Scioly Summer Study Session 2017

Remote Sensing (Test)

Topic: Climate Change Processes*

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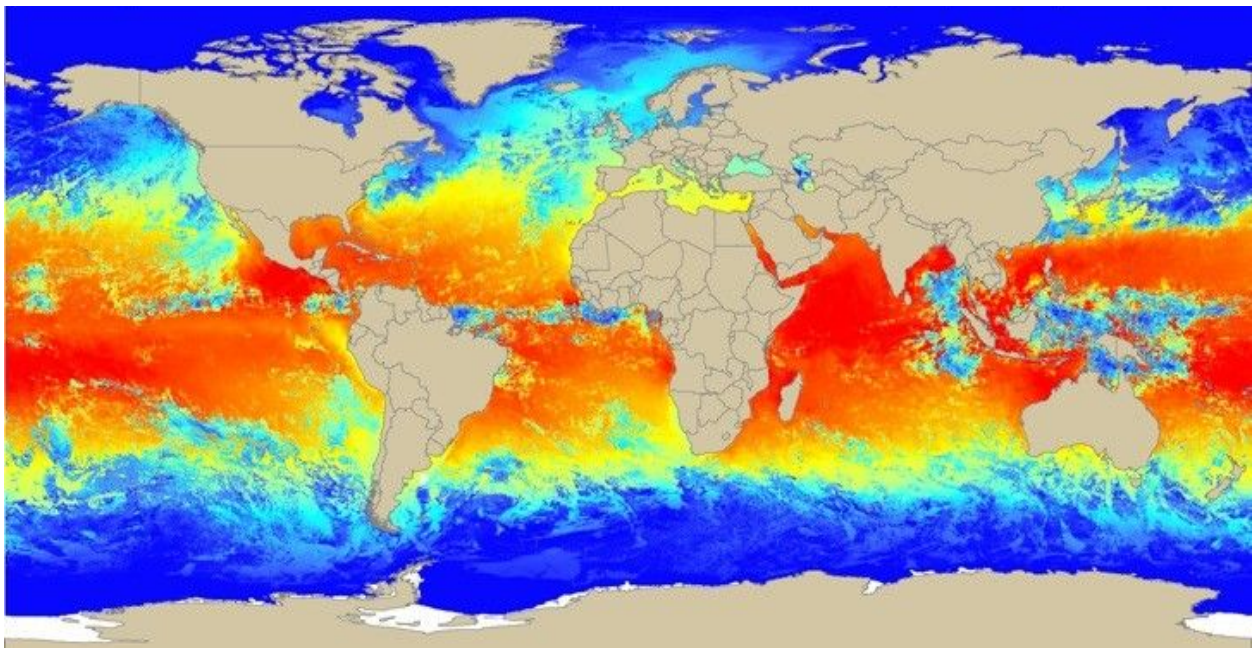
By user whythelongface (merge)



Name(s): _____

Test format:

This test is worth **150 points.** There are **four** sections:

1. Remote Sensing Technology and techniques (**50 points**)	**__ /50**
2. Data Use and Manipulation (**20 points**)	**__ /20**
3. Image Interpretation (**30 points**)	**__ /30**
4. Weather and Climate Processes (**50 points**)	**__ /50**
Total:	**__ /150**

As of the 2016-2017 season, **each person** is allowed **one** double-sided 8.5 × 11” notesheet. Each partnership is allowed a protractor, ruler, writing implements, and a **scientific** calculator. Graphing calculators are not allowed. The author wishes you best of luck on this test and in the 2017-2018 Science Olympiad season.

*The topic for the 2017-2018 season is still unknown at the time this test is being written, so it will focus on the same topic as that of the 2016-2017 season.

Part 1: Remote Sensing Technology

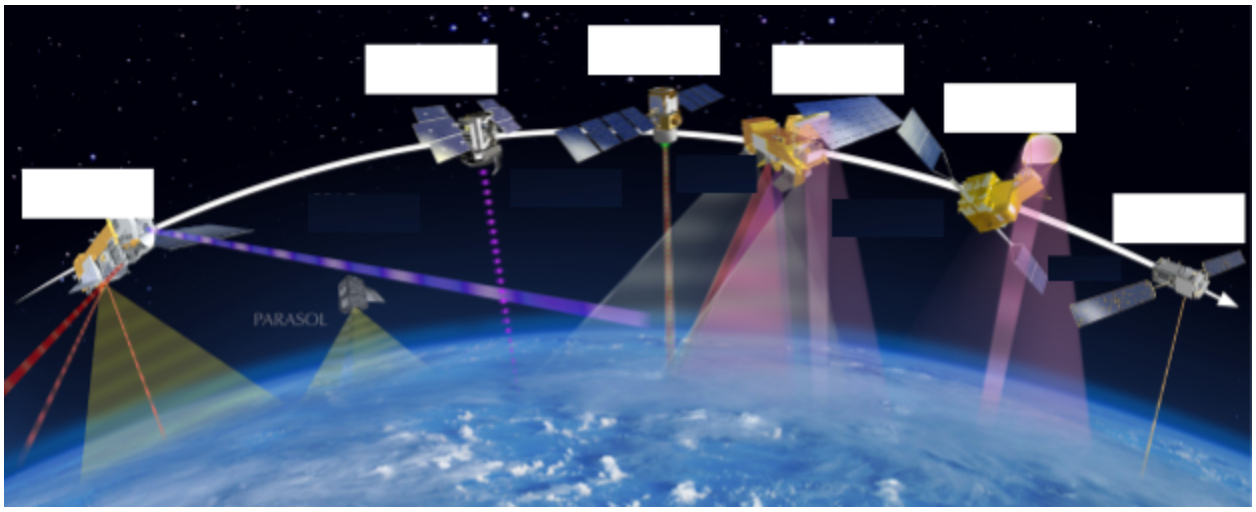
Multiple Choice (1 point each)

1. As a general rule of thumb, _____ wavelengths penetrate _____.
    a. Shorter; more
    b. Shorter; less
    c. Longer; more
    d. Longer; less
2. AMSR2 is an instrument flown on which satellite?
    a. Aqua
    b. Landsat-8
    c. GCOM-W1 "SHIZUKU"
    d. CloudSat
3. Which of the following satellites are active members of the Morning Constellation?
    a. Landsat-7
    b. EO-1
    c. CALIPSO
    d. Jason-2
4. How many Navstar satellites are theoretically necessary to locate and track a GPS receiver?
    a. 2
    b. 3
    c. 4
    d. 5
5. Which two satellites were launched in the same payload?
    a. CloudSat and CALIPSO
    b. Radarsat-1 and -2
    c. SPOT-6 and -7
    d. Suomi NPP and SMAP
6. What is band 8 on the Landsat-8 OLI?
    a. SWIR, measuring in a range of 2.1-2.3 μm
    b. VNIR, measuring in a range of 0.84-0.89 μm
    c. PAN, a panchromatic band measuring across 0.5-0.68 μm
    d. Cirrus, a special band monitoring high altitude clouds, measuring across 1.36-1.39 μm
7. What is OCO-2 data most commonly expressed as?
    a. [CO_2], the concentration of CO_2 in the air column

b. χ_{CO2}, the mole fraction of CO_2 in the air column
c. P_{CO2}, the reflectance of the air column
d. τ_{CO2}, the transmittance of the air column

8. This data format is easy to manipulate mathematically and is stored very efficiently, but is limited by spatial resolution
    a. Vector
    b. Raster
    c. Dot-grid
    d. Kernel
9. On a cross-track scanner, objects seemingly fall _____ the _____.
    a. Towards; center of image
    b. Away from; center of image
    c. Towards; nadir line
    d. Away from; nadir line
10. Cities often turn up very bright in radar images due to the _____.
    a. Orthogonal effect
    b. Cardinal effect
    c. Directional effect
    d. Urban dielectric effect

Label the following diagram of the A-train. (6 points)



What year did PARASOL cease operations? *(2 point)* _____

How much time separates a CALIPSO pass from an Aura pass? *(2 point)* _____

The A-train has to orbit low enough to obtain good data, but it has to orbit high enough to avoid atmospheric drag, which creates a need for constant maintenance. What is the orbital altitude of the A-train? *(2 point)* _____

How are radar images different from photographs? Explain three major differences. *(6 points)*

What is Synthetic Aperture Radar and why is it used? *(3 points)*

Assume the Earth is a 288K blackbody. What is the dominant wavelength emitted by the Earth? What instrument would you use to measure this radiation? Be specific. *(5 points)*

Suppose you flew a thermal infrared imager over a neighborhood to identify heat loss. At what time should you make the overhead pass? Explain. *(3 points)*

What is a panchromatic band? Why does it offer better spatial resolution than most other multispectral bands? *(2 points)*

The SPOT satellites have a finer temporal resolution than one might expect from its revisit time. Why? *(2 points)*

You are researcher monitoring the effects and spread of coral bleaching in the Great Barrier Reef, off Australia. You have access to the Landsat-7 ETM+ data sets. Which band would you use to observe coral? Why? *(3 points)*

Suppose that you just received additional funding from a generous grant. You have enough money to purchase exactly ONE additional data set from any currently operational satellite to augment your ETM+ data on the Great Barrier Reef. Which instrument and which satellite would you choose? Explain. *(4 points)*

Part 2: Data Use and Manipulation

Multiple choice (1 point each)

1. What is the process of dividing DNs into discrete subintervals and assigning each subinterval a DN called?
    a. Low pass
    b. Histogram stretch
    c. Density slicing
    d. Fourier analysis
2. Hyperspectral data is usually stored in a:
    a. Raster
    b. Data cube
    c. Histogram
    d. Data cloud
3. You fly two passes with an interferometric SAR and use the data to create:
    a. A DTM
    b. An orthophoto
    c. A stereopair
    d. A histogram
4. All of the following are reasons why lidar is good at creating DSMs EXCEPT:
    a. High sampling rate, hence more data points
    b. Ability to measure several returns, producing canopy stratification data
    c. Properties of the surface can be measured
    d. Large IFOV and swath, making data collection more efficient
5. You analyze some raw data from the Landsat-7 ETM+ and realize that the image is weird. Upon closer examination, you realize every seventh line of pixels is completely dark (DN = 0). What is this called?
    a. Line striping
    b. Line dropoff
    c. Partial line loss
    d. Periodic line failure
6. The effects of speckle can be partially rectified by:
    a. Getting more radar looks
    b. Synthesizing a longer antenna
    c. Obtaining a higher-quality sensor
    d. Setting the antenna to only record only cross-polarized data
7. Nearest-neighbor resampling involves the use of:

a. Kernels
b. Grains
c. Matrix determinants
d. Cubic convolution

8. The process of assigning the lowest DN a value of 0, the highest a value of 2^n-1, and adjusting all intermediate values based on best-fit:
    a. Histogram stretch
    b. Density slicing
    c. Extreme adjustment
    d. Linear contrast stretch

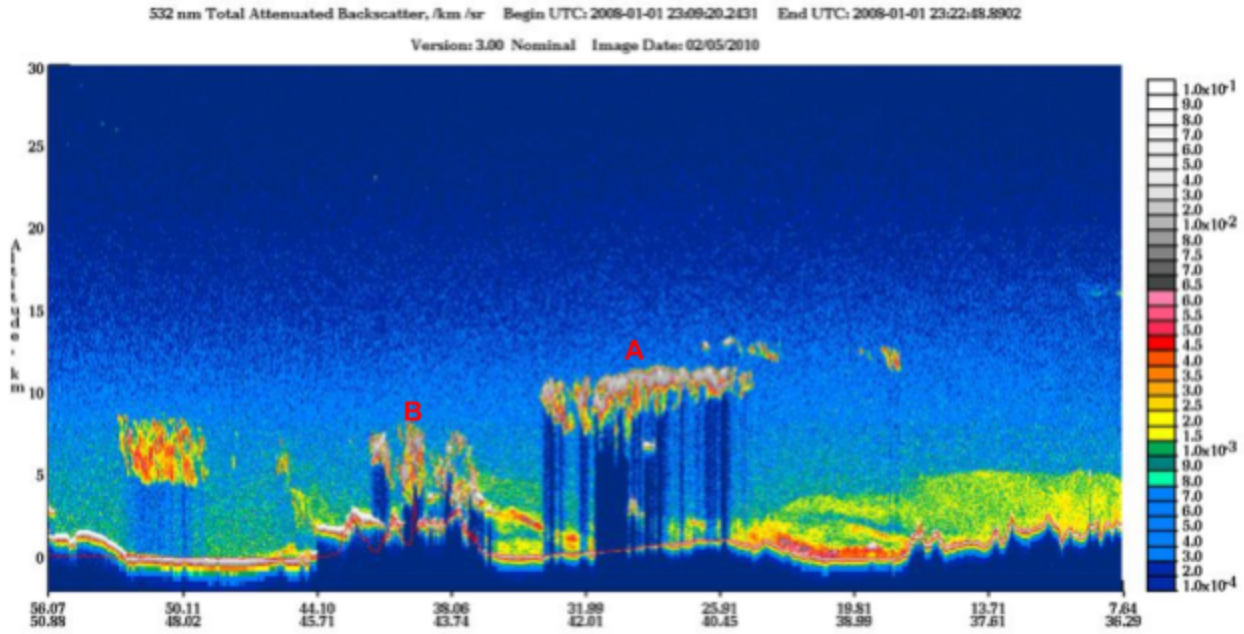
Fourier transforms are very complicated mathematical analyses. Given this fact, why are Fourier transforms so useful in data manipulation? Give two reasons. *(4 points)*

Explain the three main color systems: YMC, RGB, and IHS. What applications is each used for? *(6 points)*

Briefly explain how haze distortion is corrected in an image. *(2 points)*

Part 3: Image Interpretation

The following image was produced by the CALIOP cloud lidar.



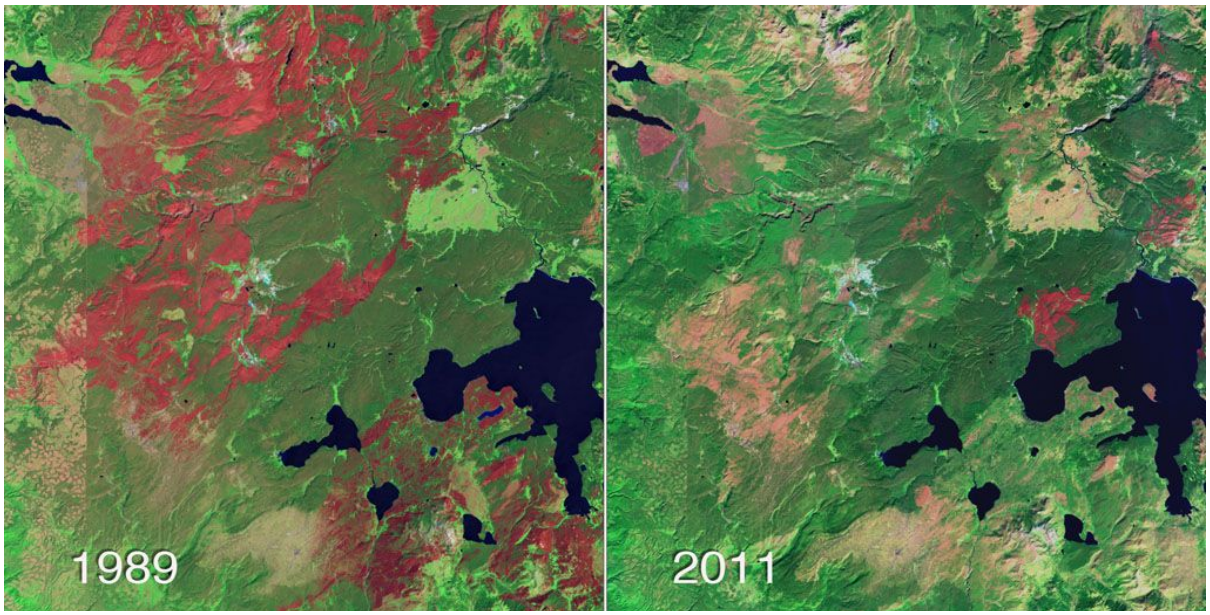
What accounts for the uniform dark blue at the top of this image? What about the lines beneath A? *(2 points)*

What causes the yellow-green coloration at 0-5 km? *(2 points)*

What kind of cloud is A? How about B? *(4 points)*

The following images are of Yellowstone National Park, where geological and climate processes are often very much entwined. This image is of the Grand Prismatic Spring, a hot pool colored by extremophilic microorganisms. It was taken by IKONOS in August 2001.

What causes the white coloration of the area surrounding the Grand Prismatic Spring? *(2 points)*



What happened to the red areas? Why is it not as prevalent in 2011 as it was in 1989? *(2 points)*

Why is the event pictured here important to the Yellowstone ecosystem? *(2 points)*

This image is a false-color taken by a Landsat TM. What band combination was used to make this image? *(2 points)*

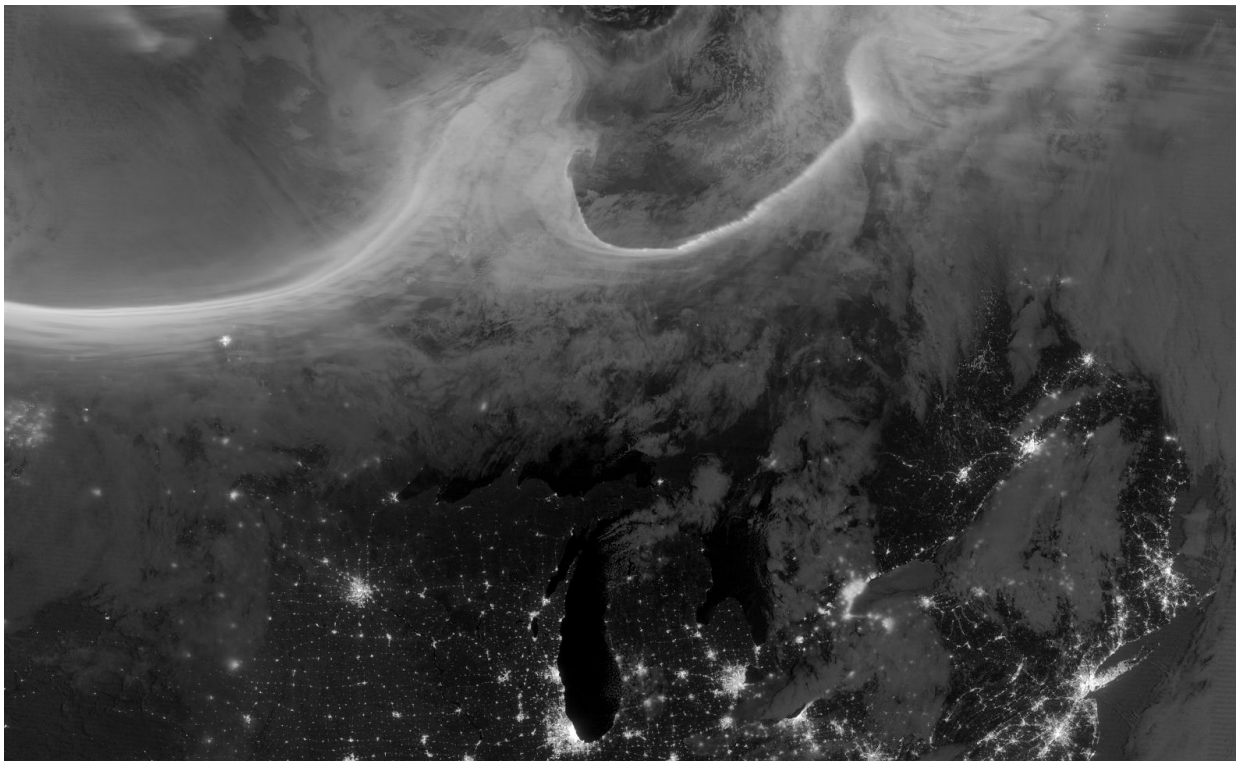
The following is an image of Lake Erie taken in 2011.

What is being pictured here? Hypothesize as to what triggered this event and support your claim. *(4 points)*

What is a potential impact this event could have on humans? *(2 points)*

Suppose you wanted to study similar events on a larger scale. You obtain MODIS data. What variable does MODIS measure that could be of use to you? *(2 point)*

The following image was captured by the VIIRS instrument on Suomi NPP in October 2012.



What location is being imaged in this image? Where in the atmosphere is this event taking place? *(2 points)*

What is that undulating light line? *(2 points)*

What problems might this event pose for humans? *(2 points)*

Part 4: Weather and Climate Processes

Where does ozone come from? Why, and how, does ozone interact with other naturally occurring gases and radiation in the atmosphere? With human pollutants? Be as specific as possible. *(4 points)*

Ozone is also an anthropogenic pollutant. Name one source of ozone emissions. *(2 points)*

Anthropogenic ozone also forms a layer in the atmosphere. Name three differences between this artificial ozone layer and the natural ozone layer. *(6 points)*

Assume the Earth is a perfect blackbody in thermal equilibrium. Given the solar insolation, 1367 W/m^2, find the average radiative temperature of the Earth. *(5 points)*

The Earth is not a perfect blackbody - it has an average emissivity of 0.612. Recalculate the average radiative temperature of the Earth. *(5 points)*

Your previous models don't account for the fact that the Earth is very shiny. In fact, the albedo of the Earth approaches 0.3. Again, recalculate the average radiative temperature of the Earth. *(5 points)*

Previously it was mentioned that the Earth is not a perfect blackbody. Most of the land on Earth approximates a blackbody *very* well, with emissivities of 0.96-0.99. So why is the average emissivity of the Earth (ε = 0.612) so *low*? *(3 points)*

Sulfur oxides are damaging pollutants released by both volcanic and human activity (burning of fossil fuels). Describe in detail one way fuel plants attempt to limit the amount of sulfur oxide gases released into the atmosphere. (4 points)

Ship tracks and contrails often have a higher-than-normal cloud albedo. Why? What is the name of the effect that describes this? (6 points)

What kind of cloud contributes most to atmospheric heat retention? (2 points)

What is stratospheric aerosol injection and how does it work? Discuss *in detail* the benefits and costs of implementing this method. (8 points)