

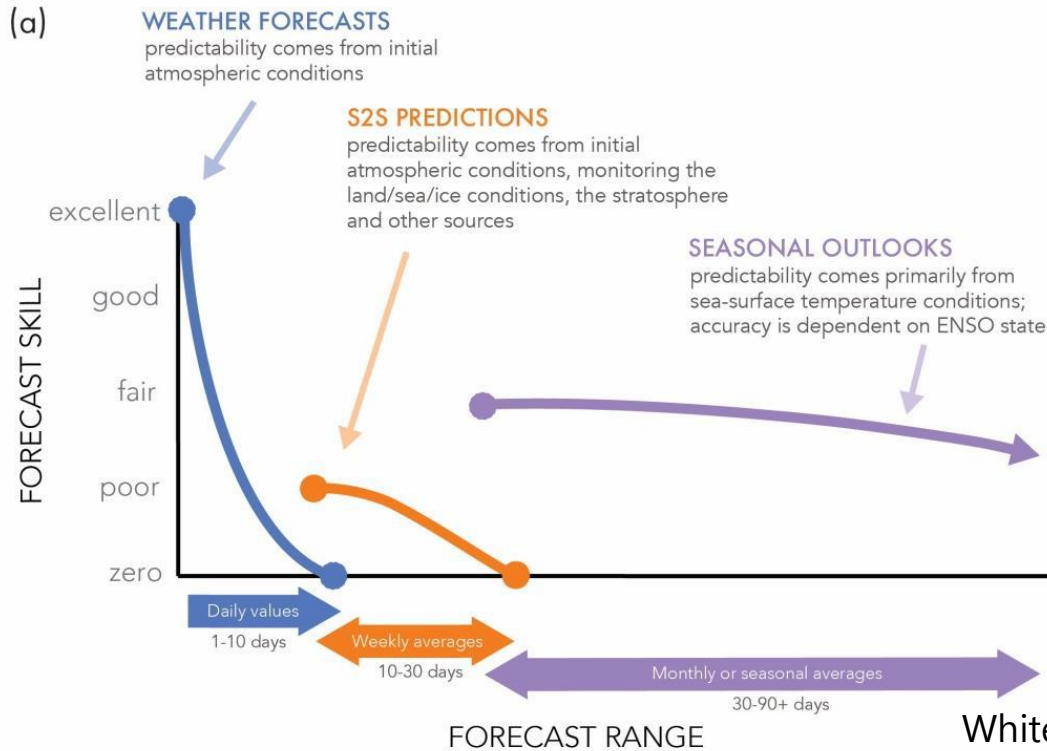
기상청 기후예측모델 개선을 위한 계절내 예측 오차 특성 분석

함수련^{1*}, 정여민¹, 임소민², 지희숙², 현유경²

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² 국립기상과학원 현업운영개발부

Background

Subseasonal-Seasonal prediction:



White et al., 2017

Background

Good Subseasonal Prediction Skill ☺

1. Good Individual Model

- Development prediction model
- Improvement processes in system

2. Diagnostic

- Systematic error
- Model error



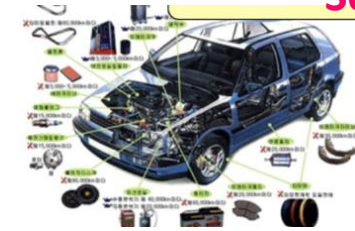
#A Dynamics



Engine



#B Physics



Software



#C Initialization



Gasoline



#D Diagnostics

Drive

Background

KMA Operational (sub)seasonal prediction

국립기상과학원)

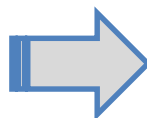
- Since 2010,
- GloSea4(2013) → GloSea5-GA3(2014) → GloSea5-GC2(2016)
→ Upgraded GloSea5-GC2 → GloSea6 (~2021)

APCC)

- GloSea5 계절내 예측 성능 평가 (S2S 참여모델과 비교 평가 포함)
- 오차특성 분석 (2019~)
→ 특성 분석 정보 및 개선 가이드라인 제공



#D Diagnostics



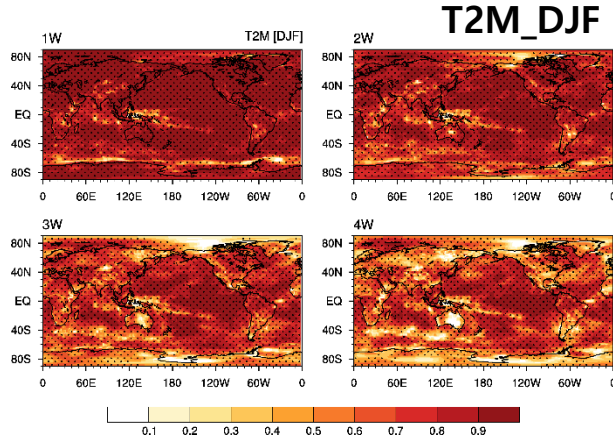
#B Physics

#C Initialization

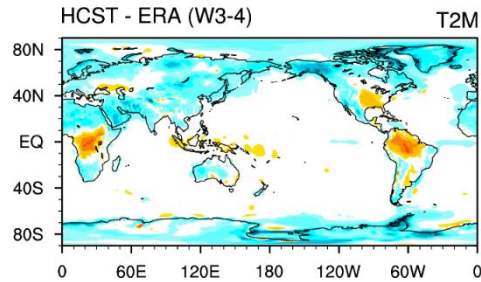
#D Diagnostics

GloSea5

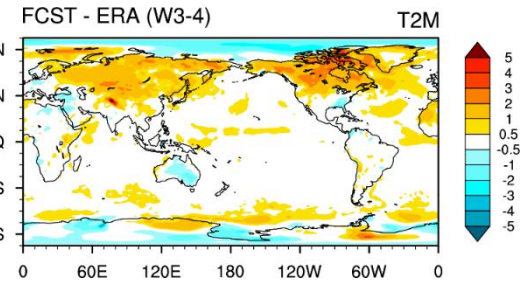
(MacLachlan et al. 2015)



Hindcast: Cold Biases!



Forecast: Warm Biases??



Question?!

- HCST skill 매우 높음, FCST 왜 안 맞을까??
 - 대부분 기관의 FCST는 5년 이내 기간, **Sample data** 작아서?
 - HCST는 재분석자료, FCST는 NWP자료가 일반적, **Initial data** 때문?

Hindcast Initial data: ERA-Interim/JRA-55, UKMO NEMOVAR

Forecast Initial data: KMA NWP/JRA-55, UKMO NEMOVAR

#C Initialization

Question?!

How important is it to have **consistency between the initial condition** of the hindcasts and real-time forecasts?

- 초기장에 따른 민감도 실험 구성

- **NWPIF**: KMA NWP initial data (Current operation system)
- **ERAiF**: ERA-Interim initial data (Same as Hindcast system)

- Resolution: N216L85/ORCA025L75
- Periods: 201710-201812 (1st, 9th, 17th, 25th)
- Ensemble member: 4 (Same as current operation system)
- System: **KMA Nuri** (Supercomputer)

Total 224case!!

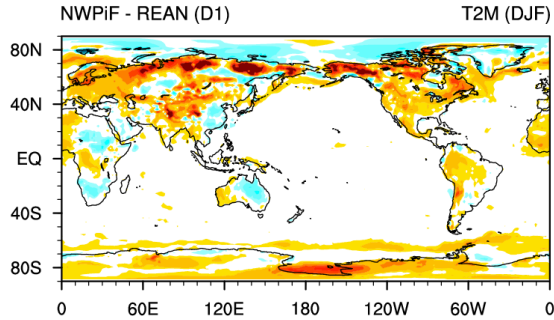
적분시간: 약 40시간/1case

작업장소: 기상과학원, 부산기상청

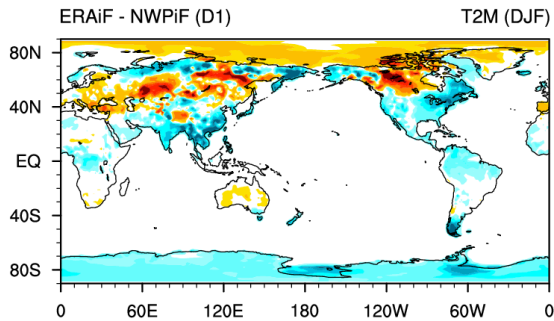
자료반출: 하드 카피 from 슈퍼컴센터

초기오차 (DAY1), DJF

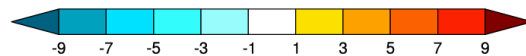
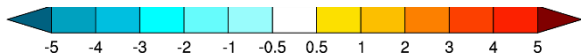
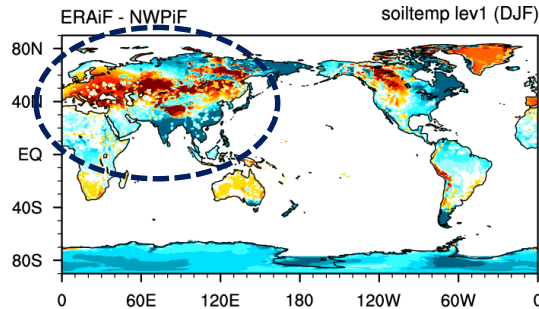
T2M NWPiF Biases



T2M ERAiF - NWPiF



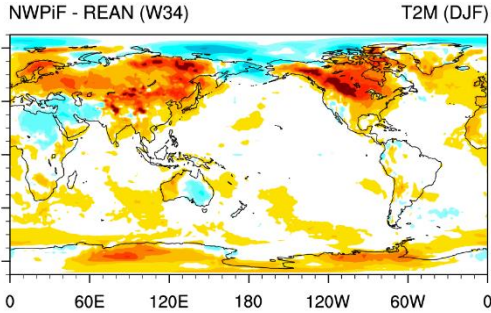
Soil Temp.



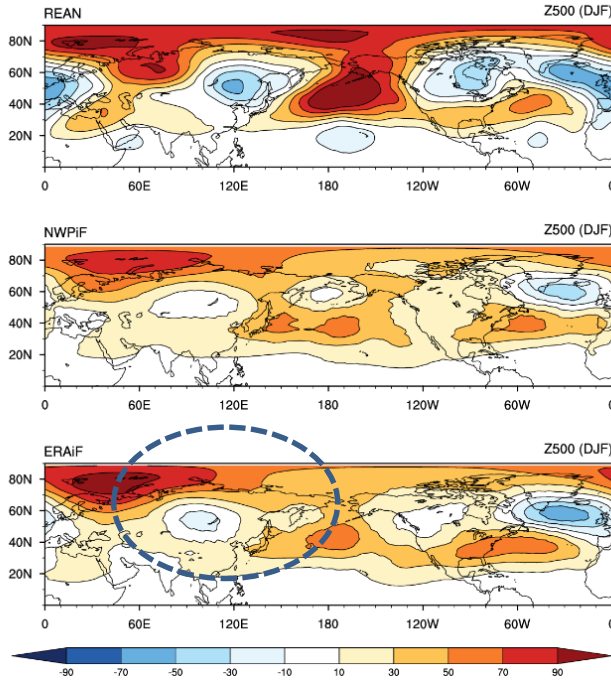
➔ D1: Land initial과 연관가능성!

계절내오차, DJF

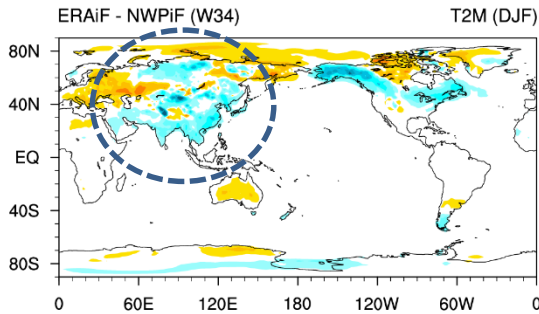
T2M NWPIF Biases



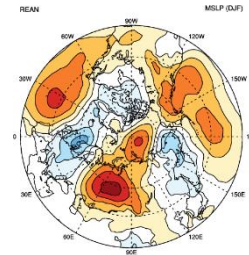
Z500



T2M ERAiF - NWPIF

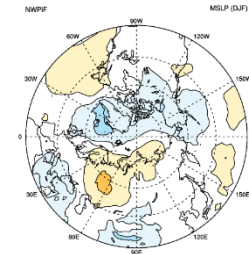


REAN

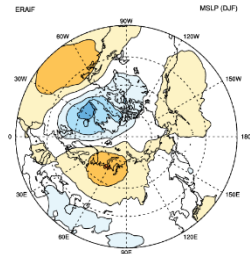


MSLP

NWPIF



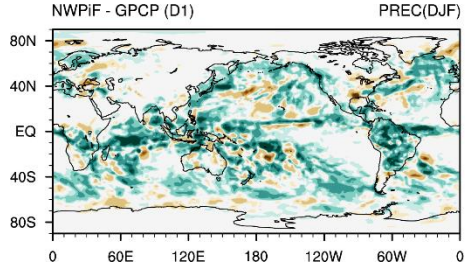
ERAiF



→ W34: 초기장 차이에 따른 동아시아 Warm biases 감소 (극지역 일부 오차 증가)

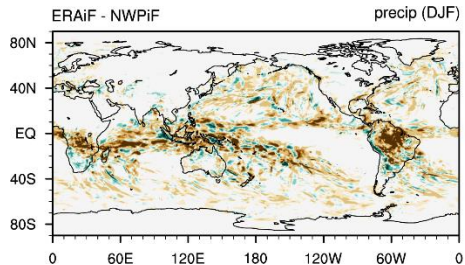
적도변동성 (강수), DJF

PRCP NWPiF Biases

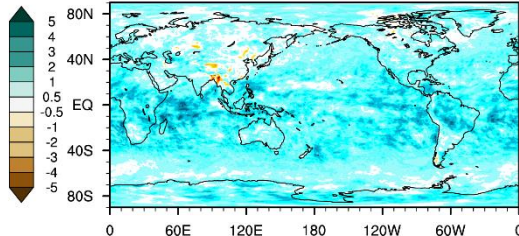


DAY1

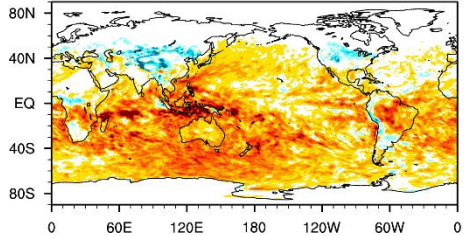
PRCP ERAiF - NWPiF



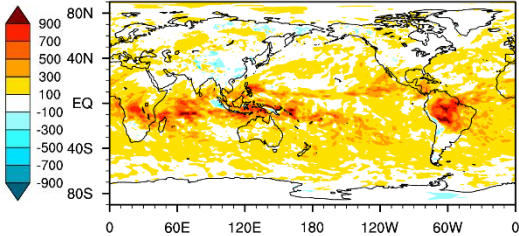
ERAiF - NWPiF Cloud (DJF)



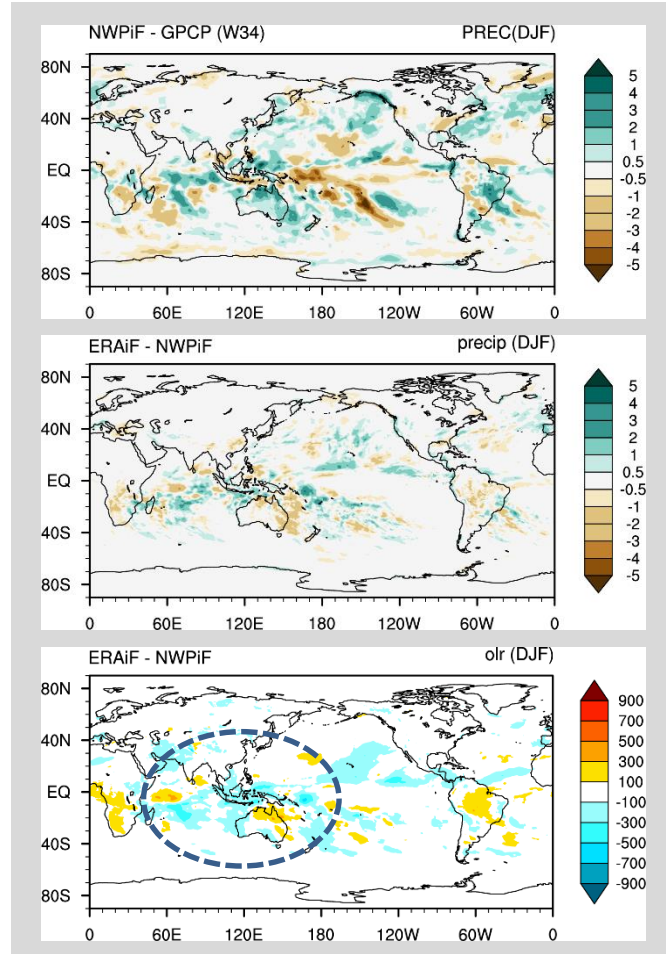
ERAiF - NWPiF solar (DJF)



ERAiF - NWPiF olr (DJF)

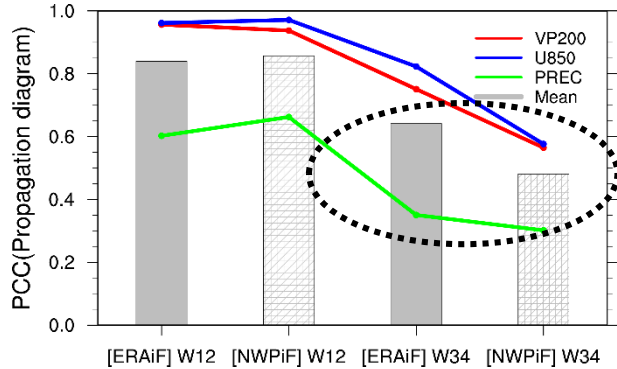


WEEKs 3-4



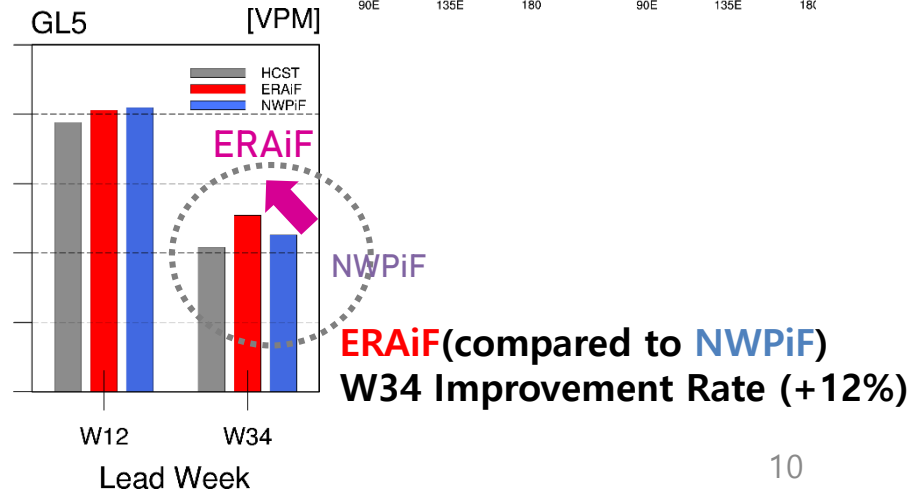
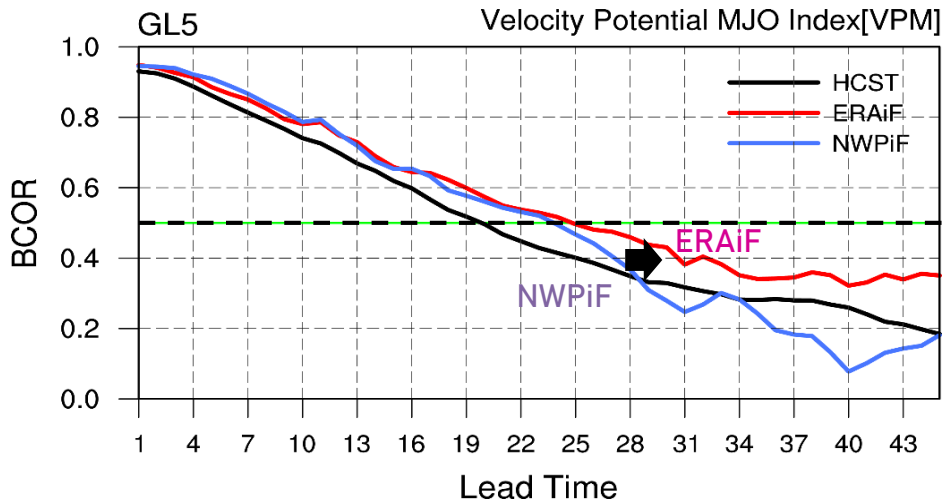
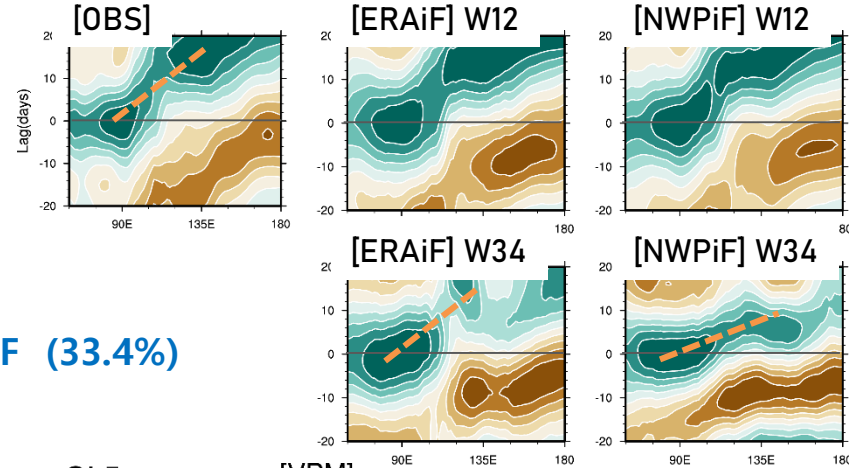
- D1: 강수 및 복사변수 초기 오차 감소
- W34: 적도 강수 오차 감소, MC conv 증가

적도변동성 (MJO), NDJFMA



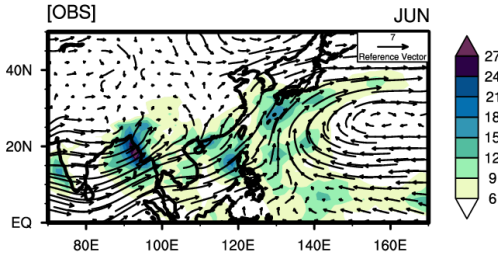
W34의 예측성:
ERAI > NWPiF (33.4%)

Period : 201711-201804
Lat: 10S-10N Lon: 60E-180E
Filtering: 20-70 Days Band Pass Filter

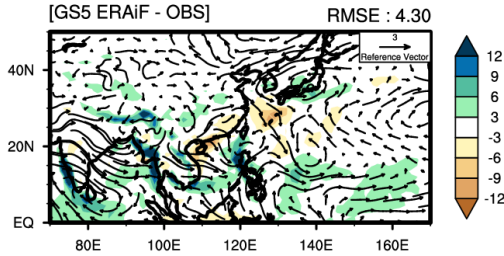


동아시아 여름 몬순 (2018JUN-AUG)

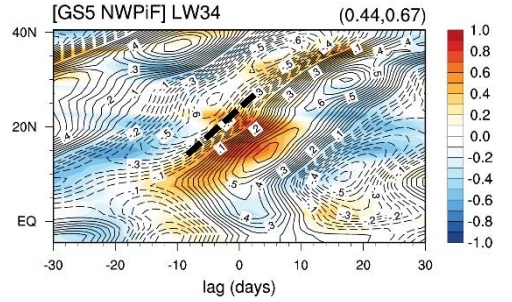
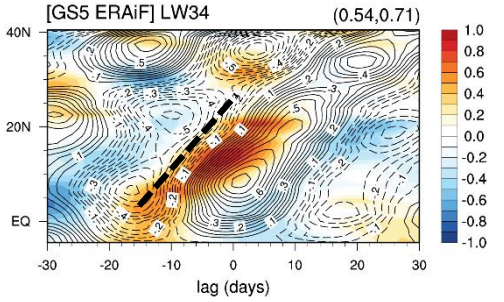
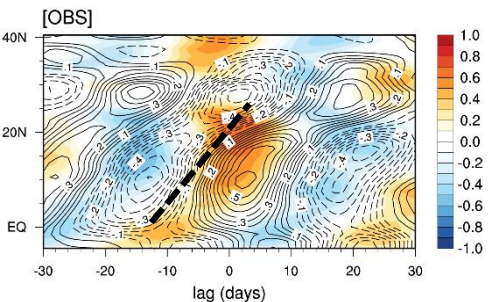
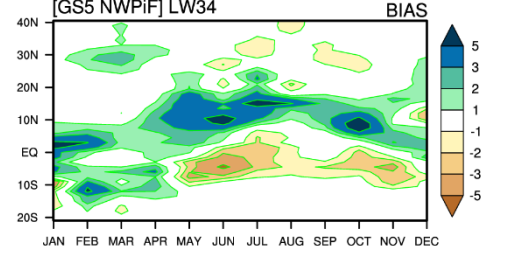
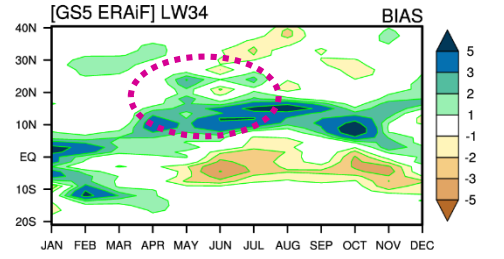
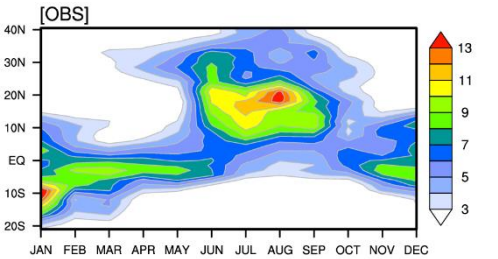
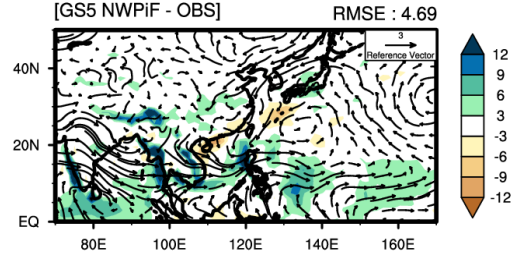
[OBS]



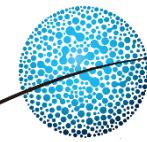
[ERAiF] W34



[NWPIF] W34

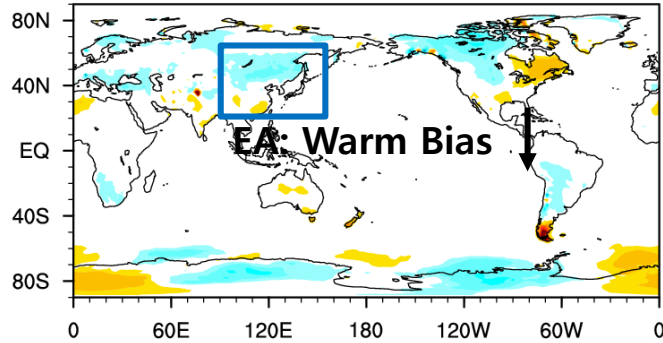


→ 초기오차 감소: 동아시아 강수 변화 거의 없음,
적도 강수 다소 개선, **filtered 강수 및 바람장 개선 확인**



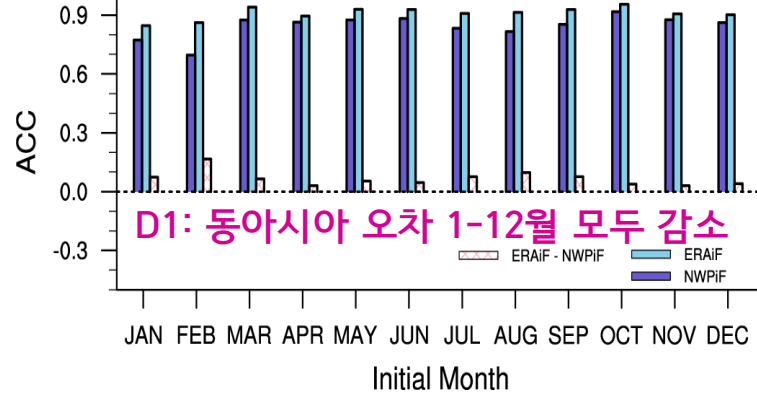
WEEKs 3-4

ERAiF - NWPiF (W34) T2M (JJA)

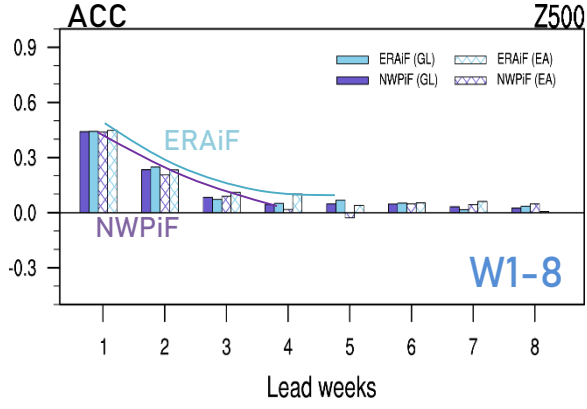
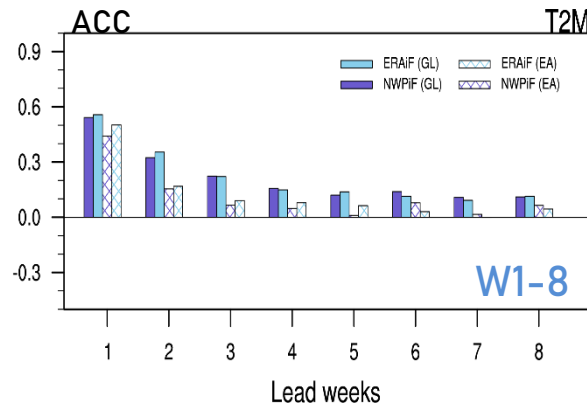
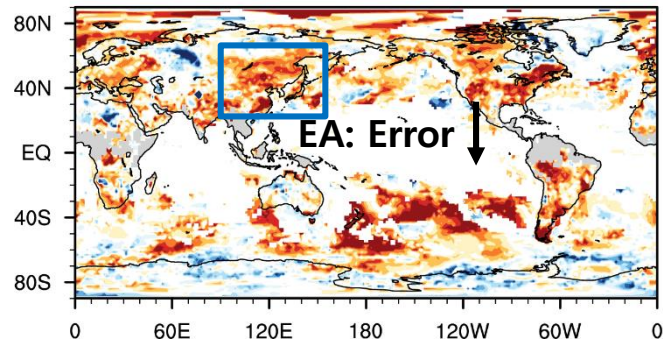


동아시아 예측성능 (2018JA)

ACC skill over EA T2M



Improvement Rate (NWPiF to ERAiF): W34 T2M (JJA)

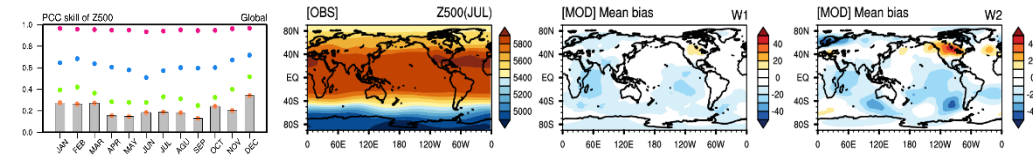


- 초기오차 감소: 동아시아 온도/순환장 오차 효과적으로 개선!
- 동아시아 계절내 예측성능 향상을 위해 초기장 개선 필수!

#D Diagnostics : GloSea5/6 계절내오차 통합 진단 틀 개발

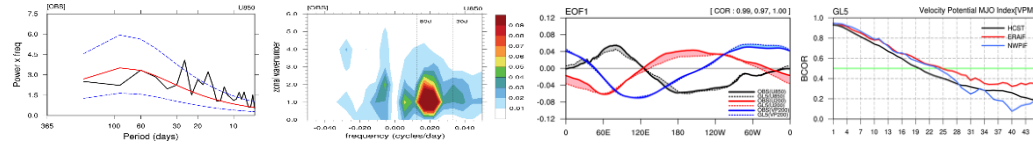
01 Mean biases

- Convert raw data(Model, OBS) format
- Post-processing for generating forecast data based lead time
- Validate monthly predictive **performance and mean biases**



02 Diagnosis MJO

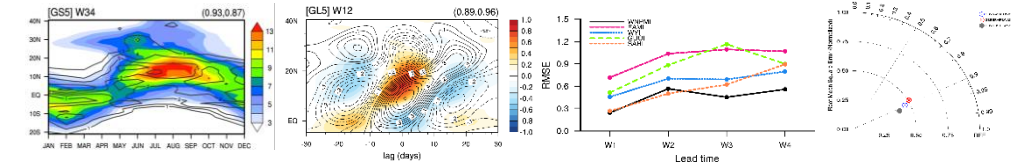
- Post-processing data for **MJO analysis**
- Diagnosis of power spectral, wavenumber frequency, MV-EOF, MJO propagation and MJO Index



- 기후예측모델 **버전간** 진단 정보 비교/평가
- 개선을 위한 **민감도 실험**의 영향 정보 비교/평가
- 기후예측모델 **개선/개발**에 따른 일관된 오차진단 가능

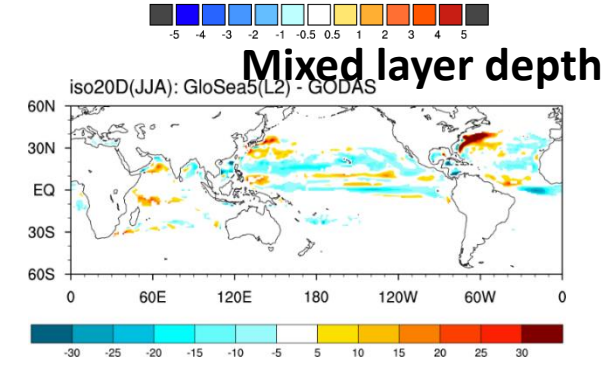
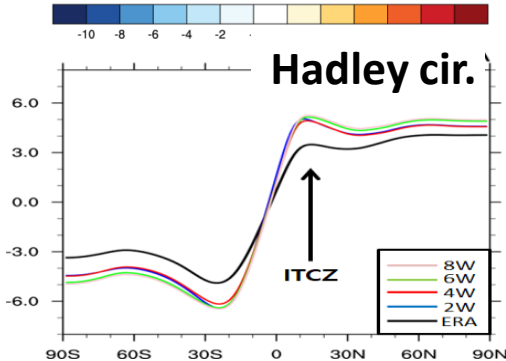
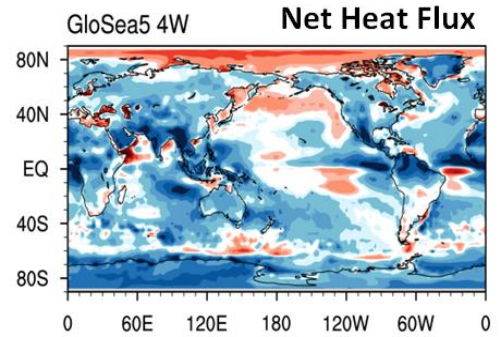
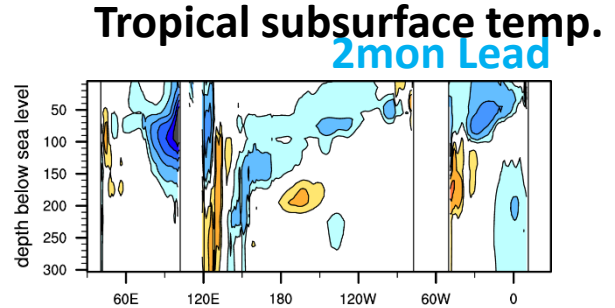
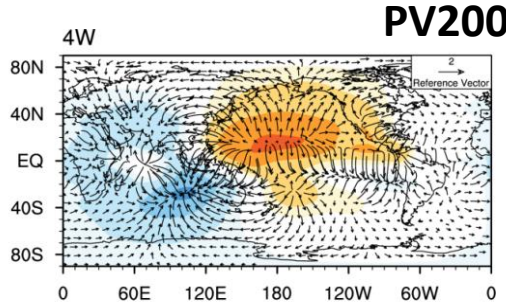
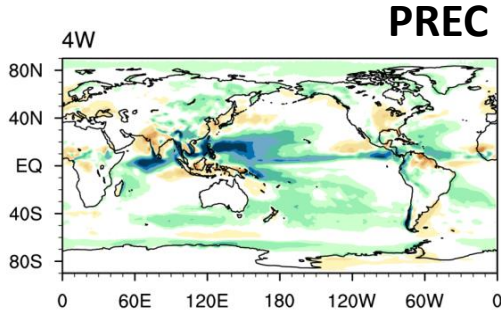
03 Diagnosis EASM

- Post-processing data for **East Asia summer monsoon analysis**
- Diagnosis of EASM index, time-latitude cross section of Prec, lag correlation of filtered Prec-U850 and Taylor diagram



#D Diagnostics : GloSea5/6 오차 특성 파악

GloSea5 HCST 계통적 오차 진단

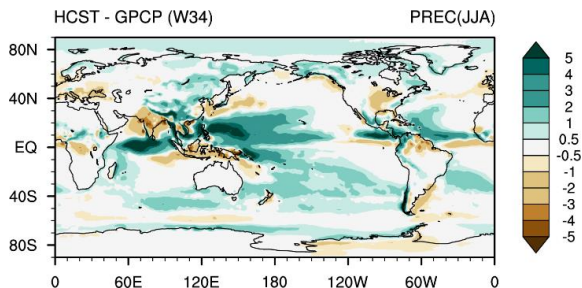


- 강한 대류활동 연관: 해들리 순환 매우 강하게 모의
- 지면 cooling 유발

- 선행기간 길어질수록 Temp, MLD 오차 증가
- ➔ 동태평양 mixing 강함: cold sst 가져옴.
- ➔ ENSO 예측력 저하로 이어질 수 있음!

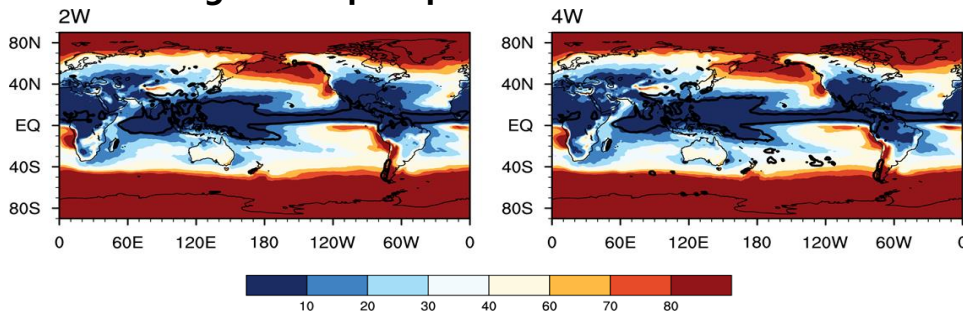
➔ 강수-구름-복사 상호작용 개선 필요!

GloSea5



- TP: Overestimated PRCP
- EA: Underestimated PRCP

Rate of large-scale precipitation



GloSea5/6: 적도 서태평양 - 동아시아 강수 오차
 → 적운모수화/미세물리과정 모두 중요

* 동아시아 지역 구름/강수 모듈 및 계수 민감도 파악

Plan

#모듈의 개선

- **microphysics**: 병합효율(Exy)증가를 통한 동아시아 강수의 민감도 평가

#구름/강수 관련 namelist 내의 계수 조정을 통한 개선

- **radiation**: 복사과정과 연관된 구름 비율 계수 (cca_sh_knob, cca_md_knob, cca_dp_knob)
- **convection**: 구름 생성과 연관된 detrainment 비율 계수 (r_det)
- **microphysics**: supercooled liquid water와 연관된 계수 (TICE)
- **cloudiness**: pdf width와 연관된 계수 (ice_width)

→ 동아시아 강수 개선 및 현업화 가이드라인 제시 예정

요약 및 결론

#1. 초기조건 영향 평가

- 초기 조건이 계절내 예측성능에 미치는 영향이 뚜렷
- NWP 초기장을 사용했을 경우, 동아시아 지표온도 양의 오차 뚜렷하게 나타남
- 재분석자료를 초기장으로 사용했을 경우, 동아시아 지표온도 양의 오차가 효과적으로 감소

→ 현재 현업으로 생산되는 계절내 예측장의 경우, 북반구 중위도의 계통적 warm biases, 북반구 고위도에서 cold biases가 뚜렷함

→ 실시간예측에 사용되는 초기장의 지면 오차 및 구름/복사와 연관된 과정 등의 개선이 필요함

#2. 진단 및 개선 가이드라인 제시

- 오차특성 통합 진단 툴 개발
- 강수-구름-복사 개선 필요성 진단
- 구름모수화 및 강수/구름 모듈 계수 조사 완료
- 미세물리과정 매개변수 및 강수/구름 모듈 계수 조정을 통한 민감도 실험 구성

→ 동아시아 강수 개선 가이드라인 제시 예정

Thank
you!



감사합니다.