Sea Surface Emissivity Observations at L-band: 
First Preliminary Results of the Wind and Salinity Experiment WISE-2000


(1) Dept. Signal Theory and Communications, Universitat Politècnica de Catalunya, Campus Nord-D3, Jordi Girona 1-3, 08034 Barcelona, Spain  
Ph: 34-93.401.60.85; Fax: 34-93.401.72.32; e-mail: camps@tsc.upc.es

(2) CSIC, Institut de Ciències del Mar, c/ Joan de Borbó, s/n, 08039 Barcelona, SPAIN

(3) LODYC, UPMC, case 100, Tour 15 2e etage, 4 Place Jussieu, 75252 PARIS CEDEX 05, FRANCE

(4) CETP, 10-12 av de l’Europe 78140 Vélizy FRANCE

(5) Departament de Termodinàmica, Facultat de Física, Dr. Moliner 50, 46100 Burjassot, Valencia, SPAIN

(6) European Space Agency, ESTEC, Keplerlaan 1, 2200-AG Noordwijk, THE NETHERLANDS

Abstract- This paper presents the first measurements processed from the data acquired with the L-band AUtomatic RAdiometer (LAURA) during the WInd and Salinity Experiment (WISE-2000). Experimental results are compared to a sea surface emissivity model developed by the Polytechnic University of Catalonia (UPC). The sensitivity of the brightness temperatures at vertical and horizontal polarizations to wind speed are discussed, as well as the weak azimuthal signature found.

I. INTRODUCTION

Sea surface salinity can be measured by passive microwave remote sensing at L-band, where the sensitivity of the brightness temperatures at vertical and horizontal polarizations shows a maximum and the atmosphere is nearly transparent. To provide global coverage of this parameter (and also of soil moisture) with three-day revisit time the Earth Explorer Opportunity Mission SMOS was selected by the European Space Agency (ESA) in May 1999. SMOS is a two-dimensional aperture synthesis interferometric radiometer whose imaging configuration presents new challenges: variation of incidence and azimuth angles, polarization mixing, wind and sea foam effects. To better understand these effects the WISE 2000 campaign (WInd and Salinity Experiment) was sponsored by ESA. Fully polarimetric L- and Ka-band radiometers, a video, an IR and a stereo-camera, and four oceanographic and meteorological buoys were installed in the Casablanca petrol platform (Fig. 1) at 40 Km from the coast of Tarragona (Spain) where the sea conditions are representative of the Mediterranean open sea with periodic influence of the Ebro river fresh water plume.

Systematic measurements were acquired from November 15th to December 19th, 2000 and continued during the January 9th to 16th, 2001. Sea state variability is an important point and at present we can only rely on the stationarity of sea state, at the scales of interest, for about 5 minutes, although it might be more. Therefore measurements were acquired in three modes of operation:

1) Mode 1, fixed observation: This is a mode for long observations at fixed direction (incidence and azimuth, the azimuth will vary with the wind direction) to study the time scale of the stability of the sea state and its consequences on L band emissivity. This mode was used pointing to the North with the radiometer and the stereo-camera pointing to the same spot.

2) Mode 2, azimuth scan: In order to detect any possible azimuthal signature of the brightness temperatures, the range of angles to be swept must be as large as possible. In our situation it was limited by the platform to 120°-150°,
depending on the elevation angle. An interleaved scan in 30° steps was used from 0° to 150°.

3) **Mode 3, elevation scan:** The elevation scans were performed from 25° to 65° in 10° steps to determine the variation of the brightness temperature with respect to the wind.

The radiometer integration time is 0.5 s. Measurements in modes 2 and 3 were 4 minutes long for each position, about 30 minutes in total.

II. DATA CALIBRATION AND PROCESSING

LAURA is an L-band fully polarimetric radiometer consisting of two Dicke-type radiometers for the vertical and horizontal polarizations (Tv and Th), and a correlation radiometer for the third and fourth Stokes parameters (U and V). The calibration of instrumental errors is described in [1]. In addition to their correction, the detection of such small signatures requires:

1) **Screening of interference-free measurements.** Fisherships radio transmitters at 156 MHz, and at 142 MHz were detected as potential interferors, among others. It was realized that H polarization is much more corrupted than V polarization, although it is not free, which was attributed to the harmonics of TV transponders. Unfortunately, this was the situation of most scans in mode 1, and in modes 2 and 3 at H-polarization and ø ≥ 45°.

2) **Pointing oscillations** due to strong winds.

3) **Atmospheric and galactic noises correction:** Based on in situ meteorological data, local hour, and antenna boresight azimuth and elevation, the down-welling atmospheric and galactic noises reflected on the sea surface, and then collected to the antenna are estimated and then subtracted from the calibrated measurements.

4) **Antenna finite beamwidth effects** [1].

III. EXPERIMENTAL MEASUREMENTS.

1) **Elevation Scans:**

Fig. 2 shows four elevation scans at horizontal (left) and vertical (right) polarizations at different wind speeds. Crosses indicated measurements and the solid line a fit with the UPC sea surface emissivity model. A modification of [2] at L-band. In general, measurements at V polarization are much neat that the corresponding ones at H-polarization because of interferences, mainly at large incidence angles.

Even though at the time of writing this paper all the data have not been yet analyzed, it seems that the brightness temperature sensitivity to wind speed is about 0.25–0.30 K/(m/s) at nadir, while it is almost negligible around 65° and V-polarization.

The amplitudes of the signatures are quite small, on the order of 0.2 – 0.3 K at low wind speeds, and about 1 – 1.5 K at 12.6 m/s wind speed and 25° incidence angle. These small signatures can even be distinguished with a ~120° angular sector scanned. In Fig. 3d, the agreement in shape and amplitude are quite good, but they appear to be displaced one from the other, probably because of a change in the wind direction during the measurement.

Fig. 6 shows the weak azimuthal variation of the third Stokes parameter, about ± 0.8 K at 25° incidence angle and 1.8 m/s, and ± 1.4 K at 35° incidence angle and 9.0 m/s. These measurements were critical because even small interferences in H and/or V distort completely the data.
In the next few months the radiometric data will be analyzed and compared to the meteorological and oceanographic data, the sea foam coverage and sea surface statistics derived from the stereo-camera. It is expected that an appropriate L-band sea surface emissivity description will be selected to develop sea surface salinity retrieval algorithms for SMOS.

A second campaign is foreseen for October-November 2001 in which airborne radiometric data will be acquired for inter-comparison with the tower-based one. After the WISE-2000 experience, probably the integration time per angular position should be halved so as to double the number of samples and improve the visual recognition of the data. Azimuth scans should be performed during periods of time in which the reflected galactic noise is minimum. Other effects as sea foam emissivity or rain would probably require controlled experiments.

**CONCLUSIONS**

This paper has briefly described the WInd and Salinity Experiment 2000 and has presented the first results of the analysis of the radiometric data. A preliminary analysis shows a wind dependence about ~ 0.25 K / (m/s) at nadir and almost negligible around 65° at V polarization. Weak azimuthal signatures are also present in Th and Tv: a fraction of a Kelvin for moderate wind speeds, that raises up to 1.5 K peak to peak at V polarization and 25°. Measurements of the third Stokes parameter show a small azimuthal signature, about ±1.4 K at 9 m/s and θ = 35°.

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**REFERENCES**
