A New Toolset for Passive Monitoring of Air Traffic and Sky Conditions at Metsähovi Station, Finland

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Astract. *Metsähovi Geodetic Reasearch Station in Southern Finland is located near the Helsinki International Airport. Some of the flight patterns to the airport enter directly to Metsähovi airspace. Robust solutions for airplane laser safety are called for. The new Metsähovi SLR system (first light due 2015) is located a few hundred meters from Metsähovi VLBI antenna and therefore active radio frequency based methods for aircraft detection (i.e., radar) are not allowed. To address the airplane safety issue and to provide the SLR operator with a tool for monitoring the observing conditions, several auxialiary sensors/systems have been obtained for Metsähovi. Here we introduce the systems and how we have integrated them into a tool for the observer.*

AirNav RadarBox 3D

In 2013 we acquired an AirNav RadarBox 3D Mode-S/ADS-B receiver which we use to track commercial air traffic over Southern Finland in real time. RadarBox provides real-time 3D position information for airplanes that transmit Mode-S/ADS-B data. The receiver comes with it's own GUI, but the data is also provided in XML format for use in other applications. In Metsähovi system the XML data is read by a program written in Python. The positions of the aircraft are transformed into Metsähovi-centric co-ordinates and plotted into an image obtained with an allsky camera. We also routinely store the daily aircraft tracks for, e.g., studying how crowded the airspace over Metsähovi is.

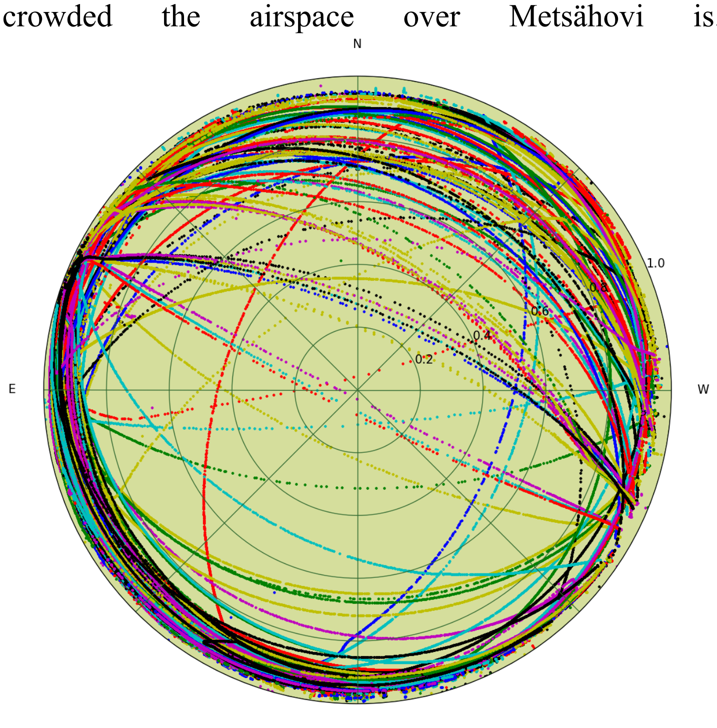

Figure 1. All airplane tracks observed at Metsähovi during June 1st 2014. The plot is a polar plot where local zenith is at the center of the plot. Most of the planes fly at apparent low altitudes, but several cross also the zenith. As the ADS-B data is sent at 2 Hz rate, there appears to be gaps in the data especially near the zenith where the apparent speed of the airplanes is the greatest.

Alcor System OMEA All Sky Camera

Also in 2013 we acquired an Alcor System OMEA all-sky camera that can provide correctly exposed 2 Mpix 185°x185° fish-eye color images both day and night, i.e., it has an adjustable aperture. The camera also has a heater that keeps the dome clear of snow and rainwater. The images taken by the camera can, especially during the day, be used to identify satellites that are not in clouded regions of the sky nor (with the aid of overlaid Airnav Radarbox data) close to airplanes. The telescope pointing direction and satellite tracks from the latest CPF files are plotted to the all-sky image with the help of a custom written Python program (see Fig 3.).

Boltwood Cloud Sensor II

We acquired a Boltwood Cloud Sensor II for monitoring the sky conditions in Metsähovi. The unit measures several meteorological parameters (wind speed, rain, humidity, etc.). The main measurement is the sky temperature vs. ambient temperature that is used for cloudiness index determination. Sky temperature is measured with a wide field-of-view bolometer. These measurements provide the operator a clear view of the current sky conditions. Cloudiness index is especially useful for night time operations, where the cloud situation is not readily seen from the all-sky image. When weather conditions are adverse to SLR operations, the operator can concentrate on other tasks, while being immediately alerted when the weather improves. The cloud sensor is currently also used to provide weekly and monthly weather statistics for Metsähovi.

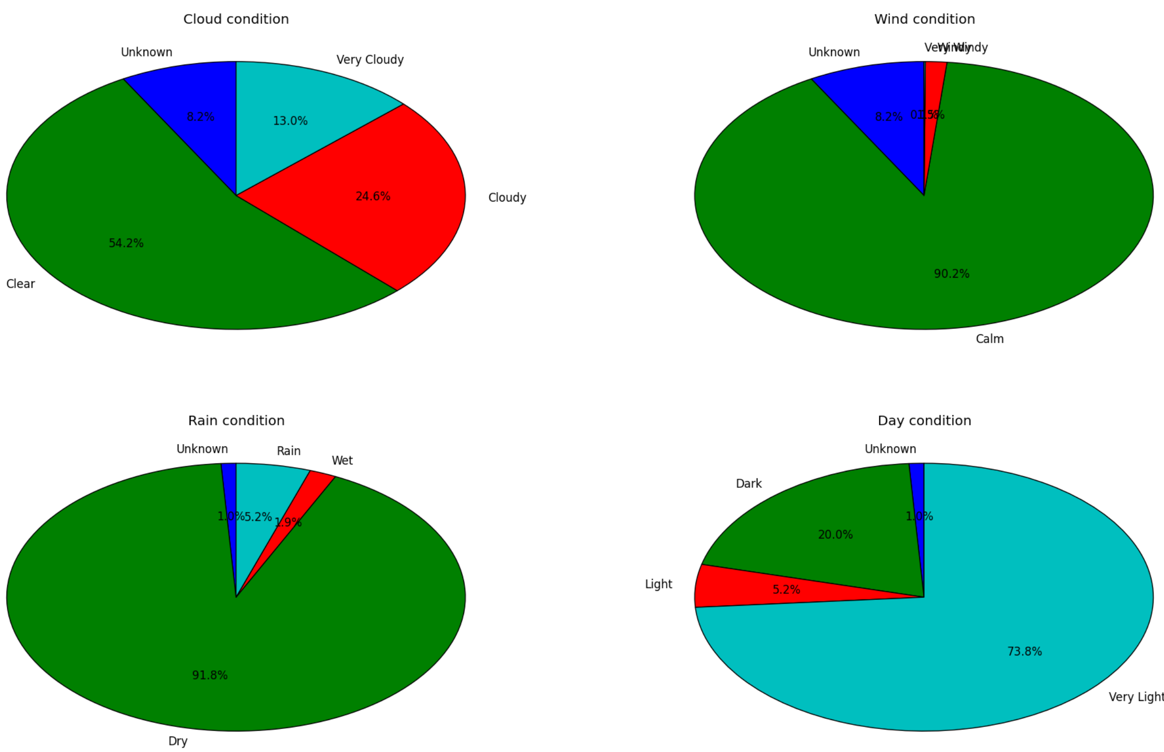

Figure 2. Weather conditions in Metsähovi during the summer of 2014 (15th May-14th August). Boltwood Cloud Sensor categorizes the conditions in five categories. Category "unknown" is mainly used in heavy rain that makes the use of, e.g., the bolometer impossible.

Python-based tool

To provide a single tool for the operator, we have developed a Python-based program which plots the airplane positions and directions to an all-sky image obtained with the OMEA camera. In addition to the airplane positions, also the tracks and positions of satellites over the Metsähovi horizon and the telescope pointing direction are plotted to the all-sky image. An alarm is rung if an aircraft is within a user-defined distance from the pointing direction of the telescope. As the all-sky image is semi-realtime (exposure time limited by the lighting conditions), this tool can also be used to identify satellites that are in cloud-free parts of the sky.

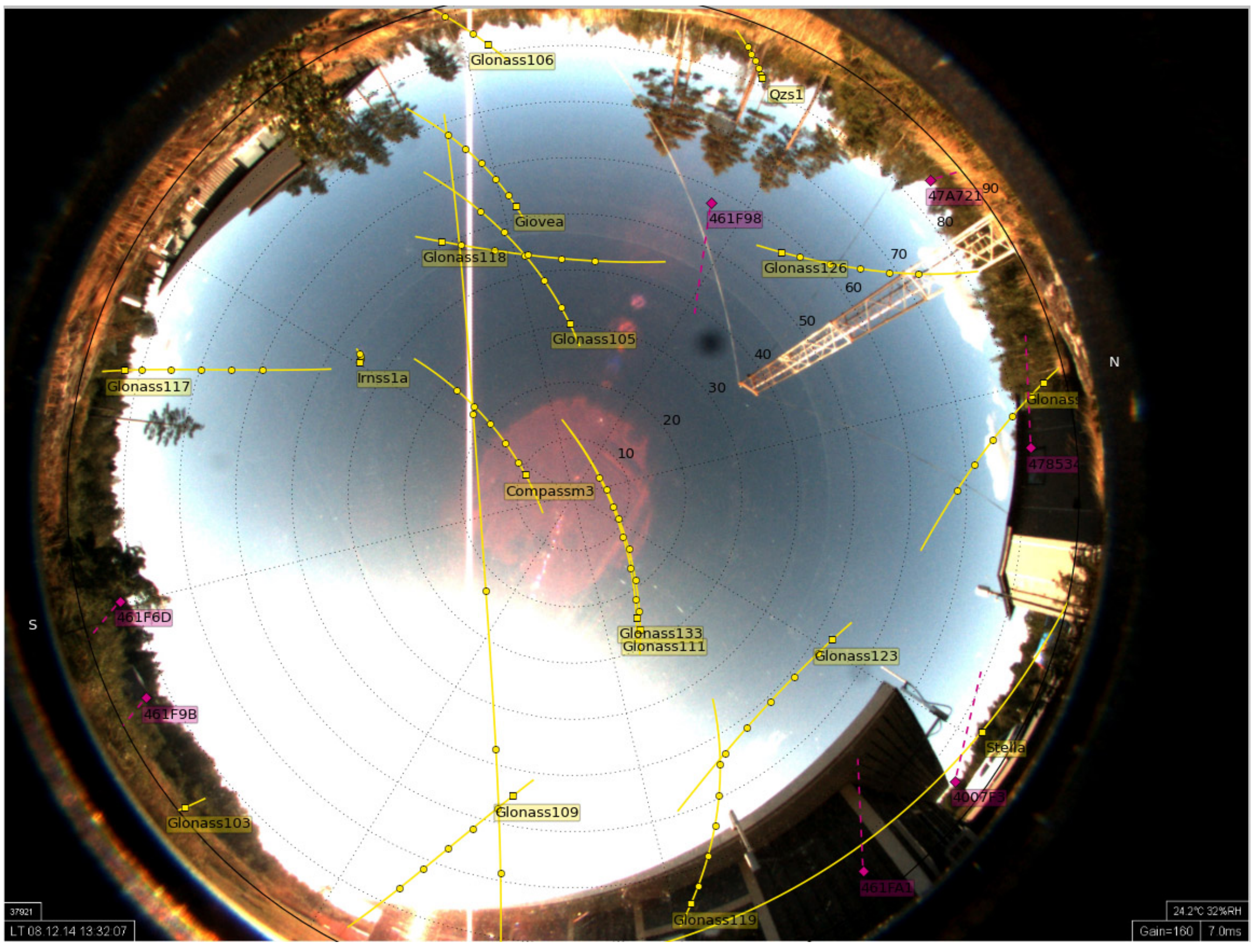

Figure 3. An example screenshot of an all-sky image overlaid with satellite and airplane position and direction data.

Conclusions and future work

Most likely, no single passive system can achieve SLR airplane safety alone and several complementary systems are required. E.g., an ADS-B receiver can only provide information about airplanes that transmit ADS-B data. Small airplanes, helicopters, hot air balloon, military airplanes, etc. currently do not send ADS-B data in Finland and further methods need to be explored to make the SLR system safe for them as well.