



# Solar System Exploration

## Science & Technology

Sitemap

SSE Home > Science & Technology > Formation of Nitrogen Atmosphere On Titan

Search

Home

News & Events

Planets

Missions

Science & Technology

Science Features

Technology Features

NASA Science Highlights

Science & Technology Reports

Astronomy Features

Multimedia

People

Kids

Education

History

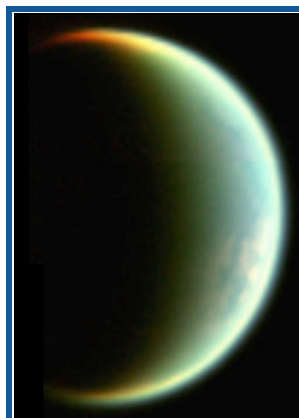
NASA

### SCIENCE HIGHLIGHT



## Formation of Nitrogen Atmosphere On Titan

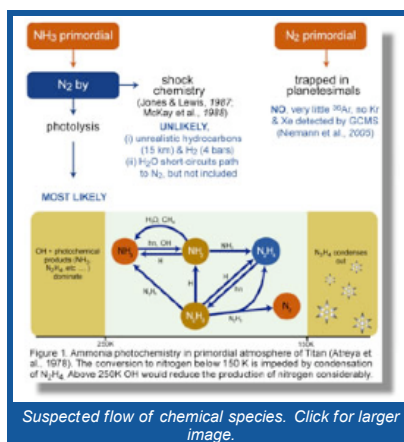
Scientists found that the data from the Huygens Gas Chromatograph Mass Spectrometer provided indirect evidence for Titan's nitrogen atmosphere originating from ammonia. Two mechanisms for the conversion of ammonia to nitrogen have been proposed previously: photolysis of ammonia, and impact driven shock chemistry. Production of nitrogen by photolysis of ammonia and the subsequent chemistry is rapid only under warm temperature conditions, since at temperatures below 150 K ammonia abundance is saturation-limited, and at temperatures above 250 K ammonia recycling competes with the formation of nitrogen. Using the photochemical model of Wilson and Atreya and the radiative equilibrium model of Adams et al., the scientists calculated rough time scales for the formation of nitrogen atmosphere on primordial Titan.



Titan through a thin haze.

### Results

They concluded the following: 1) Titan's atmospheric temperature would have been warm for a sufficient period of time to account for the formation of 3-8 bars of nitrogen from ammonia; 2) while methane and water played an important role in the nitrogen chemistry of the primordial atmosphere by partially shielding ammonia photolysis and inhibiting nitrogen formation, the increased solar flux during the T Tauri and post T Tauri phase allowed a rapid conversion from ammonia to nitrogen to take place. They also found that it was possible for the atmosphere to form the present abundance of nitrogen, even allowing for past escape, in approximately 20 million years.



Suspected flow of chemical species. Click for larger image.

### Implications

This research shows that the present inventory of nitrogen on Titan can be traced to NH<sub>3</sub> (ammonia) photochemistry, and that this was the most likely process by which Titan has acquired its nitrogen atmosphere. The conversion of ammonia to nitrogen can only occur at certain temperature conditions (between 250 and 150 K, where the nitrogen was forming). These possible temperatures would have existed for sometime (on the order of 100 million years) in Titan's atmosphere. It is interesting to consider the implications for the rest of the Cronian system: nitrogen would have been locked up in form of ammonia ice in the early sub-nebula, and therefore was brought in the same way to other Saturnian moons, such as Enceladus. Recent observations of possible molecular nitrogen on Enceladus need to be reconciled with this emerging picture.

### Significance to Solar System Exploration

As noted since the Huygens probe landed on Titan in December, 2005, Titan and Earth have a lot of similarities-- dating back to the very beginning. The most important aspect of Titan is that it has an atmosphere that has the same basic chemical building blocks as Earth. In particular, no other body in the solar system outside of Earth has a massive

nitrogen atmosphere. To these scientists, studying Titan is like looking through a window into the past of the Earth. It helps decipher the conditions existing in our solar system when Earth began to form, and helps to understand how its atmosphere came about.

- [Science Features](#)
- [Technology Features](#)
- [NASA Science Highlights](#)
- [Science & Technology Reports](#)
- [Astronomy Features](#)

Explore more of NASA on the Web:

NASA Site Network

NASA Enterprises and Field Centers



- + Awards & Recognition
- + Send to a Friend
- + The Vision for Space Exploration
- + NASA Solar System Exploration Roadmap
- + Privacy/Copyright
- + Copyright/Image Use Policy



Acting Editor: Kirk Munsell  
Webmaster: David Martin  
NASA Official: Andy Dantzler  
Last Updated: 10.24.06

- + FAQ
- + Dictionary
- + Contact Us