CRYOSAT-2: MEASURING FLUCTUATIONS OF LAND AND MARINE ICE FIELDS FROM SPACE

Richard Francis[1], Duncan Wingham[2] and Robert Cullen[1]

1. ESTEC, European Space Agency, Keplerlaan 1, Noordwijk, Zuid Holland, 2200 AG
The Netherlands
2. Department of Earth Sciences, University College London
London WC1E 6BT United Kingdom

1. INTRODUCTION

CryoSat was chosen as the first of ESA's Earth Explorer Opportunity missions in late 1999, following a competitive selection process [1]. Unfortunately, the CryoSat satellite was lost as the result of a launch failure on 8 October 2005. The decision was made to rebuild the satellite in order to complete the mission, and as a result of this the new satellite, CryoSat-2, will be launched on 25 February 2010.

2. MISSION OBJECTIVES

The mission goal of CryoSat is the measurement of secular change in the cryosphere, particularly in the elevation of the ice caps and the thickness of sea ice [2]. The required accuracy corresponds to about half of the variation expected due to natural variability, over reasonable scales for the surfaces concerned. The selected technique is radar altimetry, although the instrument has been modified to provide the enhanced capabilities needed to significantly extend the spatial coverage of previous altimetry missions, particularly ERS and EnviSat. Thus the radar includes a synthetic aperture mode which enables the along- track resolution to be improved to about 250 m. This will enable detection of leads in sea-ice which are narrower than those detected hitherto, so that operation deeper into pack-ice can be achieved with a consequent reduction in errors due to omission. Altimetry over the steep edges of ice caps is hampered by the irregular topography which, since the radar ranging is performed to the closest reflector rather than the point directly below, introduces uncertainty into the exactitude of repeat measurements. CryoSat's radar includes a second antenna and receiver chain so that interferometry may be used to determine the arrival angle of the echo and so improve localisation of the reflection. The satellite payload, which includes a DORIS receiver for precise orbit determination and a set of star trackers to measure the orientation of the interferometer, is quite complex and demanding.

3. CRYOSAT-1 LAUNCH FAILURE AND THE MISSION RECOVERY WITH CRYOSAT-2

CryoSat was launched on 8 October 2005, just less than 6 years after the start of the programme. Unfortunately the launch vehicle, a Rockot launcher derived from the Russian SS-19 ICBM, suffered an anomaly at the end of its second-stage flight, with the result that the satellite was lost, the debris falling close to the North pole. Determination to rebuild the satellite and carry out the mission was extremely widespread: within 5 months all of the necessary funding issues, legal procedures, industrial

commitments and resource demands had been solved and the programme restarted. The new satellite, inevitably called CryoSat-2, includes a large number of improvements compared to its predecessor, although many are internal changes to improve the reliability and ease of operations. More significantly, the expected lifetime has been increased. The satellite measurements will be supported by a comprehensive set of validation data, collected on the surface and from airborne platforms. These validation data, designed to specifically address the uncertainties in the interpretation of the radar echoes, have been collected during a series of carefully co-ordinated measurement campaigns over several years. Additionally, techniques to enable the collocation of surface and satellite measurements over the moving sea-ice have been developed and rehearsed, ready to support the dedicated validation campaigns during the mission.

CryoSat-2 will be launched from Baikonur, Kazakhstan on 25 February 2010. Launch was originally planned for March 2009, again with a Rockot. But lack of availability of this vehicle (more specifically, the versatile third stage added to the ICBM) has induced a change to the Dnepr launcher, also an ICBM: the SS-18. So finally, about 11 years after it was first selected, the CryoSat mission will start collecting data.

4. REFERENCES

[1] http://www.esa.int/livingplanet/cryosat

[2] Wingham, D. J., Francis, C. R., Baker, S., Bouzinac, C., Cullen, R., de Chateau-Thierry, P., Laxon, S. W., Mallow, U., Mavrocordatos, C., Phalippou, L., Ratier, G., Rey, L., Rostan, F., Viau. P. and Wallis, D., 'CryoSat: A Mission to Determine the Fluctuations in Earth's Land and Marine Ice Fields'. Advances in Space Research, 37(2006) Pp 841-871. doi:10.1016/j.asr.2005.07.027.