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Autonomous Aerial Sensors for Wind Power Meteorology

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This poster describes a new approach for measurements in wind power meteorology using small unmanned flying platforms. Large-scale wind farms, especially offshore, need an optimisation between installed wind power density and the losses in the wind farm due to wake effects between the turbines. Good measurements of the wake and wake structure are not easy to come by, especially offshore, as the use of a met mast is static and expensive, while the use of remote sensing instruments either needs significant access to the turbine to mount an instrument, or is complicated to use on a ship due to the ship's own movement. In any case, a good LIDAR or SODAR will cost many ten thousands of euros. Another current problem in wind energy is the coming generation of wind turbines in the 10-12MW class, with tip heights of over 200m. Very few measurement masts exist to verify our knowledge of atmospheric physics, and most of them are situated in quite homogeneous and gentle terrain. Here, automated Unmanned Aerial Vehicles (UAVs) could be used as either an extension of current masts or to build a network of very high 'masts' in a region of complex terrain or coastal flow conditions. In comparison to a multitude of masts, UAVs could be quite cost-effective.
In order to test this assumption and to test the limits of UAVs for wind power meteorology, this project assembles four different UAVs from four participating groups. Risø has built a lighter-than-air kite with a long tether, Bergen University flies a derivative of the Funjet, a pusher airplane of 580g total weight, now equipped with a Pitot tube, Tübingen University in conjunction with the Technical University of Braunschweig flies the Carolo, a 2m wide two prop model with a 5-hole pitot tube on the nose, and Aalborg University will use a helicopter for their part. The real-time instrumentation package built by DELTA provides high resolution data logging of turbulence, pressure, and temperature parameters which are geo-tagged (3D) with better than 10 cm accuracy using dual frequency differential GPS, which also provides precision time stamping (accurate to 100 ns) of all measurement channels on each of the parallel airborne measurement systems.
All those platforms will be flown during one week at the Danish national test station for large wind turbines at Høvsøre. The site is strongly instrumented, with 6 masts reaching up to 167m. The comparison of wind speed measurements from planes and fixed masts should give an indication of the accuracy of the measured wind field. A workshop was held as preparation, where several groups came with interesting input.