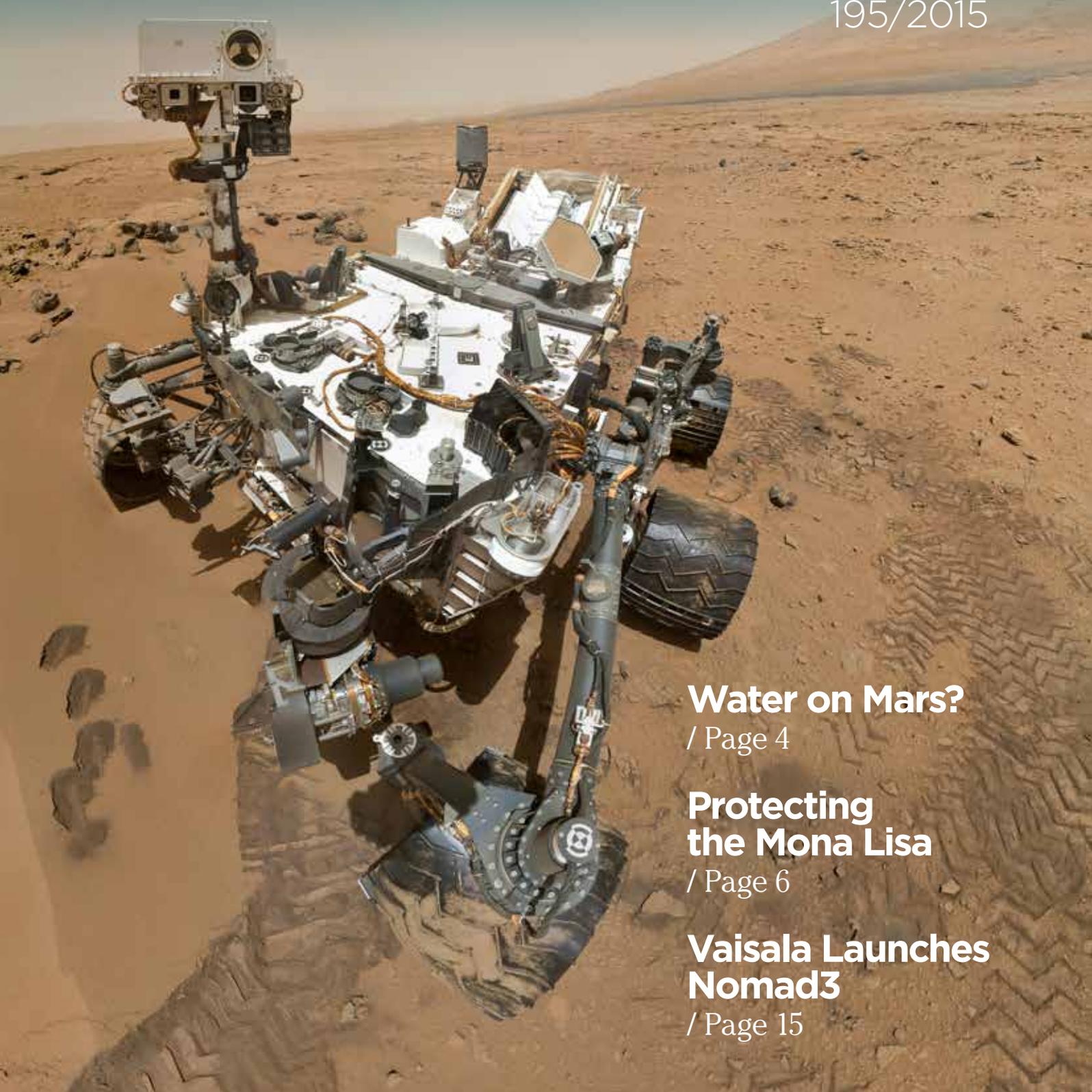


VAISALA

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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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Curiosity Inspires Us

In Vaisala, we are committed to the ideals that founded this company; quality, reliability, continuity and accuracy. However, what really drives us is curiosity. This passion to understand and learn more is never ending. We are inquisitive, and want to know more. We are tackling the most challenging weather phenomenon and meeting the most stringent regulatory requirements. We are committed in our efforts to better serve our customers. With some of the brightest minds working for Vaisala, we have built a company that delivers products, services and solutions that help to protect life and property.

Curiosity is what drives us. Recent findings of saline water on the planet Mars are an excellent example of this. Together with our valued partner, the Finnish Meteorological Institute, Vaisala has embarked on some very exciting projects that are truly out of this world.

Outer space is something that we have been measuring for over a decade. Vaisala instruments can be found onboard the International Space Station, conducting important life science research with our research partners. Vaisala instruments have also visited Saturn's moon Titan in 2005, Mars in 2008, and Mars again onboard the MSL in 2012.

Recently, NASA's Curiosity Rover, known as the Mars Science Laboratory (MSL), discovered that the dry, barren Martian landscape indeed holds liquid brine that forms at night and evaporates during the day.



Vaisala has provided standard Vaisala HUMICAP® humidity sensors and specially customized Vaisala BAROCAP® pressure sensors to the FMI instrumentation onboard the rover.

In 2014, Vaisala invested 34 million EUR into research and development. Putting this into perspective, the figure is 11% of our turnover. This investment is made into delivering world-class products, services and solutions that support our customers around the world. You could say that this investment feeds our curiosity, pushing us to develop innovative solutions to weather-related and industrial challenges.

Kjell Forsén
President and CEO

MSL humidity and pressure devices are based on Vaisala technology, which the Finnish Meteorological Institute has applied in their space instrumentation development for over 25 years. Devices based on Vaisala sensor components have visited Saturn's moon Titan in 2005, Mars in 2008, and Mars again onboard the MSL in 2012. Photo courtesy of NASA



NASA's Curiosity

Rover Uncovers Liquid Brine

Conditions on Martian Surface

Thanks to findings made by NASA's Mars Science Laboratory (MSL), better known as the Mars Curiosity rover, it can be concluded that the formation of liquid brines is possible, under certain conditions on Mars' Gale crater.

NASA's Curiosity Rover has performed surface measurements around the Gale crater near the Martian equator for more than two years. The rover features pressure and humidity devices designed to observe Martian atmosphere that have been developed by the Finnish Meteorological Institute (FMI). Recently, the Rover Environmental Monitoring Station (REMS) instrument suite, as well as the Sample Analysis at Mars (SAM) and Dynamic Albedo of Neutrons (DAN) instruments have made it possible to assess that, during night time perchlorate salts on the upper layer of the Martian surface are able to absorb sufficient moisture to form a brine solution, even if the temperature is well below zero degrees Celsius.

The humidity device REMS-H and pressure device REMS-P have been developed by FMI and are based on Vaisala's sensor components. Vaisala has provided the FMI devices onboard the rover with standard Vaisala HUMICAP® humidity sensors and specially customized Vaisala BAROCAP® pressure sensors. Thanks to the long-term stability and accuracy of these sensors, as well as their ability to tolerate dust,

chemicals, and harsh environmental conditions, the technologies are especially suitable for such demanding applications.

Uncovering Martian Secrets

Compared to Earth, Mars is a dry planet. However, there have been observations of small amounts of water in the atmosphere in the past, though never in liquid form. Martian surface temperatures vary during the night from -135 to -70 °C, and the Martian top surface layer along its equator achieves plus degree temperatures during the day time. Considering the temperature and low pressure of the atmosphere on Mars, it has been estimated that liquid water could not be present on Mars. Now, NASA's MSL and the observations it has carried out by the Gale crater, and specifically based on the measurements made by FMI and Vaisala technology, together combined with numerical models, have demonstrated otherwise.

"In the Martian atmosphere, below the surface layer at a few centimeters depth, lie sufficient quantities of perchlorate salts, which

are able to absorb water from the atmosphere. The result is a thin membranous salt-water solution, or pockets of liquid with salt content, that form during the night – despite the fact that the water film temperature is well below freezing," Head of Research at FMI, **Ari-Matti Harri**, stated. "During the day, the surface layer temperature rises, and this causes the liquid accumulated during the night to evaporate as gas. It is important to note that these findings do not yet conclude the possible existence of organic compounds on Mars." However, it can be assumed that the observed area along the Gale crater is representative of conditions throughout the Martian surface.

The Ultimate Laboratory for Atmosphere Research

The atmospheres of Mars and Earth have similar dynamics, because the axial tilt of the planets' rotation axes (25° Mars and 23,5° Earth), as well as the rotation times, meaning the length of the day (a Martian day is 24 hours and 37 minutes) are very close to each other. The dry Martian atmosphere represents a simplified laboratory model of the Earth's atmosphere. "By studying the simplified, dynamically Earth-like, atmosphere we can potentially learn something that we might miss on Earth because of the effects of water systems, vegetation, and high humidity levels," Ari-Matti Harri concludes.

Mona Lisa preserved by Vaisala

By Jean-Francois Bore, Application Sales Engineer, Vaisala

I am sure you know of the Mona Lisa, known as La Joconde in French, one of the most popular works of art in the world. You also know that it can be found in the world-renowned Louvre Museum in Paris. But what you may not know is that Vaisala helps preserve the Mona Lisa by measuring the stability of the humidity and temperature environment within its glass vitrine.

La Joconde

This 77 x 53 cm painted portrait of a woman called Mona Lisa was created by Leonardo da Vinci. The portrait is believed to have been painted at the beginning of the XVIth century. Every year millions of people from all around the world visit Paris' Louvre Art Gallery to discover Mona Lisa's enigmatic smile.

In Le Louvre, the Joconde portrait is to be found in the "salle des Etats" dedicated to the Venetian Renaissance. It is in this exhibition hall that the giant "the Wedding at Cana" (6.6 x 9.9 m) painted in 1563 by Veronese faces the vitrine of La Joconde.

Safeguarding the Mona Lisa

Mr **Wilfried Gesbert** is a climate engineer for Cofely Axima. He is in charge of the climate regulation in different areas of the museum and has been specially assigned

to monitor the conditions in the glass vitrine. "As a normal Louvre visitor you cannot even imagine the complexity of the installation" Mr Gesbert says. The vitrine has been custom made by the Italian company Goppion. Mona Lisa is illuminated by a LED lamp located in the wooden desk that was specially developed for this painting. Mr Gesbert explains, "it minimizes ultraviolet radiations and helps enhance the colours of the painting". The glass of the vitrine is bullet proof and non-reflective. A state-of-the-art air treatment system enables air to circulate through the vitrine, in the surrounding walls and in the wooden desk to keep the desired relative humidity and temperature level. Because La Joconde is painted with oil on a poplar wood support, maintaining the humidity at an appropriate level is vital for its conservation. Changes in humidity can cause the support to contract and expand. After 500 years, the

wooden support does have signs of warping" Mr Gesbert stresses.

And this is where Vaisala helps. Invisible to the public, there are two Vaisala HMT333 Humidity and Temperature Transmitters which operate inside the vitrine behind the painting. One is located near Mona Lisa's right hand and the other is located near her right eye. The relative humidity is constantly maintained at 50%RH and the temperature at 21°C. Two beds of silica gel located in the wooden desk also help compensate relative humidity fluctuations.

Once a year, the vitrine is opened, and all monitoring equipment and installed devices are carefully checked to ensure the Mona Lisa is being cared for. After this the Mona Lisa is returned to her vitrine, which is then re-sealed for another year.





The Mona Lisa (known as 'La Joconde' in French) is a world famous painting by the Italian painter Leonardo da Vinci. The painting is believed to be a portrait of Lisa Gherardini, the wife of Francesco del Giocondo.

Jean-Francois Bore, Application Sales Engineer, at Vaisala says, "The HMT333 is usually used to monitor harsh industrial processes. To monitor the conditions of the vitrine, 50%RH and 21°C, is not what I would call 'harsh industrial' conditions – however, this is The Joconde, and nothing is good enough to take care of Mona Lisa. The demand for precision and accuracy is unparalleled and this is where Vaisala brings world-class accuracy and reliable monitoring into the picture."



Numbers You Can Trust

Vaisala's Controlled Environment Capabilities are Second to None

Vaisala's Controlled Environment Business Area takes pride in professional and comprehensive specifications that are based on scientific test methods and data. For our customers this means truly reliable information with no gaps, which again helps the customer make the right decisions in their processes.

Accurate measurements for humidity, temperature, dew point, carbon dioxide, pressure and moisture in oil require faultless measurements. Vaisala's HUMICAP®, DRYCAP®, CARBOCAP® and BAROCAP® sensors are the unrivaled industry quality benchmarks.

The specification of Vaisala humidity products' accuracy (e.g. ± 1 %RH) takes into account repeatability, non-linearity, and hysteresis. The specification is given for the full measurement range - also for demanding conditions such as high humidity (90....100 %RH), unless otherwise stated. Vaisala provides accuracy specification for the entire temperature range. It is important to note that accuracy specifications which are reported at room temperature only can be misleading.

In our product materials and technical datasheets, Vaisala also specifies the calibration uncertainty separately. This consists of the uncertainty of the reference instrument as well as uncertainty of the

calibration process (e.g. the repeatability of the process, uniformity of the measurement chamber) and the unit under calibration.

The Devil is in the Details

There are important questions to ask when comparing accuracy specifications, for example:

- Is the whole humidity & temperature range covered? Statements that refer to "typical accuracy" are unreliable.
- Is repeatability included or perhaps stated separately?
- Is hysteresis included?
 - Some sensors have significant hysteresis behavior. Significant errors may occur if the calibration run is carried out by only changing the humidity values in one direction.
 - Hysteresis can also be masked if no high humidity points are contained in the calibration cycle
- Is non-linearity included? If the instrument is calibrated only at one

point after adjustment, the effect of non-linearity is neglected.

Some humidity instrument manufacturers do not take into account repeatability, linearity and hysteresis factors in the accuracy specification. They may be mentioned separately or even completely neglected.

In these cases, it is important for customers to know that they need to ask for a calibration uncertainty statement. If the information you are looking for is not visible on the data sheet, ask for a sample calibration certificate to see if you can find the details there.

A professionally made calibration uncertainty calculation includes not only the uncertainty of the reference instrument but also factors in the calibration process and unit being tested. If the calibration is performed by an accredited laboratory, the uncertainty estimations are always inspected by qualified technical specialists. The quality of calculations varies strongly among other (standard) calibration providers.



Make No Mistake – Accuracy is Key

Only true knowledge matters when accuracy counts. Furthermore, only the world's most accurate instruments can deliver it reliably. Based on nearly 80 years of experience, Vaisala has been delivering unique technologies that provide reliable and long-term stability. Proven in the harshest conditions, Vaisala's instruments ensure better efficiency, quality, safety and profitability of critical processes in hundreds of applications and in dozens of industries worldwide.

Learn more about Vaisala's Controlled Environment products at:

store.vaisala.com

Terminology

Hysteresis

The property of a device whereby it gives different output values in relation to its input values depending on the directional sequence in which the input values have been applied

Hysteresis error

The maximum deviation between the two calibration curves of the measured variable as obtained by an upscale going transverse and a downing transverse over the full range

Linearity

The closeness to which a calibration curve approximates a specified straight line

Linearity error

The absolute maximum deviation between the calibration curve and the specified straight line

Repeatability

Closeness of the agreement between the results of successive measurements of the same measure and carried out under the same conditions

Uncertainty

Parameter associated with the result of a measurement, which characterizes the dispersion of values that could reasonably be attributed to the measure. The uncertainty may be, for example, a standard deviation having a stated level of confidence.

Precision Mass Production of Lithium-air Batteries with

NIMS GREEN

by Chiaki Nakamoto, Marketing Manager, Japan, Vaisala

To achieve a low-carbon society, it is imperative to vastly improve the energy density of batteries and drastically reduce their cost. Lithium-air batteries use oxygen for generating electricity. Since an unlimited amount of oxygen can be obtained from the air during electricity generation, fewer power-generating materials are required to be packed inside the battery, making it possible to create an ultra-compact, large-capacity battery. If rechargeable lithium-air batteries become commercially viable, lithium-air batteries have the potential to vastly alter our way of life.



Highly reliable, high-accuracy measurements with fast response speed are essential to maintaining conditions in the NIMS dry room.

Meeting Stringent Requirements

Since the lithium inside lithium-air batteries easily reacts with moisture, a dry room environment is essential in their development and manufacturing processes. It is said that lithium-air batteries require an environment with much more stringent control than necessary for ordinary lithium batteries.

During the process of commercialization, it is also important to precisely determine the critical dew point that can be allowed during mass production. For this reason, it is extremely important and necessary to secure an ultra-low dew point operation environment that is controlled at a sophisticated level.

In order to achieve the ultra-low humidity environment essential for its battery R&D activities, the NIMS battery platform had an 80-m² super dry room, one of the largest in the world.

The interior of the NIMS dry room was designed to reach a normal dew point temperature of -90°C when no one was inside. However, when as many as five people entered the dry room, the dew point temperature rose as high as about -40°C. Therefore, it was essential to measure the actual dew point and also run simulations to determine the optimal positions of air inlets and ventilation openings. For this reason, too, a highly reliable, high-accuracy dew-point meter with fast response speed

was required. Moreover, because the temperature at the air inlet was close to -100°C, Dr. Kubo was searching for a highly reliable measurement instrument that could respond to subtle changes even under such harsh conditions.

Battery prototyping and evaluation tests were usually conducted inside a glove box, but operating inside such a tight space resulted in poor operability and made assembly operations difficult as well.

Proven, Solid Performance

The R&D Center of Shinryo Corporation, which delivered the dry room, conducted a series of tests to compare Vaisala DMT152 with products from other manufacturers in the process of selecting a dewpoint meter that could satisfy the requirements of the super dry room, a key facility of NIMS battery infrastructure platform. The results showed that the DMT152 was clearly superior to other products in terms of response

speed and accuracy, and therefore, it was selected.

According to the Technical Supervisor at Shinryo Corporation Research and Development Center, “response speed was an important factor in our choosing the DMT152. Reliability and the global level of confidence were also decisive factors. When it is used for constant monitoring and measurement of dew point distribution in a dry room, most challenges are related to response speed and accuracy. However, Vaisala’s dewpoint meter was backed by solid performance records with regards to long-term reliability and stability.”

“Dewpoint meters that can provide highly reliable measurements in such a harsh environment are extremely rare. Some of the products we actually tested were unable to provide acceptable results, even within their guaranteed dew point temperature range.

It was also determined that dewpoint meters using a mirror surface were unsuitable for long-term

use due to their high maintenance requirements, high cost, and large size.

Additionally, concerns about the levels of calibration and the services provided by other manufacturers also led us to select Vaisala.”

Reliability and Stability Provide Benefits

Dr. Kubo also said that when he used dewpoint meters inside a glove box in the past, he was constantly concerned about their durability and reliability and never found satisfactory products. Now, however, a total of 10 Vaisala DMT152s were being used in the dry room, eight in the dry room itself and two in dehumidifiers. For the past year of operation no problems have occurred, and he has been very impressed with the stability and accuracy of the measurement values.

Since measures such as using a circulator to constantly stir the air inside the dry room, along with multi-point measurements, are effective in ensuring uniform distribution of moisture; 10 units (eight inside the dry room) are being used to continuously monitor dew points and immediately detect any abnormality should one occur.

A system that monitors the dew point distribution inside the dry room is installed by the entrance, visually displaying subtle changes occurring inside the ultra-low dew point environment on a screen. The monitoring system visually displays the instant changes that occur in the dew point. Furthermore, the monitor displays information in eight languages, providing clear information at a glance, even for overseas visitors. The fact that the presence of people inside the dry room can be quickly recognized solely on the basis of changes in the dew point, without the need to actually see the



Dr. Kubo (centre in the top row) and Shinryo Corporation and Vaisala staff members

people, surprises many Japanese as well as international visitors. The DMT152's fast response speed is a great advantage in easily demonstrating to visitors the credibility of the dew point measurements.

Sophisticated dew point control can be implemented inside such a large super dry room, making it possible to freely create battery prototypes and evaluate battery characteristics under the same dew point environment achievable inside a glove box. Batteries can also be disassembled and analyzed/evaluated inside the dry room, vastly improving operational efficiency. Such a large-scale dry room also makes it possible to conduct state-of-the-art experiments that actually utilize larger cells and stacks.

In terms of maintenance, because the DMT152 automatically calibrates itself using its auto-calibration function, calibration is required only once every two years, simplifying maintenance¹.

There are other advantages that regular calibration can provide. For example, when research results based on high-accuracy measurements are necessary, submission of a traceability report for the measurement instrument is sometimes required. Receiving regular calibra-



tion also provides the benefit of enhancing the credibility of the data presented in research papers.

Vaisala has delivered its products to many research institutes since the early days of R&D efforts for developing lithium batteries in Japan, and wishes to continue contributing

to the development of state-of-the-art technologies through collaboration with research institutes and corporations.

Profile of Dr. Kubo
Yoshimi Kubo, D.Eng.
Team Leader, Lithium Air Battery Specially Promoted Research Team, NIMS-GREEN
Director, Battery Research Platform

Team Leader Yoshimi Kubo of Lithium Air Battery Specially Promoted Research Team, NIMS-GREEN was chosen as the leader of the next-generation battery team of Japan's national ALCA Project, established to develop low-carbon technologies. Dr. Kubo has developed a wide range of fundamental technologies for lithium-air secondary batteries, from electrode reactions to cell formation, and is conducting research on basic performance validation and application experiments toward commercialization from a long-term perspective.



¹ However, Vaisala recommend annual calibration if the user wishes to maintain a more accurate level of accuracy in research applications.

Challenge

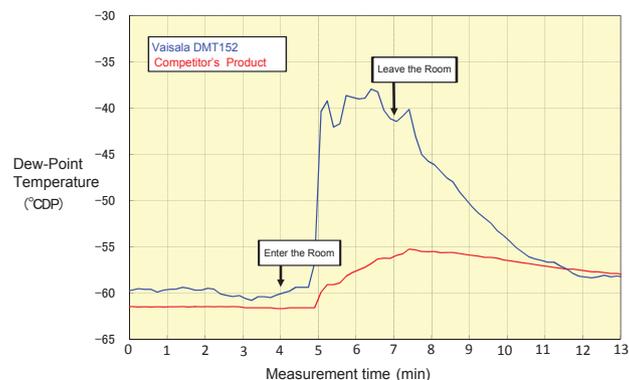
- R&D activities on lithium-air batteries, which have garnered attention as the next-generation battery, require an ultra-low dew point environment (of around -90°C) that is much lower in temperature than that necessary for conventional lithium batteries (around -60°C). Managing and controlling such an environment, however, has been extremely difficult.
- Because operations inside the small space inside a glove box result in poor work efficiency. However, as the size of the area to be controlled increases, more sophisticated control technologies (simulation-based forecasting) are required.
- As well as simulation-based forecasting method, high-accuracy dew point measurement instruments that are highly reliable and can quickly respond to subtle changes were required.
However, in most cases, dew point measurement errors are related to response speed and accuracy.
Therefore, before selecting a product, the dry room manufacturer (Shinryo Corporation) felt it necessary to carefully evaluate reliable testing results and suitability to long-term use.
- Shinryo Corporation had some concerns about the levels of calibration and repair services provided by other dewpoint meter manufacturers.

Solutions

- Based on the tests conducted to compare Vaisala DMT152 with products from other manufacturers, Shinryo Corporation recommended the DMT152 because it demonstrated superiority over other products in terms of response speed, accuracy, long-term reliability, and stability.
- The DMT152 automatically calibrates itself using its auto-calibration function, simplifying maintenance.
- Vaisala provides calibration services accredited by such organizations as the Japan Calibration Service System (JCSS), and owns accredited calibration rooms and calibration service teams possessing specialized knowledge in Japan.

Benefits

- The NIMS large super dry room, which is one of the largest in the world in terms of area, dramatically improves the operational efficiency of battery prototyping and evaluation testing indoors, making it possible to conduct state-of-the-art experiments.
- Taking continuous multi-point measurements of dew point makes it possible to instantly detect changes or abnormalities in dew point and visualize them on a monitor screen.
- Regular calibration ensures traceability and enhances the credibility of the data presented in research papers.



Vaisala Launches New Thunderstorm Tracking and Lightning Alert Management Application



This spring Vaisala has released Thunderstorm Manager, a cutting-edge professional application for tracking approaching storms and warning of imminent threats from lightning, for any location on Earth. Thunderstorm Manager combines data from Vaisala's US National Lightning Detection Network (NLDN) and Vaisala's GLD360, the network that delivers high quality, truly global lightning coverage, to deliver comprehensive lightning information at your finger-tips.

With many thousands of deaths and tens of thousands of injuries each year attributed to lightning globally, the situational awareness delivered by Thunderstorm Manager provides significant value for the protection of the public, such as at open-air arenas, parks, playgrounds or beaches, or for outdoor workers in the private sector. It supports a broad range of applications, from global or national scale lightning

Access to timely and accurate weather information is critical for organizations that need to keep operations running efficiently, assets protected, and communities or workers safe when severe weather approaches. Vaisala thunderstorm tracking systems have been providing this information for over three decades, delivering the detailed information required for weather monitoring.

surveillance, down to local-scale warning notices that can be used for community safety, keeping local ground and maintenance-crews safe, and keeping operational downtime at a minimum.

Thunderstorm Manager makes it easy to monitor thunderstorm development, enabling the user to clearly identify increases and decreases of lightning frequency within each storm, providing more comprehensive information for better understanding.

Real-Time Displays & Alerts

Thunderstorm Manager is a web-based application that empowers customers to track approaching storms in real-time. A desktop or mobile device browser can be used to access the real-time displays at anytime, anywhere around the world. Thunderstorm Manager employs a sophisticated alarm notification capability to alert customers when their sites or assets are threatened by lightning. It uses visual and audible notifications, including email

and SMS, to warn when lightning has crossed the threshold of the customer-defined range rings, or polygons.

Broad Range of Applications

For the protection of life and property, Thunderstorm Manager can be used by meteorological agencies to enhance forecasts and warnings for their entire communities and to provide warnings for specific sites such as parks, beaches, schools or sports arenas. Forestry and land management agencies can use the information to protect life and property in remote recreational areas and to identify wildfire risk. Thunderstorm Manager can also be used to manage personnel safety and manage assets at electric power companies or wind farms. For the management of critical activities, such as mining, air traffic, maritime, airport or roadway operations, Thunderstorm Manager offers the real-time displays and alerts that can save time, cost, and most importantly, lives.



Vaisala's Nomad 3 Allows Worry-Free Wind Tower Data Management

Cross-compatible, portable Vaisala wind data logger offers reliability, flexibility, and security in project decision-making.

Vaisala has launched the Nomad 3 Data Logger, a flexible and highly portable data management device that makes wind measurement easier and more economical for developers and operators around the globe.

Early siting and ongoing investment and operational decisions, based largely on the quality of wind resource data, have a direct impact on the long-term success of a wind energy project. However, the task of collecting and storing this data reliably and securely has not always been achieved in a cost-effective manner.

Data loggers currently available to the market can be complex to install and operate, leading to higher costs for training, field time, and additional features typically required for full functionality. They also often fall short when it comes to performance in rough, remote

locations and cross-compatibility with the broad range of wind measurement sensors employed across the renewable energy industry.

Furthermore, as the wind energy market expands into increasingly distant and more complex terrain worldwide, the portability and connectivity of data logging equipment for field technicians continues to grow in importance. In both emerging and established markets, it is imperative to reduce the costs and labor involved in data collection and management while maintaining data security and 100% uptime in all weather conditions.

Designed for the Wind Industry

The Nomad 3 Data Logger benefits from Vaisala's unmatched track record for reliability in harsh conditions and decades of in-house wind industry experience, including the introduction of the first data logger built specifically for the commercial wind industry back in 1981. The new device, however, has been completely re-engineered with the current challenges of developers and operators in mind.

The Nomad 3 offers technological sophistication, such as a Linux operating system, and a smaller, lighter design while remaining incredibly flexible and straightforward to use. It

is compatible with all market-leading wind sensors, affording developers far greater control over equipment choices and allowing them to contain excess costs with simple installation, low energy usage, and remote configuration features. The Nomad 3 is also ideally suited for hard to reach regions of emerging markets like South America, Asia, and Africa, since it can be conveniently carried in a backpack to sites without road access.

This rugged, compact device is supported by telemetry and data storage features that significantly enhance the owner's capacity for remote data management. Nomad 3 benefits from wireless connectivity and Vaisala's SkyServe wind data management service - a secure web portal that offers a range of fleet management tools. Online operating systems also make it accessible to any web-enabled device, such as a smartphone, tablet, or computer.

All data from the logger is highly compressed, reducing file sizes to considerably decrease the cost associated with sending information over cellular networks. Data encryption also ensures maximum security and peace of mind to the developer.

A number of partners and government laboratories have already started using the Nomad 3 as beta clients at locations around the world.

Vaisala's Otto Tiertto Awarded for Excellent Calibration Thesis

Research Scientist **Otto Tiertto**, M.Sc. (Tech), has received an award for his excellent master's thesis, approved in the Aalto University School of Engineering in 2014. In the thesis project, Otto Tiertto

designed, constructed and tested a calibration station for a rather new CO₂ sensor in the Vaisala offering. The award is granted annually for the best thesis in the field of mechanical engineering by Technol-

ogy Industries of Finland Centennial Foundation.

The sensor in question was developed in 2009–2013 for on-demand HVAC solutions such as GMW80 and GMW90 series. Tiertto's thesis work concentrates on increasing the calibration capacity through optimizing the calibration process and by building a totally new calibration station. The new station is vastly improved in comparison to its predecessor also in terms of calibration features and costs.

"Otto Tiertto has proved exceptional abilities in goal-oriented and well-grounded research. Significant results were achieved already during the research work, and the research opens interesting possibilities in the future," says **Jussi Neuvo**, Chair of the award jury.

Otto Tiertto's thesis supervisor was Professor **Kalevi Ekman** in Aalto University and his advisor in Vaisala was D.Sc. (Tech) **Mikko Aronniemi**.

A collage of various industrial and manufacturing scenes, including conveyor belts, machinery, and workers. A hand is pointing towards a central image of a Vaisala HMT330 Humidity and Temperature Transmitter. The transmitter is a small, rectangular device with a display screen and several ports.

When There's No Room for Error

When it comes to measuring humidity in harsh manufacturing environments, you don't want to cut corners. The **Vaisala HUMICAP® Humidity and Temperature Transmitter Series HMT330** is an uncompromising transmitter you can depend on for years of trouble-free performance.

- Credibility that speaks for itself – close to 80,000 installations worldwide and counting
- **10-year warranty** when annually calibrated
- A wide range of options and configurations
- Built for extreme environments
- Support and service you can count on

Your customers choose the best. Why would you choose anything less?

A circular seal with a star border, containing the number '10' and the text 'YEAR WARRANTY' around it.

Vaisala Launches a Game-Changing Transmitter for Online Transformer Condition Monitoring

High voltage transformers are a critical component in the generation and transmission of electricity. Today the power industry is facing the challenges of end-of-life equipment, impacts of overload situations, and an increasing number of faults in the network. All of these have significant consequences to the operation of transformers, and increase the risk of unexpected failures and outages. Through efficient monitoring however it is possible to successfully mitigate these issues. For example, by measuring the hydrogen content in transformer oil, as well as the speed of its formation, utilities can detect and assess the severity of a fault situation. Furthermore, moisture dramatically affects the life of a transformer; elevated moisture in oil levels accelerates the ageing of transformer insulation paper as well as the oil's ability to act as an insulator. Moisture content can change quickly and should be monitored to ensure reliable operation.

Vaisala's Moisture, Hydrogen and Temperature Transmitter MHT410 continuously monitors changes in high-voltage transformer insulating oil. Vaisala's unique probe solution allows the device to provide accurate real-time measurements and trend data which facilitates reliable decision-making. The MHT410 swiftly recognizes transformer fault conditions allowing our customers to resolve potential problems before any further damage is done. Having real-time data also allows for predictive maintenance planning which helps our customers minimize expensive service outages.



Unique Probe provides Reliable Measurements

Unlike conventional solutions, the MHT410 transmitter measures moisture, hydrogen and temperature directly in the transformer oil. Due to an innovative probe design with an adjustable probe installation depth, the sensors are positioned in direct contact with representative oil in the transformer providing accurate measurements and reliable data. The MHT410 is built to last; it doesn't have pumps, hoses, batteries or other consumable parts. A non-membrane technology, the hydrogen measurement has no service or replacement needs. Thanks to the robust design and reliable measurement technology the MHT410 makes false alarms a thing of the past.

Intuitive and Easy to Install

MHT410 integrates three critical measurement parameters in a single probe. Easy to install, the probe is ready to use within minutes. With an adjustable installation depth, the probe fits into a variety of transformer valves to ensure optimal measurement. The unit is maintenance-free, with no calibration or adjustment required after installation.

For more information, please visit www.vaisala.com/mht410

Vaisala's MHT410 will be available summer 2015.



Award-Winning Solution for New Zealand Transit Authority



The New Zealand Transport Agency (NZTA) is a government entity and has responsibility for a wide range of land transport issues including the management of the 10,895 km State Highway Network. Whilst only around 10% of the total NZ road network, it carries 50% of all New Zealand Traffic.

New Zealand's climate varies from sub-tropical in the far North to cool temperate in the far south. The central North Islands volcanic plateau and the mountainous area of the South Island receive most of the snow fall in New Zealand. Frosts can occur anywhere in New Zealand. This climate provides daily freeze thaw cycles throughout the winter season which can pose a challenge to road winter maintenance operations.

Due to environmental and public concerns, de-icing using salt was discontinued in the early 1980's, leaving grit as the only treatment available for ice conditions. In 1995, a significant winter weather event caused a nine and a half day closure of the main North-South highway across the Central plateau. This attracted enormous media attention and public discussion and initiated an investigation into improved winter maintenance operations. A key outcome of this investigation was the need to re-introduce an anti-icing strategy based around a de-icing chemical.

Seeking out world best practice, NZTA selected Calcium Magnesium Acetate as the de-icer of choice. Its proven performance overseas as a de-icer combined with minimal impact on the environment suited the requirements for New Zealand. However at 15 times the cost of standard road salt, an effective way of application management was required.

NZTA selected the Vaisala Thermal Mapping and RWIS technology and commenced a trial on the Dessert road in the Central Plateau of the North Island. This provided NZTA with 24 hour predictions of road surface temperature across the road network and provided managers with an ability to focus resources in the areas required. After a number of trial seasons, NZTA proceeded to thermally map approx. 4,300 km

of road network throughout the North and South Islands. In 2010 a contract was let for the provision of road weather forecasting services. Vaisala and MetService NZ worked together to provide a solution involving MetService atmospheric forecast products, Vaisala RWIS, Vaisala Ice-Break Road Pavement forecasts and Vaisala Forecast Thermal Maps. Just 17 Vaisala forecast RWIS covered the entire network.

In 2012, the NZTA's Chemical De-icing Environmental Risk Management project was selected as the winner of the 2012 International Road Federation's (IRF) Global Road Achievement Award in the Environ-

mental Mitigation category. Monitoring carried out for over 12 years determined that the chemical has had no long term cumulative effect on the environment.

Four years on and NZTA have been able to compile performance statistics showing greater than 90% accuracy in their treatment decision making and less than 3% wastage. The staff and maintenance contractors have developed confidence in the prediction system and use of CMA to the extent that they are able to use reduced de-icer spread rates, further enhancing environmental and economic benefits.



Vaisala Thermal Mapping and RWIS technology provide customers with the information they need to support decision-making.

Oban Airport Upgraded for Improved Safety and Operations Continuity

Scotland's Oban Airport is a CAA licensed airport owned and operated by Argyll and Bute Council. The airport serves as a link from the mainland to the nearby islands. Recently, the airport invited tender bids to renew their ageing meteorological equipment, to further improve integrity and continue with high levels of accuracy as provided by the previous system.

In 2014, Oban airport had approximately 4750 aircraft movements and some 900 helicopter movements in the same period. (Image courtesy of Oban Airport)



Graeme McCracken, Crew Commander / FISO at Oban Airport explains, "The opportunity was also taken to upgrade to a direct fixed link facilitating transfer of meteorological reports to the UK Met Office for them to provide us with site specific Terminal Aerodrome Forecasts.

As a government body, ultimately accountable to the public, we were mindful of keeping expenditure to a minimum without compromising on quality and integrity of the equipment." Graeme continues, "Oban Airport lies 24ft AMSL, fortunately as the West coast benefits from the

gulfstream heavy snow fall at this level is uncommon and generally short lived. Our prevailing weather normally comes in from the Atlantic to the West, however due to local topography the weather can certainly be very changeable and it's not uncommon to have completely



Graeme McCracken, Crew Commander / FISO says, "Our prevailing weather normally comes in from the Atlantic to the West, ... it's not uncommon to have completely differing weather conditions at both ends of the runway." (Image courtesy of Graeme McCracken, Oban Airport)

differing weather conditions at both ends of the runway."

After a lengthy vigorous competitive tendering process Vaisala emerged as the successful bidder. According to Graeme, "From initial discussions and site visits through to completion Vaisala have offered fantastic support both with personnel on the ground, by email and through remote support to our system. As our previous system utilised Vaisala hardware for all key sensors it seemed a natural progression that

the new system exclusively using Vaisala equipment should drop into place seamlessly. Not surprisingly given its pedigree, backed with a proven worldwide reputation within the aviation community the AWOS installed is a very capable, adaptable, user friendly system and offers great future expansion possibilities."

"Initially none of the prescribed screen layouts quite fully fitted the bill for our requirements; however after a few minor tweaks remotely with Vaisala working some magic we

now have a customised display that completely satisfies our requirements. Finances permitting, we hope to expand the system in the future."

To learn more about Oban Airport, visit:
www.obanandtheisles-airports.com

Global lightning coverage addresses many needs and provides new meteorological insights

Uniform high-quality lightning detection allows comparisons among all regions of the world that have not been possible until recently.

Lightning impacts society nearly everywhere around the globe. It continues to be a significant source of fatalities, injuries, damages, delays, and avoidance measures. However, our view of lightning is changing now that we know where and when it occurs, removing some of the mystery and allowing it to be addressed from a phenomenological point-of-view. Everyone has an opinion about lightning occurrence based on personal experience where they live, but comparisons have not always been available for many areas of the world. A drastic change has occurred within the last few years when several billion lightning strokes have been detected globally and recurring patterns in time and space have emerged.

Global Lightning Detection

Detecting lightning around the world in real time has been accomplished with two partial approaches. One is the deployment of satellites that typically cover the equatorial regions or part of a hemisphere with moderate resolution and detection capabilities. The other is the use of ground-based sensors that have ranges of a few hundred kilometers in national or regional networks, or up to 1500 kilometers for long-range networks. The result is that no unified view has been possible with high spatial and

time resolution and most importantly, uniform detection. These issues have been very substantially resolved over the last several years by the deployment of a network with ranges of over 6000 kilometers from each sensor. When ranges are this long, there is a large overlap of detection so that changes in detection capabilities are not abrupt, but slowly varying over entire continents or oceans. Vaisala's Global Lightning Detection GLD360 network has this unmatched capability. Local sensors are not needed to cover a country, instead lightning real-time monitoring is accomplished remotely with no local installation necessary. The critical role that these long range sensors provide is both detection of most lightning over extremely long distances and very good location accuracy.

Global Lightning Occurrence

A full three-year view of global lightning is now available showing the density of 2.4 billion strokes (Figure 1). The map shows how most of the world's lightning is over land and adjacent oceans. Also apparent is that the distribution is not uniform. Note how the Sahara, as expected, is essentially absent of lightning, and well as areas of the South Atlantic and Pacific Oceans. The equatorial trough is apparent off West Africa

and Central America, and a lightning minimum is just south of the equator in the eastern Pacific. Many of these features have not been apparent in a uniform view in the past.

Application of Global Lightning Detection

It is apparent that global lightning data help in situations where uniform data sources are advisable. Meteorological services can use lightning data over large areas with slowly varying performance for real-time monitoring, forecasting, and assimilation into numerical weather prediction models, especially in areas where no other data are available to monitor convection, such as over oceans and countries with a lesser-developed meteorological infrastructure. Maritime routing can identify areas where convective activity is found over the open ocean. Aircraft can anticipate routes with frequent lightning in real-time. Defense interests can obtain information about where the thunderstorm threat is occurring. Utility and communication companies can use archived and real-time data to know where the potential for lightning is the greatest, and plan accordingly. Recreation and outdoor occupations have the opportunity to know how to react to the lightning threat. Finally, GLD360 data have sufficiently high location accuracy and flash detection efficiency that many of these applications can be made in areas where no local high-resolution lightning detection has been installed, and may not be in place for many years in the future. Airports in developing countries where no radar data exist

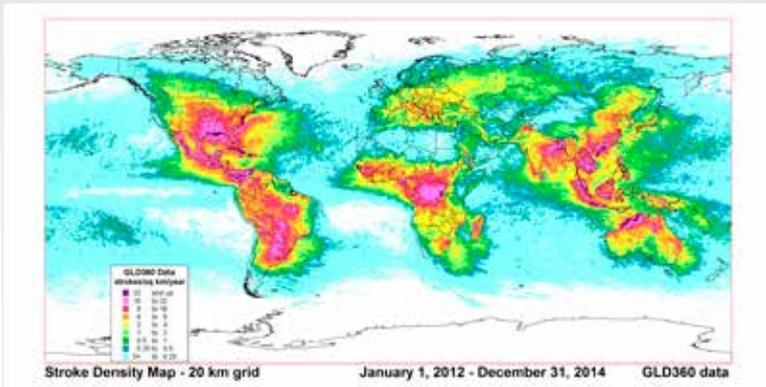


FIGURE 1. Lightning stroke density per square kilometer per year from GLD360 for the globe for January 2011 through December 2014. A total of 2,358,685,762 strokes is plotted during these three years. Scale is at lower left. The grid size is 20 by 20 km.

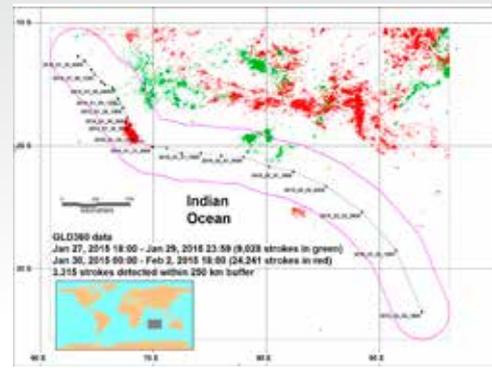


FIGURE 2. Lightning strokes from GLD360 for the globe for 27 January through 02 February 2015. The track of the eye is indicated during this period. Area of map is shown in inset.

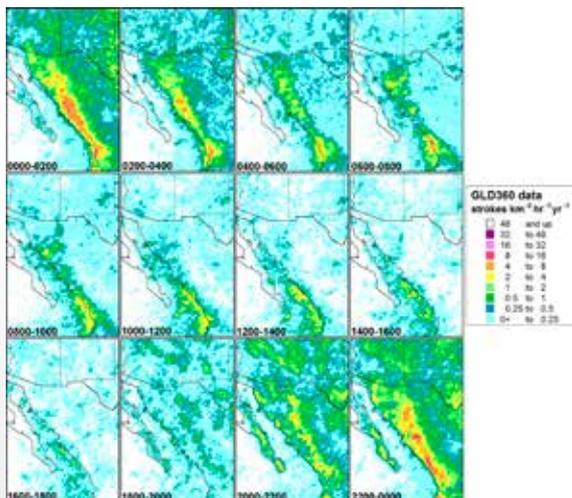


FIGURE 3. Monthly maps from April through September of lightning frequency in the northwest Mexico and the southwest United States monsoon.

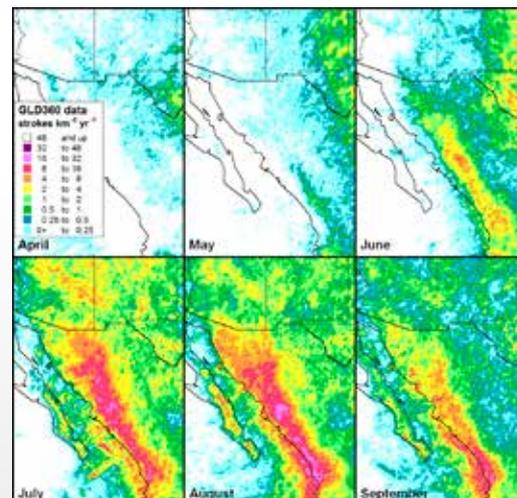


FIGURE 4. Two-hour maps of lightning frequency over the monsoon area. Time is in UTC.

can consider global lightning data for warnings without the need to place any sensors in the area due to the long range of GLD360 sensors. Additional applications in remote areas can be realized.

Meteorological Examples

With such high-quality, slowly-varying coverage, features can now be tracked over long distances in all regions. Consider the February 2015 track of tropical cyclone Eunice in the South Indian Ocean (Figure 2). Here it is seen that lightning only occurred sporadically in the eyewall, while most flashes were several hundred kilometers away. Tropical cyclones have three lightning zones: intermittent lightning occurs in the eyewall that may indicate rapid changes in structure;

a broad annulus outward from the eye is often lightning-free, while the outer rainbands often have intense lightning indicating major flooding over land. Occasionally an extremely intense cyclone will have most of its lightning only in the eyewall, but this is not typical. The uniform coverage of GLD360 allows systematic studies of all storms to be made.

Another example is to identify the time and space scales of the North American Monsoon of the southwest U.S. and northwest Mexico (Figures 3 and 4). This area has a highly concentrated maximum in lightning frequency caused by forcing due to topographic features of ocean and mountains. No other dataset can show the level of detail indicated by the lighting maps of the month and time of day. Many such studies are now possible over regions where no

continuous dataset was available; the opportunities are very broad.

Summary

Global lightning detection with high detection efficiency and location accuracy over all areas of the world is a reality. Over 800 million lightning events a year are being detected by GLD360 that can provide continuous observation of phenomena over broad areas with minimal variation in network performance. And while GLD360 provides this global perspective, and the view of large scale meteorological occurrences, it also provides local lightning detection and warnings, delivering national lightning data to national meteorological offices, and lightning alerts to mines, ports, airports and other critical operations, anywhere in the world.

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