Quieter approaches, analysis of ice clouds and landings on celestial bodies – DLR at ILA 2014

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At the 2014 Berlin Air Show (Internationale Luft- und Raumfahrtausstellung; ILA), the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) is showcasing its research results for the aerospace of tomorrow with more than 60 exhibits on the DLR stand (Hall 4), in the Space Pavilion and in the Career Center. DLR's research aircraft and helicopters will be on show in the outdoor display area.

The 'Knowledge for tomorrow' theme is about application-oriented fundamental research. The focus of this research work is on more sustainable flying, exploring new worlds in space as well as developing new ideas for wind energy originating from aeronautics research. "At ILA, we are showing that DLR works in an interdisciplinary way to derive new solutions for societal issues," said Johann-Dietrich Wörner, Chairman of the DLR Executive Board. "As the nation’s leading trade fair with a high international reputation, ILA offers the opportunity to demonstrate this and to find new partners for our work. It is important, especially today, that science and research contribute across all boundaries."

Here is a selection of the research projects to be showcased at ILA; further information on DLR's presence at ILA can be found on the DLR special website.

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Ice clouds as a climate factor – HALO research aircraft investigates condensation trails and cirrus clouds

Open questions on the formation and climate impact of clouds currently restrict the predictive power of global climate forecasts. In order to investigate in detail the climate effects of natural ice clouds, known as cirrus clouds, and the condensation trails generated by air transport, the HALO research aircraft carried out a total of 12 flights as part of the ML-CIRRUS (Mid-Latitude Cirrus) mission in March and April 2014. Under the leadership of DLR, a team of around 100 scientists from various atmospheric research institutes investigated the formation, life cycle and climate effects of naturally occurring and condensation trail cirrus clouds at altitudes of between eight and 14 kilometres above Europe and the North Atlantic. One of the most modern cloud instrumentation systems anywhere in the world was used in the process. During their investigations, the scientists paid special attention to the long-lasting condensation trail cirrus clouds created by air transport. To what extent the properties of these artificial clouds differ from natural cirrus clouds remains unexplained until now. Recent findings indicate that the warming due to condensation trail cirrus clouds may be greater than that due to carbon dioxide emission from air traffic. Locally, there are massive differences. Extensive HALO mission measurement data are currently being evaluated and should help to eliminate existing uncertainties in the understanding of the climate effects of condensation trail cirrus clouds.

HINVA – comprehensive research for slower approaches

Slower approaches mean that shorter runways can be used. They also cause less noise. How slowly and steeply a present-day commercial aircraft can approach its destination is determined by its high-lift system with its extendible leading-edge slats and flaps on the wings. Together with Airbus and European Transonic Wind Tunnel (ETW), DLR is carrying out research to significantly improve predictions of high-lift performance, thus facilitating slower approaches in the future. In 2012 at Airbus in Toulouse, researchers from the HINVA (High Lift Inflight Validation) project, together with the Technical University of Berlin, successfully conducted flight

trials of stalling in the low-speed flight envelope using DLR's A320-ATRA. At the start of 2014, cryogenic wind tunnel trials followed in the Cologne-based ETW with a purpose-built high-precision ATRA wind tunnel model and using advanced wind tunnel measuring technology. In simulating the complex aerodynamic processes that occur at maximum lift, DLR has already been able to make significant progress with the largest data centre for aviation research in Europe (C²A²S²E, Centre for Computer Applications in Aerospace Science and Engineering) and the DLR high-performance code known as TAU. For the first time ever, DLR is combining high-lift research computer simulations with flight and wind tunnel tests, where the Airbus A320-200 with extended landing flaps serves as the target configuration under real flight conditions. Further, more extensive ATRA research flights are planned in the low-speed flight envelope for autumn 2014.

Emissions from biofuels – joint research flights with NASA

Biofuels offer potential for reducing the carbon dioxide footprint of aviation and also to reduce the potential unfavourable climate effects of particulate emissions and condensation trails. The US aeronautics and space agency NASA and the German Aerospace Center (DLR), together with the Canadian National Research Council (NRC) conducted two weeks of joint flight trials in May 2014. A NASA DC-8 flew at altitudes of between nine and 12 kilometres, a typical cruise flight level, using a varying biofuel-kerosene mixture. The DLR Falcon and a NASA Falcon measured the jet engine emissions as well as the effects thereof on the formation and properties of condensation trails. In addition, NRC's T-33 examined the dynamics of the DC-8 wake. NASA led the flight campaign as part of Project ACCESS II (Alternative Fuel Effects on Contrails and Cruise Emissions); the project has more than 100 participating scientists and technicians. The starting point for the joint research flights was NASA’s Armstrong Flight Research Center in Palmdale, California.

TanDEM-X – a new topography of Earth

For more than three and a half years, two radar satellites, TerraSAR-X and TanDEM-X, have been circling Earth in close formation, capturing data for a new global topography. In order to create a Digital Elevation Model (DEM) of unprecedented accuracy, the satellites have already captured Earth's surface twice in the period up to summer 2013. Since then, they have been flying in a different formation to capture particularly difficult areas such as steep mountains from a new 'perspective'. Data for a fifth of the global land surface has already been processed into DEMs; this includes areas in Australia, North America, Russia and Africa. Upon completion of the third and fourth image acquisitions over mountainous terrain, the first elevation models of areas like the Kamchatka Peninsula have also been created. The huge volumes of data will be processed into an elevation model of the Earth by the end of 2015. The next mission for measuring the Earth is currently being evaluated in a study. For the Tandem-L mission, the radar satellites would have digital antennas and large deployable reflectors. With imaging and mapping of Earth's surface occurring 100 times faster, dynamic processes on the Earth could then also be captured.

MASCOT – final preparations for a flight to an asteroid

When, in December 2014, the Japanese spacecraft Hayabusa 2 takes off for asteroid 1999 JU3, the asteroid lander MASCOT (Mobile Asteroid Surface Scout) is also flying into space. While the Hayabusa spacecraft is to bring samples of the asteroid material back to Earth, MASCOT, which is being developed and built by DLR, will land on the asteroid surface and investigate it with four on-board instruments. The DLR radiometer will measure temperature, the magnetometer provided by the Technical University of Braunschweig will examine the magnetisation of the rock, and the spectrometer developed by the French space agency CNES will analyse the minerals and rocks that make up the asteroid. The DLR camera, the fourth instrument, will image the fine structure of the surface, thus making it possible for scientists to determine the size and shape of the particles on the asteroid surface and to map the surroundings of the landing site. Currently, the flight model of MASCOT is completing its final tests at DLR Bremen, before it is sent to Japan for installation on the Hayabusa 2 spacecraft. Since MASCOT lander has a 'hopping mechanism', measurements will be taken at several sites on the asteroid.

Rosetta and Philae – first landing on a comet

For 10 years, the Rosetta spacecraft and its lander, Philae, which was developed and built under the leadership of DLR, have been travelling to their destination, the comet 67P/ Churyumov-Gerasimenko. Both craft have awoken from hibernation, which they entered for part of their voyage to conserve energy, and have passed their 'health check'. The ESA mission will

reach a milestone with the arrival at the comet in August 2014 and the landing of Philae in November 2014. For the first time, a spacecraft will follow a comet along its orbit and, also for the first time, a lander will touch down on the surface of a comet to take measurements. The orbiter and lander are carrying a total of 21 instruments, including cameras, drills and spectrometers, which will examine the comet as it becomes increasingly active and outgasses on its flight towards the Sun. Since comets are made of primordial materials, 67P/Churyumov-Gerasimenko could help planetary researchers better understand the origin of the Solar System by providing a snapshot of the past.

Commercialisation and technology transfer

In addition to the future of the ISS, the future of the European Ariane 5 launcher will also be on the agenda of the next ESA ministerial conference, which will take place on 2 December 2014 in Luxembourg. From a German perspective, the development of the Ariane 5 is the most technically feasible and economically viable option in the medium term. In addition, DLR is responsible, in its role as the national space agency, for the implementation of German spaceflight activities and the German space programme. Here, it is particularly concerned with commercialisation, practical application and technology transfer; space is indispensable for the people on Earth, but must be faster and less costly. DLR is supporting the interface between basic research and commercial organisations with, for example, the INNOspace initiative, launched in 2013. Also interesting are what are refreered to as 'downstream markets' – industries that use data obtained or transmitted by satellites. The commercial market is by far the most successful in satellite communications (satellite television and broadcasting). In 2015, a second edition of the robotics competition 'Space Bot Cup' will be held. The focus will be on mobile exploration robots. The call for this competition will be in June 2014.

Kerosene from solar energy

In the SOLAR-JET (Solar chemical reactor demonstration and Optimization for Long-term Availability of Renewable JET fuel) project, an international research group managed to produce kerosene from sunlight, water and carbon dioxide for the first time in April 2014. Alternative biofuels can thus be produced from resources of which there is an almost unlimited supply. In future, they will be able to play an important part in the sustainability of and secure supply of fuel for air transport, which is likely to continue growing. The solar reactor developed by ETH-Zürich is on show at ILA 2014 on the DLR stand. It contains an absorber made from a metal-oxide-ceramic that can split water and carbon dioxide. This reduction is brought about by concentrated solar radiation and releases oxygen at 1500 degrees Celsius. In a subsequent reaction, the metal oxide of the reactor binds the oxygen so that a mixture of water and carbon monoxide is created. This is then transformed into kerosene using the Fischer-Tropsch process. To optimise the solar reactor, DLR researchers have simulated the process steps using a computer. In doing so, they were able to draw on experience in developing alternative fuels for the aviation sector. In the EU-funded SOLAR-JET project, DLR, ETH-Zürich, Bauhaus Luftfahrt, Shell Global Solutions and ARTTIC are working together.

Safe designer fuel for aviation

In addition to kerosene made from solar energy, which already meets all the specifications of today’s standard Jet A-1 aircraft fuel because the final production step uses the Fischer-Tropsch process, DLR is also researching a ‘designer fuel’ for aviation. This fuel is technically superior to kerosene and emits fewer pollutants into the particularly sensitive upper layers of the atmosphere during combustion. In their test facilities, DLR researchers are able to directly analyse the combustion of alternative fuels in the combustion chamber and prepare them for use in aviation. Among other things, the behaviour of the flame in the mixture comprising air and fuel in the combustion chamber and the stability of the combustion process is examined. These research findings are also important for innovations in the gas turbines of large power stations. An exhibit on the DLR stand at ILA allows viewing into the combustion chamber and illustrates how the researchers can analyse combustion in aircraft or power station turbines using optical measuring technology and computer simulations.

New ideas for wind turbines

In a helicopter, lift is generated by airflow over the rotor blades, a process which is well known to aeronautics researchers. These physical effects also work in reverse, when airflow drives a wind turbine to produce power. DLR researchers are transferring expertise from aeronautics research to wind turbines to develop new ideas for optimisation. Intelligent rotor blades, which adjust their shape to the wind speed, and lighter components, where the mass is reduced by using stiffening elements to retain stability, are approaches that DLR wishes to adopt to make

wind turbines more efficient. Functional elements integrated into the rotor blade can be equipped with a local power source for measurement probes. In its stand at ILA, DLR is showing a profile-section of a wind turbine rotor blade at a scale of 1:2, showing how rotor blades could become more advanced.

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Part of the DLR stand at the ILA Berlin Air Show 2014

At the ILA 2014 Berlin Air Show, the German Aerospace Center (DLR) is showing it aerospace research results with more than 60 exhibits on the DLR stand (Hall 4), in the Space Pavilion and the Career Center, and on the BMWi (German Federal Ministry for Economic Affairs and Energy) stand.

DLR ATRA research aircraft

The DLR Advanced Technology Research Aircraft (ATRA) research aircraft, an Airbus A320-232, at the 2014 ILA Berlin Air Show.

Credit: DLR (CC-BY 3.0).

DLR Falcon at the ILA Berlin Air Show after a research flight campaign with NASA

The DLR Falcon 20 E at the ILA Berlin Air Show after returning from a research flight campaign conducted at the NASA Armstrong Flight Research Center in Palmdale, California.

Credit: DLR (CC-BY 3.0).

The HALO research aircraft studied condensation trails and cirrus clouds

In March and April 2014, the HALO research aircraft studied the climate effects of condensation trails and cirrus clouds.

Credit: DLR (CC-BY 3.0).

Exhaust measurements in formation flight

Behind the DC-8, the scientists on board the DLR Falcon measured the exhaust gas composition.

Credit: NASA.

Philae landing on comet

Artist’s impression of the Rosetta orbiter deploying the Philae lander to comet 67P/Churyumov–Gerasimenko (not to scale).

Credit: ESA–C. Carreau/ATG medialab.

MASCOT – preparations for flight

The MASCOT asteroid lander, developed by the German Aerospace Center (DLR), is scheduled to launch in December 2014 on board the Japanese Hayabusa 2 spacecraft.

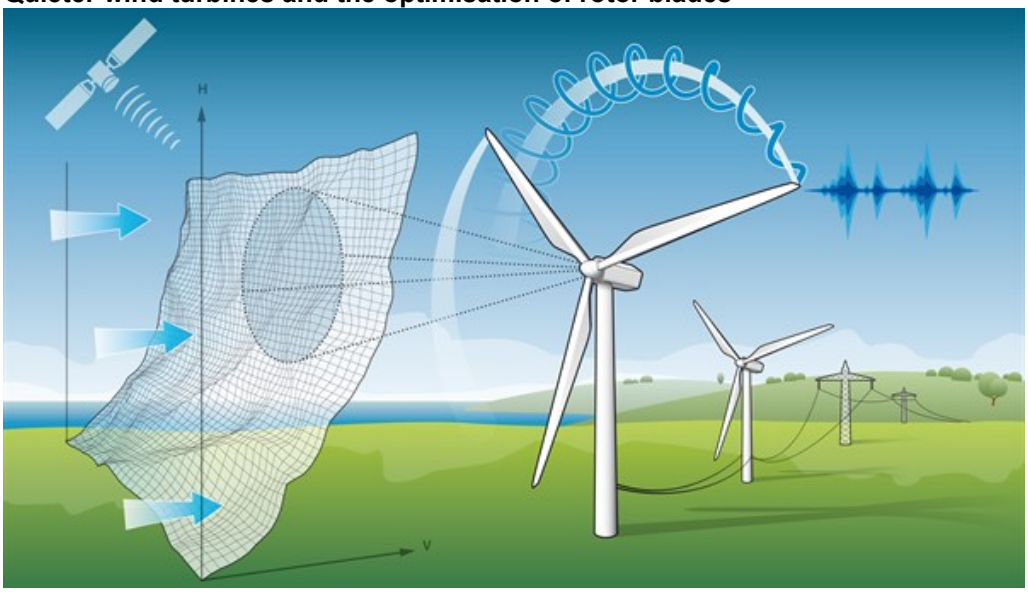
Credit: DLR (CC-BY 3.0).

SOLAR-JET: Kerosene from solar energy

An international group of researchers has succeeded in producing the world's first jet fuel from sunlight, water and carbon dioxide.

Credit: ETH-Zürich.

Quieter wind turbines and the optimisation of rotor blades



The Lower Saxony Ministry of Science and Culture is promoting the development of a research wind farm in Lower Saxony at the German Aerospace Center (DLR) with 10 million euros. DLR scientists want to develop quieter wind turbines and optimise rotor blade designs. In addition, precise wind forecasts using satellite data and lidar measurements will allow better system control.

Credit: DLR (CC-BY 3.0).

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