Environmental Setting Protocol - Example Grid Metrics

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The draft Environmental Setting protocol calculates four types of climate metrics using the EnvironmentalSetting toolkit https://github.com/nationalparkservice/EnvironmentalSetting_Toolkit.

- station-based temperature and precipitation
- station-based departures from normal temperature and precipitation
- **grid-based departures from normal temperature and precipitation**
- index-based precipitation and drought

The first two metric types are calculated for all stations that intersect the 30km areas of analysis for parks while the latter two metric types are calculated by area of analysis (AOA) bounding box extent. This notebook shows the third metric type for the 30km AOA around Agate Fossil Beds NM (AGFO). The monthly interpolated source grids and 30-year normal grids are from PRISM - the Parameter-elevation Relationships on Independent Slopes Model (http://prism.oregonstate.edu/). NPS has a license for 800m PRISM data, including the LT81m dataset used as input for deriving the metrics. The Toolkit outputs metric and, optionally, normal rasters. The license precludes direct output of the source LT81m data.

Environmental Setting protocol metrics are shown below.

ï..Metric	Description
CGP1	Monthly departures from average monthly average precipitation (% of climate normal)
CGP2	Monthly departures from average monthly minimum precipitation (% of climate normal)
CGP3	Monthly departures from average monthly maximum precipitation (% of climate normal)
CGP4	Snow-Water Equivalent Snowpack Departures from average (% of climate normal)
CGP5	Monthly Palmer Drought Severity Index
CGP6	Standardized Precipitation Index
CGT1	Monthly temperature departures from average monthly average temperature (% of climate normal)
CGT2	Monthly temperature departures from average monthly minimum temperature (% of climate normal)
CGT3	Monthly temperature departures from average monthly maximum temperature (% of climate normal)
CSP1	Heavy Precipitation Days
CSP2	Extreme Precipitation Days
CSP3	Micro-drought
CSP4	Measurable Snow Days
CSP5	Moderate Snow Days
CSP6	Heavy Snow Days
CSP7	Above Normal Precipitation Days
CSP8	Below Normal Precipitation Days
CST1	Hot Days
CST2	Cold Days
CST3	Sub-Freezing Days
CST4	Sub-Zero Days
CST5	Growing Degree Days
CST6	Heating Degree Days
CST7	Cooling Degree Days
CST8	Above Normal Temperature Days

ï..Metric	Description
CST9	Below Normal Temperature Days

Gridded Temperature and Precipitation Metrics

Gridded metric requests require the *rgdal* library (https://cran.r-project.org/web/packages/rgdal/rgdal.pdf). For formal metric requests for the protocol, the *getGriddedMetrics()* function is used with input from the *getAOAFeature()* function which retrieves the SpatialPolygon for the AOA from the standard feature service for AOAs: https://irmaservices.nps.gov/arcgis/rest/services/LandscapeDynamics/LandscapeDynamics_AOA/FeatureServer.

Note the *getGriddedMetrics()* function accepts any SpatialPolygon with a WGS84 or NAD83 geographic coordinate system spatial reference.

Exploratory plots are shown in this notebook and are written out as PNG files by the Toolkit *getGriddedMetrics()* function. In addition, a CSV file containing metric raster summary statistics is generated.

For all metrics, values returned are raw data.

Get Feature Polygon

```
agfoAOA <- getAOAFeature(unitCode = "AGFO")

## [1] "https://irmaservices.nps.gov/arcgis/rest/services/LandscapeDynamics/LandscapeDynamics_
## OGR data source with driver: GeoJSON
## Source: "temp.geojson", layer: "OGRGeoJSON"
## with 1 features
## It has 17 fields

agfoAOA

## class       : SpatialPolygonsDataFrame
## features    : 1
## extent      : -104.0662, -103.4218, 42.20853, 42.63516  (xmin, xmax, ymin, ymax)
## coord. ref. : +proj=longlat +datum=WGS84 +no_defs +ellps=WGS84 +towgs84=0,0,0
## variables   : 17
## names       : OBJECTID, UNIT_CODE, PARK_CODE,                        UNIT_NAME, NETWORK_
## min values  :        3,      AGFO,      AGFO, Agate Fossil Beds National Monument,
## max values  :        3,      AGFO,      AGFO, Agate Fossil Beds National Monument,
```
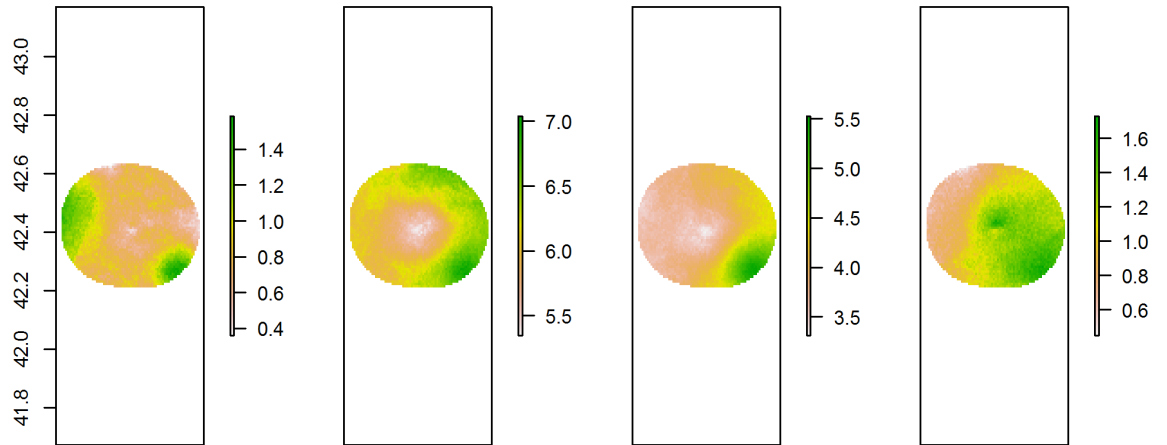
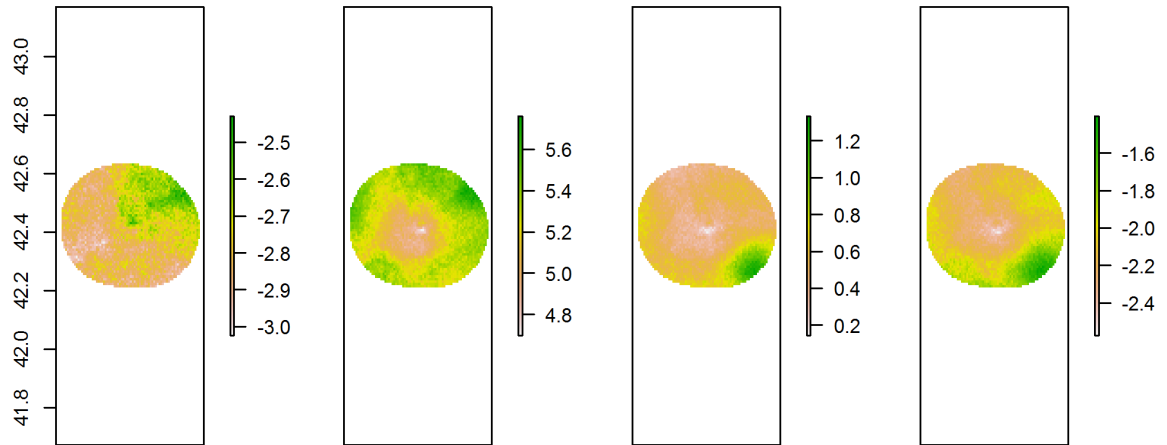## Temperature Metric Example

```
# Get CGT1, the monthly departure of mean temperature from 30-year climate normal
# (1981-2010), for 2016.
agfoTemperatureMetricStack <- getMetricGrids(featurePolygon = agfoAOA, metric = "CGT1",
    unitCode = "AGFO", sdate = "2016", edate = "2016", includeNormals = TRUE)
str(agfoTemperatureMetricStack)
```
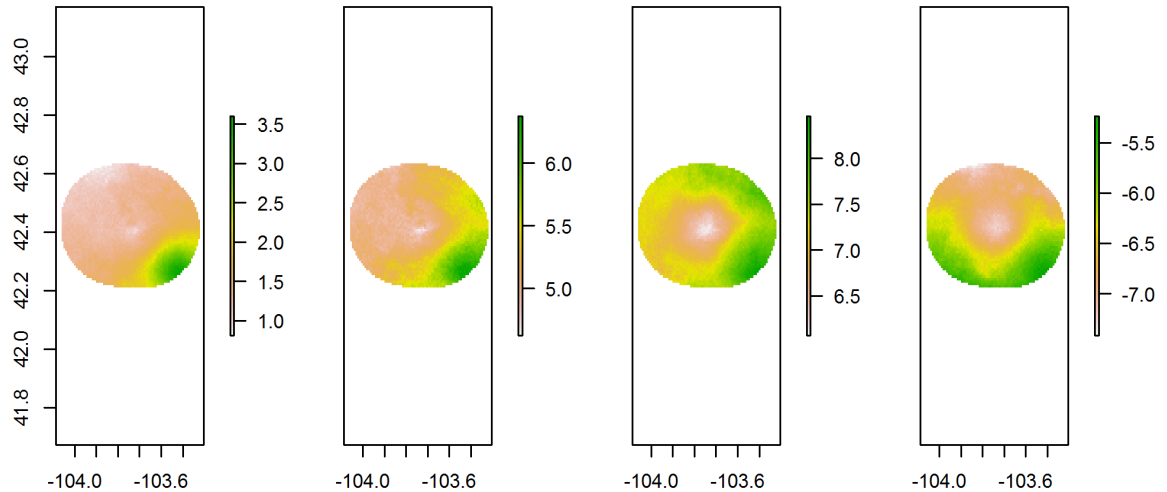
Figure 1: CGT1 Metric - Monthly Departure (deg F) from 30-year normal mean temperature
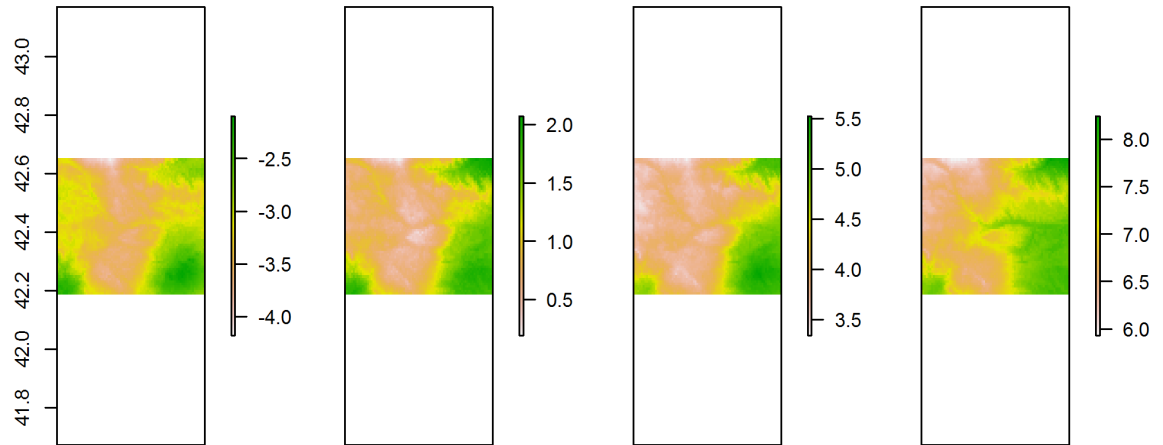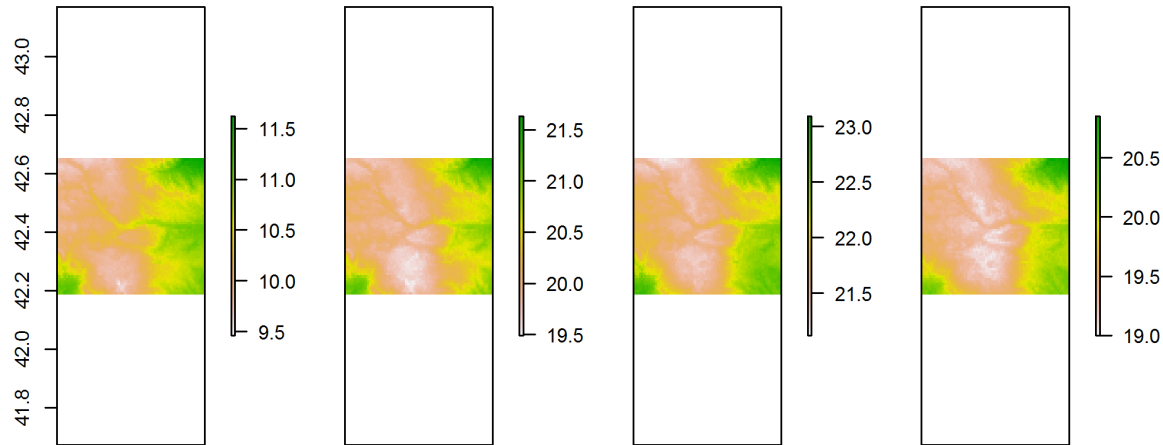
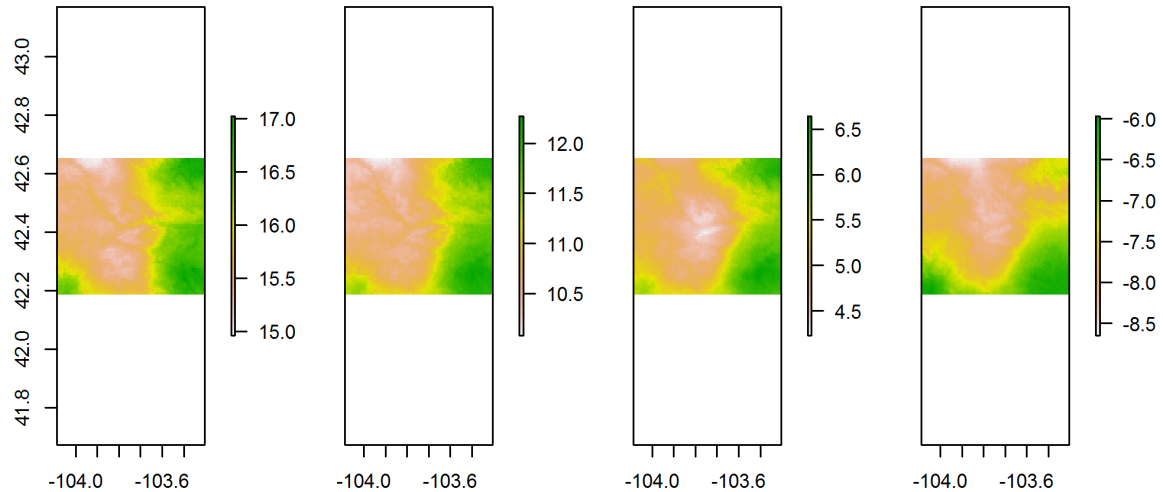Figure 2: Source LT81m Monthly Mean Temperature (deg C) Grids

Figure 3: Norm81m Monthly Normal Mean Temperature (deg C) Grids

Table 2: Monthly Summary Statistics for Departure Metric Rasters

name	metric	parameter	date	cellCount	min	max	mean	sd	var
AGFO	CGT1	tmean	2016-01	4592	0.3599992	1.584000	0.8409521	0.2085980	0.0435131
AGFO	CGT1	tmean	2016-02	4592	5.3460002	7.038000	6.1475195	0.2990967	0.0894588
AGFO	CGT1	tmean	2016-03	4592	3.3120003	5.526000	4.0155988	0.4282634	0.1834095
AGFO	CGT1	tmean	2016-04	4592	0.4500009	1.728001	1.1098237	0.2599536	0.0675759
AGFO	CGT1	tmean	2016-05	4592	-3.0239988	-2.429999	-2.7831842	0.0991064	0.0098221
AGFO	CGT1	tmean	2016-06	4592	4.6980011	5.760005	5.2717206	0.1625387	0.0264188
AGFO	CGT1	tmean	2016-07	4592	0.1439999	1.332003	0.5503738	0.1730430	0.0299439
AGFO	CGT1	tmean	2016-08	4592	-2.5740005	-1.403998	-2.0813020	0.1778765	0.0316401
AGFO	CGT1	tmean	2016-09	4592	0.8100014	3.600003	1.5521766	0.4984784	0.2484807
AGFO	CGT1	tmean	2016-10	4592	4.6260012	6.372002	5.2610938	0.3217915	0.1035498
AGFO	CGT1	tmean	2016-11	4592	6.0660000	8.460000	7.2676077	0.4239396	0.1797248
AGFO	CGT1	tmean	2016-12	4592	-7.4160015	-5.238001	-6.4350029	0.4754110	0.2260156

Precipitation Metric Example

Note: Index-based metrics will be added in a subsequent version of the Toolkit.

```r
# Get CGP1, the monthly percent of 30-year climate normal (1981-2010) mean
# temperature, for 2016.
agfoPrecipitationMetricStack <- getMetricGrids(featurePolygon = agfoAOA, metric = "CGP1",
    unitCode = "AGFO", sdate = "2016", edate = "2016", includeNormals = TRUE)
str(agfoPrecipitationMetricStack)
```
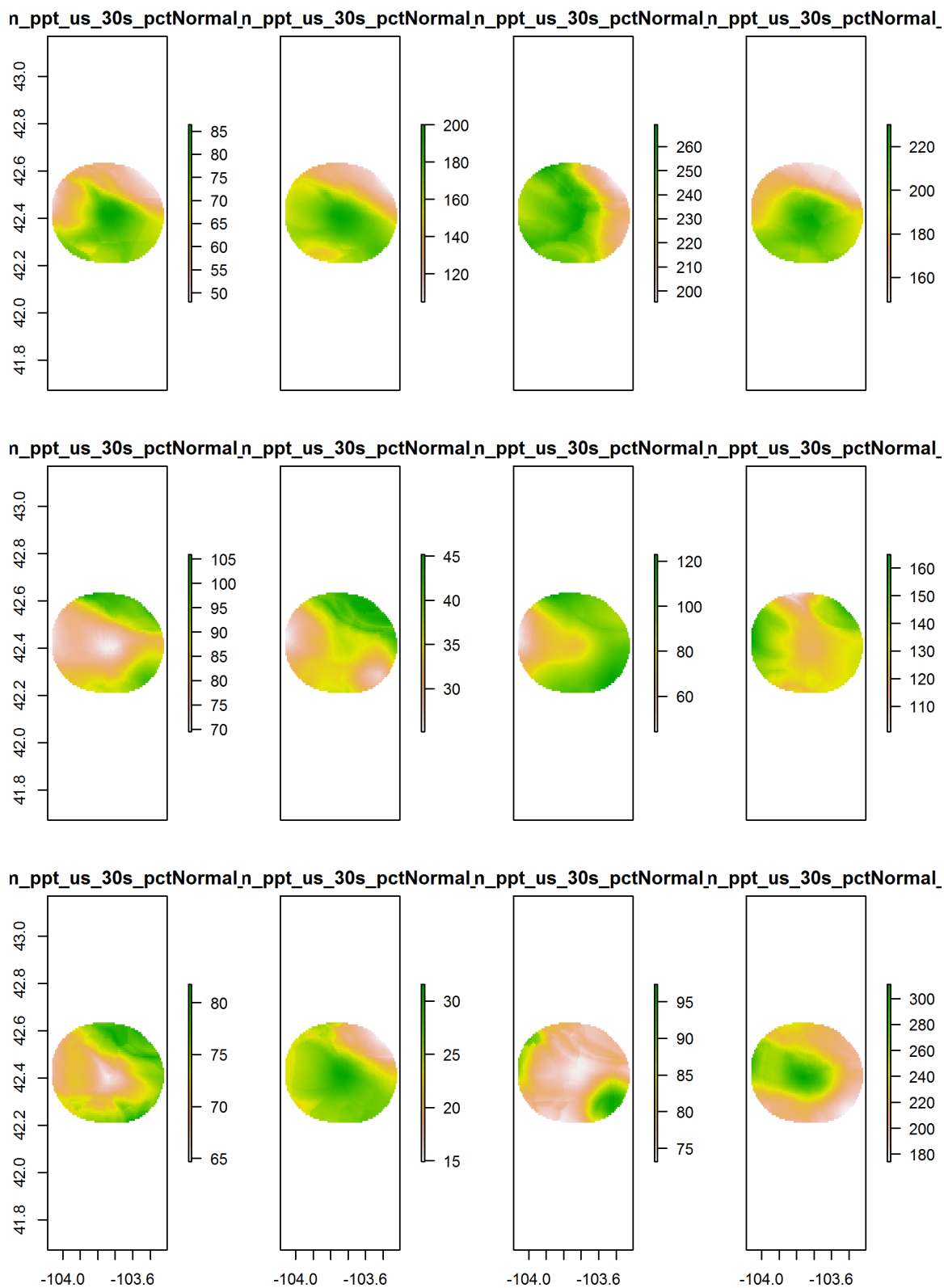
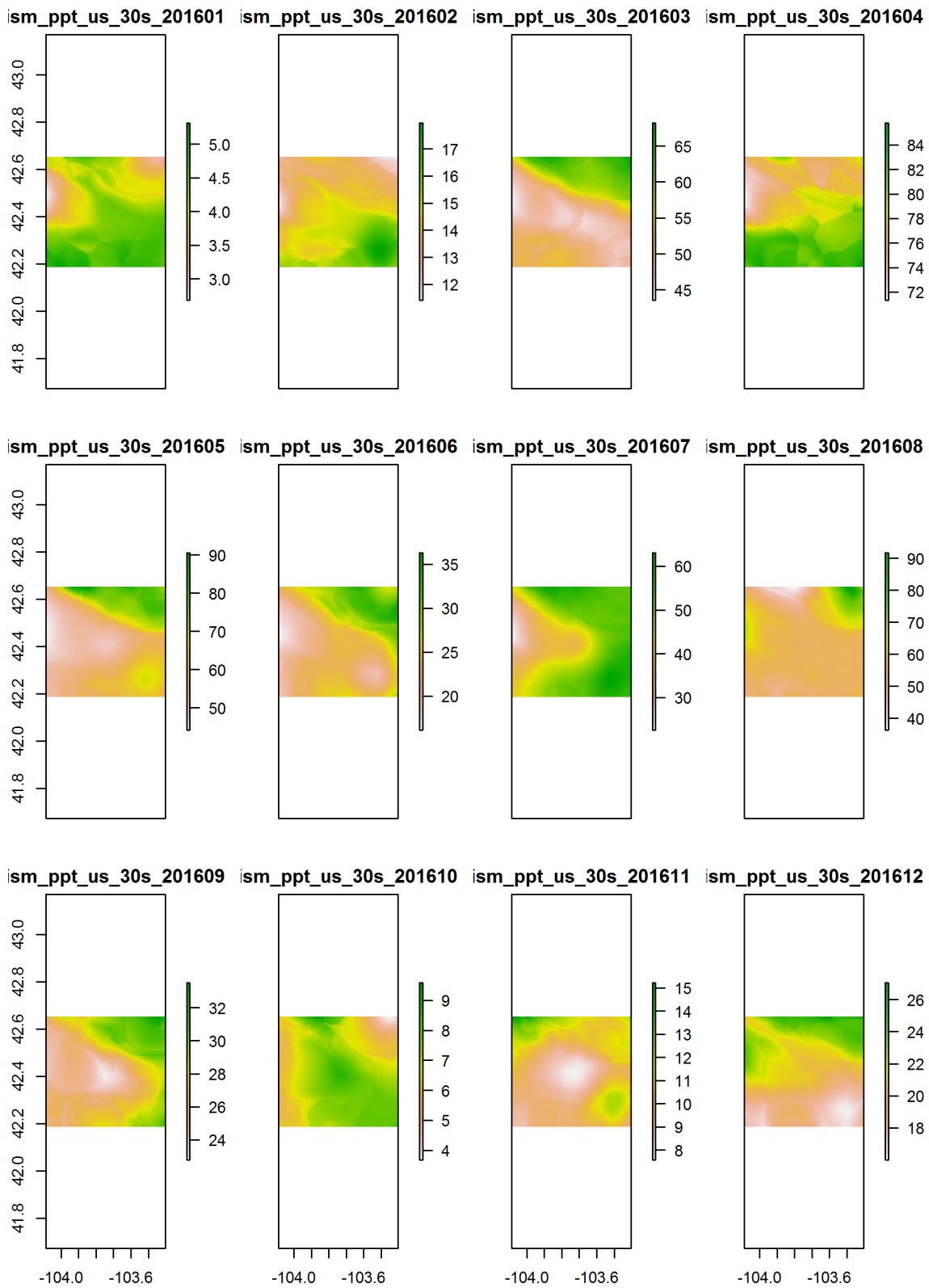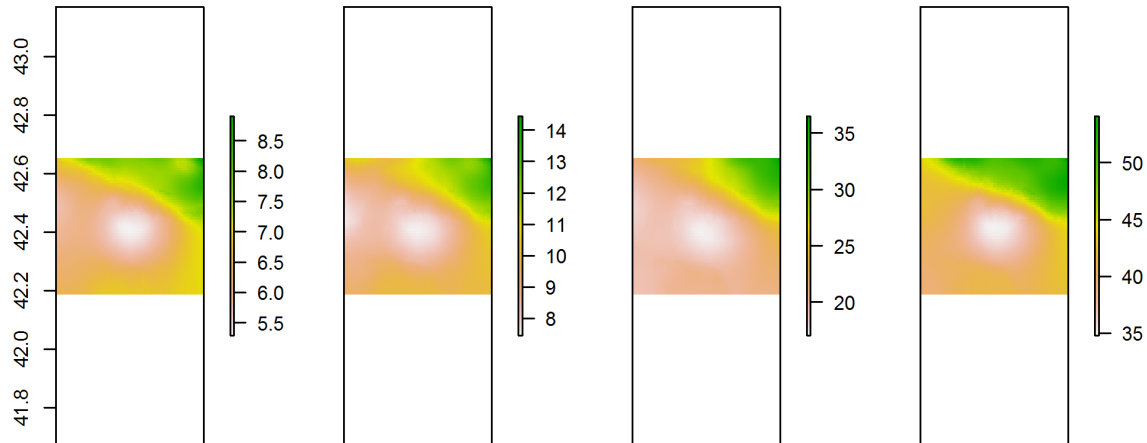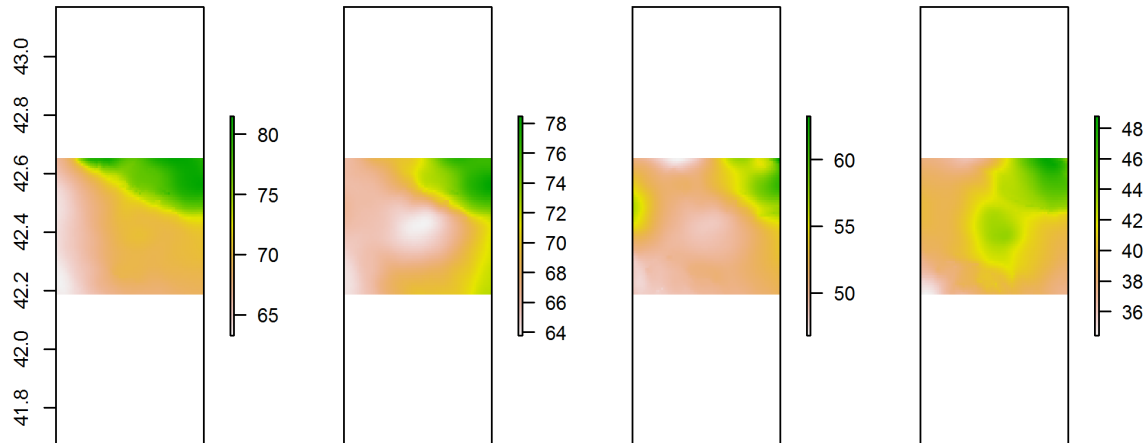Figure 4: CGP1 Metric - Monthly Percent of 30-year normal precipitation

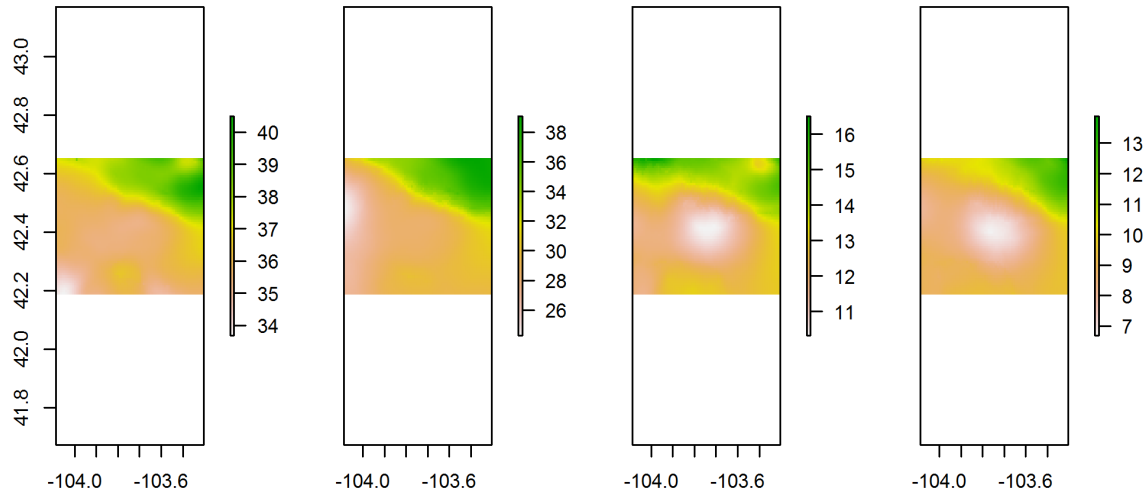Figure 5: Source LT81m Monthly Precipitation (mm) Grids

Figure 6: Norm81m Monthly Normal Precipitation (mm) Grids

Table 3: Monthly Summary Statistics for Percent Normal Metric Rasters

name	metric	parameter	date	cellCount	min	max	mean	sd	var
AGFO	CGP1	ppt	2016-01	4592	48.04598	86.39098	68.01941	9.117818	83.13460
AGFO	CGP1	ppt	2016-02	4592	105.03174	200.02686	158.53105	21.555045	464.61998
AGFO	CGP1	ppt	2016-03	4592	195.47855	269.07541	241.46118	16.716999	279.45806
AGFO	CGP1	ppt	2016-04	4592	148.82500	230.01722	192.35521	20.174502	407.01054
AGFO	CGP1	ppt	2016-05	4592	69.48404	105.90369	83.86283	8.430592	71.07489
AGFO	CGP1	ppt	2016-06	4592	25.13015	45.16215	35.15271	4.631382	21.44970
AGFO	CGP1	ppt	2016-07	4592	44.29561	122.89105	91.10175	15.942505	254.16346
AGFO	CGP1	ppt	2016-08	4592	100.79519	164.87837	133.29225	9.544619	91.09974
AGFO	CGP1	ppt	2016-09	4592	64.69186	81.75330	73.11303	3.699264	13.68456
AGFO	CGP1	ppt	2016-10	4592	14.91882	31.55642	24.90008	3.350017	11.22261
AGFO	CGP1	ppt	2016-11	4592	73.19483	97.34025	79.95706	5.240537	27.46323
AGFO	CGP1	ppt	2016-12	4592	174.23327	310.92676	235.66118	29.868599	892.13319