EASCOF-IV 2016 Nov 08 Ulaanbaatar

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

Jianghua Wan, Hongli Ren, Ying Liu, Jinqing Zuo,

Bo Lu, Ben Tian, Feifei Jin

Beijing Climate Center, China Meteorological Administration

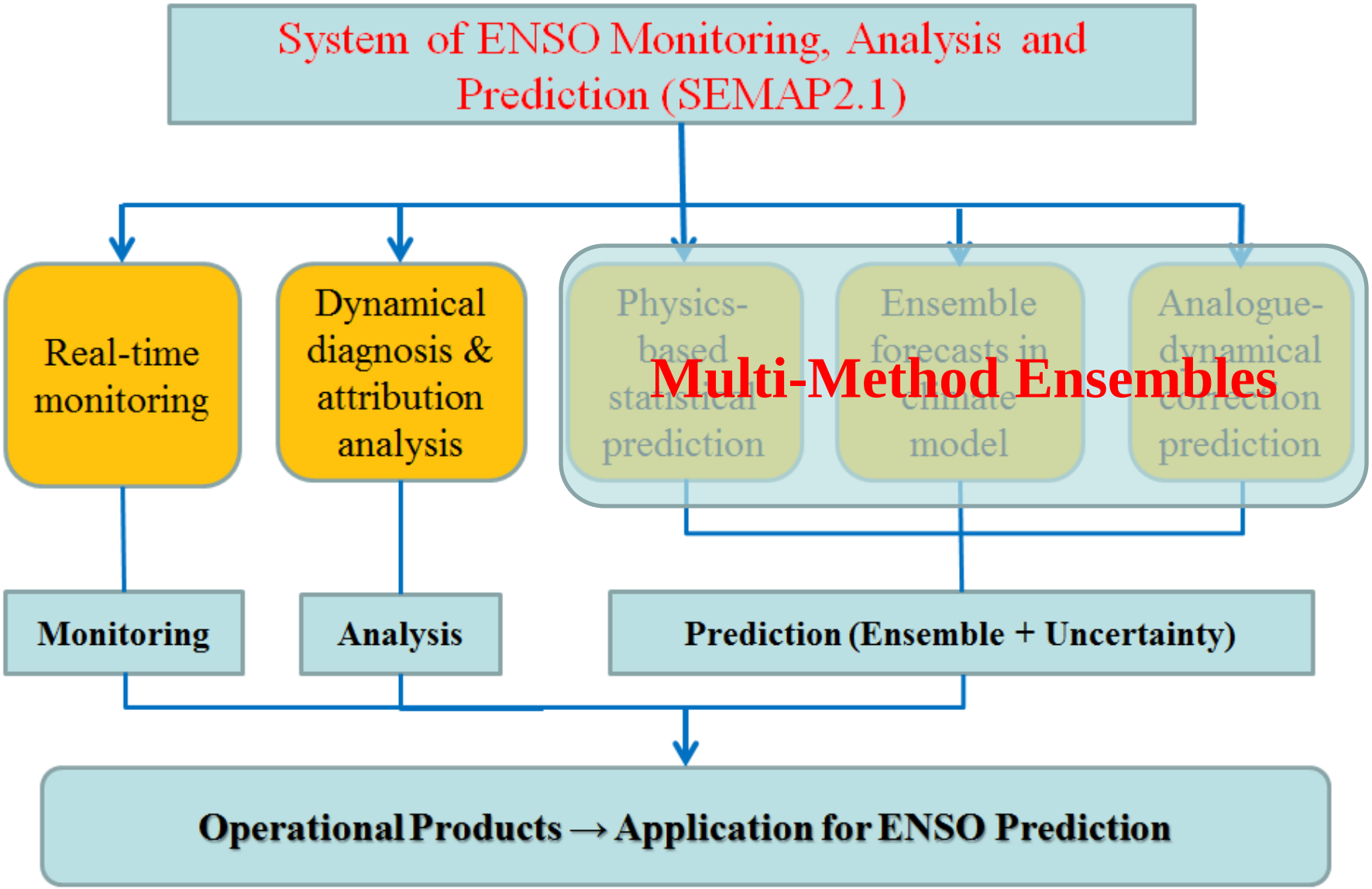
Outline

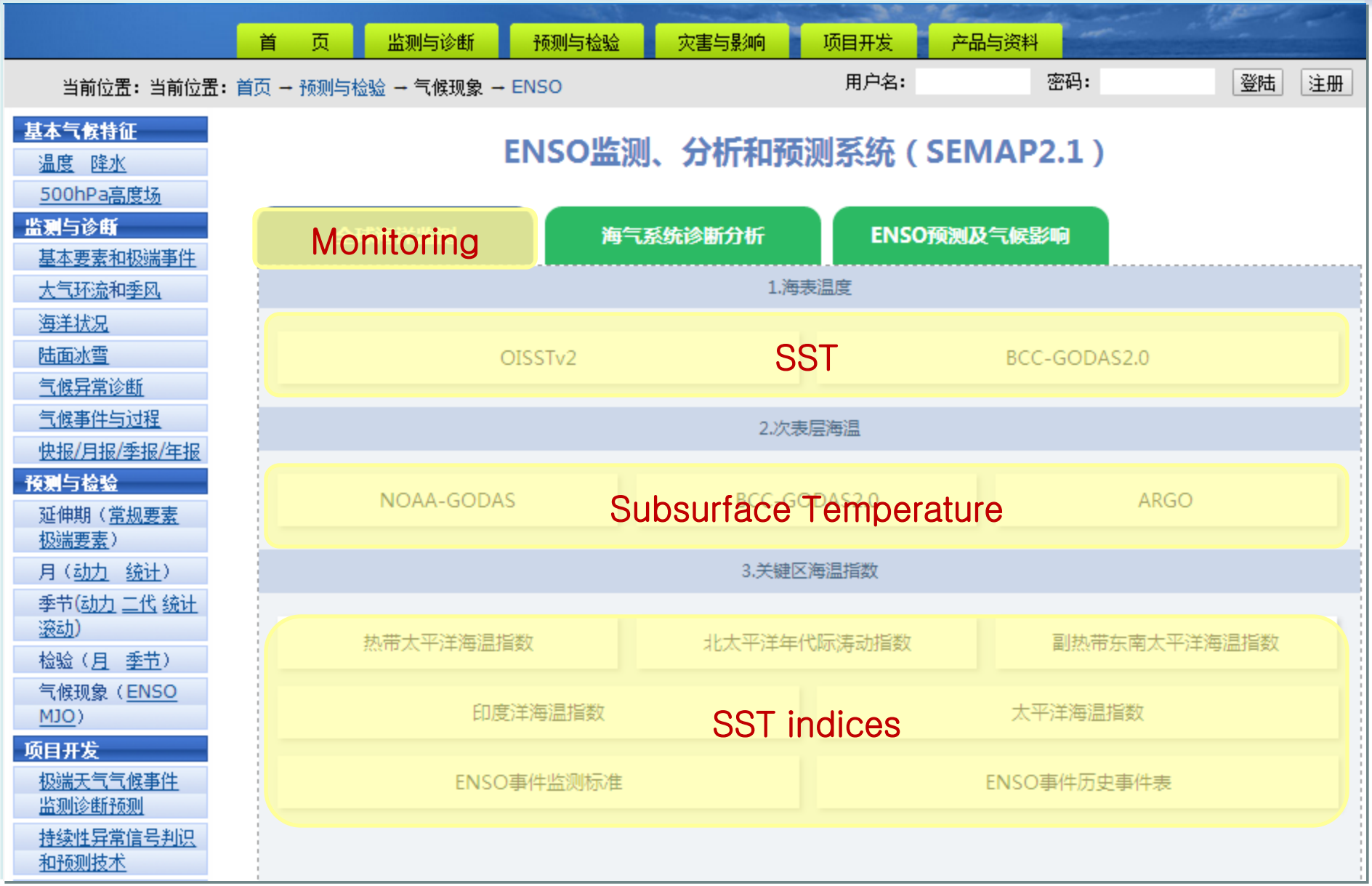
1) SEMAP2.1 System Structure

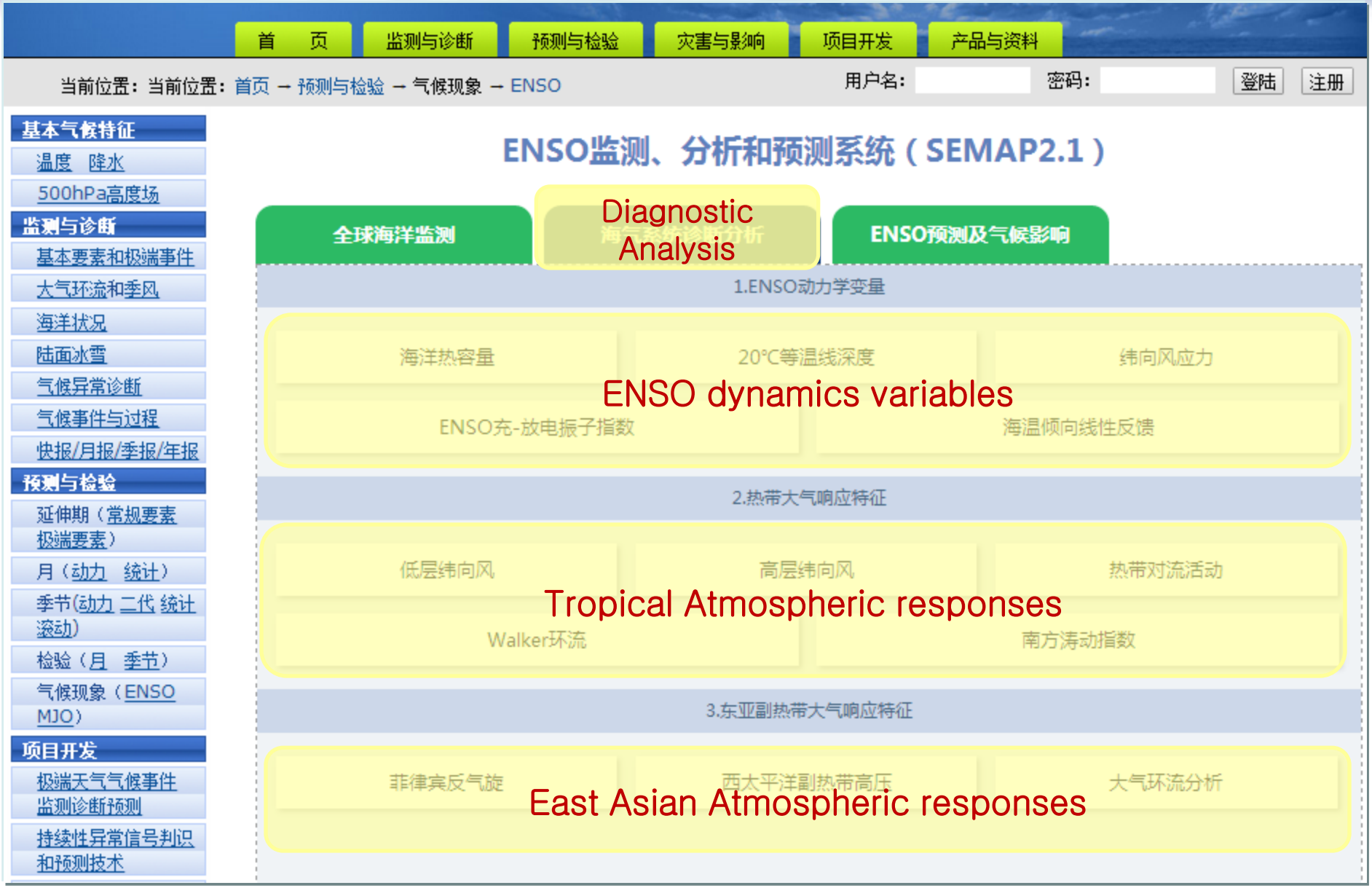
2) Performance during the 2014/2016 Strong El Nino event

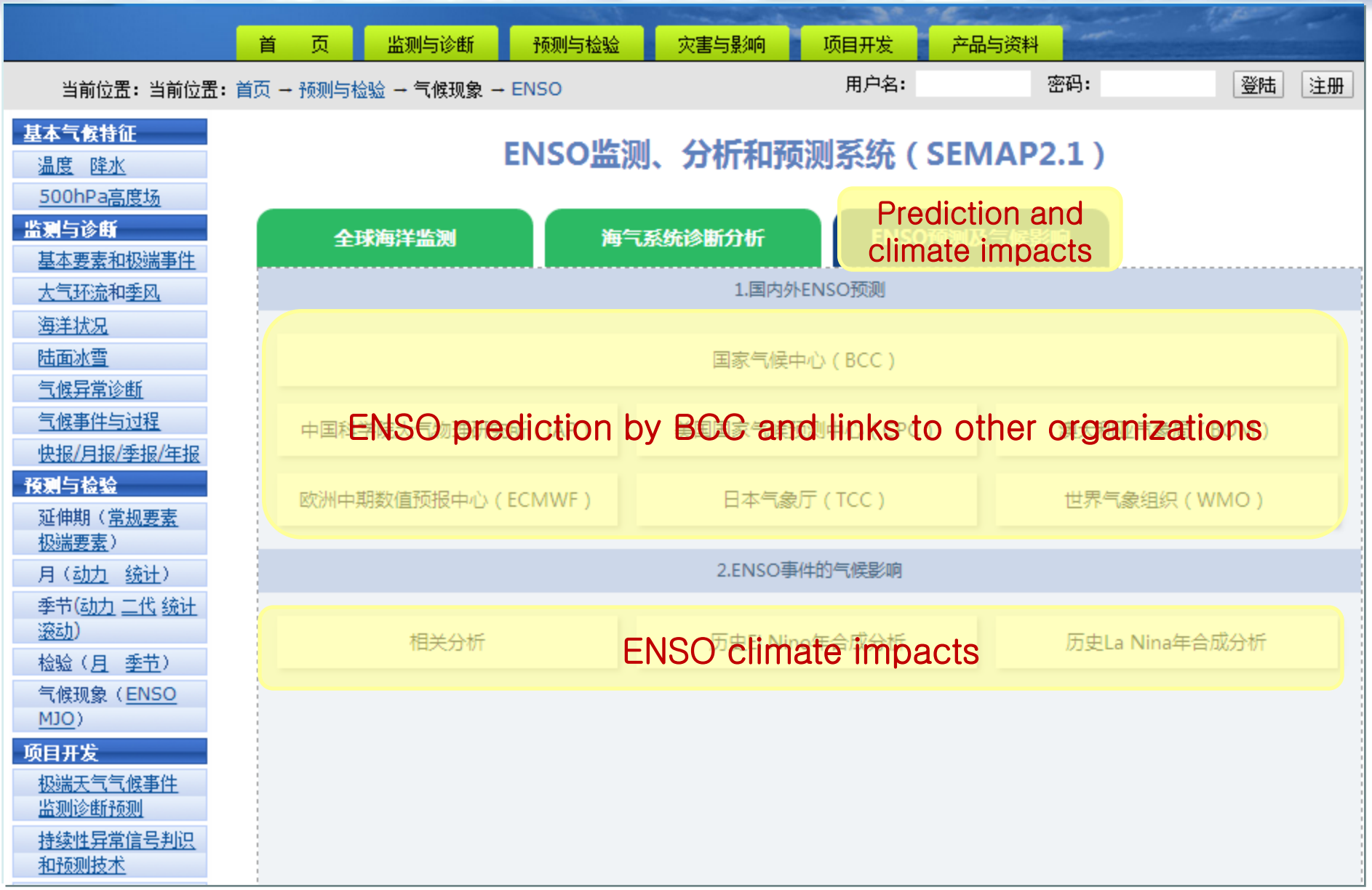
3) Outlook of ENSO for 2016/2017 winter

SEMAP2.1 System Structure




首 页
监测与诊断
预测与检验
灾害与影响
项目开发
产品与资料
当前位置：当前位置：首页 → 预测与检验 → 气候现象 → ENSO
用户名：
密码：
登陆
注册
基本气候特征
温度 降水
500hPa高度场
监测与诊断
基本要素和极端事件
大气环流和季风
海洋状况
陆面冰雪
气候异常诊断
气候事件与过程
快报/月报/季报/年报
预测与检验
延伸期（常规要素 极端要素）
月（动力 统计）
季节(动力 二代 统计 滚动)
检验（月 季节）
气候现象（ENSO MJO）
项目开发
极端天气气候事件监测诊断预测
持续性异常信号判识和预测技术
ENSO监测、分析和预测系统（SEMAP2.1）
Monitoring
海气系统诊断分析
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
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
印度洋海温指数
SST indices
太平洋海温指数
ENSO事件监测标准
ENSO事件历史事件表


首 页
监测与诊断
预测与检验
灾害与影响
项目开发
产品与资料
当前位置：当前位置：首页 – 预测与检验 – 气候现象 – ENSO
用户名：
密码：
登陆
注册
基本气候特征
温度 降水
500hPa高度场
监测与诊断
基本要素和极端事件
大气环流和季风
海洋状况
陆面冰雪
气候异常诊断
气候事件与过程
快报/月报/季报/年报
预测与检验
延伸期（常规要素 极端要素）
月（动力 统计）
季节(动力 二代 统计 滚动)
检验（月 季节）
气候现象（ENSO MJO）
项目开发
极端天气气候事件监测诊断预测
持续性异常信号判识和预测技术
ENSO监测、分析和预测系统（SEMAP2.1）
全球海洋监测
Diagnostic Analysis
ENSO预测及气候影响
1.ENSO动力学变量
海洋热容量
20℃等温线深度
纬向风应力
ENSO充-放电振子指数
海温倾向线性反馈
ENSO dynamics variables
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
Walker环流
南方涛动指数
Tropical Atmospheric responses
3.东亚副热带大气响应特征
菲律宾反气旋
西太平洋副热带高压
大气环流分析
East Asian Atmospheric responses


首 页
监测与诊断
预测与检验
灾害与影响
项目开发
产品与资料
当前位置：当前位置：首页 → 预测与检验 → 气候现象 → ENSO
用户名：
密码：
登陆
注册
基本气候特征
温度 降水
500hPa高度场
监测与诊断
基本要素和极端事件
大气环流和季风
海洋状况
陆面冰雪
气候异常诊断
气候事件与过程
快报/月报/季报/年报
预测与检验
延伸期（常规要素 极端要素）
月（动力 统计）
季节(动力 二代 统计 滚动)
检验（月 季节）
气候现象（ENSO MJO）
项目开发
极端天气气候事件监测诊断预测
持续性异常信号判识和预测技术
ENSO监测、分析和预测系统（SEMAP2.1）
全球海洋监测
海气系统诊断分析
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

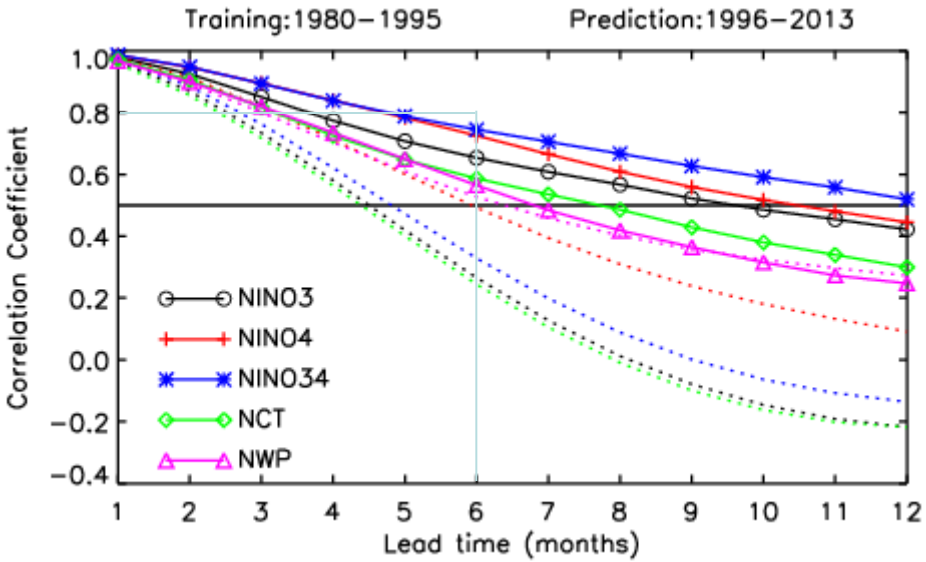
1. ENSO Physics-based statistical prediction

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。

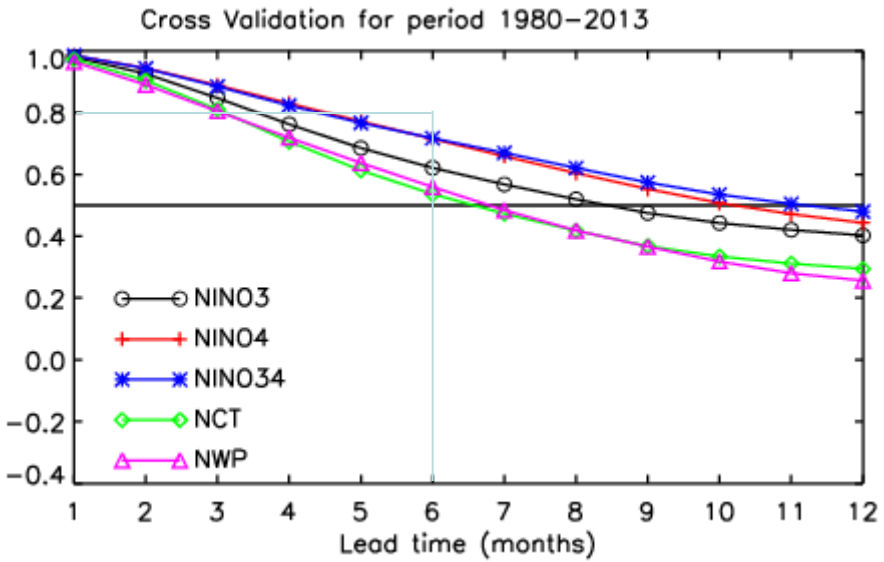
（Jin 1997; Jin and An 1999; Ren and Jin 2013）

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

Independent Sample Validation



Cross Validation



2. BCC_CSM1.1m Ensemble prediction

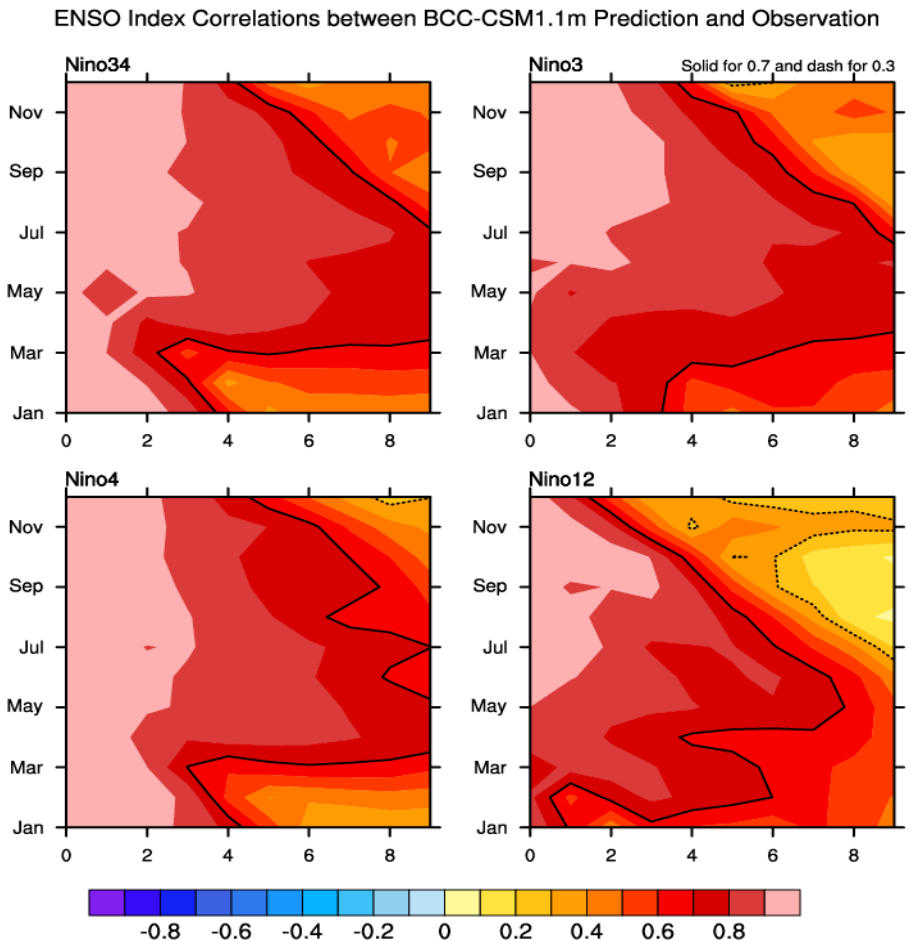
BCC-CSM1.1m — **LAF**, **SVD**

24 members

Initial Error

Horizontal res: 110km

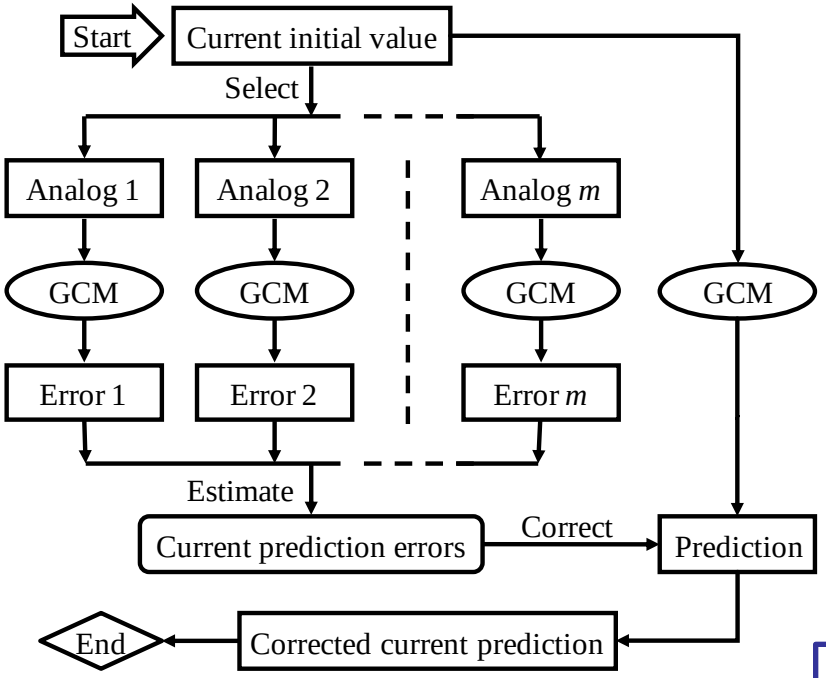
BCC_AGCM2.2: T106, 26 levels
MOM_L40: 0.333° / 1°
(Wu et al. 2014)



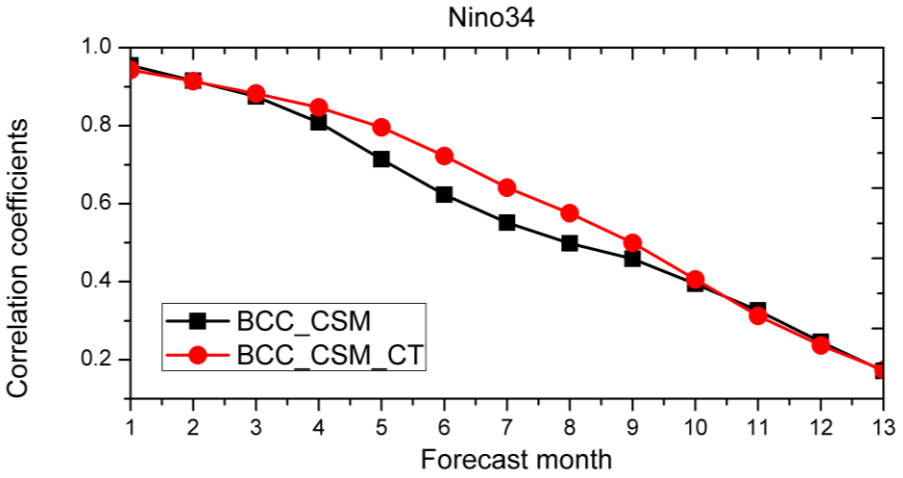
3. Analogue-dynamical correction prediction (ADEPS)

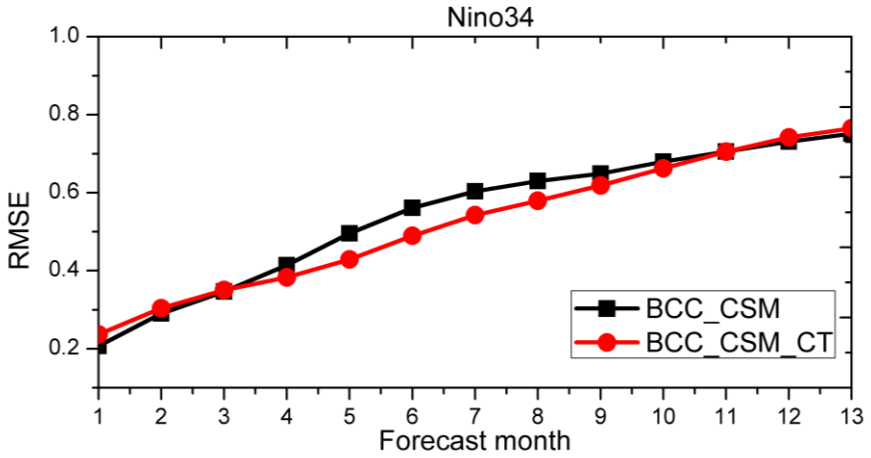
Using the historical information, we developed the analogue dynamical correction strategy to the ENSO prediction of the climate model.

$$\hat{P}_{\mathrm{M}}(\psi_0) = P_{\mathrm{M}}(\psi_0) + \tilde{P}_{\mathrm{M}}(\tilde{\psi}_j) - P_{\mathrm{M}}(\tilde{\psi}_j)$$



（Ren et al. 2014）





Model Error

Comparison of all prediction methods

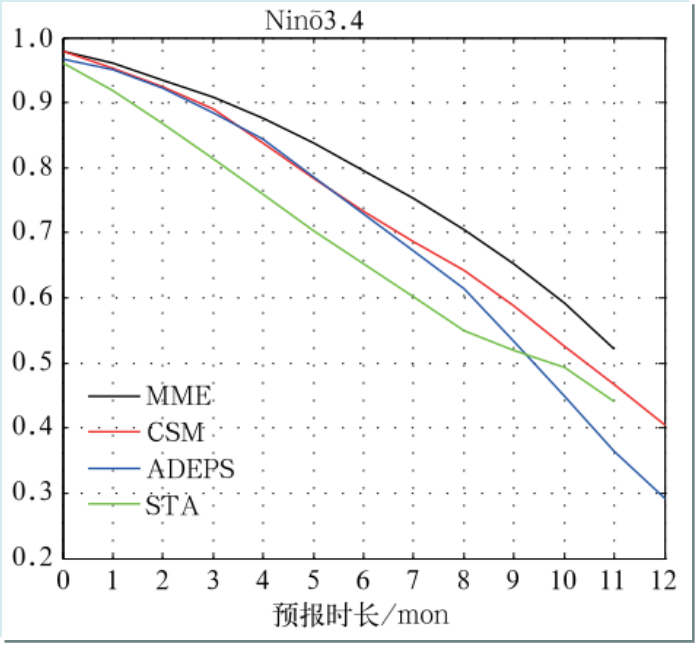


Fig. 3 Temporal anomaly correlation coefficients of Niño3.4 index prediction by SEMAP2.0 during 1996－2015 for BCC_CSM1.1m (red line), ADEPS (blue line), statistical prediction model (STA, green line), and their ensemble mean (MME, black line), respectively

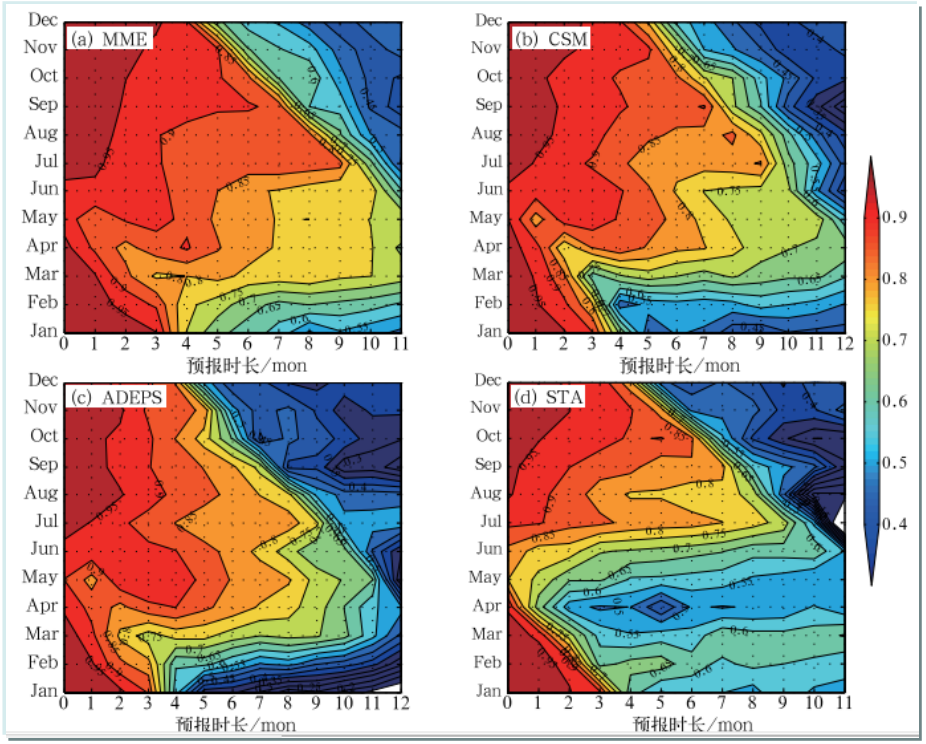
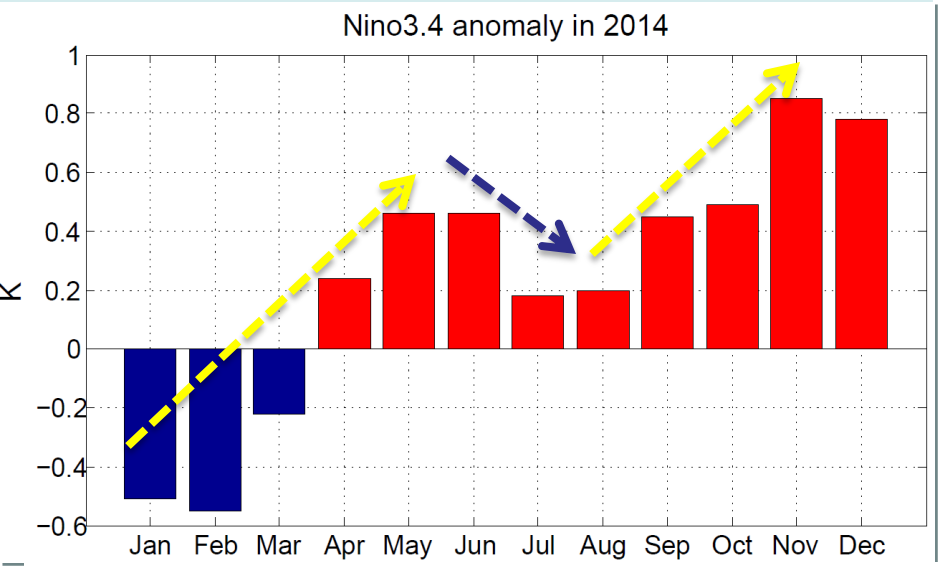
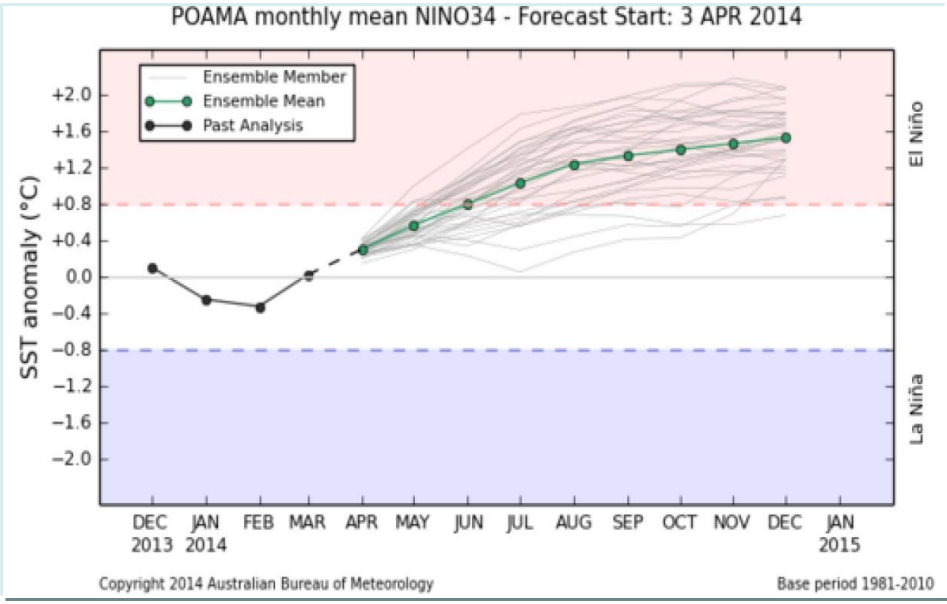


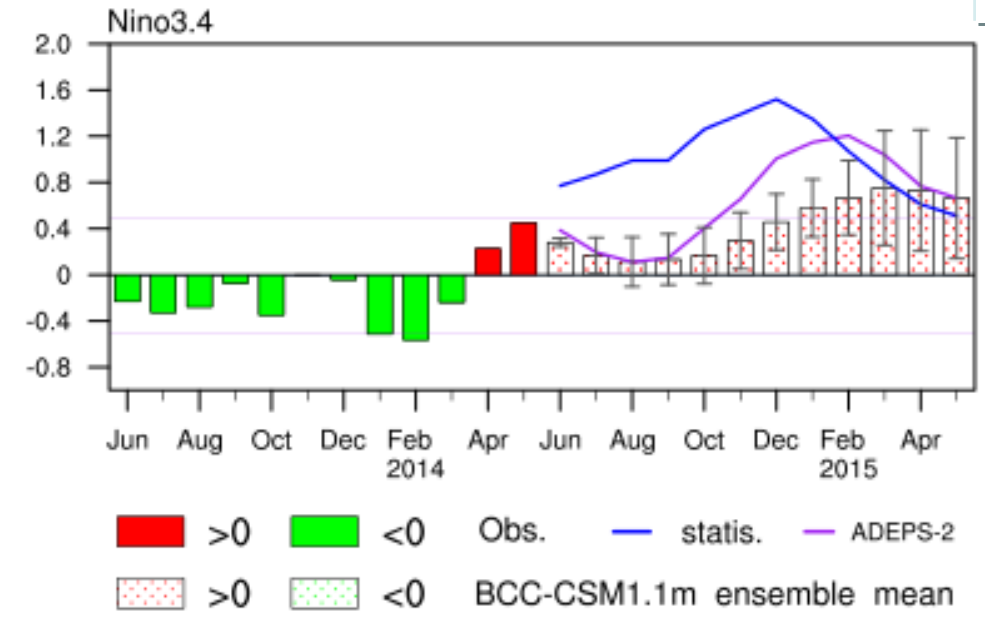
Fig. 4 Seasonal dependence of temporal anomaly correlation coefficients of Niño3.4 index prediction by SEMAP2.0 during 1996－2015 for BCC_CSM1.1m (b), ADEPS (c), statisitical prediction model (STA, d), and their ensemble mean (MME, a), respectively
(Where *x*-axis is forecast months and *y*-axis the initial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

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

2014 Spring







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

2015 Spring: ENSO type transition

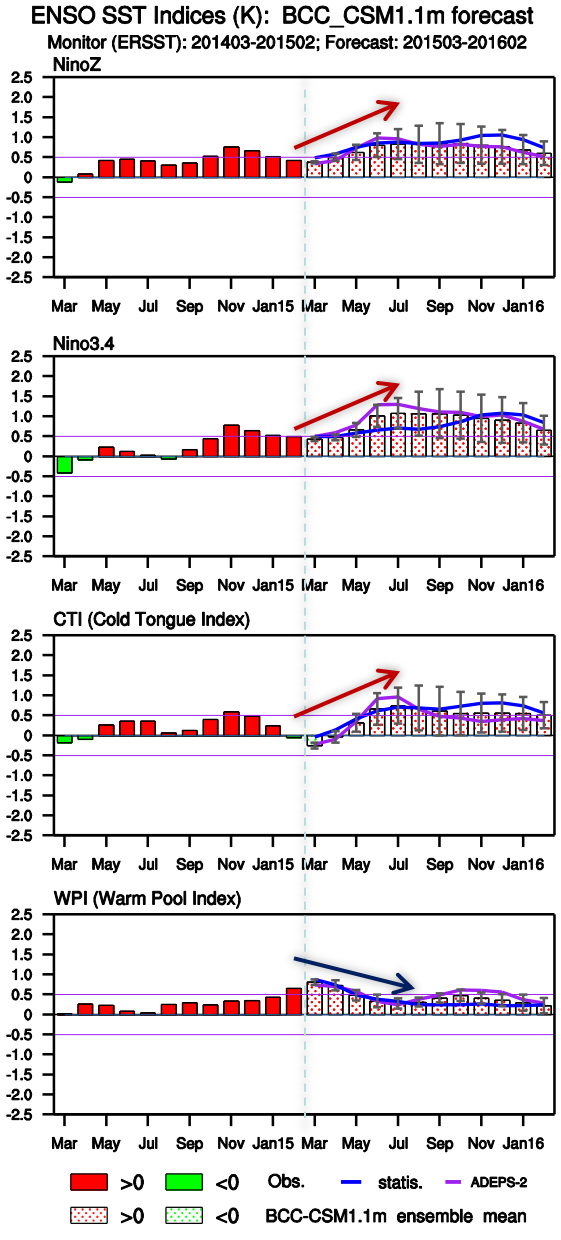
NiñoZ

Niño3.4

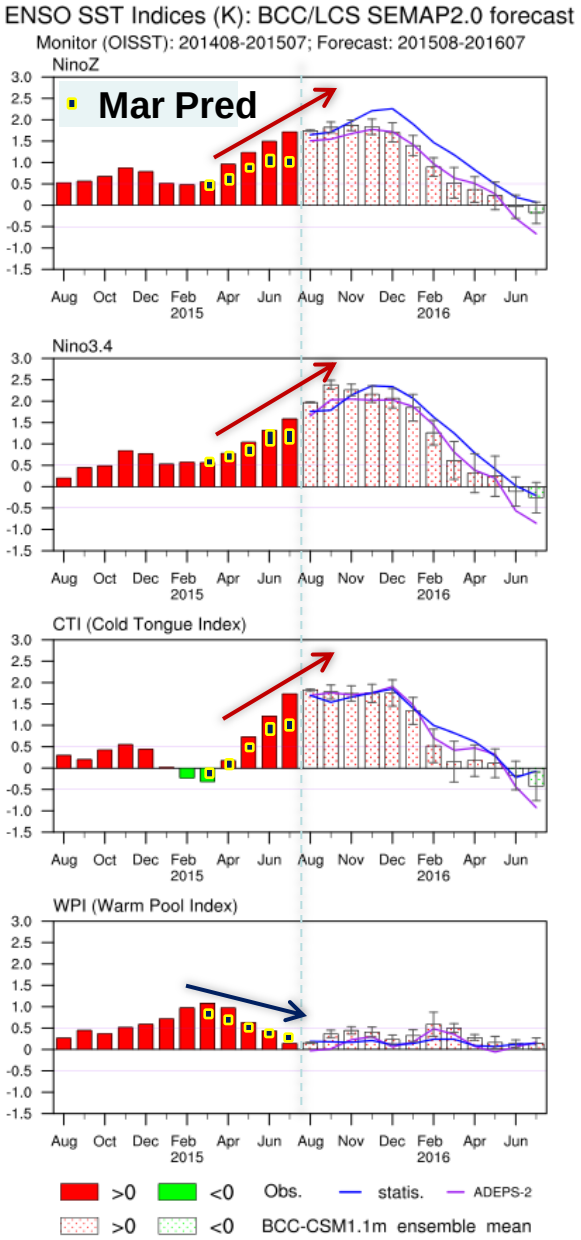
EP

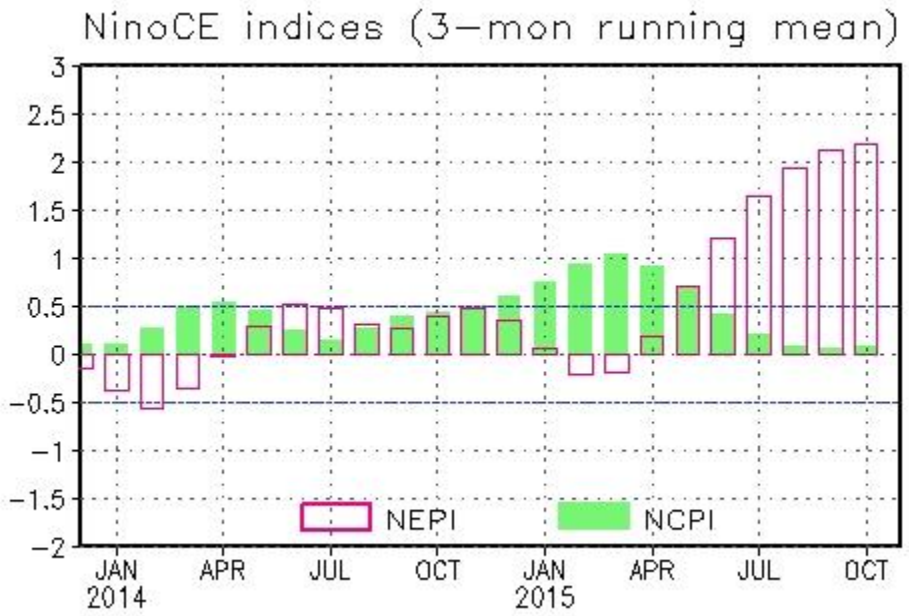
CP

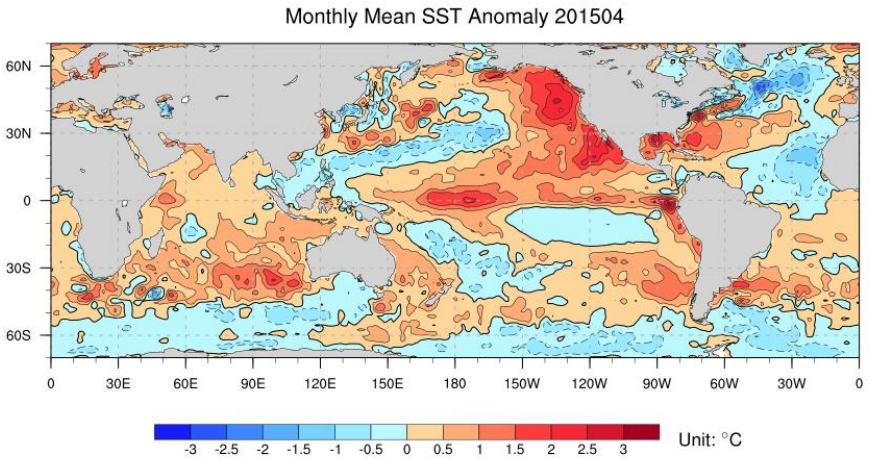
March

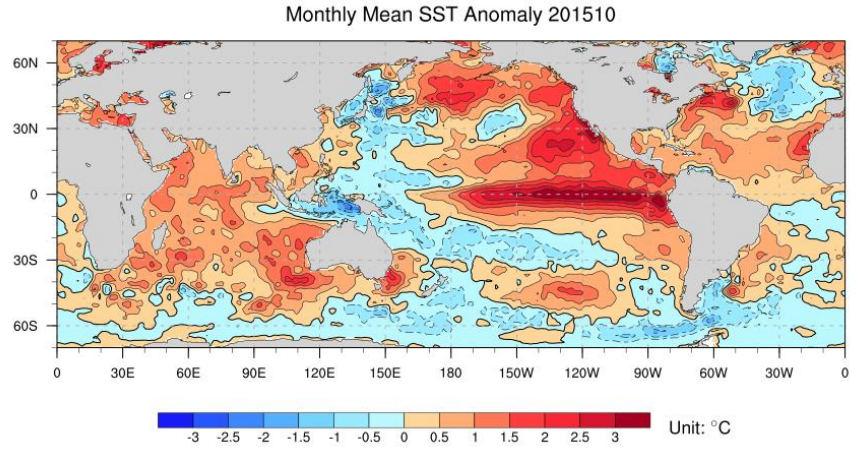


August









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

CP El Nino → EP El Nino

2015 Autumn

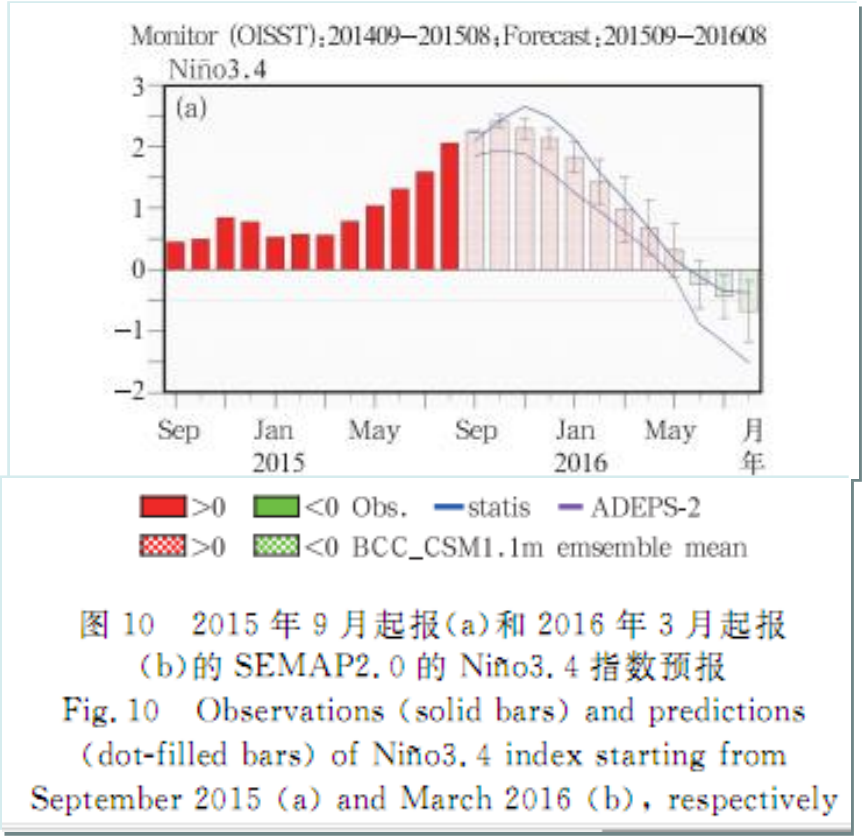
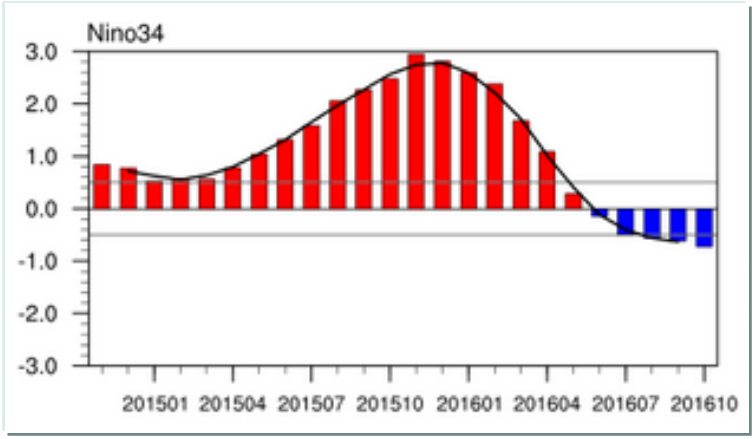
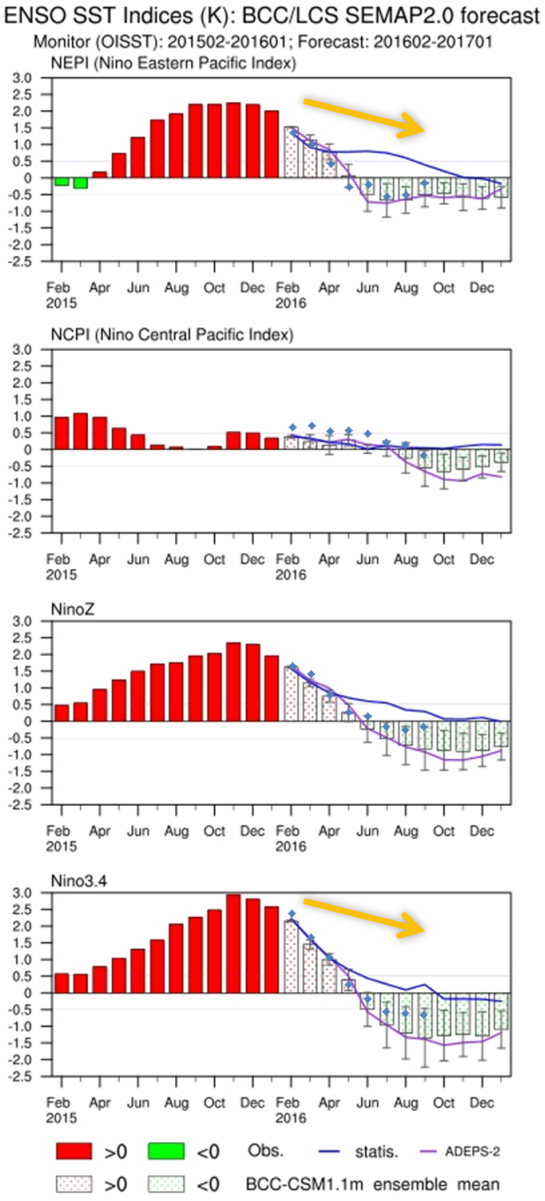


图 10　2015 年 9 月起报(a)和 2016 年 3 月起报(b)的 SEMAP2.0 的 Niño3.4 指数预报

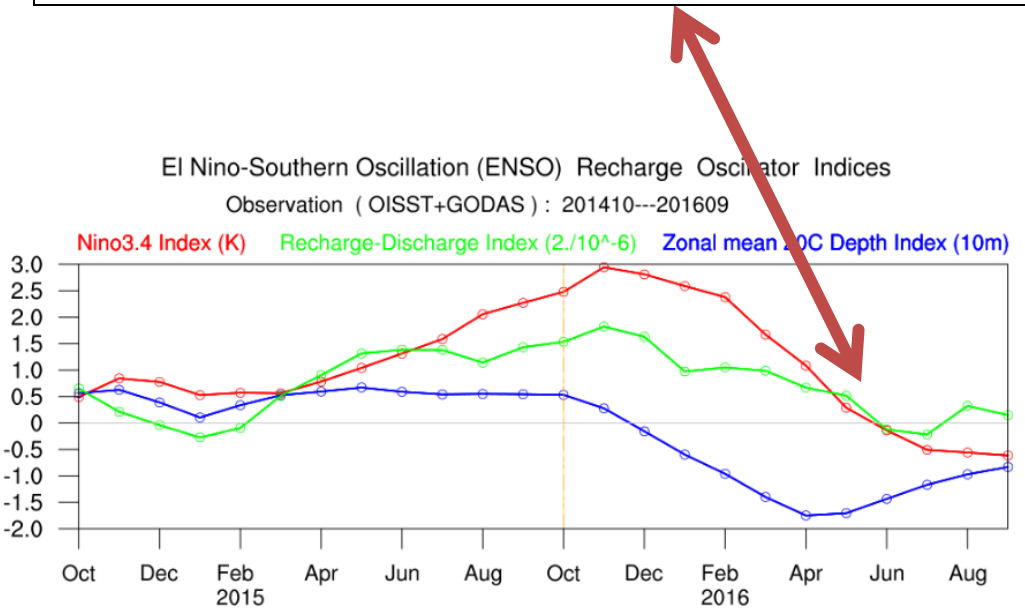
Fig. 10　Observations (solid bars) and predictions (dot-filled bars) of Niño3.4 index starting from September 2015 (a) and March 2016 (b), respectively



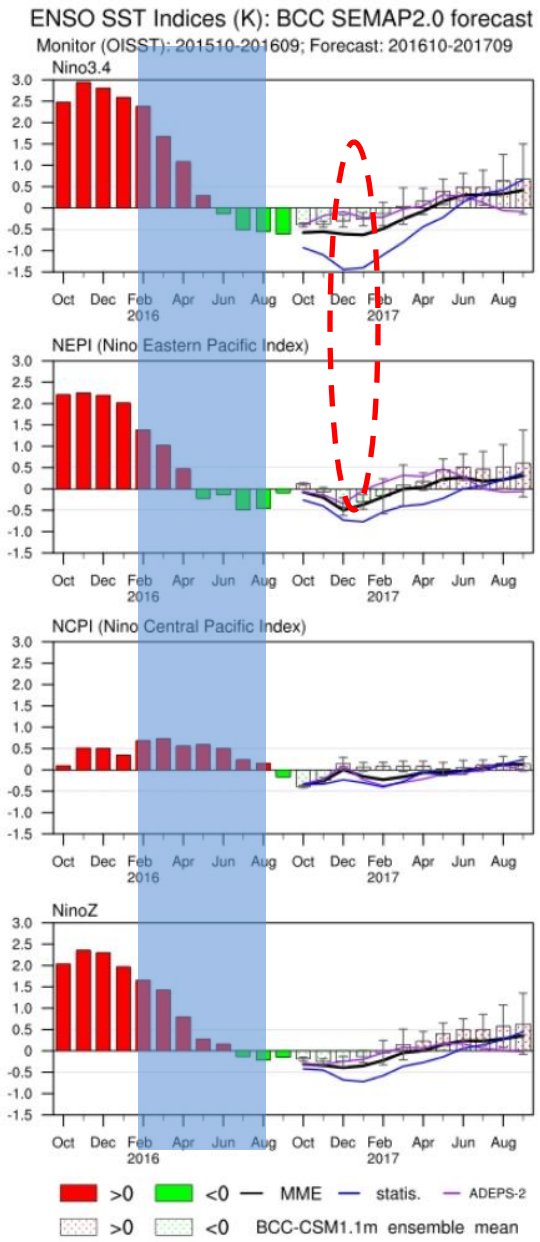
2016 Spring

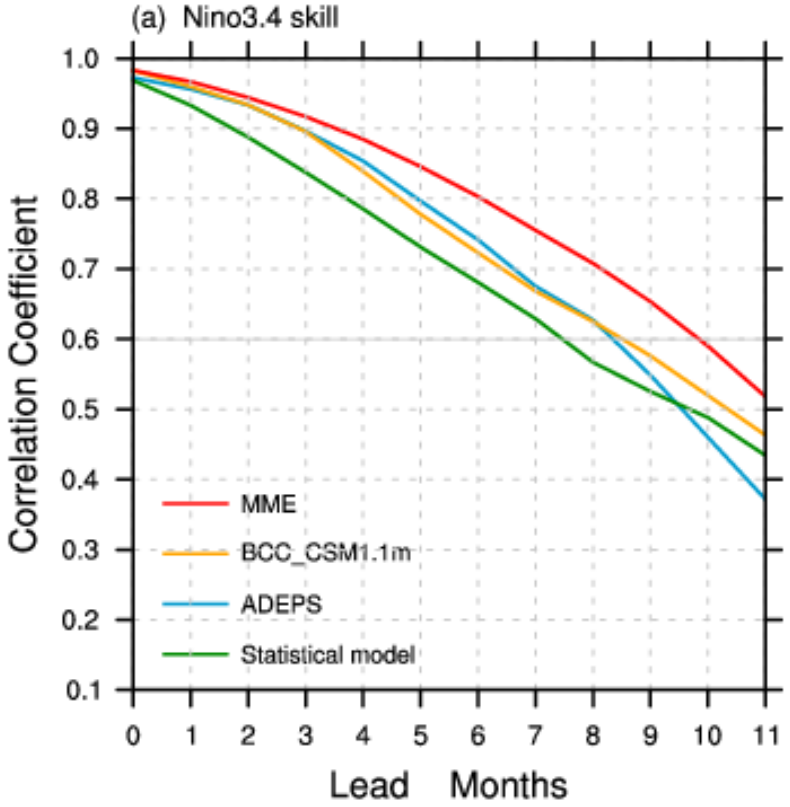


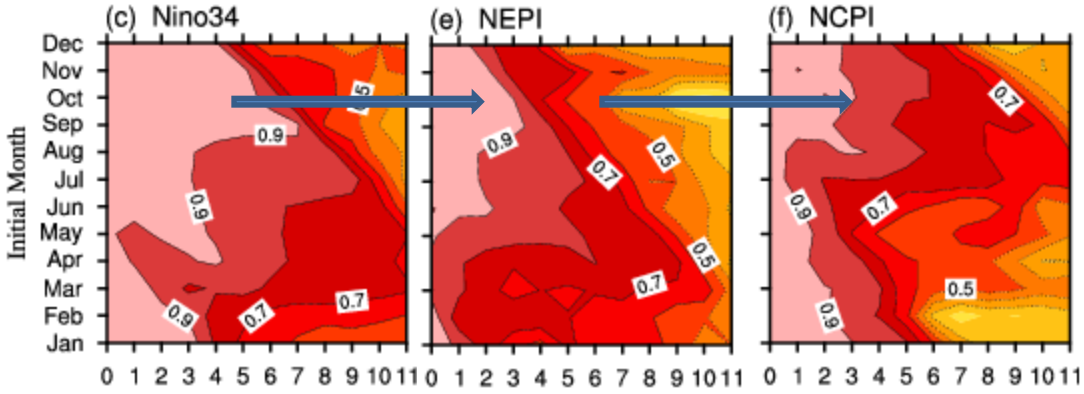
El Nino event is expected to weaken and end in May, followed by a neutral state in summer, and possibly grow into a cold event in autumn.



3) Outlook of ENSO for 2016/2017 winter

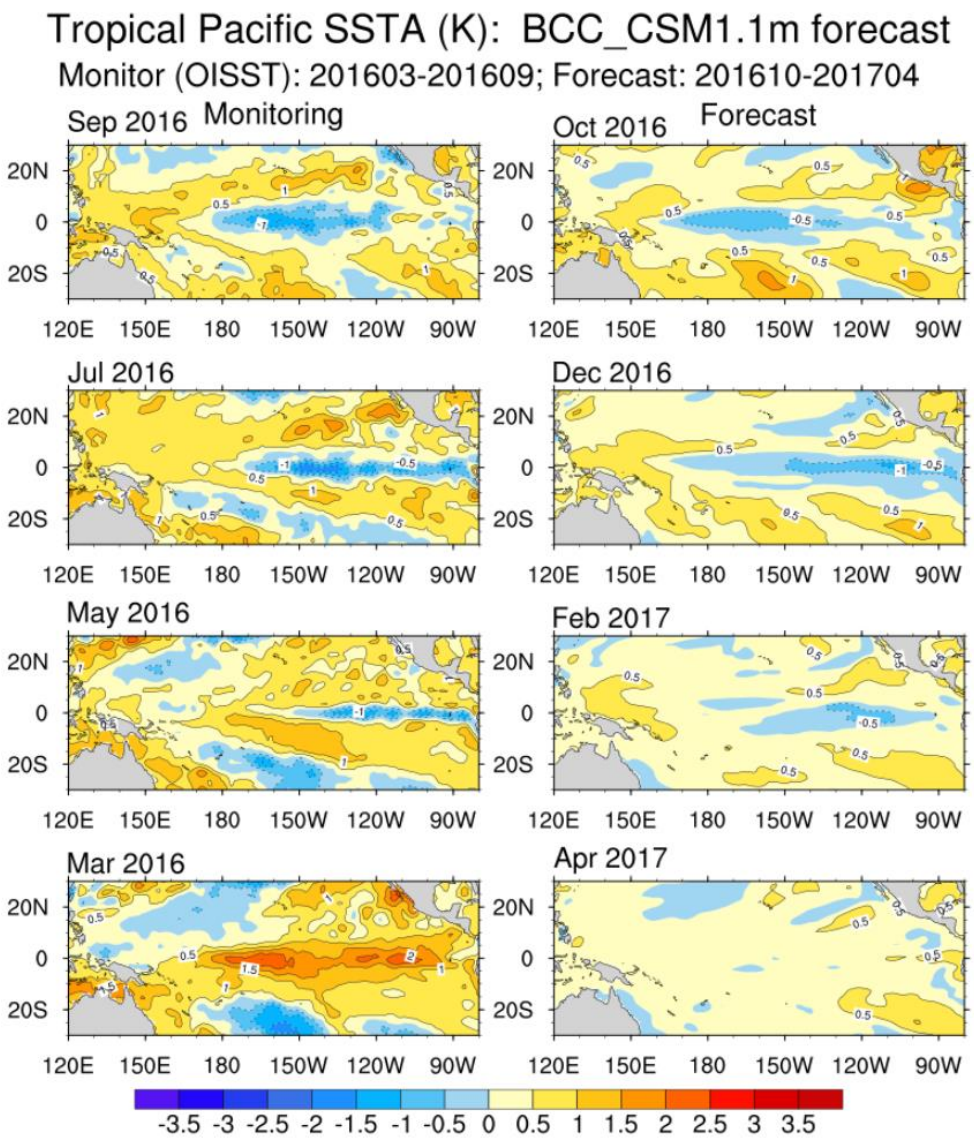






Tropical SSTA

Monitoring



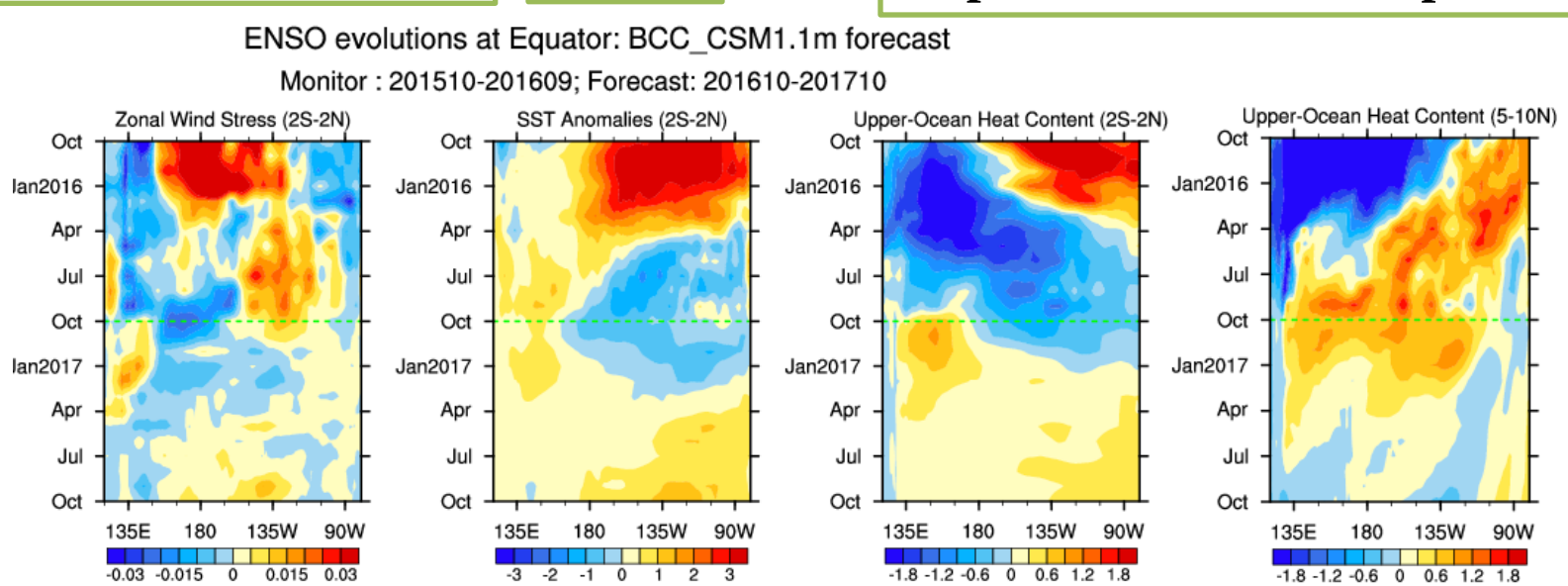
Forecast

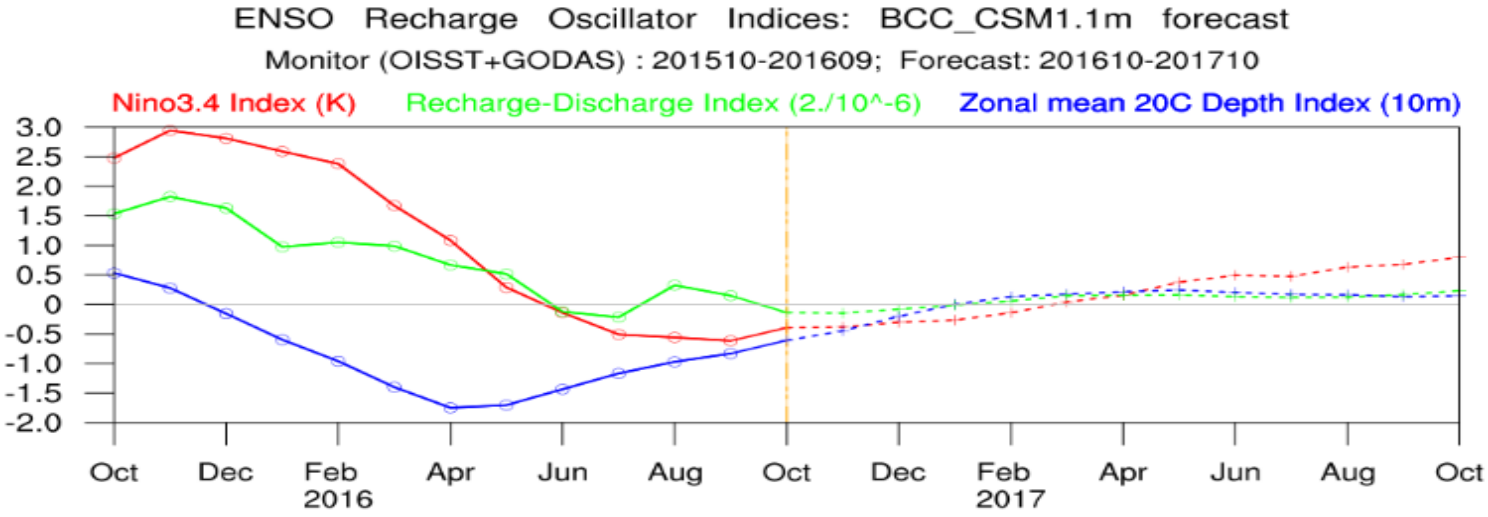
Zonal wind stress

SSTA

Upper-level ocean heat content

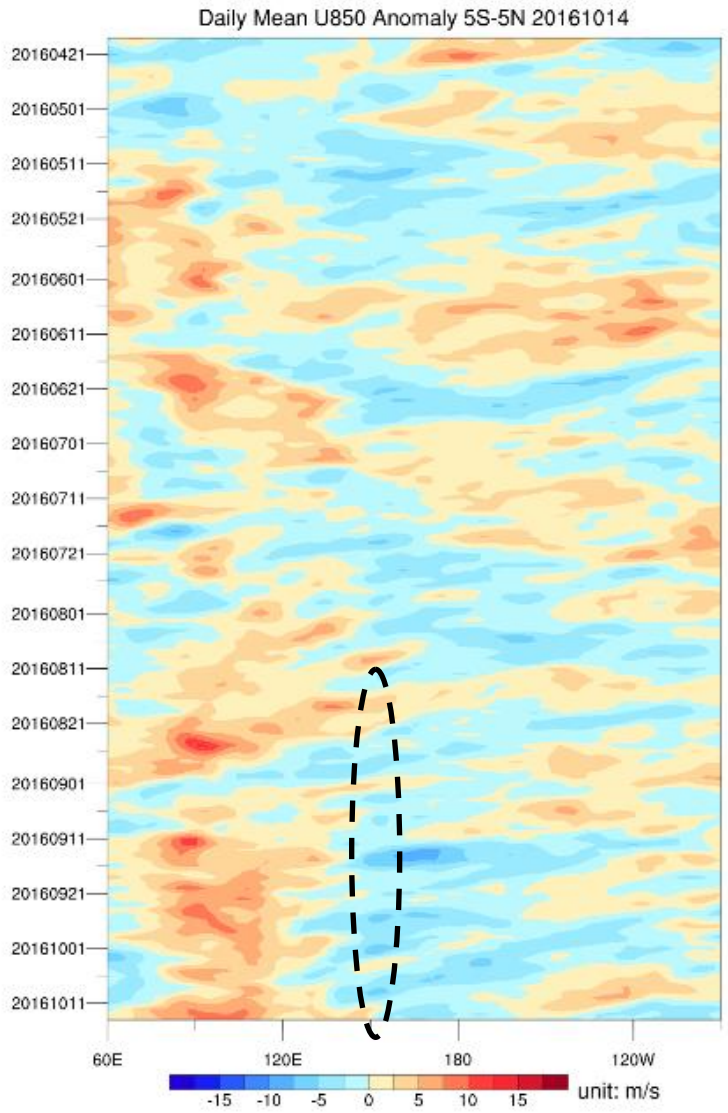
tropical **extra-tropical**

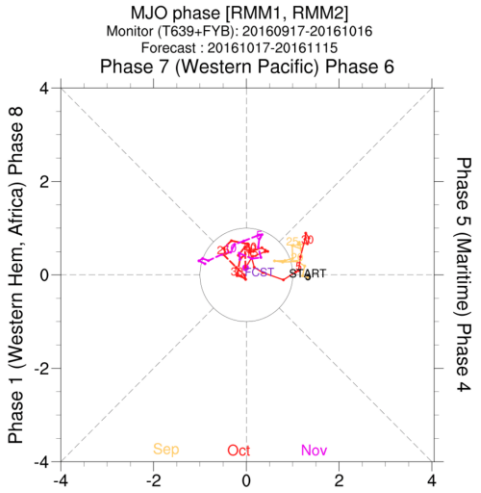




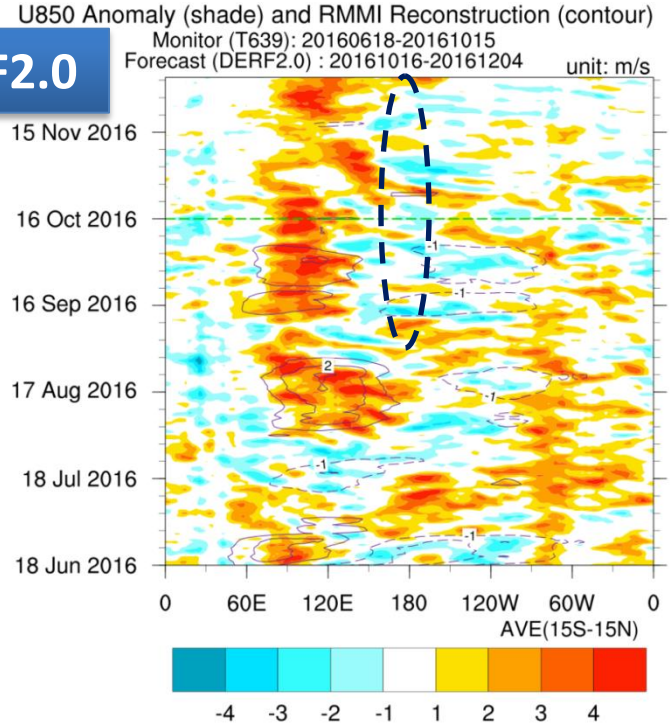
Low level daily zonal wind

NCEP/NCAR Reanalysis





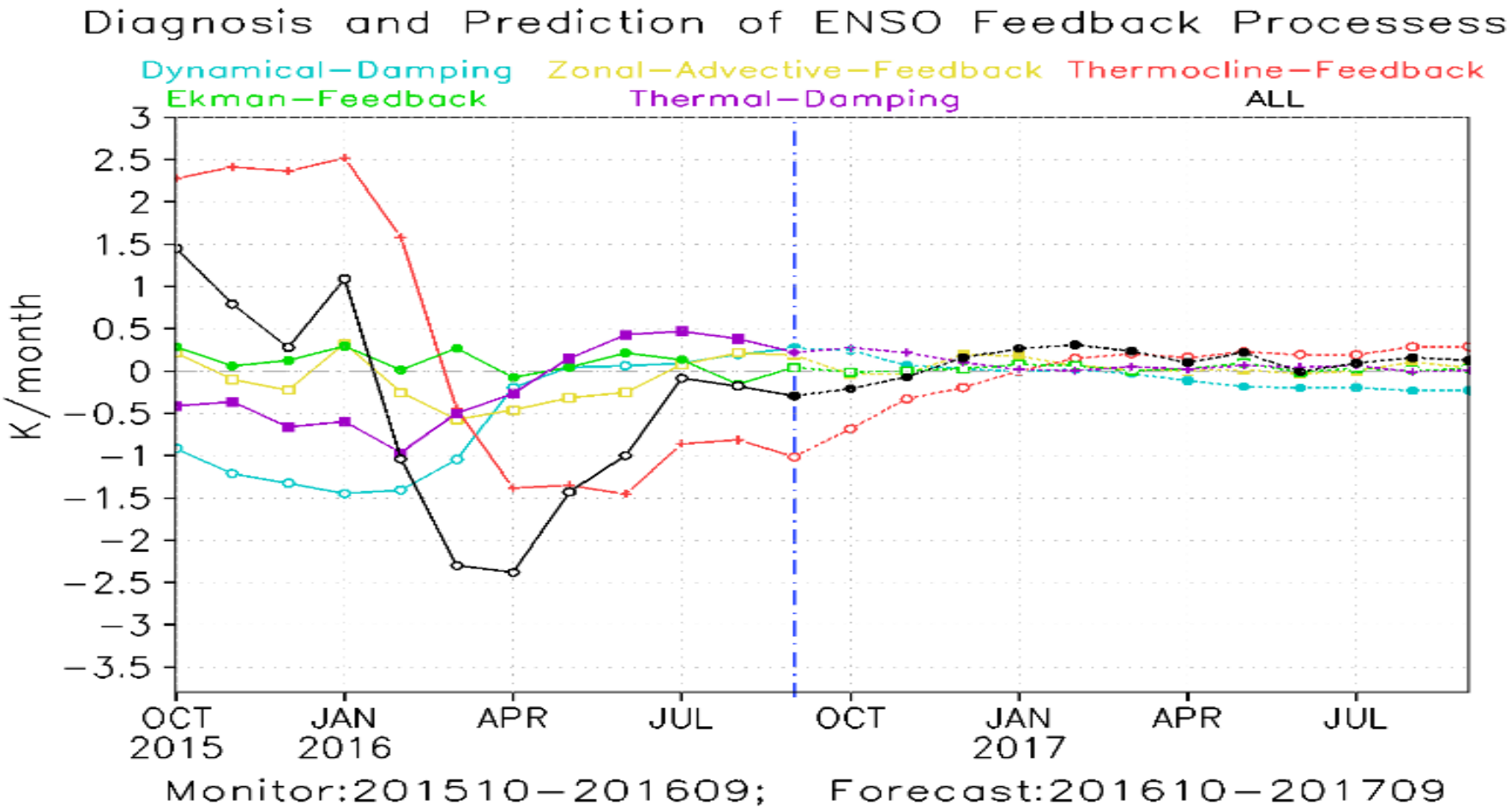
T639+DERF2.0



Dynamical Attribution Analysis based on BJ index

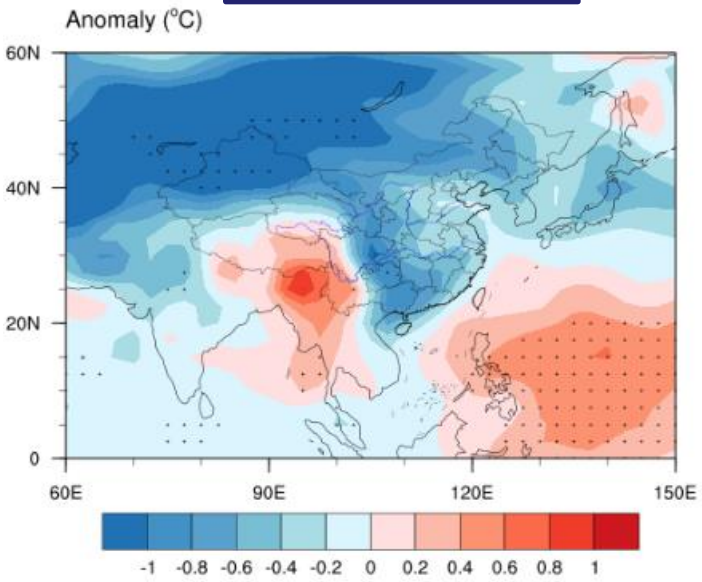
$$\frac{\partial \langle T \rangle_E}{\partial t} = -\left(\frac{\langle \overline{u} \rangle_E}{L_x} + \frac{\langle \overline{v} \rangle_E}{L_y}\right) \times \langle T \rangle_E - \langle u \rangle_E \langle \frac{\partial \overline{T}}{\partial x} \rangle_E + \left[H(\overline{w})\overline{w}_{50m}\right]_E \times \frac{T_{sub}}{H_m} - \langle w \rangle_E \langle H(\overline{w}) \frac{\partial \overline{T}}{\partial z} \rangle_E + \langle Q \rangle_E$$

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

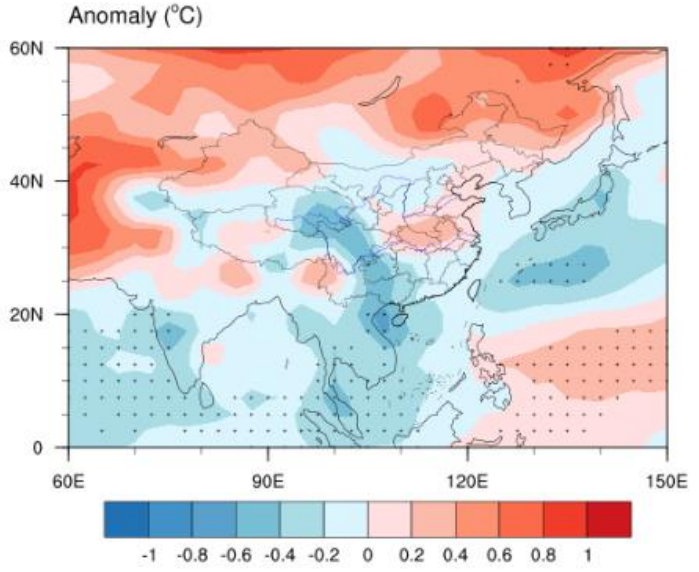


- A weak La Nina event is expected since August 2016, and could last until next spring.

La Nina Winter(0)



La Nina Spring(+1)



Thank You !