The 5<sup>th</sup> Asia-Pacific GAW Workshop on Greenhouse Gases 24 October 2013, Jeju

#### Major Issues from the New IPCC Report Climate Change 2013: The Physical Science Basis



NORKING GROUP I CONTRIBUTION TO THE HFTH ASSESSMENT REPORT OF THE NTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

 $(\mathbf{\hat{o}})$ 

KMA



Won-Tae Kwon

Korea Meteorological Administration

# Role of IPCC

The role of the IPCC is to assess on a comprehensive, objective, open and transparent basis the scientific , technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation. IPCC reports should be neutral with respect to policy, although they may need to deal objectively with scientific, technical and socio-economic factors relevant to the application of particular policies



### Structure

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE



WMO



# WGI AR5

- 2009: WGI Outline Approved → 14 Chapters & Atlas
- Authors: 259 from 39 Countries (Contributing Authors: 600 +)
- Comments: 54,677 by 1089 Experts
- SPM: ~14,000 Words, Key Messages: 19 Headlines



copyngnt@2015.KIVIA



# Contents of AR4 & AR5

	(2007) AR4	4	AR5 (2013)
1.	Historical overview of climate change		. Introduction
2.	Changes in atmospheric constituents and	- 2	Deservations: Atmosphere and Surface
	radiative forcings		B. Observations: Ocean
3.	Observations: surface and atmospheric	4	Dbservations: Cryosphere
	changes	- 5	Information from Paleoclimate Archives
4.	Observations: Changes in Snow, Ice and	e	c. Carbon and Other Biogeochemical Cycles
	Frozen Ground	7	c. Clouds and Aerosols
5.	Observations: Oceanic Climate Change	8	Anthropogenic and Natural Radiative Forcing
	and Sea Level	g	Evaluation of Climate Models
6.	Palaeoclimate	1	o. Detection and Attribution of Climate Change:
7.	Couplings Between Changes in the		from Global to Regional
	Climate System and Biogeochemistry	1	1. Near-term Climate Change: Projections and
8.	Climate Models and Their Evaluation		Predictability
9.	Understanding and Attributing Climate	1	2. Long-term Climate Change: Projections,
	Change		Commitments and Irreversibility
10	. Global Climate Projections		3. Sea Level Change
11	Regional Climate Projections	1	4. Climate Phenomena and their Relevance for
			Future Regional Climate Change
			Appendix: Atlas of Global and Regional Projections

# CUMATE CHARGE 2013

Warming of the climate system is unequivocal OBSERVATION

### **Global Mean Temperature**

The globally averaged temperature show a warming of 0.85 [0.65 to 1.06] °C, over the period 1880-2012.
Since 1901, almost the entire globe has experienced surface warming



# **Multiple Observed Indicators**



- (a) Extent of Northern Hemisphere March-April (spring) average snow cover,
- (b) Extent of Arctic July-August-September (summer) average sea ice,
- (c) change in global mean upper ocean (0-700 m) heat content relative to the mean for 1971,
- (d) global mean sea level relative to the 1900-1905 mean



# CUMATE CHANGE 2013 The Division Science Letter

Total radiative forcing is positive, and has led to an uptake of energy by the climate system DRIVERS OF CLIMATE CHANGE

# Changes in CO<sub>2</sub> Concentration





# **Radiative Forcing**



The total anthropogenic RF for 2011 relative to 1750 is 2.29 [1.13 to 3.33] W m<sup>-2</sup>. The total anthropogenic RF best estimate for 2011 is 43% higher than that reported in AR4 for the year 2005.



# CUMATE CHANGE 2013

Human influence on the climate system is clear UNDERSTANDING THE CLIMATE SYSTEM

### Greater Certainty in Attribution

- FAR (1990): "unequivocal detection not likely for a decade"
- SAR (1995): "balance of evidence suggests discernible human influence"
- TAR (2001): "most of the warming of the past 50 years is *likely* (odds 2 out of 3) due to human activities"
- AR4 (2007): "most of the warming is very likely (odds 9 out of 10) due to greenhouse gases"
- AR5 (2013): "It is *extremely likely* (odds 19 out of 20) that human influence has been the dominant cause of the observed warming since the mid-20<sup>th</sup> century."

#### A Progression of Understanding: Greater and Greater Certainty in Attribution





It is *extremely likely* that more than 50% of the warming since 1951 is due to the increase in greenhouse gases and other anthropogenic forcings together.

# CUMATE CHANGE 2013

Continued emission of greenhouse gases will cause further warming and changes in a components of the climate system

### FUTURE GLOBAL AND REGIONAL CLIMATE CHANGE

#### RCP Scenario: CO<sub>2</sub> Emission and Radiative Forcing



**RCP: Representative Concentration Pathways** 



### SRES vs RCP

#### 2100 CO<sub>2</sub> Concentration (ppm)

SRES	CO <sub>2</sub> (CO <sub>2</sub> -eq)	RCP	CO <sub>2</sub> (CO <sub>2</sub> -eq)
A1FI	970 (1550)		
A2	830 (1250)	RCP8.5	936 (1370)
A1B	720 (850)	RCP6.0	670 (850)
<b>B2</b>	600 (800)		
B1	550 (600)	RCP4.5	538 (650)
A1T	540 (700)	RCP2.6	421 (490)





<2100 CO<sub>2</sub>-eq Concentration (ppm)>



# Model Evaluation



CMIP-Coupled Model Intercomparison Project CMIP1: IPCC 2 (1995) CMIP2: IPCC 3 (2001) CMIP3: IPCC 4 (2007) CMIP5: IPCC 5 (2013)

## **Temperature:** Future Projection

- Increase of global mean surface temperatures for 2081–2100 relative to 1986–2005 is projected to *likely* be in the ranges derived from the concentration driven CMIP5 model simulations, that is, 0.3°C to 1.7°C (RCP2.6), 1.1°C to 2.6°C (RCP4.5), 1.4°C to 3.1°C (RCP6.0), 2.6°C to 4.8°C (RCP8.5).
- Global surface temperature change for the end of the 21st century is *likely* to exceed 1.5°C relative to 1850 to 1900 for all RCP scenarios except RCP2.6. It is *likely* to exceed 2°C for RCP6.0 and RCP8.5, and *more likely than not* to exceed 2°C for RCP4.5.

Commis	Temperature change (°C)			
Scenario	2046-2065	2081-2100		
RCP 2.6	1.0(0.4 ~ 1.6)	1.0(0.3 ~ 1.7)		
RCP 4.5	1.4(0.9 ~ 2.0)	1.8(1.1 ~ 2.6)		
RCP 6.0	1.3(0.8 ~ 1.8)	2.2(1.4 ~ 3.1)		
RCP 8.5	2.0(1.4 ~ 2.6)	3.7(2.6 ~ 4.8)		

<GMST change by the end of the 21st century relative to 1850-2000>

≥ <b>1.5</b> ℃	Likely	RCP4.5, RCP6.0, RCP8.5
	Likely	RCP6.0, RCP8.5
≥ <b>2.0</b> ℃	More likely than not	RCP4.5
	unlikely	RCP2.6

RCP 2.6

RCP 8.5



Change in average surface temperature (1986–2005 to 2081–2100)



#### Sea Level and Cryosphere: Future Projection

- Under all RCP scenarios the rate of sea level rise will *very likely* exceed that observed during 1971–2010 due to increased ocean warming and increased loss of mass from glaciers and ice sheets.
- The global ocean will continue to warm during the 21st century. Heat will penetrate from the surface to the deep ocean and affect ocean circulation.
- It is *very likely* that the Arctic sea ice cover will continue to shrink and thin and that Northern Hemisphere spring snow cover will decrease during the 21st century as global mean surface temperature rises. Global glacier volume will further decrease.





# Extreme Events (Table SPM.1)

Dhanamanan	Observed changes		Likelyhood of future change	
Phenomenon			Early 21 <sup>st</sup> century	Late 21 <sup>st</sup> century
Cold day & night (warmer, less frequent)	Very likely	Very likely	Likely	Virtually certain
Warm day & night (warmer, more frequent)	Very likely	Very likely	Likely	Virtually certain
Warm spell/ Heat wave (intensity, frequency)	Likely	Likely	-	Very likely
Heavy precipitation (intensity, frequency)	Likely more land area	Medium confidence	Likely over many land area	Very likely over most mid-lat land
Drought (intensity, duration)	Likely in some	Low confidence	Low confidence	Likely
Tropical cyclone (intensity)	Low confidence	Low confidence	Low confidence	More likely than not
Extreme high sea level (intensity, frequency)	Likely	Likely	Likely	Very likely

# CUMATE CHARGE 2013

Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions

CLIMATE STABLIZATION, CLIMATE CHANGE COMMITMENT AND IRREVERSIBILITY



#### Cumulative CO<sub>2</sub> Emission and Temperature Change



# CUMATE CHARGE 2013

### GLOBAL AND REGIONAL CLIMATE CHANGE ATLAS

# **Atlas: East Asia Climate Projection**

#### Temperature



# Atlas: East Asia Climate Projection





# New Climate Projection over Korea

Climate scenarios: the response of the climate system to emission scenarios of greenhouse gases, aerosols and landuse change based on population growth, energy mix, technologies, economical development, environmental policy, etc.

To investigate the potential consequences of the



Impacts and vulnerability assessment and adaptation policy on different sectors and regions



Model

\*\*\*\*\*\*\*\*\*\*\*\*\*

**IPCC** 

**WMO** 

IAV Future **IPCC DDC** 2041-205 Communit Projection Climate

(NIMR, 2013) (www.climate.go.kr)



### **Regional projection**



# IPCC WGI AR5: Key Messages

- Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased.
- Total radiative forcing is positive, and has led to an uptake of energy by the climate system. The largest contribution to total radiative forcing is caused by the increase in the atmospheric concentration of CO<sub>2</sub> since 1750.
- Human influence on the climate system is clear. This is evident from the increasing greenhouse gas concentrations in the atmosphere, positive radiative forcing, observed warming, and understanding of the climate system.
- Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions.

#### Rocky Mts National Park: Now and Then

hank Bear Lake, 1983 May Bear Lake, 2006 May Copyright © 2006 by WT Kwon