Laurent Sauvage, senior scientific advisor, and
Etienne Buessler, marketing engineer. Reuniwatt

BEYOND the horizon

As remote management of airports becomes increasingly common, a new all-sky imager from **Reuniwatt** has the potential to help controllers address cloud hazards

FIGURE 1: Reuniwatt's Sky InSight imager operating near the runway at Geneva Airport (Photo: MeteoSwiss)

Air traffic has jumped from 1.5 to 4.3 billion passengers annually in the past 15 years, and will continue to grow, potentially reaching 16 billion in 2050, according to IATA. Airport safety issues will increase in proportion.

Within the framework of the European and American air traffic management modernization programs SESAR and NEXTGEN, several projects have been conducted over the past 15 years to develop remote management of airports.

Among the main aims driving the projects is the improvement of air traffic management related to aircraft trajectories, in the context of weather forecasts. Three aspects must be considered to achieve this. First, operational management must be optimized with real-time information (variability of air traffic, infrastructure availability, weather conditions and so on). Second, this information should be shared among the various partners at the airport. Finally, new tools are needed for air traffic control, including augmented weather condition information, which will be automated and visualized by remote operators.

Cloud hazards

To improve safety and operations in airports, meteorological phenomena must be taken into account. Precipitation, poor visibility and icy conditions are among the main watch points. Approaching convective cells are another major issue in air traffic management, causing delays and potential hazards for airplanes, passengers and onboard employees.

Cumulonimbus (CB) are giant clouds, with rapid vertical development. They are associated with violent and heavy showers, lightning, tornadoes, descending gusts and hail. This makes them extremely dangerous for aircraft, especially when they are in the final descent before landing, or when taking off.

Nowcasters are therefore looking for information that will provide them with the best possible knowledge of the entire convective cloud, including its temporal and spatial development.

Augmented 360° cloud vision

Reuniwatt's engineers looked at the way its sky imagers capture modifications in sky conditions. The company's Sky InSight, a thermal infrared sky imager, has the capacity to deliver accurate information on approaching clouds, with the same accuracy day and night.

Any cloud can be detected and characterized tens of kilometers away all around the infrared

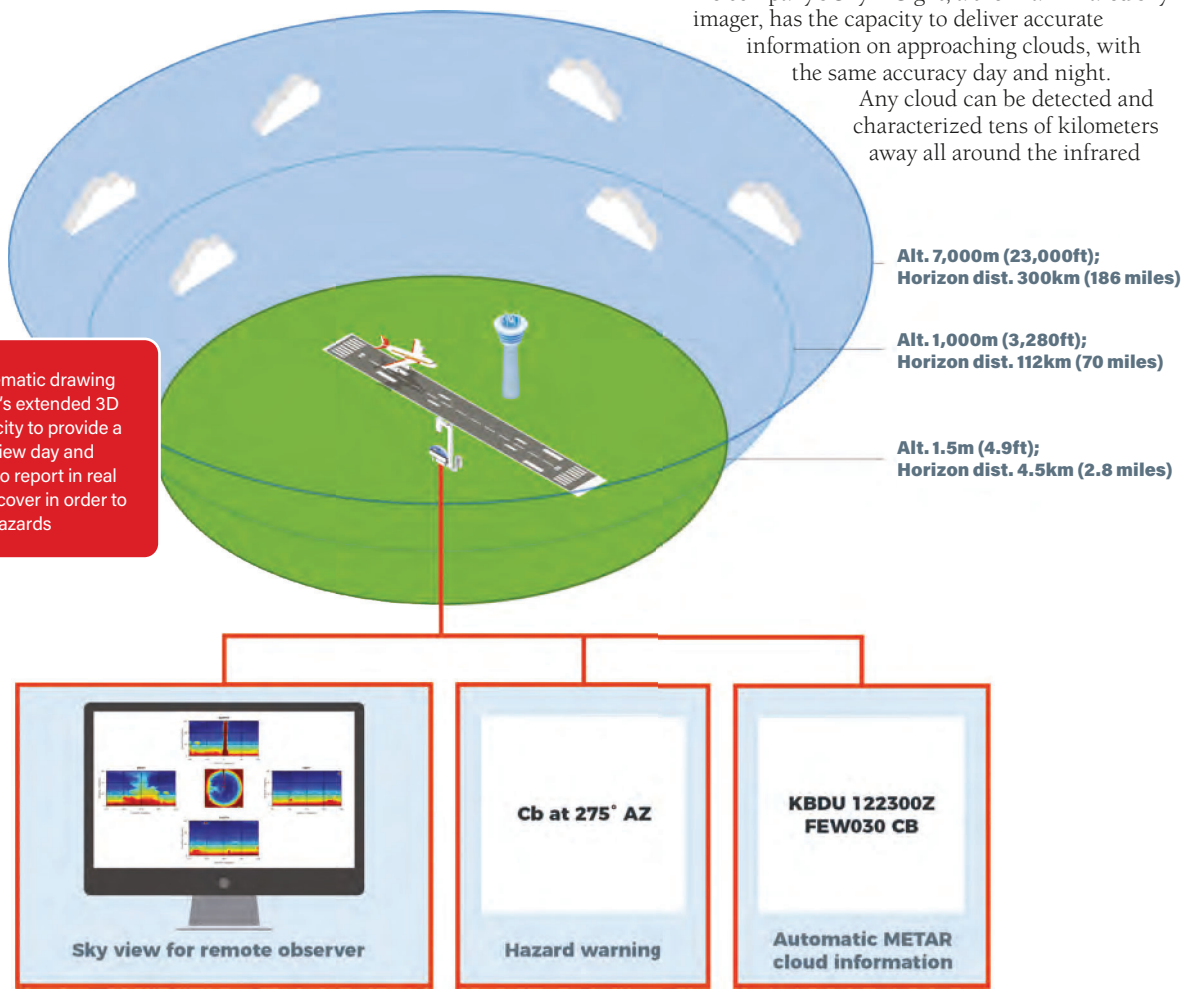
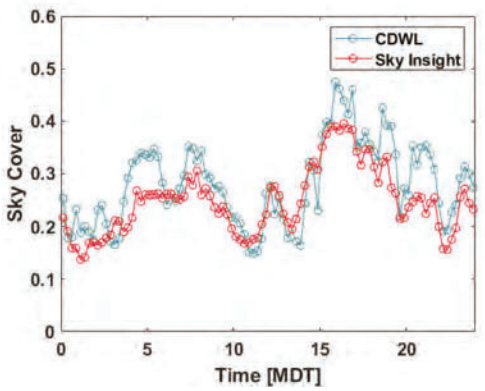


FIGURE 2: Schematic drawing of the Sky InSight's extended 3D vision, of its capacity to provide a 360° panoramic view day and night, and ability to report in real time about cloud cover in order to detect potential hazards

FIGURE 4: Results of NOAA's comparison campaign with a reference scanning lidar for cloud fraction estimation (Graph: NOAA, Sunil Baidar)



imager. Depending on its position at the airport, close to the ground or at the top of a 50m-high (164ft) control tower, its minimal range of observation can change from 4.4km (2.4 nautical miles) to 25km (13.6 nautical miles) for objects very close to the ground. Clouds at a 1km (3,280ft) altitude, or even much higher for vertically extended clouds, may be seen above the horizon hundreds of kilometers away.

From a single instrument, a 360° panoramic view of the airport surroundings is retrieved every 30 seconds and pushed to the operators and decision makers. (Figures 2 and 3).

In the event of suspicious phenomena, early warnings can be put in place hours in advance. Rapid weather changes or rising vertical cloud towers may also be immediately detected and warnings given. In particular, the Sky InSight enables the detection of cumulonimbus and congestus clouds far in advance and lets the user follow the evolution of their vertical development by tracking differences in a sequence of images, taken every 30 seconds.

Cloud cover retrieval

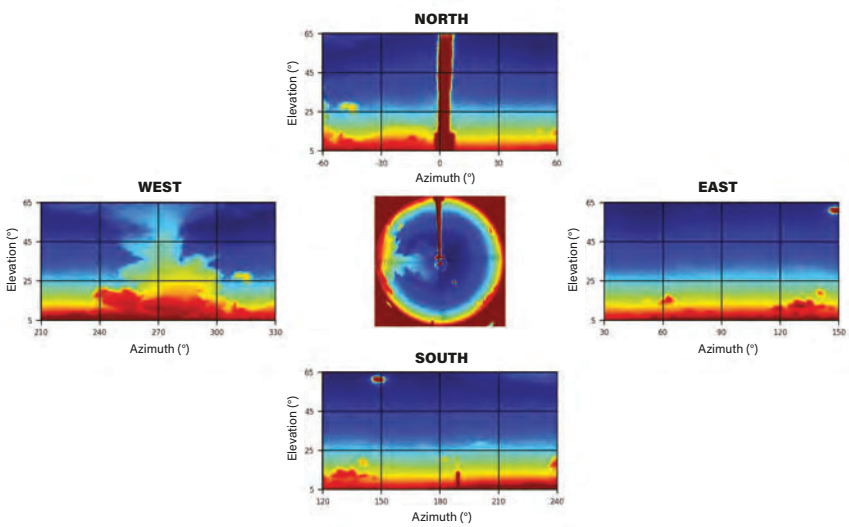
Like the human eye, sky imagers can be used for cloud cover visualization and cloud fraction estimation, expressed either in percentages or in oktas. Cloud information is sorted in meteorological aerodrome reports (METAR) in cloud cover terms: scattered, broken or overcast. The indication of clouds with vertical expansion – the most dangerous – can also be reported through alerts.

Additionally, the cloud fraction is reported as the cumulative cloud fraction in each layer.

It has been shown that human observations may induce a bias, as two observers may conclude there are different cloud covers. In addition, high frequency of reporting is inapplicable, and night-time observation is difficult to provide for practical reasons and because of the human eye's limitations, in contrast with an unmanned thermal infrared observation.

On the other hand, ceilometers are valuable instruments that are very efficient for cloud ceiling retrieval. For some years they have also been providing cloud fraction estimations. However, this information is sparse due to the fact that ceilometers' retrieval technique depends on cloud speed and wind orientation, as they only probe near-zenith fixed positions in the sky. As a result, ceilometers are unable to provide representative information on sky conditions around an airport, nor can they gauge the heterogeneity of the cloud deck and its variability within a few minutes. Furthermore, they are unable to provide information on upcoming hazards that need to be detected before reaching the runway. There is potential, however, for synergy between a co-located ceilometer with high-resolution, low-altitude cloud retrieval and the Sky InSight's vast field-of-view probing capacity.

FIGURE 3: Panoramic vision retrieved from one image of the Sky InSight. This information is pushed to a remote observer's screen for real-time evaluation. A cumulonimbus cloud is developing at 275° AZ



Current evaluation

To validate the Sky InSight's retrieval method, an evaluation campaign took place during the summer of 2018 at NOAA's Table Mountain site in Colorado. Several instruments were deployed at this BSRN (Baseline Surface Radiation Network) site, including a scanning lidar. As shown in Figure 4, the Sky InSight was finely correlated with the lidar's cloud cover curve. This correlation was as effective during the night as at day, thanks to the thermal infrared measurement capacity of the Sky InSight.

Reuniwatt's sky imager is being evaluated at Geneva Airport by MeteoSwiss, Switzerland's meteorological agency, in combination with ceilometers, radars and other meteorological instruments (Figure 1). Cloud estimation is being compared with human expert reporting and ceilometer data.

The Sky InSight is also being testing by a leading European airport operator, with a view to implementing the solution in remote control towers. The solution is expected to help automate cloud cover retrieval and provide valuable remote visualization of the sky, day and night.

Conclusion

The Sky InSight thermal imager is an affordable and low-maintenance instrument that will help remote operators make the right decisions. An enhanced vision is provided thanks to its thermal capacity and 360° vision per image. Augmented information may arise soon to catch and characterize hazardous phenomena. It will most certainly ease the remote air traffic controller's job and help tackle the issue of remotely managing a larger number of airports. ▮