An improved toolset for aircraft safety and sky condition monitoring at Metsähovi SLR - station

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INTRODUCTION

The SLR station at the Metsähovi Fundamental Geodetic Research Station in Southern Finland is located near the Helsinki International Airport and another small airport for recreational aircrafts. Use of an active radar is prohibited at the premises due to an astronomical radio telescope near the SLR and a new VGOS system which will be built 100 meters from the SLR. We use two independent ADS-B receivers for air traffic monitoring: Kinetic SBS-3 and AirNav RadarBox. In addition we have developed a visual aid tool for the operator by using a realtime allsky-image of Metsähovi sky, ADS-B information, and satellite orbit information to give the operator a good picture of the current observing conditions, e.g., which satellites are visible in cloud-free areas of the sky. For crude cloudiness index we use Boltwood II CloudSensor which shows good relation with the cloudiness index derived from MODIS data. In this presentation we show the current developments at Metsähovi SLR station for aircraft safety and for optimizing operations.

AIRCRAFT SAFETY

- **ADS-B**

Metsähovi is under the Terminal Control Area (TMA) of the Helsinki International Airport and hence all airtraffic above Metsähovi should use ADS-B transmitters.

We use two independent ADS-B receivers: Kinetic SBS-3 and AirNav Radarbox. In the current setup we have discovered that Airnav has much larger area coverage and we see much more aircrafts with the AirNav. However, the problem is probably due to poorer antenna and installation place of the Kinetic.

- **Tracking camera**

On top of the telescope we have installed a sensitive surveillance camera with a zoom lens with FOV of 4-40deg

- **Directional microphone**

For hearing helicopters and low flying small planes

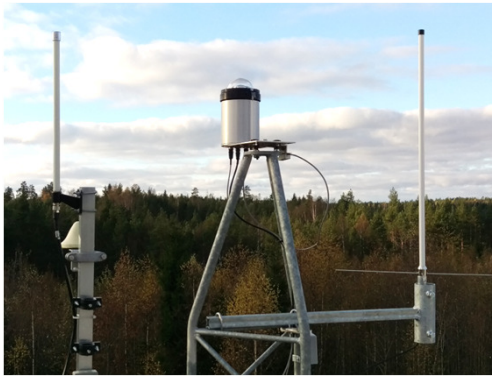

Figure 1. Top of 6m mast with Airnav ADS-B antenna on the left, Omea all sky camera in the middle and the Kinetic ADS-B antenna on the right.

SKY CONDITION MONITOR

We have developed a visual tool for the operator to help on planning the observations. The software, written in Python, displays a full-sky camera image, overlaid with aircrafts currently within a given distance, the positions and sky tracks of selected satellites, and the telescope pointing direction. The satellite positions are computed with the PyEphem package from TLE elements that can be downloaded automatically. The aircraft locations are acquired with an AirNav Radarbox ADS-B receiver located on the same mast as the camera (Figure 1.). The telescope control computer provides the pointing information. The user can configure various parameters of the display, such as satellites to be shown and altitude and distance limits for the objects.

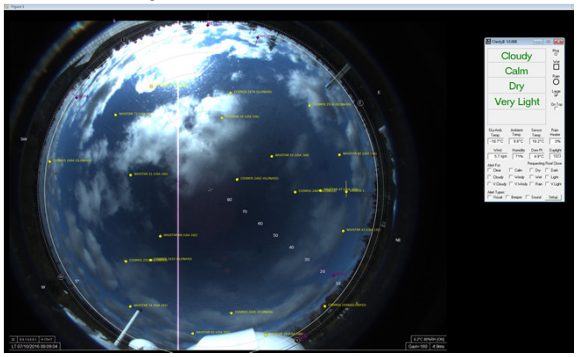

Figure 2. Screenshot showing the visual tool as well as the realtime measurements of the Boltwood II Cloudsensor. Aircraft data from ADS-B is shown in magenta, user defined satellites are shown in yellow, and magenta crosshair is the telescope pointing.

To monitor the sky conditions at Metsähovi we installed in 2014 a Boltwood II Cloudsensor. In addition to basic meteorological parameters it measures sky temperature vs. ambient temperature for cloudiness index determination. The unit has 3-4 step index for cloudiness: "Clear", "Cloudy", "Very Cloudy" and "Unknown" which occurs during rain. In Figure 3. we have plotted the monthly data between Feb 2014-Aug 2016. During daytime it overestimates the amount of clouds probably due to the thermal effect of the Sun.

These tools provide the operator a clear view of the current sky condition. In the future these information is also available remotely. 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 e.g., data processing, while being immediately alerted when the weather improves. The cloud sensor is also used to provide weekly and monthly weather statistics to help on future planning and scheduling of observations and maintenance breaks etc.

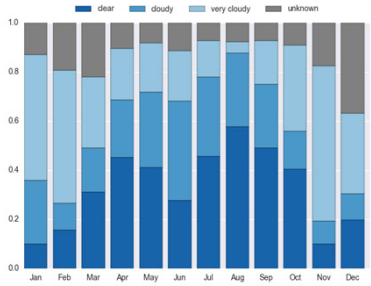

Figure 3. Monthly cloudiness index at Metsähovi based on the Boltwood data between Feb 2014 and Aug 2016. During rain the index is "unknown".

More information: http://www.fgi.fi/fgi/research/researchgroups/space-geodesy