New volcanic activity in the South Sandwich Islands

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New volcanism on Montagu Island

The first recorded eruption of Mount Belinda, on Montagu Island in the South Sandwich Islands, has been ongoing since late 2001 based upon analysis of thermal satellite imagery (1 km pixel size) from NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) instrument. Using the automated MODIS Thermal Alert system (Wright et al., 2002) at the University of Hawaii Manoa, image pixels containing volcanic activity were detected and analyzed in order to characterize the eruption. These data are displayed within 24-72 hours of image reception on http://modis.higp.hawaii.edu/cgi-bin/modis/modis.cgi.

Montagu Island is the largest of the South Sandwich Islands (Fig. 1), measuring approximately 12 km by 10 km. Mount Belinda, rising to 1370 m asl, comprises most of the island, and the island as a whole is about 90% ice covered (Fig. 2). Lava compositions range from basalt to basaltic andesite (49-53 wt. % SiO_2) with low amounts of Na_2O and K_2O. There has been no previous record of Holocene activity on Montagu, though this is due in part to the general dearth of information available - a thorough study of the island is not possible because of the general inaccessibility (only a handful of landings have been made) and the extensive ice cover. (LeMasurier and Thomson, 1990)

The first MODIS thermal alert on Montagu occurred on October 20, 2001 with a single anomalous pixel on the north side of the island. Subsequent anomalies were generally one to two pixels, with the exception of several images in August and September, 2002, which peaked at four pixels in size (Figs. 3+4). Visual inspection of the images revealed the anomalies were all located between the summit of Mount Belinda and the north shore, changing in position either due to satellite viewing geometry or actual migration of hot material. We can generally discount other possible explanations for the anomalies, the most likely being solar reflectance influencing the short-wave bands, due to the presence of clear anomalies in nighttime imagery and the concomitance of apparent low-level ash plumes in several of the images. Analysis of the 250 m visual MODIS bands show a possible lava flow field developed in the summit caldera by May 2002, as well as a faint plume originating from the apparent main vent near the true summit. Any lava emplaced on the summit ice sheet would result in localized disintegration of the ice cover, possibly confining the flow field to some degree as happened at Veniaminof, Alaska in 1983-84 (Alaska Volcano Observatory: www.avo.alaska.edu). Corroborating the coarse-resolution observations of activity, a Landsat 7 Enhanced Thematic Mapper Plus (ETM+) image (15-60 m pixel size) dated January 4, 2002, shows the early stages of the eruption were marked by ash fall on the north flank emanating from a central vent near the summit of Mount Belinda.

Although previous eruptions have been recorded elsewhere in the archipelago (e.g. Coombs and Landis, 1966), ongoing volcanic activity has only recently been detected and studied in the South Sandwich Islands. These islands are all volcanic in origin, but sufficiently distant from population centers and shipping lanes that eruptions, if and when they do occur, currently go unnoticed. Visual observations of the islands probably do not occur on more than few days each year (LeMasurier and Thomson, 1990). Satellite data have recently provided observations of volcanic activity in the group, and offer the only practical means to regularly characterize activity in these islands. Specifically, using Advanced Very High Resolution Radiometer (AVHRR) data, Lachlan-Cope et al. (2001) discovered and analyzed an active lava lake on the summit of Saunders Island, north of Montagu. During that study (based on AVHRR images obtained in the period March 1995 to February 1998), apparent plumes and unreported single anomalous pixels were also observed intermittently on images of Montagu Island and may indicate rare and sporadic volcanic activity prior to that now observed. However, during field investigations by one of us (JLS) in January 1997, Montagu Island was viewed from Saunders Island and was apparently inactive, with the summit region entirely clothed in snow and ice. Hand-held photographs of the island obtained in September 1992 also show the summit to be wholly inactive. Those observations suggest that the activity reported here is likely a recent phenomenon, and has probably increased relative to previous unconfirmed 1995-1998 levels.

Continued activity at Saunders Island lava lake

The existence of a recurrent active lava lake in the Mount Michael summit crater (Fig. 2) on Saunders Island was first established by Lachlan-Cope et al. (2001) using AVHRR imagery from 1995-1998. Likewise, the MODIS Thermal Alert system has detected repeated thermal anomalies throughout 2000-2002 in the summit area (Fig. 3), indicating that activity at the lava lake has continued to the present day. Anomalous pixels were detected intermittently and were all one to two pixels in size, consistent with the relatively small confines of the crater. The timing of anomalous images in this study likely has more to do with the viewing limitations imposed by weather (persistent cloud cover masks any emitted surface radiance in the majority of images) than it has to do with fluctuations in activity levels, so caution should be taken when using this plot of radiance (Fig. 4) as a proxy for lava lake vigor.

References

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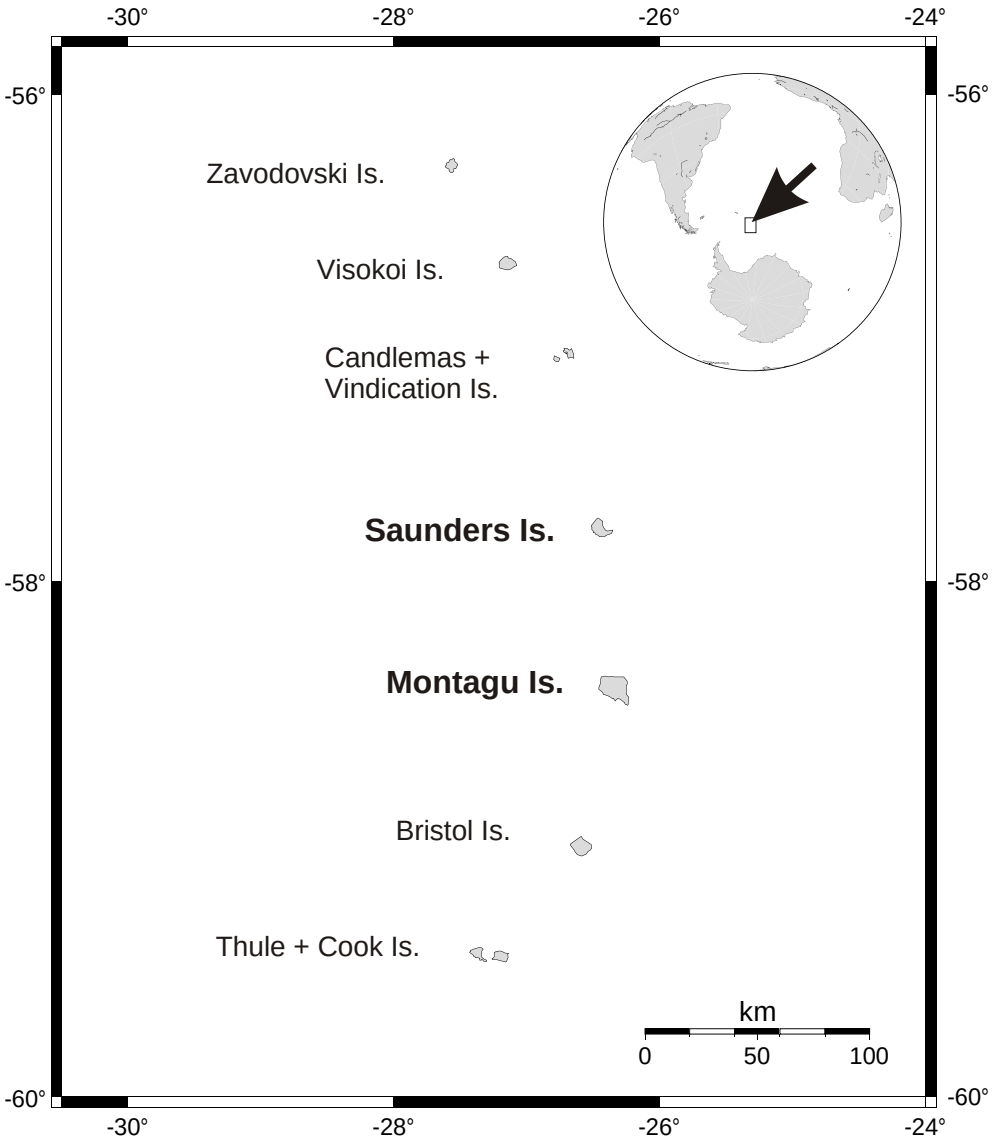

Figure 1. The South Sandwich Island archipelago, located in the Scotia Sea. The South Sandwich Trench lies approximately 100 km east, paralleling the trend of the islands.

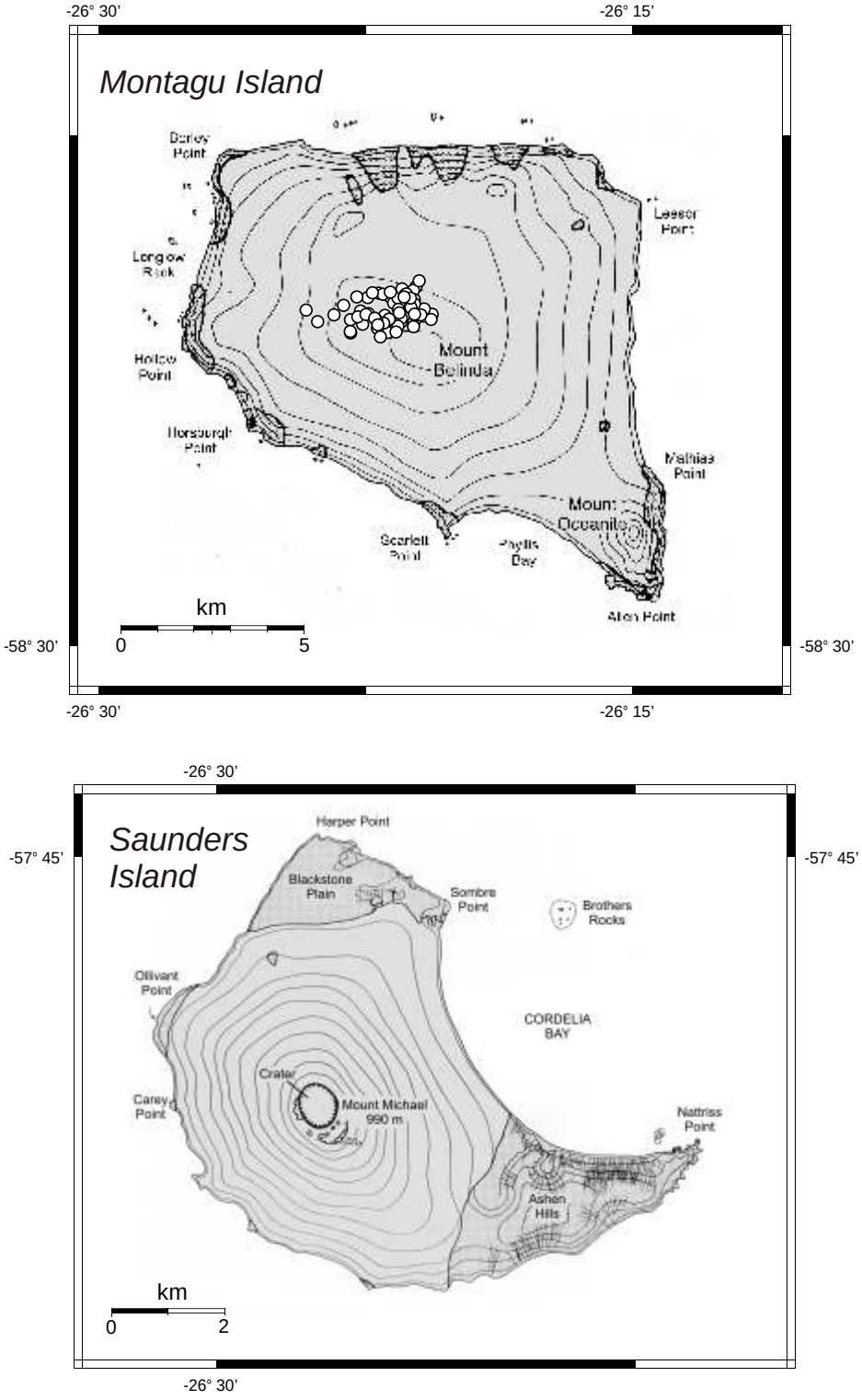

Figure 2. Detailed maps of Montagu and Saunders Islands, adapted from Holdgate and Baker, 1979. Stippled areas show rock outcrop, the remainder is snow or ice covered. Relief is shown by form lines which should not be interpreted as fixed-interval contours. On Montagu, the circles show the location of all anomalous pixels detected since Oct. 2001.

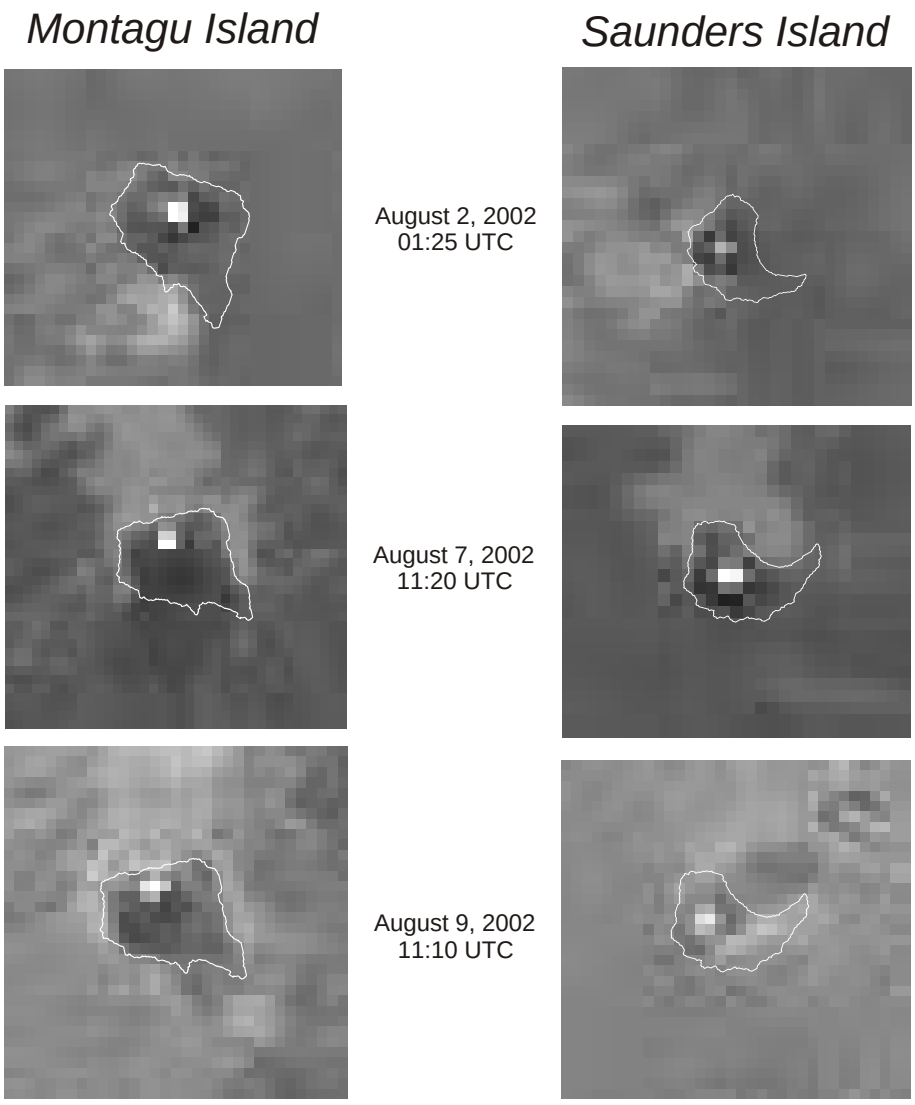

Figure 3. Selected MODIS images showing thermal anomalies at Montagu and Saunders Islands. Band 20 (3.7 microns) is shown here. The thermal anomalies at Montagu appear to be located between the summit of Mount Belinda (see Fig. 2) and the north shore. Anomalous pixels on Saunders Island correspond to the lava lake in the summit crater of Mt. Michael volcano (Fig. 2). Images are not georeferenced for radiance integrity, therefore coastlines are approximate.

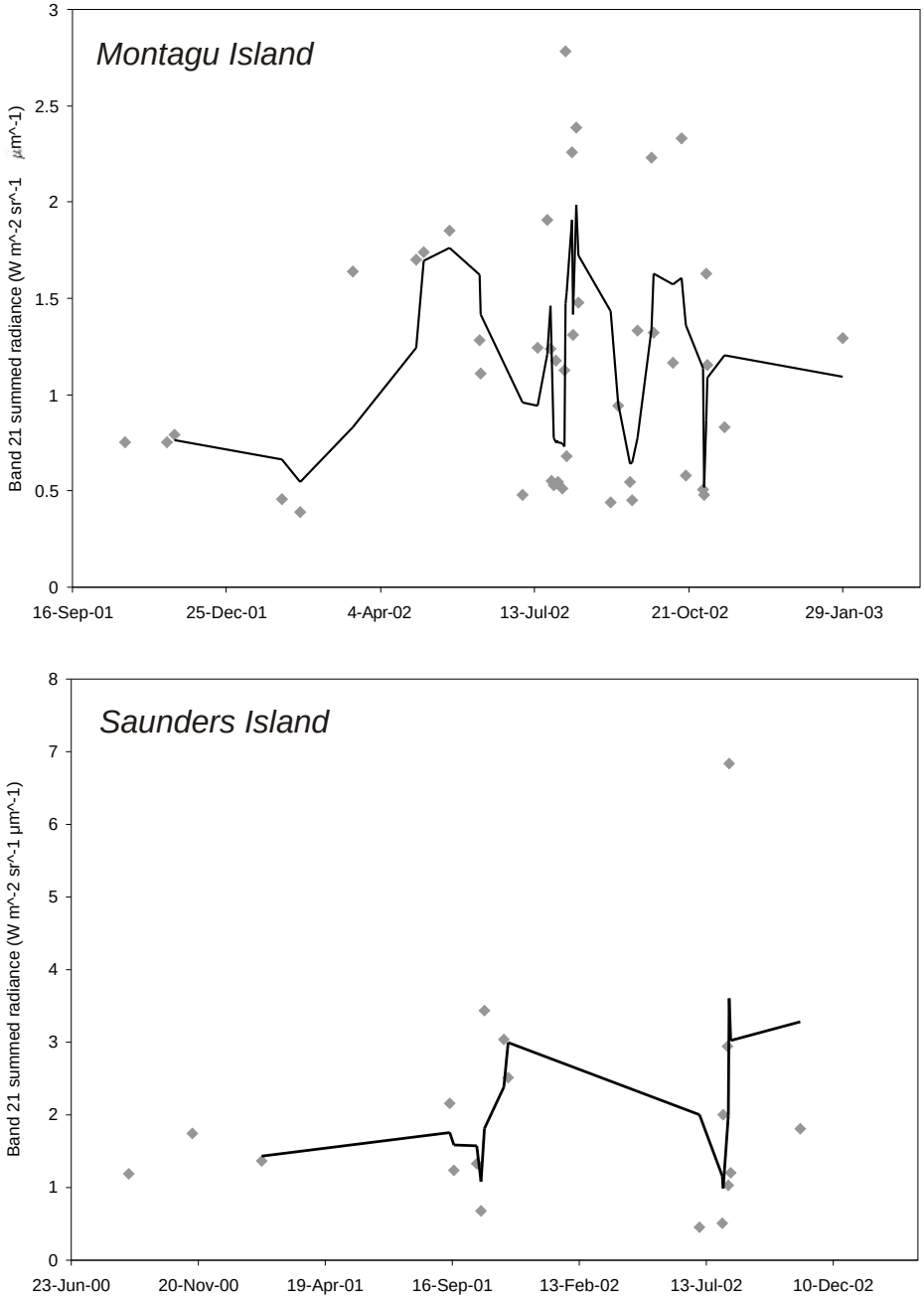

Figure 4. Summed radiance of anomalous pixels in each image. Band 21 (3.9 microns) was used for these plots. Points show the result for each image, and the line is a three point running mean of values. Note the different time scales for each plot.