# Estimating Stream Metabolism By Use of RStudio®

Lydia Jefferson and Alba Argerich

School of Natural Resources, University of Missouri, Columbia, MO

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# Background

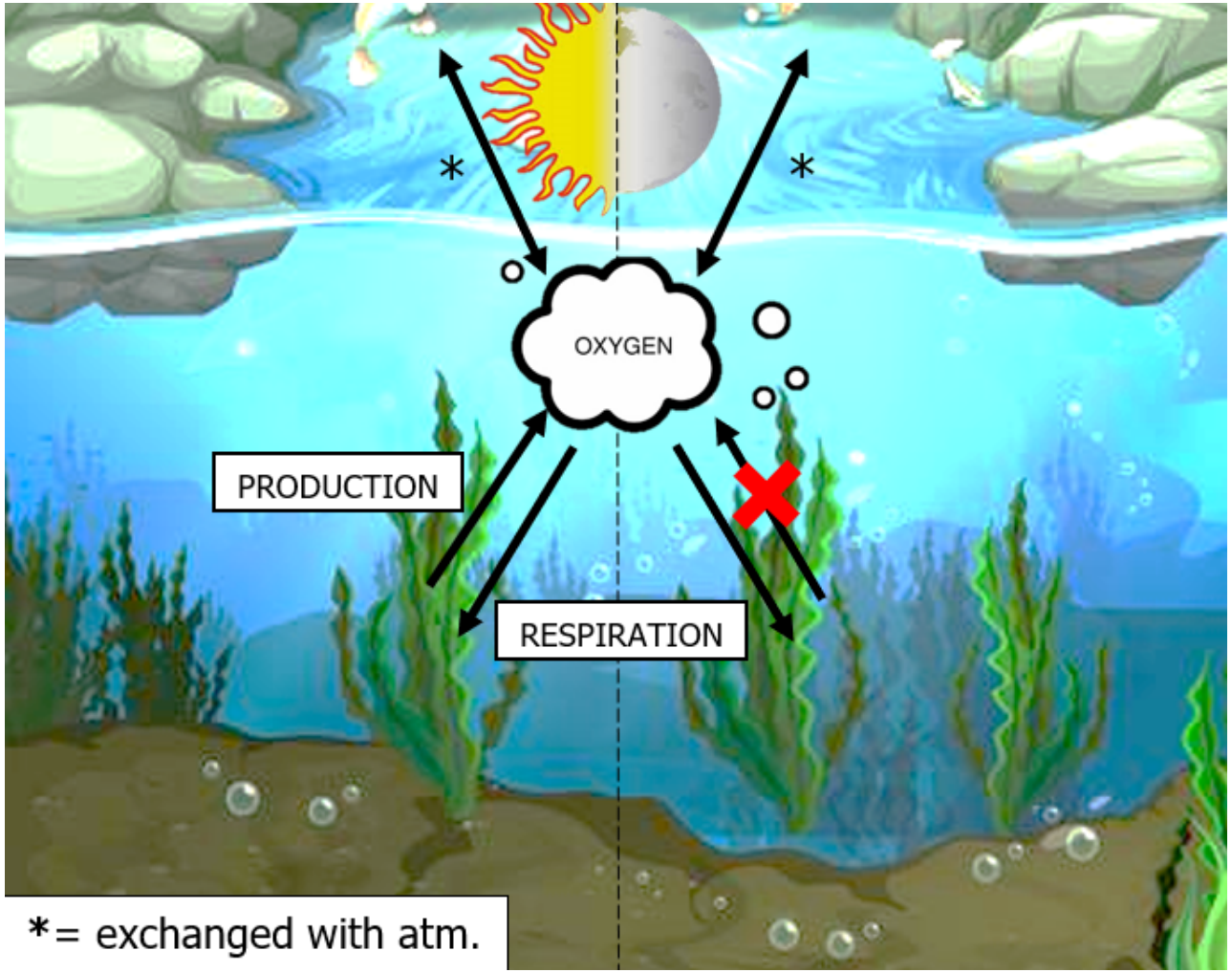
The estimation of a stream's metabolism has been used as an indicator of aquatic health. This is due to two major processes, primary production and ecosystem respiration, dictating the stream's response to environmental influences. In this study we will analyze various data from a stream in KCMO, a stream in Joplin, MO, and a stream in Oregon to identify the relationships between land use and stream metabolism.

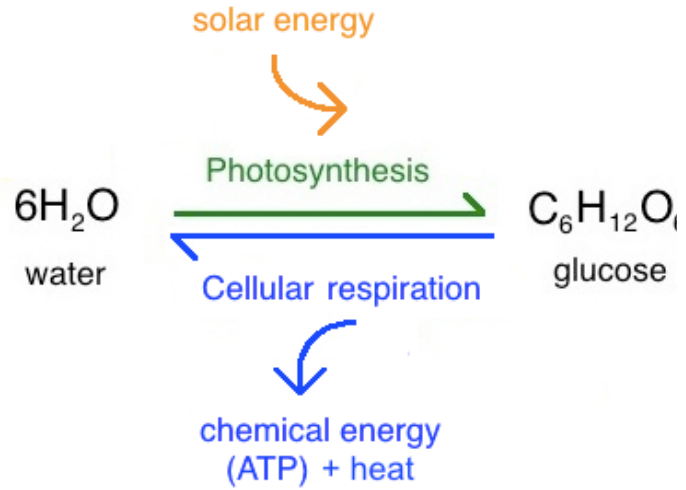
**How can the estimation of stream metabolism rates improve our understanding of the overall health of freshwater bodies relative to land use practices?**

# Methods

Primary production is the process in which organisms use solar radiation to synthesize organic compounds from carbon dioxide. Therefore, Gross primary production (GPP) is the total amount of matter these organisms create within a period of time.

Respiration is the process that converts the chemical energy stored in organic compounds to energy useable for organisms. Ecosystem respiration (ER) is the total amount of organic matter decomposed within a period of time. As GPP releases Oxygen, and ER uses it, the changes in dissolved oxygen can be used to estimate stream metabolism.




Our model is able to estimate stream metabolism in part due to primary production not occurring at nighttime, shown this figure. As also shown in this figure, oxygen is constantly being exchanged with the atmosphere.

# Stream Metabolism Model

Dissolved oxygen and water temperature data has been collected at each site using an optical oxygen sensor every five minutes for more than one week.

$$\frac{(dO_2)}{dt} = GPP + ER + G$$

$$O_i = O_{i-\Delta t} + \left(\frac{GPP}{z} + \frac{ER}{z} + K_O\left(O_{sat(i-\Delta t)} - O_{i-\Delta t}\right)\right)\Delta t$$

Data from the sensors will be uploaded into Integrated Development Environment (IDE) RStudio® and run with the "StreamMetabolizer" package (Appling et al. 2018). The Bayesian statistical model will be used to estimate the daily GPP and ER.

# Known Study Sites

Urban

1

Mining

2

Forest

3

1. Brush Creek, Kansas City, MO - Longitude: -92.7137
2. Stream located in Joplin, MO - Longitude: -94.5133
3. McRae Creek, Oregon – Longitude: -122.1655

# Input Data → MODEL → Output

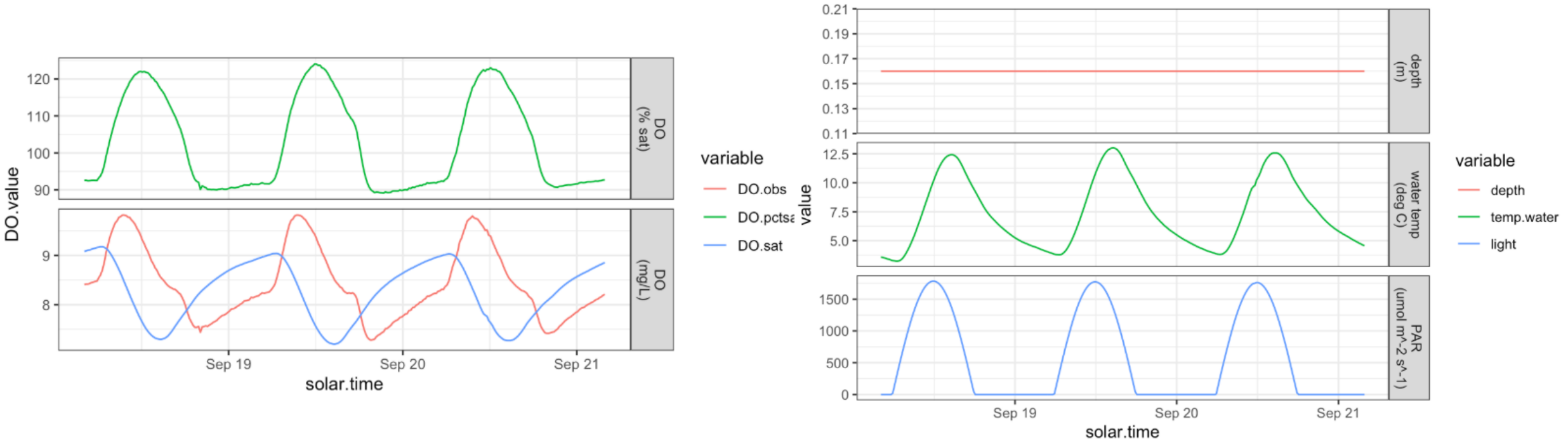
- Solar Time
- Observed Dissolved Oxygen
- Dissolved Oxygen Saturation (%)
- Water Depth
- Water Temperature

- Primary Production Rate
- Respiration Rate
- Gas Exchange Coefficient

## Explanatory Variables

- Precipitation*
- Solar Radiation
- Land Use (Past and Current)
- Air and Water Temperature*

# Data Analysis Examples:




**Figures generated by RStudio®** will showcase the different variables being observed and measured. These variables are used by the model to estimate GPP and ER, which will then be inserted into the two stream metabolism equations above.**

# Expected Results:

- Differences in water temperature will have an affect on Dissolved Oxygen Saturation
- Stream flow changes due to precipitation and temperature
- Algae and plants present in the stream will have an affect on primary production and ecosystem respiration
- Land use affects: contaminants in Joplin stream might inhibit algae growth, more nutrients correlated to higher GPP

# Citations

Appling, Alison P., Robert O. Hall, Charles B. Yackulic, and Maite Arroita. "Overcoming Equifinality: Leveraging Long Time Series for Stream Metabolism Estimation." Journal of Geophysical Research: Biogeosciences 123, no. 2 (February 2018): 624–45. https://doi.org/10.1002/2017JG004140.

# Acknowledgements

*Weather event data (temp./precipitation) will be provided by Climate Stations located near each study site.

**Figure examples for this presentation are from the "streamMetabolizer" software developed by Appling et al. (2018).

Joplin stream picture provided by Jessi Wilson.

McRae Creek picture provided by Alba Argerich.