



HyspIRI: Thermal Infrared Science Question 5

Earth Surface Composition and Change

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The Overarching Question (5):

- What is the composition and temperature of the exposed surface of the Earth? How do these factors change over time and affect land use and habitability?

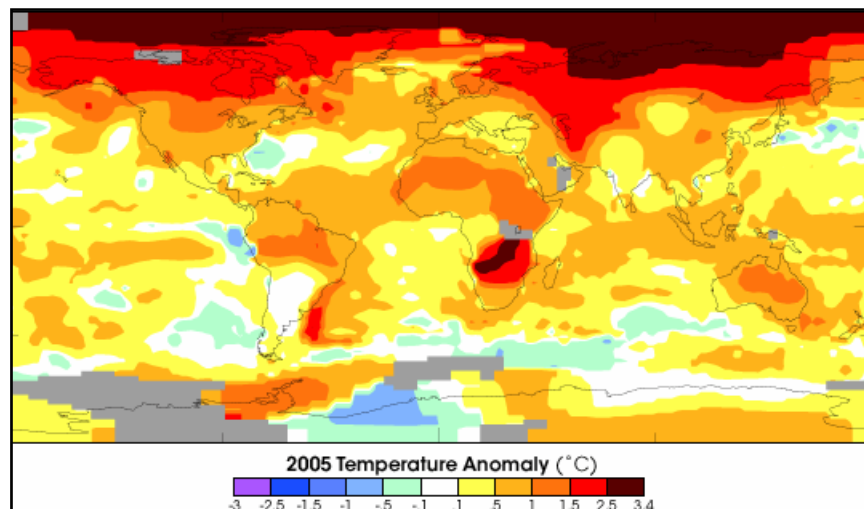


Image credit: NASA Goddard Institute for Space Studies (GISS)

Global surface temperature anomaly in 2005. According to the NASA Goddard Institute for Space Studies (GISS), 2005 was one of the warmest years in over a century.



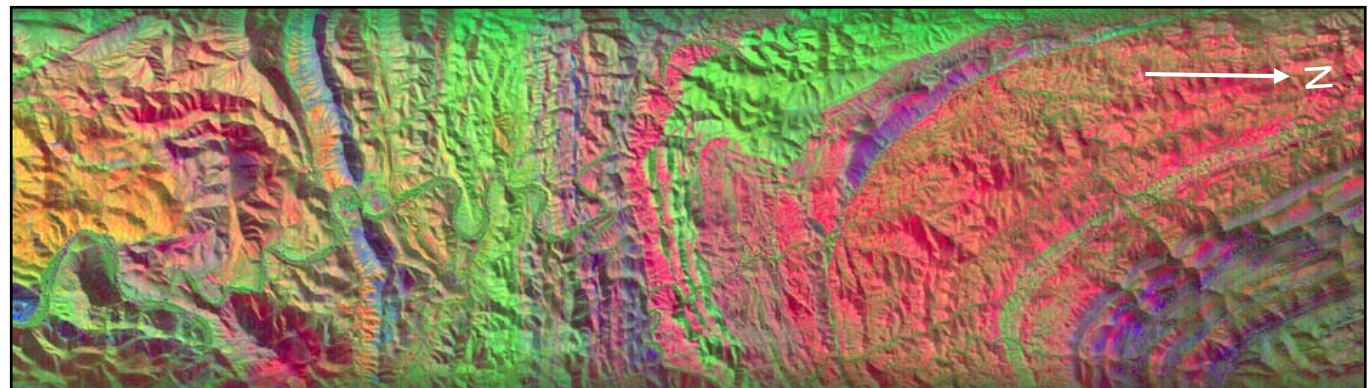
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TQ5: Sub Question 1:

- What is the spectrally observable mineralogy of the Earth's surface and how does this relate to geochemical and surficial processes? (DS 114)
 - The emitted energy from exposed terrestrial surface of the Earth can be uniquely helpful in identifying rocks, minerals and soils.
 - Spaceborne measurements from HypsIRI will be used to derive surface temperatures and emissivities of a variety of Earth's surfaces.

TIMS Enhanced Thermal Infrared Image showing emissivity variation in different surface lithologies.



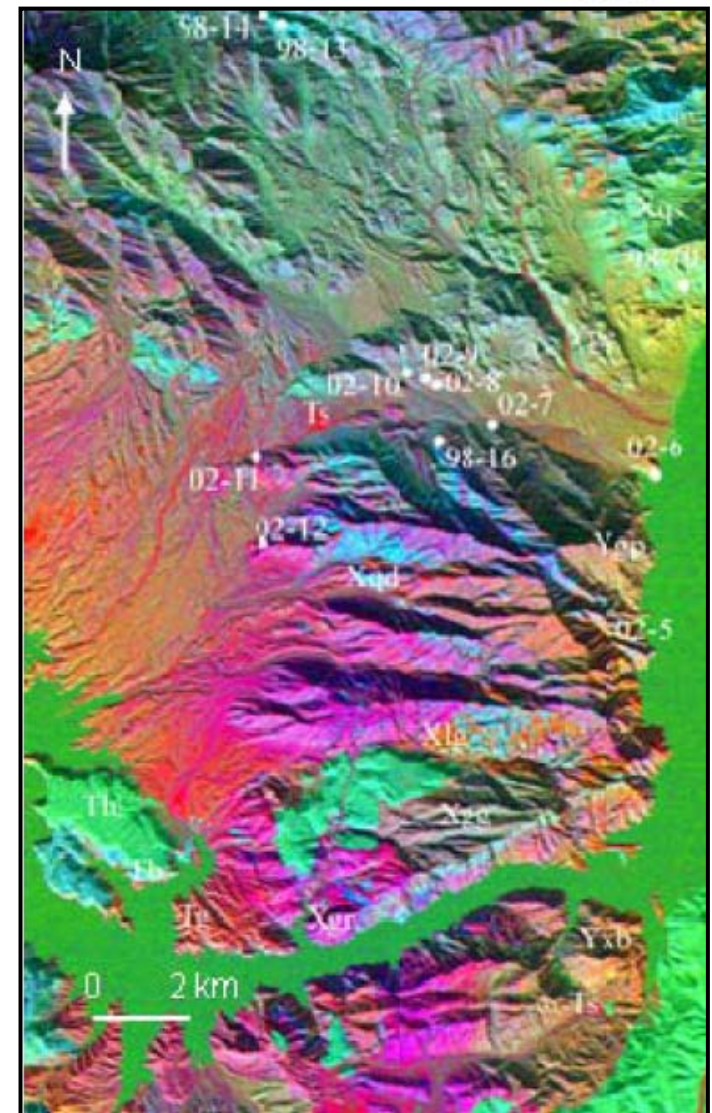


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- Emissivity variations are particularly useful for mapping structures and areas of mineralization.
- Framework silicates, such as quartz and feldspar, show min. emissivity at shorter wavelengths (8.5 μm). Silicates with sheet, chain, and isolated tetrahedral structure show minimum emissivity at progressively longer wavelengths (Hunt, 1980).
- This helps to discriminate the felsic and mafic rock composition remotely.

Simulated HypsIRI image for the area around Lake Mead, Nevada. Three TIR bands are processed with a decorrelation stretch algorithm and displayed in red, green and blue respectively. Image Credits: Simon Hook, JPL



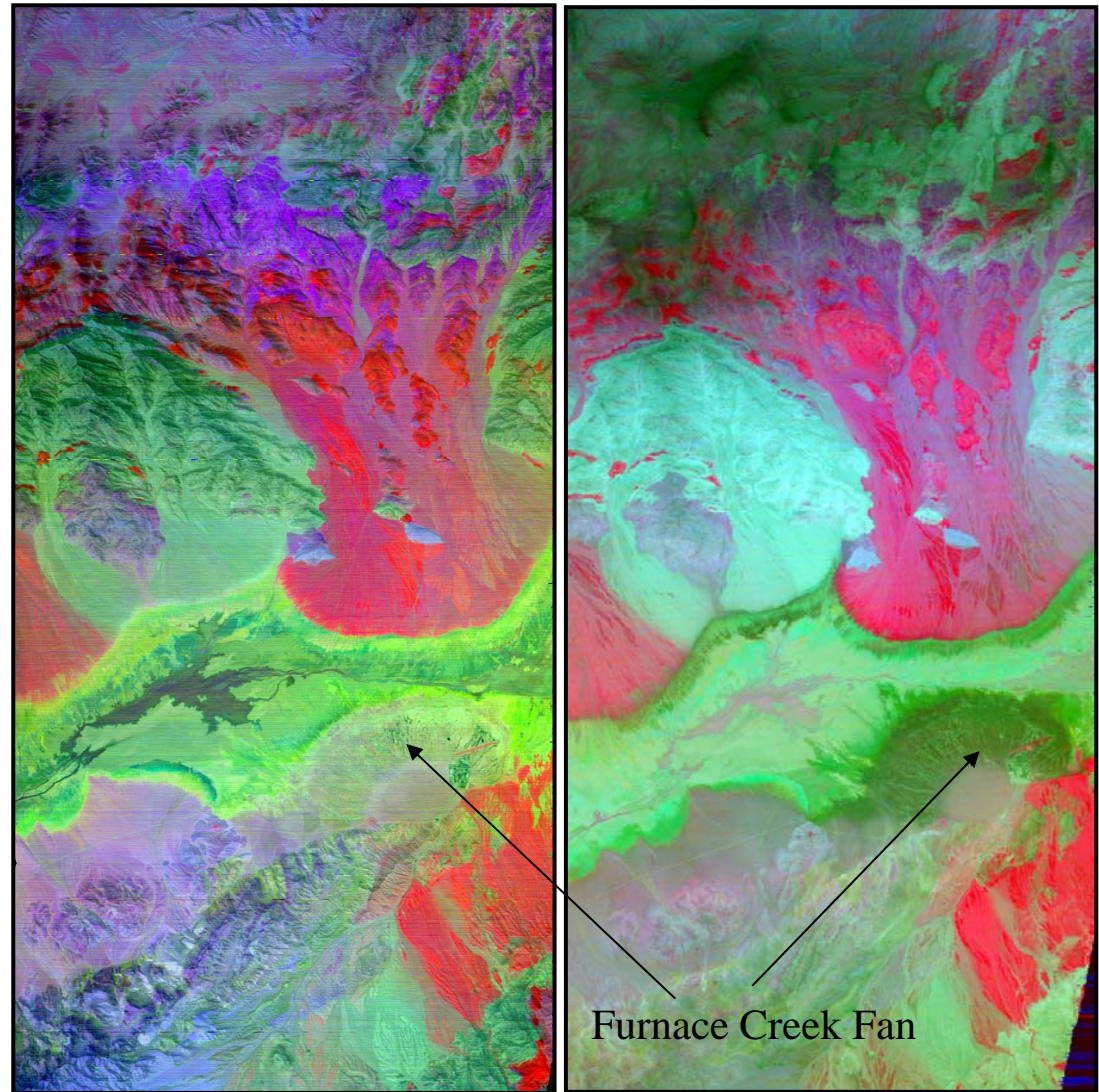


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- Between day and night Earth surface composition remains the same but temperature changes.
- HypsIRI image pairs will be used to map temperatures during day and night to extract further information about properties of surface (thermal inertia).

TIMS Day Night Image Pair: Notice how Furnace Creek fan is much cooler at night. Water seeping out of Fan evaporates during day but collects at night. Image Courtesy: Simon Hook, JPL.



TIMS 5,3,1 RGB; 7-22-1983; 28 m

Day

TIMS 5,3,1 RGB; 7-21-1983; 28 m

Night

Furnace Creek Fan

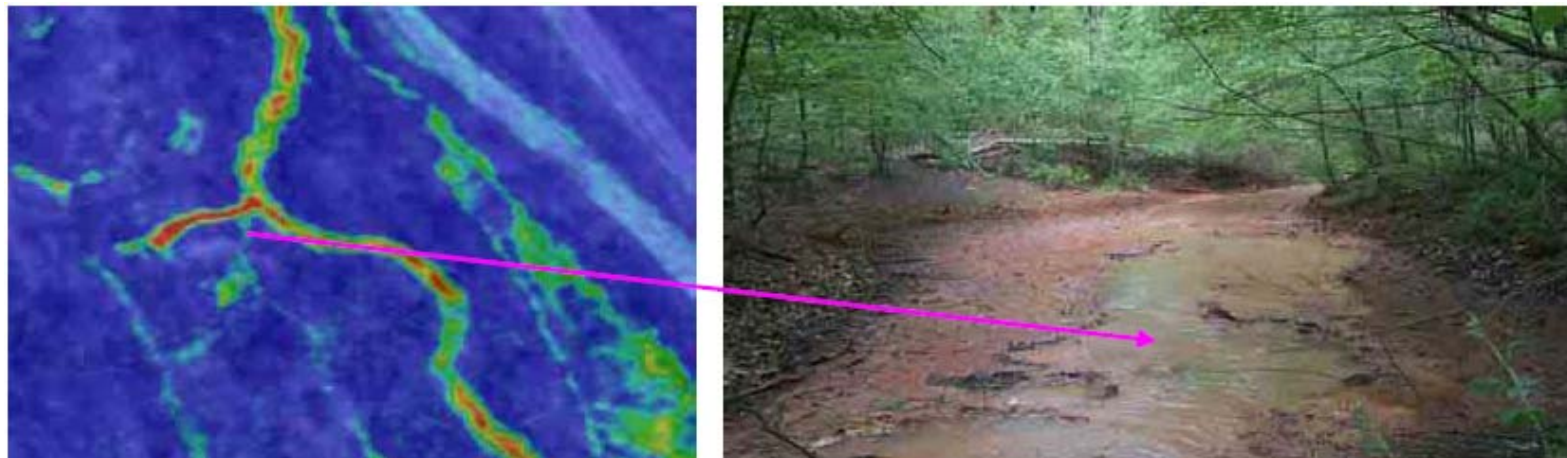


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TQ5: Sub Question 2:

- What is the nature and extent of man-made disturbance of the Earth's surface associated with exploitation of non-renewable resources (oil & gas, mining)? How do these vary over time? (DS 227)



Airborne TIR image (left) showing elevated temperatures corresponding to areas of Acid Mine Drainage (field photo on right). Image Source: Ackman, T.E., 2003.



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TQ5: Sub Question 3:

- How do surface temperature anomalies (hot spots) relate to deeper thermal sources, such as buried lava tubes, underground coal fires and engineering structures? How do changes in the surface temperatures relate to changing nature of the deep seated hot source? (DS 243).



Active lava tubes with skylight, Kilauea Volcano, Hawaii. Image Credits: Christina Heliker



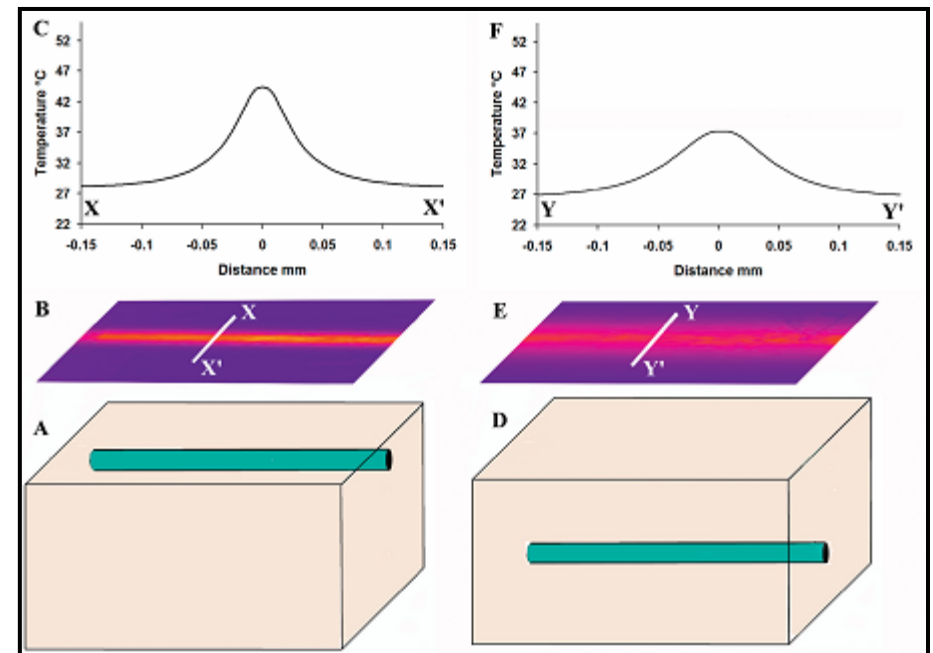
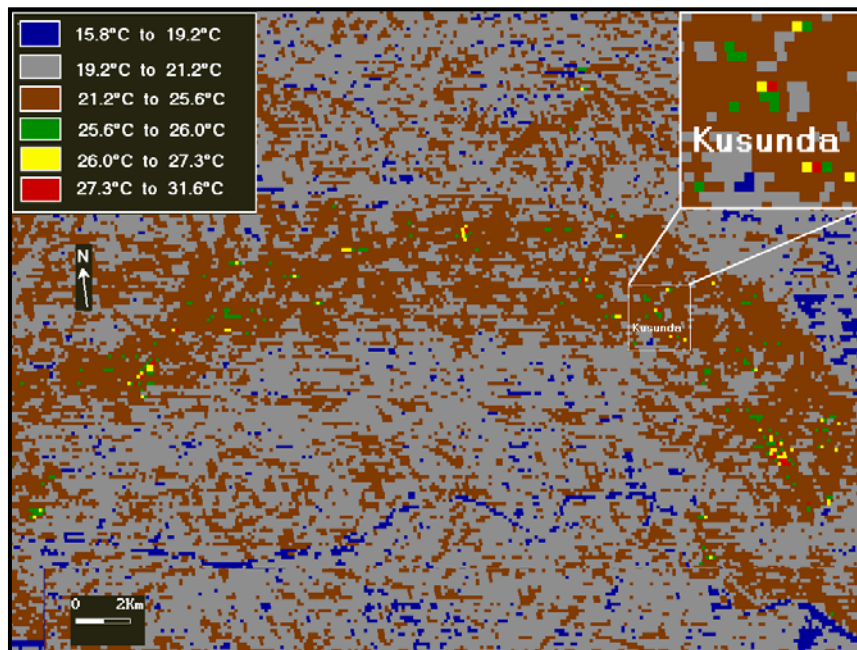
Underground coal fire, Jharia Coalfield, India. Image Credits: Anupma Prakash



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- The temperature profile across these hot spots holds clues to the depth of the heat source. Assuming that heat is conducting linearly in a semi-infinite medium, numerical modeling reveals that the shallower sources cause narrow peaky thermal profiles, while deeper sources cause broad and more subtle thermal profiles (Berthelote et al. 2007).



Processed Landsat TM Band 6 image showing locations of underground coal fires, Jharia Coalfield, India. HypsIRI data will be used to map temperature anomalies, extract thermal profiles, and numerically derive the depth to the hot sources. Image Credits: Anupma Prakash

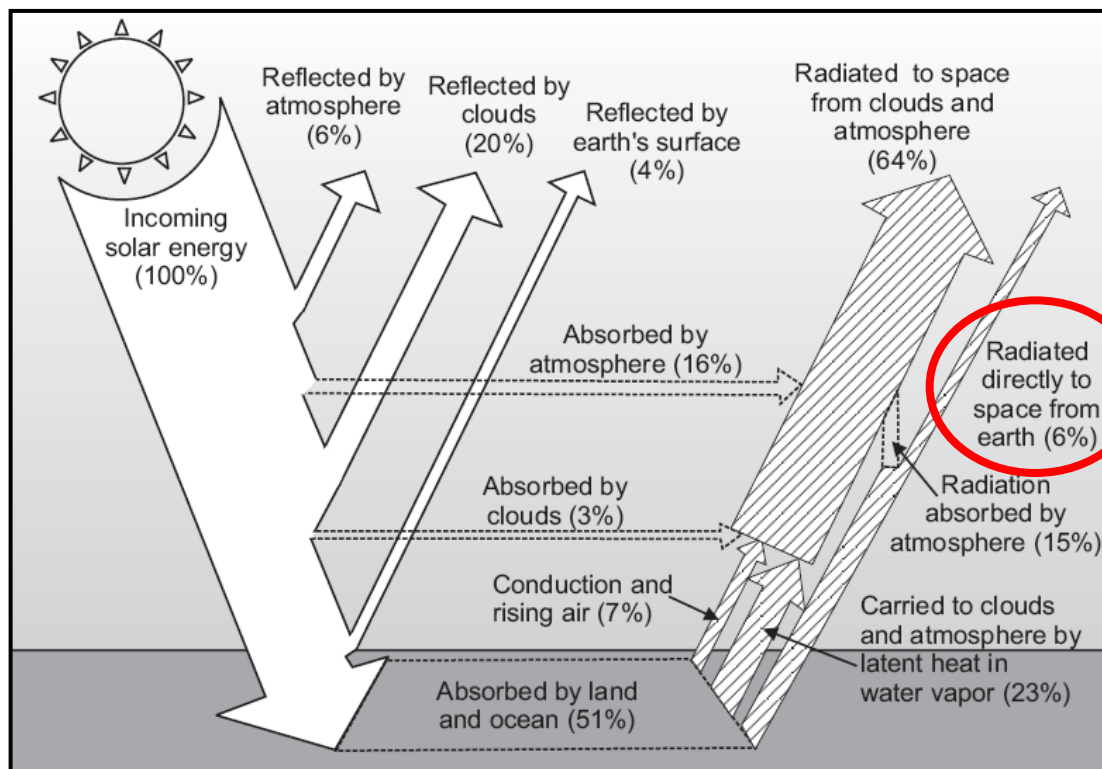


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TQ5: Sub Question 4:

- What is the spatial distribution pattern of surface temperatures and emissivities of various land surfaces and how do these influence the Earth's heat budget?



- Land surface has diverse composition with variable emissivity.
- Amount of energy emitted by the land surface is not well understood.

Earth's Heat Energy Budget. Source: Manual of Remote Sensing, 2008. After NASA's Earth Radiation Budget Experiment.

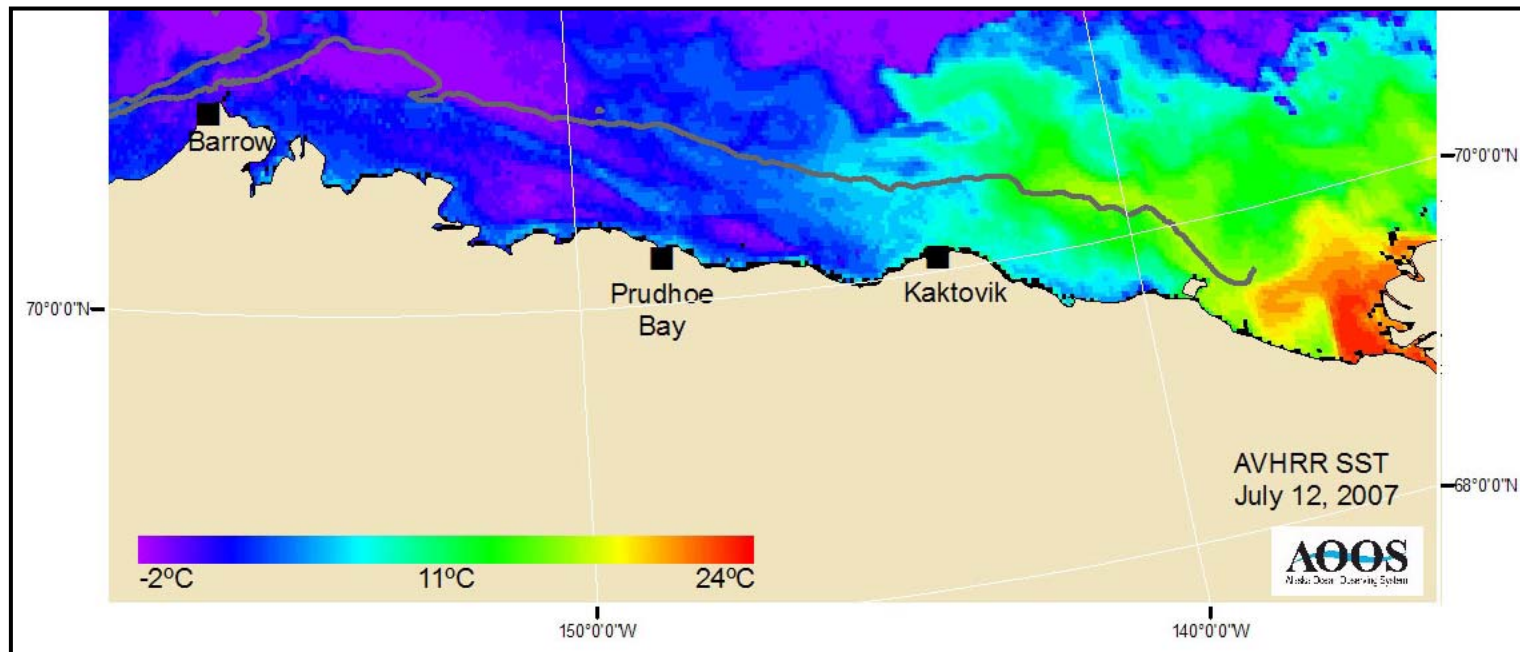


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TQ5: Sub Question 5:

- What are the changes in temperature patterns in shallow coastal ocean habitats? (DS 378)



Processed MODIS TIR image of the coast of Arctic Alaska. Propagation of the Mackenzie River outflow into the Beaufort Sea brings heat and influences temperatures in coastal waters, breakup of sea ice, and thermal habitats of a variety of flora and fauna. Image Courtesy: Rachael Potter, UAF. Okkonen et al, 2008 (submitted to JGR)



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TQ5: Summary:

HypsIRI data will be used to map the composition of the surface of the Earth and look for changes related to anthropogenic and non-anthropogenic drivers.