Boundary-layer drifting balloons for chemistry-dynamics studies in the Mediterranean region

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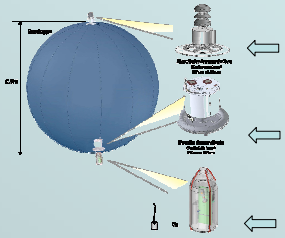
The BLPB (Boundary layer pressurized balloon)

The CNES (French Space Agency) has developed for a long time the capacity of designing, building and equipping drifting BLPBs. The current system consists in a spherical, 2.5 m diameter envelope, and gondolas in which are embarked the sensors, the acquisition system and the data transmission unit via the Iridium satellite communication network.



The « generic » instrumentation consists of a package for pressure, temperature and moisture measurement, installed on the top of the balloon.

The central gondola, including data recording and satellite transmission unit, is installed inside the envelope

Additional instrumentation, according to the objectives of the campaign can be installed in a gondola hanged below the balloon.

Flight levels and lifetime

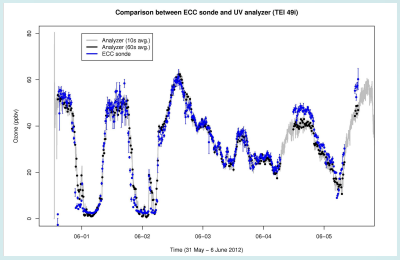
The balloons fly at a constant density level, except when their mass changes due to gas leakage or liquid water presence on the envelope in rainy or dew deposit conditions.

Low energy consumption allows a balloon lifetime as high as several weeks. The main limitation results from the restrictions for safety reasons: the flights are authorized over the seas, but are generally prohibited over continental areas. In the Mediterranean region, the expected trajectories therefore would rarely exceed 2-3 days.

Additional measurement: ozone concentration

The ozone probe is an adaptation of a commercial electrochemical (ECC) unit for which power supply and output signal acquisition are provided by the balloon gondola. Its operation in the intermittent mode (e.g. two min. every quarter-hour) extends its lifetime up to several days.

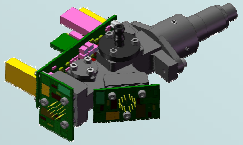
After a spin-up period of less than one minute, the ECC sonde has demonstrated its capability to correctly measure the ozone concentration once switched on. The comparison with a UV TEI analyser has revealed that the sonde was able to reproduce, in the intermittent more, both the rapid (few min.) and slow (diurnal cycle) variations for a time period as long as 4 days.



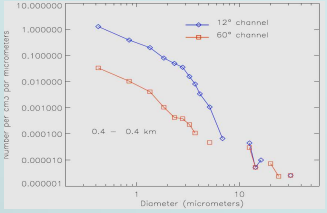
Time series on a 6-day period of the ozone concentration measured by a UV analyser (at 10-s and 1-min average, gray and black dots, respectively), and the intermittent ECC sonde (blue)

Additional measurement: light optical aerosol counter (LOAC)

Jointly developed by Environment SA company, and the LPC2E Lab. in Orléans (France), the LOAC for BLPB is a miniaturized, low-energy consumption version of a counter developed for air quality monitoring concerns. From the light diffused at two different angles, the number of particles in 20 bins of size larger than 0.3 µm in diameter, as well as the nature of the particles, can be estimated. The design of the sonde can be seen below, as well as an illustration of the size distribution observed at the two angles of observation.



Model of the LOAC system

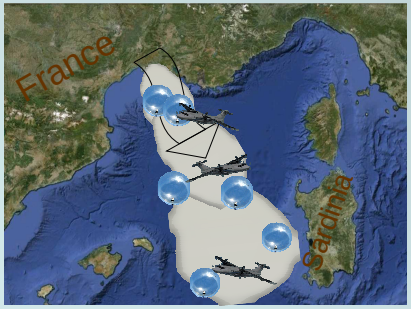


Aerosol size distribution observed at the two light diffusion angles

The 2012 and 2013 Mediterranean operations: the Chemistry and Aerosol Mediterranean Experiment (ChArMEx)

The 2012 TRAQA campaign

From 25 June to 13 July 2012, a joint aircraft-balloon experiment aims at following a pollutant plume issued from highly industrialized areas close to the French Mediterranean shoreline. BLPBs will document the Lagrangian evolution of the ozone concentration, and serve as targets for the plume chemical documentation by the French ATR-42 aircraft during about two days.

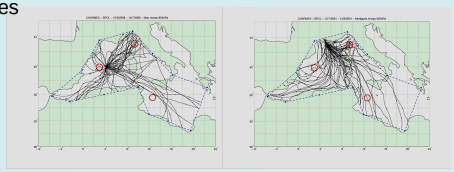


Sketch of the balloon-aircraft observation strategy during the TRansport and Air QuAlity campaign

The 2013 ChArMEx campaigns

In summer 2013, two campaigns will be based on a combined aircraft-balloon observation strategy. The first one (ADRIMED) will document the radiative impact of desert dust laden air masses coming from Africa. The second campaign will mimic the TRAQA strategy, with a focus on secondary organic aerosol formation. For both campaigns, the balloon launching place will be chosen according to the air mass trajectory study, based on operational analyses during the 2001-2011 period.

The areas of interest for the balloon-aircraft joint missions in summer 2013: desertic dust cloud (left), anthropogenic pollution combined with biogenic emissions (right)



Balloon trajectories simulated in operational ECMWF analyses: launching from Balearic islands (left) and from Marseilles (France, right)

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