National Aeronautics and Space Administration

The Uranian moons as possible active worlds

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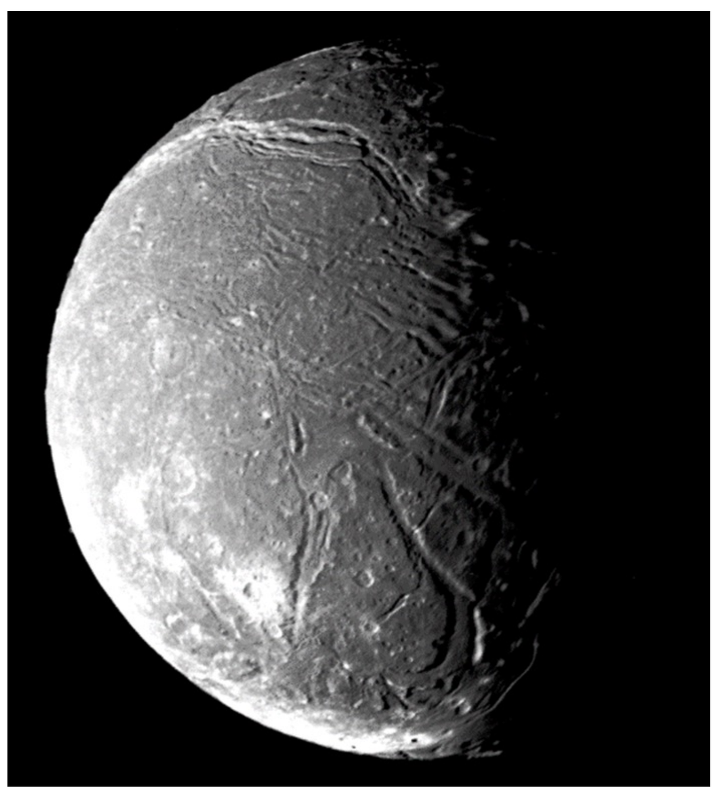
Strategic Focus Area: Ice Giant Science Leadership - Strategic Initiative Leader: David H Atkinson

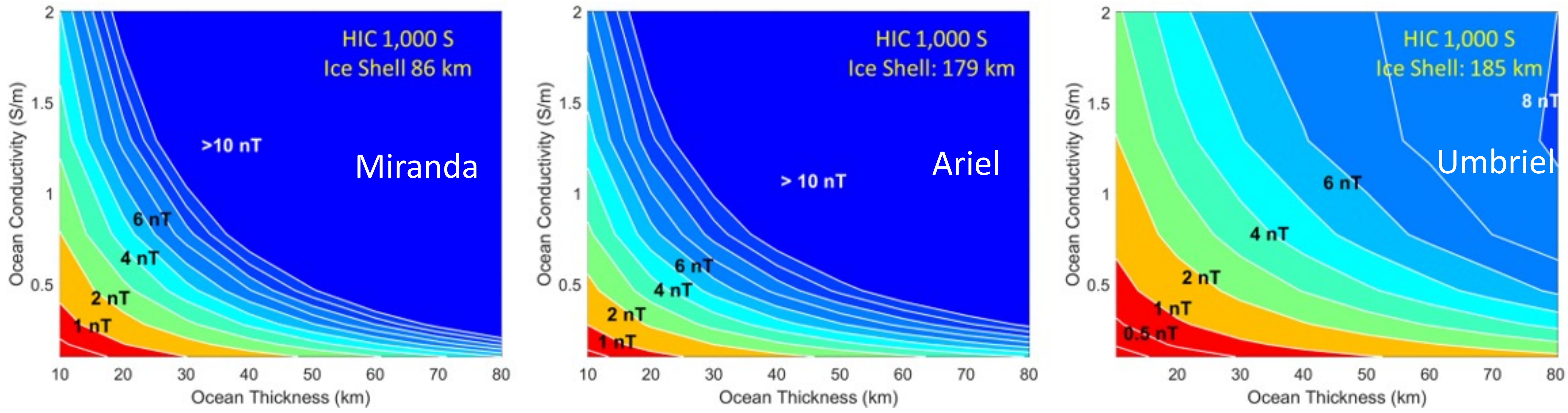
Objectives:

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 exception of a brief burst of activity around the Voyager 2 flyby in 1986, the field of Uranian moon science has been relatively dormant. With the recommendation of a Uranus flagship as the number one priority in the recent planetary decadal survey, this field is experiencing renewed interest. To ensure that a possible future 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.

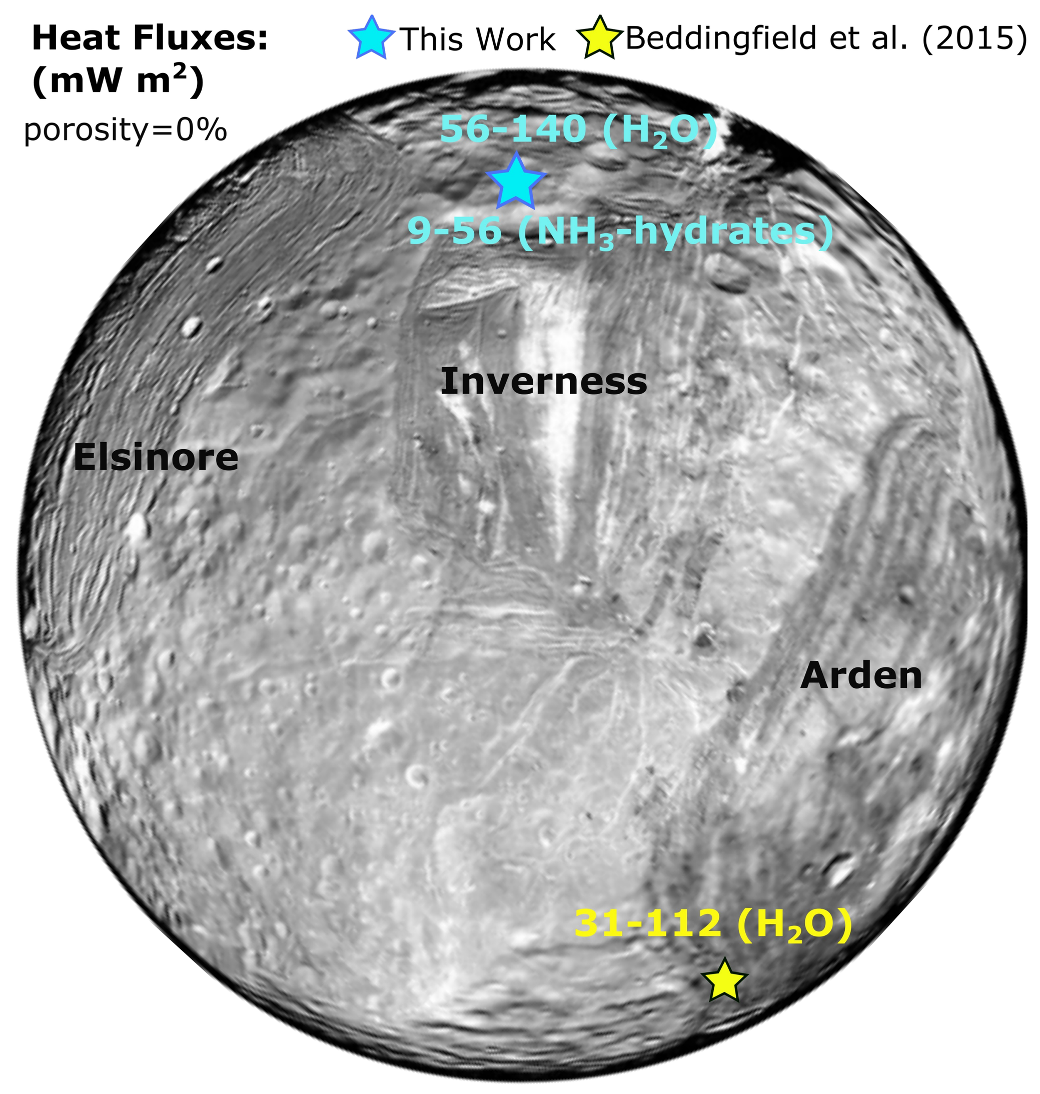


Predicted magnetic induction responses from sub-surface oceans on Miranda, Ariel, and Umbriel. These results demonstrate that detectable signatures of sub-surface oceans would be present for a range of possible ocean thicknesses and conductivities/salinities.

Approach and results: We have modeled 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.

We have carried out geologic mapping and flexure analysis to investigate the region around Inverness Corona, the youngest terrain on Miranda. Our results indicate that the moon has experienced high heat flux within the geologically recent past (< 100 Myr). Such past periods of enhanced heating may have contributed to maintaining a sub-surface liquid water ocean on Miranda throughout more of the moon's lifetime.

We have established a magnetic field particle tracing model for Uranus and developed the first ever model of charged particle flux at the Uranian moons. These will be used to evaluate the radiation processing of Ariel's surface, and to evaluate the radiation destruction timescales for material emplaced onto the surface from cryovolcanic activity.



Publications:

Cochrane, Vance, Nordheim, Styczinski, Masters, Regoli, In Search of Subsurface Oceans within the Uranian Moons [JGR Planets , 2021]

Beddingfield, Leonard, Cartwright, Elder, Nordheim: High Heat Flux near Miranda's Inverness Corona Consistent with a Geologically Recent Heating Event [Planetary Science Journal, 2022]

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.**

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