December 19, 2023

Lake Stratification

What is lake stratification? Why does it occur? What are the implications for lake ecology?

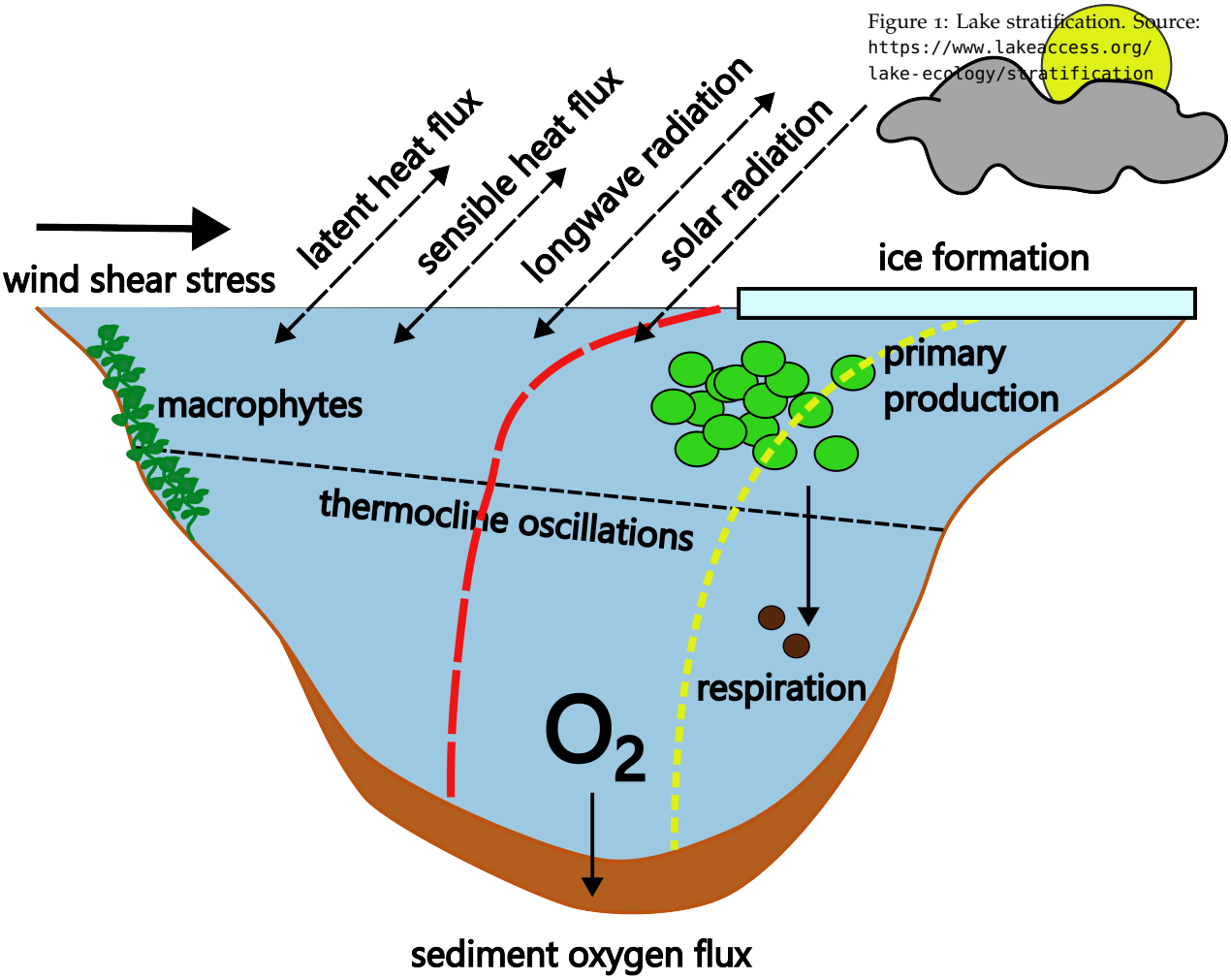


Figure 1: Lake stratification. Source: https://www.lakeaccess.org/lake-ecology/stratification

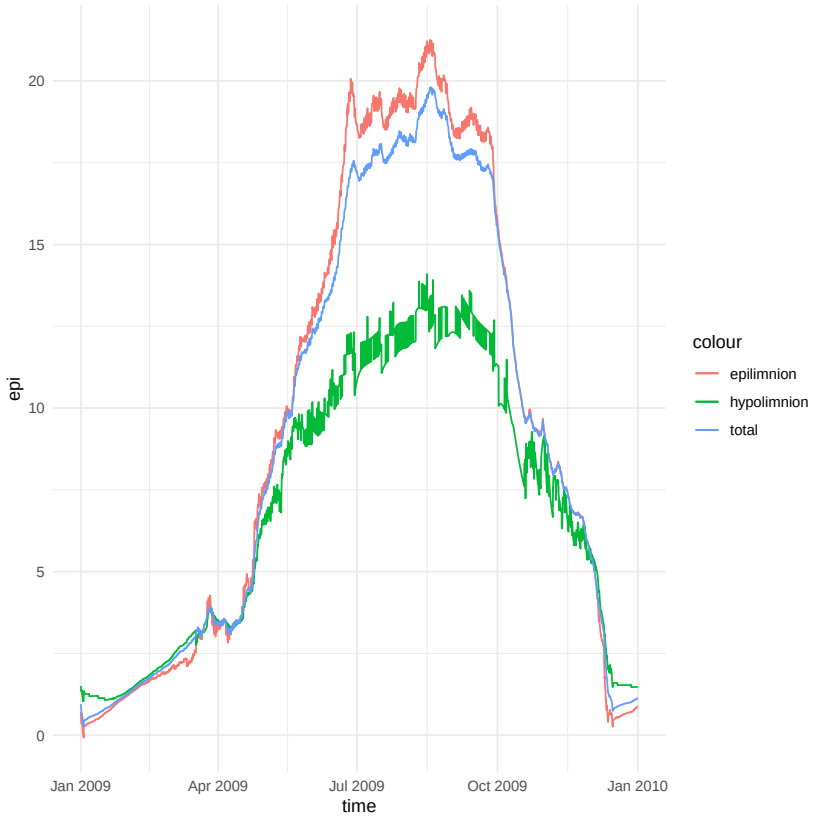
hrefhttps://portal.edirepository.org/nis/mapbrowse?scope=knb-lter-ntlidentifier=1revision=60North Temperate Lakes LTER: Chemical Limnology of Primary Study Lakes: Nutrients, pH and Carbon 1981 - current

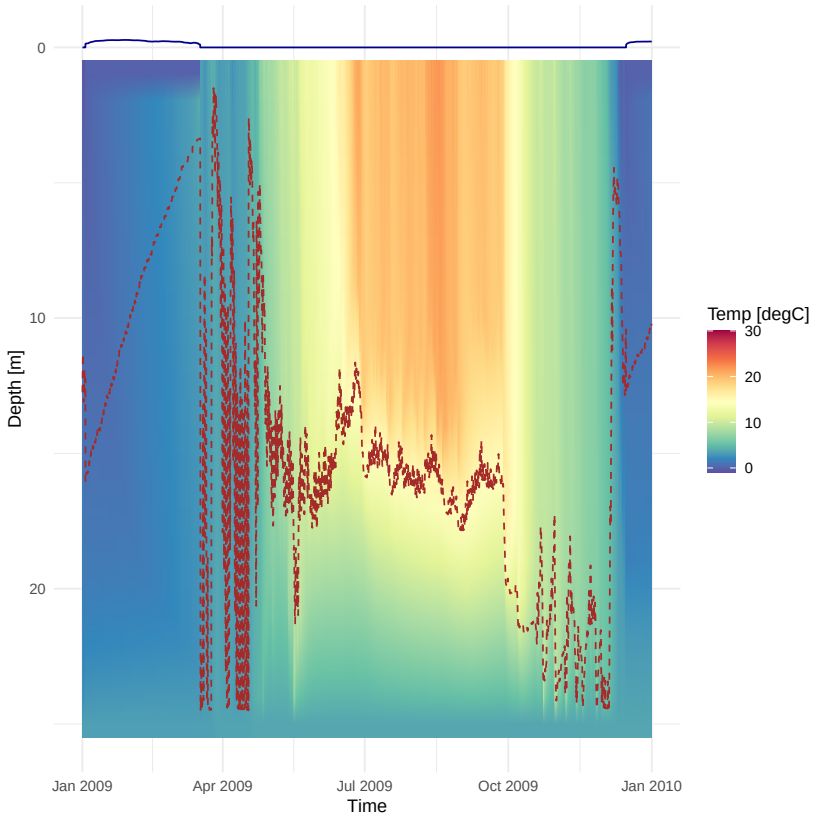
```
# Model lake stratification using LakeR
```

```
# Load the LakeModelR package
library("LakeModelR")
```

Modeling Lake Temperatures

```
## Loading required package:  tidyverse
## - Attaching packages ------------------------- tidyverse
1.3.2 -
  ## v ggplot2 3.3.6     v purrr   1.0.2
  ## v tibble  3.2.1     v dplyr   1.1.4
  ## v tidyr   1.2.0     v stringr 1.5.1
  ## v readr   2.1.2     v forcats 0.5.2
  ## - Conflicts --------------------------- tidyverse_conflicts()
-
  ## x dplyr::filter() masks stats::filter()
  ## x dplyr::lag()    masks stats::lag()
  ## Joining with ‘by = join_by(dt)‘
  ## Joining with ‘by = join_by(dt, datetime, Shortwave_Radiation_Downwelling_wattPerMeterSquared,
Longwave_Radiation_Downwelling_wattPerMeterSquared, Air_Temperature_celsius,
Relative_Humidity_percent, Ten_Meter_Elevation_Wind_Speed_meterPerSecond,
Precipitation_millimeterPerDay, Snowfall_millimeterPerDay,
Surface_Level_Barometric_Pressure_pascal, date, Cloud_Cover,
ea)‘
## Warning in initial_profile(initfile = system.file("extdata",
"observedTemp.txt", :  Meteorological starting date is 2009-01-01,
but observed data starts 20 days later on 2009-01-21
## What a beautiful day to run a lake model.==========================================================
## Have a lovely rest of your day!
```

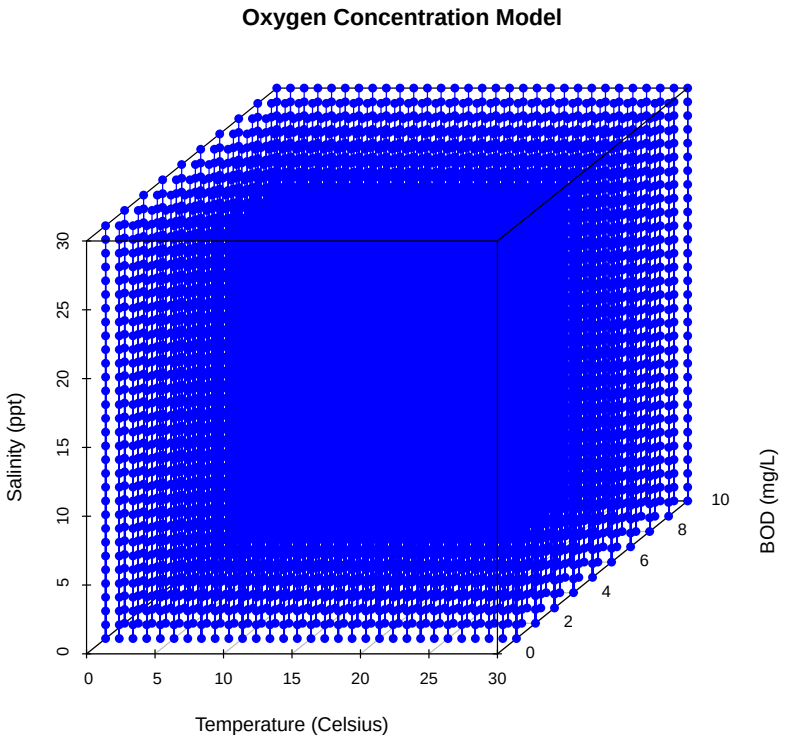

20
15
10
5
0
epi
Jan 2009
Apr 2009
Jul 2009
Oct 2009
Jan 2010
time
colour
epilimnion
hypolimnion
total



Lake Mixing

```r
# Model Oxygen Concentrations in Water

# Parameters
temperature <- seq(0, 30, by = 1)  # Temperature in degrees Celsius
bod <- seq(1, 10, by = 1)  # Biological Oxygen Demand (BOD) in mg/L
salinity <- seq(0, 30, by = 1)  # Salinity in ppt (parts per thousand)

# Model coefficients (example values, replace with actual coefficients)
coeff_temp <- 0.5
coeff_bod <- -0.2
coeff_salinity <- -0.1
intercept <- 10

# Function to model oxygen concentration
model_oxygen_concentration <- function(temp, bod, salinity) {
  return(intercept + coeff_temp * temp + coeff_bod * bod + coeff_salinity * salinity)
}
```

```r
# Generate a grid of combinations of temperature, BOD, and salinity
grid <- expand.grid(temperature = temperature, bod = bod, salinity = salinity)

# Model oxygen concentration for each combination
grid$oxygen_concentration <- model_oxygen_concentration(grid$temperature, grid$bod, grid$salinity)

# Plotting the results
library("scatterplot3d")

scatterplot3d(grid$temperature, grid$bod, grid$salinity, color = "blue",
              main = "Oxygen Concentration Model",
              xlab = "Temperature (Celsius)",
              ylab = "BOD (mg/L)",
              zlab = "Salinity (ppt)",
              pch = 16,
              type = "h")
```




```r
# Add model surface
fit <- lm(oxygen_concentration ~ temperature + bod + salinity, data = grid)
fit_surface <- predict(fit, newdata = grid)
```

```
scatterplot3d(grid$temperature, grid$bod, grid$salinity, color = "blue", add = TRUE,
              grid = FALSE, fit = fit_surface)

## Warning in title(main, sub, ...):  "add" is not a graphical
parameter
## Warning in title(main, sub, ...):  "fit" is not a graphical
parameter
## Warning in plot.xy(xy.coords(x, y), type = type, ...):
"add" is not a graphical parameter
## Warning in plot.xy(xy.coords(x, y), type = type, ...):
"fit" is not a graphical parameter
```