EPSC Abstracts
Vol. 10, EPSC2015-456, 2015
European Planetary Science Congress 2015

Distribution of H_2O and CO_2 in the inner coma of 67P/CG as observed by VIRTIS-M onboard Rosetta

F. Capaccioni[1], G. Piccioni[1], A. Migliorini[1], D. Bockelée-Morvan[2], G.Filacchione[1], S. Erard[2], C. Leyrat[2], M. Combi[3], M.T. Capria[1] , J. Benkhoff[4], M. Blecka[5], M. Combes[2], J. Crovisier[2], M.C. De Sanctis[1], P. Drossart[2], T. Encrenaz[2], U. Fink[6], W. Ip[7], P. Irwin[8], F. Taylor[8], G.P. Tozzi[9], N. Biver[2], D. Grassi[1], M. Gudipati[10], F. Merlin[2], G. Rinaldi[1] and the VIRTIS Science Team, [1]Istituto di Astrofisica e Planetologia Spaziali, Istituto Nazionale di Astrofisica, Rome, Italy, [2]LESIA-Observatoire de Paris, Meudon, France, [3]Space Physics Research Laboratory, The University of Michigan, Ann Arbor, USA, [4]ESA, ESTEC, The Netherlands, [5]Space Research Centre, Polish Academy of Sciences, Warsaw, Poland, [6]Lunar Planetary Laboratory, University of Arizona, Tucson, USA, [7]National Central University, Taipei, Taiwan, [8]Departement of Physics, Oxford University, Oxford, UK, [9]INAF - Osservatorio Astrofisico di Arcetri, Firenze, Italy, [10]NASA JPL, Pasadena, USA.

VIRTIS (Visible, Infrared and Thermal Imaging Spectrometers) is a dual channel spectrometer; VIRTIS-M (M for Mapper) is a hyper-spectral imager covering a wide spectral range with two detectors: a CCD (VIS) ranging from 0.25 through 1.0 μm and an HgCdTe detector (IR) covering the 1.0 through 5.1 μm region. VIRTIS-M uses a slit and a scan mirror to generate images with spatial resolution of 250 μrad over a FOV of 64 mrad. The second channel is VIRTIS-H (H for High resolution), a point spectrometer with high spectral resolution ($\lambda/\Delta\lambda$=3000@3 μm) in the range 2-5 μm [1].

The VIRTIS instrument has been used to investigate the molecular composition of the coma of 67P/CG by observing resonant fluorescent excitation in the 2 to 5 μm spectral region. The spectrum consists of emission bands superimposed on a background continuum. The strongest features are the bands of H_2O at 2.7 μm and the CO_2 band at 4.27 μm [1]. The high spectral resolution of VIRTIS-H obtains a detailed description of the fluorescent bands, while the mapping capability of VIRTIS-M extends the coverage in the spatial dimension to map and monitor the abundance of water and carbon dioxide in space and time.

We have already reported [2,3,4] some preliminary observations by VIRTIS of H_2O and CO_2 in the coma. In the present work we perform a systematic mapping of the distribution and variability of these molecules using VIRTIS-M measurements of their band areas.

All the spectra were carefully selected to avoid contamination due to nucleus radiance. A median filter is applied on the spatial dimensions of each data cube to minimise the pixel-to-pixel residual variability. This is at the expense of some reduction in the spatial resolution, which is still in the order of few tens of metres and thus adequate for the study of the spatial distribution of the volatiles. Typical spectra are shown in Figure 1.

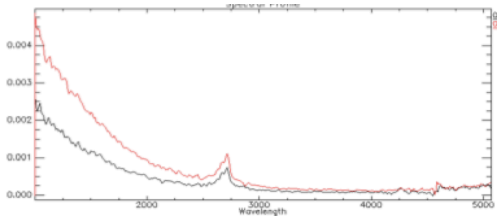

Figure 1: Example of radiance spectra, expressed in W/m^{-2} sr^{-1} μm^{-1}, after the spatial filtering process. The black curve is a spectrum of a pixel in the cube 00387393237, while red refers to the same pixel in the cube 00387396837. The water band at 2.7 μm is clearly visible. The CO_2 emission band at 4.27 μm can be seen in the black spectrum

For each of the two molecules we derive the band areas by removing the estimated continuum level from the measured radiance and use the band areas to derive the H_2O and CO_2 molecules column densities, see Figure 2. The two VIRTIS channels perfectly complement each other, VR-M providing the mapping capability and VR-H the high spectral

resolution required to fix the absolute abundance scale accurately. The data set used here allows us to study the diurnal evolution of the activity above specific regions of the nucleus surface, including the most active areas, and to analyze the relative abundances of water vapour and carbon dioxide. The presentation will describe the results obtained.

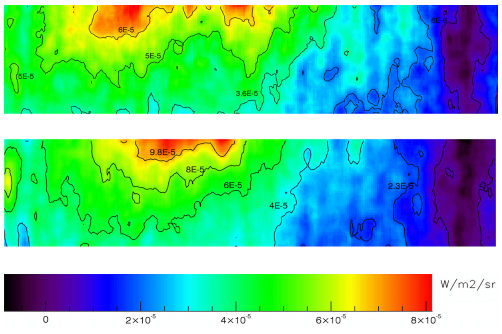

Figure 2: Typical water vapour band area maps derived from two consecutive VIRTIS-M data cubes obtained on 11th April 2015. The frame size is approximately 6.5 by 1.8 km., and the surface of the nucleus is about 1 km above the top of each frame.

Acknowledgements

The authors would like to thank ASI - Italy, CNES - France, DLR - Germany, NASA-USA for supporting this research. VIRTIS was built by a consortium formed by Italy, France and Germany, under the scientific responsibility of the Istituto di Astrofisica e Planetologia Spaziali of INAF, Italy, which guides also the scientific operations. The consortium includes also the Laboratoire d'études spatiales et d'instrumentation en astrophysique of the Observatoire de Paris, France, and the Institut für Planetenforschung of DLR, Germany. The authors wish to thank the Rosetta Science Ground Segment and the Rosetta Mission Operations Centre for their continuous support.

References

[1] Coradini et al.: VIRTIS: an imaging spectrometer for the rosetta mission. Space Science Reviews, Volume 128, Issue 1-4, pp. 529-559, 2007.

[2] Bockelee-Morvan et al, AGU, 2014

[3] Bockelee-Morvan et al: First observations of H2O and CO2 in comet 67P/Churyumov-Gerasimenko with VIRTIS onboard Rosetta. submitted to A&A, 2015.

[4] Capaccioni et al.: water vapour and carbon dioxide ir emissions in 67P/CG coma: first detection by Rosetta/VIRTIS-M. 46th Lunar and Planetary Science Conference, March 2015, contribution N1832, p2494, 2015