Europe on Earth Observation Lidar

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This paper presents the lidar initiatives undertaken in Europe and the role of lidar in the broad context of Earth Observation. It discusses the lidar missions that have been already studied in the last two decades in order to anticipate the directions in the near future. To do so, the lidar missions are put in the general context of the satellite meteorology venture started fifty years ago when NOAA launched the 1st meteorological satellite TIROS-1, in April 1960. Later, the European Space Agency (ESA) joined USA and launched Meteostat-1 in November 1977. Today, the picture is broader while an increasing number of countries get involved in satellite meteorology. The first generation of met satellite carried passive instruments i.e. imager, radiometer, vertical sounder, with multi-spectral or hyper-spectral capability, relying on solar illumination or thermal emission of the scene to be investigated. In the 70's, building on a tremendous R& D activity, a new era in Earth observation started with radar technology in space and the launch of NASA's SEASAT in 1978. Then, lidar was the third technology in order of appearance to go to space when the NASA's LITE mission flew on the space shuttle for 10 days in 1994. Contrary to passive remote sensors, both radar and lidar carry their own sources of EM radiation to generate the signals scattered by the targets i.e. atmospheric particles and molecules, or underlying surfaces. This is a huge difference between active and passive techniques with respect to performance and key technologies that demand more satellite resources for a lidar instrument. The LITE mission was the first to demonstrate the Earth Observation capability of pulsed laser remote sensing technique to profile 2D scattering layers (clouds and aerosols) in the depth of the atmosphere.

At present, the potential lidar missions are discussed in the broad context of all affordable techniques in space in terms of cost and benefit to the community. Along this line, most lidar missions are designed as breakthrough mission to bring new information in the field of climate and meteorology for radiation budget, greenhouse gases, and atmospheric dynamics. At present, Europe's main contribution works through the CALIPSO mission conducted in NASA-CNES cooperation since 1999. CALIPSO was launched in April 2006 and still in full operation in 2013 in the Afternoon Train formation. ESA's Atmospheric Dynamics Mission-Aeolus is a Doppler lidar mission under development to be launched in 2015 for the retrieval of wind velocity with great accuracy in the lower atmosphere. The ESA-JAXA's EARTH-CARE mission will be launched in 2016 to continue the objective of CALIPSO and A-Train. In the meantime, ESA also studied two missions addressing concentration of key atmospheric trace gas: i) the WALES mission for the retrieval of water vapor in the troposphere and lower stratosphere, and ii) the A-SCOPE mission for the retrieval of the CO2 column with 1-ppm accuracy for the determination of CO2 fluxes. Both missions were not selected after phase A and phase 0, respectively, due to technology limitation. In 2009, two European national agencies i.e. CNES in France and DLR in Germany, decide to study a space borne lidar missions so-called MERLIN for the retrieval of methane (CH4) fluxes. MERLIN is under development for a launch in 2017. Building on what we have now, we will discuss the potential lidar mission(s) in the 2020' decades.