THE COMPOSITION OF PLUTO'S ATMOSPHERE. M. Summers\textsuperscript{1}, L.A. Young\textsuperscript{2}, G.R. Gladstone\textsuperscript{3}, D. F. Strobel\textsuperscript{4}, M.J. Person\textsuperscript{5}, 'George Mason University, MSN 3F3, George Mason University, Fairfax, VA 22030, msummers@gmu.edu, \textsuperscript{2}Southwest Research Institute, Boulder, CO, \textsuperscript{3}Southwest Research Institute, San Antonio, TX, \textsuperscript{4}The Johns Hopkins University, Baltimore, MD, \textsuperscript{5}Massachusetts Institute of Technology, Boston, MA.

Introduction: The observations obtained by the New Horizons spacecraft flyby of Pluto on July 14, 2015 have provided a watershed for our understanding of the composition of Pluto's atmosphere \cite{Gladstone2016}. The key observations that provided compositional information during the flyby were the Radio Experiment (REX) instrument, that performed uplink X-band radio occultations, the Alice instrument, that carried out extreme- and far-ultraviolet solar occultations, and the Long Range Reconnaissance Imager (LORRI) and the Multispectral Visible Imaging Camera (MVIC) \cite{Young2018}.

These observations, along with chemical and thermal models, have provided a coherent and consistent picture of the vertical distribution of nitrogen and methane, as well as temperature, in Pluto’s atmosphere from the surface to upper atmosphere at nearly ~1500 altitude \cite{Strobel1996}. In addition, Alice measured ultraviolet absorption due to the minor constituents C2H2, C2H4, C2H6, and HCN from which their abundances have been determined in the lower and middle atmosphere (below ~400 km).

These observations have also revealed a global haze layer extending from the ground to over 500 altitude \cite{Cheng2017}. The haze distribution is complex, with numerous individual thin haze layers embedded within the background haze. The formation of this haze is intimately tied to the distribution of the condensable species that were detected by Alice, including C2H2, C2H4, C2H6, and HCN \cite{Strobel2017}, as well as the temperature structure. Thus the haze provides indirect information on the distribution of photochemically produced species that complement the Alice measurements.

In this review we will discuss the key observations that have given us this understanding of the compositional structure of Pluto’s lower (< 30 km), middle (30-400 km) and upper (> 400 km) atmosphere, along with the associated compositional measurement uncertainties \cite{Young2018, Gladstone2018}. We will also discuss how the compositional information informs our understanding of chemical, dynamical and thermal processes controlling the chemical structure of the atmosphere. And finally, we will identify important and yet unanswered questions that require new and/or better laboratory measurements and models needed to improve our understanding of Pluto’s atmospheric composition.