JUPITER'S POSSIBLE LOW WATER ABUNDANCE AS A TESTIMONIAL OF PECULIAR FORMATION CONDITIONS. O. Mousis[1], A. Aguichine[1], A. Schneeberger[1], T. Cavalié[2], J.I. Lunine[3], K.E. Mandt[4], and U. Srisuchinwong[1]. [1]Aix Marseille Univ, Institut Origines, CNRS, CNES, LAM, Marseille, France (olivier.mousis@lam.fr), [2]Laboratoire d'Astrophysique de Bordeaux, Univ. Bordeaux, CNRS, Pessac, France, [3]Cornell University, Ithaca, NY, USA, [4]Johns Hopkins Applied Physics Laboratory, Laurel, MD, USA.

Introduction: Observations of extrasolar planets have shown the possible existence of a new class of giant planets, the so-called carbon-rich planets (CRP) [1]. A CRP is defined as a planet with a carbon-to-oxygen (C/O) ratio ≥ 1. In the solar system, the C/O ratio remains poorly constrained in the giant planets because obtaining a measurement of the water abundance below the meteorologically active layer is difficult. Despite these difficult characterization conditions, several reasons suggest that Jupiter could be a CRP. Recent formation scenarios of Jupiter invoke a substantial migration of the planet during its growth, perhaps interior to the location of the snowline in the protosolar nebula (PSN) [2,3]. This possibility is supported by Juno's measurement of the deep-water abundance in Jupiter, suggesting it could be subsolar [4,5].

In the following, we investigate the potential mechanisms at play in the PSN that could generate a C/O ratio ≥ 1 in the solids and vapors that evolve throughout the disk. To do so, we use a 1D accretion disk model to compute the properties of the protosolar nebula (PSN) that includes radial transport of trace species, present in the form of refractory dust, a mixture of ices and their vapors, to compute the composition of the PSN [6,7]. We focus on the radial transport of volatile species by advection-diffusion combined with the effect of icelines, computed as sublimation/condensation rates. Initially, the disk is uniformly filled with H_2O, PH_3, CO, CO_2, CH_4, CH_3OH, NH_3, N_2, H_2S, Ar, Kr and Xe, corresponding to the main bearers of C, N, O, P, S, Ar, Kr and Xe. As the PSN evolves, solid particles drift inward due to gas drag. Volatile species are thus efficiently transported to their respective icelines, where they sublimate. Two cases are considered for the formation of crystalline ices in the PSN: i) presence of pure condensates and vapors, and ii) presence of clathrates, pure condensates, and vapors. The latter case is ruled by the presence of available crystalline water at the considered location and epoch of the PSN evolution.

At the locations and epochs when the C/O ratio ≥ 1 in the PSN, we examine if the disk composition is consistent with the supersolar C, N, S, Ar, Kr, and Xe abundances measured by the Galileo probe in the envelope of Jupiter. *This strategy allows us to identify the epoch of the PSN evolution and the region where Jupiter could have formed with properties corresponding to those of CRPs.*

References. [1] Madhusudhan, N., Mousis, O., Johnson, T.V., et al. (2011), ApJ, 743, 191. [2] Walsh, K.J., Morbidelli, A., Raymond, S.N., O'Brien, D.P., & Mandell, A.M. (2011), Nature, 475, 7355. [3] Liu, B., Raymond, S.B., & Jacobson, S.A. 2021, Nature, 604, 643. [4] Li, C. et al. (2020), Nature Astronomy, 4, 609. [5] Helled, R., et al. (2022), Icarus, 378, 114937. [6] Aguichine, A., Mousis, O., & Lunine, J.I. PSJ, in press. [7] Schneeberger, A., Mousis, O., Aguichine, A., et al. (2022), in prep.