Evolution of the reservoir of volatiles in the protosolar nebula

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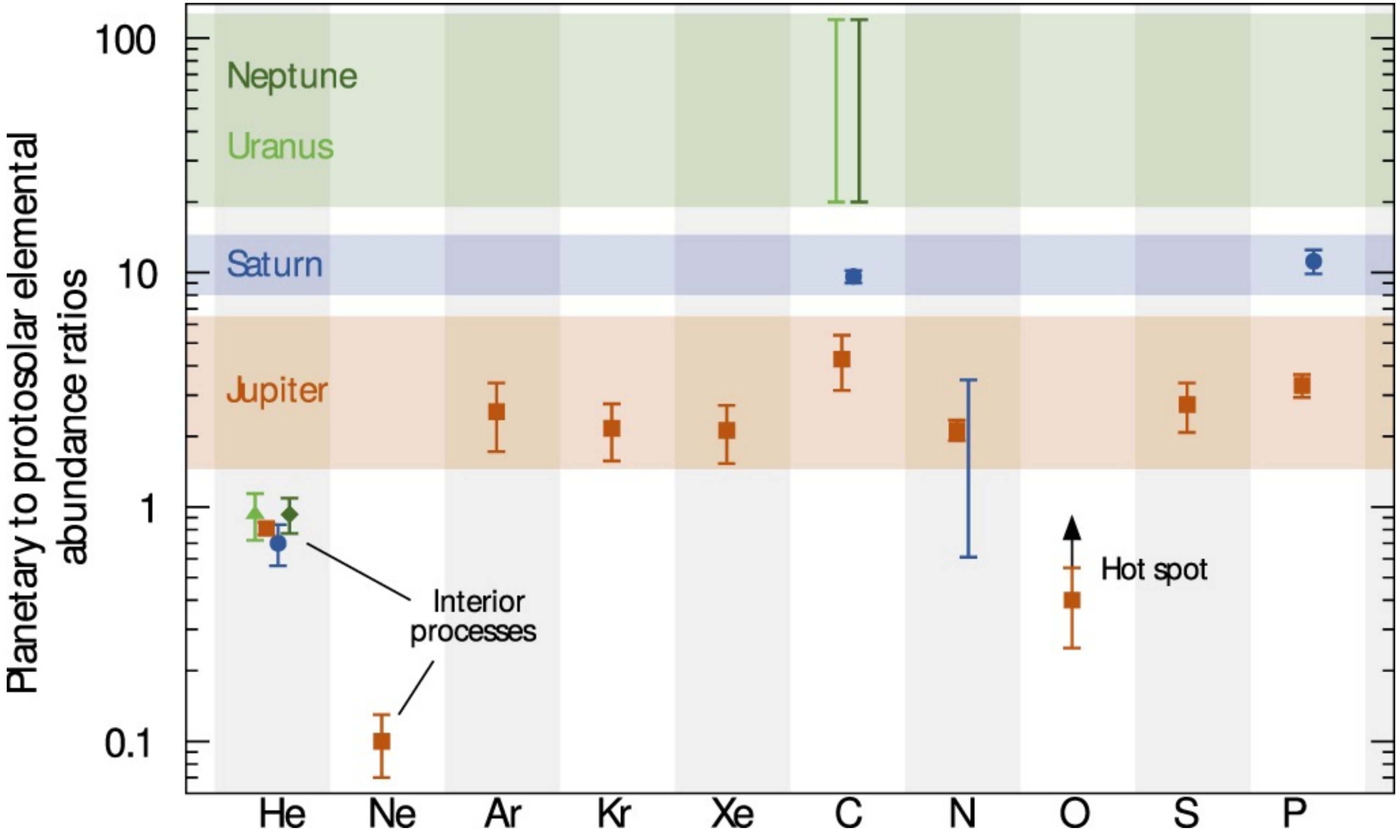
Volatiles in Giant Planets



High volatile enrichments in gas and ice giants :

- **Jupiter :** 2-3 times protosolar abundances
- **Saturn :** 10 times
- **Uranus & Neptune :** Up to 100 times

Volatiles in comets

C/2016 R2 PanSTARRs

- A ‘dry’ comet with only a ratio H_2O/CO of 0.32%.
- A N2 rich comet with a ratio N_2/CO of 0.6 %

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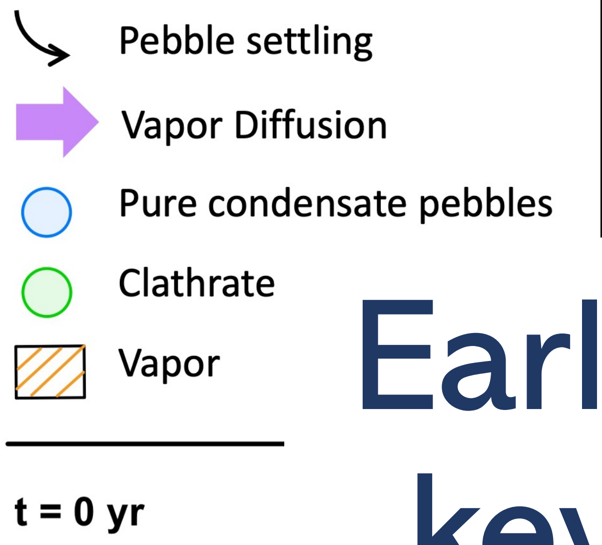
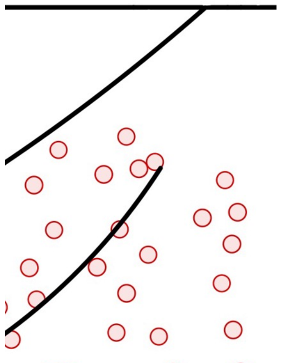
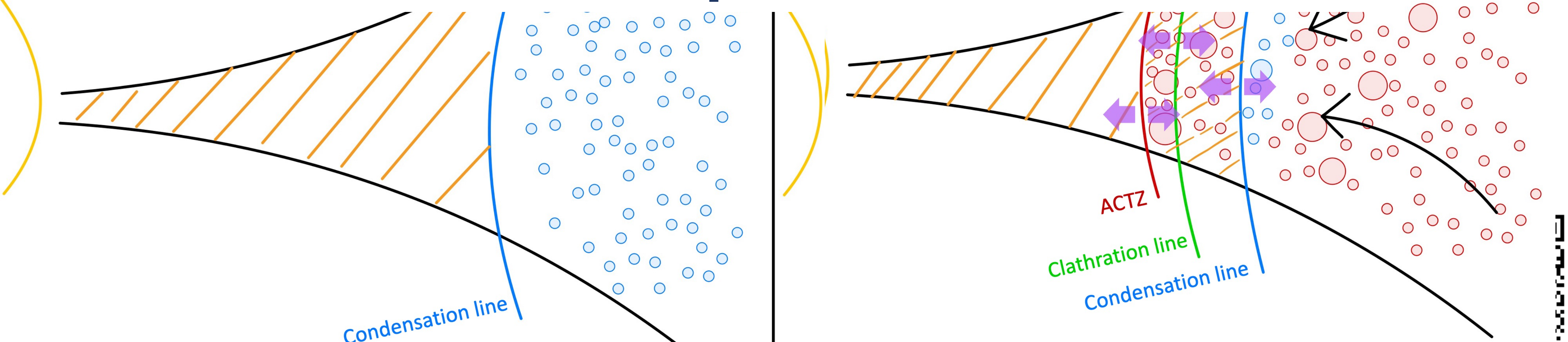


Early species evolution is a key to understands those composition





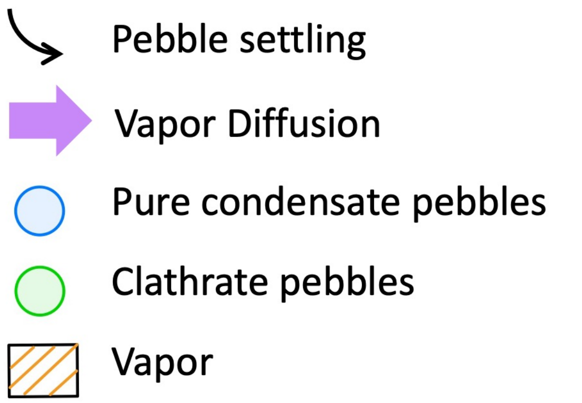
Two possible scenarios

Scenario I : Infall of pure condensates

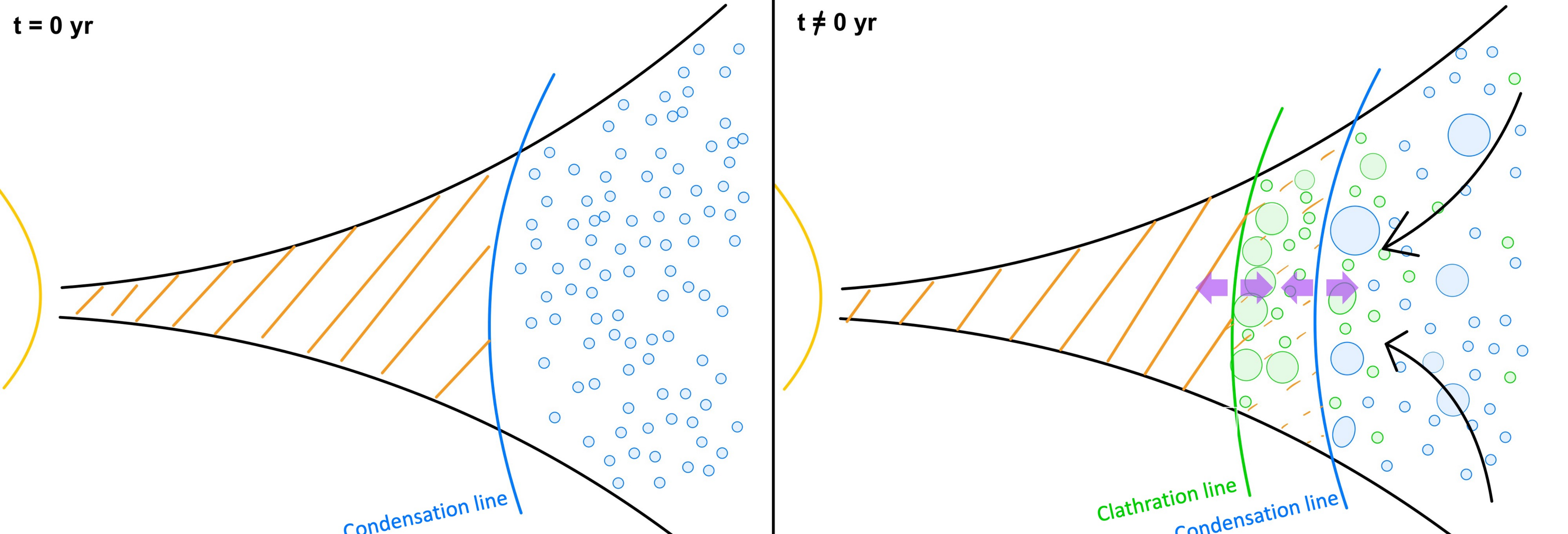
- The PSN is filled with pure condensates and vapor
- The PSN was heated enough to convert all amorphous ice into crystalline ice.

Scenario II : infall of amorphous ice

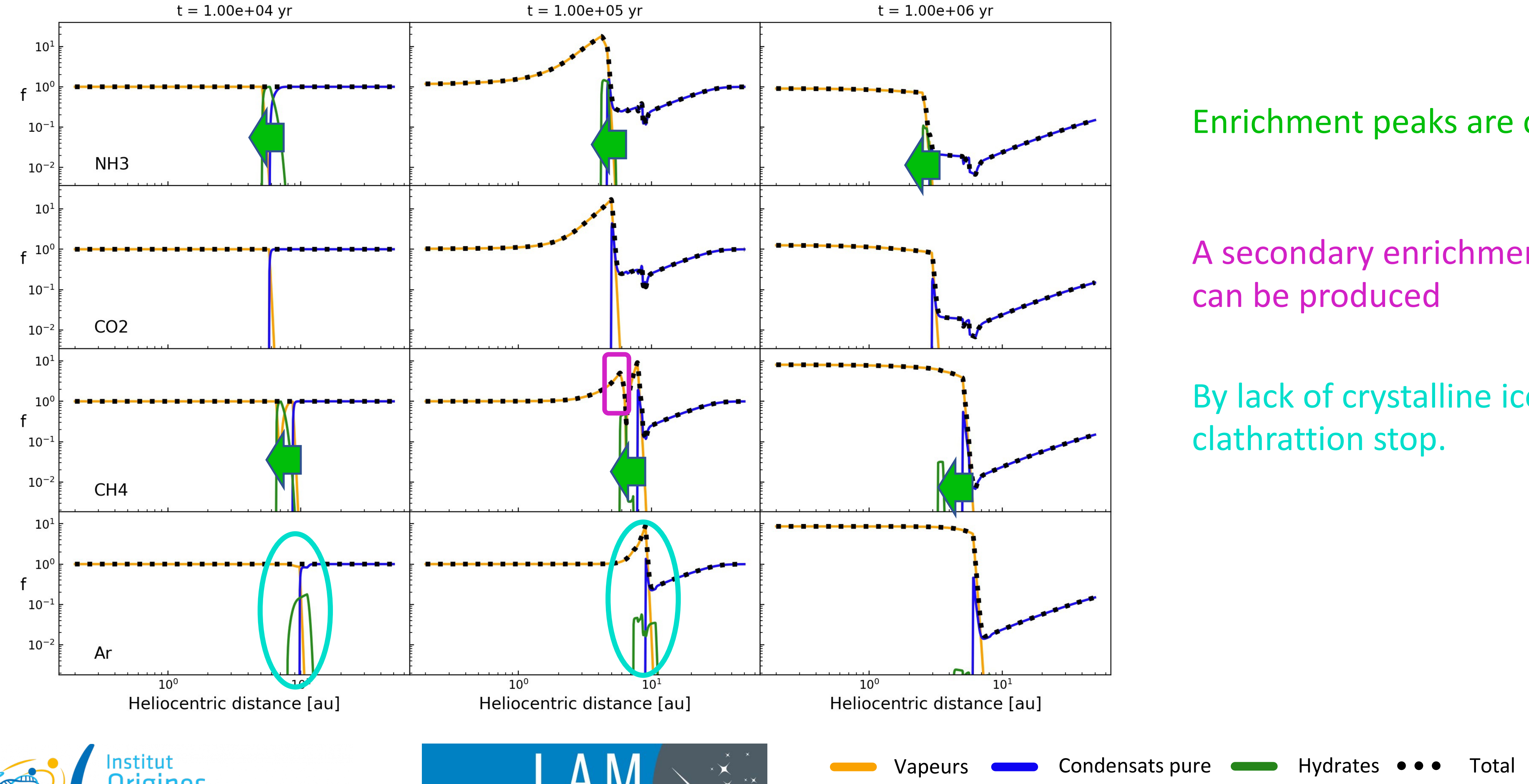
- The PSN is filled with vapor trapped in amorphous ice and vapor
- Amorphous to Crystalline Transition temperature of 135K



Scenario I : Delivery of pure condensates



Scenario I : Main features



Enrichment peaks are closer to the sun

A secondary enrichment peak can be produced

By lack of crystalline ice, clathrattion stop.

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Scenario II : Delivery of amorphous ice

Pebble settling

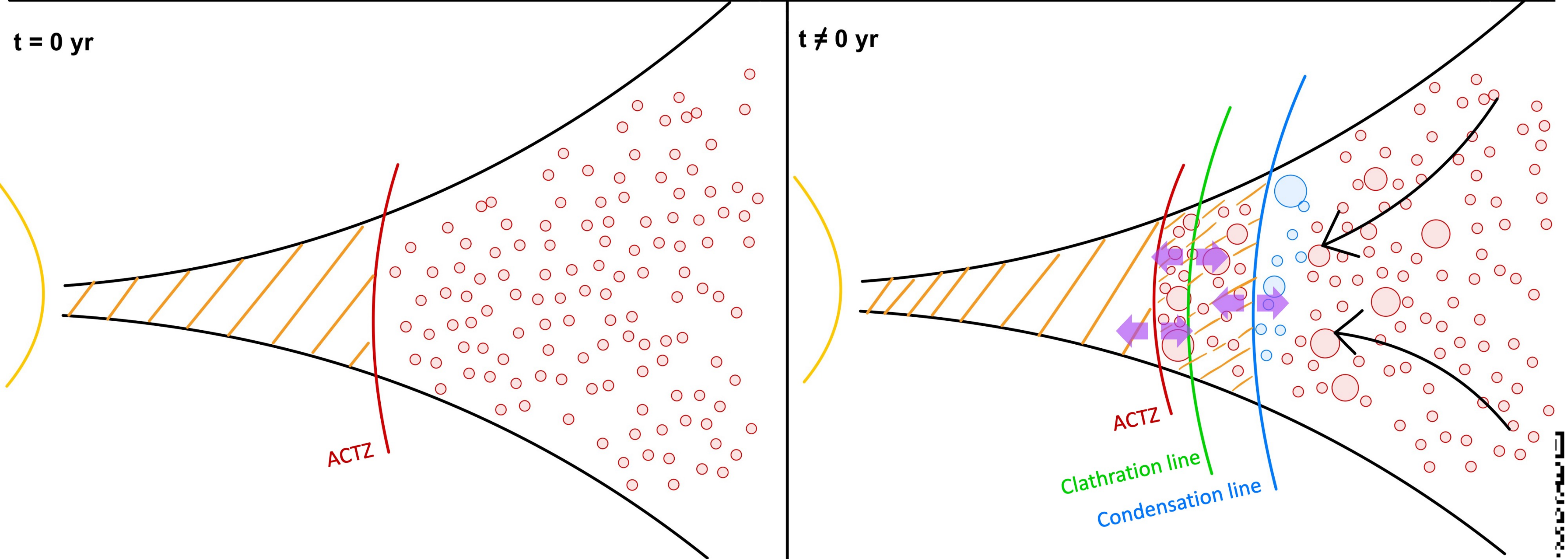
Vapor Diffusion

Amorphous ice pebbles

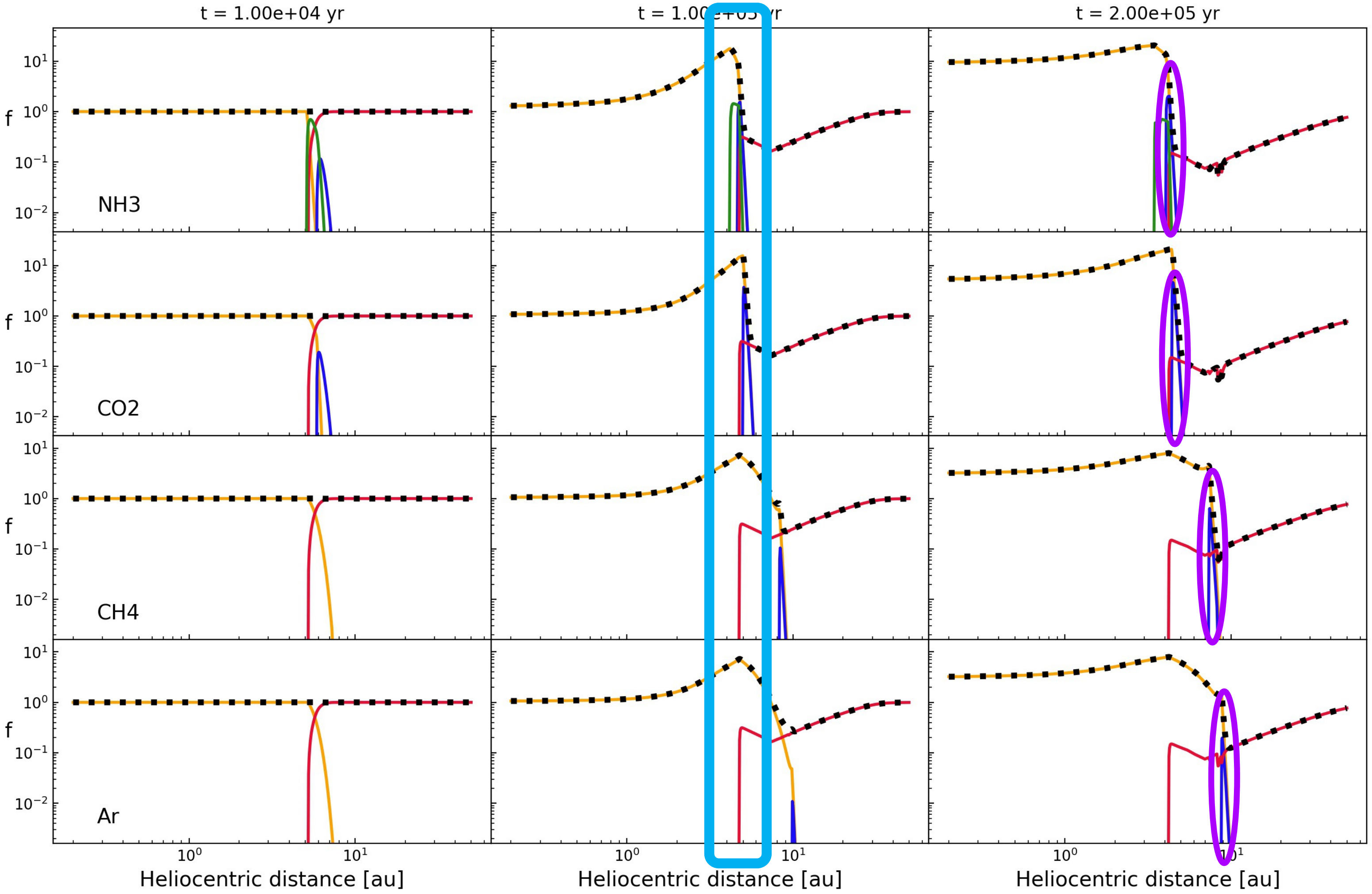
Pure condensate pebbles

Clathrate pebbles

Vapor



Scenario II : Main features



All enrichment peaks are centered around the ACTZ at 5 AU

A region dominated by pure condensates form at the condensation lines

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Conclusion

- Clathrate hydrates have an impact on volatiles' radial distribution of a PSN filled with pure condensates
  - Creating closer enrichment peaks if the species is entirely entrapped in clathrates
  - Creating a secondary enrichment peak if the species is only partially entrapped
- Amorphous ice inhibit clathrate formation in the PSN
  - Clathration lines are further from the sun than the ACTZ
  - A narrow pure condensate abundance peak form if the condensation line is close enough