

6 LIST OF ACTIONS

6.1 General, cross-cutting, actions

#	Title	Action	Benefit	Time frame	Who	Performance indicator	Annual cost	Addressed in SARGIP 2017	Comment
Action G1:	Guidance and best practice for adaptation observations	Produce guidance and best practice for climate observations for adaptation. This would include advice on using the global and regional requirements at a national and local level, and guidance and best practice on prioritization of observations, implementation, data stewardship and reporting. Promote the use of this guidance by parties and donors. Review the use of this guidance and requirements and revise as needed.	Encourage high-quality, consistent and comparable observations.	Version one available in 2018, thereafter review and refine, as needed.	GCOS in association with users and other stakeholders	Availability and use of specifications	US\$ 10 000-100 000	Y	May update info from SARGIP 2017
Action G2:	Specification of high-resolution data	Specify the high resolution climate data requirements. In response to user needs for climate adaptation planning, develop high-resolution observational requirements and guidance and distribute widely. Promote coordination among climate observation systems at different scales from subnational to global, particularly through relevant focal points, national coordinators and regional climate centres and alliances. Ensure that this work responds to other work streams under UNFCCC's Research and Systematic Observation agenda item and the SDGs. Ensure these data are openly accessible to all users.	Develops a broad understanding of climate observational needs. Ensures consistency of climate observations and thus enables their wide use.	2018 and ongoing thereafter	GCOS in association with users and other stakeholders	Availability and use of specifications	US\$ 10 000-100 000	Y	May update info from SARGIP 2017
Action G3:	Development of indicators of climate change	Develop a list of climate indicators that describe the ongoing impacts of climate change in a holistic way. Consider the work of WMO, IPCC and others. Indicators may include: heating of the ocean, rising sea level, increasing ocean acidity, melting glaciers and decreasing snow, changes in Arctic sea ice, changes in vegetation characteristics and distributions and land-cover changes.	Communicate better the full range of ongoing climate change in the Earth system	2017	GCOS in association with other relevant parties, including WMO and IPCC	Agreed list of indicators (for example, 6 in number)	US\$10 000-100 000	Y	May update info from SARGIP 2017
Action G4:	Indicators for adaptation and risk drivers	Promote definition of, and research supporting, the development of indicators linking physical and social drivers relating to exposure, vulnerability and improved resilience, in line with national requirements	Tracking of progress of climate change and adaptation, improved capacity to respond and avoid loss	2017	GCOS with relevant agencies and national bodies	Definition and development of relevant risk assessments	US\$ 10 000-100 000	Y	May update info from SARGIP 2017
Action G5:	Identification of global climate observation synergies with other multilateral environmental agreements	Ensure a scientifically rigorous assessment of the exact requirements of common variables and identify a common set of specifications between GCOS and CBD and UNCCD; ensure that maximum benefits are taken from GCOS ECVs in implementing the SDG process, including addressing multiple-benefits across SDG goals, fulfilling the climate specific goal (SDG 13) and providing support to transparent global development and climate finance prioritization (SDG 17); explore how ECV data can contribute to: (a) The Ramsar Convention; (b) The Sendai Framework for Disaster Risk Reduction; (c) other MEAs.	Improved information exchange between Conventions, cost savings, shared capacity building and outreach, and coordinated approaches to observation providers	Ongoing (2017 for Rio conventions, 2018 for Ramsar and Sendai)	GCOS, CBD Secretariat, UNCCD Secretariat and the Global Mechanism, GEO Secretariat and GEO Biodiversity Observation Network, GCOS and sponsors + Parties (through national statistics offices) and GEO (GEO Initiative on the SDGs (G-I3)), GCOS, Ramsar Convention, Open-ended Intergovernmental Expert Working Group on Indicators and Terminology Relating to Disaster Risk Reduction, ICSE-ESS-UNISDR programme (RDR, Secretariats of other MEAs)	Climate service components optimized for disaster risk reduction	US\$ 10 000-100 000	N	
Action G6:	Assisting developing countries to maintain or renovate climate observation systems and to improve climate observations networks	Provide financial support to GCM through its trust fund; cooperate between donors to provide targeted support to countries to improve their observational systems; propose suitable projects for support	Targeted expert assistance to improve key monitoring networks	Continuous	Developed countries, developing country aid banks, WMO VCP, GEF and other funds for UNFCCC, the United Nations Development Programme (UNDP), national aid agencies; project proposals coordinated by GCOS panels, GCM Board and potential donor countries	Funds received by the trust fund; increasing number of projects supporting countries	US\$ 1-10 million	N	
Action G7:	GCOS coordinator	Activate national coordinators	Coordinated planning and implementation of systematic climate observing systems across the many national departments and agencies involved with their provision	Ongoing	Relevant divisions at national governmental level responsible for the coordination of climate observation	Annual reports describing and assessing progress made in national coordination in compliance with the coordinator's responsibilities; establishing a national climate observations inventory and publication of annual reports	US\$ 10 000-100 000/year/national government	N	
Action G8:	Regional workshops	Hold regional workshops to identify needs and regional cooperation, starting with Africa	Improve key monitoring networks to fill gaps in regions	2018-2020	GCOS secretariat in coordination with the UNFCCC Secretariat and national coordinators and the involvement and coordination with existing capacity-building activities, for example WCSP programmes such as CLIVAR or COBACE	Workshop outputs describing regional plans and priority national needs	US\$ 1-10 million (total for six workshops)	N	
Action G9:	Communication strategy	Develop and implement a GCOS communication strategy	Targeted expert assistance to improve key monitoring networks	Develop strategy/plan in 2017; implement in subsequent years	GCOS Secretariat	Increased monitoring and use of GCMAP and monitoring of ECVs; increased donations to GCM; climate monitoring included in national plans and/or reporting to UNFCCC; production of material and improved website; participation in international meetings	US\$ 100 000-1 million	N	
Action G10:	Maintain ECV requirements	Routinely maintain, review and revise list of ECV requirements. The GCOS secretariat will ensure that there is a consistent approach between panels.	Clear, consistent and complete list of ECV requirements as a basis for national and international climate observations ensures consistency between observations.	GCOS Panels, GCOS Secretariat	Develop a systematic approach in 2017 and review every five years	Annually updated list of ECV requirements.	US\$ 1 000-10 000 for experts	N	This action needs clarification: are there really annual updates? How / where are they published? Any comment on the consistency?
Action G11:	Review of availability of climate data records	Provide a structured, comprehensive and accessible view as to what CDRs are currently available, and what are planned to exist, together with an assessment of the degree of compliance of such records with the GCOS requirements for the ECV products indicated in Annex A.	Improve planning of satellite-derived climate data acquisition	ECOV/GMS Working Group on Climate for records contributing to the ECV products that are indicated in Annex A.	End 2016 and updated every two years thereafter.	Online availability of an inventory of current and future CDRs, together with an assessment of compliance with GCOS requirements	Covered by ECOS and GMS agencies	Y	ECV Inventory + GCOS-compliance assessment
Action G12:	Gap-analysis of climate data records	Establish a gap analysis process and associated actions, to: (a) address gaps/deficiencies in the current available set of CDRs; and (b) ensure continuity of records, and address gaps through the appropriate planning of future satellite missions for the ECV products indicated in Annex A.	Increase the utility of the CDRs	ECOV/GMS Working Group on Climate for records contributing to the ECV products that are indicated in Annex A.	End 2017, and updated every two years thereafter.	Availability of gap analysis and associated action plan	Covered by ECOS and GMS agencies	Y	Gap Analysis + Coordinated Action Plan
Action G13:	Review of ECV observation networks	For all ECV products not covered by a review following actions G11 and G12: develop and implement a process to regularly review ECV observation networks, comparing their products with the ECV product requirements; identify gaps between the observations and the requirements; identify any deficiencies and develop remediation plans with relevant organizations; and ensure the data is discoverable and accessible. This action may also contribute to the definition of reference-grade observing network and standards. The GCOS science panels should identify stakeholders who will perform this review and regularly check all ECV products are being reviewed.	Increase quality and availability of climate observations	Organizations listed in Annex A. GCOS panels to maintain oversight.	Develop and demonstrate review process in 2017. Review each ECV's observing systems at least every four years.	Reports of results of ECV reviews produced by panels each year.	US\$ 100 000-1 million also part of the work of panels	N	
Action G14:	Maintain and improve coordination	Maintain and improve coordination with other global observing systems (such as GOSOS and FluNet), satellite agencies (especially through GMS and CEOS), those providing climate services (such as GFCs, Copernicus and NERC climate departments), GEO Flagships (such as GEO Carbon, GEO Blue Planet, Oceans and Society), Regional Climate Centres and WMO technical commissions and other users such as UNFCCC and IPCC.	Improved and more efficient observation systems.	GCOS Secretariat and Science Panels	On going	Reports to GCOS Steering Committee and science panels	Part of ongoing tasks of GCOS	N	
Action G15:	Open data policies	Ensure free and unrestricted data access by encouraging that data policies facilitating the open exchange and archiving of all ECVs are followed; encouraging national parties to develop new data policies where appropriate, assessing and regularly reporting of status of data access	Access to data by all users in all countries at minimum cost	Parties and international agencies, appropriate technical commissions and international programmes; GCOS Secretariat.	Continuing, of high priority.	Number of countries adhering to data policies favouring free and open exchange of ECV data.	US\$ 100 000-1 million	Y	We can generate an indicator, based on the ECV Inventory 'Accessibility' information.
Action G16:	Metadata	1. GCOS to work with WMO to ensure that the WIGOS metadata standard meets GCOS requirements for metadata, where relevant; 2. Develop metadata standards for those observing systems where they do not exist.	Improved access and discoverability of datasets	Operators of GCOS-related systems, including data centres	Continuous	Number of ECV-related datasets accessible through standard mechanisms	US\$ 100 000-1 million (US\$ 20 000 per data centre) (10% in non-Arctic Parties)	N	Standard mechanisms? Can we actually provide any feedback here, for the space-observable ECVs?
Action G17:	Support to national data centres	Ensure national data centres are supported to enable timely, efficient and quality-controlled flow of observations to international data centres where they exist; ensure timely flow of feedback from monitoring centres to observing network operators	Long-term, sustainable, provision of timely data and improved data quality	Parties with coordination by appropriate technical commissions and international programmes	Continuing, of high priority	Data receipt at centres and archives	US\$ 10-30 million (70% in non-Arctic Parties)	N	
Action G18:	Long-term accessibility of data	Ensure that data centres follow best practice in data stewardship to ensure long-term preservation of data according to guidance to be developed by WMO	Preservation of data for future generations	Funding agencies for data centre	Ongoing	Data held in compliant data centres and holdings and accessible to users	US\$ 1-10 million	N	
Action G19:	Data access and discoverability	Identify and develop means of discovering and accessing all relevant CDRs and other relevant products. Ensure there is access to metadata that clearly distinguishes each data product and describes its adherence to the GCMAP	Increase access to CDRs	GCOS, GEO, US National Oceanographic and Atmospheric Administration (NOAA)	Develop plans in 2017	Reports of results of ECV reviews produced by panels each year	US\$10 000-100 000	N	
Action G20:	Use of digital object identifiers for data records	GCOS to encourage international data centres to introduce DOIs for their data records of ECV and recommend datasets producers to follow this practice	Help researchers to discover relevant data more easily	GCOS panels	Ongoing	Number of data records having an assigned DOI	Should be part of network planning and implementation.	Y	Observe number for satellite data records in ECV Inventory
Action G21:	Collaboration with WMO CCI on climate data management	GCOS secretariat to engage with WMO CCI on development of regulatory and guidance on climate data management	Users to climate data will have easier access to data	GCOS secretariat and WMO CCI	Ongoing until 2019	Guidance material publication	None	N	
Action G22:	Implementation of new production streams in global reanalysis	Continue comprehensive global reanalyses and implement planned new production streams using improved data-assimilation systems and better collections of observations; provide information on the uncertainty of products and feedback on data usage by the assimilation systems	Improved reanalysis datasets	Global reanalysis production centres	Ongoing	Number and specifications of global reanalyses in production; improved results from evaluations of performance; user uptake of uncertainty information; extent to which observational archives are enhanced with feedback from reanalysis	US\$ 10-30 million	N	
Action G23:	Develop coupled reanalysis	Further develop coupled reanalysis and improve the coupled modelling and data assimilation methodology	Provide coupled reanalysis data sets	Global reanalysis production centres and other centres undertaking research in data assimilation	Ongoing	Number, specification and demonstrated benefits of coupled reanalyses	US\$ 1-10 million	N	
Action G24:	Improve capability of long-range reanalysis	Improve the capability of long-scale reanalysis using sparse observations datasets	Provide longer reanalysis datasets	Global reanalysis production centres and other centres undertaking research in data assimilation	Ongoing	Demonstrated improvements in the representation of long-term variability and change in century-scale reanalyses	US\$ 1-10 million	N	
Action G25:	Implementation of regional reanalysis	Develop and implement regional reanalysis and other approaches to downscaling the information from global data products	Capability to capture climate variability on a regional scale	Dataset producers	Ongoing	Number and evaluated performance of regional reanalyses and other downscaled datasets	US\$ 1-10 million	N	
Action G26:	Preservation of early satellite data	Ensure long-term data preservation of early satellite raw and level 1 data, including metadata	Extend CDRs back in time	Space agencies	Ongoing	Data archive statistics at space agencies for old satellite data	US\$ 1-10 million	Y	Can provide feedback, from comparison of inventory #2 and #3 on instrument data usage, but could also collect information from agencies in WGIclimate on data rescue activities. Have a nice example of EUM NSDC collaboration.
Action G27:	Recovery of instrumental climate data	Continue the recovery of instrumental climate data that are not held in a modern digital format and encourage more imaging and digitization	Improve access to historical observations datasets	Agencies holding significant volumes of unrecovered data, specific projects focused on data recovery	Ongoing	Data increases in archive-centre holdings and data used in product generation; register entries recording data-recovery activities (see following action)	US\$ 1-10 million	N	
Action G28:	Register of data-recovery activities	Populate and maintain a register or registers of data-recovery activities	Facilitate planning of data rescue	WMO CCI and other institutions holding records with related responsibilities;	Ongoing	Existence and degree of population of register(s).	US\$ 1 000-10 000	N	Action should be extended to satellite data or its mayby G26
Action G29:	Scanned records	Log scans with appropriate international data centre if digitization does not follow scanning, assemble class of scanned record for digitization, for example by crowdsourcing	Facilitate planning of data rescue	Institutions that have scanned data but not undertaken digitization; receiving data centres for assembly of records.	Ongoing	Statistics on holdings and organization of scanned records by data centres	US\$ 10 000-100 000	N	Action should be extended to satellite data or its mayby G26
Action G30:	Sharing historical data records	Share recovered historical data records	Improved access to historical datasets to all users	Institutions that have recovered data records but not made them widely available.	Ongoing	Number of released data records as reported in registers	US\$ 10 000-100 000	N	
Action G31:	Improve gravimetric measurements from space	Prepare for satellite missions to provide continuity and consider improved performance to meet the observational requirements in Table 2	Improved monitoring of water transport and distribution.	Space agencies.	For 2023	Published plans and agreed missions	US\$500 000-1million	Y	May update info from SARGIP 2017

Action G3:	Improved bathymetry	Support increased level of multibeam seabed mapping both synchronously with ocean observation initiatives and separately as dedicated basin-scale mapping initiatives	Better representation of ocean volume, improved ability to model ocean currents and mixing	Institutions that fund vessel-based science studies and programmes and/or have access to survey platforms with existing multibeam survey infrastructure	For 2023	Availability of improved bathymetry data	US\$ 30-100 million	Y	May update info from SARIGP 2017
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6.2 Atmospheric Domain Actions

#	Title	Action	Benefit	Time frame	Who	Performance indicator	Annual cost	Addressed in SARGP 2017	ECV	Comment
Action A1:	Near-real-time and historical GCOS Surface Network availability	Improve the availability of near-real-time and historical GSN data especially over Africa and the tropical Pacific	Improved access for users to near-real-time GSN data	National Meteorological Services, regional centres in coordination/cooperation with WMO CBS, and with advice from AOPC	Continuous for monitoring GSN performance and receipt of data at archive centre	AOPC review of data archive statistics at the World Data Center for Meteorology at Asheville, NC, USA, annually and national communications to users	US\$ 10-15 million	N		
Action A2:	Land database	Set up a framework for an integrated land database which includes all the atmospheric and surface ECVs and across all reporting timecales	Centralized archive for all parameters. Facilitates QC among elements, identifying gaps in the data, efficient gathering and provision of rescued historical data, integrated analysis and monitoring of ECVs. Supports climate assessments, extremes, etc. Standardized formats and metadata	NCI and contributing centres	Framework agreed by 2018	Report progress annually to AOPC	US\$ 100 60-1million	N		
Action A3:	International exchange of SYNOP and CLIMAT reports	Obtain further progress in the systematic international exchange of both hourly SYNOP reports and daily and monthly CLIMAT reports from all stations	Enhanced holdings; data archive	NMHS, regional centres in coordination/cooperation with WMO CBS, and with advice from AOPC	Continuous, with significant improvement in receipt of RSN synoptic and CLIMAT data by 2019	Data archive statistics at data centres	US\$ 100 000-1 million	N		
Action A4:	Surface observing stations: transition from manual to automatic	Follow guidelines and procedures for the transition from manual to automatic surface observing stations	More stable time series	Parties operating GSN stations in coordination/cooperation with WMO CBS, CMO, WMO CBS for review	Ongoing	Implementation noted in national communications; relevant information provided	US\$ 30-100 million	N		
Action A5:	Transition to BUFR	Encourage dual transmission of TAC and BUFR for at least 6 months and longer if inconsistencies are seen (to compare the two data streams for accuracy)	Transition to BUFR does not introduce discontinuities in the datasets. BUFR allows metadata to be stored with data	Parties operating GSN stations for implementation	Ongoing for implementation; review by 2018	Proven capability to store BUFR messages giving same quality or better as TAC data	US\$ 100 000-1 million	N		
Action A6:	Air temperature measurements	Enhance air temperature measurements networks in remote or sparsely populated areas and over the ocean	Improved coverage for better depiction of climate system	National Parties and international coordination structures such as the Global Cryosphere Watch (GCW)	Ongoing	Coverage of air temperature measurements	US\$ 10-30 million	N		
Action A7:	Atmospheric pressure sensors on drifting buoys	Enhance to 100% the percentage of drifting buoys incorporating atmospheric pressure sensors, in particular by benefiting from barometer upgrade programmes	Measurements over oceans of surface pressure will improve coverage	Parties deploying drifting buoys and buoy operating organizations, coordinated through IACMAM, with advice from AOPC and AOPC	Ongoing	Percentage of buoys with sea-level pressure (SLP) sensors in tropics and sub-tropics	US\$ 100 000-100 000	N		
Action A8:	Provide precipitation data to the Global Precipitation Climatology Centre	Submit all precipitation data from national networks to the Global Precipitation Climatology Centre at the Deutscher Wetterdienst	Improved estimates of extremes and finer-scale spatial and temporal detail that address mitigation and adaptation requirements	National Meteorological and Hydrological Services, with coordination through the WMO CCI and the GFCS	Ongoing	Percentage of nations providing all their holdings of precipitation data to international data centres	US\$ 100 000-1 million	N		
Action A9:	Submit water vapour data	Submit water vapour (humidity) data from national networks and marine platforms to the international data centres	Improved coverage of surface water vapour measurements	NMHS, through WMO CBS and international data centres, with input from AOPC	Ongoing	Data availability in analysis centres and archive and scientific reports on the use of these data	US\$ 100 000-1 million	N		
Action A10:	Incorporating national sunshine records into data centres	National sunshine records should be incorporated into International Data Centres.	Better description of surface radiation fields	NMHS	Implement in next 2 years	Sunshine record archive established in international data centres in analysis centres by 2018	US\$ 1-10 million	N		
Action A11:	Operation of the the GCOS Baseline Network for Surface Radiation	Ensure continued long-term operation of the BSRN and expand the network to obtain globally more representative coverage and improve communications between station operators and the archive centre	Continuing baseline surface radiation climate record at BSRN sites	Parties' national services and research programmes operating BSRN sites in cooperation with AOPC and the WCP/GEWEX Radiation Panel	Ongoing	The number of BSRN stations regularly submitting valid data to international data centres	US\$ 100 000-1million	Y		ECV inventory may contain information on usage of BSRN for validation of satellite records
Action A12:	Surface radiation data to the World Radiation Data Centre	Submit surface radiation data with quality indicators from national networks to the WRDC; expand deployment of surface radiation measurements over ocean	Expand central archive; data crucial to constrain global radiation budgets and for satellite product validation; more data over ocean would fill an existing gap	NMHS and others, in collaboration with WRDC	Ongoing	Data availability in WRDC	US\$ 1-10 million	N		
Action A13:	Implement vision for future of GCOS Upper-Air Network operation	Show demonstrable steps towards implementing the vision articulated in the GCOS Networks Meeting in 2014[1] relating to the future of GUAN operation	Improved data quality, better integrated with GRUAN and more closely aligned with WIGOS framework	Task team of AOPC with GCOS Secretariat in collaboration with relevant WMO commissions and WIGOS	2019 for adoption at Nineteenth World Meteorological Congress	Annual reporting in progress at AOPC of task team	US\$ 100 000-1 million	N		
Action A14:	Evaluation of benefits for the GCOS Upper-Air Networks	Quantify the benefits of aspects of GUAN operation including attaining 30 RPs or 10 RPs, twice-daily as opposed to daily ascents and the value of remote sensed GUAN sites	Better guidance to GUAN managers, improved scientific rationale for decision-making	WVP and reanalysis centres	Completed by 2018	Published analysis (in peer reviewed literature plus longer report)	US\$ 10 000-100 000	N		
Action A15:	Implementation of Reference Upper-Air Network	Continual implementation of GRUAN meteorologically traceable observations, including operational requirements and data management, archiving and analysis and give priority to implementation of sites in the tropics, South America and Africa	Reference quality measurements for other networks, in particular GUAN, process understanding and satellite call-out	Working Group on GRUAN, NMHS and research agencies in cooperation with AOPC, WMO CBS and the Lead Centre for GRUAN	Implementation largely completed by 2015	Number of data contributing reference-quality data streams for archival and analysis and number of data streams with meteorological traceability and uncertainty characterization; better integration with WMO activities and inclusion in the WIGOS framework	US\$ 30-30 million	Y		ECV inventory may contain information on usage of BSRN for validation of satellite records
Action A16:	Implementation of satellite calibration missions	Implement a sustained satellite climate calibration mission or missions	Improved quality of satellite radiance data for climate monitoring	Space agencies	Ongoing	Commitment to implement by the next status report in 2020; proof-of-concept proven on ISS Pathfinder	US\$ 300-300 million	Y		May update info from SARGP 2017
Action A17:	Retain original measured values for radiance data	For radiance data and any other data that require substantive processing from the original measurement (e.g. digital counts) to the final estimate of the measured (e.g. T and q) profiles through the lower stratosphere, the original measured values should be retained to allow subsequent reprocessing	Possibility to reprocess data as required; improved data provenance	HMEI (manufacturer), NMHS, archive centres	Ongoing	Original measurement raw data and metadata available at recognized repositories	US\$ 100 000-1million	N		
Action A18:	Hyperspectral radiances reprocessing	Undertake a programme of consistent reprocessing of the satellite hyperspectral sounder radiances	Consistent time series of hyperspectral radiances for monitoring and reanalysis; improved CDRS computed from the FCDRs	Space agencies	Ongoing	Reprocessed FCDRs available for hyperspectral sounders	US\$ 300 000-1million	Y		Some information on the existence of FCDRs could be inferred from the ECV inventory
Action A19:	Reprocessing of atmospheric motion vectors	Continual reprocessing of AMVs derived from geostationary satellite imagery in a coordinated manner across agencies	Consistent time series of AMVs for monitoring and reanalysis; improved CDRS computed from the FCDRs	Space agencies	Ongoing	Reprocessed FCDRs available for upper-air winds	US\$ 100 000-1 million	Y	Upper-air winds	Some information on the existence of FCDRs could be inferred from the ECV inventory
Action A20:	Increase the coverage of aircraft observations	Further expand the coverage provided by AMDAR, especially over poorly observed regions such as Africa and South America	Improved coverage of upper-air wind for monitoring and reanalysis	NMHS, WIGOS, RA1 and II	Ongoing	Data available in recognized archives	US\$ 1-10 million	N		
Action A21:	Implementation of space-based wind-profiling system	Assuming the success of ADM/Aeolus, implement an operational space-based wind profiling system with global coverage	Improved depiction of upper-air windfields; improved reanalysis; 3D aerosol measurements as a by-product	Space agencies	Implement once ADM/Aeolus concept is proven to provide benefit	Commitment to launch ADM follow-on mission	US\$ 300-300 million	Y		May update info from SARGP 2017
Action A22:	Develop a repository of water vapour climate data records	Develop and populate a globally recognized repository of GWS 6-month total daily and total column water data and metadata	Reanalysis, water vapour CDRS	AOPC to identify the appropriate responsible body	By 2018	Number of sites providing historical data to the repository	US\$ 100 000-1 million	Y		ECV inventory and gap analysis provides information. Action is very busy. IPI indicates only ground based is through of which doesn't fit with PARASIS
Action A23:	Measure of water vapour in the upper troposphere/lower stratosphere	Promote the development of more economical and environmentally friendly instrumentation for measuring accurate in situ water-vapour concentrations in the UT/LS	Improved UT/LS water vapour characterization, water-vapour CDRS	NMHS, National measurements institutes, HMEI and GRUAN	Ongoing	Number of sites providing high-quality data to archives	US\$ 30-30 million	N		
Action A24:	Implementation of archive for radar reflectivity	To implement a global historical archive of radar reflectivities (or products of reflectivities are not available) and associated metadata in a commonly agreed format	Better validation of reanalyses; improved meteorological cycle understanding	NMHS, data centres, WIGOS	Ongoing	Data available in recognized archive, agreed data policy	US\$ 1-10 million	N		
Action A25:	Continuity of global satellite precipitation products	Ensure continuity of global satellite precipitation products similar to GPM	Precipitation estimates over oceans for global assessment of water cycle elements and their trends	Space agencies	Ongoing	Long-term homogeneous satellite-based global precipitation products	US\$ 30-100 million	Y	Precipitation	Gap Analysis
Action A26:	Development of methodology for consolidated precipitation estimates	Develop methods of blending (rain gauge, radar and satellite precipitation)	Better precipitation estimates	WMO technical commissions.	By 2020	Availability of consolidated precipitation estimates	US\$ 10 000-100 000	Y		Maybe gap analysis if we have blended products
Action A27:	Dedicated satellite Earth Radiation Budget mission	Ensure sustained incident total and spectral solar irradiances and ERB observations, with at least one dedicated satellite instrument operating at any one time	Seasonal forecasting, reanalysis, model validation	Space agencies	Ongoing	Long-term data availability at archives	US\$ 100-100 million	Y	Earth Radiation Budget	Feedback based on contents of the ECV inventory
Action A28:	In situ profiles and radiation	To understand the vertical profile of radiation requires development and deployment of technologies to measure in-situ profiles	Understanding of 3D radiation field; model validation, better understanding of radiative forcings	NMHS, National measurements institutes, WMO	Ongoing	Data availability in NMS archives	US\$ 1-10 million	N		
Action A29:	Lightning	To define the requirement for lightning measurements, including data exchange, for climate monitoring and to encourage space agencies and operators of ground-based systems to provide global coverage and reprocessing of existing datasets	Ability to monitor trends in severe storms	ECOS AOPC and space agencies	Requirements to be defined by 2017	Update to Annex A for lightning and commitments by space agencies to include lightning imagers on all geostationary platforms. Reprocessed satellite datasets of lightning products	US\$ 10-30 million	Y	Lightning	Feedback based on contents of the ECV inventory
Action A30:	Water vapour and ozone measurement in upper troposphere and lower and upper stratosphere	Re-establish sustained limb-scanning satellite measurement of profiles of water vapour, ozone and other important species from UT/LS up to 30 km	Ensured continuity of global coverage of vertical profiles of UT/LS constituents	Space agencies	Ongoing, with urgency in initial planning to minimize data gap	Continuity of UT/LS and upper stratospheric data records	US\$ 100-100 million	Y	Water Vapour; Ozone	Feedback based on contents of the ECV inventory
Action A31:	Validation of satellite remote-sensing	Engage existing networks of ground-based, remote sensing stations (e.g. NDACC, TCCON, GRUAN) to ensure adequate, sustained delivery of data from MADRAS, charge coupled device (CCD) spectrometers, lidar, and FTIR instruments for validating satellite remote-sensing of the atmosphere	Validation, improvement and correction of satellite retrievals	Space agencies, working with existing networks and environmental protection agencies	Ongoing, with urgency in initial planning to minimize data gap	Availability of comprehensive validation reports and near-real-time monitoring based on data from the networks	US\$ 1-10 million	Y		Feedback from ECV inventory if used for validation
Action A32:	Fundamental Climate Data Records and Climate Data Records for greenhouse gas and aerosols ECVs	Extend and refine the satellite data records (FCDRs and CDRS) for GHG and aerosol ECVs	Improved record of GHG concentrations	Space agencies	Ongoing	Availability of validated FCDRs and CDRS for GHGs and aerosols	US\$ 1-10 million	Y	GHG, Aerosols	Direct feedback for TCCON, indirect for FCDRs
Action A33:	Maintain WMO GAW CO ₂ and CH ₄ monitoring networks	Maintain and enhance the WMO GAW Global Atmospheric CO ₂ and CH ₄ monitoring networks as major contributions to the GCOS Comprehensive Networks for CO ₂ and CH ₄ . Advance the measurement of isotopic forms of CO ₂ and CH ₄ , and of appropriate tracers to separate human from natural influences on the CO ₂ and CH ₄ budgets	A well-maintained, ground-based and in situ network provides the basis for understanding trends and distributions of GHGs	National Environmental Services, NMHS, research agencies under the guidance of WMO GAW and its Scientific Advisory Group on Greenhouse Gases	Ongoing	Data flow to archive and analysis centres	US\$ 1-10 million	N		
Action A34:	Requirements for in situ column composition measurements	Define the requirements for providing vertical profiles of CO ₂ , CH ₄ and other GHGs, using recently emerging technology, such as balloon capture technique[2]	Ability to provide widespread, accurate, in situ vertical profiles; economically an excellent tool for validating satellite retrievals and reanalysis transport models	ECOS AOPC and space agencies	Requirements to be defined by 2018	Update to Annex A to include vertical profiles and RCO, the dry air column-averaged mole-fraction of CO ₂	US\$ 5 million	N		
Action A35:	Space-based measurements of CO ₂ and CH ₄ implementation	Assess the value of the data provided by current space-based measurements of CO ₂ and CH ₄ , and develop and implement proposals for follow-on missions accordingly	Validation of global records of principal greenhouse gases; informing decision-makers in urgent efforts to manage GHG emissions	Research institutions and space agencies	Assessments are ongoing and jointly pursued by research institutions	Approval of subsequent missions to measure GHGs	US\$ 30-100 million	Y	GHG	ECV inventory may contain information on usage of data-A40-M40 for validation of satellite records
Action A36:	N ₂ O, halocarbon and SF ₆ networks/measurements	Maintain networks for N ₂ O, halocarbon and SF ₆ measurements	Informs the parties to the Montreal Protocol, provides records of long-lived non-CO ₂ GHGs and offers potential tracers for attribution of CO ₂ increases	National research agencies, national environmental services, NMHS, through WMO GAW	Ongoing	Data flow to archive and analysis centres	US\$ 30-100 million	Y		
Action A37:	Ozone network coverage	Urgently restore the coverage the extent possible and maintain the quality and continuity of the GCOS Global Baseline (profile, total and surface level) Ozone Networks coordinated by WMO GAW.	Provides validation of satellite retrievals and information on global trends and distributions of ozone	Parties' national research agencies and NMHS, through WMO GAW and network partners, in consultation with AOPC	Ongoing	Improved and sustained network coverage and data quality	US\$ 1-10 million	Y		May from ECV inventory if used for validation of existing data records
Action A38:	Timeliness and dissemination of ozone data	Improve timeliness and completeness of submission and dissemination of surface ozone, ozone column and profile data to users, WDCGG and WOUDC	Improved timeliness of satellite retrieval validation and availability of information for determining global trends and distributions of ozone	Parties' national research agencies and services that submit data to WDCGG and WOUDC, through WMO GAW and network partners	Ongoing	Network coverage, operating statistics and timeliness of delivery	US\$ 100 000-1 million	N		

Action A39	Monitoring of aerosol properties	Provide more accurate measurement-based estimates of global and regional direct aerosol radiative forcing (DARF) at the top of the atmosphere and its uncertainties, and determine aerosol forcing of the surface and in the atmosphere through accurate monitoring of the 3D distribution of aerosols and aerosol properties. Ensure continuity of monitoring programs based on in situ ground-based measurement of aerosol properties.	Reducing uncertainties in DARF and the anthropogenic contributions to DARF, and the uncertainty in climate sensitivity and future predictions of surface temperature. Better constraints on aerosol type needed for atmospheric correction and more accurate ocean property retrieval than currently available.	Partner national services, research agencies and space agencies, with guidance from AOPC and in cooperation with WMO GAW and AERONET	Ongoing, baseline in situ components and satellite strategy is currently defined.	Availability of the necessary measurements, appropriate plans for future	US\$ 30-30 million	Y	Aerosols	Info on data records in Gap Analysis report.
Action A40	Continuity of products of precursors of ozone and secondary aerosols	Ensure continuity of products based on space-based, ground-based and in situ measurements of the precursors (NO _x , SO ₂ , HCHO, NH ₃ and CO) of ozone and secondary aerosol and derive consistent emission databases, seeking to improve spatial resolution to about 1 x 1 km ² for air quality	Improved understanding of how air pollution influences climate forcing and how climate change influences air quality.	Space agencies, in collaboration with national environmental agencies and INMIS.	Ongoing	Availability of the necessary measurements, appropriate plans for future missions, and derived emission databases.	US\$ 300-300 million	Y	Precursors	Info on data records in Gap Analysis report.

6 LIST OF ACTIONS

6.3 Ocean Domain Actions

#	Title	Action	Benefit	Time frame	Who	Performance indicator	Annual cost	Addresses in SAEGIP 2017	ECV	Comment
Action 01	Coordination of enhanced shelf and coastal observations for climate	Assess existing international, national and regional plans that address the needs to monitor and predict the climate of coastal regions and develop plans where they do not exist.	Detailed specific observational requirements in the coastal regions for improved understanding, assessment and prediction of the impact of climate on the coastal environment	2024, with interim assessment of progress by 2021	GOOS, GRAL, ICOMM OCG	An internationally recognized coordination activity	US\$ 10-30 million	N		
Action 02	Integration and data access	Improve discoverability and interoperability, comparability and traceability of ocean observations among ocean observing networks for all ECVs (including ECVs of other domains).	Improved access to data, ease of integration across data sources	Continuous	Parties' national research programmes and data management infrastructure, OOPC, International Ocean Carbon Coordination Project (IOCCP), the WCP Data Advisory Council (WDAC), ICOMM Data Management Programme Area (DMPA), GLOBE Blue Project	Timely and open access to quality-controlled observational data	US\$ 1-10 million	N		
Action 03	Data quality	Sustain and increase efforts for quality control and reprocessing of current and historical data records.	Improved quality of ocean climate data	Continuous	Parties' national ocean research agencies and data management infrastructure, supported by ICOMM OMPA, IOCC, WCP CLW&B Project	Improved record of uniform quality control	US\$ 1-10 million	N		
Action 04	Development of climatologies and reanalysis products	Maintained research and institutional support for the production of ocean gridded data products and reanalysis products, and coordinated intercomparison activities.	Improved quality and availability of integrated ocean products for climate change detection and validation of climate projections and initialization of weather- and marine forecasting models.	Continuous	Parties' national research programmes and operational agencies, WCP CLW&B, ESOP, GODAE OceanView and the ICOMM Expert Team on Operational Ocean Forecasting (ETOFFS), IOCCP	Regular updates of global ocean synthesis products	US\$ 1-10 million	N		
Action 05	Sustained support for ocean observations	Strengthen funding of the ocean observing system to move towards a more sustained long-term funding structure and broaden support by engaging more agencies and nations in sustained ocean observing through capacity building.	A more resilient observing system that is less exposed to changes in national research priorities.	2026	Parties' national research programmes, funding streams and operational agencies, capacity building through the Partnership for Observations of the Global Ocean (POGO)	Observing system performance indicators continuously at or above 90%, increasing number of agencies and nations contributing to sustained observations	US\$ 30-100 million	N		
Action 06	Technology development	Continued support for development of satellite capabilities, autonomous platforms and climate-quality sensors from pilot phases to mature stage.	Continued improvements to the sustained observing system to fill gaps, take new measurements, at lower cost per observation.	Continuous	National research programmes supported by the GOOS expert panels, CEOS Conventions Teams, ICOMM OCG and other groups.	Development of climate-quality data provided in near real-time to internationally agreed data centres.	US\$ 30-100 million	N		
Action 07	Observing system development and evaluation	Support and engage in systems based observing system development projects established through GOOS as detailed in this Plan and efforts for the ongoing evaluation of the observing system.	Continued improvements to the sustained observing system ensure it is robust, integrated and meets future needs.	Continuous	National research programmes supported by the GOOS expert panels and regional alliances	Periodic evaluation of observing system against requirements and expansion of support for sustained observations	US\$ 100-200 million (mainly to Annex I Parties)	N		
Action 08	Satellite sea-surface temperature product development	Continue the provision of best possible SST fields based on a continuous coverage mix of polar orbiting (including dual view) and geostationary IR measurements, combined with passive MFR coverages, and appropriate linkage with the comprehensive in situ networks	Global routine calibrated mapping of SST for climate monitoring and weather and subseasonal to seasonal prediction systems	Continuous	Space agencies, coordinated through GOOS High Resolution Sea Surface Temperature Project (GHRST), CEOS, COMS and WMO Space Programme	Agreement of plans for maintaining a GOOS Virtual Constellation for SST, ongoing satellite operation, routine delivery of SST products	US\$ 1-10 million	Y	SST	Gap Analysis shows what is missing
Action 09	Upper-ocean temperature observing system	Maintain a global upper ocean (0-2000 m) temperature observing system for the assessment of ocean temperature and heat content change and its contribution to sea-level rise	High-quality ocean temperature time series for accurate estimates of annual ocean heat storage as a function of depth and its spatial distribution to assess the role in the ocean in the Earth's energy balance and ocean warming contribution to sea-level change	Continuous	Parties' national agencies working with GOOS observational networks (Diffract, CEOS, Argo, SOOP, OceanSTES), in cooperation with the Observations Coordination Group of ICOMM.	Spatial coverage, interoperability of observations platforms, annually updated global upper-ocean temperature records	US\$ 10-100 million	Y	SST	Maybe if the surface is included in this Action.
Action 010	Full-depth temperature observing system	Develop and begin implementation of a full-depth ocean temperature observing system to support the decadal global assessment of the total ocean heat content and thermocline sea-level rise	High-quality, deep-ocean temperature time series for accurate estimates of biennial to decadal ocean heat storage below 2000 m and its spatial distribution to assess the role in the Earth's energy balance and ocean-warming contribution to sea-level change	Observational system in place by 2026	Parties, national agencies working with GOOS observational networks (Argo, GO-SHIP, OceanSTES), in cooperation with the ICOMM Observations Coordination Group	Design study completed and targeted implementation begins, spatial coverage, interoperability of observations platforms	US\$ 30-100 million	N		
Action 011	Ocean salinity observing system	Maintain and grow a global ocean salinity observing system for the assessment of ocean salinity and freshwater content change and its contribution to global hydrological cycle	High-quality ocean salinity time-series for accurate estimates of annual (0-2000 m) to decadal (below 2000 m) ocean freshwater changes and its spatial distribution to assess the role on the ocean in the Earth's hydrological cycle and contribution to sea-level change. Improved initialization of weather- and climate forecasting systems	Continuous	Parties' national agencies working with GOOS observational networks (CEOS, SOOP, Argo, GO-SHIP, OceanSTES), in cooperation with the ICOMM Observations Coordination Group	Spatial coverage, interoperability of observations platforms, annually updated global ocean salinity records	US\$ 30-100 million (10% non-Annex I Parties)	Y		Japan Segment consideration from gaps analysis.
Action 012	Ocean current gridded products	Maintain gridded ocean surface and subsurface current products based on satellite, drifting-buoy and Argo programme, other observations and data-assimilating models	High-quality ocean current observations for climate services and marine operational systems	Continuous	Parties' national agencies working with CEOS, GOOS observational networks (POOP, Argo, GO-SHIP, OceanSTES, Drifters) in cooperation with the ICOMM Observations Coordination Group, Godae OceanView and reanalysis projects	Spatial coverage, interoperability of observation platforms	US\$ 1-10 million (10% non-Annex I Parties)	Y	Ocean surface currents	Gap analysis
Action 013	Sea level observations	Maintain and develop a global sea surface height observing system from observational and satellite networks for annual assessment of sea level and sea-level rise	Quality control and accurate global sea level and regional sea level variability dataset	Continuous	Parties' national agencies working with CEOS, GOOS observational networks (e.g. GLOSS), in cooperation with the ICOMM Observations Coordination Group	Spatial coverage, interoperability of observations platforms, annually updated global sea-level data	US\$ 30-100 million	Y	Sea level	Gap Analysis
Action 014	Contributing to sea state climatologies	Maintain and improve the global sea state observing system from the observational networks to inform wave models/climatologies for assessment of wave climate, to trend and variability and contribution to extremes of sea level, expand observations on surface-reference moorings and drifters	Routine observations of wave climate and extremes in support of marine/climate services	Continuous	Parties' national agencies coordinated through GOOS, OOPC, GRAL, OceanSTES, OOPC, guidance from the ICOMM Expert Team on Waves and Coastal Hazard Forecasting Systems (ETWCH)	Number of global wave observations available routinely at International Data Centres.	US\$ 1-10 million	N		
Action 015	In situ sea ice observations	Plan, establish and sustain systematic in situ observations from sea ice, buoys, visual surveys (SOOP and aircraft) and in-water upward-looking Sonar (UIS)	Long time series for validation of satellite data and model fields; short- and long-term forecasting of sea ice conditions, ocean-atmosphere-sea ice interaction and process studies	Integrated Arctic Observing System design and demonstration project funded by EU for 2017-2020	National and international services and research programmes, Copernicus, European Space Agency, European Commission, EU PolarNET, Arctic-RODS (in EuroGOOS), CLW&B, ICOMM, OOPC	Establishment of agreement and frameworks for coordination and implementation of sustained Arctic (EU PolarNET and Arctic RODS, which will be extended with the new funded project (see time frame) and Southern Ocean observations (SOOP)	US\$ 30-100 million	N		
Action 016	Ocean surface stress observations +A20420	Develop requirements and review system design (satellite and in situ) for observing OSS ECV and commence implementation	Agreed plan for design of surface stress observing system to improve ocean-surface stress products	Internationally agreed plans published and establish ECVs by 2019	CEOS and in situ networks	Publication of internationally agreed plans, establishment of agreements/frameworks for coordination according to plan	US\$ 100,000-1 million		Ocean surface stress	
Action 017	Ocean surface heat flux observing system	Develop requirements and system design for observing Ocean surface heat flux ECV (utilizing indirect and direct methods) and commence implementation	Agreed plan for high-quality heat-flux data required to improve weather/climate products	Complete programme design and begin implementation of observational system by 2019	GOOS observational networks (CEOS, OceanSTES, SOOP), in cooperation with the ICOMM Observations Coordination Group	Publication of observing network plan; spatial coverage, interoperability of observation platforms	US\$ 10-30 million	Y		
Action 018	Surface ocean partial pressure of CO ₂ moorings	Sustain the surface reference mooring CO ₂ network and increase the number of sites to cover all major biogeochemical regions to resolve seasonal cycle	Increased information on seasonal and longer variability in key ocean stress	Continuous	IOCCP, in consultation with OOPC implementation through national services and research programmes	Flow of data of adequate quality into SCAT	US\$ 1-10 million	N		
Action 019	Building multidisciplinary time series	Add inorganic carbon and basic physical measurements to existing biological time-series, considering particular spatial gaps in current observing system, aiming for balanced representation of the full range of natural variability	Improved understanding of the regional effects of ocean acidification	Continuous	Parties' national research programmes supported by GDA-ON, GOOS Biogeochemistry and Biology and Ecosystems expert panels.	Flow of data of adequate quality to data centres	US\$ 1-10 million	N		
Action 020	Nutrient observation standards and best practices	Increase the use of nutrient CRM in ship-based hydrographic programmes	Increased accuracy of nutrient measurements	Continuous	IOCCP, in consultation with OOPC implementation through national services and research programmes, SCOR working group 147 "Towards comparability of global oceanic nutrient data"	Increased consistency of nutrient data	US\$ 1-10 million	N		
Action 021	Sustaining tracer observations	Maintain capacity to measure transient tracers on the GO-SHIP network. Encourage technological development to encompass additional tracers that provide additional information on ventilation.	Information on ocean ventilation and variability in ventilation	Continuous	IOCCP, in consultation with OOPC implementation through national services and research programmes	Number of high-quality transient tracer measurements on the repeat hydrography programme	US\$ 1-10 million	N		
Action 022	Develop sustained N ₂ O observations	Develop an observing network for ocean N ₂ O observations, with particular emphasis on regions with known high oceanic N ₂ O production/mission rates	Improved estimate of oceanic emissions by improved spatial and temporal coverage, detecting seasonal and interannual variability	Continuous	IOCCP, in consultation with OOPC implementation through national services and research programmes; SCOR WG 143 Dissolved N ₂ O and CH ₄ measurements, working towards a global network of ocean time series measurements of N ₂ O and CH ₄	Flow of data of adequate quality into MEMENTO	US\$ 1-10 million	N		
Action 023	In situ ocean colour/radiometry data	Continue support for generation and maintenance of climate-quality in situ OCR data, including developing new high-resolution sensors of high radiometric quality, for improving satellite algorithms, validating products and for establishing product uncertainties characterization, with global coverage and validity, including coastal (Case-2) waters, and capable of dealing with user requirements for products at a variety of time and space scales	Monitoring of changes and variability in ocean colour and derived products	Implement plan beyond 2007 after completion of ESA OCE activities	CEOS space agencies, in consultation with IOCCG and GEO through INSTU OCE initiative of IOCCG, and in accordance with the recommendations contained in the IOCCG INSTU-OCE White Paper (see http://www.ioccg.org/groups/INSTU-OCE_White_Paper.pdf)	Free and open access to up-to-date, multi-sensor global products for climate research; flow of data into agreed archives; summary interpreted data products available as well as original data.	US\$ 30-100 million	Y	Ocean colour	Action Title doesn't fit to the rest of description, is this really purely in-situ, why space agencies then. ECV inventory provides info on Ocean Colour data sets.
Action 024	Ocean colour algorithm development	Support continued research and technology development to ensure that the best and the most up-to-date algorithms are used for processing the ocean-colour time-series data in a consistent manner for climate research, to develop product suites suitable for application across wide ranges of water types, including coastal water types; to study inter-sensor differences and minimize them before multi-sensor data are merged; to provide quality assurance and uncertainty characterization of products	Improved quality of ocean colour products, particularly in coastal waters and complex water types	Implement plan as accepted by CEOS agencies in 2009	CEOS space agencies, in consultation with IOCCG and GEO	Improved algorithms for a range of water-property types	missing	Y	Ocean colour	maybe
Action 025	Satellite-based phytoplankton biomass estimates	Establish a plan to improve and test regional algorithms to convert satellite observations to water column integrated phytoplankton biomass through implementing in situ phytoplankton observations to water column integrated phytoplankton biomass that are collected simultaneously with the measurement of other important physical and biogeochemical variables.	Baseline information on plankton implementation build-up to 2020	CEOS space agencies, in consultation with IOCCG, including Satellite PFT Intercomparison Project, parties' national research agencies, working with SCOR and GOOS	Publication of internationally agreed plans; establishment of agreements/frameworks for coordination of a sustained global phytoplankton observing system with consistent sensors and a focused global program of in situ calibration	Flow of data into agreed archives; summary interpreted data products available as well as original data.	US\$ 100,000-1 million	Y	Ocean Colour	???
Action 026	Fundamental Continuous Plankton Recorder and supporting observations	Establish plan for, and implement, global CPR surveys, including extension to (sub)tropical areas and integration of data from supporting observation programmes	Information on variability and trends in plankton	Internationally agreed plans published by end 2019; implementation build-up to 2020	Parties' national research agencies, working with SCOR and GOOS Biology and Ecosystems Panel, GME-TS, Global Alliance of CPR Surveys, OceanSTES	Publication of internationally agreed plans; establishment of agreements/frameworks for coordination of sustained global CPR surveys supported by repeated surveys at fixed locations; implementation according to plan; flow of data into agreed archives; summary of interpreted data products available	US\$ 10-30 million	N		
Action 027	Strengthened network of coral reef observation sites	Strengthen the global network of long-term observation sites covering all major coral-reef habitats within interconnected regional hubs, encourage collection of physical, biogeochemical, biological and ecological measurements, following common and intercalibrated protocols and design, and implement capacity-building workshops	Accurate global monitoring of changes in coral reef cover, health and pressures	2016-2020	Parties' national research and operational agencies, supported by GCMM, GOOS Biology and Ecosystems Panel, GRAs and other partners	Reporting on implementation status of network	US\$ 30-100 million	N		

Action 028	Global networks of observation sites for mangroves, seagrasses, macroalgae	Advance the establishment of global networks of long-term observation sites for seagrass beds, mangrove forests and macroalgal communities (including kelp forests) and encourage collection of physical, biogeochemical, biological and ecological measurements, following common and interrelated protocols and designs and implement capacity building workshops	Accurate global monitoring of changes in mangroves, seagrasses and macroalgal cover	2016-2020.	Parties' national research and operational agencies, supported by GOOS Biology and Ecosystems Panel, GBA and other partners in consultation with CBD and Ramsar Convention on Wetlands	Reporting on implementation status of network.	US\$ 30-100 million	N		
Action 029	In situ data for satellite calibration and validation	Maintain in situ observations of surface ECV measurements from existing observations networks (including surface drifting buoys, GOOP ships, tropical moorings, reference moorings, Argo drifting floats, and research ships) for calibration and validation of satellite data, undertake a review of requirements of observations	Comprehensive in situ observations for calibration and validation of satellite data	Continuous, review by 2020	Parties' national services and ocean research programmes, through GOOS, IOOE and ICOMM, in collaboration with WMO/ICES/IAEA and CEOS.	Data availability at international data centres.	US\$ 1-10 million	Y	Ocean ECVs	Can we provide any feedback here on the ground-based networks used for calibration?
Action 030	Satellite sea-surface temperature	Secure future passive microwave missions capable of SST measurements	Ensure SST coverage in regions of high cloud coverage	Continuous	Space agencies, coordinated through CEOS, CEOS and WMO Space Programme in consultation with the Global High Resolution Sea Surface Temperature Project (GLORYS)	Agreement of plans for maintaining required microwave SST missions	US\$ 400-300 million (for securing needed missions)	N	SST	Gap analysis
Action 031	Satellite sea-surface height	Ensure continuous coverage from one higher-precision, medium-inclination altimeter and two medium-precision, higher-inclination altimeters, including a satellite altimetry reference mission with no gap between each satellite to ensure that each mission following another has a recovery period (6-8 months) to intercalibrate against other altimeters of TERS/2 altimetry missions.	Global routine calibrated mapping of SSH, intercalibration period between difference satellite altimeters	Continuous	Space agencies, with coordination through the OSTST, CEOS Constellation for Ocean Surface Topography, CEOS and the WMO Space Programme.	Satellites operating; provision of data to analysis centres	US\$ 30-100 million	Y	Sea Level	??? Information from OSCAR? (a bit far fetched.... as this is specifically for the reference missions (TOPEX, Jason-1/2/3))
Action 032	Satellite sea-surface salinity	Ensure the continuity of space-based SSS measurements	Continue satellite SSS record to facilitate research (ocean circulation, climate variability, water cycle, and marine biogeochemistry), operation (seasonal climate forecast, short-term ocean forecast, ecological forecast) and linkage with the atmosphere	Continuous	Space agencies, coordinated through OSTST, CEOS, CEOS and WMO Space Programme and in situ network	Agreement of plans for maintaining a CEOS virtual constellation for SSS, ongoing satellite operation, routine delivery of SSS products	US\$ 30-100 million (for securing needed missions)	Y	SSS	Feedback from ECV inventory contents
Action 033	Satellite sea state	Continue to improve the delivery and quality of sea-state fields, based on satellite missions with in situ network	Global routine calibrated mapping of sea state	Continuous	Space agencies, coordinated through CEOS, CEOS, and WMO Space Programme and in situ network	Agreement of plans for maintaining a CEOS virtual constellation for sea state	US\$ 1-10 million (for generation of datasets)	Y	Sea State	Feedback from ECV inventory contents
Action 034	Satellite ocean surface stress	Continue to improve the delivery and quality of ocean surface stress fields based on satellite missions with the comprehensive in situ networks (e.g. meteorological moorings); improve resolution with the benefit of near coastal data; improved coverage of the diurnal and semi-diurnal cycles.	Global routine calibrated mapping of ocean surface stress	Continuous	Space agencies, coordinated through OSTST, CEOS, CEOS and WMO Space Programme and in situ network	Agreement of plans for maintaining a CEOS virtual constellation for ocean surface stress	empty	Y	Ocean Surface Stress	Feedback from ECV inventory contents
Action 035	Satellite sea ice	Ensure sustained satellite-based (microwave radiometry, SAR, altimetry, visible and IR) sea-ice products; high-inclination altimetry (e.g. Cryosat follow-on) also desired	Global routine, calibrated mapping of sea ice	Continuous	Parties' national services, research programmes and space agencies, coordinated through the WMO Space Programme and Global Cryosphere Watch, CEOS and CEOS; national services for in situ systems, coordinated through WCRP C2 and ICOMM	Sea-ice data in international data centres	US\$ 1-10 million (for generation of datasets)	Y	Sea Ice	Feedback from ECV inventory contents
Action 036	Satellite ocean colour	Support generation of long-term multi-sensor climate quality OAR time series that are corrected for inter-sensor bias as needed and that have quantitative uncertainty characterization, with global coverage and validity, including coastal (Case 2) waters, and capable of dealing with user requirements for products at a variety of space and timescales.	Global routine calibrated mapping of ocean colour, including coastal (Case 2) regions	Implement plan beyond 2017	ICES space agencies, in consultation with IOCCG and GEO; agencies responsible for operational Earth observations, such as NOAA in the USA and Copernicus in the European Union	Free and open access to up-to-date, multi-sensor global products for climate research; flow of data into agreed archives	US\$ 1-10 million (for generation of datasets)	Y	Ocean Colour	Feedback from ECV inventory contents
Action 037	Argo array	Sustain and expand the Argo profiling float network of at least one float every 3° x 3° in the ocean, including regional seas and the seasonal ice zone (approximately 3800 floats)	Global climate-quality observations of the broad-scale subsurface global ocean temperature and salinity down to 2 000 m	Continuous	Parties participating in the Argo programme and in cooperation with the ICOMM Observations Coordination Group	Spatial coverage and number of active floats	US\$ 30 million	N		
Action 038	Development of a biogeochemical Argo array	Deploy a global array of 1 000 profiling floats ("A-T") equipped with pH, oxygen, nitrate, chlorophyll fluorescence, backscatter and downwelling irradiance sensors, consistent with the Biogeochemical Argo Science and Implementation Plan	Global observations of the broad-scale subsurface global ocean biogeochemistry down to 2 000 m	In place by 2026; review progress in 2021	Parties, in cooperation with the Argo Programme and the ICOMM Observations Coordination Group	Number of floats reporting oxygen and biogeochemical variables	US\$ 25 million	N		
Action 039	Development of a deep Argo array	Deploy global array of approximately 1 200 deep Argo floats at 5° x 5° spacing, covering all ocean regions deeper than 2 000 m	Global climate-quality observations of the broad-scale subsurface global ocean temperature and salinity below 2 000 m	Array in place and maintained by 2026; review progress in 2021	Parties participating in the Argo programme and in cooperation with the ICOMM Observations Coordination Group	Spatial coverage and number of active deep floats	US\$ 20 million	N		
Action 040	GO-SHIP	Maintain a high-quality, full-depth, multi-disciplinary ship-based decadal survey of the global ocean (approximately 60 sections) and provide a platform to deploy autonomous components of the ocean-observing system and test new technology	Global, comprehensive, full-depth, decadal ocean inventory of ECVs	Continuous	National research programmes supported by the GO-SHIP Project, ICOMM Ocean Coordination Group and GOOS	Percentage coverage of the sections and completion of Level 1 measurements	US\$ 10-30 million	N		
Action 041	Develop fixed point time series	Build and maintain a globally distributed network of multi-disciplinary, fixed-point surface and subsurface time series, using mooring, ship and other fixed instruments	Comprehensive high temporal resolution time series characterizing trends and variability in key ocean elements	Continuous	Parties' national services and ocean research agencies responding to the OceanSITES plan working with GOOS Panels and GRAs	Mooring operational and reporting to archives	US\$ 30-100 million	N		
Action 042	Maintain the Tropical Moored Buoy system	Maintain the Tropical Moored Buoy system	Contribute to observing state of the tropical ocean climate, particularly focused on coupled air-sea processes and high frequency variability and for prediction of ENSO events	Continuous	Parties' national agencies, coordinated through the ICOMM Tropical Moored Buoy Implementation Panel, following guidance from scientific development projects (e.g. TPOS 2020, IDE-I, AtlanticOS)	Data acquisition at international data centres and robust design requirements articulated	US\$ 30-100 million	N		
Action 043	Develop time-series-based biogeochemical data	Establish a coordinated network of ship-based multidisciplinary time series that is geographically representative; initiate a global data product of time-series-based biogeochemical data	Global comprehensive regular observations of ocean biogeochemistry, complementary to the GO-SHIP decadal survey	Internationally agreed plans published by end 2018; implementation build-up to the GO-SHIP decadal survey	Parties' national research agencies, working with IOCCP and user groups, such as ISMETS	Publication of internationally agreed plans; timely availability of data in internationally agreed data centres	US\$ 30-30 million	N		
Action 044	Meteorological moorings	Maintain measurements on surface moored buoys of meteorological parameters (air temperature, humidity, SST, wind speed and direction) and expand range of parameters measured (surface pressure, waves, precipitation and radiation); ensure observational metadata are available for all moored buoy moorings, both for current data and for the historical archive	Comprehensive marine meteorological observation delivery	Continuous	Parties' national services and ocean research agencies, BCP, OceanSITES	Mooring operational and reporting to archives	US\$ 30-100 million	N		
Action 045	Wave measurements on moorings	Develop a strategy and implement a wave measurement component as part of the Surface Reference Mooring Network (SRMN and OceanSITES)	Comprehensive in situ reference observations of wave parameters	Complete plan and begin implementation by 2020	Parties operating moorings, BCP, OceanSITES, coordinated through the ICOMM Expert Team on Waves and Coastal Hazards	Sea-state measurement at the international data centres	US\$ 1-10 million	N		
Action 046	Observations of sea ice from buoys and visual survey	Establish and sustain systematic in situ observations from sea-ice buoys, visual survey (GOOP and Aircraft) and US in the Arctic and Antarctic	Enable tracking of variability in ice thickness and extent	Continuous	Arctic Party research agencies, supported by the Arctic Council; Party research agencies, supported by CIVAR Southern Ocean Panel, ICOMM, working with C2C and DOOP	Establishment of agreements/frameworks for Arctic and Southern Ocean observations; implementation commences in 2016	US\$ 10-30 million	N		
Action 047	Sustain drifter array	Sustain global coverage of the drifting buoy array (at least 1 300 drifting buoys to cover oceans in the latitudes between 60S and 60N, excluding marginal seas, plus additional coverage for these areas) with ocean temperature sensors and atmospheric pressure sensors on all drifting buoys	Routine broad-scale observations of surface temperature and sea level pressure in support of NWP climate data products (e.g. SST) and WDClim for climate-quality flux estimates	Continuous	Parties' national services and research programmes through ICOMM, BCP and the Ship Observations Team (SOT)	Data submitted to analysis centres and archives	US\$ 1-10 million	N		
Action 048	Underway observations from research and servicing vessels	Ensure where possible that ancillary underway observations are collected during research voyages and routine mooring servicing cruises	Improved coverage of underway observations, particularly in data-poor, open oceans, and complementary to moored buoy arrays	Continuous	National research agencies in consultation with the ICOMM Ship Observations Team and GO-SHIP	Improved observations from research vessels	US\$ 1-10 million	N		
Action 049	Improve measurements from Voluntary Observing Ships	Improve the quality and spatial coverage of VOS observations, by working collaboratively with stakeholders having interests in the maritime transportation industry; continue efforts to validate utility of VOS observations for a range of applications, including NWP, marine climate, fisheries and validation of remote sensed observations; improve metadata acquisition and management for as many VOS as possible through VOSGIM, together with improved measurement systems	Improved coverage of routine marine meteorological observations in support of NWP	Continuous	National meteorological agencies and climate services, with commercial shipping companies in consultation with the ICOMM Ship Observations Team	Increased quantity and quality of VOS reports	US\$1-10 million	N		
Action 050	Improve measurements of underway thermosalinograph data	Improve the quality and spatial coverage of underway temperature and salinity data; ensure observations are archived and quality controlled when collected complementary to other observing programmes	Improved coverage of surface temperature and salinity observations	Continuous	National meteorological agencies and climate services, research agencies with the commercial shipping companies in consultation with the ICOMM Ship Observations Team	Increased quantity and quality of VOS reports	US\$ 1-10 million	N		
Action 051	Sustain ship-of-opportunity expendable bathythermograph/pendent conductivity temperature depth	Sustain the existing, multi-decadal, ship-of-opportunity MBT/CTD transoceanic network in areas of significant scientific value	Eddy resolving transects of major ocean basins, enabling basin-scale heat fluxes to be estimated and forming a global underpinning boundary - current observing system	Continuous	Parties' national agencies, coordinated through ICOMM SOT	Data submitted to archive; percentage coverage of the sections	US\$ 1-10 million	N		
Action 052	Coordination of underway pCO ₂ observations and agreed best practices	Improve coordination, outreach and tracking of implementation and measurements of a global surface water CO ₂ observing system; implement an internationally agreed strategy for measuring surface pCO ₂ on ships and autonomous platforms and improve coordination of network, timely data submission to the SOCAT data portal	Delivery of a high-quality global dataset of surface ocean pCO ₂ ; enabling accurate estimates of ocean fluxes of carbon dioxide	Establishment of global monitoring group by 2018; continuous, coordinated network by 2020	IOCCP in coordination with ODP, ICOMM OCG and ICOMMADPS; implementation through Parties' national services and research agencies	Tracking assets within 3 months of completion of voyage; data delivery to SOCAT	US\$ 30-30 million	N		
Action 053	Underway biogeochemistry observations	Sustain current transect basin sampling lines of pCO ₂ and extend the coverage to priority areas by starting new lines (GOOS-195, arctic SITES); implement routine pCO ₂ measurements on research vessels; develop and deploy a global ship-based reference network of robust autonomous in situ instrumentation for Ocean Biogeochemical ECVs	Enables routine observations of multiple surface Ocean Biogeochemical ECVs, leading to improved coverage	Plan and implement a global network of SOOP vessels, equipped with instrumentation by 2020	Parties' national ocean research agencies in association with the GOOS, Biogeochemistry Panel, IOCCP, in consultation with ICOMM OCG	Improved flow of data to SOCAT; and project implemented; progress towards global coverage with consistent measurements as determined by number of ships with calibrated sensors providing quality data	US\$ 30-30 million	N		
Action 054	Continuous plankton recorder surveys	Implement global CPR surveys	Towards global transects of surface zooplankton, plankton species diversity and variability, plus an indicator of phytoplankton productivity	2026; review progress by 2021	Parties' national research agencies, through GACS and the GOOS Biology and Ecosystems Panel	Continuation of and sustained global CPR according to plan	US\$ 30-30 million	N		
Action 055	Maintain tide gauges	Implement and maintain a set of gauges based on the GLDSS Core Network (approximately 300 tide gauges) with geostatically located, high accuracy gauges; ensure continuous acquisition, real-time exchange and archiving of high-frequency data; build a consistent time series, including historical sea-level records, with all regional and local tide-gauge measurements referenced to the same global geodetic reference system	The GLDSS Core Network is the backbone serving the multiple missions that GLDSS is called on to serve. Not all core stations serve every mission and not all stations for a given mission are part of the core. The Core Network serves to set standards and is intended to serve as the example for the development of regional networks. The GLDSS climate set serves to put the short altimetry record into a proper context, serves as the ground truth for the developing satellite dataset, and also provides continuity if climate capable altimetry missions have interruptions in the future.	Continuous	Parties' national agencies, coordinated through ICOMM GLDSS of	Data availability at international data centres; global coverage; number of capacity building projects	US\$ 1-10 million	N		
Action 056	Developing a global glider observing system	Design and begin implementation of a globally distributed network of multi-disciplinary glider missions across the continental shelf seas to the open ocean as part of a glider reference coastal-open ocean observation network	Multi-disciplinary, high-frequency observations enabling the linkage of open ocean and coastal environments and cross-shelf exchange of properties	Framework and plan developed by 2020	National research programmes coordinated through the global glider programme and GOOS	Published, internationally agreed plan and implementation of sustained coastal boundary-open ocean sections	US\$ 30-30 million	N		
Action 057	Developing a global animal-tagging observing system	Move towards global coordination of planned tagging for ecosystem and climate applications, including the coordination of deployment locations/species and QAVC of recipient data	High-frequency 1/5 profile data in polar regions and in the ice zone; filling a critical gap in the observing systems; high-frequency 1/5 profile data in other regions providing complementary data to other observing systems and likely high-frequency sampling of physical features of interest to foraging animals such as fronts and eddies	Framework and plan developed by 2020	National research programmes coordinated through SOOS, SAOON GOOS	An internationally recognized coordination activity, and observing plan	US\$ 30-30 million	N		

Action 145	Land-surface temperature in situ network expansion	Expand the in situ network of permanent, high-quality IR radiometers for dedicated LST validation	LST datasets better validated and cover more land surface types; independent validation of stated accuracies providing credibility to satellite LST products	Network concept and approach by 2017; implementation by 2018	Parties' national services and research agencies, space data providers, GOCF-GOLD, NASA-ILUC, TOPC, GOS, WCV/LPV, LSTE	Establishment of a comprehensive network of ground sites with high-quality in situ measurements suitable for validating the different sensors; results from in situ radiometer intercomparison exercises	US\$ 3-10 million (10-20 sites at US\$ 100,000 per site)	Y		
Action 146	Land-surface temperature radiometric calibration	Radiometric calibration intercomparisons and uncertainties for LST sensors	LST datasets better calibrated and cover all land surface types; independent validation of stated accuracies providing credibility to satellite LST products	Network concept and approach by 2017; implementation by 2018	Coordinated by CEOS WCV/Infared and Visible Optical Sensors subgroups/IGOSs and supported by space agencies	ECV generators taking into account radiometric calibration uncertainties, jointly with calibrations being referenced to a common framework	US\$ 3-10 million	Y	LST	??? Here a feedback would only be possible after deep digging into documentation...
Action 147	Land-cover experts	Maintain and strengthen a global network of land-cover/land-use experts to develop and update an independent, very high spatial-resolution reference dataset for global land-cover map accuracy assessment; facilitate access to land-use and management information to support the development of global-scale land-use products	For GLC map developers, GLC map users	Network concept and approach by 2017; implementation by 2018	GOCF-GOLD, CEOS WCV/LPV, Parties' national services and research agencies, space data providers, NASA-ILUC, TOPC	Global L2C map developers using the reference data developed by the operational network	US\$ 100 000-1 million	Y		
Action 148	Annual land-cover products	Generate annual land-cover products over key regions that allow change assessment across time (including for the six IPCC AFOLU land categories) at 30m-300m spatial resolutions, according to internationally agreed standards and accompanied by statistical descriptions of their accuracy	For mitigation and adaptation communities	2017 and beyond	Space agencies, GOCF-GOLD, Copernicus Land Service, USGS, University of Maryland (JLMO) GoogleEarth	Product delivered and used by a large community; use of standard approaches for validation and uncertainty metrics	US\$ 3-10 million	Y	Land cover	Feedback from ECV Inventory contents?
Action 149	Land-cover change	Generate global-scale land-cover products with an annual frequency and long-term records that allow change assessment across time (including as much as possible for the six IPCC AFOLU land categories), at resolutions between 30m and 1 km, according to internationally agreed standards and accompanied by statistical descriptions of their accuracy	To climate change modellers, others	2017 and beyond	Space agencies, research institutes, GOCF-GOLD, Copernicus Land Service	Product delivered and used; use of standard approaches for validation and uncertainty metrics	US\$ 3-10 million	Y	Land cover	Feedback from ECV Inventory contents?
Action 150	Land-cover community consensus	Develop a community consensus strategy and priorities for collecting to include information on land management in current land-cover datasets and start collecting relevant datasets and observations, building ongoing activities	To climate change modellers, mitigation and adaptation user communities	Concept and approach by 2017; start implementation by 2018	Parties' national services and research agencies, space agencies, GOCF-GOLD, NASA-ILUC, TOPC, UMD-GoogleEarth, ERS, ESA, USGS, GOCF-GOLD, FAO, GEO	Product delivered and used	US\$ 100 000-1 million	Y		
Action 151	Deforestation	Develop yearly deforestation (forest clearing) and degradation (partial clearing) for key regions that allow change assessment across time at 10-30 m spatial resolutions, according to internationally agreed definitions	To provide annual monitoring of deforestation and forest degradation to support management and reporting	Concept and approach by 2017; implementation by 2018	Parties' national services and research agencies, space agencies, GOCF-GOLD, NASA-ILUC, UMD-GoogleEarth, TOPC	Indicators-based standard validation approach for change of forest cover and attributions associated with deforestation and degradation; product delivered and used	US\$ 100 000-1 million	Y		
Action 152	Collaboration on above ground biomass	Encourage inter-agency collaboration on developing optimal methods to combine biomass estimates from current and upcoming missions (e.g. ESA BIOMASS, NASA GEDI and NASA-ISRO NISAR, JAXA PALSAR, CONAE LACONIC)	Reduced error, cross-validation, combining strengths of different sensors in different biomass ranges	Most key missions are expected to be in orbit between 2024 and 2026	ESA, NASA, JAXA, NASA-ISRO, CONAE	A strategy to combine biomass estimates from different sensors, together with algorithms and processing methods	US\$ 100 000-1 million	Y	AGB	Feedback from ECV Inventory contents?
Action 153	Above-ground biomass validation strategies	Encourage inter-agency collaboration to develop validation strategies for upcoming missions aimed at measuring biomass (e.g. ESA BIOMASS, NASA GEDI and NASA-ISRO NISAR), to include combined use of in situ and airborne lidar biomass measurements	Potential to produce more comprehensive validation of biomass estimates by cost sharing. Greater consistency between biomass estimates from different sensors because of assessment against common reference data	From now until the operational phase of the various sensors (2016-2022)	ESA, NASA, JAXA, NASA-ISRO, CONAE	Formal agreement between agencies on a strategy for joint gathering and sharing of validation data, together with funding of specific elements of the overall set of validation data	US\$ 10 000-100 000	Y		
Action 154	Above-ground biomass validation sites	Develop a set of validation sites covering the major forest types, especially in the tropics, at which high-quality biomass estimations can be made, using standard protocols developed from ground measurements or airborne lidar techniques	Essential to give confidence in satellite-derived biomass estimates at global scale	From now up to the operational phase of the various sensors (2016-2022)	Space agencies working with key in situ networks (e.g. RainFor, Afrifron, the International Centre for Tropical Forest Science), GEO-GLI	Establishment of a comprehensive network of ground sites with high-quality in situ biomass estimates with uncertainty assessments suitable for validating the different sensors	US\$ 30-100 million (50 tropical sites covering all forest types; US\$ 20 million estimate for temperate and boreal sites not yet formulated)	Y		
Action 155	Above-ground biomass data access	Promote access to well-calibrated and validated regional- and national-scale biomass maps that are increasingly being produced from airborne lidar	Essential to give confidence in satellite-derived biomass estimates at global scale	From now until the operational phase of the various sensors (2016-2022)	GEO-GLI, other national and international bodies producing biomass maps	Availability of multiple regional to country-scale maps of biomass derived from airborne lidar; use of standard protocols for uncertainty assessment of lidar estimation of biomass	US\$ 100 000-100 000 (does not include monitoring costs)	Y		
Action 156	Above-ground biomass: forest inventories	Improve access to high-quality forest inventories, especially in the tropics, including those developed for research purposes and REDD+	Extends the data available for validating satellite-derived biomass data	From now until the operational phase of the various sensors (2016-2022)	GEO-GLI, other national and international bodies producing or funding forest inventories	Access to databases of ground-based biomass measurements derived from forest inventories purposes; improved maps	US\$ 10 000-100 000	Y		
Action 157	Soil carbon: carbon mapping	Cooperate with the soil-carbon mapping exercises to advocate accurate maps of soil carbon	Improved data accuracy	Ongoing	TOPC and GOS	Number of flux sites making measurements	US\$100-10 000	N		
Action 158	Soil carbon change	Encourage flux sites to measure soil carbon at five-year intervals and record soil management activities; use this to supplement long-term experiments that are monitoring soil carbon	Improved in situ observations will improve accuracy	Ongoing	TOPC and GOS	Number of flux sites making measurements	US\$10 000-100 000	N		
Action 159	Soil carbon - historical	Provide global maps of the extent of historical (pre-1950, wetland and permafrost) and their depth	Improve understanding of carbon pools at risk from climate change	Ongoing	Research communities, ISRIC, HIASD and the Global Soil Map	Availability of maps	US\$ 10 000-100 000	N	Land cover?	??? Not sure...
Action 160	Historic fire data	Reanalyse the historical fire-disturbance satellite data (1982 to present)	Climate-modelling communities	By 2020	Space agencies, working with research groups coordinated by GOCF-GOLD-Fire by 2020	Establishment of a consistent dataset, including the globally available AVHRR data record	US\$ 3-10 million	Y	Fire	Feedback from ECV Inventory contents?
Action 161	Operational global burned area and fire radiative power	Continue the production of operational, global burned area active fire (with associated FRP) products, with metadata and uncertainty characterizations that meet the global requirements and have necessary product back up to ensure operational delivery of products to users	Climate-modelling communities, space agencies, civil protection services, fire managers, other users	Continuous	Space agencies, Copernicus Global Land Service, Copernicus Atmospheric Monitoring Service, GOCF-GOLD	Availability of products that meet user needs	US\$ 3-10 million	Y	Fire	Feedback from ECV Inventory contents?
Action 162	Fire maps	Consistently map global burned area at < 100m resolution on a near-daily basis from combinations of satellite products (Sentinel-2, Landsat, Sentinel-1, PROBA3) work towards deriving consistent measures of fire severity, fire types, fuel moisture and related plant-fuel parameters	Climate-modelling communities, space agencies, civil protection services, fire managers, other users	By 2020	Space agencies, research organizations, international organizations in collaboration with GOCF-GOLD-Fire	Availability of data and products	US\$ 3-10 million	Y	Fire	Feedback from ECV Inventory contents?
Action 163	Fire validation	Continuation of validation activity around the detection of fire-disturbed areas from satellites to show that theoretical requirements are being met; work to reduce the errors of commission and omission; provide better than expected uncertainty characterizations of fire disturbance products	Climate-modelling communities	Continuous	Space agencies and research organizations, supported by GOCF-LPV	Publication of temporal accuracy	US\$ 3-10 million	Y	Fire	Feedback from ECV Inventory contents? Far fetched...
Action 164	Fire disturbance model development	Continuation of joint projects between research groups involved in the development of atmospheric transport models, dynamic vegetation models and GHG emission models, the climate-modelling and transport-modelling community and those involved in the continual algorithm development, validation and uncertainty characterizations of fire disturbance products from satellite data the Earth observation and modelling community, contribute to better understanding of fire risk and fire risk modelling	Climate-modelling communities, Copernicus Programme	Continuous	Space agencies (NASA, ESA, etc.), inter-agency bodies (GOCF-GOLD, CEOS, EUMW, Meteosat, etc.), Copernicus Global Land Service, Copernicus Atmospheric Monitoring Service, GOCF-GOLD	Projects that engage climate and atmospheric transport modellers and product development community	US\$ 1-10 million	Y		
Action 165	Anthropogenic water use	Collect, archive and disseminate information related to anthropogenic water use	Accurate and up-to-date data on water availability and stress	Continuous	UN-Water, IWM and FAO through AQUASTAT in collaboration with UN Statistics Division and other data sources	Information contained in the AQUASTAT database.	US\$ 100 000-1 million	N		
Action 166	Pilot projects: anthropogenic water use	Develop and implement pilot data-collection exercises for water use	Demonstrate data collection approaches for wide implementation	2016-2019	UN-Water, IWM and FAO through AQUASTAT in collaboration with the Convention on the Protection and Use of Transboundary Watercourses and International Lakes	Completed data collection in pilot areas	US\$ 100 000-1 million	N		
Action 167	Improve global estimates of anthropogenic greenhouse gas emissions	Continue to produce annual global estimates of emissions from fossil fuel, industry, agriculture and waste; improve these estimates by following IPCC methods using Tier 2 for significant sectors; this will require a global knowledge of fuel carbon contents and a consideration of the accuracy of the statistics used	Improved tracking of global anthropogenic emissions	Ongoing, with annual updates	EA, FAO, Global Carbon Project (GCP), Carbon Emissions Information Analysis Centre (CEIAS), Emissions Database for Global Atmospheric Research (EDGAR)	Availability of improved estimates.	US\$ 10 000-100 000	N		
Action 168	Use of satellites for land use, land use change and forestry emissions/removals	Support the improvement of estimates of emissions and removals from Forestry and Land-use change by using satellite data to monitor changes where ground-based data are insufficient.	Improved global and national monitoring of LULUCF	Ongoing.	National reporting supported by international agencies through programmes such as LMREDD and GFPI	Availability of satellite data	US\$ 100 000-1 million	Y	Land cover	Feedback from ECV Inventory contents? Far-fetched...
Action 169	Research on the land sink	Research to better understand the land sink, its processes and magnitudes	Better understanding of the global carbon cycle	Ongoing	GCP, research groups	Published results	US\$ 100 000-1 million	N		
Action 170	Use of inverse modelling techniques to support emission inventories	Develop inverse modelling methods to support and add credibility to emission inventories, develop and disseminate examples for several GHGs	Added credibility of national emission/removal estimates and demonstration of inventory methodologies	Ongoing	National inventory agencies, researchers	Published results	US\$ 3-10 million	N		
Action 171	Prepare for a carbon-monitoring system	Preparatory work to develop a carbon monitoring system to be operational by 2035; Development development of comprehensive monitoring systems of measurements of atmospheric concentrations and of emission fluxes from anthropogenic areas and point sources to include space based monitoring, in situ flux and flux tower measurements and the necessary transport and assimilation models	Improved estimates of national emissions and removals	Initial demonstration results by 2023 - complete systems unlikely before 2030	Space agencies	Published results	US\$ 10-100 billion	Y	GHG	Related to the GHG Monitoring activities
Action 172	Prepare for a latent and sensible heat flux ECV	Review the feasibility of global monitoring of latent and sensible heat fluxes from the land surface; prepare proposals for such an ECV; Development of comprehensive monitoring systems of measurements of atmospheric concentrations and emission fluxes from anthropogenic point sources, to include space based monitoring, in situ flux and flux tower measurements and the necessary transport and assimilation models	Improve understanding of heat fluxes over land	2017	TOPC	Proposals for consideration by GOS Steering Committee	US\$10 000-100 000	N		