EARTH OBSERVATION SYMPOSIUM (B1)
Future Earth Observation Systems (2)

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# A NOVEL APPROACH TO MICROWAVE INTERFEROMETRIC RADIOMETRY IN THE GEOSTATIONARY ORBIT USING FORMATION FLIGHT

**Abstract**

Microwave radiometry has been a highly fruitful area of satellite remote-sensing of the Earth, producing a wide variety of data products including global maps of surface and sea-surface temperature, soil moisture and ocean salinity, precipitation, tropospheric temperature and humidity.

All radiometers to date, however, have been operating in low Earth orbit, and to address the important need for improved temporal resolution for such applications as meteorology, the feasibility of deploying a radiometer to the geostationary orbit has been in consideration. Radiometers suffer from very poor spatial resolution due to the diffraction limit at microwave frequencies. This means that an unacceptably large antenna and corresponding instrument are required in geostationary orbit to provide the resolution required for meteorology. As a result of the required size there have been a number of aperture synthesis techniques explored by ESA, NASA and NSSC, China. All of these techniques, however, are still based on a single large satellite.

In the design discussed in this paper a novel approach to aperture synthesis using a number of smaller spacecraft flying in formation is proposed. This approach has several advantages, including virtually unbounded scalability of synthesised aperture sizes, and several unique challenges, including the need for synchronised local oscillators and relative orbit determination and control in sub-wavelength scales.

To discuss the practical implications of these advantages and challenges, two formation flight configurations for microwave interferometry are proposed: a constellation of a single large satellite with several microsatellites, and a constellation of several large satellites.

The first concept employs a rotating Y-shaped interferometer in formation with a constellation of nine free-flying microsatellites. The effective diameter of the synthesised aperture is 14.4 m, which corresponds to a spatial resolution of 17.3 km at 53 GHz from the geostationary orbit. The total mass of the constellation can be within 2 tonnes, and is deployable on a single launch vehicle.

The second concept is a constellation of six formation-flying interferometers, with a 28.8 m aperture, and a spatial resolution of 8.6 km at 53 GHz. While this configuration synthesises larger apertures, the total mass can exceed 5 tonnes, and may require multiple launches and rendezvous at the operational orbit.

The behaviour of such constellations in the geostationary orbit under the influence of the Earth's triaxiality, solar radiation pressure and luni-solar perturbations is studied with the aid of numerical orbital propagation. The radiometric performance of both scenarios are estimated through numerical simulation.