Global Water Monitor & Forecast Watch List

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Introduction

The ISciences Water Security Indicator Model (WSIM) monitors and forecasts water anomalies on a global basis. Each month we produce data and a report that document current conditions and provide forecasts with lead times from 1-9 months. WSIM has been run continuously since April 2011 and has been validated against subsequently observed data.

ISciences also provides assessments of the impacts of water anomalies on people, agriculture, and electricity generation. Detailed data and reports are available for purchase. Additional information and pricing is available upon request.

We have recently completed the latest Water Security Indicator Model (WSIM) analysis of global water anomalies using observed temperature and precipitation through June 2018 and an ensemble of forecasts issued the last week of June 2018. This edition of *Global Water Monitor & Forecast Watch List* presents a selection of regions likely to encounter significant water anomalies in the next few months.

All maps have half-degree resolution and depict our composite water anomaly index, which is based on WSIM estimates of soil moisture, evapotranspiration deficit, runoff, and total blue water anomalies. Shades of red indicate deficits and shades of blue indicate surpluses. Since different variables are used to estimate deficits and surpluses, it is possible for a single half-degree cell to register both a deficit and a surplus in a given month. These cases are depicted on the maps in shades of purple, with the more extreme value (deficit or surplus) used to determine the shade.

Deficits and surpluses are stated in terms of return period – a measure that characterizes the rarity of an anomaly. For example, a return period of 10 years indicates an anomaly that would occur, on average, once every ten years. Higher return periods indicate more extreme and, therefore, more disruptive anomalies. Anomaly levels correspond to return periods: abnormal=3-5 years, moderate=5-10 years, severe=10-20 years, extreme=20-40 years, and exceptional=greater than 40 years. Return period is computed by comparison to cell-specific distributions of data from 1950 through 2009.

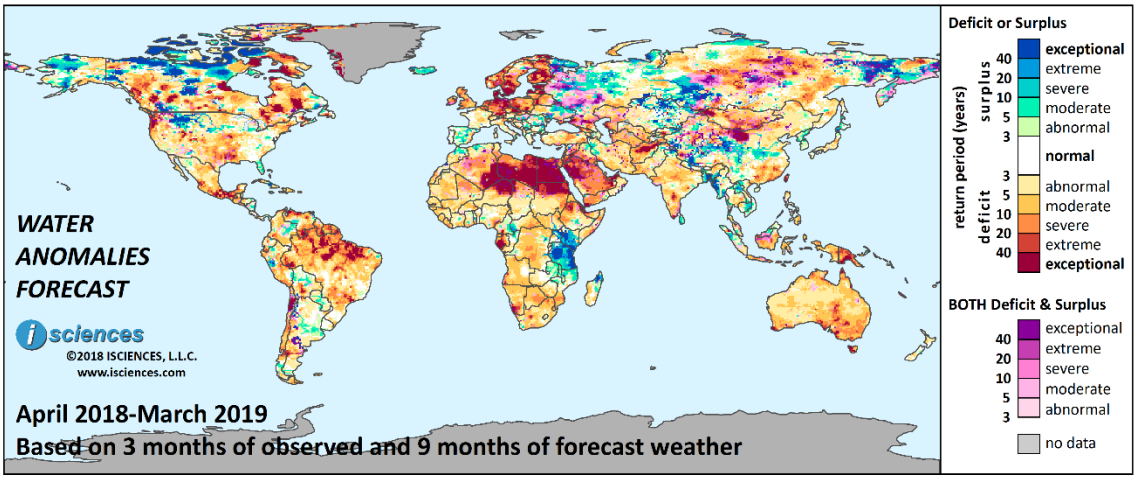
Please note that the WSIM model makes use of seasonal temperature and precipitation forecasts produced by the U.S. National Oceanic and Atmospheric Administration (NOAA) Climate Forecast System Version 2 (CFSv2). These forecasts predict broad temperature and precipitation patterns, but do not effectively predict singular events such as tropical storms. Detailed outlooks and analyses of tropical storms are available from NOAA National Hurricane Center.

There are numerous regions around the world where country borders are contested. ISciences depicts country boundaries on these maps solely to provide some geographic context. The boundaries are nominal, not legal, descriptions of each entity. The use of these boundaries does not imply any judgement on the legal status of any territory, or any endorsement or acceptance of disputed boundaries on the part of ISciences or our data providers.

Worldwide Water Watch List

This map presents a selection of regions likely to encounter significant water anomalies during the one year period beginning in April 2018 and running through March 2019 using 3 months of observed temperature and precipitation data and 9 months of forecast data.

ISCIENCES WORLDWIDE WATER WATCH LIST ISSUED JULY 2018



Watch List: Regional Synopsis

This synopsis provides highlights of regional water forecasts. More detailed analysis is available in "Watch List: Regional Details" immediately following the synopsis.

United States: The forecast through September indicates that, while exceptional water deficits will diminish overall and in the Southwest and Southern Rockies in particular, moderate to severe deficits are expected in a wide path from Missouri to the Gulf. Deficits may be intense in Louisiana, along the Arkansas and Canadian Rivers, and the Pacific Northwest coast. In the Northeast, deficits will persist and spread further in Maine. Significant surpluses will persist in the Northern Rockies, and surpluses will emerge in much of Florida.

Canada: Exceptional water deficits are forecast to decrease, though vast blocks will persist. These areas include: Quebec from the Caniapiscau Reservoir to the St. Lawrence River; surrounding Lake Mistassini, QC; Ontario's eastern border; northeastern Manitoba; the Lower Athabasca River region in Alberta; surrounding Prince George, British Columbia; and, northwestern BC. Intense surpluses will persist from northwestern Saskatchewan reaching west to Fort McMurray, Alberta, and in southeastern BC.

Mexico, Central America, and the Caribbean: Over the next few months, significant water deficits will emerge in southern Mexico including Michoacán, Guerrero, Puebla, Veracruz, Oaxaca, Tabasco, and Chiapas. Exceptional deficits will also reach into Central America, emerging in Guatemala, El Salvador, and western Honduras. Deficits will downgrade somewhat in western Cuba but intensify in Haiti and the Dominican Republic, and Jamaica will transition from surplus to deficit.

South America: Exceptional water deficits will diminish over the next few months but large pockets are forecast for Brazil in Acre, Rondônia, Pará, Tocantins, Goiás, western Minas Gerais, northern Mato Grosso do Sul, and São Paolo. Deficits elsewhere include: Venezuela surrounding Caracas; western Ecuador; a path from east of Lima, Peru through the Atacama Desert in Chile; and, along the Río Paraguay. Surpluses are forecast for Peru's Huánuco Region; central and eastern Colombia into Apure, Venezuela; southeastern Peru into central Bolivia; and, the eastern Argentine Pampas.

Europe: The forecast through September indicates that widespread water deficits in Central, Eastern, and Northern Europe will downgrade from exceptional levels in most affected regions but remain intense, especially in Central Europe and Finland. Deficits are expected to be extreme on many rivers including the Oder, Elbe, Danube, and Rhine. Surpluses are forecast for the Iberian Peninsula, parts of Eastern Europe and the Balkans, and European Russia.

Africa: Exceptional water deficits will shrink and downgrade across North Africa and along the Red Sea but deficits will remain widespread and intense. Intense deficits are also forecast for western Ethiopia, southern Gabon, northwestern Botswana, central Zambia, and western Madagascar. Exceptional surpluses will persist in East Africa; extreme surpluses are forecast for the conjoined borders of Cameroon, Central African Republic, and Republic of the Congo; and surpluses of lesser intensity are forecast for westernmost Democratic Republic of the Congo.

Middle East: The forecast through September indicates that water deficits will downgrade in the Levant but remain intense in West Bank and Lebanon, and deficits will intensify on the Arabian Peninsula. In Turkey, deficits will downgrade and shrink somewhat but much of Turkey will continue in moderate to severe deficit with some pockets of greater intensity. Exceptional deficits will persist in southern Iraq, and severe deficits west of the Euphrates River. In Iran, deficits will increase and become more intense.

Central Asia and Russia: In Central Asia, water deficits will increase and intensify in Turkmenistan, Uzbekistan, western Kazakhstan, and Tajikistan and extreme deficits will persist in central Kyrgyzstan. Surpluses are forecast for northern Kazakhstan and south of Lake Balkhash. In Russia, deficits will moderate in the Caucasus and North Caucasus. Severe deficits will increase along the Ural River around Orenburg. Surpluses are forecast along the Ob, Irtysh, and Ishim Rivers and the Upper Ob and Tom River Basins. Moderate surpluses are forecast for the Northern European Plain.

South Asia: Through September, exceptional water deficits will increase in Afghanistan, reaching the southern border to dominate roughly two-thirds of the country. Deficits in southern Pakistan are expected to shrink and moderate; moderate surpluses are forecast along the Indus River in the north. In India, primarily moderate deficits will persist in a wide band across the center of the country, but may be more intense in Madhya Pradesh, Chhattisgarh, Jharkhand, and Odisha. Deficits will increase and intensify in southern India. Surpluses in Bangladesh will shrink and downgrade.

Southeast Asia and the Pacific: The forecast indicates a transition away from widespread, intense water surplus to deficit. Deficits are forecast for peninsular Malaysia, Borneo, Sulawesi, New Guinea, Java, pockets in Sumatra, and eastern Mindanao. Deficits will diminish somewhat in northwestern Cambodia,

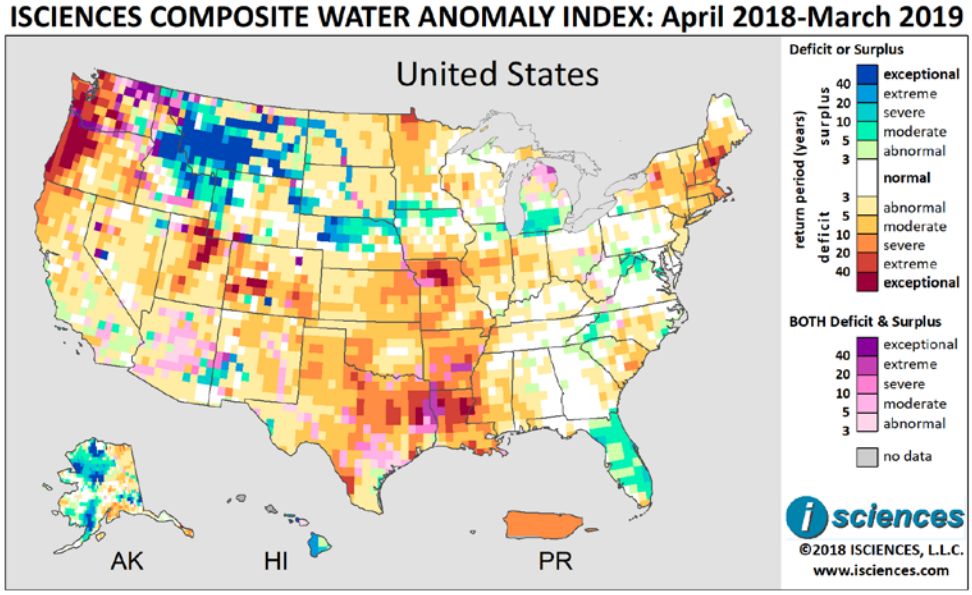
increase in southeastern Thailand, and emerge in Vietnam east of Hanoi and in central Myanmar. Surpluses are forecast for western and southern Myanmar, northern Laos, northwestern Vietnam, eastern Cambodia into Vietnam, central Philippines, and East Nusa Tenggara.

East Asia: Through September, exceptional water deficits in Mongolia, Inner Mongolia, and southern Xinjiang will diminish considerably, as well as in Southeast China and Taiwan. Moderate to severe deficits will persist in the Southeast with some pockets of exceptional deficit lingering in Hunan. Widespread surpluses will diminish overall, but surpluses of varying severity will persist in the Lower and Middle Reaches of the Yellow River, the Han River Basin, Qinghai, Yunnan, Hainan, and western Tibet.

Australia & New Zealand: Moderate water deficits, punctuated by more intense pockets, are expected across a large portion of eastern and southeastern Australia, scattered across the north, and in the southwest. Deficits may be intense in the southwest, and in the east near Adelaide and Melbourne, from Canberra to Sydney, and around Brisbane. Moderate deficits are forecast in New Zealand and intense deficits in New Caledonia.

Watch List: Regional Details

United States



Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

The 12-month forecast indicates intense water deficits in the Northeast, from Missouri to the Gulf, the Southern Rockies, and Pacific Northwest, and intense surpluses in the Northern Rockies.

In the Northeast, deficits are forecast through New York State to the Atlantic and will be especially intense in southern Maine. Some pockets of moderate deficit are also forecast in the Carolinas. Primarily moderate surpluses are expected throughout most of Florida except the Panhandle, and also in southern Michigan, eastern West Virginia, and western North Carolina.

In the center of the country, deficits of varying severity are forecast from Missouri south to the Gulf, including eastern Kansas, most of Oklahoma, Arkansas, Texas, and Louisiana. Deficits are expected to be intense in Louisiana, eastern Texas, and northern Missouri. Moderate deficits are forecast in Minnesota but may be more severe near the central Canadian border. Intense deficits are forecast for pockets of Utah and Colorado, and deficits will blanket much of western Oregon and western Washington. Deficits will be primarily moderate in northern California. Surpluses are forecast for much of Montana and central Idaho and are expected to be exceptional. Extreme surpluses are forecast for the Missouri and Yellowstone Rivers, moderate to exceptional surpluses for northern Nebraska, and generally moderate surpluses along the western border of Iowa and Minnesota.

Outside the contiguous US, extreme surpluses are forecast for Hawaii, and also Alaska in the northwest, from Bristol Bay well into the interior, and in the southeast in the upper reaches of the Copper and

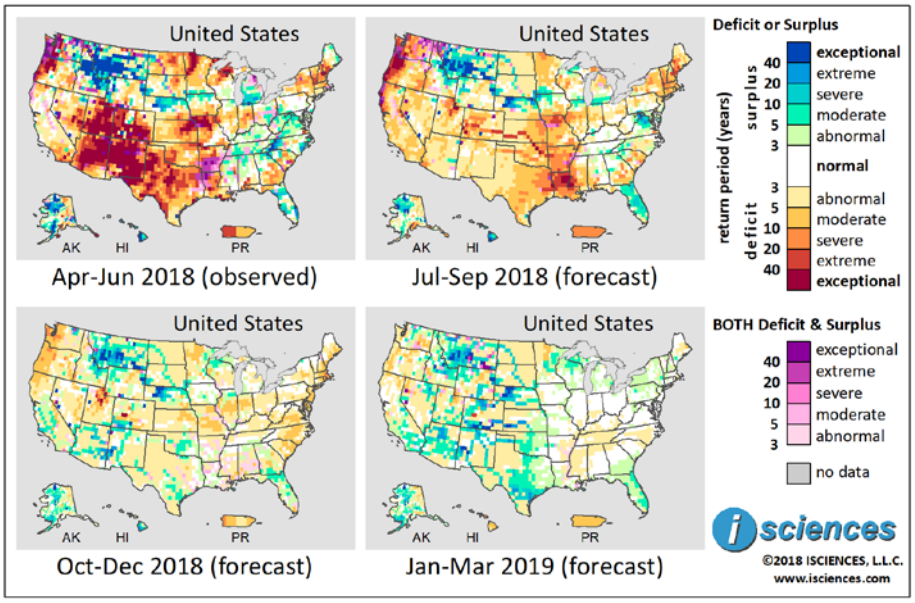
Susitna Rivers. Deficits are forecast around Anchorage and the Kenai Peninsula. In Puerto Rico, severe deficits are expected throughout the country.

The 3-month maps (below) show the evolving conditions in more detail.

The near-term forecast through September indicates that, while exceptional deficits will diminish overall and in the Southwest and Southern Rockies in particular, moderate to severe deficits are expected in a wide path from Kansas and Missouri through Oklahoma, Arkansas, eastern Texas, Louisiana, and eastern Mississippi. Deficits may be extreme to exceptional in northern Louisiana. Exceptional deficits are forecast along the Arkansas River through Nebraska and Colorado, and severe deficits are forecast along the Canadian River. Moderate deficits will emerge in many parts of California with more severe deficits along the northern coast. Deficits will increase in Oregon and Washington, remaining especially intense in western Oregon. On the opposite side of the country, deficits will persist in the Northeast and spread further into Maine. Moderate to severe deficits are forecast for pockets South Carolina and southern Georgia. Deficits in the Upper Midwest are expected to moderate.

Significant surplus conditions will persist in Montana and into Idaho, and northern Nebraska. Severe surpluses are forecast for the Missouri River and the border of Iowa and Minnesota. Surpluses will increase in Florida, covering nearly all of the state outside of the Panhandle, and will become more intense in northern Virginia. Surpluses of generally lesser intensity are forecast for southern Michigan and the western tip of Michigan's Northern Peninsula, and northern Illinois.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019



Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

From October through December, deficits will decrease nation-wide, leaving some intense deficits in northern Utah, and primarily moderate deficits in the Pacific Northwest, northern Minnesota,

northeastern Kansas, Missouri, central Illinois, and northern Indiana. Moderate deficits are also forecast scattered along the East Coast from Maine though the Carolinas. Surpluses will remain widespread in Montana, and will persist in surrounding states as previously described. Surpluses will diminish in Florida but emerge in northern Wisconsin, central Oklahoma, southeastern Texas, Arizona, New Mexico, southwestern Colorado, and pockets of central California.

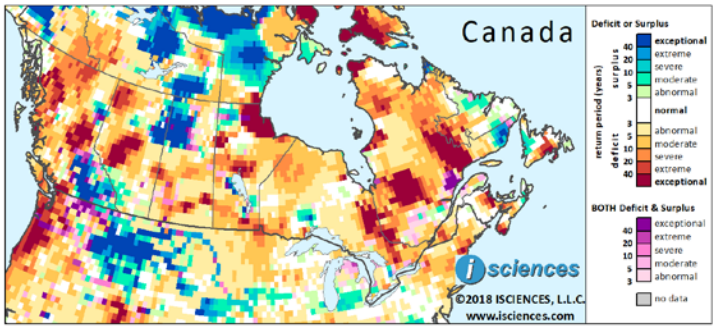
The forecast for the final months – January through March – indicates the emergence of surpluses in many parts of the western half of the country, including the Southwest, Texas, and along many rivers. Near-normal conditions are expected for most of the nation's eastern half, along with some surpluses in Florida and the Great Lakes States.

(It should be noted that forecast skill declines with longer lead times.)

Canada

The 12-month outlook for Canada through March 2019 (right) indicates water deficits of varying intensity in many parts of the country with the exception of southern British Columbia and northwestern Saskatchewan into Alberta, where intense surpluses are expected.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019



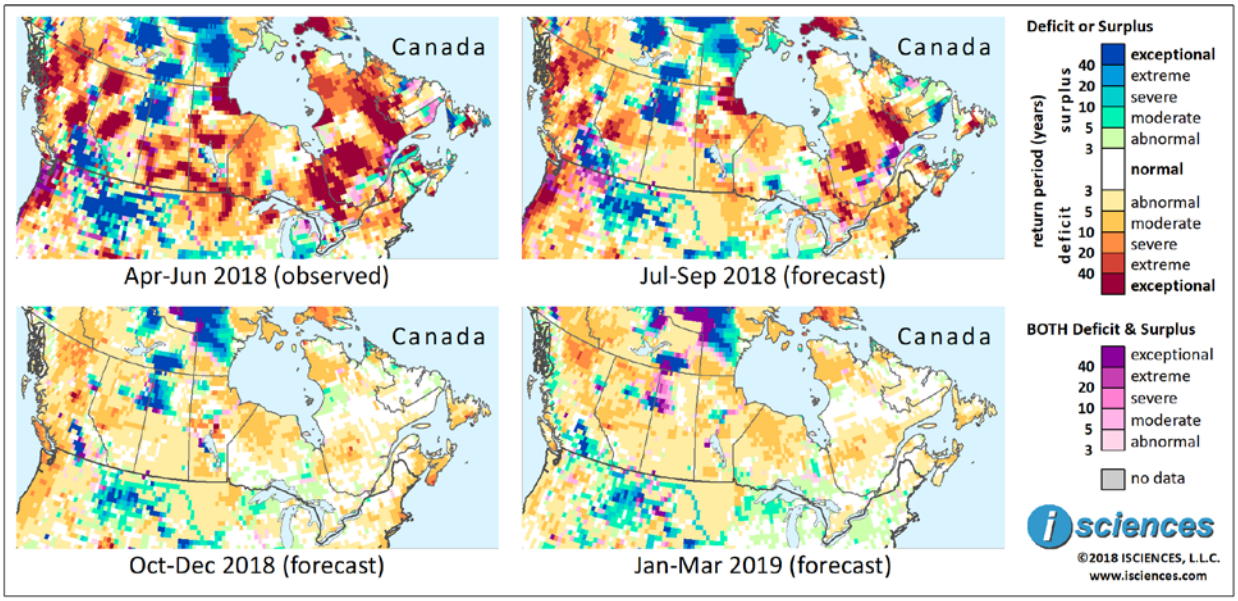
Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

Intense deficits are forecast to encompass vast blocks in: eastern Quebec from the Caniapiscau Reservoir to the St. Lawrence River; surrounding Lake Mistassini in central Quebec; Ontario's eastern border; northeastern Manitoba and north of Lake Winnipeg; the Lower Athabasca and Lower Peace River regions of Alberta; surrounding Prince George, British Columbia; and, northwestern BC. Though smaller than the aforementioned areas, pockets of intense deficit are also forecast in southern Saskatchewan and Manitoba including around Regina (SK) and Winnipeg (MB).

Exceptional surplus conditions are expected in a large block of northwestern Saskatchewan around Churchill Lake westward to Fort McMurray, Alberta; and surrounding Kamloops and Kelowna, BC.

The 3-month maps (below) show the evolving conditions in more detail.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019



Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

The forecast through September indicates some retreat of exceptional deficits overall. However, exceptional deficits will persist in Quebec from the Caniapiscau Reservoir to the St. Lawrence River and surrounding Lake Mistassini. Deficits will be moderate to severe around Montreal but could be extreme slightly east surrounding Sherbrooke. A wide path of both deficit and surplus conditions is forecast west of the St. Lawrence River.

In Ontario, deficits along the eastern border will shrink but persist and are expected to remain intense, though conditions around Ottawa will be moderate. Surpluses will increase around Lake Nipigon near Lake Superior, normal conditions are forecast northeast of Lake Superior to James Bay, and moderate deficits are expected elsewhere.

In the Prairie Provinces, moderate deficits are forecast for southern Manitoba but will be severe in the southeast and also north of Lake Winnipeg. Surpluses of exceptional intensity will persist in a vast block of northwestern Saskatchewan reaching west to Fort McMurray, Alberta. Deficits in the Lower Peace River Region of northwestern Alberta will downgrade, and while exceptional deficits will shrink in the Upper Athabasca Region intense conditions will persist. Intense deficits are also forecast to persist in northwestern BC and in a large pocket surrounding Prince George. Intense surpluses will persist in southeastern region of the province, and intense deficits in southern Vancouver Island and inland along the lower reaches of the Fraser River.

From October through December deficits nationwide are expected to decrease and moderate, leaving much of the eastern half of the country with normal to moderate conditions. Deficits may be more severe in Nova Scotia. Intense deficits are forecast for central Manitoba north of Lake Winnipeg and north of Prince George, BC, and deficits will be severe on Vancouver Island. Surpluses are expected to shrink in southeastern BC but remain exceptional around Kelowna. The large block of surplus in northwestern Saskatchewan will diminish and downgrade slightly but exceptional conditions will persist around Fort McMurray, Alberta.

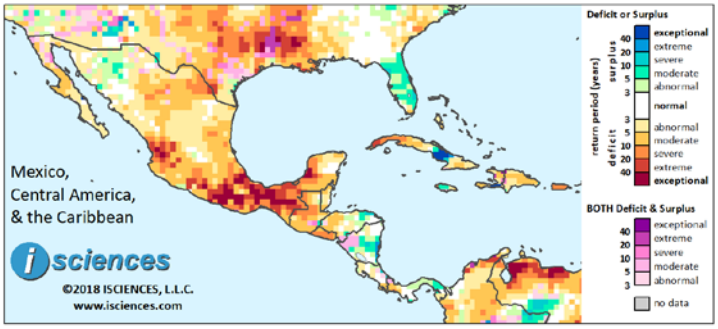
The forecast for the final three months – January through March – indicates a pattern of anomalies similar to the prior three-month forecast.

(It should be noted that forecast skill declines with longer lead times.)

Mexico, Central America, and the Caribbean

The 12-month forecast ending March 2019 (right) indicates severe to exceptional water deficits in southern Mexico. Primarily moderate deficits are forecast in the central north, and some mild surpluses are expected along the border of Sonora and Chihuahua in the northwest.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019



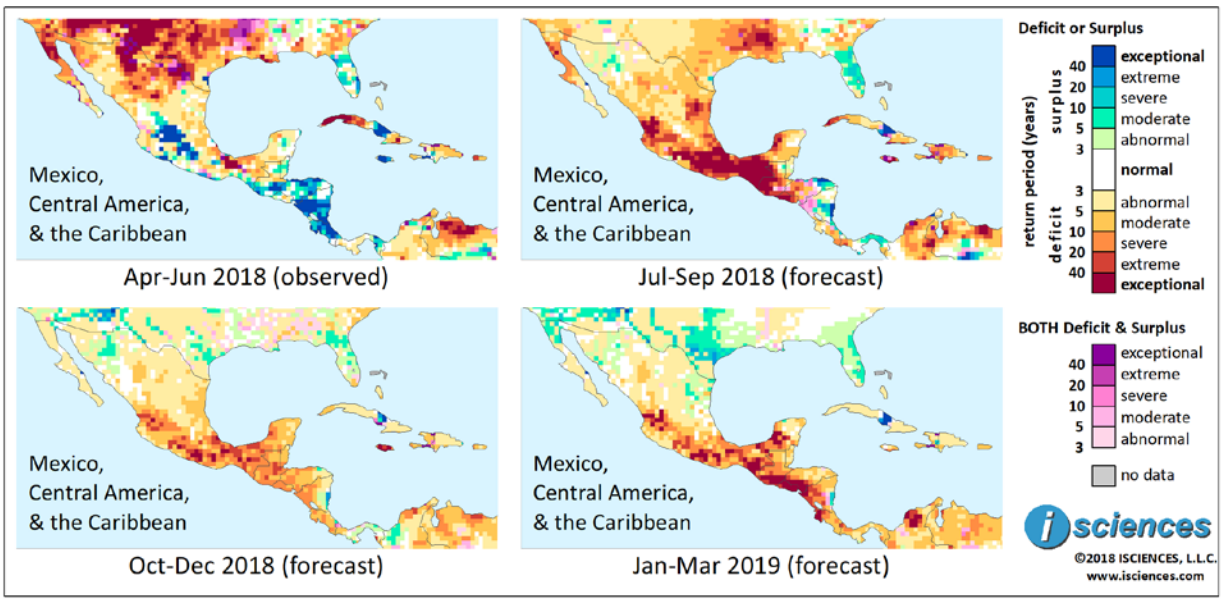
Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

In Central America, moderate to severe deficits are forecast for Guatemala and El Salvador. Surpluses are forecast in northeastern Honduras, central Nicaragua, and eastern Panama.

In the Caribbean, intense deficits are forecast for western Cuba and moderate deficits for much of Hispaniola. Surpluses are expected in central Cuba and Jamaica.

The 3-month maps (below) show the evolving conditions in more detail.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019



Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

The July through September map above indicates the emergence of significant deficits in southern Mexico. Widespread extreme to exceptional deficits are expected to emerge in Michoacán, Guerrero, Puebla, Veracruz, Oaxaca, Tabasco, Chiapas, and along the Gulf shore of the Yucatan Peninsula. Deficits

are also expected to be intense in Nayarit in the west and Tamaulipas in the east. Severe deficits will persist in the northern Baja Peninsula, moderate deficits are forecast in large pockets across northern Mexico, and moderate surpluses will emerge along the border of Sonora and Chihuahua.

Exceptional deficits will also reach into Central America, emerging in Guatemala, El Salvador, western Honduras, and with lesser intensity, Costa Rica. Surpluses are forecast for eastern Honduras, southeastern Nicaragua, and eastern Panama. In the Caribbean, deficits will downgrade somewhat in western Cuba but intensify in Haiti and the Dominican Republic. Conditions in Jamaica are forecast to transition from surplus to deficit.

From October through December deficits will downgrade slightly in Nayarit and southern Mexico, though conditions will be severe to extreme. Deficits are expected to moderate in Tamaulipas and downgrade to merely mild in Baja and much of northern Mexico. Moderate surpluses will increase along the Sonora/Chihuahua border areas, and will emerge along the Rio Grande in Chihuahua. Moderate to extreme deficits are forecast for most of Central America. Deficits will become intense in Jamaica, but downgrade in Cuba, Haiti, and Dominican Republic.

The forecast for the final three months – January through March – indicates that deficits in southern Mexico and Central America will intensify, with more pockets of exceptional deficit. Moderate surpluses will emerge in northern Baja and eastern Mexico, and along the Rio Grande to the Gulf.

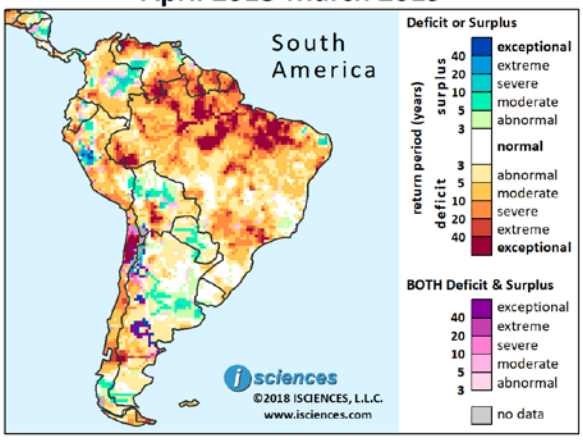
(It should be noted that forecast skill declines with longer lead times.)

South America

The 12-month forecast through March 2019 indicates significant water deficits in large pockets across northern Brazil, and many areas of moderate deficit elsewhere in the country and the continent. Deficits may be exceptional in the states of Amapá, Pará, Maranhão, Amazonas, and Acre, as well as farther south in São Paulo.

Significant deficits are also forecast for Guyana, Suriname, French Guiana, Venezuela, south-central Bolivia beginning near Cochabamba, northern Chile (Atacama Desert), and along the Chubut River in Patagonia.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019

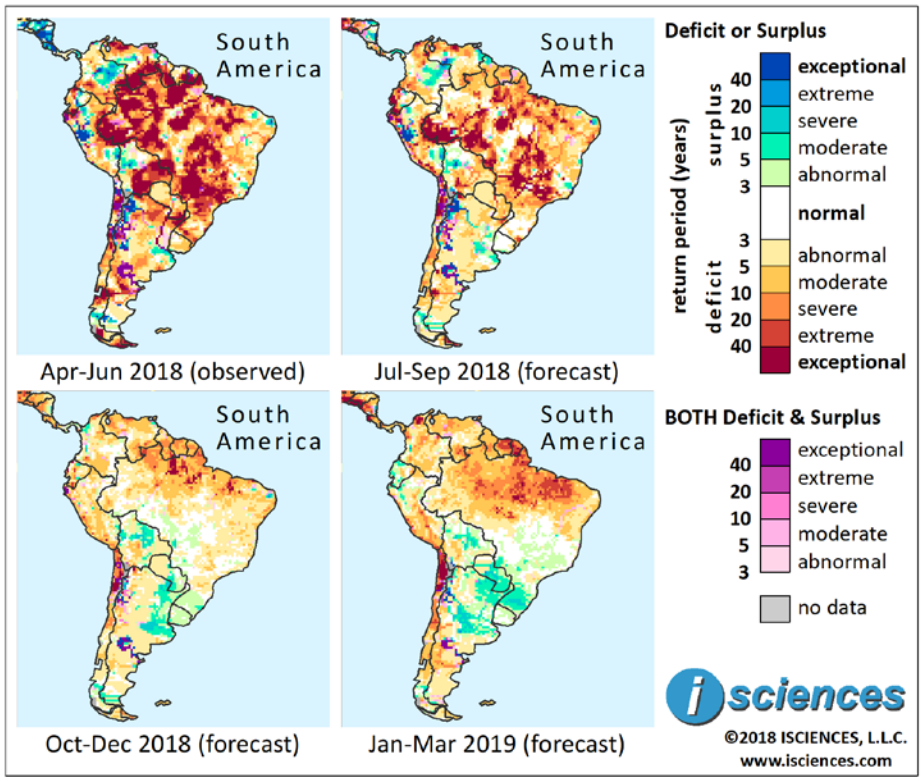


Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

Areas of surplus include: eastern Colombia into Venezuela; Huánuco Region of central Peru; Peru's border with Bolivia and well into central Bolivia; central Paraguay; Brazil's easternmost tip (Rio Grande do Norte); the Argentine Pampas and Neuquen, Argentina; and Patagonia surrounding O'Higgins/San Martín Lake and Rio Santa Cruz.

The 3-month maps (below) for the same 12-month period show the evolving conditions in greater detail.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019



Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

Though the extent of exceptional deficit will diminish in South America over the next several months, large pockets of intense deficit are forecast for Brazil in Acre, Rondônia, Pará, Tocantins, Goiás, western Minas Gerais, northern Mato Grosso do Sul, and São Paolo. Deficits are also expected to be intense along many rivers. Deficits of varying intensity are forecast for much of the remainder of the country.

A complicated patchwork of anomalies is forecast for the rest of the continent. Intense deficits are forecast for: Venezuela surrounding Caracas in the north; western Ecuador; along a dotted path from east of Lima, Peru through the Atacama Desert in Chile where both deficits and surpluses are expected as conditions change; and, the upper reaches of Río Chubut in Patagonian Argentina. Deficits in southern Bolivia will shrink and downgrade overall, and in neighboring Paraguay extreme deficits are forecast along the Río Paraguay in the center of the country. Deficits of varying severity are expected in many other regions.

Intense surpluses will persist in Peru's Huánuco Region, and in Salta, Mendoza, and Neuquén Provinces in Argentina. Surpluses elsewhere include: far eastern Venezuela and across the border into northern Guyana; central and eastern Colombia and into Apure Province, Venezuela; southeastern Peru into

central Bolivia; and, along the Río Salado in northwestern Argentina, the eastern Argentina Pampas, and southern Patagonia.

From October through December deficits will downgrade and diminish overall and surpluses will increase in central and southeastern regions of the continent. In Brazil, deficits will diminish in the nation's southern two-thirds with conditions becoming moderate or even normal. In the northern states, however, severe deficits are expected along with pockets of exceptional intensity. Primarily moderate deficits are forecast for Peru, Ecuador, much of Colombia, and Venezuela, but deficits may be more intense in Guyana, Suriname and French Guiana, as well as in northern Chile. Moderate to severe surpluses are forecast for north-central Bolivia; along the Río Paraguay; and Argentina's Iberá Wetlands, eastern Pampas, and southern Patagonia. Mild surpluses will emerge in Uruguay and neighboring Rio Grande do Sul, Brazil.

In the final quarter – January through March – severe to extreme deficits will increase in Brazil's northern half, Suriname, French Guiana, and Chile. Surpluses will increase in Paraguay, Rio Grande do Sul, Brazil and northern Argentina.

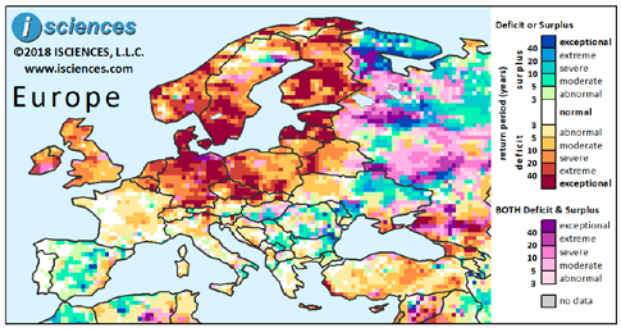
(It should be noted that forecast skill declines with longer lead times.)

Europe

The 12-month forecast indicates deficits blanketing much of Central, Eastern, and Northern Europe. Deficits are expected to reach exceptional intensity in many areas including Finland, southern Sweden, Estonia, Latvia, Denmark, Germany, and eastern Czechia.

Surpluses are forecast for parts of Ukraine, Moldova, Hungary, Serbia, Kosovo, Romania, Bulgaria, Spain, and European Russia.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019

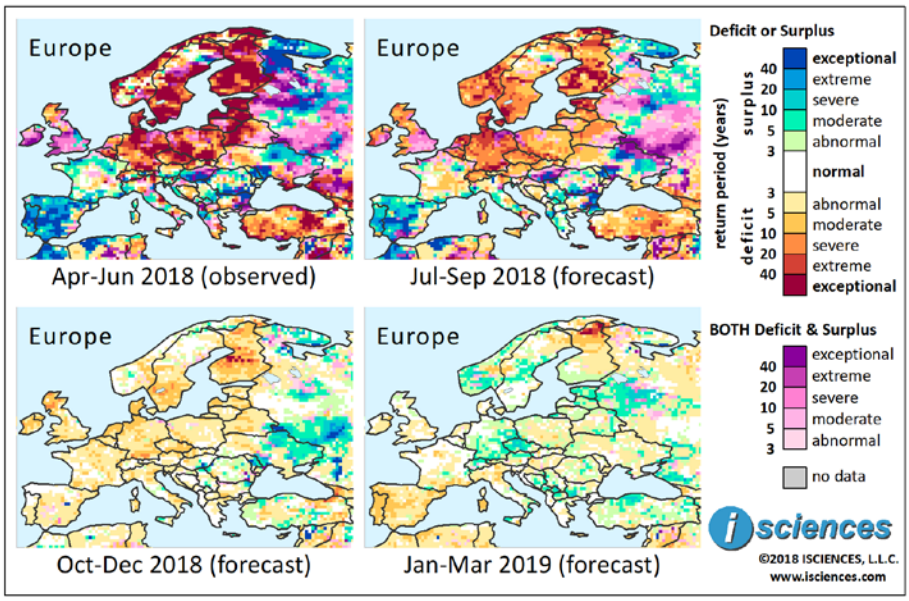


Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

Conditions of both deficit and surplus are also expected in European Russia as transitions occur.

The 3-month composites (below) for the same 12-month time period show the evolving conditions.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019



Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

The forecast through September indicates widespread deficits of varying severity in Central, Eastern, and Northern Europe, and though deficits will downgrade from exceptional levels in most of the affected regions, deficits will remain severe to extreme. Specifically, intense deficits are forecast for Finland, Sweden, Norway, Estonia, Denmark, Netherlands, Belgium, Germany, and Czechia. Deficits are expected to be extreme on many rivers including the Oder, Elbe, Danube, and Rhine. Moderate to

severe deficits are forecast for Ireland, Scotland, Wales, Switzerland, Austria, Poland, Slovakia, Lithuania, and Belarus. Moderate deficits are expected to increase in central France.

Surpluses will persist on the Iberian Peninsula and may be exceptional between the Tajo and Guadiana Rivers, and from Toledo south to Granada. Intense surpluses are also forecast for southern Hungary, Moldova, large pockets in Ukraine, southern Romania along the Danube, and eastern Bulgaria. Surpluses of lesser intensity are expected in pockets of the Balkans; along France's southern coast, and a pocket north of Dijon; and Piedmont, Tuscany, and Campania, Italy. In European Russia, surpluses ranging from moderate to exceptional are forecast but both deficits and surpluses are also expected as transitions occur.

As is evident in the paler coloration on the October through December forecast, water anomalies – both deficits and surpluses – are expected to diminish and downgrade considerably, leaving primarily mild to moderate deficits in Central, Eastern, and Northern Europe, and some surpluses Eastern Europe and Russia. However, severe to exceptional deficits are forecast for central Finland, and severe pockets in southern Germany and in Scotland. Conditions on the Iberian Peninsula will transition to normal or mild deficit. Surpluses are forecast for eastern Belarus, eastern Ukraine, central Moldova into Ukraine, southern Hungary, and northeastern Bulgaria, and may be especially intense in eastern Belarus. In European Russia, surpluses will persist around Rybinsk Reservoir and re-emerge in the Don River Basin, the Volga Uplands, and north of the Caucasus.

The forecast for the remaining months – January through March – indicates some moderate deficits on the Iberian Peninsula and some intense deficits in northern Finland. Moderate surpluses are forecast for Central Europe, parts of Northern Europe, the Baltics, and pockets of the Balkans, Eastern Europe, and western European Russia.

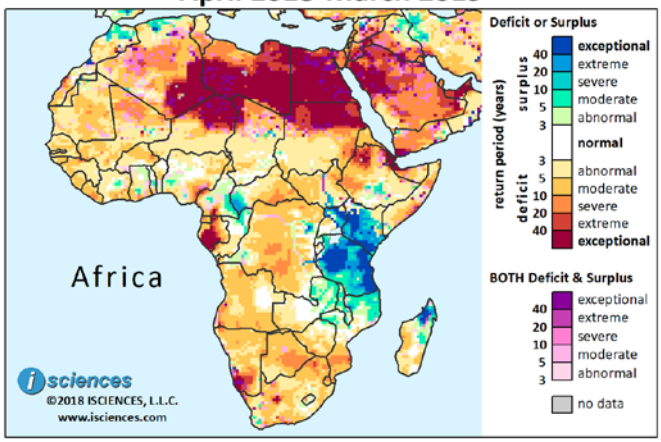
(It should be noted that forecast skill declines with longer lead times.)

Africa

The 12-month forecast (right) indicates exceptional water deficits in northern Africa from southeastern Algeria to the Red Sea. Intense surpluses are expected in East Africa.

Other areas of intense deficit include eastern Eritrea, Djibouti, westernmost Somaliland, northwestern Ethiopia, Gabon, and southwestern Namibia. Moderate deficits are forecast for many other parts of Africa, with areas of severe deficit in northern Algeria, northern Mali, western Ethiopia, south-central Democratic Republic of the Congo, eastern Botswana and southern Mozambique.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019

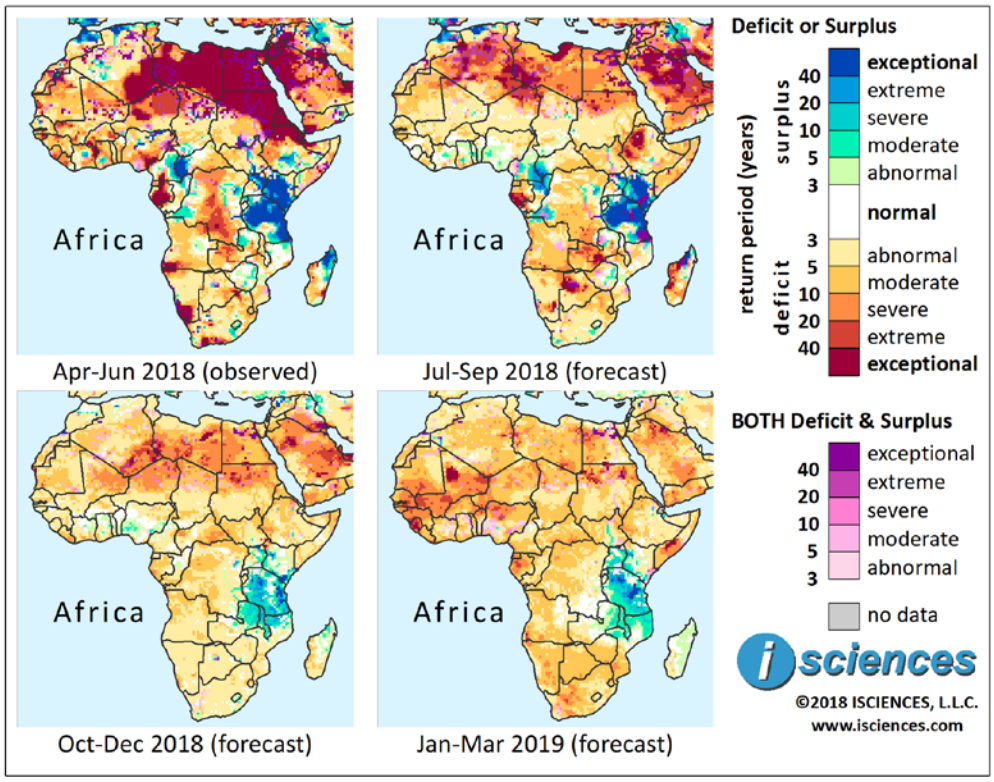


Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

In East Africa, severe to exceptional surpluses are forecast for Tanzania, northern Madagascar, Kenya, northern Uganda, the White Nile in southern South Sudan, and, to a lesser degree, western Central African Republic into Cameroon. Moderate surpluses are indicated for northern Zambia and northern Mozambique.

The 3-month maps (below) show the evolving conditions in greater detail.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019



Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

The forecast through September indicates that exceptional deficits will shrink and downgrade across North Africa and along the Red Sea. Exceptional deficits will persist along Libya's northeastern coast, including Benghazi; deficits nearly as intense at the intersection of Algeria, Libya, and Niger; and severe deficits in the remainder of Libya and in Egypt and northern Sudan. Intense deficits are forecast for western Ethiopia, and are expected to emerge in much of Algeria, though conditions of both deficit and surplus will intermingle in the north-central region. Surpluses will persist in northern Morocco and Algeria's central coast.

Mild deficits are forecast across the Sahel, and relatively normal conditions in West African nations along the northern shore of the Gulf of Guinea. Africa's southern half will remain a patchwork of water conditions. Exceptional deficits will persist in southern Gabon and emerge in northwestern Botswana. Intense deficits are also forecast in Zambia surrounding Lusaka and along the Kafue River. Deficits in western Madagascar will become extreme. Exceptional surpluses will persist in East Africa; extreme surpluses are forecast for the conjoined borders of Cameroon, Central African Republic, and Republic of the Congo; and surpluses of lesser intensity are forecast for westernmost Democratic Republic of the Congo.

The forecast for October through December indicates severe to extreme deficits across the Sahara and northern Sahel, primarily moderate deficits in central Africa, and mild deficits in the south. In East Africa,

surpluses will retreat considerably in Kenya and Uganda, downgrade to severe in Tanzania, and emerge in northern Zambia, Malawi, and northwestern Mozambique.

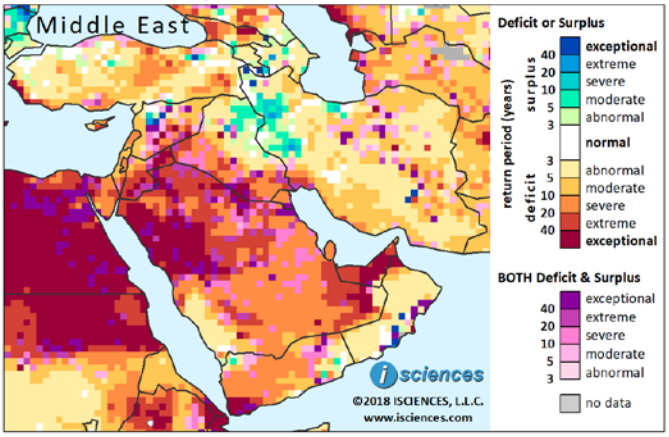
The forecast for the final quarter – January through March – indicates that deficits will moderate across the north; emerge with severe to extreme intensity in West Africa, Gabon, and southern Somalia; and intensify to primarily moderate levels in southern Africa. Little change is expected in surplus conditions in East Africa.

(It should be noted that forecast skill declines with longer lead times.)

Middle East

The forecast for the 12-month period ending March 2019 (right) indicates a range of intense deficits for many parts of the Arabian Peninsula and parts of the Levant, and relatively moderate conditions elsewhere in the region.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019



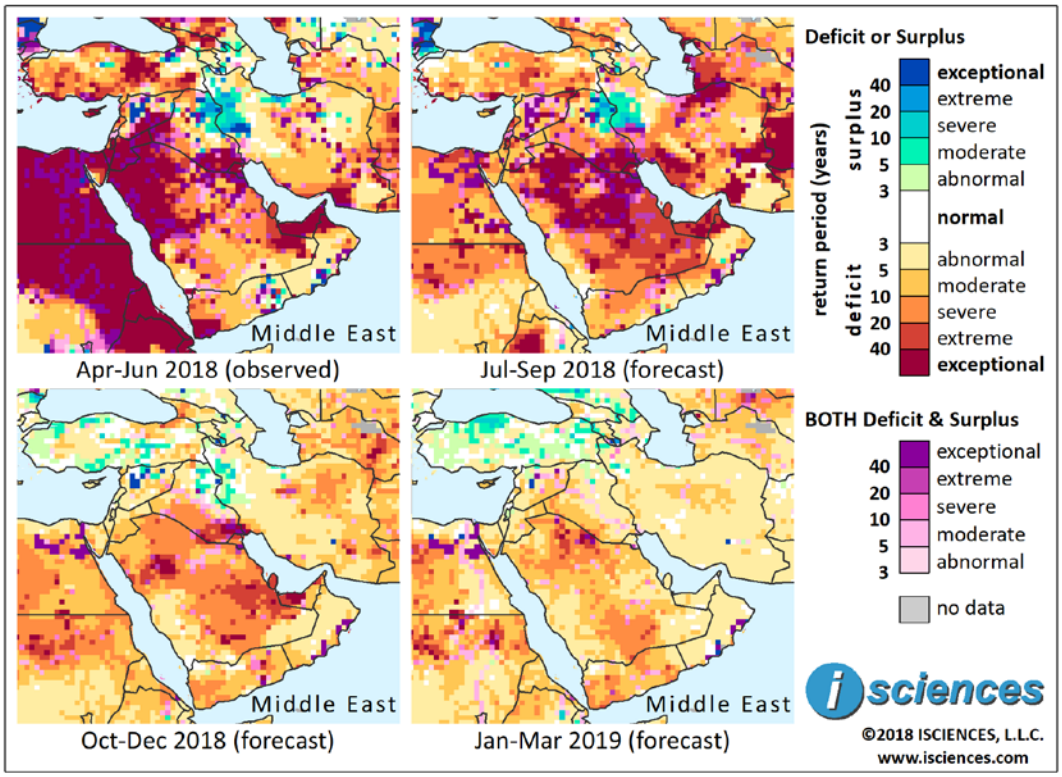
Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

Extreme to exceptional deficits are expected to dominate northern Saudi Arabia, Jordan, and United Arab Emirates. Primarily severe deficits are forecast for West Bank, Lebanon, Iraq west of the Euphrates River, Kuwait, southern Saudi Arabia, Qatar, and most of Yemen, though conditions will be exceptional in southwest Yemen.

Moderate to severe deficits are forecast for central and southeastern Turkey, and some exceptional deficits are expected along the western coast. Intense deficits are forecast for Turkey's northern neighbor, Georgia, and mixed conditions are forecast for Syria. Some surpluses are expected in a broad band encompassing the Iraq/Iran border, and moderate deficits are forecast for many other parts of Iran, though deficits in southern Khuzestan Province will be extreme.

The 3-month maps (below) show the evolving conditions in greater detail.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019



Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

The forecast for the next several months through September indicates that deficits in the Levant will downgrade but remain intense in West Bank and Lebanon. Exceptional deficits are forecast for much of northern Saudi Arabia and deficits in the south will intensify. Deficit conditions are expected to be extreme in Qatar, United Arab Emirates, and across the border into Oman. Moderate to severe deficits are forecast for southern Oman and for Yemen.

In Turkey and Cyprus deficits will downgrade and shrink somewhat but much of Turkey will continue in moderate to severe deficit with more intense pockets in the center of the country. Deficits will moderate in Georgia. Exceptional deficits are forecast to persist in southern Iraq and severe deficits west of the Euphrates River. In Iran deficits will increase and become more intense, with large blocks of exceptional deficits in the south along the Persian Gulf and near the Strait of Hormuz, from eastern Kerman Province to Afghanistan, and in the north along the western border of Turkmenistan. Surpluses will persist along the northern Iraq/Iran border.

From October through December exceptional deficits in Saudi Arabia will nearly disappear though severe to extreme deficits will persist. Deficits in southern Iraq will diminish only slightly but remain extreme to exceptional, and severe deficits will persist in the west. Extreme to exceptional deficits will

also persist in Qatar and western UAE, moderate to severe deficits will persist in Yemen, and deficits in Oman will downgrade to mild. Deficits will downgrade in the Levant as well, becoming mild overall, and in Iran, becoming mild to moderate with some more intense pockets in the east. Turkey is expected to transition away from deficits to scattered, moderate surpluses, including along the Sakarya River and along the Firat River south of Keban Dam Lake.

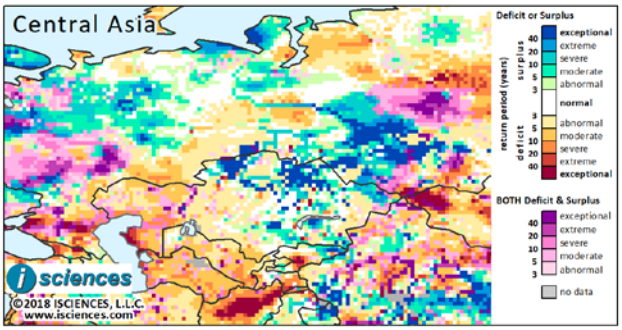
The forecast for the final quarter – January through March – indicates that deficits will diminish in much of the region, but persist in Saudi Arabia and Yemen. Pockets of moderate surpluses will increase in Turkey.

(It should be noted that forecast skill declines with longer lead times.)

Central Asia and Russia

The 12-month forecast indicates widespread surpluses reaching exceptional levels in the Upper Ob and Tom River Basins in Russia, severe surpluses along the Irtysh and Ishim Rivers, and moderate surpluses on the Lower Ob River. Severe surpluses are forecast for the Vakh River, a tributary of the Ob, but moderate to severe deficits are expected in the Bolshoy Yugan River watershed in the Middle Ob region.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019



Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

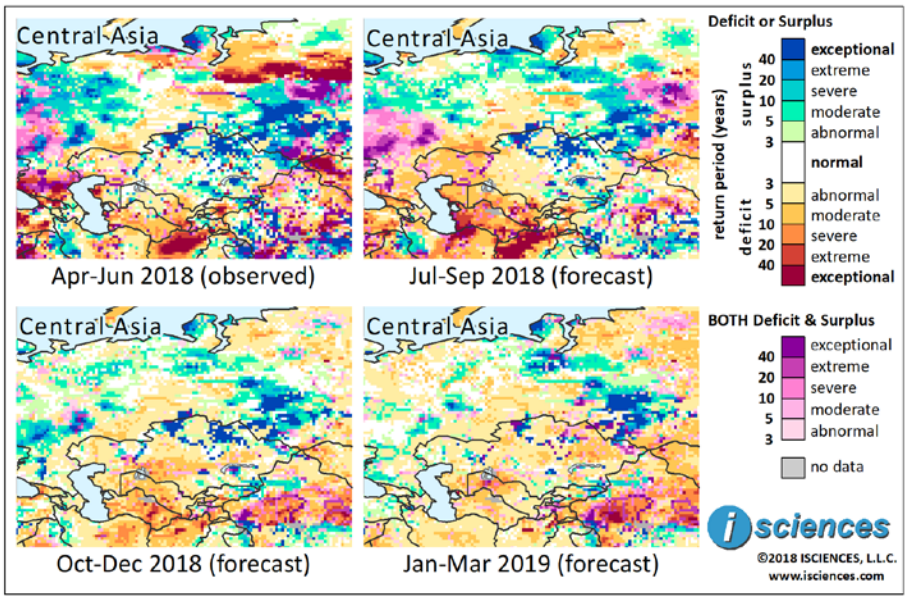
Moderate deficits are forecast in southeastern Yamal Peninsula and eastward, becoming more intense in the Central Siberian Plateau. Intense deficits are also forecast in the Caucasus, with both deficits and surpluses in the North Caucasus. Deficits are also forecast for the middle Ural River and may be severe around Orenburg.

In European Russia, widespread surpluses of varying severity are forecast in the north, and conditions of both surplus and deficits are expected in the south as transitions occur.

In Central Asia, deficits are forecast for Turkmenistan, much of Uzbekistan, western Kazakhstan, eastern Tajikistan, and central Kyrgyzstan, and will be especially intense in Kyrgyzstan and on the Caspian coast. Surpluses are forecast for eastern Kyrgyzstan and northern and eastern Kazakhstan.

The 3-month composites (below) for the same 12-month period show the evolving conditions in more detail.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019



Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

The forecast through September in Central Asia indicates that deficits will increase and intensify in Turkmenistan, Uzbekistan, western Kazakhstan, and Tajikistan and may be extreme in Turkmenistan and exceptional in southeastern Uzbekistan. Extreme deficits will persist in central Kyrgyzstan but surpluses are forecast in the east. Surpluses are also forecast for northern Kazakhstan and a pocket south of Lake Balkhash leading southeast along the Ili River.

In Russia, deficits will moderate in the Caucasus and North Caucasus. Severe deficits will increase along the Ural River around Orenburg, and a broad path of primarily mild deficits will emerge leading northeast to join more severe deficits in the Bolshoy Yugan River watershed in the Middle Ob region. Surpluses are forecast along the Ob, Irtysh, and Ishim Rivers and will be exceptional in the Upper Ob Basin west of Tomsk and also in the Tom River Basin. Deficits in southern Yamal and into the Central Siberian Plateau are expected to moderate and transition to surplus in some regions. In European Russia, moderate surpluses are forecast for much of the Northern European Plain, and conditions of both deficit and surplus (shown in purple) are expected in the south.

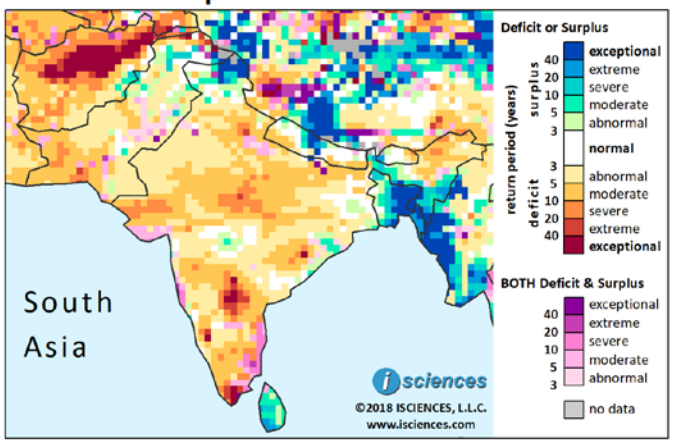
From October through December, deficits in Central Asia will downgrade somewhat but some areas of intense deficit will persist in Turkmenistan, and moderate to severe deficits will emerge in central Kazakhstan. In Russia, aforementioned deficits will downgrade to mild, though moderate deficits will persist along the Ural River around Orenburg and along the river's route through Kazakhstan to the Caspian Sea. Surpluses in northern European Russia will diminish but intense surpluses are expected to re-emerge in the Don River Basin and the Volga Uplands.

The forecast for the final months – January through March – indicates that both deficits and surpluses will generally diminish in Central Asia, and surpluses will diminish in western Russia but persist in the Ob River Basin.

(It should be noted that forecast skill declines with longer lead times.)

South Asia

The 12-month forecast indicates exceptional water deficits in Afghanistan's northern half and deficits of varying severity throughout much of the rest of the country. Moderate to severe deficits are forecast for southern Baluchistan, Pakistan.



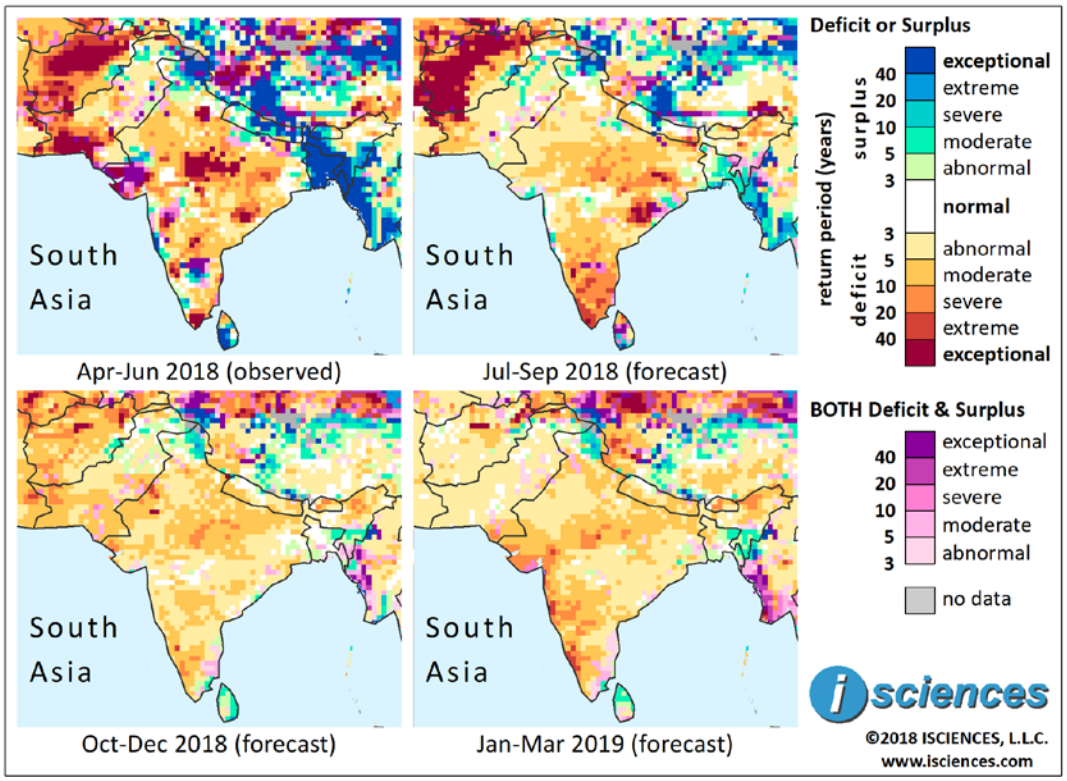
Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

In India, intense deficits are expected at the intersection of Karnataka, Telangana, and Andhra Pradesh, and also at the country's southernmost tip. Primarily moderate deficits are forecast in a vast band from Gujarat through the center of the county and into the Gangetic Plain, but deficits may be severe in northern Gujarat and central Madhya Pradesh. Deficits are also forecast for India's Far Northeast. Surpluses are forecast for Jammu and Kashmir in the north and Tripura and Mizoram in the far east.

Elsewhere in the region, surpluses are expected in Bangladesh that will be of exceptional intensity in the east, as will those in central Nepal along the Gandaki River. Primarily moderate surpluses are forecast for Sri Lanka.

The 3-month composites (below) show the evolving conditions in greater detail.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019



Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

From July through September exceptional deficits in Afghanistan, already widespread, will increase, reaching the southern border to dominate roughly two-thirds of the country. Deficits in southern Pakistan are expected to shrink and moderate, persisting in southwestern Baluchistan. Some moderate surplus is forecast along the Indus River in the north.

In India, primarily moderate deficits will persist in a wide band across the center of the country. But while deficits in Madhya Pradesh are expected to downgrade from exceptional, they will be severe. Severe deficits are also forecast for Chhattisgarh, and deficits may reach exceptional intensity in Jharkhand and southwestern Odisha. Deficits will increase and intensify in southern India, becoming severe to extreme, particularly in Kerala. Moderate to severe deficits are expected to emerge in the Far Northeast. Surpluses will shrink in Jammu and Kashmir.

Surpluses will also shrink in Nepal, persisting with exceptional intensity on the Gandaki River, and some deficits will emerge in the southwest and southeast. Bhutan will transition from surplus to mild deficit, and surpluses in Bangladesh will shrink and downgrade. In Sri Lanka, deficits are forecast in the north, and both deficits and surpluses in the south.

From October through December, deficits in Afghanistan will downgrade, becoming primarily moderate, but deficits may be severe along the Helmand and Harirud Rivers, and even more intense in a few

pockets in the north. Moderate deficits will increase across southern Pakistan, while surpluses along the Indus River in the north will transition to normal conditions. Primarily moderate deficits will continue to emerge across India's northern half, as well as in the Far Northeast. However, some more intense pockets are forecast in western Gujarat, Rajasthan, and central Madhya Pradesh. Deficits in the south are expected to moderate. In Nepal, conditions along the Gandaki River will transition from surplus to normal, and moderate deficits are forecast in much of the rest of the country. Deficits are also forecast for Bhutan, and may be severe in the west. Conditions in Bangladesh will return to near-normal, with some moderate surpluses in the east and across the border into India. Moderate surpluses are also forecast for Sri Lanka.

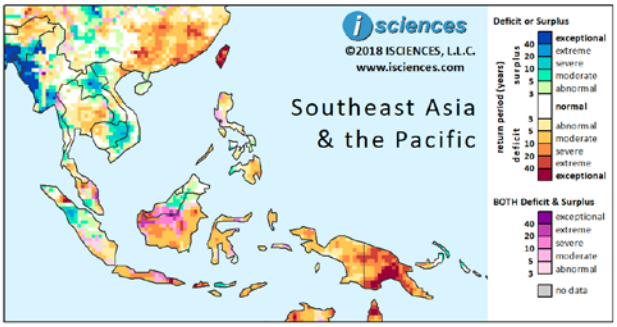
The forecast for the final period – January through March – indicates that deficits will diminish significantly in Afghanistan and Pakistan. Mild to severe deficits are forecast for India, Nepal, and Bhutan.

(It should be noted that forecast skill declines with longer lead times.)

Southeast Asia and the Pacific

The 12-month map (right) indicates intense water deficits in Papua New Guinea that may be exceptional around the Gulf of Papua. Intense deficits are also expected in West Nusa Tenggara, Indonesia. Deficits of varying severity are forecast for Indonesian Borneo, Sulawesi, Java, Timor, West Papua, pockets of peninsular Malaysia, northeastern Sumatra, eastern Mindanao and other parts of the Philippines, southeastern Thailand into northwestern Cambodia, and Vietnam east of Hanoi.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019

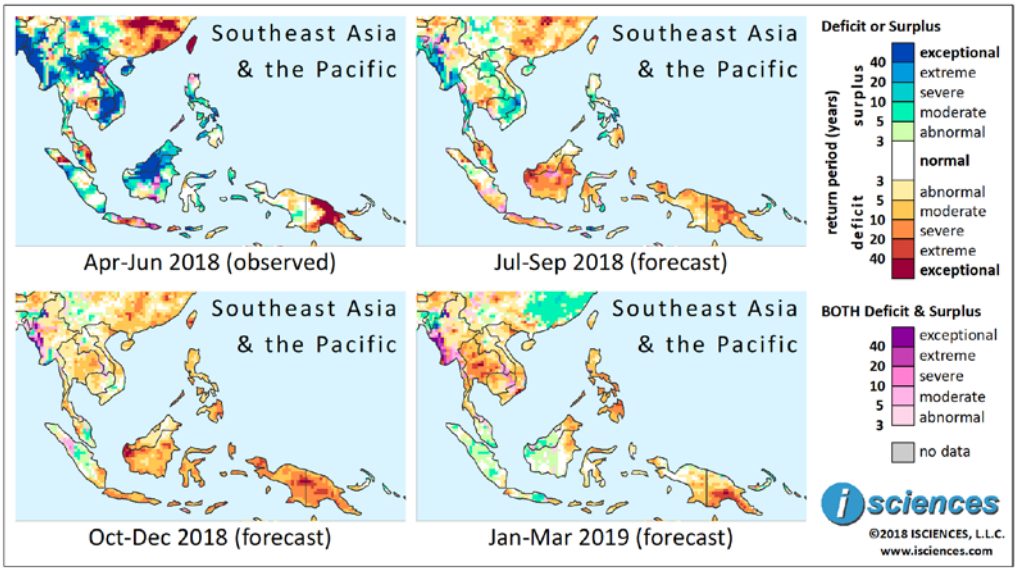


Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

Exceptional surpluses are forecast for western Myanmar. Surplus areas of varying severity include: southern Myanmar, northern Laos into northwestern Vietnam, eastern Cambodia reaching into Laos and Vietnam, Kuala Lumpur and across the Malacca Strait to north-central Sumatra, northeastern Malaysian Borneo, and East Nusa Tenggara.

The 3-month maps (below) show the evolving conditions in more detail.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019



Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

The near-term forecast through September indicates a transition away from widespread, intense surplus to deficit. Notably, moderate to extreme deficits are forecast for much of Borneo, Sulawesi, New Guinea, Java, pockets in Sumatra, and eastern Mindanao. Deficits are expected to increase in peninsular Malaysia. In Southeast Asia, deficits will diminish somewhat in northwestern Cambodia but will increase

nearby in southeastern Thailand. Moderate to extreme deficits will emerge in northern Vietnam east of Hanoi, and some moderate deficits will emerge in north central Vietnam and central Myanmar.

Surpluses are forecast for western and southern Myanmar, northern Laos, northwestern Vietnam, eastern Cambodia into Vietnam, central Philippines, and East Nusa Tenggara. Surpluses are expected to be especially intense in western Myanmar and along the Sittaung River, Vietnam's Central Highlands, and East Nusa Tenggara.

From October through December, surpluses will nearly disappear in the region, lingering along the Sittaung River in southern Myanmar and from the southern Malaysian Peninsula into central Sumatra. Moderate to extreme deficits are expected in the rest of Indonesia, Papua New Guinea, and Philippines, as well as pockets of Malaysia and southern Sumatra. Primarily moderate deficits are forecast for central Myanmar (Myitnge River), the eastern half of Thailand into Laos and western Cambodia, central Vietnam. Severe deficits will persist in a pocket of northeast Vietnam east of Hanoi.

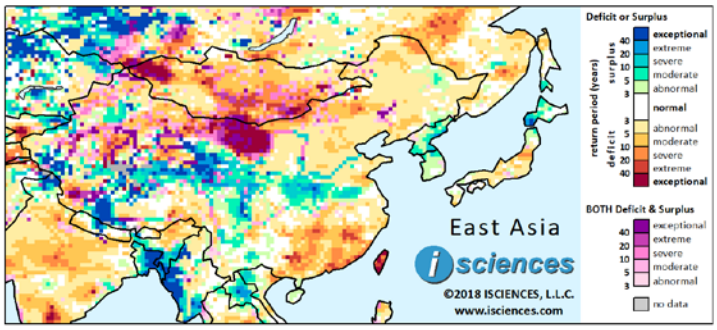
The forecast for the final months – January through March – indicates that deficits in Malaysia and Indonesia will diminish, transitioning to normal or moderate surplus conditions in many areas. Deficits are expected persist elsewhere in Southeast Asia, Philippines, and New Guinea.

(It should be noted that forecast skill declines with longer lead times.)

East Asia

The 12-month forecast for East Asia indicates exceptional water deficits in a large block of western Inner Mongolia and deficits nearly as intense in much of Taiwan. Moderate to exceptional deficits are forecast for Mongolia and moderate to extreme deficits in Southeast China.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019



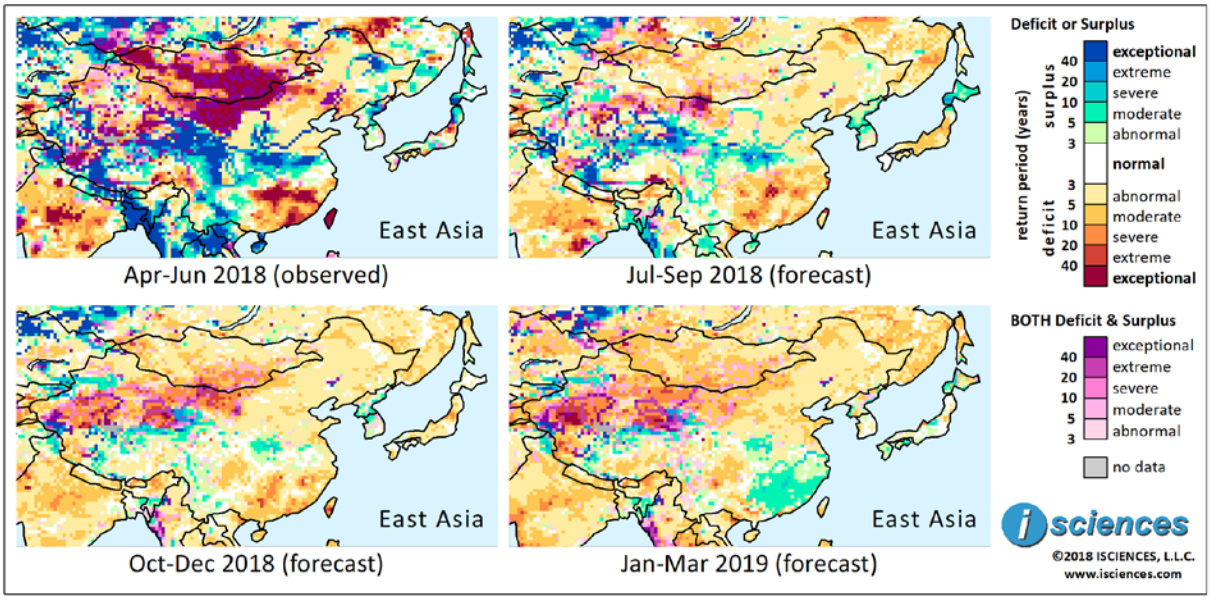
Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

Severe surpluses are expected along the Hudi River in Anhui leading west to surpluses in the Han River Basin (Hanjiang), an eastern tributary of the Yangtze, which may be extreme in Henan. Farther west, surpluses reaching exceptional intensity are forecast throughout much of Qinghai and central Sichuan. Along the Yellow River (Huang), severe surpluses are forecast on the middle and lower reaches. In southern China, severe surpluses are forecast in the Nanpan River Basin in eastern Yunnan and the Jinsha (Yangtze) in northwestern Yunnan. Surpluses are expected to reach exceptional intensity in western Tibet and along the western Yarlung River (Brahmaputra) north of Nepal.

Surpluses are forecast for North Korea, northern South Korea, and western Hokkaido, Japan.

The 3-month time series maps below show the evolving conditions in more detail.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019



Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

The near-term forecast through September indicates that the extent of exceptional deficits in Mongolia and Inner Mongolia through southern Xinjiang will diminish considerably, as well as in Southeast China and Taiwan. A large pocket of exceptional deficits will persist in western Inner Mongolia mixed with conditions of both deficit and surplus as transitions occur. In the Southeast, moderate to severe deficits will persist in Guizhou, Hunan, Guangxi, Jiangxi, Guangdong, Jiangxi, Fujian, Zhejiang, Hong Kong, and Taiwan, with some pockets of exceptional deficit lingering in Hunan.

Surpluses on the Lower and Middle Reaches of the Yellow River will downgrade, and while the extent of exceptional surpluses will shrink in Qinghai, intense surpluses will persist. Surpluses in the Han River Basin will also diminish and downgrade, but intense surpluses remain in the forecast for western Henan, southern Shaanxi, and southern Gansu. Downgrades are also forecast for the Nanpan River in eastern Yunnan and the Jinsha River (Yangtze) in northwestern Yunnan, though surpluses will be severe in the northwest. Exceptional surpluses are forecast in western Tibet and along the western Yarlung (Brahmaputra) River, with deficits in eastern Tibet. Surpluses in Hainan will moderate.

Primarily moderate surpluses are forecast for North Korea and northern South Korea. In Japan, surpluses are forecast for Hokkaido and moderate deficits in Honshu.

The forecast for October through December indicates that deficits will persist in Southeast China downgrading slightly; moderate deficits will emerge in Hainan and intense deficits will re-emerge in southern Taiwan. Deficits in southern Mongolia will become severe, and severe to extreme deficits will expand from western Inner Mongolia through Xinjiang, though some areas will exhibit both deficit and surplus. Surpluses will persist in aforementioned areas but will diminish. Conditions in Hokkaido are expected to normalize.

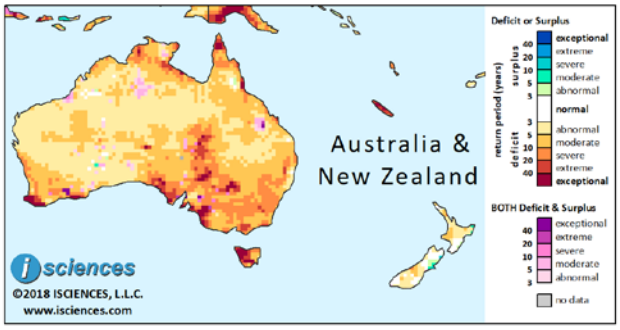
The forecast for the final months – January through March – indicates that conditions in Southeast China will transition from deficit to moderate surplus, but deficits elsewhere, as indicated in the preceding three-month forecast, will persist in China and Mongolia.

(It should be noted that forecast skill declines with longer lead times.)

Australia & New Zealand

The 12-month forecast (right) shows deficits of varying intensity covering much of eastern Australia, the far north, and southwest. Areas of intense deficit include: the southwestern tip of Western Australia, along the shore of South Australia, eastern SA, between the Darling and Lachlan Rivers in New South Wales, and Tasmania.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019



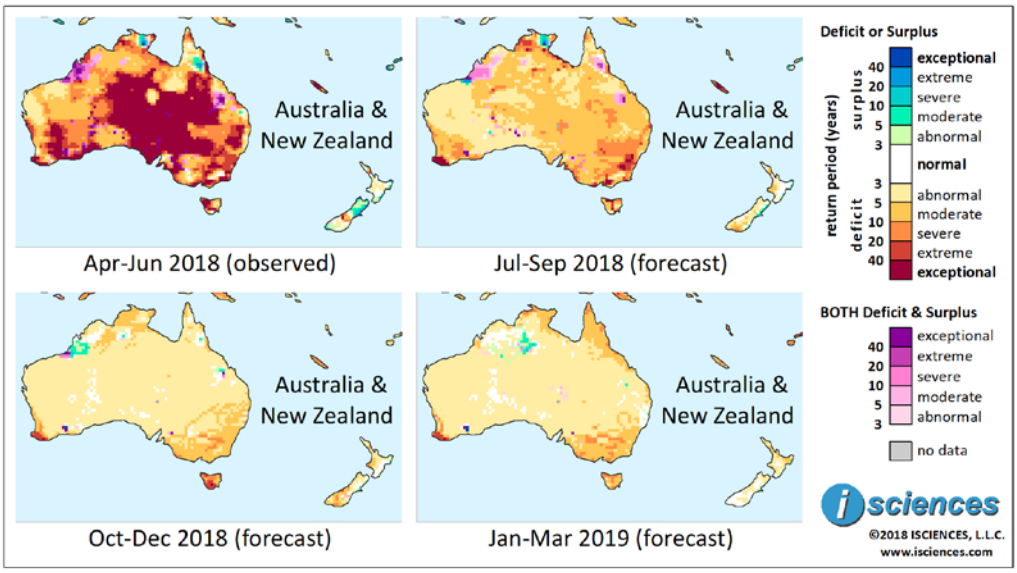
Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

Severe deficits are expected in parts of the Murray-Darling Basin.

Conditions in New Zealand are forecast to be relatively normal, with some pockets of moderate deficit north of Auckland and in the south around Aoraki/Mount Cook National Park, and surplus conditions near Christchurch. Significant deficits are forecast for New Caledonia.

The 3-month maps (below) show the evolving conditions in greater detail.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: April 2018-March 2019



Based on observed data through June 2018 and forecasts issued June 24-30, 2018.

As is apparent in the map series above, the forecast indicates that the exceptional deficits which have dominated a vast stretch of Australia in prior months will nearly disappear, though deficits of varying severity will persist. From July through September moderate deficits, punctuated by more intense pockets, are expected across a large portion of the east and southeast, scattered across the north, and in the southwest tip of the country. Deficits are expected to be exceptional in the southwest from

Busselton to Albany, and nearly as intense in pockets along the southeast coast near Adelaide and Melbourne, from Canberra to Sydney, and around Brisbane. Severe deficits are forecast for the Murray-Darling Basin. Deficits of varying intensity are expected in Tasmania. In the north, severe to exceptional deficits are forecast near Darwin and in the Daly River region of Northern Territory (NT), along the NT shore of the Gulf of Carpentaria, and south of Cairns in Queensland (QLD). Surpluses are forecast for Arnhem Land, NT.

Moderate to extreme surpluses are forecast in southwest Kimberley region of Western Australia (WA), but conditions of both surplus and deficit are also forecast as transitions occur. Likewise, both deficits and surpluses are forecast for the Atherton Tablelands and Mackenzie River regions of QLD.

In New Zealand, some primarily moderate deficits are forecast for southern South Island and northern North Island, and surpluses along the eastern shores from Christchurch north. Severe to extreme deficits will persist in New Caledonia.

From October through December deficits are expected to shrink considerably and moderate overall, leaving some extreme deficits in the southwest tip of WA in the Blackwood River region, and primarily moderate deficits in the southeast from Adelaide through Victoria and New South Wales (NSW). Deficits may be severe in the Riverina region of NSW. Intense deficits will continue to emerge in Tasmania, particularly in the south and the Derwent Estuary.

Moderate surpluses will re-emerge in southwest Kimberley, WA east of Broome, while conditions slightly south will exhibit both deficit and surplus. Moderate surpluses may re-emerge in a small pocket in the Atherton Tablelands and also near the Mackenzie River in QLD. Deficits will increase slightly in New Zealand, and though deficits in New Caledonia will downgrade they will be severe.

The forecast for the final months – January through March – indicates a pattern of deficits similar to the prior three-month forecast, but conditions will moderate in Tasmania, normalize in New Zealand, and deficits will emerge on the Cape York Peninsula of northern QLD.

(It should be noted that forecast skill declines with longer lead times.)