Separate Signals from Noises in the GEFS Reforecasts II Using Principal Component Analysis

Ping Liu, Stony Brook University
Yuejian Zhu, EMC/NCEP/NOAA
Qin Zhang, CPC/NCEP/NOAA

Post-processing Workshop, NCEP, January 20, 2016

1

Motivations

Week-2 and longer predictions reach and exceed the 1st-type predictability limit determined by well developed initial errors that would shadow signals in the raw model output.

Conventional bias correction and calibration approaches generally do not separate signals and noises, which would less sufficiently take advantage of the signals to improve prediction skill at week 2-4.

Motivations

We are testing whether the principal component analysis (PCA) is effective to separate the persistent signals from the noises before calibration and thus to potentially extend the predictability.

Below are some preliminary results using ≥ 10 days blocking episodes at Z500 as signals.
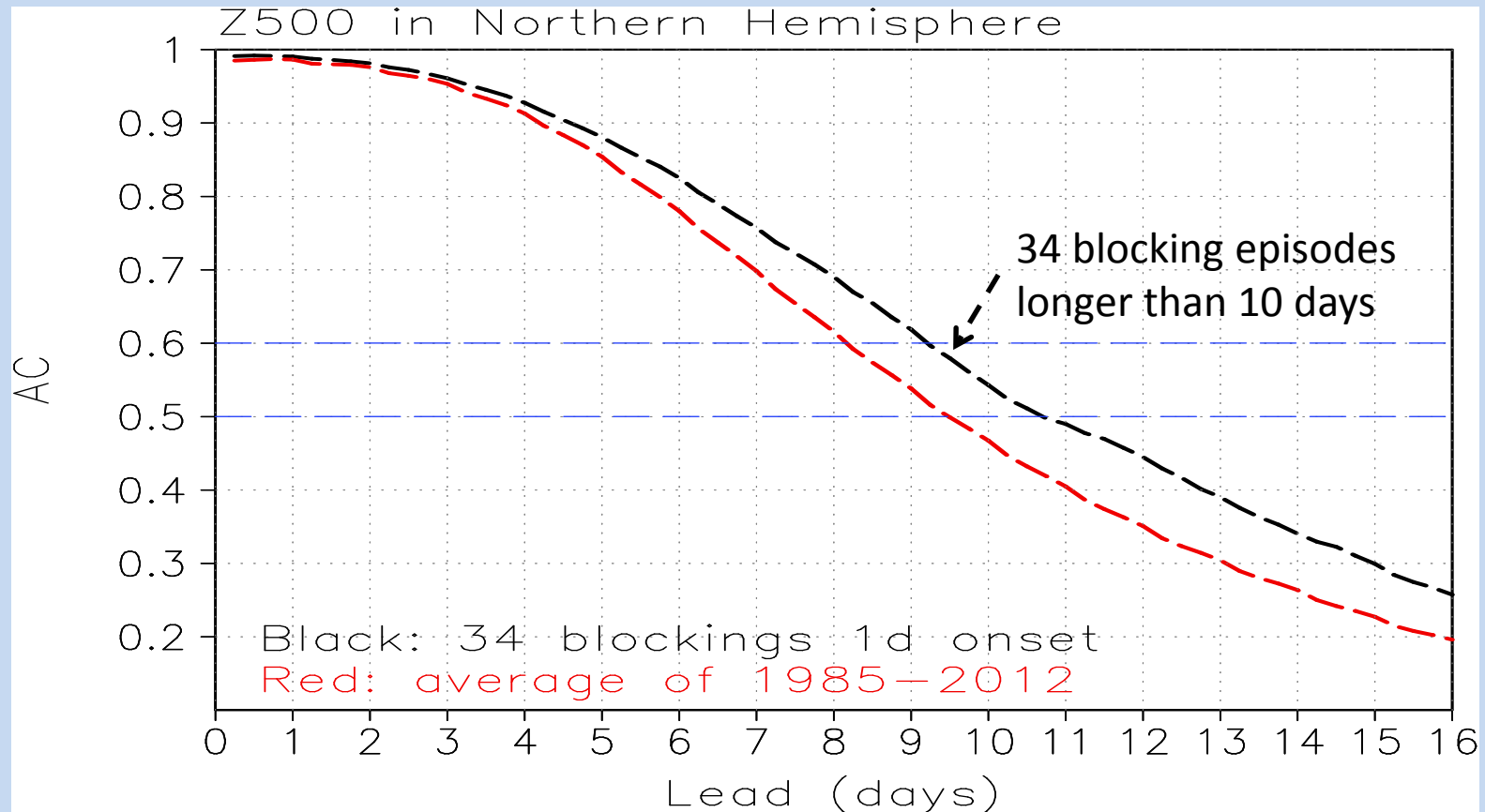
3

Data and Methodology

GEFS Reforecasts II (Hamill et al. 2013): 1985-2015, 16-day lead, 1°×1°, 6-hrly. Z500 at 20°~80°N, model climatology (LTM and first 3 modes of the annual cycle) removed; PCA leading modes at 50%, 60%, 75%, and 85% explained variance

NCEP-NCAR Reanalysis: interpolated to 1°×1°

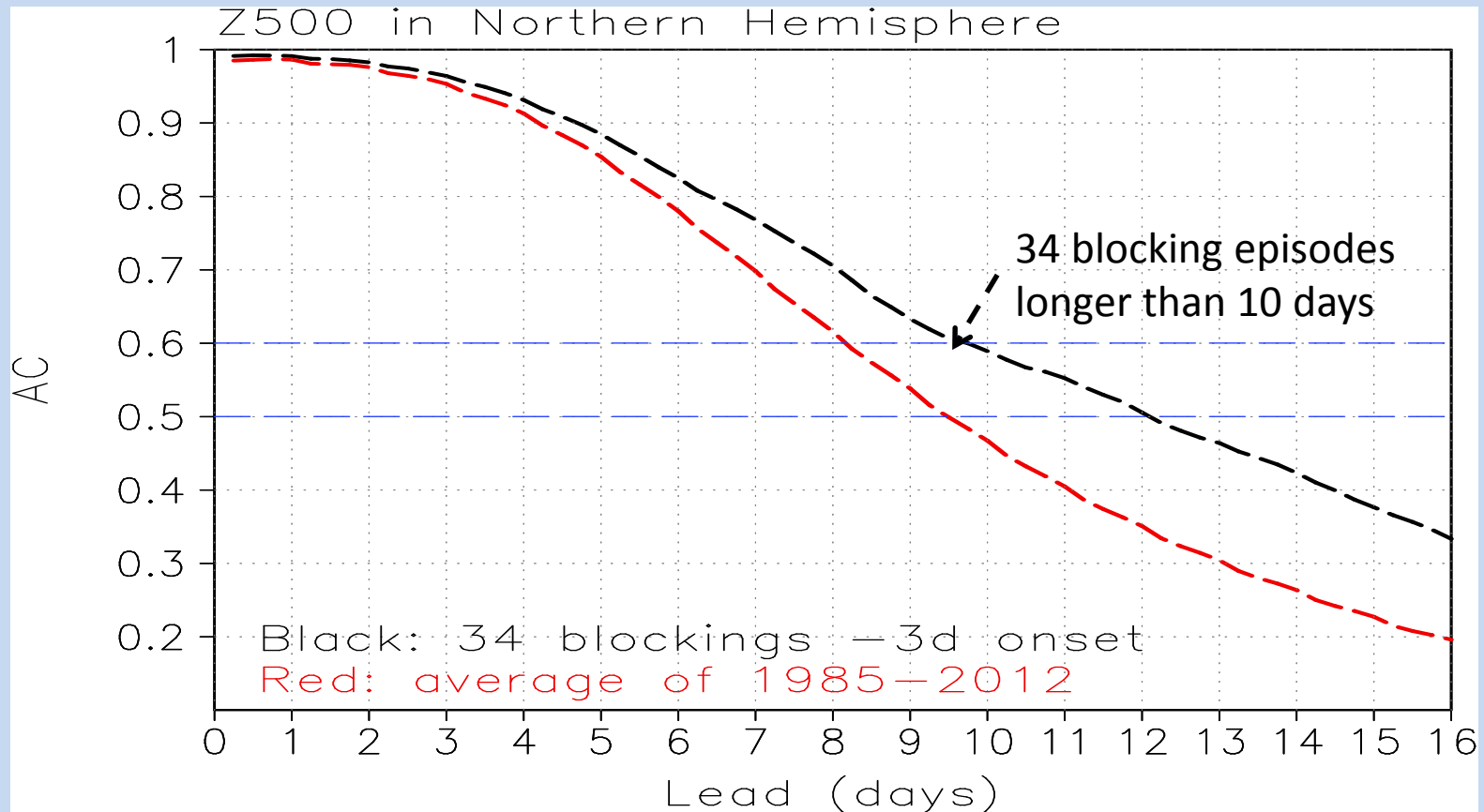Signals: blocking episodes $\geq$ 10 days, 34 in total (Colucci and Kelleher 2015; their Table a1)

Blockings Extend Predictability
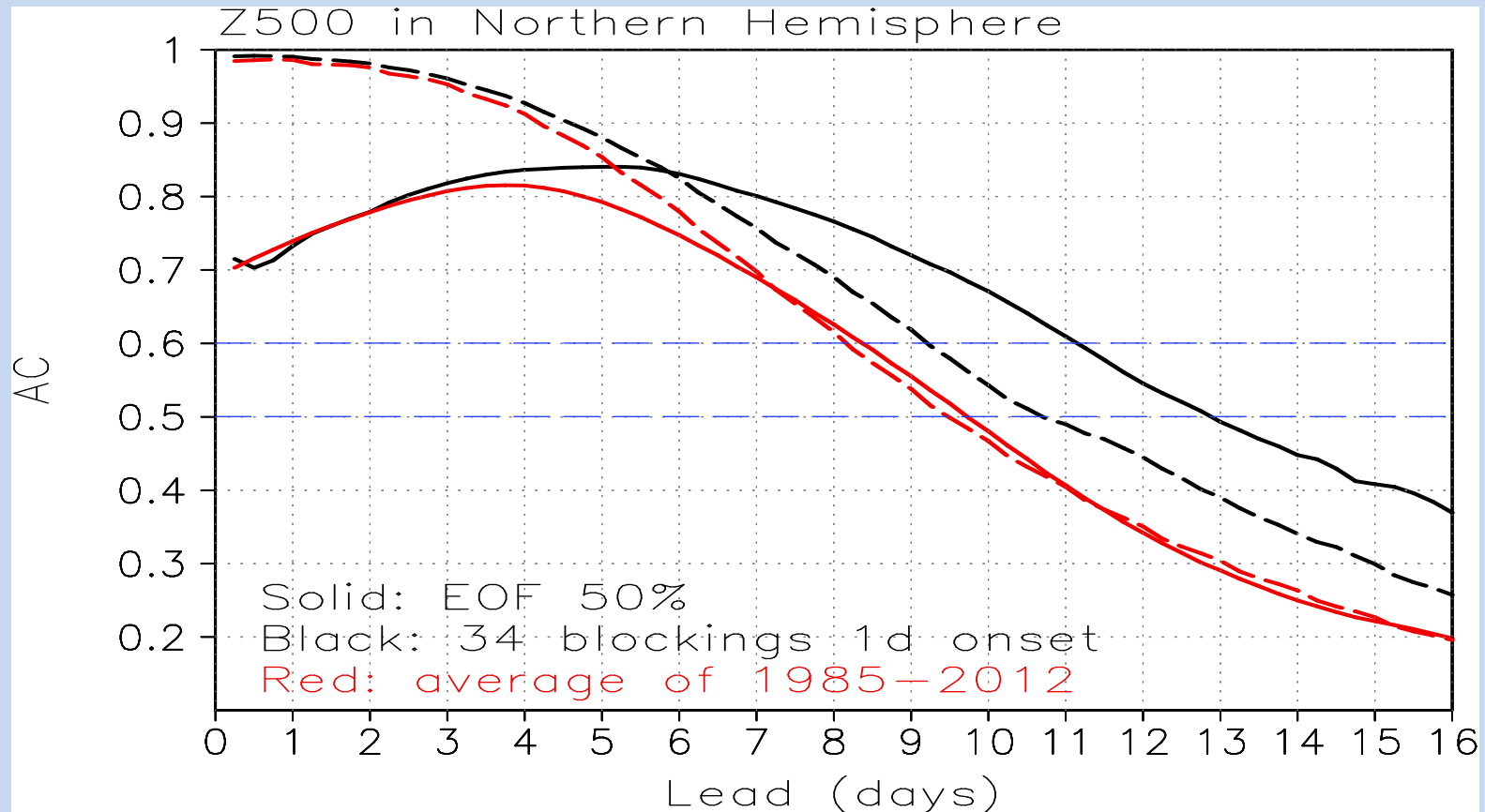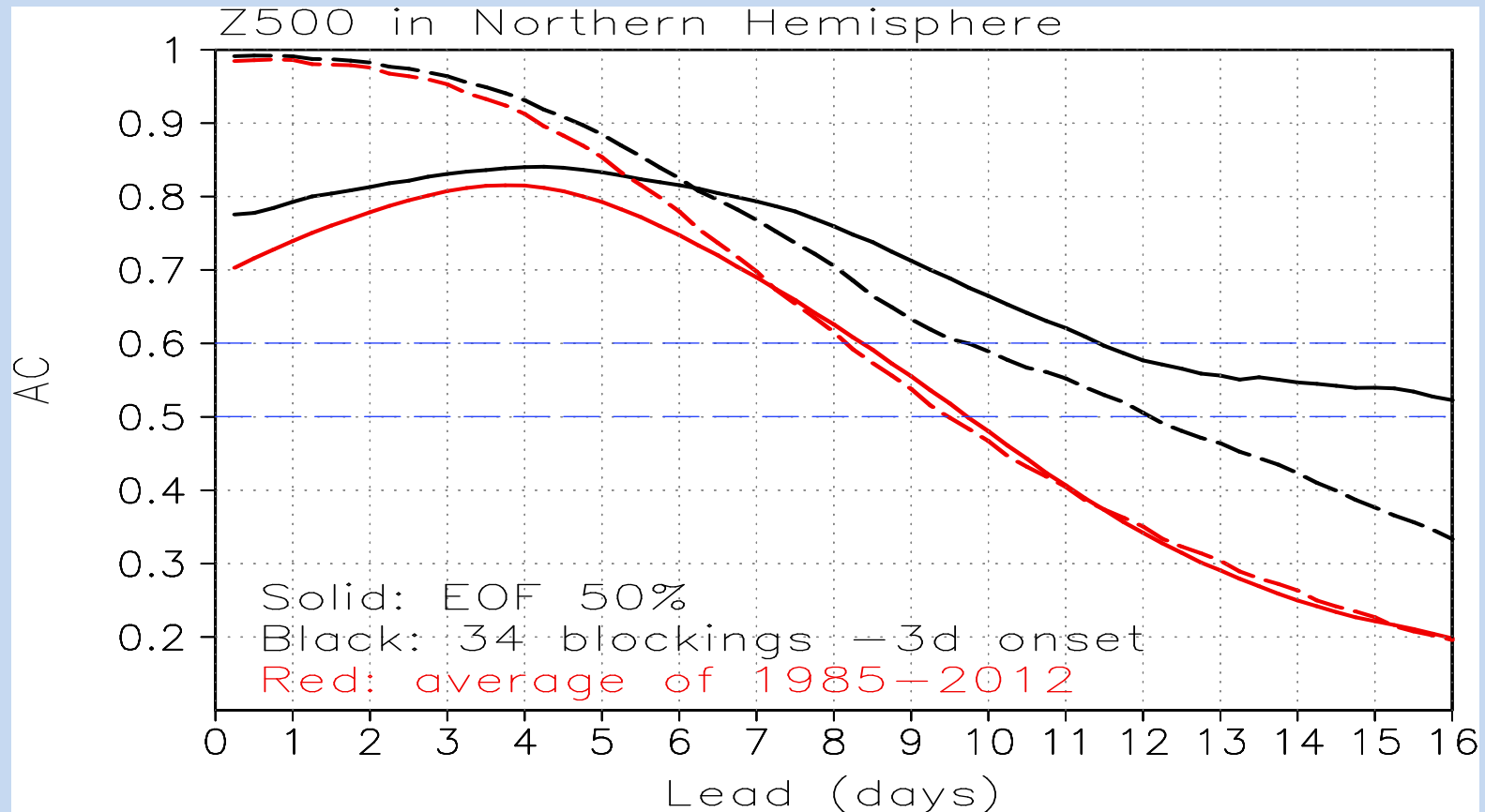## -- AC skill above 0.5 (raw model anomalies)

Z500 in Northern Hemisphere

34 blocking episodes longer than 10 days

Black: 34 blockings 1d onset
Red: average of 1985-2012

AC

Lead (days)

Blockings Extend Predictability
-- AC skill above 0.5 (raw model anomalies)

Z500 in Northern Hemisphere

34 blocking episodes longer than 10 days

Black: 34 blockings -3d onset
Red: average of 1985-2012

AC (y-axis), Lead (days) (x-axis)

PCA Leading Modes Further Extend the Predictability – retained 50% variance

Z500 in Northern Hemisphere

Solid: EOF 50%
Black: 34 blockings 1d onset
Red: average of 1985−2012

Y-axis: AC
X-axis: Lead (days)

PCA Leading Modes Further Extend the Predictability – retained 50% variance, -3d

Z500 in Northern Hemisphere

Solid: EOF 50%
Black: 34 blockings -3d onset
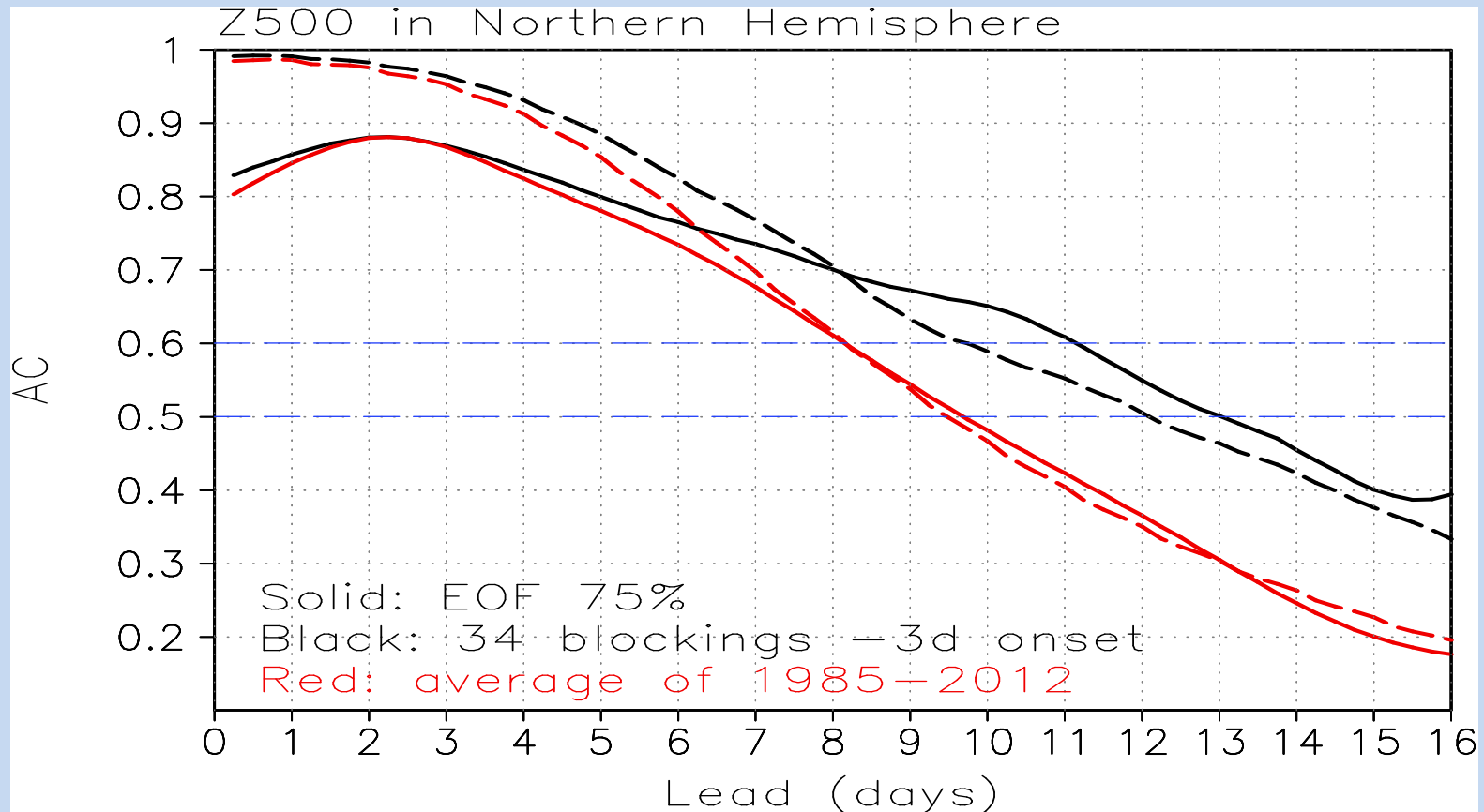Red: average of 1985-2012

AC

Lead (days)

8

Sensitivity to the Retained Variance
-- 60% - smaller gain than 50%
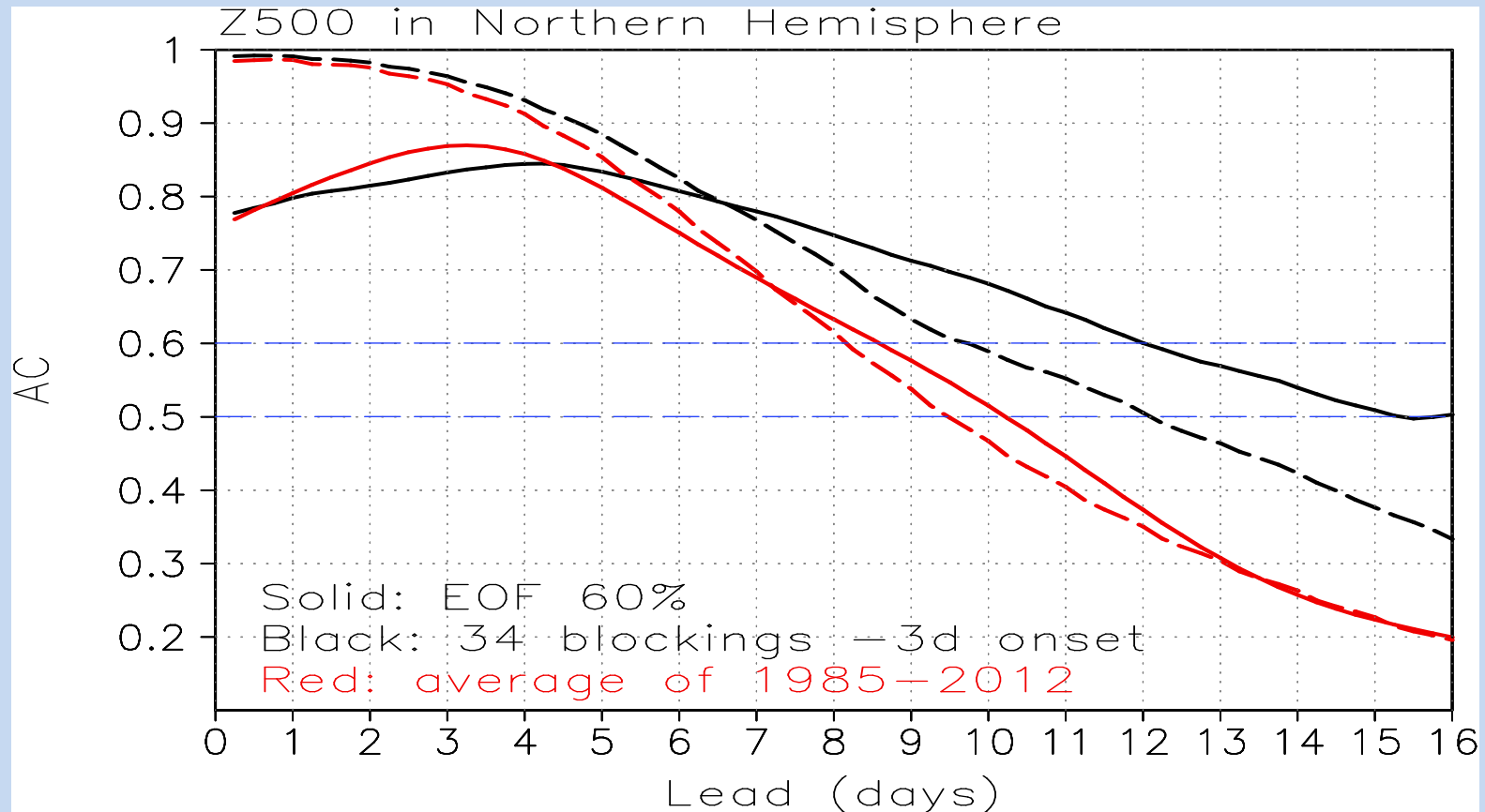
Sensitivity to the Retained Variance
-- 75% - even smaller gain

Z500 in Northern Hemisphere

Solid: EOF 75%
Black: 34 blockings -3d onset
Red: average of 1985-2012

Sensitivity to the Retained Variance
-- 85%, virtually no gain
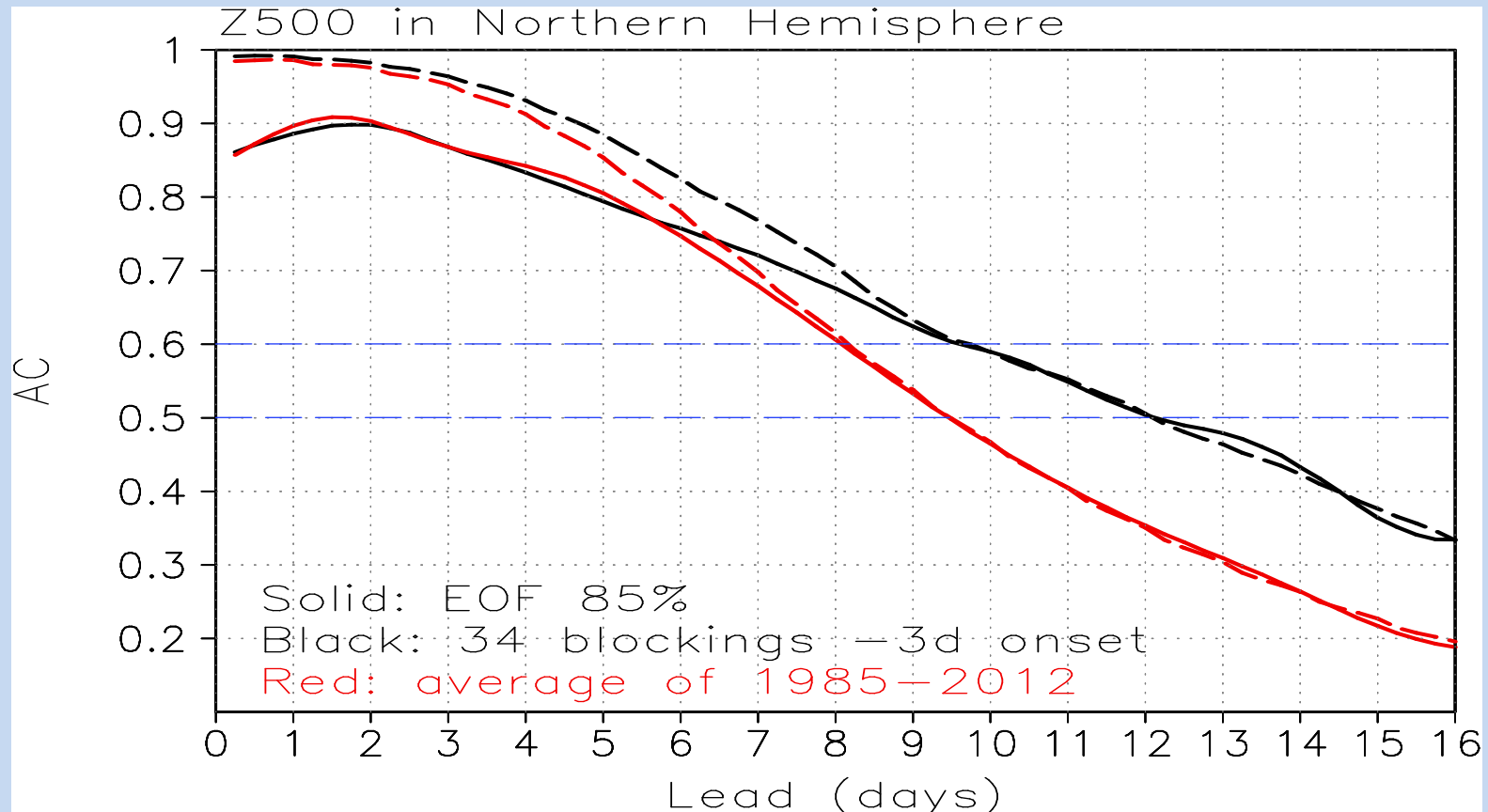
Conclusions

PCA is capable of separating signals from noises and thus potentially extend prediction skill of the GEFS at week 2-4.

50-60% retained PCAs appear ideal.

Ongoing

How the PCA would improve the predictions of MJO, blocking, and TC genesis.

For Round-2 R2O NGGPS:

How the PCA would improve BSS and RPSS, reliability and sharpness in precipitation and T_{2m} over the CONUS.