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Comet 67P/CG: surface temperature maps from Rosetta/VIRTIS during the pre-landing phase

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Abstract.

It was seldom possible, with observations carried out from spaceborne facilities, to derive spatially-resolved thermal maps of small bodies, and even more rarely this result was achieved in the case of close observations of comets. The Visible InfraRed Thermal Imaging Spectrometer (VIRTIS) onboard the Rosetta Orbiter Coradini (2007) is able to obtain hyperspectral images of the observed targets in 864 wavelengths simultaneously, in the overall spectral range 0.25-5.1 μm, with the major goal of inferring and mapping the surface composition and temperature of comet 67P/Churyumov-Gerasimenko. VIRTIS spectra acquired on the dayside of the comet's nucleus show the thermal emission of the surface at wavelengths ¿ 3.5 μm, which can be exploited to derive and map the surface temperature at different spatial scales and under changing lighting conditions. To do this, we rely on a Bayesian approach that was previously adopted to derive surface temperature maps of the two asteroids 2678 Steins and 21 Lutetia, encountered by Rosetta during its long cruise phase towards the comet Coradini (2011); Keihm (2012), and of the large asteroid Vesta from the entire infrared dataset acquired by the VIR instrument onboard the Dawn spacecraft Tosi (2014). In this paper we summarize the main results concerning the thermal mapping of comet 67P, obtained by VIRTIS in the first months of observation at a resolution between 1000 and 1 m, and at a heliocentric distance between 3.6 and 3.4 AU. Comet 67P was shown to be everywhere rich in organic materials with little to no water ice visible on the surface Capaccioni (2015). In the range of heliocentric distances from 3.59 to 2.74 AU, daytime surface temperatures were overall comprised in the range between 180 and 220 K Tosi (2015), which is incompatible with large exposures of water ice and is consistent with a low-albedo, organics-rich surface. Maximum temperature values as high as 230 K were recorded in very few places Tosi (2015). In the above period, the highest values of surface temperature were obtained with observations carried out at small phase angles, implying that the observed surface has a large predominance of small incidence angles, and local solar times centered around the maximum daily insolation. In all cases, direct correlation with topographic features was observed, i.e. largest temperature values were generally associated with the smallest values of illumination angles, while no evidence was found of thermal anomalies, i.e. places of the surface that are in-

trinsically warmer or cooler than surrounding terrains observed at the same local solar time and under similar solar illumination.

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