FY23 Strategic Initiatives Research and Technology Development (SRTD)

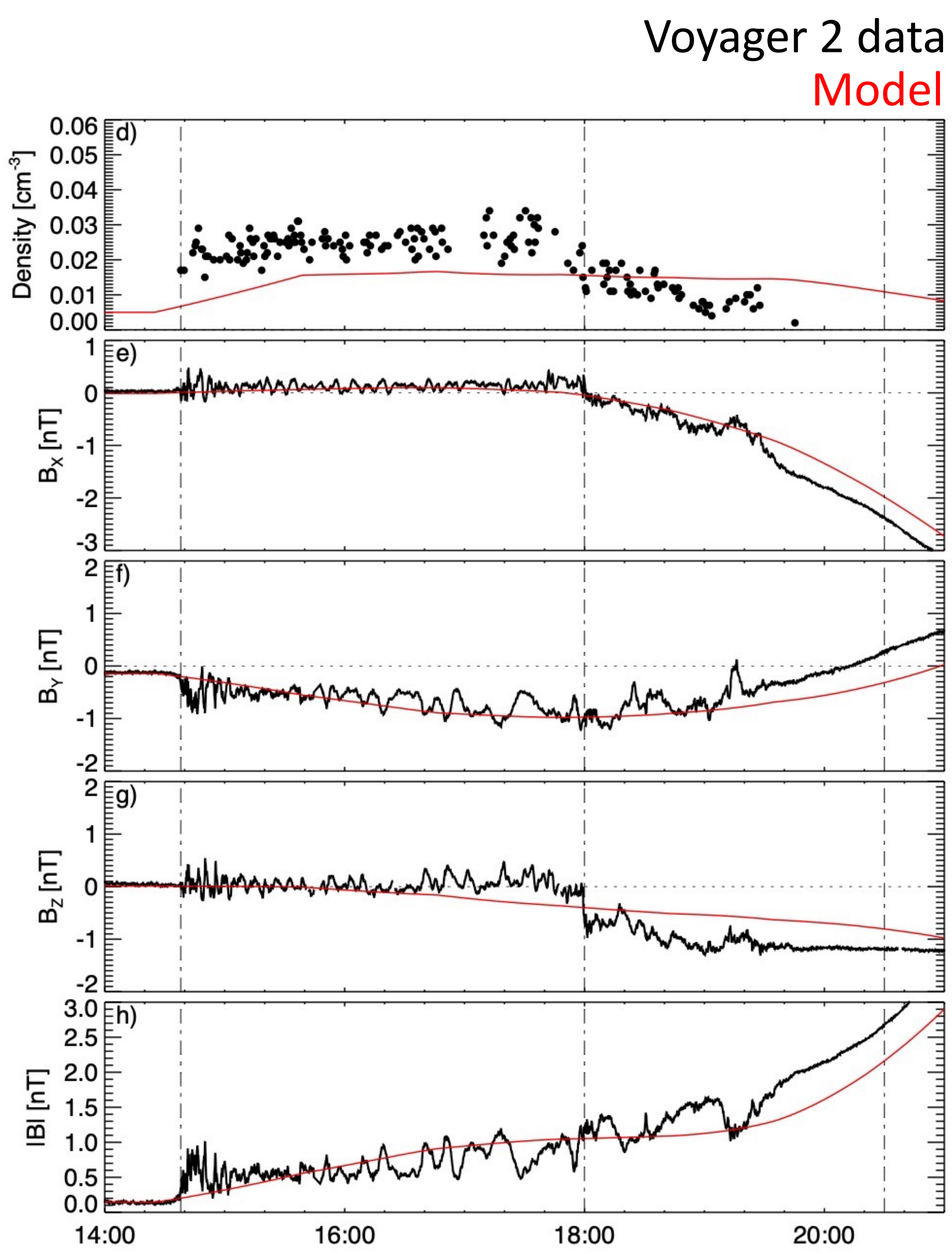
Understanding Ice Giant Magnetospheres

Principal Investigator: Neil Murphy (326); **Co-Investigators:** Jamie Jasinski (322), Xing Meng (335), Tom Andre Nordheim (322), Xianzhe Jia (University of Michigan)

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

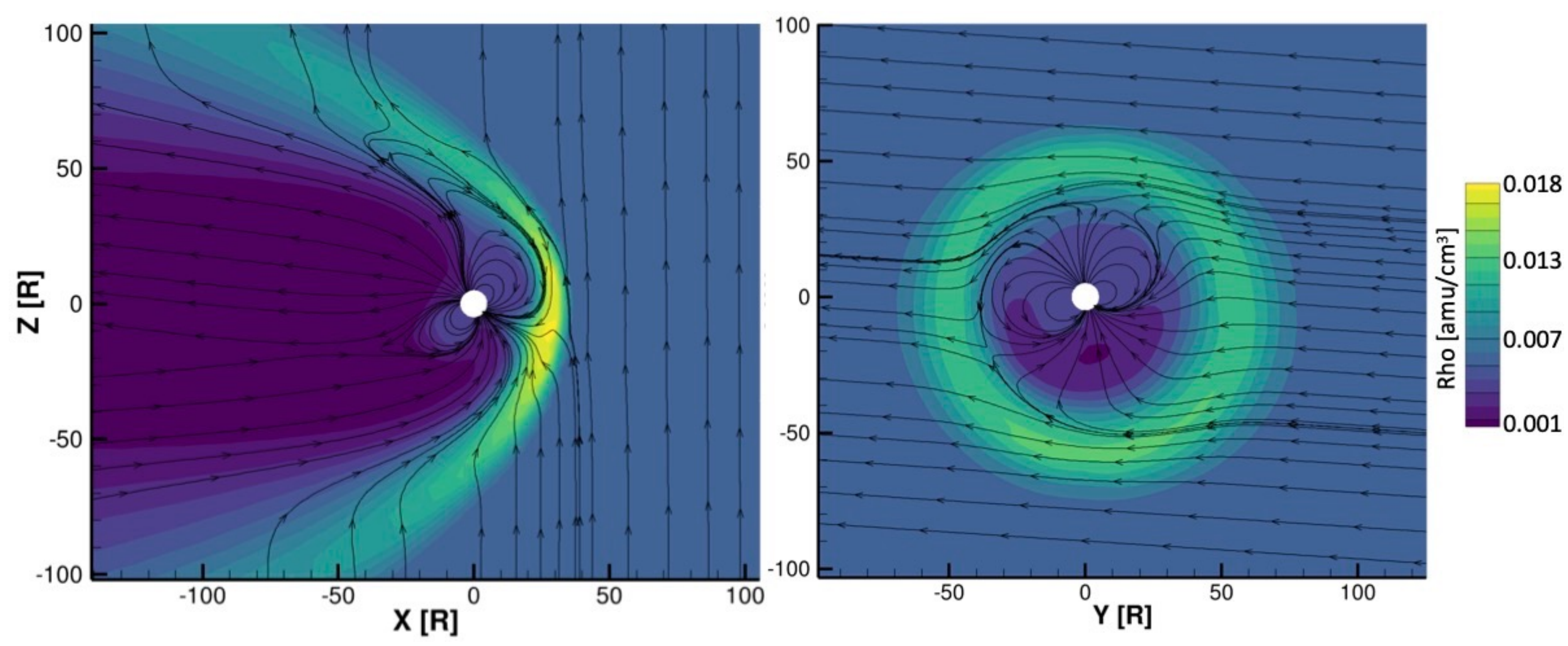
Objectives:
Our overarching objective is to enhance JPL's involvement in Ice Giant Planet Magnetospheric research, in preparation for a potential Uranus strategic mission later in this decade. Using data obtained during the Voyager flybys, we have developed an up-to-date description of the Uranus and Neptune magnetospheres to provide the basis for comparison to simulations.

Using existing state-of-the art code we initiated magnetospheric MHD models that accurately simulate the magnetic field and plasma environment at Uranus and Neptune, and their interaction with the solar wind. This will enable us to make predictions of the plasma environments at Uranus and Neptune, and their interaction with the solar wind, allowing space weather predictions for planning and preparation of future missions.



Significance/Benefits to JPL and NASA:
This R&TD investment will increase JPL's expertise and profile in the field of Ice Giant Science: It will result in high-profile publications, and will nurture collaborations with established members of the planetary magnetospheres community.

It will help in guiding the definition of magnetospheric science and measurement requirements for future Ice Giant Flagship missions and will provide opportunities to develop instruments for such missions.



Background:
Research into Ice Giant magnetospheres has been limited although a small number of groups worldwide have recently initiated magnetohydrodynamic (MHD) simulations to explore interactions with the solar wind and charged particle transport into the atmosphere. Simple theoretical approximations to estimate various processes at these magnetospheres have also been published. Despite data from the Voyager 2 flybys and Earth-based observations since that time, many fundamental aspects of ice giants are still unknown.

Approach and Results:
Initially we analyzed Voyager magnetic field and plasma data taken at Uranus and Neptune, to identify important boundaries, to gain a better understanding of the fundamental processes occurring. We have published a paper re-analyzing Voyager 2 measurements about Neptune's interaction with the solar wind (Jasinski et al., 2022).

We have also discovered that the Uranian flyby occurred during extreme solar wind conditions which resulted in the extreme magnetospheric properties that Voyager 2 observed (Jasinski et al., under review).

We have also found that moon induction investigations at Oberon and Titania are possible since they orbit within Uranus' magnetosphere (Jasinski & Cochrane, in prep.).

Uranus and Neptune had only had single Voyager pass each, the data from which poorly constrains the global magnetosphere. To understand the structure and dynamics of the magnetosphere on a global scale, over short (diurnal) and long (seasonal) timescales, we have carried out a number of simulations.

In collaboration with the University of Michigan's Prof. Xianzhe Jia, we are using the most advanced version of the BATSRUS MHD code (Developed at the University of Michigan), to produce high-fidelity models of the Uranian and Neptunian magnetospheres. Using this code allows us to produce high-fidelity models that are superior to the current state-of-the-art Ice Giant plasma simulations.

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Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

www.nasa.gov

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Publications:

Jamie M. Jasinski, Neil Murphy, Xianzhe Jia and James A. Slavin, *Neptune's Pole-on Magnetosphere: Dayside Reconnection Observations by Voyager* 2022), The Planetary Science Journal, Volume 3, Number 4,

PI/Task Mgr. Contact Information:

Email: Neil.Murphy@jpl.nasa.gov