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Unmanned Aerial Systems for scientific research

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In the last decade a very wide spectrum of Unmanned Aerial Systems (UAS) has been developed, essentially for military purposes. They range from very small aircraft, weighing a few kg, to stratospheric aeroplanes with total weight of many tonnes. Endurance also varies very markedly, from a few hours to $\leq$ 60 hours, and possibly more in the next future.

Environmental Research and Services (ERS) Srl., Florence, has carried out a scoping study for the UK Natural Environmental Research Council, to identify key Earth and Environmental Science issues which can best be tackled by means of unmanned aerial platforms.
The study focused on issues which could not easily be solved using other platforms, as manned aircraft, airships and satellites. Topics included:

· glaciology (including both continental ice-sheets and sea-ice)
· volcanology
· coastal and ocean observation
· Exchange processes between sea and atmosphere
· atmospheric turbulence, transport, and chemistry in the planetary boundary layer, in the free troposphere and in the upper troposphere – lower stratosphere (UTLS).

Different platforms are best suited to each of these tasks. Platforms range from mini UAS, to Middle Altitude and Long Endurance (MALE) and High Altitude and Long Endurance (HALE) platforms, from electric aircraft to diesel-turbocharged platforms, from solar to turbofan aircraft. Generally long endurance and the capability to fly beyond line of sight are required for most scientific missions.

An example is the application of UAS to the measurement of the extension and depth of sea and continental ice. Such measurements are of primary importance in the evaluation of climatic change. While with satellites it is possible to measure the extent of ice, measuring the depth can only be accomplished by using radar operating at relatively low altitudes. A tactical or a MALE UAS could be equipped with VHL radar which can penetrate ice and hence used to measure the depth of ice sheets. A platform which could fly for over 20 hours over the ice pack or over the Antarctic continent could measure the horizontal and vertical extent of the ice sheet over unprecedented areas. Technical challenges, such as ensuring safe take-off and landing, appear not to be insurmountable.

A second example is the study of the UTLS using a HALE platform such as the Global Hawk. Such a platform is well-suited for circumpolar flights, in which the same air masses could be encountered in a single flight, providing a quasi-lagrangian view of stratospheric ozone chemistry during the polar winter. Transects from the mid latitudes to the subtropics could also be designed, to study exchange processes across the tropopause and the age of air in the stratosphere.

We will illustrate other possible scientific missions using other types of UAS platforms.