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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Growth through Renewal

To achieve success and growth, it is important to have the courage to renew your business. It is quite common that companies who stick to tried and tested success formulas for too long, will actually fail. It's easy to ignore the changes happening in the marketplace, especially when they are difficult and involve risk. However, the famous quote from Heraclitus, "the only thing that is constant is change", is completely true.

Vaisala is no stranger to change and renewal. For example, with Weather Radar, we successfully entered into a new and dynamic market area, pushing the envelope for new technologies along the way. Renewal is not easy; it demands commitment and perseverance, belief in the actions you have set in motion, even when you do not see successful results immediately. In order to renew, you need to let go of something. This can be very challenging, whether it is a change in portfolio, or ways of working. Resources are limited and therefore it is important to make sure the right people are in the right place in order to meet the demands of the future.

We have been in the environmental business for nearly 80 years. This experience is our key competitive advantage, and it is upon this knowledge and these capabilities, that we are building our future success. To date, Vaisala has sold over 100 Weather Radar systems around the world, from the tropics to the arctic, our capabilities and track record is second to none.

Looking into the future, however, the most important thing is to understand the customer's circumstances and operations. You also have to have insight into how they are changing and a vision of how you can be a part of those changes and developments going forward. We have grown by expanding into new growth areas through our existing competencies, as well as through the addition of new and complementary skills and capabilities, both organically and through acquisitions.

On this premise and with this approach, we have expanded our operations into weather-dependent renewable energy, weather-based information services, as well as the life-science industry where measuring prevailing conditions and monitoring these are critical to customers.

Constant change allows our staff the opportunity to develop their competences and expand into new areas. The success of Vaisala depends completely on the work of our expert and capable staff.

The work we do at Vaisala is meaningful with an impact on societies around the world. This makes it all the more important for us to always reach for our very best performance.

Kjell Forsén
President and CEO

Developing an Accurate, Reliable Weather Radar

Vaisala Weather Radar development began in 2005 and has its in foundations in technical innovation. Using new antenna technology, Vaisala was able to increase measurement accuracy and improve the performance of radar technology, allowing for dual polarization measurements to be used for hydrometeor classification. Vaisala was the first to launch commercial hydrometeor classification algorithm, included within the Interactive Radar Information System (IRIS)software, alongside developing a high quality product that provides superior measurement capabilities to support weather forecasting.

Dual Polarization and Doppler Radar

For decades, Doppler weather radar has been one of the most important tools for meteorologists. The weather radar has always been used for nowcasting and related applications, such as aviation and severe weather monitoring. Today's weather radar employs dual polarization technology to produce clear, clutter-free high-resolution pictures of rainfall events. Dual polarization weather radar has become the standard for modern weather radar systems.

Developed in collaboration with leading universities in the US and Finland, Vaisala Weather Radar are designed to meet the most demanding customer requirements. Intelligent mechanical design, online remote monitoring and control, as well as calibration and data monitoring utilities, produce superior data quality and high data availability when combined with dual polarization technology. This enables the delivery of world-class radar applications incorporating intuitive graphical displays.

A dual polarized radar transmitter simultaneously transmits microwave pulses, both horizontally and vertically polarized. When these signals reflect off the objects present in the air, such as rain or snow, the receiver must be able to accurately interpret the echo as it returns. This information can be used to identify if the signal has

encountered rain, snow or hail; the system can also measure wind direction and speed. In addition, birds and insects can be separated from the data stream.

Vaisala's Weather Radar prototype was completed in 2005, and is still in research and development use in Kumpula, Helsinki. A production prototype has been in use in our research laboratory since spring 2006.

Joining Forces with Sigmet

In December 2005, Vaisala signed a contract to acquire 100% of the stock of Westford-based Sigmet Inc. in the United States. Sigmet was a world leading provider in signal processing and weather radar software. They also brought more than 20 years of experience on weather radar markets, especially in weather radar upgrades.

Today, the Vaisala Sigmet product line offering of signal processors and application software is completely integrated with Vaisala´s excellent C-band weather radar hardware. Its core customers are meteorological and hydrological institutes, as well as integrators of meteorological systems.

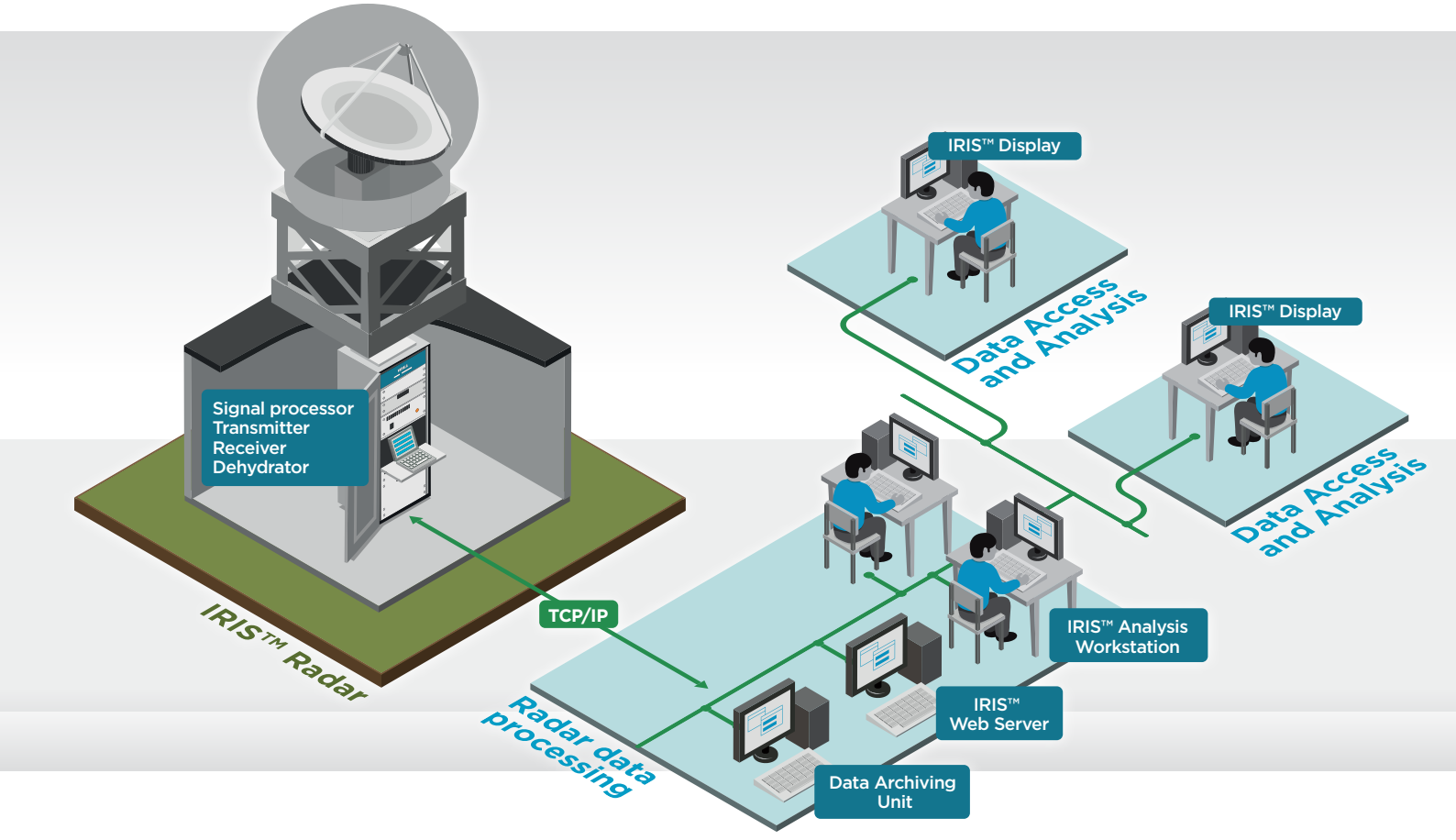
Research Focus

For Vaisala, developing an accurate and reliable weather radar was an important research and development effort. Working together with leading international research institutes and partners, and utilizing innovative technology at the core of radar development. The radar's dual polarization technology enables more precise information on the quantity and quality of precipitation. Intelligent mechanics allow for typically very remotely located weather radar to be almost maintenance free, further lowering end user costs.

Paving the Way

Vaisala has always been driven to facilitate the end-user's tasks. For example, by actively informing the user about the prevailing precipitation situation. Vaisala has also integrated lightning data to the radar display, this way thunderstorm developments can be observed from the same display unit.

Vaisala pushed the C-band weather radar technology to a new level. This guarantees more accurate measurements with lower purchase and maintenance costs. This also helped dual polarization technology become the operational standard. Vaisala´s start in the weather radar business was really successful. To date, Vaisala's Weather Radar has been delivered to locations around the world, with over 100 units sold since 2007.



Why C-band for Weather Radar?

by Heikki Pohjola

The modern dual polarization C-band radar has distinct advantages compared to the lower frequency S-band radar. By nature the higher frequency C-band experiences attenuation. Fortunately, this can now be mitigated with dual polarization attenuation correction, which means that C-Band technology no longer limits the measurement range. Utilizing best-in-class technology, Vaisala's WRM200 Dual Polarization Weather Radar achieves the same detection capability than any S-band radar, for half the price of an S-band system.

Busting C-Band Myths

C-band dual polarization and S-band weather radars have the same detection range, reaching up to 500 km, in the case of thunderstorm top height of more than 15 km. Detection range is limited only by the Earth's curvature, and not the technology itself as was the case in the past when dual polarization C-band radars were not available.

Typically, weather radars in operational weather radar networks have measurement ranges of 250 km. This is particularly the case in cold climates, where precipitation occurs in a relatively shallow layer and because of that the detection range in many cases can be limited.

Figure 1 on page 7 shows the height of the radar beam (1 degree) at the lowest elevation, at 0.5 degree. Black bars over the solid blue line show the beam broadening. One can see that at 300 km range from the radar, the radar beam height is 8 km and already 12.5 km at the range of 400 km. This is why in most cases, even in tropical climates, the detection range of the radar is limited by the Earth curvature, and not the radar technology or frequency (X, C or S) itself.

Radar Frequency – Sensitivity vs Attenuation

The C-band radar, utilizing higher frequency than S-band, is for distributed targets 4 times (6 dB) more sensitive than S-band. This allows the C-band system to use a less powerful transmitter, smaller antenna and lighter weight pedestal. The result is improved cost efficiency with lower capital expenditure, the smaller, more agile system is also more reliable and easier to maintain. For example, Vaisala's WRM200 needs just one maintenance visit per year, saving costs and reducing the need to travel on-site.

Technically, the choice of radar frequency (the wavelength) is a compromise between optimizing the sensitivity of the radar for identifying the atmospheric targets and limiting the degree of attenuation (the loss of sensitivity) along the signal path. Radars utilizing shorter wavelengths i.e. high frequency (X- and C-band) have a clear advantage in terms of signal sensitivity to longer wavelengths (S-band).

Dual Polarization Attenuation Correction

Attenuation of heavy rain can be corrected by over 40 dB when using the modern dual polarization C-band weather radar using the attenuation correction algorithm. This gives C-band dual polarization radar the same performance levels as the more expensive S-band radar. This makes the investment into large S-band radars with high civil infrastructure cost, limited installation sites, and high maintenance cost both unnecessary and uneconomical.

Conversely, higher wavelengths experience significant attenuation effects generated by the hydrometeors along their signal trajectory. In practice, intense rain often leads to a complete loss of the X-band signal, severely limiting the range of X-band radar usability to some 50 km. This makes X-band more or less useless for operational purposes especially in climates with heavy precipitation. The moderately attenuated C-band radar signals can still penetrate through even the most intense rain. To simplify, in order to achieve the same sensitivity as a 250 KW C band system, a comparable S band system would need a 1 MW transmitter!

Figure 2 on page 7 shows the horizontal signal (red) and vertical signal (blue) propagation through the atmosphere. The more intense the rain is the more oblate the rain drops are, which is causing the difference in propagation speed between horizontal and vertical signal i.e. phase shift used for attenuation correction.

Proven Cost Benefits of C-band Radar

Vaisala WRM200 dual polarization weather radar achieves the same

detection capability as S-band, at half the cost.

The primary motivation for significantly increased popularity of C-band radar is that a turnkey-installed C-band system is half the price of an S-band system when using comparable antenna gain and transmission power. Also, C-band radars, at roughly half the size of an S-band system (4.5 m vs 10 m antenna dish), are easier to site in environmentally and/or socially sensitive areas. Additional cost savings emerge through significantly less expensive maintenance costs over the life-cycle of the system.

With the move of dual polarization techniques from the laboratory into production weather radar systems, as proven with the Vaisala WRM200, many weather services that traditionally used S-band systems are making the transition to use dual polarization C-band systems.

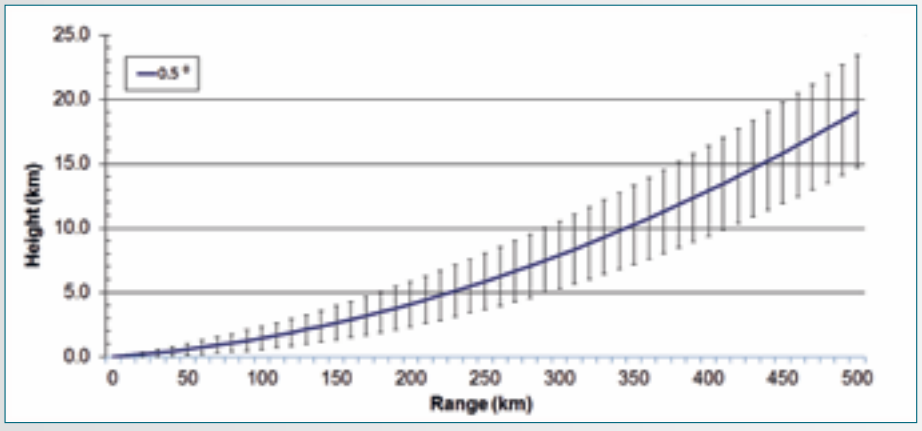


Figure 1

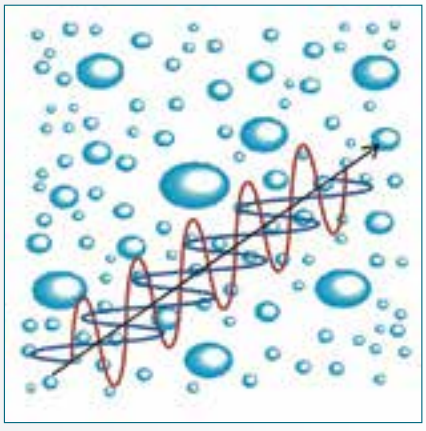


Figure 2

Turning a Weather Radar into a Decision Support System Depends on

Software Algorithms and Data Quality

by Jason Selzler

Vaisala entered the Weather Radar business in 2006. Through its own efforts and the acquisition of Sigmet, Vaisala Weather Radar quickly began to pioneer the technology that can be found in most weather radar around the world today. In 2009, the team from Sigmet was awarded the AMS Award for Outstanding Services to Meteorology by a Corporation "For major advances over many years to signal processing and display systems for both research and operational weather radars around the world." With the world's leading experts onboard, Vaisala quickly began to build a name for itself with world-class radar capabilities.

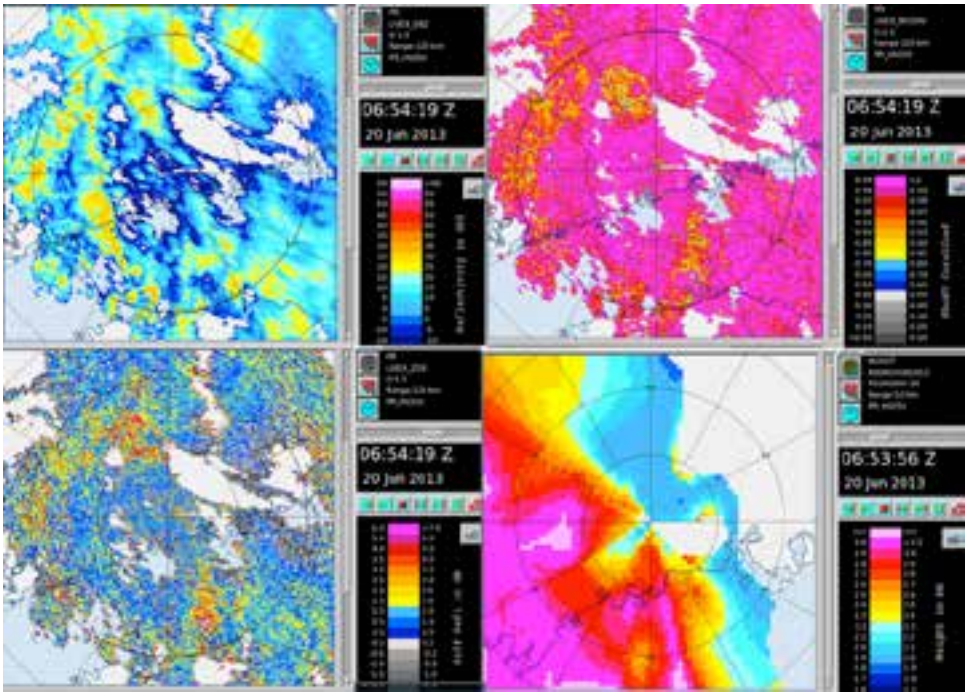


Figure 1: Example of radar derived melting level heights from Vaisala's Kerava radar during frontal passage are shown in the lower right panel. Weather radar has the capability to show higher spatial and temporal resolution than other sampling methods.

Remote Monitoring of the Melting Level Height

The altitude of the melting layer is a significant phenomenon in atmospheric observations. During precipitation events it typically consists of initially frozen hydrometeors falling into warmer air where they melt. Knowing the evolution and location of this layer is important in several types of scenarios such as determining rain/snow at the surface and as an indicator of icing levels for aircraft. The data can also be used to determine the likelihood of hail and lightning, evaluate the quality of numerical weather prediction forecasts, and improve radar derived rainfall estimates, hydrometeor classification as well as attenuation corrections.

The melting layer can have large temporal and spatial variability. Smooth transitions are generally found in stratiform precipitation while complicated structures rapidly evolve in thunderstorms. The melting level may be absent during the winter season and warm rain processes. The current operational methodologies to observe the melting level come from the approximately 700 sounding sites

twice a day, satellite observations and commercial aircraft, obtained during their climbs/descents into airports. This leaves a large portion of the world unsampled.
The radar echoes from melting hydrometeors differ from both the true liquid and ice phase. The melting particles can be identified using data from dual polarization radar. Vaisala has developed an automatic and robust method to measure the characteristics of the melting level every 3 – 7 minutes within the scanning range of the radar site.

Mitigation of New Threats to Data Quality

As the world continues to have an ever increasing need to wirelessly transmit and receive data for our laptops, portable gaming systems, and especially smartphones, there is an increasing strain on mobile broadband data to support the load. A Cisco research report forecast the mobile broadband data traffic will increase by a factor of 39 times between 2009 and end of 2014. To mitigate the need for higher amount of broadband data, during the 2003 World Radio Conference the International Telecommunications Union recommended using the frequency spectrum of 5470 – 5725 MHz for Radio Local Area Networks (RLAN) on a non-interfering basis with existing licensed systems. These systems are primarily C-band weather radar systems. Unfortunately due to the release of many non-compliant devices as well as the non-interference technology not performing to the needed capabilities, interference started to appear in localized C-band weather radar systems in the late 2000's and is now a global problem.

Likewise the need for clean, cheap, energy production is growing due to increasing worldwide demand and the attempt to mitigate climate change caused by burning fossil fuels. Wind Energy has become a reasonable economic choice to meet the needs for clean energy and new wind energy capacity is expected to double by 2020. However, as wind turbines get bigger, reaching higher and higher into the sky, and as the number of farms grow, they are increasingly within the line of sight of existing weather radar sites.

Normal ground clutter is suppressed in weather radar data using the assumption that ground clutter does not move, or has zero velocity. If we remove all data that has zero velocity, ideally the ground clutter has been suppressed, and any inadvertently removed weather data can be restored. However, large wind turbines can obstruct a weather radar site, often appearing to have a random velocity due to the rotating blades and their orientation to the radar site. They cause transmitted radar energy to bounce off many objects in unknown directions before finally returning back to the radar system creating false radar echo at ranges farther than the wind farm. Thus traditional filtering techniques will not work, and left unmitigated the ability to detect severe storm indicators will be degraded as false alarms increase.

Vaisala has been tackling these new problems by using the capabilities of dual polarization radar to distinguish between meteorological and non-meteorological targets. As the data produced by dual polarization radar is sensitive to the shape, liquid/ice phase, density, and orientation of hydrometeor particles we can use these properties together, along with some spatial consistency, to determine the likelihood of the targets to in fact be a meteorological target. We call this technique the Polarimetric Meteorological Index (PMI).

⇨⇨⇨

Figure 2: Melting level heights derived for an eight day period. The algorithm also obtains the quality of the estimate, shown either as high or low confidence with standard deviation. The red dots are the height of the 0oc isotherm from local radiosonde data. Times with missing heights from radar observations happen with the lack of hydrometeorological scatter, i.e. 'clear air' days.

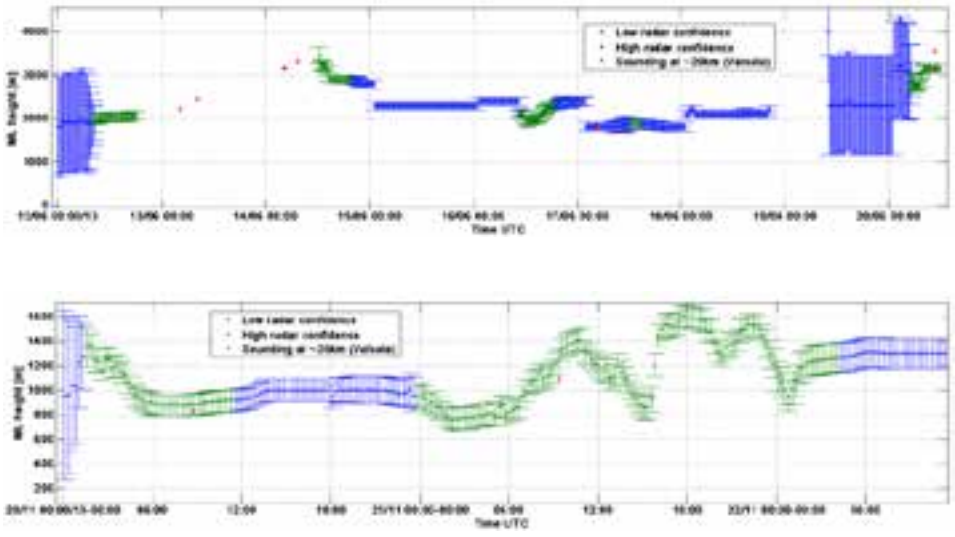


Figure 3: This chart demonstrates the greater temporal resolution possible with radar estimated melting level heights during a 24 hour period compared to the two measurements made by synoptic soundings.

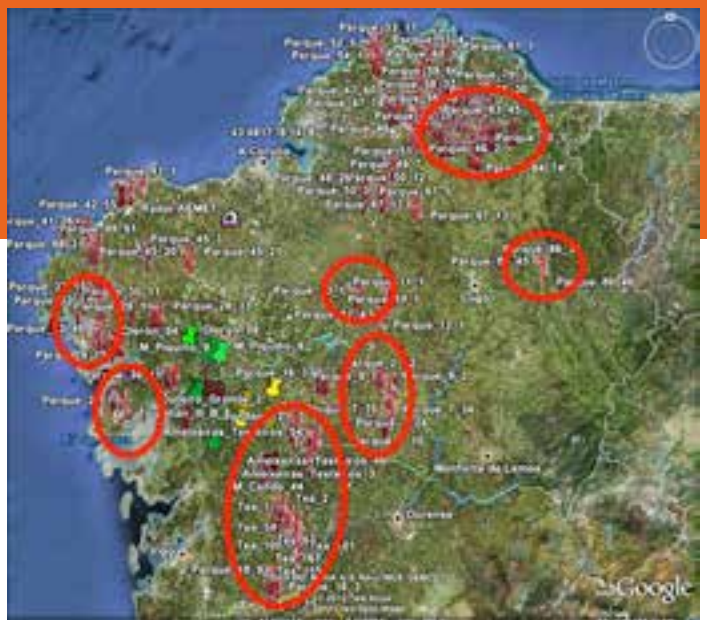


Figure 4: Compilation of active wind turbine parks in the range of coverage of MeteoGalicia's WRM200 at Valga radar site. There are about three thousand individual turbines in the radar line-of-sight.

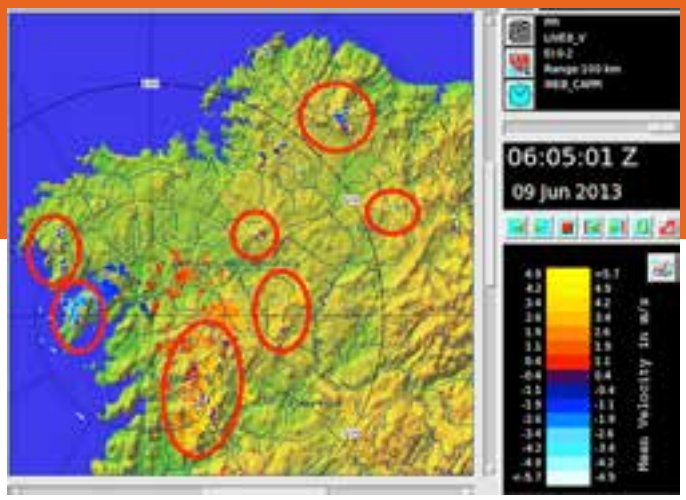


Figure 5: The radial velocity data from the Valga radar after traditional ground clutter filtering. The 'moving' targets within the circled areas are in fact wind turbines.

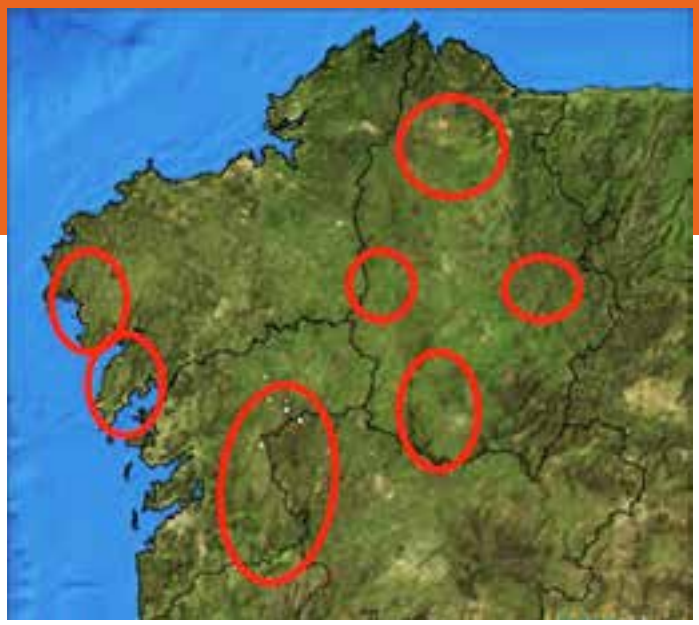


Figure 6: Six hour rainfall accumulation from fields of reflectivity in fair weather conditions on June 9th 2013 00-06 UTC (see Figure 5). PMI and other standard features of quality control remove the echo from about three thousand wind turbines in radar line-of-sight, effectively. Residual clutter is negligible in terms of rainfall.

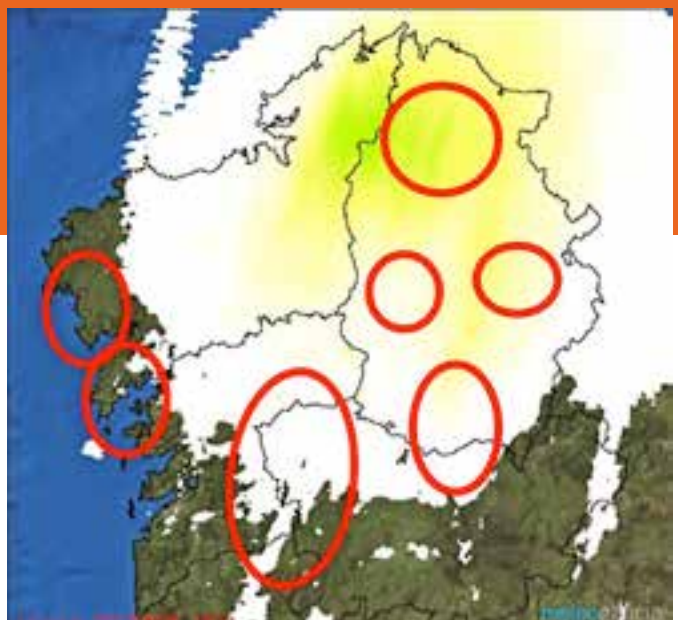


Figure 7: as in Figure 6, but during an event of large scale precipitation on July 9th 2014 00-06 UTC. Fields of accumulated rain fall appear smooth in the regions of wind farming, no gaps nor anomalous excess accumulations are seen at farm locations in comparison to proximate locations.

A Cost-Effective and Quick Upgrade to Dual Polarization for C-band Weather Radars

Thanks to Vaisala's new Antenna-Mounted Receiver WRB912 for C-Band Weather radar, customers can reap all the benefits of dual polarization for a fraction of the cost, and in a fraction of the time. Vaisala's new antenna-mounted receivers allow you to upgrade, rather than completely replace, your existing single-polarization system. Apart from the obvious data quality and availability benefits this brings, it will also greatly reduce your maintenance costs – and at a lower initial investment than a full radar replacement.

Upgrading, rather than a carrying out a full replacement offers a lower initial investment in comparison to a full radar replacement. Furthermore, online calibration and maintenance functionalities reduce the need for site visits and associated costs. Finally, when onsite maintenance is needed, these can be completed quickly due to the easy accessibility of components.

With their precise rainfall measurement capacity, dual-polarization weather radars have superseded single-polarization radars as the standard for modern systems. However, upgrading old single-polarization radars has been an expensive and time-consuming project – until now. Vaisala's new antenna-mounted receivers make the upgrade far more affordable and faster to complete. The antenna-mounted receivers can be up and running in less than two weeks.

Dual Polarization in Less Than 2 Weeks

An antenna-mounted receiver makes it possible to send and receive both signal channels through one channel rather than separately through the pedestal. As the need for expensive and time-consuming mechanical modernization of the pedestal is eliminated, the upgrade is simple and quick to perform. The upgrade is a tried and tested one-size-fits-all product that only requires minimal site-specific adjustments.

Before each installation, we carry out a detailed site survey to ensure that the upgrade is suitable for your equipment and that the installation phase proceeds quickly and smoothly. Each delivery has its own defined project flow that details exactly what will happen when. Our extensive project management expertise means that we can typically have your upgrade your fully operational with less than two weeks radar downtime.

Savings in Maintenance Costs

The savings don't stop when the upgrade is installed – maintenance costs over the upgraded radar's remaining lifetime will also be considerably lower than with your current radar. As calibration and so much of the maintenance can be carried out online, there is less need for site visits, reducing associated travel and labor costs. And when a technician is required on site, the easily accessible and replaceable units mean that repairs are quick and easy.

Better for Your Budget, Better for the Environment

Extending the lifetime of existing mechanical hardware, rather than scrapping it prematurely, not only makes financial sense, it makes environmental sense too, as no new natural resources need to be used.

Is an upgrade the right choice for you?

For many organizations, upgrading to dual polarization makes more sense than completely replacing existing single-polarization technology. If you have a good enough antenna for dual polarization characteristics with solid mechanical parts, you will benefit from the upgrade. For older systems, the mechanical hardware will likely fail before the lifetime of the upgrade is over, thereby full replacement with dual-polarization radar, such as Vaisala WRM200, is recommended.

Contact sales@vaisala.com to find out whether upgrading to dual polarization is right for you!

World-Class Radar Capabilities

Weather Radars for Meteorological Solutions

With its new innovative design solutions Vaisala has become a leading supplier of C-band weather radars. A high quality, high performance antenna coupled with the world leading Sigmet signal processors and IRIS application software will ensure high radar data quality that meets even the most stringent requirements of dual polarization applications in the most demanding environments. The advanced design and high-quality manufacturing of the antenna and pedestal also contribute to low maintenance costs during the lifetime of the system.

With over 100 installed systems around the world - from tropical to freezing climates - Vaisala Weather Radar is second to none. Vaisala can supply solutions from radar upgrades to large scale turn key projects with tower construction and infrastructure works, alongside full project management and maintenance services.

Aeronautica Civil de Colombia, Colombia

For the special administrative unit of the local civil aviation authority (UAEAC), the radar is of vital importance as it helps to optimize the meteorological service. This leads to improved security in aerial navigation at the most important airport of the country. The weather radar is located on a nearby mountain, Tablazo, in the vicinity of Colombia's capital city of Bogotá to monitor El Dorado International Airport. El Dorado is a major hub in Latin America and it is the largest cargo airport in the region. The real-time lightning data collected from the Vaisala Global Lightning Dataset GLD360 service greatly enhances forecasting and early warnings capability for high seas, thunderstorms and cyclones approaching from the Pacific, the Atlantic, as well as neighboring countries. Vaisala's Weather Radar, combined with lightning detection equipment, helps to safely manage air traffic, and provides advance warning on severe weather events.

New Zealand Met Service, New Zealand

Challenging topography and geographical isolation means that weather forecasting in New Zealand is no easy task. MetService, the country's national meteorological service, trusted Vaisala to underpin its five-year, NZD 12 million weather radar expansion program. The radar enables monitoring of weather systems over the Pacific Ocean immediately to the east of the North Island, as well as over its central and eastern parts. Dual polarization capability brings a host of benefits for forecasters, providing them with much more detailed information on weather systems – including the ability to distinguish between liquid and frozen precipitation within rainclouds – enabling much more accurate and timely forecasting.

MeteoGalicia, Spain

MeteoGalicia, the 10-year-old regional meteorological service of the Environmental Department of Xunta de Galicia was tasked with ensuring rapid and reliable meteorological forecasts and weather warnings for the region of Galicia. To achieve this goal, the organization needed to augment its current measurement capabilities with a highly accurate weather radar system. After carefully considering several competitive offers, MeteoGalicia was confident that Vaisala offered the best solution. Vaisala's professionalism, care and the expertise of Vaisala's customer service played an important part in the final decision, alongside the versatility of the Vaisala solution portfolio. As MeteoGalicia was already equipped with many of the basic components required for a full-scale early warning system – weather stations, rain gauges, and the decision support software (DSS) module – Vaisala rounded out the system with the Vaisala Dual Polarization Weather Radar WRM200. MeteoGalicia also opted for the Vaisala Lightning Detection system, consisting of a network of four sensors and an upper-air sounding system. The entire solution is supported with a five-year service contract to ensure the system continues to operate at maximum efficiency.

India

The megacity of Delhi is extremely vulnerable to flooding, with annual monsoons bringing torrential rain and causing local flash floods. Floods regularly cause major damage to buildings, housing and roads, leading to substantial economic losses and human suffering. Vaisala has installed weather radar in Delhi which was taken into operational use in January 2012. With the help of the radar it is now possible to forecast and monitor approaching precipitation patterns. This helps local authorities prepare preventive actions against urban flooding caused by heavy rain and storms.

Companhia Energética de Minas Gerais (CEMIG), Brazil

Companhia Energética de Minas Gerais (CEMIG) is a Brazilian power company headquartered in the capital of Minas Gerais, in Belo Horizonte. The company is one of the largest power generators and distributors in Brazil, and is responsible for 12 percent of the energy distributed nationally. Vaisala has delivered a WRM200 turnkey weather radar installation to CEMIG which is used to forecast the availability of water resources near the Belo Horizonte hydropower dam. In addition, the radar is used to forecast and monitor severe weather in the area, giving local authorities advance warning of any approaching storms to facilitate preparedness for extreme weather events.

Vaisala's Dr. Ryan Said Receives Inaugural HMEI Award for Young Engineers

The Association of Hydro-Meteorological Equipment Industry (HMEI) has awarded Dr. Ryan Said the Award for Young Engineers. The award was presented at the WMO World Weather Open Science Conference, in Montréal, Canada, in August 2014.

This inaugural award recognizes Dr. Said's work on mastering hardware and software solutions in the development and implementation of Vaisala's global lightning detection network, which generates the commercial Global Lightning Dataset GLD360. The network provides real-time lightning data for accurate and early detection and tracking of severe weather. Dr. Said earned his Ph.D. from Stanford University in Electrical Engineering. Prior to joining Vaisala, he was awarded a patent for a new technique to detect and locate lightning with high accuracy on a global scale using a relatively sparse array of terrestrial receivers. This patent, "Long-range lightning detection and characterization system and method" (US 8073622 B2), which was published on December 6, 2011, is licensed by Vaisala and represents the core technological breakthrough in the GLD360. In addition to the patent filing, Dr. Said has published two papers related to this work. The first, "Long-range lightning geolocation using a VLF radio atmospheric waveform bank," (J. Geophys. Res., 2010), details the methodology behind the new lightning detection technology. The second, "Highly intense lightning over the oceans: Estimated peak currents from global GLD360 observations," (J. Geophys. Res., 2013), leverages the unique capability of this network to estimate peak currents on a global scale to present the first estimate of the spatial distribution of global peak current averages.

In addition to creating the necessary intellectual property, Dr. Said was the primary developer for the GLD360 core software working as both a scientist and software engineer. Through his development and subsequent implementation of this global lightning detection network, Dr. Said has made a tremendous contribution to the field of hydrometeorology, and indeed all other fields that relate in some way to convective weather systems.

Proven Reliability

The best-in-class Vaisala HUMICAP® Humidity and Temperature Transmitter Series HMT330 is built for incredibly stable measurement in just about any environment – clean or dirty, hot or cold.

Vaisala now provides a 10-year warranty program for the Vaisala HUMICAP® Humidity and Temperature Transmitter Series HMT330 when it is calibrated annually at a Vaisala Service Center. This warranty program is available to all new customers, and does not require separate registration.

According to Sanna Lehtinen, Product Manager, "This decision is based on the fact that a very limited amount of HMT330 really needs repair during their long lifetime. We wanted the market to realize that we manufacture reliable products that can have even 10 year warranty. The long warranty time is a concrete differentiator from our competition. The same HUMICAP sensors are used widely in Vaisala products, and this program, despite being limited to HMT330 Series, is a clear signal of how confident we are about our world class sensor technology".

President of Finland Visits Vaisala Headquarters

***Sauli Niinistö**, the President of the Republic of Finland visited Vaisala's headquarters on September 12th, 2014. During the visit, President Niinistö met with Vaisala management and staff, as well as participated in a factory tour. The visit was hosted by Vaisala President and CEO **Kjell Forsén**.*

Cornwall leads the way with Next Generation Weather Stations

Cornwall Council is responsible for over 4,530 miles (7,250 kilometers) of road from major principal roads to narrow country lanes. Winter service provision is an important part of keeping the transport moving around the county, with £1m being spent each year on salting the roads affected by winter weather. The Council's strategy involves salting major roads when there is a risk of ice, clearing snow and reacting to floods and fallen trees. To ensure correct and timely decisions are made, it is critical for winter service decision makers to know what is happening on the network day and night. In August this year the Council took the decision to invest in the latest technology in the field of road weather sensing to enhance the winter service delivered to users of the highway.

By the end of September, the world's first network of next generation road weather stations had been installed. The twelve stations, provided by the leading weather sensor manufacturer Vaisala, are the first of their brand new RWS200 weather station.

Mark Edgehill, Project Manager for Vaisala said "We were very happy to work on this project. Due to the time of year, the installation schedule has been short. We have worked very closely with SSE Enterprise to ensure we met the deadline." SSE Enterprise is contracted to provide a range of services across the County and has championed the upgrade of the road weather station network.

The weather stations are designed to provide highly accurate information for road managers, so they can tackle whatever the icy winter weather throws at them. The design of the stations include a high level of protection against lightning, and also a range of sophisticated weather sensing devices that report conditions at regular intervals throughout the day and night. This means a constant weather eye is kept on Cornwall's roads to ensure that they are as safe and free flowing as possible at any time of the year. These installations put Cornwall right on the crest of the technology wave in keeping with its fabulous coastline.

Lydia Hewitt, ITC Operations Officer for Cornwall Council, said of the installation "In these challenging times of austerity this is a very exciting project for Cornwall. We are very pleased to be working with Vaisala on such a project. The new stations will provide accurate information allowing for enhanced decisions for salting to be made. This is a capital investment that will deliver revenue savings in both equipment maintenance and road salting."

Danny Johns, Regional Manager, EMEA, Vaisala said, "The new weather stations have been a long time in development, so it's a great pleasure to see them all up and running in Cornwall. We look forward to a long partnership with the county, and we sincerely hope that this new technology brings benefits to all the road users throughout this beautiful countryside."

For further information please contact

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Air Handling Equipment Inc. Uses Vaisala Dew Point Instruments to Offer Accurate Monitoring Services of Commercial Air Dryers

Industrial Processes Rely on Clean, Dry Compressed Air

Robotic and pneumatic tools used in industrial applications operate with compressed air. Monitoring and controlling moisture in compressed air is critical to ensuring a contaminant-free process and equipment reliability since water vapor in compressed air can cause clogging, microbial contamination, freezing and machinery breakdowns. Air Handling Equipment Inc., a full-service air compressor and dryer distributor in Ohio, helps companies in automotive, food and industrial production monitor dew point to ensure their compressed air equipment and dryers in their facilities are operating per specification. A growing part of their service business is offering predictive maintenance to prevent problems related to water vapor in compressed air from occurring.

Routine Audits Aid in Reliability

Using Vaisala dew point instruments, Air Handling Equipment technicians are able to provide predictive maintenance to their customers by conducting routine reliability audits and by tracking the dew point results. Over time, a trend report can be generated which allows them to see how the equipment is performing compared to specification. Armed with this information they can more easily spot trends in equipment performance that may predict a performance issue before it could result in costly, unplanned downtime.

Commercial Air Dryers Remove Moisture

To remove moisture from compressed air two types of commercial air dryers are generally used: refrigerant and desiccant. Refrigerant dryers are used in general assembly applications and condense water vapor via mechanical refrigeration at dew point temperatures near 40°F. Desiccant dryers are typically used in high-tech applications where higher quality compressed air is required. These dryers use chemical desiccants to absorb water vapor at dew point temperatures to -40°F and lower. To ensure the dryers are working properly routine monitoring of the dew point is needed.

Accuracy and Logging of Dew Point

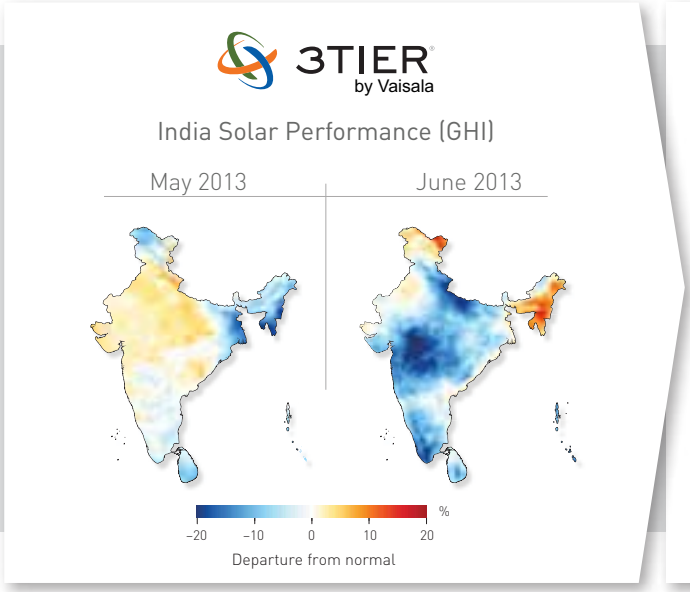
Air Handling Equipment services desiccant and refrigerant dryers, so using one instrument that is accurate over a wide range of dew point temperatures is their preferred solution. The company observed a comparison test of dew point instruments where Vaisala instruments clearly proved their accuracy in both types of dryers. In addition, Vaisala DRYCAP® Dew Point and Temperature Transmitters log data points in 20 minute intervals which are saved in the unit's memory for one year, providing Air Handling Equipment the temporal resolution needed to identify trouble spots and trends before there is a downstream problem in their customer's equipment and production process.

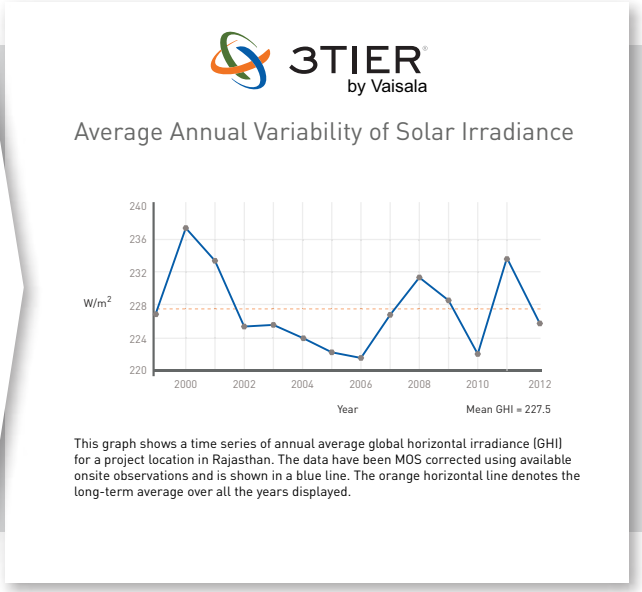
Accurate Handheld Dew Point Meter

Air Handling Equipment also relies on Vaisala's hand-held dew point instrument, DM70, for its field service technicians to easily and accurately spot check dew point during their audit services. Both the fixed and portable units have easy-to-read LCD displays.

C-WET/MNRE Select 3TIER to Develop National Solar Atlas of India

Publicly available solar information from the Indian government will guide development, attract investment, and accelerate the growth of solar energy.





3TIER India Private Ltd., a wholly owned subsidiary of Vaisala and the leading source for global renewable energy assessment and forecasting information, has been selected through a global tender for satellite data to create a Solar Atlas of India. The signed agreement is with the Centre for Wind Energy Technology (C-WET), an autonomous research and development institution that forms a part of the Indian Ministry of New and Renewable Energy (MNRE). Under the terms of agreement, 3TIER will work directly with C-WET to develop and disseminate critical investor-grade information that will enable India to meet its ambitious solar energy capacity targets.

C-WET is entrusted by the Indian government through a mission mode project to create and share commercially relevant weather resource information with prospective future financiers and the wider investor community. This ambition forms part of a wider strategy to ensure adequate solar radiation data is available to the domestic and international business community, with a particular emphasis on those that have already identified the Indian market to be of strong solar investment interest.

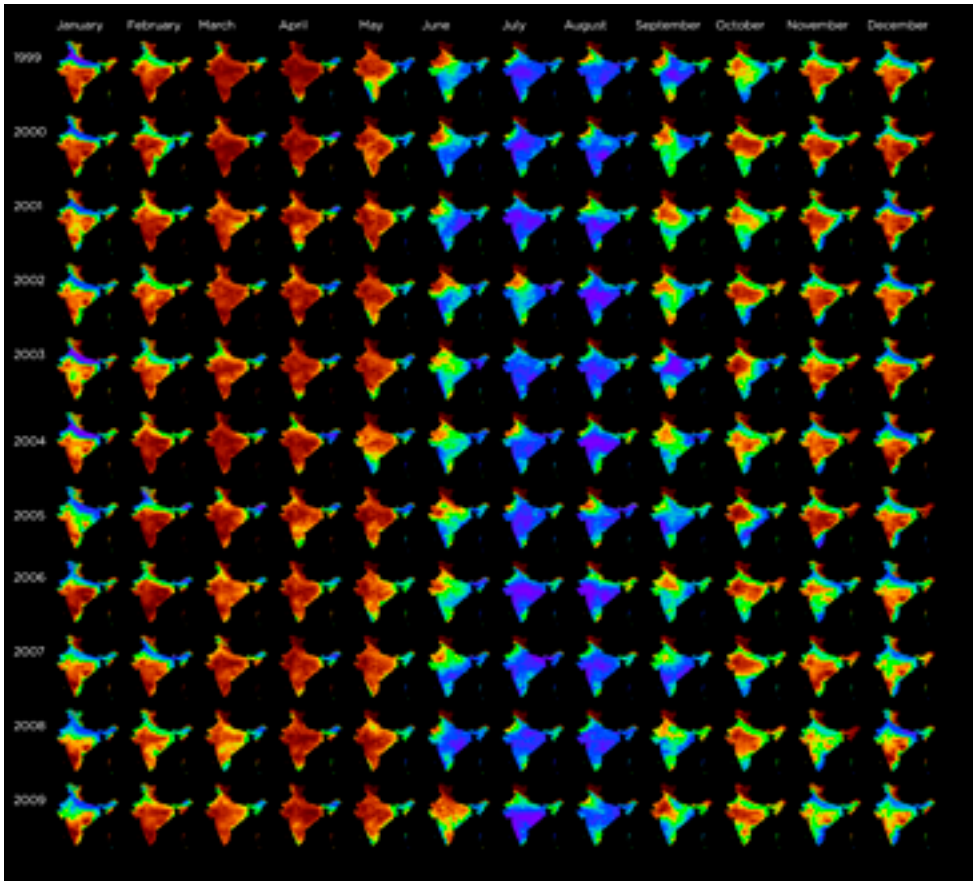
"The collaboration between 3TIER and C-WET will greatly help in evaluating and prioritizing required infrastructure, such as solar generation facilities, storage technology, and transmission lines - in essence, answering where and how to invest in order to harness India's considerable solar energy potential," said Dr. **S. Gomathinayagam**, Executive Director, C-WET. "The resulting nationwide solar study will help investors and market players clear the first hurdle in the process by filling a critical information gap."

Under the Jawaharlal Nehru National Solar Mission (JNNSM), India aims to reach 20 GW of grid tied solar power, 2 GW of off grid solar power, and 20 million square meters of solar thermal collector area by 2022. Meeting these targets will require long-term market certainty in order to attract the necessary inward investment of capital.

"Long-term certainty is not solely generated by strong, stable government policy," said Mr. **Nikhilesh Singh,** Managing Director of 3TIER India. "It also requires long-term certainty in the resource. Prospective developers and investors need information to quickly assess whether solar projects will be commercially viable and able to meet energy production expectations. A large part of ensuring project feasibility is optimal siting.

"This involves appropriately sizing the system to match the available energy resource, evaluating proximity to transmission and major centers for energy demand, as well as ensuring that the infrastructure is equipped to manage the influx of energy from a variable source. The forthcoming Solar Atlas will provide a detailed view of India's solar power resources, which while vast, vary significantly both across geography and over time."

Having a clear understanding of resource variability prior to investment is crucial since falling short of energy estimates has a direct impact on project production and profitability. 3TIER pioneered the use of satellite technologies in calculating pre-construction solar energy estimates and has set the global best practices for project planning. To date, this has enabled global project developers to secure investments worth over €4 billion.



This state-of-the-art satellite methodology analyzes the range of factors that impact surface irradiance conditions, such as cloud movement, air quality, and cyclical events like cyclone seasons and monsoons. In a previous study by 3TIER, India's monsoon was shown to cause resource reductions of as much as 30-40% in some parts of the country from pre-onset solar production. The timing and impact of the monsoon vary significantly from year to year and can be strongly felt - even in typically sunny regions like Rajasthan.

The Solar Atlas will provide a clearer understanding of this weather anomaly along with spatial and hourly solar irradiation variability. It will include a series of monthly solar resource maps covering the entire country and long-term solar resource and meteorological datasets at 115 locations.

"All information will be regularly updated to include the most recent months and will be validated by C-WET's Solar Radiation Resource Assessment (SRRA) stations spread across the country," said Dr. **G. Giridhar**, Director of the SRRA Mission Mode Project at C-WET. The data quality checks and accuracy levels are facilitated through an active collaboration between C-WET Chennai and Deutsche Gessellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

Smooth, Ongoing Transitions to RS41 Continue

More and more customers are transitioning to the new Vaisala Radiosonde RS41 which features key improvements on various technical and usability factors. Here we take a quick look at some of the key differences between the RS41 and the previous radiosonde model, RS92.

Vaisala Radiosonde RS41 is a major new platform in the long continuum of the history of Vaisala radiosonde development, incorporating new technological solutions for accurate atmospheric temperature, humidity and pressure profile measurement. The RS41 is operated with Vaisala DigiCORA® Sounding System MW41 as part of the 4th Generation Vaisala sounding system.

Temperature	RS41-SG	RS92-SGPD
Sensor type	**Platinum Resistor**	**Capacitive wire**
Combined uncertainty in sounding[1)]	0.3 ºC < 16 km 0.4 ºC > 16 km	0.5 ºC < 16 km 0.5 ºC > 16 km
Reproducibility in sounding[2)]	0.15 ºC > 100 hPa 0.3 ºC < 100 hPa	0.2 ºC > 100 hPa 0.5 ºC < 100 hPa
Repeatability in calibration[3)]	0.1 ºC	0.15 ºC
Response time (63.2 %, 6 m/s, 1000 hPa)	0.5 s Time lag correction applied, negligible residual errors	0.4 s No time lag correction
Ground check	No correction needed. In-built temperature check to find faulty units	Corrected against Pt100 reference

1) 2-sigma (k=2) confidence level (95.5%) combined uncertainty.
2) Standard deviation of differences in twin soundings, ascent rate above 3 m/s.
3) Standard deviation of differences between two successive repeated calibrations, k=2 confidence level.

User-friendly Sounding Preparations

RS41 incorporates multiple improvements over RS92 for usability and reliability during sounding preparations. For example, it incorporates features such as an integrated GPS antenna, wireless short range communication, status LED indicators, integrated low-weight batteries and a separate unwinder. The ground preparation phase is fully automated to "zero-click sounding operation"-level with DigiCORA® Sounding System MW41 and Ground Check Device RI41. Vaisala Radiosonde RS41-SG uses the Global Positioning System (GPS) for observations of height, pressure, horizontal location and wind.

Alongside being smaller and lighter, the RS41 is also easier to prepare for sounding. Based on customer feedback and opportunities provided by new technologies, the RS41 pre-flight check and frequency setting is performed in a highly-automated process using the Ground Check Device RI41. No cables or drying desiccants for a reference are needed; simply place the RS41 on the RI41 pad to prepare the radiosonde for sounding. The DigiCORA system communicates directly with the radiosonde and completes the process without user intervention. A green LED light indicates that the radiosonde is ready to go. This simple upgrade to the sounding preparation process removes time-consuming steps from the previous, more cumbersome way of preparing

Figure 1

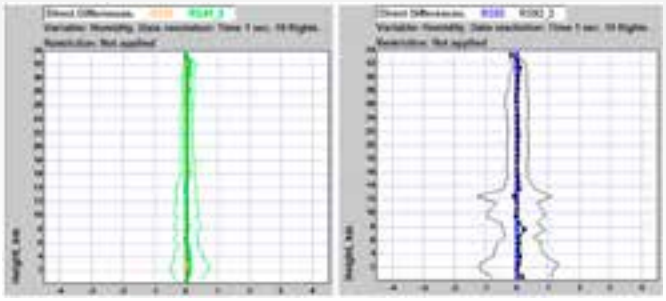
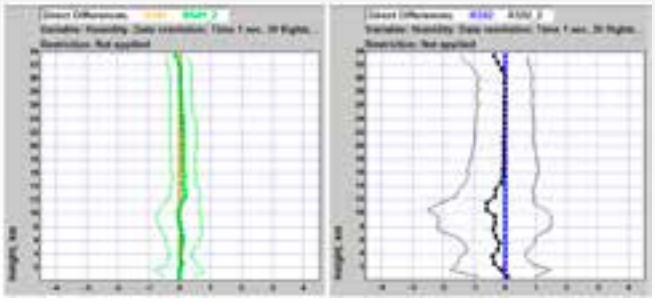


Figure 2



Figures 1 and 2 illustrate humidity reproducibility (precision) test results for RS41-RS41 and RS92-RS92 pairs in Camborne, Nov. 2013 comparison, RS41 demonstrating improved precision during both night (Figure 1) and day time (Figure 2).

Figure 3

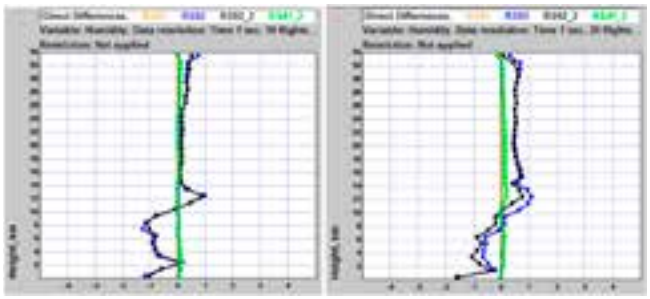


Figure 3. RS92 vs. RS41 humidity differences at night (left) and day time (right) in Camborne test. The differences are within 2 %RH, which is a typical result also in other mid and higher latitude campaigns.

the RS92. These updates also lead to improved reliability for sounding operations. In the RS41, the sensor boom is positioned for flight with a fail-safe solution, which pushes the boom into the correct flying position, every time.

Technically-Speaking, a Better Radiosonde

Temperature measurement with the Vaisala Radiosonde RS41-SG is based on a resistive platinum temperature sensor technology, used widely in reference temperature measurement applications. Table 1 on the left presents the comparison of RS41 and RS92 temperature measurement specifications.

When measuring humidity, the RS41 Radiosonde utilizes capacitive Vaisala HUMICAP® polymer sensor technology as does the RS92. With an integrated on-chip temperature sensor the humidity measurement concept is capable of eliminating solar radiation induced bias. The sensor is heated during flight to prevent icing. The heating and on-chip temperature measurement features are also used during the radiosonde ground preparation phase for humidity sensor reconditioning and ground checking; the use of physical zero humidity point removes the need for adjustment with desiccants.

Proven in the Field with Soaring Results

The RS41 has been tested in sounding test campaigns in several locations representing various climatological conditions. Mid-latitude test campaigns have been performed in Camborne, UK, and in Libus, Prague, Czech Republic. Higher latitude test flights have been done in Finland (Vantaa and Sodankylä). For tropical conditions tests, flights have been performed in Penang, Malaysia.

A large-scale RS41 and RS92 sounding test campaign was performed in Camborne, UK, in November 2013. 30 ascents, with four radiosondes each (two RS92s and two RS41s) were launched from the Met Office's weather station site in Camborne during November 2013 in varying weather conditions. The RS92 software and model versions were the same as those used in the WMO inter-comparison of high-quality radiosonde systems, in Yangjiang, China, 2010, and the design of the trial followed the methodology of WMO inter-comparisons. The UK Met Office has provided a scientifically independent report from the data produced by the trial. Figures 1, 2, and 3 present some characteristic results for humidity from the data set. RS41 humidity reproducibility is improved compared with RS92. Direct differences between RS41 and RS92 are less than 2 %RH. The results for humidity in Camborne test are in line with other tests performed in mid and higher latitudes. Larger mean differences ≈ 5 %RH between RS41 and RS92 humidity were detected at daytime in tropical tropopause region at very cold temperatures.

Herbalife Adopts Continuous Mapping Strategy to Strengthen Environmental Monitoring

Founded in 1980, Herbalife Ltd. is a global nutritional company that provides dietary supplements, vitamins, and personal care products in over 90 countries through a network of more than 3 million independent members. To ensure products are protected during manufacturing, packaging and storage, Herbalife maintains strict controls over environmental parameters with a risk-based approach.

In its global distribution centers, quality testing labs, and manufacturing facilities, the company adheres to Current Good Manufacturing Practices (cGMP) and strives to meet or exceed all requirements that ensure the purity, safety and efficacy of Herbalife products from manufacture to final distribution. To meet the highest standards, Herbalife Quality managers decided to perform several year-long thermal mapping studies to qualify storage environments according to regulatory guidance. The results of these studies would then be used to design the long-term monitoring systems for the warehouses. However, upon further examination, Herbalife's Quality team decided that if they were going to set up the mapping sensors, taking down half the measurement points after the studies were complete might be unnecessary. Instead, by leaving a higher number of sensors in place, as typically required in a mapping/validation study, facility managers would have access to more in depth data for detailed analysis and better decision making. **Gary Swanson**, Senior Vice President of Quality for Herbalife International says, "We wondered if we wouldn't be better off maintaining the higher density of sensors for long-term monitoring and decided to leave all sensors in place. This essentially resulted in 'continuous mapping' of these environments. We have used this system for three years and found it very successful."

The continuous mapping setup provided information representative of year-round conditions while eliminating the time and cost of resources typically required for intermittent mapping studies. Herbalife's storage and manufacturing areas range from 1,000 to 750,000 square feet and vary greatly in environmental attributes such as air conditioning, control systems, and climatic zones. Swanson notes that warehouses can have subtle fluctuations in temperature. Such problems often only become visible after analysis of data collected over a long time. Giving an example, Swanson says, "In Taiwan our continuous mapping method showed after six months that, although the warehouse had functional air conditioning, there were definitely a few excursions occurring. This information allowed us to intelligently reconfigure the warehouse HVAC system to create more even temperatures throughout." Another advantage of high sensor density is that if one sensor does fail or lose communication, personnel still have full visibility of warehouse conditions. This increases the sense of control and confidence in an alarm

situation. In early 2014, one of Herbalife's warehouses underwent a regulatory inspection. Over the days of the inspection, the Herbalife Quality team outlined the continuous mapping method. "We were in the middle of the inspection," says Swanson, "and the inspector requested some formal planning documents to provide detailed data on our rationale for continuous mapping. This required analysis that we couldn't execute during the inspection. But, Vaisala provided us with documents we were able to give to the inspector while he was still on site. In the end, the inspector reviewed and accepted the monitoring system's setup."

While evaluating monitoring system vendors, Herbalife tested multiple systems. Key requirements included: a system scalable to any size of warehouse, in any type of climate, and consistency in implementation and management. Over six months, Swanson and the Herbalife Quality and Facilities Management team evaluated several systems before selecting the Vaisala Continuous Monitoring System.

According to Swanson, "Some key features that contributed to our final selection included the 10-year battery life of the data loggers, plus their ability to be validated. We also appreciated Vaisala's global service capabilities, especially their ability to provide site evaluation, installation, and validation execution services in many locations. It was important to us that the system could be deployed internationally and Vaisala was the only company we found that could support us throughout our other regions, ensuring proper training, support and system uptime."

CHALLENGE

- **Environmental**
  Herbalife has warehouses in worldwide climatic zones 1, 2, 3, 4a and 4b: from hot tropical, hot dry, to cold. They require a system that can be stretched to the extremes of environmental conditions.
- **Historical Reporting**
  To ensure compliance, Herbalife must have reporting capabilities that prove adherence to regulatory requirements. These reports must satisfy the global regulatory inspectors that visit Herbalife facilities throughout the year.
- **Guaranteed Product Quality**
  The Company needs to manage the overall product quality throughout the supply chain and adhere to current Good Manufacturing Practices (cGMP). Combined with Herbalife's own standards of Quality, this compliance guarantees that all Herbalife members and their customers receive the highest quality and safest products available.

SOLUTION

- **High Performance Hardware**
  The Vaisala Continuous Monitoring System (CMS) can use a wide array of high-performance sensors to monitor temperature, relative humidity, differential pressure, door switches, and more. With 10-year battery life and months of data redundancy in each sensor's memory, records are secure and gap-free.
- **Meet Quality Standards**
  The Vaisala CMS ensures that Herbalife can meet or exceed rigorous regulatory standards. The system provides industry-leading sensing accuracy and calibration is locally available from Vaisala's Regional Service Centers.
- **Multilingual**
  The Vaisala CMS software viewLinc is available in English, German, French, Swedish, Chinese, Japanese, Spanish and Portuguese, with User Guides and Quick Starts.
- **FDA 21 CFR Part 11 Compliance**
  The system includes triple data redundancy, Audit Trail, customizable graphing, and automated reporting options.

BENEFITS

- **Enterprise Solution**
  Herbalife's goal of an enterprise-wide monitoring solution for global processing and storage facilities was met across almost 100 global distribution centers, quality testing labs, and manufacturing facilities.
- **System Support**
  Vaisala provides 24/7 technical support. We offer web-based self-service training tools along with expert guidance on the use and configuration of the CMS. An annual system analysis is available to review system performance and ensure that business objectives are being met.
- **Eliminate Product Loss**
  The Vaisala CMS ensures that facilities personnel maintain full control of monitored areas, identify any problems quickly, and respond with corrective actions. The option of continuous mapping sensor configuration provides better data for long-term analysis.
- **Peace of Mind**
  Vaisala's experienced validation and calibration experts are available online and by phone 365 days per year, as well as during inspections/audits to provide analysis, technical and calibration information, and formal reports to satisfy regulatory requirements.

Guest Article by Professor Dr. Alexander Höhn / Colorado University

Space Life Science Research Prepares Mankind for Long-Distance Space Travel

Dr. Alexander Höhn, adjunct Associate Professor of Aerospace Engineering Sciences at Colorado University, talks about the challenges and demands on life science research in space. Vaisala sensors have supported Dr. Höhn and his team on several projects that are simply out of this world.

Imagine the future with manned flights to Mars and long-distance space exploration missions. Long travel times make it impossible to pack all the clean water, fresh air and food supplies to go. Instead, food and life support consumables, such as water and oxygen, must be produced on-site. Space life science research helps mankind to realize the vision.

Understanding the Effects of Microgravity

Astronauts lose bone and muscle mass during long space missions as they no longer have to work against gravity. The same happens to plants and animals. Space life science research explores how the lack of gravity, more precisely microgravity, affects living organisms. In addition, this research helps to develop advanced life support systems, including agriculture and water purification bioreactors, for long-distance space missions.

The only way to explore how microgravity influences living organisms is to go to space. In the small sealed space capsules, however, the effects of gravity need to be isolated from other environmental factors, such as the amount of light, varying temperature and humidity levels, as well as fluctuating carbon dioxide, oxygen and trace gas contaminant concentrations. Researchers often apply on-board centrifuges to create artificial gravity in space. With the help of centrifuges, on-board space shuttle plant growth experiments can be performed both in microgravity and at defined artificial gravity while keeping other variables constant. This test set-up attempts to ensure that the effects of gravity can be isolated from other factors.

Controlled Environments in Space

Life science and space biology experiments, whether cellular organisms, plants in small greenhouses, or rodents in their habitats, may be severely affected by changes in the environmental conditions. The carbon dioxide level in a spacecraft can reach as high as 1%, even in the presence of scrubbers that clean the air by selectively removing carbon dioxide. Temperature and humidity often fluctuate between +18 to +30°C and 40-60 %RH, respectively, excluding even larger fluctuations during the pre-flight integration and launch periods. For biology experiments, such spacecraft environmental controls are often not adequate.

Scientists at BioServe Space Technologies at the University of Colorado have been using Vaisala's carbon dioxide, humidity, and temperature sensors to control life science experiments both onboard Space Shuttle flights and at the International Space Station (ISS) since 1992 to regulate plant growth and animal habitat environments.

Project Risk Management

The costs of an individual space life science project are difficult to estimate. Space flights are typically carried out for multiple purposes, thus the launch costs are not carried by an individual research project. However, building a miniature greenhouse that is viable in space costs around one million USD. The typical weight of such a greenhouse is approximately 100 kg. On the average, launching 1 kg of goods costs around 10 – 20 000 USD. Thus the greenhouse launch costs are around 1-2 million USD.

Space shuttles no longer fly, and resupply and transport missions to the ISS now take place less frequently using smaller, rocket-launched space

capsules. Thus careful planning is necessary to get the job done right on the first go. Regarding instrumentation, Vaisala has taken away the risk by building products that are waterproof, environmentally protected, can just be plugged in, and they work. Vaisala sensors have never shown unexplained behavior in our applications. They have far exceeded expected and certified calibration and stability levels and usable periods. As there are plenty of things to worry about when planning a life science experiment in space, Vaisala has been chosen time after time to avoid unnecessary risks.

New Focus on Preventing Bone and Muscle Loss

During the last 10 years the focus in space life science research using plants and space agriculture has been somewhat reduced, and higher emphasis was given to finding ways to prevent bone and muscle mass loss due to microgravity. In order to study this, a future flight will resume US animal research aboard the ISS and transport 20 mice to the International Space Station. A fail-proof life support system with trustworthy sensors is a necessity to ensure their survival during transport to space.

Due to the long history of reliable operation and positive experience, excellent stability and ease of integration in the past, HMP110 sensors were again selected to control the payload that provides essential life support functions for the mice during the transport flight. The HMP110s will be used both for controlling humidity through scrubbers, and to record temperature and humidity for post-flight science and engineering analysis. Active carbon dioxide feedback controls are not implemented as the scrubbers are operational throughout the flight.

A Long Journey with Vaisala Sensors

We found Vaisala in early 1990s while searching for small, rugged carbon dioxide sensors. The humidity probe HUMITTER 50Y was taken into service at the same time. Sensors from other manufacturers were also tested but nothing else worked as reliably.

Over the years, the legacy sensors have been replaced with GMM220 series CO_2 modules and HMP110 humidity and temperature probes. However, the long retired sensors are still functional and continue to show reasonable readings after almost 20 years. This is quite impressive considering they have been exposed to environmental conditions far exceeding their design envelope such as condensation during unpowered payload phases, high launch vibrations, as well as microgravity and spaceflight environments.

About the author

Professor Dr. Alexander Höhn, born in Stuttgart, Germany, works as an Associate Professor of Aerospace Engineering Sciences at Colorado University. He holds a PhD in Aerospace Engineering Sciences and has developed payloads for over 35 missions including NASA's Space Shuttle Program, the International Space Station, as well as parabolic and sounding rocket flights over the past 25 years. The span of life science experiments ranges from cellular organisms and bioreactors to plant growth chambers as well as small rodent habitats for space biology and medicine experiments.

Vaisala's Innovative Roads Observations Change the Game

Every day, intelligent transportation systems (ITS) help bring travelers safely to their destination, from airport runways to highways and railways.

Vaisala is launching an entirely new Road Weather Station known as the RWS200. Combined with our RoadDSS™ Software suite, Vaisala is able to offer a revolutionary total intelligent Road Weather Information System called iRWIS. The system consists of intelligent roadside hardware making its own decisions, and sophisticated decision support software, with improved measurement reliability.

Innovations for improved measurements

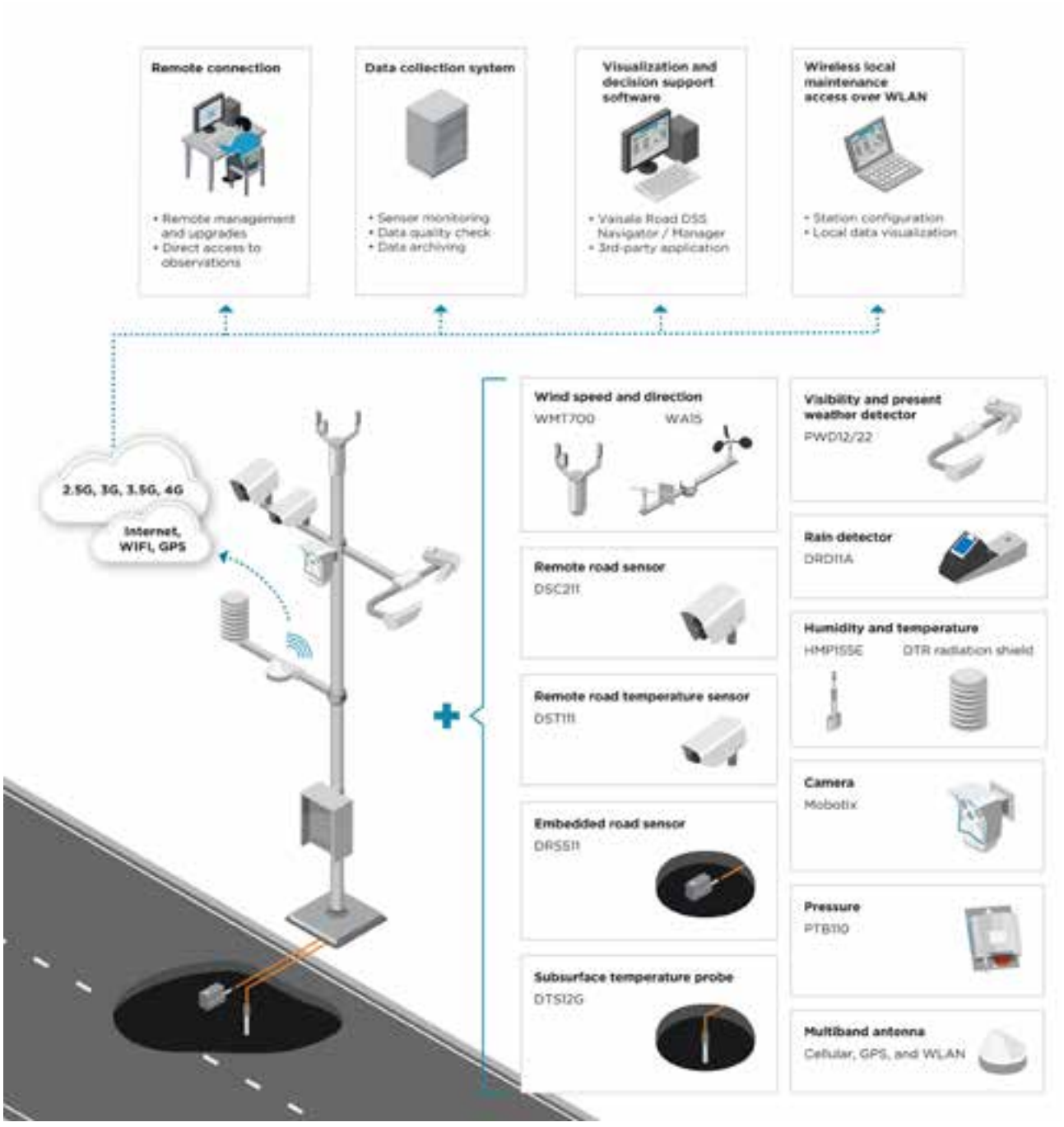
Weather impacts road transportation throughout the year caused by different phenomena such as snow and ice, heavy rains, fog, high winds, and sand storms. Traditional road weather observation systems are designed to conduct measurements on prevailing road, rail or runway surface conditions and transmit data messages. The iRWIS offers an intelligent solution, from improved accuracy to network management and up-to-the-minute maintenance information of the entire monitoring network.

Road weather stations can consist of a variety of sensors to collect atmospheric information and data on road conditions depending on the user's needs. The key component to Vaisala road weather solutions is the Road Weather Station RWS200, which has been designed with the future of road weather and ITS in mind. The RWS200 processor contains several sophisticated algorithms that bring in raw data from the pavement sensor, and by using other atmospheric information, can create better calculations of surface conditions. The RWS200 is also equipped with its own battery and includes smart power management to ensure reliable data collection even when power supply becomes unstable. Finally, the RWS200 utilizes state-of-the-art sensors that are accurate and reliable in the most demanding weather conditions. These all help to improve decision-making and reduce costs, while offering greater operational efficiency.

Increased capabilities

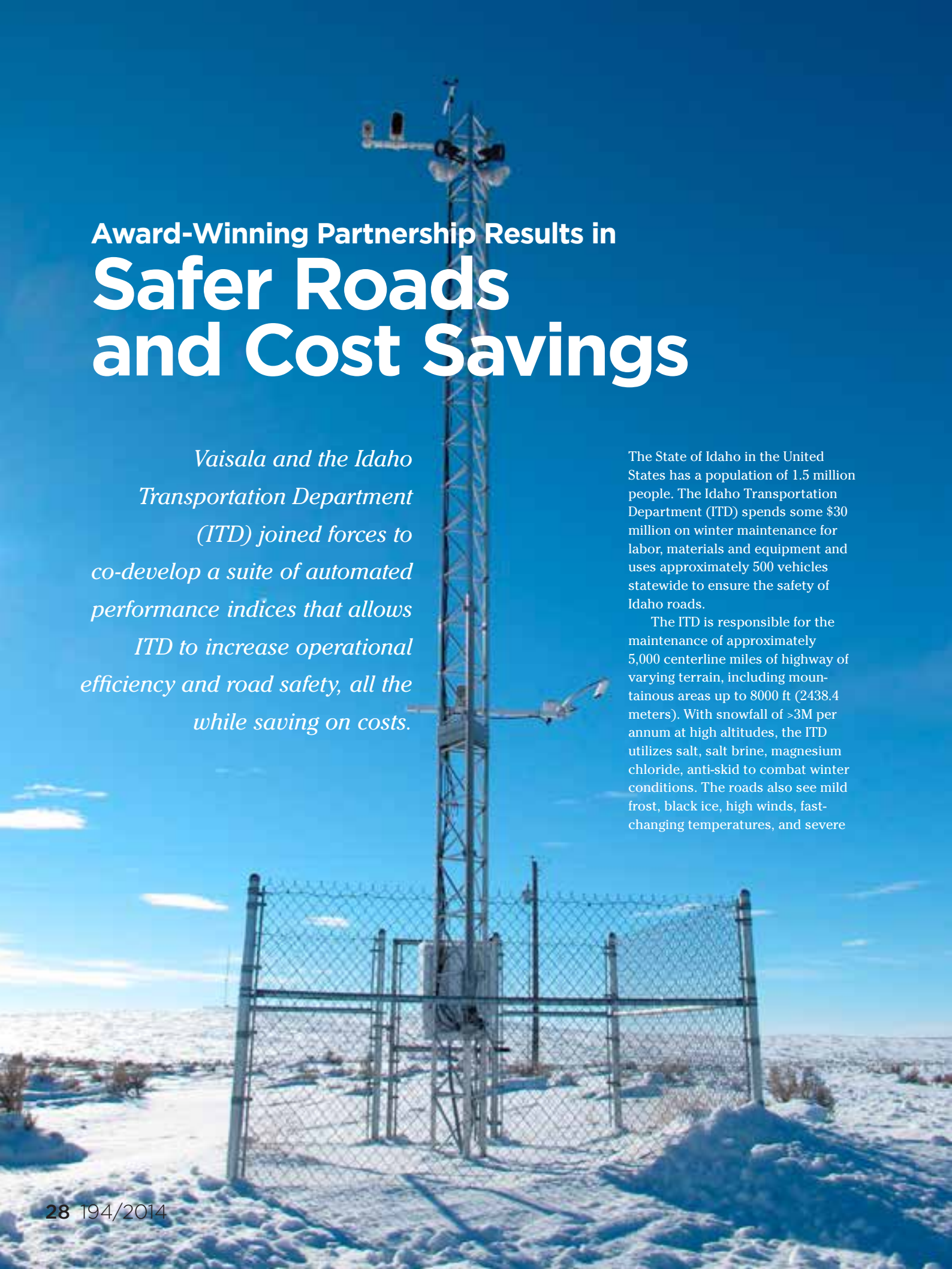
The new system is flexible, from the scalable software solutions to RWS200 allowing customers to deploy exactly the hardware they need. When providing uninterrupted, real-time data to support 24/7 road maintenance operations reliability is critical, Vaisala has decades of experience producing reliable weather solutions.

Making decisions about the weather is an important part of a road authority's job, and knowing exactly what is going on with the roadway, now and in the future, is key. Vaisala RoadDSS is a suite of software solutions, offered by Vaisala



cloud services, giving you a resilient method of display and storage, ensuring access to your information anytime, anywhere. Each software solution is tiered to meet the needs of the agency.

"We are excited to offer our customers the latest industry leading road weather technology," says Antero Järvinen, Director of Vaisala Road and Rail Business. "iRWIS is all about providing end-to-end solutions that are intelligent, flexible, and reliable, so that our customers can keep their roads moving smoothly through any weather condition."



Award-Winning Partnership Results in

Safer Roads and Cost Savings

Vaisala and the Idaho Transportation Department (ITD) joined forces to co-develop a suite of automated performance indices that allows ITD to increase operational efficiency and road safety, all the while saving on costs.

The State of Idaho in the United States has a population of 1.5 million people. The Idaho Transportation Department (ITD) spends some $30 million on winter maintenance for labor, materials and equipment and uses approximately 500 vehicles statewide to ensure the safety of Idaho roads.

The ITD is responsible for the maintenance of approximately 5,000 centerline miles of highway of varying terrain, including mountainous areas up to 8000 ft (2438.4 meters). With snowfall of >3M per annum at high altitudes, the ITD utilizes salt, salt brine, magnesium chloride, anti-skid to combat winter conditions. The roads also see mild frost, black ice, high winds, fast-changing temperatures, and severe

storms delivering a couple of feet of snow overnight. In Idaho, the weather patterns influenced by the Pacific, 350 miles to west and Rocky Mountains.

Using data collected by Vaisala's road monitoring network, ITD is able to rapidly assess how an individual storm event is impacting their state and understand on a granular level how effective their treatments are. This allows them to better deploy resources and train staff to improve their responses for future storms. This means that ITD can rapidly identify extreme events and coordinate the appropriate resources where possible. Should an extreme event outstrip available resources, then public messaging can be coordinated to keep the population informed throughout the event.

Largest Deployment of Remote Sensors in North America

Recently, Vaisala completed the installation of 106 non-intrusive sensors in combination with their Road Weather Information System (RWIS), which is one of the largest deployment of remote sensors in North America. Each RWIS location measures observed weather conditions, including air temperature, dew point, wind speed, surface state and surface temperature, as well as surface slipperiness.

Vaisala operates and maintains the RWIS network, including data collection, storage, quality inspections and information dissemination to enable effective winter maintenance decisions. Road weather information is accessed using Vaisala's RoadDSS decision support software suite.

The key to the RWIS network is the addition of the non-intrusive sensors. By providing a grip or slipperiness value it gives ITD a quantitative measurement of road condition. This value is then used to create the performance measures.

The installation of the road network monitoring system in the past few years has resulted in material savings of up to 40% in some instances. In addition, there has been a substantial reduction in vehicle crash fatalities of over 50% in some areas.

Co-Creation for Better Performance

Working together to improve performance Vaisala and ITD joined forces to enable effective co-creation of automated performance indices. These include the ranking of the severity of each winter storm, making assessments on the efficiency of maintenance operations to deal with storm, and enables post-storm analysis to capture improvement opportunities and learnings.

ITD and Vaisala are continuing to fine tune and develop even more effective means to anticipate and counter extreme events. This is expected to include the ability to better forecast and assess the impact of extreme events

There is huge global potential for economic, environmental and safety efficiencies as more road authorities adopt and adapt these proven approaches. In Idaho, the results speak for themselves, a reduction in de-icing chemicals of up to 40% and a substantial reduction in vehicle crash fatalities of over 50% in some areas, has led to a clear win-win situation, with safer roads, less money spent, and increased efficiency. In 2013, ITD & Vaisala were recognized with the importance of these developments in the USA by winning the prestigious National Road Safety Foundation Award and the Best of Rural ITS.

Guest Article by Rigel Kivi / Finnish Meteorological Institute

Ozone Soundings at Sodankylä Using the New Vaisala Radiosonde RS41

RS41 is a recently developed radiosonde, representing the fourth generation of Vaisala radiosondes. Since early 2014 it has been possible to perform ozone soundings using the RS41 radiosonde and special sensor software provided by Vaisala Oy. The fourth generation system is expected to replace the previous RS92 radiosonde model and the Metgraph software. The RS92 system became operational about ten years ago and has been widely used by the worldwide ozonesonde network. To perform ozone soundings the new RS41 radiosonde has been equipped with an OIF411 interface, which is an upgrade to the previous model OIF921, with enhanced functionality and possibility to involve special sensors.

Performance Testing in Two Phases

At the Finnish Meteorological Institute (FMI) we had an opportunity to test the performance of the new telemetry and software system for ozone in February and April 2014 by performing balloon flights over Sodankylä. Our results are presented in Table 1 (page 32) and Figures 1-5 on page 33.

Sharing the Ozone Sensor

First two ozonesonde test flights in February 2014 involved two different ozone interfaces and telemetry chains, while both interfaces were attached to one single ozone sensor. Also the telemetry and ozone processing software in both cases was the software provided by the MW41 system. Any observed differences in ozone should therefore be attributed to differences in the ozone interface boards OIF411 and OIF92 and to differences in between the radiosondes RS41 and RS92. We found that, despite using two different telemetry chains, the average relative difference in ozone was smaller than 2 % in both cases (Table 1). Profile comparisons indicate, that the largest relative differences correspond to the layers of relatively low ozone concentration found in troposphere and in the uppermost part of the ozone partial pressure profiles (Figure 1 and 2). These two sounding were separated by four hours. Therefore stratospheric ozone variability was relatively small as expected, while we were able to observe short term variability in the lowermost stratosphere from tropopause to the altitude of 15 km.

Separate Ozone Sensors

In April 2014 we performed 3 dual sonde flights over Sodankylä (Figure 3-5). In each case we prepared two different ozone sensors according to the standard operational procedures (WMO, 2011). Both ozone sensor packages were attached to a 2.5 m long sounding rig and were separated from the rig by 80 cm lines. This type of setup of dual ozone sondes should allow ventilation of the radiosonde sensors due to the rotation of the sensor package. The ozone data measured via OIF411 or OIF921 interfaces were received with MW41and MW31 systems. According to these comparisons the difference in ozone was less than 3 % for each individual case and in average of 3 flights the relative difference was 0.6 %. This is less than the expected ozone sensor uncertainty (WMO, 2011).

Total Ozone Results

Table 1 presents total ozone retrievals using ground based (GB) instruments and corresponding total ozone columns calculated from the sonde measurements. In April the GB total ozone retrievals were based on Brewer #037 spectrophotometer direct sun measurements at the balloon launch site. In February 2014 the GB measurements were taken by SAOZ (Système d'Analyse par Observation Zénithale) spectrometer at Sodankylä. It is a common practice to calculate a ratio of GB

measurement to estimated column ozone, based on sonde observations. During the test flights in 2014 we found average ratios of 1.02 in case of GB/OIF411 and 1.01 in case of GB/OIF921. These ratios indicate very good agreement with our GB measurements.

A Long-term Ozone Program at Sodankylä

FMI established a long term ozonesonde program in late 1980s. Ozonesondes are launched from Sodankylä on regular basis and from Jokioinen on campaign basis. In the southern hemisphere FMI performs regular ozone soundings over Marambio at the Antarctic Peninsula, in cooperation with Servicio Meteorológico Nacional (SMN) of Argentina. Sodankylä in northern Finland has a unique location, because at the same site it is possible to sample air inside and outside the stratospheric vortex. During January to March season more than half of the sondes have measured air inside the stratospheric vortex in average. For example in late March 2011 extremely low ozone levels in the Arctic Vortex were observed from Sodankylä and other locations (Manney et al., 2011). During the event measured ozone at 18-20 km was up to 80 percent lower than climatological ozone values at that time of the year.

Ozonesonde Data Quality

Ozonesonde data quality has increased significantly since 1990s, thanks to improvements in the radiosonde systems, operational procedures and quality of the ozone sensors. Thus the sondes can be used for climatological studies and as a reference for long term validation of satellite borne ozone sensors. Long term satellite based ozone observations are available for example from NASA's Aura satellite, which started its mission in late 2004 and is now celebrating ten years of constant operation. MLS and OMI sensors on board Aura satellite are still operational and provide ozone measurements. In case of comparisons with the Sodankylä ozonesonde data we found that Aura MLS-sonde relative difference from 20 to 30 km of altitude was less than 2%. OMI versus sonde comparisons showed an average sonde to satellite ozone ratios of the order of 1.00. This result was confirmed by simultaneous Brewer observations.

Recently the issue of ozonesonde transfer functions has been studied by various groups, based on dual soundings under different climatic conditions. In Sodankylä EN-SCI and SPC type of ozonesondes have been flown in dual and multiple sonde payloads, using sensing solutions of 1 % and 0.5 % KI (Kivi et al, 2007). Transfer functions can be estimated to correct time series at a station, which has changed operating procedures during long term measurements.

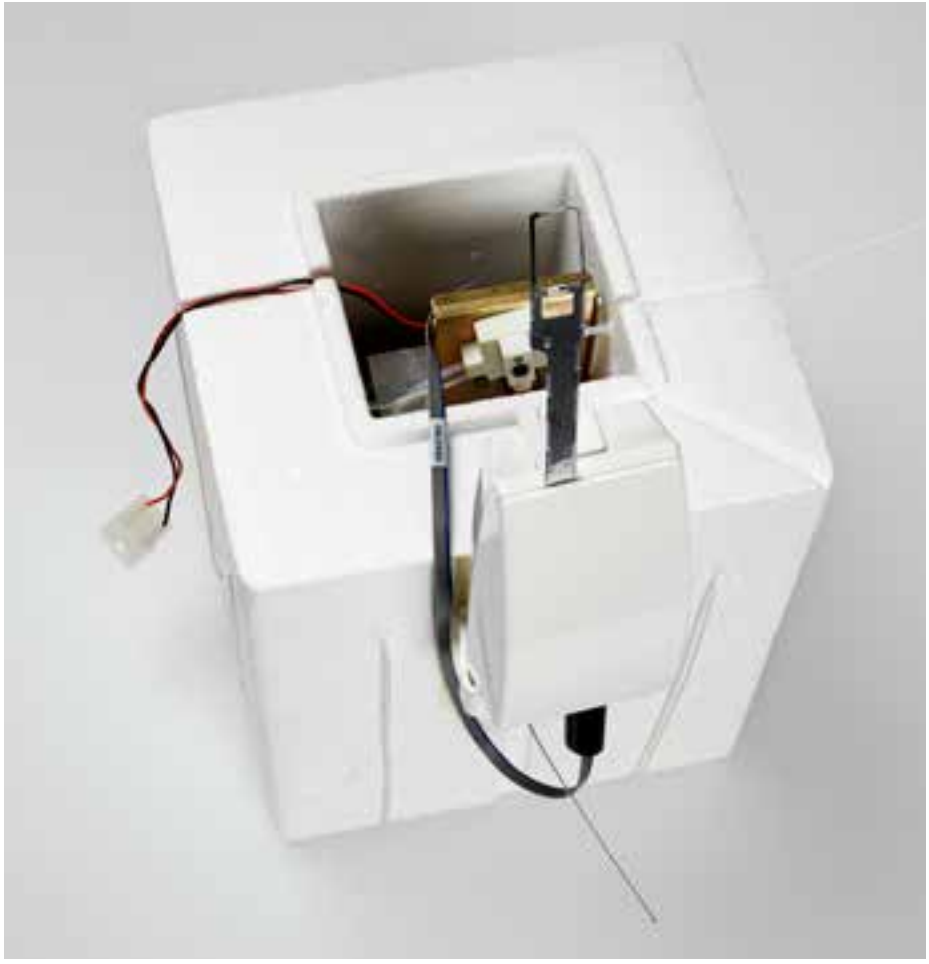
Ozonesonde data is contributing to various research projects and long term activities in international scale. Sodankylä station is involved in well known networks such as GAW (Global Atmospheric Watch), NDACC (Network for Detection of Atmospheric Composition Changes) and GRUAN (WMO Global Climate Observing System Reference Upper Air Network). One of the largest international efforts has been a coordinated ozonesonde campaign called Match, which has been dedicated to studies of stratospheric ozone depletion. The most recent Match campaign took place in winter 2013/2014 over the northern high and mid latitude ozonesonde sites.

Table 1 presents total ozone retrievals using ground based (GB) instruments and corresponding total ozone columns calculated from the sonde measurements. These ratios indicate very good agreement with our GB measurements.

Sonde launch time	OIF411 (DU)	OIF921 (DU)	Brewer or SAOZ (DU)	GB/OIF411	GB/OIF921
February 6, 2014 8:43 UT	283.0	284.3	287.3	1.02	1.01
February 6, 2014 12:47 UT	273.4	278.7	287.3	1.05	1.03
April 8, 2014 9:00 UT	425.6	421.4	422.8	0.99	1.00
April 8, 2014 13:00 UT	427.7	429.5	425.7	1.00	0.99
April 9, 2014 12:37 UT	360.6	368.8	373.0	1.03	1.01

Long-term Data in Trend Studies

The long-term sonde data from Sodankylä has been used in trend studies. The data series provide evidence of increase of tropospheric ozone since mid-1990s. Similar tendencies are seen in the data observed at other high-latitude stations, with significant increases during January to April season. During the same winter/spring season observations in stratosphere show relatively large inter-annual and longer term variations compared to the other seasons. In the layer from 150 to 30 hPa (approximately 14-24 km) we found negative trends of -1.97 ± 0.95 %/year for the time period 1989-1997 and non-significant trends for the time period since 1998.



Preparations for ozone sounding with Vaisala Radiosonde RS41 and Ozone Interface.

Figure 1

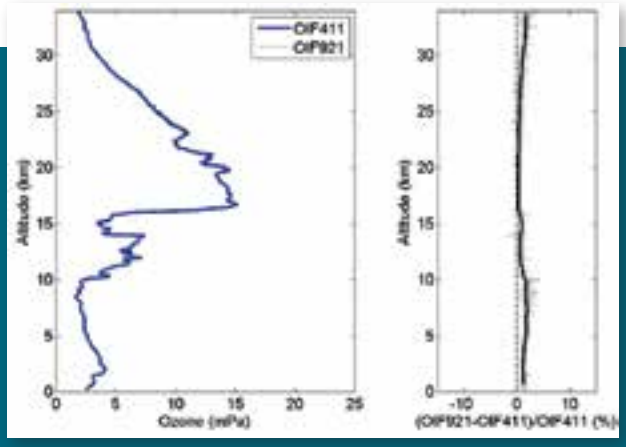


Figure 2

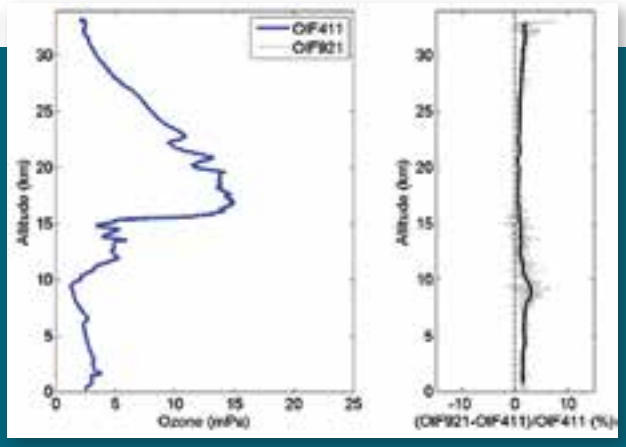


Figure 1 and 2. Test flights at Sodankylä using in each case a common ozone sensor and two different ozone interfaces (OIF921 and OIF411). The receiving ground station was MW41 in both cases. Left: profiles of ozone partial pressure measured by two systems from surface to the stratosphere. Right: relative differences in percent between the two systems (OIF921-OIF411)/OIF411. Black curve represents medium averaged differences, while each single data point comparison, with 1 second time resolution, is shown by the grey line in the background.

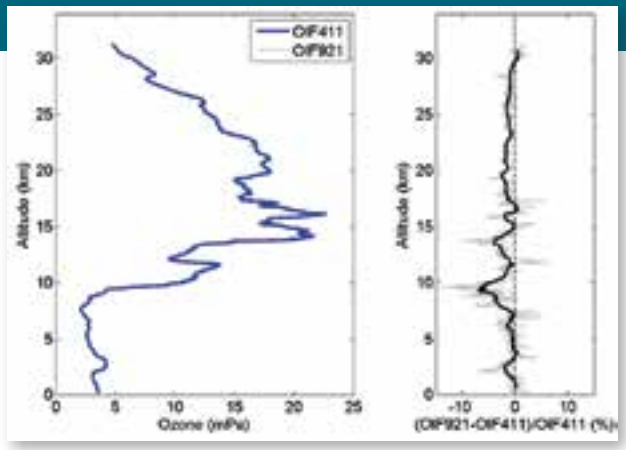


Figure 3

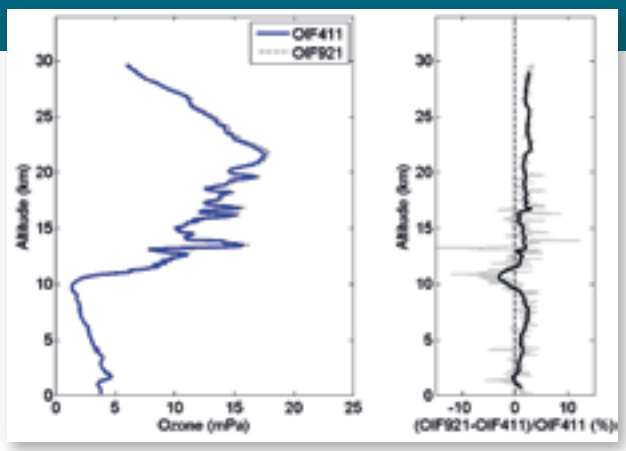


Figure 5

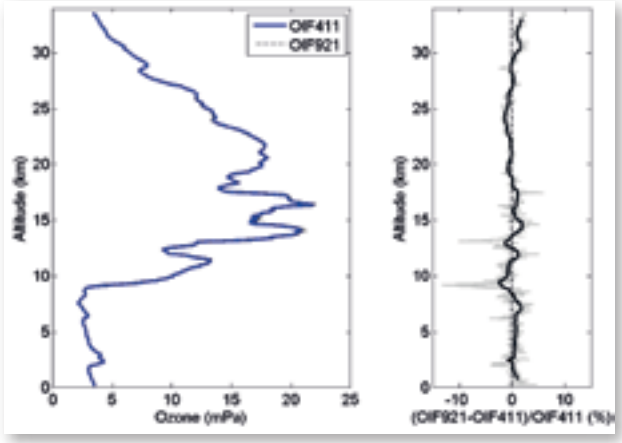


Figure 4

Figure 3, 4 and 5. Test flights at Sodankylä using in each case separate ozone sensors. In each dual sensor flight we had the first ENS-SCI ECC type of ozonesonde attached to an RS92 radiosonde and the data were received via the OIF921 interface and the MW31 system; the second ozonesonde of the same type and production batch was attached to the RS41 radiosonde and the data were received via the OIF411 interface and the MW41 system. Left: profiles of ozone partial pressure from surface to the stratosphere. Right: relative differences in percent between the two systems (OIF921-OIF411)/OIF411. Black curve represents medium averaged differences, while each single data point comparison, with 1 second time resolution, is shown by the grey line in the background.

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Customer Satisfaction Survey 2014

Vaisala has completed the Customer Satisfaction Survey for 2014. The annual survey is conducted by an independent agency. Below, ***Jim Alexander*** *from The Leadership Factor provides an overview of this year's results.*

Vaisala Makes Good Gains in Customer Satisfaction

Vaisala's latest survey of customer satisfaction was carried out independently by The Leadership Factor during July and August 2014. Approximately 850 customers took part, reliably representing Vaisala customers in all regions and market segments. The results showed the great majority of customers to be receiving excellent products and service support and that the result this year was the highest since the independent survey began six years ago. Vaisala's overall performance places them among the best manufacturing companies.

Vaisala have succeeded in delivering an even better customer experience than a year ago in many aspects of the relationship, achieving high scores in areas which are key priorities for customers - product quality, product availability, staff expertise, customer support (being easy to deal with) and value for money.

The survey also revealed that Vaisala customers, similar to most customers in a wide range of markets, would like things to happen more quickly so although improvements have already been achieved customers would appreciate further gains.

Jim Alexander
The Leadership Factor

Benefit from Vaisala's Data Services

Information services are an important part of Vaisala's portfolio. Offering a diverse range of data services provides customers with the option of buying data, rather than setting up their own individual systems. We provide full monitoring services for your measurement network, saving customers time and money by removing the need to build, staff, and equip a network control center of your own. Vaisala adopts industry best practices and green technology, utilizing close-coupled cooling, lights-out management, virtualization, and clustering.

World-Class Data Services

Vaisala offers data services to applications across our customer-base ranging from meteorology to aviation, roads, and energy customers, as well as life science and other measurements.

Lightning data plays a critical part in safe and secure operations across a variety of industries. Vaisala Global Lightning Dataset GLD360 is a service which provides real-time lightning data for accurate and early detection as well as tracking of severe weather anywhere over land and sea. The service is delivered as a dedicated data stream – no investment in hardware necessary. In the USA, Vaisala owns and operates the National Lightning Detection Network (NLDN) that provides accurate lightning data information across the United States. Vaisala also offers STRIKEnet®, an online lightning location report that objectively and accurately reports individual cloud-to-ground lightning strikes at a specific location on the date of loss. Vaisala STRIKEnet® is available 24 hours a day, seven days a week and within minutes, with reports viewable online.

For energy customers, Vaisala offers wind resource assessment as a data service. Whether you are in a phase of 1) evaluating and planning a Wind Farm site or 2) operating an existing one, Vaisala can offer relevant data for day-to-day decision making. Our data communication, management, and quality services offering maximize data availability, so that you can concentrate on running a successful operation. Additionally a portfolio of life cycle services ensures that your wind farm operations run smoothly and in an optimal way over its entire life cycle.

Focus on Your Operations

A number of service levels are offered, from simply collecting routine data to management of every aspect of data collection, storage, quality, processing and delivery. Our data service centers work together to offer 99.9% uptime for all systems housed by Vaisala. Data services can be contracted on a multi-year basis, or through an as-needed data package.

Vaisala Data Services specializes in weather data for the aviation, road and energy industries. We have over 20 years of data center management experience. With RHCE Certified LINUX system administrators and CISCO CCISP/CCNA Certified network engineers, bringing together 140 years of combined IT weather application experience.

Providing added security is at the core of Vaisala data services, your data stays within Vaisala and is managed by a team of weather and environmental data experts. We work directly with the industry and take responsibility of managing your system data so that you can focus on your operations.

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