GLMM workshop 7 July 2016

Instructors: David Schneider, with Louis Charron, Devin Flawd, Kyle Millar, Anne St. Pierre Provencher, Sam Trueman

First session	1 PM	Room SN2109	Writing the model
Break			
Second session	2 PM	SN 2018/2025	F-ratios from Expected Mean Squares
Break			
Third session	3:30	SN 2067/2071	Executing the analysis

Goal of the first session – Writing Statistical Models

GLM	The General Linear Model	Fixed Effects + Normal Error
GzLM	The Generalized Linear model	Fixed Effects + Non-normal Errors
GLMM	The General Linear Mixed Model	Fixed + Random + Normal
GzLMM	The Generalized Linear Mixed Model	Fixed + Random + Non-normal

Goal of the second session - Writing out the expected mean squares
Forming unambiguous likelihood ratio tests (F, t, χ^2)

Goal of the third session - Executing a GLMM in a statistical package
Interpreting the output

Model Revision.

13. Motard-Cote et al (2012) compared bacterial dimethylsulfate yield (DMSy) in Baffin Bay surface water with DMSy in Arctic Surface Water from the north. DMS is the main vector by which sulfur is transferred from the ocean to the atmosphere, with potential cooling effects on climate when oxidized to sulfate aerosols. The authors expected lower DMSy in BB water (4 stations with 2 casts per station) than ASW (4 stations with 2 casts) due to greater bacterial activity in BB water.

Assign a symbol to the response variable _____

Assign a symbol to each explanatory variable,
State whether each variable is random or fixed, with an explanation

_____ _____

_____ _____

Write the model then write the degrees of freedom below each term in the model.

Model _____

df _____

Model Revision. From Random to fixed factors

The stations in the DMSy data were taken on transects running from west to east, with each transect crossing from one water mass to the other. The stations are thus not random in the sense of having been chosen at random within each water mass. If we assume transects were chosen randomly, and are a sample of all possible transects, then we have a random factor that can be crossed with the fixed factor, water mass. Here is a two way table for transect X watermass, showing station number in each cell of the table.

Write the model then write the degrees of freedom below each term in s model that includes an interactive effect term.

Model _____

df _____

What happens if we only have 1 mean per station?

Luckily, we can backcalculate the DMSy for each of the two casts at a station.

Number of observations = _____
Rewrite the Model with df based on the cast data rather than the station means.

Model _____

df _____

Random Or Fixed	Source	df	Fill in the ANOVA table Fixed X Random = Random Error is random

The transects in the DMSy data were taken on prescribed transect to represent south to north variation in water mass characteristics. Rewrite the ANOVA table with transect as a fixed factor

Random Or Fixed	Source	df

7. Model revision: Fixed versus Random, Crossed versus Nested

Example: Motard Cote et al

	As published	RevDesign1	RevDesign2	RevDesign3
Water mass	Fixed	Fixed	Fixed	Fixed
Station	Random	Fixed (revisit)	Random	Fixed
Transect			Fixed	Fixed
Cast		Random	Random	Random

Revised design 1 treats station as fixed: the stations were arranged in a systematic fashion in space. Each station could be revisited.

Revised design 2 includes transect, which was fixed before the cruise, to capture zonal variation in water mass dynamics. Influx from the north (ASW) compared to influx from the south (BB). Zonal variation in light regime and insolation. Station is haphazard: location varies haphazardly by time of transit

Revised design 3 treats transect and station as fixed: revisit the transects and station locations reported by Motard Cote et al.

Write the model for three categorical variables, including all 4 interaction terms,

then using the two-way table test, cross off the interaction terms that cannot be estimated, for each of the 4 models above.

As published _____

Rev Design 1 _____

Rev Design 2 _____

Rev1 Design 3 _____