

Cyclic tremor at the Soufriere Hills Volcano, Montserrat, 1996-2001

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Introduction

An important feature of the seismicity associated with the 1995-2001 eruption of the Soufriere Hills Volcano has been the occurrence of episodes of cyclic tremor. On the helicorders these tremor cycles appear as alternate bands of strong and weak seismicity, from which the term “banded tremor” arises [Fig. 1]. Banded tremor was first identified at the Soufriere Hills Volcano on 29 July 1996, in the RSAM data [Fig. 2]. This was quickly recognised as signal associated with pressure cycles in the volcanic system, but strong evidence did not come until mid-1997 when tilt cycles were also recorded, and allowed the phase relation between tilt and tremor to be examined. Further breakthroughs came in late-1999 when COSPEC measurements shed light on the relation between tremor cycles and degassing. To date 10 episodes of cyclic tremor have been recorded, lasting from a few days to a few months, and consisting of tremor cycles with periods ranging from 3-24 hours [Table 1]. Here we present a comprehensive re-analysis of the RSAM and tilt data on which previous works have drawn, and discuss work in progress to

Start date	End date	Number of cycles	Mean interval (hours)	Mean cycle amplitude (RSAM)	Maximum cycle amplitude (RSAM)	Stations showing tilt cycles
28-Jul-1996	13-Sep-1996	137	6	573	1701	
12-Dec-1996	8-Feb-1997	100	10	501	1637	CHPK
23-May-1997	2-Sep-1997	144	11	386	1412	CHP3
?	?	RSAM data not available				
4-Feb-1998	25-Feb-1998	34	11	284	861	
25-Mar-1999	29-Mar-1999	3	10	372	429	
12-Oct-1999	13-Oct-1999	4	4	204	314	
1-Nov-1999	20-Feb-2000	160	9	177	626	
22-Mar-2000	16-Apr-2000	84	7	152	434	
25-Feb-2001	04-Mar-2001	11	12	833	1807	
ALL		688	9	362	1807	

Table 1: Statistics of cyclic tremor episodes.

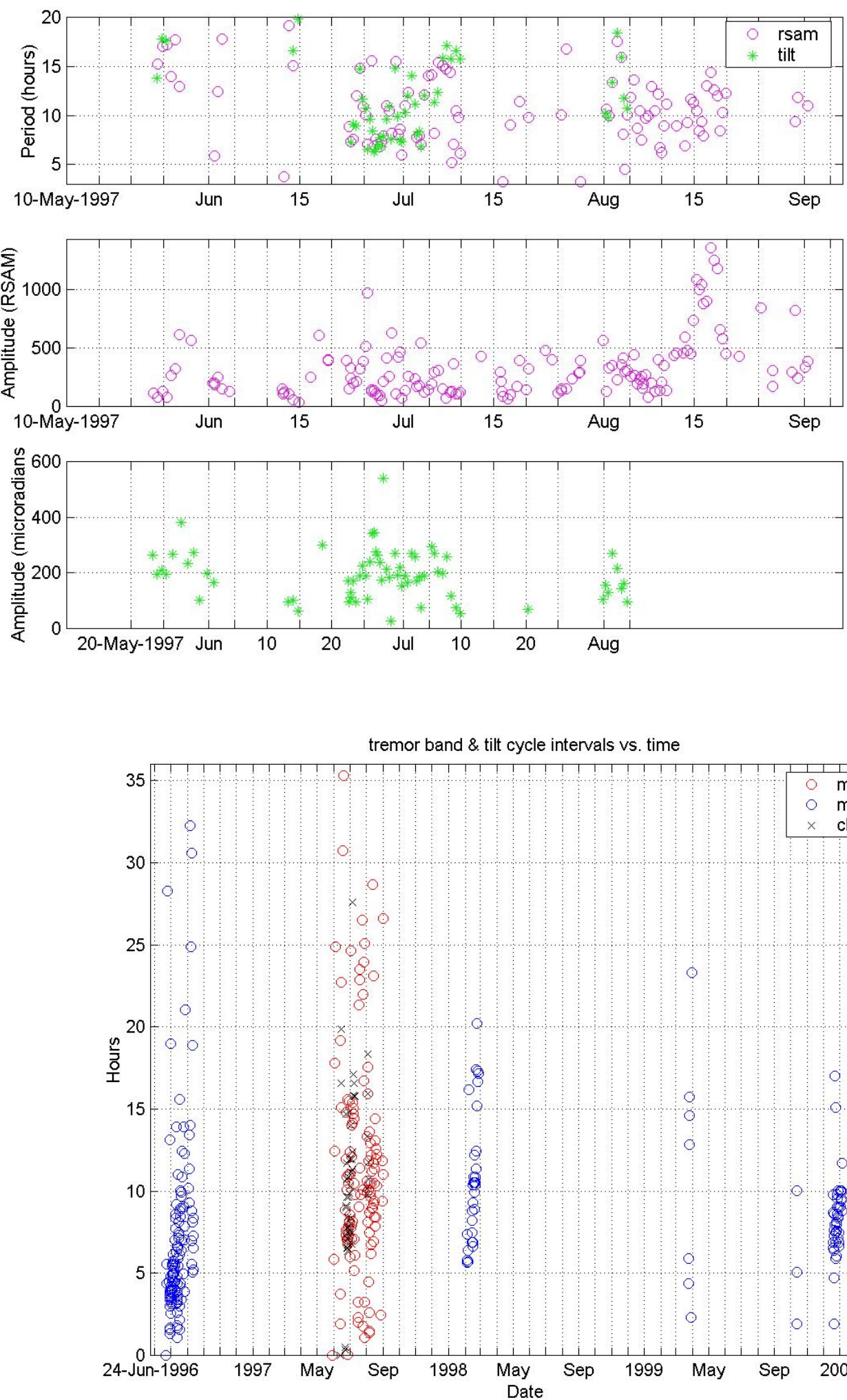


Figure 1: Banded tremor as it appears on a helicorder. This example is from 26 Feb 2001 – 1 Mar 2001, station MRYT.

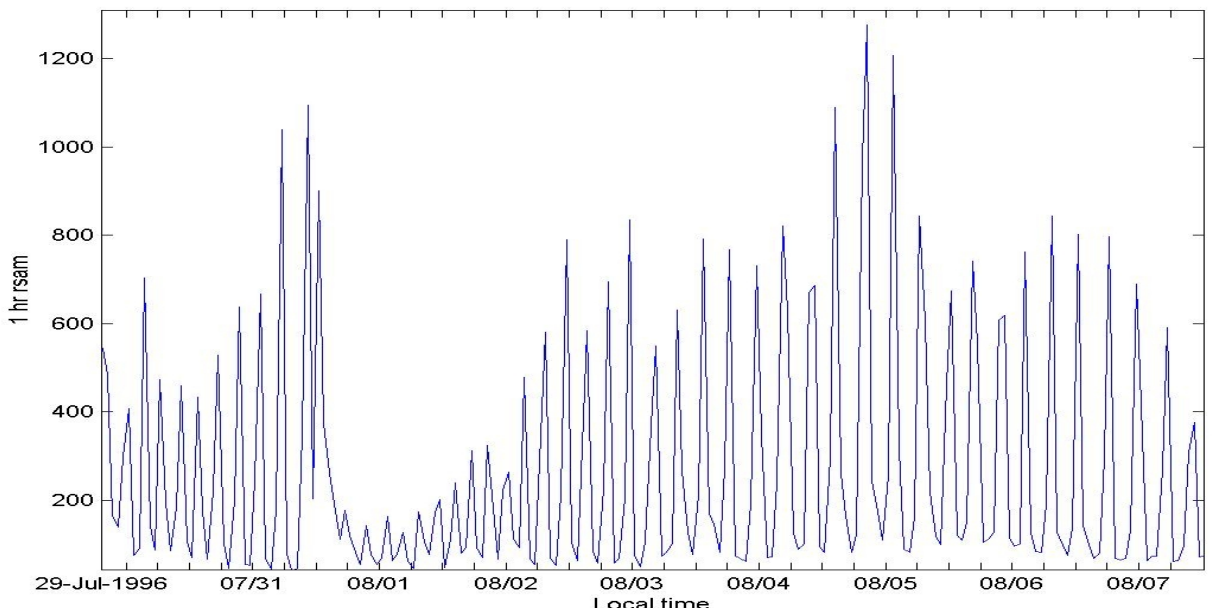
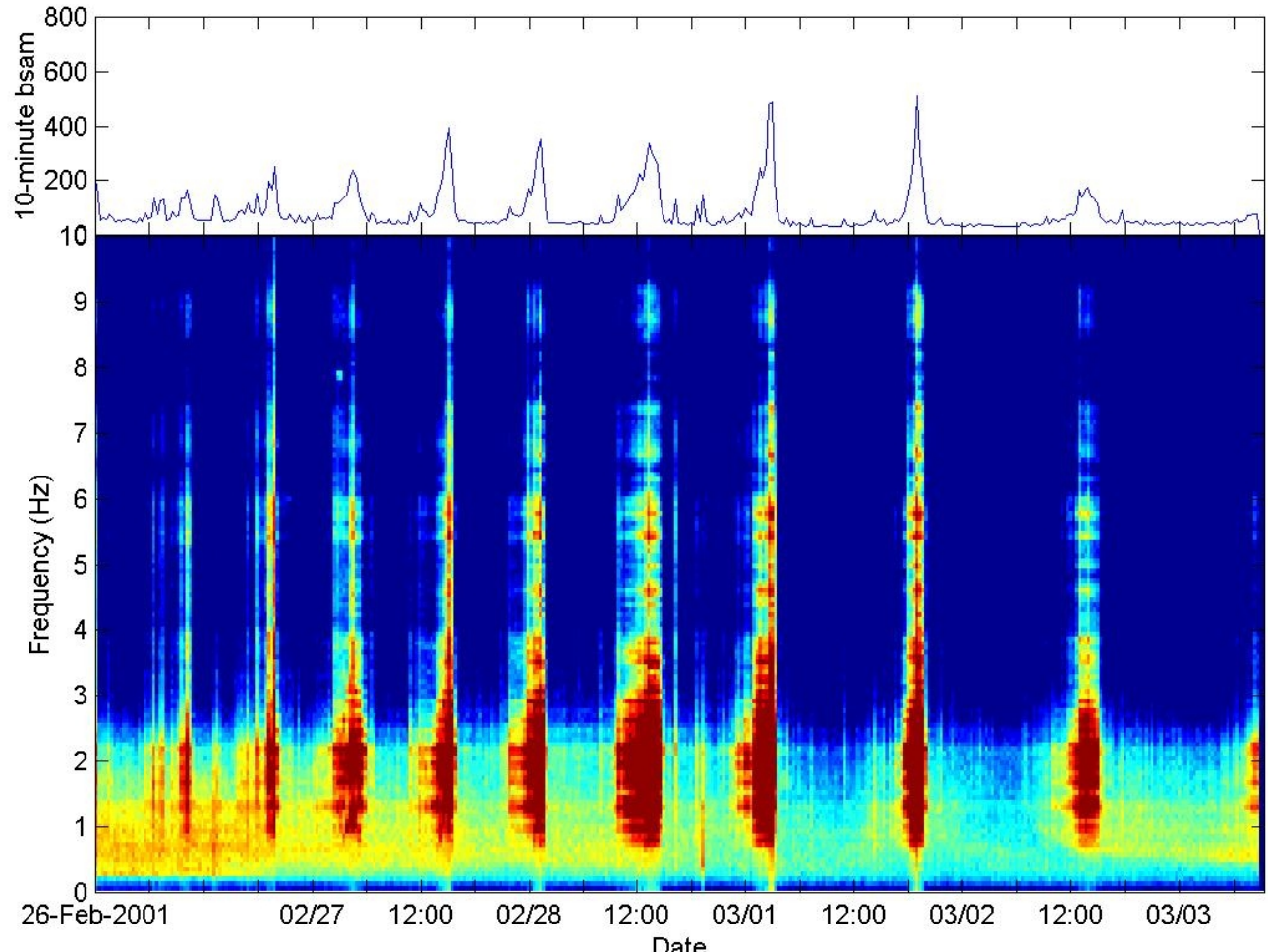
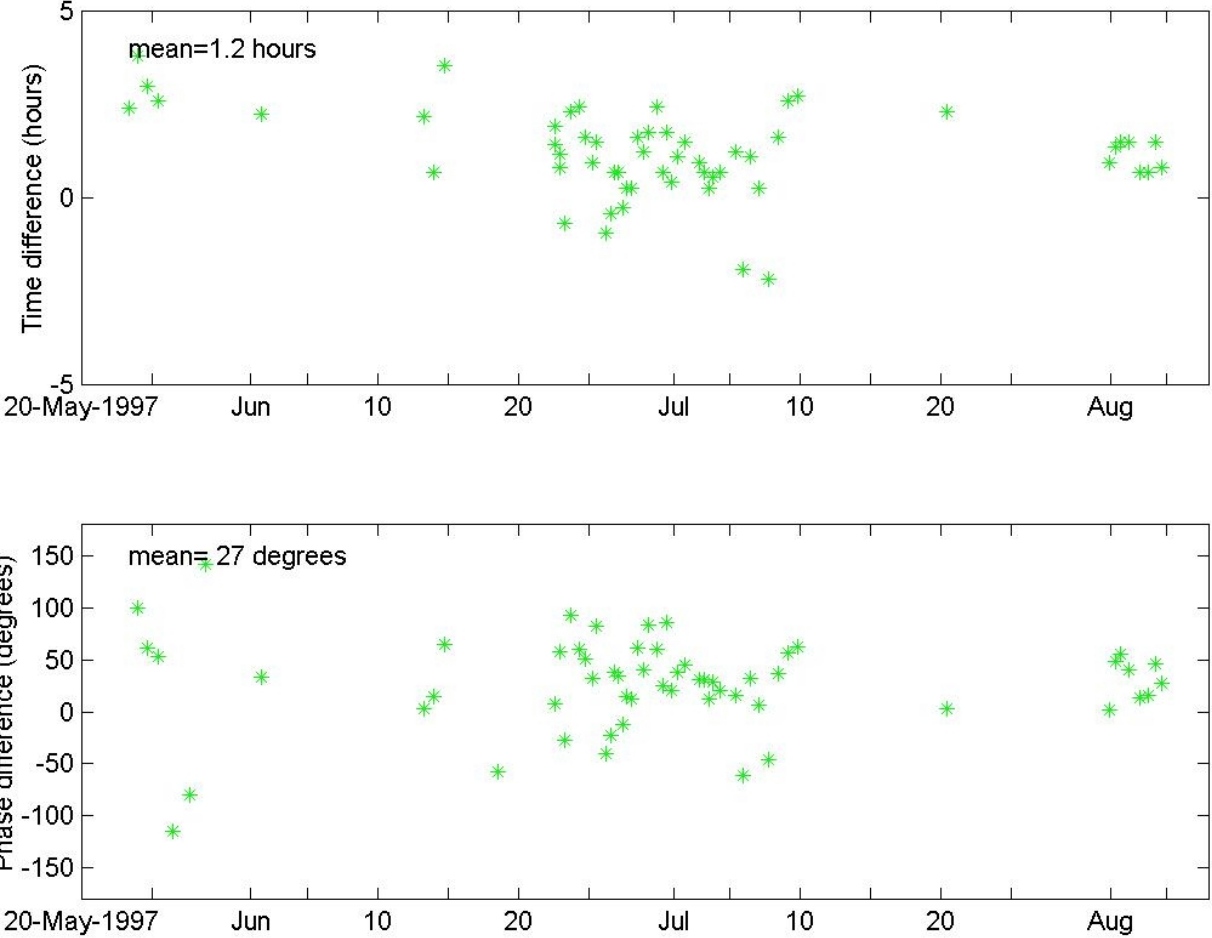
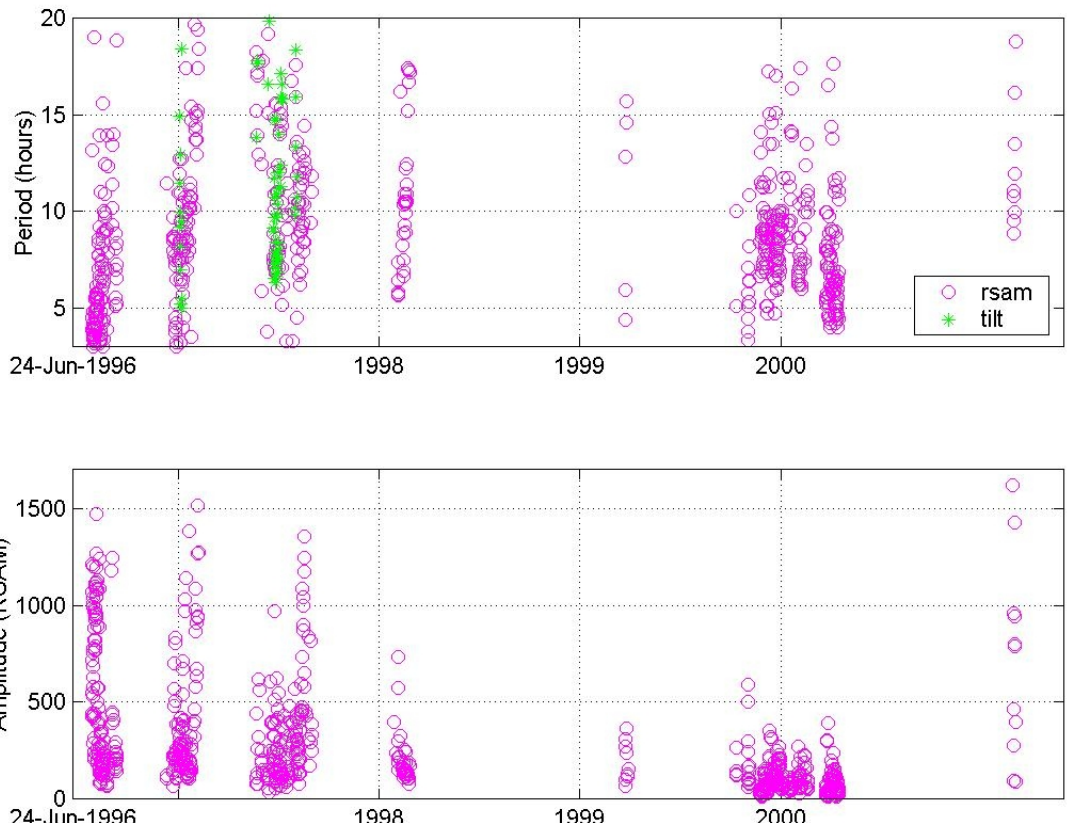
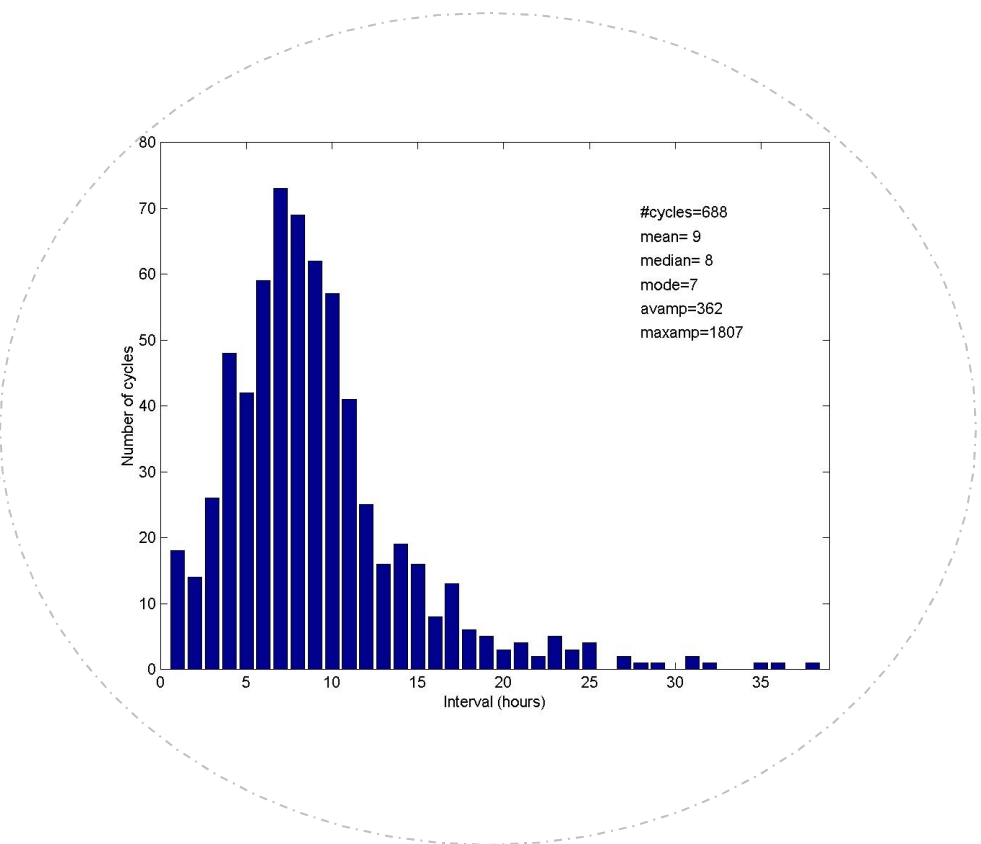
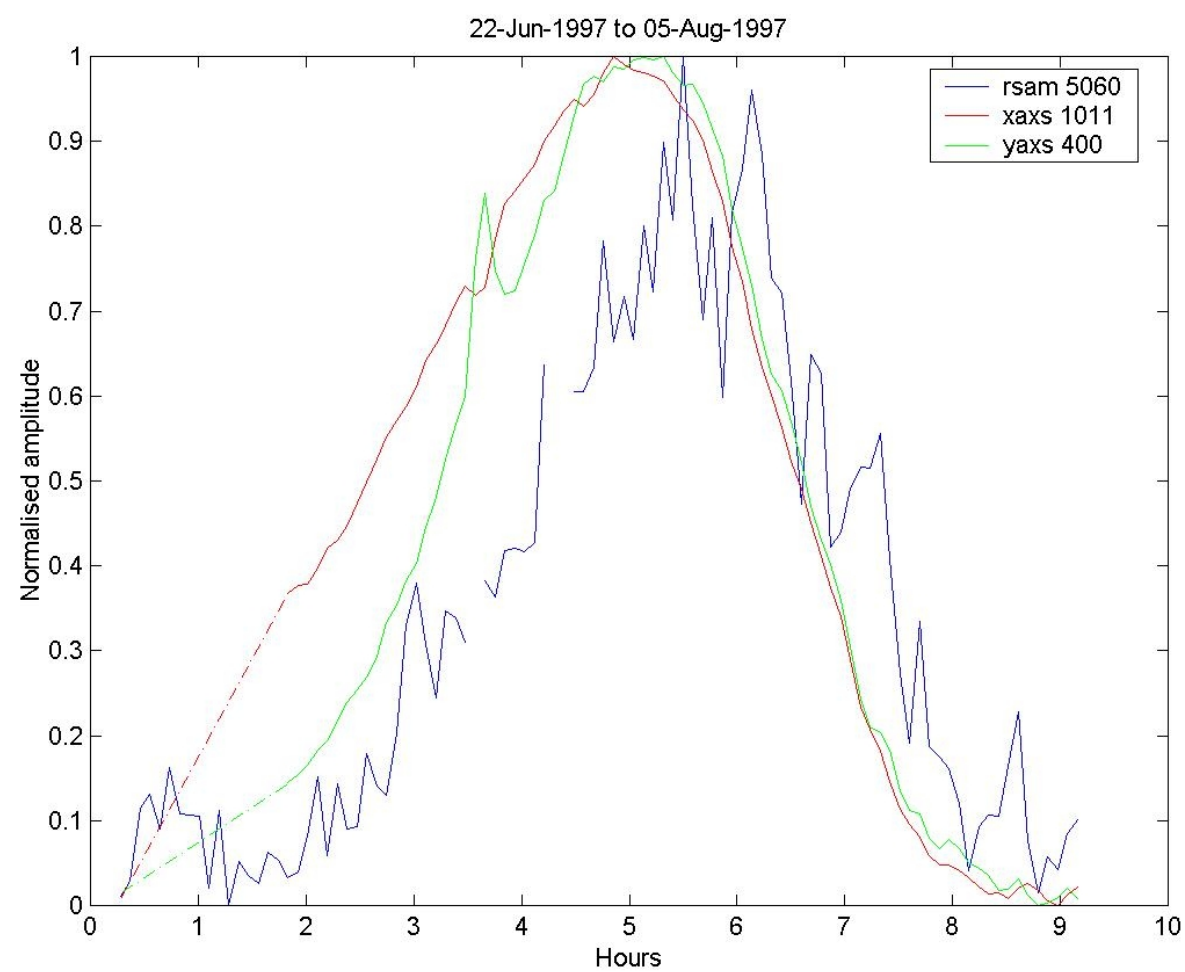


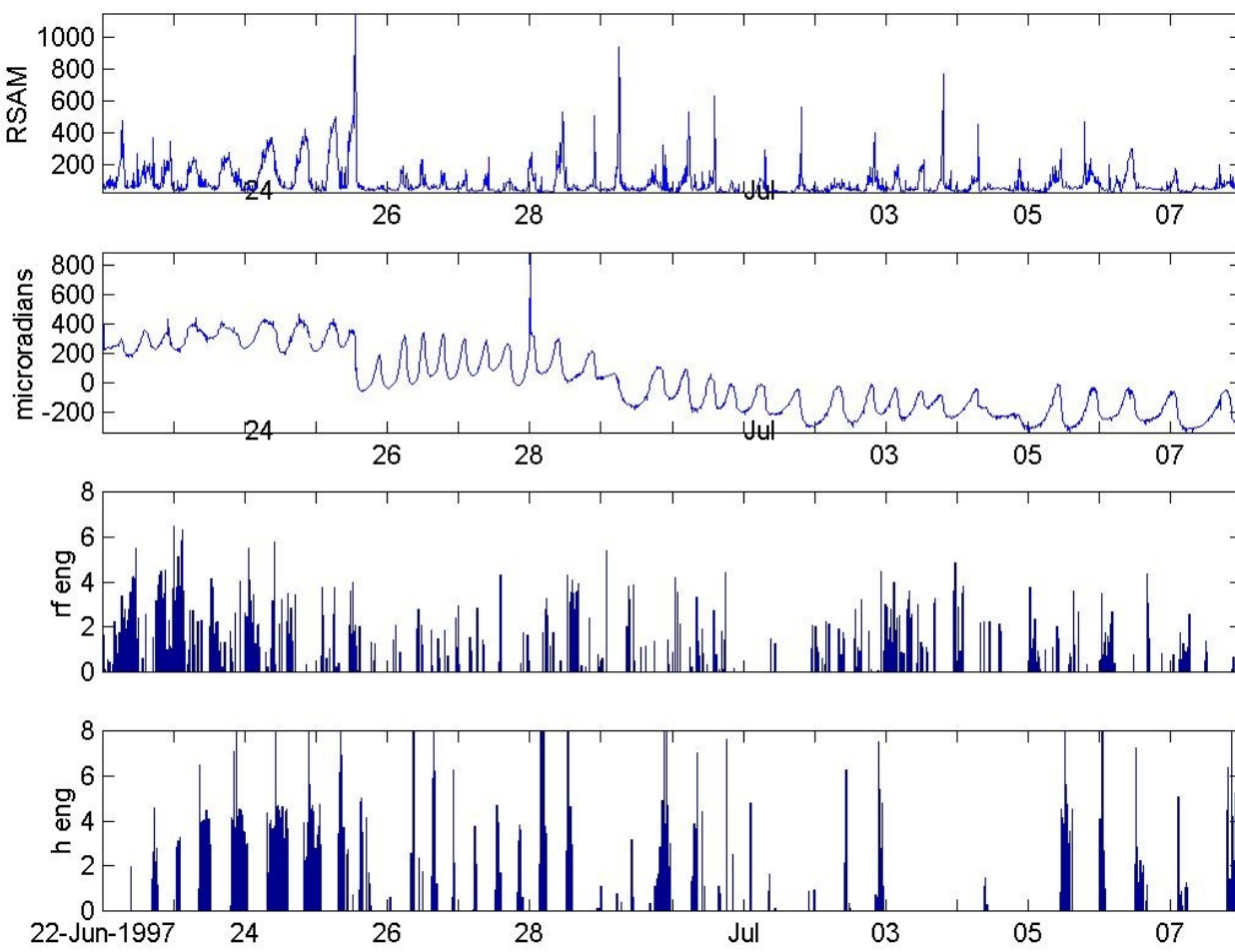
Figure 2: RSAM data show tremor cycles very clearly. A problem with RSAM data is that they do not distinguish between hybrids/tremor and other types of activity such as rockfalls, regional earthquakes etc.



Spectrogram showing the cyclic tremor episode that occurred between 26 Feb and 3 Mar 2001.



Stacked (normalised) tilt and tremor cycle from 22 Jun – 5 August 1997. The tremor cycle has a phase of +30° with respect to the tilt cycle.



Relationship between tremor cycles, tilt cycles, rockfall energy and hybrid earthquake energy. Further analysis of the occurrence times of different event