COOPERATIVE AGREEMENT #NCC 2-994
between
NASA Ames Research Center
and
The Catholic University of America

PHOTOCHEMISTRY OF PLUTO'S ATMOSPHERE

FINAL TECHNICAL REPORT

This work included studies of two problems:

I. Modeling of thermal balance, structure, and escape processes in Pluto's upper atmosphere.

This study has been completed in full. A new method of analytic solution for the equation of hydrodynamic flow from an atmosphere has been developed. It was found that the ultraviolet absorption by methane which was previously ignored is even more important in Pluto's thermal balance than the extreme ultraviolet absorption by nitrogen. Two basic models of the lower atmosphere have been suggested, with a tropopause and a planetary surface at the bottom of the stellar occultation lightcurve, respectively. Vertical profiles of temperature, density, gas velocity, and the CH_4 mixing ratio have been calculated for these two models at low, mean, and high solar activity (six models). We prove that Pluto's atmosphere is restricted to 3000-4500 km, which makes possible a close flyby of future spacecraft. Implication for Pluto's evolution have also been discussed.

2. Modeling of Pluto's photochemistry.

Based on the results of (1), we have made some changes in the basic continuity equation and in the boundary conditions which reflect a unique case of hydrodynamic escape and therefore have not been used in modeling of other planetary atmospheres. We model the photochemistry of 44 neutral and 23 ion species. This work requiered solution of a set of 67 second-order nonlinear ordinary differential equations. Two models have been developed. Each model consists of the vertical profiles for 67 species, their escape and precipitation rates. These models predict the chemical structure and basic chemical processes in the current atmosphere and possible implication of these processes for evolution. This study has also been completed in full.

The results of this work presume major revisions in two chapters of *Pluto and Charon* (eds S. A. Stern and D. J. Tholen, Univ. Arizona Press, Tucson, 1997). These results have been published in

1. V. A. Krasnopolsky. Hydrodynamic flow of N_2 from Pluto. *J. Geophys. Res. (Planets) 104*, 5955-5962, 1999.

2. V. A. Krasnopolsky and D. P. Cruikshank. Photochemistry of Pluto's atmosphere and ionosphere near perihelion. *J. Geophys. Res. (Planets) 104*, 21,979-21,996, 1999.

and presented at

1. The 23rd General Assembly of the European Geophysical Society, April 1998, Nice, France.

2. The 30th Annual Meeting of the AAS Division for Planetary Sciences, October 1998, Madison, Wisconsin.

3. Workshop for Pluto and Triton, September 1999, Flagstaff, Arizona.

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