National Aeronautics and Space Administration

The Uranian moons as possible active worlds

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Program: FY21 R&TD Strategic Initiative **Strategic Focus Area: Ice Giant Science Leadership**

Objectives:

The purpose of this project is to determine if the surface geology and surface compositions of the Uranian moons indicate recent endogenic activity and possible subsurface oceans.

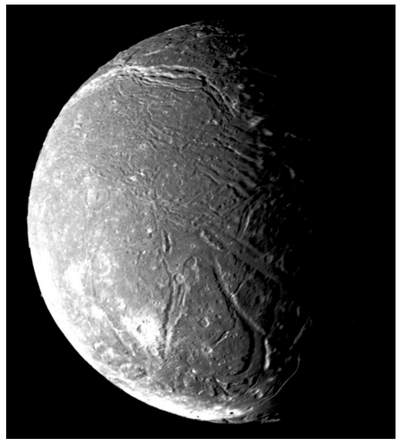
- Does the distribution of volatiles and the observed surface geology of the Uranian moons indicate recent activity?
- Could a magnetometer be used to detect subsurface oceans on the Uranian moons?
- What are the key spectral features that an infrared spectrometer on a future Uranus mission will need to detect and characterize?

Background:

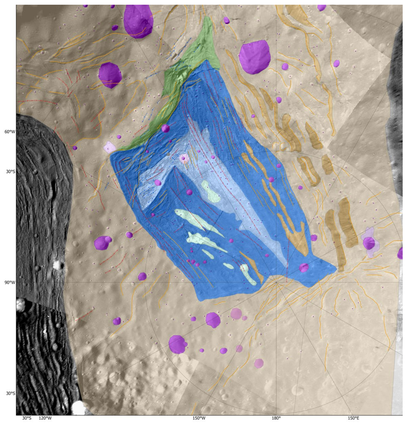
With the recommendation of a Uranus orbiter as the third priority flagship in the 2013-2022 Planetary Science Decadal Survey, and the recent publication of the NASA Ice Giant Science Definition Team report, the field of Ice Giant science is experiencing greatly renewed interest, and it is plausible that the upcoming Decadal Survey may recommend a flagship mission to an Ice Giant system as a high priority. To ensure that an Ice Giants flagship mission is led by JPL, it is urgent to foster research on Ice Giant systems so as to position JPL scientists as the strongest candidates to lead such a future endeavor. The goal of this project is to advance our understanding of the Uranian moons, and the materials from which they formed, thereby significantly advancing on the current state of the art, and establishing JPL as a leader in the field of Ice Giant moon science.

Significance & benefits to JPL/NASA:

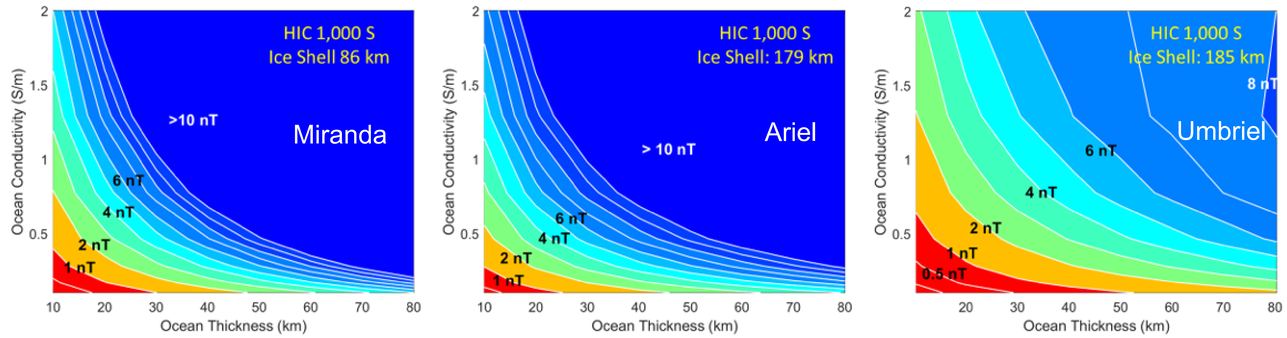
Our work has attracted attention to Ice Giant moon science that is being conducted at JPL, and is contributing to establishing JPL as a leader in the field. Most significantly, we have investigated the possibility of detecting sub-surface oceans at the Uranian moons using magnetic induction, finding that oceans should be readily detectable even from a single flyby with a spacecraft. This is **highly enabling for future missions to the Uranian system.**



The Uranian moon Ariel as seen by Voyager 2



Geologic map of the Inverness Corona region on Miranda



Predicted magnetic induction responses from sub-surface oceans on Miranda, Ariel, and Umbriel. These results demonstrate that detectable signatures of sub-surface oceans would be present for a range of possible ocean thicknesses and conductivities/salinities.

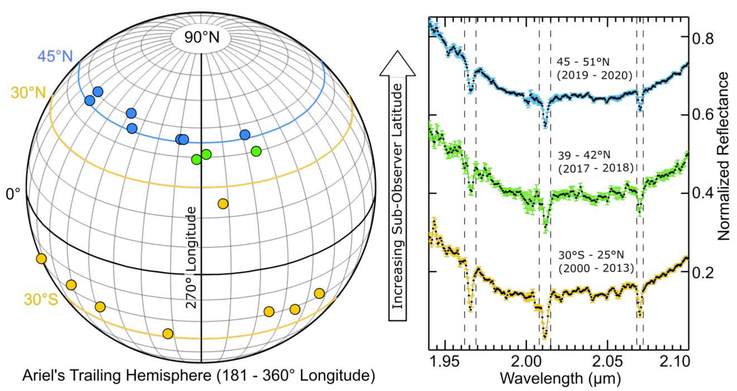
Approach and results:

We have analyzed past ground-based telescope observations of volatiles on the Uranian moons, finding that CO2 on the surface of the moon Ariel is experiencing seasonal transport across the surface.

We have established a model for charged particle bombardment of the Uranian moons. Using the charged particle bombardment model, we have carried out simulations of magnetospheric electron bombardment at Ariel. We will use the results of the model to investigate the role of charged particle weathering in the production and destruction of volatiles on the surface.

We have carried out a sophisticated modelling study of magnetic induction within the Uranian moons. We find that any present day sub-surface oceans would be readily detectable at the moons Miranda, Ariel, and Umbriel. Significantly, we predict that **oceans within these moons could be detected from a single flyby.**

By reprocessing Voyager 2 observations, we have carried out geologic mapping of the area surrounding Inverness Corona on Miranda. We have generated a digital elevation model and extracted topographic profiles of select geologic features in the Inverness Corona region. The topographic profiles in conjunction with the geologic map will be used to carry out flexure analysis to assess the past heat flow during the formation of Inverness Corona and the thermal history of Miranda, which is key to understanding its potential as an ocean world.



Ground-based observations of volatiles (CO_2) on Ariel, a possible tracer of geologic activity

Publications:

Cartwright, R. J. Nordheim, T. A. et al., A CO2 cycle on Ariel: Radiolytic production and migration to low latitudes, Under review in the Planetary Science Journal

C. J. Cochrane, S. D. Vance, T. A. Nordheim, M. Styczinski, A. Masters, L. H. Regoli, In Search of Subsurface Oceans within the Uranian Moons, Under review in the Journal of Geophysical Research - Planets

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