Belgium's National Report on activities related to the Global Climate Observing System

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TABLE OF CONTENT

Introduction

This report constitutes the submission by Belgium on progress with the GCOS implementation plan, as requested by the Subsidiary Body for Scientific and Technological Advice of the UNFCCC in December 2007 (cf. SBSTA conclusions on Research and systematic observation in document FCCC/SBSTA/2007/16). It provides additional information on national GCOS activities using the revised "UNFCCC reporting guidelines on global climate change observing systems" in order to reflect the priorities of the Global Climate Observing System implementation plan and incorporate the reporting on essential climate variables as approved by COP 13 in Bali.
It will contribute to the GCOS progress report five years after the launch of the GCOS implementation plan and a revised second edition of the implementation plan that will be presented to the UNFCCC in June 2009.

This report is based on a quick survey and is not totally exhaustive. An updated, more complete and official version will be transmitted within the 5th National Communication in January 2010.

1. Common issues

1.1. Programmes and activities for contributing observations of the essential climate variables (EVCs) to the international community and to support national and regional activities.

In Belgium the observations of essential climate variables cut across several federal research institutes, regional agencies and universities. Competences for systematic long term observations of various climate relevant variables as well as for observations within the framework of research projects are distributed among the federal and federated authorities.
Here follows a non exhaustive overview of the main institutions involved:

Institutions that are part of the PPS Science Policy

In Belgium the competence for measuring long term meteorological variables lies with the Royal Meteorological Institute (KMI-IRM). It is also monitoring tropospherical ozone and to a certain extent also aerosols.

The Belgian Institute for Space Aeronomy (BIRA-IASB) is actively involved in the Network for the Detection of Atmospheric Composition Change (NDACC, formerly the NDSC), a major contributor to GCOS. In addition to operating its own NDACC-certified instruments at three stations in Europe and one station on Reunion Island, it also co-chairs three Working Groups of the network: the Infrared WG, the UV-Visible WG, and the satellite WG. Several NDACC measurement activities of BIRA-IASB are carried out in collaboration with University of Liège (ULg-IAGL) and Free University of Brussels (ULB-SPECAT).

- BIRA-IASB operates a CIMEL sunphotometer contributing aerosol AOD measurements to the AErosol RObotic NETwork (AERONET).
- BIRA-IASB contributes to the operational retrieval algorithms for several satellite measurements of ECVs, by providing prototype retrieval algorithms and by working on their transfer to the operational environment. ECVs: methane and aerosols for IASI on board of the EUMETSAT MetOp series, and ozone for the ERS-2 GOME, Envisat SCIAMACHY and GOME-2 satellites.
- BIRA-IASB contributes actively to other international satellite missions measuring ECVs through geophysical validation and retrieval studies.
- BIRA-IASB retrieves stratospheric aerosols from the SAGE and GOMOS satellite missions, and develops unified, long-term databases of stratospheric aerosols measured by different satellite instruments.
- BIRA-IASB develops and operates the BASCOE 4D-var chemical data assimilation system. BASCOE has particular capabilities of generating consolidated long-term and global data sets of ozone and other GHGs through the re-analyse of satellite data records.

The Management Unit of the North Sea Mathematical Models and the Scheldt estuary, abbreviated to MUMM, is a department of the Royal Belgian Institute of Natural Sciences (RBINS), a federal scientific establishment that comes under the PPS Science Policy. The MUMM holds the 'National Oceanographic Data Centre ' for the UNESCO International Oceanographic Commission (http://www.mumm.ac.be/EN/

Other institutions

The University of Liege (ULg-IAGL)

- ULg-IAGL is charge of the long-term operation of ground-based FTIR spectrometers at the International Scientific Station at the Jungfraujoch, a primary site of NDACC.

- ULg-IAGL contributes to ground-based GHGs measurement campaigns involving NDACC-certified FTIR instrumentation
- ULg-IAGL contributes to the geophysical validation of satellite measurements of several ECVs.

The 'Université Libre de Bruxelles (ULB-SPECAT)

- ULB-SPECAT develops prototype retrieval algorithms for atmospheric GHGs measurements from the MetOp-A IASI satellite sensor.
- ULB-SPECAT contributes to ground-based GHGs measurement campaigns involving NDACC-certified FTIR instrumentation

The PPS Science Policy acts as Belgian Space Agency.
Through the Public Planning Service Science Policy, Belgium contributes to the earth observation activities of ESA. It is also a partner in the SPOT vegetation project and a contributor to EUMETSAT. Within the PRODEX programme, scientific teams are funded to study data from EUMETSAT. And its SAF-Hydrology, SAF-Land, SAF Ozone and Space based Exploration of the chemistry and physics of the earth's atmosphere
GCOS is part of GEOSS. Belgium participates in GEOSS (Group on Earth Observation System of Systems), wherein the EC-initiative GMES represents an important and independent contribution of Europe. It is very strongly involved in the EC's GMES integrated project on land cover and vegetation entitled 'GEOLAND' and in particular within the work units regarding Food Security and Crop Monitoring.

1.2. (Essential) climate variables (EVCs) observations being undertaken in climate research programmes

Climate change, its impacts, adaptation and mitigation have been studied in the framework of the Global Change Programme (1990-1996), the First (SPSD I - 1996-2000) and the Second Plan in support for a sustainable development (SPSD 2 – 2000 – 2006) and at present they are being studied within the Scientific Support Plan for a Sustainable Development. (2006 – 2009). (SSD) The projects within this Plan include experimental networks and observing systems specially established as part of this time-limited research programme. Some of these projects are a continuation on projects that started in the eighties, such as those related to Antarctica, global change etc.
The climate variables include also paleodata.

Within this Plan, BELSPO has not yet a clear-cut data policy.

1.3. Efforts being undertaken to ensure that high-quality climate data records are collected, retained and made accessible for use by current and future generations of scientists and decision-makers of all Parties

BIRA-IASB (Belgian Institute for Space Aeronomy) contributes to high-level committees and bodies establishing frameworks and recommendations for a better harmonisation and interoperability of Earth Observation data (including ECVs).

- As a member of the Committee on Earth Observation Satellites (CEOS) Working Group on Calibration and Validation (WGCV) and the Vice-Chair of its Atmospheric Composition Sub Group (ACSG), BIRA-IASB contributes to the GEO Task DA-06-02, "to develop a GEO data quality strategy, beginning with space based observations and evaluating expansion to in-situ observations". Work addresses issues of data policy and data exchange, harmonisation of metadata, establishment of standards and best practices for cal/val, and classification of cal/val sites. GCMPs are considered appropriately.
- BIRA-IASB contributes to the GEO-CEOS effort to establish a Quality Assurance framework for Earth Observation (QA4EO). A draft document is currently under review by the CEOS WGCV and the GEO.

- BIRA-IASB contributes to several research projects funded by the PPS Science Policy, PRODEX, ESA, EUMETSAT and the EC, and aiming at reducing inhomogeneities between satellite data records obtained by different instruments and from different platforms.
- Work on retrieval algorithms and associated operational processors for improving the multi-mission consistency of the ozone column data records provided by the GOME, SCIAMACHY and GOME-2 satellites. Consistency with the US TOMS satellite series (1978-1993 and 1996-2005) is also considered.
- Multi-mission satellite validation of ECV measurements using established ground-based networks (NDACC, SHADOZ, GAW/WOUDC) as a standard reference.
- Contribution to the development of ESA's Generic Environment for Cal/val Analysis (GECA), in order to ensure consistent data handling, cal/val manipulations, quality information reporting and metadata generation among ESA satellite missions, ESA's Third Party Missions (TPMs), EUMETSAT, and NASA missions.
- Multi-dimensional characterisation of the information on atmospheric ECVs measured by ground-based and satellite remote sensing, with a view of improving validation techniques, chemical assimilation and interpretation of the data.

All the research data (biological, chemical and physical) of the funded projects within the North Sea programme since 1997 are stored in the IDOD database managed by the BMDC (Belgian Marine Data Centre) of the Management Unit of the Mathematical Model of the North Sea (MUMM).

The Flanders Marine Institute (VLIZ) is the coordination and information platform for marine scientific research in Flanders. The VLIZ is a focal point for marine and coastal-related research and serves as an international contact point. Major activities are the management of the Flemish Marine Data and Information Centre (FMDC).

1.4. Efforts being undertaken to ensure that international data centres are established and/or strengthened for all the ECVs

BIRA-IASB and ULg-IAGL submit regularly atmospheric ECVs measurements - by ground-based FTIR and DOAS spectrometry - to the NDACC data centre maintained by NOAA NCEP. These data are retrieved, quality controlled, consolidated, formatted and documented by metadata files according to the NDACC rules.

BIRA-IASB submits also regularly CIMEL aerosol data to the AERONET archive.

1.5. Passed, actual and/or planned activities for capacity-building

Lake Tanganyika

A monitoring of Lake Tanganyika was implemented by the partners from the CLIMLAKE (2000-2006) and CLIMFISH (2004-2006) projects in collaboration with the Department of Fisheries in Zambia and the Tanzania Fisheries Research Institute).
Regular lake observations (every two weeks) were done at two lake stations: one in Zambia and one in Tanzania .The monitoring has stopped after the end of those projects.

Lake Tanganyika being one the most important of freshwater body in the world (17 % of the volume of freshwater), we suggest that it would be included in a long term monitoring for the essential variables particularly also because it is situated in an area of the world where important gaps of climatic observations are noted. This would insure that time series are completed beyond the life time of a particular research project which seldom last more than 4 years.

Ile de la Réunion
Ile de La Réunion is a French Department and is certainly not falling into the category of small island developing states, but bilateral technical cooperation conducted with BIRA-IASB enhances considerably the regional facilities in this part of world (Indian Ocean). In the framework of NDACC, on a campaign basis, BIRA-IASB and ULB-SPECAT have carried out since 2002 measurements by FTIR spectrometry of the total column and tropospheric column of various atmospheric ECVs at Ile de La Réunion: ozone, water vapour, methane and nitrous oxide. Regular measurements of CO_2 by FTIR spectroscopy will be implemented by BIRA-IASB at Ile de La Réunion, starting mid-2009, in accordance with the GCMPs. These measurements will contribute to the TCCON network that is affiliated to NDACC, and data will be archived in the TCCON international data centre.

Uganda and Kenya
The CLANIMAE (Climatic and Anthropogenic Impacts on African Ecosystems) project is ongoing and uses multiple paleo-environmental proxies in lake-sediment cores from Uganda and Kenya to reconstruct both past climatic variability and the history of vegetation and water-quality changes during recent millennia. Its main objectives are to separate the influences of natural climate variability and human impact on East African terrestrial ecosystems, and to determine the relative magnitude of pre-20th century anthropogenic land clearance compared to recent landscape alteration.

1.6. Initiatives undertaken to acquire paleoclimate data, in particular activities to extend the data record in time and into new regions, and to improve the synthesis of these data.

Antarctica
Coastal Antarctica forms a crucial link between the ice cores and the marine sediment cores from the Southern Ocean, but paleoclimate records from the region are still largely lacking. The SSD projects LAQUAN and HOLANT aim at studying past climate variability in coastal Maritime, east and sub Antarctica by analysing biological, biogeochemical and sedimentological proxies in lake sediment cores. All data are made available through international peer-reviewed publications. Members of HOLANT also contributed to the SCAR synthesis report 'Antarctic Climate Change and the Environment'.

The main results obtained in the LAQUAN project regarding past climate and environmental changes can be articulated as follows:

- A robust diatom-based transfer functions to quantitatively reconstruct past changes in the moisture balance in coastal east Antarctic lakes was developed (Verleyen et al. 2003).
- Changes in the moisture balance during the past 120,000 years were reconstructed using lake sediment cores from the Larsemann Hills (Prydz Bay, 69°23'S-76°53'E). This record was the first reconstruction of pre-Holocene (>10,500 years) climate and environmental variability in coastal east Antarctica. The Prydz Bay region was warmer than today during the previous interglacial (the Eemian) as evidenced by lake level high stands and a particular diatom flora currently characteristic for the warmer sub-Antarctic region (Hodgson et al. 2005a, 2006).
- An early and Late Holocene climate optimum was detected in the lake sediment records from the Larsemann Hills (Verleyen et al. 2004a, 2004b). The early Holocene climate optimum is coincident with a warm period detected in ice cores, whereas the late Holocene Hypsithermal is slightly out of phase with existing ice core records (Hodgson et al. in press).
- Reconstructions of changes in the ultraviolet radiation using fossil pigments showed that UV levels were on yearly average higher during the last glacial period than during the previous and present interglacial periods (Hodgson et al. 2005b). A study with a higher temporal resolution showed that UV radiation was variable during the Late Holocene with peaks largely coincident with solar minima (Verleyen et al. 2005a).
- A relative sea level (RSL) curve for the Prydz Bay region extended an existing record with c. 5000 years. The RSL record showed that a contribution of the east Antarctic ice sheet to

melting water pulse IA (MWP IA) cannot be ruled out (Verleyen et al. 2005b). MWP IA was an exceptional large ice-melting event during the past deglaciation phase.

- Changes in the moisture balance in lakes from the Windmill Islands (66°20'S-110°3'E) were quantitatively reconstructed on a high temporal resolution. The three studied lakes experienced salinization during the most recent decades probably as a result of changes in climate and weather patterns (e.g. increased wind speed, snow cover and related feedback mechanisms).

The main results obtained and expected within the ongoing HOLANT project regarding past climate and environmental changes are listed below. For all these topics successfully obtained field data are currently being interpreted and analysed:

- A robust diatom-based transfer function and fossil pigment-based indices to quantitatively reconstruct past changes in the lake productivity were developed. As lake primary production is a function of air temperature in Maritime Antarctic lakes, the transfer function and indices will allow to indirectly reconstructing past temperature variability throughout lake sediment cores.
- Past climate and environmental changes will be reconstructed from the North-eastern site of the Antarctic Peninsula. The records extend span the entire Holocene.
- A new Holocene RSL curve for the North-eastern site of the Antarctic Peninsula is being developed and will allow to infer past changes in ice sheet volume in a region where glaciers are currently retreating
- Holocene environmental changes in South Georgia are being reconstructed on a high temporal resolution
- Diatom-based transfer functions (Verleyen et al. 2003, see above) are being extended and will allow to quantitatively reconstruct past changes in the moisture balance in east Antarctic lakes between 40°E and 110°E
- Lake sediment cores were obtained to study past climate and environmental changes in the coastal areas of the Dronning Maud Land region, a sector for which palaeoclimate data are currently lacking (Hodgson et al. in press).
- An existing RSL curve will be extended with lake sediment records from the Lützow Holm Bay region and allow bettering assessing past changes in the volume of this part of the East Antarctic ice sheet.
- The integration of records with palaeoclimate records from the ice sheet and the Southern Ocean is an integral part of the HOLANT project and related international research initiatives and programs (e.g. the British Antarctic Survey program CACHE PEP).

Chili

The SPSD II project ENSO-CHILI analysed the sedimentary records in two Chilean lake basins with the following goals:

- To assess whether events like ENSO have been recorded in these lakes.
- To identify connections between the records.
- To determine whether the recorded variations are global or local,
- To confront our observations and results with existing climate models.

A multi-disciplinary analysis of these cores (including physical properties, sedimentology, age dating, tephrochronology, palynology and mathematical treatment) with a basin-wide interpretation of the spatial and temporal evolution of the sedimentary environment was done.. The outcome of the project is a well-dated, multi-proxy record - at high resolution - of variations in terrigenous sediment supply and of vegetation changes during the Holocene. Such a record is be instrumental in improving the knowledge of the natural cyclicities of the world's climate system and on how and how fast specific climate changes may have a global impact.

East Africa

The SSD project CLANIMAE responds to the urgent need of a correct long-term perspective to today's climate-environment-human interactions in tropical East Africa, by simultaneous high-

resolution reconstruction of both past climatic variability and the history of vegetation and water-quality changes through multi-disciplinary analyses of dated lake-sediment records. The climate reconstructions will integrate information on biological, geochemical and sedimentological proxy indicators of past changes in the water balance of study lakes.
The CLANIMAE team has modern and historical surface-temperature data on more than 50 western Uganda crater lakes (i.e. ~70% of all regional lakes), based on compilation and standardisation of all available historical lake-monitoring data, (UGent-Limnology unpublished data 2000-2002) and new CLANIMAE lake-monitoring data 2007-2008.
Since 02/2007 temperature logger profiles are made in 3 western Uganda crater lakes and since 08/2007 in 5 lakes. The recording is continuously at 2-h intervals. It will continue for resp. 30 and 36 months.

Other old data about Africa
The Museum for Central Africa has old (from late colonial period) monthly data (from «Bulletin climatologique annuel du Congo Belge et du Ruanda-Burundi» which have been digitized for the period 1950-1959:

-Air T° max (83 stations)
-Air T° min (83 stations)
-Evaporation (83 stations)
-Humidity (60 stations)
-Sunshine (54 stations)
-Precipitations (16 stations)

Many other data are however archived at the Royal Meteorological Institute and at the Royal Archives Institute , but we have no access to those data which are not in database format (not digitised) .

1.7. Difficulties encountered

Although the KMI-IRM is designated as GCOS focal point, for the time being there is no formal GCOS National Coordinator or Coordination Committee in Belgium. Some institutes, more than others, take the responsibility to coordinate relevant data, support international databases and contribute to international efforts. More and more, individual researchers report their data and observations through international research programmes, international databases and their publications. This relative lack of coordination made it difficult to collect and compile the information presented in this report. In this context, the PPS Science Policy was commissioned to elaborate this report, in a rather limited period of time. The short timeframe, limited availability of data on ECVs, and the absence of a GCOS coordinator, made not possible to provide a fully comprehensive inventory. This report has to be considered as a boost for taking action within Belgium for a better coordination, permanent financial support and full implementation of the GCOS Plan.

The guidelines appeared to be sometimes difficult to apply, in particular with regard to Belgian participation in EU, ESA, EUMETSAT and other international organisations. Maybe it could be useful to let also the international organisations prepare a report on their GCOS implementation

2. *Atmospheric essential climate variables*

2.1. National contributions to the surface bases atmospheric essential climate variables

The atmospheric essential climate variables are measured by the KMI-RMI.
The climatological network counts 270 stations spread over Belgium whereby observers send their data daily or weekly to the KMI. Data can be accessed from ww.kmi.be/meteo/view/nl/214871-Klimatologisch+netwerk.html. KMI –RMI has observational data covering the last few decades
Their database is a valuable tool to evaluate the performance of regional climate models over Belgium

Table 1a. National contributions to the surface bases atmospheric essential climate variables

Contributing networks in the GCOS implementation plan	ECV's *	Number Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
GCOS Surface Air temperature Network (GSN)	air °t	1				
	precipitation	1				
Full World Weather Watch/Global Observing System (WWW/GOS) surface network	air °t air pressure wind speed and direction water vapour	15				
	precipitation	1				
Baseline Surface Radiation Network (BSRN)	surface radiation					
Solar radiation and radiation balance data	surface radiation	15		17	4	4
Ocean drifting buoys	air°t air pressure					
Moored buoys	air°t air pressure					
Voluntary Observing Ship Climate Project (VOSClim)	air °t air pressure wind speed and direction water vapour					

Ocean Reference Mooring Network and sites on small isolated islands	air °t wind speed and direction, air pressure					

*Parties should note that the list of ECVs given for each network is indicative of the expected observations from that network. A single response/data entry is expected for each network except for those networks for which precipitation is reported, where a separate response/data entry is requested owing to its particular importance with regard to the Convention.

Other observations outside these networks

Monitoring Network Flemish Banks'

The Observation stations of the 'Monitoring Network Flemish Banks' Meetnet Vlaamse Banken) (Belgian Coast) are not part of any GCOS observation network. It is a local monitoring network with several stations very close to each other. The Monitoring Network Flemish Banks (was set up for the acquisition of real-time oceanographical and meteorological data along the Belgian coast and on the Belgian continental shelf.

- The oceanographic parameters monitored are waves, tidal height, current and water temperature.
- The meteorological parameters are wind, air pressure, air temperature and rainfall (see 'about' page for details on these measurements, including locations).

The Network is sponsored by the government of Flanders, and set up and maintained by the Coastal Division of the Agency for Maritime and Coastal Services (MDK). VLIZ has been invited to make data resulting from the Monitoring Network available to third parties. Measurements are available at http://www.vliz.be/vmdcdata/midas/mvb.php?listloc

Lake Tanganyika

For the atmosphere, historical information (air temperature, precipitation) was purchased from the official local meteorological stations while complementary meteorological data was measured near the lake. Also time series from MODIS and AVHRR products provided the surface temperature (from 1985 to 2006). Results are published. Several of those are submitted or in preparation.

Climate model data processed for Belgium

Climate model data from the PRUDENCE RCM database

The European PRUDENCE project produced regional climate change scenarios specifically for Europe and was consequently chosen as the main source of climate change scenarios. PRUDENCE is an acronym for Prediction of Regional scenarios and Uncertainties for Defining EuropeaN Climate change risks and Effects. It is a project with many European partners, funded by the EU 5th Framework Program and having as goal the evaluation of climate change risks over Europe in the end of the current century, as predicted by the most recent (at the project time) climate models. The project applied dynamic downscaling to generate climate data at small scales (12-60km). The PRUDENCE project carried out a series of 30-year long climate simulations for the reference period (1961-1990) and at the end of the 21st century (2071-2100). The models were run using A2 and B2 SRES scenarios and coupled with two Atmosphere Ocean Global Circulation Models (AOGCMs). The results of these simulations were then used to drive geographically more detailed RCM-based simulations (11 RCMs in total). The project ended in 2004 and at its end, the simulation data from its participants were freely available in public domain of the project host (http://prudence.dmi.dk). They were processed (daily

time scale) for the variable precipitation and the following variables used to calculate potential reference evapotranspiration using the Bultot method of the Royal Meteorological Institute of Belgium:

- Mean Sea Level Pressure (MSLP)
- Total radiation balance (SWdown)
- Cloud covering (clcov)
- 2-meter temperature (t2m)
- 10-meter wind (w10m)
- Humidity

The final series are daily precipitation and daily potential evapotranspiration for each climate model grid cell covering the Belgian territory (for precipitation) or for the grid cell closest to the Uccle ground meteorological station (for potential evapotranspiration). 30-years series are derived for both the present reference period (1960-1990) and for the scenario period at the end of this century (2070-2100) for each climate model simulation listed in Table 1b

Table b shows the 21 PRUDENCE control experiments (1961-1990) that were derived.

Table shows the 31 RCM scenarios (2071-2100) for the future projections.

GCM data from the IPCC AR4 database

The GCM experiments were required to account for the extra uncertainty related to emission scenarios. However, given the differences in priorities, the IPCC AR4 models would not necessarily fit the same criteria for the CCI-HYDR project analysis; the control and scenario periods of the AR4

GCMs do not in general coincide with those of the PRUDENCE RCMs. Nonetheless, many of the GCMs fit the criteria which allows for checking the estimated PRUDENCE projections which were only based on the A2 and B2 scenarios. **Error! Reference source not found.** shows the GCMs that were used from the AR4 GCM database (http://www.ipcc-data.org).

Table 1b: PRUDENCE control series (1961-1990) used in the project.

PRUDENCE PARTNER	MEMBER	CONTROL	GCM	RCM
Météo France (France)	CNRM	DA9	Observed SST	ARPEGE
Danish Meteorological Institute (Denmark)	DMI	ECC	ECHAM5	HIRHAM
		ecctrl	ECHAM4/OPYC	HIRHAM
		HC1	HadAM3H	HIRHAM
		HC2	HadAM3H	HIRHAM
		HC3	HadAM3H	HIRHAM
		F25	HadAM3H	HIRHAM
Swiss Federal Institute of Technology (Switzerland)	ETH	HC_CTL	HadAM3H	CHRM
GKSS Forschungszentrum Geesthacht GmbH (Deutschland)	GKSS	CTL	HadAM3H	CLM
		CTLsn	HadAM3H	CLM (improved)
Met. Office Hadley Centre (United Kingdom)	HC	adeha	HadAM3P	HadRM3P
		adehb	HadAM3P	HadRM3P
		adehc	HadAM3P	HadRM3P
The Abdus Salam Intl. Centre for Theoretical Physics (Italy)	ICTP	ref	HadAM3H	RegCM
Koninklijk Nederlands Meteorologisch Instituut (The Netherlands)	KNMI	HC1	HadAM3H	RACMO
Norwegian Meteorological Institute (Norway)	METNO	HADCN	HadAM3H	HIRHAM
Max-Planck-Institut für Meteorologie (Deutschland)	MPI	3003	HadAM3H	REMO
Swedish Meteorological and Hydrological Institute (Sweden)	SMHI	HCCTL	HadAM3H	RCAO
		MPICTL	ECHAM4/OPYC	RCAO
		HCCTL_22	HadAM3H	RCAO (High res.)
Universidad Complutense de Madrid (Spain)	UCM	control	HadAM3H	PROMES

Table 1c : PRUDENCE scenario series (2071-2100) used in the project.

MEMBER	SCENARIO	RESOLUTION (Km)	SCENARIO	GCM	RCM
SMHI	SMHI-MPI-A2	49	A2	ECHAM4/OPYC	RCAO
	SMHI-MPI-B2	49	B2	ECHAM4/OPYC	
	SMHI-HC-22	24	A2	HadAM3H	
	SMHI-A2	49	A2	HadAM3H	
	SMHI-B2	49	B2	HadAM3H	
KNMI	KNMI	47	A2	HadAM3H	RACMO
METNO	METNO-A2	53	A2	HadAM3H	HIRHAM
	METNO-B2	53	B2	HadAM3H	
DMI	DMI-S25	25	A2	HadAM3H	HIRHAM
	DMI-ecsc-A2	50	A2	ECHAM4/OPYC	
	DMI-ecsc-B2	50	B2	ECHAM4/OPYC	
	DMI-HS1	50	A2	HadAM3H	
	DMI-HS2	50	A2	HadAM3H	
	DMI-HS3	50	A2	HadAM3H	
ETH	ETH	55	A2	HadAM3H	CHRM
HC	HC-adhfa	50	A2	HadAM3P	HadRM3P
	HC-adhfe	50	A2	HadAM3P	
	HC-adhff	50	A2	HadAM3P	
	HC-adhfd-B2	50	B2	HadAM3P	
MPI	MPI-3005	55	A2	HadAM3H	REMO
	MPI-3006	55	A2	HadAM3H	
CNRM	CNRM-DC9	59	A2	ARPEGE	ARPEGE
	CNRM-DE5	59	A2	ARPEGE	
	CNRM-DE6	59	A2	ARPEGE	
	CNRM-DE7	59	A2	ARPEGE	
GKSS	GKSS-SN	55	A2	HadAM3H	CLM
	GKSS	55	A2	HadAM3H	CLM
ICTP	ICTP-A2	52	A2	HadAM3H	RegCM
	ICTP-B2	52	B2	HadAM3H	RegCM
UCM	UCM-A2	52	A2	HadAM3H	PROMES
	UCM-A2	52	B2	HadAM3H	

Table 1d. National contributions to the upper-air atmospheric climate variables

Contributing networks in the GCOS implementation plan	ECV's *	Number r of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
GCOS Upper Air Network (GUAN)	upper-air °t upper-air wind speed and direction upper-air water vapour					
Full WWW/GOS Upper Air Network	upper-air °t upper-air wind speed and direction upper-air water vapour					

(Remark: no input received for the table)

2.2. National contributions to atmospheric composition

CO_2 - carbon dioxide

Measurements of CO_2 (carbon dioxide) by FTIR (Fourier transform infrared) spectroscopy will be implemented by BIRA-IASB at Ile de La Reunion starting mid-2009, in the frame of the TCCON (Total Carbon Column Observing Network) that is affiliated to NDACC (Network for the Detection of Atmospheric Composition Change), and in accordance with the GCMPs (GCOS Climate Monitoring Principles).

CH_4 – methane

In the framework of the NDACC, Belgian researchers (ULg-IAGL - University of Liège) and BIRA-IASB carry out measurements by FTIR spectrometry of CH_4 (methane) total column and tropospheric column. NDACC-affiliated FTIR measurements have been carried out at Jungfraujoch since 1990. They have also been performed on a campaign basis at Ile de La Réunion since 2002 (in collaboration with ULB-SPECAT). A campaign also took place in Uccle in 2006-2007.

Other Greenhouse Gases

Tropospheric and total column amounts of other GHGs like H_2O (water vapour), N_2O (Nitrous oxide), O_3 (ozone) and some HCFC (hydro chlorofluorocarbon) are also observed by NDACC-affiliated FTIR instruments at the Jungfraujoch (routine) and Ile de La Reunion (campaign basis).

In addition to direct GHG, source gases affecting the oxidizing capacity of the troposphere -and hence indirectly influencing climate- are also part of the investigations by the ULg-IAGL. Efforts undertaken within the framework of the AGACC project are allowing the generation of time series of advanced data products which will soon be submitted to the NDACC archiving facility (e.g. for CO, HCN, C_2H_2)

Methane in non GCOS stations: gas hydrates in Siberia
Local destabilisation of gas hydrates, causing abrupt release of large amounts of greenhouse gases into the atmosphere and hence inducing global warming, has been studied in detail at Lake Baikal (Siberia) by the as well as in the Black sea by *UGent-RCMG*

Ozone
Belgium has 1 WMO/GAW column ozone network-station operational at Uccle, with 2 Brewer instruments and one Dobson. The station is a complementary NDACC station. No additional station is foreseen for 2010. The data are delivered to WOUDC and NDACC international data-centres. The complete data-sets (1971-present, 1984-present, 2001-present for the Dobson, Brewer 016 and Brewer 178 instruments respectively) are available at WOUDC and NDACC.
The Brewer instruments also provide spectral UV irradiation data at the surface (SSD - AGACC project).

BIRA-IASB performs routine measurements by UV-visible DOAS spectrometers of the ozone total column at the NDACC stations of the Jungfraujoch (Switzerland), Harestua (Norway), and Observatoire de Haute Provence (OHP, France) since 1990, 1994 and 1998, respectively. Belgian researchers (ULg-IAGL and BIRA-IASB) carry out daily measurements by FTIR spectrometry of the ozone total column and tropospheric column at the Jungfraujoch since 1990. In the framework of NDACC, FTIR measurements have also been performed on a campaign basis at Ile de La Reunion since 2002 (in collaboration with ULB-SPECAT). A campaign also took place at Uccle in 2006-2007.
Discussions are ongoing about contributions of NDACC to GRUAN (Global Reference Upper Air Network)

The sondes used for the ozone profiles provide also vertical profiles of temperature, humidity and wind. The AGACC project investigates the time series of humidity, with focus on the levels around the tropopause.
These ozone sonde observations are performed in the framework of the Solar-terrestrial Centre of excellence

Aerosols
In the framework of AERONET, a CIMEL sunphotometer is operating in Uccle since July 2006 for the measurement of aerosol optical depth and properties.
As part of WMO/GAW aerosol network the Brewer instruments (at the Station in Uccle) provide also aerosol optical depth in the UV, available at Uccle. These data are not in International databases.

It is foreseen that at the Princess Elisabeth Station at Antarctica the monitoring of other aerosol properties (ao PM10 mass) will be started in 2009-2010 (BelAtmos project).

In the framework of SPSD and SSD projects, UGent-INW is performing long-term aerosol collections at a number of sites (Spitsbergen, since 1991; Israel, since 1995; Zimbabwe, 1994-2000. It was involved in the investigation of the physical, chemical, and optical-radiative characteristics of aerosol parameters of relevance to direct radiative forcing. Among the relevant radiative aerosol properties are the aerosol refractive index, light scattering and light absorption, and column-integrated optical depth.
UGent-INW and UA-Phar are also contributing to research in the Amazon Basin, Brazil, dealing with the indirect climatic effect of biomass burning aerosols and in the Negev desert.

Table 1e. National contributions to atmospheric composition

Contributing networks in the GCOS implementation plan	ECV's *	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
World Meteorological Organisation/Global Atmosphere Watch (WMO/GAW) Global atmospheric CO_2 and CH_4 Monitoring Network	Carbon dioxide	0	0	1	0	0
	Methane	2	1	1	1	1
	Other GHGs	2	1	1	1	1
WMO/GAW ozone sonde network [(a)]	Ozone	1	1	1	1	1
WMO/GAW column ozone network [(b)]	Ozone	5	4	4	4	4
WMO/GAW Aerosol Network [(c)]	Aerosol optical depth	1	1	1	1	1
	Other aerosol properties			1		

[(a)] Including SHADOZ, NDACC, remote sensing and ozone sondes.
[(b)] Including filter, Dobson and Brewer stations.
[(c)] Including AERONET, SKYNET, BSRN and GAWPER.

2.3. *Satellite observations : availability of satellite measurements of atmospheric ECVs*

Table 2. Global products requiring satellite observations – atmospheric essential climate variables

ECVs/ **Global products requiring satellite observations**	**Fundamental climate data records** **required for product generation** **(from past, current and future missions**
Surface wind speed and direction Surface vector winds analyses, particularly from reanalysis	Passive microwave radiances and scatterometry
Upper-air temperature Homogenized upper-air temperature analyses: extended MSU-equivalent temperature record, new record for upper-troposphere and lower-stratosphere temperature using data from radio occultation, temperature analyses obtained from reanalyses	Passive microwave radiances, GPS radio occultation, high-spectral resolution IR radiances for use in reanalysis
Water vapour Total column water vapour over the ocean and over land, tropospheric and lower stratospheric profiles of water vapour	Passive microwave radiances, UV/VIS radiances, IR imagery and soundings in the 6.7um band, microwave soundings in the 183 GHz band ***See below***
Cloud properties Cloud radiative properties (initially key ISCCP products)	VIS/IR imagery, IR and microwave soundings **See below**
Precipitation Improved estimates of precipitation, both as derived from specific satellite instruments and as provided by composite products	Passive microwave radiances, high-frequency geostationary IR measurements, active radar (for calibration)
Earth radiation budget Top-of-atmosphere Earth radiation budget on a continuous basis	Broadband radiances, spectrally-resolved solar irradiances, geostationary multi spectral imagery
Ozone Profiles and total column of ozone	UV/VIS and IR microwave radiances ***BIRA-IASB, ULg-IAGL, ULB-SPECAT contribute to the retrieval and validation of ozone column/profile and GHGs profiles (including water vapour, N_2O, and CH_4), of the temperature profile, and of aerosol properties from satellite instruments on ERS-2 (GOME), Envisat (GOMOS, MIPAS and SCIAMACHY), MetOp-A (GOME-2 and IASI), and SCISAT-1 (ACE-FTS and ACE-MAESTRO); they also contribute to the validation of similar products from US and Chinese satellites.***
Aerosol properties Aerosol optical depth and other aerosol properties	VIS/NIR/SWIR radiances
Carbon dioxide, methane and other long-lived greenhouse gases Distribution of greenhouse gases, such as CO2 and CH4, of sufficient quality to estimate regional sources and sinks	NIR/IR radiances
Upper-air wind Upper-air wind analyses, particularly from reanalysis	VIS/IR imagery, Doppler wind lidar
Atmospheric reanalyses	Key FCDRs and products identified in this report, and other data of value to the analyses

Belgian Participation to space programmes plans to ensure availability of past and future data and metadata records of the satellite measurements for the atmospheric ECVs and associated global products

BIRA-IASB, ULg-IAGL, ULB-SPECAT contribute to the retrieval and/or validation and/or writing of related metadata (documentation, error analysis, quality information, harmonisation of formats) for the following satellite data records:

- Temperature vertical profile from Envisat MIPAS (since 2002) and SCISAT-1 ACE-FTS (since 2003)
- Column/profile of GHGs, including water vapour, N_2O, and CH_4, from Envisat MIPAS (since 2002), SCISAT-1 ACE-FTS (since 2003), MetOp-A IASI (since 2007)
- Ozone total column from ERS-2 GOME (since 1995), Envisat SCIAMACHY (since 2002), MetOp-A GOME-2 and IASI (since 2007), TOMS (N7-TOMS 1978-1993 and EP-TOMS 1996-2005) Aura OMI (since 2004). The GOME, SCIAMACHY and GOME-2 Data Processors operated at DLR on behalf of ESA and of EUMETSAT are based on the same prototype retrieval algorithm developed at BIRA-IASB. Special care is given to ensure long-term integrity and multi-mission consistency of the TOMS/GOME/SCIAMACHY/GOME-2 data records.
- Ozone vertical profile from ERS-2 GOME (1995-2003), Envisat (GOMOS, MIPAS and SCIAMACHY since 2002), SCISAT-1 (ACE-FTS and ACE-MAESTRO since 2003), MetOp-A IASI (since 2007), ERBS SAGE-II (1984-2005), NOAA-11 SBUV/2 (1988-2001), UARS HALOE and MLS (1991-2005), SPOT-3 POAM-II (1994-1996), SPOT-4 POAM-III (1998-2005). Special care is given to investigate and improve the long-term integrity and multi-mission consistency of the ozone profile data records.
- Carbon dioxide measured by the US OCO and the future Japanese GOSAT mission – This is planned for the future.

BIRA-IASB, ULg-IAGL, ULB-SPECAT contribute to the retrieval and validation of ozone column/profile and GHGs profiles (including water vapour, N_2O, and CH_4), of the temperature profile, and of aerosol properties from satellite instruments on ERS-2 (GOME), Envisat (GOMOS, MIPAS and SCIAMACHY), MetOp-A (GOME-2 and IASI), and SCISAT-1 (ACE-FTS and ACE-MAESTRO); they also contribute to the validation of similar products from US and Chinese satellites.

Synergistic use of satellite (e.g. ACE-FTS, IASI) and ground-based measurements is performed to better characterize the involved datasets and the variability, seasonal modulations and vertical distributions of the targeted species (e.g. H_2O).

3. Oceanic essential climate variables

3.1. National contributions of oceanographic ECV observations to the international community, paying special attention to the requirements outlined in the GCOS implementation plan.

The Belgica: an oceanographic research ship and service provider

The oceanographic research ship Belgica belongs to the Belgian State and falls under the responsibility of the Belgian Science Policy. The ship and its scientific equipment are managed by MUMM, which is also responsible for planning and organising scientific campaigns at sea
This all-purpose research vessel, which spends around two hundred days a year at sea, both monitors the quality of the marine environment and undertakes numerous expeditions for scientific research.
The Belgica monitors the quality of the marine ecosystem by constantly collecting all sorts of data on the biological, chemical, physical, geological and hydrodynamic processes. Her work area is the marine waters under Belgian jurisdiction and the "Greater North Sea", with occasional excursions up to Morocco and the Polar Circle. The vessel measures continuously several ECV's such as air temperature, wind, sea surface temperature and salinity, radiance, pCO_2. This system will be extended by 2009 to cover other biochemical data such as nutrients and plankton. These automatic data are sent to the shore twice a day or, in case of need, upon request. They are incorporated in Operational Oceanography procedures (within GOOS). The Belgica must thus be viewed as a mobile station collecting ECV's in her work area.

Table 3a. National contributions to the oceanic essential climate variables surface

Contributing networks in the GCOS implementation plan	ECV's *	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
Global surface drifting buoy array on 5x5 degree resolution	Sea surface temperature, sea level pressure, position-change-based current					
GLOSS Core Sea-level Network	sea level					
Voluntary observing ships (VOS)	all feasible surface ECVs	1 [a]		1[a]	1[a]	1 [b]
Ship of opportunity programme	all feasible surface ECVs					

a if the Belgica may be considered as a VOS
b if data from 1970 may be considered as historical

Partial pressure of CO_2 (pCO_2) in the Upper Scheldt and Bay of Calvi

Partial pressure of CO_2 (pCO_2) continuous measurements have been carried out since November 2002 in the upper Scheldt estuary (city of Antwerp). These data have been archived at the CARBOOCEAN data-base and will be archived at CDIAC in late 2010.

Partial pressure of CO_2 (pCO_2) continuous measurements have been carried out since August 2006 in the Bay of Calvi (Corsica) on a shallow mooring (10 m depth).

Table 3b. National contributions to the oceanic essential climate variables – water column

Contributing networks in the GCOS implementation plan	ECV's *	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
Global reference mooring network	all feasible surface and subsurface ECVs	2		2		
Global tropical moored buoy network	all feasible surface and subsurface ECVs					
Argo network	Temperature, salinity, current					
Carbon inventory survey lines	Temperature, salinity, ocean tracers, biogeochemistry variables					

Partial pressure of CO2 (pCO2) ((Southern Bight of the North Sea, English Channel, Bay of Biscay, Iberian coast)

Partial pressure of CO2 (pCO2) underway measurements have been carried out on every cruise of the RV Belgica since September 2002 (Southern Bight of the North Sea, English Channel, Bay of Biscay, Iberian coast). These data have been archived at the CARBOOCEAN data-base, will be included in the SOCAT data-base (public release in late 2009), and will be archived at CDIAC in late 2010.

Other parameters (not included in the table)

The following parameters were measured by ANCH-VUB (F. Dehairs) and MRAC-KMMA (L. André, D. Cardinal) during the SPSD BELCANTO and the FWO VERTIGO projects

Parameters: concentrations
Dissolved barium, silicate vertical profiles and transects
Particulate barium, calcium, strontium, aluminium, silicon profiles and transects
Particulate organic carbon and nitrogen profiles in upper 100m and transects
Specific biomarker (lipids) vertical profiles and transects

Stable C isotopic composition of bulk organic matter and biomarkers
Stable silicon isotopes of dissolved silicate and particulate Si

Parameters: activities and rates
Primary production and new production rates (from 13C, 15N uptake experiments)
Silicon uptake and dissolution rates (30Si uptake experiments)
234Th activity deficits in the upper 100m; 234Th export flux; Carbon export flux
Mesopelagic organic carbon remineralisation rates based on the barium-barite proxy

Regions studied:

Southern Ocean:
- Section Tasmania to Prydz Bay, including Prydz Bay; sampled 1991 (R/V Aurora Australis)
- WOCE SR3 line; Tasmania-Antarctica) + adjacent areas (140°-145°E); sampled 1998 (SAZ'98), 2001 (CLIVAR SR3), 2007 (SAZ-SENSE); (R/V Aurora Australis)
- WOCE I06 line; 30°E; sampled 1993 (CIVA-1; R/V Marion Dufresne)
- 30°E -90°E area; sampled 1987, 1994, 1995 (ANTARES 2, 3, 4; R/V Marion Dufresne)
- Kerguelen, Crozet area; sampled 1999, 2004 (R/V Marion Dufresne)
- Greenwich Meridian and Weddell Sea; sampled 1988 (EPOS-2); 1990 (ANTIX/2); 1992 (ANTX/6 & ANTX/7); 2004 (EIFEX); 2006 (ANTXXII-3); 2008 (BONUS; (R/V Polarstern and Marion Dufresne II)
- SAZ sediment trap time series station (140°E; subantarctic); operated by ACE-CRC but includes a sediment trap (IRS type) owned by us (R/V Aurora Australis)

Pacific:
ALOHA, Hawaii time series station; sampled 2004 (R/V Kilo Moana)
Subarctic Pacific (Japanese K2 time series station); sampled 2005 (R/V R. Revelle)

Data are, or will become, available in the following data bases:
http://www.obs-vlfr.fr/proof/vt/op/ec/keops/keo_involved.htm
http://www.cmar.csiro.au/datacentre/saz-sense/
http://ocb.whoi.edu/jg/dir/OCB/VERTIGO/
http://www.univ-brest.fr/IUEM/BONUS-GOODHOPE/

3.2. Actions in nominating national focal points for implementation of the oceanic observing system for climate and establishing partnerships between the ocean research and operational communities.

BMDC (Belgian Marine Data Centre)

All the research data (biological, chemical and physical) of the funded projects within the SPSD and SSD North Sea research programmes since 1997 as well as data resulting from various monitoring activities are stored - after a rigorous quality control - in the database managed by the BMDC (Belgian Marine Data Centre) of the Management Unit of the Mathematical Model of the North Sea (MUMM). The database can be accessed at this web page www.mumm.ac.be/datacentre

This database was developed in the frame of the project "IDOD: Integrated and dynamical oceanographic data management" within the programme "Sustainable Management of the North Sea - SPSD I". It lead to the IDOD Information System, made of the IDOD data base, the user interface, the spatial analysis tool and the statistical analysis tool. The system continues to be fed with new and historical data and to evolve according to the needs of the users and the progresses of the technology.

The environmental data with their physical meta-information are made available at the international level, through the International Council for the Exploration of the Sea. Actions are ongoing to double this transmission system, in the direction of the European Environmental Agency.

Flanders Marine Data and Information Centre (VMDC),

One of the major activities of the he Flanders Marine Institute (VLIZ) is the management of the Flanders Marine Data and Information Centre (VMDC). The VLIZ is a focal point for marine and coastal-related research and serves as an international contact point. The VLIZ signs cooperation agreements with Flemish research groups and administrations and furthermore integrates its activities in national and international networks.
It can be accessed by http://www.vliz.be

The Monitoring Network Flemish Banks
The Monitoring Network Flemish Banks (Meetnet Vlaamse Banken) was set up for the acquisition of real-time oceanographical and meteorological data along the Belgian coast and on the Belgian continental shelf.

- The oceanographic parameters monitored are waves, tidal height, current and water temperature.
- The meteorological parameters are wind, air pressure, air temperature and rainfall (see 'about' page for details on these measurements, including locations).

The Network is sponsored by the government of Flanders, and set up and maintained by the Coastal Division of the Agency for Maritime and Coastal Services VLIZ has been invited to make data resulting from the Monitoring Network available to third parties. Measurements are available at http://www.vliz.be/vmdcdata/midas/mvb.php?listloc

Belgian contribution to the International Project of Antarctic Buoys (IPAB) of the World Climate Research Programme (WCRP).
The buoy is situated on the sea ice. It has a GPS, a thermometer, a barometer and an ARGOS transmitter. The buoy was left there during the SIMBA cruise (S.F. Ackley, University of Texas; J.-L. Tison, ULB-GLACIOL; B. Delille, ULG-MARE) It is a Belgian contribution to the International Project of Antarctic Buoys (IPAB)of the World Climate Research Programme (WCRP). Measured variables are :hourly position of the buoy, air temperature and air pressure at the sea surface during the period 2/10/07 - 06/01/08

3.3. availability of data and metadata records of the satellite measurements for the oceanic ECVs

Table 4. Global products requiring satellite observations – oceans

ECVs **Global products requiring satellite observations**	**Fundamental climate data records required for product generation (from past, current and future missions**
Sea Ice Sea ice concentration	Microwave and visible imagery
Sea Level Sea level and variability of its global mean	Altimetry
Sea Surface Temperature Sea surface temperature	Single and multi-view IR and microwave imagery
Ocean Colour Ocean colour and oceanic chlorophyll-a concentration derived from ocean colour	Multi-spectral VIS imagery
Sea State Wave height and other measures of sea state (wave direction, wavelength, time period)	Altimetry
Ocean Salinity Research towards the measurement of changes	Microwave radiances

in sea surface salinity	
Ocean Reanalyses Altimeter and ocean surface satellite measurements	Key FCDRs and products identified in this report, and other data of value to the analyses

The Management Unit of the North Sea Mathematical Models and the Scheldt estuary generates the following products in the framework of its Belcolour project (2001 – 2011):

- Maps: Sea Surface Temperature (SST), chlorophyll a (CHL), Total Suspended Matter (TSM)
- Near real time (NRT) images: MODIS/ MERIS automatically processed, unvalidated maps (SST, CHL, TSM and quasi true colour) are made available for the last 14 days.

For more information: http://www.mumm.ac.be/BELCOLOUR/EN/Products/index.php

4. Terrestrial essential climate variables

4.1. national contributions of terrestrial ECV observations to the international community

Measuring C stocks in soils

Data from more than 13,000 geo-referenced soil profile descriptions, collected between 1950 and 1970, are used to assess the average and ranges of SOC stocks in Belgian soils. The CASTEC (Carbon Sequestration in Terrestrial Ecosystems) and METAGE (Modelling Ecosystem Trace Gas Emissions) projects are updating the C stock data, using routine soil fertility analyses for arable and grassland soils and forest inventory data for forest soils. SOC stocks for 1990, 1995, and 2000 are available.

Measurements of the net exchange flux of CO_2 between the atmosphere and the ecosystem

The Brasschaat , Gontrode-Almoeseneie and Vielsalm experimental stations measure the net exchange flux of CO_2 between the atmosphere and the ecosystem (NEE – Net Ecosystem Exchange) with eddy covariance systems. These experimental stations are respectively managed by UA-PLECO, UGent-Plantecology and FUSAGx-ECOPHYS). Funding of the Brasschaat station (also linked to CARBOEUROPE) within the ICOS initiative is at present taken under consideration.

Uganda crater lakes

The SSD project CLANIMAE responds to the urgent need of a correct long-term perspective to today's climate-environment-human interactions in tropical East Africa, by simultaneous high-resolution reconstruction of both past climatic variability and the history of vegetation and water-quality changes through multi-disciplinary analyses of dated lake-sediment records. The climate reconstructions will integrate information on biological, geochemical and sedimentological proxy indicators of past changes in the water balance of study lakes.

The CLANIMAE team has modern and historical surface-temperature data on more than 50 western Uganda crater lakes (i.e. ~70% of all regional lakes), based on compilation and standardisation of all available historical lake-monitoring data, (UGent-Limnology unpublished data 2000-2002) and new CLANIMAE lake-monitoring data 2007-2008.

Since 02/2007 temperature logger profiles are made in 3 western Uganda crater lakes and since 08/2007 in 5 lakes. The recording is continuously at 2-h intervals. It will continue for resp. 30 and 36 months.

Belgian participation to FP 7 project: PRUDENCE

The European PRUDENCE project produced regional climate change scenarios specifically for Europe and was consequently chosen as the main source of climate change scenarios. PRUDENCE is an acronym for Prediction of Regional scenarios and Uncertainties for Defining EuropeaN Climate change risks and Effects. It is a project with many European partners, funded by the EU 5th Framework Program and having as goal the evaluation of climate change risks over Europe in the end of the current century, as predicted by the most recent (at the project time) climate models. The project applied dynamic downscaling to generate climate data at small scales (12-60km). The PRUDENCE project carried out a series of 30-year long climate simulations for the reference period (1961-1990) and at the end of the 21st century (2071-2100). The models were run using A2 and B2 SRES scenarios and coupled with two Atmosphere Ocean Global Circulation Models (AOGCMs). The results of these simulations were then used to drive geographically more detailed RCM-based simulations (11 RCMs in total). The project ended in 2004 and at its end, the simulation data from its participants were freely available in public domain of the project host (http://prudence.dmi.dk). They were processed (daily time scale) for the variable precipitation and the following variables used to calculate potential reference evapotranspiration using the Bultot method of the Royal Meteorological Institute of Belgium:

- Mean Sea Level Pressure (MSLP)
- Total radiation balance (SWdown)
- Cloud covering (clcov)

- 2-meter temperature (t2m)
- 10-meter wind (w10m)
- Humidity

The final series are daily precipitation and daily potential evapotranspiration for each climate model grid cell covering the Belgian territory (for precipitation) or for the grid cell closest to the Uccle ground meteorological station (for potential evapotranspiration). 30-years series are derived for both the present reference period (1960-1990) and for the scenario period at the end of this century (2070-2100) for each climate model simulation listed in Table 1.
Table 1 shows the 21 PRUDENCE control experiments (1961-1990) that were derived. Table 2 shows the 31 RCM scenarios (2071-2100) for the future projections.

Lake temperature and conductivity lake Tanganyika (Zambia)
Amongst the essential variables mentioned as essential by GCOS , lake temperature and conductivity were measured: Water level was also recorded in Zambia. A paper co-authored by the KMMA-MRAC and published in "Nature" for example has clearly shown the increasing lake temperature and probable impact on the food web.

Antarctic ice-sheet dynamics and climatic change: Modelling and Ice Composition Studies
The SSD project AMICS contributes to the international research effort leading to an improved understanding of the dynamic behaviour of the Antarctic ice sheet resulting from climatic change. It aims at a better knowledge of the internal dynamics of the Antarctic ice sheet and to a better assessment of the interactions of the ice sheet with its boundary conditions. Therefore, it will develop a numerical model to translate the results of the ice-composition analyses into physical processes, hence providing the scientific community with a model tool of complex basal interaction. As basal processes play an important role in the onset of fast-flowing areas such as ice streams, the role of ice streams, outlet glaciers and ice shelves in the stability of the Antarctic ice sheet and their influence on the variability of the ice sheet with changing climate will be investigated.
Both research teams are involved in the ongoing EPICA project (European Project for Ice Coring in Antarctica).

Table 5. National contributions to terrestrial domain essential climate variables

Contributing networks in the GCOS implementation plan	ECV's *	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
GCOS baseline river discharge network (GTN-R)	River discharge					
GCOS Baseline Lake Level/ Area/Temperature Network (GTN-L)	Lake level/area/ temperature					

WWW/GOS synoptic network	Snow cover					
GCOS glacier monitoring network (GTN-G)	Glaciers mass balance and length, also ice sheet mass balance					
GCOS permafrost monitoring network (GTN-P)	Permafrost borehole temperatures and active layer thickness					

(No input in the table)

4.2. availability of data and metadata records of the satellite measurements for the terrestrial ECVs

Table 6. Global products requiring satellite observations – terrestrial

ECVs/ Global products requiring satellite observations	**Fundamental climate data records required for product generation (from past, current and future missions)**
Lakes Maps of lakes, lake levels, surface temperatures of lakes in the Global Terrestrial Network for Lakes	VIS/NIR imagery and radar imagery, altimetry, high-resolution IR imagery
Glaciers and ice caps Maps of the areas covered by glaciers other than ice sheets, ice sheet elevation changes for mass balance determination	High-resolution VIS/NIR/SWIR optical imagery, altimetry
Snow cover Snow areal extent	Moderate-resolution VIS/NIR/IR and passive microwave imagery
Albedo Directional hemispherical (black sky) albedo	Multispectral and broadband imagery
Land cover Moderate-resolution maps of land-cover type, high-resolution maps of land-cover type, for the detection of land-cover change	Moderate-resolution multispectral VIS/NIR imagery, high-resolution multispectral VIS/NIR imagery
fAPAR Maps of fAPAR	VIS/NIR imagery
LAI Maps of LAI	VIS/NIR imagery
Biomass Research towards global, above ground forest biomass and forest biomass change	L band/P band SAR, Laser altimetry
Fire disturbance Burnt area, supplemented by active fire maps and fire radiated power	VIS/NIR/SWIR/TIR moderate-resolution multispectral imagery
Soil moisture Research towards global near-surface soil moisture map (up to 10 cm soil depth)	Active and passive microwave

(No input for the table)

Belgium has been a partner in the VEGETATION programme since the beginning. VEGETATION is a multispectral optical VIS/NIR instrument, which acquires data of the entire terrestrial surface on a daily basis. It is operational since 1998.

The programme is committed to deliver data until the end of 2012. In order to ensure data continuity after 2012, a new mission under the name of PROBA-V is being prepared by the European Space Agency for launch late 2011 and will be built by Belgian companies.

Since 1998, VITO hosts the SPOT VEGETATION image processing and archiving centre. This centre processes all data received from the optical low-resolution vegetation instrument on board the SPOT4 and SPOT5 satellite, archives the processed data, compiles the image catalogue, and forwards finished products to data users.
For more information: http://www.vgt.vito.be/

Within its department for remote sensing and earth observation processes, the project Global Earth Observation in Support of Climate Change and Environmental Security Studies produces following terrestrial ECV's which can be freely downloaded from this site http://geofront.vgt.vito.be/geosuccess

Biomass related products:
- Net Primary Productivity > Carbon sinks and sources, Kyoto protocol, deforestation, environmental pollution
- Net Ecosystem Productivity > Carbon sinks and sources, Kyoto protocol
- Dry Matter Productivity > Crop yield forecasting, food security

Landcover product:
- Biome Classification > Ecology, biodiversity

Fire disturbance product:
- Burn Scar Detection > Atmospheric emissions, green recovery
- Burnt area products > New burnt areas detected in the last month.

Leaf area index > Derived from the combined use of ATSR and VEGETATION instruments.

fAPAR > Derived from the daily LAI intermediate products, combined with viewing and solar zenith angles and a ground cover based LUT.

Vegetation Growth Cycle Parameters > Derived from the LAI products. It is a yearly product containing information on the growth season.

Vietnam
Some Radar data and VHR satellite data (multi spectral & Panchromatic) over Vietnam were used in order to create /update local cartography and to derive environmental information such as flood vulnerability and Aquaculture Sustainability Index (project still ongoing).

China- the ARCHIMOD project
The ARCHIMOD project focuses on the set up of a spatially distributed and regional hydrological model for the Tarim river basin located in the Xinjiang Province of the P.R. of China. Part of the tasks of the ARCHIMOD project focus on the processing of satellite data, more specifically, AQUA MODIS, Feng-Yung 2C, CORONA, LANDSAT and SSM/I data. This encompasses the production of cloud and snow masks, LST and broadband albedo, evapotranspiration and evaporative fraction, snow depth, rainfall, NDVI, soil moisture content, land use data and energy balance fluxes for the ROI of

the Xinjiang Province. The hydrological model for the Tarim basin, developed by K.U.Leuven is utilized to assimilate the remote sensing inputs as cited here above. Hence the data use and data processing tasks in this project focus on algorithm development and product validation in the field of the remote sensing of hydrological variables.

Actually the iMODIS processing chain first version, as developed by Vito for AQUA MODIS raw data, has been transferred to the local Chinese partners (XIEG). Hence the MODIS archive present in XIEG can be processed to its full extent. Vito processed one and a half year of data (2004 – 2005) originating from Fukang receiving station as a benchmark for the processing of the full archive. The Fukang receiving station has a receiving footprint covering the complete Xinjiang province, which by and large has a surface area of over 160,000 km².

The project includes the development and running of the following iMODIS chain product lines:
1) Cloud and snow cover identification, snow cover and depth products;
2) Broadband albedo product;
3) Land Surface Temperature product (LST);
4) Energy balance products;
5) Evapotranspiration and evaporative fraction (ET and EF) products;
6) Rainfall product;
7) Soil moisture content (SMC) product;
8) Snow cover/depth product for the Tarim basin ROI;
9) Land cover / Land use product;
10) SRTM 90 meter DEM product for the Tarim basin ROI;
11) Data Assimilation of RS products in a distributed regional rainfall / run-off model for the Tarim basin.

The above-reported remote sensing based products on precipitation, snow cover and snow depth, temperature and evapotranspiration are assimilated in input layers for a distributed regional rainfall-runoff model. This model allows predictions to be made of river flow discharges, water levels, soil moisture content and groundwater levels across the study area.

5. Additional information

5.1. Princess Elisabeth Research Station

Belgium built a new Antarctic research station, the Princess Elisabeth Research Station. In February 2009 the first monitoring activities will start including continuous weather observations, geodynamic observations and measurement of aerosol particles.

The BELATMOproject in a first stage will monitor O_3 & related trace gases, UV Radiation & aerosol particles (physical, chemical, optical properties, impact on climate, in-situ production, long-range transport ,trends ,pollution level, natural and anthropogenic sources) The instruments used will be aethalometer, CIMEL, Nephelometer ,TEOM, CPC and SMPS.
In a future stage the BELATMOS project will measure Trace Gases : BrO, NO_2, OClO, O (atmospheric profiles, in-situ production ,long-range transport ,trends, tropospheric (ozone) chemistry, stratospheric ozone layer (O_3-hole), atmospheric photochemistry) using a
Brewer spectrophotometer, MAX-DOAS and sounding

The HydrAnt project will improve knowledge on surface mass balance (SMB) & atmospheric branch of the hydrological cycle (ABHC) in Antarctica , make a detailed evaluation of representation of the ABHC in atmospheric models and improve representation of SMB and ABHC in atmospheric models. The instruments that will be used are ;
AWS, Ceilometer, Infrared Radiation Pyrometer, Microwave Radiometer (2), Micro Rain Radar (2)

BELISSIMA, the project on Belgian Ice Sheet- Shelf Ice Measurements in Antarctica: aims at coupling of ice-dynamic surveying of the glaciers with ice-modelling & geochemical-isotopic studies It will use Ice-penetrating radar survey, Ice core drilling and radar survey to determine thickness of meteoric ice layer

The BELDIVA project performs microcosm experiments to mimic climate changes and detect the response of biological communities. It will search i.e. for fossils in paleolakes (i.e. shorelines during lake level highstands) to reconstruct past changes in the precipitation-evaporation balance

5.2. Phenology

The MODIRISK project will provide data on the distribution of endemic and invasive mosquitoes in Belgium. It will supply predictive spatial models on the presence/absence of mosquitoes and will contribute to understand the impact of eco-climatic changes on their distribution. Furthermore data will be linked up and compared with similar ongoing projects in The Netherlands. An improved understanding of the biodiversity of mosquito vectors is an essential step towards a better understanding of the ecology of the diseases they transmit.

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acronym	full	website
ACSG	Atmospheric Composition Sub Group	
AERONET	AErosol RObotic NETwork	
AGACC	Advanced exploitation of Ground-based measurements for Atmospheric Chemistry and Climate applications	http://www.oma.be/AGACC/Home.html
AMICS	Antarctic ice-sheet dynamics and climatic change: Modelling and Ice Composition Studies	http://homepages.ulb.ac.be/~fpattyn/amics/welcome.html
AOD	aerosol optical depths	
ARGOS	World tracking and environmental monitoring by satellite	http://www.argos-system.org/
BASCOE	Belgian Assimilation System of Chemical Observations from Envisat	http://www.bascoe.oma.be/index.html
BIRA-IASB	Belgisch Instituut voor Ruimte-Aëronomie - Institut d'Aéronomie Spatiale de Belgique- Belgian Institute for Space Aeronomy	http://www.bira.be
BMDC	Belgian Marine Data Centre	www.mumm.ac.be/datacentre/ -
BSRN	Baseline Surface Radiation Network	http://bsrn.ethz.ch/
CACHE PEP	Natural climate variability – extending the Americas palaeoclimate transect through the Antarctic peninsula to the pole	http://www.antarctica.ac.uk/bas_research/current_programmes/cac
CARBOEUROPE	Assesment of the European Terrestrial Carbon Balance.	*www.carboeurope.org/*
CARBOOCEAN	Marine carbon sources and sinks assessment	http://www.carboocean.org/
CDIAC	Carbon Dioxide Information Analysis Center	http://cdiac.ornl.gov/
CEOS	Committee on Earth Observation Satellites	http://www.ceos.org/
CHL	chlorophyll	
CIMEL		
CLANIMAY	Climatic and Anthropogenic Impacts on African Ecosystems	www.belspo.be/belspo/ssd/science/projects/CLANIMAE_en.pdf
COP	Conference of Parties	
DLR	German Aerospace Center	www.dlr.de/en/
EC	European Commission	http://europa.eu.int/comm/index_en.htm
ENSO	El Niño Southern Oscillation	
ENSO-CHILI	A continuous holocene record of ENSO variability in Southern Chile - A clue to a better understanding of interhemispheric climate teleconnections	http://www.belspo.be/belspo/fedra/proj.asp?l=en&COD=EV/10
EPICA	European Project for Ice Coring in Antarctica	http://www.esf.org/index.php?id=855
EP-TOMS	Earth Probe TOMS	http://jwocky.gsfc.nasa.gov/eptoms/ep_v8.html
ERBS	Earth Radiation Budget Satellite	
ERS-2	European Remote Sensing Satellite-2	
ESA	European Space Agency	http://www.esa.int
EUMETSAT	European Organisation for the	http://www.eumetsat.int/Home/index.htm

	Exploitation of Meteorological Satellites	
EVCs	Essential Climate Variables	
fAPAR	Fraction of Absorbed Photosynthetically Active Radiation	
FMDC	Flemish Marine Data and Information Centre (FMDC)	www.vliz.be/EN/Data_Centre/Data_Centre_intro
FTIR	Fourier Transform InfraRed	
FTS	Fourier Transform Spectrometer	
FUSAGx-ECOPHYS	Unité de Biologie végétale - Ecophysiology des arbres forestiers	http://www.fsagx.ac.be/ecophys/index.htm
GAW	Global Atmosphere Watch	http://www.wmo.int/pages/prog/arep/gaw/gaw_home_en.html
GAW	Global Atmosphere Watch	http://www.wmo.ch/index-en.html
GAWPER	Global Atmosphere Watch Precision Filter Radiometer Network	
GCMP	Generate Climate Monitoring Products	http://www.gcmp.dwd.de/
GCMPs	GCOS Climate Monitoring Principles	http://www.wmo.ch/pages/prog/gcos/index.php?name=monitoringp
GCOS	Global Climate Observing System	http://www.wmo.int/pages/prog/gcos/
GEO	intergovernmental Group on Earth Observations	www.earthobservations.org/
GEOLAND	Integrated GMES project on land cocver and vegetation	http://www.gmes-geoland.info/PROJ/index.php
GEOSS	Global Earth Observation System of Systems	http://www.epa.gov/geoss/
GHG	Greenhouse Gas	
GMES	Global Monitoring for Environment and Security	http://gmes.jrc.it/
GOME	Global Ozone Monitoring Experiment	http://earth.esa.int/services/esa_doc/doc_gom.html
GOMOS	Global Ozone Monitoring by Occultation of Stars	http://envisat.esa.int/instruments/gomos/
GOOS	Global Ocean Observing System	www.ioc-goos.org/
GOS	Global Observing System	http://www.wmo.int/pages/prog/www/OSY/GOS.html
GRUAN	Global Reference Upper Air Network	
GSN	Baseline Surface Radiation Network	
GTN-G	GCOS glacier monitoring network	
GTN-L	GCOS lake level/area/temperature network	
GTN-P	GCOS permafrost monitoring network	
GTN-R	GCOS baseline discharge network	
HOLANT	HOLANT - Holocene climate variability and ecosystem change in coastal East and Maritime Antarctica	http://www.holant.ugent.be/
IASI	Infrared Atmospheric Sounding Interferometer	
IRM-KMI	Institut Royal Météorologique – Koninklijk Meteorologisch Instituut - Royal Meteorological Institute	http://www.ozone.meteo.be/
IRM-KMI	Institut Royal Météorologique – Koninklijk Meteorologisch Instituut	http://www.meteo.be/meteo/view/en/65239-Home.html?fromlangch

	- Royal Meteorological Institute	
KMMA-MRAC	Koninklijk Museum voor Midden-Afrika-Musée Royal d'Afrique Centrale Royal Museum for Central Africa	http://www.africamuseum.be/
LAI	Leaf Area Index	
LAQUANT	Late Quaternary climate history of coastal Antarctic environments: a multi-proxy approach	http://www.laquan.ugent.be/
MeTOp	Meteorological Operational satellite (EUMETSAT)	
MIPAS	Michelson Interferometer for Passive Atmospheric Sounding	
MODIRISK	biodiversity of mosquitoes and monitoring/predicting its changes	http://www.modirisk.be/modirisk/GeneralSite/Generalpage.asp?WP
MUMM	Management Unit of the North Sea Mathematical Models and the Scheldt estuary	http://www.mumm.ac.be
MWP IA	meltwater pulse	
NCEP	National Centres for Environmental Predictions	http://www.ncep.noaa.gov/
NDAC	Network for the Detection of Atmospheric Composition Change	http://www.ndsc.ncep.noaa.gov/
NOAA	National Oceanic and Atmospheric Administration	www.noaa.gov/
NRT	near real time	
OCO	Orbiting Carbon Observatory	http://www.oco.noaa.gov/index.jsp?show_page=page_resource_lin
OMI	Ozone Monitoring Instrument	
PRODEX	PROgramme de Développement d'EXperiences scientifiques	http://sci.esa.int/science-e/www/area/index.cfm?fareaid=76
PRUDENCE	Prediction of Regional scenarios and Uncertainties for Defining EuropeaN Climate change risks and Effects	http://prudence.dmi.dk/
QA4EO	Quality Assurance Framework for Earth Observation data	calvalportal.ceos.org/CalValPortal/qa4eoInfo.d
RBINS	Royal Belgian Institute of Natural Sciences	http://www.naturalsciences.be/
RCMG	Renard Centre for Marine Geology	www.rcmg.ugent.be
RSL	Relative Sea Level	
SAF	Satellite Application Facility	
SAGE	Stratospheric Aerosol and Gas Experiment	
SBUV	Solar Backscatter UltraViolet	
SCAR	Scientific Committee on Antarctic Research	http://www.scar.org/
SCIAMACHY	SCanning Imaging Absorption SpectroMeter for Atmospheric CHartographY	http://envisat.esa.int/instruments/sciamachy/
SciSAT	Science SATellite	
SHADOZ	Southern Hemisphere ADditional OZonesondes	http://croc.gsfc.nasa.gov/shadoz/
SIMBA	Sea Ice Mass Balance in the Antarctic	
SKYNET	observation network to understand aerosol -cloud-radiation interaction in the atmosphere	http://atmos.cr.chiba-u.ac.jp/

SOCAT	Surface Ocean CO2 Atlas (SOCAT)	
SPSD I	Multiannual Scientific Support Plan for a Sustainable Development Policy	http://www.belspo.be/belspo/home/port_en.stm
SPSD II	Second Multiannual Scientific Support Plan for a Sustainable Development Policy	http://www.belspo.be/belspo/home/port_en.stm
SSD	Science for a Sustainable Development	http://www.belspo.be/belspo/ssd/index_en.stm
SST	sea surface temperature	
SWIR	shortwave infrared	
TCCON	Total Carbon Observing Network	http://www.tccon.caltech.edu/
TIR	thermal infrared	
TSM	total suspended matter	
UA-PLECO	Research group on plant and vegetation ecology	http://www.uia.ac.be/bio/pleco/
UARS	Upper Atmosphere Research Satellite	http://umpgal.gsfc.nasa.gov/
ULB-SPECAT	Unité de spectroscopie de l'atmosphère	http://www.ulb.ac.be/rech/inventaire/unites/ULB587.html
ULB-Glaciol	Univeristé Libre de Bruxelles - Laboratory of Glaciology	http://dev.ulb.ac.be/glaciol/index.htm
Ulg-IAGL	Institut d'Astrophysique et Géophysique/Institute of Astrophysics and Geophysics	www.astro.ulg.ac.be/
ULG-MARE	University of Liège - Interfacultary Center for Marine Research (MARE)	http://www2.ulg.ac.be/oceanbio/MARE/
Ulg-URAP	Unité de Recherche Argiles et Paléoclimats	http://www.ulg.ac.be/urap/
UNESCO	United Nations Educational, Scientific and Cultural Organization	http://portal.unesco.org/
UNFCCC	United Nations Framework Convention on Climate Change	http://www.unfccc.de/
VIS-NIR	visible and near-infrared (VIS-NIR	
VITO	Vlaamse Instelling voor Technologisch Onderzoek	http://www.vito.be/english/
VLIZ	Vlaams Instituut voor de zee/Flanders Marine Institute	www.vliz.be/EN/
VOSclim	Voluntary Observing Ship Climate Project	http://lwf.ncdc.noaa.gov/oa/climate/vosclim/vosclim.html
WCRP	World Climate Research Programme	http://www.wmo.ch/web/wcrp/wcrp-home.html
WGCV	Working Group for Calibration and Validation	wgcv.ceos.org/wgcv/wgcv.htm
WMO		
WOUDC	World Ozone and Ultraviolet Radiation Data Centre	http://www.woudc.org/index_e.html
WWW	World Weather Watch	http://www.wmo.ch/pages/prog/www/index_en.html