Exploring the Earth gravity field requires the removal of short term mass variations in the atmosphere, since these mass changes cause time variant gravity field forces acting on the orbiting satellites as well as on Superconducting Gravimeters (SG). The determination of accurate atmospheric gravity field coefficients (AGC) is indispensable to avoid aliasing effects within satellite missions. In this study we apply new methods for the determination of the AGC, focusing on the vertical distribution of the density in the atmosphere. So we combine the accuracy of the vertical integration approach and the technical undemanding surface pressure approach using the surface pressure and the centre of mass of the actual atmospheric column, which leads to an improvement of about 40% at the second degree, smaller improvements of about some percentages at low and high degrees, but none in middle degrees. We use pressure level and surface pressure data from the European Centre for Medium-Range Weather Forecasts (ECMWF), reduced to the ETOPO5 topography to obtain a stable and consistent reference surface for all datasets. To correct the atmospheric effects for SG those results can be used, i.e. the global contribution of the effect is obtained directly from the AGC. To model the regional share, pressure level data with 0.1° resolution and ETOPO1 are introduced. To overcome the low temporal resolution of those numerical weather models and the insufficient point-mass assumption in the near field, an analytical model is implemented. First results for the SG at the Conrad Observatory near Vienna are presented.