Problems

For these problems, use the following code to load in phytoplankton data, covariates, and z-score all the data. Then use `dat` and `covars` directly in your code.

```
phytos = c("Cryptomonas", "Diatoms", "Greens",
           "Unicells", "Other.algae")
yrs = lakeWAplanktonTrans[,"Year"]%in%1985:1994
dat = t(lakeWAplanktonTrans[yrs,phytos])
prec = diag(1/sqrt(apply(dat, 1, var, na.rm=TRUE)))
avg = apply(dat, 1, mean, na.rm=TRUE)
dat = prec %*% (dat-avg)
rownames(dat) = phytos
covars = rbind(Temp=lakeWAplanktonTrans[yrs,"Temp"],
               TP=lakeWAplanktonTrans[yrs,"TP"])
prec = diag(1/sqrt(apply(covars, 1, var)))
avg = apply(covars, 1, mean)
covars =  prec %*% (covars-avg)
rownames(covars) = c("Temp","TP")
```

Here are some guidelines to help you answer the questions:

- Use a MARSS model that allows for both observation and process error.
- Assume that the observation errors are independent and identically distributed. You can further assume that any process errors are independent from one another, but the variances differ by taxon.
- Assume that each group is an observation of its own process. This means `Z="identity"`.
- Use `B="diagonal and unequal"`. This implies that each of the taxa are operating under varying degrees of density-dependence, and that they do not interact with any of the other taxa.
- All the data have been de-meaned and $\mathbf{Z}$ identity, therefore use `U="zero"` and `A="zero"`.
- Include a plot of residuals versus time and acf of residuals for each question.
- Use AICc to compare models.

0.1 How does month affect the mean phytoplankton population growth rates? Show a plot of mean growth rate versus month. Estimate seasonal effects without any covariate (Temp, TP) effects.

0.2 It is likely that both temperature and total phosphorus (TP) affect phytoplankton population growth rates. Using MARSS models, evaluate which is the more important driver or if both are important. Leave out the seasonal covariates from question 1, i.e. only use Temp and TP as covariates.

0.3 Evaluate whether the effect of temperature on phytoplankton manifests itself via their underlying physiology (by affecting algal growth rates and thus abundance) or because physical changes in the water stratification makes them easier/harder to sample in some months. Leave out the seasonal covariates from question 1, i.e. only use Temp and TP as covariates.

0.4 Is there support for temperature or TP affecting all functional groups' growth rates the same, or are the effects on one taxon different from another?

0.5 Compare your results for questions 2-4 using an observation error only model, by using the lm() function.

0.6 Then compare to a process error only model using the arima() function with the xreg argument.

0.7 Compute a time-series cross-validation metric for the models and compare the results that you got using AICc for model comparison.