**OBSERVATIONS OF URANUS' DYNAMIC ATMOSPHERE: CONSEQUENCES FOR PROBE-ORBITER MEASUREMENTS.** R. Hueso[1] and T. Guillot[2], [1]Física Aplicada, UPV/EHU, Escuela de Ingeniería de Bilbao, Plaza Ingeniero Torres Quevedo, 1 48013 Bilbao, Spain (ricardo.hueso@ehu.eus), [2]Université Côte d'Azur, Observatoire de la Côte d'Azur, CNRS, Laboratoire Lagrange, CS 34229 F-06304 NICE Cedex 4 (tristan.guillot@oca.eu).

Uranus atmosphere is enigmatic in many aspects. The apparently bland visual aspect of the planet hides a complex band system that is decoupled from a simple set of broad jets [1-2]. Being a planet with a tilted axis, seasonal changes are strong in the stratosphere [3], and accumulated observations since the Voyager 2 flyby show variations in the overall albedo, abundance of hazes, visual aspect of the planet, and frequency of apparently convective systems [2].

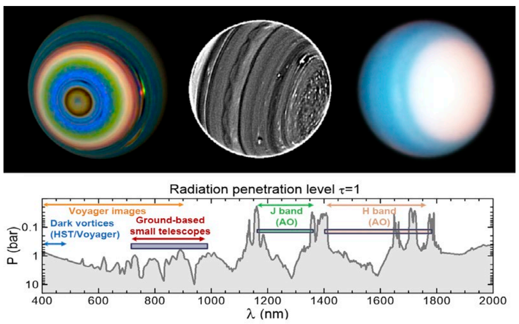


*Figure 1. Changes in Uranus visual appearance since the Voyager 2 flyby in different wavelengths. The lower panel shows a modeled radiation penetration level for an hydrogen atmosphere in the absence of clouds. Observations in J and H band, where Adaptive Optic observations work best are limited to the upper troposphere. Figure adapted from [2].*

The spatial heterogeneity of the upper atmosphere includes hazes, cloud systems, abundance of methane, winds (and possibly their vertical shear through latitudinal gradients of temperature and condensables).

Many of these heterogeneous properties can be investigated with the 30-m class telescopes under development (ELT, GMT, and TMT). Their planned exquisite Adaptive Optic Systems will offer the capability to image and obtain image and spectroscopic data of Uranus with a spatial resolution that might reach the 3 mas scale (roughly 50 km over Uranus' surface at the sub-Earth point). However, they will not be able to observe the lower cloud systems, like dark spots possibly formed in the H2S cloud layer [7]. More importantly, these ground-based observations might not observe the location where a probe could enter the atmosphere, or the various time-scales associated to meteorological systems. Experience gained through the Galileo mission shows how important such a characterization can be [7].

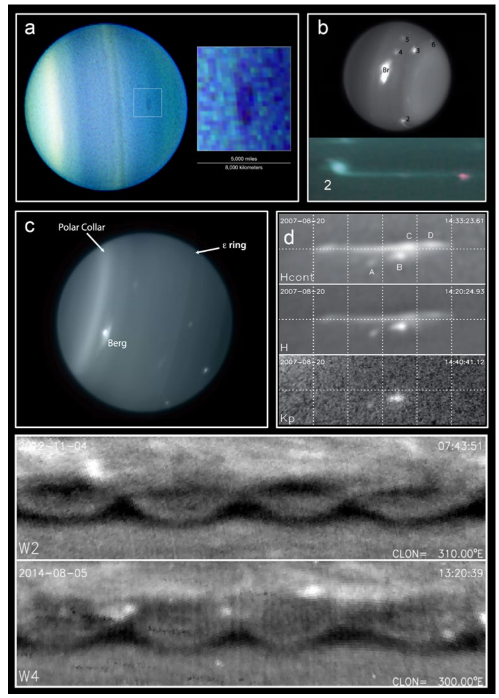


*Figure 2. Selection of high-resolution observations of Uranus showing: (a) a dark spot only observable in short wavelengths [4]; (b) bright haze systems in 2014 with one of them possibly of convective origin (feature 2 in the image) [5]; (c-d) the long-lived Berg system [6]; (e) details of equatorial waves [1]. Figure adapted from [2].*

Here we will discuss the role of orbiter observations to characterize the probe entry location, and how the combination of both data sets will provide a transformative understanding of atmospheric dynamics in hydrogen atmospheres rich in volatiles.

**References:**

[1] Sromovsky, L.A. et al., Icarus (2015)
[2] Hueso, R. and Sánchez-Lavega, A., SSR (2019)
[3] Moses et al. Icarus (2018)
[4] Hammel et al. Icarus (2009)
[5] de Pater et al. Icarus (2015)
[6] de Pater et al. Icarus (2011)
[7] Wong, M.H. et al. AJ (2020)
[8] Orton, G.S. et al. JGR: Planets (1998).