GLOBAL WARMING: THE BERING GLACIER RETREAT AND SEA LEVEL RISE

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ABSTRACT

Scientists have been divided over the issue of the existence of global warming. There is new, compelling evidence that global warming is driving climate change and sea level rise in the Arctic Region. Specifically, the Bering Glacier is currently undergoing rapid retreat indicated by its daily release of 30,000 c.f.s. of freshwater into the Pacific Ocean. The purpose of this research paper is threefold: to use remote sensing technology to show the rapid retreat of the Bering Glacier since its last surge in 1995, to use the GIS/GPS Red Hen Technology to create a 2007 aerial photography map of the retreating edge of the Bering Glacier, and to demonstrate exactly how much ice calving has taken place since 2006. During this twelve month period, the Bering Glacier retreated .52 Km. How this retreat is influencing sea level rise globally is considered also.

BACKGROUND

The rapid melting rates of the Bering Glacier (**30,000 cfs into the Pacific Ocean!),** and other glaciers around the world, are increasing the threat of **catastrophic flooding due to rising** sea levels, potentially affecting 136 coastal cities around the world.The threat of sea level rise brings with it a myriad of issues such as coastal erosion, destruction of marine life, vulnerability of national assets, and flooding. A study conducted by the Organization for Cooperation and Economic Development (OCED) has identified 136 low-lying coastal cities-worldwide-as being at great risk to coastal flooding by 2030 and 2070.

The study of **global warming in the arctic region** the Bering Glacier retreat and sea level rise arose from a formation of a research partnership of 4 institutions. These were **; a)** Michigan Tech Research Institute (MTRI), located at the University of Michigan, Ann Arbor**, b) the** Bureau Of Land Management: Bering Glacier falls under BLM jurisdiction, c) the USGS and Southern University:. At Southern University the effort was led by CEES and CCZARS (NASA supported)

Bering Glacier Geography

Bering Glacier, Alaska is the largest and longest glacier in continental North America. It has an area of approximately 5,175 km². The glacier covers 6% of the glacier cover area of Alaska. 15-20% of Alaska total glacier ice (frozen freshwater). Bering Glacier is the largest surging glacier in America (last surge occurred 1993-1995). The entire glacier lies within 100km of the Gulf of Alaska.

Vitus Lake Terminus

a. Depth in excess of 150m in spots; since 1995, lake has increased doubled in size, from 60km² to over 120km².
b. Rapid Bering Glacier Retreat is driven by increased ice calving, influenced by warming climate.
c. Bering Glacier only 300 miles from Arctic Circle.

Bering Glacier, Climate Change, and Policy Implications

The 2008 S.U. Team's Bering Glacier Research will also include climate change and policy implications.

Policy Research Questions

- The 2008 S.U. Policy Research Team will focus on specific policy questions such as:
  - (a) What current policy options exist in addressing climate change and how effective are they? (Massachusetts vs. EPA, 2007)
  - (b) What does the rapid rate of melting at the Bering Glacier mean to proximate and distant coastal cities?
  - (c) What impact does CO2 and other GHG emissions have on glacial melting?
  - (d) How should the 2007/2008 Bering research drive future policy changes on climate control?

GOALS OF THE STUDY

2007 Study Goals

a. To participate in a hands-on summer research experience at the Bureau of Land Management's Bering Glacier Camp located 45 minutes southwest of Cordova, Alaska.
b. To contribute to the growing bank of research related to the Bering Glacier.
c. To assist the partnership with policy development related to the Bering Glacier.

Long Term Goals

a. To continue a systematic investigation of the Bering Glacier's rapid retreat since 2006.
b. To enrich student knowledge of the Bering Glacier and its retreat based on climate change, both locally and globally.
c. To study the policy implications regarding global sea level rise and carbon dioxide emissions.

OBJECTIVES

a. To assist the various research teams that come to the Bering Glacier Camp with their data collection.

b. To participate in the following research activities: (1) water quality (2) seismic activity (3) resistivity (4) vegetation and land-use classification (5) GIS/Remote Sensing Mapping and (6) GPS.

d. To formalize a new research project that will be conducted by the Southern University Research Team, beginning during the summer 2008.

e. To propose a research project that involves the "*measurement of the rate of Bering Glacier Retreat and Sea Level Rise on Coastal Cities, using GIS/Remote Sensing Technology."*

f. To share the findings of the 2007 Southern University Research Team related to the Bering Glacier retreat.

g. To re-fly the Bering Glacier Terminus in order to create a new aerial photography map layer of the glacier's 2008 terminus.

h. To collect Bering Glacier elevation data using Geo-XH and Zephyr Antenna & Survey Grid Technology for 2008, and use dataset to compare with 2009 elevation measurements.

i. To use Laser Range Finder Technology to collect 2008 baseline Z-value (Elevation) data that can be used to measure increase or decrease in glacier volume by 2009.

METHODOLOGY

The research scope involves

a) Studies in water Quality, Seismic activity and Resistivity,
b) Helicopter and Boat Research Trip
c) Vegetation and Land-use Classification Bering Glacier

Proposed Research Projects: Summer 2008
Project-01

- Re-fly the Bering Glacier Terminus using RedHen VMS-X Technology (Fully integrated GPS/Video solution, enabling direct-to-DVD Recording.
- Generate a 2008 aerial photography Map layer to compare with the 2007 map layer.
- Calculate differential ice lost areas: 2007 to 2008. Compare archived satellite imagery.

VMS-X Red Hen video/GPS system

- Mini DVD 1.4 GB about 30 minutes worth of recording.
- Battery powered
- Garmin Geko 201, WAAS-enabled, 10K point track log, digital compass.

Project-02

- Geo-XH and Zephyr Antenna Technology
- Land on Bering Glacier (Helicopter aided).

- Collect 10 GPS points: X,Y,Z (**Elevation).**
- Establish a GPS Grid baseline to measure change detection of Z values.
- 2008 to 2009 X,Y,Z elevation change.
- ± 20cm Horizontal accuracy / ± 40-60cm "Z" Vertical Accuracy.
- Assess decrease or increase in BG elevation.

Geo-XH and Zephyr antenna

Project-03

- Laser Range Finder (Contour XLR ic w/GeoXH data collector.
- Collect data related to difficult to reach targets: BG/iceberg elevation, slopes, areas, perimeter, etc.

Contour XLR ic with the GeoXH GPS

- The Contour XLR is rugged and waterproof. So When snow, rain, fog or heavy dust hamper range performance, simply switch to "poor weather" mode and blast through to your target

Project-04:Optional

- Survey Grid Solution: Base Station and Rover Technology (Trimble R8 GNSS).
- Position base station over BG benchmark for 4 hours.
- Land on BG & collect 10 survey GPS points (Simultaneously recorded by base station).
- Compare base station data w/NGS-CORS.
- ± 1cm Horizontal Accuracy/ ± 2-3cm "Z" Vertical Accuracy.

Trimble R8 GNSS (Base + Rover)

Bering Glacier Camp

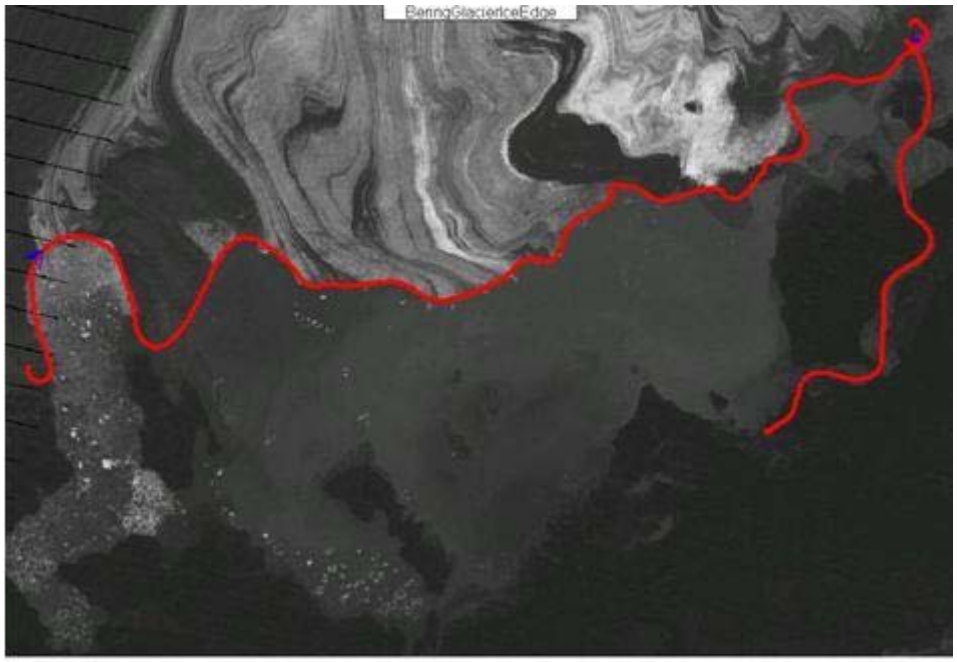
- Camp is operated each summer by the BLM.
- It is located on the edge of Vitus Lake on the former terminal moraine of the Bering Glacier.
- Camp runs from late June to early August.
- Outfitted with refueling airstrip, kitchen and mess tent, command center, restrooms, showers.
- Camp can host 25 scientists and students at a given time.

PRELIMINARY FINDINGS FOR 2007

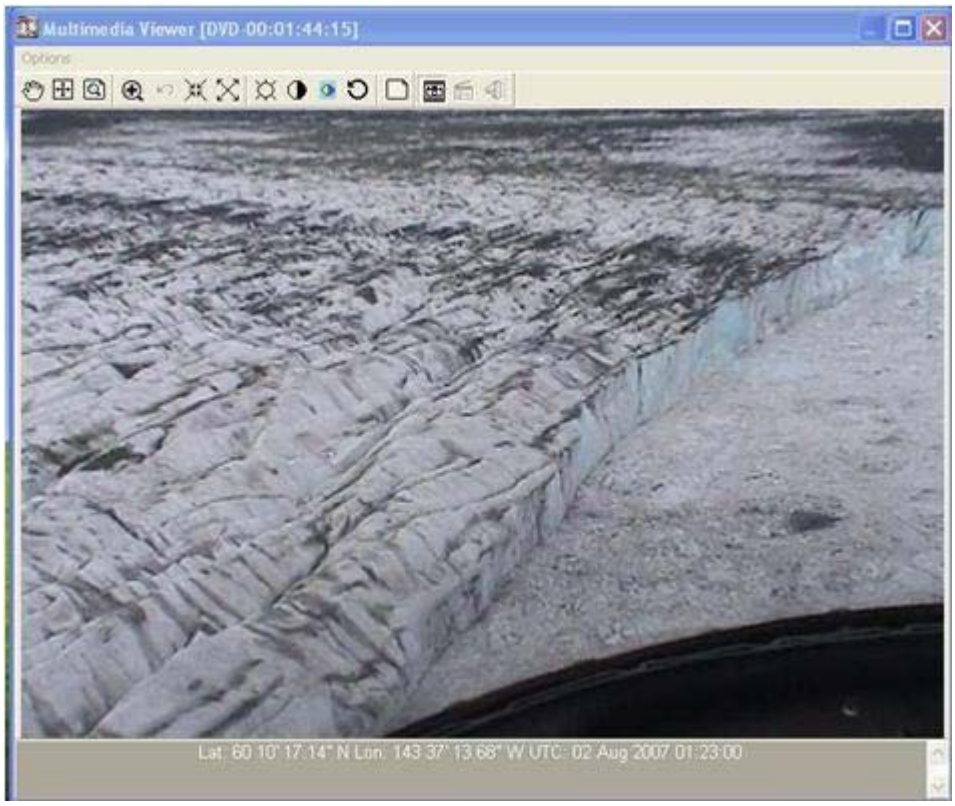
Bering Glacier Terminus: 2006 (courtesy Google maps)

Helicopter Fly-Over of Terminus map layer-August 2007- 2006 Sat. imagery

Helicopter Fly-Over of Terminus map layer-August 2007- 2007 Sat. imagery



Snap shot GPS coordinates and video Imagery using Red Hen



DISCUSSION: AERIAL RETREAT DETECTION

Scientists have recently come to a consensus that global warming is the main force driving climate change worldwide. Of major concern is to what extent policymakers in low-lying coastal cities are aware of the current, rapid retreat of the Bering Glacier? By August 2007, it was recognized that the Bering Glacier-daily-releases 30,000 cfs of freshwater into the Pacific Ocean. In one minute, this sum is a staggering 180,000 cfs! During the summer 2007, RedHen Technology, aided by aerial helicopter flyover, was used to create a 2007 aerial photography map of the retreating edge of the Bering Glacier. From 2006 to 2007, the Bering Glacier retreated .52 km. To determine if this retreat trend remains in effect, a 2008 aerial photography map of the Bering Glacier's Terminus will be developed using helicopter flyover. Moreover, using Laser Range Finder Technology, the height (Z Value) of the Bering Glacier's Terminus will be established to collect 2008 baseline data, which can indicate increase or decrease in glacier volume by 2009. Furthermore, during 2008, a melting index model will be implemented to collect 2008 baseline data, which can demonstrate differential melting based on the number of days melting took place and the area(s) where melting occurred. Lastly, policy implications, regarding sea level rise, coastal population, and infrastructure, will be researched for the 156 low-lying coastal cities that the 2008 Organization for Cooperation and Economic Development (OECD)Report (ENV/WKP(2007)1 has identified as being at great risk to catastrophic flooding by 2030 and 2070.

CONCLUSIONS

This study is at its initial phase. The results presented here are from the first expedition. During this twelve month period, the Bering Glacier retreated .52 Km. How this retreat is influencing sea level rise globally is considered also.

The study of glacier fluctuations is relevant to an understanding of climate and climate change over temporal scales from years to a century or more, and at regional to global spatial scales. As glaciers wax and wane, they store or release water; this "natural regulation" of runoff from glacierized areas is critical to water supply and use in many mountain areas. This storage or release of water also affects global sea level; at least one third of the observed sea level rise in the last 100 years has come from the melting of glaciers exclusive of the Greenland and Antarctic Ice Sheets. The melting of polar ice caps and northern hemisphere has long terms implication to sea level rise in the Gulf of Mexico. Studies that assist in the assessment of the wetlands, and other environmental habitats of the Gulf of Mexico that are essential to the development and healthy maintenance of its fisheries. This research will also provide an early detection system of the declination of habitat conditions prior to their loss to enable better, more successful management of the Gulf of Mexico's environmental habitat. Because the coast and wetlands of the State of Louisiana and throughout the United States' coastal regions are degrading at alarming rates, this research thrust will assist in providing on-going, comprehensive studies and partnerships between research institutions, government and industry to effectively address this problem

SOUTHERN UNIVERSITY RESEARCH TEAM

The Southern University field research team consisted of i) Dr. Michael Stubblefield, Vice Chancellor for Sponsored Research (PI), ii) Dr. Lionel D. Lyles, Research Thrust Lead Three (Landuse and Landcover) and Director of Public Policy Ph.D. Program (Co-PI), iii) Dr. Reva Hines, Associate Professor Political Science and Policy Program Assistant (CO-PI). Laboratory analysis was coordinated with Dr. Fulbert Namwamba, GIS lab director. The field staff consisted of a) Pamela Brue, Research Program Coordinator, b) Alaa Shams, GIS Computer Lab Technician, c) Jacquole Landry, Senior CCZARS Scholar, c) Mykel Delandro, CCZARS Scholar and Charena XXXX, CCZARS Scholar

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