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Up in the Air

Unmanned Aircrafts for Pipeline Safety and Monitoring

By Gregory Penza

Drones seem to be almost everywhere recently. Whether military personnel are using drones for national security issues or businesses are delivering packages to customers, these Unmanned Aerial Vehicles (UAVs) are filling the airspace quickly. In the oil and gas industry, UAV technology offers a broad range of benefits that allow the industry to improve in multiple areas. The foremost important one being to monitor the security and safety of pipeline infrastructure.

In 2015, the U.S. Federal Aviation Administration issued more than 1,000 exemptions allowing companies to safely operate commercial unmanned aerial systems (UAS). In order to fly a small UAS for commercial purposes the FAA requires that businesses file a 333 petition for exemption. This process is relatively lengthy. However, it ensures that businesses are held accountable to the health and safety of the communities they intend to fly over. A priority that is paramount to smooth operations in every aspect of work in the gas industry.

Currently, the FAA requires certain rules be followed for all UAS operators flying for commercial business purposes. These rules include:

- No unauthorized persons in the flight area.
- Observe a minimum safe altitude to allow for obstacle and terrain clearance.
- UAS operator must have a current pilot's license.
- All flights are limited to 400 ft maximum altitude.
- Visual line of sight operations only.
- The UAV must be below 55 lbs, operate at low speeds and operate at least 3 miles away from any airport.

Given the rules, the more advanced UAS come with cutting-edge software packages that are ready to be programmed and tailored for specific missions. Additionally, automatic flight ceilings, horizontal boundaries, speed and return to home points can all be pre-set to ensure the safety of the operators and the public. This means that inspecting oil and gas pipelines is even easier, because the technology to locate key features is already accessible at the pilot's fingertips. With the aid of high powered cameras, zoom lenses, gas sensors and additional sensing technology; data collection and transmission through Wi-Fi and radio frequency brings difficult to detect information to a client in a matter of minutes.

Benefiting the Industry

For those in the gas industry specifically, operating a UAS presents several options to revolutionize pipeline monitoring operations and can offer a range of new services that will improve worker and customer safety, reduce carbon footprints and ultimately cut costs.

When properly used, tethered UAS are beneficial for monitoring the security of transmission mains. Because the tether can provide power, data links and, of course, a tether to the ground, technicians can easily recognize potential security threats along the lengthy pipelines without having to worry about limitations set by battery life.

"The use of tethered drones has its advantages, most notable, with monitoring the security of gas transmission pipelines," says George Ragula, distribution technology manager for Public Service Enterprise Group (PSEG) in New Jersey. "Being able to monitor a long stretch of main and alert third parties of potential issues surrounding this sensitive territory is a valuable way to leverage drone technology."

Monitoring transmission pipelines is a difficult and often times a dangerous task for workers as well.

"For example, mains that run along a highway or in areas with thick brush means that reaching the main for visual inspection puts workers in danger," Ragula says. "Avoiding these difficult-to-access and right-of-way issues can be reduced significantly with an untethered UAS maneuvering where workers, helicopters and even tethered drones are at risk."

Transmission mains are not the only areas where UAS can provide effective, yet practical functions. In the highly trafficked areas of cities and suburbs, gas distribution utilities can monitor gas leaks, infrastructure and third party work with a UAS. As a result utilities are increasing worker and customer safety, reducing costs associated with site evaluation and inspection and ensuring that resources are being properly allocated.

Additionally, UAS operators are able to monitor gas leaks in hard to access, dangerous areas such as under bridges, which would once put workers at risk. Now those same inspections can be performed without ever having to take your feet off the ground.

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EXTENDED RANGE FORECAST OF ATLANTIC SEASONAL HURRICANE ACTIVITY AND LANDFALL STRIKE PROBABILITY FOR 2016

By Philip J. Klotzbach
With special assistance from William M. Gray

We anticipate that the 2016 Atlantic basin hurricane season will have approximately average activity. The current weakening El Niño is likely to transition to either neutral or La Niña conditions by the peak of the Atlantic hurricane season. While the tropical Atlantic is relatively warm, the far North Atlantic is quite cold, potentially indicative of a negative phase of the Atlantic Multi-Decadal Oscillation, We anticipate a near-average probability for major hurricanes making landfall along the United States coastline and in the Caribbean. As is the case with all hurricane seasons, coastal residents are reminded that it only takes one hurricane making landfall to make it an active season for them. They should prepare the same for every season, regardless of how much activity is predicted.

ATLANTIC BASIN SEASONAL HURRICANE FORECAST FOR 2016

Forecast Parameter And 1981-2010 Median (in parentheses)	Issue Date 14 April 2016	Observed Activity Through March 2016	Total Seasonal Forecast (Including Alex)
Named Storms (NS) (12.0)	12	1	13
Named Storm Days (NSD) (60.1)	50	2	52
Hurricanes (H) (6.5)	5	1	6
Hurricane Days (HD) (21.3)	20	1	21
Major Hurricanes (MH) (2.0)	2	0	2
Major Hurricane Days (MHD) (3.9)	4	0	4
Accumulated Cyclone Energy (ACE) (92)	90	3	93
Net Tropical Cyclone Activity (NTC) (103%)	95	6	101

*Hurricane Alex formed in January 2016. Over the remainder of the document, our seasonal forecast numbers refer to TCs forming after Alex.

PROBABILITIES FOR AT LEAST ONE MAJOR (CATEGORY 3-4-5) HURRICANE LANDFALL ON EACH OF THE FOLLOWING COASTAL AREAS:

1) Entire U.S. coastline-50% (average for last century is 52%)
2) U.S. East Coast Including Peninsula Florida-30% (average for last century is 31%)
3) Gulf Coast from the Florida Panhandle westward to Brownsville-29% (average for last century is 30%)
4)

PROBABILITY FOR AT LEAST ONE MAJOR (CATERGORY 3-4-5) HURRICANE TRACKING INTO THE CARIBBEAN (10-20˚N, 60-88˚W)

1) 40% (average for last century is 42%)

Information obtained through March 2016 indicates that the 2016 Atlantic hurricane season will have activity near the median 1981-2010 season. We emphasize that there is a large uncertainty in this prediction.

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Hydraulic Fracturing Drinking Water Draft Assessment

Part 1 of a 6 part series.

Since the early 2000s, oil and natural gas production in the United States has been transformed through technological innovation. Hydraulic fracturing, combined with advanced directional drilling techniques, made it possible to economically extract oil and gas resources previously inaccessible. The resulting surge in production increased domestic energy supplies and brought economic benefits to many areas of the United States.

The growth in domestic oil and gas production also raised concerns about potential impacts to human health and the environment, including potential effects on the quality and quantity of drinking water resources. Some residents living close to oil and gas production wells have reported changes in the quality of drinking water and assert that hydraulic fracturing is responsible for these changes. Other concerns include competition for water between hydraulic fracturing activities and other water users, especially in areas of the country experiencing drought, and the disposal of wastewater generated from hydraulic fracturing.

The U.S. Congress urged the U.S. Environmental Protection Agency (EPA) to study the relationship between hydraulic fracturing and drinking water. This report synthesizes available scientific literature and data to assess the potential for hydraulic fracturing for oil and gas to change the quality or quantity of drinking water resources, and identifies factors affecting the frequency or severity of any potential changes. This report can be used by federal, tribal, state, and local officials; industry; and the public to better understand and address any vulnerabilities of drinking water resources to hydraulic fracturing activities.

What is Hydraulic Fracturing?

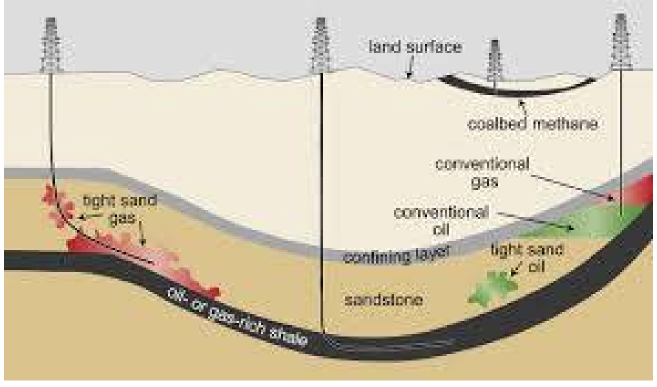
Hydraulic fracturing is a stimulation technique used to increase oil and gas production from underground rock formations. Hydraulic fracturing involves the injection of fluids under pressures great enough to fracture the oil-and-gas-producing formations. The fluid generally consists of water, chemicals, and proppant (commonly sand). The proppant holds open the newly created fractures after the injection pressure is released. Oil and gas flow through the fractures and up the production well to the surface.

Hydraulic fracturing has been used since the late 1940s and, for the first 50 years, was mostly used in vertical wells in conventional formations. Conventional formations often allow oil and natural gas to flow to the wellbore without hydraulic fracturing and typically contain trapped oil and natural gas that migrated from other subsurface locations. Hydraulic fracturing can be used to enhance oil and gas production from these formations. In unconventional formations, hydraulic fracturing is needed to extract economical quantities of oil and gas. Hydraulic fracturing is still used in conventional settings, but the process has evolved; technological developments (including horizontal and directional drilling) have led to the use of hydraulic fracturing in unconventional hydrocarbon formations that could not otherwise be profitably produced (see Figure ES-1).

These formations include:

- **Shales.** Organic-rich, black shales are the source rocks in which oil and gas form on geological timescales. Oil and gas are contained in the pore space of the shale. Some shales contain predominantly gas or oil; many shale formations contain both.
- **Tight formations.** "Tight" formations are relatively low permeability, non-shale, sedimentary formations that can contain oil and gas. Like in shales, oil and gas are contained in the pore space of the formation. Tight formations can include sandstones, siltstone, and carbonates, among others.
- **Coalbeds.** In coalbeds, methane (the primary component of natural gas) is generally absorbed to the coal rather than contained in the pore space or structurally trapped in the formation. Pumping the injected and native water out of the coalbeds after fracturing serves to depressurize the coal, thereby allowing the methane to desorb and flow into the well and to the surface.

Figure ES-1. Schematic cross-section of general types of oil and gas resources and the orientations of production wells used in hydraulic fracturing.



Shown are conceptual illustrations of types of oil and gas wells. A vertical well is producing from a conventional oil and gas deposit (right). In this case, a gray confining layer serves to "trap" oil (green) or gas (red). Also shown are wells producing from unconventional formations: a vertical coalbed methane well (second from right); a horizontal well producing from a shale formation (center); and a well producing from a tight sand formation. Note: figure not to scale.

The combined use of hydraulic fracturing with horizontal (or more generically, directional) drilling has led to an increase in oil and gas activities in areas of the country with historical oil and gas production, and an expansion of oil and gas activities to new regions of the country.

Scope of the Assessment

We defined the scope of this assessment by the following activities involving water that support hydraulic fracturing (i.e., the hydraulic fracturing water cycle; see Figure ES-2):

- **Water acquisition**: the withdrawal of ground or surface water needed for hydraulic fracturing fluids;
- **Chemical mixing**: the mixing of water, chemicals, and proppant on the well pad to create the hydraulic fracturing fluid;
- **Well injection**: the injection of hydraulic fracturing fluids into the well to fracture the geologic formation;
- **Flowback and produced water**: the return of injectected fluid and water produced from the formation (collectively referred to as produced water in this report) to the surface, and subsequent transport for reuse, treatment, or disposal; and
- **Wastewater treatment and waste disposal**: the reuse, treatment and release, or disposal of wastewater generated at the well pad, including produced water.

This assessment reviews, analyzes, and synthesizes information relevant to the potential impacts of hydraulic fracturing on drinking water resources at each stage of the hydraulic fracturing water cycle. Impacts are defined as any change in the quality or quantity of drinking water resources. Where possible, we identify the mechanisms responsible or potentially responsible for any impacts. For example, a spill of hydraulic fracturing fluid is a mechanism by which drinking water resources could be impacted.

Drinking water resources are defined within this report as any body of ground water or surface water that now serves, or in the future could serve, as a source of drinking water for public or private use. This is broader than most federal and state regulatory definitions of drinking water and encompasses both fresh and non-fresh bodies of water. Trends indicate that both types of water bodies are currently being used, and will continue to be used in the future, as sources of drinking water.

This assessment focuses on the potential impacts from activities in the hydraulic fracturing water cycle on drinking water resources.

We do this so federal, tribal, state, and local officials; industry and the public can better understand and address any vulnerabilities of drinking water resources to hydraulic fracturing activities. We do not address other concerns raised about hydraulic fracturing specifically or about oil and gas exploration and production activities more generally. Activities that are not considered include: acquisition and transport of constituents of hydraulic fracturing fluids besides water (i.e., sand mining and chemical production) outside of the stated water cycle; site selection and well pad development; other infrastructure development (i.e., roads, pipelines, compressor stations); site reclamation; and well closure. A summary and evaluation of current or proposed regulations and policies is beyond the scope of this report. Additionally, this report does not discuss the potential impacts of hydraulic fracturing on other water users (e.g., agriculture or industry), other aspects of the environment (e.g., seismicity, air quality, or ecosystems), worker health or safety, or communities. Furthermore, this report is not a human health risk assessment. It does

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Up in the Air

Continued from page 1.

Future of Inspection

Staying ahead of challenging problems in an age-old industry can establish a gas or energy utility with a UAS at the forefront of innovation. With new EPA regulations, green energy initiatives and other government mandates the oil and gas industry has pressure to pioneer new programs and initiatives that safeguard infrastructure, while continuing on a path of constant improvement.

Aubrey Anderson, aerospace engineer and head of drone operations for New York-based ULC Robotics Inc. says there's no end to discovering new uses and applications for drones in the energy industry.

“Innovation is the future of pipeline and utility inspection and the key to what has made ULC’s Research and Development Robotics Program so successful,” Anderson says. “We’re taking more than 15 years of gas leak inspection and robotic development experience and focusing it towards creating a new realm of aerial innovation customized for the gas and utility industries.”

When gas and energy utilities are seeking dynamic technologies to drive innovation and increase efficiency, UAS can provide exciting new opportunities and fulfill an essential duty—ensuring the security of pipeline infrastructure, employees and customers.

“One of the greatest advantages to utilizing UAS in the gas and utility industries is the ability to inspect hard to access areas in a safe and efficient manner without putting workers or customers in danger, all at an affordable rate,” Anderson said. “We can provide standard aerial visual surveillance and gas leak inspection for pipelines and utility systems or work to design custom solutions that meet a client's individual needs. The sky’s the limit. Up to 400 ft anyways.”

EXTENDED RANGE FOECAST OF ATLANTIC SEASONAL HURRICANE ACTIVITY AND LANDFALL STRIKE PROBABILITY FOR 2016

Continued from page 1.

We estimate that 2016 will have an additional 5 hurricanes (median is 6.5), 12 named storms (median is 12.0), 50 named storm days (median is 60.1), 20 hurricane days (median is 21.3), 2 major (Category 3-4-5) hurricanes (median is 2.0) and 4 major hurricane days (median is 3.9). The probability of U.S. major hurricane landfall is estimated to be about 90 percent of the long-period average. We expect Atlantic basin Accumulated Cyclone Energy (ACE) and net Tropical Cyclone (NTC) activity in 2016 to be approximately 95 percent of their long-term averages.

This forecast is based on an extended-range early April statistical prediction scheme that was developed utilizing 29 years of past data. Analog predictors are also utilized. We anticipate an average Atlantic basin hurricane season. While shear-enhancing El Niño conditions are likely to dissipate in the next several months, the far North Atlantic is quite cold. These cold anomalies tend to force atmospheric conditions that are less conducive for Atlantic hurricane formation and intensification.

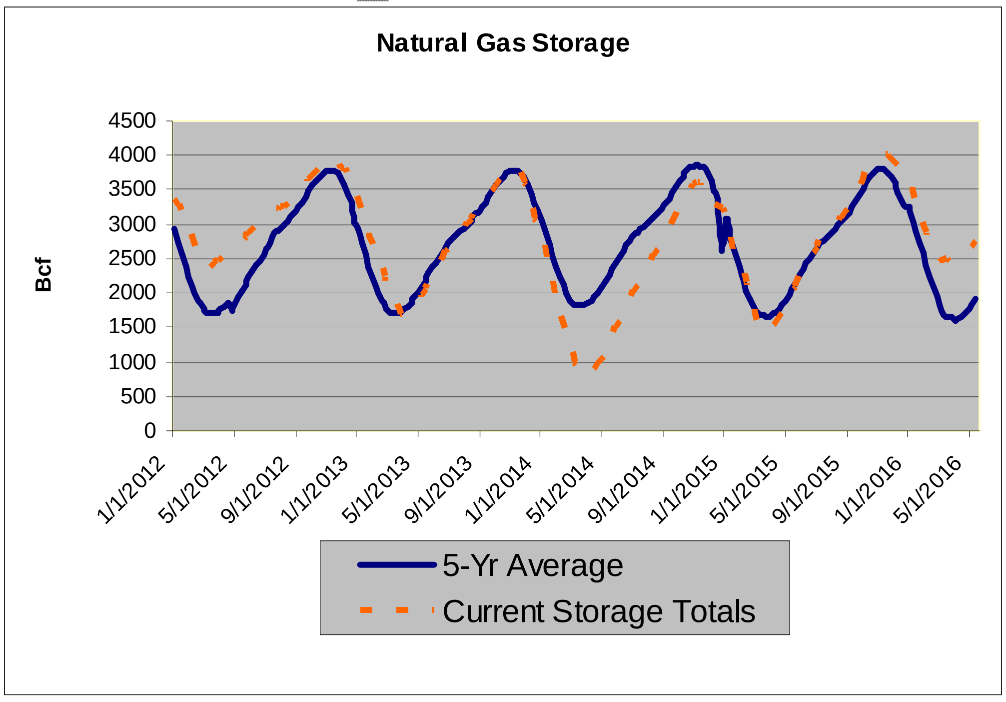
ABOUT CSU TROPICAL METEOROLOGY PROJECT

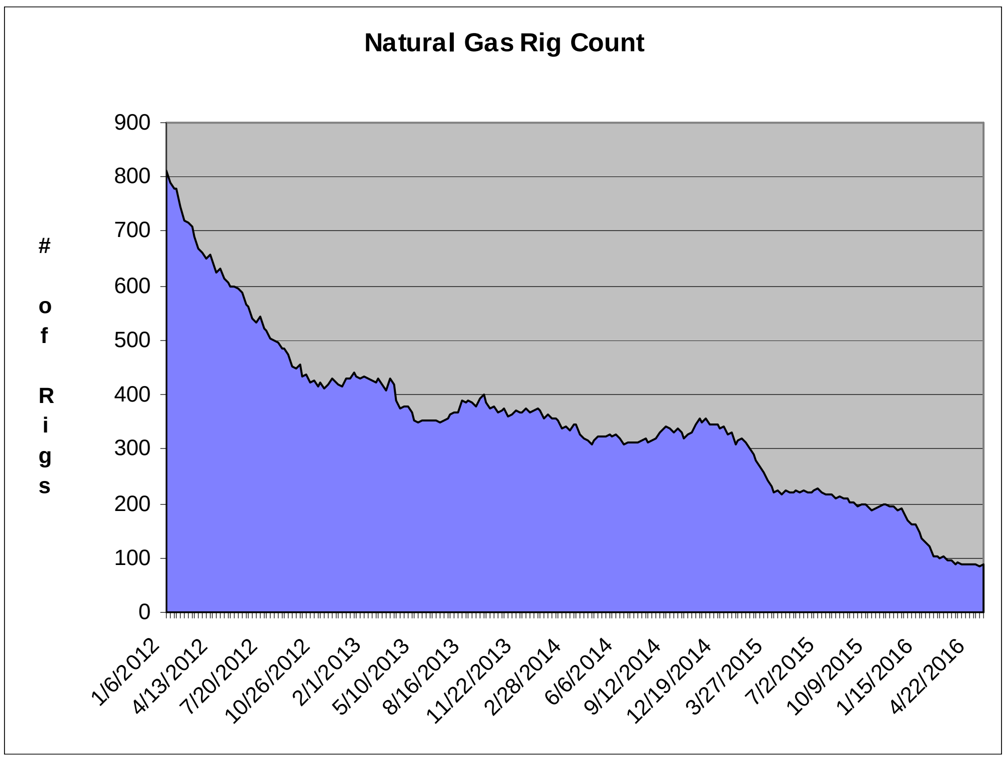
This is the 33rd year in which the CSU Tropical Meteorology Project has made forecasts of the upcoming season’s Atlantic basin hurricane activity. Our research team has shown that a sizable portion of the year-to-year variability of Atlantic tropical cyclone (TC) activity can be hindcast with skill exceeding climatology. This year’s April forecast is based on a statistical methodology derived from 29 years of past data. Qualitative adjustments are added to accommodate additional processes which may not be explicitly represented by our statistical analyses. These evolving forecast techniques are based on a variety of climate-related global and regional predictors previously shown to be related to the forthcoming seasonal Atlantic basin TC activity and landfall probability. We believe that seasonal forecasts must be based on methods that show significant hindcast skill in application to long periods of prior data. It is only through hindcast skill that one can demonstrate that seasonal forecast skill is possible. This is a valid methodology provided that the atmosphere continues to behave in the future as it has in the past.

The best predictors do not necessarily have the best individual correlations with hurricane activity. The best forecast parameters are those that explain the portion of the variance of seasonal hurricane activity that is not associated with the other forecast variables. It is possible for an important hurricane forecast parameter to show little direct relationship to a predictand by itself but to have an important influence when included with a set of 2-3 other predictors.

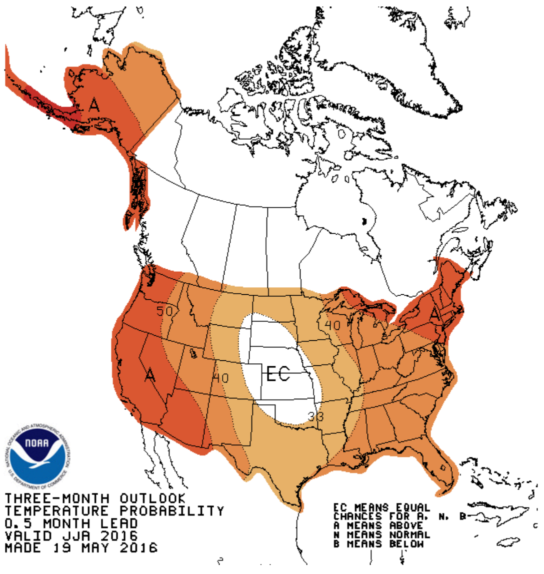
A direct correlation of a forecast parameter may not be the best measure of the importance of this predictor to the skill of a 3-4 parameter forecast model. This is the nature of the seasonal or climate forecast problem where one is dealing with a very complicated atmospheric-oceanic system that is highly non-linear. There is a maze of changing physical linkages between the many variables. These linkages can undergo unknown changes from weekly to decadal time scales. It is impossible to understand how all of these processes interact with each other. No one can completely understand the full complexity of the atmosphere-ocean system. But, it is still possible to develop a reliable statistical forecast scheme which incorporates a number of the climate system's non-linear interactions. Any seasonal or climate forecast scheme should show significant hindcast skill before it is used in real-time forecasts.

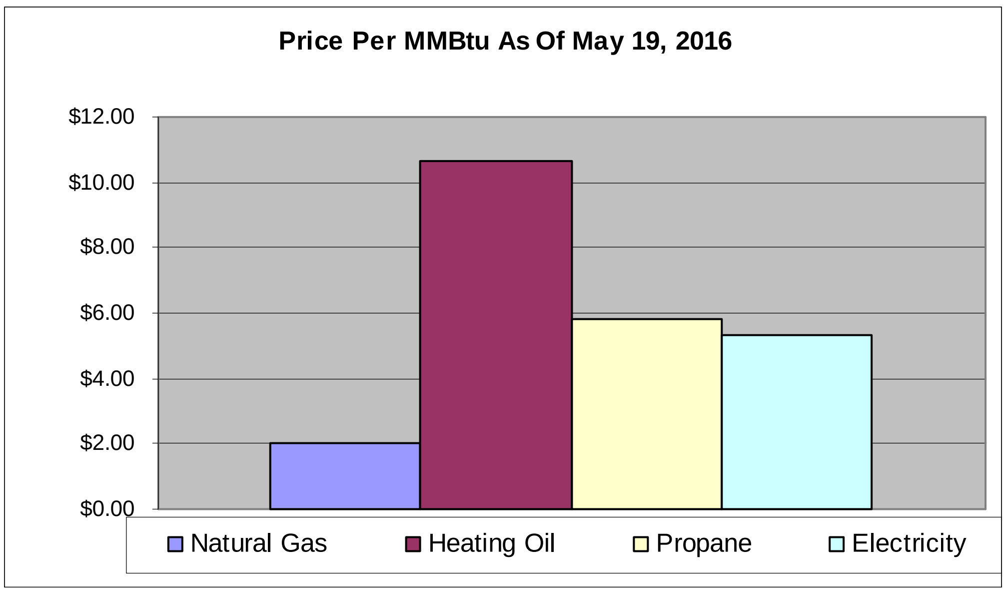
Snapshots





Seasonal Temperature Outlook
June – July – August





2016 US summer forecast: More 90-degree days than normal to scorch East; West to battle drought, fires

AccuWeather

As a strong El Niño fades, the weather across the country will slowly change. In much of the eastern United States, a hot summer is in store.

Rain and thunderstorms will dominate the pattern in the central and southern Plains, while the opposite occurs in California and the Northwest, and scarce rainfall leads to severe drought conditions.

Heat will come on strong in June for the Northeast and mid-Atlantic, including in New York City, Boston, and Hartford, Connecticut. However, severe weather in July could turn the warm pattern on its head.

“July is a tricky month where there may be a few cool-downs from thunderstorms and back door fronts, but other than that I think June, July and August, you’ll see your series of heat waves,” AccuWeather Expert Long-Range Forecaster Paul Pastelok said.

For the season, the intense heat will lead to increasingly dry conditions, which could boost the fire threat across the Northeast.

Heat will also extend down into the Southeast and Gulf Coast; however, humidity will be higher than in areas farther north.

The lingering effects of El Niño will limit the chances of early season tropical development, but activity will ramp up during the month of August.

“With a trend toward a La Niña pattern, along with warming waters and less wind shear over the Gulf of Mexico, this can lead to impacts anywhere on the Gulf Coast and including the east coast of Florida,” Pastelok said.

After heavy spring rainfall for the Gulf Coast, above-normal rain for the summer season my lead to bouts of flooding.

Dryness and heat will be another common theme in the Midwest and northern Plains states.

Heat will develop late spring and early summer across these areas and tighten its grip throughout the season.

“Actually we are seeing evidence of this in parts of the region already,” Pastelok said. “If the rest of the spring works out as planned, then these areas may fall into a drought with frequent heat waves during the summer.”

Indianapolis, Indiana, Chicago and Minneapolis could enter a minor to moderate drought, he said.

While much of the country will endure above-normal temperatures this season, the southern Plains region my be the only exception.

Rainfall and thunderstorms will be frequent over this region, keeping temperatures at bay.

“Abnormally dry conditions already present in eastern New Mexico, the northern Texas Panhandle and southwestern Kansas are expected to persist, although there will be enough chances for rain to prevent conditions from deteriorating to widespread significant drought,” Pastelok said.

In the Southwest, a weaker monsoon season is forecast overall, despite a strong start in July. The pattern will quickly trail off in August, leading to normal to slightly above-normal precipitation.

Despite the rain, the risk for fires will be high due to increased wind.

Though the El Niño pattern brought much-needed rain to northern and central California, Southern California wasn’t quite as lucky. Drought will remain in this area and intensify into the summer season.

We have a long-term drought going on and we didn’t get much rain in Southern California, so Los Angeles, Burbank, Riverside-they’re still in drought conditions,. They’re going to feel the heat there,” Pastelok said.

Wildfires will also be a significant threat.

In the Northwest and much of central and Northern California, El Niño led to a wetter-than-normal winter, but it fell short of what was needed to eliminate the drought.

“The Northwest and northern California are coming off a good winter and spring with rainfall and snowfall,” Pastelok said.

However, it wasn’t enough to provide long-term relief.

Significant drought conditions may return in the middle and latter part of summer and may result in another year of rampant wildfires for northern California and the Northwest.

Hydraulic Fracturing Drinking Water Draft Assessment

Continued from page 2.

not identify populations that are exposed to chemicals, estimate the extent of exposure, or estimate the incidence of human health impacts.

Figure ES-2. The stages of the hydraulic fracturing water cycle.

Shown here is a generalized landscape depicting the activities of the hydraulic fracturing water cycle and their relationship to each other, as well as their relationship to drinking water resources. Arrows depict the movement of water and chemicals. Specific activities in the “Wastewater Treatment and Waste Disposal” inset are (a) underground injection control (UIC) well disposal, (b) wastewater treatment and reuse, and (c) wastewater treatment and discharge at a centralized waste treatment (CWT) facility. Note: Figure not to scale.

To be continued Summer 2016 Issue.