A SUB MILLIMETRE-WAVE AIRBORNE DEMONSTRATOR FOR THE OBSERVATION OF PRECIPITATION AND ICE CLOUDS

J.E.Charlton[1], S.Buehler[2], E.Defer[3], C.Prigent[3],B.Moyna[4], C.Lee[5], P de Maagt[6], V.Kangas[6]

[1]Sula Systems, [2]Lulea Technical University, [3]L'Observatoire de Paris-LERMA, [4]Rutherford Appleton Laboratory, [5]The Met Office, [6]European Space Agency.

ABSTRACT

A strong interest is emerging for satellite observations of clouds and rain at millimetre and sub-millimetre frequencies. 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 ~50μm diameter) whereas the available microwave measurements below 190 GHz are limited to the observations of large ice particles (larger than ~200μm) 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). The geostationary satellites offer the possibility of a quasi-continuous cover 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-millimeter Imaging Radiometer (CIWSIR)[1,2] 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)[3,4], 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 and that is the development of a sub-millimetre wave airborne demonstrator for both ice cloud and precipitation observations and which will be able to prove the feasibility of the scientific principles of both the CIWSIR and GOMAS missions. The paper will describe the derivation of the demonstrator requirements, consideration of the available platform and instrument options, the design of the selected concept, performance prediction and the current status of the development plan for the build, test and integration of the demonstrator as well as the outline of a proof of concept flight campaign. It will present the outcome of the study which describes a demonstrator design based upon the new Met Office International Sub Millimetre-wave Airborne Radiometer (ISMAR) which is due to for it's first test flight on the FAAM BAe-146in July 2010, the first phase of which is already approved for manufacture in 2009.

REFERENCES

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