VAISALA News

164/2004

GPS and Loran-C windfinding comparison
Vaisala Radiosonde RS92 Validation Trial at CHMI

Major Wind Profiler Deliveries

Modular technology for focused performance
New Vaisala Thunderstorm Information System

International Lightning Detection Conference ILDC 2004 in Helsinki

Vaisala Supports THORPEX Research Program

VAISALA News

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Vaisala in Brief

– We develop, manufacture and market products and services for environmental and industrial measurements.

– The purpose of these measurements is to provide a basis for a better quality of life, cost savings, environmental protection, improved safety and better performance.

– We focus on market segments where we can be the world leader, the preferred supplier. We put a high priority on customer satisfaction and product leadership. We secure our competitive advantage through economies of scale and scope.

PHOTO COURTESY OF SMHI, VIKEN, SWEDEN

Beside standard meteorological parameters, the Vaisala Automatic Weather Station MAWS301 now covers also hydrological measurement. Hydrological sensors, advanced telemetry and data processing features have been combined to a basic MAWS301. The new hydrological monitoring solutions cover hydrological parameters in streams, rivers, lakes, reservoirs and harbors.

The importance of weather services in field artillery operations has been focused in many recent studies. Weather services and their accuracy were the central theme at the accuracy test firing, CoMETFire, which was held in Denmark in September, 2003. Vaisala provided weather services to the Finnish team at the trial.

The 18th Professor Vilho Vaisala Award at WMO was awarded to three scientists of the Paul Scherrer Institute, Switzerland, for their paper entitled "Hygroscopicity of Aerosol Particles at Low Temperatures. New Low-Temperature H-TDMA Instrument: Setup and First Applications". The new instrument allows the water uptake of submicrometer aerosol particles to be determined at temperatures below 0°C, which is important information for the Global Atmosphere Watch (GAW) of WMO.

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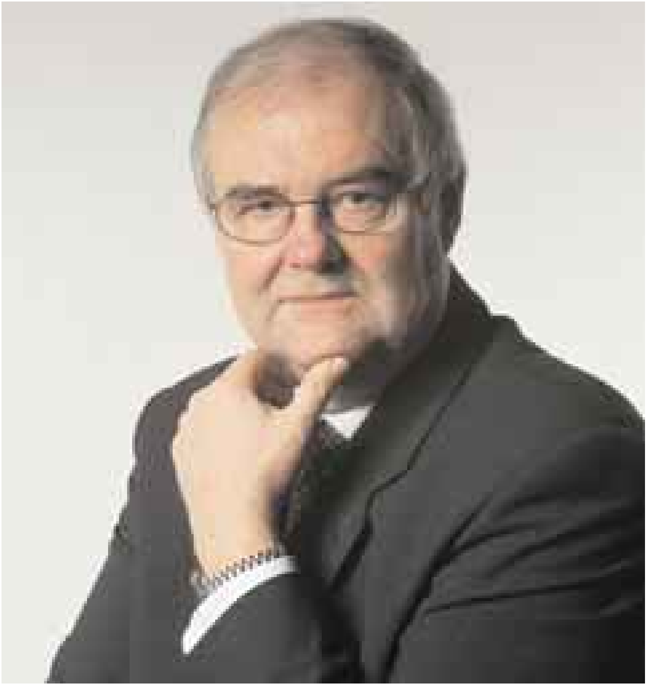
New platforms

Product development can proceed in incremental steps, or in real breakthrough leaps. Incremental progress is based on known technology. However, from time to time, an entirely new concept is adopted. In this case we can talk about "platform development", while extensions or improvements to existing product platforms are "derivatives".

On the following pages we introduce two important new product platforms.

An example of a new, digital-age radiosonde system is the Vaisala Radiosonde RS92 and related ground equipment, DigiCORA® and software radio. Many new features can be gained when we add computing technology to a radiosonde. Code-correlating GPS windfinding provides very high data availability and accuracy. The digital radio downlink is reliable, requires less bandwidth and less transmitting power, which allows the use of a smaller battery. A software radio is needed to gain these features, but it also enables multiple simultaneous soundings. System performance can be maintained or improved over its entire lifetime, mainly through software upgrades.

Another major new product platform is the Vaisala Thunderstorm Information System. The system combines two proven technologies, known as Vaisala IMPACT and Vaisala SAFIR, in a modular structure. By offering both low frequency (LF) and very high frequency (VHF) technologies in one platform, the system can be easily optimized.



A suitable detection technology can be chosen on the basis of the application. LF is less expensive, since it requires a smaller number of measurement stations, whereas VHF provides total lightning detection which better serves the needs of forecasting thunderstorms. Total lightning information is crucial in applications such as aviation. Both technologies can be combined into one system, building a solution that utilizes VHF in some areas, LF in others, or both of them. Future extensions will be easy because of the system's modular construction. This translates into long product lifetimes and a good return on investment.

The operational use of windprofilers by meteorological institutes is almost a breakthrough. Wind profiling has long been a promising and interesting technology. However, the real professionals in meteorology, the meteorological institutes, have used it very little operationally. Air quality and aviation have been the main application areas. I believe that the example of the UK Met Office and Deutscher Wetterdienst will encourage other institutes to follow.

New generations always reach further and are more competent and more successful, no matter whether we are talking about people or products. ●

Pekka Ketonen
President and CEO

Pavla Skrivankova
Head of the Upper Air and Surface Observation Department
Czech Hydrometeorological Institute
Czech Republic

Comparing GPS and Loran-C windfinding performance

Vaisala Radiosonde RS92 Validation Trial at Prague-Libus

The Czech Hydrometeorological Institute (CHMI) plans to start using Vaisala Radiosondes RS92 and the Vaisala DigiCORA® Sounding System MW21 at its Prague-Libus aerological station. Striving to ensure the highest possible data quality and homogeneity of the time series, the CHMI carried out a validation trial of the Loran-C and GPS windfinding models of the RS92 and of the sounding system MW21 during the period May 26 - June 6, 2003.

The Czech Hydrometeorological Institute's sounding station at the Prague-Libus observatory,

Short history of the Czech aerology

The first experimental aerological measurements with radiosondes started in 1946 at the Ruzyne airport in Prague. Since then, many substantial changes have taken place. The location of the aerological station, sensors and radiosondes, the procedures for handling the radiosondes, the total aerological system and software have all been changed at least once. The Prague-Libus aerological station (50.02°N, 14.45°E, 304 m, WMO ID: 11520) started operating officially in 1970 when the new observatory was inaugurated. The basic parameters - pressure, temperature, humidity (PTU) and wind profiles - were measured at 00 and 12 UTC to start with, and only wind was measured at 06 and 18 UTC. However, in 1974, the observations were extended to cover all parameters four times a day. In 1978, the observational schedule was enhanced with ozone soundings, which took place all year round until 1982. Since then, the Prague-Libus station has measured the vertical profiles of ozone three times per week from January to April.

The Vaisala DigiCORA® Sounding System MW11 was installed at the Prague-Libus station in 1991, which started to use Vaisala Radiosondes RS80 in January 1992. The introduction of the new ground equipment and new radiosondes was the most important milestone in aerological measurement in the Czech Republic. The new very accurate radiosondes, together with the automation of post-flight data processing, improved the data quality to a high level.

In 1994, the Prague-Libus station extended its scope to radioactivity measurements and started to measure vertical profiles of beta and gamma activity. In 2000, the schedule of radioactivity soundings was changed from once-a-month to once every four months (in January, April, July and October). Since the beginning of 1999, Vaisala Radiosondes RS90 have been used for routine soundings at the Prague-Libus station, but a transition to the recently introduced Vaisala Radiosondes RS92 and the DigiCORA® Sounding System MW21 is being planned.

Validation trial aims

The accuracy of radiosonde measurement is very important to meteorologists, not only for numerical weather forecasts, but also in aviation. It is therefore vital to determine the effect of ra-

A balloon with Vaisala Radiosondes RS90 and RS92 with Loran-C windfinding suspended about 1 m below a bamboo rig ready for release at Prague-Libus, Czech Republic. From the left: Mr. Cernoch and Mrs. Skrivankova.

diosonde change and to evaluate the differences in data brought about by a transition to a new radiosonde type is of crucial importance. A comparison of "old" and "new" radiosondes is a useful source of such information. The main aim of the validation trial at Prague-Libus was to evaluate radiosonde sensor performance. However, the data transmission of both of Vaisala's sounding systems - the MW11 and MW21 - was tested too.

Test setup

The Prague-Libus comparison test consisted of 33 dual soundings. On every flight, two types of radiosondes were suspended about 1 meter below a bamboo rod, approximately 60 m below a single balloon. In most cases, the comparison soundings were made at 06, 12 and 18 UTC (WMO standard sounding times). For the Loran-C windfinding comparison, the RS92-KL radiosondes were compared with the RS90-AL, while the RS92-SGP radiosondes were launched together with the RS80-15G to compare the GPS windfinding. The MW11 ground equipment collected the data from the RS80 and RS90 radiosondes, whereas the MW21 was used to process the RS92 data.

The calibration of the RS92-SGP was checked in the field immediately prior to launch. The RS80-15G and the RS90-AL calibrations were also checked. At the time of testing, the Ground Check Set GC25 was under development and could not yet be used for the RS92-KL.

Data processing

Data were processed using edited 5-second data on the MW11 and MW21. Vertical profiles of pressure, temperature, humidity and wind were compared. Direct differences computed on a time scale were used as the "first" step check on the data. The software developed for WMO radiosonde intercomparison (Radio and Ozonesonde Comparison and Evaluation Software Package) was used as an additional validation step. The RS92 data were used as the reference and were checked against the corresponding values on the RS80 or RS90. Vertical profiles of pressure, temperature, humidity and wind differences were analyzed on a pressure scale. Figures 1 and 2 show the RS80 vs. RS92 and RS90 vs. RS92 mean pressure differences. Temperature and humidity differences are shown in figures 3, 4 and 5, 6 respectively. The wind direction and wind speed comparison is presented in figures 7, 8 and 9, 10.

At the end of the trial, ➤

Mr. Cernoch performing pre-flight preparations for the RS92 .

the heights of standard pressure levels 500, 300, 200, 100 and 50 hPa were compared against the ALADIN model analysis (see table 1). The ALADIN (Aire-Limitée Adaptation Dynamique developement International) is a numerical model of the atmosphere developed by an international team working mainly at Météo-France. The results calculated by the ALADIN model are used for the short-range weather forecasting in the CHMI's weather service while the Prague-Libus station uses the ALADIN forecast of heights of standard pressure levels as a quality check routine.

Test results

As expected, there were bigger differences between the PTU values measured by the RS80 and the RS92 sensors than between those of the RS90 and RS92. The differences in pressure measurements between the RS92 and RS80 originate mainly from the different pressure sensors in these two radiosonde types. The RS80 is equipped with an aneroid BAROCAP® pressure sensor while the RS92 and RS90 are equipped with a silicon BAROCAP® pressure sensor. The aneroid sensor is known to have a positive pressure bias as its internal temperature changes from a higher to a colder temperature [1]. Near the ground the RS92 indicated lower pressures than the RS80. In the stratosphere, the average difference between the RS92 and RS80 pressure measurement was about -0.4 hPa (see fig. 1).

The ground check pressure correction was performed only for the RS90-AL, which can be one of the reasons for the difference in pressure measurement from the RS92 and RS90. The average difference between the RS92 and RS90 pressure measurement was about -0.3 hPa (see fig. 2).

The differences between temperature observations for the RS92 and RS80, presented in fig. 3, are in line with the results of the RS90 radiosonde test in Vienna [2] and with the Met Office RS90 temperature sensor evaluations [3]. A small warm bias in the RS80 temperature measurement was seen in the troposphere. In the stratosphere, the faster RS92 temperature sensor response together with the differences in the radiation corrections between RS92 and RS80 resulted in an increasing deviation of the temperature profile. The RS92 temperature sensor is the same as in the RS90. Consequently, the differences in temperature measurement were mostly between -0.1°C and 0.1°C up to the 20-hPa pressure level. The increase of bias above the 20-hPa level (see fig. 4) would require a more comprehensive testing.

The heated H-HUMICAP® is a fast, defrosting humidity sensor used in the RS90 and RS92 radiosondes, while the RS80 employs an earlier version of the A-HUMICAP®, which has no heating. The big differences in humidity profiles from between the RS92 and RS80 are caused by the RS80 humidity sensor's problems at temperatures below -40°C (see fig. 5). The H-HUMICAP heated humidity sensor can correctly measure higher humidityy at cold temperatures than the A-HUMICAP can. Figure 6 shows the variability in the RS92 and RS90 humidity measurements. The RS90-AL radiosonde was reconditioned prior to the flight, whereas the RS92-KL was not. The differences in humidity measurements were between -2.5 % and 2.5%. The Ground Check Set GC25 will enable the RS92-KL to be operated with a reconditioning procedure, which is expected to decrease the deviation in humidity measurements caused by chemical contaminants, for example.

The Prague-Libus station

Figure 1. RS80-RS92 pressure differences mean value and standard deviation (blue RS92, red RS80).

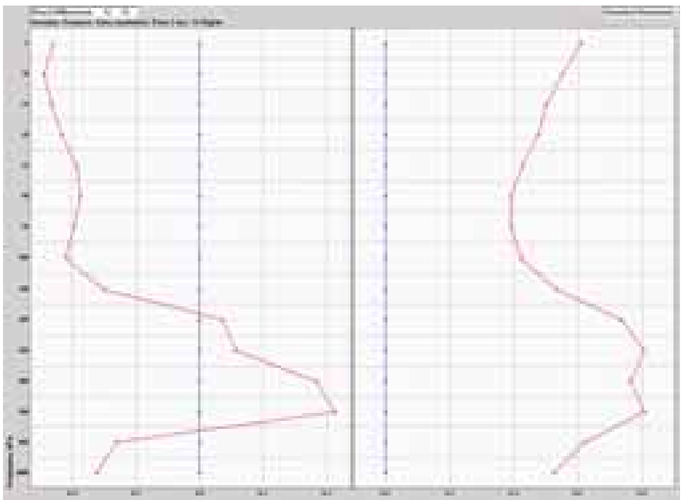
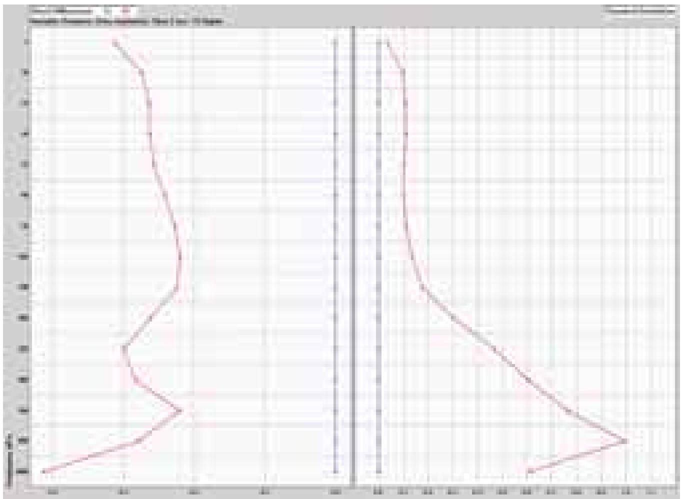


Figure 2. RS90-RS92 pressure differences mean value and standard deviation (blue RS92, red RS90).



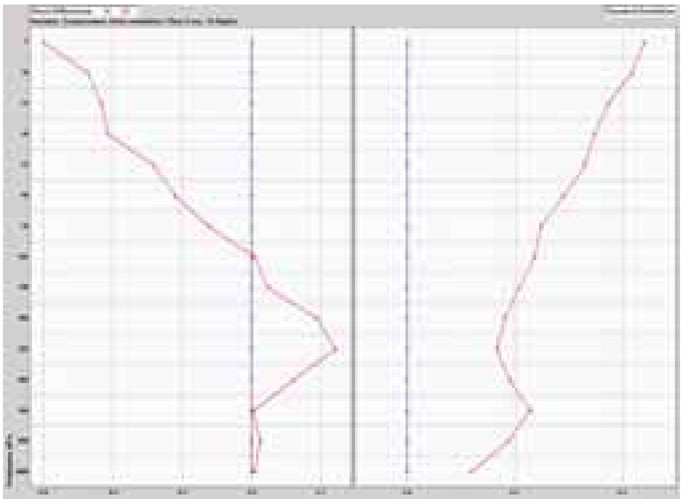


Figure 3. RS80-RS92 temperature differences mean value and standard deviation. (blue RS92, red RS80).

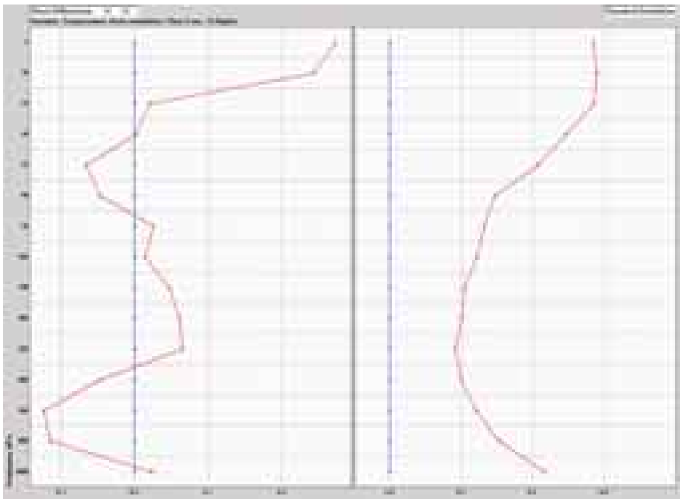


Figure 4. RS90-RS92 temperature differences mean value and standard deviation (blue RS92, red RS90).

performs most regular wind measurements with the RS90-AL radiosonde with Loran-C windfinding. If weather conditions are bad and there are disturbances of the Loran-C signals, the RS80-15G with GPS windfinding is used. Therefore, both the Loran-C and the GPS models of radiosondes were tested. Very low wind prevailed nearly all the time during the validation trial. The MW11 ground system was less sensitive than the MW21. When the signal quality was low, the MW11 system produced more interpolated wind data than the MW21. Consequently, the differences in wind direction and speed for the Loran-C radiosondes were bigger than with the GPS windfinding. The wind measurements obtained with GPS windfinding were more consistent. Figure 7 presents the wind direction bias between the RS92-SGP and the RS80-15G. The differences in wind speed measurement were between -0.1 m/s and 0.1 m/s (see figure 8). A comparison of the RS92-KL and RS90-AL wind direction and wind speed data is presented in figures 9 and 10. The wind speed differs between -0.1 m/s and 0.4 m/s.

The height differences of a particular sounding did not exceed 30 m until 100 hPa and 40 m until 50 hPa in relation to the ALADIN numerical model. Table 1 shows the mean values and standard deviations on 500, 300, 200, 100 and 50 hPa standard pressure levels.

Summary

The differences between PTU values measured by the RS92 and the RS90 are smaller than the variance between the RS92 and the RS80 PTU measurements. The RS92 radiosonde performs better than the RS80 and is comparable with the RS90. Pre-flight preparation of the RS92 is more convenient. An EEPROM for calibration coefficients is placed on the motherboard.

It was found that interferences from local transmissions immediately before or during a launch are a possible reason for the gaps found in the RS80 GPS wind measurements at the Prague-Libus station. A television tower is near the station. Upgrading to the RS92 with GPS windfinding, which is less susceptible to this type of interference, should improve the wind measurement and reduce the failure rate.

The MW21 frequency analyzer, windfinding system ➤

Figure 5. RS80-RS92 humidity differences mean value and standard deviation (blue RS92, red RS80).

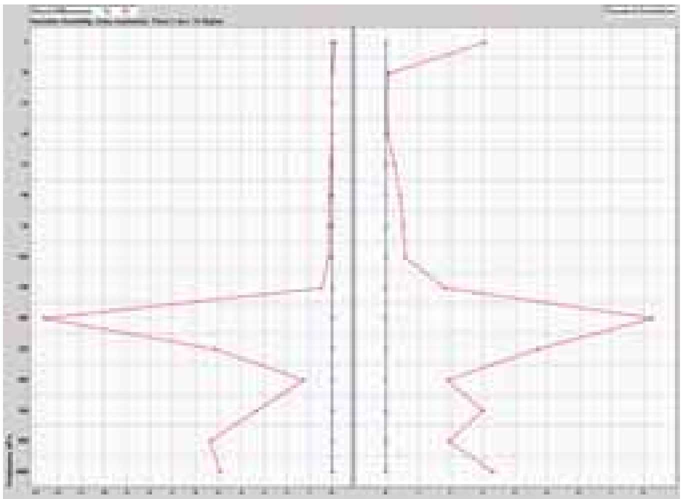


Figure 6. RS90-RS92 humidity differences mean value and standard deviation (blue RS92, red RS90).

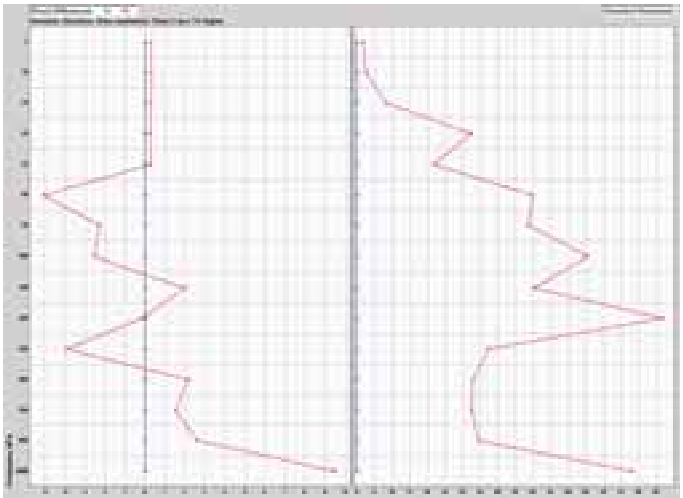


Figure 7. RS80-RS92 wind direction differences mean value and standard deviation (blue RS92, red RS80).

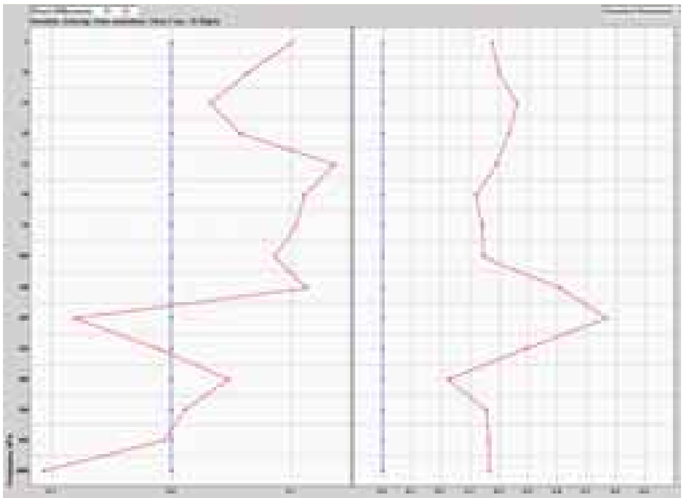


Figure 8. RS80-RS92 wind speed differences mean value and standard deviation (blue RS92, red RS80).

status display and thermodynamical diagrams are very useful tools from for the user. Improved signal processing leads to better utilization of wind measurement. The MW21 produces less interpolated wind data than the MW11.

The transition from the RS90 to the RS92 should not significantly affect the consistency of upper-air measurement at Prague-Libus. On the contrary, it is expected that the data quality and availability will improve. The validation trial demonstrated the good performance of the MW21 together with the RS92 radiosondes. ●

	GPS radiosonde versus ALADIN model heights			
	RS80-15G	(n=14)	**RS92 SGP**	(n=14)
P[hPa]	Mean [m]	STD dev. [m]	Mean [m]	STD dev. [m]
500	-6,4	7	-6	6,4
300	-7,4	10,1	-3,4	8,7
200	-10,9	9,6	-3,4	5,9
100	-15,9	10,9	-6,7	7,3
50	-21,8	10,1	-12,3	9,3
	LORAN radiosonde versus ALADIN model heights			
	RS90-AL	(n=14)	**RS92 KL**	(n=14)
P[hPa]	Mean [m]	STD dev. [m]	Mean [m]	STD dev. [m]
500	-5,4	8,9	-7	7,2
300	-2,4	8,1	-2,7	6,6
200	1	11,3	2,4	8,2
100	-6,2	12,4	-3,5	10,6
50	-12,7	14,5	-9,4	12,9

Table 1. Height differences (radiosonde - ALADIN model) on the standard pressure levels 500, 300, 200, 100 and 50 hPa.

References

[1] Smout, R., Elms, J., Lyth, D., Nash, J., 2001: Met Office RS90 Pressure Sensor Evaluations. New Technology in Upper-air Observations report.

[2] Finne, M., 1998: Promising Pilot Test Results of the New RS90 Radiosonde in Vienna. Vaisala News, 147, 8-10.

[3] Smout, R., Elms, J., Lyth, D., Nash, J., 2001: Met Office RS90 Temperature Sensor Evaluations. New Technology in Upper-air Observations report.

Figure 9. RS90-RS92 wind direction differences mean value and standard deviation (blue RS92, red RS90).

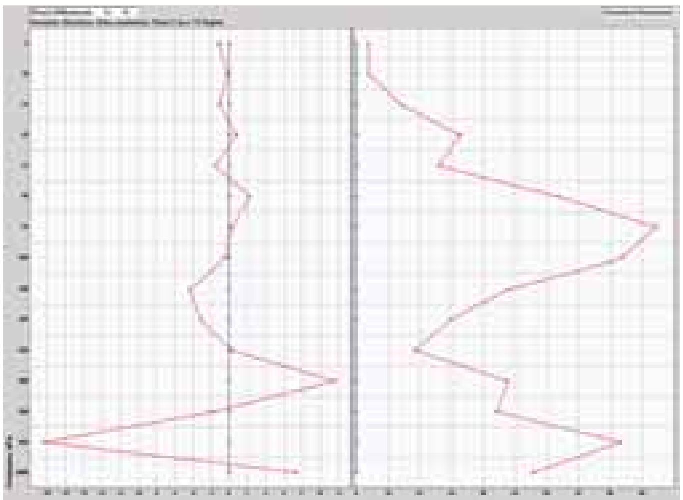
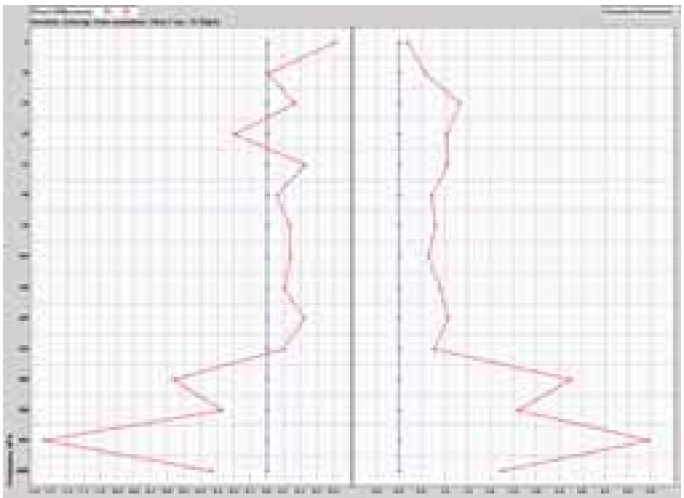


Figure 10. RS90-RS92 wind speed differences mean value (blue RS92, red RS90).



Ritva Siikamäki, MA
Editor-in-Chief
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Introducing the Vaisala Radiosonde RS92-KL

New Radiosonde with Loran-C Windfinding

Complementing the new Vaisala Radiosonde RS92 family, the version with Loran-C windfinding and analog data transmission is now available. The Vaisala Radiosonde RS92-KL incorporates the same fast-response pressure, temperature and humidity (PTU) sensors that are used in the Vaisala Radiosonde RS90 family. Providing proven PTU measurement performance, the RS92-KL will also make the transition to new windfinding easier, should the possible phaseout of the Loran-C network occur in the future.

The Vaisala Radiosonde RS92-KL is the most recent addition to the RS92 product family, which was launched in 2003 with the introduction of the GPS windfinding and digital telemetry model. The product family also comprises a PTU-only model, the RS92-K.

The RS92-KL uses analog data transmission and has the same fast-response PTU sensors that are used in the Vaisala Radiosonde RS90 family: the Vaisala BAROCAP® pressure sensor, the Vaisala F-THERMOCAP® temperature sensor and the Vaisala H-HUMICAP® humidity sensor. Moreover, the RS92-KL version of the RS92 offers an automatic reconditioning procedure for humidity sensors as a new feature. The prior-to-flight automatic reconditioning procedure removes any contamination from the humidity sensor surface and thus eliminates the so-called dry-bias phenomena of RH measurement. Consequently, the PTU measurement performance of the analog Vaisala Radiosonde is equivalent to or better than that of the Vaisala Radiosonde RS90 family. All of the PTU sensors are calibrated with the Vaisala CAL4 calibration machine.

The Vaisala Radiosonde RS92-KL operates with analog telemetry and utilizes Loran-C windfinding.

Preparing for the transition to new windfinding technology

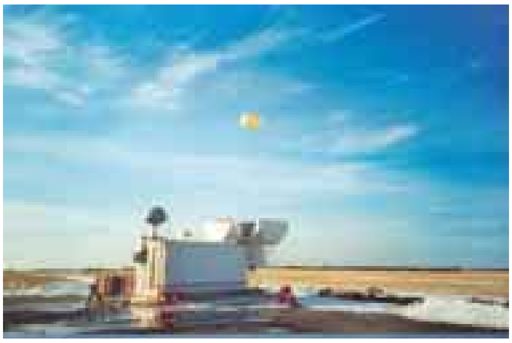
The RS92-KL utilizes the Loran-C navigation network for windfinding. This means that you can go on using Loran-C windfinding while getting ready for its possible phaseout. Should this take place in the future, transition to another windfinding technology will be easier as you will have already adapted the RS92 sounding platform.

Economical telemetry

The Vaisala Radiosonde RS92-KL operates over a conventional analog telemetry link of 400 MHz. In this way an effective windfinding method is offered at a low cost, thanks to the simple implementation of the Loran-C signal relay link.

Easy ground check procedure

Ground check for the RS92-KL is performed with the new Vaisala Ground Check Set GC25 in a stand-alone capacity. However, if you use the Vaisala DigiCORA® Sounding System MW21, the RS92-KL's calibration coefficients can be fed into the system from a diskette or CD-rom. In the near future it will be possible to feed the calibration coefficients automatically from the GC25 to the Vaisala DigiCORA® Sounding System MW21 via a cable link. ●



The Norwegian Meteorological Institute has unmanned stations at Sola, Ørland and Bodø, operating a Vaisala DigiCORA® Unmanned Sounding Station AUTOSONDE. The picture shows the system at Sola and Ørland.

Ritva Siikamäki, MA
Editor-in-Chief
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Vaisala DigiCORA® Unmanned Sounding Station AUTOSONDE

Supporting Synoptic Observations in Norway

The Norwegian Meteorological Institute (Meteorologisk institutt, NMI) has operated three Vaisala DigiCORA® Unmanned Sounding Station AUTOSONDE systems for several years. The AUTOSONDE systems supply continuous and reliable upper-air data to the synoptic observation network. One system is located at Sola in the western part of Norway, one unit is located at Ørland in central Norway and the last one in Bodø in northern Norway.

The Norwegian Meteorological Institute is the main provider of meteorological services to the public in Norway and also engages in related research activities. To meet synoptic upper-air observation needs, the Meteorological Institute uses Vaisala DigiCORA® Unmanned Sounding Station AUTOSONDE systems at three sites, which supply continuous and reliable upper-air data to the synoptic observation network. One system is located at Sola in the western part of Norway, one unit is located at Ørland in central Norway and the last is in Bodø in northern Norway. In order to measure surface weather data, the sites are equipped with Vaisala MILOS Data Collection Systems from which the AUTOSONDE automatically retrieves surface weather observations.

"Each of these AUTOSONDE systems operates automatically and performs two synoptic soundings daily, using Vaisala RS80 Radiosondes. All of the systems are remotely controlled from Blindern in Oslo," says Mr. Jon Halvard Berntsen. As a Section Engineer, Jon Berntsen is responsible for programming and maintenance activities related to the AUTOSONDE systems, including the software, radio systems and data communications. He also takes care of issues related to the system's mechanics or pneumatics, while local staff at the sites handle the periodic loading of the system with radiosondes, balloons and gas.

According to Berntsen, remote control is very useful. Smaller technical problems can usually be handled by giving instructions to the local maintenance staff by phone. Thanks to the high quality of Vaisala's products, there is seldom a need to travel to the site, he says. Since changing to CISCO routers (the ISDN dial-up modem connection proved to be a bit unreliable at the beginning), data communications have worked without problems. Regular maintenance visits are made once a year to the AUTOSONDE sites to check that everything is fine. As the installation sites are very windy, the systems at Bodø and Ørland are fitted with auxiliary covers in the balloon launcher vessel. These systems operate reliably even in harsh conditions and high winds, which is crucial, since the sites are difficult to access.

Berntsen says that if you don't count the need to change the wind sensor bearings regularly, the system can be considered almost maintenance-free. He laughs that the birds, bees and butterflies that tend to get into the system cause the most faults, and spiders may jam the balloon detection sensor every now and then, since that's their favorite spot. Whenever technical issues come up that require consultation with Vaisala, it is always easy to contact the Vaisala help desk. It's important that help is easily accessible. ●

Jussi Åkerberg, M. Sc. (Eng.)
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Introducing the Vaisala Software Radio

State-of-the-Art Radiosonde Telemetry

In connection with the launch of the next generation of sounding systems Vaisala will launch a new state-of-the-art ground equipment radio receiver, the Vaisala Software Radio. Used together with the new digital Vaisala Radiosonde RS92-AGP this technology is the answer to the increasing demand for telemetry link performance and bandwidth efficiency. The new radio receiver technology introduces a fully digital telemetry link that enhances the use of radiosondes and ground equipment in many ways.

The fully digital telemetry link using the Software Radio between the Vaisala Radiosonde RS92-AGP and the ground equipment Vaisala DigiCORA® Sounding System enables the use of modern digital modulation methods, error correction algorithms and telemetry diagnostics. The technology used in the Software Radio is similar to that used in cellular phones and their base stations.

The telemetry link performance of the new sounding system is based on the properties of GMSK (Gaussian Minimum Shift Keying) modulation, Reed-Solomon error correcting coding and the Software Radio receiver. The new system allows reliable low-power narrowband radiosonde transmission and increases the temporal data resolution to two levels per second.

Software Radio

The Vaisala Software Radio is a modular, multifunctional and reconfigurable software receiver, which offers excellent dynamic range and network connection. It will replace the current Vaisala radiosonde receiver URR20/UPP201 in the most recent generation of Vaisala sounding ground equipment, the Vaisala DigiCORA® Sounding System. The Software Radio is intended to act as the receiving system of all existing and forthcoming Vaisala transmitter types of the current generations of Vaisala radiosonde, such as RS80, RS90, RS92 and later.

The Software Radio hardware consists of a low-noise antenna amplifier which resides in the antenna, a Radiofrequency receiver unit operating at 400 MHz and a receiver processor unit (see figure 1).

In the 400 MHz RF unit, the whole of the 400 – 406 MHz meteorological frequency band is first converted into an intermediate frequency (IF) band of 16 – 22 MHz. The IF signal is then sampled with a high-performance 14-bit analog-to-digital converter, whereby a sam- ➤

pling rate of 64 Msamples/second is used. The digital signal is filtered and down converted to the baseband with a digital down converter (DDC) in the Receiver Processor unit, as shown in fig. 2. Using multiple digital down converters enables multichannel reception.

Further processing of the signal, comprising demodulation, error detection and correction and telemetry analysis, is done in a powerful 32-bit floating point digital signal processor (DSP).

The signal processor sends the data to a front processor server process that handles the data delivery to the sounding software client processes, according to the data subscriptions. The server process communicates with the GPS unit of the sounding processing subsystem and also delivers the local GPS data for windfinding.

The main emphasis in the design of the radio receiver was on improving spurious free dynamic range and sensitivity over its predecessors. Some specifications of the 400 MHz RF unit are shown in table 1.

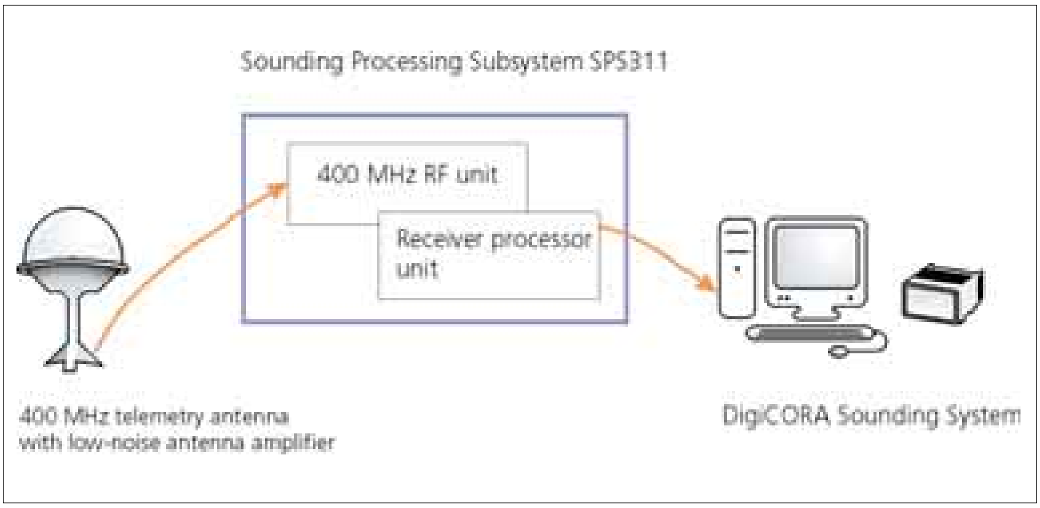


Figure 1. The software radio hardware: a low-noise antenna amplifier, a 400 MHz RF receiver unit and a receiver processor unit.

Frequency Range	400 – 406 MHz
Noise Figure	8 dB
Intermediate Frequency	16 – 22 MHz
Image Rejection	45 dB
Spurious Free Dynamic Range	80 dB
Third Order Intercept Point (IIP3)	+16 dBm
Maximum Input Power Level	-9 dBm full scale

Table 1. Main specifications of the RF unit

Telemetry link

Digital telemetry

Figure 3 illustrates the general principle of the digital telemetry link. Digital systems use digital modulation that modulates the carrier directly.

In a digital transmitter the waveforms are generated as sampled digital signals, converted from digital to analog via a wideband digital-to-analog converter (DAC) and then possibly upconverted from intermediate frequency (IF) to radio frequency (RF).

The digital receiver, similarly, employs a wideband analog-to-digital converter (ADC) that captures the whole of the interesting frequency band. The receiver then extracts, downconverts and demodulates the channel waveform using software loaded on a general-purpose digital signal processor.[1]

Implementation of the telemetry

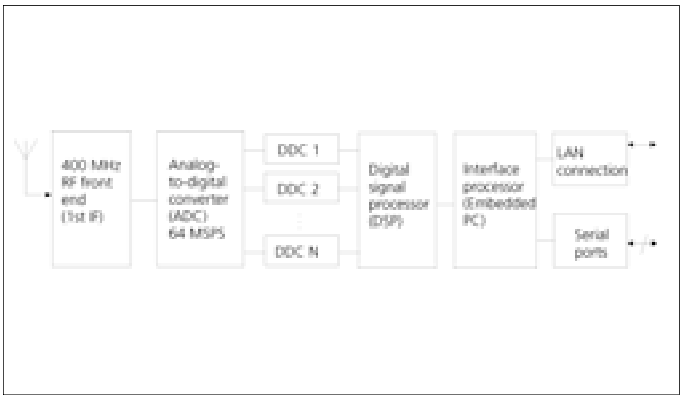
The RS92-AGP transmits a GMSK (Gaussian Minimum Shift Keying) modulated signal which carries 2400-bit data frames at a data rate of 4800 bps. The radiosonde frame is divided into several sub-blocks. Each sub-block is followed by a CRC-16 checksum to make sure that the data is valid. In addition, each data frame is protected with Reed-Solomon checkbytes, which are used in error correction. A maximum of 12 corrupted 8-bit-long bytes can be corrected within one 255-byte-long data frame. The data is also scrambled to get a uniform distribution of ones and zeros and to avoid long sequences of the same value.

At the receiver end, the demodulated baseband data is descrambled and the Reed-Solomon error-correcting algorithm is applied. The data is then validated using the checksums. Figure 4 shows the different signal processing phases in the transmitter and in the Software Radio receiver.

GMSK modulation

The transmitter modulates the carrier wave by GMSK-modulation (Gaussian Minimum Shift Keying). GMSK modulation offers a compromise between high spectrum efficiency and an acceptable level of demodulation complexity. It enables a narrow spectral width and thus enables several channels to be used in the allowed frequency band. GMSK-modulation also makes it possible to achieve a low level of adjacent channel interference. A GMSK-modulated signal has

Figure 2. Signal processing sequence of the Software Radio.



SNo	Range [km]	Height [km]	FER with EEC [%]	FER no EEC [%]
Y3627235	78	26	0.120	6.740
Y3627738	52	18	0.140	7.690
Y3627219	51	20	0.034	6.660
Y3627201	53	26	1.930	10.850
Y3627212	54	21	0.014	6.700
Y3627203	54	24	0.012	2.390
Y3627210	50	27	0.048	5.110
Y3627211	47	24	0.013	5.220
Y3627204	48	25	0.012	4.990
Y3627198	71	27	0.150	7.160
Y3627196	70	30	0.390	6.890
Y3627205	72	30	0.390	6.500
Y3627206	80	28	0.010	5.560
Y0617110	161	28	3.680	9.840
Y0647077	146	30	1.940	6.620
Y0647086	173	26	0.190	4.320
Y0617071	100	28	0.510	7.270
Y0647084	100	29	0.360	6.990
Y0647078	76	34	0.017	7.490
Y0647098	50	13	0.036	3.800
Y0617005	108	34	0.016	0.240
Y0537028	161	27	0.097	2.460

Table 2. Results of the test soundings.

a constant envelope, enabling the signal to be amplified with simple nonlinear amplifiers. This reduces the power consumption, an important advantage in battery-powered devices.[2]

Reed-Solomon

The Reed-Solomon error correction coding is a widely used error correcting method in wireless communications. It is suitable for applications in which data is naturally structured as blocks. The Reed-Solomon encoder adds redundant bits to a block of digital data and the encoder attempts to recover the original data distorted by the transmission channel. However, the redundancy level is not high and for this reason Reed-Solomon is suitable for applications in which channel capacity is relatively low.

By nature, Reed-Solomon coding is especially effective in correcting burst errors; that is, data is not handled by bits but by m-bit long symbols. An (n, k) Reed-Solomon code has $n = 2^m - 1$ code symbols and k message symbols. The number of parity check symbols is $n - k = 2 \cdot t$. Such a code is capable of correcting t erroneous symbols in the code.

The code used in the radiosonde is $RS(255,231)$, $m = 8$. Therefore 12 erroneous symbols per block of 255 symbols can be recovered. This means that 4.7% of the symbols can be erroneous.

Reed-Solomon coding enables transmission error correction at the receiver and so the needed signal-to-noise ratio may be reduced without losing any information. It is also possible to calculate the coding gain for a given code. With the Reed-Solomon code described above, the coding gain is approximately 4 dB. In other words, with Reed-Solomon coding the transmitter signal power can be greatly reduced in comparison to a similar system that does not use Reed-Solomon coding.[3]

CRC-16 Checksum

The Reed-Solomon decoder does not reliably detect more errors than it can itself correct. In addition to the Reed-Solomon coding, a special checksum must be used to reliably detect frames, which have more errors than can be corrected by the Reed-Solomon decoder. Sub-blocks with a valid checksum can be used even if the rest of the frame is corrupted.

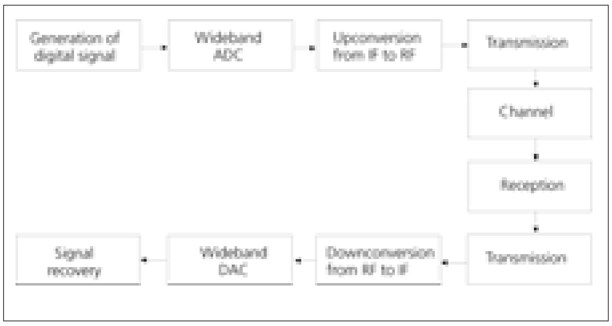


Figure 3. Digital telemetry link.

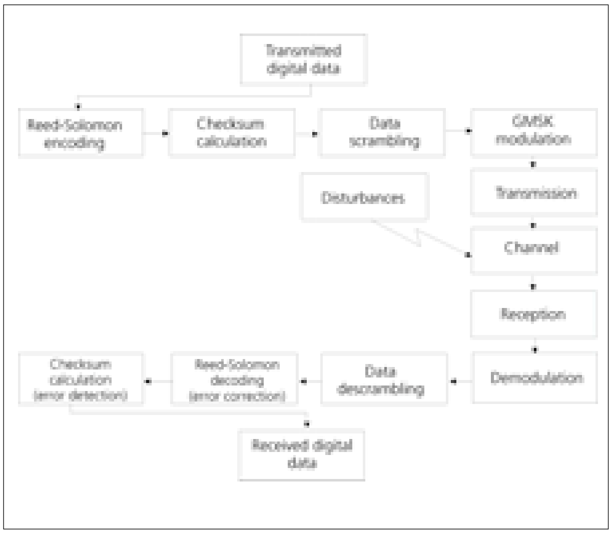


Figure 4. Digital signal processing in the transmitter and in the receiver.

Sounding tests

The performance of the telemetry with different types of antennas and the effect of the Reed-Solomon algorithm are discussed next. The results have been collected from three test sounding sets using the Vaisala Radiosonde RS92-AGP and the Software Radio receiver. The soundings were conducted at the premises of the Jokioinen Observatory of the Finnish Meteorological Institute in 2003.

Test setup

The measurement setup at Jokioinen is presented in figure 5. There were two different setups, one using a directional antenna and the other using an omnidirectional antenna. The GPS antenna signal was shared for the two systems.

Test results

Antenna performance

The transmitted signal is affected in several ways during the transmission. It is bent, scattered and reflected in the atmosphere. At 400 MHz and within the distances coming up in the radiosonde soundings, these phenomena are not very significant. The most important propagation mechanisms of the radiosonde signal are line-of-sight propagation and multipath propagation. The latter is problematic, because it can cause fading that degrades the performance of the telemetry link. Buildings, hills, forests and other obstacles can cause diffraction and fading through multipath propagation. This makes the performance of the telemetry ➤

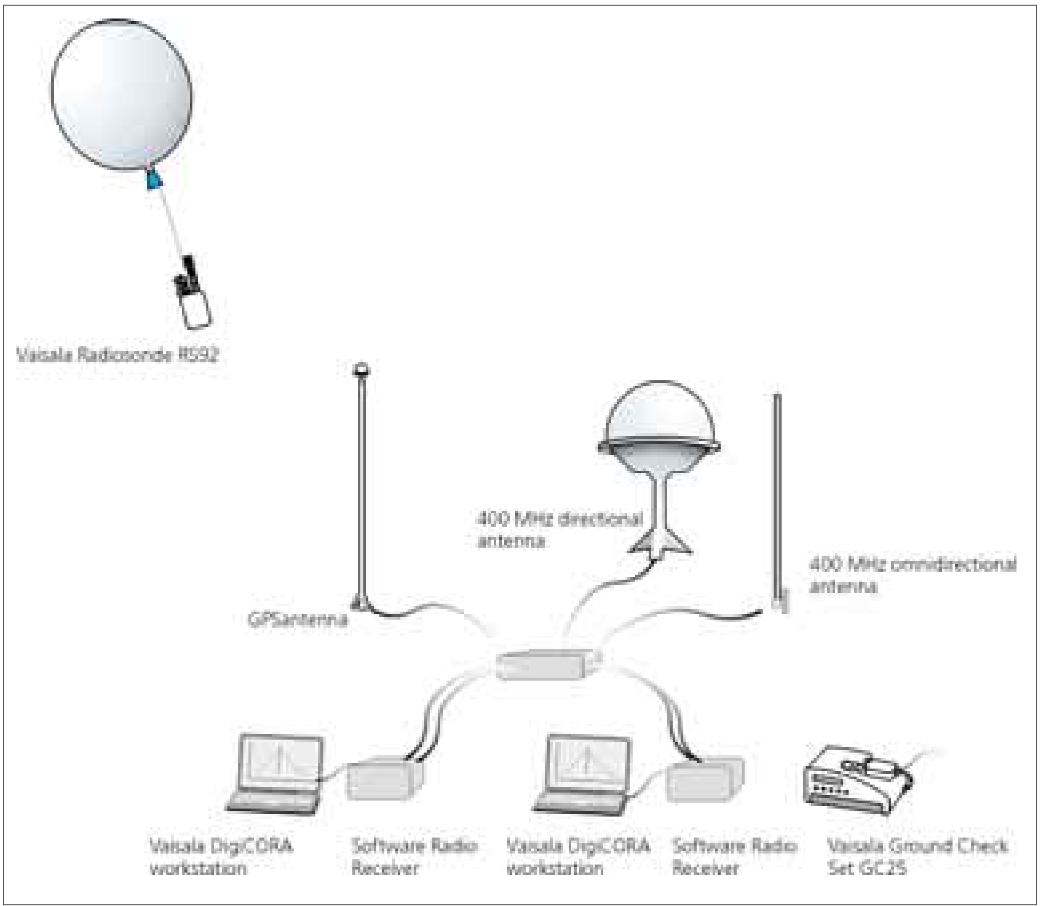


Figure 5. Test setup.

link also dependent on the sounding environment, the antenna type that is used and the location of the antenna[4].

To compare telemetry link performance with the directional and omnidirectional antennas, single RS92-AGP radiosondes were received. Both setups are presented in figure 5.

Signal to noise ratios (SNR) and occurred frame errors for both antennas in an exceptionally long sounding are shown in figure 6. With the omnidirectional antenna the error count starts to increase after 160 km and the signal is too weak for reception at about 270 km. The directional antenna performed well up to 320 km.

As can be expected, there are rather large variations in the SNR with both antennas. It can also be seen that there are more rapid changes with the omnidirectional antenna. The omnidirectional antenna is more sensitive to multipath fading which is the most important reason for signal level variations. It is also probable that the narrower radiation pattern of the omnidirectional antenna is more sensitive to the movements of the radiosonde during the ascent[5].

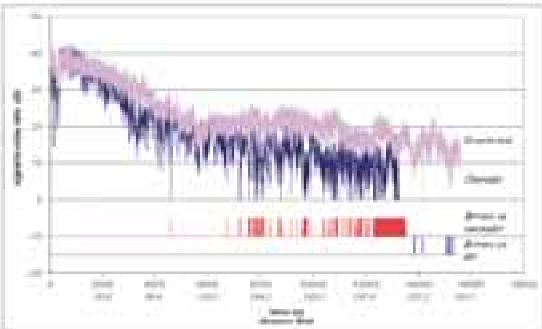


Figure 6. Test sounding with two antennas.

Effect of Reed-Solomon algorithm

The effect of the Reed-Solomon algorithm was studied with the omnidirectional antenna using three-position antenna switch with two empty positions. The radiosonde search algorithm selecting the antenna switch position caused additional errors that were all corrected by the Reed-Solomon algorithm.

The results of the test soundings can be seen in table 2. In the table, “FER with EEC” stands for frame error ratio with error correction and “FER no EEC” is frame error ratio with no error correction.

As shown in table 2, the Reed-Solomon algorithm has a dramatic effect on FER. The selected Reed-Solomon code RS(255,231) seems to be capable of correcting most errors within the sounding range in most cases. In practice this also means that the burst errors are less than 12 bytes long.

Summary

The fully digital telemetry link between the RS92-AGP radiosonde and the ground equipment using the Software Radio enables the use of modern digital modulation methods, error correction algorithms and telemetry diagnostics. In the test series the achieved average frame error ratio was below 0.5%. ●

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1 Mitola (1996)
2 A. Linz, A. Hendrickson (1996)
3 F. Carden (1995), A. Houghton (1997)
4 Pousi (2003)
5 Pousi (2003)

Reijo Miettinen, Senior Lieutenant
Leader of the Meteorological Platoon
Finnish Defense Forces
Niinisalo
Finland

Enhanced meteorological accuracy test trial CoMETFire

Weather Services Play a Central Role

The importance of weather services for field artillery operations has been the focus of many recent studies. Accordingly, weather service accuracy was selected as the central theme at the CoMETFire accuracy test firing held in Denmark in September, 2003. The Finnish Defense Forces participated in the trial as a member of NATO's Partnership for Peace (PfP) program, with Vaisala providing the weather services to the Finnish team at the trial.

Two NATO working groups on meteorogical services have concluded that 67 % of errors in the opening of artillery fire are caused by weather, while 22% depend on the aerodynamics of the ammunition and 10% on differences in muzzle velocity. Consequently, the most effective way to influence the accuracy of artillery fire is to reduce the influence of weather by using advanced weather observation methods.

The objective of the CoMETfire test firing was to fire some 600 shots with the German PzH 2000 (PanzarHaupitze 2000) howitzer at a range of 27 kilometers. During the test firing period, several groups of weather servicemen were positioned in various locations in North Jutland, seven of them utilizing sounding systems and one using a wind profiler.

The Finnish weather services team consisted of Sr. Lt. Reijo Miettinen, Sakari Kajosaari and Päivi Peltoniemi of Vaisala (from left to right).

Assessing the importance of weather data

During the rehearsal, 45 soundings were performed daily. To study the effect of the terrain on the weather messages, some of the soundings were made concurrently, with a distance of up to 140 km between sounding sites. Soundings were also performed within the same area at intervals of 20 minutes to assess the stability of the weather. The total number of soundings amounted to 540, carried out on 12 days during the two-week rehearsal period. Additionally, test soundings were made at the beginning of the rehearsal with all of the seven sounding systems.

The weather service's main task was to calculate fire control data by utilizing the weather computation model produced by the weather service. This virtual model was complemented with calculated messages in NATO's METCM weather message format. These were further used as the basis for calculating a more accurate model, in the new meteorological grid format (METGM), covering the entire rehearsal area.

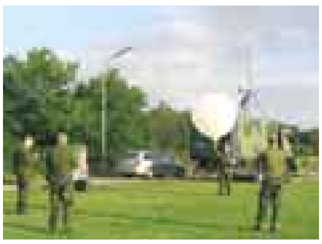
Meteorological experts supported Finland's team

The Finnish Defense Forces team that participated in the trial purchased sounding services from Vaisala, the Finnish supplier of weather measurement instruments. Project Manager Päivi Peltoniemi and Development Manager Sakari Kajosaari of Vaisala were responsible for the weather services. A representative of the military, Senior Lieutenant Reijo Miettinen of the Meteorological Platoon of the Finnish Defense Forces, was appointed to lead the Finnish department at the trial. Although the weather services functioned without any problems during the rehearsal, there was a lot of gazing up into the air - constantly following the flight of a sounding balloon. Finland's team carried out eight soundings daily, some at an interval of one hour, which kept the team busy throughout.

A PzH200 howitzer at the test firing site in Denmark.

Conclusions

The test firing proceeded well and the working groups obtained a lot of data from the tests. However, final analyses and conclusions based on the test results will be ready only in April - May 2004. The new findings may turn out to be useful in improving the accuracy of artillery and mortar systems while at the same time reducing the frequency of soundings. This, in turn, can help in minimizing the need for maintenance. ●



With Danish colleagues looking on, Lieutenant Reijo Miettinen sends a weather balloon in a competition to see which team can reach the highest altitude with its sounding balloon. Finland swept the competition (3-0).

Ritva Siikamäki, MA
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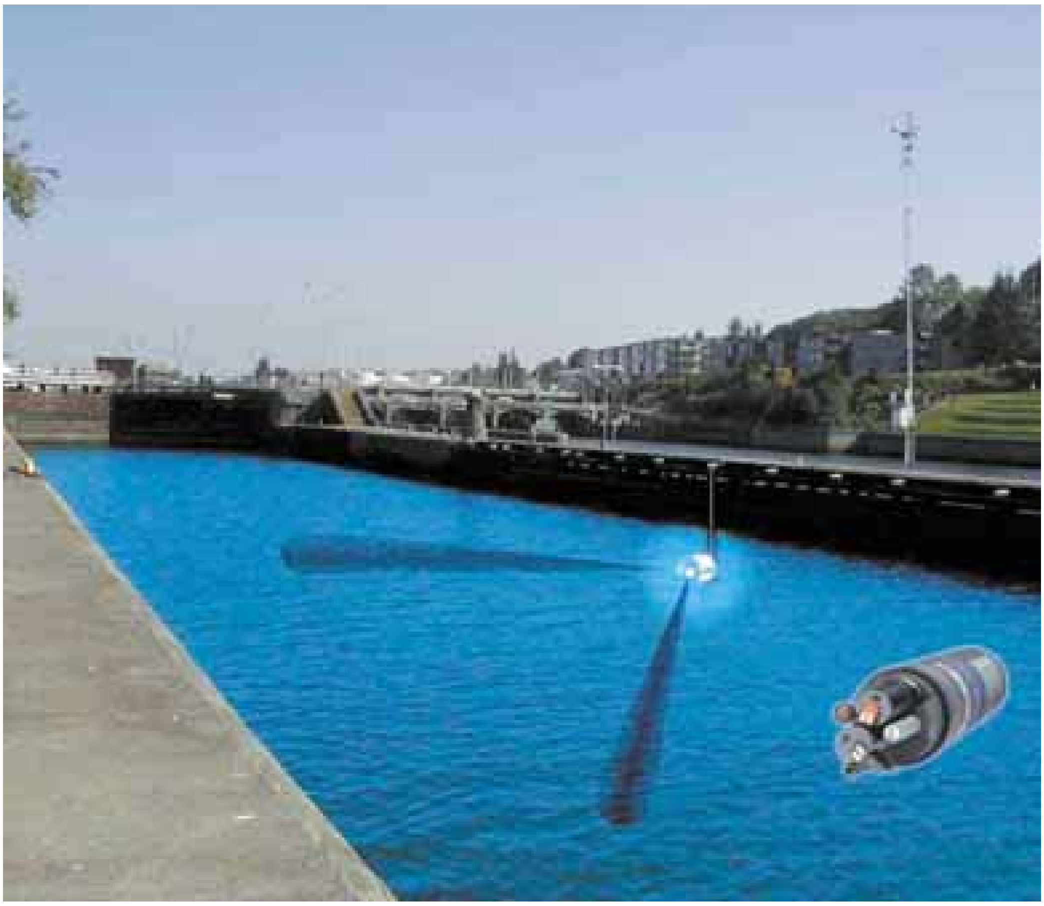
Vaisala Automatic Weather Station MAWS301

Enhanced for Hydrology

Alongside standard meteorological parameters, the Vaisala Automatic Weather Station MAWS301 also now covers hydrological measurement, all integrated into a cost-effective platform for hydrological monitoring. Hydrological sensors, advanced telemetry and data processing features have been combined with the basic MAWS301. The new hydrological monitoring solutions cover hydrological parameters in streams, rivers, lakes, reservoirs and harbors. The hydrological monitoring system based on the Vaisala Automatic Weather Station MAWS301 improves your ability to protect life, property and the environment and contribute to sustainable development.

MAWS301 integrates water quality and velocity sensors and meteorological sensors to a compact data logging and telemetry system.



The Vaisala Automatic Weather Station MAWS301 is available as a stand-alone system, acting as a cost-effective platform for hydrological monitoring. Additionally, Vaisala can design a hydrological monitoring network solution to your specifications by interfacing the Vaisala Automatic Weather Station MAWS301 with sensors that monitor water level and flow and water quality - in addition to meteorological parameters. A wide variety of measurement technologies are available which offer a balanced and reliable solution, the right performance without excess field maintenance needs or installation costs. By duplicating sensor, data logging and telecommunications technology across networks, operators of meteorological and hydrological networks can minimize the cost of network design, network maintenance, spare part stocking and training.

Submersible pressure water level sensor

Vaisala offers several high-performance sensors for measuring water level, all of which are easy to install and maintain. The standard sensor suite of the MAWS301 includes the sensor interfaces and default settings for a submersible water level sensor that determines water level by measuring the water pressure above the submerged sensor. A high-performance pressure sensor measures water pressure accurately, with the measurement technology housed in a stainless steel assembly. The multi-cored vented cable compensates for changes in atmospheric pressure. For those sites where condensation in vented cables causes problems, Vaisala also has a solution. Installing an absolute pressure sensor for level measurements eliminates the vented cable, and the pressure sensor in the MAWS301 system compensates for atmospheric pressure.

Vaisala Radar Water Level Sensor QRH101

The Vaisala Radar Water Level Sensor QHR101 is contact-free measurement instrument based on microwave technology. Offering accurate measurements, the QHR101 is insensitive to mud, driftwood, leaves, fog and variations of air temperature within the measurement range. The QHR101 provides a measurement range of 0 to 20 meters with an accuracy of better than ± 1 cm.

The QHR101 is easy to install on existing structures. Consuming little power, it is the ideal water level sensor for remote monitoring applications where minimal maintenance is of paramount importance.

Vaisala Bubbler Water Level Sensor QHB101

The Vaisala Bubbler Water Level Sensor QHB101 is a robust sensor for measuring the water level in surface waters. The measurement principle is based on a proportioning system, whereby a mini-compressor injects air through a pressure tube into the water at adjustable intervals. The resulting pressure in the tube corresponds to the hydrostatic pressure above the mounting-piece of the tube. Tube pressure is measured with an accurate sensor that is securely installed either indoors or in the equipment enclosure. Only the pressure tube is submerged, not the electronics.

The bubbler sensor is easily installed and does not require frequent servicing. With the MAWS301 controlling its operation, the QHB101 consumes little power, which makes it well suited to remote sites.

Measuring water level in stilling wells

The shaft encoder is the ideal solution for measuring the water level at hydrological sites with stilling wells. The shaft encoder produces pulses as the shaft rotates, totalizes the signal, and outputs the data through SDI12 or RS232 serial channels. The data describes absolute changes in water level change in relation to a set datum. The data can also be read on the LCD display which shows range, resolution, time, date and current water level. Vaisala offers several solutions with a resolution ranging from 1 mm to 8 mm.

Multiparameter water quality probes

YSI's multiparameter water quality sondes are used for the unattended and simultaneous monitoring of a wide range of water quality parameters. The field-replaceable probes together with the extended-deployment technology of YSI 6600EDS increases deployment time without site visits and thus significantly lowers maintenance costs. The MAWS301 supports a wide range of YSI sondes ensuring a cost-effective and reliable solution for your applications.

Acoustic Doppler Profilers for flow measurements

Easily installed on riverbanks, bridge abutments or other vertical structures, SonTek Argonaut-SL (Side-Looking) current meters are advanced Doppler sonars for the accurate measurement of water velocity in a horizontal layer. In case the mounting structure disturbs water flow around the instrument, the starting point of the velocity cell can be moved several meters away to eliminate the interference. By adding an optional vertical beam, water level can be measured concurrently with water velocity, allowing real-time discharge calculation.

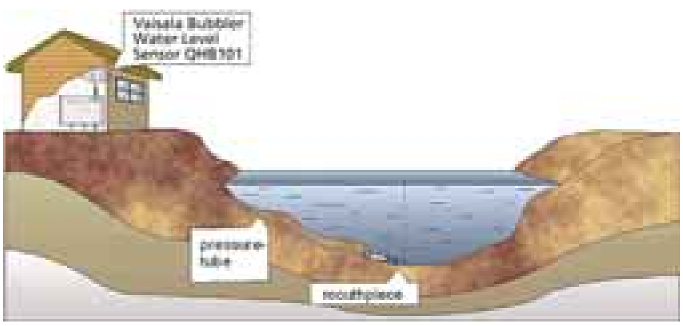
The bottom-mounted Argonaut-XR and Argonaut-SW sensors monitor flow and water level in rivers, natural streams and man-made channels. The signal processing technology is all-digital, ensuring reliable data collection within a user-programmable cell that is vertically oriented and extends all the way to the water surface. These instruments are ideal for environments with stratified or complex flow conditions or for when water levels vary greatly. The robust SonTek Argonaut current meters have been designed for continuous in-situ monitoring and do not require calibration. Moreover, biological growth does not affect their accuracy, which minimizes operational costs.

Versatile telemetry solutions

With an appropriate telecommunications solution, network coverage can be extended to the most remote locations at an optimized operational cost. A single MAWS301 station can accommodate multiple telemetry solutions for measurement locations that regularly experience flooding, for example, and from where data must be obtained under all circumstances. The telemetry solution can comprise PSTN and cellular networks, and the GSM/GPRS (General Packet Radio Service) network including FTP protocol. Additionally, satellite systems, such as GOES, METEOSAT, INMARSAT-C, OrbComm, AutoTrac, Iridium or UHF, and Spread Spectrum radio modems can be used. ●

The Vaisal Radar Water Level Sensor QHR101 is an accurate and contact-free measuring device.

The Vaisala Bubble Water Level Sensor QHB101 measures the water level in surface waters.



Vaisala Thawing the Market in Canada

Vaisala has had recent successes in the Canadian Road Weather Information System (RWIS) market. A number of systems have been installed and commissioned in the provinces of Ontario and Newfoundland. Nova Scotia has also signed on with Vaisala, with several systems taken into use in fall 2003.

Karl Boivin
Sales Manager
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Canada

RWIS station located at Mt. Forest, Ontario. Station includes a suite of sensors as well as video camera located on the top left boom.

Image from Mt. Forest video camera.

Vaisala has worked closely with the province of Ontario in 2002 and 2003 in the installation and commissioning of thirty Road Weather Information System (RWIS) sites throughout the province. The installation of this network was completed in spring 2003. The province will count on Vaisala's RWIS stations to help manage snow, ice and fog situations, and to assist in making decisions that make Ontario's roads safer for the public. Having such a network of RWIS will also allow the Ministry of Transportation to proactively maintain their roads during harsh winter conditions.

All the Ontario weather station sites collect and monitor temperature, relative humidity, wind speed, wind direction, pavement condition and precipitation occurrence. The Vaisala Present Weather Detector PWD11 is also included in the system to detect falling snow and assess its intensity and accumulation. Some sites are also equipped with video cameras so that photos of the roadway can be taken and viewed by the Vaisala Processing Unit DMC586.

The Vaisala server, located at Environment Canada's centralized data processing center in Ottawa, polls all RWIS sites via phone modem. The data is then converted into CSV file format and exported to Environment Canada's website where various road authorities can view the information and take the appropriate proactive road maintenance decisions.

In Newfoundland, the city of St. John's recently made the decision to replace existing road weather systems with Vaisala RWIS stations. Pavement condition monitoring is one of the key measurements that has been improved with the installation of the Vaisala systems. AMEC Earth & Environmental Limited, the company responsible for providing weather forecasts to the city as well as procuring and maintaining the RWIS network, were the first to notice the positive difference in measurements and data from the equipment. Stephen Green, Meteorological Lead at AMEC, was looking for an immediate solution that would allow him to accurately identify the presence of chemicals on the roadway. "Our experience to date with Vaisala equipment has been that it provides reliable and accurate data, unlike the previous manufacturer's equipment," he says.

Vaisala has recently completed the installation of ten RWIS systems throughout the eastern province of Nova Scotia. These sites were commissioned and operational in fall 2003 for use during the 2003-2004 winter months. Using such technology improves safety by allowing road crews to treat roadways before an unsafe event occurs, which ultimately saves lives. In addition, these proactive measures allow the use of less de-icing chemicals, thereby helping the provinces to contribute to a reduction in the environmental impact of winter maintenance.

In Ontario, the Ministry of Transportation Ontario's (MTO) is completing the third phase of their RWIS program to which Vaisala is planning to deliver thirty RWISs by January 2004. With this addition, MTO will have 60 Vaisala RWIS systems. ●

One of ten Vaisala RWIS stations installed in Nova Scotia.

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Managing Director
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Italy

Vaisala Products Promote Traffic Safety in Italy

The Vaisala Present Weather PWD11 accounts for a success story in traffic safety applications in Italy. Numerous motorway companies have complemented their Vaisala Road Weather Stations with a PWD11 for present weather measurement. The PWD11 is also used as a stand-alone device to be integrated in their monitoring network for winter maintenance and road traffic safety. Moreover, other traffic weather products, such as the Vaisala IceBreak, IceCast and IceWeb road traffic weather applications, are also gaining ground in Italy.

Since its launch, the Vaisala Present Weather Detector PWD11 has been widely used in Italy in traffic safety applications. A number of motorway companies, such as Autostrada dei Fiori, Società Autostrade Ligure Toscana, and Auto Camionabile della Cisa, have adopted the PWD11 as the right complement for their Vaisala Road Weather Stations. Besides enhancing road weather station measurements, the PWD11 is also used as a stand-alone device to be integrated in the winter maintenance and road traffic safety monitoring network, for instance by Autostrade Centro Padane (ACP).

In the winter season 2003 - 2004 two more motorways will start using IceCast systems; on the Torino-Milano motorway a total of nine Vaisala Road Weather Stations, complemented with a PWD11, will be taken into use. The Torino-Piacenza motorway and the Piemonte Provincial Road leading to Sestriere will also employ Vaisala Road Weather Stations, both equipped with a PWD11.

On the Piemonte Provincial Road, the road weather station will be the first station of the network planned for the Turin 2006 Winter Olympic program. The Regional Office for the Protection of the Environment, ARPA Piemonte, will provide 24-hour road temperature forecasts to the Torino-Piacenza motorway and its road authority. These forecasts are based on in-situ measurements collected by the road weather stations and on ARPA Piemonte's forecasting model input. These data are further processed with the Vaisala IceBreak road condition forecasting model. Once ready, the forecasts will be sent to the motorway and road authority every afternoon, to allow for the advance and correct planning of winter maintenance activities.

Enhancing safety with visibility measurements

Vaisala has supplied a large number of PWD11 stand-alone sensors to Serenissima Infracom for installation on the motorway stretch between Brescia and Padova. After an intercomparison between several types of visibility sensor, the PWD11 was selected as a reliable visibility measurement device to be used within the frame of the drivers' assistance system, Companion, that Serenissima Infracom has set up on their motorway. The PWD11 visibility measurements are fed to the Companion system, which provides "guidance" to drivers in foggy conditions by activating an illuminated path. The system is activated on the basis of the visibility threshold. Serenissima Infracom has installed as many as sixty PWD11 units so far.

The Venice Water Transport Company (ACTV) relies on the PWD11 for visibility monitoring at the Venetian Lagoon. The local Italian integrator, Telematica e Trasporti Srl, supplied Venice Water Transport Company with a network of five PWD11 units which have been operational since 2002.

Vaisala IceWeb at Autostrade Centro Padane

Autostrade Centro Padane, the pioneer in the use of the Vaisala IceCast system in Italy, will start using IceWeb in winter 2003. The Vaisala IceWeb is a new product that creates HTML pages from standard, pre-defined IceCast Viewer displays. These pages make the road weather information, usually accessed through IceView, available through Internet and Intranet applications. By using the Internet or an Intranet, communication costs can be reduced considerably and users can also monitor the data easily. With the IceWeb server, the system administrator defines the HTML pages to be made available for users to view in their web browsers. Sensor and forecast data can be viewed in tabular, graphical or cartographical formats. Webcam images are also supported. ●

The Venice Water Transport Company (ACTV) relies on the Vaisala Present Weather Detector PWD11 for monitoring visibility at the Venetian Lagoon.

PHOTO COURTECY OF KAI MÖNKKÖNEN

A gliding plane reaching the finishing line at Leszno.

Ritva Siikamäki, MA
Editor-in-Chief
Vaisala Helsinki
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The Finnish Aeronautical Association and Vaisala cooperate to support the

Gliding World Championships 2003

The 28th Gliding World Championships were held in Leszno, Poland, from July 27 to August 10, 2003. The event attracted more competitors than ever before and championships were run in four FAI classes in the same airfield. In total, 128 gliding planes from 31 countries competed in standard, 15-meter, 18-meter, and open class. The competitors were given traditional racing tasks with turning points, but also tasks within assigned areas. Twelve competition days were held in the two-week period, during which all the planes completed their tasks without any accidents. The pilots and organizers found the accurate local weather data provided by the Vaisala Aviation Weather Reporter AW11 invaluable.

The Finnish gliding team that participated in the competition was supported by the Suomen Ilmailuliitto (The Finnish Aeronautical Association), which concluded a cooperation contract with Vaisala for the season 2003. In cooperation with The Finnish Aeronautical Association, Vaisala also provided the organizers with an Aviation Weather Reporter AW11 for the period of the championships. The accurate local

PHOTO COURTESY OF KAI MÖNKKÖNEN

Highly efficient, although maybe not so beautiful, Cmelak planes with turbo prop engines were used for towing the gliding planes.

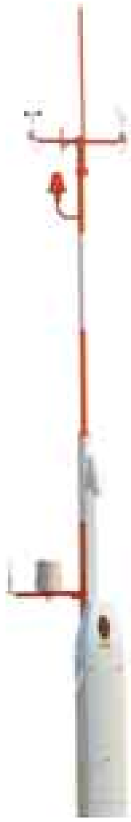
weather data was used by the meteo people for planning the day's tasks and schedule and by the pilots during their flights to get real-time data from the airport to monitor weather changes and to decide on the correct landing direction.

Bringing aviation enthusiasts together

The Finnish Aeronautical Association, a member of Fédération Aéronautique Internationale (FAI), could be described as an umbrella association promoting all the aviation sports in Finland, explains Mr. Kai Mönkkönen, Secretary General of the Finnish Aeronautical Association. "This is somewhat of an exception in aviation sports, where one national association is usually dedicated to one sport. For instance, parachuting would be organized in a separate association, while at the Finnish Aeronautical Association this sport belongs to the same union as gliding, hot-air ballooning, model plane building, experimental plane building, etc.," points out Mönkkönen.

With some 11,000 members, the association acts as a link between people that are active in these sports all over Finland. This is the most "visible" part of the activities, but, and maybe even more importantly, the association also answers for training in the field, aircraft inspection activities and competitions, whilst working in close cooperation with the aviation authorities to promote aviation safety. Moreover, the association owns and runs an aviation training institute at Räyskälä, which specializes in arranging training courses at various levels in aviation sports. The institute is the largest in Scandinavia, and especially popular with parachutists.

According to Mönkkönen, the Finnish Aeronautical Association – like aviation itself – has a much longer tradition in Finland than one would expect, with many local clubs celebrating their 80 year anniversary ➤



The Vaisala Aviation Weather Reporter is an unmanned automatic weather station, specifically designed for small and mediumsized airports and heliports.

The airfield at Leszno was an excellent venue for the Gliding World Championships which were a success with a record-breaking number of participants.

this year or in the near future.

As the Finnish Aeronautical Association is a sports association, it receives subsidies from the Ministry of Education, but membership fees and sponsorship contracts account for a substantial part of the financing, explains Mönkkönen. In this respect, the cooperation contract with Vaisala has been very important and, indirectly, it also made the Finnish team's participation in the gliding championships possible.

Smooth preparations and success

The President of The Finnish Aeronautical Association, Mr. Tapio Savolainen, who acted as the jury president at Leszno, describes the event as an all-time success. However, some difficulties came up during the training week, including the interpretation of the regulations. There were more planes participating than ever before. All of the 128 planes on the starting line were towed into air in just 45 minutes. The longest task extended to 725 kilometers which broke the record in the open class.

Even if the Finnish teams were only among the winners on two competition days, Finland and Vaisala certainly became known among the participants and spectators through the team's presence combined with the reliable weather service from the Vaisala Aviation Weather Reporter. In addition, the Finnish evening event organized by Vaisala and the Finnish team at the end of the training week was a success. Savolainen mentions that the party attracted a huge crowd to the hangar and people enjoyed themselves. The event was highly appreciated – just like the tent sauna which was dubbed the Vaisala Heavy Weather Station.

Both Savolainen and Mönkkönen describe the cooperation with Vaisala, which focused on the gliding championships, as something completely new, finding it an interesting learning experience. "The key to mutual success was to truly cooperate and work together to find solutions to a number of unexpected questions that came up along the way. Many ideas were discovered and discussed when preparing for the Finnish team's trip to the championships," remarks Mönkkönen. The cooperation is a two-way street: for the Finnish Aeronautical Association it enhances the possibilities to organize activities, while from Vaisala's point of view it acts as a source of important feedback from users, representing many different sports. For instance, the output of the AW11 has been slightly modified on the basis of the experience at Räyskälä aviation training institute. The system now better meets the needs of parachuting planes that constantly need information on cloud height and winds. ●

What is gliding?

Gliding, or soaring, is flying without an engine. The only sources of power are warm ascending air currents, thermals, or uphill blowing winds, "waves", in mountainous areas. Finding these "cheap and clean ways to go up and stay there" is dependent on one critical factor – the weather.

Gliding usually starts with towing or winching. Self-starting with a small engine is also possible, but not very common, because of the high price of these planes.

After being lifted with some help from friends to a height of 500–1000 meters, glider pilots usually start looking for something to help them rise even higher and stay there. This can last more than 10 hours and take a glider plane and pilot hundreds or thousands of kilometers. Some gliders are very good at aerobatics, so, for example, looping and spinning is another popular way to enjoy gliding on cross-country flights.

Most gliders are operated by private pilots or flying clubs. Joining a club is usually the best way to start gliding. After getting a license, the clubs usually offer a chance to start training to sharpen one's skills. As in many other fields, practice makes perfect in gliding. With each flight, the ideal time to perfect one's skills lasts approximately as long as the active soaring. ●

PHOTO COURTESY OF KAI MÖNKKÖNEN

The Finnish team's secret weapon was the tent sauna, the Vaisala Heavy Weather Station. The humidity and temperature of the sauna were monitored with Vaisala instruments.

The Vaisala Aviation Weather Reporter AW11 is used at the heliports of the Arma dei Carabinieri in Italy.

Maria Rita Leccese
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Vaisala Aviation Weather Reporter AW11

Supporting at Italian Air Force Heliports

Vaisala recently delivered and installed one Italian-speaking Vaisala Aviation Weather Reporter AW11 at a heliport base, located near Rome, that has been recently renewed by Calzoni, Panerai Sistemi Division. The AW11 is also used in field emergency situations by the Italian Air Forces.

The Arma dei Carabinieri originally selected the AW11 as they found it a suitable solution for their heliports and for the Italian Air Forces' field emergency situations. The AW11 is a fully automatic stand-alone weather observation and reporting system which provides meteorological data for helicopters/aircraft flying to airfields with no meteorological support on the ground. The AW11 measures all standard aviation weather parameters: sky condition (cloud layer height and coverage), visibility, air pressure, temperature, dewpoint, wind speed and direction.

All the data is processed and presented in weather reports that the system generates automatically. The reports provide an accurate description of the prevailing weather conditions at the aviation site. The system outputs the weather report in a clear human voice, via the built-in VHF radio, which allows pilots approaching the site easy access to the weather data.

The speech output of the fully automatic AW11 installed at the heliports upgraded by Calzoni uses the Italian language to report the weather conditions. The local operator will also be able to record a message header and provide additional information at the end of the message. In addition to the speech output via VHF radio there is a PC at the site, connected to the system through the telephone network, that provides weather data display and system configuration monitoring in the operators' room. ●

Herb Winston
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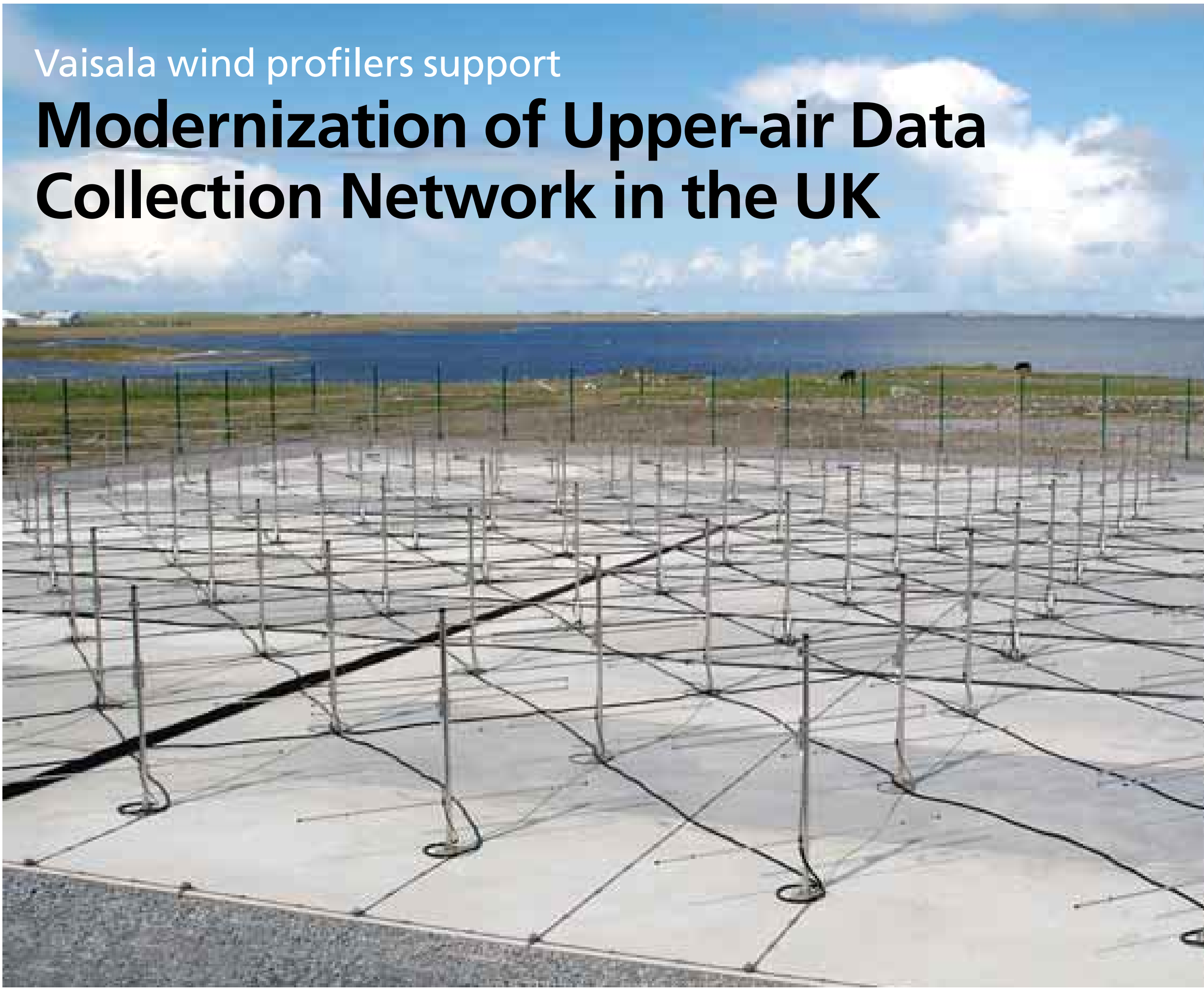
Vaisala wind profilers support

Modernization of Upper-air Data Collection Network in the UK



The UK Met Office has started using Vaisala wind profilers as part of a modernization effort in its upper-air data collection observation network, in which radar wind profilers are playing a significant role. A Vaisala Tropospheric Wind Profiler LAP®-12000 was installed in the Outer Hebrides, Scotland in fall 2003. The system, located on South Uist, is required to operate reliably and unattended in harsh weather conditions.

The UK Met Office is modernizing its operational upper-air data collection network. This modernization effort emphasizes integrated data sets through the deployment of new instrumentation that increases automation, reduces recurring labor costs and improves temporal and spatial data resolution.

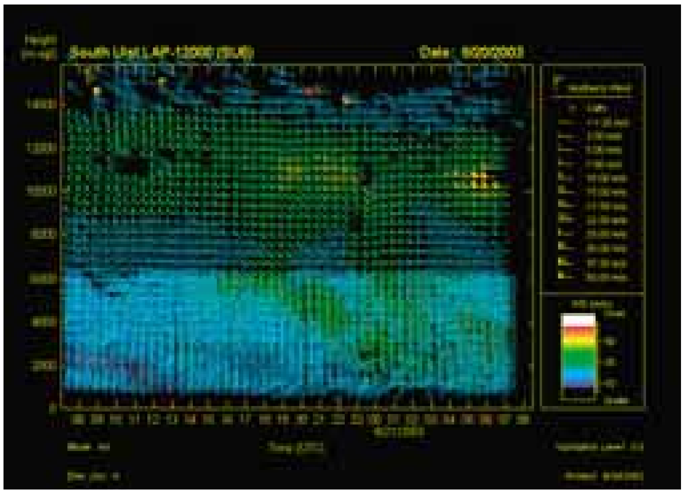
Wind profilers have played a

significant role in this modernization effort. The Met Office operates three operational boundary layer Vaisala LAP®-3000 Lower Atmosphere Profilers in Camborne, Dunkeswell and Wattisham in England. Operating at either 915 MHz or 1290 MHz, these profilers have reliably provided lower tropospheric wind data for several years. A fourth LAP®-3000 “research” system has also provided data from several locations within Scotland and Wales in support of the expanding wind profiler program.

More recently, the Met Office decided to decommission its upper-air rawinsonde station in Stornoway, Scotland and to replace it with a wind profiler. The new wind profiler system, to be installed on South Uist Island in the Outer Hebrides, Scotland, was required to provide consitent wind data to a 12-km altitude. The system must also meet the operational needs of the UK Met Office by supporting continuous and remote operation, functioning reliably and unattended in an extremely hostile environment. The profiler will have six months between scheduled site visits, and achieve a ten-year operational life cycle. Vaisala was awarded a contract to manufacture and deliver its LAP®-12000 wind profiling radar to Met Office.

The Vaisala Tropospheric Wind Profiler LAP®-12000 combines electronics and signal processing licensed and manufactured by Vaisala under a Cooperative Research and Development Agreement (CRADA) with the National Oceanic and Atmospheric Administration (NOAA). The antenna and final amplifier are provided by ATRAD Pty. The system operates at a frequency of 64 MHz and has a final amplifier providing a peak output power of over 60 kW. The antenna array (see photo), constructed from 144 three-element Yagi-Uda stainless steel antennas, is electrically steerable in 5 directions and occupies an area of approximately 1025 m².

The data system incorporates a Vaisala’s Digital IF receiver, which was officially launched at the World Meteorological Organization’s METEOREX 2002 exhibition in Bratislava, Slovak Republic. The digital IF receiver has subsequently been integrated across the Vaisala LAP® wind profiler product line.



Sample of wind profiler data display at South Uist.

The system was delivered to the Met Office in August 2003. A one-month test was performed by the Met Office to evaluate the system’s operational reliability, data recovery and wind measurement accuracy. After confirming that the delivered system met the tender specification, the system was accepted on September 15, 2003. The LAP®-12000 which will become operational in early 2004 is the main upper-air sounding system for the Western Isles of the UK. Observations from this site are also used by European Met Services through the EUMETNET WINPROF Program.

Vaisala will continue to support the Met Office by providing technical expertise on the use and implementation of the advanced signal processing features available in the Digital IF architecture. These include Wavelets, Multiple Peak Picking and an experimental Droplet Size Distribution algorithm. The wind profiler at South Uist is part of the COST Wind Initiative for a Network Demonstration in Europe, CWINDE, which comprises numerous wind profiler sites across Europe.

Our readers are welcome to review the South Uist data from the official CWINDE Web site at http://www.met-office.gov.uk/research/interproj/cwinde/profiler/index.html. Simply click on the South Uist location on the map and then scroll down to the 64 MHz data set. Twelve-hour data plots are provided for both high mode and low mode wind data. ●

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Vaisala LAP®-16000 Tropospheric Radar Profiler to

Deutscher Wetterdienst Expanding Upper-air Observing Network

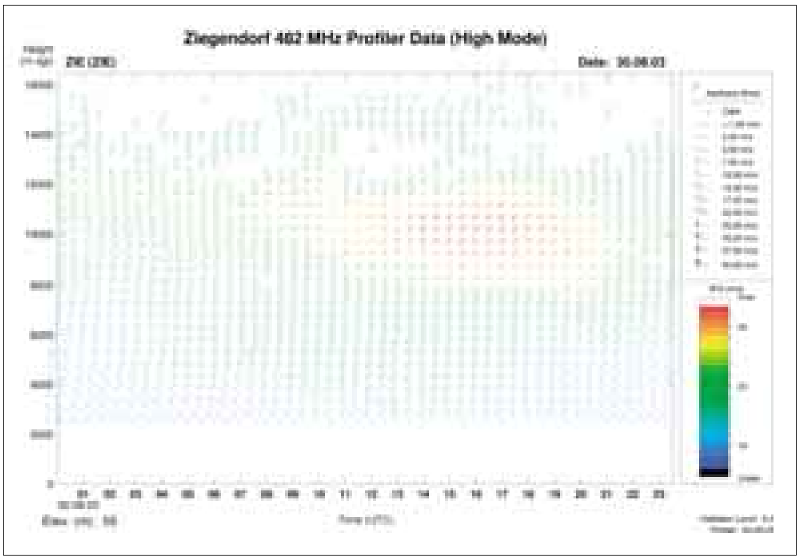
A Vaisala Tropospheric Radar Profiler LAP®-16000 was handed over to the German Weather Service, Deutscher Wetterdienst (DWD), on September 26, 2003. This profiler installation at Ziegendorf in Mecklenburg-Vorpommern is the first of three under the Vaisala contract from DWD to expand their upper-air observing network.

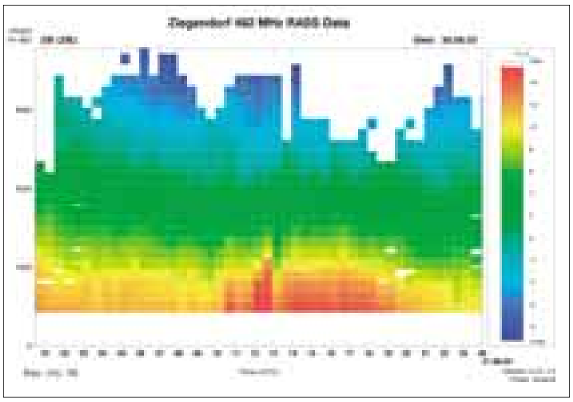
Vaisala Tropospheric Radar Profiler LAP®-16000 at Ziegendorf.

Operating on the 482 MHz frequency, the newly commissioned wind profiler at Ziegendorf measures wind speed and direction up to 16 km above ground level (agl). With the Radio Acoustic Sounding System (RASS), virtual temperature profiles are obtained up to 4 km agl.

A first prototype of the 482 MHz wind profiler was delivered to DWD in 1996 for evaluation at their research center in Lindenberg, Germany. Based on experience gained with the prototype, the system has been further developed. The new profilers will support DWD operations by providing continuous wind and temperature profiles to improve weather forecasting.

The LAP®-16000 Wind Profilers that are now being delivered have been improved in many respects compared to the prototype. The antenna array now consists of 180 coaxial colinear antennas with 14 dipoles each, controlled by an electronically actuated phase shifter to provide the five different beams with an optimum antenna pattern. Antenna array power tapering and a surrounding earth wall have also been added to reduce unwanted signals from low-angle antenna side-lobes. The radar transmitter is now based upon advanced LD-MOS transistors and utilizes eight off-the-shelf TV transmitter amplifiers from FTK Rohde & Schwarz GmbH in Berlin. This amplifier has been specially modified for the pulse transmission mode for wind profiler operation. The nominal output peak power of the modular transmitter system is 16 kW. The effective isotropi-





The Graph-XM® software provides data visualization schemes such as time-height cross sections of wind barbs. Examples of data displays from the profiler at Ziegendorf.

Transmit and receive control unit at the equipment shelter.

The Radio Acoustic Sounding System (RASS) provides virtual temperature profiles, pictured is one of the four RASS units.

cally radiated power (EIRP) is 48 MW due to the antenna gain.

The transmit control electronics include a pulse shaping unit that constrains the occupied bandwidth within a narrow range. The receiver unit includes digital IF electronics, resulting in increased dynamic range and improved signal processing. Data processing with the Vaisala LAP-XM® software, which provides system control and signal processing functions, has been enhanced to include special features to meet DWD-specific requirements. The data display and communication capabilities were also delivered according to DWD specifications. The entire system includes built-in recording of internal operating parameters so that the functional status of system components can be remotely monitored over a network connection using an internet browser.

With a truly global team and sub-suppliers coming from Germany, Finland and the U.S., the first system delivery at Ziegendorf has been finalized within the originally planned timeframe. The extended testing and verification process was accomplished jointly by Vaisala and the DWD research and operations teams from Lindenberg and Hamburg.

For the next system, which will be installed at Nordholz in Lower-Saxonia, the infrastructure is currently under preparation and delivery to DWD is planned for the summer of 2004. Delivery of the third system to Bavaria is scheduled for early 2005. ●

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New Vaisala Thunderstorm Information System

A Revolution in Lightning Detection Networks with Modular Technology for Focused Performance

As the market leader in lightning detection technologies, Vaisala constantly develops products that enhance meteorological forecasting, nowcasting and historic analysis. The new Vaisala Thunderstorm Information System introduces the next generation of modular lightning detection sensor and processing platforms, which continue the Vaisala tradition of scientific expertise and innovation. The Vaisala Thunderstorm Information System allows users to select the ideal sensor configuration for a particular network and combine it with appropriate data processing, archival and display tools into a solution that meets lightning detection needs in meteorology, hydrology, electric power distribution, aviation, defense and telecommunications.

The Vaisala Thunderstorm Information System enables the selection of new modular total lightning and cloud-to-ground lightning sensors, all of which utilize a new common central processing platform along with proven display and analysis application software. The new design philosophy offers planned application evolvement paths that meet customer's growing needs and accommodate for priorities that change over time.

For comprehensive lightning information and accurate detection of the lightning types that are most indicative of thunderstorm development, the TS series combines the two most effective lightning detection technologies. The proven very high frequency (VHF) interferometry technology provides extremely high performance in the detection of cloud lightning, while the low frequency (LF) combined magnetic direction finding and time-of-arrival technology offers the highest detection efficiency and most accurate location for cloud-to-ground lightning strokes.

Design takes budget considerations into account

Appreciating customers' needs, Vaisala has worked to provide science-based, reliable solutions that take into account not only customers' technical requirements but also their financial situation. With large networks such as thunderstorm information systems, important design criteria include working within established budgets and planning for evolution and enhancements as budget cycles permit. The modular design philosophy of the TS series allows current or future network owners to select the system configuration or upgrade path that will best address their particular applications and priorities. It is important to note that it is fully compatible with its predecessors, Vaisala IMPACT, Vaisala SAFIR, and Vaisala LPATS IV sensor-based networks.

New modular sensors for focused performance

The sensor component of the TS series is designed to offer the network owner maximum flexibility and evolution opportunities through a modular sensor platform designed to host different sensing technologies. Sensor platform development has focused on enhancing equipment reliability and offering more comprehensive total lightning detection and continued high performance in detecting and locating cloud-to-ground lightning strokes.

This translates into improved flexibility, as the sensors can be tailored for current or future applications. For high-performance detection of cloud lightning, the sensors employ the proven VHF interferometry technology. Cloud-to-ground lightning events are detected with the unique combination of LF magnetic direction finding and time-of-arrival technologies, which have been verified to provide the highest detection efficiency and most accurate location finding for this type of lightning. The sensor design combines these sophisticated technologies and offers comprehensive lightning information, enabling a network owner to capture both the depth and breadth of the lightning information required.

The primary sensor selection includes the two main sensor types: the Vaisala Thunderstorm Total Lightning Sensor LS8000, and the Vaisala Thunderstorm CG Enhanced Lightning Sensor LS7000.

Vaisala Thunderstorm Total Lightning Sensor LS8000

The Vaisala Total Lightning Sensor LS8000 detects cloud lightning using VHF interferometry and employs combined LF magnetic direction finding and time-of-arrival methods for detecting cloud-to-ground lightning strokes. The sensor provides 90% detection efficiency of cloud lightning and cloud-to-ground lightning and a median location accuracy of 500 meters for cloud-to-ground lightning strokes.

The LS8000 is designed for applications that require the fast and accurate measurement of thunderstorm phases by detecting cloud lightning early and comprehensively detecting cloud-to-ground lightning. Important users of the LS8000 are meteorological agencies and hydrological agencies, as well as airport and air traffic operations for the close monitoring and nowcasting of thunderstorm cells.

The flexibility of the modular sensor design also provides for two other versions of the VHF interferometry-type sensor: the Cloud Lightning Sensor LS7200, a VHF-only version for the detection of cloud lightning, and the Cloud Enhanced Lightning Sensor LS7500, a VHF, LF time-of-arrival version. Both of these versions complement a cloud-to-ground detection network.

Vaisala Thunderstorm CG Enhanced Lightning Sensor LS7000

The Vaisala CG Enhanced Lightning Sensor LS7000 accurately locates cloud-to-ground lightning strokes using the combined LF magnetic direction finding and time-of-arrival technologies. It provides 90% detection efficiency of cloud-to-ground lightning with a median location accuracy of 500 meters.

Total Lightning Sensor LS8000 (right) and CG Enhanced Lightning Sensor LS7000 (left) are based on a modular design; the lightning detection capabilities of each sensor can be adapted and a blend of these sensors can be used in a network.

The LS7000 sensor is ideal for applications where the primary concern is the comprehensive detection of cloud-to-ground lightning with accurate measurements of lightning characteristics, such as amplitude, polarity, and lightning type discrimination. The LS7000 also provides a survey level of cloud lightning detection (5–30% detection efficiency) by detecting the LF emissions of cloud lightning events.

The LS7000 capabilities are important for electric power utilities, telecommunications, defense, and forestry agencies. In these applications, location accuracy is critical to identify threats and correlate events relative to specific locations, such as a power substation or communications tower, or to investigate a possible wildland fire ignition.

A simplified version of the sensor, the Vaisala CG Lightning Sensor LS5000, using LF time-of-arrival only, is available to the user when site characteristics do not satisfy the higher quality standards of the LS7000 and LS8000.

Heart of the system: Central Processor CP8000

To address all of the lightning application needs of the network owner, the TS series system design is based on flexibility. The beauty of the new central processing platform is that, for the first time, a single UNIX central processor simultaneously handles data from all the sensor types.

The central processing suite consists of a Vaisala Thunderstorm Central Processor CP8000 and a Vaisala Thunderstorm Archive Processor AP5000. The CP8000, which forms the core of the system, processes and analyzes the raw lightning data from the various sensors and also monitors network perfor- ➤

Sensor model	Modular acquisition platform	Sensing technologies			Application and performance focus
		VHF ITF	LF MDF	LF TOA	
LS8000	X	X	X	X	Meteorology, aviation, hydrology, electric power, defense, forestry Total lightning High redundancy; calibrated lightning parameters Medium to large area coverage
LS7200	X	X			Airports, air traffic management, metropolitan area nowcasting Cloud lightning Short to medium area coverage
LS7000	X		X	X	Electric power, forestry, telecommunications Cloud-to-ground lightning High redundancy; calibrated lightning parameters Large area coverage
LS5000	X			X	Meteorology, electric power Cloud-to-ground lightning Used for non-LF (B-field) compliant sites; non-calibrated lightning parameters Large area coverage

Table 1. Sensor models, technologies and key applications.

mance. The CP8000 ingests the raw data resulting from the LF and VHF emissions of cloud and cloud-to-ground lightning events, processes the data into solution data and then forwards the data to the Archive Processor AP5000, or directly to the appropriate real-time displays. The AP5000 specializes in archiving the data for forensic applications.

The CP8000's user interface, the Common Desktop Environment (CDE), provides the operator with easy access to the raw data captured by the sensors and to the resulting lightning solutions. In addition, the CP8000 provides user-friendly sensor interface tools, which allow easy configuration and the hands-off monitoring of network operation.

Stable and reliable platform

The CP8000 runs on a UNIX platform, using the SUN Solaris operating system. Over the years UNIX-based central processing platforms have proven to be reliable, stable components of lightning information systems. This contributes to high operational uptime – a key requirement for all systems.

Vaisala Real-time Lightning Tracking Software LTraX® was designed for lightning monitoring by electric power utilities.

Proven real-time display software applications

Display software applications retrieve solution data directly from the CP8000. The Vaisala Processing and Display Module PDM is recommended for many weather forecasting operations, since it offers a comprehensive display of total lightning information and specialized nowcasting of thunderstorm cell evolution and intensity. In turn, Vaisala Real-time Lightning Tracking Software LTraX® is ideal for electric power utility applications. Its strength is in accurate lightning mapping relative to fixed assets such as transmission lines, and in quick query functions.

Application-specific analysis software

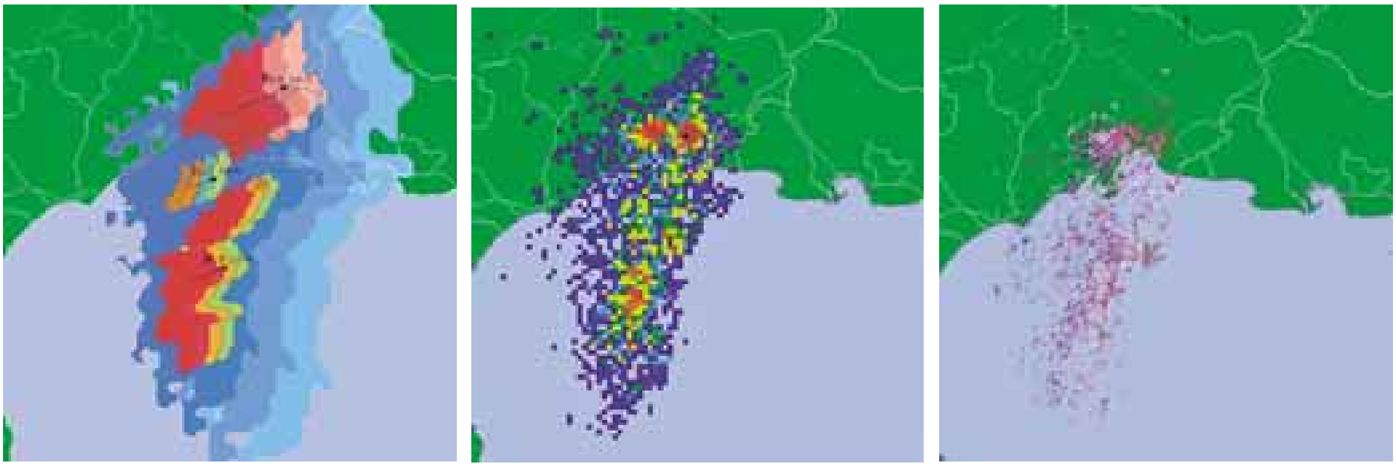
The historical analysis software receives data directly from the Archive Processor AP5000. The Vaisala Fault Analysis and Lightning Location System FALLS® is the benchmark for weather incident analysis. Vaisala FALLS was designed in cooperation with the Electric Power Research Institute (EPRI) for electric power utilities, to reduce lightning-caused faults by correlating events to lightning and then protecting vulnerable areas with more intelligent, preventative engineering and design. Although originally developed for the power utility sector, FALLS offers lightning activity density graphs and historical lightning stroke parameter data, and is often used by meteorological agencies for research and disaster planning. A lighter version of the historical analysis software is also available with the Vaisala Data Analysis Module DAM.

Meteorology: Nowcasting empowered with total lightning

The integration of total lightning data with radar, satellite and other meteorological data plays an increasingly important role in the forecasting and nowcasting activities of meteorological, hydrological, and aviation agencies around the world. Additionally, lightning data can provide critical thunderstorm cell information in areas prone to radar blockage.

Nowcasting empowered with total lightning enables the tracking and early identification of threatening thunderstorm cells and associated heavy precipitation or highly convective areas.

In the United States, lightning information is used on a daily basis by different agencies of the National Oceanic and Atmospheric Administration (NOAA). Moreover, all regional National Weather Service forecasting offices use lightning information provided by Vaisala in their forecasting activities. Worldwide, Vaisala lightning detection networks serve the forecasting needs



Vaisala Processing and Display Module PDM nowcasts thunderstorm cell evolution, maps total lightning density and tracks total lightning.

of meteorological and hydrological agencies in more than 40 countries.

Hydrology: Lightning data completes severe weather data set

Similar to the application for meteorology, the TS series is also suited to the needs of hydrological agencies, complementing other sources of severe weather data. The primary concerns of many hydrological services include the early identification of severe thunderstorms and the anticipation of intense precipitation phases. The TS series provides data that allows the relationship between lightning activity and precipitation to be mapped out, as well as allowing the assessment and nowcasting of precipitation potential.

Aviation: Air traffic control and the airport environment

In aviation, total lightning information is critical in monitoring two fundamental domains: en-route traffic and terminal and airport areas. Intense convective activity with updrafts of up to 200 km/h and high concentrations of hydrometeors is a significant hazard for aircraft en-route and during terminal air operations. These dangers take the form of cloud lightning and intense turbulence, gust fronts, wind shears, microbursts, hail and ice formation.

Airport and terminal ground hazards include cloud-to-ground lightning threats, which endanger ground crews involved with aircraft fueling, maintenance, baggage handling and passenger transfer. These ground-safety applications may be addressed with the Vaisala Precision Lightning Warning System PLWS, which includes LS8000 or LS7000 sensors with local electric field mills, specialty warning software, and remote warning equipment.

In the United States, Vaisala's National Lightning Detection Network® (NLDN®) provides real-time and historical lightning data, which is used to support the US National Weather Service, FAA air route traffic control centers (ARTCC), traffic control centers (TRACON) and many individual FAA towers. Moreover, airports around the world also use Vaisala lightning information systems for air safety, as well as the Vaisala PLWS for airport ground safety operations.

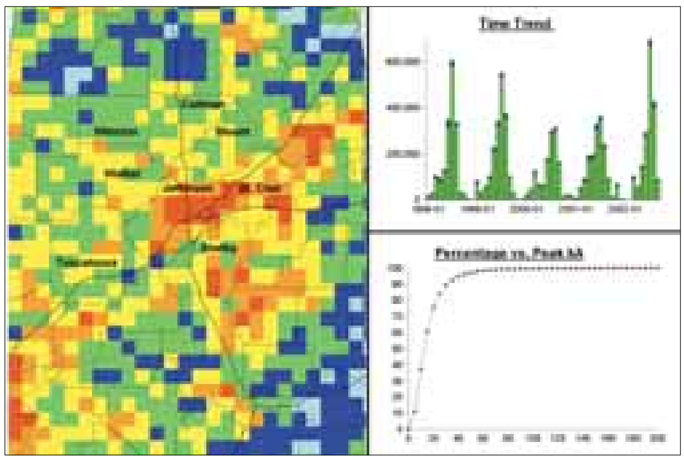
Electric power: Preparing to minimize thunderstorm impact

Electric power utilities use real-time lightning tracking and thunderstorm forecasting to preposition resources for quicker response times if lightning or thunderstorms threaten to interrupt power generation or delivery. Along with thunderstorm monitoring, power utilities are also the leaders in using historic cloud-to-ground lightning analysis tools to design better protection schemes and implement preventative maintenance that reduces operational interruptions caused by lightning. To this end, the Vaisala Fault Analysis and Lightning Location Software FALLS is the right tool for time trend and incident analysis. Vaisala's lightning detection systems currently serve more than 150 electric power utilities around the world.

Pursuing scientific and innovative excellence

The Vaisala Thunderstorm Information System is the result of many years of development, scientific expertise, and experience in installing and supporting lightning detection networks around the world for the most demanding of users. This now culminates in the most sophisticated and versatile lightning detection solution available on the world market. Thanks to its modular design, its integration of the full spectrum of lightning detection technologies, and its complete compatibility with existing Vaisala lightning detection networks, the new Vaisala Thunderstorm Information System allows existing and new network owners to select the system and evolvement path that will address all of their lightning information requirements – now and in the future. ●

Vaisala Fault Analysis and Lightning Location Software FALLS® provides detailed lightning analysis maps and reports.



The PWD series is a sensor family that can be easily and economically upgraded to meet growing measurement needs.

Ritva Siikamäki, MA
Editor-in-Chief
Vaisala Helsinki
Finland

New product family of

Present Weather Detectors and Visibility Sensors

Vaisala has launched two new visibility sensors, the PWD10 and PWD20, to complement the Vaisala PWD-series of Present Weather and Visibility Sensors. The versatile PWD Series is designed to meet the visibility and present weather measurement needs of road authorities, aviation authorities and meteorological organizations. Offering proven technology and flexible upgrade possibilities, new measurement capabilities can be added to the PWD sensors to meet growing measurement needs.

The Vaisala PWD-series provides road authorities, aviation authorities and meteorological organizations with the features they require: a visibility measurement range (MOR), characterization of reduced visibility, precipitation type identification, precipitation accumulation/intensity measurement, and report formats (WMO, NWS code tables). The Vaisala Visibility Sensors PWD10 and PWD20 are new models, complementing the PWD-series offering that also comprises the Present Weather Detectors PWD12 and PWD22. Please see table 1 for details on the models and their applications.

Proven measurement technology

The Vaisala Present Weather Detectors PWD12 and PWD22 identify precipitation type by assessing the water content of the precipitation with a capacitive device - the Vaisala RAINCAP® sensor element. This information is then combined with optical forward scatter and temperature measurements. These three independent measurements are processed through sophisticated algorithms to produce an accurate evaluation of the weather type according to the WMO and NWS code tables.

Calibrated accuracy and innovative design

Vaisala PWD-series sensors are all calibrated with reference to a highly accurate transmissometer, and employ the proven forward-scatter measurement principle to measure Meteorological Optical Range (MOR). The visibility sensor's design offers protection against contamination: the optical components point downwards, and the hoods protect the lenses against precipitation, spray and dust. The weather-proof design of the PWD sensors translates into accurate measurement results in all conditions, while reducing the need for maintenance to a minimum. Optional hood heaters are recommended for wintry conditions to prevent ice and snow accumulation.

Easy installation and expandability

All PWD sensors are compact and light-weight. They come with a cable and connector for easy installation, and can be mounted in many ways on any existing mast. The measurement capabilities of the Vaisala PWD-series sensors can be easily and economically upgraded to meet measurement needs that grow over time.

Road weather applications

The Vaisala Visibility Sensor PWD10 offers economical and reliable visibility measurement for road weather applications. In the road environment low visibility is a serious safety hazard and significantly reduses traffic flow. Providing a measurement range of 10 – 2,000 meters (32 – 6500 ft), the PWD10 is, for example, recommended for road weather systems which alert drivers to reduced visibility.

For advanced road weather applications, the Vaisala Present Weather Detector PWD12 provides accurate visibility and present weather measurement in the road environment. Besides measuring visibility the PWD12 also indicates the cause of reduced visibility, by identifying precipitation type and intensity. In other words, the PWD provides a more complete picture of the weather conditions, which is valuable information for road authorities in the short-range planning of road maintenance operations.

Long-range visibility measurement

The Vaisala Visibility Sensor PWD20 offers a longer measurement range than the PWD10, extending it to 10 – 20,000 meters (32 – 65,600 ft). The long-range visibility measurement is useful in diverse applications, covering harbors, coastal areas, heliports and windmill parks where visibility measurement is necessary. The PWD22 sensor also incorporates long-range visibility measurement capability.

Meteorological applications

The Vaisala Present Weather Detector PWD22 is a combined forward scatter visibility and present weather sensor that provides a visibility measurement range of 10 – 20,000 meters (32 – 65,600 ft). The PWD22 is recommended for automatic weather stations, especially low-power AWSs, that are used for general meteorological and aviation applications. Its capability of detecting freezing precipitation and reporting present weather in WMO METAR code format makes it a valuable addition to AWOS systems.

Vaisala Present Weather Detector PWD22.

Tactical applications

The special Vaisala Present Weather Sensor PWD11A used in TACMET stations will be replaced with the new PWD22M model, painted green. The software and mechanical interfaces of the PWD22M are entirely compatible with the PWD11A and it fits the PWD11A slot in the TACMET Carry Case. The PWD22M will gradually replace the PWD11A.

PWD12, PWD22 vs. PWD11, PWD21

In comparison with the former models, PWD11 and PWD21, the new PWD12 and PWD22 offer considerably more installation flexibility and can be fitted with optional heaters in wintry conditions. A luminance sensor option is available for use in Automated Weather Observing Systems (AWOSs) and the new models have lower power consumption than the former ones. Additionally, detection sensitivity in light precipitation has been improved in the PWD22, which is equipped with two RAINCAP® sensor elements. It is now easier to integrate PWD series products with simple data collection systems, since the new PWD10 and PWD20 visibility sensors also incorporate new analog outputs beside the standard serial line interfaces.

Road weather systems will be equipped with the PWD12 instead of the former PWD11 model. The new present weather detector model PWD22 will replace the current PWD21 model in other applications. The software and mechanical interfaces of the PWD12 and PWD22 are compatible with the older PWD11 and PWD21 models. With the new PWD-series, Vaisala reinforces its position as the world's leading provider of optical sensors. The existing line of Vaisala visibility and present weather sensors – the FS11, FD12P, FD12 and MITRAS Transmissometer – will continue to be manufactured. ●

Table 1. PWD Series products and their main applications

Product type		Main applications, main features
Visibility sensor	PWD10	Road weather systems, accurate visibility measurement up to 2 km
	PWD20	Meteorological and aviation weather, offers long-range visibility measurement up to 20 km
Present weather detector	PWD12	Demanding road weather applications, short-term planning of maintenance operations, combined visibility and precipitation type sensor
	PWD22	General meteorological applications, Automatic Weather Stations, capacity to detect freezing conditions supports warnings for safety hazards, combined visibility and precipitation type sensor

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Vaisala supporting THORPEX

Extensive Research Program on

THORPEX – A Global Atmospheric Research Programme is an observing-system research and predictability experiment that aims to study and improve the effectiveness of both earth-based and space-based atmospheric observing systems. In January 2003, Vaisala announced a co-sponsorship opportunity to support an extensive post-doctoral research program on observing systems. The international evaluation panel for the awards has accepted two proposals. One award goes to MétéoFrance's study "Towards the optimal combination of advanced sounder data and in-situ profiles for the short-range forecast of synoptic events". The research project of the University of Reading and the UK Met Office "Atlantic TOST (THORPEX Observing Systems Test) Evaluation of Predictive Skill" has received the second award.

The skillful long-range prediction of high-impact weather is a significant scientific and societal challenge for the 21st century. Recent improvements in atmospheric observing technology, data assimilation methods, numerical model formulation, and the use of ensemble techniques have all contributed to substantial increases in forecast skill. Despite these advances, limitations still exist in our ability to forecast high-impact weather events.

In support of this program Vaisala co-sponsors postdoctoral research fellowships that aim to support improved global numerical weather prediction as a result of improved observations. The studies in this program seek to assess the value and effectiveness of:

1) earth-based atmospheric observing strategies;

2) new and existing earth-based in-situ observing systems and remote sensing systems; or

3) the interplay between earth-based and space-based observing systems.

Seeking improvements to weather prediction

The ten-year research program will be carried out under the auspices of the World Weather Research Program (WWRP) of the World Meteorological Organization (WMO). THORPEX includes international collaboration between the operational and research communities. The primary objective of THORPEX is to accelerate improvements in the prediction of high-impact weather on time scales extending to two weeks. Moreover, THORPEX research aims at enhancing the societal value of advanced forecast products. The program covers both short-range (up to 3 days), medium-range (3 to 7 days) and extended-range (two week) weather predictions. It will examine predictability and observing-systems issues, and establish the potential to produce significant, statistically verifiable improvements in forecasts of high-impact weather. The THORPEX program, which is global in scope, builds upon and coordinates advances being made in the operational forecasting and basic-research communities. The weather events to be considered include systems of mid-latitude, arctic, or tropical origin, since they often contain significant embedded mesoscale features.

Evaluation procedure

As expected, numerous proposals were received from scientists at weather prediction centers, in academia, and at non-profit research institutions. Awards were only available to support new postdoctoral appointees. An Evaluation Panel consisting of representatives from Vaisala and the THORPEX community evaluated proposals submitted before the deadline. Additionally, the evaluation panel included a representative from the WWRP/Science Steering Committee and at-large community representatives.

The proposals were evaluated as to their relevance to the observing system goals of THORPEX and the role of current and future measurement systems in support of global numerical weather prediction. Additionally, the scientific clarity and rigor of the proposal, the quality of the proposal document, and likelihood of success were important factors in the evaluation. The qualifications of the postdoctoral scientist and scientific supervisor, the scientific and technical support of the host institution(s) and the commitment of the host institution(s) to the equal-cost-sharing criterion of the fellowship program were also considered.

Two projects awarded

One award was made to MétéoFrance for the study "Towards the optimal combination of advanced sounder data and in

Observing Systems

Earth and space based observing systems have been improved recently, but the research community still faces considerable challenges for ever more accurate and reliable observing systems.

situ profiles for the short-range forecast of synoptic events". The research project of the University of Reading and the UK Met Office "Atlantic TOST (THORPEX Observing Systems Test) Evaluation of Predictive Skill" received the second award.

In the MétéoFrance project, Hua Zhang of the China Meteorological Administration will be the post-doctoral scientist, under the supervision of Florence Rabier and Alain Joly; Dr. Zhang received his Ph.D. degree from Lanzhou University, Gansu, China. The research project will utilize the China-Japan region with its high-density Rawinsonde Observation programs (RAOBs). In the second award, the post-doctoral scientist is Dr. Gudrun Petersen from Iceland, who received her Ph.D. degree from the University of Oslo, Norway.

Each award is for a period of up to two years. Awards are subject to co-funding by one or more host institutions in addition to Vaisala.

Second THORPEX program announcement

Within the THORPEX program, a second round of awards has been announced in December 2003. Support will be available for two additional proposals. Details of the second announcement can be found on Vaisala's website: http://www.vaisala.com. ●

ECAM 2003 in Rome focuses on

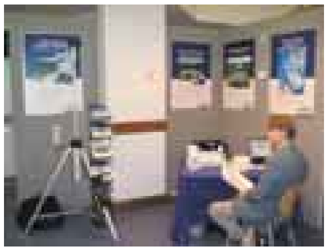
Strategies in Meteorology, Accuracy of Forecasts and Weather Warnings

The annual general meeting of the European Meteorological Society and the European Conference on Applications of Meteorology (ECAM) were held in Rome in September 2003. The events brought together European meteorologists to share their views on the strategies and trends within meteorology. A central theme of discussions was reflection on the strategies of national meteorological services and private companies operating in the field. The challenges imposed on meteorological services by current demands on the accuracy of forecasts was also the subject of lively discussion, with a special view on the capability of providing timely warning services.

The 6th ECAM conference and the EMS annual meeting were jointly organized by the Italian Meteorological Service and the Air Force and hosted with the courtesy of the Italian National Research Council. The participants, some 400 in total, included European national meteorological services, international organizations, government agencies, universities, private service providers and users of meteorological services. The main themes at ECAM were the use of forecasting tools, the impacts of weather forecasts on the economy, the verification of weather forecasts and the role of meteorology in global monitoring of the environment and safety.

The European Meteorological Society, which was founded in September 1999, held its third annual general meeting in Rome. The EMS annual meeting reflected on strategies in meteorology, the commercialization of services and the role of the European Meteorological Society (EMS). Presentations were given on the strategies of national and regional meteorological services, the European Centre for Medium-Range Weather Forecasts, EUMETNET, the European Space Agency and private companies, including a presentation of Vaisala's strategy by President and CEO Pekka Ketonen. These formed a comprehensive overview of current topics and future developments in the field.

A special session was also devoted to the role of meteorology in safeguarding civil protection and cooperation with civil safety authorities. Beside providing reliable and timely warnings for severe weather events, such as severe storms and floods, meteorological services also face the challenge of meeting the needs of various external customers whose operations can benefit from weather information. In many countries, projects to extend automated surface weather observation networks are being planned, and views were exchanged on this topical issue, too. At a special joint session of ECAM and EMS, the future contribution of satellites to the progress of meteorology was discussed, considering observation, telecommunication, positioning and synchronizing aspects both in the mid and long term perspective. The conclusions of this session stated that the space-based component of the WMO Global Observing System (GOS) is expanding quickly and stressed the need for cooperation at various levels of operation, and across various disciplines.



Vaisala showcased new products, such as the new digital radiosonde RS92, at ECAM 2003 in Rome.

An exhibition was also arranged in conjunction with ECAM, with seven companies presenting their newest technologies and products. We would hereby like to thank General Roberto Sorani and his staff for the opportunity Vaisala was given to exhibit at ECAM 2003 and for the good organization and success of the event. Within the themes of the ECAM conference, Mr. Jaakko Hirvensalo, as a Vaisala Product Line Manager, gave a presentation on the new digital Vaisala Radiosonde RS92. The new radiosonde model, along with the new ground check set and sounding system, attracted a lot of interest among the participants who stopped at Vaisala's booth for further discussion welcoming the improved processing and enhanced user-friendly features of the system with enthusiasm. Other Vaisala products on display included the Vaisala AUTOSONDE system and various lightning detection products. Vaisala also hosted a dinner at the event where the lively discussion on the role of meteorology continued. Vaisala's agent for weather observation products in Italy, Eurelettronica Icas Srl, contributed greatly to Vaisala' success at the event, and special thanks go to the company's managing director Maria Rita Leccese and her staff.

The next EMS meeting and ECAM conference is scheduled to be held in 2004. The theme of the event will be extended to cover issues of hydrology more comprehensively. ●

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The 18th Professor Vilho Vaisala Award at WMO awarded to Three Scientists of the Paul Scherrer Institute

The winners of the 18th Professor Vilho Vaisala Award at WMO are three scientists of the Paul Scherrer Institute, Switzerland, for their paper entitled "Hygroscopicity of Aerosol Particles at Low Temperatures. New Low-Temperature H-TDMA Instrument: Setup and First Applications". The award ceremony was held in October, 2003 at the WMO headquarters in Geneva. Prof. G. O. P. Obasi, Secretary-General of the WMO, presented the award to Dr. Urs Baltensperger, Dr. Martin Gysel and Dr. Ernest Weingartner.

The award ceremony at WMO headquarters in Geneva, Switzerland, was attended by Dr. Daniel K. Keuerleber-Burk, Permanent Representative of Switzerland with WMO, Prof. Dr. Ralph Eichler, Director of the Paul Scherrer Institute, and Mr. Pekka Ketonen, President and CEO of Vaisala.

New instrument for measuring hygroscopicity at temperatures below 0°C

The winning paper "Hygroscopicity of Aerosol Particles at Low Temperatures. New Low-Temperature H-TDMA Instrument: Setup and First Applications" was published in Environmental Science & Technology, Vol. 36, 55 -62, 2002. In this paper Dr. Urs Baltensperger, Dr. Martin Gysel and Dr. Ernest Weingartner present a new instrument, the Hygroscopicity Tandem Differential Mobility Analyzer (H-TDMA), that allows the water uptake of submicrometer aerosol particles to be determined at temperatures below 0°C. The instrument can be used for determining the hygroscopic growth of aerosol particles at sub-zero temperatures. In addition to describing the instrument's development, operation principle and characteristics, the paper also discusses field tests and applications of the method, as well as comparing the theory with laboratory measurements.

Chemical composition of the atmosphere

At the ceremony, Prof. Obasi underlined in his statement the importance of the newly developed instrument for the Global Atmosphere Watch (GAW) of WMO, a program that monitors the chemical composition of the atmosphere with the aim of providing a database of the changes caused by natural and anthropogenic influences. Such information is essential for studies on climate change, the ozone layer, and pollutants. In this context atmospheric aerosols also play an important role.

The new instrument investigates how aerosol particles change their size when they are transferred from dry conditions to a well defined higher relative humidity. The instrument introduces the ability to perform measurements in sub-zero conditions, which will provide new insights into aerosol behavior and cloud formation under sub-zero temperatures in the atmosphere. Moreover, Prof. Obasi also stressed in his statement the contribution of the Paul Scherrer Institute (PSI), which is a multi-disciplinary research center for natural sciences and ➤

technology, and the largest national research institute in Switzerland.

Aerosols essential in radiation balance

Atmospheric aerosols are important for air quality, acid deposition, visibility reduction, and the formation of clouds and precipitation. Moreover, they may also affect the earth's climate, directly through the absorption and reflection of incoming solar radiation and indirectly through the modification of cloud properties. The indirect aerosol effect is the process that represents the largest source of uncertainty in climate forcing, as outlined in the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) in 2001. While the positive climate forcing of greenhouse gases can be estimated quite well, more information and methods are needed to understand the complex aerosol-cloud-climate system that causes negative forcing.

Hygroscopic properties of aerosols are crucial

The hygroscopic water uptake of atmospheric particles is of particular importance for their direct and indirect climate effects, mainly because of increased particle sizes under high relative humidity conditions. Light scattering, one of the most relevant quantities for the direct aerosol effect, depends strongly on particle size. Hygroscopic particles act more readily as cloud condensation nuclei, and are therefore important for the indirect aerosol effect.

The effect of RH on aerosols can be measured with a number of instruments, of which the H-DTMA method has mostly been used in the boundary layer. Since the aerosols' indirect effect occurs mainly in the middle and upper troposphere, hygroscopic properties must be measured at ambient temperatures in order to prevent artifacts caused by the volatilization of semivolatile compounds. An ideal field test site for studies of the free tropospheric aerosol is the high-alpine research station Jungfraujoch, where an extensive series of field measurements was performed. The new low-temperature H-TDMA enabled the hygroscopicity measurements to be conducted at ambient temperatures for the first time. Beside discussing and analyzing these field measurements, the paper discusses the hygroscopic properties of laboratory-generated particles and compares observed behavior with the theory.

Prof. G. O. P. Obasi, Secretary-General of the WMO, and Mr. Pekka Ketonen presented the award to Dr. Urs Baltensperger, Dr. Martin Gysel and Dr. Ernest Weingartner.

The 18th Professor Vilho Vaisala Award was presented to Dr. Urs Baltensperger, Dr. Martin Gysel and Dr. Ernest Weingartner at the WMO headquarters in Geneva by the WMO General Secretary G. O. P. Obasi. Attendees of the ceremony, from left: Hong Yan, Assistant Secretary-General, WMO, Michel Jarraud, Deputy Secretary-General, WMO, Prof. G.O.P Obasi, Secretary-General, Dr. Ernest Weingartner, Prof. Ralph Eichler, Director, PSI, Dr. Martin Gysel, PSI, Mr. Daniel K. Keuerleber-Burk, Permanent Representative of Switzerland to WMO, Dr. Urs Baltenspensperger and Mr. Pekka Ketonen, President and CEO, Vaisala.

Designed to encourage research programs

To date, there have been 43 scientists from 9 countries who have received the Professor Vilho Vaisala Award. This is the third time that Swiss scientists have received the award.

The Professor Vilho Vaisala Award was established in 1985 and is administrated by the World Meteorological Organization (WMO). It is awarded to encourage and stimulate interest in important research supportive of WMO's programs, in the field of meteorological and climatic observation methods and instruments. ●

New understanding of the relationships and impacts of lightning

Welcome to ILDC 2004 in Helsinki

Vaisala invites you to attend the 18th International Lightning Detection Conference to be held 7-9 June 2004 in Helsinki, Finland. This biannual conference provides a unique and important forum for presentations and discussion related to education, research, and applications development in lightning detection technologies. The theme of the conference is "New understanding of the relationships and impacts of lightning: Improving real-world applications with advances in detection, research, and data integration".

ILDC 2004 will focus on research, emerging trends, and case studies that contribute to a deeper understanding of lightning information.

International Lightning Detection Conference ILDC presenters and attendees share a common passion for understanding lightning and how it affects the world we live in. Professionals in the fields of aerospace, atmospheric research, aviation, data center management, emergency response management, electrical engineering, electric power, explosive and ordnance management, forestry, golf and recreation, lightning research, meteorology, mining, telecommunications and weather media are all invited.

Conference venue

The ILDC 2004 will be the first ILDC held in Europe. Helsinki offers beautiful Baltic summers and centuries of history and culture influenced by the East and the West.

The conference will be held at the Scandic Hotel Grand Marina and Marina Congress Center. The venue is centrally located, overlooking the harbor and close to Uspenski Cathedral, the Presidential Palace, the market place, Senate Square, and downtown shopping and restaurants.

Papers and presentations

Papers and presentations at ILDC 2004 will discuss all aspects of lightning detection and lightning data applications, with a special focus on how lightning data can be or is currently being used to address real-world challenges.

ILDC 2004 will focus on research, emerging trends, and case studies that contribute to a deeper understanding of lightning information, used alone or integrated with other data sets, in these areas:

- Meteorological correlations
- Hydrometeorological applications
- Forecasting and nowcasting
- Land and forestry management
- Aviation management
- Asset and facility protection
- Telecommunications performance
- Forensic analysis and damage investigation

Abstracts of the papers have been assessed and acceptance notification for conference papers will begin on January 5, 2004. Final papers to be printed in the conference preprint materials are due March 26, 2004.

In addition to conference papers and presentations, a Vaisala Thunderstorm Technology Exhibit will be arranged, which conference attendees are welcome to visit during breaks. After ILDC 2004, the European Lightning Detection Workshop (ELDW) and European Cooperation Lightning Detection (EUCLID) are scheduled to be held on 10-11 June 2004 at the same venue.

Information on-line

For details on the schedule and on presentations, please visit www.vaisala.com/ILDC2004, where you can also register online. Travel and accommodation information is also available at the same address. ●

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