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New calibrated spectral observations and modelling of Europa from Galileo/NIMS

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Abstract

The Near Infrared Mapping Spectrometer (NIMS) observations at wavelengths 0.7-5.3 μm of the Jovian moon Europa are being reprocessed using information gained throughout and beyond the Galileo mission. Early analysis of these reprocessed data (three observations, including a global scale one of the anti-Jovian and trailing hemispheres at 47 km spatial resolution) show evidence of spectral features not or only weakly apparent before [1]. These include strong absorption bands attributed to CO_2 and SO_2 (centered near 4.25 and 4.0 μm, respectively). The strong hydrate bands, including at near 1.5 and 1.95 μm, are now more clearly defined. The largest amounts of CO_2 and the most well defined hydrate bands are strongly associated with the (endogenic) dark reddish regions on the surface [1, 2]. We will present results from newly calibrated observations that we are currently working on.

1. Introduction

Europa is the second outward from Jupiter of the four Galilean satellites. It is similar in size to the Earth's moon, and has a young crater-free surface. The interior has a dense rocky/metallic core surrounded by a low density shell 80-170 km thick that is assumed to be primarily ice and/or water. The magnetic signature of Europa implies the presence of a conducting liquid subsurface ocean. Additionally, spectra from Galileo/NIMS showed the surface to be partly covered by heavily hydrated materials such as sulfate salts [3, 4] and/or sulfuric acid hydrate [5, 6]. The hydrated material is concentrated in the regions of darker brownish coloring that occur in some chaos regions and along linea, and may be linked to possible endogenic materials from the subsurface [3].

2. Completed observations

The NIMS builds up spectral images by recording a spectrum over 20 mirror positions and up to 408 wavelengths. These wavelengths are sensed by 17 discrete detectors, each of which covers a small region of the spectrum. The third dimension of the spectral image is filled out by scanning the instrument field-of-view slowly perpendicular to the mirror motion [7]. The NIMS observations of the icy satellites are now being reexamined and recalibrated using new techniques [8, 9, 10]. The Europa observations needed an improved despiking process for the spectra longer than 3 μm, where radiation spikes outnumber the good data by a ratio of 2:1, or more. The first Europa observation to be processed was TERINC (Terra Incognito) from the E6 orbit, which was known to have fewer spikes overall than average. This is a global scale observation with a pixel scale of 47 km

This observation was dark-corrected and radiometrically calibrated using the best dark and calibration values and wavelength list [11]. The wavelengths up to 2.4 μm were despiked using our usual procedure [12]. The short wavelength process yielded about 20% spikes. For the wavelengths longer than about 2.75 μm the same despiking was used with much tighter parameters. This despiking was repeated three times to remove most of the visible spikes. Then a few hundred remaining small spikes were manually removed up to 4.4 μm. Beyond this wavelength the spectra have just a few digital numbers (DN) of signal, and contain no information other than a general shape. These wavelengths were constrained to be near spectra from areal averages [1]. The final frequency of spikes in this region was 70-80%.

Two additional Europa data sets were calibrated, SUCOMP2 (pixel scale 7.5 km) [2] from orbit 6 and LINEA (pixel scale 17 km) from orbit 3. Both have considerable amounts of dark hydrate, but both have a

spike abundance of 80-90% in the longwave part that make mapping of features in individual spectra nearly impossible.

3. Newly processed observations

The possible observations to be shown will be from the following table.

Table 1: NIMS observations of Europa

Orbit No.	Obs. name	Location	Pix. scale (km)
G1	NHILAT	240W, 45N	79
G2	LEADMP	290W, EQ	336
C3	ELIMB	220W, 25S	30
E4	SUCOMP1	320W, 55S	8
E4	SUCOMP2	300W, 30N	15
E4	SUCOMP3	320W, 55N	3
E6	SUCOMP1	270W, 25S	7.5
G7	FLEXUSA	180W, 30N	44
G7	FLEXUSB	200W, 35S	42
G7	FLEXUSC	180W, 35S	41
G7	TYREMA	145W, 35N	12

We will attempt some linear modeling of the calibrated data sets along the lines of [13], using at least two hydrates and water ice of various grain sizes.

4. Summary

After demonstrating the ability to calibrate and despike NIMS Europa observations [1, 2], we will apply these techniques to further observations and model the results. We will also look for CO_2 and SO_2 bands in the data if the noise level allows.

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