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Addendum

ANNEX

I. Research [Development] and Systematic Observation

* In order to facilitate processing, the consolidated working document is being reproduced as A/AC.237/Misc.17 and Add.1-9. The present addendum is thus an integral part of the whole document, an edited version of which will be published subsequently as an annex to the report of the Committee on the work of its fourth session.

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ANNEX I

**[RESEARCH [TECHNOLOGICAL] [[AND] DEVELOPMENT] AND SYSTEMATIC
OBSERVATION] [TECHNOLOGICAL AND SCIENTIFIC RESEARCH AND SYSTEMATIC
OBSERVATION]**

[1. The Parties recognize that [the] major [scientific] [issues] [uncertainties] [[in the] state of knowledge] related to climate change [,and its relation to development,] are:]

[Possible Alternative Chapeau

The following areas are suggested for the purposes of Article [V.II], in the promotion of and cooperation in research, technological development and systematic observation relevant to climate change:]

- (a) understanding the interactions between changes in the climate system and the physical, chemical, biological, hydrological and geological processes and solar cycles in the atmosphere, oceans and land;
 - [(b) documentation of the contemporary and historic changes in the Earth's climate through long-term systematic observations of the Earth's atmosphere, oceans, terrestrial and socio-economic systems;]
 - [(c) developing models of the Earth climate system and prediction of the magnitude and rate of future climate change in the global, regional and national scales, due to both natural processes and human activities;]
 - (d) understanding the impacts of climate change [and the response to it] on ecosystems and social and economic systems; and
 - (e) evaluating the methodologies for assessing options for mitigating and adapting to climate change, including consideration of [socio-economic] costs and benefits of such options [including opportunity costs of foregoing options].
- [[2. [The Parties recognize the need to cooperate] [Indicative list of areas where cooperation] in conducting research [and development] and systematic observation [is needed], in accordance with Article 2 [, in such areas as]:]

- (a) Systematic Observations. Long term systematic observations of the Earth's atmosphere, oceans, seas, terrestrial and socio-economic systems on global and regional scales, including documenting the contemporary and historical changes in the Earth's environment using an integrated space, land and ocean based [global climate] observing system and relevant paleoenvironmental data. [Full use of existing weather and climate observing systems should be ensured.] Specifically there is a need for systematic observations to measure and/or estimate:

(i) atmospheric parameters, including,

- greenhouse gases, aerosols and their possible precursors;
- clouds, by type, amount, height, composition and optical properties;
- precipitation, evaporation and water vapour, temperature, wind and radiative fields.

(ii) oceanic parameters, including,

- ocean fluxes, particularly of heat and of greenhouse gases, aerosols, and their possible precursors between the ocean surface and atmosphere;
- sea level, temperature, roughness, circulation, ice cover, chemical composition, biological activity and colour.

[(iii) coastal zone parameters, including,

- sea level, temperature and other relevant meteorological and oceanographic parameters;
- parameters defining state and viability of coastal ecosystems, including coral and planktonic populations;
- parameters defining the quality and viability of human settlements.]

(iv) terrestrial parameters, including,

- fluxes of heat and of greenhouse gases, aerosols, and their possible precursors between ecosystems and the atmosphere;
- extent, state and productivity of managed and unmanaged ecosystems;

- physical surface characteristics, such as temperature, albedo, roughness, soil parameters, snow, ice, permafrost, glaciers, lake levels, and river discharge; and
- geodynamic, seismic and volcanic processes and their consequences.

(v) socio-economic parameters, including,

- [- consumption patterns;]
- population dynamics;
- urban development;
- rural population;
- type, extent and variability of land use practices;
- economic variables including reserves of natural resources, incremental costs, debt problems, [commodity prices] and terms of trade;
- geographic characteristics of countries;
- technology and practices in energy, forestry, agriculture, transport, hydrology, and industry;
- human health.

(b) Process research. Research of the coupled physical, chemical, biological, [hydrological, geological,] economic and social processes that affect the Earth's climate system. There is a need for an improved understanding of the processes [and development of methodologies] governing:

(i) the sources and sinks of greenhouse gases, aerosols, and their possible precursors, which affect future atmospheric concentrations and the Earth's radiative balance, and how these may be influenced by climate change. Specifically:

- identification, quantification and development of an understanding of the processes that control oceanic, terrestrial, and atmospheric sources, sinks and reservoirs of anthropogenic and natural origin;
- quantitative estimation of radiative properties and lifetimes;
- improved indices that reflect the radiative forcing of greenhouse gases [, taking into account historical emissions];

- development and improvement of methodologies for national inventories of sources, sinks and reservoirs.

(ii) atmospheric cycling of [radiation,] heat and water, with emphasis on cloud formation, dissipation and radiative properties, which influence the response of the atmosphere to greenhouse forcing. Specifically, research on:

- the atmospheric distribution of water vapour, precipitation, and clouds;
- evaluating the radiative properties of clouds;
- evaluating the temporal variability of solar radiative input and atmospheric transmission;
- the evaluation and mapping of surface albedo.

(iii) oceans, which influence the patterns and rate of climate change. Specifically, studies to establish the mechanisms governing:

- ocean dynamics;
- the transport of heat and chemicals;
- exchanges of energy and chemicals with the atmosphere;
- interactions between the ocean and land;
- the role of biological processes in the cycling of carbon and sulfur and their response to anthropogenic activities;
- sea level changes.

(iv) the role of terrestrial systems in hydrological and ecological processes, which affect regional climate change and water availability. Specifically, studies of the role of terrestrial geophysical and biological, hydrological processes in the cycling of energy, water and nutrients on land and exchange with the atmosphere, [the sea level rise and rivers of fresh water] and their response to environmental changes.

(v) the cryosphere, particularly in polar regions, which affects global sea level changes and regional climate change. Specifically, studies of:

- the mass balance of polar ice sheets and glaciers and their response to climate change;
- the role of sea ice in the atmosphere-ocean exchange of energy;

- the processes controlling snow accumulation, redistribution, and seasonal melting;
- the dynamics of permafrost systems.

[(vi) the biosphere and the oceans, including those of the Antarctica and the Arctic regions, as reservoirs or sinks, as well as ways and means of preserving and enhancing sinks and reservoirs and creating new ones.]

(vii) [economic and social] [development] processes, which contribute and react to climate change. Specifically, studies of how the climate system [influences and] is influenced by:

- [natural resource endowment;]
- economic growth, policies and practices;
- technology and practices in a wide range of sectors including energy, agriculture, forestry, transportation and industry; and
- social systems, policies and practices.

(c) Modelling and prediction. Prediction of the magnitude and rate of future climate change, including an identification and assessment of uncertainties, through the development and validation of integrated climate system models with enhanced [local and] regional [and national] resolution, social and economic models, and the links and feedbacks between climate change and social and economic processes [and development paths]. At a global [, and] regional [and national] scale, there is a need for [broadened and improved efforts related to]:

- (i) [improved] representation within models of processes affecting climate;
- (ii) evaluation of the predictability of climate;
- (iii) comparison of model output with current observation, past records and transient climate parameters;
- (iv) development of fully coupled climate models, which integrate the effects of changing atmospheric radiative properties with changes in physical, chemical, [and] biological [, hydrological, geological] processes [in solar cycles] and between the atmosphere, oceans and land, linked to social and economic models, and

- (v) simulation of climate change based on different emission scenarios.
- (d) Impact research. Research to [evaluate and to] develop methodologies for evaluating the local and regional [and national] impacts of climate change, and identifying the environmental, economic and social consequences. There is a need for an improved understanding of the impact of climate change on:
- (i) natural terrestrial, aquatic and coastal ecosystems and resources. As a function of rate and magnitude of climate change, determining the sensitivity of:
- ecosystems (e.g., productivity, extent) to changes in temperature, hydrological system (e.g., groundwater, precipitation, soil moisture), atmospheric composition, and sea level;
 - changes in stability and composition in ecosystems; and
 - the biological diversity of marine life [in the oceans] including shifts in marine organisms.
- (ii) agriculture, forestry and fisheries. Conducting regional studies of the impacts of climate change on:
- potential productivity of crops;
 - the vulnerability of major crops and their varieties;
 - the abundance and distribution of fisheries;
 - socio-economics of changed transport, storage processing and marketing conditions.
- (iii) water resources. Examining, on a regional basis, effects of changes in the hydrological cycle on:
- provision of drinking, irrigation and industrial water supplies;
 - impact on agriculture [and]
 - [- inland navigation;]
 - combined effects of climate change and land use changes on water resources;
 - drought and desertification.

(iv) coastal environment

- sea level and temperature[s] [changes], and their subsequent regional impacts on geological and ecological processes, including coral and planktonic populations;
- the viability and quality of human settlements; and
- frequency and magnitude of marine disasters such as severe storms and storm surges and their impact on coastal structures.

(v) social systems and economics. Investigating the effects of changes in climate, weather, [and] sea level [and temperature] on:

- disease vectors, viability of pathogens, nutrition and other factors relevant to human health;
- the viability and quality of land use, human settlements, the built environment and all other aspects contributing to the quality of life;
- the economic, social and cultural consequences for societies, especially for [vulnerable small island countries] [those particularly vulnerable].

(e) Research to develop [response measures, including development of technology for the] [methodologies on the] mitigation of, and adaptation to, climate change, including for:(i) examining options for reducing sources and/or increasing sinks of greenhouse gases and their potential precursors

- from energy, industrial, commercial, domestic and transport sources through studies of:
 - . technology options for low emission, high efficiency and alternative technologies, including biotechnology, biomass, wind and solar energy, and technologies for greenhouse gas fixation;
 - . applicability, cost and social factors affecting use of conventional and newly developed technology options;
- from forestry and agriculture through studies of:
 - . methods for reducing emissions and/or increasing sinks;
 - . applicability, cost and social factors affecting use of lower emission or enhanced sink practices;
- from oceans through studies of methods, costs and consequences of increasing oceanic uptake;

- by utilizing economic and other policy instruments; and
- through education and public information techniques.

(ii) Examining options for adapting to a changing climate of:

- natural terrestrial, aquatic and coastal ecosystems and resources;
- agriculture, forestry and fisheries;
- water resources;
- coastal environment; and
- social systems and economics.

(iii) Assessing the costs, benefits, and environmental and social consequences of mitigation and adaptation responses, including:

- as a function of the timing and magnitude of climate change;
- the direct and indirect links between responses and economic activity, [including eradication of poverty and trade]; and
- the distributional and other social implications of responses within and between countries and regions; and
- countries which are not in a position to use substitutes for fossil fuels or do not possess the flexibility to switch to non-fossil fuels.

(iv) Environmentally safe and sound technologies, practices and measures.]

[3. The Parties recognize the need to support existing international or intergovernmental programmes or organizations aiming at defining, conducting, assessing and/or financing research, development and systematic observation as described in paragraphs 1 and 2 of this Annex. In particular, the Parties acknowledge the following programmes and their subsidiary programmes, and organizations:

- Intergovernmental Panel on Climate Change (IPCC);
- World Climate Programme (WCP)
- International Geosphere-Biosphere Programme (IGBP).]

[POSSIBLE ALTERNATIVE TEXT FOR ANNEX I

1. The Parties recognize that the major scientific issues related to climate change are:
 - (a) Understanding the interactions between changes in the climate system and the physical, chemical, biological, and geological processes in the atmosphere, oceans and land;
 - (b) Understanding the impacts of climate change on ecosystems and social and economic systems;
 - (c) Evaluating the methodologies for mitigating and adapting to climate change, including consideration of costs and benefits of such options.

To resolve these problems, the active participation of all countries is required.

2. The Parties recognize, in accordance with Article V. 2. (Research [and Development] and Systematic Observation), the need to cooperate in the establishment of a global climatic observation system in using and developing existing networks of measurement, transmission, processing and data storage. In particular, it is necessary to undertake systematic observations in order to measure directly or indirectly:

- (a) Atmospheric parameters, including,
 - (i) Greenhouse gases, aerosols and their possible precursors;
 - (ii) Clouds, by type, amount, height, composition and optical properties;
 - (iii) Precipitation, humidity, evaporation and water vapour, temperature, wind and radiative fields.
- (b) Oceanic parameters, including,
 - (i) Ocean fluxes, particularly of heat and of greenhouse gases, aerosols, and their possible precursors between the ocean surface and atmosphere;
 - (ii) Sea level, temperature, roughness, circulation, ice cover, chemical composition, biological activity and colour.

(c) Terrestrial parameters,

- (i) Fluxes of heat and of greenhouse gases, aerosols, and their possible precursors between ecosystems and the atmosphere;
- (ii) Extent, state and productivity of managed and unmanaged ecosystems;
- (iii) Physical characteristics, such as temperature, albedo, roughness, soil parameters, snow, ice, permafrost, glaciers, lakes and rivers.

(d) Socio-economic parameters, including,

- (i) Population dynamics;
- (ii) Urban development;
- (iii) Type, extent and variability of land use practices;
- (iv) Economic variables including reserves of natural resources, and geographic characteristics of countries;
- (v) Technology and practices in energy, forestry, agriculture, transport, hydrology, and industry;
- (vi) Human health.

3. The Parties, in accordance with Article [V. 2.] (Research and Development and Systematic Observation), recognize the need to cooperate in conducting research and development in such areas as:

- (a) Process research. Research of the coupled physical, chemical, biological, geological, economic and social processes that affect the Earth's climate system. There is a need for an improved understanding of the processes and development of methodologies governing:
 - (i) The sources and sinks of greenhouse gases, aerosols, and their precursors, which affect atmospheric concentrations and the possible impact of a climate change;
 - (ii) Atmospheric cycling of radiation, heat and water, with emphasis on cloud formation, dissipation and radiative properties, which influence

the response of the atmosphere to greenhouse forcing;

- (iii) Oceans, which influence geographical distributions and the rate (pace) of the climate change.
 - (iv) The role of terrestrial systems in hydrological and ecological processes, which affect regional climate change and water availability;
 - (v) The cryosphere, particularly in polar regions, which affects global sea level changes and regional climate change; and
 - (vi) Economic and social processes, which contribute and react to climate change.
- (b) Modelling and prediction. Prediction of the magnitude and rate of future climate change, including an assessment of uncertainties, through the development and validation of integrated climate system models with enhanced regional and national resolution, social and economic models, and the links and feedbacks between climate change and social and economic processes. At a global, regional and national scale, there is a need for:
- (i) Improved representation within models of processes affecting climate;
 - (ii) Evaluation of the predictability of climate;
 - (iii) Comparison of model output with current observation;
 - (iv) Development of fully coupled climate models.

- (c) Impacts. Evaluation of the local and regional impacts of climate change, and identifying the environmental, economic and social consequences. There is a need for an improved understanding of the impact of climate change on the following activities and fields:

- (i) Natural terrestrial, aquatic and coastal ecosystems and resources;
- (ii) Agriculture, forestry and fisheries;
- (iii) Water resources;
- (iv) Coastal environment;
- (v) Social systems and economics.

- (d) Development of methods for mitigation and adaptation to climate change. In particular:

- (i) Examining options for reducing sources and/increasing sinks of greenhouse gases aerosols and their precursors;
- (ii) Examining options for adapting to climate changes;
- (iii) Development of technologies which are safe, rational and ecologically sound;
- (iv) Assessing the costs, benefits, and environmental and social consequences of mitigation and adaptation responses.

4. The Parties recognize the particular needs of the developing countries in the following areas:

- (a) Observation and data analysis.

- (i) It is necessary to help them to increase their capacity to observations and data analysis;
- (ii) Undertake systematic observations mentioned in sub-paragraphs (a) to (d) of paragraph 2;

- (iii) Exchange observations with other countries, especially on a regional basis;
 - (iv) Process, locally and at a regional level, data in view to using it for their economic development and studying responses to mitigate and adapt themselves to climate change.
- (b) Research and technological innovations.

The aim is simultaneously to, inter alia, promote sustainable development, reduce greenhouse gases emissions, increase the sinks and improve adaptive possibilities to climate changes. This concerns, in particular, the following sectors:

- (i) Agriculture (reduction of soil carbon emissions, adaptation to drought, limitation of desertification, etc.);
- (ii) Energy (promotion of bioenergy and other renewable energies, energy conservation etc.);
- (iii) Forestry (reduction of pressure for deforestation, promotion of forestry for food, stabilization of agriculture); and
- (iv) coastal zones and fisheries.

To meet these objectives, developing countries should be able to increase the means spent for:

- training and research;
- technological innovations and research, in cooperation with industrialized or developing countries.]