Stratospheric aerostat – a new high altitude scientific platform

A stratospheric aerostat is a lighter-than-air aircraft which can fly in the stratosphere with long endurance, high payload-to-weight ratio and low energy consumption. Generally, the stratospheric aerostat mainly includes the near space airship and high altitude balloon which are divided into two modes: station keeping and cruise with the wind[1] (Figure 1). It is ideally suited to provide potential applications especially for border patrol, homeland security, maritime and airborne surveillance, data and communications relay, and environmental research that require reliable and persistent station keeping capability. Meanwhile, as a new high altitude scientific platform (HASP), the stratospheric aerostat is required to provide scientific and technological investigations, including fundamental scientific discoveries that contribute to the understanding of the Earth, the solar system, and the universe.

Such an HASP would allow researchers to tackle challenging problems in design, energy and material science. In fact, this scientific platform is difficult to build due to the multidisciplinary constraints. This is why the process is not very successful and the results are not as good as expected in tests.

The last 20 years have witnessed the projects establishment and researches of HASP in various countries, especially the developed countries in Europe and America, which greatly promote the development of HASP. In particular, with the rapid development of related subjects, the flight tests of these scientific platforms are more frequent recently.

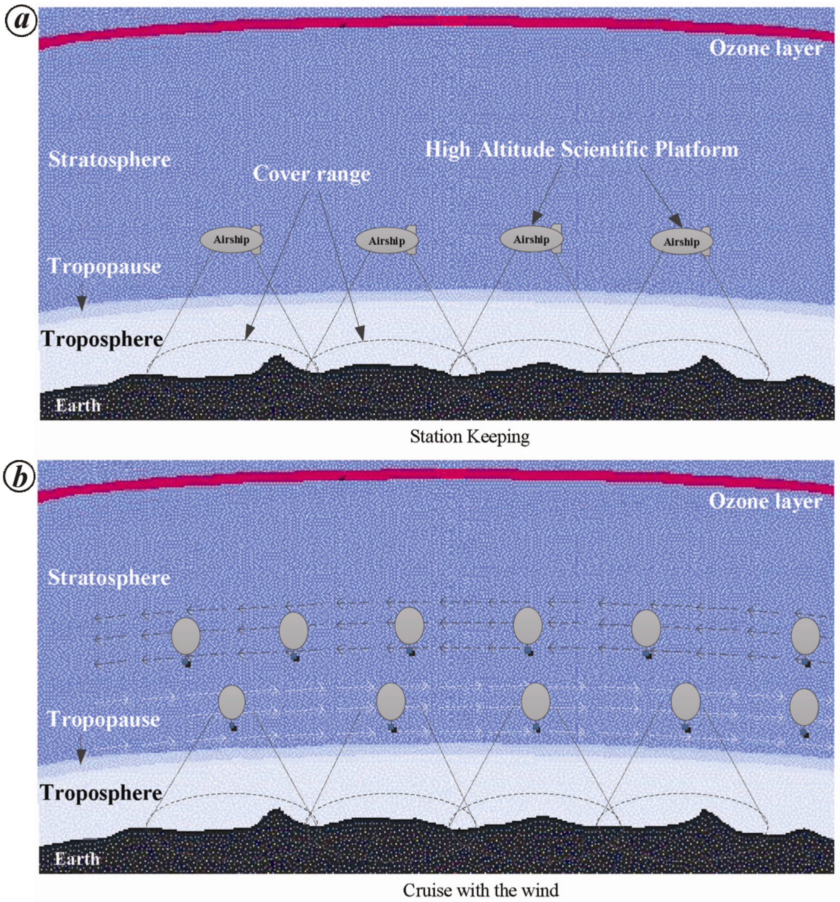

Figure 1. Comparison of two kinds of high altitude scientific platforms. ***a***, Station keeping: the propulsion subsystem is to provide enough thrust to overcome the drag of platform, then to remain stationary. ***b***, Cruise with the wind: the platforms are directed by rising or descending into a layer of wind blowing in the desired direction. (In the stratosphere, there are many layers of wind, and each layer of wind varies in direction and speed.)

Researches on HASP are concerned on the energy and management, control system design, the performance test of airborne equipment and the capability of station keeping. Significant progress has been made during the flight tests. For example, NASA successfully released a super pressure balloon loading the COSI (The Compton Spectrometer and Imager) to explore the gamma-ray bursts, black hole, and the mysterious origin of the galactic positron and to study the birth and growth of the new galactic elements on 17 May 2016. Meanwhile, this high altitude balloon also carried an infrasound detector developed by Chapel Hill of the university of South Carolina to record the low frequency sound waves in the stratosphere. Not only that, NASA is planning to launch the next balloon to search the primordial gravitational waves and validate the cosmic inflation theory. The Project Loon is developed by *Google* to solve the problem of high-speed and free internet service at relatively low price in most of economically underdeveloped areas (Africa, South America, Southeast Asia, etc.) through deploying HASPs. In this project, three control strategies are employed to adjust the height and attitude of the platform[2]. In addition, the airship team of Beihang University has launched the China's first near space airship on 13 October 2015. The team achieved a number of key technologies such as high performance envelope material, flexible thin-film solar cells, high efficiency energy storage battery technology and integrated test[3]. This near space platform was equipped with wideband communication, high resolution observation and spatial imaging and situational awareness systems to perform a variety of tasks. In addition, Japan, France, India and other countries have also conducted flight tests of HASP.

For the purpose of long-endurance scientific research, there are still challenges to be overcome in the following studies. To list some of the major ones, we consider the following:

Energy. Renewable energy system used currently mainly including photovoltaic cells, regenerative fuel cell, rechargeable lithium batteries is a critical appendage which provides primary power sources for long endurance scientific platform. However, the efficiency of flexible thin film photovoltaic cells is generally low (8–14%)[4]. The specific energy, environmental adaptability, storage technology and safety of fuel cells and lithium batteries still need to be improved. In addition, a high reliability energy management system is urgently required. The unconventional energy systems, such as wireless power transmission system, should be studied.

Material. The envelope material has always been one of the most difficult technical challenges for realizing the HASP scale application. The ultra-light synthetic fibres, with high breaking strength need to be developed, and multifunctional film for special environment should be designed.

Airborne equipment and ground facilities. There is a lack of researches on airborne equipment and ground facilities for HASP. Existing airborne equipments and auxiliary ground facilities do not suit the platform quite well. Many measuring and test instruments for specific tasks require considerable researches and designs.

The HASP is a new systematic project which involves a lot of basic science theories and technologies. Although some projects have been carried out and tested, many key technologies need to be challenged due to the latest discovered issues in these flight tests. Further studies involving energy, material instruments and facilities should be necessary to promote progress on this matter. These techniques, coupled with basic researches in the field of aeronautics and astronautics, will help obtain desired results on HASP.

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Jun Li, Mingyun Lv and **Kangwen Sun*,** School of Aeronautic Science and Engineering, Beihang University, 37 Xueyuan Road, Beijing 100191, PR China; **Yuanyuan Zhang,** College of Geoscience and Surveying Engineering, China University of Mining and Technology, Ding No. II Xueyan Road, Beijing 100083, PR China.
*e-mail: kangwensun513@163.com

Indian government unveils National Disaster Management Plan, 2016

On 1 June 2016, the Indian government released its National Disaster Management Plan (NDMP), 2016 (ref. 1). The plan is produced by the National Disaster Management Authority (NDMA), which is an apex body for co-ordination and governance of nation-wide disaster management activities in India. NDMP aims to make India disaster resilient and reduce the loss of lives both from the natural hazards and the human-induced disasters. It covers all phases of disaster management, namely, prevention, mitigation, response and recovery. In the plan document, Prime Minister Narendra Modi describes the significance of the plan: 'The aim of the plan is to make India disaster resilient. It will help to maximize the ability of the country to cope with disasters at all levels by integrating disaster risk reduction into development and by increasing the preparedness to response to all kinds of disasters. The plan takes into account global trends in disaster management. It incorporates the approach enunciated in the Sendai Framework for Disaster Risk Reduction 2015–2030, which is an agreement under the auspices of the United Nations to which India is a signatory.' This national plan is prepared in continuation of the National Policy on Disaster Management, 2009. But, NDMP draws the guiding principles from the post-2015 development agenda, i.e. 2030 Development Agenda of the United Nations. The guiding principles of NDMP are explicitly elaborated in its vision statement, which states: 'Make India disaster resilient, achieve substantial disaster risk reduction, and significantly decrease the losses of life, livelihoods, and assets – economic, physical, social, cultural, and environmental – by maximizing the ability to cope with disasters at all levels of administration as well as among communities'[2].

The scope of NDMP encompasses all kinds of disasters arising from the natural hazards or from the human-induced disasters. The plan document recognizes eight categories of natural hazards, namely, (i) cyclone and wind (including tropical cyclones and storm surge), (ii) floods, (iii) urban floods, (iv) earthquake, (v) tsunami, (vi) landslides and snow avalanches, (vii) drought, and (viii) cold wave and frost. The human-induced disasters listed are (i) chemical or industrial disaster, (ii) nuclear or radiological emergency and (iii) fire risk (including forest fire). In a table in NDMP document, 15 categories of disasters are listed and the nodal ministry for management or mitigation of different disasters identified.

The plan document indicates three-tier hierarchy in administering disaster management. From top down these are: (i) national disaster management authority, (ii) state disaster management authority and (iii) district disaster management authority. NDMA is the apex body responsible for laying down the policies, plans and guidelines for disaster management for ensuring timely and effective response to disaster across the country. In addition to the institutions of authority, the country also maintains a National Disaster Response Force (NDRF) and State Disaster Response Force (SDRF) in every state and union territory. NDRF and SDRFs are responsible for rapid action and recovery at the disaster sites anywhere in the country. The responsibilities of capacity building, training and research are performed by the National Institute of Disaster Management (NIDM).

There also exists an advisory institution in South Asia, namely, SAARC Disaster Management Centre, where the Indian government is an active member for disaster risks reduction (DRR) and