

Integrated System Optimization of Controlled Meteorological (CMET) Balloons

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Controlled Meteorological (CMET) balloons provide a new a platform for atmospheric observation and research. Operating on the principle of partial compression, CMET balloons are notable for their altitude control, small size (400 g payload), long-duration flight capability (days to weeks), and global two-way communication via satellite. These balloons were flown for the first time during the International Consortium for Atmospheric Research on Transport and Transformations (ICARTT) campaign in 2004 and the Southeast Texas Tetroon Study (SETTS) in 2005. They were used to track air parcels for repeated sampling by instrumented aircraft in order to measure chemical evolution in a quasi-Lagrangian reference frame. Advances in the design, construction, and operation of CMET balloon as integrated systems are discussed.

I. Introduction

DURING the past few decades, advances in global communications, control electronics, and materials have enabled the development of miniature altitude-controlled balloons that can remain aloft for days at a time while responding to commands and relaying data to operators on the ground via the internet. Such balloons, which can change altitude on command and navigate using wind shear, have applications in atmospheric science, weather monitoring, and communications. We describe the development and flight performance of one such platform, a Controlled Meteorological (CMET) balloon that operates on the principle of differential expansion altitude control.¹

CMET balloons are not the first autonomous balloons to have reversible altitude control and long-duration flight capability. Air ballast balloons, in particular, have been in use for more than a decade.²⁻⁵ Air ballast balloons are substantially larger than CMET balloons and are able to maintain a stable altitude even in precipitation. The small size of CMET balloons, however, confers many advantages. CMET balloons can be transported in automobiles, launched in windy conditions, and flown in more populated areas. The natural instability of CMET balloons allows them to perform repeated atmospheric soundings with great efficiency.

CMET balloons were first flown during the International Consortium for Atmospheric Research on Transport and Transformations (ICARTT) campaign in 2004. Five CMET balloons, each weighing 1.2 kg, were launched from locations along the New England coastline. Flights lasting between 12 hours and five days tracked air pollution from the greater New York and Boston metropolitan areas. Following this campaign, improvements were made to the balloon electronics, materials, physical design, and software. Changes reduced the total mass of the balloon and payload to 760 grams and provided the capability to perform vertical soundings with high precision. Five of these

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