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Characterizing Jupiter's Atmosphere from Observations of Thermal Emission by Juno and Ground-Based Supporting Observations

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A network of Earth-based observations of the Jovian environment continues to expand and enhance the science return of the Juno mission. This report focuses on joint discoveries made by Juno's Microwave Radiometer (MWR), the Jupiter Infrared Auroral Mapper (JIRAM), and supporting thermal-infrared ground-based observations at 5-25 microns. The latter were made from the Infrared Telescope Facility (IRTF), the Subaru Telescope and the Very Large Telescope. Cross-references to the cloud field from Juno's JunoCam instrument and Earth-based observations, including high-resolution observations from the Hubble Space Telescope, the IRTF and the Gemini North Telescope are also extremely useful. The thermal observations clarify the properties responsible for the observed emissions: variability of temperatures, clouds or gaseous constituents. Orton et al. (2017, GRL 44, 4607-4614, doi: 10.1002/2017GL073019) made an initial comparison between MWR and JIRAM results, together with ancillary 5-micron IRTF imaging and with JunoCam imaging; these showed a high correlation of MWR, JIRAM and 5-micron ground-based radiances in regions of low cloud opacity but only partial correlation of radiances emerging from 0.5-5 bar levels of the atmosphere in general. Including more than the PJ1 data available to Orton et al. (2017), we find a high but incomplete correlation of radiances associated with 5-micron hot spots, with no measurements to date of radiances we would expect from the extremely desiccated conditions in the Galileo probe entry site. Ground-based mid-infrared observations of the Great Red Spot support the assertion that the variability in radiance detected by the MWR near the 0.7-bar level arises as much from variability in temperatures as from variability in the gaseous ammonia humidity. Earth-based measurements of the temperature field in Jupiter's polar regions show a remarkable coincidence of the boundaries of a cold polar vortex, extending from the troposphere through the stratosphere, with the boundaries of polar haze layers. Measurements of auroral-related stratospheric heating show that they are completely enclosed within the classical auroral oval and coincide with UV emission by particles associated with open field lines of the magnetosphere.