Sensor: MINERVA
Sampling interval: 1 min

The sensor system MINERVA comprise as suite of different sensors connceted to a central data storage unit. The most important meteorological parameters have been measured and archived with this sensor system installed at the Weather Mast Hamburg since 1995. Cup anemometer and wind vane have been replaced with ultra sonic anemometers in 2000. The dew point mirrors used for the humidity measurement turned out to be quite unreliable and were replaced with Vaisala Humicaps between 2001 and 2004. It is planned to replace the complete MINERVA system by a more state-of-the-art system within the years to come.

This is the list of available data:

Code	Unit	Description
P002	hPa	air pressure, 2 m above ground

The air pressure measurement takes place at 2 m above the ground at the small weather hut immediately at the base of the main weather mast using a pressure sensor of type Vaisala PTB-200A.

TT002	°C	air temperature, 2 m altitude
TT010	°C	air temperature, 10 m altitude
TT050	°C	air temperature, 50 m altitude
TT070	°C	air temperature, 70 m altitude
TT110	°C	air temperature, 110 m altitude
TT175	°C	air temperature, 175 m altitude
TT250	°C	air temperature, 250 m altitude

The air temperature is measured with platinum resistance thermometers (PT100). The sensors are protected against direct radiation in ventilated housings. Measurements at 2 m and 10 m altitude take place at the small (10 m mast) next to the tall one while for all other measurement altitudes the sensors housings are mounted at arms extending horizontally from the main mast.

RHHC002	%	relative humidity, 2 m altitude
RHHC010	%	relative humidity, 10 m altitude
RHHC050	%	relative humidity, 50 m altitude
RHHC110	%	relative humidity, 110 m altitude
RHHC175	%	relative humidity, 175 m altitude
RHHC250	%	relative humidity, 250 m altitude

Relative humidity is measured (since 2004) with capacitive humidity sensors of type Vaisala HMP-45 ("Humicap"). These sensors are located in the same housings as the PT100 (see air temperature). Albeit humidity measurements took place before 2004 with dew point mirrors it cannot be recommend to using those data.

DTHC002	dew point temperature, 2 m altitude
DTHC010	dew point temperature, 10 m altitude
DTHC050	dew point temperature, 50 m altitude
DTHC110	dew point temperature, 110 m altitude
DTHC175	dew point temperature, 175 m altitude
DTHC250	dew point temperature, 250 m altitude

Dew point temperature is calculated from air temperature and relative humidity measurements.

TS000	°C	surface temperature (KT4/KT19)

The surface temperature is measured with an infrared radiometer (Heitronics KT4/KT19) mounted at an altitude of 2 m, looking at the meadow next the the main mast. The absolute accuracy is about 1-2 K, temperature changes can be measured with 0.1 K accuracy. It is recommended to check the absolute accuracy for days with melting snow.

LW010	W/m²	incident long-wave radiation

The long-wave radiation incident from the upper half space is measured with a Pyrgeometer at an altitude of about 10 m on top of the small mast. The outgoing long-wave radiation (emitted by the surface) is not measured. In order to estimate a long-wave radiation balance we recommend to calculating the outgoing long-wave radiation with the emissivity of the site (0.984) and the surface temperature (TS000, see above).

G010	W/m²	incident short-wave radiation

The short-wave radiation incident from the upper half space (global radiation) is measured with a Pyranometer at an altitude of about 10 m on top of the small mast. The reflected shortwave radiation is not measured. In order to estimate a short-wave radiation balance we recommend to calculating the reflected short-wave radiation with the albedo of the site (0.210) and the incidence short-wave radiation.

GSM010	min	duration of sunshine / interval
GTM010	min	duration of no sunshine / interval
GXM010	min	theoretical sunshine duration / interval

Global radiation data are used to compute the duration of sunshine and no sunshine within a defined time interval. The sum of both is (should be) the theoretical sunshine duration. A difference between GXM010 and GSM010+GTM010 indicates gaps in the time series.

ND002	mm	precipitation amount / time interval

The amount of precipitation is recorded with a tipping bucket and a Hellmann-type precipitation collector with a resolution of 0.1 mm / time interval. Temperature-dependent heating of the device allows measurement of solid precipitation (snow) with almost the same accuracy.

Sensor: SONICxxx (xxx = 010, 050, 110, 175, 250)
Sampling interval: 5 min

Sensors named SONICxxx are ultra sonic anemometers (METEK USA-1) and measure the u-, v-, and w- component of the wind speed as well as its fluctuations at an altitude xxx. The original sampling is 20 Hz. A processor integrated into the sensor calculates mean, standard deviation, covariance, and more, of wind speed and directiomn. These ultra sonic devices replace the ordinary cup anemometer and wind vane data (see MINERVA) since the end of 2000.
Since 2004 data of a so-called Böenschreiber are available as well. This data set contains data at higher sampling (1 minute) and an extended set of variables (see BOExxx). This data set is mentioned here because in recent years the SONIC250 had transmission problems, while BOE250 was recording in a more reliable manner.

SNC_Uxxx	m/s	u-component of wind vector
SNC_Vxxx	m/s	v-component of wind vector
SNC_VELxxx	m/s	wind speed (skalar)
SNC_DIRxxx	°	wind direction

Naming convention: SNC_ : sensor type → SONIC; U and V: mean horizontal wind vector components; VEL und DIR: wind speed and wind direction

Sensor: BOExxx (xxx = 010, 050, 110, 175, 250)
Sampling interval: 1 min

This is not a sensor but a software package (Böenschreiber → gust recorder) used to analyse the SONICxxx data in a different way. Differences apply to the recording as well as to the processing of the 20 Hz data. One major difference is the different sampling interval. Another major difference is the recording of the maximum wind speed observed in gusts. This “sensor” has been used starting in 2004. Since SONICxxx and BOExxx are recorded and processed on two independent computers data gaps in one sensor can often filled by data from the other sensor.

BUxxx	m/s	u-component of wind vector
BVxxx	m/s	v-component of wind vector
BVELSxxx	m/s	wind speed (skalar)
BDIRExxx	°	wind direction
BBxxx	m/s	wind speed of strongest gust

Naming convention: B: sensor type → Böenschreiber; U and V: mean horizontal wind vector components; VELS: scalar mean wind speed derived from 20 Hz data; DIRE: Mean wind direction derived over unit vector; B: maximum 3-second mean wind speed.

Sensor: USAT280
Sampling interval: 1 min

The sensor USAT280 is a combination of BOE and a more recently developed ultra sonic anemometer (a new version off the METEK USA-1). The first sensor of this type has been installed in 280 m altitude in summer 2010. USAT280 records the same parameters as BOExxx plus air temperature plus relative humidity. This type of sensor is planned to replace the other SONIC and BOE sensors.

U_BU280	m/s	u-component of wind vector
U_BV280	m/s	v-component of wind vector
U_BVELS280	m/s	wind speed (skalar mean)
U_BDIRE280	°	wind direction (unit vector mean)
U_BB280	m/s	wind speed of strongest gust
U_TT280	°C	air temperature at 280 m altitude
U_RH280	%	relative humidity at 280 m altitude
U_DT280	°C	dewpoint temperature at 280 m altitude

Naming convention: U: sensor; BU to BB: see BOExxx; TT to DT: see MINERVA. The dewpoint temperature is calculated from air temperature and relative humidity.

Sensor: IRSS88
Sampling interval: 1 min

This sensor has an infrared light barrier to count precipitation particles, e.g. rain drops. Precipitation is defined when counting 5 drops / minute and more, otherwise the sensor records “no precipitation”. The sensor is mounted in 1 m altitude next to the tipping bucket rain sensor.

IRSDM001	min	time duration with precipitation
IRSTM001	min	time duration without precipitation

Naming convention: IRSDM: Number of minutes with precipitation in time interval; IRSTM: Number of minutes without precipitation in time interval; IRSDM+ISRTM shoud equal the length of the time interval, otherwise the data set has gaps.