



# THE PEAC CENTER

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## **An Update of El Niño 2014: Global and Regional Perspectives**

(PEAC's Role in Reducing Vulnerability to  
Climate Hazards)

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Graduate Assistant:  
Alejandro Ludert



# OBJECTIVES

- The primary focuses of this presentation is to provide an updated overview of El Niño 2014 from current oceanic and atmospheric interactions;
- The perspective of local climate (sea level, rainfall, TC, etc.) variability and impacts on global to regional scale;
- Synthesis of the overall hazard management activities of the PEAC Center by visiting various aspects of the historical and current operational framework.

# PEAC Center (1994 to Today)

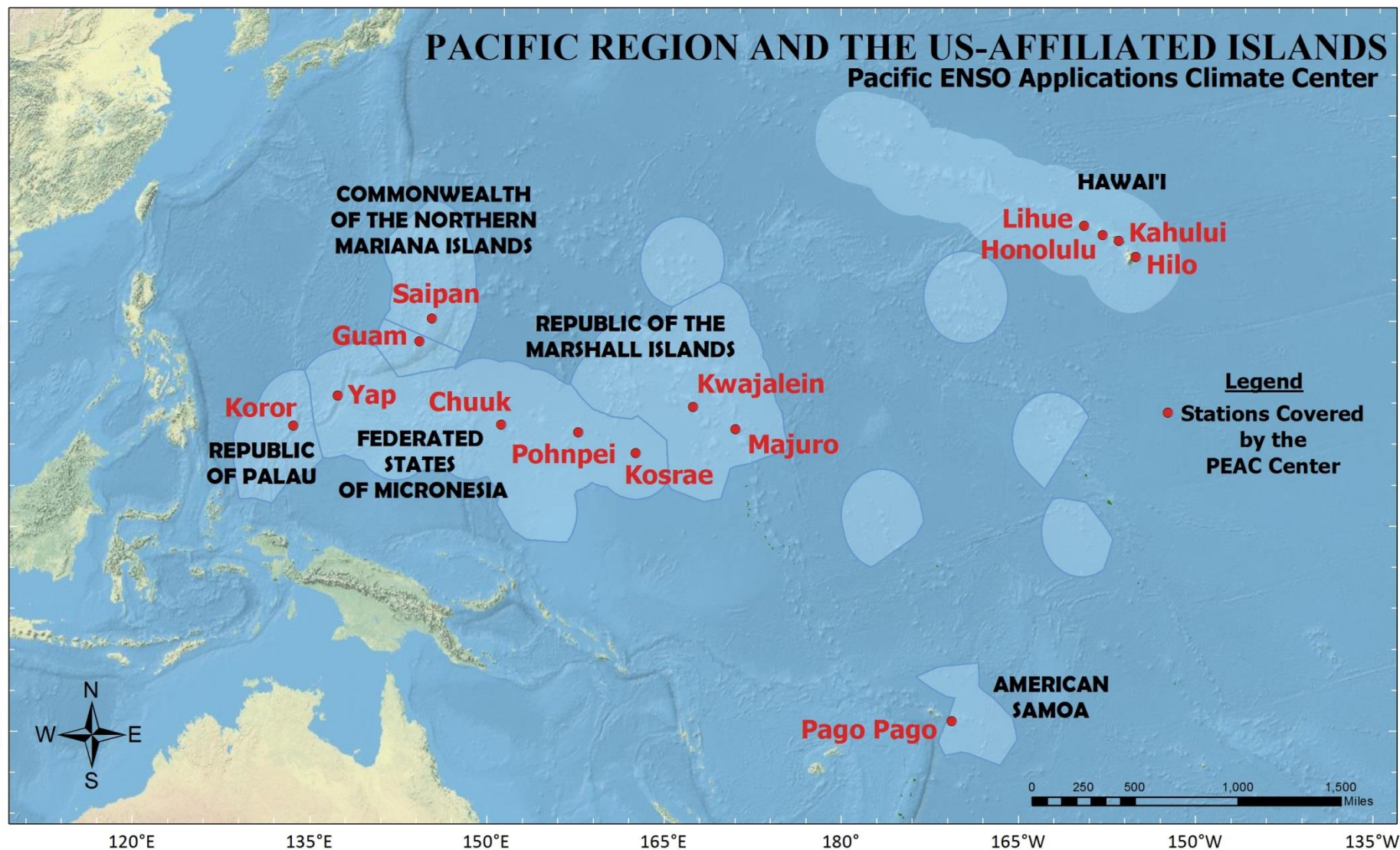
- **The mission of PEAC is to**
  - **Conduct research**
  - **Develop information products**
  - **Specific to the U.S.-Affiliated Pacific Islands (USAPI) on the ENSO climate cycle**
- **Support of planning and management activities in climate-sensitive sectors of importance to the communities of the USAPI**
- **Bridge the gap between global El Niño forecasts and the need of the USAPI for tailored, actionable climate forecasts for their specific islands**

# PEAC and our partners



- Additional Partners:
  - NOAA Climate Prediction Center
  - IRI University of Columbia
  - NOAA National Climatic Data Center
  - Pacific Region Integrated Sciences and Assessments
  - Pacific Climate Information Systems

# The PEAC region



# Climate Vulnerabilities

- Rainfall variability
  - Drought
  - River overflow
- Sea Level variability
  - Inundation
  - Saline intrusion
  - Coral Bleaching
- Tropical Cyclone vulnerability



## Support climate-sensitive sectors of importance to the communities of the US-Affiliated Pacific Islands

- Water resource management
- Fisheries
- Agriculture
- Disaster managers
- Public utilities
- Tourism
- Coastal zone management
- Other economic and environmental sectors

# The PEAC Products

- Monthly issued Seasonal Forecasts
  - Rainfall
  - Sea Level
- Quarterly
  - PEAC Newsletter
  - One Pager
  - Tropical Cyclone Predictions



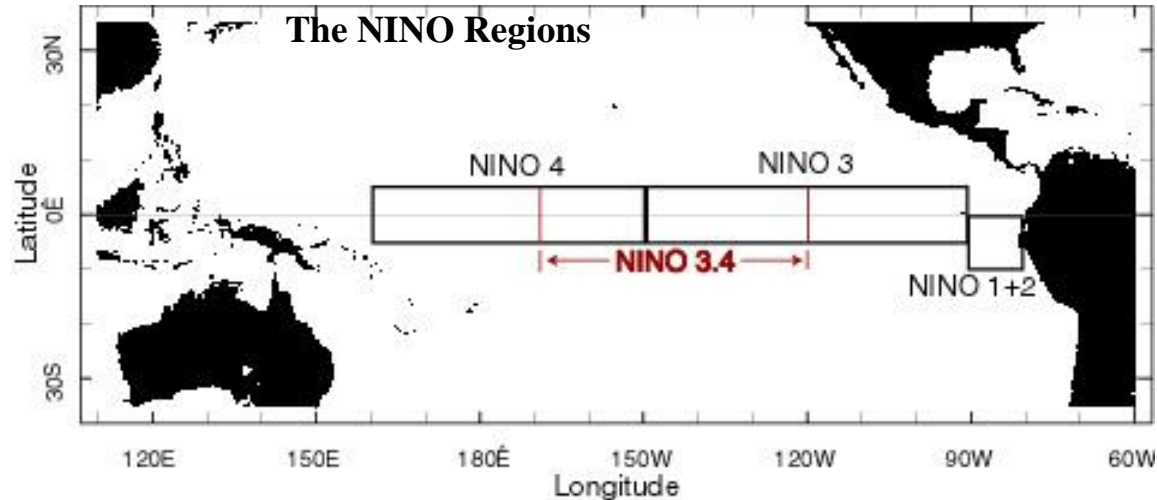
# EL NIÑO

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General Overview

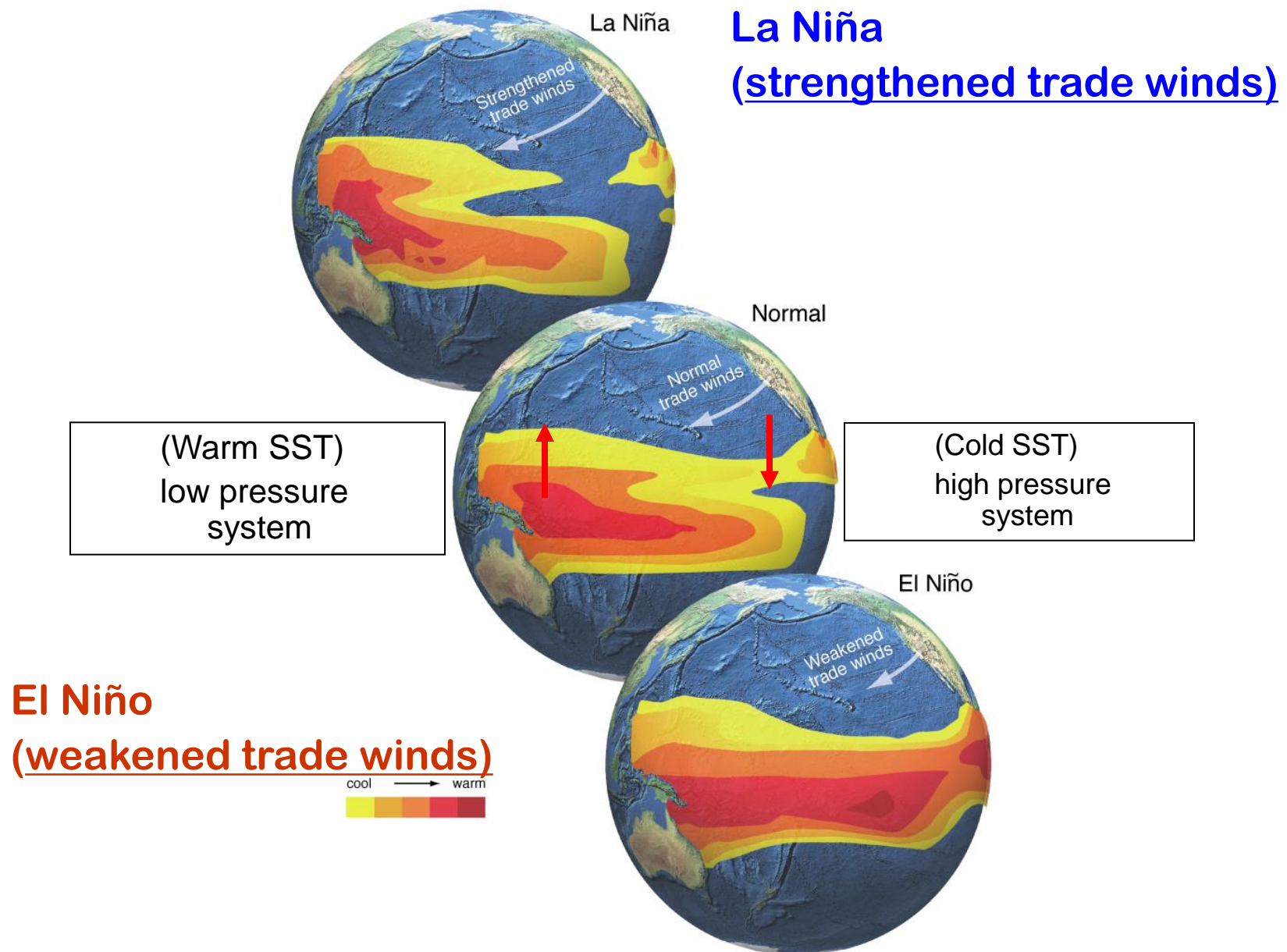


**El Niño is a major warming of the equatorial waters in the Pacific Ocean. It usually occur every 3 to 7 years,**

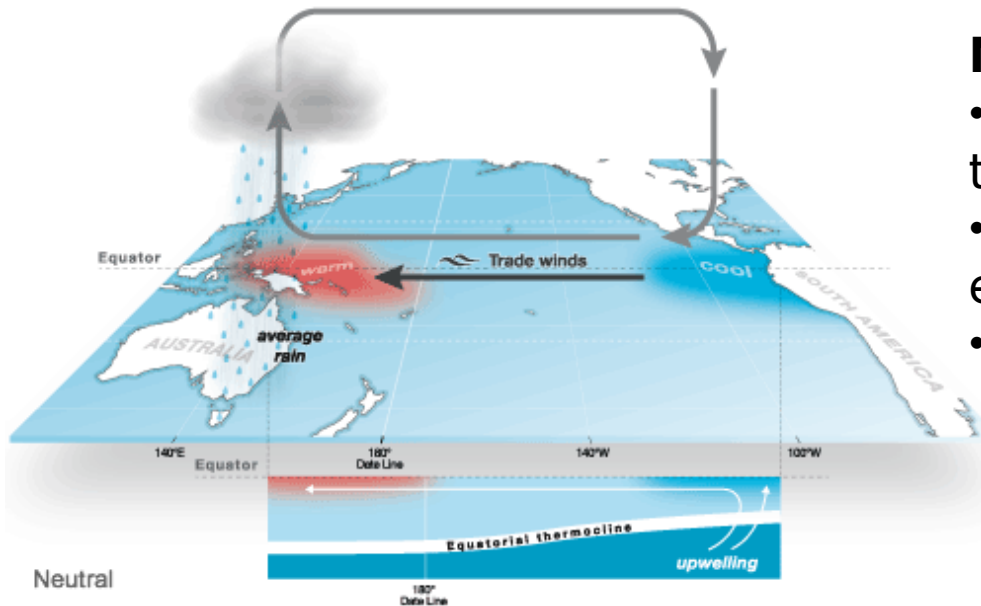


- *NINO 1+2* (0-10S, 80-90W)
  - Warms first when an El Niño event develops
- *NINO 3* (5S-5N; 150W-90W)
  - Has the largest variability in SST on El Niño time scales
- *NINO 3.4* (5S-5N; 170W-120W)
  - Has large variability on El Niño time scales, and that is closer (than NINO 3) to the region where changes in local SST are important for shifting the large region of rainfall typically located in the far western Pacific.
- *NINO 4* (5S-5N: 160E-150W)
  - Changes of SST lead to total values around 27.5C, which is thought to be an important threshold in producing rainfall

# La Niña and El Niño



# El Niño in a nutshell

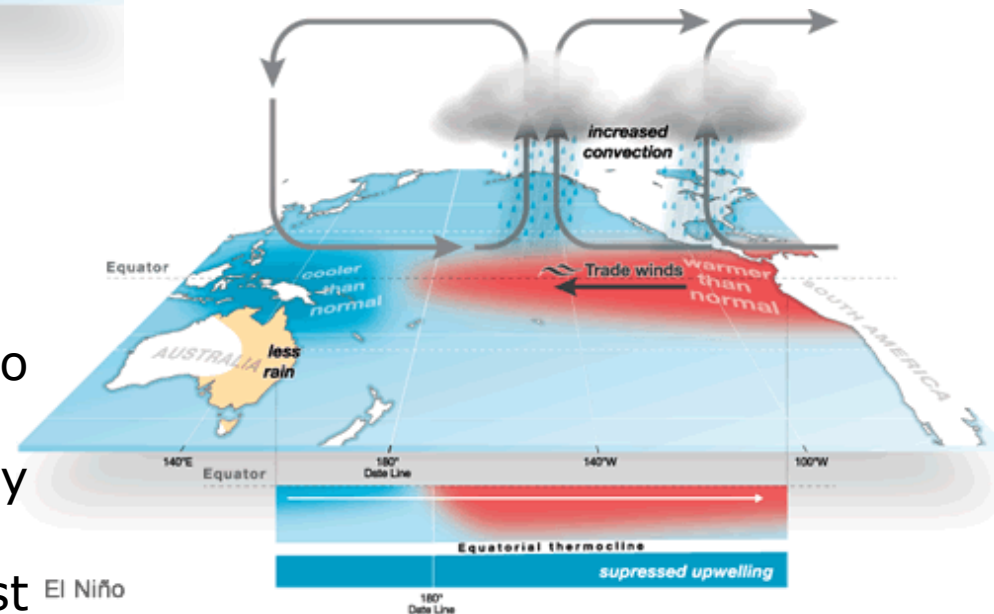


## Neutral Conditions:

- Cold sea surface temperatures to the east and warm to the west
- Strong trade winds blowing from east to west
- Rainfall over the Western Pacific

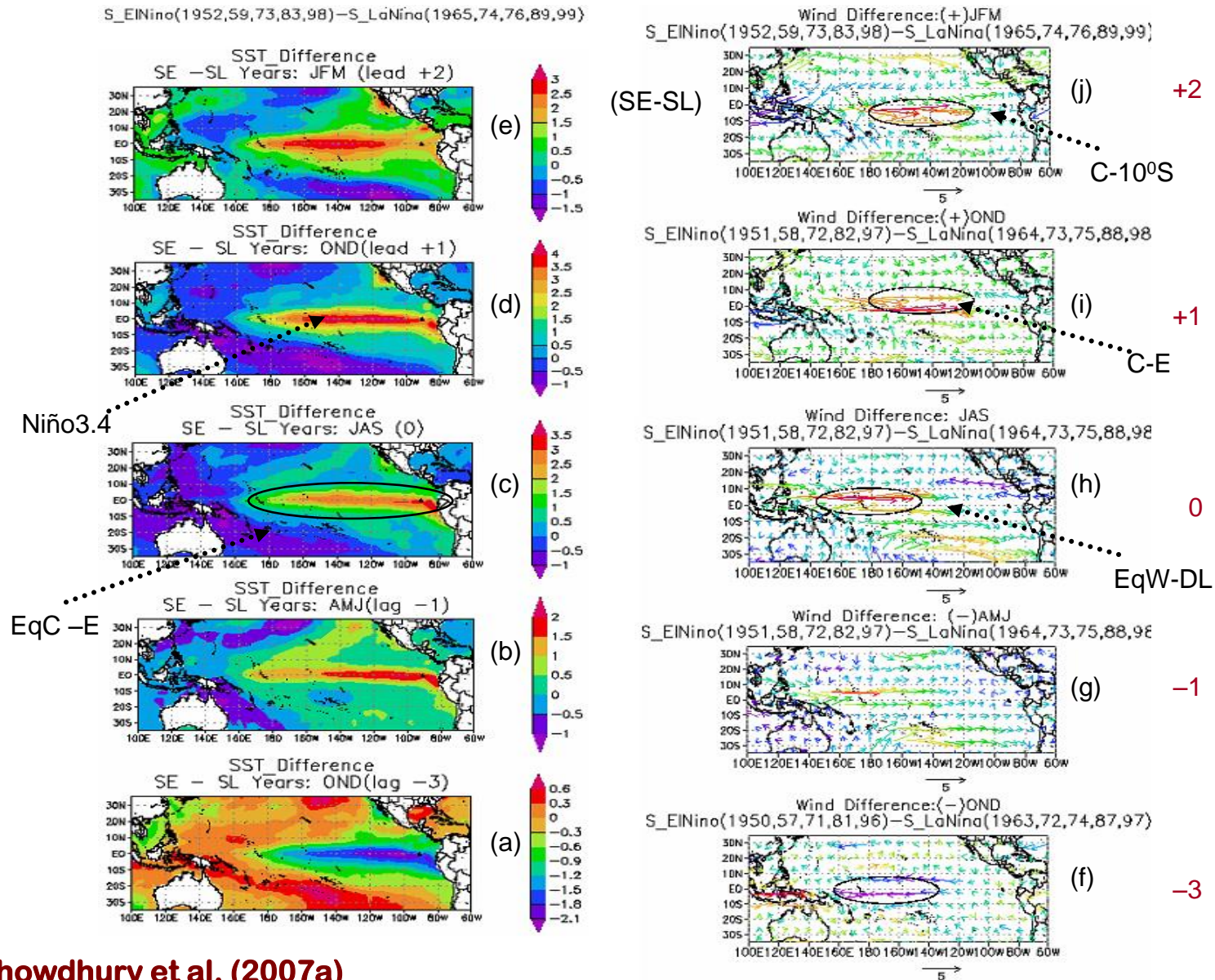
## El Niño Conditions:

- Warm sea surface temperatures to the east and cold to the west
- Weakened trade winds, westerly winds over east Pacific
- Rainfall over the Central and East Pacific



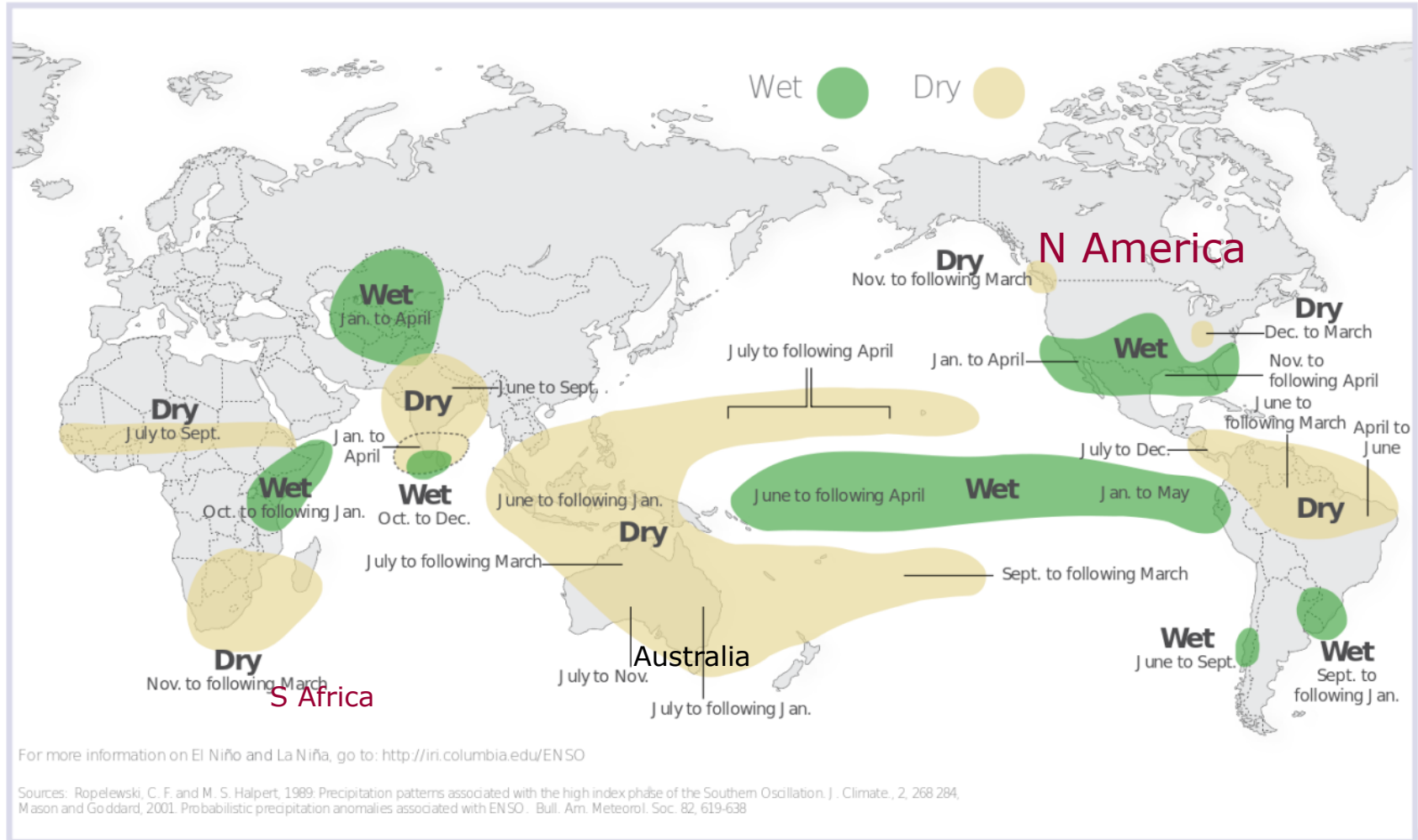
Figures from <http://www.bom.gov.au/climate/enso/history/In-2010-12/three-phases-of-ENSO.shtml>

# Composites of Strong El Niño and Strong La Niña Years

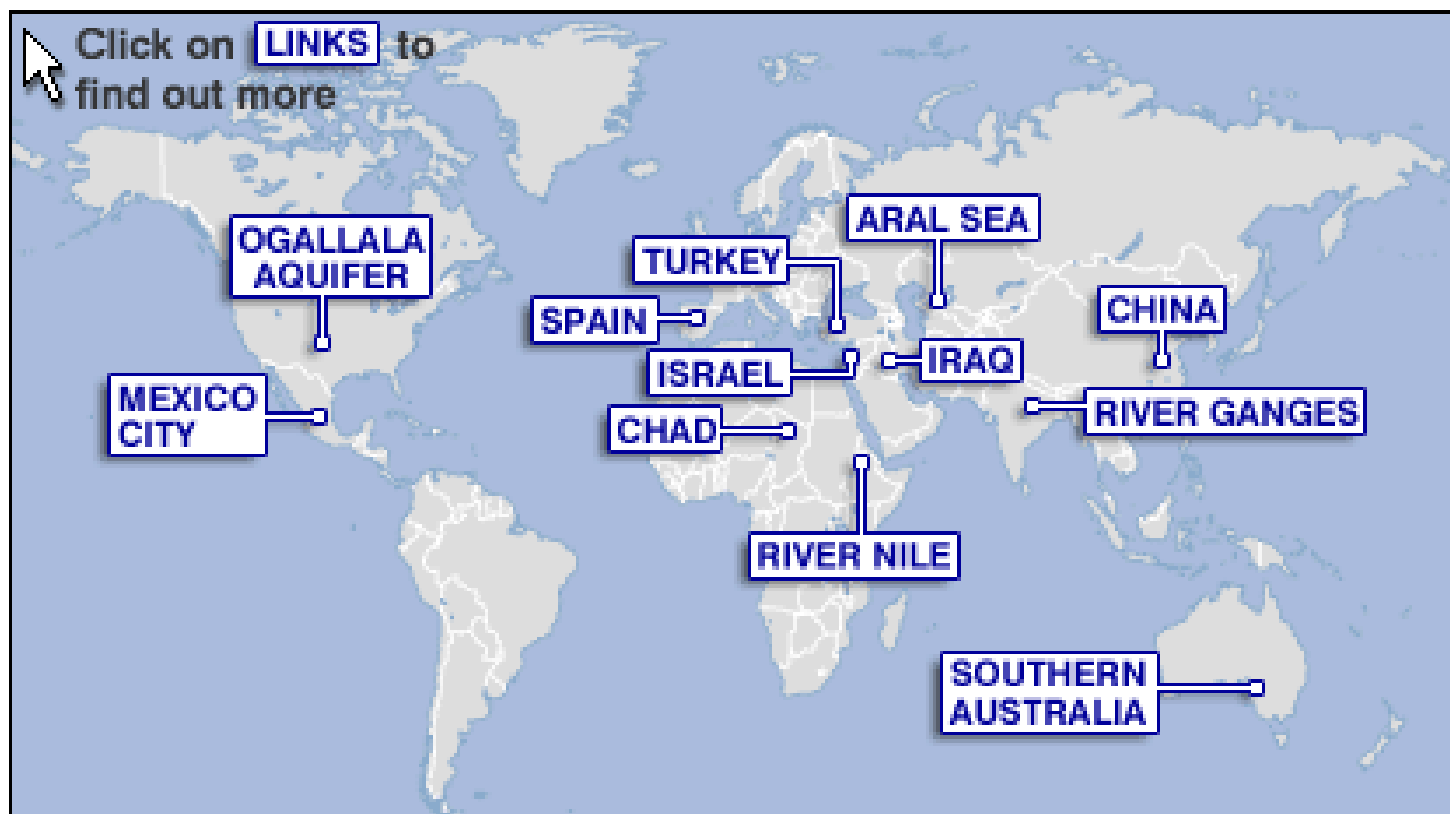


## El Niño and Rainfall

El Niño conditions in the tropical Pacific are known to shift rainfall patterns in many different parts of the world. Although they vary somewhat from one El Niño to the next, the strongest shifts remain fairly consistent in the regions and seasons shown on the map below.



# Hotspots of Climate hazards

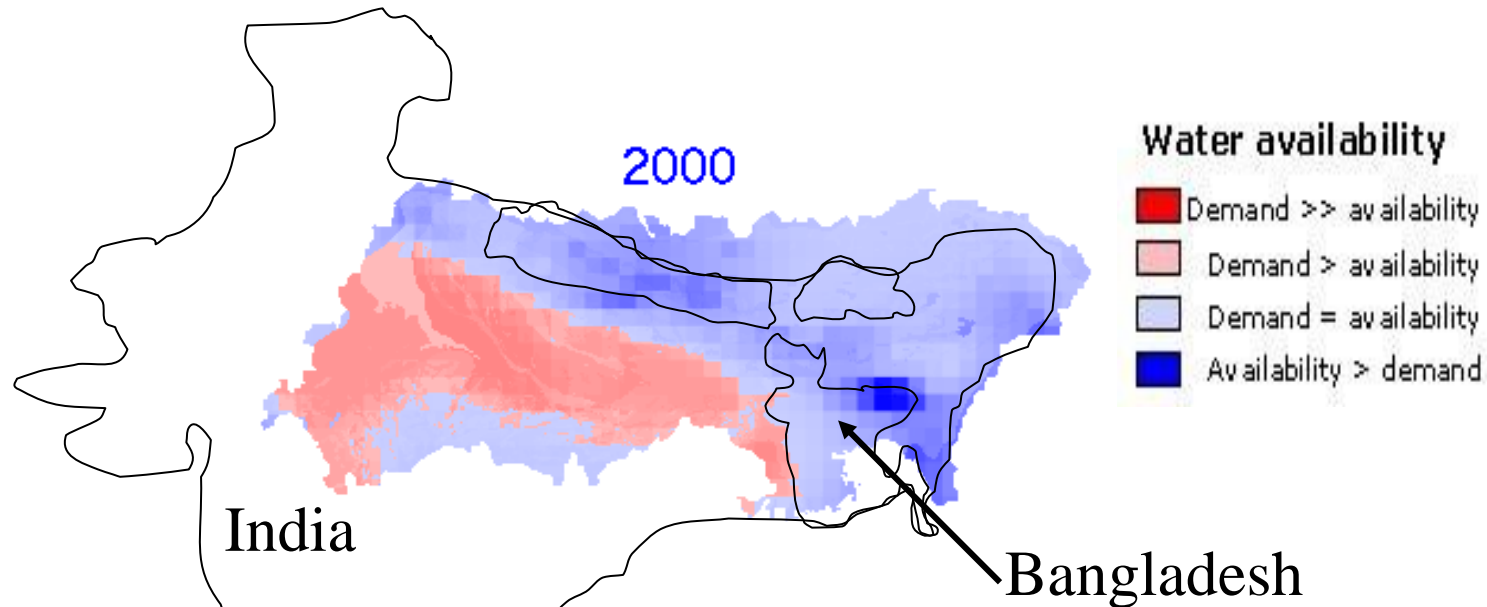


- Ogallala Aquifer : Cut off ; Mexico City: Sinking from the
- Spain: Water diversion
- Chad: Shrunk by 95% ; River Nile: Water sharing ; Israel/Jordan: River Jordan ; Iraq: 90% of wetlands loss ; Turkey: Water-rich ; Aral Sea: Toxic desert ; China: Flood (south), drought (north) ; Indus River: Pakistan and India ; Ganges: Bangladesh and India ; Brahmaputra/Meghna: India/China/Bangladesh

# 'Hot Spots' of Climate Hazards: Bangladesh

## Climate variability/change

– Water scarcity: A looming crisis?

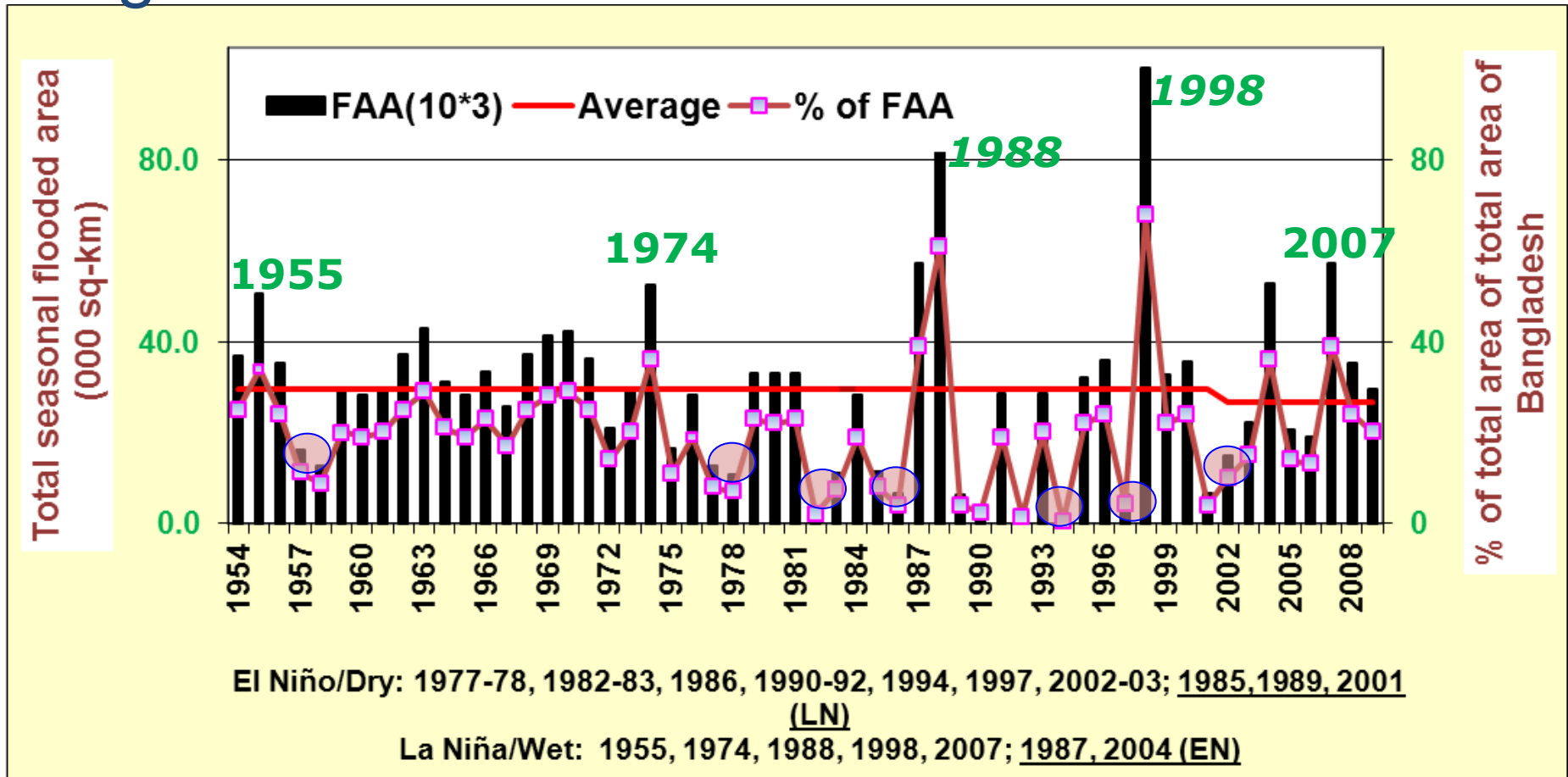


2030: - 3% in winter, +11% in monsoon,  
2050: -37% and +28%

Water availability in the Ganges, Brahmaputra  
Meghna region – 'Comparison between current  
situation and the year 2050'



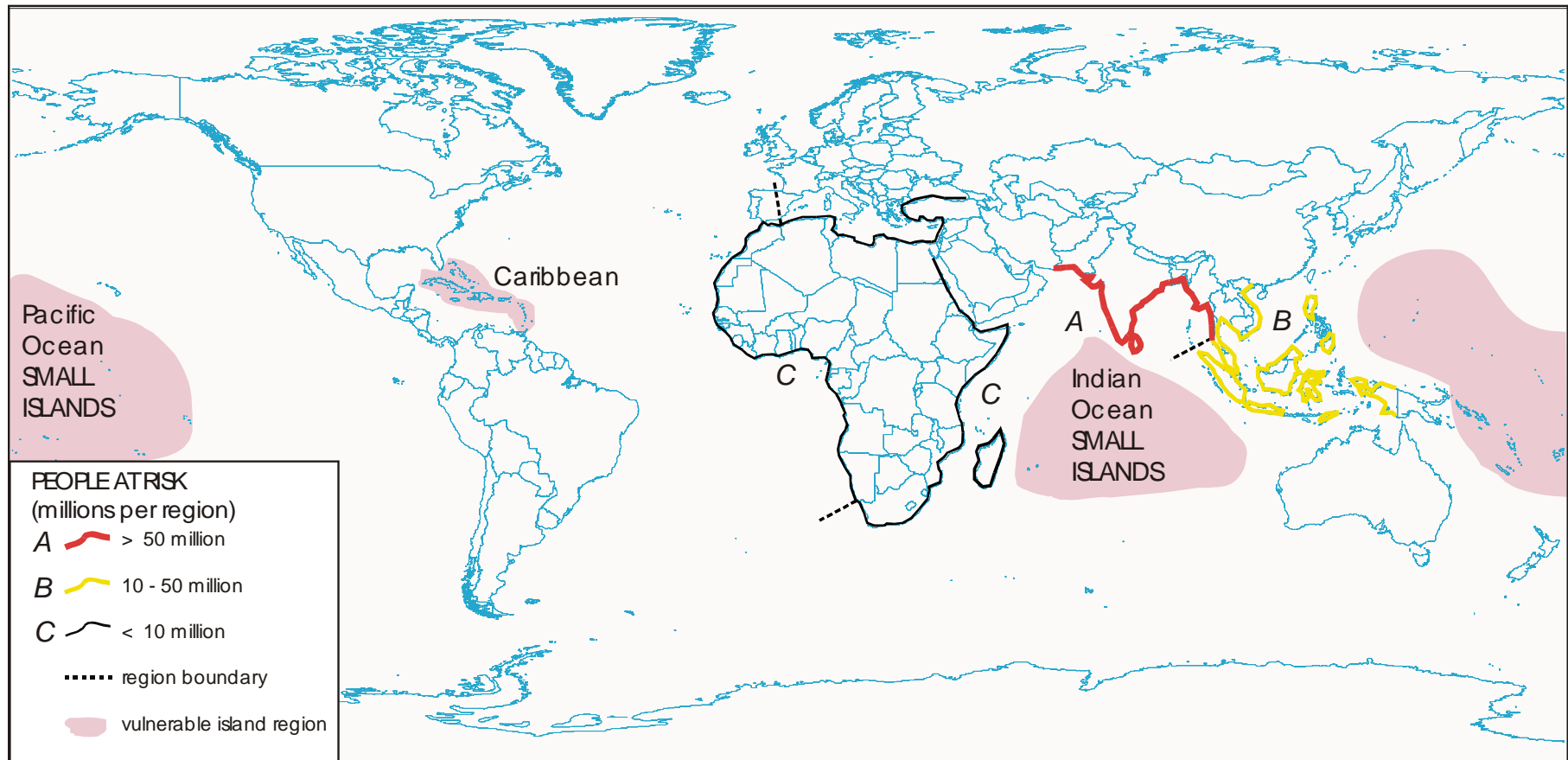
# El Niño relationship to seasonal flooding in Bangladesh



Bangladesh floods are connected to ENSO—El Niño to lower and La Niña to higher than normal flooding  
 >>>1988 and 1998 are two 'rapid ENSO transition year'

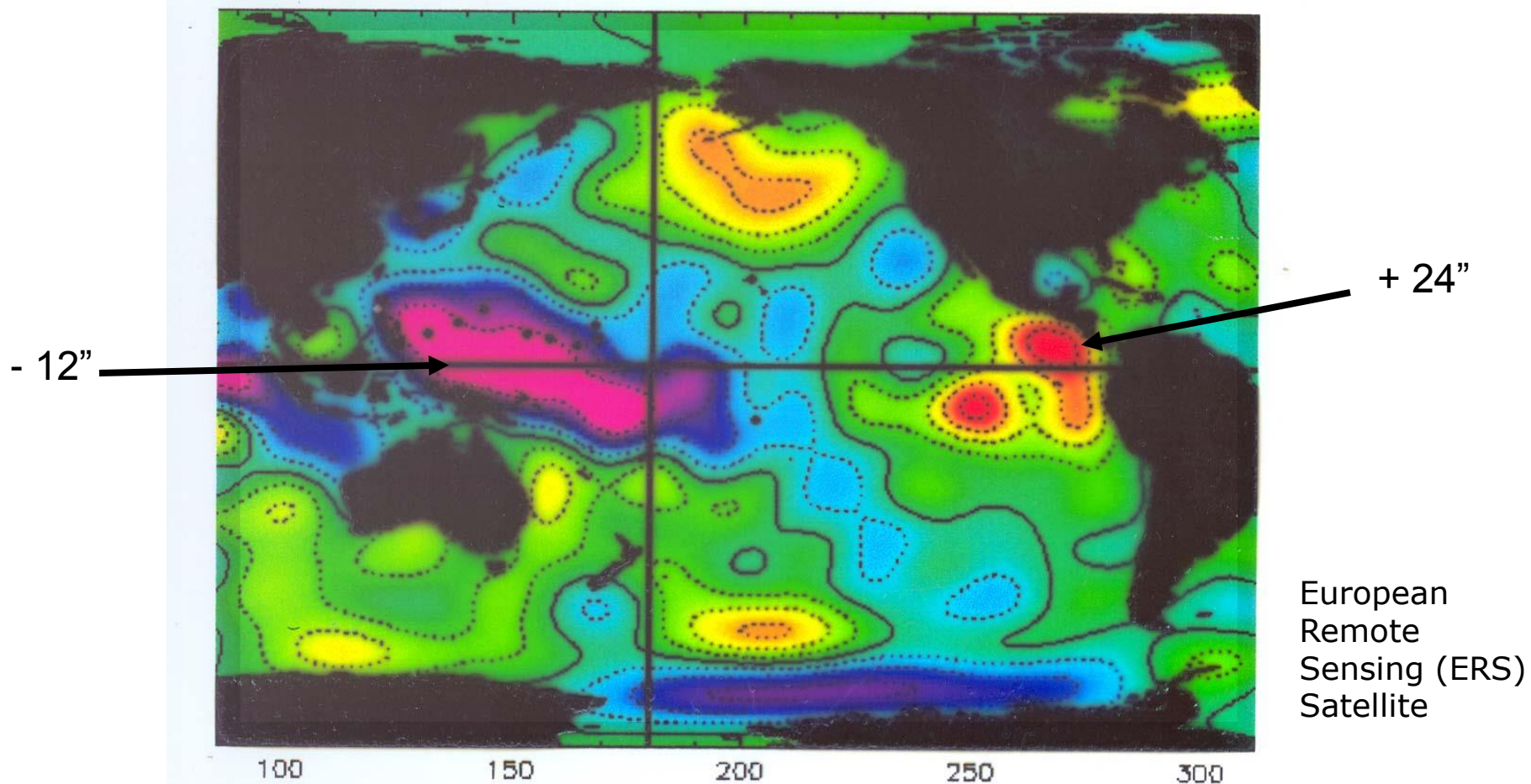


# Vulnerable Regions Mid-estimate (45 cm) by the 2080s



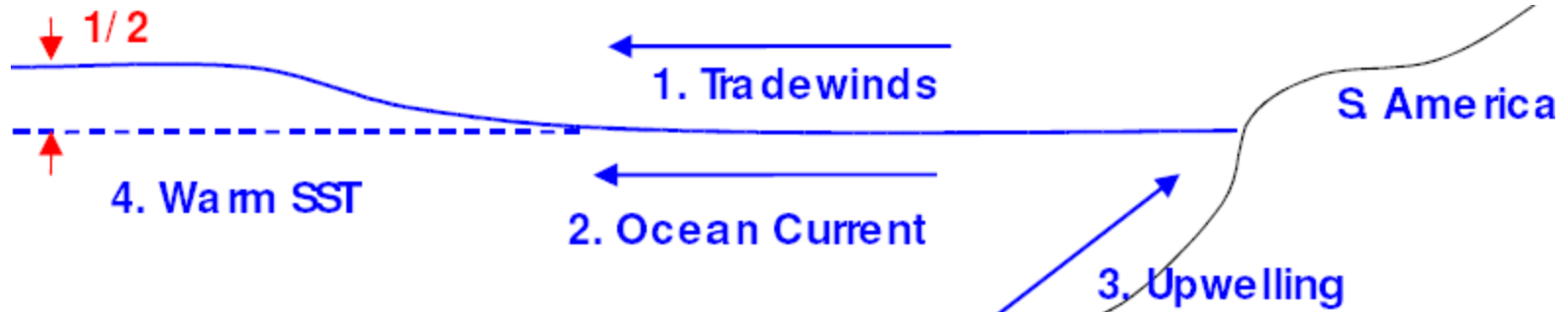
# El Niño and Sea Level (97-98 example)

ERS Sea Level Anomaly – January 1998



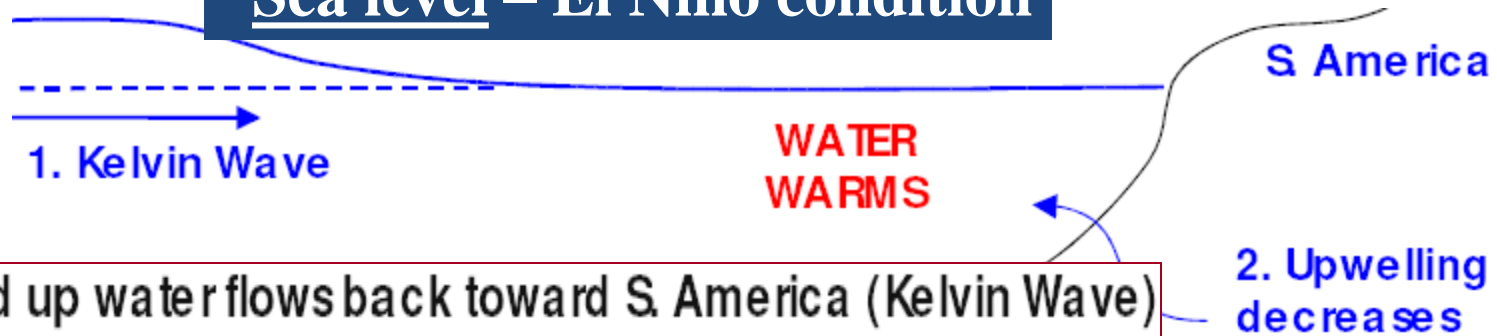
From March 2014 to May, sea level in Yap has dropped from +7.2 inches to +2.7 inches and about 9 inches drop in Malakal!

# Sea level – Normal/ La Niña condition



1. Trade winds blow east to west (easterly)
2. Wind “pushes” water towards west (equatorial current)
3. Upwelling results in relatively cool SST in Eastern Pacific
4. Water warms from solar energy as it moves west ==> SST increases from east to west along equator
5. Sea level higher in west ~ 1/2 meter (18 inches)

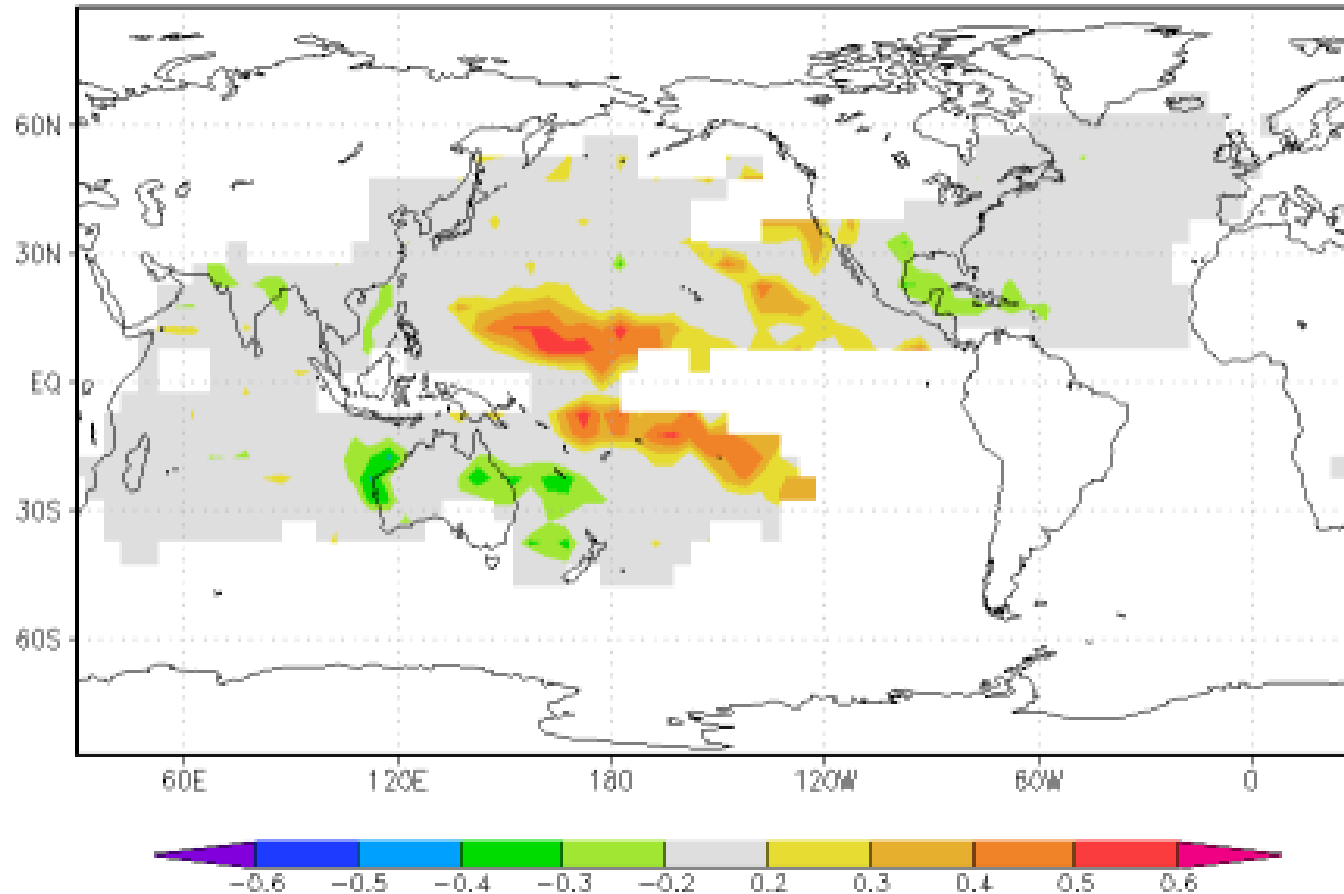
# Sea level – El Niño condition



1. Piled up water flows back toward S. America (Kelvin Wave)
2. Little or no upwelling
3. Water in East Pacific warms quickly

# El Niño and Tropical Cyclones

corr Jul–Jun averaged NINO3.4 index  
with Jul–Jun averaged MIT #TS tracks 1856:2004

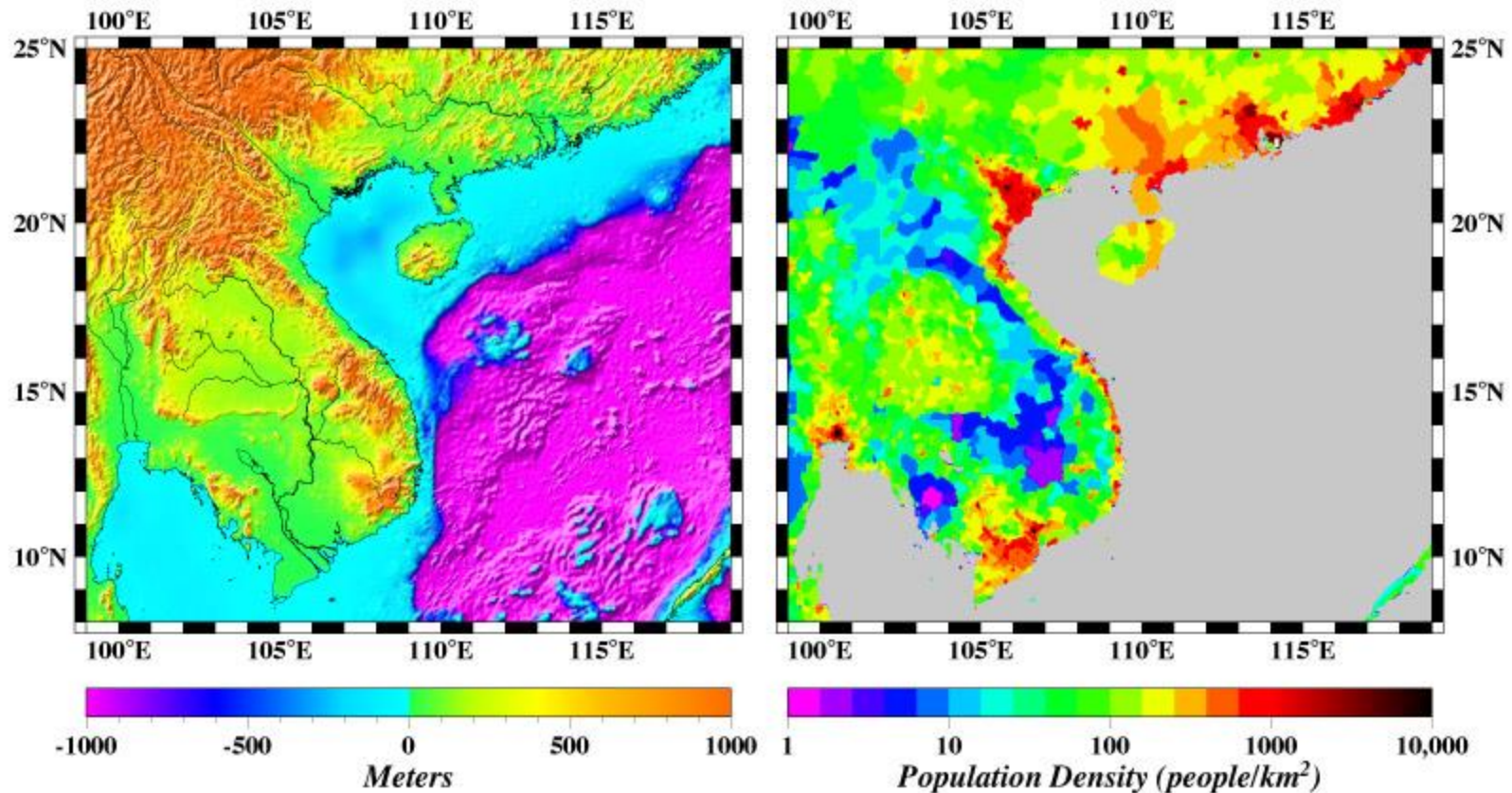


El Niño shifts TC genesis Eastward over the North and South Western Pacific

- Less TC activity
  - Australia
  - Philippines
- More TC activity
  - Tropical Pacific
  - Hawaii
  - American Samoa

# Elevation and Population Density Maps for Southeast Asia

Indo-China Peninsula



Source: Nicholls and Small, 2002.

# The Direct impacts of ENSO on the USAPI communities

1997-1998 El Niño



- Low rainfall/low sea level
- Water rationing in Majuro
- Crop losses in F.S. of Micronesia, R. Marshall Islands, C.N. Mariana Islands
- Palau experienced 9-month drought

2007-2008 La Niña



- Damage of roads and infrastructures
- Impacts on agriculture /aquaculture through inundations; decline in soil quality
- Changes in surface/groundwater quality

# The 2010 water and power crisis in Bangladesh: Is El Niño to be blamed partly?

The recent water and power crisis: Is El Niño to be blamed partly? - Windows Internet Explorer

http://www.thedailystar.net/newDesign/news-details.php?nid=138476

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The recent water and power crisis: Is El Niño to be bla...

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**LATEST NEWS** BNP to probe Ramu violence

Saturday, May 15, 2010

Environment


## The recent water and power crisis: Is El Niño to be blamed partly?

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Dr. Md. Rashed Chowdhury

LET me start with a classic example of Venezuela—the country officially called the Bolivarian Republic of Venezuela. This is a tropical country on the northern coast of South America. The republic is a former Spanish colony that won its independence in 1821. Like Bangladesh, Venezuela is in the midst of a genuine power and water crisis. There may not be a clear cut answer to this question "What is causing Venezuela's energy crisis", and different people provide differing interpretations.

Submit

Done Internet 100%

- Venezuela was in the midst of a genuine power and water crisis
- Among others, pointing the finger at weather changes, President Chávez said "It's El Niño," partly to be blamed for this recent crunch;
- The El Niño is blamed to have resulted in a lack of rainfall and the cause of water shortages, which in turn have starved Venezuela's hydroelectric dams which provide approximately three quarters of the nation's electricity.

# ENSO (SST) and Cholera

## –Correlation map

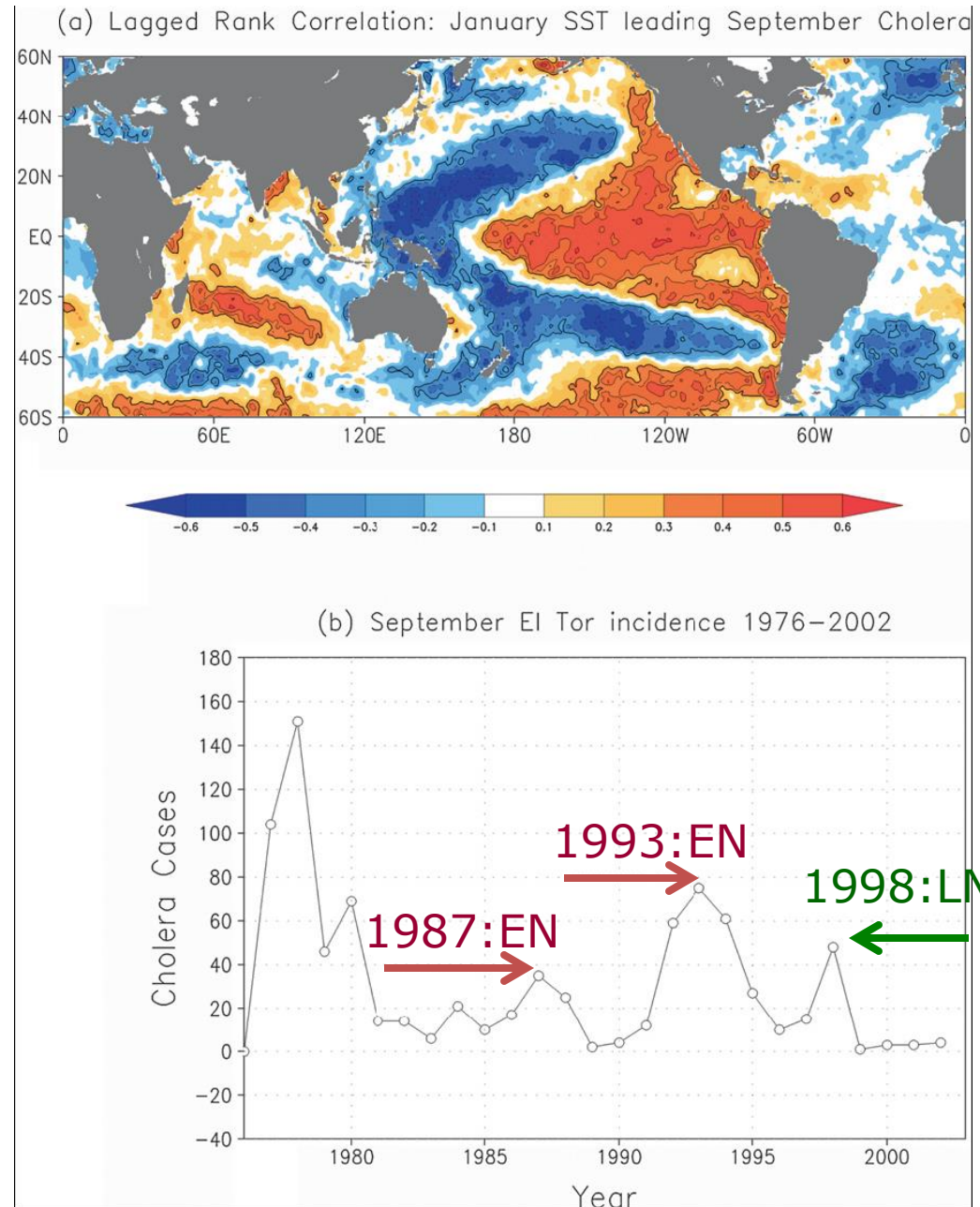
### Role of the Western Tropical and Central Extratropical Pacific

(a) Lagged rank correlation between September El Tor cholera cases and preceding January.

Contours denote regions significant at the 90% level. Shading and interval is 0.1.

(b) Incidence of Matlab El Tor cholera cases for 1976–2002 September.

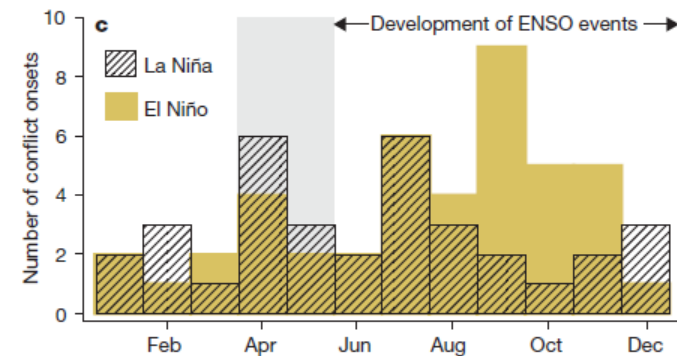
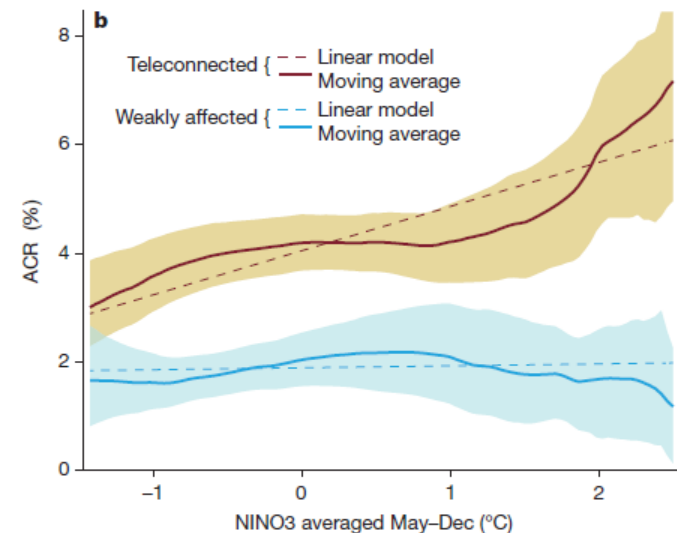
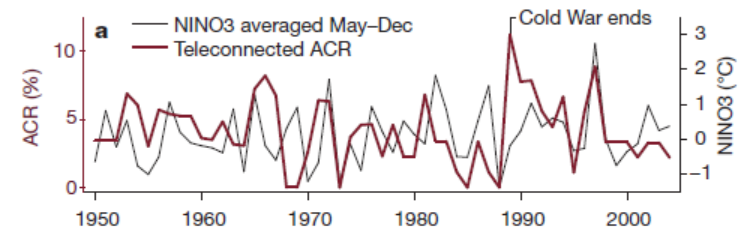
Source: Cash et al. (2008, 2009), JOC





# Conflict risk associated with ENSO

- a) Time series of NINO 3 and Annual Conflict Risk (ACR) for the teleconnected group
- b) Linear and non-parametric fit of ACR against NINO 3
- c) Number of conflict onsets in teleconnected countries during
  - El Niño, solid bars
  - La Niña, hatched bars



# EL NIÑO

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2014-2015 El Niño Forecasts

# A developing El Niño during 2014?

During the last four weeks

- Positive SST anomalies persisted in the eastern equatorial Pacific
- Increased just west of the Date Line
- Weak negative anomalies developed in portions of the east-central equatorial Pacific

The evolution of Sea Surface Temperature, Subsurface temperatures are all supportive to

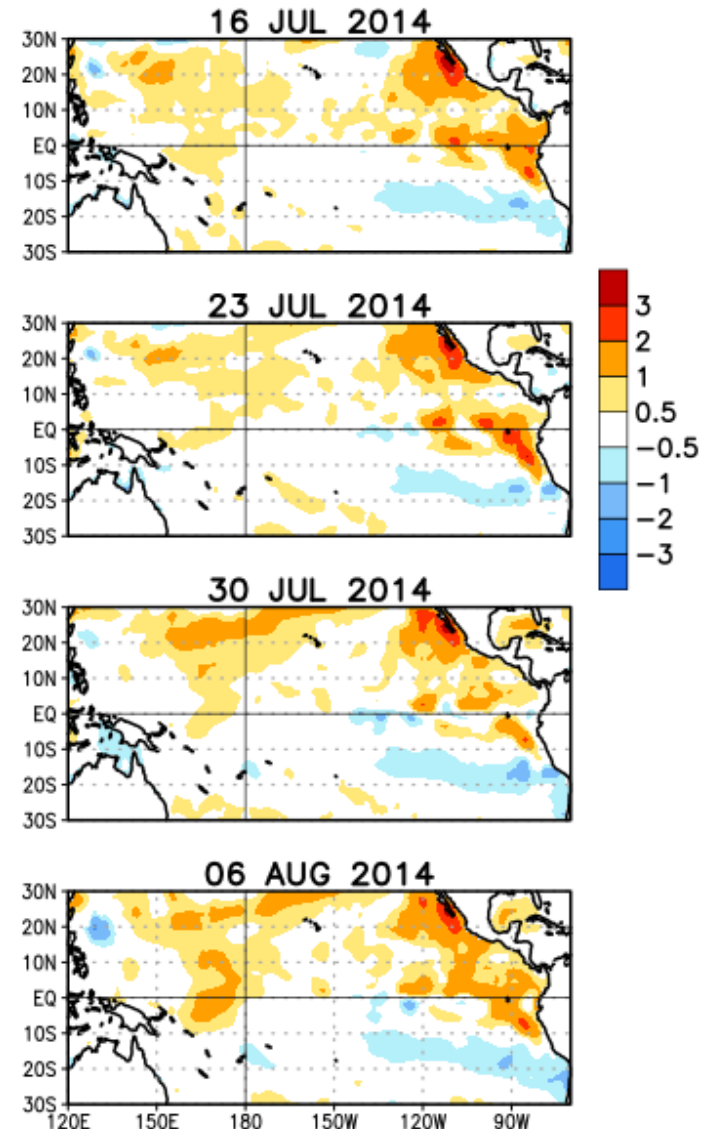
**El Niño event (moderate)**

Atmospheric signatures are present but less prominent.

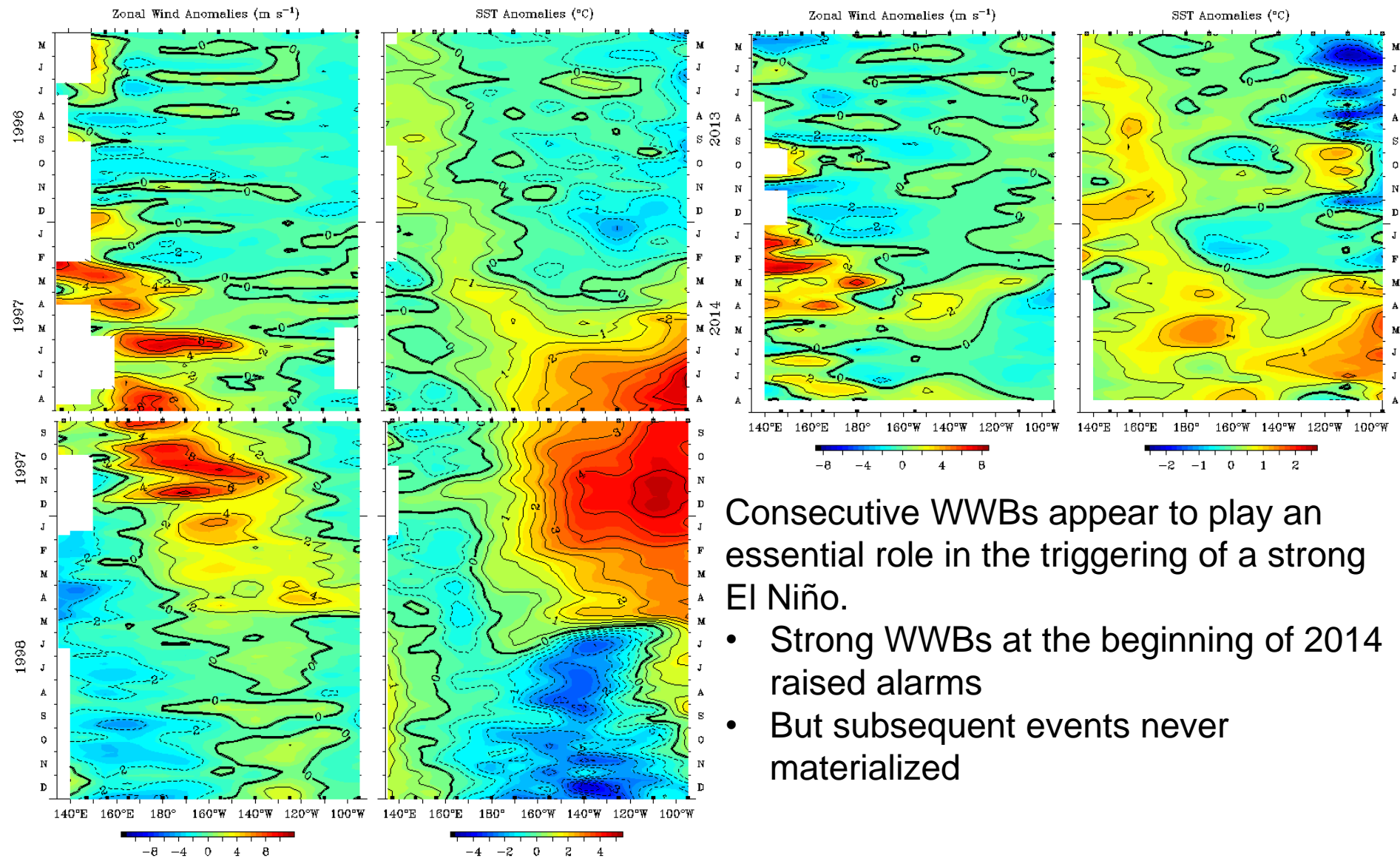
Figure From

[http://www.cpc.ncep.noaa.gov/products/analysis\\_monitoring/lanina/ens\\_o\\_evolution-status-fcsts-web.ppt](http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/ens_o_evolution-status-fcsts-web.ppt)

Weekly SST Anomalies (DEG C)



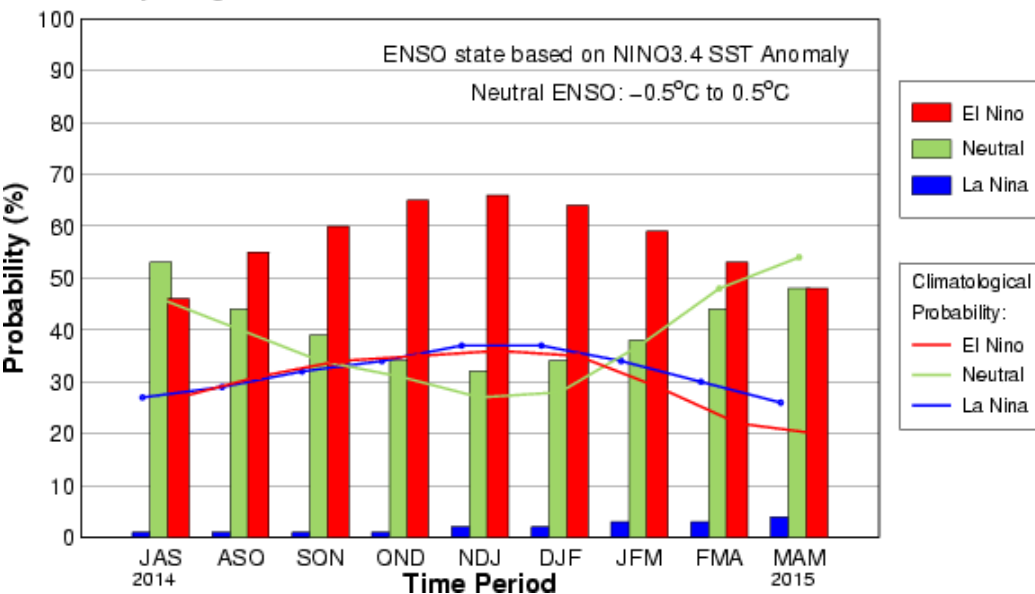
# Westerly Wind and Ocean Response: 1997-98 vs Now



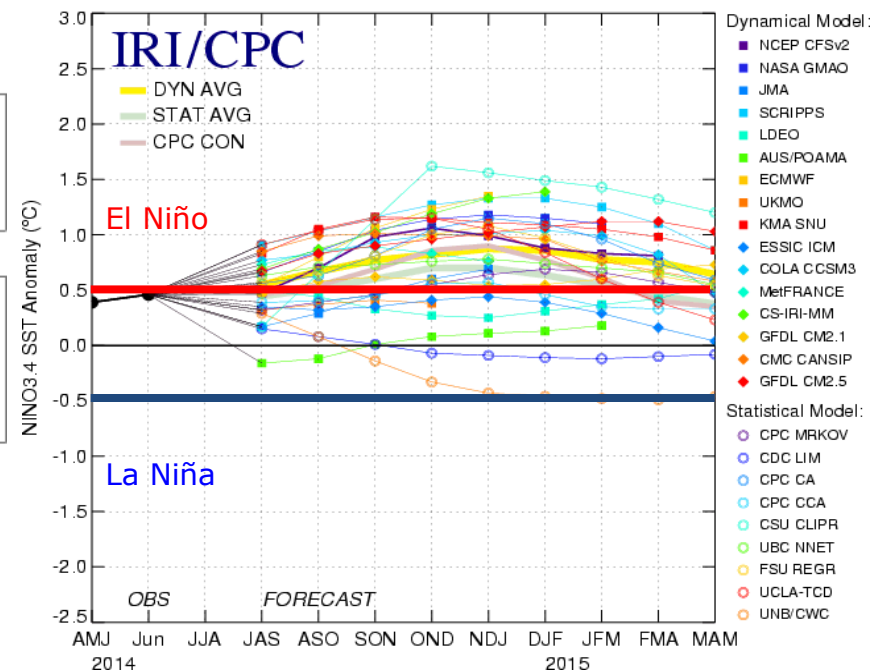
# CPC/IRI Probabilistic ENSO Outlook

(Updated Aug 11, 2014)

Early–Aug CPC/IRI Consensus Probabilistic ENSO Forecast



Mid-Jul 2014 Plume of Model ENSO Predictions



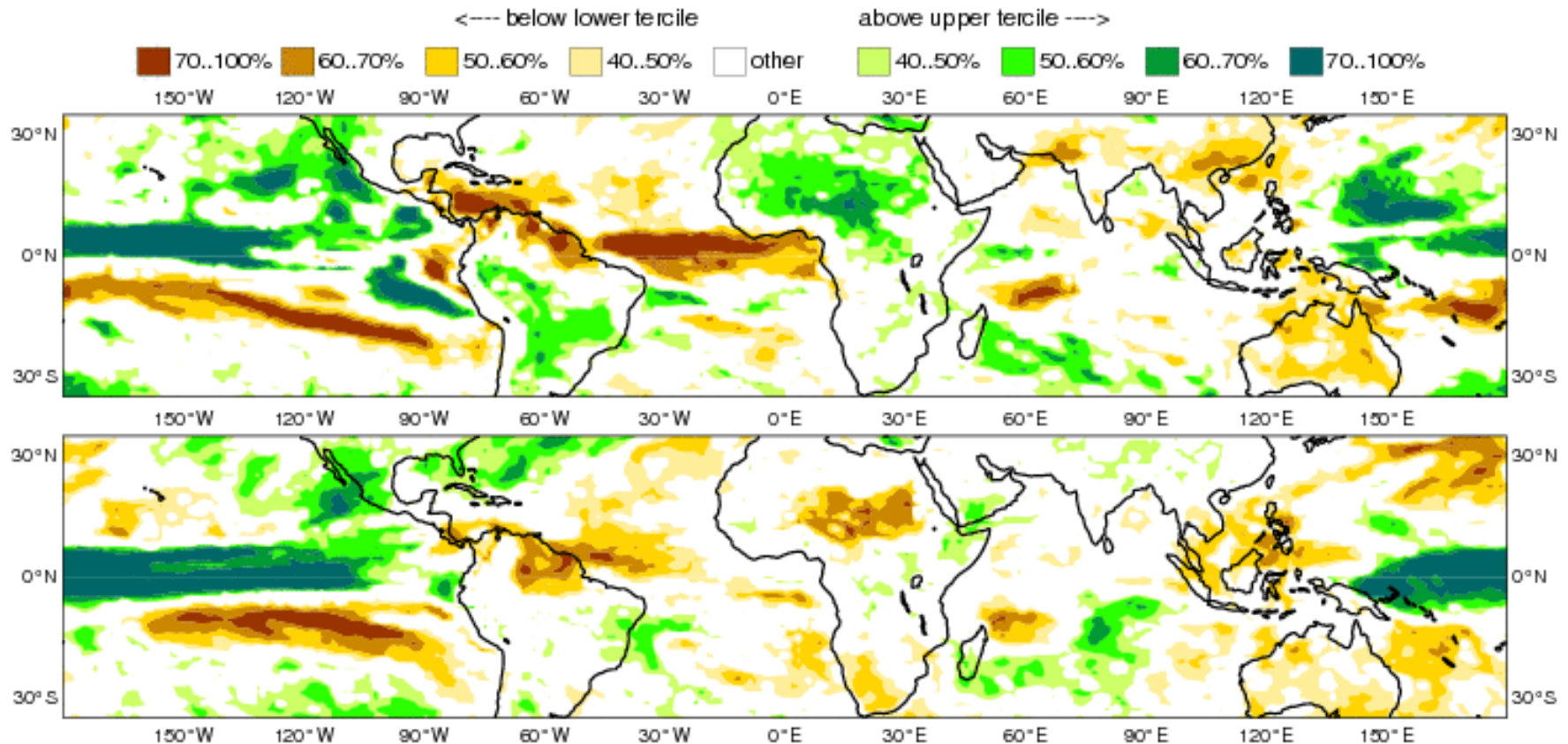
The chances of El Niño increase during the remainder of 2014,

- 60% by Fall (SON)
- 65% during the late fall/early winter
- rapidly decaying afterwards.

Most models predict El Niño sea surface temperatures anomalies for 2014-2015

# Tropical Rainfall Forecasts (Sep 2014-Jan 2015)

ECMWF forecasts issued 2014-08-01



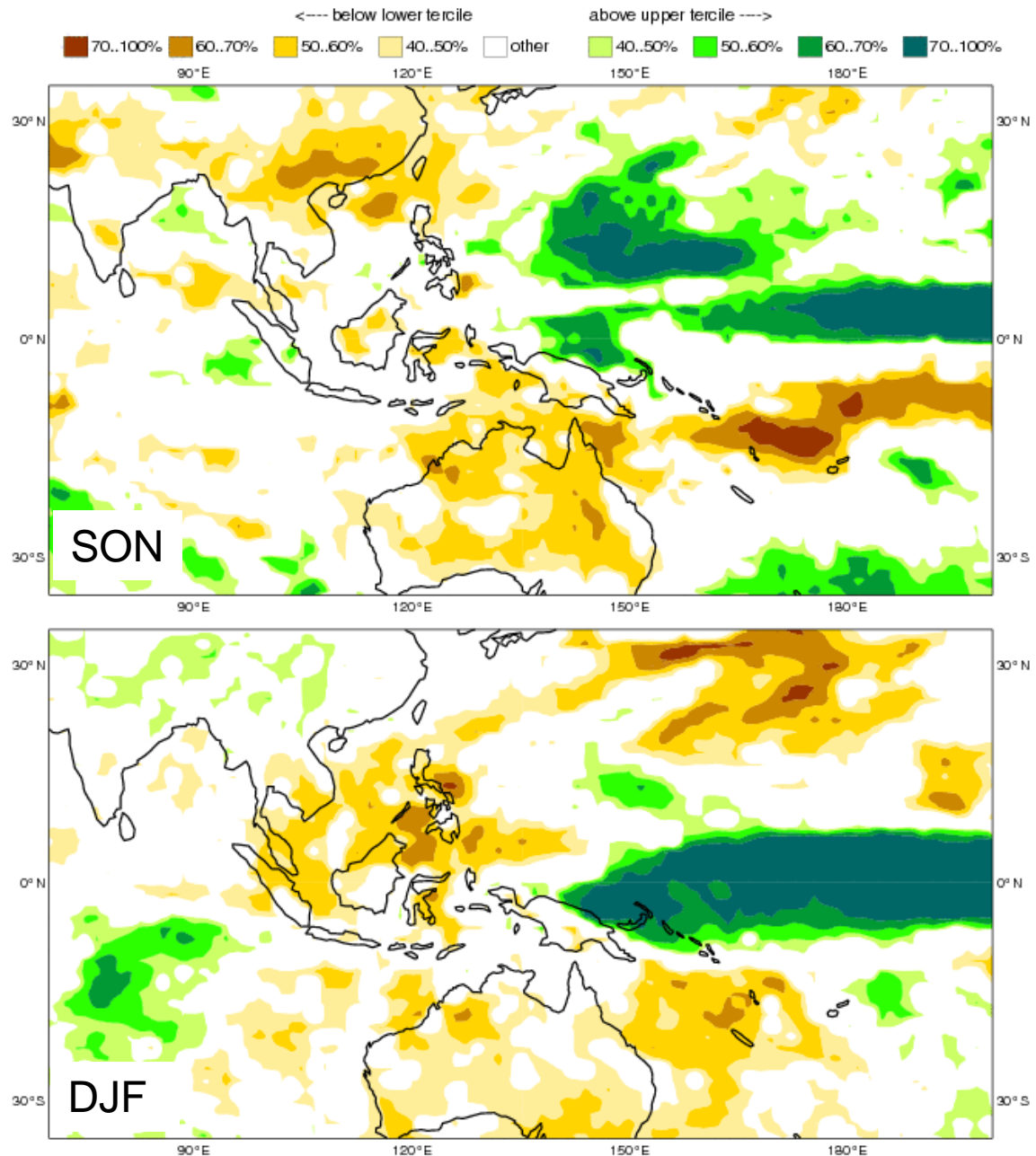
- Wet conditions over the Central Pacific extend eastward towards Peru
- Hawaii likely to become more dry

# Asia Pacific

## Forecasts

### Sep 2014-Feb 2015

- Wet conditions over the tropical Western North Pacific become dry as the seasons progress
  - Pacific Islands likely drought during DJF
- China: Dry conditions during Fall give way to normal conditions
- Philippines and South East Asia; dry conditions likely to worsen
- Indian subcontinent; dry conditions become normal
- Australia: Dry conditions somewhat ameliorated



# USAPI Rainfall and Sea level forecast

For the ASO season

- Sea level is expected to be marginally above average and continue dropping
- Rainfall
  - Dry conditions expected to progress from west to east

Tide Gauge Station	Forecast Anomaly for ASO 2014 (in inches)			
	Seasonal MEAN Anomaly	Standard Deviation of ASO season	Seasonal MAX Anomaly	Standard Deviation of ASO season
Marianas, Guam	+3.2	+3.6	+18(2)	+3.5
Malakal, Palau	+2.4	+4.5	+39(3)	+4.6
Yap, FSM	+3.3	+4.8	+31(4)	+4.8
Chuuk, FSM**	+3.3	*	+30(4)	*
Pohnpei, FSM	+3.6	+3.4	+32(4)	+3.3
Majuro, RMI	+2.5	+2.5	+42(3)	+3.2
Kwajalein, RMI	+3.7	+3.0	+42(4)	+3.5
Pago Pago, American Samoa	+4.8	+3.4	+30(5)	+3.9
Honolulu, Hawaii	+2.5	+1.8	+21(2)	+2.3
Hilo, Hawaii	+2.0	+1.8	+23(2)	+2.4

(\*) Data Unavailable

Values for Chuuk (\*\*) are guesstimated based on estimates from neighboring tide stations and observations from WSO Chuuk. Anomaly between 0-±1 inch are considered to be negligible and are denoted by \*\*\*(+/-). Figures in parenthesis represent year-to-year seasonal anomaly.

Anomalies within the range of (+/-) 2 inches are unlikely to cause any adverse climatic impact.

Model:		Final Outlook	Final Probabilities
Republic of Palau			
Koror	L 7 ° 22' N, λ 134° 32' E	Avg-below	35:35:30
Federated States of Micronesia			
Yap	L 9° 29' N, λ 138° 05' E	Average	30:40:30
Chuuk	L 7° 28' N, λ 151° 51' E	Avg-above	30:35:35
Pohnpei	L 6° 59' N, λ 158° 12' E	Avg-above	30:35:35
Kosrae	L 5° 21' N, λ 162° 57' E	Avg-above	30:35:35
Republic of the Marshall Islands			
Kwajalein	L 8° 43' N, λ 167° 44' E	Avg-above	30:35:35
Majuro	L 7° 04' N, λ 171° 17' E	Avg-above	30:35:35
Guam and CNMI			
Guam	L 13° 29' N, λ 144° 48' E	Above	25:35:40
Saipan	L 15° 06' N, λ 145° 48' E	Above	25:35:40
American Samoa			
Pago Pago	L 14° 20' S, λ 170° 43' E	Avg-above	30:35:35
State of Hawaii			
Lihue	L 21° 59' N, λ 159° 20' E	Above	30:33:40
Honolulu	L 21° 19' N, λ 157° 56' W	Above	30:30:40
Kahului	L 20° 54' N, λ 156° 26' E	Avg-above	30:35:35
Hilo	L 19° 43' N, λ 155° 03' E	Avg-above	30:35:35

Forecasts for the ASO season issued on August 18 2014 available at <http://www.prh.noaa.gov/peac/forecast.php>



# General Conclusions about the 2014 event

- ENSO Neutral conditions continue
  - Lack of strong SST anomalies
  - Lack of coherent atmospheric response
- Earlier this year, indicators of a strong event raised the alarms as to a possible strong event
  - Westerly wind burst, downwelling Kelvin wave
  - However, we have not had another west wind event since
- Right now, we are looking at a moderate event, but a weak event is also possible.
  - 65% chance of El Niño conditions by fall/early winter
  - We just came out of the "Springtime Barrier"
  - Subsequent predictions should have less uncertainty
- We are currently in an **El Niño Watch** as designated by the US Climate Prediction Center.
  - The declaration of an actual El Niño will probably occur later this fall.
- The impacts for Individual USAPI States are usually tied to the intensity of the event.

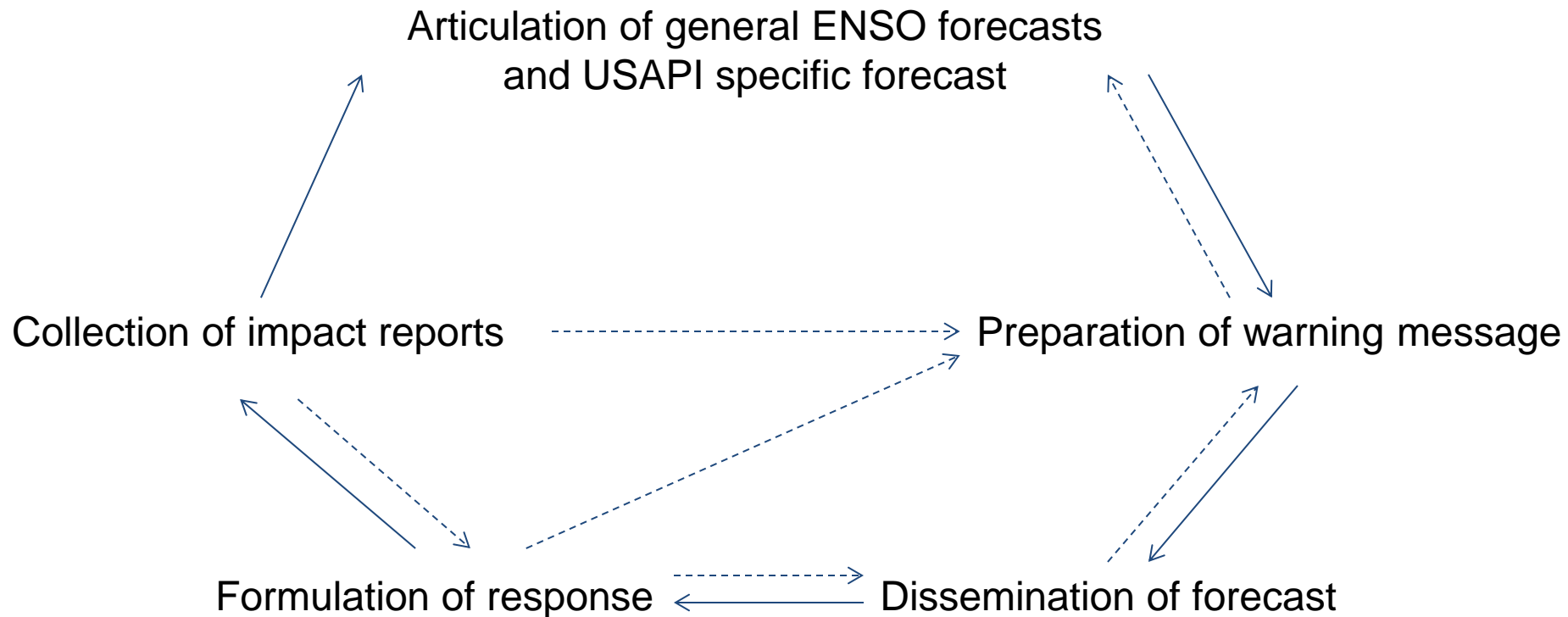
# PEAC OUTREACH

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From forecast onward

# PEAC Center: Forecast-to-Verification

- The PEAC Center is involved in all stages of the forecast to mitigation process



# PEAC Center and the 2014 El Niño

- When the early signs of a developing El Niño were clear during early 2014
  - The development of El Niño was discussed in our conference call as early as February
    - Reaching PEAC Contributors
  - Special issue of the PEAC Newsletter sent out to our users during April
    - Reaching ~400 recipients
  - PEAC site visit was programmed for July
    - Directly reaching local government officials and decision makers
    - Also served as an internal evaluation of operations



# PEAC partnership

- The PEAC Center strives to foster a sense of community and partnership with the communities we serve
  - This is specially important to effectively reach local governments and decision makers and affect local adaptation and mitigation policy
  - PEAC Center contributors are an integral part of the PEAC Forecasts-to-Feedback process





# The PEAC Center

The Pacific ENSO Applications Climate  
Center



Photo courtesy of Lt.  
Charlene Felkley

# PEAC contacts

- Pacific ENSO Applications Climate (PEAC) Center:

LTJG Carl Noblitt, PEAC Outreach Officer, at [808-956-2324](tel:808-956-2324) for information on PEAC, the Pacific ENSO Update and ENSO-related climate data for the Pacific Islands.

Dr. Rashed Chowdhury, Principal Research Scientist, at 808-956-2324 for information on ENSO and sea-level variability in the USAPI.

Alejandro Ludert, Graduate Research Assistant and Webmaster, at 808-956-2324 for information related to the PEAC website.

- Weather Forecast Office (WFO) Guam:

Chip Guard, Warning Coordination Meteorologist, at 671-472-0900 for information on tropical cyclones and climate in the USAPI.

- University of Guam - Water and Environmental Research Institute (WERI):

Dr. Mark Lander, PEAC Meteorologist, at 671-735-2685 for information on tropical cyclones and climate in the USAPI.

- University of Hawai'i - Joint Institute of Marine and Atmospheric Research (JIMAR), School of Ocean and Earth Science and Technology (SOEST), Department of Oceanography:

Dr. Mark Merrifield, PEAC Principal Investigator at 808-956-6161 for more information on sea level and climate in Hawai'i.

- NOAA National Weather Service, Weather Forecast Office (WFO) Honolulu:

Tom Evans, PEAC Director, at 808-973-5270 NOAA National Weather Service