Ground-Based Infrared Surveillance of Jupiter's Atmosphere

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A large set of images of Jupiter was made prior to and during the epoch of Galileo's remote sensing and in situ observations of Jupiter, as well as the Cassini encounter with that planet, from NASA's Infrared Telescope Facility (IRTF) at the dry summit of Manua Kea, Hawaii. Near-infrared images were made between 1.58 and 4.78 microns with an IRTF facility camera. Longer-wavelength thermal images were made between 7 and 24 microns with a variety of guest cameras, but primarily with JPL's MIRLIN system and a consortium-operated MIRAC system. A full set of images across those wavelengths was made before and on approach of the Galileo spacecraft to Jupiter, and on every orbit encounter that included remote sensing during the primary and extended missions. In addtion, images were made at 5 near-infrared wavelengths that surveyed cloud and auroral properties of the planet whenever the IRTF near-ir facility camear was scheduled for a full night; these images were made available publicly and will soon be available from the Planetary Data System / Atmospheres Node. Comparisons between these images and both Galileo and Cassini results show interesting correlations between different observational phenomena related to the same physical cause. For example, Jupiter's vertical cloud particle structure and albedo properties associate warm 5-micron regions (deep cloud-tops) with dark 1.58-micron albedo particles. The spacing of 5-micron hot spots and "interleaved" high-cloud areas indicate that a global-scale wave structure is likely to be responsible for maintaining the periodicity and other mesoscale properties of these features. The anticyclonic Great Red Spot and white ovals are cold planetary regions and that clearly arise from convective upwelling and overshoot of the radiative-convective boundary, carrying moist gas that forms clouds. However, not necessarily associated with visible features are the weaker cyclonic regions of warm air that represent forced downwelling of dry air. Other regions of moderately warm air are associated with some of the darkest features on the visible face of the planet, and we presume that these also represent regions of forced downwelling. The implication is that the deeper clouds in Jupiter may be some of the darkest albedo. Other thermal phenomena are clearly dissociated from most of the visible cloud structure: planetary-scale waves are apparent in both the stratosphere and troposphere, with strong amplitudes near mid-latitudes. These features do not move at the cloud-tracked flow rate, but much more slowly and retrograde in both troposphere and stratosphere. They are likely associated with one another and a manifestation of upwelling waves that have been used to describe the quasi-quadrennial oscillation of the stratospheric temperature field. Another such phenomenon, the heating of the upper stratosphere by auroral-related processes, has a time scale for heating up that may be as short as hours, indicating the very tenuous part of the atmosphere from which it originates.