



Strengthening Flood Forecasting in ASEAN Member States through Regional Trainings and Coordination

Module 1

Water and Climate

- Prologue: A Diverse and Interconnected Earth
- The Role of the Water Cycle in the Climate System
- Climate Change and Frequent Flooding
- Epilogue: Disaster Resilience and Sustainability



WORLD
METEOROLOGICAL
ORGANIZATION



Centre
Under the auspices
of UNESCO



International Centre for Water
Hazard and Risk Management
under the auspices of UNESCO



Public Works Research Institute,
National Research and Development
Agency, Japan

Toshio Koike
Executive Director
ICHARM, PWRI





Strengthening Flood Forecasting in ASEAN Member States through Regional Trainings and Coordination

Module 1

Water and Climate

- Prologue: A Diverse and Interconnected Earth
- The Role of the Water Cycle in the Climate System
- Climate Change and Frequent Flooding
- Epilogue: Disaster Resilience and Sustainability



WORLD
METEOROLOGICAL
ORGANIZATION



Centre
Under the auspices
of UNESCO



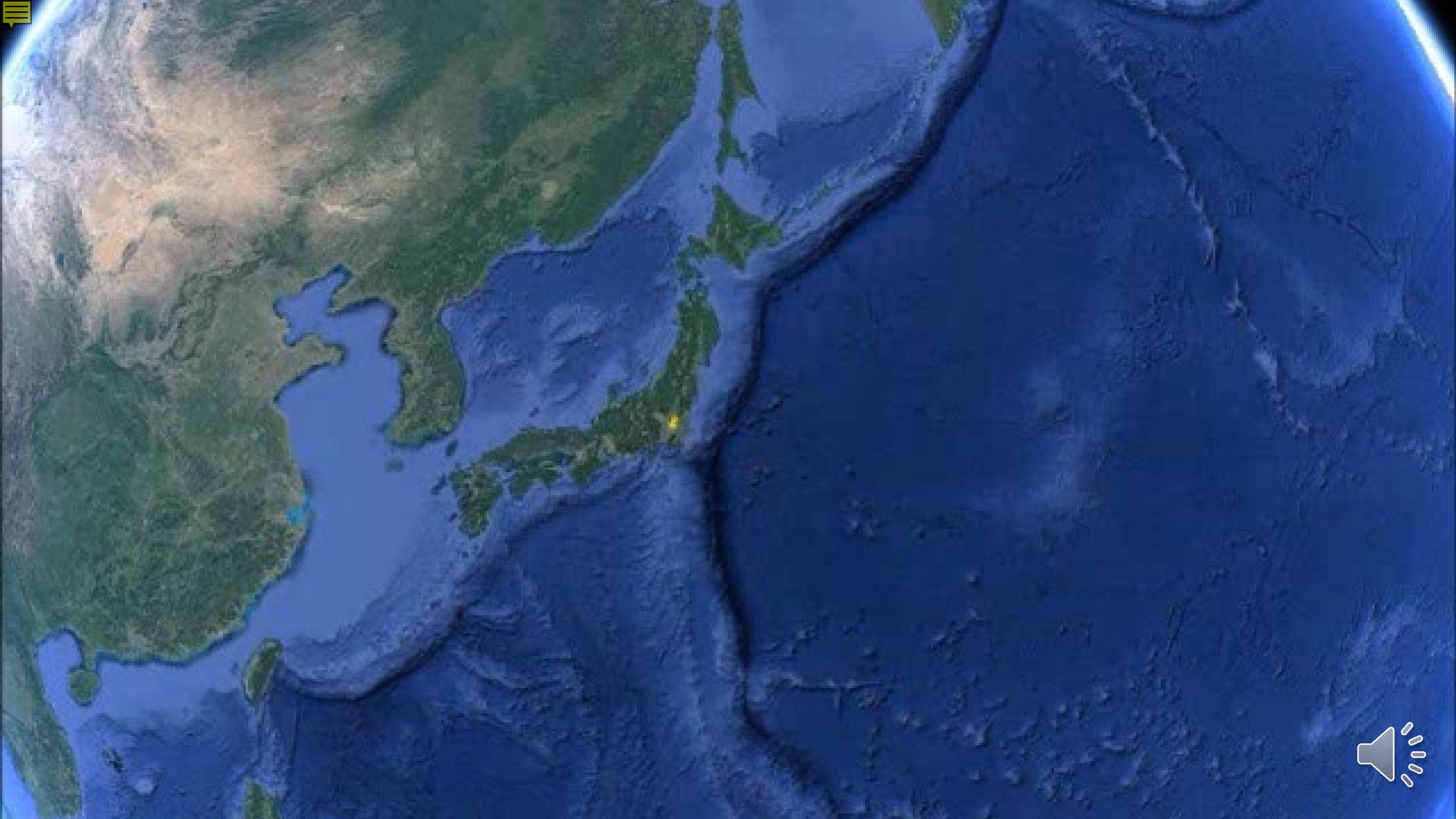
International Centre for Water
Hazard and Risk Management
under the auspices of UNESCO



Public Works Research Institute,
National Research and Development
Agency, Japan

Toshio Koike
Executive Director
ICHARM, PWRI







A 32m tower in Yakutsk, Siberia,
measuring the exchange of
water, heat and matter between
the forest and the atmosphere.
(November 24, 1997)









Yakutsk





A 50m tower in Manaus, Amazon,
measuring the exchange of water,
heat and matter between the
forest and the atmosphere.
(February 8, 1998)





July/2013



September/2013



November/2013





Law and slender trees



A towering giant reaching 40m into the sky





high	—	Productivity	—	low
active	—	Microbial Activity	—	inactive
strong	—	Natural Predator	—	weak
strong	—	Meteorological Disturbance	—	weak
complicated	—	Coexistence	—	simple
diversity	—	Survival Strategy	—	monotony

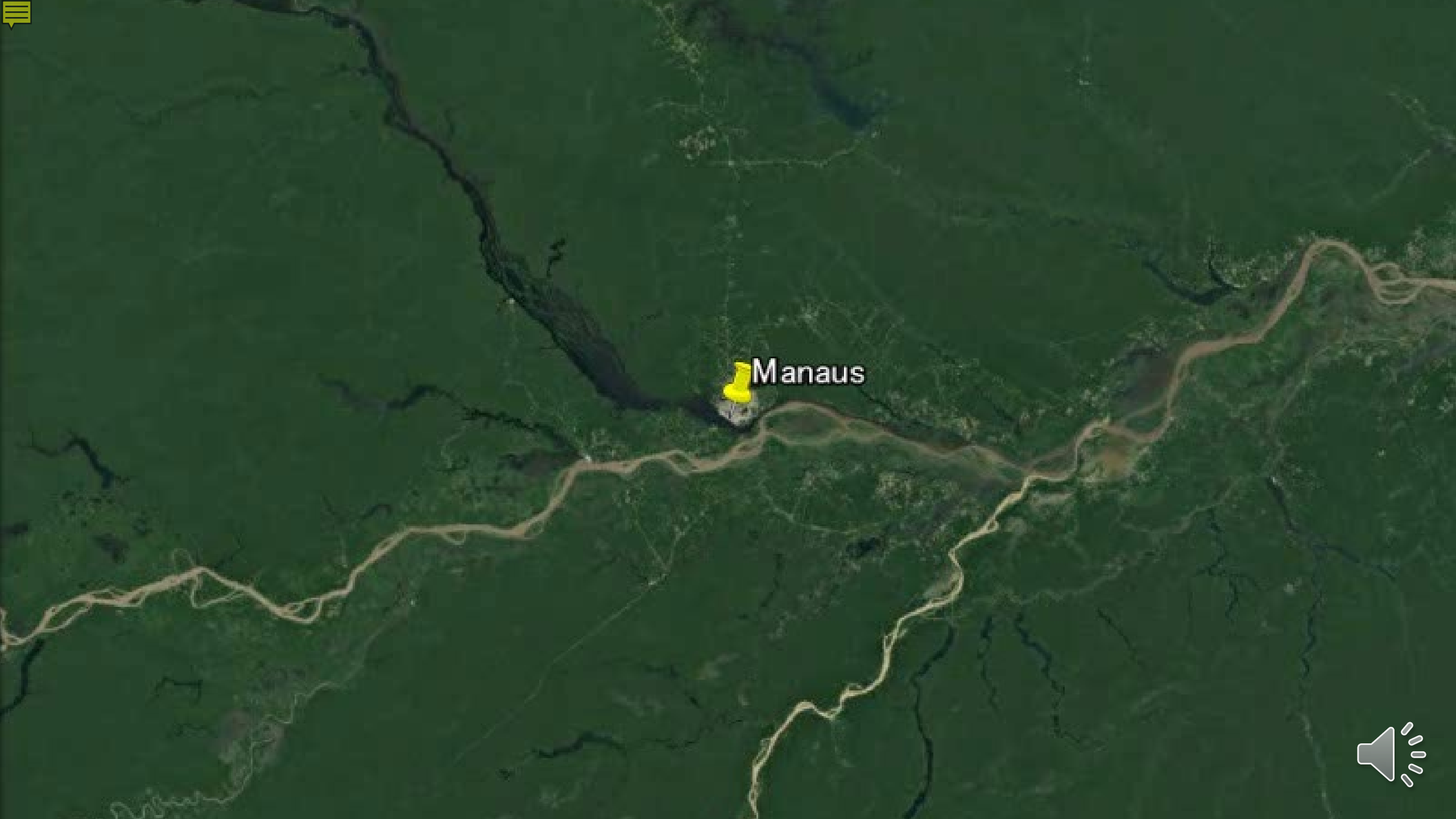
N (nitrogen)

P (phosphoric acid)

K (potassium, Kalium)

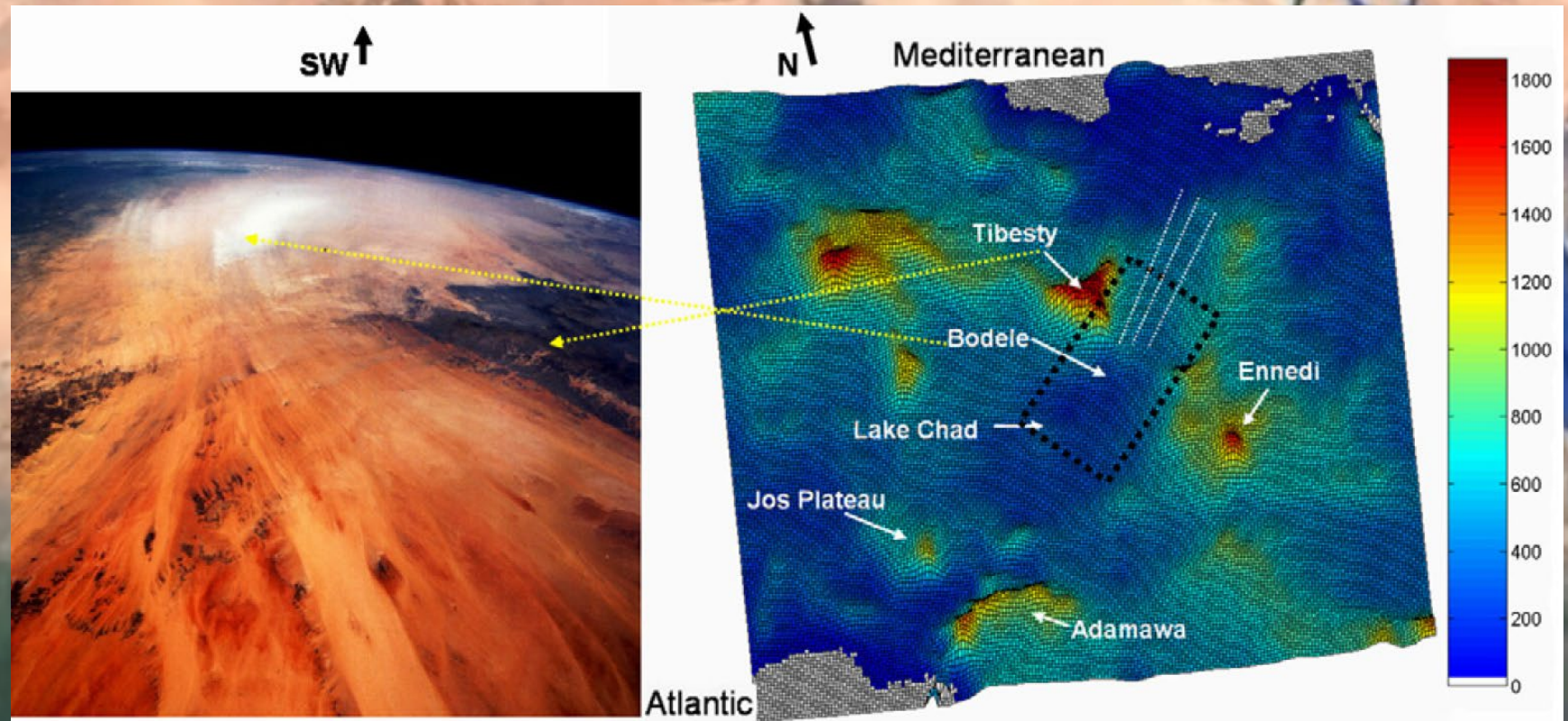
water-soluble materials



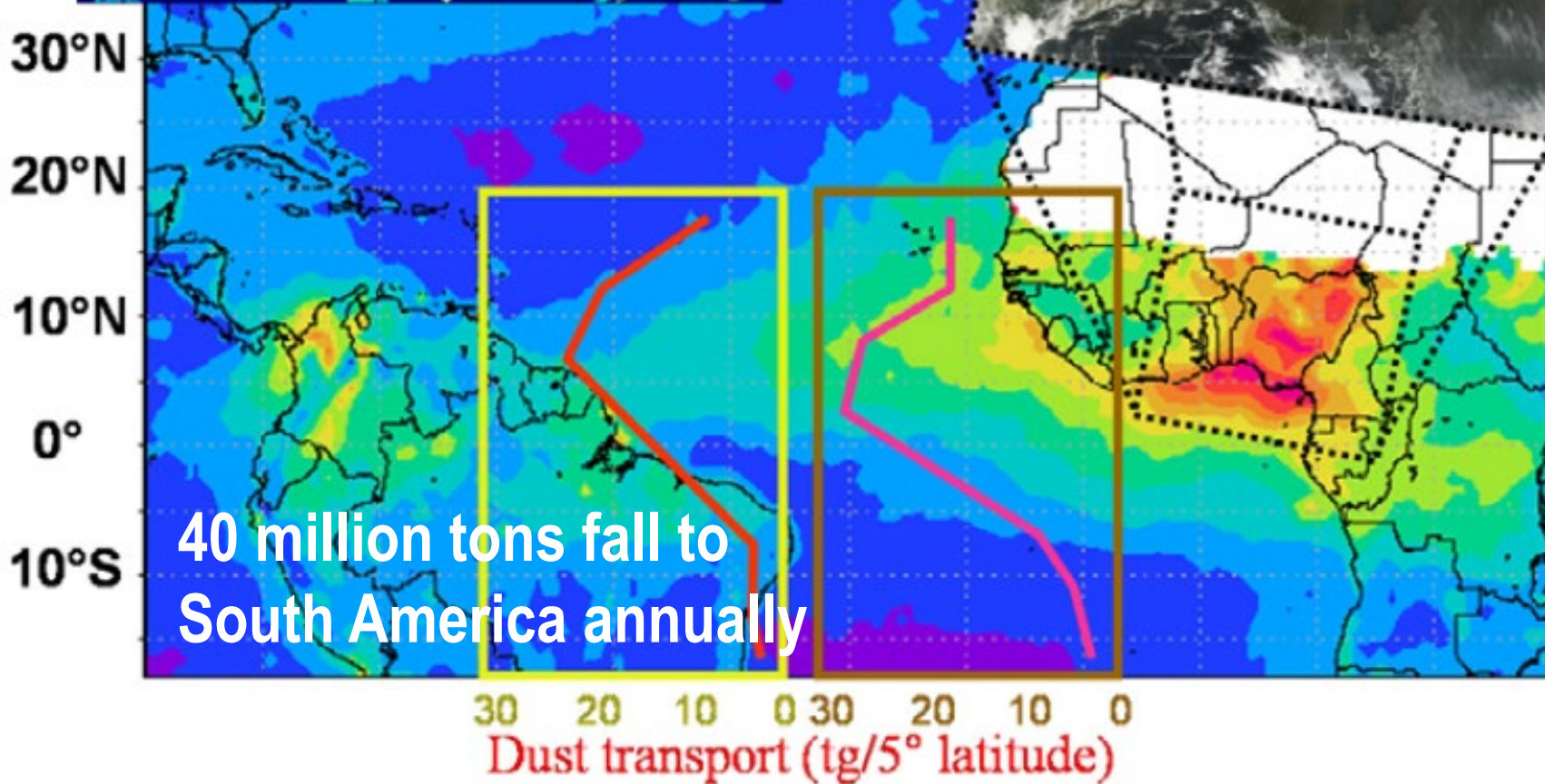
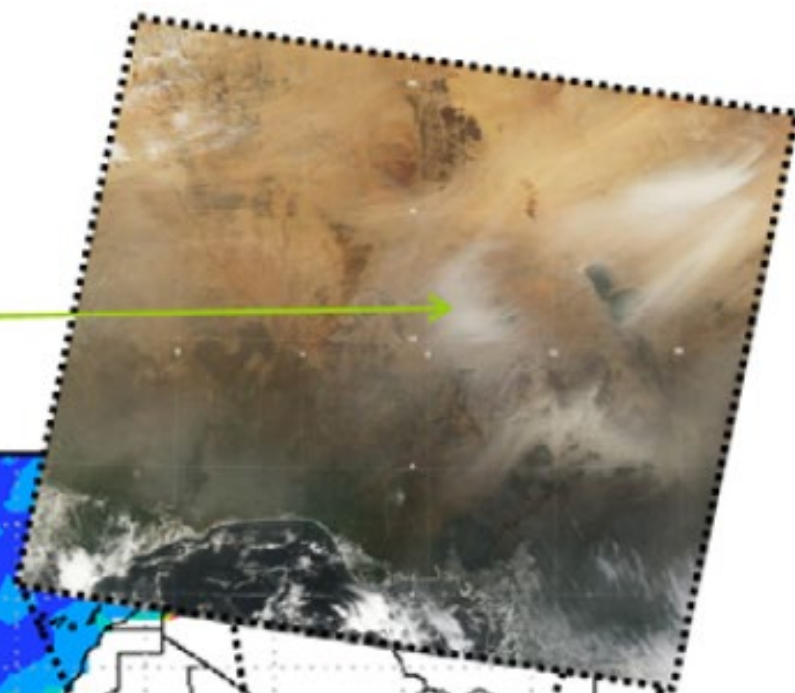
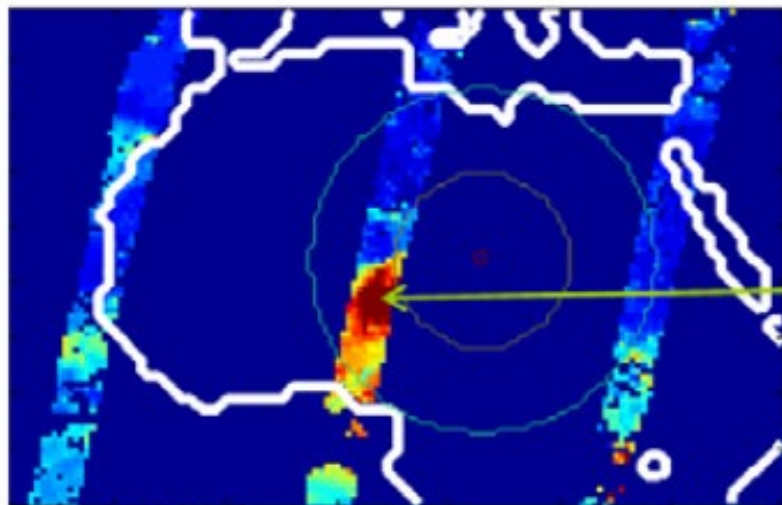


Manaus









40 million tons fall to
South America annually

In winter,
700,000 tons per day,
or
80 million tons per year,
are sent to the Atlantic Ocean,
with 56% of that originating
from the Bodele Depression.



 **Bodele Depression**





Strengthening Flood Forecasting in ASEAN Member States through Regional Trainings and Coordination

Module 1

Water and Climate

- Prologue: A Diverse and Interconnected Earth
- **The Role of the Water Cycle in the Climate System**
- Climate Change and Frequent Flooding
- Epilogue: Disaster Resilience and Sustainability

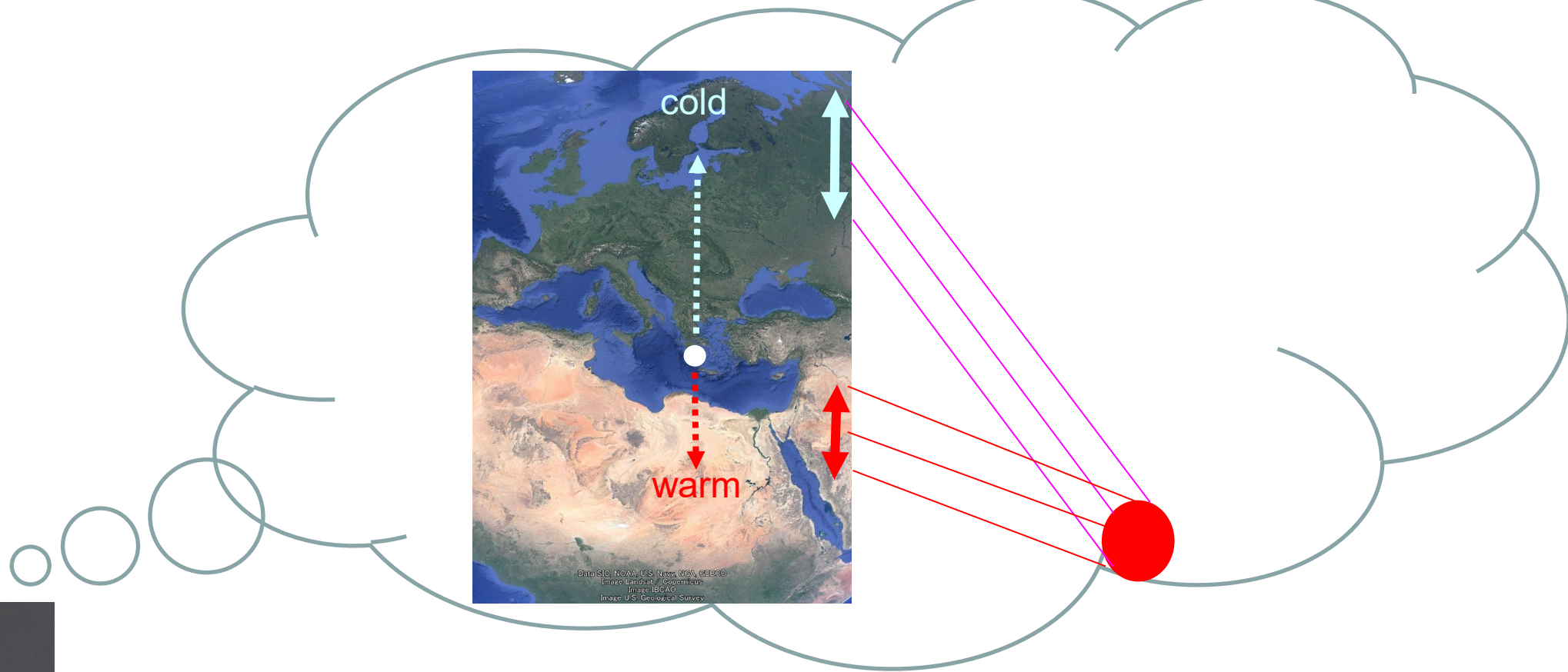


WORLD
METEOROLOGICAL
ORGANIZATION



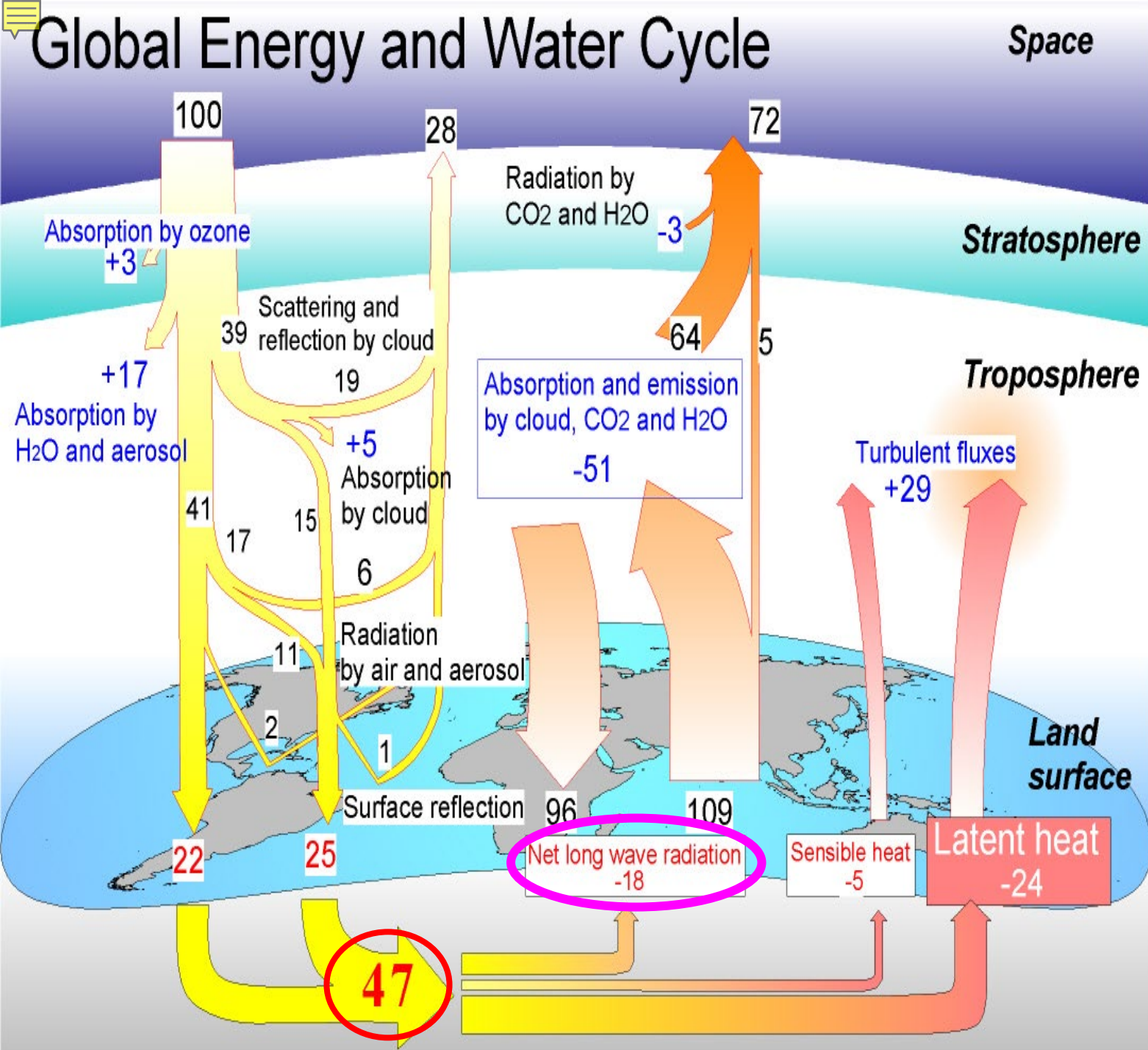
Toshio Koike
Executive Director
ICHARM, PWRI





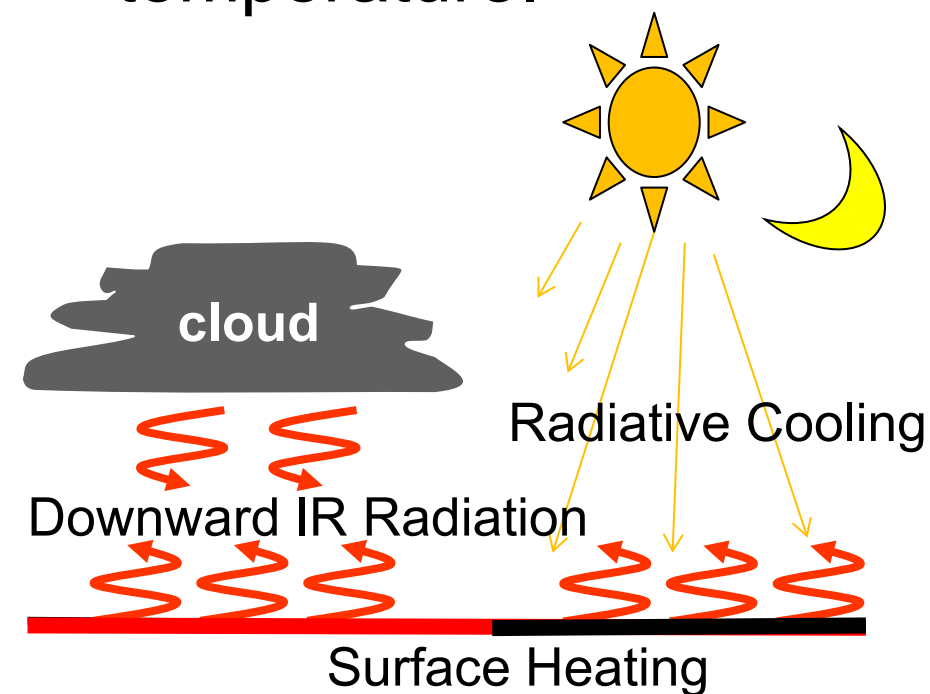
The English word '**climate**' comes from the Ancient Greek word '**klima**', which originally meant '**inclination**' or '**slope**'.

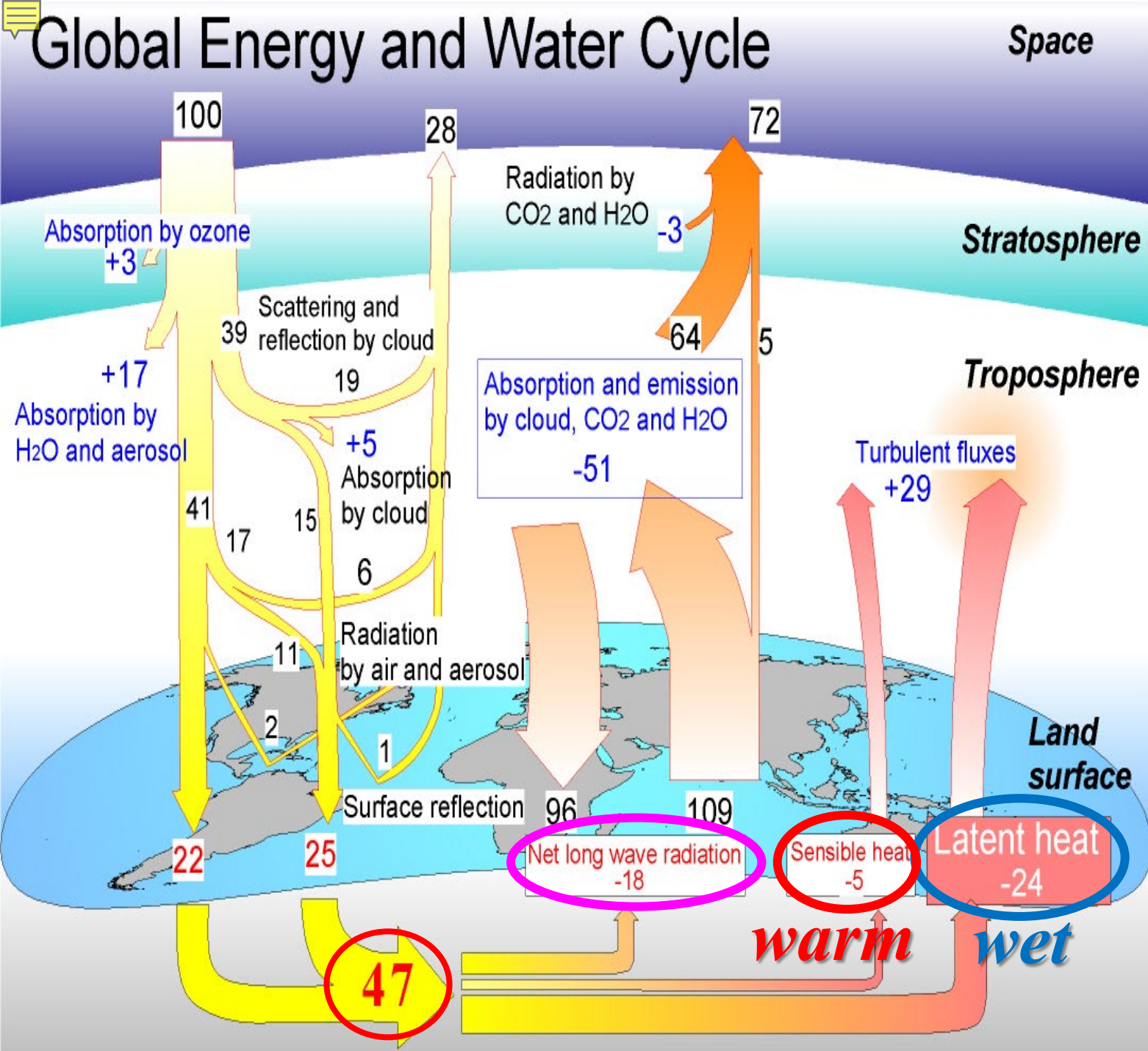
The ancient Greeks believed that **the angle of sunlight** changed as one travelled north or south, resulting in regional differences in temperature and environment. 



Stefan-Boltzmann Law

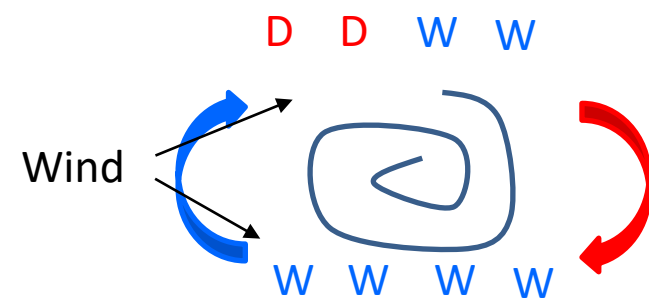
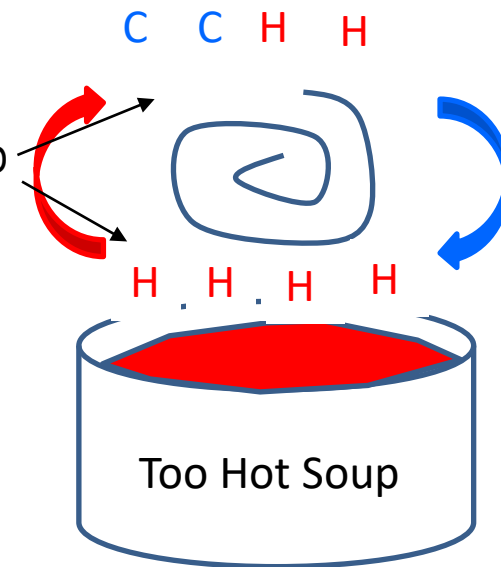
Material emits radiative energy with the forth power of the surface temperature.





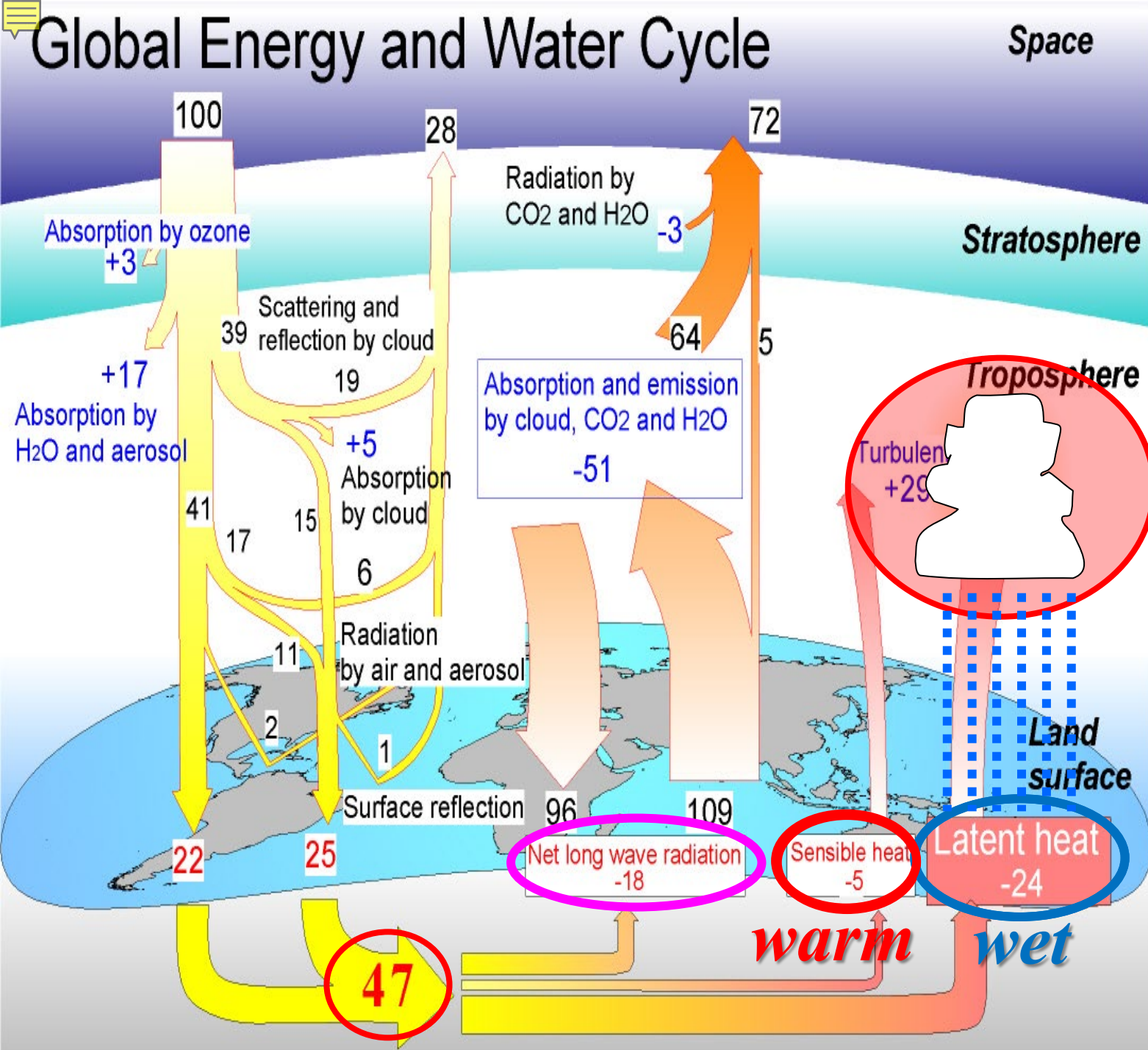
20

Blow on the soup to cool it down.



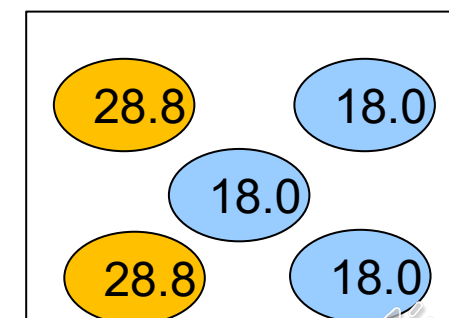
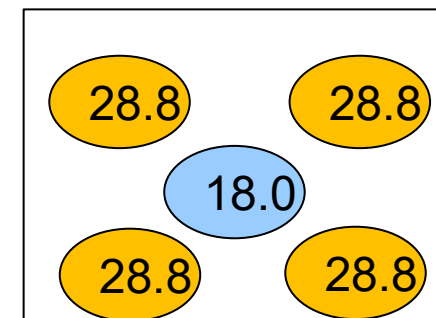
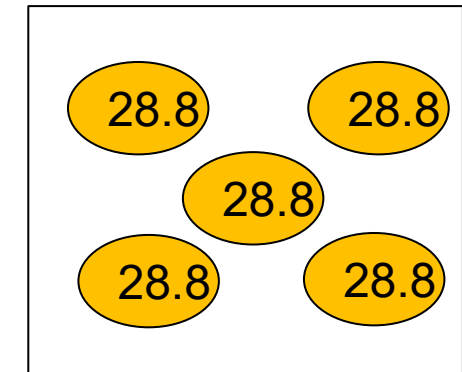
sprinkling water



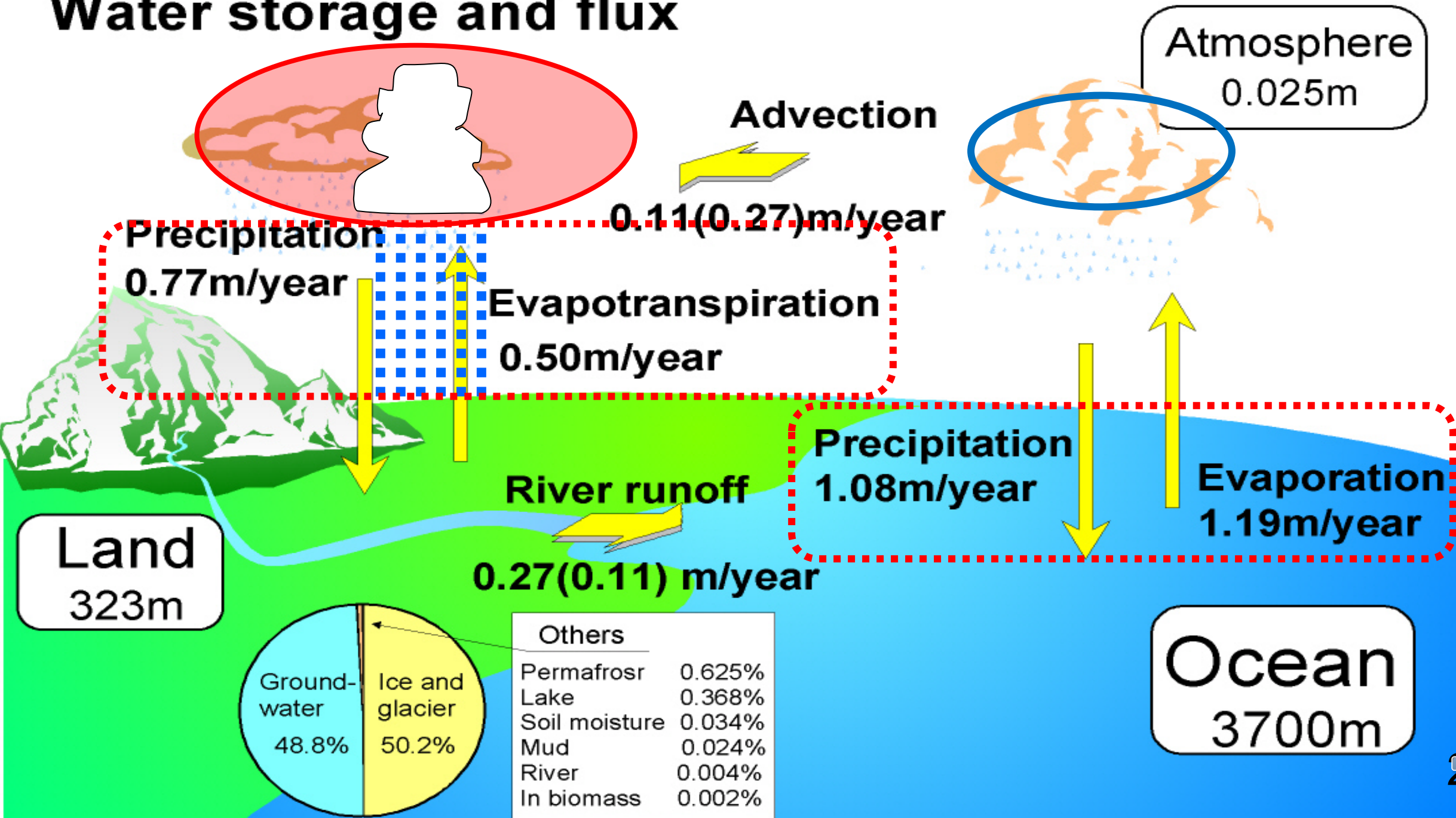


Warm Air - Cool Air 21 Dry Air - Wet Air

Regardless of kinds of gases, a same number of molecules is included in a certain volume of gas under a certain temperature and pressure.



Water storage and flux





Strengthening Flood Forecasting in ASEAN Member States through Regional Trainings and Coordination

Module 1

Water and Climate

- Prologue: A Diverse and Interconnected Earth
- The Role of the Water Cycle in the Climate System
- **Climate Change and Frequent Flooding**
- Epilogue: Disaster Resilience and Sustainability



WORLD
METEOROLOGICAL
ORGANIZATION



Centre
Under the auspices
of UNESCO



International Centre for Water
Hazard and Risk Management
under the auspices of UNESCO



Public Works Research Institute,
National Research and Development
Agency, Japan

Toshio Koike
Executive Director
ICHARM, PWRI





Climate Change and Frequent Flooding

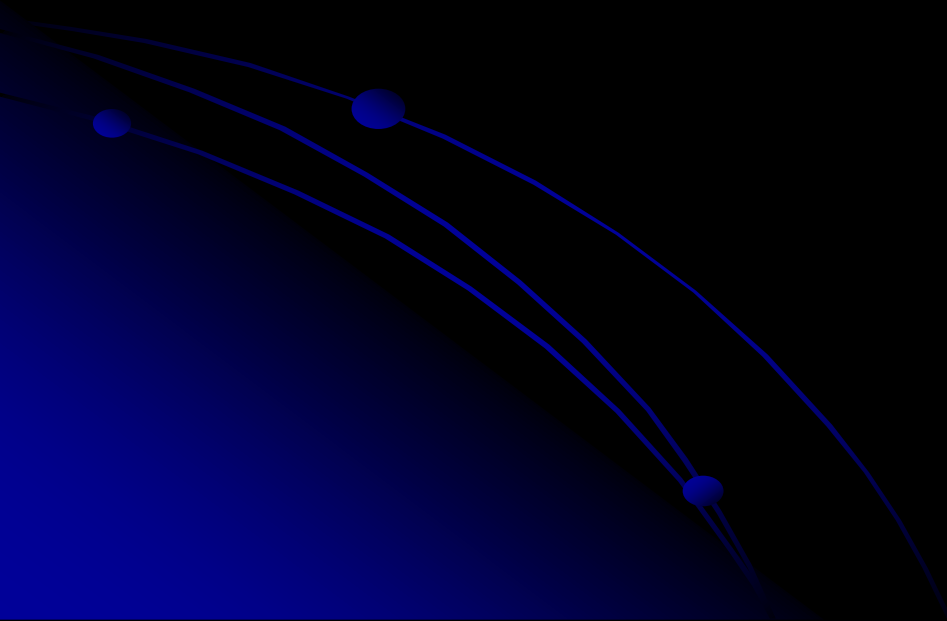
Is the frequency of heavy rainfall likely to increase due to climate change?





Climate Change and Frequent Flooding

Is the frequency of heavy rainfall likely to increase due to **climate change**?



Is the climate changing?

Warming of the climate system is unequivocal. IPCC/AR4 (2007)

The Intergovernmental Panel on Climate Change (IPCC):

an intergovernmental organization which determines the state of knowledge on climate change.

Five Assessment Reports (AR):

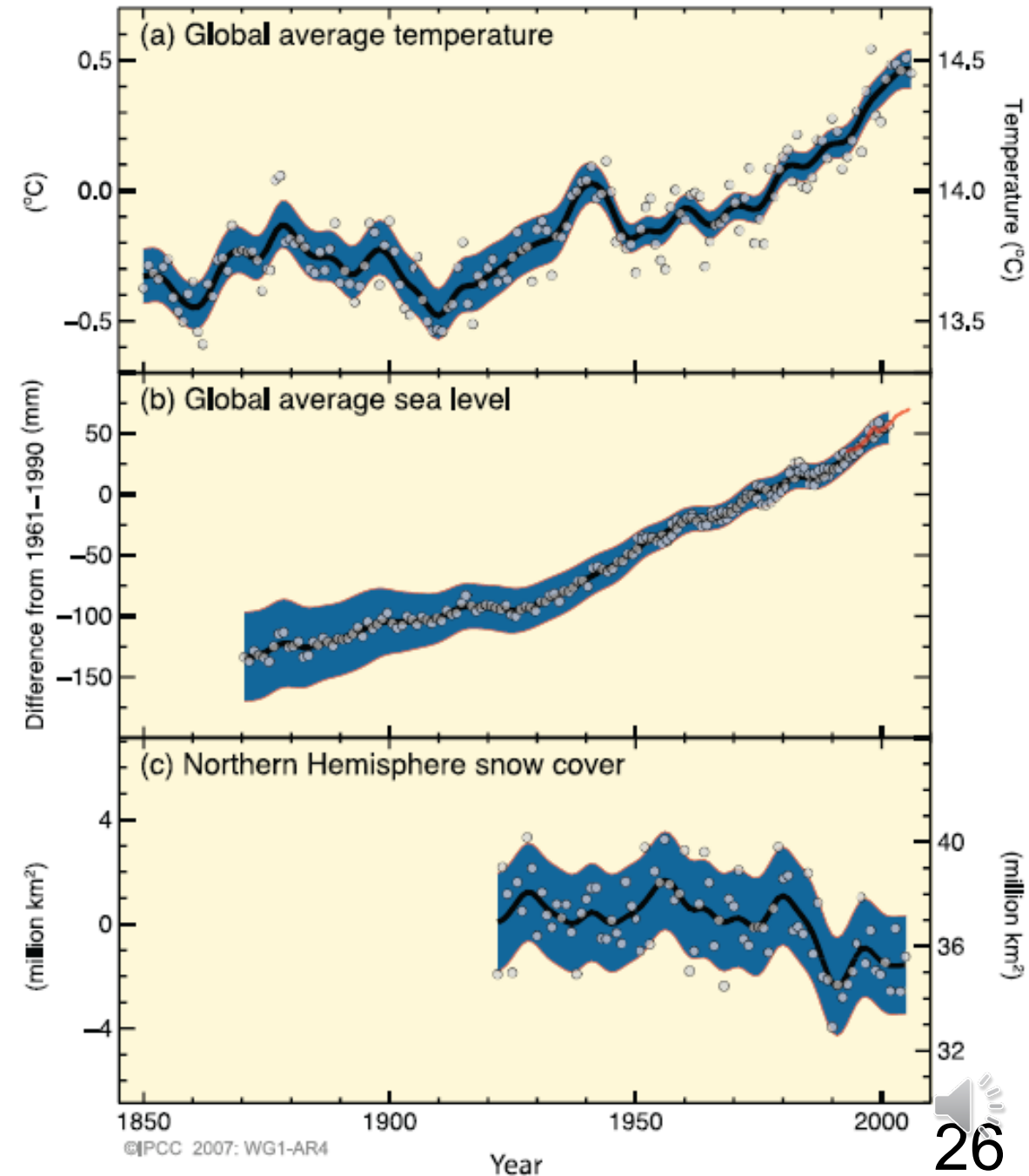
1990, 1995, 2001, **2007**, 2013-2014, 2021-2022.

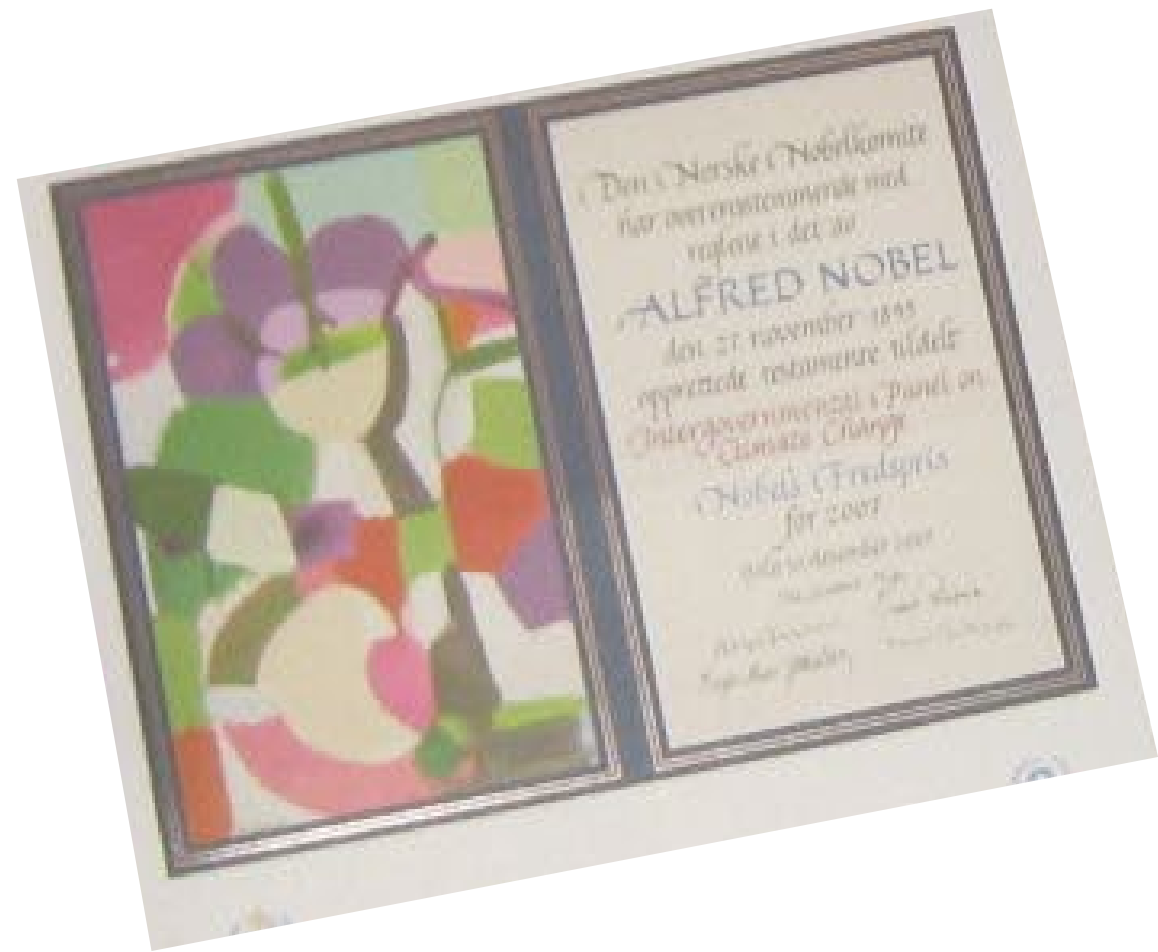
Three Working Groups:

WG I: physical science basis

WG II: impacts, adaptation, vulnerability

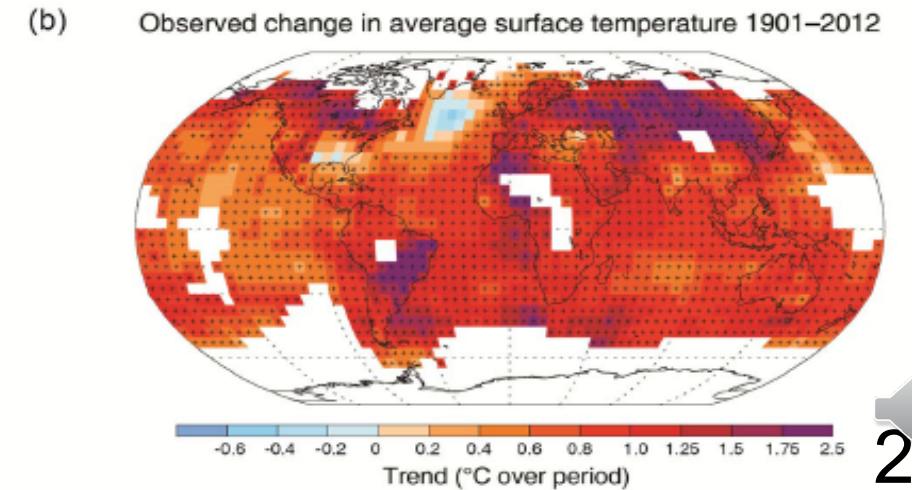
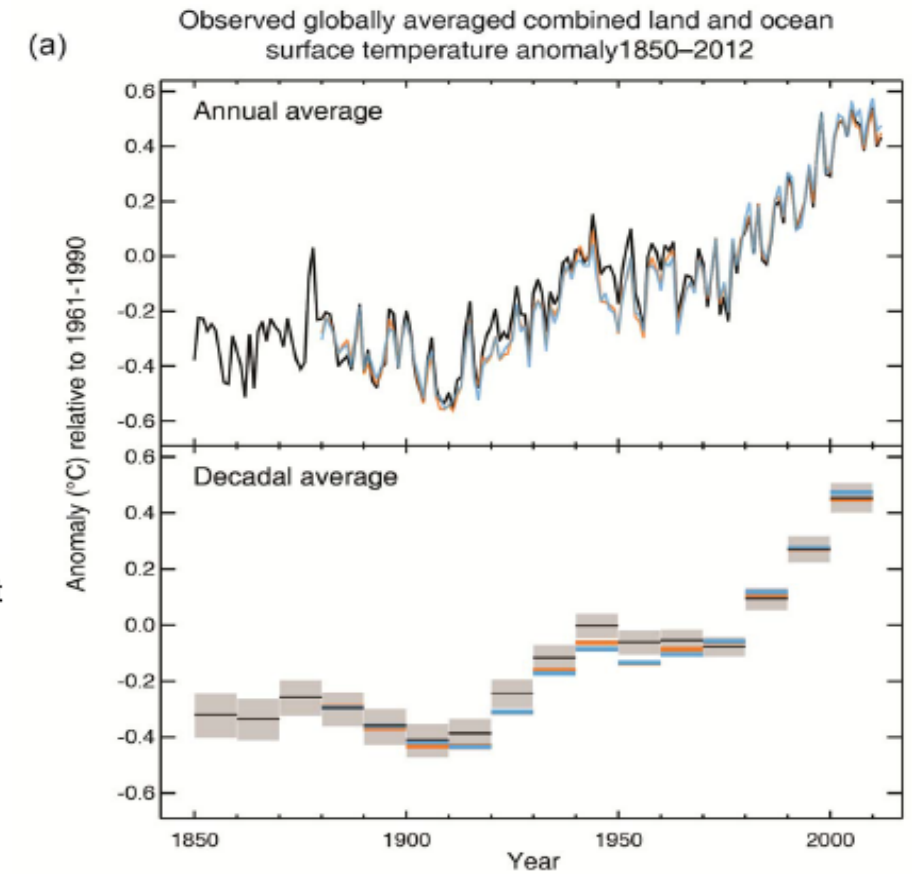
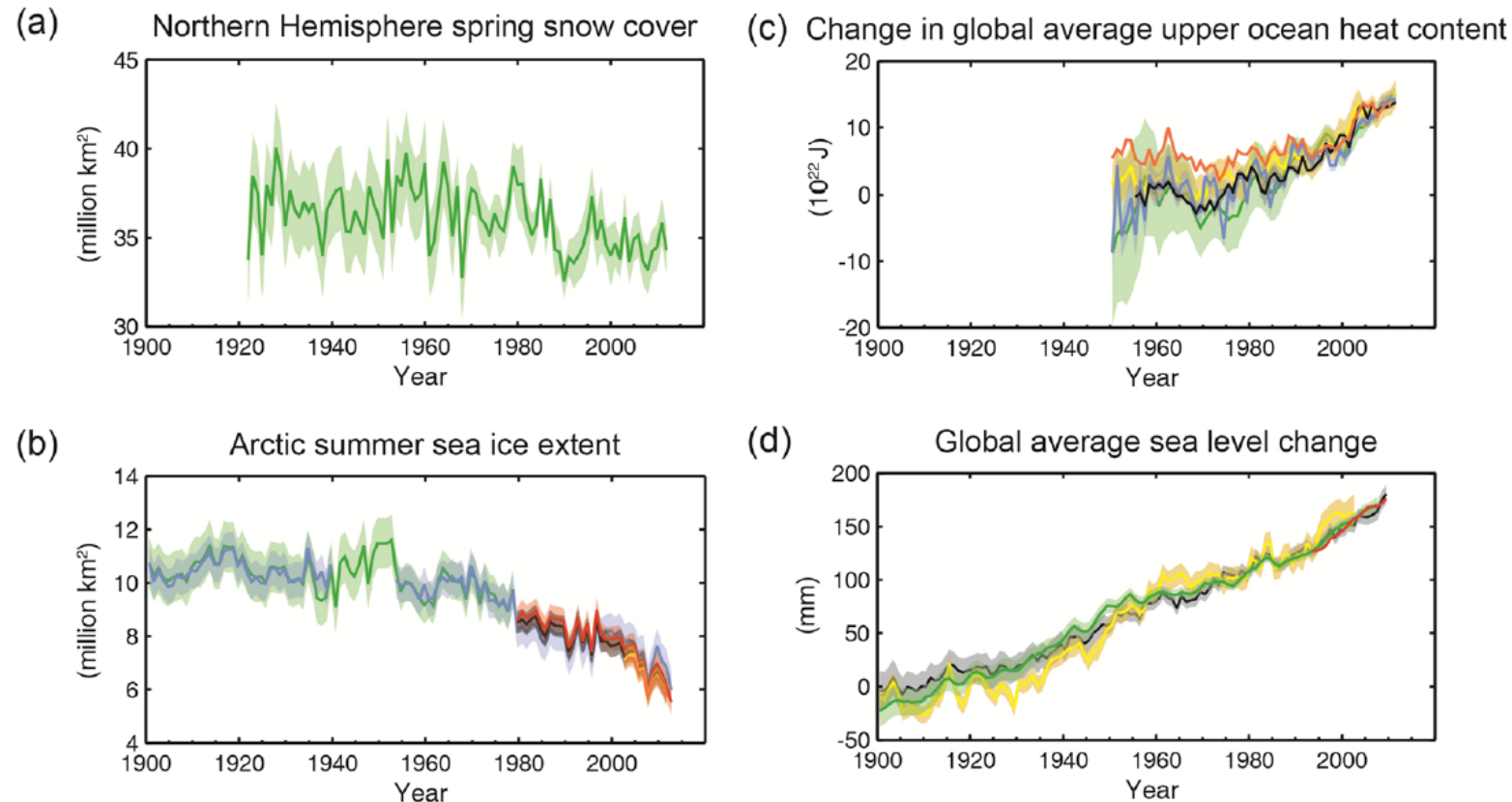
WG III: mitigation of climate change

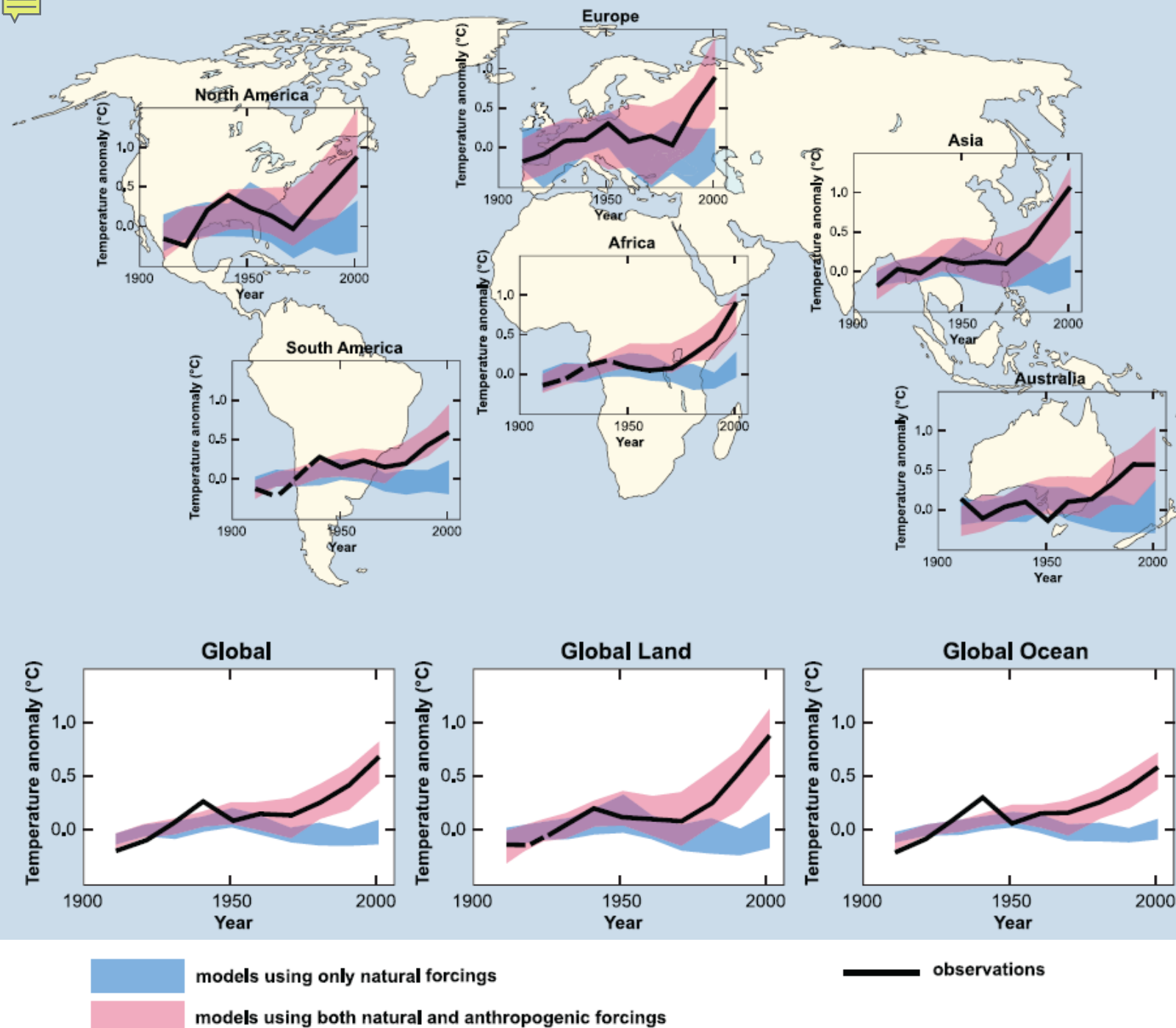




Is the climate changing?

**Warming of the climate system
is unequivocal. IPCC/AR5 (2013)**





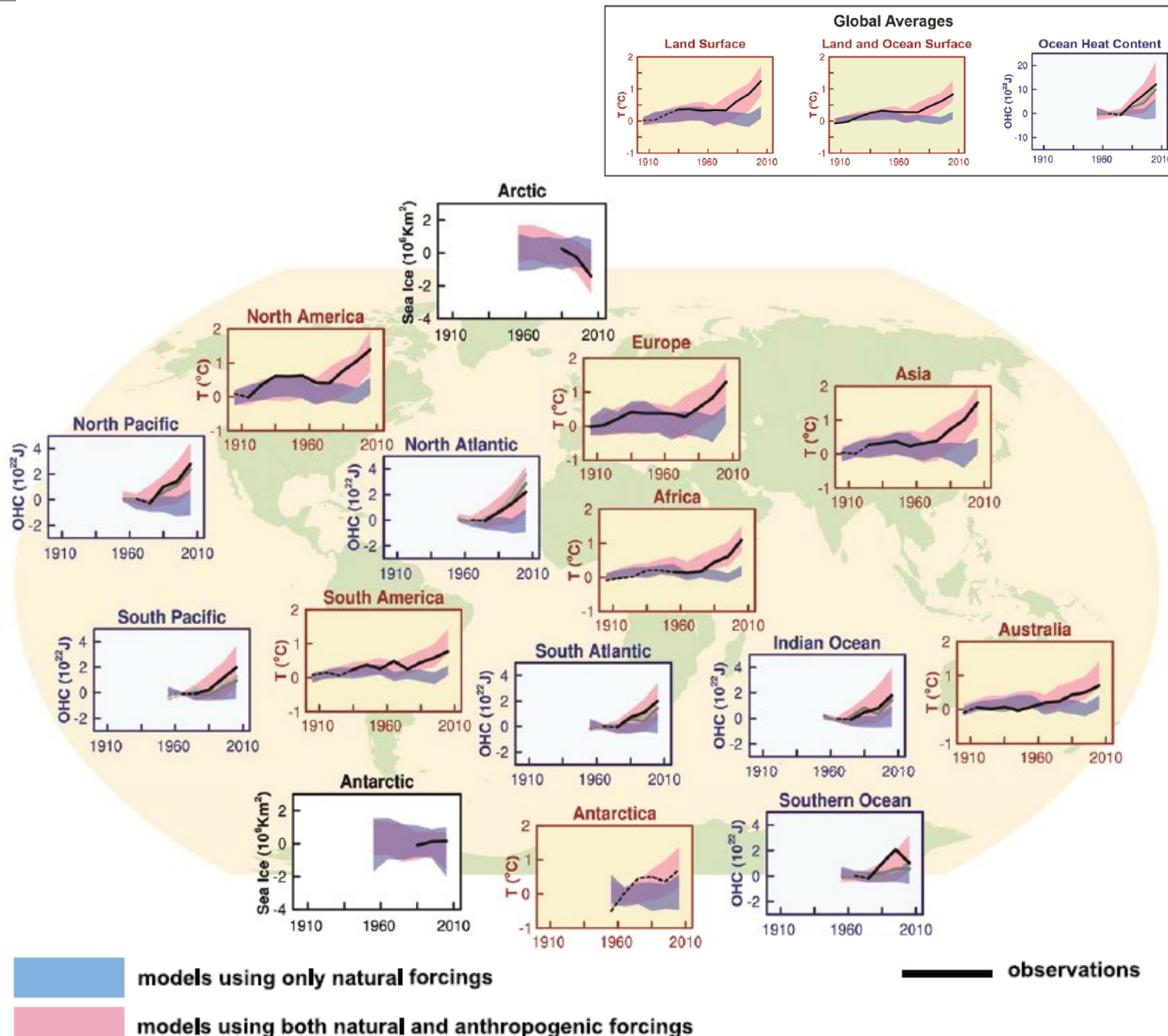
What does change the climate?

Most of the observed increase in global average temperatures since the mid-20th century is **very likely** due to the observed increase in anthropogenic greenhouse gas concentrations. (IPCC/AR4, 2007)



What does change the climate?

It is extremely likely that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcings together. (IPCC/AR5, 2013)

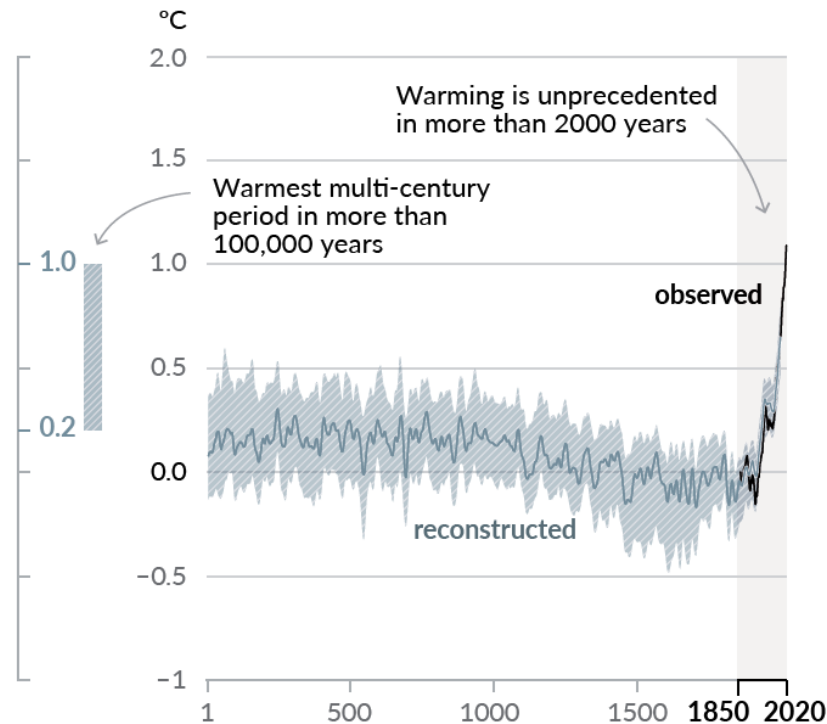


Is the climate changing? / What does change the climate?

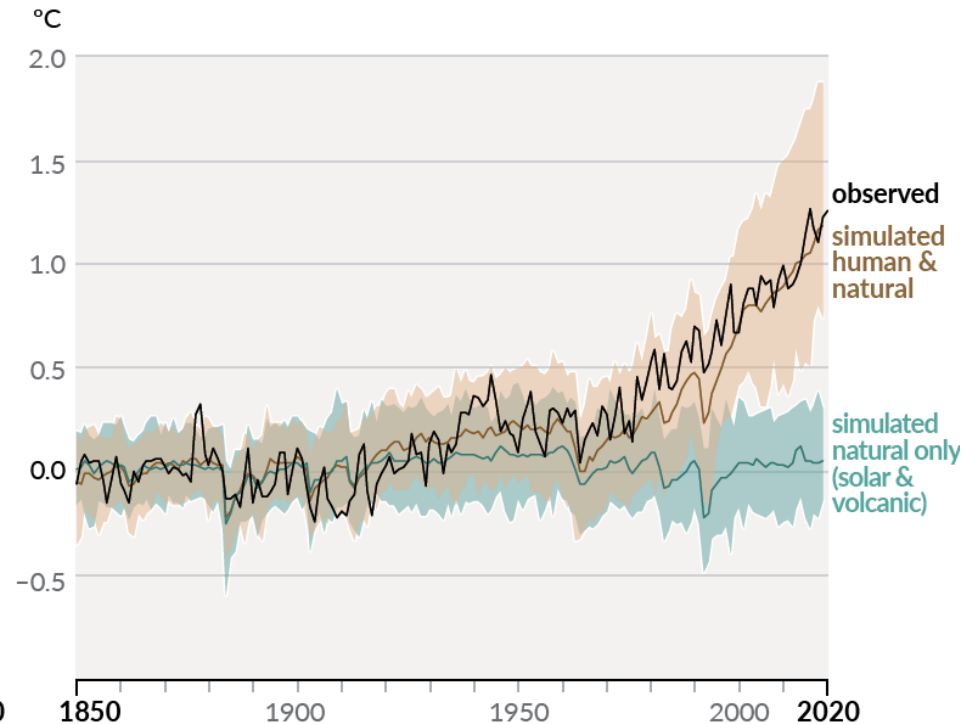
Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

Changes in global surface temperature relative to 1850–1900

(a) Change in global surface temperature (decadal average) as **reconstructed** (1–2000) and **observed** (1850–2020)



(b) Change in global surface temperature (annual average) as **observed** and simulated using **human & natural** and **only natural** factors (both 1850–2020)



It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred. (IPCC/AR6, 2021)



Climate Change and Frequent Flooding

Is the frequency of **heavy rainfall** likely to increase due to climate change?



2021 Nobel Prize in Physics



Dr. Syukuro MANABE

radiation --- convection equilibrium

(green house effect)
long-wave radiation

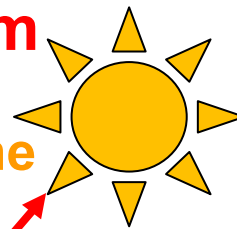
sunshine

convection

Heavy
Rainfall

subsidence → dry

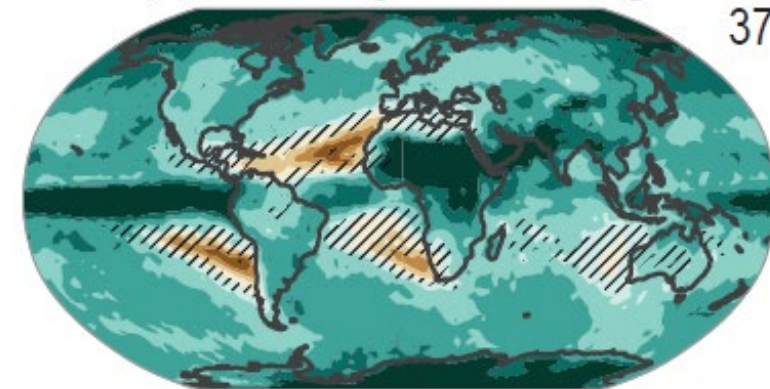
subsidence → dry



IPCC/AR6/WG1, 2021

The frequency and intensity of heavy precipitation events have increased since the 1950s over most land area for which observational data are sufficient for trend analysis.

(c) At 4.0°C global warming



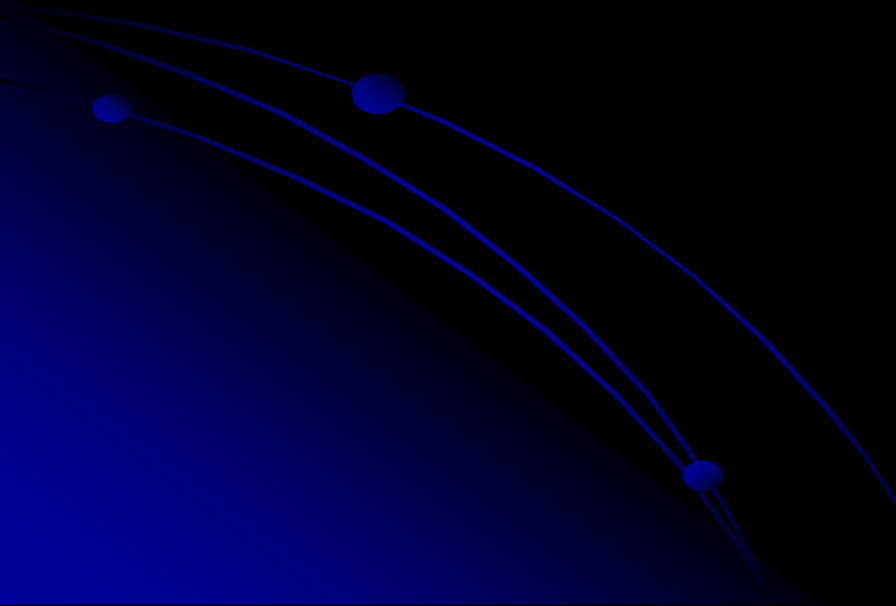
At the global scale, extreme daily precipitation events are projected to intensify by about 7% for each 1 °C of global warming.



Climate Change and Frequent Flooding

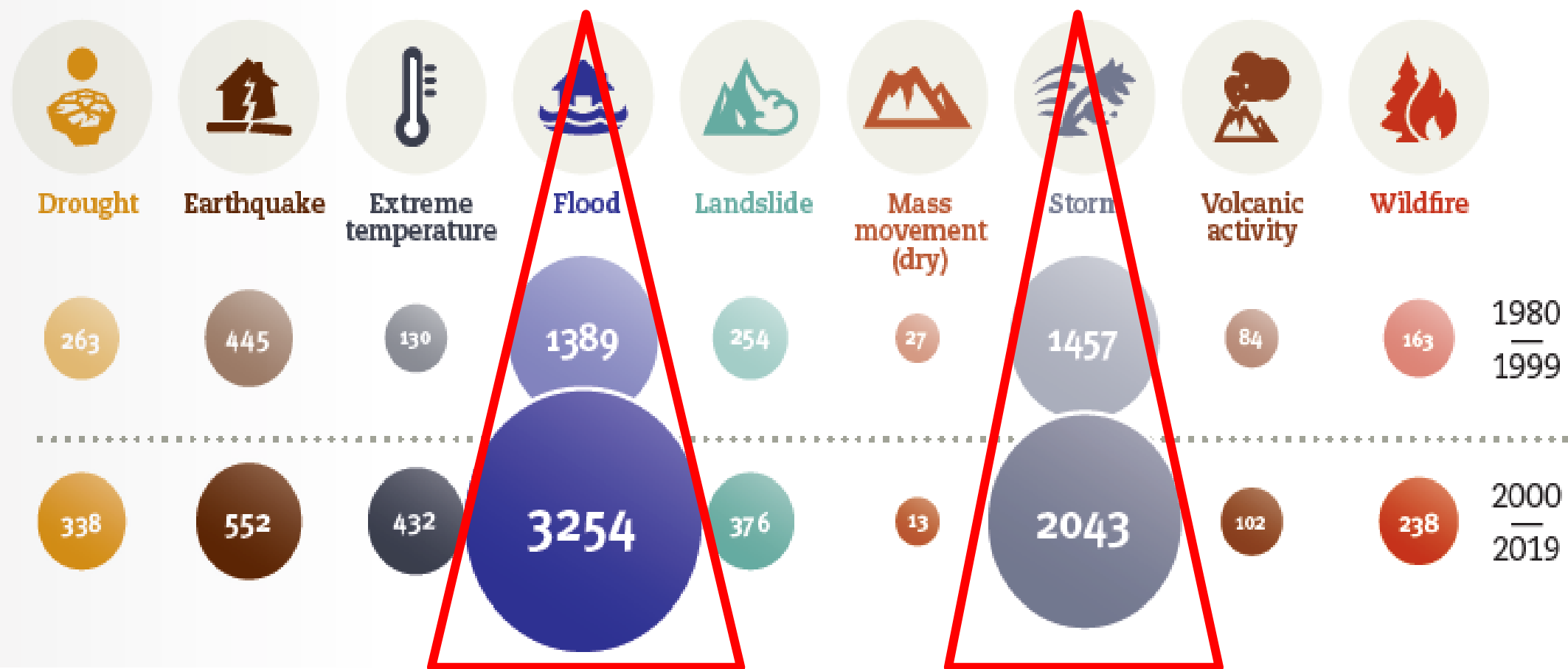
Is the frequency of heavy rainfall likely to increase due to climate change?

YES





Total disaster events by type: 1980-1999 vs. 2000-2019





Strengthening Flood Forecasting in ASEAN Member States through Regional Trainings and Coordination

Module 1

Water and Climate

- Prologue: A Diverse and Interconnected Earth
- The Role of the Water Cycle in the Climate System
- Climate Change and Frequent Flooding
- **Epilogue: Disaster Resilience and Sustainability**



WORLD
METEOROLOGICAL
ORGANIZATION



Toshio Koike
Executive Director
ICHARM, PWRI



Transformative Step towards a Sustainable and Resilient Path

Coordinated and Integrated Efforts for Working Together

mitigation

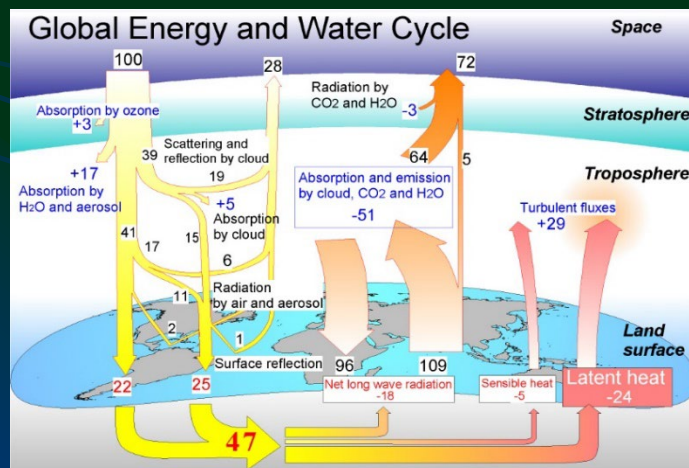
Climate Change

adaptation

Regime Shift

Extremes

Climate System



Water Cycle

Food

Energy

Ecosystem

Urban

QoL

Poverty

Gender

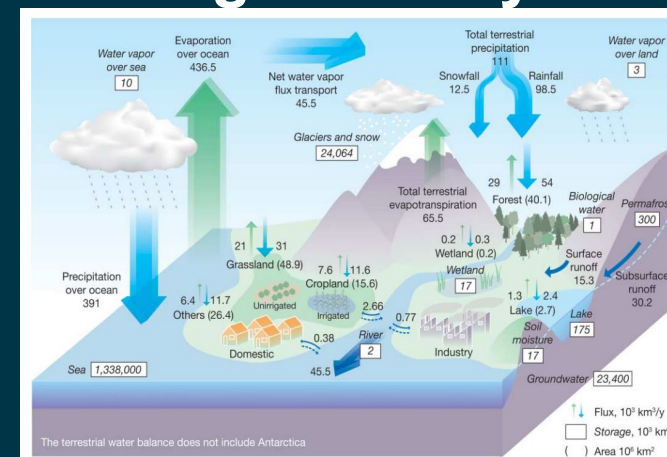
Inequity

Peace

Space/Time

Floods/Droughts

Water Resources Management System



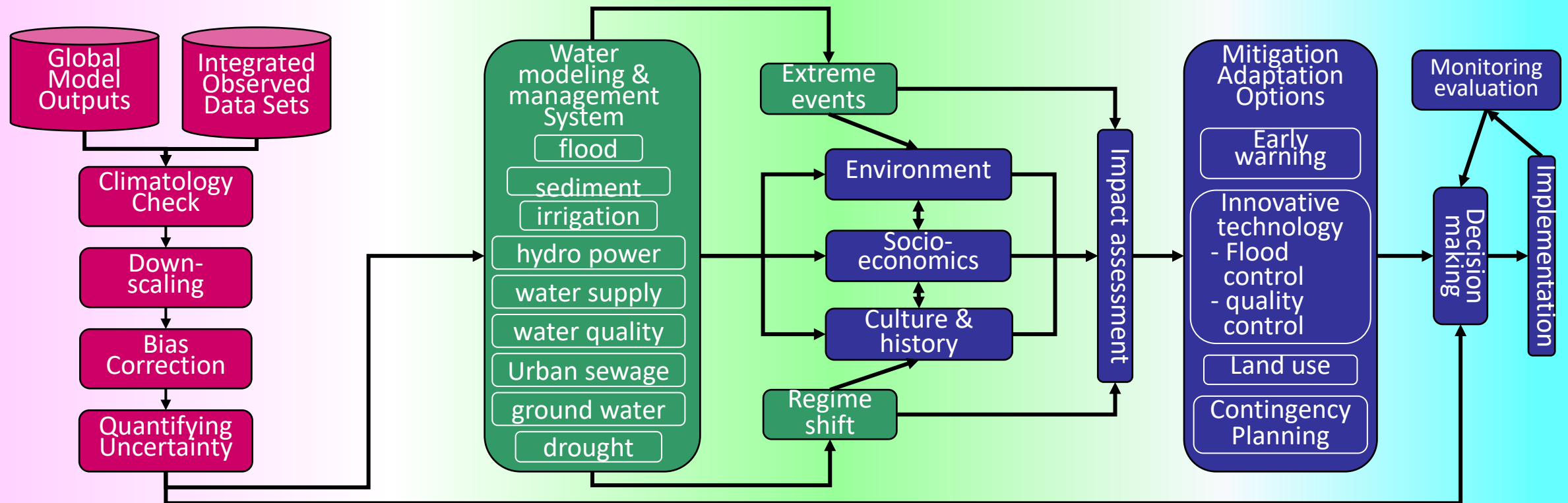
Knowledge Integration: **Synthesis**

Capacity Building: **Facilitator**

Meteorological observation, modeling and prediction

Hydrological observation, modeling and prediction

Cross-sectoral decision-making support



Promoting Knowledge Integration: **Synthesis**

Capacity Building and Education: **Facilitator**





Strengthening Flood Forecasting in ASEAN Member States through Regional Trainings and Coordination

Module 1

Water and Climate

- Prologue: A Diverse and Interconnected Earth
- The Role of the Water Cycle in the Climate System
- Climate Change and Frequent Flooding
- Epilogue: Disaster Resilience and Sustainability



WORLD
METEOROLOGICAL
ORGANIZATION



Toshio Koike
Executive Director
ICHARM, PWRI

