

## Azores

### Overview

The Azores is a group of nine islands located in the North Atlantic approximately 1200 km west of Portugal and scattered over an area of approximately 1,000 km<sup>2</sup> (Figure 1). The islands are volcanic in origin and are the largest group of peaks of the Mid-Atlantic Ridge to form islands (Figure 1).

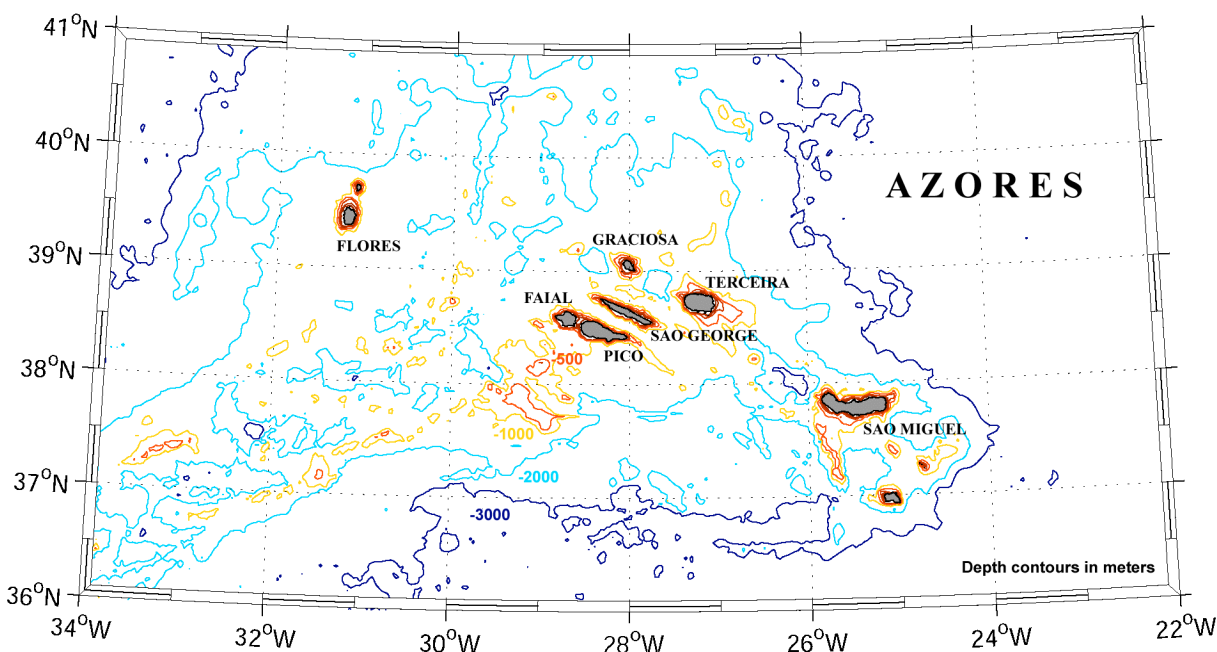


Figure 1. Bathymetry map of the Azores. [Smith and Sandwell, 1997]

### Observations

There has been little scientific study of internal waves around the Azores. Satellite imagery suggests that the internal waves in and around the Azores are generated by the interaction of tidal or current flow with bathymetry, primarily lower peaks of the Mid-Atlantic Ridge. The waves are expected to occur primarily during the summer (June to September) when solar heating produces a seasonal thermocline in the North Atlantic. The internal wave signatures appear similar to those observed around other island groups (e.g. the Galapagos).

Table 1 - Months when internal waves have been observed around the Azores.  
 (Numbers indicate unique dates in that month when waves have been noted)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
				1	1	2	9	1			

Figure 2 is a MODIS visible image taken over four of the Azores' central islands. The image shows the signature of internal waves propagating to the southwest. The waves were most likely generated in the region between Terceira and Sao Miguel. In addition the image contains the signature of a second wave group propagating to the southeast, indicating a generation source somewhere south of the islands.

Figures 3 and 4 show a SEASAT SAR image collected on 4 August 1978 [Fu and Holt, 1982]. The SEASAT observations show a complex distribution of internal wave signatures extending to the northeast of Terceira. This kind of complex distribution of internal wave signatures has been observed around other volcanic island groups and is the result of a large number of internal wave sources. The area in the lower right hand corner (east-southeast of Terceira) has a prodigious number of wave packets propagating primarily to the north. A second source exists west of Terceira whose waves can be seen propagating to the north-northeast. Interpacket separations are approximately 37 km, giving an implied propagation speed of around 0.8 m/s. Figure 3 shows the SEASAT image overlaid with the bathymetry. The bathymetry rises to less than 200 meters of the surface in a number of locations; any or all of which could produce internal waves in the area.

Figure 5 – 7 are ASTER VNIR images taken around the islands. Figure 5 shows wave signatures similar to those observed in the MODIS data (Figure 2) with generation taking place between Terceira and Sao Miguel. In this case the signatures are of internal waves propagating to the northeast. Figure 6 is an ASTER image showing signatures southeast of the Azores islands. The bathymetry map (Figure 1) shows that this is an area with a complex bathymetry that includes a number of seamounts. Figure 7 shows internal wave signatures southwest of Sao Miguel that resemble those observed around Terceira in the SEASAT data (Figure 4).

## References

- Fu, L.L., and B. Holt, 1982, Seasat Views Oceans and Sea Ice with Synthetic Aperture Radar, JPL Publication 81-120
- Smith, W. H. F., and D. T. Sandwell, 1997; Global seafloor topography from satellite altimetry and ship depth soundings, *Science*, v. **277**, 1957-1962  
[http://topex.ucsd.edu/marine\\_topo/mar\\_topo.html](http://topex.ucsd.edu/marine_topo/mar_topo.html)

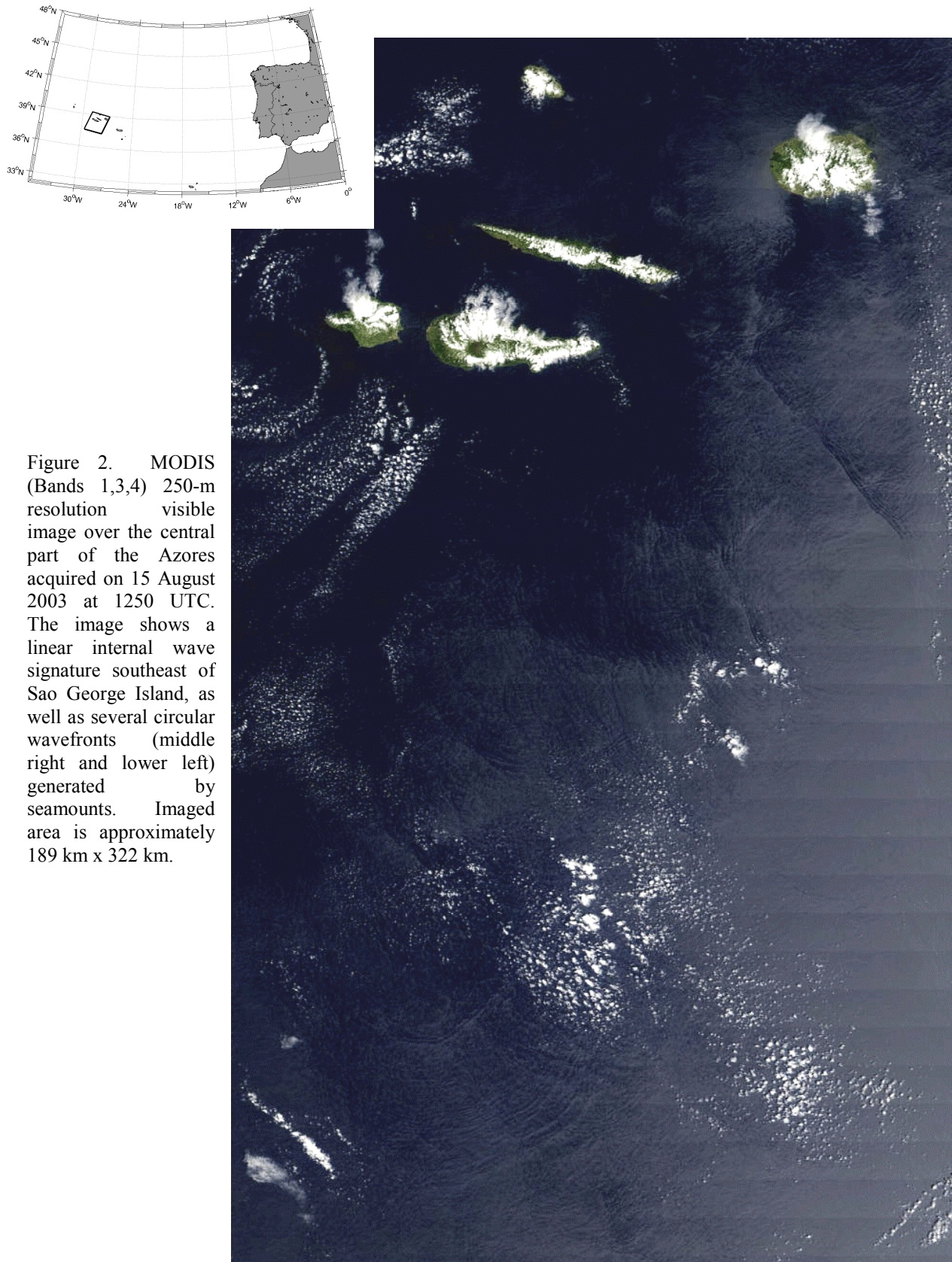


Figure 2. MODIS (Bands 1,3,4) 250-m resolution visible image over the central part of the Azores acquired on 15 August 2003 at 1250 UTC. The image shows a linear internal wave signature southeast of Sao George Island, as well as several circular wavefronts (middle right and lower left) generated by seamounts. Imaged area is approximately 189 km x 322 km.



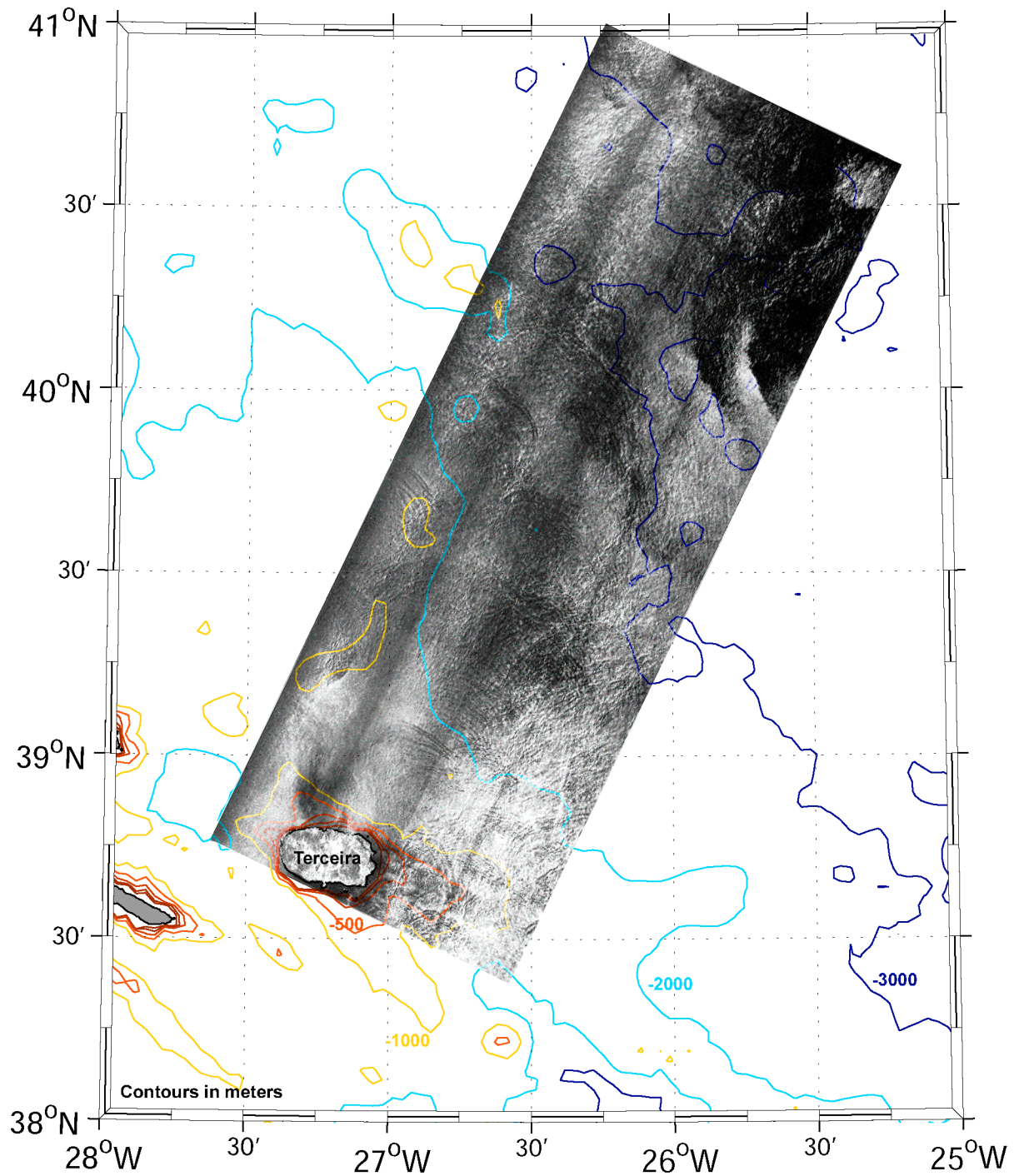


Figure 3. SEASAT (L-band, HH) SAR image from 4 August 1978 shown with the local bathymetry. [Smith and Sandwell, 1997]

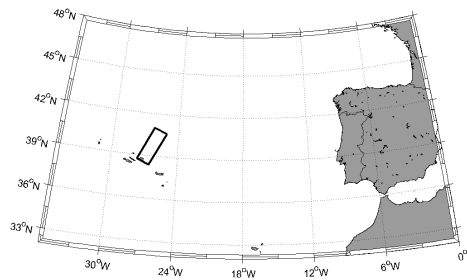


Figure 4. SEASAT (L-Band, HH) SAR image of internal waves northeast of Terceira in the Azores. Image was acquired on 4 August 1978 at 2142 UTC (Rev 556). Imaged area is 100 km x 270 km. [Image courtesy NASA JPL, After Fu and Holt, 1982]





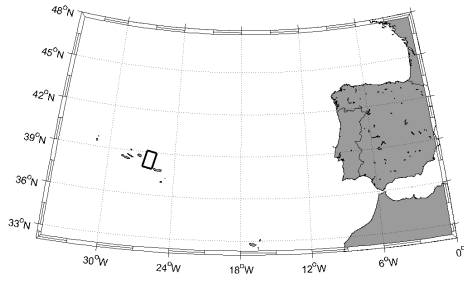
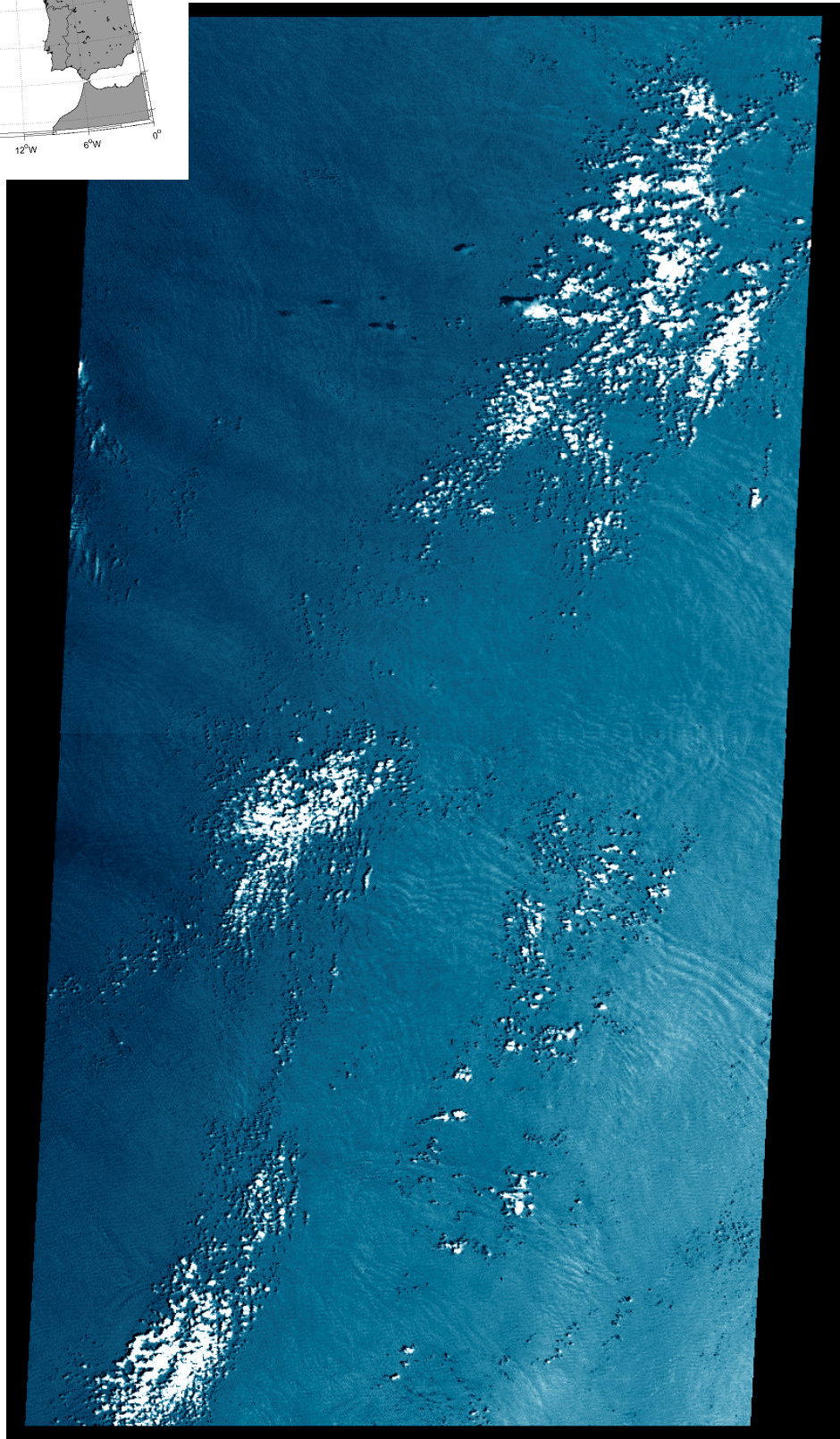


Figure 5. ASTER false-color VNIR image over the Azores acquired on 1 July 2001 at 1254 UTC. The image shows the signature of several internal wave packets propagating to the northeast. Imaged area is 60 km x 120 km.





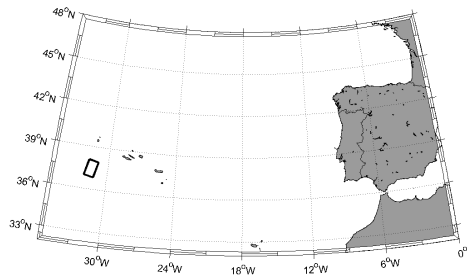
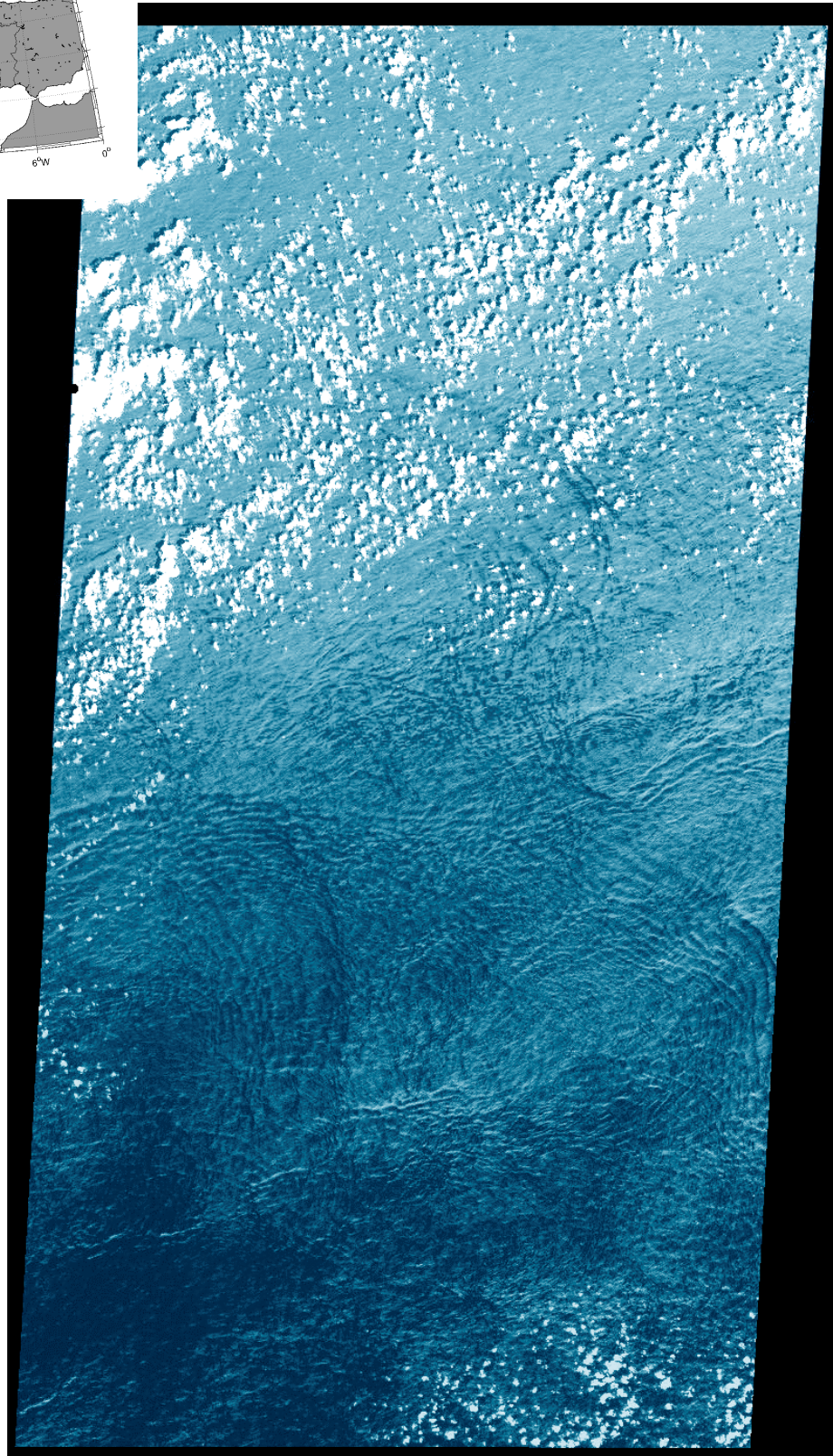


Figure 6. ASTER false-color VNIR image near the Azores acquired on 7 August 2001 at 1313 UTC. The image shows the strong signature of several internal wave groups propagating toward the northeast. The waves were generated by a seamount. Imaged area is 60 km x 120 km.





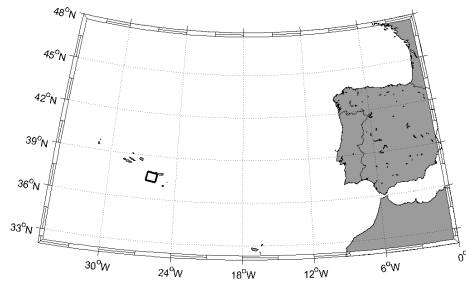


Figure 7. ASTER false-color VNIR image over the southeast Azores acquired on 4 August 2002 at 1242 UTC. The image shows the signature of several fine scale internal wave packets propagating in a variety of directions. Imaged area is 60 km x 60 km.

