EXPERIMENTAL RELATIONSHIP BETWEEN THE SEA BRIGHTNESS TEMPERATURE CHANGES AND THE GNSS-R DELAY-DOPPLER MAPS

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1. INTRODUCTION

Water plays a key role in all the geological and biological processes that take place in our planet. Cycling endlessly between oceans, atmosphere and land, it triggers and supports life, shapes the Earth and drives the weather and the climate. Recalling that oceans account for more than 96% of water on Earth, it seems sensible to study the mechanisms that govern the ocean-to-atmosphere interface. The sea surface salinity (SSS) is an oceanographic parameter that depends on the balance between precipitation and river discharge fresh water, ice melting, atmospheric evaporation, and mixing and circulation of the ocean surface water with deep water below. Salinity and temperature are the two variables that control the density of the ocean water, which increases with increasing salinity and decreasing temperature. Density itself is a very important oceanographic parameter, since ocean currents are generated by horizontal differences in density, and also its vertical profile determines the effect that surface winds, heating, and cooling have on subsurface waters. The radiometric measurements at L-band provide the best estimate of SSS. However, the sea surface roughness heavily influences the measured brightness temperatures, thus masking the SSS signature [1]. A potentially feasible approach to overcome this situation is to use the scattering of opportunity signals over the sea surface to retrieve geophysical parameters [2-4]. Particularly, the signals of the Global Navigation Satellite Systems such as GPS or GLONASS could be received and processed after reflecting over the sea to infer the roughness state [5-6]. This GNSS-R approach has recently been studied for the future follow-on Soil Moisture and Ocean Salinity (SMOS) mission SMOSops. It is expected that the collocated measurements of sea brightness temperature and reflected GNSS signal can result in a significant improvement of the retrieved SSS. The Passive Advance Unit (PAU) project aims at demonstrating this sensor synergy. It was proposed in 2003 to the European Science Foundation (ESF) within the frame of the European Young Investigator (EURYI) Awards program, and was funded in 2004 [7]. Its scientific goals are to perform ocean monitoring by passive remote sensing, improve the knowledge of the relationship of the GNSS-R signal with the sea state, and improve the knowledge on the relationship between L-band brightness temperature and sea state. To accomplish these goals the PAU sensor consists of an L-band digital beamforming radiometer, a GPS reflectometer, and an infrared radiometer.

2. GNSS REFLECTOMETRY

Global Navigation Satellite Systems (GNSS) are satellite constellations that cover the entire Earth with their navigation signals to provide time and position information to users located on or near the Earth. Such systems are used nowadays in a wide range of everyday situations, such as fleet management, search and rescue, wildlife tracking, vehicle guidance or leisure interactive maps, among many others. So far the American GPS is the only fully operational GNSS. The Russian GLONASS system is partially deployed, whereas the European GALILEO is scheduled to be operational in 2013. There are other planned GNSS systems, such as the Chinese COMPASS or the Indian IRNSS that are to be operative in the future. Altogether, more than 75 GNSS satellites will be available when all the currently planned systems are deployed. To acquire the GNSS signal it is necessary to correlate it with a locally generated replica of the PRN code and a phasor to compensate the Doppler frequency shift due to the relative movement of the transmitter and the receiver. The correlation value is proportional to the power scattered at different delay and Doppler bins, and it is known as Delay Doppler Map (DDM). For a specular surface the DDM will be very similar to that obtained when acquiring direct signal, except for a scale factor due to the Fresnel reflection coefficient of the surface. However, the rougher the surface the more spread the DDM. As explained in [8], the region of the scattering surface from where reflections that reach the receiver originate is known as the *glistening zone*. Its extension depends on the roughness, and for a perfectly flat sea it will be reduced to a single point (the specular reflection point). This glistening zone comprises several different delay and Doppler bins, so that the resulting signal that reaches the receiver is made up of a variety of components with different delay and Doppler shifts. The correlation process selects a given surface patch and extracts the power reflected on that particular surface region. The sea state parameterizes the scattering coefficient, which in turn determines the glistening zone extension and shape. Thus, the measured DDM conveys information regarding the sea state.

3. ALBATROSS 2008 MEASUREMENT CAMPAING

The normalized DDM volume is envisioned as a single parameter to account for the sea roughness when performing SSS retrieval by means of L-band radiometry. To test this assumption the Advanced L-Band emissivity and Reflectivity Observations of the Sea Surface 2008 campaign (ALBATROSS 2008) was conducted [9]. The aim was to acquire an exhaustive dataset of GNSS reflections and radiometric brightness temperatures over the sea surface under several sea-roughness conditions using ground-based sensors. Additionally, oceanographic buoys gathering ground truth data WHICH ONE? were moored near the observation site. The field experiment lasted for 6 weeks since May 27th to July 4th, 2008, in an attempt to catch different sea state conditions. In [9] preliminary data processing linking the DDM volume to the roughness data provided by the buoys showed a good correlation between both variables. The present paper will present the first results of merging the GNSS-R data with the L-band radiometric measurements, to test the ability of performing the SSS roughness correction with the GNSS-R observables.

4. REFERENCES

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