

Evaluation of the Subseasonal Forecast

- From GEFS SubX to FV3 GEFSv12

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Acknowledgments:
EMC ensemble team
EMC model development members
ESRL/PSD scientists
NWS OSTI and NOAA's CPO MAPP program.

8th NCEP Ensemble User's Workshop
College Park, MD
August 29, 2019

Outlines

- **SubX GEFS - review**
- **FV3 GEFS configurations**
 - SubX GEFS vs. FV3 GEFS
- **Evaluation of Retrospective Forecast (2017-2018)**
 - MJO (RMM skill/Error, propagation)
- **Evaluation of Reforecast (1989-1999)**
 - MJO - Raw vs. bias corrected
 - MJO - FV3 GEFS vs. CFS
 - NAO and PNA - FV3 GEFS vs. CFS
- **Summary**

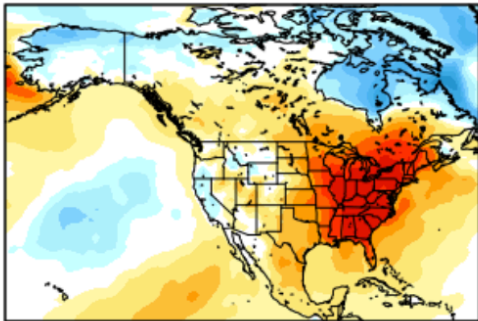
The Subseasonal Experiment (SubX)

By the Numbers...

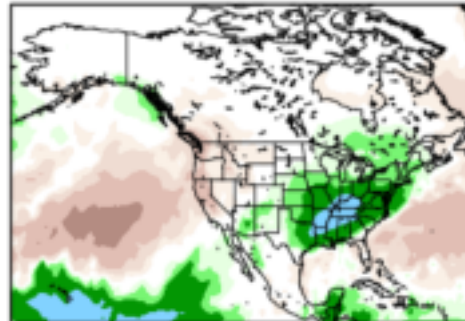
- 7** Global Models
- 17** Years of Retrospective Forecasts
- 1** Year of Real-time Forecasts
- 3-4** Week guidance for CPC Outlooks

Real-time Multi-model Forecasts

MME (63 Ensemble Members)



MME (63 Ensemble Members)



IRI Data Library

Models SubX
Models SubX: Subseasonal Experiment (SubX).

Documents

- [overview](#) an outline showing sub-datasets of this dataset
- [CTB](#) NOAA Climate Test Bed Website
- [Data Cite DOI Metadata](#) DOI:10.7916/D8PQ249H
- [SubX Data Information](#) Model/Data information from SubX Project Website
- [SubX Project](#) SubX Project Website

Datasets and Variables

- [CESM](#) Models SubX CESM(46LCESM1 30LCESM1)
- [ECCC](#) Models SubX ECCC(GEM)
- [EMC](#) Models SubX EMC(GEFS)
- [ESRL](#) Models SubX ESRL(FIM1)
- [GMAO](#) Models SubX GMAO(GEOS_V2p1)
- [NRL](#) Models SubX NRL(NESM)
- [RSMAS](#) Models SubX RSMAS(CCSM4)

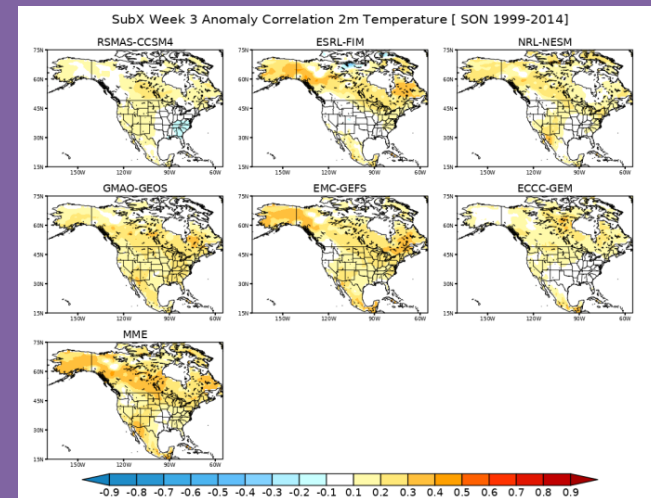
Forecast & Hindcast data publicly available

Current Data Holdings (Last updated: Feb 14, 2018)

Re-Forecasts																		
Model	Ens Members	Init Interval	P1	P2	Climo	Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ECCC-GEM	4	7-days	☑	☑		1995-2014	☑											
EMC-GEFS	11	7-days	☑	☑		1999-2016	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
ESRL-FIM	4	7-days	☑	☑		1999-2016	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
GMAO-GEOS	4	5-days	☑			1999-2015	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
NRL-NESM	1	4 inits every 7-days	☑	☑		1999-2016	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
RSMAS-CCSM4	3	7-days				1999-2016	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
NCEP-CFSv2	4	1-days			tas_pr	1999-2016	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

<http://iridl.ideo.columbia.edu/SOURCES/.Models/.SubX/>

Skill Evaluation



<http://cola.gmu.edu/kpegion/subx>

SubX Team



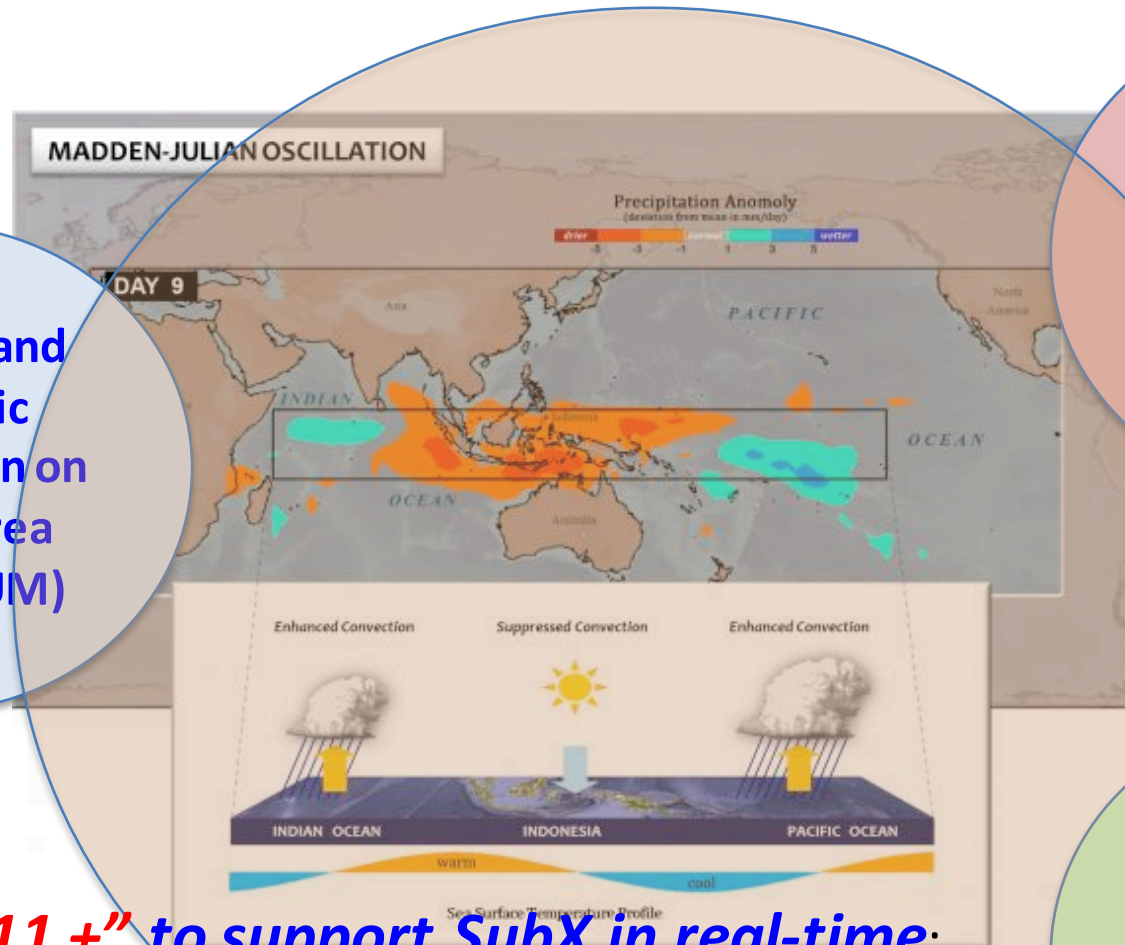
Key Areas Focused on ...

Ensemble and Stochastic perturbation on tropical area (SPPT, SHUM)

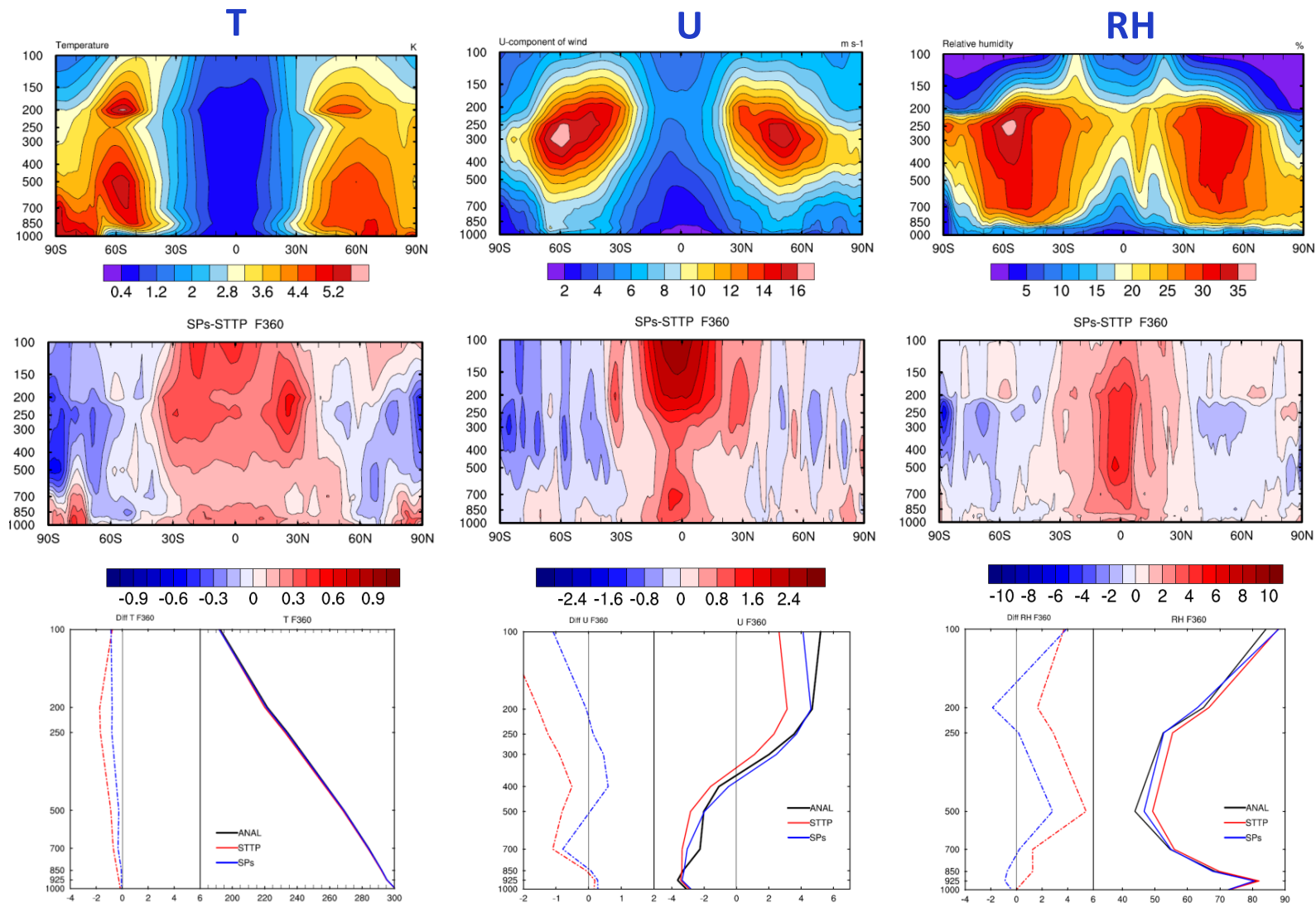
Atmosphere Ocean Interaction (2-Tier SST)

Tropical convections cloud, radiation, precipitation and et al. (SA Conv)

- **“GEFS v11 +” to support SubX in real-time:**
 - ✓ SPPT+SHUM+SKEB (SPs) with control version of SST;
 - ✓ SPs with bias corrected CFSv2 forecast SST (SPs+CFSBC);
 - ✓ SPs with bias corrected CFSv2 forecast SST and scale aware convection scheme (SPs+CFSBC+CNV) ;



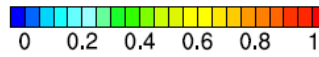
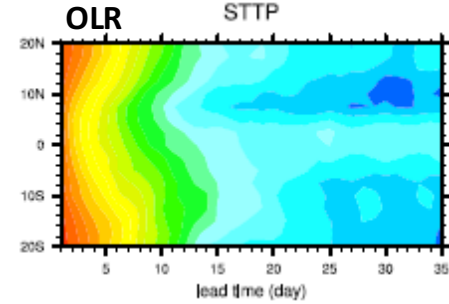
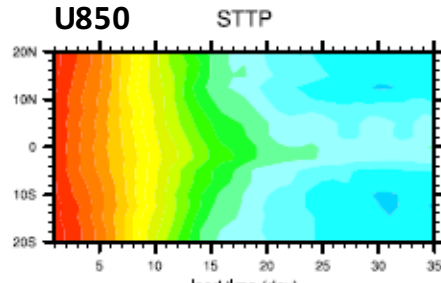
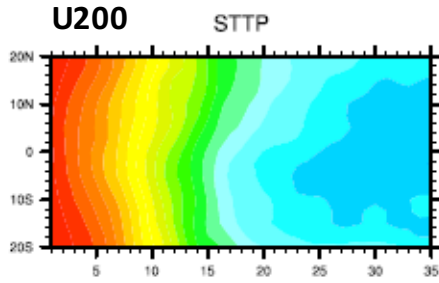
Impact of the Stochastic Physics (SPs)



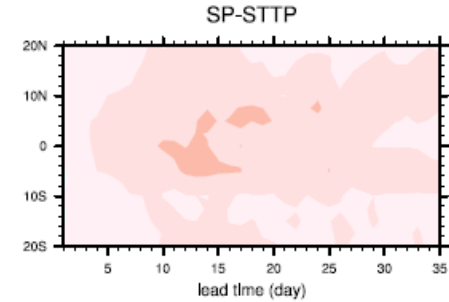
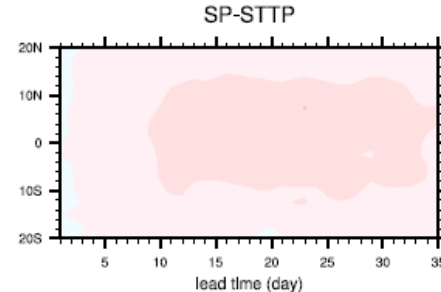
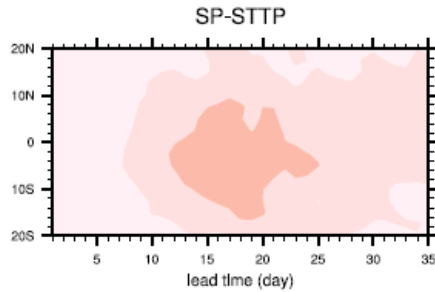
Averaged ensemble spread of the perturbed members in GEFs for temperature, zonal wind and relative humidity at 360 forecast hour (top row, left to right); the difference between SPs and STTP for the corresponding variables (middle row); vertical profiles (solid) and mean errors (dash) for the corresponding variables (bottom row). For each plot, 6 samples during March 2016 (March 1, 6, 11, 16, 21 and 26) was used to calculate the averaged ensemble spread and error.

Effect of Each Configuration (ACC)

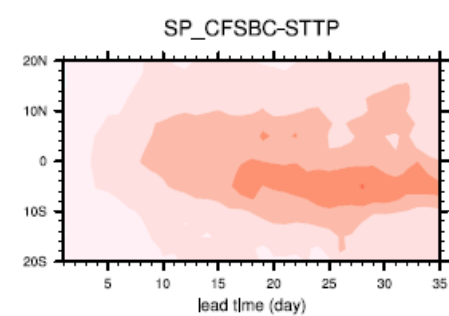
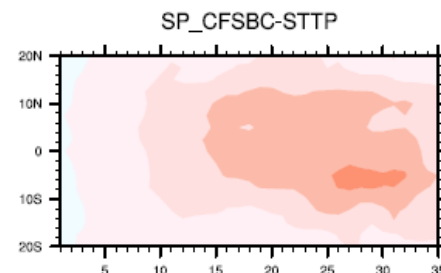
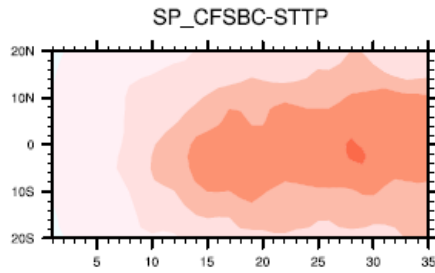
CTL



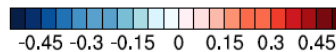
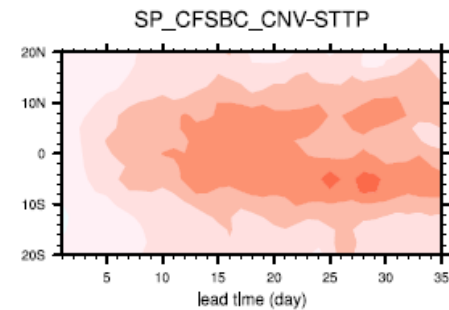
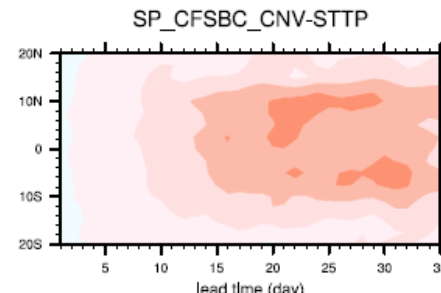
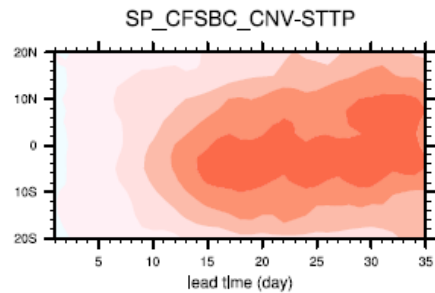
SPs - CTL



SPs+CFSBC - CTL



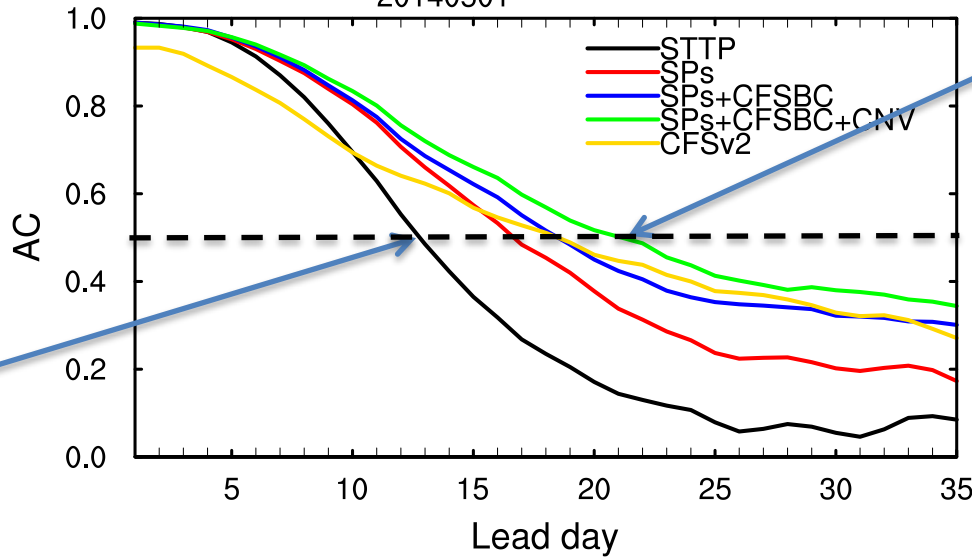
SPs+CFSBC +CNV - CTL



MJO Forecast Skills for 2-yr Experiments

MJO skill: **RMM1+RMM2**
20140501

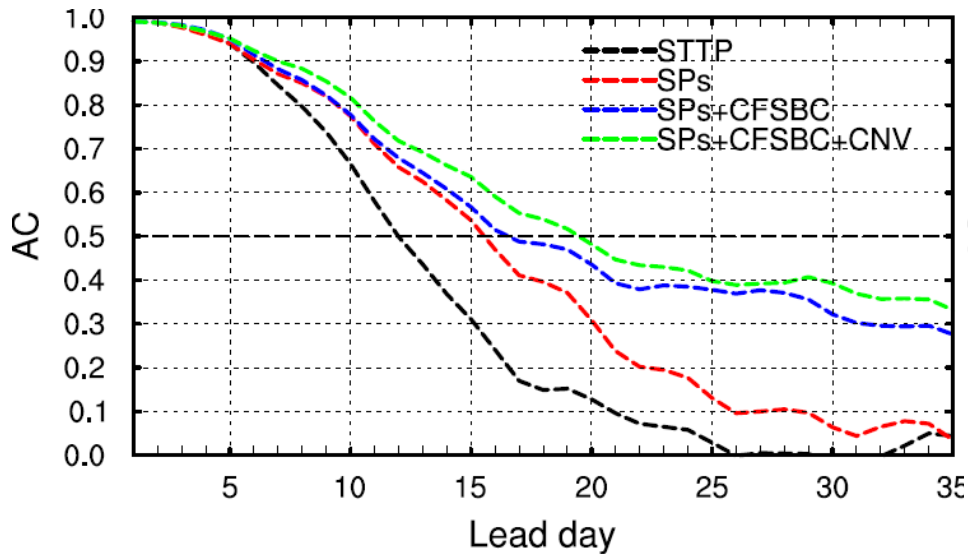
22 days



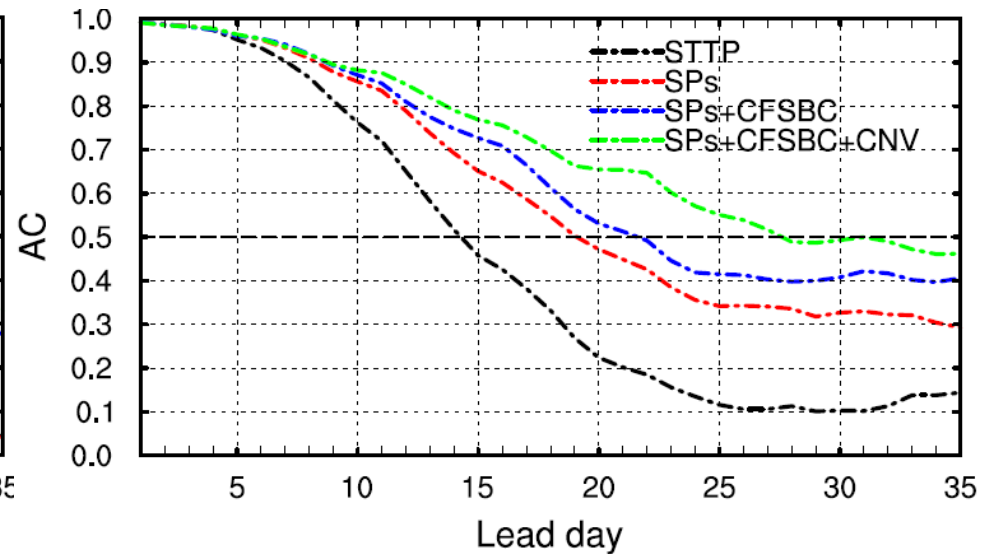
Improve MJO skills
from 12.5 days to 22
days

12.5 days

RMM1



RMM2



FV3 GEFS Configurations

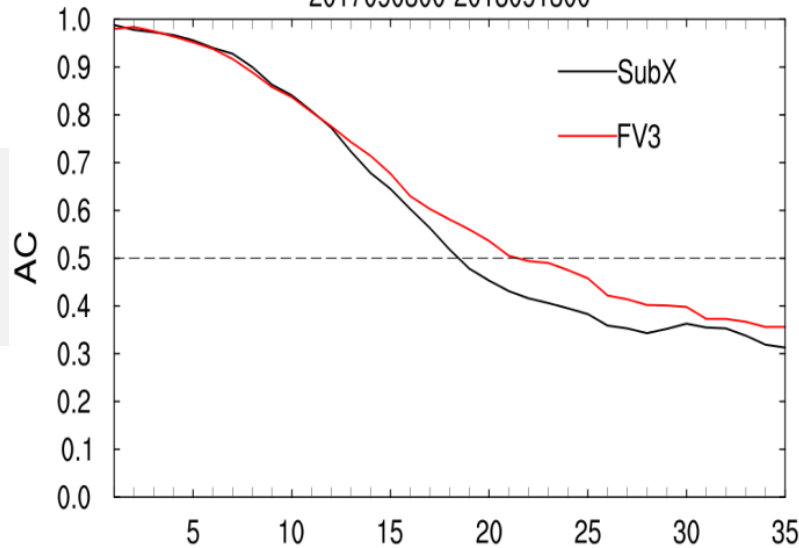
(SubX GEFS vs. FV3 GEFS)

	Base Model Components				Ensemble		
	Atmosphere	Ocean	Sea Ice	Land	Initial	Stochastic	ENS
SubX GEFS	T _L 574 L64 Days 0-8 T _L 382 Days 8-35; Convection: SAS Microphysics: ZhaoCarr ICs: GFS analysis;	Prescribed: 2-tiered	Three-layer thermodyna mics sea-ice model ICs: SSM/I	NOAH, T _L 574 ICs: GLDAS	atm DA (EnKF f06)	SPPT SKEB SHUM	1 + 20
FV3 GEFS (v12)	C384 L64, Days 0-35 Convection: SAS (updated) Microphysics: GFDL ICs: FV3 GFS analysis	Prescribed: 2-tiered Diurnal	Three-layer thermodyna mics sea-ice model ICs: SSM/I	NOAH updated, C384 ICs: GLDAS	atm FV3DA (EnKF f06)	SPPT SKEB	1 + 30

MJO Forecast Skill (Retrospective Experiments)

MJO skill: RMM1+RMM2
2017090300-2018091300

RMMs

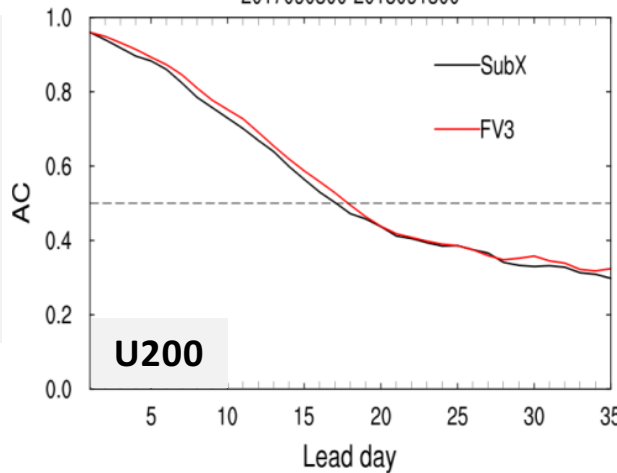


One year period

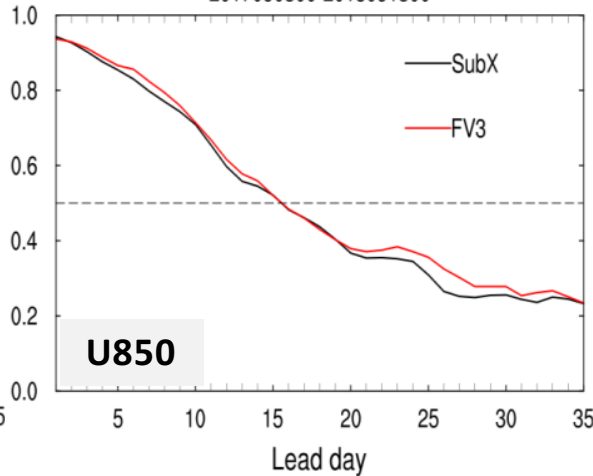
- FV3 GEFS > SubX for ~3 days;
- Slight improvement in U200 and U850;
- Noticeable improvement in OLR in FV3GEFS

MJO skill: U200
2017090300-2018091300

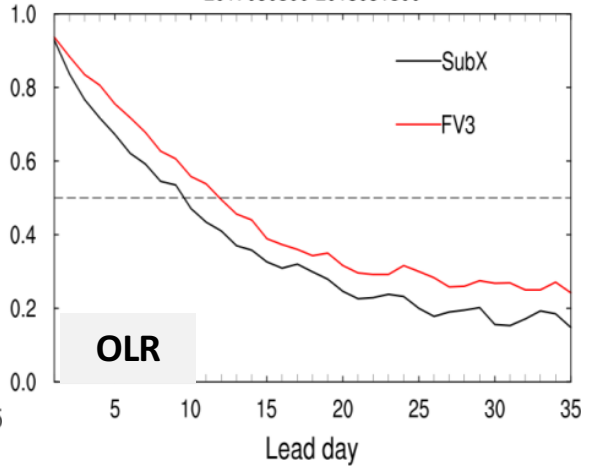
Components



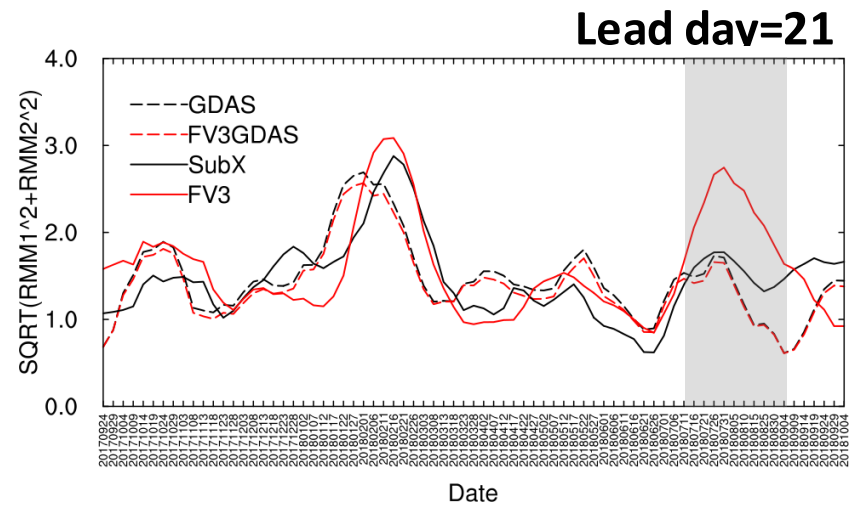
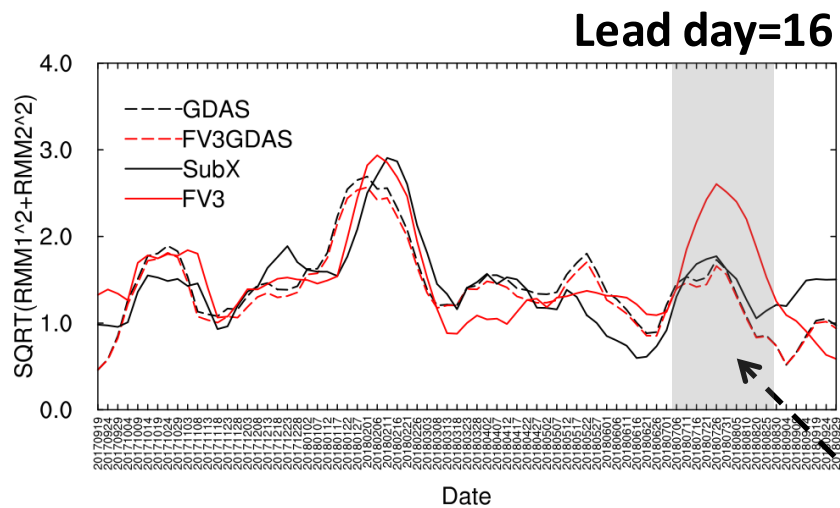
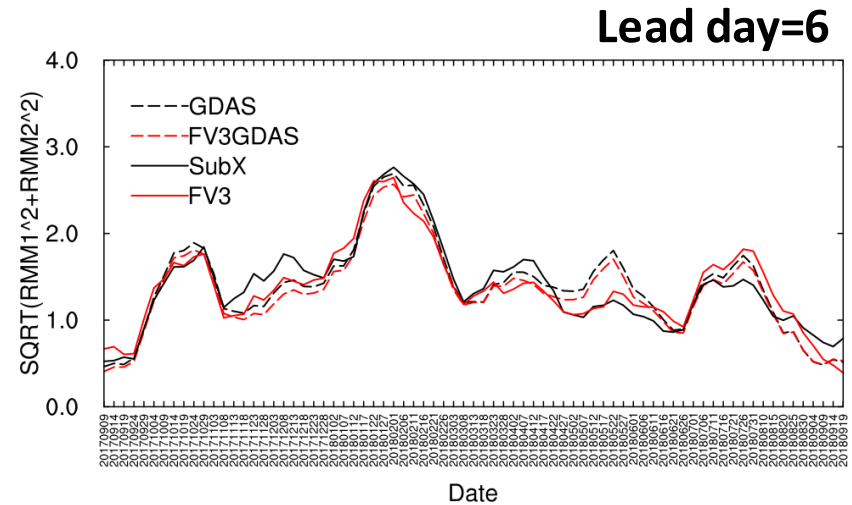
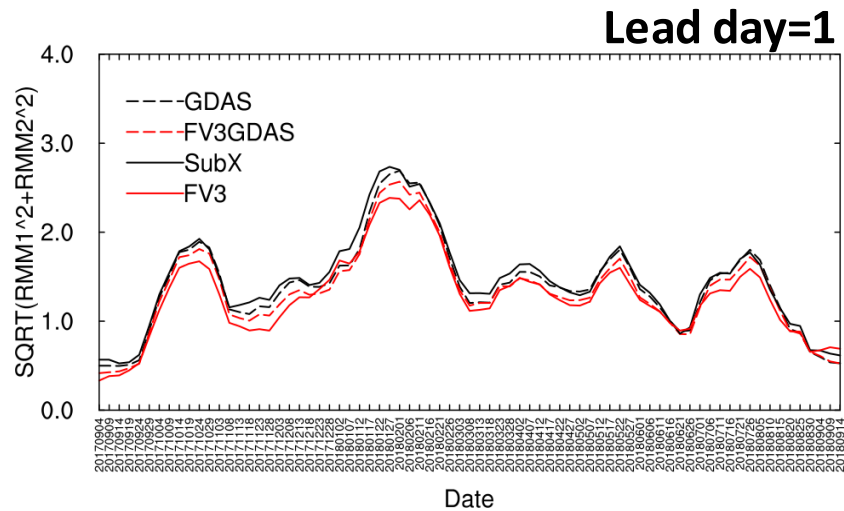
MJO skill: U850
2017090300-2018091300



MJO skill: OLR
2017090300-2018091300

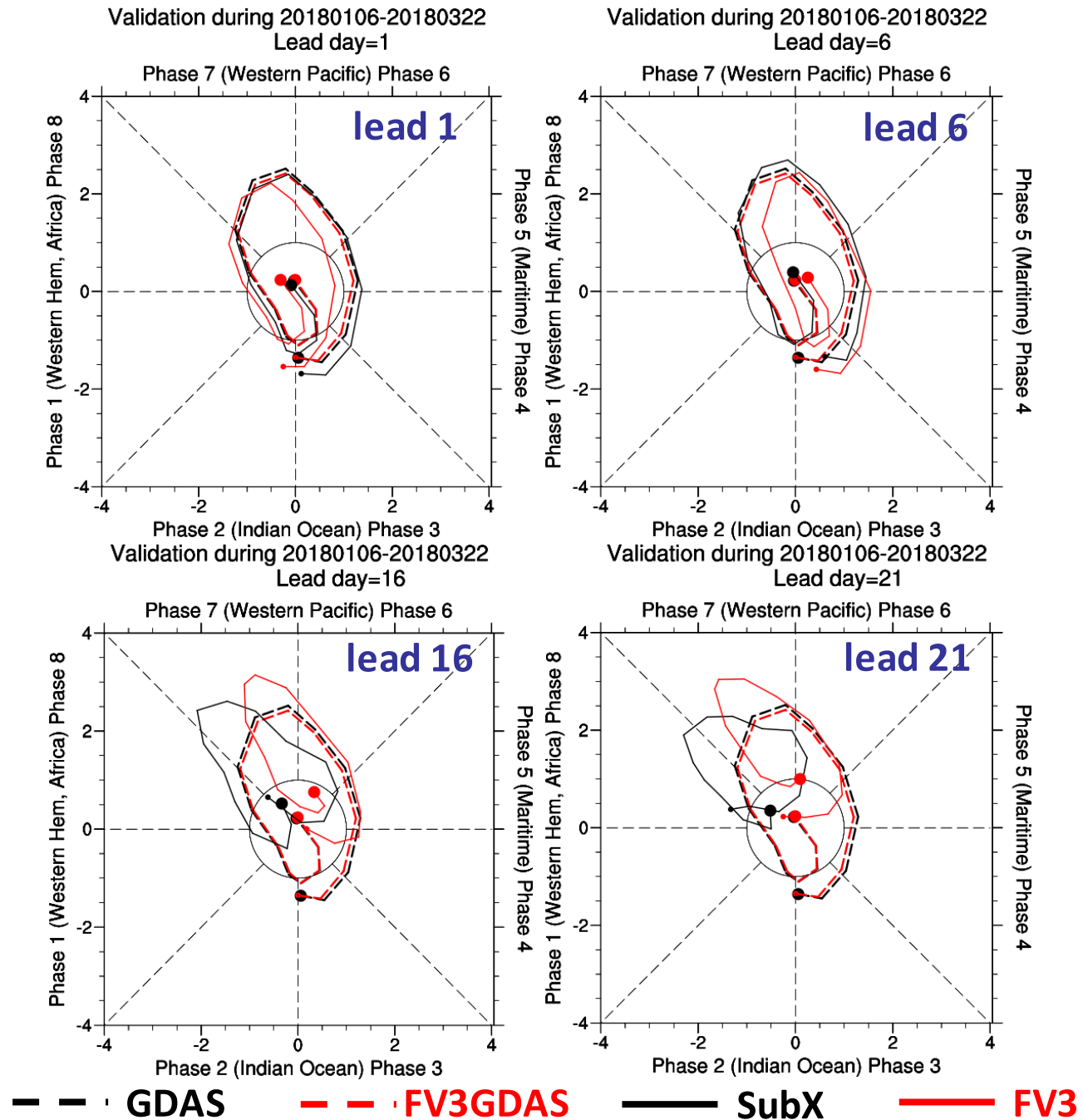


Variability of the MJO RMM index



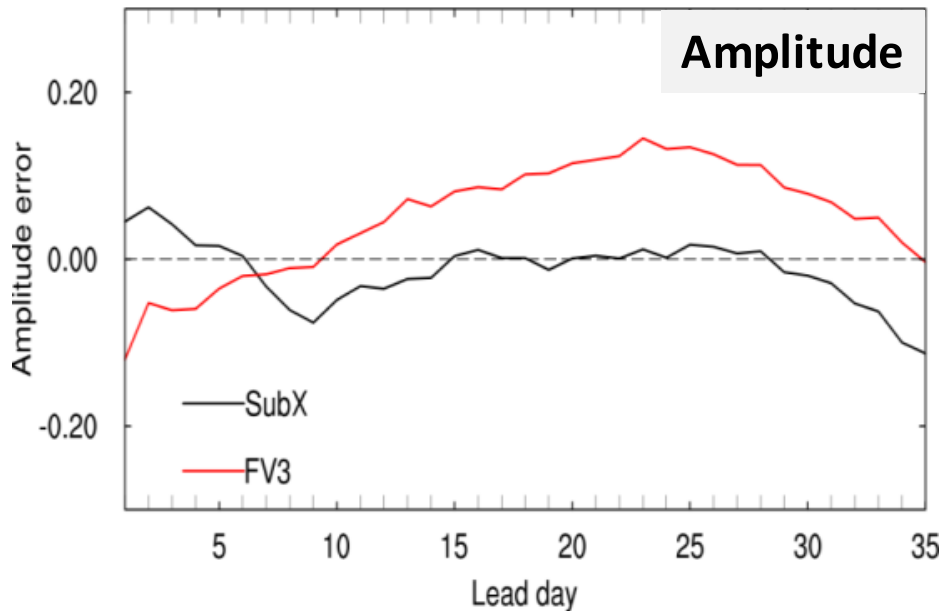
20180701-20180820

MJO evolution



MJO RMM Amplitude and Phase Error

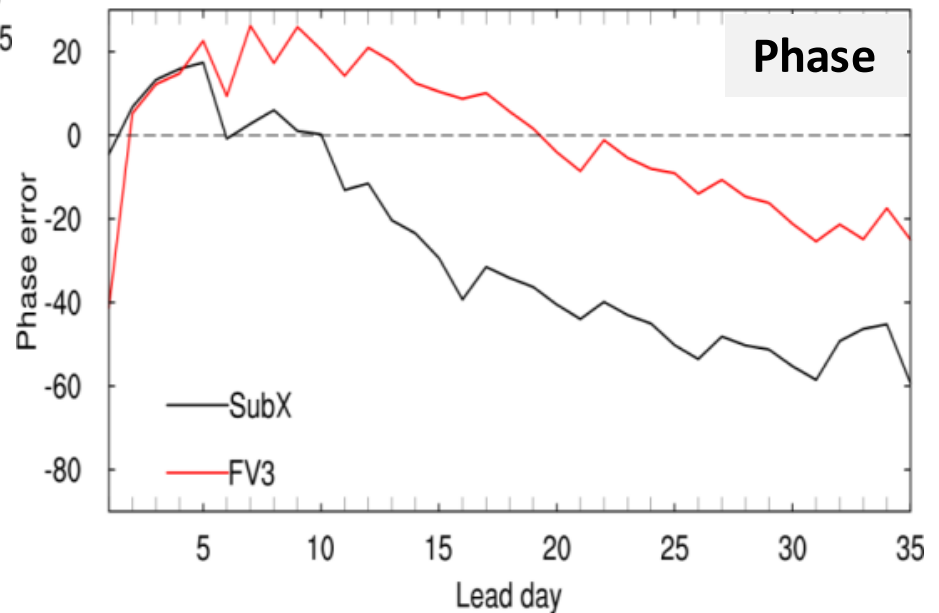
Amplitude Error (2017090300-2018091300)



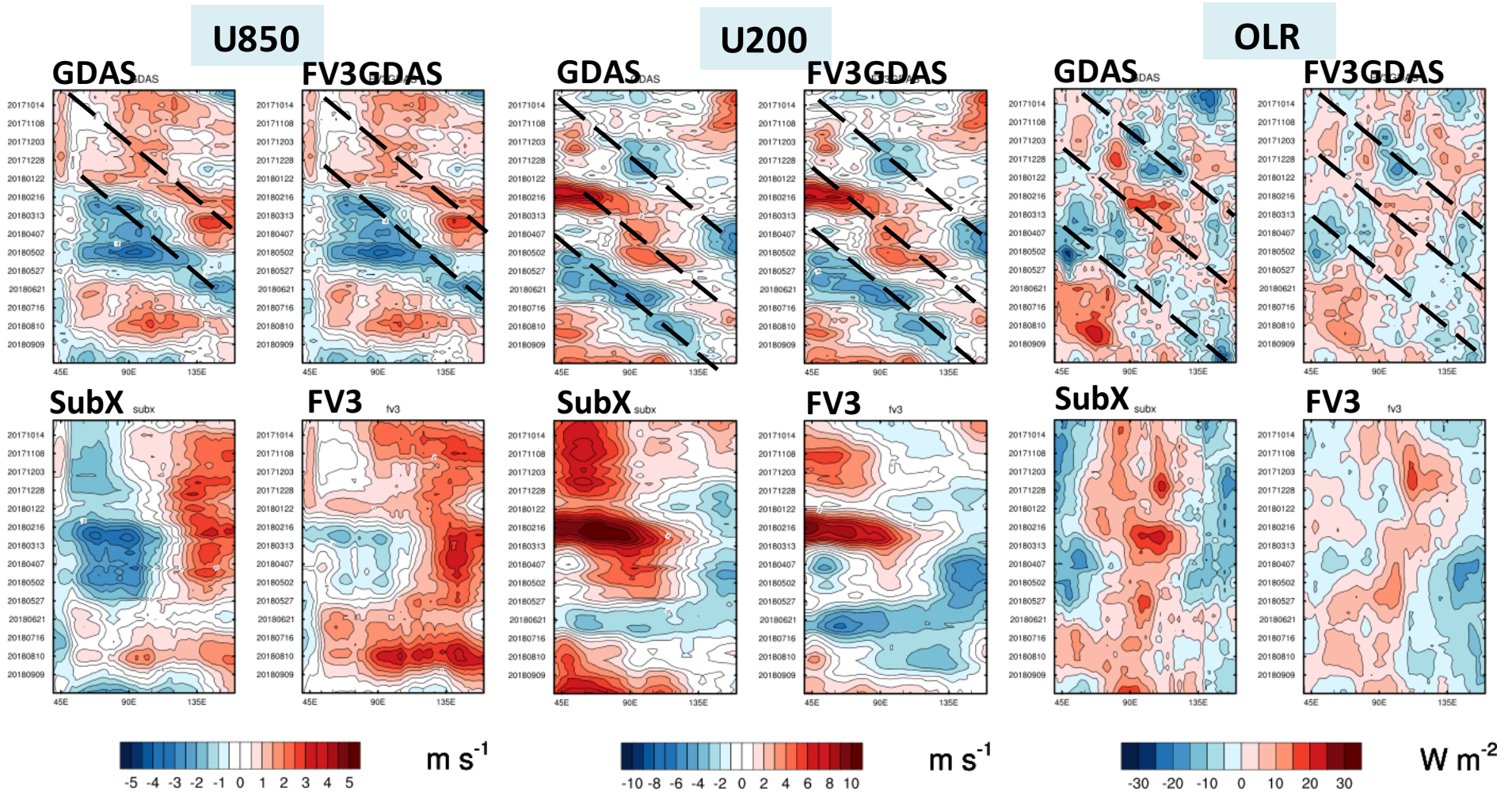
- Generally, **FV3GEFS has larger amplitude bias (too strong) than SubX**

- **FV3GEFS MJO propagates too fast at shorter lead time and then turns slower;**
- **FV3GEFS shows less phase bias for longer lead time (FV3GEFS propagates also slow but better than SubX)**

Phase Error (2017090300-2018091300)

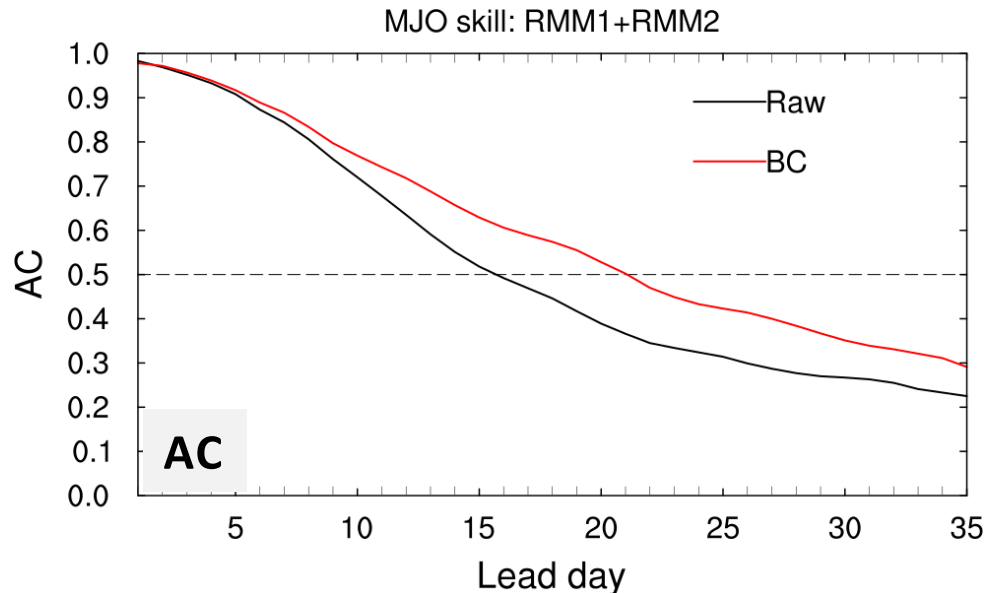


MJO propagation : lead day=16

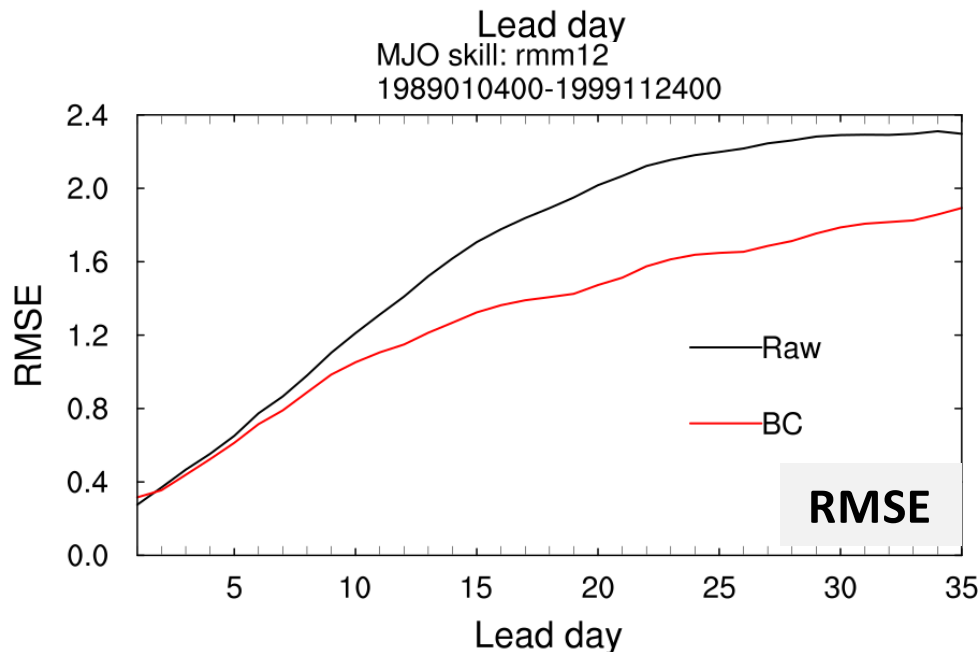


- Bias over both **Indian Ocean and West Pacific**
- Both SubX and FV3 didn't show good propagation

Bias Corrected MJO Forecast Skill (1989-1999)



Based on 11 years reforecast



Definition

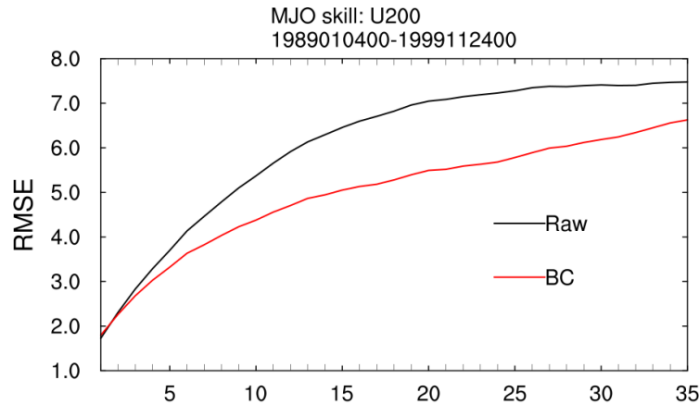
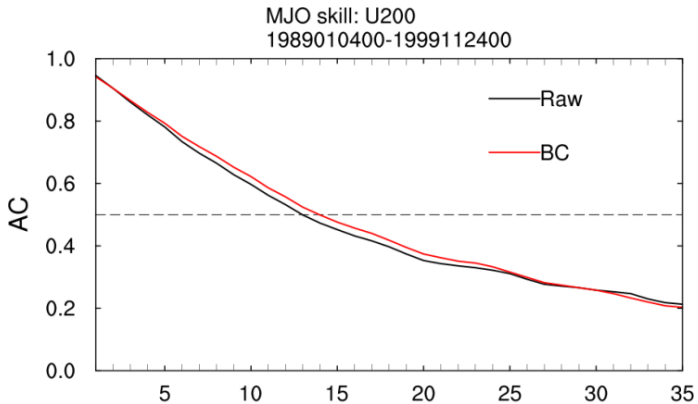
- **Raw:** Using CFSR Clim. for both CFSR analysis and Reforecast
- **BC:** Using CFSR Clim. for CFSR analysis and ensemble mean Clim. for Reforecast

Bias Corrected MJO Forecast Skill (1989-1999)

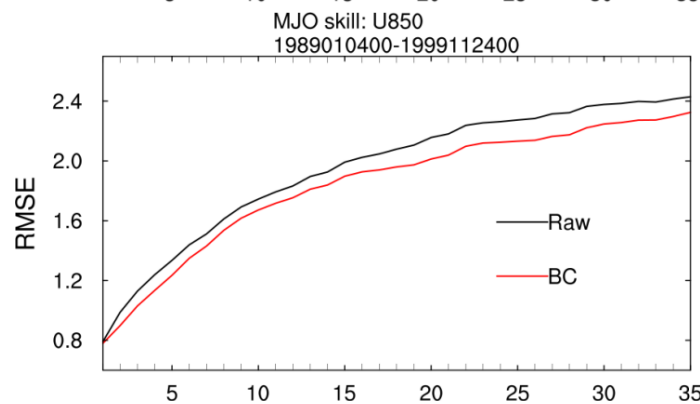
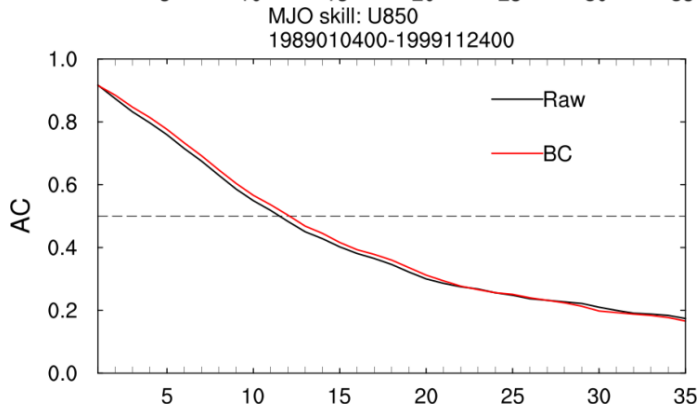
AC Skill

RMSE Skill

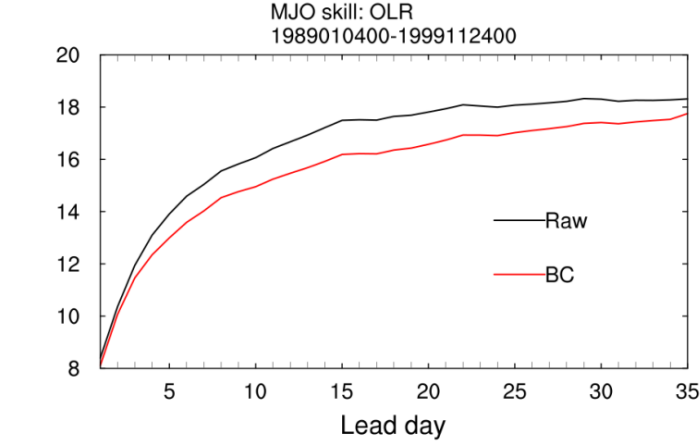
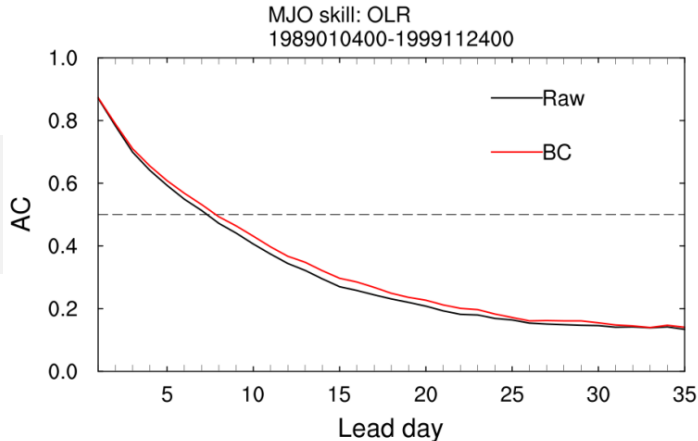
U200



U850



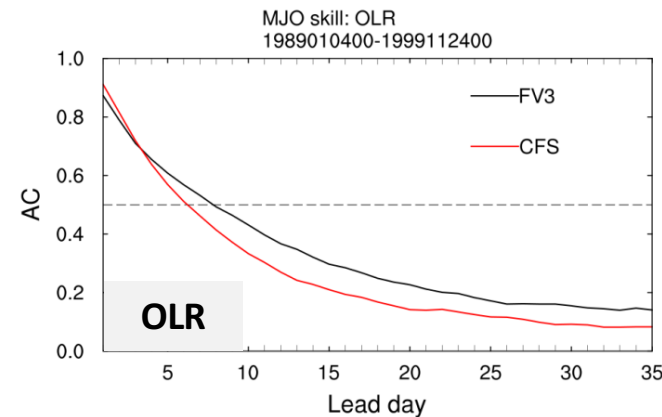
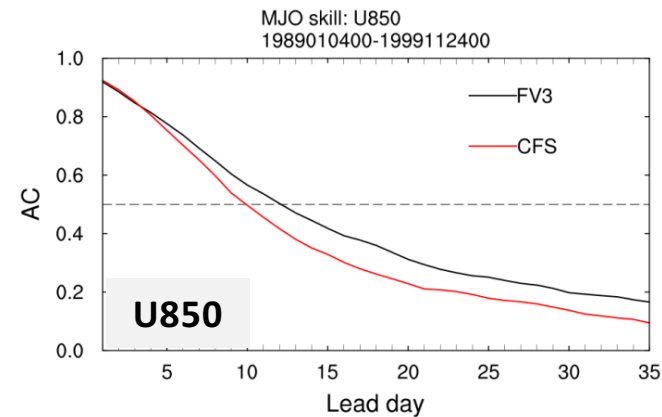
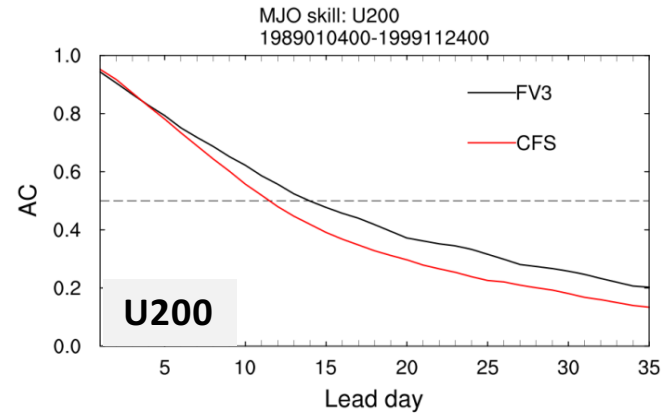
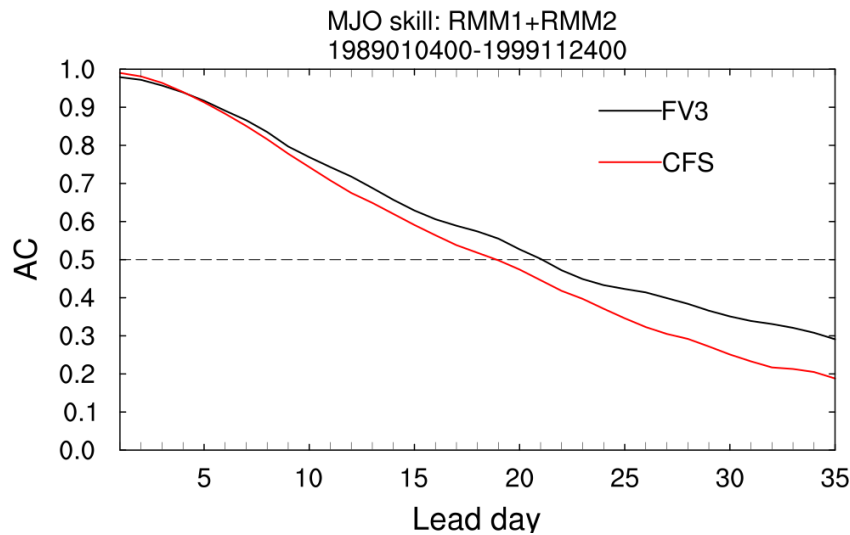
OLR



MJO (1989-1999)

FV3 GEFS vs. CFSv2

MJO RMMs ACC

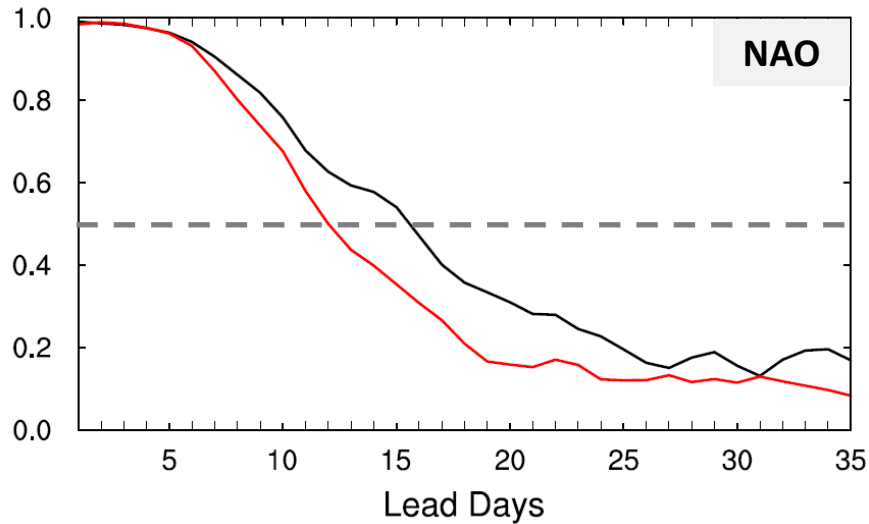


MJO Components

- For MJO RMM skill, FV3 GEFS > CFS for ~ 2 days
- For MJO components skill, FV3 GEFS > CFS

NAO & PNA (1989-1999)

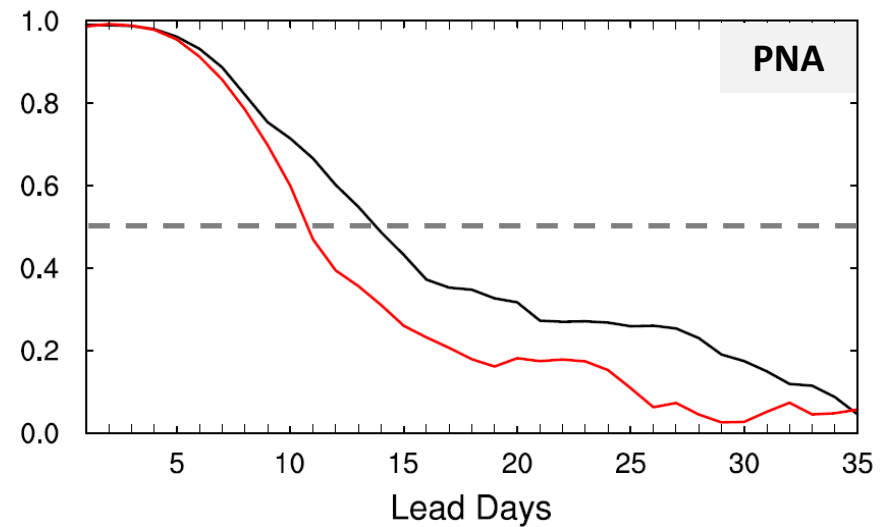
NAO ACC skill (1989_1999)



FV3 GEFS vs. CFSv2

— GEFS_FV3
— CFS

PNA ACC skill (1989_1999)



- For both NAO and PNA skill, FV3 GEFS > CFS for ~ 3 days

Summary

- **Retrospective Forecast:**
 - 3 day improvement in MJO RMM deterministic skill in FV3 compared to SubX
 - FV3 GEFS MJO amplitude is too strong, propagation forecast is better in FV3GEFS than SubX GEFS but still slow
- **Reforecast:**
 - MJO: BC skill > Raw skill for 5 days (increases from 16 days to 21 days)
 - MJO: FV3 GEFS > CFS AC skill for 2 days
 - NAO & PNA: FV3 GEFS > CFS AC skill for 3 days
- **Caveat:**
 - Due to the limit of the model data, for 1989-1999 period, FV3 GEFS uses 10 member ensemble mean, while CFS uses control member only.