SINGLE-PASS MAGNETOMETRIC OCEAN DETECTION AT TRITON. K. K. Khurana[1], K. L. Mitchell[2], J. C. Castillo-Rogez[2] and the Trident Team. [1]Institute of Geophysics and Planetary Physics, UCLA, Los Angeles, CA, 90095, [2]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA.

Introduction: The NASA Roadmap to Ocean Worlds [1] highlighted Triton as the highest priority candidate ocean world to target in the near-term. A Jupiter gravity assist opportunity has been identified that would enable a low-cost ballistic trajectory mission to Triton that can fit under the Discovery 2019 cap [2]. We present an analysis demonstrating definitive ocean detection at Triton can be performed using magnetometric induction techniques [3] in a single flyby, given reasonable assumptions about ocean characteristics.

Model Constraints: We assume (i) no internal dynamo, thus negligible intrinsic magnetic fields, and (ii) that plasma interaction fields can be subtracted using *in situ* measurements or exploiting different functional characteristics. Ocean detection is achieved by resolving ocean induction response from that of the ionosphere, both of which have similar functional characteristics and are primarily a function of conductivity, conductance (height-integrated conductivity) and the frequency of the primary field (the time-varying Neptunian field in the rest frame of Triton).

Ocean. Conductance is greater for thicker, more saline oceans. Geochemical modeling of aqueous alteration for Triton-like water-to-rock ratios yields a salinity at chemical equilibrium of ~5 wt% [4]. Serpentinization and leaching will be advanced in the course of differentiation, so we consider > 0.5 wt% salinity to be a conservative lower bound. We anticipate an H_2O layer of ~220 ± 100 km, and so a starting ocean thickness of > 100 km. This implies a shell with conductivity of > 0.5 S m^{-1}, and conductance of > 50,000 S, consistent with the lower bound determined for Europa's ocean [5]. A progressively freezing ocean would enrich in salts, not impacting conductance until equilibrium concentrations are exceeded.

Ionosphere. Triton's ionospheric induction response is functionally similar to a hypothesized ocean, and so challenging to differentiate. Voyager 2 radio occultations revealed ingress and egress peak e$^-$ densities of 2.3-4.6 × 10^4 cm^{-3} [6], consistent with conductance of < 1-2 × 10^4 S [7]. This approximates an ~200-km thick conductive shell of < 0.05 S m^{-1}.

Results: The geometry of the Neptune-Triton system results in two dominant frequencies, at ~14.4-hr synodic rotation period and at the ~141-hr period relating to Triton's inclined orbit. The former elicits a near-saturated but the latter only a weak response from the ionosphere owing to their different skin depths, allowing a magnetometer to "see through" the ionosphere at the latter period. Contrasts in phase delays in induction at the 14.4 hr period for no ocean (>55°) and an ocean (<~15°) located below an intense ionosphere provides another clear discriminator (see Fig. 1). Extensive exploration of parameter space using a 4-shell model reveals that an ocean will be distinguished by very different vector magnetometer responses, even assuming an unfavorable set of ocean and ionosphere parameters, driven by the relative induction phase lag of >40° between ocean and null (ionosphere-only) hypotheses. Exploiting this requires a robust contemporaneous model of ionospheric conductivity to assess the null hypothesis response, using plasma spectrometry or radio science occultations.

References: [1] Hendrix, A. R. et al. (2019) *Astrobio. 19*, doi:10.1089/ast.2018.1955. [2] Prockter L. M. et al. (2019) *LPS L*, Abstract #3188; Mitchell K. L. et al. (2019) *LPS L,* Abstract #3200. [3] Khurana K. K. et al. (1998) *Nature 395*, 777-780. [4] Castillo-Rogez J. C. et al. (2018) *MPS 53*, 1820-1843. [5] Schilling N. et al. (2007) *Icarus 192*, 41-55. [6] Tyler G. L. et al. (1989) *Science 246*, 1466-83. [7] Strobel D. F. et al. (1990) *GRL 17*, 1661-1664.

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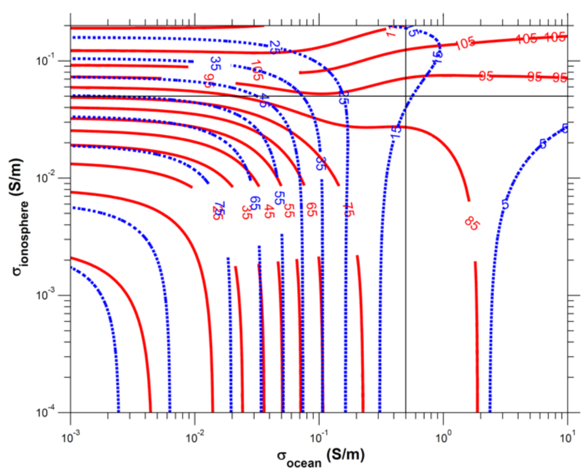

Fig. 1: Magnitude of induction response at the dominant 14-hr magnetic period (red lines, normalized to Triton's surface and therefore can exceed 100%) is a poor indicator of an ocean in the presence of an intense ionosphere. However, phase lag (dotted blue lines) is considerably greater (by >40°) if no ocean is present, providing a useful discriminator. Horizontal black line is the upper limit of ionospheric conductivity and the vertical black line marks the lower limit of ocean conductivity.