

Portugal - Atlantic Coast

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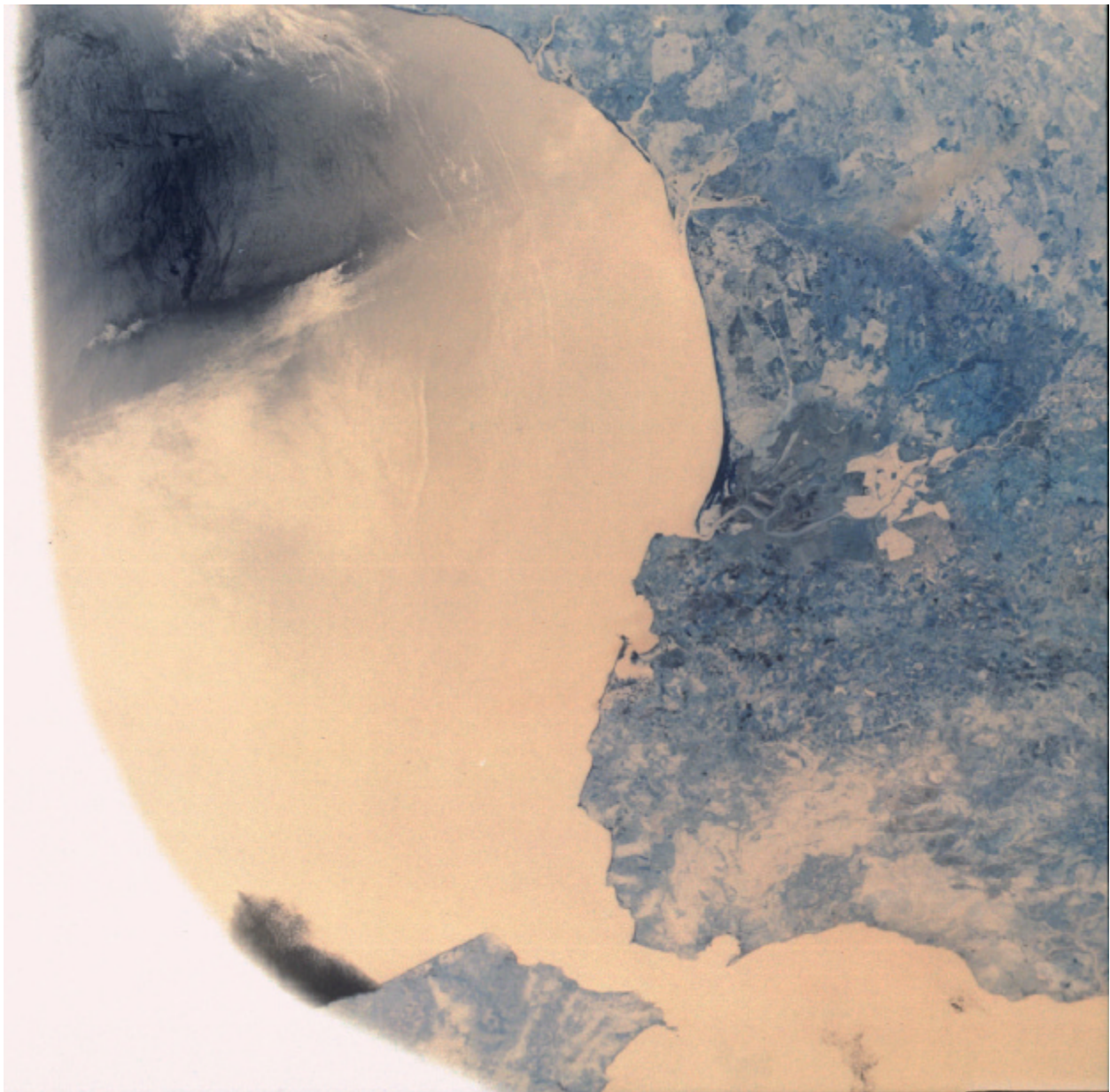


Figure 1. Apollo-Soyuz Test Project astronaut photograph (AST-27-2367) of the Gulf of Cadiz, Spain acquired in July 1975. The sunglint image is color inverted to help highlight the internal wave signatures. Two packets of internal waves are visible, one at the edge of the continental shelf (bright vertical band near image center), the other approximately 25 km shoreward (bright vertical bands above and right of the first internal wave). The lead soliton wavelengths are approximately 2 km. [From Apel, 1979]

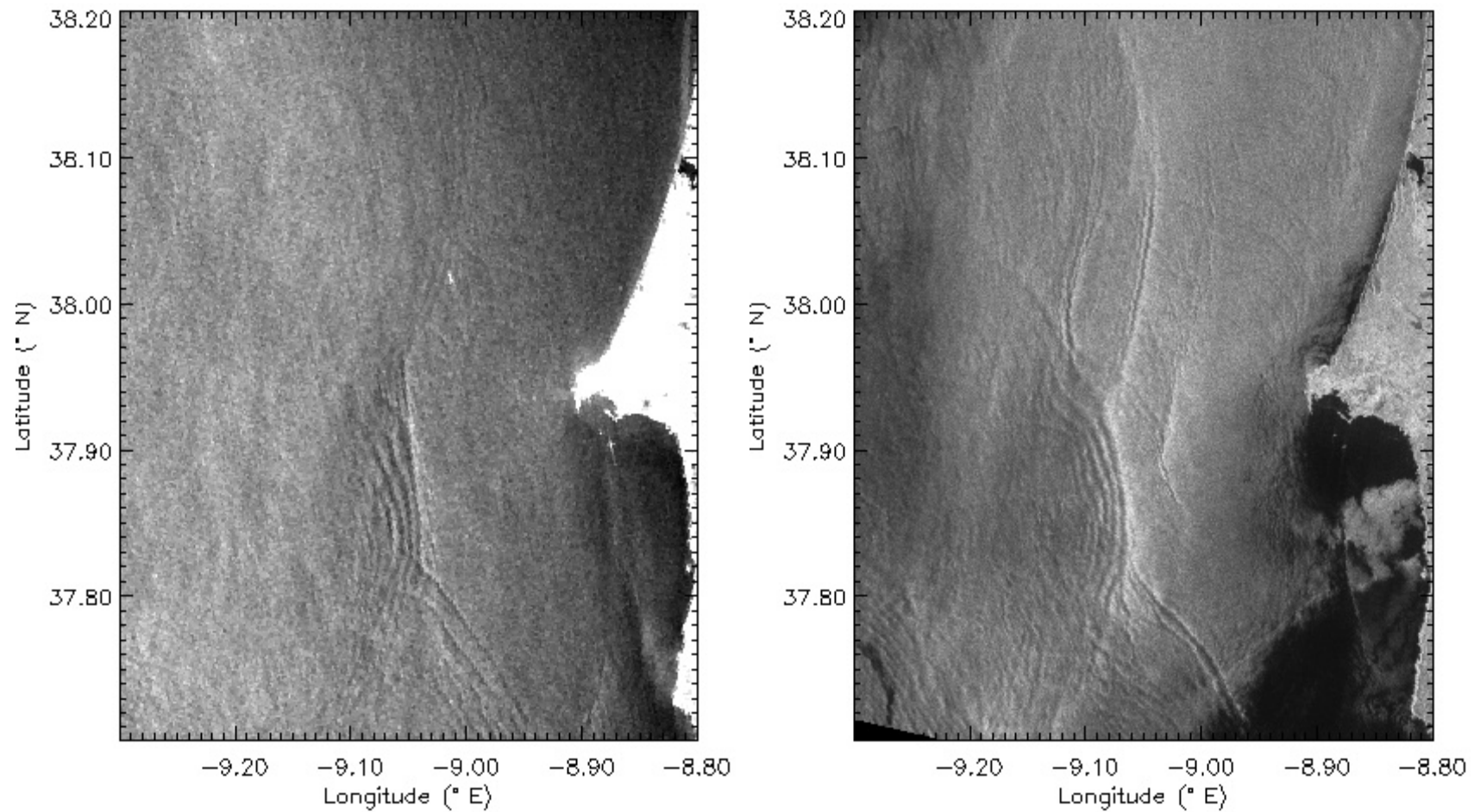


Figure 2. RADARSAT SAR images of Cape Sines region. a). 7th July 1999, 0647 GMT, 7 days after springs, 2 hours 2 minutes before High Water Sines, b) 6th July 1999, 1832 GMT, 6 days after springs, 1 hour 33 minutes before High Water. The images are separated by 12 hours 15 minutes.

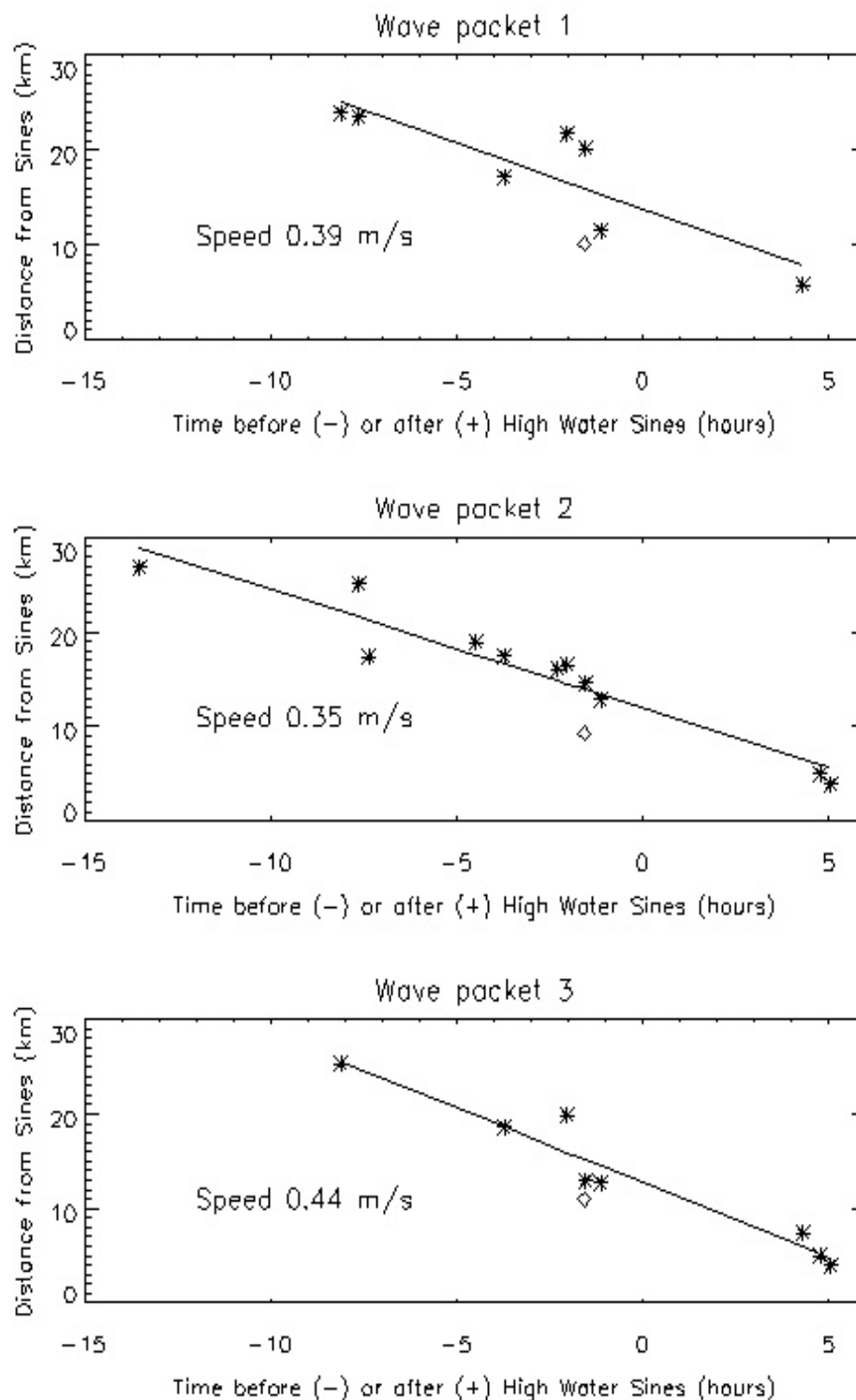


Figure 3. Distance of the leading internal wave from Cape Sines, as a function of point in the tidal cycle (at the port of Sines). Images from June to August are included only. Data points are shown as asterisks, except 8th August 1999 (diamond). A least-square fit is shown and the speed of progression is marked on each plot. The times of Higher Water for the port of Sines has been collected from the Portuguese and the UK Admiralty Tide Tables.

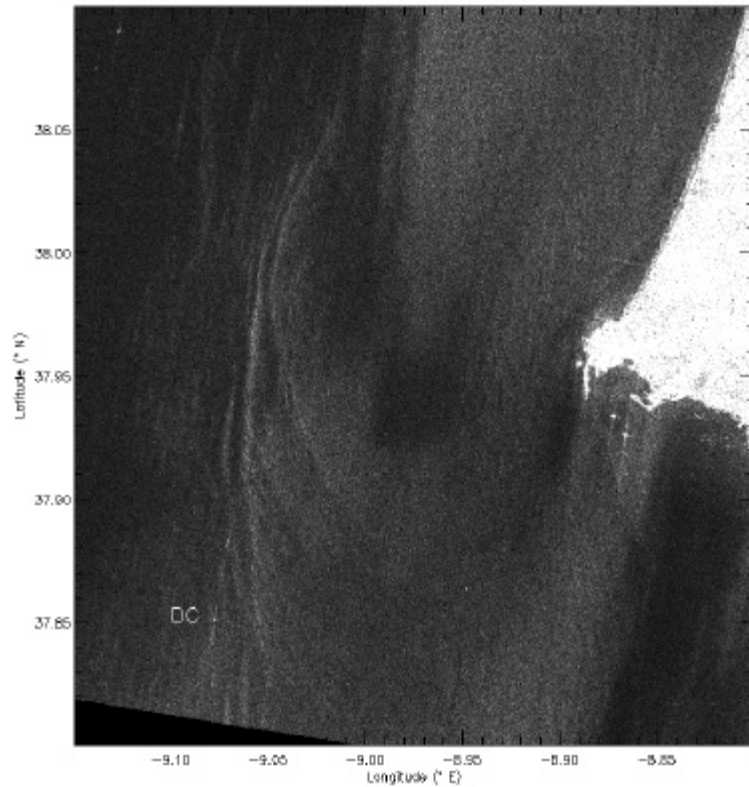
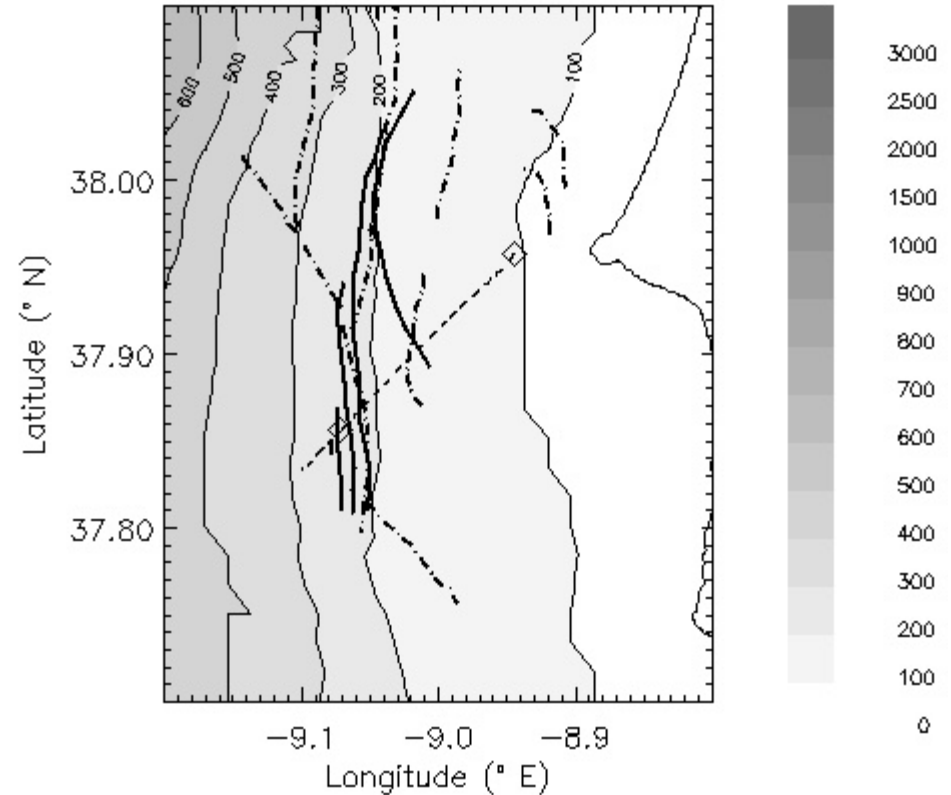


Figure 4a. RADARSAT SAR 21st July 1999, 0638 GMT, 6 days after springs, 2 hours 17 minutes before High Water showing internal waves close to NRP Dom Carlos (bright speckle to the right of the annotation 'DC').



(b). Figure 4b. Ship track 21st July shown as dashed line (from north-east to south-west) with the positions of first encounter of internal wave packets shown as diamonds towards either end of the survey. Solid lines show the internal wavefronts on the SAR image of the 21st July 1999, and dot-dashed lines show the leading internal wavefronts from the image of the 7th July. Grey scale shows the bathymetry (m) from Instituto Hidrografico

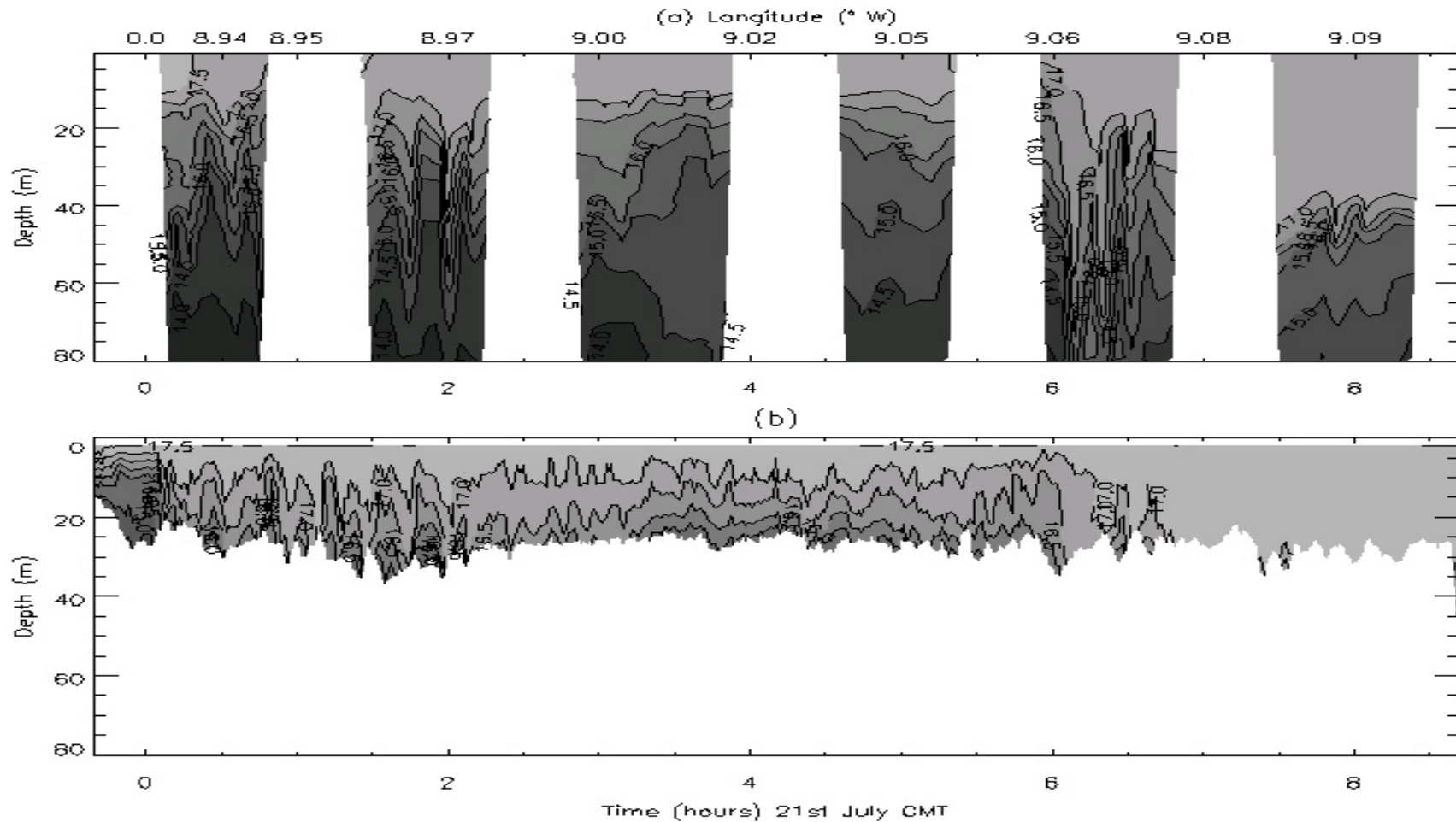


Figure 5 The complete Dom Carlos survey data for the period 2330 hours GMT 20th July to 0842 hours GMT, 21st July 1999. a) Contours of temperature (° C) against depth and time from CTD data by NRP Dom Carlos along the track shown in Figure 6b. The figure shows a number of internal wave oscillations, particularly between 0000 and 0200 hours, and between 0600 and 0700 hours GMT, as well as an underlying internal tide wave. b) The corresponding time series of temperature versus depth from a towed line of temperature sensors, measured to a maximum depth of around 30-m. The longitude position of the ship is shown at the top of (a).

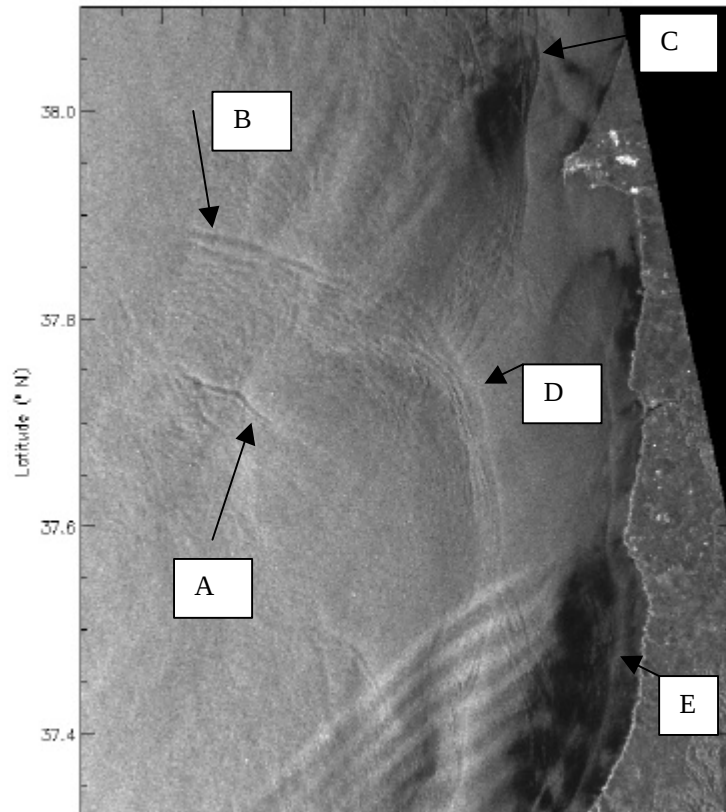


Figure 6a. ERS-2 SAR 18th June 1999, 2254 GMT, 3 days after springs, 4 hours 46 minutes after High Water. The distinctive oceanic internal wave packets include: 'C' close to the coast, 'A' and 'B' propagating to the north-north-west, a long wavefront 'D' which merges with 'B' at its northern end and runs parallel to the coast at the eastern end: and a faint line of high backscatter 'E' which may be an internal wave very close to the coast, or possibly an upwelling front. Note also broader white stripes in the bottom right corner, aligned southwest to northeast, which are probably atmospheric internal waves. ©ESA 1999

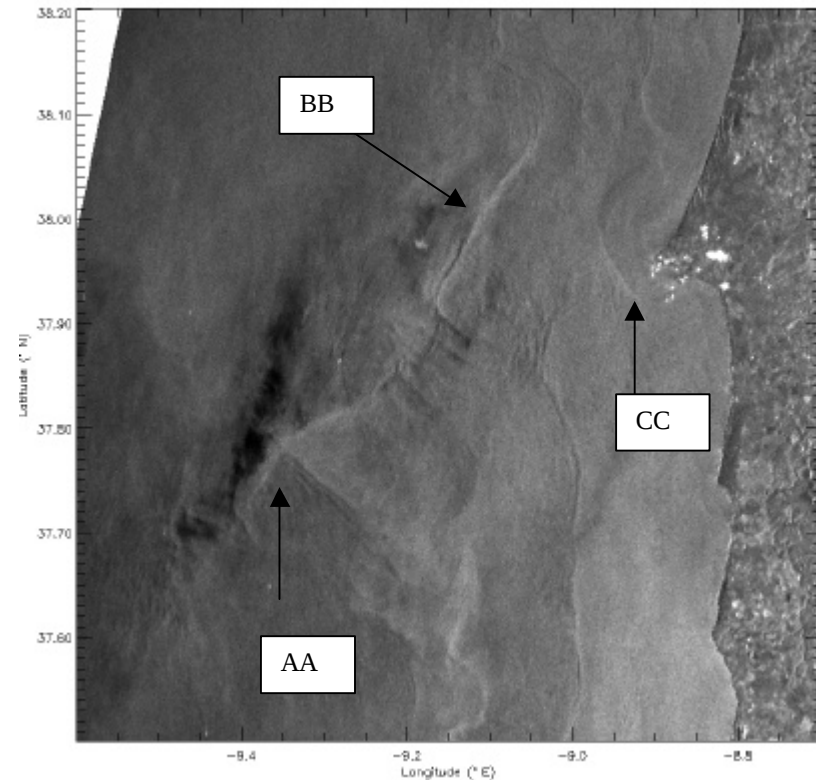


Figure 6b. ERS-2 SAR 5th May 2000, 1119 GMT, 4 hours before High Water Sines, 2 days after springs. Note the complex feature 'AA' in deep water with almost pyramid-like bright edges next to a broad dark band of backscatter, another feature 'BB' approaching the coast, and a wavefront 'CC' which encircles the headland of Cape Sines.

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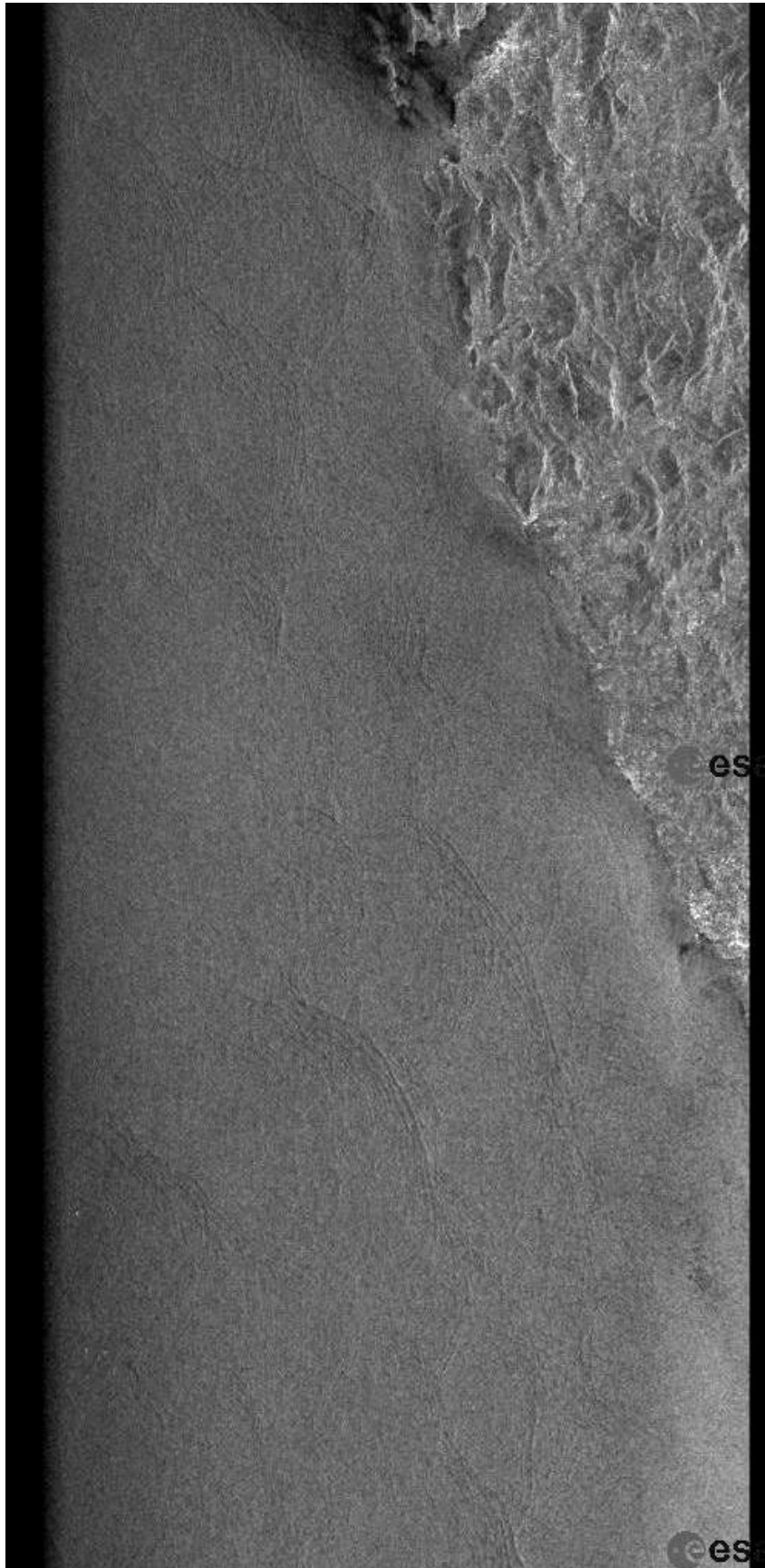


Figure 7. ERS-1 C-band VV survey image of the Northern Coast of Portugal showing significant internal wave activity on the continental shelf. Image was acquired August 8, 1994, 11:22 GMT. Image dimensions are 100 km x 200 km centered at 41.375 N. Latitude, 9.01 W. Longitude. (Orbit 16020 Frames 2763 and 2781). Internal wave signatures extend to frame 2799 (not shown) which was contiguous at bottom. ©ESA 1994

References

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