



CGMS-39 WMO-WP-23  
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Discussed in WG II, WG III

## OUTCOME OF THE GCOS IMPLEMENTATION PLAN SATELLITE SUPPLEMENT UPDATING

The draft up-date of the satellite-based component of the in 2010 updated "Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC" provides supplemental detail related to the generation of global climate products derived from measurements made from satellites.

A first analysis of the information which was provided to the draft satellite supplement is showing that Surface Wind, Precipitation, Upper-Air Temperature, Upper-Air Wind, Water Vapour, Cloud Properties, Aerosols, Fraction of Absorbed Photosynthetically Active Radiation (FAPAR), Leaf Area Index (LAI) and Fire Disturbance are covered by a specific "agent for implementation", i.e., a CGMS working group or dedicated project or programme.

Sea Ice, Sea Level, Sea Surface Temperature (SST), Sea State, Snow cover, Biomass, Soil moisture, Ice sheets, Lakes, Land cover, Earth Radiation Budget (ERB), Greenhouse Gases (GHGs), Ozone, Precursors are covered by CGMS in general, but the draft report did not specify a dedicated group.

Further, CGMS is not addressing Sea Surface Salinity, Ocean Colour and Glaciers / Ice Caps.

Action/Recommendation proposed:

CGMS members to review Annex 1 of CGMS-39 WMO-WP-23.

## OUTCOME OF THE GCOS IMPLEMENTATION PLAN SATELLITE SUPPLEMENT UPDATING

### 1 INTRODUCTION

The draft up-date of the satellite-based component of the in 2010 updated “Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC” provides supplemental detail related to the generation of global climate products derived from measurements made from satellites.

The detailed specifications, often in conjunction with the need for *in situ* data for calibration and validation, have been made traceable to the 2011 updated GCOS implementation plan. The document is intended to assist Parties<sup>1</sup> supporting Earth observation from space, and/or supporting the use of such observations in the generation of climate products, in responding to the requirements of the GCOS Implementation Plan.

All Parties can play an important role as users and potential generators of climate products derived from satellites, as well as through the vital contribution of *in situ* observations that are required for the derivation of the climate products specified in this report. Parties should respond to the needs expressed in the GCOS Implementation Plan, supplemented by the 2011 updated satellite-based component. They should do so by working, as appropriate, with their space agencies, and in conjunction with international bodies such as WMO, IOC, ICSU, UNEP, FAO, and other relevant bodies, such as the Committee on Earth Observation Satellites (CEOS), the Coordination Group for Meteorological Satellites (CGMS) and the Group on Earth Observations (GEO).

### 2 A first Action Analysis for CGMS

The list of ECVs in the table below, plus other variables for which supporting measurements are needed, is expected to evolve slowly as scientific knowledge and requirements are extended, and as technological developments permit. A small number of variables, specifically groundwater, permafrost, atmospheric constituents in the mesosphere, and surface pressure have been noted in the draft report as requiring further research for the development of routine monitoring capabilities from space.

**ECVs for which satellite observations make a significant contribution  
(Source: *Draft Satellite Supplement*  
to the in 2010 updated GCOS Implementation Plan)**

Domain	Essential Climate Variables
<b>Atmospheric</b> (over land,	Surface wind speed and direction, Precipitation, Upper-air temperature, Upper-air wind speed and direction, Water vapour, Cloud properties, Earth radiation budget (including solar irradiance), Carbon dioxide, Methane, and other long-lived greenhouse gases, Ozone and Aerosol properties, supported by their precursors.

<sup>1</sup> Parties in the context of this report are signatory countries of the UNFCCC.

sea and ice)	
<b>Oceanic</b>	Sea-surface temperature, Sea-surface salinity, Sea level, Sea state, Sea ice, Ocean colour.
<b>Terrestrial</b>	Lakes, Snow cover, Glaciers and ice caps, Ice sheets, Albedo, Land cover (including vegetation type), Fraction of absorbed photosynthetically active radiation (FAPAR), Leaf area index (LAI), Above-ground biomass, Fire disturbance, Soil moisture.

The table in the Annex 1 shows the number of actions as identified in the draft satellite supplement to the 2010 updated GCOS Implementation Plan in relation to CGMS working groups.

Annex 2 is provided as background information. This document lists all actions from the 2010 updated GCOS Implementation Plan in which space agencies, CEOS and/or CGMS are listed as "Agents for Implementation".

### 3 CONCLUSIONS

The analysis of the information which was provided to the satellite supplement is showing that CGMS as the general body is identified as agent for implementation for the ECVs: Sea Ice, Sea Level, SST, Sea State, Snow cover, Biomass, Soil moisture, Ice sheets, Lakes, Land cover, ERB, GHGs, Ozone, Precursors.

For the following ECVs dedicated CGMS working groups could be identified: Surface Wind, Precipitation, UA Temp, UA Wind, Water Vapour, Cloud Properties, Aerosols, FAPAR, LAI and Fire Disturbance.

CGMS is not addressing Sea Surface Salinity, Ocean Colour and Glaciers/ Ice Caps. Those ECVs are addressed by CEOS and its dedicated working groups.

It is recommended that CGMS members review Annex 1.



Annex 1

Number of actions upon a specific ECV / Responsible agent for implementation*		Surface Wind	Precip	UA Temp	UA Wind	Water Vapour	Clouds	ERB	GHG	O3	Aerosols	Precip	SST	SL	SS	SS	SS	Sea Ice	Sea Level	Lakes	Snow Cover	Glaciers	Land Use	FAPAR	LAI	Biomass	Fire
<b>CGMS</b>	Sea Ice, Sea Level, SST, Sea State, Snow cover, Biomass, Soil moisture, Ice sheets, Lakes, Land cover, ERB, GHGs, Ozone, Precursors						1	1	1			1	1	1		1	1		1	1		1				1	
Working Group II Satellite products																											
1.International ATOVS working group (ITWG), which organizes the International TOVS Study Conferences (ITSC)				1		1	1																				
2.International Radio Occultation Working Group (IROWG)				1																							
3.International Precipitation Working Group (IPWG)			1																								
4.International Satellite Winds Working Group (IWWG)		1			1																						
Working Group III Contingency Planning																											
Initiatives: SCOPE-CM - Sustained, Co-Ordinated Processing of Environmental Satellite Data for Climate Monitoring		1	1		1	1	1				1													1			
Initiatives: GSICS - Global Space-based Inter-Calibration System			1	1																				1	1	1	1
<b>Total actions</b>		<b>2</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>

	ECV is covered by a specific "agent for implementation", i.e. ,a CGMS working group or dedicated project or programme
	ECV is covered by CGMS in general, but the Satellite Supplement did not specify a dedicated group
	ECV is covered by "space agencies", but the Satellite Supplement did not identify neither the principle body, i.e., CEOS or CGMS, nor a dedicated programme or project

## IMPLEMENTATION PLAN FOR THE GLOBAL OBSERVING SYSTEM FOR CLIMATE IN SUPPORT OF THE UNFCCC (2010 Update)

### List of Actions and 'Agents for Implementation' for which the 'Agents' are Space Agencies, CGMS, or CEOS

#### Action C8 [IP-04 C10]

**Action:** Ensure continuity and over-lap of key satellite sensors; recording and archiving of all satellite metadata; maintaining appropriate data formats for all archived data; providing data service systems that ensure accessibility; undertaking reprocessing of all data relevant to climate for inclusion in integrated climate analyses and reanalyses, undertaking sustained generation of satellite-based ECV products.

**Who:** Space agencies and satellite data reprocessing centres.

**Time-Frame:** Continuing, of high priority.

**Performance Indicator:** Continuity and consistency of data records.

**Annual Cost Implications:** Covered in the domains.

#### Action C21

**Action:** Implement modern distributed data services, drawing on the experiences of the WIS as it develops, with emphasis on building capacity in developing countries and countries with economies in transition, both to enable these countries to benefit from the large volumes of data available world-wide and to enable these countries to more readily provide their data to the rest of the world.

**Who:** Parties' national services and space agencies for implementation in general, and Parties through their support of multinational and bilateral technical cooperation programmes, and the GCOS Cooperation Mechanism.

**Time-Frame:** Continuing, with particular focus on the 2011-2014 time period.

**Performance Indicator:** Volumes of data transmitted and received by countries and agencies.

**Annual Cost Implications:** 30-100M US\$ (90% in non-Annex-I Parties).

#### Action A8

**Action:** Ensure continuity of satellite precipitation products.

**Who:** Space agencies.

**Time-Frame:** Continuous.

**Performance Indicator:** Long-term homogeneous satellite-based global precipitation products.

**Annual Cost Implications:** 10-30M US\$ (for generation of climate products, assuming missions funded for other operational purposes) (Mainly by Annex-I Parties).

#### Action A11<sup>2</sup> [IP-04 A11]

**Action:** Ensure continuous generation of wind-related products from AM and PM satellite scatterometers or equivalent observations.

**Who:** Space agencies.

**Time-Frame:** Continuous.

**Performance Indicator:** Long-term satellite observations of surface winds every six hours.

**Annual Cost Implications:** 1-10M US\$ (Mainly by Annex-I Parties).

#### Action A19

**Action:** Implement and evaluate a satellite climate calibration mission, e.g., CLARREO.

**Who:** Space agencies (e.g., NOAA, NASA, etc).

**Time-Frame:** Ongoing.

**Performance Indicator:** Improved quality of satellite radiance data for climate monitoring.

**Annual Cost Implications:** 100-300M US\$ (Mainly by Annex-I Parties).

<sup>2</sup> See also Action O19.

**Action A20** [A19 IP-04]

**Action:** Ensure the continued derivation of MSU-like radiance data, and establish FCDRs from the high-resolution IR sounders, following the GCMPs.  
**Who:** Space agencies.  
**Time-Frame:** Continuing.  
**Performance Indicator:** Quality and quantity of data; availability of data and products.  
**Annual Cost Implications:** 1-10M US\$ (for generation of datasets, assuming missions, including overlap and launch-on-failure policies, are funded for other operational purposes) (Mainly by Annex-I Parties).

**Action A21** [A20 IP-04]

**Action:** Ensure the continuity of the constellation of GNSS RO satellites.  
**Who:** Space agencies.  
**Time-Frame:** Ongoing; replacement for current COSMIC constellation needs to be approved urgently to avoid or minimise a data gap.  
**Performance Indicator:** Volume of data available and percentage of data exchanged.  
**Annual Cost Implications:** 10-30M US\$ (Mainly by Annex-I Parties).

**Action A23** [IP-04 A22]

**Action:** Continue the climate data record of visible and infrared radiances, e.g., from the International Satellite Cloud Climatology Project, and include additional data streams as they become available; pursue reprocessing as a continuous activity taking into account lessons learnt from preceding research.  
**Who:** Space agencies, for processing.  
**Time-Frame:** Continuous.  
**Performance Indicator:** Long-term availability of global homogeneous data at high frequency.  
**Annual Cost Implications:** 10-30M US\$ (for generation of datasets and products) (Mainly by Annex-I Parties).

**Action A24** [IP-04 A23]

**Action:** Research to improve observations of the three-dimensional spatial and temporal distribution of cloud properties.  
**Who:** Parties' national research and space agencies, in cooperation with the WCRP.  
**Time-Frame:** Continuous.  
**Performance Indicator:** New cloud products.  
**Annual Cost Implications:** 30-100M US\$ (Mainly by Annex-I Parties).

**Action A25** [IP-04 A24]

**Action:** Ensure continuation of Earth Radiation Budget observations, with at least one dedicated satellite mission operating at any one time.  
**Who:** Space agencies.  
**Time-Frame:** Ongoing.  
**Performance Indicator:** Long-term data availability at archives.  
**Annual Cost Implications:** 30-100M US\$ (Mainly by Annex-I Parties).

**Action A26**

**Action:** Establish long-term limb-scanning satellite measurement of profiles of water vapour, ozone and other important species from the UT/LS up to 50 km.  
**Who:** Space agencies, in conjunction with WMO GAW.  
**Time-Frame:** Ongoing, with urgency in initial planning to minimize data gap.  
**Performance Indicator:** Continuity of UT/LS and upper stratospheric data records.  
**Annual Cost Implications:** 100-300M US\$ (including mission costs) (Mainly by Annex-I Parties).

**Action A27**

**Action:** Establish a network of ground stations (MAXDOAS, lidar, FTIR) capable of validating satellite remote sensing of the troposphere.  
**Who:** Space agencies, working with existing networks and environmental protection agencies.  
**Time-Frame:** Urgent.  
**Performance Indicator:** Availability of comprehensive validation reports and near real-time monitoring based on the data from the network.  
**Annual Cost Implications:** 10-30M US\$ (30% in non-Annex-I Parties).

**Action A28** [IP-04 A27]

**Action:** Maintain and enhance the WMO GAW Global Atmospheric CO<sub>2</sub> and CH<sub>4</sub> Monitoring Networks as major contributions to the GCOS Comprehensive Networks for CO<sub>2</sub> and CH<sub>4</sub>.  
**Who:** Parties' national services, research agencies, and space agencies, under the guidance of WMO GAW and its Scientific Advisory Group for Greenhouse Gases, in cooperation with the AOPC.  
**Time-Frame:** Ongoing.  
**Performance Indicator:** Dataflow to archive and analyses centres.  
**Annual Cost Implications:** 10-30M US\$ (50% in non-Annex-I Parties).

**Action A29**

**Action:** Assess the value of the data provided by current space-based measurements of CO<sub>2</sub> and CH<sub>4</sub>, and develop and implement proposals for follow-on missions accordingly.  
**Who:** Parties' research institutions and space agencies.  
**Time-Frame:** Urgent, to minimise data gap following GOSAT.  
**Performance Indicator:** Assessment and proposal documents; approval of consequent missions.  
**Annual Cost Implications:** 1-10M US\$ initially, increasing with implementation (10% in non-Annex-I Parties).

**Action A32**

**Action:** Continue production of satellite ozone data records (column, tropospheric ozone and ozone profiles) suitable for studies of interannual variability and trend analysis. Reconcile residual differences between ozone datasets produced by different satellite systems.  
**Who:** Space agencies.  
**Time-Frame:** Ongoing.  
**Performance Indicator:** Statistics on availability and quality of data.  
**Annual Cost Implications:** 10-30M US\$ (Mainly by Annex-I Parties).

**Action A33 [IP-04 A31]**

**Action:** Develop and implement a coordinated strategy to monitor and analyse the distribution of aerosols and aerosol properties. The strategy should address the definition of a GCOS baseline network or networks for *in situ* measurements, assess the needs and capabilities for operational and research satellite missions for the next two decades, and propose arrangements for coordinated mission planning.  
**Who:** Parties' national services, research agencies and space agencies, with guidance from AOPC and in cooperation with WMO GAW and AERONET.  
**Time-Frame:** Ongoing, with definition of baseline *in situ* components and satellite strategy by 2011.  
**Performance Indicator:** Designation of GCOS baseline network(s). Strategy document, followed by implementation of strategy.  
**Annual Cost Implications:** 10-30M US\$ (20% in non-Annex-I Parties).

**Action A34**

**Action:** Ensure continuity of products based on space-based measurement of the precursors (NO<sub>2</sub>, SO<sub>2</sub>, HCHO and CO in particular) of ozone and aerosols and derive consistent emission databases, seeking to improve temporal and spatial resolution.  
**Who:** Space agencies, in collaboration with national environmental agencies and meteorological services.  
**Time-Frame:** Requirement has to be taken into account now in mission planning, to avoid a gap in the 2020 timeframe.  
**Performance Indicator:** Availability of the necessary measurements, appropriate plans for future missions, and derived emission data bases.  
**Annual Cost Implications:** 10-30M US\$ (10% in non-Annex-I Parties).

**Action O4 [IP-04 O7]**

**Action:** Ensure coordination of contributions to CEOS Virtual Constellations for each ocean surface ECV, in relation to *in situ* ocean observing systems.  
**Who:** Space agencies, in consultation with CEOS Virtual Constellation teams, JCOMM, and GCOS.  
**Time-Frame:** Continuous.  
**Performance Indicators:** Annually updated charts on adequacy of commitments to space-based ocean observing system from CEOS.  
**Annual Cost Implications:** <1M US\$ (Mainly by Annex-I Parties and implementation cost covered in Actions below).

**Action O7 [IP-04 O9]**

**Action:** Continue the provision of best possible SST fields based on a continuous coverage-mix of polar orbiting IR and geostationary IR measurements, combined with passive microwave coverage, and appropriate linkage with the comprehensive *in situ* networks noted in O8.  
**Who:** Space agencies, coordinated through CEOS, CGMS, and WMO Space Programme.  
**Time-Frame:** Continuing.  
**Performance Indicator:** Agreement of plans for maintaining a CEOS Virtual Constellation for SST.  
**Annual Cost Implications:** 1-10M US\$ (for generation of datasets) (Mainly by Annex-I Parties).

**Action O10 [IP-04 O12]**

**Action:** Ensure continuous coverage from one higher-precision, medium-inclination altimeter and two medium-precision, higher-inclination altimeters.  
**Who:** Space agencies, with coordination through the CEOS Constellation for Ocean Surface Topography, CGMS, and the WMO Space Programme.  
**Time-Frame:** Continuous.  
**Performance Indicator:** Satellites operating, and provision of data to analysis centres.  
**Annual Cost Implications:** 30-100M US\$ (Mainly by Annex-I Parties).

**Action O12 [IP-04 O16]**

**Action:** Research programmes should investigate the feasibility of utilizing satellite data to help resolve global fields of SSS.  
**Who:** Space agencies, in collaboration with the ocean research community.  
**Time-Frame:** Feasibility studies complete by 2014.  
**Performance Indicator:** Reports in literature and to OOPC.  
**Annual Cost Implications:** 1-10M US\$ (Mainly by Annex-I Parties).

**Action O15 [IP-04 O18]**



**Action:** Implement continuity of ocean colour radiance datasets through the plan for an Ocean Colour Radiometry Virtual Constellation.

**Who:** CEOS space agencies, in consultation with IOCCG and GEO.

**Time-Frame:** Implement plan as accepted by CEOS agencies in 2009.

**Performance Indicator:** Global coverage with consistent sensors operating according to the GCMPs; flow of data into agreed archives.

**Annual Cost Implications:** 30-100M US\$ (10% in non-Annex-I Parties).



**Action O19** [IP-04 O23]

**Action:** Ensure sustained satellite-based (microwave, SAR, visible and IR) sea-ice products.  
**Who:** Parties' national services, research programmes and space agencies, coordinated through the WMO Space Programme and Global Cryosphere Watch, CGMS, and CEOS; National services for *in situ* systems, coordinated through WCRP CliC and JCOMM.  
**Time-Frame:** Continuing.  
**Performance Indicator:** Sea-ice data in International Data Centres.  
**Annual Cost Implications:** 1-10M US\$ (Mainly by Annex-I Parties).

**Action O20** [IP-04 O21]

**Action:** Document the status of global sea-ice analysis and reanalysis product uncertainty (via a quantitative summary comparison of sea-ice products) and to prepare a plan to improve the products.  
**Who:** Parties' national agencies, supported by WCRP CliC and JCOMM Expert Team on Sea Ice (ETSI).  
**Time-Frame:** By end of 2011.  
**Performance Indicators:** Peer-reviewed articles on state of sea-ice analysis uncertainty; Publication of internationally-agreed strategy to reduce uncertainty.  
**Annual Cost Implications:** <1M US\$ (Mainly Annex-I Parties).

**Action O28** [IP-04 O29]

**Action:** Develop projects designed to assemble the *in situ* and satellite data into a composite reference reanalysis dataset, and to sustain projects to assimilate the data into models in ocean reanalysis projects.  
**Who:** Parties' national ocean research programmes and space supported by WCRP.  
**Time-Frame:** Continuous.  
**Performance Indicator:** Project for data assembly launched, availability and scientific use of ocean reanalysis products.  
**Annual Cost Implications:** 1-10M US\$ (10% in non-Annex-I Parties).

**Action O41** [IP-04 O3]

**Action:** Promote and facilitate research and development (new improved technologies in particular), in support of the global ocean observing system for climate.  
**Who:** Parties' national ocean research programmes and space agencies, in cooperation with GOOS, GCOS, and WCRP.  
**Time-Frame:** Continuing.  
**Performance Indicator:** More cost-effective and efficient methods and networks; strong research efforts related to the observing system; number of additional ECVs feasible for sustained observation; improved utility of ocean climate products.  
**Annual Cost Implications:** 30-100M US\$ (10% in non-Annex-I Parties).

**Action T5**

**Action:** Develop an experimental evaporation product from existing networks and satellite observations.  
**Who:** Parties, national services, research groups through GTN-H, IGWCO, TOPC, GEWEX Land Flux Panel and WCRP CliC.  
**Time frame:** 2013-2015.  
**Performance indicator:** Availability of a validated global satellite product of total evaporation.  
**Annual Cost Implications:** 1-10M US\$ (10% in non-Annex-I Parties).

**Action T8** [IP-04 T6]

**Action:** Submit weekly/monthly lake level/area data to the International Data Centre; submit weekly/monthly altimeter-derived lake levels by space agencies to HYDROLARE.  
**Who:** National Hydrological Services through WMO CHy, and other institutions and agencies providing and holding data; space agencies; HYDROLARE.  
**Time-Frame:** 90% coverage of available data from GTN-L by 2012.  
**Performance Indicator:** Completeness of database.  
**Annual Cost Implications:** 1-10M US\$ (40% in non-Annex-I Parties).

**Action T10** [IP-04 T8]

**Action:** Submit weekly surface and sub-surface water temperature, date of freeze-up and date of break-up of lakes in GTN-L to HYDROLARE.  
**Who:** National Hydrological Services and other institutions and agencies holding and providing data; space agencies.  
**Time-frame:** Continuous.  
**Performance Indicator:** Completeness of database  
**Annual Cost Implications:** <1M US\$ (40% in non-Annex-I Parties).

**Action T13**

**Action:** Develop a record of validated globally-gridded near-surface soil moisture from satellites.  
**Who:** Parties' national services and research programmes, through GEWEX and TOPC in collaboration with space agencies.  
**Time frame:** 2014.  
**Performance indicator:** Availability of globally validated soil moisture products from the early satellites until now.  
**Annual Cost Implications:** 1-10M US\$ (10% in non-Annex-I Parties).

**Action:** Develop Global Terrestrial Network for Soil Moisture (GTN-SM).  
**Who:** Parties' national services and research programmes, through IGWCO, GEWEX and TOPC in collaboration with space agencies.  
**Time frame:** 2014.  
**Performance indicator:** Fully functional GTN-SM with a set of *in situ* observations (possibly co-located with reference network, cf. T3), with standard measurement protocol and data quality and archiving procedures.  
**Annual Cost Implications:** 1-10M US\$ (40% in non-Annex-I Parties).

**Action T16** [IP-04 T11]

**Action:** Obtain integrated analyses of snow cover over both hemispheres.  
**Who:** Space agencies and research agencies in cooperation with WMO GCW and CliC, with advice from TOPC, AOPC and IACS  
**Time-Frame:** Continuous.  
**Performance Indicator:** Availability of snow-cover products for both hemispheres.  
**Annual Cost Implications:** 1-10M US\$ (Mainly by Annex-I Parties).

**Action T20** [IP-04 T14]

**Action:** Ensure continuity of laser, altimetry, and gravity satellite missions adequate to monitor ice masses over decadal timeframes.  
**Who:** Space agencies, in cooperation with WCRP CliC and TOPC.  
**Time-Frame:** New sensors to be launched: 10-30 years.  
**Performance Indicator:** Appropriate follow-on missions agreed.  
**Annual Cost Implications:** 30-100M US\$ (Mainly by Annex-I Parties).

**Action T23** [IP-04 T17]

**Action:** Implement operational mapping of seasonal soil freeze/thaw through an international initiative for monitoring seasonally-frozen ground in non-permafrost regions.  
**Who:** Parties, space agencies, national services, and NSIDC, with guidance from International Permafrost Association, the IGOS Cryosphere Theme team, and WMO GCW.  
**Time-Frame:** Complete by 2013.  
**Performance Indicator:** Number and quality of mapping products published.  
**Annual Cost Implications:** 1-10M US\$ (10% in non-Annex-I Parties).

**Action T24** [IP-04 T19]

**Action:** Obtain, archive and make available *in situ* calibration/validation measurements and co-located albedo products from all space agencies generating such products; promote benchmarking activities to assess the quality and reliability of albedo products.  
**Who:** Space agencies in cooperation with CEOS WGCV.  
**Time-Frame:** Full benchmarking/intercomparison by 2012.  
**Performance Indicator:** Publication of inter-comparison/validation reports.  
**Annual Cost Implications:** 1-10M US\$ (20% in non-Annex-I Parties).

**Action T25** [IP-04 T21]

**Action:** Implement globally coordinated and linked data processing to retrieve land surface albedo from a range of sensors on a daily and global basis using both archived and current Earth Observation systems.  
**Who:** Space agencies, through the CGMS and WMO Space Programme.  
**Time-Frame:** Reprocess archived data by 2012, then generate continuously.  
**Performance Indicator:** Completeness of archive.  
**Annual Cost Implications:** 1-10M US\$ (Mainly by Annex-I Parties)

**Action T27** [IP-04 T26]

**Action:** Generate annual products documenting global land-cover characteristics and dynamics at resolutions between 250 m and 1 km, according to internationally-agreed standards and accompanied by statistical descriptions of their accuracy.  
**Who:** Parties' national services, research institutes and space agencies in collaboration with GLCN and GOF-C-GOLD research partners and the GEO Forest Carbon Tracking task team.  
**Time-Frame:** By 2011, then continuously.  
**Performance Indicator:** Dataset availability.  
**Annual Cost Implications:** 1-10M US\$ (20% in non-Annex-I Parties).

**Action T28** [IP-04 T27]

**Action:** Generate maps documenting global land cover based on continuous 10-30 m land surface imager radiances every 5 years, according to internationally-agreed standards and accompanied by statistical descriptions of their accuracy.  
**Who:** Space agencies, in cooperation with GCOS, GTOS, GOF-C-GOLD, GLCN, and other members of CEOS.  
**Time-Frame:** First by 2012, then continuously.  
**Performance Indicator:** Availability of operational plans, funding mechanisms, eventually maps.  
**Annual Cost Implications:** 10-30M US\$ (20% in non-Annex-I Parties).

**Action T29** [IP-04 T29]<sup>3</sup>

**Action:** Establish a calibration/validation network of *in situ* reference sites for FAPAR and LAI and conduct systematic, comprehensive evaluation campaigns to understand and resolve differences between the products and increase their accuracy.  
**Who:** Parties' national and regional research centres, in cooperation with space agencies coordinated by CEOS WGCV, GCOS and GTOS.  
**Time-Frame:** Network operational by 2012.  
**Performance Indicator:** Data available to analysis centres.  
**Annual Cost Implications:** 1-10M US\$ (40% in non-Annex-I Parties).

**Action T30** [IP-04 T30]

**Action:** Evaluate the various LAI satellite products and benchmark them against *in situ* measurements to arrive at an agreed operational product.  
**Who:** Parties' national and regional research centres, in cooperation with space agencies and CEOS WGCV, GCOS/TOPC, and GTOS.  
**Time-Frame:** Benchmark by 2012.  
**Performance Indicator:** Agreement on operational product.  
**Annual Cost Implications:** 1-10M US\$ (10% in non-Annex-I Parties).

**Action T31** [IP-04 T28]

**Action:** Operationalize the generation of FAPAR and LAI products as gridded global products at spatial resolution of 2 km or better over time periods as long as possible.  
**Who:** Space agencies, coordinated through CEOS WGCV, with advice from GCOS and GTOS.  
**Time-Frame:** 2012.  
**Performance Indicator:** One or more countries or operational data providers accept the charge of generating, maintaining, and distributing global FAPAR products.  
**Annual Cost Implications:** 10-30M US\$ (10% in non-Annex-I Parties).

**Action T32**

**Action:** Develop demonstration datasets of above ground biomass across all biomes.  
**Who:** Parties, space agencies, national institutes, research organizations, FAO in association with GTOS, TOPC, and the GOF-C-GOLD Biomass Working Group.  
**Time frame:** 2012.  
**Performance Indicator:** Availability of global gridded estimates of above ground biomass and associated carbon content.  
**Annual Cost Implications:** 1-10M US\$ (20% in non-Annex-I Parties).

**Action T34**

**Action:** Develop globally gridded estimates of terrestrial carbon flux from *in situ* observations and satellite products and assimilation/inversions models.  
**Who:** Reanalysis centres and research organisations, in association with national institutes, space agencies, and FAO/GTOS (TCO and TOPC).  
**Time Frame:** 2014-2019.  
**Performance indicator:** Availability of data assimilation systems and global time series of maps of various terrestrial components of carbon exchange (e.g., GPP, NEP, and NBP).  
**Annual Cost Implications:** 10-30M US\$ (Mainly by Annex-I Parties).

<sup>3</sup> See Action T3.

**Action T35** [IP-04 T32]

**Action:** Reanalyse the historical fire disturbance satellite data (1982 to present).  
**Who:** Space agencies, working with research groups coordinated by GOFC-GOLD.  
**Time-Frame:** By 2012.  
**Performance Indicator:** Establishment of a consistent dataset, including the globally available 1 km AVHRR data record.  
**Annual Cost Implications:** 1-10M US\$ (Mainly by Annex-I Parties).

**Action T36** [IP-04 T33]

**Action:** Continue generation of consistent burnt area, active fire, and FRP products from low orbit satellites, including version intercomparisons to allow un-biased, long-term record development.  
**Who:** Space agencies, in collaboration with GOFC-GOLD.  
**Time-Frame:** Continuous.  
**Performance Indicator:** Availability of data.  
**Annual Cost Implications:** 1-10M US\$ (Mainly by Annex-I Parties).

**Action T37** [IP-04 T34]

**Action:** Develop and apply validation protocol to fire disturbance data.  
**Who:** Space agencies and research organizations.  
**Time-Frame:** By 2012.  
**Performance Indicator:** Publication of accuracy statistics.  
**Annual Cost Implications:** 1-10M US\$ (Mainly by Annex-I Parties)

**Action T39**

**Action:** Develop set of active fire and FRP products from the global suite of operational geostationary satellites.  
**Who:** Through operators of geostationary systems, via CGMS, GSICS, and GOFC-GOLD.  
**Time-Frame:** Continuous.  
**Performance Indicator:** Availability of products.  
**Annual Cost Implications:** 1-10M US\$ (Mainly by Annex-I Parties).