VAR

2024-04-09

Modelling Monthly Rainfall(mm) in India’s Coastal states using Vector Autoregression (VAR)

library(tidyverse)

## ── Attaching core tidyverse packages ──────────────────────── tidyverse 2.0.0 ──  
## ✔ dplyr 1.1.3 ✔ readr 2.1.4  
## ✔ forcats 1.0.0 ✔ stringr 1.5.0  
## ✔ ggplot2 3.5.0 ✔ tibble 3.2.1  
## ✔ lubridate 1.9.2 ✔ tidyr 1.3.0  
## ✔ purrr 1.0.2   
## ── Conflicts ────────────────────────────────────────── tidyverse\_conflicts() ──  
## ✖ dplyr::filter() masks stats::filter()  
## ✖ dplyr::lag() masks stats::lag()  
## ℹ Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors

library(dplyr)  
library(vars)

## Loading required package: MASS  
##   
## Attaching package: 'MASS'  
##   
## The following object is masked from 'package:dplyr':  
##   
## select  
##   
## Loading required package: strucchange  
## Loading required package: zoo  
##   
## Attaching package: 'zoo'  
##   
## The following objects are masked from 'package:base':  
##   
## as.Date, as.Date.numeric  
##   
## Loading required package: sandwich  
##   
## Attaching package: 'strucchange'  
##   
## The following object is masked from 'package:stringr':  
##   
## boundary  
##   
## Loading required package: urca  
## Loading required package: lmtest

monthly<-read\_csv("~/Desktop/DATA450Spring24/cleaning\_&\_FullDatasets/Rainfall\_Data\_LL.csv")

## Rows: 4187 Columns: 22  
## ── Column specification ────────────────────────────────────────────────────────  
## Delimiter: ","  
## chr (2): Name, SUBDIVISION  
## dbl (20): YEAR, JAN, FEB, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC, ...  
##   
## ℹ Use `spec()` to retrieve the full column specification for this data.  
## ℹ Specify the column types or set `show\_col\_types = FALSE` to quiet this message.

data<-monthly%>%filter(YEAR>=1970 & YEAR<2017)%>%dplyr::select(SUBDIVISION,YEAR,JAN,FEB,MAR,APR,MAY,JUN,JUL,AUG,SEP,OCT,NOV,DEC)%>%  
pivot\_longer(cols = c("JAN", "FEB", "MAR", "APR", "MAY", "JUN", "JUL","AUG","SEP","OCT","NOV","DEC"),names\_to = "Month", values\_to = "Rainfall")%>%  
 mutate(Date = paste(YEAR, Month, sep = "-")) %>%  
 dplyr::select(-YEAR, -Month)%>%  
 pivot\_wider(names\_from = SUBDIVISION, values\_from = Rainfall)  
data2<-monthly%>%filter(YEAR == 2017)%>%dplyr::select(SUBDIVISION,YEAR,JAN,FEB,MAR,APR,MAY,JUN,JUL,AUG,SEP,OCT,NOV,DEC)%>%  
pivot\_longer(cols = c("JAN", "FEB", "MAR", "APR", "MAY", "JUN", "JUL","AUG","SEP","OCT","NOV","DEC"),names\_to = "Month", values\_to = "Rainfall")%>%  
 mutate(Date = paste(YEAR, Month, sep = "-")) %>%  
 dplyr::select(-YEAR, -Month)%>%  
 pivot\_wider(names\_from = SUBDIVISION, values\_from = Rainfall)  
west<-data%>%dplyr::select(Date,Kerala,Lakshadweep,'Madhya Maharashtra','Coastal Karnataka','Konkan & Goa')

Rainfall<-as.ts(west[, -1], frequency = 12, start = 1970)  
VARselect(Rainfall, type = "trend", lag.max = 12, season = 12)

## $selection  
## AIC(n) HQ(n) SC(n) FPE(n)   
## 3 2 1 3   
##   
## $criteria  
## 1 2 3 4 5  
## AIC(n) 4.314454e+01 4.304736e+01 4.301605e+01 4.302238e+01 4.307379e+01  
## HQ(n) 4.340407e+01 4.338321e+01 4.342824e+01 4.351090e+01 4.363864e+01  
## SC(n) 4.380877e+01 4.390694e+01 4.407100e+01 4.427268e+01 4.451945e+01  
## FPE(n) 5.463605e+18 4.958169e+18 4.806231e+18 4.837979e+18 5.095017e+18  
## 6 7 8 9 10  
## AIC(n) 4.312443e+01 4.318188e+01 4.323365e+01 4.326205e+01 4.327359e+01  
## HQ(n) 4.376561e+01 4.389939e+01 4.402749e+01 4.413223e+01 4.422010e+01  
## SC(n) 4.476546e+01 4.501826e+01 4.526539e+01 4.548915e+01 4.569606e+01  
## FPE(n) 5.362195e+18 5.682610e+18 5.988968e+18 6.166998e+18 6.245242e+18  
## 11 12  
## AIC(n) 4.325177e+01 4.318453e+01  
## HQ(n) 4.427461e+01 4.428370e+01  
## SC(n) 4.586960e+01 4.599771e+01  
## FPE(n) 6.118132e+18 5.728607e+18

var\_model <- VAR(Rainfall, p = 2, type = "trend", season = 12)  
summary(var\_model)

##   
## VAR Estimation Results:  
## =========================   
## Endogenous variables: Kerala, Lakshadweep, Madhya.Maharashtra, Coastal.Karnataka, Konkan...Goa   
## Deterministic variables: trend   
## Sample size: 562   
## Log Likelihood: -15973.509   
## Roots of the characteristic polynomial:  
## 0.8388 0.4622 0.4111 0.3377 0.3377 0.2952 0.2104 0.2104 0.1049 0.1049  
## Call:  
## VAR(y = Rainfall, p = 2, type = "trend", season = 12L)  
##   
##   
## Estimation results for equation Kerala:   
## =======================================   
## Kerala = Kerala.l1 + Lakshadweep.l1 + Madhya.Maharashtra.l1 + Coastal.Karnataka.l1 + Konkan...Goa.l1 + Kerala.l2 + Lakshadweep.l2 + Madhya.Maharashtra.l2 + Coastal.Karnataka.l2 + Konkan...Goa.l2 + trend + sd1 + sd2 + sd3 + sd4 + sd5 + sd6 + sd7 + sd8 + sd9 + sd10 + sd11   
##   
## Estimate Std. Error t value Pr(>|t|)   
## Kerala.l1 0.04788 0.07959 0.602 0.547684   
## Lakshadweep.l1 0.28198 0.08349 3.378 0.000784 \*\*\*  
## Madhya.Maharashtra.l1 0.27319 0.17474 1.563 0.118546   
## Coastal.Karnataka.l1 0.04735 0.06725 0.704 0.481660   
## Konkan...Goa.l1 0.05179 0.06802 0.761 0.446769   
## Kerala.l2 0.11913 0.07976 1.494 0.135869   
## Lakshadweep.l2 0.04000 0.08481 0.472 0.637406   
## Madhya.Maharashtra.l2 0.11385 0.17491 0.651 0.515381   
## Coastal.Karnataka.l2 0.12649 0.06750 1.874 0.061482 .   
## Konkan...Goa.l2 0.01105 0.06778 0.163 0.870504   
## trend 0.14798 0.02937 5.038 6.42e-07 \*\*\*  
## sd1 48.46699 26.59958 1.822 0.068993 .   
## sd2 92.88576 28.43780 3.266 0.001159 \*\*   
## sd3 119.60999 28.79385 4.154 3.80e-05 \*\*\*  
## sd4 191.78528 28.63738 6.697 5.35e-11 \*\*\*  
## sd5 278.64857 28.08572 9.921 < 2e-16 \*\*\*  
## sd6 640.71232 27.17015 23.581 < 2e-16 \*\*\*  
## sd7 427.39566 39.36662 10.857 < 2e-16 \*\*\*  
## sd8 -1.90589 47.94802 -0.040 0.968308   
## sd9 -141.11185 50.42931 -2.798 0.005322 \*\*   
## sd10 51.11846 40.61841 1.259 0.208753   
## sd11 59.35140 29.26796 2.028 0.043065 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
##   
## Residual standard error: 121.5 on 540 degrees of freedom  
## Multiple R-Squared: 0.8722, Adjusted R-squared: 0.867   
## F-statistic: 167.6 on 22 and 540 DF, p-value: < 2.2e-16   
##   
##   
## Estimation results for equation Lakshadweep:   
## ============================================   
## Lakshadweep = Kerala.l1 + Lakshadweep.l1 + Madhya.Maharashtra.l1 + Coastal.Karnataka.l1 + Konkan...Goa.l1 + Kerala.l2 + Lakshadweep.l2 + Madhya.Maharashtra.l2 + Coastal.Karnataka.l2 + Konkan...Goa.l2 + trend + sd1 + sd2 + sd3 + sd4 + sd5 + sd6 + sd7 + sd8 + sd9 + sd10 + sd11   
##   
## Estimate Std. Error t value Pr(>|t|)   
## Kerala.l1 0.001146 0.053612 0.021 0.98296   
## Lakshadweep.l1 0.135090 0.056234 2.402 0.01663 \*   
## Madhya.Maharashtra.l1 0.094681 0.117702 0.804 0.42151   
## Coastal.Karnataka.l1 0.023349 0.045297 0.515 0.60644   
## Konkan...Goa.l1 0.092127 0.045818 2.011 0.04485 \*   
## Kerala.l2 0.063363 0.053727 1.179 0.23878   
## Lakshadweep.l2 0.082823 0.057128 1.450 0.14770   
## Madhya.Maharashtra.l2 0.191490 0.117814 1.625 0.10467   
## Coastal.Karnataka.l2 0.035214 0.045465 0.775 0.43896   
## Konkan...Goa.l2 -0.012240 0.045653 -0.268 0.78872   
## trend 0.073164 0.019785 3.698 0.00024 \*\*\*  
## sd1 4.634288 17.916729 0.259 0.79600   
## sd2 20.931092 19.154906 1.093 0.27500   
## sd3 29.055793 19.394732 1.498 0.13468   
## sd4 54.787333 19.289336 2.840 0.00468 \*\*   
## sd5 153.533498 18.917754 8.116 3.28e-15 \*\*\*  
## sd6 313.112369 18.301050 17.109 < 2e-16 \*\*\*  
## sd7 134.653529 26.516252 5.078 5.26e-07 \*\*\*  
## sd8 -52.002323 32.296444 -1.610 0.10795   
## sd9 -84.708872 33.967768 -2.494 0.01294 \*   
## sd10 -14.523138 27.359423 -0.531 0.59576   
## sd11 35.474873 19.714078 1.799 0.07250 .   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
##   
## Residual standard error: 81.81 on 540 degrees of freedom  
## Multiple R-Squared: 0.8099, Adjusted R-squared: 0.8022   
## F-statistic: 104.6 on 22 and 540 DF, p-value: < 2.2e-16   
##   
##   
## Estimation results for equation Madhya.Maharashtra:   
## ===================================================   
## Madhya.Maharashtra = Kerala.l1 + Lakshadweep.l1 + Madhya.Maharashtra.l1 + Coastal.Karnataka.l1 + Konkan...Goa.l1 + Kerala.l2 + Lakshadweep.l2 + Madhya.Maharashtra.l2 + Coastal.Karnataka.l2 + Konkan...Goa.l2 + trend + sd1 + sd2 + sd3 + sd4 + sd5 + sd6 + sd7 + sd8 + sd9 + sd10 + sd11   
##   
## Estimate Std. Error t value Pr(>|t|)   
## Kerala.l1 0.046550 0.029655 1.570 0.117070   
## Lakshadweep.l1 0.092447 0.031105 2.972 0.003090 \*\*   
## Madhya.Maharashtra.l1 0.241501 0.065106 3.709 0.000229 \*\*\*  
## Coastal.Karnataka.l1 -0.039101 0.025056 -1.561 0.119219   
## Konkan...Goa.l1 0.002968 0.025344 0.117 0.906824   
## Kerala.l2 -0.016490 0.029719 -0.555 0.579202   
## Lakshadweep.l2 0.046003 0.031600 1.456 0.146025   
## Madhya.Maharashtra.l2 0.058711 0.065168 0.901 0.368036   
## Coastal.Karnataka.l2 0.048655 0.025149 1.935 0.053550 .   
## Konkan...Goa.l2 0.023414 0.025253 0.927 0.354250   
## trend 0.049072 0.010944 4.484 8.96e-06 \*\*\*  
## sd1 21.755263 9.910513 2.195 0.028576 \*   
## sd2 31.715048 10.595401 2.993 0.002886 \*\*   
## sd3 36.484018 10.728060 3.401 0.000722 \*\*\*  
## sd4 38.295661 10.669760 3.589 0.000362 \*\*\*  
## sd5 44.226992 10.464222 4.226 2.79e-05 \*\*\*  
## sd6 173.711847 10.123097 17.160 < 2e-16 \*\*\*  
## sd7 196.398151 14.667278 13.390 < 2e-16 \*\*\*  
## sd8 95.224059 17.864551 5.330 1.44e-07 \*\*\*  
## sd9 38.766465 18.789032 2.063 0.039566 \*   
## sd10 -18.888885 15.133672 -1.248 0.212522   
## sd11 -17.965706 10.904704 -1.648 0.100033   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
##   
## Residual standard error: 45.25 on 540 degrees of freedom  
## Multiple R-Squared: 0.8691, Adjusted R-squared: 0.8637   
## F-statistic: 162.9 on 22 and 540 DF, p-value: < 2.2e-16   
##   
##   
## Estimation results for equation Coastal.Karnataka:   
## ==================================================   
## Coastal.Karnataka = Kerala.l1 + Lakshadweep.l1 + Madhya.Maharashtra.l1 + Coastal.Karnataka.l1 + Konkan...Goa.l1 + Kerala.l2 + Lakshadweep.l2 + Madhya.Maharashtra.l2 + Coastal.Karnataka.l2 + Konkan...Goa.l2 + trend + sd1 + sd2 + sd3 + sd4 + sd5 + sd6 + sd7 + sd8 + sd9 + sd10 + sd11   
##   
## Estimate Std. Error t value Pr(>|t|)   
## Kerala.l1 0.04040 0.09805 0.412 0.680481   
## Lakshadweep.l1 0.43593 0.10285 4.239 2.65e-05 \*\*\*  
## Madhya.Maharashtra.l1 0.33986 0.21527 1.579 0.114970   
## Coastal.Karnataka.l1 0.05217 0.08285 0.630 0.529128   
## Konkan...Goa.l1 0.04276 0.08380 0.510 0.610101   
## Kerala.l2 0.07475 0.09826 0.761 0.447161   
## Lakshadweep.l2 0.10071 0.10448 0.964 0.335539   
## Madhya.Maharashtra.l2 0.11062 0.21547 0.513 0.607896   
## Coastal.Karnataka.l2 0.20187 0.08315 2.428 0.015522 \*   
## Konkan...Goa.l2 0.05585 0.08350 0.669 0.503824   
## trend 0.16249 0.03618 4.491 8.69e-06 \*\*\*  
## sd1 86.15044 32.76821 2.629 0.008805 \*\*   
## sd2 133.53509 35.03273 3.812 0.000154 \*\*\*  
## sd3 151.79263 35.47135 4.279 2.22e-05 \*\*\*  
## sd4 170.00785 35.27859 4.819 1.88e-06 \*\*\*  
## sd5 234.90955 34.59900 6.789 2.97e-11 \*\*\*  
## sd6 906.78119 33.47110 27.091 < 2e-16 \*\*\*  
## sd7 903.53826 48.49602 18.631 < 2e-16 \*\*\*  
## sd8 314.71735 59.06750 5.328 1.46e-07 \*\*\*  
## sd9 -193.47687 62.12422 -3.114 0.001941 \*\*   
## sd10 -116.42186 50.03811 -2.327 0.020352 \*   
## sd11 -35.28798 36.05541 -0.979 0.328159   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
##   
## Residual standard error: 149.6 on 540 degrees of freedom  
## Multiple R-Squared: 0.9137, Adjusted R-squared: 0.9102   
## F-statistic: 259.8 on 22 and 540 DF, p-value: < 2.2e-16   
##   
##   
## Estimation results for equation Konkan...Goa:   
## =============================================   
## Konkan...Goa = Kerala.l1 + Lakshadweep.l1 + Madhya.Maharashtra.l1 + Coastal.Karnataka.l1 + Konkan...Goa.l1 + Kerala.l2 + Lakshadweep.l2 + Madhya.Maharashtra.l2 + Coastal.Karnataka.l2 + Konkan...Goa.l2 + trend + sd1 + sd2 + sd3 + sd4 + sd5 + sd6 + sd7 + sd8 + sd9 + sd10 + sd11   
##   
## Estimate Std. Error t value Pr(>|t|)   
## Kerala.l1 0.13691 0.08813 1.553 0.120915   
## Lakshadweep.l1 0.41612 0.09244 4.501 8.28e-06 \*\*\*  
## Madhya.Maharashtra.l1 0.25648 0.19349 1.326 0.185560   
## Coastal.Karnataka.l1 -0.14942 0.07447 -2.007 0.045299 \*   
## Konkan...Goa.l1 0.14106 0.07532 1.873 0.061637 .   
## Kerala.l2 -0.04822 0.08832 -0.546 0.585288   
## Lakshadweep.l2 0.07675 0.09391 0.817 0.414176   
## Madhya.Maharashtra.l2 0.25445 0.19368 1.314 0.189477   
## Coastal.Karnataka.l2 0.13948 0.07474 1.866 0.062551 .   
## Konkan...Goa.l2 0.13029 0.07505 1.736 0.083136 .   
## trend 0.17451 0.03252 5.365 1.20e-07 \*\*\*  
## sd1 80.86761 29.45364 2.746 0.006242 \*\*   
## sd2 111.91403 31.48910 3.554 0.000413 \*\*\*  
## sd3 120.46399 31.88336 3.778 0.000175 \*\*\*  
## sd4 118.38558 31.71010 3.733 0.000209 \*\*\*  
## sd5 126.38235 31.09925 4.064 5.54e-05 \*\*\*  
## sd6 754.16561 30.08544 25.067 < 2e-16 \*\*\*  
## sd7 900.01625 43.59056 20.647 < 2e-16 \*\*\*  
## sd8 363.03883 53.09272 6.838 2.18e-11 \*\*\*  
## sd9 -47.13781 55.84024 -0.844 0.398957   
## sd10 -172.68248 44.97666 -3.839 0.000138 \*\*\*  
## sd11 -91.94750 32.40834 -2.837 0.004723 \*\*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
##   
## Residual standard error: 134.5 on 540 degrees of freedom  
## Multiple R-Squared: 0.9152, Adjusted R-squared: 0.9117   
## F-statistic: 264.8 on 22 and 540 DF, p-value: < 2.2e-16   
##   
##   
##   
## Covariance matrix of residuals:  
## Kerala Lakshadweep Madhya.Maharashtra Coastal.Karnataka  
## Kerala 14591 6338 2871 13804  
## Lakshadweep 6338 6617 1302 6006  
## Madhya.Maharashtra 2871 1302 2031 3678  
## Coastal.Karnataka 13804 6006 3678 22138  
## Konkan...Goa 8266 3873 4343 14119  
## Konkan...Goa  
## Kerala 8266  
## Lakshadweep 3873  
## Madhya.Maharashtra 4343  
## Coastal.Karnataka 14119  
## Konkan...Goa 17910  
##   
## Correlation matrix of residuals:  
## Kerala Lakshadweep Madhya.Maharashtra Coastal.Karnataka  
## Kerala 1.0000 0.6450 0.5275 0.7681  
## Lakshadweep 0.6450 1.0000 0.3551 0.4963  
## Madhya.Maharashtra 0.5275 0.3551 1.0000 0.5485  
## Coastal.Karnataka 0.7681 0.4963 0.5485 1.0000  
## Konkan...Goa 0.5113 0.3557 0.7201 0.7091  
## Konkan...Goa  
## Kerala 0.5113  
## Lakshadweep 0.3557  
## Madhya.Maharashtra 0.7201  
## Coastal.Karnataka 0.7091  
## Konkan...Goa 1.0000

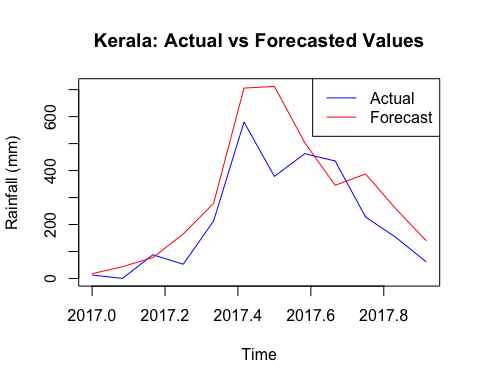
#acf(residuals(var\_model))  
AIC(var\_model)

## [1] 32167.02

###Kerala

forecast<-predict(var\_model, n.ahead = 12)  
keralaforecast <- data.frame(forecast$fcst$Kerala[, "fcst"])  
kerala2017<-data2%>%dplyr::select(Kerala)

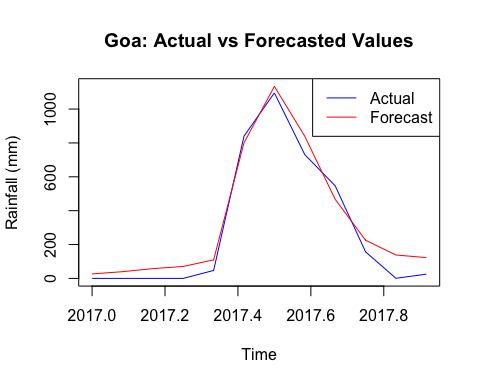
kerala\_ts <- ts(kerala2017$Kerala, start = 2017, frequency = 12)  
forecast\_ts <- ts(keralaforecast$forecast.fcst.Kerala....fcst.., start = 2017, frequency = 12)  
  
# Plot the real and forecasted values using ts.plot  
ts.plot(kerala\_ts, forecast\_ts, col = c("blue","red"), xlab = "Time", ylab = "Rainfall (mm)", main = "Kerala: Actual vs Forecasted Values")  
legend("topright", legend = c("Actual", "Forecast"), col = c("blue", "red"), lty = 1)



###Konkan & Goa

Goaforecast <- data.frame(forecast$fcst$Konkan...Goa[, "fcst"])  
Goa2017<-data2%>%dplyr::select('Konkan & Goa')

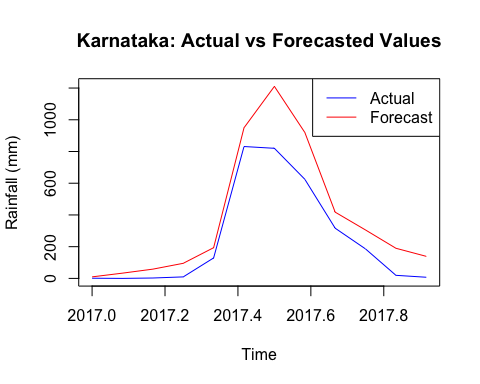
Goa\_ts <- ts(Goa2017, start = 2017, frequency = 12)  
Goafore\_ts <- ts(Goaforecast, start = 2017, frequency = 12)  
  
# Plot the real and forecasted values using ts.plot  
ts.plot(Goa\_ts, Goafore\_ts, col = c("blue","red"),xlab = "Time", ylab = "Rainfall (mm)", main = "Goa: Actual vs Forecasted Values")  
legend("topright", legend = c("Actual", "Forecast"), col = c("blue", "red"), lty = 1)



### Karnataka

Karforecast<-data.frame(forecast$fcst$Coastal.Karnataka[, "fcst"])  
Kar2017<-data2%>%dplyr::select('Coastal Karnataka')

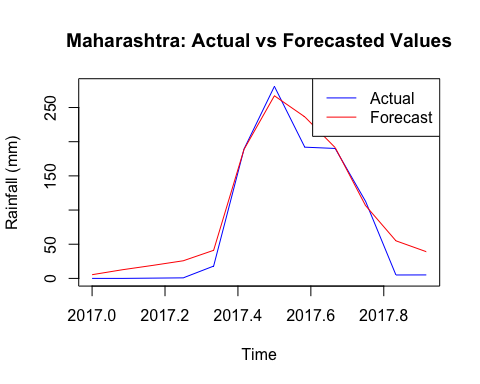
Kar\_ts <- ts(Kar2017, start = 2017, frequency = 12)  
Karfore\_ts <- ts(Karforecast, start = 2017, frequency = 12)  
  
# Plot the real and forecasted values using ts.plot  
ts.plot(Kar\_ts, Karfore\_ts, col = c("blue","red"),xlab = "Time", ylab = "Rainfall (mm)", main = "Karnataka: Actual vs Forecasted Values")  
legend("topright", legend = c("Actual", "Forecast"), col = c("blue", "red"), lty = 1)



###Madhya Maharashtra

Madforecast<-data.frame(forecast$fcst$Madhya.Maharashtra[, "fcst"])  
Mad2017<-data2%>%dplyr::select('Madhya Maharashtra')

Mad\_ts <- ts(Mad2017, start = 2017, frequency = 12)  
Madfore\_ts <- ts(Madforecast, start = 2017, frequency = 12)  
  
# Plot the real and forecasted values using ts.plot  
ts.plot(Mad\_ts, Madfore\_ts, col = c("blue","red"),xlab = "Time", ylab = "Rainfall (mm)", main = "Maharashtra: Actual vs Forecasted Values")  
legend("topright", legend = c("Actual", "Forecast"), col = c("blue", "red"), lty = 1)



###Lakshadweep ## data :- <http://hydro.imd.gov.in/hydrometweb/(S(0x1t0y55wwukfpudrsbvn355))/PRODUCTS/Publications/Rainfall%20Statistics%20of%20India%20-%202017/Rainfall%20Statistics%20of%20India%20-%202017.pdf>

Lakforecast<-data.frame(forecast$fcst$Lakshadweep[, "fcst"])  
Lak2017<-data.frame(Rainfall = c(21.3,0.9,100.2,1.8,145.7,521.9,164.2,206.2,216.0,137.1,63.5,160.1))

Lak\_ts <- ts(Lak2017, start = 2017, frequency = 12)  
Lakfore\_ts <- ts(Lakforecast, start = 2017, frequency = 12)  
  
# Plot the real and forecasted values using ts.plot  
ts.plot(Lak\_ts, Lakfore\_ts, col = c("blue","red"),xlab = "Time", ylab = "Rainfall (mm)", main = "Lakshadweep: Actual vs Forecasted Values")  
legend("topright", legend = c("Actual", "Forecast"), col = c("blue", "red"), lty = 1)

