# A Southern Hemisphere Footprint in the American Midwest

Cécile Penland *and* Luda Matrosova

*NOAA/ESRL/Physical Sciences Division*

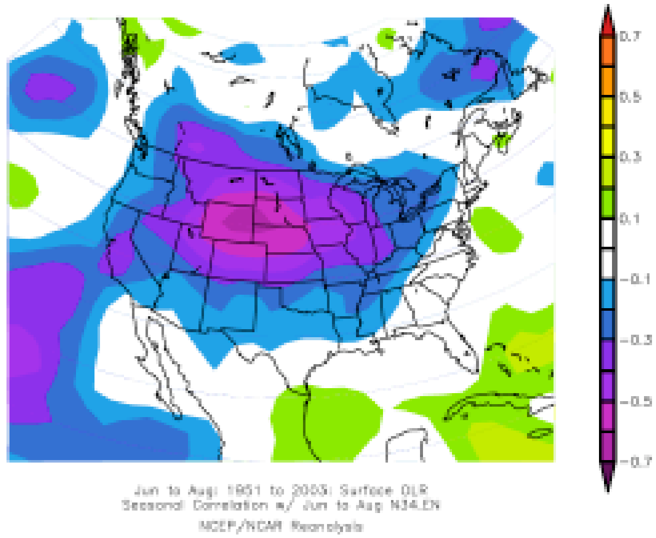



Fig. 1: Contemporaneous correlation between Niño3.4 SST anomaly and JJA OLR.

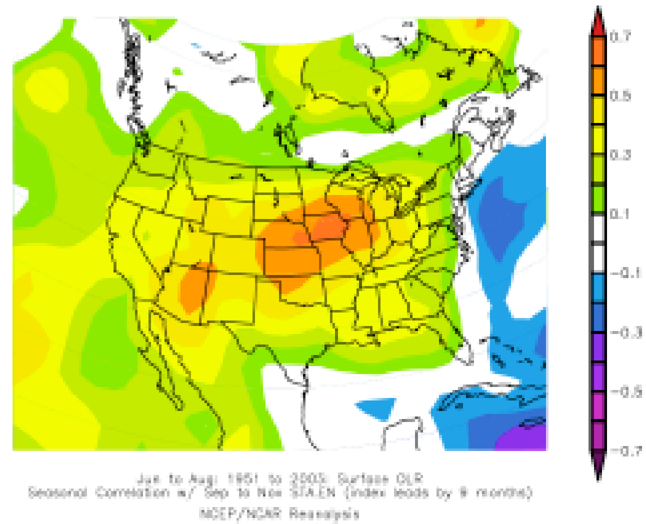



Fig. 2: Correlation between JJA OLR and El Niño signal in STA SSTA. STA SSTA leads by 9 months.

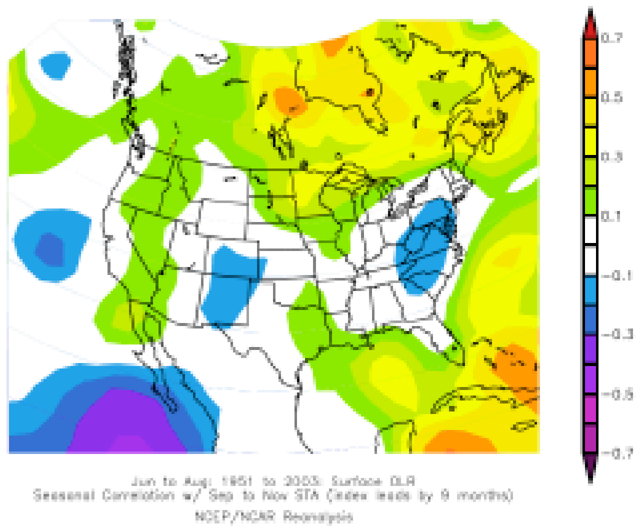



Fig. 3: Correlation between JJA OLR and unfiltered STA SST anomaly. STA SSTA leads by 9 months.

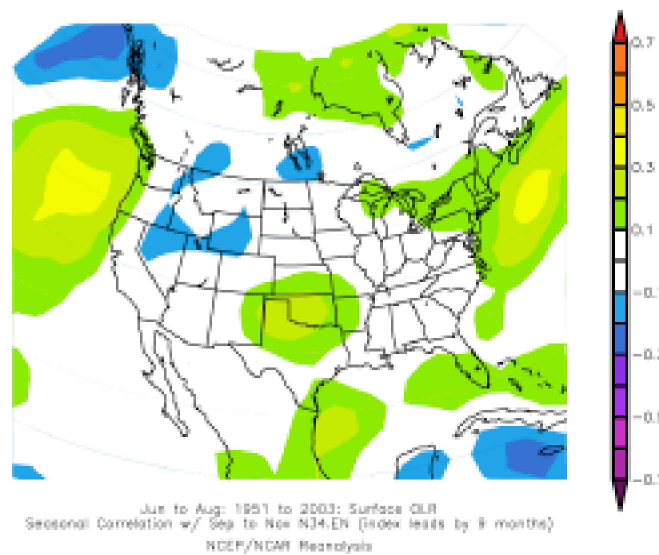



Fig. 4 Correlation between JJA OLR and Niño 3.4 SST anomaly. Niño 3.4 SSTA leads by 9 months.

# The non-normal filter is based on linear inverse modeling:

$d\boldsymbol{T}/dt = \mathsf{B}\boldsymbol{T} + \xi$, with $< \xi(t+\tau)\, \xi^{T}(t) > = \mathsf{Q}(t)\delta(\tau)$

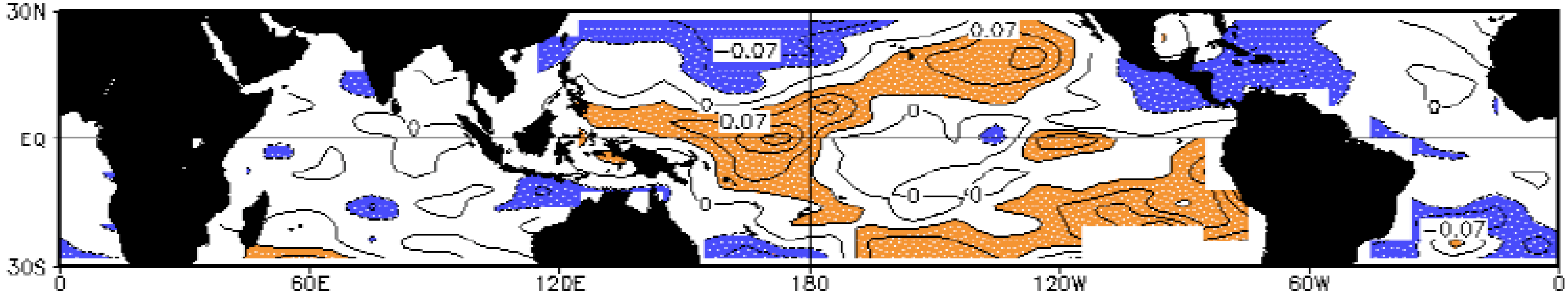
Best prediction at time $t+\tau$ given $\boldsymbol{T}(t)$ is $\mathsf{G}(\tau)\, \boldsymbol{T}(t)$,

where $\mathsf{G}(\tau) = \exp(\mathsf{B}\tau) = <\boldsymbol{T}(t+\tau)\boldsymbol{T}^{\mathrm{T}}(t)> < \boldsymbol{T}(t)\boldsymbol{T}^{\mathrm{T}}(t)>^{-1}$

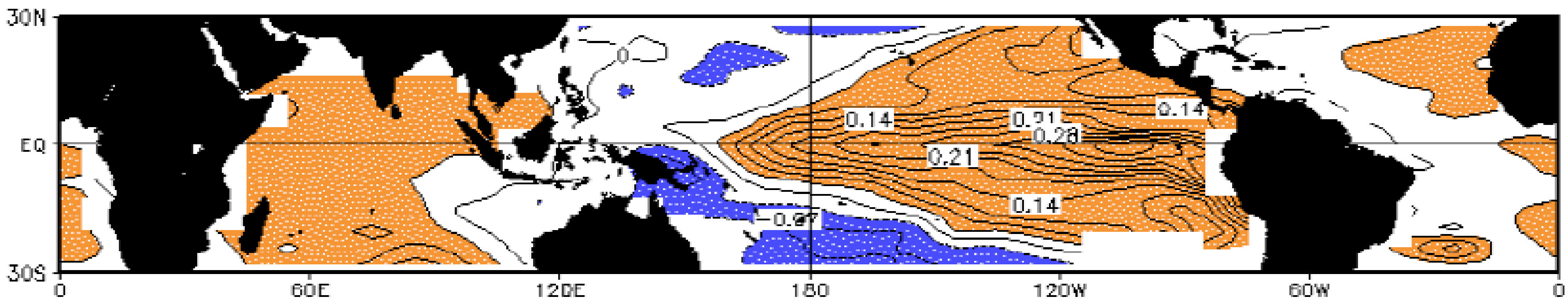
Eigenvectors of $\mathsf{G}(\tau)$ are the ***"normal" modes*** $\{\mathbf{u}_i\}$.

Eigenvectors of $\mathsf{G}^{\mathrm{T}}(\tau)$ are the ***"adjoints"*** $\{\mathbf{v}_i\}$.

This optimal initial pattern…



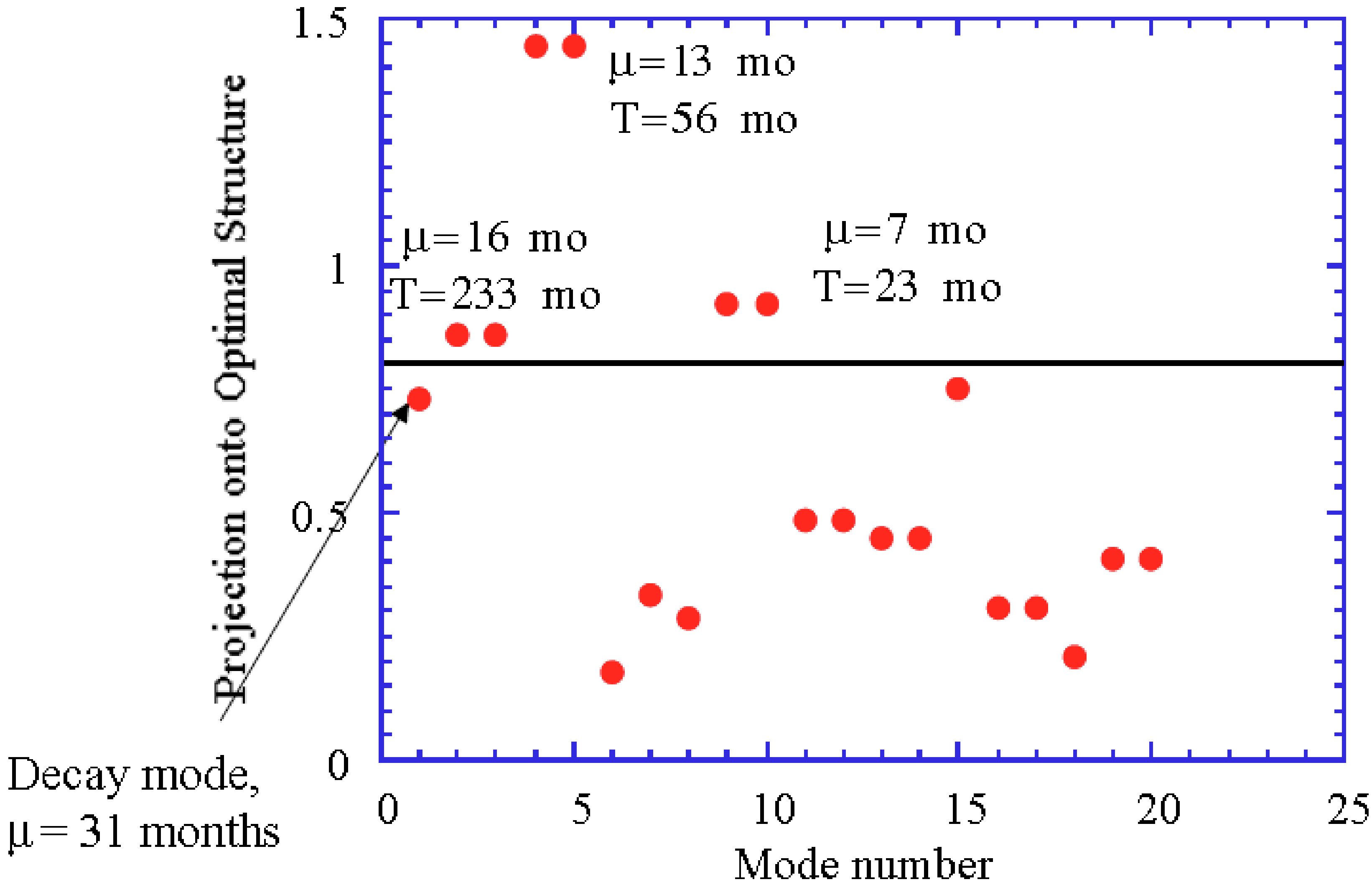

…evolves into this one 6 to 9 months later.



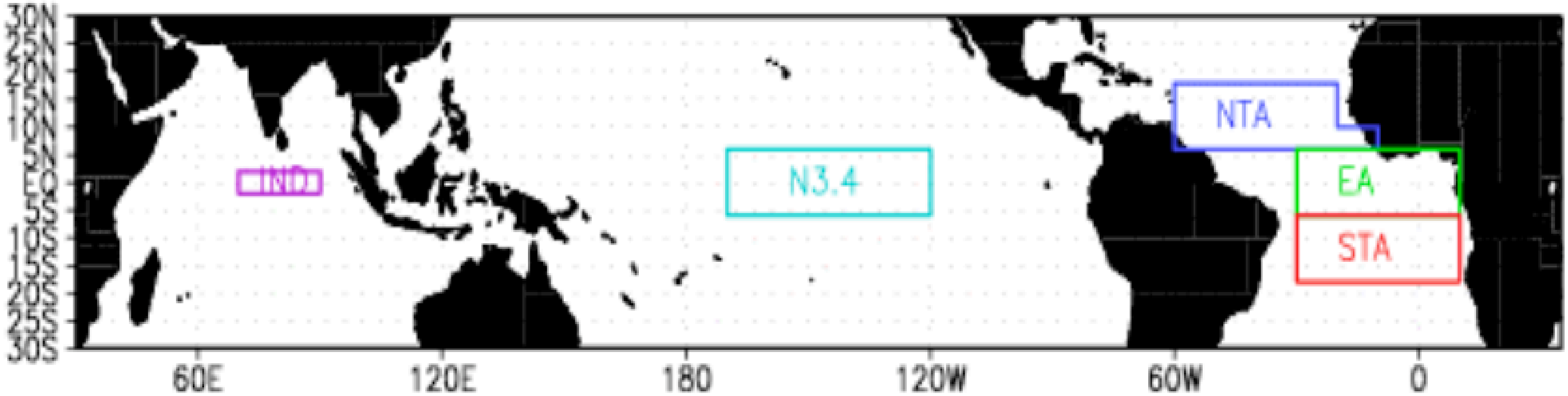

Penland and Matrosova (2006)

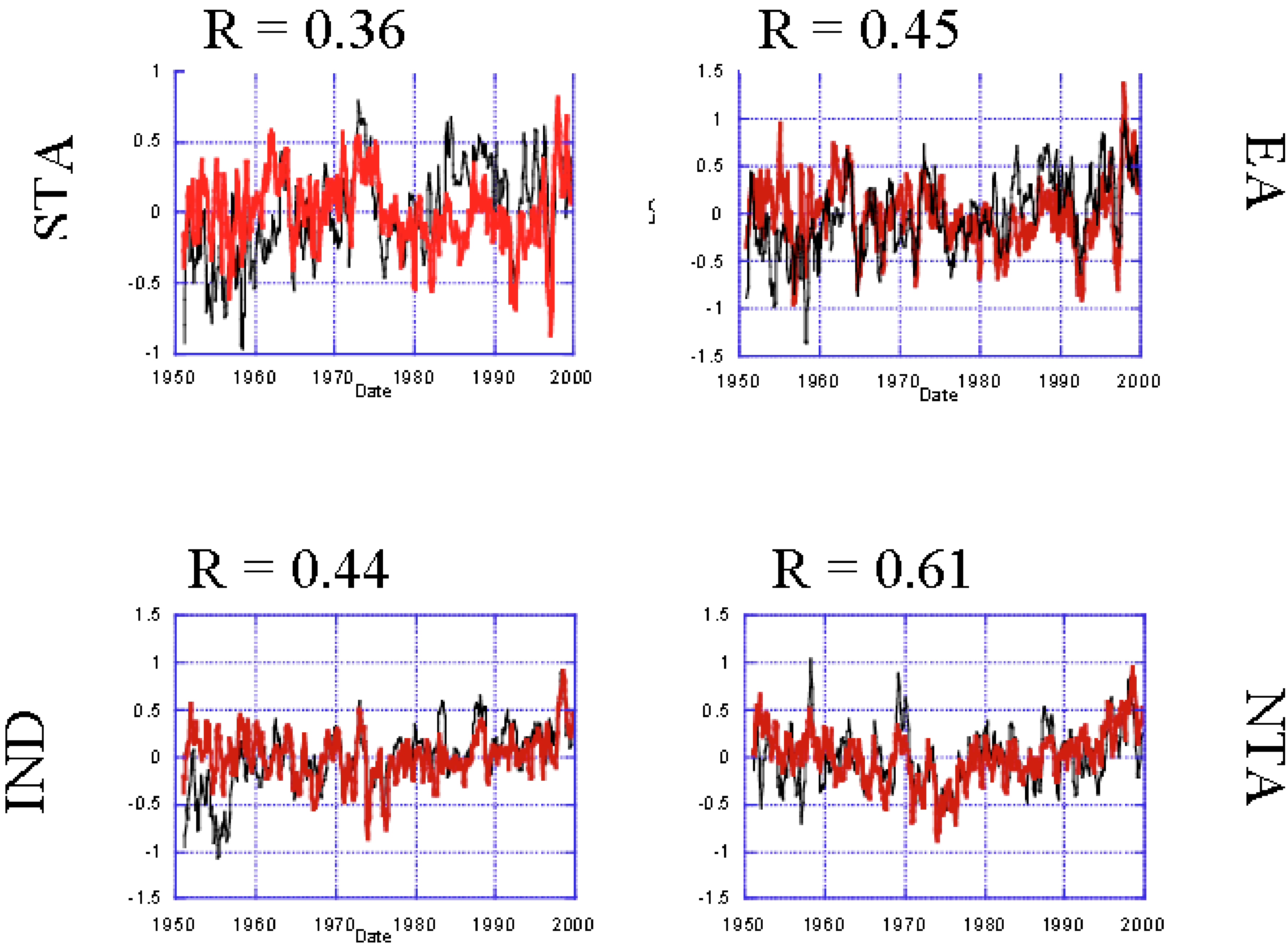
# Projection of adjoints onto O.S. and modal timescales.

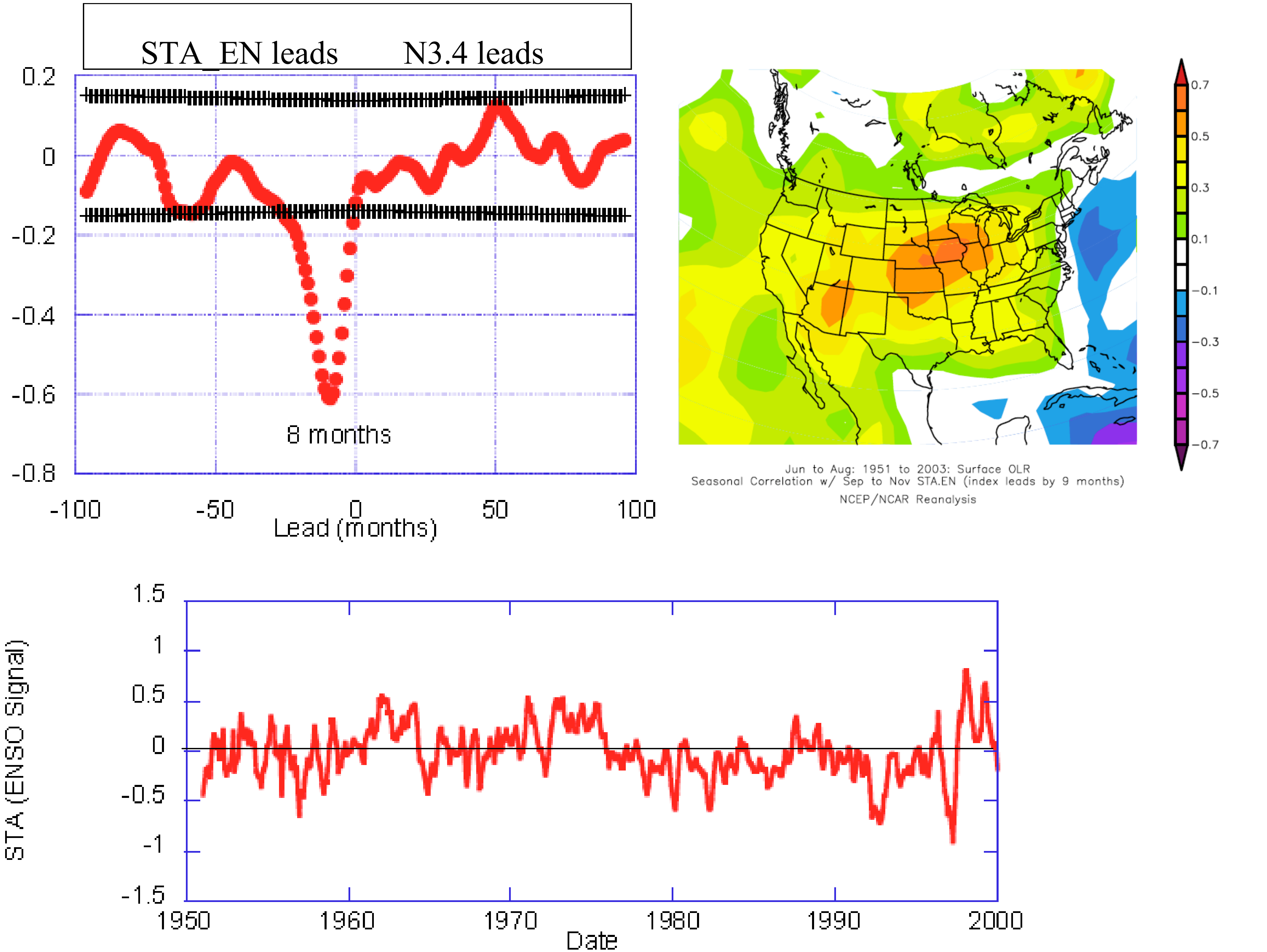
μ= decay time
T = Period

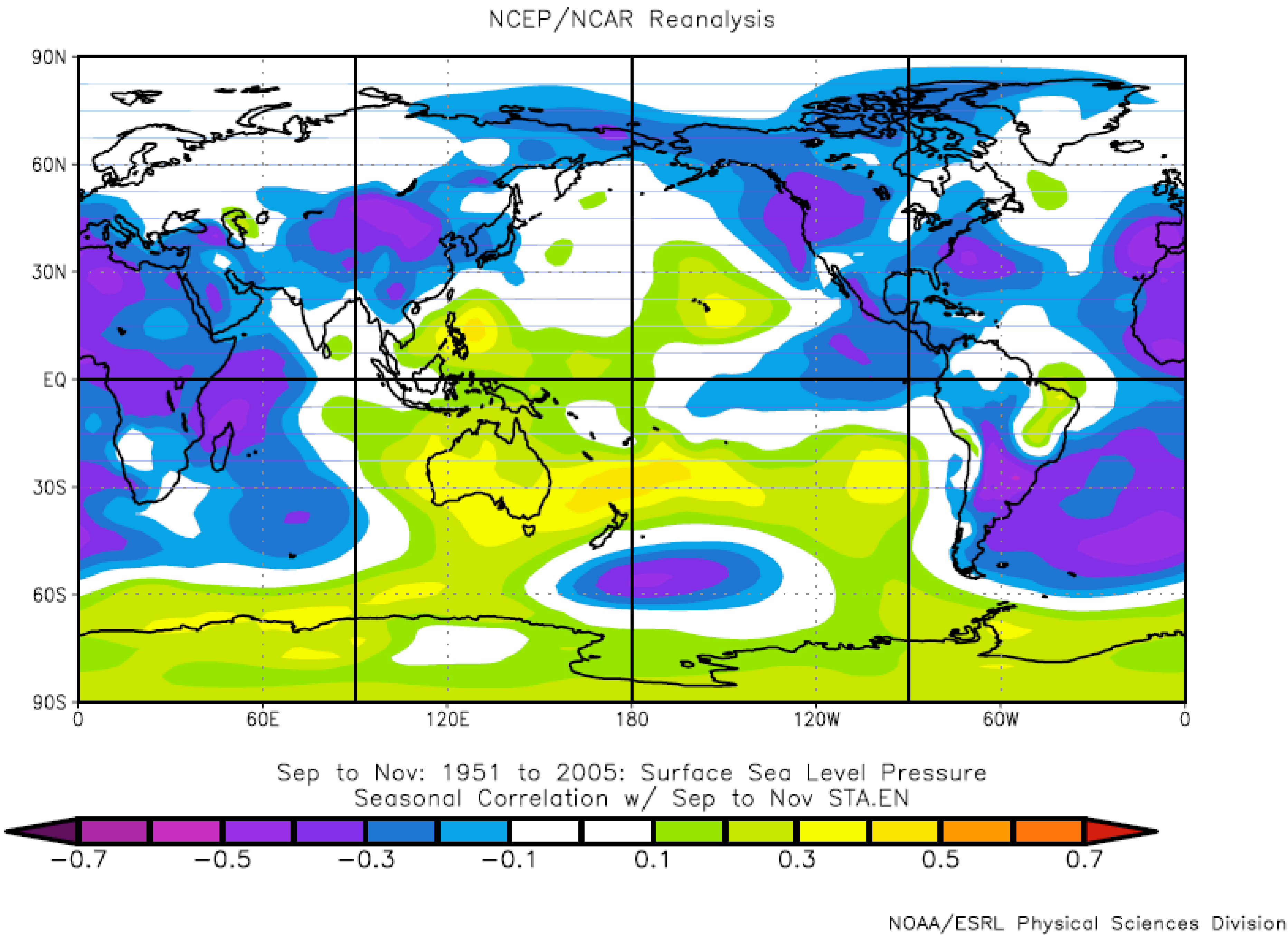


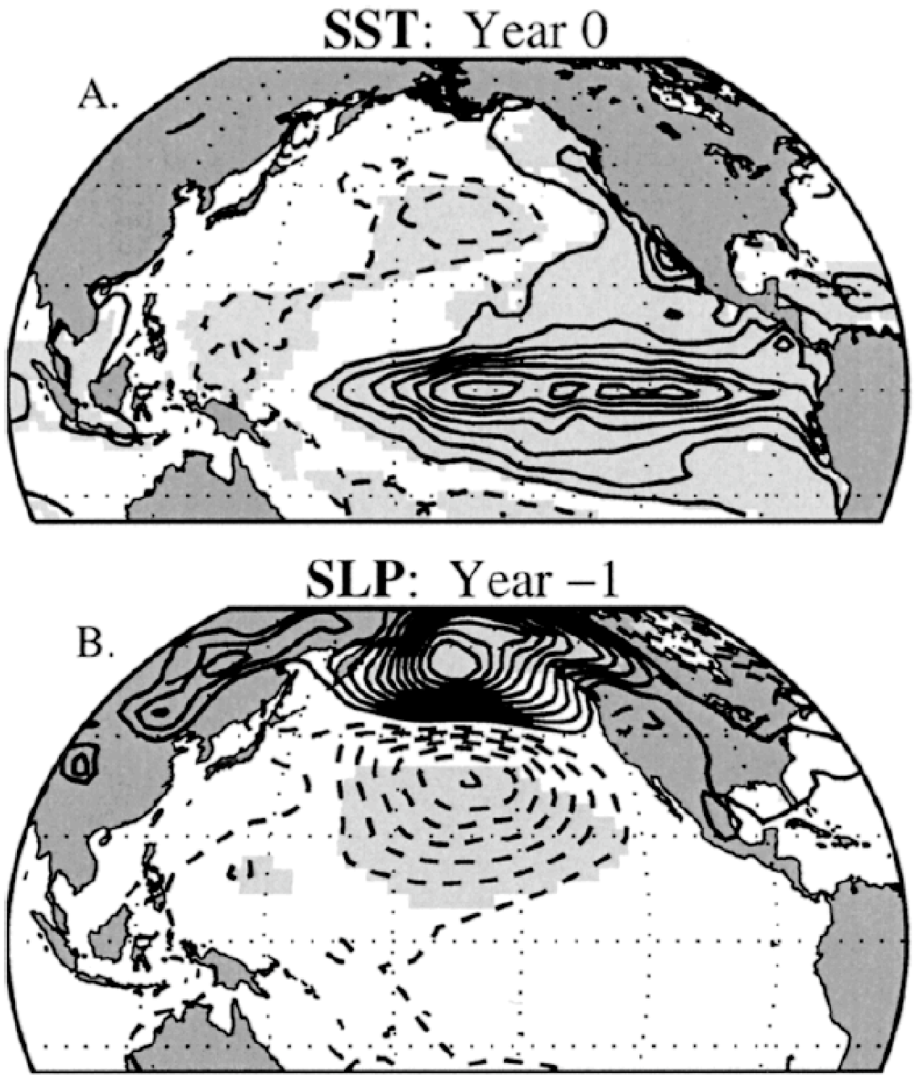
Location of indices: N3.4, IND, NTA, EA, and STA.

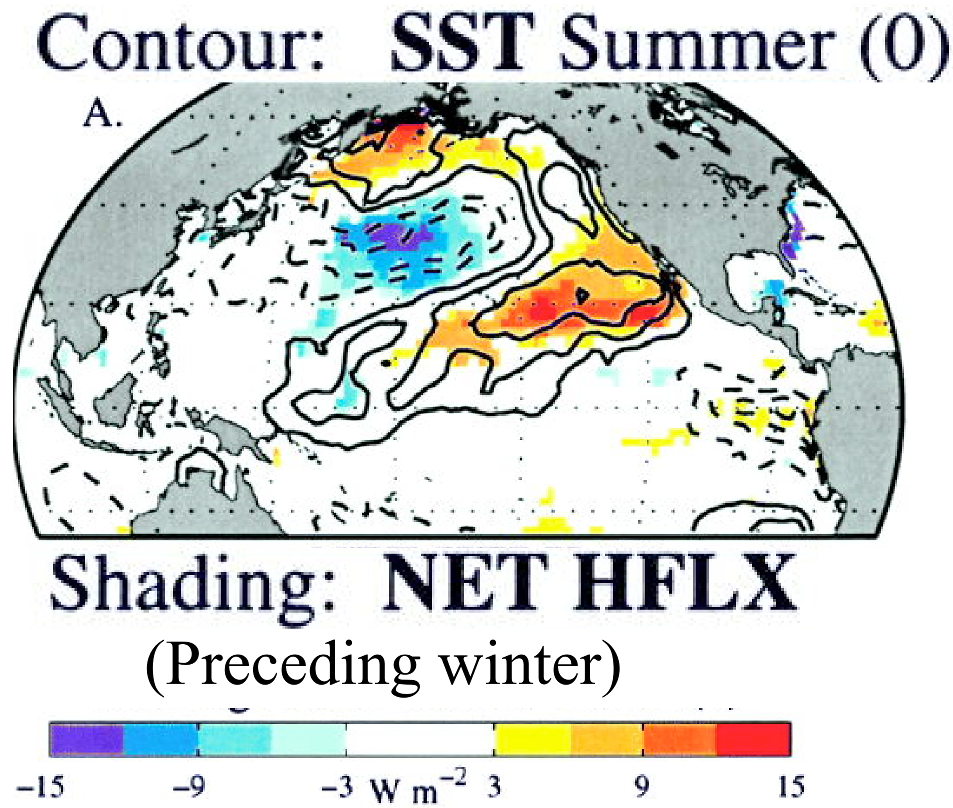


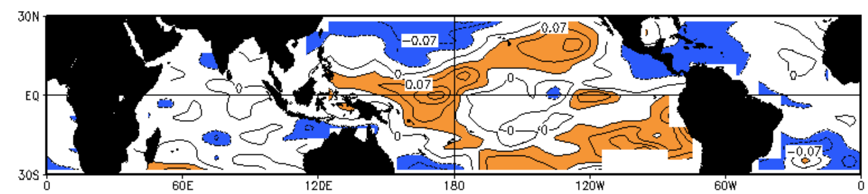

R = 0.36
STA
1
0.5
0
-0.5
-1
1950
1960
1970
1980
1990
2000
Date
R = 0.45
EA
1.5
1
0.5
0
-0.5
-1
-1.5
1950
1960
1970
1980
1990
2000
Date
R = 0.44
IND
1.5
1
0.5
0
-0.5
-1
-1.5
1950
1960
1970
1980
1990
2000
Date
R = 0.61
NTA
1.5
1
0.5
0
-0.5
-1
-1.5
1950
1960
1970
1980
1990
2000


STA_EN leads
N3.4 leads
0.2
0
-0.2
-0.4
-0.6
-0.8
8 months
-100
-50
0
50
100
Lead (months)
Jun to Aug: 1951 to 2003: Surface OLR
Seasonal Correlation w/ Sep to Nov STA.EN (index leads by 9 months)
NCEP/NCAR Reanalysis
0.7
0.5
0.3
0.1
−0.1
−0.3
−0.5
−0.7
1.5
1
0.5
0
-0.5
-1
-1.5
STA (ENSO Signal)
1950
1960
1970
1980
1990
2000
Date

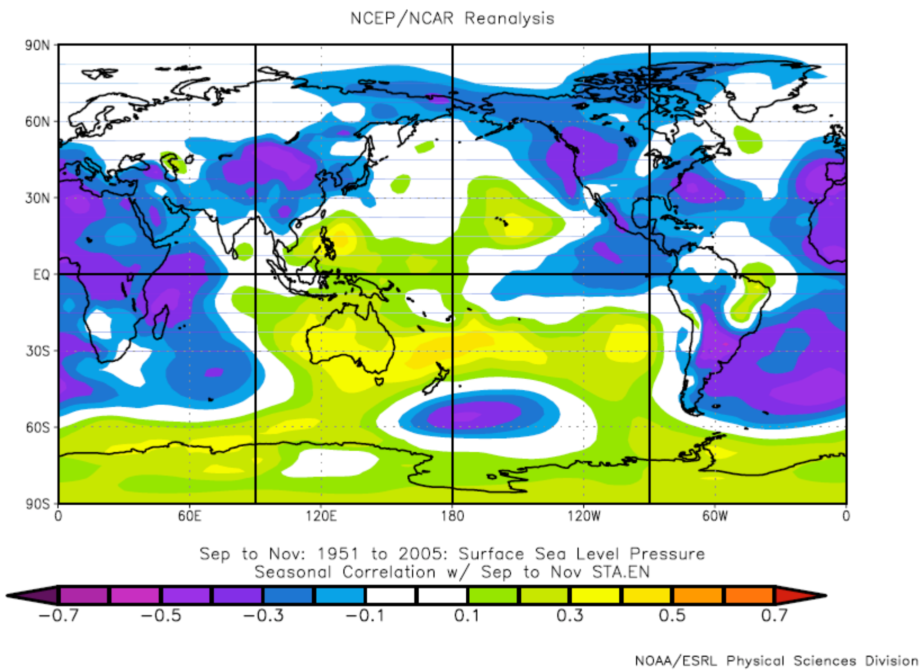

NCEP/NCAR Reanalysis
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
Sep to Nov: 1951 to 2005: Surface Sea Level Pressure
Seasonal Correlation w/ Sep to Nov STA.EN
−0.7
−0.5
−0.3
−0.1
0.1
0.3
0.5
0.7
NOAA/ESRL Physical Sciences Division

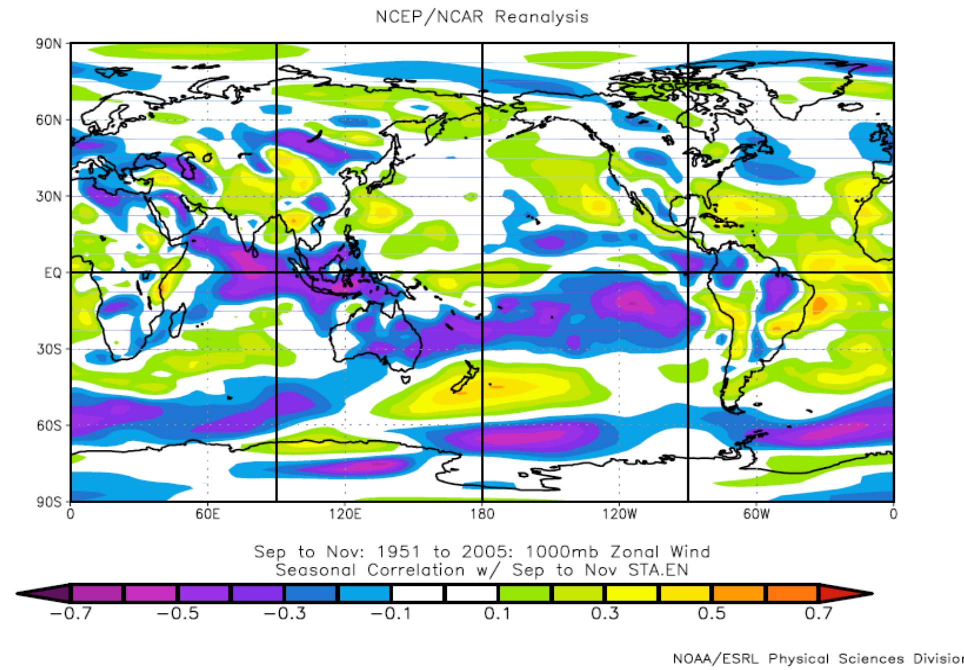


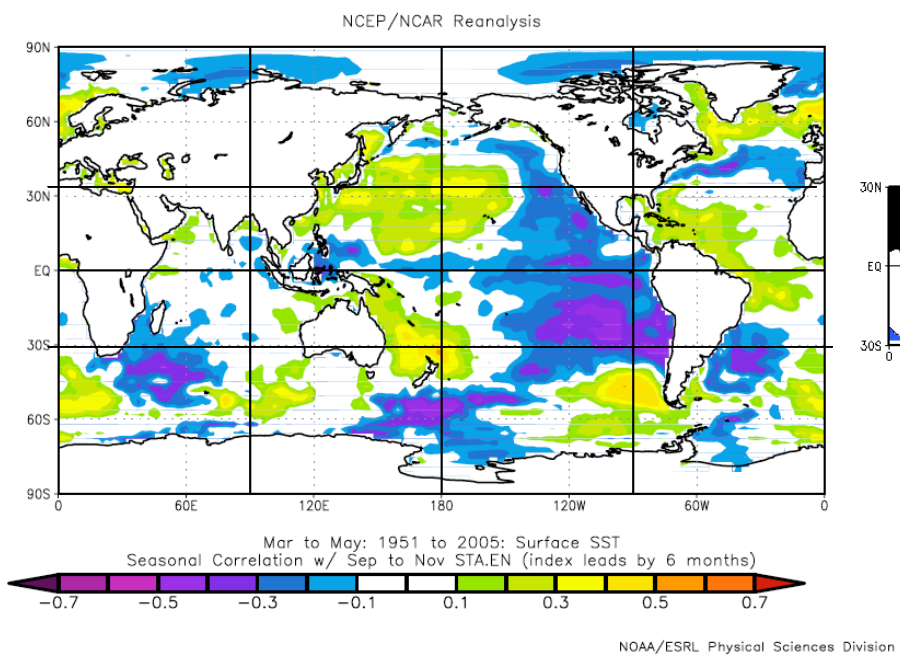



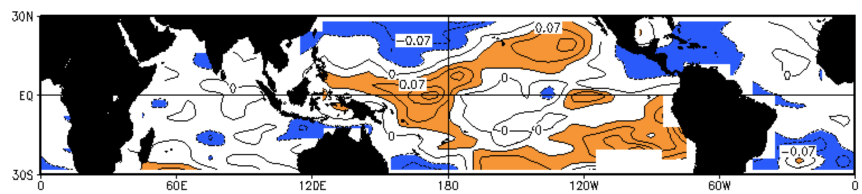



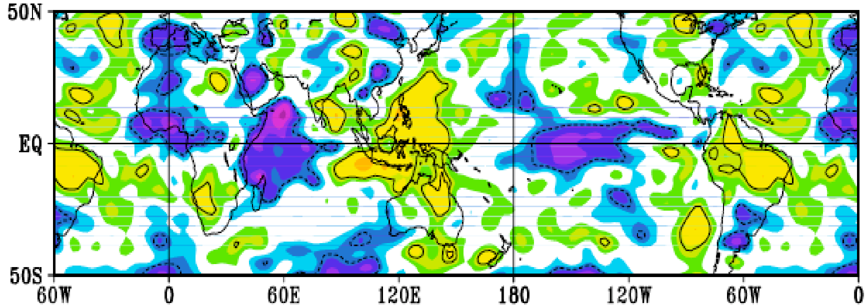

Vimont et al. 2003

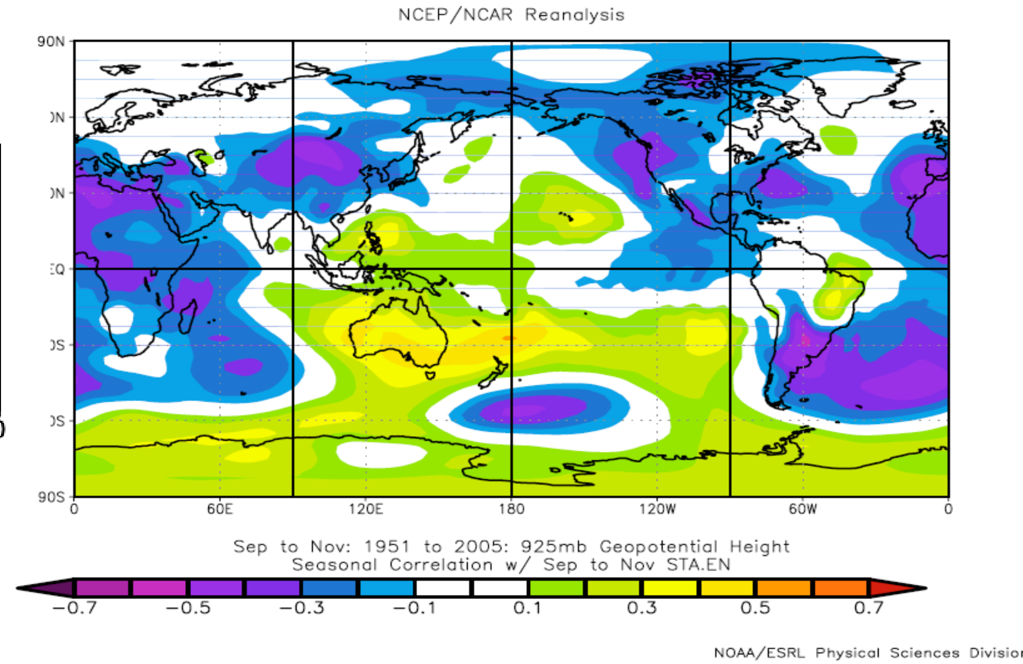

NCEP/NCAR Reanalysis
Sep to Nov: 1951 to 2005: Surface Sea Level Pressure
Seasonal Correlation w/ Sep to Nov STA.EN
−0.7 −0.5 −0.3 −0.1 0.1 0.3 0.5 0.7
NOAA/ESRL Physical Sciences Division


NCEP/NCAR Reanalysis
Sep to Nov: 1951 to 2005: 1000mb Zonal Wind
Seasonal Correlation w/ Sep to Nov STA.EN
−0.7 −0.5 −0.3 −0.1 0.1 0.3 0.5 0.7
NOAA/ESRL Physical Sciences Division

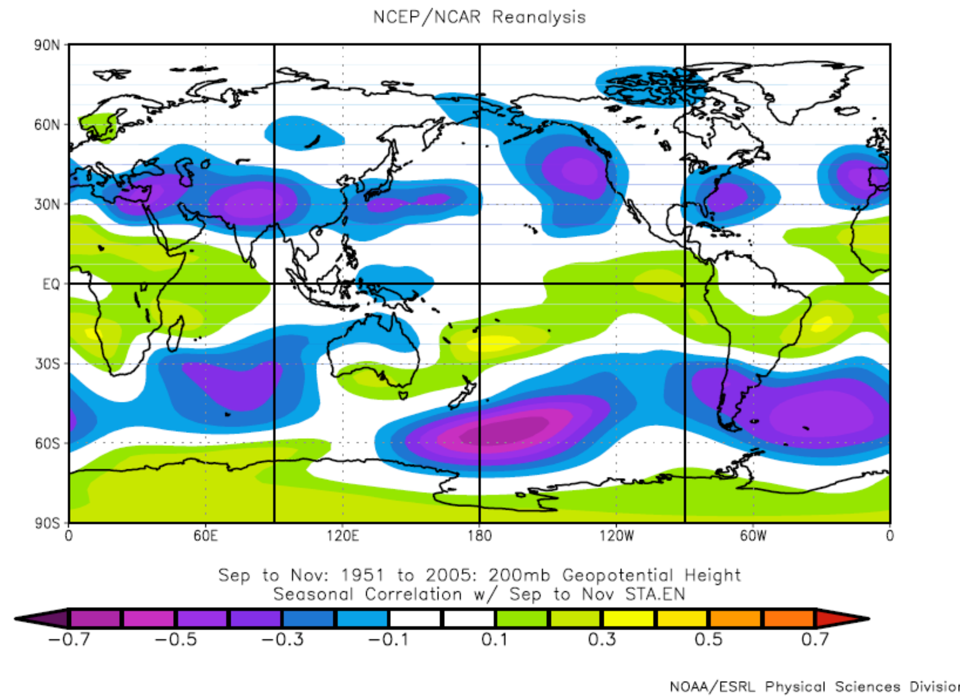

NCEP/NCAR Reanalysis
Mar to May: 1951 to 2005: Surface SST
Seasonal Correlation w/ Sep to Nov STA.EN (index leads by 6 months)
−0.7 −0.5 −0.3 −0.1 0.1 0.3 0.5 0.7
NOAA/ESRL Physical Sciences Division






ϕ is baroclinic over Africa, the West Indian Ocean, and the East tropical Atlantic. Harder to tell west of far S. America.



# *Conclusion*

- Convection conspires to increase the SH Pacific trades and decrease the SH Atlantic trades (or vice versa). This increases the probability of La Niña/El Niño, which in turn affects precipitation in the N. American midwest.