World Meteorological Organization

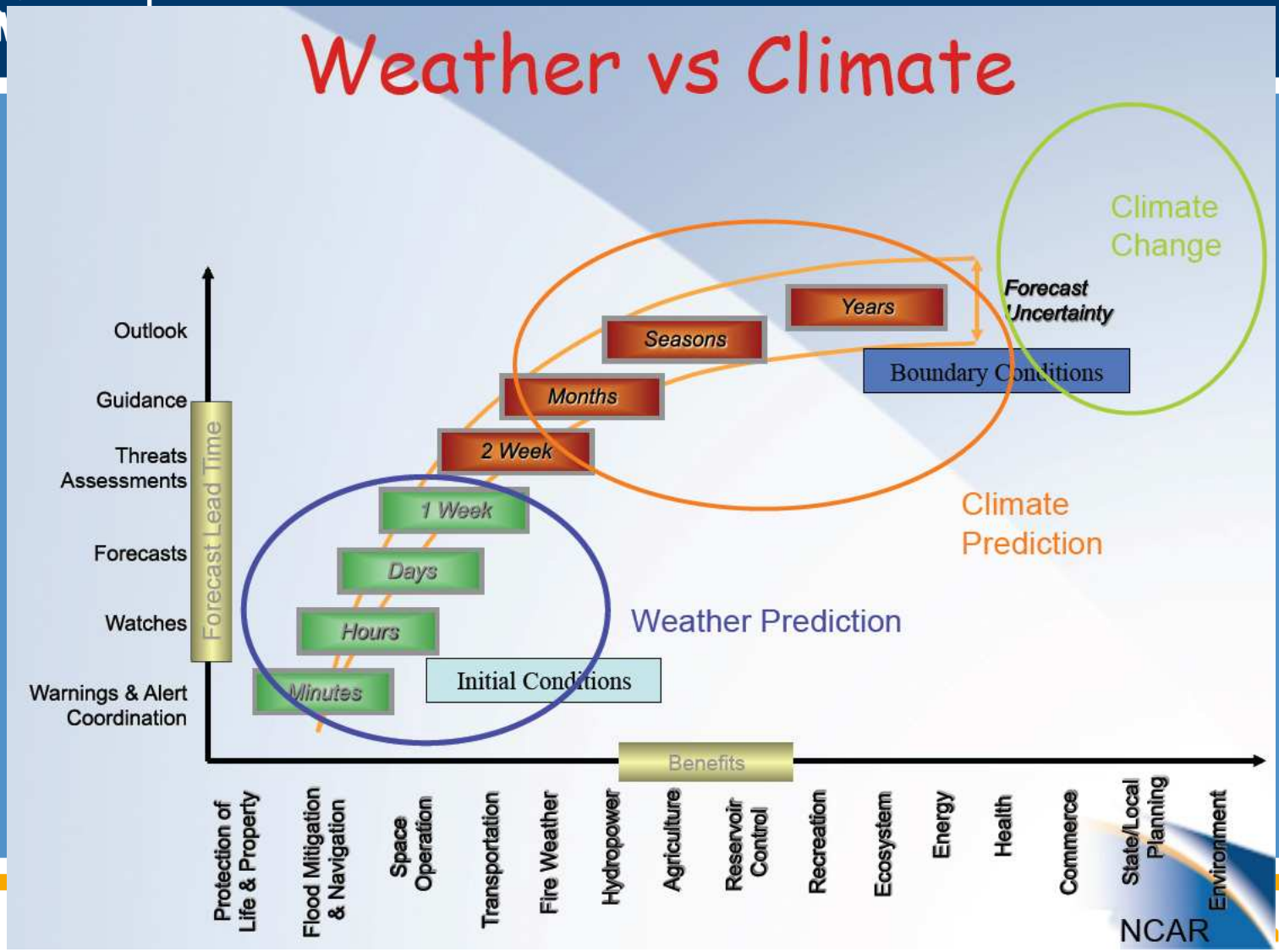
Weather • Climate • Water

WMO Role in Monitoring Climate Change

By
Omar Baddour
Obaddour@wmo.int

Towards a seamless transition from weather to climate prediction

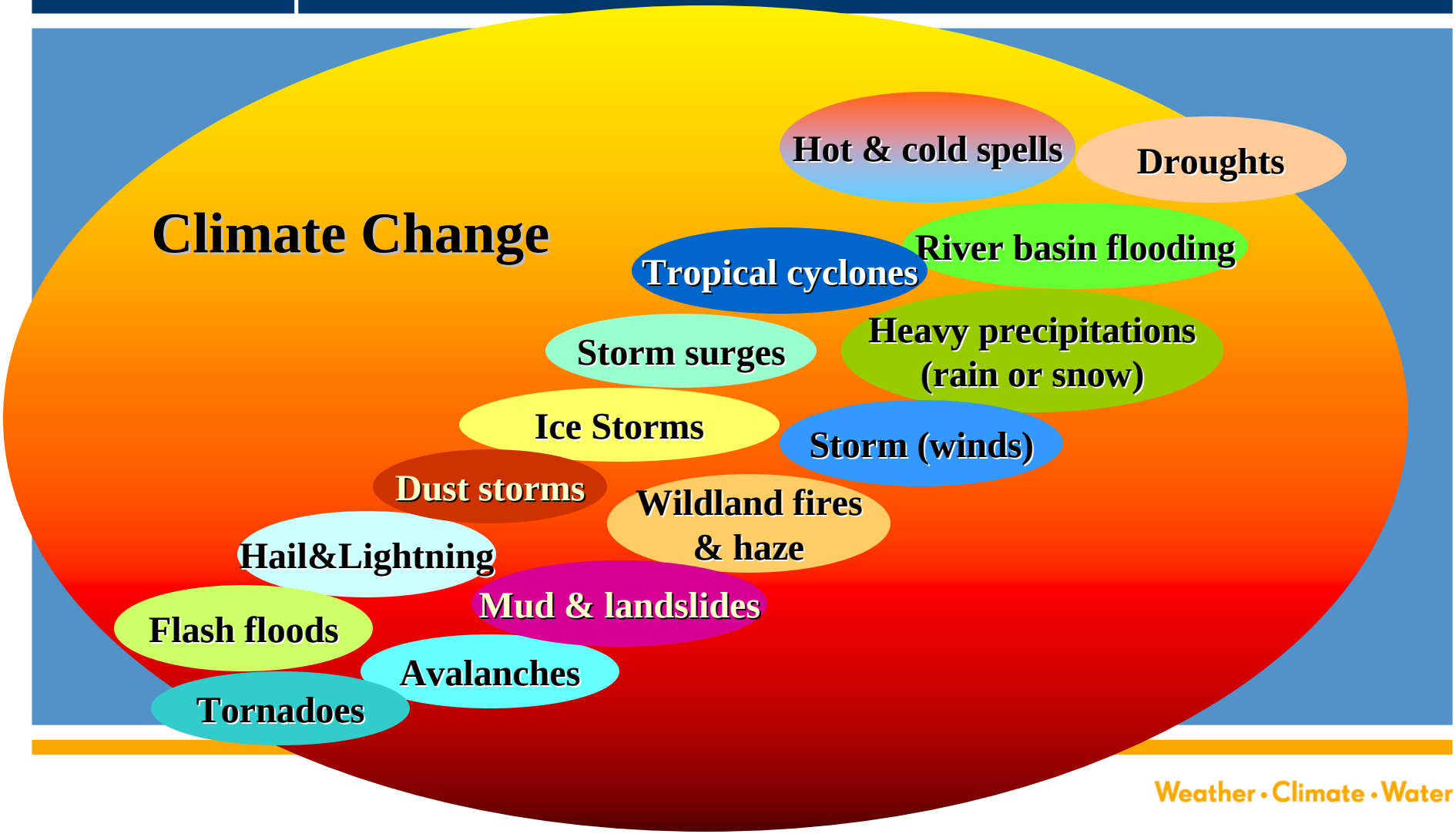
World Meteorological Organization



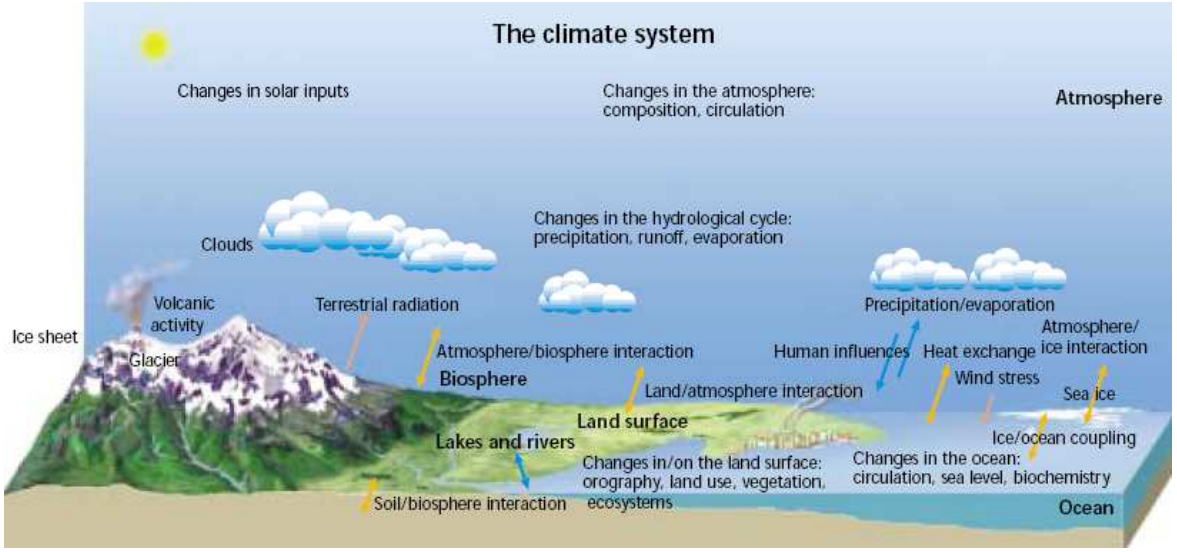
ate • Water

World Meteorological Organization

Weather • Climate • Water



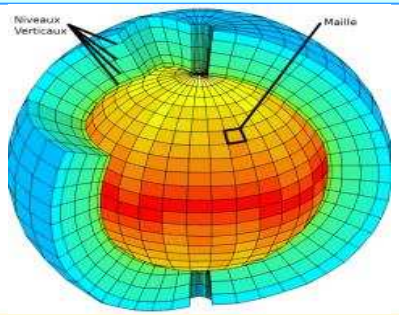
Climatology : A Science for Understanding, Monitoring and Predicting the State of the Climate



Climate is described /studied using **statistical analysis** of meteorological data

Climatology

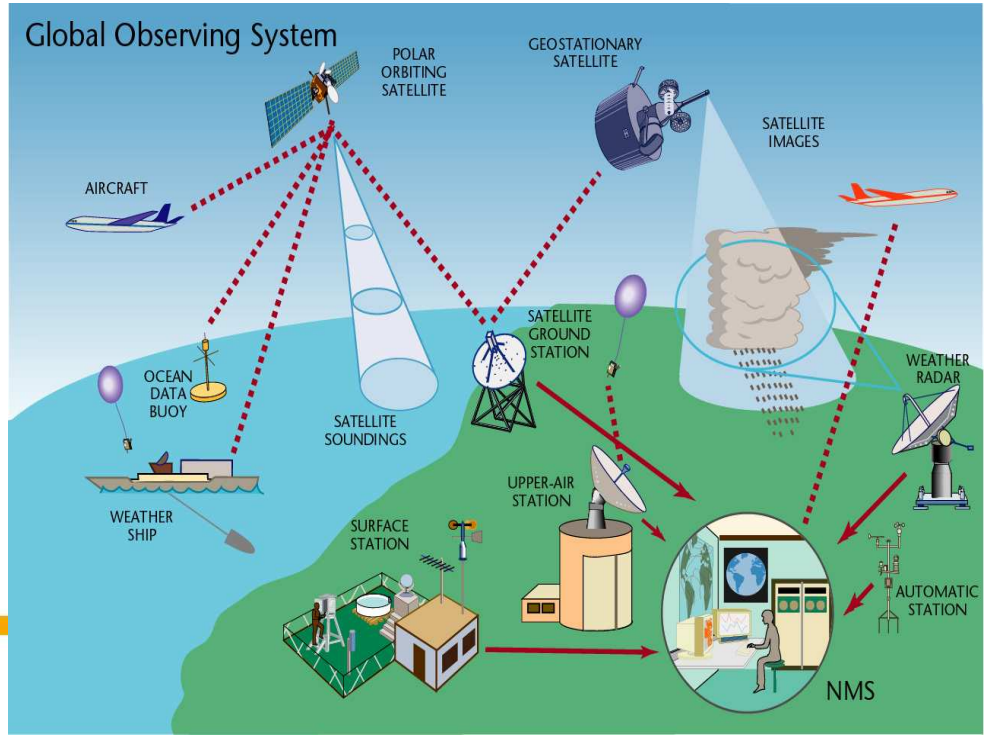
Modern development of climatology include extensive use Of **computer models** for climate simulation and predictions



WMO Global Observing Systems

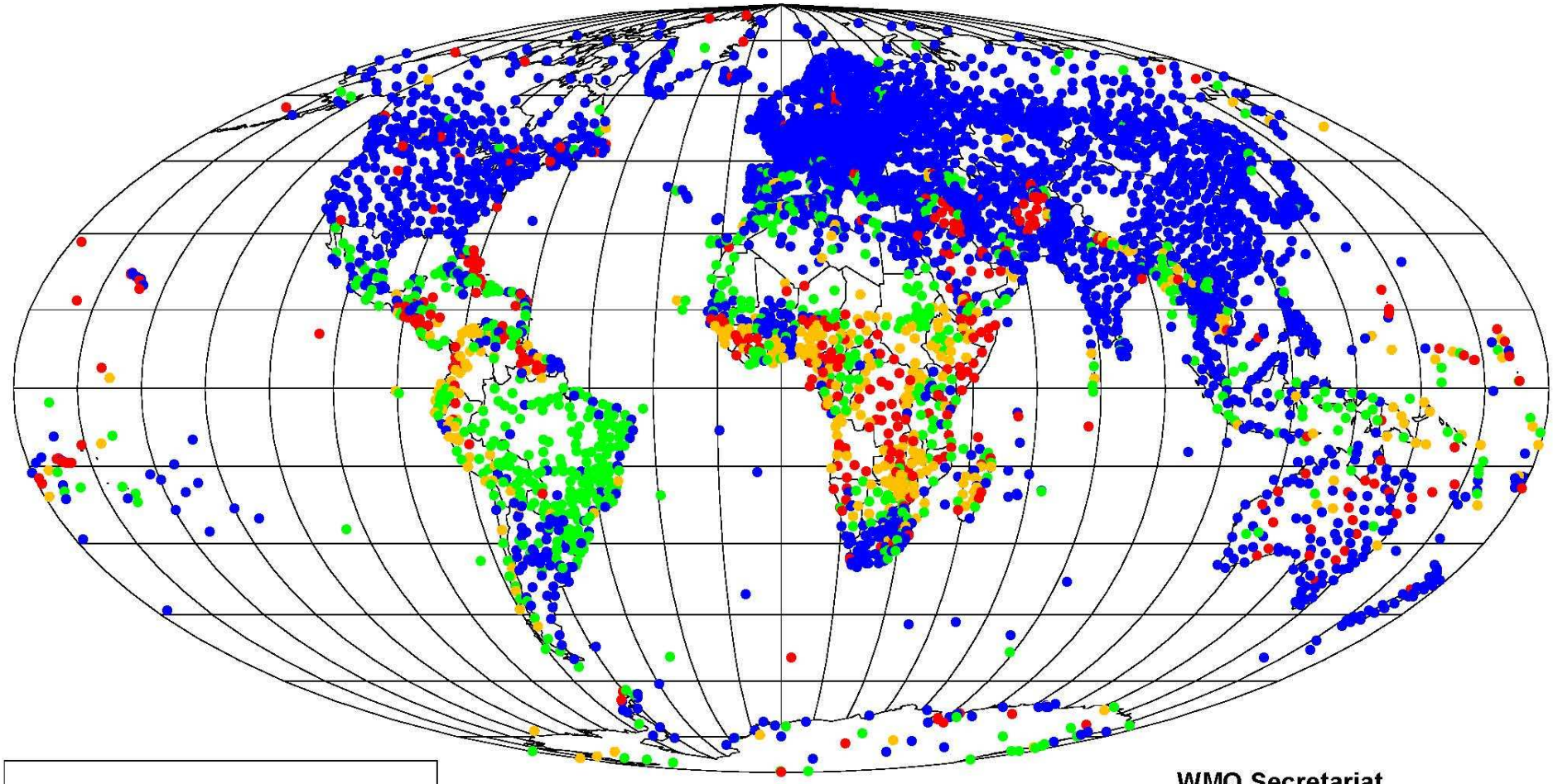
- World Weather Watch - Global Observing System (GOS, 1963), WMO backbone system

  - Surface & Ocean in situ observing networks
  - Upper-air networks
  - Surface remote sensing (Radar) networks
  - Airborne and observations
  - Satellite constellations



Annual Global Monitoring 1-15/10/2008

SYNOP reports made at 00, 06, 12 and 18 UTC at RBSN stations

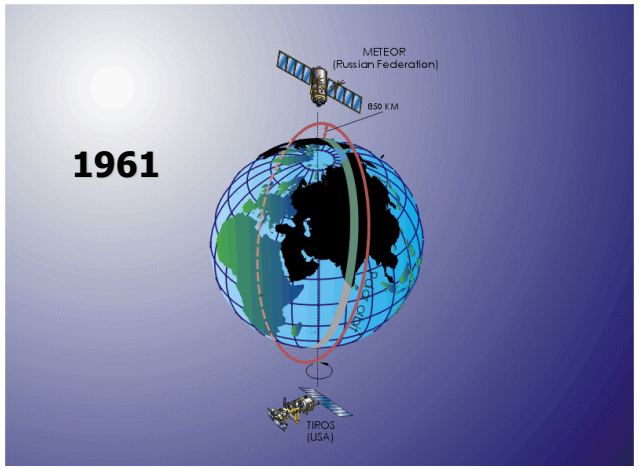


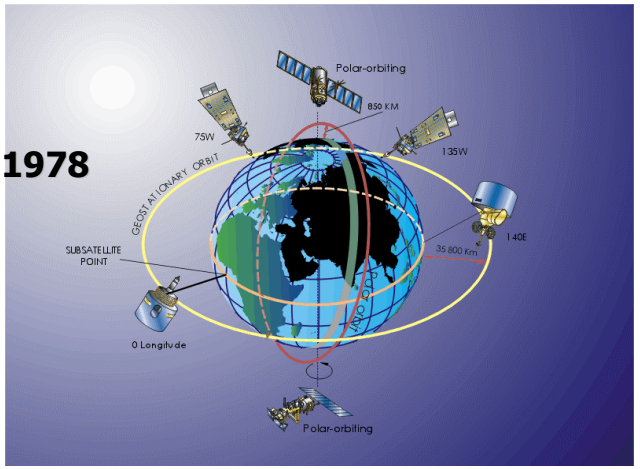
Percentage of reports received:

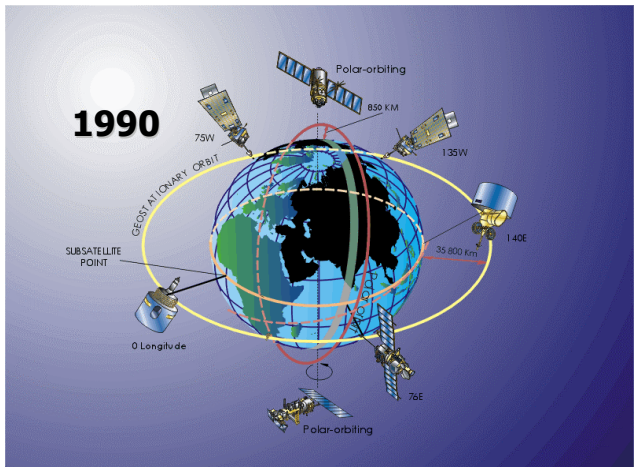
- 90 to 100 per cent (2912 stations)
- 45 to 90 per cent (697 stations)
- Less than 45 per cent (325 stations)
- Silent stations (350 stations)

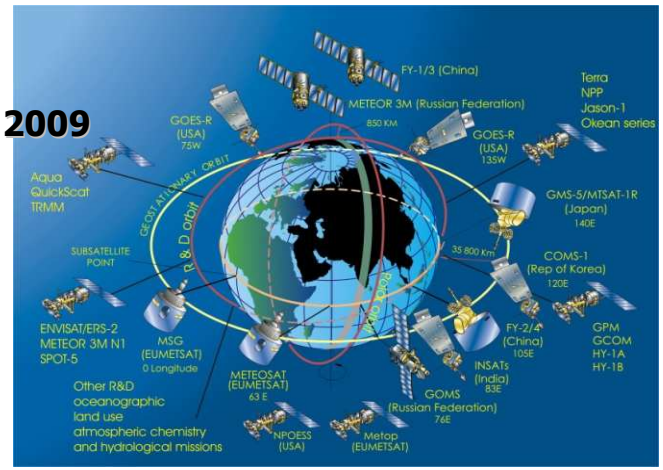
WMO Secretariat

GOS Space-based development









WMO Co-sponsored Global Observing Systems

--Global Ocean Observing System (GOOS) for Climate

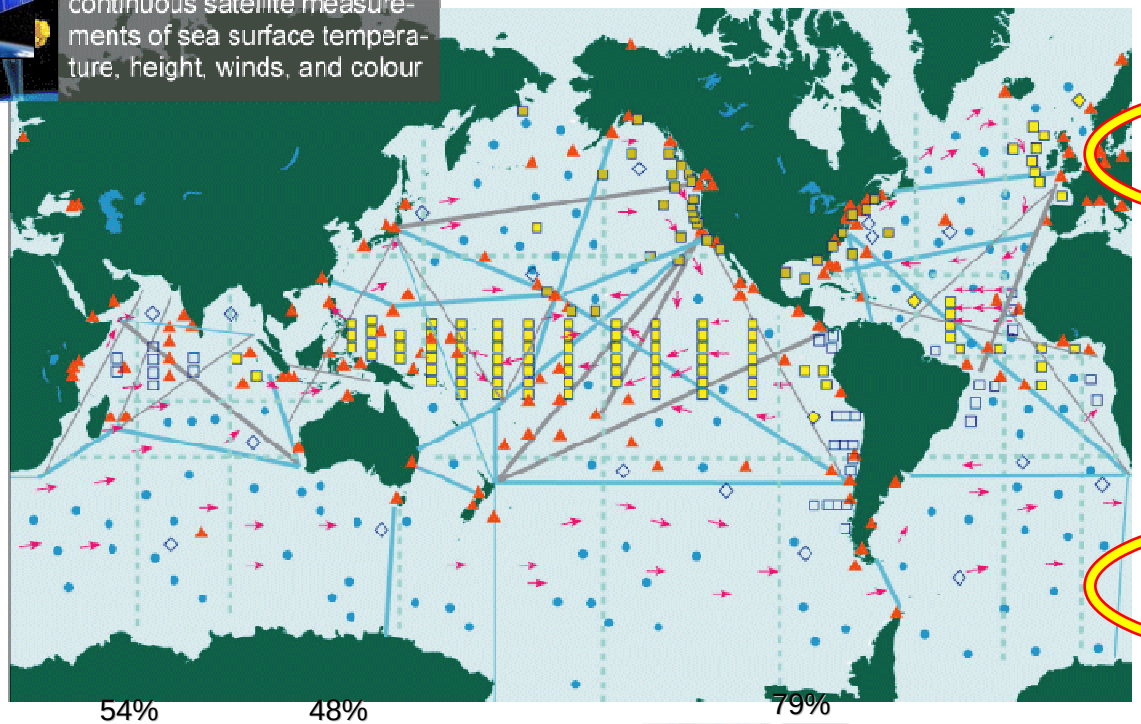
IOC, UNEP, WMO and ICSU

continuous satellite measurements of sea surface temperature, height, winds, and colour

Total *in situ* networks

61%

March 2009

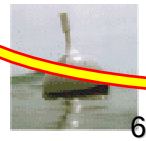


87%

Surface measurements from volunteer ships (VOSclim)

200 ships in pilot project

100%



Global **drifting surface buoy** array

5° resolution array: 1250 floats

66%

Tide gauge network (GCOS subset of GLOSS core network)

170 real-time reporting gauges

81%

XBT sub-surface temperature section network

51 lines occupied

100%

Profiling float network (Argo)

3° resolution array: 3000 floats

59%

Repeat **hydrography** and **carbon inventory**

Full ocean survey in 10 years

54%

Reference time series

58 sites

48%

Global **reference mooring** network

29 moorings planned

79%

Global tropical **moored buoy** network

119 moorings planned

GCOS GOOS jcomm

Weather · Climate · Water

Characterizing the Climate System

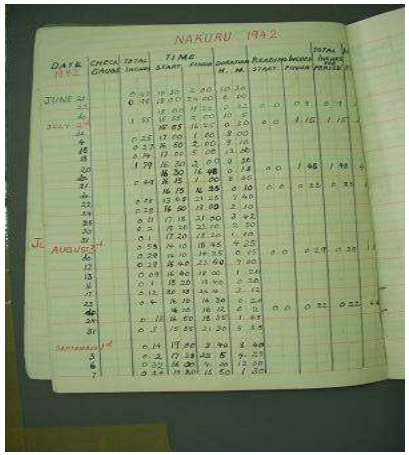
Essential Climate Variables Climate System Monitoring (ECVs)

Atmospheric: 15 surface, upper air, and composition ECVs

Oceanic: 19 surface and sub-surface ECVs

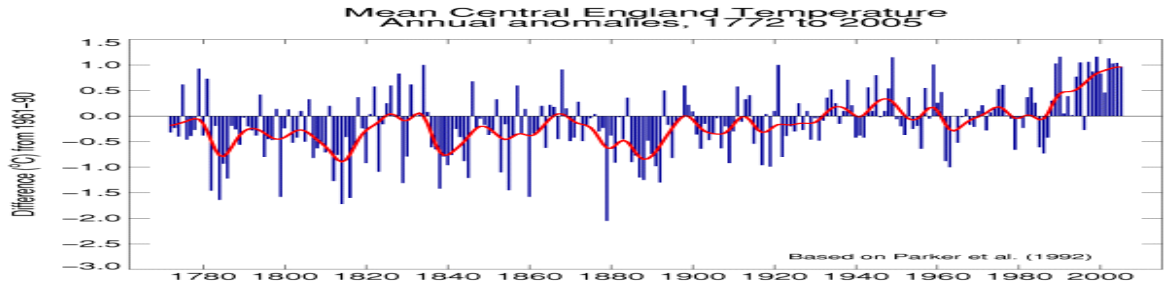
Terrestrial: 16 water and snow related, land cover, biomass ECVs

Domain	Essential Climate Variables
Atmospheric	Surface[1]:Air temperature, Wind speed and direction, Water vapour, Pressure, Precipitation, Surface radiation budget. Upper-air: Temperature, Wind speed and direction, Water vapour, Cloud properties, Earth radiation budget (including solar irradiance). Composition: Carbon dioxide, Methane, and other long-lived greenhouse gases, Ozone and Aerosol, supported by their precursors[2]
Oceanic	Surface[3]: Sea-surface temperature, Sea-surface salinity, Sea level, Sea state, Sea ice, Surface current, Ocean colour (for biological activity), Carbon dioxide partial pressure, Ocean acidity, Sub-surface: Temperature, Salinity, Current, Nutrients, Carbon dioxide, partial pressure, Ocean acidity, Oxygentracers, Phytoplankton; Marine biodiversity and habitat properties[4]
Terrestrial	River discharge, Water use, Ground water, Lake Levels, Snow cover, Glaciers and ice caps, Ice sheets, Permafrost, Albedo, Land cover (including vegetation type), Fraction of absorbed photosynthetically active radiation (fAPAR), Leaf area index (LAI), Above-ground biomass, Soil carbon, Fire disturbance, Soil moisture, Terrestrial biodiversity and habitat properties[9]



DAta REscue (DARE)

- Modern Archiving Systems
- Large and adequate Storage Facilities
- Protection of storing Facilities (Backup)
- Data Recovery and Digitisation
- Training



Capacity Building for developing countries
A must for adaptation

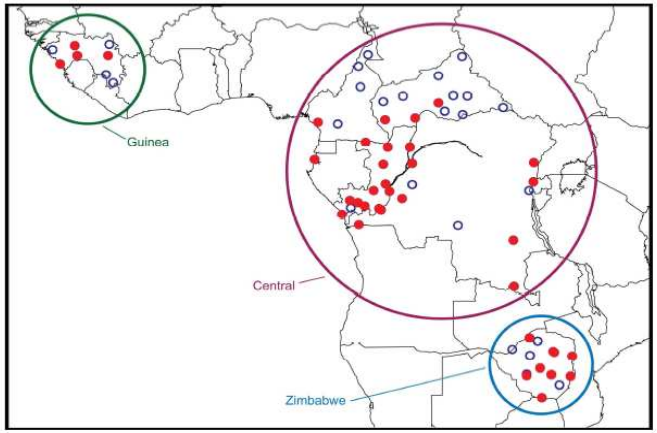
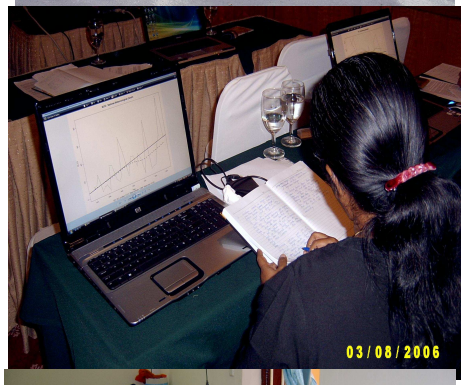


Fig. 1. The location of the stations available during or after the Brazzaville workshop. Stations with poor quality or too short record for this analysis are shown as open blue circles. Stations shown by solid red circles were used to produce three regional analyses: (1) Guinea includes stations from Guinea Conakry, (2) Central covers Western Central Africa and includes stations from Cameroon, Central African Republic, Democratic Republic of Congo, Gabon and Republic of Congo, and (3) Zimbabwe.

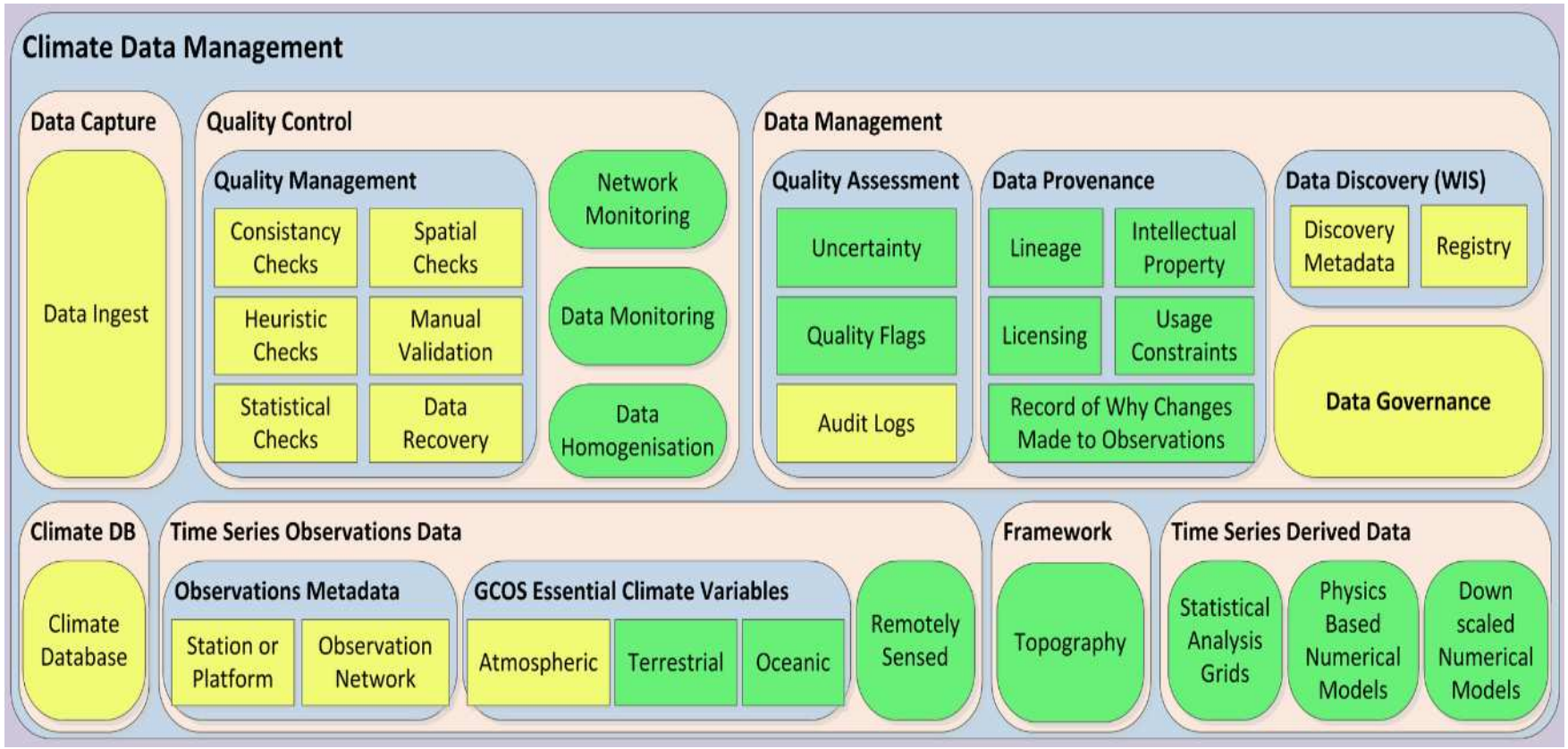


<u>Investing in</u> maintaining national climate observation networks

<u>Training</u> and Training…

Data Management for Climate: Concept

- Quality Longevity (permanence) Lineage



Courtesy by Bruce Bannerman, Bureau of Meteorology, Australia; CCl Expert Team on Climate Data Management

Climate Variability and Climate Change

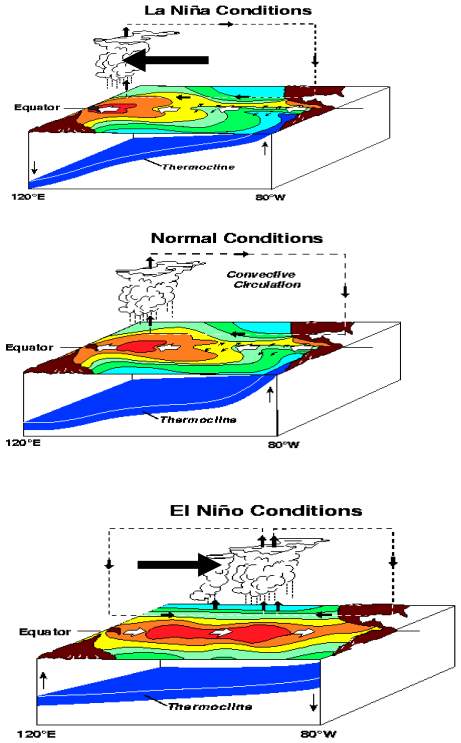
- Weather varies on daily time scale. Climate varies on longer time scales monthly, seasonal to inter-annual

  → **Climate Variability**

- Changes occurring on decade or more refers to a changing of the average state of the Climate

  → **Climate Change**

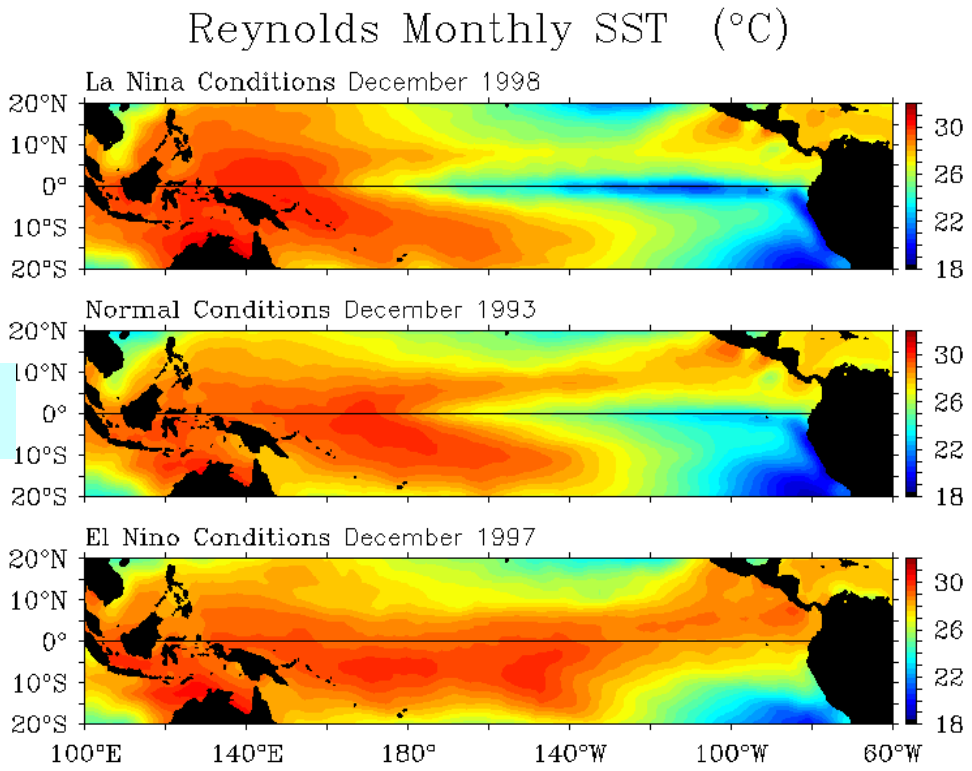
El Nino - LaNina



LaNina

Neutral

ElNino



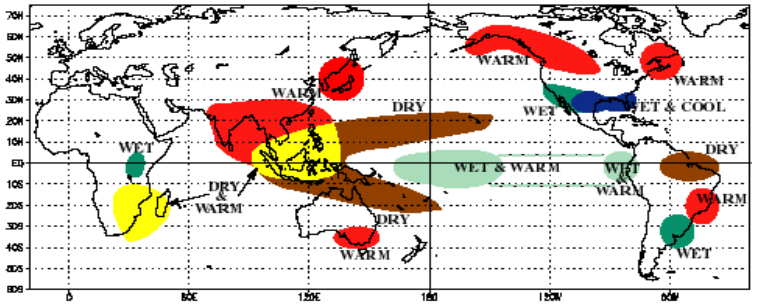
TAO Project Office/PMEL/NOAA

ElNino/LaNina impacts

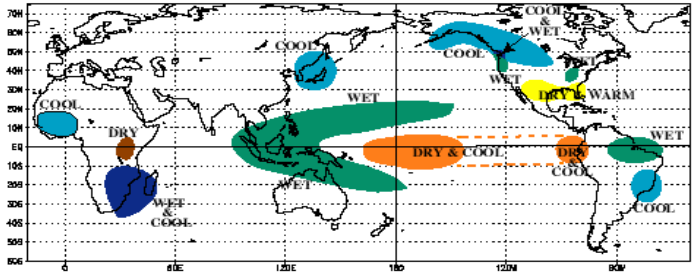
ELNINO

LANINA

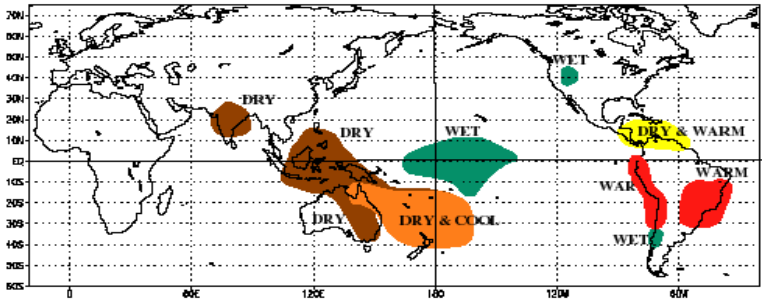
WARM EPISODE RELATIONSHIPS DECEMBER - FEBRUARY



COLD EPISODE RELATIONSHIPS DECEMBER - FEBRUARY

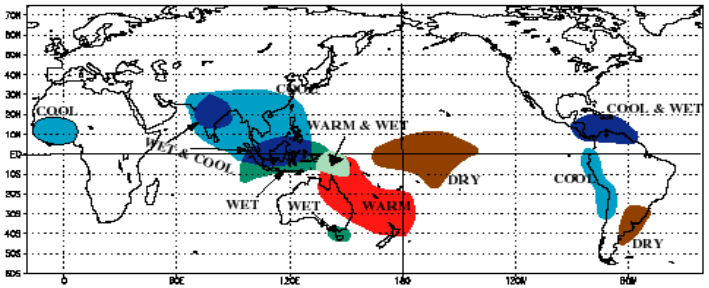


WARM EPISODE RELATIONSHIPS JUNE - AUGUST



Climate Prediction Center
NCEP

COLD EPISODE RELATIONSHIPS JUNE - AUGUST

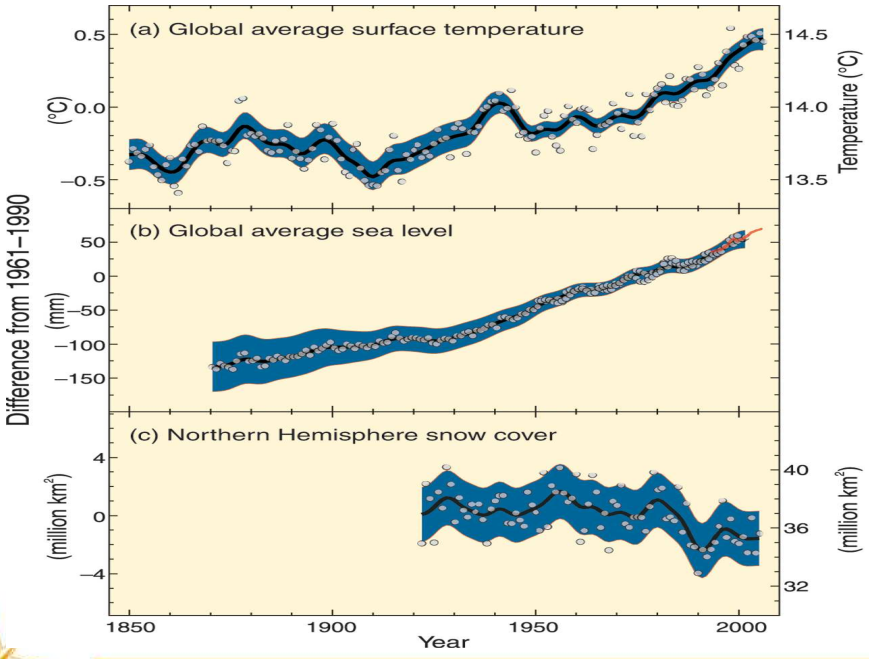


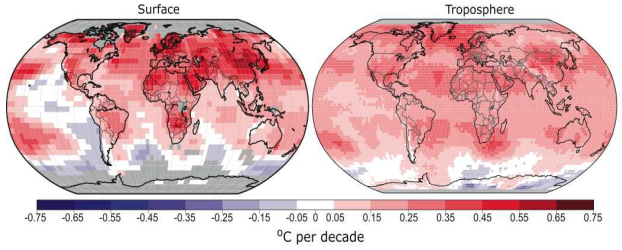
Climate Prediction Center
NCEP

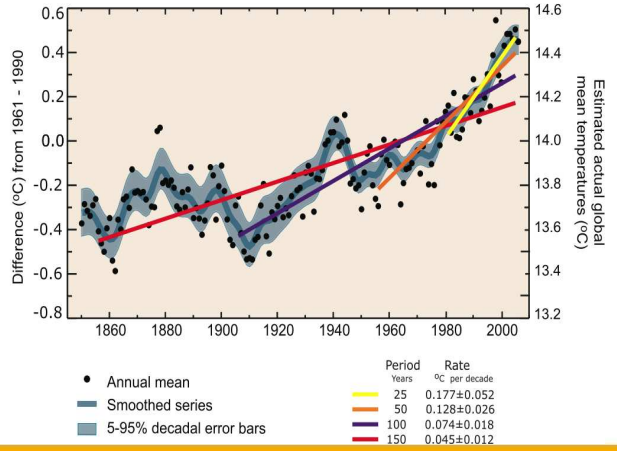
Climate Change

Observational evidence (IPCC-2007)

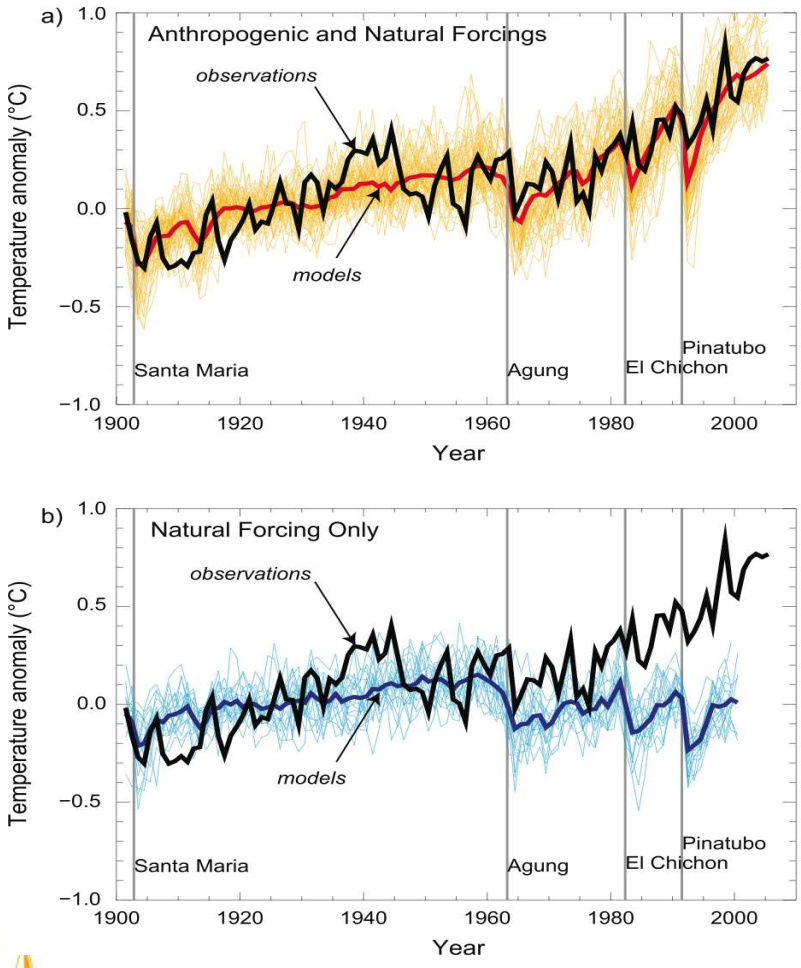
- **Warming of the climate system is unequivocal**
- increase in global average air/ocean temperatures, rising global average sea level,
- widespread melting of snow and ice
- **Globally the Earh Surface Temperature has increased by +0.74℃ in the past 100 years**

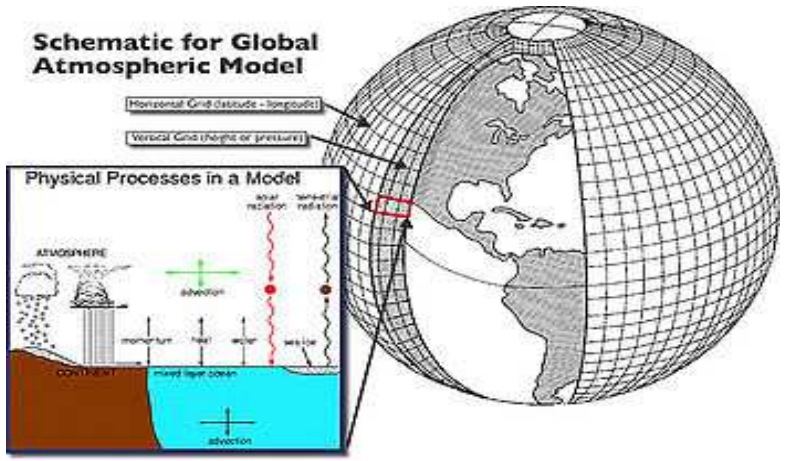






Evidence from model simulations





- Model simulations that include estimates of natural and anthropogenic forcing are now able to **reproduce** large scale aspects of the observed surface warming over the past century.
- http://www-pcmdi.llnl.gov/ipcc/about_ipcc.php

Physical and biological systems
Observational & Statistical finding

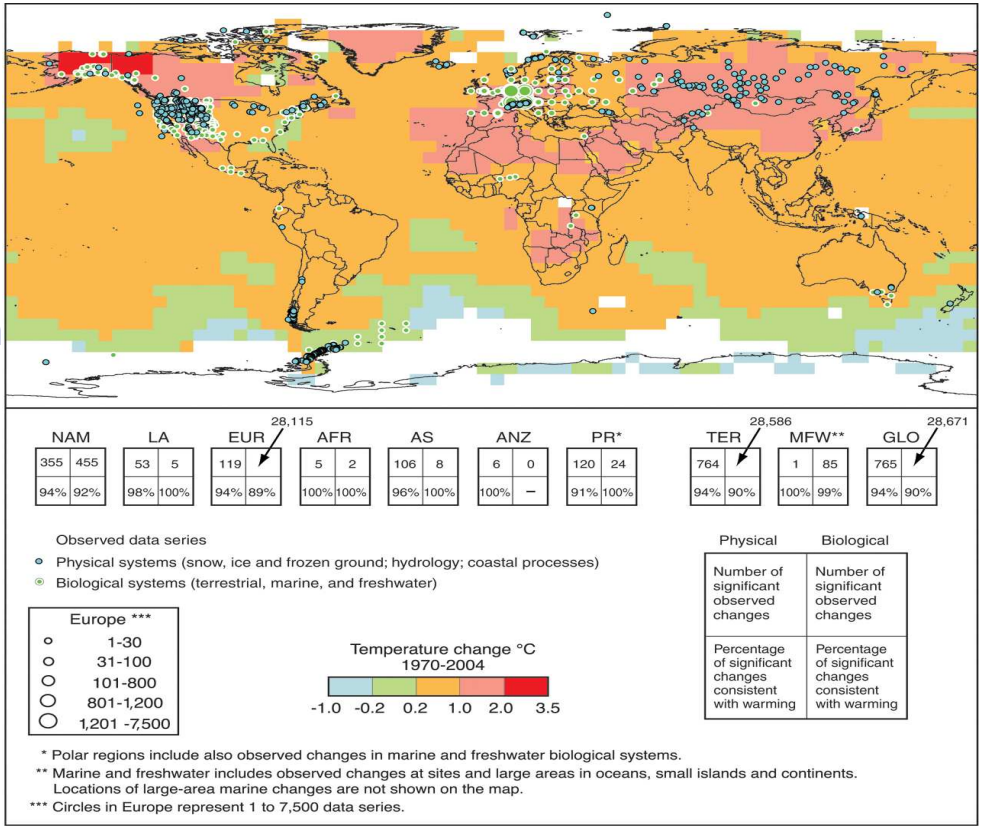
Tundra, boreal forest, mountain, mediterranean-type, mangroves, salt marshes, coral reefs and the sea-ice

low-lying coasts, water resources in some dry regions at mid-latitudes and in the dry topics and in areas dependent on snow and ice melt,

Agriculture in low-latitude regions,

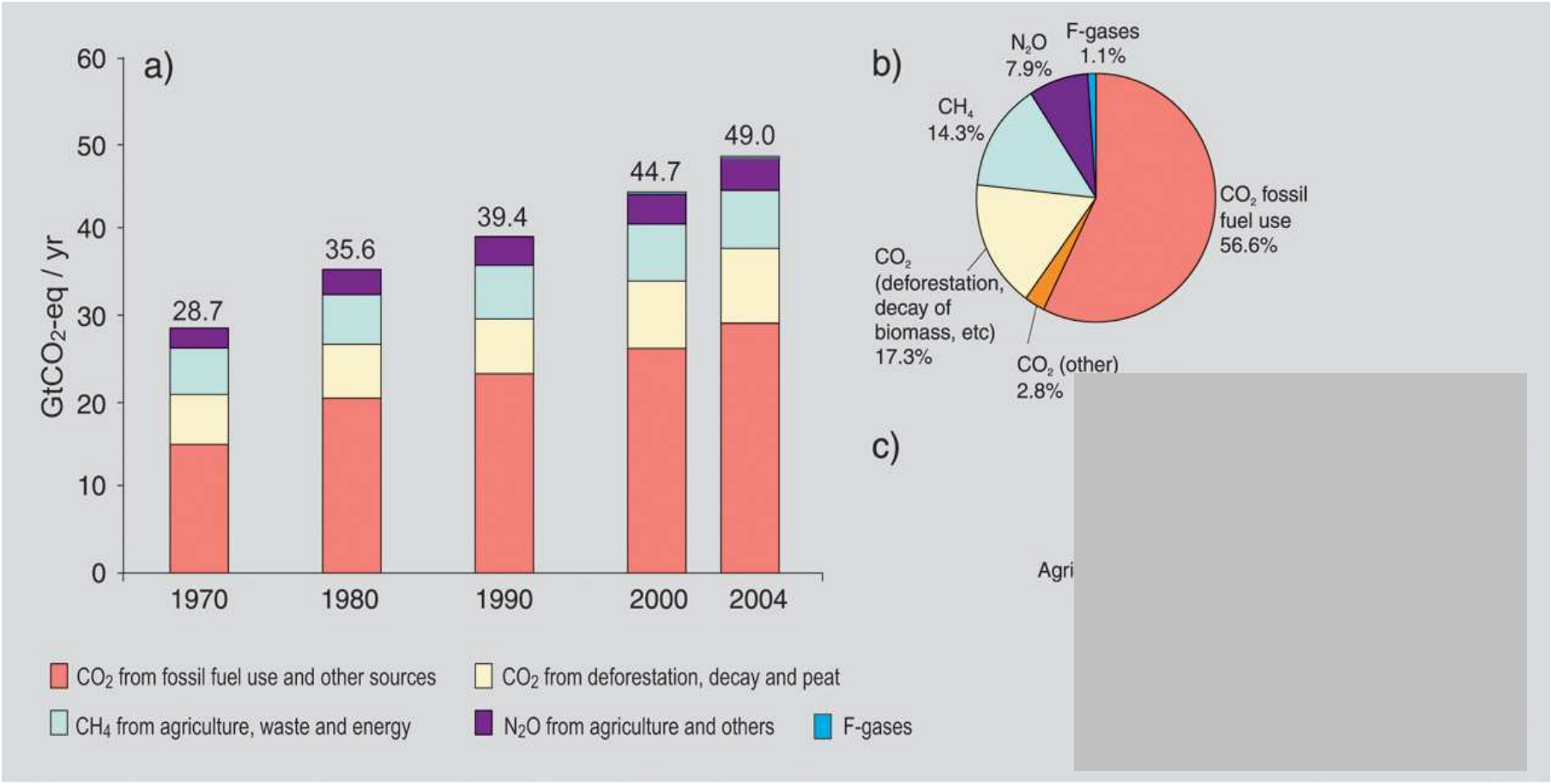
Human health in areas with low adaptive capacity.

→The Arctic, Africa, small islands and Asian and African megadeltas.



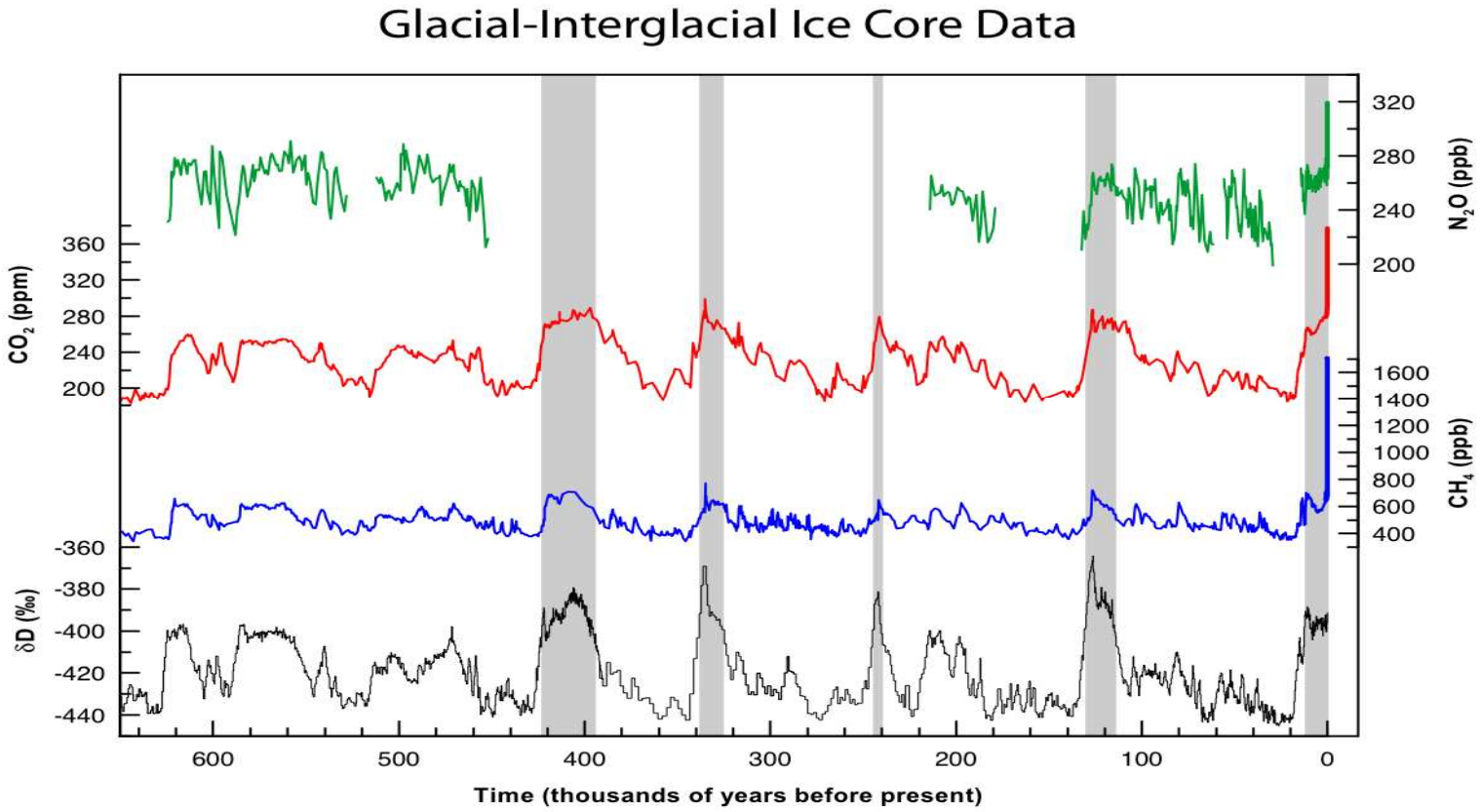
29.000 data series on physical and biological systems (from 75 studies)
→ 89% consistent with the changes expected as a result of global warming

Green House Gazes in the Atmosphere



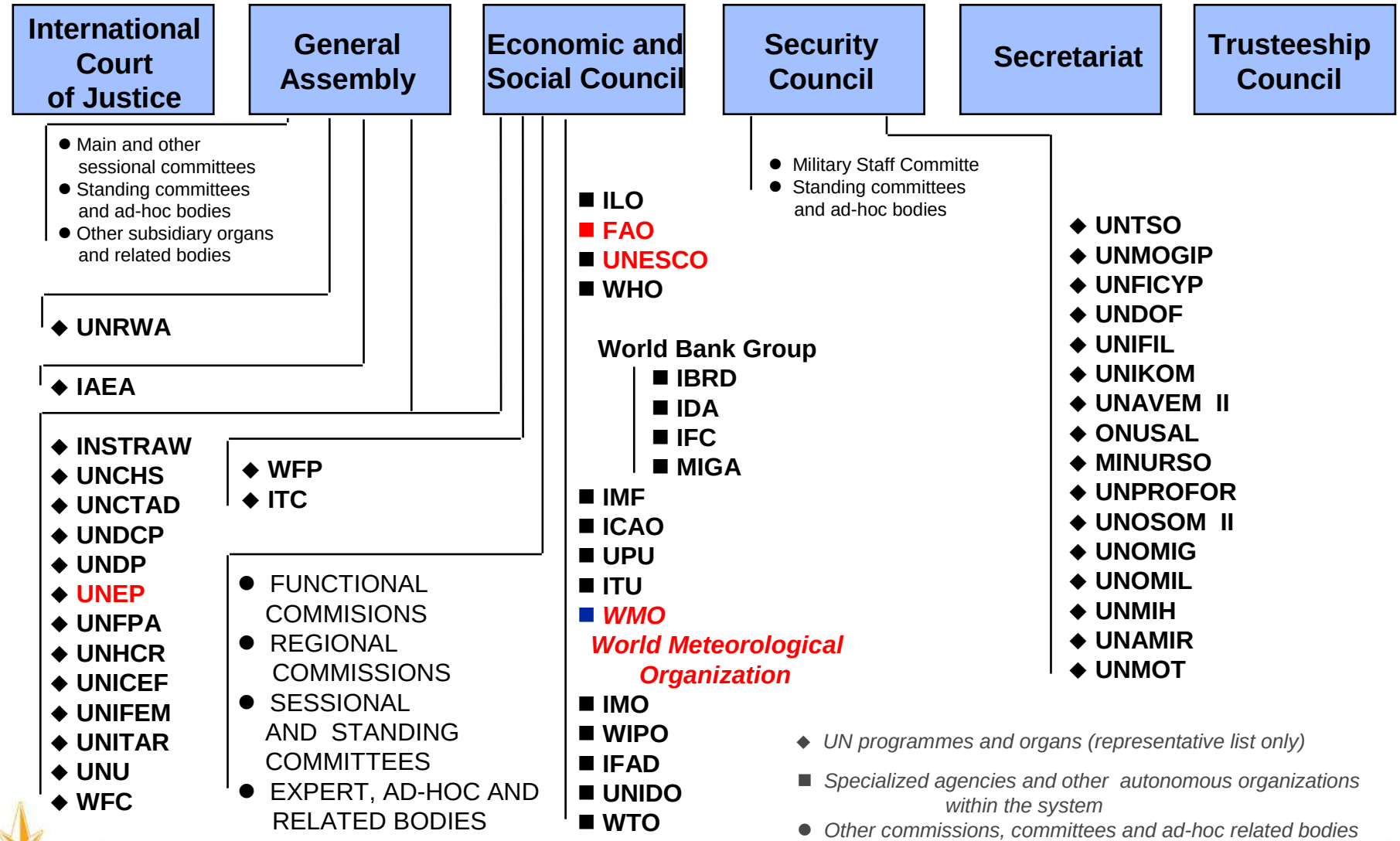
CO2

CH4



In <u>2008</u> CO2 Concentration in the atmosphere was 385.2 ppm, 38% higher than the pre-industrial time. 85% of the increased radiative forcing over the past decade

WMO in The United Nations System



WMO Statement on the Status of the Global Climate

WMO, working with UNEP (United Nations Environment Programme), is responsible for the periodic assessments of climate change issued by the Intergovernmental Panel on Climate Change (IPCC). In June 1993, the 45th session of the Executive Council of WMO decided that greater efforts were needed to promote the WMO role as a provider of credible scientific information on climate and its variability and requested that arrangements be made for the regular wide distribution of WMO statements on the status of the global climate. In response to this decision, statements have been provided annually through the WCDMP.

2011

2010

2009

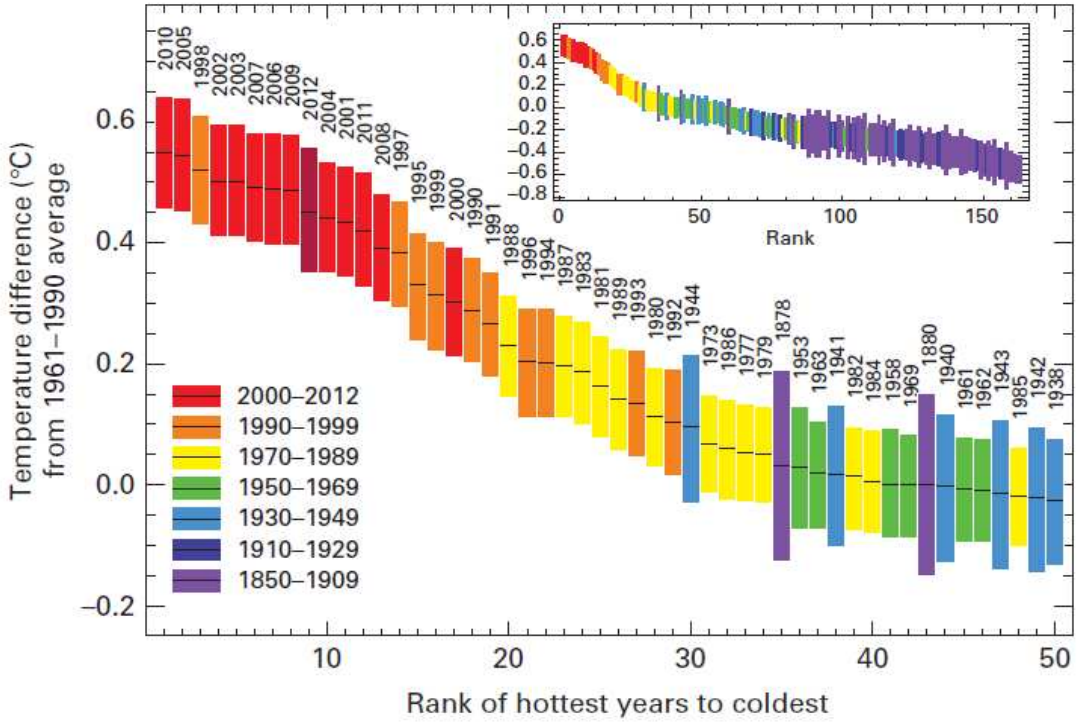
2008

2007

2006

See the complete series of online available WMO climate statements

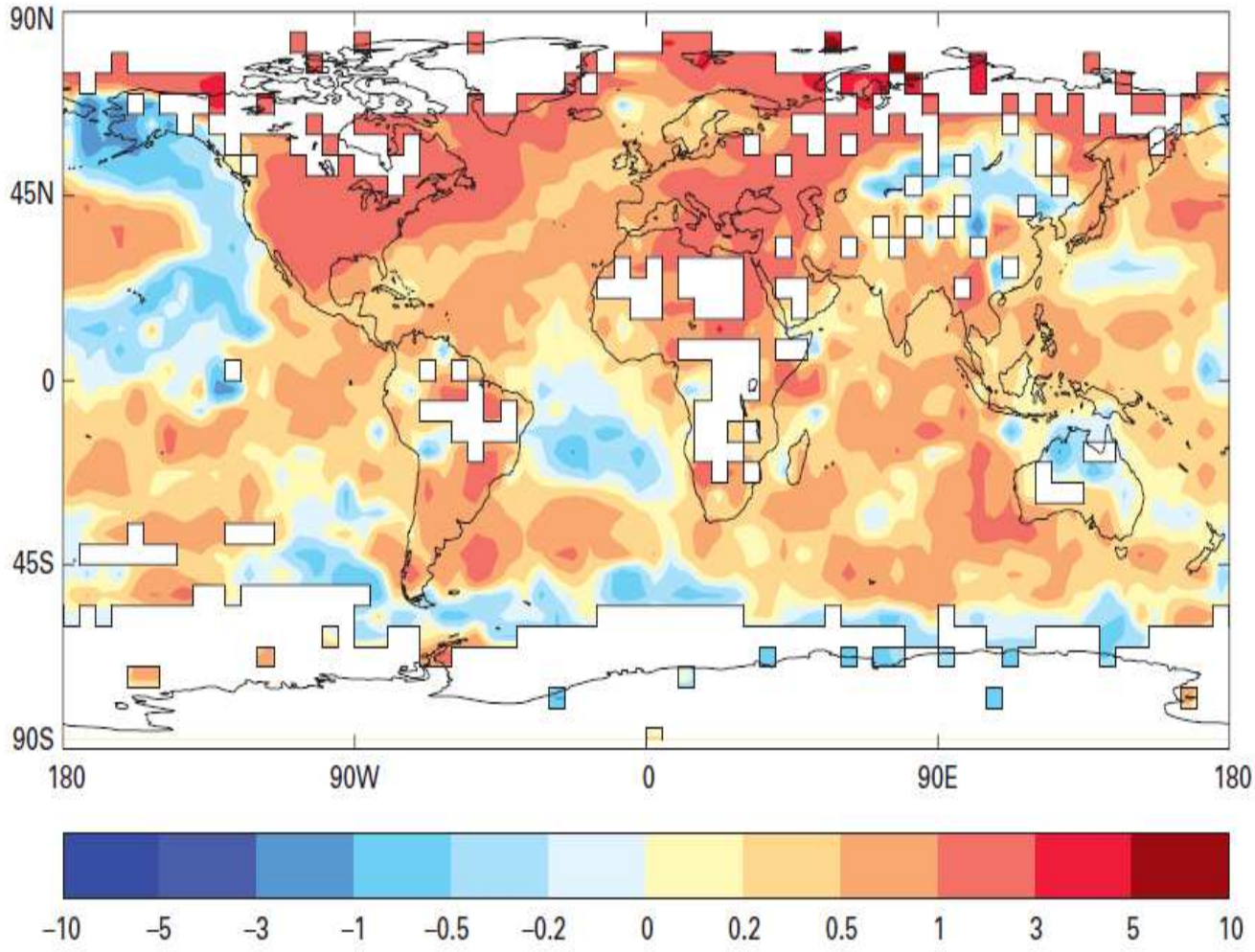
Climate in 2012 Global Temperature



- The years 2001–2012 were all among the top 13 warmest years on record.
- The 2012 global land and ocean temperature anomaly was only 0.1℃ less than the record high value observed in 2010

Climate in 2012 : Temperature Worldwide

Figure 1. Global land surface and sea surface temperature anomalies (°C) for 2012, relative to 1961–1990
(Source: Met Office Hadley Centre, UK, and Climatic Research Unit, University of East Anglia, United Kingdom)



Climate in 2012 : Major impacts

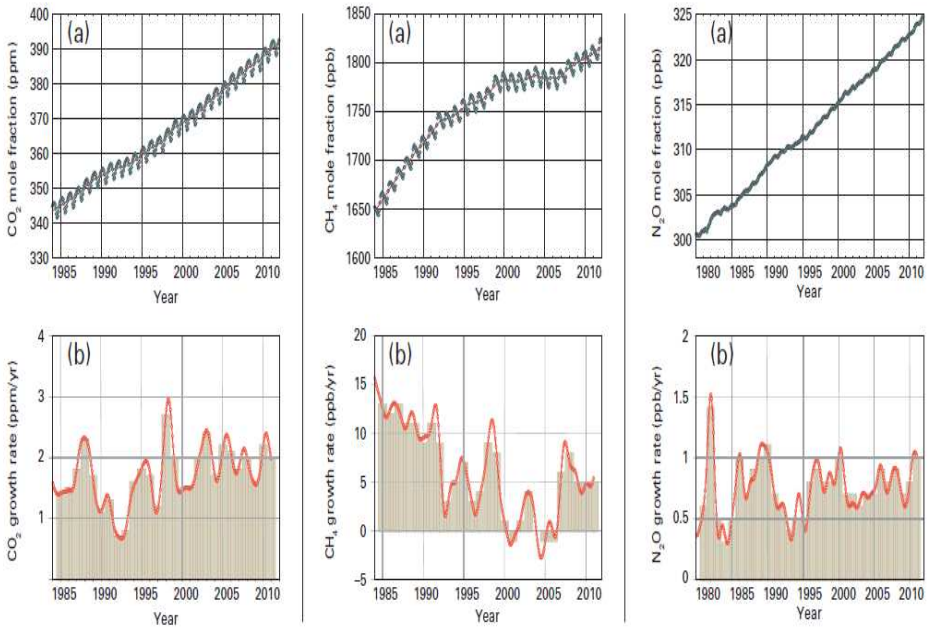
ESTIMATES OF CASUALTIES, NUMBER OF PEOPLE AFFECTED AND LOSSES FOR FIVE SIGNIFICANT EXTREME WEATHER AND CLIMATE EVENTS

Event	Location	Date	Casualties	No. of affected	Losses (US$)
Hurricane *Sandy*	The Caribbean and contiguous United States	Late October	Over 230	~62 million	~70 billion
Typhoon *Bopha*	Mindanao, Philippines	Early December	Over 1 000 fatalities, with nearly 900 people missing	~6 million	Over 49 million
Cold wave	Most of Europe and northern Africa	Mid-January to early February	Over 650	—	~660 million
Floods	West Africa	July–September	340	~3 million	5.8 million
Drought	Contiguous United States	Throughout the year	—	164 million	Multi-billion

STATE OF GREENHOUSE GASES IN THE ATMOSPHERE

- Globally averaged mixing ratios of carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O) reached new highs in 2011,
- The globally averaged CO2 mixing ratio in 2011 reached 390.9±0.1 ppm, which is 40 per cent higher than the pre-industrial level (before 1750),
- The annual increase from 2010 to 2011 was 2.0 ppm, which is higher than the average growth rate for the 1990s (~1.5 ppm/yr).

Figure 8. Left: Globally averaged CO_2 mole fraction (a) and its growth rate (b) from 1984 to 2011. Annually averaged growth rate is shown by columns at (b). Centre: Globally averaged CH_4 mole fraction (a) and its growth rate (b) from 1984 to 2011. Annually averaged growth rate is shown by columns at (b). Right: Globally averaged N_2O mole fraction (a) and its growth rate (b) from 1980 to 2011. Annually averaged growth rate is shown by columns at (b).



Sea Ice depleting quickly

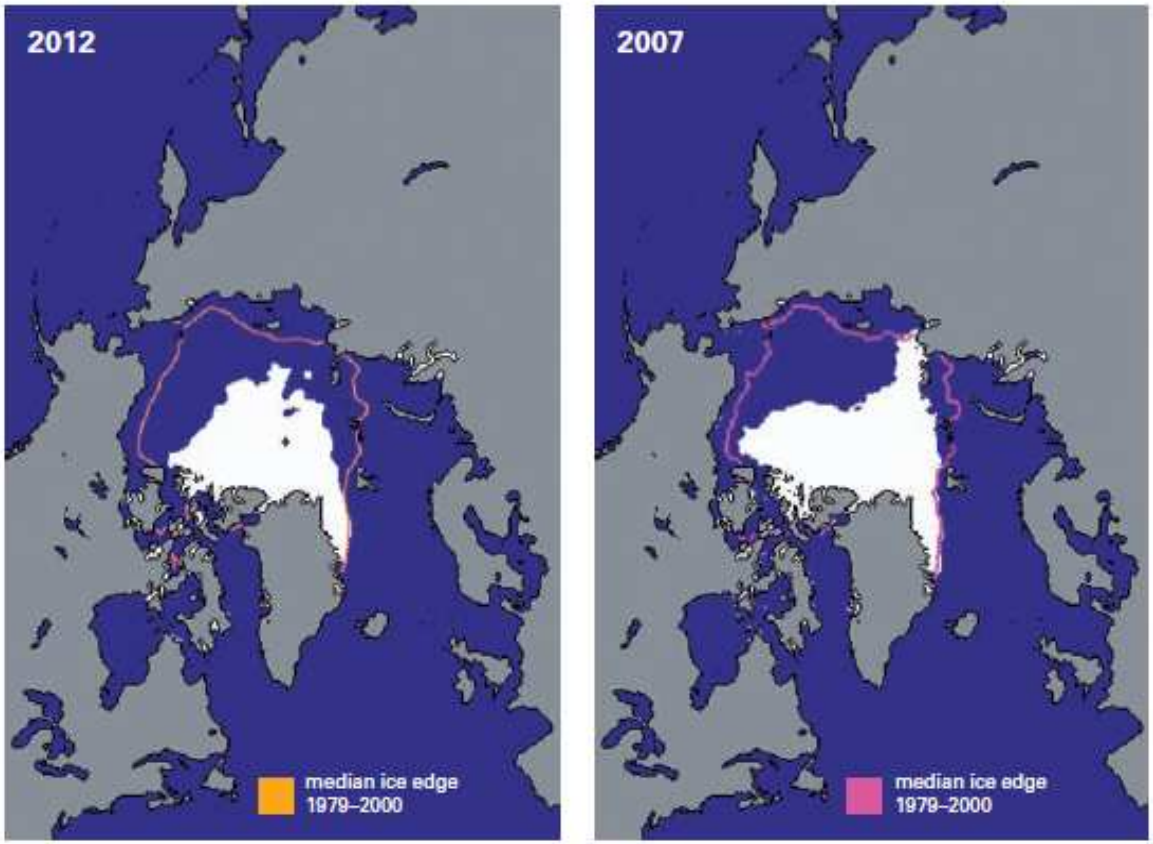
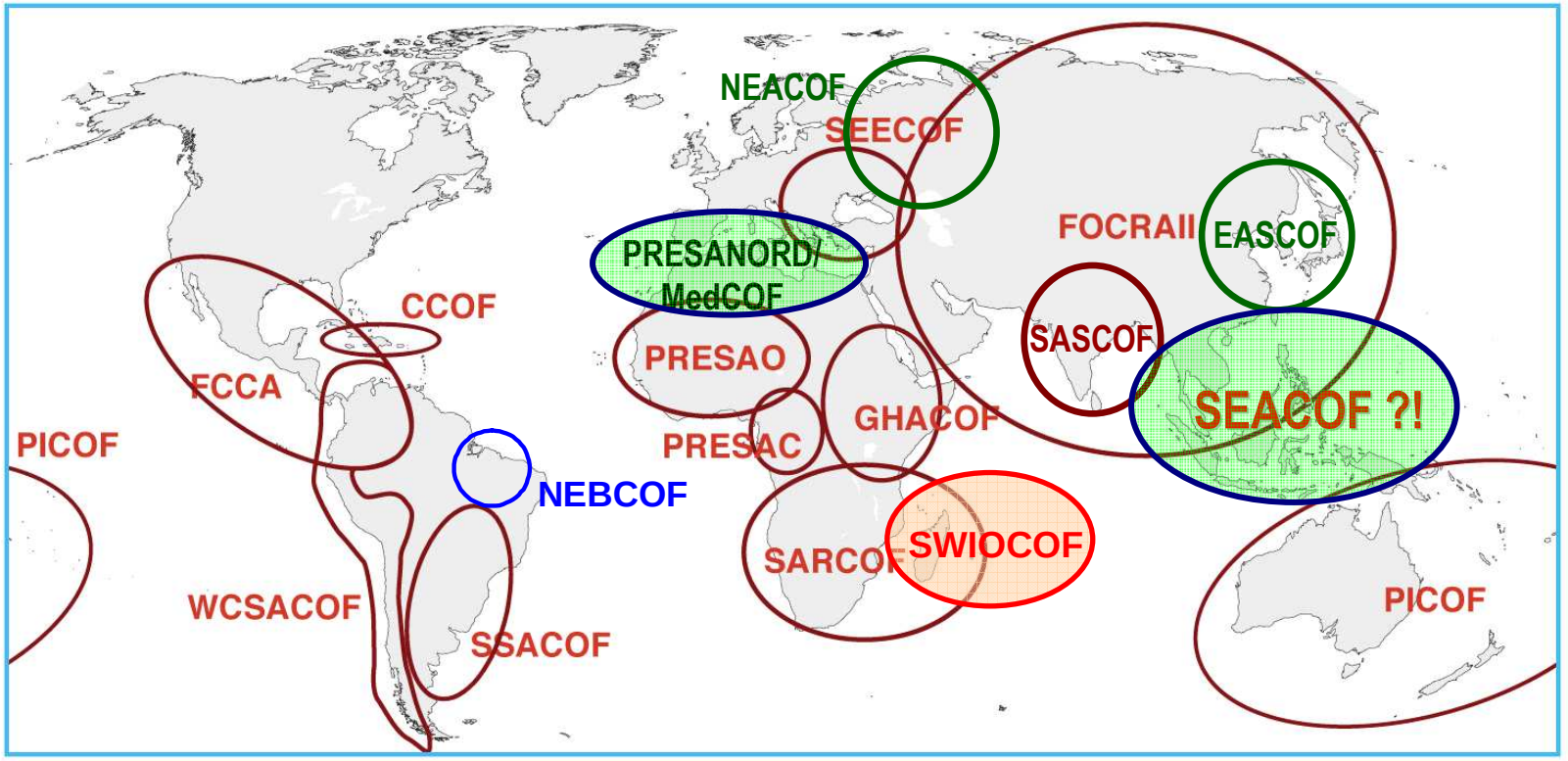


Figure 7. Northern hemisphere minimum sea-ice extent for September 2012 (lowest on record, left) and September 2007 (second lowest on record, right); the magenta/orange line indicates the long-term median from the 1979–2000 base period. *(Source: National Snow and Ice Data Center, United States)*

Regional Climate Outlook Forums Help foreseeing Seasonal climate behavior in the Regions



Mission & Objectives

World Climate Research Programme coordinates international climate research to improve:

(1) climate predictions and

(2) our understanding of human influence on climate

"for use in an increasing range of practical applications of direct relevance, benefit and value to society"

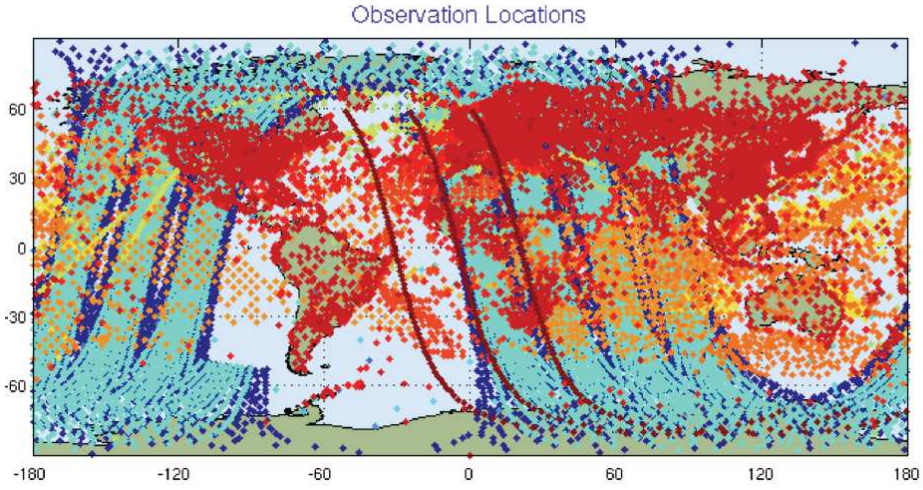
(WCRP Strategic Framework 2005-2015).

WCRP 4th International Reanalysis Conference

7-11 May 2012

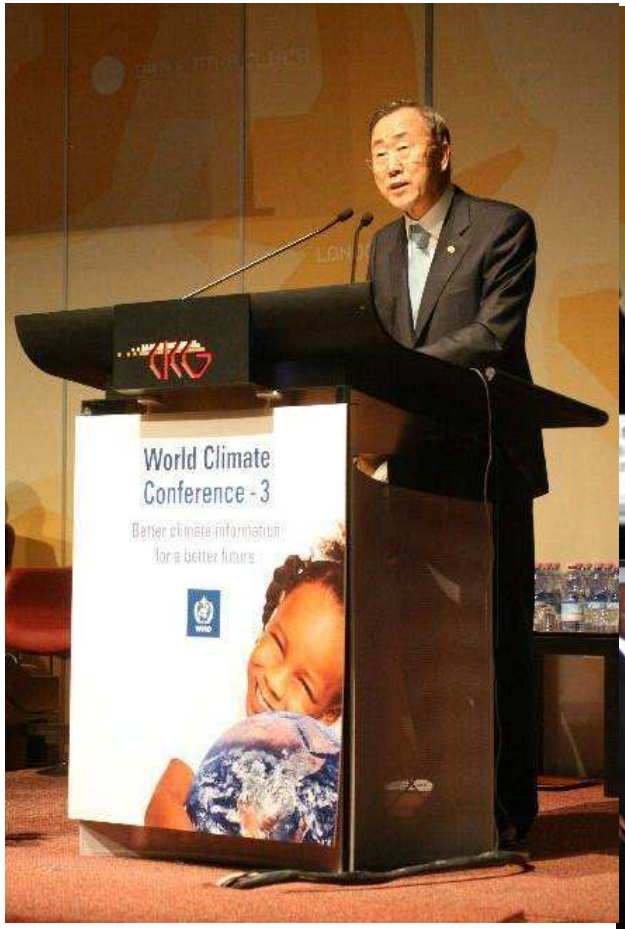
Silver Spring, Maryland USA

Agency Priorities: An Open Panel Discussion with Conference Participants



As many as four million observations are analyzed during 6-hours windows in the 2000s. More than 50 billion observations can be analyzed over 30 years (Courtesy of M. Bosilovich)

World Climate Conference-3



Aug 31 – Sept 4, 2009, GENEVA

Weather · Climate · Water

WCC-3 High-level Declaration
(approved on 3 September 2009)

DO 1 We, Heads of State and Government, Ministers and Heads of Delegation present at the High-level Segment of the World Climate Conference-3 (WCC-3) in Geneva, noting the findings of the Expert Segment of the Conference;

OP 1 Decide to establish a Global Framework for Climate Services (hereafter referred to as "the Framework") to strengthen production, availability, delivery and application of science-based climate prediction and services;

OP 2 Request th **tion of the Declaration an intergovernm** **erence and to endorse the composition of a** **retary-General of the WMO with due**

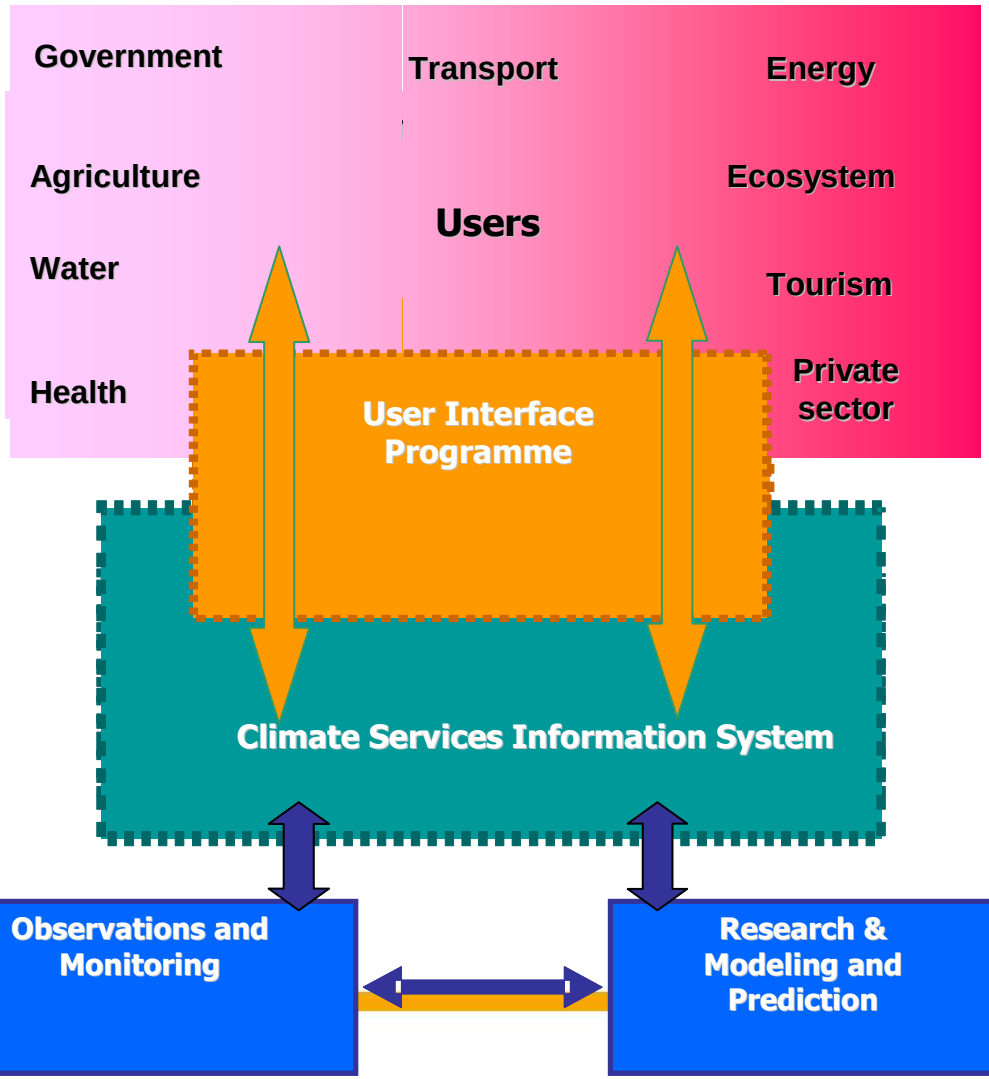
Decide to establish a Global Framework for Climate Services

OP 3 Decide that the task force will, after wide consultation with governments, partner organizations and relevant stakeholders, prepare a report, including recommendations on proposed elements of the Framework, to the Secretary-General of WMO within 12 months of the task force being set up. The report should contain findings and proposed next steps for developing and implementing a Framework. In the development of their report, the taskforce will take into account the concepts outlined in the annexed Brief Note;

OP 4 Decide further that the report of the task force shall be circulated by the Secretary-General of WMO to Member States of the WMO for consideration at the next WMO Congress in 2011, with a view to the adoption of a Framework and a plan for its implementation; and

OP 5 Invite the Secretary-General of WMO to provide the report to relevant organizations, including the UN Secretary-General.

Components of
Global Framework for Climate Services



World Meteorological Organization

Weather · Climate · Water

Thank you for your attention

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