remote sensing

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Editorial

Editorial for: Remote Sensing Methods and Applications for Traffic Meteorology

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Recently, remote sensing for traffic and especially aviation meteorology has become a focus of attention by the aviation industry and air navigation services. Aviation meteorology providers have increased their research efforts accordingly. The motivation for this new demand is manifold.

In order to increase the capacities of airports and airspace, methods for seamless and optimized operation of airlines, airports, and air navigation service providers require direct integration of meteorological data into their respective systems.

Furthermore, recently the bandwidths of communication systems have reached a level which allows for the in-flight transmission of meteorological data from the ground into the cockpit. As a result, pilots are enabled to base their decisions on an improved database which can be visualized on their electronic flight bags and are not limited to onboard radar systems and bulletins in traditional alphanumeric code anymore. Thus, the situational awareness of pilots is improved leading to increased flight safety.

Finally, the dawn of a new generation of geostationary satellites which promise unprecedented capabilities enables new developments. Not only will the spatial and temporal resolution increase notably but also new instruments like lightning sensors will enable 24/7 weather surveillance and nowcasting of weather phenomena like thunderstorms, aircraft icing conditions, and turbulence.

All this coincides with the advent of new powerful methods in artificial intelligence, which paves the way for new possibilities for data fusion and data analysis in order to extract and combine information most efficiently.

The special issue reflects this trend, as all four submitted papers deal with satellite remote sensing, while two of them apply machine learning and the other two utilize new methods in a more traditional context yet still progressive fashion.

Han et al. [1] apply a machine-learning method to geostationary satellite data in order to detect convective initiation (CI). CI marks the onset of convection which might lead to severe thunderstorms. As such, CI is a highly relevant feature and a satisfactory detection has been a long-standing issue in remote sensing. Using twelve different interest fields, remarkable PODs (Probability of Detection) of around 80% with FARs (False Alarm Rate) of around 40% are achieved by the authors. It is found that the most important interested fields are channels and channel differences in the IR-region of the spectrum. A special feature of the approach is the associated model tuning which updates the training dataset and thus improves the performance and applicability of the algorithm.

Müller et al. [2] also tackle the issue of detecting the early stages of convection and developing thunderstorm cells. However, their approach is significantly different, as neither artificial intelligence nor classical atmospheric motion vectors are utilized. Rather a normalized updraft strength (NUS) vector product is computed from temporal and spatial gradients in water vapor channels of geostationary satellite data. For values above a certain experimentally derived threshold, NUS is an adequate measure to differentiate between advection and convection and thus can be applied to identify areas where convective clouds develop. Two months of data are analyzed and compared to lightning detections. The study yields PODs between 80% and 90% associated with FARs of 22%–36%.

In an earlier paper, Müller et al. [3] elaborate on the successful detection of mature thunderstorm cells by geostationary satellite measurements. Due to the associated phenomena like hail, turbulence, and icing, these clouds pose a significant threat, not the least to aircraft. The authors use different combinations of satellite channels in order to optimize detection. Additionally, the role of several stability filter adjustments like KO-Index and CAPE (Convective Available Potential Energy) from numerical weather prediction models is investigated. It is shown that these filters can be successfully used in order to limit the detection to thermodynamically instable regions of the atmosphere, thereby reducing the false alarm rate of thunderstorm identification. The authors' findings show that by application of those filters the critical success index can be increased by ten percent.

Sim et al. [4] focus in their work on the detection of aircraft icing by geostationary satellite measurements. Aircraft icing also poses a significant threat during flight, although deicing and anti-icing technologies exist. The authors explicitly focus in their study on East Asia, as in this area there is a lack of experience with satellite studies in the context of icing. Two different machine learning algorithms are applied to different satellite sensors available in this region of the world. Pilot reports are used as reference data. The authors then compare the results with existing icing models. While the two machine learning algorithms produced comparable results (PODs of about 80%), they both significantly outperformed the classical model (POD of 36%).

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