# Systematic Observation at the forty-ninth session of the Subsidiary Body for Scientific and Technological Advice

## Note by the Chair of the SBSTA

*23 November 2018*

## A. Introduction

1. Research and systematic observation is agenda item 6 of the draft provisional agenda for the forty-ninth session of the Subsidiary Body for Scientific and Technological Advice (SBSTA 49).[1] The focus of this agenda item at SBSTA 49 will be systematic observation, in line with past conclusions of SBSTA.[2]

2. This information note has been prepared by the Chair of the SBSTA to support Parties in their work at SBSTA 49 on agenda item 6. It seeks to summarize the information to be considered and clarify possible issues and opportunities for consideration by Parties. More specifically, it provides a summary of the SBSTA mandates, updates on relevant activities under the Convention and relevant activities reported by the systematic observation community.

3. In relation to agenda item 6, and as provided in the annotated agenda,[3] SBSTA 49 will be invited to consider this matter and the information received with a view to determining any further action it deems appropriate.

4. This note is provided without any prejudice towards the final results of discussions at SBSTA 49.

## B. Relevant mandates and resources

5. SBSTA 45 noted the **Earth Information Day** organized in 2016 by the secretariat under the guidance of the SBSTA Chair, and invited Parties to consider inviting the secretariat to organize similar events during the implementation of the Global Climate Observing System (GCOS) implementation plan, *The Global Observing System for Climate: Implementation Needs*, on the basis of views submitted by Parties by SBSTA 49.

6. As of the date of publication of this note, submissions have been received from Austria and the European Commission on behalf of the European Union and its Member States, Japan and Switzerland.[4]

7. SBSTA 45 and 47 invited on a regular basis, as appropriate:

a) The secretariat of the Global Climate Observing System (GCOS) to report on progress made in the implementation of the GCOS implementation plan;[5]

b) World Meteorological Organization (WMO) to provide submissions on the state of the global climate;[6]

c) WMO to report on progress in implementing the Global Framework for Climate Services (GFCS);[7]

d) The Committee on Earth Observation Satellites (CEOS) and the Coordination Group for Meteorological Satellites (CGMS) to report on progress.[8]

[1] See https://unfccc.int/topics/science/workstreams/systematic-observation.
[2] FCCC/SBSTA/2012/5 paragraph 46.
[3] FCCC/SBSTA/2018/7, paragraphs 26-30.
[4] See http://www4.unfccc.int/sites/submissionportal/Pages/Home.aspx.
[5] FCCC/SBSTA/2016/4, paragraph 41.
[6] FCCC/SBSTA/2016/4, paragraph 43.
[7] FCCC/SBSTA/2017/7, paragraph 57.
[8] FCCC/SBSTA/2017/7, paragraph 56.

8. Submissions, statements and reports on progress provided to the SBSTA[9] include:

a) CEOS and CGMS statement reporting on progress on Coordinated Response to UNFCCC Needs for Global Observations;[10]

b) Space agency report in support of the Paris Agreement;[11]

c) GCOS statement to SBSTA on report on progress;[12]

d) Inter-American Institute for Global Change Research (IAI) statement;

e) IPCC statement;

f) WCRP statement;

g) WMO statement on the State of the Global Climate 2018;

h) WMO Annual Greenhouse Gas Bulletin.[13]

i) WMO submission to SBSTA 49: Outcomes of the Seventieth session of the WMO Executive Council with updates on other WMO activities with respect to UNFCCC and implementation of the Paris Agreement;[14]

j) WMO submission on progress on the Global Framework for Climate Services.[15]

9. Further relevant documents from GCOS include:

a) The GCOS report by its Task Team on the Paris Agreement on Systematic Observations and the Paris Agreement;[16]

b) The GCOS-WMO Integrated Global Observing System (WIGOS) Pacific region observing network plan;[17]

10. A number of side events during COP24 will be relevant, including:

a) Joint UNFCCC and WMO event: Innovative Atmospheric observation-based tools to support climate mitigation action on Tuesday 4 December 2018, 18:30–20.00, Room 6;

b) Joint UNFCCC, IPCC, WMO and European Commission event: Climate information for decision making on Tuesday 11 December 2018, 18:30–20:00, Room 1.

11. There will be a SBSTA-IPCC special event: Unpacking the new scientific knowledge and key findings in the IPCC Special Report on Global Warming of 1.5°C[18] on Tuesday 4 December 2018, 15.00–18.00, Room "Slask" Plenary 2.[19]

12. This year, 2018, marks the thirtieth year anniversary of IPCC. To celebrate this anniversary, the IPCC and WMO will have a pavilion (Booth number 11) at the climate change conference. WMO and GCOS are involved in a number of events at the pavilion.

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9 All submissions available at https://www4.unfccc.int/sites/submissionsstaging/Pages/Home.aspx or https://unfccc.int/topics/science/workstreams/systematic-observation/upcoming-negotiations.
10 See https://unfccc.int/documents/184345.
11 See https://unfccc.int/documents/184388.
12 See https://unfccc.int/documents/184346.
13 See https://public.wmo.int/en/resources/library/wmo-greenhouse-gas-bulletin. Press release on 22 November 2018.
14 See https://unfccc.int/documents/184348.
15 See https://unfccc.int/documents/184349.
16 Available at https://unfccc.int/topics/science/workstreams/systematic-observation/upcoming-negotiations.
17 Available at https://gcos.wmo.int/en/regional-workshops/pacific-workshop.
18 See http://ipcc.ch/report/sr15/.
19 See https://unfccc.int/event/sbsta-ipcc-special-event-unpacking-the-new-scientific-knowledge-and-key-findings-in-the-ipcc-special.

## C. Relevant activities under UNFCCC

13. The **tenth meeting of the research dialogue** took place on 3 May 2018. A summary report by the SBSTA Chair of meeting is available online.[20] The meeting identified a number of observation needs (see also Section E below);

14. The Adaptation **Committee (**AC) finalized the 2019–2021 flexible workplan[21] it at its 14th meeting.[22] The AC agreed that its work should be ambitious, strategic, inspiring and results-driven, with the AC striving to become a recognized interface between science, policy and practice. In its report to the COP,[23] the AC recommended that the COP consider, inter alia: inviting relevant institutions under the Convention and non-Party stakeholders to strengthen support (financial, technical, technological and capacity-building support) for adaptation planning, including for climate data and information, noting the urgency for adaptation action to address current, near-term and long-term risks of climate change;

15. The multi-stakeholder workshop: Implementing the functions of the **Local Communities and Indigenous Peoples Platform** (LCIPP),[24] was held in Bonn during SBSTA 48 on 1 May 2018. The multi-stakeholder workshop was the first activity of the LCIPP which had been created at COP 21 and fully operationalised at COP 23 (2017).[25] The summary report of the multi-stakeholder workshop, prepared by the secretariat under the guidance of the co-moderators, highlights that local communities and indigenous peoples' holistic view and cumulative knowledge of the environment complement other knowledge systems with local observations and insight. Workshop participants underlined that local communities and indigenous peoples hold tailored, granular knowledge and expertise in practices that stem from generations of on-the-ground climate observations and interactions with the environment. Such knowledge enables better understanding of the environment at a much finer spatial-scale and a greater temporal-depth. Opportunities identified at the workshop include greater collaboration and integration of scientific and traditional knowledge, including: exploring synergy between local communities and indigenous peoples' best climate observation practices and activities undertaken by the Global Climate Observing Systems (GCOS) to better inform global climate mitigation and adaptation efforts; and fostering collaboration between transdisciplinary observatories and LCs and IPs to co-produce knowledge products.

16. The **NAP Expo 2018**,[26] 4–6 April 2018, Sharm el Sheikh, Egypt, held a session on climate data and scenarios and open National Adaptation Plans (NAPs) focussing on best available methodologies for analyzing past climatic trends and information on climate scenario data for assessing potential future impacts and risks and applying the IPCC guidance. The session also discussed approaches to standardize representation of changes, vulnerability and risk in communicating with multiple stakeholders. A summary poster was presented at RD 10.[27]

## D. Update on activities by key partners

### 1. CEOS and CGMS

17. The CEOS inputs to SBSTA 49 (see paragraph 8(a) and (b) above) are the statement reporting on progress by CEOS and CGMS on **Coordinated Response to UNFCCC Needs for Global Observations**[28] and **the Space Agency Report in Support of the Paris Agreement.**

18. The Joint CEOS/CGMS Working Group on Climate (WGClimate) consolidated its first **gap analysis**[29] **based on the web-based ECV Inventory** of more than 900 existing and planned climate data

[20] See https://unfccc.int/event/tenth-meeting-of-the-research-dialogue-rd-10.
[21] AC/2018/15, see https://unfccc.int/sites/default/files/resource/ac14_workplan.pdf.
[22] See https://unfccc.int/node/65600.
[23] See https://unfccc.int/process/bodies/constituted-bodies/adaptation-committee-ac.
[24] See https://unfccc.int/topics/local-communities-and-indigenous-peoples-platform/events-and-meetings/workshops-meetings/multi-stakeholder-workshop-on-the-local-communities-and-indigenous-peoples-platform.
[25] Decision 2/CP.23 (FCCC/CP/2017/11/Add.1).
[26] See http://napexpo.org/2018/.
[27] See https://unfccc.int/sites/default/files/resource/2.33%20Teichmann__Climate-scenario-data-for-NAPs_Poster__GERICS_2018-05-03__final.pdf.
[28] See https://unfccc.int/documents/184345.
[29] See http://ceos.org/document_management/Working_Groups/WGClimate/Documents/WGClimate_ECV-Inventory_Gap_Analysis_Report_v1.1.pdf.

records of GCOS ECVs observable from space published in 2017.[30] The analysis achieved a **full assessment of climate data records against GCOS criteria. For eight ECVs including $CO_2$ and $CH_4$, it identified gaps in planned future measurements that would prevent the continuation of climate data records**. It also assessed how the use of past and current satellite measurements could be further optimised. From a space agency perspective, the identification of gaps and their traceability to ECV products and satellite instruments provides a sufficient basis for future planning. CEOS and CGMS foresee annual updates of the web-based ECV Inventory and incremental gap analyses addressing specific sets of ECVs performed by the Joint Working Group on Climate that will further improve the ability of space agencies for a targeted response to the UNFCCC needs for global observations facilitated by GCOS.

19. **Space agencies provided a first comprehensive analysis[31] of the space based state-of-the art of atmospheric greenhouse gas monitoring capabilities in support of international, regional and national climate policy**. This analysis provides a reference for individual agencies planning missions in this domain as well as for the broader coordination of **virtual and dedicated constellations** of space-based $CO_2$ and $CH_4$ sensors among space agencies through CEOS and CGMS. To build a strong foundation for the space-based elements of an operational atmospheric $CO_2$ and $CH_4$ monitoring system that can be implemented within the next few years and to maximize its impact towards the achievement of Nationally Determined Contributions (NDCs) and for the global stocktake, a series of specific steps is identified for space agencies' consideration. This includes the outline of a prototype system, based on available space-based assets, which could inform the first global stocktake in 2023 and an operational system that could support the second global stocktake in 2028.

20. Space agencies were actively engaged in the **refinement process of the IPCC Greenhouse Gas Inventory guidelines**. The Second Order Draft now contains information on the potential contributions of space-based observations to improve the greenhouse gas emission estimates, in particular with the planned new satellite missions.

21. The Joint CEOS/CGMS Working Group on Climate delivered an analysis detailing **existing and potential future contributions of space agencies in support of the implementation of the Paris Agreement**,[32] in particular for future arising observational needs for adaptation monitoring and global stocktake.

22. CEOS continues to provide systematic satellite observations for forest monitoring through the **Global Forest Observations Initiative** (GFOI) and is supporting countries in the use of observations for their **National Forest Monitoring Systems** (NFMS) to provide fully measured, reported and verified (MRV) information **for the United Nations initiative on Reducing Emissions from Deforestation and Forest Degradation** (REDD+) in developing countries.

## 2. GCOS

23. GCOS provided an update on progress to SBSTA 49 (see paragraph 8(c) above), reporting on progress including:

a) Promoting **Global Climate Indicators**;
b) **Task Team on Paris Agreement**;
c) Using radar to compliment precipitation climatology;
d) Lightning observations for climate applications;
e) **Regional workshops** in light of importance of climate adaptation;
f) **Observations for adaptation**;
g) Progress in providing **access to ECVs**;
h) Continued **commitment of space agencies**;
i) GCOS network management;
j) Developing the **ocean observing system for climate**;
k) Regional Ocean Observing System reviews and development projects;

[30] See www.climatemonitoring.info.
[31] See http://ceos.org/document_management/Virtual_Constellations/ACC/Documents/CEOS_AC-VC_GHG_White_Paper_Version_1_20181009.pdf.
[32] See http://ceos.org/wp-content/uploads/2018/06/2.1-DRAFT-CEOS-Statement-on-Paris-Agreement_v1.1_20181116.pdf.

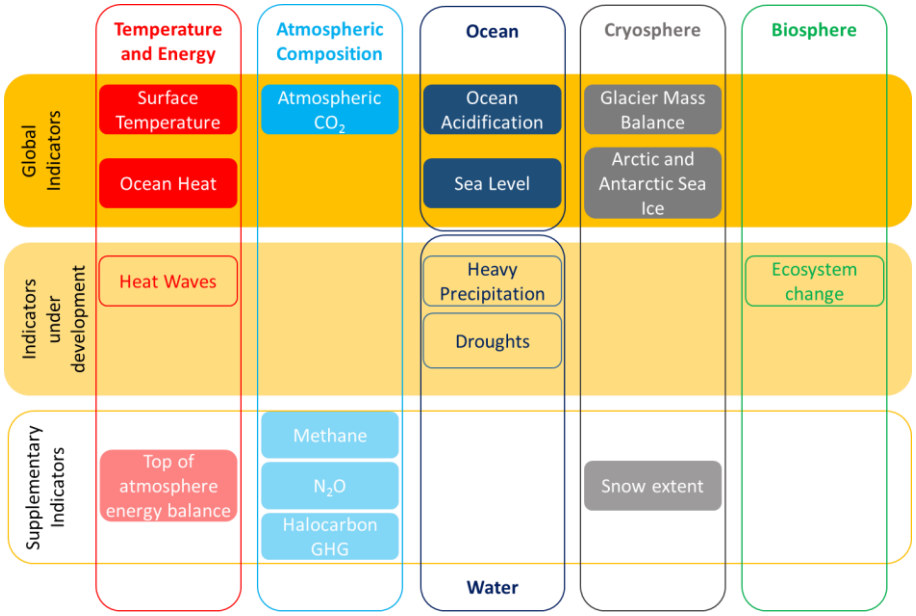
l) Observing System implementation and performance tracking;

m) OceanObs'19 Decadal Conference;

n) **Planning cycle for the GCOS towards the Global Stocktake**.

24. GCOS have identified the **Global Climate Indicators**[33] which have been noted by the SBSTA.[34] The **seven headline indicators** are complemented by a set of subsidiary indicators that provide additional information and allow a more detailed picture of the changes in the respective domain (figure 1). They comprise key information for temperature and energy, atmospheric composition, ocean and water as well as the cryosphere. The indicators have been identified by scientists and communication specialists in a discursive process led by GCOS. They form the basis of the annual WMO Statement of the State of the Global Climate (as identified in 5c above), as well as other reports such as the European State of the Climate by Copernicus Climate Change Service (C3S).[35]

Figure 1
**Global Climate Indicators**




*Source*: GCOS

25. As recognised in the **GCOS implementation plan**[36] and mandated at SBSTA 45,[37] GCOS in collaboration with relevant partners, is undertaking a series of **regional workshops**.

26. The first workshop, the GCOS / WMO Integrated Global Observing System (WIGOS) for the Pacific Small Island Developing States, took place in Nadi, Fiji, October 2017.[38] Since SBSTA 47, GCOS have published the report of the workshop[39] and developed a **Pacific region observing network plan**,[40] in collaboration with the Secretariat of the Pacific Regional Environmental Programme (SPREP), the Pacific Islands Communication and Infrastructure Panel (PICI), and Pacific Meteorological Council;

27. A joint GCOS / Copernicus / WIGOS / GFCS workshop in collaboration with UNFCCC was held in Entebbe, Uganda, 31 October - 2 November 2018 on **improving the value chain from observations to climate services to support climate policy, adaptation and mitigation in East Africa**.[41] The workshop outcomes will include a report and a regional plan to improve the value chain from observations to climate services in East Africa. The key messages from the workshop are provided in Box 1.

[33] See https://gcos.wmo.int/en/global-climate-indicators.
[34] FCCC/SBSTA/2017/7, paragraphs 53 and 54.
[35] See https://climate.copernicus.eu/CopernicusESC.
[36] See https://public.wmo.int/en/programmes/global-climate-observing-system.
[37] FCCC/SBSTA/2016/4, paragraph 39.
[38] See https://gcos.wmo.int/en/regional-workshops/pacific-workshop.
[39] See https://unfccc.int/documents/183703.
[40] See https://gcos.wmo.int/en/regional-workshops/pacific-workshop.
[41] See https://gcos.wmo.int/en/regional-workshops/east-africa-workshop.

Box 1

**Key messages from the Joint GCOS / Copernicus / WIGOS / GFCS Workshop in collaboration with UNFCCC, Improving the value chain from observations to climate services to support climate policy, adaptation and mitigation in East Africa.**

1. Most of the value of sustained, systematic meteorological observations can only be realised at a national level if they are reported and exchanged internationally. International reporting of a basic network of surface and upper air observations leads to improvements in local weather prediction and national seasonal forecasts of temperature and precipitation. Global numerical weather prediction and reanalysis are used to provide the boundary conditions for local models and assessments.
2. While most of the five countries in the region (Uganda, Burundi, Kenya, Rwanda and Tanzania) have **operating** networks and sites and are meeting minimum WMO requirements, many of the stations are not fully **reporting** as needed by international centres for global numerical weather prediction and reanalysis (hourly for surface stations and every 12 hours for upper air observations Currently, in Africa, only about 10% of the surface and 20% of the radiosonde stations that are required to report meet this need.
3. The accuracy of climate services depends on the quality and quantity of the observations. Observations underpin all climate services, planning climate policy and adaptation.
4. Currently, WMO mandatory requirements, are not sufficient to support global NWP and consequently national climate services. However, the proposed WMO Global Basic Observation Network (GBON) will allow numerical weather prediction and reanalysis centres to meet the regional needs.
5. The workshop recognised the support of governments in the region for observations, but further and sustained support is needed for the required long term sustainability of observation
6. The regional plan should include the following outline, developed at the workshop, to improve the value chain from observations to climate services in East Africa:
    a. Planning to ensure the sustainability of systems and staff: recognising the value of life cycle management of equipment and in-house staff training and mentoring;
    b. Calibration and maintenance policies,
    c. Meeting the observational needs of international centres for global numerical weather prediction and reanalysis centres,
    d. Building on the benefits of the HIGHWAY project[42] around Lake Victoria to enable fully functioning regional network of stations.
    e. Support regional collaboration to build technical and operational capabilities
7. Training by a representative of the Copernicus Climate Data Store increased the understanding of participants on how its global datasets can be used locally to produce nationally tailored climate services.
8. The workshop noted the opportunities to use the global datasets from global numerical weather prediction and reanalysis centres by national meteorological and hydrological services (NMHS) to support national climate services.
9. NMHS wish to improve the ways they communicate forecasts, such as the probabilities of extreme events, to the public and decision makers.

    Regional climate service platforms could support communication and science-based decision making on adaptation.

[42] See https://www.metoffice.gov.uk/about-us/what/international/projects/wiser/highway.

28. The 26th GCOS Steering Committee meeting took place in Helsinki, Finland, from 23–26 October 2018.[43] A number of actions, as reported in the GCOS statement, were agreed at the meeting including:

a) Approval of the paper by the GCOS Task Team on Systematic Observations and the Paris Agreement, "**GCOS support to the Paris Agreement and the Global Stocktake**" (gcos - 222). The paper considers the Paris Agreement in detail and suggests suitable activities that GCOS should undertake or support to assist in the implementation of the Paris Agreement.[44]

b) Approval on the **GCOS Strategic Plan**,[45] developed to address the needs for climate observations in light of the Paris Agreement, Sustainable Development Goals and Sendai Framework for disaster risk reduction, as well as recent developments in observing technologies.

c) **Coordinating support for adaptation** including through setting up a steering committee subgroup on adaptation to provide strategic guidance on the GCOS approach to adaptation recognizing the UNFCCC/IPCC approach to adaptation management by National Adaptation Plans (NAPs) and the Global stocktake;

d) Building **collaboration with the WCRP** in the development of indicators;

e) Aligning strategies and partnerships with the **ocean observing community** through the Global Ocean Observing System (GOOS);

f) **Coordinating with the WMO Global Basic Observing Network (GBON);**

g) **Approval** to develop **fact sheets for all ECVs** (see Annex for draft example).

## 3. GEO

29. The Group on Earth Observations (GEO) held GEO Week 2018 in Kyoto, Japan, 29 October - 2 November 2018.[46] The event explored the efforts and opportunities for the use of Earth observations for the benefit of humankind, focusing on GEO's three **priority areas: the Paris Climate Agreement**, the UN Sustainable Development Goals and the Sendai Framework for Disaster Risk Reduction. Session 3 of the GEO Week focused on Earth observations in Support of the Paris Agreement. A representative from the UNFCCC Secretariat delivered an opening plenary keynote for the Paris Agreement panel session at the GEO week providing guidance for the GEO community to engage more comprehensively around the use of Earth observations in support of the Paris Agreement. GEO are undertaking a mapping of climate change activities across their entire portfolio of activities.

30. The GEO highlights 2017–2018[47] describes the work of the GEO community over the last two years, including the concrete action areas identified by GEO in supporting the Paris Agreement, including:

a) The GEO Climate Workshop: Earth Observations for the Paris Agreement,[48] 12–13 June 2018 to **enhance the understanding of how the Earth Observation community can support implementation of the Paris Agreement and discuss a more integrated approach** to climate across the GEO Work Programme. These include:

(i) helping to improve climate data access;

(ii) supporting actions on mitigation, adaptation and loss and damage;

(iii) integrating climate with SDGs, Sendai Framework and other Rio Conventions;

(iv) engaging with national stakeholders (e.g. in National Adaptation Planning);

(v) supporting IPCC processes (2019 Refinement of 2006 IPCC Guidelines on National GHG Inventories; Sixth Assessment Cycle);

(vi) responding to actions in the GCOS Implementation Plan; and,

[43] See https://public.wmo.int/en/programmes/global-climate-observing-system/gcos-steering-committee for agenda, presentations and other information.
[44] See https://library.wmo.int/index.php?lvl=notice_display&id=20689.
[45] See https://ane4bf-datap1.s3-eu-west-1.amazonaws.com/wmocms/s3fs-public/ckeditor/files/Doc.5e_-_GCOS_Strategy_V2.0.docx?wNVKVXUysoCrY.Eu0fd5MDgCta6I_CY6.
[46] See http://earthobservations.org/geo15.php.
[47] See https://www.earthobservations.org/article.php?id=324.
[48] See http://www.earthobservations.org/me_201806_wps.php?t=climate_workshop.

(vii) enhancing the use of climate data records for a variety of application areas, including drought monitoring, renewable energy assessments and health early warning systems.

b) The establishment of the GEO Carbon and GHG Initiative steering committee and secretariat to discuss joint activities in the carbon observation space, and to align the various organizational agendas on carbon observations across the atmospheric, oceanic and terrestrial domains

## 4. Global Carbon Project

31. The global carbon budget 2018 will be published during SBSTA 49 and available from the global carbon project website.[49] See also paragraph 46(d) below in regards to gaps and needs.

## 5. IPCC

32. The IPCC published ***Global Warming of 1.5 °C****: an IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* on 8 October 2018.[50]

33. In the special report, the IPCC identified a number of **knowledge gaps**, some of which could be addressed by the systematic observation community. Most scientific literature specific to global warming of 1.5℃ is only just emerging, knowledge gaps are identified in the following sections of the report: [51]

a) Section 2.6: this section identifies knowledge gaps on geophysical understanding (the carbon-cycle response, the role of non-$CO_2$ emissions and on the evaluation of an appropriate historic baseline); integrated assessment approaches; and Carbon Dioxide Removal (CDR) (most 1.5℃ and 2℃ pathways are heavily reliant on CDR – but there is uncertainty in its feasibility, potential, future deployment and environmental and societal impact);

b) Section 3.7: this section identifies that the number of impact studies specifically focused on 1.5℃ lags behind climate change projections in general, due in part to the dependence of the former on the latter; and there are also insufficient studies focusing on regional changes, impacts and consequences at +1.5℃ and +2℃ of global warming. Gaps have been identified in methods and tools and in understanding (of Earth systems and 1.5℃, physical and chemical characteristics of a 1.5℃ world, terrestrial and freshwater systems and ocean systems);

c) Section 4.6 and Table 4.13: this section explores knowledge gaps that have emerged from the assessment of mitigation, adaptation and CDR options and Solar Radiation Modification (SRM) measures, enabling conditions, and synergies and tradeoffs ;

d) Section 5.7: this section identifies gaps in the literature on linkages between a 1.5℃ warmer world and different dimensions of sustainable development.

## 6. UN and Oceans activities

34. The Global Ocean Observing System (GOOS), led by Intergovernmental Oceanographic Commission (UNESCO-IOC), is currently developing the **GOOS 2030 Strategy** which sets a broad and high-level framework for global ocean observing over the next decade. It does not specify the numerous organizations or components of the observing system that are and will be integral partners in delivering the strategic framework. These partnerships will be laid out in an associated GOOS Implementation Plan. The final draft of the GOOS 2030 Strategy will be presented to the IOC Assembly for acceptance and endorsement in July 2019.

35. The Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM)[52] have developed a new **Ocean Observing System Report Card**[53] to provide a snapshot of

[49] See http://www.globalcarbonproject.org/carbonbudget/.
[50] See http://ipcc.ch/report/sr15/.
[51] Some of these gaps will also be discussed at the IPCC Special Event (see paragraph 11 above).
[52] See https://www.jcomm.info/.
[53] See http://www.jcommops.org/reportcard2018/. Pdf is available at http://www.jcommops.org/reportcard2018/reportcard.pdf.

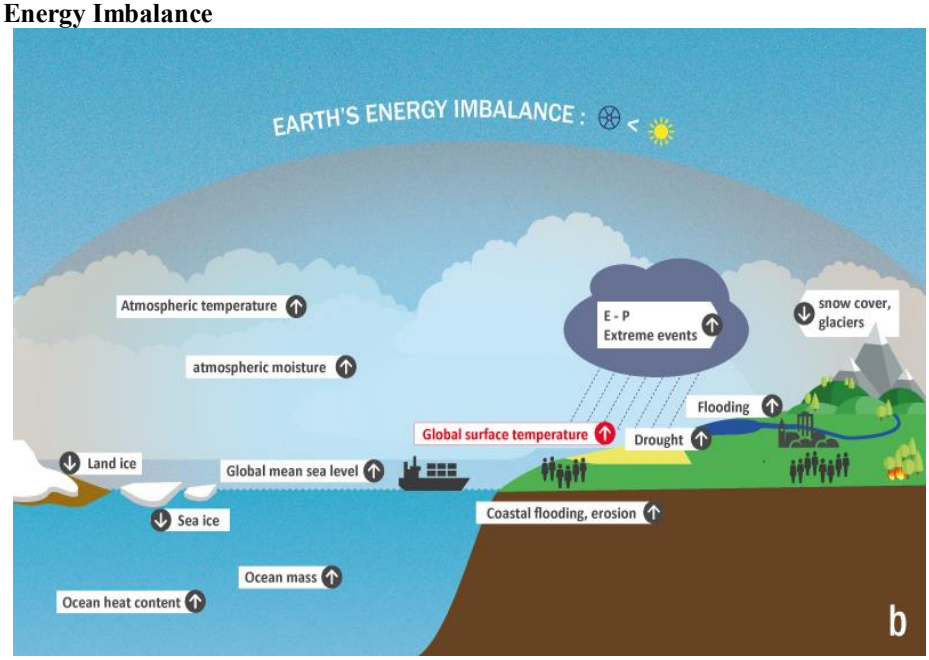
ocean observations, which are critical to predict and manage extreme weather and coastal hazards as well as to monitor the state of our seas.

## 7. WCRP

36. The WCRP are pursuing a number of activities relevant to the observation community and climate data. **WCRP have developed a Strategic Plan** (2019–2029)[54] and continue to **progress work on the WCRP Coupled Model Intercomparison Project Phase 6** (CMIP6).[55] The first **CMIP6 dataset** was released in August 2018, through a significant improvement in the infrastructure for data management.[56] The CMIP represents one of society's most robust and reliable sources for climate information and WCRP contributes to the climate data service and to the development of climate change scenarios at the national and local levels, through the CMIP and the CORDEX (Coordinated Regional Climate Downscaling Experiment) projects. The growing dependency on CMIP products by a broad research community and by national and international climate services implies that basic CMIP activities, such as the creation of forcing datasets, require substantial efforts.

37. Human-induced atmospheric composition changes cause a radiative imbalance, **Earth Energy Imbalance (**EEI), at top-of-atmosphere which is driving global warming and thus EEI is a fundamental metric of climate change. A WCRP concerted **international effort is under-way to estimate EEI and its impacts**, to assess gaps in the global climate observing system, and the performance of Earth system models and reanalyses of past data (see figure 2). A main challenge is to reduce uncertainties in EEI, and to understand its variations from the annual cycle, El Niño and decadal changes to long-term anthropogenic climate change.

Figure 2
**Earth's Energy Imbalance**




*Source*: 'Symptoms' of positive EEI, including rises in Earth's surface temperature, ocean heat content, ocean mass, global mean sea level, atmospheric temperature and moisture, drought, flooding and erosion, increased extreme events, and evaporation − precipitation (E−P), as well as a decrease in land and sea ice, snow cover and glaciers. (von Schuckmann et al., doi:10.1038/nclimate2876).

38. The international community, through the WCRP, recently published an extensive study assessing the various datasets (space-based and in situ observations, model estimates, and algorithms) used to estimate **components of sea-level rise** since the start of the altimetry era in 1993.[57] The altimetry-based global mean sea level rise averages 3.1 (± 0.3 mm) per year, with an acceleration of 0.1 mm per year over the 25-year period (1993–present period); and ocean thermal expansion, glaciers, Greenland and Antarctica contribute 42 %, 21 %, 15 % and 8 %.[58] This information is the same as that reported in the WMO statement

[54] See https://www.wcrp-climate.org/wcrp-sp-overview.
[55] See http://www.wcrp-climate.org/wgcm-cmip/wgcm-cmip6.
[56] Earth System Grid Federation, see https://esgf.llnl.gov/.
[57] See https://www.seanoe.org/data/00437/54854/.
[58] See https://www.earth-syst-sci-data.net/10/1551/2018/essd-10-1551-2018.pdf.

on the state of the global climate. Substantial uncertainty remains, in particular, for the land water storage component.

39. The CORDEX-CORE (**Coordinated Output for Regional Evaluation**) framework aims at delivering a high-resolution climate data-set (~0.22 degrees) for all major land-masses of the world and make these data publicly available for use in climate change and climate impact studies. **Reliable observation data are essential for the evaluation of historical CORDEX-CORE** simulations and the detection and correction of bias in the downscaling. This forms a critical component in the development of robust regional climate messages by the scientific community and climate services. CORDEX implicitly informs the development of adaptation knowledge in the Lima Adaptation Knowledge Initiative (LAKI)[59] sub-regions through the production of downscaled data, flagship pilot studies and regional workshops, such as through the CORDEX-Africa climate Atlas.[60]

40. In regards to cities, the G**lobal Research and Action Agenda on Cities and Climate Change Science,**[61] identifies **knowledge gaps in** Observation**, Data, Modelling and Scenarios at the City Level** as one of four cross-cutting issues. The science community is working on proof-of-concept of a service offering **urban Essential Climate Variables (ECV) and impact indicators** based on temperature and other climatic variables, together with air pollutant concentrations. This information will bring more consistent and useful data to different sectors operating in urban areas, e.g. related to infrastructure and health.[62]

## 8. WMO

41. The WMO provided a number of submissions (see paragraph 8(g)-(j) above), as requested by the SBSTA.

42. The **WMO statement on the state of the global climate in 2018**,[63] includes updates on the global climate indicators (see figure 1 above).

43. The **report on outcomes of the Seventieth session of the WMO Executive Council** (EC-70) with updates on other WMO activities with respect to UNFCCC and implementation of the Paris Agreement includes information on the following outcomes of EC-70:

a) Decision 8 **Integrated Greenhouse Gas Information System** (IG3IS) Science Implementation Plan and Updates

b) Decision 9 Promoting the use and interpretation of climate change projections on regional and national scales

c) Decision 54 **Decade of Ocean Science for Sustainable Development**

d) Recommendation 1 On the approach to **cataloguing high-impact events**

e) Recommendation 3 Strengthening WMO contributions to the **provision of climate information and services** in support of policy and decision-making

f) Implementation of the **Global Cryosphere Watch** and the WMO focus on polar and high-mountain activities

g) Recommendation 17 Preoperational phase of the **Global Cryosphere Watch**

h) Resolution 29 Global Cryosphere Watch Surface Observing Network (CryoNet)

i) Recommendation 17 Preoperational phase of the Global Cryosphere Watch

j) Decision 45 Polar Space Task Group (PSTG)

k) Resolution 28 WMO as an observer with the Arctic Council

l) Decision 42 WMO High-mountain Summit 2019

m) Decision 43 **Proposal for the declaration of 2020 as the United Nations International Year of Snow and Ice**

[59] See https://unfccc.int/topics/adaptation-and-resilience/workstreams/nairobi-work-programme-nwp/the-lima-adaptation-knowledge-initiative.

[60] See https://unfccc.int/sites/default/files/resource/2.35%20WCRP_Lennard%20CORDEXAfricaImpactAtlas.pdf.

[61] See https://citiesipcc.org/beyond/global-research-and-action-agenda-on-cities-and-climate-change-science.

[62] One example is the Copernicus **Urban SIS: Climate Information for European Cities,** see http://urbansis.climate.copernicus.eu.

[63] As requested by SBSTA, available at https://public.wmo.int/en/wmo-statement-state-of-global-climate.

n) Decision 47 (EC-70) - **Polar Regional Climate Centres and Regional Climate Outlook Forums** (RCOFs)

44. The **update on GFCS** identifies that the GFCS have developed Step-by-Step Guideline for members who are **establishing a National Framework for Climate Services** (NFCS).[64] NFCSs have been and continue to be developed in an increasing number of countries.[65] The Green Climate Fund (GCF) has recognised NFCS as an essential element for the implementation of projects, which are being submitted to the GCF. Other actors, such as the World Bank, are integrating NFCSs into their hydromet investment activities.

45. Following lessons learned in its role so far, the **GFCS is moving towards a more strategic role** of tracking the global climate services portfolio and its outcomes, supporting knowledge sharing, and providing coordinated technical advisory services.

## E. Observation needs identified by the scientific community at the tenth meeting of the research dialogue

46. A number of observation needs were identified by the scientific community at the tenth meeting of the research dialogue, some are highlighted below.

a) The observation needs for research and modelling on human settlements, oceans and land and their importance for the implementation of the Paris Agreement include the set of urban ECVs, which are being developed by WCRP and GCOS with the assistance/advice of relevant stakeholder across the finance and insurance sectors (see paragraph 40 above).

b) **Sustained ocean observations** are vital to help inform decision makers on how the ocean is responding to global warming and how it can continue playing its critical role in regulating the climate system, mitigating climate change, and helping increase resilience to climate change impacts.

c) Opportunities exist to provide a comprehensive ensemble of variables for **integrative ecosystem** observations serving climate change adaptation and mitigation as well as biodiversity conservation, which should be co-produced with **indigenous knowledge**.

d) A number of observation needs on **the carbon cycle, and its observation requirements,** in support of the Paris Agreement. were identified by the scientific research community. Parties' could greatly help in reducing uncertainties in observing the global carbon cycle,[66] including through:

i) Increasing access to availability of rainfall data (critical to assessment of the land carbon sink) – currently a lot of rain gauge data exists around the world they are not, as yet, openly available for research. These are needed to improve estimates of the land $CO_2$ sink.

ii) Increasing the coverage of surface ocean $pCO_2$ data, especially in high-latitude during winter. These are needed to improve estimates of the ocean $CO_2$ sink.

iii) Increasing the number of vertical profiles of atmospheric $CO_2$ concentrations in sparsely sampled regions with large carbon fluxes (such as Boreal Eurasia, Tropical Africa, Indonesia, and South America). In addition to serving as direct constraint on the fluxes, these are also the areas where satellite $CO_2$ observations might in the near future be used as primary data source, which need to be rigorously checked by using independent *in-situ* data.

iv) Providing more detail on reported information including: Statistics on fossil fuel emissions – information on not just how much coal is combusted but also the quality of the coal, the combustion process (such as is the coal washed or not?); and information on land cover change not just at country level – but where is the change occurring, what is the fate of the harvested products, information on the biomass such as the age of the trees.

v) The use of remotely sensed products in forests assessments would improve their reliability beyond those based on statistics reported at the country level. Additional information on annual activities related to deforestation and forest degradation, including at the small scale (sub-national level) would improve assessment of the effect of those activities on the land CO2 sink.

[64] See https://library.wmo.int/doc_num.php?explnum_id=4335.
[65] See http://www.wmo.int/gfcs/NFCS_status.
[66] See http://www.globalcarbonproject.org/carbonbudget/.

## F. Possible issues for consideration

47. I hope that this note provides delegates with a good overview of the documents and issues for consideration at SBSTA 49 under agenda item 6 on research and systematic observations. I invite you to use it as an entry point for your preparations for the session and further explore the relevant documents that are available on the UNFCCC[67] and observer organizations' web sites using the links and references included in this note. I also invite Parties to reflect on the information provided and consider the guidance that SBSTA could provide for furthering support for current and future action under the UNFCCC on this matter.

48. Parties may wish to welcome the publications, reports, statements and updates provided by relevant organizations, and note any relevant issues and concerns.

49. Parties may wish to welcome the submissions by Parties on the Earth Information Day and agree to invite the secretariat to organise an Earth Information Day annually at future sessional meetings on systematic observation, starting from COP 25 onwards. The Earth Information Day could be an important opportunity for exchange of information on the state of the global climate system and developments on systematic observation to inform implementation of the Paris Agreement.

50. The SBSTA could consider the importance systematic observation to support Paris Agreement action, climate services and monitoring progress of adaptation and mitigation, as well as the observation requirements of the global stocktake. Furthermore, the SBSTA could note the need to address the gaps and needs in observation, including those identified in submissions as well as at the tenth meeting of the research dialogue.

51. In regards to the GCOS regional workshops, Parties may wish to recognise the Pacific region observing network plan.[68] Parties may also wish to recognise the messages from the Joint GCOS / Copernicus / WIGOS / GFCS Workshop in collaboration with UNFCCC, Improving the value chain from observations to climate services to support climate policy, adaptation and mitigation in East Africa.

52. Furthermore, in regards to climate services, Parties may wish to recognise the value chain from observation to climate services, and to decision making and monitoring on mitigation and adaptation, including the ongoing activities by the observation community, addressing gaps and needs, increasing access to data, updating on progress at future meetings and the importance of co-production of knowledge for climate services and sharing information regionally.

53. In regards to GHG monitoring, Parties may wish to recognise the increasing potential of in-situ and remote monitoring of GHG concentrations (so called bottom-up approaches) combined with inverse modelling techniques (so called top-down approaches) to support Parties' national GHG emission reporting under the Convention and Paris Agreement. In this regard, Parties could consider the adoption by WMO EC-70 of the Integrated Greenhouse Gas Information System Science Implementation Plan; the work of the satellite community in defining an optimum GHG monitoring constellation; and how the new possibilities in monitoring GHGs can be reflected in the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Furthermore, Parties may consider recognising the work of the satellite community in the launch of new satellites for GHG monitoring as well as the importance of sustaining and increasing ground-based measurements, particularly in developing countries, to support Parties' action and reporting under the Paris Agreement as well as the need to build capacity and research to use these approaches.

[67] See http://unfccc.int/3462.
[68] See https://gcos.wmo.int/en/regional-workshops/pacific-workshop.

## G. Background

54. The Convention calls on Parties to promote and cooperate in research and systematic observation of the climate system, including through support to existing international programmes and networks (Articles 4.1(g) and 5).

55. The Paris Agreement clearly identifies the need for an effective and progressive response to the urgent threat of climate change based on the basis of the best available scientific knowledge. Article 7 .7(c) states that Parties should strengthen scientific knowledge on climate, including research, systematic observation of the climate system and early warning systems, in a manner that informs climate services and supports decision-making.

56. The UNFCCC needs to rely on scientific data and information from the UN system that are authoritative, for policy making as well as for supporting the needs of countries for adaptation and mitigation planning and implementation. Information provision and implementation of needs by Parties is supported by intergovernmental panels, programmes and networks including GCOS, CEOS, WMO, WCRP, IPCC, UNESCO-IOC and other agencies.[69]

57. An informal compilation of all text and mandates on systematic observation from the Convention, Paris Agreement, COP decisions and conclusions, and SBSTA and SBI conclusions is available to assist negotiators in referencing relevant material under this agenda item.[70]

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[69] See http://unfccc.int/7539.
[70] See https://unfccc.int/documents/64602.

## Annex: Example of ECV Fact Sheet (currently in development by GCOS)


### ECV IN BRIEF

| | |
|---|---|
| Domain: | Atmosphere |
| Subdomain: | Surface |
| ECV Stewards: | Philipp Jones, Elizabeth Kent |
| Scientific Area: | Energy and Temperature |
| ECV Products: | Temperature |

### Surface Temperature

Surface air temperature has profound and widespread impacts on both natural systems and on human lives and activities. It affects health, agriculture, energy demand and much more. Extremes of surface air temperature, both heat waves and extreme cold periods, are particular important for human health. Surface air temperature provides a key indicator of climate change, contributing to the "global surface temperature record". A goal of limiting changes in global surface temperature provides the measure for the Paris climate agreement.

### ECV Product[1]

| PRODUCT | DEFINITION | REQUIREMENTS | | | | |
|---|---|---|---|---|---|---|
| | | FREQUENCY | RESOLUTION | REQUIRED MEASUREMENT UNCERTAINTY | STABILITY | STANDARDS/ REFERENCES |
| TEMPERATURE | **Air temperature at a known height above surface specified in the metadata** | Hourly; Daily Tx/Tn | Site | 0.1K | 0.02K/decade | AOPC |

### Data Sources[2]

**Gridded In Situ Data:**

- Berkeley Earth Surface Temperature
  - www.berkeleyearth.org
- Climatic Research Unit (CRU) land surface air temperature data set (CRUTEM4)
  - https://www.metoffice.gov.uk/hadobs/crutem4/

[1] Current Products and Requirements as in the Implementation Plan 2016 (GCOS-200). GCOS is reviewing and will update the requirements as part of their contribution to the UNFCCC Global Stocktake. More information on: climatedata.wmo.int.
[2] This list provides sources for openly accessible data sets with worldwide coverage for which metadata is available. It is curated by the respective GCOS ECV Steward(s) and reflects the status as of 10/2018. The list does not claim to be complete. Anyone with a suitable dataset who would like it to be added to this list should contact GCOS.

- GISS Surface Temperature Analysis (GISTEMP)
  - https://data.giss.nasa.gov/gistemp/
- Gridded Temperature And Precipitation Climate Extremes Indices (Climdex Data)
  - http://www.climdex.org/datasets.html
- Gridded Night Marine Air Temperature (HadNMAT2) Global Temperature
  - https://www.metoffice.gov.uk/hadobs/hadnmat2/
- Hadley Centre Climatic Research Unit global historical surface temperature (HadCRUT4)
  - https://www.metoffice.gov.uk/hadobs/hadcrut4/
- Japan Meteorological Agency (JMA) Global Temperature
  https://ds.data.jma.go.jp/tcc/tcc/products/gwp/temp/ann_wld.html
- National Oceanic and Atmospheric Administration (NOAA) Global Temperature
  - https://www.ncdc.noaa.gov/data-access/marineocean-data/noaa-global-surface-temperature-noaaglobaltemp

**In Situ Data:**

- Integrated Surface Database (ISD) of the National Centers for Environmental Information (NCEI) of the National Oceanic and Atmospheric Administration (NOAA)
  https://www.ncdc.noaa.gov/isd/data-access
- Global Historical Climatology Network Daily (GHCN-Daily) of the National Centers for Environmental Information (NCEI) of the National Oceanic and Atmospheric Administration
  - https://data.noaa.gov/dataset/global-historical-climatology-network-daily-ghcn-daily-version-3
- Hadley Centre Integrated Surface Database (HadISD)
  - https://www.metoffice.gov.uk/hadobs/hadisd/
- International Comprehensive Ocean-Atmosphere Data Set (ICOADS)
  - https://rda.ucar.edu/datasets/ds548.0/
- International Surface Temperature Initiative (ISTI)
  - http://www.surfacetemperatures.org/

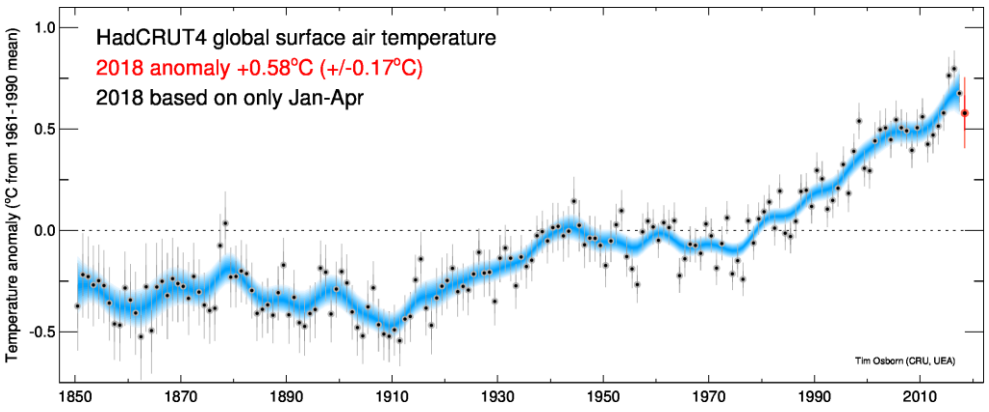
**Reanalysis:**

- REANALYSES.ORG (Inventory for Reanalysis)
  - http://reanalyses.org

**Satellite:**

- Satellite ECV Inventory by the CEOS/CGMS Working Group on Climate (WGClimate)
  - http://climatemonitoring.info/ecvinventory

## Global Surface Air Temperature




*Estimates of average global surface temperature anomalies (degC with respect to the 1961-1990 mean) during the instrumental period (dots: median estimates; vertical bars: 95% uncertainty ranges) and decadally-smoothed values (graded shading from dark to light blue for values from the median to the outer 95% uncertainty) from HadCRUT4.*

Source: Tim Osborn (CRU, UEA), https://crudata.uea.ac.uk/~timo/diag/tempdiag.htm. HadCRUT4 data: Morice CP, Kennedy JJ, Rayner NA and Jones PD (2012) Quantifying uncertainties in global and regional temperature change using an ensemble of observational estimates: the HadCRUT4 dataset. Journal of Geophysical Research, 117, D08101, doi:10.1029/2011JD017187.