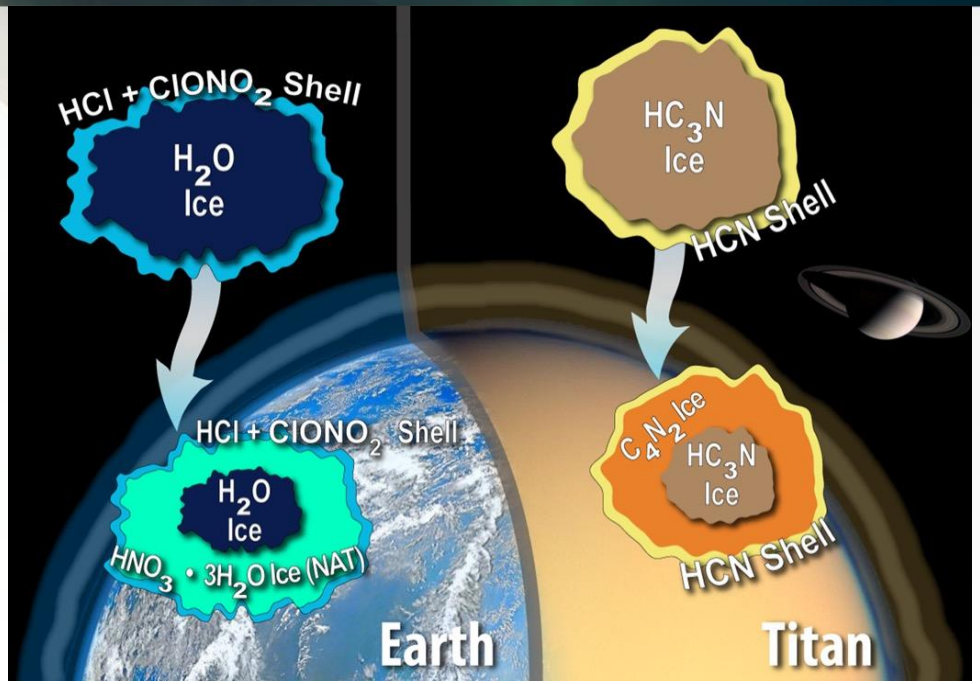
New Ice Formation Mechanism on Titan

Solid-state chemistry in Titan's ice clouds could be responsible for important physical and chemical atmospheric processes.

- If ice clouds form via vapor condensation, which they typically do, then the ice must be in equilibrium with its vapor. However, observations from Cassini's Composite InfraRed Spectrometer (CIRS) reveal Titan's C_4N_2 vapor to be highly subsaturated, and therefore not in equilibrium with the ice.
- An alternate formation method for Titan's polar stratospheric C_4N_2 ice clouds is solid-state photolysis (breakdown by sunlight) of extant HCN and HC_3N ice particles.
- In Earth's polar stratosphere, solid-state chemistry of gaseous HCl and $ClONO_2$ occurs on the surfaces of water ice particles to form HNO_3 ice and gaseous Cl_2.
- On the Earth, this chlorine chemistry on water ice particles in the stratosphere leads to ozone destruction, while on Titan the creation of nitrile ices lead to extreme radiative cooling in the stratosphere. The similarity between these processes on different planets could explain the extremely complex cloud structure of Titan's stratosphere.



On Earth, the formation of nitric acid trihydrate [$HNO_3 \cdot 3H_2O$ (NAT)] ice particles are produced via adsorption of HCl and $ClONO_2$ vapors onto pre-existing H_2O ice particles. On Titan, C_4N_2 ice may be produced from photolysis of pre-existing HCN and HC_3N ice particles.

Anderson et al. (2016), *GRL*