SCIENCE OLYMPIAD 2016-2017

REMOTE SENSING

CAPTAINS' TRYOUTS EXAM

TEAM NUMBER _____

TEAM NAME _____

COMPETITOR NAMES

_____

_____

SCORE _____/160

PLACE _____

Directions

- You will have 50 minute to complete the exam
- Work and units required for each calculation question
- Use correct significant figures
- Allowed materials
    - One 8.5" x 11" sheet of notes
    - 2 non-programmable, non-graphing calculators
    - Metric Ruler
    - Protractor
- You may take the test apart, but staple in the correct order at the end of the exam period
- If you take the test apart, please write your team number on every page
- Record all answers on the provided answer sheet
- Point values for a question are in parentheses after the question
- Tiebreakers are marked with an asterisk (*)
- Please write neatly. Handwriting that cannot be read will not be scored.

Constants:

h=6.626 x 10^-34 J*s

$\hbar$=1.054 x 10^-34 J*s

c=3.00 x 10^8 m/s

g=9.8 m/s^2

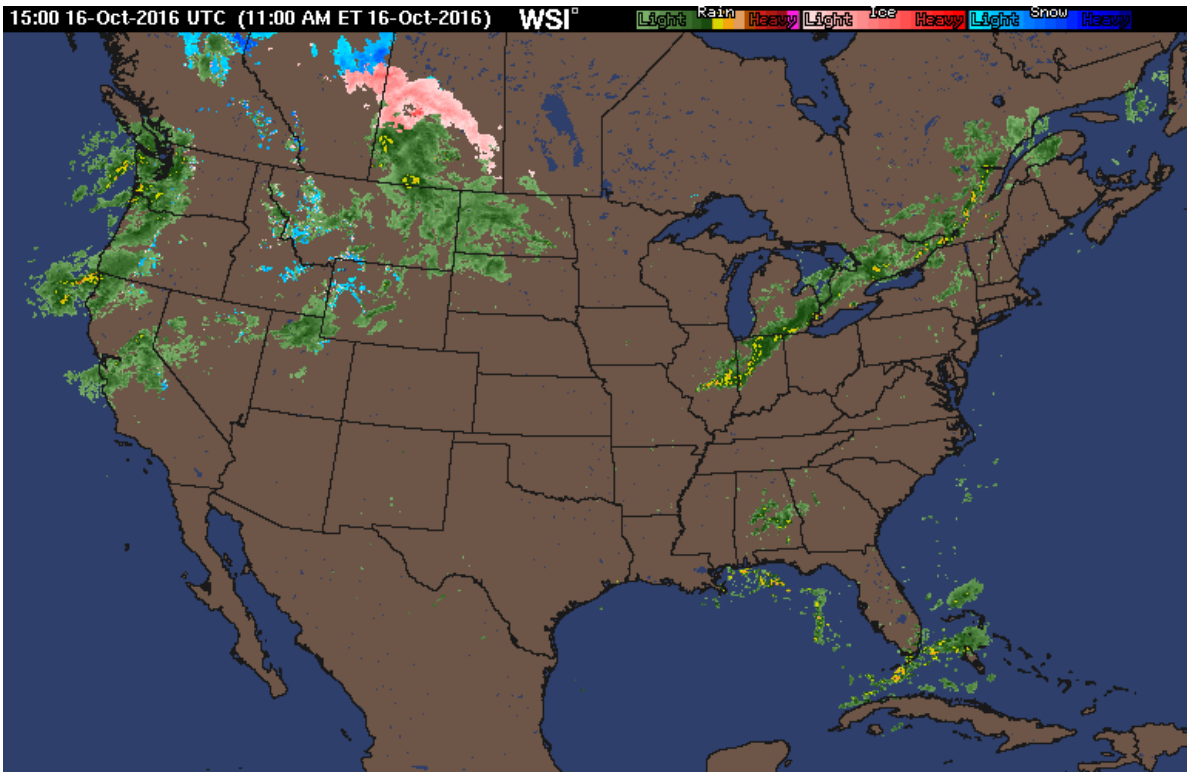
σ=5.67 x 10^-8 W m^-2 K^-4

K_s=1361 W/m^2

R_{Earth} =6371 km

b=2.897*10^-3 m*K ≈ 2900 µm*K

Use Image A for questions 1-6. © Intellicast



1. What type of map is shown in image A? (2)

2. What technique is used to produce the map shown in image A? (2)

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3. Explain how this technique works to produce the information used to generate image A. (5)

4. What two pieces of information vital to weather prediction are picked up using the technique from question 2? (3)

5. Across which mountain range is there mixed precipitation, ice, and snow? (2)

6. In the northern hemisphere, how do storm systems move? (2)

7. Image B is (**specular, diffuse**) reflection while Image C is (**specular, diffuse**) reflection. (2)

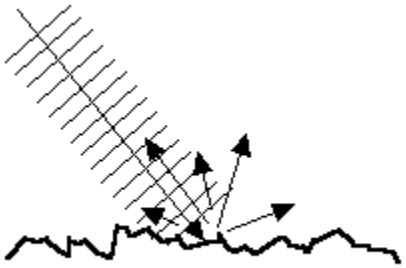

Image B © CRISP

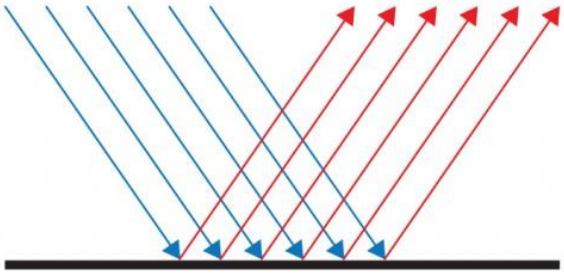

Image C © Ocean Optics

8. Specular reflection is usually produced by (2)
    a. Rough surfaces
    b. Hard surfaces
    c. Shiny surfaces
    d. Smooth surfaces

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9. Explain how diffuse reflection happens. Using a diagram may help (4).

10. Pick two of the following and explain the application of Mie scattering (5).

    Meteorology
    Oncology
    Materials Science
    Particle Sizing
    Microbiology

11. When does Mie scattering occur in the atmosphere? (2)
    a. When particles are the same as the wavelengths being scattered
    b. When the particles are larger than the wavelengths being scattered
    c. When the particles move faster than the wavelengths being scattered
    d. When the particles travel in opposite directions with the wavelength being scattered
12. When does the Rayleigh approximation become ineffective? (2)
    a. When the particle size becomes larger than 50% of the wavelength of incident radiation
    b. When the particle size becomes smaller than 5% of the wavelength of incident radiation
    c. When the particle size becomes larger than 10% of the wavelength of incident radiation
    d. When the particle size becomes larger than 37% of the wavelength of incident radiation
13. Gustav Mie solved which equations to formulate Mie scattering theory? (2)
    a. Stefan-Boltzmann's Equations
    b. Planck's Formulas
    c. Maxwell's Equations
    d. Rutherford's Equations

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14. What is the range of energy that a photon can emit if the photon is visible light? (11)

15. Find the maximum wavelength for an emission of a blackbody with surface temperature 3293° C. What type of EMR is it? If it is within the visible range, please name its color. (6)

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16. If $E_{intercepted}=K_s*A$, where K_S is the solar constant (a measure of how much energy the Earth receives from the sun) and A=surface area, calculate the energy intercepted and the average temperature of the Earth (in Kelvin). Average albedo is about 31%. (8)

17. How can LiDAR be used to measure tree diameters? (3)

18. Explain a "return" in the context of LiDAR. How is the information from the first return, intermediate returns, and last return different? (5)

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19. What is the typical wavelength at which LiDAR is employed? Which part of the electromagnetic spectrum does this wavelength belong to? (4)

20. Why is this wavelength used? (4)

Use Image D for questions 21 – 24.

21. What technique is used to generate the right part of the image? Give both the abbreviation and full name. (2)

22. In this case, red represents the highest value for this measure. What numerical value represents the highest value, and what numerical value represents the lowest value? (2)

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23. Assume that for a section of a leaf, red=0.15 and NIR=0.44. Calculate the measure indicated in question #21. What does this indicate about this section of the leaf? (4)

24. Would the red result from greater photosynthesis in that part of the leaf or other natural variations? Why? (3)

What do these acronyms and abbreviations stand for? (1 point each)

25. AVHRR
26. GIS
27. HCMM
28. AMSR-E
29. RADAR
30. SPOT
31. SAR
32. CALIPSO
33. TRMM
34. EOS
35. CERES

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Use Image E for questions 36 – 43. © NASA

36. Image E was generated using data from the AMSR-E. Three AMSRs have been operated. Name each and the satellite they operated on (5).

37. Explain the calibration of the AMSR-E. (4)

38. What does Image E show? (2)

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39. The orange line is the average sea ice maximum for the past 30 years while the map is from March 24th, 2016, when the arctic sea ice reached its maximum. What does this difference mean? (2)

40. It turns out that the maximum ice levels of any given year has a low correlation with the minimum ice levels. Why does this phenomenon occur? (3)

41. AMSR-E has 6 bands, operating at 6.93, 10.65, 18.7, 23.8, 36.5, and 89 Ghz. What do each of these bands represent? (3)

42. Is AMSR-E a panchromatic, multispectral, superspectral, or hyperspectral imaging system? Why? (2)

43. AMSR-E generates seven sets of data mapped daily. Name 3 of them (3).

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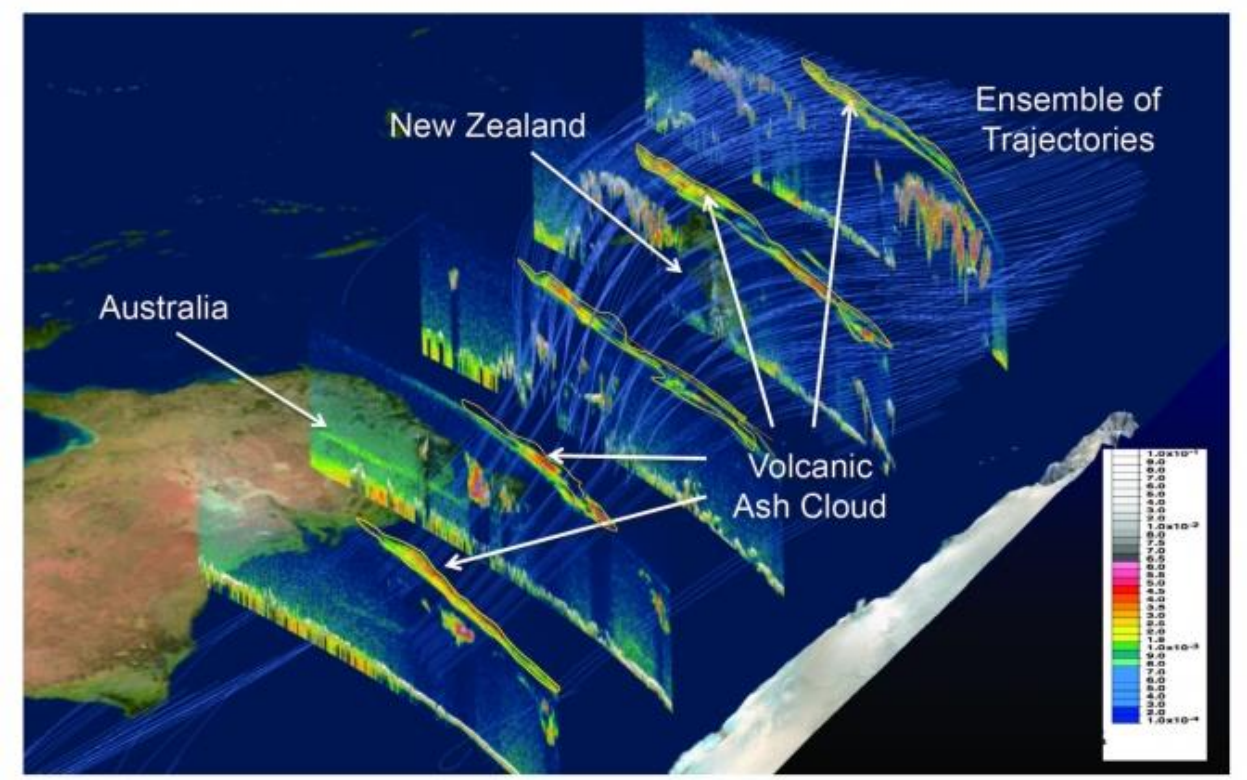
Use Image F for questions 44 – 45.



44. Two of the A-Train systems can generate an image like this. Which two systems, and how does it generate this data? (4)

45. How can the data generated by this system aid the modeling of a volcanic clouds? (3)

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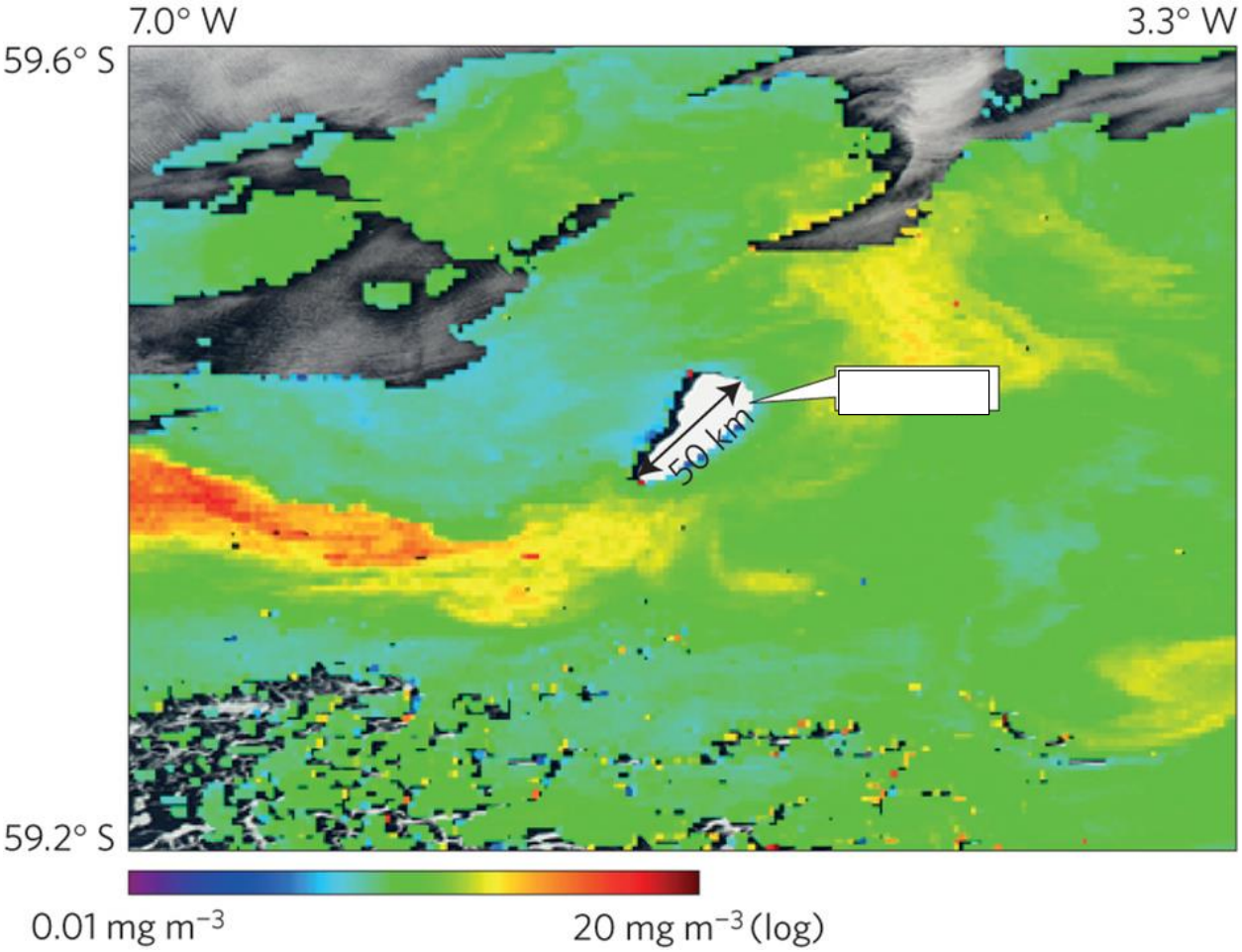
Use Image G for Questions 46 – 49.



46. Based on the units given, what is Image G depicting? (2)

47. Which satellite system on the A-Train could have generated Image G? (2)

48. How does the data shown in Image G allow generation of data about ocean GPP and NPP? (4)

49. Based on information that Image G was taken near Greenland, what is the white blob in the middle of the image most likely represent? (2)

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50. Carbon cycle

Fill the following chart with these terms. Label two sinks and two sources (15)

A. Root respiration
B. Organic Carbon
C. Sunlight
D. Auto and factory emissions
E. Animal respiration
F. Decay organisms
G. Ocean Uptake
H. Plant respiration
I. Fossils and fossil fuels
J. Organic Carbon
K. Photosynthesis

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