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Celebrating Titan's one year atmospheric evolution since Voyager with Cassini/CIRS

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We analyze Cassini Composite Infrared Spectrometer (CIRS) data taken during the numerous Titan flybys from 2004-2010 and compare them to the 1980 Voyager 1 flyby values inferred from the re-analysis of the Infrared Radiometer Spectrometer (IRIS) spectra. Seven years after Cassini's Saturn orbit insertion, we look at the evolution of the chemical composition by combining (a) Voyager/IRIS measurements from 1980, (b) Cassini/CIRS continuous recordings from 2004 to 2010 and (c) the intervening ground- and space- based observations, we have in hand almost a complete picture of the stratospheric evolution within a Titan year.

We have probed Titan's stratosphere using the Cassini Composite Infrared Spectrometer (CIRS) looking for temporal variations in temperature and composition, within the duration of the Cassini mission and with respect to the remote infrared measurements acquired during the Voyager encounter in 1980, exactly a Titan year ago in 2010 (Ls of about 9° corresponding to the V1 encounter is reached again in mid 2010). We have re-analyzed all the Voyager 1 /IRIS data from 1980 with the most recent spectroscopic data and using the radiative transfer code that was applied to the first V1 retrievals [2] and ISO inferences [3] as well as more recent Cassini spectra analyses [4,5]. The re-analysis shows that the V1 retrievals in 1995 were correct for all molecules and latitudes except for the species where the spectroscopic parameters have significantly changed recently.

Our radiative transfer code was also applied to CIRS spectral averages corresponding to flybys binned over 10° in latitude for both medium (2.5 cm-1) and higher (0.5 cm-1) resolutions and from nadir and limb data both. In analyzing the spectra, we search for variations in temperature and composition at northern (around 50°N), equatorial and southern (around 50°S) latitudes. Latitudinal variations were previously inferred in a number of works [4 - 9]. We look here for variations in temperature and composition as the season on Titan progresses and compare them to V1/IRIS, ISO and other ground-based reported composition values (Coustenis et al., 2012, in preparation).

With this study we seek to set constraints on seasonal, photochemical and circulation models and to make predictions as to the spatial variations of the chemical composition on Titan from a time when the season is exactly the one of the Voyager encounter and then moves towards summer solstice in the north during the Cassini extended Solstice mission.

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