The atmosphere is a critical quantity for the determination of terrestrial and celestial reference frames from VLBI observations for several reasons: The atmosphere delays signals from extragalactic radio sources on their way to the radio telescopes, its varying mass distribution deforms the Earth surface, and the telescope structure changes as a function of temperature. In this presentation, we investigate the influence of various analysis options for loading, delay, and thermal deformation modelling on the terrestrial and celestial reference frame. For example, we assess the impact of two different a priori gradient models (a spherical harmonic expansion based on data from the ECMWF vs. site-specific values based on data of DAO) and different elevation dependencies of the gradient mapping functions on estimated station and source coordinates, and we look for correlations between delay, loading, and deformation models. The complete set of VLBI observations since 1984 was analysed with the Vienna VLBI Software VieVS, and the various effects were compared using real data against simulations.