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VAISALA

NEWS

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Vaisala in Brief

Vaisala is a global leader in environmental and industrial measurement. Building on 75 years of experience, Vaisala contributes to a better quality of life by providing a comprehensive range of innovative observation and measurement products and services for chosen weather-related and industrial markets. Headquartered in Finland, Vaisala employs approximately 1,400 professionals worldwide and is listed on the NASDAQ OMX Helsinki stock exchange.

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New Winds Blowing

As Bob Dylan sings, "the times they are a-changing" – so has Vaisala been on a journey to transform itself from a product-based company to a customer-focused company. I like to think that we are making progress in this respect, while fully recognizing that we still have work to do. However, there has certainly been a shift to a new mindset internally and I am happy to see this coming through our innovation funnel. Not just with products, such as the new Vaisala Radiosonde RS41, but also through our corporate aspirations, such as the recent acquisitions of Second Wind and 3TIER.

Let me start with the new Vaisala Radiosonde RS41, the new 'work-horse' for meteorologists. This project has been under development for several years. The radiosonde, as well as the entire 4th generation sounding system, including the ground equipment, has been developed with customer feedback as the driving force for innovation. By listening to our customers, taking ownership of the challenges they face and the issues they were having with conducting soundings, we began to develop solutions in earnest. Solutions, which offer truly value-adding benefits to our customers across the entire sounding process, from start to finish. The new radiosonde is a giant leap forward, and the RS41 has truly 'raised the bar' in the reliability, consistency, accuracy as well as usability of conducting soundings.

I am proud to say, Vaisala has done this on our customers terms.

We are a science-based innovator, for example, Vaisala works closely with universities and institutions. Vaisala also employs researchers who are working on scientific challenges and issues that go beyond the business side of weather and environmental measurement. We have an important role to play when it comes to securing our customers performance, and we take this role very seriously. The products and systems Vaisala produces support decision-making across transportation authorities, meteorological agencies, industrial environments, hospitals and pharmaceutical companies, to name a few. Quality and safety are our greatest priority, whether it is monitoring the atmosphere in an incubator for infants, or the efficient application of data gathered by our road weather system to ensure preventive winter road maintenance – we are an active partner in the daily operations of our customers. To succeed in this task, it is important to also look beyond the engineering and programming work, and understand the science behind the technology.

Kjell Forsén
President and CEO

Accurate Trustworthy Data, Always

RS41 Takes Flight

Customer feedback has been the driving force in the development of the new easy to use, high quality, and reliable sounding system. At the heart of the 4th Generation Sounding System, the Vaisala Radiosonde RS41 features upgraded data consistency and improved usability, applying the best metrological practices and error prevention solutions.

Over the past 80 years the Vaisala radiosonde has been developed in response to customer needs, all the while focused on improving the quality of measurements, as well as the reliability of the device. Today, the radiosonde is a fine-tuned measurement instrument which is able to withstand extreme weather conditions, while conducting accurate measurements.

When development of the 4th generation sounding system began, Vaisala went to its customers with a simple objective, to give customers what they want in order to maximize the value of soundings for their operations. Vaisala Soundings System MW41 was launched in mid-2012 followed by Vaisala Radiosonde RS41 launch in October 2013 at the Technology World Expo (MTWE2013) in Brussels to meet these requirements. The RS41 radiosonde and MW41 soundings system entity, while delivering industry-leading data accuracy, streamlines launch preparations, reduce the possibility of human error, and lowers operational costs of upper-air weather observations.

For all RS92 users there will be support and a convenient upgrade path available to transfer from RS92 to RS41.

Customer-Driven R&D

Over 1000 test soundings were conducted during the development of the RS41, in five different countries around the globe to cover different climates. The new radiosonde has been honed to perfection through laboratory and sounding tests. The development team has observed customers in action, to better understand how the radiosonde, ground check, sounding system and software as well as the unwinder are used in various environments, under different conditions. The findings played an important part in the design and development program. “The RS41 has definitely been developed in association with customers; field observations, feedback on concepts, usability testing and field testing were conducted in five countries

with 17 customer organizations, in four applications areas and involved over 50 people." **Johanna Lentonen**, Product Area Manager, Soundings, explains.

The new RS41 features upgrades to the humidity and temperature sensors which ensure greater data reliability, and accuracy, that customers expect from Vaisala. The streamlined radiosonde launch process with the new maintenance-free ground check device, clear and logical use of MW41 soundings system as well as remote use of MW41 are examples of new features that were added based on customer cooperation. The new compact radiosonde design is easier to handle and 60% lighter, allowing 20% more launches using the same quantity of gas as needed with the RS92.

User-Friendly Soundings

The MW41 provides a user-friendly system for sounding operations and administration. As Lentonen explains, "The 4th generation sounding system MW41 is extremely easy to use, with optimized and automated operations that can be configured in a very logical and clear manner. Ease-of-use contributes to smooth operations as well as data quality ensuring that products are used correctly."

In addition to a web-based fined-tuned user interface for MW41, the wireless communication between RS41 and MW41 makes preparations convenient. All in all pre-launch preparation is now easier with more automation. As error-free launches are important to customers, an LED status light was added to the RS41 to indicate when it is ready to launch. In case of any damage, for example during transportation, comprehensive pre-flight diagnostics alert customers of non-functional units before launch.

The RS41 automated ground check includes several functional checks: temperature check, humidity sensor reconditioning, humidity check and radiosonde parameter set-up. Ground check is performed prior to flight using the Vaisala Ground Check Device RI41 which is connected to the MW41.

"The ground check is fully automated, being integrated into the MW41. The radiosonde is simply placed onto the ground check device and the process is initiated automatically. Only one click is required during whole process – namely one mechanical click as the radiosonde is attached to the unwinder which connects it to the balloon" Lentonen explains.

Another improvement based on customer research was the redesign of the unwinder. Now, when the unwinder is attached to the RS41, the sensor boom is automatically bent to the correct angle, eliminating the risk of incorrect placement and ensuring accurate observations. Furthermore the unwinder and balloon can be prepared in advance, as the unwinder does not need to be connected to the radiosonde during the ground check process.

Pioneering Sensors

The temperature sensor of RS41 was completely re-designed. This sensor was developed in-house and is manufactured in Vaisala's own clean room, based on stable and linear platinum sensor technology. It is tailored for radiosonde application and features very quick response time with minimal solar radiation error. Several key features of the temperature sensor help diminish measurement uncertainties related to solar radiation and cloud moisture. The hydrophobic coating provides protection against evaporative cooling once the radiosonde emerges from clouds. SI-Traceable Calibration lays a solid foundation for a reliable end result.

The new RS41 humidity sensor has a temperature sensor integrated on the chip to compensate for the effects of solar radiation in real time resulting in a very precise measurement. Conditions within clouds, temperature, and solar radiation can heat or cool the humidity sensor, affecting otherwise the accuracy of relative humidity. The sensor element is very accurate throughout the whole sounding and features fast response time to detect the fine structures of atmosphere.

"In the new radiosonde, 4th generation humidity sensor offers important added capabilities, including an integrated temperature sensor and built-in heating functionality. In addition to improved accuracy during sounding, this 4th generation concept enables desiccant free accurate prior-flight check for humidity which is unique and a clear improvement," Lentonen explains.

In the RS41-SG model, the pressure is derived from GPS height measurement. In RS41 the GPS solution is based on a solid hardware solution; special attention has been paid to interference tolerance. State-of-the-art hardware solution combined with optimized custom signal processing provides a very reliable end result.

The RS41 has undergone thorough and rigorous testing at Vaisala and by independent parties. SI-traceability combined with professionally verified measurement accuracy gives credibility to the accuracy of the data. Vaisala's dedication to data accuracy and highest quality is why experts trust Vaisala's radiosondes for their upper-air weather observations.

Sounding Generations

The First Generation Vaisala radiosondes (1936-1972) were largely based on innovations by Professor **Vilho Väisälä**. These sondes utilized traditional sensor technology - hair hygrometers to measure humidity and bi-metallic temperature sensors. Products included several radiosonde models for operational and research use; RS11, RS12, RS13 and RS16. The sensors were mounted in a duct for protection and had a mechanical switch. Pressure was measured with a metallic aneroid. At the 1937 World Fair in Paris, the Vaisala Radiosonde RS11 won a Gold Medal. Over these decades, innovations like the thin-wire thermometer, optical theodolites and 28MHz radiotheodolites for windfinding were introduced.

***Esa Saarinen**, a retired Finnish Meteorological Institute employee, recalls that there was 14 staff working at the observatory in Jokioinen in the early days, on the outskirts of Forssa in Finland. Among other tasks, staff would conduct soundings, "It would take eight hours to complete one sounding, and we would conduct four or five soundings per day."*

In 1973, the Radiosonde RS21 was launched using ground-breaking HUMICAP® thin film humidity sensor and improved temperature sensor. The Second Generation (1973-1993) was a significant step forward.

As Mr. Saarinen recalls. "We moved from listening to beeps with an antenna to a completely new way of sounding. The MicroCORA® changed the way we conducted soundings, new radiosondes were introduced with the HUMICAP® humidity sensor, new temperature sensor, and it was the first computer we had at the observatory. For some of the older staff members, we had to write instructions on how to use the system. This was a giant leap in how we used to do things at the observatory."

Launched in 1975, the CORA® Automatic Sounding System used wind measurement based on the Omega NAVAID network. Simultaneously, the 400MHz frequency band was opened up for radiosonde transmission which enabled mobile sounding systems. In 1981, the RS80 was the first radiosonde to use a sensor boom that exposed the sensors to ambient air, moving away from using ducts to protect the sensors. Vaisala introduced the DigiCORA® in 1985. New computer technology enabled computers to automatically process the data from the radiosonde into meteorological messages.

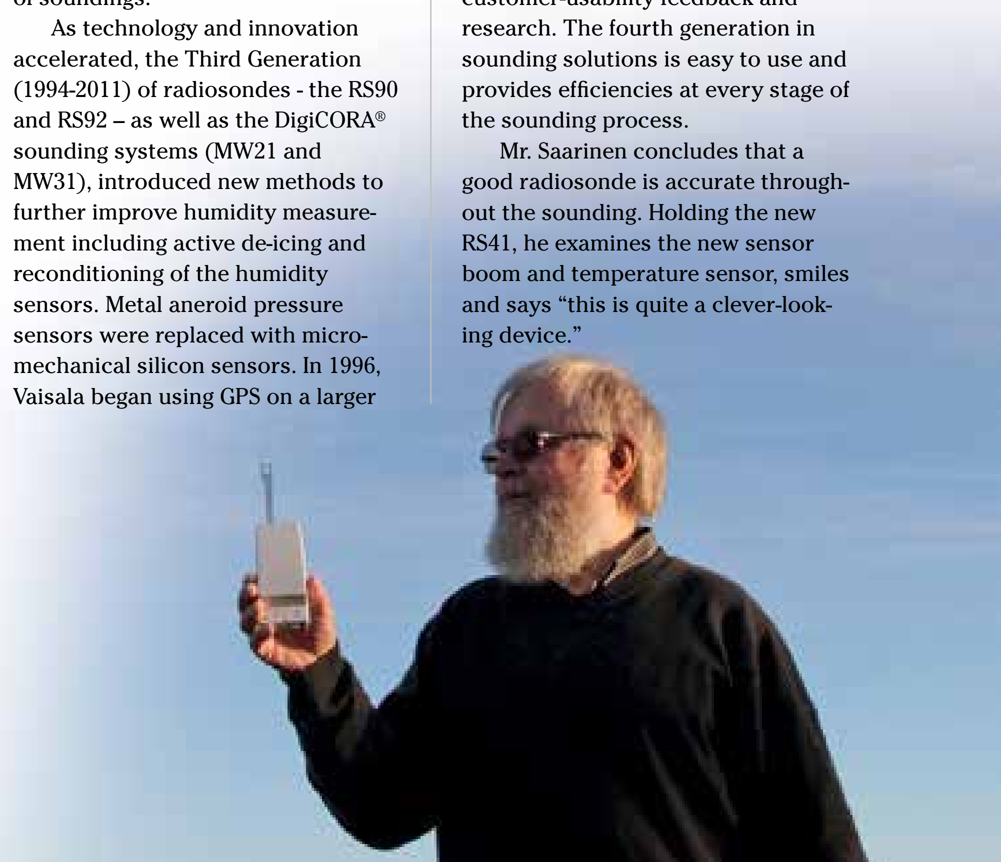
According to Mr. Saarinen, "At this stage many of the older sounding staff had retired, and there was no need to hire replacements as the technology had advanced to a point where we simply did not need that many people to conduct a sounding. It would take just a few hours to set up a sounding, using the second generation system less people were needed to conduct the same number of soundings."

As technology and innovation accelerated, the Third Generation (1994-2011) of radiosondes - the RS90 and RS92 – as well as the DigiCORA® sounding systems (MW21 and MW31), introduced new methods to further improve humidity measurement including active de-icing and reconditioning of the humidity sensors. Metal aneroid pressure sensors were replaced with micromechanical silicon sensors. In 1996, Vaisala began using GPS on a larger scale for upper-air wind measurements. Personal desktop computers were introduced to process the sounding data using DigiCORA® software. The first automated Vaisala Sounding System, the AUTOSONDE®, was also introduced. This unmanned Sounding System allowed Vaisala customers to extend their upper-air network to remote, hard-to-access locations.

"Today the Jokioinen station is manned by just two people, and they are responsible for a number of automatic weather stations in the region. The AUTOSONDE® conducts two soundings per day and has automated the entire process, manual soundings are infrequent." Mr. Saarinen explains.

The Fourth Generation in sounding solutions is represented by a combination of technology and usability improvements. The RS41 uses an advanced humidity sensor and stable platinum resistive temperature sensor, as well as reliable GPS technology to provide the basis for the consistent measurement performance. When developing the RS41 and MW41 special attention was paid to developing each product using customer-usability feedback and research. The fourth generation in sounding solutions is easy to use and provides efficiencies at every stage of the sounding process.

Mr. Saarinen concludes that a good radiosonde is accurate throughout the sounding. Holding the new RS41, he examines the new sensor boom and temperature sensor, smiles and says "this is quite a clever-looking device."



MW41 Enabling Consistent, High Performance Soundings

The 4th Generation Sounding comprises the Vaisala Radiosonde RS41, the DigiCORA® Sounding System MW41 and the Ground Check Device RI41 or GC41, which is required to connect the RS41 to the MW41 ground system. The MW41 system is compatible with the latest generation of Windows operating systems making the MW41 easy and cost efficient for customers to integrate into existing computer systems. The MW41 interface is based on a web browser. Furthermore, the MW41 can be connected to Vaisala Automatic Weather Stations (AWS), which provide highly accurate surface weather information further simplifying sounding operations and reducing human error.

Diagnostic Tools

RS41 internal diagnostics alert users to any problems with the RS41 throughout launch preparation and during flight. The MW41 system has a complete set of diagnostic tools to give customers visibility to the status of equipment, the system, and logs events. These diagnostics ensure you have accurate consistent data quality throughout the entire process.

Message and Report Configuration

Triggers can be set for automatic report and message generation based on time, pressure, height, and termination. The MW41 system can create and edit WMO messages and special text reports using the validated data. Data is also available in XML format. Meteorological message generation follows the latest WMO regulations including TEMP, PILOT, and BUFR coding.

Remote Configuration and Monitoring of Sounding Systems

A key advantage of the new MW41 system is the ability to monitor and retrieve sounding data in graphical and numerical format in real time from a remote location, either through local area network or the internet. If you are in charge of multiple sounding stations, the MW41 makes it easy to efficiently manage the configuration of sounding stations from anywhere.

Web-Based User Interface

The DigiCORA® Sounding System MW41 user interface was designed to be intuitive and powerful, giving customers flexibility when setting up sounding stations, users, peripheral equipment and hardware, and reports. Through intensive research and user-focused workshops and interviews, a new web-based interface was created that is easy to navigate, reduces human error and training time, and is efficient at every stage of the sounding process.

Depending on the Vaisala Sounding System currently in use, many of the same hardware components can be used with the MW41 system. The MW41 uses the same hardware platform as the MW31, and current antenna installations can be utilized. An upgrade path for any Vaisala sounding system (MW31, MW21, MW15, and even MW11) is available, allowing customers to upgrade their existing systems to utilize the new radiosonde. The MW41 system can be used with both RS92 and RS41 radiosondes.

Vaisala Radiosonde RS41 Performance Characterization

Radiosonde data is indirectly affecting our lives every day. Taking into account its importance for weather forecasting and climatology, Vaisala has invested considerable amount of energy to characterize the performance of RS41 thoroughly in order to be able to make solid promises to society on the benefits of radiosonde data.

RS41 Measurement Performance

In terms of measurement performance, the key characteristics of the Vaisala Radiosonde RS41 are its excellent repeatability and reliability in all soundings conditions. A number of factors contribute to this high-level performance, such as state-of-the-art sensor technology, professional manufacturing methods, extensive quality controls and easy-to-use systems minimizing the risk for human errors.

The accuracy of atmospheric data provided by RS41 is comprehensively described by defining the combined uncertainty of the measurement during sounding. The uncertainty analysis is implemented following the recommendation of JCGM 100:2008. For the RS41, the measurement uncertainties are expressed using a coverage factor of k=2. The combined uncertainty in sounding covers all typical measurement conditions, and takes into account calibration, sensor modeling, storage and sounding related dynamic phenomenon.

Reproducibility in sounding is tested by twin soundings, attaching two RS41 radiosondes of the same type onto one balloon and comparing how well the two radiosondes behave compared to each other. Reproducibility as standard deviation of differences in twin soundings results are presented in Tables 1 and 2. This method gives a very good experimental and fact based measure of data consistency. As demonstrated also in Figure 1, the RS41 data consistency is excellent also in very demanding conditions.

Both the accuracy and the consistency of RS41 data have been improved taking soundings data quality to a whole new level.

Results Against Reference Instruments

The Vaisala Radiosonde RS41 performance is thoroughly tested in the laboratory - independent tests from the calibration system are an important part of quality assurance and uncertainty analysis.

In addition to laboratory testing, over 1000 soundings were conducted during development. First, to find the optimum product concept. Then, to fine-tune the details and finally to characterize the performance. During development, soundings were performed in five countries covering various climates, site environments and satellite geometries. On top of extensive amount of comparisons with RS92, the performance of which was validated in WMO Intercomparison of High Quality Radiosonde

Table 1. Pressure, Temperature, Humidity and Height performance figures for the Vaisala Radiosonde RS41.GPS derived pressure and geopotential height.

RS41 ACCURACY	Pressure (hPa)	Temperature (°C)	Humidity (%RH)	Geopotential Height (gpm)
Combined uncertainty in sounding	1 > 100 hPa 0.3 < 100 hPa 0.04 < 10 hPa	0.3 < 16km 0.4 > 16km	4	10.0
Reproducibility in sounding	0.5 > 100 hPa 0.2 < 100 hPa 0.04 < 10 hPa	0.15 < 16km 0.3 > 16km	2	6.0

Table 2. Wind performance figures for the Vaisala Radiosonde RS41.

RS41 ACCURACY	Wind Velocity (deg)	Wind Direction
Reproducibility in sounding	0.15	2

Table 3. Differences in standard pressure levelheights between RS41 (GPS based) and RS92 (pressure sensor based). Sample size 20.

Standard pressure level	RS41 - RS92 average differences in height	RS41 - RS92 standard deviation
850 hPa	-0.2 gpm	2.1 gpm
100 hPa	5.5 gpm	4.9 gpm
20 hPa	-0.6 gpm	7.8 gpm

Systems, Yangjiang, China 2010, other types of references have been used as well.

Humidity

Using a cryogenic frostpoint hygrometer (CFH) as a reference, RS41 humidity measurement has been verified in test soundings both in Finland (lat. 60° N) and Malaysia (lat. 5° N). An example of a sounding carried out in Malaysia in 2013 is presented in Figure 2. Here, the frostpoint reading of the CFH is quality controlled and also converted to relative humidity based on the temperature data gathered by the RS41. As Figure 2 shows, RS41 results correlate well with CFH.

Temperature

Using a multi-thermometer measurement as a reference, RS41 temperature measurement has been verified in test soundings in Finland and Malaysia. A statistical analysis of 20 daytime soundings is presented in Figure 3. The differences are very small (< 0.1 °C) throughout the entire sounding, well below measurement uncertainties.

Pressure and Geopotential Height

With pressure sensor based measurements of RS92 as a reference, RS41 GPS based pressure and geopotential height measurements have also been verified in test soundings in both Finland and Malaysia to cover different satellite geometries. As shown in Table 2, GPS-based observations in RS41-SG and pressure sensor observations in RS92-SGP compare well, the height differences in standard pressure levels are very small.

RS92-SGP soundings can be configured to report GPS based pressure and geopotential height. RS92 GPS based measurements were validated in WMO Intercomparison of High Quality Radiosonde Systems, Yangjiang, China 2010, and have been used as well to verify RS41 results, as presented in White Papers [1], [2], [3].

Data Continuity Following the Replacement of RS92 with RS41

The impact of the switch from the RS92 to the RS41 on climatological time series is estimated to be moderate. The improved accuracy of RS41 data does not affect average measurement values as much as it affects the consistency of the data. Also the differences between GPS based RS41-SG and pressure sensor based RS92 are very small both in pressure and geopotential height. So far, tests indicate that the most significant impact on average values will be seen in humidity measurements in tropical climates, especially in the humid conditions of the upper troposphere.

The statistical differences between the RS92 and RS41 are described in Comparison of Vaisala Radiosondes RS41 and RS92 [2] using experimental sounding results. The information will also be made available at www.vaisala.com to ensure easy and open access to this important metadata for end users.

Data Continuity with RS41 in Operational Use

Vaisala intends to offer the best possible tools for climate research, including accurate measurement instruments with carefully estimated uncertainty budgets, as well as tools and metadata for managing data continuity.

Vaisala will announce all changes to the RS41 product that could affect the homogeneity of climatological data series on www.vaisala.com.

Quality Assurance Plan

The RS41 radiosonde has been thoroughly characterized during its development by Vaisala; also customer tests have been conducted. And the work continues; we need to ensure the performance stays reliable and consistent over the coming years. That is guaranteed by »

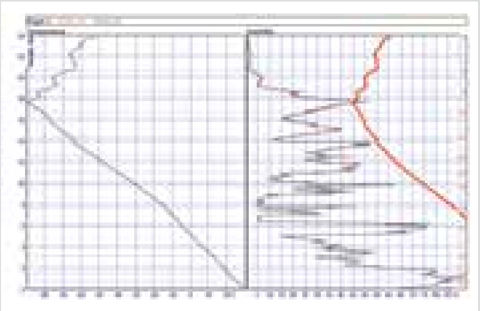


Figure 1. An example of responsive, yet highly reproducible humidity profiles (right), measured by two RS41 units at daytime in the tropics. The thick red profile indicates a saturated RH level. The temperature profile (left) extends close to -90°C. The profiles of two units overlap each other through-out the whole profile.

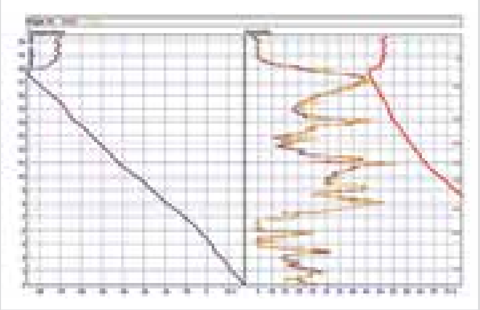


Figure 2. An example of a sounding carried out in 2013 in Penang, Malaysia, against a CFH reference measurement. The figure shows relative humidity as measured by CFH (yellow) and the RS41 (brown).

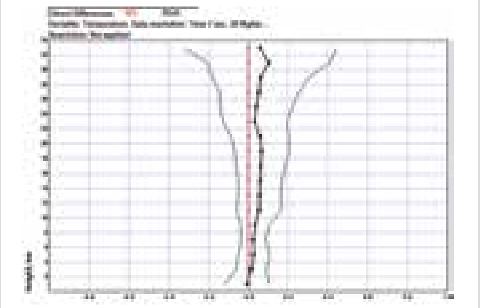


Figure 3. A twin-sounding comparison of RS41 temperature measurement against a multi-thermometer reference instrument – average temperature difference (wide black line) and standard deviation of differences (thin black line).

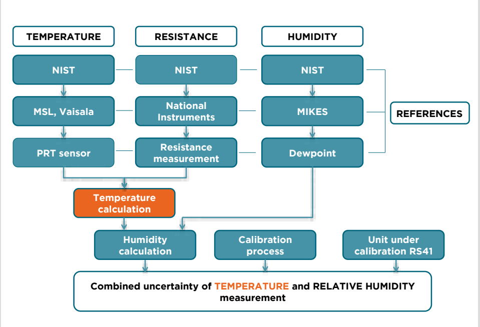


Figure 4. Chain of Traceability and Uncertainty Components for Temperature and Humidity Calibration of RS41

solid design solutions and professional manufacturing methods and, as importantly, through an extensive Quality Assurance Plan which we follow with pride, throughout the lifetime of the RS41.

One very important factor is to anchor the end-result to known references. That's why every RS41 radiosonde is factory calibrated against references that are traceable to international standards. Traceability combined with comprehensive uncertainty analysis over the measurement range and continuous Quality Assurance Measures makes it possible to trust the radiosonde data of atmospheric conditions day after day all over the globe. After all, accurate trustworthy data is the reason why upper air in-situ measurements are done.

White Papers

In addition to product Datasheet with key performance figures, there are several White Papers and other documentation available from Vaisala for more detailed information:

[1] Vaisala Radiosonde RS41 Measurement Performance, White Paper, 2014

[2] Comparison of Vaisala Radiosondes RS41 and RS92, White Paper, 2013

[3] GPS-Based Measurement of Height and Pressure with Vaisala Radiosonde RS41, White Paper, 2013

[4] Comparison of Radiosonde Data from Vaisala Sounding systems MW41 and MW21/MW31, White Paper, 2013

[5] Vaisala Radiosonde RS41 Calibration Accuracy and Traceability, 2014

[6] Climate Monitoring and Research, Vaisala Contributes to Earth's Climate Knowledge, White Paper, 2009.

[7] Vaisala RS41 trial in the Czech Republic, Vaisala News 192, pages 14-17

Customer Testing

17 different customers - over 50 people - were influencing GEN4 development in various ways. It is greatly thanks to these people that products turned the way they are.

GEN4 product testing carried out by customer organizations: MW41 sounding system testing was carried out at Praha-Libus station (WMO #11520) in Prague, the Czech Republic, and Jyväskylä station (WMO #02935) in Finland. The soundings were carried out during summer and fall of 2012 by staff from the **Czech Hydrometeorological Institute** and the **Finnish Meteorological Institute**. [4]

The **Czech Hydrometeorological Institute** has also conducted extensive RS41 and RS92 intercomparison test during fall of 2013. [7]

Intercomparison tests of the RS41 with the exact same RS92 configuration that was used in World Meteorological Organization WMO) Intercomparison of High Quality Radiosonde Systems, Yangjiang, China 2010, have been conducted by the **UK Met Office** at Camborne Station (WMO #03808), which is a WMO designated radiosonde intercomparison site under the Commission for Instruments and Methods of Observation (CIMO). Intercomparison soundings were performed between October-November 2013 in demanding conditions, including low, thick cloud covers and high winds. 20 daytime and 10 nighttime comparison soundings with a total of 120 radiosondes.

Climatology

Climate change is a major worldwide societal and political challenge. Fundamental to all facets of the climate debate is the need for an extremely accurate, precise, and representative record of atmospheric changes. In addition to introducing more precise instruments for operational and research use, it is imperative to guarantee continuity of observation datasets. Accordingly, Vaisala has established a public, web-based database that will provide radiosonde-related information to facilitate the homogenization of climatological time series. [6]

All relevant changes in sensor design, procedures, and related software that could affect the homogeneity of climatological data series have been documented on Vaisala's website, www.vaisala.com, since the launch of the RS92 radiosonde in 2003. Vaisala will continue this practice with RS41.
www.vaisala.com ⇨ Meteorology ⇨ Products ⇨ Sounding Systems and Radiosondes ⇨ Sounding Data Continuity

Vaisala Acquires

Renewable Energy Assessment and Forecasting Services Company

Vaisala strengthens its position in the renewable energy market through the acquisition of 3TIER Inc., a US-based company with USD 9.0 million net sales in 2012 and 55 employees. The value of the deal is EUR 10.7 million. Vaisala is using its existing cash balance to finance the transaction. This acquisition will not have a material impact on Vaisala's 2013 financial result or balance sheet. Market guidance for 2014 will include also 3TIER's impact on Vaisala's financial result and it will be disclosed on February 10, 2014 in Vaisala's financial report for January-December 2013.

3TIER is an experienced provider of renewable energy assessment and forecasting services to the largest utilities, energy traders, financiers, and project developers around the world. With a staff of experts in weather, climate, and wind and solar risk, 3TIER helps its clients make profitable energy decisions. 3TIER provides project feasibility, asset management and forecasting services to companies operating in the renewable energy market globally. While the majority of 3TIER's business comes from the wind energy market, the company also serves customers in the solar and hydro energy markets. 3TIER complements Vaisala's strong environmental sensing business, and its international distribution network will provide significant growth opportunities in Brazil, Nordic countries, China, Australia, India and the USA.

"The renewable energy market is a focus area of Vaisala's Weather business, and the acquisition of 3TIER with its wind and solar energy emphasis, aligns perfectly with Vaisala's strategy. Wind energy represents an extensive market with long-term growth opportunities. 3TIER brings Vaisala valuable capabilities in renewable energy assessment and forecasting services applicable across our other segments as well," tells **Kai Konola**, Executive Vice President of Vaisala Weather Business.

Vaisala's strategic intent has been to build a stronger position in the renewable energy sector. The acquisitions of Second Wind in August and 3TIER today are logical steps, and together with Vaisala's offering create a full service renewable energy observation and information services business.

Sampsa Lahtinen
Joins Vaisala

Sampsa Lahtinen, M.Sc. (El. Eng.), has been appointed Executive Vice President of Vaisala's Controlled Environment business area and a member of Vaisala Management Group as of October 22, 2013. Sampsa Lahtinen will report to **Kjell Forsén**, President and CEO.

Sampsa Lahtinen has worked in several managerial positions in Nokia Siemens Networks (NSN), Nokia Networks and Nokia for over 20 years, and has a broad experience of leading global businesses and customer relationships. During his NSN years Lahtinen, stationed in London, was in charge of Vodafone Group business globally in 2009-2012, and headed West Europe business in 2006-2009. He has also worked in Latin America as Regional Manager for Nokia Networks and as CEO of Nokia Mexico subsidiary. Most recently, Sampsa Lahtinen has been an independent advisor and investor to startup companies.

McKesson Delivers Pharmaceuticals Safely & Reliably with Vaisala's CMS in 60 Distribution Centers

McKesson is the oldest and largest healthcare services company in North America, supplying branded, generic, and over-the-counter drugs to over 40,000 customers comprising more than 50% of U.S. hospitals and 96% of the top 25 health plan providers. In 2011, Facilities Manager **Joe Cwiertniewicz** initiated a vendor selection process to find a solution for monitoring temperature and humidity conditions in McKesson's refrigerators, freezers, warehouses and other controlled environments. Cwiertniewicz and his team evaluated four monitoring systems through a review process that included the installation of the competing systems for testing in various environments.

After reviewing the systems, Cwiertniewicz and the CMS installation project team selected the Vaisala Continuous Monitoring System (CMS) because it provided automated and customizable reporting, as well as installation, validation, and on-site calibrations.

An important difference between Vaisala and the competing monitoring systems was Vaisala's ability to support the installation and validation of the system in McKesson's network of facilities comprising sixty distribution centers throughout the U.S.. Cwiertniewicz knew that large-scale installations have an inherent risk of overshooting time and budget allocations. Cwiertniewicz says, "The Vaisala team is well qualified and became a part of our team. We shared the sense of responsibility to meet the requirements by the deadlines. This was a major reason that our original goal of project completion within two years was met."

The teamwork between the companies has benefitted Vaisala as well because the McKesson team now works with Vaisala's software developers to further improve the CMS software. Says Cwiertniewicz. "We offer guidance to Vaisala on optimizing their software, especially for large installations, and Vaisala provides the kind of support that guarantees our system is up and running, 24/7."

Preparing for Extreme Weather

In 2010, the Finnish Meteorological Institute (FMI) launched a cooperation project (FNEP) with the Department of Hydrology and Meteorology (DHM) of Nepal. The aim of this project has been to improve Nepalese meteorological expertise and operational preparedness for natural disasters. Nepal is extremely vulnerable to the effects of climate change with natural disasters increasing steadily. Natural disasters claimed an average of 950 lives and caused approximately EUR 11.4 million in material damage each year.

The project, which started in February 2010, was financed by the Finnish Ministry for Foreign Affairs through ICI (Institutional Cooperation Instrument) funds from the Unit for Asia and Oceania. The ICI is a financing instrument for inter-institutional development cooperation that promotes cooperation between government institutions and agencies. The objective is to strengthen the skills and know-how of government actors, such as ministries, institutions in developing countries.

Increasing Challenges

Nepal faces serious climate risks. Based on the Climate Change Vulnerability Index, it is the 4th most climate vulnerable country in the world, with poverty and adaptive capacity being some of the key determining factors. Weather conditions in Nepal are challenging, because there may be both drought and flooding caused by torrential rains simultaneously in various parts of the country. Annually, about 30 people are killed by thunderstorms. However, the greatest damage is caused by floods and landslides. Floods also have other health effects since it is difficult to secure the supply of clean water during flooding. Epidemics caused by the lack of clean water annually result in an average of 400 deaths. Well-developed weather and climate services would allow for the more effective management of adverse impacts on the Nepalese economy and population brought about by extreme weather phenomena.

The goal of the cooperation project is to enhance preparedness and capabilities among the Nepalese authorities and to improve preparation for weather-related natural disasters, which will be more common in the future because of climate change. Good weather and climate services enable more effective management of the adverse effects of climate change and extreme weather events on the economy and human health.

Continued Cooperation

Today the Finnish Meteorological Institute continues this successful co-operation with the Department of Hydrology and Meteorology of Nepal. The FNEP2 project will continue development of DHM's meteorological data collection and quality control as well as train employees in several areas of meteorology. In addition, an effort is being made to provide new meteorological services by developing DHM's weather updates. The project will be realized through training, workshops, and familiarization visits in both Nepal and Finland. The project will be carried out in co-operation with a similar ICI project being run by the FMI in Bhutan.

During the first FNEP project, between 2010-2012 the project focused on, for example, the updating of Nepalese weather stations and training of DHM employees, in areas such as data management and technical maintenance of hardware. During the project, 48 people participated in training sessions, with a total of 260 training days logged. As part of the project, FMI also conducted a socioeconomic study, whose results speak for themselves: each euro invested in Nepal's weather and climate services saves 6-11 euros in social assets through a higher level of preparedness.

Vaisala provided the GLD360 Lightning Dataset (GLD360) for a trial period to support the FMI's FNEP project. This trial period was arranged during the pre-monsoon season between April–June 2012, when lightning activity is the highest in Nepal. This was the first time ever DHM was able to utilize lightning data. During the trial period FMI trained DHM personnel to use lightning location data, including an introduction to lightning location techniques and principles, as well as the actual hands-on training for the operational DHM forecasters. The lightning location system used was the Vaisala GLD360, which offers almost global coverage. For further information, please see the report "Thunderstorm characteristics in Nepal during the pre-monsoon season 2012" by A. Mäkelä et al. / Atmospheric Research Journal 137 (2014) 91–99.

In addition, a modern Vaisala weather station was purchased and installed in Pokhara during the first FNEP project.

By **Martin Motl,**
Head of the Upper Air Division
Czech Hydrometeorological Institute (CHMI)

Vaisala RS41 Trial in the Czech Republic

The newest generation of radiosondes developed by Vaisala, the RS41 type, has been introduced recently at the Meteorological Technology World Expo (MTWE) in Brussels. Before the release there have been trials completed in the Fall of 2013 at Czech Hydrometeorological Institute (CHMI) in order to evaluate functionality and precision of the new sounding system.

CHMI and Vaisala before 2013 trial

First contact of Czech aerology and Vaisala is dated back into early 50s of 20th century. Few years after the war Vaisala radiosondes were used in our institute. The modern Vaisala radiosondes have been used in CHMI since February 1992 until now.

In the period 1992-1998 CHMI used RS80 radiosondes, 1999-2003 the RS90 was used. During May and June 2003 there has been trial testing consisting of 33 dual soundings at our station in order to compare RS80, RS90 and RS92 radiosondes. In the last 10 year period RS92 has been in use.

Steps towards the August trial

We feel honored that we've been allowed to see development of the new system during last two years and that we could share our feelings, opinions and experience with MW41 and RS41 with developers. Our first contact with RS41 was in January 2011 when we were invited by Vaisala for a brief introduction of the planned new generation sounding system. In October 2011 the first presentation of RS41 at our station was done by Vaisala, which gave us the chance to discuss with Vaisala what we would like to see different in the new system. Since March 2012 we tested MW41 software with RS92 sondes at our station with the first data made from this software sent to GTS during autumn 2012. On 26th – 29th August 2013, shortly before official introduction of RS41 at MTWE, there was a trial made at our station in order to compare RS41 radiosondes with RS92.

System setup and testing process

During the trial, 22 soundings with same setup were made. To cover day and night behavior, soundings were spread almost equally during 4 days – from August 26 to August 29.

Martin Motl, Head of the Upper Air Department, with sounding operator Miroslav Klučina prepare wooden cross-rod.

Miroslav Klučina with Pavla Skřivánková, the Deputy-Director for Meteorology and Climatology, and Zdeněk Černoch (Chief Operator).

In each sounding there were used 4 radiosondes - two of RS41 and two of RS92. Sondes were hanging about 60 cm under wooden cross-rod, so they made corners of square with a side of about 1,5 m. The cross-rod itself with parachute was about 50 meters under the balloon. Data from both RS41 were processed with MW41 system while one of RS92 was processed with MW21 and the other one with new MW41. From previous tests when we processed simultaneously data from one RS92 sonde with two systems – MW21 and MW41 – we already knew that this won't affect results. During whole testing period we were lucky with the weather – almost no wind close to the ground, so it was easy to launch our setups.

The following metrics for the evaluation were used: direct differences between old and new sondes to discover possible systematic errors, standard deviations between two pairs of sondes of the same type to reveal accuracy of sensors, and comparison of geopotential heights on standard isobaric levels with the results from weather prediction model ALADIN used in CHMI on regular basis as a quality check. »

Pressure level	Average difference [m]		Standard deviation [m]	
	RS92	RS41	RS92	RS41
100 hPa	2.3	1.8	4.0	4.3
30hPa	13.6	13.6	15.5	14.9
20hPa	18.7	18.7	20.1	19.9
10hPa	22.3	22.9	28.1	26.0

Height differences between radiosondes and ALADIN weather prediction model. Sample of 22 sondes from each type.

Test results

We were probably most interested in results of pressure and height comparison. RS92 sonde computes height from measured pressure and temperature. This apporach was changed and RS41 computes pressure from temperature and height. This change was possible thanks to the improved accuracy of GPS height measuring.

One sounding with pressure sensor fault was excluded from the evaluation – one RS92 measured 1.2 hPa more than all other sondes even on 5 hPa level. Comparison didn't show any significant bias (lower than 10 m in all levels up to 32 km), but the standard deviation was much lower for the new type of sonde (Figure 1). RS41 standard deviation is between 2 and 3 meters for all levels, but RS92 standard deviation rises from similar values in lower levels up to 90 meters in 34 km. Comparison with WPM ALADIN in Table 1 doesn't show any important differences between sondes.

Because pressure is variable highly connected with height, there was no surprise that we observed very similar behavior. Maximum difference was some 0.3 hPa decreasing to zero when reaching higher levels, standard deviation (Figure 2) decreasing to 0.02 hPa for RS41 instead of 0.1 for RS92.

According to wind measurements, there were no significant differences between two types of sondes – wind velocity difference below 0.1 m/s for all levels, standard deviation lower than 0.1 m/s up to 24 km, raised to 0.5 m/s around 30 km for both systems.

Differences between day and night temperature measurements are illustrated in Figure 3 to 5. Differences in day (Figure 3) were higher than at night, but still lower than 0.2 °C. Temperature standard deviation in night (Figure 4) was from 0.02 to 0.09 °C for both types of sondes. Daily standard deviations progressed from 0.02 on surface up to 0.2 in 34 km for new type of sondes, from 0.08 to 0.4 for the old one (Figure 5). The performance of day soundings was better for RS41 than RS92, when RS41 standard deviation varies between 50-70% compared to standard deviation of RS92. In one sounding RS41 temperature deviated non-typically from the other RS41 and RS92s for unknown reason. This sounding was not included to the statistical analysis in order to get representative data set.

As RS92 sondes hadn't been reconditioned during testing, the humidity measurement of RS92 does not represent operational RS92 data. Regardless, RS41 measured correctly in this sample, so reproducibility of measurement represented by standard deviations could be used. On the Figure 6 we can see that they are lower than 1% in whole profile. In order to compare humidity sensors of RS92 and RS41, 10 more flight tests were conducted to get good RS92 reference set for this comparison. In this case dual soundings were with one RS92 and one RS41. Figure 7

shows the result of these soundings. The 1% difference is caused by higher sensitivity of the new sensor. It reacts faster, so on average it shows higher humidity in heights where sonde more often enters the cloud layer and less humidity in heights where it comes out.

Summary

Trial itself fulfilled our expectations. We found the new system quite easy to handle and we also had maximal weather support. Much less fragile temperature sensor worth noticing, which reduces danger of physical damaging while handling before the launch. There weren't found any significant biases between RS41 and RS92. It seems that new approach with measuring height from GPS and computing pressure is a step in the right direction. Results indicate higher precision of RS41 height and pressure data, also precision of other parameters seems to be increased due to the lower standard deviations of RS41. New humidity sensor apparently reacts faster on changes in atmosphere.

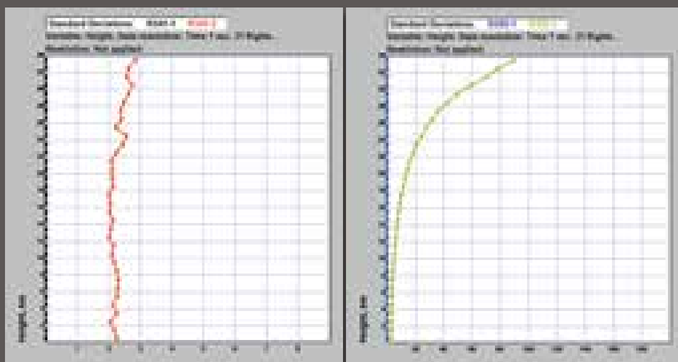


Figure 1: Standard deviations of geopotential height measurements for RS41 sondes (left) and RS92 sondes (right).

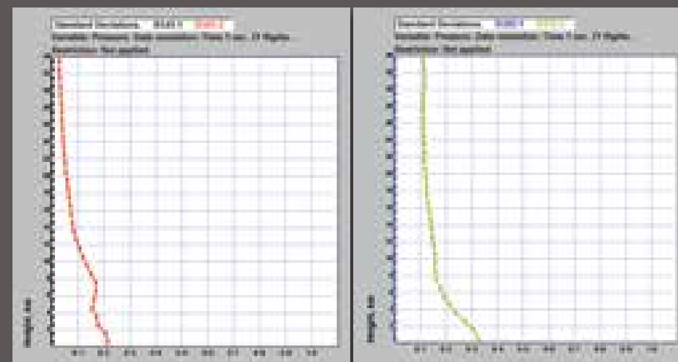


Figure 2: Standard deviations of pressure measurements for RS41 sondes (left) and RS92 sondes (right).

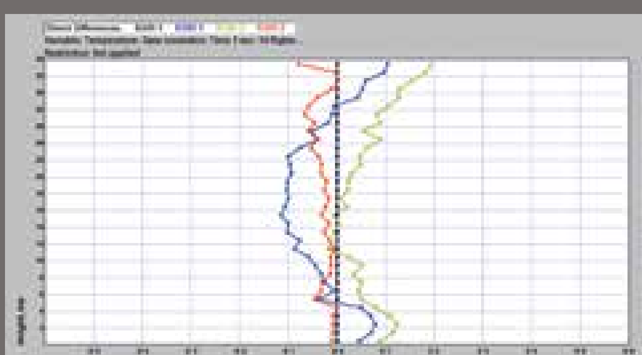


Figure 3: Temperature direct differences during day soundings. RS41_1 as a reference.

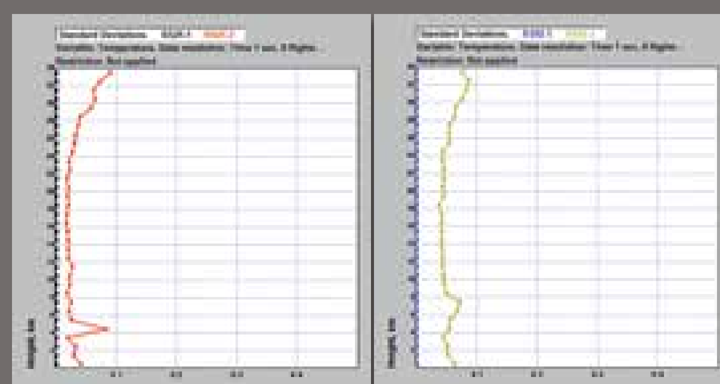


Figure 4: Temperature standard deviation during night soundings for RS41 sondes (left) and RS92 sondes (right).

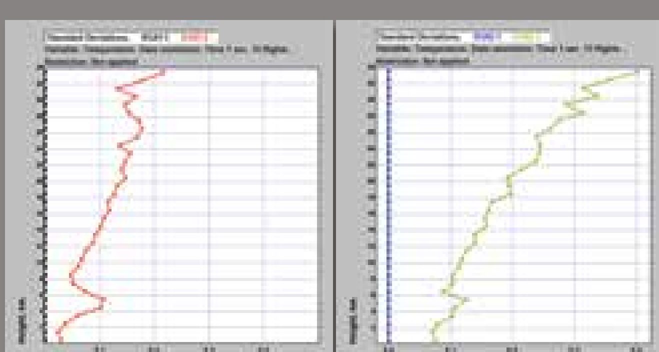


Figure 5: Temperature standard deviation during day soundings for RS41 sondes (left) and RS92 sondes (right).

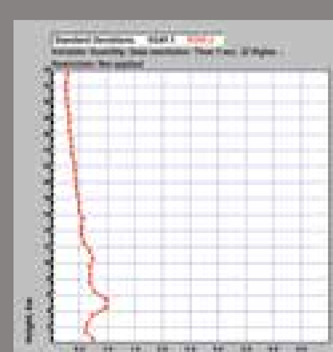


Figure 6: Standard deviation of RS41 humidity.

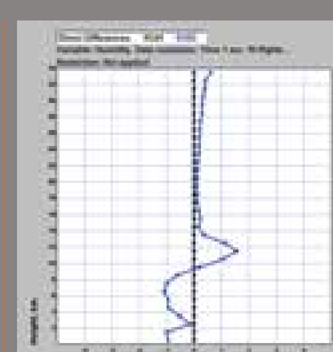


Figure 7: Humidity direct differences, RS41 as a reference.

Vaisala Releases the Advanced Total Lightning™ Sensor, the Latest in Precision Lightning Geolocation Technology

Vaisala's lightning detection technology sets the standard for the lightning industry. Customers worldwide rely on our leading expertise in lightning data and information systems. Vaisala delivers the highest standards of accuracy and reliability in sensor technology, central processing, application software, and customer support.

Vaisala introduces its new Advanced Total Lightning™ sensor, the LS7002, offering the latest in precision lightning technology. It is the first, non-VHF, lightning detection sensor to detect Total Lightning and, at the same time, correctly differentiate between cloud and cloud-to-ground lightning. The sensor is designed to operate as part of a network to provide real-time data for operations focused on tracking cloud and cloud-to-ground lightning threats to ground-based and airborne assets. The sensor is suitable for meteorological and climatological measurements, as well as applications in aviation, telecommunications, power utility, defense and forestry.

Unparalleled Lightning Detection Efficiency

The Vaisala LS7002 sensor detects low frequency (LF) electromagnetic signals generated by lightning. The sensor is designed with extremely precise geolocation capability, as well as industry-leading measurement accuracy of lightning strength

and lightning type classification. The LS7002 also offers calibrated lightning parameters, and the sensor does not require calibration during normal operations, which leads to cost savings without any operational breaks.

An LS7002 network uses a patented combination of time-of-arrival and magnetic direction finding techniques to deliver superior detection efficiency, optimal location accuracy, with excellent system redundancy, while still utilizing fewer sensors - no other company provides this blend of cost efficiency and scientifically validated best performance. Vaisala lightning technology means that a larger area of coverage can be monitored with fewer sensors, providing a detection system with lower lifetime network ownership costs than any other technology.

In addition, an efficient, light-weight electronics module allows for easy installation and maintenance with stand-alone, rooftop and indoor electronic mounting options. When working in severe weather locations, the sensor electronics can be installed separate from antenna installation.

Advanced Total Lightning™ Network

Whenever a new Vaisala lightning sensor is introduced, such as the LS7002, Vaisala also uses the opportunity to update its Total Lightning ProcessorTM (TLP). This processor is used within Vaisala's lightning detection networks and is designed to provide data for a wide range of applications. The TLP allows users the flexibility to select features that are best suited for their requirements. Licenses are available for the following TLP™ features, including: system and sensor performance monitoring; network performance mapping; as well as detection efficiency (DE) and location accuracy (LA) projections. There is also an advanced lightning type classification option for "burst" processing and advanced waveform parameters.

These features provide more efficient network operations, stabilized performance, and deliver advanced information with regard to geolocated lightning events. The TLP100™ Series processes data from Vaisala's low frequency (LF) sensors delivering unmatched performance; detecting, characterizing and classifying cloud pulses and cloud-to-ground strokes. The TLP200™ Series processes data from both Vaisala's LF and very high frequency (VHF) sensors providing Total Lightning Mapping solutions, including the full spatial extent of any lightning threat.

Game-Changing AWS310

The Vaisala Automatic Weather Station AWS310 was launched in June 2013 to offer customers a cost-effective alternative without compromising reliability and durability. The system is pre-configured, with the best sensor and reporting options for quick installation and improved usability, without compromising data acquisition and quality.

The AWS310 can also be customized to meet individual customer demands or to operate as part of an existing data collection network. As Product Manager **Tero Muttilainen** explains, "The AWS310 brings something new to the table. We are able to support both large networks and respond to smaller orders more efficiently with a solid and reliable product that offers customers improved usability in the field. Alongside being easy to install, easy to use, and easy to expand, the system can be delivered within just four weeks."

Easy to Install

Through simple and affordable installation, customers will also save both money and time. As an example, the AWS310 utilizes the new cost-effective and robust 10-meter DKP110 mast, which does not require concrete foundations or an installation expert.

The system can be had with WMO-compliant sensors for validated data that can be visualized using the optional Vaisala MCC301 PC display software. In its pre-configured setup, the customer may choose from a range of sensor options to measure air temperature and humidity, barometric pressure, wind speed and direction, precipitation amount, solar radiation, present weather and visibility, cloud height, soil temperature, soil moisture and snow depth. In addition, several parameters such as dew point, QFF, QFE and QNH pressure, precipitation accumulation and intensity, sunshine duration and evapotranspiration are calculated. The system is ready for usteroe out-of-the-box with the AWS-specific

Vaisala sensors. Following initial installation, adding sensors or setting alarms and reporting intervals has been simplified to enhance usability.

Easy to Operate

As a stand-alone weather data collection system, users are able to acquire data remotely with a range of standard sensor and communication options or customize the system according to their own specifications. Users can also collect and visualize the data on a regular office PC using Vaisala Observation Console MCC301 data collection software.

The AWS310 is delivered with three ready-made reporting options. These can also be customized in case there are special requirements, or if the user seeks to fit the AWS310 as part of an existing data collection system or AWS network. For example, if BUFR, SYNOP or METAR reports are required, these can be easily added to the system thanks to the flexibility of the system.

Easy to Maintain

The AWS310 offers reduced operational and maintenance costs. According to Tero, “A key benefit for users with this system is the long calibration intervals. As the pre-configured AWS310 sensor set has a low risk of drifting or sudden calibration changes, it is able to maintain excellent long-term stability.” Vaisala also offers on-site calibration equipment so users can check and adjust sensors on-site. Additional benefit of AWS310 is that you don’t always have to be on site to update or adjust settings of the system. When operating in GSM/GPRS networks, AWS310 can be reached remotely with self-diagnostic reports available from the data logger and from the sensors, and it can even automatically download a new data logger setup from a network server.

Field-proven reliability combined with accuracy in harsh environments

makes the system an excellent choice for customers. From synoptic meteorology and climatological research, to hydrology and urban meteorology – the Vaisala AWS310 is the ideal solution for a wide range of applications.

“This is a system that can be depended upon to perform effectively in all weather conditions and climates. Customers will benefit from cost-savings thanks to the system’s pre-configured setup. The product is generating a great deal of interest, thanks to its affordability, usability, and expandability,” Tero summarizes.

Safe Port Operations with Maritime Observation Systems

Accurate, real-time local weather and sea-state information provided by modern maritime weather monitoring systems reduces the uncertainty and risks associated with making operational decisions, in and around the port.

Weather monitoring systems, such as those offered by Vaisala, provide local real-time data collection, intuitive display software, data storage and management. They also facilitate access to real-time and historical weather information for all necessary parties, from ships' captains and tug masters to crane operators and mooring teams.

Confident Operational Decision-Making

What to monitor, where, and how will depend on the characteristics of the port in question. Reliable and accurate measurement of visibility, wind direction and wind speed are critical to ensuring navigational safety, especially where large tankers are operating. In addition, oceanographic measurements such as current, wave height, sea level, and salinity can all be part of a modern system supporting complex port environments.

Confident operational decision making is enabled by utilizing reliable meteorological data. The heart of any system is the weather station, which collects, processes, and communicates the information from the connected measurement equipment. The Vaisala AWS430 Maritime Observation System provides a wide range of meteorological and statistical calculation options, integrating all essential weather measurements into one single system and data stream.

For oil and gas operations, and liquid natural gas (LNG) transportation in particular, severe weather – especially lightning – can present a significant safety risk when vessels are in port loading or unloading their cargo. The danger posed by lightning was brought into sharp focus in 2011, when the tanker Bunga Alpinia was struck during the loading of methanol at a terminal in the South China Sea. The resulting explosion led to five fatalities, a significant environmental threat to the surrounding area, and the almost total destruction of the vessel. A reliable lightning detection system would have provided advance warning of the potential danger, allowing decision-makers to halt sensitive operations prior to lightning threatening the safety of the operation.

Prevention Drives Safety, Readiness Attracts Business

With a modern weather monitoring system in place, weather-critical operations can be carried out when conditions are optimal and halted when there is a safety risk. Lightning poses an explosion risk, and approaching storms and high winds can interfere with crane operations, preventing loading and unloading. Accurate weather information and forecasting not only ensure the safest possible operation portside they also enhance the attractiveness of the terminal to potential customers. In an increasingly competitive market, a comprehensive weather monitoring system can give a port that extra edge.

While real-time weather information is not critical for all harbor operations– passenger ferries and hard-cargo vessels, for example, can often operate in even the most demanding conditions – it is a critical resource in the case of emergency situations, in terms of determining liability and processing insurance claims.

Value Through Partnering

One of the major challenges faced by port operators when deciding to implement weather observation systems is how to gain a better understanding of the weather in relation to their specific environment. How does it affect operations and, therefore, what should be measured, where, and how? This is where close collaboration with a knowledgeable partner is extremely valuable, particularly when it comes to determining the optimal location for sensor equipment and predicting the behavior of the potential parameters to be measured.

For oil and gas operations, and again LNG in particular, a supplier with an in-depth knowledge of electrical storm behavior and detection, and the capability to support hazardous locations or explosive atmospheres is critical to ensuring safety and enabling effective planning of operations.

Services such as the Vaisala Global Lightning Dataset GLD360 can be combined with local lightning sensors, displays, and alarms for on-site lightning detection. A comprehensive system like this will provide early warning and tracking of thunderstorm movement.

For port operators, a modern and accurate maritime observation system provides a crystal-clear picture of the conditions out on the water and sky – whatever the weather.

Science-Based Innovation

Dr. **Walter Dabberdt** is well-known as a leading meteorologist, scientist and thought leader. He is an American Meteorological Society (AMS) member and Fellow, and served as AMS President in 2008. Walt is also a Fellow of the Royal Meteorological Society, as well as a past member of the National Academy of Sciences' Board on Atmospheric Sciences and Climate. He also serves on several institutional advisory boards. Dr. Dabberdt spent his early career at the Stanford Research Institute (now SRI International), before joining the National Center for Atmospheric Research (NCAR) as a Scientist and Facility Manager, and later as the NCAR Associate Director.

Cutting Edge Research

One of the first campaigns Walt worked on at the Stanford Research Institute literally put him on the edge of environmental research, measuring carbon monoxide and how it dispersed in the urban environment. "At that time, there were very limited controls on automobiles and one of the big concerns back then was carbon monoxide. My task on that project was to make measurements of the spatial distribution and dispersion of CO in and around the cities of San Jose and St. Louis. To do this we had to position the equipment on a pod mounted on the outside of a helicopter. So for about 40 hours I was flying around those cities with no door on the side of the helicopter, strapped in with a seatbelt and adjusting the measurement system which was literally outside the helicopter – not exactly what I expected to be doing after researching turbulence theory in grad school."

Meteorology Takes Flight

Walt describes the past decades as a 'golden age' for meteorology. "If you stand back and take a longer view, I can really say that the last forty years have been the golden age for meteorology. Obviously our ability to make numerical predictions has improved dramatically and you could surmise that is due to advancements in computing architecture, the ability to write better code and to better parameterize atmospheric physics, but much if not all of that has been enabled by advances in our measurement capabilities. Sensing systems have improved, particularly in the remote sensing area – both ground-based and satellite-based systems. But what really allowed us to take advantage of those improvements are the data assimilation systems. These are able to assimilate measurement data in a way that they can be optimally used in today's weather prediction models." According to Walt, without the advances in assimilation methods the full benefit of those observing systems would not have been realized. "These developments are all inter-related. The advances over the years have been phenomenal and we can see it in the quality of today's weather products."

Drs. Walter Dabberdt and Kevin Petty are widely recognized Vaisala scientists and thought leaders in the global weather community. Highlighted below are some of their thoughts and reflections on a diverse number of weather-related issues.

Vaisala's Chief Science Officer, Dr. **Kevin Petty** completed his BS degree in Mathematics from Illinois College as well as M.S. and Ph.D. degrees in Atmospheric Science from Ohio State University. Prior to joining Vaisala, he has held positions as a Project Scientist and Scientific Program Manager with the National Center for Atmospheric Research (NCAR), and has also served as an accident investigator for the National Transportation Safety Board (NTSB).

Enabling Technologies

Kevin believes the importance of the role of technology in meteorology over the years cannot be overstated. "Technological achievements have allowed us to experience advancements and improvements in a number of meteorological-related disciplines. Some of the main technological achievements have been realized in the areas of observations, data exploitation, numerical weather prediction, computing, and communication." Kevin explains that "these advancements in observing capabilities have resulted in more accurate, timely observations that can more effectively support the assessment and prediction of atmospheric conditions, particularly those that have a notable impact on people, property, and the environment."

"Not only has technology enabled the production of new, superior meteorological observations over the last several decades, but the ability to exploit these data has also improved considerably. Researchers and developers have constructed and employed scientific tools and techniques that can take advantage of observational data. Examples include statistical techniques, machine learning, neural networks, data assimilation, and numerical methods, to name just a few. As these tools and techniques have advanced, we have seen considerable improvements in the ability to analyze and forecast atmospheric conditions.

"In my opinion, the translation and communication of data and information is potentially one of the most important, yet overlooked, aspects of meteorology when dealing with the protection of life, property, and the environment," he adds. "Here too, technology has facilitated sizeable improvements. Technological advances in the areas of algorithm development and application software have cultivated decision support systems capable of supplying decision-makers and the general public with vital meteorological-based information concerning their operations or area of interest. More importantly, in some of the more superior applications, what was once complex meteorological data has been translated into user-specific information that can be easily interpreted by those less familiar with meteorological data and its usage. In addition, the output from advanced »

scientific techniques, such as ensemble modeling, has been combined with pioneering information delivery platforms and practices to better communicate forecast uncertainty, which can be a critical element in the decision-making process."

Extreme Weather Preparedness

When asked about our role in supporting preparedness for extreme weather events, Kevin explains that Vaisala products contribute to the process of assessing and forecasting high-impact weather events. "For example, forecasting agencies and organizations can use Vaisala's radiosonde technology to gain a better understanding of the structure of the atmosphere from the surface to upper levels. This understanding can further aid in determining locations for potential severe weather outbreaks. The assimilation of these upper-air data into the numerical modeling process helps to optimize the forecasts produced by global and regional models by delivering more accurate initial conditions of the atmosphere, enhancing and supporting forecast of extreme weather events." He adds that, "another important element related to minimizing the impact of extreme weather on life and property is the ability to nowcast (i.e., short-term predictions from 0 to 3 hours into the future) the conditions associated with high-impact weather events."

Vaisala's product portfolio delivers a number of tools to meet the nowcasting challenges in several markets. For instance, Vaisala has developed technology that provides data and information on regional and global lightning activity, a key indicator of convectively induced hazardous weather. Kevin continues, "not only can this information be used to warn the public of the potential dangers associated with lightning itself, but it can also be used as a real-time proxy for high-impact weather. Vaisala's weather radar also allows end users to observe and nowcast high-impact weather situations in all seasons and provide notifications to the public regarding the potential for weather-related hazards prior to their arrival." In reference to road safety and surface transportation industry Vaisala products that target extreme weather conditions. "For example, the roads and aviation decision makers can use Vaisala's remote sensing technology (DSC111) to determine and predict whether pavement conditions will be dry, wet, icy, or snow covered, enabling operations personnel to take appropriate actions to mitigate the impact of extreme winter weather. These examples illustrate the fact that Vaisala's diverse portfolio of in situ and remote sensing products can directly contribute to lessening the effects of high-impact weather."

"I believe Vaisala's information services technology is breaching new ground in the dissemination and communication of data and information specific to operations in multiple sectors. Vaisala is using its core offering in the area of observing capabilities and coupling that with novel algorithms and customer information to create applications designed to reduce the impacts of extreme weather." In conclusion, Kevin adds that "these end-to-end solutions supply comprehensive capabilities with a focus on enhancing the safety, efficiency, and effectiveness of an end user's operations. This means that instead of providing general, high-level data and information regarding current and future state of the atmospheric, the aim is to produce and communicate data and information that is specific and targeted to an end user's or organization's operational responsibilities and interests."

The Changing Climate

Since the 1930s, Vaisala has been committed to conducting research and development that has resulted in measurement devices and systems capable of facilitating both fundamental and applied research of the Earth system, with a focus on the atmosphere. The observations and information produced by Vaisala's offerings have enabled scientists across the globe to unlock answers to some of the most pressing environmental issues. Along these lines, Vaisala is committed to supporting investigations into one of the most persistent, pressing issues of the 21st century – climate change.

Walt recalls a meeting of the American Geophysical Union roughly 30 years ago. "It was in San Francisco, and I attended a climate session where scientists were starting to present the results of their climate modeling studies. And if you look back at those model results you'd say this is unusable, because it was so coarse and simplistic," Walt explains. "Today, we've got global climate models that are no longer just atmospheric models – they are truly coupled models that simulate the interactions between the atmosphere and the oceans and land surfaces, sea ice, glaciers, and so on."

Kevin adds that, "regardless of whether one's interest is in answering questions associated with natural processes or human-induced climate change, it is essential to have a highly precise, accurate record of atmospheric changes over adequate temporal scales, along with diverse spatial resolution. It is also important to have a record of forcing mechanisms (factors that influence climate)." Through its corporate responsibility initiatives, Vaisala is not only taking steps to deploy current technologies that will support climate research, but it is investing in the development and distribution of new and improved technologies that will enable the production of supplemental climate data.

"It's truly impressive that this can be done a century out into the future and with reasonable certainty concerning the changes in atmosphere conditions due to changes in gaseous and particulate emissions. This is really a grand challenge that is being successfully addressed." Walt explains, and the science is solid, "When you evaluate the performance of these climate models by applying them in reverse over the past 100-plus years, the degree of accuracy that these models have achieved is remarkable. Are they perfect? Of course not. Will they ever be perfect? No. But will they be good enough to support the making of sound political decisions? I think yes."

Making a Difference

According to Walt, Vaisala can, does and will continue to play an important role in the climate debate. He explains that much of the so-called climate data is actually data that was collected for weather measurement purposes, for which we have a long data record. But there are other measurements that we will need to further improve our understanding of the atmosphere for climate prediction purposes.

"I believe what Vaisala is doing in the area of the reference radiosonde is a prime example of where we will be truly recognized as the global leader of upper-air climate measurements – not only upper-air weather measurements. Water vapor data, in particular, is an important gap in our knowledge for both weather and climate. On the weather side we're developing new systems to measure water vapor in the lower troposphere, while at the same time, with the reference radiosonde, we are developing an instrument that makes high-quality measurements of water vapor into the lower stratosphere. And that is really important for understanding the total climate system, because water vapor is a major greenhouse gas."

Observations of another key greenhouse gas, carbon dioxide (CO_2), can currently be obtained through the use of Vaisala's CARBOCAP® CO_2 sensor. Kevin explains, "This sensor has the capacity to provide stable, reliable measurements in support of a wide range of applications, including indoor and outdoor monitoring. One of the most fundamental climate change indicators is temperature, and Vaisala's temperature sensing technology has been used in surface-based observing networks to contribute to official climate records. Possibly one of the more unique and unexploited opportunities for obtaining climate data and information can be found in Vaisala's Global Lightning Dataset GLD360. This dataset, which became available in 2009, can potentially help climate scientists identify and resolve changes in convective precipitation frequency and intensity (also correlated with temperature change), further enhancing our understanding of climate change and its impact.

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