

Global Water Monitor & Forecast Watch List

December 14, 2018

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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 are 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 November 2018 and an ensemble of forecasts issued the last week of November 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 the [NOAA National Hurricane Center](#).

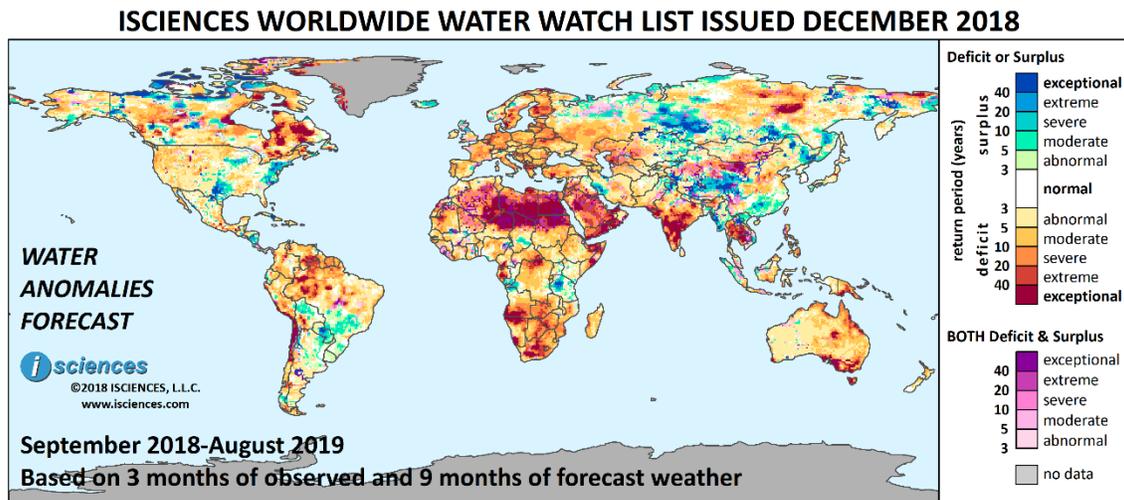
There are numerous regions around the world where country borders are contested. ISciences depicts country boundaries on these maps solely to provide some geographic context. The boundaries are nominal, not legal, descriptions of each entity. The use of these boundaries does not imply any judgement on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

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Worldwide Water Watch List

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



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: Through February, widespread intense water surpluses will persist in the center of the country and in the east. Surpluses will cut a broad path from Michigan’s Upper Peninsula, passing through Iowa and reaching the eastern half of Texas. Surpluses are also forecast for the northern Ohio River Basin and in the east from southern New York through Florida’s Panhandle, and will be extreme in eastern Pennsylvania. Areas of deficit include: northern New York, northern Maine, southern Florida, northwestern Wyoming, Colorado, and western Oregon.

Canada: The forecast through February indicates a pattern of anomalies similar to the prior three months, including: exceptional water deficits in Quebec, notably in the Ottawa-Gatineau River region in the south and across the border into Ontario; intense deficits in the Middle and Upper Reaches of the Athabasca River watershed in Alberta; and intense surpluses in southeastern British Columbia. Deficits are expected to increase in southern Saskatchewan where anomalies will be severe to exceptional.

Mexico, Central America, and the Caribbean: For the next three months, water surpluses will persist in northern Coahuila, Mexico, and along a diagonal from southern Durango through Mexico City, broken by a pocket of exceptional deficits in southern Puebla, and continuing into northern Oaxaca. Intense surpluses are forecast in Nicaragua. Areas of deficit include: the Rio Grande in Chihuahua, northern Yucatan, western Panama, Jamaica, Haiti, and Dominican Republic.

South America: Exceptional water deficits will diminish considerably over the next several months but through February intense deficits are forecast in: southern Amazonas, Brazil; southeastern Venezuela; northern Chile; and southwestern Bolivia. Deficits of varying intensity are forecast in the northwest quadrant of the continent. Areas of surplus include: Amapá, Brazil, and southern Mato Grosso through western Minas Gerais; northern Bolivia; Paraguay; and the Paraná River in Argentina to Buenos Aires.

Europe: Though the extent and intensity of water deficits in Europe will diminish considerably through February, severe to exceptional anomalies are forecast in Finland, pockets of Sweden, southern European Russia, Denmark, Netherlands, Belgium, Luxembourg, western Germany, and eastern Slovenia and the Sava River Basin in Croatia and northern Bosnia-Herzegovina. Areas of surplus include Norway, northern European Russia, and the United Kingdom.

Africa: The forecast through February indicates that water deficits will downgrade considerably. However, areas with notably intense conditions include western Ethiopia; pockets of northern Somalia, Nigeria, and southwestern Cameroon; southwestern Angola into Namibia; and, Lesotho and the Orange River region of Northern Cape, South Africa. Surpluses are forecast for Tanzania, southern Congo into western DRC and northern Angola, and south-central Chad.

Middle East: Water deficits are expected to shrink and downgrade through February though intense deficits are forecast for Yemen's western and eastern thirds and severe deficits in Saudi Arabia's large south-central region of Riyadh. Surpluses will persist in western Iran north of the Red Sea and across the border into Iraq and will remain intense. Surpluses are also forecast along Iran's western Caspian Sea coast; north of Kirkuk, Iraq; and in eastern Turkey.

Central Asia and Russia: The forecast through February indicates intense water surpluses on the Ob, Vakh, Pur, and Taz Rivers in Russia. Surpluses will be widespread in the Middle Ob region and the Yenisei River watershed. Severe to extreme deficits are forecast for western Kazakhstan, reaching across the northern border into the Ural River watershed in Russia. Surpluses are expected in northern Kazakhstan, eastern Kyrgyzstan, western Tajikistan, and along the Zerafshon River in Uzbekistan. Deficits are forecast for eastern Tajikistan and central Kyrgyzstan.

South Asia: Through February, exceptional water deficits are forecast in India from Gujarat through Maharashtra and Karnataka, and deficits of varying severity in many regions south of the Gangetic Plain and to the west in Rajasthan. In Pakistan, isolated intense deficits are possible in Karachi. Moderate deficits are forecast in northern Afghanistan, but conditions may be intense northeast of Kabul and along the Harirud River in the west. In Bangladesh, exceptional surpluses are forecast in Chittagong.

Southeast Asia and the Pacific: The forecast through February indicates that water deficits will persist in western Cambodia and Thailand, emerge in the Philippines, and increase in Papua New Guinea. Deficits will be exceptional in Cambodia. Areas of surpluses include: northern Laos, northern Vietnam and parts of the Central Highlands, Malaysia, Sumatra, and northwestern Borneo. Surpluses may be intense in Riau and Jambi, Sumatra, and along the Kapuas River in Borneo.

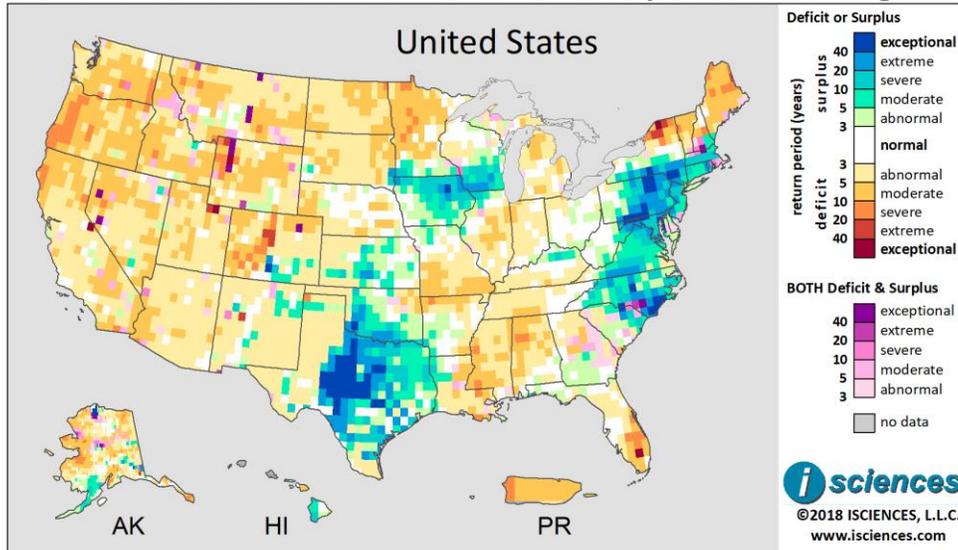
East Asia: The forecast through February indicates a vast stretch of intense water deficit from southern Mongolia and western Inner Mongolia to China's western border, including areas of both deficit and surplus as transitions occur. Exceptional deficits are also forecast for Hebei, with deficits of somewhat lesser intensity reaching through Beijing and Shanxi. A vast block of intense surplus is expected from the Yangtze River through southeastern China. Moderate surpluses are forecast for South Korea.

Australia & New Zealand: The forecast through February indicates that intense water deficits will nearly disappear, persisting in Tasmania, pockets of Victoria and New South Wales, and around Busselton in Western Australia. Deficits will be severe on the Murray River. Moderate deficits are forecast across northern Australia. In New Zealand, deficits are forecast in the north and surpluses in the south from Christchurch to Dunedin. Deficits in New Caledonia will moderate.

Watch List: Regional Details

United States

ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

The 12-month forecast ending August 2019 indicates significant blocks of water surplus in three regions: the East Coast from southern New Hampshire through North Carolina; much of Texas into Oklahoma and Kansas; and Iowa and southern Wisconsin. Surpluses are expected to be extreme to exceptional in the heart of Texas surrounding the Edwards Plateau, eastern Pennsylvania, and coastal North Carolina around Wilmington.

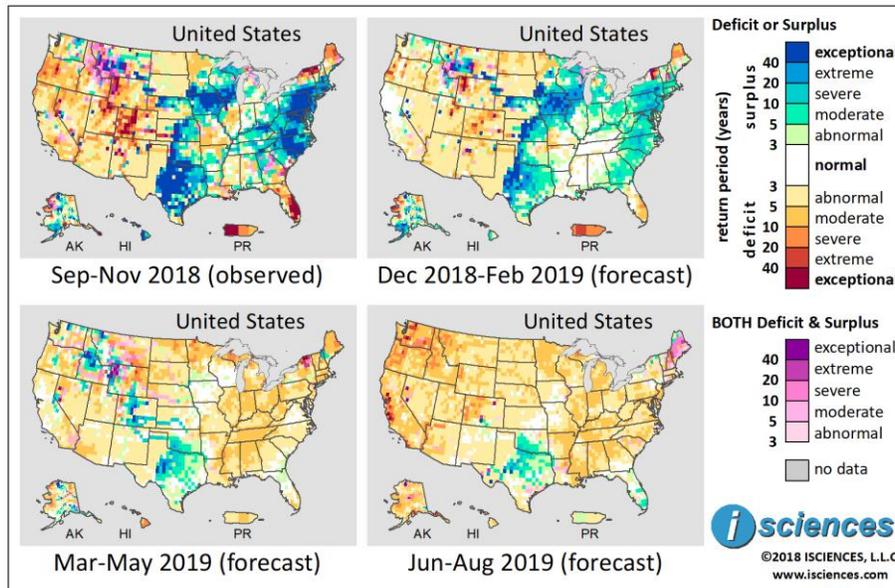
With the exception of the Ohio River Basin where conditions will be relatively normal, deficits will dapple much of the rest of the country though anomalies will be primarily mild to moderate. Pockets of deficit are forecast for the Upper Midwest, Rocky Mountain States, and the West. Deficits may reach severe intensity in western Oregon; and severe to extreme intensity in northwestern Wyoming, the western Uinta Mountains of northeastern Utah, and central and southeastern Colorado. Generally moderate deficits are forecast for much of Minnesota, pockets of Michigan, central Illinois, southern Missouri, eastern Louisiana, Mississippi, and Alabama. In the US Northeast, deficits will be moderate to exceptional in northern New York, and moderate in Vermont, central New Hampshire, and Maine. Deficits in southern Florida are expected to be moderate to severe but may be exceptional in a small pocket of the northern Everglades.

Outside the contiguous US, moderate to severe deficits are forecast for Puerto Rico. In Hawaii, surpluses are forecast for western Hawai'i and western Moloka'i, and moderate deficits on Maui.

A patchwork of conditions is forecast for Alaska including: surpluses on the Alaska Peninsula reaching inland, the upper reaches of the Copper and Susitna Rivers, and in the far north southeast of Barrow; and, deficits in the Seward Peninsula and into western Alaska, around Anchorage, and the Alexander Archipelago in the Alaska Panhandle.

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

ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

Though the extent of exceptional surpluses is forecast to shrink from December through February, widespread and intense surpluses will persist in the center of the country and in the east. Intense surpluses will continue to cut a broad path from Michigan’s Upper Peninsula through Wisconsin, southern Minnesota, Iowa, northern Missouri, eastern Kansas, central Oklahoma and central and eastern Texas, with anomalies of exceptional intensity along much of that path. Moderate surpluses are forecast for Michigan’s Lower Peninsula and the northern Ohio River Basin, leading to widespread surpluses in the east from southern New York and Massachusetts down along the Eastern Seaboard through Florida’s Panhandle. Surpluses are expected to reach extreme intensity in eastern Pennsylvania and nearby regions in neighboring states.

Deficits are forecast for northern New York, northern Maine, and southern Florida, and may be especially intense in New York. Conditions will be nearly normal from the southern Ohio River Basin to the Gulf of Mexico.

In the western half of the US, mild deficits are forecast overall punctuated by pockets of more intense anomalies, deficits as well as surpluses. Conditions in California are expected to be relatively normal. Severe to exceptional deficits are forecast for northwestern Wyoming, and moderate to extreme deficits

in Colorado, north-central Utah, and western Oregon. Intense surpluses are forecast for northern Nebraska, a patch south of the Black Hills on the Wyoming-South Dakota border, southeastern Montana, and between Great Falls, Helena, and Billings, Montana.

From March through May, widespread surpluses forecast for the eastern half of the country in prior months will nearly disappear, and moderate deficits will emerge from Michigan through the Ohio River Valley to the Gulf, and also in the Northeast. Surpluses will persist in Texas and Oklahoma but will downgrade, though pockets of exceptional surplus are possible in Texas. Central Colorado will transition from deficit to surplus, as will the Arkansas and Canadian Rivers. Both deficits and surpluses are forecast for northwestern Wyoming as deficits emerge in the north; surpluses will emerge in central Idaho but diminish in western Montana; and surpluses will emerge in California and Nevada near Lake Tahoe. Moderate to severe deficits are forecast for parts of the Northern Plains.

The forecast for the final months – June through August – indicates surpluses in Texas, Oklahoma and pockets of southern Florida, and primarily mild to moderate deficits in much of the remainder of the nation. However, deficits are forecast to be more intense in central California and the Pacific Northwest.

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

Canada

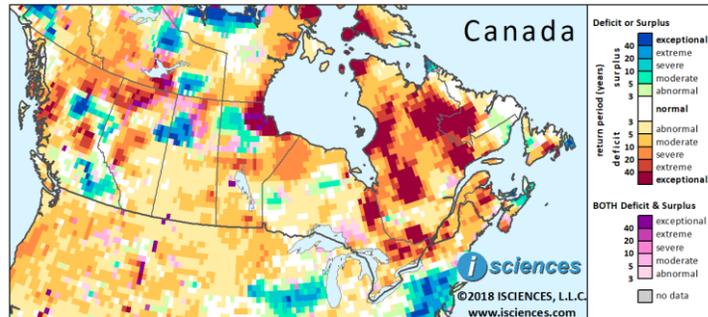
The 12-month outlook for Canada through August 2019 indicates vast pockets of intense water deficit in the east as well as some large pockets nearly as intense elsewhere in the nation. Relatively mild deficits are expected across southern portions of the Prairie Provinces. Areas of surplus include southeastern British Columbia.

Intense deficits are forecast to encompass large blocks of the eastern half of the nation including in: Quebec from the Caniapiscau Reservoir to beyond Michikamau Lake in Labrador, near the Gulf of St. Lawrence, around Lake Mistassini, and the Gatineau River region near Ottawa; Ontario along the eastern border. Severe to exceptional deficits are also forecast for: northeastern Manitoba along Hudson Bay; the Upper and Middle Athabasca River region and northwestern Alberta; the Upper Fraser River Basin in British Columbia (BC), and the Skeena River region in northwestern BC.

Areas of surplus include: northern Nova Scotia and Prince Edward Island; northwestern Manitoba; northwestern Saskatchewan around Churchill Lake west to Fort McMurray, Alberta; northern BC around Williston Lake and along the Peace River past Fort St. John; and, southeastern BC.

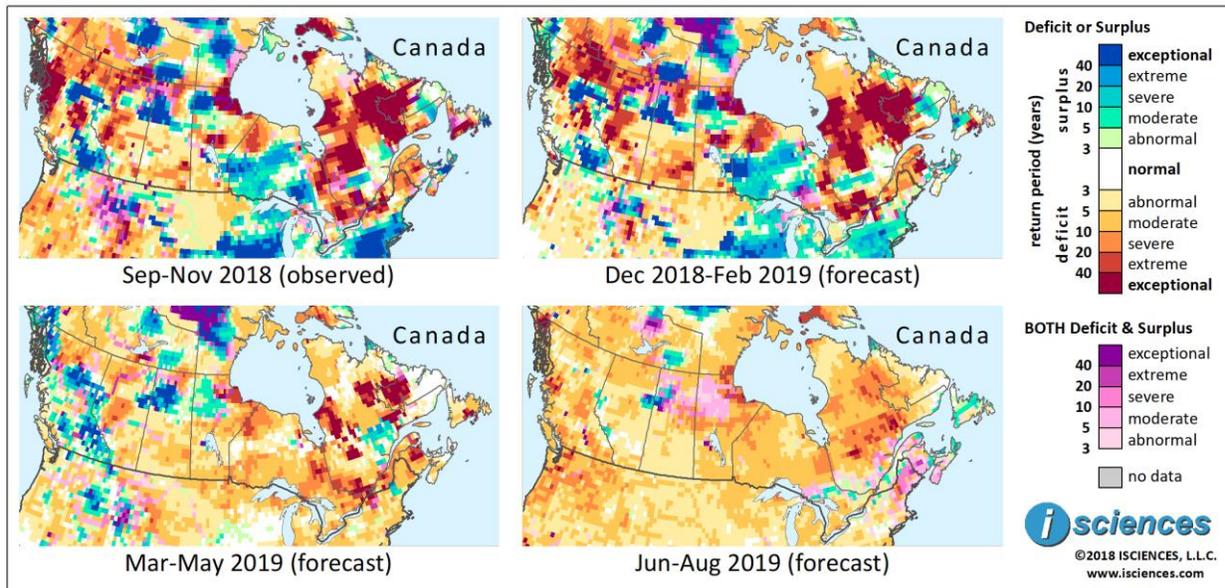
The 3-month maps (below) show the evolving conditions in more detail.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

The forecast through February indicates a pattern of anomalies similar to the prior three months. However, deficits are expected to increase and intensify in southern Saskatchewan where anomalies will be severe to exceptional.

The overall pattern of persistent anomalies during this period includes the conditions that follow. Widespread, exceptional deficits are forecast across central Quebec (QC) into central Labrador, and intense deficits in southern QC in the Ottawa-Gatineau River region and across the border into Southern Ontario (ON). Intense deficits will also persist along the Ontario-Quebec border corridor, and in the Severn River region of northwestern ON. Surpluses will persist in much of the remaining area of ON. In Manitoba (MB), intense deficits are forecast in the northeast around Hudson Bay and north of Lake Winnipeg; intense surpluses are expected in northwestern MB.

In Saskatchewan, deficits will increase and intensify in the south, as previously noted; intense, widespread surpluses are forecast in the northwest and across the border past Fort McMurray, Alberta (AB). Deficits in the Middle Reaches of the Athabasca River in AB will intensify, becoming extreme, and exceptional deficits in the Upper Reaches will persist, as will intense conditions in the far northwest of the province. And in BC, intense surpluses will persist in the southeast and in the northeast from Fort St. John past Williston Lake; deficits in the Skeena River region of the northwest will shrink but persist with intensity.

From March through May, the extent of exceptional deficits will shrink in QC and nearly disappear elsewhere in the country, but intense anomalies will persist, notably in the Ottawa-Gatineau River region in southern QC leading past Montreal to Quebec. Surpluses will emerge in QC west of Manicouagan Reservoir. Conditions in Northern Ontario will transition from surplus to deficit. Deficits in

the southern portion of the Prairie Provinces will moderate, and deficits farther north, while downgrading, may be severe. Surpluses will increase in BC.

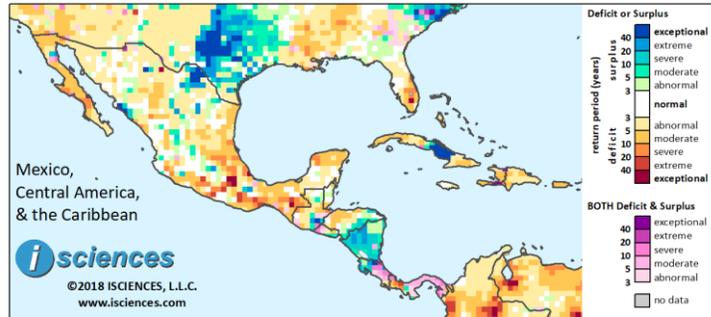
The forecast for the final three months – June through August – indicates widespread mild to severe deficits blanketing much of the nation along with some pockets of greater intensity. Surpluses will emerge in Newfoundland, and will shrink but persist in northwestern SK.

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

Mexico, Central America, and the Caribbean

The 12-month forecast ending August 2019 indicates deficits of varying intensity peppered throughout Mexico's southern states from the Gulf of Mexico to the Gulf of Tehuantepec, and primarily moderate deficits along the northern Gulf and in the northern Yucatan Peninsula. Moderate to severe deficits are forecast for the central Baja Peninsula, and moderate deficits from southern Chihuahua into central Durango. Intense surpluses are forecast for northern Coahuila and along Sinaloa's northern coast on the Gulf of California, with some small pockets of lesser intensity in the center of the country.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



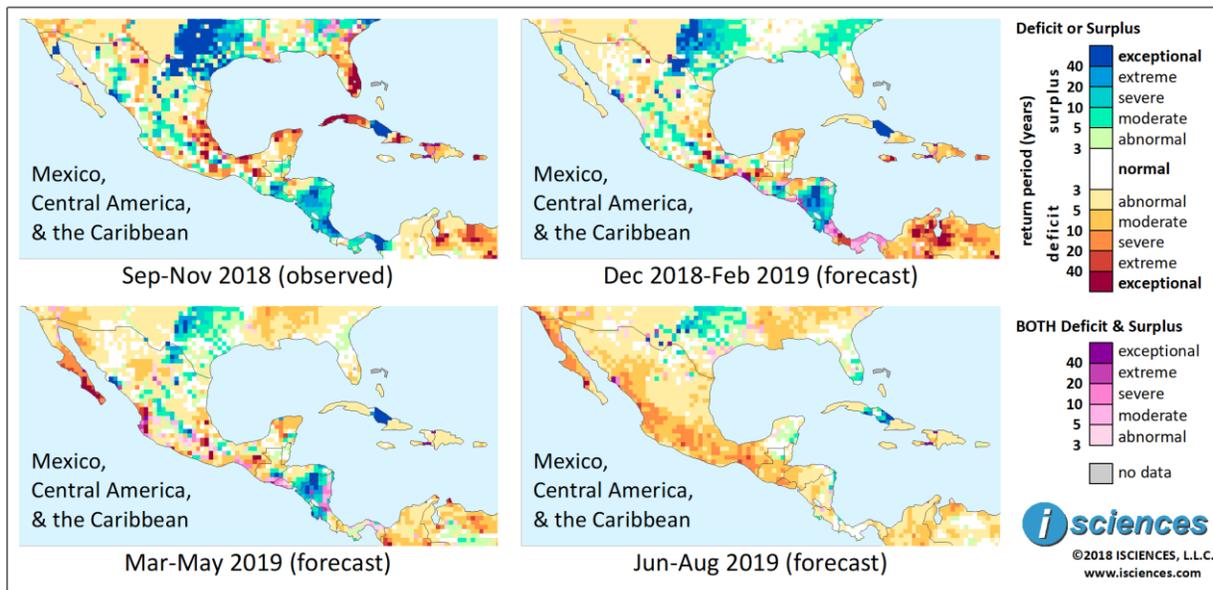
Based on observed data through November 2018 and forecasts issued November 24-30, 2018.

In Central America, severe surpluses are forecast for Nicaragua reaching across its borders into Honduras and Costa Rica. Intense surpluses are also forecast east of Guatemala City, Guatemala. Moderate deficits are expected in western Honduras, and severe to extreme deficits in western Panama. In the Caribbean, some moderate deficits are expected in Haiti and pockets of Cuba.

Some moderate deficits are forecast for Haiti.

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

ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

A complex distribution of water anomalies is forecast in the region over the next six months. Through February, intense surpluses will persist in northern Coahuila, Mexico and along Sinaloa's northern coast on the Gulf of California. Surpluses are expected to retreat from southwestern Chihuahua but re-emerge in a small pocket in the center of the state. Surpluses will persist in eastern Durango and along a diagonal from southern Durango through Mexico City, broken by a pocket of exceptional deficits in southern Puebla, and continuing into northern Oaxaca. Moderate surpluses are forecast from Aguascalientes to Puerto Vallarta.

Moderate to severe deficits are expected in the northern Yucatan Peninsula and deficits of varying intensity in scattered small pockets throughout the southern states. In the north, deficits will be moderate to severe along the Rio Grande in Chihuahua.

In Central America, surpluses will intensify in Nicaragua, becoming exceptional in the north and into Honduras. Surpluses are also forecast for western Costa Rica and southeastern Guatemala into western El Salvador. Primarily moderate deficits are expected in southern Belize, central Guatemala, and western Honduras. Extreme to exceptional deficits are forecast for western Panama. In the Caribbean, Deficits of similar intensity are expected in Jamaica, and of lesser intensity in Haiti and Dominican Republic.

From March through May, severe to exceptional deficits will emerge in southern Baja and in Nayarit, Mexico. Surpluses will downgrade in northern Coahuila and shrink somewhat along the aforementioned diagonal the center of the country. Moderate deficits will increase in southern Chihuahua and northern Durango, primarily moderate deficits will persist in northern Yucatan, and small, isolated pockets of deficit remain in the forecast for southern Mexico. Surpluses will persist in Nicaragua, southern Honduras, and western Costa Rica. Deficits will retreat from Panama and the Caribbean.

The forecast for the final three months – June through August – indicates moderate to severe deficits in Baja and in western and southern Mexico. Some moderate deficits are also forecast for northern Central America.

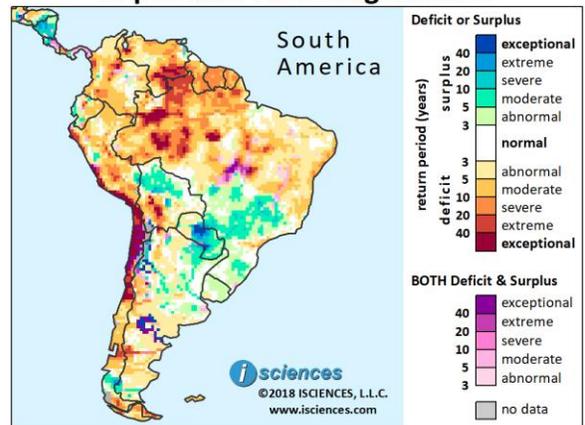
(It should be noted that forecast skill declines with longer lead times.)

South America

The 12-month forecast through August 2019 indicates water deficits of varying intensity in the western Amazon Basin of Brazil reaching into neighboring nations to the north and west. Exceptional deficits are expected to trace a path along the continent's Pacific coast from northern Peru past Santiago, Chile, and deficits of similar intensity are forecast for southwestern Bolivia beginning near Cochabamba.

Surpluses are forecast in parts of the continent's mid-section, and anomalies will be extreme to exceptional in central Paraguay. Primarily moderate surpluses will extend from eastern Paraguay through Brazilian states to the northeast and south into Argentina, trailing along the Paraná River to Buenos Aires. Surpluses are also forecast for: northern Bolivia; northern Rio Grande do Sul, Brazil; Neuquén Province, Argentina; and, Patagonia surrounding O'Higgins/San Martín Lake and along Río Santa Cruz.

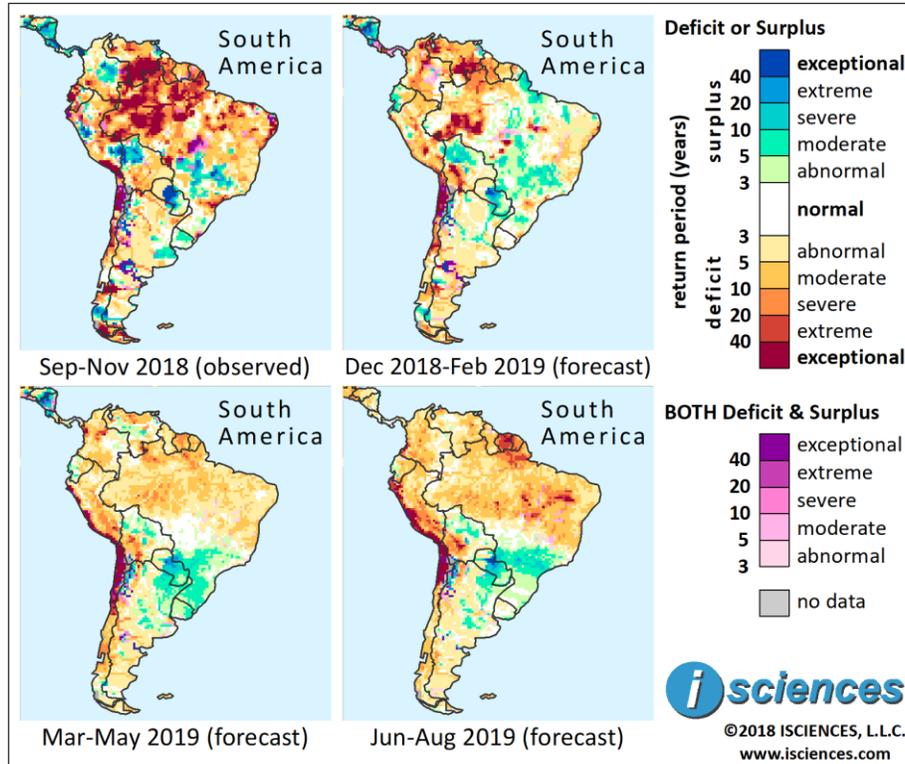
ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

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

ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

The extent of exceptional deficits in the region will diminish considerably over the next several months. However, through February exceptional deficits are forecast for: southern Amazonas, central Mato Grosso, and northern Tocantins, Brazil; southeastern and northwestern Venezuela; northern Chile; and southwestern Bolivia in an arc from La Paz to the southern border. Deficits of lesser intensity are forecast in Peru, Colombia, Venezuela, Guyana, Suriname, and western French Guiana.

Amapá, Brazil will transition from deficit to moderate surplus, as will western Ecuador. Moderate surpluses will also emerge in Pará, Brazil along the Xingu and Iriiri Rivers and pockets of central Brazil. Surpluses will moderate but increase in extent from southern Mato Grosso through western Minas Gerais, and will also increase in northern Rio Grande do Sul. In Bolivia, surpluses in the north will downgrade but increase in extent. Surpluses will downgrade somewhat in central Paraguay but remain intense, and moderate surpluses will emerge across the border into Argentina along the Paraná River to Buenos Aires. Regions of prior surplus in Uruguay and the Argentine Pampas are expected to normalize.

The forecast for March through May indicates primarily moderate deficits in the Amazon Basin and mild deficits in eastern Brazil. Deficits will shrink and downgrade in Brazil's northern neighbors, though severe deficits are forecast for Suriname and extreme deficits in pockets of northwestern Colombia.

Exceptional deficits will persist and increase in Chile's northern half. Deficits of equal intensity will emerge along most of coastal Peru, and severe deficits are forecast for southern Peru. In Bolivia, surpluses in the north will shrink and deficits in the southwest, though downgrading from exceptional, will be extreme. Surpluses will increase from central Peru into northeastern Argentina and Brazil's southernmost states – while conditions normalize in Mato Grosso – and will emerge in eastern Uruguay. Anomalies are expected to be moderate overall but may be extreme in central Paraguay.

In the final quarter – June through August – deficits will increase across Brazil's northern breadth, intensifying in the east, as well as in Suriname, French Guiana, and Peru. Surpluses will persist in Paraguay and increase in Brazilian states to the east through São Paulo.

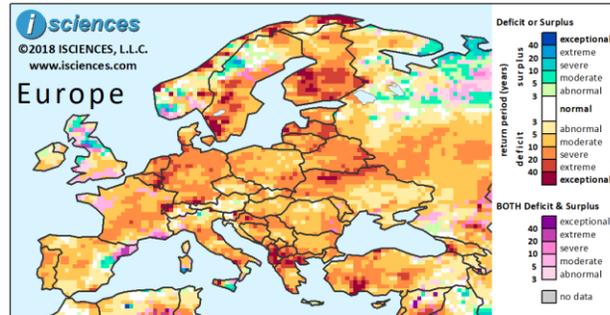
(It should be noted that forecast skill declines with longer lead times.)

Europe

The 12-month forecast through August 2019 indicates moderate to extreme deficits throughout most of Europe. Areas of intense deficit include southern Finland, southern Sweden, Latvia, Albania, Macedonia, and Greece.

Pockets of primarily moderate surplus are forecast for northern European Russia, west-central Sweden, southwestern Norway, Scotland, Spain northwest of Valencia, southern Sardinia, and southeastern Sicily.

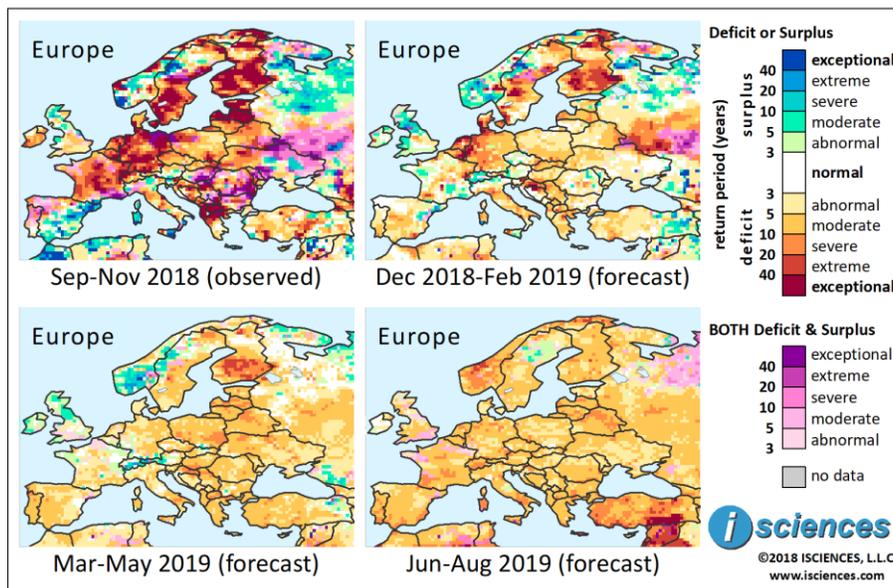
ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

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

ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

The extent and intensity of deficits in Europe will diminish considerably through February. However, severe to exceptional anomalies are forecast in Finland, pockets of Sweden, southern European Russia, Denmark, Netherlands, Belgium, Luxembourg, western Germany, and eastern Slovenia and the Sava River Basin in Croatia and northern Bosnia-Herzegovina. Primarily moderate deficits are forecast in Eastern Europe and the Balkans, as well as much of Italy. Southern Spain will transition from surplus to moderate deficit. Surpluses are forecast for Norway, northern European Russia, Wales, Scotland,

Northern Ireland, Switzerland, pockets in the Middle Loire Valley and southeastern France, and northeastern Spain.

From March through May, conditions of moderate deficit, along with some severe pockets, will prevail in much of Eastern Europe, the Baltics, and the Balkans. Extreme deficits will persist in southern Finland and moderate deficits are forecast for southern Norway and southern European Russia. Moderate deficits are also forecast for Germany, the western Iberian Peninsula, and pockets of southern France and Italy. Surpluses are expected in Norway, northern England and pockets of Scotland and Ireland, and Switzerland into Austria. Conditions in northern European Russia will normalize overall with some lingering surpluses, and surpluses are expected in the northwest Caucasus.

The forecast for the remaining months – June through August – indicates primarily moderate deficit conditions throughout nearly all of Europe with pockets of severe deficits.

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

Africa

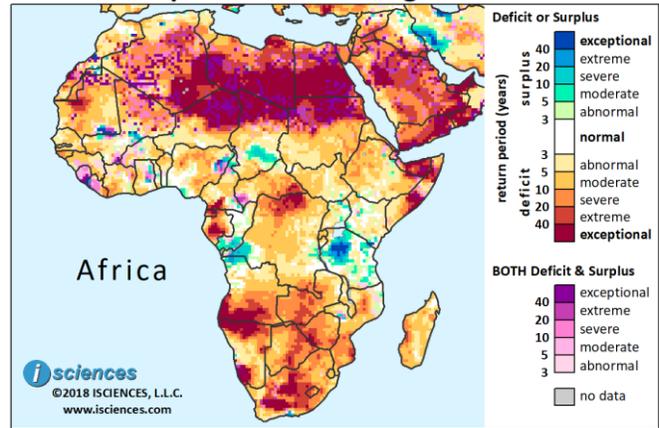
The 12-month forecast through August 2019 indicates a vast block of exceptional water deficit in northern Africa from eastern Algeria and northern Mali to the Red Sea. Intense deficits are forecast throughout southern Africa with exceptional deficits in southern Angola, northern and southeastern Namibia, and Northern Cape, South Africa. Other areas of intense deficit include: northern Democratic Republic of the Congo reaching north into Central African Republic; southern Cameroon and Gabon; and Somalia.

Deficits are expected to be severe along the Blue Nile and the Atbara Rivers.

Areas of surplus include: Tanzania, southeastern Chad, southern Congo, westernmost Democratic Republic of the Congo, and northernmost Angola. Surpluses are expected to reach exceptional intensity in western Tanzania.

Primarily moderate deficits are forecast for much of the remainder of the continent and in Madagascar.

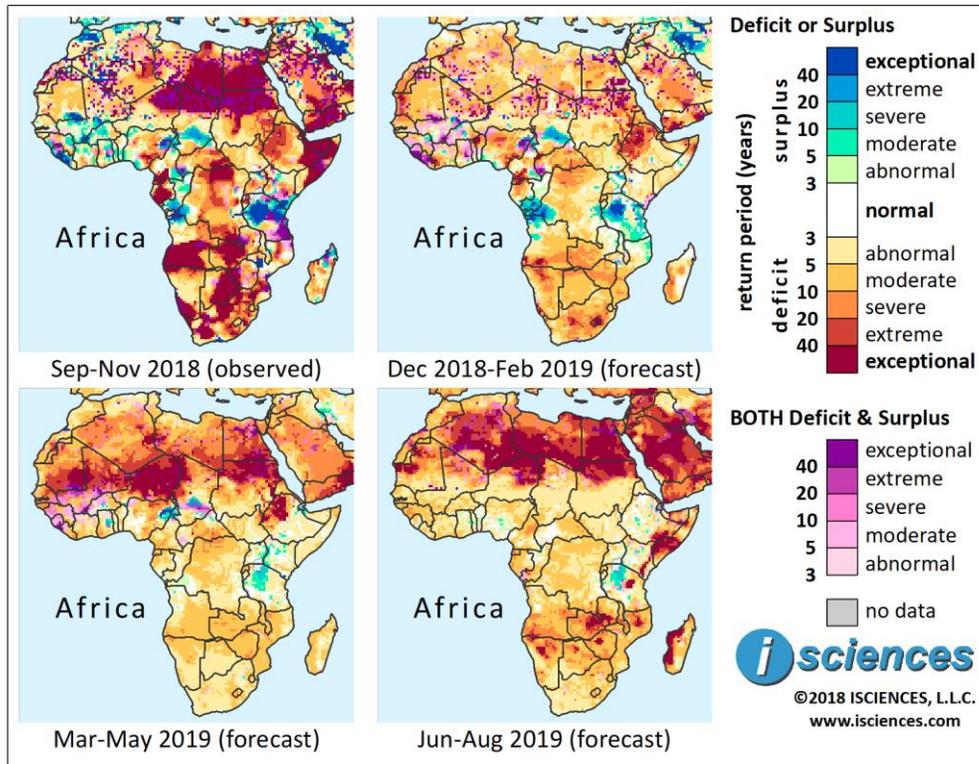
ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

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

ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

The forecast through February indicates that deficits in Africa will downgrade considerably but will leave some notably intense conditions in: western Ethiopia; pockets of northern Somalia, Nigeria, and southwestern Cameroon; southwestern Angola into Namibia; and, Lesotho and the Orange River region of Northern Cape, South Africa. Primarily moderate deficits are forecast across northern Africa peppered with conditions of both deficit and surplus across the southern Sahara. Deficits may be more intense in Western Sahara and western Mauritania. Moderate to severe deficits are forecast for Central African Republic and Democratic Republic of the Congo (DRC). Moderate to severe deficits are also forecast throughout southern Africa – with more intense conditions as noted previously – and in western Madagascar.

Exceptional surpluses will persist in western Tanzania leading across Lake Tanganyika into DRC, and moderate surpluses will re-emerge in eastern Tanzania. Surpluses are also forecast in northern Uganda and along the Victoria Nile. Moderate to exceptional surpluses will persist in southern Congo reaching into western DRC and northern Angola. Severe to extreme surpluses are expected to continue in south-central Chad.

From March through May, deficits will intensify considerably across northern Africa and will include large pockets of exceptional deficit in eastern Mauritania, Niger, and northern Sudan. Deficits in western Ethiopia are expected to shrink slightly but the extent of exceptional deficits will increase around Lake Tana in the north. Deficits in central and southern Africa will moderate. Surpluses will nearly disappear in eastern Tanzania and will moderate in the west. Some pockets of moderate surplus are forecast to emerge in northern Kenya. Surpluses will shrink in Chad, re-emerge in the Upper Benue River region of northeastern Nigeria and around northern Lake Volta in Ghana, and retreat from southern Congo, DRC, and Angola.

During the final quarter – June through August – deficits will continue to intensify across northern Africa as exceptional deficits emerge from Liberia to the Red Sea. Moderate deficits are forecast for much of the remainder of the continent but may be more intense in southern Somalia and many pockets in southern Africa, including central Zambia and the Okavango Delta in Botswana. Exceptional deficits are also forecast during this period for western Madagascar.

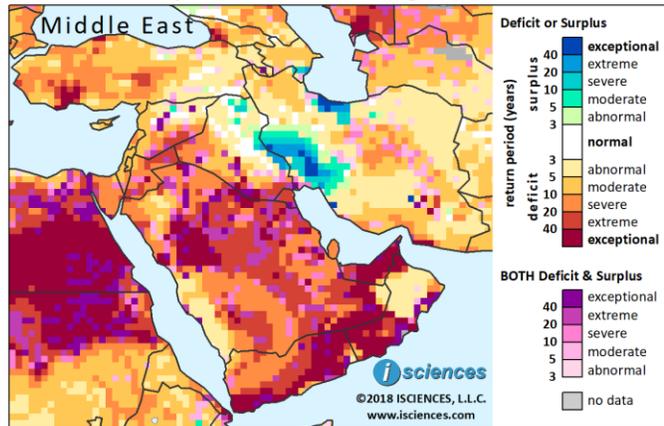
(It should be noted that forecast skill declines with longer lead times.)

Middle East

The forecast for the 12-month period ending August 2019 indicates widespread, intense water deficits on the Arabian Peninsula including exceptional deficits in Al Madinah, Saudi Arabia; United Arab Emirates; Yemen; and western Oman. Extreme deficits are forecast for Kuwait and southern Iraq, and deficits of varying severity in the Levant. Other areas of deficit include western Turkey, Georgia, and central Iran.

Surpluses ranging from moderate to exceptional are forecast for western Iran in provinces north of the Red Sea and across the border into Iraq. Surpluses are also forecast along Iran's central Caspian Sea coast.

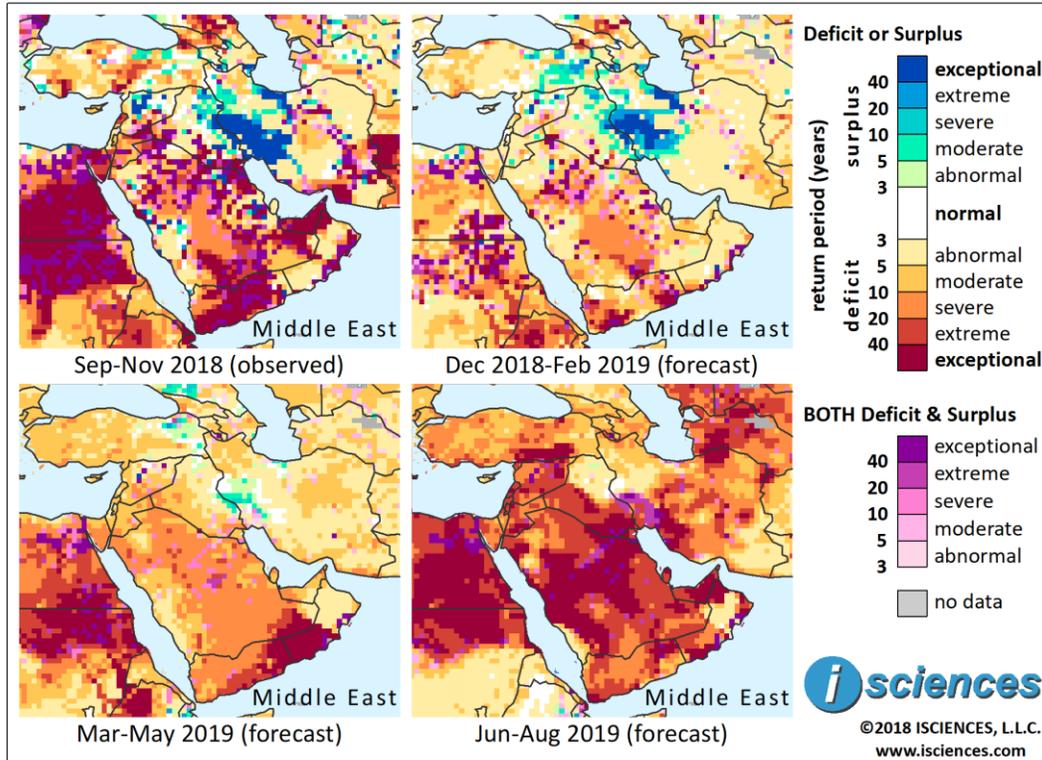
ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

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

ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

Deficits are expected to shrink and downgrade in the region through February. However, severe to exceptional deficits are forecast for Yemen’s western and eastern thirds. Severe deficits are expected in Saudi Arabia’s large south-central region of Riyadh, with pockets of varying intensity farther north. Moderate deficits are forecast for pockets of western Turkey and for southeastern Iran. Surpluses will persist in western Iran north of the Red Sea – and across the border into Iraq – and will remain intense, ranging from moderate to exceptional. Surpluses will also persist along Iran’s western Caspian Sea coast reaching inland. Moderate to severe surpluses are forecast to persist in north of Kirkuk, Iraq and will emerge in eastern Turkey.

From March through May, surpluses in the region will shrink considerably and downgrade, leaving some moderate conditions across the central Iraq-Iran border and small pockets in eastern Turkey. Deficits will increase on the Arabian Peninsula with severe deficits forecast for most of Saudi Arabia, severe to exceptional deficits throughout Yemen, and exceptional deficits in western Oman. Primarily moderate deficits will emerge in the Levant, central and northwestern Iran, the South Caucasus, and much of Turkey’s western two-thirds.

In the final quarter – June through August – deficits are expected to increase and intensify considerably in the region with severe to exceptional anomalies forecast for the Arabian Peninsula, the Levant, Turkey, western and southern Iraq, and much of Iran.

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

Central Asia and Russia

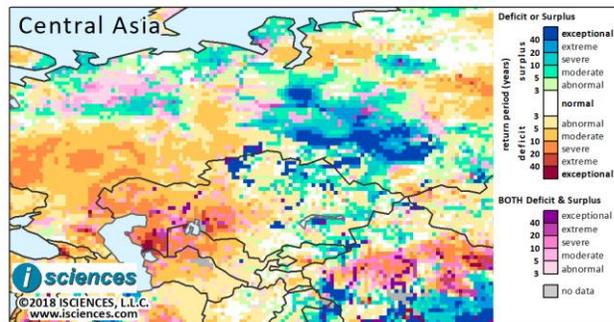
The 12-month forecast through August 2019 indicates deficits in Turkmenistan, Uzbekistan and western Kazakhstan, which will be particularly intense in Kazakhstan between the Caspian Sea and the Uzbek border. Moderate to severe deficits are forecast in the Volga River Basin of Russia, and deficits of somewhat greater intensity in a narrow band north of the Caucasus Mountains.

Widespread surpluses are forecast in the Ob River Basin that will reach exceptional intensity. Surpluses are also forecast in the Vakh River region, an eastern tributary of the Ob. Intense surpluses are expected in the Tom River watershed, and primarily moderate surpluses along the Irtysh and Ishim Rivers.

The forecast for northern and eastern Kazakhstan and eastern Kyrgyzstan also indicates surpluses.

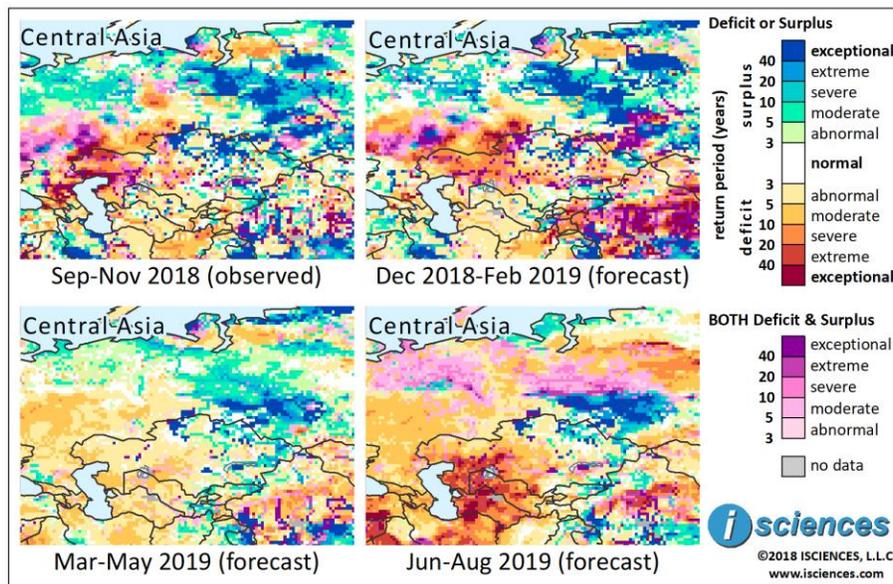
The 3-month composites (below) for the same 12-month period show the evolving conditions in more detail.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

The forecast through February indicates intense surpluses on the Ob River in Russia, and along the Vakh, Pur, and Taz Rivers. Surpluses will be widespread in the Middle Ob region and also in the Yenisei River

watershed. Surpluses will shrink somewhat in the Northern European Plain but persist and intensify slightly in the Vychegda Lowland. Severe to extreme deficits are forecast for western Kazakhstan, reaching across the northern border into Russia and the Ural River watershed where deficits could reach exceptional intensity. Both deficits and surpluses are forecast in the Middle Volga Region, and deficits in Russia north of Ukraine.

Intense surpluses are expected in pockets of northern Kazakhstan, moderate to severe surpluses in eastern Kyrgyzstan, western Tajikistan, and along the Zerafshon River in Uzbekistan. Severe to extreme deficits are expected in eastern Tajikistan and in central Kyrgyzstan.

From March through May deficits in western Kazakhstan and the Ural River watershed will downgrade to mild or moderate; moderate deficits are forecast for the Volga River Basin. Widespread surpluses will persist in the Ob River Basin but will downgrade to moderate to severe in the Lower and Middle Ob regions, while remaining more intense in the southern Ob Basin. Surpluses will shrink and downgrade west of the Ob in the Vychegda Lowlands and east of the Ob in the Yenisei watershed. Some moderate deficits are forecast for Turkmenistan and Uzbekistan, and primarily moderate surpluses for eastern Kazakhstan, eastern Kyrgyzstan, and western Tajikistan.

The forecast for the final months – June through August – indicates a significant increase in the extent and intensity of deficits in Turkmenistan, Uzbekistan and western Kazakhstan, with severe to extreme anomalies. Moderate deficits will increase in the Volga Basin and south through the Caucasus. As deficits emerge in northern Russia conditions of both deficit and surplus are forecast, including in the Northern European Plain and the Lower and Middle Ob regions. Surpluses in the Upper Ob and Tom River regions will increase.

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

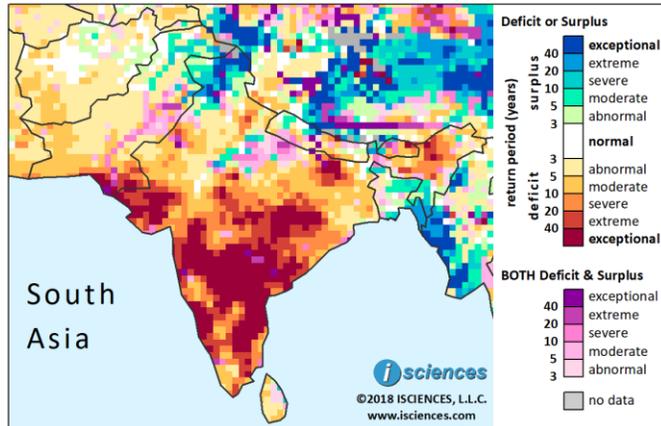
South Asia

The 12-month forecast through August 2019 indicates intense water deficits throughout India's southern half including exceptional deficits in Gujarat, Chhattisgarh, Maharashtra, Telangana, Andhra Pradesh, Goa, Karnataka, and Tamil Nadu, as well as Bihar in the eastern Gangetic Plain. Severe to extreme deficits are forecast for India's Far Northeast reaching into Bhutan. Moderate deficits are expected in southwestern Afghanistan and southern Pakistan.

Surpluses ranging from severe to exceptional are forecast in Jammu and Kashmir, Himachal Pradesh, and Punjab, India. Primarily moderate surpluses are forecast for eastern Bangladesh and Indian states to the east, but surpluses may be extreme in Chittagong Division, Bangladesh. Surpluses are also expected along the northern Indus River in Pakistan.

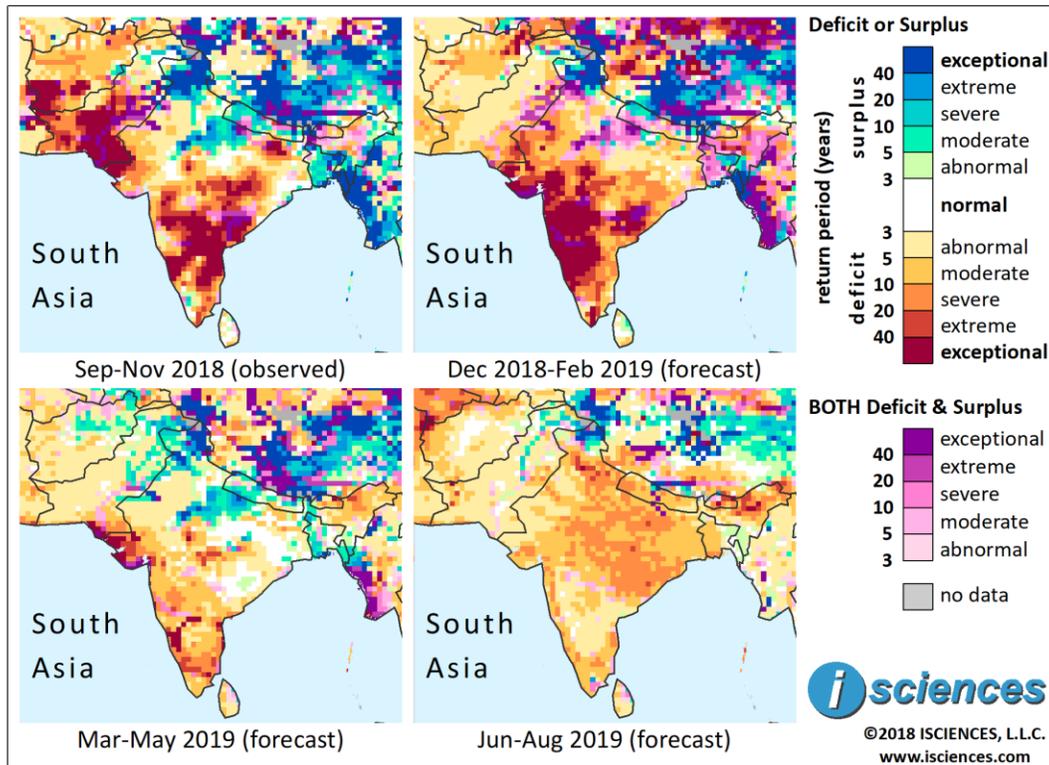
The 3-month composites (below) show the evolving conditions in greater detail.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

The near-term forecast through February indicates a vast block of exceptional deficits in India from Gujarat through Maharashtra and Karnataka, and deficits of varying severity in many regions south of the Gangetic Plain and to the west in Rajasthan. Intense deficits are also forecast in parts of India's Far Northeast and into Bhutan. Intense surpluses are expected to persist in northern India in Jammu and Kashmir and Himachal Pradesh. Both deficits and surpluses are forecast in the western Gangetic Plain as surpluses recede and deficits emerge, with similar conditions in Nepal.

Primarily moderate deficits are expected in northern Afghanistan though conditions may be more intense northeast of Kabul and along the Harirud River in the west. Some pockets of moderate deficit are forecast for southern Pakistan, with more intense deficits possible in Karachi and east of Hyderabad. Conditions of both surplus and deficit are forecast along the Ravi and Sutlej Rivers in the northeast. In Bangladesh, surpluses are forecast in the east and may be exceptional in Chittagong Division.

From March through May, deficits in India are expected to moderate overall and some regions in the country's eastern third will normalize. However, intense deficits will persist throughout Gujarat, in central Madhya Pradesh, along the Tungabhadra River through Karnataka, and in pockets of the southern states. Surpluses are expected to re-emerge in the western Gangetic Plain and along the Chambal River. Surpluses in the north will downgrade somewhat and moderate surpluses will re-emerge in Punjab. In Pakistan, moderate surpluses will re-emerge along rivers in the north, while intense deficits

around Karachi in the south increase slightly. Northern Afghanistan will transition out of deficit to some areas of moderate surplus, and deficits along the Harirud River will nearly disappear. Moderate surpluses will re-emerge in Nepal and western Bangladesh, while deficits in Chittagong downgrade to moderate.

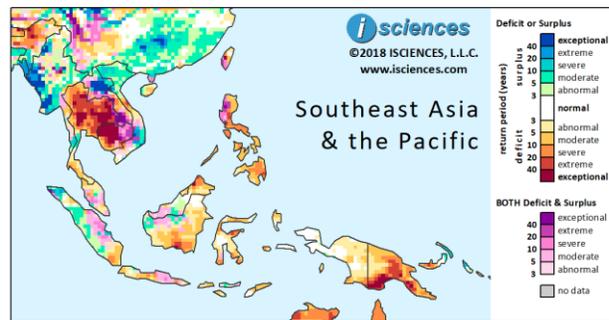
The forecast for the final months – June through August – indicates moderate to severe deficits emerging throughout much of India and into Nepal and Bangladesh. Moderate surpluses are forecast along the northern Indus River in Pakistan.

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

Southeast Asia and the Pacific

The 12-month forecast through August 2019 indicates exceptional water deficits in much of western Cambodia, and severe to exceptional deficits throughout Thailand. Moderate to severe deficits are forecast for the Philippines, northeastern and southern Borneo, and pockets in Sulawesi. In Papua New Guinea, deficits of varying intensity are expected with exceptional deficits in the south.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019

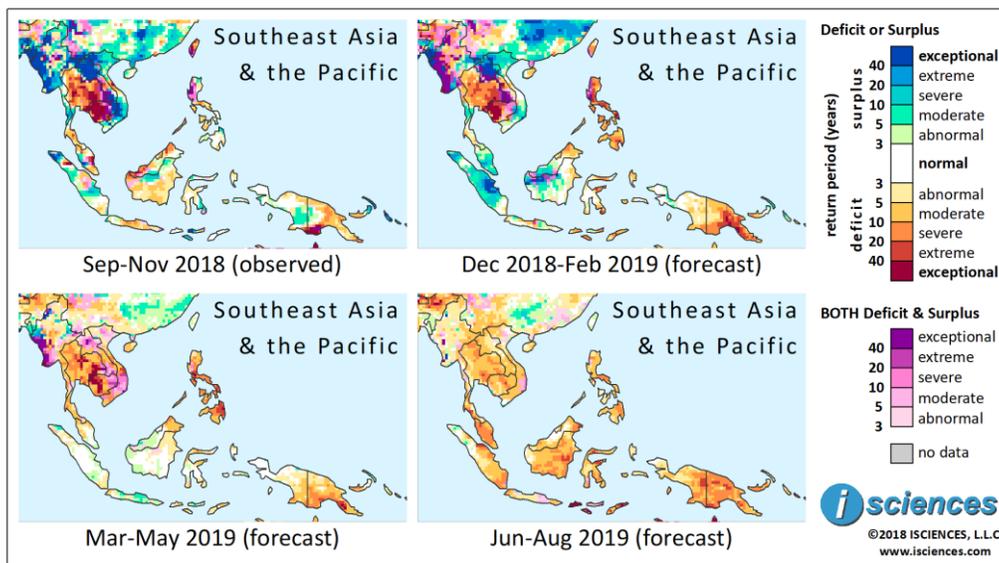


Based on observed data through November 2018 and forecasts issued November 24-30, 2018.

Surpluses are forecast for Myanmar, northern Laos, northern Vietnam and Dak Lak and nearby provinces in Vietnam's Central Highlands. Surpluses are expected to be exceptional in western Myanmar and the Irrawaddy Delta, and in northern Laos. Surpluses of lesser intensity are forecast in pockets of Sumatra and Borneo.

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

ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

The near-term forecast through February indicates that exceptional deficits will persist in western Cambodia, shrinking slightly, and severe to extreme deficits will persist in Thailand. Intense deficits are expected to emerge in the Philippines. In Papua New Guinea (PNG), deficits will increase, emerging throughout the Bird's Tail Peninsula (Papuan Peninsula) in the southeast, but deficits west of the Gulf of Papua will downgrade from exceptional to severe. Pockets of deficit are also forecast for parts of Sulawesi and the Lesser Sunda Islands. Surpluses will remain exceptional in northern Laos and severe in

northern Vietnam, while those in southern Vietnam downgrade and shrink. In Myanmar, conditions of both surplus and deficit are expected as transitions occur. Surpluses of varying intensity are expected to emerge in peninsular Malaysia, Sumatra, and northwestern Borneo. Surpluses may be especially intense Riau and Jambi, Sumatra, and in Borneo along the Kapuas River.

From March through May, surpluses in Malaysia, Sumatra, and Borneo will nearly disappear. Some pockets of moderate surplus are forecast in Java. In western Cambodia, exceptional deficits will shrink but persist around Tonlé Sap. Deficits will downgrade overall in Thailand but remain widespread and may intensify to exceptional in pockets in the east and center of the country. Conditions of both surplus and deficit are forecast in Myanmar, Laos, and Vietnam as surpluses recede and transitions occur. Deficits of varying intensity remain in the forecast for the Philippines, downgrading in the north but intensifying in the south. Deficits in PNG will downgrade but persist.

The forecast for the final months – June through August – indicates moderate to severe deficit conditions in many parts of the region

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

East Asia

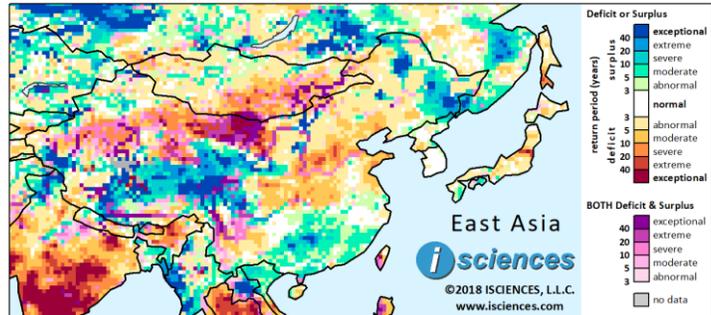
The 12-month forecast for East Asia through August 2019 indicates widespread intense surpluses in: Heilongjiang, Jilin, and northern Inner Mongolia in Northeast China; the Upper Yellow River Basin in Qinghai; Sichuan; and Tibet. Surpluses of lesser intensity are forecast for southeastern China and the Pearl River watershed.

Deficits reaching exceptional intensity are forecast for western Inner Mongolia, along with conditions of both deficit and surplus (purple) as transitions occur. Severe deficits are forecast in Xinjiang and in southeastern Mongolia. Primarily moderate to severe deficits are expected from eastern Sichuan to Beijing, including northern Hubei, Henan, Shaanxi, Shanxi, Hebei. Moderate deficits are forecast for the Shandong Peninsula.

Nearly normal conditions are forecast for the Korean Peninsula. In Japan, some moderate surpluses are expected in Kyushu and Shikoku and deficits in central Honshu.

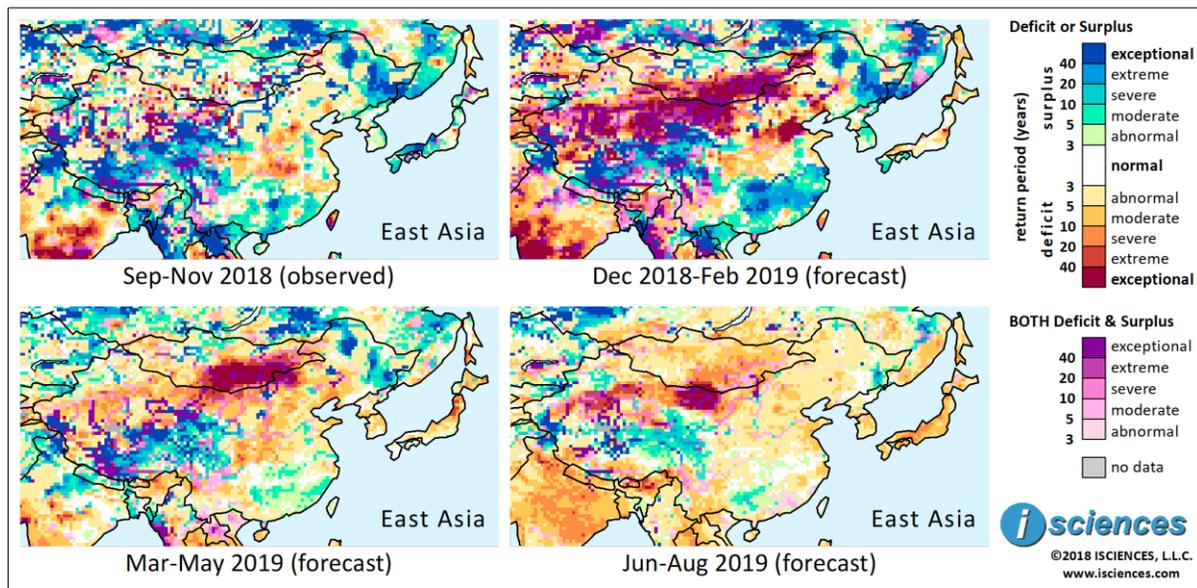
The 3-month time series maps below show the evolving conditions in more detail.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

The forecast through February indicates a vast stretch of intense water deficits from southern Mongolia and western Inner Mongolia through Xinjiang to China's western border. Conditions of both deficit and surplus are also indicated as transitions occur. Exceptional deficits are forecast for Hebei, with deficits of somewhat lesser intensity reaching through Beijing and Shanxi, and also in nearby western Liaoning. Moderate deficits are forecast for eastern Sichuan, Shaanxi, Hubei, and Henan, and severe deficits in southern Taiwan.

Surpluses will increase and intensify significantly along the Yangtze and through southeastern China and will be exceptional along the path of the Yangtze as it passes through Wuhan in Hubei. Exceptional surpluses are also expected in eastern Guangxi and Hunan, and in Shanghai. Extreme surpluses are forecast along the Lower Yangtze, and from central Hunan through Jiangxi and Fujian. Other areas of intense surplus in China include Tibet, Qinghai, and western Sichuan.

Moderate surpluses are forecast for northern South Korea, and in Kyushu and Shikoku, Japan. Some pockets of deficit are expected in Honshu and Hokkaido.

From March through May, surpluses in southeastern China will diminish considerably leaving moderate surpluses along parts of the Lower Yangtze River and in Shanghai, Fujian, Jiangxi, Hunan, and Guangxi. Exceptional deficits will persist in southeastern Mongolia but will downgrade from western Inner Mongolia through Xinjiang. Intense deficits in Hebei, Beijing, Shanxi, and Liaoning will also downgrade. Moderate to severe deficits are forecast for eastern Sichuan, Shaanxi, and Hubei. On the Korean Peninsula moderate deficits will emerge. Deficits will increase in Japan, particularly northern Honshu.

The forecast for the final three months – June through August – indicates that surpluses in China will shrink and downgrade overall, persisting in southern Heilongjiang, parts of the Tibetan Plateau, and Guangxi. Deficits will also downgrade overall but exceptional deficits are forecast for a large block of western Inner Mongolia and a wide band across Xinjiang. Deficits are forecast for the Korean Peninsula and Japan.

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

Australia & New Zealand

The 12-month forecast through August 2019 shows intense deficits in South Australia, Victoria, New South Wales, Tasmania, and the Diamantina River Basin in southwestern Queensland. Deficits will also be intense from Rockhampton in eastern Queensland through the Cape York Peninsula; from the southern shore of the Gulf of Carpentaria into Top End, Northern Territory; and in the Blackwood River region near Busselton in the tip of Western Australia.

ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



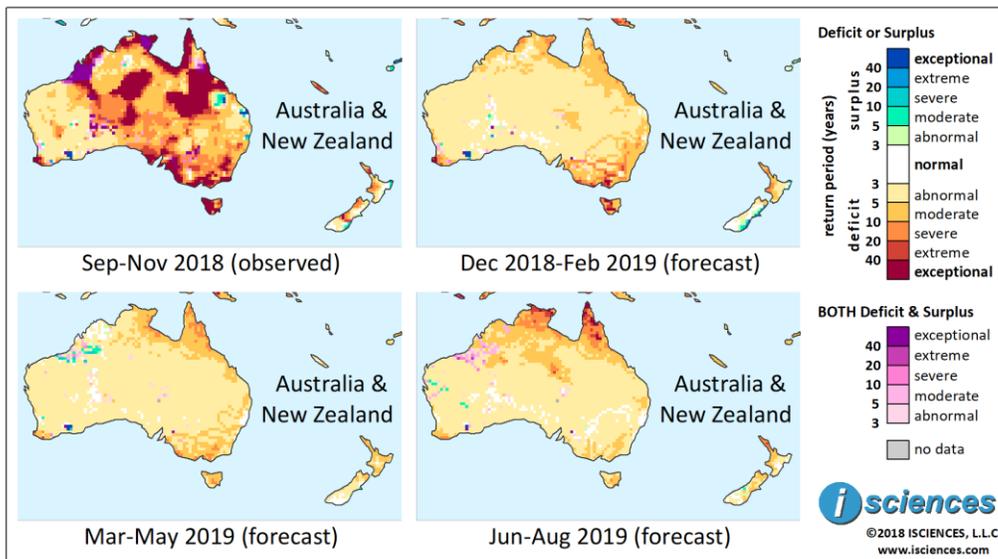
Based on observed data through November 2018 and forecasts issued November 24-30, 2018.

In the Murray-Darling Basin deficits are expected to be exceptional along the Murray River, severe on Lachlan and Macquarie, and moderate on the Darling.

Moderate deficits are forecast for northern New Zealand but may be more intense north of Auckland. Moderate to severe deficits are forecast for New Caledonia.

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

ISCIENCES COMPOSITE WATER ANOMALY INDEX: September 2018-August 2019



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

The forecast through February indicates that the intense deficits that have dominated many parts of Australia in prior months will nearly disappear. However, severe to exceptional deficits will persist in Tasmania, pockets of Victoria, and around Busselton in the tip of Western Australia (WA). Moderate to severe deficits are forecast for parts of New South Wales (NSW). Deficits on the Murray River are

expected to be severe, while moderate deficits are forecast for the Darling, Lachlan, and Macquarie Rivers. Deficits may be severe in the Riverina region of NSW. Primarily moderate deficits are forecast in a wide arc across northern Australia from Rockhampton in eastern Queensland (QLD), through the Cape York Peninsula QLD, in Top End Northern Territory (NT), and into the Kimberley Plateau WA. In New Zealand, moderate to severe deficits are forecast for western North Island, and surpluses are forecast along the coast of South Island from Christchurch to Dunedin. Deficits in New Caledonia will moderate.

From March through May, deficits in southeastern Australia and around Busselton WA will moderate overall. Moderate deficits will persist in the north around the Gulf of Carpentaria and through Cape York Peninsula, with some severe pockets. Conditions in the Kimberley Plateau will normalize, and some moderate surpluses are expected to emerge south of the Fitzroy River. Moderate deficits are forecast for northern New Zealand, and conditions in New Caledonia are expected to normalize.

The forecast for the final months – June through August – indicates intense deficits across northern Australia, and near-normal conditions elsewhere in the country. Moderate deficits may re-emerge in New Caledonia and deficits in New Zealand may intensify north of Auckland.

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