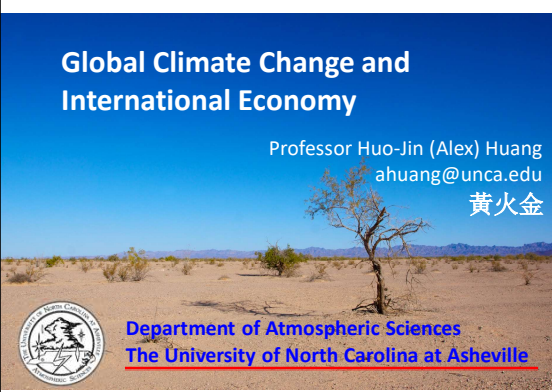


## Global Climate Change and International Economy

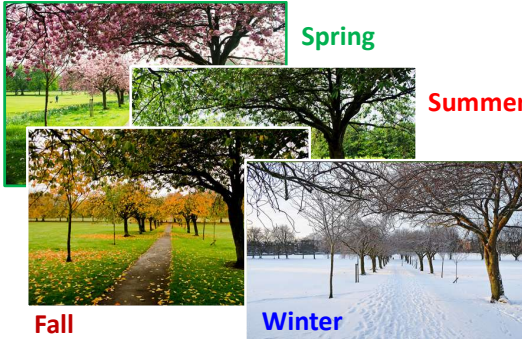
Professor Huo-Jin (Alex) Huang  
ahuang@unca.edu  
黄火金



**Department of Atmospheric Sciences**  
**The University of North Carolina at Asheville**

National Dong Hwa University, Hualien, Taiwan, ROC, 11/21/2017

### Climate does Change ! Just like Seasons !!



**Spring**      **Summer**  
**Fall**      **Winter**

[http://all-free-download.com/free-photos/download/the\\_four\\_seasons\\_209357.html](http://all-free-download.com/free-photos/download/the_four_seasons_209357.html)

### Is Our Beautiful Earth Getting Sick?



<http://epic.gsfc.nasa.gov/>      Earth Polychromatic Imaging Camera (EPIC)

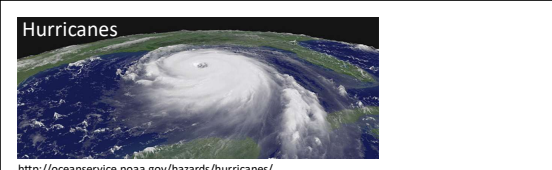
### It seems that we are experiencing more natural disasters!



**Forest Fire**      **Drought**      **Flooding**


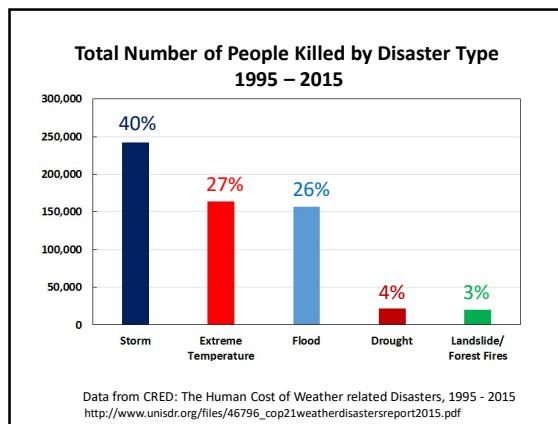
[http://www.noaa.gov/features/04\\_resources/fire2.html](http://www.noaa.gov/features/04_resources/fire2.html)  
[http://www.noaa.gov/features/monitoring\\_0209/images/drought.jpg](http://www.noaa.gov/features/monitoring_0209/images/drought.jpg)  
<http://www.nesdis.noaa.gov/fourbox/04-29-13/>

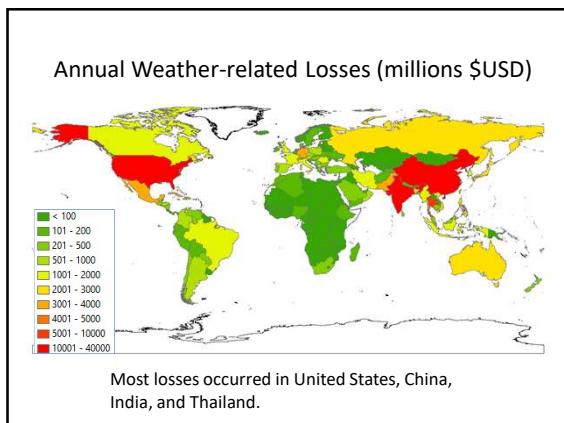
### Hurricanes



<http://oceanservice.noaa.gov/hazards/hurricanes/>

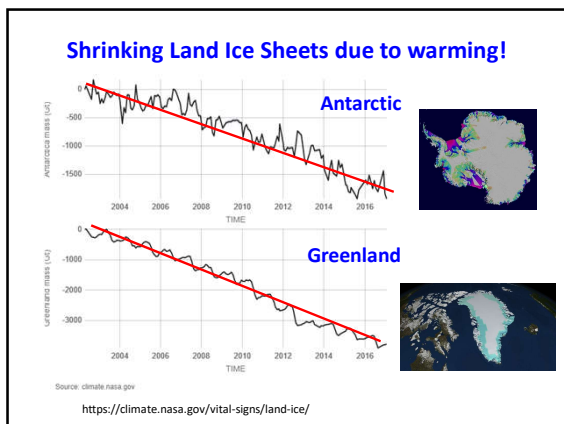
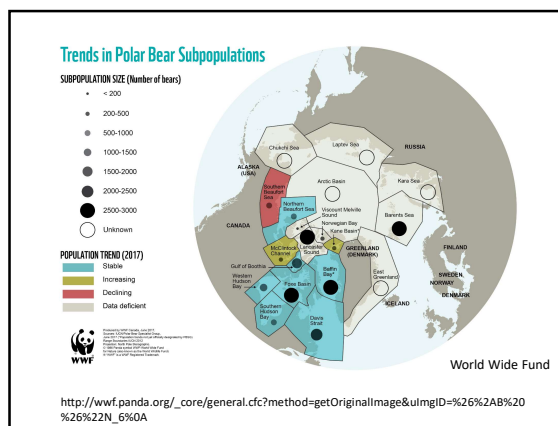
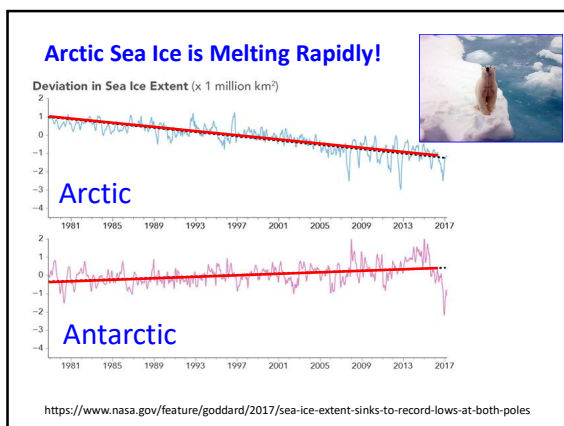
### Extreme Temperatures



### Outline

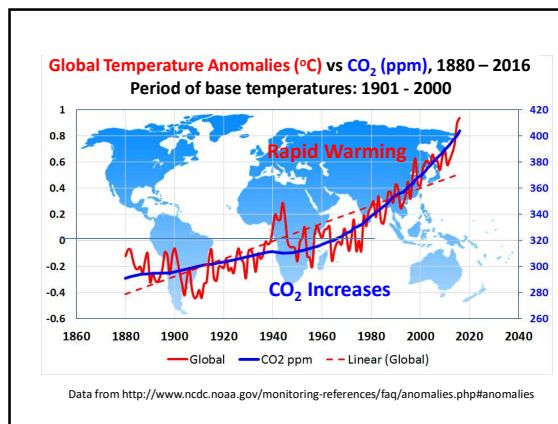
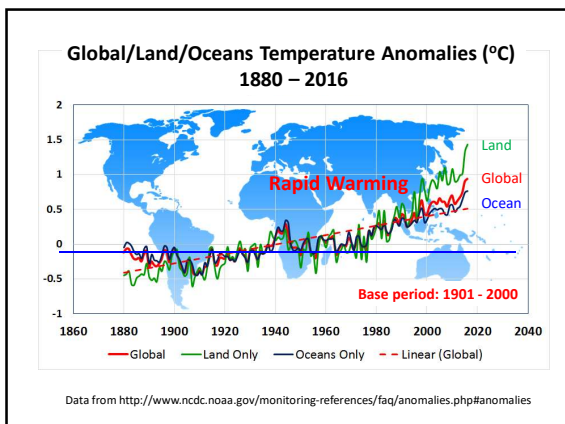
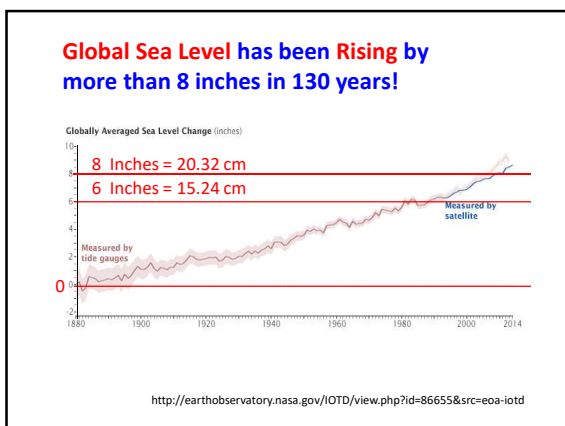
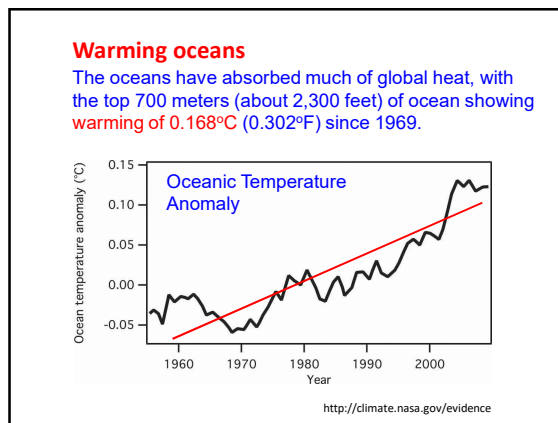
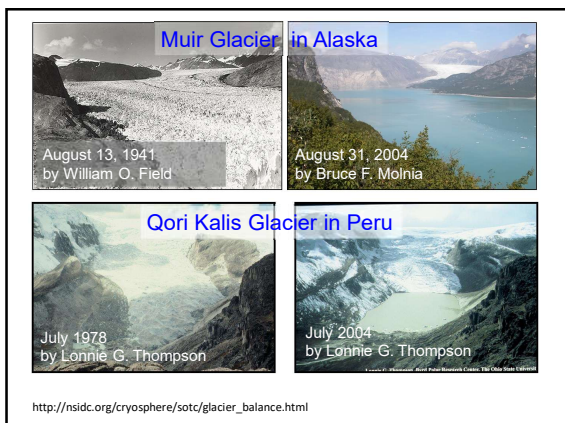
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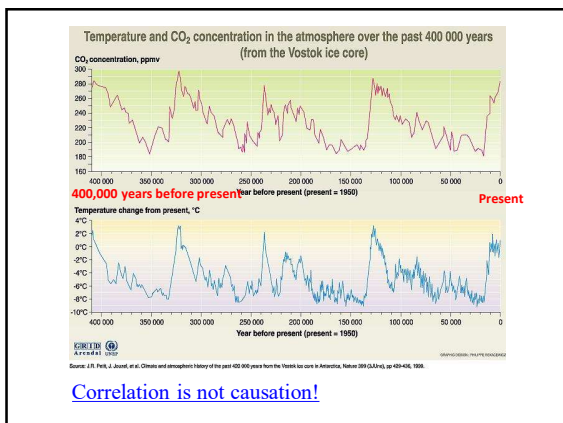


### Glaciers are retreating!

The disappearing snowcap of Mount Kilimanjaro, Tanzania.

[http://nsidc.org/cryosphere/sotc/glacier\\_balance.html](http://nsidc.org/cryosphere/sotc/glacier_balance.html)  
<https://climate.nasa.gov/interactives/global-ice-viewer/#/1/16>





### Atmospheric Greenhouse Effect

Sunlight passes the atmosphere and warms the earth's surface. Earth's surface then radiates the longwave radiation back to space. Most of the outgoing longwave radiation from the earth's surface is absorbed by the greenhouse gases and re-emitted in all directions, warming the surface of the earth and the lower atmosphere.

**Greenhouse Gases**

- Water vapor (H<sub>2</sub>O)
- Nitrous oxide (N<sub>2</sub>O)
- Carbon dioxide (CO<sub>2</sub>)
- Methane (CH<sub>4</sub>)

**Venus**  
Too much greenhouse effect  
T = 462°C

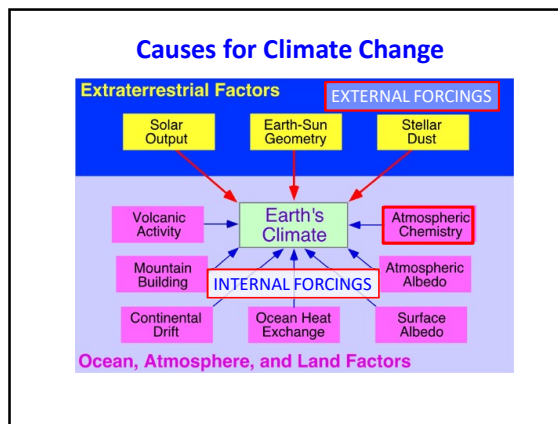
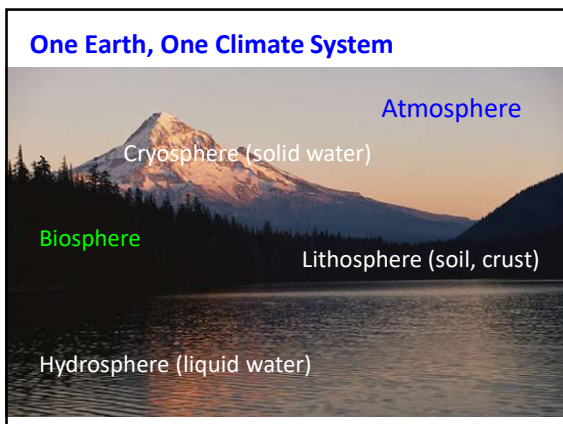
**Mars**  
No greenhouse effect  
T = -60°C

<http://climate.nasa.gov/causes/>

Our Earth is at the **right** distance from the sun, and it has the **right** composition of gases in the atmosphere to provide us with the **right** amount of greenhouse effect, so that we can survive comfortably at **15°C!**

**Thanks! Atmospheric Greenhouse Effect**

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**Earth and Sun Geometry**

**Eccentricity**  
(100,000-year cycle)

**Obliquity**  
(44,000-year cycle)

**Precession**  
(22,000-year cycle)

Milankovitch Cycles of variations in earth's orbit (1920)

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**The Sun**

**Solar Output**

Corona  
Chromosphere (atmosphere)  
Photosphere (surface)  
Prominence (solar storm)

D: 1,390,000 km  
Mass:  $1.989 \times 10^{30}$  kg  
T: 5,800 K (surface)  
15,600,000 K (core)

A gaseous body:  
74% Hydrogen  
24% Helium

**Sunspot Cycle of 11 years**

Monthly Averaged Sunspot Numbers (V2.0)

More sunspots indicate stronger solar activities and solar winds/storms!

23  
24

https://solarscience.msfc.nasa.gov/images/Zurich\_Color\_Small.jpg

**Internal Forcings**

- Continental drift/polar wandering
- Topography/mountain building/sea floor spreading
- Land and sea distribution
- Volcanic eruptions
- Variations of atmospheric compositions
- Snow and ice cover

**Plate Tectonics/Continental Drift**

**Internal Forcings**

PERMIAN 225 million years ago  
TRIASSIC 200 million years ago  
JURASSIC 135 million years ago  
CRETACEOUS 65 million years ago  
PRESENT DAY

**Plate Tectonics/Continental Drift**

**Internal Forcings**

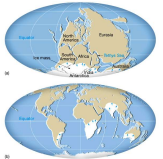

100 Ma into the Future

Australia

The geography of the earth in 100 million years from now!

### Internal Forcings

- Continental drift/polar wandering
- Topography/mountain building/sea floor spreading
- Land and sea distribution
- Volcanic eruptions !!! (Cooling the earth!)
- Variations of atmospheric compositions !!!
- Snow and ice cover !!!

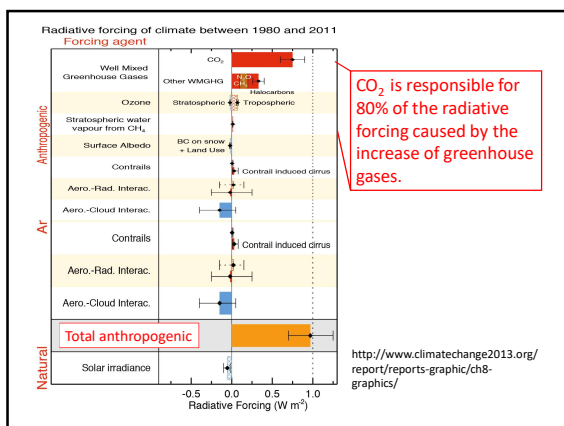



### How to determine Climate Forcings?

Represent them in  $W/m^2$ , therefore they are called "radiative forcings".

Radiative forcing is a direct measure of the amount that the Earth's energy budget is out of balance, thereby contributing to climate change.

<https://pixabay.com/en/sunset-sun-abendstimmung-1626515/>

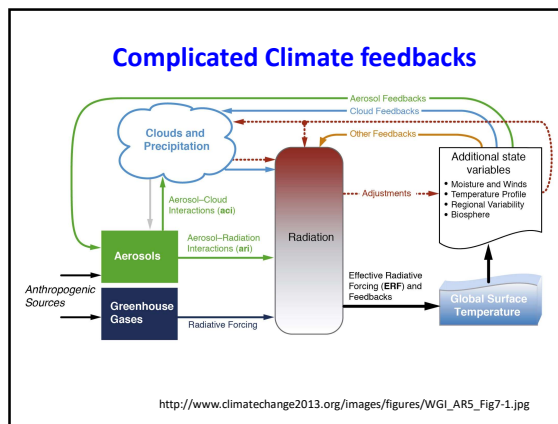


### How about Climate Feedback Mechanisms?

**Climate feedbacks** are processes that change as a result of a change in forcing, and cause additional climate change.

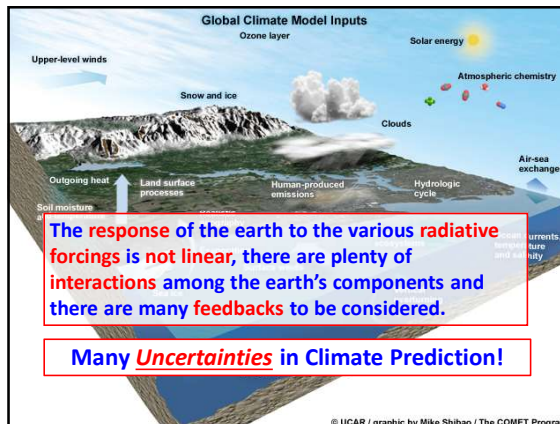
The **positive feedback** amplifies the initial change; while the **negative feedback** reduces it.

**Climate Feedback** is a cause-effect cycle that may amplify (positive feedback) or dampen (negative feedback) the initial change after the cycle is completed.



**In short, climate changes are due to**

- External and Internal Natural **Forcings**
- Interactions and **feedbacks**
- The **increased concentration of carbon dioxide** may partially contribute to the **global warming** since 1950's, and it has therefore caused the global climate to change.
- Most carbon dioxide emission comes from the **burning of fossil fuel** (coal, oil, natural gas) for energy use.

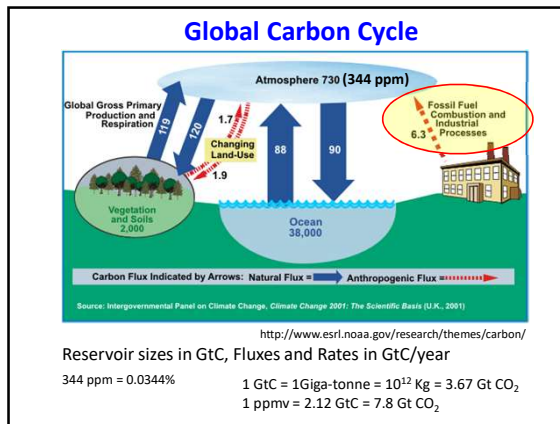
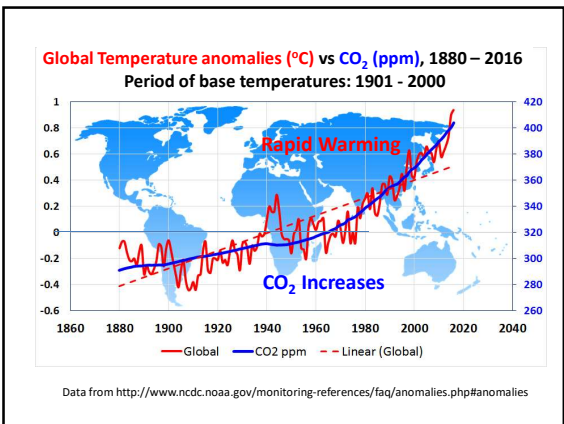


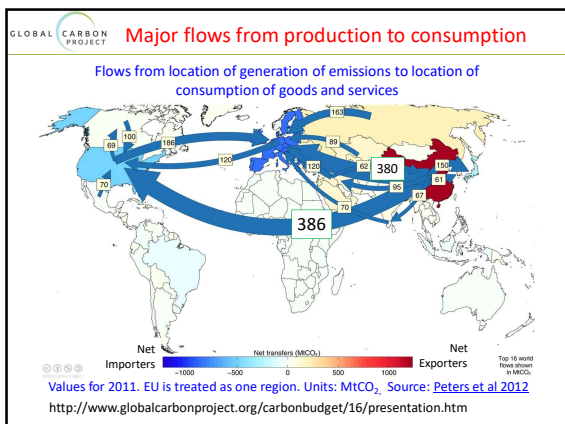
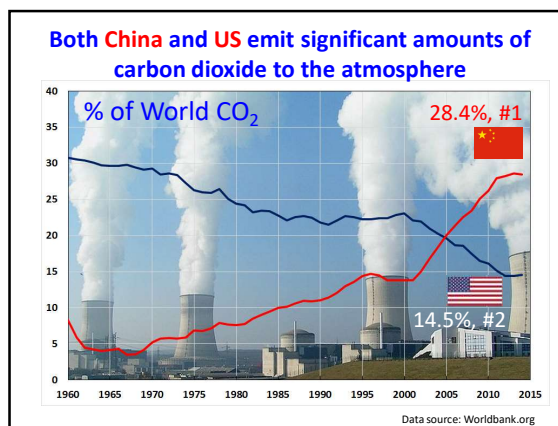
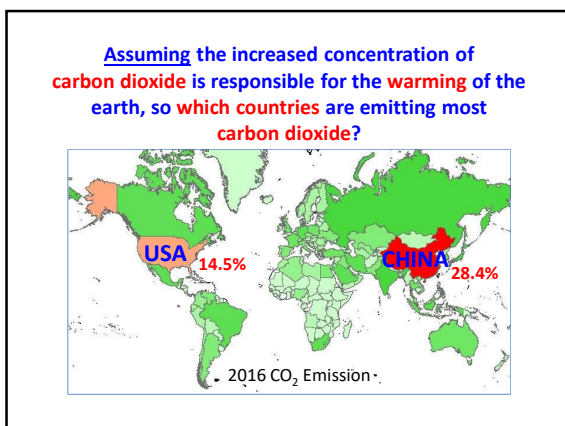
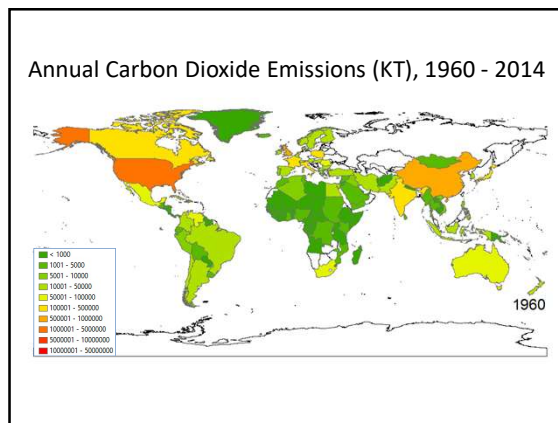
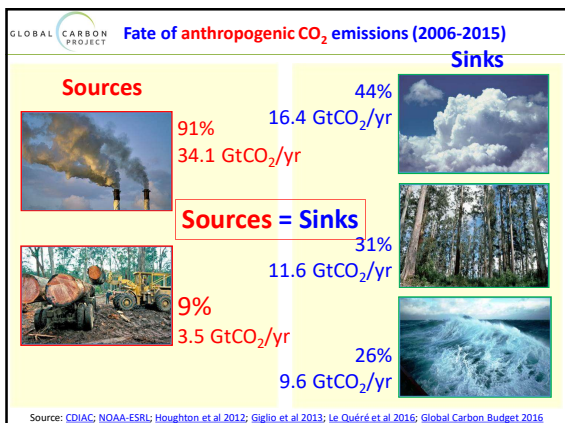
We have **Uncertainties** in observing and understanding the earth's climate!

Such as the observations of **Aerosols, Clouds, Ocean Circulation, Carbon Cycles, and Precipitation.**

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How about Carbon Dioxide Emissions from other Countries in the World?

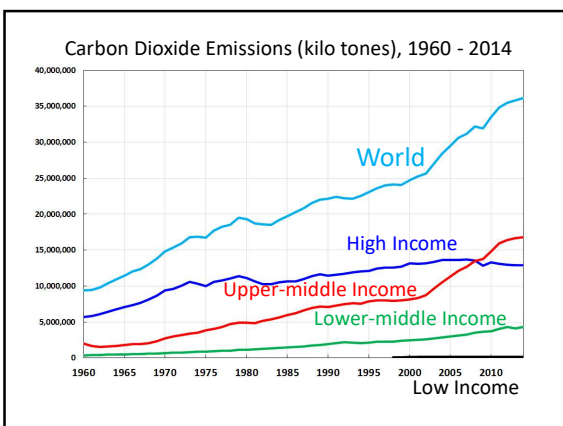
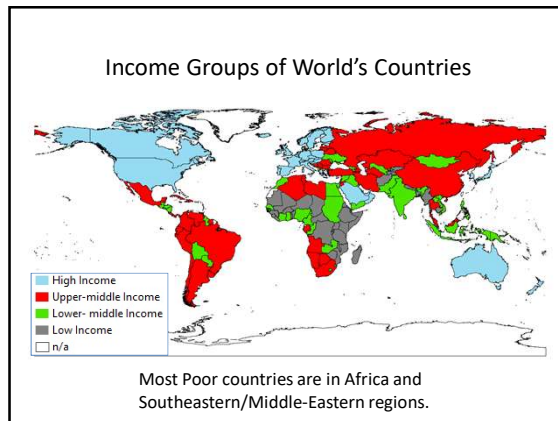


According to World Bank Country and Lending Groups

Income Group	GNI per capita
High Income	> \$12,236
Upper-Middle Income	\$3,956 - \$12,236
Lower-Middle Income	\$1,006 - \$3,955
Low Income	< \$1,005

■ High Income  
■ Upper-middle Income  
■ Lower- middle Income  
■ Low Income  
 n/a

GNI: Gross National Income



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**Climate Change Affects Everything that Everyone Does Everywhere !**

<http://epa.gov/climatestudents/impacts/effects/index.html>

**What to Expect in Climate Change?**

- Accelerating sea level rise and increased coastal flooding
- Increased oceanic acidity
- More frequent and intense heat waves
- Increased extreme weather events (drought and flooding)
- Widespread forest fires
- Shortage of fresh water
- Changing seasons
- Migration of animals and plants
- Destruction of coral reefs
- Growing health impacts

<http://epa.gov/climatestudents/impacts/signs/index.html>

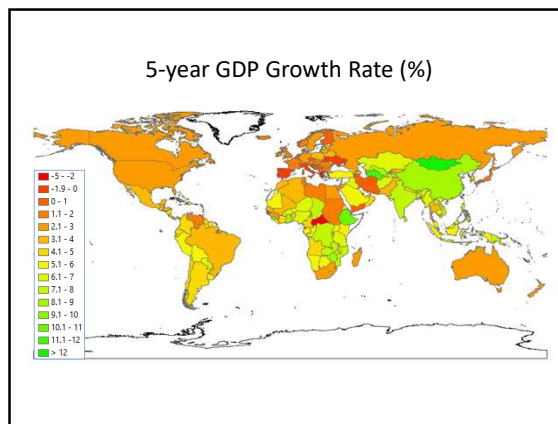
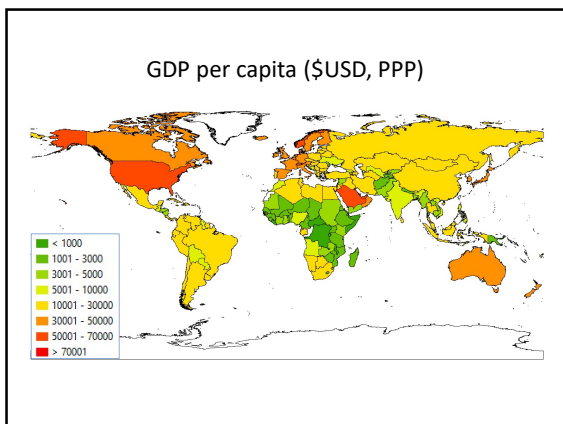
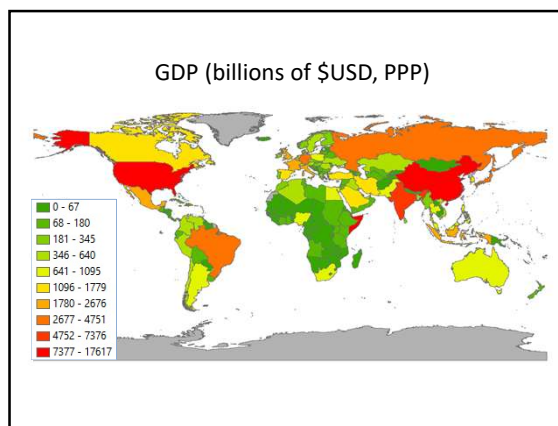
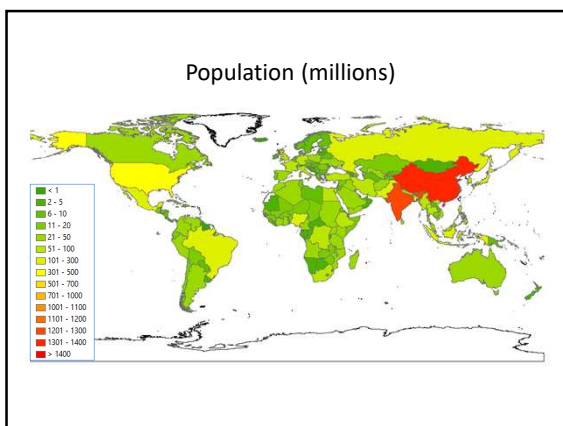
**Impacts of Climate Change on**

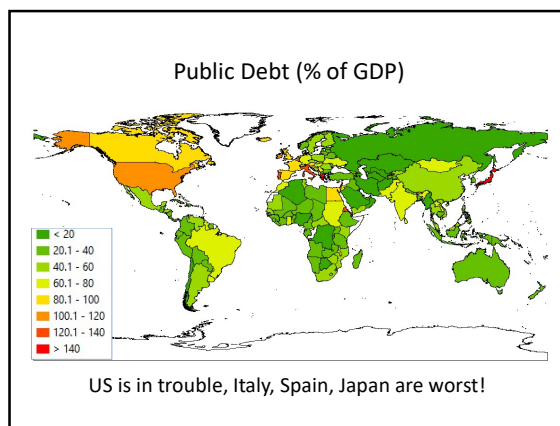
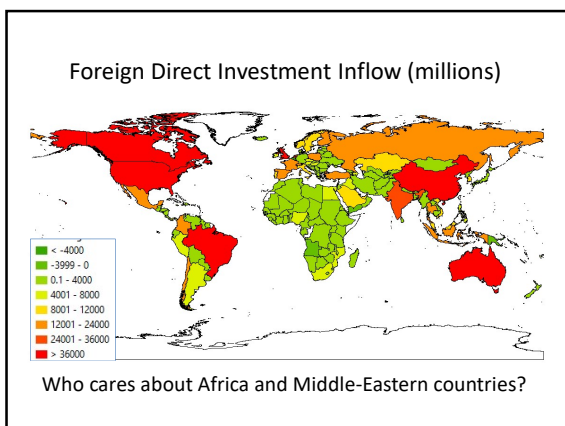
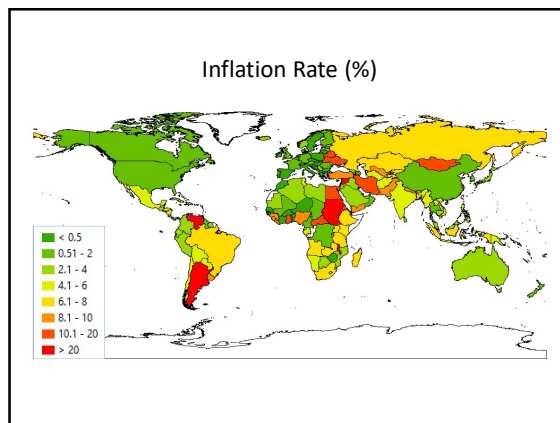
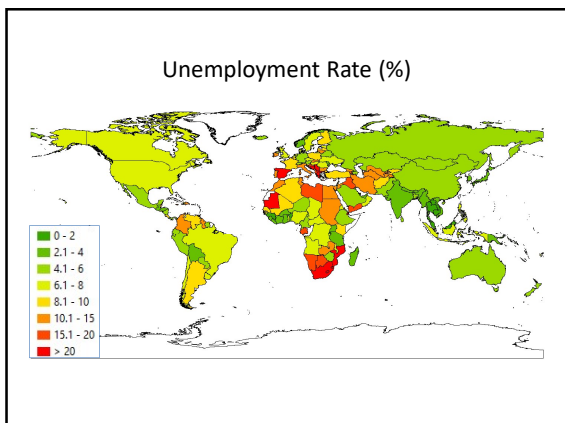
- Weather Patterns: Flooding, Drought, Sea level rising, Forest fires, Tropical cyclones
- Water Supply and Quality: Reducing water supply, Glacier melting, Water pollution
- Agriculture and Food: Deforestation, desertification, Drought
- Human Health: Heat stress, Air pollution, Malnutrition, Diseases, Poverty
- Living Shelter: Destruction, Displacement
- Vulnerable Population: Women, Children, the Elderly and Indigenous people
- National Security: Scarce resources, Conflict, Instability
- Ecosystems: Migration, Variation, Alteration, Extinction



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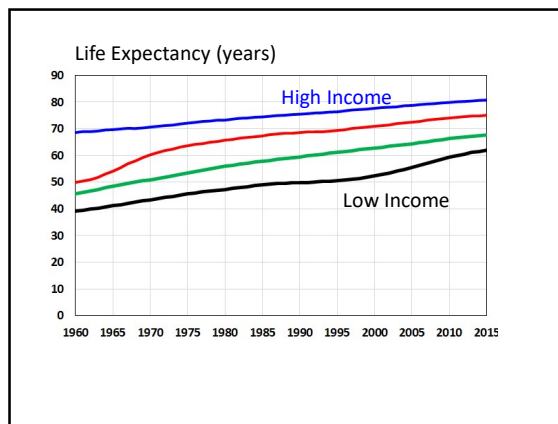
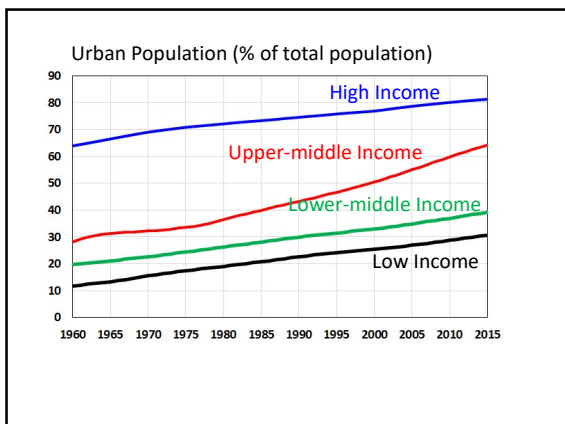
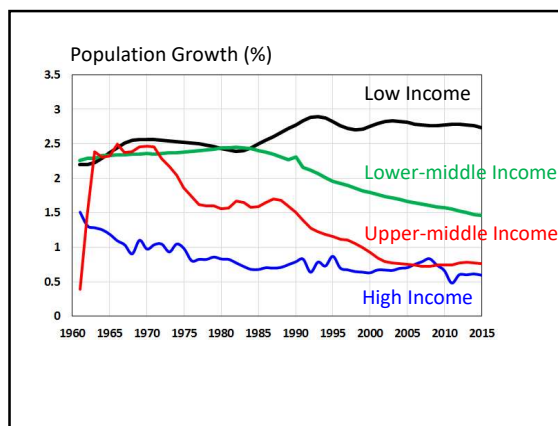
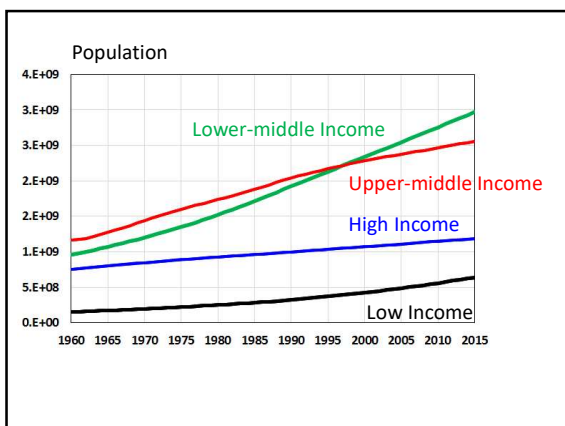
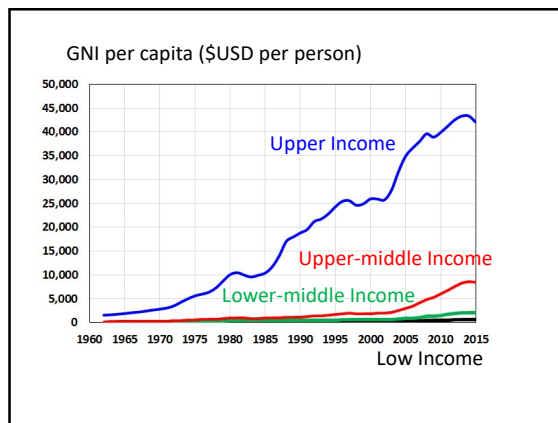
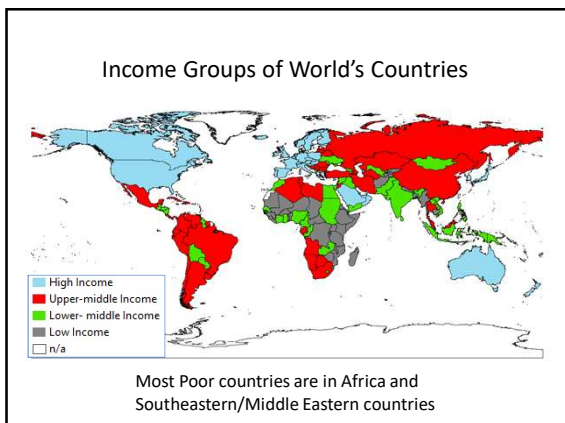
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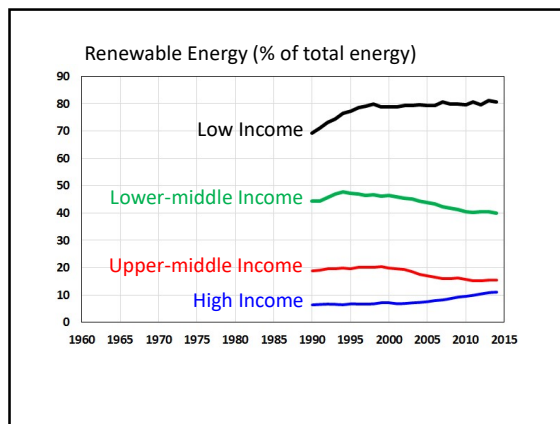
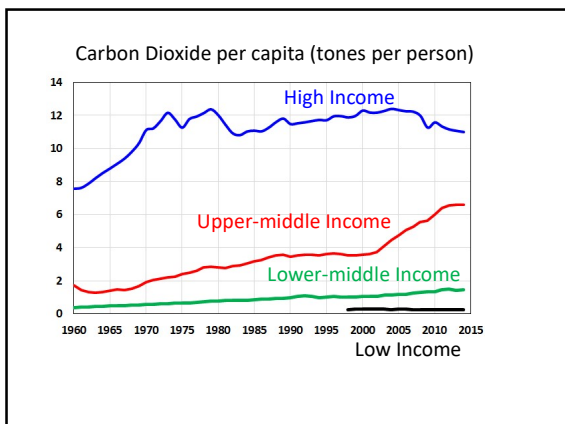
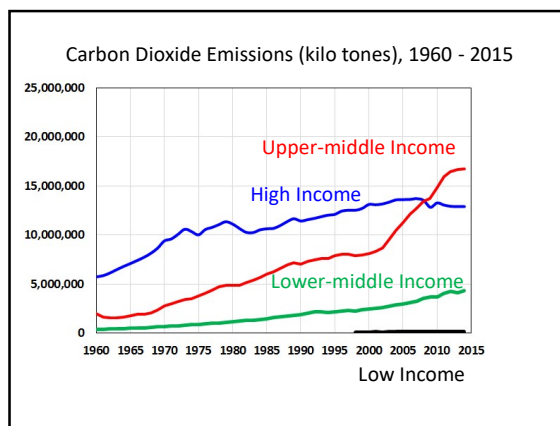
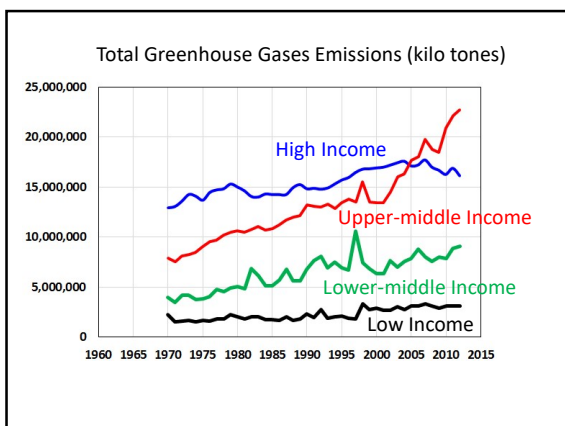
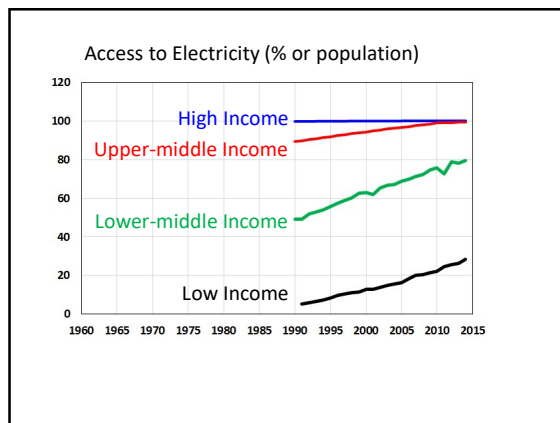
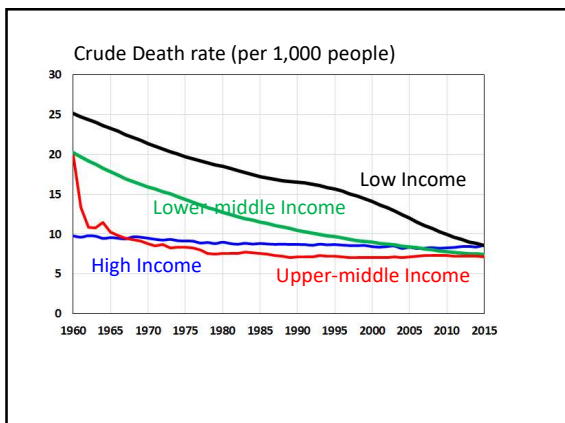
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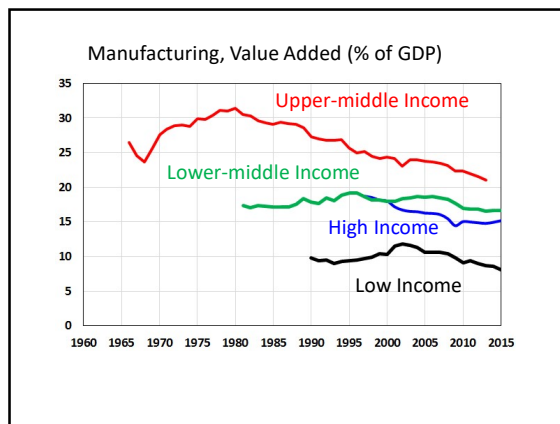
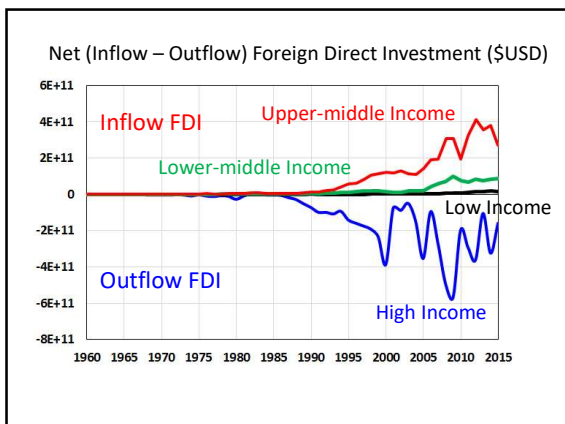
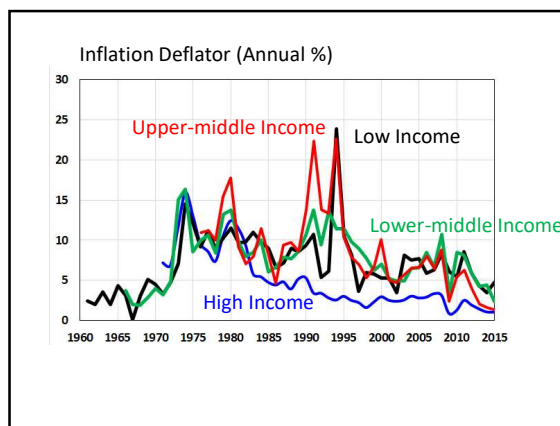
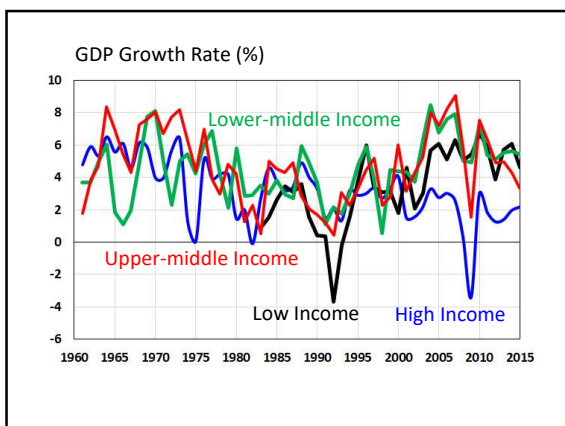
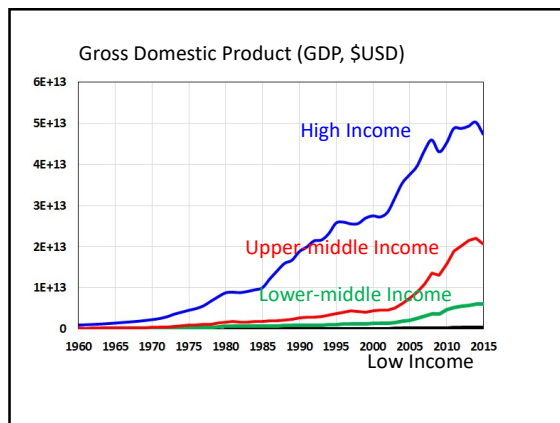
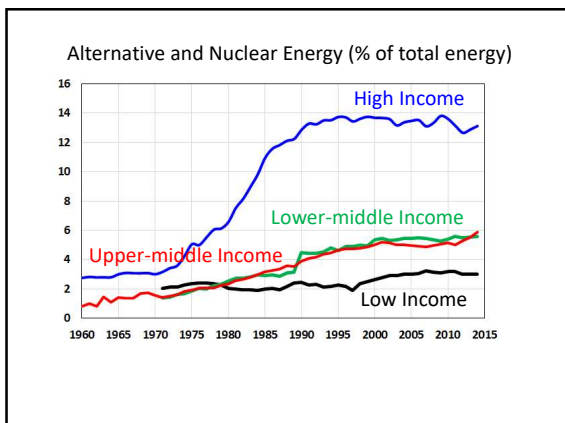
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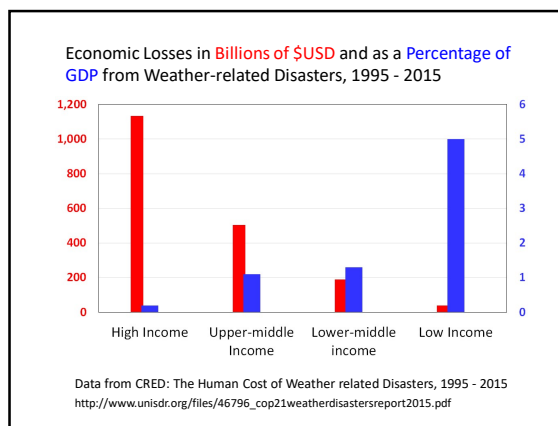
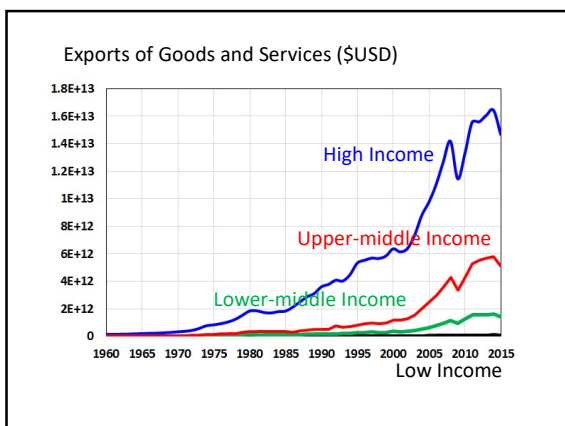
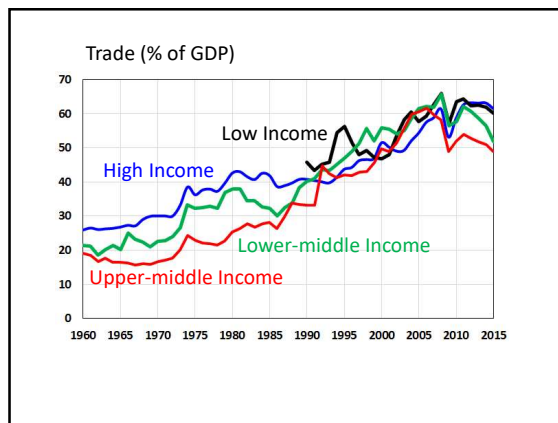
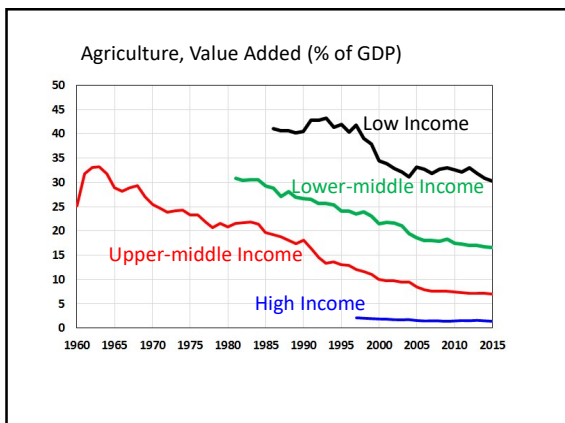
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GNI: Gross National Income



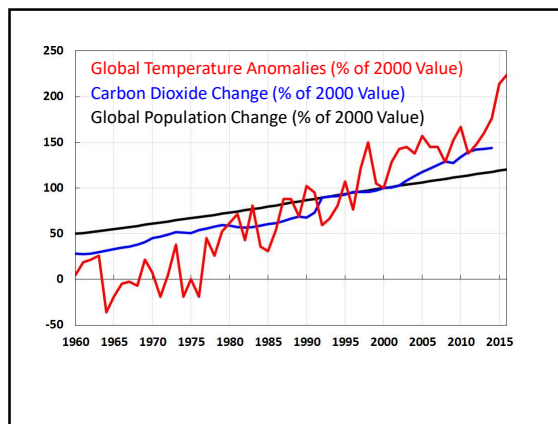


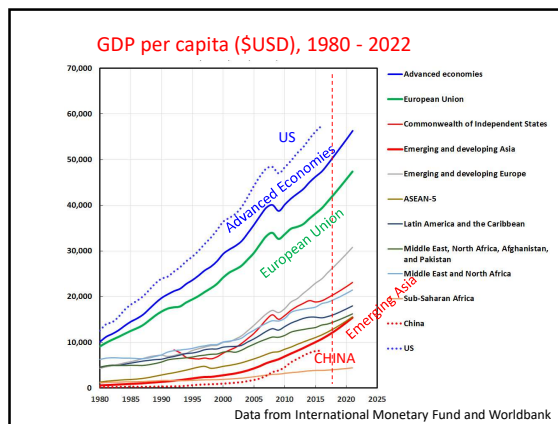
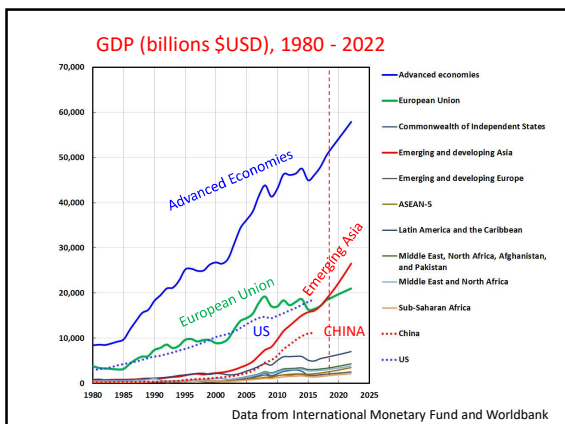
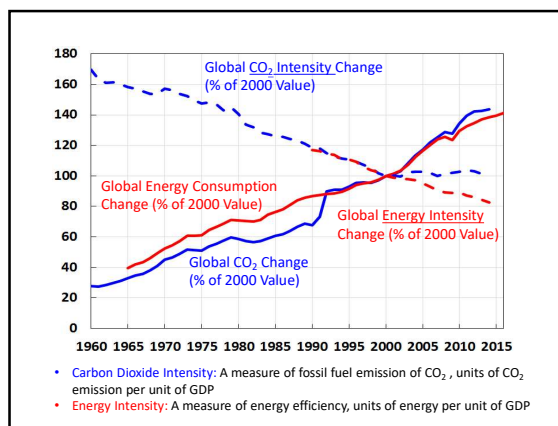
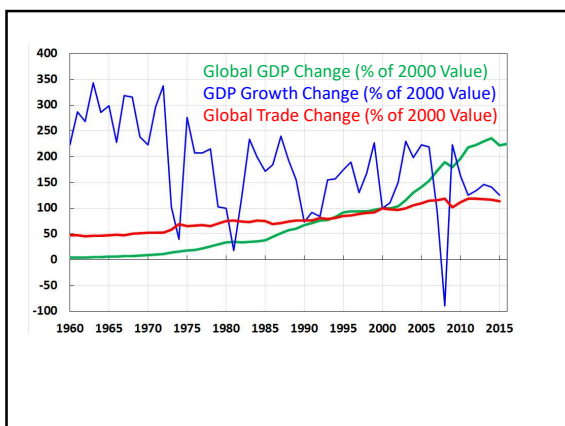
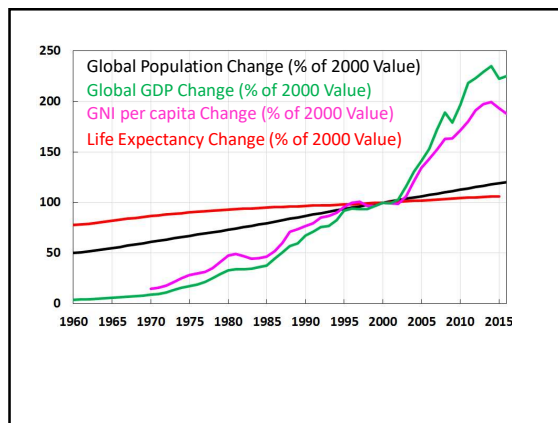
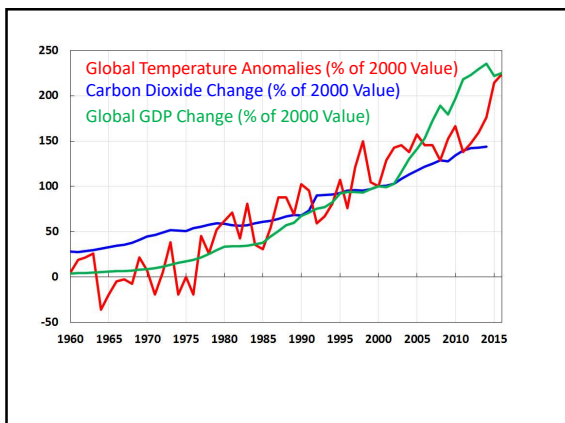




## Outline

- Evidences of Climate Change
- Causes for Climate Change
- Carbon Dioxide and Climate Change
- Impacts of Climate Change
- Status of International Economy
- Inequality of Global Economy
- **Future Global Economy**
- Ready for the Future

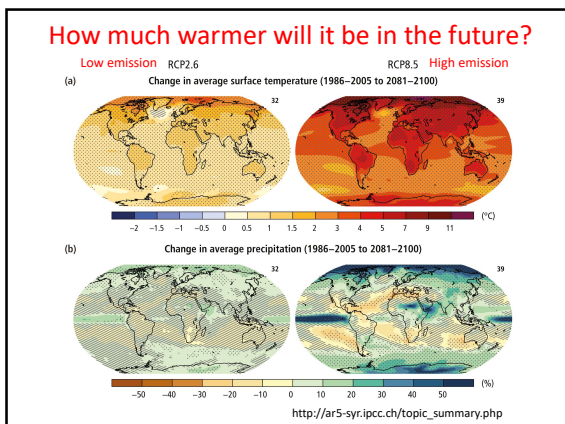
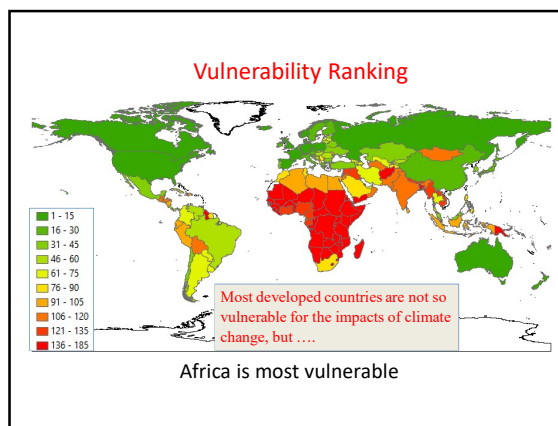
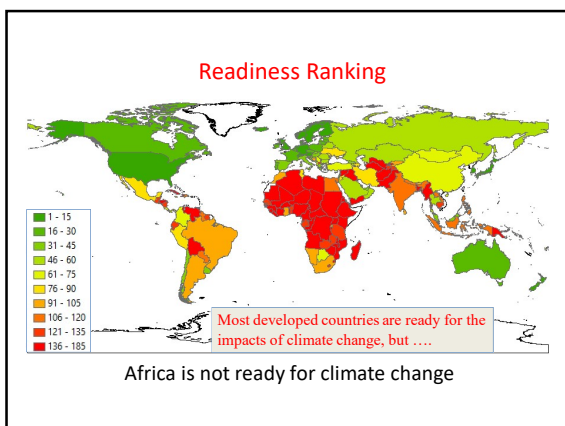
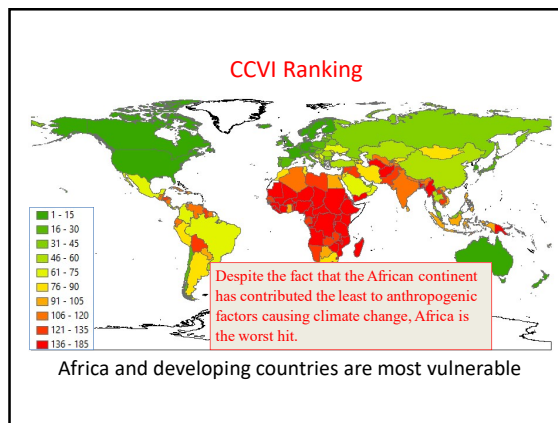






### Outline

- Evidences of Climate Change
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### What can we DO about climate change?

- Develop **renewable** energy
- Advance **green** technology
- Strengthen international **cooperation**
- Accelerate **balanced** economic progress
- Do **your share** of protecting the environment

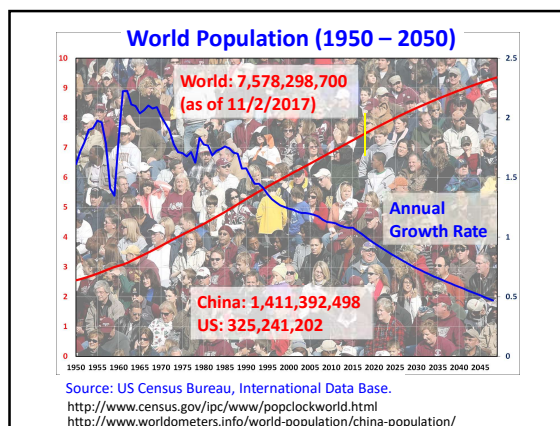
<http://epa.gov/climatestudents/impacts/effects/index.html>

### Summary

- Climate Change is happening
- Climate Change is natural and human-made
- Advancing technology helps
- Green energy is expanded but inadequate
- Personal responsibilities are good but limited
- Impacts of Climate Change differ between countries
- Global economy will continue to grow
- Inequality of economy needs to be addressed

What we can do is to love this Earth as much as we can!

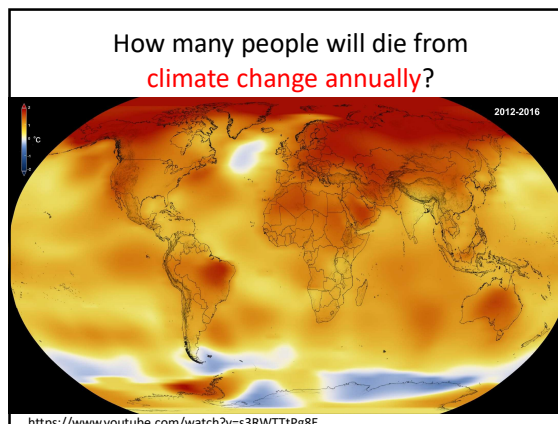
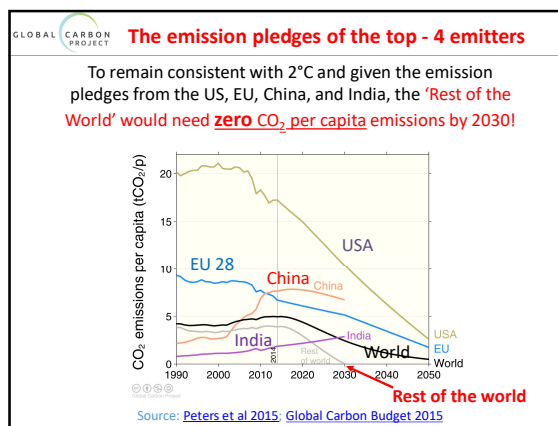
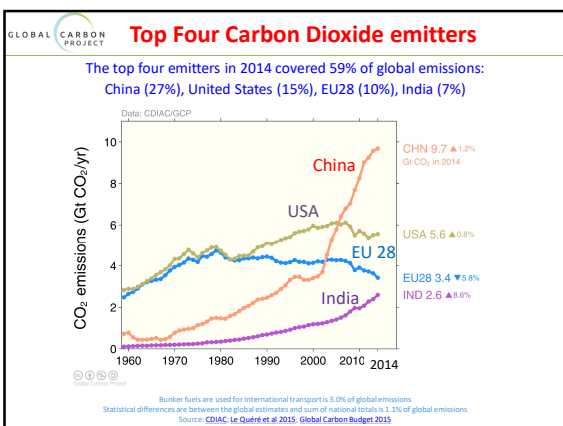
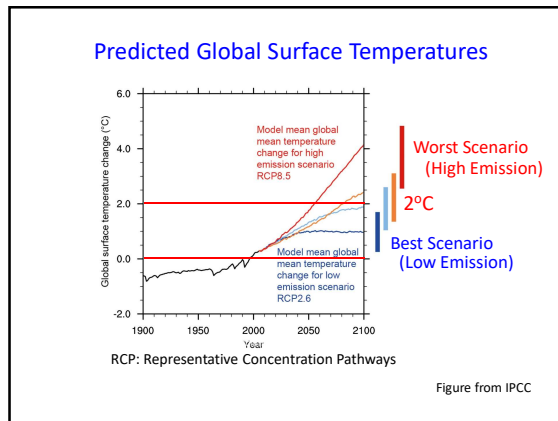
Last Thought #1



How do we Survive with 8.3 billion people on earth in 2030 ?

Last Thought #2

Will the **2015 Paris Agreement** Succeed in Reducing Global Carbon Dioxide Emissions?



How many people will die from **climate change annually?**



**250,000 annually between 2030 and 2050 according to World Health Organization**

<http://www.who.int/mediacentre/factsheets/fs266/en/>

**For Comparison:**

How many people died in **Tangshan earthquake** in China on July 28, 1976? **400,000**

How many people died in **Indian Ocean Tsunami** on December 26, 2004? **280,000**

How many people died in **Cyclone Nargis in Myanmar** on May 2, 2008? **138,000**

How many people died in **Haiti Earthquake** on January 12, 2010? **160,000**

How many people have died in **Syria civil war** conflict since 2011? **400,000**

How many people died due to **suicide** worldwide in 2016? **800,000**

How many people died in **traffic accidents** worldwide in 2013? **1.25 million**

How many **children under 5 years old** died worldwide in 2015? **5.9 million**

How many people died because of **Tobacco use** worldwide in 2016? **6 million**

How many people died from **heart attack** worldwide in 2012? **17.5 million**

How many people died in **Taiwan** in 2015? **163,858**

<http://www.who.int/mediacentre/news/releases/2015/child-mortality-report/en/>  
[http://www.who.int/gho/road\\_safety/en/](http://www.who.int/gho/road_safety/en/)  
<https://eng.stat.gov.tw/lp.asp?CtNode=2265&CtUnit=1072&BaseDSD=36&mp=5>

**Don't we Have Enough Crises to deal with currently?**

**What do you think?**

**Expensive and Outrageous International Meetings on Climate Change**



**Paris 2015, France, 11/30-12/11/2015, COP 21 of UNFCCC (United Nations Framework Convention on Climate Change)**

**COP: Conference of Parties**

**Kyoto Protocol, Japan, December 1997**  
 Bali Road Map, Indonesia, December 2007, COP 13  
 Copenhagen Conference, December 2009, COP 15  
 Cancun Agreements, Mexico, December 2010, COP 16,  
 Durban Outcomes, South Africa, December 2011, COP 17  
 Doha Climate Gateway, Qatar, December 2012, COP 18  
 Warsaw Meeting, Poland, November 2013, COP 19  
 Lima Conference, Peru, December 2014, COP 20  
 Paris Conference, France, November 2015, COP 21  
 Marrakesh Conference, Morocco, November 2016, COP 22  
 Bonn Conference, Germany, November 2017, COP 23



[http://unfccc.int/meetings/paris\\_nov\\_2015/items/9288.php](http://unfccc.int/meetings/paris_nov_2015/items/9288.php)  
<http://www.cop21.gouv.fr/en/cop21-cmp11/what-cop21-cmp11>

### How much did it cost for COP 21 in Paris, France in December 2015?

- Lodging: 36,000 people x 11 nights x US \$1000 = \$396 million
- Food: 40,000 x 11 days x \$500 = \$220 million
- Flights: 40,000 x \$2000 = \$80 million
- Limousines: 40,000 x 11 x \$800 = \$352 million
- Entertainment: 40,000 x 11 x \$1000 x 10% = \$44 million

**HIGH TOTAL: 1,102 million US dollars**

- Lodging: 36,000 people x 11 nights x US \$500 = \$198 million
- Food: 40,000 x 11 days x \$500 = \$220 million
- Flights: 40,000 x \$2000 = \$80 million
- Limousines: 40,000 x 11 x \$200 = \$88 million
- Entertainment: 40,000 x 11 x \$1000 x 10% = \$44 million

**LOW TOTAL: 630 million US dollars**

<http://wattsupwiththat.com/2015/11/01/will-paris-cop21-cost-more-to-host-than-it-raises-in-green-pledges/>  
<https://www.carbonbrief.org/analysis-which-countries-have-sent-the-most-delegates-to-cop21>

## What do you think?

### How many more international meetings do we really need for understanding and dealing with issues of climate change?

### 2016 IPCC International Meetings

[http://www.ipcc.ch/scripts/\\_calendar\\_template.php?wg=8](http://www.ipcc.ch/scripts/_calendar_template.php?wg=8)

Date	Description and Venue
25 Jan - 28 Jan	TFI - Expert Meeting to collect EFD8 and Software users feedback (Kobe, Japan)
26 Jan - 27 Jan	TGICA Expert Meeting (Geneva, Switzerland)
9 Feb - 10 Feb	IPCC Expert Meeting on Communication (Oslo, Norway) <span style="float: right;">50 IPCC members</span>
16 Feb - 17 Feb	51st Session of the IPCC Bureau (MNO, Geneva, Switzerland)
11 Apr - 13 Apr	43rd Session of the IPCC (Nairobi, Kenya)
14 Apr - 14 Apr	Executive Committee Meeting (Nairobi, Kenya)
25 Apr - 26 Apr	TFI - Expert meeting for Technical Assessment of IPCC Inventory Guidelines follow-up on specified issue from the 2015 expert meetings (Wollongong, Australia)
27 Apr - 29 Apr	TFI - Expert Meeting for Technical Assessment of IPCC Inventory Guidelines-Cross-sectoral issues (Wollongong, Australia)
6 Jul - 8 Jul	TGICA-24 (Helsinki, Finland)

### 2016 IPCC International Meetings

Date	Description and Venue
15 Aug - 18 Aug	Scoping Meeting Special Report on 1.5° (Geneva, Switzerland)
18 Aug - 19 Aug	52nd Session of the IPCC Bureau (Geneva, Switzerland)
29 Aug - 31 Aug	Future Earth/IPCC/PROVIA Workshop on Lessons Learnt and Gaps in Knowledge in WGI/WGII/WGIII AR5 (Stockholm, Sweden)
29 Aug - 31 Aug	TFI - Scoping Meeting for Methodology Reports (Minsk, Belarus)
1 Sep - 2 Sep	TFI - 28th Session of the Task Force Bureau (Minsk, Belarus)
3 Oct - 30 Oct	Call for Scoping Nominations for AR6
17 Oct - 20 Oct	44th Session of the IPCC (Bangkok, Thailand)
21 Oct - 21 Oct	Executive Committee Meeting (Bangkok, Thailand) <span style="float: right;">COP 22: November 7 – 18, 2016 Marrakech, Morocco</span>
6 Dec - 9 Dec	Scoping of the IPCC Special Report on "Climate change and oceans and the cryosphere" (Monaco)
12 Dec - 15 Dec	TFI - 14th Editorial Board Meetings (Bali, Indonesia)
13 Dec - 14 Dec	TFI - 13th & 14th Meetings on Data for the EFD8 (Bali, Indonesia)

### 2017 IPCC International Meetings

[https://www.ipcc.ch/scripts/\\_calendar\\_template.php?wg=8](https://www.ipcc.ch/scripts/_calendar_template.php?wg=8)

Date	Description and Venue
23 Jan - 29 Jan	Decision on Scoping Nominations (AR6)
13 Feb - 16 Feb	WG III/III - Scoping of the "Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems" (organized by WGIII) (Dublin, Ireland)
6 Mar - 10 Mar	WG III/III - Special Report on 1.5°C First Lead Author Meeting (organized by WGI) (Sao Jose Dos Campos, Brazil)
14 Mar - 17 Mar	TFI - "Use of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories - IPCC Expert Meeting to collect EFD8 and Software users' feedback" (Kitakyushu, Japan)
26 Mar - 27 Mar	53rd Session of the IPCC Bureau (March 26-27 a.m.) (Guadalajara, Mexico)
28 Mar - 31 Mar	45th Session of the IPCC (Guadalajara, Mexico)
26 Apr - 28 Apr	WG III - Expert Meeting on Mitigation, Sustainability and Climate Stabilisation Scenarios (Addis Ababa, Ethiopia)
1 May - 5 May	AR6 Scoping Meeting (Addis Ababa, Ethiopia)
5 Jun - 11 Jun	WG III/III - Second Lead Author Meeting for the SR15 (organized by WG I) (Eveloe, UK)
7 Jun - 14 Jun	TFI - Methodology Report: First Lead Author Meeting for the Elaboration of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, 1-a (Energy, IPPU, Waste) / 1-b (Agriculture, Forestry and Other Land Use - AFOLU) / 1-c (General Guidance and Reporting - GGR) (Bilbao, Spain)

### 2017 IPCC International Meetings

Date	Description and Venue
5 Sep - 5 Sep	54th session of the IPCC Bureau (Montreal, Canada)
6 Sep - 10 Sep	46th Session of the IPCC (Montreal, Canada)
11 Sep - 22 Oct	Call for CLALALARE Nominations (ARR)
24 Sep - 24 Sep	TFI - Second Lead Author Meeting for the Elaboration of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Coordinating Lead Author Meeting (Victoria Falls, Zimbabwe)
25 Sep - 28 Sep	TFI - Second Lead Author Meeting for the Elaboration of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Victoria Falls, Zimbabwe)
29 Sep - 29 Sep	TFI - Twenty-Ninth Meeting of the Bureau of the IPCC Task Force on National Greenhouse Gas Inventories (Victoria Falls, Zimbabwe)
2 Oct - 6 Oct	WG III - First Lead Author Meeting for Special Report on the Ocean and Cryosphere in a Changing Climate (organized by WGIII) (Nadi, Fiji)
16 Oct - 20 Oct	WG IV/III - First Lead Author Meeting on Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. (organized by WG III) (Oslo, Norway) <b>COP 23:</b>
23 Oct - 29 Oct	WG IV/III - Third Lead Author Meeting on SR15 (organized by WG I) (Malmö, Sweden) <b>November 6 – 17, 2017, Bonn, Germany</b>
12 Dec - 15 Dec	TFI - 16th Meeting of the IPCC Emission Factor Database (EFDB) Editorial Board (Paris, France)
13 Dec - 14 Dec	TFI - 16th Expert Meeting on Data for the IPCC Emission Factor Database (EFDB) (IPCC/IEA Expert Meeting on Data: Energy data collection, energy statistics and data for the IPCC EFDB) (Paris, France)

Why are we still talking about (future) impacts of climate change when there are many crises occurring around the world right now?

Why do they talk about climate change?  
Because it is

- In the future
- What they have
- Their privileges
- Their job security
- Safe to talk about climate change
- Easy to talk about climate change

