# Chilbolton Observatory broadband radiometers

## Introduction

The purpose of this document is to describe the range of broadband radiometers, operating in the visible and IR, which are deployed at Chilbolton Observatory. It is aimed at both Chilbolton Observatory staff and visiting scientists who may wish to use the data. The section on aligning the solar tracker is aimed at Chilbolton Observatory staff.

All of the radiometers, and the solar tracker on which some of them are mounted, are manufactured by Kipp and Zonen.

## Radiometers

The details of the radiometers and how they are used are described in the following table. Information is also available at <https://www.chilbolton.stfc.ac.uk/Pages/Solar-and-infrared-upwelling-and-downwelling-radiation.aspx>.

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| **Radiometer model** | **Location** | **Wavelength range and purpose** |
| CM21 | Solar tracker on receive cabin roof | 305 – 2800 nm  Total downwelling (whole sky) irradiance |
| CMP21 | Solar tracker on receive cabin roof | 285 – 2800 nm  Diffuse component (whole sky excluding sun) of irradiance |
| CHP1 | Solar tracker on receive cabin roof | 200 – 4000 nm  Direct component (sun only) irradiance |
| CG4 | Solar tracker on receive cabin roof | 4.5 – 42 μm  Total downwelling (whole sky) irradiance |
| CNR4 | Flux compound on 500m range | 300 – 2800 nm (shortwave), 4.5 – 42 μm (longwave)  Includes 4 measurements: downwelling and upwelling irradiance in each of the above wavelength ranges. |
| CNR1 | Flux compound on 500m range | Old instrument, uncalibrated since manufacture, no fans to prevent condensation, included for information only.  Includes 4 measurements: downwelling and upwelling irradiance in each of the above wavelength ranges. |

Near-real-time data from some of these instruments can be seen at <https://www.chilbolton.stfc.ac.uk/Pages/Visible-and-IR-radiation-sensors.aspx> and <https://www.chilbolton.stfc.ac.uk/Pages/Yesterday-Visible-and-IR-radiation-sensors.aspx>.

## Maintenance

The broadband radiometers are cleaned at approximately 2 week intervals. All except the CNR1 incorporate fans to ensure that condensation and frost cannot form and that wetting by rain dries as quickly as possible. The alignment of the solar tracker is checked at the same time if the sun is shining, or at other times if there is reason to suspect the alignment.

The radiometers are calibrated by Kipp and Zonen at approximately 2 year intervals. In many years of operation (approximately 20 years for the CM21 and CG4) their calibration has been stable to within a few percent or less, with no unexpected changes in calibration.

## Solar tracker alignment

The solar tracker alignment is critical to the reliability of data from the CMP21 and CHP1 (diffuse and direct irradiance) instruments. It will normally continue to operate reliably if aligned, but can be pushed out of alignment by strong winds or birds landing on it.

A key sign that the alignment is incorrect is if the CHP1 fails to measure a signal, or measures too small a signal, when the sun is unobscured. Typical clear-sky values at Chilbolton at noon are ~900 – 1000 Wm-2 in summer and ~700 – 800 Wm-2 in winter. Our routine checks compare the total irradiance measured by the CM21 with the sum of diffuse irradiance (from the CMP21) and the vertical component of the direct irradiance from the CHP1 (calculated as measured direct irradiance x cos(solar zenith angle)). These calculated and measured total irradiance values should be in good agreement.

To check the alignment, observe the shadow cast by the shadow ball on the CMP21. If it is not completely shading the sensor (at the base of the glass dome), the alignment should be adjusted using the following procedure. There are also instructions in the Kipp and Zonen SOLYS2 manual.

1. Power-cycle the solar tracker and let it come to rest (takes ~ 5minutes).
2. The CHP1, mounted in the bracket on the side of the solar tracker, has no orientation adjustment of its own, so is dependent on the alignment of the tracker. Hence it must be aligned first. There are 2 pinholes in its housing. Adjust the solar tracker until the sun is transmitted through both of these pinholes. This can most easily be done in the morning, as the CHP1 is more easily reached when the solar tracker is pointing east. The azimuth of the solar tracker is adjusted by undoing the 3 allen bolts between the base of the solar tracker and its mount and manually turning it to align the azimuth. The elevation is adjusted by undoing the 2 allen set screws in the circular plates that attach the black shadow arms to the elevation mechanism. It is easiest to do this with 2 people, one to support the shadow arm and one to observe the pinholes on the CHP1.
3. At this stage, you can pause and allow the CHP1 to collect data to ensure that it is seeing a sensible magnitude of signal (providing reassurance that the CHP1 is correctly aligned), or proceed immediately to the next step.
4. Once the CHP1 is well aligned, check the shadow on the CMP21. It should be relatively central. If not, you can make further small adjustments using the same adjustments as in step 2, but if too much adjustment is needed, either step 2 wasn’t completed correctly or the shadow ball position in the shadow arm frame needs to be adjusted. That process needs access to the instrument from a MEWP as it is hard to reach from the cabin roof.
5. Power cycle the solar tracker and check the alignment after it comes to rest. If you are concerned that the alignment is still not good, repeat the alignment process from step 2.

## Data file names

Data are quality-controlled and written in a netCDF format before archiving at the Centre for Environmental Data Analysis (CEDA). The names and structure of these files changed in April 2020.

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| **Radiometer** | **Data file name April 2020 onwards** | **Data file name prior to April 2020** |
| CM21 | ncas-radiometer-1\_cao\_yyyymmdd\_radiation\_v1.0.nc | cfarr-radiometer-vis\_chilbolton\_yyyymmdd.nc |
| CMP21 | ncas-radiometer-2\_cao\_yyyymmdd\_radiation\_v1.0.nc | cfarr-radiometer-vis\_chilbolton\_yyyymmdd.nc |
| CG4 | ncas-radiometer-3\_cao\_yyyymmdd\_radiation\_v1.0.nc | cfarr-radiometer-ir\_chilbolton\_yyyymmdd.nc |
| CHP1 | ncas-radiometer-4\_cao\_yyyymmdd\_radiation\_v1.0.nc | cfarr-radiometer-vis-direct\_chilbolton\_yyyymmdd.nc |
| CNR4 | ncas-radiometer-5\_cao\_yyyymmdd\_radiation\_v1.0.nc | cfarr-net-flux-radiometer\_chilbolton\_yyyymmdd.nc |
| CNR1 | Not written as netCDF |  |

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