Geophysical Research Abstracts
Vol. 16, EGU2014-8752, 2014
EGU General Assembly 2014

Uranus and Neptune structure models with ab initio EOS data for CH4, NH3, and H_2O

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Uranus and Neptune are supposed to be rich in ices in their deep interiors as their mean density closely resembles that of liquid water. Moreover, highly super-solar abundances of CH4 and CO, indicative of internal water, have been observed in their atmospheres. We here compare ab initio equations of state for CH4, NH3, and H_2O and apply them to compute ice-rich, adiabatic internal structure models of Uranus and Neptune. The explicit consideration of the light ices CH4 and NH3 allows us to put tighter constraints on the minimum H/He abundance in their deep interior, which was found to be non-zero in all previous Uranus and in most of the Neptune models that were based on water as a proxy for ices. In particular, we investigate if hydrogen in the deep interior can solely be a result of assumed Carbon sedimentation (diamond rain), as an alternative scenario to the early accretion of H/He containing material during the formation of the planets. We conclude by discussing the deep internal H/He abundance in light of rock-rich and warmer-than-adiabatic interiors, which has been suggested to explain Uranus' low intrinsic luminosity. Our models serve to better understand the formation and bulk composition of Neptune-sized planets.