A GLOBAL FRAMEWORK FOR ACHIEVING THE 2-DEGREE C LIMIT ON TEMPERATURE RISE

THE DEEP DECARBONIZATION PATHWAY PROJECT

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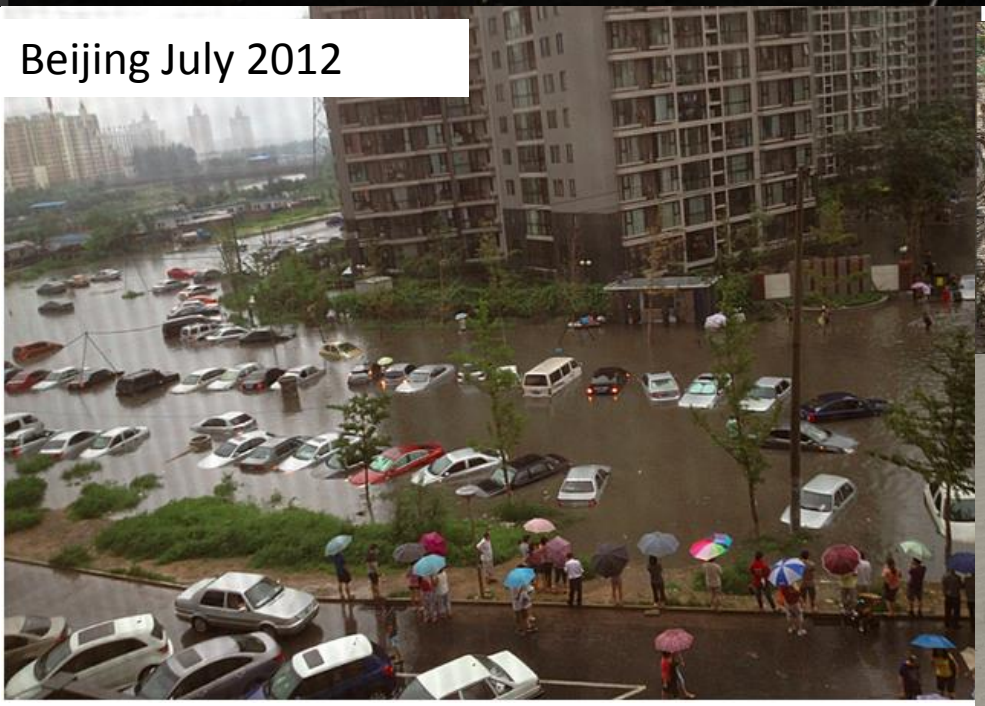
MAY 22, 2014

Manhattan Oct 2012

Bangkok October 2011

Beijing July 2012

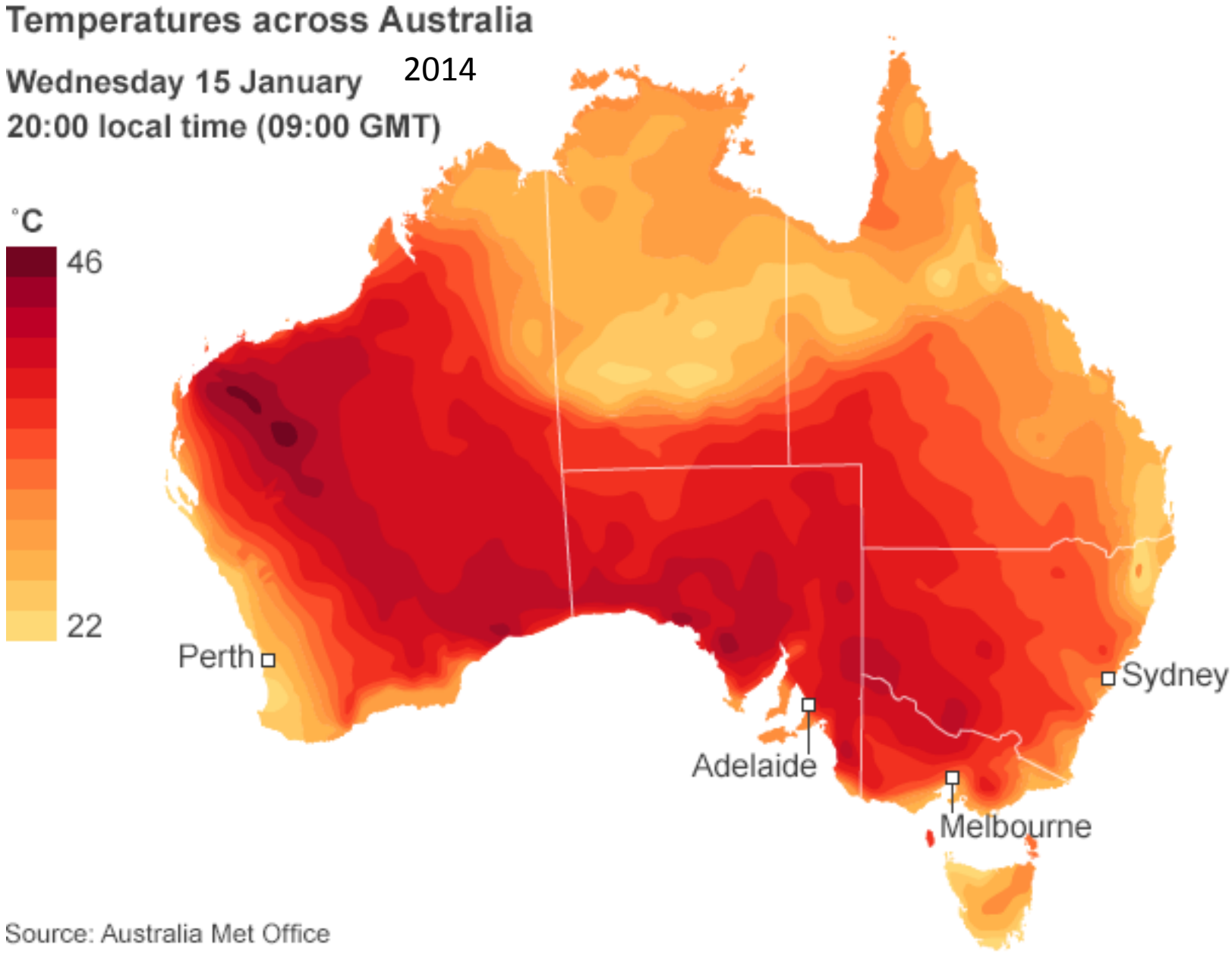


Indiana Maize, August 2012

Chad 2012

PERTH 2011

QUEENSLAND FLOODS, JANUARY 2013


Temperatures across Australia
Wednesday 15 January
20:00 local time (09:00 GMT)
2014
°C
46
22
Perth
Adelaide
Melbourne
Sydney
Source: Australia Met Office

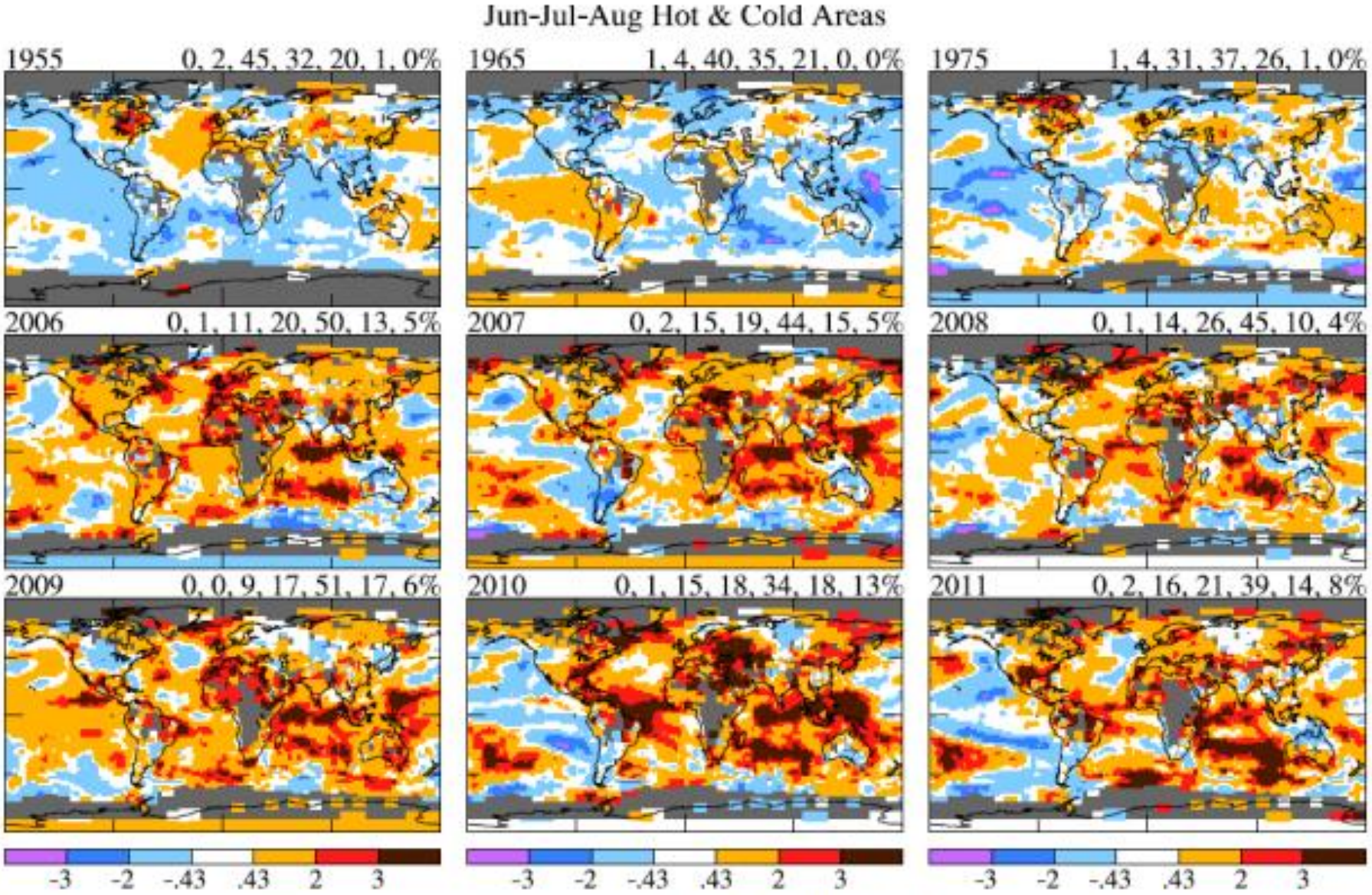
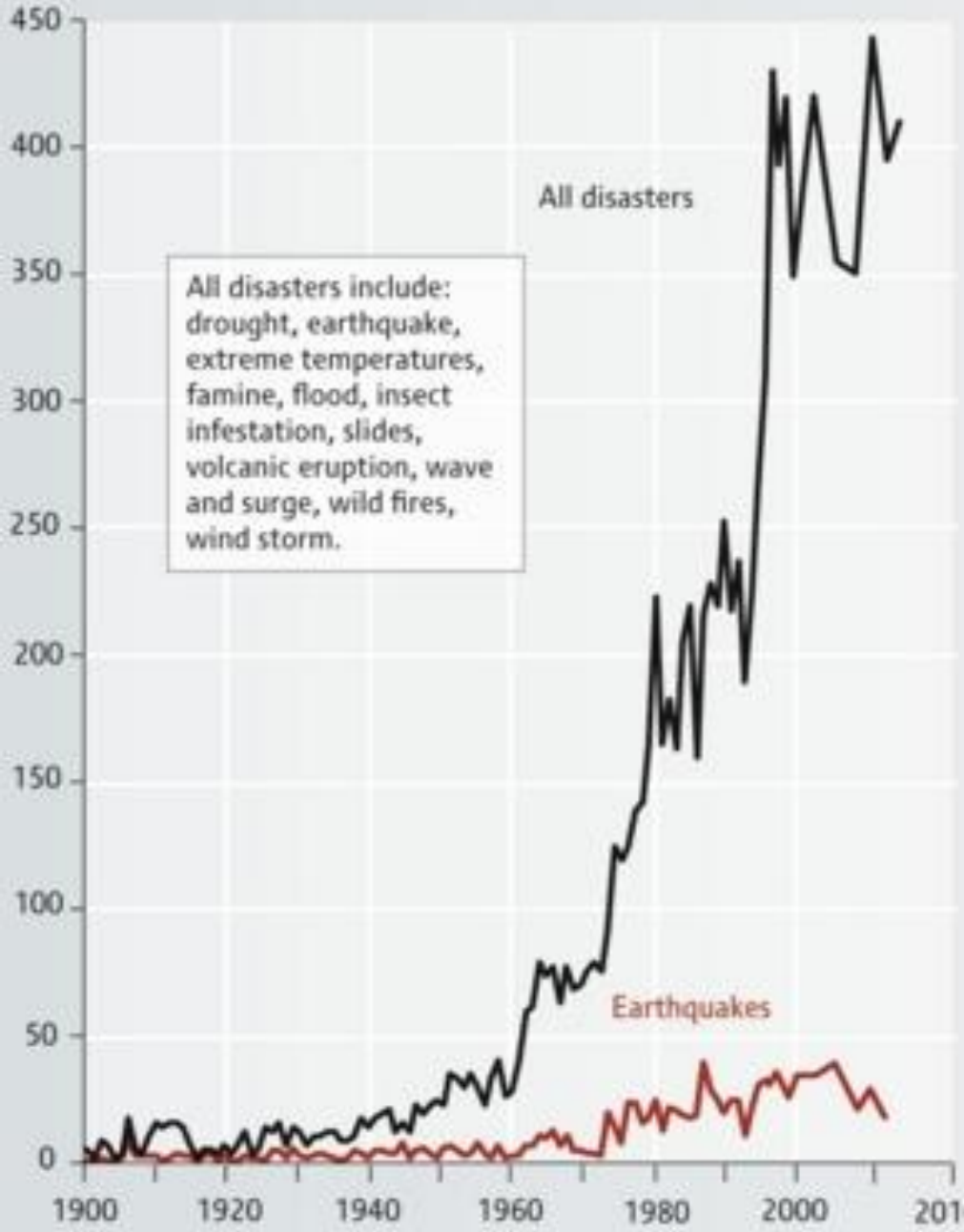


Fig. 3. Jun-Jul-Aug surface temperature anomalies in 1955, 1965, 1975 and in 2006-2011 relative to 1951-1980 mean temperature in units of the local standard deviation of temperature. The numbers above each map are the percent of surface area covered by each of the categories in the color bar.

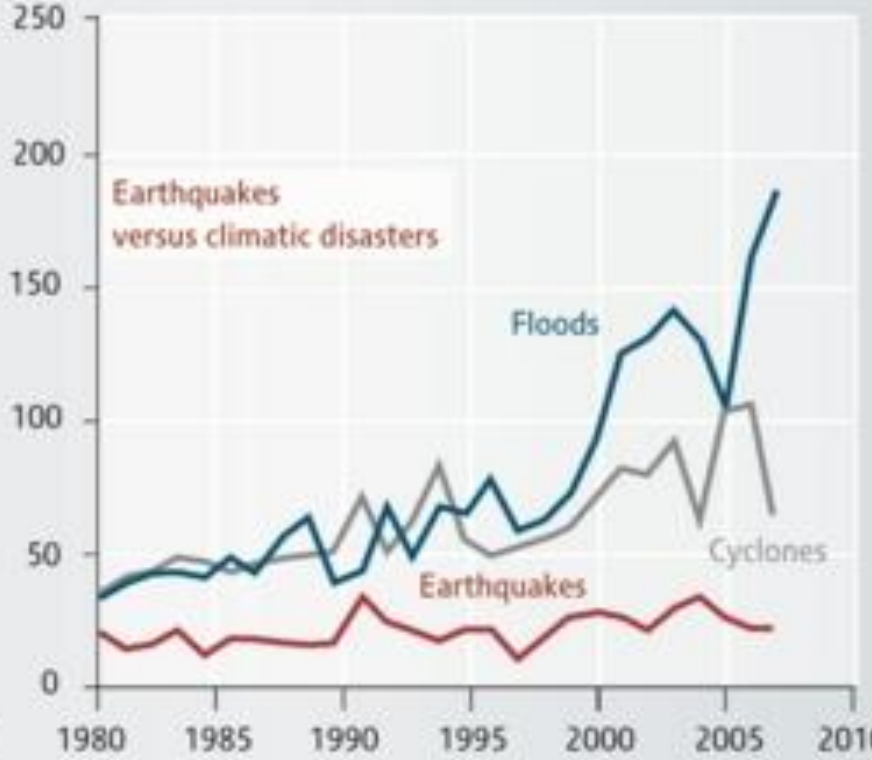
Number of disasters

per year



Trends in number of reported disasters

Much of the increase in the number of hazardous events reported is probably due to significant improvements in information access and also to population growth, but the number of floods and cyclones reported is still rising compared to earthquakes. Is global warming affecting the frequency of natural hazards?



Source: CRED Annual Disaster Statistical Review 2006: 2007

Why 2°C?
The Political Commitment

- Ultimate objective of UNFCCC is to achieve "... stabilization of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system”
- Cancun agreement (decision 1/CP.16) “recognizes that deep cuts in global GHG emissions are required according to science, and as documented in IPCC AR4, … so as to hold the increase in global average temperature below 2 °C above pre-industrial levels”

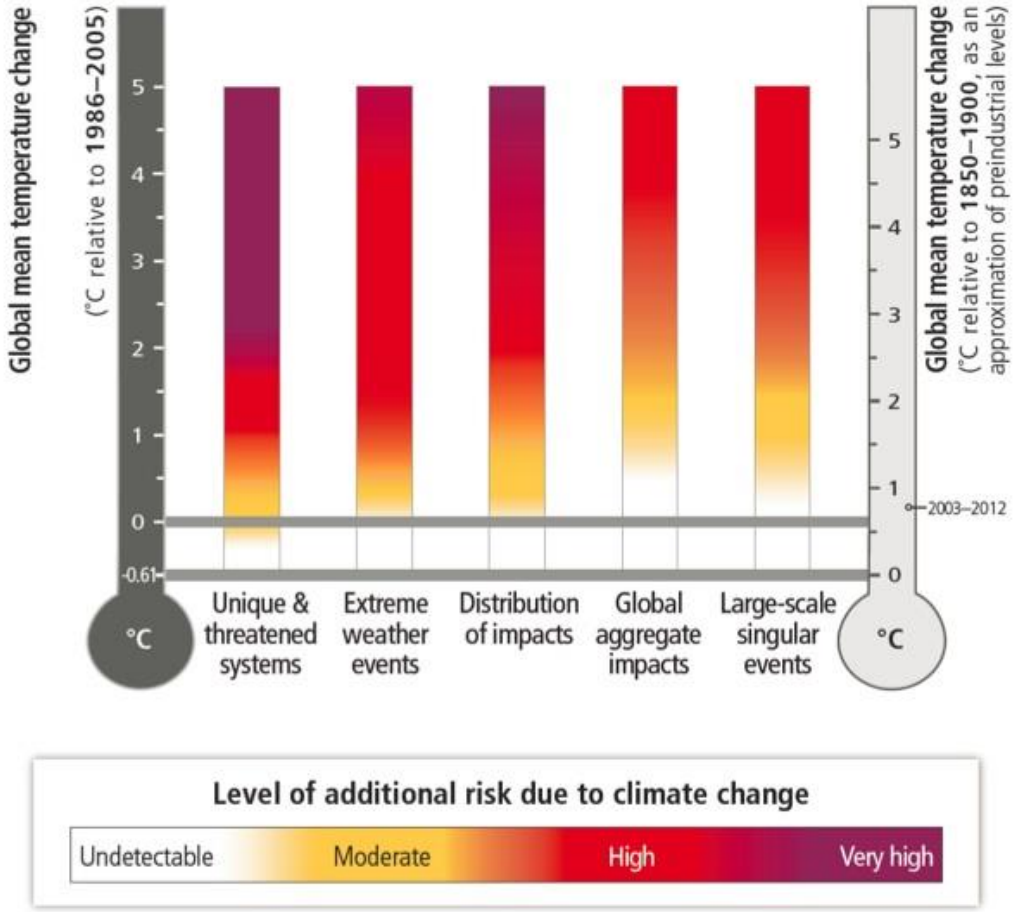
Some Leading Scientists Argue For a Limit of 1°C and Small Island States Argue for a Limit of 1.5°C

- Hansen et al (2013): a warming of 2°C, could cause "major dislocations for civilization"

- The argument for a 1°C target:
  - Makes it closer to climate variations experienced as normal during the Holocene (the recent 10,000 years)
  - Makes it likelier that the biosphere, and the soil, would be able to sequester a substantial proportion of the CO_2

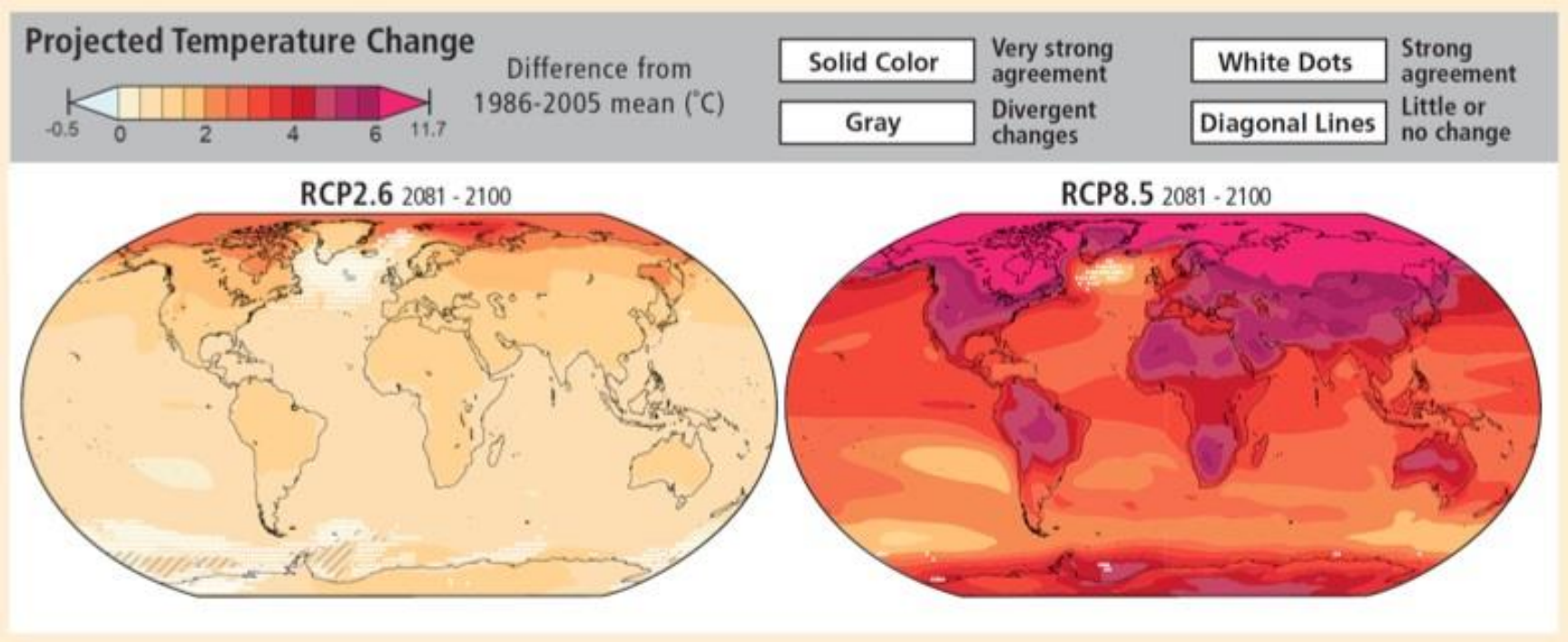
- The Cancun agreement (and subsequent COP decisions) "also recognizes the need to consider… strengthening the long-term global goal …(to) 1.5°C"

The IPCC AR5 confirms the risks of exceeding a 2°C increase in global mean temperature



Source: IPCC AR5 WGII Summary for Policymakers

The Business As Usual Scenario Would Lead to a 4.5°C or More Global Mean Temperature Increase



Source: IPCC AR5 WGII Summary for Policymakers

COP21 in 2015 is the Last Chance to Take the 2°C Target Seriously

Some argue that 2°C is impossible to achieve, but:

- Very few countries, not even the largest emitters, have looked seriously at 2°C pathways
- There is no “Plan B,” no natural “backup” agreement if 2°C fails
- The global political costs of abandoning the 2° C could be devastating to the UNFCCC

Steps Involved in Taking 2°C Seriously

1. Establish the global carbon budget for 2°C
2. Determine global trajectory to stay within the carbon budget
3. Identify key global technology milestones by country grouping
4. Global technology roundtables are instituted involving all interested countries
5. Each nation develops a Deep Decarbonization Pathway to 2050, with a further sketch to 2100
6. Large-scale implementation, supported by means of implementation (finance, technology, capacity building), as agreed under UNFCCC

1. Establish global carbon budget for 2°C (1/2)

- IPCC AR5 WGI Summary for Policy Makers:
- Limiting the warming caused by anthropogenic CO_2 emissions alone to less than 2°C since preindustrial level with a likely (>66%) chance will require cumulative CO_2 emissions from all anthropogenic sources to stay below **1000 GtC** (3670 $GtCO_2$)
- When accounting for non-CO_2 forcings, this carbon budget is reduced to **790 GtC** (2900 GtCO2)
- An amount of **515** [445 to 585] **GtC**, was already emitted by 2011

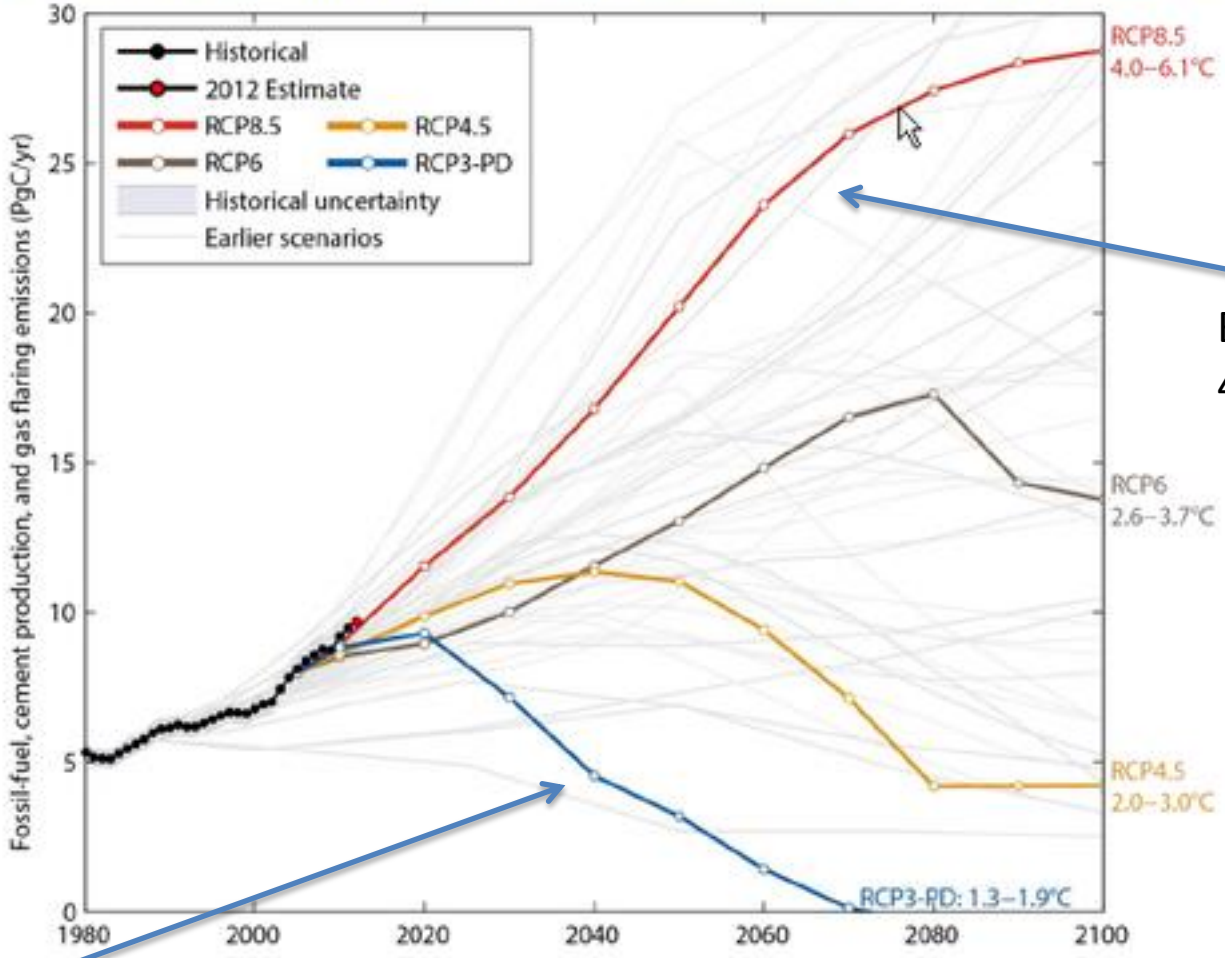
1. Establish global carbon budget for 2°C (2/2)

- The remaining carbon budget to have a likely (>66%) chance of limiting global warming to less than 2°C is therefore of: **275 GtC** (1000 $GtCO_2$)
- Accounting for warming effects of increases in non-CO_2 greenhouse gases, reductions in aerosols, or the release of greenhouse gases from permafrost, could further reduce the global carbon budget
- We are adding approximately 10Gt of C (36 Gt of CO_2) per year in the atmosphere. Under the BAU scenario, the entire carbon budget would therefore be exhausted in less than 30 years

2. Determine global trajectory to stay within carbon budget (1/2)

- Plausible trajectory for Overall CO_2e:
  - From 50 Gt of CO_2 equivalent today
  - To 44 Gt of CO_2 equivalent in 2020
  - To 35 Gt of CO_2 equivalent in 2030
  - To 22 Gt of CO_2 equivalent in 2050
  - To « net-zero emissions » before the end of the century
- Zoom on CO_2 from energy:
  - CO_2 energy emissions fall from 36 Gt to 16 Gt by 2050
  - Per capita emissions of CO_2 energy fall from 4.9 t to 1.6 t
  - CO_2 energy emissions per $1000 of world GDP fall from 390kg to around 50kg

Emissions are heading to a 4.0-6.1°C "likely" increase in temperature
Large and sustained mitigation is required to keep below 2°C



BAU:
4-6 degree C

2-degree C

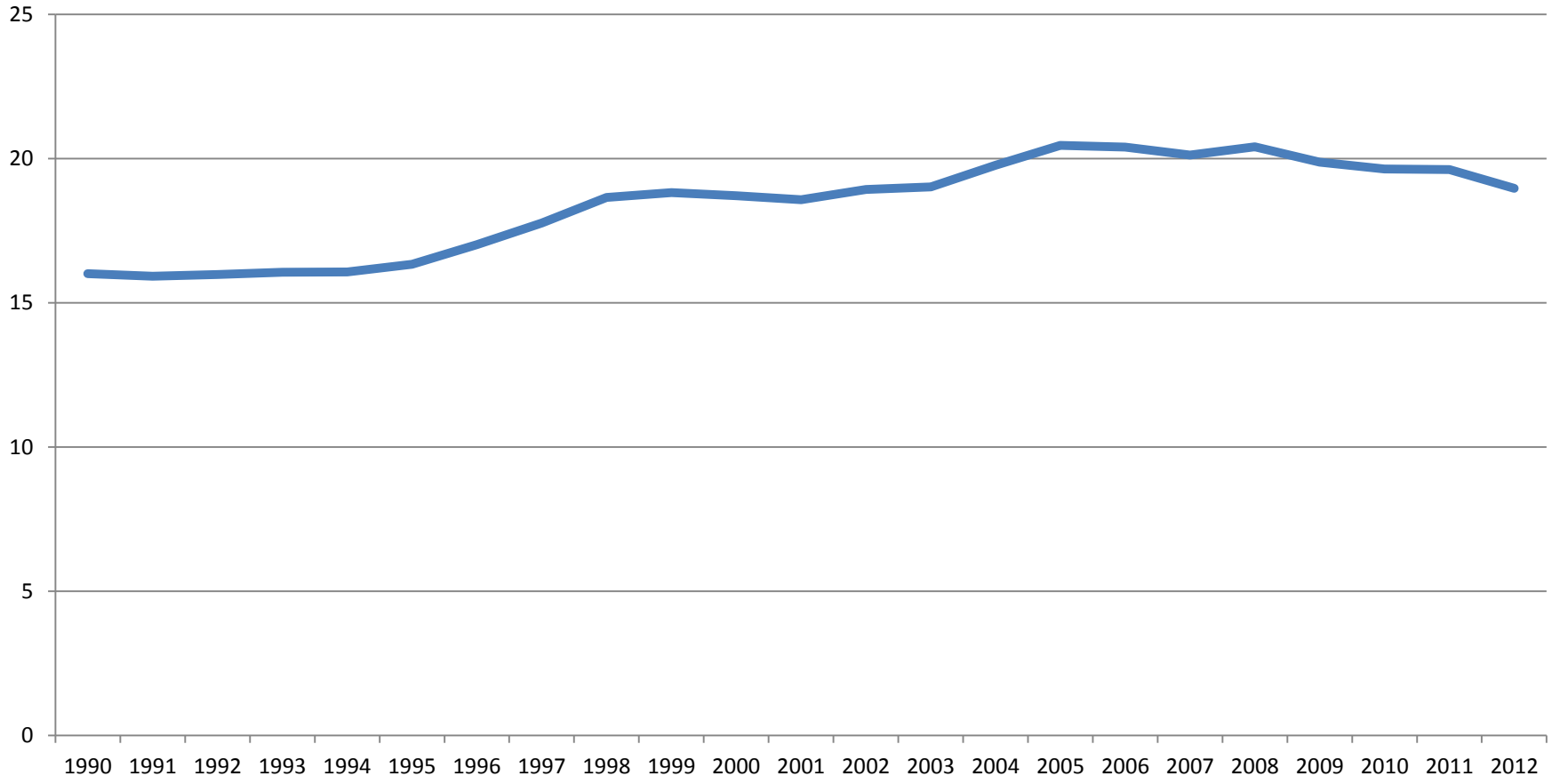
Linear interpolation is used between individual datapoints

Source: Peters et al. 2012a; Global Carbon Project 2012;

CO2-ENERGY EMISSIONS CONSISTENT WITH 2-DEGREE C LIMIT

Cumulative Emissions Remaining	Around 1,000 Billion Tons
Current CO2 Emissions Per Year	35 billion tons CO2 (or 10 billion C)
Years remaining at Current Rate	Around 29
Target Emissions 2050	Around 15 billion tons
Target Emissions 2070	Around 0 billion tons
Total Carbon in Proved Coal Reserves	2,126 billion tons
Total CO2 in Proved Oil Reserves	723 billion tons
Total CO2 in Proved Gas Reserves	356 billion tons

Australia's CO2 Emissions Per Person, 1990-2012



3. Identify Key Global Technology Milestones by Country Grouping (1/2)

The “must-haves” of deep decarbonization strategies

1. **Newly installed power generation** each year rated at <300kg CO_2 per MWh by 2025 and <200kg per MWh by 2040 (2035/2050 for low-income countries)
2. **No new coal-fired power plants** licensed for construction after 2018 except with CCS (2025 for LICs)
3. **All existing coal-fired power plants retrofitted with CCS**, or closed, by 2030 (2040 in LICs)
4. All **new residential and commercial buildings** heated by electricity or co-generation after 2025 (2035 for LICs)

3. Identify key global technology milestones by country grouping (2/2)

5. **Moratorium on development of new coal deposits and non-conventional fossil fuel reserves** (e.g. oil sands, Arctic oil, deep-ocean oil, or methane hydrates) after 2015
   - Moratoriums to be lifted in the event that CCS or other technologies radically change the future carbon budget
6. All new **personal vehicles** sold after 2030 with zero tailpipe emissions, e.g. electric or fuel-cell power (2035 for LICs, and all **commercial vehicles** with electric, natural-gas power, or sustainable, low-CO2 biofuels
7. Global standards on **CO_2 intensities for appliances and industrial processes** by 2025 (2035 in LICs)

4. Establish international technology roundtables

- Need global low-carbon technology roundtables to
  - Develop shared vision of low-carbon technology pathways among the countries, businesses, and scientists
  - Drive innovation process (c.f. semi-conductor industry)
- The IEA has pioneered low-carbon technology roadmaps:
  - **Carbon Capture Storage (CCS)**, Concentrating Solar Power (CSP), electric and plug-in hybrid vehicles, energy efficient buildings, energy storage, hydrogen, nuclear power, solar photovoltaic energy, smart grids, wind energy)
- These roadmaps could serve as basis for international technology roundtables

5. Develop National Deep Decarbonization Pathways

Five key elements of National Deep Decarbonization Pathways:

1. Energy efficiency: Technical (e.g. buildings, vehicles) and structural (e.g. urban planning, modal shift)
2. Decarbonization ("almost-zero" emissions) of the power sector (enabled by smart grids)
3. Electrification of final energy demand (e.g. electric heating, electric vehicles)
4. Reduction of process emissions from industries (e.g. cement, steel)
5. Reduction of emissions from land use, land use change, and forestry

MEANS OF IMPLEMENTATION:

MITIGATION AND ADAPTATION FINANCING

TECHNOLOGY TRANSFER

CAPACITY BUILDING

THE KEY PLAYERS

US, EU, CHINA, INDIA, RUSSIA, AUSTRALIA, CANADA, GCC

ARE THE KEY TO MANAGING THE GLOBAL FOSSIL FUEL RESERVES

CO2 EMISSIONS, BILLION METRIC TONS, 2012

Country/Group	CO2 Emissions
China	9.9
United States	5.2
European Union	3.7
India	2.0
Russia	1.8
World	34.5
Top 5 % of World	65.5

COAL RESERVES, BILLION METRIC TONS, 2012

Country	Reserves
United States	237.2
Russia	157.0
China	114.5
Australia	76.4
India	60.6
World	880.9
Top 5 % of World	73.3%

COAL CONSUMPTION, MILLION TONS, 2012

Country	Reserves
China	1873
United States	438
India	298
Japan	124
Russia	94
World	3730
Top 5 % World	75.8%

OIL RESERVES, BILLION BARRELS, 2012

Country/Group	Reserves
GCC	494.6
Venezuela	297.6
Canada	173.9
Iran	157
Iraq	150
World	1668.9
Top 5% World	76.3

OIL CONSUMPTION, BILLION BARRELS, 2012

Country	Consumption
United States	819.9
EU	611.3
China	483.7
Japan	218.2
GCC	191.2
World	4130.5
Top 5	56.3%

NATURAL GAS RESERVES, BILLION CUBIC FEET, 2012

Country	Reserves
GCC	1494.5
Iran	1187.3
Russia	1162.5
Turkmenistan	618.1
Venezuela	196.4
World	6614.1
Top 5	67.5%

NATURAL GAS CONSUMPTION, BILLION CUBIC FEET, 2012

Country	Gas Consumption
United States	722.1
EU	443.9
Russia	416.2
GCC	209.1
Iran	156.1
World	3314.4
Top 5	58.8%

AN ILLUSTRATIVE PATH TO NEGOTIATING SUCCESS:

US + CHINA

+ EU

+ AUSTRALIA AND CANADA

+ GCC

+ INDIA

+ RUSSIA

+ ROW AND MEANS OF IMPLEMENTATION

The SDSN Deep Decarbonization Pathway Project (DDPP)

- National deep decarbonization pathways
- A transparent and inclusive international coordination process
- Pathways consistent with 2°C: all countries converge to 1.67 tCO_2 per capita by 2050
- Long-term pathways to 2050, with sketch to 2100
- Sectoral disaggregation and technologically explicit pathways

DDPP outputs:

- 1st report to the UN Secretary General in July 2014
- 2nd report to the French President Q1 2015
- Ongoing discussions within countries