REASON CLUTTERGRAMS OF CILIX RIDGED PLAINS USING A NOVEL SIMULATOR BASED ON A ROUGH FACET INTEGRAL FORMULATION.

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Introduction: The REASON instrument (Radar for Europa Assessment and Sounding: Ocean to Near-surface) of the upcoming Europa Clipper spacecraft is a dual-frequency radar sounder, operating at both 9 MHz (HF band) and 60 MHz (VHF band) that will make detailed observations of Jupiter's moon Europa. Radar sounders are remote sensing instruments that operate by sending electromagnetic pulses towards the body of interest and by collecting any eventual reflections from surface and subsurface features on the considered body, allowing for the imaging and characterization of features such as, in the case of Europa, underground water lakes or the ice-ocean interface.

Part of ensuring a successful campaign at Europa relies on correctly predicting the backscattering from surface features (clutter), to be able to discriminate them from subsurface features of interest.

We have developed an advanced backscattering simulation method that is able to reproduce both the coherent and incoherent backscatter from a given terrain [1]. The simulator is based on the discretised Stratton-Chu formula [2], but in lieu of considering a digital elevation model (DEM) with planar facets, this new simulator is able to consider facets with a statistically-defined roughness (following a Gaussian distribution of heights with variance σ^2, and having an isotropic Gaussian correlation function of coherence length l), leading to a much more accurate depiction of the backscattered field, especially with coarsely-resolved DEMs. The coherent portion of the signal corresponds to the deterministic part of the DEM, whereas the incoherent portion of the signal arises from the statistically-defined roughness of the facets.

In this abstract we present preliminary radar clutter simulations (cluttergrams) of Europan Cilix ridged terrain, as it would be seen through the REASON instrument at an altitude of 50 km, for one possible combination of inputs. We do not consider the mitigating effect of azimuth processing in this demonstration, nor did we include the antenna patterns of REASON.

Cilix DEM and small-scale roughness: The DEM of the region of interest was produced from Galileo stereo images and has a resolution of 150 m [3], and can be seen in Figure 1. The gaps in the DEM result from the DEM generation process.

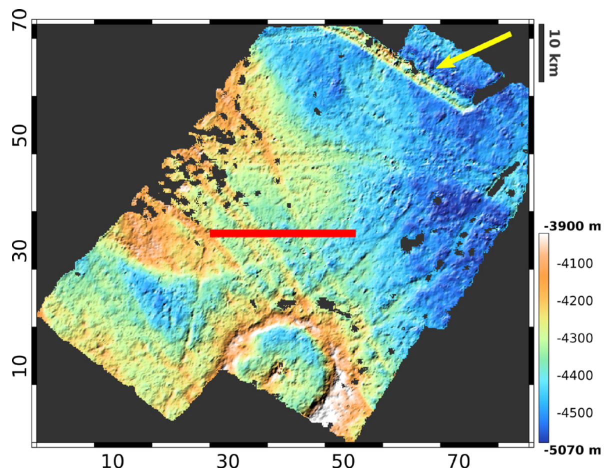

Figure 1: Digital elevation model of Cilix ridged plains [3]. The red line represents the simulations ground track, and the yellow arrow highlights a prominent double ridge.

We ran simulations with both smooth and rough facets, to highlight the effect of small-scale roughness. In the case of rough facets, the following parameters were considered: σ = 2.2 m, l = 60 m for the HF simulation; and σ = 0.5 m, l = 5 m for the VHF simulation. These values stem from extrapolation of ridged plains roughness at wavelength scales [4].

REASON cluttergrams and discussion: The simulations for the HF component, with and without facet-level roughness, are shown in Figure 2. Those for the VHF component are shown in Figure 3.

Comparing the simulations with smooth and rough facets, we observe that incoherent scattering is likely to be prominent at Europa, and that small-scale roughness cannot be neglected. Predictably, this has particular importance for the higher-frequency component.

When small-scale roughness is indeed considered, both HF and VHF cluttergrams are mainly dominated by incoherent backscatter, although the VHF simulation shows more structure. A prominent feature visible in both images is the echo from the double ridge at the top end of the DEM, highlighted with a yellow arrow in all figures. Interestingly, the double ridge is much more prominent in the simulations with rough facets, as if roughness was "correcting" the fact the angle is not necessarily specular for the chosen altitude. We note, however, that these simulations are only range-compressed, and that once along-track processing is

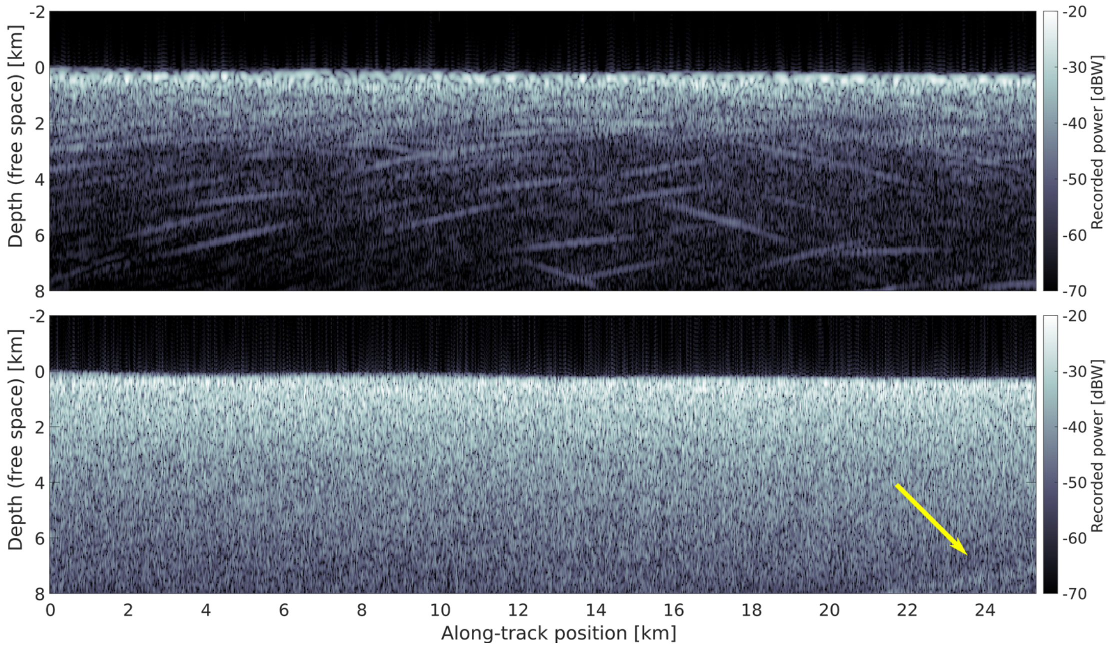

Figure 2: HF simulations (range-compressed). Top: using the DEM with smooth facets. Bottom: using rough facets.

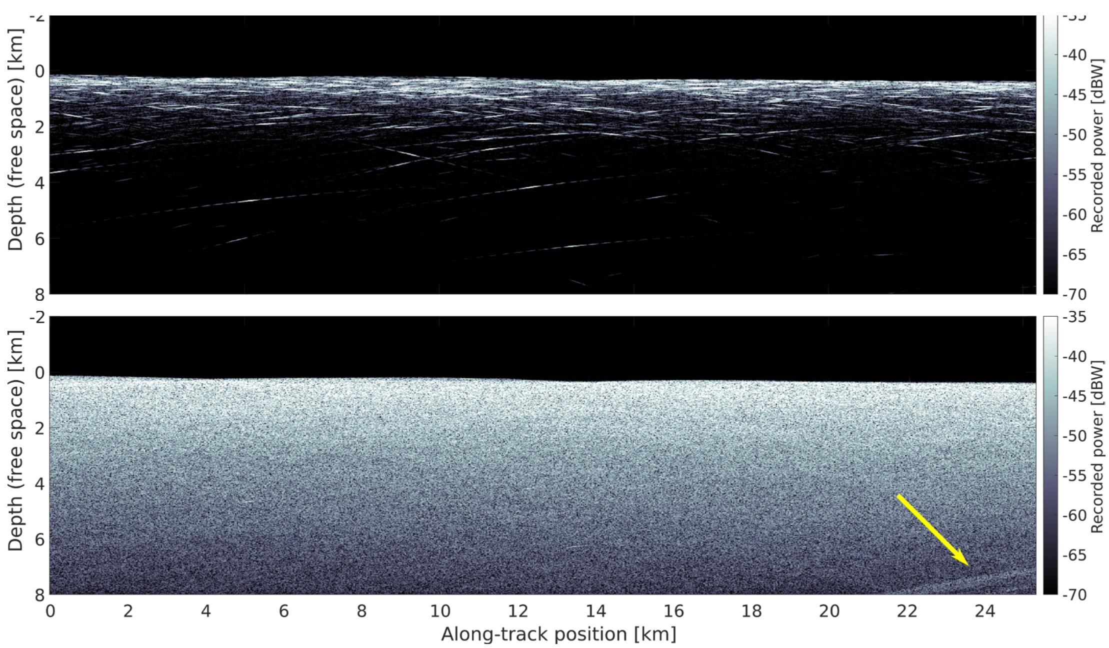

Figure 3: VHF simulations (range-compressed). Top: using the DEM with smooth facets. Bottom: using rough facets.

applied, this diffuse clutter will be greatly suppressed with respect to any coherent subsurface signal that might be present in the real data [5].

Future work: On this basis of simulations such as these, the clutter experienced by REASON can be analysed and characterised on a case-by-case basis.

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