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2000 Summer Field Season Report
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This summer field season was very intensive for our group and included research sites in Prudhoe Bay, Barrow, Atqasuk, and Seward Peninsula, Alaska, as well as a new site on the Chukotka Peninsula, Russia. Site locations and details will be outlined at the end of this report. This report is a summary of our summer 2000 field season in Alaska. Larger scale remote sensing activities have already been reported in a previous SDSU Remote Sensing field season report.

Year 2000 Field Conditions

Preliminary results based on our meteorological towers located in Prudhoe Bay, Barrow and Atqasuk, Alaska, indicate that the 2000 field season was wetter than in the past two field seasons. Total precipitation for the 2000 summer season at Barrow was 93.2 mm of rain, an increase of 25.5 mm and 10.2 mm from 1999 and 1998 respectively. When averaged over the entire growing season (June-September) at our Barrow flux site, ambient air temperatures were 2.3 (C, a decrease of 1.4 (C from 1998 and roughly the same as in 1999.

Measurements

Tundra Manipulations Experiment

The full factorial heating and water manipulation experiment was continued at Barrow, Alaska. The site was established in the fall of 1998 and this year was the second full season of measurements. The experiment is very effective in manipulation of tundra soil temperatures as well as a decreased and increased water table depth within the manipulations plots. Carbon fluxes in the control plots compare favorably with the eddy covariance tower located several hundred meters away while the manipulated treatments show differences in carbon flux from the control plots.

Preliminary results indicate that with increased soil temperatures, there is enhanced CO_2 uptake. Water table manipulation shows an additive effect on uptake, but appears to have a much weaker effect on fluxes alone and smaller in magnitude than that of increases in temperature. Preliminary NDVI values are higher in the heated plots compared to the controls, indicating possibly enhanced photosynthetic capacity with soil heating. The second year of data collection indicates that increases in CO_2 uptake seen in the first year of manipulation have continued, with levels similar to those seen in the 1999 growing season. Further data analysis will reveal if there have been significant changes between the two years and will determine trajectories and rates of acclimation of simulated climate change on this ecosystem.

Tower Based Eddy Covariance - North Slope

Measurements of mass, momentum and energy are measured year-round at Prudhoe Bay, Barrow and Atqasuk. These towers were established in 1994, 1997, and 1998 for Prudhoe Bay, Barrow, and Atqasuk respectively and have been running nearly continuously since then.

Preliminary analysis of these data from Barrow shows a net growing season sink for the growing season (June to September). This is a decrease in magnitude of the sink strength in 2000 compared to the previous two field seasons. The Atqasuk area is typically warmer and drier than Barrow as well as having a different tundra vegetation type. Our eddy covariance measurements in Atqasuk show a net source of carbon for the time between June and September. This is a change in direction and magnitude from the 1999 field season; Atqasuk was a very small sink in 1999 for the same time period.

These preliminary results do not include the data we have for the "cold" months between October-May, but preliminary analysis of these data indicate that when summed over the entire year, Arctic tundra ecosystems are a net source of carbon to the atmosphere.

Tower Based Eddy Covariance - Seward Peninsula

A portable tower was deployed to the Quartz Creek region of the Seward Peninsula between July 25 and August 6. Three sites were measured in the

area corresponding to sites selected by Larry Hinzman et al. in which they
have established long-term meteorological and hydrological stations and include a young (following fire) and an old tussock tundra site (unburned),
as well as a shrub dominated site. The time of the measurements were a few
weeks past peak season, and it rained for 5-6 of the 12 days. Measurements
between these times shows the young burn site to be a net source of carbon
of 0.09 to 0.12 gC d-1, the old tussock tundra was a small net sink of approximately -0.27 to -0.99 gC d-1, and the shrub area having the largest
net sink activity of -1.53 to -2.08 gC d-1.

Tower Based Eddy Covariance - Chukotka Peninsula, Russia

During the summer of 1999, we were able to train Drs. Dmitri Zamolodchikov
and Dmitri Karelin in the eddy covariance technique. That year they brought
with them to Russia a portable eddy covariance tower and have since established
a site in Lavrentia on the Chukotka Peninsula. The eddy covariance tower was
established in typical tundra with dwarf-shrub (Betula, Salix, Empetrum, Vaccinum) hummock (Carex-Eriophorum) lowlands. The period of continuous measurements was between July 22 and October 12. In addition, measurements of
thaw depth, soil moisture, phenology and photosynthesis measurements were taken
on approximately a weekly interval. Average daily carbon flux for late July-August was a net sink of approximately -0.64 gC m-2 d-1 compared to September/early October where it was a net source of 0.62 gC m-2 d-1. Though
this is the first year for eddy covariance measurements, this is actually the
third field season on the Chukotka Peninsula, with the two previous seasons
funded in part by the RITE Foundation. It should also be noted that a CALM
grid was established at this site as well.

Airplane Based Eddy Covariance

Measurements of mass (CO_2, H_2O), momentum and energy over large spatial scales
were done using our dedicated research aircraft (SDSU Sky Arrow). The Sky
Arrow arrived in Prudhoe Bay on 15 June and was flown to Barrow on 18 June. We

established three major flux transects which we concentrated on for the entire growing season. The first transect was originally established in 1998 and flown by the NOAA-ATDD Long-EZ, and continued flights in the late season of 1999 by the SDSU Sky Arrow, and continued this year by the SDSU Sky Arrow Environmental Research Aircraft. This transect is approximately 175 km long and begins over the ocean northeast of Barrow and extends 73 km to the south of Atqasuk. The second transect is an East to West transect spanning 80 km from Admirality Bay to Peard Bay. The third transect was flown over Tusivoak Lake, a large freshwater lake 16 km long, located 30 km to the west-southwest of Barrow. All flux flights were done at 10 meters above ground level (yes, 10 meters) at speeds between 27 to 53 m s-1 (60-112 km hr-1) depending on wind velocity. We accumulated over 185 hours of flight time this season throughout many different weather conditions.

Airplane Based Digital Imagery and Spectral Reflectance

Measurements of spectral reflectance were taken simultaneously with the flux measurements. Particular flights included hyperspectral measurements simultaneous to the flux flights. Additional spectral measurements were taken with the SDSU Sky Arrow with an ADAR spectral imaging system from 3600' and 7200' above the Barrow area providing a resolution of 0.5m and 1.0m respectively. The ADAR cameras record four spectral bands (red, green, blue and near-IR) and the images could be constructed in a mosaic for use in AVHRR satellite comparisons.

Chamber Based Soil Respiration Measurements

An attempt this year was made to measure tundra soil respiration using chamber-based techniques. Soil respiration measurements were made within outlying areas of the flux footprint of the eddy covariance towers in Barrow and Atqasuk. Measurements were made once a week for full diurnal measurements at each site.

Tundra Vegetation Demography Study

Dr. Tom Ebert continued his third season of measurements of tundra vegetation demography in Barrow and Atqasuk. Permanent 30m transect lines at Barrow and Atqasuk were resampled using a digital video camera (620 x 480 pixels) mounted on a 3-meter boom. Photographing smaller plots (25 cm x 30 cm) than in 1998 has increased resolution but with an associated increase in the number of pictures that must be analyzed. Each 30 meter transect consists of two bands 25 cm wide, one from 0-25 and the second from 25 to 50cm which gives 200 images per 30 x 0.5m transect. Images from 2000 are paired with 1999 images so changes in individual plants can be measured. Measurements are change in size, which can be either positive or negative, loss (death), or addition of new individuals. Numbers of flowers are counted and provide a measure of size-specific reproduction. Transitions are used in a size-based demographic model to predict rate of population change and to explore the sensitivity and stability characteristics of plant species. There are six original Barrow and five additional Barrow transects (each 10m long) were photographed on the abandoned road at the Old IBP site.
There are two sites at Atqasuk, each with three transects.

Methane Flux Measurements

Methane flux measurements were conducted between 12 June and 7 October headed by Dr. Yoshinobu Harazono of Japan's National Institute of Agro-Environmental Sciences in collaboration with SDSU. Their measurement site is located about 0.8 kilometers to the Southwest of our main eddy covariance tower in Barrow and located in an area called Central Marsh. The site was established in the spring of 1999 and ran throughout the winter into this field season. Methane flux measurements were done using a modified aerodynamic gradient method using a special FID detector.
The aerodynamic parameters were corrected with measurements made simultaneously from an eddy covariance system measuring CO2, H2O and energy exchange. Preliminary reports indicate a source of methane of 2.9 gCH4 m-2 for the dates between 12 June to 7 October, lower methane emissions compared to 1999, which had 6.6 gCH4 m-2.

Student Involvement

Three undergraduates, one masters and two PhD students (in addition to a number of Research Assistants) worked on projects this past summer.

Undergraduates each had a project that they were responsible in addition to helping with day-to-day data collection, reduction, and equipment maintenance for the group effort. SDSU undergraduate Alejandra Ramos focused her summer research on seasonal soil moisture changes with season and depth using TDR collected data. Phillip Lambert, community college student at Grossmont College looked at species specific changes in plants under varying soil temperatures and water levels. Bob Chapman, a post-baccalaureate at SDSU just starting a Master's degree in ecology also helped us this summer. You can find Glen Kinoshita's masters work under "Tundra Manipulations Experiment", Hyojung Kwon's PhD work in tower based eddy covariance and Rommel Zulueta's PhD work with airplane based regional scale fluxes.

Linkages to other projects

ARCUS sponsored education workshop - In April of 2000, SDSU GCRG members Steve Hastings and Adrienne Marriott attended an ARCUS sponsored workshop in Fairbanks, AK on science education in the Arctic. With assistance from BASC, this set the stage for K-6 educational activities in Barrow in concert with the research activities this past summer.

PISCES - Partnerships Involving the Scientific Community In Elementary Schools -
Alejandra Rios, a GCRG-PISCES Science Corps student from San Diego worked with students at Barrow's Ipalook Elementary School in the summer of 2000. Ms. Rios's activities in Barrow continued as she worked with the Inupiat Heritage Center on a culturally relevant Global Change Exhibit. This allows a direct connection of NSF OPP funded Global Change Research to a local context with very high visibility. In addition to posters on global change, an animal fur display was made, as well as plant and a hands-on weather box.

CSULA - California State University Los Angeles
Dr. John Gammon has a new grant to study hyperspectral relationships of vegetation and carbon sequestration in the Arctic. Gammon et al. has established sites adjacent but outside of our eddy covariance flux footprint area that has a tram system along a 100 meter transect for taking hyperspectral measurements. This hyperspectral instrumentation was also installed on the SDSU Sky Arrow for simultaneous measurements with airplane-based measurements.

NIAES - National Institute of Agro-Environmental Sciences
Dr. Yoshinobu Harazono has worked in a collaborative effort to measure fluxes of CO2, H2O and energy in Arctic systems dating back to 1993. He has had towers based in Prudhoe Bay and Happy Valley and has joined our research in Barrow since 1999. His eddy covariance system is located in a wet sedge marsh area called Central Marsh, and besides his eddy covariance measurements of mass, momentum and energy, he also measures methane fluxes. Harazono et al. is attempting for a second year to measure methane fluxes into the winter at Barrow Alaska.

Site Locations

Barrow

SDSU Eddy covariance tower:
71∞ 21' 00.00" N : 156∞ 37' 18.53" W

SDSU Tundra manipulations:
71∞ 19' 18.36" N : 156∞ 37' 06.35" W

SDSU Demography transect:
Six Barrow sites:
71∞ 18' (between 43.7" and 58.9") N : 156∞ 35'
(between 31.6 and 40.7") W

NIAES Eddy covariance and CH4 flux tower:
71∞ 19' 16.86" N : 156∞ 37' 18.53" W

CSULA Hyperspectral transect:
71∞ 19' 21.24" N : 156∞ 36' 24.15" W

Atqasuk

SDSU Eddy covariance tower:
70∞ 28' 10.6" N : 157∞ 24' 32.2" W

SDSU Demography transect:
Two sites at Atqasuk, each with three transects.
70∞ 27' 1.9" N : 157∞ 24' 25.4" W
70∞ 26' 47.3" N : 157∞ 24' 12.9" W

Prudhoe Bay

SDSU Eddy covariance tower:
70∞ 16' 53.5" N : 148∞ 53' 05.4" W

Seward Peninsula

SDSU Eddy covariance tower:
Location 1: 65∞ 26' 24.0" N : 164∞ 34' 43.8" W
Location 2: 65∞ 27' 17.4" N : 164∞ 37' 46.2" W
Location 3: 65∞ 25' 45.6" N : 164∞ 38' 43.2" W

Airplane Flightline Transects

Barrow North-South transect:
North end: 71∞ 30' 00.0" N : 156∞ 27' 00.0" W

South end: 70∞ 00' 00.0" N : 157∞ 45' 00.0" W

Barrow East-West transect:
East end: 70∞ 50' 00.0" N : 155∞ 55' 00.0" W
West end: 70∞ 50' 00.0" N : 158∞ 05' 00.0" W

Tusivoak Lake transect:
North end: 71∞ 08' 40.00" N : 156∞ 13' 00.0" W
South end: 71∞ 00' 30.00" N : 156∞ 03' 00.0" W