Cat: Re-Rating Challenges in the Face of Global Warming and Higher Frequency of Natural Disasters and Greater Severity of Loss

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Climate and Weather

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The Difference Between Weather and Climate

"Climate is what we expect; weather is what we get."

– Mark Twain, 1887

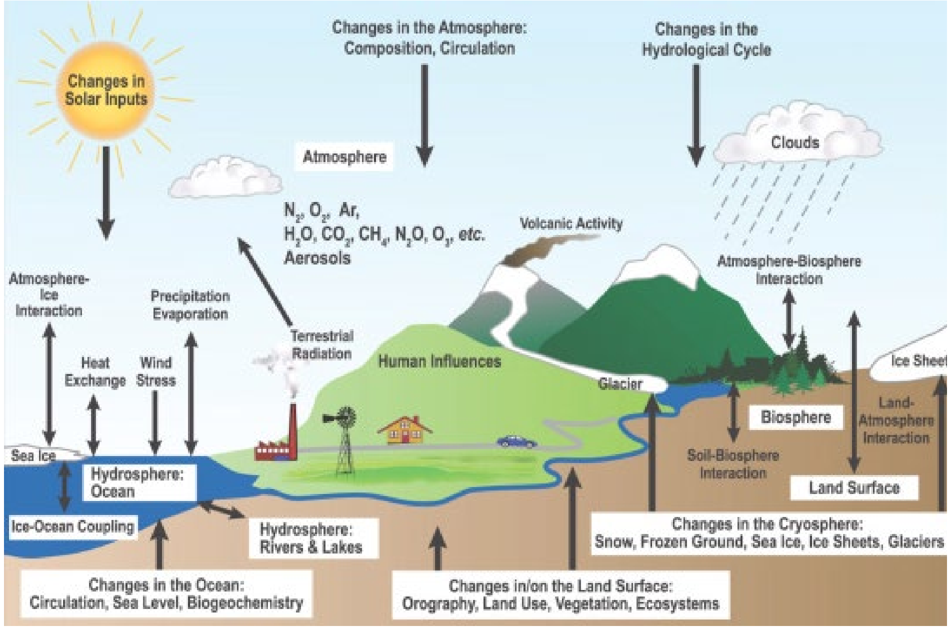
- **Weather:** atmospheric conditions over a ***short period of time (hour, day, week)*** over a particular area. Weather exhibits short-term fluctuations, sometimes extreme, in temperature and precipitation types and amounts.
- **Climate:** atmospheric trends over a ***longer period of time (season, year, decade, century)*** over a particular area. Climate shows trends in temperature and precipitation data that is compared to multi-year averages.

What Is Climate Change?

- Intergovernmental Panel on Climate Change definition is a change
  - identified using statistical or other tests
  - in the mean or the variability
  - persists for an extended period

- Climate change may be due to
  - natural internal processes
  - external forcings
  - persistent anthropogenic changes

  in the composition of the atmosphere or in land use



Source: http://www.oceanclimatechange.org.au/

Climate is a complex system, driven by many Variables

- Solar Input Changes
- Atmospheric Circulation
- Atmospheric Composition
- Clouds
- Sea Ice
- Volcanic Activity
- Atmosphere-Ice Interaction
- Precipitation Evaporation
- Ocean Oscillations
- Land Surface/Ocean Changes
- Glaciers
- Land-Atmosphere Heat Transfer

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Climate Change Statistics

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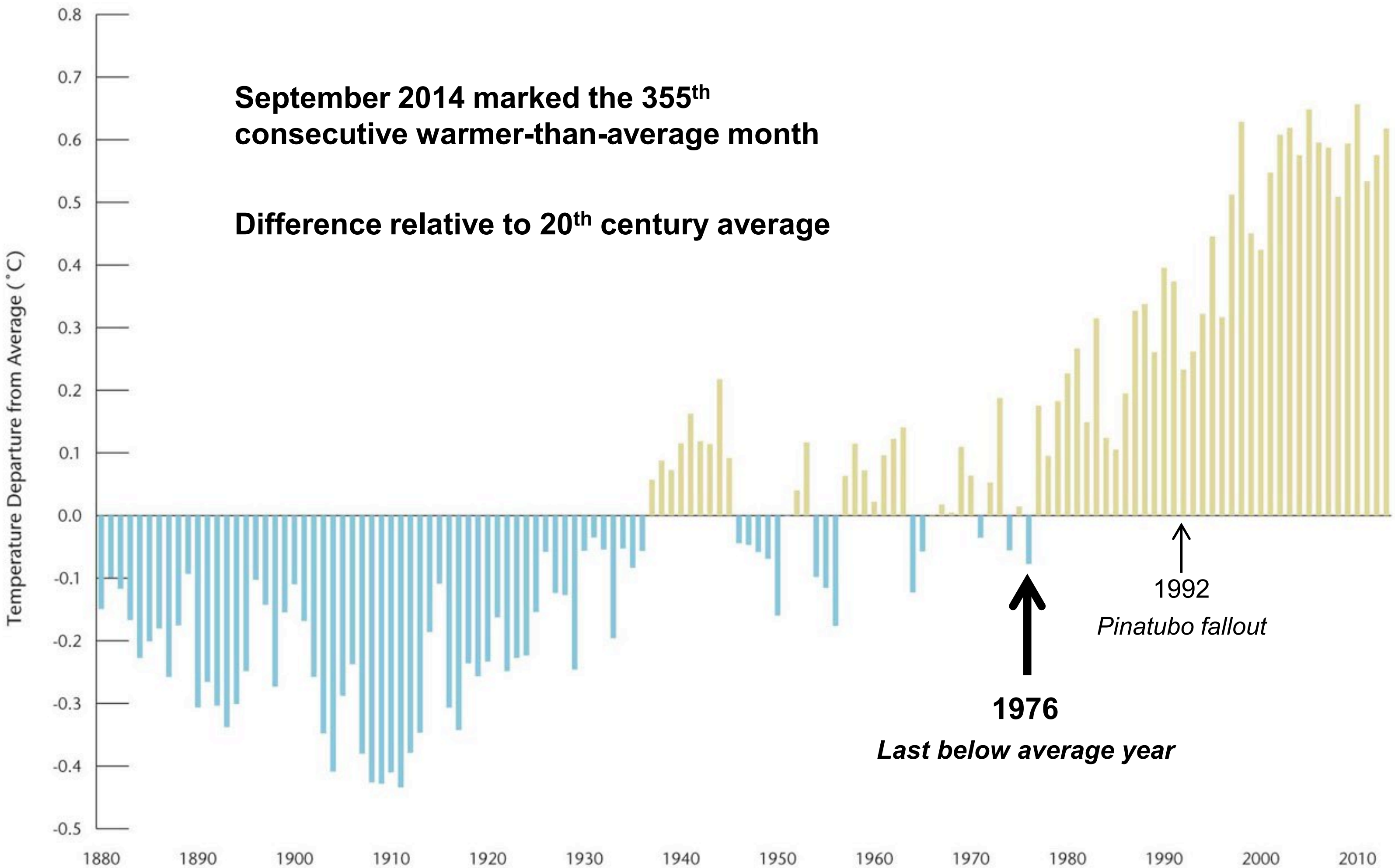
Global Land and Ocean Surface Temperature: 1880-2013



Source: National Climatic Data Center, NOAA

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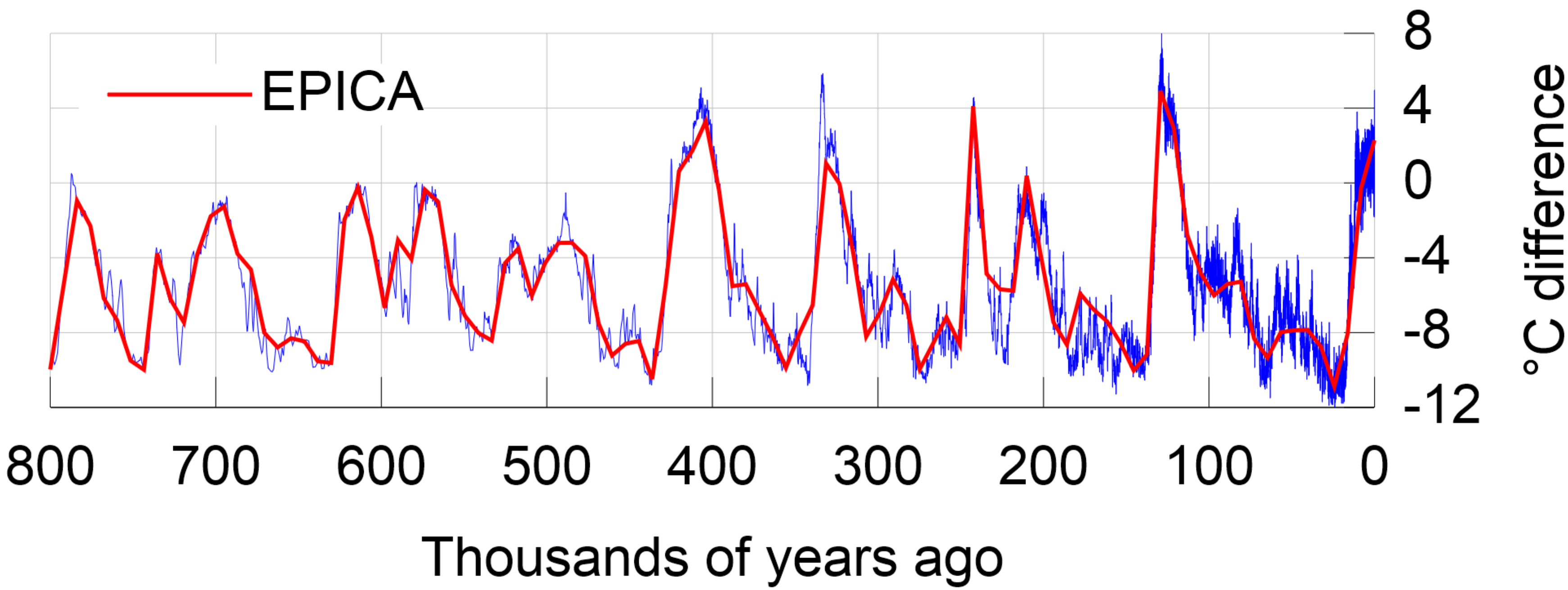
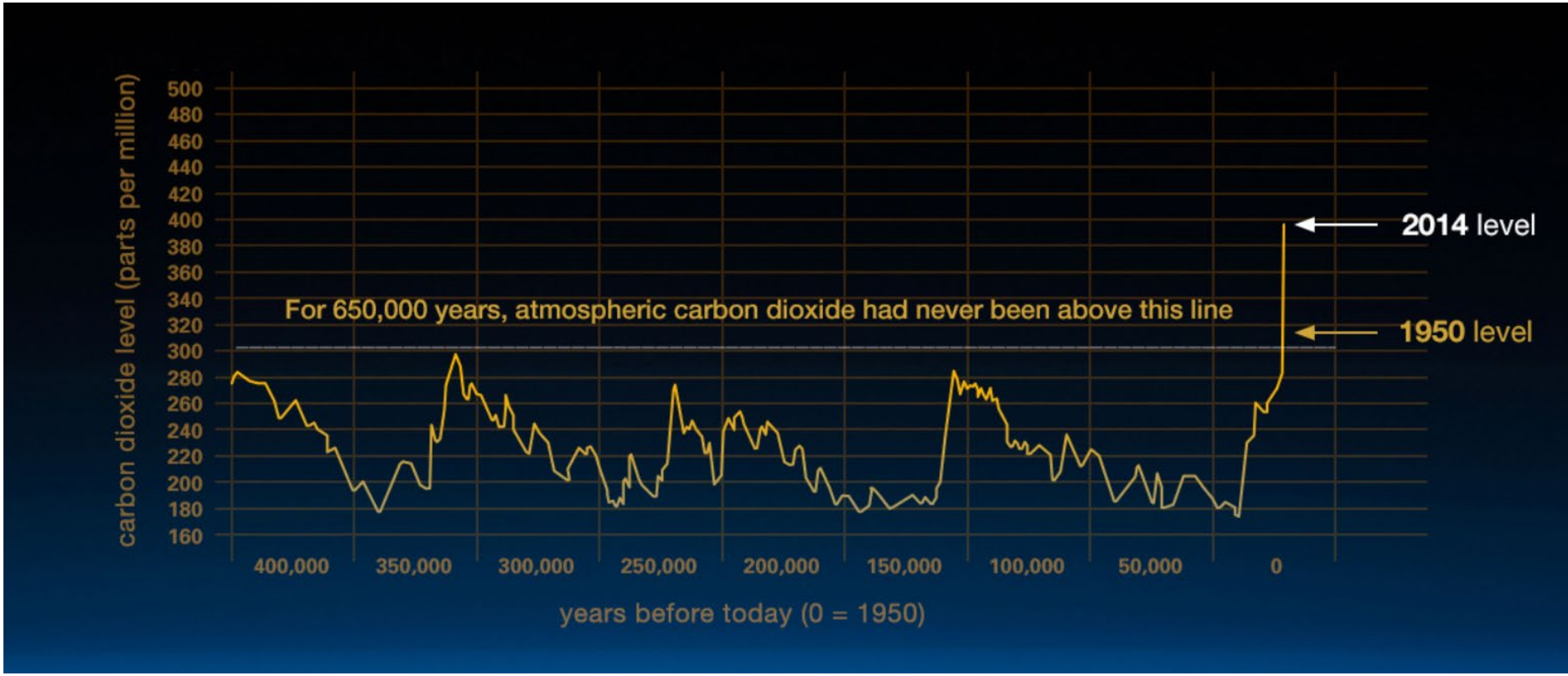
Historical Temperature Has Varied Naturally over Hundreds of Thousands of Years



- Eight glacial to inter-glacial cycles shown in the last 800,000 years
- EPICA is the European Project for Ice Coring in Antarctica

Source: http://en.wikipedia.org/wiki/Temperature_record

Global CO_2 is Rising & at Record Highs Over Last 650,000 Years



Source: http://climate.nasa.gov/evidence/

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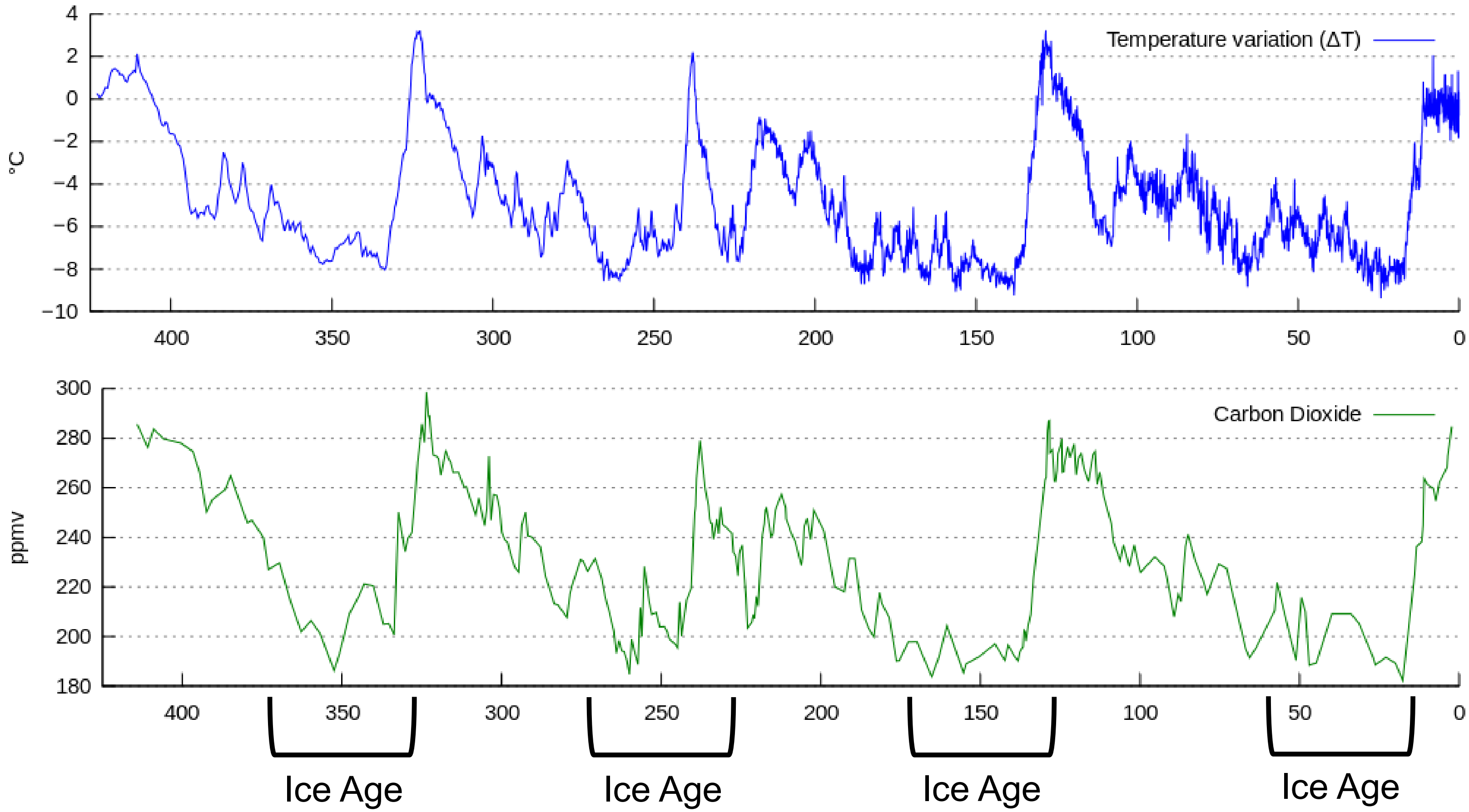
Data Shows Clear Co-movement between CO_2 and Temperatures

- In the past 400,000+ years, ice ages have coincided with reduced CO_2 levels



Source: Vostok ice core data, NCDC, NOAA; http://en.wikipedia.org/wiki/Ice_age

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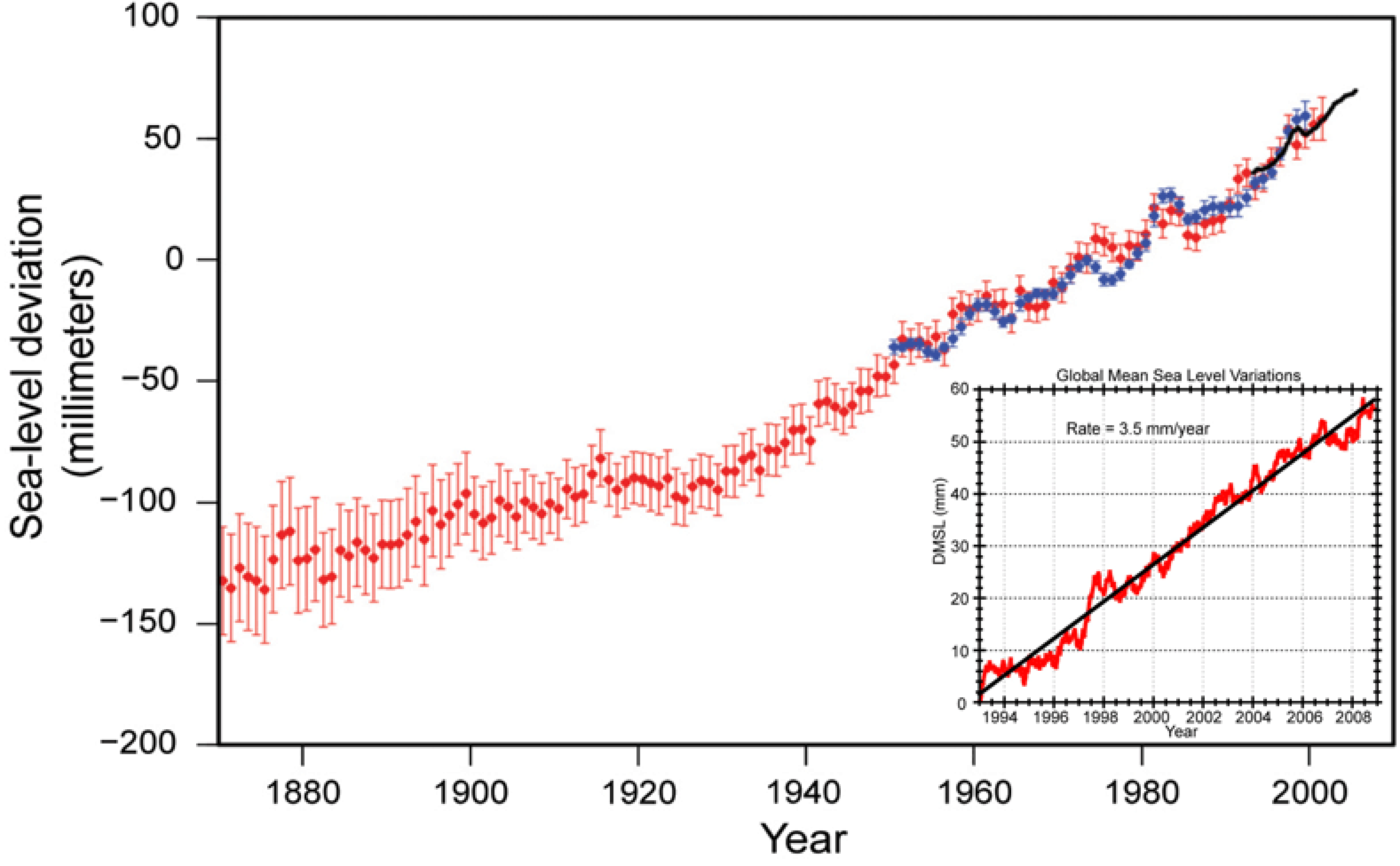
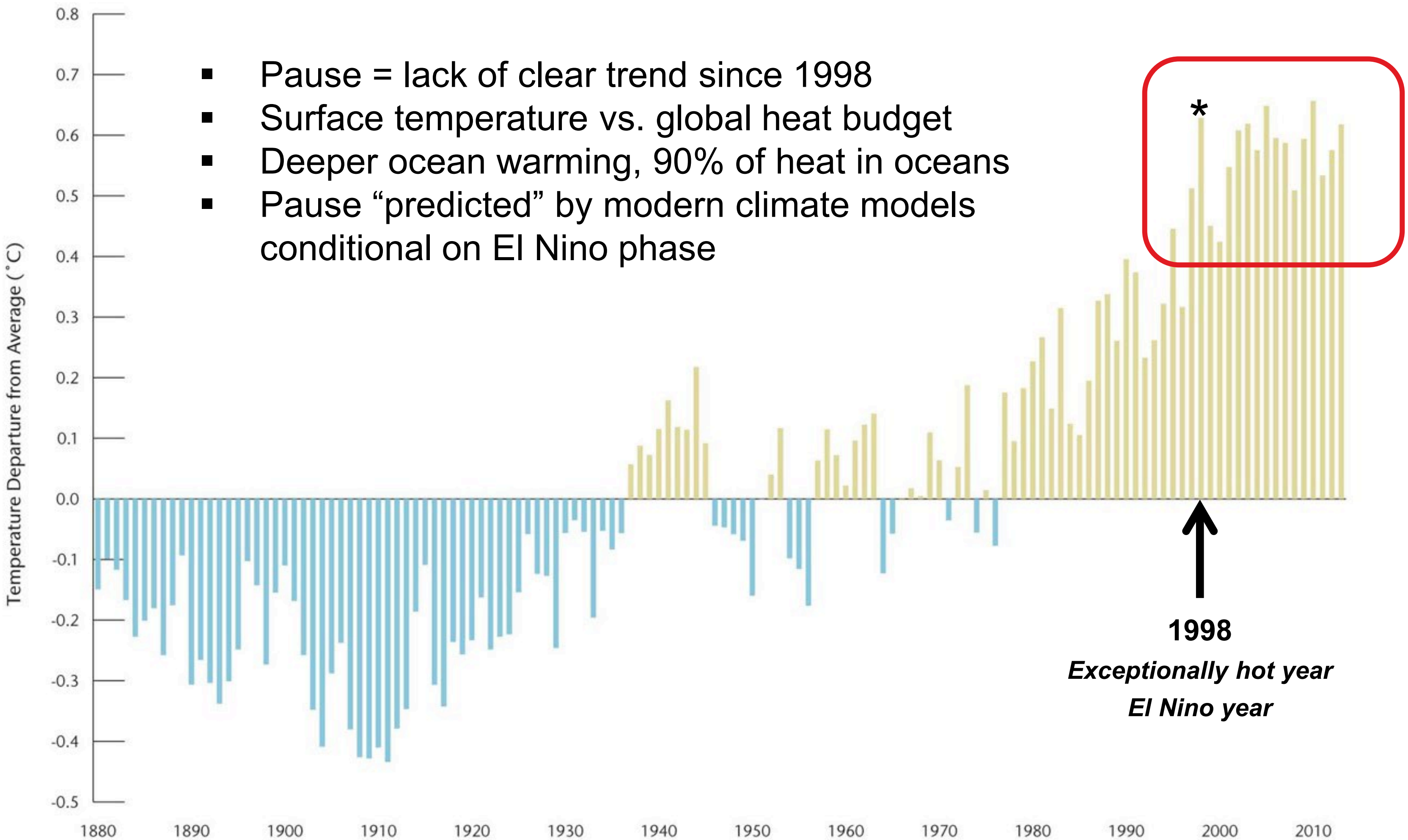
Rising Sea Levels, 1880 to 2010



Source: http://www.ncdc.noaa.gov/indicators/

“Pause” in Warming?

- Pause = lack of clear trend since 1998
- Surface temperature vs. global heat budget
- Deeper ocean warming, 90% of heat in oceans
- Pause “predicted” by modern climate models conditional on El Nino phase



Source: National Climatic Data Center, NOAA

Historical Event Frequency

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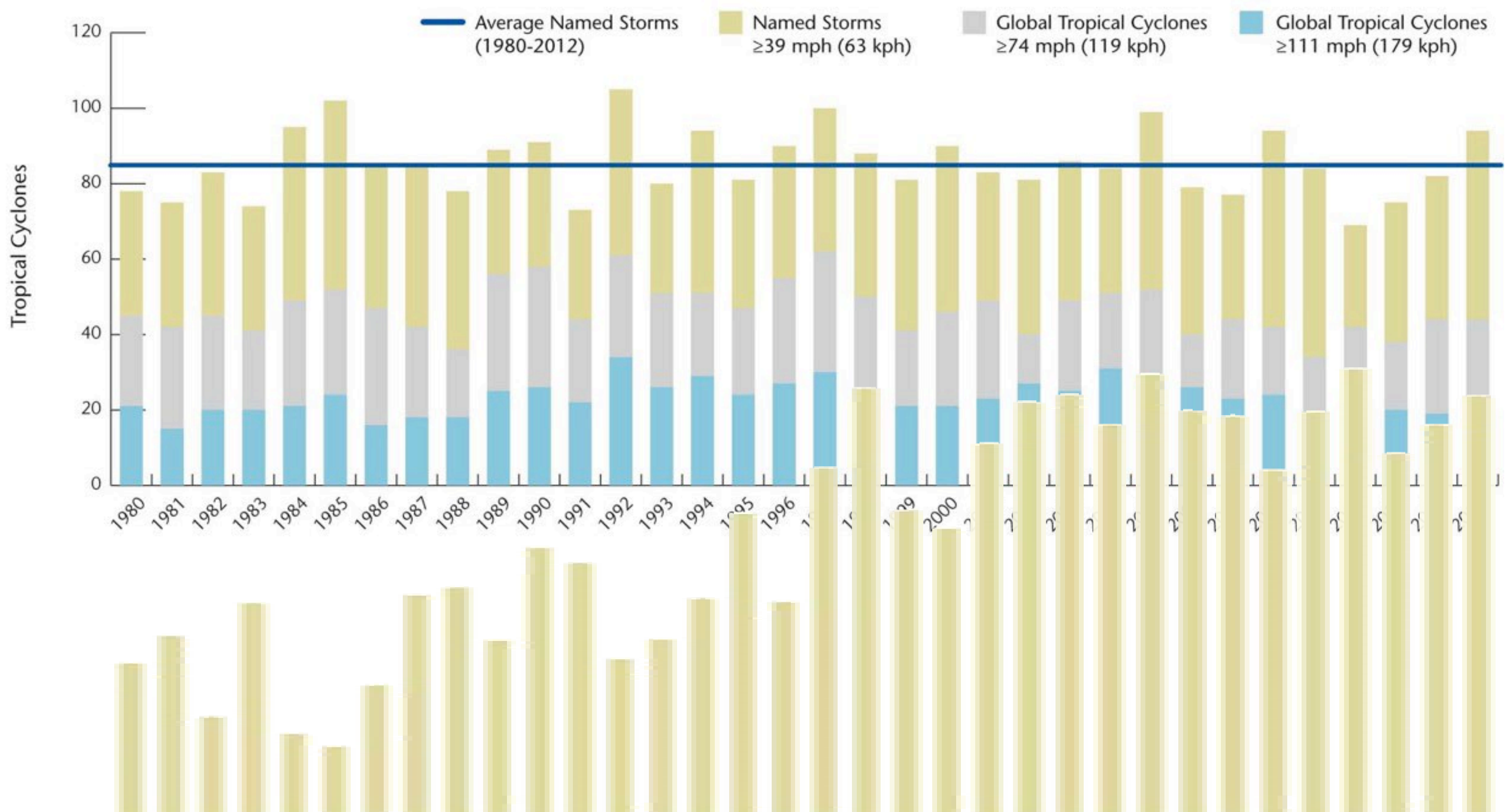
Global Tropical Cyclone Activity (1980-2013)



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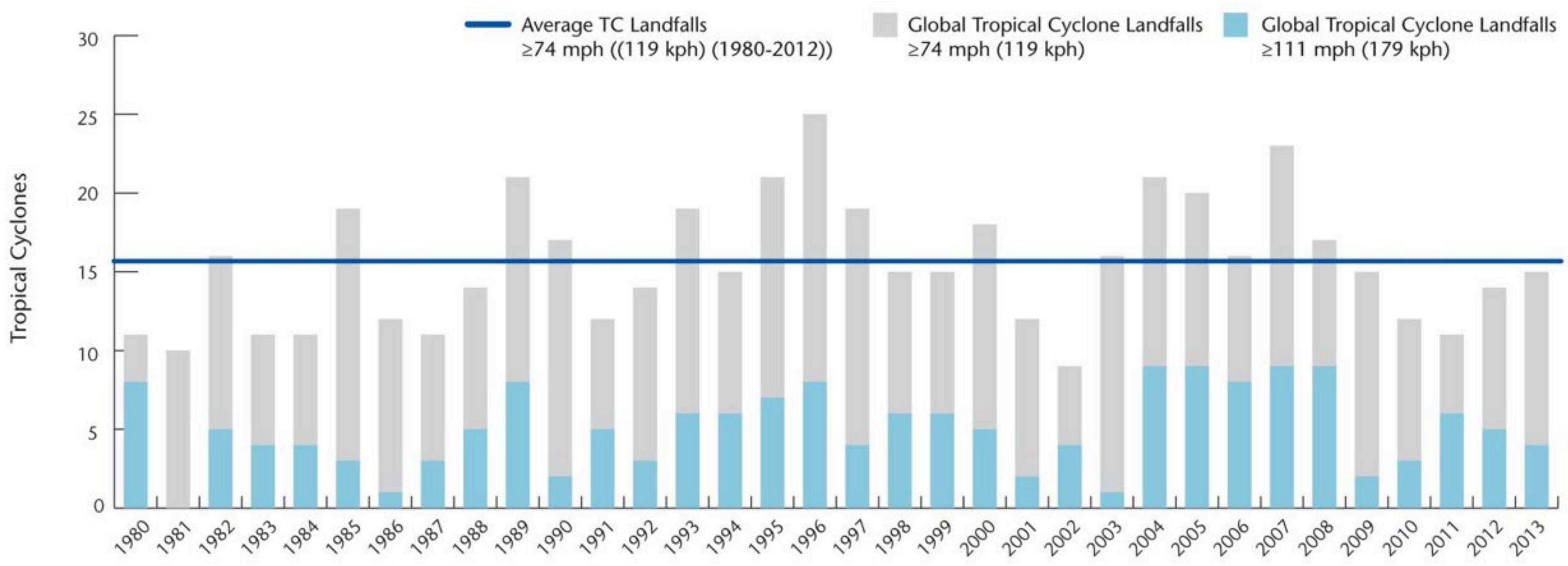
Source: Impact Forecasting Annual Global Climate & Catastrophe Report, 2013

Global Tropical Cyclone Landfalls (1980-2013)



Source: Impact Forecasting Annual Global Climate & Catastrophe Report, 2013

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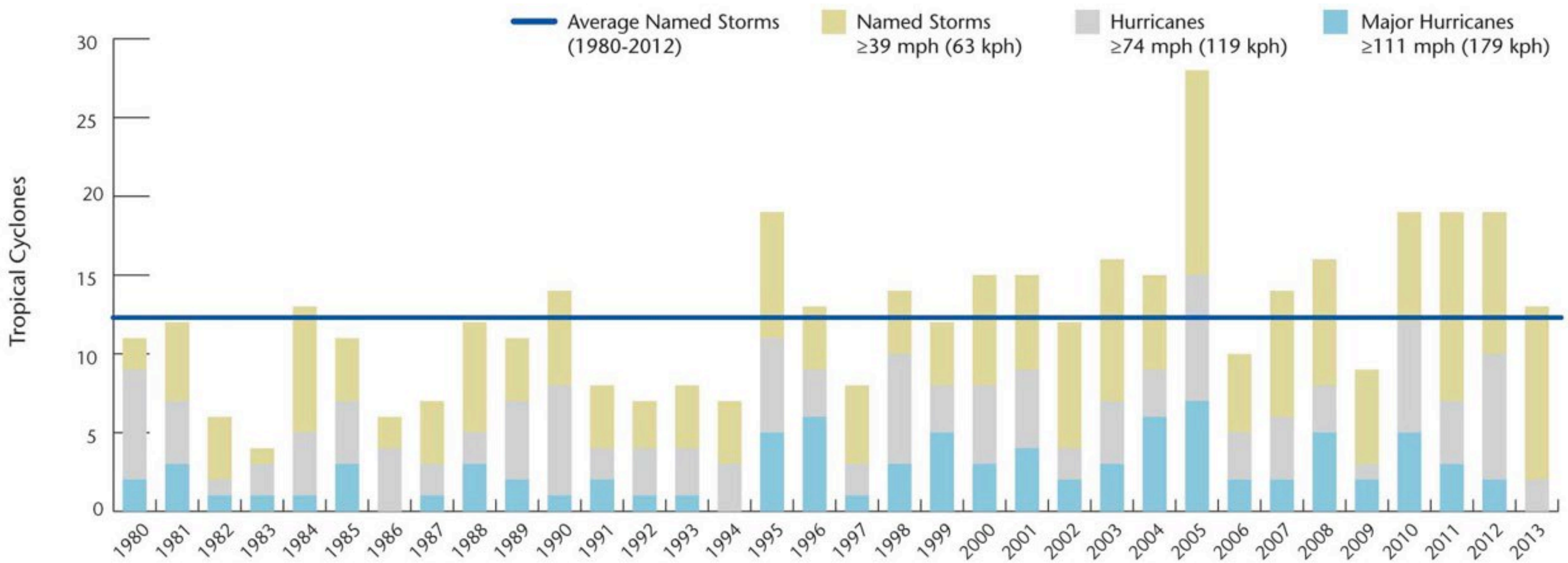
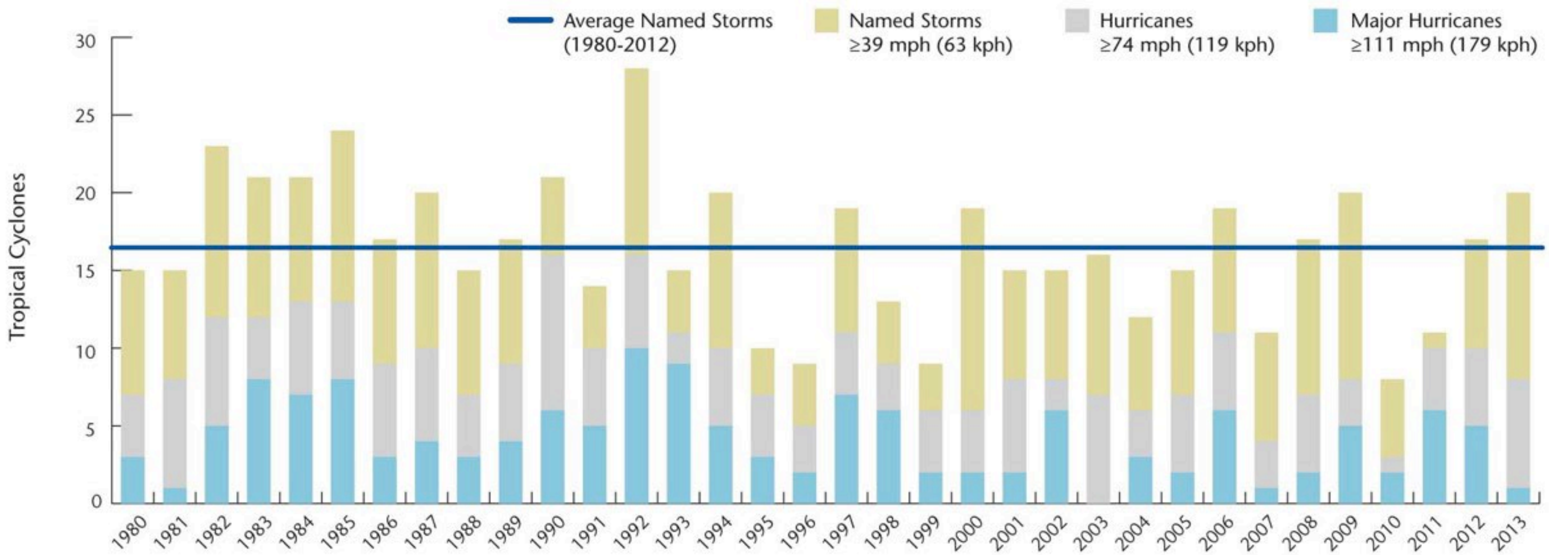
Atlantic Basin Tropical Cyclone Activity (1980-2013)



- Longer term hurricane frequency trend impacted by better data collection
- Data available from 1850 to present, but reliable data using satellite observations only from 1959
- Better monitoring of Eastern Atlantic Ocean now due to buoys and satellites
- Some upward trend apparent, driven by average ENSO conditions over the period
- Despite more basin activity frequency of landfalling hurricanes well below average since 2005

Source: Impact Forecasting Annual Global Climate & Catastrophe Report, 2013

Eastern Pacific Basin Tropical Cyclone Activity (1960-2013)



- Some downward trend apparent, also driven by average ENSO conditions over the period
- El Nino effect opposite in Pacific and Atlantic

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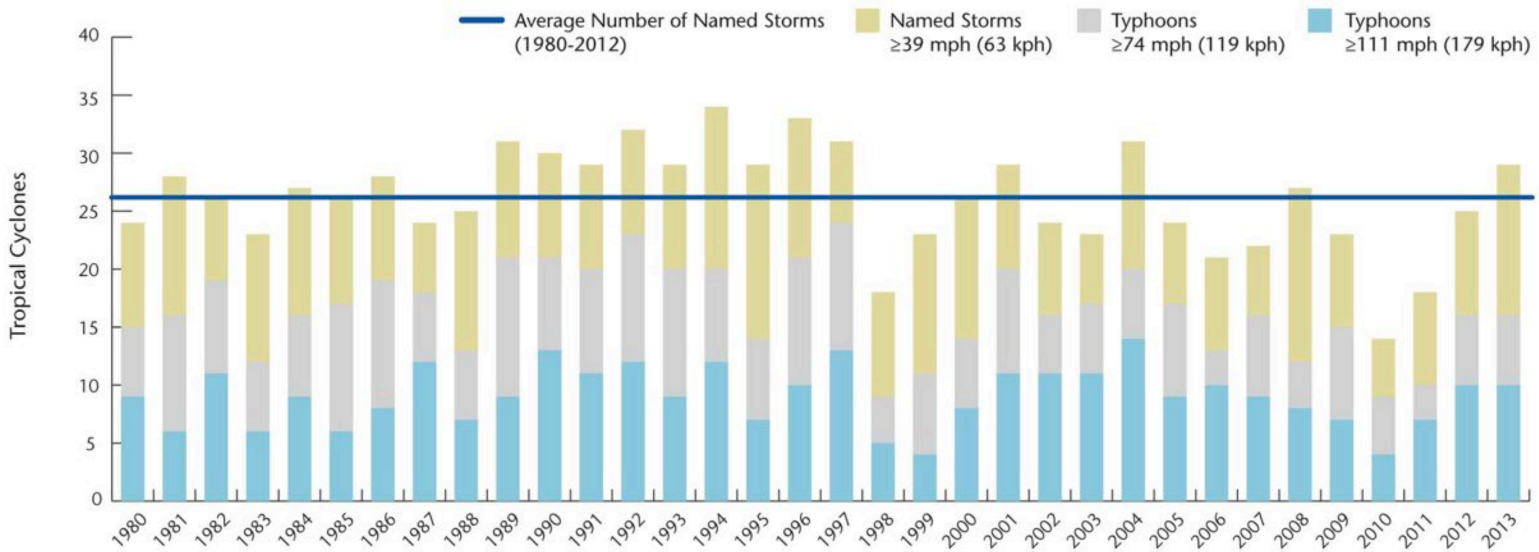
Source: Impact Forecasting Annual Global Climate & Catastrophe Report, 2013

Western Pacific Basin Tropical Cyclone Activity (1980-2013)



Source: Impact Forecasting Annual Global Climate & Catastrophe Report, 2013

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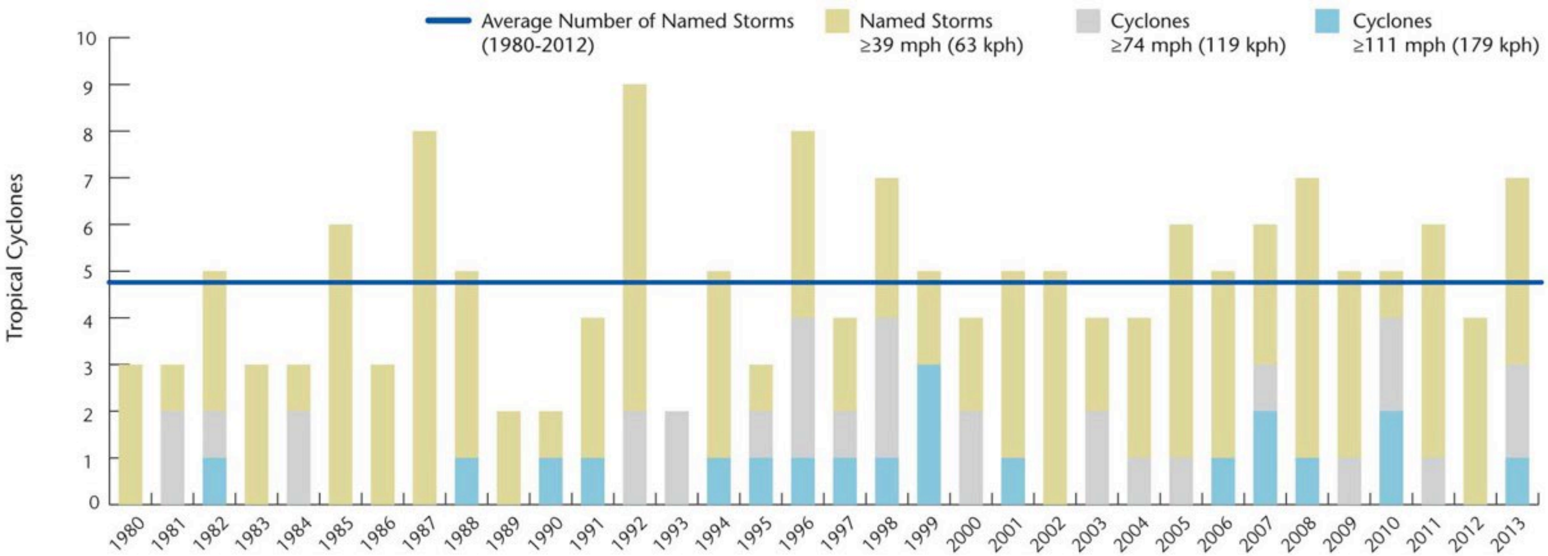
North Indian Basin Tropical Cyclone Activity (1980-2013)



Source: Impact Forecasting Annual Global Climate & Catastrophe Report, 2013

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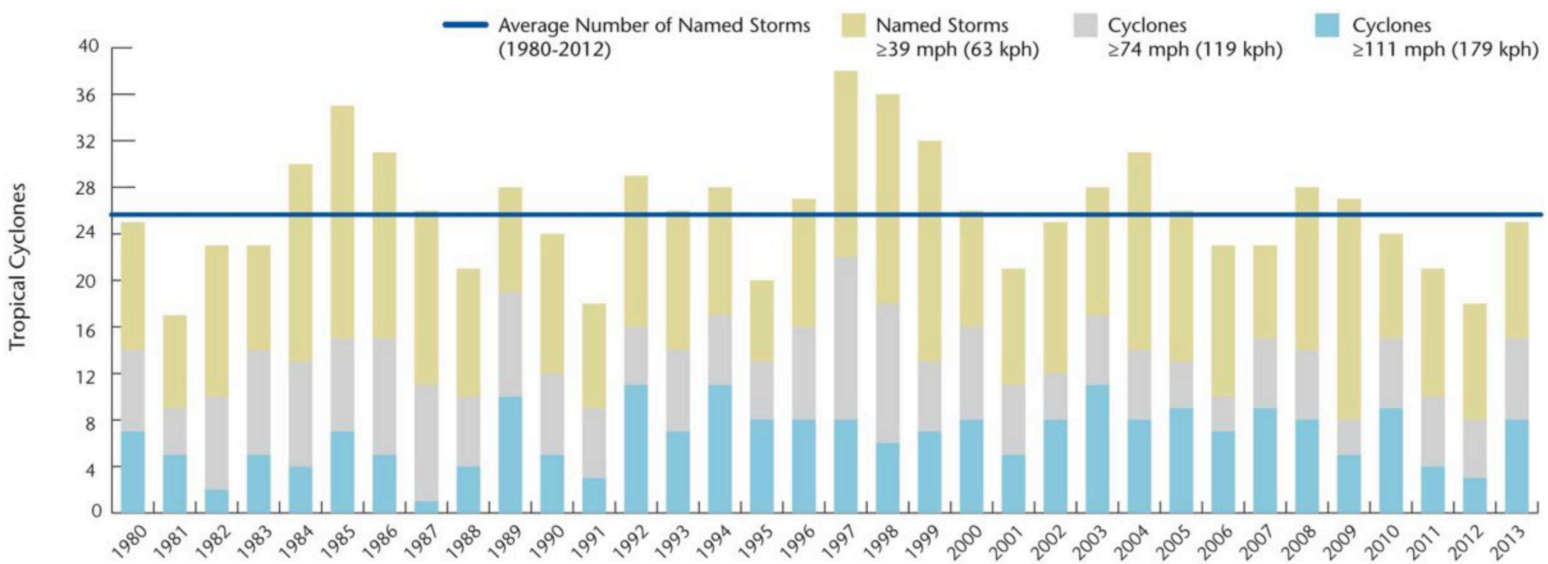
Southern Hemisphere Tropical Cyclone Activity (1980-2013)



Source: Impact Forecasting Annual Global Climate & Catastrophe Report, 2013

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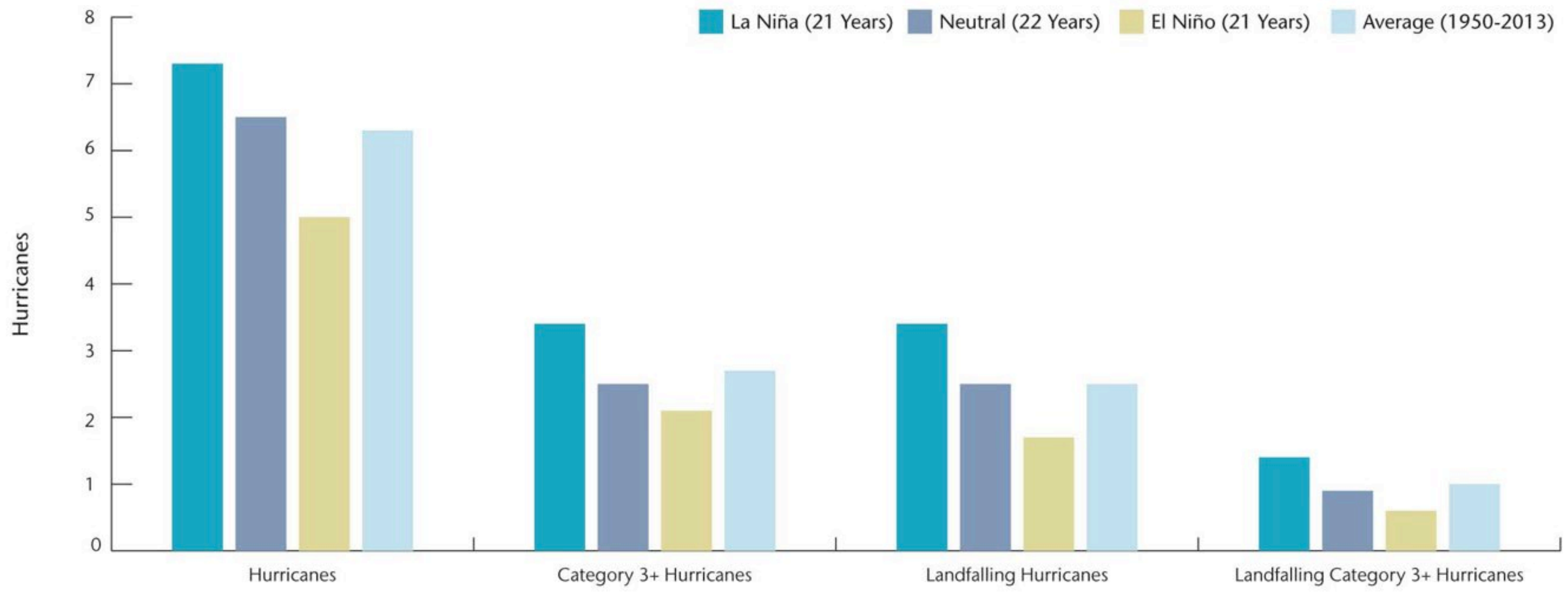
Oscillations Can Cause Multi-Year Changes

- ENSO (El Niño/Southern Oscillation): an anomalous warming or cooling of the waters off the west South America coast into the central Pacific Ocean
  - El Niño (warm phase)
    - Increase in frequency of cyclones in East, Central and West Pacific Basins
    - Wet for southern West Coast of US
  - La Niña (cool phase)
    - Increase frequency of cyclones/hurricanes in Atlantic, North Indian Basin

- Other important oscillations include the
  - PDO (Pacific Decadal Oscillation): a 15 to 30-year anomalous warming or cooling of the waters in the North Pacific Ocean
  - NAO (North Atlantic Oscillation): non-periodical fluctuations in atmospheric pressure between the Icelandic low pressure cell and the Azores high pressure cell

Atlantic Basin Hurricane Frequency by ENSO Phase (1950-2013)



Source: Impact Forecasting Annual Global Climate & Catastrophe Report, 2013

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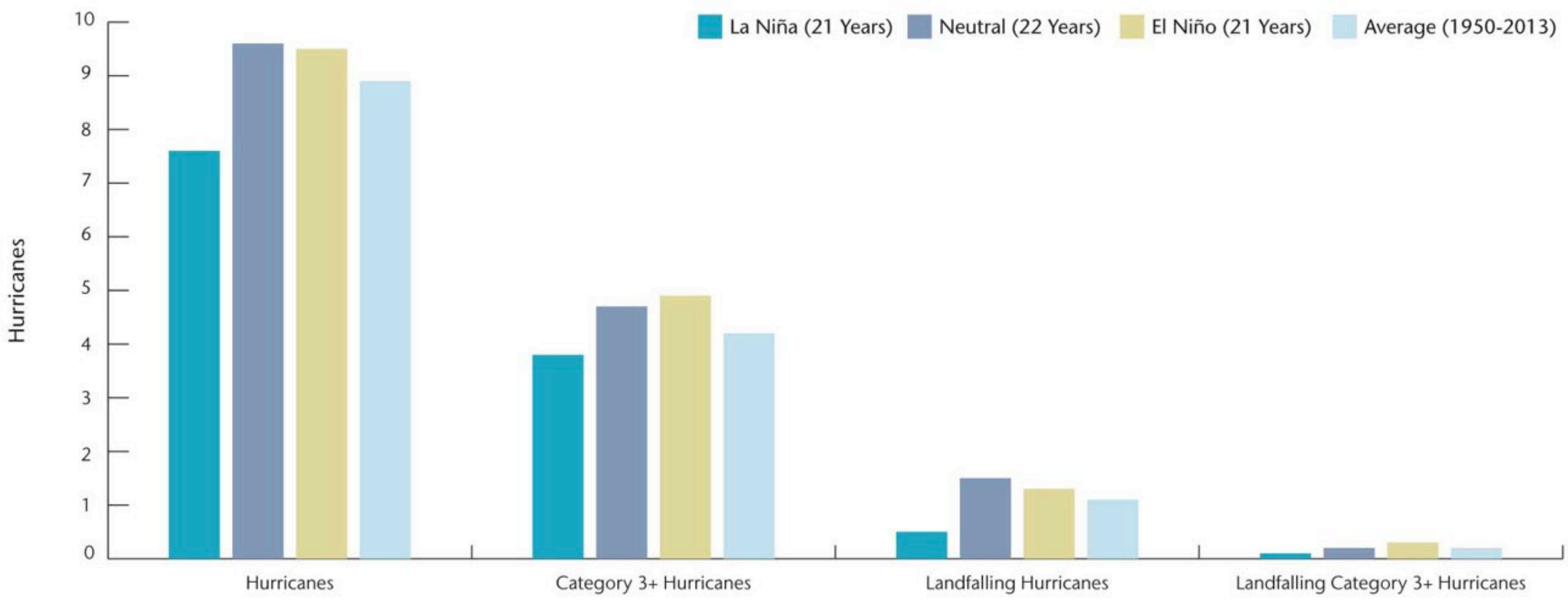
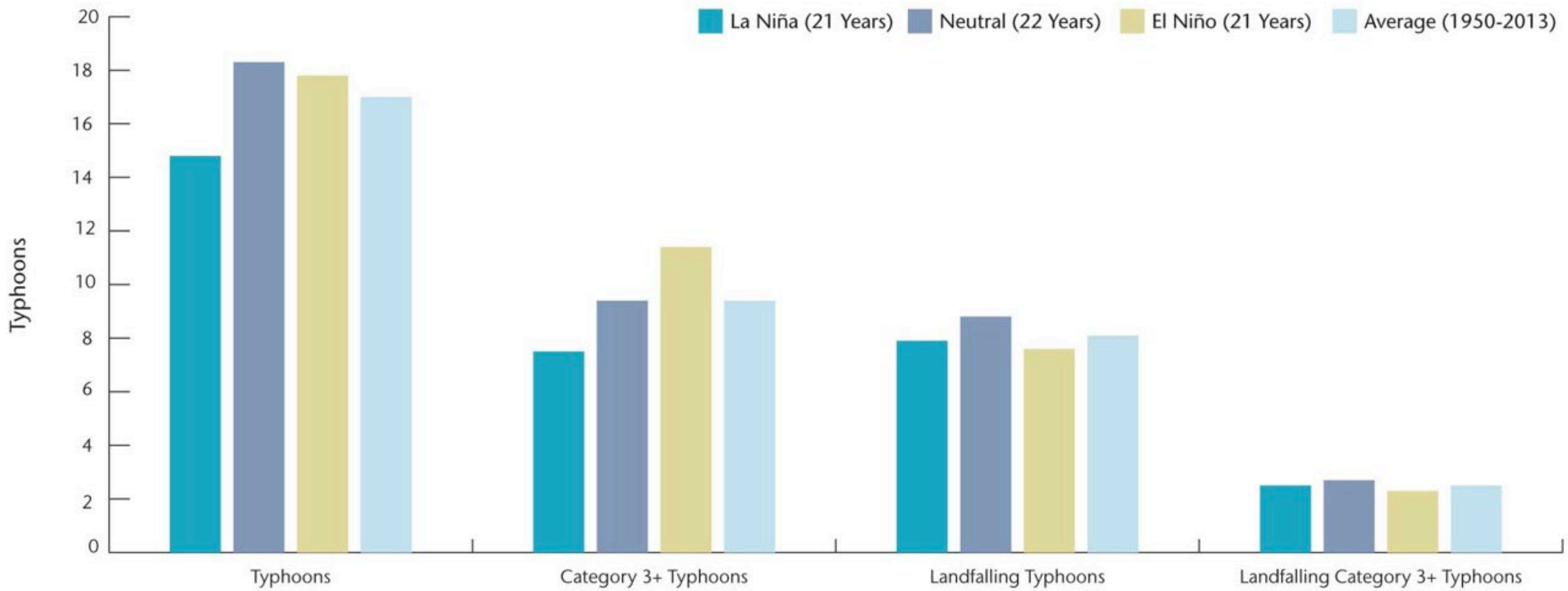
East & Central Pacific Basin Hurricane Frequency by ENSO Phase (1980-2013)



Source: Impact Forecasting Annual Global Climate & Catastrophe Report, 2013

Western Pacific Basin Typhoon Frequency by ENSO Phase (1950-2013)



Source: Impact Forecasting Annual Global Climate & Catastrophe Report, 2013

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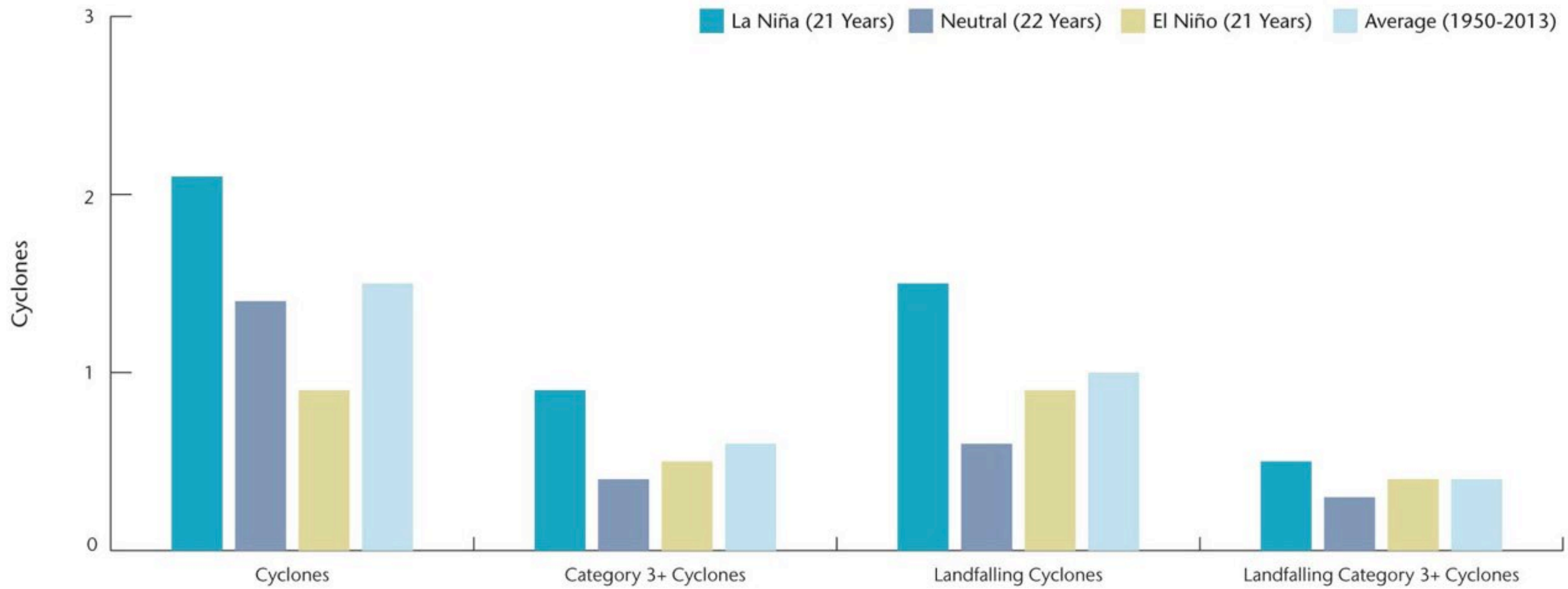
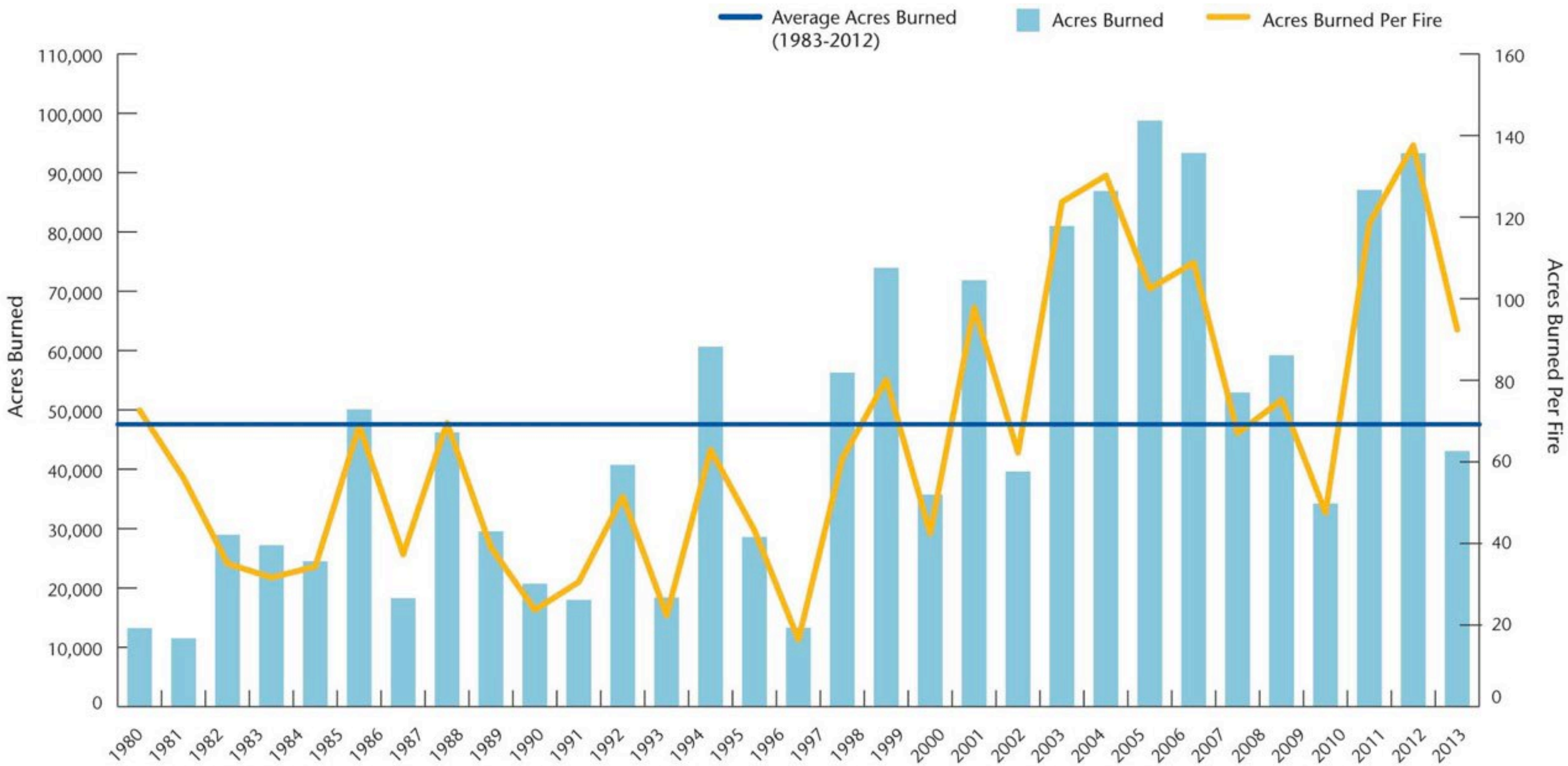
North Indian Basin Cyclone Frequency by ENSO Phase (1980-2013)



Source: Impact Forecasting Annual Global Climate & Catastrophe Report, 2013

Man-made Influences: United States Wildfire Activity (1983-2013)



- The U.S. Forest Service and the National Park Service enacted policy major changes in 1995
- The change led to fire agencies allowing non-threatening urban fires to burn themselves out, and increase controlled burns to mitigate risks, resulting in more acres burned on average post 1995
- The number of fires has remained flat over time

Source: Impact Forecasting Annual Global Climate & Catastrophe Report, 2013

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Economic and Insured Loss Trends

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Impact Forecasting Catastrophe Loss Database

- Impact Forecasting is the catastrophe model development center of excellence within Aon Benfield
- Analyzes the financial implications of natural and man-made catastrophes around the world and publishes monthly and annual recaps of global activity
- Impact Forecasting defines a catastrophe event as one causing at least one of
  - Economic loss of $50M or more (current dollars)
  - Insured loss of $25M or more
  - 10 fatalities or more
  - 50 injured or more
  - 2000 or more structures damaged
- Catastrophe loss database since 1980 captures 8460 individual tropical cyclone, drought, flooding, windstorm, severe weather, earthquake, wildfire, winter weather and other events
  - 42% flooding
  - 24% severe weather
  - 10% tropical cyclone
- http://catastropheinsight.aonbenfield.com/Pages/Home.aspx

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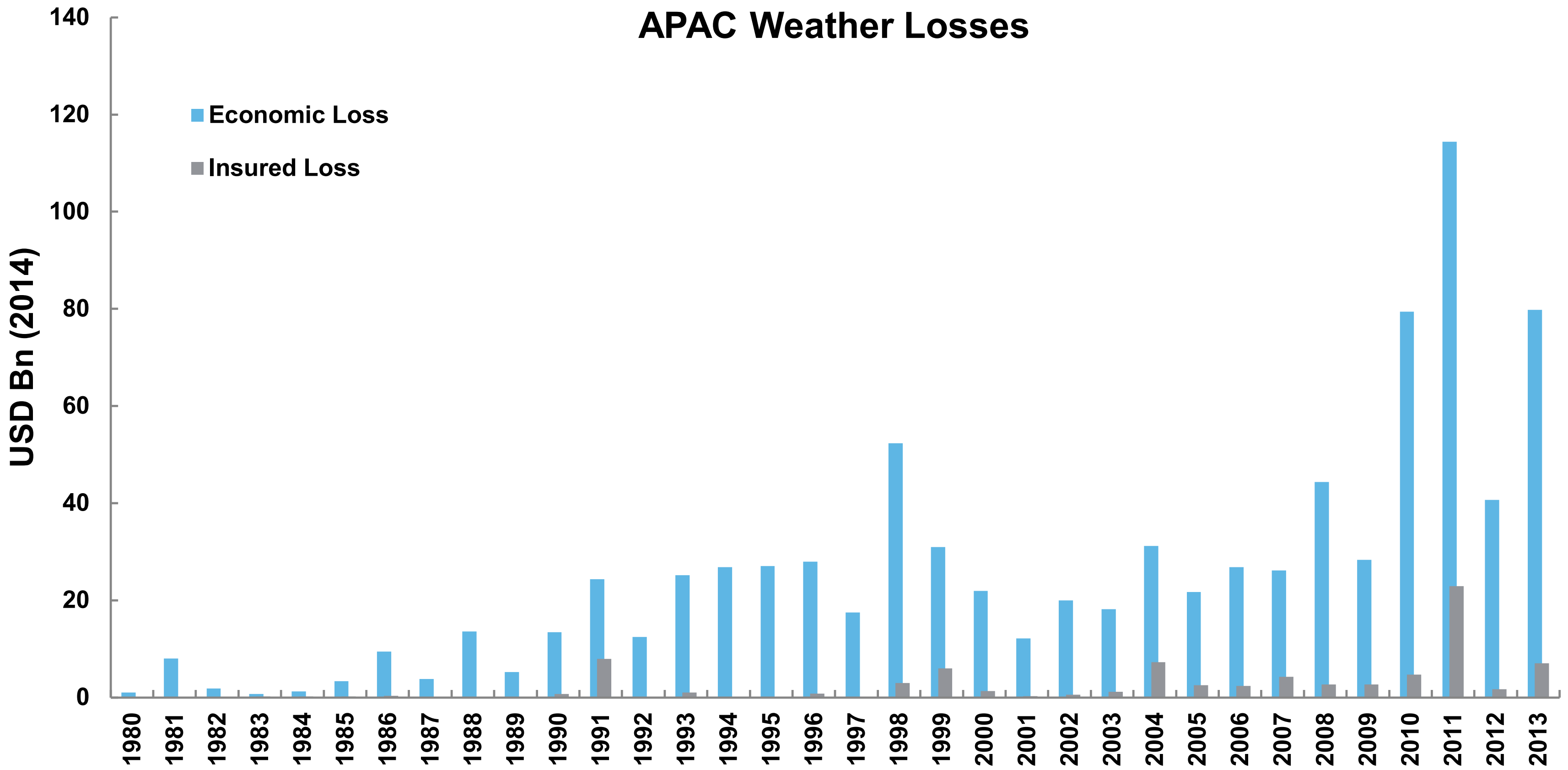
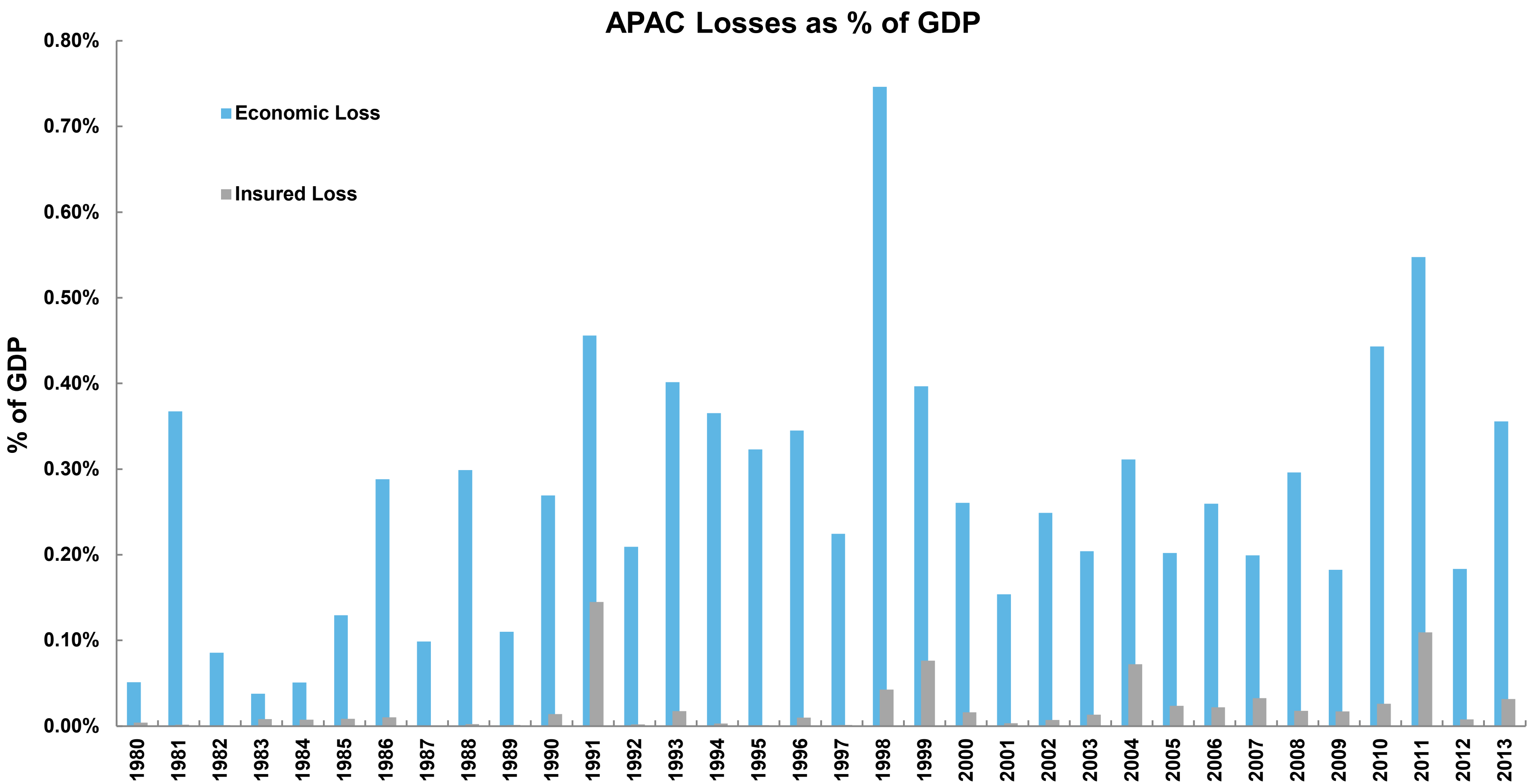
APAC Economic and Insured Losses (1980-2013)



Source: Aon Benfield

- Losses show a clear upwards trend, in part caused by significantly improved data collection and reporting since 1990
- Losses adjusted for inflation to 2014 dollars
- Losses are not adjusted for other economic dynamics: increased GDP, urbanization, insurance penetration, building values etc.

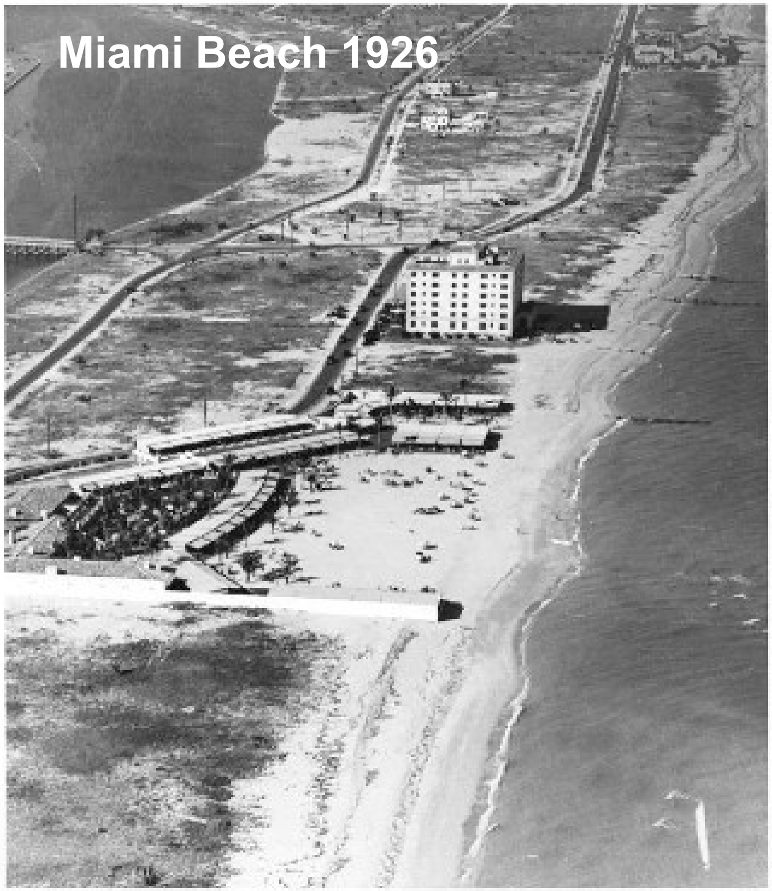
APAC Economic and Insured Losses as Percentage of GDP (1980-2013)



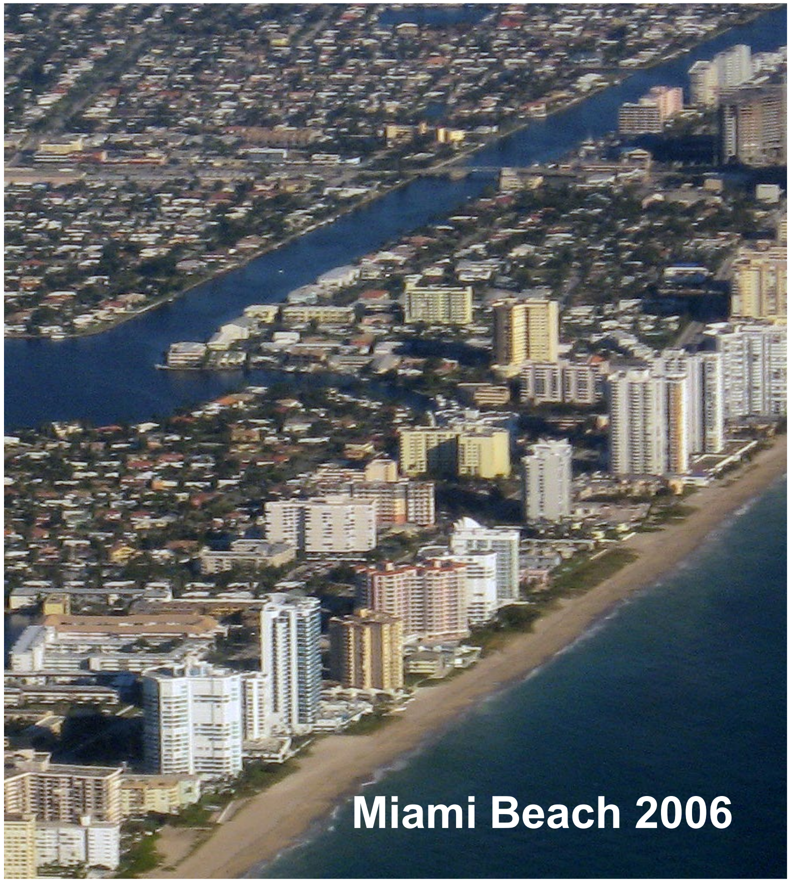
Source: Aon Benfield & World Bank GDP (Current US$)

- Losses as a percentage of GDP provide a clearer picture
- 3.4% annual upward trend in economic loss to GDP (and -1.0% since 1990), driven by
  - Improved reporting
  - Increasing urbanization and concentrations in catastrophe exposed areas
  - Increasing insurance penetration

Coastal Migration and Build-up: Miami Beach, 1926-2006



Source: Wendler Collection



Source: Joel Gratz © 2006

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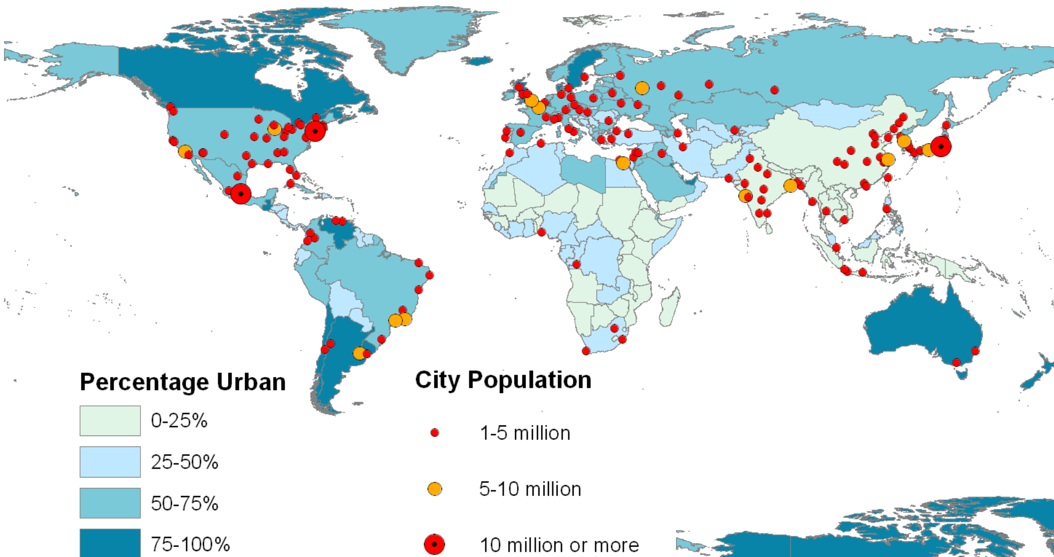
Urbanization: Shanghai Pudong 1990 and Today

Binhai Sea, China: Swampy Region to Manufacturing Center in 20 Years

Development in China: These Landsat images show Binhai, China in 1992 (L) and 2012 (R). The city is located on the coast of the Bohai Sea. The 2012 photograph shows large scale urbanisation compared to the 1992 image. Binhai was transformed in 1990 from a swampy region into a major economic zone. It is currently home to numerous aerospace, oil and chemical, and other manufacturing industries.

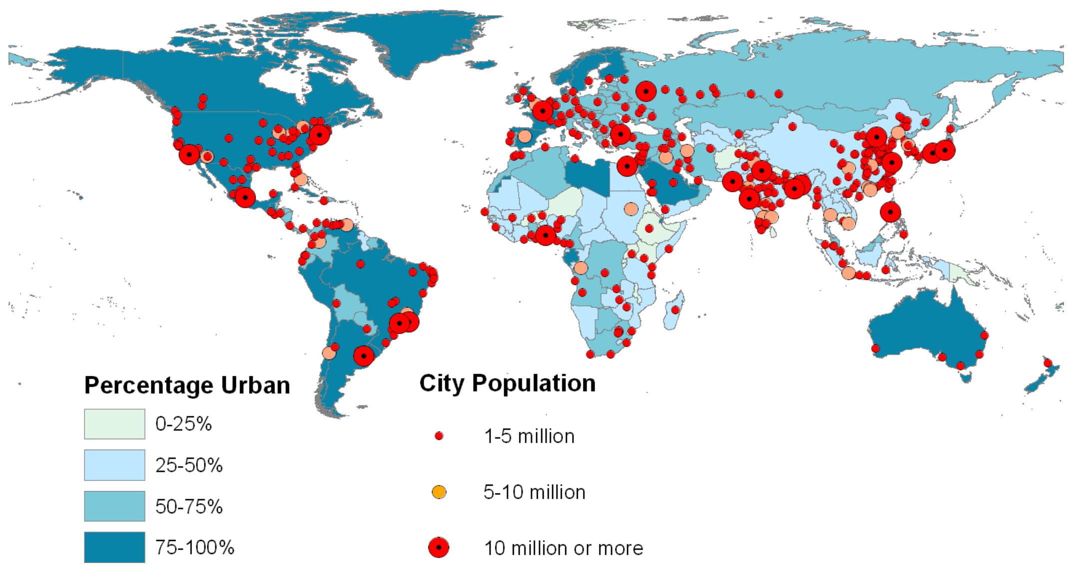
Source: http://www.dailymail.co.uk/sciencetech/article-2177202/The-changing-face-Earth-Dramatic-high-resolution-satellite-images-world-changed-decades.html

Global Urbanization Trends



- 1975, left
  - World population 4.07 billion
  - 37% of world population urban
  - Urban population: 1.5 billion
- 2009, below
  - World population 6.84 billion
  - 50% of world population urban
  - Urban population: 3.4 billion

Urban population increased by **128%** between 1975 and 2009



Source: UN Department of Economic and Social Affairs, http://esa.un.org/unpd/wup/Maps/maps_1_2009_large.htm
Population: http://www.geohive.com/earth/his_history3.aspx

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Changing Societal Conditions Driving Increased Exposure to Flood

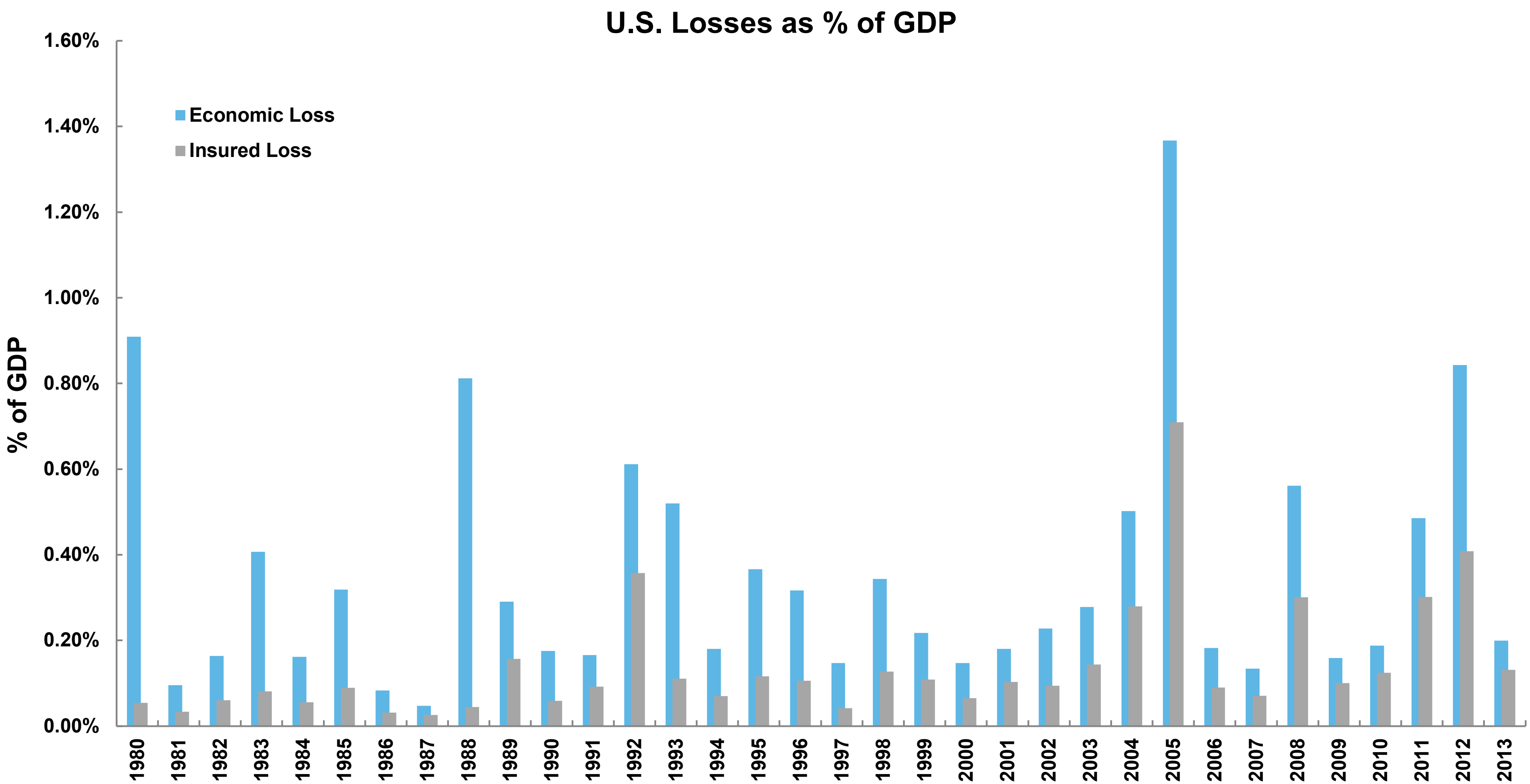
Table 2.2 Flood exposure by World Bank region as modelled[9] (million people per year)

Region	1970	1980	1990	2000	2010
East Asia and the Pacific (EAP)	9.4	11.4	13.9	16.2	18.0
Europe and Central Asia (ECA)	1.0	1.1	1.2	1.2	1.2
Latin America and the Caribbean (LAC)	0.6	0.8	1.0	1.2	1.3
Middle East and North Africa (MENA)	0.2	0.3	0.4	0.5	0.5
OECD countries (OECD)	1.4	1.5	1.6	1.8	1.9
South Asia (SAS)	19.3	24.8	31.4	38.2	44.7
Sub-Saharan Africa (SSA)	0.5	0.7	1.0	1.4	1.8
World	**32.4**	**40.6**	**50.5**	**60.5**	**69.4**

- 130%+ increase in flood exposed population in SE Asia and by nearly 100% in East Asia, accounting for majority of global increase

Source: Global Assessment Report on Disaster Risk Reduction, 2011, http://www.preventionweb.net/english/hyogo/gar/2011/en/what/chapter2_2.html

United States Economic & Insured Losses as Percentage of GDP (1980-2013)



Source: Aon Benfield & World Bank GDP (Current US$)

- Net trend of economic loss to GDP in US is 1.3% p.a., owing to
  - Population shifts to coastal and southern states
  - Increase in insured values, average size of home increased from 1600 sq feet to 2500+ since 1975, 1.1% per year

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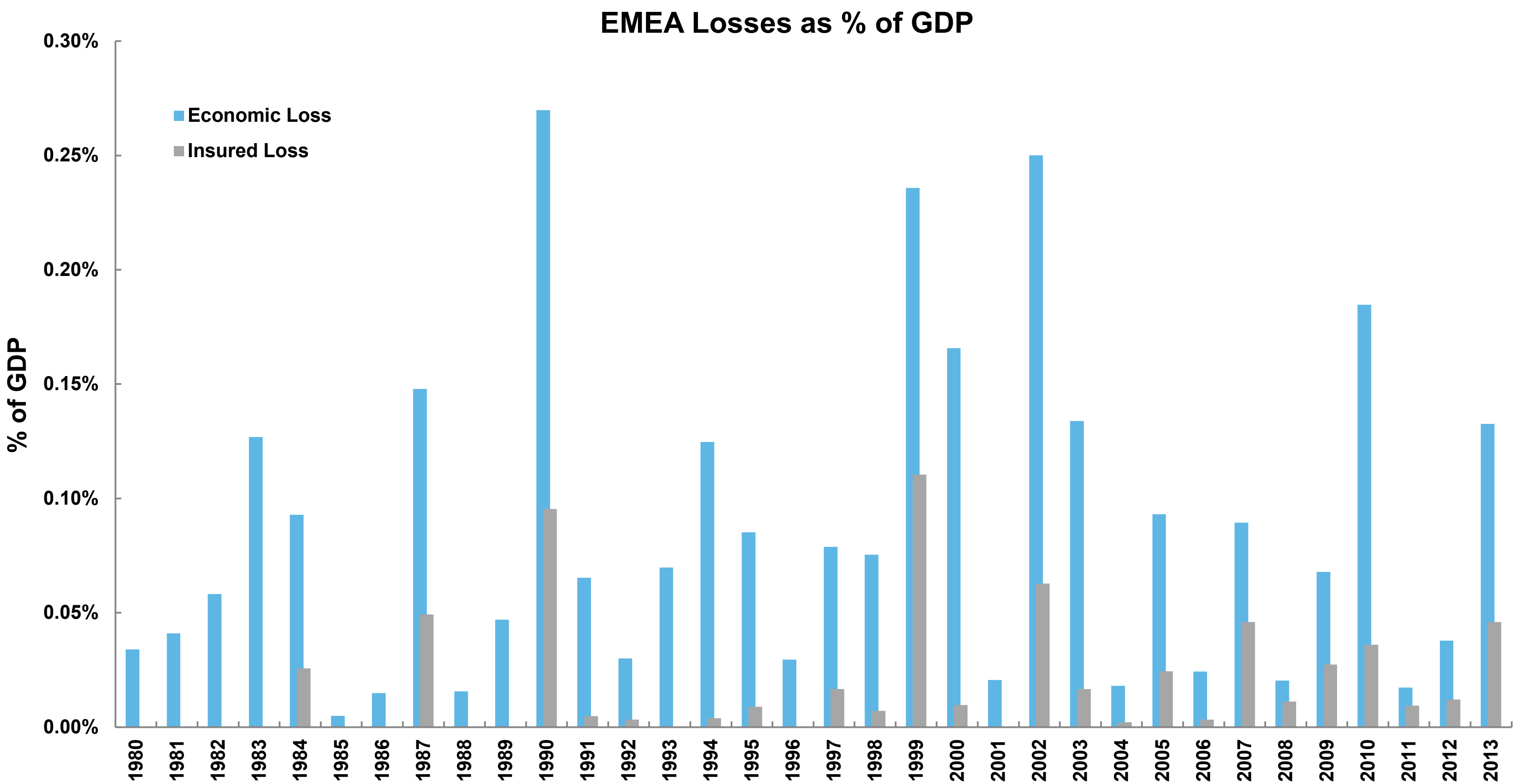
EMEA Economic and Insured Losses as Percentage of GDP (1980-2013)



Source: Aon Benfield & World Bank GDP (Current US$)

- Net trend of economic loss to GDP in EMEA is 1.1% p.a.
- Same drivers as in U.S.

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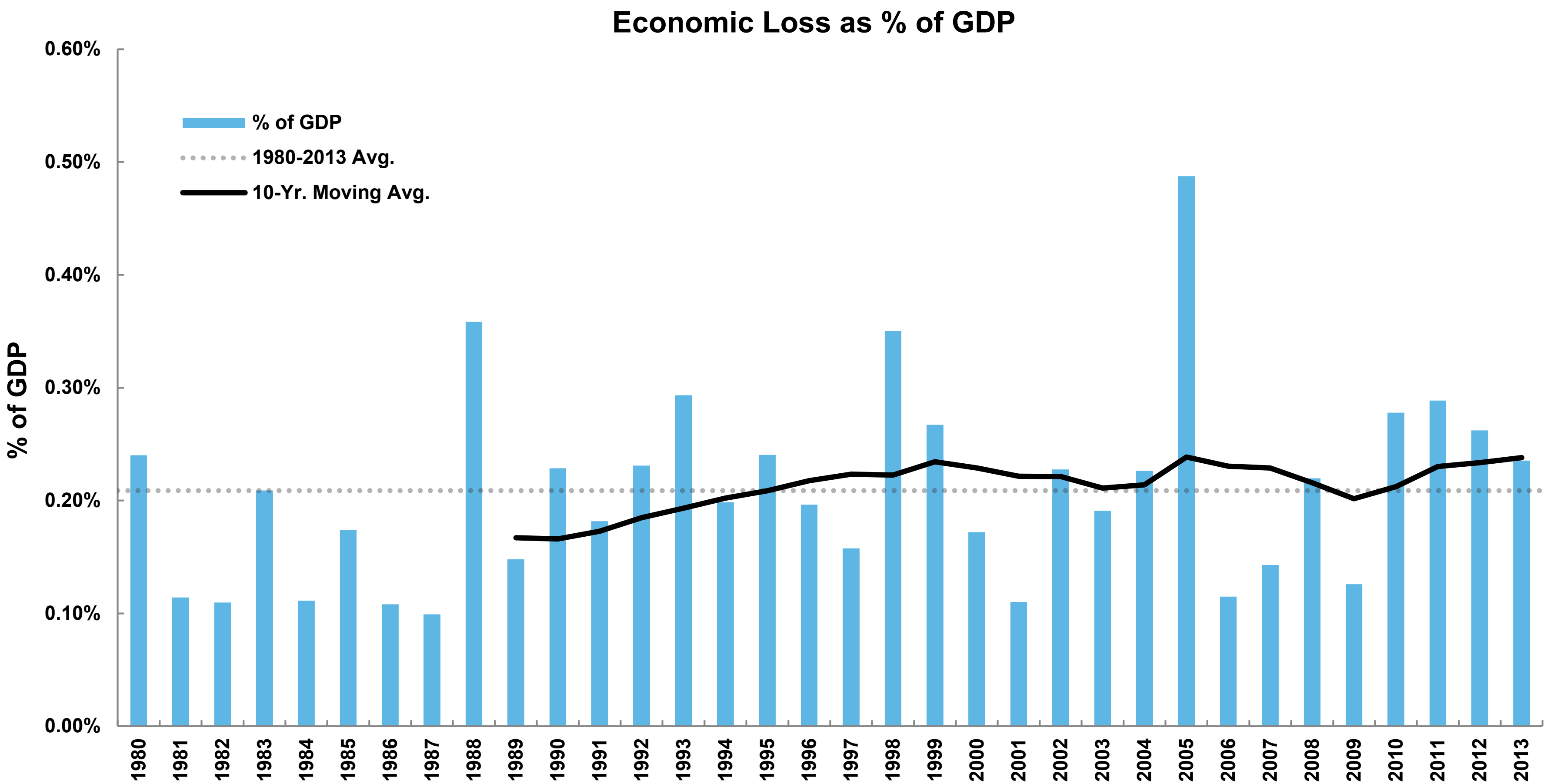
Global Economic Loss to GDP



Source: Aon Benfield & World Bank GDP (Current US$)

- Globally, economic losses as a percent of GDP show a 1.3% p.a. upward trend since 1980, but a very slight negative trend since 1990, reflecting a number of factors including growing population concentrations, particularly in catastrophe exposed areas

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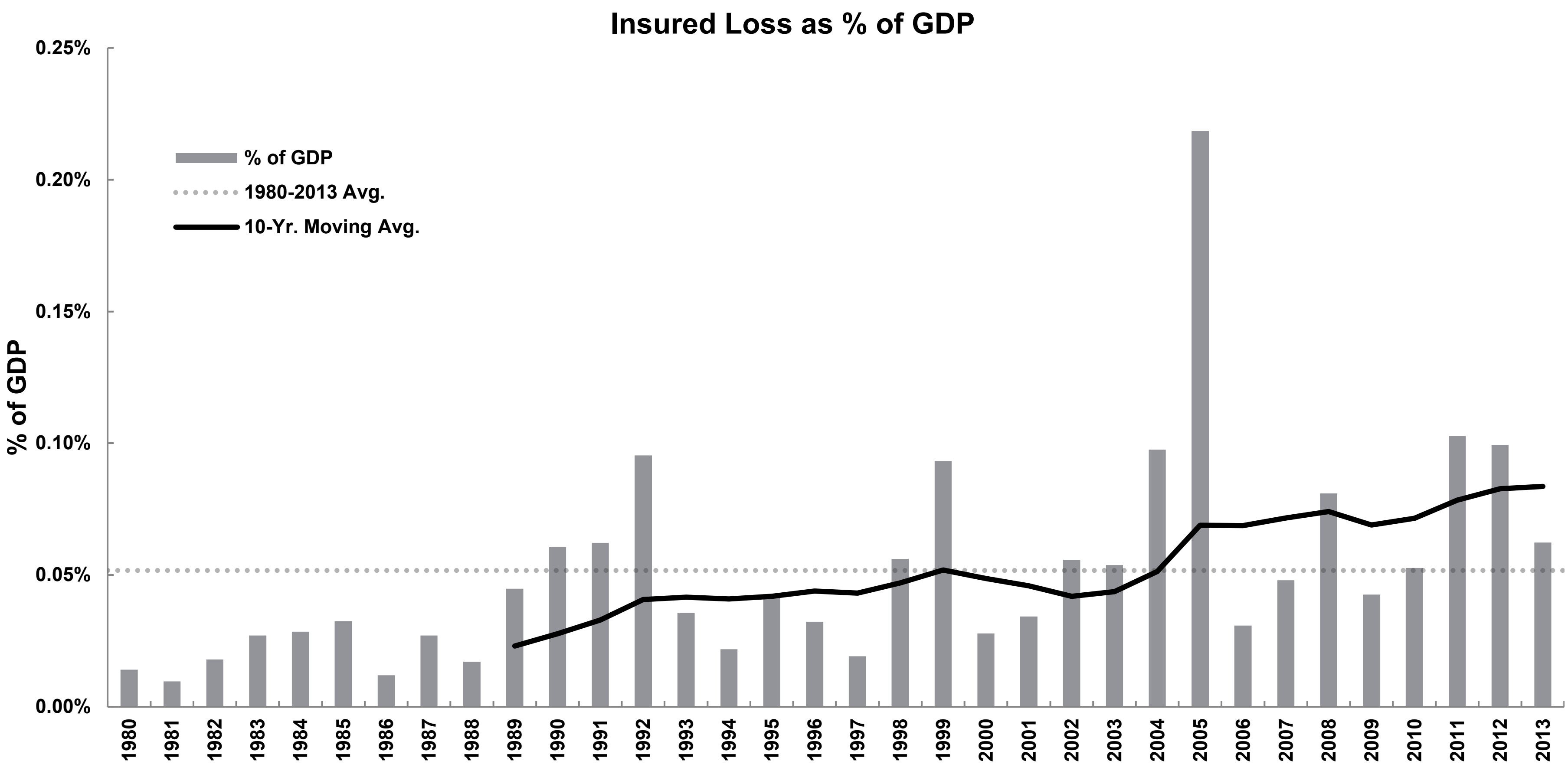
Global Insured Loss to GDP



Source: Aon Benfield & World Bank GDP (Current US$)

- Globally, economic losses as a percent of GDP show a 4.6% p.a. upward trend since 1980, and a 2.5% trend since 1990, reflecting increased insurance penetration, mix of losses by peril and geography (2004, 2005, 2012 large hurricane losses in high-insurance penetration U.S.), and increasing concentrations & urbanization in cat exposed areas

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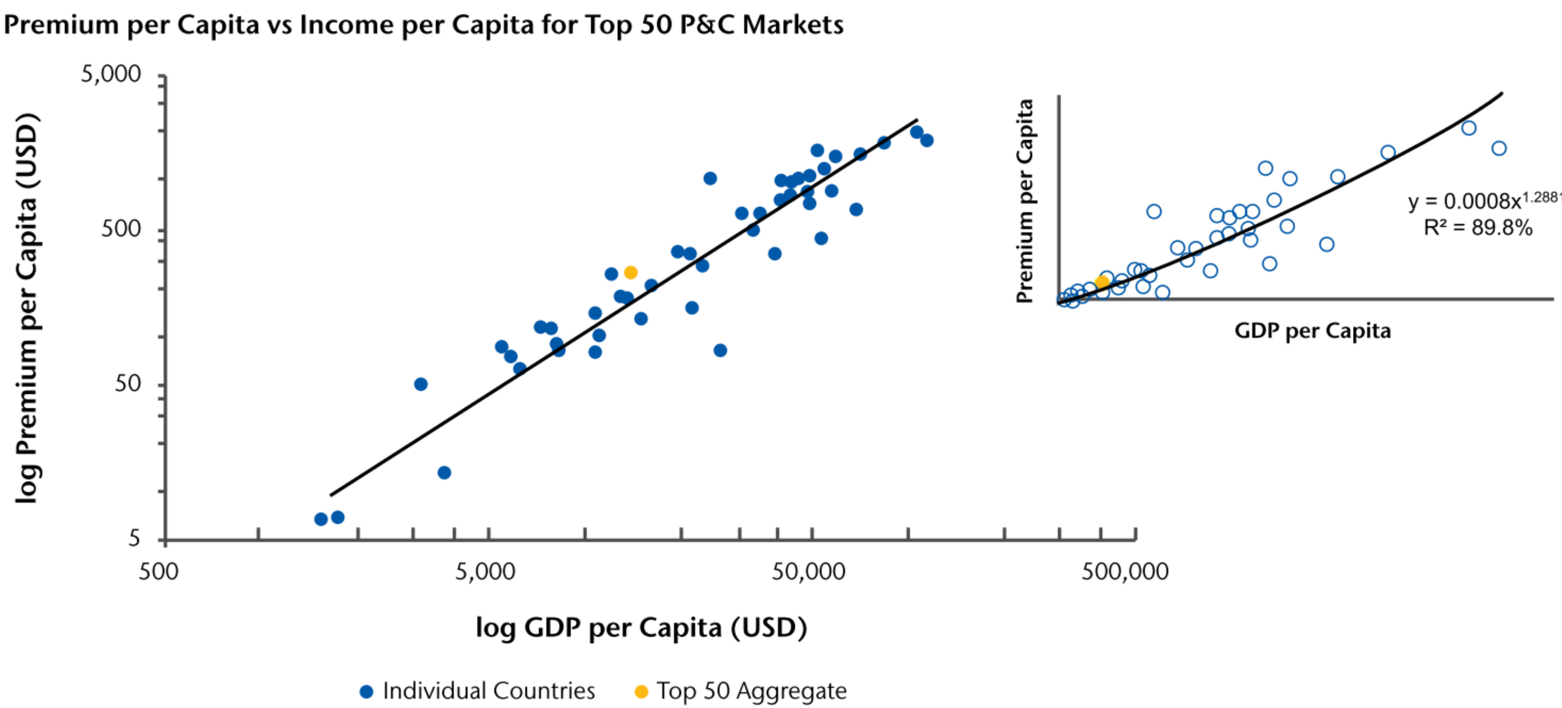
Insurance Penetration Increases with Wealth



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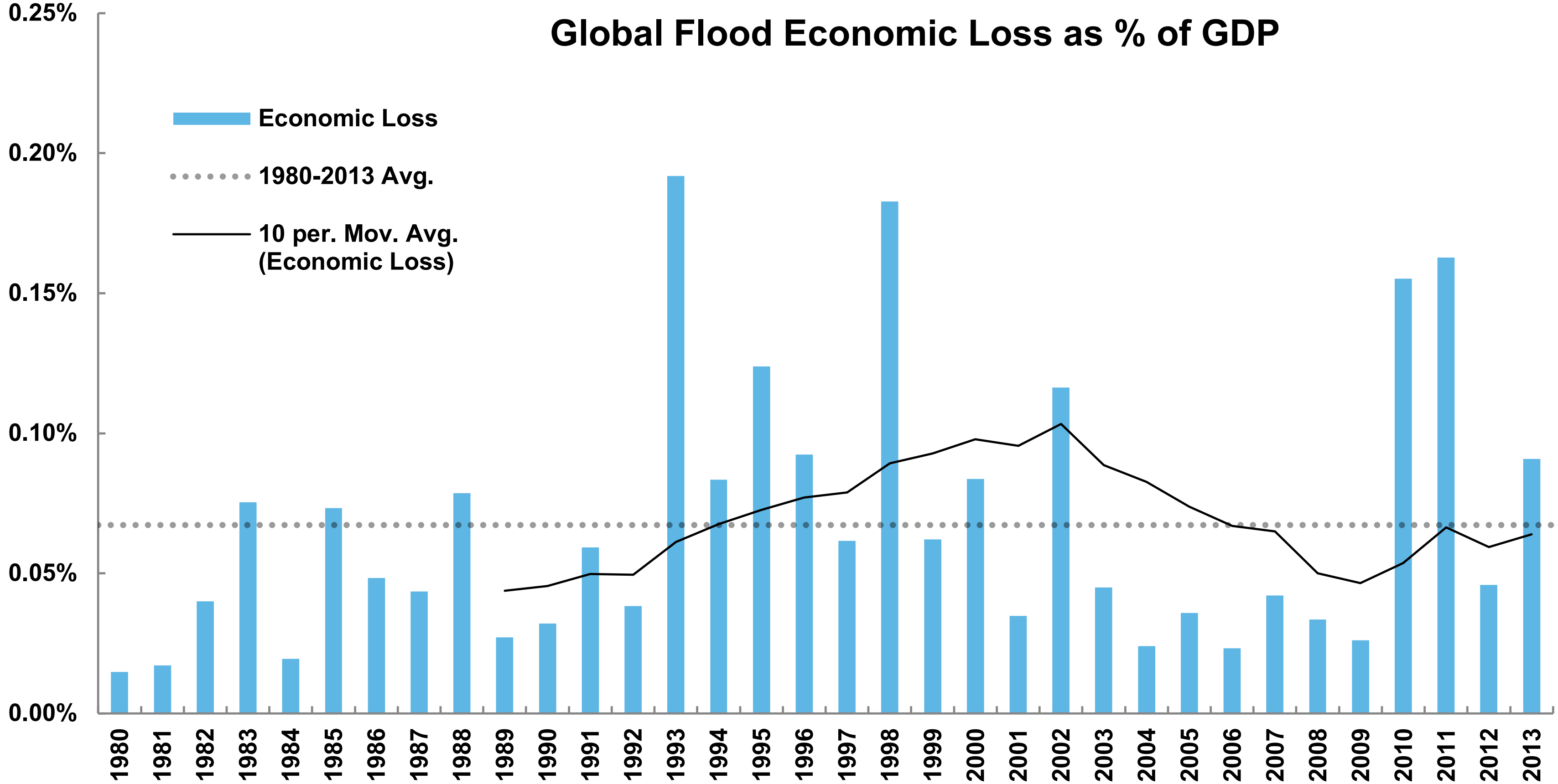
Source: Aon Benfield Insurance Risk Study, Eighth Edition, 2012

Flood: Global Losses to GDP



Source: Aon Benfield

- Data shows 1.8% annual trend in loss to GDP

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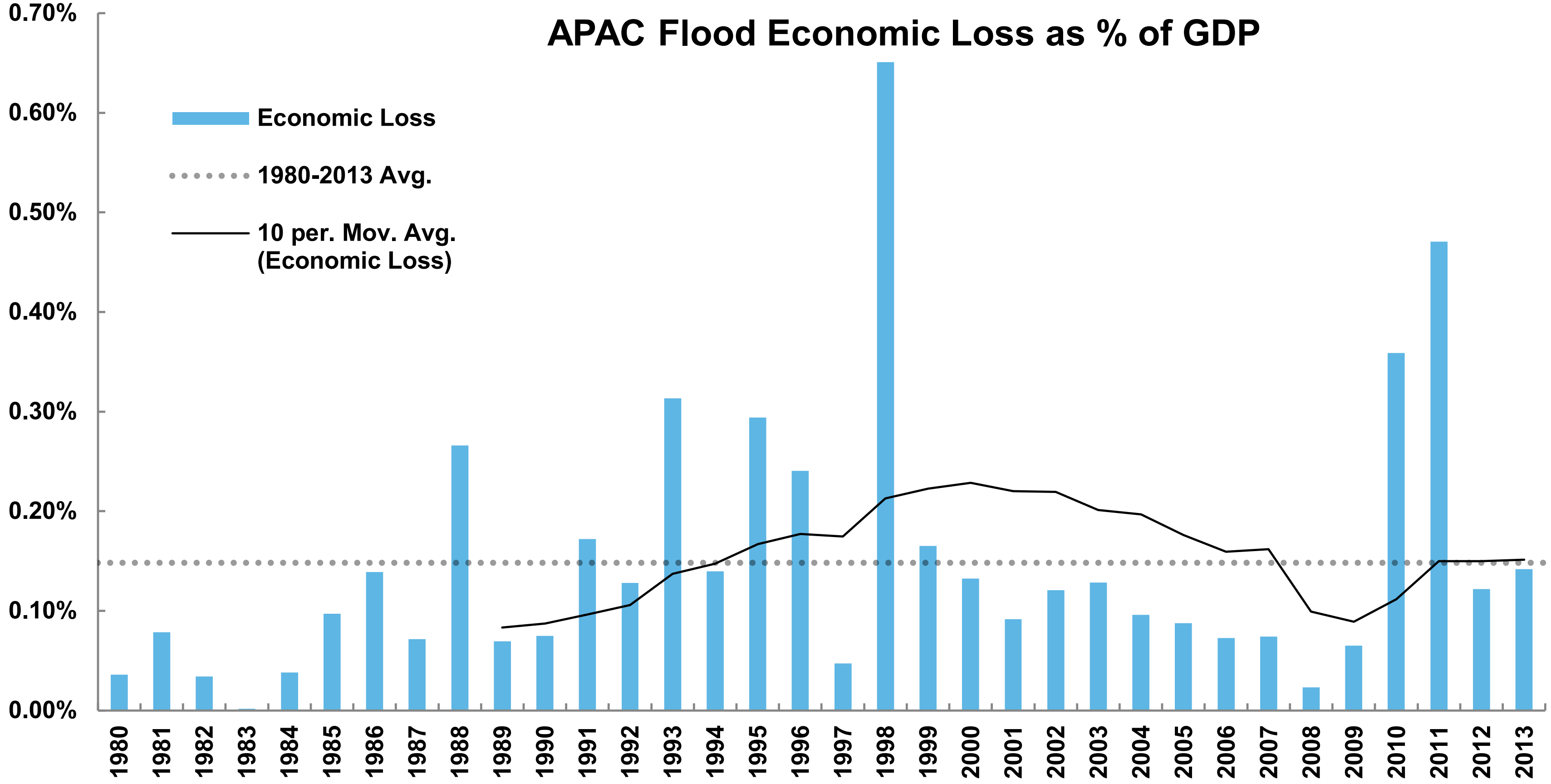
Flood: APAC Losses to GDP



Source: Aon Benfield

- Loss shows greater trend of 3.5% p.a., in part reflecting changed land use
- Event in 1998 driven by $30B economic loss from July-September China flooding of Yangtze River, considered worst flood in Northern China in 40 years. 4000 people were killed and more than 13 million houses were damaged or destroyed
- Thailand loss higher dollars amount but lower impact owing to growth in GDP

Conclusions

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Pricing and Product Design

- Insurance pricing for cat risk combines two main components
  - Estimated loss cost
  - Risk, or profit load, driven by supply and demand for capacity

- Estimated loss cost uses experience or model (exposure) method
  - Experience methods based on 3+ (!) year histories, can over-fit loss cost to recent years
  - Model pricing more stable, provided loss event fits within the model; model change impacts
  - Almost all products combine elements of each approach

- Supply and demand for capacity
  - Market very reactive to supply and demand dynamics
  - Today's high capacity putting pressure on rates in peak zones
  - Non-peak zones still benefitting from a diversification effect
  - No indication of capacity shortage

- Product design: insurance contracts re-priced on an annual basis, providing flexibility to respond quickly to changes in perceived loss potential
  - Regulators and rating agencies drive relatively inelastic demand

Summary

- No increase in frequency of most severe cyclone, typhoon, hurricane events on a global basis
- Flat to 1.3% trend in economic loss to GDP and 2.5% to 4.6% trend insured loss to GDP
  - Net positive trend driven by demographics, urbanization, change in land use, growing population concentrations in catastrophe prone areas, and increasing insurance penetration
- Strong insurance and reinsurance capacity supply increases, with Aon Benfield's estimate of capital available for reinsurance increasing 8.2% p.a. from $400 billion in 2009 to $570 billion in 2014Q2 and 2.9% increase in reinsurance capital to global GDP
- Any climate change effects will occur gradually over many decades
  - (Mostly) annual property policies give insurance industry time to react and adjust
  - Weather variability far greater than any long-term climate change effect
  - Surprise losses from inadequately understood exposures continue to challenge pricing models
  - Data problems largely under control of insurers and reinsurers
- Insurance and reinsurance pricing able to react quickly to changes in understood exposure, with experience rated providing natural stabilizer
  - Regulation and affordability issues do represent some risk to the primary industry's ability to adjust to trends in certain geographies
- **Climate uncertainty drives higher property insurance demand and is a manageable, positive long-term growth opportunity for insurers and reinsurers**

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