PLUTO ATMOSPHERE PHOTOCHEMICAL MODELS FOR NEW HORIZONS. G. R. Gladstone[1], Y. L. Yung[2], and M. L. Wong[2], [1]Southwest Research Institute, 6220 Culebra Road, San Antonio, TX 78238 (rgladstone@swri.edu), [2] Caltech, 1201 E. California Blvd., Pasadena, CA 91125 (yly@gps.caltech.edu, mlwong@caltech.edu).

Introduction: During the New Horizons flyby of the Pluto system on July 14, 2015 a number of observations will be made to determine the structure, composition, and variability of Pluto's atmosphere. A key observation of this type is the Alice solar occultation, which will measure the full disk ultraviolet (52-187 nm) spectral flux from the Sun through ingress and egress behind Pluto, about one hour after closest approach. This observation will be used to determine the temperature and vertical density profiles of N_2, CH_4, and various minor species above two regions of very different surface albedo. Nearly simultaneous Earth ingress and egress occultations observed in X-band uplink will provide profiles of temperature and pressure in Pluto's lower atmosphere, and electron densities in the ionosphere. Wave structures in both the solar and radio occultation data will provide constraints on atmospheric dynamics. In order to interpret and understand these data sets, we have modified a 1-D Titan photochemical model to Pluto, for the epoch of the New Horizons flyby. The model uses a similar, but updated reaction list to that of [1] and [2], and adopts the results of [3] for the background atmosphere.

Here we examine the large effect that the assumed eddy diffusion profile has on the predicted abundance profiles of major higher hydrocarbons and nitriles expected in Pluto's tenuous atmosphere. We estimate the eddy diffusion coefficient as a function of altitude using the free convection formulation given by [4], with the mixing length defined with respect to atmospheric stability [5]. As with [5], we set a lower bound to the mixing length of 0.1 scale heights in the radiative regions of the atmosphere. The entire profile is scaled by a constant factor such that the surface value is a fixed value ranging from 3×10^3 to 2×10^7 $cm^2\ s^{-1}$, and these model K profiles are shown in Fig. 1.

The results illustrate a fundamental dichotomy in the atmosphere of Pluto. In the upper atmosphere, hydrocarbons and nitriles are photochemically produced. Near and at the much colder surface, these compounds condense and are permanently removed from the atmosphere. The eddy diffusion profile K connects the two regions via transport. Thus, in the limit of a very small K (as assumed in [1]), photochemistry dominates throughout the atmosphere until very near the surface. The model prediction of the photochemical ptoducts (e.g., C_2H_2 and HCN) are high, except near the surface. As K is increased, faster transport leads to rapid loss of of the higher hydrocarbon and nitrile photochemical products (see acetylene and hydrogen cyanide profiles in Figs. 2 and 3, respectively).

These results will be tested by the Alice solar occultation measurements, as shown in Fig. 4.

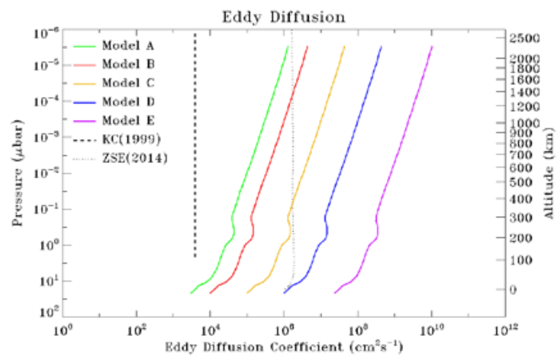

Fig. 1. The five solid colors show the model eddy diffusion coefficient profiles for Pluto's atmosphere used in this study. The black dashed line shows the constant $K=4\times10^3$ $cm^2\ s^{-1}$ eddy diffusion used by [1], and the dotted black line shows the eddy diffusion profile used by [3].

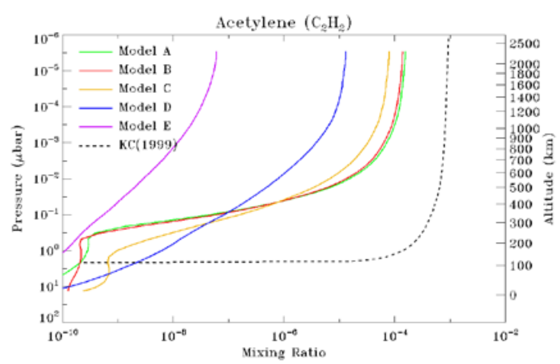

Fig. 2. Predicted abundance profiles for acetylene in Pluto's atmosphere. The five solid colors show C_2H_2 mixing ratios obtained for surface eddy diffusion coefficients (K_0) as indicated, with $K\propto n^{-0.5}$. The black dashed line shows the C_2H_2 obtained by [1], with constant $K=4\times10^3$ $cm^2\ s^{-1}$.

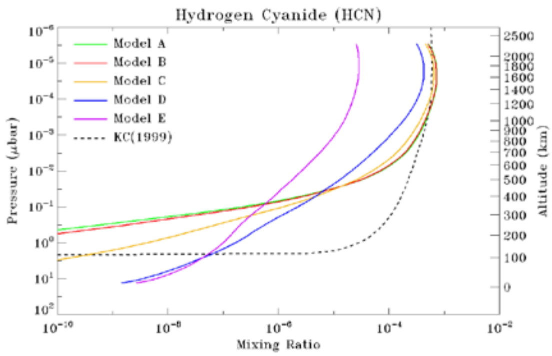

Fig. 3. As for Fig. 2, but for hydrogen cyanide (HCN) rather than acetylene (C_2H_2).

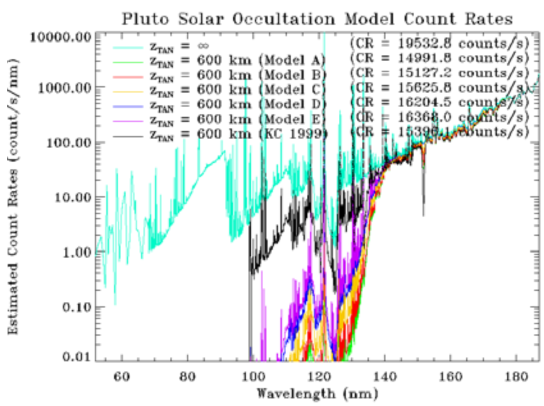

Fig. 4. Simulated Alice count rate spectrum during a solar occultation by Pluto, with the Sun at a tangent altitude of 600 km. The actual eddy diffusion profile will be well determined by these data.

References: [1] Krasnopolsky V. A. & Cruikshank D. P. (1999) *JGR, 104,* 21,979. [2] Wong M. L., Yung Y. L. & Gladstone G. R. (2014), AGU abstract # P31E-07. [3] Zhu X., Strobel D. F. & Erwin J. T. (2014) *Icarus, 228,* 301. [4] Gierasch P. J. & Conrath B. J. (1985) in *Recent Advances in Planetary Meteorology*, Cambridge University Press, New York. [5] Ackerman A. S. & Marley M. S. (2001) *ApJ*, 556, 872.