Uranus Atmospheric Model for Engineering Application

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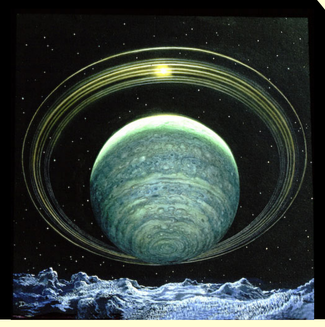


Background

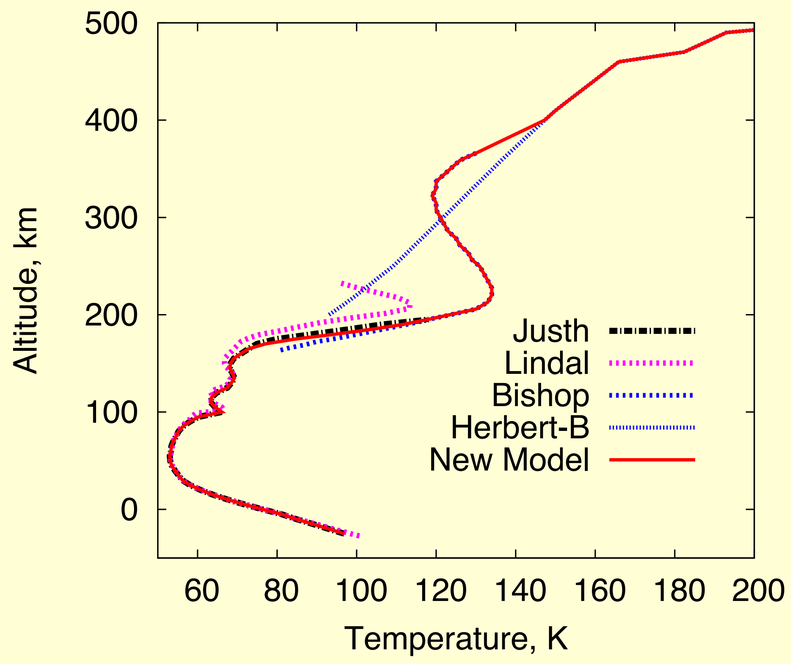
Most of what is known about the Uranus atmosphere came from the Voyager-2 fly-by that occurred on 24 January 1986. No other spacecraft has since travelled near Uranus. The seminal atmospheric model publications originating from this flyby were by G.F. Lindal, et al [1] for the lower atmosphere and F. Herbert, et al [2] for the upper atmosphere. Herbert's original paper was soon superseded by a paper by J. Bishop, et al [3].

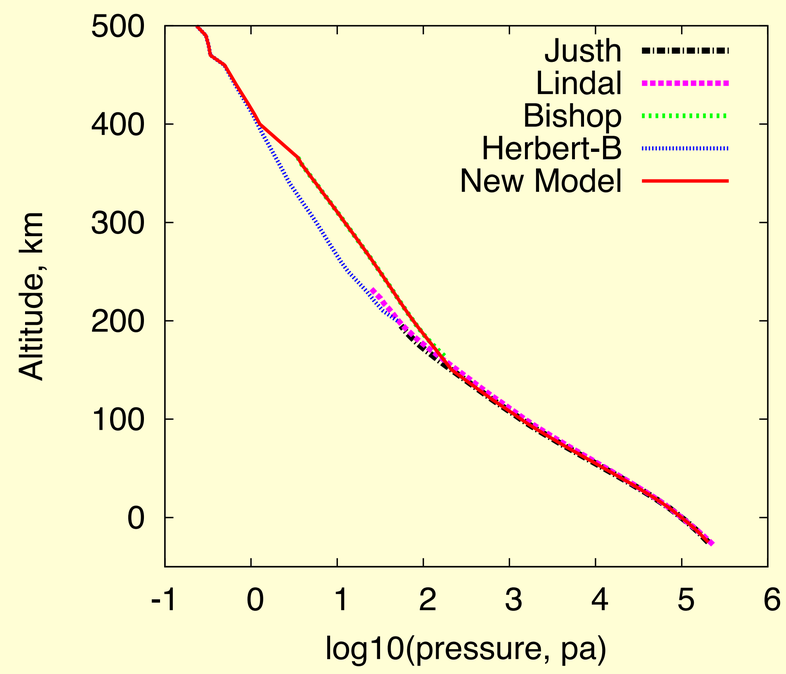
The Need for a Uranus Atmospheric Model for Engineering Application

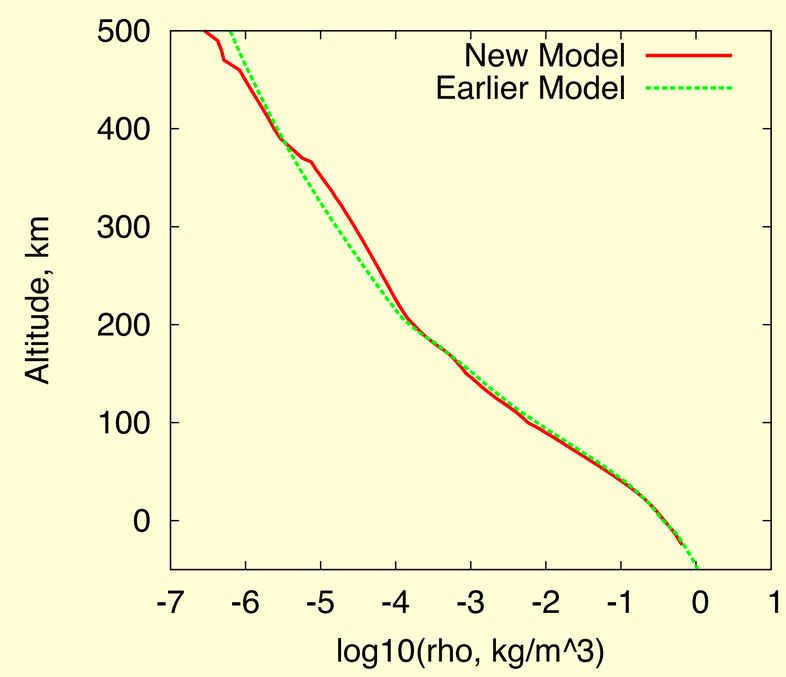
The Entry Vehicle Technology project was tasked to perform a study that established a range of probe atmospheric entry environments based on the Uranus Flagship mission outlined in the Planetary Science Decadal Survey [4]. This study necessitated trajectory simulations of probes entering the atmosphere of Uranus. An earlier atmospheric model for Uranus existed but this model's range was insufficient for the study and the model's origins were unknown. A new atmospheric model for Uranus was required that covered the entire altitude range of interest and was directly traceable to the seminal papers of the Voyager-2 fly-by.

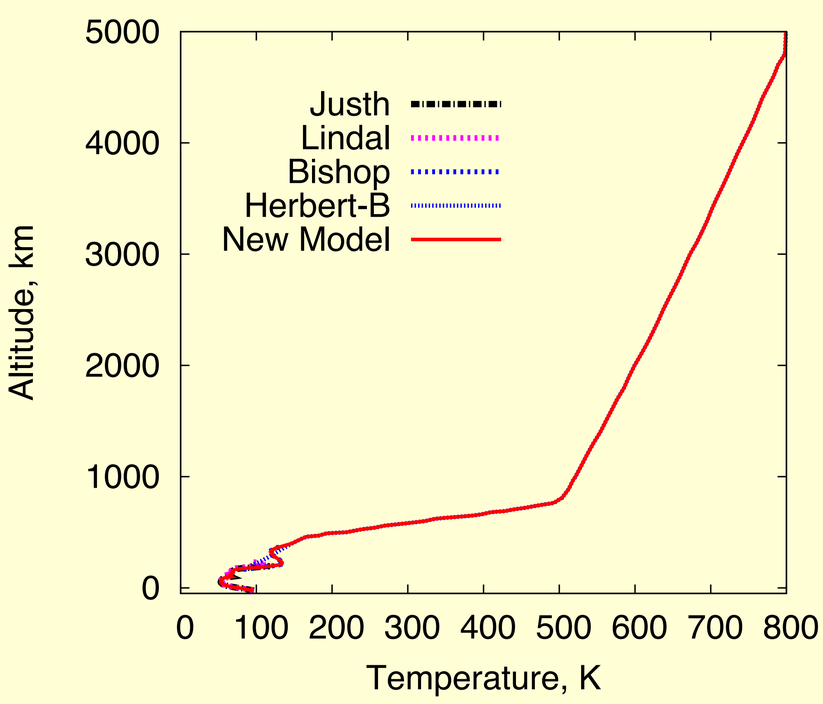
Methodology

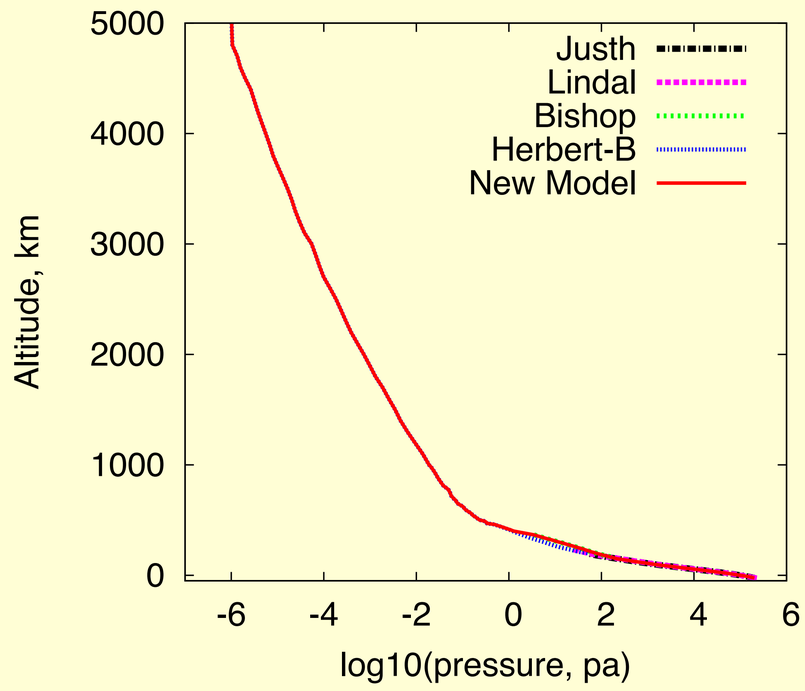
Data was digitized from the seminal papers [1][2][3]. A single use data management program was written to read in the seminal data and interpolate them into a new unified atmospheric model. The best stratospheric atmospheric model that was found, comes from Table 1 of Bishop, et al's paper [3]. A significant aspect of Bishop's model was its clear indication of a mesopause. When the Bishop model was plotted on top of the Justh and Lindal models, it was discovered that the Justh model tended to better overlay [5]. Users of this Voyager era-derived model should be mindful that there is evidence for significant seasonal variation in the thermal profiles (to be expected since Uranus' axis-of-rotation is nearly in its orbital plane) [6].

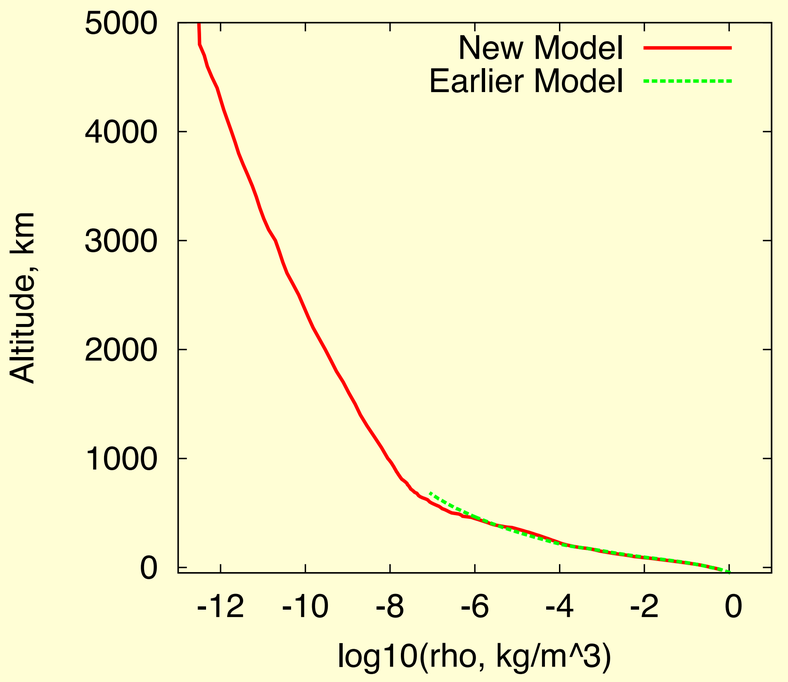












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[2] "The Upper Atmosphere of Uranus: EUV Occultations Observed by Voyager 2", Floyd Herbert, B.R. Sandel, R.V. Yelle, J.B. Holberg, A.L. Broadfoot, D.E. Shemansky, S.K. Atreya and P.N. Romani, J. of Geophysical Research, Vol. 92, No. A13, Pg. 15,093- 15,109, 30 Dec 1987.

[3] "Reanalysis of Voyager 2 UVS Occultations at Uranus: Hydrocarbon Mixing Ratios in the Equatorial Stratosphere", J. Bishop, S.K. Atreya, F. Herbert and P. Romani, Icarus, Vol. 88, No. Pg. 448-464, 1990.

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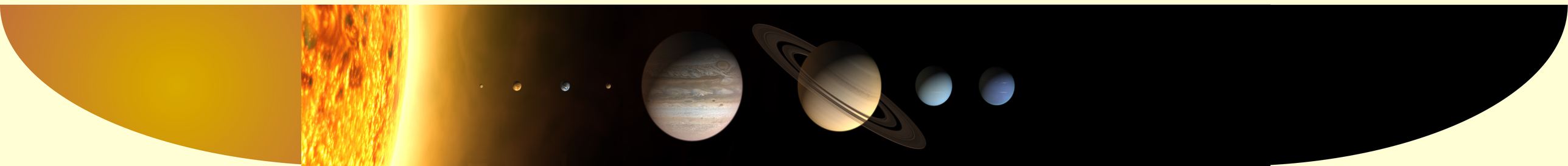
[5] *private communications*, Hillary Justh, NASA, Marshall Space Flight Center.

[6] "Post-Equinoctial Observations of the Ionosphere of Uranus", Melin, Henrik, et al, Icarus, Volume 223, Issue 2, p. 741-748, 2013.

Note: This atmospheric model will be documented in a NASA-TM as well as published in an archival journal.