



동북아시아 봄철 가뭄 예측성 및 가뭄과 연관된 대기 패턴 예측의 중요성

김병희, 감종훈

포항공과대학교 수문기후연구실

2023년 6월 26일
제4차 APCC 기후예측워크숍

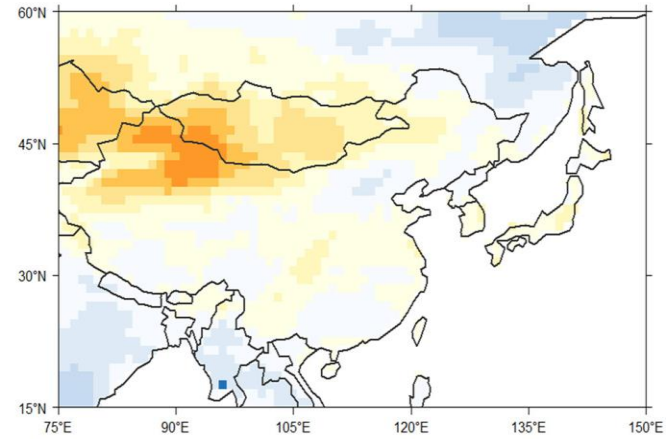
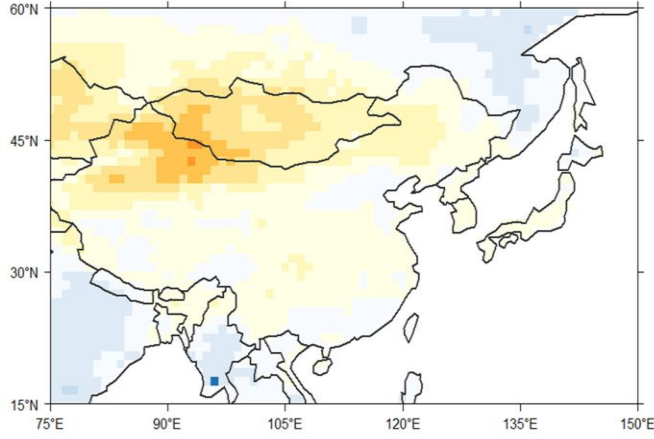
CMIP6 동아시아 미래 가뭄 전망



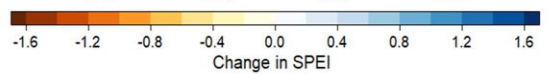
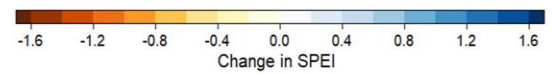
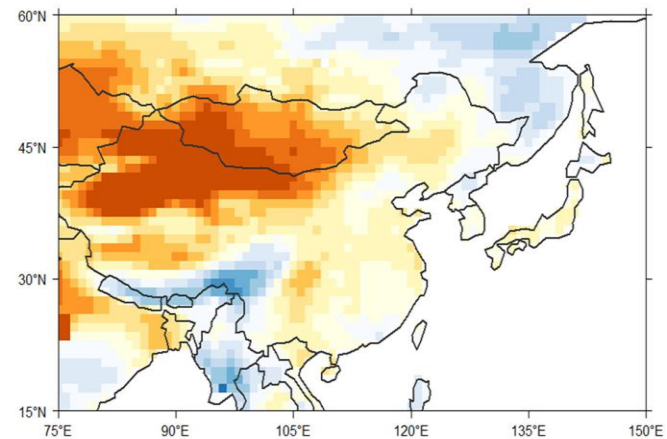
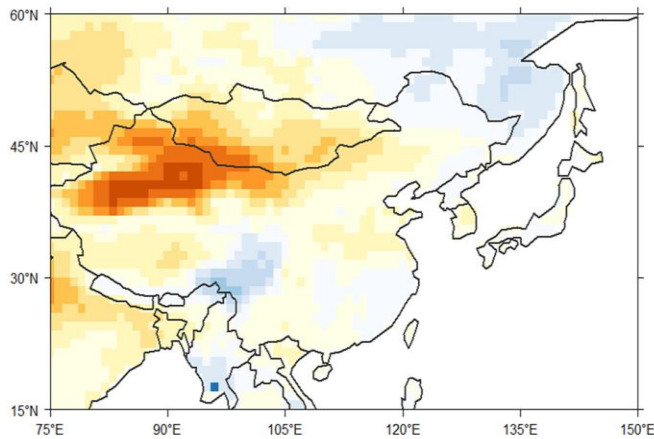
(a) SSP 2-4.5

(b) SSP 5-8.5

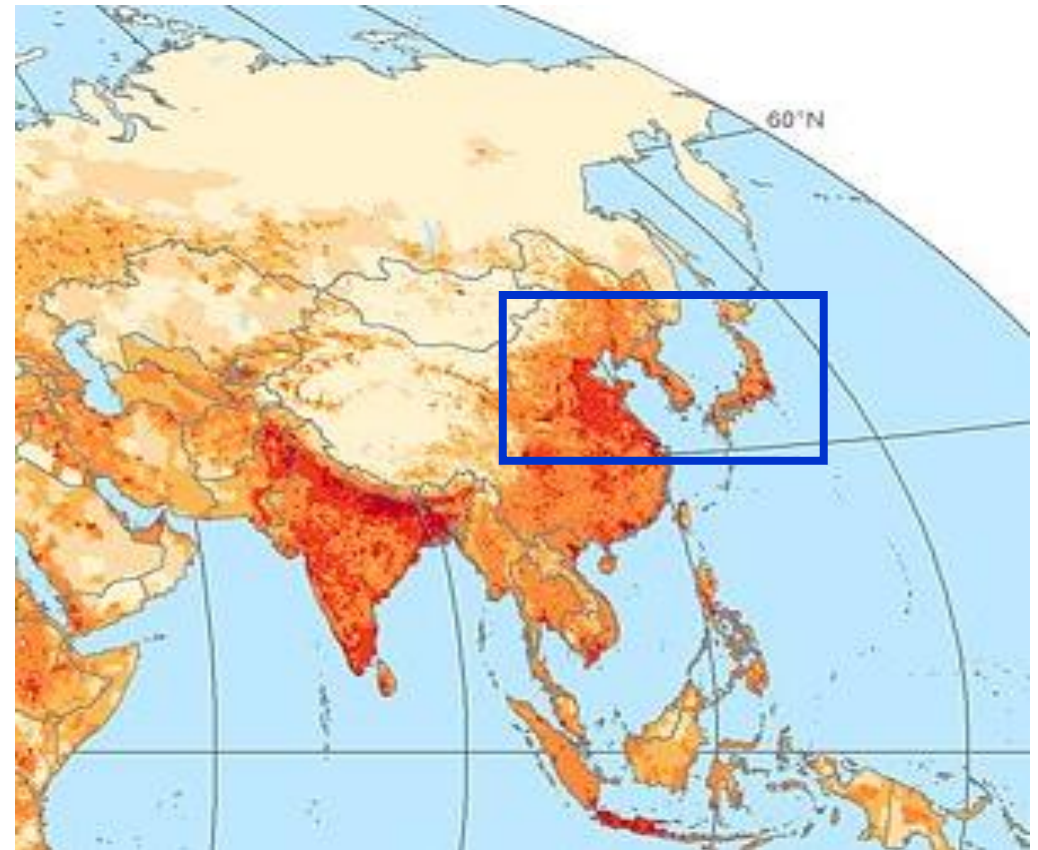
2020-2039



2080-2099



아시아 인구 밀도 현황 (2020)



(Population density from Earth Data)

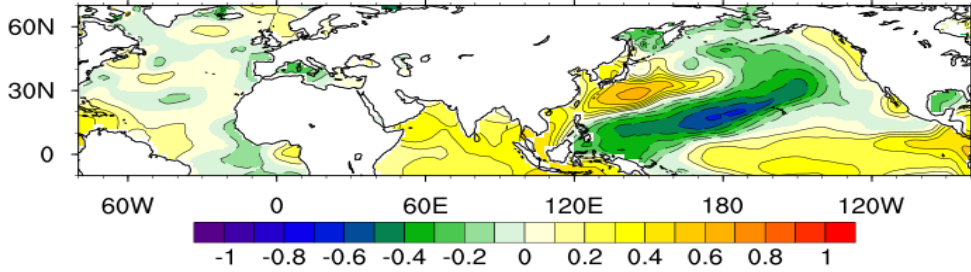
(Kim et al. 2021)

1. 동북아시아 봄철 강수 변동성과 연관된 해양 및 대기 패턴에 대한 계절 예보 모델들의 성능은?
2. 현재 계절 예보 모델 시스템에서 동북아시아 지역의 봄철 가뭄 예측성은?
3. 동북아시아 봄철 가뭄 예측에 있어서 해수면 온도 및 대기 순환 예측성과 관련이 있는가?

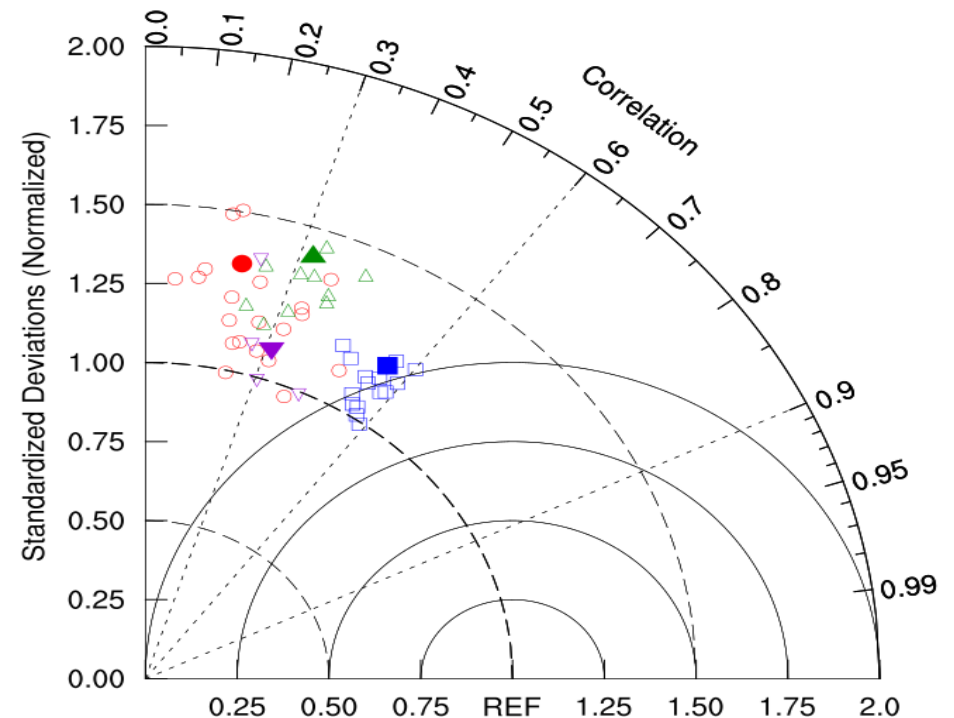
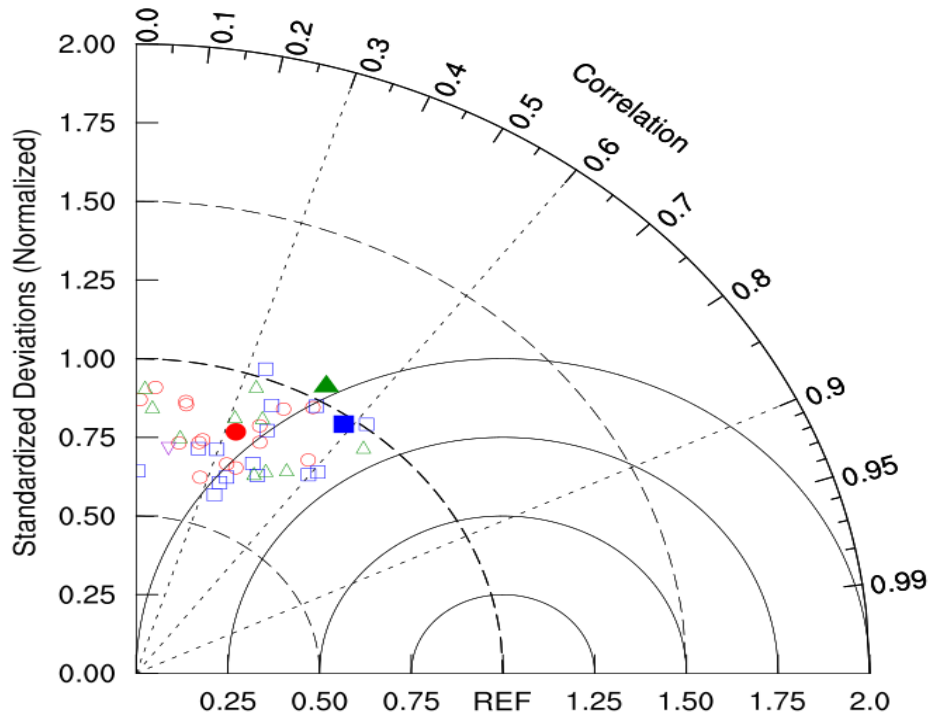
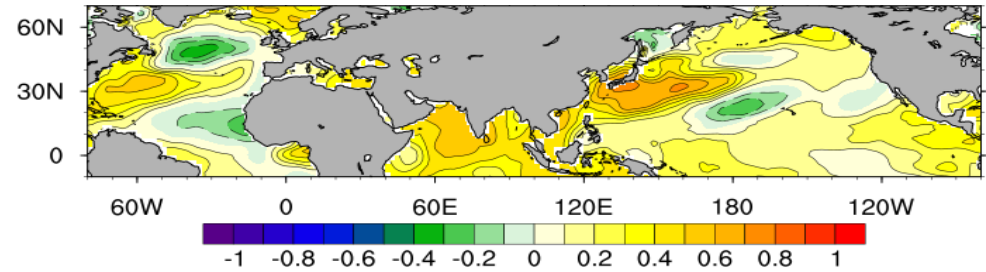
- **ERA5 reanalysis data (1992-2022)**
: precipitation, 200hPa geopotential height, 200hPa zonal wind, 850hPa zonal & meridional wind
- **ERSST v5 sea surface temperature data (1992-2022)**
- **North American Multi-Model Ensemble (NMME) forecasting system**
: precipitation, 200hPa geopotential height, sea surface temperature

Model	Hindcast	Forecast	Ens#
CanSIPS-IC3	198101-202012	202110-202212	20
GFDL-SPEAR	199201-202012	202101-202211	15
CCSM4	198201-202212	-	10
NASA-GEOSS2S	198103-201612	201702-202211	4

Correlation map of SST and NEA prec.

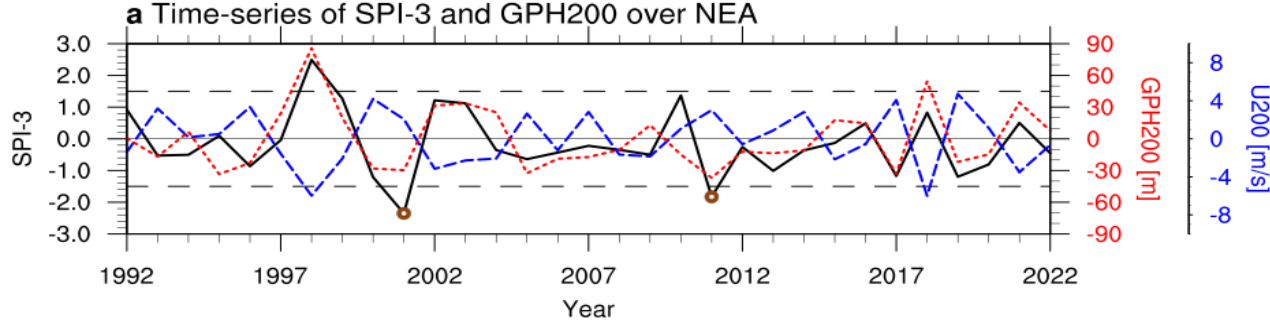


Correlation map of SST and NEA GPH200

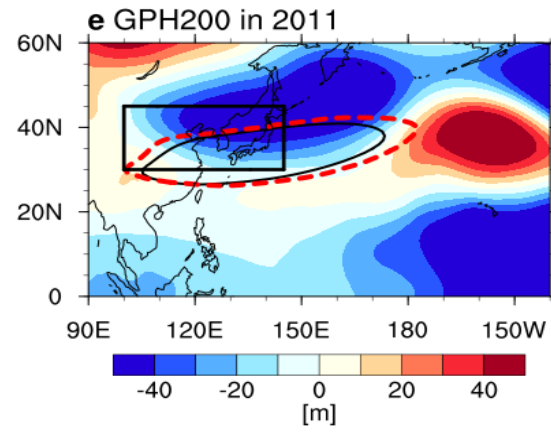
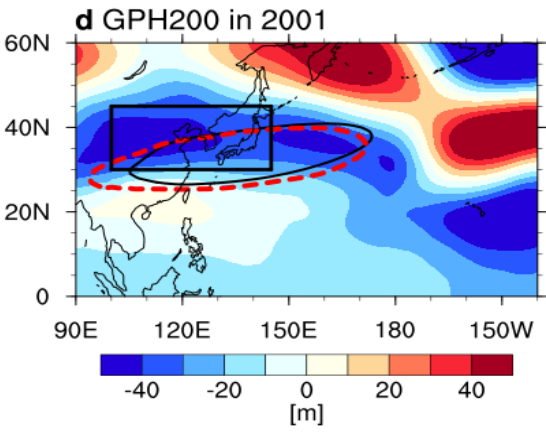
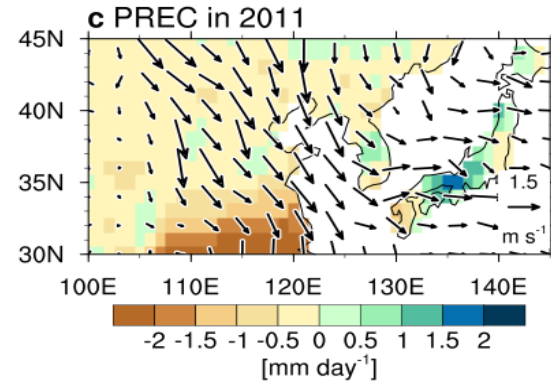
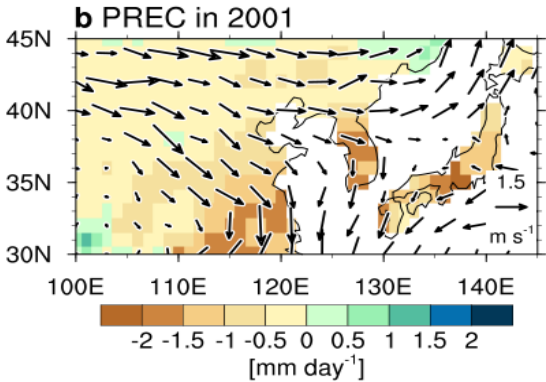


- CanSIPS-IC3
- GFDL-SPEAR
- ▲ CCSM4
- ▼ NASA-GEOSS2S

동북아시아 봄 가뭄의 특징



TCC btw SPI-3 & GPH200 : 0.75
 TCC btw SPI-3 & U200 : -0.72
 TCC btw GPH200 & U200 : -0.88



- 극한 봄 가뭄 (SPI-3 < 1.5) 연도 : 2001, 2011
- 동북아시아 봄 가뭄 특징
 - ✓ 동북아시아 대기 하층 북풍 강화
 - ✓ 동아시아 제트류 강화
 - ✓ 동북아시아 대기 상층 저기압성 순환

NMME 모델들의 동북아시아 봄철 가뭄 예측 확률



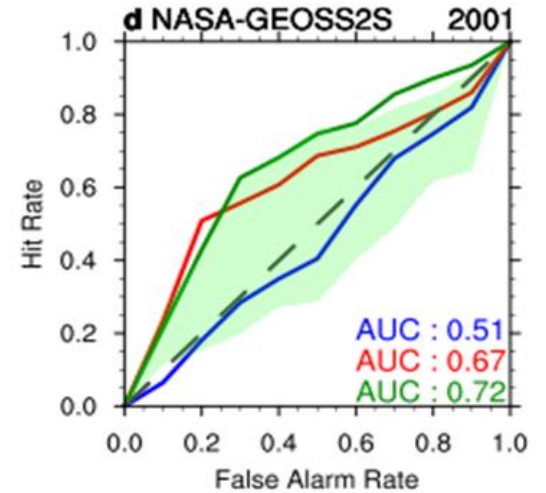
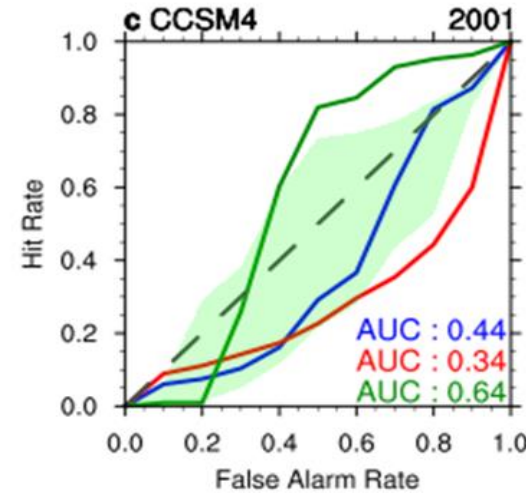
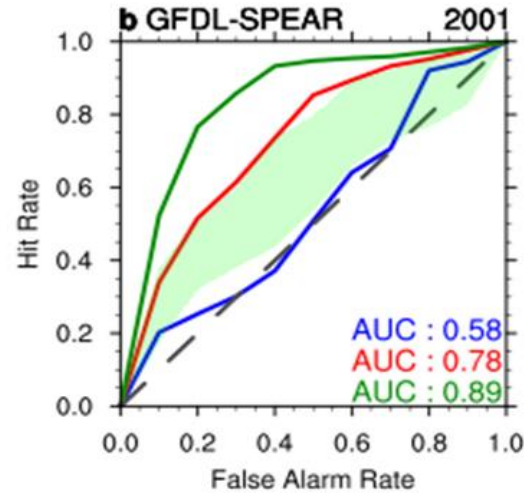
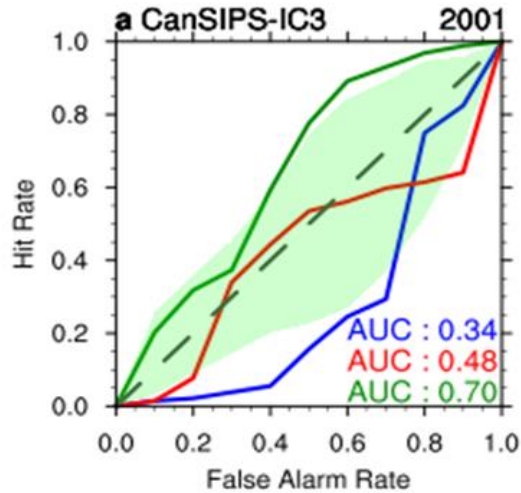
CanSIPS-IC3

GFDL-SPEAR

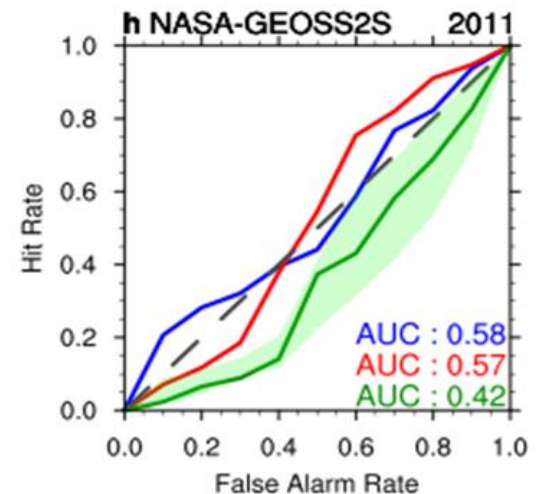
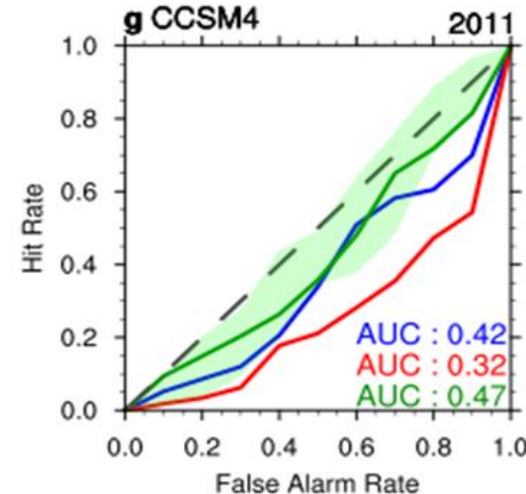
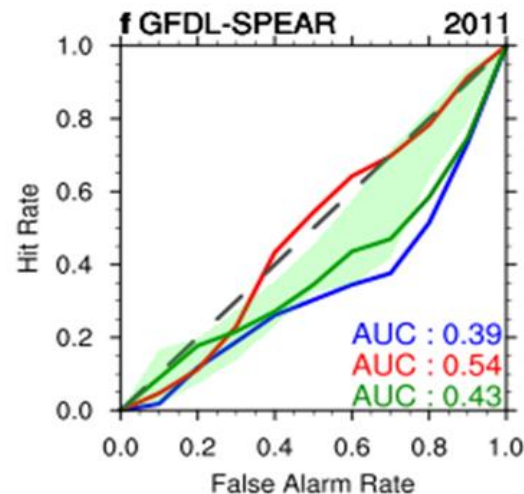
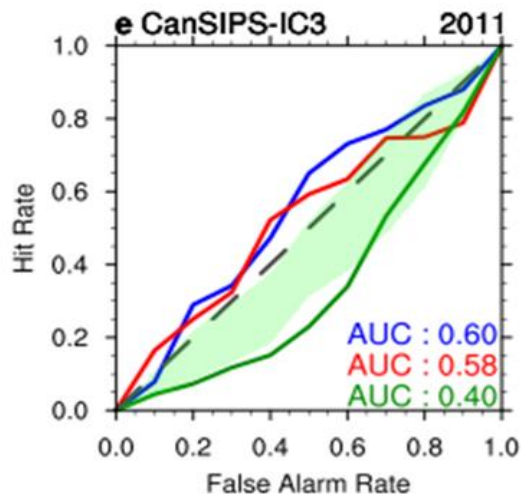
CCSM4

NASA-GEOSS2S

2001



2011



AUC > 0.7
Good performance

— Jan — Feb — Mar

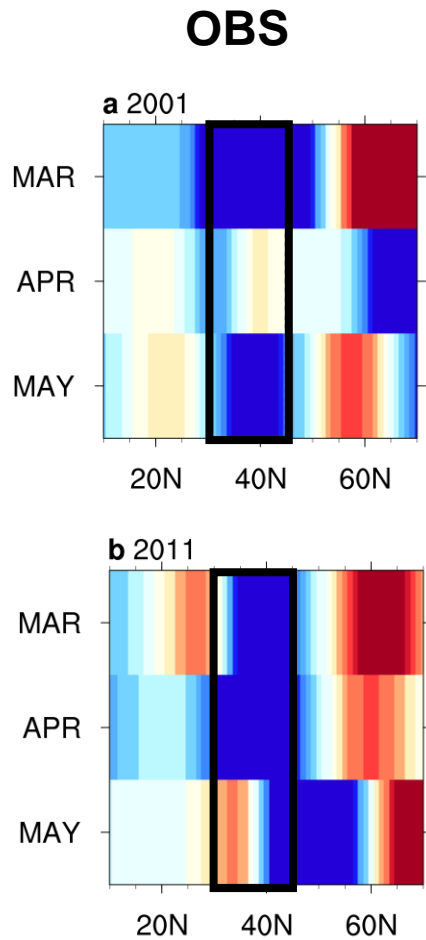
NMME 모델들의 봄철 가뭄해 대기 상층 순환 예측

* Initial month = Mar

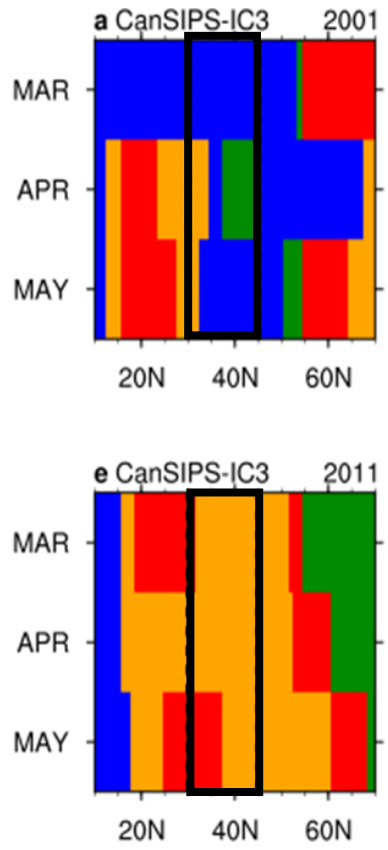


2001

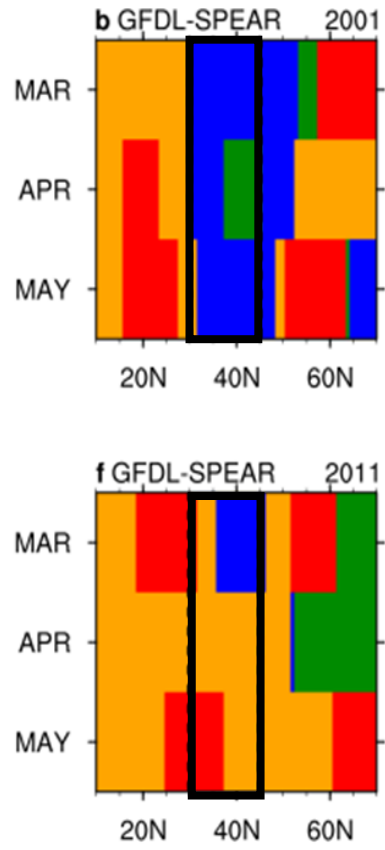
2011



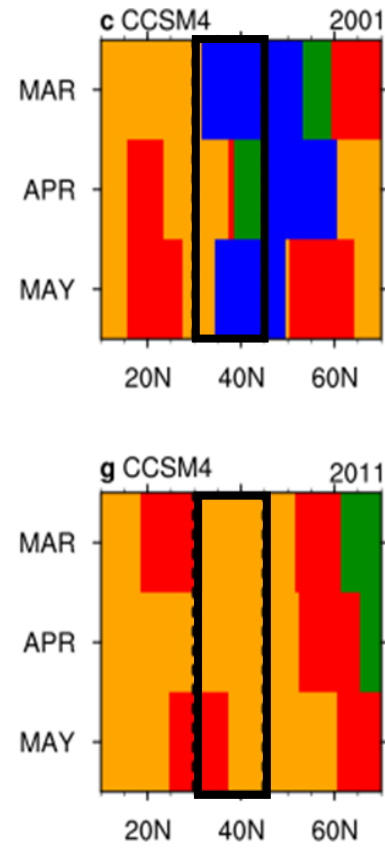
CanSIPS-IC3



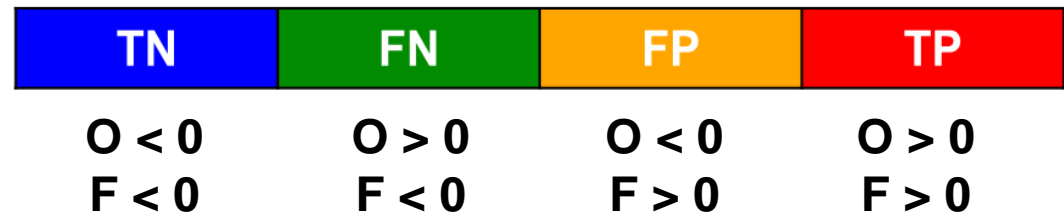
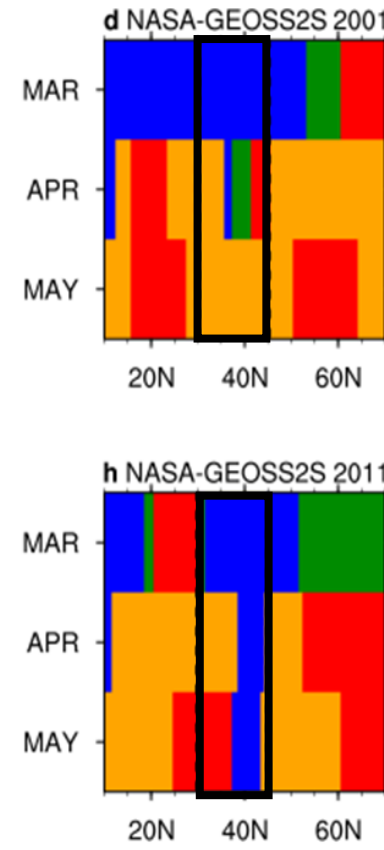
GFDL-SPEAR



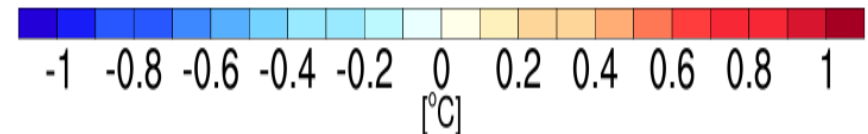
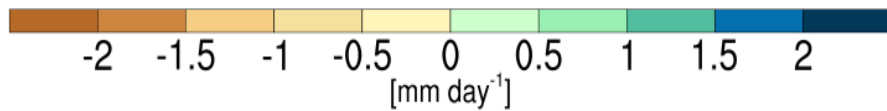
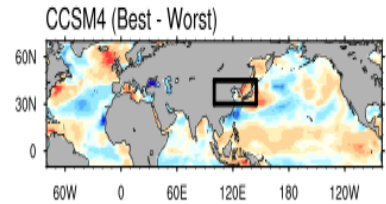
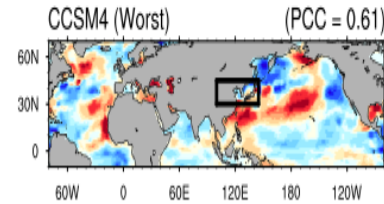
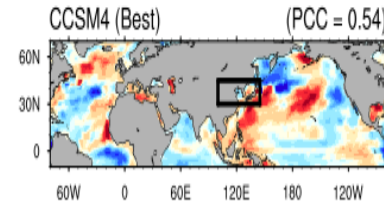
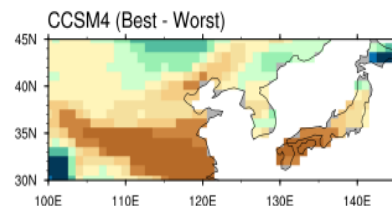
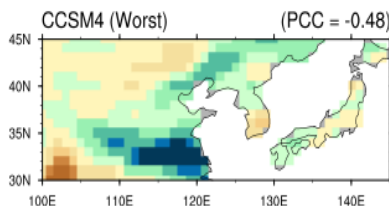
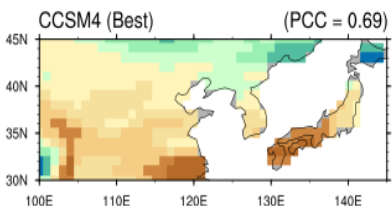
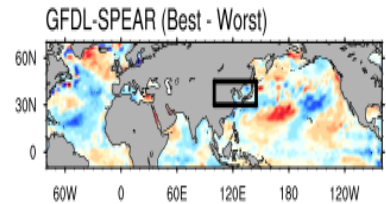
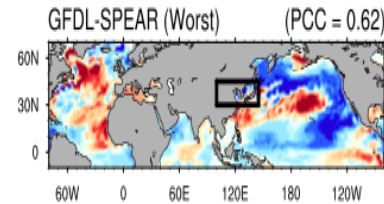
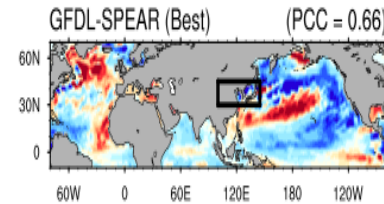
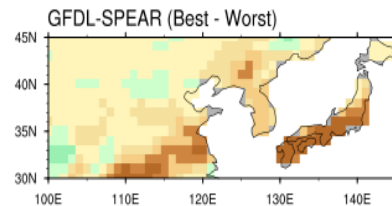
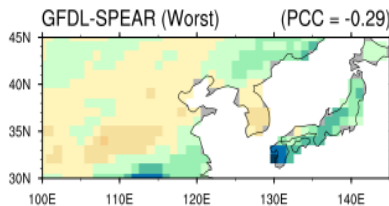
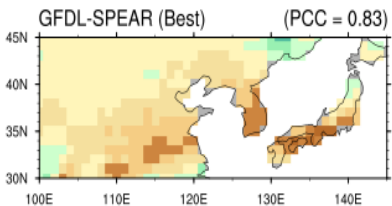
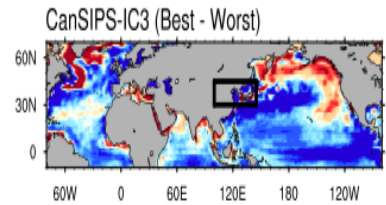
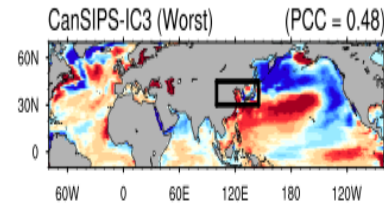
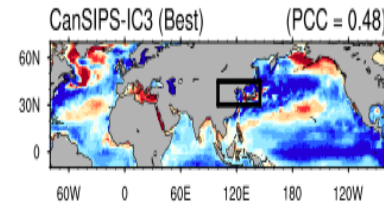
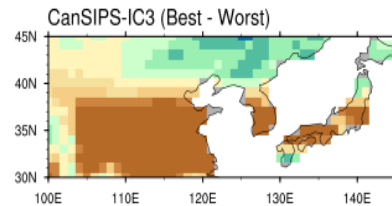
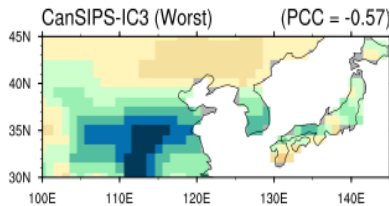
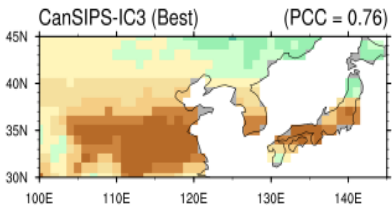
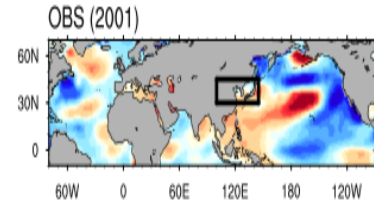
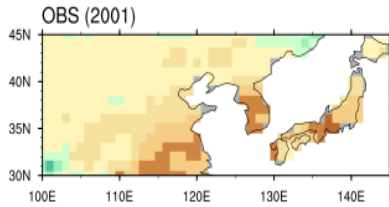
CCSM4



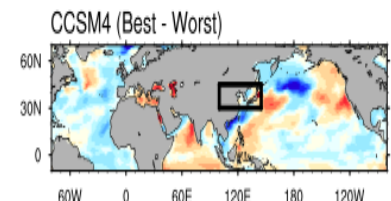
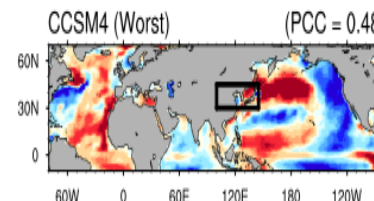
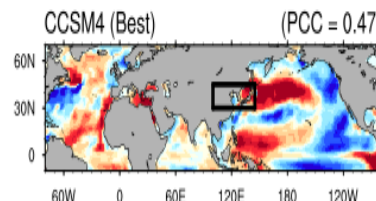
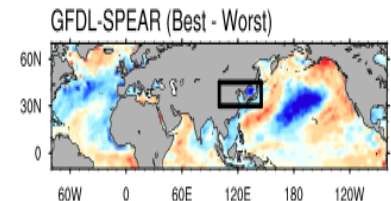
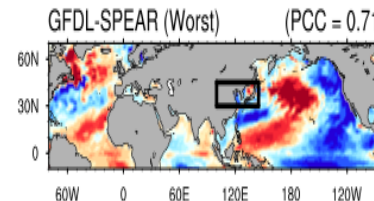
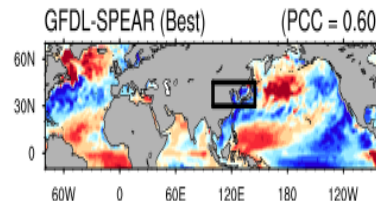
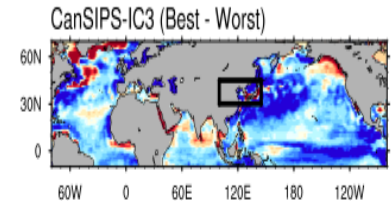
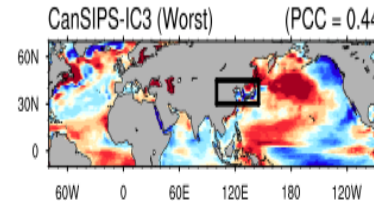
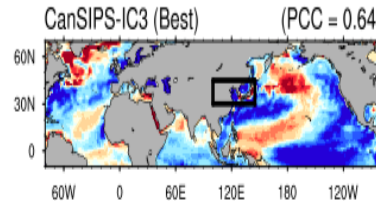
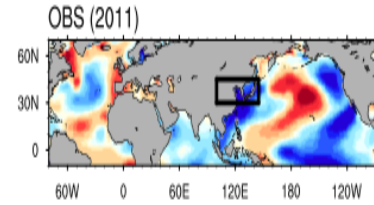
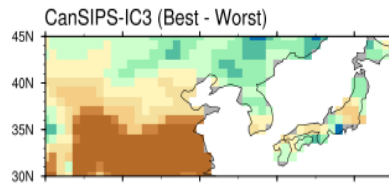
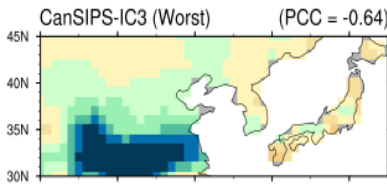
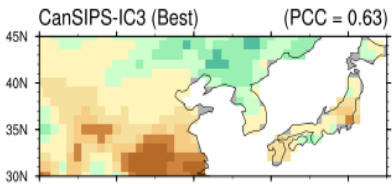
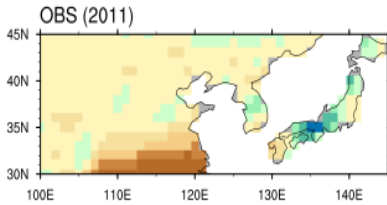
NASA-GEOSS2S



2001년 봄 해수면 온도 예측성



2011년 봄 해수면 온도 예측성



PCC for SST

2001

2011

CanSIPS-IC3

0.48

0.64

GFDL-SPEAR

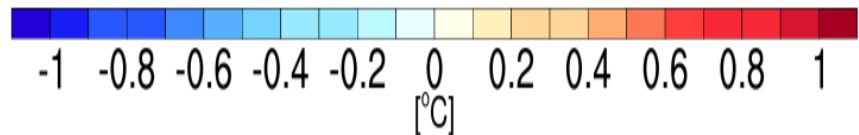
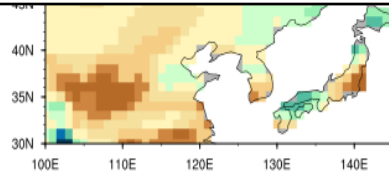
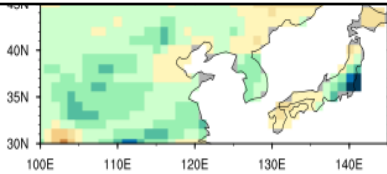
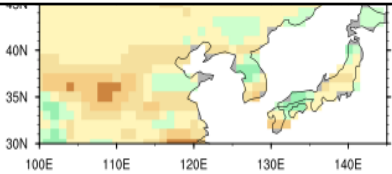
0.66

0.60

CCSM4

0.54

0.47

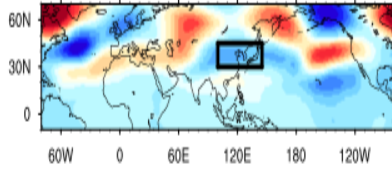


동북아시아 봄 가뭄 시기 대기 순환 예측성: Best vs Worst ensemble



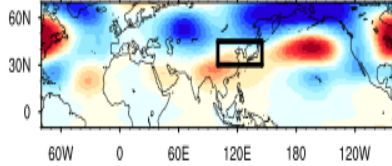
2001

OBS (2001)

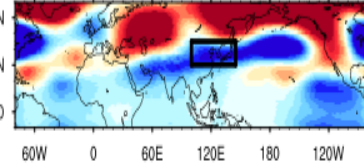


CanSIPS-IC3 (Best) (PCC = 0.51)

CanSIPS-IC3 (Worst) (PCC = 0.07)

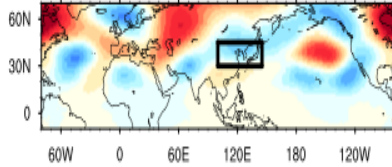


CanSIPS-IC3 (Best - Worst)

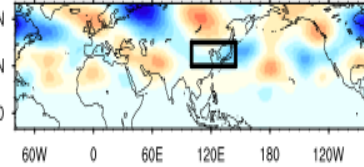


GFDL-SPEAR (Best) (PCC = 0.52)

GFDL-SPEAR (Worst) (PCC = 0.59)

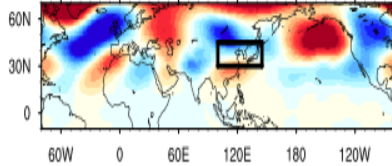


GFDL-SPEAR (Best - Worst)

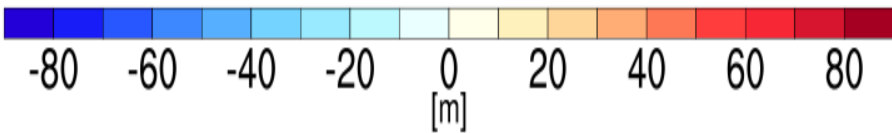
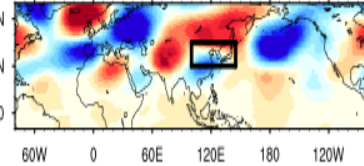


CCSM4 (Best) (PCC = 0.31)

CCSM4 (Worst) (PCC = 0.38)

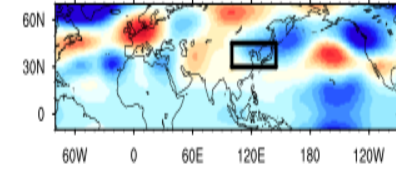


CCSM4 (Best - Worst)

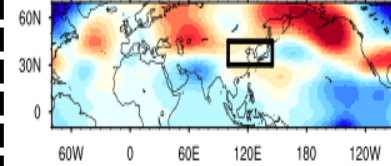


2011

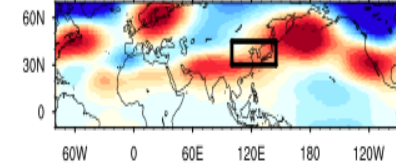
OBS (2011)



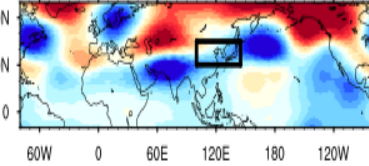
CanSIPS-IC3 (Best) (PCC = 0.32)



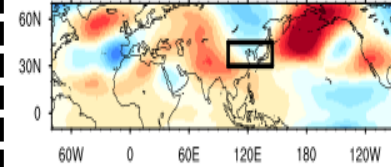
CanSIPS-IC3 (Worst) (PCC = 0.38)



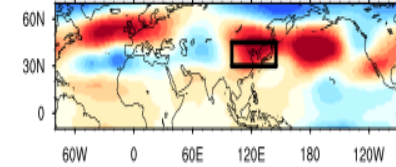
CanSIPS-IC3 (Best - Worst)



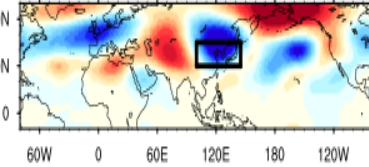
GFDL-SPEAR (Best) (PCC = -0.06)



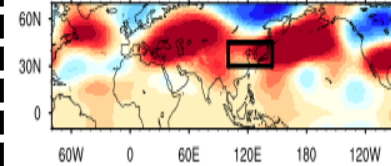
GFDL-SPEAR (Worst) (PCC = 0.17)



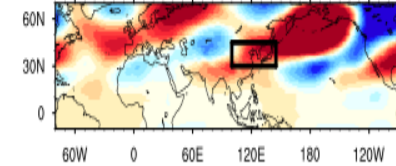
GFDL-SPEAR (Best - Worst)



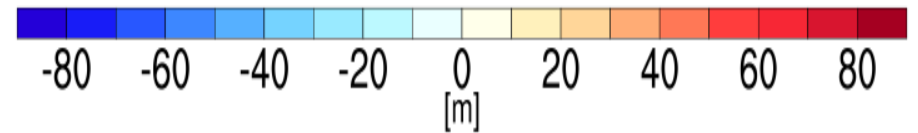
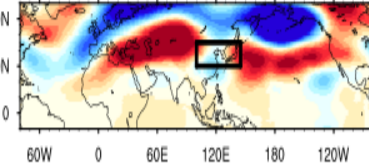
CCSM4 (Best) (PCC = -0.17)



CCSM4 (Worst) (PCC = -0.05)



CCSM4 (Best - Worst)



- 동북아시아 봄철 강수 변동성은 대기 상층의 저기압성 순환과 연관 있으며, NMME에서 대기 순환-해수면 온도 상호 패턴을 잘 모의하는 모델 (GFDL-SPEAR)이 상대적으로 동북아시아 봄철 강수 예측성이 높다.
- 2001년 가뭄에 대한 예측 확률은 대부분의 NMME 모델에서 높은 편이지만 2011년 가뭄에 대한 예측 확률은 상당히 낮다. 그 이유로는 동북아시아 상층에서 가뭄과 연관된 저기압성 순환이 아닌 고기압성 순환을 예측하기 때문이다.
- 대기에 강제력으로 작용하는 해수면 온도의 예측성능은 두 가뭄 시기에 뚜렷한 차이가 없다. 이는 해수면 온도의 예측성은 동북아시아 가뭄 예측성과 연관이 없으며 대기 순환 변동성에 대한 예측 성능이 중요함을 의미한다.

경청해주셔서 감사합니다.