# Modeling Extreme Atmospheric Environments and Habitable Climates

J.L. Hollingsworth
*NASA Ames Research Center/SJSUF*
*MS: 245-3, Moffett Field, CA 94035-1000 USA*
jeffh@humbabe.arc.nasa.gov

R.E. Young
*Space Science Division*
*NASA Ames Research Center*
*MS: 245-3, Moffett Field, CA 94035-1000 USA*

We present progress on research related to extreme meteorological environments and plausible habitable climates using coupled global atmosphere, ocean, land-surface and sea-ice models. Our investigations seek to better constrain boundaries of the "Habitable Zone" (HZ) for terrestrial-sized planets, O(0.8–1.5 AU), values often derived from globally-averaged (e.g., 1D radiative-convective equilibrium) climate models. Orbital obliquity, eccentricity and longitude of perihelion (i.e., Milankovitch cycles) ultimately determine the occurrence and intensity of seasonal temperature contrasts in the atmospheres and near-surface environments of rotating, differentially-heated, terrestrial-like planets orbiting solar-type stars. The sensitivity of the climate response to extreme Milankovitch forcings is explored. By balance constraints, the east-west symmetric overturning (i.e., Hadley) circulation is critically dependent on the intensity and distribution of differential net diabatic heating arising from stellar insolation. Planetary rotation also influences the latitudinal extent of the overturning circulation, with slowly rotating atmospheres exhibiting a more poleward-reaching Hadley cell. One of the models we adapt is a simplified yet fully coupled atmosphere-ocean-sea-ice model. Another model is a recent version of the NCAR Community Climate Systems Model (CCSM). The coupled climate models are applied in extreme, hypothetical studies of the Earth (and Earth-like planets) at the orbital distance between Venus and Mars. For present-day terrestrial conditions, extreme orbital configurations have been studied to assess the response and range of variability in climate processes (e.g., changes in the intensity and geographic locations of maximal synoptic-period variability), and ultimately, whether water in its multi-phases can co-exist within the planetary near-surface environment.