www.fieldclimate.com - integrating field monitoring, climate control for energy efficiency including traceability for investors, governmental organizations and stakeholders

Dr. Heinrich Denzer (heiner.denzer@metos.at), Gottfried J. Pessl (gottfried.Pessl@metos.at), Pessl Instruments GmbH. Weiz, Austria

Abstract: Actual monitoring devices of METOS are reporting data automatically to the www.fieldclimate.com webserver, where users build their data management using climate and soil moisture monitoring, tracking and logistic recorders, tunnel and greenhouse monitors, storage and silo monitors. Multiple accesses from many work places for different purposes and from everywhere in the world is given. Data are maintained and backup is taken. Data used for traceability can be accessed by packers, buyers and investors. Traceability and crop diaries are managed on this site too. Actuators controlled by SMS can be started and stopped from www.fieldclimate.com. This control can be automated by making activation or shut off a function of climate or soil moisture data. www.fieldclimate.com is the central place to manage monitoring and control for farm operations remotely. The system is scalable from individual farms to corporate farming. The design of the hard- and firmware allows easy integration of other precision farm technology into the whole system.

Key word: www.fieldclimate.com, web server, moisture monitoring, traceability, data management, disease monitoring, irrigation management, SMS, automation, climate monitoring, tracking, crop diaries, spray diaries, weather forecast, iMetos, GPS, GPRS, GSM, spray thrift, stakeholders, sustainability, energy efficiency

Introduction: Decades of invention in agricultural climate and soil moisture monitoring taught us that there is a need for an integrative solution bringing together monitoring and control on one platform. Having this platform on farmers PC showed up to be very support intensive for agents and advisors. Broadband Internet access allows shifting applications from local PC to web servers where maintenance and service can be done very much more effective. The availability and good coverage of GSM and GPRS services allows us to use these data transmission techniques in fields and orchards where we monitor climate and soil moisture is necessary. Actual modems are integrating GSM and GPS radio elements and are perfect to transmit position information into www.fieldclimate.com. Position, date and time are integrated with information about spray weather, machine action, driver, vehicle speed, machinery attached to the vehicle and many more.

Small controls connected by SMS services to www.fieldclimate.com are making www.fieldclimate.com to a virtual control centre for multiple agricultural automation tasks.

Climate and soil moisture monitoring: Past and present of the brand METOS is strongly related to climate monitoring in orchards and vineyards for plant disease management. Since 1988 METOS electronic weather stations are used together with plant disease models to optimize the use of agrochemicals. Our clients are individual growers in Austria, Italy, Germany, France, Hungary, Poland and many more countries working on high agronomic
standards. Our devices have moved from stand alone disease predictors to data loggers combined with PC software for data management and plant disease modeling. Climate monitoring is sensing and logging. Giving tools for agricultural management is communicating this data to the farm or orchard manager more. An electronic weather station is used for plant disease management has to measure the communication part is creating a successful product for farmer and producer.

iMETOS devices are designed to use the GSM/GPRS communication to transmit data to a web server without using additional software. The communication is not added to the device. The GPRS communication is the core to which the monitoring application ads on.

From the monitoring we can differentiate the following tasks:

+ Temperature monitoring for frost or heat alert
+ Monitoring of global weather for statistics and global warming
+ Flood warning and land slide risk assessments
+ Weather monitoring for plant disease and pest management
+ Weather and soil moisture monitoring for irrigation management
+ Soil moisture and salinity monitoring for sustainability in irrigation and fertilization

With respect to many users we have to mention one task more:

+ Weather monitoring for documentation and on farm long term studies

Temperature monitoring for frost or heat alert is done by one temperature sensor in minimum. Special tasks like temperature monitoring in asparagus dams in order to give alert for moving off the plastic cover will need specific sensors. Important for this application is that the iMETOS sends an SMS to one or more persons and they will take action when the message reaches them. Thresholds for the alerts are set on [www.fieldclimate.com](http://www.fieldclimate.com).

Weather monitoring for plant and pest management is widely used in apple and vine production. Sensors for temperature, relative humidity, precipitation and leaf wetness are used for the most of the plant disease models. [www.fieldclimate.com](http://www.fieldclimate.com) has plant disease models for Vine, apple and pears, stone fruits, carrots, onions, potatoes, tomatoes, sunflower, sugar beet, wheat and rice. The models are informing about infection periods, risks or periods favorable for the plant disease. Some models are giving or applying specific plant protection strategies others giving information to improve the plant disease control.

[www.fieldclimate.com](http://www.fieldclimate.com) gives the opportunity to enter the spray diary for an unlimited number of orchards, vineyards or fields. The information coming from the disease
models together with the spray diary are a very valuable documentation to improve agricultural practices for packers, marketing organizations or supermarkets.

Weather monitoring for irrigation management means to measure temperature, relative humidity, wind speed and global radiation in the field. This data is used to calculate the reference evapotranspiration following the FAO Irrigation and drainage paper 56 (ALLEN R. G., L. S. PEREIRA, D. RAES and M. SMITH, 1998). Reference evapotranspiration is used to calculate crop specific evapotranspiration for specific fields, gardens, orchards or vineyards. Crop stages, days from planting, precipitation and rain efficacy is used to calculate field specific water balances.

Soil moisture monitoring with electronic tensiometers, watermark sensors, capacitive sensors type ech2o probe and enviroscan is done by iMETOS systems (GEORGE, B.H. 2006). This data is send to the website and is used for irrigation management. Salinity monitoring using frequency domain reflectometry is new for agricultural monitoring (BAUMHARD, R.L., R.J. LASCANO and S.R. EVETT, 2000). It offers in sandy soil a good possibility to trace the move of nitrogen through the soil into the water table. The use of multiple depth salinity sensors is giving information about salt content in different soil levels as well as the water content. This data helps to understand the move of fertilizer to adopt irrigation and fertilization to avoid fertilizer to move into the water table. Having the salinity and soil moisture data combined in the internet makes it easy to open them up for auditing institutions.

Spray weather monitoring: Pesticide leeway is depending on wind speed, vapor pressure deficit, droplet size and speed of the sprayer. Monitoring wind speed and vapor pressure deficit can show us when to adjust speed and droplet size (nozzle) to reduce drift. If we record this climate data together with the data about time, position and driving speed we can document good agricultural practice for auditing institutions. It is again quite beneficial to have this data in the internet where there is no technical barrier to data access.

Machinery and vehicle tracking: Contractors and machine sharing organizations need data about position and use of the rented out machinery and labor. Bigger farm and horticultural enterprises need information about machine use and machine position too. The information about position can be retrieved by the use of GSM/GPRS modems with a GPS chipset
combined. This device will give a GPS position accuracy of approximately 15 m which can be improved widely by the use of A-GPS (Assisted GPS) if this is requested by the client. With this we have position and speed over ground. This information can be combined with the information from sensors connected to the device:

- Pressure switches to control the function of pumps to record the work of applicators for liquids
- Inductive position sensors to control the position of bars to record the work of applicators for granulates
- Vibration switches to control the work of stationary but vibrating devices like wood chippers
- Temperature sensors to record the work of winter service vehicles
- Relative humidity sensors to record the work of hay harvesters
- Emergency switches to give back up to operators

Having this data sent to a web server gives first of all access to everybody who is entitled and secondly it allows the use of the services given by the map solute or google maps API and with this there is no need to run a GIS for the single clients.

More advanced services can be designed by joining the tracking devices with RFID readers. We can read the drivers identification number to allow automatic work reporting. We can identify the machinery coupled to a tractor and from this we can do automatic work reporting as a base of cost objective accounting or to track the pesticide can in order to verify that the right chemical is in tank of the sprayer.

**Services offered by www.fieldclimate.com:**
Having the data send by the different devices in field the website offers services by the use of this data. First of all there are the services of data presentation like tabling, graphing, summarizing or GIS mapping. Pessl Instruments core business up to now has been the plant disease modeling. www.fieldclimate.com offers plant disease models for:

- Vine grapes:
- *Uncinula necator* risk, giving risk information to adjust the spray program (GUBLER, W. D.; THOMAS, C. S. 2000)
- *Botrytis cinerea* risk, giving risk information to adjust the spray program (Broome, J. C., English, J. T. Marois, J. J., Latorre, B. A. and Aviles, J. C. 1995.)
- *Eupoecilia ambiguella* and *Lobesia botrana*, flight and egg laying dates (Wegner-Kiß, G.; Rühl, K. 2000)

**Apples and Pears:**
- *Venturia inaequalis* infection, pointing out dates of ascospore and conidia infection (SCHWABE, W. 1980)
- *Venturia inaequalis* ascospore discharge, pointing out relative amount of ascospore available for infection (MACHARDY, W. E. 1996)
- *Venturia pirina* infection, pointing out ascospore and conidia infection dates (*SPOTTS* R. A., CERVANTES L. A 1991)
- *Erwinia amyloflora* risk, pointing out the risk of infection (*SMITH* T. J. 2002)
- *Cydia pomonella* flight and egg laying dates (*ALSTON*, D., *MURRAY*, M. REDING 2006)

**Potato and tomato:**
- *Phytophtora infestans*, infection periods, spray interval (*JOHNSON* S. B. 2005)
- *Alternaria alternata* spray interval (*JASINSKI* J. 2005)

**Onions:**
- *Botrytis squamosa* infection (*Vincelli*, PC; Lorbeer, JW 1989)
- *Peronsopora destructor* infection (*HILLDEBRAND* P. D. and *J.C. SUTTON* 1984)

**Sugar beets:**
- *Cercospora beticola* spray interval (*Shane* W. W., P. S. Teng 1985)

**Oilseed rape, canola:**
- *Sclerotinia sclerotina* apothecia formation

**Wheat**
- *Puccinia* ssp infection
- *Septoria* ssp. infection
- *Fusarium* ssp infection

**Stone fruit, Carrots, asparagus, strawberries …**

These models are combined with forms to enter observations about crop stages and with a spray diary. Multiple interfaces to run different decision support models from other developers like RIM_PRO, PlantPlus (DACOM), Welte etc. are offered and actively promoted.
Irrigation services and irrigation automation: Soil water balance based on evapotranspiration (ET) and crop factors and soil water balance based on volumetric soil moisture measurement and plant water uptake are two services offered by www.fieldclimate.com. This services have moved from the growers individual PC to the web server. The benefits are an easier interaction between grower and irrigation advisor. And it frees the grower from data maintenance. The use of tensiometers for soil water data do not need extra services to be transformed into applicable irrigation advice. Simple rules for irrigation on crop and stage specific water tension are sufficient to use these types of sensors.

The outcome of soil water balance sheets and/or water tension is used for automation by the web server. It easy connects a valve controlled by a SMS control device to one or multiple sensor outputs and the web server opens or closes the valve when the output reaches the threshold.

Discussion and perspectives: Our plant disease models are calculated on base of local weather data. For future it is planned to extend the model output by a prospective part which integrates localized weather forecast. For this service we are looking for a partner offering us an interface to interact by our web services. Up to now we could not find services giving us the possibility to automatic upload last 24 hour weather data and position and getting back 48 hour forecast. We are open for anybody offering such a service with a working automation.

Spray dairies and plant stage protocols together with climate and disease model data can be used for traceability and quality control. Pessl Instruments is not experienced in this services but the presence of the data in the internet and the available interfaces (SOAP) are offering collaboration with auditing instances to use this data.

Tracking and work protocol data can be used for cost objective accounting and for accounting of contractors. Again this is not the business of Pessl Instruments but the available web interfaces can be used by companies working in this field and willing to offer their services web based.

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