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Hurricane Aware web app showing active hurricanes, cyclones and typhoons

EXPANDING HORIZONS

One company aims to enhance the meteorological sector using location intelligence

Mapping and spatial analytics software specialist Esri empowers the meteorological sector through location intelligence – the process of visualizing, analyzing and discovering relationships in geospatial data to solve challenging real-world problems.

For its 2020 meeting, the American Meteorological Society (AMS) identified a number of new challenges and opportunities for the discipline, including a more outcome-focused view; integrating meteorology with broader physical, social, policy and economic contexts; expanding communication and collaboration across its diverse practitioners; and addressing the challenges of big data. Geographic information systems (GIS) technology powers location intelligence and can help address and achieve the challenges and opportunities facing meteorology.

Modern meteorology involves the integration of many disparate types of data into a cohesive forecast information product. Esri provides a massive collection of geographic information from around the globe called the Living Atlas of the World. Living Atlas content can be combined with third-party data to create new maps and applications that place forecasts within a larger context. The atlas includes weather and climate maps, apps and ready-to-use data layers.

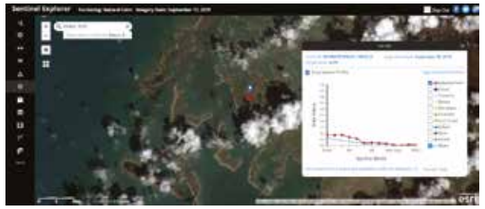
For example, the Hurricane Aware app (go.esri.com/HurricaneAware) leverages the Active Hurricanes layer from Living Atlas and provides the most recent forecast information for all hurricanes, cyclones and typhoons around the world from the National Hurricane Center and Joint Typhoon Warning Center. The app will also automatically check and display the latest forecast and allows the user to view populations affected in the forecast area (an example of the power of the integration capabilities of GIS). The Living Atlas also contains contributions from partners such as NOAA. For example, the Living Atlas contains a nowCOAST time-enabled map service that provides a map depicting the latest surface weather and marine weather observations at observing sites using symbology from the international station model.

Near real-time surface *in situ* observations displayed using the station model

BIG DATA MANAGEMENT

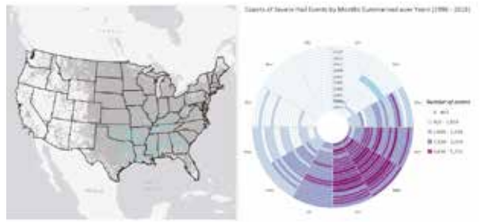
With an abundance of satellites and remote-sensing devices monitoring weather systems all over the world, meteorologists now have more data available to them than ever before. Accessing the right data at the right time is critical to facilitate on-target forecasting and analysis, and to support decision making. Understanding what data you have and ensuring it is cataloged appropriately is critical to effective forecasting. ArcGIS image management is able to organize overlapping, time-variant and multi-resolution images from multiple sources and makes them available for visualization, analysis and sharing.

But more data doesn't necessarily translate into improved predictions. GIS allows you to turn data into actionable meteorological information products. Esri Silver-Tier Partner Weather Decision Technologies (WDT) uses advanced GIS from Esri to better organize and analyze meteorological big data. WDT provides weather forecasting and mapping services to many industries: energy corporations to help them predict electrical outages and keep offshore oil rigs safe; agriculture agencies for crop insurance; freight transportation companies to aid with route design; and concert and sporting event organizers for planning and safety.



Natural color rendering and spectral profile of Abaco, Bahamas, several days after the landfall of Hurricane Dorian

Alternate climate zones for the conterminous US derived using unsupervised spatial machine learning



Anomalous hail events in February 2008 and 2009. The data clock and map are linked, so selecting the two anomalous years in the data clock selects the associated events in the map

The Sentinel Explorer application (go.esri.com/SentinelExplorer) is another example of how a massive collection of data can be organized. This web application, powered by ArcGIS for Server, shows analysis of Sentinel-2 satellite, 10m (33ft) multi-spectral, multi-temporal, 13-band images with visual renderings and indices. The imagery is sourced from Sentinel-2 on Amazon Web Services (AWS). Using this app, users can explore Sentinel's bands and see how the planet's vegetation, agriculture and cities might be impacted by meteorological events. Additionally, users can access the Sentinel-2 archive to visualize how Earth's surface has changed over several months.

VISUALIZATION

GIS allows organizations and businesses to explore, understand and find meaning in their meteorological data with dynamic, analytical maps. Users can bring together disparate data to see how things overlap and connect; visualize spatial patterns in both 2D and 3D; validate assumptions, evaluate results and aggregate data within a map; interact with maps and dynamic charts linked to the user's data; compare categories and amounts, visualize distributions and frequency, explore relationships and correlations, and understand change over time or distance; interpret the results of the user's analysis and communicate the findings; visually simulate the movement of data with 3D fly-throughs, time-series animations, and real-time dynamic maps; view historic trends and real-time patterns over time; and help decision makers and stakeholders understand what the sophisticated forecasting models convey.

ANALYSIS

Meteorological analysis can be enhanced by going beyond simple map visualizations and integrating location data and explicitly spatial techniques. Esri provides a comprehensive set of spatial analytical methods and algorithms that can find clusters, make predictions and quantify how patterns change over time.

Analysis of meteorological data happens in a variety of ways: small datasets on a desktop application, analysis-ready data in data cubes, and massive archives of satellite imagery in the cloud. ArcGIS scales to match. The same tools can be used on a desktop to test or perform an analysis and then scaled up on ArcGIS Image Server for raster analytics or ArcGIS GeoAnalytics Server for vector data. Analysis can also be scaled up with a distributed processing, storage and sharing system.

SHARING

The AMS has highlighted the need for expanding communication and collaboration across diverse practitioners and GIS is a powerful platform for doing just that. The ArcGIS platform makes it easy to publish live, dynamic, rapidly updated data. Users can work collaboratively and share analytical models, results and tools securely within their team and organization, and even with members outside the business.

One of the biggest challenges facing meteorology today is making forecasts actionable. ArcGIS helps turn sophisticated analysis into compelling stories using built-in storytelling capabilities that incorporate text, images and videos.

CONCLUSION

Meteorology is the oldest atmospheric science and has always embraced and incorporated technological change. GIS is a platform that integrates a wide variety of technologies and analytical methods and can help meteorologists understand and communicate weather patterns and drive decisions that improve safety and reduce the economic disruption from meteorological events. ▮

Call to action

Learn more about GIS and how it can be integrated into meteorological workflows by visiting Esri at the following events:

- American Geophysical Union Fall Meeting, December 9-13, 2019, San Francisco, California
- American Meteorological Society Meeting, January 12-16, 2020, Boston, Massachusetts
- European Geophysical Union Meeting, May 2-8, 2020, Vienna, Austria