GuMNet: Guadarrama Monitoring Network initiative (Spain)

GuMNet Team *

EGU General Assembly 2017

1. Infrastructure:

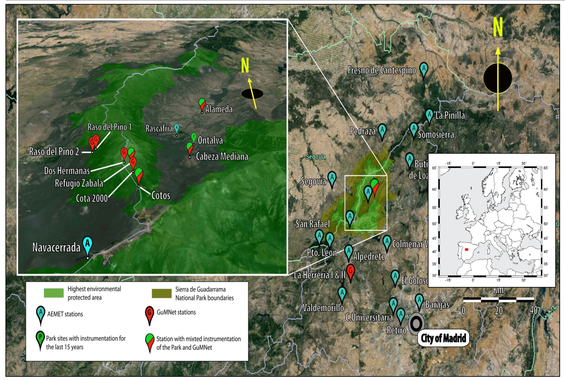


Fig. 1. Spatial distribution of the GuMNet automatic atmospheric and subsurface stations over the Sierra de Guadarrama and other meteorological stations in the area.

GuMNet (**Guadarrama Monitoring Network**) is a joint initiative to build up an **observational atmospheric and sub-surface observational infrastructure** in the Sierra de Madrid-Segovia, central Spain. The resulting network consists of the following instrumentation:

- **10 complete WMO-type standard meteorological stations**.
- **15 experimental boreholes** for monitoring the **subsurface temperature evolution**, distributed over 8. **8 trenches** for direct monitoring of **temperature and humidity of the soil,** in the first couple of meters below the surface.
- **2 anemometric stations** including WMO standard set ups as well as **CO_2 and H_2O vapor flux** trace analyzers and **eddy covariance measurements** .

The locations range between 920 m. a. s. l. most of the sites are distributed over the **National Park Sierra de Guadarrama** (PNSG), an environmentally protected area (Figure 1; green shading). The GuMNet initiative will be complemented by locations endorsed by the **Spanish National Meteorological Agency** (AEMET, see blue icons). GuMNet builds upon a network of 5 sites (green icons) including meteorological instrumentation within the PNSG that have been operational over 10 to 15 years. 4 of these sites have been updated and extended with new meteorological instrumentation and also incorporated soil and subsurface monitoring infrastructure (green/red icons). This region is characterized by a complex topography and heterogeneous vegetation cover offering a variety of different micro-climate setups, e.g. pine forest, scrub, pastures, or bare soil/rock areas. The GuMNet initiative is supported by research groups and funded by the **Moncloa Campus of Excellence** with additional infrastructure and collaboration support by the PNSG and CIEMAT (see *GuMNet team). The goal of GuMNet is to create a meeting point to develop educational, research and managment synergies between diverse institutions and research groups of wide range of disciplines.

2. Observational data example

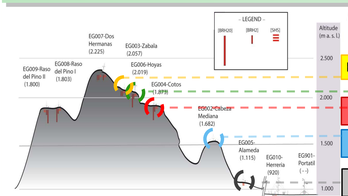


Fig. 3. Technical sheet of the EG006 Site

Fig. 2 . (Left) Altitude distribution of GuMNet automatic weather over the Peñalara orography. Note the coverage on North and South sides above 1.500 m a. s. l

The altitudinal distribution of stations (note the range from 920 – 2.225 m a. s. l.), allows to monitorize the evolution of: thermal inversions (see figure 4); regional anabatic and catabatic winds.

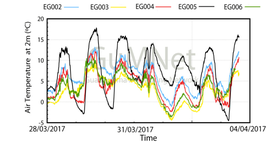


Fig. 4. Air temperature at 2m at five sites. Note the thermal inversion in clear sky days.

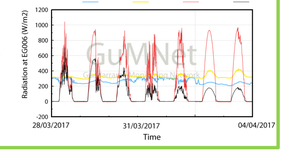


Fig. 5. 4-component radiation measured at EG006.

3. Eddy covariance fluxes

EG008-La Herreria I is a fixed anemometric tower with wind speed (VV) and air temperature (TA) sensors at three different heights (2, 6 and 8 meters). This configuration is complemented with an in-situ **open-path mid-infrared absorption gas analyzer** integrated with a three dimensional **sonic anemometer** (CO2+AS3). Likewise, the station includes the standard WMO meteorological sensors, two experimental boreholes (BRH20, BRH2) and a trench (SHS).

A complementary **portable station, EG009-La Herreria II** is also operational for comparison purposes at this site or for use in intensive measurement campaigns elsewhere. It includes subsurface sensors: temperature (TS), humidity (SHS) and heat flux (FCS) measurements for soil monitoring.

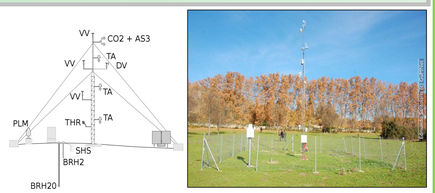


Fig 6. EG010- La Herreria automatic weather station is located in the municipality of El Escorial at 920 m.a.s.l. Atmospheric instrumentation been designed to study boundary layer evolution and CO_2 fluxes.

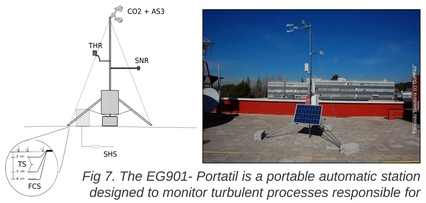


Fig 7. The EG901- Portatil is a portable automatic station designed to monitor turbulent processes responsible for soil respiration and gas exchange, such as CO_2 and H_2O vapor fluxes.

4. Atmosphere observations.

The standard WMO GuMNet station includes also: an **alpine wind monitor** (DVV), an **air temperature and humidity** sensor (THR), **ultrasonic snow height** sensor (SAN), a **4 component net radiation** sensor (SNR) and **a rain gauge** (PLM) specially designed for snow measurements. A GPRS connection is established between all the remote stations and a central server. This configuration allows to download the recorded data once a day and to verify the operational state of the instrumentation, hence **minimizing the loss of data,** like after a snowstorm (Fig 8).

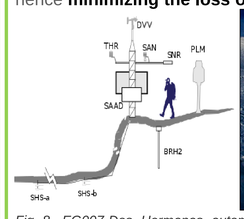


Fig 8. EG007-Dos Hermanas automatic weather station after a snowstorm. The stations is anchored in the wall of the glacier circus of Peñalara at 2.225 m.a.s.l. It has standard atmospheric instrumentation. The subsurface instrumentation consists of three temperature monitoring boreholes, one of them designed for skin temperature measurements. Besides, two trenches measure temperature and humidity, near the station and another one is located 30 m downslope below an area where snow tends to accumulate until the summer.

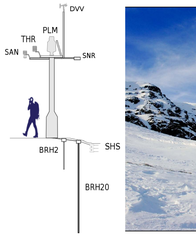


Fig 9. EG006-Hoyas automatic weather station is located in the glaciar cirque valley of Peñalara at 2.019 m.a.s.l. with realtively high grass and wetlands. The design aims at minimizing the enviromental impact. A single mast houses all atmospheric instrumentation. Since it is located in an area of high accumulation of snow during the winter season, the mast is configured to be over the snow cover and highly visible.

5. Subsurface observations.

The majority of GuMNet sites include subsurface temperature monitoring sensors. Boreholes are drilled and shaped casings installed to easily place and replace temperature sensors at **14 different depths** at each station. This is done at two monitored **experimental boreholes of 2 (BRH2) and 20 meters depth (BRH20).**

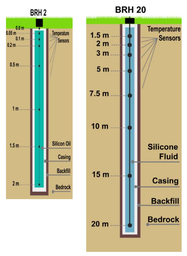


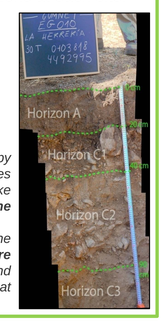
*Fig. 10.Scheme of the 20 m **(BRH20)** and 2 m **(BRH2)** borehole showing the casing of PVC and silicone oil filling where 8 temperature sensors (pt1000) are immersed at different depths in each borehole. The density of measurement points is higher close to the surface to improve the resolution of the subsurface temperature.*

Fig. 11. The Core Rock extracted during borehole drilling.

Trenches (SHS) are daug in the first layers (1-2 m) of sediment to introduce **temperature and humidity sensors**. This allows to establish and document the soil horizons at each site.

*Fig. 12. Once the spectroscopy analysis is done, a set of samples are taken in order to rmake subsequent **analysis in the laboratory***

*Fig. 13. Before covering the trench, **soil horizons are determined** and temperature and humidity sensors are placed at different depths.*



6. Informative website: http://www.ucm.es/gumnet/

Fig 14. (Left) QR code of GuMNet website. (Right) Appearance and subpages of the website.

- **About GuMNet:** Brief description of the initiative, participating institutions, contact staff and legal disclame.
- **The Facility:** Sites description, recorded variables, deployed instrumentation and maps of the area.
- **Research:** Conferences, publications and theses related.
- **International:** Current international partnerships with other networks.
- **Outreach:** Summary of activities and informative products. Videos, posters, informative broucheres and media news.
- **Internal:** Space reserved for authorized collaborators. Working groups, space for material exchange in development.

* 7. GuMNet team (institutions and research groups)

- **PalMA** (UCM), *Paleoclimate Modeling and Analysis*
- **MicroVAR** (UCM), *Micrometeorology and climate Variability*
- **GFAM** (UCM), *Geografía Física de Alta Montaña*
- **CEI** (UCM, UPM), *Campus de Excelencia Internacional*
- **PDC** (UCM), Plataforma de Divulgación Científica
- **CPD** (UCM), *Centro de Procesamiento de Datos*
- **CEIGRAM** (UPM), *Centro de Estudios e Investigación para la Gestion de Riesgos Agrarios y Medioambientales*
- *Departamento* ***Energías Renovables*** (CIEMAT)
- *Departamento* ***Medio Ambiente*** (CIEMAT)
- **IGEO** (UCM-CSIC), *Instituto de Geociencias*
- **AEMET,** *Agencia Estatal de Meteorología*
- **PNSG**, *Parque Nacional Sierra de Guadarrama*
- **PN,** *Patrimonio Nacional*

Contacts: Jesus Fidel Gonzalez Rouco [jfgr@ucm.es]
Edmundo Santolaria-Canales [edmundo.santolaria@ucm.es]