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Enhancing ACIS Maps: Increasing Usability through a GIS Portal

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The High Plains Regional Climate Center (HPRCC) is one of six NOAA Regional Climate Centers (RCCs) in the United States that aims to provide timely climate data and information to the public for cost-effective decision-making. As part of a three-tiered approach to climate services, the RCCs address needs on the national, regional, state, and local scales for a variety of sectors including agriculture, energy, natural resource management, research, transportation, and water resources. Working together, the RCCs develop and disseminate a wide range of value-added climate products and services.

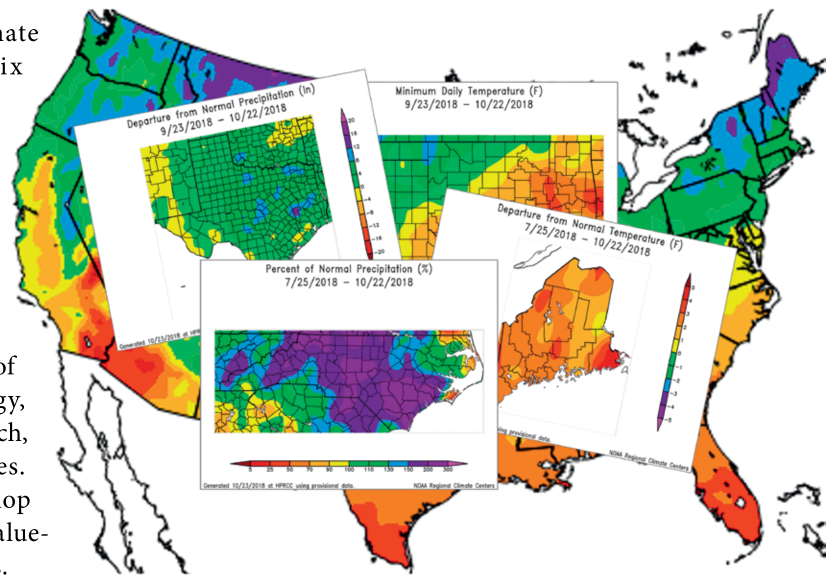

Fig. 1. ACIS Climate Summary Maps depicting temperature and precipitation values and anomaly data for various states.

One of the HPRCC's most popular products is the Applied Climate Information System (ACIS) Climate Summary Maps, which have been in production since 2003 (Fig. 1; https://hprcc.unl.edu/maps.php?map=ACISClimateMaps). The maps are utilized by a variety of sectors and are often used in print and online publications. Over time, the maps have become a staple for climate and drought monitoring as they are updated on a daily basis using near-real-time temperature and precipitation data.

To provide quick and efficient access for users, all maps are pre-generated utilizing the Grid Analysis and Display System (GRADS) and its Cressman interpolation scheme, with static images appearing instantly when requested. The pregeneration process takes about 7 hours, using over 10 million data values, which are aggregated to create 18,576 maps on a daily basis. Each of these maps is created for a predefined list of time periods (last 7 days, last 14 days, last 30 days, etc.) and areas at individual state, regional, and national levels (https://hprcc.unl.edu/products/ACIS_Products.pdf). In a typical week, these maps are accessed over 20,000 times by visitors to the HPRCC website. Due to the volume of users and their changing needs, map offerings have expanded over the years to meet specific user requests. Since the inception of the project, new variables have been added, including the Standardized Precipitation Index (SPI), based on a two-parameter Gamma distribution (McKee et al. 1993), as well as new regions, such as the Missouri River basin and the Corn Belt. Most recently, all 50 states and U.S. territories were added as individual map options.

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MOTIVATION FOR ENHANCEMENTS.

Despite the variety of maps offered, unmet needs remained because, in exchange for speed of access, the static suite of ACIS Climate Summary Maps does not allow for customization by the user. Over the years, users have requested specialized regions, customized color schemes, and the data used to produce the maps. Typically, if a user wanted to create a customized map using the same data included in the ACIS Climate Summary Maps, several steps would need to be taken. For instance, the user would need to acquire climate data, calculate variables of interest (e.g., SPI or temperature anomalies), and then plot the data.

Computing skills and knowledge of utilizing climate data are barriers to creating custom maps for many users. For example, the user must determine which stations are appropriate to map or what level of data completeness is sufficient for specific applications. For the ACIS Climate Summary Maps, these decisions have already been made by experienced climatologists and programmers. This combination of end-user needs and the barriers to users producing customized maps led to the creation of ACIS Climate Summary Maps in GIS formats. Producing the maps in GIS formats provides users with a custom mapping experience, while also maintaining ease of use.

GENERATION OF GIS PRODUCTS.

New gridding and mapping software had to be implemented in order to provide users with the ability to integrate additional datasets and gridded layers, and to customize contouring and location parameters. The new GIS versions of the ACIS Climate Summary Maps are generated through custom, Python-based software at the HPRCC. The software ingests station data, including Normals data, from ACIS Web Services (ACIS-WS; www.rcc-acis.org/docs_datasets.html). Basic quality-control procedures are performed by ACIS-WS prior to ingestion. The software then calculates all derived variables, such as SPI, and interpolates a grid based off of this point data using a natural neighbors interpolation scheme on a 1/8° grid. The grid is output in netCDF (Network Common Data Form) format and is then used by the software to produce the point and filled polygon (filled contours) shapefiles (netCDF versions of the data are available here: https://hprcc.unl.edu/thredds/).

This method offers a significant improvement over the older, script-based solution that is still being used to create the static ACIS Climate Summary Maps. Savvy users will notice that the HPRCC GIS and netCDF products update faster than the static map images on the website. Time-to-product on these original scripts takes approximately 7 hours, while the new software can produce a complete product suite in less than 4 hours. This is largely due to more efficient data processing. Efforts are underway to complete a full transition of the static maps to the new product generation software in 2020.

Using the shapefiles with GIS software, users can zoom to a region of choice, customize color schemes, or overlay datasets (Figs. 2 and 3). These climate layers can be incorporated into more complex spatial analyses or models in areas such as crop production, water resources, and transportation. Some potential uses of the data include

- identifying areas at risk of wildfire by overlaying vegetation data, precipitation deficits, and maximum temperatures;
- monitoring for emerging drought by combining rangeland conditions with departure from normal temperature and precipitation data;

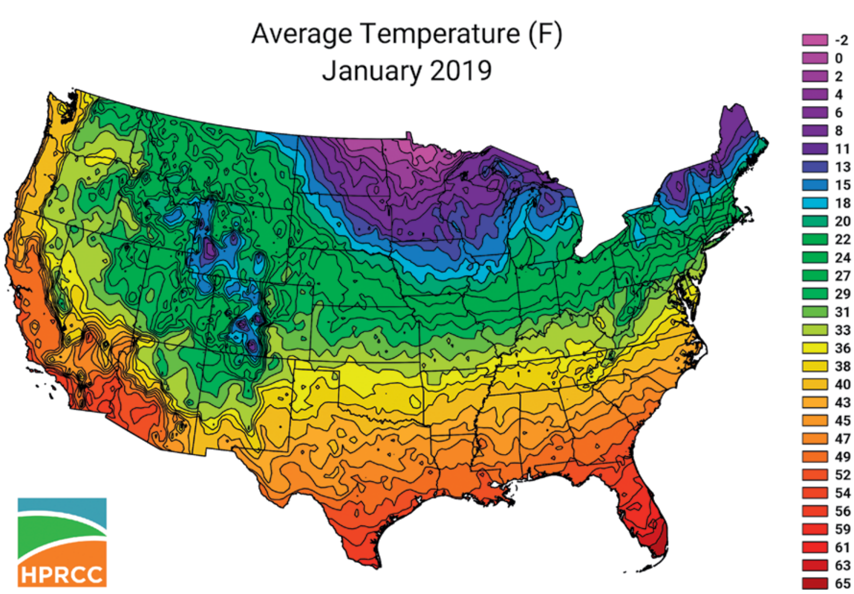

Fig. 2. Sample temperature map showing customized contour intervals and colors.

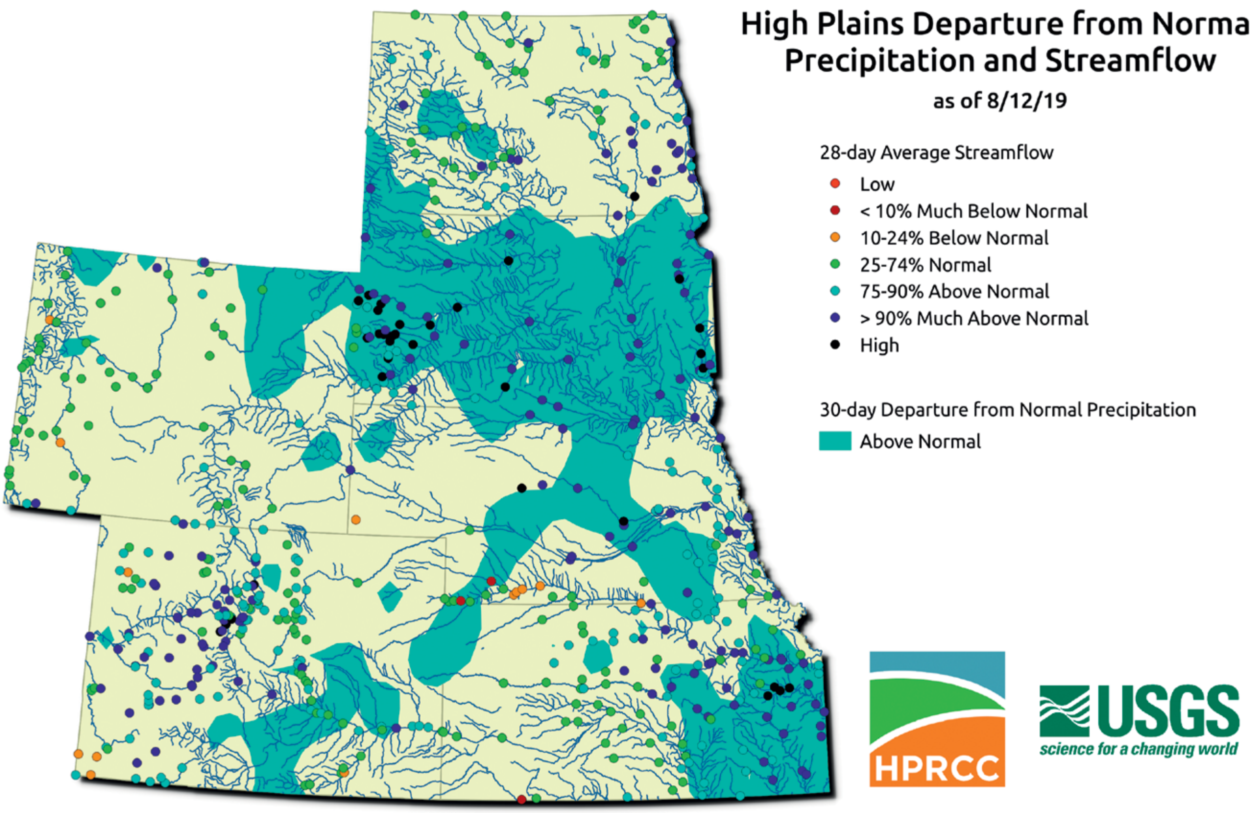

Fig. 3. Sample precipitation and streamflow map showing customized layers.

- monitoring for flood risk by overlaying streamflow and snowpack data with percent of normal precipitation data; and
- identifying emerging areas for public health impacts by combining temperature and precipitation data with local vector-borne disease information.

HPRCC GIS PORTAL. The primary method for obtaining the ACIS-based GIS data is through an online GIS Portal, which can be accessed at https://hprcc.unl.edu/gis/. The GIS Portal offers users access to the data in three ways: Direct Downloads, GeoServer, and Data Archive. Tutorials and examples are also available through the GIS Portal to help get users started.

Direct downloads. Access to individual shapefiles is available through the Direct Downloads option. A simple table displays an entry for each map option, along with the type (point data or contour), time scale (last 7 days, last 14 days, etc.), date/time the files were updated, and links to the files needed to display each shapefile properly (SHP, SHX, PRJ, and DBF). The table can be filtered by time scale for more efficient searching. The Direct Downloads page is accessible at https://hprcc.unl.edu/gis/listing.php.

GeoServer access. Access to the shapefiles is also available via a GeoServer. This allows users to directly access the data within their GIS software through a connection to the GeoServer. For frequent users of the data, this eliminates the burden of downloading individual shapefiles on a regular basis. The GeoServer offers Web Feature Services (WFS) and Web Map Services (WMS) and also produces Keyhole Markup Language (KML) files, which are utilized by visualization programs such as Google Earth and Global Mapper. WFS provides direct access to the underlying data contained in the maps, for example, temperature, departure from normal temperature, SPI, etc. This allows for direct manipulation of the data, since users can easily query the data or add/delete features to/from the dataset. WMS, on the other hand, provides direct access to the image representation of the dataset. This provides prestyled data but does not have the robust customization that WFS allows. At this time,

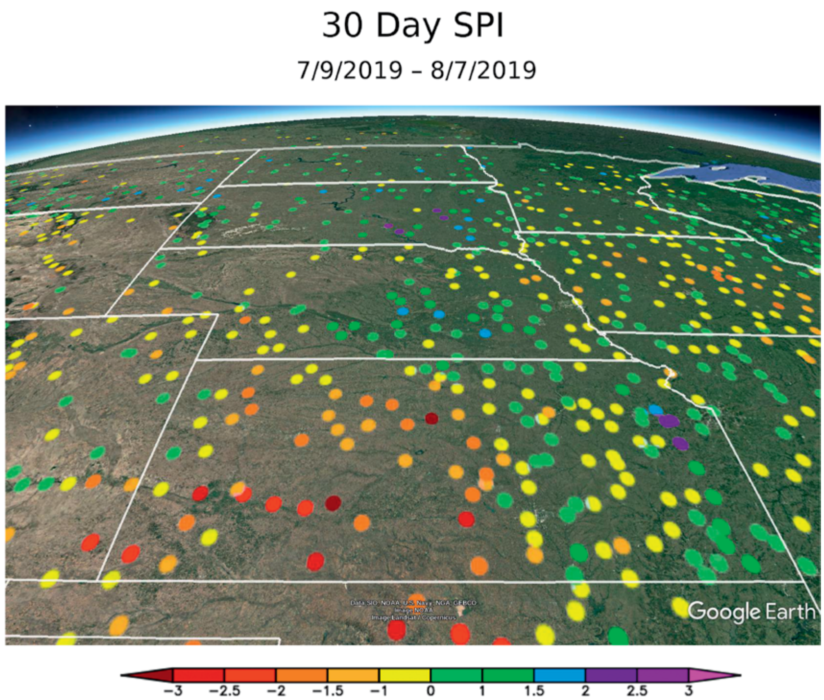

Fig. 4. Prototype of 30-day SPI data displayed in Google Earth, looking north from Oklahoma.

only WFS is offered through the GeoServer; however, WMS and KML will be offered in the future.

The GeoServer also acts as a centralized location for linking to data from web applications. Users can create their own web tools using Application Programming Interfaces (APIs) like Google Maps or Bing Maps, and simply add the ACIS-based GIS products as a layer. The layers are fully customizable, allowing for user-created color tables and features, which can help users integrate other datasets or shapefiles into their own analyses. The GeoServer is accessible at https://hprcc.unl.edu/geoserver/web/.

Data archive. To complement the archive of static ACIS Climate Summary Maps, shapefiles are also archived on monthly, seasonal, and annual time scales. These archived files are updated several times after the end of each time period to allow for the inclusion of late-arriving or corrected data. As with the static maps, the date of generation is the date of the archival. On the Data Archive page, a table displays each map option, along with the data type, time scale, date/time the files were updated, and links to the files needed to display each shapefile properly. The archive, which begins in 2018, is accessible at https://hprcc.unl.edu/gis/archive.php.

CURRENT USES AND FUTURE CAPABILITIES.

Early users of the ACIS-based GIS data have been primarily from the climate and drought monitoring community. For example, the authors of the U.S. Drought Monitor utilize the data on a weekly basis in order to assess current conditions and inform the creation of the U.S. Drought Monitor map (https://droughtmonitor.unl.edu/). Additionally, the National Integrated Drought Information System (NIDIS) Northeast Drought Early Warning System (DEWS) is using the data to create custom maps for the NIDIS Northeast DEWS Dashboard Prototype (http://nedews.nrcc.cornell.edu/). This user base is anticipated to grow over time.

Since its inception last fall, the new HPRCC GIS Portal has been featured at workshops, conferences, tools café sessions, and webinars. Initial feedback indicates growing interest from a variety of users. Several broadcast meteorologists across the country would like to utilize the ACIS-based GIS data in their on-air weather forecast segments. With the addition of WMS/KML capabilities in the future, the data can be added directly to broadcast graphics packages, which would help to spread awareness of the tools to the general public and potential users (Fig. 4). College educators have indicated that the ACIS-based GIS data could be incorporated into coursework to introduce data retrieval, analysis, and visualization techniques. Students could use software, such as ArcGIS or QGIS, to display or import shapefiles, while also using a statistics package such as R via the GeoServer. As new needs and applications emerge, the HPRCC is committed to updating and enhancing the GIS Portal to meet these demands.

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FOR FURTHER READING

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