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In the development of Mars climate models, modeling clouds is an important challenge, and especially for CO_2 clouds. This is due to the complexity of the atmospheric processes involved that may imply rethinking microphysical theories, but also to the scarcity of observations. In the late 90's, Mars Orbiter Laser Altimeter was one of the instruments aboard the Mars Global Surveyor spacecraft. Its first goal was to build a precise map of Mars' topography through laser altimetry but its sensitivity allowed for cloud observations as well . Thus, previous studies (Neumann & al. 2003 Ivanov & Muhlemann 2001) have shown that some laser returns were cloud signatures coming from the atmosphere. However, at that time, the huge amount of data was analysed using simple distinction criteria.

We use K-means clustering algorithms to computationally analyse MOLA data. In order to optimise the method, we first determine the best observed parameters to distinguish the different kinds of returns (surface, noise and clouds). The best number of clusters is determined using three independent methods : elbow, silhouette score and gap statistics. The method is tested on a restricted sample (10 % of the dataset) and then applied to the full raw dataset. Once that cloud cluster identified, we can plot spatial and temporal distributions of the cloud returns and compare them with previous results.

As mentioned by Neumann & al. (2003), the product of surface reflectivity and two-way transmissivity of the atmosphere appears as the best parameter discriminating between surface and cloud returns. A unique number of clusters (6) is identified by all three optimisation methods. Among those clusters, one clearly identifies cloud returns, while others represent noise and surface returns. Our methods allows us to identify more clouds than previous studies. Our cloud distribution remains coherent with the ones given in previous studies, showing the viability of our method. We will present a catalog of cloud returns coming from MOLA data. We are now working to separate different kinds of clouds within these returns (absorptive and reflective clouds, CO_2 / water clouds, dust ...) using machine learning algorithms and a recent MOLA surface reflectivity map (Heavens & al. 2016).