---TITLE: Ecosystem metabolism for an arctic warm spring-stream (Ivishak Hot Spring, Alaska)

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---DATA SET OVERVIEW:
-Abstract: We investigated the productivity of a perennial, Arctic spring-stream. Ivishak Spring has the stable discharge (~131 L/s) and temperature (~4-8oC) typical for springs. It is unusual, however, in having an annual cycle of daylight from 24 hrs/d (summer) to 0 hrs/d (winter). We tested the hypothesis that stored detritus would buffer carbon limitation during winter when gross primary production (GPP) is minimized, resulting in constant rates of community respiration (CR) year-round due to constant temperatures. We used open-channel methods to measure GPP and CR monthly from March 2007 to August 2009. Mean annual GPP was 458 gC/m2. Such a level is typical for temperate desert-streams but was surprising for an Arctic stream. Annual CR (887 gC/m2) was also remarkable. The high metabolism of this stream is explained by an open canopy, moderate year-round temperatures, stable bed, and high bryophyte biomass (48 gAFDM/m2). Strong seasonal cycles of GPP were mirrored by CR (r=0.65) indicating the possibility of carbon limitation during winter. This result falsified our hypothesis that CR would be relatively stable year-round due to a detritus buffer and constant temperature.
-Time period covered by the data: March 2007 through August 2009.

-Physical location of the measurement: a ca. 200-m stream reach from 69o 1.420'N, 147o 43.276'W to 69o 1.506'N, 147o 43.240'W; elevation = ca. 396 m. Ivishak spring is a tributary of the Ivishak River, a braided river that flows through the Arctic National Wildlife Refuge (ANWR) on the North Slope of the Brooks Range, Alaska. Substrata consist of physically stable, cobble-size particles that are often covered by bryophytes (Parker and Huryn 2011). The habitat structure consists of a relatively uniform run with infrequent pools for at least 300 m downstream of the high-gradient spring orifice. Pools are infrequent. Discharge is relatively constant at 136 L s-1, mean annual water temperature ranges from 7.3oC at the source to 5.8oC about 300 m below the source. The temperature at the source is constant, whereas the temperature at the bottom of the reach shows an annual fluctuation of about 3-4 oC. Summer nutrient concentrations are relatively low for headwater streams of the eastern North Slope (i.e., SRP= 0.10 umol L-1, NH4= 0.05 umol L-1, NOx= 5.3 umol L-1; Huryn et al. 2005, Parker 2004, Parker and Huryn, in press, Benstead and Huryn, in press). Riparian vegetation consists of dense thickets of willows (Salix spp.) 1 to 2 m in height. A grove of balsam poplar (Populus balsamifera) trees 3 to 4 m in height grows along one bank of the stream.
-Data source: n/a.
-World Wide Web address references: n/a

---INSTRUMENT DESCRIPTION:
Dissolved oxygen concentration (DO, mg O2 L-1, resolution +/-0.1 mg O2/L), the base data required for estimating GPP and CR, and temperature (oC, resolution +/-0.1oC) were recorded at 3 min intervals for a minimum of 24 hrs using Hydrolab MS5 Minisondes (Hatch Hydromet, Loveland, CO, U.S.A) fitted with Luminescent Dissolved Oxygen (LDO, resolution 0.1 mg O2/L) sensors. Photosynthetically active radiation (PAR, ?mol s-1 m-2) was measured simultaneously with DO using an underwater quantum sensor (LI-190SA, LI-COR, Lincoln, NE, U.S.A., resolution 0.01 Êmol s-1 m-2) interfaced with a digital recorder. PAR was measured every second and data were recorded as 5-min means. Barometric pressure (resolution < 0.02 kPa) was measured using HOBO U20 Water Level Data Logger - U20-001-01.

INSTRUMENT	SENSOR	PRECISION	FREQUENCY
HOBO U20 - U20-001-01		< +/- 0.02 kPa	5 min
Hydrolab MS5 Minisonde	LDO	+/-0.1 mg O2/L	3 min
Hydrolab MS5 Minisonde	Temp	+/-0.1 oC	3 min
LiCor LI-1400	LI-190SA	0.01 umol/s/m	1 s (5-min mean recorded)

---DATA COLLECTION and PROCESSING:
Dissolved oxygen concentration: LDO sensors were calibrated at the field site using air saturated water at the ambient stream temperature. Following calibration, the sondes were placed together in a 20-L bucket containing aerated stream water to assess synchrony of DO measurements among instruments. After a period of 30 minutes or longer, the sondes were positioned at either end of a study reach [2 sondes at 0-m = US (?upstream?), 2 sondes at 200-m = DS (?downstream?)]. At the end of the deployment the sondes were again placed together in a 20-L bucket containing oxygen saturated stream water to assess synchrony of DO measurements among instruments. The DO profiles measured in aerated stream water immediately prior to and following deployment were used to determine the relative accuracy of the sondes and to correct for instrument drift which was minor. This procedure was not possible for data collected during December. The study site was not visited in December 2007 and 2008 due to limited daylight hours. DO was measured during these periods by programming the sondes during November to autostart at the appropriate interval in December. The sondes were recovered the following January.
The PAR sensor was placed ~10 cm below the surface of the water (approximated average reach depth) in an unshaded reach (e.g., no overhead canopy, low riparian cover). PAR was measured every second and data were recorded as 5-min means. The field site was not visited during December 2007 and December 2008. PAR was measured during December by deploying light meters from November through January. PAR measurements were converted to 3-min intervals to match the DO measurement interval by interpolation.
Barometric pressure was measured and recorded continuously as mm Hg at 5-min intervals throughout the study in the riparian zone near the downstream end of the study reach. PAR and barometric pressure measurements were converted to 3-min intervals to match the DO measurement interval by linear interpolation.

---DATA FORMAT
-Data file structure: column delimited ASCII.
-Data format and layout: data are provided in columns indicated by headers containing the variable name and units

-List of parameters with units, sampling intervals, frequency, range:

PARAMETER	UNITS	SAMPLING INTERVAL	FREQUENCY	RANGE
BP	mm Hg	semi-monthly	3-min	
US_water-temp	oC	semi-monthly	3-min	
US_DO	mg O2/L	semi-monthly	3-min	
PAR	umol/s/m	semi-monthly	3-min	
DS_water_temp	oC	semi-monthly	3-min	
DS_DO	mg O2/L	semi-monthly	3-min	

-Description of flags, codes used in the data, and definitions: n/a

---DATA REMARKS

-PIs assessment of the data: We have high confidence in these data. Having said this, we did experience significant problems with the Hydrolab data sondes due to malfunctions during deployment. Because we used the sondes in pairs (2 DS, 2 US), however, we were fortunate to always have at least one properly functioning US sonde and one properly functioning DS sonde during every deployment.

---REFERENCES

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