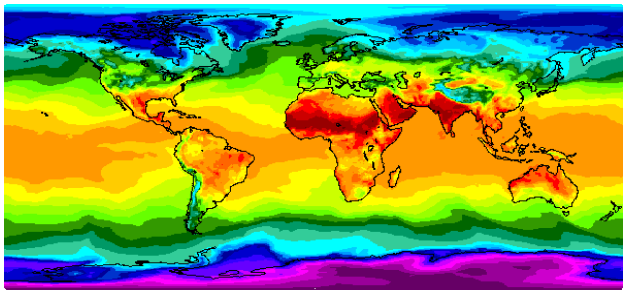
Application note: N°F040

September 2013



Meteorology: Numercial Weather Prediction

Facts & figures:

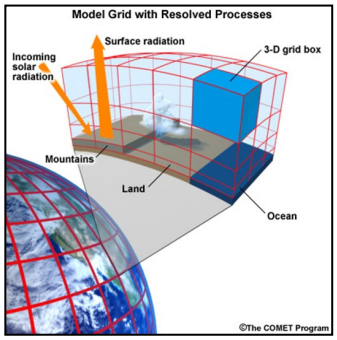
17.8 cm is the diameter of the largest hailstone ever recorded.

Sukkur City in Pakistan is one of the most humid places in the world with 30 °C dew point & a felt air temperature of 65 °C.

A study showed that a small thunderstorm system holds more than 10 million tons of water.

No two weather patterns are completely alike.

Some weather models assimilates data obtained from more than 25,000 weather stations.



Model of the earth's atmosphere

Discussed in this edition:

The calculation of weather data

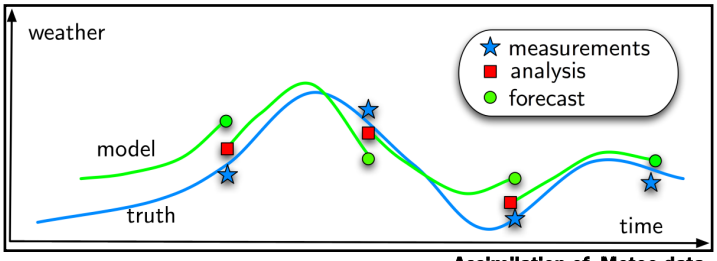
What is the weather going to be like tomorrow? For a long time, people have tried to predict weather conditions using the hydrologic climate cycle.

In the early 1920`s scientists were able to compile a six hour forecast. Back then it took six weeks to calculate by hand the weather data collected at two points in Europe and create a useful illustrative model.

Today, supercomputers are used to predict the weather for a period of several weeks. The complex modelling programs require several million data points for parameters such as temperature, humidity, pressure, vertical & horizontal wind velocity with time stamps and absolute coordinates. To create a correlation between the data and the environment, scientists "slice" the atmosphere virtually into smaller horizontal & vertical parts - this process is called ***discretization***. It is more useful to compute the chronological change of the parameters using this model.

Meteorological events that are too "small" such as a single thunderhead, layer clouds or smaller turbulences will be parameterised through variables. This ***parameterization*** is a science of its own that aims to reduce uncertainties as best as possible.

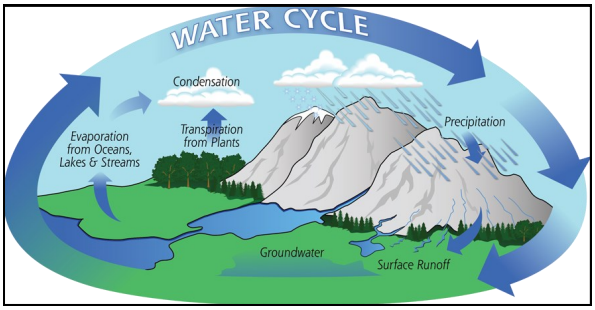
Every forecast calculation starts with the current weather conditions. The quality of this input is crucial for the accuracy of the final forecast. Meteorologists link the forecast of yesterday's weather with the actual measured parameters. Only large data centres are capable of computing this ***data assimilation***. The overall result is a best possible calculation basis to predict the weather for the next day. If this groundwork is flawed the forecast may be incorrect, for example it could report rain at the wrong location.



Assimilation of Meteo data

Today's meteorological mathematicians also take parameters into account that change extremely slowly compared to the other factors. Growth and the reduction of polar ice, or the temperature of the oceans are summarised as ***boundary values***

After a model is run using all the available data, meteorologists process and customize reports for a wide range of target groups such as public authorities, flight control centres, energy producers, industries and many more, including the issue of specific warnings.



The weather forecast is the numerical prediction of the water cycle in the atmosphere

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rotronic MEASUREMENT SOLUTIONS

Application note: N°F040 September 2013

Why the need to measure humidity?

As described above, the daily weather forecast relies on the precise measurement of weather parameters. The science of numerical weather prediction aims to describe the daily hydrologic cycle in numbers - humidity plays an important role in this - data errors will multiply during calculations.

$$\frac{d\rho_w}{dt} = -\rho_w \cdot \vec{\nabla} \cdot \vec{v} + \dot{W}$$

Humidity values influence weather calculations e.g. through the ***water vapour balance equation*** - this formula expresses the influence of humidity through rain & condensation, and visa versa.

Incorrect measurement or incomplete humidity data directly leads to wrong predictions of a huge number of weather phenomena; this can include the condensation altitude of clouds, locations of hyetal regions, fog layers and storms.

In 1999, incorrect data sent by a weather station in Nova Scotia, Canada led to an incorrect forecast for Hurricane Lothar two days before it hit Central Europe. Authorities were insufficiently prepared to alert people in time.

Weather station on Mt. Washington USA

What solution can Rotronic offer?

Rotronic products are used in weather stations around the globe. They provide temperature & humidity data continuously with high accuracy even in demanding environments.

Rotronic manufactures a range of **meteorological probes and weather shields** to meet the standards required by meteorological organizations.

MP102H/402H with HC2-S3

Rotronic products:

Humidity and temperature probes & meteorological shields:

- **MP102H/402 with interchangeable HC2-S3 probe**
  ±0.8 %rh and ±0.1 K, 0...100 %rh, -40…+80 °C, optional passive Pt100 sensor, all psychometric values available, resistant to air pollution & condensation, current or voltage outputs available, IP65 protection

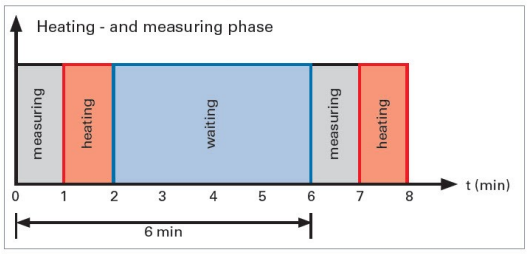
HC2-S Heated Sensor with SMD thermo sensor element

- **HC2-S Heated Sensor**
  Special heated sensors for extreme humid conditions. A heating cycle prevents condensation on the sensor to avoid unrealistic humidity readings.
  ±1.3 %rh & ±0.15 K, 0...100 %rh,
  -50…+100 °C, temperature, humidity & dew point measurements.

- **Meteo Shields RS12T / RS24T, AC1000/1002/1003**
  AC series: Naturally ventilated meteo shields, 9 plates, 10 plates & 14 plates
  RS series: Actively ventilated for highest accuracy -30...60 °C, 0...100 %rh, 12/24 VDC

Measuring - heating - cooling phases

The complete cycle (measuring - heating - cooling) takes six minutes.



Current consumption rises up to 35 mA (at 3.3 VDC) during the heating phase. To ensure a correct heating function, 35 mA is required.

Customer benefits:

Accuracy: Choosing Rotronic products gives you the best accuracy available. Precise and uninterrupted humidity measurements are crucial for every weather prediction calculation & for usable results

Communication: A wide range of analogue outputs and digital interfaces ensures that Rotronic products are easy to integrate in weather stations & networks.

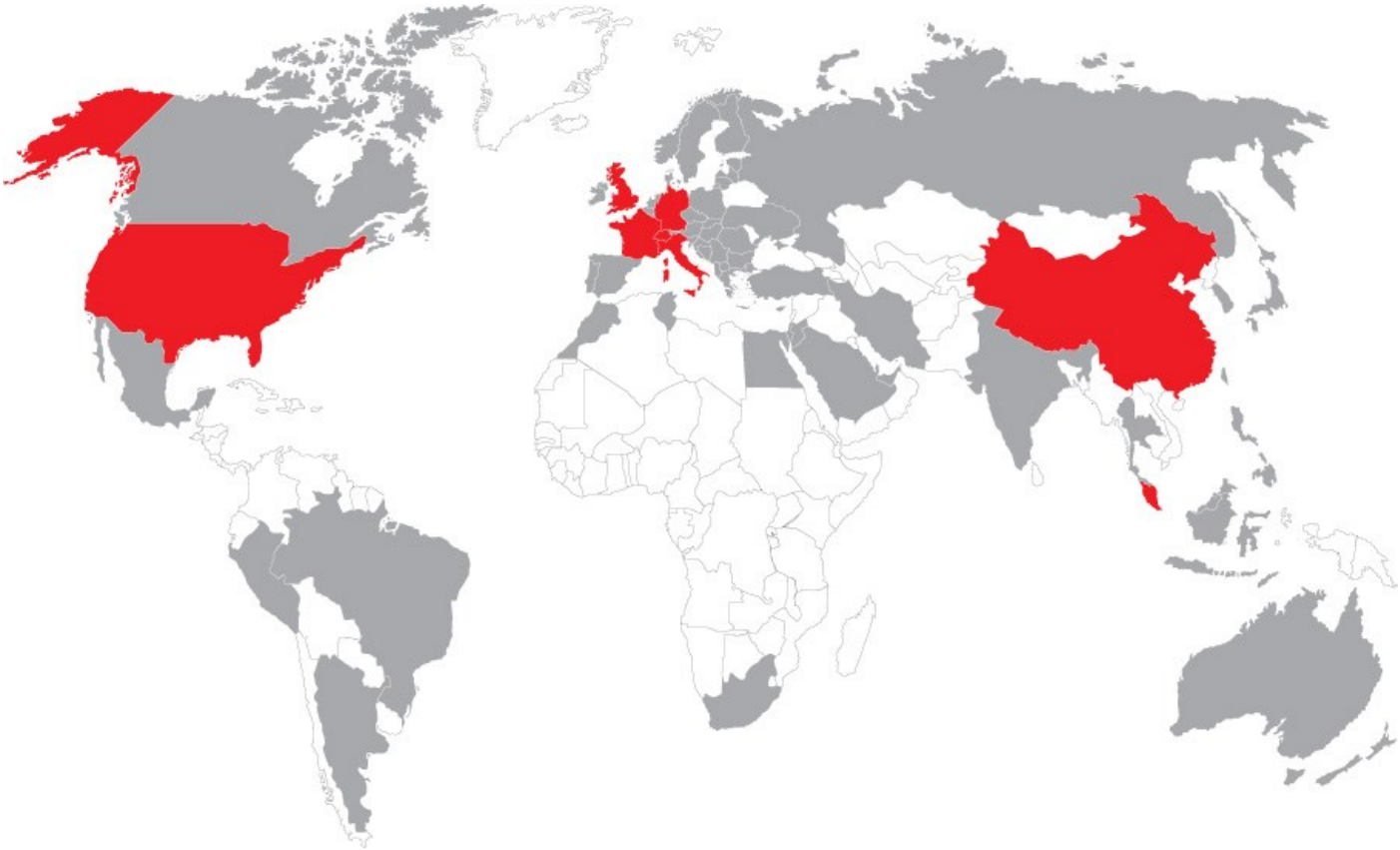
Long term stability: With high measurement performance and low sensor drift of below 1 %rh per year, Rotronic probes require reduced maintenance which has a direct positive impact on the efficiency and accuracy of weather stations in the field. All Rotronic sensors can be calibrated and adjusted.

RS12T/RS24T, actively ventilated

AC1003

Contact us:

Rotronic is represented in more than 40 countries around the world. An up-to-date list of all our partners is available at www.rotronic.com



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