A NOACHIAN “GREENHOUSE”: EARTH MODELS FOR A GLOBAL HYDROLOGIC BUDGET OF THE MARS NORTHERN PLAINS, M. A. Chan¹, T. J. Parker², P. W. Jewell¹, G. Komatsu¹, and J. Ormòö, ¹University of Utah, Department of Geology and Geophysics, 115 S. 1460 E. Rm. 383 FASB, Salt Lake City, UT 84112-0102, ²Jet Propulsion Laboratory M/S 183-501, 4800 Oak Grove Drive Pasadena, CA 91109, ³International Research School of Planetary Sciences, Università d’Annunzio, Viale Pindaro 42, 65127 Pescara, Italy (goro@irsps.unich.it), ⁴Centro de Astrobiología (CSIC-INTA), Ctra de Torrejón a Ajalvir, km 4, 28850 Torrejón de Ardoz, Spain.

Introduction: The idea of a Mars ocean in the Northern Plains has persisted for over two decades and has not been disproven even after multiple generations of new and higher resolution data [1-8]. To understand a global ocean concept for Mars, a useful comparison is a similar widespread sea-level high on Earth. Mars’ Noachian epoch has been compared to Earth’s Archean because of their early ages, but the Archean is poorly constrained due to its antiquity and recycled record over time. However, Earth’s Cretaceous eustatic sea-level high is a defining period of the planet’s global rock record and hydrologic budget.

Concept: Both the Cretaceous and Noachian time periods were planet global warm cycles of likely equitable greenhouse climate due to peak “ocean” level highs (Fig. 1), and the modulating effect of the large water bodies. Increased volcanism, in the form of seafloor spreading or hot spots on Earth (e.g., Ontong Java) and Tharsis activity on Mars, could have contributed outgassing emissions to help fuel increased (warmer) temperatures. These factors might have provided conditions more conducive to extraterrestrial life associated with liquid water during a global greenhouse.

Many water features and aqueous mineralogies associated with the Noachian [9] further suggest this was a global warming period for Mars. Long stratigraphic records on Mars (e.g., the kilometers-thick section at Gale Crater [10]) are likely to be preserved because of global water level highs. Such records may contain cyclicity that could result from fluctuations or changes in the water budget, similar to the sequence stratigraphy distinguishable on Earth. Furthermore, Cretaceous depositional systems may have a bearing on Mars greenhouse deposits during the Noachian.

Even if Cretaceous geomorphic shoreline records could have been preserved (due to a lack of plate tectonics like Mars), they still would not have all been contiguous due to multiple water levels and adjustments over time controlled by climate, isostasy, shoreline geomorphology, and other complicating surface processes. Earth’s large lake systems hold promise for deciphering geomorphic expressions without strong tidal effects or recycling, but these bodies are still relatively small and shallow. Pleistocene erosional wave-cut shorelines terraces and large bars and spits are prominent in desert climates where rapid withdrawal of

Fig. 1. Comparison of potential planetary greenhouse cycles: A. Earth reconstruction during the Cretaceous sea level high (Campanian 80 mya, from Scotese paleomap project [11]) and B. Mars reconstruction during the Noachian with a hypothetical ocean in the Mars Northern Plains (NASA/Goddard Space Flight Center Scientific Visualization Studio).

water occurred due to climate change, but sometimes subtle depositional features such as beach ridges in remote imagery are only recognizable because of vegetation enhancements due to moisture sensitivities.

Summary: The increase of Mars data from both remote imaging and rovers continues to refine our knowledge of Mars geologic history. A Noachian greenhouse time facilitated by an ocean in the Northern Plains may hold the most promise for broad syntheses via a depositional rock record in areas such as Gale Crater (regardless of shorelines), with a stratigraphic record affected and preserved by its high global water budget.