

## Indonesian Seas

- Bali Sea
- Banda Sea
- Cream Sea
- Flores Sea
- Java Sea
- Makassar Strait
- Molucca Sea
- Savu Sea

### Overview

The Indonesian Seas are the regional bodies of water in and around the Indonesian Archipelago. The seas extend between approximately 12° S to 3° N and 110° to 132°E (Figure 1). The region separates the Pacific and Indian Oceans.

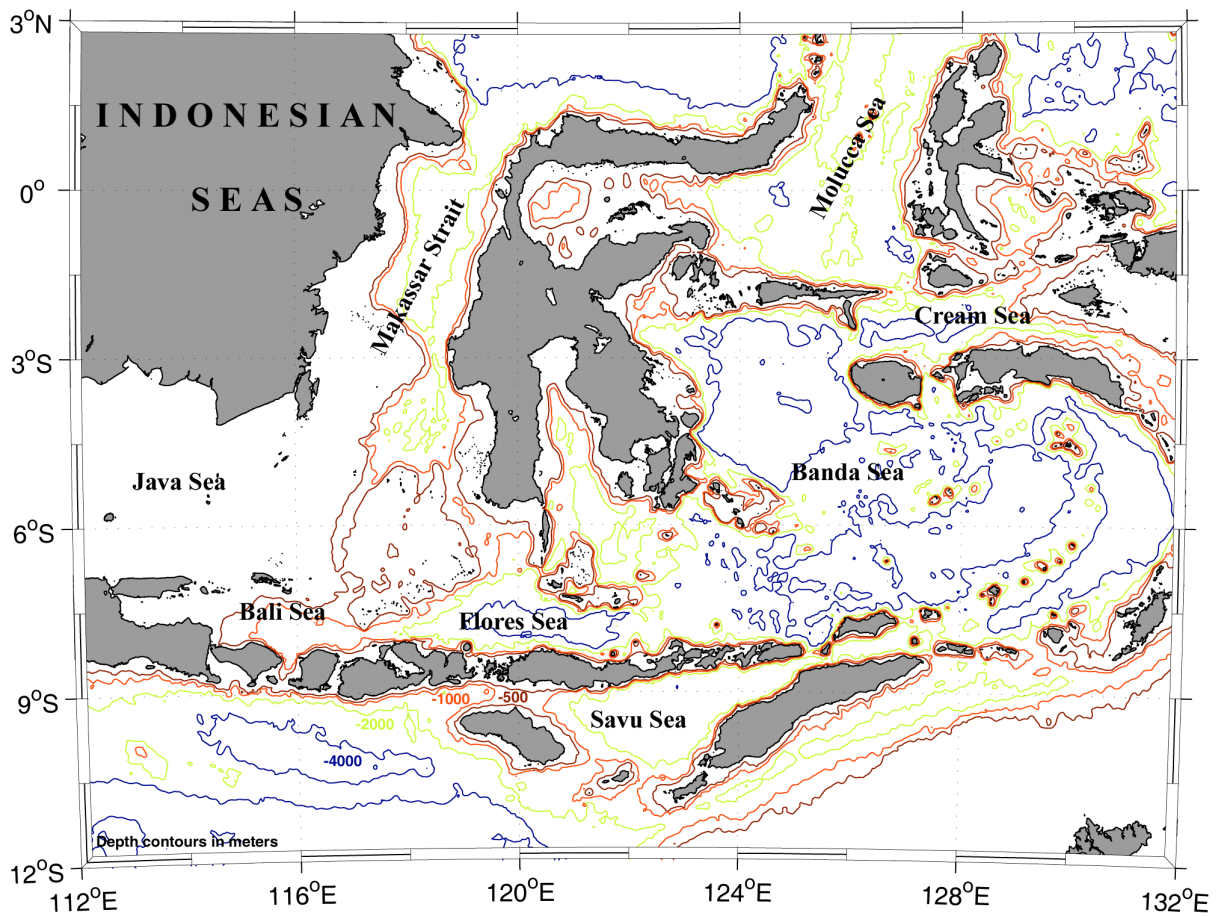


Figure 1. Bathymetry of the Indonesian Archipelago. [Smith and Sandwell, 1997]

### Observations

Indonesian Archipelago is most extensive archipelago in the world with more than 15,000 islands. The shallow bathymetry and the strong tidal currents between the islands give rise to the generation of internal waves throughout the archipelago. As a result there are a very

large number of internal wave sources throughout the region. Since the Indonesian Seas border the equator, the stratification of the waters in this sea area does not change very much with season, and internal wave activity is expected to take place all year round. Table 2 shows the months of the year during which internal waves have been observed in the Bali, Molucca, Banda and Savu Seas

Table 1 - Months when internal waves have been observed in the Bali Sea.  
 (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	2	1	1	1			1	1	3	2	3

Months when Internal Waves have been observed in the Molucca Sea.

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

Months when Internal Waves have been observed in the Banda Sea.

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

Months when Internal Waves have been observed in the Savu Sea.

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

With the exception of the Bali Sea and Lombok Strait areas, there has been very little scientific research on the internal waves in the Indonesian Seas. *Mitnik and Alpers* [2000] examined six ERS SAR collection dates over the Lombok Strait. Their analysis concluded that the waves propagating northward into the Bali Sea have almost always a regular circular shape while the ones propagating southward into the Indian Ocean have a very irregular shape due to the strongly horizontally varying current field south of the sill.

The Bali Sea internal wave packets contained between 10 and 15 solitons/packets, with packet separations ranging between 85 and 115 km. These separation distances imply a speed between 1.8 and 2.6 m/s if one assumes that they are generated by the semi-diurnal tide.

The irregular shape of the internal wave signatures propagating south out of the Lombok Strait into the Indian Ocean is also due in part to the generation on both sides of Nusa Penida. Wavelengths of the waves varied from 2 km to less than 1 km with only about 7 solitons per packet visible. Some of the variations compared to the northward propagating waves comes from the fact that the southward propagating waves were imaged only within a 100 km of their generation point.

## References

- Mitnik, L., and W. Alpers: "Sea surface circulations through the Lombok Strait studied by ERS SAR", Proceedings of The Fifth Pacific Ocean Remote Sensing Conference (PORSEC 2000), Goa, India, 5-8 December, Vol. I, 313-317, 2000.
- 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)

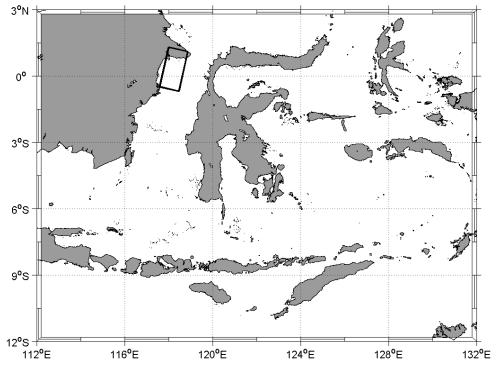


Figure 2. ERS-2 (C-Band, VV) SAR image of the Strait of Makassar acquired on 21 November 1997 at 0226 UTC (orbit 13597, Frames 3591, 3609). The image shows an internal wave train propagating south-southeast out of the Celebes Sea and into the Makassar Strait. Imaged area is 100 km x 200 km. ©ESA 1997. [Image courtesy of *The Tropical and Subtropical Ocean Viewed by ERS SAR* <http://www.ifm.uni-hamburg.de/ers-sar/>]



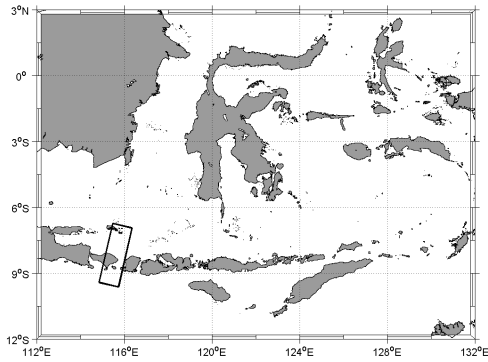
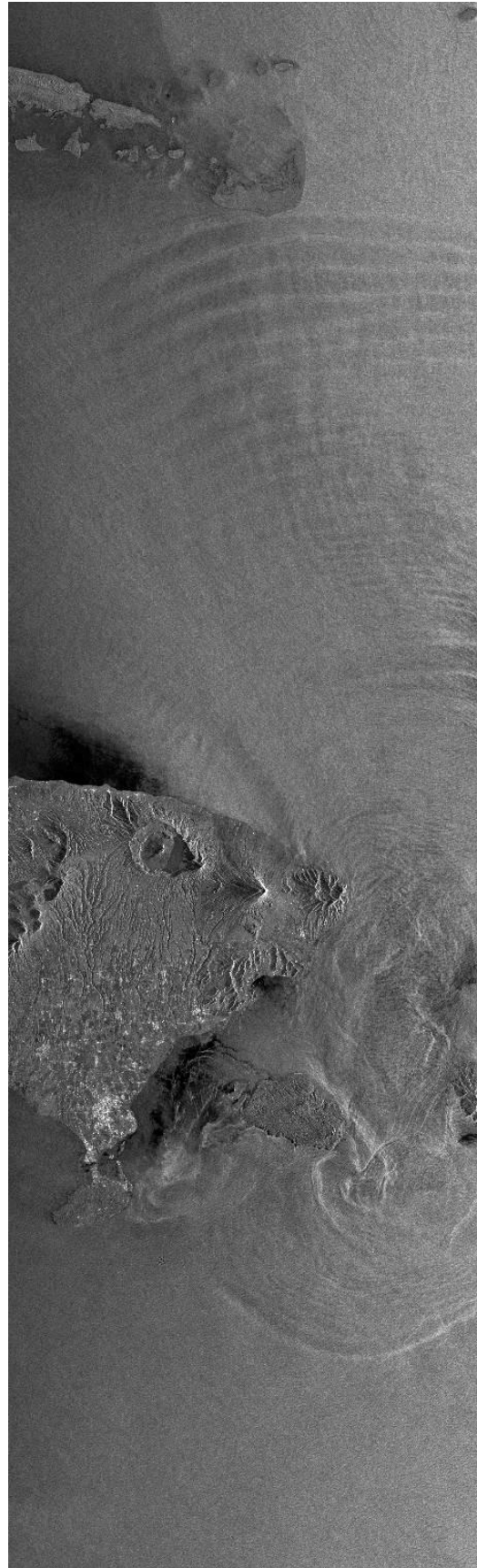


Figure 3. ERS-1 (C-Band, VV) SAR image of Bali Sea collected on 23 April 1996 at 0232 UTC (orbit: 24955, frames: 3753, 3771, 3789). The image shows an internal wave packets radiating north into the Bali Sea and approaching the Kanagan Island and coral reefs. The length of the packet is approximately 80 km and the leading wavelength is almost 6 km. Imaged area is 100 km x 300 km. ©ESA 1996. [Image courtesy of *The Tropical and Subtropical Ocean Viewed by ERS SAR* <http://www.ifm.uni-hamburg.de/ers-sar/>]



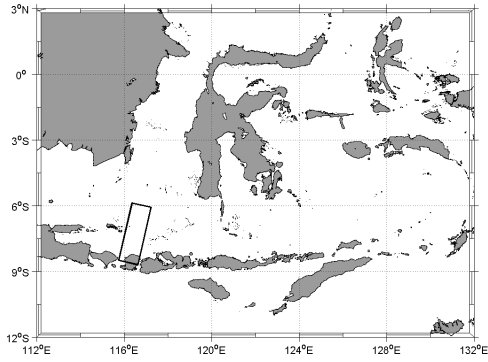


Figure 4. ERS-2 (C-Band, VV) SAR image of Bali Sea acquired on 21 November 1997 at 0230 UTC (orbit: 13527, frames: 3735, 3753, 3771). The image shows three internal wave packets radiating westward across the Bali Sea (north of Lombok). The waves most likely originate near the island groups north of Sumbawa in the Flores Sea. Two isolated solitons, from the Lombok Strait are also visible propagating northward. Imaged area is 100 km x 300 km ©ESA 1997. [Image courtesy of Dr Werner Alpers, University of Hamburg, Hamburg Germany]

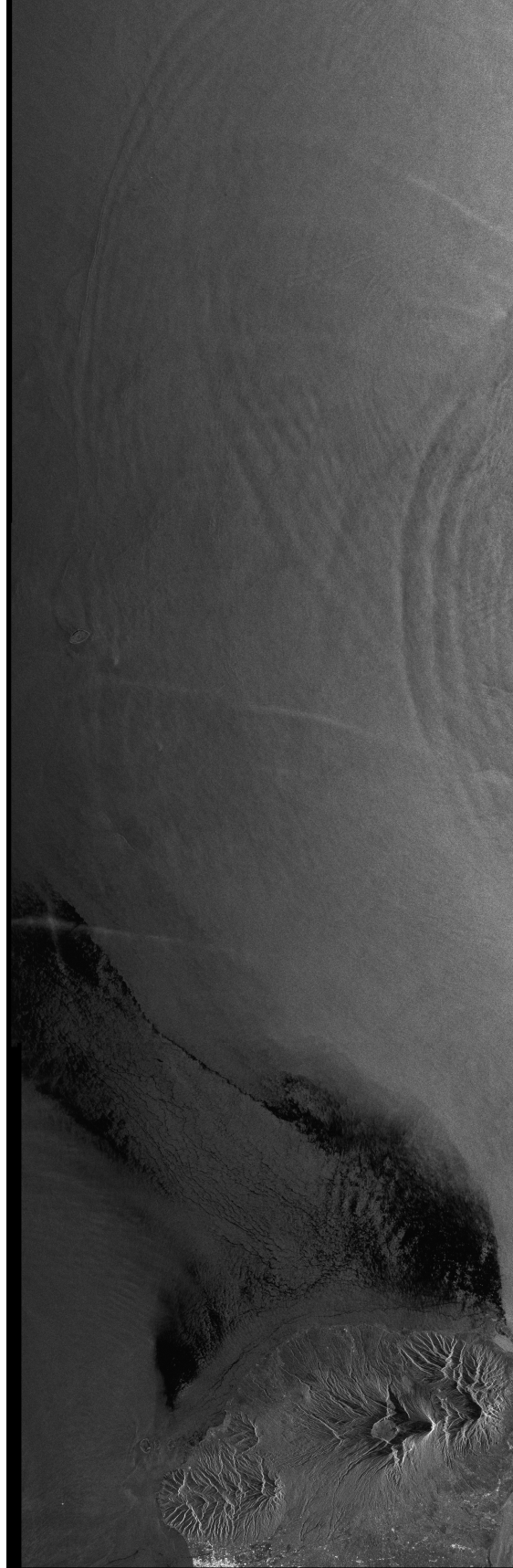
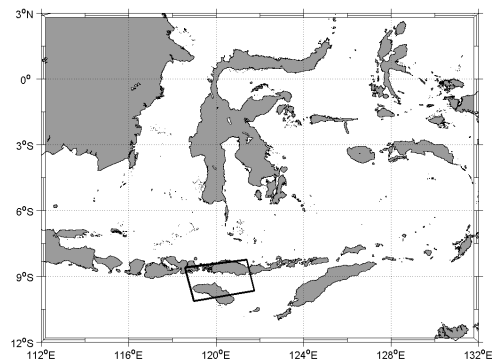
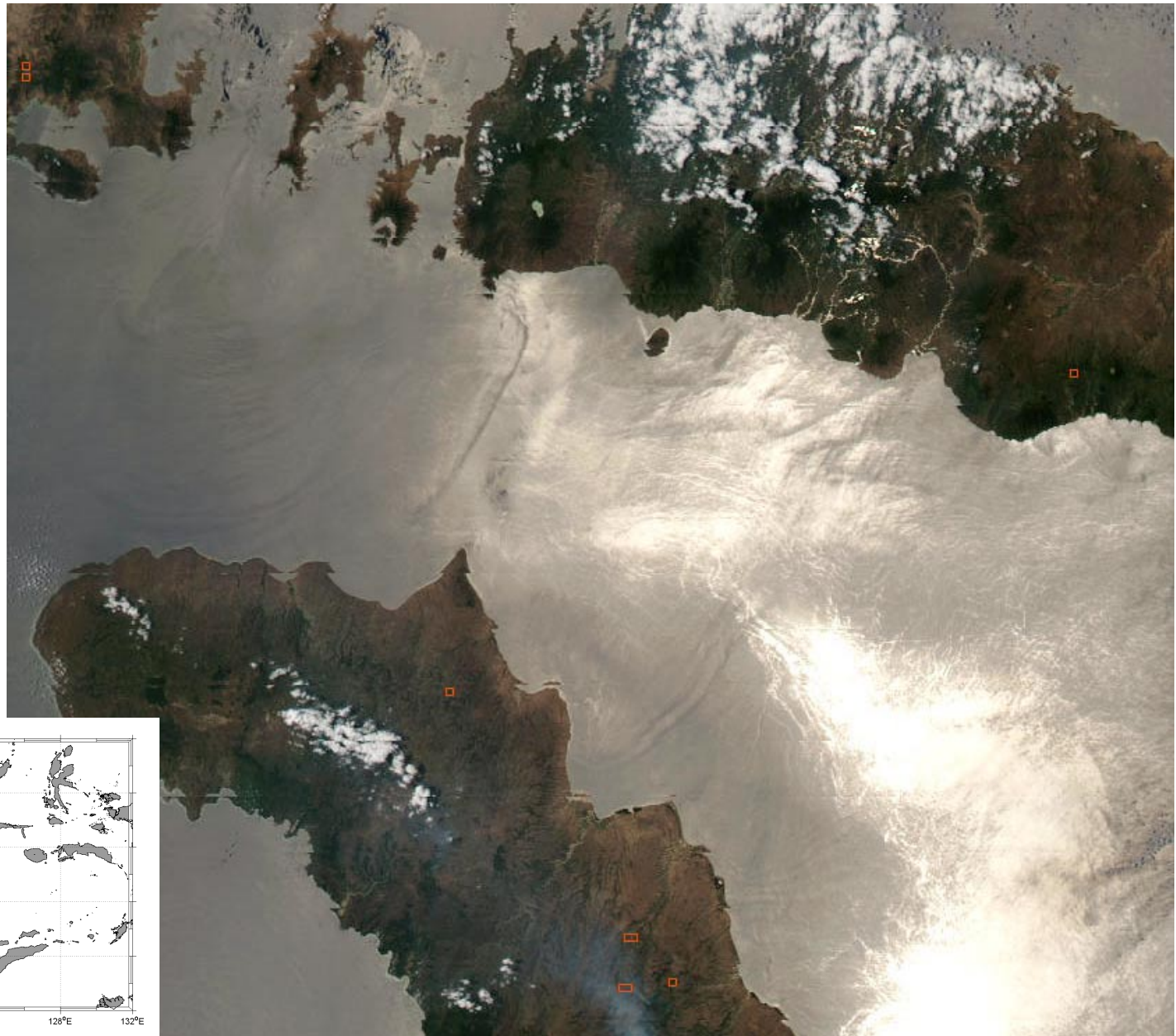


Figure 5. MODIS (Bands 1,3,4) 250-m resolution visible image of the western part of the Savu Sea acquired on 7 March 2003 at 0225 UTC. The image shows three packets of internal waves propagating eastward between the islands of Flores and Sumba. The eastern most packet is partly obscured by the sunglint and only visible along the coast of Sumba. Imaged area is approximately 212 km x 185 km.



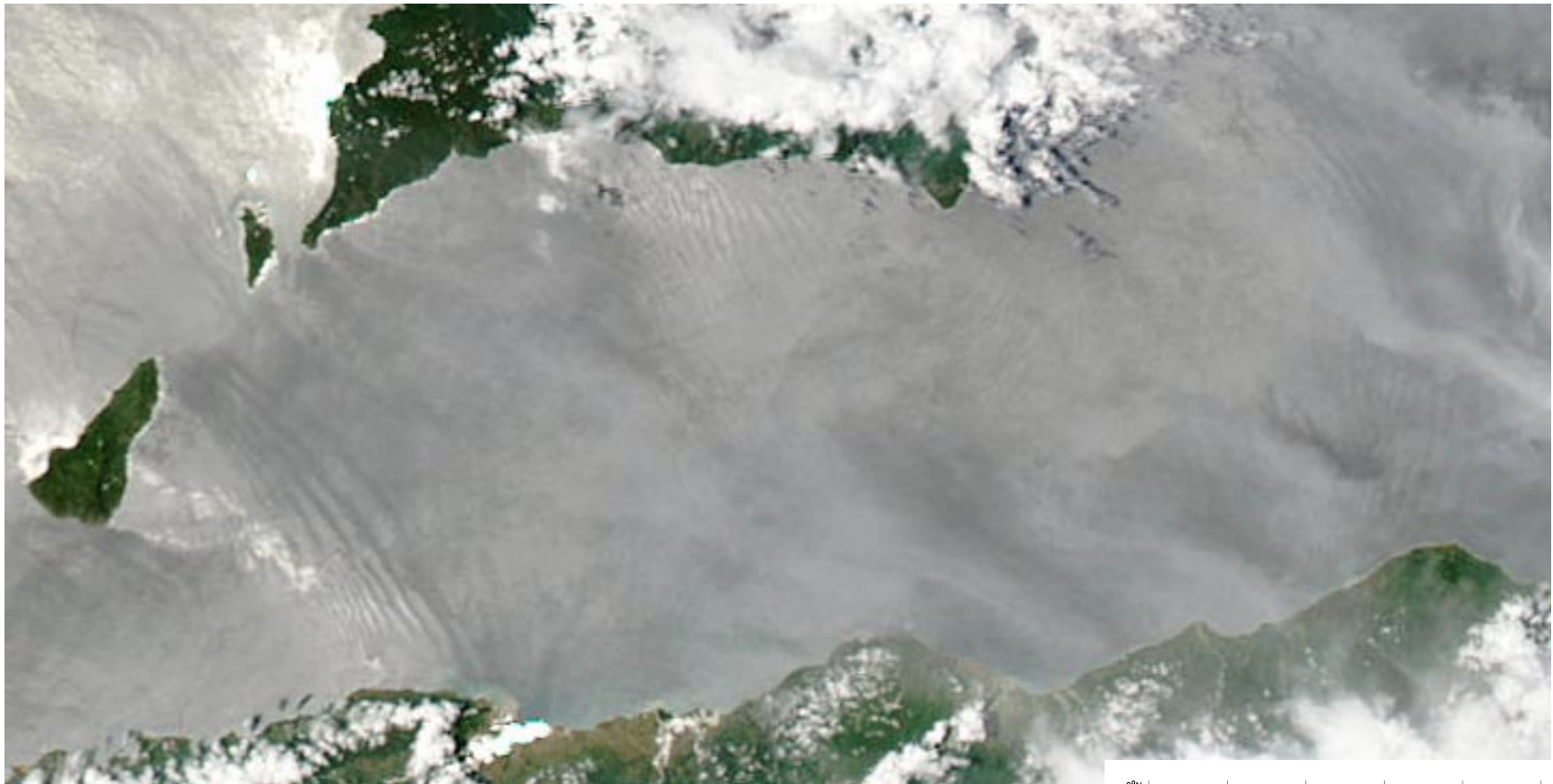
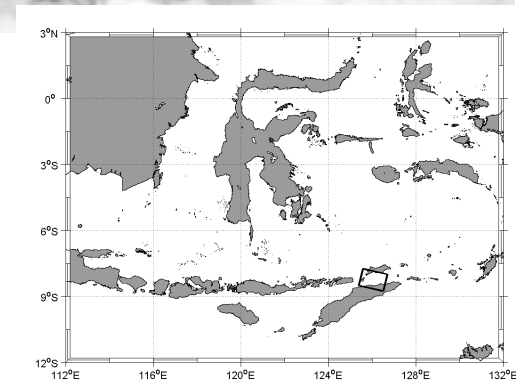


Figure 6. MODIS (Bands 1,3,4) 250-m resolution visible image of the eastern part of the Savu Sea acquired on 24 February 2004 at 0505UTC. The image shows an internal wave packets propagating eastward between the islands of Wetar and Timor. Imaged area is approximately 180 km x 90 km.



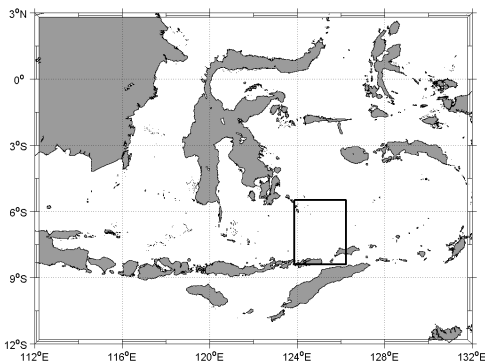
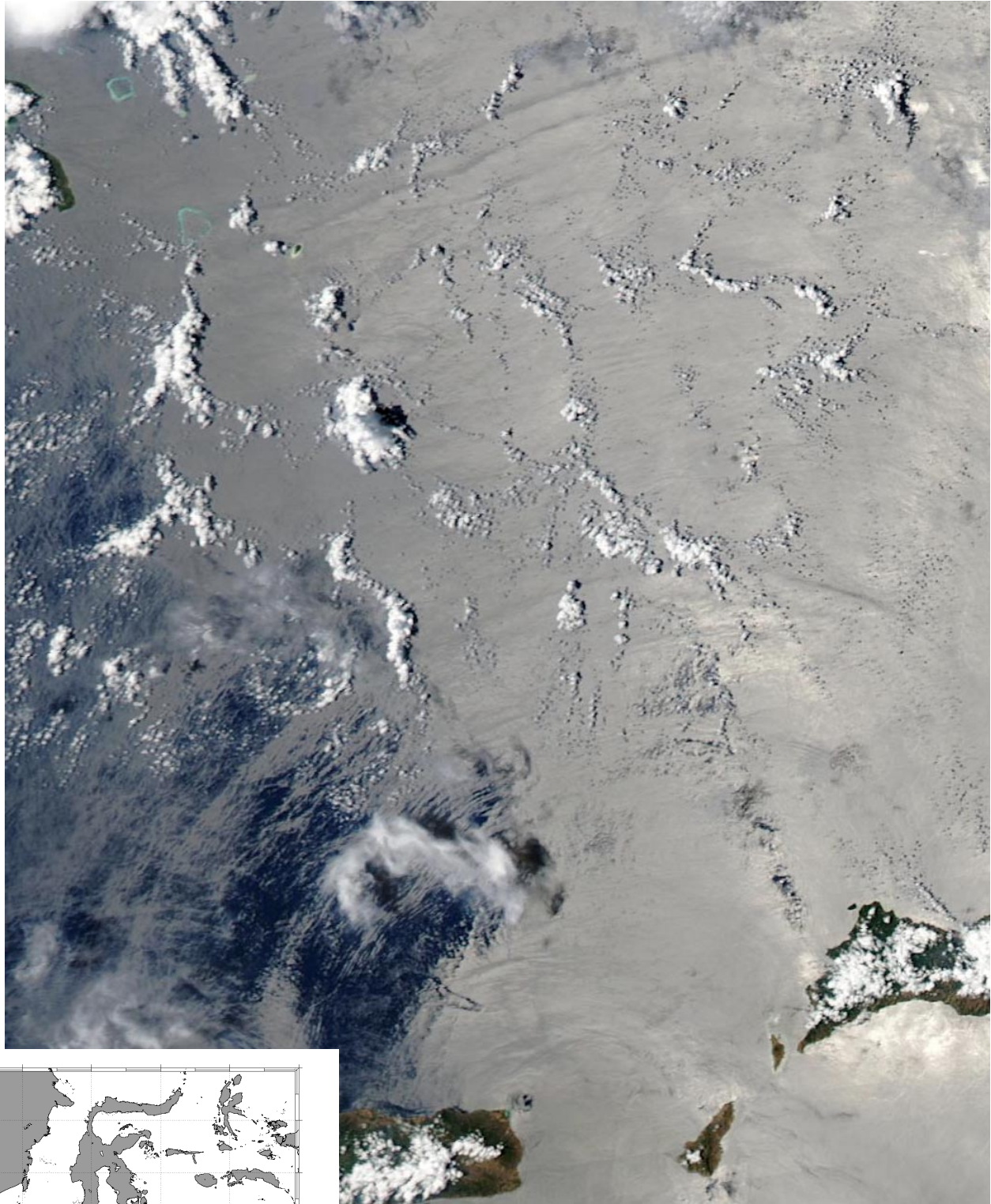


Figure 7. MODIS (Bands 1,3,4) 250-m resolution visible image of the southern part of the Banda Sea acquired on 28 October 2003 at 0205 UTC. The image shows an internal wave packets propagating north-northwest into the Banda Sea. The waves originate between the islands of Alor and Wetar. Imaged area is approximately 260 km x 315 km



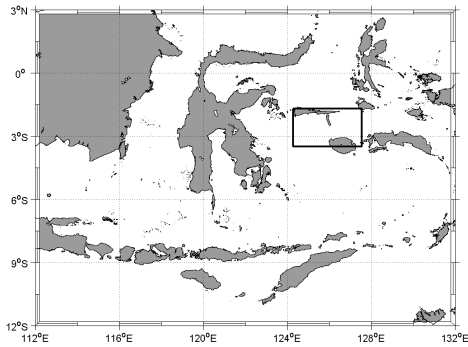


Figure 8. MODIS (Bands 1,3,4) 250-m resolution visible image of the Kepulauan Sula Islands between the Banda and Cream Seas acquired on 28 October 2003 at 0205 UTC. The image shows internal wave packets propagating eastward into the Banda Sea as well internal waves in the western Cream Sea propagating to the south-southwest. The internal waves in this area are fine scale near the 250-meter resolution limit of the MODIS sensor. Imaged area is approximately 366 km x 200 km

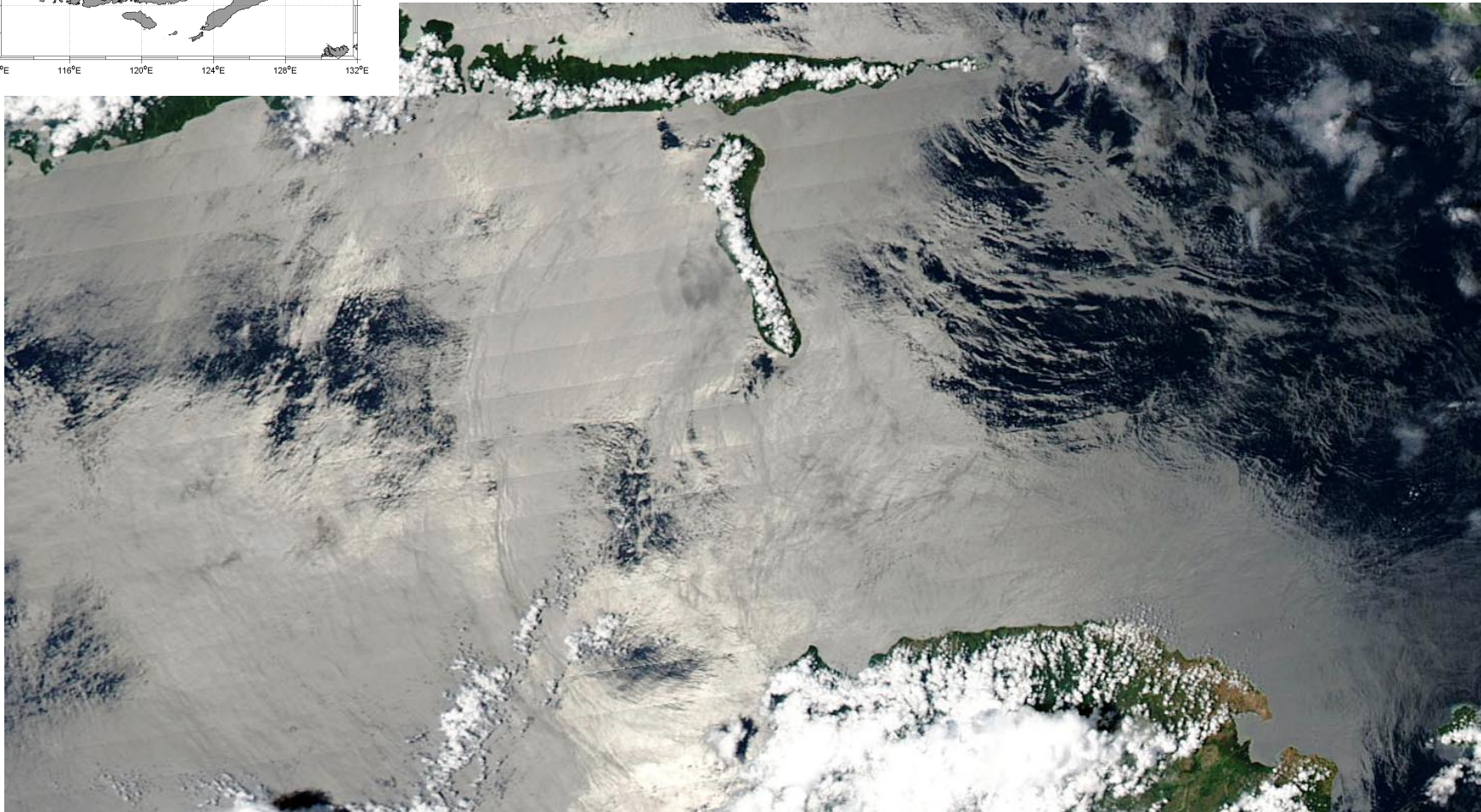
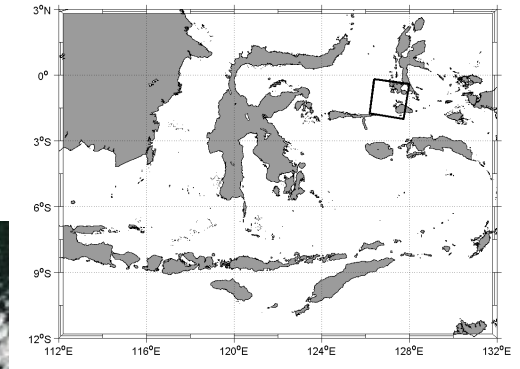
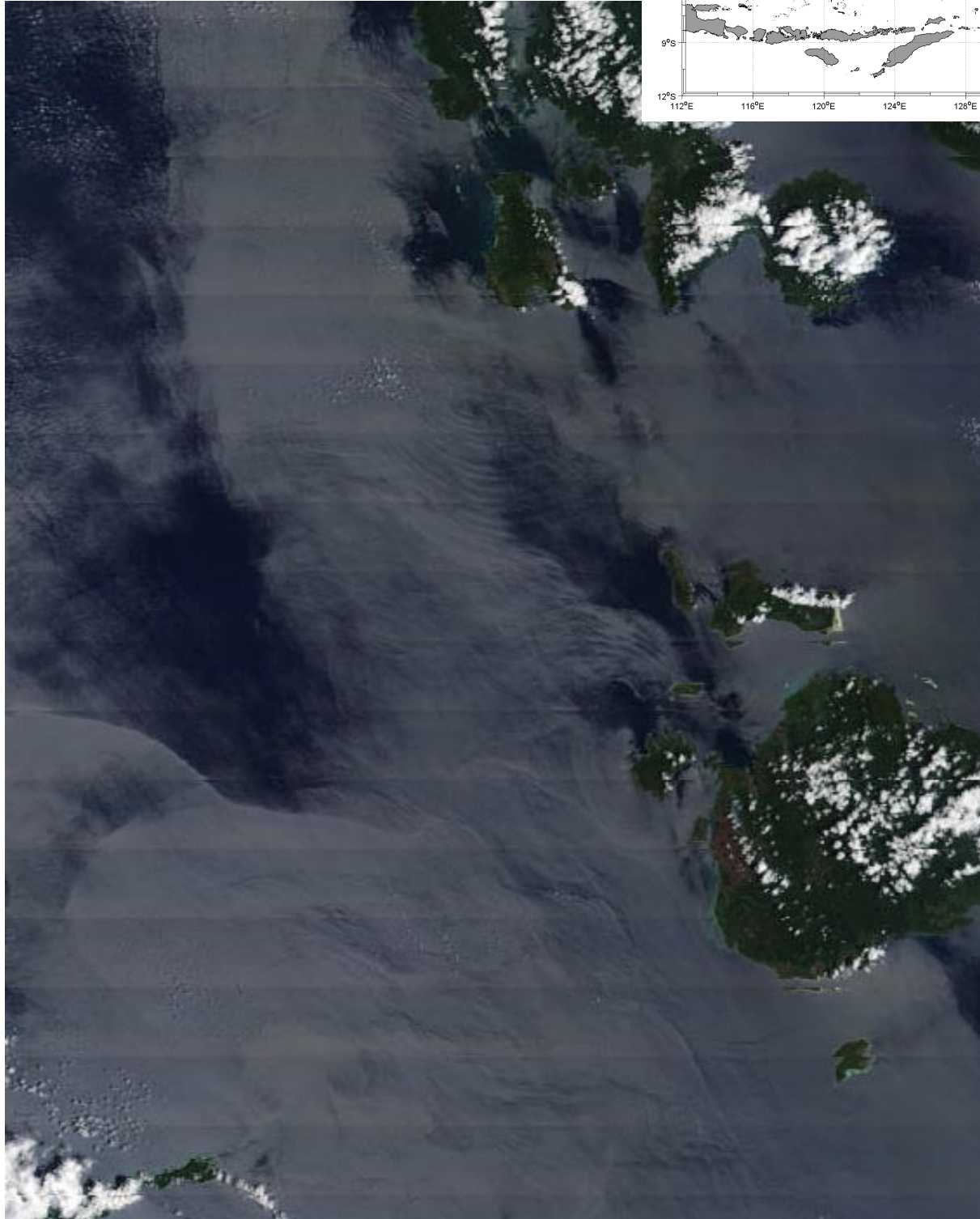


Figure 9. MODIS (Bands 1,3,4) 250-m resolution visible image of the islands Batjan and Obi in the southeastern Molucca Sea acquired on 20 January 2003 at 0215 UTC. The image shows an internal wave packets propagating both towards and away from the islands. The internal waves are fine scale near the 250-meter resolution limit of the MODIS sensor. Imaged area is approximately 141 km x 176 km



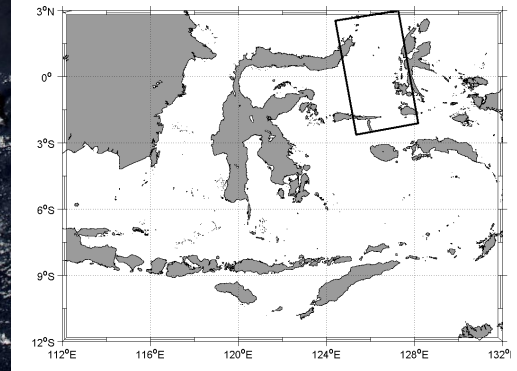
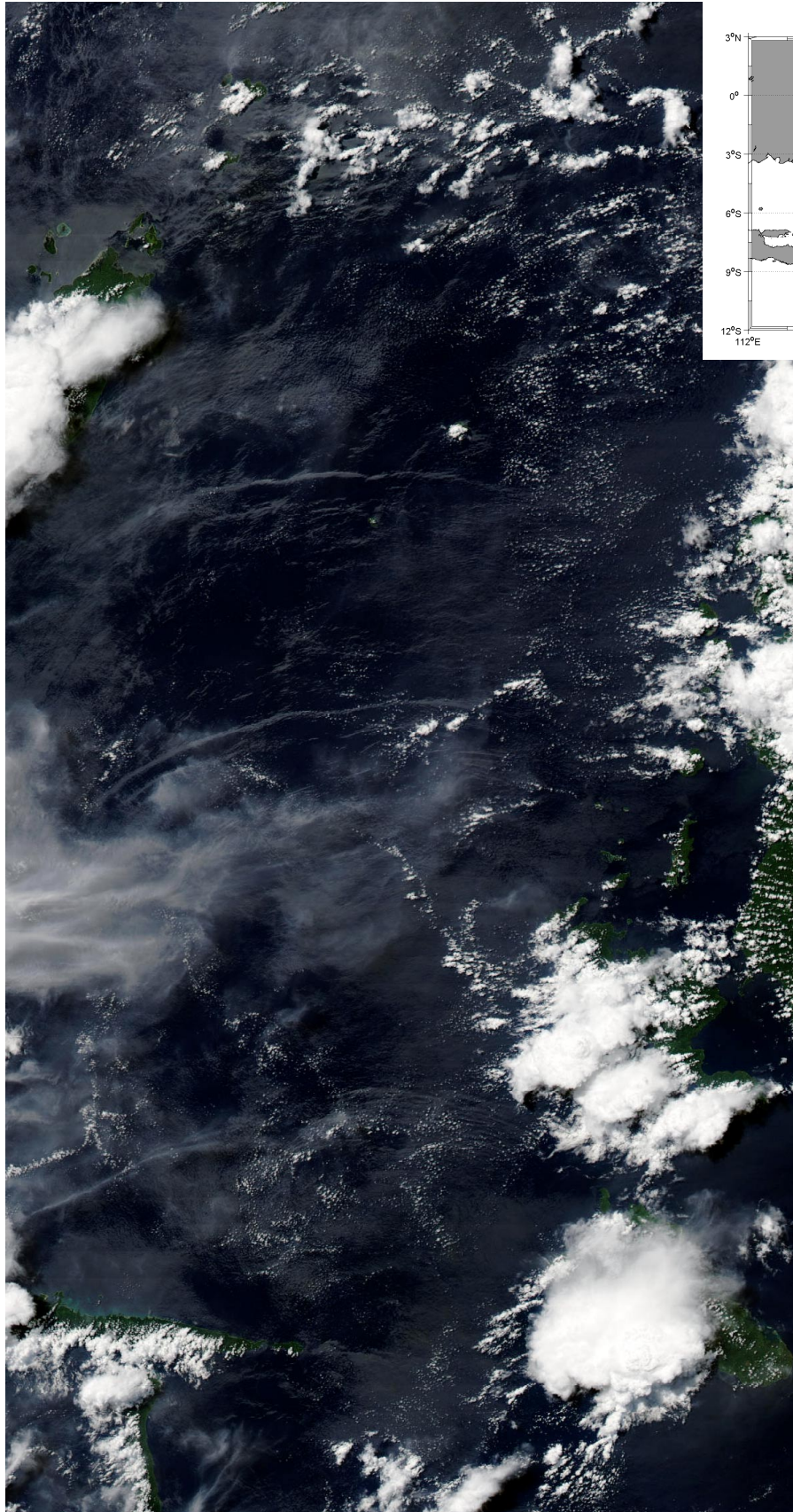


Figure 10. MODIS (Bands 1,3,4) 250-m resolution visible image of the Molucca Sea acquired on 5 May 2003 at 0500 UTC. The image shows three internal wave packets (2 mature, one nascent) propagating north. Imaged area is approximately 298 km x 566 km

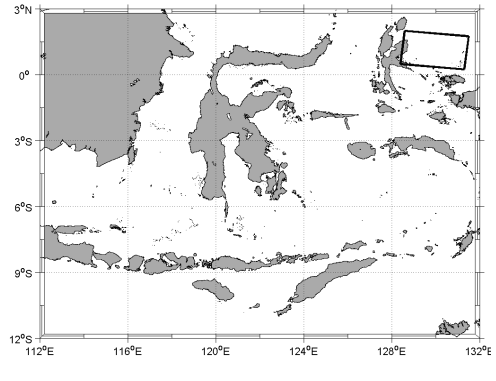


Figure 11. MODIS (Bands 1,3,4) 250-m resolution visible image of the Philippine Sea east of Halmehra Island acquired on 22 January 2003 at 0200 UTC. The image shows an internal wave packet propagating to the northeast. Imaged area is approximately 268 km x 162 km

