CARBON IN COMETS. M. Womack, [1]University of South Florida

Introduction: Comets provide a unique opportunity to study the formation of the solar system since they are among the best-preserved specimens of the material of the protosolar nebula cloud out of which the solar system formed. Comets may have delivered important organics to a young Earth, and even now they contribute material to solar system bodies. Understanding how comets become active and generate comae is critical to developing a robust model of nucleus composition and structure. Comets exhibit different kinds of activity, depending on how far they are from the Sun. Comets within 3 AU of the Sun, for example, are dominated by the sublimation of water ice directly from the nucleus. On the other hand, many comets that are active beyond 3 AU appear to be driven by CO and CO_2 outgassing and sometimes expel dramatic outbursts of gas and dust. In addition, to sublimating directly off the nucleus, some molecules are released into comae by photodissociation of molecules already in the coma ("extended sources"), which can give misleading results about the amounts and kinds of activity in comets.

Cometary Carbon inventory: Carbon is the fourth most abundant element in the universe and its chemical behavior is predicted to have played a significant role in the overall chemistry of the early solar system. Interestingly, carbon is measurably depleted when compared to interstellar values in the gaseous component of most comets, and it may be found primarily in the solid organic component. In order to correctly account for the atomic carbon budget in comets, it is vital to know whether the observed gaseous species sublimated directly from the nucleus, or were produced from larger molecules, dust, or icy grains from the coma. Furthermore, while water is the dominant ice in comets, the relative abundances of the dominant organic species, such as CO, CO_2, CH_3OH, HCN, H_2CO, CH_4, can vary significantly among comets. These differences can be attributed to different formation environments and/or processing histories.

Coma Formation and Abundances: Understanding how comae are generated in comets is critical to developing accurate models of nucleus composition. In order to convert measured gas production rates (molecules per second) to chemical abundances, models for the distribution and kinematics of gas species are needed, along with laboratory data. It is also important to know whether the observed gaseous species sublimated directly from the nucleus, or sublimated from icy grains in the coma, or are photodissociation products of other distributed sources. Carbon monoxide and CO_2 are of special interest, because although water ice sublimation clearly dominates the activity for most observed comets, CO and CO_2 drive the activity of most comets beyond 4 AU, and can contribute to activity closer to the Sun. Furthermore, measured abundance ratios, such as CO/CH_4, CO/CO_2, and CO/N_2, can provide important constraints to the physical and chemical environment of the comet-forming regions, which will be discussed.