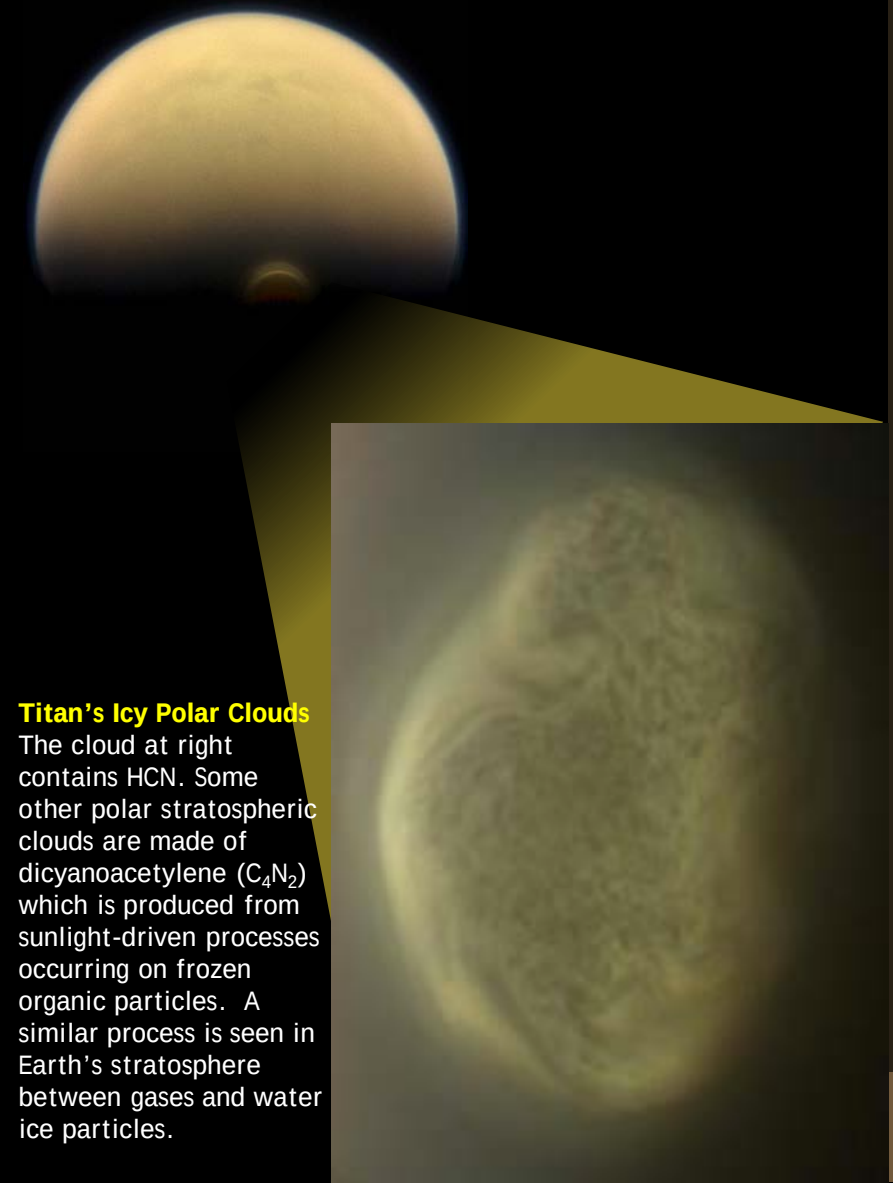
# ‘Impossible’ Cloud on Titan Explained



**Titan’s Icy Polar Clouds**
The cloud at right contains HCN. Some other polar stratospheric clouds are made of dicyanoacetylene ($C_4N_2$) which is produced from sunlight-driven processes occurring on frozen organic particles. A similar process is seen in Earth’s stratosphere between gases and water ice particles.

Cloud crystals in the super-cold environment of Titan are revealing surprising solid-state chemical processes that illuminate similar chemistry occurring in Earth’s polar stratospheric clouds.

Titan’s spring brings polar ice clouds made of dicyanoacetylene ($C_4N_2$) molecules. The presence of these polar clouds seemed impossible, because Cassini infrared measurements showed there is not enough $C_4N_2$ in the stratosphere to form the observed ice clouds. So where does the $C_4N_2$ come from?

Cassini found that springtime sunshine kicks off an ‘on-site’ manufacturing process that produces the icy raw material for the $C_4N_2$ clouds. Photochemical reactions between hydrogen cyanide (HCN) and cyanoacetylene ($HC_3N$) in Titan’s stratosphere were found to produce $C_4N_2$. This unexpected photochemical effect on icy solids explains how these seemingly ‘impossible’ clouds form in Titan’s springtime polar stratosphere!

Something similar occurs in Earth’s polar stratosphere, where solid-state chemistry involving chlorine is at the heart of ozone loss in Earth’s atmosphere. Comparison of the atmospheres of Earth and Titan informs us on the fundamental processes that occur throughout nature.

Solid-state photochemistry as a formation mechanism for Titan's stratospheric $C_4N_2$ ice clouds. C. Anderson, R. Samuelson, Y. Yung and J. McLain, *Geophysical Research Letters*, **43**, 3088-3094, 2016.