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Jupiter's Thermal Structure on the Eve of Juno's Arrival and an NEB Expansion Event

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We report on a continuing program of ground-based thermal-infrared imaging spectroscopy to explore variability in Jupiter's atmospheric temperatures, winds, clouds and composition in support of the NASA/Juno mission, scheduled to arrive at Jupiter in July 2016. Observations during the 2015/16 apparition, centred on opposition on March 8th 2016, will be presented from NASA's Infrared Telescope Facility (IRTF) and ESO's Very Large Telescope (VLT) as part of a world-wide campaign to characterise the Jovian atmosphere to support Juno. Thermal and chemical contrasts, combined with the visible-light record from the amateur community, show that Jupiter's North Equatorial Belt (NEB) is presently expanding northwards. The combination of thermal and visible observations will allow us to determine the environmental conditions underlying this belt/zone variability. Radiometrically calibrated spectral scan maps of Jupiter have been regularly obtained using the TEXES instrument (Texas Echelon cross Echelle Spectrograph, Lacy et al. 2002, PASP 114, p153-168) on the IRTF since 2012, and observations are planned in January and April 2016. Ten settings between 5 and 25 μm (10-20 cm-1 wide settings at spectral resolutions of 2000-10000) were selected to be sensitive to jovian temperatures (via H2, CH4 and CH3D), tropospheric phosphine and ammonia, tropospheric haze opacity and stratospheric hydrocarbons ethane and acetylene. These will be supplemented by photometric imaging from the VLT/VISIR instrument (Lagage et al., 2004, Messenger 117, p12-16) in ten narrow-band filters to determine temperatures associated with discrete phenomena (vortices, plumes, waves) at higher diffraction-limited spatial resolution. Spectra and images are inverted via the NEMESIS retrieval algorithm (Irwin et al., 2008, JSQRT 109, p1136-1150) to map temperatures at multiple altitudes (1-600 mbar), winds, aerosol opacity and gaseous composition. Our most recent observations (November 2015) revealed (i) a regular stratospheric wave pattern in stratospheric temperatures between 20 and 30°N (i.e. above the North Tropical Zone and Temperate Belt, NTropZ and NTB, respectively), possibly associated with the northward expansion of the broad North Equatorial Belt (NEB); (ii) tropospheric thermal variability along the NEB itself with correlations between aerosol variability in the 600-mbar region (sensed at 8.6 μm) and the 2-3 bar region (sensed at 5 μm). This appears to coincide with similar NEB and NTropZ wave structure observed in reflected sunlight near 2 μm, based on images from the SpeX instrument on the IRTF. Zonal mean distributions of temperature, phosphine, ammonia, aerosols and hydrocarbons will be compared to those derived by the Cassini Composite Infrared Spectrometer (CIRS) 15 years earlier. High-resolution VLT images of the Great Red Spot will be compared between 2008 and 2016 to understand the thermochemical changes associated with its recent shrinkage. All images and maps of retrieved properties will be assembled as a database (JCliD) to aid in the interpretation of Juno data during 2016-2017.