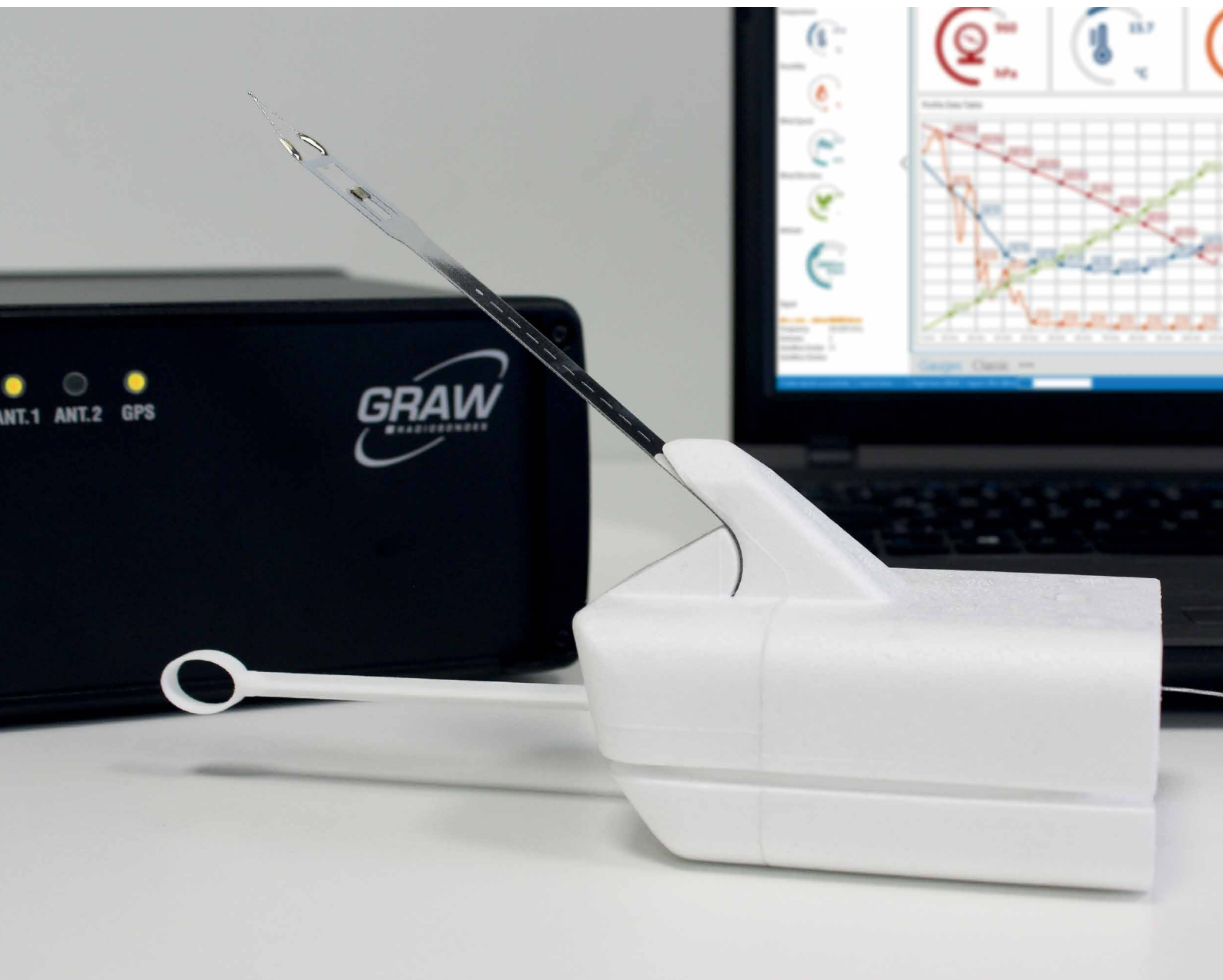


# Upper Air Sounding Systems



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# Meteorology – a World of Extremes



On the ground it is +40°C, yet at an altitude of just 11 km it is already -60°C. From extreme dryness to extreme humidity. From complete calm to gale-force winds. Meteorology is a world of extremes and extreme conditions require maximum performance. The road to such maximum performance is long. In addition to experience and passion you need the courage to think outside the box and turn ideas into reality. Like extreme athletes, we push ourselves to the limit and beyond to achieve the extraordinary with a single focus: cutting-edge technology in the form of robust and reliable products.

## **Welcome to GRAW Radiosondes - the home of weather**

We can't control the weather, but we can keep you informed. As one of the leading manufacturers of radiosondes, we draw upon more than 80 years of experience in weather measuring technology as one of the first companies to operate in this area. Our satisfied customers include weather services as well as renowned meteorological research institutes, universities and institutions worldwide.

We look forward to welcoming you as a customer and discussing your needs personally.



# Radiosonde DFM-17

- Multi GNSS PTU radiosonde (GPS, GLONASS, BEIDOU)
- Excellent temperature and humidity accuracy
- Highly stable transmitter
- Status indication via status LEDs
- Heated humidity sensor
- Optional XDATA interface
- Optional barometric pressure sensor
- Optional ground check via Near Field Communication (NFC)

## Our new little one – ready for ascent

The DFM-17 radiosonde is designed for reliable measurement of the atmospheric profile of pressure, temperature, humidity, wind speed and wind direction from the ground to a height of 40 km. Data records are continuously sent to the ground station via a stable radio connection. All sensors are supplied „Ready-to-Fly“ - 100 % factory-set calibrated. An additional calibration before the flight is not necessary. Temperature and humidity sensors ensure measurements during the ascent, and are not influenced by thermal effects of the housing. A mirrored surface reduces the susceptibility to errors by solar radiation. The ceramic temperature sensor guarantees a fast reaction time due to low mass and heat capacity. The capacitive polymer and heated humidity sensor is protected against icing. The telemetry of the radiosonde was developed for an interference-free transmission of the data and is capable of horizontal distances up to 300 km. The continuous detection and transmission of the measured values of all sensors of the radiosonde is performed in a time window of less than one second. The operating status of the battery, GNSS

and radiosonde sensors is indicated by three status LEDs. This makes it easy to check the proper functionality of the radiosonde before launch. The DFM-17 radiosondes can be initialized either via a serial interface or via integrated near field communication.



### Radiosonde DFM-17 - Technical Data

Size / Weight	Dimensions (body)	90 x 67 x 44 mm
	Weight	63 g
Power	Battery type	2 x Lithium CR123A
	Operating time	> 240 min.
Temperature	Measurement range	-90 to +60 °C
	Resolution	0.01 °C (internal)
	Reproducibility in sounding	< 0.2 °C
Humidity	Measurement range	0 to 100 %rH
	Resolution	0.1 %rH
	Reproducibility in sounding	< 2 %rH
Pressure	Measurement range	1100 to 1 hPa
	Resolution	0.01 hPa (internal)
	Uncertainty > 100 hPa	< 1 hPa
	Uncertainty 100 - 10 hPa	< 0.3 hPa
Geopotential height	Measurement range	-500 m to 40,000 m
	Resolution	0.1 m
	Uncertainty	< 8 m
	Reproducibility in sounding	< 5 m
Wind speed	Measurement range	0 to 200 m/s
	Resolution	0.01 m/s (internal)
	Uncertainty	< 0.1 m/s
Wind direction	Measurement range	0 to 360°
	Resolution	0.01°
	Uncertainty	< 1°
Telemetry	Sampling rate	1 data set per second
	Tuning range	400 - 405.99 MHz
	Bandwidth	< 12 kHz
	Max. range	> 250 km
	Frequency stability, 90% probability	< 1 kHz
GNSS receiver	Emission bandwidth	acc. to EN 302 054
	Type	GPS / GLONASS / BEIDOU
	Number of channels	72



# Pilotsonde PS-15

- Wind-detection by multi GNSS (GPS, GLONASS, BEIDOU)
- Highly stable transmitter
- Status indication via status LEDs
- Optional XDATA interface
- Optional barometric pressure sensor

## Our latest innovation

The pilotsonde PS-15 is based on the well-established high quality GRAW radiosonde system DFM. In fact, it is a GPS radiosonde without sensors for humidity and temperature. It can replace conventional Pilot soundings with optical radio-theodolites by a fully automatic sounding system at very low costs. The PS-15 is fully compatible with all GRAW Upper Air Sounding Systems and can be used in combination with normal PTU radiosondes. The optional XDATA interface allows using the telemetry of the PS-15 for transmitting any external sensor data down to the receiving system.

## It takes only 30 seconds

Before start, the Pilotsonde is simply connected to a standard USB port of the computer. The software GRAWMET will guide you through the necessary steps (e. g. setting of the desired frequency). The complete process takes less than 30 seconds, thereafter the Pilotsonde is ready to fly. The Pilotsonde PS-15 works with one high performance Lithium battery. The running time of the battery is around 90 minutes (sufficient to reach altitudes > 25 km). Thanks to the optional integrated XDATA interface, many scientific sensors (e. g. ECC ozone, CFH, etc.) can be directly connected to the Pilotsonde. The Pilotsonde can be used as a carrier for the scientific data gathered by the

Pilotsonde PS-15 – Technical Data		
Size / Weight	Dimensions (body)	75 mm (height); 35 mm (diameter)
	Weight	49 g
Power	Battery type	1 x Lithium CR123A
	Operating time	> 90 min.
Pressure	Measurement range	1100 to 1 hPa
	Resolution	0.01 hPa (internal)
	Uncertainty > 100 hPa	< 1 hPa
	Uncertainty 100 - 10 hPa	< 0.3 hPa
Geopotential height	Measurement range	-500 m to 40,000 m
	Resolution	0.1 m
	Uncertainty	< 8 m
	Reproducibility in sounding	< 5 m
Wind speed	Measurement range	0 to 200 m/s
	Resolution	0.01 m/s (internal)
	Uncertainty	< 0.1 m/s
Wind direction	Measurement range	0 to 360°
	Resolution	0.01°
	Uncertainty	< 1°
Telemetry	Sampling rate	1 data set per second
	Tuning range	400 - 405.99 MHz
	Bandwidth	< 12 kHz
	Max. range	> 250 km
	Frequency stability, 90% probability	< 1 kHz
GNSS receiver	Emission bandwidth	acc. to EN 302 054
	Type	GPS / GLONASS / BEIDOU
	Number of channels	72

external scientific sensors flying on the same balloon. The data will be sent down to the receiving system together with the GPS data of the Pilotsonde. The Pilotsonde is fully compatible with all other GRAW equipment. That means the same ground equipment (antennas, receiver, software) can be used for both Pilotsonde as for the PTU radiosondes. This saves costs as only one ground equipment is needed for two applications.





# Groundstation GS-E

- Fully software-controlled groundstation
- Compatible with all modern computers and Windows® operating systems
- Flexible due to mains and battery operation for stationary and mobile use
- Optimal reception through automatic antenna switching

## Simply clever

The GS-E belongs to a new generation of groundstations which are fully controlled via our meteorological evaluation software GRAWMET. Complex and expensive hardware circuits and susceptibility to error due to hardware wear are now a thing of the past. All signal processing is performed via an integrated “Software Defined Radio” application (SDR) which also optimises the reception. All receiver settings can be configured via software. This makes the GS-E a cost-effective alternative to groundstations which use digital signal processors for signal processing. This means that it is flexible to changes in signal transmission and can be adapted to new transmission standards. The receiver bandwidth of 400 to 406 MHz ensures sufficient scope and interference-free reception.

## Groundstation GS-E - Technical Data

<b>Weight</b>	3300 g
<b>Dimensions</b>	320 x 190 x 90 mm
<b>Power supply</b>	110 ... 250 V/AC 10 ... 32 V/DC
<b>Frequency range</b>	400 - 406 MHz
<b>Connections</b>	2 x 400 MHz antennas 1 x GPS antenna 1 x GPS repeater 1 x USB connection for computer 1 x USB connection for radiosonde
<b>Tuning steps</b>	20 kHz
<b>Supported operating systems</b>	Windows® 10 (recommended)
<b>PC</b>	Standard PC or notebook

## We speak Windows®

The GS-E can be used with all modern, powerful computers (desktop PCs, notebooks, etc.) and almost all Windows® operating systems (Windows® 10). As every office or laboratory is equipped with a PC nowadays, this does not represent additional costs for the operation of a groundstation. Simply ask our technicians whether your computer or notebook is suitable for the groundstation.

## Get some fresh air with us

The GS-E groundstation makes it possible. At approx. 3 kg, it is truly lightweight. It can be operated either with mains voltage (100 - 240 V/AC) or low voltage

(10 - 30 V/DC). This makes it the ideal solution - even for mobile use. Combine with a notebook and you're ready to go. Now nothing stands in the way of a visit to the sounding location.

## Twice as nice

As standard, our groundstation is fitted with automatic antenna switching for two receiving antennas to optimally cover different sounding angles even in the case of large sloping distances. The switching is controlled by our meteorological GRAWMET software and automatically switches to the antenna with the better reception. This ensures that you always have optimum reception.

## Worry-free guaranteed

We also offer tempting warranty extensions. Thanks to the fully fan-free design and the robust, encapsulated housing, the GS-E is completely maintenance-free.





# Groundstation GS-U

- Fully waterproof for harsh environments
- Small and light weight with integrated battery pack
- Ideal for portable / mobile applications
- Compatible with all modern computers and Windows® operating systems
- Full-range receiver
- Fully software controlled
- Easy to operate

## What do you want to achieve?

The GS-U groundstation includes our proven SDR (software defined receiver) and comes with an integrated rechargeable battery pack. It fulfils all the requirements of a modern, highly-mobile system: it is extremely small, light and ready for action in no time and offers maximum reliability during use.

## Just like its sister

The GS-U is a full range system with performance characteristics similar to our well proven GS-E system. All groundstation hardware is packed in a protective and padded waterproof Pelicase with external connections to computer (USB), antenna and power supply. The integrated rechargeable battery pack makes the GS-U an ideal solution for all mobile applications. The GS-U is fully controlled via USB by the GRAWMET-software and behaves like a GS-E groundstation. No manual settings must be done.

### Groundstation GS-U – Technical Data

Weight	3900 g
Dimensions	270 x 245 x 120 mm
Power supply	Power adapter 100 ... 240 V/AC / 12 V/DC Car connecting cable 12 ... 14 V
Runtime integrated battery pack	> 3 hours
Frequency range	400 – 406 MHz
Connections	1 x 400 MHz antenna 1 x USB 1 x power adapter
Tuning steps	20 kHz
Receiving range	> 100 km
Protection	IP65 (waterproof)
PC	Standard PC or Notebook (Windows®)





# Groundstation GS-B



- The mobile groundstation for extreme ambient conditions
- With integrated, robust notebook
- Completely splash-proof design IP65

## The new outdoor fashion for your expedition

The GS-B groundstation is the ideal companion for field work and expeditions. The extremely robust Pelicase housing is equipped with an integrated receiver module, an antenna switch and a GPS module for stationary GPS. In addition, a resistant and water-proof ruggedized notebook with pre-installed software for evaluating meteorological data is installed in the housing. All connections are also water-proof.

## Groundstation GS-B – Technical Data

<b>Weight</b>	19.5 kg
<b>Dimensions</b>	425 x 525 x 215 mm
<b>Power supply</b>	110 ... 240 V/AC 12 ... 32 V/DC
<b>Frequency range</b>	400 - 406 MHz
<b>Connections</b>	2 x 400 MHz antennas 1 x GPS antenna 1 x GPS repeater 2 x USB connection 1 x RS-232 for weather station
<b>Protection class</b>	IP65
<b>Operating temperature</b>	-10 ... +50 °C
<b>Operating humidity</b>	0 ... 100 % rH
<b>Storage temperature</b>	-20 ... +60 °C
<b>Storage humidity</b>	30 ... 90 % rH
<b>Supported operating systems</b>	Windows® 10

## Our feature-length backup for data acquisition

In addition to operation with mains voltage (100 to 240 V/AC), the groundstation can also be operated with low voltage (12 to 30 V/DC). This enables connection to the power supply of a utility vehicle, for example. A powerful back-up battery also provides power to the groundstation for over 90 minutes in the event of a disruption (e. g. if the

supply voltage fails), so that you can always complete your sounding.

## Just like its sister

Just like its little sister GS-E, the GS-B groundstation is completely software-controlled and can be operated with two 400 MHz antennas for optimal reception. In addition it offers the option of communicating with external weather stations via an RS-232 interface.







# Antennas and Antenna Systems

- For fixed installations and mobile carrier systems
- Versions for mobile use available

## Always a good choice

Our antennas can be used universally, both for stationary and mobile purposes. The standard antenna system consists of an omnidirectional 400 MHz antenna, a GPS antenna for stationary GPS and, optionally, a helical 400 MHz antenna which is used for overhead sounding. They are easy to install on masts on buildings or on mobile carrier systems using appropriate brackets. We offer mobile carrier systems in a variety of versions and finishings.

## Stability is key

The mobile tripod systems provide optimal support even in difficult sounding situations. An omnidirectional, helical and a GPS antenna can all be mounted on one folding tripod. In favour of lower procurement costs, reduced weight and increased flexibility the helical antenna can also be omitted. The tripod has three continuously adjustable feet as well as a bracing mechanism and stands steadily on uneven ground or even on slopes. We can adjust the length of the connection cable to meet your needs. When it comes to transportation, we offer an optional aluminium transport box which accommodates the complete antenna system including all the connection cables and accessories.

### Omnidirectional Antenna

Type	Dipole antenna
Weight	1900 g
Height	63 cm
Bandwidth	400 - 406 MHz
Gain	3.5 dBi



### Helical Antenna

Type	Helical antenna
Weight	2600 g
Height	38 cm
Bandwidth	400 - 406 MHz
Gain	3.5 dBi



### GPS Antenna

Type	Helical antenna
Weight	230 g
Height	24 cm
Centre frequency	1575.42 MHz



	Model A (large)	Model B (medium)	Model C (small)
Own weight	7500 g	3600 g	2000 g
Pack size	20 x 20 x 110 cm	19 x 19 x 51 cm	13 x 20 x 46 cm
Structural height	min. 112 cm / max. 180 cm	min. 55 cm / max. 73 cm	min. 13 cm / max. 143 cm



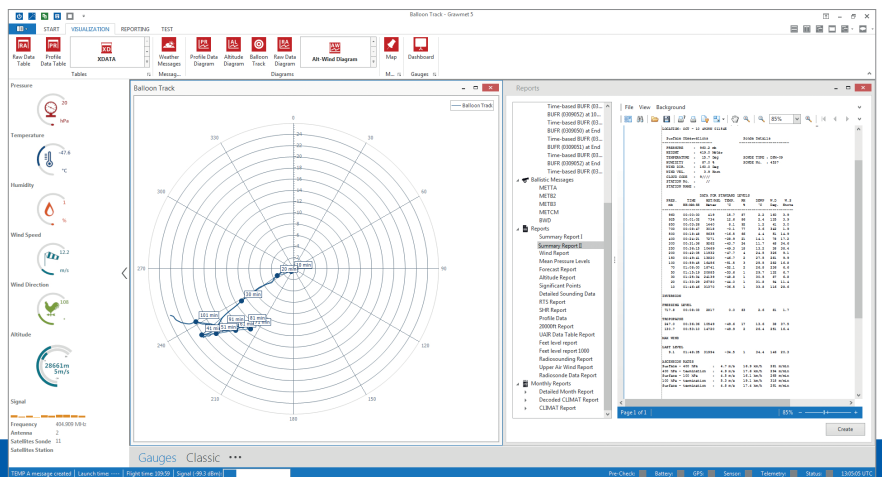
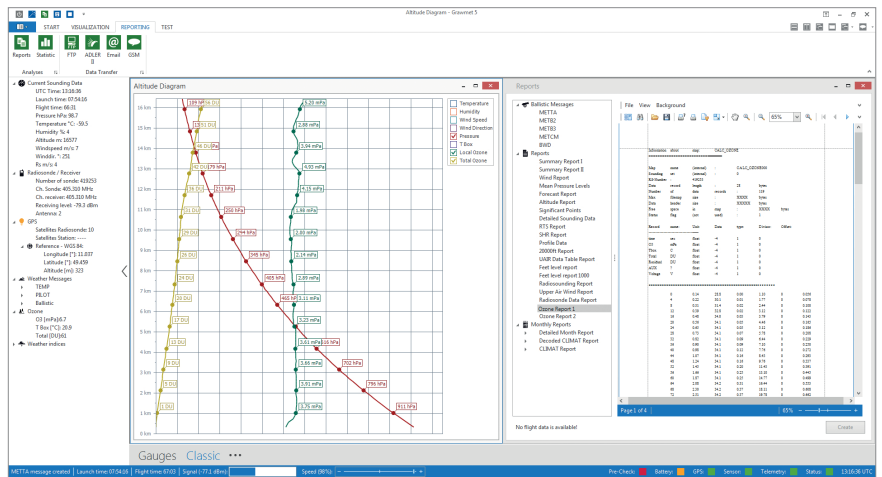


# Software GRAWMET

- User-friendly, intuitive operation and individually adjustable user interface
- Status viewlet for status notifications and visualisation of current sounding data
- Database-driven, graphical and tabular viewing and evaluation of meteorological measuring data
- Remote monitoring



Software GRAWMET	
<b>Graphics</b>	Profile data, Altitude diagram, Flight map (Open Street Map, Bing) Tephigram, T-Log (P), Skew-T, Emagram, Stüve diagram, Balloon track, Hodograph
<b>Messages</b>	PILOT, TEMP, BUFR, CLIMAT
<b>Weather indices</b>	LFC, LCL, CCL, Showalter Index, CAPE, CINH, EL-Equilibrium Level, K-Index, Total Index, KO Index, Refractive Index, Modified Refractive Index
<b>Reports</b>	Customisation, several output formats (text, pdf, csv, xls)
<b>Statistics</b>	Max/Min/Average values, Balloon Height statistic, Flight Path statistic
<b>External sensors</b>	Ozone functionality fully integrated, raw data output of other external sensors (XDATA, XML)
<b>Data transmission</b>	FTP, SFTP, SMS, Email, Sockets

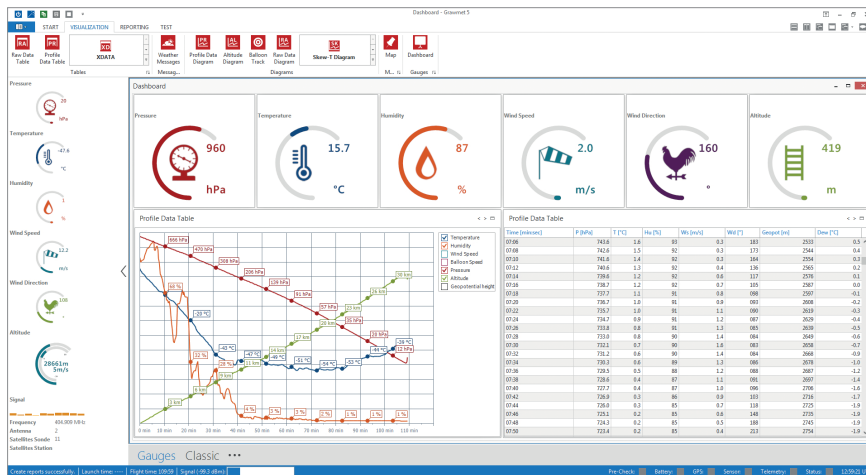


## Switch on, plug in and go

No redundant clicks. No time-consuming preparation. You can concentrate purely on the analysis and evaluation of the data. The sounding is detected automatically. You are automatically provided with the graphical and tabular views that are relevant for you. Following sounding there's no need to worry about the transfer of your results. GRAWMET takes care of this for you.

## See what's happening – with the GRAWMET status-viewlet

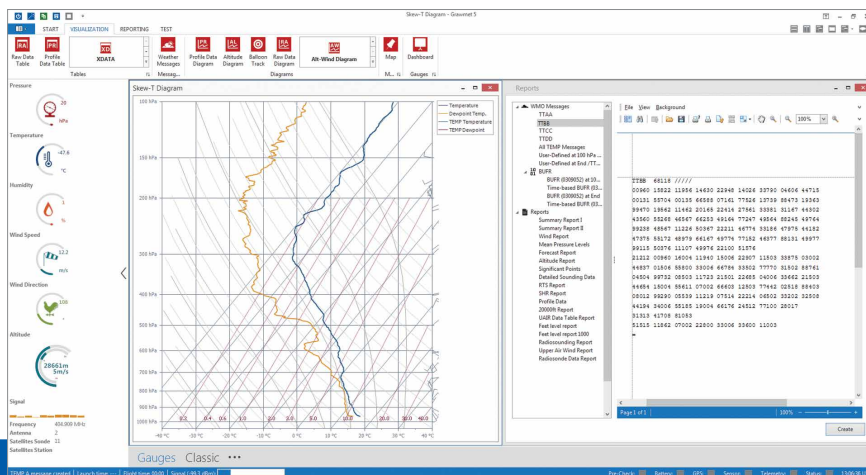
GRAWMET allows you to always keep an eye on the status of your sounding and your current sounding data. GRAWMET offers a clear status viewlet which provides you with a rapid overview of current events, measurement data, receiver data, the status of weather messages and the quality of the data reception. A status bar



or pop-up window provides real-time information regarding current events.

## GRAWMET remembers everything

GRAWMET saves all results and sounding data in a database. You can call up the results of past soundings from the archive or simulate a sounding again at any time. All diagrams, reports, weather messages and weather indices are available at the touch of a button for each sounding. A statistics function also enables long-term monitoring of weather developments based on previous soundings. This enables trends to be detected and predicted.





# GRAWgo for mobile phones

- Cloud-solution to manage Upper Air Sounding stations
- User-friendly, intuitive operation and individually adjustable user interface
- Status viewlet for status notifications and visualisation of current sounding data
- Cloud-database-driven, graphical and tabular viewing and evaluation of meteorological measuring data
- Watch the status of several stations, last operations, flight information
- Event triggered push notifications
- Available for iPhone and Android smartphones

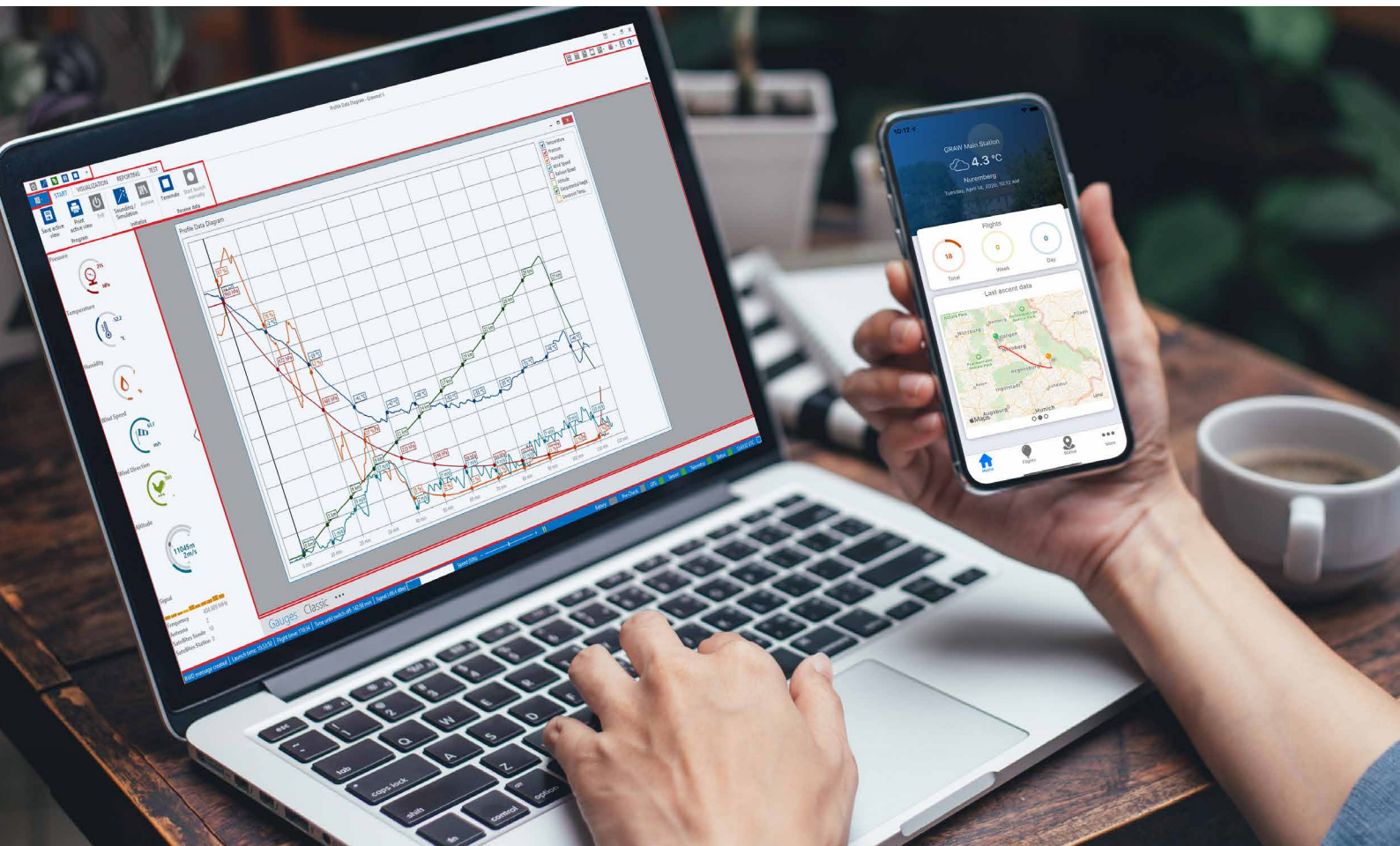
## Cloud-based analysis GRAWgo - Technical Data

<b>Graphics</b>	Profile data, Altitude diagram, Pressure diagram
<b>Messages</b>	TEMP, PILOT 100 mb, End summary
<b>Flight track</b>	Flight track in maps
<b>Push notification</b>	Start detected, burst detected notification, error notification

### Use it wherever you go

GRAWgo is the latest cloud-based solution to monitor your upper air sounding stations. Access your stations from anywhere at any time with your smartphone. GRAWgo allows you to always keep an eye on the status of your sounding and your current sounding data of all stations. Features like the overview of current events and push notifications (start and balloon burst detection, error detection), measurement and receiver data, status of weather messages, charts, quality of data reception, flight track view, etc. make this

App the perfect companion for mobile monitoring. A further and great application possibility of GRAWgo is the local status monitoring during the ascent preparation, since you get all necessary status information during preparation and during the ascent start directly on-site. The App-based application is intuitive and easy to use and it is available for iOS and Android smartphones.





# Solar-powered Autolauncher

## Autonomous radiosonde soundings

Our automatic radiosonde launcher can work fully autonomously and perform up to 6 unmanned radiosonde soundings. Thanks to its integrated solar panels and batteries, it does not require any special infrastructure and can easily be deployed everywhere.

A built-in weather station provides the necessary ground data for the initialization process. The complete flight can be observed remotely via any smartphone or a web interface. The radiosonde data is received by two antennas (omnidirectional and helical) to provide a full coverage in all possible weather conditions. During the radiosonde sounding, the collected data, status information and standardized messages can be transmitted via LTE.



### Technical Data (extract)

<b>Power Supply</b>	12 VDC / 200-240 VAC / solar panels
<b>Loading Capacity:</b>	6 radiosondes
<b>Max. Balloonsize</b>	350 g
<b>Gas type</b>	Helium
<b>Dimensions</b>	2.44 m x 2.99 m x 3.21 m

### FEATURES

- Compact design
- No carousel, low maintenance and reliable
- Easy to install, no power supply or data interface needed
- Reliable transmission of the collected data via LTE
- Increases the percentage of successful radiosonde soundings





# Accessories

- Balloon filling unit for use with helium or hydrogen
- Unwinder and parachute

### If you want more, you need the right equipment

We can take care of it. We provide the right equipment for any sounding and all requirements. From balloons of different sizes, unwinders and parachutes to balloon filling units.

We offer the **SO-2 balloon filling unit** in different designs for filling balloons with helium or hydrogen and for varied balloon sizes. A mechanical filling stop ensures the correct amount of gas so that you reach the required sounding speed and altitude. And for those of you on the go, we have a matching transport box for carrying your equipment.

The **SO-3 balloon filling unit** is our smallest version for use with helium. It was developed for extremely mobile use and simply consists of a filler neck, a connecting hose with pressure reducer and some filling weights.

### Slow but steady wins the race

The first few metres of ascent pose the most risk for the radiosonde in the event of strong winds. Strong, sudden turbulence and the associated pulling forces place strain on the attachment and can damage the radiosonde. To avoid this, we recommend the use of unwinders. They reduce the pulling forces at the start of ascent until the balloon has reached its ascent rate. The optional parachute ensures that the radiosonde is able to safely reach solid ground again following the sounding.



SO-2 balloon filling unit



SO-3 balloon filling unit



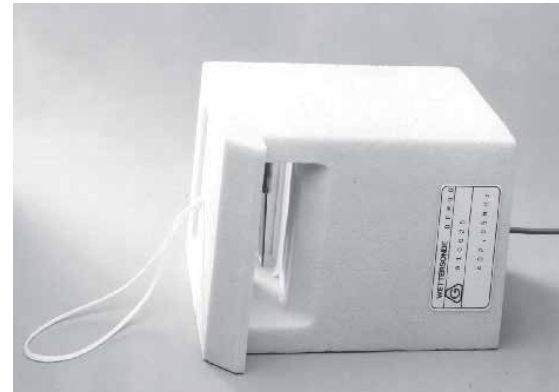
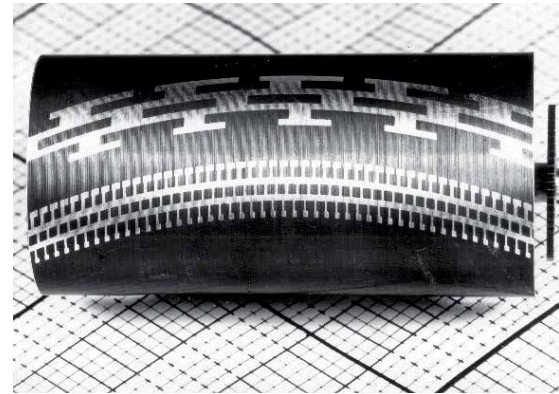
Unwinder UW1

Technical Data	Unwinder UW1	Unwinder UW2
Weight	70 g	30 g
Cord length	30 m (other lengths on request)	30 m (other lengths on request)
Maximum payload	5000 g	600 g
Unwinding speed	approx. 0.1 m/s (payload 200 g) approx. 0.3 m/s (payload 2500 g)	approx. 0.5 m/s (payload 200 g) approx. 1.5 m/s (payload 600 g)



## How it all began

- 1938 Founding of the company Dr. GRAW Messgeräte in Berlin, Germany by the physicist Dr. Graw
- 1942 Dr. Graw developed and patented the key component of the radiosonde, the Graw morse encoding cylinder
- 1948 Relocation of the company to Nuremberg, Germany
- 1976 Horst Schmidmer (owner of the NORIS Group GmbH) took over all shares of Dr. Graw
- 1990 Development of the first purely digital radiosonde DFM-90
- 1995 Development of the first GPS radiosonde DFM-90 DGPS
- 1998 Development of the optimised DFM-97 GPS radiosonde
- 2003 Company is renamed „GRAW Radiosondes GmbH & Co. KG“
- 2004 Development starts on the GPS radiosonde DFM-06
- 2006 Market launch of the DFM-06 radiosonde
- 2010 Market launch of the DFM-09 radiosonde
- 2016 Market launch of the pilotsonde PS-15
- 2018 Development of GRAWgo cloud solution
- 2019 Market launch of the radiosonde DFM-17
- 2022 New development: Solar-powered Autolauncher



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