

Arthur Clarke Mars Greenhouse
Devon Island, Nunavut, Canada

2005 fall growth season
Preliminary report

**Canadian Space Agency
Space Sciences
Planetary exploration programme**

Revision history

Date	Author	Revision	Description
24 January 2006	Richard Giroux	Initial release	N/A

DOCUMENT DESCRIPTION

This document describes a series of events that happened during the 2005 fall growth season of the Arthur Clarke Mars Greenhouse, Devon Island, Nunavut, Canada.

ABBREVIATIONS

ACMG	Arthur Clarke Mars Greenhouse
CSA	Canadian Space Agency
OCE	Ontario Centers of Excellence
MDA	MacDonald, Dettwiler and Associates Ltd.

1. Background

In 2002, researchers at the Canadian Space Agency (CSA), with partners from industry and academia in Canada and in the United States, participated in the construction and inaugural operation of the Arthur Clarke Mars Greenhouse (ACMG), an experimental greenhouse established on Devon Island, High Arctic, under the auspices of the NASA Haughton-Mars Project. SpaceRef Interactive donated the ACMG with additional sponsorship from the CSA, the Ontario Centers of Excellence (OCE), MacDonald, Dettwiler and Associates Ltd. (MDA), the University of Guelph and Simon Fraser University. The ACMG is owned by the Mars Institute with Dr. Alain Berinstain of the CSA as the Principal Investigator. Devon Island (Figure 1) is a remote location that serves as a potential Moon and Mars analog for specific areas of research in geology, astrobiology, and space exploration technologies. It is the site of a very well preserved impact structure and of many other geologic features with potential counterparts on the Moon and Mars. Each summer the site brings together researchers from around the world.



Figure 1: Devon Island, Nunavut, Canada

2. Sequence of events – fall growth season

Starting mainly in mid-September, a series of unusual events happened at the ACMG. This section relates the events as they occurred.

21 August 2005

The limit switch indicating an open door was triggered. However, the interior webcams have shown no signs of activity.

16 September 2005

The exterior webcam show the first sign of tracks around the greenhouse, although no people are on site at this time (see Figure 2).



Figure 2: Tracks around the greenhouse, 16 September 2005

28-29-30 September 2005

During the time between the two pictures of 28 September and 29 September, a block of rockwool moved inside the greenhouse, as shown in Figure 3 and Figure 4. Then, this block has been "pushed" further during the time between 29 and 30 September, as shown between Figure 4 and Figure 5. The trays on top have also moved right by a small amount.



**Figure 3: 28 September 2005 ;
12:15 local time**



**Figure 4: 29 September 2005 ;
12:19 local time**



**Figure 5: 30 September 2005 ;
12:23 local time**

30 September 2005

Shortly after 11:00, the thermocouple measuring the temperature of the heat recovery system (barrel filled with a mixture of water and antifreeze) failed. The channel 0 of Module TC-120 @3 reads this thermocouple and Figure 6 illustrates the failure.

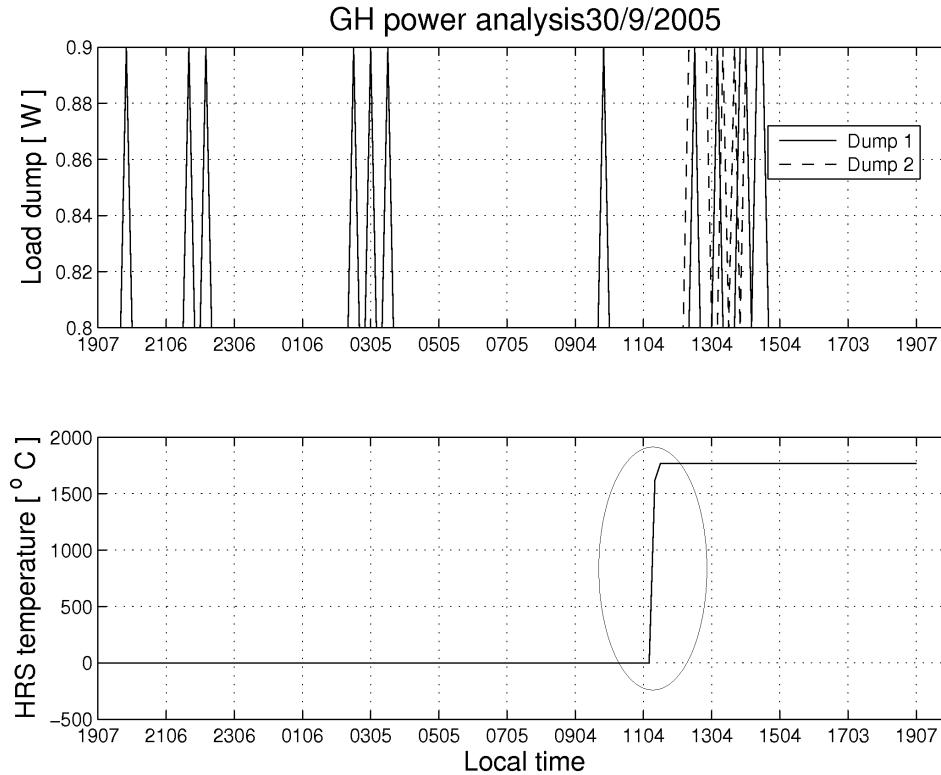


Figure 6: HRS Thermocouple failure

This thermocouple is firmly attached to the ABS pipe that goes into the barrel, as shown in Figure 7 and Figure 8. From testing at the CSA HQ, the input reading of 1770 °C means that the thermocouple is open (either the wire been cut, the thermocouple hot junction been detached or the wire been pulled out the module block terminal).



Figure 7: HRS thermocouple assembly



Figure 8: HRS thermocouple close-up

1 October 2005

The exterior webcam is obstructed, probably by a snowstorm. The power load data indicated it is still powered when turned on.

5 October 2005

14:41 local time: Outside webcam takes a new picture, but still obstructed by what appears to be snow (see Figure 9).

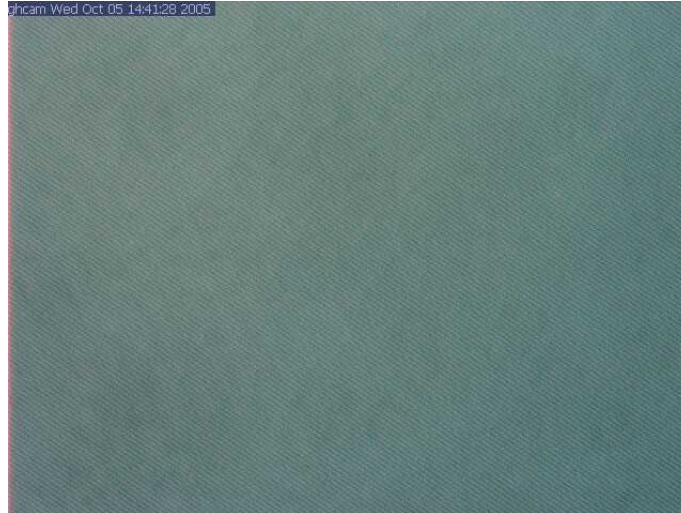


Figure 9: Last picture from the external webcam, 5 October 2005

17:00 local time: The thermocouple measuring the outside air temperature fails. This thermocouple is on the exterior side of the west wall of the greenhouse structure. Figure 10 shows the reading of 1770 °C, again meaning an open thermocouple.

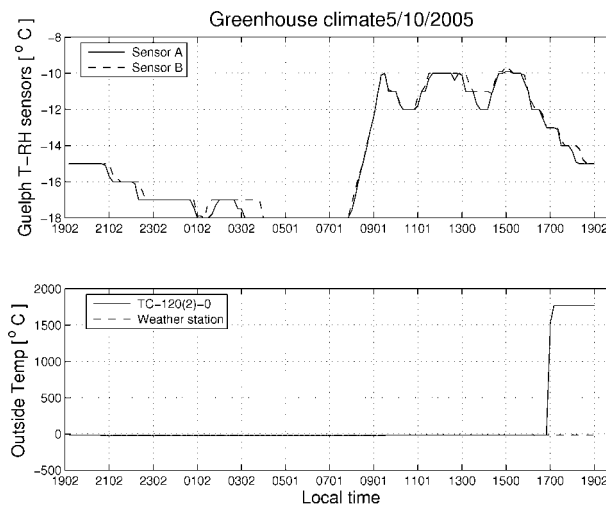


Figure 10: Thermocouple on outside of west wall failed

6 October 2005

The exterior webcam no longer responds. No new pictures available (only the picture from 5 October is there). The controlled power relay turns on but no power load from this action is seen. Figure 11 shows the missing load from October 8th 2005 (the missing load was more clear on that day).

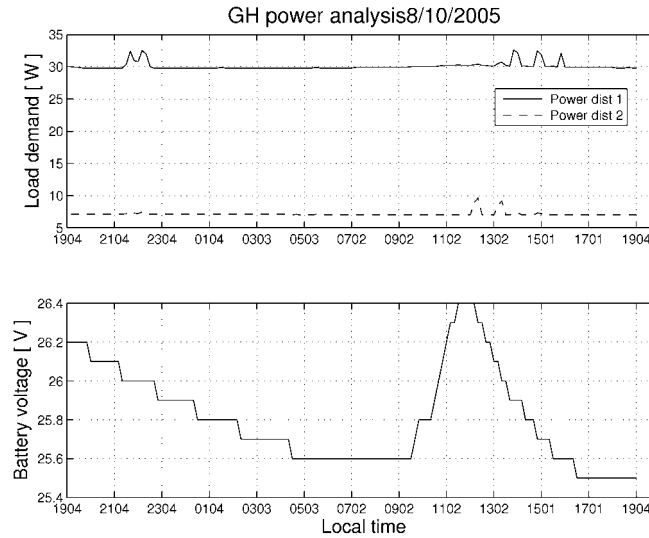


Figure 11: Missing load from the external webcam

6-7 October 2005

Between 6 October and 7 October, the growth trays moved again, but to a point where the last two trays flipped over.



Figure 12: 6 October 2005



Figure 13: 7 October 2005

10-11 October 2005

Snow is coming in from the ventilation hole of the heaters, but also from the bottom right corner of the pictures, where moving parts have happened before (Figure 14 and Figure 15).



Figure 14: 10 October 2005



Figure 15: 11 October 2005

19-23 October 2005

The same event of the 28-29-30 September 2005 happens again, and is depicted in Figure 16 to Figure 20. However this time, the white block appeared and disappeared again. In addition, the unused trays under the growth tray have moved, from 22 October to 23 October.



Figure 16: 18 October 2005



Figure 17: 19 October 2005



Figure 18: 20 October 2005



Figure 19: 22 October 2005



Figure 20: 23 October 2005

28 October – 1 November 2005

Snow starts to get in the greenhouse by the East end (Figure 21 and Figure 22). A few days afterwards, snow is also accumulating at the West end (Figure 23 and Figure 24).

**Figure 21: 28 October 2005****Figure 22: 29 October 2005****Figure 23: 31 October 2005****Figure 24: 1 November 2005**

2 November 2005

Since that time, no unusual events have occurred. The dark season is approaching soon as can be inferred by the sun altitude (see Figure 25); hence no more pictures will be available until late February 2006.

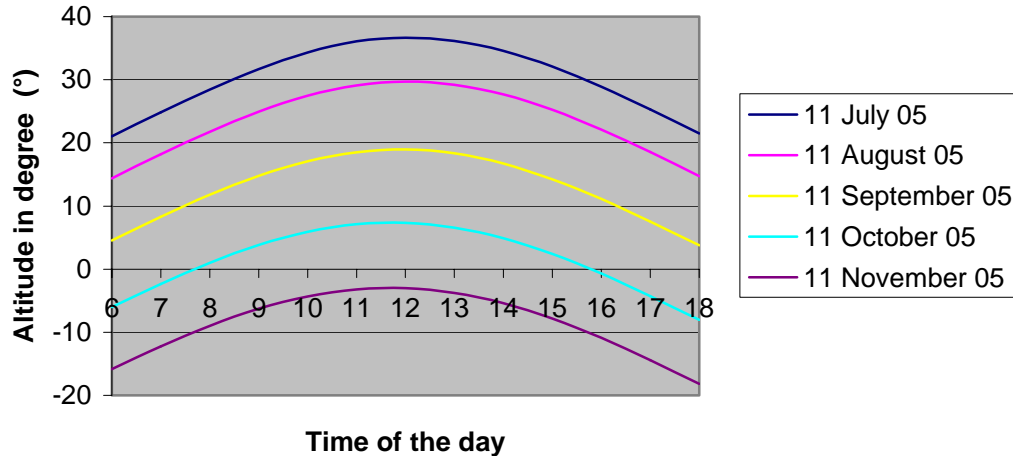


Figure 25: Sun altitude for different time of the year
(http://www.geocities.com/senol_gulgonul/sun/)

Also, the cold season will imply the shut down of the data acquisition and control system to preserve the charge of the batteries (although keeping powered the satellite communication and the embedded computer). By doing so, the batteries will be able to survive even though the temperature can drop around -50°C .

3. Conclusion

This report was intended to cover the sequence of unusual events that occurred during the fall growth season of the ACMG. Comments, hypothesis and conclusions will be drawn in the final report of the fall growth season. However, it is likely that the causes of the event (and the real consequences) will be only assessed once a team of researchers will go on site in late April 2006.