

Infrared Observations of Jupiter: Time Dependence of Temperatures and Tracer Constituents

G. Orton, B. Fisher, K. Baines, M. Ressler, E. Ustinov, P. Yanamandra-Fisher⁽¹⁾, W. Hoffman⁽²⁾, D. Deming⁽³⁾, J. Harrington⁽⁴⁾

(1) Jet Propulsion Laboratory, California Institute of Technology, USA

(2) U. Arizona, USA

(3) NASA Goddard Space Flight Center, USA

(4) Cornell U., USA

email: go@orton.jpl.nasa.gov

Between 1995 and 2002, a large set of images of Jupiter were obtained in support of the Galileo mission in-situ and remote sensing exploration of the atmosphere. This period also included the epoch of the Cassini encounter with Jupiter. Observations were made from the NASA Infrared Telescope Facility (IRTF) at the summit of Mauna Kea, Hawaii. Middle-infrared 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 arrival of the spacecraft at Jupiter, and on every orbit encounter that included remote sensing during the primary and extended missions. These were supplemented by 1.58- to 4.78-micron images that surveyed cloud and auroral properties, with a further set of data taken in a subset of the near-ir wavelengths to survey cloud and auroral changes in the planet whenever the IRTF nir facility camera was scheduled.

The ongoing reduction and analysis of the data reveal a variety of interesting phenomena. For example, Jupiter's 5-micron "hot spots" are undistinguished in the temperature field near 100-400 mbar pressure, implying that the upper troposphere is uninvolved with the clearing phenomenon; on the other hand, the upper-level (~600 mbar) condensate ammonia ice cloud is devoid of particles in this region - unlike anywhere else, implying that within a scale height of the "uninvolved" temperature field the cloud particles are unmistakably involved in the clearing phenomena. The longitudinal spacing and interleaving of hot spots and "plumes" implies a global-scale wave structure is responsible for maintaining the zonal periodicity of these features. The anticyclonic Great Red Spot and white ovals are cold planetary regions that clearly arise from convective upwelling and overshoot of the radiative-convective boundary, carrying moist gas that forms clouds. However, the weaker cyclonic regions of warm air that represent forced downwelling of dry air are not necessarily associated with visible cloud features. 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 to be associated with one another, and they are probably 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 warming that may be as short as hours, indicating the very tenuous part of the atmosphere from which it originates.