As one of the most important Active Traffic Management strategies, Adaptive Traffic Signal Control (ATSC) helps improve traffic operation of signalized arterials and urban roads by adjusting the signal timing to accommodate real-time traffic conditions. Recently, with the rapid development of artificial intelligence, many researchers have employed deep reinforcement learning (DRL) algorithms to develop ATSCs. However, most of them are not practice-ready. The reasons are two-fold: first, they are not developed based on real-world traffic dynamics and most of them require the complete information of the entire traffic system. Second, their impacts on traffic safety are always concerns but remain unclear. Aiming at filling the research gaps, existing traffic detection systems on arterials were reviewed and investigated to provide high-quality data feeds to ATSCs. Specifically, two machine-learning frameworks were developed to improve the quality of travel time data and pedestrian count data. Then, to evaluate the effectiveness of DRL-based ATSC on the real-world traffic dynamics, a decentralized network-level ATSC using multi-agent DRL was developed and evaluated in a simulated real-world network. The evaluation results confirmed that the proposed ATSC outperforms the actuated traffic signals in the field in terms of travel time reduction. To address the potential safety issue of DRL based ATSC, an ATSC optimizing both traffic efficiency and safety simultaneously was proposed based on multi-objective DRL. The developed ATSC was tested in a simulated real-world intersection and it successfully improved traffic safety without deteriorating efficiency. In conclusion, the developed ATSCs are capable of effectively controlling real-world traffic and benefit both traffic efficiency and safety.