ENSO outlook

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Outline

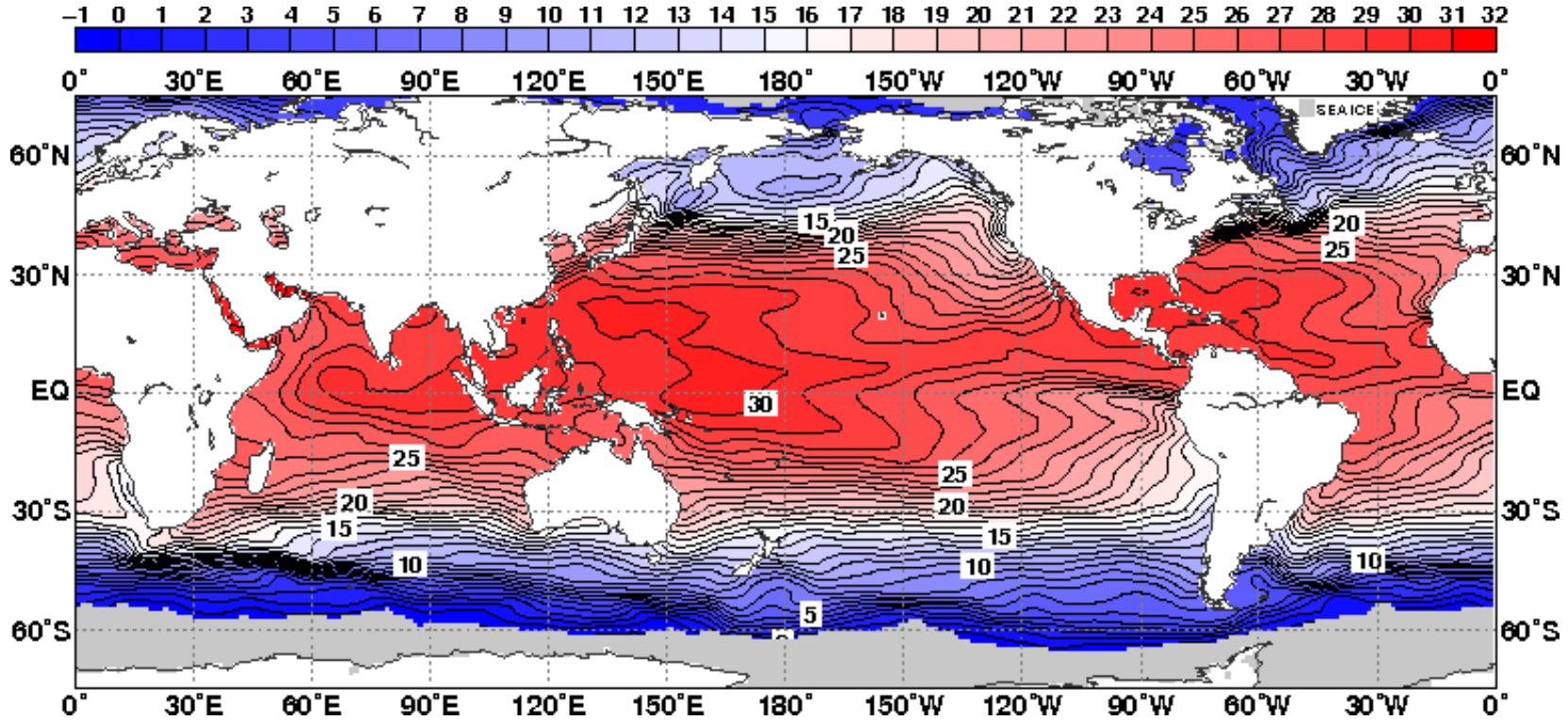
1. JMA's system for ENSO monitoring and prediction
2. Current conditions
3. Outlook
4. Summary

1. JMA's system for ENSO monitoring and prediction

- *SST analysis: COBE-SST*
- *Ocean data assimilation: MOVE-G*
- *Prediction model: JMA/MRI-CGCM*

Sea surface temperature: COBE-SST

- **Using only in-situ observations.**
- **Horizontal resolution: 1˚ x 1˚**
- **Optimal interpolation (OI)**
- **Provided as monthly averaged grid point data.**

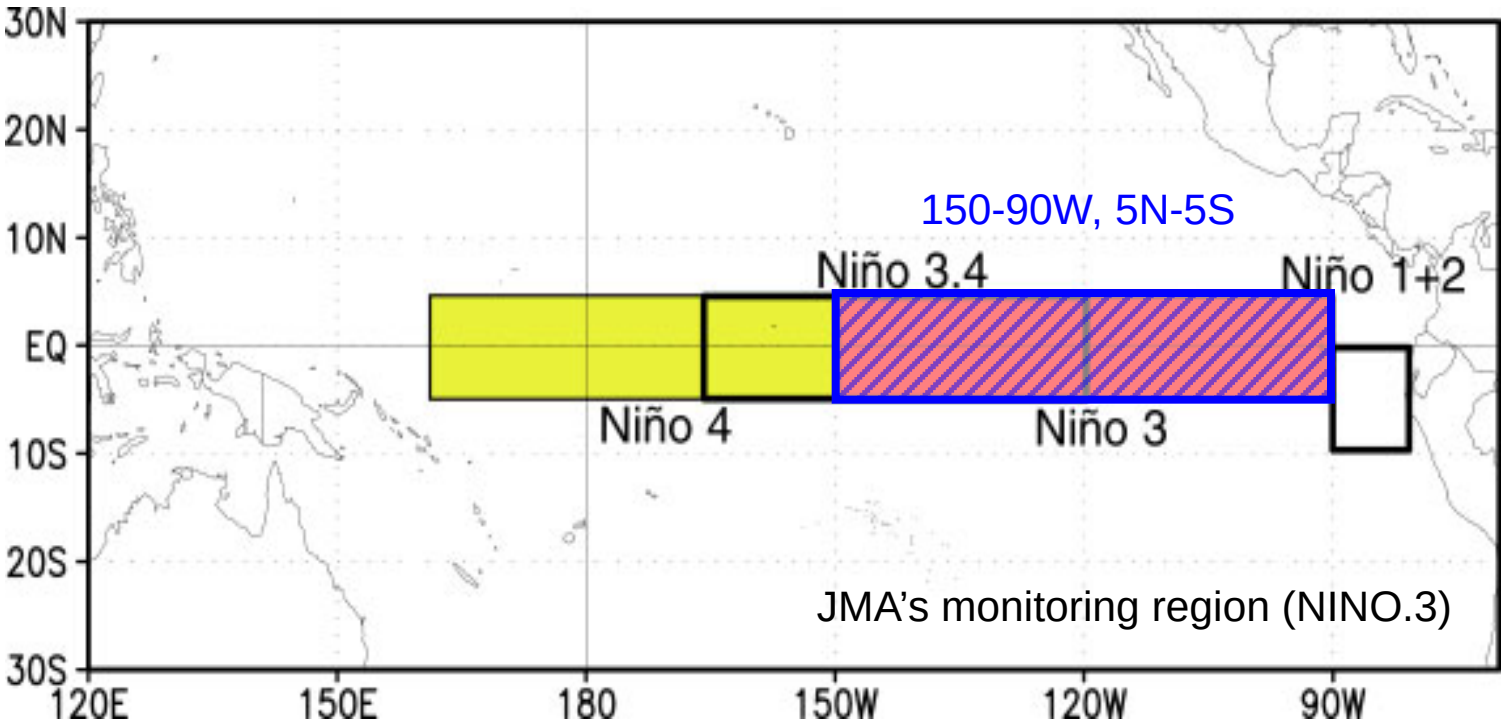


1-month mean sea surface temperature observed in Sep. 2014 when the conditions in the equatorial Pacific Ocean stayed close to normal.

Quantitative definition of El Niño (La Niña) event

Definition of El Niño (La Niña) by JMA

- *5-month running mean of NINO.3 SST deviation stays +0.5ºC or higher (-0.5ºC or lower) for 6 consecutive months or longer.*
- *NINO.3 SST deviation is defined as deviation from the latest 30-year (e.g. 1984-2013 for the year 2014) average.*



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Ocean Data Assimilation System: MOVE-G

Past

Ocean General Circulation Model (MRI.COM)

Prediction

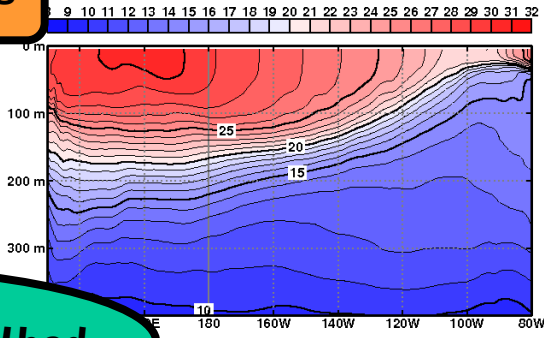
Future

IAU (Incremental Analysis Update)

First Guess

Objective Analysis

Climatology



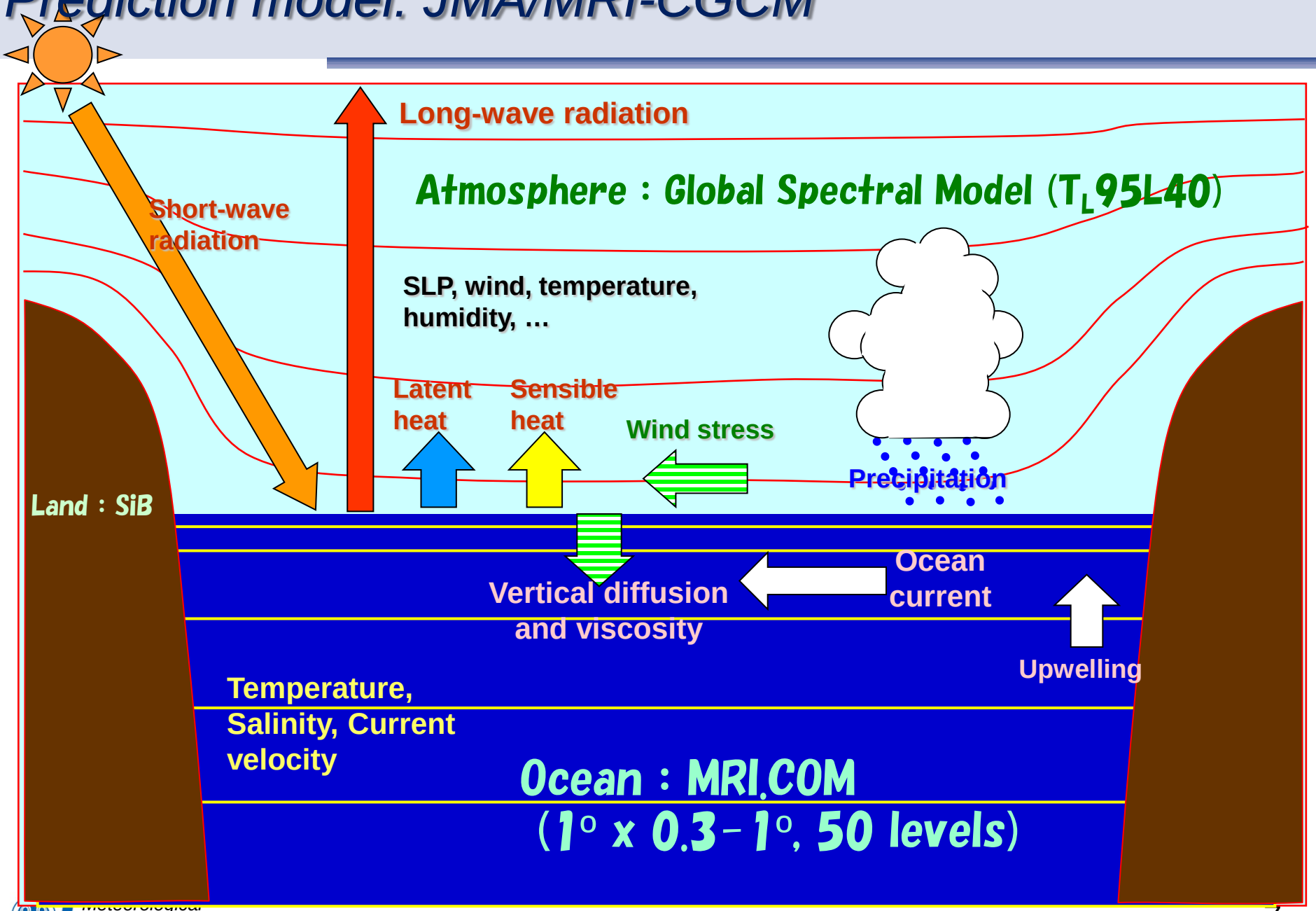
Observations

- **Temperature**
- **Salinity**
- **Sea surface height**

3-D Variational Method

3DVAR: An analysis method for seeking for the physically-consistent optimal data field that is expected to have the least deviation from the true value based upon statistical assumptions.

Prediction model: JMA/MRI-CGCM

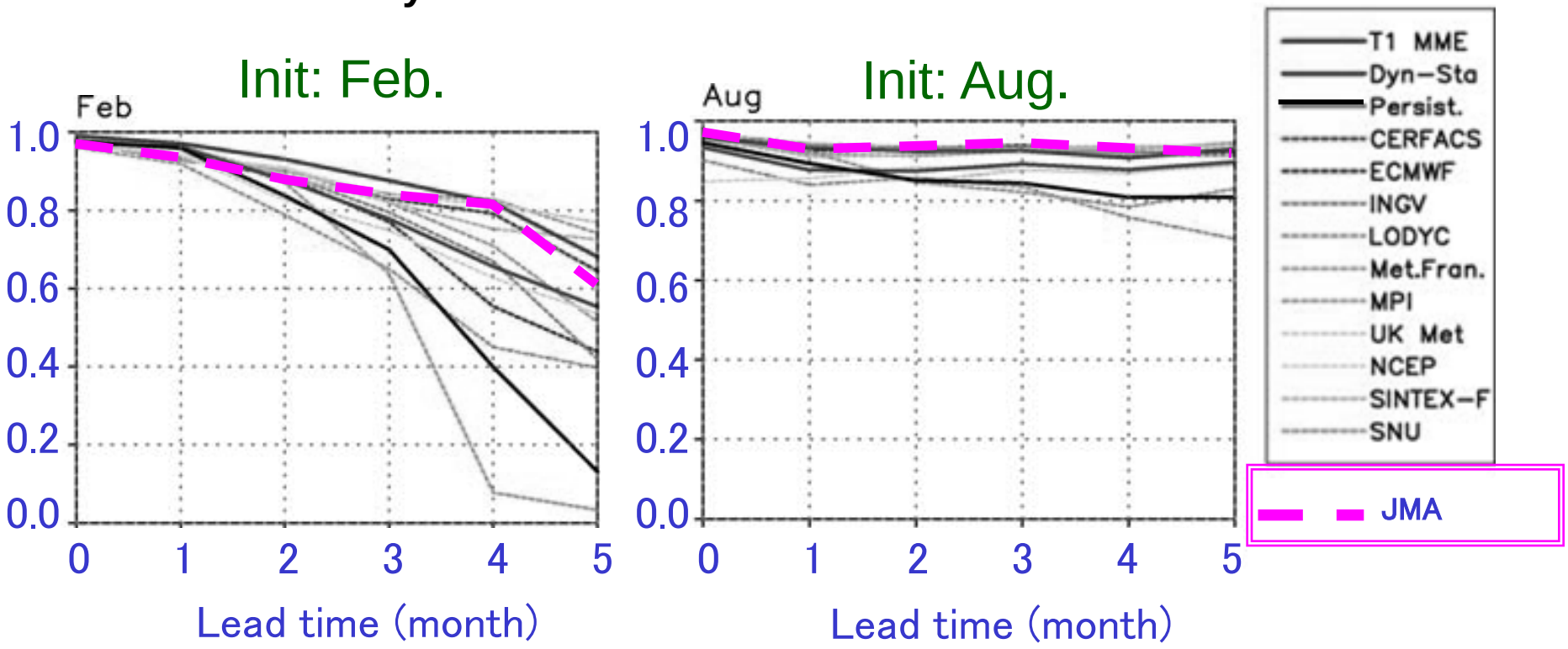


Prediction model: JMA/MRI-CGCM

	JMA/MRI-CGCM (Current)	JMA/MRI-CGCM2 (Next)
Atmosphere (JMA-AGCM)	***TL95L40***, ~180km, Up to ***0.4hPa***	***TL159L60*** , ~110km, Up to ***0.1hPa*** ***Stochastic Tendency Perturbation*** ***GHG forcing*** from RCP4.5 scenario
Ocean (MRI.COM) (Tsujino et al 2010)	1.0° (lon) x ***0.3-1*** ° (lat) ***L51*** 75°S-75°N Ocean ***Sea-ice climatology***	1.0° (lon) x ***0.3-0.5*** ° (lat) ***L53*** ***Global Ocean with Tripolar Grid*** ***Sea-ice model***
Coupler (Scup) (Yoshimura and Yukimoto 2008)	1-hour coupling interval ***Momentum and heat flux adjustments***	1-hour coupling interval ***No flux adjustment***
Initial Condition	Atmosphere: ***JRA-25*** Land: ***Climatology with ERA-15 forcing*** Ocean: ***MOVE/MRI.COM-G*** T, S&SSH (Usui et al. 2006) ***Sea-ice climatology***	Atmosphere: ***JRA-55*** Land: ***JRA-55 land analysis*** Ocean: ***MOVE/MRI.COM-G2*** T, S & SSH ***Sea-ice model***
Ensemble Size	51 (***9*** BGMs, ***6*** days with 5-day LAF)	51 (***13*** BGMs, ***4*** days with 5-day LAF)

Prediction model performance

Anomaly correlations for NINO-3.4 SSTA



（JMA's results overlayed on Fig. 8 of Jin *et al.* 2008）

Jin E. K., James L. Kinter III, B. Wang, C.-K. Park, I.-S. Kang, B. P. Kirtman, J.-S. Kug, A. Kumar, J.-J. Luo, J. Schemm, J. Shukla and T. Yamagata, 2008: Current status of ENSO prediction skill in coupled ocean–atmosphere models. *Clim. Dyn.*, **31**, 647–666.

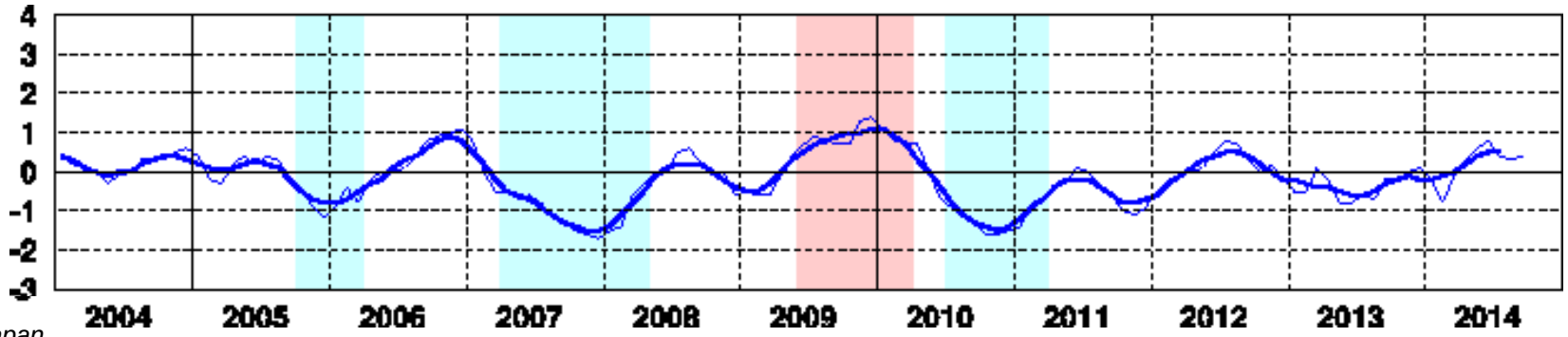
（10 member ensemble mean, 1980～2001）

2. Current Conditions

ENSO monitoring indices (NINO.3 SST)

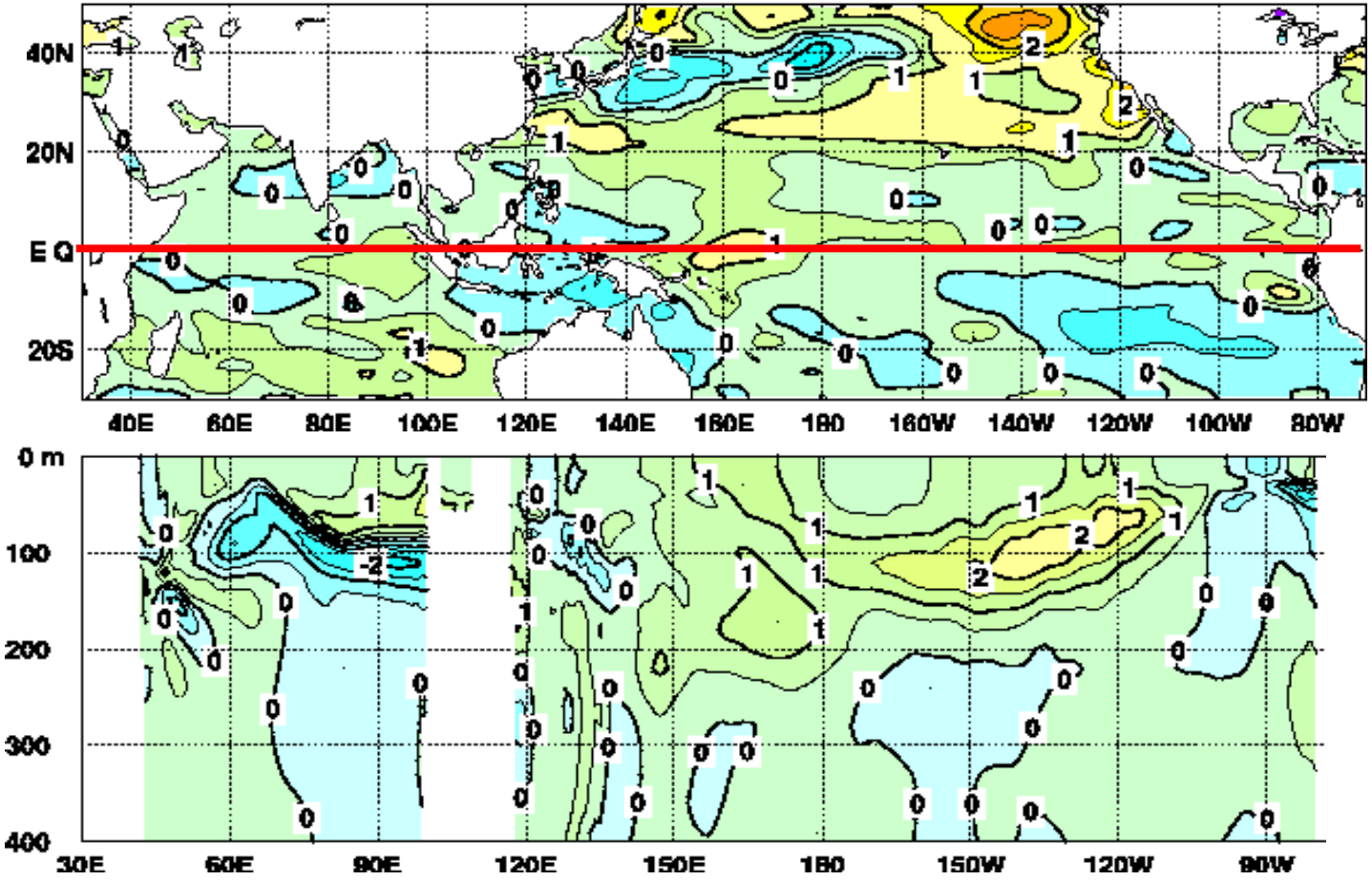
- *The monthly NINO.3 SST deviation in September was +0.4ºC .*
- *The 5-month running mean values for July was +0.5ºC .*

	2013			2014								
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.
Monthly mean SST	24.7	24.9	25.1	25.3	25.5	27.0	27.7	27.6	27.2	26.1	25.3	25.3
SST deviation	-0.2	0.0	+0.1	-0.2	-0.8	-0.1	+0.3	+0.6	+0.8	+0.4	+0.3	+0.4
5-month mean	-0.2	-0.1	-0.2	-0.2	-0.1	0.0	+0.2	+0.4	+0.5	+0.5		
SOI	0.0	+0.8	+0.1	+1.1	0.0	-0.9	+0.8	+0.7	+0.2	-0.2	-0.9	-0.6



Oceanic conditions in the tropics 1

- *SSTs were remarkably above normal in the western equatorial Pacific.*
- *Subsurface temperatures were above normal in most regions from the western to eastern equatorial Pacific.*



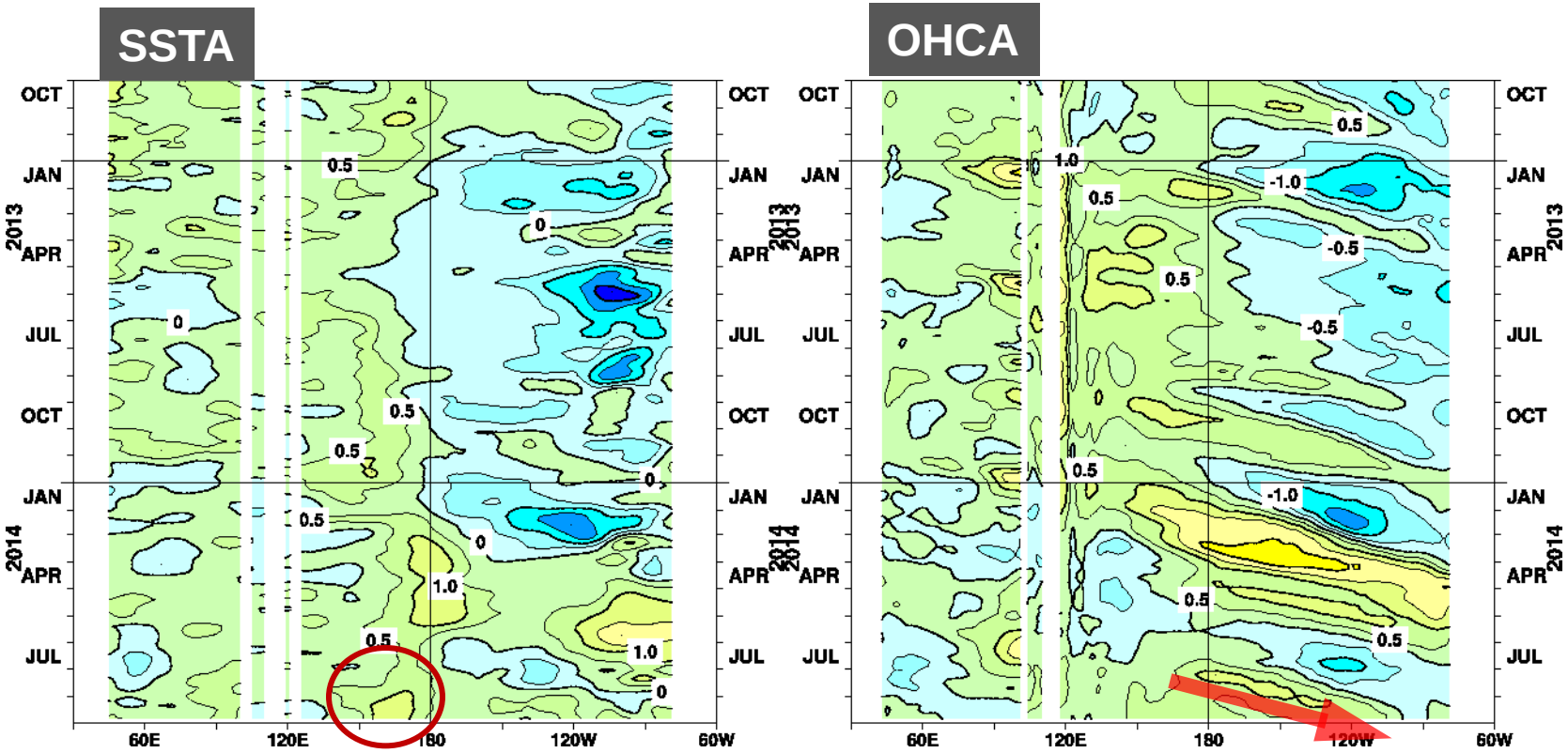
Analyses of the equatorial Pacific Ocean conditions for September, 2014.

(above) SST anomaly

(below) Vertical section of temperature anomaly along the equator

Oceanic conditions in the tropics 2

- *Positive SSTAs strengthened in the western equatorial Pacific.*
- *A Warm Kelvin wave propagated eastward and weakened in September.*



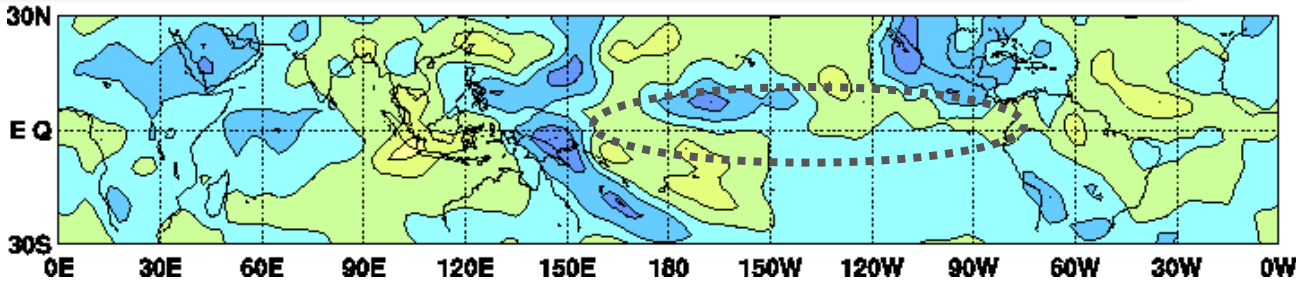
Longitude-time section of SSTA(left) and OHCA(right) along the equator from Oct. 2013 to Sep. 2014.
OHC (ocean heat content) is water temperature vertically averaged from the surface to 300m depth.

Atmospheric conditions in tropics

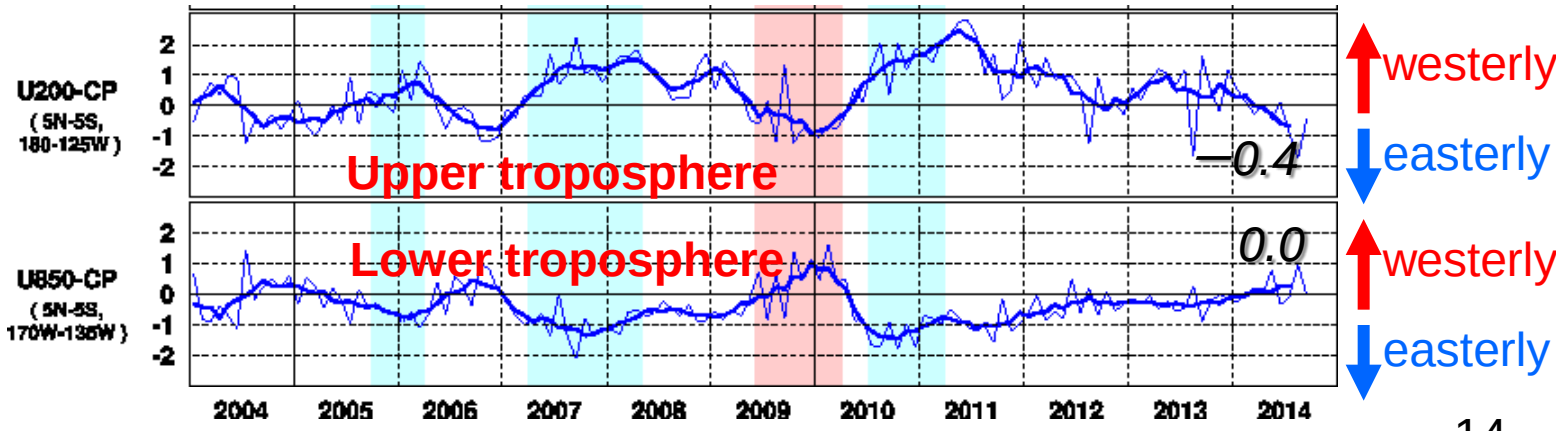
- *Atmospheric convective activities were near normal from near the date line to the eastern equatorial Pacific.*
- *Easterly winds in the lower troposphere were near normal in the central equatorial Pacific.*

⇒ **ENSO neutral conditions continued**.

OLR anomalies Sep. 2014
Blue: more active
Yellow: less active



Zonal wind indices in the central equatorial Pacific

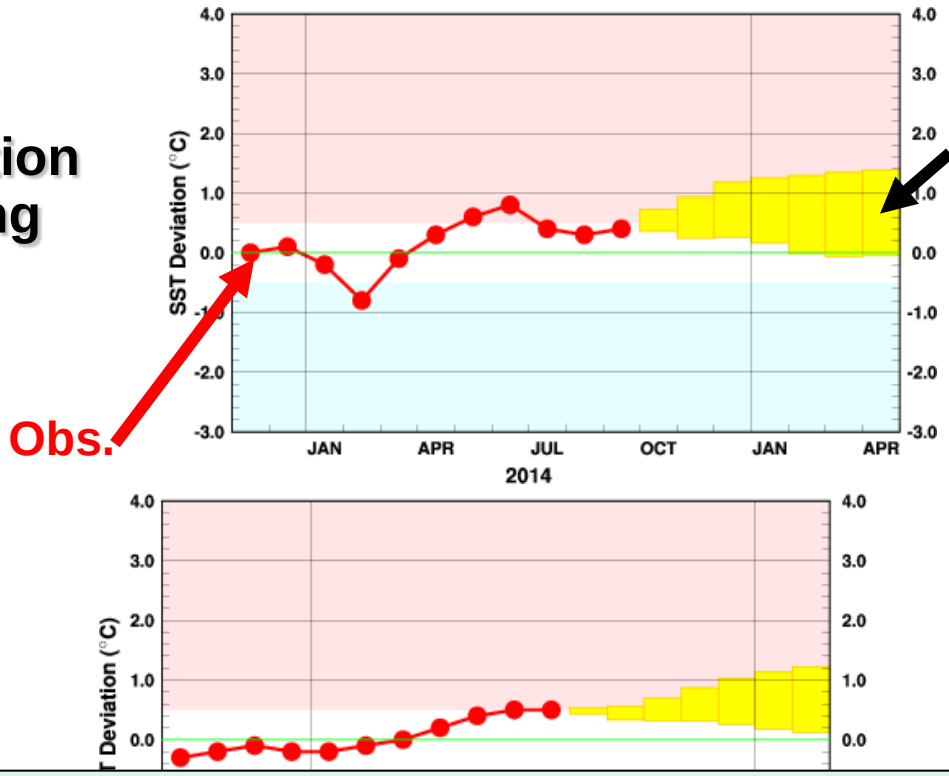


3. Outlook

Model prediction (JMA/MRI-CGCM)

✓*NINO.3 SST will be near normal or above normal during the northern hemisphere autumn and winter.*

NINO.3 SST deviation from 30-year sliding mean



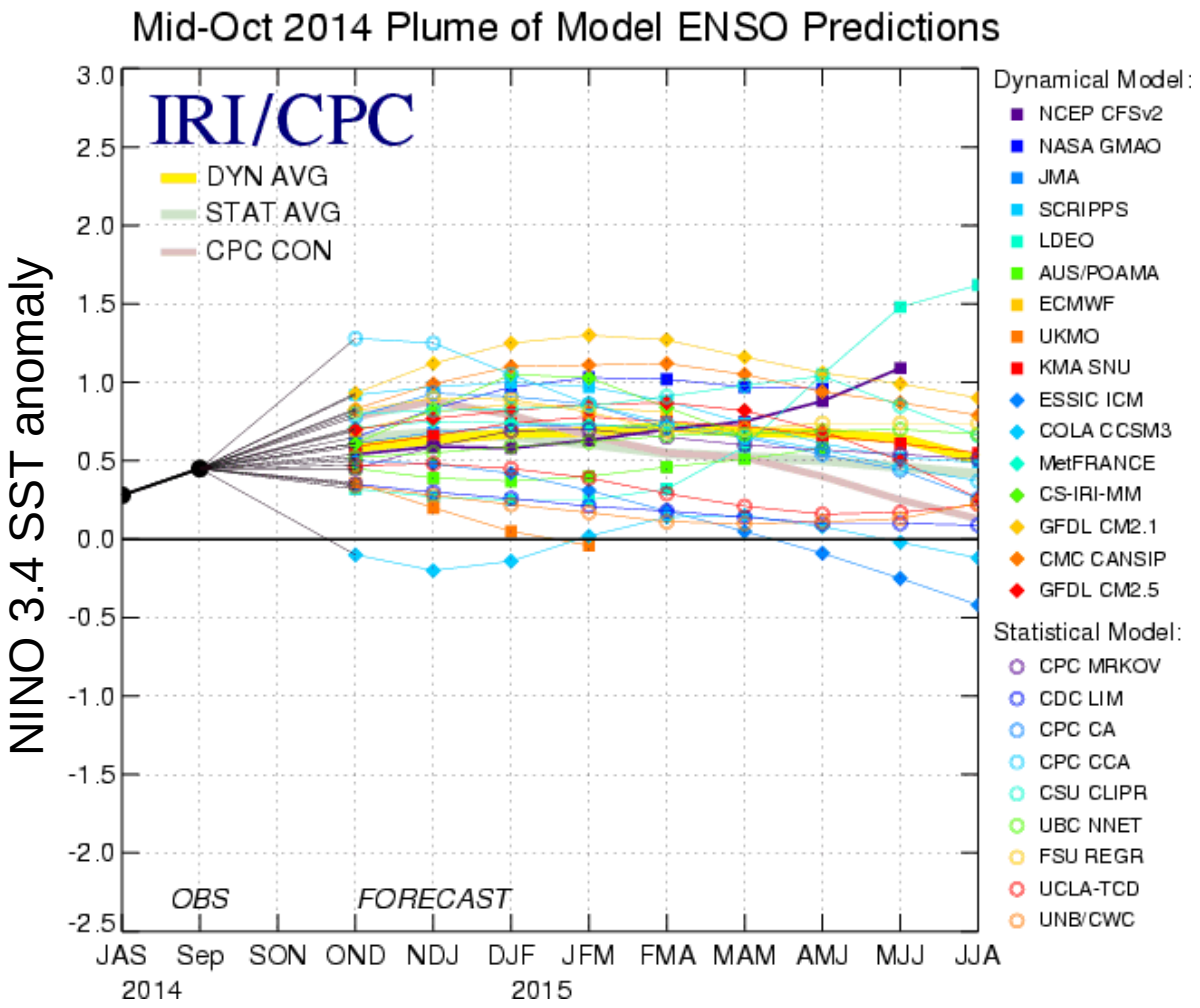
Each box denotes the range where the SST deviation will be included with the probability of 70%.

5-month running mean

⇒ *The possibility of development of El Niño conditions during the northern hemisphere autumn and winter is comparable to that of continuation of ENSO neutral conditions.*

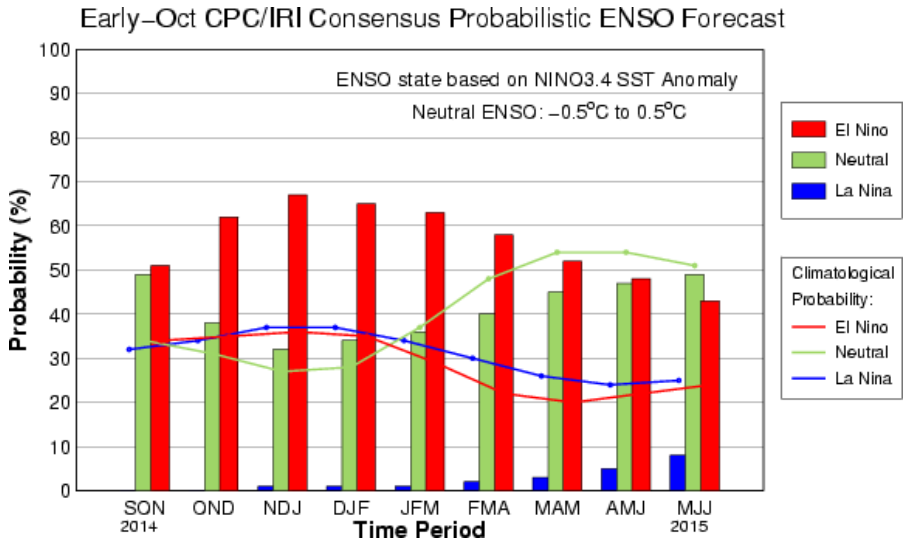
Model predictions (compiled by IRI)

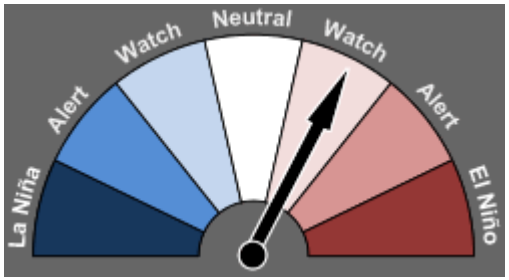
✓*For winter (DJF), about 70% of the models predict El Niño.*



Outlooks from NOAA and BoM(Australia)

✓*NOAA: El Niño is favored to begin in the next 1-2 months and last into the Northern Hemisphere spring 2015.*
✓*BoM: Chance of El Niño remains at least 50%.*





BoM's ENSO Tracker status remains at El Niño WATCH level

4. Summary

Summary

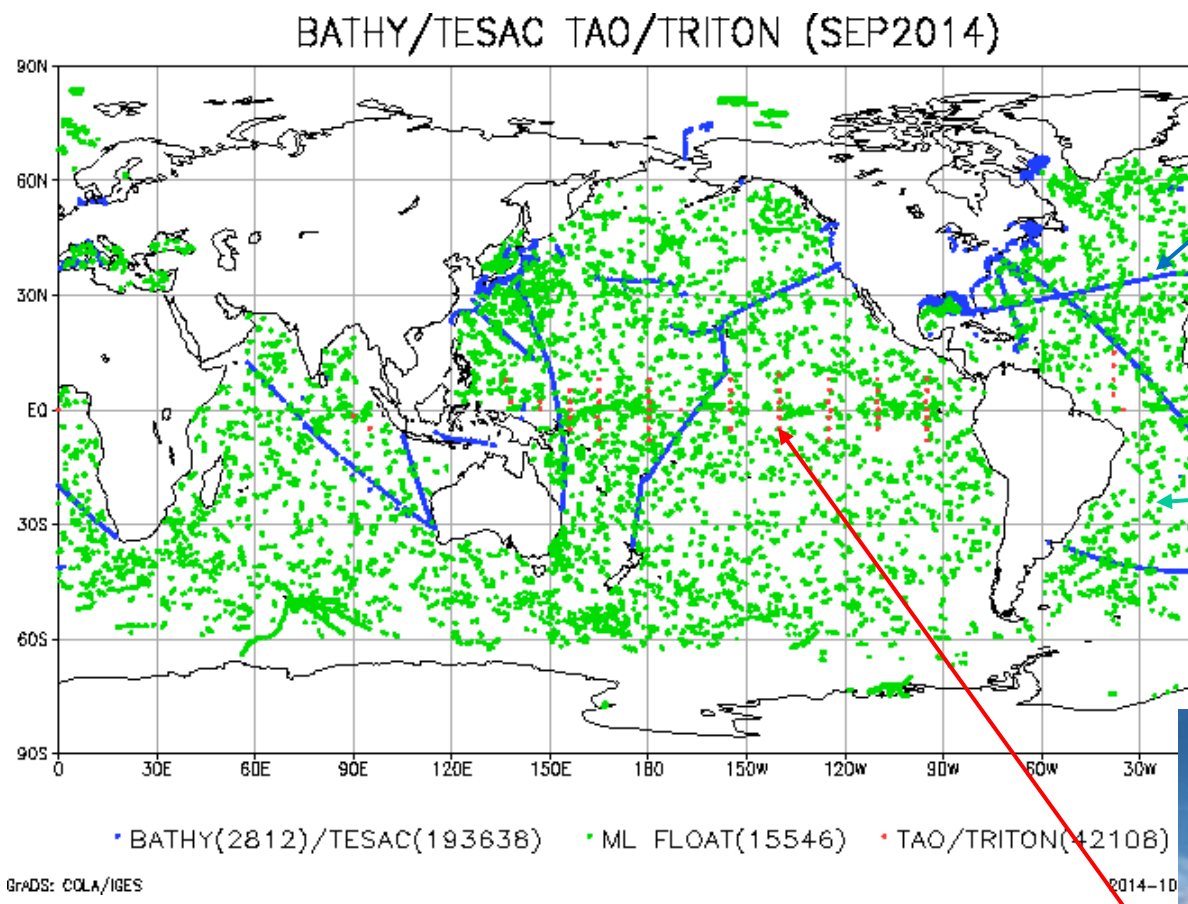
- *ENSO neutral conditions continued in the equatorial Pacific.*
- *The possibility of development of El Niño conditions during the northern hemisphere autumn and winter is comparable to that of continuation of ENSO neutral conditions.*

- *Current condition*
  - ✓ Oceanic and atmospheric conditions in the equatorial Pacific indicate ENSO neutral conditions.
    - ➢ JMA's monthly ENSO Monitoring Index (NINO.3) in September : +0.4ºC
    - ➢ Positive SSTA in the western equatorial Pacific
    - ➢ Positive OHCA in most regions of the equatorial Pacific
    - ➢ Near normal zonal winds over the central equatorial Pacific
    - ➢ Near normal atmospheric convections from near the dateline to the eastern equatorial Pacific
- *Predictions by JMA/MRI-CGCM*
  - ✓ NINO.3 SST will be near normal or above normal during the northern hemisphere autumn and winter.

Thank you

Backup Slides

Ocean observing network for El Niño monitoring



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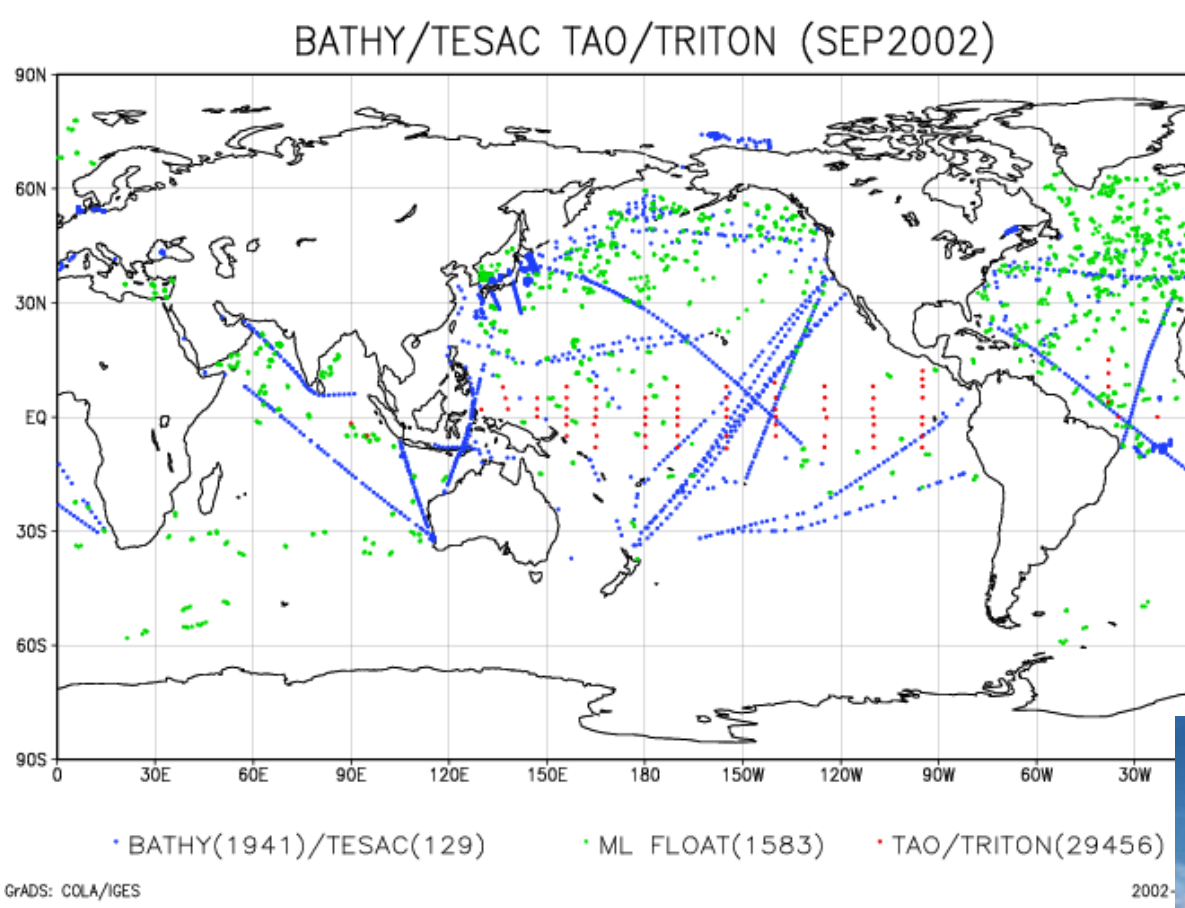
Ocean observing network for El Niño monitoring



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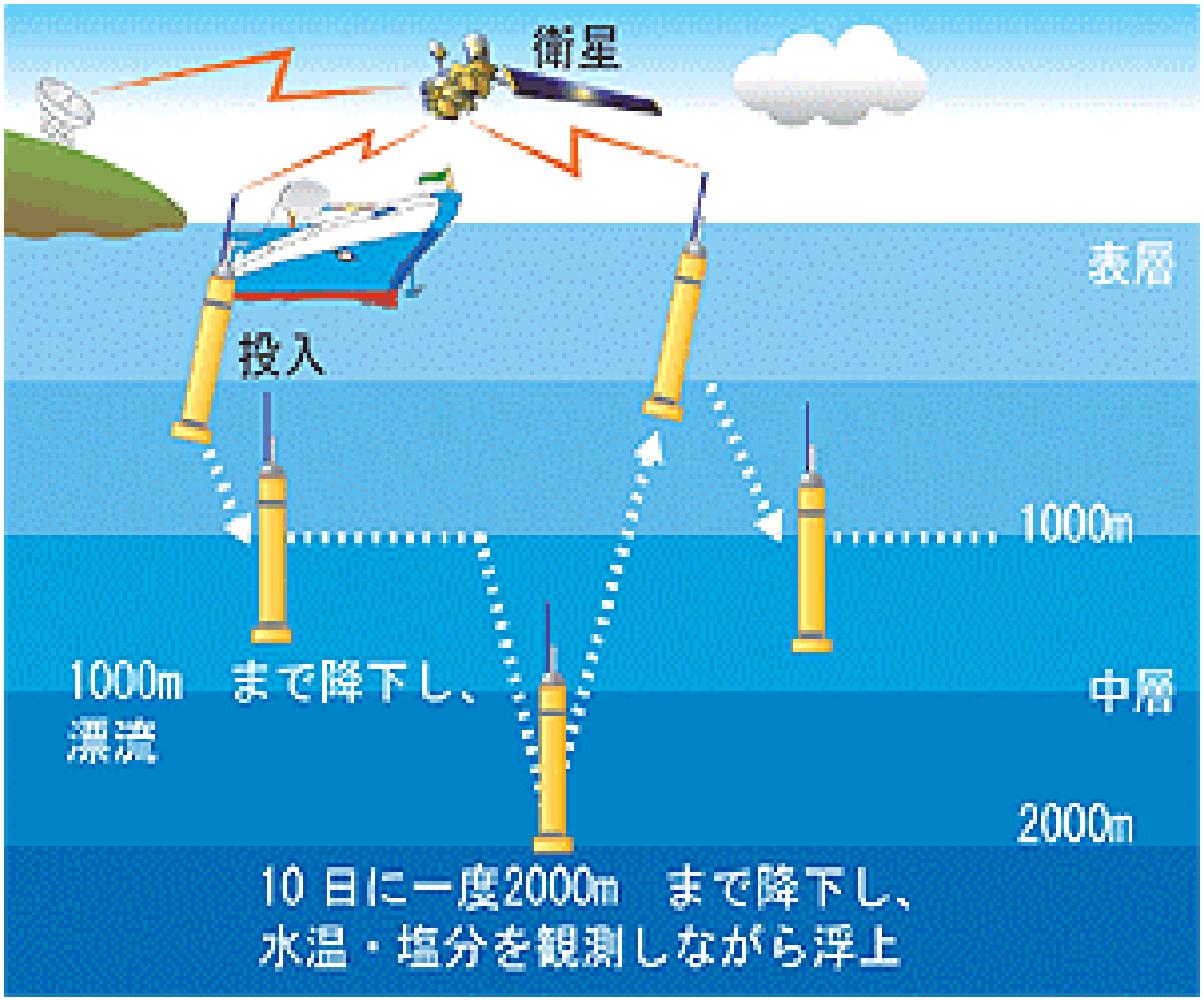
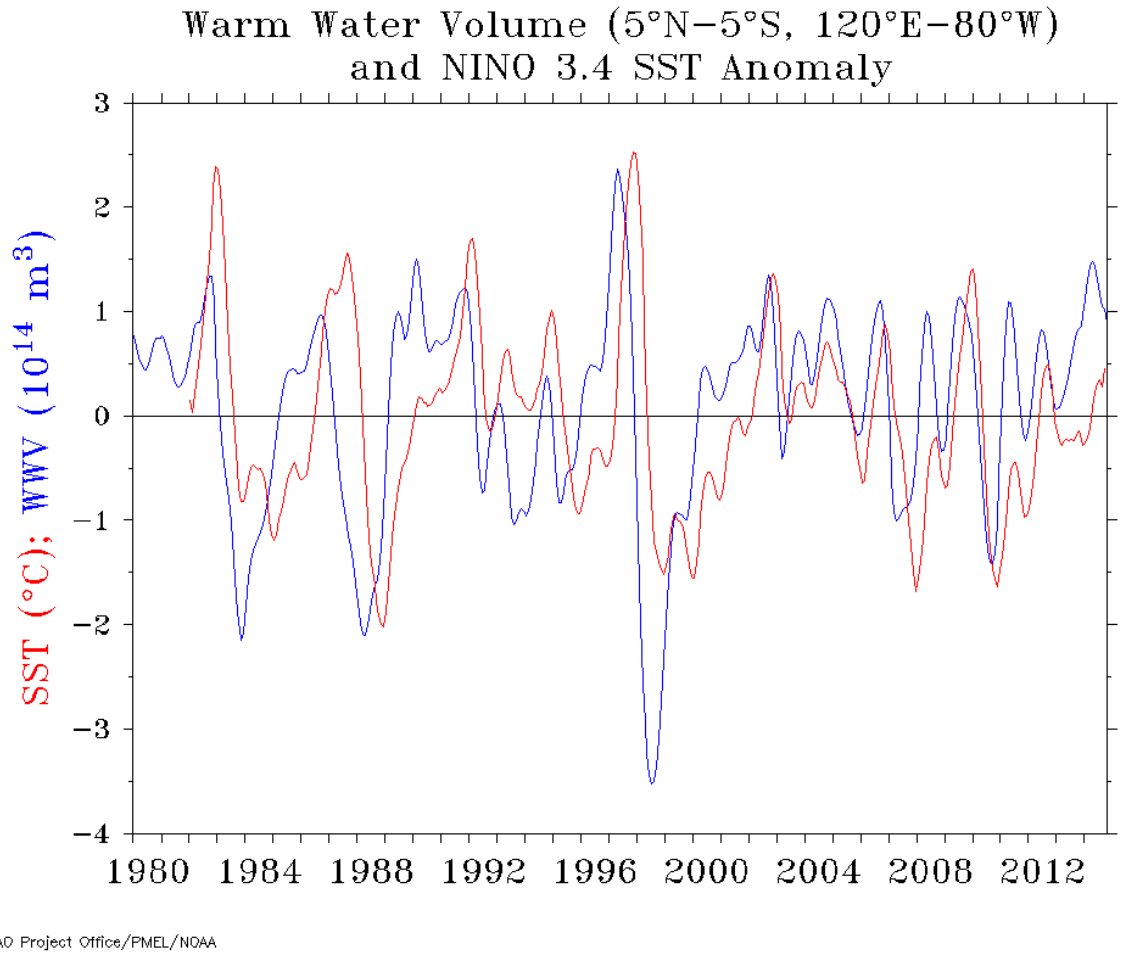
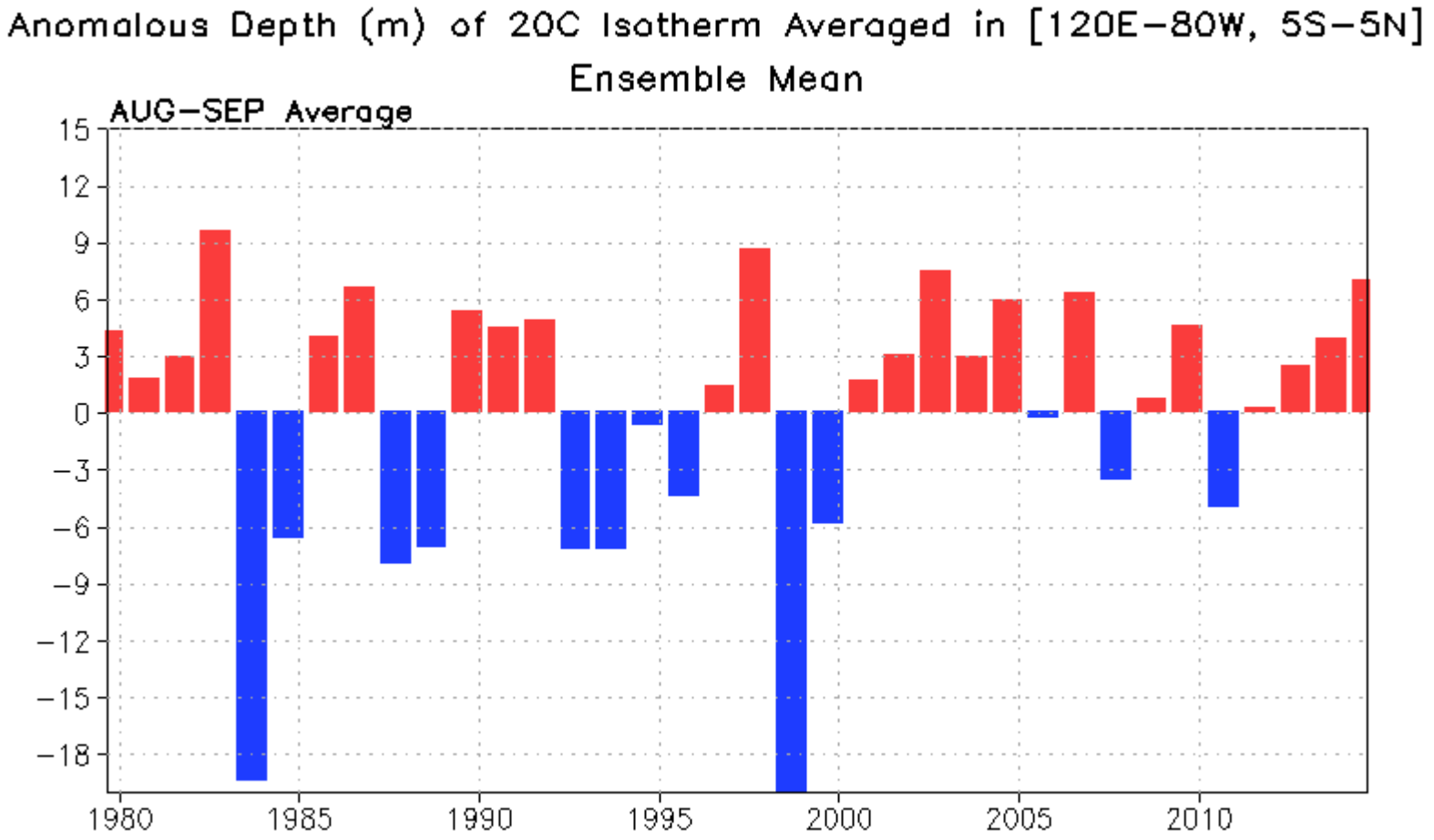
Ocean observing network for El Niño monitoring



WWV (from PMEL Web site)



WWV (from CPC Web site)



Recent SST indices (10-day mean)

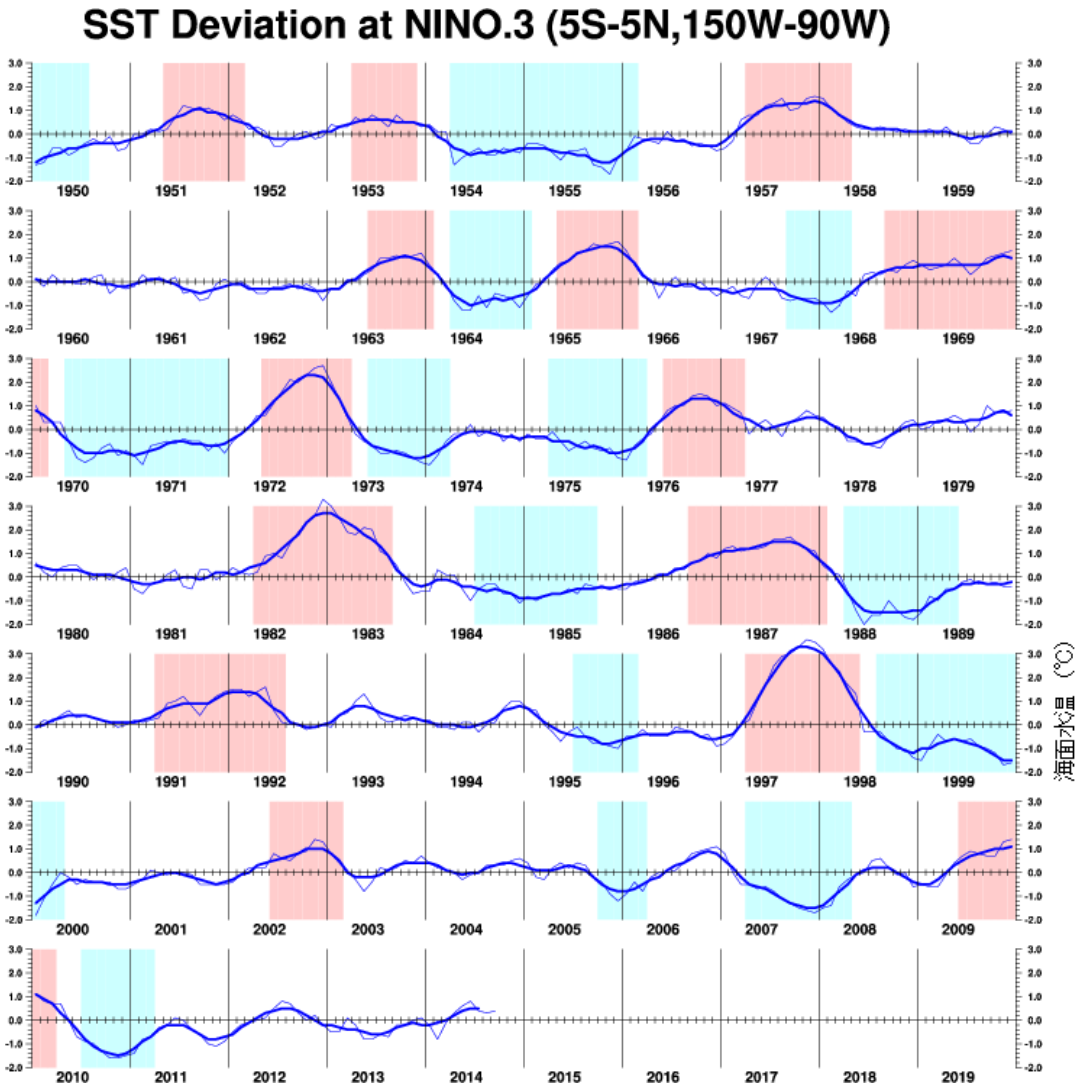
2014/10		
25.5	25.5	***
24.8	24.9	24.8
0.7	0.6	***

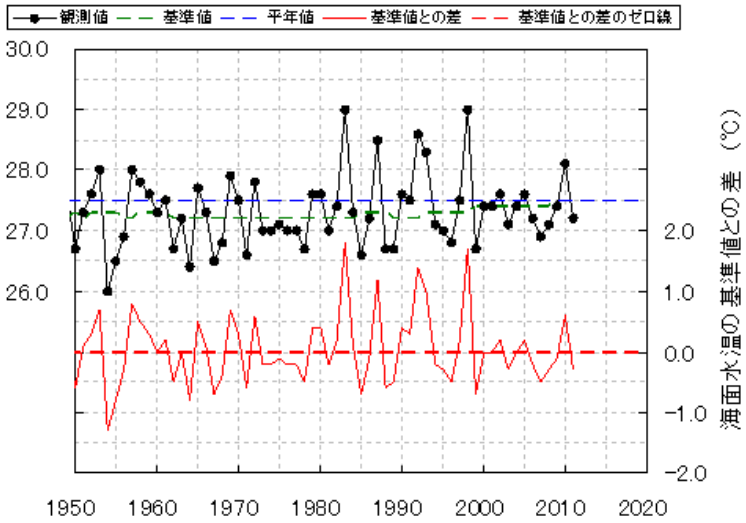
海域		2014/04			2014/05			2014/06			2014/07			2014/08			2014/09			2014/10		
NINO.3 5N-5S 150W-90W	海面水温	27.7	27.7	27.8	27.6	27.6	27.5	27.4	27.3	27.1	26.7	26.2	25.7	25.4	25.3	25.2	25.2	25.3	25.3	25.5	25.5	***
	基準値	27.3	27.4	27.2	27.1	27.0	26.8	26.6	26.4	26.1	25.9	25.7	25.4	25.2	25.0	24.9	24.9	24.9	24.8	24.8	24.9	24.8
	差	0.4	0.3	0.6	0.5	0.6	0.7	0.8	0.9	1.0	0.8	0.5	0.3	0.2	0.3	0.3	0.3	0.4	0.5	0.7	0.6	***

海域		2014/04			2014/05			2014/06			2014/07			2014/08			2014/09			2014/10		
NINO.WEST 15N-Eq. 130E-150E	海面水温	28.95	29.11	29.46	29.82	29.64	29.96	30.06	30.30	30.20	29.85	29.59	29.34	29.36	29.51	29.81	29.74	29.46	29.47	29.49	29.46	****
	基準値	29.10	29.23	29.35	29.47	29.60	29.64	29.68	29.73	29.70	29.67	29.64	29.57	29.51	29.45	29.52	29.59	29.67	29.67	29.68	29.69	29.68
	差	-0.15	-0.12	0.11	0.35	0.04	0.32	0.38	0.57	0.50	0.18	-0.05	-0.23	-0.15	0.06	0.29	0.15	-0.21	-0.20	-0.19	-0.23	****

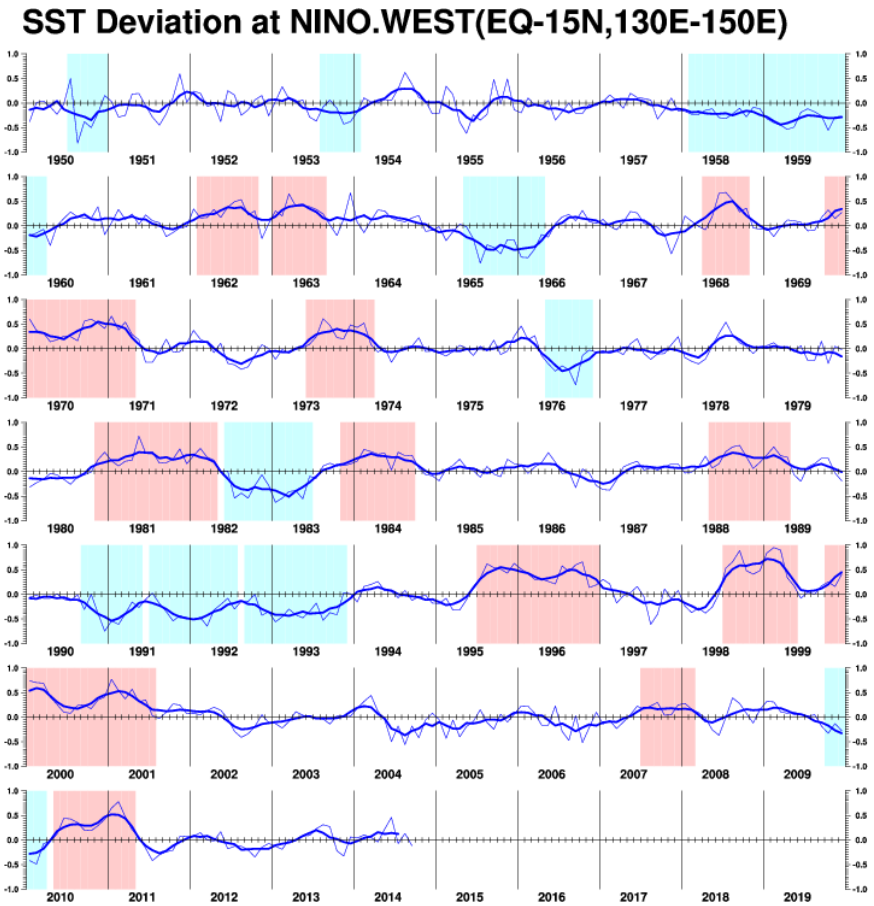
海域		2014/04			2014/05			2014/06			2014/07			2014/08			2014/09			2014/10		
IOBW 20N-20S 40E-100E	海面水温	29.09	29.29	29.43	29.32	29.28	29.01	28.74	28.36	28.00	27.75	27.44	27.19	27.03	27.12	27.23	27.26	27.26	27.48	27.77	27.89	****
	基準値	29.07	29.23	29.16	29.09	29.03	28.76	28.50	28.24	27.97	27.70	27.44	27.35	27.27	27.19	27.24	27.29	27.34	27.49	27.64	27.80	27.89
	差	0.02	0.06	0.27	0.23	0.25	0.25	0.24	0.12	0.03	0.05	0.00	-0.16	-0.24	-0.07	-0.01	-0.03	-0.08	-0.01	0.13	0.09	****

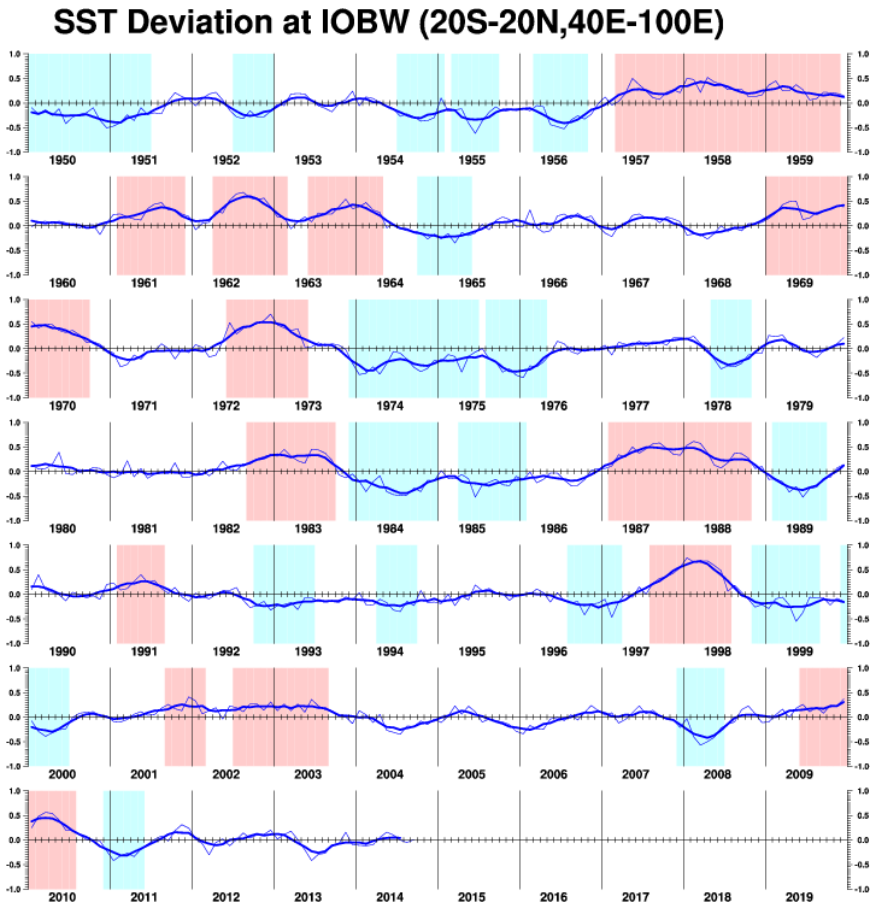
Historical ENSO events



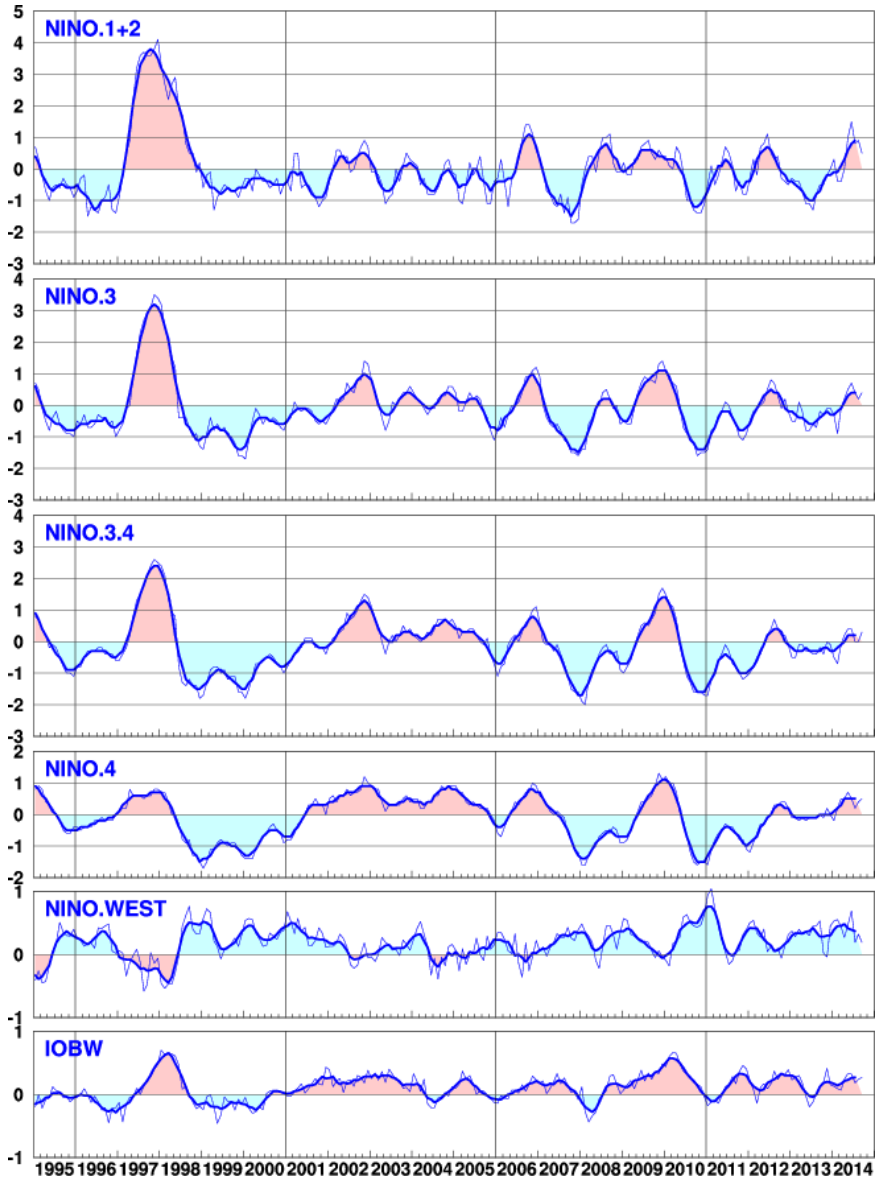


NINO.WEST / IOBW



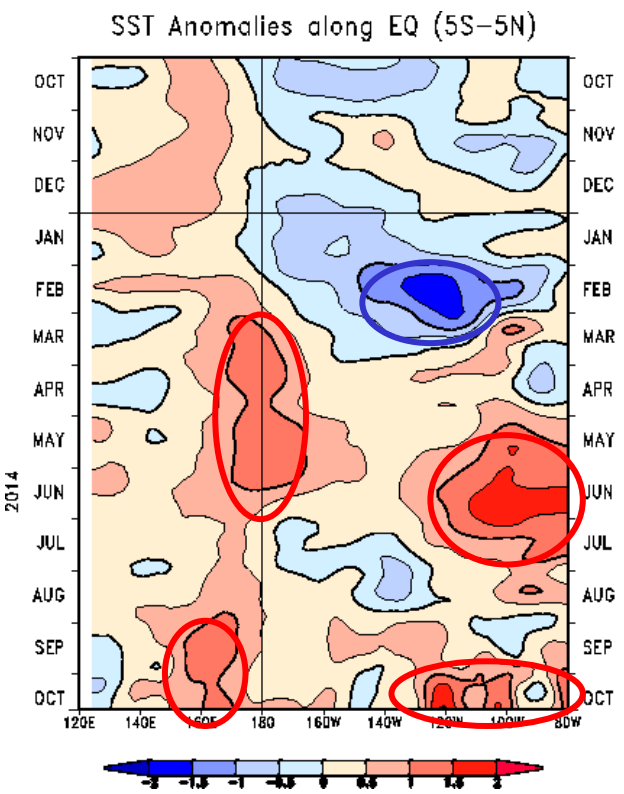


SST indices (not detrended)

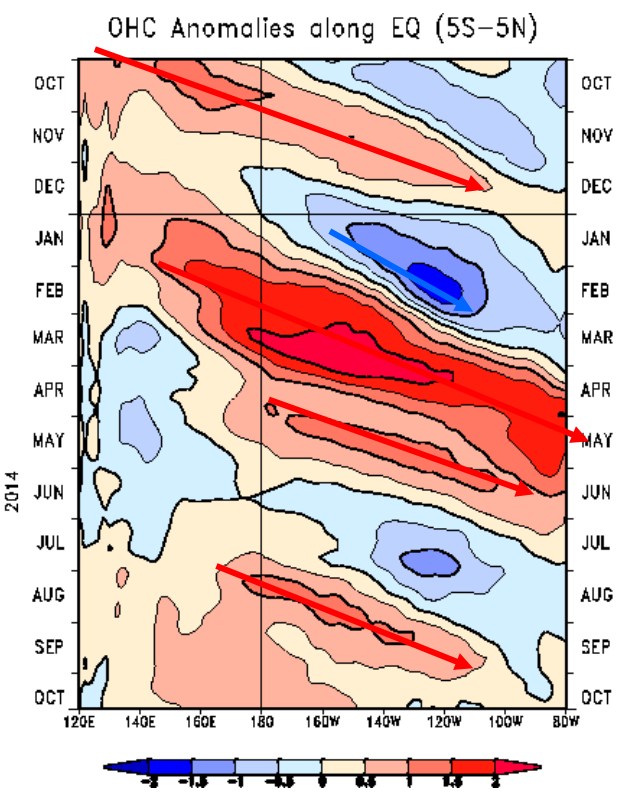


Time-longitude sections along Eq.

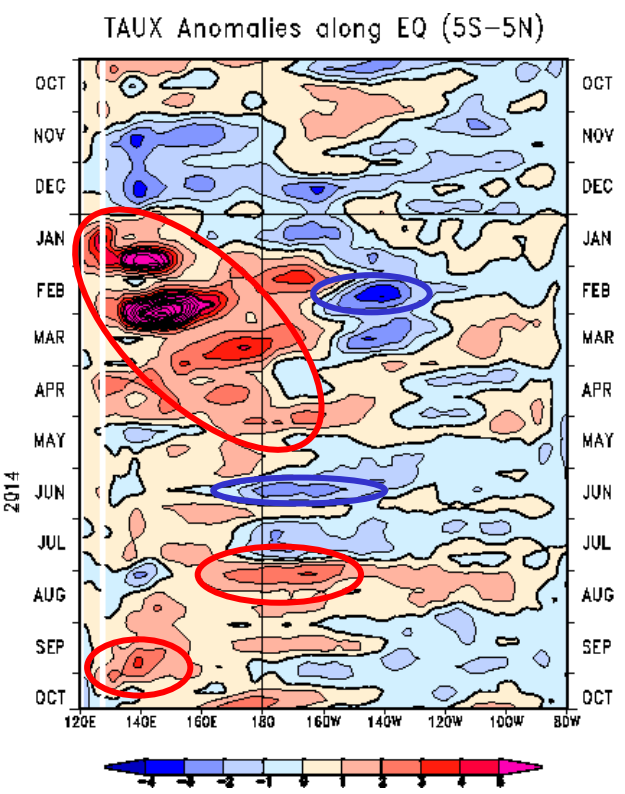
SSTA



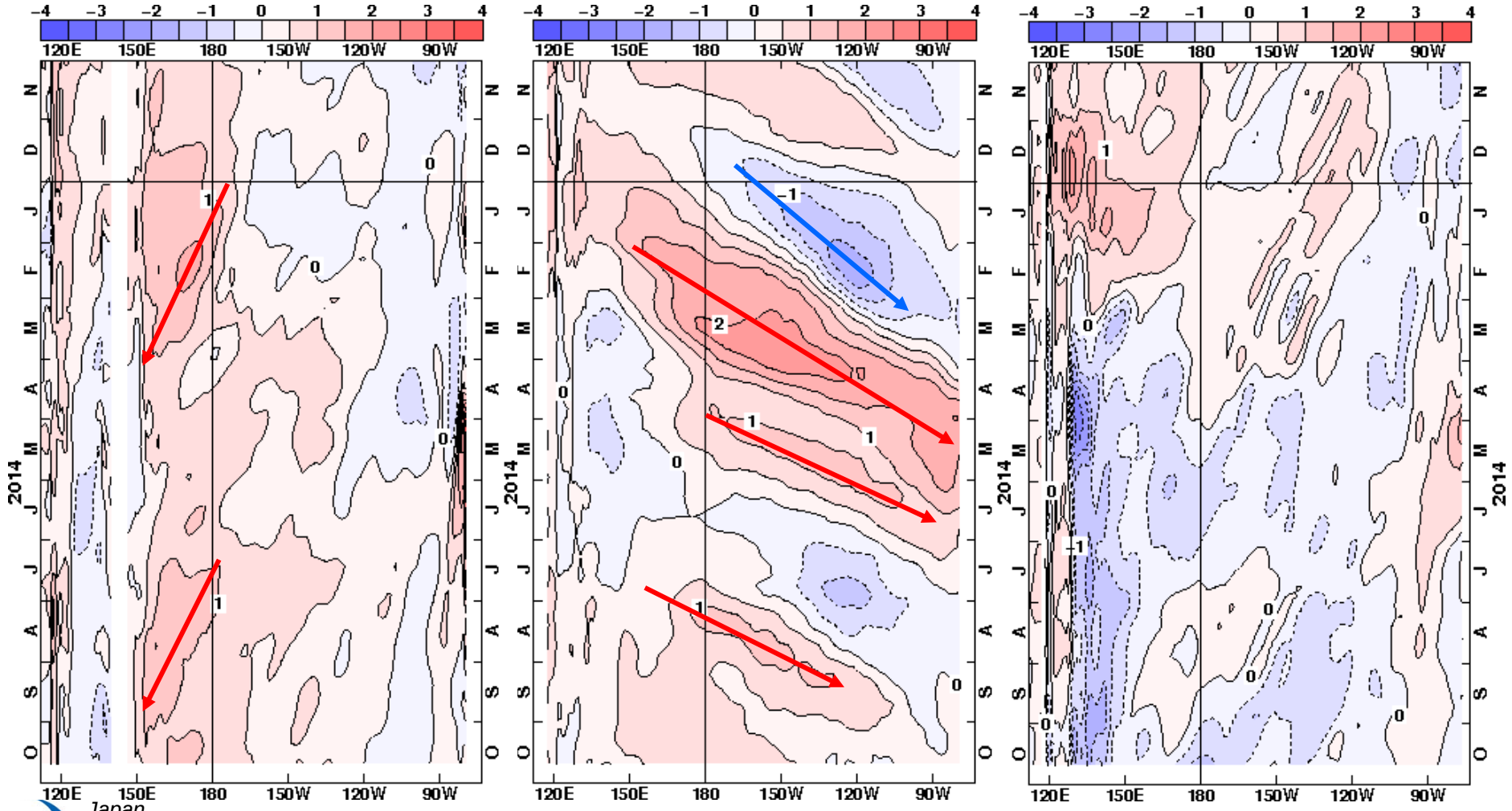
OHCA



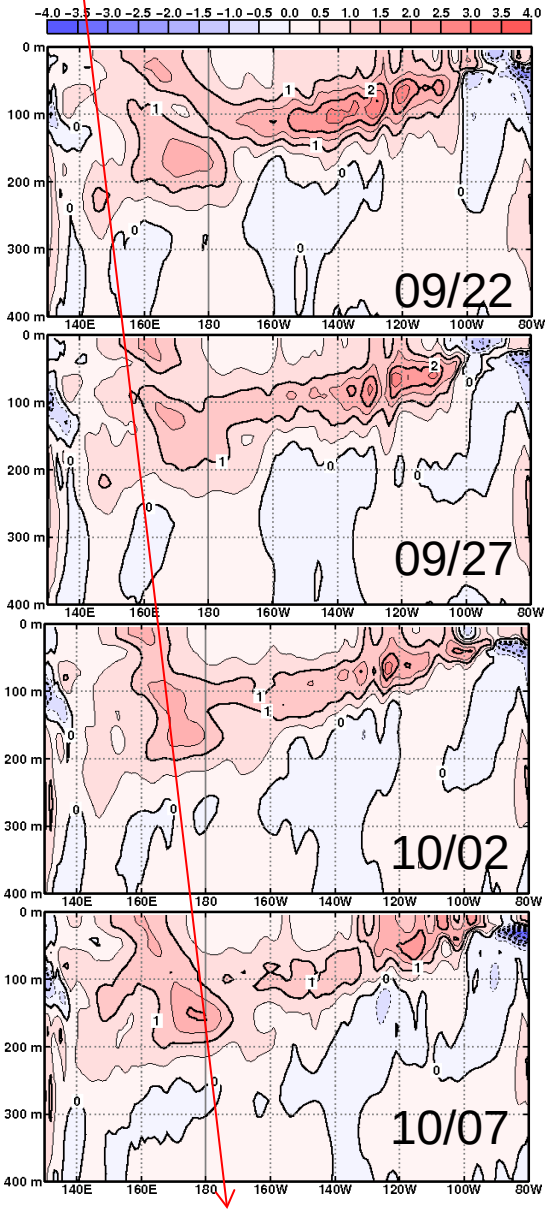
WSXA

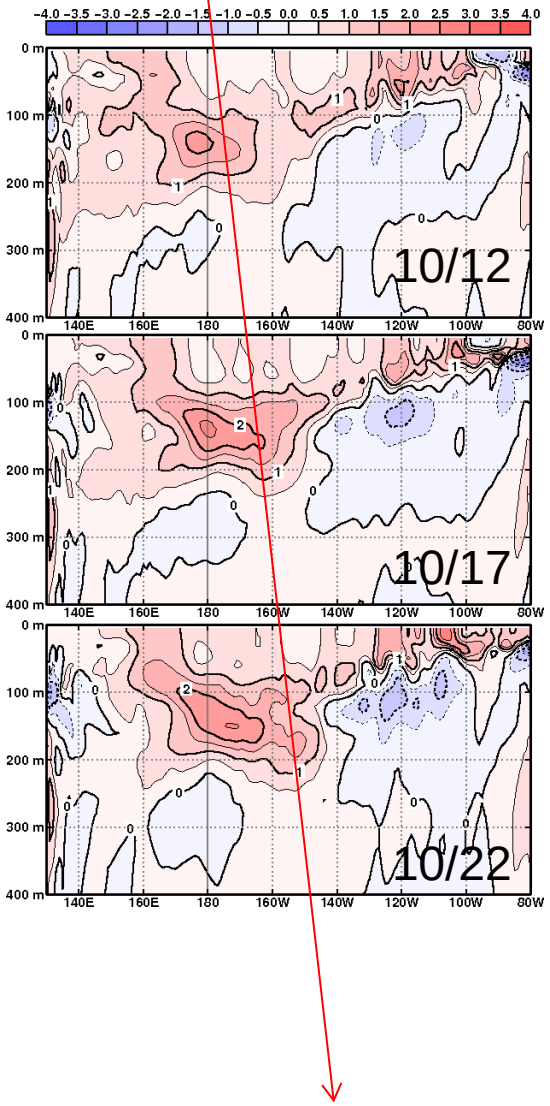


Time-longitude sections of OHCA



Eq. Pac. sections (pentad mean)





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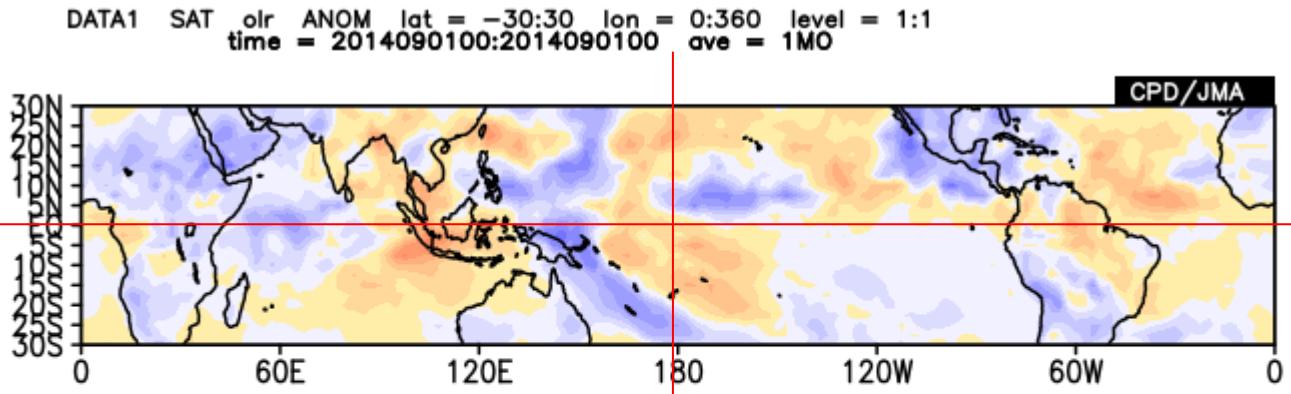
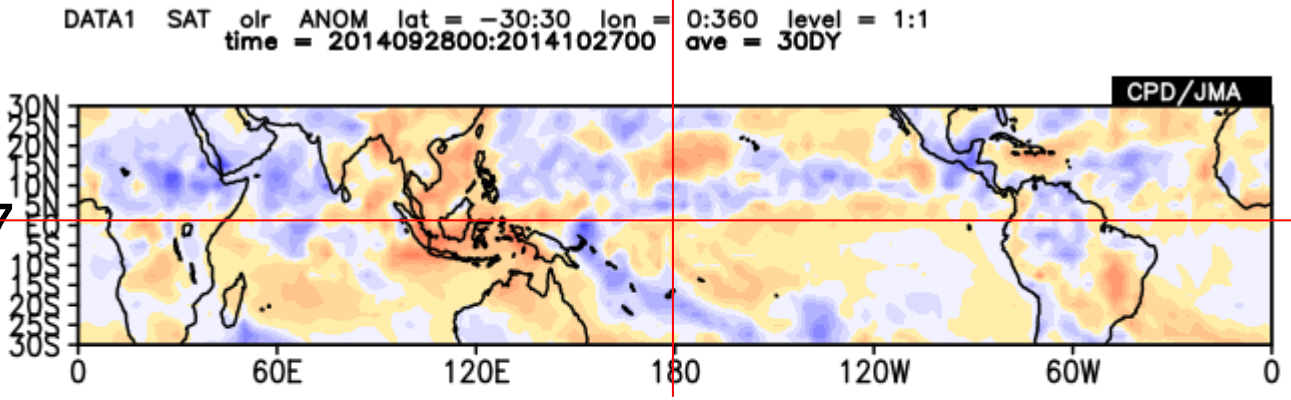
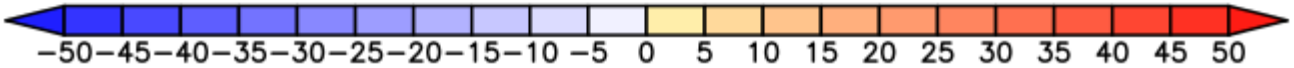
OLR anomalies in tropics

September



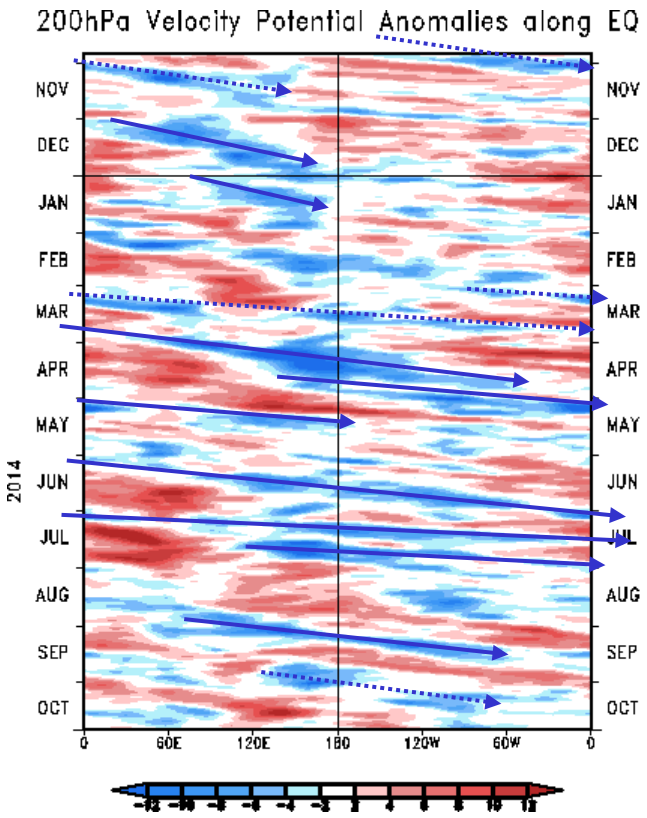
09/28-10/27



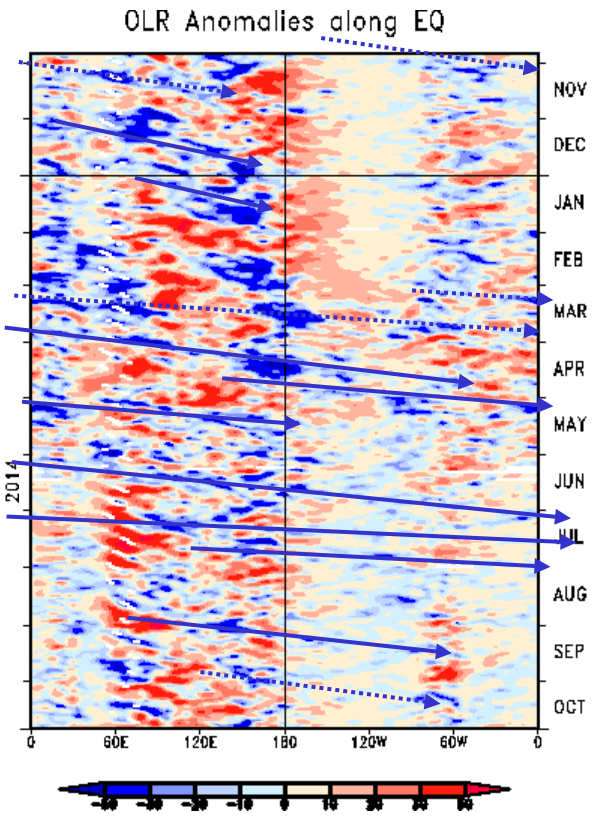


Time-longitude sections along Eq.

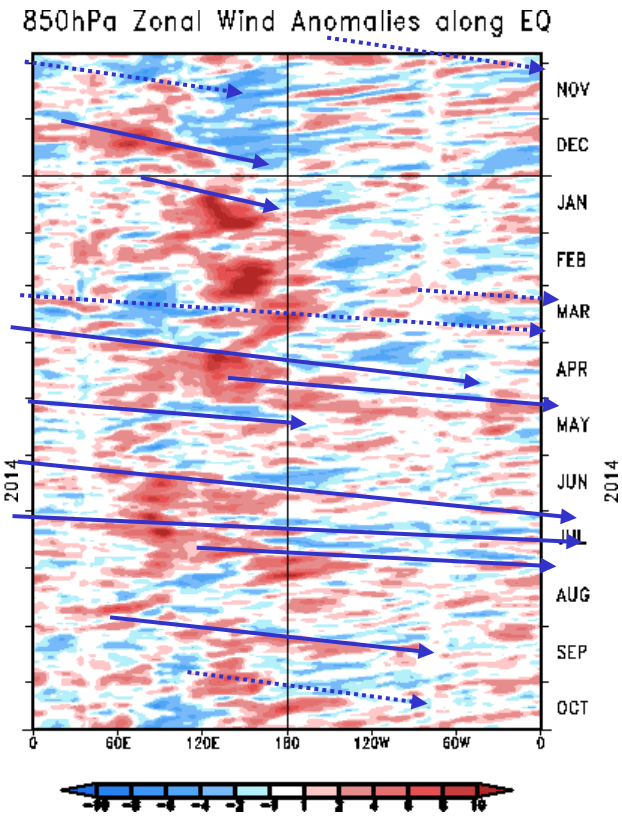
χ200



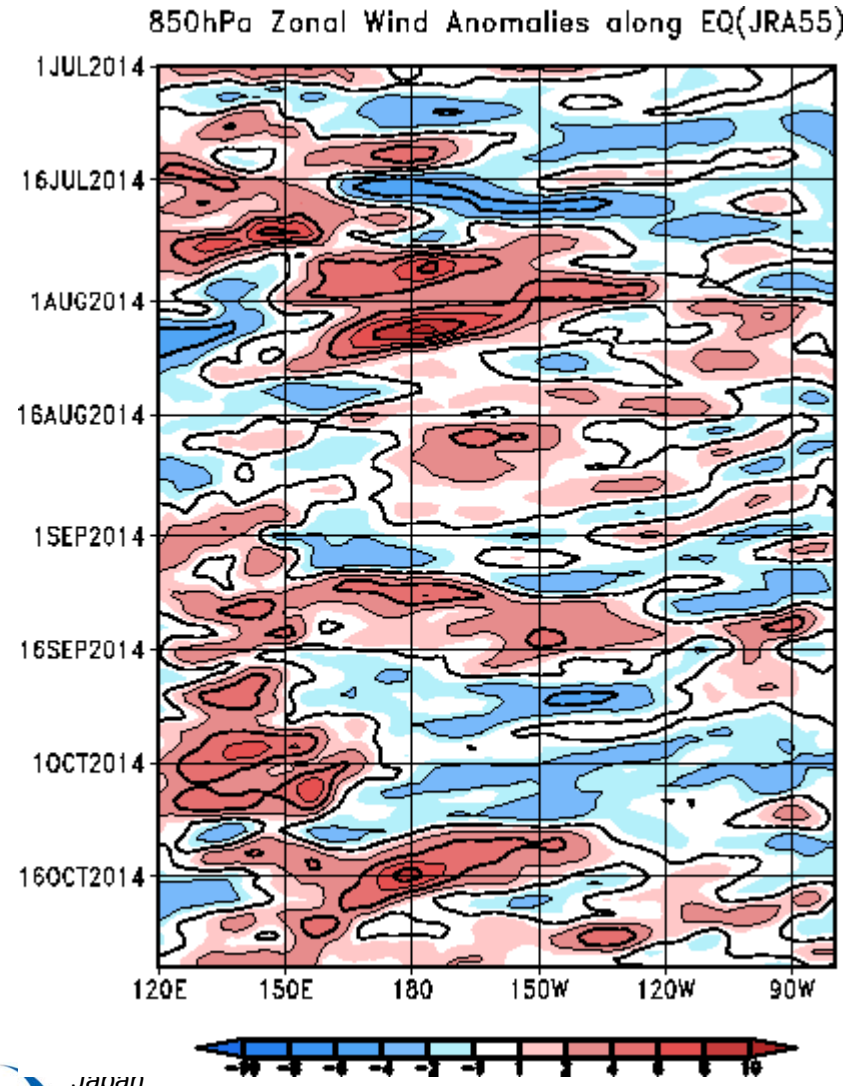
OLR

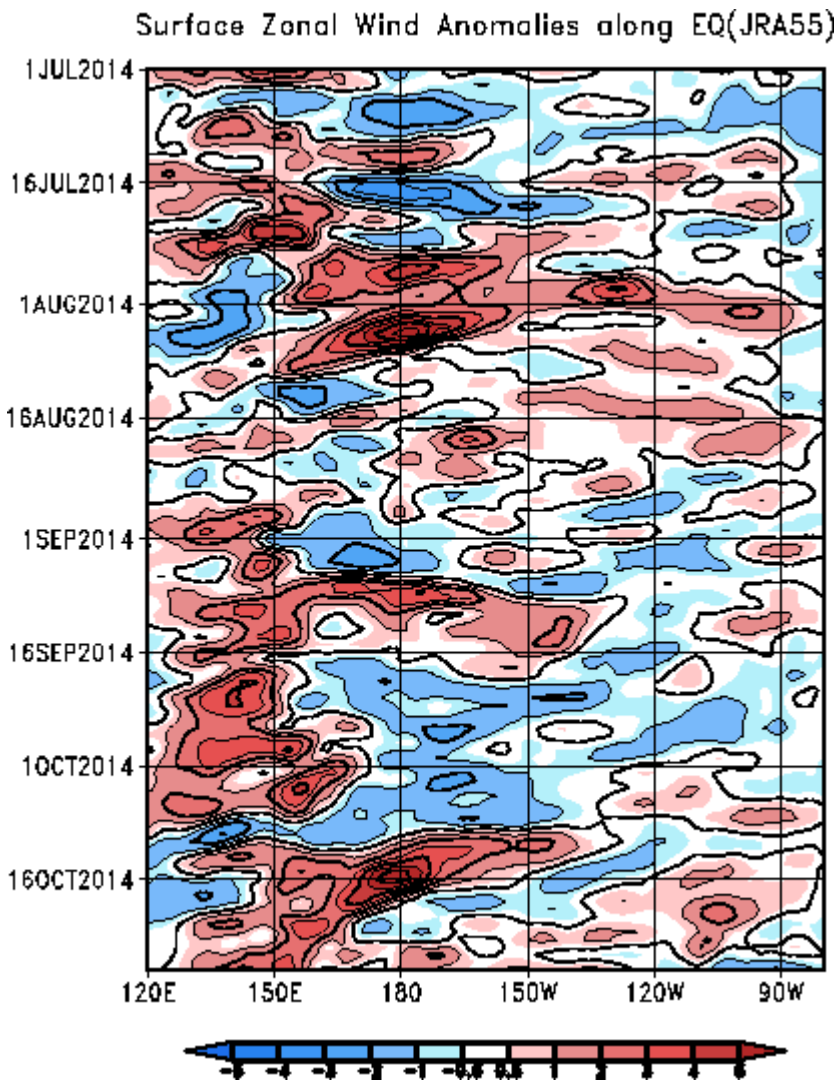


U850



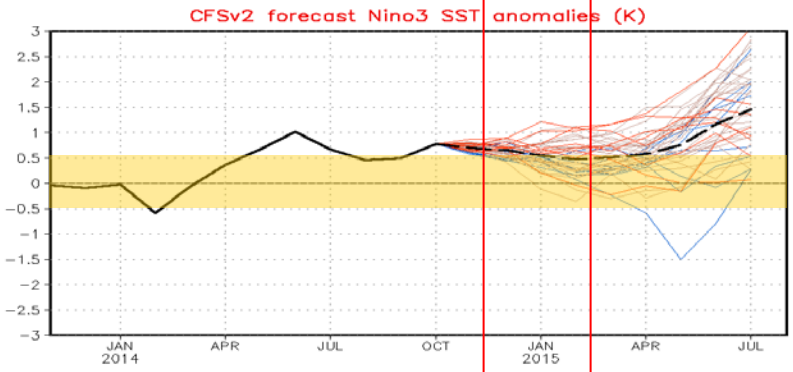
Time-longitude sections of zonal wind anomalies along Eq.



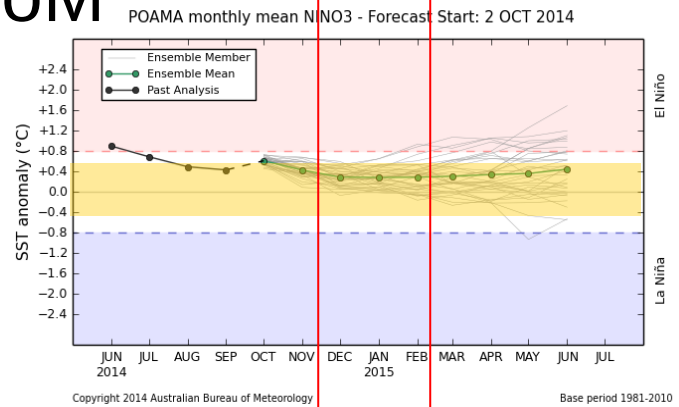


Model predictions by other centers

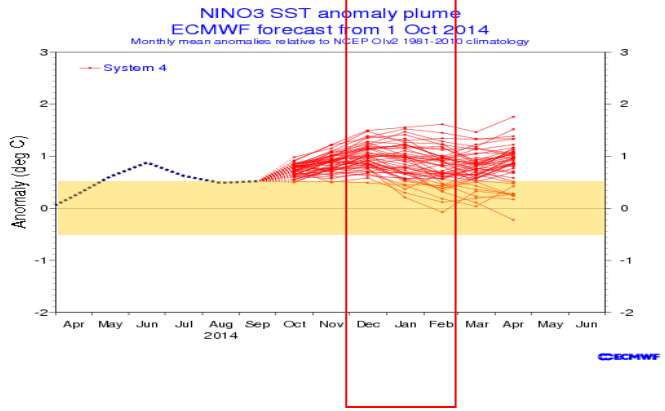
NOAA/CPC



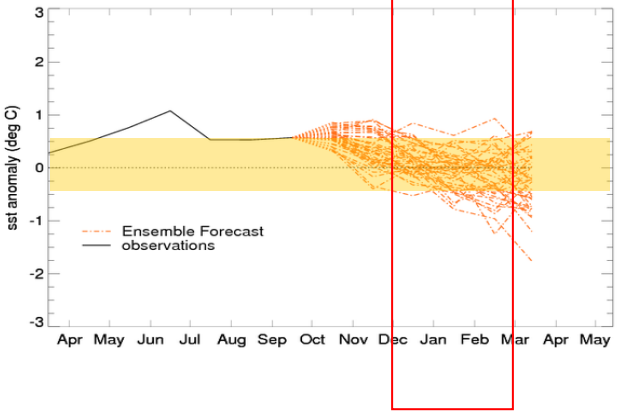
AUS/BoM



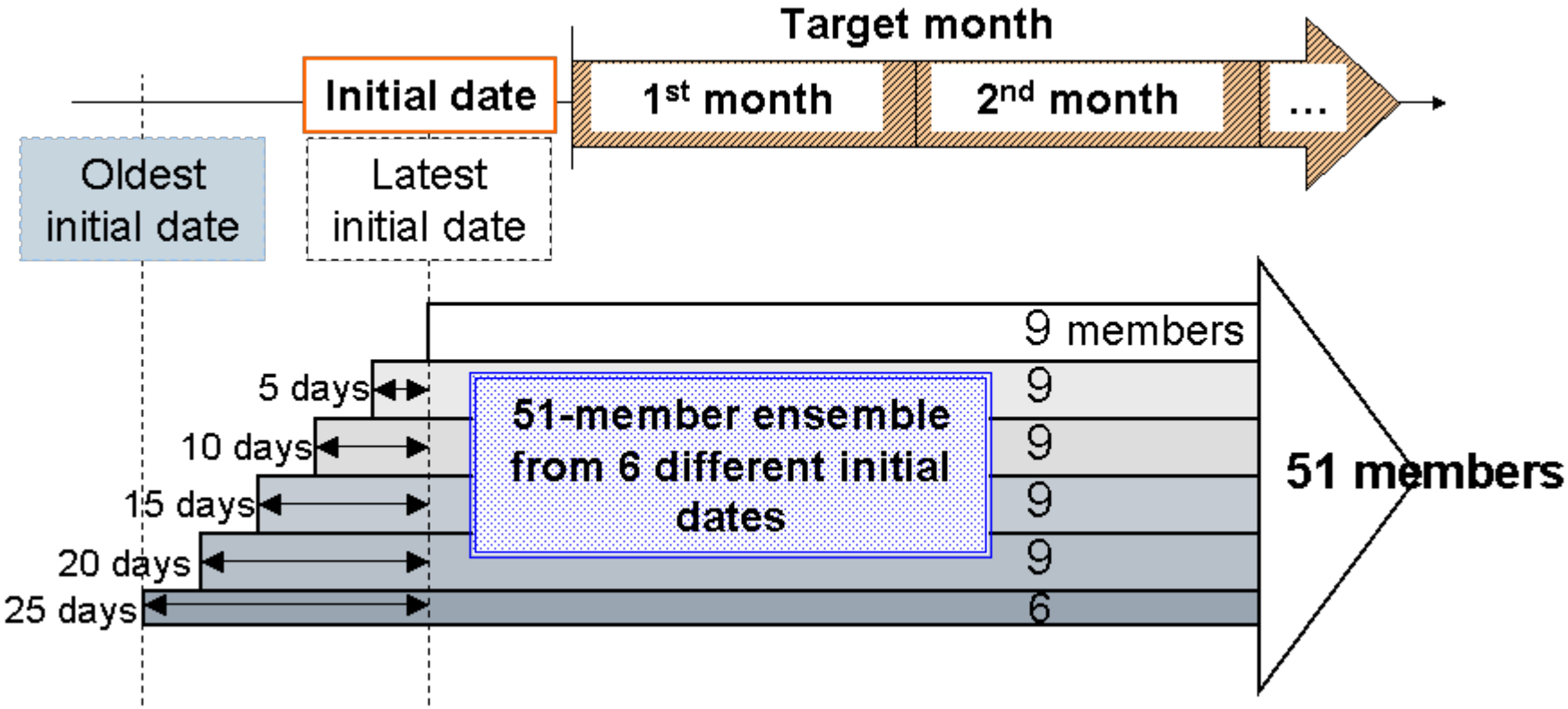
ECMWF



UKMet

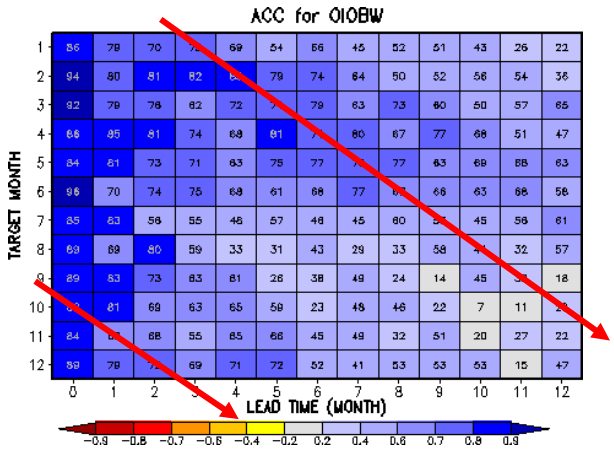


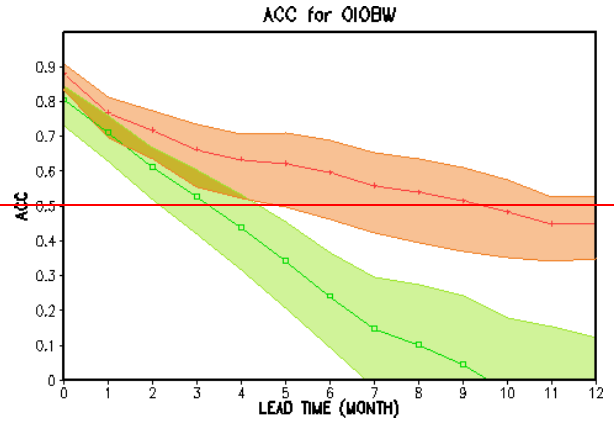
JMA/MRI-CGCM: ensemble method



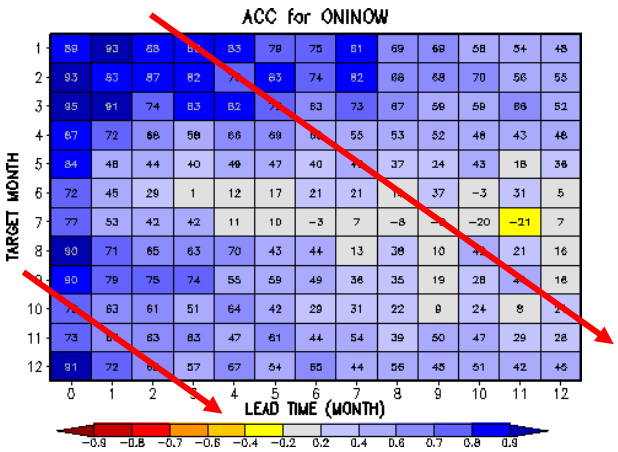
JMA/MRI-CGCM hindcast skills (1979-2007)

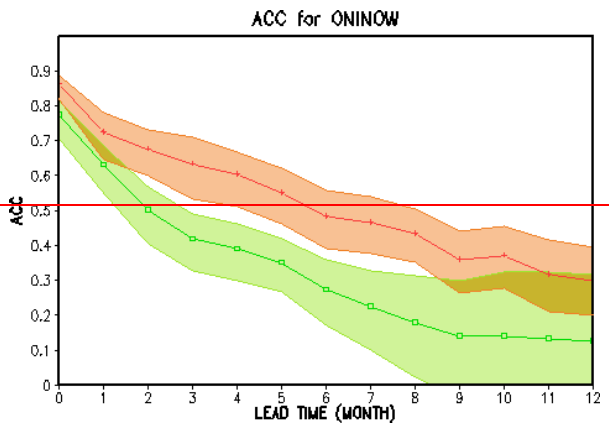
IOBW



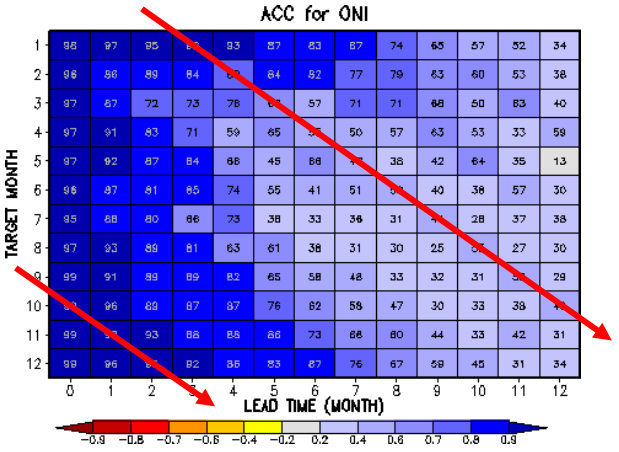


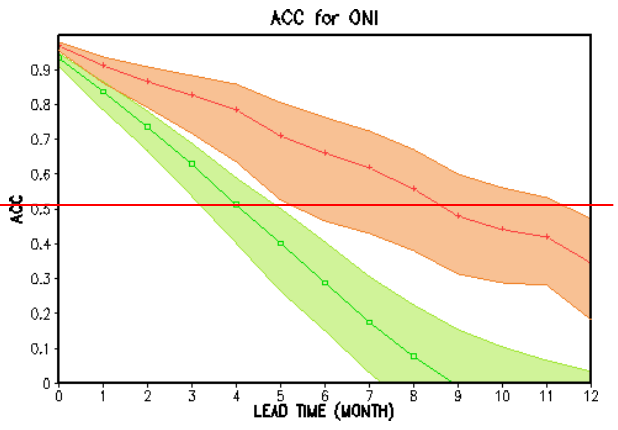
NINO.WEST





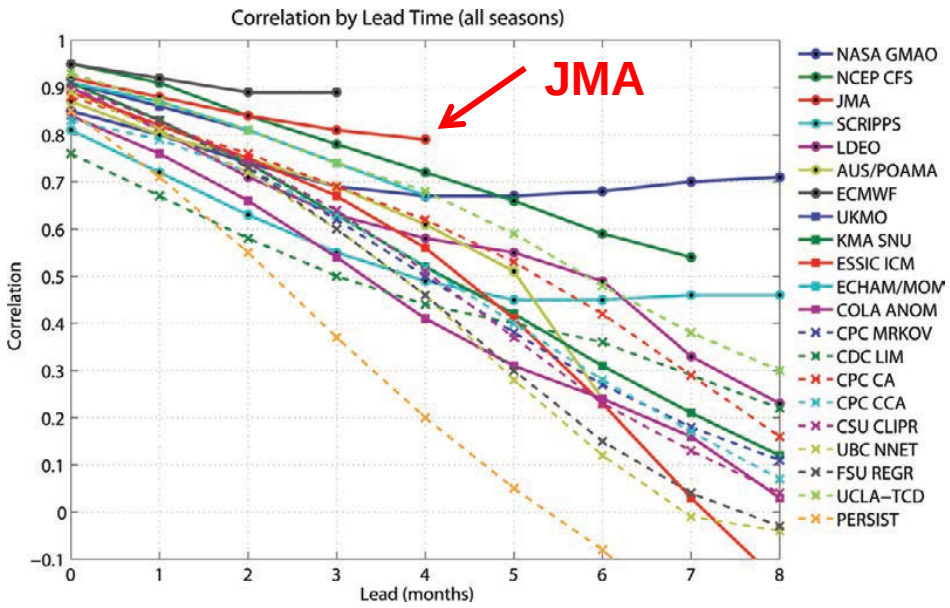
NINO.3





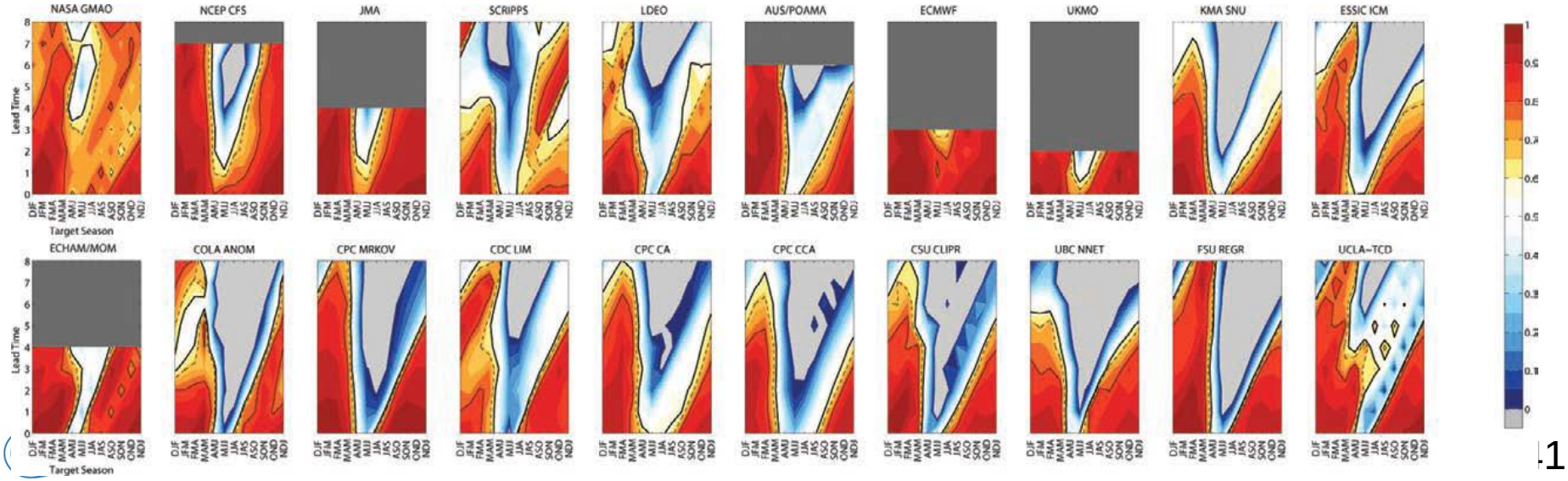
SKILL OF REAL-TIME SEASONAL ENSO MODEL PREDICTIONS (2002–11)

Barnston et al. (2012)



Temporal correlation between model forecasts and observations for all seasons combined, as a function of lead time.

Temporal correlation between model forecasts and observations as a function of target season and lead time.



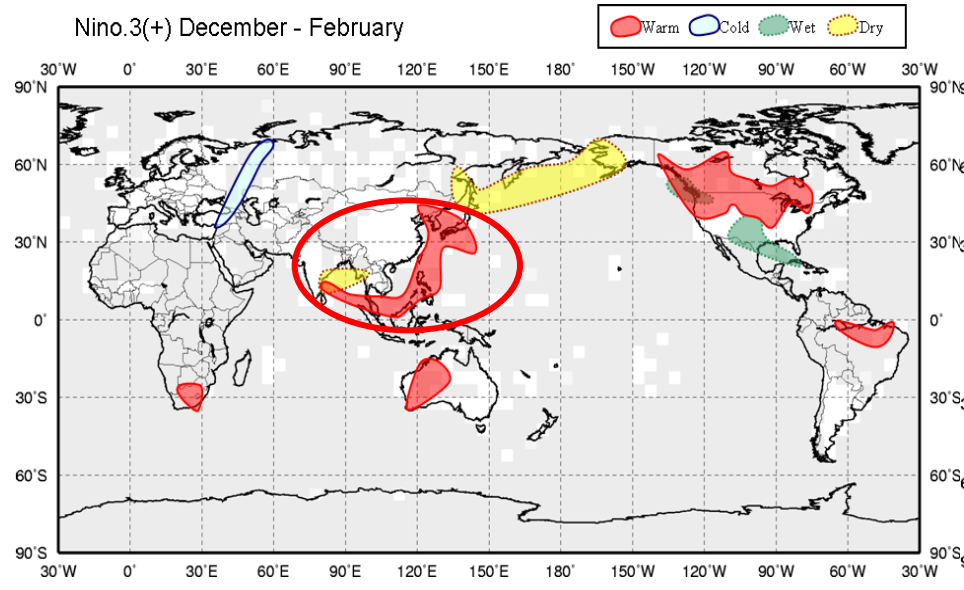
Climate tendencies during El Niño/La Niña in boreal winter

The maps show the regions where climate tendencies observed during El Niño/La Niña events are statistically significant in boreal winter.

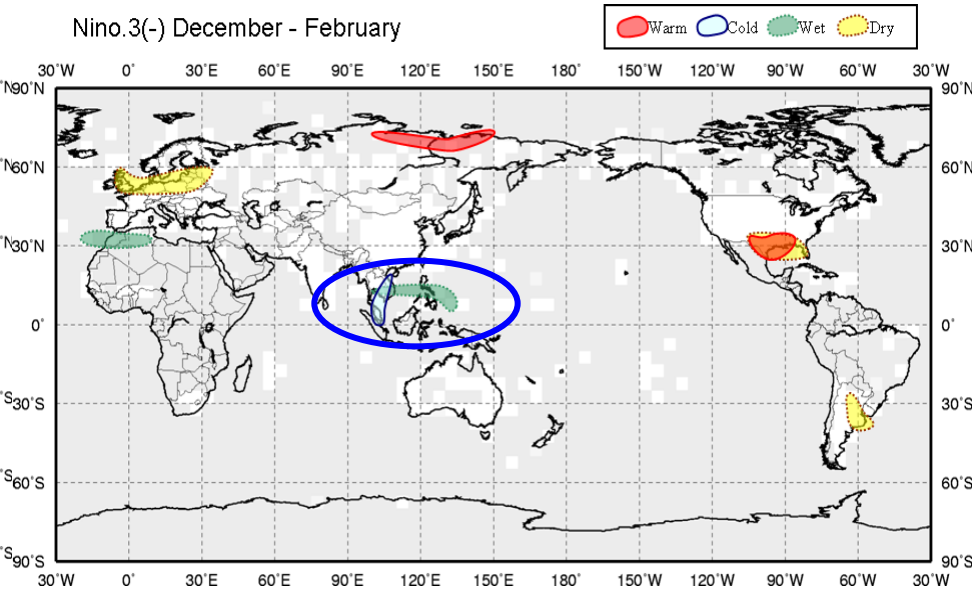
✓*El Niño* : warm tendencies from Malaysia to the Philippines

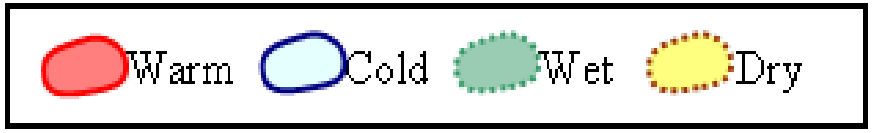
✓*La Niña* : cool and wet tendencies from Cambodia to Malaysia

El Niño



La Niña



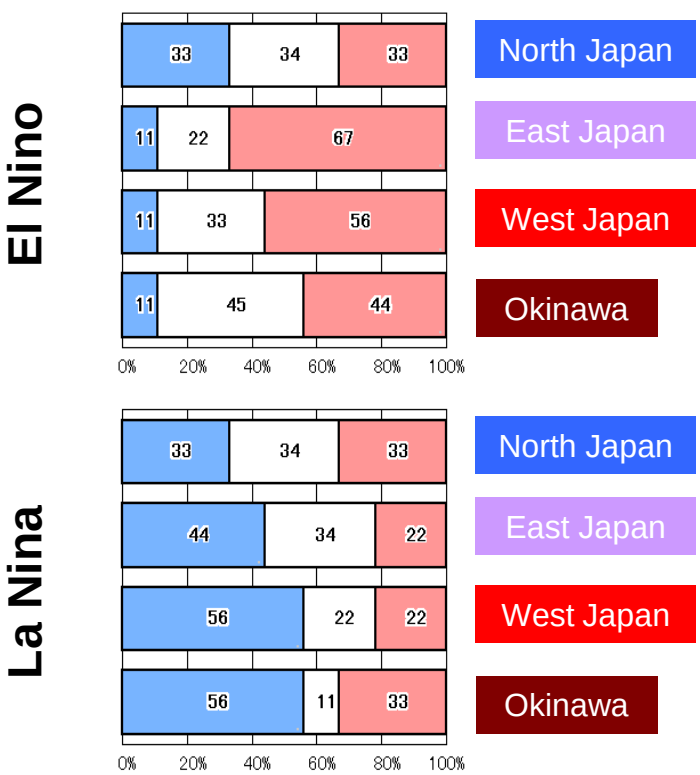


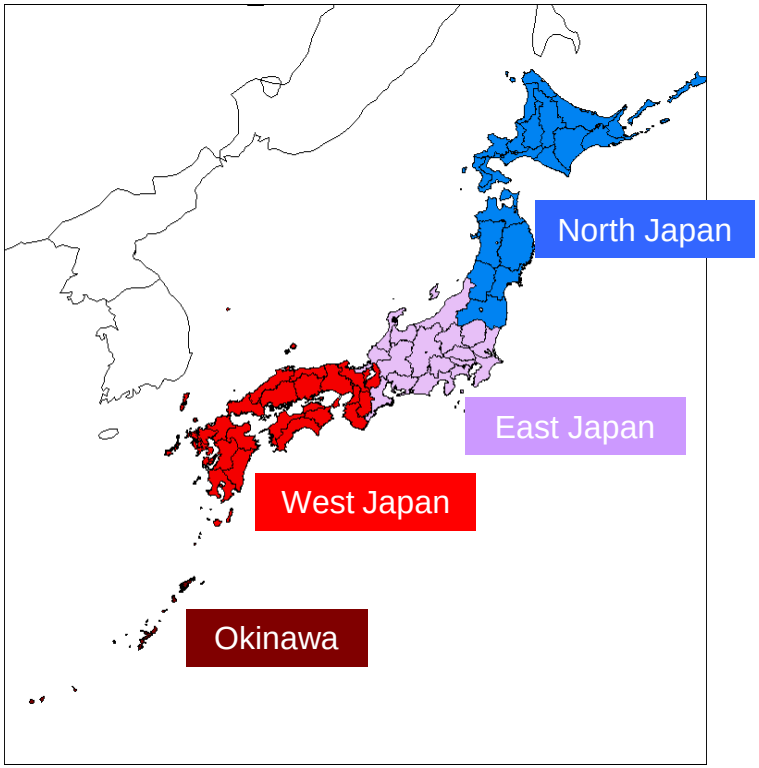
Japan Meteorological Agency

ENSO impacts on the climate in Japan

Statistics indicate :

- *Warm winter tendencies during El Niño*
- *Cold winter tendencies during La Niña.*

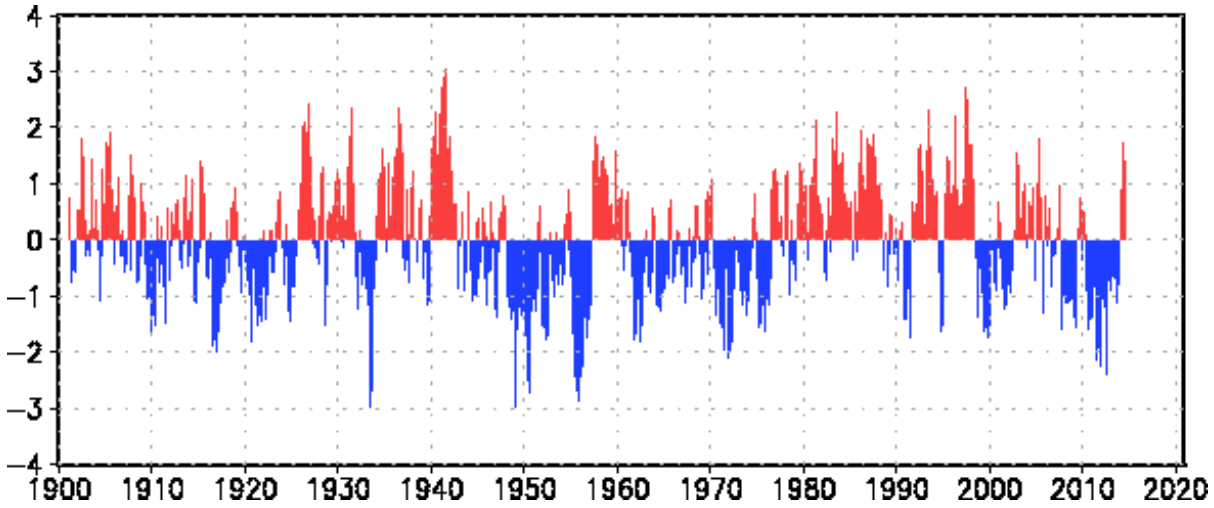


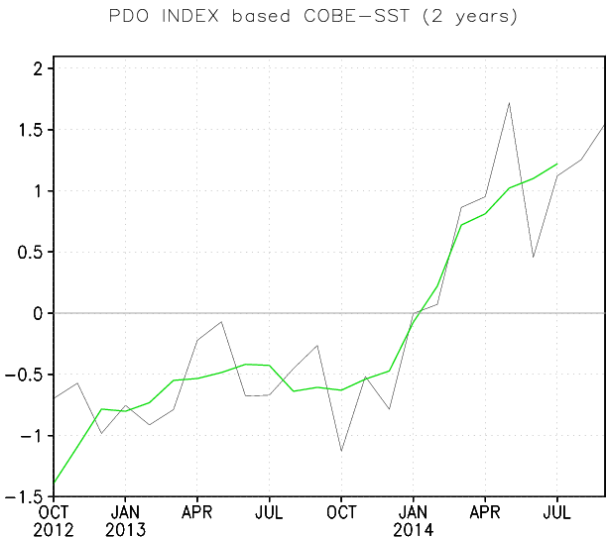


Frequency distribution for air temperature in boreal winter during El Niño (above) and La Nina (below), in terms of 3 ranges of warmer-than-climatological condition, near-climatological condition, and lower-than-climatological condition

Japan Meteorological Agency

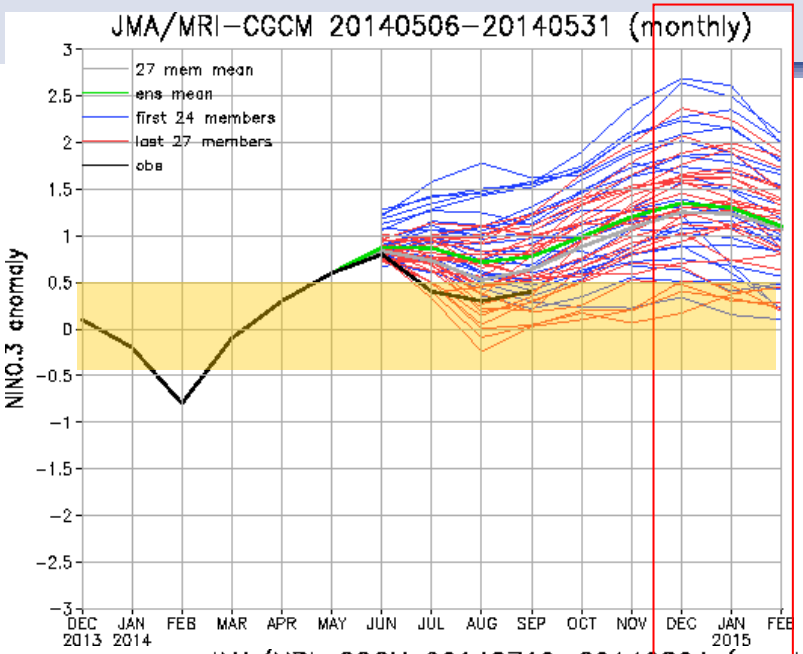
PDO

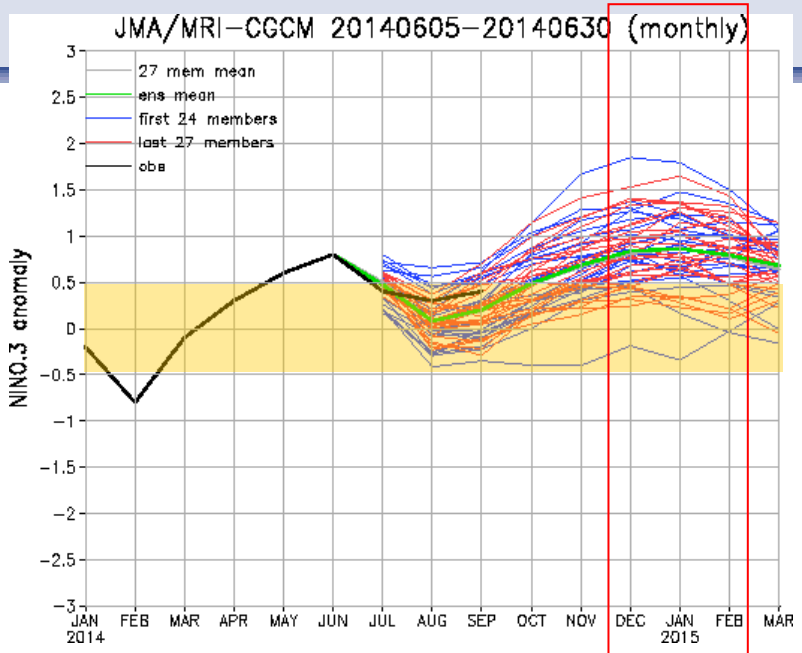


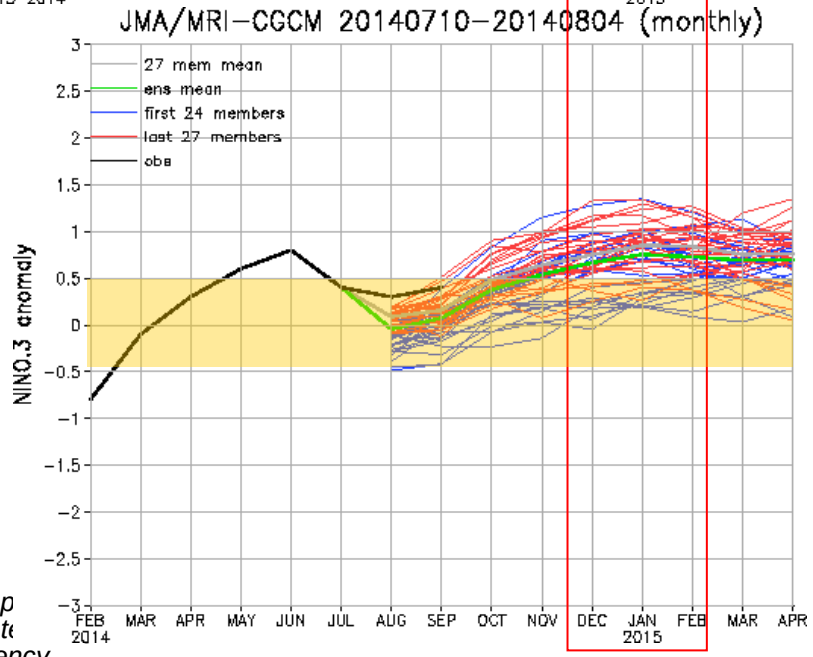


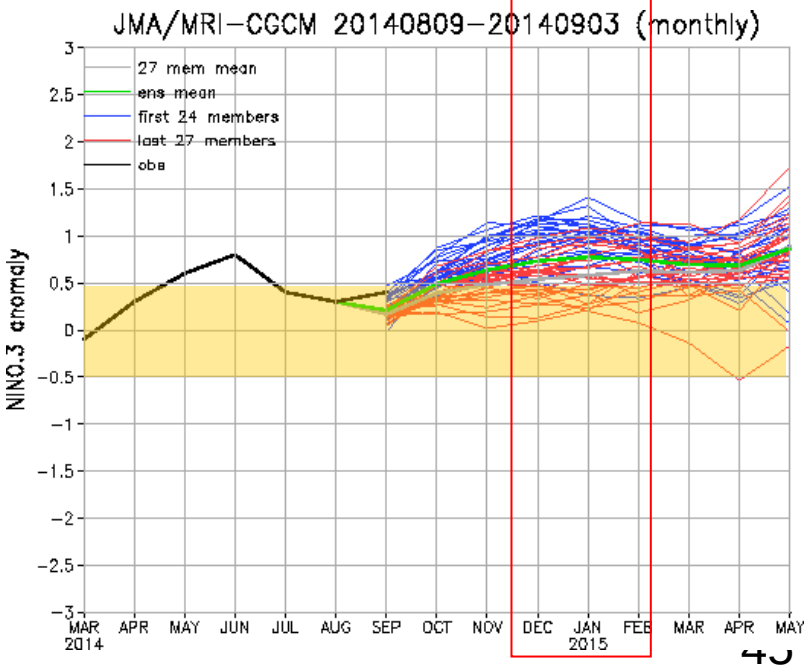
Japan Meteorological Agency

JMA/MRI-CGCM recent prediction

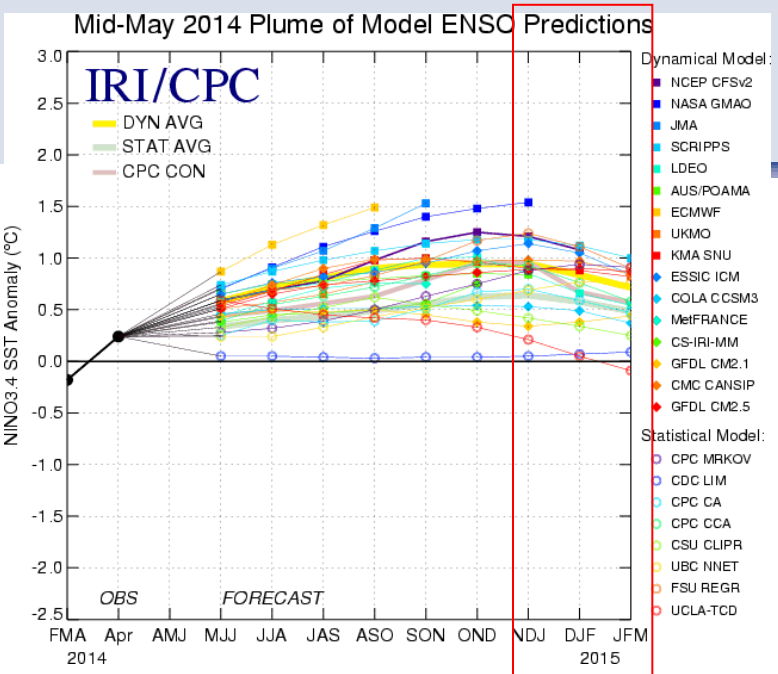


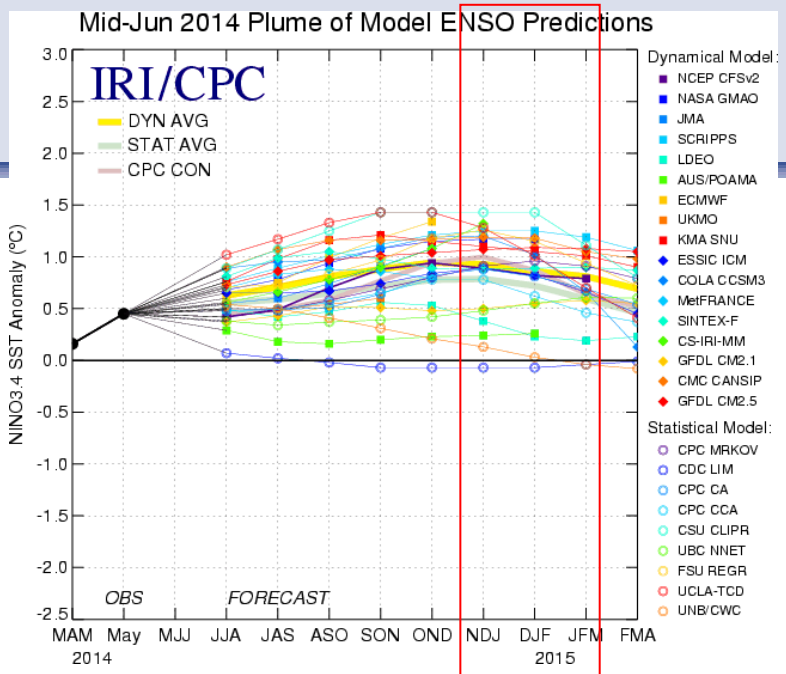






Jap
Met
Agency


Mid-May 2014 Plume of Model ENSO Predictions
IRI/CPC
DYN AVG
STAT AVG
CPC CON
NINO3.4 SST Anomaly (°C)
OBS
FORECAST
FMA Apr AMJ MJJ JJA JAS ASO SON OND NDJ DJF JFM
2014
2015
Dynamical Model:
NCEP CFSv2
NASA GMAO
JMA
SCRIPPS
LDEO
AUS/POAMA
ECMWF
UKMO
KMA SNU
ESSIC ICM
COLA CCSM3
MetFRANCE
CS-IRI-MM
GFDL CM2.1
CMC CANSIP
GFDL CM2.5
Statistical Model:
CPC MRKOV
CDC LIM
CPC CA
CPC CCA
CSU CLIPR
UBC NNET
FSU REGR
UCLA-TCD


Mid-Jun 2014 Plume of Model ENSO Predictions
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MAM May MJJ JJA JAS ASO SON OND NDJ DJF JFM FMA
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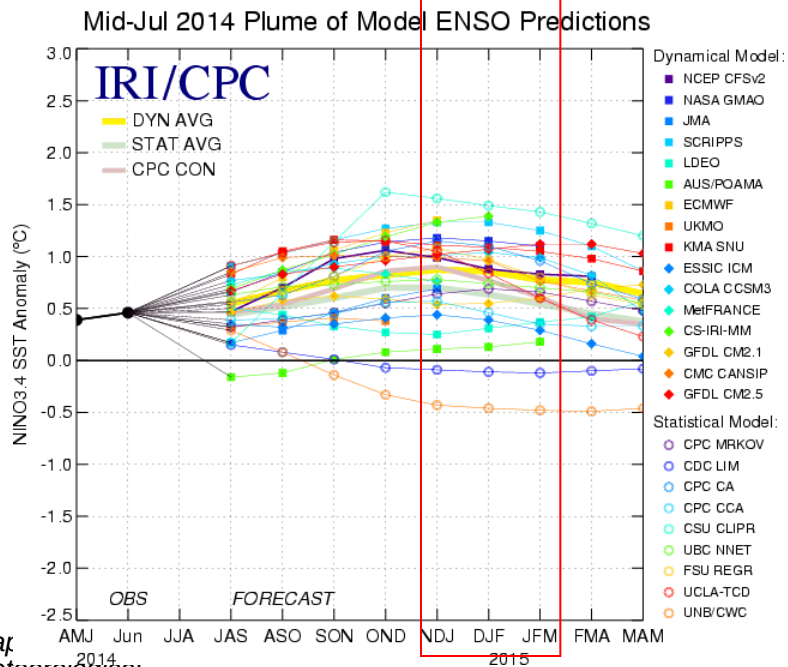
Mid-Jul 2014 Plume of Model ENSO Predictions
IRI/CPC
DYN AVG
STAT AVG
CPC CON
NINO3.4 SST Anomaly (°C)
OBS
FORECAST
AMJ Jun JJA JAS ASO SON OND NDJ DJF JFM FMA MAM
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2015
Dynamical Model:
NCEP CFSv2
NASA GMAO
JMA
SCRIPPS
LDEO
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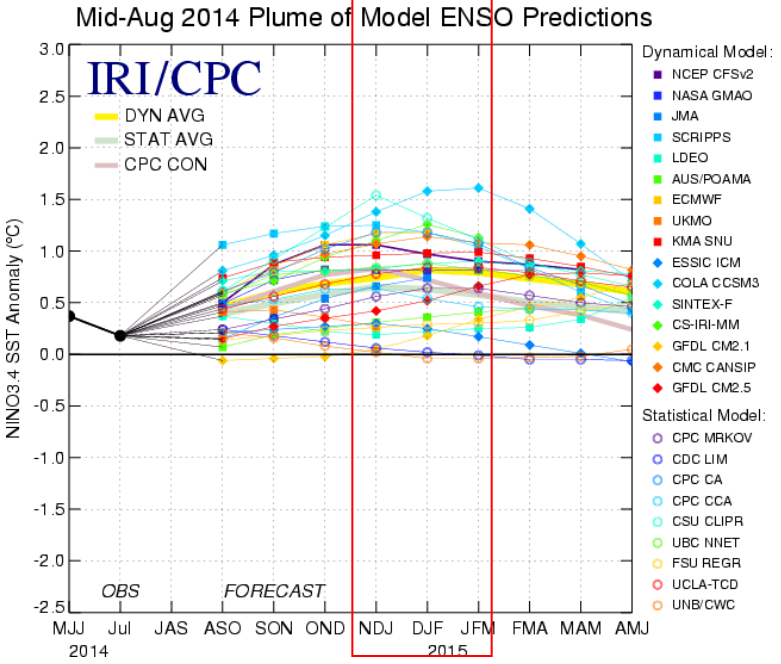
Mid-Aug 2014 Plume of Model ENSO Predictions
IRI/CPC
DYN AVG
STAT AVG
CPC CON
NINO3.4 SST Anomaly (°C)
OBS
FORECAST
MJJ Jul JAS ASO SON OND NDJ DJF JFM FMA MAM AMJ
2014
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NASA GMAO
JMA
SCRIPPS
LDEO
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CPC CA
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CSU CLIPR
UBC NNET
FSU REGR
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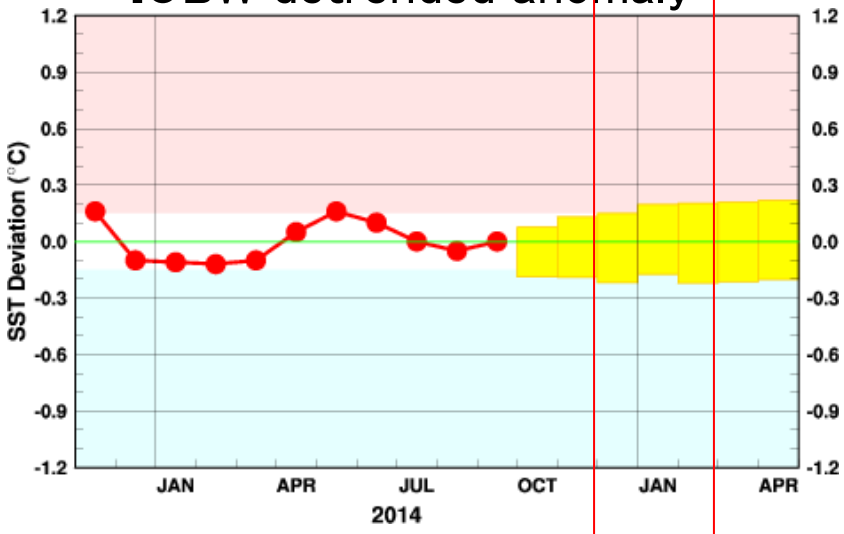
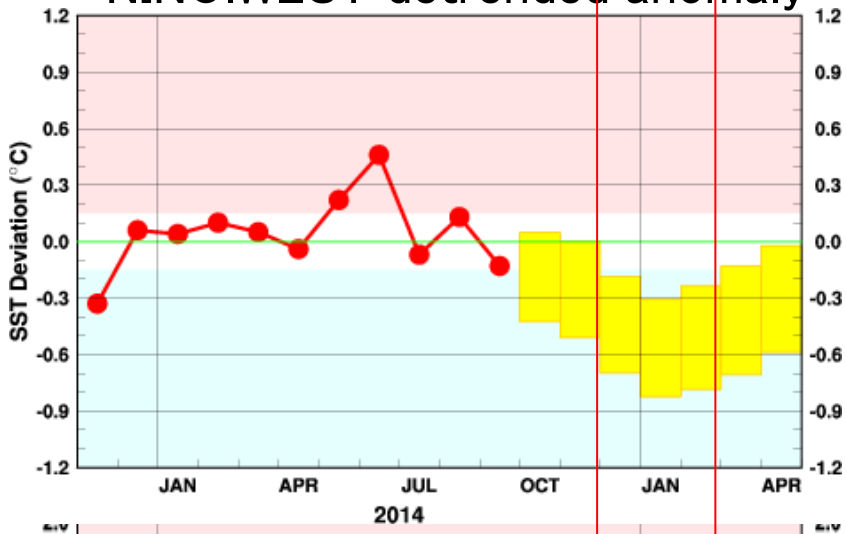
UNB/CWC

IOBW & NINO.WEST SST predicted by JMA/MRI-CGCM

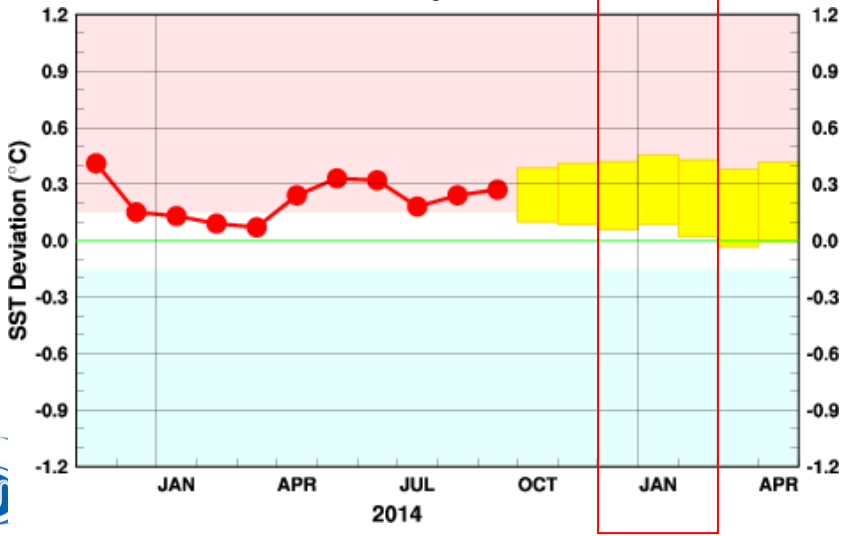
IOBW detrended anomaly



NINO.WEST detrended anomaly



IOBW anomaly (not detrended)



NINO.WEST anomaly (not detrended)