MOIST CONVECTION IN ABYSSAL HYDROGEN ATMOSPHERES: URANUS AS A LABORATORY FOR METEOROLOGY ACROSS THE GALAXY. S. Markham[1], T. Guillot[1] and C. Li[2], [1]Université Côte d'Azur, Observatoire de la Côte d'Azur, CNRS, Laboratoire Lagrange, France (steve.markham@oca.eu). [2]University of Michigan Dept. Climate and Space Sciences Engineering, Ann Arbor, USA

Abstract: Uranus is a close solar system analogue to a highly abundant class of exoplanets involving a deep hydrogen envelope heavily enriched in condensable species. In this work we comment on two poorly understood theoretical problems related to this configuration: convective inhibition, and deep rain.

Due to the differences in molecular weight between hydrogen and condensing species (e.g., methane, water), convection may shut down on Uranus, impeding efficient heat transfer between the interior and the atmosphere. While this possibility has been demonstrated theoretically, existing observational evidence cannot conclusively determine the extent to which convective inhibition affects Uranus' atmospheric structure and intrinsic heat flux. While this is of course of interest in the context of understanding Uranus itself, it has broader implications as a natural laboratory of the fluid dynamic phenomenon itself. If convective inhibition indeed plays a central role in governing Uranus' climate and heat flow, then it may likewise be important on exoplanets where we expect the effect of convective inhibition to be even more extreme. Therefore characterizing the role of convective inhibition on Uranus' thermal structure and meteorology should be a priority for a Uranus mission, in which a probe would play a crucial role.

Another consequence of moist convection in abyssal hydrogen atmospheres involves understanding the hydrodynamics of vaporized rainy downdrafts. Juno mission observations suggest ammonia may be depleted to depths far beneath its vaporization level. While "mushball theory" provides a satisfying explanation to this observation, we cannot rule out the possibility that there may be important additional contributing factors. In particular, moist convection is characterized by spatial and temporal intermittency in convective activity. We argue that a spatially concentrated over-dense downwelling thermal may not mix efficiently with its surroundings. Such a thermal can remain coherent and spatially concentrated while penetrating to great depths. Characterizing the vertical and latitudinal spatial variation of methane will allow us to assess the extent to which observations of ammonia on Jupiter are particular to the peculiarities of the Jovian multicomponent system, or to what extent they may be a more common consequence of moist convection in abyssal atmospheres. Therefore a global mapping of methane distribution in Uranus' troposphere is likewise an attractive goal with far-reaching implications, and should be considered when designing an in situ mission.

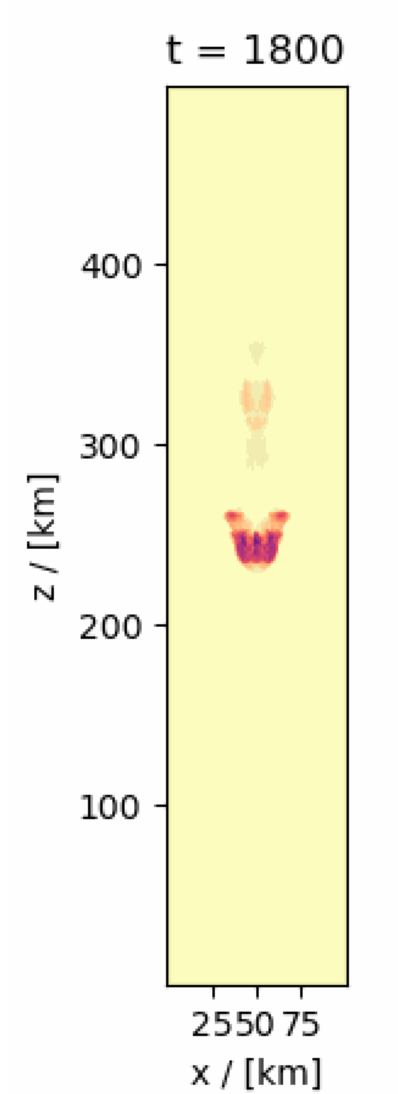

Figure: Snapshot of a high resolution 3D simulation of a localized downwelling thermal in a highly compressible environment.