

# ISMAR: Towards a Sub Millimetre-Wave Airborne Demonstrator for the Observation of Precipitation and Ice Clouds

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## Abstract

A strong interest is emerging for satellite observations of clouds and rain at millimetre and sub-millimetre wavelengths. The motivations are twofold: Firstly, there is a lack of information on the characteristics of ice clouds. On average, approximately 20% of the globe is covered by high clouds, with substantial impact on the global radiative budget depending on the optical properties of the ice particles. No existing satellite instrument is capable of observing the large variety of ice cloud properties. The visible and thermal domains are essentially sensitive to the thin cirrus (particles with sizes below  $\sim 50\mu\text{m}$  diameter) whereas the available microwave measurements below 190 GHz are limited to the observations of large ice particles (larger than  $\sim 200\mu\text{m}$ ) present in deep convective clouds. Millimetre and sub-millimetre observations could fill the gap and provide information on the intermediate ice cloud types and crystal habits. Secondly, there is a need for observations for now-casting of extreme weather events. Microwave measurements show a more direct relation with precipitation than visible and infrared observations. However, so far passive microwave instruments are only available on low orbit satellites and the temporal sampling of the same area is limited, even in the case of a satellite constellation (with eight over-flights per day in the case of the Global Precipitation Measurement from a constellation of satellites). Geostationary satellites offer the possibility of quasi-continuous coverage of large portions of the Earth. The main difficulty is to obtain adequate spatial resolutions from a geostationary orbit, with an antenna of a reasonable size. One solution is thus to observe at higher frequencies than currently measured today from operational satellites i.e. the sub-millimetre wave range.

Two projects have been submitted to ESA in recent years as Next Earth Explorer core missions: (a) The Cloud Ice Water Sub-millimetre Imaging Radiometer (CIWSIR), which is dedicated to the observations and characterization of ice clouds from a polar orbit, focusing on climate studies and (b) The Geostationary Observatory for Microwave Atmospheric Sounding (GOMAS), the key objective of which is the estimation of precipitation with a high temporal sampling, for now-casting. Although neither of these missions has yet been selected, several technical and scientific preparatory activities are underway in Europe to allow these mission concepts to mature.

This paper reports on one of these preparatory activities; the design of a sub-millimetre wave airborne demonstrator for both ice cloud and precipitation observations which will be able to prove the feasibility of the scientific principles of both the CIWSIR and GOMAS missions. The paper will describe a demonstrator design based upon the new Met Office International Sub Millimetre-wave Airborne Radiometer (ISMAR) which is now under development with a first test flight scheduled for November 2010.