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More than meets the eye:

Evolving surface weather observations

A changing world

The number of weather- and climate-related disasters has more than doubled over the past 40 years, and this trend is truly global.

Any country or region can fall victim to catastrophic weather events, whether these are familiar events that have increased in severity due to climate change, or new kinds of events that the region has never had to deal with before. With these changes come staggering implications for the national economy, population safety, infrastructure, trade, and more.

Unfortunately, the most dramatic increases in weather-related disasters are taking places in countries with lower GDPs and underdeveloped weather infrastructures, so their impact tends to be more severe and carry more long-term consequences. It comes as no surprise that leaders in meteorology and related fields list budget constraints and inadequate technology as two of their most important challenges today.

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Now is clearly the time for an evolution in surface weather observations. But what should that look like? This eBook explains how emerging technologies and new practices are making surface weather observation more attainable and actionable in budget-scarce environments.

The damages of accelerating climate disasters

- $145B annual direct economic loss to disaster-hit countries (1998–2017)
- 26M people pushed into poverty each year
- Low-income countries are much less able to assess and report damages
- Reported losses from extreme weather rose 151% from 1998–2017

Source: United Nations Office for Disaster Risk Reduction, "Economic Losses, Poverty & Disasters Report, 1998-2017"

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Megatrends we see today

Several trends explain the increasing demand on surface weather observation systems and their related infrastructures. Though they apply to different sectors (government, industry, research and meteorology, etc.) they all highlight the need for climate situational awareness — something that many communities and countries still lack.

Climate change

Reliable observations and forecasts are necessary for protecting lives and infrastructure as extreme weather events increase globally. **Now more than ever, stakeholders in government and industry need to be informed by real-time, localized environmental observation tools.**

Resource efficiency and circular economy

The circular economy focuses on the reuse and reintroduction of materials back into the value chain instead of turning them into waste. **This resource efficiency model requires active, data-driven resource assessment and environmental impact data.**

Renewable energy

Various forms of clean and renewable energy are becoming increasingly competitive and common. **The variable nature of renewable energy sources highlights the importance of site selection, real-time forecasting capabilities, and continuous monitoring.**

Digitalization

Digitalization changes the behavior and operation of consumers and companies. The Internet of Things (IoT) makes it possible to connect devices through cloud services and use data in powerful new ways, enabling new kinds of digital services. **These changes demand remote sensing equipment that is compatible, easily integrated, and cloud-ready.**

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Smart energy production and utilization

The increased global demand for energy is an inevitable result of the expanding population and growth in digitalization and industrialization. **To meet the future energy needs, production and consumption of energy need to become more efficient.**

Future of mobility

Automation, digitalization, and innovative energy sources will change traffic and the modes of transportation. **Observations and analyses on the environment and road state enhance the safety and efficiency of traffic in different conditions.**

Urbanization

As cities grow, the number of people subjected to their environmental conditions grows as well. Concentration of population, traffic, and industrial processes brings on changes in weather and environmental conditions, such as air quality. **This means that localized understandings of the weather are increasingly important.**

Well-being and health

People are increasingly interested in their health and conscious about their surrounding environments. **Environmental monitoring of indoor and outdoor conditions helps to secure people's health and well-being.**

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On July 30, 2020, NASA's Perseverance rover headed for Mars carrying Vaisala's space-proof humidity and pressure sensors. These sensors are cornerstone of accurate and reliable weather observation solutions. Weather observation solutions needs to evolve to meet modern measurement demands: Accomplish more tasks with less hardware, leverage the cloud, and embrace new practices such as IoT and edge computing — all while maintaining first-class reliability and accuracy.

The value of consolidation

Today, observations that used to require many separate sensors can also be conducted with fewer, or even a single, solution. This brings many benefits for accuracy, reliability, and even data security.

How observation technology is evolving

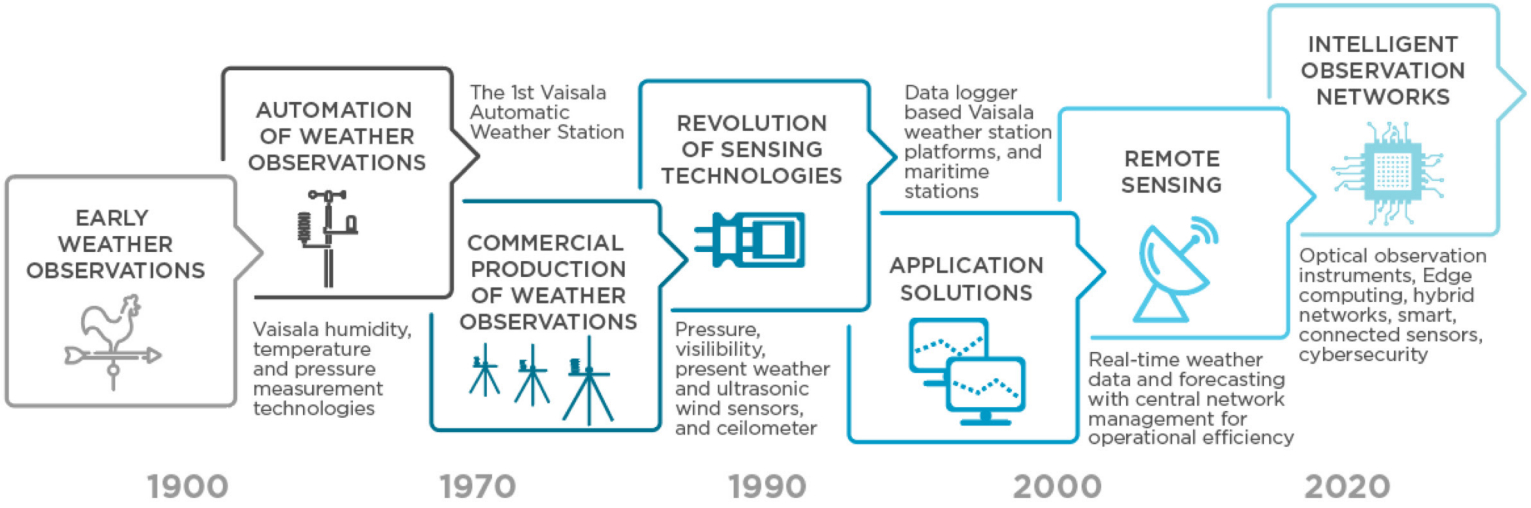
Innovative optical observation technology sets a new standard in precipitation identification, quantification, and visibility determination accuracy. One sensor can potentially replace multiple sensors by providing very accurate information about visibility and present weather (visibility and present weather sensor), droplet size distribution and reflectivity (disdrometer), freezing rain type (freezing rain sensor), and rain accumulation (rain gauge).

Lidars are already proven for their exceptional accuracy in cloud height measurement and backscatter profiling. In the near future, lidars will provide other valuable data, even to smaller meteorological agencies or local governments.

Modern, multipurpose instruments bring many benefits beyond consolidation. They also provide:

- Equal or better accuracy
- Significantly less maintenance
- Longer life cycle
- Better reliability
- Lower lifecycle costs
- Improved cybersecurity

These solutions also share a focus on future-compatible features, such as modular expansion and improved network integration. They allow users to do more with less — a constant priority no matter the industry or purpose — and result in longer, more problem-free service lives, even under the harshest conditions.



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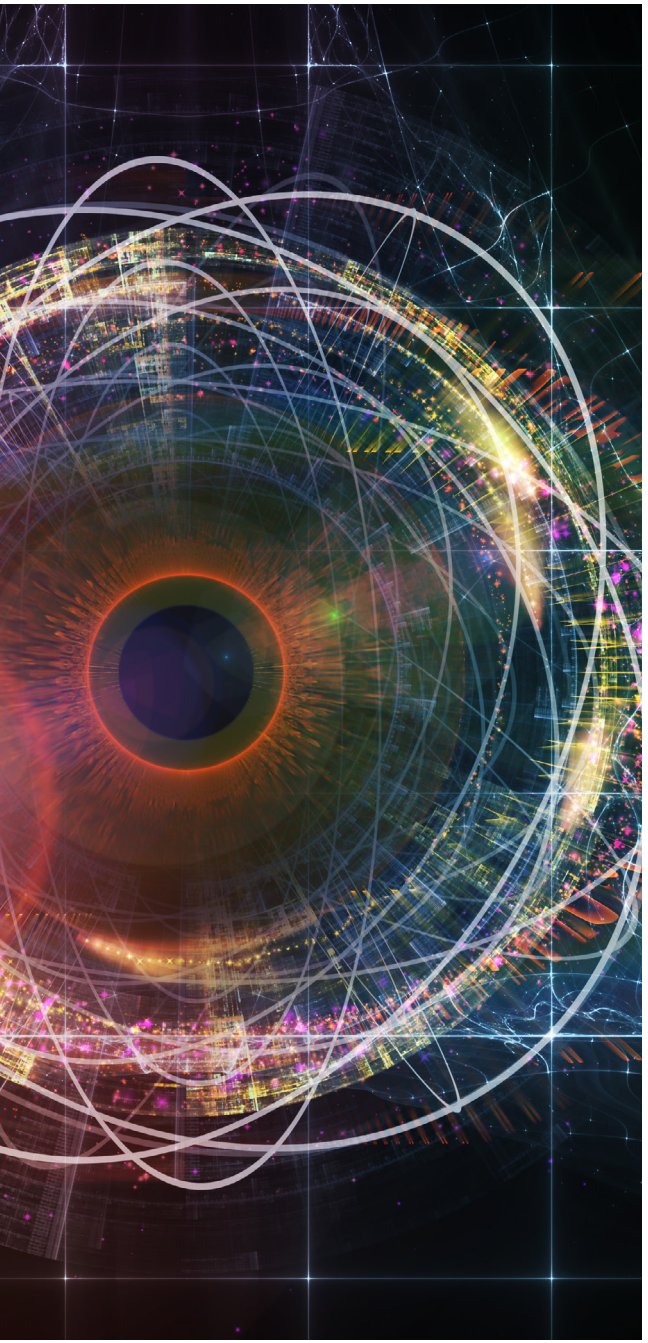

Signs of the future:
Intelligence and connectedness

Advances in today's observation systems frequently have to do with data management and data security. Modern trends such as cloud computing, AI, and edge computing have been studied by the weather observation industry, as these technologies have the potential to further improve the accuracy, operational efficiency, and resiliency of weather sensors and systems.

It is helpful to group these advances into two categories: intelligence and connectedness.

Intelligence Substantial automation and metadata collection	**Connectedness** To other local devices and broader infrastructure
Device management (automated maintenance and software updates)	Secure wired/wireless internet access for smart features
Monitoring and alerting	Machine-to-machine interface
Event logging, data logging	External gateway or integrated sensor gateway
Observation statistics	
Device and site metadata	
Observation quality metadata	
Wired/wireless local area communication	

Smart, connected sensors

As the table above shows, future smart sensors could have enough processing power to handle more sophisticated functionalities, like device management, monitoring, and proactive alerts based on monitored parameters. They also have intelligent capabilities including automated diagnostics and software updates.

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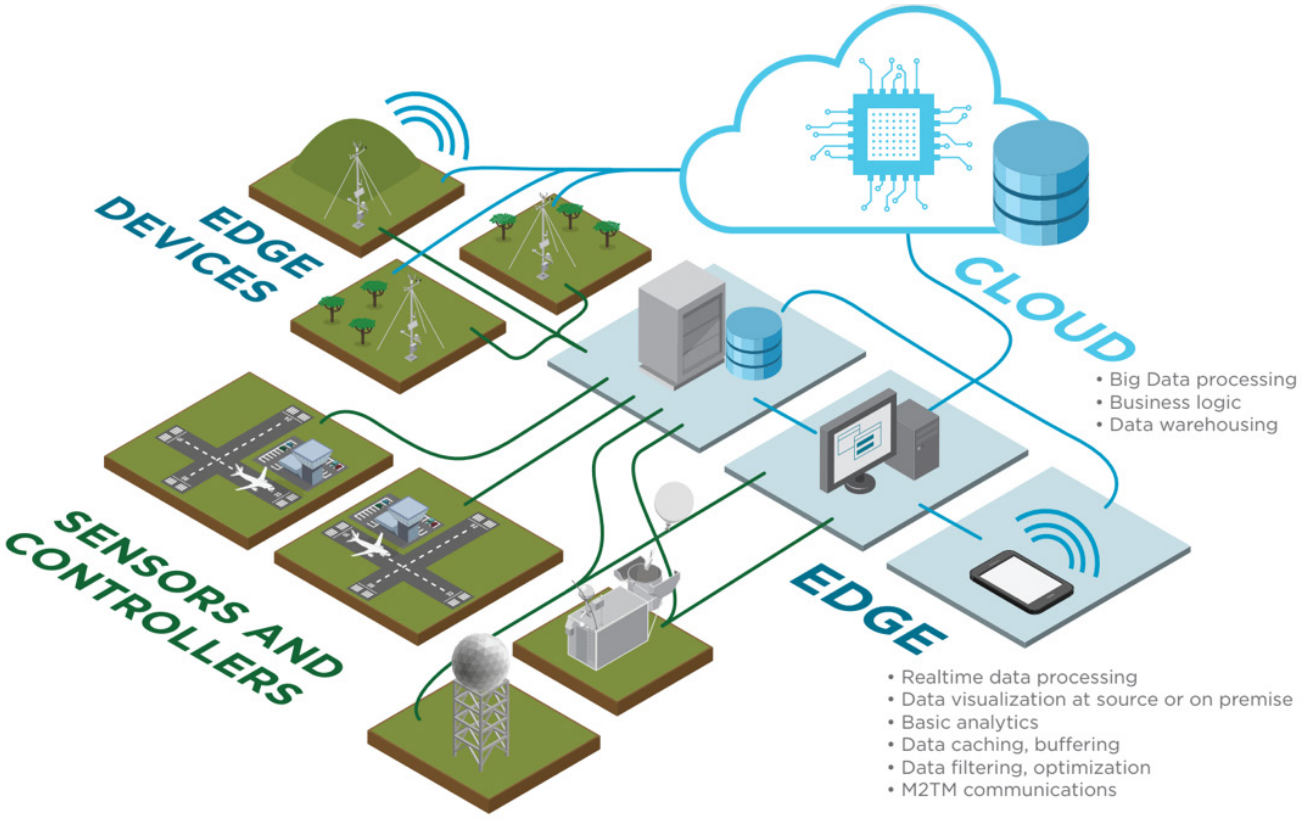
Implementing edge computing

Edge computing refers to completing data analysis at or near the source of the data itself, rather than transmitting the data to a data center or cloud before it can be processed. This might not seem like much of a difference (after all, data travels to the data center at the speed of light) but it can create notable performance gains. For example, edge computing avoids latency and the need to queue the data within the larger IT ecosystem. It also allows for more efficient machine-to-machine communication, which is important in an data rich environment.

Edge computing can also enable an observation site to operate more or less autonomously, without relying on information being passed between it and some other central processing system. Today's weather observation systems generate a massive amount of data — this is one of their strengths, after all — so any efficiencies provided by edge computing could result in faster analysis and forecasting, as well as saved bandwidth for the rest of the IT infrastructure.



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Cybersecurity

Because weather observation networks provide data that is crucial to a community's (or even an entire country's) security and safety, they have become targets for cybersecurity attacks. In 2017, IoT attacks rose by 600%,[1] which tells us that distributed devices like weather sensors have been "discovered" as likely targets by cybercriminals.

Still, we know from informal surveys that IT managers tend to have less confidence in observation network security than they do in IT infrastructure more broadly. This conversation will continue to evolve and gain attention.

600%: Year-over-year increase in Internet of Things cyberattacks[2]

62% of global organizations cannot claim that they are equipped to handle a cyberattack[3]

43% of cyberattacks are directed at small organizations because attackers know they are under-resourced and unprepared[4]

Can you hack it?

Vaisala has anticipated the increased attention paid to observation networks (from cybercriminals as well as from IT departments) and we have built our solutions to rigorous security standards. For example, in January 2020, Vaisala took part in the Nokia Hackathon, which awards prizes of up to 10,000 Euro for hacking into network-connected devices. Vaisala contributed one of our newest technologies to see how secure it was.

The hackers were unable to compromise it, even after several hours of intense work. Along the way, we learned important lessons that we can apply in the future. Not all companies would have submitted one of their newest technologies to a Hackathon, but we are extremely glad we did so.

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Observation technology is always evolving. Vaisala has the solutions and the guidance.

Your communities rely on you to provide the most reliable and accurate weather information available. You can rely on Vaisala to help you succeed, even when the industry is changing rapidly.

For decades, Vaisala's meteorological innovations have turned observation into human impact. We are the industry's trusted leader, not just for our sensors and technologies, but for our partnership, training, and guidance throughout the entire project life cycle. Vaisala's decades of investment in science and research are unmatched in the industry, as is our commitment to you and the communities you serve.

www.vaisala.com/meteorology

Trusted weather observations for a sustainable future

[1]Source: Symantec

[2]Source: Symantec, 2017 data

[3]Source: IBM

[4]Source: Small Business Trends