



Calibration and Evaluation of GEFS Ensemble Forecasts at Weeks 2-4

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Overviews

- ◆ 1st-kind predictability ~ 2 weeks (Lorenz 1982; update?) is at the lower end of the targeted lead-time range 2-4 weeks of the NGGPS
- ◆ Growing chaotic noises or damping signals make NGGPS forecasts at 2-4 weeks more difficult
- ◆ Post-processing the NGGPS ensemble forecasts can separate long-lasting signals from noises before calibration and/or clustering





Overviews

- ◆ Selected signals in the current GEFS
 - Seasonal cycle - first removed for EOF
 - Madden-Julian Oscillation
 - Atmospheric Blocking
 - Tropical Cyclone-genesis

- ◆ EOF/PCA as primary approach for separation
 - dominant mode, no edge effect, and complete basis with limited number of modes
 - Limitations: empirical, stationary, cut-off variance



Status - Overall

- ◆ Retrieved the GEFS Reforecasts II (*Hamill et al. 2013*)
ESRL/NOAA website and HPSS/JET tapes
- ◆ References
GFS FNL and NCEP/DOE Reanalysis II
- ◆ Computed the seasonal cycle at each lead time
1st 4 harmonics of annual cycle 1985-2014
thanks to the long records from reforecasts
(not other replacements such as running mean)





Status - Overall

- ◆ Computed the anomalies at each lead time
- ◆ EOF/PCA decomposing and reconstructing retaining the first 30-90% variance
- ◆ Preliminary results to demonstrate it works
- ◆ Future work – how to refine and incorporate it into the existing packages

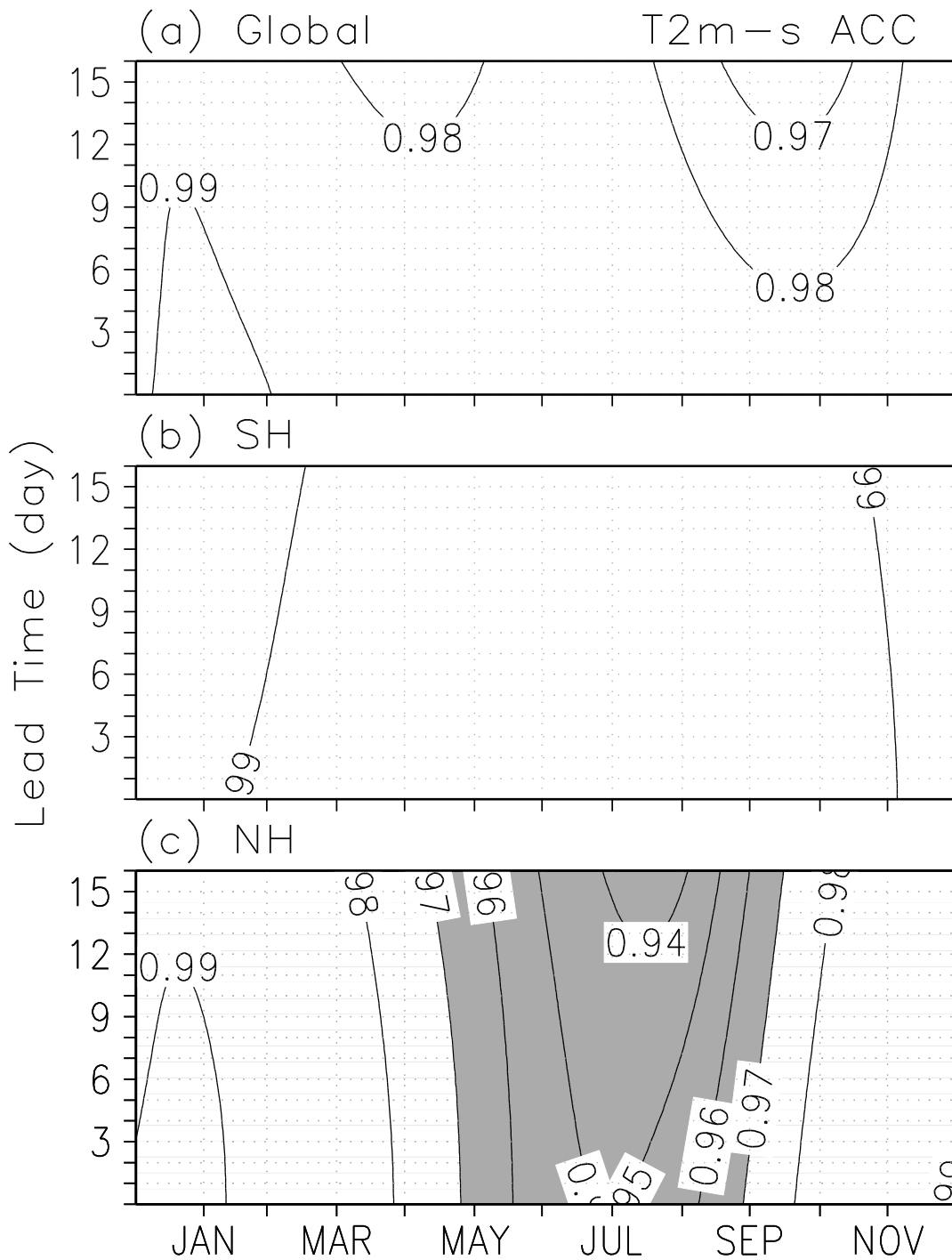


Preliminary Results

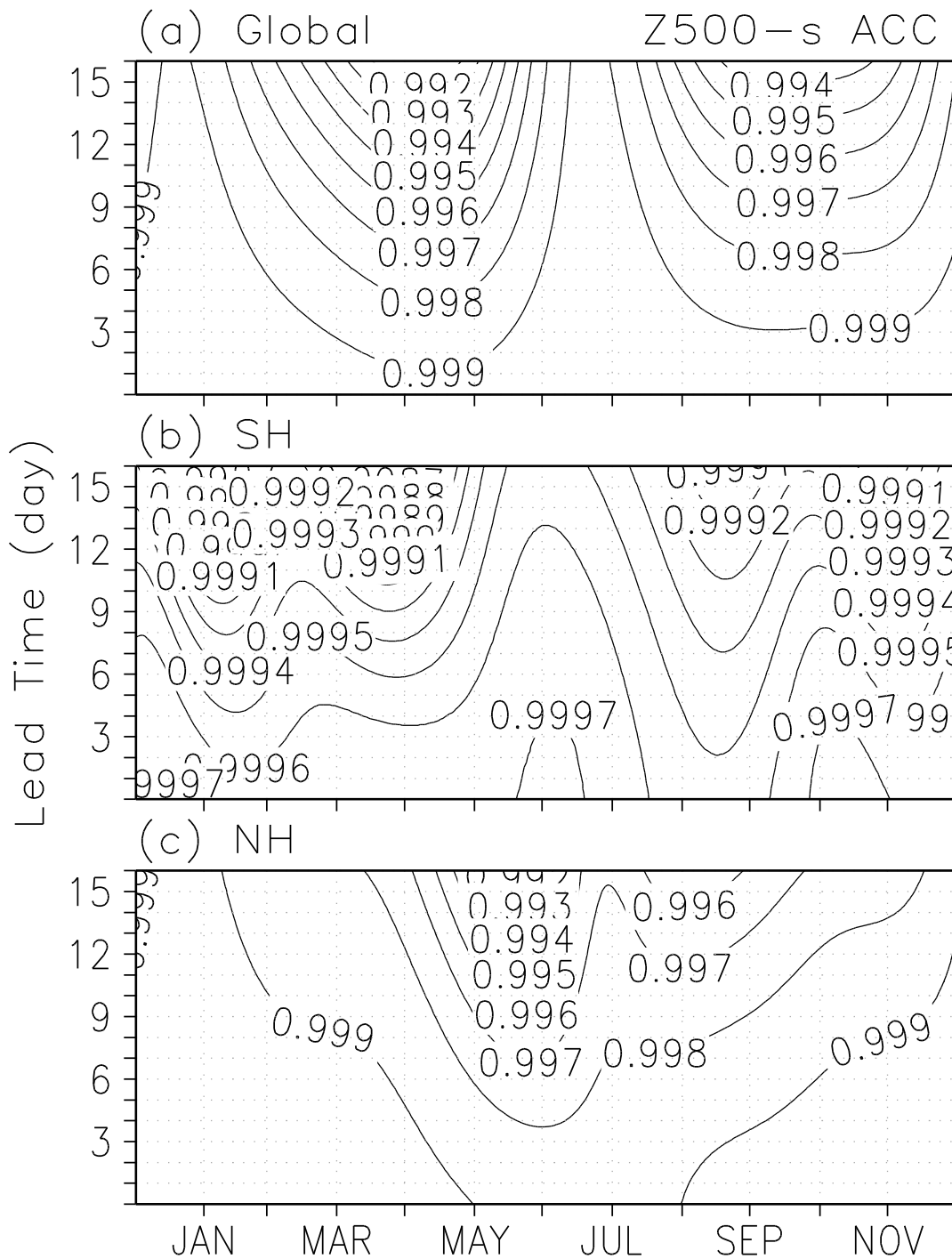
- Seasonal Cycle

Ping Liu, Yuejian Zhu, Qin Zhang, Linjong Zhou
Hong Guan, Taylor Mandelbaum

- ◆ Spatial correlation of T_{2m} , Z500 at global, NH, SH



Inconsistency



Precipitation?



Anomalies raw and EOF-R

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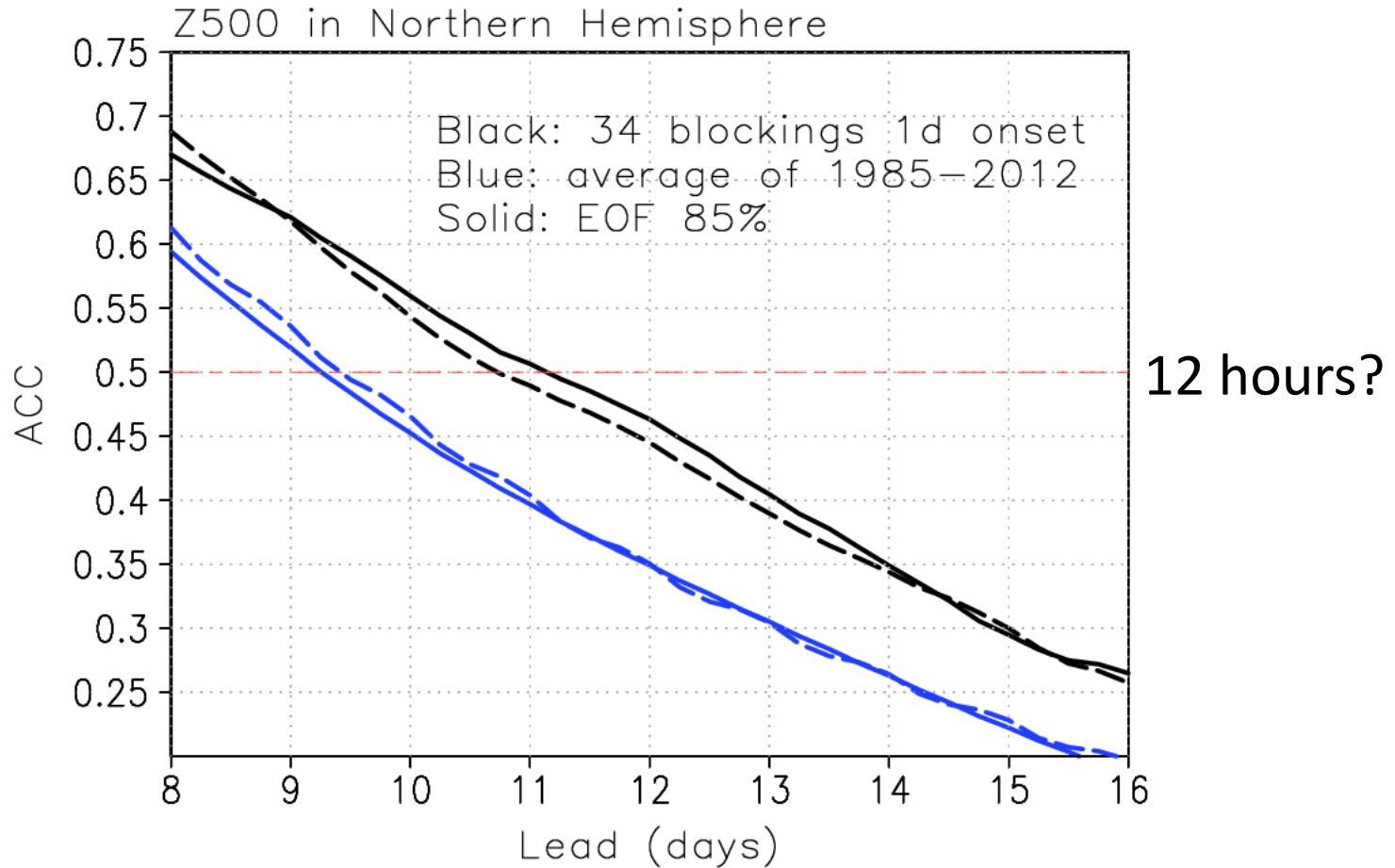
- ◆ Spatial correlation of Z500 at global, NH, SH with and without strong/long blocking episodes (*Colucci and Kelleher 2015 JAS*)



Onset	Decay	Duration	Lat	Lon
19850201	19850213	12	57.5	307.5
19851207	19851216	9	62.5	330.0
19851223	19860102	10	55.0	182.5
19860204	19860213	9	55.0	350.0
19861222	19870104	13	60.0	212.5
19880203	19880215	12	67.5	7.5
19890113	19890123	10	47.5	97.5
19891216	19891226	10	55.0	277.5
19900101	19900110	9	52.5	147.5
19900302	19900314	12	72.5	12.5
19901224	19910103	10	57.5	182.5
19911229	19920112	14	47.5	112.5
19930107	19930127	20	42.5	15.0
19940228	19940311	11	47.5	152.5
19941208	19941229	21	55.0	162.5
19950125	19950207	13	50.0	172.5
19950217	19950228	11	70.0	350.0



Onset	Decay	Duration	Lat	Lon
19950221	19950310	17	72.5	10.0
19950303	19950314	11	72.5	352.5
19951209	19951231	22	52.5	172.5
19951224	19960110	17	55.0	307.5
19960102	19960113	11	60.0	327.5
20000109	20000120	11	45.0	15.0
20001215	20010108	24	60.0	177.5
20011118	20011202	14	60.0	175.0
20011212	20011221	9	55.0	10.0
20030222	20030307	13	47.5	25.0
20050112	20050122	10	40.0	32.5
20050217	20050301	12	45.0	230.0
20071216	20071226	10	52.5	5.0
20080114	20080125	11	47.5	37.5
20101129	20101212	13	60.0	22.5
20101219	20101228	9	70.0	15.0
20110115	20110125	10	57.5	170.0



34 long blockings: Table A1 in *Colucci and Kelleher (2015 JAS)*; PV at 250 hPa surface



Blocking

Ping Liu, Linjiong Zhou, Malaquias Pena Mendez, Yuejan Zhu, Qin Zhang, Raymond Sukhdeo

- ◆ Z500-based index (*Tibaldi and Molteni 1990; Barns et al. 2012; Hamill and Kiladis 2014 for GEFS*)

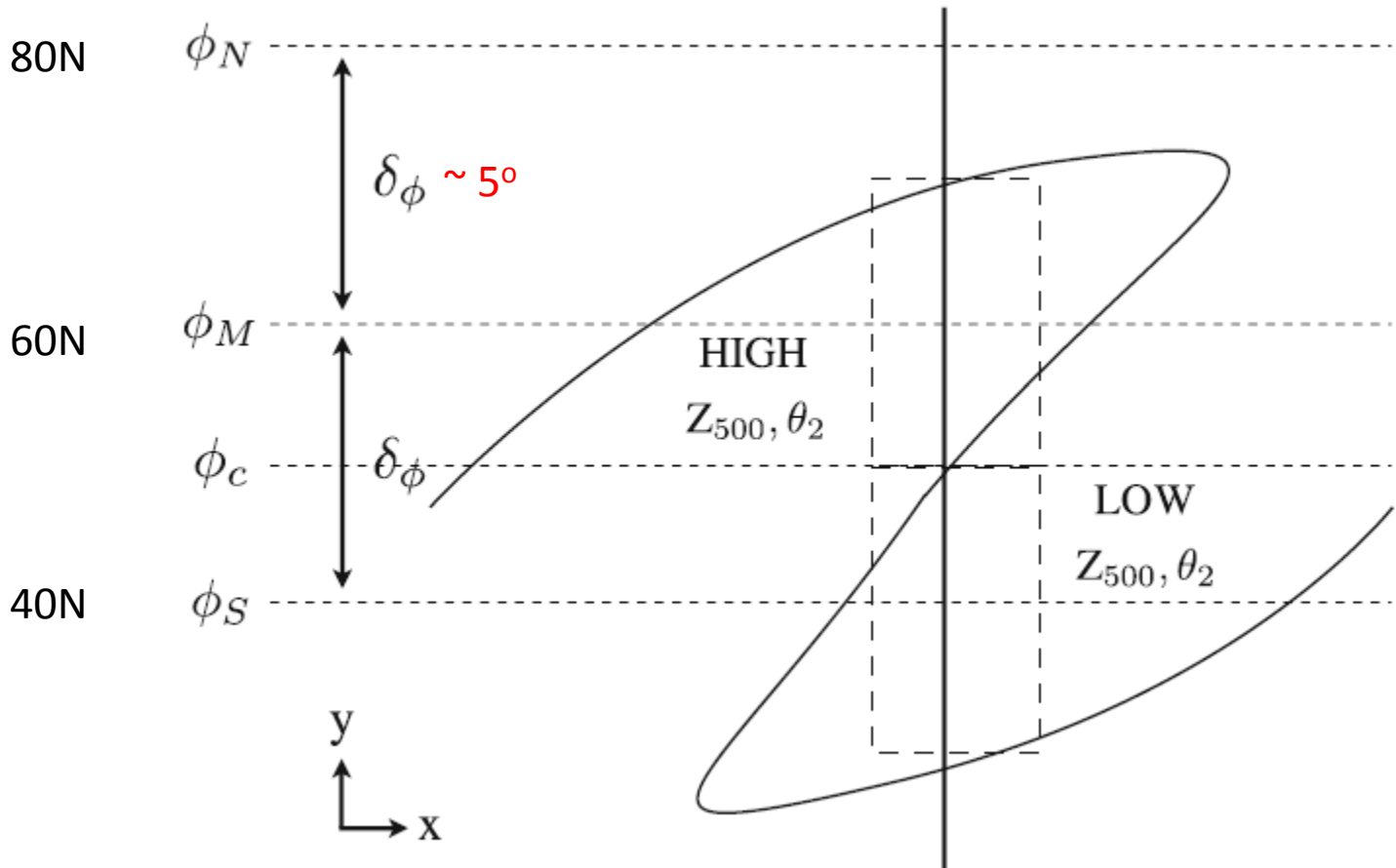
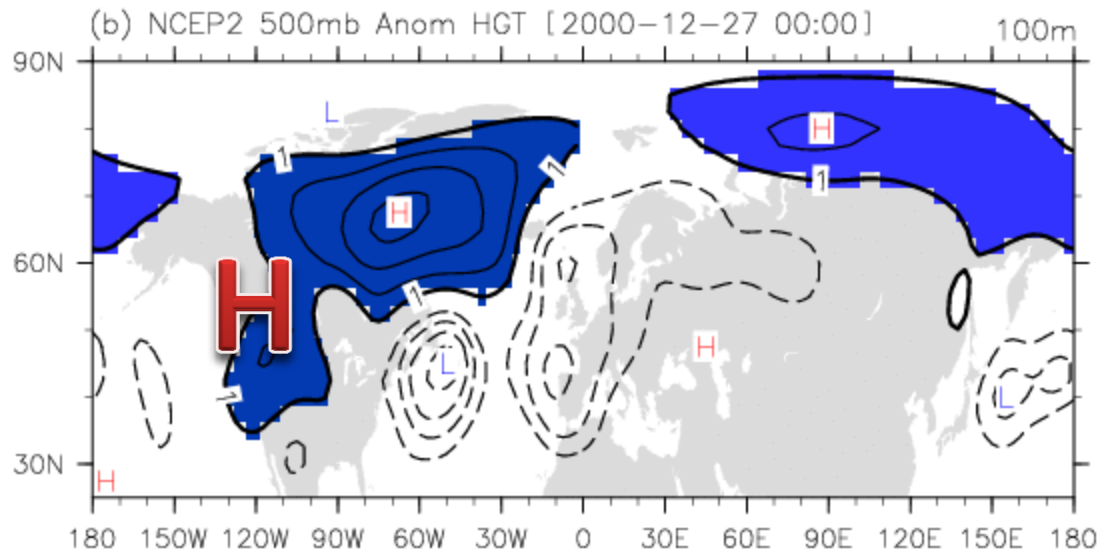
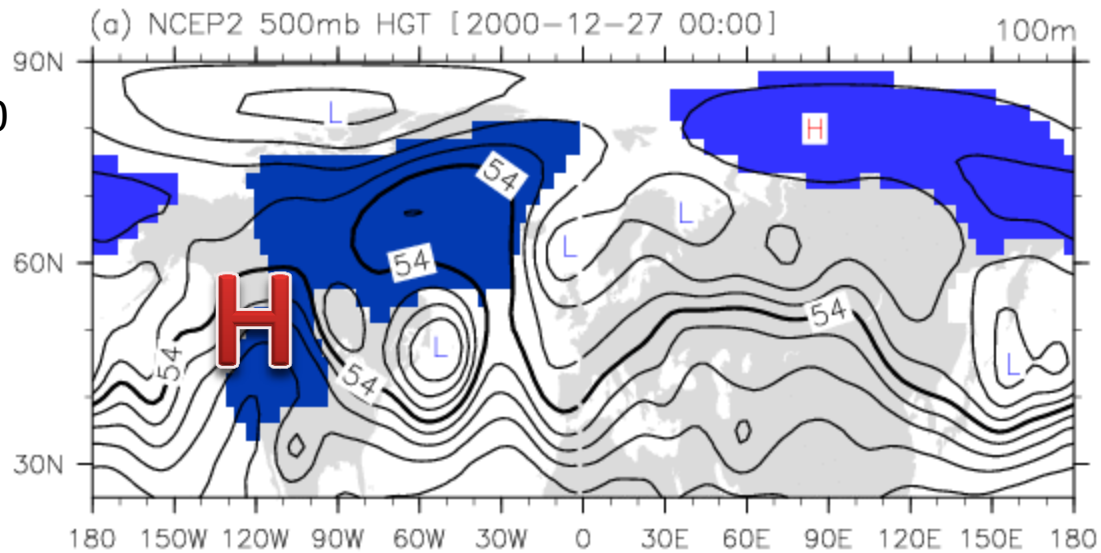


Fig. 2 A simple schematic showing the different latitudes used to define a blocking anticyclone with the 500 mb geopotential height field and the potential temperature field on the PV-2 Surface. (Barns et al. 2012 *Clim. Dyn.*)



Charney et al. 1980
-- Z500 anomalies



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Is a blocking always closed after seasonal cycle is removed?



Blocking

Ping Liu, Linjiong Zhou, Malaquias Pena Mendez, Yuejan Zhu, Qin Zhang, Raymond Sukhdeo

- ◆ Object tracking blocking episodes (*Liu et al., in preparation, O2R*)
Simplify identification of Omega, Rex, cutoff, ring of fire, split flow
Gravity center, intensity, impacting area
onset, duration, and decay



MJO

Qin Zhang, Malaquias Pena Mendez, Ping Liu, Yuejian Zhu, Breanna Zavadoff, Taylor Mandelbaum

- ◆ RMM framework (*Wheeler and Hendon 2004; Lin et al. 2008*)

First two CEOF modes of OLR, U850, U200

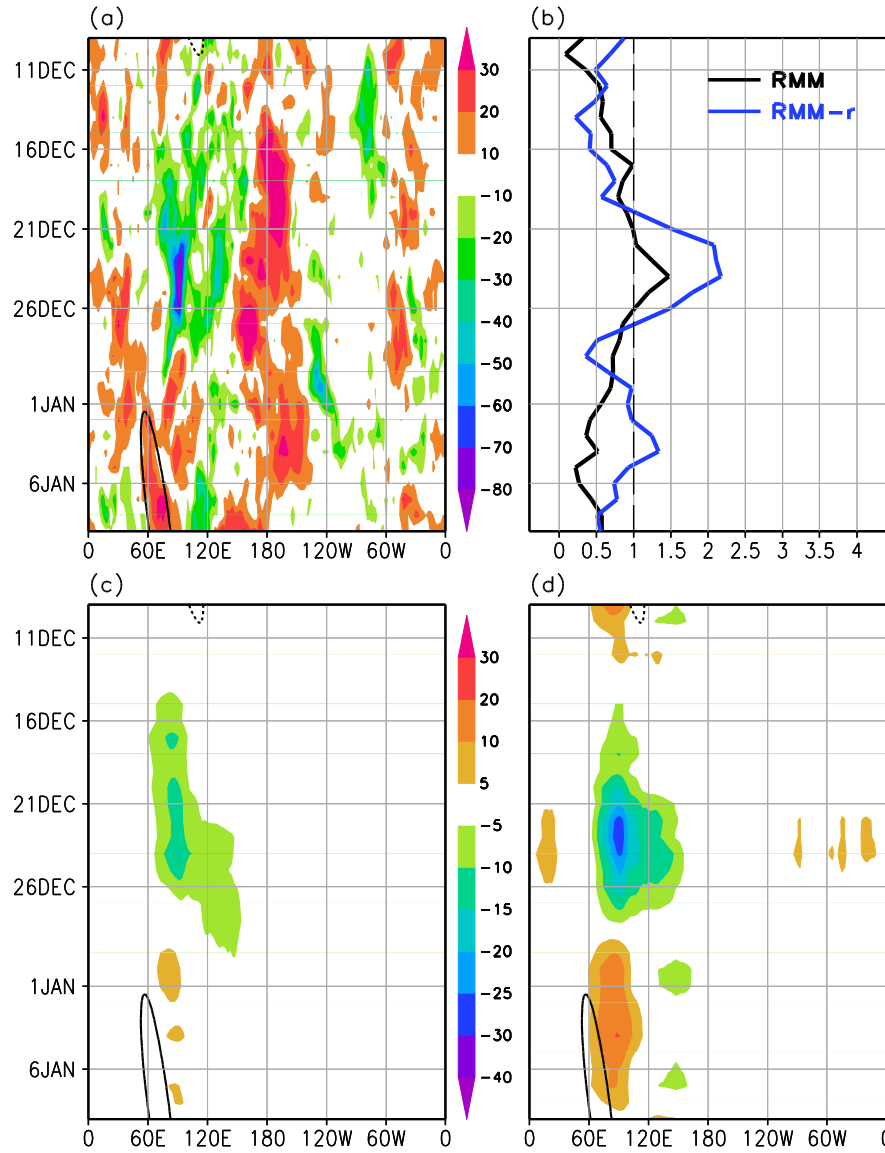
OLR is minor in RMM-E while balanced in RMM-r

A revised Real-time Multivariate MJO index (Liu et al., submitted to Mon. Wea. Rev.) **O2R**



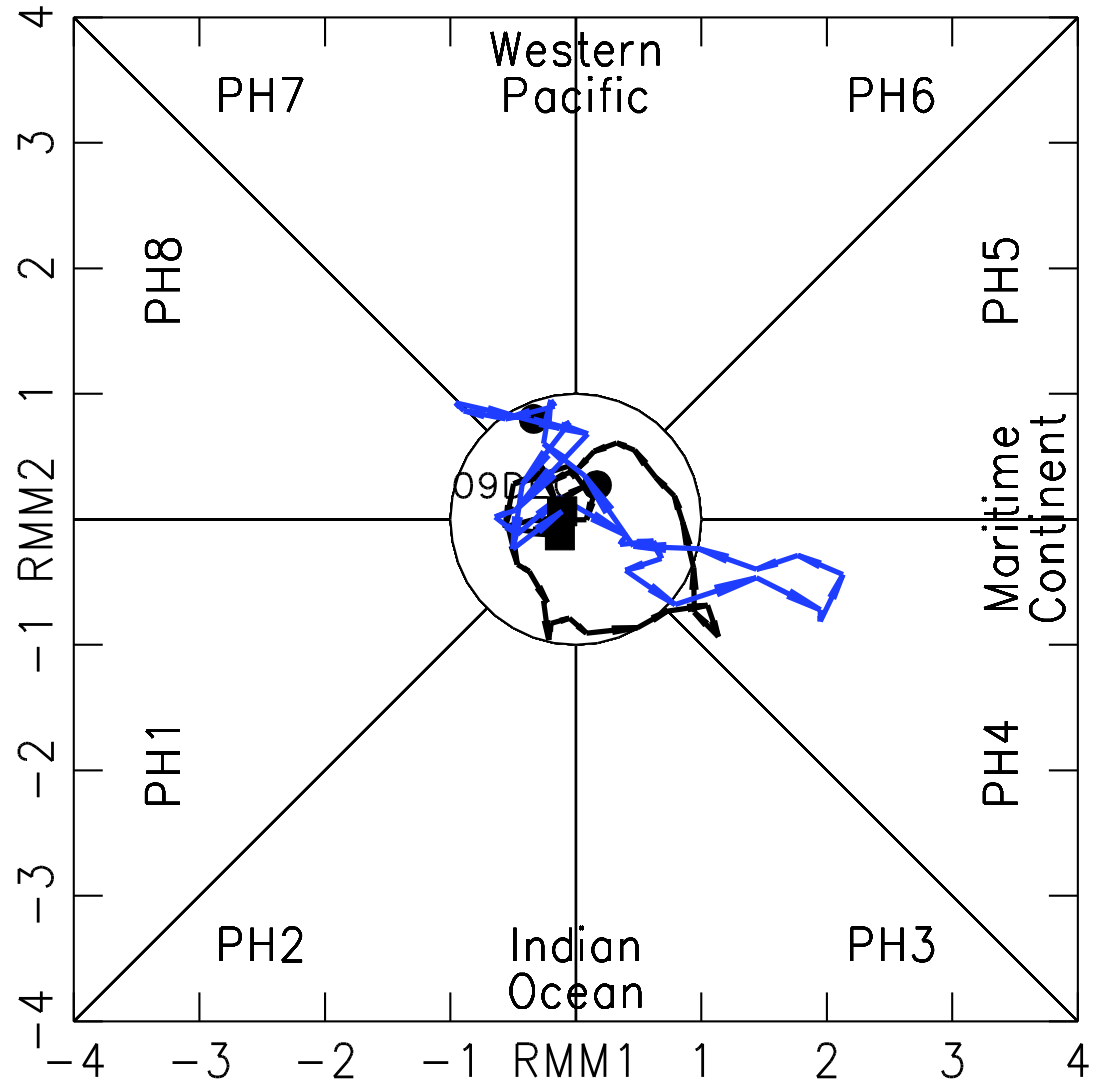


Arguable DYNAMO MJO case





Arguable DYNAMO
MJO case





MJO

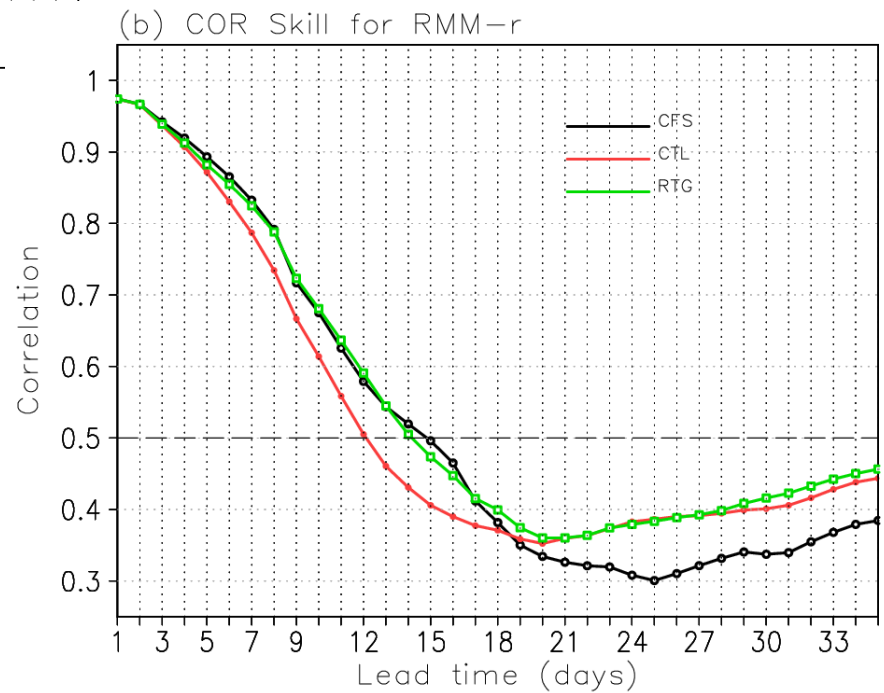
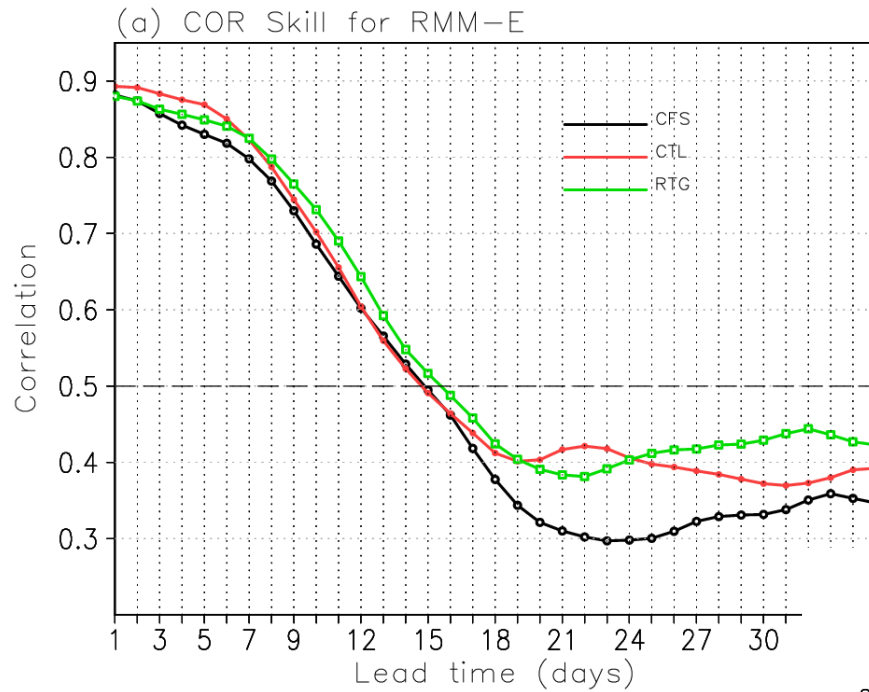
11 - ensemble member, N - number of forecasts
 a - analysis, f - forecast, τ - lead time

$$\text{COR}(\tau) = \frac{\sum_{j=1}^{11} \sum_{i=1}^N [\text{RMM1}_i^a \text{RMM1}_{ij}^f + \text{RMM2}_i^a \text{RMM2}_{ij}^f]}{\sqrt{\sum_{j=1}^{11} \sum_{i=1}^N [\text{RMM1}_i^{a2} + \text{RMM2}_i^{a2}]}} \sqrt{\sum_{j=1}^{11} \sum_{i=1}^N [\text{RMM1}_{ij}^{f2} + \text{RMM2}_{ij}^{f2}]} \quad (1)$$

$$\text{RMSE}(\tau) = \sqrt{\frac{1}{N \times 11} \sum_{j=1}^{11} \sum_{i=1}^N \{[\text{RMM1}_i^a - \text{RMM1}_{ij}^f]^2 + [\text{RMM2}_i^a - \text{RMM2}_{ij}^f]^2\}}, \quad (2)$$

(Hamill and Kiladis 2014)





After EOF reconstruction?





Tropical cyclone genesis

Jiayi Peng, Yuejian Zhu, Breanna Zavadoff, Ping Liu



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Algorithms for TC genesis probabilistic forecast



How to define global model TC genesis?

The prediction vortices in Global Ensemble Forecast Systems are very weak. (25kts ?)

Step No.1: (for GEFS, ECMWF, CMC, FNMOC ensembles)

We track every vortex by checking:

- 1)850/700hPa/surface relative vorticity (max)
- 2)850/700hPa geopotential height (min)
- 3)Sea level pressure (min)
- 4)850/700hPa/surface wind speed (min)
- 5)SLP gradient (0.0015mb/km), Wind speed at 850hPa ($\geq 1.5\text{m/s}$)
- 6)Closed SLP contour checked

Step No.2: (for GEFS and ECMWF ensemble)

We filter those vortices based on the following criteria:

- 1)Surface maximum wind speed $\geq 10\text{kts}$
- 2)850hPa maximum vorticity $\geq 10^{**(-4)} 1/\text{s}$
- 3)300-500hPa temperature anomaly $\geq 0.5\text{c}$





Tropical cyclone genesis

Jiayi Peng, Yuejian Zhu, Breanna Zavadoff, Ping Liu

- ◆ To reduce false alarm rate in the GEFS, we are testing Relaxed screening thresholds (*Halperin et al. 2013*) for the GEFS
 - $MSLP_{min}$ with at least one closed isobar
 - 850-hPa ζ_{max} within $2.5^\circ \times 2.5^\circ$ of $MSLP_{min}$
 - maximum $Z_{250-850}$ within 2° of the $MSLP_{min}$
 - $|V|_{925} \geq |V|_c$ within 5° of the $MSLP_{min}$
 - The above criteria hold for at least 24 hours

- ◆ Object tracking (similar to the package for tracking blocking)





Future Directions

- ◆ Calibrate the seasonal cycle and EOF modes
- ◆ Extend the analyses to each ensemble member
- ◆ Evaluations – packages from the GEFS group and CPC
- ◆ Tracking and calibrating the blocking, TC genesis
- ◆ Data sharing
- ◆ Incorporate it into the existing packages and for NGGPS

