Giant Planet Atmospheres Do Not Have Stellar Composition

1. Processes that matter

0. Main carriers of CNOH as a function of time

1. Which snow lines and where are they

   - Assume nitrogen is mainly in N_2 and NH_3; assume hydrocarbons are primarily CH_4 → three cases:
     (a) all nitrogen is N_2 and no CH_4
     (b) 10% of nitrogen is NH_3 and no CH_4
     (c) all nitrogen is N_2 and 5% of carbon is in CH_4
   - binding energy for $N_2 = 790 \pm 25$ K (Öberg et al. 2005)
   - N_2 abundance: look in Pontoppidan et al. (2003), papers cited in Bisschop et al. (2006)
   - NH_3 abundance: Lahuis & van Dishoeck (2000), Boogert et al. (2008), Dodson-Robinson et al. (2009)
   - make C/O and N/O ratio plots similar to Figure 1 in Öberg et al. (2011)

2. Snow line evolution with time

   - consider evolution both in terms of disk temperature and chemical composition
   - Garaud & Lin (2007), also papers by Scott Kenyon

3. Shape of snow line

   - include "cold finger effect", e.g. Stevenson & Lunine (1988), Cuzzi & Zahnle (2004), Ciesla & Cuzzi (2006)
   - Stevenson & Lunine (1988) derive an approximate cold finger solution for the size of the area where the surface density of water ice is enhanced near the orbit of Jupiter

4. Planetesimal build-up including drift

   - calculate drift rate as a function of the size of the planetesimal and compare to the evaporation rate; follow Weidenschilling (1977), Chiang & Youdin (2010) (which has all the correct coefficients) for the drift calculation

- also calculate desorption timescale and the distance traveled by the planetesimal as a function of radius (e.g., for the H_2O and CO snowlines)

5. Core accretion including migration
   - can derive analytic formula similar to equation (2) from Öberg et al. (2011) that takes into account different C/O ratio between different snow lines
   - discuss both Type I and Type II migration
6. Runaway atmospheric accretion
7. Late stage accretion
8. Core dredging
   - refs in Lodders (2009); also Stevenson (1985), Guillot et al. (2004)

Other things to consider:

- Potential planet formation locations
- Monte Carlo simulation including the processes that we find are relevant

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