Weather extremes and modes of large-scale variability

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with inputs from Judith Perlwitz and Lisa Alexander

Overview

- Some common modes of variability
- Links between modes of variability and extremes
  - El Niño-Southern Oscillation
  - North Atlantic Oscillation, blocking in Europe

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Modes of variability

- The global atmospheric circulation has a number of preferred patterns of variability, all of which have effects found in surface climate variations
  - Southern Oscillation: seesaw of pressure between the eastern and western tropical Pacific Ocean
  - North Atlantic Oscillation: seesaw of pressure between middle and high latitudes of the Atlantic
  - Northern Annular Mode: seesaw of pressure between middle and high latitudes of the Northern Hemisphere
  - Southern Annular Mode: seesaw of pressure between middle and high latitudes of the Southern Hemisphere
  - Pacific-North American pattern

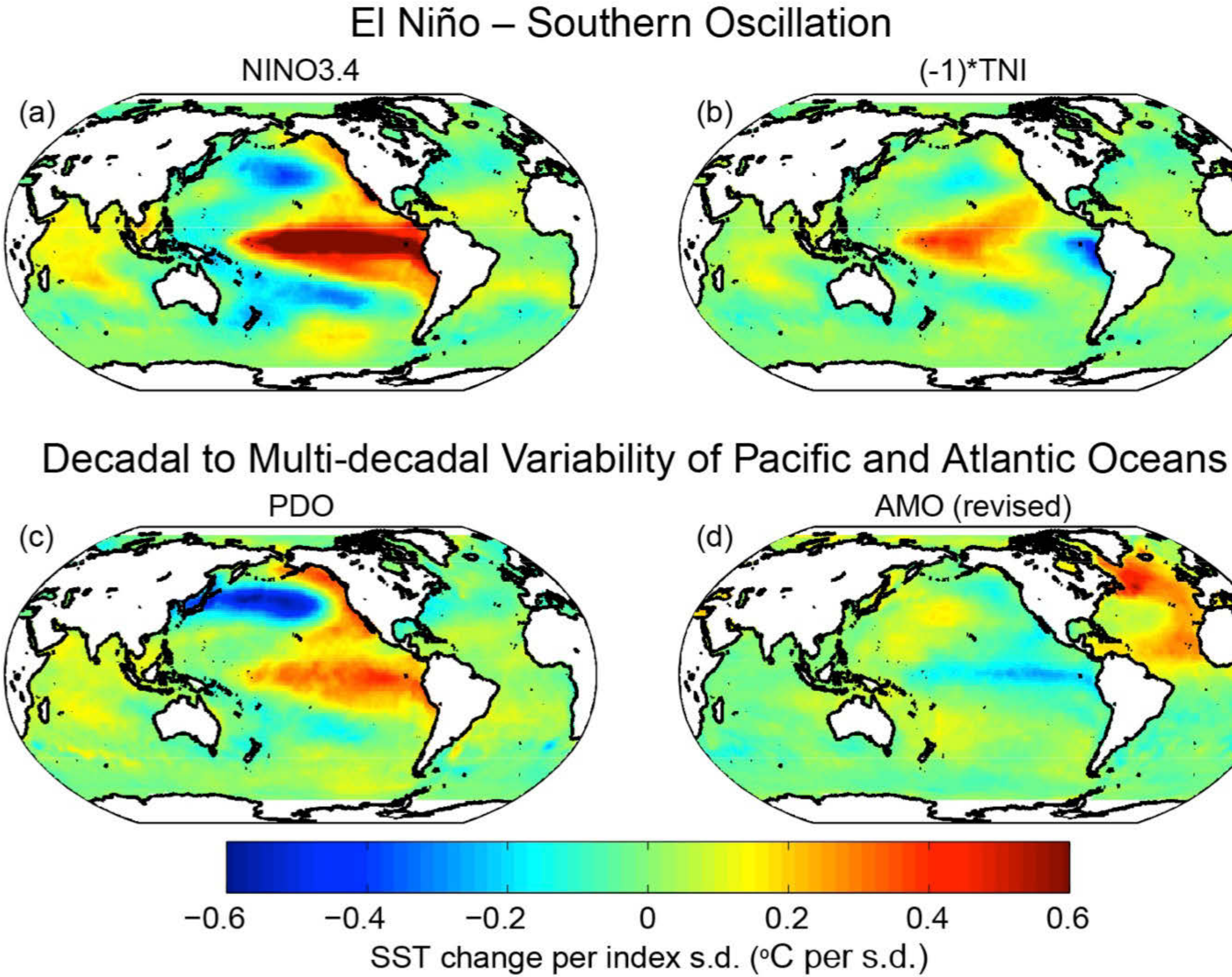

Fig Box 2.5-2, IPCC AR5 WG1

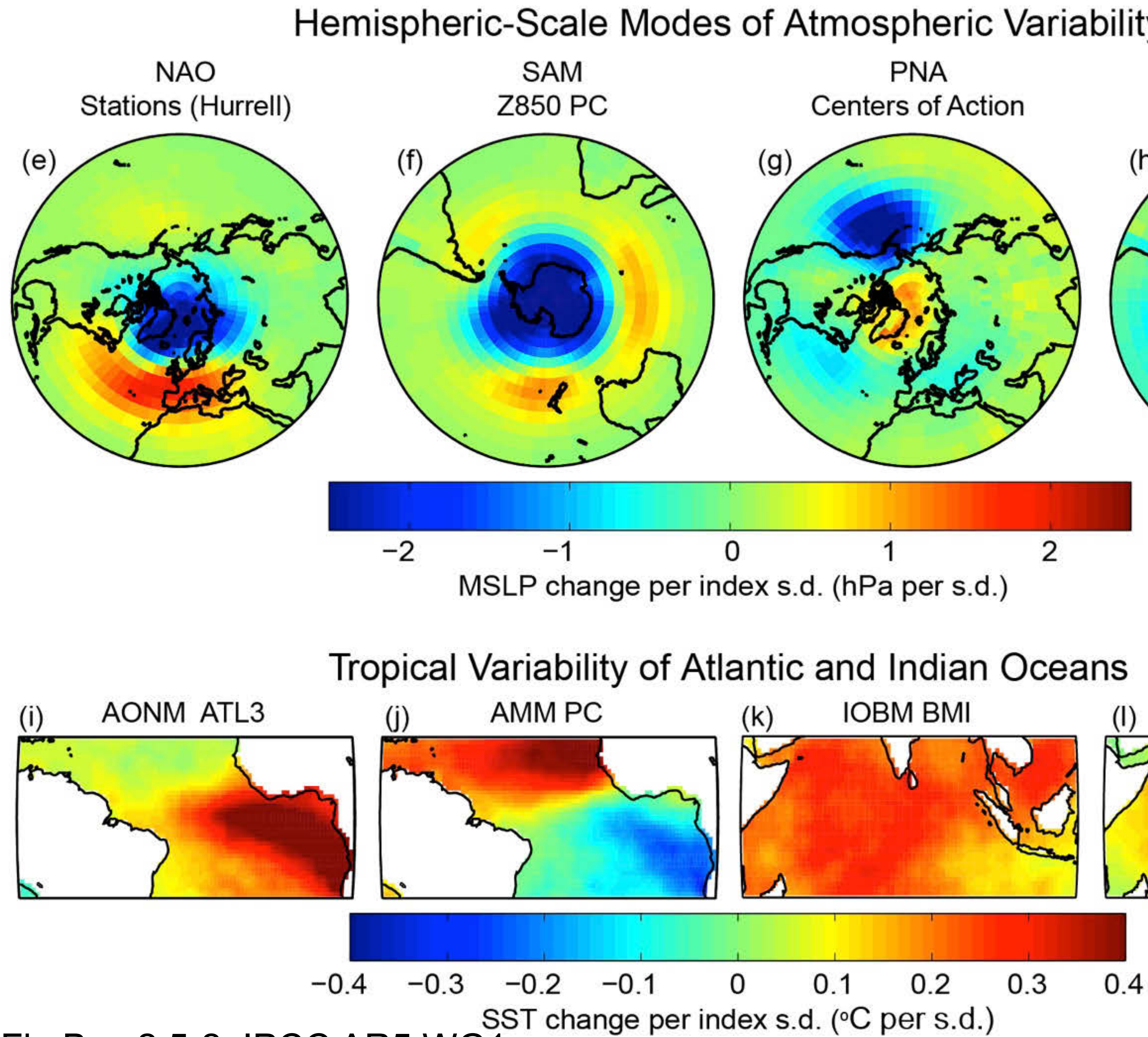

Fig Box 2.5-2, IPCC AR5 WG1

Modes of variability

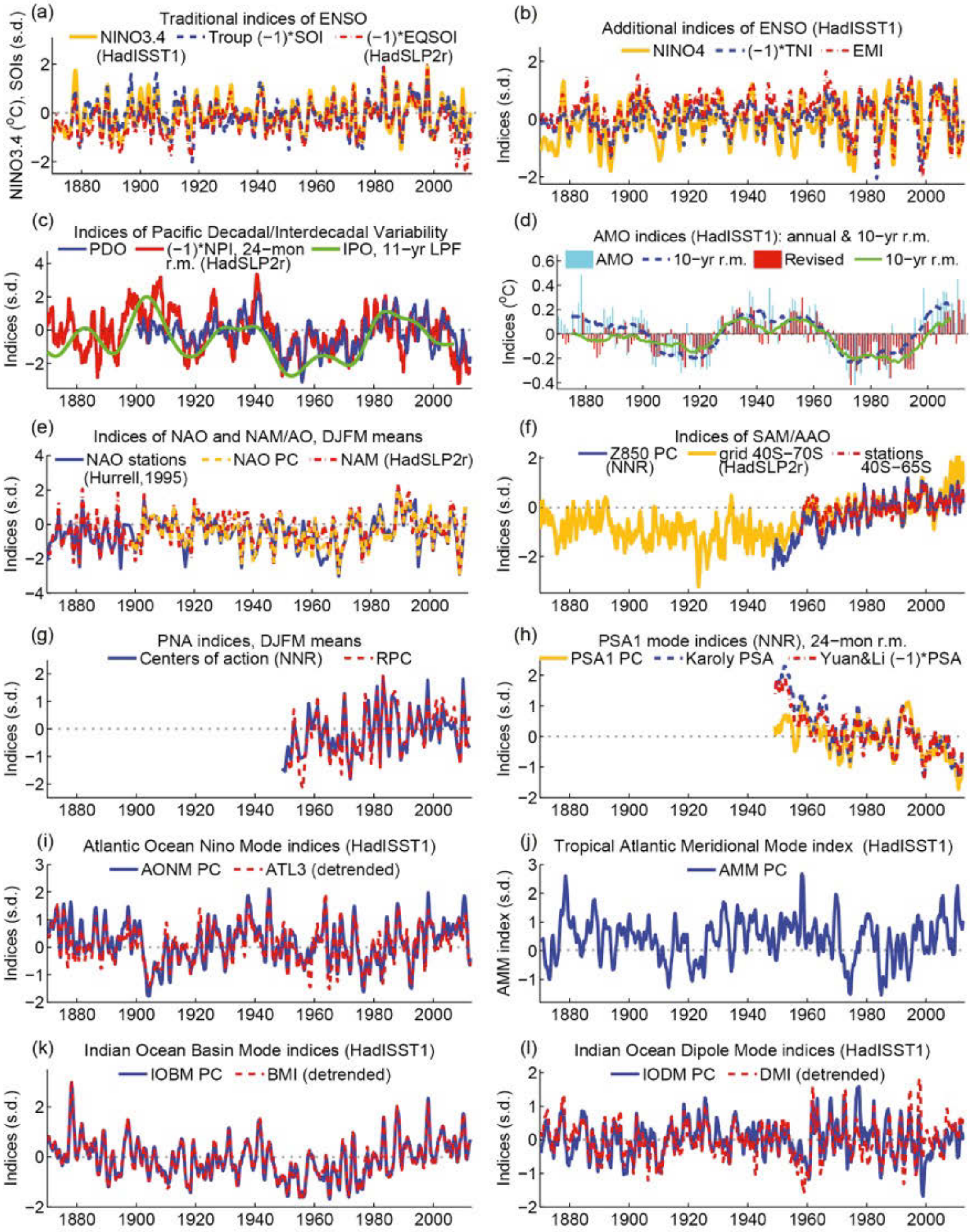

Fig Box 2.5-2, IPCC AR5 WG1

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Modes of variability and regional climate impacts

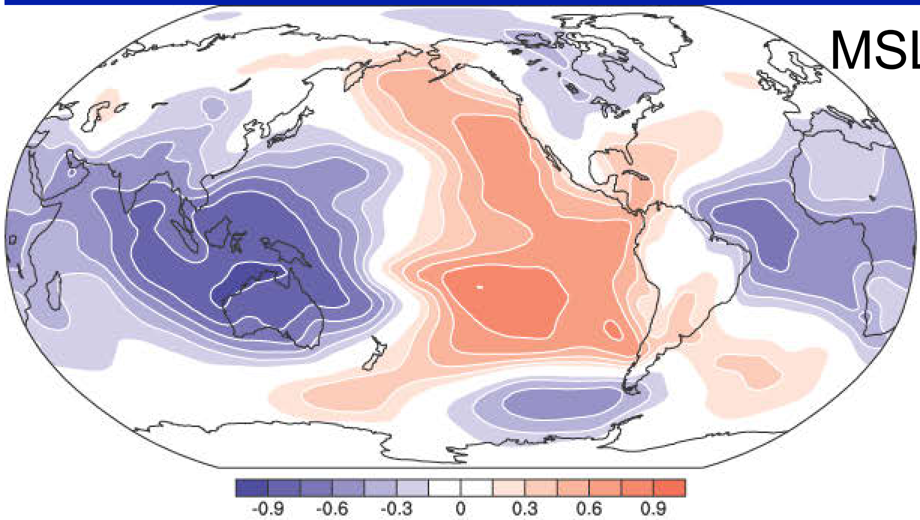
- The Climatedogs: the four drivers that influence Victoria (Australia) climate
  http://www.depi.vic.gov.au/agriculture-and-food/farm-management/weather-and-climate/understanding-weather-and-climate/the-climatedogs-the-four-drivers-that-influence-victoriaas-climate
- The Pacific adventures of the climate crab
  http://www.pacificclimatechangescience.org/animations/climatecrab/

El Niño-Southern Oscillation

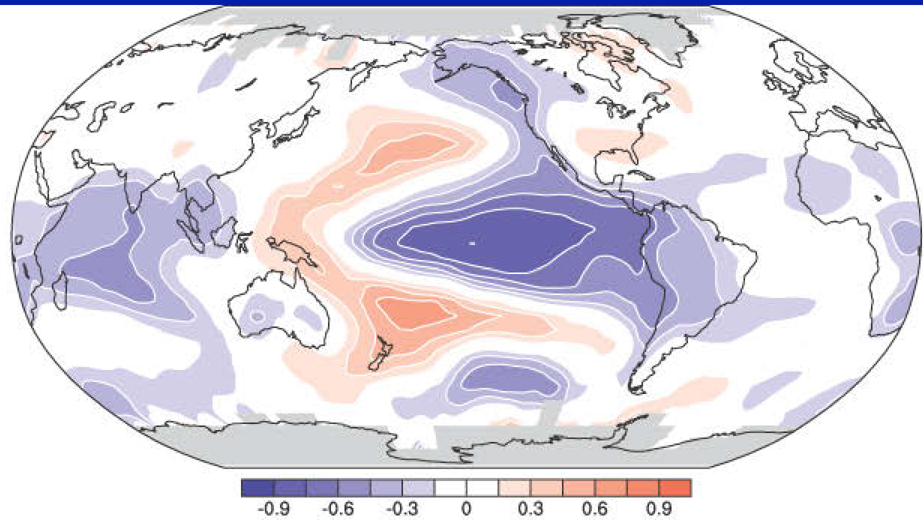
Correlations of year-to-year variations with the Southern Oscillation Index for the May-April year

From Fig 3.27, IPCC AR4 WG1

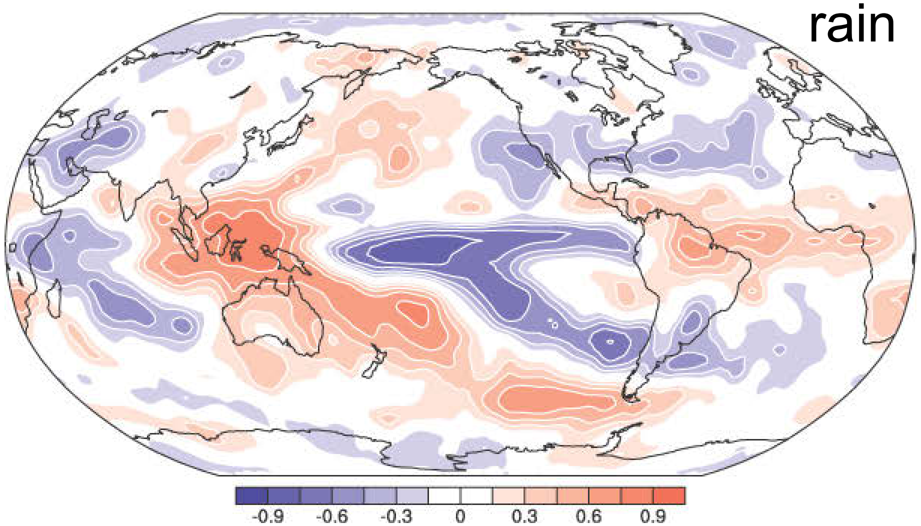
MSLP

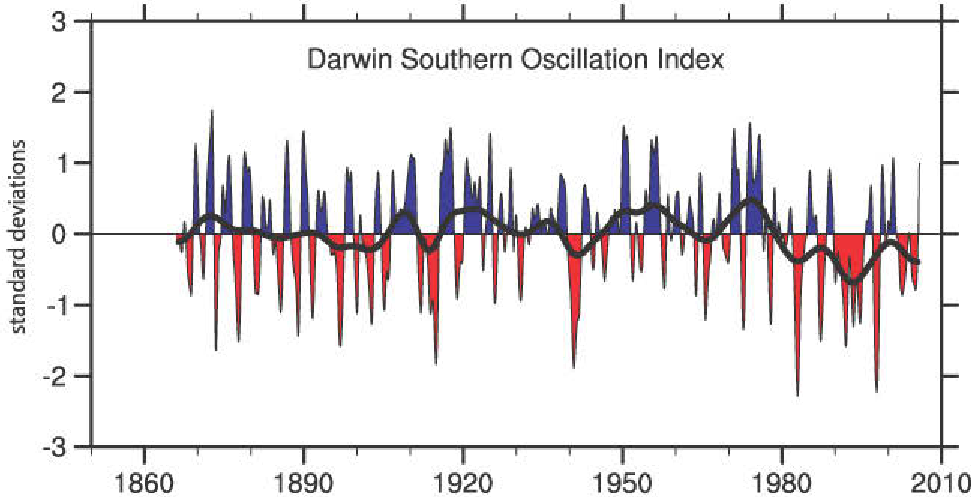


surface temperature

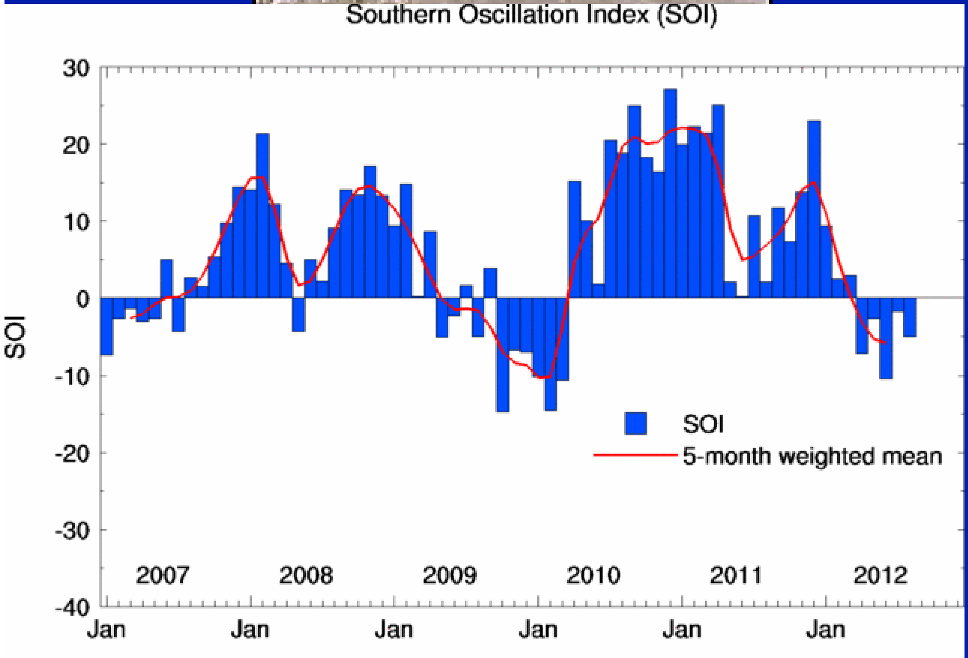


rain



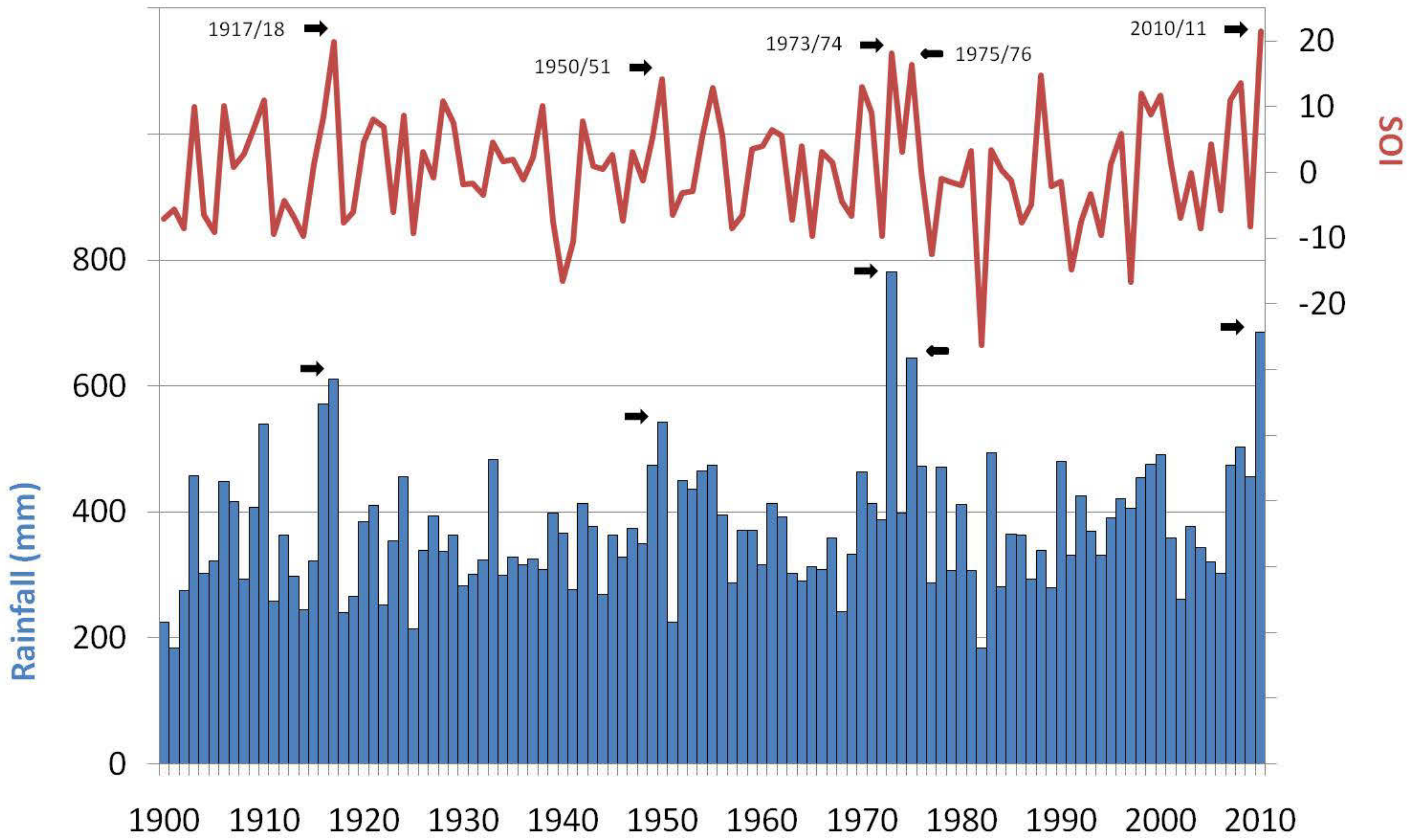


Australian floods Jan 2011



La Niña and eastern Australian rainfall

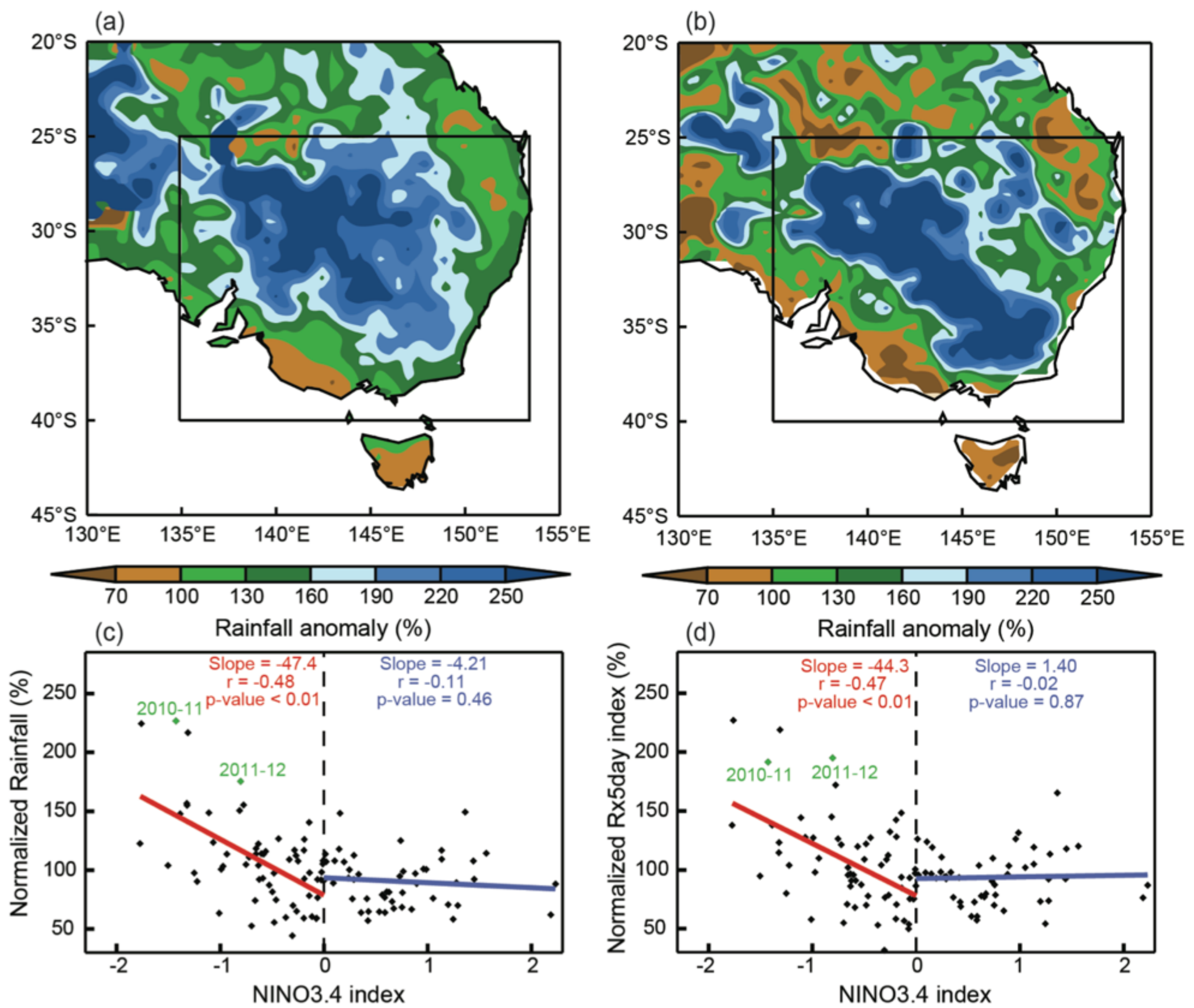
Spring and Summer SOI and Eastern Australian Rainfall



Heavy rainfall in Oct-Mar 2011-12 in SE Aust

Observed Oct 2011-Mar 2012 anomalies in

total rainfall   max 5 day rain



Impact of ENSO

From King et al, BAMS, 2013

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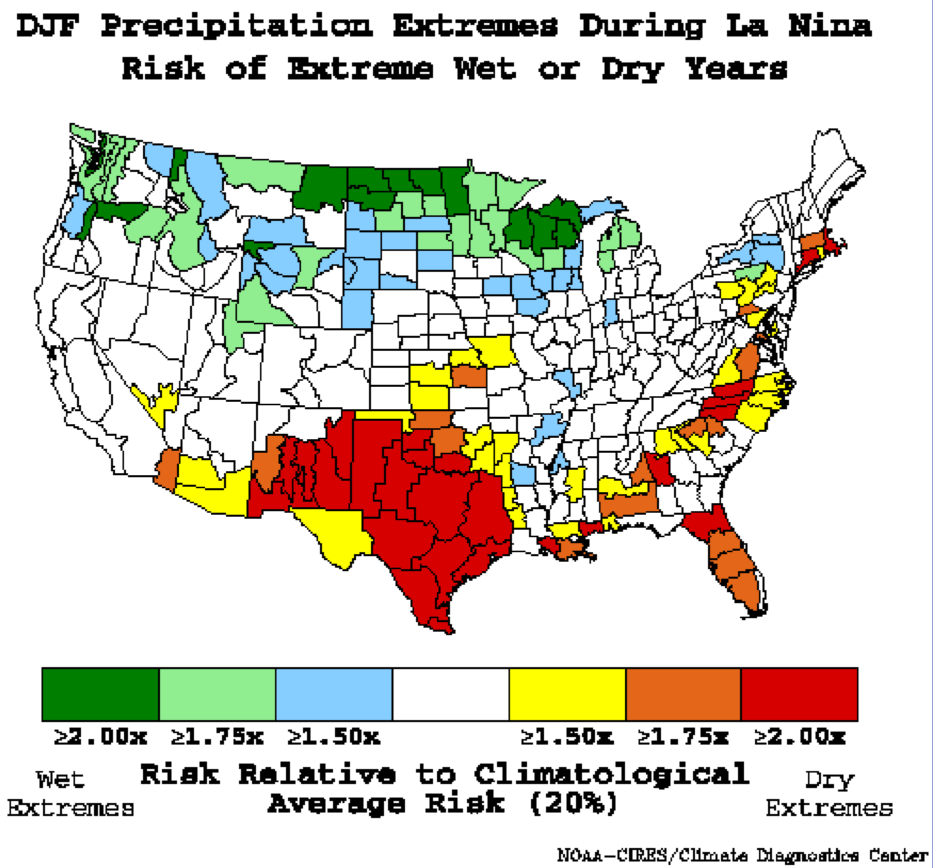
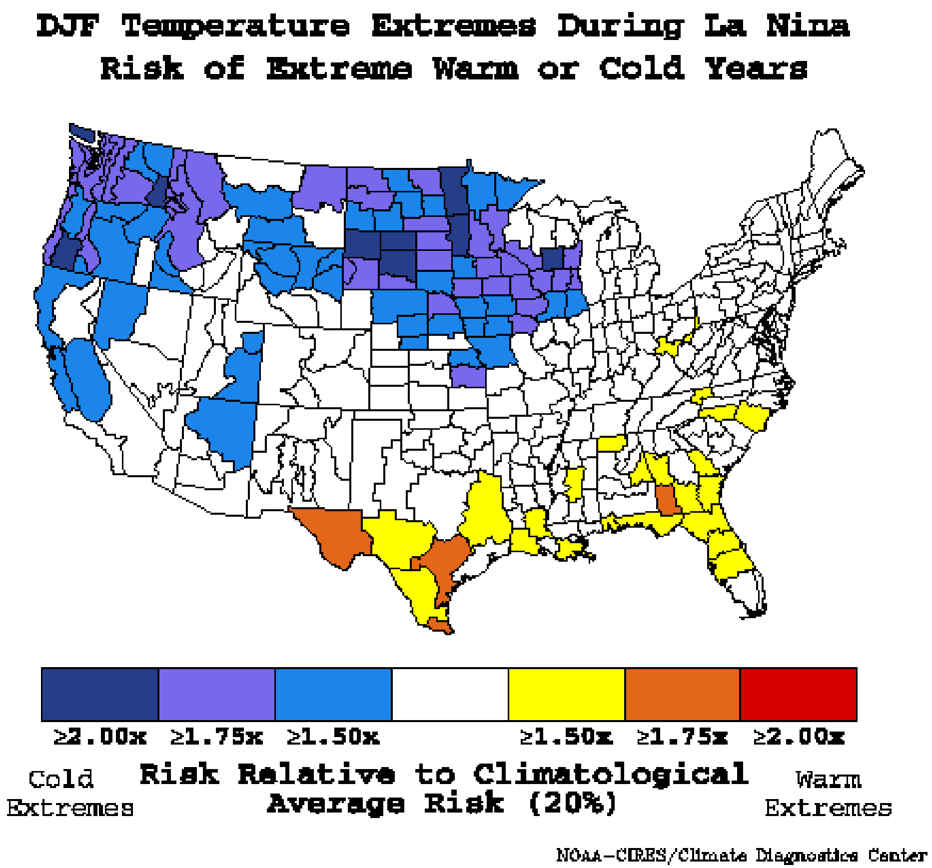
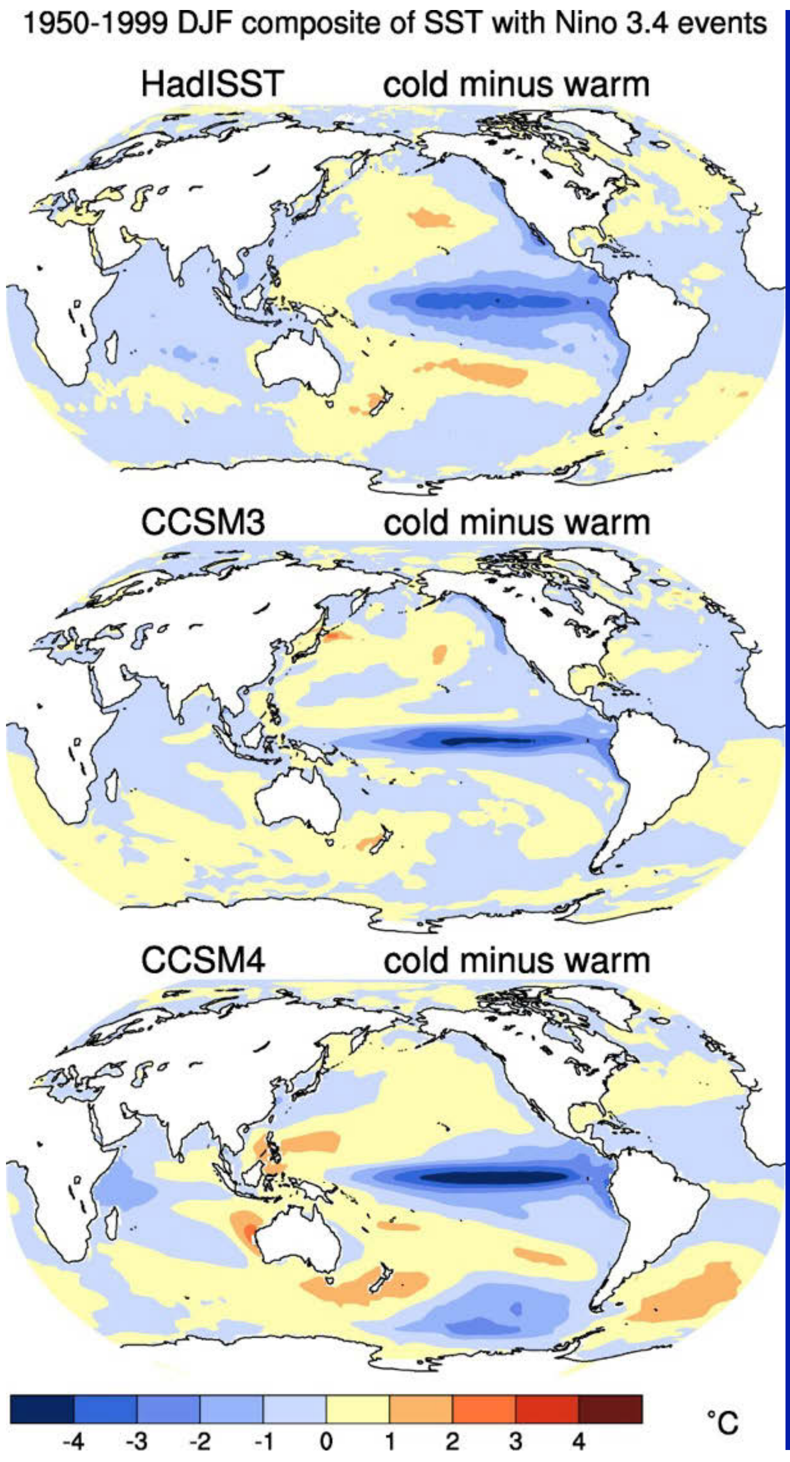
La Niña effects in the US

Changes in probability of extreme seasonal mean temperature and precipitation anomalies







La Niña SST anomalies from observations and model simulations

From Arblaster and Alexander, GRL, 2012

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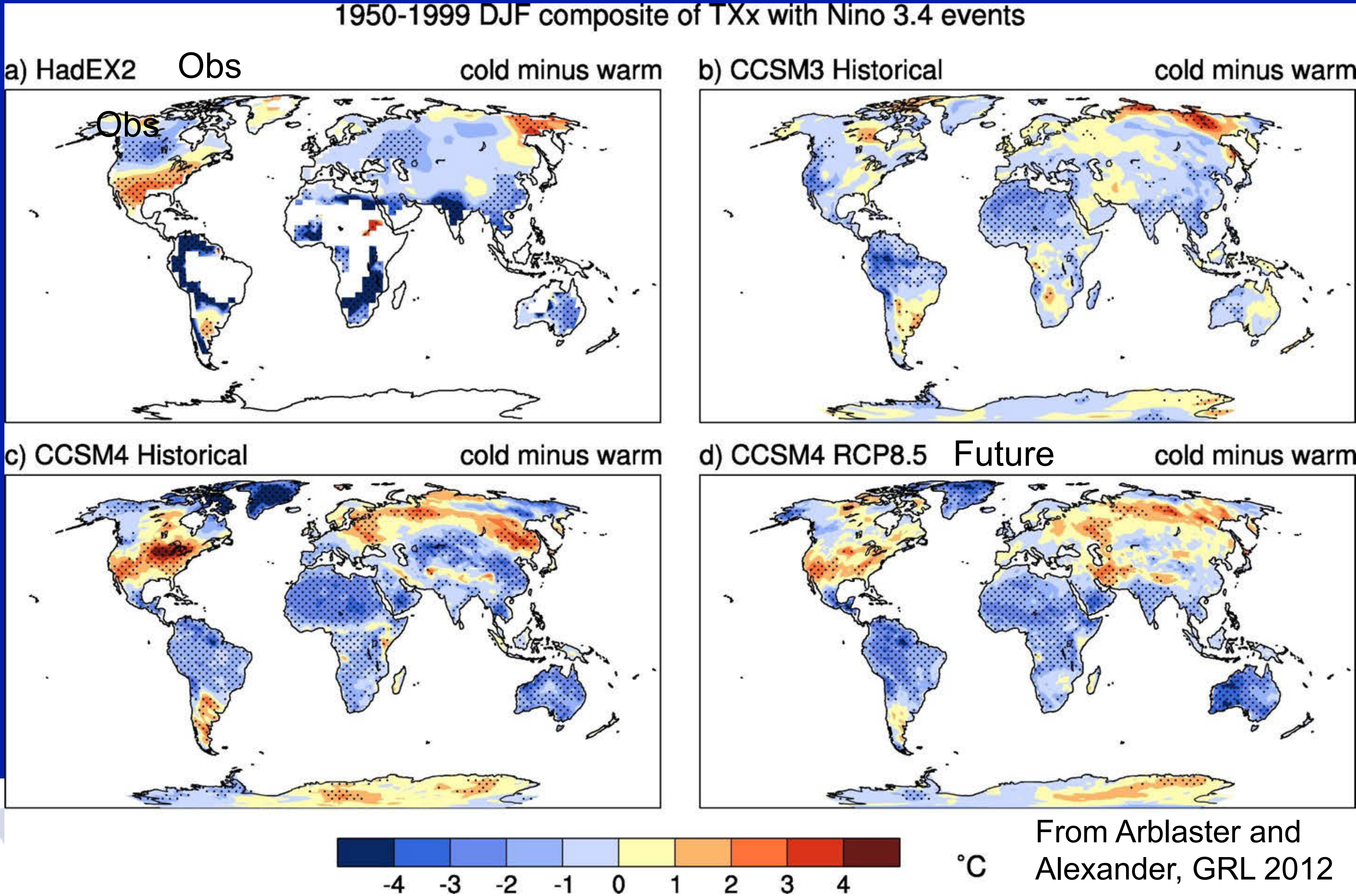
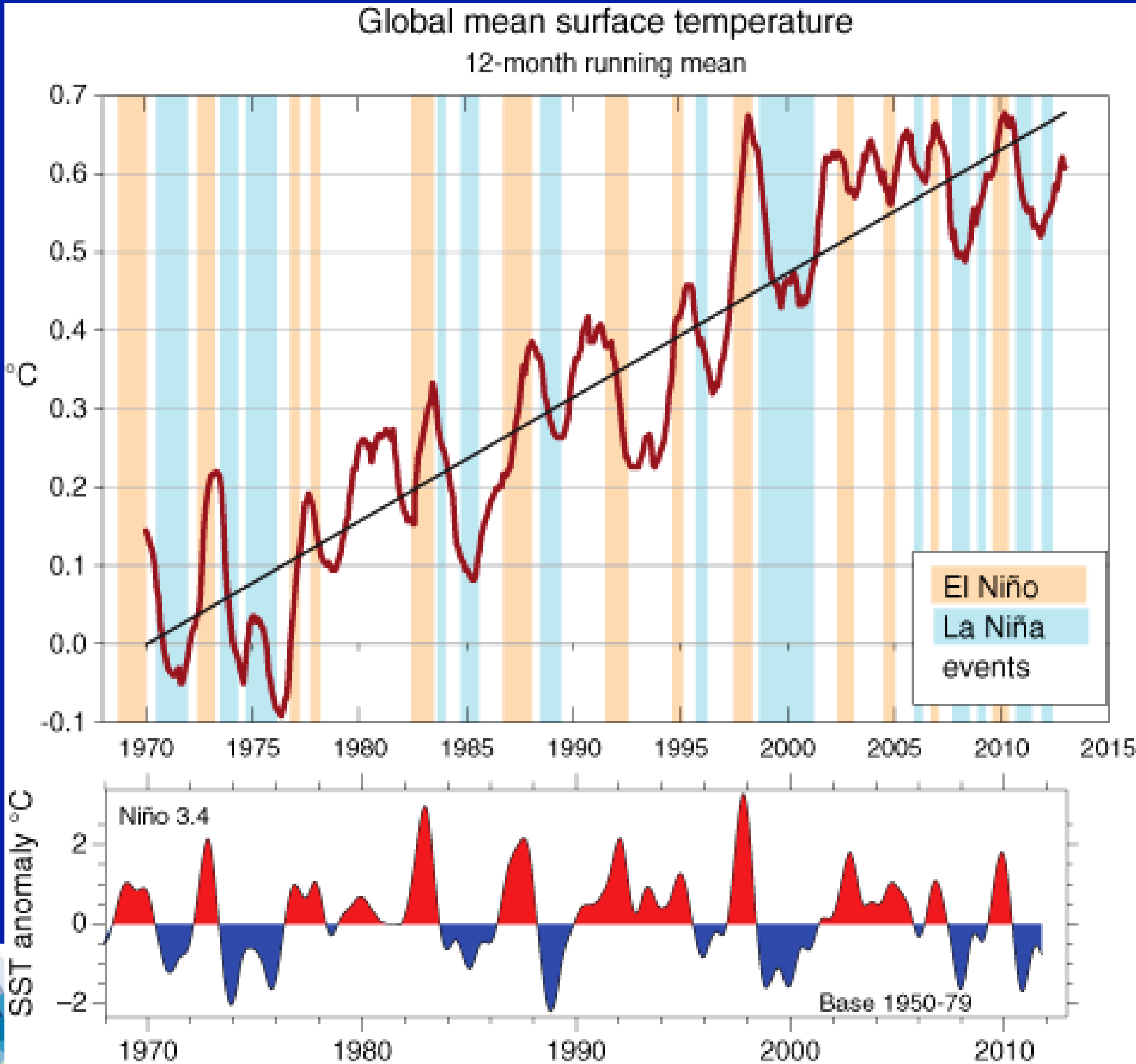
Changes in temperature of hottest day in DJF season due to ENSO in observations and models



From Arblaster and Alexander, GRL 2012

El Niño and global mean temperature



From Trenberth and Fasullo, *Earth's Future*, 2013

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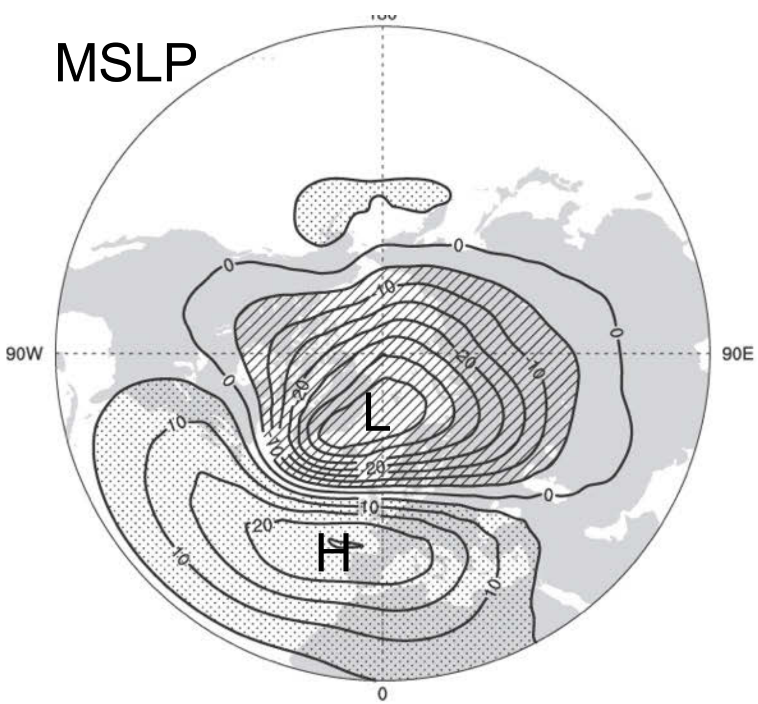
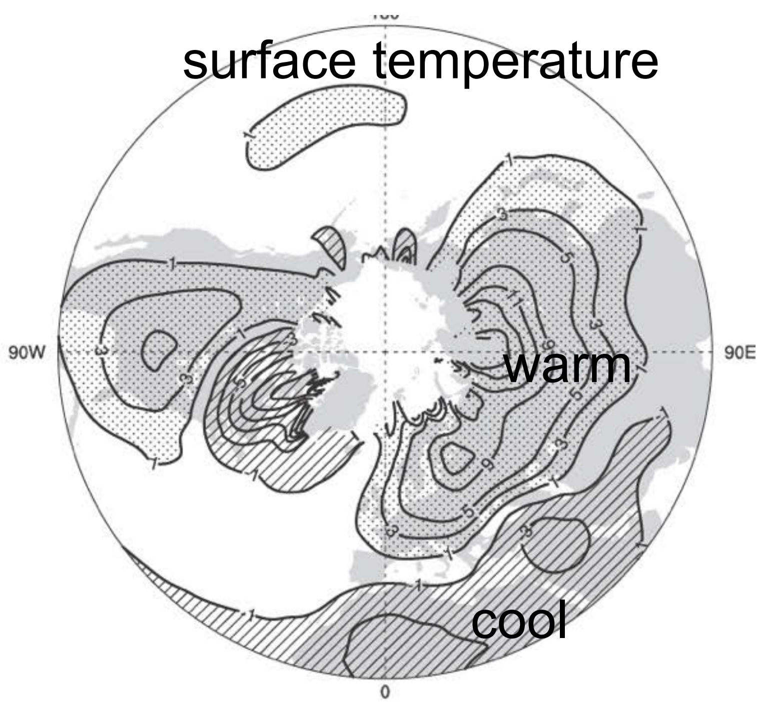
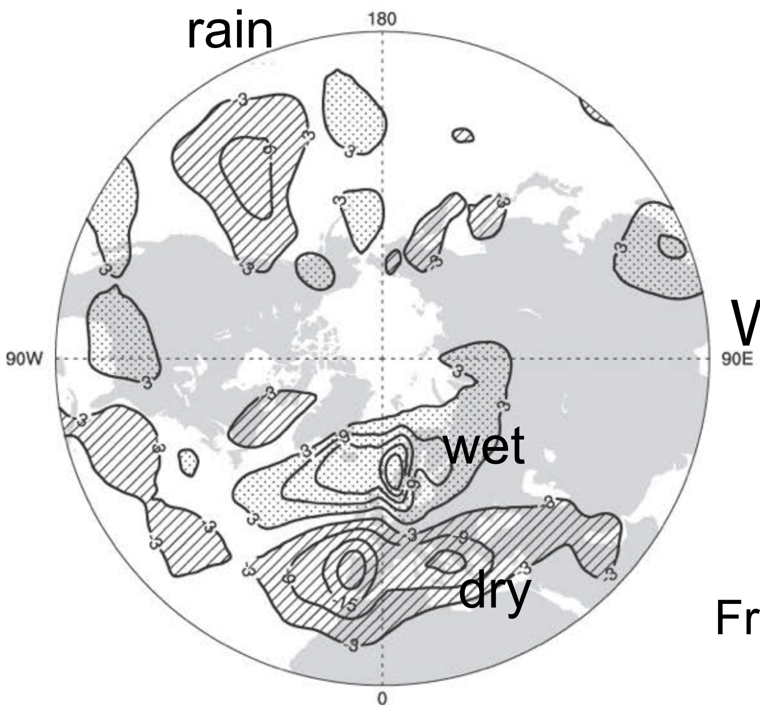






North Atlantic Oscillation

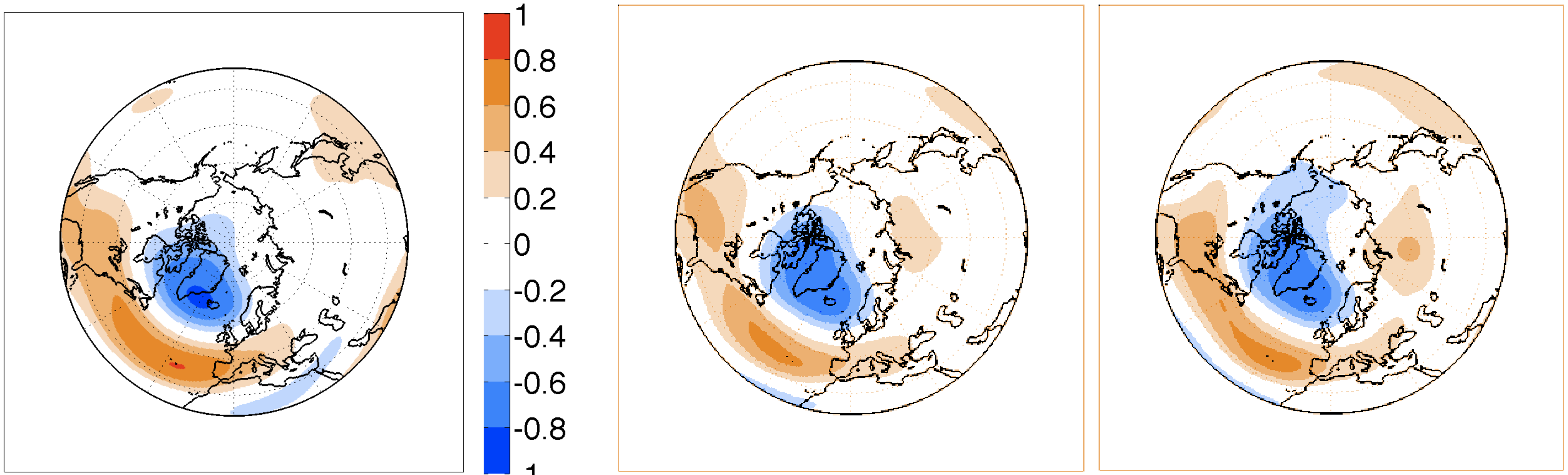
Winter variations associated with unit deviation of the NAO index

From Fig 3.30, IPCC AR4 WGI

Observed and simulated NAO

Correlations of winter 500hPa height anomalies with NAO index from observations and CMIP3 20C3M simulations

CPC CGCM3.1(T63) HadGEM1



from Gonzalez-Reviriego et al, 2010

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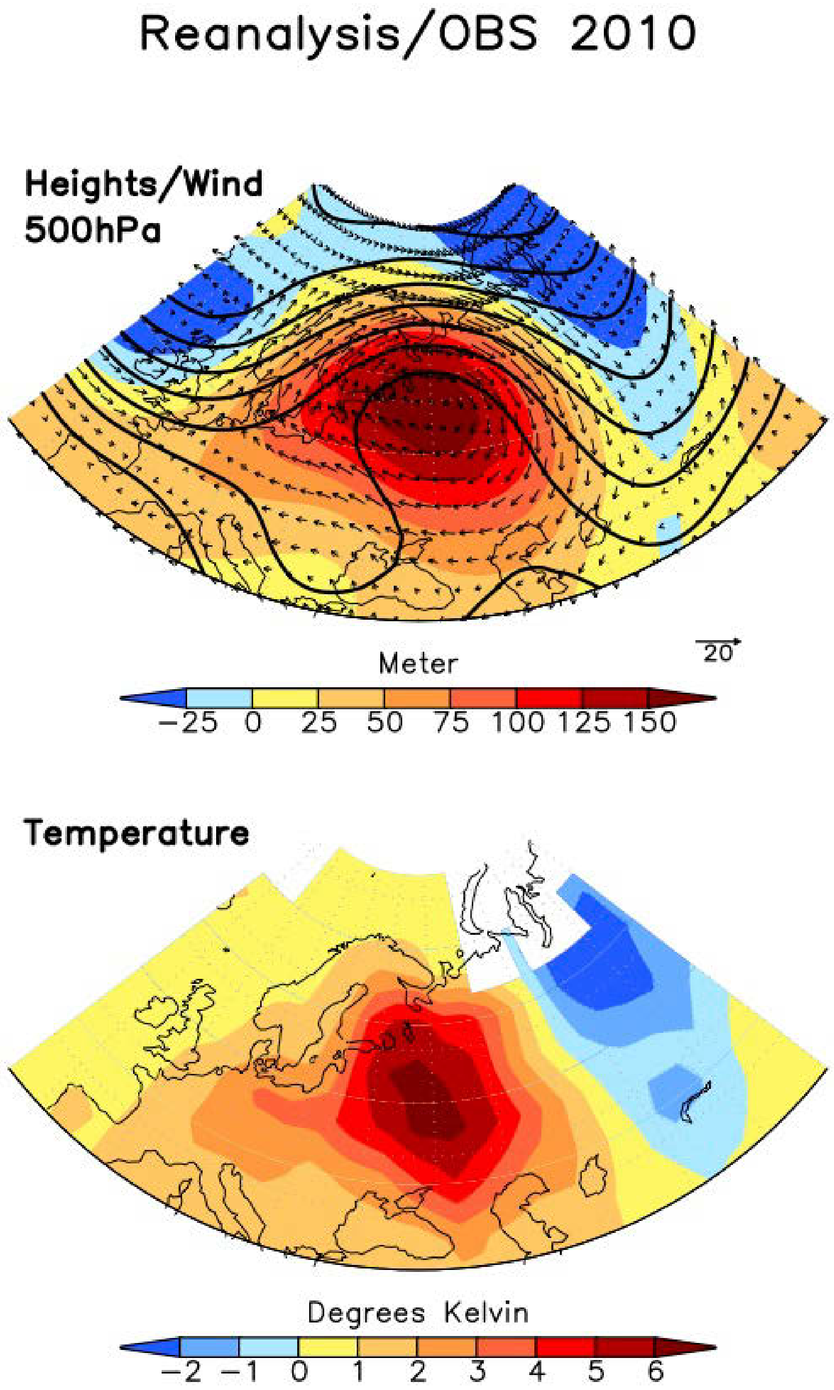

2010 Russian heat wave

associated with blocking

Observed 500 hPa geopotential heights and winds

Observed temperature anomalies

From Judith Perlwitz

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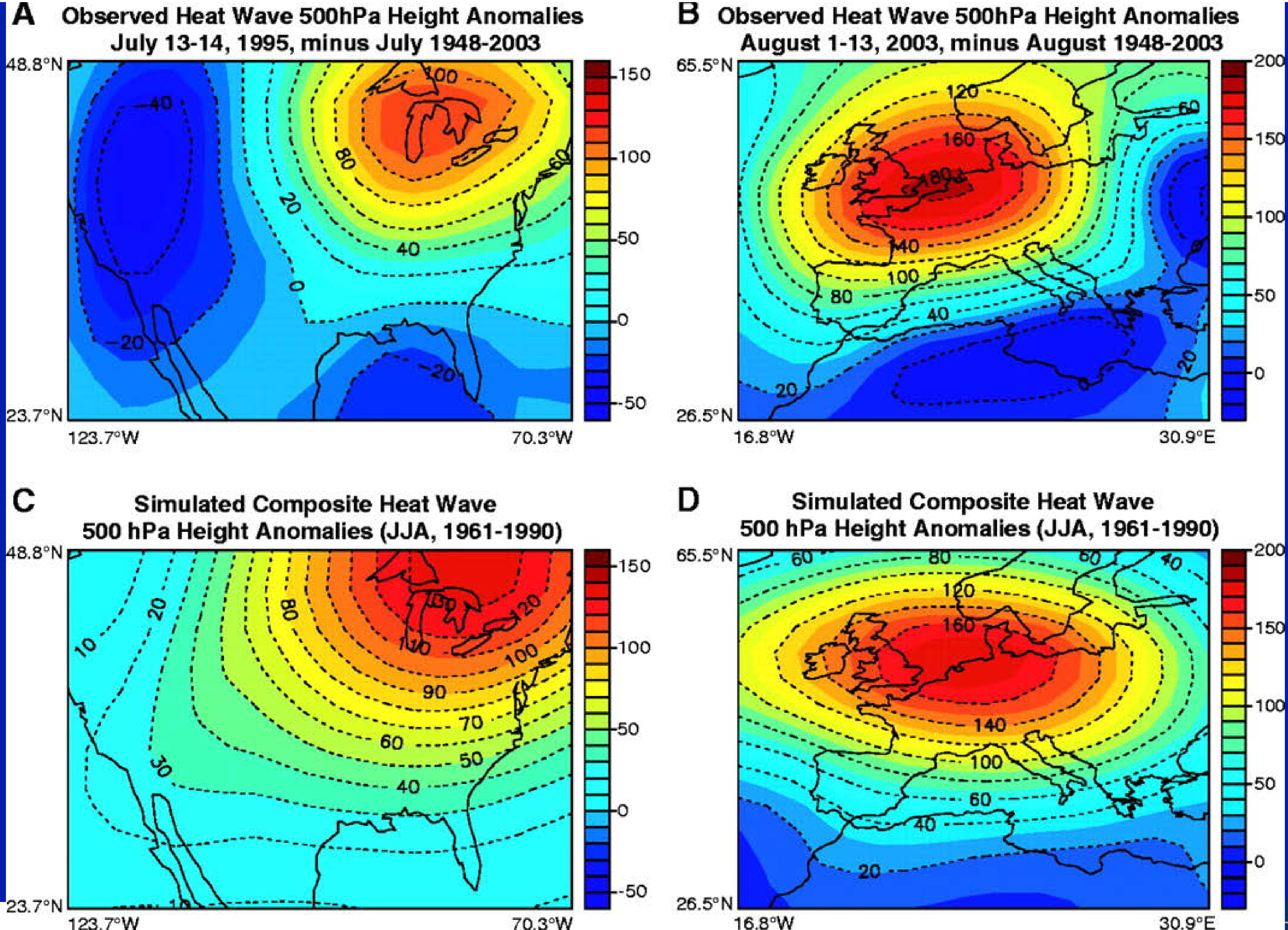

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from Meehl et al 2004

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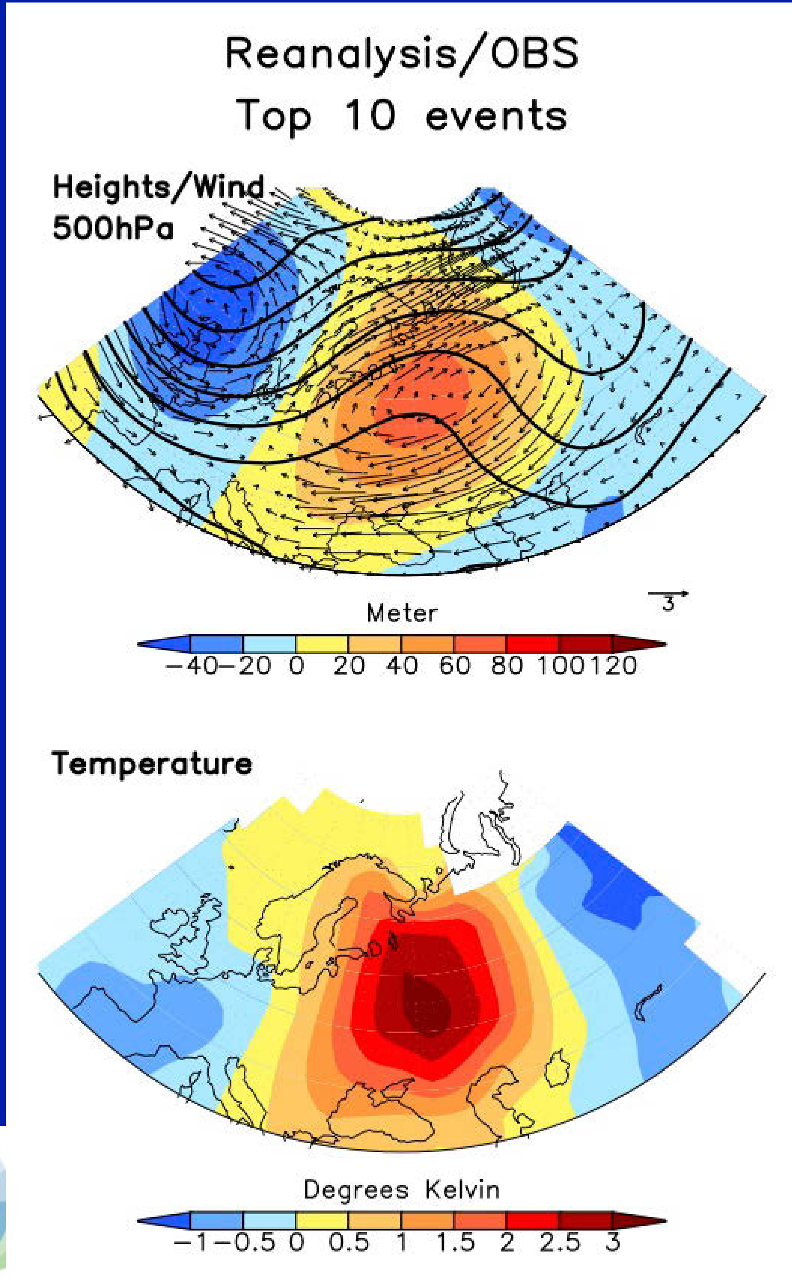
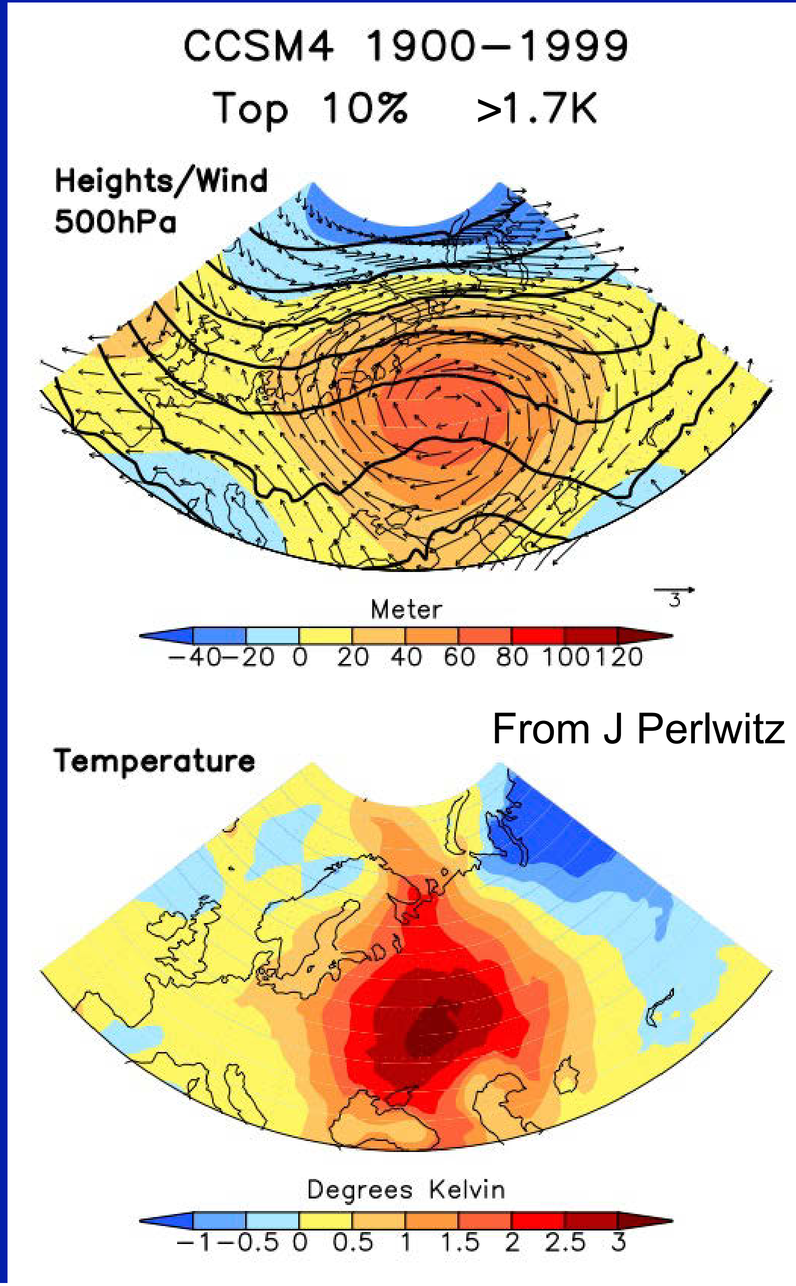
Observed and simulated events





Summary

- Common modes of variability affect seasonal climate variations and the likelihood of weather extremes in many regions
- Large-scale climate variations associated with modes of variability can be simulated reasonably well by climate models
- Details of the spatial structure and temporal persistence of modes, such as blocking, is key to the representation of extremes and is not as well simulated

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