DEVELOPMENT OF A LOBE-DIFFERENCING CORRELATION RADIOMETER (LDCR) FOR AIRBORNE UAV SSS MAPPING

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1. INTRODUCTION

The LDCR is an ultra-lightweight L-band digital lobe-differencing correlation radiometer intended for airborne UAV sea surface salinity (SSS) mapping. Recent progress has been made in the development of the LDCR. This paper discusses the motivations for developing the LDCR, its potential applications, and its current state of its development.

2. BACKGROUND

One of the most critical of environmental parameters yet to be adequately measured is sea surface salinity, which impacts major ocean circulation and a number of biological oceanic processes [8]. Currently, efforts are underway which begin to address the issue of global salinity measurement using satellites, but no low-cost method is currently available to provide salinity data at resolutions suitable for estuary or coastal modeling. Even for the open ocean the spatial and temporal resolution of salinity data from planned satellite missions such as Aquarius [1] and SMOS [2] will be unable to provide detailed information on the impact of localized events such as gyres, precipitation, or wind induced surface mixing.

3. SYSTEM CONFIGURATION

The lobe-differencing correlation radiometer (LDCR) is comprised of two primary subsystems: an RF frontend and digital back-end. The lobe-differencing correlation technique uses simple simple printed GeCoCo antenna elements in a small 2 x 2 array to measure the brightness temperature difference between the ocean surface and cold space, thus providing accurate calibration. Figure 1 shows the antenna pattern simulation.

4. ANTENNA DESIGN

As illustrated in Figure 1, the lobe-differencing antenna consists of an L-band printed dipole array based on an endfire configuration of coaxial-colinear (CoCo) elements. Each of the four array elements will consist of a 6-segment generalized CoCo antenna. The planar nature of the printed CoCo antenna provides an extremely lightweight and aerodynamic structure that will trail the UAV with minimal impact on flight behavior. By using a 90° balanced hybrid coupler, two moderately-broad antenna lobes (one in the zenith and one in the nadir direction) are formed.
Cancellation of horizontal radiation is performed by spacing two such co-phased endfire arrays a distance of one-half wavelength apart. The resulting beams are primarily selective to nadir and zenith directions, and provide effective sensitivity to L-band emission over a pixel of size commensurate with the aircraft altitude. In this manner the nadir beam will thus observe primarily ocean emission and the zenith beam will provide a precise reference by observing the stable cosmic background radiation.

5. SYSTEM DESIGN

The radiometric front end design implements a correlation radiometer and provides sum and difference channels of the zenith and nadir looking beams, which are sampled digitally. The calibration system is over-solved by the inclusion of a PIN diode switch and calibration terminator for each channel designed such that the sum and difference channels may be composed of (1) the nadir and zenith beams, (2) the nadir beam and a calibration terminator, (3) the zenith beam and a calibration terminator, or (4) two calibration terminators. The sum-difference channels are sampled at 200 MSPS by a 14-bit two-channel simultaneously sampling A/D. A Xilinx Virtex5 FPGA performs real-time preliminary data processing on each channel as shown in Figure 2. The final two elements of the pipeline are computed on a host PC which collects and stores the data.

4. ANTICIPATED DEPLOYMENT

Currently a prototype of the LDCR is under development. Initial deployment of the radiometric front end and backend is anticipated for Fall 2008 onboard the NASA DC-8 to support the Atmosphere-Surface Interaction Mechanisms During Arctic Sea-Ice Freeze-Up (AMISA) mission in August 2008.

11. REFERENCES