# WORLD METEOROLOGICAL ORGANIZATION

## World Climate Services Programme

Climate Data and Monitoring

## WCDMP-No. 84

**Expert meeting on the WMO Statements on the State of the Global Climate**

Geneva, Switzerland

20-21 February 2017

MEETING REPORT

WMO OMM

## WMO General Regulations

*Regulation 42*

Recommendations of working groups shall have no status within the Organization until they have been approved by the responsible constituent body. In the case of joint working groups the recommendations must be concurred with by the presidents of the constituent bodies concerned before being submitted to the designated constituent body.

*Regulation 43*

In the case of a recommendation made by a working group between sessions of the responsible constituent body, either in a session of a working group or by correspondence, the president of the body may, as an exceptional measure, approve the recommendation of behalf of the constituent body when the matter is, in his opinion, urgent and does not appear to imply new obligations for Members. He may then submit this recommendation for adoption by the Executive Council or to the President of the Organization for action in accordance with Regulation 9(5).

**EXECUTIVE SUMMARY**

The Expert meeting on the WMO Statements of the Global Climate discussed current status of the WMO Statement on Global Climate , addressed key challenges including those relevant to Data and analysis, open science issues and information on impacts. The meeting provided an excellent forum to express ideas for resolving some of these challenges and provided guidance for an innovative approach for the WMO Statements and issued recommendations for the implementation.

The meeting was chaired by Dr John Kennedy from the UK Met office.
Mr Omar Baddour from WMO provided the secretariat support.

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## 1. Summary of introductory Session

Maxx Dilley from WMO welcomed the participants on behalf WMO Secretary General. He informed that at the occasion of COP22, WMO made a communication to the UNFCCC Subsidiary Body for Scientific and Technological Advice (SBSTA), on the five year Climate Statement 2011-2015 and the provisional annual Statement on the State of the Global Climate in 2016; therefore the value accrues from allowing parties to make reference to WMO Statements. He highlighted that the rationale behind this meeting is to ensure that the WMO Statements on the State of the Global Climate are consistent with other reports particularly because they are planned to be reported in the context of the UNFCCC Global Stock-take that will start in 2023. He noted, there is also difficulty in the attribution of loss and damages to extreme events which arise from a mixture of factors such as exposure and vulnerability in addition to the physical aspects of the event. There is also a challenge about how to verify the information and how to make a robust link to climate change if one exists.

David Carlson from WCRP (World Climate Research Programme) emphasized that a changing climate is also a less predictable climate and this will affect prediction skill. He informed the meeting that WCRP works chiefly through peer-reviewed research products. The most prominent new ones include the Global carbon budget, the Global energy budget and the Sea-level budget which are available with time-lags of around 12-15 months. The importance of ensuring the quality of the information while maintaining the timeliness of the WMO Statement should be kept in mind to sustain the credibility of the product. He noted the challenge of combining different sources of information that are available on very different timescales. He assured the meeting that the scientific community will be ready to help in contributing to the improvement of the WMO Statement.

Carolin Richter from GCOS introduced the work being done, through GCOS, on indicators of climate change. These are categorized into two sets: historical indicators and future indicators. It was noted that temperature is not sufficient as an indicator of climate change because it does not give a complete picture of the physical or socio-economic aspects of the whole earth climate. The indicators were conceived to help communicate a broader understanding of climate change to a wider audience. She provided guidance on the criteria to be used for indicators; i.e. relevance, representativeness, traceability, timeliness and that they should be limited in number. She provided the current list of indicators which have been proposed by WMO and others. Several of the indicators still need complete characterization. Some important elements, such as precipitation, cannot easily be reduced to a single global indicator.

Ellen Hansen from UNHCR emphasized the need to be cautious when reporting on the linkage between climate and the forcible displacement of people noting that there are some challenges with respect to attribution and causality; impact; predictability; and speed vs quality in reporting. She noted that many of these challenges are shared on the physical science side. While it is clear that there are linkages between climate change and forced displacement, including conflict and armed violence, the causality is not direct. Climate change is clearly a "threat multiplier", and can exacerbate the potential for conflict. She also noted that those who have been displaced may be more vulnerable to natural hazards. The likelihood of being displaced by disasters has doubled since the 1970s (IDMC 2016). UNHCR is currently undertaking a study to explore the relationships between climate change, displacement and conflict. UNHCR look forward to collaborating with the WMO and other agencies on this defining issue of our time.

## 2. Challenges relevant to Data and analysis

### 2.1 Introduction of the topic

Blair Trewin presented on experiences from the preparation of WMO statements, including the process for preparing the statements and the sources of information included in these statements. These include international data centres and national meteorological services (either through direct contributions or through material published on their own websites). Input from NMSs is improving but there is still limited coverage from Africa, south and west Asia, and Central America.

Impact information is another major challenge because of a lack of authoritative sources, although input from other UN agencies is addressing this to some extent. Economic losses are especially difficult to quantify. National and international statistical agencies may have useful information, but it is not necessarily available within the time frame of the WMO Statement.

Mxolisi Shongwe presented the planning and requirements for next IPCC reports. A series of special reports are expected to be delivered during the current IPCC cycle, including a Special Report on global warming of 1.5°C (SR1.5) which is expected to be released in late 2018. A special report on climate change and Oceans and the Cryosphere (SROCC) and a special report on climate change, desertification, land degradation and sustainable land management (SR2), are both expected to be released in late 2019. The sixth Assessment report (AR6) is expected to be released in 2021.While the process of nomination of lead authors in these reports go through the IPCC procedural nomination / selection process, there are opportunities for volunteer chapter scientists, contributing authors and government and experts reviewers.

### 2.2 Discussion summary

a) CCl experts are encouraged to be involved in IPCC reports as well as seek ways for reviewing the WMO Statement by IPCC affiliated experts in relevant WGs.

b) Inconsistent reporting is a key issue. Tropical cyclones (TC) are one example: different RSMCs have different ways of determining TC intensity. The second example is the reporting on extremes from the countries which doesn't follow a standard approach, therefore it is difficult in many cases to get useful information which can be put in historical or geographical context. An authoritative archive of national / major city extremes would be useful.

c) Produce guidance on GCOS indicators for climate change**;** involve social scientists to co-develop these indicators (relevance);Consider including other data sets in the WMO analysis (JMA, China) and Reanalysis which assimilates available data including both in-situ and satellite sources using a weather forecasting system. In order to assess the value of including these analyses, their scientific provenance – e.g. peer review, ease of availability – will need to be assessed. Where analyses cover only certain areas (such as land) their use should be considered in the appropriate sections or context.

d) GHG: WMO GHG report uses WMO standards but not peer-reviewed, IPCC use NOAA, which is peer reviewed. WMO Statement can use both;

e) See ways for collaboration with Carbon budget group. 12-month lag product, growth rate included, very good on uncertainties using IPCC language. Includes also a year ahead prediction;

f) Use two periods for the analysis: prior to 1980 and after 1980; The latter period allows greater use of satellite and reanalysis products. The period 1961-1990 useful as reference period for in-situ analysis but not for satellite derived analyses or reanalysis. Pre-industrial definition? Paris agreement didn't mention any definition on pre-industrial period; using pre-industrial baselines for Global temperatures and GHG is currently adopted, but not feasible for the majority of ECVs, due to a lack of data prior to 1900.

g) Precipitation: new development is ongoing by GPCC to add uncertainty analysis. ETCCDI extreme indices could be used for monitoring precipitation statistics;

h) Identify a limited number of stations for achieving quality (GSN stations);

i) Use sea-level budget in combination with global averages to provide deeper context. It informs on various causes and regional distributions and is very useful for linking with impacts on coastal areas. It is a quality product and there are therefore constraints leading to slow delivery. Ocean Heat content will be ready on annual basis (IQUOD);

j) Include rates in addition to averages and anomalies, depending on the variable. Add a short summary on extreme conditions in recent years and comparison with the current year;

k) Link with Satellite community - a research quality is there - publishing papers interim CDRs. As a way of dealing with latency;

l) Seek the use of a global index of Accumulate Cyclone Energy (ACE) as an indicator for cyclonic activity; (provided by NOAA/NCEI)

m) A reliable database of national and regional extreme events is needed;

# 3. Open Science questions and Impacts

## 3.1 Introduction of the topic

John Kennedy introduced the topic with a presentation. The WMO annual statement occasionally highlights aspects of the climate that are complex, poorly understood or that are based on short records or records that are hard to update in a timely manner. Exploring possible mechanisms to ensure that these topics are handled in a scientifically responsible way was the subject of the second session. The difficulties were highlighted using specific examples: cooling in the Southern Ocean, long-term trends in Antarctic sea ice, glaciers and permafrost. This list is likely to grow in the future, even as items on it are resolved in the scientific literature, because interest often attaches to "surprising" features in the global picture that the WMO statements provide. As an example, Southern Ocean cooling and Antarctic sea-ice increases are interesting because they conflict with general expectations of warming and melting ice.
In addition a number of generic problems were highlighted: attribution and urban influences.
Attribution of events to specific causes, be they natural (e.g. El Niño) or human caused (e.g. greenhouse gases) is difficult to do on the typical time scales required by the WMO

annual statements. Operational attribution systems are being developed and have been highlighted in a previous annual statement, but are not yet regularly available. The difficulty of concisely and quantitatively informing about attribution on an annual basis was highlighted. There is also a question about how the high-impact extremes that get studied are selected and whether that is appropriate for the WMO annual statement, which has aimed at providing globally representative coverage. The attribution of impacts was also raised, bearing in mind the already great difficulties in attributing the physical aspects of extreme events and in gathering timely, relevant and accurate impact information as well as the different ways that various stakeholders talk about attribution and causality.

Urban influences are often regarded as undesirable in large scale assessments as urban areas are relatively over-represented in station-based data sets. Detecting and minimizing urban influence in near real time data sets remains a challenge. However, for impacts-relevant climate change metrics, urban influence might be an important factor as global populations migrate from rural to urban areas, changing their relative exposure against a background of large scale and regional climate change.

## 3.2 Discussion summary

### *On science issues*

a) There is a need to describe methods used for the attribution of extreme events;

b) One way to address open science issues is to provide a richer context: e.g. showing the 3-dimensional structure of temperature change in the Southern Ocean, surface salinity, relevant climate system dynamics, etc;

c) Understanding the residual influence of urbanization on observations is a key for the WMO statement on large scales. Data set providers typically deal with inhomogeneities in some way and there is continual reassessment of urban influence on large scale temperature averages. Need to inform on the value and limitations of homogenization and residual artificial changes that might affect the assessments; Reanalyzes, whilst not free from inhomogeneities, do not suffer from the same limitations as purely observation based data sets. Precipitation is difficult to homogenize. A method exists for Europe but areas such as deserts remain challenging. There are various national approaches, but these are not necessarily consistent. Reanalyzes can potentially help here too as they provide precipitation as a primary output;

d) Urban heat influence is an important consideration for future Statements; some parameters are imperfect and need some improvement, more attention or major improvement. We need to produce a table summarizing what is feasible and when it can be done;

e) We need – to an extent – to anticipate skeptical arguments, whilst of course acknowledging the existing facts;

f) Multi-year statement were identified as the best place for providing information on attribution as it allows the scientific aspects to be more fully explored through (extended) peer review; it was also highlighted that there is a need for exchanging information with the Regional Climate Centers in selecting the extreme event case studies;

g) One narrative that can be exploited in the annual statement is that on the role of science and how science works (alternatively, science at work). Side bars could be

a safe option for providing information that is more experimental, based on science that is less mature or that is still being actively developed. Side bars can also be used to explore new ways of presenting or synthesizing data. The annual statements might also be a way to identify and feed through questions that require further research.

***On impacts issues***

a) Reporting on impacts clearly adds value to the reports. Policy makers are obviously interested in connecting scientific information to tangible risks for their populations, including displacement. There are good reports (UNHCR, FAO, WHO and others) and WGs to liaise with for aligning climate and impact information. A workable schedule needs to be established, which accounts for the different reporting timelines in the relevant agencies. There will typically be a lag ranging from weeks to several months or more;
b) UNHCR is ready to contribute to WMO statements on impacts and coordinate input from the community studying . (e.g.NI and PDD related work, UNFCCC TF displacement, IDMC Global Estimate, UNHCR global report, etc.). We need to clarify who is responsible for what: climate information versus impacts;
c) Impact of climate related hazards on agriculture and food security is available via FAO. It was noted that around 25% of the loss and damage in the agricultural sector is due to natural hazards. New publication on 2013-2016 trend and specific case studies, such as drought in Ethiopia, Indonesia. Detailed reports every two years, and quarter reports every two months – the latter were especially valuable in the preparation of the 2016 statement. FAO is working on an Information System to monitor damage and loss from disasters in the agriculture sectors. Launched expert workshops on this with WMO participation. FAO links with Sendai Framework;
d) WHO there are regular products but it was not clear how they tie with WMO Statements (Research 2030-2050 on future heat mortality, every five years). Country profiles, Key products need alignment and entry points;
e) Regional analysis is attractive, backed by regional bodies and supported by UNFCCC. IPCC also considers regional scale. Regions don't necessarily match. And definitions potentially need to be sharpened;
f) Positive impact information (such as good crops in areas with favorable climatic conditions) should not be overlooked.

# 4. Scoping an innovative WMO Statements on Climate

## 4.1 Identification of policy-relevant climate indicators to focus on, in the cover stories of the Statement.

A number of indicators have been consistently used in assessing climate variability and climate change. Many of them are science-oriented and cannot necessarily be used for policy needs in a way that is simple, relevant and easy to understand. Others, such as global surface temperature averages, despite the attention given to them, provide only a partial reflection of changes in the whole climate system. The following list of indicators was proposed to be considered for their relevancy, feasibility, routine availability and because they meet the required quality standards. Together they can provide a more complete picture of global climate change. ( Additional background is provided in Annex-1). Noting the delays that can be involved in the processing of data, the most up-to-date and complete indicators should be used and the periods for which they are relevant should also be carefully documented.

## Temperature

Global surface temperature analysis allows a simple, quick indicator to measure the warming trend globally. It should be supplemented with analysis at regional level as well. Global temperature analysis is currently routinely provided by NOAA/NCEI, NASA, Met office, UK and ECMWF/Copernicus using Reanalysis approach. JMA (Japan) also maintain a global temperature data set. CMA (China) have a global land temperature data set and will, in time, likely provide a global temperature data set. These data sets can potentially add value to the global temperature analysis but it will be necessary to consider their scientific provenance and traceability. Ideally, data sets used in the annual statement should be supported by peer-reviewed publications and be publicly available. NOAA NCEI has started providing continental temperature analysis which provides a good opportunity to regionalise the indicator.

## GHG / Carbon budget

Information on GHG concentration provided by WMO/GAW should be complemented by additional information from the Carbon budget for the most recent available year. Data on GHG and Carbon budget have a near-12-month lag time.

## Cryosphere

The cryosphere component of the Earth system includes solid precipitation, snow cover, sea ice, lake and river ice, glaciers, ice caps, ice sheets, permafrost, and seasonally frozen ground. The cryosphere provides some of the most useful indicators of climate change, yet is one the most under-sampled domains of the Earth system. The most readily and operationally produced data and analyses of the cryosphere include: Sea-ice extent in the Arctic and Antarctic (available, updated daily and monthly from NSIDC); Northern hemisphere snow cover (from Rutgers University Snow Lab) and Mountain glacier analysis (from the World Glacier Monitoring Service). Greenland ice sheet analysis is made available by the Danish Meteorological Institute but the record is short.

## Sea level and Ocean/heat content

Global mean sea level is routinely assessed by CSIRO and others (including the University of Colorado Sea-level research group). Annual sea level analysis can take a few months before it is released (As of 31 March 2016, data are only available to the end of August 2016 due to the transition to a new satellite). Sea-level budget analysis can be used to discern the various sources contributing to global seal level changes. However this has been available only in recent years (and with a considerable lag) thanks to the improvements in the observing system from satellites and Argo ocean profiling floats. Global sea-level information can be supplemented by regional analyses where these are relevant. Ocean heat content provides a complement to global surface temperature, being less variable and a more direct measure of the fundamental energy imbalance that leads to climate change. NCEI provide regular updates of ocean heat content. Deep ocean warming also factors into the sea-level budget.

## Precipitation

Global precipitation analysis is provided by the Global Precipitation Climatology Centre (GPCC), in Germany. It uses data collected through WMO systems and channels. Currently, the precipitation analysis is provided on a monthly basis following quality control. The geographical distribution of precipitation extremes on seasonal, annual and multi-year time scale is a powerful means to inform on droughts, excesses of rain, and the influence of other changing features in the climate systems, such as monsoon, ENSO, Oscillations, dipoles, etc. Global precipitation percentile map produced by GPCC is being used in the WMO statements for this purpose.

**Extreme events**
While extreme events cannot be described consistently and systematically with a single meaningful indicator to reflect climate change at global scale, nevertheless assessing the change in the frequency and /or intensity of extreme weather and climate events, can be a powerful means to understand risks due to climate variability and change. It is important to consolidate and aggregate information on extremes at global and regional scales with specific indicators. The WMO Expert Team on Climate Change Detection and Indices (ETCCDI) developed a suit of indices using daily time-series of temperature and precipitation at a station level. $90^{th}$ percentile of daily $T_{max}$, daily $T_{min}$ and 24-hr total precipitation are a few examples of the suite of 27 indices. These indices provide a potential basis for investigating more closely with other groups (GFCS, UN agencies) the best selection of indices to inform on specific extremes at local, regional and global scales. Accumulated Cyclone Energy was suggested as a replacement for counts of tropical storms.

## 4.2 A way forward to harmonise reference periods and baselines

1981-2010 was proposed as the standard reference period for the annual statement. Not only is it the period recommended by WMO for routine climate monitoring, but it also allows for consistent reporting of information based on country information (the Expert Team on National Climate Monitoring Products has made a decision to adopt the use of the 1981-2010 period), global in situ data sets, satellite data sets and reanalyzes.

In addition, changes in key indicators (such as global temperature) relative to baseline periods which are important for other purposes, will be reported in a sidebar along with information supporting their inclusion and characterizing the use and value of these different baselines. These additional periods include: 1961-1990 for consistency with climate change reporting; 1985-2006 to harmonize with the IPCC; and a suitably defined "pre-industrial" period to inform in the context of UNFCCC and COP.(Additional background is provided in Annex-1)

## 4.3 A solid and pragmatic approach for informing on attribution and open science issues

As the provision of information on attribution is still maturing and requires time to gather sufficient data and perform careful analysis and peer review, it is therefore advised not to regularly include attribution in the annual statements, but to discuss it in multi-year climate reports. The annual statements could be used to highlight extreme events which might help to guide the selection of extreme events for future attribution studies, thus feeding through into the multi-year statements. Limited attribution statements, such as "El Niño contributes between 0.1 and 0.2°C" to the global average, which are based on well-established science, can still be used.

"Side bars" could be a way of providing information that is more complex (a "deep dive"), more experimental, based on science that is less mature, or areas that are still being actively developed with appropriate caveats. They can also be used to explore new ways of presenting or synthesizing data. The use of sidebars can help to promote a narrative around the role of science and how science works through the annual statements. (WCRP to lead on this part) The WMO annual statements could also serve to highlight open science issues and bring these to the attention of researchers via the WCRP.

## 4.4 A pathway for intersecting with IPCC and multi-year Statements. What is the best strategy for synchronisation?

CCl experts involved in the WMO Statements should be involved in contributing to the IPCC reports, including the report on 1.5° and the 6th Assessment report. Experts need to be nominated – usually by country – to act as IPCC authors, but a nomination does not guarantee acceptance as an author, therefore the WMO needs to explore how representation can be ensured. As well as acting as chapter authors, CCl experts can also register as expert reviewers of the IPCC reports. On the other hand WMO Statements will benefit from the review by IPCC relevant WGs.

## 4.5 A way forward for impact information, UN agency input, country inputs and other sources

The report will be divided into two strands, one focusing on the physical aspects of the weather and climate and another focusing on impacts associated with extreme events based on information provided by UN agencies. In order to ensure clarity around the provenance and ownership of these two strands of information and to maintain the integrity of the reports as a whole, WMO will lead on the first and leadership of the other will be taken on by a UN agency in collaboration with others on a rotational basis. The extent to which these two strands can be practically integrated – to provide an overall synthesis, or as separate sections within a common report – needs to be explored. WMO will maintain overall ownership of the process, but the partnership with the other UN agencies will be clearly indicated. ( Additional background is provided in Annex-1)

## 4.6 A new mechanism for authoring, contributing and reviewing the publication

A list of authors will be defined on annual basis, each author will be responsible for a section. The responsibility for the composition of the whole document will be given to a lead author assisted by WMO Secretariat and selected on voluntary basis from the pool of climate experts. A lead on the impact section from the designated UN agency will also need to be identified. A calendar should be provided via the WMO web pages to ensure that end-to-end publication process is described well in advance, including call for contribution, designation of authors, timelines for drafts, review and the release of the provisional and final publications. Guidance for authors – based on the experience of past coordinators – should also be provided. Guidance for reviewers should make it clear that the expectations for review are distinct from those for a typical peer-reviewed scientific paper as the methods and datasets will, for the most part, be updates of well-established products. WCRP will assist in a providing narratives on open science issues to be included in the Statement.

## 4.7 Citation and reference issues

Data and analysis should be supported by citing the sources and the references following WMO publication standards. In addition to the current practices for acknowledging contributions from international data and analysis centers and input from the countries, acknowledgment of the authors and the contribution of the UN organizations will be adopted as well.

## 5. Recommendations

1. Start to implement the proposed improvements to the extent possible at the issuance of the next WMO Statement on the State of the Global Climate in 2017;
2. Consider the potential for another face-to-face meeting to ensure maximum attendance of UN agencies;
3. WMO Secretariat to liaise with IPCC secretariat on CCl experts involvement in IPCC reports and their collaboration with WGs for reviewing the WMO Statement.

# ANNEX-1: Additional background

## Baselines and reference periods

It is common practice to compare recent climate data with averages from a long-term reference period. WMO decided, at its 2015 Congress, to adopt 1981-2010 as a standard reference period for routine climate monitoring purposes, whilst retaining 1961-1990 as the baseline for long-term analyses of climate change. For the purpose of communication in the context of UNFCCC, the reference to pre-industrial period will be used as much as data allows. No set definition exists for the "pre-industrial" period. A number of periods have been proposed with respect to temperature observations, such as 1850-1900 and 1880-1900. The available data indicate that these periods all give outcomes within 0.1 °C of each other. 1880-1900 will be used in the WMO Statements as a reference period for pre-industrial temperatures, to match the availability of data from global data sets which start in 1880. In the case of greenhouse gases, for which ice cores provide reliable data well before the start of the instrumental period, 1750 is used as the end of the pre-industrial period. The use of a reference period that is based on data post-1980 would allow for the consistent handling of data sets based on satellite retrievals and reanalyzes.

## Climate indicators

### Global Temperature

Global surface temperature analysis allows a simple, quick indicator to measure the warming trend globally. It should be supplemented with analysis at regional level as well. Global temperature analysis is currently routinely provided by NOAA/NCEI, NASA, Met office, UK and ECMWF/Copernicus using Reanalysis approach. JMA (Japan) also maintain a global temperature data set. CMA (China) have a global land temperature data set and will in time likely provide a global temperature data set. These data sets can potentially add value to the global temperature analysis but it will be necessary to consider their scientific provenance and traceability. NOAA NCEI has started providing continental temperature analysis which provides a good opportunity to regionalise the indicator.

### Cryosphere

It is noted that the WMO Global Cryosphere Watch may have a role to play in future in facilitating the gathering and analysis of information for the cryosphere.

*Sea ice:* Over the Arctic, sea ice forms from frozen waters of the closed Arctic ocean, therefore its status at the end of the winter (build up season) and summer (melt season) provides indication on the downtrend in the arctic sea ice extent associated with long term temperature increase. While in the Antarctic The open ocean allows the forming sea ice to move more freely, resulting in higher drift speeds. Also, because there is no land boundary to the north, the sea ice is free to float northward into warmer waters where it eventually melts. As a result, almost all of the sea ice that forms during the Antarctic winter melts during the summer. Sea ice in the Arctic and Antarctic is routinely monitored by NSIDC and made available on monthly timescale.

*Snow cover:* Northern hemisphere snow cover data is maintained by global Snow Laboratory, Rutgers university in USA. Also Snow cover data is available from NSIDC

*Glaciers:* Mountain glacier analysis are available from the World Glacier Monitoring Service under the auspices of ICSU (WDS), IUGG (IACS), UNEP, UNESCO and WMO.

*Ice sheets:* Greenland ice sheet analysis is made available by the Danish Meteorological Institute.

## Sea level budget

Sea level budget (http://tos.org/oceanography/article/balancing-the-sea-level-budget ) Monitoring sea level change, and understanding its causes are crucial for understanding climate change from a scientific and an impact point of view. By measuring the ocean's temperature, salinity, mass, and surface height, it is possible to identify various contributions to recent sea level rise. With these observations, sea level change is determined in terms of total sea level and its two major components, ocean mass and steric (density-related) sea level. The sea level budget is "closed" when the sum of the independent components agrees with measurements of total sea level, indicating that the observations can be used to interpret the causes of sea level change. Global monitoring of sea level from space-based radar altimeters has been available since the early 1990s, while weighing changes in ocean mass have been available for less than 10 years with satellite gravity missions. Even more recently, the Argo array of profiling floats achieved a level of coverage that now allows assessment of global sea level change due to temperature and salinity in the upper 2,000 m of the ocean. Only during the overlapping period of all three observing systems can the sea level budget be directly addressed by observations.

Global and regional sea-level analyses are produced with a few months lag by CSIRO and other centres, including the University of Colorado Sea-level Research Group.

## Socio-economic impacts

## FAO perspective

1) FAO methodology for the monitoring of damages and loss in agriculture sectors is accepted by the OEIWG (open ended intergovernmental working group) chair and secretariat and member states. This will be used to monitor indicator C2a (direct agricultural loss of the Sendai framework.
2) FAO liaison with UNFCCC warsaw international mechanism for loss and damage associated with climate change issues related to agricultural sectors.
3) FAO El Nino 2015-2016 report early action or early response for agriculture food security, updated every 2-3 months.

## UNHCR perspective

1) Data collection : predominantly on Internal Displacement in disaster contexts (incl. geophysical events)/ Lack of robust and consistent data on climate change related cross-border displacement and slow onset related displacement.
2) UNHCR does not publish data on projection on displacement related to climate change. Alarming future data is not always helpful. We analyse trends from the past years. These trends project an increase of displacement. In this context we work with states on preventing and addressing displacement.
3) On displacement and attribution, UNHCR faces 2 layers of challenges:
    - First layer: is displacement caused by disaster/climate change?: causality is indirect. Displacement is the consequence of exposure+ vulnerability + natural hazard
    - Second layer: is the disaster/slow onset attributable to climate change? From a protection perspective we don't differentiate between persons displaced by climate change and people displaced by other disasters that are not climate change related, eg geophysical event. Hence "*displacement in the context of/or/ related to disasters and/ including the adverse effects of climate change*" is the language used to address impact attribution. This language

was endorsed by 109 States in the Protection Agenda of the Nansen Initiative on cross border displacement in the contexts of disasters and climate change. Another challenge on attribution is the link between conflict and climate change. There is no direct causality between climate change and conflict. The linkage is far more complex and involves a range of other factors. Climate change is perceived as a "threat multiplier."

## WHO perspective

1) Suggested Health studies for tracking impacts:
   - WHO Global Burden of Disease attributed to Climate (5 yr update)
   - UNFCCC-WHO Country Profiles (rolling production/database under construction and bi-annual update targets)
   - Lancet Tracking Progress http://lancetcountdown.org/ - Annual publication, impact focus

2) WHO/UNFCCC Profiles Background: In 2015 WHO/UNFCCC produced over 40 Climate and Health Country Profiles that provide decision-makers of both high- and LMICs with country-specific, evidence-based snapshots of the climate hazards and health risks, in order to present opportunities for health protection and to track national progress in policy response and implementation. The project established a global platform for reporting climate related health risks and opportunities for action; strengthened the linkages between climate and health communities; promoted innovative research on national climate hazard and health impact modeling; and engaged an inter-ministerial network of climate and health focal points to develop, advance and disseminate the findings. Now entering phase 2, the project aims to double the number of available profiles in 2017.
   Phase 1 revealed a range of methodological and data related challenges to generate national climate projections for health impacts, particularly with respect to extreme weather events. WHO and the University of East Anglia, invite WMO staff and experts to a presentation on these challenges and are seeking advice on how to improve round-two. Profiles can be found here http://www.who.int/globalchange/resources/countries/en/

3) WHO releases a quantitative assessment of the health impacts of climate change. This constitutes an update and a further development of the assessment that was first published by WHO for the year 2000, now with a wider range of health impacts, and projections for future years. The assessment takes into account a subset of the possible health impacts, and assumes continued economic growth and health progress. Even under these conditions, it concludes that climate change is expected to cause approximately 250 000 additional deaths per year between 2030 and 2050; 38 000 due to heat exposure in elderly people, 48 000 due to diarrhoea, 60 000 due to malaria, and 95 000 due to childhood undernutrition. Results indicate that the burden of disease from climate change in the future will continue to fall mainly on children in developing countries, but that other population groups will be increasingly affected.

## ANNEX-2: Agenda

Expert meeting on the WMO Statement on Climate
**WMO headquarter : 20-21 February 2017**
**Meeting room : Salle C2**

DAY-1: Monday 20 February

**09:00 Introductory session**

- Opening : Secretary General representative 10'
- Introduction around the table 10'
- Why do we need to revisit the WMO Annual Statement on the State of the global climate: **Maxx Dilley** *, Director Climate Prediction and Adaptation Branch, WMO* (10', reference to sessions 1,3)
- Emerging science and open issues, **David Carlson**, *Director World Climate Research Programme* (WCRP) (10', reference to session 2)
- Recent work on climate indicators: **Carolin Richter,** *Director Global Climate Observing System* (10', reference to session 3)
- A perspective from UNHCR**:** **Ms Ellen Hansen**, Special Adviser to the Assistant High Commissioner for Protection (10', reference to session 2)
- Structure of the meeting and expected outcome: **Omar Baddour,** 10'

**10:30 Break**

**10:45-13:00**

**Session 1: Challenges relevant to Data and analysis**

- Introductory talk: **Blair Trewin, Bureau of Meteorology, Australia**
- Planning and requirements for next IPCC reports: **IPCC** (10', reference to session 3)
- Perspectives from the participants on the following aspects:
- Global Data sets and analysis (Temperature, GHG, Precipitation, Cryosphere, Sea level, etc.)
- Baselines, uncertainties
- GHG concentration, Carbone Budget
- Reports on national climate information and extreme events

**Lunch break : 13:00 – 14:00**

**14:00- 17:30**

**Session 2: Open science issues, attribution and impacts**

- Introductory talk: **John Kennedy, Met Office, United Kingdom**
- Discussions and advice on current state of knowledge and use of existing data and analysis. Focus on
- Southern Ocean cooling, Antarctica sea ice, ice sheet, glaciers, permafrost, urban heat influence, attribution of extreme events,
- How to concisely and quantitatively inform about attribution on annual basis, how to select high-impact extremes to be represented in the annual statement,
- Attribution of observed trends: climate variability versus long-term signal, examples from 2015 and 2016,
- Linking regional large-scale anomalies to major modes of climate variability

**16:00- 16:15 Break**

- Round table on current status of work on impacts : UN agencies perspectives
- Discussions and advice on current state of knowledge and information on impacts. Focus on:
- Data collection, analysis and reporting
- Attribution of impacts: contribution of various factors, direct influence, indirect influence, cumulative influences, etc.
- What is the best approach on impacts: global analysis, specific cases studies, etc.
- In addition to observed inconsistencies in the data , what is the added value of providing information on impacts in the WMO climate statement?

**DAY-2: Tuesday , 21 February**

**09:00-13:00**

**Session 3: Scoping an innovative WMO Statements on Climate**

- Summary Session 1 and Session 2
- Framing Recommendations on:
- Policy-relevant climate indicators to focus on, in the cover stories of the Statement
- A way forward to harmonise reference periods and baselines
- A solid and pragmatic approach for informing about attribution and open science issues
- A pathway for intersecting with IPCC and multi-year reports. What is the best strategy for synchronisation?
- A way forward for impact information, UN agency input, country inputs, other sources (EM-DAT, etc.)
- A new mechanism for authoring, contributing and reviewing the publication
- Citation and reference issues

**13:00 Closure of the meeting**

## ANNEX-3: List of Participants

### 1. International climate experts

Mr Derek ARNDT, NOAA/NCEI, USA
Dr John KENNEDY, Met Office, UK
Dr Aleksandr STERIN, ROSHYDROMET, Russian Federation
Mr Kiyotoshi TAKAHASHI, JMA, Japan
Mr Jean-Noël THEPAUT, ECMWF, UK
Dr Blair TREWIN, BOM, Australia
Dr Markus ZIESE, GPCC, Germany

### 2. IPCC

Mxolisi SHONGWE, IPCC Secretariat

### 3. UN agencies

Allen HANSEN, Special Adviser to the Assistant High Commissioner for Protection, UNHCR
Marine FRANK, Climate Change and Disaster Displacement Officer, UNHCR
Wirya KHIM, Natural Resources/Climate Change Officer, FAO
Joy SHUMAKE-GUILLEMOT, WHO/WMO Climate and Health Project Officer, GFCS Office

### 4. WMO Secretariat :

David CARLSON, D/WCRP,
Maxx DILLEY, D/CLPA
Filipe Lucio, D/GFCS.O
Carolin RICHTER, D/GCOS
Valentin AICH, JPO/GCOS
Erica ALLIS, Senior Programme Manager/GFCS
Omar BADDOUR, C/DMA
Simon EGGLESTON, TOPC/GCOS
Anne-Claire FONTAN, SO/WDS
Peer HECHLER, SO/DMA
Katherine HILL, OOPC/GCOS
Ata HUSSAIN , Project Coordination Officer, DPFS/WDS
Oksana TARASOVA, C/ARE
Caterina TASSONE, AOPC/GCOS
Michael WILLIAMS, C/CPA