# Adaptive deployment of balloons within HyMeX.

A. Doerenbecher[e] and C. Basdevant[d]
alex.doerenbecher@meteo.fr

## 1. Introduction

The BAMED[a] project contributes to the international and multidisciplinary project HyMeX[b]. BAMED, which is supported by the CNES[c], also involves the LMD[d] and the CNRM[e]. The project deals with atmospheric boundary layer drifting balloons to be deployed during the SOP (Special Observation Period) of HyMeX (in 2012 and 2013). The scientific objective for both LMD and CNRM is to prepare a deployment strategy, which is relevant for the needs of HyMeX. This strategy includes the selection of some launching sites and the development of a so-called targeting guidance tool that helps for the launching decisions in real-time. Indeed, the deployment of the balloons will be tailored for the numerical weather prediction (NWP) at various scales (sub-synoptic and mesoscale). The balloons are "Boundary Layer Pressurized Balloon" (BLPB) and "Aéroclippers". Both types are designed and built by CNES. The paper will start by describing the HyMeX context and the balloons. Then some considerations about the launching sites will be considered prior to a sketch of the guidance system to be implemented in HyMeX.

## 2. Experimental context

### 2.1 HyMeX

The HyMeX project aims to better monitor the hydrological water cycle in the Mediterranean basin at various scales and in each compartment of the system: atmosphere, ocean and at the continental interface (hydrology). The scales to be studied stretch from very short (e.g. flash floods) to long range (e.g. ocean deep circulation). To enable such a monitoring, various observing strategies are combined with dedicated modelling efforts. "Long", "enhanced" and "special observing periods" are embedded. The SOPs focus on intense events of limited duration (a few hours to a few days).

- SOP 1 (September/October 2012, North-Western basin) documents heavy precipitation events (HPE). Balloons will sample the moist low-level air flow converging toward the convective areas.
- SOP 2 (February-March 2013, North-Western basin): documents dense water formation related to strong regional winds (Mistral and Tramontana) that lead to the onset of deep oceanic convection. Balloons will sample fluxes at sea surface at the southern limit of the Gulf of Lion.

### 2.2 The aerostats (see also diagrams on figure 1).

The balloons prepared in BAMED will be deployed during SOPs. BLPBs drift at a constant density level, in the range of 925-850 hPa. These balloons have been designed to resist the heavy rain episodes likely to occur along their trajectories above the Mediterranean Sea. A shelter contains sensors for pressure, temperature, humidity and GPS positioning (additional instrumentation is possible). The wind will be deduced from sequential positions as the BLPBs have Lagrangian trajectories. The Aéroclipper consists of an airship-shaped balloon towing a marine gondola at the ocean surface. The guide rope between the two bodies is about 30 meters long and holds the sensors that indirectly collect ocean surface fluxes. The wind is measured, as these balloons have not a Lagrangian drift, due to the surface drag from the marine gondola.

## 3. Launching site selection

These balloons will be deployed above the Mediterranean Sea, which is the least observed atmospheric area within the North-Western basin. They will collect in-situ observations in the flow upstream of the

[a] BAMED = **Ba**lloons in the **Med**iterranean
[b] HyMeX = **Hy**drological cycle in the **M**editerranean **Ex**periment (http://www.hymex.org/)
[c] CNES = **C***entre* **N***ational des* **É***tudes* **S***patiales* (http://www.cnes.fr/)
[d] LMD = **L***aboratoire de* **M***étéorologie* **D***ynamique* (http://www.lmd.jussieu.fr/)
[e] CNRM = **C***entre* **N***ational de* **R***echerche* **M***étéorologiques*, Météo-France, Toulouse (http://www.cnrm.meteo.fr/)

events of interest. Thus the collected data are expected to be of great interest for the NWP, especially the high-resolution mesoscale models to be implemented during HyMeX (e.g. AROME West-Med). As a consequence, the balloons will transmit the data in near real-time. Moreover, the balloons launch strategy should optimize both the impact of the data in the NWP and the logistical constraints. It is crucial to choose the launching sites that are the most propitious to reach HyMeX targets. A selection of alternative sites spread around the western Mediterranean basin has been evaluated with trajectories simulated on a series of past cases. The meteorological data used were both analyses and forecast compute either with ECMWF or Météo-France global model or with high-resolution model. The trial implied to define targets within the weather events and to maximize the number of trajectories reaching these targets together with their length and to minimize the loss of platforms. The statistics showed that a launching site in the Balearic Islands such as Mahòn in Minorca is a good trade-off for the SOP 1. A site on the French coasts close to Montpellier would be the ideal solution for the SOP 2.

## 4. Targeting guidance

As for any field campaign in which specific phenomena ought to be chased with limited observing resources, an adaptive observation strategy is worth being used to increase the rate of success. This strategy may include a decision-making tool. A trajectory simulator and a targeting tool developed respectively LMD and CNRM will be interfaced to produce a guidance to be sent to the field teams, in order to help them preparing the balloons and launching them at most propitious time. The diagram 2 sketches the system to be built and implemented at the HyMeX operation centre.

## Conclusions

The BAMED project allowed capitalizing on the CNES know-how with the low-level drifting balloons that were deployed within prior field campaigns such as VASCO[f], CIRENE[f] or AMMA[g]. The novelty is to chase specific phenomena within a real-time data collection system supporting numerical environmental prediction.

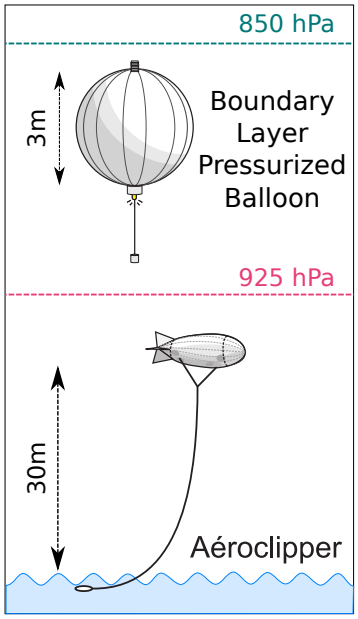


**Figure 1:** *Drifting balloons to be deployed by the CNES during HyMeX.*

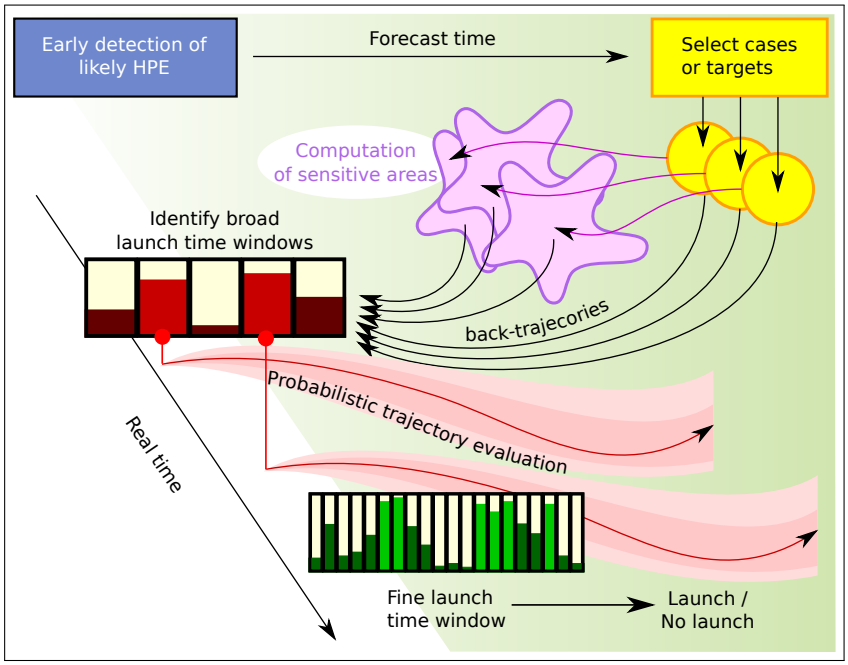


**Figure 2:** *Principle of the launching guidance tool to be implemented in the SOPs of HyMeX*

[f] http://www.lmd.ens.fr/vasco/
[g] **A**frican **M**onsoon **M**ultiscale **A**nalysis (http://www.amma-international.org/)