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Comet 67P: Thermal Maps and Local Properties as Derived from Rosetta/VIRTIS data

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Comet 67P is shown to be everywhere rich in organic materials with little to no water ice visible on the surface. In the range of heliocentric distances from 3.59 to 2.74 AU, daytime observed surface temperatures retrieved from VIRTIS data are overall comprised in the range between 180 and 220 K, which is incompatible with large exposures of water ice and is consistent with a low-albedo, organics-rich surface. The accuracy of temperature retrieval is as good as a few K in regions of the comet unaffected by shadowing or limb proximity. Maximum temperature values as high as 230 K have been recorded in very few places. The highest values of surface temperature in the early Mapping phase were obtained in August 2014, during observations at small phase angles implying that the observed surface has a large predominance of small incidence angles, and local solar times (LST) centered around the maximum daily insolation. In all cases, direct correlation with topographic features is observed, i.e. largest temperature values are generally associated with the smallest values of illumination angles. So far, there is no evidence of thermal anomalies, i.e. places of the surface that are intrinsically warmer or cooler than surrounding terrains observed at the same local solar time and under similar solar illumination.

For a given LST, the maximum temperature mainly depends on the solar incidence angle and on surface properties such as thermal inertia and albedo. Since VIRTIS is able to observe the same point of the surface on various occasions under different conditions of solar illumination and LST, it is possible to reconstruct the temperature of that point at different times of the comet’s day, thus building diurnal profiles of temperature that are useful to constrain thermal inertia.

The availability of spatially-resolved, accurate temperature observations, significantly spaced out in local solar time, provides clues to the physical structure local features, which complements the compositional investigation based on imaging spectroscopy data collected at shorter wavelengths.

In the VIRTIS thermal images, a note of great interest is provided by the ‘neck’ of the comet close to the ‘body’, where, because of the concave shape, the ‘head’ casts prominent shadows on some areas when they experience maximum daily insolation. This is a place potentially subjected to considerable thermal stresses. We evaluate both the spatial thermal gradients and the temporal thermal gradients, providing implications for the surface structure.

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