1 Introduction

1.1 *Background and Need*

The accuracy of the weather prediction models, and the impact that accurate forecasts can have on national economic activities, depends on the distribution and frequency of sampling of atmospheric data. Presently the ubiquitous and "expendable" radiosonde package is the instrument of choice, at least in most developed countries. They are also used in developing countries, but the cost of the units has prevented widespread use. Radiosonde observations are considered the single most important component of the current atmospheric observation system, providing essential information required for weather prediction models.

The most popular method for employing a radiosonde is to attach it to a helium or hydrogen filled weather balloon, launch it, and monitor the radio transmissions until the balloon bursts or goes out of radio range. The data sent normally includes pressure, temperature, and humidity. When the balloon bursts the instrument package, which has a mass of about 0.3 kg, falls to earth. The difficulty and cost of recovering the instrument normally exceeds the value of the device so they are generally considered expendable.

There are a variety of techniques for wind determination from radiosonde systems. Most radiosonde systems in the US use a radiotheodolite, a parabolic antenna that automatically follows the radiosonde by pointing in the direction of the maximum signal strength. However, because of low maintenance costs, lower initial costs, and simplicity of the equipment, a Global Positioning System (GPS)-based windfinding system is being adopted in many countries. Radiosonde manufacturers have responded to this change by developing a radiosonde based on the GPS. The cost of the GPS sondes however is higher, and is near $160 a unit, compared with $90 per unit for older systems. This in effect almost doubles the cost of providing the atmospheric data needed for the forecast prediction models.

The use of expendable radiosondes worldwide is high. More than 1000 expendable sondes are launched daily with about 150 of these being launched in the US alone. Thus the total daily expenditures worldwide is about $100,000 with $15,000 a day being spent in the US. Should a full conversion to GPS systems occur, the daily costs will increase to approximately $200,000 worldwide and $25,000 in the US. This is a significant cost increase for many weather services to absorb.

1.2 Goal

The goal of this project was to demonstrate a cost-effective method for recovering the radiosondes used in measuring atmospheric data for weather prediction models. The availability of a recoverable sonde will allow an increased distribution of the device and an increased frequency of sampling. A recoverable instrument package will result in greater accuracy of the prediction models or in lower cost for the current accuracy of forecasts or a combination of both.

The ideal solution would be a reusable vehicle that is launched in a manner consistent with current practice (i.e. by balloon) but would return to the launch site or to another recovery site. This would allow the reuse of the vehicle and the instrumentation and a subsequent significant reduction in the cost of the operation. To provide an expanded distribution, the ideal device would need to be designed to the lowest possible acquisition cost. This concept will provide the weather service with a flexible means to balance the trade-off between the accuracy of prediction and the cost constraints for daily predictions and research efforts. Additionally, given the large numbers of devices launched daily, the negative environmental impact of the disposable devices would be eliminated.

1.3 Report Overview

The remainder of this report addresses the design philosophy - the mission, aerodynamic design, and vehicle design of a Glidersonde; the design of a prototype vehicle for demonstrating the feasibility of the concept; the navigation system; and the flight tests conducted with the prototype Glidersonde.