



EASCOF-IV 2016 Nov 08 Ulaanbaatar

An Introduction to the System of ENSO Monitoring, Analysis and Prediction (SEMAP2.1)

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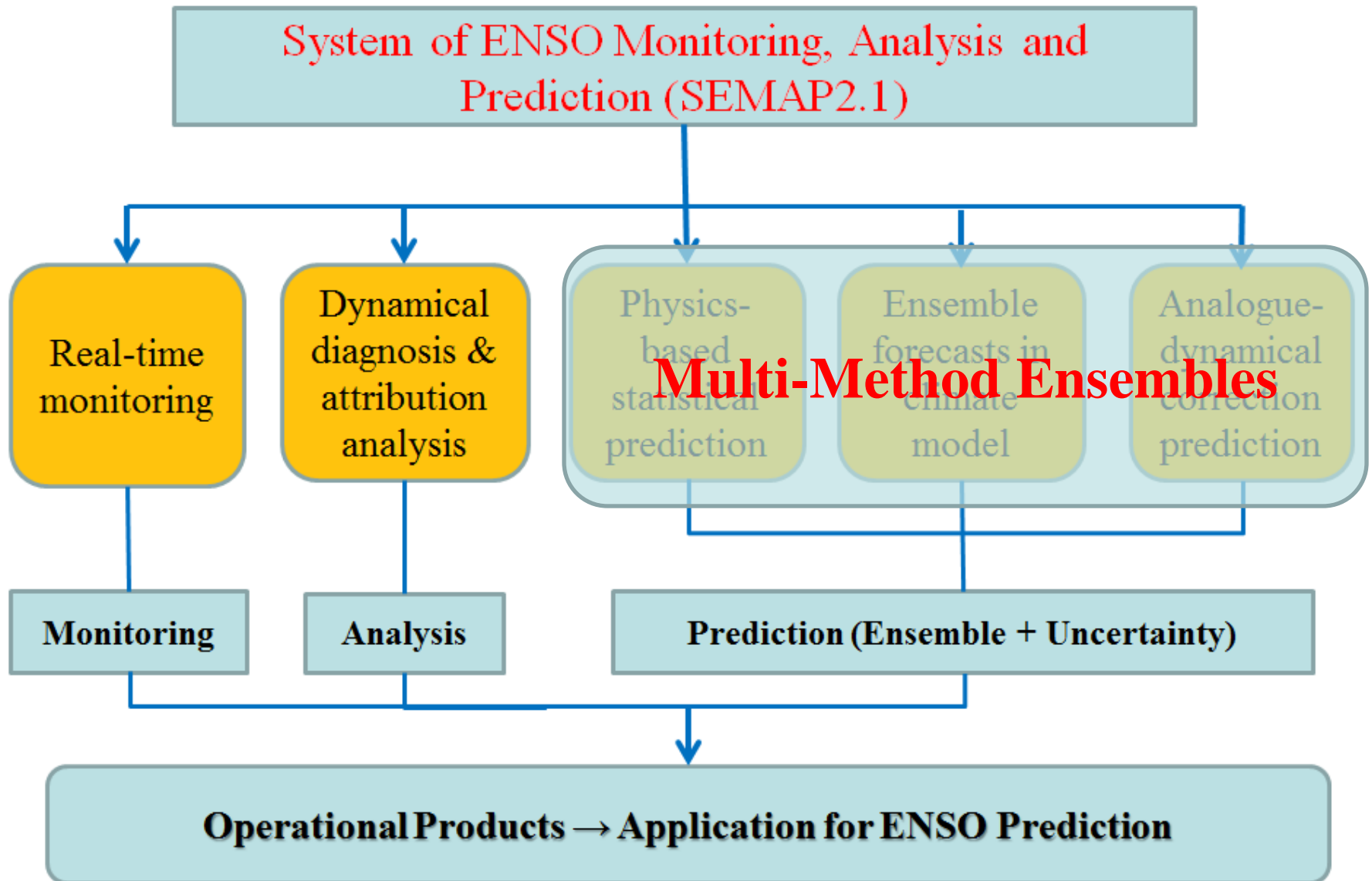
Outline

1) SEMAP2.1 System Structure

2) Performance during the 2014/2016 Strong El Nino event

3) Outlook of ENSO for 2016/2017 winter

SEMAP2.1 System Structure



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ENSO预测及气候影响

1.海表温度

OISSTv2

SST

BCC-GODAS2.0

2.次表层海温

NOAA-GODAS

Subsurface Temperature

BCC-GODAS2.0

ARGO

3.关键区海温指数

热带太平洋海温指数

北太平洋年代际涛动指数

副热带东南太平洋海温指数

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SST indices

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ENSO预测及气候影响

1. ENSO动力学变量

海洋热容量

20°C等温线深度

纬向风应力

ENSO dynamics variables

ENSO充-放电振子指数

海温倾向线性反馈

2. 热带大气响应特征

低层纬向风

高层纬向风

热带对流活动

Tropical Atmospheric responses

Walker环流

南方涛动指数

3. 东亚副热带大气响应特征

菲律宾反气旋

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Prediction and
climate impacts

1.国内外ENSO预测

国家气候中心 (BCC)

ENSO prediction by BCC and links to other organizations

欧洲中期数值预报中心 (ECMWF)

日本气象厅 (TCC)

世界气象组织 (WMO)

2. ENSO事件的气候影响

相关分析

ENSO climate impacts

历史Niño年合成分析

历史La Nina年合成分析

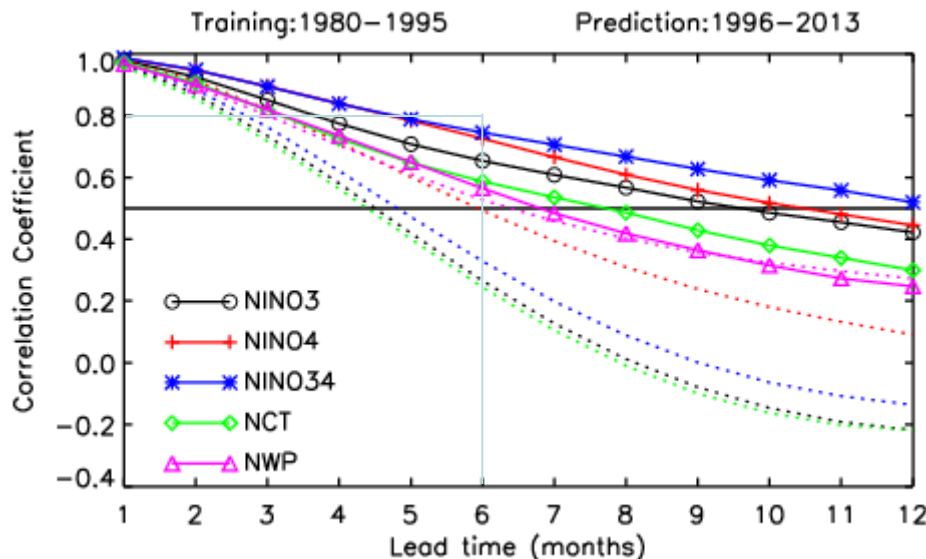
1. ENSO Physics-based statistical prediction

Based on the ENSO recharge oscillator theory and forcing factors, the statistical model focus on two types of ENSO prediction. Predictive factors consists of **Niño index**, tropical Pacific **WWV index**, **WP zonal wind stress index**, **IOD index**.

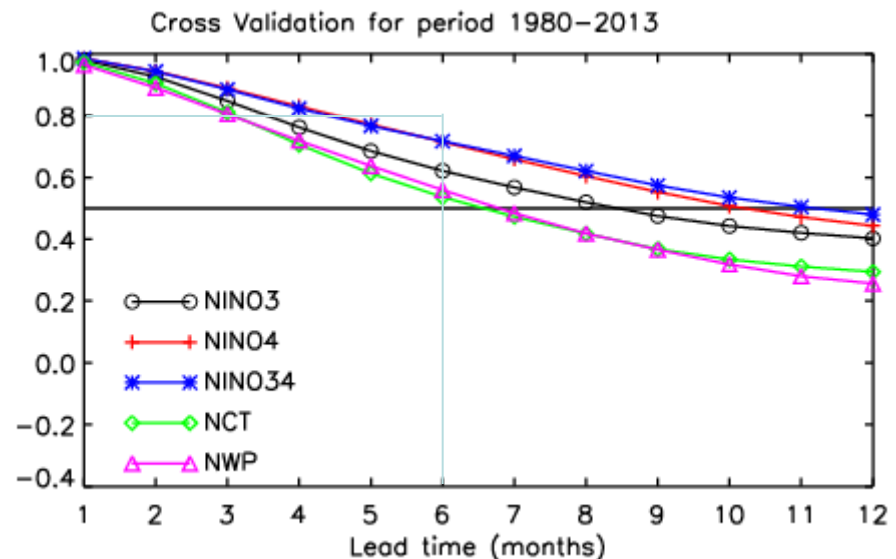
(Jin 1997; Jin and An 1999; Ren and Jin 2013)

$$\text{Nino}(t + \Delta t) = \alpha \text{Nino}(t) + \beta \tau(t) + \gamma \text{WWV}(t) + f \text{IOD}(t) + c$$

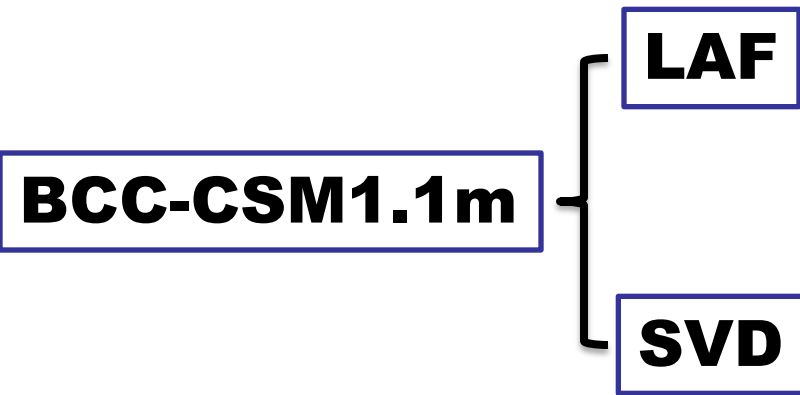
Independent Sample Validation



Cross Validation



2. BCC_CSM1.1m Ensemble prediction



24 members

Initial Error

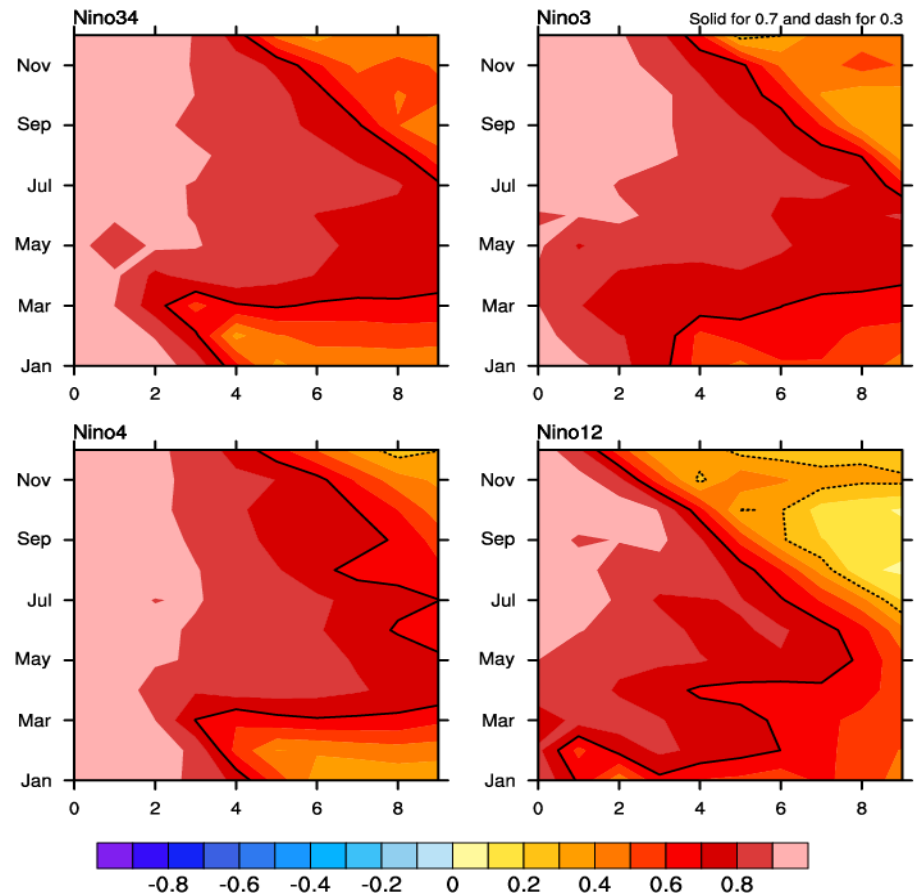
Horizontal res: 110km

BCC_AGCM2.2: T106, 26 levels

MOM_L40: $0.333^\circ / 1^\circ$

(Wu et al. 2014)

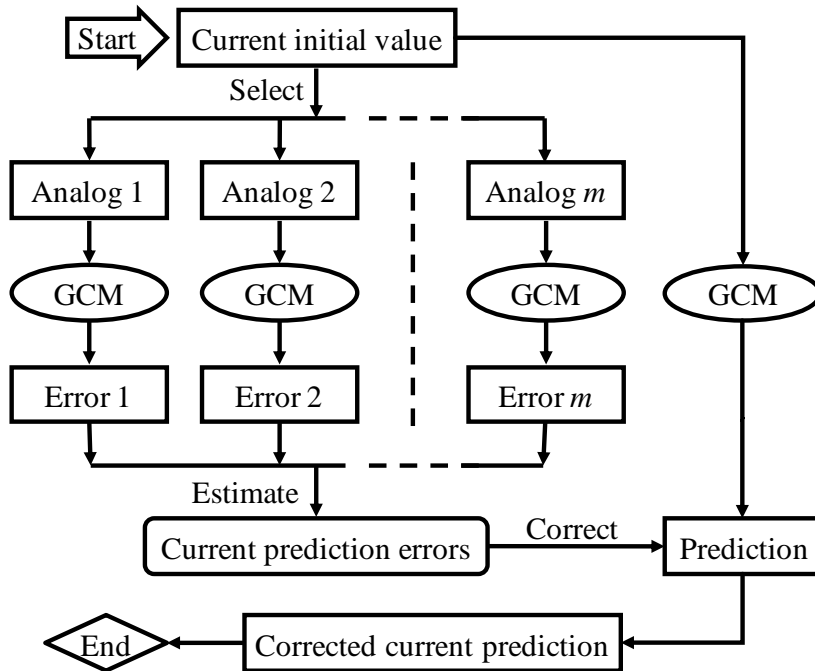
ENSO Index Correlations between BCC-CSM1.1m Prediction and Observation



3. Analogue-dynamical correction prediction (ADEPS)

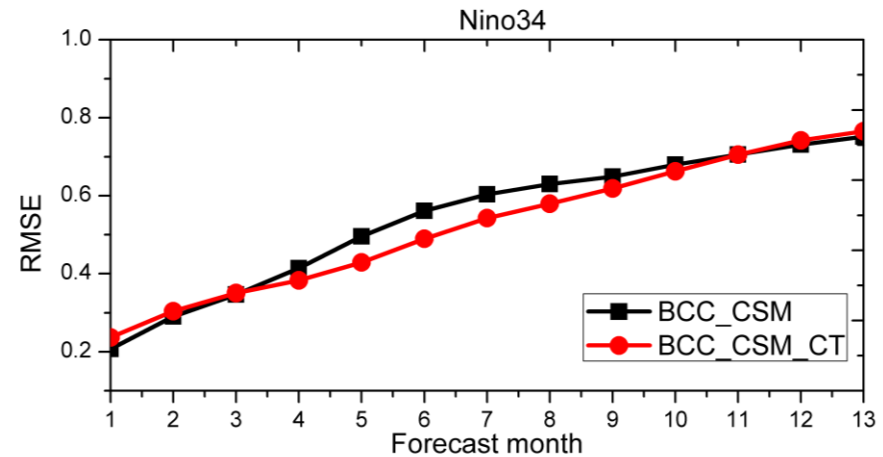
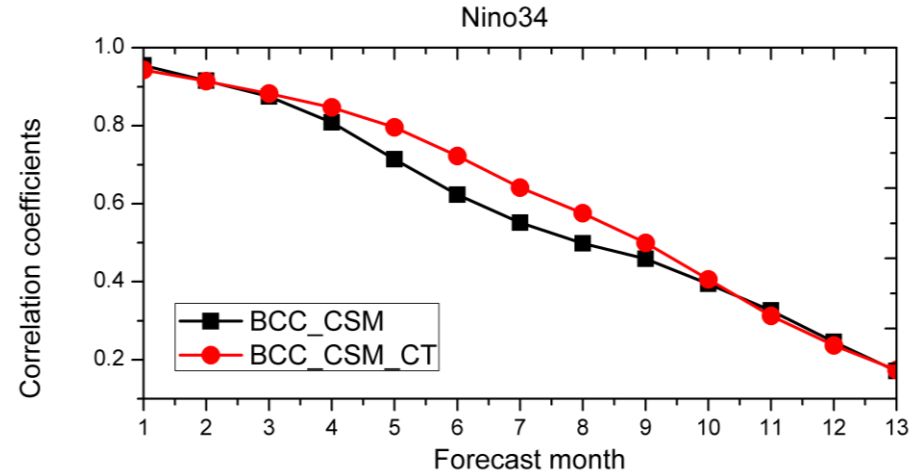
Using the historical information, we developed the analogue dynamical correction strategy to the ENSO prediction of the climate model.

$$\hat{P}_M(\psi_0) = P_M(\psi_0) + \tilde{P}_M(\tilde{\psi}_j) - P_M(\tilde{\psi}_j)$$



(Ren et al. 2014)

Model Error



Comparison of all prediction methods

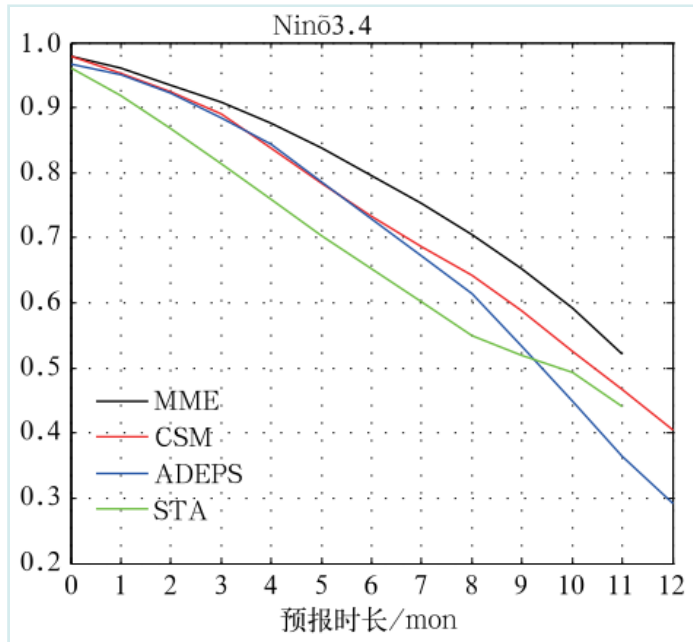


Fig. 3 Temporal anomaly correlation coefficients of Niño3.4 index prediction by SEMAP2.0 during 1996–2015 for BCC_CSM1.1m (red line), ADEPS (blue line), statistical prediction model (STA, green line), and their ensemble mean (MME, black line), respectively

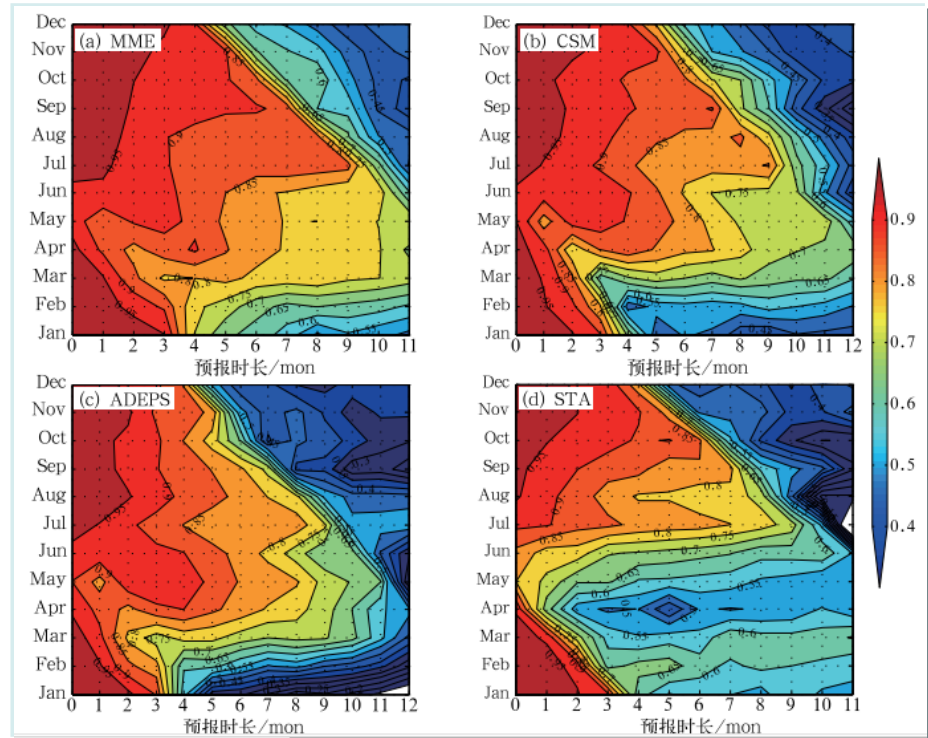
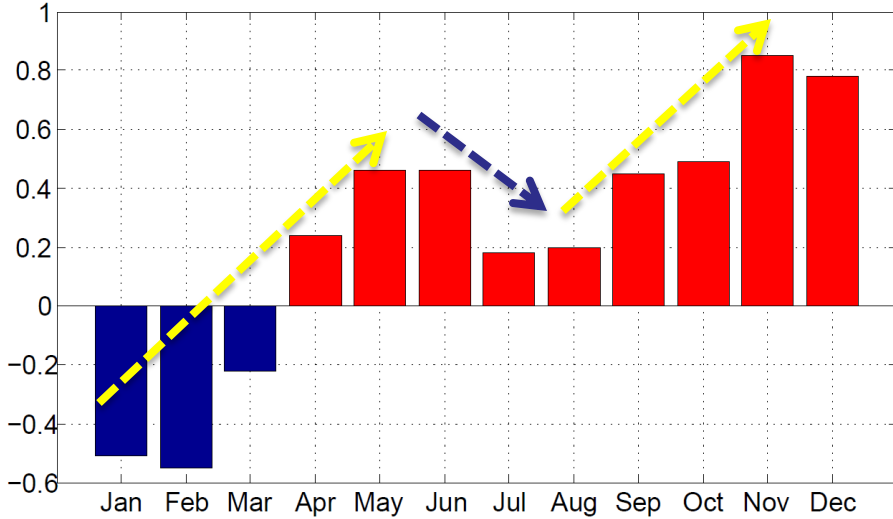


Fig. 4 Seasonal dependence of temporal anomaly correlation coefficients of Niño3.4 index prediction by SEMAP2.0 during 1996–2015 for BCC_CSM1.1m (b), ADEPS (c), statistical prediction model (STA, d), and their ensemble mean (MME, a), respectively
 (Where x -axis is forecast months and y -axis the initial calendar months)

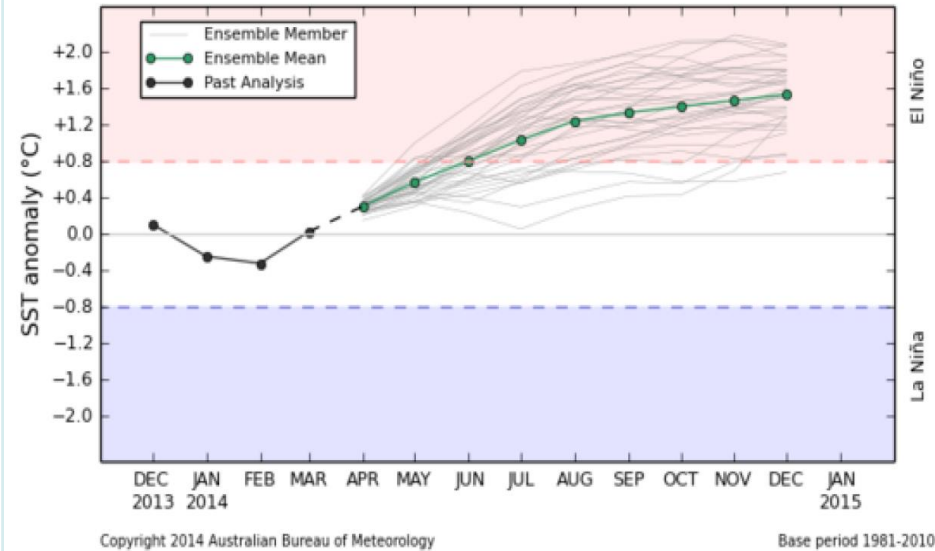
2) Performance of the 2014/2016 Strong El Niño event

2014 Spring

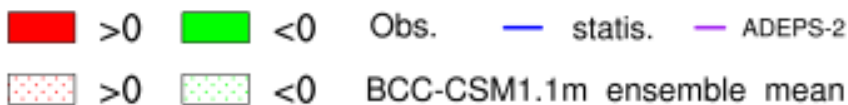
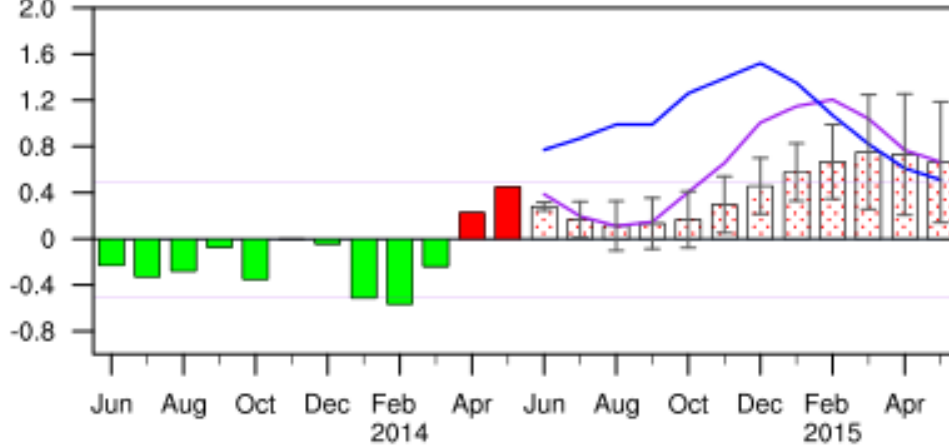
Nino3.4 anomaly in 2014



POAMA monthly mean NINO34 - Forecast Start: 3 APR 2014



Nino3.4

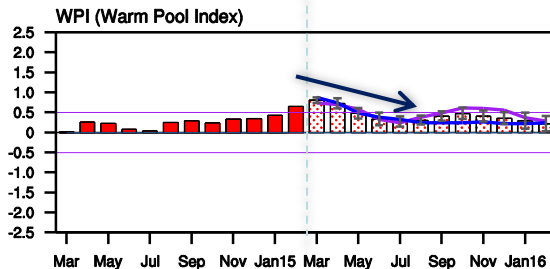
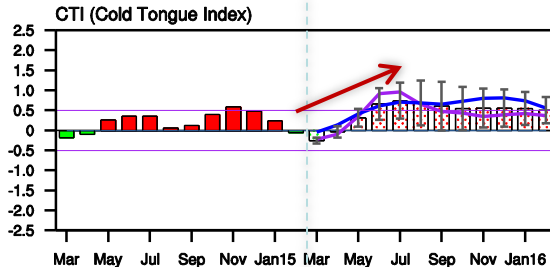
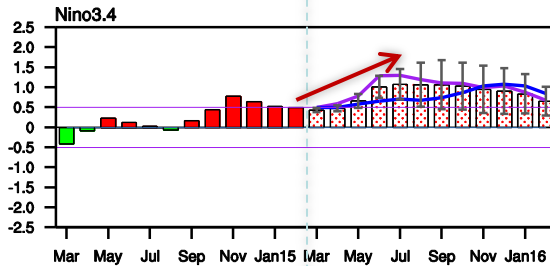
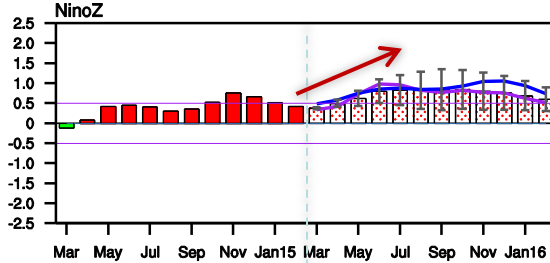


ADEPS-2: ENSO fluctuation in the summer-autumn seasons of 2014

2015 Spring: ENSO type transition

March

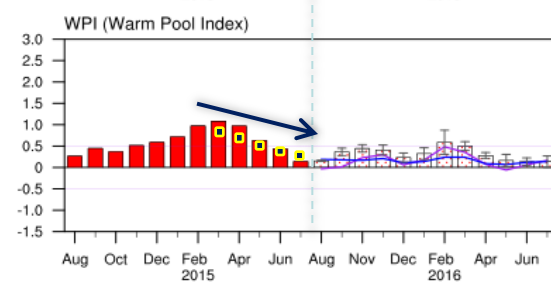
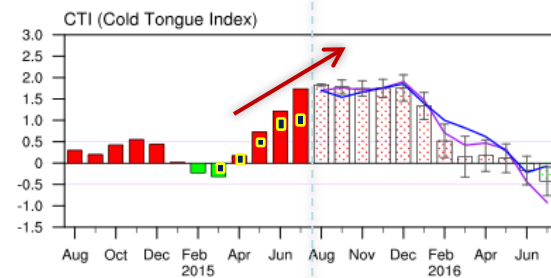
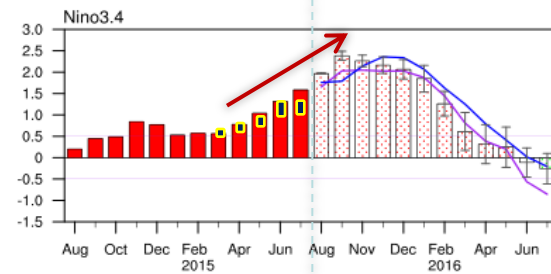
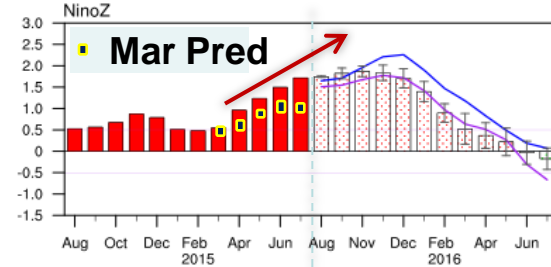
ENSO SST Indices (K): BCC_CSM1.1m forecast
 Monitor (ERSST): 201403-201502; Forecast: 201503-201602



■ >0 ■ <0 Obs. — statis. — ADEPS-2
 >0 <0 BCC-CSM1.1m ensemble mean

August

ENSO SST Indices (K): BCC/LCS SEMAP2.0 forecast
 Monitor (OISST): 201408-201507; Forecast: 201508-201607



■ >0 ■ <0 Obs. — statis. — ADEPS-2
 >0 <0 BCC-CSM1.1m ensemble mean

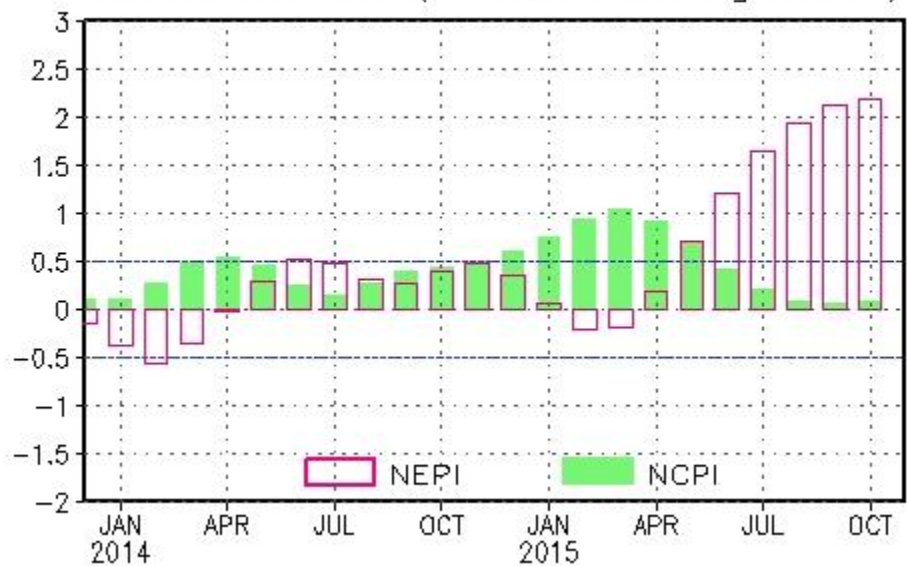
NiñoZ

Niño3.4

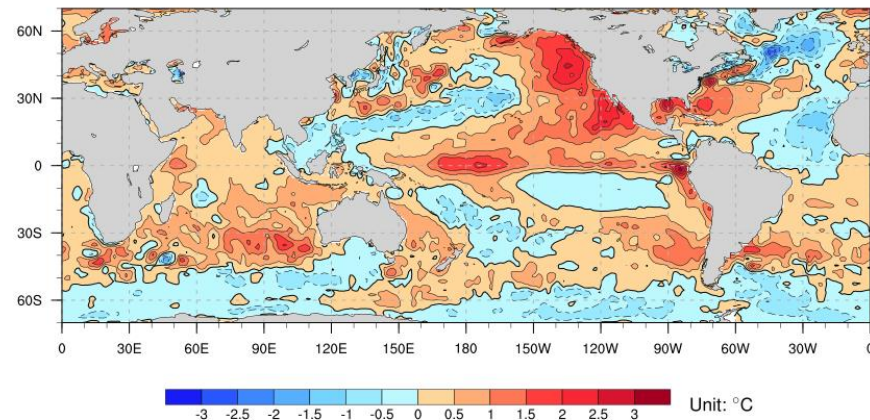
EP

CP

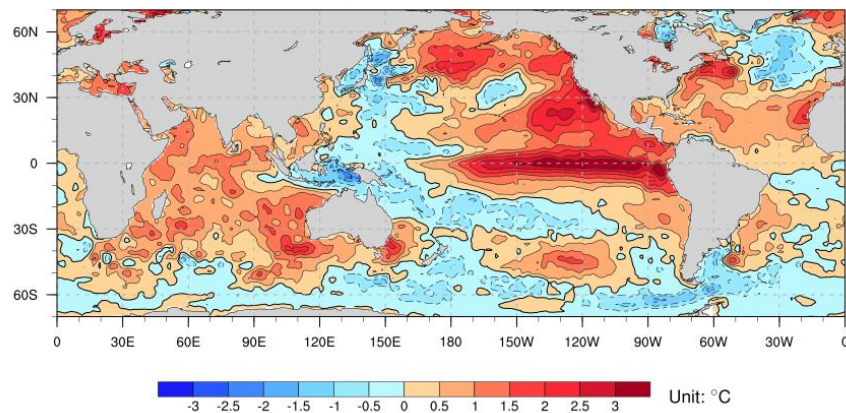
NinoCE indices (3-mon running mean)



Monthly Mean SST Anomaly 201504



Monthly Mean SST Anomaly 201510



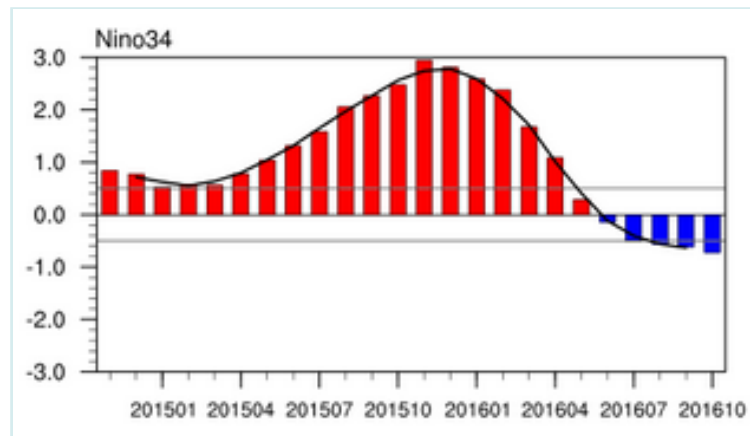
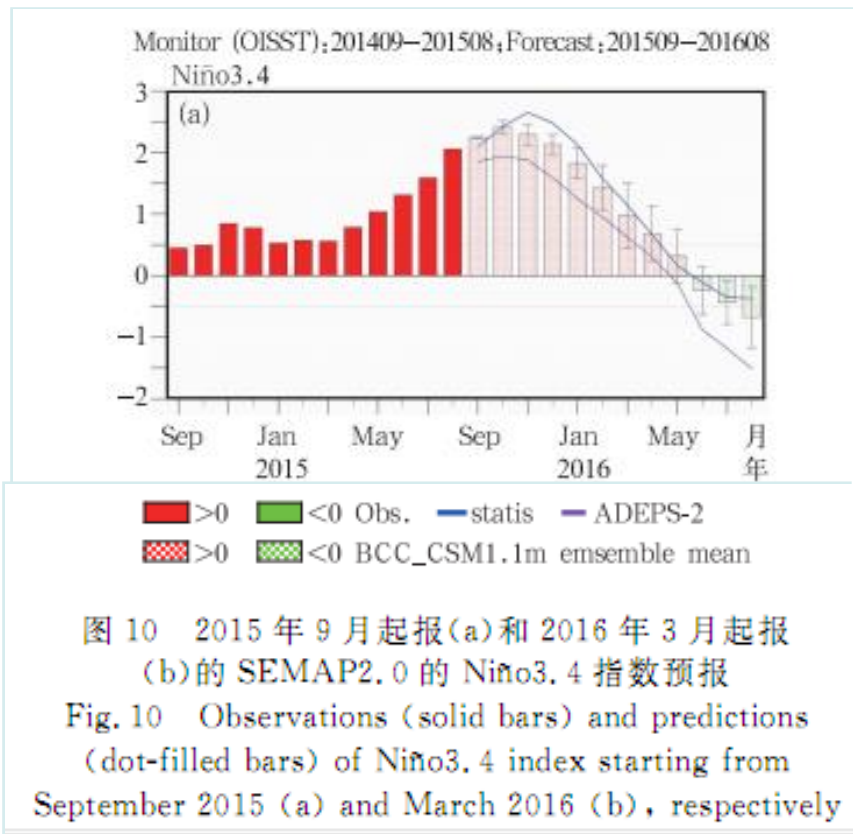
$$\begin{cases} NEPI = N_3 - \alpha N_4 \\ NCPI = N_4 - \alpha N_3 \end{cases} \alpha = \begin{cases} 2/5, & N_3 N_4 > 0 \\ 0, & \text{otherwise.} \end{cases}$$

CP El Nino



EP El Nino

2015 Autumn

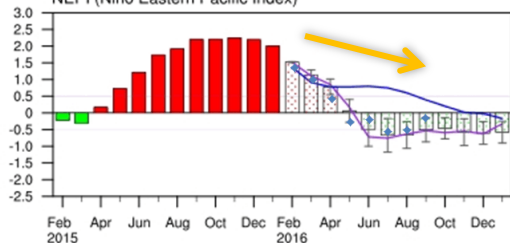


2016 Spring

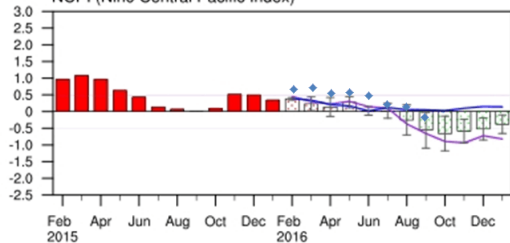
ENSO SST Indices (K): BCC/LCS SEMAP2.0 forecast

Monitor (OISST): 201502-201601; Forecast: 201602-201701

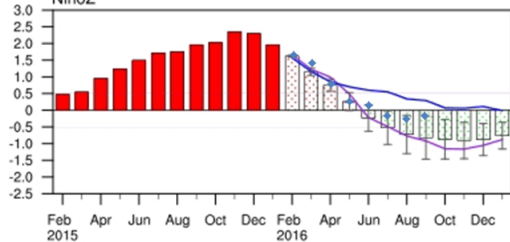
NEPI (Nino Eastern Pacific Index)



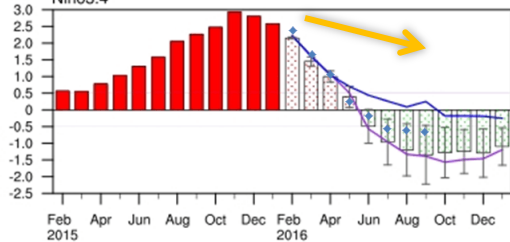
NCPI (Nino Central Pacific Index)



NinoZ



Nino3.4

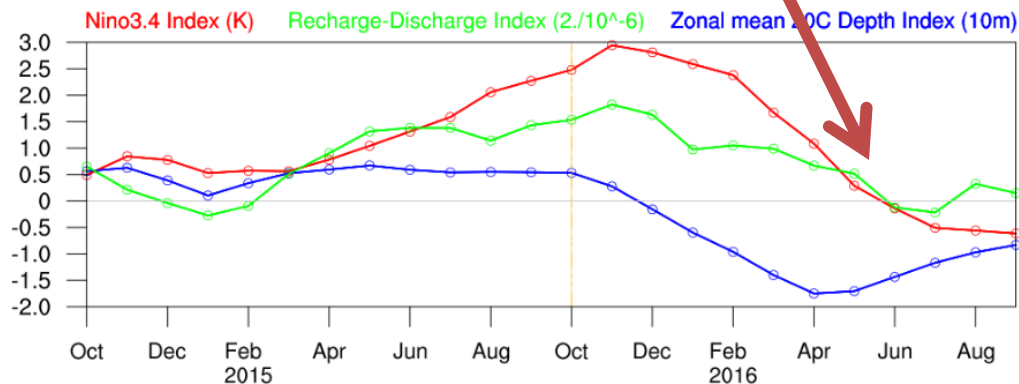


■ >0 ■ <0 Obs. — statis. — ADEPS-2
 >0 <0 BCC-CSM1.1m ensemble mean

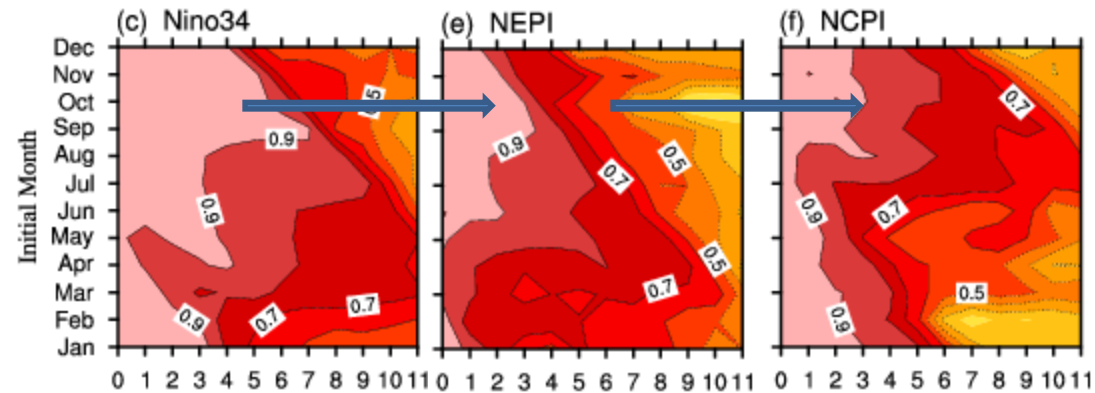
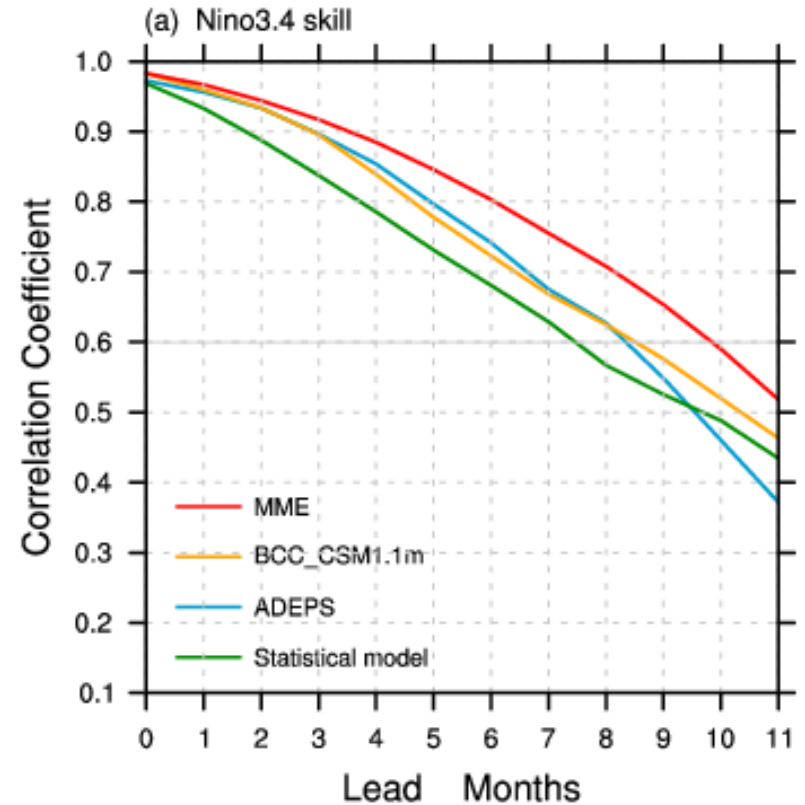
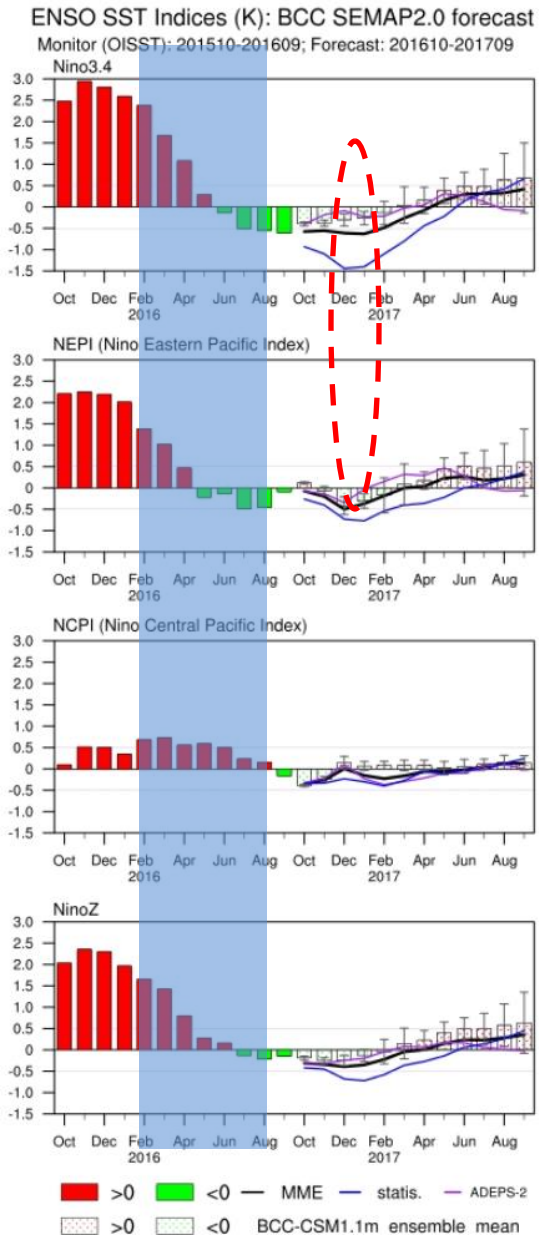
El Nino event is expected to weaken and end in May, followed by a neutral state in summer, and possibly grow into a cold event in autumn.

El Nino-Southern Oscillation (ENSO) Recharge Oscillator Indices

Observation (OISST+GODAS) : 201410---201609



3) Outlook of ENSO for 2016/2017 winter

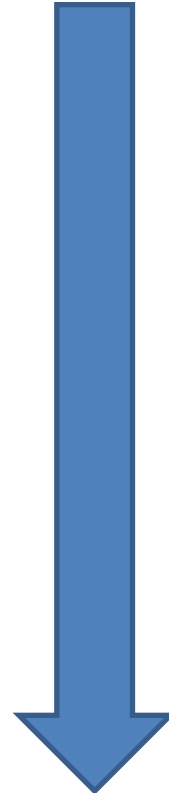
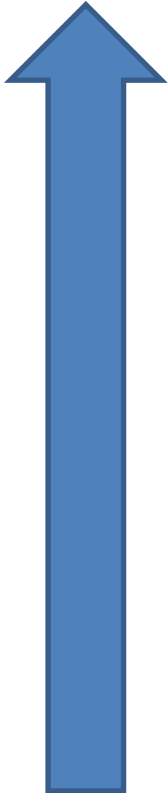
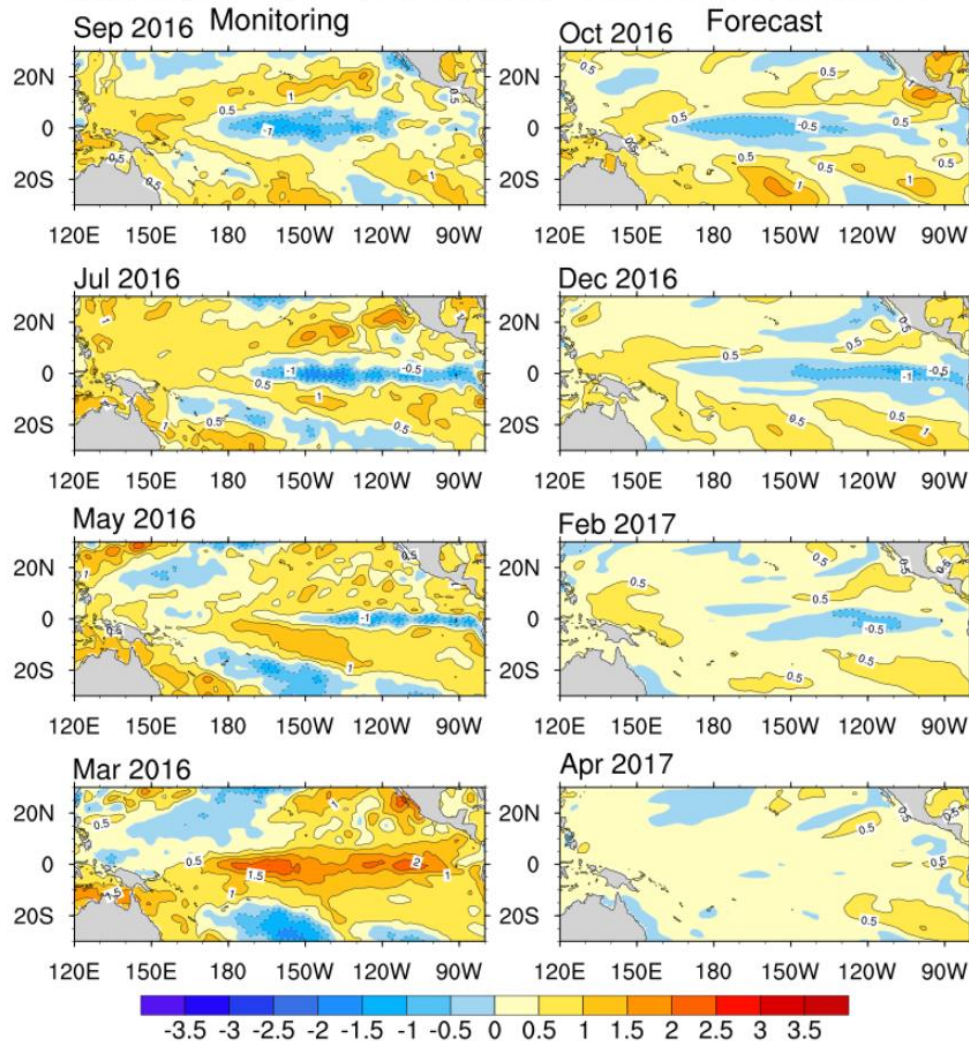


Tropical SSTA

Tropical Pacific SSTA (K): BCC_CSM1.1m forecast
Monitor (OISST): 201603-201609; Forecast: 201610-201704

Monitoring

Forecast



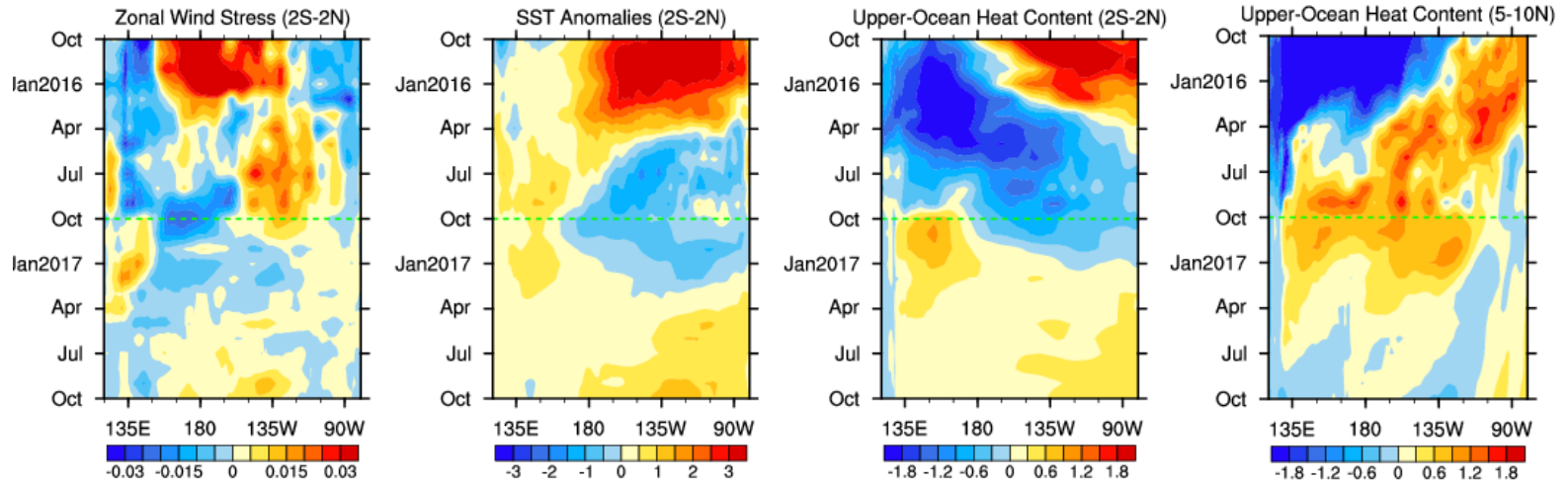
Zonal wind stress

SSTA

Upper-level ocean heat content
tropical extra-tropical

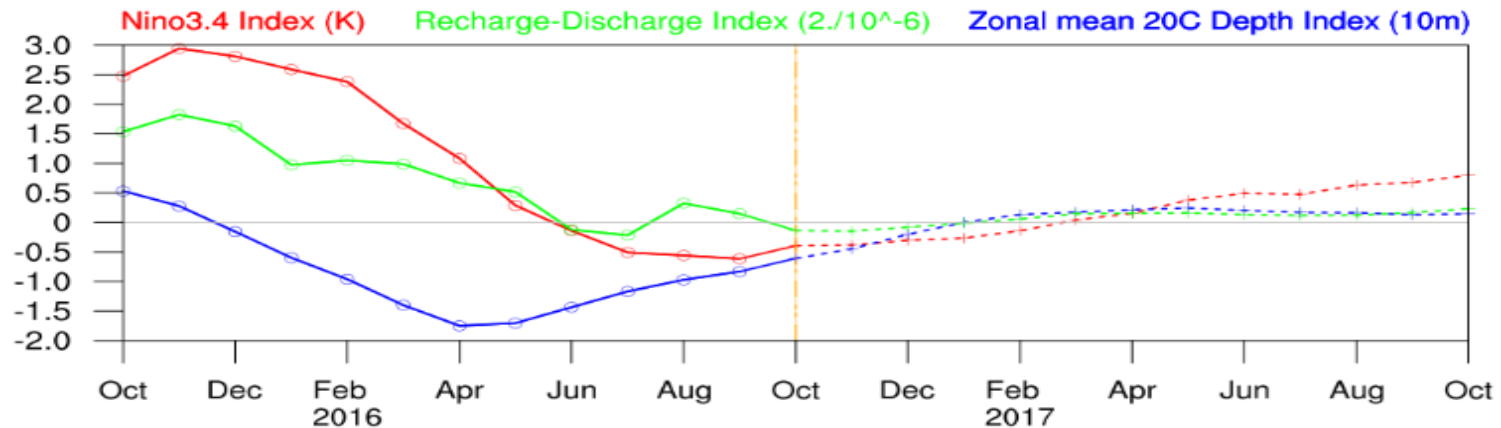
ENSO evolutions at Equator: BCC_CSM1.1m forecast

Monitor : 201510-201609; Forecast: 201610-201710



ENSO Recharge Oscillator Indices: BCC_CSM1.1m forecast

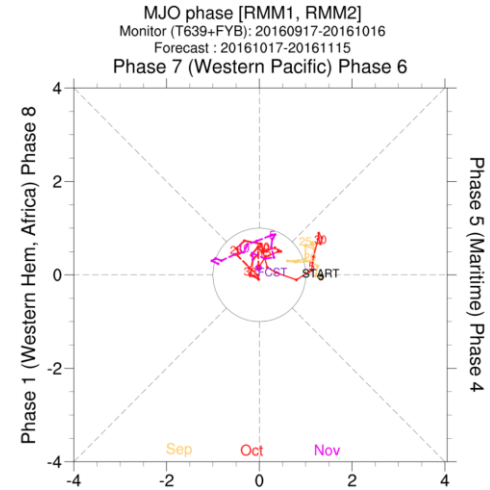
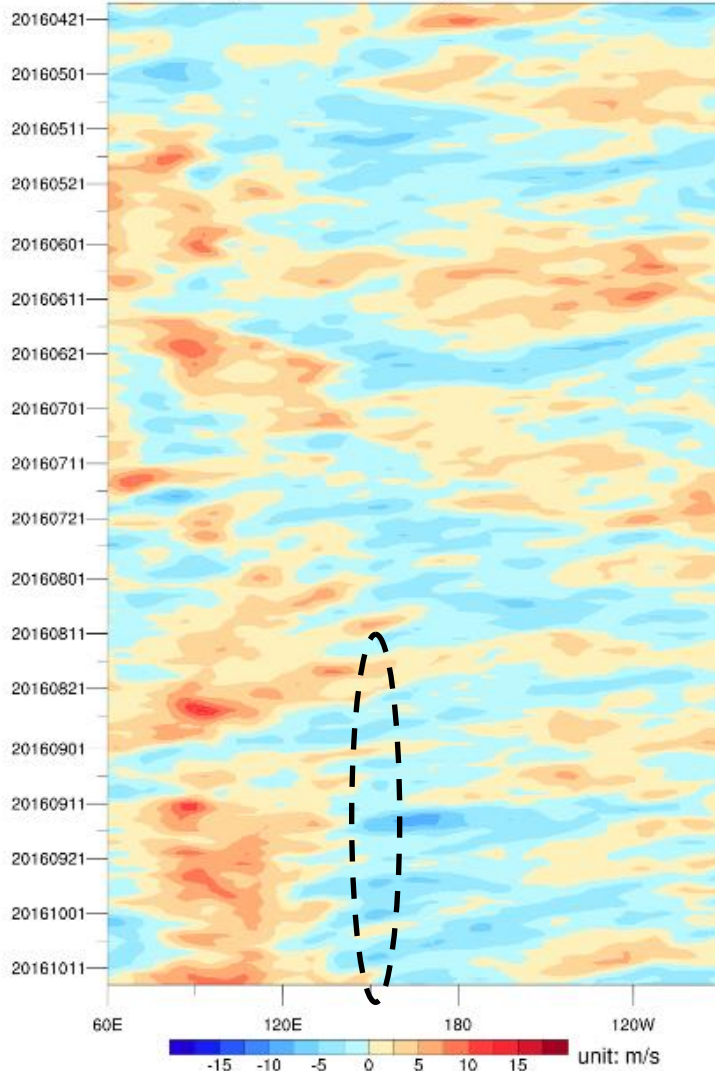
Monitor (OISST+GODAS) : 201510-201609; Forecast: 201610-201710



Low level daily zonal wind

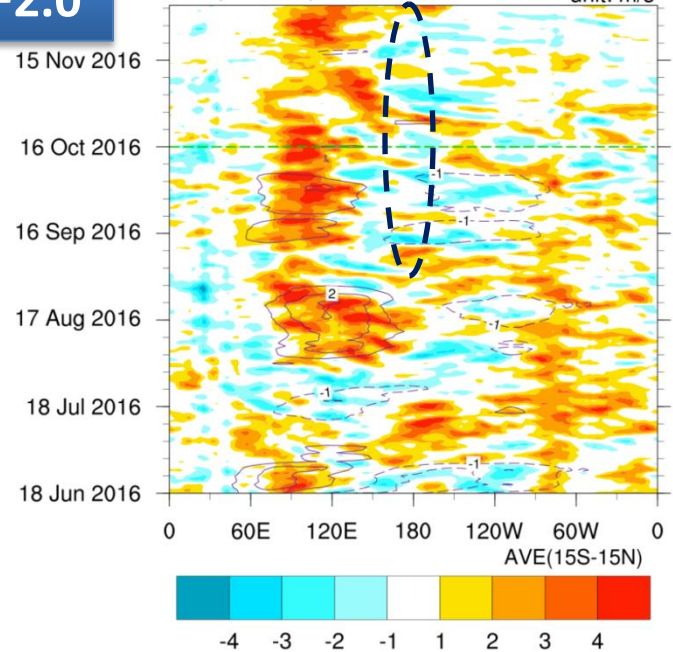
NCEP/NCAR Reanalysis

Daily Mean U850 Anomaly 5S-5N 20161014



T639+DERF2.0

U850 Anomaly (shade) and RMMI Reconstruction (contour)
 Monitor (T639): 20160618-20161015
 Forecast (DERF2.0) : 20161016-20161204 unit: m/s



Dynamical Attribution Analysis based on BJ index

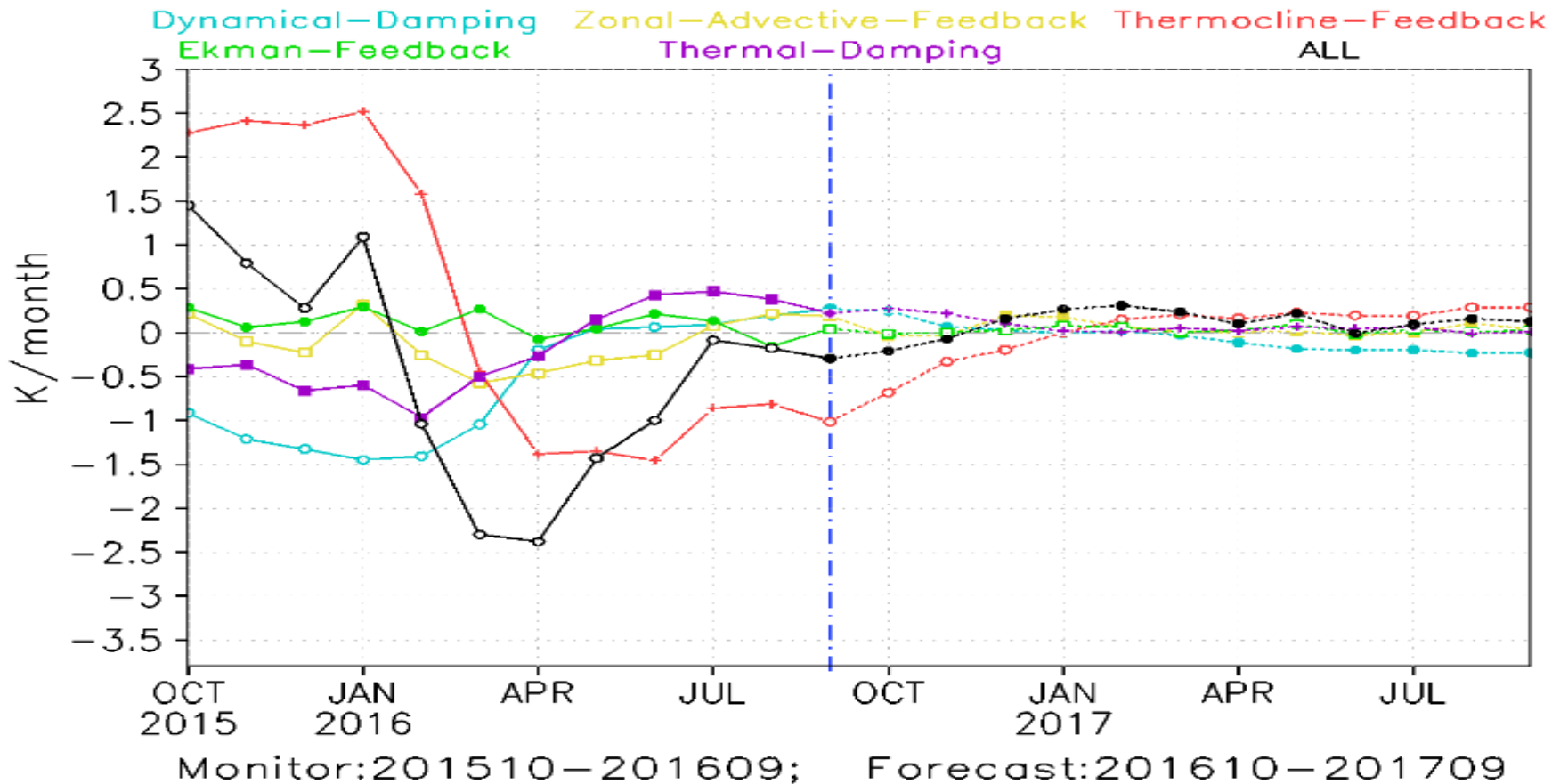
$$\frac{\partial \langle T \rangle_E}{\partial t} = - \left(\frac{\langle \bar{u} \rangle_E}{L_x} + \frac{\langle \bar{v} \rangle_E}{L_y} \right) \times \langle T \rangle_E -$$

$$\langle u \rangle_E \left\langle \frac{\partial \bar{T}}{\partial x} \right\rangle_E + [H(\bar{w}) \bar{w}_{50m}]_E \times$$

$$\frac{T_{mb}}{H_m} - \langle w \rangle_E \left\langle H(\bar{w}) \frac{\partial \bar{T}}{\partial z} \right\rangle_E + \langle Q \rangle_E$$

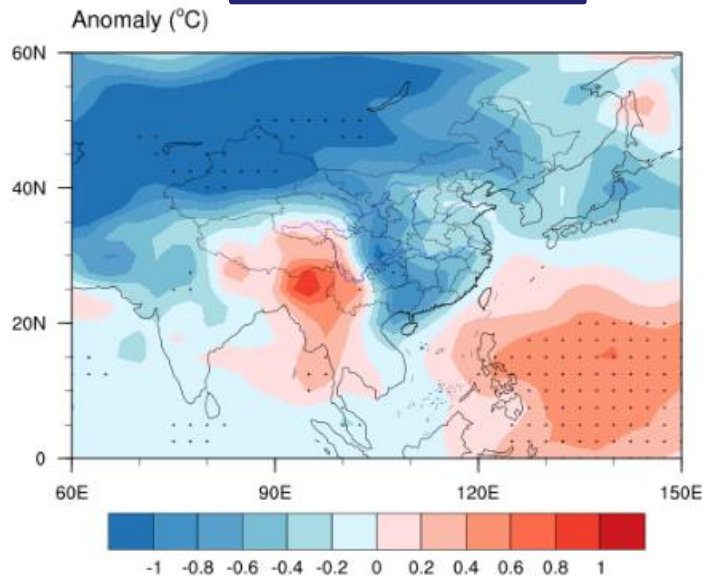
Bjerknes (BJ) stability index (Jin et al., 2006)

Diagnosis and Prediction of ENSO Feedback Processes

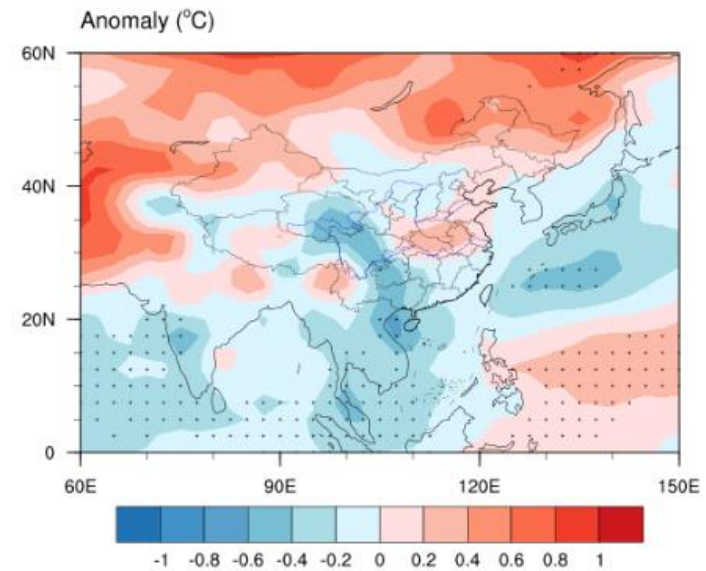


- A weak La Nina event is expected since August 2016, and could last until next spring.

La Nina Winter(0)



La Nina Spring(+1)



Thank You !