WMO Role in Monitoring Climate Change

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Towards a seamless transition from weather to climate prediction

World Meteorological Organization

Weather vs Climate

- Outlook
- Guidance
- Threats Assessments
- Forecasts
- Watches
- Warnings & Alert Coordination

Forecast Lead Time

- Initial Conditions
- Days
- Hours
- Minutes
- 1 Week
- 2 Week
- Months
- Seasons
- Years

Forecast Change

Climate Change

Boundary Conditions

Benefits

Benefits

Protection of Life & Property
Flood Mitigation & Navigation
Space Operation
Transportation
Fire Weather
Hydropower
Agriculture
Research Control
Recreation
Ecosystem
Energy
Health
Commerce
State/Local Planning
Environment

NCAR
Climate Change

- Tropical cyclones
- Storm surges
- Ice Storms
- Dust storms
- Hail & Lightning
- Flash floods
- Tornadoes
- Avalanches
- Mud & landslides
- Wildland fires & haze

- Heavy precipitations (rain or snow)
- Storm (winds)
- River basin flooding
- Hot & cold spells
- Droughts

World Meteorological Organization
Weather • Climate • Water
Climatology: A Science for Understanding, Monitoring and Predicting the State of the Climate

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

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

Climatology
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 (360 stations)

The designation employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the WMO Secretariat concerning the legal status of any country, territory, city or area.
GOS Space-based development
WMO Co-sponsored Global Observing Systems
--Global Ocean Observing System (GOOS) for Climate

IOC, UNEP, WMO and ICSU

Total *in situ* networks 61%  March 2009

- Surface measurements from volunteer ships (VOSclin)
  - 200 ships in pilot project 100%
- Global drifting surface buoy array
  - 66% resolution array; 1200 floats
- Tide gauge network (GCOS subset of GLOSS core network)
  - 81% real-time reporting gauges
- XBT sub-surface temperature section network
  - 100% lines occupied
- Profiling float network (Argo)
  - 59% completion array; 2500 floats
- Repeat hydrography and carbon inventory
  - Full ocean survey in 10 years

Continuous satellite measurements of sea surface temperature, height, winds, and colour.
Characterizing the Climate System
Essential Climate Variables Climate System Monitoring (ECVs)

Atmospheric: 15 surface, upper air, and composition ECVs

Oceanic: 19 surface and subsurface ECVs

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

<table>
<thead>
<tr>
<th>Domain</th>
<th>Essential Climate Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oceanic</td>
<td>Surface: 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, Oxygen tracers, Phytoplankton; Marine biodiversity and habitat properties.</td>
</tr>
<tr>
<td>Terrestrial</td>
<td>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.</td>
</tr>
</tbody>
</table>
DAta REscue (DARE)

- Modern Archiving Systems
- Large and adequate Storage Facilities
- Protection of storing Facilities (Backup)
- Data Recovery and Digitisation
- Training
Investing in maintaining national climate observation networks

Training and Training…
Data Management for Climate: **Concept**

- **Quality**  
- **Longevity** *(permanence)*  
- **Lineage*
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

Reynolds Monthly SST (°C)

La Nina Conditions December 1998

Normal Conditions December 1993

El Nino Conditions December 1997

LaNina

Neutral

ElNino

TAO Project Office/PMEL/NOAA
ElNino/LaNina impacts

**ELNINO**

**LANINA**

**WARM EPISODE RELATIONSHIPS**

- **DECEMBER - FEBRUARY**

- **JUNE - AUGUST**

**COLD EPISODE RELATIONSHIPS**

- **DECEMBER - FEBRUARY**

- **JUNE - AUGUST**
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 Earth Surface Temperature has increased by +0.74°C 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 Gases in the Atmosphere

a) Annual increase in GtCO₂-eq/yr from 1970 to 2004:
- 1970: 28.7
- 1980: 35.6
- 1990: 39.4
- 2000: 44.7
- 2004: 49.0

b) Breakdown of greenhouse gases (in %):
- CO₂ - Fossil fuel use: 56.6%
- CO₂ - Deforestation, decay of biomass: 17.3%
- CH₄: 14.3%
- N₂O: 7.9%
- F-gases: 1.1%

CO₂ emissions from various sources:
- CO₂ from fossil fuel use and other sources
- CO₂ from deforestation, decay and peat
- CH₄ from agriculture, waste and energy
- N₂O from agriculture and others
- F-gases

Weather • Climate • Water
In 2008 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 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.

See the complete series of online available WMO climate statements
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°C 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

<table>
<thead>
<tr>
<th>Event</th>
<th>Location</th>
<th>Date</th>
<th>Casualties</th>
<th>No. of affected</th>
<th>Losses (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hurricane Sandy</td>
<td>The Caribbean and contiguous U.S.</td>
<td>Late October</td>
<td>Over 230</td>
<td>~62 million</td>
<td>~70 billion</td>
</tr>
<tr>
<td>Typhoon Bopha</td>
<td>Mindanao, Philippines</td>
<td>Early December</td>
<td>Over 1000 fatalities, with nearly 900 people missing</td>
<td>~6 million</td>
<td>Over 49 million</td>
</tr>
<tr>
<td>Cold wave</td>
<td>Most of Europe and northern Africa</td>
<td>Mid-January to early February</td>
<td>Over 650</td>
<td>—</td>
<td>~660 million</td>
</tr>
<tr>
<td>Floods</td>
<td>West Africa</td>
<td>July-September</td>
<td>340</td>
<td>~3 million</td>
<td>5.8 million</td>
</tr>
<tr>
<td>Drought</td>
<td>Contiguous United States</td>
<td>Throughout the year</td>
<td>—</td>
<td>164 million</td>
<td>Multi-billion</td>
</tr>
</tbody>
</table>
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).
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
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 the Secretary-General of WMO to convene within four months of the adoption of the Declaration an intergovernmental meeting of member states of the WMO to approve the terms of reference and to endorse the composition of a task force of high-level, independent advisors to be appointed by the Secretary-General of the WMO with due consideration to expertise, geographic and gender balance;

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
Thank you for your attention

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www.wmo.int