GuMNet: A high altitude Monitoring Network in the Guadarrama mountains, Madrid (Spain)

GuMNet Team*

1. Infrastructure:

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

- 10 complete WMO standard meteorological stations
- 15 experimental boreholes for monitoring the subsurface temperature evolution, distributed over the 8 WMO-type stations
- 8 trenches for direct monitoring of temperature and humidity of the soil, at each station
- 2 anemometric stations including a WMO standard set up as well as CO2 and H2O vapor flux trace analyzers and eddy covariance measurements

These high altitude locations are within the National Park Sierra de Guadarrama (PNSG), an environmentally protected area (Figure 1). 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 for 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/hidden 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 AEMET (see “GuMNet team”). The goal of GuMNet is to create a meeting point to develop educational and research synergies between diverse institutions and research groups of wide range of disciplines.

3. Eddy covariance CO2 flux

EG008-La Herreria I is a fixed anemometric tower with wind speed (VV) and air temperature (TA) sensors at three different heights. 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, the two experimental boreholes (BRH3, BRH5) and a trench (SHS). A complementary twin 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.

4. Atmospheric 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 GPS-based 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 health status of the instrumentation, hence minimizing the loss of data, if after a snowstorm (Fig. 9).

5. Software management system

The different parts of the GuMNet infrastructure and the communication system are wrapped up under a software management tool. The GuMNet-Software will help to track and maintain instrumentation as well as managing data observations and data-users in order to register all the interactions that may be relevant to facilitate data interpretation and management of the network. The vision of GuMNet is to serve as a high mountain laboratory by providing high quality data and derived products for research, teaching and leisure users of the Guadarrama mountains.

6. GuMNet team (institutions and research groups)

- PUMA (UCM), Paleoclimate Modeling and Analysis
- MicroVAR (UCM), Micrometeorology and climate Variability
- GFAM (UCM), Geografía física de Alta Montaña
- CEI (UCM, UPV), Campus de Excelencia Internacional
- POC (UCM), Plataforma de Divulgación Científica
- CPD (UCM), Centro de Procesamiento de Datos
- CEGRAM (UPM), Centro de Estudis e Investigación para la Gestión de Riscos Agrario e Medioambiental
- Depamento Energías Renovables (CIEMAT)
- Universidad de Medio Ambiente (CIEMAT)
- IECE (UCM-CSIC), Instituto de Ciencias de la Tierra
- AEMET, Agencia Estatal de Meteorología
- PNSG, Parque Nacional Sierra de Guadarrama
- PALMA, Palacio de Infraestructuras
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* GuMNet Team includes subsurface temperature monitoring infrastructure. Boreholes are drilled and shaped casings installed to easily place and replace temperature sensors at three different depths at each station. This is done at two monitored experimental boreholes of 20 m and 20 meters depth (BRH20).

Fig. 2. Attribute distribution of GuMNet automatic weather stations including the surface and subsurface infrastructure over the Pajares moraine. Note the covering of North and South sides above the Pajares moraine. GuMNet sites provide two weather sites and a portable station.

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Fig. 7. Spatial distribution of GuMNet automatic weather stations across the Sierra de Guadarrama and other meteorological stations in the area.

http://www.ucm.es/gumnet/