Unmanned Aircraft Systems in Meteorology

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Weather is an important phenomenon that affects everyday human activities. From energy supplies to outdoor sporting activities, the weather patterns of the world affect all people in some way. Weather is important for growing crops, supplying energy, determining sporting events, and the people's dress and style. With the constant chaos that keeps coming along with weather, such as bigger hurricanes, more persistent droughts, and rising temperatures, the importance of recording and tracking different weather phenomenon is more important than ever.

A large part of the weather phenomenon is tracked and recorded with unmanned aircraft systems (UAS) and unmanned aircraft vehicles (UAV). The rise of UAS being used in meteorology has revolutionized the entire industry. From improved technologies to safer ways of communication and recording data, the importance of UAS have been visualized more than ever before. UAS are part of the future for meteorology and are incredibly significant in the meteorological and aviation industries.

History

There are many ways weather has been documented remotely throughout the centuries. The first advancement in remote meteorology was performed in the 1750s with the usage of kites. In Europe, a thermometer was commonly used with kites to record temperatures. After the invention of hot air weather balloons, the advancement in meteorology increased significantly. New ways of recording temperature, barometric pressure, and other instrumentation techniques explored the chemistry and structure of the upper atmosphere. Many of these studies were manned to be more accurate. With the usage of manned balloons, many of the fatalities and risks of meteorology were more apparent. According to weather.gov, “In 1862, two men

nearly died from the extreme cold and lack of air. In a later flight taken over Europe in 1875, two French ‘Aeronauts’ died as a result of inadequate breathing equipment.” This influenced and was the motivation for the use of unmanned aircraft use in meteorology.

Later, many unmanned operations took place in space and on Earth. The first weather satellite, the US TRIOS I, was launched in 1960 and relayed information, imagery, and sensor data to ground stations. Even though the major reason satellites were being launched into space was to deter Soviet aggression, some unique benefits came out of it. About thirty years later in 1991, unmanned aircraft were designed to record ozone depletion and develop ways to combat it. Combating climate change has been influential in helping to build up the UAS market in the meteorological industry as it is cheaper and less impactful on the environment than satellites or manned operations.

Since 2013, meteorology has been influenced by UAS, and it is becoming more common to use drones for this application. It has been found that it is safer and more effective to use drones. According to prophotouav.com, “drones in the sky will provide real-time data which will be used to protect thousands of lives.” In instances like a tornado or severe thunderstorm, drones are quicker on the ground and are safer for all.

Meteorological Applications

With the rise of drone use, the possibilities of research and recording are extensive and have been done many times. Three areas that were more extensive in the study with UAS are thermals, humidity, and wind. These are the most variable in piloting and in weather in general and are common concepts to understand. With these, the common building blocks of meteorology are made and everything else is based upon them.

Thermals or temperature recording observations can be used in a variety of applications not only in meteorology but in wildlife conservation, construction, and climate science. In the case of Witczuk et al., “Drones enable safe operations at low flying altitudes, and at night – a time that often offers the optimal conditions for wildlife monitoring,” showing the impact on forests in Poland and the use of infrared technologies. A major part of wildlife conservation is climate science which has a big impact on the ecosystem and biodiversity in general. More and more common UAS are being used in the study of shifting glaciers. One such study is “Evaluation of the AMPS Boundary Layer Simulations on the Ross Ice Shelf, Antarctica, with Unmanned Aircraft Observations” (Wille et al., 2017). Most studies of this sort are not only conducted to combat rising sea levels but also to ensure logistics are running smoothly such as stability of ice for planes to land on when arriving in Antarctica. Applications like such are important to determine thermals as rising temperature affects human and wildlife habitation.

Another major use of UAS that is not as apparent is their use in recording precipitation and humidity. Many UAS add another predictor in the forecasting of weather patterns and cloud patterns. In the study, “Applications of Uncrewed Aerial Vehicles (UAVs) in Winter Precipitation-Type Forecasts,” performed with a CopterSonde 2.5, many data models were utilized to predict a more accurate forecast in the areas of impact as shown. The report also states “that precipitation-type forecasts are more sharply influenced by the initial conditions of a model as opposed to forecasting lead time suggesting that observations such as this may be beneficial,” leading us to the conclusion that UAS provide faster time analysis and more accurate on the spot forecasting.

The final and most common of the three uses are the UAS used for wind measurements. UAS are being used in measuring wind velocity and tornadoes for a variety of reasons with the

most commonly acknowledged as being the safety of the flights which is much greater as human lives are at much less risk. As stated by Frew et al.,

> "The study of severe local storms is well-suited for unmanned aircraft systems since the spatial and temporal domains can be relatively short and flying piloted aircraft into these environments is too dangerous. The rapid growth of unmanned aircraft system (UAS) technology and open source avionics has enabled various academic and government institutions to deploy UAS for atmospheric science."

Many of the hardest predictors to measure in meteorology are wind patterns and speeds on a constantly changing basis. The use of UAS in the fold has made this variance much easier to measure and in a much safer way.

Conclusion

Many of the first discoveries in meteorology and data recording were done by kite and weather balloon and this led to abounding in scientific thought across the discipline. Many advancements in weather balloon and satellite technology influenced the study of weather and impacted the study all around. With the expansion of UAS in meteorology, many new applications came forth some notable being thermal, humidity, precipitation, and wind velocity and direction. As part of the increase for UAS in meteorology, many factors like the reliability of data, speed of data processing, and increased safety of meteorology have impacted the industryas a whole. New technologies have increased the industry and have modernized it into a scientific powerhouse. The effective source of UAS in the domain of meteorology is on an upward progression and will continue that way.

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