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THE SYNERGY OF HISTORY AND EL NIÑO SOUTHERN OSCILLATION FOR ENHANCED DROUGHT AND FLOOD MANAGEMENT

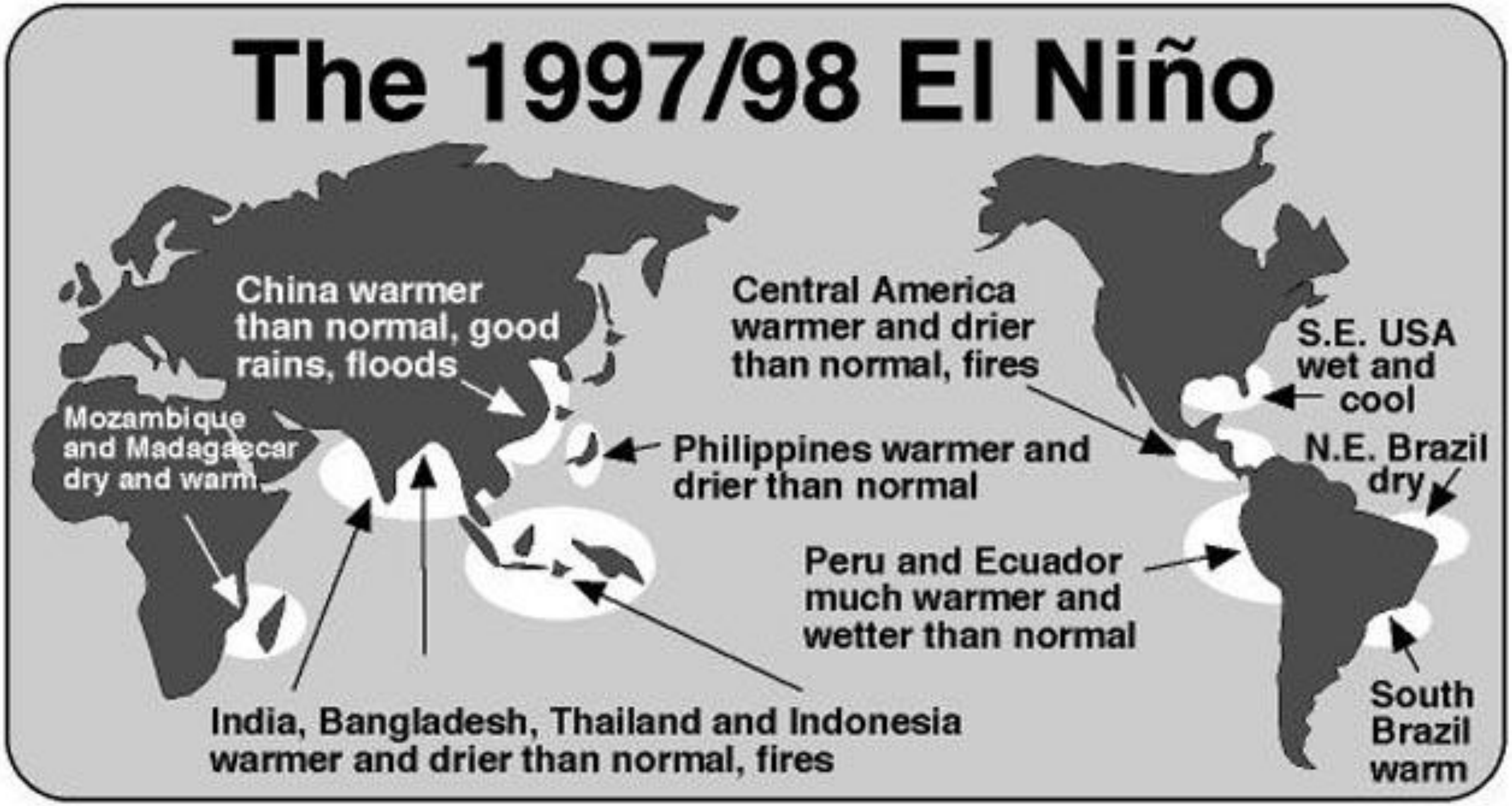
Kamran Emami
kkemami@gmail.com

Presentation outlines

1. ENSO (The El Niño Southern Oscillation)
2. Background
3. Monitoring the ENSO Indices
4. Historical Droughts and Floods in Iran
5. Conclusions and current strong El Nino

- **For the first time in human history, the American scientists forecasted extreme floods in California and Florida six months in advance in the summer 1997 by using the teleconnection with El Niño Southern Oscillation (ENSO). In fact, the maximum annual precipitations in a period of 120 years were recorded in 1998.**

Global Effects of ENSO



Economic Gain of $15 Billion in U.S. in 1997-98

Impacts of 1997–98 El Niño–Generated Weather in the United States

Stanley A. Changnon
Changnon Climatologist, Mahomet, Illinois

TABLE 1. National tally of impacts from weather conditions attributed to El Niño, 1997–98.

LOSSES

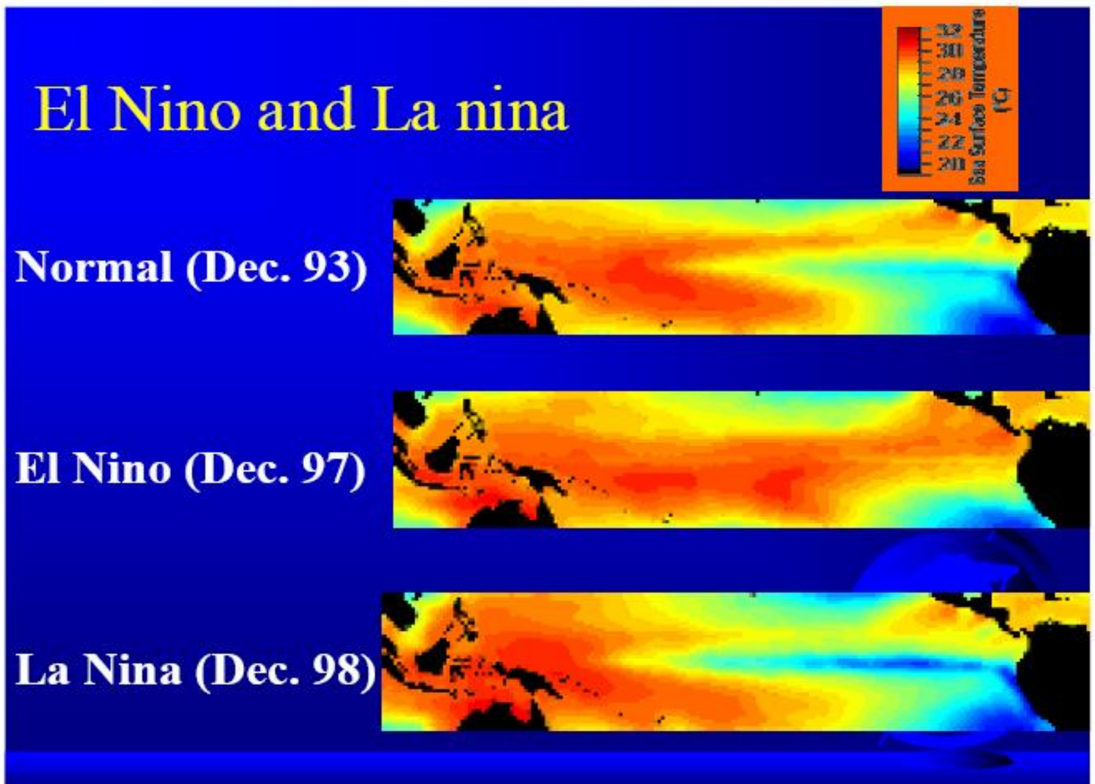
Human lives lost = 189
Economic losses and costs = $4.2–$4.5 billion

BENEFITS

Human lives saved = 850
Economic gains = $19.6–$19.9 billion

ENSO

E`l Niño, which occurs every 2 to 7 years, is an abnormal warming of the eastern Pacific waters that interferes with the normal trade wind patterns. ENSO is perhaps the most important mechanism affecting weather patterns on time scales of a season out to a few years

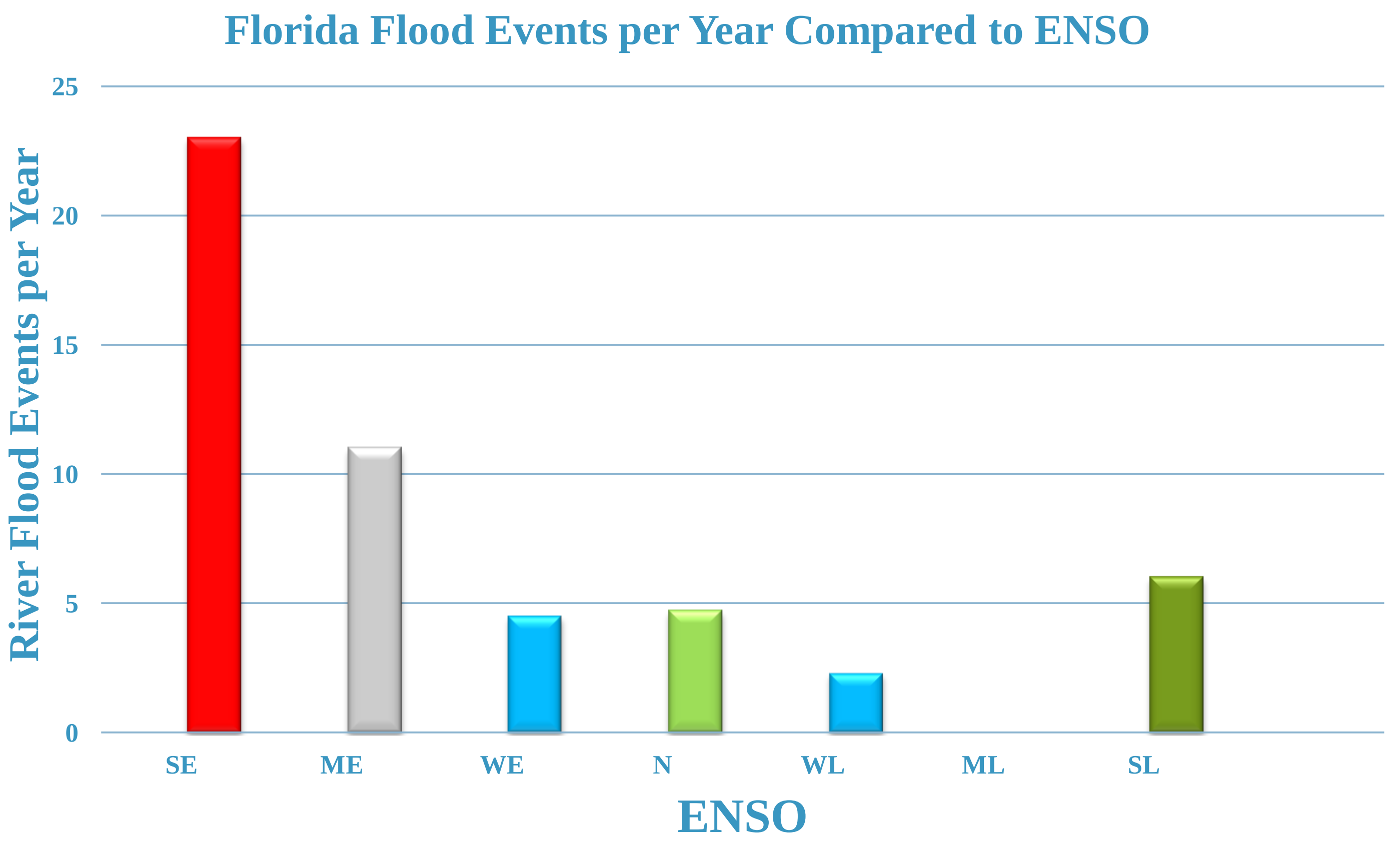


Under Normal Conditions

Presentation outlines

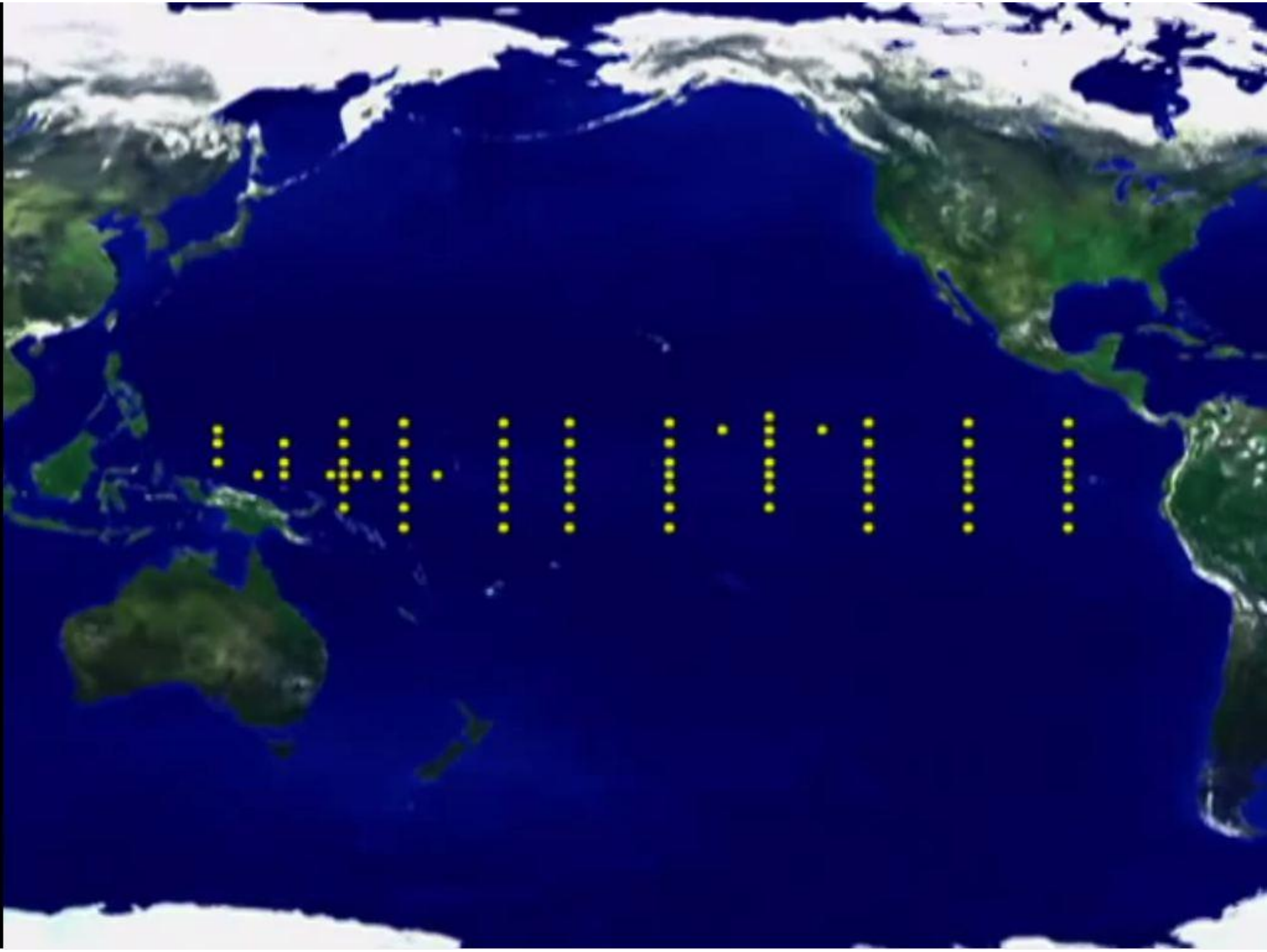
Teleconnection in atmospheric science refers to climate anomalies being related to each other at large distances (typically thousands of kilometers

ENSO teleconnection with Floods in Florida



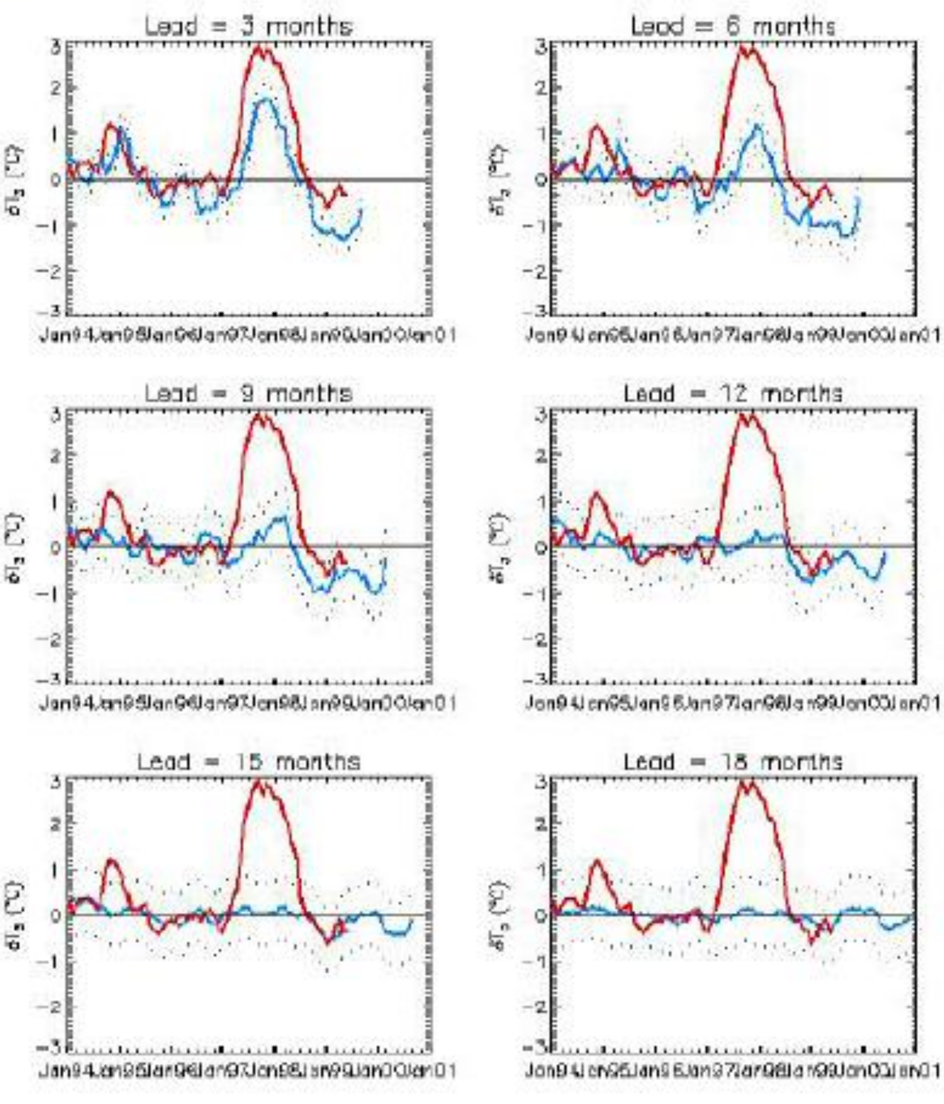
Forest Fires in Indonesia (1998)


ATLAS



- **SST forecasting**
- **Dynamic**
- **Statistical**

Models



ENSO Indices (reconstructed)

Number	Index	Period (year)	Number	Index	Period (year)
1	TNA-data	165	13	NAO-long-data=jonesNAO-data	189
2	TPI-long- data	113	14	NAO_ice_dat	189
3	GLB TS	129	15	NAO_gib_dat	189
4	CLB-TS+dsst	129	16	NAO_azo_dat	145
5	CLB-TS_long_data	129	17	GLBTSSST_long_data	130
6	madrasmslp_dat	213	18	SOI-tah-data	154
7	AMO-SM-long-data	149	19	SOI-long-data	144
8	tavegl_long_data	160	20	SOI-dar-dat	143
9	Nina3.4_data	139	21	rNao-long-data	350
10	Ninol2	129	22	PDO-long-data	108
11	Nino4_long_data	139	23	NP-long-data	110
12	Nino3_long_data	139			

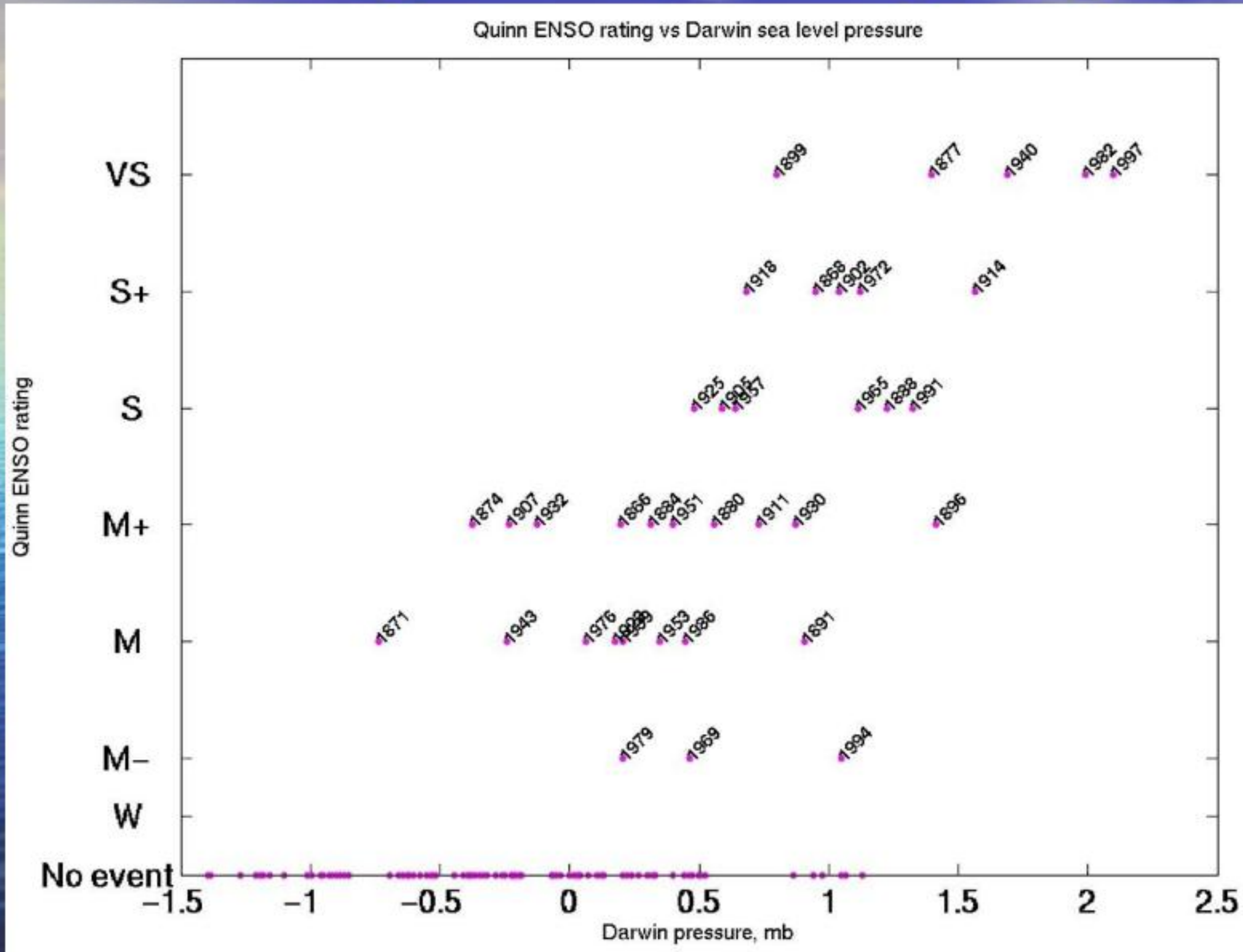
William Quinn's *et al.* [1987] references for El Niño events chronologies

14,452 QUINN ET AL.: EL NIÑO OCCURRENCES OVER PAST FOUR AND A HALF CENTURIES

TABLE 2. El Niño Events of Moderate and Near-Moderate Intensities, Their Confidence Ratings, and Information Sources

El Niño Event	Event Strength	Confidence Rating	Information Sources
1806–1807	M	3	*Stevenson* [1829], *Remy* [1931], and *Unanue* [1815]
1812	M	4	*Palma* [1894] and *Gonzalez* [1913]
1817	M+	5	*Eguiguren* [1894], *Labarthe* [1914], *Portocarrero* [1926], and *Taulis* [1934]
1819	M+	4	*Eguiguren* [1894] and *Taulis* [1934]
1821	M	5	*Eguiguren* [1894], *Fuchs* [1925], *Remy* [1931], and *Taulis* [1934]
1824	M	5	*Spruce* [1864], *Basadre* [1884], and *Eguiguren* [1894]
1832	M	5	*Spruce* [1864], and *Eguiguren* [1894]
1837	M	5	*Eguiguren* [1894], *Labarthe* [1914], *Portocarrero* [1926], and *Taulis* [1934]
1850	M	5	*Eguiguren* [1894], *Fuchs* [1925], and *Taulis* [1934]
1854	W/M	4	*Spruce* [1864], *Eguiguren* [1894], and *Taulis* [1934]
1857–1858	M+	5	*Eguiguren* [1894], *Labarthe* [1914], *Portocarrero* [1926], *Gaudron* [1925], *Zegarra* [1926], and *Taulis* [1934]
1860	M	4	*Labarthe* [1914], *Portocarrero* [1926], and *Taulis* [1934]
1866	M	4	*Eguiguren* [1894], *Labarthe* [1914], *Bachmann* [1921], and *Portocarrero* [1926]
1867–1868	M	4	*El Comercio* (January 10, 1872), *Raimondi* [1897], *Taulis* [1934], and *Eguiguren* [1894]
1874	M	4	*Bravo* [1903], *La Patria* (February 9, 1874), and *Bachmann* [1921]
1880	M	4	*Eguiguren* [1894], *Puls* [1895], and *Taulis* [1934]
1887–1889	W/M	5	*Eguiguren* [1894], *Labarthe* [1914], *Portocarrero* [1926], and *Taulis* [1934]
1896–1897	M+	4	*Bravo* [1903], *El Comercio* (February 3, 1897, and February 22, 1897), and *Bachmann* [1921]
1902	M+	4	*El Comercio* (February 17, 1902), *Bachmann* [1921], and *Taulis* [1934]
1905	W/M	4	*Bachmann* [1921], and *Taulis* [1934]
1907	M	3	*Remy* [1931], and *Paz Soldan* [1908]
1914	M+	5	*Labarthe* [1914], *Portocarrero* [1926],

Quinn ENSO ratings vs Darwin atmospheric pressure



The synergy of History and ENSO

1-Hydrological records are normally available for a period of 40-70 years

2- ENSO indices records are reconstructed for a period of 150 to 300 years

USE HISTORICAL DOCUMENTS!

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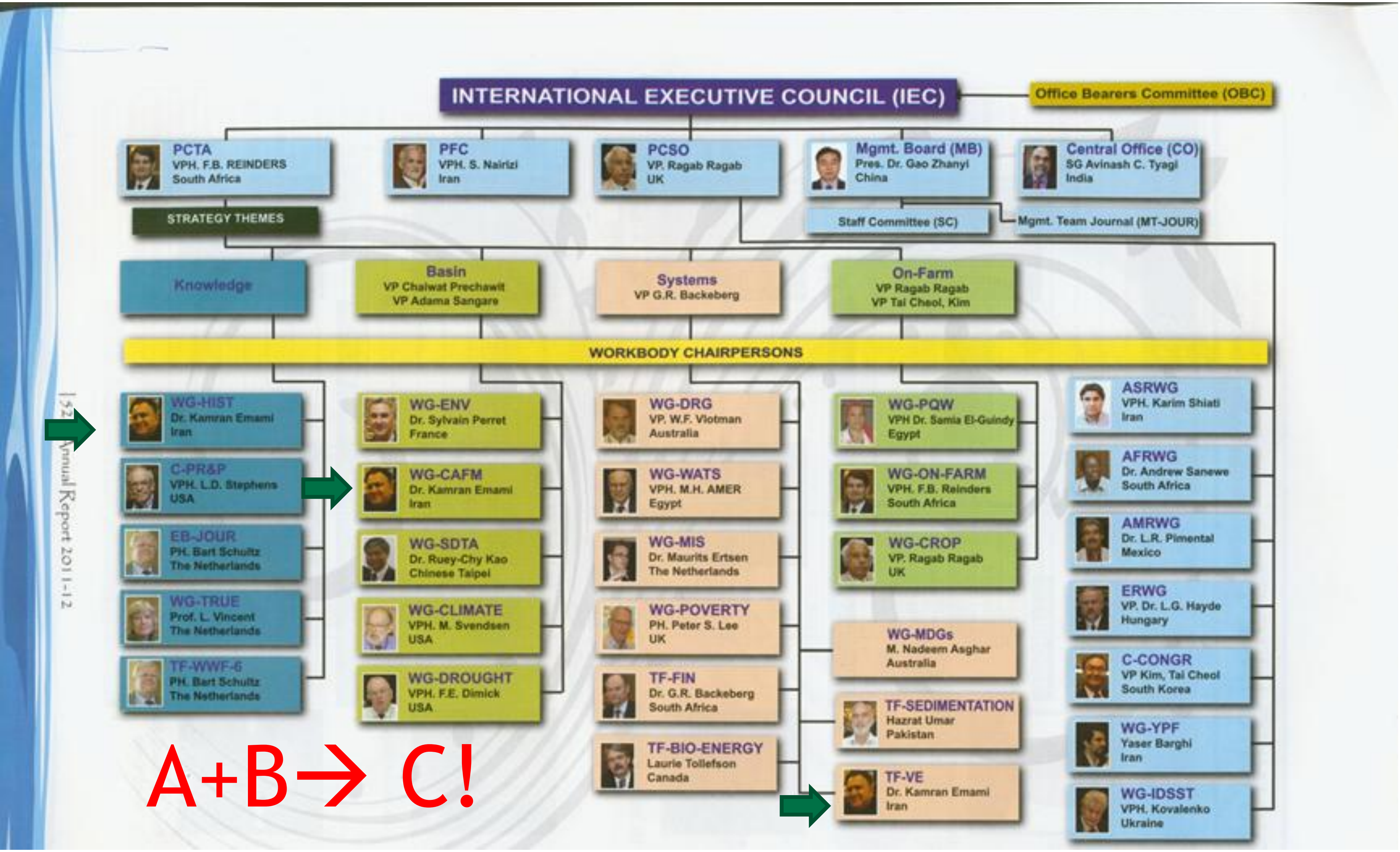
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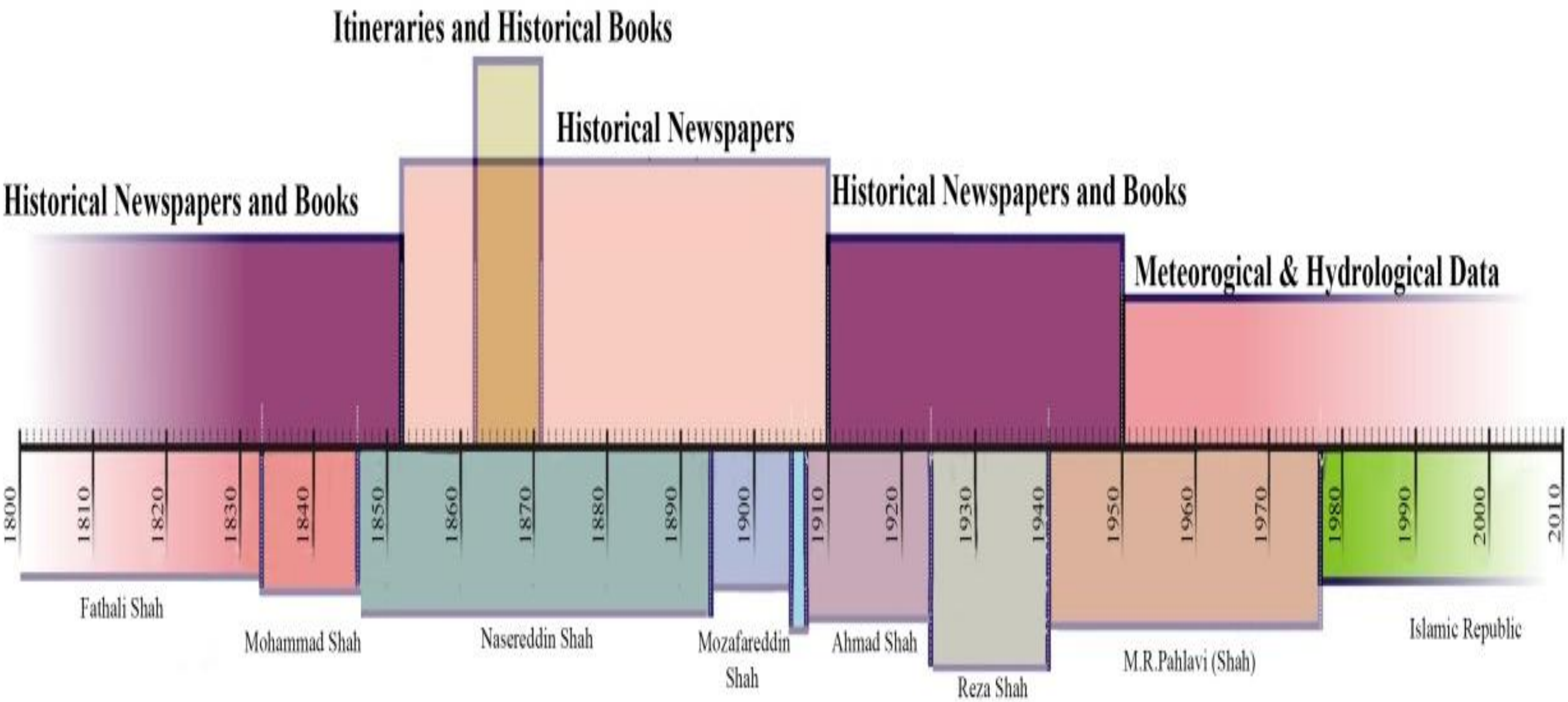
152 Annual Report 2011-12

A+B→ C!

History and ENSO

Shadorovan Historical Bridge (failure by overtopping in 1885)

Historical Documents used in the research

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Nixon Spacemen Talk,
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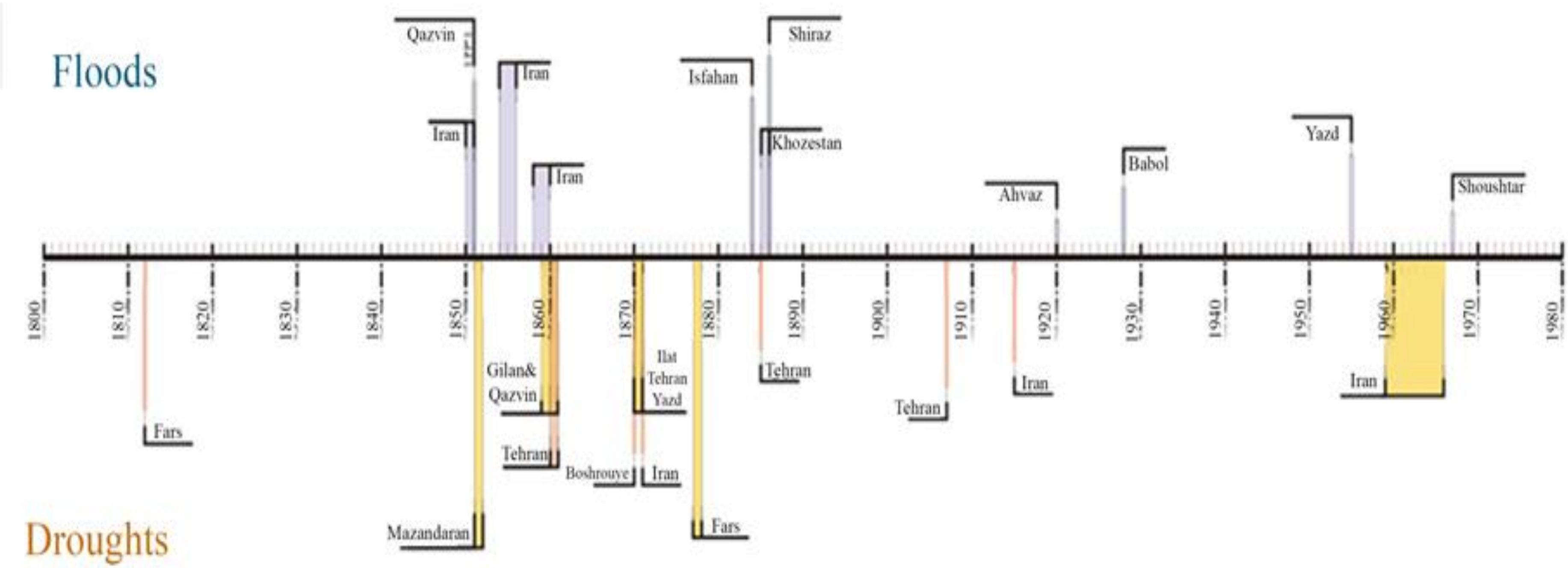
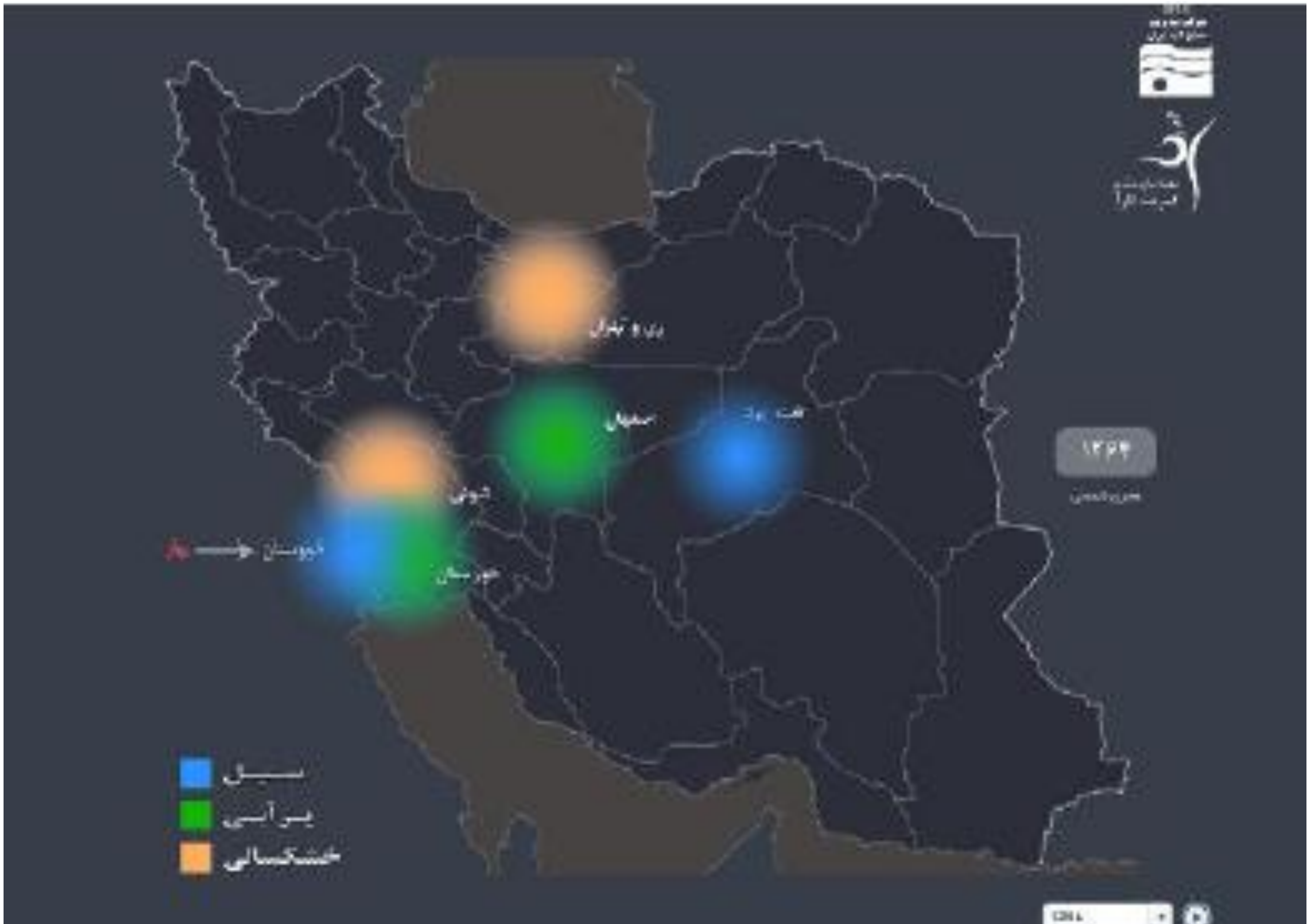
Historical Floods and Droughts in the past 200 years



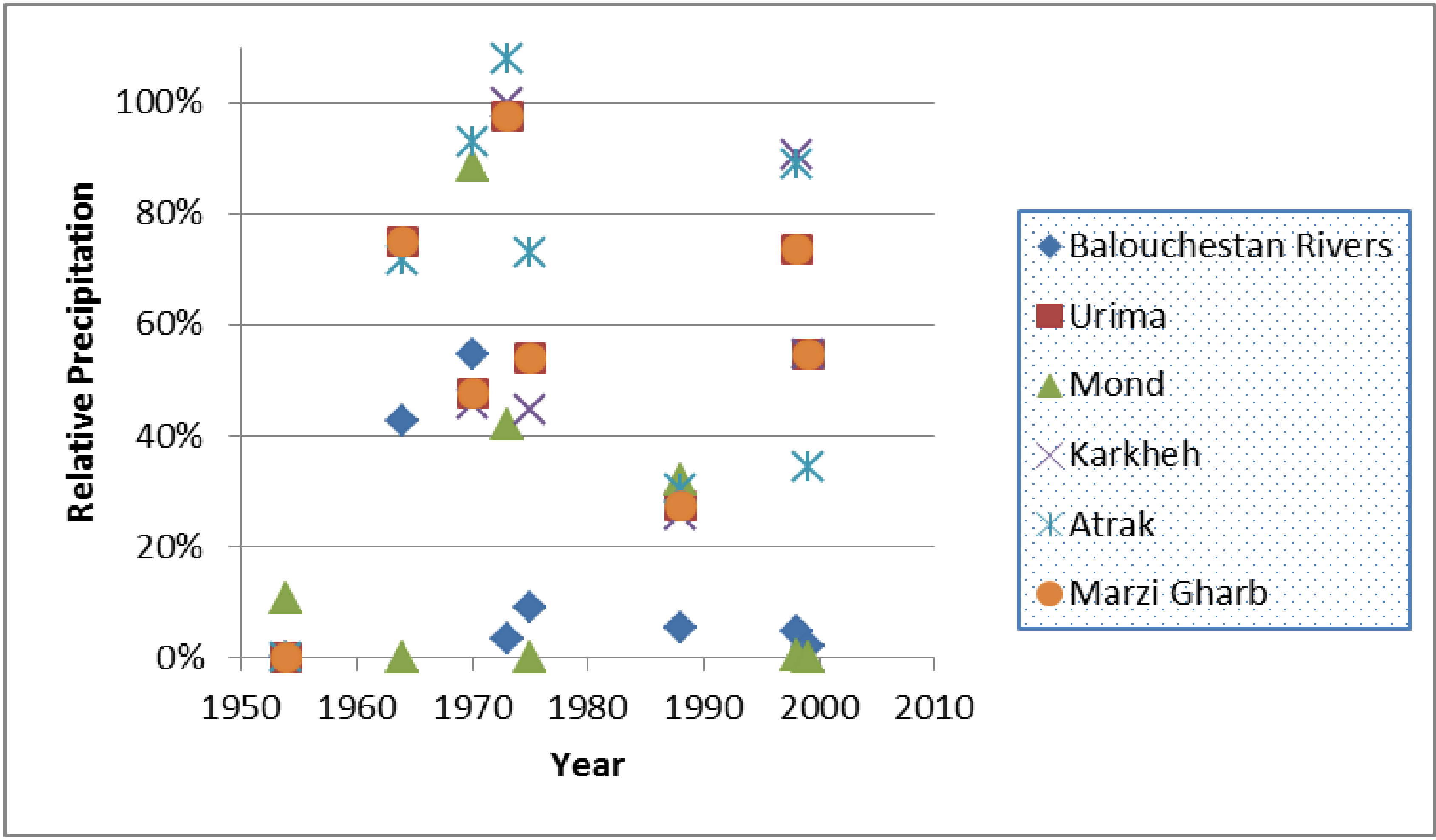
Data Bank of Historical Floods and Droughts

Data Bank of Historical Floods and Droughts

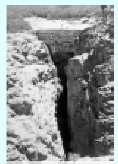


The basins used for climate forecasting (2015)

The relative precipitations observed in strong La Nina years compared to the long-term average (100%)



Drought Warning in 2007 (3 month in advance)



شماره:۳۵۶۹/ک/۸۶

تاریخ : ۸۶/۰۸/۳۰

پیوست: دارد.

سد کریت ایران پانصد و پنجاه سال بلندترین سد جهان محسوب می‌گردید و یکی از بزرگترین شاهکارهای مهندسی آب بشمار می‌رود

جناب آقای مهندس مقدوری

مدیر عامل محترم آب منطقه‌ای تهران

موضوع: پیش‌بینی بارش زمستان ۱۳۸۶ و بهار ۱۳۸۷

با سلام و احترام

همانطوریکه استحضار دارید برای اولین بار در تاریخ، در سال ۱۹۹۷ دانشمندان آمریکایی با استفاده از پیش‌بینی‌های اقلیمی، سیلاب‌های بزرگ ایالت‌های کالیفرنیا و فلوریدا را از شش ماه قبل بدرستی پیش‌بینی کردند. مبنای این پیش‌بینی‌ها پدیده‌های ال‌نینو و لانینا در اقیانوس آرام می‌باشد و در سال ۱۳۷۸ در آبگیری زودهنگام سد کرخه پیش‌بینی‌های اقلیمی با موفقیت مورد استفاده قرار گرفته است (مقاله پیوست). در چند ماه گذشته پدیده لانینا در اقیانوس آرام حاکم بوده و پیش‌بینی شده است که این مسئله ادامه خواهد یافت. با توجه به اینکه در سال‌های لانینا در بسیاری از مناطق کشور احتمال بارش کمتر از متوسط افزایش می‌یابد، توصیه می‌شود آن شرکت مطالعات لازم در مورد پیش‌بینی، منابع آب عمده تحت مدیریت خود را (آب‌های سطحی و زیرزمینی) با استفاده از پارامترهای مربوطه (SOI، MEI و ...) در دستور کار قرار دهد. در این رابطه این شرکت با سابقه ۸ سال در این زمینه آمادگی خود را برای انجام این مطالعات اعلام می‌دارد.

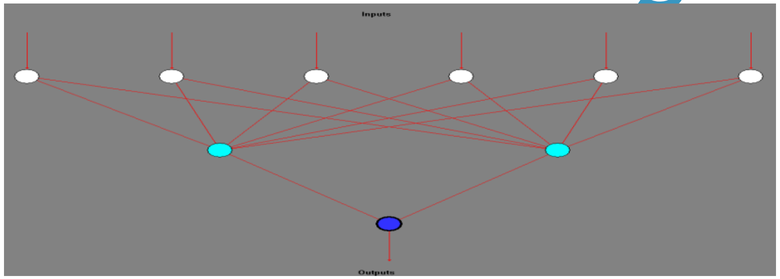
کامران امامی

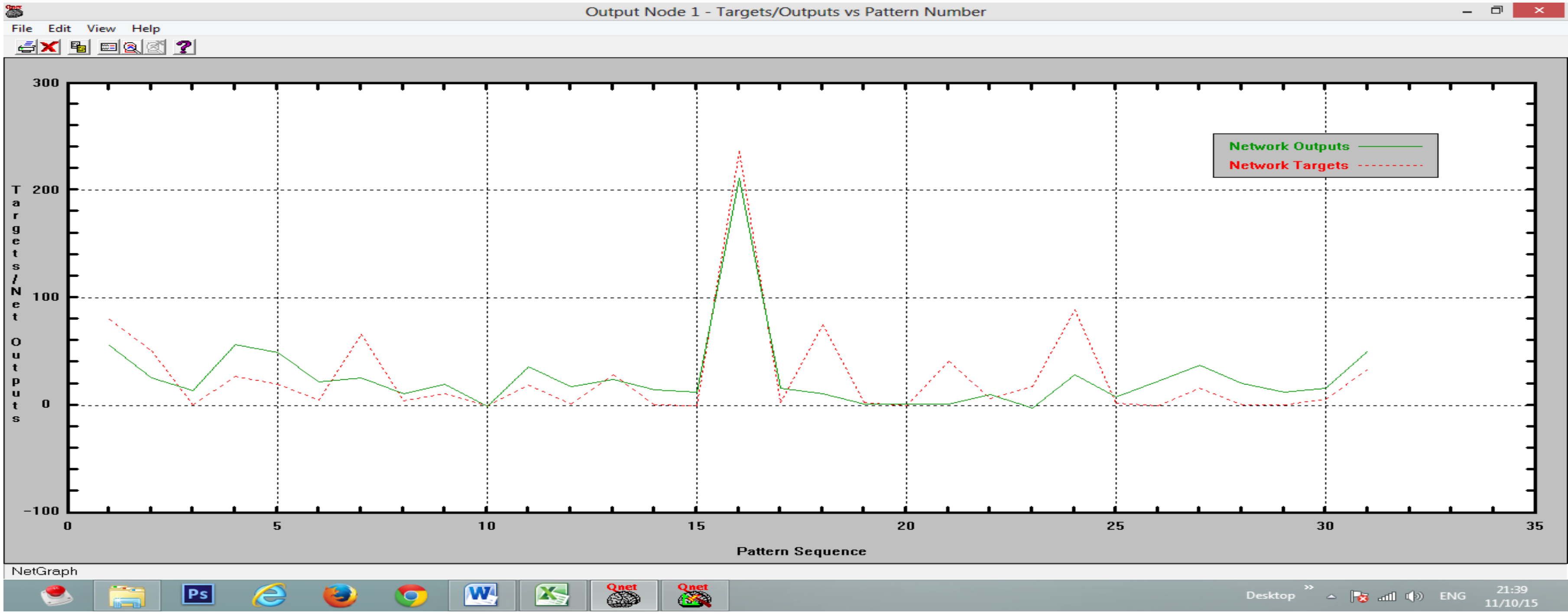
مدیر عامل

Historical Droughts

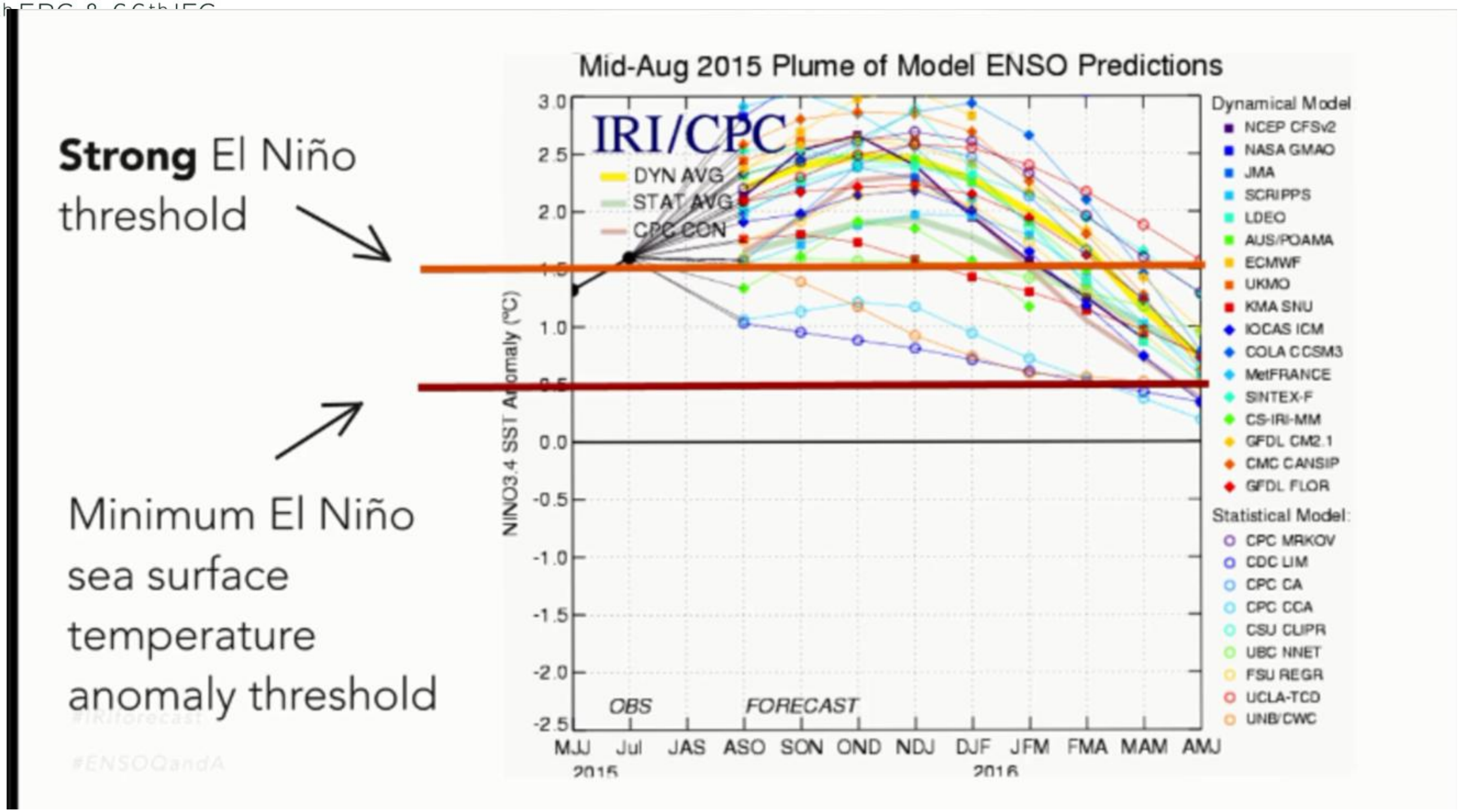
1866	Orissa famine of 1866	India	1 million[59]
1866–1868	Finnish famine of 1866–1868. About 15% of the entire population died	Finland, northern Sweden	150,000+
1869	Rajputana famine of 1869	India	1.5 million[59]
1870–1871	Famine in Persia	Iran (present day)	2 million[60][unreliable source?]
1873–1874	Famine in Anatolia caused by drought and floods[61][62]	Turkey (present day)	
1879	1879 Famine in Ireland. Unlike previous famines, this famine mainly caused hunger and food shortages but little mortality.	Ireland	
1873–74	Bihar famine of 1873–74. Mortality was avoided in a massive relief campaign	India	0
1876–1879	ENSO Famine in India, China, Brazil, Northern Africa (and other countries). Famine in northern China killed 13 million people.[63] 5.25 million died in the Great Famine of 1876–78 in India	India, China, Brazil, Northern Africa (and other countries).	
1878-1880	Famine in St. Lawrence Island, Alaska[64]	United States	
1888–1892	Ethiopian Great famine. About one-third of the population died.[65][66] Conditions worsen with cholera outbreaks (1889–92), a typhus epidemic, and a major smallpox epidemic (1889–90).	Ethiopia	
1891–1892		Russia	375,000–500,000[67][68]
1896–1897	ENSO famine in northern China leading in part to the Boxer Rebellion	China	
1896–1902	ENSO famine in India[69]	India	
1907, 1911	Famines in east-central China[citation needed]	China	
1914–1918	Mount Lebanon famine during World War I which killed about a third of the population[70]	Lebanon	
1916–1917	Famine caused by the British blockade of Germany in WWI	Germany	
1916–1917	Winter famine in Russia[citation needed]	Russia	
1917–1919	Famine in Persia. As much as 1/4 of the population living in the north of Iran died in the famine[71]	Iran (present day)	
1917–1921	A series of famines in Turkestan at the time of the Bolshevik revolution killed about a sixth of the population[72]	Turkestan	
1921	Russian famine of 1921	Russia	5 million[73]
1921–1922	1921–1922 famine in Tatarstan	Russia	
1924–1925	Famine in Volga German colonies in Russia. One-third of the entire population perished[74]	Russia	
1928–1929	Famine in Ruanda-Burundi, causing large migrations to the Congo	Rwanda and Burundi (present day)	
1928–1930	Famine in northern China. The drought resulted in 3 million deaths	China	3 million

Incorporating Historical data in the ANN modeling



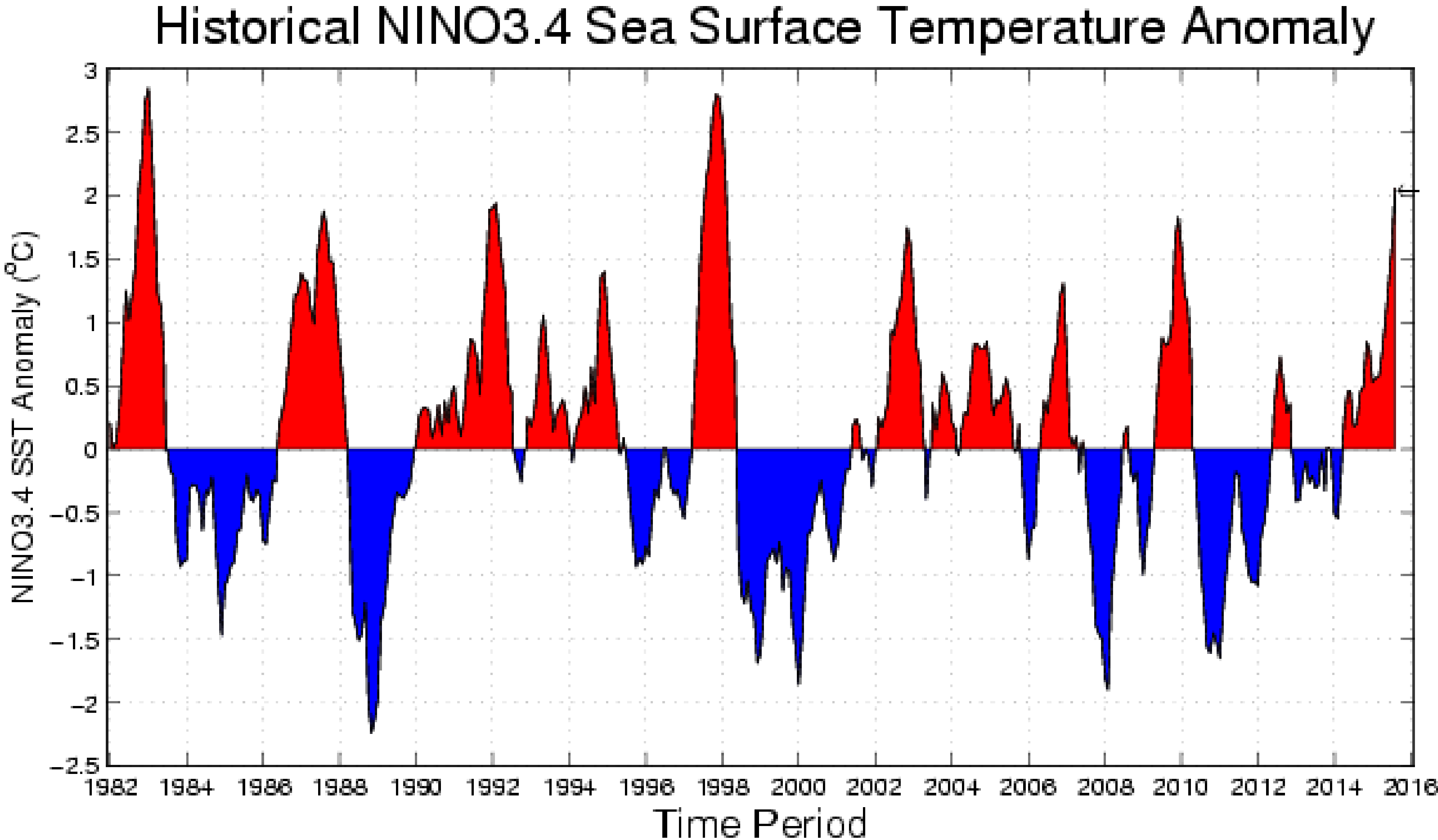


Strong El Nino Forecasted for



CPC/IRI Early-Month Consensus ENSO Forecast Probabilities

Season	La Niña	Neutral	El Niño
ASO 2015	~0%	~0%	100%
SON 2015	~0%	1%	99%
OND 2015	~0%	1%	99%
NDJ 2015	~0%	2%	98%
DJF 2015	~0%	3%	97%
JFM 2016	1%	5%	94%
FMA 2016	1%	12%	87%
MAM 2016	2%	23%	75%
AMJ 2016	5%	40%	55%



Historical NINO3.4 Sea Surface Temperature Anomaly
NINO3.4 SST Anomaly (°C)
3
2.5
2
1.5
1
0.5
0
−0.5
−1
−1.5
−2
−2.5
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Time Period

EL NIÑO/SOUTHERN OSCILLATION (ENSO) DIAGNOSTIC DISCUSSION

issued by

CLIMATE PREDICTION CENTER/NCEP/NWS
and the International Research Institute for Climate and Society

10 September 2015

ENSO Alert System Status: El Niño Advisory

Synopsis: There is an approximately 95% chance that El Niño will continue through Northern Hemisphere winter 2015-16, gradually weakening through spring 2016.

During August, sea surface temperature (SST) anomalies were near or greater than +2.0°C across the eastern half of the tropical Pacific (Fig. 1). SST anomalies increased in the Niño-3.4 and Niño 3- regions, were approximately unchanged in the Niño-4 region, and decreased in the Niño-1+2 region (Fig. 2). Large positive subsurface temperature anomalies persisted in the central and east-central equatorial Pacific during the month (Fig. 3), with the largest departures exceeding 6°C (Fig. 4). The atmosphere remained coupled to the anomalous oceanic warmth, with significant low-level westerly wind anomalies and upper-level easterly wind anomalies persisting from the western to east-central tropical Pacific. Also, the traditional and equatorial Southern Oscillation Index (SOI) were again negative, consistent with enhanced convection over the central and eastern equatorial Pacific and suppressed convection over Indonesia (Fig. 5). Collectively, these atmospheric and oceanic anomalies reflect a strong El Niño.

All models surveyed predict El Niño to continue into the Northern Hemisphere spring 2016, and all multi-model averages predict a peak in late fall/early winter (3-month values of the Niño-3.4 index of +1.5°C or greater; Fig. 6). The forecaster consensus unanimously favors a strong El Niño, with peak 3-month SST departures in the Nino 3.4 region near or exceeding +2.0°C. Overall, there is an approximately 95% chance that El Niño will continue through Northern Hemisphere winter 2015-16, gradually weakening through spring 2016 (click CPC/IRI consensus forecast for the chance of each outcome for each 3-month period).

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Conclusions:

1. Seasonal Forecasts are the key to efficient management of droughts and floods.
2. ENSO based forecasting models have great potential in providing reliable forecast 3 to 4 months in ADVANCE.
3. The B/C of climate forecast can exceed 1000 to 1 **(In the United States alone, the benefit versus cost for the forecasting capability proposed by NOAA is about 300 to 1.)**
4. Historical droughts and floods can enhance the accuracy of the climate models.
5. In View of current strong El Nino, wet autumn was forecasted for most of the basins of Iran in early summer.

An important caveat!

In any variable pattern of weather, El Niño is only part of the story.
But for Strong events, the ENSO effects would be more pronounced and forecasting skills would be improved.

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