# Where did all that water come from? Models and speculations about insolation-driven movement of water on Mars.

M. H. Hecht, Jet Propulsion Laboratory, California Institute of Technology )

Calculation of the periodic variations in the martian orbital parameters by Ward [1] and subsequent refinements to the theory [2,3] have inspired numerous models of variation of the martian water cycle. Most of these models have focused on variations in planetary obliquity on a both a short-term (110 kyr) time scale as well as larger oscillations occuring over millions of years. To a lesser extent, variations in planetary eccentricity have also been considered. The third and fastest mode of variation, the precession of the longitude of perihelion, has generally been deemphasized because, among the three parameters, it is the only one that does not change the integrated annual insolation. But as a result of this precession, the asymmetry in peak summer insolation between the poles exceeds 50%, with the maximum cycling between poles every 25.5 kyrs.

The relative contribution of these different elements to orbital forcing of climate takes on particular importance in the context of apparently recent water-related features such as gullies or polar layered deposits (PLD). Christensen, for example, recently indentified mantling of heavily gullied crater walls as residual dust-covered snow deposits that were responsible for the formation of the gullies in a previous epoch[4]. Christensen assumed that the snow was originally deposited at a period of high obliquity which was stabilized against sublimation by a lag deposit of dust.

It is suggested here that not obliquity, but the short-term oscillations associated with precession of the perihelion may play the dominant role in the formation of gullies, major strata in the polar layered deposits (PLD), and other water-related features.

**References:** [1] Ward W.R. (1974), *J. Geophys. Res. 79*, 3375-3386. [2] Laskar J. (1990), *Icarus 88,* 266-291. [3] Laskar J., Levrard B., Mustard J.F. (2002), *Nature 419*, 375-377. [4] Christensen P.R. (2002), *Nature **422***, 45-48.

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