



STATUS OF THE CARPENTRAS BSRN STATION (CAR)

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Carpentras Radiometric Centre

The Centre

Carpentras is a small city in the south-east of France, close to the Mediterranean sea (50km), 20km away from Avignon and 100km away from Marseille. Carpentras Radiometric Centre building was built in the countryside, between vineyards and orchards (cherries, apples, ...) several kilometers south of the Mont Ventoux. Since 1968 the building houses a meteorological station belonging to Meteo France as well as the Radiometric Centre; it has a large terrace (10mx22m) where sensors and trackers are installed. CARPENTRAS RADIOMETRIC CENTRE is integrated within the "sensor" division of the Direction of Observation Systems of Meteo France. Most of the centre activities revolve around the maintenance and calibration of radiance sensors used by the French national network (Pyranometers, Pyrhemometers, Pyrgeometers and UV-B Pyranometers). Some private operators are also part of the clients. Calibration operations of pyranometers and pyrhemometer are performed using as reference an Absolute Cavity Pyrhemometer PMO6, calibrated in the World Radiation Center (Davos) on a regular basis.

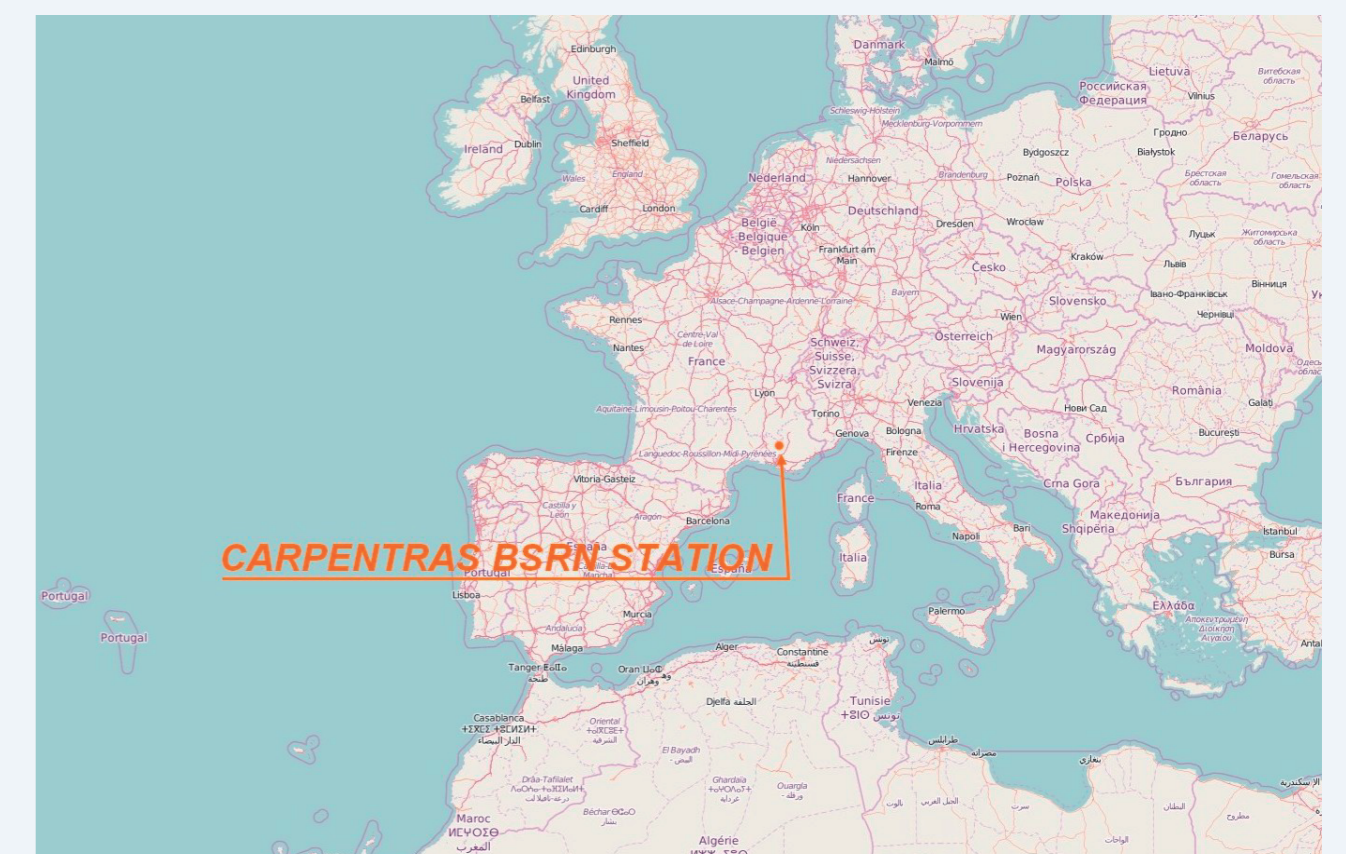
The climate is of Mediterranean type with strong contrasts between years and a marked seasonal variability with little frequent precipitation (only 80 to 100 days a year) and a very bright sky thanks to the prevailing wind the Mistral (Mistraou, master in "Provençal"). Blowing between 70 and 120 days a year it purifies and dry out the atmosphere, allowing the sun to shine completely an average of 2800 hours a year, July by counting more than 350 hours to him only.

The BSRN Station

The Centre joined the BSRN journey at the beginning, thanks to the participation of Mr Jean OLIVIERI to the Zurich meeting in September 1994. The first data transmission happened in September 1996 and has continued since, about 20 years of uninterrupted data. The transmitted data have belonged to the LR100 group since the beginning; the LR500 group (UV) has been added in 2013.

1996	Equipment	2016
Kipp&Zonen CM11	Short-wave downward (GLOBAL) radiation	Kipp&Zonen CM21
Eppley NIP	Direct radiation	Kipp&Zonen CHP1
Kipp&Zonen CM11	Diffuse radiation	Kipp&Zonen CM21
Eppley PIR	Long-wave downward	Kipp&Zonen CGR4
-	UV-b global	Kipp&Zonen UV-5-B-T
SciTech 2AP	Tracker	Kipp&Zonen Solys2
Campbell Cr10x	Data Logger	Campbell CR3000

Evolution of the Carpentras BSRN Station equipment, from 1996 to 2016.



Carpentras localisation on the map



BSRN sensors on Solys2 tracker

A Platform for scientific projects.

Calibration Platform for Aeronet (Aeroneteurope)

Through diverse European projects, several sites came onboard PHOTONS network. Today, the European activity (called AERONET EUROPE) is partly supported by the ACTRIS project (I3/FP7) and managed by LOA/CNRS/University of Lille 1 [1]. "Service d'Observation PHOTONS", managed by LOA, is a national service supported by CNRS/INSU, CNES and Lille University and is the historical French component of AERONET [2]. Its main mission is to perform long term and high quality observation of aerosol properties relevant for a better understanding of the atmosphere. More precisely, the basic activities consist in monitoring a network of sites/instruments located in France, Africa and Europe. The direct sun observations (from 340 to 1640 nm) provide an accurate measure of the atmospheric extinction yielding the Aerosols Optical Depth (AOD), a parameter quantifying the aerosols load in the local atmosphere. The instrument also measures the downward spectral sky radiances allowing, thanks to complex algorithms, the determination of relevant columnar aerosols properties. This is achieved by maintaining observation continuity, performing regular calibration and annual maintenance.

The calibration activity is centralized at Lille University in relation with Meteo France in Carpentras and Meteo Spain (AEMET) in Tenerife, Canary Island. After running for about 12 months on site, each photometer must be re-calibrated (post-calibration) by staying on multiple dedicated sites, the first being Meteo France Radiometric Centre located in Carpentras (France), chosen for its exceptional location and its number of days of sunshine. Each instrument stays between 1 and 3 weeks, the time to perform the AOD calibration, comparing with a reference instrument (also called "Master"), itself calibrated every 4 month at high altitude without aerosol.

Then, it goes back to the LOA in Villeneuve d'Ascq where luminance and polarization calibrations are performed using integrating spheres for radiance calibration. The maintenance can then be realized before a new full calibration (pre-calibration), prior to on-site deployment, is performed. Between pre-calibration and post-calibration, each channel calibration coefficient is interpolated, giving a daily calibration coefficient.

[1] <http://loaphotons.univ-lille1.fr/photons/>
 [2] <http://aeronet.gsfc.nasa.gov/>

Technical facilities for CEA solar research

Since years, the solar group at CEA Cadarache(Provence, France) studies the solar resource for Photovoltaics and for solar thermal applications [<http://www.cea.fr/english-portal>] The collaboration with the Meteo France Radiometric Centre in Carpentras allows a fruitful cooperation thanks to the skills of the 2 public bodies:

- The comparison of the absolute cavity radiometers of the 2 institutes and the development of methods for the calibration of pyranometers(see [1])
- The determination of the long-term value of the solar resource for Photovoltaics in Provence thanks to more than 3 decades of irradiance data at the Radiometric Centre (see [2])
- The study of the variability of the solar resource in several sites and climates, in a common work with the universities in Reunion Island, Corsica, Guadeloupe and Martinique (see [3]).

Regarding this last point, the measurement of the variability of irradiance in several sites in Provence is essential because in this region where the electric grid is weakly interconnected because of the proximity of the Mediterranean Sea and the Alps Mountains, a very high proportion of photovoltaic power will be introduced in the electric grids in the near future. These high penetration rates will require the setup of large capacities of power smoothing and energy storage at different time and space scales. The sizing of these capacities will depend heavily on the available solar resource and on the accuracy of its prediction.

[1] Guérin de Montgareuil, A., J.-P. Morel, et al. (2006). Performance PV France 2005-2015, a French national program on the Performance of Photovoltaics. 21st European Photovoltaic Solar Energy Conference, Dresden, Germany.
 [2] Guérin de Montgareuil, A. and J.-P. Morel (2013). Assessment of the Photovoltaic Potential and application of the MotherPV method at the French Radiometric Centre of the World Meteorological Organization. 28th European Photovoltaic Solar Energy Conference, Paris, France.
 [3] Guérin de Montgareuil, A. J.-P. Morel, S. Mével, et al. (2016). A New Method For the Benchmarking of Irradiance Prediction. 32th European Photovoltaic Solar Energy Conference, Munich, Germany.



Photometers calibration on the terrace



CEA experimentation on «Mont-Aigoual» site

Acknowledgements

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- CEA experiments at Carpentras center are lead by Mr Antoine GUERIN DE MONTGAREUIL.