Sky-Sailor Solar Powered Airplane
Proved Continuous Flight

The Sky-Sailor, an unmanned solar airplane prototype built at ETH Zürich, just proved the feasibility of solar flight at constant altitude. On the 20th of June 2008 at 12h33, the 3.2 meters airplane took off from the MG Zugerland airfield in Niederwil, Switzerland. During the afternoon, the half square meter of solar cells gave enough energy to power the motor and at the same time completely charge the battery, while the airplane was following a circular trajectory at 200m above ground. The night proved to be quite windy which required more power than expected. This flight phase from dusk till dawn was particularly critical as the only source of energy was the battery that slowly discharged. In the early morning at 6h10, the solar panels started progressively to supply power again. The battery, which still had 5.8% capacity, started a new charge cycle. At 15h35 on Saturday 21st, it was completely full, which demonstrated an onboard energy higher than 24h before, proving thus continuous flight using solar energy only. The airplane landed some minutes later after a flight of more than 27 hours. With an average speed of 32.2 km/h, it covered more than 874 kilometers what represents more than the distance from Zurich to London.

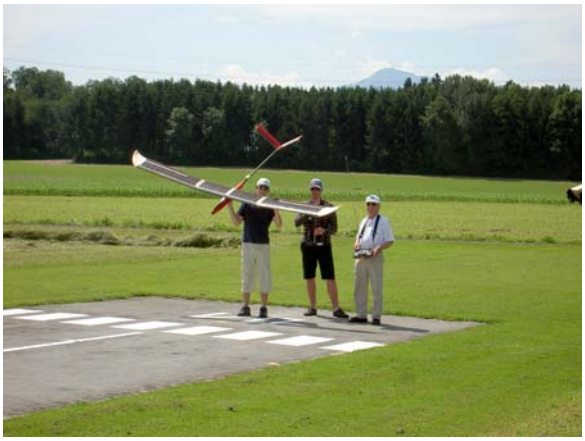
With the exception of launching and landing, the airplane was flown completely automatically using an autopilot developed at ETHZ specifically to be lightweight and low power consumption. The data of the GPS, the pressure sensors and the inertial measurement unit were processed by the onboard microcontroller that then sent orders to the ailerons, the rudder, the elevator and the motor to keep following the trajectory. On the ground, a control station allowed to continuously monitor the airplane status with the data sent five times per second. The interface contained a 3D representation of the airframe on the region map, with flight instruments showing speed, altitude, heading, etc. but also a clear view of the energy exchanges between the solar panels, the battery and the motor.

The main challenge lies in the design and the sizing optimization of the various elements that have to be extremely lightweight and efficient, and consume extremely low power for what concerns the electronics. The airframe, made of composite materials, was realized by Walter Engel, a world expert in ultra-light model airplane construction. Flexible silicon solar cells cover the wing and supply a maximum power of 90W to the brushless motor that needs under calm conditions only 14W to 15W for level flight. The surplus is then used to charge the lithium-ion battery. Thus, the efficiencies all along this energy chain, from the solar panels to the propeller have to be as high as possible.

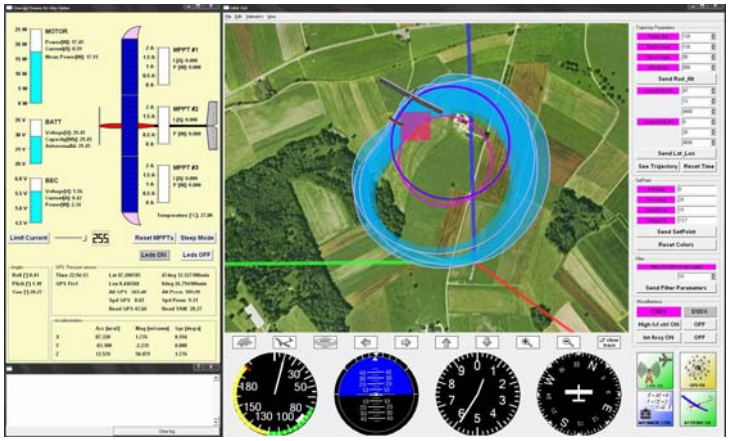
The History of solar aviation started already 34 years ago, but with airplanes able to fly only during a very short time around noon. Then with improvements in key technologies like solar cells, energy storage, motors and electronics, the performances increased constantly. The objective to fly 24h using only solar energy was achieved in 2005 in

California by the 4.75 meters wingspan Solong airplane that used not only solar panels energy but also warm updrafts to gain altitude. In 2007, the 18 meters British prototype Zephyr also showed continuous flight at high altitude in New Mexico. Sky-Sailor is the first to demonstrate this ability with a wingspan of less than 4 meters at a constant altitude. A complete history of solar flight is available at: http://sky-sailor.epfl.ch/docs/History.pdf

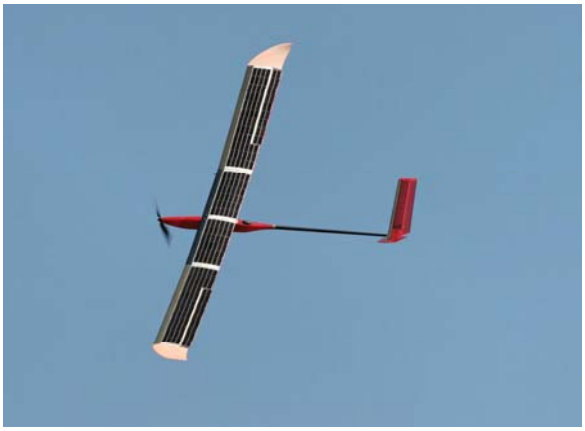
The Sky-Sailor solar airplane project started within the framework of a study for the European Space Agency to evaluate the feasibility of continuous solar flight on Mars. A first step was the realization of such flight on Earth with a demonstrator prototype. That became the subject of the Phd Thesis of André Noth, member of the Sky-Sailor project team in the Autonomous Systems Lab of EPFL that moved to ETHZ in 2006. The thesis, which will be presented in October 2008, tackles the problems of solar airplane design, presenting a new design methodology that is valid for micro air vehicles of less than 1m wingspan to manned airplanes of 80 m wingspan. Such long endurance autonomous vehicle can have also numerous applications on our planet, like traffic monitoring, border surveillance, forest fire fighting or power line inspection.



The airplane ready for the launch



The graphical user interface



The Sky-Sailor in flight

Pictures available on http://sky-sailor.epfl.ch
➔ Media ➔ Pictures

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Technical specifications

Flight

Launch	Friday, 20th of June 2008, 12h33m29s
Landing	Saturday, 21st of June 2008, 15h39m01s
Flight time	27h05m32s
Distance covered	874.4 km
Nominal flight speed	32.3 km/h (8.97 m/s)

Airplane

Wingspan	3.2 m
Take-off mass	2.416 kg
Wing area	0.776 m^2
Configuration	3 axis V-Tail motorized glider
Materials	Carbon, Aramide, Balsa
Nominal flight speed	30.2 km/h (8.4 m/s)

Battery

Type	Lithium-Ion (Panasonic NCR18650)
Capacity	253 Wh
Min/Max Voltage	24 V / 33.7 V
Mass	1.056 kg

Propulsion group

Motor	Brushless (LRK Strecker 228,10; 44Wdg; 0,37; 16 Mag; 440t/V)
Propeller	Solariane carbone prop (Prof. Schoeberl)
Controller	Jeti Advance 45 Plus
Reduction gearbox ratio	9:1
Min Electrical Power for level flight (calm atmospheric conditions)	14-15 W
Max Electrical Power (for hand launch)	120 W

Solar Panels

Cell type	RWE-S-32 Thin Silicon Cells
Number of cells	216
Max Power	~ 90 W