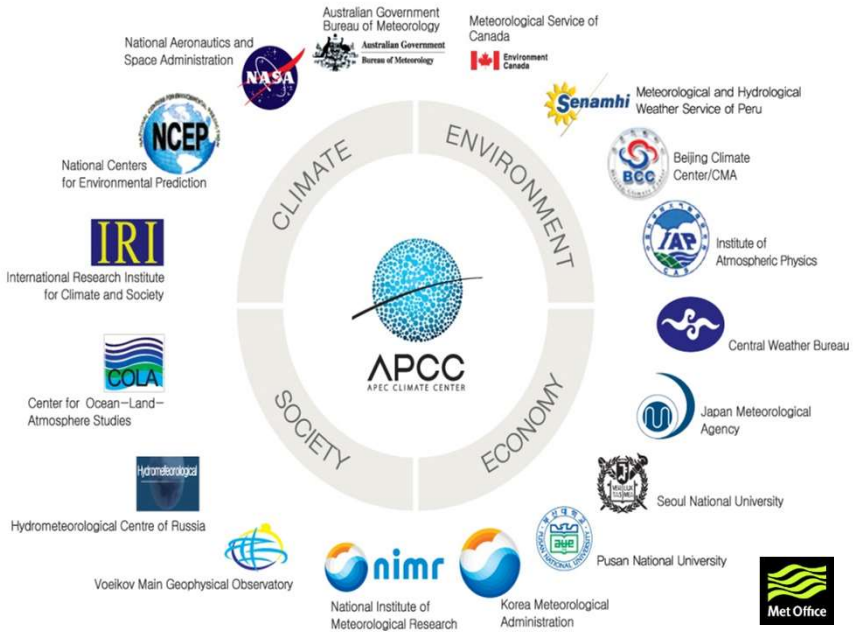

# Seasonal Climate Prediction System

APCC Activities

# Climate Prediction

**APCC has developed a climate prediction system based on a Multi-Model Ensemble (MME) technique, which collects seasonal forecast data from 17 institutes in 9 economies**

– In order to enhance the reliability of its MME climate services, APCC continuously performs forecast verification against observational data

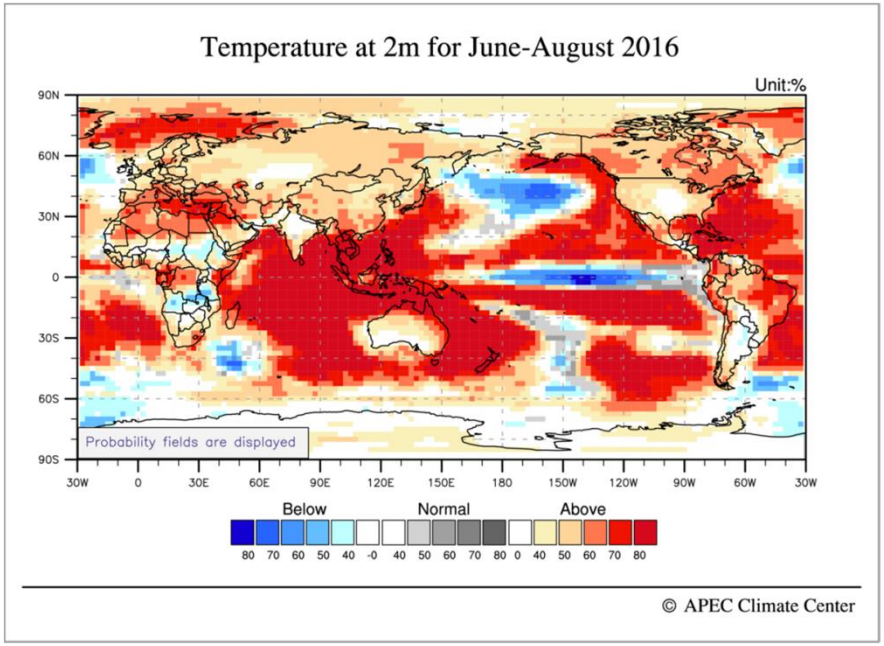


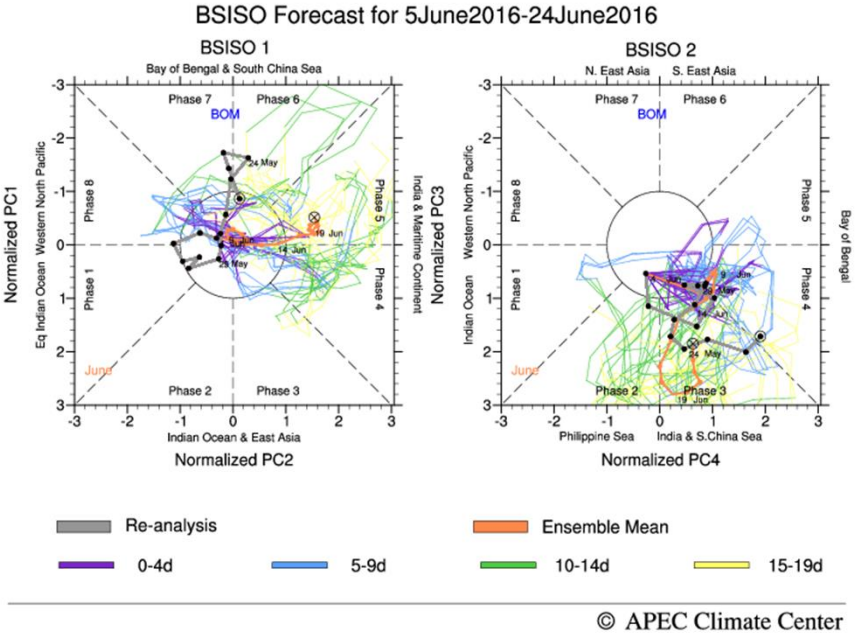
APCC Activities

# Climate Prediction

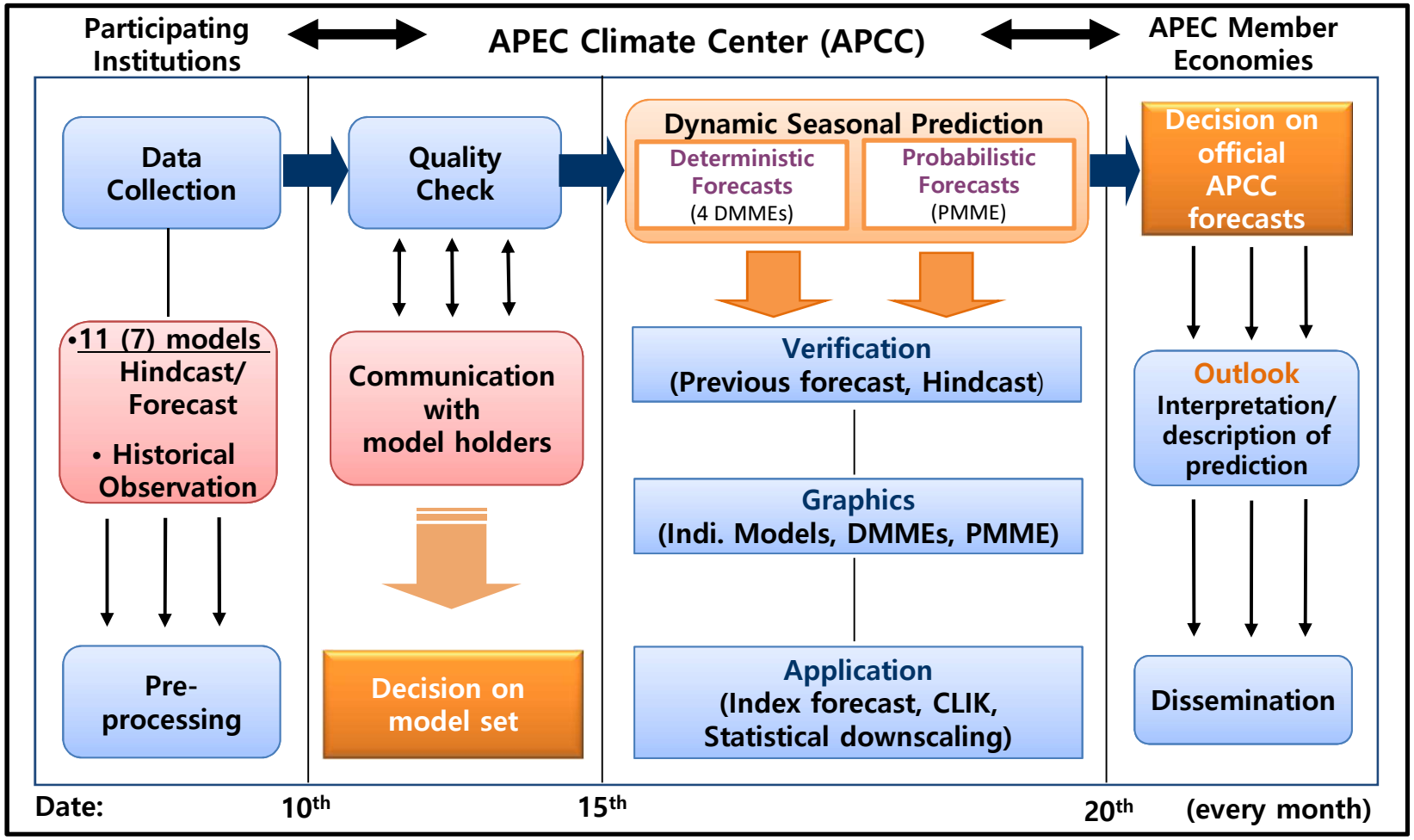
**MME forecast products include:** www.apcc21.org

- Monthly 3-month and 6-month lead climate prediction information based on multi-model ensemble system
- BSISO Forecast: Scaling up from seasonal to intraseasonal forecasting



# Time Schedule of Forecast



# Work assignment

❖ **Mission:**

Providing high quality climate forecast information

❖ **Purpose:**

**Operation** and **Application** of the APCC in-house models

## *1. Operation:*

***For Seasonal climate forecast system***

- Providing the seasonal forecast information to MME system every month
- Improving the forecast skill

## *2. Application:*

***For Dynamical/statistical downscaling***

- Providing the 6-hourly timescale dataset

***For Subseasonal climate forecast system***

- Validation of SCoPS prediction data on subseasonal timescale
- Setting up the subseasonal forecast system
- Plan to join to APCC BSISO forecast system

# APCC Climate Prediction models

## APCC in-house models

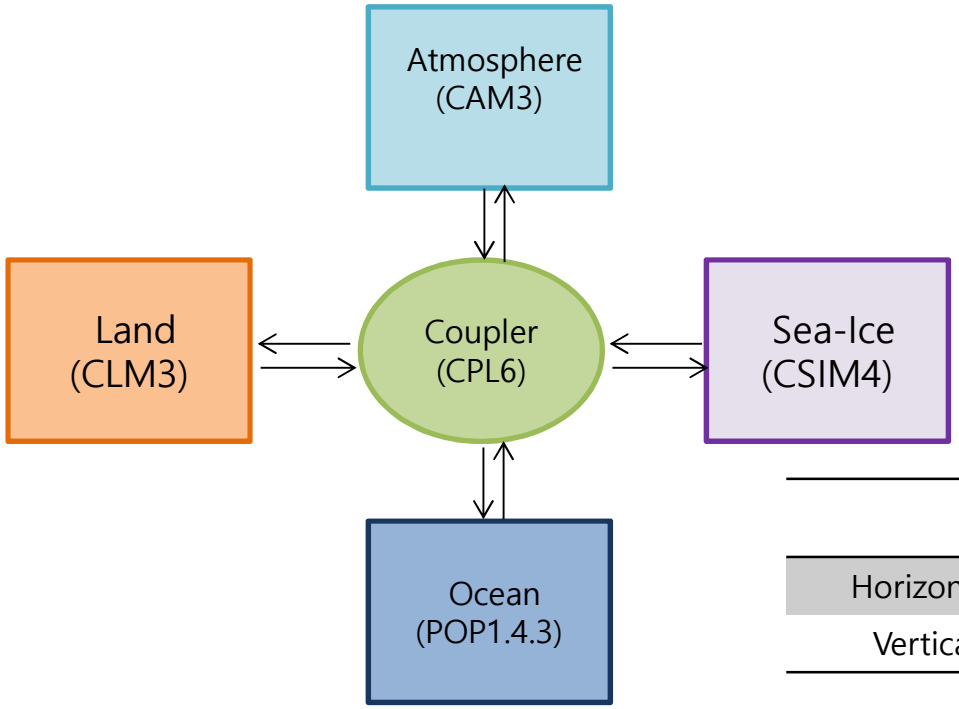
- The APCC has been provide the seasonal prediction data using the Community Climate System Model version 3 (CCSM3) with nudging of SST (APCC CCSM3, Collins et al. 2006; Jeong et al. 2008)
- Recently, the APCC has newly developed the Seamless Coupled Prediction System (SCoPS) with a research group of the University of Hawaii to improve the seasonal forecast skills.
- SCoPS consists of high-resolution atmosphere-ocean-land-sea ice coupled model with improved initialization schemes for predicting subseasonal to seasonal climate.
- For operational providing seasonal climate prediction, the capabilities of this system should analyze for various target seasons, different regions and time periods with a wide range of variables.

# APCC Climate Prediction models

## Evaluation of prediction skill of the CCSM3, SCoPS hindcasts

- Evaluation and the identification of the systematic biases in the global prediction, judged from long-term averaged states with many ensembles
- Global divergent field at the upper troposphere in contributions from the Hadley, Walker and monsoon circulation using a seasonal mean velocity potential field
- Prediction skill of ENSO, East Asian summer and winter monsoon, which are major drivers of weather and clilmate variability in East Asia

# CCSM3 Framework




| | Atmosphere | Ocean |
|---|---|---|
| Horizontal | T85 (1.4°x1.4°) | gx1v3(0.3°-1°) |
| Vertical | L26 | L40 |

- NCAR in USA
- Coupling frequency : 1/day
- 78 CPUs in APCC HPC (ATM:32, LSM:12, OCN:24, CSIM:8, Coupler:2)
- Integration time : approx. 5hr/7month

- Reference : Collins WD, Bitz CM, Blackmon ML, Bonan GB, Bretherton CS, Carton JA, Chang P, Doney SC, Hack JJ, Henderson TB et al (2006) The community climate system model version 3 (CCSM3). J Clim 19(11):2122–2143

# *Initialization method: Ocean Temp. 3D nudging*

**CCSM3**

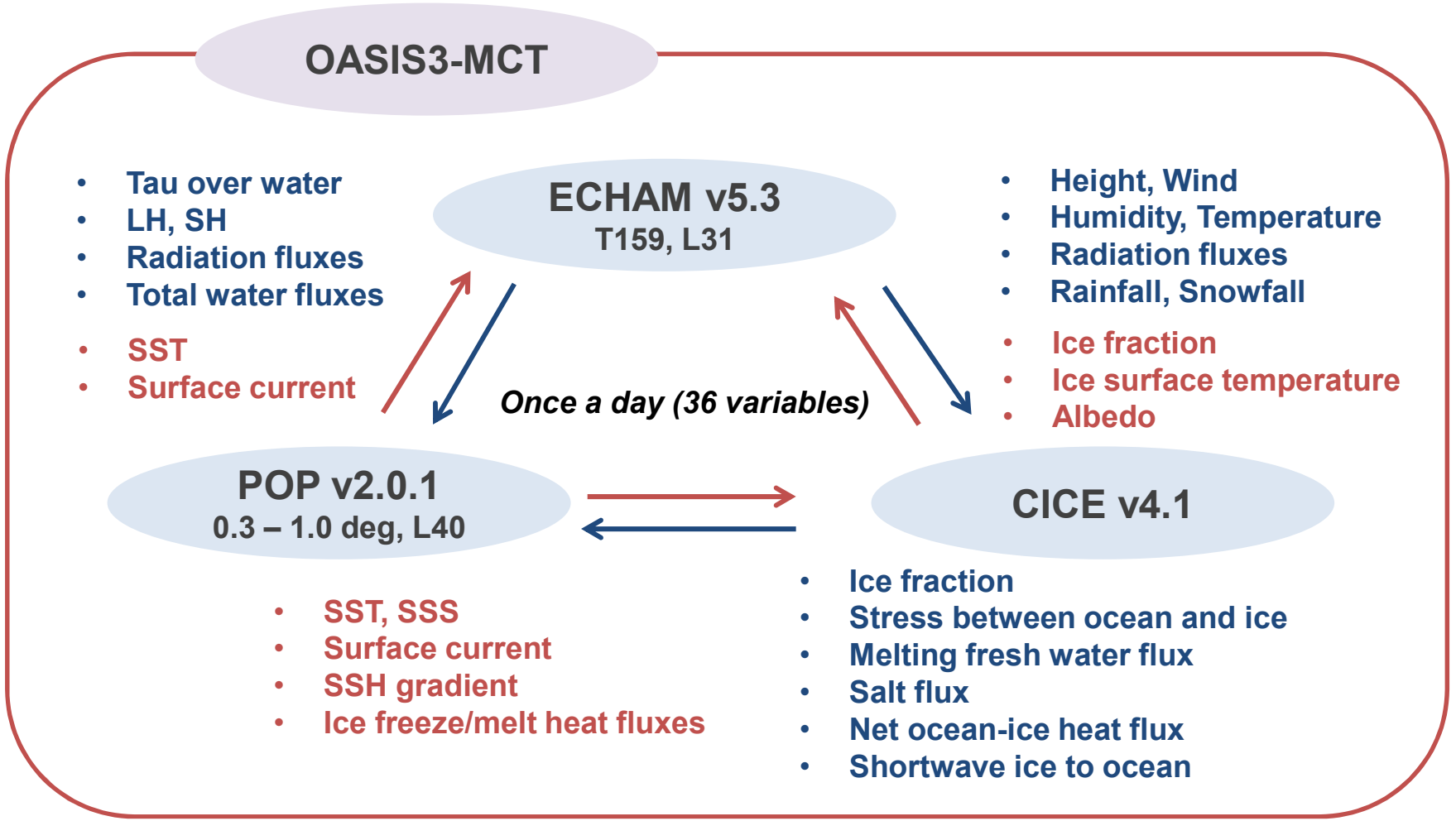
- CCSM3 POP1.4.3
- Ocean Temp. nudging
- Global/40 levels
- 5 days relaxation time
- Jan 1, 1982 ~ recent

*Pentad 3D Ocean Temp. → Daily 3D Ocean Temp. (Linear Interpolation)*

- Initial condition of CCSM3 Hindcast simulation
- Restart files of ATM, LSM, OCN, ICE

- Hindcast Simulation with ICs from Ocean Temp. Nudging
  - Ensemble members : 10
  - Ensemble generation methods: Time lagged forecasting method [Brankovic et al. 1990]
    - ATM/LSM/ICE ICs: the 1st, 6th, 11th, 16th, 21st , and the last 5 days of every month
    - Ocean IC: 22 ~ 26th every month
  - Hindcast period: 1982~2013 (32 years)
  - 7month integration

# SCoPS Framework



# Initialization method: Integrated Atm.-Ocn. initialization

**SCoPS**

- Integrated Atmosphere-Ocean Initialization : combining 3-D atmospheric initialization and the advanced Ensemble Adjustment Kalman Filter (EAKF) methods
- Jan 1, 1982 ~ recent
- 50S – 50N, till 400meter

*CFSR atmosphere variable, XBT & ARGO ocean variable (Forecast: ARGO only)*

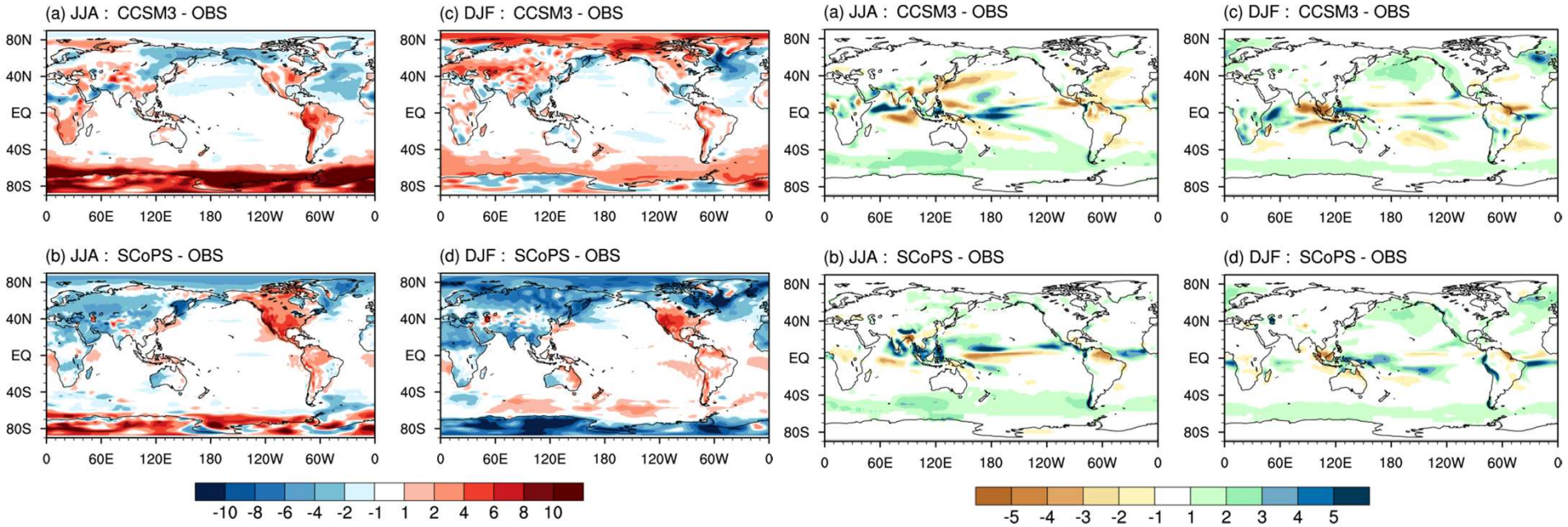
- Initial condition of SCoPS Hindcast simulation
- Restart files of ATM, OCN, ICE

- Hindcast Simulation
  - Total Ensemble members : 10
  - Time lagged forecasting with perturbation ensemble spread by ENKF
  - - ATM/OCN/ICE ICs: the 1st, 5th of every month
    - 5 perturbation initial data
  - Hindcast period: 1982~2013 (32 years)
  - 7month integration

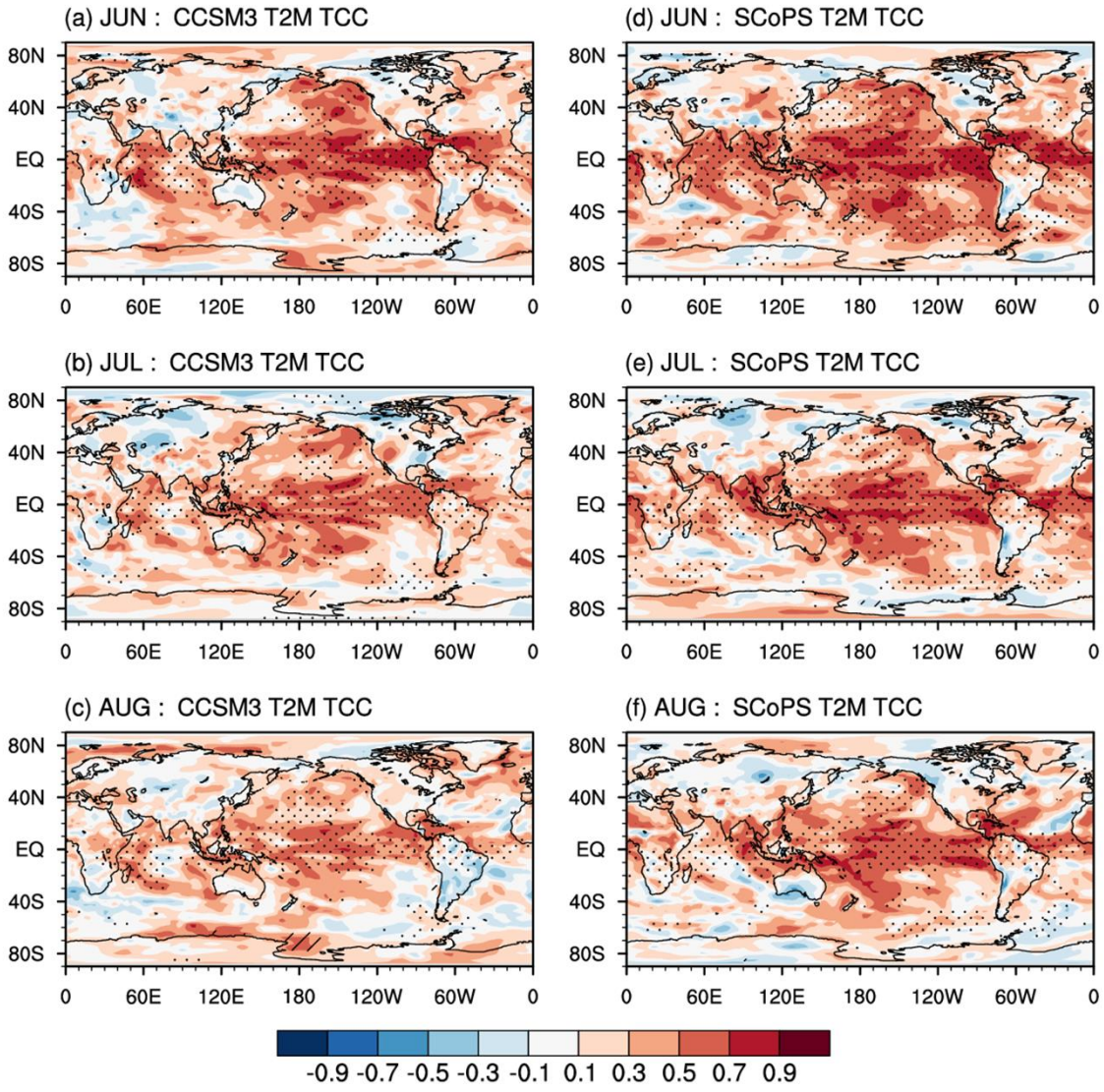
# ❖ Seasonal-mean biases of Temperature and Precipitation

***Surface Temperature*** ***Precipitation***

***JJA (1mon lead)*** ***DJF (1mon lead)*** ***JJA (1mon lead)*** ***DJF (1mon lead)***

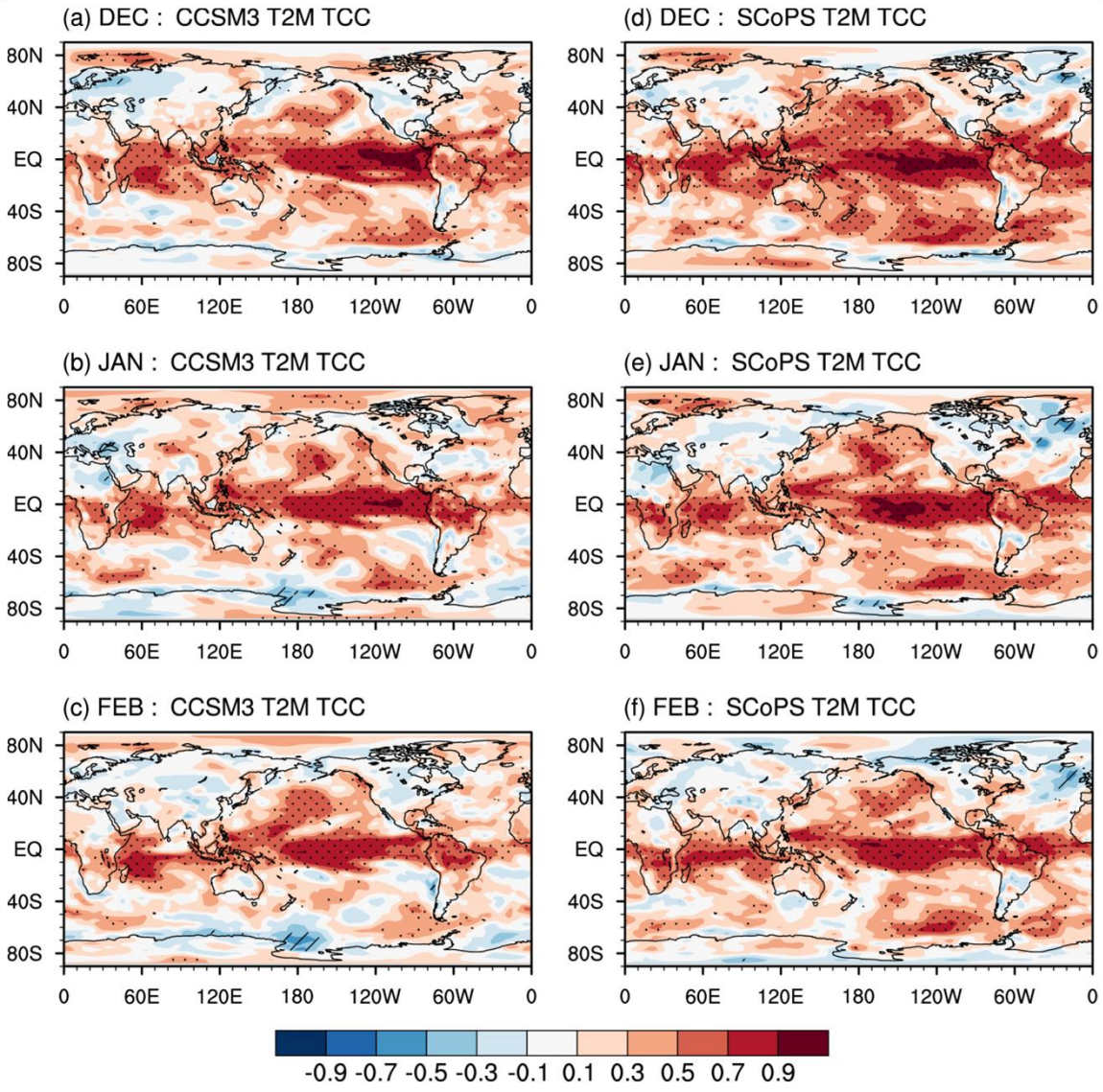


# ❖ Prediction skill map in May hindcast (JJA; May Start)




***Surface Temperature***

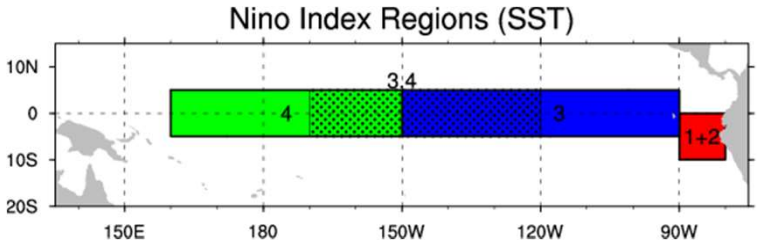
# ❖ Prediction skill map in Nov hindcast (DJF; Nov Start)

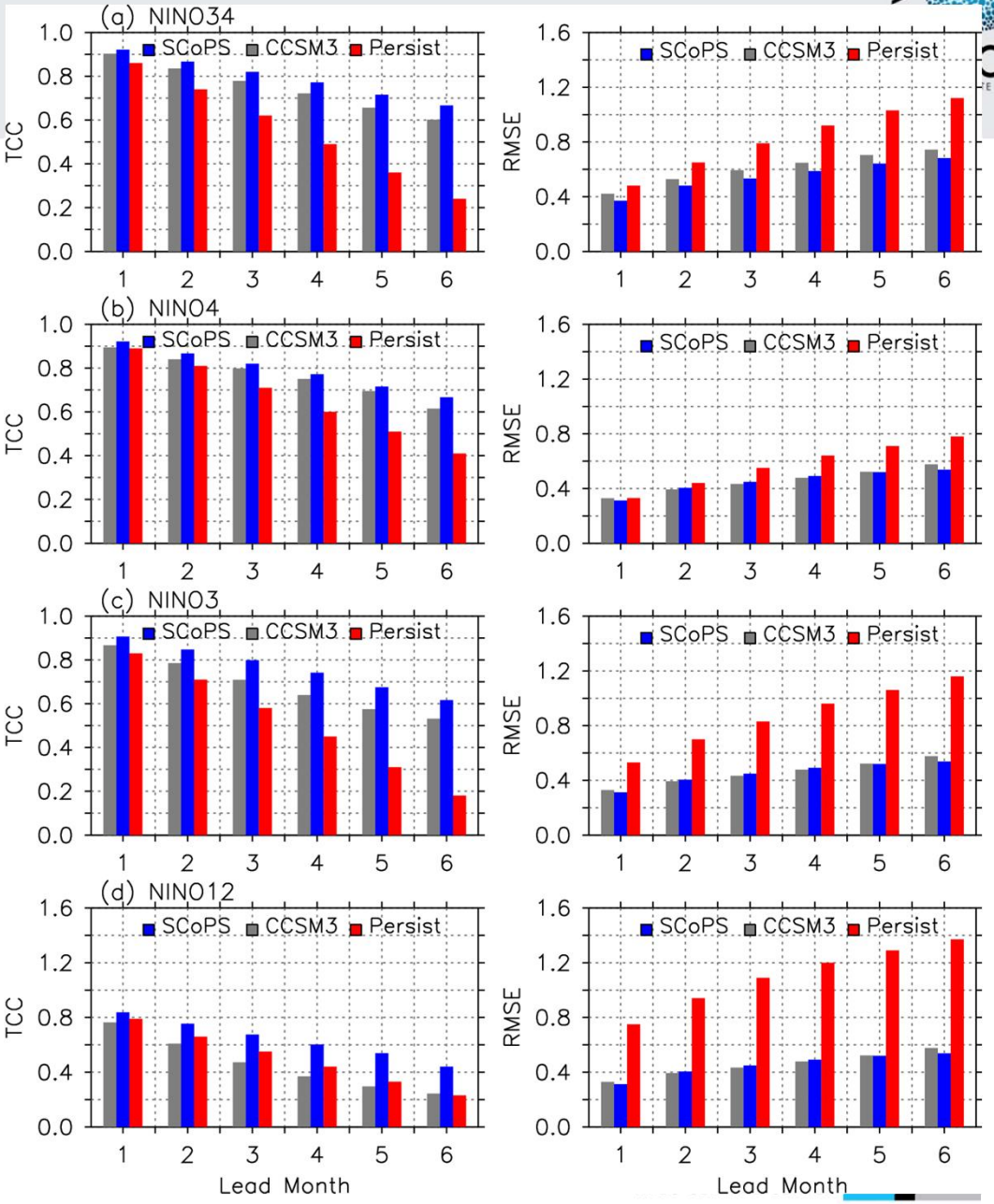



***Surface Temperature***

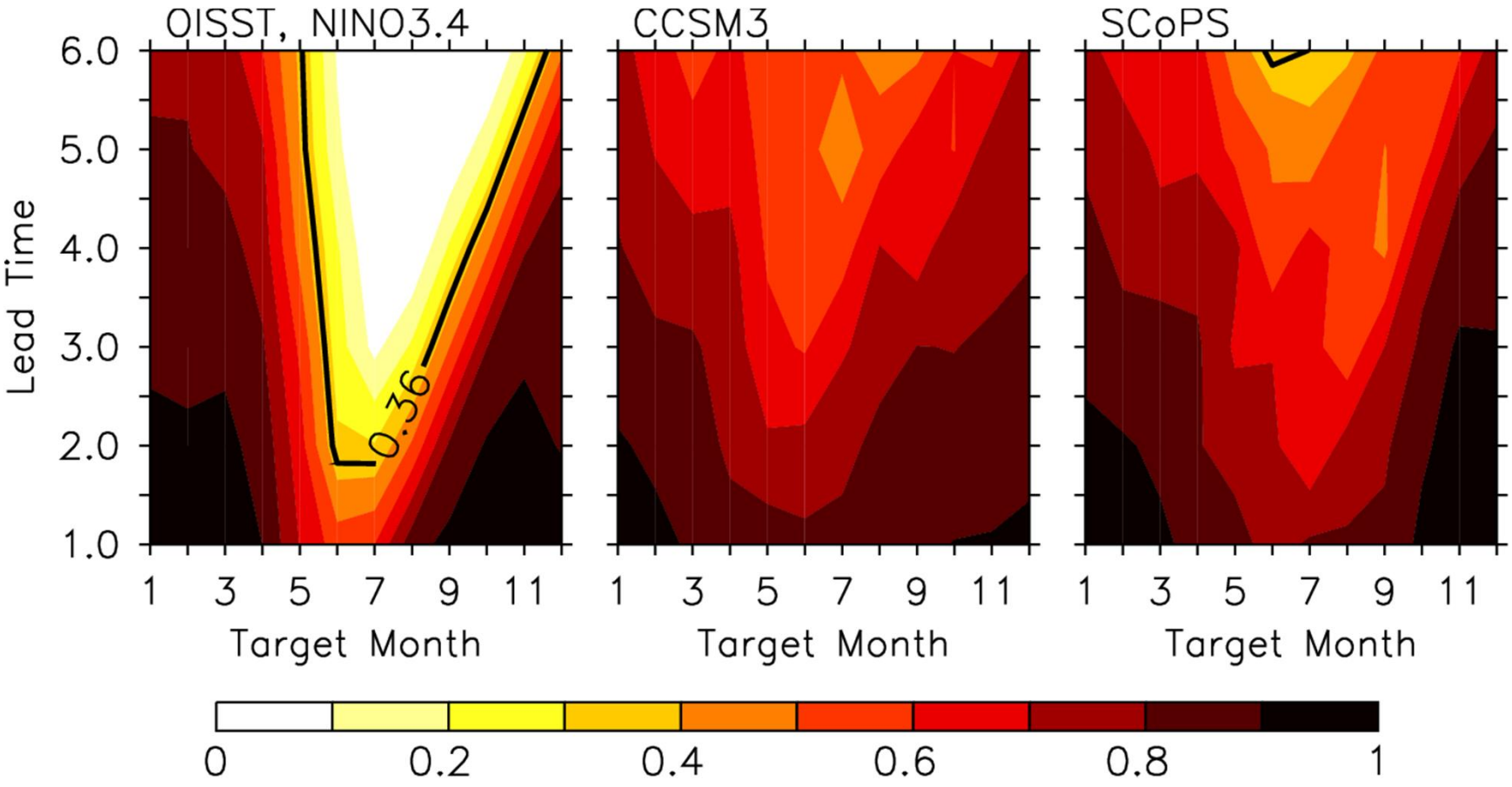
# ❖ ENSO prediction: Index

- **TCC and RMSE from 1-month lead to 6-month lead**



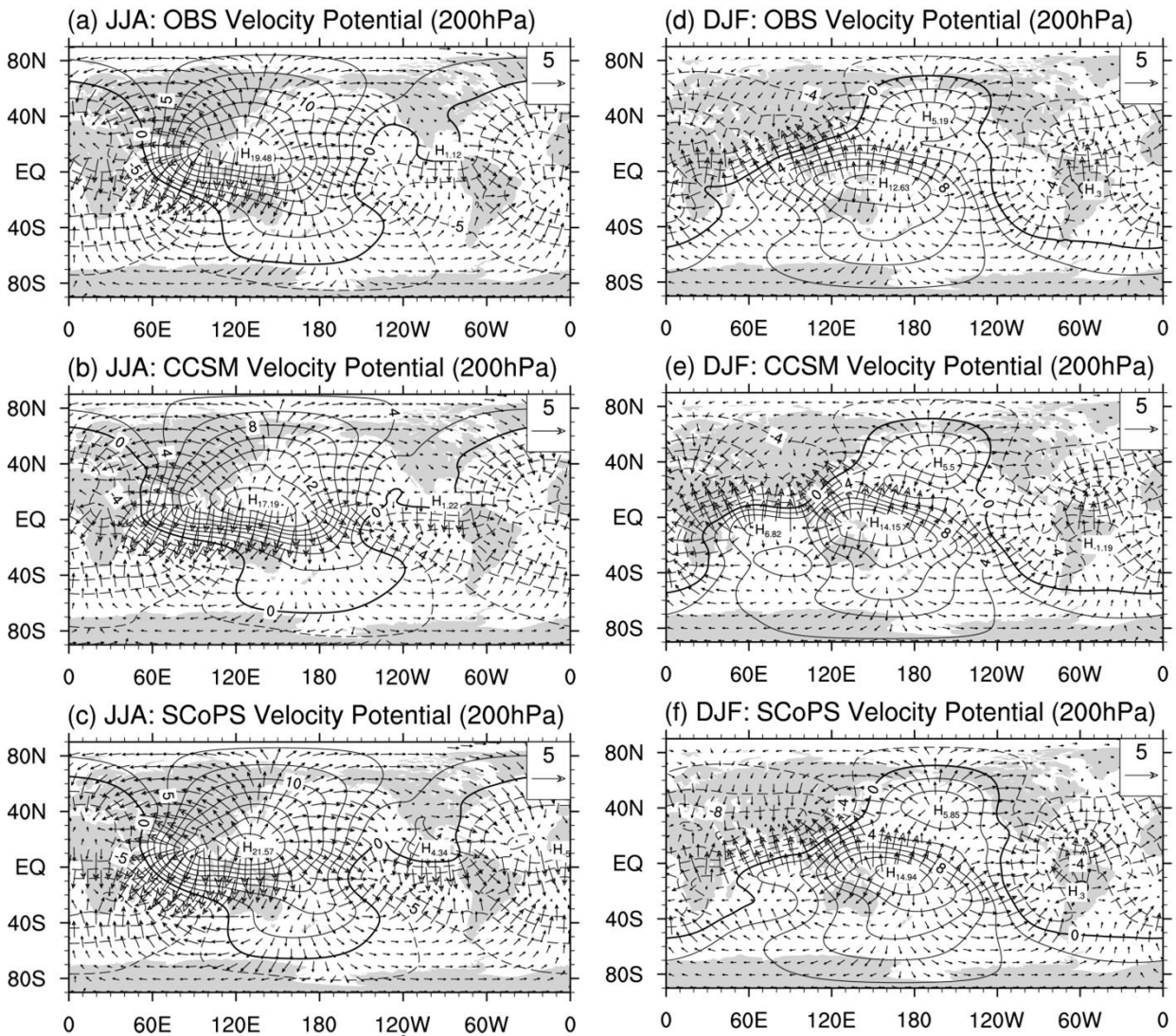



# ❖ ENSO prediction: Seasonal dependence



# ❖ 200hPa Velocity Potential

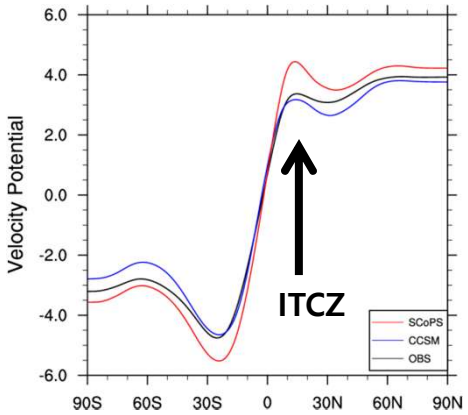
***JJA (MAY start)*** ***DJF (NOV start)***



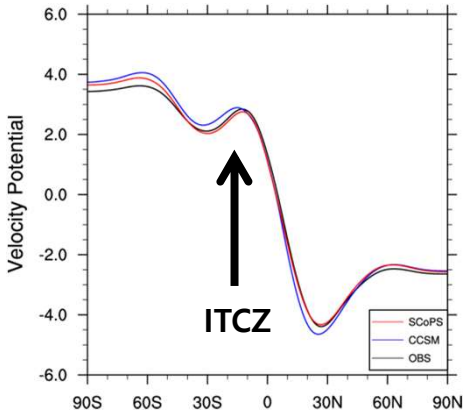

*Positive(negative): divergence(convergence)*

**Hadley circulation intensity**

***JJA (MAY start)***

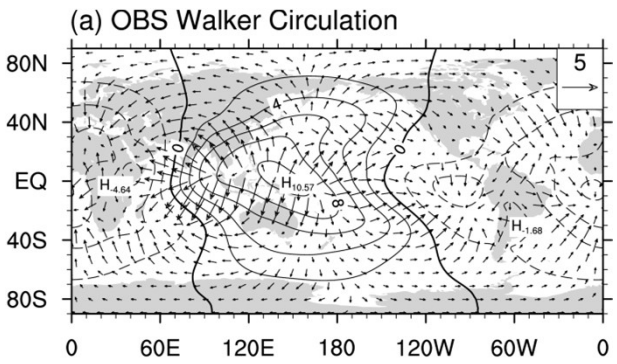



***DJF (NOV start)***

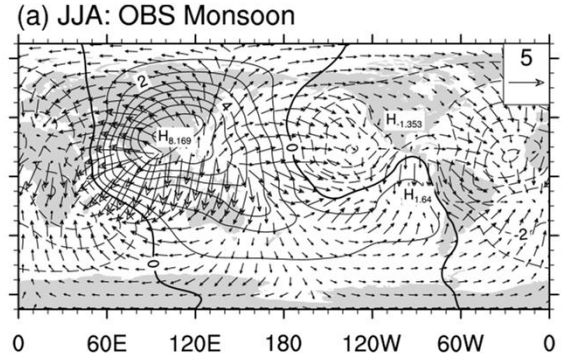


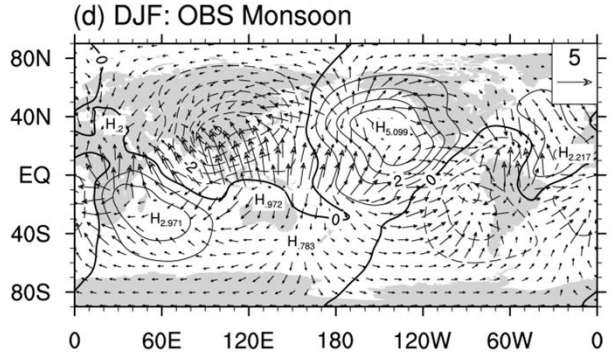
# ❖ Deviation from Zonal mean (Walker) and Annual Mean (Monsoon)

## *Walker Circulation*



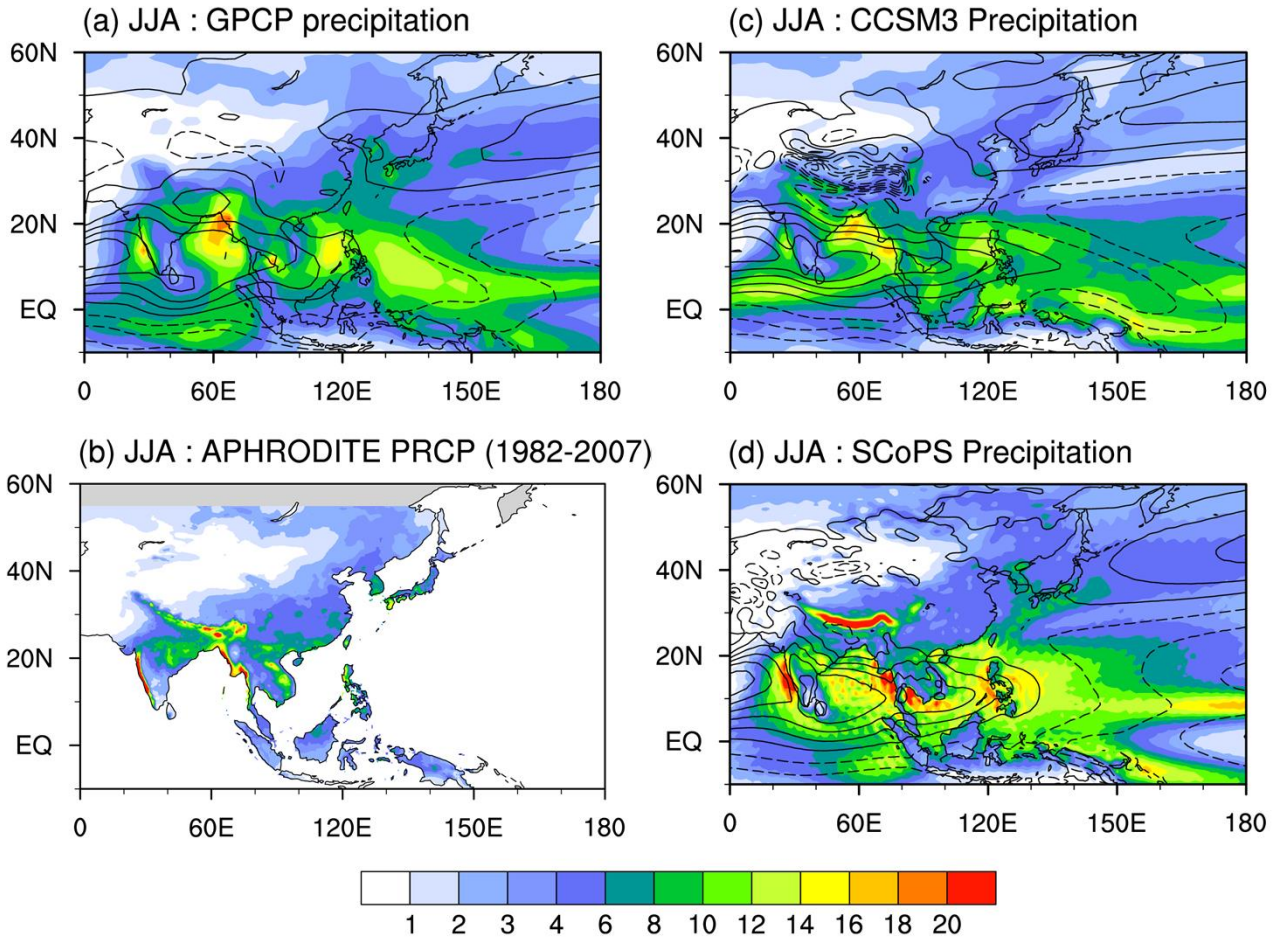

## *Monsoon Circulation*



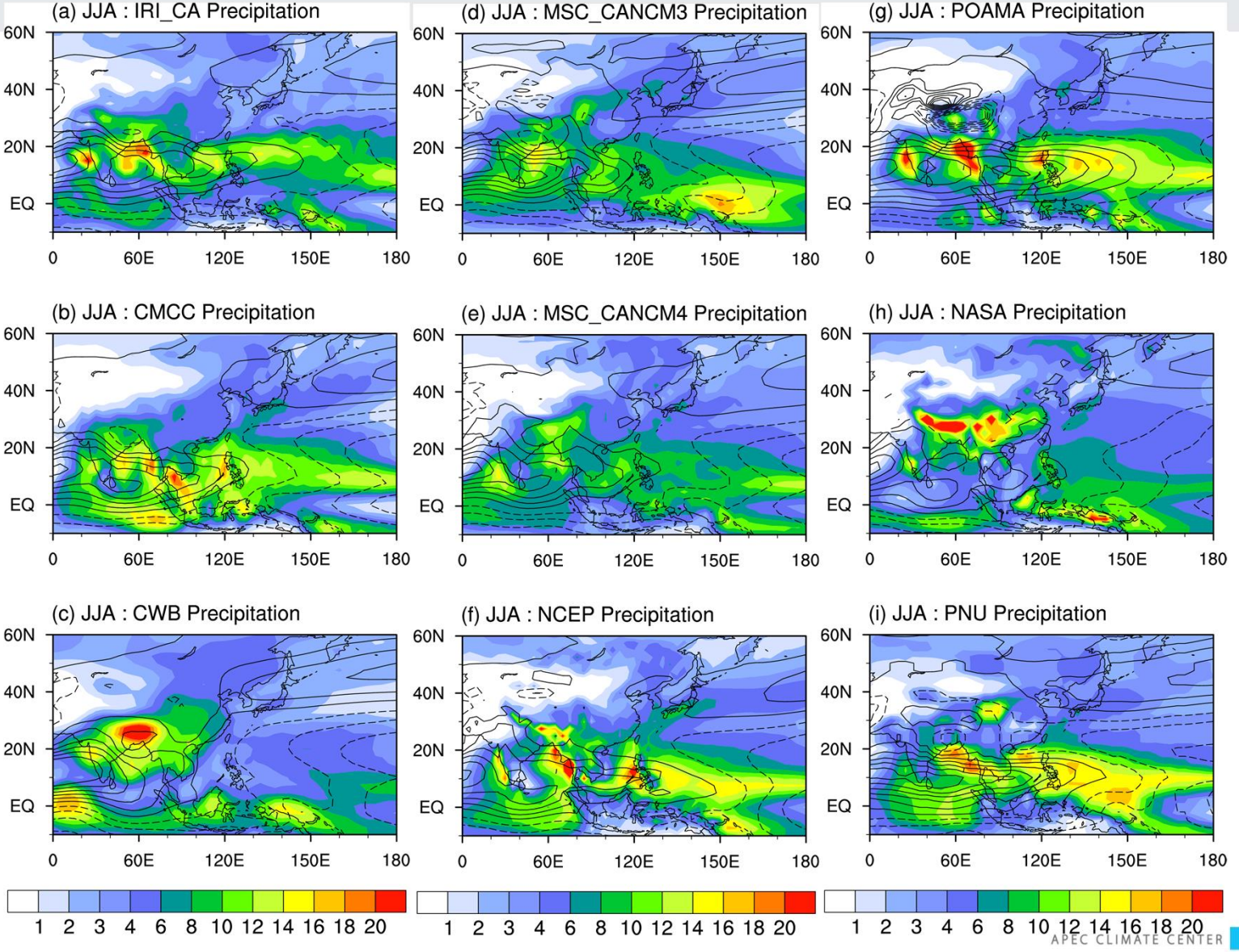
# ❖ East Asia (JJA)

JJA(May start) Precipitation



# ❖ East Asia (JJA)

JJA(May start) Precipitation



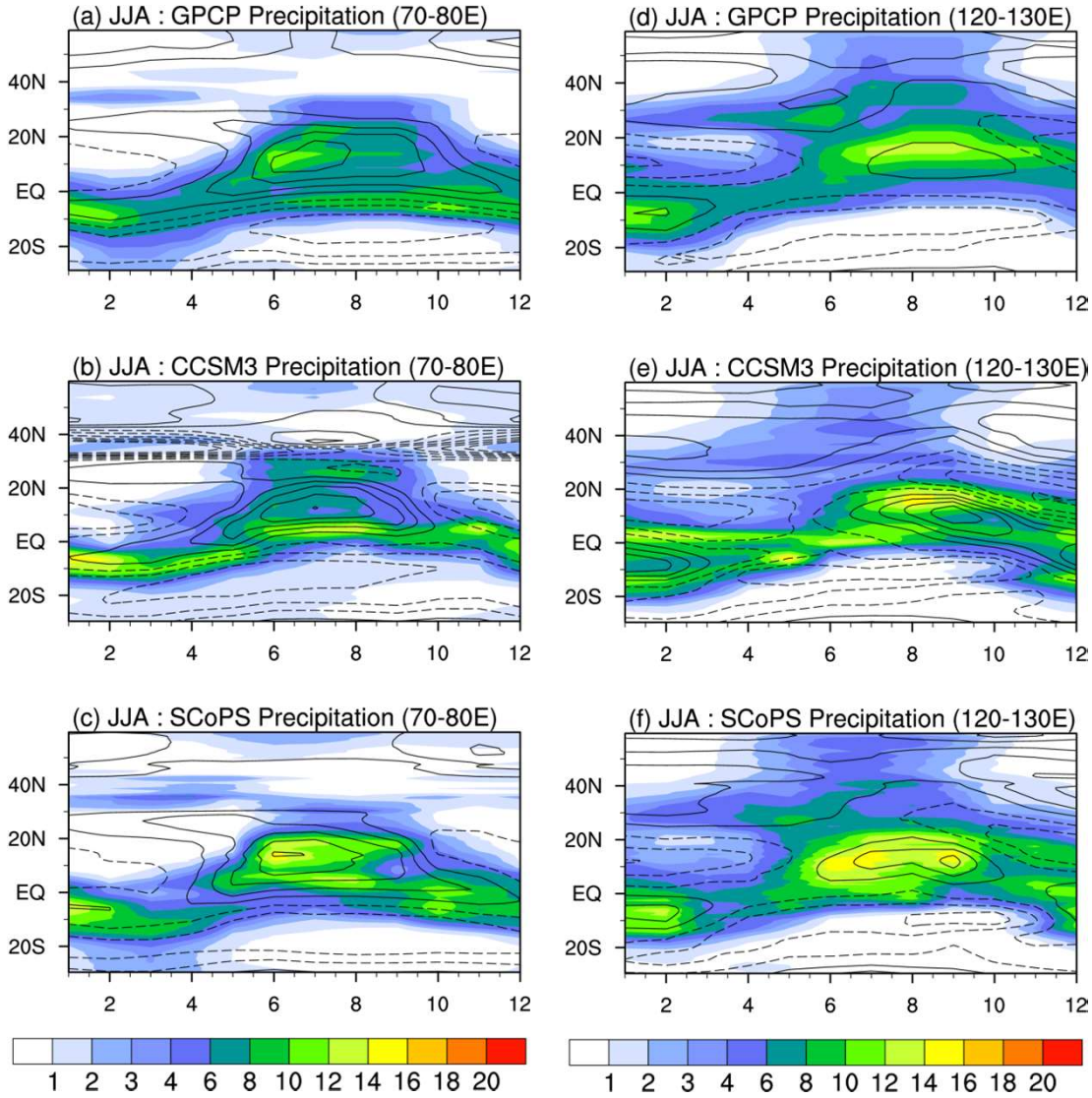
# ❖ East Asia (JJA)

Latitude-time cross-section *(Feb, May, Aug, Nov start)*

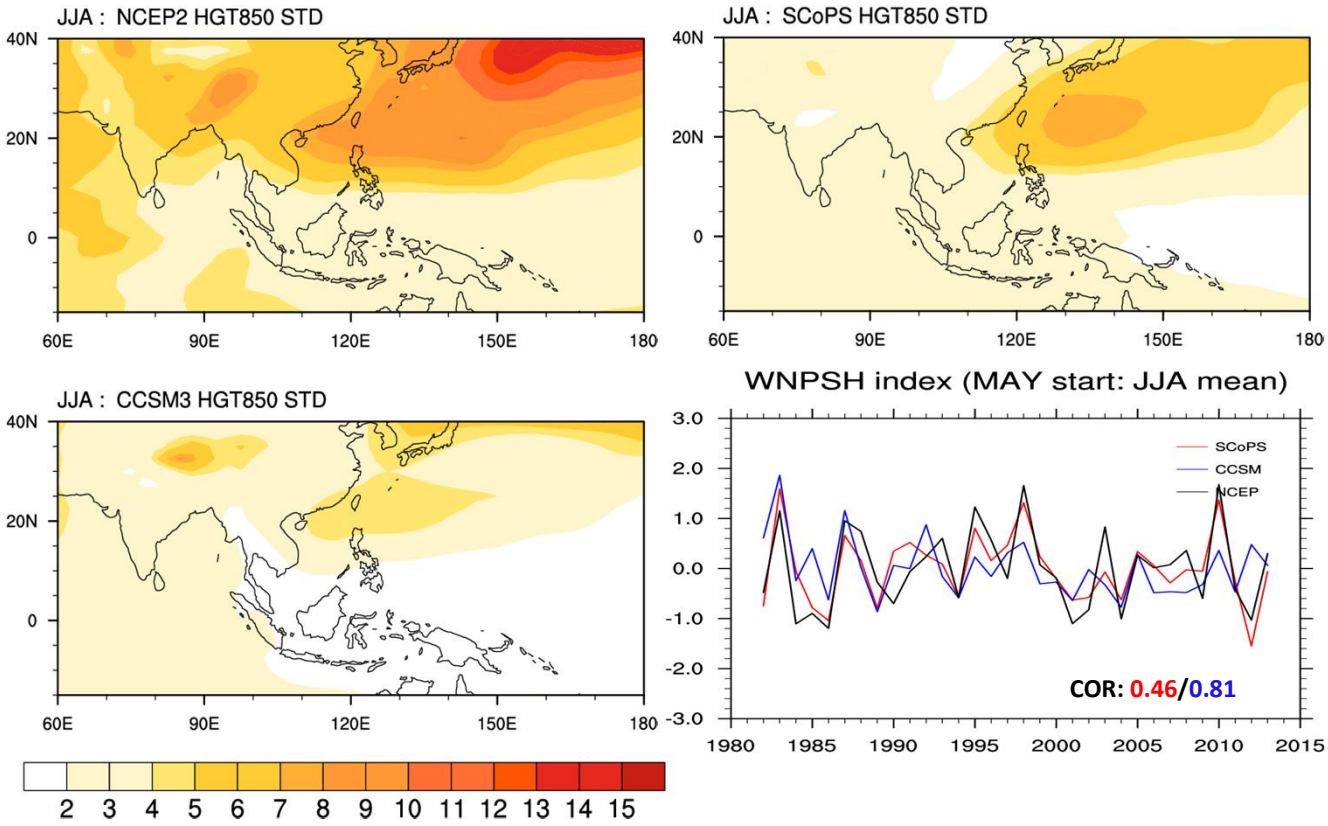
**OBS**

**CCSM3**

**SCoPS**



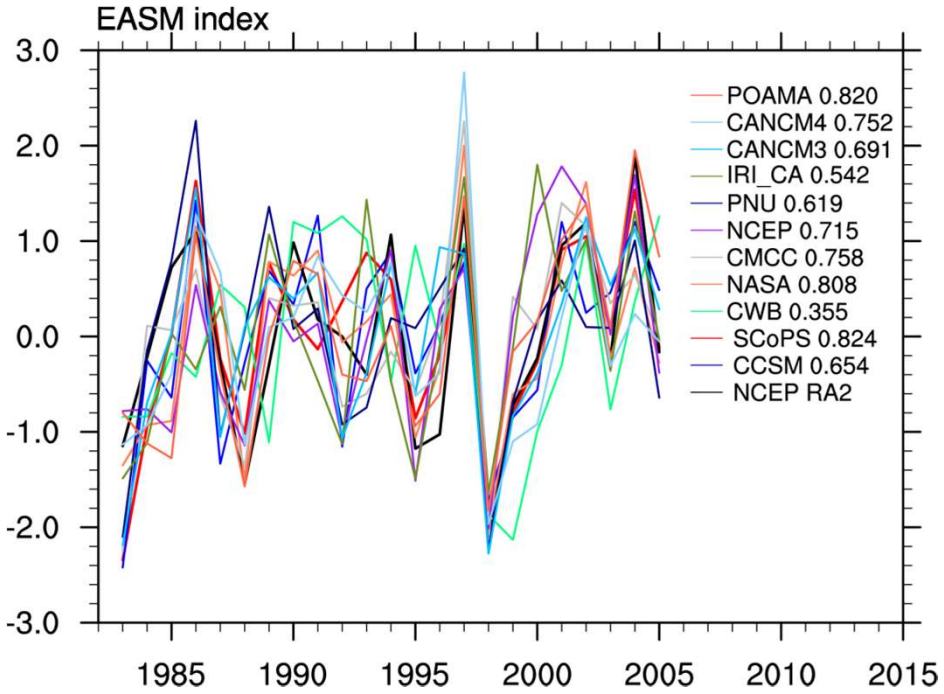
# ❖ East Asia (JJA ; May start)




**WNPSH index, Wang et al. (2013)**

- Defined as the normalized anomaly of JJA GPH850 over the region of maximum variability (115-150E, 15-25N).

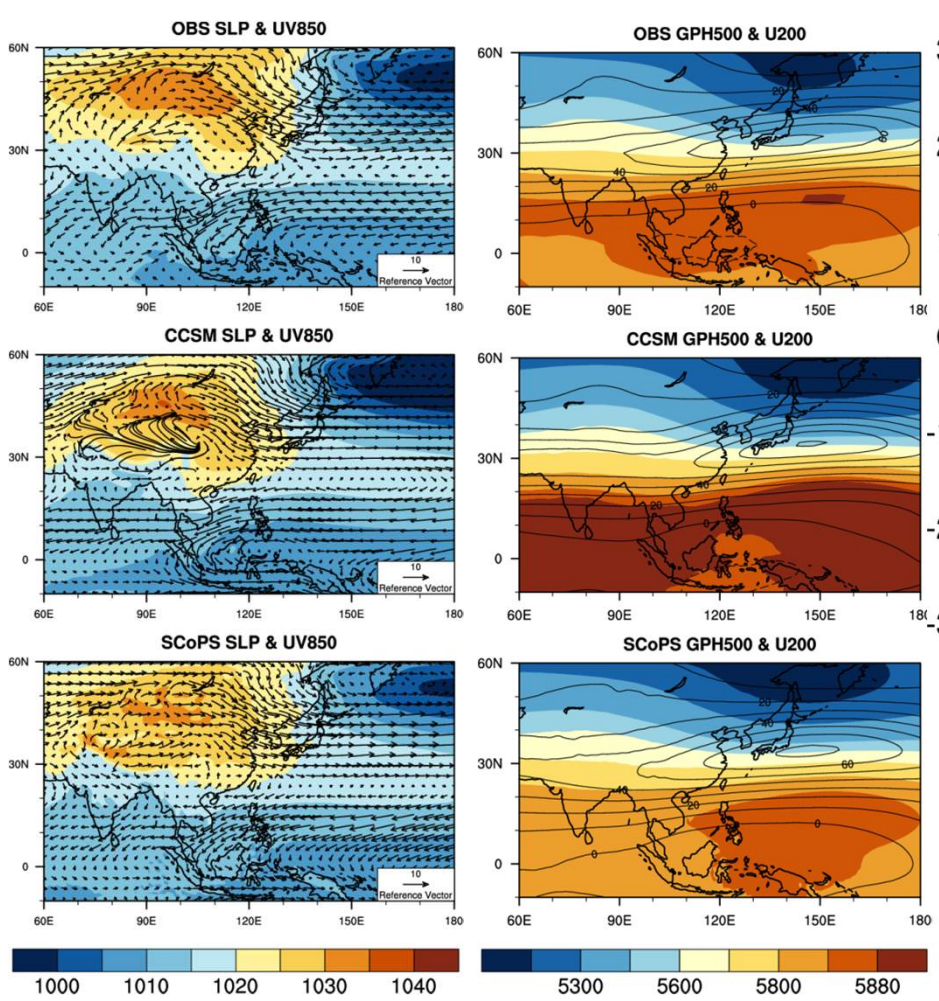
# ❖ East Asia (JJA ; May start)

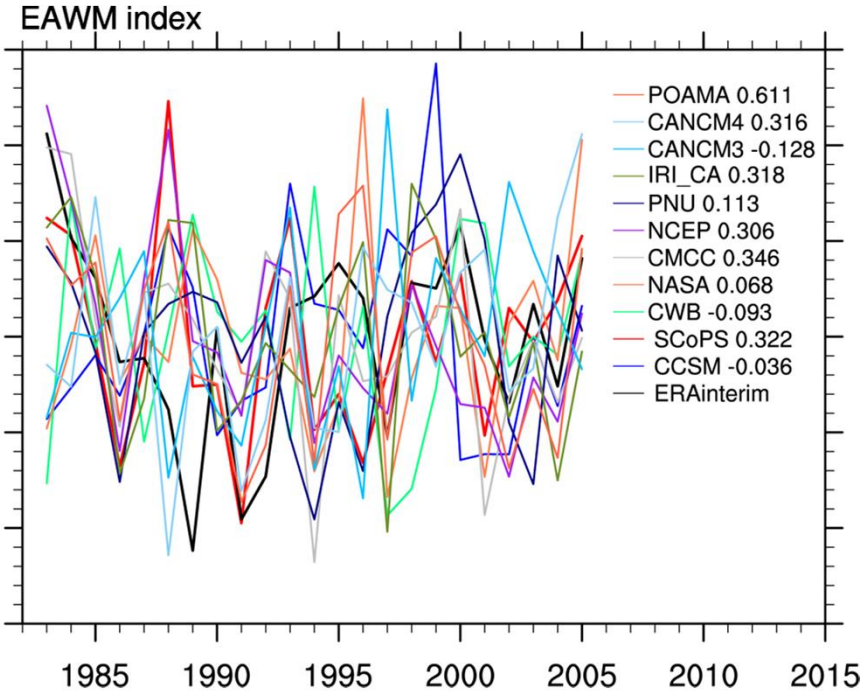



**EASM index, Lee et al. (2014)**

- Defined as the 850hPa zonal wind anomaly difference between the average of 5-10N and 130-150E and that of 25-30N and 110-130E.

# ❖ East Asia (DJF ; NOV start)



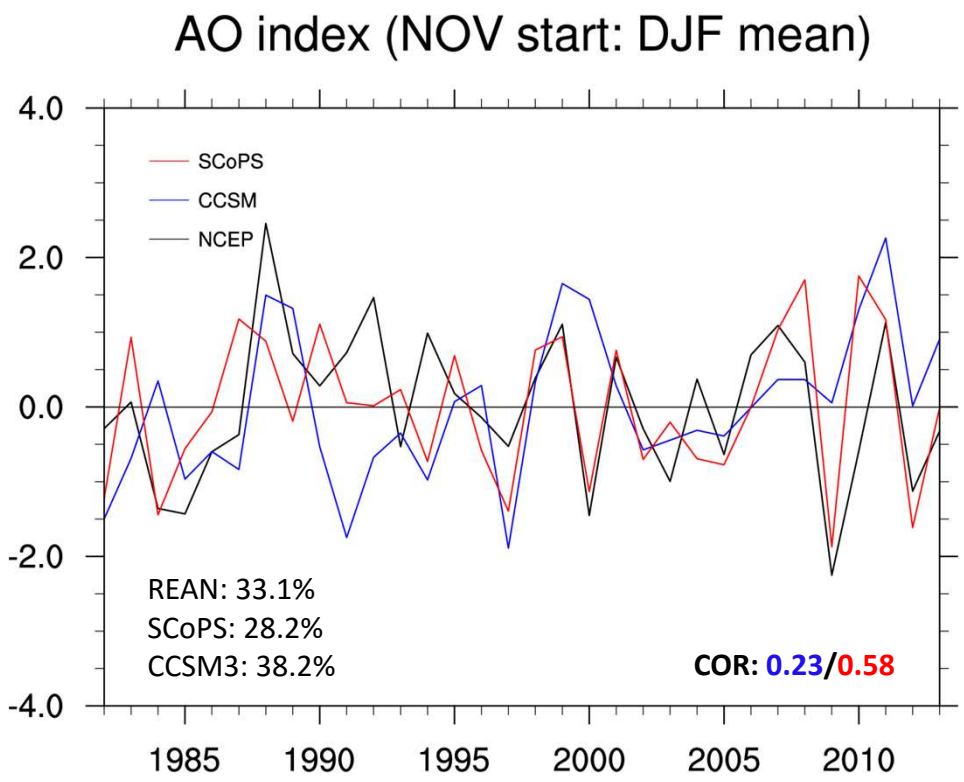



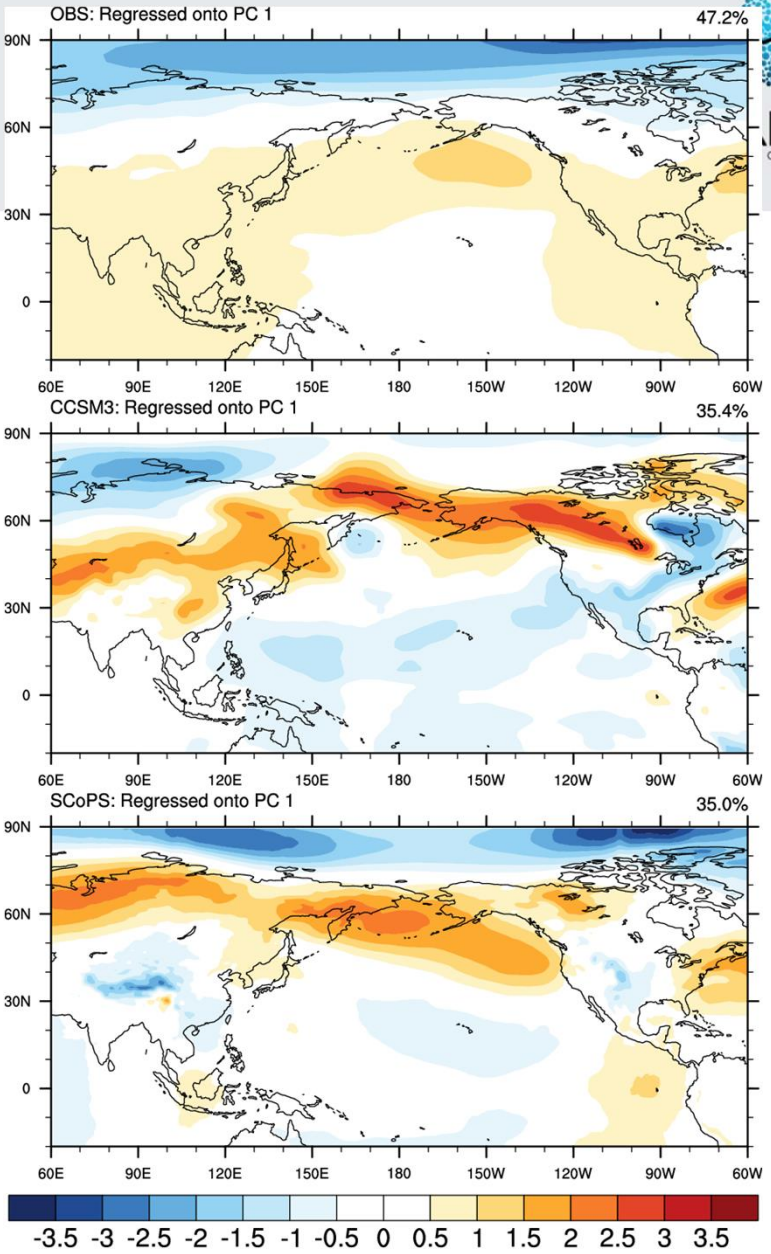

**EAWM index, Li and Yang (2010)**

Defined as the 200hPa zonal wind anomaly,
(U1-U2+U1-U3)/2

U1 = U200(30-35˚N/90-160˚E)
U2 = U200(50-60˚N/70-170˚E)
U3 = U200(5˚S-10˚N/90-160˚E)

# ❖ East Asia (DJF ; NOV start)




**AO index, Thompson and Wallace (1998)**

Defined as principal component of the 1st EOF mode from monthly mean sea level pressure anomalies

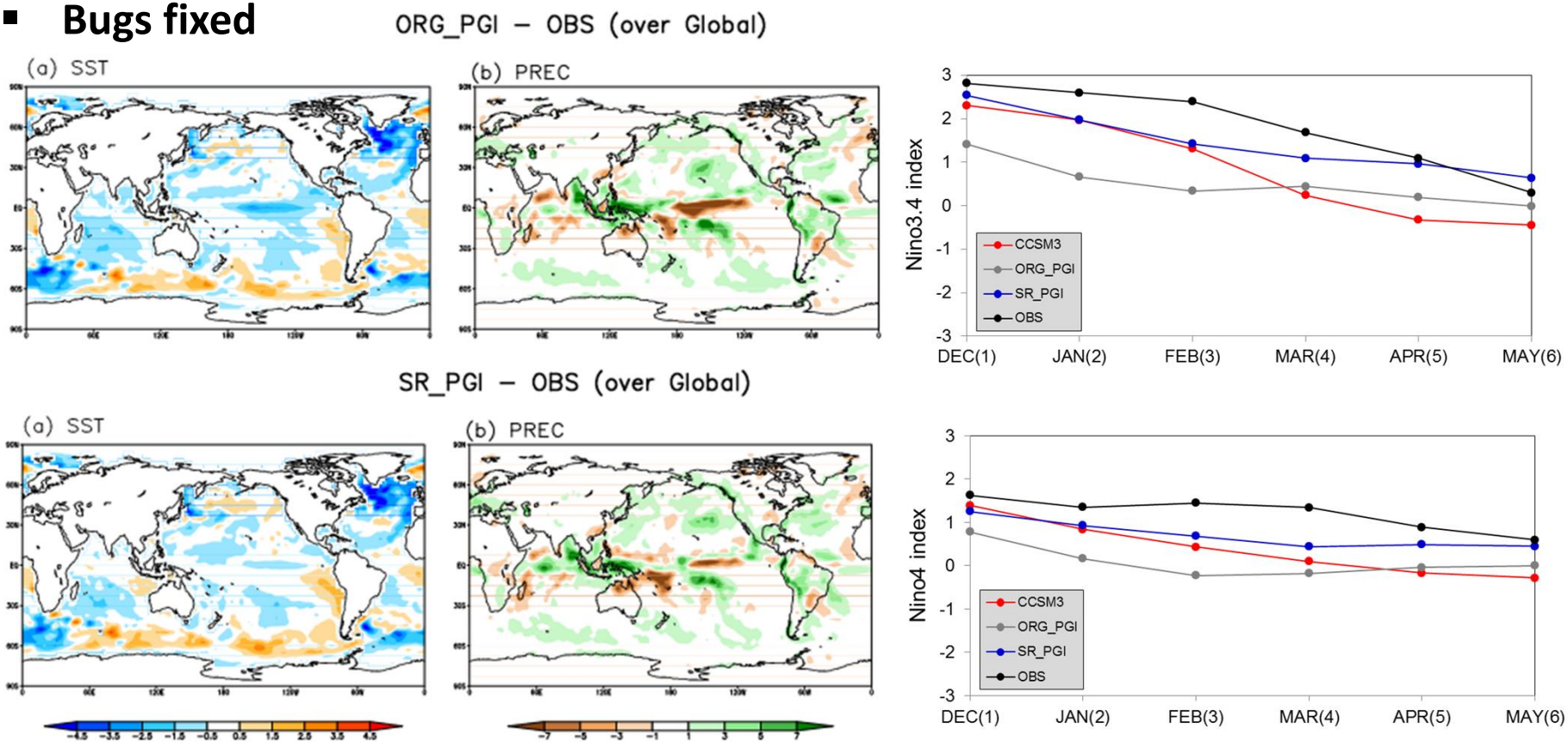
# Summary

## Evaluation of prediction skill of the CCSM, SCoPS hindcasts

- Overall both CCSM3 and SCoPS system exhibits realistic representations of the basic climate although systematic biases are found from surface temperature and precipitation.
- SCoPS shows more realistic representation than CCSM3 for Walker and monsoon circulation from analysis using upper tropospheric velocity potential, although intensity of Hadley circulation tends to quite overestimated.
- One remarkable thing is that northward migrated rainband related to the Changma during May to August is also captured by SCoPS. In case of East Asian monsoon index prediction, the SCoPS show a higher correlation coefficient between the observed and predicted indices than the CCSM3 for both summer and winter season.
- Based on results, SCoPS is more skillful than CCSM3 in prediction of seasonal climate variability including the East Asian summer and winter monsoon.

# *Improvement:*
# Seamless Coupled Prediction System

- **Bugs fixed**



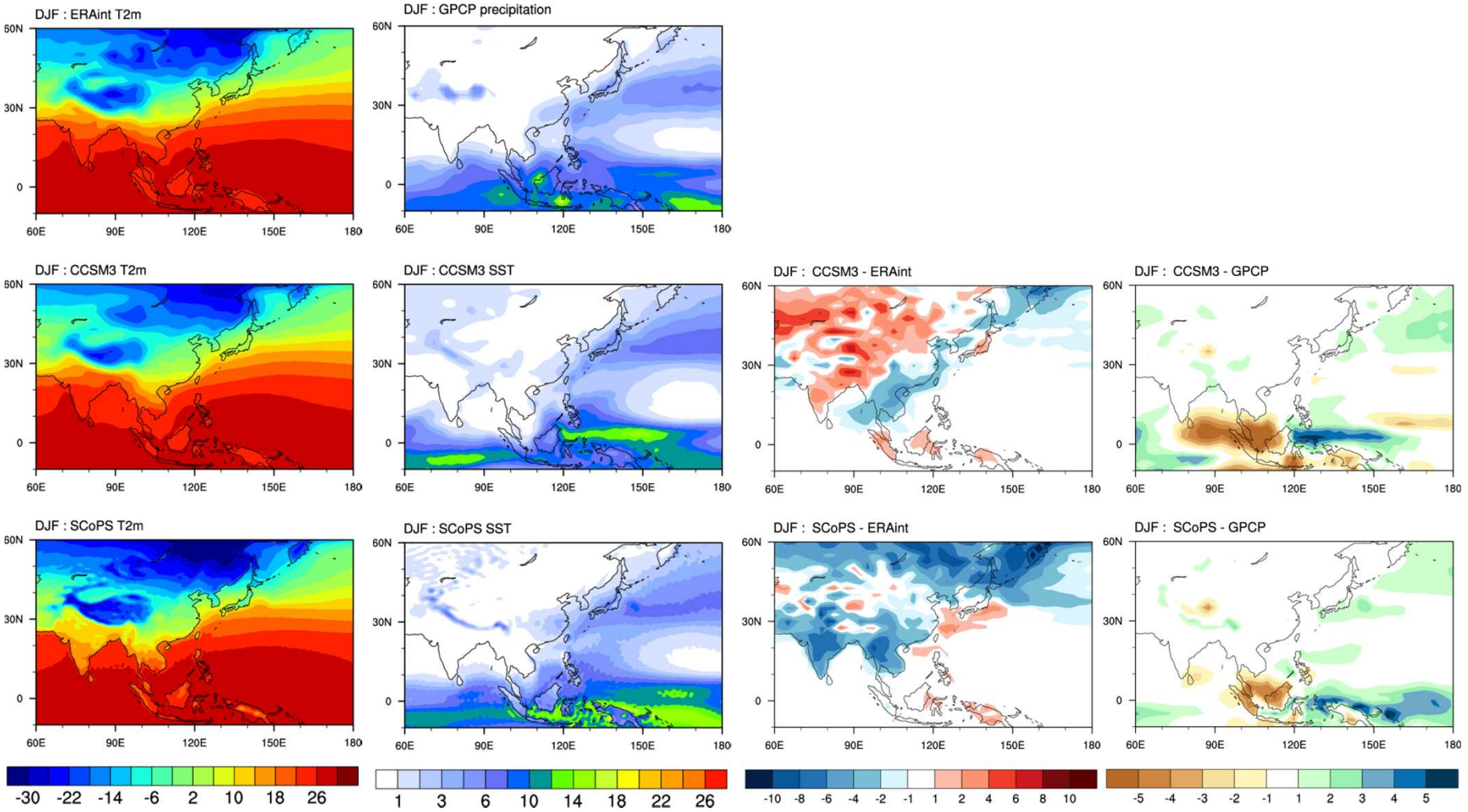

- **Improvement: Ensemble member, Vertical resolution, Physics, Land initialization…**

# Thank you for your attention!

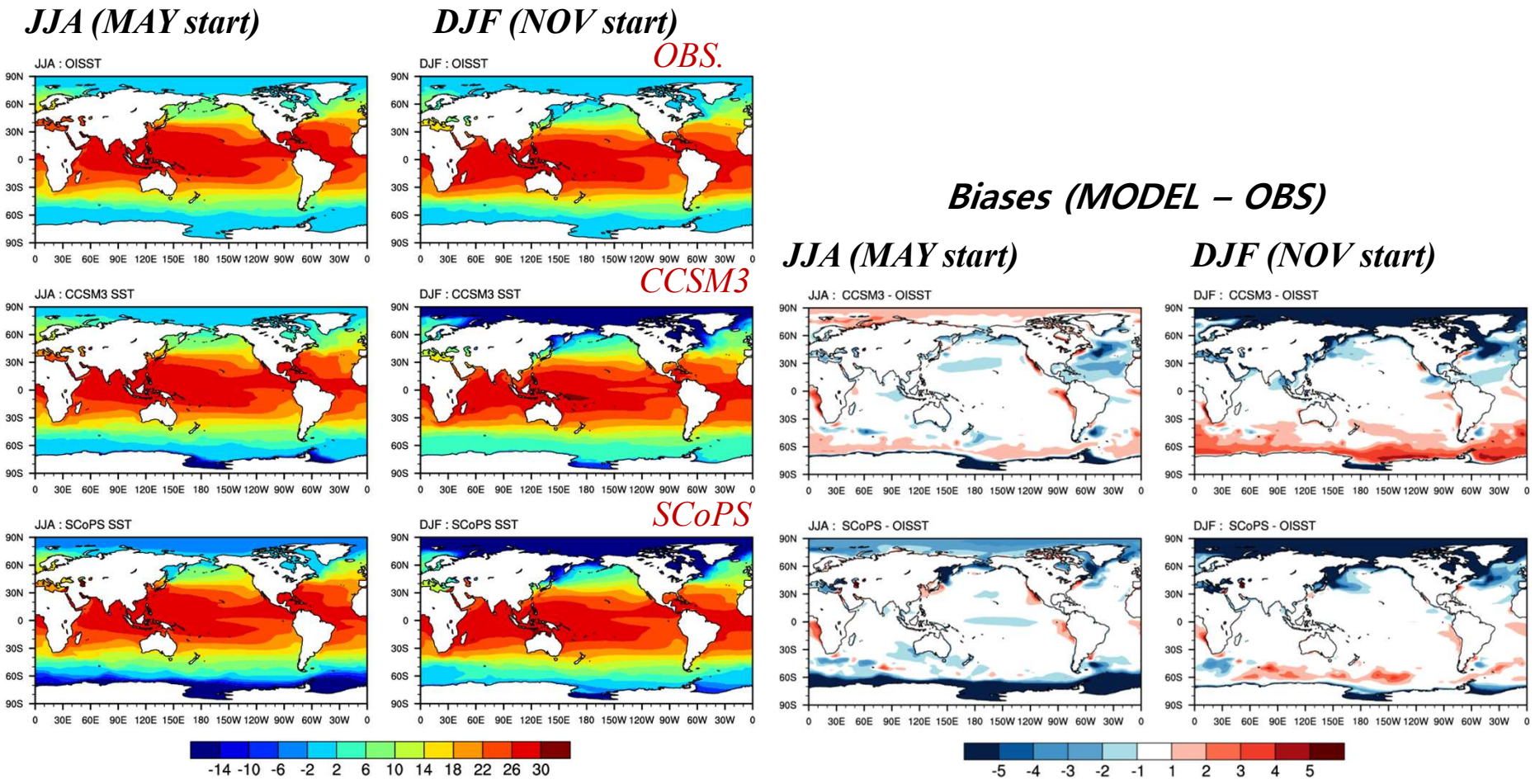
# Physics (Atmos.) status: CCSM3 vs. SCoPS

| | CCSM3 (CAM3) | SCoPS (ECHAM5.3) |
|---|---|---|
| Resolution | T85L26 | T159L31 |
| Convection | Boville et al. 2006 (Based on Zhang and McFarlane 1995; plume ensemble approach) | Nordeng 1994 (Based on Tiedtke 1989; mass flux scheme) |
| Microphysics | Boville et al. 2006 (Based on Zhang et al. 2003, but liquid + ice cloud condensation) | Lohmann and Roeckner 1996 (liquid + ice cloud condensation) |
| Cloudiness | diagnostic from conv. & strat. clouds | Sundqvist et al. 1989 (diagnostic from RH) |
| Radiation | Collines et al. 2001 (longwave: interactions with water vapor, maximum/random overapping) | Fouquart and Bonnel 1980 & RRTM LW; Mlawer et al. 1997, maximum/random overapping |
| Surface | Oleson et al. 2004; Dickinson et al. 2006(CLM3, 10layer soil) | Roeckner et al. 2003(5layer soil) |

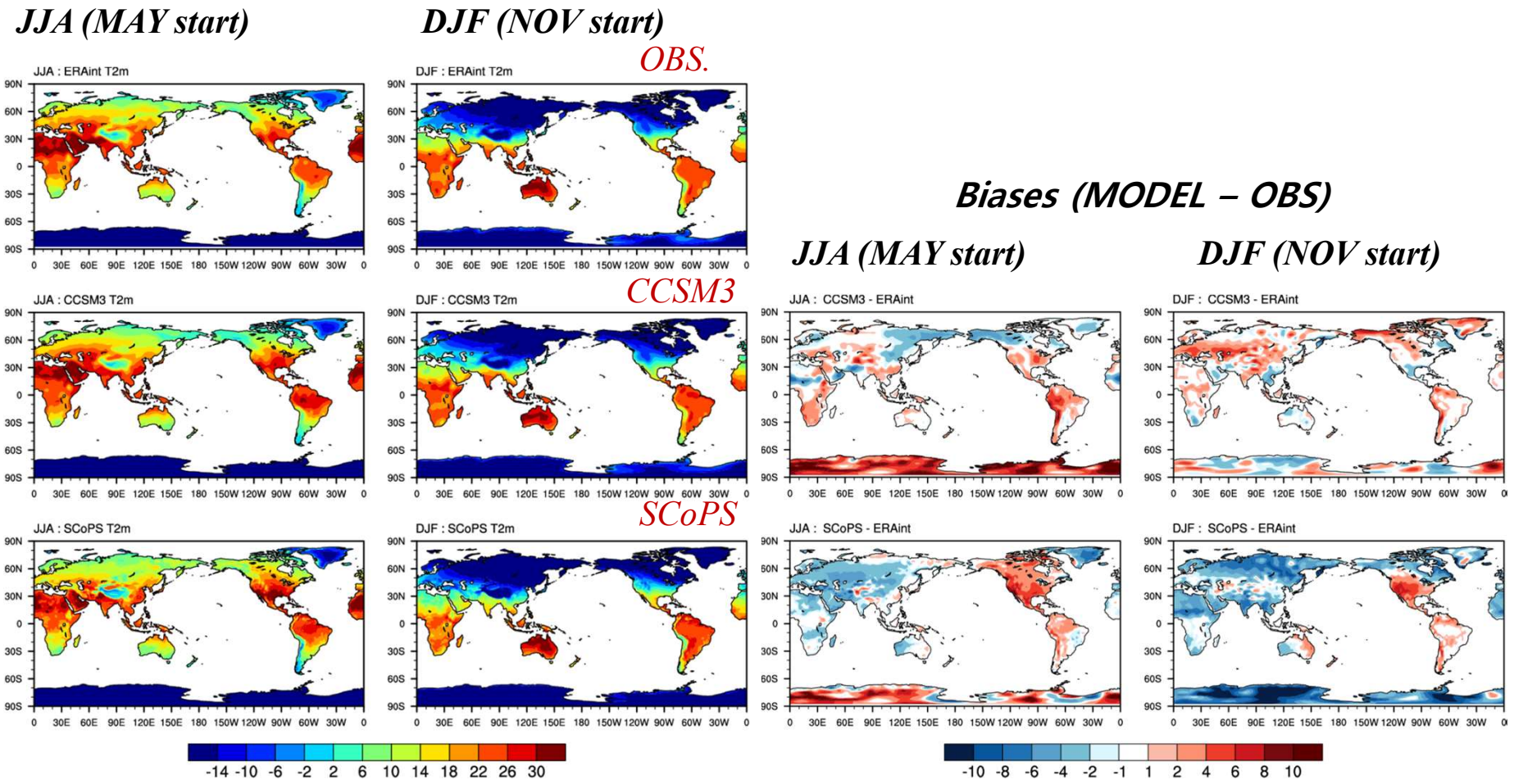
# ❖ East Asia (DJF ; NOV start)



# ❖ Seasonal-mean SST



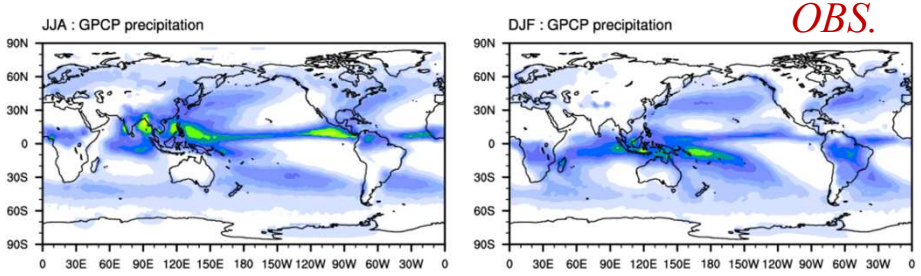
# ❖ Seasonal-mean 2m Temperature



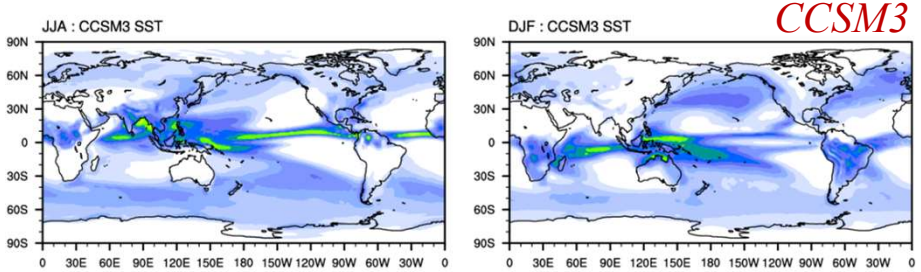
# ❖ Seasonal-mean Precipitation

*JJA (MAY start)* *DJF (NOV start)*

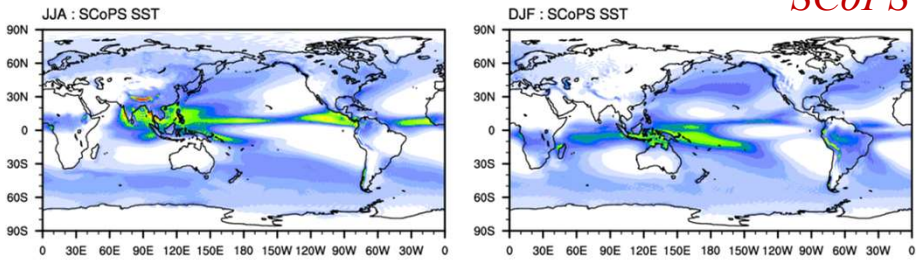
OBS.




CCSM3



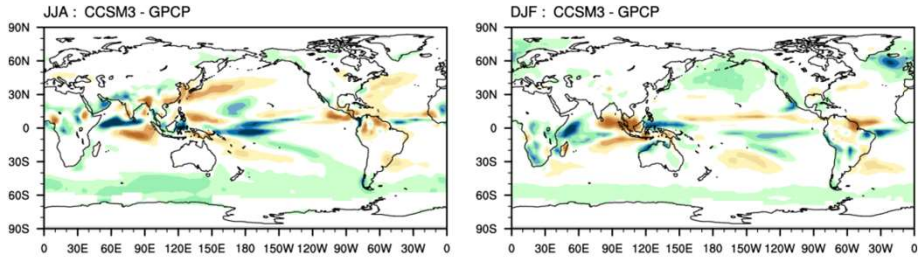

SCoPS

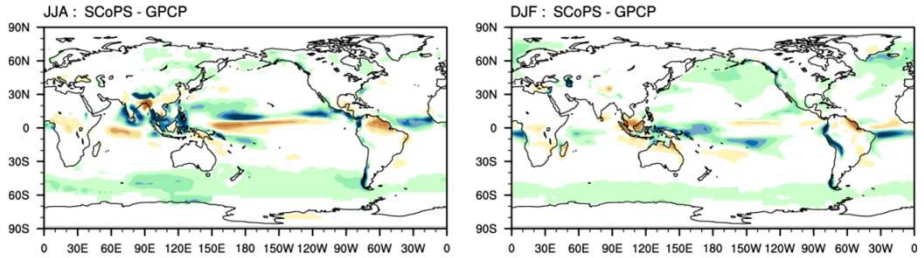


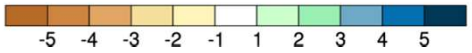


*Biases (MODEL – OBS)*

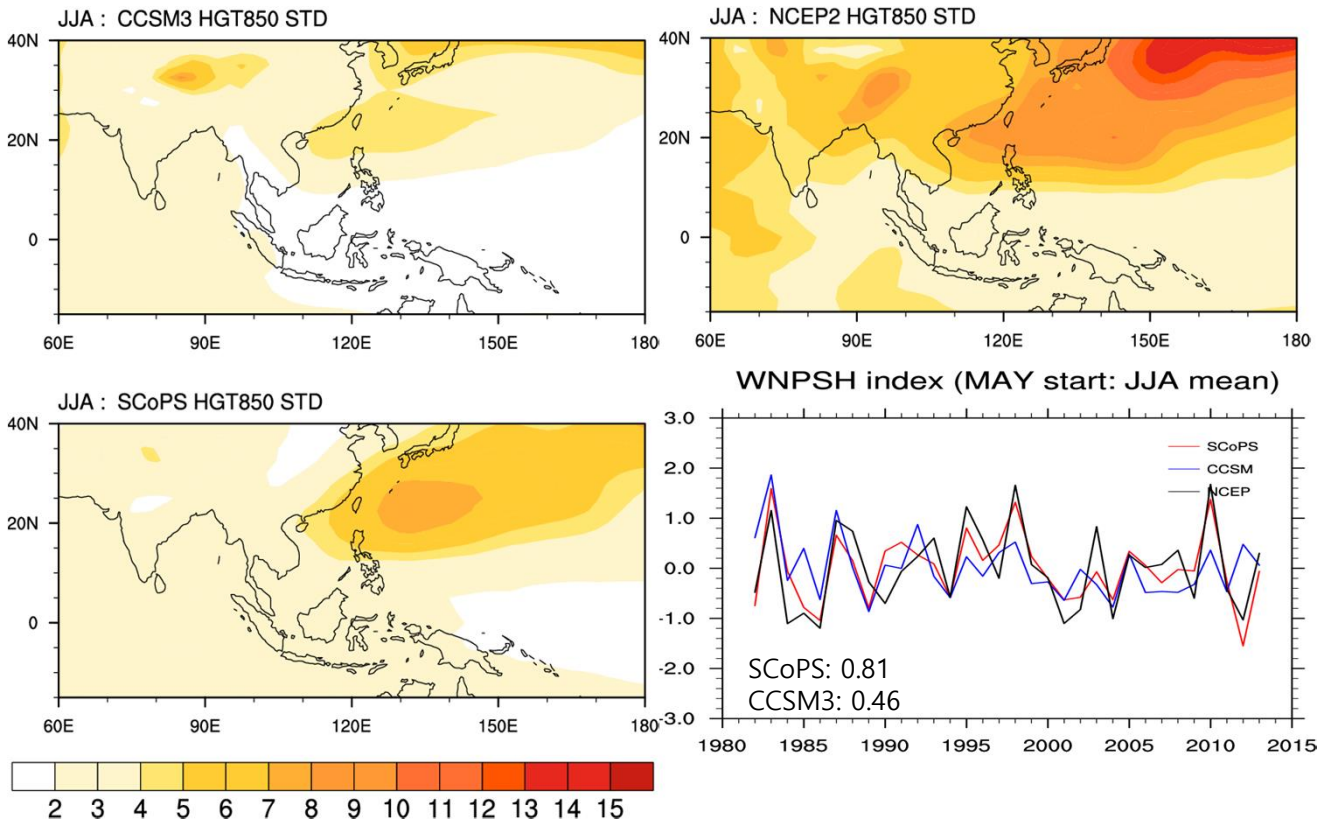
*JJA (MAY start)* *DJF (NOV start)*



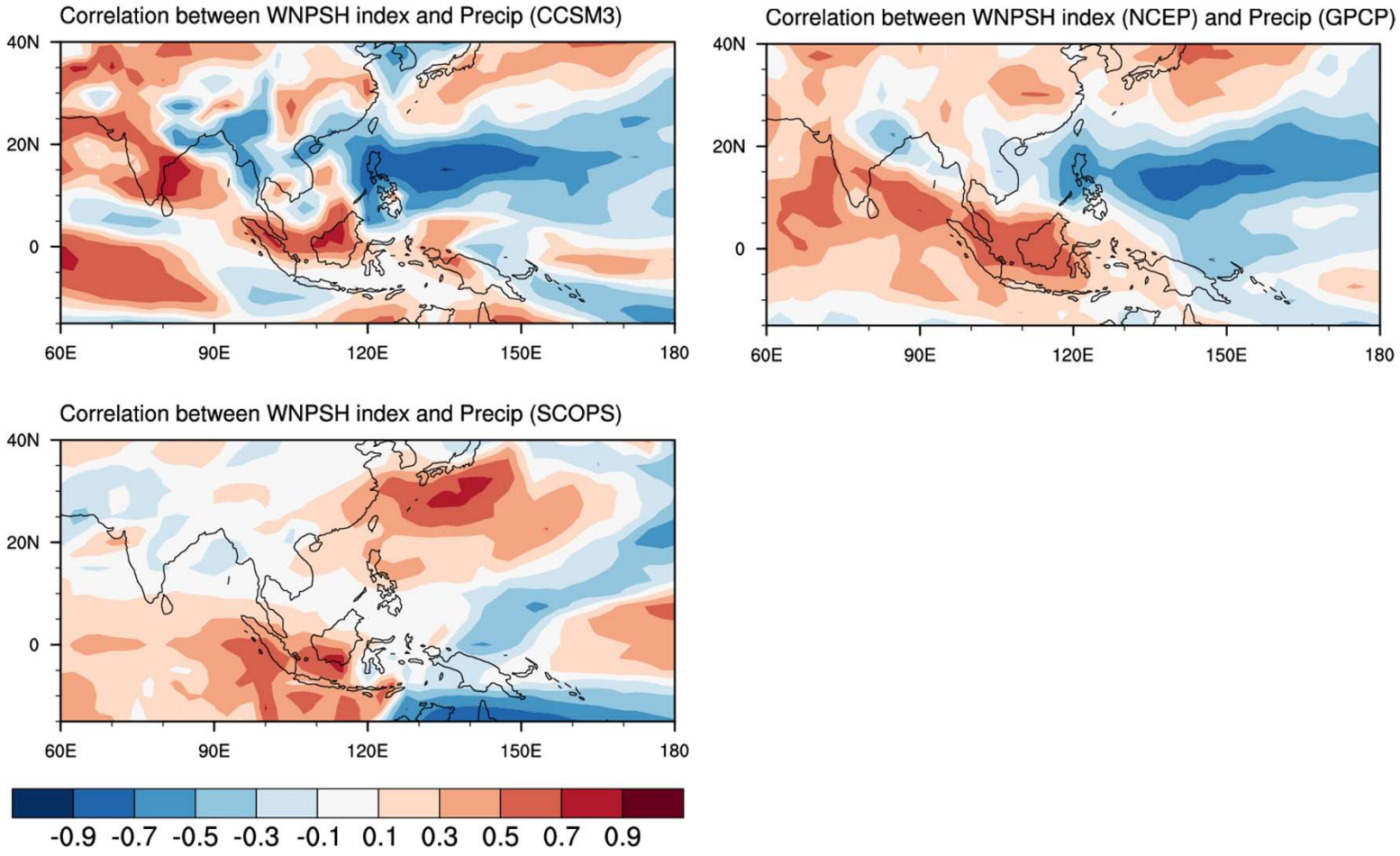
# ❖ East Asia (JJA ; May start)




**WNPSH index, Wang et al. (2013)**

- Defined as the nomalized anomaly of JJA GPH850 over the region of maximum variability (115-150E, 15-25N).

# ❖ East Asia (JJA ; May start)




**WNPSH index, Wang et al. (2013)**

- Defined as the nomalized anomaly of JJA GPH850 over the region of maximum variability (115-150E, 15-25N).

# Background
# APCC-MME participants

- For 3-month seasonal forecast, 12 agencies are in use.

| Institute | Remark | Institute | Remark |
|---|---|---|---|
| 1. BoM | | 9. PNU | |
| 2. MSC | | 10. HMC | |
| 3. BCC | | 11. MGO | AMIP-type hindcast (not in use) |
| 4. CWB | | 12. Met Office | Insufficient hindcast (not in use) |
| 5. CMCC | New member since 2014 | 13. IRI | |
| 6. JMA | | 14. COLA | AMIP-type hindcast (not in use) |
| 7. APCC | | 15. NCEP/NOAA | |
| 8. KMA | Insufficient hindcast (not in use) | 16. NASA | |

# Background
# APCC-MME participants

- **For 6-month seasonal forecast, 7 agencies are in use.**

| Institute | Model Name | AGCM/resolution | OGCM/resolution | Ensemble number |
|---|---|---|---|---|
| 1. APCC | APCC (CCSM3) | CAM3/T85L26 | POP1.3/Gxlv3_L40 | 10 |
| 2. NCEP | NCEP CFSV2 | GFS/T126L64 | MOM4/L40 | 20 |
| 3. BOM | POAMA | BAM v3.0d/T57L17 | ACOM2/0.5-1.5lat x 2lon L25 | 30 |
| 4. NASA | NASA | GEOS-5AGCM/L72 | MOM4/L40 | 11 |
| 5. MSC | CANCM3 | AGCM3/T63L35 | OGCM4/L40 | 10 |
| 5. MSC | CANCM4 | AGCM4/T63L35 | OGCM4/L40 | 10 |
| 6. CMCC | CMCC_SPS | ECHAM5.3/T63L19 | OPA8.2/L31 | 9 |
| 7. PNU | PNU | CCM3/T42L18 | MOM3/L29 | 10 |

Total = 110

# ２０１６年度第１回 領域気候予測・次世代陸面モデル開発・モデル応用及び社会実装に関する合同ワークショップ（案）

第１版（２０１７／１／１０）

２０１７年１月１６日（月）～１７日（火）
札幌定山渓森の謌

議事次第

１月１６日（月）
９：００－　９：１０　趣旨説明（芳村）
９：１０−１２：１０　第一部：極端現象・領域気候予測に関する研究
- 9:10 創生 20km 解像度 MGCM-RGCM 結果の解析（芳村）
- 9:20 Dynamical downscaling simulation over East Asia using RSM-ROMS (Xiaojun)
- 9:50 気候モデルにおける力学的 DS 手法をディープラーニングで代替する手法の開発（板谷）
- 10:10 ベイズ平均を用いた予測精度の向上（原田）
- 10:30 大気のエネルギーバランスから見た極端現象（山田）
- 10:50 2016 年 8 月北海道豪雨を含めた流域の降雨特性（小林彩）
- 11:10 継続時間と降水面積の関数としての想定最大外力（極端降水）の見積もり（日比野）
- 11:30 水惑星条件下における海面水温変化に対する極端現象の応答（一瀬）
- 11:50 Satellite-based precipitation analysis under different weather systems (Azariah)

１２：１０−１３：３０　昼食
１３：３０−１４：００　招待講演「Assessment of seasonal prediction skill of new APCC in-house model」（Dr Suryun Ham）
１４：００−１６：００　第二部：次世代陸面モデル開発に関する研究
- 14:00 GSWP3 and LS3MIP & Development of global land surface modeling / validation / benchmarking framework（Kim）
- 14:20 新しい陸モデルフレームワークの開発：全球オフライン実験（新田）
- 14:40 全球土砂動態モデルの構築（鳩野）
- 15:00 1km 解像度陸面モデルによる河川水位の検証とデータ同化（薮）
- 15:20 全球及び日本域洪水予測システムの構築と検証（石塚）
- 15:40 グリーンランド北西部カナック氷河の積雪観測に基づいた積雪微生物の繁殖モデルの開発（大沼）

１６：００−１６：１０　休憩

１６：１０−１８：１０　第三部：モデル応用及び社会実装に関する研究

- 16:10 5 年間で得たものとこれから（筆保）
- 16:30 数値シミュレーションに基づく台風の強風ハザード評価：台風のモグラムの開発（山崎）
- 16:50 d4PDF を用いた北太平洋の台風発生環境馬の将来と現在気候の差（小林直）
- 17:10 Reconstruction of historical weather using weather diaries (Panduka)
- 17:30 再生可能エネルギーの普及による気候変動の可能性について（大森）
- 17:50 Floods and climate refugee (Nomura)

１８：１０−２０：００　懇談会
２０：００−２２：００　創生取りまとめに向けた総合討論及び将来構想

１月１７日（火）
　９：００−１０：００　総合討論の続き
１０：００−１０：１０　クロージング

# FY2016 1st Joint Workshop for Regional Climate Projection, Next Generation Land Surface Model Development, and Model Application and Implementation (Draft)

0th version (7 Dec 2016)

Monday 16 to Tuesday 17 January, 2017
at Morinouta Hotel, Jozankei, Sapporo

Agenda

Monday January 16
9:00-9:10 Opening
9:10-12:10 1st Session on Regional Climate Projection
12:10-13:30 Lunch Break
13:30-14:00 Invited speech (Dr. Suryun Ham)
14:00-16:00 2nd Session on Next Generation Land Surface Model Development
16:00-16:10 Coffee Break
16:10-18:10 3rd Session on Model Application and Implementation
18:10-20:00 Reception
20:00-22:00 General Discussion

Tuesday January 17
9:00-10:00 General Discussion (continued)
10:00-10:10 Closing