RADAR ALTIMETRY OVER THE GULF OF MEXICO OIL SPILL

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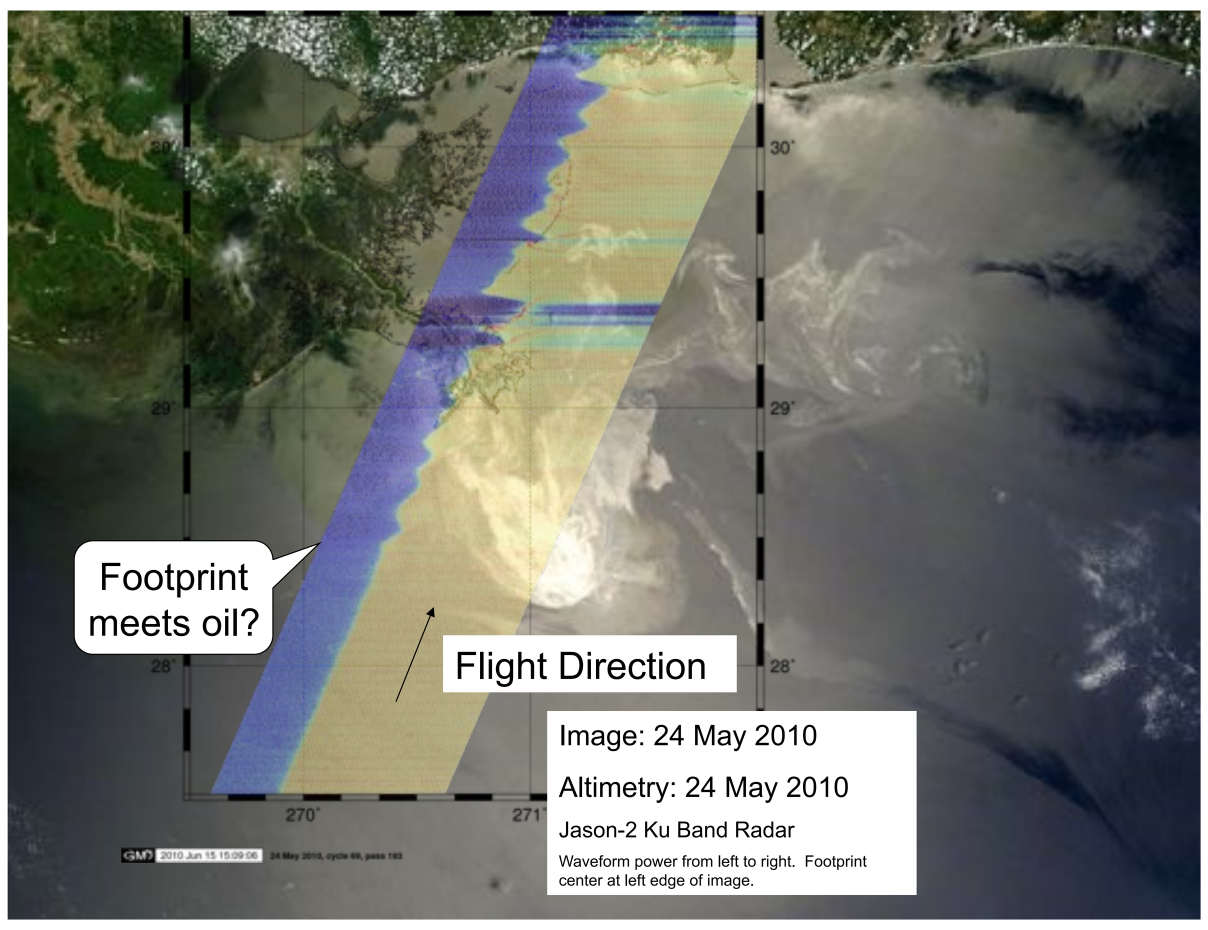
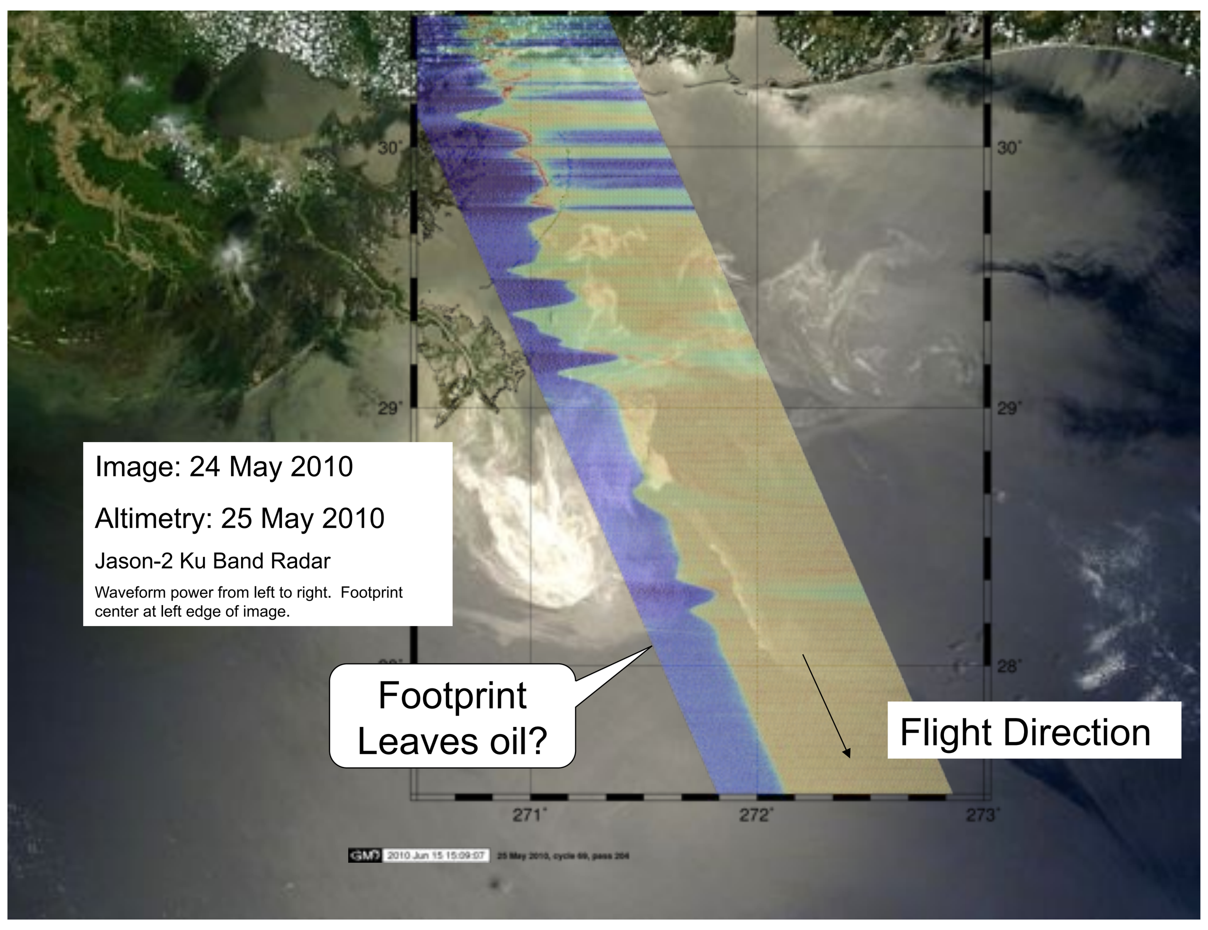
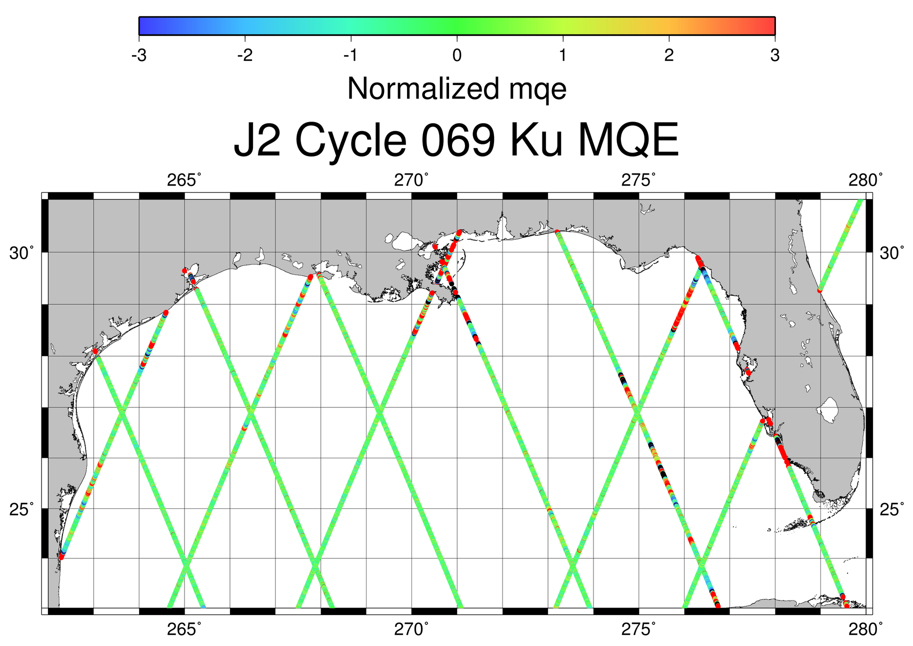
ABSTRACT: We are examining radar altimeter waveforms and derived parameters at 20 Hz over the Gulf of Mexico, comparing results before and after 20 April 2010 when the Deepwater Horizon oil spill began, and comparing results in clear water with results in spill-affected areas. We use optical, multi-spectral, and SAR imagery to identify these areas. At the time of writing of this Abstract (17 June 2010) the analysis is preliminary and is limited to the Jason-1 and Jason-2 altimeters. We hope to extend this analysis with additional EnviSat and CryoSat2 data by the time of the OST-ST 2010 meeting.

We find that waveforms over oil contain bright and/or specular reflectors with power levels strongly exceeding those of normal waveforms. The effect of these is to disrupt the automatic gain control, to drive the nadir return away from the intended track point, and to cause atypical values to be reported for pulse peakiness, mean quadratic error, off-nadir angle, sigma-naught, and significant wave height. This is seen in both Ku and C band data. We are working to identify a set of threshold values that will allow oil / no oil discriminations to be mapped confidently and automatically with the altimeter, accounting for variability in these data in the region outside the 20 April spill. It appears that "oil like" results, though uncommon, are not rare throughout at least the northeastern Gulf of Mexico, including prior to 20 April 2010.

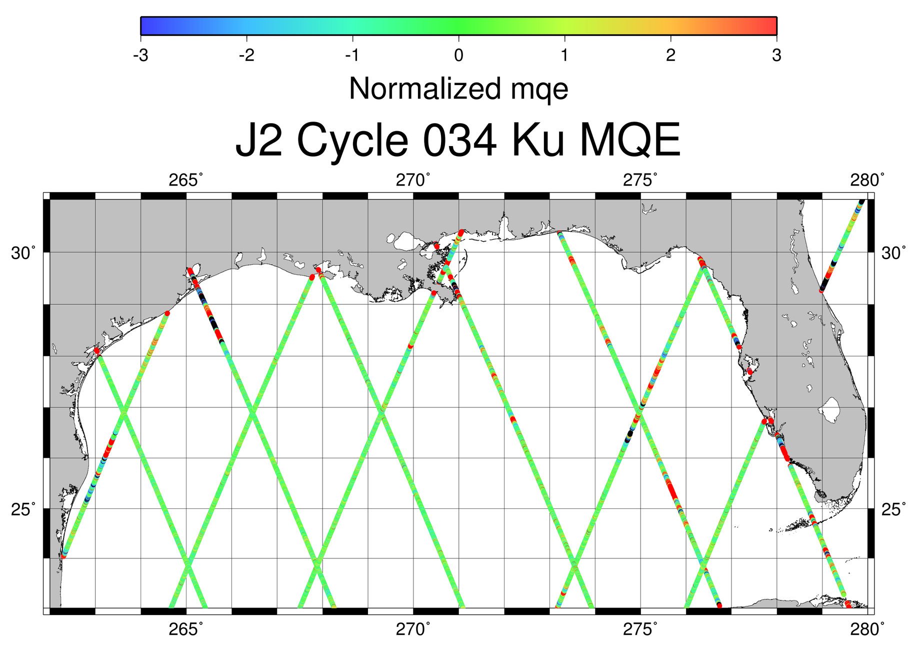


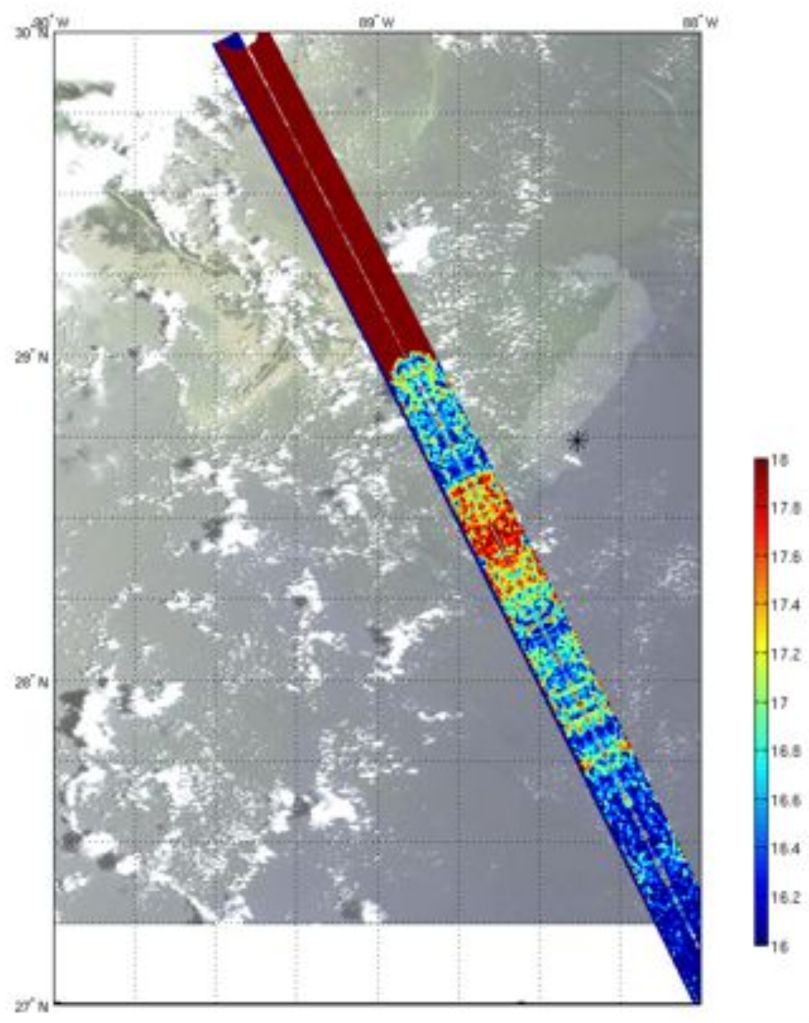
Oil on the ocean surface makes the surface unusually reflective at Ku and C band, causing a "bloom" of sigma-0 and a disruption of the waveform's shape and track point. This affects all geophysical tracker outputs (range, sigma-0, SWH, etc.) and also other parameters (MQE, pulse peakiness, etc.) These parameters, and waveforms, are available at 20 Hz for both Ku and C band in Jason-1 and Jason-2. We looked at all of these.





Waveform Parameters: At first we thought it would be simple to search for unusual values of waveform parameters, such as the Mean Quadratic Error shown here. (MQE is a measure of the misfit of the Brown model waveform found by retracking.) We compared values over the spill to values elsewhere in the Gulf (at left), and also compared values obtained at similar times one year earlier (at right). However, we found that the unusual values over the oil spill (around 271 E, 29 N at left) also occur throughout the Gulf (e.g. 275 E, 25 to 27 N, in both maps left and right). We speculate that thin films of oil are common throughout the Gulf.





A better way: Inversion of waveforms for a swath of sigma-0 (backscatter coefficient) values. J. Tournadre, B. Chapron and colleagues at IFREMER have developed an inversion scheme which takes as input a sequence of waveforms and estimates a swath of backscatter coefficients. After we had begun our work on the oil spill, we saw their presentation at the ESA Living Planet symposium in Bergen last July. Following that meeting, we asked them to try their technique on the oil spill, and they produced the image shown at left. This is C band backscatter.

The inversion technique seems to be finding the oil fairly well. There is necessarily some ambiguity in the location of these high-backscatter areas by their technique. In particular, the cross-track position is ambiguous as to whether the bright reflector lies to the left or the right of the nadir ground track.

We were so impressed by their results that we did not try to develop our approach any further.

Conclusions:

- Thin films of oil may cause disruption of normal altimeter tracking of the sea surface.
- In the Gulf of Mexico these may be very common, and not only due to the Deepwater Horizon oil spill of April 2010.
- The inversion scheme of Tournadre et al. is a promising way to investigate variations in backscatter, including oil films.