The extraordinary success of the LHC in delivering proton-proton collisions with large integrated luminosity allows the study of top-quark-enriched data samples with unprecedented statistics. This opens new possibilities for the assessment and further refinements of detector performance, and of data analysis tools.

At the same time, different aspects of top-quark event modeling, as implemented in Monte Carlo simulations, can be tested and confronted with data with impressive precision. As an example, the description of the extra QCD radiation accompanying the top-anti-top system can be refined based on measurements.

In this context, the experimental challenges and recent results on precision top-quark physics measurements within the ATLAS experiment are summarized and reviewed. In particular, the recent ATLAS top-quark mass result, obtained using a three dimensional template method, which allows the simultaneous determination of the top-quark mass together with a global jet energy scale factor (JSF), and a relative b-quark jet to light-quark jet energy scale factor (bJSF), will be presented. This analysis achieves a relative precision on the top quark mass of 0.9%. The outlook towards the next LHC top-quark mass combination effort will also be discussed. In addition, recent ATLAS measurements of the top anti-top pair polarization and of the Wtb vertex structure will be described.