

Visualizing cover data at each step of the data preparation workflow

```
library(tidyverse)
library(sf)
library(terra)
library(ggpubr)
ggplot2::theme_set(theme_classic())
```

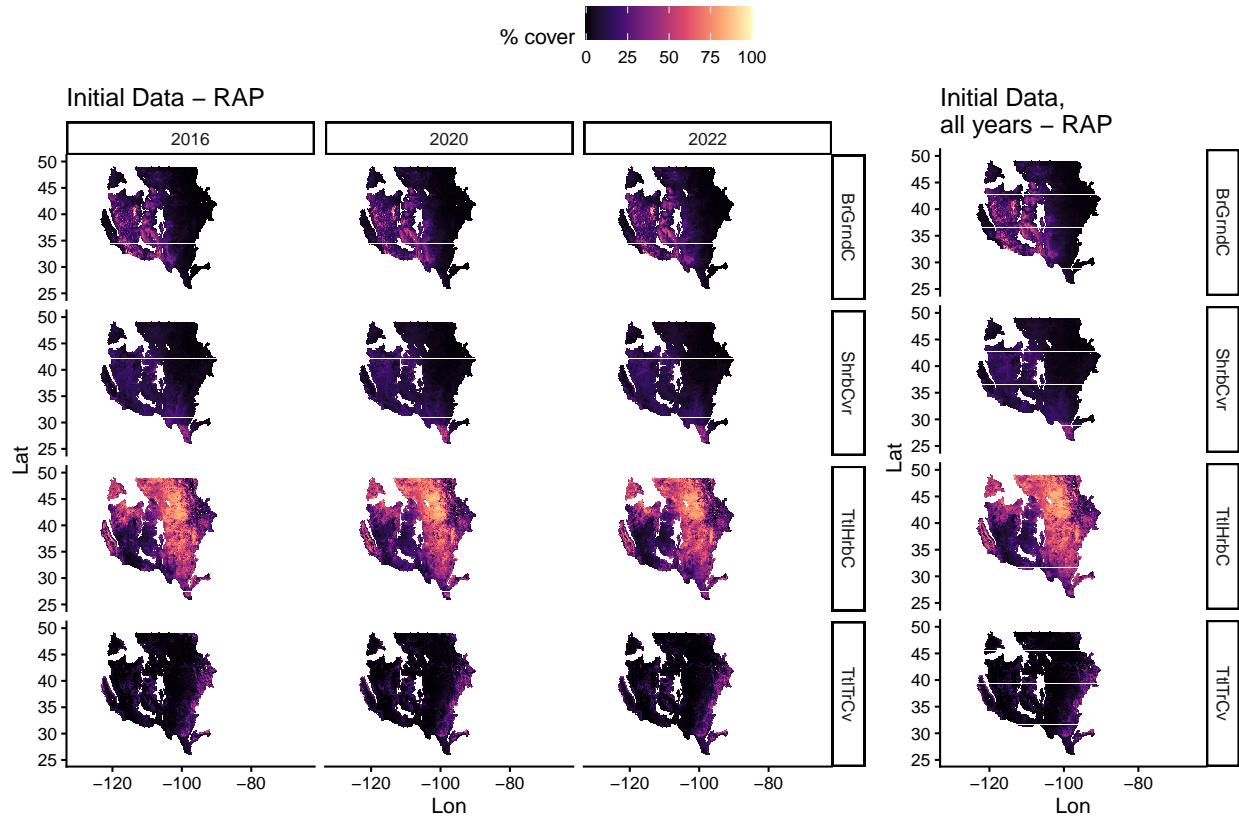
This document visualizes the data of vegetation cover by functional type that we use in subsequent analysis at each step of the data-processing workflow. These maps serve both as a reference and a check that the workflow is performing as intended.

For the sake of simplified comparison, I show data from 2016, 2020, and 2022, which are years for which we have easy to access rasters of FIA data to compare to.

RAP

Initial dataset

```
## Reading layer 'vegCompPoints' from data source
##   '/Users/astearns/Documents/Dropbox_static/Work/NAU_USGS_postdoc/cleanPED/PED_vegClimModels/Data_pro
## using driver 'ESRI Shapefile'
## Simple feature collection with 1266274 features and 30 fields
## Geometry type: POINT
## Dimension: XY
## Bounding box: xmin: -124.7004 ymin: 24.68798 xmax: -67.10236 ymax: 49.3489
## Geodetic CRS: WGS 84
```



After removing burned area

```

# Read in data
dat_2 <- readRDS(file = "../../Data_processed/CoverData/dataForAnalysis_fireRemoved.rds")
# trim to be only later than 2000, which is what we want to use for further analysis
dat_2 <- dat_2 %>%
  filter(Year >= 2000)

## make figure for RAP
# get data just for RAP
RAP_2 <- dat_2 %>%
  filter(Source == "RAP") %>%
  pivot_longer(cols = c(ShrbCvr, TtlTrCv, TtlHrbC, BrGrndC#, AngTrC_, CnfTrC_, C3GrmC_, C4GrmC_, FrbCrv),
               names_to = "coverType",
               values_to = "coverValues"
  ) %>%
  filter(!is.na(coverValues))

ggarrange(ggplot(RAP_2 %>%
  filter(Year %in% c(2016, 2020, 2022))) +
  facet_grid(rows = vars(coverType), cols = vars(Year)) +
  stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
  scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
                       limits = c(0,100)) +

```

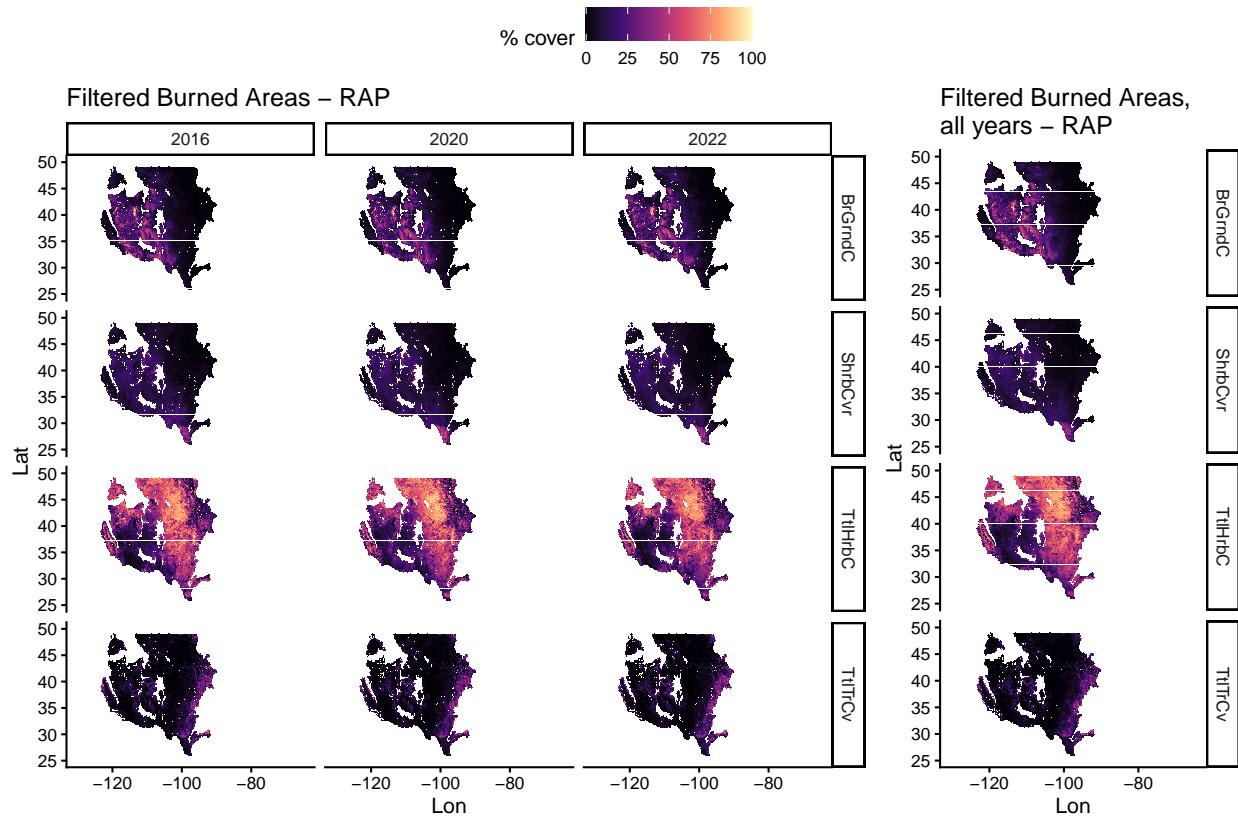
```

#geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
#geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
xlim(c(-130,-65)) +
ylim(c(25, 50)) +
ggtitle("Filtered Burned Areas - RAP"),

ggplot(RAP_2) +
facet_grid(rows = vars(coverType)) +
stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
limits = c(0,100)) +
#geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
#geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
xlim(c(-130,-65)) +
ylim(c(25, 50)) +
ggtitle("Filtered Burned Areas, \nall years - RAP "),

ncol = 2, align = "h",
common.legend = TRUE,
widths = c(.7, .3)
)

```



After ‘coarsifying’ LANDFIRE data

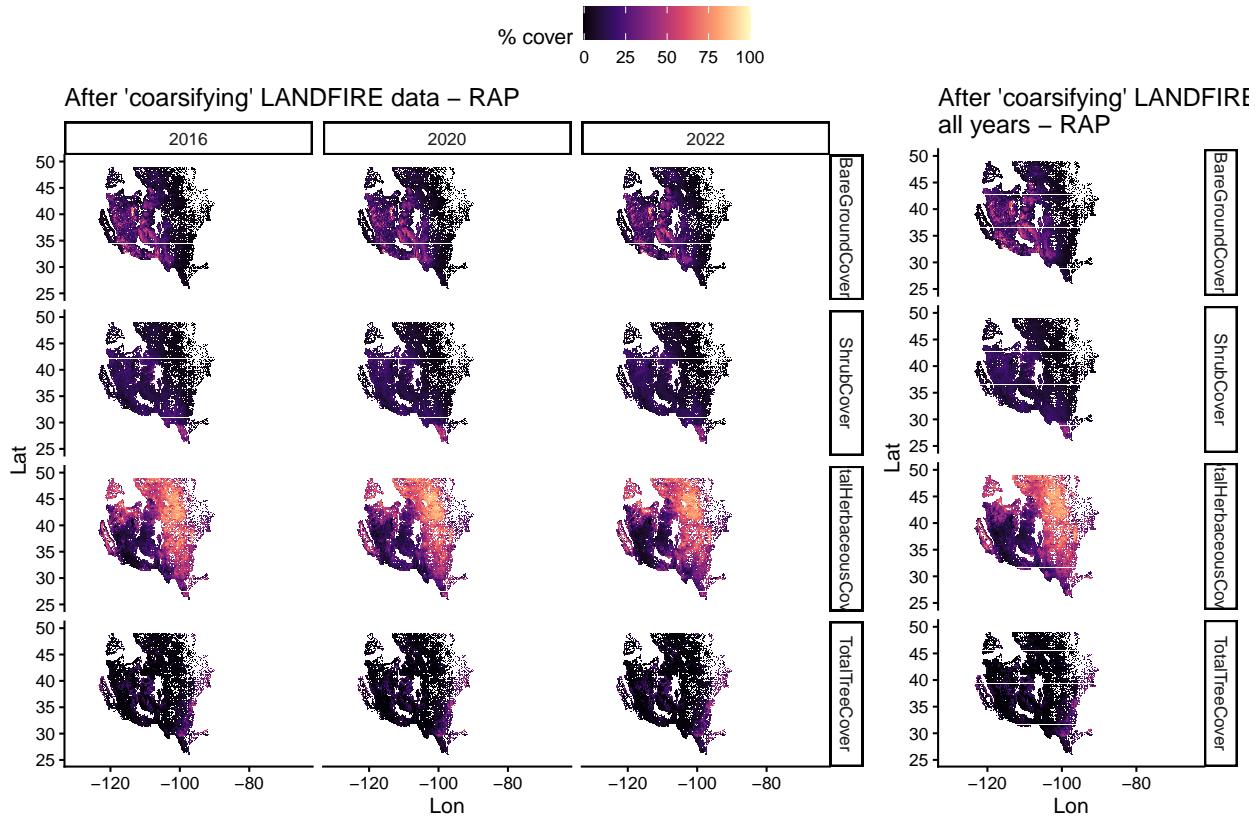
```
# Read in data
dat_3 <- readRDS(file = "../../Data_processed/CoverData/data_beforeSpatialAveraging_sampledLANDFIRE.RDS")
# trim to be only later than 2000, which is what we want to use for further analysis
dat_3 <- dat_3 %>%
  filter(Year >= 2000)

## make figure for RAP
# get data just for RAP
RAP_3 <- dat_3 %>%
  filter(Source == "RAP") %>%
  pivot_longer(cols = c(#ShrbCvr, TtlTrCv, TtlHrbC, BrGrndC,
    ShrubCover, TotalTreeCover, TotalHerbaceousCover, BareGroundCover, AngTrC_, CnfTrC_, C3GrmC_, C4GrnC_),
    names_to = "coverType",
    values_to = "coverValues"
  ) %>%
  filter(!is.na(coverValues))

ggarrange(ggplot(RAP_3 %>%
  filter(Year %in% c(2016, 2020, 2022))) +
  facet_grid(rows = vars(coverType), cols = vars(Year)) +
  stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
  scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
    limits = c(0,100)) +
  #geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
  #geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
  xlim(c(-130,-65)) +
  ylim(c(25, 50)) +
  ggtitle("After 'coarsifying' LANDFIRE data - RAP"),

  ggplot(RAP_3) +
  facet_grid(rows = vars(coverType)) +
  stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
  scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
    limits = c(0,100)) +
  #geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
  #geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
  xlim(c(-130,-65)) +
  ylim(c(25, 50)) +
  ggtitle("After 'coarsifying' LANDFIRE data, \nall years - RAP "),

  ncol = 2, align = "h",
  common.legend = TRUE,
  widths = c(.7, .3)
)
```



AIM (BLM Assessment, Inventory and Monitoring data)

Initial Dataset

```
## make figure for LDC
# get data just for LDC
LDC_1 <- dat_1 %>%
  st_zm() %>%
  filter(Source == "LDC") %>%
  #st_drop_geometry() %>%
  pivot_longer(cols = c(ShrbCvr, TtlTrCv, TtlHrbC, BrGrndC#, AngTrC_, CnfTrC_, C3GrmC_, C4GrmC_, FrbCvr),
               ),
  names_to = "coverType",
  values_to = "coverValues"
) %>%
filter(!is.na(coverValues))
#filter(coverType == "ShrbCvr" & Year == 2016) %>%

ggarrange(ggplot(LDC_1 %>%
  filter(Year %in% c(2016, 2020, 2022))) +
  facet_grid(rows = vars(coverType), cols = vars(Year)) +
  stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
  scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
  limits = c(0,100)) +
```

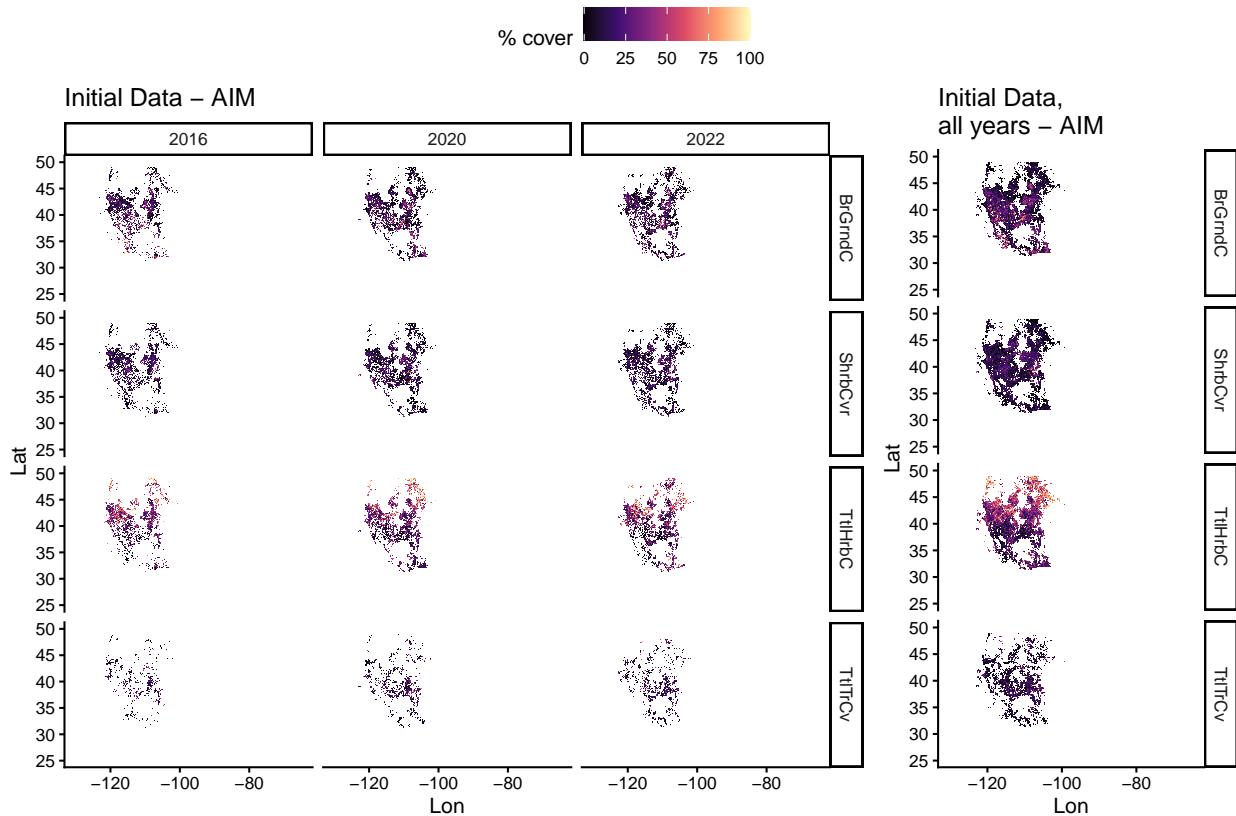
```

#geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
#geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
xlim(c(-130,-65)) +
ylim(c(25, 50)) +
ggtitle("Initial Data - AIM"),

ggplot(LDC_1) +
facet_grid(rows = vars(coverType)) +
stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
limits = c(0,100)) +
#geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
#geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
xlim(c(-130,-65)) +
ylim(c(25, 50)) +
ggtitle("Initial Data, \nall years - AIM "),

ncol = 2, align = "h",
common.legend = TRUE,
widths = c(.7, .3)
)

```



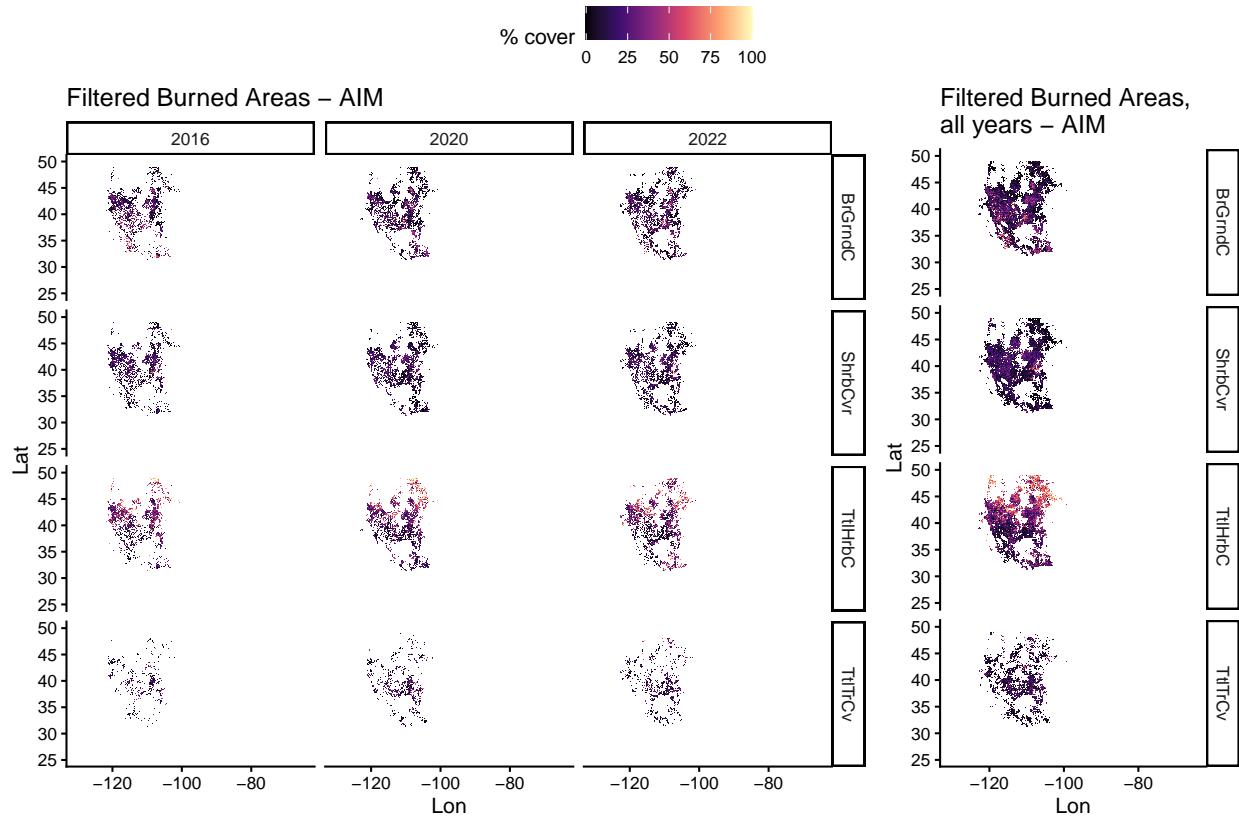
After removing burned area

```
## make figure for LDC
# get data just for LDC
AIM_2 <- dat_2 %>%
  filter(Source == "LDC") %>%
  pivot_longer(cols = c(ShrbCvr, TtlTrCv, TtlHrbC, BrGrndC#, AngTrC_, CnfTrC_, C3GrmC_, C4GrmC_, FrbCvry),
               ),
  names_to = "coverType",
  values_to = "coverValues"
) %>%
filter(!is.na(coverValues))

ggarrange(ggplot(AIM_2 %>%
  filter(Year %in% c(2016, 2020, 2022))) +
  facet_grid(rows = vars(coverType), cols = vars(Year)) +
  stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
  scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
                        limits = c(0,100)) +
  #geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
  #geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
  xlim(c(-130,-65)) +
  ylim(c(25, 50)) +
  ggtitle("Filtered Burned Areas - AIM"),

  ggplot(AIM_2) +
  facet_grid(rows = vars(coverType)) +
  stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
  scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
                        limits = c(0,100)) +
  #geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
  #geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
  xlim(c(-130,-65)) +
  ylim(c(25, 50)) +
  ggtitle("Filtered Burned Areas, \nall years - AIM "),

  ncol = 2, align = "h",
  common.legend = TRUE,
  widths = c(.7, .3)
)
```



After ‘coarsifying’ LANDFIRE data

```

## make figure for AIM
# get data just for AIM
AIM_3 <- dat_3 %>%
  filter(Source == "LDC") %>%
  pivot_longer(cols = c(ShrubCover, TotalTreeCover, TotalHerbaceousCover, BareGroundCover#, AngTrC_, Cn),
               ),
  names_to = "coverType",
  values_to = "coverValues"
) %>%
filter(!is.na(coverValues))

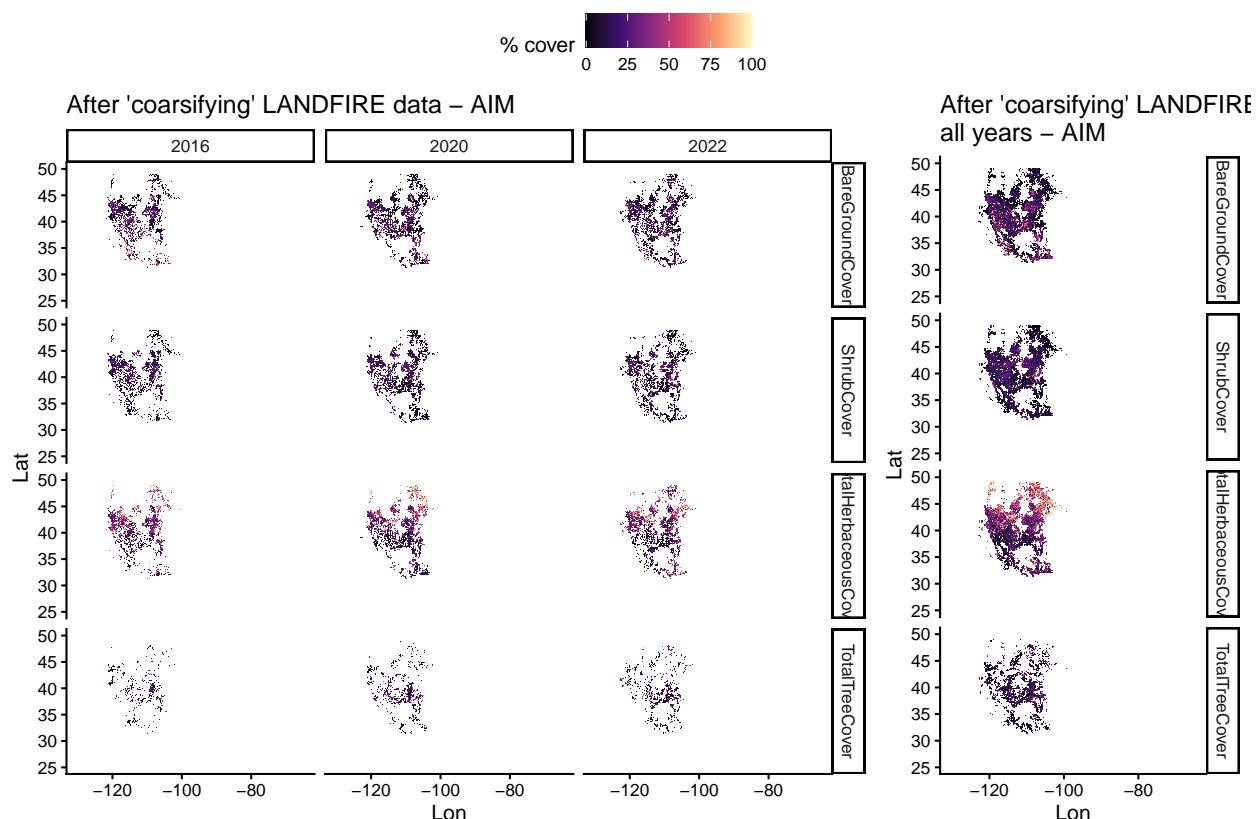
ggarrange(ggplot(AIM_3 %>%
  filter(Year %in% c(2016, 2020, 2022))) +
  facet_grid(rows = vars(coverType), cols = vars(Year)) +
  stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
  scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
                       limits = c(0,100)) +
  #geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
  #geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
  xlim(c(-130,-65)) +
  ylim(c(25, 50)) +
  ggtitle("After 'coarsifying' LANDFIRE data - AIM"),
)

```

```

ggplot(AIM_3) +
  facet_grid(rows = vars(coverType)) +
  stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
    scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
    limits = c(0,100)) +
  #geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
  #geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
  xlim(c(-130,-65)) +
  ylim(c(25, 50)) +
  ggtitle("After 'coarsifying' LANDFIRE data, \nall years - AIM "),
  ncol = 2, align = "h",
  common.legend = TRUE,
  widths = c(.7, .3)
)

```



FIA (USFS Forest Inventory and Analysis data)

Initial Dataset

```

## make figure for FIA
# get data just for FIA
FIA_1 <- dat_1 %>%

```

```

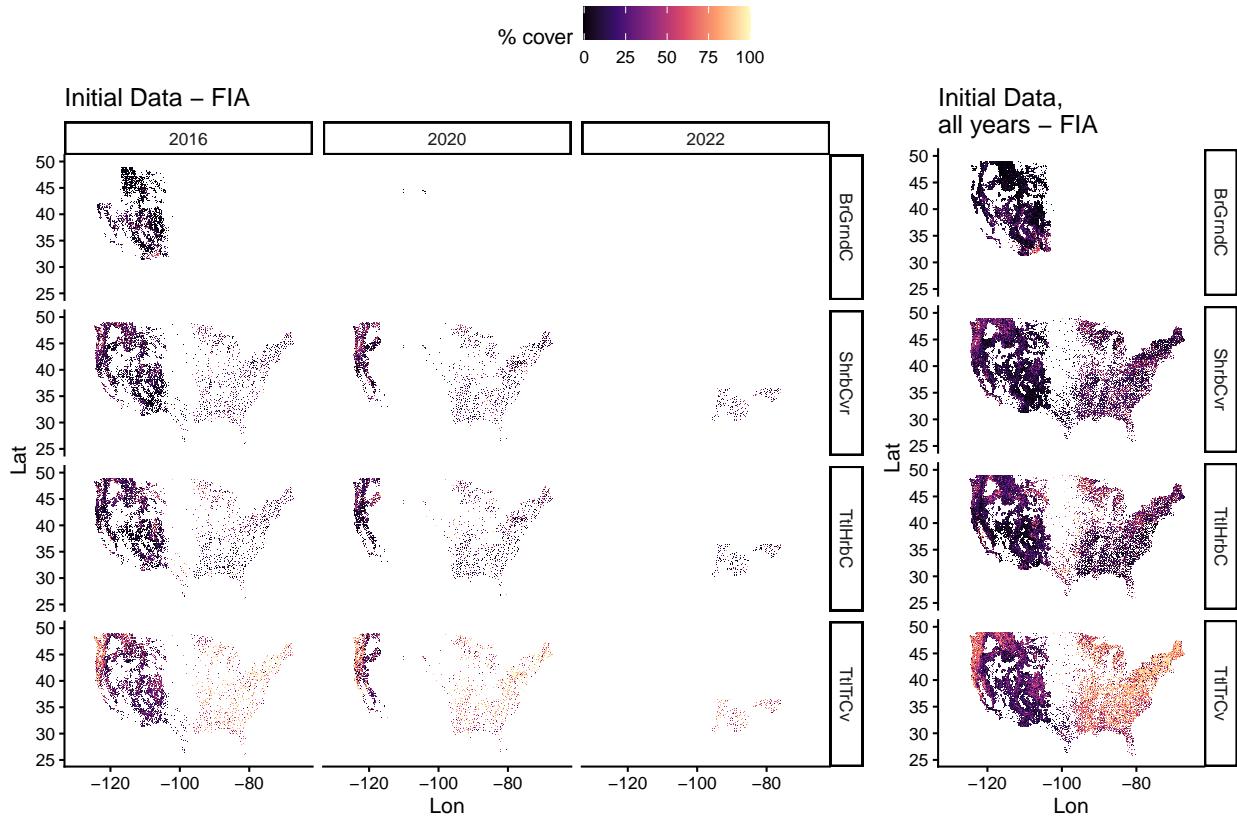
st_zm() %>%
  filter(Source == "FIA") %>%
  #st_drop_geometry() %>%
  pivot_longer(cols = c(ShrbCvr, TtlTrCv, TtlHrbC, BrGrndC#, AngTrC_, CnfTrC_, C3GfrmC_, C4GfrmC_, FrbCvry),
               ),
  names_to = "coverType",
  values_to = "coverValues"
) %>%
filter(!is.na(coverValues))

ggarrange(ggplot(FIA_1 %>%
  filter(Year %in% c(2016, 2020, 2022))) +
  facet_grid(rows = vars(coverType), cols = vars(Year)) +
  stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
  scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
                        limits = c(0,100)) +
  #geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
  #geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
  xlim(c(-130,-65)) +
  ylim(c(25, 50)) +
  ggtitle("Initial Data - FIA"),

  ggplot(FIA_1) +
  facet_grid(rows = vars(coverType)) +
  stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
  scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
                        limits = c(0,100)) +
  #geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
  #geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
  xlim(c(-130,-65)) +
  ylim(c(25, 50)) +
  ggtitle("Initial Data, \nall years - FIA "),

  ncol = 2, align = "h",
  common.legend = TRUE,
  widths = c(.7, .3)
)

```



After removing burned area

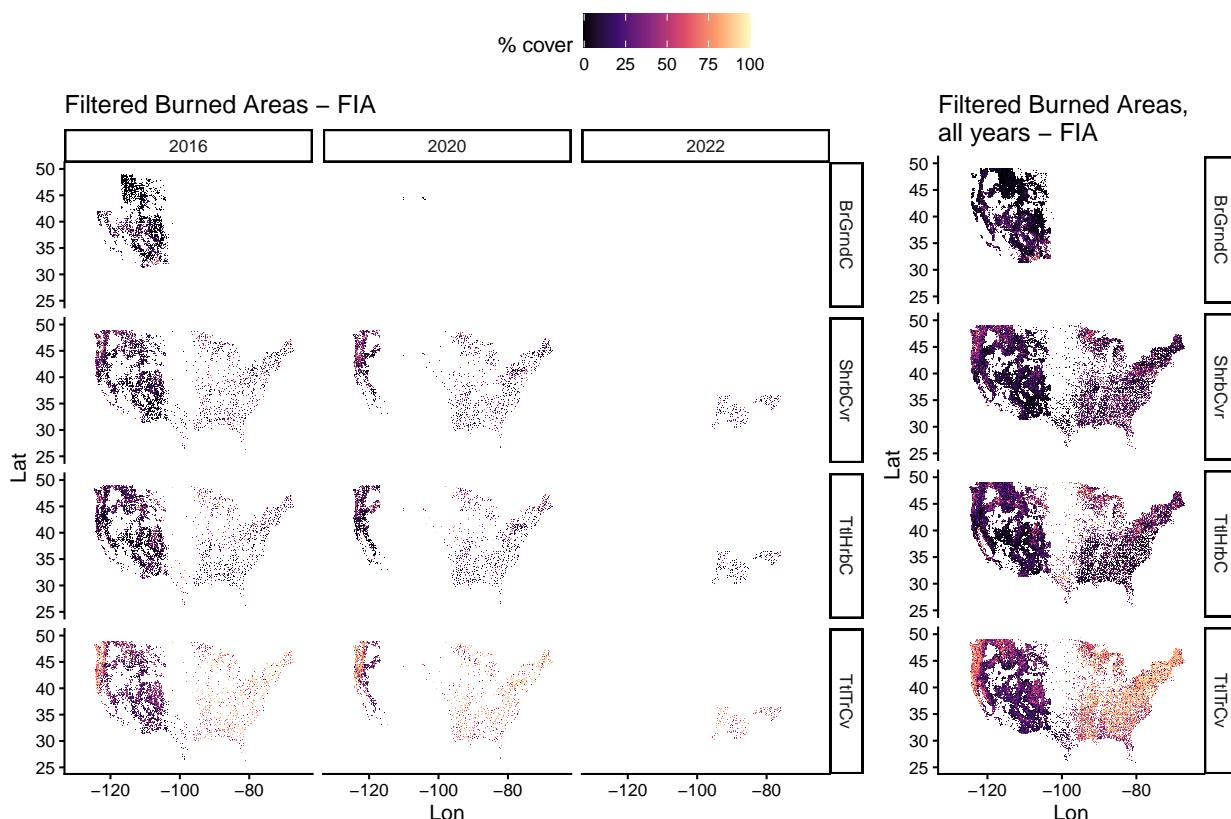
```
## make figure for FIA
# get data just for FIA
FIA_2 <- dat_2 %>%
  filter(Source == "FIA") %>%
  pivot_longer(cols = c(ShrbCvr, TtlTrCv, TtlHrbC, BrGrndC#, AngTrC_, CnfTrC_, C3GrmC_, C4GrmC_, FrbCvr),
               ),
  names_to = "coverType",
  values_to = "coverValues"
) %>%
filter(!is.na(coverValues))

ggarrange(ggplot(FIA_2 %>%
  filter(Year %in% c(2016, 2020, 2022))) +
  facet_grid(rows = vars(coverType), cols = vars(Year)) +
  stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
  scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
  limits = c(0,100)) +
  #geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
  #geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
  xlim(c(-130,-65)) +
  ylim(c(25, 50)) +
  ggtitle("Filtered Burned Areas - FIA"),
```

```

ggplot(FIA_2) +
  facet_grid(rows = vars(coverType)) +
  stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
  scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
                        limits = c(0,100)) +
  #geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
  #geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
  xlim(c(-130,-65)) +
  ylim(c(25, 50)) +
  ggtitle("Filtered Burned Areas, \nall years - FIA "),
  ncol = 2, align = "h",
  common.legend = TRUE,
  widths = c(.7, .3)
)

```



After ‘coarsifying’ LANDFIRE data

```

## make figure for FIA
# get data just for FIA
FIA_3 <- dat_3 %>%
  filter(Source == "FIA") %>%
  pivot_longer(cols = c(ShrubCover, TotalTreeCover, TotalHerbaceousCover, BareGroundCover#, AngTrC_, Cn),
               )

```

```

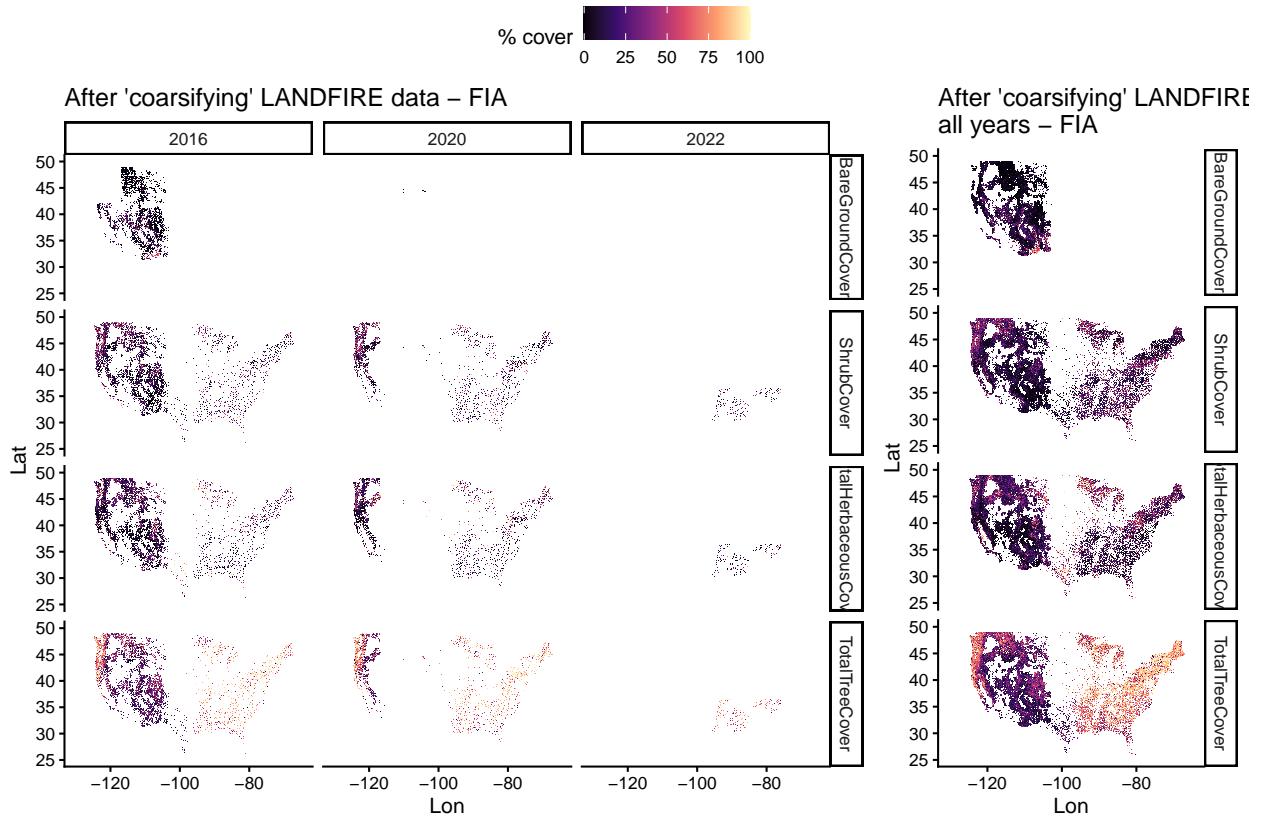
    names_to = "coverType",
    values_to = "coverValues"
  ) %>%
filter(!is.na(coverValues))

ggarrange(ggplot(FIA_3 %>%
  filter(Year %in% c(2016, 2020, 2022))) +
  facet_grid(rows = vars(coverType), cols = vars(Year)) +
  stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
  scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
                        limits = c(0,100)) +
  #geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
  #geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
  xlim(c(-130,-65)) +
  ylim(c(25, 50)) +
  ggtitle("After 'coarsifying' LANDFIRE data - FIA"),

  ggplot(FIA_3) +
  facet_grid(rows = vars(coverType)) +
  stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
  scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
                        limits = c(0,100)) +
  #geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
  #geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
  xlim(c(-130,-65)) +
  ylim(c(25, 50)) +
  ggtitle("After 'coarsifying' LANDFIRE data, \nall years - FIA "),

  ncol = 2, align = "h",
  common.legend = TRUE,
  widths = c(.7, .3)
)

```



LANDFIRE Reference database (use different years for LANDFIRE due to data availability)

Initial Dataset

```
## make figure for LANDFIRE
# get data just for LANDFIRE
LANDFIRE_1 <- dat_1 %>%
  st_zm() %>%
  filter(Source == "LANDFIRE") %>%
  #st_drop_geometry() %>%
  pivot_longer(cols = c(ShrbCvr, TtlTrCv, TtlHrbC, BrGrndC#, AngTrC_, CnfTrC_, C3GrcM_, C4GrcM_, FrbCrv),
              ),
  names_to = "coverType",
  values_to = "coverValues"
  ) %>%
filter(!is.na(coverValues))

ggarrange(ggplot(LANDFIRE_1 %>%
  filter(Year %in% c(2003, 2007, 2015))) +
  facet_grid(rows = vars(coverType), cols = vars(Year)) +
  stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
  scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover")),
```

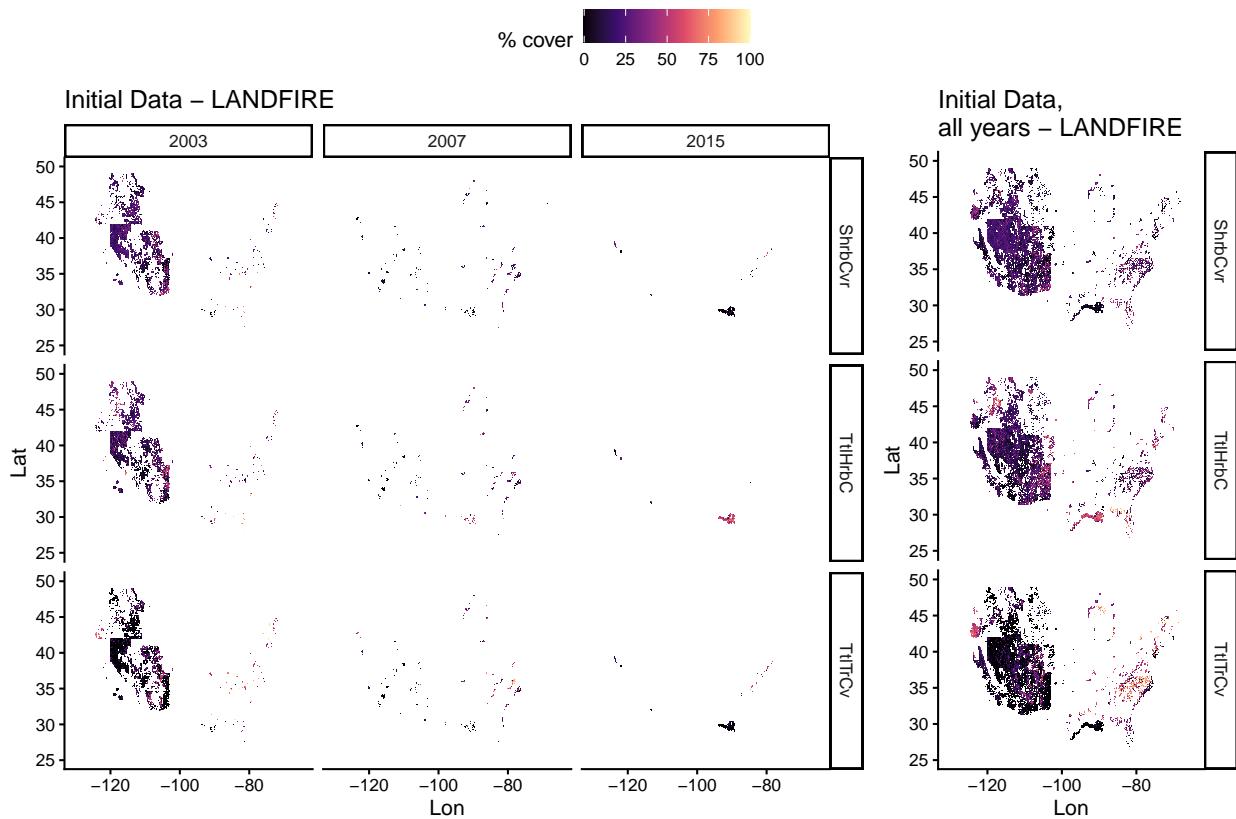
```

            limits = c(0,100)) +
  #geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
  #geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
  xlim(c(-130,-65)) +
  ylim(c(25, 50)) +
  ggtitle("Initial Data - LANDFIRE"),

ggplot(LANDFIRE_1) +
facet_grid(rows = vars(coverType)) +
stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
  scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
  limits = c(0,100)) +
  #geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
  #geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
  xlim(c(-130,-65)) +
  ylim(c(25, 50)) +
  ggtitle("Initial Data, \nall years - LANDFIRE "),

ncol = 2, align = "h",
common.legend = TRUE,
widths = c(.7, .3)
)

```



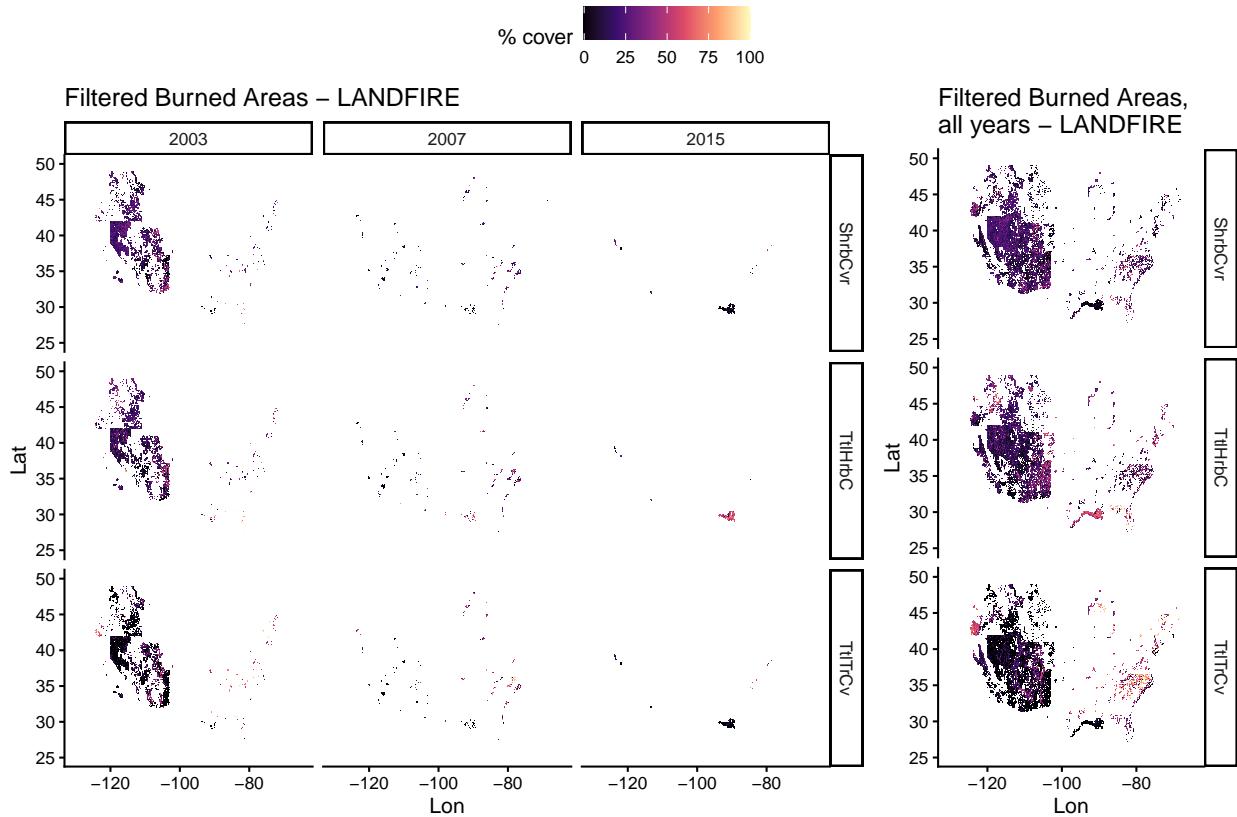
After removing burned area

```
## make figure for LANDFIRE
# get data just for LANDFIRE
LANDFIRE_2 <- dat_2 %>%
  filter(Source == "LANDFIRE") %>%
  pivot_longer(cols = c(ShrbCvr, TtlTrCv, TtlHrbC, BrGrndC#, AngTrC_, CnfTrC_, C3GrmC_, C4GrmC_, FrbCvry),
               ),
  names_to = "coverType",
  values_to = "coverValues"
) %>%
filter(!is.na(coverValues))

ggarrange(ggplot(LANDFIRE_2 %>%
  filter(Year %in% c(2003, 2007, 2015))) +
  facet_grid(rows = vars(coverType), cols = vars(Year)) +
  stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
  scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
                        limits = c(0,100)) +
  #geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
  #geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
  xlim(c(-130,-65)) +
  ylim(c(25, 50)) +
  ggtitle("Filtered Burned Areas - LANDFIRE"),

  ggplot(LANDFIRE_2) +
  facet_grid(rows = vars(coverType)) +
  stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
  scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
                        limits = c(0,100)) +
  #geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
  #geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
  xlim(c(-130,-65)) +
  ylim(c(25, 50)) +
  ggtitle("Filtered Burned Areas, \nall years - LANDFIRE "),

  ncol = 2, align = "h",
  common.legend = TRUE,
  widths = c(.7, .3)
)
```



After ‘coarsifying’ LANDFIRE data

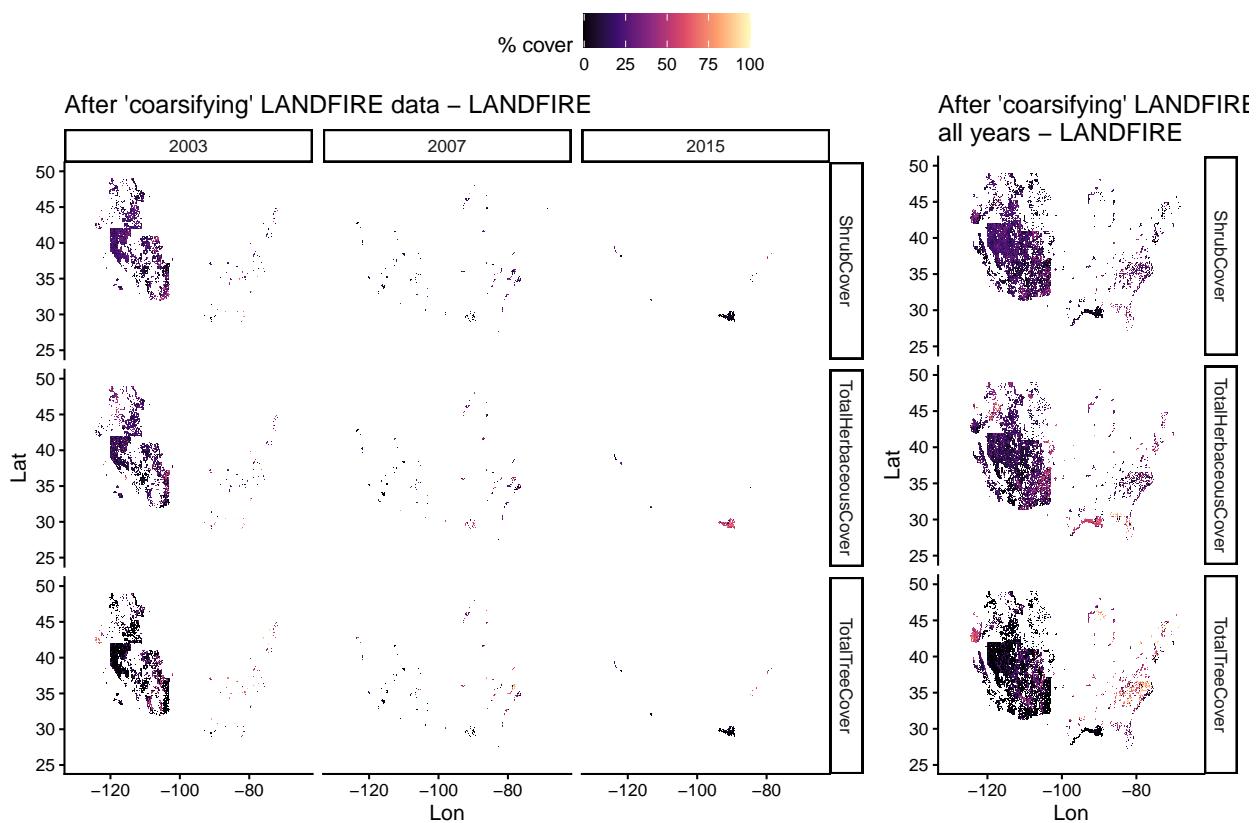
```
## make figure for LANDFIRE
# get data just for LANDFIRE
LANDFIRE_3 <- dat_3 %>%
  filter(Source == "LANDFIRE") %>%
  pivot_longer(cols = c(ShrubCover, TotalTreeCover, TotalHerbaceousCover, BareGroundCover#, AngTrC_, Cn),
               ),
  names_to = "coverType",
  values_to = "coverValues"
) %>%
filter(!is.na(coverValues))

ggarrange(ggplot(LANDFIRE_3 %>%
  filter(Year %in% c(2003, 2007, 2015))) +
  facet_grid(rows = vars(coverType), cols = vars(Year)) +
  stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
  scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
                        limits = c(0,100)) +
  #geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
  #geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
  xlim(c(-130,-65)) +
  ylim(c(25, 50)) +
  ggtitle("After 'coarsifying' LANDFIRE data - LANDFIRE"),
```

```

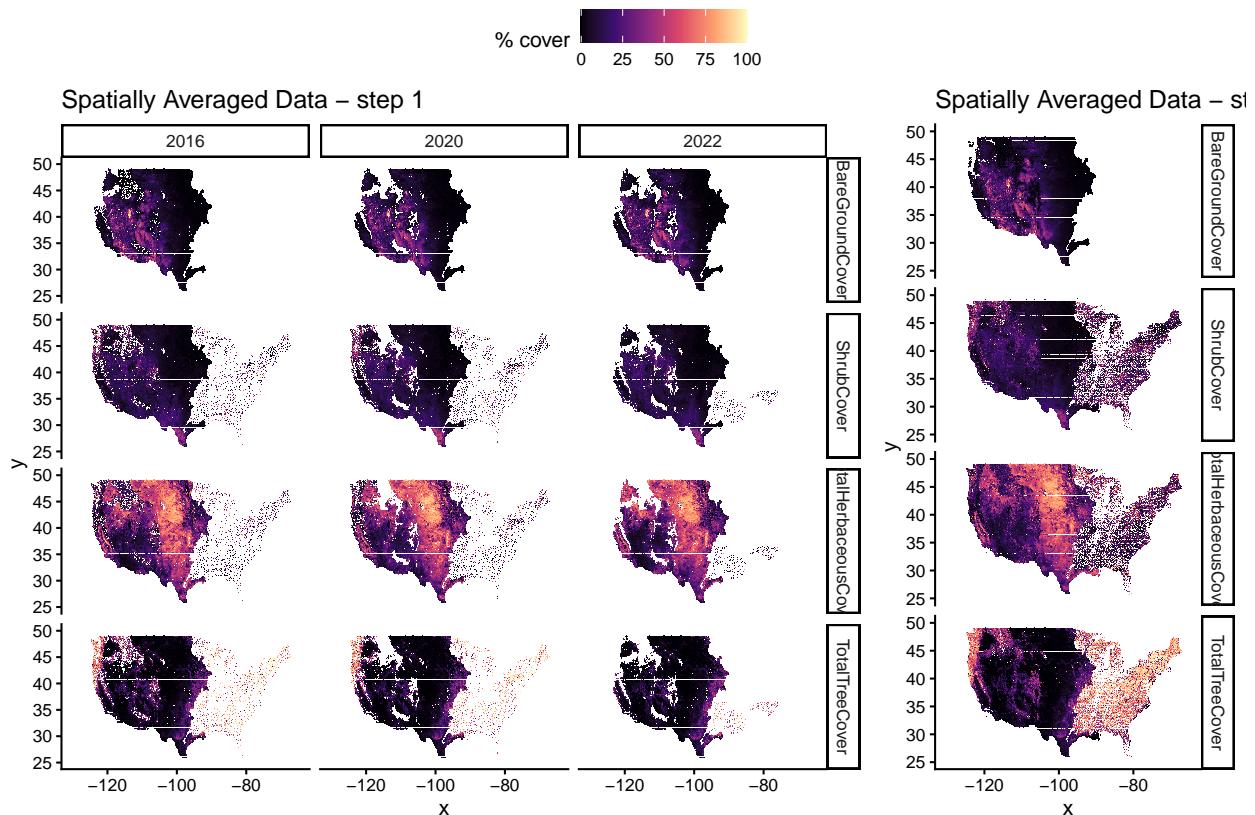
ggplot(LANDFIRE_3) +
  facet_grid(rows = vars(coverType)) +
  stat_summary_2d(aes(x = Lon, y = Lat, z = coverValues), fun = mean, binwidth = .1) +
    scale_fill_viridis_c(option = "A", guide = guide_colorbar(title = "% cover"),
    limits = c(0,100)) +
  #geom_raster(aes(x = Lon, y = Lat, fill = coverValues)) +
  #geom_point(aes(x = Lon, y = Lat, col = coverValues)) +
  xlim(c(-130,-65)) +
  ylim(c(25, 50)) +
  ggtitle("After 'coarsifying' LANDFIRE data, \nall years - LANDFIRE"),
  ncol = 2, align = "h",
  common.legend = TRUE,
  widths = c(.7, .3)
)

```

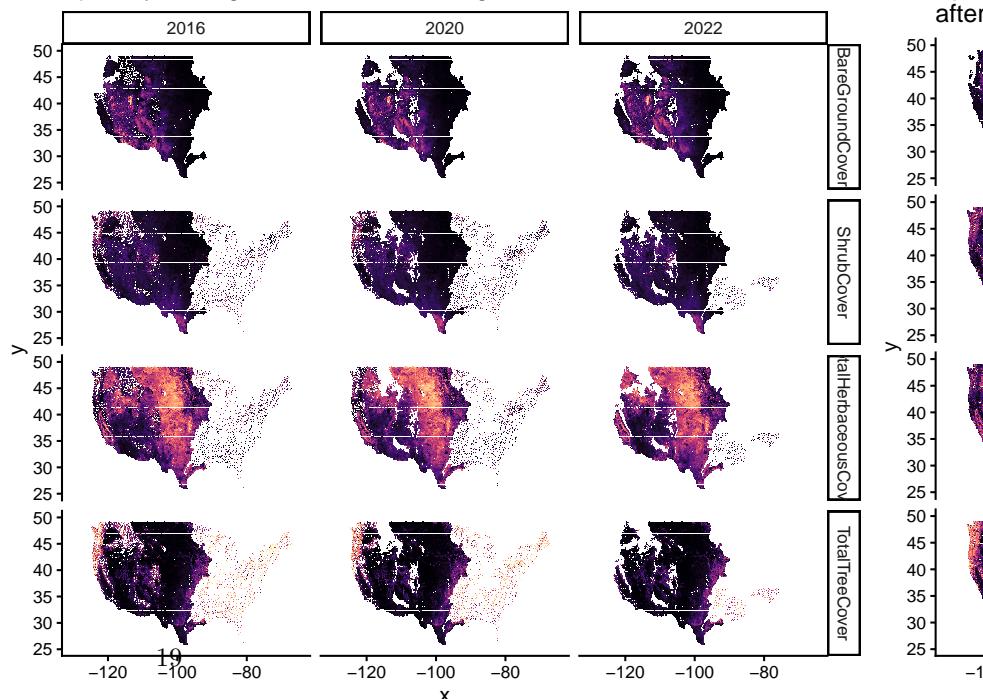


After data has been spatially averaged (can no longer look at data by data source)

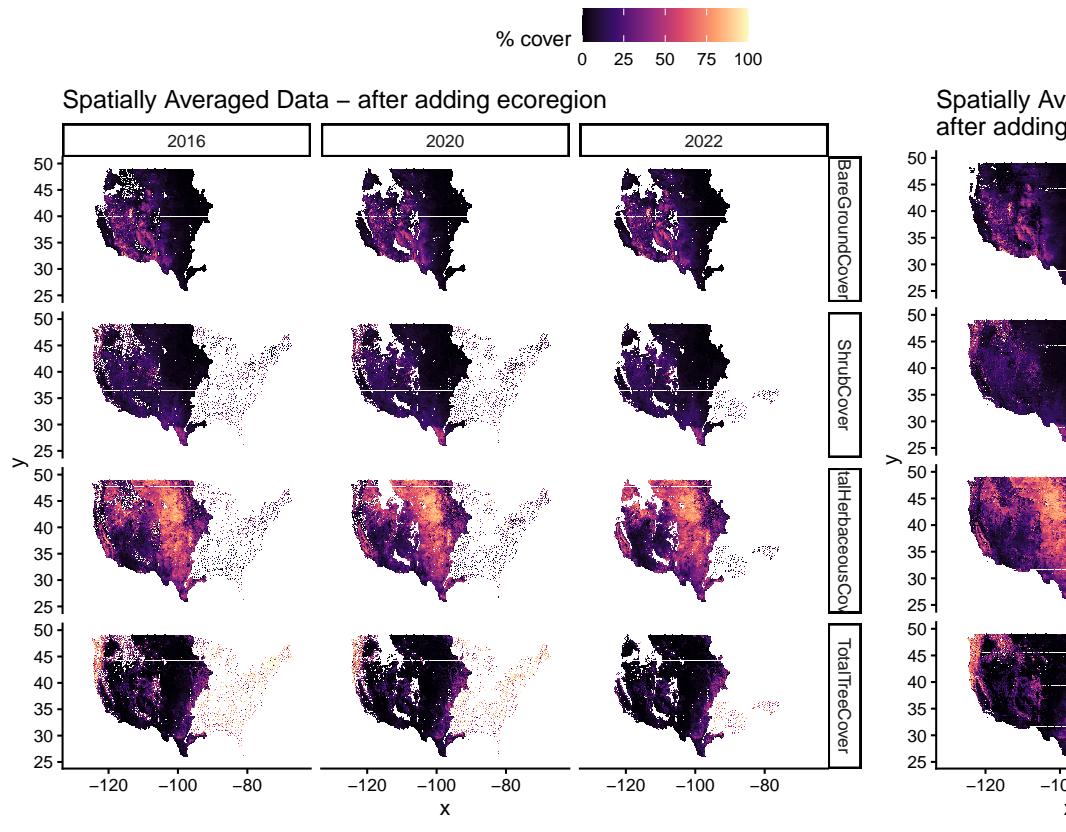
After initial spatial averaging



Spatially Averaged Data – after adding climate/weather



After adding climate/weather data



After adding ecoregion data

After adding soils data and removing RAP points that are in ag/developed areas

