VERTICAL AEROSOL DISTRIBUTION IN THE TROPOSPHERE AND STRATOSPHERE OF SATURN FROM CASSINI/VIMS DATA . E. D'Aversa[1], G.Bellucci[1], F.Altieri[1], F.G.Carrozzo[1], and R.H.Brown[2], [1]Istituto di Fisica dello Spazio Inteplanetario, IFSI/INAF, Via Fosso del Cavaliere 100 00133 Rome Italy, emiliano.daversa@ifsi-roma.inaf.it. [2]Lunar and Planetary Laboratory, University of Arizona, Tucson AZ USA.

Introduction: The aerosol content of the Saturn's atmosphere plays an essential role in determining its radiative and thermal balance. Moreover, the three-dimensional distribution of suspended particles can be useful as a tracer of atmospheric motions overall the planet. Observations acquired by Cassini/VIMS (Visual and Infrared Mapping Spectrometer), consisting in a large set of multispectral images obtained in the last 3 years, in different condition of illumination and spatial resolution, covering the 0.4–5 µm spectral range, are very promising in allowing a systematic retrieval of aerosol distribution in space and time.

Analysis: Radiative transfer calculations in a Saturn model atmosphere show that VIMS spectral range is mainly sensitive to aerosols near the tropopause (pressure level of about 100 mbar). The absorption of solar radiation by methane and scattering by the lower clouds do not allow to probe deeper then some bars at these wavelengths.

We have applied inversion techniques to a selected set of VIMS data, in order to retrieve the vertical profile of the scattering density. Spectra have been selected based on illumination and observation angles less than 60°. Only some spectral channel for each spectrum, between 1 and 3.5 µm, have been included in the analysis, depending on their estimated probing capability in the model atmosphere. For the inversion we used the same scattering assumptions as illustrated in Stam et al. 2001, [1].

Therefore the main hypothesis of the model for inversion are:

1. Barotropic atmosphere.
2. Gaseous absorption due to methane and hydrogen collision-induced.
3. Scattering efficiency linearly varying with wavelength, with a slope varying with altitude.
4. Negligible multiple scattering.

The inversion of the VIMS spectra could provide the variation with altitude of the scattering density and the scattering slope (as defined in Stam et al.,2001 [1]) between pressure levels of about 6 mbar and 10 bar, without any assumptions on the nature and sizes of the scatterers.

After inversion, the modeling of the retrieved scattering density by means of microphysical parameters could allow the decoupling of variables in order to retrieve the density of aerosol particles. From this point of view, the most critical approximations are the hypotheses 3 and 4. The former could only be valid in a narrow spectral range, mainly for small-sized aerosol grains, and far enough from eventual absorption bands of the aerosol material. The latter does not affect the retrieval of scattering density, but could give wrong estimation of the real aerosol density, as a consequence of the intrinsic non-linearity of multiple scattering processes.

Therefore, in order to better constrain the aerosol distribution, we implemented an iterative process to simulate each retrieved scattering density profile by means of direct radiative transfer calculations varying the aerosols optical properties (grain size distribution and refraction index), obtaining a set of allowed aerosol properties for each scattering profile. Finally, the best aerosol distribution is selected evaluating the corresponding multiple scattering contribution to the outgoing radiance and comparing it to the VIMS original spectrum.

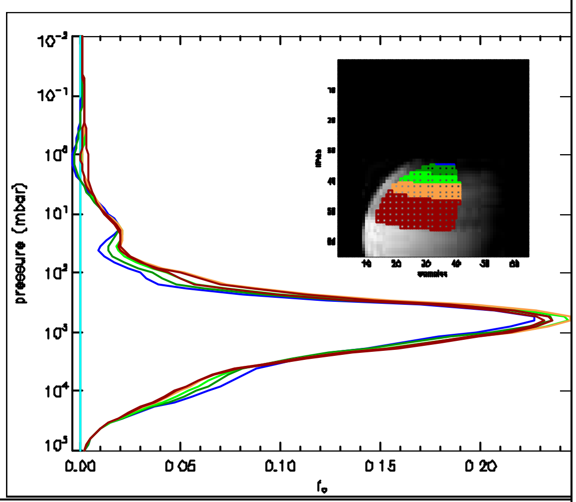

Fig.1. Examples of vertical profiles of scattering in the Saturn's southern hemisphere. Each curve represents a spatial average over a different latitudinal region, with the color code shown in the inset.

Results: Preliminary analyses show a two layers structure in the globally-averaged vertical scattering distribution. The main concentration has a maximum near the 500 mbar pressure level, and appears upper confined from the tropopause, while the minor one is located in the stratosphere near the 20 mbar level.

A moderate-resolution survey extended to the southern hemisphere shows two main features (fig.1):

a) moving from tropical to polar latitudes the tropopause level appears gradually depleted of aerosols.

b) moving from tropical to polar latitudes the pick level of the thinner stratospheric layer gradually moves to higher altitude.

A general meridional circulation is outlined from these preliminary results, characterized by polar subsidence in the troposphere and polar upwelling in the stratosphere. These results are in agreement with reported clues on polar depletion of phosphine (Baines et al. 2007, [2]; Fletcher et al. 2008, [3]), thought to be indicative of deep tropospheric subsidence near the poles.

References: [1] Stam D. M. et al. (2001) Icarus, 152, 407-422. [2] Baines K. et al. (2007) Geophys.Res.Abstr. 9, 02109. [3] Fletcher L. N. et al. (2008) Science, 319, 79-81.