THE RESEARCH AIRCRAFT OF THE GERMAN ACADEMY FOR AVIATION AND TRAVEL MEDICINE: FIRST INFLIGHT MEASUREMENTS

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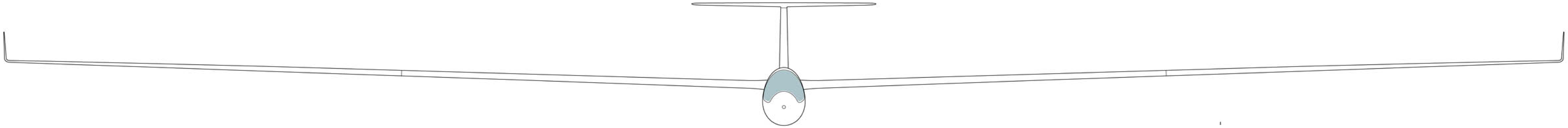

Introduction

Fig. 1: The self-launching research aircraft ASH 30 Mi

In 2013 the German Academy for Aviation and Travel Medicine purchased a research aircraft (ASH 30 Mi) produced by SCHLEICHER Co. Germany.

TECHNICAL DATA OF THE ASH 30 Mi:

Fig. 2: ASH 30 Mi with Wankel engine popped up

Span width	26.5 m
Wing surface	17.17 m²
Climb performance	2.7 m/s
Fuselage length	9.33 m
Fuselage height	0.998 m
Empty weight	630 kg
Glide ratio	> 60
Max. TOW	850 kg
Max. speed	270 km/h

The intention for that was to ameliorate the training process of aeromedical examiners and to promote aeromedical research.
The research aircraft is equipped with a medical monitoring system, which was specially designed for the special conditions of the ASH 30 by the Karlsruhe Institute of Technology. This system enables simultaneous recording of both flight and physiological data.

Fig. 3: The ASH 30 Mi with display of sensors and spaces available

After completion of the necessary adjustments, first inflight measurements started in October 2014.

Question

Firstly, it was to verify whether the methods used were suited to produce feasible inflight results regarding vital data such as heart rate (HR), heart rate variability (HRV) and respiratory rate.
Secondly, recorded data were attributed to various flight phases (takeoff, normal flight, landing), but also to flight duration and altitude.

Methods

For medical inflight measurements the ASH 30 Mi [Fig. 1] possesses a data logger (careMon DL) made by Corvolution Co. in Karlsruhe.

It is a miniaturized data recorder of matchbox size which is attached to a chest belt [Fig. 4]. Integrated in the belt are six electrodes for ECG and thorax impedance recording [Fig. 5]. The data logger records raw data such as ECG, respiratory parameters, accelerations in all three spatial axes and the temperature. Subsequently, the software calculates a number of further physiological data such as heart rate, heart rate variability (LF/HF and RMSSD) and the respiratory rate.

Via Google Earth the flight path can be depicted in a 3-dimensional image to which the physiological data can be allocated [Fig. 8]. In addition, and by using another software, the measured parameters can be assigned to special flight phases (i.e. takeoff, normal flight and landing) and, similar to a multichannel chart recorder, displayed and compared [Fig. 7].

Fig. 4: Chest belt with the data logger on the RH side of thorax.

Fig. 5: Chest belts with integrated electrodes for ECG and thorax impedance recordings.

Results

Altogether 29 flights across Germany (10), France (8), and Namibia (11) with a total of 110 flight hours could be analyzed. 12 out of 29 flights were longer than 5 hours, 7 flights were shorter than 1 hour. The average altitude exceeded 3000 m in 12 flights; it was below 1000 m in two flights.

I. COMPARISON OF SINGLE FLIGHT PHASES

A comparison of single flight phases revealed that the highest values were reached during takeoff (99.3 + 16.31 bpm). During normal flight, HR decreased significantly (89.0 + 12.81 bpm) and increased again during the landing phase (90.67 + 14.20 bpm). The respiratory rate behaved similarly.

Mean HR for all flights was 90.19 + 12.98 bpm (max. 153 bpm, min 56 bpm).
Inflight LF/HF ratios were higher than the standard values derived from literature indicating an increased sympathetic tone in pilots. In contrast, the root mean square of successive differences (RMSSD) tended to rise with increasing flight duration, arguing for an incremental parasympathetic influence.

Results continued

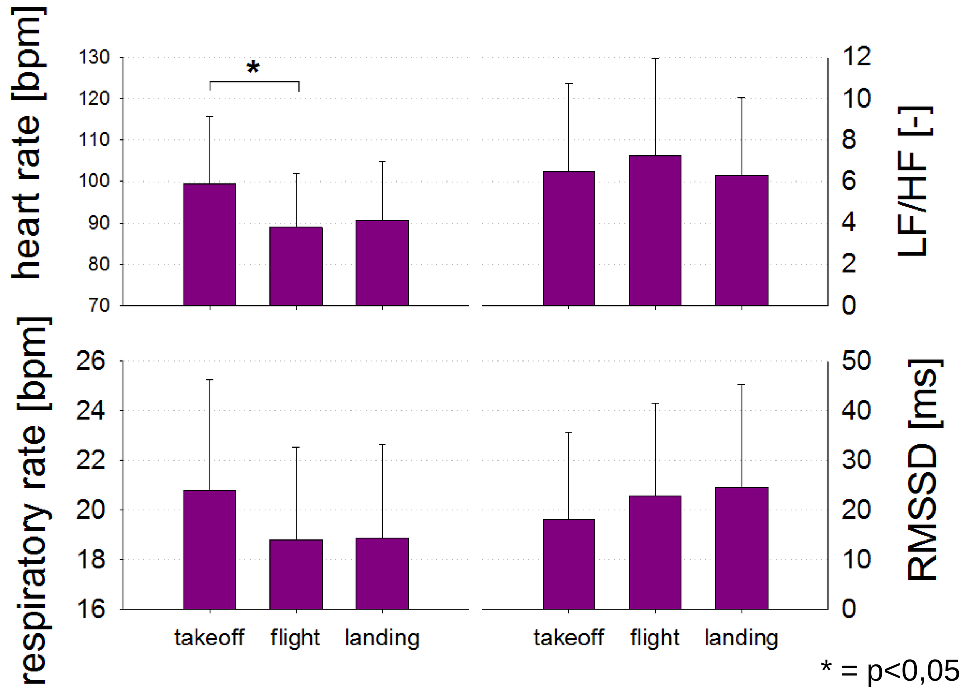

Fig. 6: Behavior of heart rate, respiratory rate and selected parameters of heart rate variability (LF/HF-ratio, RMSSD) in different flight phases.

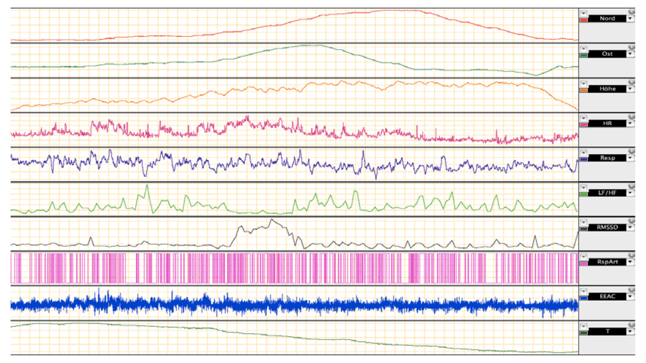

Fig. 7: Example for a display of the recorded data versus time.

II. THE INFLUENCE OF ALTITUDE

In flights above 3000 m (n = 12) HR was significantly lower than in flights below 1500 m (n = 6).
This was likely due to the decelerating (bradycardic) action resulting from oxygen supplementation in high-altitude flights. This, however, has to be proved by enhancing the number of flights.

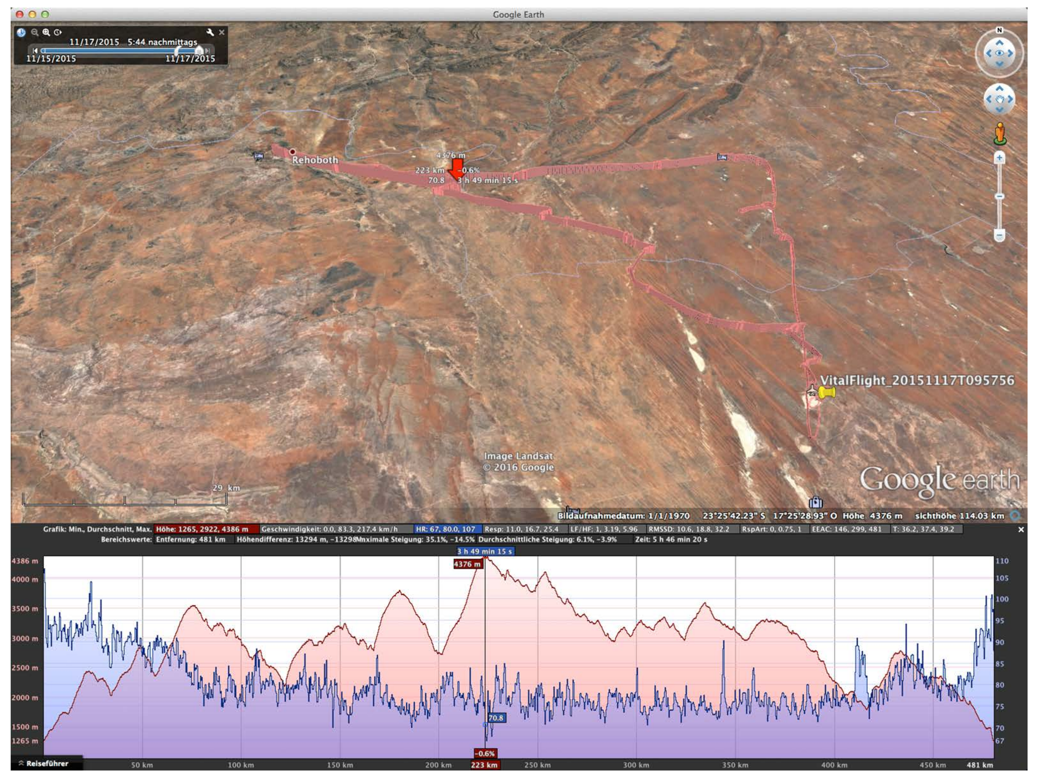

Fig. 8: Example for a flight in Namibia with display of flight path, flight altitude and the behaviour of heart rate during the flight.

Discussion

In conclusion, the measuring technique proved to be user-friendly and easy to operate. Even during long flights the data recorded were plausible with only a few artefacts.
The system should be completed by sensors enabling a detection of possible inflight oxygen deficiencies.

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