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Detection of cometary activity during 67P/Churyumov-Gerasimenko pre-perihelion by means of GIADA-VIRTIS data fusion

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Previous works based on data provided by the Rosetta/VIRTIS imaging spectrometer demonstrated the occurrence of a water diurnal cycle (De Sanctis et al., 2015) and the occurrence of recently exposed water ice outfalls (Filacchione et al. 2016) on the nucleus of the comet 67P/Churyumov-Gerasimenko well before the perihelion passage. Longobardo et al. (2017) found a systematic 3.2 [U+F06D]m absorption band center (shortward) shift following an increase in surface temperature, interpreted as due to cometary activity: high temperatures lead to underlying water ice exposure.

In this work, pre-perihelion cometary activity has been further investigated, combining the VIRTIS data with those by GIADA, the dust detector onboard Rosetta. In particular, we considered the measurements performed, from August to December 2014, by two of the three GIADA sub-systems: the Grain Detector System (GDS) and the Impact Sensor (IS). Following Della Corte et al. (2015) we separated the particles in “compact”, i.e. high-density particles (IS and GDS-IS detections and GDS isolated detections), and “fluffy” detected as “dust showers” (GDS dust showers), i.e. particles detected only by the GDS and clustered in time (Della Corte et al. 2015; Fulle et al., 2015). A third category is a mixture of the two, detected by GIADA as a compact particle immediately followed by a dust shower (Fulle et al., 2016). For particles detected by both subsystems, velocity, momentum and mass are determined. For particles detected only by the IS, the velocity is inferred by applying an empirical relation (Della Corte et al., 2016). For the third category we assigned a unique velocity given by the compact particle velocity associated with the shower.

We retrieved the source region for individual compact particles and for the dust showers coupled with compact particles, assuming a radial trajectory along which the particle: 1) is uniformly accelerated in the first 11 km from the nucleus (i.e. acceleration region, Ivanovski et al. 2017); 2) has a constant speed out of the acceleration region.

Our analysis provides the following main results:

1) Good correlation between the two studied categories of particles source regions, i.e. the source of the two different types of particles is likely the same.

2) Correlation between number of particles detected by GIADA and the 3.2 micrometer band shift magnitude observed by VIRTIS in each comet region observed during the considered period, corroborating that the band center shift with temperature is due to the diurnal pre-perihelion cometary activity.

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