**ANNEX A: ECV product requirement tables**

This Annex presents requirements for the ECV products for all ECVs in this Implementation Plan. As these requirements are for products, they are independent of the observational method, whether mainly satellite or in situ. GCOS recognizes that these requirements have not been always well described, especially for in situ-based observations and observations needed for adaptation, and there are actions in this Implementation Plan to refine the list before the end of 2017 and then to maintain it as needs and observational capacities change.

These requirements follow on from, and update, previous product requirements provided for satellite-based ECV products in the GCOS satellite supplements to the Implementation Plans for 2004 and 2010.[[1]](#footnote-1) The requirements contained in these supplements have been of considerable importance for satellite data providers. They have proved extremely effective in accelerating implementation initiatives by these communities both through concerted efforts, globally, for coordination (i.e. the CEOS-CGMS Working Group on Climate,[[2]](#footnote-2) as well as in the definition and implementation of dedicated programmes at the level of individual space agencies (e.g. ESA’s CCI programme[[3]](#footnote-3)).

Whilst the value of these supplements is clear, the delay introduced by their preparation and the corresponding response from space agencies, resulted in some inefficiencies: space agencies were only able to provide a combined response to the Implementation Plan and Satellite Supplement shortly before the GCOS review, the Status Report, was written, leaving little time for implementation.

This Implementation Plan therefore includes the core component of the previous supplements (i.e. the ECV product requirements themselves) and extends them to cover all ECVs. This will allow a better review of whether or not the observing systems are achieving their goals and will align the reviews with the overall GCOS review cycle and reporting to the UNFCCC. Merging the ECV product requirements with the Implementation Plan itself has additional advantages such as a more direct and traceable link between the Implementation Plan actions and the product requirements (i.e. where an action is proposed to improve the accuracy of a product).

By no means is this intended to undermine the importance of data providers (e.g. WMO, GOOS and the space agencies) in supporting the implementation of GCOS. On the contrary, it should be seen as for a key step towards improved and consistent reporting to SBSTA.

This addition of requirements for in situ-based ECV products is more complicated, due to the greater fragmentation of the communities with the relevant knowledge. In this Annex, an attempt is made to provide a first coherent and exhaustive representation of ECV product requirements but further consultations with the user communities are needed to ensure that these values better represent their needs and not just observational system capabilities. Action G10 is included in the Implementation Plan to further consolidate and refine these requirements over the course of the next Implementation Plan cycle.

The ECV products requirements in this Annex should be considered target requirements, i.e. requirements that data providers should aim to achieve over the next 10 years. Annex B provides an explanation of some of the terms used in this annex.

NOTES:

1. The required measurement uncertainties are presented as 95% confidence intervals (approximately two standard deviations);[[4]](#footnote-4)
2. Stability is quoted per decade, unless otherwise indicated;
3. Resolution is horizontal resolution where one value is quoted.
4. **Atmospheric ECV product requirements.**

| **Atmospheric ECV product requirements** | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ECV | Product | Frequency | Resolution | Required measurement uncertainty | Stability (per decade) | Standards/ references | Entity (see Part II, section 2.2)[[5]](#footnote-5) | |
| Satellite | In situ |
| Surface wind  speed and direction | Surface wind speed and direction | 3 h | 10 km/NA | 0.5 m/s and mean quadratic statistics to 10% of the locally prevailing mean wind speed, for speed >20 m/s | 0.05 m/s/decade | For stability: International Vector Winds Science Team Meeting (M. Bourassa) | WGClimate | WIGOS |
| Precipitation | Estimates of liquid and solid precipitation | Monthly (resolving diurnal cycles and with statistics of three-hour values) | 25 km/NA | 0.5 mm/h | 0.02 mm/decade | CMSAF requirements related to the HOAPS release 4.0 (CM-12611) | WGClimate | WIGOS |
| Temperature  (surface) |  | Hourly | Site | 0.1 K | 0.02 K/decade | P. Jones |  | WIGOS |
| Daily Tx/Tn | 0.1 K |  | WIGOS |
| Pressure (surface) |  | Hourly | Site | 0.1 hPa | 0.02 hPa/decade | P. Jones |  | WIGOS |
| Water vapour  (surface) |  | Hourly | Site | RH 1%  DP 0.1 K | 0.5%/decade  0.02 K/decade | Kate Willet |  | WIGOS |
| Temperature  (upper-air) | Tropospheric temperature profile | 4 h | 25 km/1 km | 0.5 K | 0.05 K |  | WGClimate | WIGOS |
| Stratospheric remperature profile | 4 h | 100 km/2 km | 0.5 K | 0.05 K |  | WGClimate | WIGOS |
| Temperature of deep atmospheric layers | Monthly averages | 100 km/5 km | 0.2 K | 0.02 K |  | WGClimate | WIGOS |
| Wind speed and direction (upper-air) | Upper-air wind retrievals | 1 h | 10 km/0.5 km | 2m/s, 20° | 0.5m/s, 5° |  | WGClimate | WIGOS |

| **Atmospheric ECV product requirements** | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ECV | Product | Frequency | Resolution | Required measurement uncertainty | Stability (per decade) | Standards/ references | Entity (see Part II, section 2.2)[[6]](#footnote-6) | |
| Satellite | In situ |
| Earth radiation budget | Top-of-atmosphere ERB long-wave | Monthly (resolving diurnal cycle) | 100 km/NA | Requirements on global mean: 1 W/m2 | 0.2 W/m2/decade | NOAA Tech. Rep. NESDIS 134 | WGClimate |  |
| Top-of-atmosphere ERB short-wave (reflected) | Monthly (resolving diurnal cycle) | 100 km/NA | Requirements on global mean: 1.0 W/m2 | 0.3W/m2/decade | NOAA Tech. Rep. NESDIS 134 | WGClimate |  |
| Total solar irradiance | Daily | NA/NA | 0.035% | 0.01%/decade |  | WGClimate |  |
| Solar spectral irradiance | Daily | Spectral resolution:  1 nm < 290 nm  2 nm (290–1 000 nm)  5 nm (1 000–1 600 nm)  10 nm (1 600–3 200 nm)  20 nm (3 200-6 400 nm)  40 nm (6 400-10 020)  20 000 nm (spacing up to 160 000 nm) | 0.3% (200–2400 nm) | 1%(200–2 400 nm/ decade |  | WGClimate | WIGOS |

| **Atmospheric ECV product requirements** | | | | | | | | | |
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| ECV | Product | | Frequency | Resolution | Required measurement uncertainty | Stability (per decade) | Standards/ references | Entity (see Part II, section 2.2)[[7]](#footnote-7) | |
| Satellite | In situ |
| Surface radiation budget | Surface ERB long-wave | | Monthly (resolving diurnal cycle) | 100 km/NA | Requirements on global mean: 1 W/m2 | 0.2W/m2/decade |  | WGClimate | WIGOS |
| Surface ERB short-wave | | Monthly(resolving diurnal cycle) | 100km/NA | Requirements on global mean: 1 W/m2 | 0.2 W/m2/decade |  | WGClimate | WIGOS |
| Water vapour | Total column water vapour | | 4 h | 25 km/NA | 2% | 0.3% |  | WClimate |  |
| Tropospheric and lower-stratospheric profiles of water vapour | | 4 h (troposphere),  daily (stratosphere) | 25 km/2 km  100–200 km/2 km | 5% | 0.3% |  | WGClimate |  |
| Upper tropospheric humidity | | Hourly | 25 km/NA | 5% | 0.3% |  | WGClimate |  |
| Cloud properties | Cloud amount | 3 h | | 50 km/NA | 0.01–0.05 | 0.01/decade | ESA CCI CMUG tables  (http://www.esa-cmug-cci.org/) | WGClimate |  |
| Cloud-top pressure | 3 h | | 50 km/NA | 15–50h Pa | 3–15 hPa |  | WGClimate |  |
| Cloud-top temperature | 3 h | | 50 km/NA | 1–5 K | 0.25 K/decade |  | WGClimate |  |
| Cloud optical depth | 3 h | | 50 km/NA | 10% | 2% |  | WGClimate |  |
| Cloud water path (liquid and ice) | 3 h | | 50 km/NA | 25% | 5% |  |  |  |
| Cloud effective particle radius (liquid + ice) | 3 h | | 50 km/NA | 1 µm; | 1 µm/decade |  |  |  |
| Lightning |  | Daily | | 10 km |  |  | MTG EURD[[8]](#footnote-8) | WGClimate | WIGOS |
| **Atmospheric ECV product requirements** | | | | | | | | | |
| ECV | Product | Frequency | | Resolution | Required measurement uncertainty | Stability (per decade) | Standards/ references | Entity (see Part II, section 2.2)[[9]](#footnote-9) | |
| Satellite | In situ |
| Carbon dioxide,  Methane and other greenhouse[[10]](#footnote-10)  gases | Tropospheric CO2 column | 4 h | | 5–10 km/NA | 1 ppm | 1.5 ppm/decade | ESA CCI CMUG tables  (<http://www.esa-cmug-cci.org/>) | WGClimate |  |
| Tropospheric CO2 | 4 h | | 5–10 km/5 km | 1 ppm | 1.5 ppm |  |  | GAW |
| Tropospheric CH4 column | 4 h | | 5–10 km/NA | 10 ppb | 7 ppb |  | WGClimate |  |
| Tropospheric CH4 | 4 h | | 5–10 km/5 km | 0.5 ppb | 0.7 ppb |  |  | GAW |
| Stratospheric CH4 | Daily | | 100–200 km/2 km | 5% | 0.3% |  |  | GAW |
| Ozone93 | Total column ozone | 4 h | | 20–50 km/NA | Max (2%; 5 DU) | 1% |  | WGClimate |  |
| Troposphere ozone | 4 h | | 20–50 km/5 km | 10-15% | 2% |  | WGClimate | GAW |
| Ozone profile in upper and lower stratosphere | 4 h | | 100–200 km/1–2 km | 10% | 2% |  | WGClimate |  |
| Ozone profile in upper strato- and mesosphere | Daily | | 100–200 km/3 km | 5–20% | 2% |  | WGClimate |  |
| Precursors (supporting the aerosol and ozone ECVs)93 | NO2 tropospheric column | 4 h | | 5–10 km/NA | Max (20%, 0.03 DU) | 2% |  | WGClimate |  |
| SO2,HCHO tropospheric columns | 4 h | | 5–10 km/NA | Max (30%, 0.04 DU) | 5% |  | WGClimate |  |
| CO tropospheric column | 4 h | | 5–10 km/NA | Max (20%, 20 DU) | 2% |  | WGClimate |  |
| CO tropospheric profile | 4 h | | 10 km/5 km | 20% | 2% |  | WGClimate |  |

| **Atmospheric ECV product requirements** | | | | | | | | |
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| ECV | Product | Frequency | Resolution | Required measurement uncertainty | Stability (per decade) | Standards/ references | Entity (see Part II, section 2.2)[[11]](#footnote-11) | |
| Satellite | In situ |
| Aerosol properties | Aerosol optical depth | 4 h | 5–10 km/NA | Max (0.03; 10%) | 0.02/decade | ESA CCI CMUG tables  (<http://www.esa-cmug-cci.org/>) | WGClimate |  |
| Single-scattering albedo | 4 h | 5–10 km/NA | 0.03 | 0.01 |  | WGClimate |  |
| Aerosol-layer height | 4 h | 5–10 km/NA | 1 km | 0.5 km |  | WGClimate |  |
| Aerosol-extinction coefficient profile | Weekly | 200–500 km/1 km (near tropopause) 2 km (mid-stratosphere) | 10%, | 20% |  | WGClimate |  |

1. **Ocean ECV product requirements**

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| **Ocean ECV product requirements** | | | | | | | | |
| ECV | Products | Frequency | Resolution | Required measurement uncertainty | Stability (per decade unless otherwise specified) | Standards/ References | Entity (see Part II, section 2.2)[[12]](#footnote-12) | |
| Satellite | In situ |
| Sea-surface temperature | Sea-surface temperature | Hourly to weekly | 1–100 km | 0.1 K over 100-km scales | < 0.03 K over 100-km scales | See EOV Specification sheets  [www.goosocean.org/eov](http://www.goosocean.org/eov) | WGClimate | JCOMM |
| Subsurface temperature | Interior temperature | Hourly to monthly | 1–10 km | 0.01 K | Not specified |  | JCOMM |
| Sea-surface sSalinity | Sea-surface salinity | Hourly to monthly | 1–100 km | 0.01 psu | 0.001 psu | WGClimate | JCOMM |
| Subsurface salinity | Interior salinity | Hourly to monthly | 1–10 km | 0.01 psu | Not specified |  | JCOMM |
| Surface currents | Surface geostrophic current | Hourly to weekly | 30 km | 5 cm/s | Not specified | WGClimate | JCOMM |
| Subsurface curents | Interior currents | Hourly to weekly | 1–10 km | 0.02 m/s | Not specified |  | JCOMM |
| Sea level | Global mean sea level | Weekly to monthly | 10–100 km | 2–4 mm (global mean); 1  cm over a grid mesh | < 0.3 mm/yr (global mean) | WGClimate | JCOMM |
| Regional sea level | Hourly to weekly | 10 km | 1 cm (over grid mesh of 50–100 km) | < 1 mm/yr (for grid mesh of 50–100 km) | WGClimate | JCOMM |
| Sea state | Wave height | 3-hourly | 25 km | 10 cm | 5 cm | WGClimate | JCOMM |
| Surface stress | Surface stress | Hourly-monthly | 10–100 km | 0.001–4 Nm2 | Not specified |  | JCOMM |

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| **Ocean ECV product requirements** | | | | | | | | |
| ECV | Products | Frequency | Resolution | Required measurement uncertainty | Stability (per decade unless otherwise specified) | Standards/ References | Entity (see Part II, section 2.2)[[13]](#footnote-13) | |
| Satellite | In situ |
| Ocean-surface heat flux | Latent heat flux | Hourly to monthly | 1–25 km | 10–15 Wm2 | 1–2 Wm2 | See EOV Specification sheets  [www.goosocean.org/eov](http://www.goosocean.org/eov) |  | JCOMM |
| Sensible heat flux | Hourly to monthly | 1–25 km | 10–15 Wm2 | 1–2 Wm2 |  | JCOMM |
| Radiative heat flux | Hourly to monthly | 1–25 km | 10–15 Wm2 | 1–2 Wm2 |  | JCOMM |
| Sea ice | Sea-Ice concentration | Weekly | 1–15 km | 5% ice area fraction | 5% | WGClimate |  |
| Sea-ice extent/edge | Weekly | 1–5 km | 5 km | Unspecified | WGClimate |  |
| Sea-ice thickness | Monthly | 25 km | 0.1 m | Unspecified | WGClimate |  |
| Sea-ice drift | Weekly | 5 km | 1 km/day | Unspecified | WGClimate |  |
| Oxygen | Interior ocean oxygen concentration | Weekly to decadal | 3-20° degrees | 0.5 µmol–2 µmol |  |  | GOOS |
| Nutrients | Interior ocean concentrations of silicate, phosphate, nitrate | Decadal | Every 20° | PO4: ±0.05 (μmol)  NO3: ±0.03 (μmol)  Si: ±0.1 (μmol) |  |  | GOOS |
| Inorganic carbon | Interior ocean carbon storage. At least 2 of: DIC, TA or pH | Decadal | Every 20° | TA/DIC ± 2 μmol  pH ± 0.005 |  |  | GOOS |
| pCO2 (to provide air–sea flux of CO2) | Weekly to decadal | Every 10° (denser in the coastal domain, surface) | ±2 μatm |  |  | GOOS |

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| **Ocean ECV product requirements** | | | | | | | | |
| ECV | Products | Frequency | Resolution | Required measurement uncertainty | Stability (per decade unless otherwise specified) | Standards/ References | Entity (see Part II, section 2.2)[[14]](#footnote-14) | |
| Satellite | In situ |
| Transient tracers | Interior ocean CFC-12, CFC-11, SF6, tritium, 3He, 14C, 39Ar | Annual to decadal | Every 20° | CFCs and SF6 ±1% Tritium ±0.5%, 0.005 TU  δ3He ± 0.15%  14C ±0.4 % |  | See EOV Specification sheets  [www.goosocean.org/eov](http://www.goosocean.org/eov) |  | GOOS |
| Nitrous oxide | Interior ocean N2O | Annual to decadal | Every 20° | Discrete samples: ~± 5%;  cont. sampling: <± 1% |  |  | GOOS |
| N2O air–sea flux |  |  |  |
| Ocean colour | Water-leaving radiance | Daily | 4 km | 5% (blue and green wavelengths) | 0.5% | WGClimate |  |
| Chlorophyll-a concentration | Weekly averages | 4 km | 30% | 3% | WGClimate |  |
| Plankton | Phytoplankton | Requirements under assessment by GOOS Biology Panel | | | | |  | GOOS |
| Zooplankton |  | GOOS |
| Marine habitat Properties | Coral reefs,  mangrove forests, seagrass beds, Macroalgal Communities | TBD | GOOS |

1. **Terrestrial ECV product requirements**

| **Terrestrial ECV product requirements** | | | | | | | | |
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| ECV | Products | Frequency | Resolution | Required measurement uncertainty | Stability (per decade unless otherwise specified) | Standards/ References | Entity (see Part II, section 2.2)[[15]](#footnote-15) | |
| Satellite | In Situ |
| River discharge | River discharge | Daily | Per river | 10 % (relative) |  | ISO/TC 113: WMO (2010) WMO (2008(a)) WMO (2009) |  | WHYCOS |
| Water Level | Daily | 100 m | 10 cm | 1 cm/yr |  | WHYCOS |
| Flow velocity | Few times per year for station calibration | Per river | 10 % (relative) |  |  | WHYCOS |
| Cross-section | Few times per year for station calibration | Per river | 10 % (relative) |  |  | WHYCOS |
| Groundwater | Groundwater volume change | Monthly | 100 km | 10 cm | TBD | ISO/TC 147  ISO 5667-18:2001 part 18 |  | WHYCOS |
| Groundwater level | Weekly | Per well | 1 cm |  |  | WHYCOS |
| Groundwater recharge | Weekly | Per well | 10 % (relative) |  |  | WHYCOS |
| Groundwater discharge | Weekly | Per well | 10 % (relative) |  |  | WHYCOS |
| Wellhead level | Weekly | Per well | 1 cm |  |  | WHYCOS |
| Water quality | Weekly | Per well | TBD |  |  |  | TBD |
| Lakes | Lake water level | Daily | 100 m | 3 cm for large lakes,  10 cm for the remainder | 1 cm/decade | WMO (2006, 2008(a) | WGClimate | HYDROLARE |
| Water extent | Daily | 20 m | 10 % (relative)  5% (for 70 largest lakes) | 5%/decade | WGClimate | HYDROLARE |
| Lake surface-water temperature | Weekly | 300 m | 1 K | 0.1 K/decade | WGClimate | HYDROLARE |
| Lake-ice thickness | Monthly | 100m | 1–2 cm |  |  | WGClimate | HYDROLARE |
| Lake-ice cover | Daily | 300 m | 10 % | 1 % /decade |  | WGClimate | HYDROLARE |
| Lake colour (Lake water-leaving reflectance) | Weekly | 300 m | 30 % | 1 %/decade |  | WGClimate |  |

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| **Terrestrial ECV product requirements** | | | | | | | | |
| ECV | Products | Frequency | Resolution | Required measurement uncertainty | Stability (per decade unless otherwise specified) | Standards/ References | Entity (see Part II, section 2.2) | |
| Satellite | In Situ |
| Soil moisture | Surface soil moisture | Daily | 1–25 km | 0.04 m3/m3 | 0.01 m3/m3/year | WMO (2008(b)) | WGClimate | ISMN |
| Freeze/thaw | Daily | 1–25 km | 90 % | TBD |  | WGClimate | ISMN |
| Surface inundation | Daily | 1–25 km | 90 % | TBD |  |  | ISMN |
| Root-zone soil moisture | Daily | 1–25 km | 0.04 m3/m3 | 0.01 m3/m3/year |  |  | ISMN |
| Snow | Area covered by snow | Daily | 1 km (100 m in complex terrain) | 5% (maximum error of omission and commission in snow area); location accuracy better than 1/3 IFOV with target IFOV 100 m in areas of complex terrain, 1 km elsewhere | 4% (maximum error of omission and commission in snow area); location accuracy better than 1/3 IFOV with target IFOV 100 m in areas of complex terrain, 1 km elsewhere | WMO (2008(c)), IGOS (2007), IACS/UNESCO(2009) |  | WIGOS, GCW |
| Snow depth | Daily | 1 km (100 m in complex terrain) | 10 mm | 10 mm |  | WIGOS, GCW |
| Snow-water equivalent | Daily | 1 km | 10mm | 10 mm |  |  | WIGOS, GCW |
| Glaciers | Glacier area | Annual (at end of ablation season) | Horizontal 15–30 m | 5% |  | IGOS (2009),  Paul et al. (2009),  Zemp et al. (2013) | WGClimate | GCW |
| Glacier elevation change | Decadal | Horizontal 30 m–100 m x vertical 1 m | 2 m/decade | 1 m/decade | WGClimate | GCW |
| Glacier mass change | Seasonal to annual (the latter at end of ablation period) | Vertical: 0.01 m or 10 kg/m2 (at point location) | Better than 200 kg/m2/year (glacier-wide) |  | WGClimate | GCW |
| Ice sheets and ice shelves | Surface elevation cChange | 30 days | Horizontal 100 m | 0.1m/year | 0.1m/year |  | WGClimate | GCW |
| Ice velocity | 30 days | Horizontal 100 m | 0.1m/year | 0.1m/year | WGClimate | GCW |
| Ice mass change | 30 days | Horizontal 50 km | 10 km3/year | 10 km3/year | WGClimate | GCW |
| Grounding line location and thickness | Yearly | Horizontal 100 m  Vertical 10 m | 1 m | 10 m | WGClimate | GCW |

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| **Terrestrial ECV product requirements** | | | | | | | | | |
| ECV | Products | | Frequency | Resolution | Required measurement uncertainty | Stability (per decade unless otherwise specified) | Standards/ References | Entity (see Part II, section 2.2) | |
| Satellite | In Situ |
| Permafrost | | Thermal state of permafrost | Daily to weekly | Sufficient sites to characterize each bio-climate zone | 0.1 K |  |  |  | GCW |
| Active layer thickness | 2 cm |  |  | GCW |
| Fraction of FAPAR | | Maps of FAPAR for modelling | Daily | 200/500 m | Max (10%; 0.05) | Max (3%; 0.02) |  | WGClimate |  |
| Maps of FAPAR for adaptation |  | 50m | Max (10%; 0.05) | Max (3%; 0.02) | WGClimate |  |
| Leaf area index | | Maps of LAI for modelling | Daily | 250 m | Max (15%) | Max (10%; 0.25) |  | WGClimate |  |
| Maps of LAI for adaptation |  | 50 m |  |  | WGClimate |  |
| Albedo | | Maps of DHR albedo for adaptation | Daily | 50 m | Max (5%; 0.0025) | Max (1%; 0.001) |  | WGClimate | BSRN |
| Maps of BHR albedo for adaptation |  | 50 m | Max (5%; 0.0025) | Max (1%; 0.001) | WGClimate | BSRN |
| Maps of DHR albedo for modelling | Daily | 200/500 m | Max (5%; 0.0025) | Max (1%; 0.001) | WGClimate |  |
| Maps of BHR albedo for modelling |  | 200/500 m | Max (5%; 0.0025) | Max (1%; 0.001) | WGClimate |  |
| Land-surface temperature | | Maps of land-surface temperature | 3 hour | 1 km | 1 K | <0.1 K/decade |  | WGClimate |  |
| Above-ground biomass | | Maps of AGB | Annual | 500 m-1 km (based on satellite observations of 100–200 m) | < 20% error for biomass values > 50 t/ha, and 10 t/ha for biomass values ≤ 50 t/ha | 10% | No agreed standards but see: GOFC-GOLD (2015b) GFOI (2013) | WGClimate |  |

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| **Terrestrial ECV product requirements** | | | | | | | | | |
| ECV | Products | | Frequency | Resolution | Required measurement uncertainty | Stability (per decade unless otherwise specified) | Standards/ References | Entity (see Part II, section 2.2) | |
| Satellite | In Situ |
| Land cover | | Maps of land cover | Annual | 250 m | 15% (maximum error of omission and commission in mapping individual classes), location accuracy better than 1/3 IFOV with target IFOV 250 m | 15% (maximum error of omission and commission in mapping individual classes), location accuracy better than 1/3 IFOV with target IFOV 250 m | No agreed standards but see GLCN (2014) and GOFC-GOLD (2015(a)) | WGClimate | GOFC-GOLD |
| Maps of high-resolution land cover | 5 year | 10–30 m | 5% (maximum error of omission and commission in mapping individual classes), location accuracy better than 1/3 IFOV with target IFOV 10–30 m | 5% (maximum error of omission and commission in mapping individual classes), location accuracy better than 1/3 IFOV with target IFOV 10–30 m |  | WGClimate | GOFC-GOLD |
| Maps of key IPCC land use, related changes and land-management types | 1–10 years (including historical data) | 10–1 000 m (depending on time period) | 20% (maximum error of omission and commission in mapping individual classes), location accuracy better than 1/3 IFOV with target IFOV | 20% (maximum error of omission and commission in mapping individual classes), location accuracy better than 1/3 IFOV with target IFOV | IPCC (2006) |  | GOFC-GOLD |
| Soil carbon | | % carbon in soil | 5–10 years | 20 km |  |  |  |  | TBD |
| Mineral soil bulk density to 30  cm and 1 m | 5–10 years | 20 km |  |  |  | TBD |
| Peatlands total depth of profile, area and location | 5–10 years | 2 m vertical 20 m horizontal | 10% |  |  | TBD |

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| **Terrestrial ECV product requirements** | | | | | | | | |
| ECV | Products | Frequency | Resolution | Required measurement uncertainty | Stability (per decade unless otherwise specified) | Standards/ References | Entity (see Part II, section 2.2) | |
| Satellite | In Situ |
| Fire | Burnt Areas | 24 hours | 30 m | 15% (error of omission and commission), compared to 30-m observations |  | None | WGClimate |  |
| Active fire maps | 6 hours at all latitudes from polar-orbiting and 1 hour from geostationary | 0.25-1 km (polar);  1–3 km (geo) | 5% error of commission  10% error of omission  Based on per-fire comparisons for fires above target threshold of 5 MW/km² equivalent integrated FRP per pixel (i.e. for a 0.5 km² pixel the target threshold would be 2.5 MW, for a 9 km² pixel it would be 45 MW). |  | WGClimate |  |
| Fire radiative power | 6 hours at all latitudes from polar-orbiting and 1 hour from geostationary | 0.25-1 km (polar)  1–3 km (geo) | 10% integrated over pixel. Based on target detection threshold of 5 MW/km² equivalent integrated FRP per pixel (i.e. for a 0.5 km² pixel the target threshold would be 2.5 MW, for a 9 km² pixel it would be 45 MW).and with the same detection accuracy as the Active Fire Maps. |  | WGClimate |  |

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| **Terrestrial ECV product requirements** | | | | | | | | |
| ECV | Products | Frequency | Resolution | Required measurement uncertainty | Stability (per decade unless otherwise specified) | Standards/ References | Entity (see Part II, section 2.2) | |
| Satellite | In Situ |
| Anthropogenic greenhouse-gas fluxes | Emissions from fossil fuel use, industry, agriculture and waste sectors | Annual | By country and sector | Globally 5%  Nationally 10% |  | IPCC (2006)  IPCC (2013) |  | TBD[[16]](#footnote-16) |
| Emissions/ removals by IPCC land categories | Annual | By country/region | Globally 15%  Nationally 20% |  |  |  |
| Estimated fluxes by inversions of observed atmospheric composition - continental | Annual | 1 000–10 000 km | 10% |  | Maps for modelling and adaptation | WGClimate |
| Estimated fluxes by inversions of observed atmospheric composition - national | Annual | 100–1 000 km | 30% |  |  | WGClimate |
| High-resolution CO2 column concentrations to monitor point sources | 4 hourly | 1 km | 1ppm |  |  | WGClimate |
| Latent and sensible heat fluxes | TOPC is considering the practicality of this being an ECV and, if so, what the requirements might be. | | | | | | | |

Stakeholders:

AQUASTAT FAO database and data collection system on water use

BSRN Baseline Surface Radiation Network

GAW WMO Global Atmosphere Watch

GCP Global Carbon Project

GCW WMO Global Cryosphere Watch

GOFC-GOLD Global Observation for Forest Cover and Land Dynamics

GOOS Global Ocean Observing System Sponsored by WMO, UNESCO-IOC, UNEP and ICSU

GTN-G Global Terrestrial Network - Glaciers

GTN-H Global Terrestrial Network - Hydrology

GTN-P Global terrestrial Network - Permafrost

HYDROLARE International Data Centre on Hydrology of Lakes and Reservoirs

JCOMM WMO-IOC Joint Technical Commission for Oceanography and Marine Meteorology

WGClimate Joint CEOS/CGMS working group on climate

WHYCOS WMO World Hydrological Cycle Observing System (a WMO programme)

WIGOS WMO Integrated Global Observing System

**Box 10: Terrestrial standards: references.**

CEN (2010) Hydrometry - Measurement of snow water equivalent using snow mass registration devices. CEN/TR 15996:2010, Brussels.

FAO (2000) Land Cover Classification System. Food and Agriculture Organization of the United Nations

GFOI (2013) Integrating Remote-sensing and Ground-based Observations for Estimation of Emissions and Removals of Greenhouse Gases in Forests: Methods and Guidance Pub: GEO, Geneva, Switzerland, 2014. ISBN 978-92-990047-4-6.

GLCN (2014) Global Land Cover Network (GLCN) Land Cover Classification System (LCCS), see <http://www.glcn.org/>

GOFC-GOLD (2015(a)) See <http://www.gofcgold.wur.nl/>

GOFC-GOLD (2015(b)) REDD+ Sourcebook November COP21 Edition, November 2015

IACS/UNESCO (2009) International Classification of Seasonal Snow on the Ground,

IGOS (2007(a)) WMO/TD-No. 1405. 100 pp. CEN, 2010, Hydrometry - Measurement of snow water equivalent using snow mass registration devices. CEN/TR 15996:2010, Brussels.

IGOS (2007(b)) Integrated Global Observing Strategy Cryosphere Theme Report - For the Monitoring of our Environment from Space and from Earth. Geneva: World Meteorological Organization. WMO/TD-No. 1405. 100 pp.

IPCC (2006) 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan

ISO 5667-18:2001 part 18 Guidance on sampling of groundwater at contaminated sites. Manual methods for the measurement of a groundwater level in a well.

ISO/TC 113 ISO/Technical Committee 113: A1:AD21 61 published ISO standards related to the TC and its Subcommittees

ISO/TC 147 ISO/TC 147/SC 6 N 120, Guidance on the sampling of groundwater;

ISO 5667-18:2001 part 18 Guidance on sampling of groundwater at contaminated sites.

Östrem G. and M. Brugmann, 1991, Glacier Mass Balance Measurements. A manual for field and office work. National Hydrology Research Institute (Canada), Science Report No. 4, 224 pp.

Paul, F., Barry, et al. (2009): Glacier mass-balance measurements: a manual for field and office work, NHRI Science Report. 224 pp.

WMO (2006) Technical Regulation Vol.lII, Hydrology,  2006 edition, Basic  Documents №2 ,

WMO (2008a) Guide to Hydrological Practice, WMO, № 16, Sixth edition, 2008

WMO (2008b) WMO Guide to Meteorological Instruments and Methods of Observation (Chapter 11).

WMO (2008c) Guide to meteorological instruments and methods of observation, WMO-No. 8, (Updated in 2010 and 2012).

WMO (2009) Guide to Hydrological Practices, Volume II: (WMO 168)

WMO (2010) Manual on Stream Gauging, Vol. I & 2: (WMO 1044)

1. GCOS, 2011: *Systematic Observation Requirements for Satellite-based Products for Climate: Supplemental details to the satellite-based component of the ”Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC (2010 Update)”*. GCOS-154, WMO, Geneva, December 2011.

   GCOS, 2006: *Systematic Observation Requirements for Satellite-based Products for Climate: Supplemental details to the satellite-based component of the “Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC*”. GCOS-107, WMO, Geneva, September 2006. [↑](#footnote-ref-1)
2. <http://ceos.org/ourwork/workinggroups/climate/> [↑](#footnote-ref-2)
3. <http://cci.esa.int> [↑](#footnote-ref-3)
4. WMO, 2012: *Guide to Meteorological Instruments and Methods of Observation.* WMO-No. 8, 2008 edition updated in 2010 (Section 1.6.4.3), WMO, Geneva [↑](#footnote-ref-4)
5. Responsible for analysing ECV products according to actions G11, G12 and G13.

   Key to abbreviations is given at the end of this annex. The GCOS Science panels will review and update this allocation as necessary. [↑](#footnote-ref-5)
6. Responsible for analysing ECV products according to actions G11, G12 and G13.

   Key to abbreviations is given at the end of this annex. The GCOS Science panels will review and update this allocation as necessary. [↑](#footnote-ref-6)
7. Responsible for analysing ECV products according to actions G11, G12 and G13.

   Key to abbreviations is given at the end of this annex. The GCOS Science panels will review and update this allocation as necessary. [↑](#footnote-ref-7)
8. http://www.eumetsat.int/website/home/Satellites/FutureSatellites/MeteosatThirdGeneration/index.html?lang=EN [↑](#footnote-ref-8)
9. Responsible for analysing ECV products according to actions G11, G12 and G13.

   Key to abbreviations is given at the end of this annex. The GCOS Science panels will review and update this allocation as necessary. [↑](#footnote-ref-9)
10. These requirements for global products have been derived by AOPC to support understanding of fluxes of greenhouse gases. GAW is developing requirements of the ground-based segment that would support this (Task Team on Observational Requirements and Satellite Measurements as regards Atmospheric Composition and Related Physical Parameters, <http://www.wmo.int/pages/prog/arep/gaw/TaskTeamObsReq.html>). GCOS will coordinate with GAW to ensure compatibility of all observational requirements. [↑](#footnote-ref-10)
11. Responsible for analysing ECV products according to actions G11, G12 and G13.

    Key to abbreviations is given at the end of this annex. The GCOS Science panels will review and update this allocation as necessary. [↑](#footnote-ref-11)
12. Responsible for analysing ECV products according to actions G11, G12 and G13

    Key to abbreviations is given at the end of this annex. The GCOS Science panels will review and update this allocation as needed. [↑](#footnote-ref-12)
13. Responsible for analysing ECV products according to actions G11, G12 and G13

    Key to abbreviations is given at the end of this annex. The GCOS Science panels will review and update this allocation as needed. [↑](#footnote-ref-13)
14. Responsible for analysing ECV products according to actions G11, G12 and G13

    Key to abbreviations is given at the end of this annex. The GCOS Science panels will review and update this allocation as needed. [↑](#footnote-ref-14)
15. Responsible for analysing ECV products according to actions G11, G12 and G13

    Key to abbreviations is given at the end of this annex. The GCOS Science panels will review and update this allocation as needed. [↑](#footnote-ref-15)
16. While GAW has responsibilities for the composition measurements, there is no single body considering the overall flux estimates though this has been done to some extent by the GCP. [↑](#footnote-ref-16)