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W-band Radar aboard the International Space Station for Geo-climatic and Hydro-meteorological Tracing: a mission concept

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The basic idea of the WRIGHT (W-band Radar aboard the International Space Station for Geo-climatic and hydro-meteorological Tracing) mission is to foster the measurement of one of the key issue in global and regional climate, namely the hydro-meteorological cycle, and specifically the cloud water content spatial and temporal microphysics and dynamics. Cloud water distribution is one of the most important issues in heat exchange and transfer for Earth climate and Earth-Sun radiative balance. At regional and global level perturbations of the hydro-meteorological cycle are the driving features of climate changes with huge impact on economical and social aspects of human lives.

Cloud water phase, either liquid or ice or mixed, is an essential knowledge for properly characterizing the climate feedbacks due to the atmosphere. Cloud vertical and horizontal distribution, in terms of texture and stratification, is also crucial to understand its albedo properties and to further study the nucleation processes due to atmospheric aerosols at different layer heights. Light stratiform precipitation is of outmost importance within the global hydrological cycle, as it accounts for more than 75% of global precipitation. Moreover, the three-dimensional (3D) dynamics of clouds, in terms of wind field mean and deviation, is crucial to assess the cloud formation and development phenomena as well as the atmospheric turbulence processes. The assessment of cloud microphysical and dynamical properties for geo-climatic applications needs a mid-long term measurement baseline with stable and accurate instrumentation.

The WRIGHT mission is able to cope with above mentioned issues by exploiting new capabilities of the emerging millimeter-wave technology. The WRIGHT mission is aimed at embarking a W-Band Hybrid Imaging Radar (WHIR), with a 94-GHz scanning, Doppler, and pulse-compression capabilities, aboard the International Space Station (ISS) at 355-km orbit height with an inclination of 51.6°. The employment of a W-band radar is not new in space, as CloudSat satellite has been carrying a nadir-pointing incoherent one since 2007 whereas the EarthCARE mission foresees a W-band nadir-pointing incoherent radar together with a lidar, both in a sun-synchronous. However, the unique features of the WRIGHT advanced radar are: i) WHIR will be a scanning instrument thus proving multi-level reflectivity imagery of the cloudy atmosphere for the first time from space; ii) WHIR will be coherent and capable to measure slant-path radial Doppler frequency whose knowledge will provide a velocity field for the first time from space; iii) the pulse-compression capability of WHIR will provide a range resolution of few hundreds of meters with a fine detailed vertical sampling of the atmospheric scenario; iii) the embarkment aboard the ISS will allow WHIR to be a well-maintained and easily replicable instrument thus allowing a mid-long term scenario (if the ISS program will last) of stable and homogeneous measurements for the equatorial, tropical and mid-latitude regions.