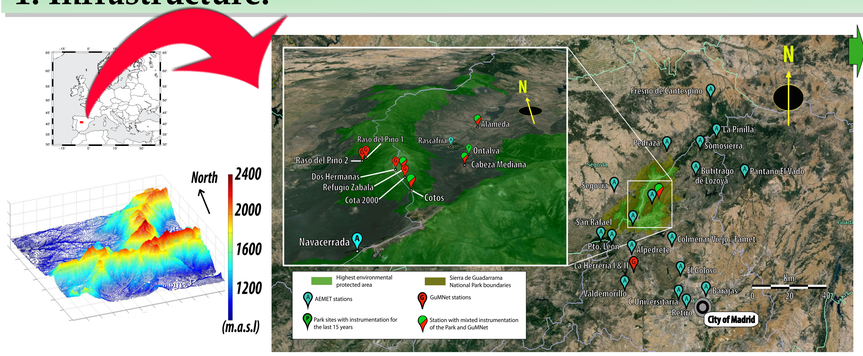
GuMNet: A high altitude Monitoring Network in the Guadarrama mountains, Madrid (Spain)

GuMNet Team *

Temporary web page:
http://tifon.fis.ucm.es/~gumnet

1. Infrastructure:

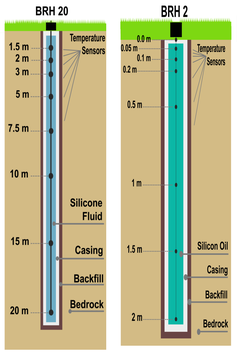


GuMNet (**Guadarrama Monitoring Network**) is a joint initiative to build up an **observational meteorological and sub-surface infrastructure** in the Sierra de Madrid, central Spain. The resulting network consists of the following instrumentation:

- **8 complete WMO standard meteorological stations**,
- **14 experimental boreholes** for monitoring the **subsurface temperature evolution**, distributed over the 8 WMO-typesites,
- **8 trenches** for direct monitoring of **temperature and humidity of the soil**, at each station,
- **2 anemometric stations** jointly with **CO_2 and H_2O 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 (see left figure, green area). 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 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. The network and its web site server **will be fully operational in 2016.**

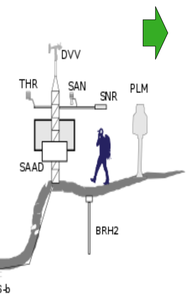
2. Soil and subsurface



An interesting feature of the GuMNet observation sites is the monitoring of subsurface temperatures. Temperature sensors are being placed at **14 different depths** at each station through two monitored **experimental boreholes of 2 (BRH2) and 20 meters depth (BRH20).** Both BRHs are filled with silicon oil to avoid freezing effects. Additionally, a trench (SHS) will be 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 as well as monitoring soil temperature and moisture.

[Top]: Drilling work at EG004-Raso del Pino I site. [Bottom]: **Core rocks** obtained by drilling the experimental boreholes. The **analysis of the samples** jointly with the **soil horizons will provide valuable metadata** of the soil and subsurface biological, physical and chemical properties that will provide complementary information to the future **GuMNet database**.

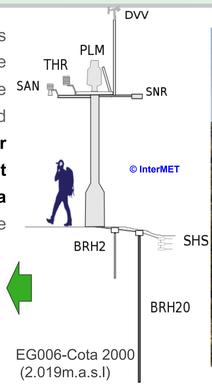
3. Atmosphere



EG005-Dos Hermanas (2.225m.a.s.l)

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 health status of the instrumentation, hence **minimizing the loss of data**. The standard GuMNet station [left] includes: 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. Note the additional subsurface infrastructure (BRH2, SHS).

EG006-Cota2000 is an example of **experimental compact meteorological station**, designed to minimize the environmental impact and to withstand high snow covered periods.

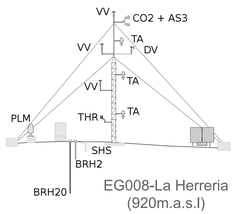


EG006-Cota 2000 (2.019m.a.s.l)

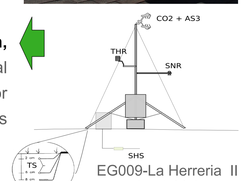
4. Eddy covariance CO_2 flux

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 and the trench.

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.



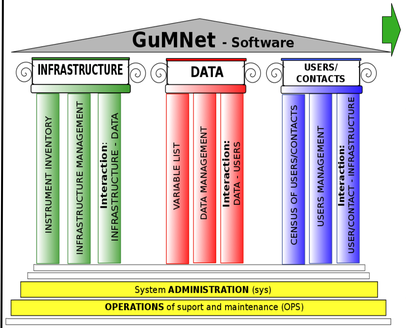
EG008-La Herreria (920m.a.s.l)



EG009-La Herreria II (portable)

(CO_2 + AS3) Campbell © Irgason

5. Software management system



The different parts of the GuMNet infrastructure and the communication system will be wrapped up under a **software management tool**. The GuMNet-Software will help to track and maintain instrumentation as well as **managing data and data-users** in order to registries all the interactions that may be **relevant to facilitate data interpretation** and management of the system.

The vision of GuMNet is to **serve as a high mountain laboratory by providing data and derived products** for research, teaching and leisure users of the Guadarrama mountains.

* 6. GuMNet team (institutions and a few names)

- **UCM :**
  - PalMA, Paleoclimate Modeling and Analysis : *J. F. González-Rouco (PI), E. Santolaria-Canales.*
  - MicroVAR, Micrometeorology and climate Variability: *C. Yagüe, G. Maqueda, L. Duran.*
  - GFAM, Geografía Física de Alta Montaña : *D. Palacios, J. Ubeda.*
  - CEI, Campus de Excelencia Internacional*: A. Casado, L. Semprún.*
  - PDC, Plataforma de Divulgación Científica *: J.Antonio Jimenez, R. Jimeno.*
  - CPD, Centro de Procesamiento de Datos: *J. De Castro .*
- **UPM:** CEIGRAM, Centro de Estudios e Investigación para la Gestion de Riesgos Agrarios y Medioambientales: *A. Tarquis, E. Luque, A. Saa.*
- **CIEMAT:**
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  - Departamento Medio Ambiente: *Rosa M. Inclán, T. Schmid*
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- **AEMET:** Agencia Estatal de Meteorología: *E.Rodríguez, M. J. Casado.*
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