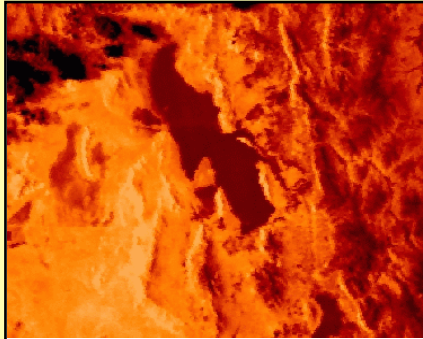




Climatology and Variability of Satellite-derived Temperature of the Great Salt Lake

Erik T. Crosman and John D. Horel

NOAA Cooperative Institute for Regional Prediction, University of Utah



Cool Lake, Hot Desert. AVHRR enhanced 3.55-3.93 μm thermal IR image of the Great Salt Lake at 5:55 p.m. on August 10th, 2004. Used by the U.S. Forest Service to locate fires, hot objects appear white with cooler surfaces represented by darker colors.

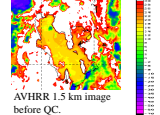
1. Introduction

Thermal characteristics of the Great Salt Lake (GSL) are investigated using NOAA/NASA Advanced Very High Resolution Radiometer (AVHRR) and Moderate Resolution Imaging Spectroradiometer (MODIS) sea surface temperature data sets.

GOAL: obtain a climatology of lake temperature and determine the extent to which satellite-derived temperature can be used to describe lake stratification, evaporation, heat fluxes, and regional climate trends.

2. Data and Validation

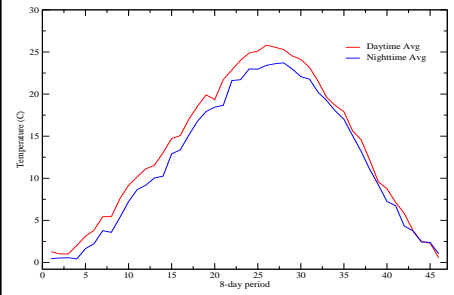
- AVHRR SST 1985-present, 4-km, 2x day
- AVHRR SST 2002-present, 1.5 km, 2x day
- MODIS SST 2000-present, 1.0 km, 2x day



- Quality control algorithms applied
- Satellite temperatures validated against in situ observations

3. Annual and Diurnal Lake Temperature Cycle

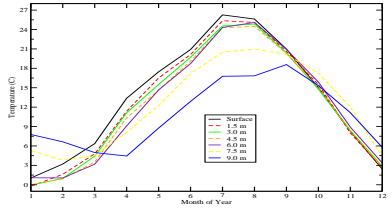
- Climatology of 1985-2004 satellite-derived lake temperature
- Average amplitude of 25 $^{\circ}\text{C}$
- Less nighttime cooling during fall
- Average diurnal temperature cycle 1-2 $^{\circ}\text{C}$ from February-September



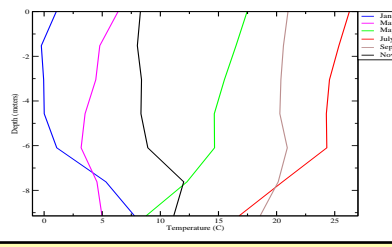
A Shrinking Lake. The impacts of a multi-year drought are evident in the above photographs of the GSL taken from the International Space Station in the summers of 2001 (top) and 2003 (bottom).

4. Lake Temperature and Stratification

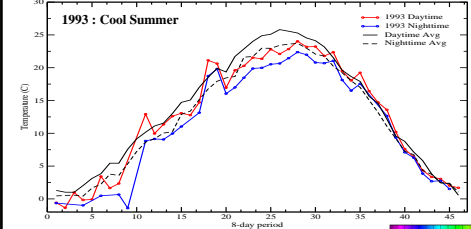
- Stratification and depth of mixing variable
- Stratification reversal from winter to summer
- Link between diurnal cycle and convective overturning
- Remote thermal sensing may provide new insight



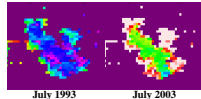
Annual temperature cycle at various depths in the south arm of the GSL (top) and bi-monthly vertical temperature profiles (bottom). Data courtesy of J. W. Gwynn, Utah Geological Survey.



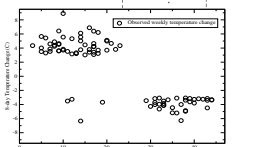
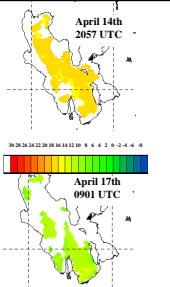
5. Temperature Trends and Variability



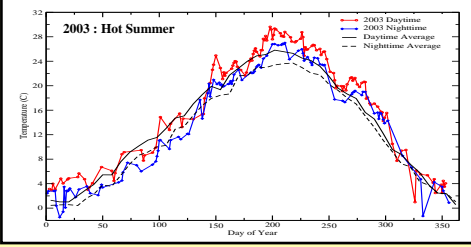
The Great Salt Lake responds rapidly to atmospheric temperature change because of its shallow depth and large surface area. Significant lake temperature fluctuations occur on daily to interannual time scales. Over the last two decades, 1993 and 2003 saw the coolest and warmest average summer lake temperature, respectively.



The Tax Day storm of April 15th, 2002 cooled the GSL by 8-10 $^{\circ}\text{C}$. The transfer of heat and moisture from the lake to the atmosphere is critical in driving lake-effect snowstorms.



Observed temperature changes ($>3^{\circ}\text{C}$) 1985-2004 between consecutive 8-day (weekly) periods for nighttime satellite passes.



Large (greater than 3 $^{\circ}\text{C}$) weekly temperature rises are more frequent and larger in amplitude as the lake warms than are significant weekly temperature drops as the lake cools. This asymmetry is indicative of the higher thermal inertia of the lake surface layers in the fall. In addition, large lake temperature variability is coupled to the meteorologically active period from mid-winter through the spring; while there is an absence of observed large temperature rises during the fall months, several large temperature drops are seen in the spring.

6. Applications and Future Work

Lake-effect snowstorm forecasting. Remote sensing of the lake helps to estimate the conditions favorable for the occurrence of lake-effect snowstorms.

Stratification and mixing. Satellite and in situ heat flux measurements could provide valuable information on lake stratification and energy transfer, which influences the time scale of the thermal response of the lake to atmospheric forcing.

Regional climate variations. Monitoring of fluctuations in volume, surface area, and temperature of the Great Salt Lake help to define the hydrological cycle of the Great Salt Lake Basin.