The J9 Strasbourg Observatory hosts since July 1996 the CO26 relative superconducting gravimeter built by the GWR company. It replaced an earlier instrument (TT70) installed in February 1987. To follow the long-term variations of gravity and calibrate the cryogenic gravimeter, we perform regular absolute gravity measurements using the FG5 #206 designed by Microg-Lacoste. Between December 2003 and December 2009, 10 to 15 absolute gravity series every year have been recorded with time lengths ranging from one day to one week. After removing geophysical corrections (for instance, solid Earth and ocean tides, polar motion, atmospheric pressure), we have observed, for 10 time series of absolute gravity measurements, significant variations up to 4 to 5 µGal per day. In this paper, we compare simultaneous recordings of the absolute and superconducting relative gravimeters. After applying the same corrections to both sets of data, we obtain in the two series similar unmodelled gravity variations, which, therefore, do not have an instrumental origin. They often occur when atmospheric pressure exhibits large and quick variations. The classical atmospheric pressure correction to gravity variations, which involves a constant admittance of -0.3 µGal/hPa between gravity and local pressure, is probably not appropriate for large and rapid pressure variations. We compare our observations to more precise atmospheric loading computations which take into account the pressure field at the station but also regionally around the station. The discrepancy between the local admittance and the loading approach is discussed in terms of the unmodelled gravity signals previously mentioned.