The PRISM Climate & Weather System in Crop Insurance

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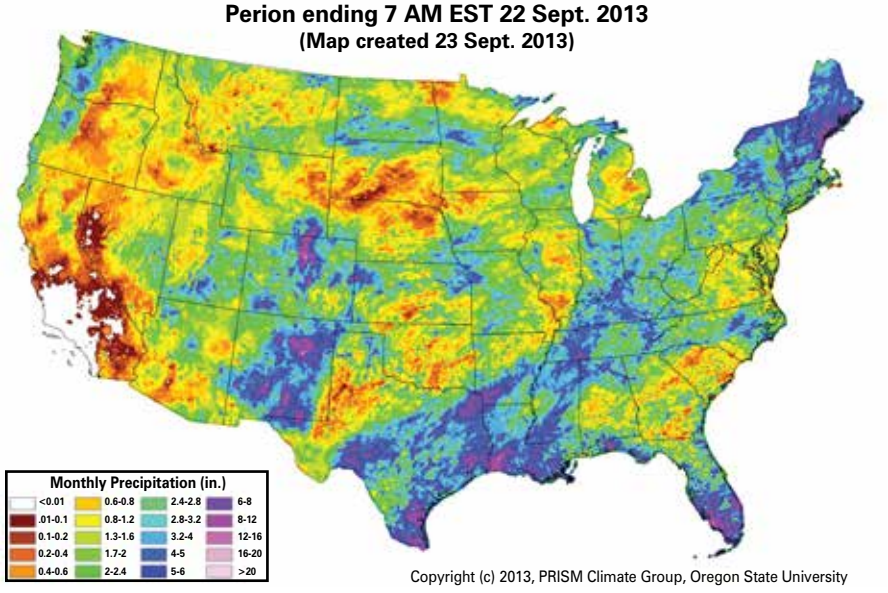
In our first article (August 2013, pp. 4-6), we recounted the origins of the PRISM Climate and Weather System, developed by Oregon State University's PRISM Climate Group, and how it works to create detailed weather and climate maps across the country. We explained how weather and climate are arguably the most powerful drivers of both agricultural and natural systems, and have profound effects on how our society functions. Weather is what we experience day to day, while climate is a longer-term summary of expected weather conditions. Spatial weather and climate data, usually in the form of continuous grids of pixels that describe temperature and precipitation conditions, are key inputs to crop insurance activities. In 2010, the USDA Risk Management Agency (RMA) asked PRISM to help improve their climate and weather data for crop insurance needs, both in underwriting and compliance. In this article, we will tell you about the development of PRISM data to support crop insurance compliance activities, introduce an innovative web portal that allows approved insurance providers (AIPs) to access this information in simple and intuitive ways, and describe how the crop insurance industry is adopting PRISM tools to improve the efficiency and integrity of the program.

Taking Science to the Next Level

Before the RMA established a relationship with PRISM, PRISM was routinely producing climate maps at monthly and annual time steps. For crop insurance, however, daily data were needed to be able to resolve severe rainstorms, heat waves, cold snaps, and other short-term weather events. PRISM spent much of the first year of its RMA part-

Figure 1. **1-22 September 2013 Total Precipitation**

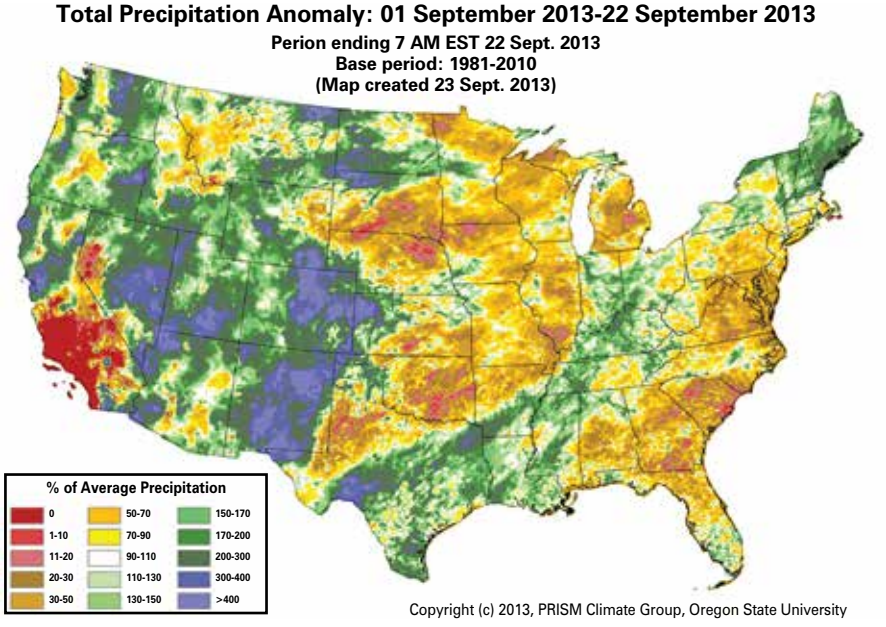


PRISM total precipitation accumulation for the period 1-22 September 2013. Parts of Colorado and New Mexico received in excess of their normal annual rainfall in just a few days. However, in adjacent West Texas, conditions were very dry. These maps are updated every day for use in crop insurance.

nership doing research and retooling their mapping system to meet the challenges of creating accurate temperature and precipitation maps every day. The result was the most sophisticated daily maps currently available in the lower 48 states. Mapping daily precipitation was the most challenging, owing to the spotty nature of small-scale showers and thunderstorms commonly experienced over much the U.S. during the growing season. East of the Rockies, the spatial detail of the maps was improved with the addition of National Weather Service NEXRAD radar products. In addition, PRISM established close relationships with high-quality observing networks across the country to ensure that the best data were used in the maps. These included national networks operated by several federal departments, as well as state and local agencies. Interestingly, the largest and fastest growing precipitation network in the country is a volunteer network called CoCoRaHS (Community Collaborative Rain, Hail, and Snow network), which boasts more than 20,000 observers nationwide. Anyone can become a CoCoRaHS observer (**http://cocorahs.org**). Such high-density precipitation measurements are essential to the accurate estimation of daily precipitation. Figure 1 is an example of the intricate patterns that daily precipitation can have, even after summing over the first 22 days of September 2013. Note the record-breaking 16-20-inch accumulations near Boulder, Colorado and more than 12 inches in parts of New Mexico, causing widespread, devastating flood damage. These areas received rainfall in just a few days that equaled or exceeded their normal rainfall for the entire year. (Contrast these amounts with almost completely dry conditions in parts of West Texas.) What is perhaps more important for crop insurance, however, is how these precipitation totals compare to normally expected values. Figure 2 shows the same precipitation totals as in Figure 1, but expressed as a percentage of the PRISM 1981-2010 normal rainfall for this time period—a so-called "anomaly map." Here we see that parts of the West received more than 400 percent of normal, while the East was mixed bag, from above normal to very dry. In south Florida, rainfall amounts of nearly the same magnitude as those in Colorado registered as only 150 percent of normal, because the 1981-2010 average rainfall there is much greater at this time of year. The strange criss-cross streaks seen in the eastern plains and Midwest are the overlapping tracks of storm cells that passed over these areas during this period; dominant trajectories were SW-to-NE and NW-to-SE.

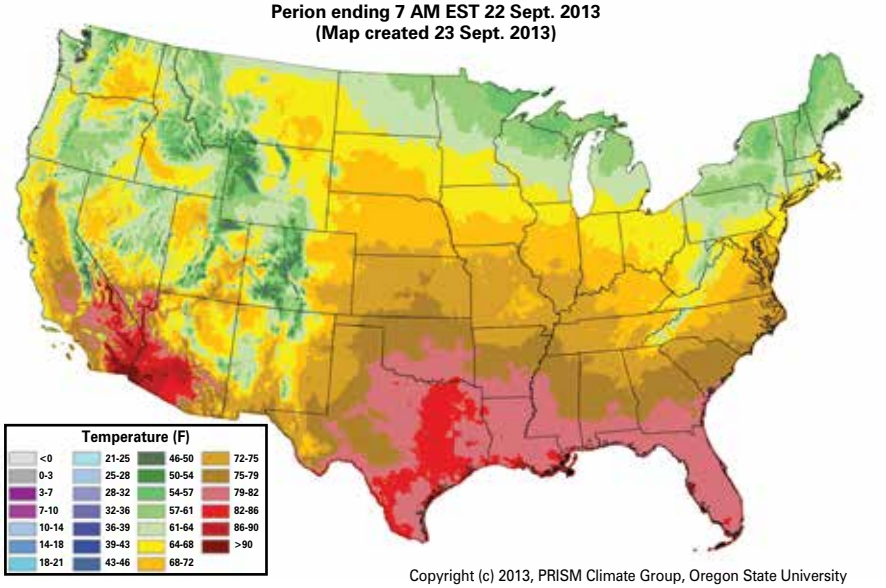
Anomaly maps are also useful in evaluating temperature conditions. Figure 3 shows the actual mean temperature for the first 22 days of September, 2013. The effects of terrain and marine influence are easily seen in the West, where mountain and immediate coastal areas are relatively cool. Otherwise, temperatures generally become warmer as one moves

Figure 2. **1-22 September 2013 Precipitation Percent of Normal**



PRISM precipitation anomaly compared to the 1981-2010 normal for the period 1-22 September 2013. Some areas in the western US exceeded 400 percent of normal, while the East was a mixed bag, from above normal to very dry. These maps are updated every day for use in crop insurance.

Figure 3. **1-22 September 2013 Mean Daily Temperature**



PRISM mean daily temperature averaged over the period 1-22 September 2013.

from north to south. The anomaly map for the same time period (Figure 4) shows us a different story; Montana and the northwestern plains experienced temperatures 7-10 degrees above normal, with significant warm anomalies extending all the way to the Gulf Coast. In fact, most of the country was experiencing warmer than normal conditions at this time.

Using PRISM Data for loss adjustment— **PRISM/RMA Web Portal**

The goal of the PRISM program in loss adjustment is to increase the accuracy and efficiency of a process that requires the AIP's to assess over 300,000 crop insurance claims per year. When evaluating a producer's claim for crop damage caused by weather, two questions need to be addressed. First, did the claimed damaging event occur? Answering this question requires short-time-scale weather information on a daily or monthly time step. Second, was the event severe enough to support a loss claim? This requires a long-term climatic context for the event and a measure of how unusual an event was. Given the large number of claims, adjusters must be able to answer these questions quickly and accurately. To this end, PRISM crafted a web portal that takes the kinds of spatial data we discussed above and packages them into forms that adjusters can easily use. Here we give some examples of how the PRISM/RMA web portal interacts with adjusters.

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The PRISM/RMA web portal was developed in collaboration with the Northwest Alliance for Computational Science and Engineering (NACSE), PRISM's parent organization at Oregon State University. NACSE is a world leader in usability engineering, and specializes in developing web portals that are intuitive and easy to use. The portal is open to AIP and RMA personnel, and the design is based on the kinds of data and reports requested by RMA for large claim arbitration hearings. When a user enters the portal, they can select from five different activities:

Check Recent Conditions: View national-level precipitation and temperature patterns; see how recent conditions compare with historical patterns.

Explore Long-term Averages: See 30-year averages for precipitation and temperature; compare with averages over the most recent 10 years.

View Summary Assessment: Select a particular location and time period; compare average conditions with longer-term data.

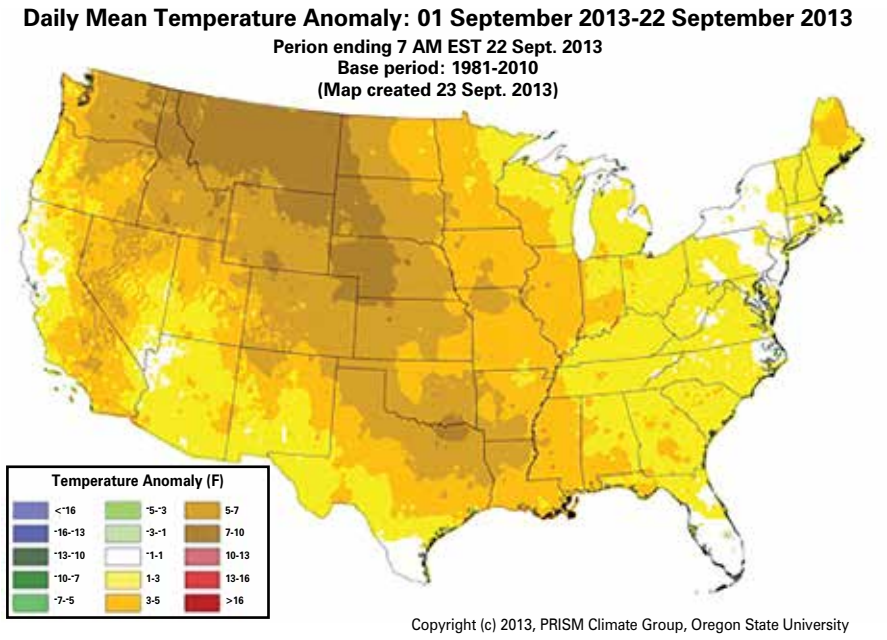
Explore Detailed Data: View plots of time-series data for a selected location; download time-series data corresponding to that location.

Generate Customized Reports for Prevented Planting: Select a 16-month "insurance period" and location; get an on-demand report analyzing precipitation patterns.

The Recent Conditions section allows users to view national maps similar to those in Figures 1-4 to gain an understanding of conditions as they evolve, which may aid in identifying potential crop loss "hot spots." One may expect an increase in claims from areas experiencing unusual temperature or moisture conditions, for example. The Long-Term Averages section provides zoom-able PRISM maps of official USDA 1981-2010 monthly average temperature and precipitation. These are the baseline "normals" on which the anomaly maps in the Recent Conditions section are based. Also provided are averages for the previous ten years, to show recent trends that may have occurred.

The Summary Assessment, Detailed Data, and Custom Report sections have sophisticated map servers that make it easy to locate the field in question. The user can enter a CLU (common land unit) identifier; PLSS township, range, section; latitude/longitude; or just click on the map. The Summary Assessment section provides a quick overview of temperature and precipitation conditions at a given location and time period, and evaluates how it stacks up against other years. Figure 5 shows summary assessment results obtained for the 2010 tobacco-growing season near Raleigh, North Carolina. It is immediately obvious that overall the season was very warm, as indicated by the colored

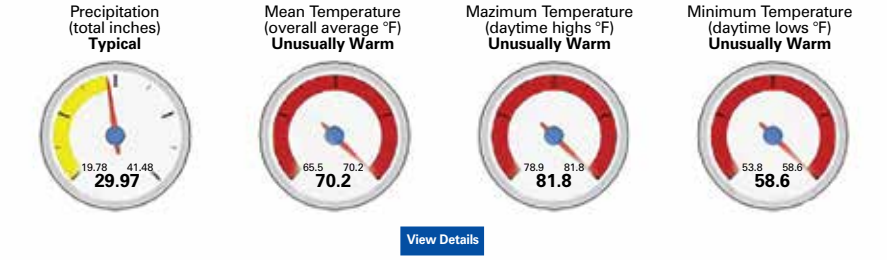
Figure 4. **1-22 September 2013 Mean Daily Temperature Departure from Normal**



PRISM average daily temperature departure from normal for the period 1-22 September 2013. Most of the country was warmer than usual, with the northwestern plains averaging 7-10 degrees above normal.

Figure 5. **PRISM/RMA Web Portal Summary of the 2010 Tobacco Growing Season Near Raleigh, North Carolina**

Location: **Lat: 35.8485 Lon: -78.4770 (North Carolina-Wake County**
Elevation: **299 ft**
Start Date: **April 2010** Data for this date is **unlikely to change** [How data stability is calculated]
End Date: **November 2010** Data for this date is **unlikely to change** [About PRISM estimates]
Assessment Basis: **30-year normals (1981-2010)** [How comparison periods are calculated]
Plant Hardiness Zone: **7b: 5 to 10°F** [What are the plant hardiness zones]



View Details

	Selected Period	1981-2010 Normal	Percent of 1981-2010 Normal	Rank in Normal Period & Assessment [How rank is used]
Precipitation (total)	29.97°	31.13°	96.3%	**16/30-Typical**

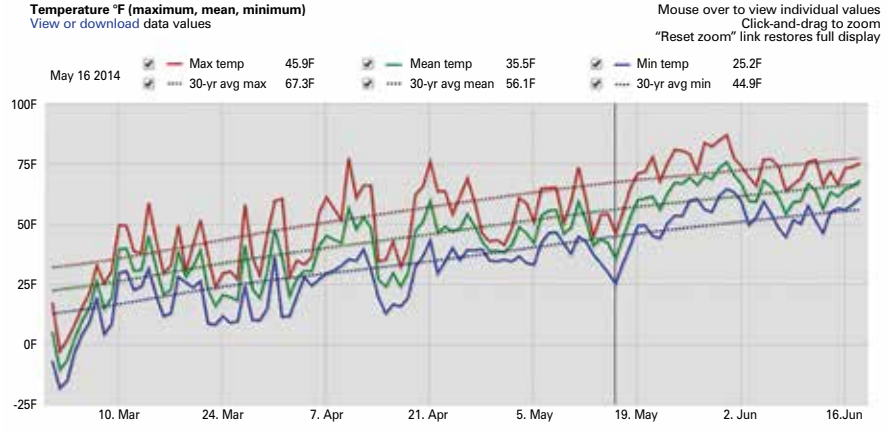
	Selected Period	1981-2010 Normal	Deviation from 1981-2010 Normal	Rank in Normal Period & Assessment [How rank is used]
Mean Temperature (overall average)	70.2°F	67.6°F	+2.6°F	**1/30 = Unusually Warm**
Maximum Temperature (daytime highs)	81.8°F	79.0°F	+2.8°F	**1/30 = Unusually Warm**
Minimum Temperature (nighttime lows)	58.6°F	56.2°F	+2.4°F	**1/30 = Unusually Warm**

View Details

PRISM/RMA portal screen capture of temperature and precipitation conditions for the 2010 tobacco-growing season (April-November) near Raleigh, North Carolina. Large dials show that precipitation conditions were typical, but that temperatures were unusually warm for this time of year. The terms" typical" and "unusually warm" are based on how 2010 ranked among the 30 years 1981-2010. 2010 ranked as the warmest of these years (1/30).

Figure 6. **Daily Temperature Data for 1 March-18 June 2014 in Brookings County, South Dakota**

Location: **Lat: 44.3697 Lon: -96.7905 (South Dakota-Brookings County); T111N R50W Sec 35**
Elevation: **1,699 ft** [About PRISM estimates]
Start Date: **1 March 2014** Data for this date is **likely to change** [How data stability is calculated]
End Date: **18 June 2014** Data for this date is **preliminary** [How daily averages are calculated]
Assessment Basis: **Prior 30 years (1984-2013)** [How comparison periods are calculated]
Plant Hardiness Zone: **4b: -25 to -20°F** [What are the plant hardiness zones]



PRISM/RMA portal screen capture of daily temperature data (red: maximum, green: mean, and blue: minimum) for 1 March–18 June 2014 in Brookings County, South Dakota. Long-term averages are plotted as smooth, dashed lines. Mouse is hovering over a hard freeze (25.2°F) on 16 May. Data can be downloaded directly to a spreadsheet for documentation or further analysis.

dials. The table below the dials presents the data in two ways: deviation from normal, and ranking over the 1981-2010 normal period (or over a variable number of recent years). In this example, temperatures averaged 2-3 degrees above the 1981-2010 normal, but it is not until these temperatures are ranked among other years that we see how significant that 2-3-degree anomaly is. The right-hand side of the table ranks the 2010 season as the warmest of all 30 years, ranking number 1 out of 30. It is assigned the category "unusually warm," which is reserved for the warmest 10 percent of the years (90th+ percentile). The 70th-90th percentiles are termed "warm," 30th-70th are "typical," 10th-30th "cool," and the lowest 10 percent "unusually cool." A similar ranking scheme is used for precipitation, except that the terms "wet" and "dry" are used. These category names provide a way for the adjuster to describe an event or period in meaningful, but plainly understood, terms.

The Detailed Data section allows the user to access the data underlying the summary assessment, or just peruse data for a location of interest. Upon entering a location and time period, an interactive daily or monthly time series plot is returned. Figure 7 shows a plot of daily maximum, mean, and minimum temperatures for the period 1 March–18 June 2014 for a field in Brookings County, South Dakota. This kind of information might be used to identify a late spring freeze; in this example, a hard freeze of 25°F occurred on 16 May, 20°F below the 30-year average of 45°F. Data values appear when the mouse is dragged over a line, and lines can be turned off and on. The data can also be downloaded directly to spreadsheet with the click of the mouse.

The Custom Report section is very popular, and uses sophisticated computer algorithms to produce full-text reports describing precipitation conditions during the 16-month "insurance period" leading up to a prevented planting claim. The user enters the field location and planting month and year, and the report generator does the rest. The report contains fully formatted text, tables, and figures describing the climatology of the field location, station data used in the assessment, monthly total and accumulated precipitation leading up to the planting month, and how each month is ranked and classified (as in the Summary Assessment section) when compared to the 1981-2010 normals and the prior 10 years. The report contains interactive ta-

bles and figures, but can also be downloaded as a static PDF document.

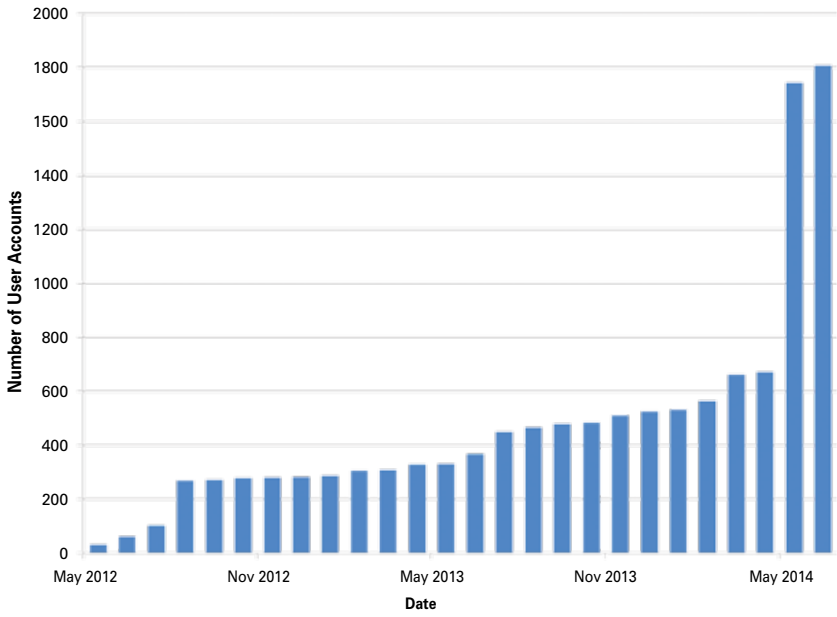
In Figures 5 and 6, we see that the Plant Hardiness Zone is given for these field locations (upper left: 7b in Wake County, NC and 4b in Brookings County, SD). These values were taken directly from the official 2012 USDA Plant Hardiness Zone Map, also developed by the PRISM Climate Group.

Portal Adoption History

The PRISM/RMA portal went live in May 2011, and was demonstrated through on-line webinars to a handful of early adopters at RMA regional and compliance offices. Over the next ten months, the portal was improved based on RMA feedback, and was used successfully in several large claim arbitration hearings. In March 2012, it was opened to the AIPs, the portal's main intended audience. After another round of demonstration webinars, AIPs were allowed up to thirty user accounts per company for testing and feedback, pushing the total number of accounts to about 250 (Figure 7). Based on increased interest and positive feedback from the AIPs, the thirty-account limit was subsequently lifted, allowing the account total to rise gradually to over 600 by April 2014. And in May 2014, user accounts increased by an additional 1,300. To accommodate this substantial increase in usage, NACSE moved the portal to a faster set of servers and implemented other changes to increase performance (it was undesirable for a user to have to wait more than a few seconds to retrieve results). As of June 2014 there were 1,800 active user accounts on the portal. The expectation and hope is that interest and usage will continue to grow throughout the crop insurance industry.

A large effort is also underway to develop the science needed to provide spatial data on humidity, solar radiation, and wind, which are needed to estimate water balance deficits and surpluses, important in determining crop stress conditions.

Figure 7. **Growth in the Number of PRISM/RMA Portal User Accounts**



Time history of the number of active PRISM/RMA portal user accounts from May 2012 to June 2014. The portal went online for "early adopter" testing in May 2011, and was opened to AIPs in March 2012. The number of accounts increased to about 250 by the summer of 2012, then grew gradually to about 650 by April 2014. In May 2014, Rain and Hail requested accounts for all of their 1,300 adjusters. As of June 2014, there were 1,800 registered users.

Public **Portal**

Based on RMA's vision of benefiting the wider community, PRISM has opened a new, expanded portal that is open to the general public. Its intended audience is users of spatial weather and climate data, and the emphasis is on providing datasets in the most efficient way possible. Both daily and monthly datasets are available, and are derived from the data used in the PRISM/RMA portal. For the more casual user who does not require actual data, many map images are provided to quickly illustrate what has been happening across the country recently, as well as in the more distant past. PRISM will shortly be adding images of drought conditions to its map gallery. The public portal URL is **http://prism.oregonstate.edu**.

What's Next

PRISM's relationship with RMA and the AIPs is expected to be a long-term one. Consequently, the next steps for PRISM development are numerous and wide-ranging. On the compliance side, plans for the web portal include adding: 1) information about National Weather Service severe weather warnings, useful in assessing hail and wind damage claims; 2) a custom report section for drought claims; 3) accumulated degree-day data to help identify critical crop development stages; and 4) more map-based products to better assess the spatial extent and patterns of unusual conditions. A large effort is also underway to develop the science needed to provide spatial data on humidity, solar radiation, and wind, which are needed to estimate water balance deficits and surpluses, important in determining crop stress conditions.

PRISM is also working to support crop insurance underwriting activities. A new model, called PRISM-EM (PRISM Environmental Model) uses PRISM climate data and soils information to identify areas of high and low risk for traditional crops, as well as new crops currently grown on limited acreage in the U.S., such as bio-fuel feedstocks (switchgrass, energycane, etc.). Such information will be useful in setting rates and determining where crop insurance should be offered.