26th Nov 18

Documentation on the Terrestrial Observatory of Viesalm (OTV)

1. Owners/Authors

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This report was written by Anne De Ligne and Tanguy Manise.

2. Site description

The Vielsalm site is a mature forest of beech (*Fagus sylvatica* L. ; 110 years old) and Douglas fir (*Pseudotsuga Menziesii* (Mirb.) Franco ; 83 years old) mainly. Other species are also present in the overstory : Norway spruce (*Picea abies* (L.) Karst.), Scots pine (*Pinus sylvestris* L.), Silver fir (*Abies alba* Mill.), Western Hemlock (*Tsuga Heterophylla* (Raf.) Sarg), Silver birch (*Betula pendula* Roth.) and Oaks (Quercus sp.).

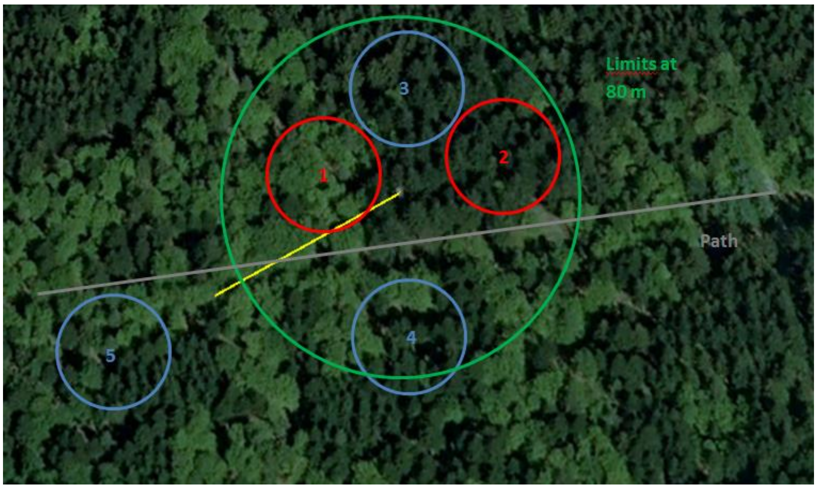
The canopy height is 34,6 meters (measured in 2014).

The understory is heterogeneous with twenty different species, including seven woody species and five species of mosses. The most represented species are *Abies alba* Mill., *Picea abies* (L.) Karst., *Dicranium scoparium* Hedw., *Polytrichum formosum* Hedw., *Dryopteris filix-mas* L., *Rubus Caesius* L. and *Vaccinium myrtillus* L.

3. Site localisation

Site geographical coordinates are 50°18'17.76"N - 5°59'53.21"E

The plan view below shows the sub-plots of the site. The two first sub-plots (in red on the plan) are priority for the ICOS (Integrated Carbon Observation System) project.



Main wind : 240°
Mean peak footprint : 285 m
Location of sub-plot 1 : 283° - 34.87 m
Location of sub-plot 2 : 70° - 45,24 m
Location of sub-plot 3 : 3° - 44 m
Location of sub-plot 4 : 170° - 63 m
Location of sub-plot 5 : 240° - 140 m.

Sub-plots are 25 meters radius.

4. Flux measurements

4.1 List of sensors variables

Variables Code List :

TABLE 1: Base names for data variable labels[1]

Variable	Units	Description
TIMEKEEPING		
TIMESTAMP	YYYYMMDDHHMMSS	ISO timestamp - short format
GASES		
CO2	umolCO2 mol-1	Carbon Dioxide (CO2) mole fraction
H2O	mmolH2O mol-1	Water (H2O) vapor mole fraction
CH4	nmolCH4 mol-1	Methane (CH4) mole fraction
NO	nmolNO mol-1	Nitric oxide (NO) mole fraction
NO2	nmolNO2 mol-1	Nitrogen dioxide (NO2) mole fraction
N2O	nmolN2O mol-1	Nitrous Oxide (N2O) mole fraction
O3	nmolO3 mol-1	Ozone (O3) mole fraction
FC	umolCO2 m-2 s-1	Carbon Dioxide (CO2) flux
FCH4	nmolCH4 m-2 s-1	Methane (CH4) flux
FNO	nmolFNO m-2 s-1	Nitric oxide (NO) flux
FNO2	nmolFNO2 m-2 s-1	Nitrogen dioxide (NO2) flux
FN2O	nmolN2O m-2 s-1	Nitrous oxide (N2O) flux
FO3	nmolFO3 m-2 s-1	Ozone (O3) flux
SC	umolCO2 m-2 s-1	CO2 storage flux
SCH4	nmolCH4 mol-1	Methane (CH4) storage flux
SNO	nmolNO mol-1	Nitric oxide (NO) storage flux
SNO2	nmolNO2 mol-1	Nitrogen dioxide (NO2) storage flux
SN2O	nmolN2O mol-1	Nitrous oxide (N2O) storage flux
SO3	nmolO3 mol-1	Ozone (O3) storage flux

[1] Please see Appendix A for timekeeping base names used for transitional and compatibility purposes.

FOOTPRINT		
FETCH_MAX	m	Distance at which footprint contribution is maximum
FETCH_90	m	Distance at which footprint cumulative probability is 90%
FETCH_80	m	Distance at which footprint cumulative probability is 80%
FETCH_70	m	Distance at which footprint cumulative probability is 70%
FETCH_FILTER	adimensional	Footprint quality flag: 0 identifies data measured when wind coming from direction that should be discarded
FC_SSITC_TEST	adimensional	Quality check - Mauder and Foken 2004
FCH4_SSITC_TEST	adimensional	Quality check - Mauder and Foken 2004
FNO_SSITC_TEST	adimensional	Quality check - Mauder and Foken 2004
FNO2_SSITC_TEST	adimensional	Quality check - Mauder and Foken 2004
FN2O_SSITC_TEST	adimensional	Quality check - Mauder and Foken 2004
FO3_SSITC_TEST	adimensional	Quality check - Mauder and Foken 2004
HEAT		
G	W m-2	Soil heat flux
H	W m-2	Sensible heat flux
LE	W m-2	Latent heat flux
SG	W m-2	Heat storage in the soil above the soil heat fluxes measurement
SH	W m-2	Heat storage in the air
SLE	W m-2	Latent heat storage flux
SB	W m-2	Heat storage in biomass
H_SSITC_TEST	adimensional	Quality check - Mauder and Foken 2004
LE_SSITC_TEST	adimensional	Quality check - Mauder and Foken 2004
MET_WIND		
WD	Decimal degrees	Wind direction
WS	m s-1	Wind speed
WS_MAX	m s-1	maximum WS in the averaging period
USTAR	m s-1	Friction velocity
ZL	adimensional	Stability parameter
TAU	Kg m-2 s-1	Momentum flux
MO_LENGTH	m	Monin-Obukhov length
U_SIGMA	m s-1	Standard deviation of velocity fluctuations (towards main-wind direction after coordinates rotation)
V_SIGMA	m s-1	Standard deviation of lateral velocity fluctuations (cross main-wind direction after coordinates rotation)
W_SIGMA	m s-1	Standard deviation of vertical velocity fluctuations
TAU_SSITC_TEST	adimensional	Quality check - Mauder and Foken 2004
MET_ATM		
PA	kPa	Atmospheric pressure
RH	%	Relative humidity, range 0-100

TA	deg C	Air temperature
VPD	hPa	Vapor Pressure Deficit
T_SONIC	deg C	Sonic temperature
T_SONIC_SIGMA	deg C	Standard deviation of sonic temperature
PBLH	m	Planetary boundary layer height
MET_SOIL		
SWC	%	Soil water content (volumetric), range 0-100
TS	deg C	Soil temperature
WATER_TABLE_DEPTH	cm	Water table depth
MET_RAD		
ALB	%	Albedo, range 0-100
APAR	umol m-2 s-1	Absorbed PAR
FAPAR	%	Fraction of absorbed PAR, range 0-100
FIPAR	%	Fraction of intercepted PAR, range 0-100
NETRAD	W m-2	Net radiation
PPFD_IN	umolPhoton m-2 s-1	Photosynthetic photon flux density, incoming
PPFD_OUT	umolPhoton m-2 s-1	Photosynthetic photon flux density, outgoing
PPFD_BC_IN	umolPhoton m-2 s-1	Photosynthetic photon flux density, below canopy incoming
PPFD_BC_OUT	umolPhoton m-2 s-1	Photosynthetic photon flux density, below canopy outgoing
PPFD_DIF	umolPhoton m-2 s-1	Photosynthetic photon flux density, diffuse incoming
PPFD_DIR	umolPhoton m-2 s-1	Photosynthetic photon flux density, direct incoming
SW_IN	W m-2	Shortwave radiation, incoming
SW_OUT	W m-2	Shortwave radiation, outgoing
SW_BC_IN	W m-2	shortwave radiation, below canopy incoming
SW_BC_OUT	W m-2	shortwave radiation, below canopy outgoing
SW_DIF	W m-2	Shortwave radiation, diffuse incoming
SW_DIR	W m-2	Shortwave radiation, direct incoming
LW_IN	W m-2	Longwave radiation, incoming
LW_OUT	W m-2	Longwave radiation, outgoing
LW_BC_IN	W m-2	Longwave radiation, below canopy incoming
LW_BC_OUT	W m-2	Longwave radiation, below canopy outgoing
SPEC_RED_IN	umolPhoton m-2 s-1	Radiation (red band), incoming
SPEC_RED_OUT	umolPhoton m-2 s-1	Radiation (red band), outgoing
SPEC_RED_REFL	adimensional	Reflectance (red band)
SPEC_NIR_IN	umolPhoton m-2 s-1	Radiation (near infra-red band), incoming
SPEC_NIR_OUT	umolPhoton m-2 s-1	Radiation (near infra-red band), outgoing
SPEC_NIR_REFL	adimensional	Reflectance (near infra-red band)
SPEC_PRI_TGT_IN	umolPhoton m-2 s-1	Radiation for PRI target band (e.g., 531 nm), incoming
SPEC_PRI_TGT_OUT	umolPhoton m-2 s-1	Radiation for PRI target band (e.g., 531 nm), outgoing
SPEC_PRI_TGT_REFL	adimensional	Reflectance for PRI target band (e.g., 531 nm)
SPEC_PRI_REF_IN	umolPhoton m-2 s-1	Radiation for PRI reference band (e.g., 570 nm), incoming
SPEC_PRI_REF_OUT	umolPhoton m-2 s-1	Radiation for PRI reference band (e.g., 570 nm), outgoing

SPEC_PRI_REF_REFL	adimensional	Reflectance for PRI reference band (e.g., 570 nm)
NDVI	adimensional	Normalized Difference Vegetation Index
PRI	adimensional	Photochemical Reflectance Index
R_UVA	W m-2	UVA radiation, incoming
R_UVB	W m-2	UVB radiation, incoming
MET_PRECIP		
P	mm	Precipitation
P_RAIN	mm	Rainfall
P_SNOW	mm	Snowfall
D_SNOW	cm	Snow depth
RUNOFF	mm	Run off
BIOLOGICAL		
DBH	cm	Diameter of tree measured at breast height (1.3m) with continuous dendrometers
LEAF_WET	%	Leaf wetness, range 0-100
SAP_DT	deg C	Difference of probes temperature for sapflow measurements
SAP_FLOW	mmolH2O m-2 s-1	Sap flow measurement
STEMFLOW	mm	Stemflow
THROUGHFALL	mm	Excess water from wet leaves reaching the ground
T_BOLE	deg C	Bole temperature
T_CANOPY	deg C	Temperature of the canopy
PRODUCTS		
NEE	umolCO2 m-2 s-1	Net Ecosystem Exchange
RECO	umolCO2 m-2 s-1	Ecosystem Respiration
GPP	umolCO2 m-2 s-1	Gross Primary Productivity

Source : http://www.europe-fluxdata.eu/home/guidelines/obtaining-data/variables-and-formats

In addition of the variable name it is requested to use a 3 figures code which identifies univocally the location within the site where measurements are taken. The importance of this code is related to the possibility to associate to each variable a set of metadata like the method or instrument used, the measurement depth/height, the last calibration of the sensor etc.
Generally, the name of the variable has to be indicated as:

$$\mathbf{VAR\_x_1\_x_2\_x_3}$$

VAR= variable name (refer to the list of input variables)
The first figure stands for the position of the sensors on a 2D space. For instance, if soil temperature is measured at 3 different locations, these can be numbered as 1, 2, 3.

TS_1_x_x	**TS_2_x_x**	**TS_3_x_x**
location 1	*location 2*	*location 3*

The second figure represents the vertical level (height above the ground/depth of the soil) of the sensors. Supposing to measure soil temperature at 3 different depths along a vertical profile at each location, then each variable can be identified as follows:

TS_1_1_x	**TS_2_1_x**	**TS_3_1_x**	*depth 1*
TS_1_2_x	**TS_2_2_x**	**TS_3_2_x**	*depth 2*
TS_1_3_x	**TS_2_3_x**	**TS_3_3_x**	*depth 3*
location 1	*location 2*	*location 3*	

Numeration increases moving downwards along a vertical profile but same number at two different locations can indicate different height/depth, that is specified in the metadata. So for example the deeper soil temperature measurement point in two different profiles of 4 sensors each will be indicated as TS_1_4_1 and TS_2_4_1 even if the first is at 80cm and the second 120cm below ground. The third figure identifies the presence of replicated measurements in the same location. For instance, given 2 replicates of soil temperature measurements at position 1 and depth 1 (i.e. for sensors comparison), these would be indicated as:

TS_1_1_1 **TS_1_1_2**

Another example where the third figure should be used is for measurements at tree level like sap flow sensors. In this case the first figure indicate the tree (again specified in the metadata), the second the measurement height if you have for example sap flow measurements on the same tree at different heights and the third can be used to identify different sensors at the same height, commonly used in sap flow measurements.

4.2 Timestamp

The timestamp of data is 30 minutes. From 2015, meteorological data are acquired with a frequency of 0.1 Hz and are averaged by 30 minutes.

Data found on the European Fluxes Database Cluster are in Local Time without daylight saving time (UTC+1).

The timestamp of variables found in internal files (MET, FLX, BRUT, UNCOR) are in the UTC time until April 2015. On the 1st May 2015, those internal files are in UTC+1.
L2 files are always in UTC+1.

4.3 Sensors

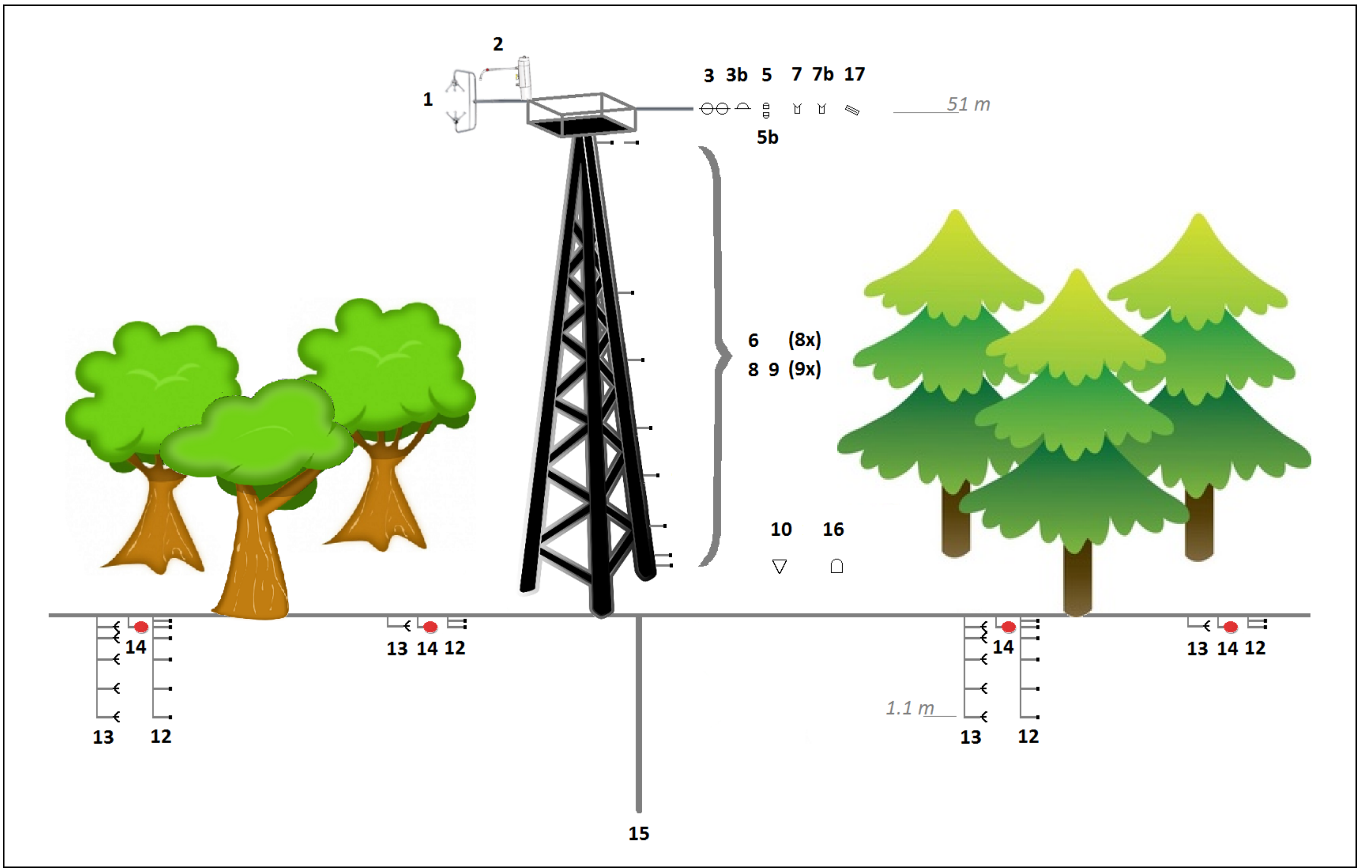
The sensors used are listed below for different periods.

- 01/11/2014 to now: installation of sensor with ICOS project.
- 01/05/2009 to 01/11/2014: construction of a pylon of 50 meters high.

- 01/08/1996 to 01/05/2009: first tower, a scaffolding of 40 meters high.

The list is complete for 2014 and further. Before 2014, an investigation has been conducted to gather a maximum of previous information in this document; it's possible that some information is missing before 2014. If you have any question or comment, please contact us (Anne.DeLigne@ulg.ac.be).

From 01/11/2014, ICOS Project



	Date of installation	Device	Reference	Variable	Code	Height (m)	nbr.
1	1.04.2014	Sonic anemometer	Solent Research HS-50, Gill Instruments Lymington, UK	Wind velocity	WS_1_1_1 WD_1_1_1	51	1
2	1.04.2014	Infrared gaz analyser	LI-7200, LI-COR, Lincoln, NE, USA	Concentration of CO2 and of H2O	CO2_1_1_1 H2O_1_1_1	51	1
3	13.03.2015	Pyrradiometer	CNR 4, Kipp and Zonen, Delft, NL	Solar radiation	SW_IN_1_1_1, SW_OUT_1_1_1, LW_IN_1_1_1, LW_OUT_1_1_1, NETRAD_1_1_1	51	1
3b	1.05.2009	Pyranometer	CM5, Kipp and Zonen, Delft, NL	Global solar radiation (bis)	SW_IN_1_1_2	51	1
5	13.03.2015	Photo-receptor Cells	PAR Quantum sensor SKP 215 Skye Instruments Limited, UK	Photosynthetic Photon Flux Density	PPFD_IN_1_1_1	51	1

5b	13.03.2015	Photo-receptor Cells	PAR Quantum sensor SKP 215 Skye Instruments Limited, UK	Reflected Photosynthetic Photon Flux Density	PPFD_OUT_1_1_1	51	1
6	16.09.2014	Infrared gaz analyser	Li-7000, LI-COR, Lincoln (NE, USA)	CO_2 and H_2O concentration	CO2_1_1_2 - CO2_1_8_1, H2O_1_1_2 – H2O_1_8_1	49.5, 30.9, 18.9, 10.85, 7.1, 3, 0.93, 0.4	8
7	1.02.2015	Tipping Bucket Rain Gauge	52202, R.M. Young Company, Traverse city, MI, USA	Precipitation	P_1_1_2	51	1
7b	1.05.2009	Tipping Bucket Rain Gauge	52202, R.M. Young Company, Traverse city, MI, USA	Precipitation	P_1_1_1	51	1
8 - 9	13.11.2014	Thermistor and electrical capacitive hygrometer	RHT2nl, Delta-T Devices Ltd, Cambridge, UK	Air temperature Air humidity	TA_1_1_1 - TA_1_8_1, RH_1_1_1 - RH_1_8_1, TA_1_1_2, RH_1_1_2	50.8, 30.4, 18.45, 12.41, 6.35, 2.65, 1.45, 0.3	9
10	27.03.2015	Barometer	PTB110/CS106, Campbell Scientific, Logan, UT, USA	Atmospheric pressure	PA_1_1_1	1.5	1
12	13.10.2014	Electrical resistance thermometer	PT 107, Campbell Scientific, Logan, UT, USA	Soil temperature	TS_1_1_1 - TS_1_6_1 (Sub-plot 1), TS_2_1_1 - TS_2_6_1 (Sub-plot 2), TS_3_1_1, TS_3_2_1 (Sub-plot 1), TS_4_1_1, TS_4_2_1 (Sub-plot 2)	-0.01, -0.05, -0.18, -0.42, -0.76, -1.1	16
13	13.10.2014	Water Content Reflectometer	CS616, Campbell Scientific, Logan, UT, USA	Soil moisture	SWC_1_1_1 - SWC_1_5_1 (Sub-plot 1), SWC_2_1_1 - SWC_2_5_1 (Sub-plot 2), SWC_3_1_1 (Sub-plot 1), SWC_4_1_1 (Sub-plot 2)	-0.05, -0.18, -0.42, -0.76, -1.1	12

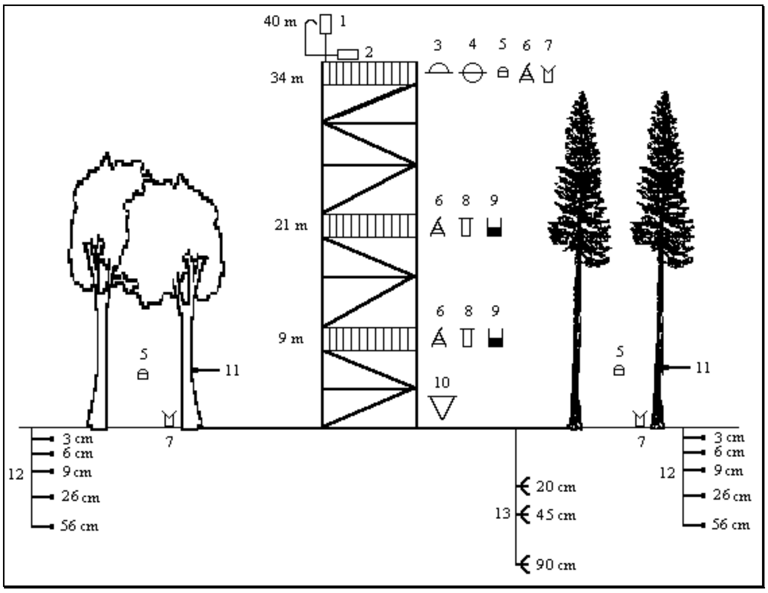
14	13.10.2014	Self-Calibrating Soil Heat Flux Plate	HFP01SC, Hukseflux Thermal Sensors B.V., Delft, NL	Soil Heat Flux	G_1_1_1 (Sub-plot 1), G_2_1_1 (Sub-plot 2), G_3_1_1 (Sub-plot 1), G_4_1_1 (Sub-plot 2)	-0.05	4
15	5.02.2015	Pressure Transducer	CS451, Campbell Scientific, Logan, UT, USA	Water table depth	WATER_TABLE_DEPTH _1_1_1	-4	1
16	1.12.2014	Sonic Ranging Sensor	SR50A-L, Campbell Scientific, Logan, UT, USA	Snow depth	D_SNOW_1_1_1	2.5	1
17	13.03.2015	Infra-red Remote Temperature Sensor	IR 120, Campbell Scientific, Logan, UT, USA	Canopy temperature	T_CANOPY_1_1_1	51	1
-	22.10.2007	NDVI sensor	Labo ESE Unif Paris	NDVI	NDVI_1_1_1	51	1

01/05/2009 to 01/11/2014

	Date of installation	Device	Reference	Variable	Code	Height (m)	nbr.
1	1.08.1996	Sonic anemometer	Solent 1012R2, Gill Instruments Lymington, UK	Wind velocity	WS_1_1_1 WD_1_1_1	52	1
2	1.08.1996	Infrared gaz analyser	LI-6262, LI-COR, Lincoln, NE, USA	Concentration of CO2 and of H2O	CO2_1_1_1 H2O_1_1_1	52	1
3	1.05.2009	Pyranometer	CM5, Kipp and Zonen, Delft, NL	Global solar radiation	SW_IN_1_1_1	51	1
4	5.11.2003	Pyrradiometer	Q*7.1, REBS, Seattle, WA, USA	Net solar radiation	NETRAD_1_1_1	51	2
5	28.09.2006	Photo-receptor Cells	PAR Quantum sensor SKP 215 Skye Instruments Limited, UK	Photosynthetic Photon Flux Density	PPFD_IN_1_1_1	51	1
6	3.11.2009	Infrared gaz analyser	LI-820, LI-COR, Lincoln, NE, USA	CO_2 concentration	CO2_1_2_1 to CO2_1_9_1	49.5, 30.9, 18.9, 10.85, 7.1, 3, 0.93, 0.4	8
7	1.05.2009	Tipping Bucket Rain Gauge	52202, R.M. Young Company, Traverse city, MI, USA	Precipitation	P_1_1_1	51	1
8 - 9	1.05.2009	Thermistor and electrical capacitive hygrometer	RHT2nl, Delta-T Devices Ltd, Cambridge, UK	Air temperature Air humidity	TA_1_1_1, TA_1_2_1, RH_1_1_1, RH_1_2_1	50, 12	2
10	1.08.1996	Barometer	MPX4115A, Motorola, Phoenix, AR, USA	Atmospheric pressure	PA_1_1_1	-	1
12	16.10.2006	Thermometer with platinium resistance	PT 1000, Hy-Cal Eng., El Monte, CA, USA	Soil temperature	TS_1_1_1 - TS_1_5_1	-0.03, -0.08, -0.13, -0.27, -0.57	5
13	1.08.1996	Time domain reflectometer	ML2, ThetaProbe, Delta-T Devices Ltd, Cambridge, UK	Soil moisture	SWC_1_1_1, SWC_1_2_1, SWC_1_3_1	-0.2, -0.45, -0.9	3

-	22.10.2007	NDVI sensor	labo ESE Unif Paris	NDVI	NDVI_1_1_1	51	1

01/08/1996 to 01/05/2009



List of sensors, made in 2002:

	Date of installation	Device	Reference	Variable	Code	Height (m)	nbr.
1	1.08.1996	Sonic anemometer	Solent 1012R2, Gill Instruments Lymington, UK	Wind velocity	WS_1_1_1 WD_1_1_1	40	1
2	1.08.1996	Infrared gaz analyser	LI-6262, LI-COR, Lincoln, NE, USA	Concentration of CO2 and of H2O	CO2_1_1_1 H2O_1_1_1	40	1
3	1.08.1996	Pyranometer	CM5, Kipp and Zonen, Delft, NL	Global solar radiation	SW_IN_1_1_1	34	1
4	1.08.1996	Pyrradiometer	8111, Schenck, Wien, Austria	Net solar radiation	NETRAD_1_1_1	34	2
5	1.08.1996	Photo-receptor Cells	SD101Q, Delta-T Devices Ltd, Cambridge, UK	Photosynthetically active Radiation	PPFD_IN_1_1_1	34	17
6	1.08.1996	Infrared gaz analyser	WMA-2, PP system, Hitchin, UK	CO_2 concentration	CO2_1_2_1, CO2_1_3_1, CO2_1_4_1	36, 21, 9	3
7	1.08.1996	Collector + Tipping Bucket	Unit of physics, FUSAGx, Gembloux (B)	Precipitation	P_1_1_1	34	1
8	1.08.1996	Thermometer with platinium resistance	PT 1000, Hy-Cal Eng., El Monte, CA, USA	Air temperature	TA_1_1_1, TA_1_2_1	21, 9	2

9	1.08.1996	Electrical capacitive hygrometer	Unit of physics, FUSAGx, Gembloux (B) RH2, General Eastern, Watertown, MA, USA	Air humidity	RH_1_1_1, RH_1_2_1	21, 9	2
10	1.08.1996	Barometer	MPX4115A, Motorola, Phoenix, AR, USA	Atmospheric pressure	PA_1_1_1	-	1
11	1.08.1996	Thermometer with platinium resistance	PT 1000, Hy-Cal Eng., El Monte, CA, USA	Bole temperature	T_BOLE_1_1_1	-	8
12	1.08.1996	Thermometer with platinium resistance	PT 1000, Hy-Cal Eng., El Monte, CA, USA	Soil temperature	TS_1_1_1, TS_1_2_1, TS_1_3_1, TS_1_4_1, TS_1_5_1	-0.04, -0.065, -0.1, -0.27, -0.57	5
13	1.08.1996	Time domain reflectometer	ML2, ThetaProbe, Delta-T Devices Ltd, Cambridge, UK	Soil moisture	SWC_1_1_1, SWC_1_2_1, SWC_1_3_1	-0.2, -0.45, -0.9	3

Modifications

- * Before 24/03/1997, the eddy covariance system was at 36m high.
- ** CO2 profile has been replaced by a profile of 8 points on the 01/04/2002.

	Date of installation	Device	Reference	Variable	Code	Height (m)	nbr.
6	1.04.2002	Infrared gaz analyser	WMA-2, PP system, Hitchin, UK	CO_2 concentration	CO2_1_2_1, CO2_1_3_1, CO2_1_4_1, CO2_1_5_1, CO2_1_6_1, CO2_1_7_1, CO2_1_8_1, CO2_1_9_1	36, 32, 24, 16, 6.05, 2.98, 0.98, 0.41	8

- New sensors

	Date of installation	Device	Reference	Variable	Code	Height (m)	nbr.
4	5.11.2003	Pyrradiometer	Q*7.1, REBS, Seattle, WA, USA	Net solar radiation	NETRAD_1_1_1	34	2
	20.04.2006	Photo-receptor Cells	BF3, Delta-T Devices Ltd, Cambridge, UK	diffuse PPFD	PPFD_DIF_1_1_1	34	1
5	28.09.2006	Photo-receptor Cells	PAR Quantum sensor SKP 215 Skye Instruments Limited, UK	Photosynthetic Photon Flux Density	PPFD_IN_1_1_1	34	1
8 - 9	28.09.2006	Thermistor and electrical capacitive hygrometer	RHT2nl, Delta-T Devices Ltd, Cambridge, UK	Air temperature Air humidity	TA_1_1_1, TA_1_2_1, RH_1_1_1, RH_1_2_1	21, 9	2
12	16.10.2006	Thermometer with platinium resistance	PT 1000, Hy-Cal Eng., El Monte, CA, USA	Soil temperature	TS_1_1_1, TS_1_2_1, TS_1_3_1, TS_1_4_1, TS_1_5_1	-0.03, -0.08, -0.13, -0.27, -0.57	5
-	22.10.2007	NDVI sensor	Labo ESE Unif Paris	NDVI	NDVI_1_1_1	34	1

4.4 Process

Soft

The soft used to process data hasn't been always the same.
Edisol has been used from 1996 to 2003. (using : Running mean)

Then, Eddysoft has been used. (using : Block average, 2D coordinate rotation)

For the period 1996-2003, because some raw data (.slt file) has been lost (erased CD's), we keep the data processed by Edisol.

Canopy Height

3 inventories made in 1996, 2009 and 2014 allowed us to estimate the annual increment of canopy height. These canopy heights have been used to calculate the stability parameter.

Year	Measured canopy height	Estimated canopy height
1996	32.0 m	32.0 m
1997		32.2 m
1998		32.4 m
1999		32.6 m
2000		32.7 m
2001		32.9 m
2002		33.1 m
2003		33.3 m
2004		33.5 m
2005		33.7 m
2006		33.9 m
2007		34.0 m
2008		34.2 m
2009		34.4 m
2010	34.6 m	34.6 m
2011		34.6 m
2012		34.6 m
2013		34.6 m
2014	34.6 m	34.6 m

High frequency correction

The high frequency correction has been investigated for 2 sectors, 60° - 240° and 240°-60°.

The procedure of high frequency correction is described in De Ligne, 2016, *Method for high frequency correction for CO_2 and water vapour fluxes.*

5. Biomass measurements

Sub-plots for biomass measurements were installed in early 2014. Before this, four inventories (1996, 2009, 2010 and 2012 ; tree girth measurement at breast height and tree height (only in 1996 and 2010)) were made on a surface of 1 hectare around the tower. Other measurements were made before 2014 :

- Leaf area index in 2010 and 2011 with three different techniques (LAI2200, litter traps and PAR sensors).
- To study trees phenology, a camera was installed on the top of the tower in March 2010.

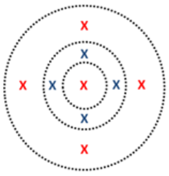
The table below lists variables that are and will be measured from 2014.

Variables	Unit	Technique	Spatial scale	Temporal scale	2014	2015	2016	2017	2018
Girth measurement at breast height	cm	-	2 ha around the tower	Once in 2015	-	x	-	-	-
Girth measurement at breast height	cm	-	5 sub-plots	Once a year in winter	-	x	x	x	x
Tree height + canopy height	m	-	5 sub-plots	Once a year in winter	-	x	-	-	-
Leaf area index	m^2/m^2	DPH	5 sub-plots	Once a month during growing season + once in winter	x	x	x	x	x
		LAI2200	5 sub-plots	Once a month during the growing season + once in winter	x	x	x	x	x
		Litter traps	5 sub-plots	Twice a month at the end of the growing season	x	x	-	-	-
Leaf area to mass ratio	G dry matter / cm^2	-	2 first sub-plots	Once a year	-	x	x	x	x
C and N mass fraction	G element / Kg dry matter	-	2 first sub-plots	Once a year	x	-	-	-	x
Biomass of understory	G dry matter / m^2	Destructive sampling	2 first sub-plots	Once a year at peak LAI	x	x	x	-	-
Leaf area index of understory	m^2/m^2	Destructive sampling	2 first sub-plots	Once a year at peak LAI	x	x	x	-	-
Soil carbon content	Kg/m^2	*Still to be defined*	Whole field	Once every 10 years	-	-	-	-	-
Phenology	Days of the beginning and the end	-	Whole forest	Every year	x	x	x	x	x

	of growing season								
Information (Management and disturbance)	-	-	Whole forest	Continuously	x	x	x	x	x

DPH (Hemispherical canopy photography) is an optical technique that is used to study plant canopy structures via photographs acquired through a combination of a camera and hemispherical (fisheye) lens from upward or downward looking pictures. This technique is able to capture the species-, site- and age-related differences in canopy architecture, based on light attenuation and contrast between features within the photo (sky versus canopy). Hemispherical photographs provide a very large, generally with a close 180°, field of view.

LAI2200 is an optical instrument that calculate Leaf area index from measurements of the penetration of light through the forest canopy (Beer-Lambert law).



Whatever the technique used to measure Leaf area index, measurements are taken on the same pattern in sub-plots : one in the center, four at 8 meters from the center and four at 16 meters from the center and oriented to the four cardinal points (see figure next).