Exploring the World of Science

2026 Remote Sensing C Example Test

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1 Initial Remarks

- This document was partially created based on draft rules, and so may not be 100% up to date. Please refer to the official Science Olympiad 2026 Rules Manuals as well as Rules Corrections and Clarifications (all available via the national website `https://soinc.org`) for the finalized event topics and rules of competition.
- Every year there are several hundred Science Olympiad tournaments hosted nationwide, which means several hundred Remote Sensing C event supervisors and several hundred interpretations of the content covered in the event rules. While I intend this example test to provide useful guidance for event supervisors from my relevant expertise, remember that the rules manual (including rules corrections and clarifications) is the official source. The approach taken in this example test is ultimately just a result of the author's interpretation of the rules and anticipated tournament circumstances, and cannot account for all scenarios.
- This test is posted publically, so the exam content should not be reused at existing tournaments, as that would merely be testing which students happened to have read over and filed away this document in their event binder, rather than any genuine mastery of the event topics.

2 Introduction

Event supervisors sometimes find that the process of translating the event rules into the structure of a quality test to be a challenging process, especially if you don't have much prior experience as a Science Olympiad event supervisor. This example test is meant to serve as an illustration for how you might approach the test-writing process for this event.

In ordinary use, this test would be composed of multiple files - for ease of reference, they are all provided in this single document, as follows:

- Intro and Annotations (pages 2-5), not part of the test but provided for the purposes of explanation and guidance
- Test Packet (pages 6-8)
- Image Sheet (pages 9-10)
- Answer Sheet (pages 11-12)
- Key (pages 13-14)

Feel free to read over the test itself before coming back to the annotations, as that might make it easier to follow.

3 Annotations

Alongside the example test, I've included here extensive annotations describing the choices I made while writing this test, to help guide your process.

3.1 General Notes

- The most common practice for general test layout is the four-document split that I have used for this example test. You might find a different approach to be more relevant depending on your circumstances and writing style (e.g. perhaps combining some of these documents as one), but this is a good baseline to check against, in terms of goals to reach with your document split.
  - Test Packet - exam questions and general instructions
  - Image Sheet - any images referenced for the exam content, often separated to save on color printing costs
  - Answer Sheet - separate pages for students to write their answers
  - Key - formatted identically to the answer sheet, as this helps to speed up grading
- Science Olympiad competitors span a wide variety of skill levels, both within and between tournaments. A good test needs to be relevant and distinguishing for students who may have prepared for only a few days, as well as students who have been preparing extensively for the entire school year. This example test is written for my estimation of a median Science Olympiad tournament, so depending on your tournament's circumstances you may want a harder or easier test, and potentially a longer or shorter length as well (though I expect very few tests would benefit from being more than 3x or less than 0.5x this test's length). My personal targets are to try to have the lowest-ranking teams at a tournament scoring around 15% while the highest-ranking teams are around 70%, though this will depend a lot on your writing style - just aim to have enough leeway to avoid excessive tiebreaking on both the high and low end, as that would give luck a much larger role in rankings.
- It's rarely feasible for one test to cover every single topic area on the event rules, but as an event supervisor, you should aim to cover a reasonable representative sample, and avoid skewing too far from the topic distribution. We don't want students to blow off some topics from the rules purely because they aren't showing up on tests very much.
- I write my tests in sections, with a tendency to progressively increase question difficulty both within and between sections. My sections don't necessarily map neatly to exactly one of the four major topic areas on the event rules (which have explicitly defined approximate percentage targets) - instead I usually integrate aspects of a few topic areas into one section. You might have a different approach, as this is just a method I use to integrate content and ensure that I have good coverage of the topics.
- Having point values clearly labeled on all documents does a lot to make things clear for students and consistent in grading. I tend to break apart problems into discrete questions rather than writing bulky all-in-one questions, as I find that this speeds up grading and can help guide students of different skill levels more effectively.
- The instructions listed on the cover of the test packet are a generic version of what I tend to use. You might want to do things differently, but I'll explain some of my choices here,
  - A 50-minute test-taking period within a 60-minute session (the extra time being for logistical allowance) separated by intermissions of 10 or 15 minutes is the most common setup, but if you tournament has shorter sessions, you may want to reduce the test-taking period to ensure that you aren't running overtime and causing problems for other events.

  - This instruction set allows students to take apart and write on the test packet and image sheet (though the latter would only be a single sheet of paper for this example test). If you don't have enough copies for every team and are instead reusing them between sessions, you might want to disallow students from doing this.
  - For many events I don't find significant figures to be of much value (depends on the event, of course) but you may find it useful to do otherwise, as they do sometimes give you the ability to define unique correct answers for numerical questions rather than having to compute a verifiably sufficient acceptable range. I am partial to the approach of disregarding them in many cases as I would rather have the approachability of the concepts instead, as Science Olympiad often tries to avoid high math-based barriers to entry where feasible.
  - I have tried other tiebreaker methods over the years, but the goal of needing to reliably and efficiently break every tie across the entire spectrum of skill levels is a challenging one, and I have yet to find a convincingly superior option to comparing questions in order and structuring a general increase in question difficulty across the course of the test.

- I tend not to write multiple choice questions very much, but this is just my own choice (to ensure that students aren't overly prioritizing questions just based on being multiple choice or not, and to keep pushing my skills forward in communicating understanding through question design). There are definitely some skilled event supervisors who do have moderate amounts of multiple choice questions on their tests.
- Be aware of the resources that students are allowed to have under the rules - a binder containing whatever information they wish, as well as rulers, protractors, and non-programmable calculators
- Time is often at a premium when grading for Science Olympiad, so thinking about ways to increase efficiency and accuracy ahead of time is important. Having an identically-formatted answer sheet and key, with clear point values, and a fast but accurate grading scheme, can easily pay off with a 2-3x grading speedup.

3.2 Notes - Section A

- The first section deals with relatively more foundational concepts related primarily to spectroscopy.
- Image 1 is modified slightly from the original for question-writing purposes.
- Over the course of this section, the questions build up subsequent steps from spectroscopy in the abstract, to applying the information from Image 1 to a simple scenario, to analyzing how this scenario affects some fundamental aspects of sensor and satellite design.
- Question 5 - the active vs. passive sensing question type is one I find rather convenient as it's both an approachable concept and one that can be applied to a wide variety of scenarios without becoming repetitive, and asking students to think about the particular situation each time.
- As I mentioned earlier, I tend to mix topics within sections somewhat - while this section deals primarily with spectroscopy, Question 7 for example also deals with orbital mechanics, and Question 6 is a form of image analysis where the focus is on the technique rather than the data.

3.3 Notes - Section B

- This section involves no images. For my writing style, that happens sometimes in cases like this section which centers around a particular atmospheric gas and its relations to various key topics.

- Questions in this section explore nitrous oxide in relation to, in order, the greenhouse effect, ozone, depletion, and its role in the nitrogen cycle. I've attempted to mix in a degree of both easier and harder questions for the various links.

3.4 Notes - Section C

- Images 3 and 5 were also used in the Remote Sensing C Content Introduction, posted on soinc.org - that document is targeted more toward students, but may be of interest to event supervisors as well, especially if you don't have a particular subject matter expertise in the event topics.
- In addition to the direct image characteristics, this section uses the image as a connecting point for questions about the data collection, and the earth systems impacting the data.

3.5 Notes - Section D

- As usual, questions are a mixture of more direct interpretations progressing to interpretation and reasoning about related effects.

3.6 Notes - Section E

- For this section, I've mainly stuck to the more fundamental aspects of energy balance modeling, as it's a topic that scales up rather quickly, and I try to break apart the analysis into smaller steps as much as possible to keep things approachable for a mid-level tournament. For a lower-level tournament, I might consider less analytical questions, or perhaps even honing in on specific aspects of the model as a way to potentially create easier analytical questions. For a higher-level tournament I might add additional parameters to the model (e.g. deviations from perfect blackbodies, or atmospheric modeling) and ask questions about their effects.

3.7 Notes - Section F

- Little to say about this section that I haven't already mentioned before - beginning with more direct image interpretation, expanding to various connected topics (in this case, indirect measurement of desired information, the physical basis of the relevant data gathering, and relevance to climate processes).

Example Test soinc.org
July 32nd, 2025

Exploring the World of Science

Remote Sensing C
Test Packet

Written by: Araneesh Pratap

Instructions

1. You will have 50 minutes to take this test.
2. Answer all questions on your Answer Sheet. The space provided for each question is sufficient to fit a response earning full points.
3. All questions have their value indicated in parentheses, both in this Test Packet and on the Answer Sheet. This test has a total of 90 points.
4. You are free to write on and take apart the pages of the Test Packet or Image Sheet as you wish.
5. For numerical questions, answers within a reasonable range will earn full credit - accounting for significant figures is not required.
6. Ties will be broken by comparing points earned for each question in order.

Section A - 10 points

Refer to Image 1 for these questions. This image shows part of an electromagnetic spectrum relating to atmospheric water vapor.

1. What property is measured on the x-axis of this image? (1)
2. Does this image show an emission spectrum, absorption spectrum, or something else? (1)
3. Consider the leftmost peak on this spectrum. What region of the electromagnetic spectrum is this peak in? (2)
4. Consider Image 2. Suppose you were to use an imaging sensor tuned to the absorption peak from the previous question. Which part of Image 2 (give the letter) would this sensor be most useful for distinguishing? (2)
5. Suppose you want to use light that already exists in the atmosphere for this sensor. Is this an example of active or passive sensing? (1)
6. Considering the information provided, would this sensor work better with shortwave or longwave radiation? (1)
7. Based on your answer to previous question, what type of orbit might be particularly useful to maintain consistent observations for this sensor? (2)

Section B - 15 points

In this section, we'll explore the relevance of nitrous oxide for the topics of this event.

8. What is the chemical formula for nitrous oxide? (1)
9. Nitrous oxide is a major greenhouse gas. What effect does a greenhouse gas have on atmospheric temperatures? (1)
10. What is the primary spectroscopic property that defines greenhouse gases? (3)
11. Nitrous oxide has recently become the most significant agent of ozone depletion in the stratosphere. What class of molecules was formerly more significant in this role? (2)
12. Ozone depletion results in the conversion of ozone into what other oxygen compound? (2)
13. What is the primary anthropogenic origin of atmospheric nitrous oxide? (3)
14. Nitrous oxide is primarily produced as a contaminant by what type of organisms? (1)
15. What is the name of the nitrogen cycle process from the previous question? (2)

Section C - 15 points

Refer to Image 3 for these questions.

16. Are the concentrations in this image on the surface, in the atmosphere, or neither? (1)
17. Note the unit of measurement "ppm" on this image. What is the full name of this unit? (1)
18. What is the approximate concentration measured across most of the United States on this image? (2)
19. This data was collected by the satellite OCO-2. Does OCO-2 use passive or active sensing? (1)
20. The measurement of carbon dioxide excludes which major atmospheric component from the denominator? (2)
21. What is the reason for the exclusion from the previous question? (2)
22. Consider the high concentrations located in Southern Africa on this map. What is the reason for these? (3)
23. OCO-2 performs the previously mentioned exclusion by detecting which element? (1)
24. OCO-2 has an orbital period of 98.82 minutes, but a repeat period of 16 days. How many times, to the nearest whole number, does it cross the equator across a full repeat period? (2)

Section D - 10 points

Refer to Image 4 for these questions. This image shows flux data captured by CERES.

25. What is the primary determinant of total flux from an object? (1)
26. What surface or atmospheric features cause the various blue/white regions on this map? (2)
27. What is the reason for the color of the features from the previous question? (2)
28. Consider the Red Sea, marked on this image by the letter A. What is the reason for the color difference between this oceanic region and the adjacent land regions? (4)
29. What does "TOA" in the measurement key stand for? (1)

Section E - 20 points

For this section, we'll examine some aspects of the Earth's energy balance of incoming and outgoing radiation, modeling the Earth and the Sun as ideal blackbodies.

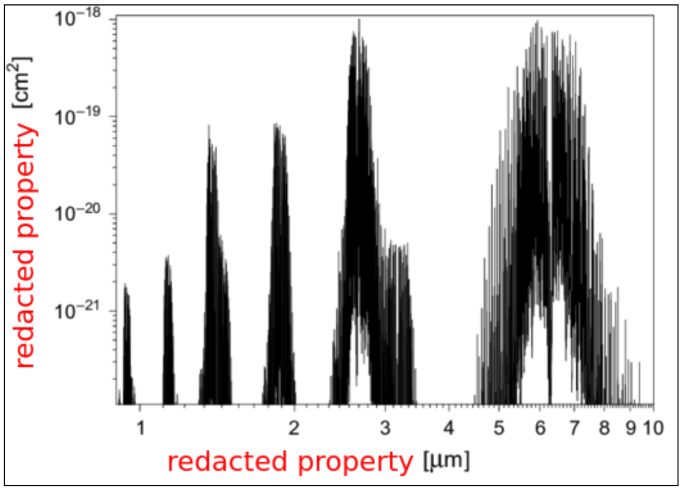
30. The Sun's surface temperature is approximately 5770 Kelvin. What is the radiant flux emitted at its surface? (4)
31. The distance between the Earth and the Sun is 149.6 billion meters, while the Sun's radius is 696 million meters. What is the ratio of the flux at the Sun's surface divided by the flux at the Earth's position? (3)
32. Considering that the Earth's radius is 6371 km, what is the effective area of the Earth that receives solar shortwave radiation? (4)
33. What is the ratio between the emission area of longwave radiation from the Earth's surface, divided by the effective shortwave radiation flux area from the previous question? (3)
34. How does your answer from the previous question relate to the at-Earth fluxes of longwave and shortwave radiation in this model? (4)
35. Suppose we increased the Earth's albedo in this model from 0 to a number between 0 and 1. Would this increase or decrease the Earth's equilibrium temperature? (2)

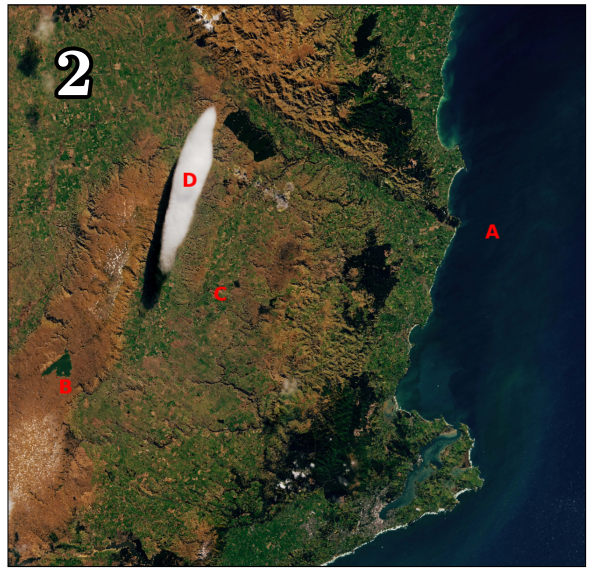
Section F - 20 points

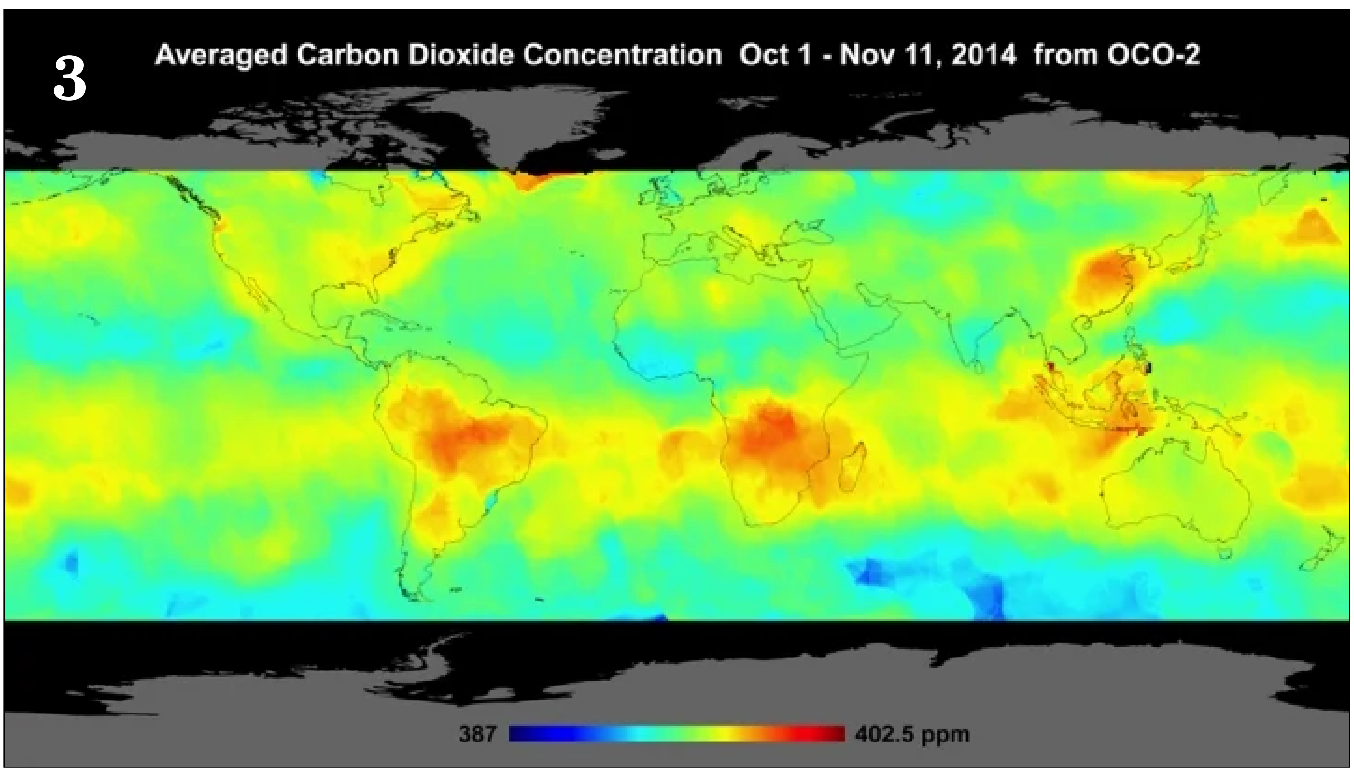
Refer to Image 5 for these questions. This image shows sea surface height data collected by Jason 3.

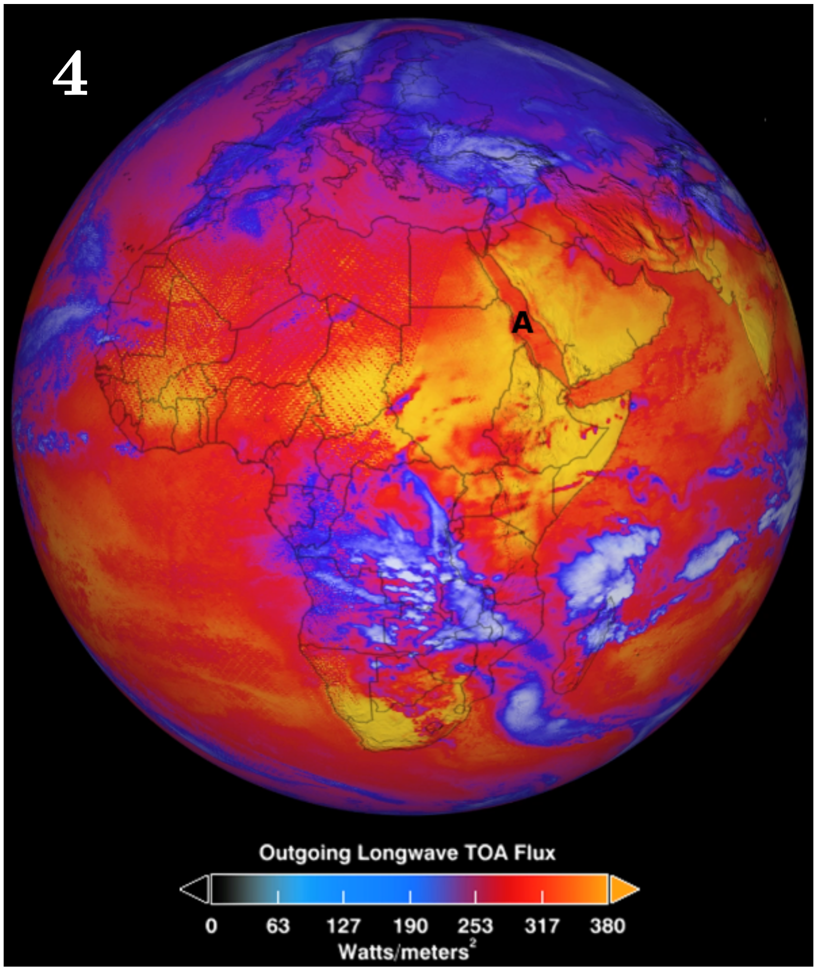
36. What unit is being used for the scale on this image? (1)
37. Notice that the scale is centered around 0, with positive and negative values. What is the meaning of a 0 on this scale. (2)
38. Sea surface height is particularly useful as a proxy for what other property? (2)
39. Explain the connection between the two properties from the previous question. (4)
40. Jason 3 uses radar altimetry to determine sea surface height. Is this a form of active or passive sensing? (1)
41. In radar altimetry, what property of the radar signals is of primary relevance to the final measurement? (3)
42. After atmospheric corrections and the information from the previous question, what additional information is necessary for satellite radar altimetry? (2)
43. Does the data in image indicate an El Niño, La Niña, or neutral pattern? (2)
44. Considering your answer to the previous question, what can you say about the strength of easterly circulation in the mapped region? (3)

1

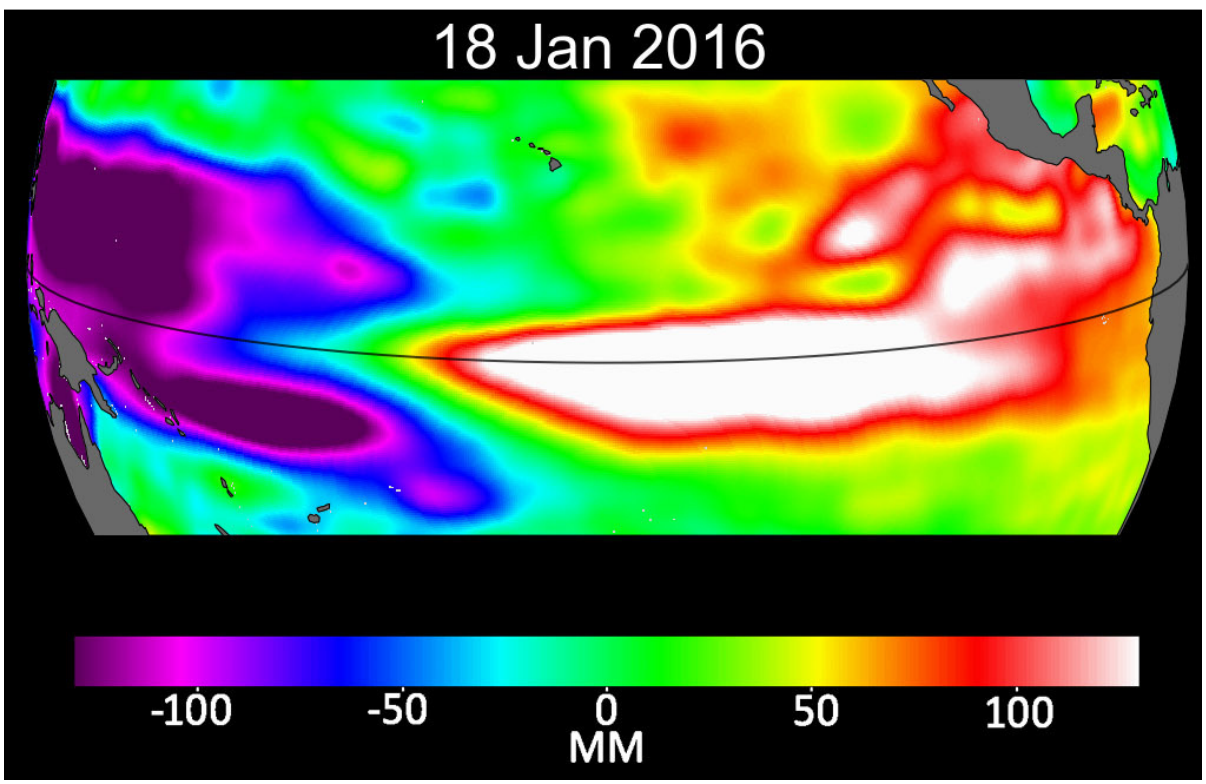

10^{-18}
10^{-19}
10^{-20}
10^{-21}
redacted property [cm^2]
1
2
3
4
5
6
7
8
9 10
redacted property [μm]


2
A
B
C
D


3
Averaged Carbon Dioxide Concentration Oct 1 - Nov 11, 2014 from OCO-2
387
402.5 ppm


4
A
Outgoing Longwave TOA Flux
0 63 127 190 253 317 380
Watts/meters^2

5


18 Jan 2016
-100 -50 0 50 100
MM

Team Name: ______________________ Team #: ______ Score: / 90

Competitor Name(s): ______________________

Section A ____/10 points

1. ______________ (1)
2. ______________ (1)
3. ______________ (2)
4. ______ (2)
5. ______________ (1)
6. ______________ (1)
7. ______________ (2)

Section B ____/15 points

8. ______ (1)
9. ______________ (1)
10. ______________
______________ (3)
11. ______________ (2)
12. ______________ (2)
13. ______________ (3)
14. ______________ (1)
15. ______________ (2)

Section C ____/15 points

16. ______________ (1)
17. ______________ (1)
18. ______ ppm (2)
19. ______________ (1)
20. ______________ (2)
21. ______________
____
______________ (2)
22. ______________
____
______________ (3)
23. ______________ (1)
24. ______ (2)

Section D ____/10 points

25. ______________ (1)
26. ______________ (2)
27. ______________
______________ (2)
28. ______________
____
____
______________ (4)
29. ______________ (1)

Section E ____/20 points

30. ______________ MW/m^2 (4)

31. ______________ (3)

32. ______________ Tm^2 (4)

33. ____________________________________ (3)

34. ____

____

____________________________________ (4)

35. ____________________________________ (2)

Section F ____/20 points

36. ____________________________________ (1)

37. ____________________________________ (2)

38. ____________________________________ (2)

39. ____

____

____________________________________ (4)

40. ____________________________________ (1)

41. ____

____________________________________ (3)

42. ____________________________________ (2)

43. ____________________________________ (2)

44. ____________________________________ (3)

Team Name: ______________________ Team #: ____ Score: 90 / 90

Competitor Name(s): ______________________

Section A 10/10 points

1. Wavelength (1) (1)
2. Absorption spectrum (1) (1)
3. Near (1) Infrared (1) (2)
4. D (2) (2)
5. Passive (1) (1)
6. Shortwave (1) (1)
7. Sun-synchronous (2, 1 for polar) (2)

Section B 15/15 points

8. N_2O (1) (1)
9. Increase (1) (1)
10. Absorption (1) of shortwave light/light emitted by Earth (2) (3)
11. Chlorofluorocarbons (2) (2)
12. Diatomic/molecular oxygen (2) (2)
13. Nitrogen-based (1) fertilizer (2) (3)
14. Bacteria (1) (1)
15. Denitrification (2) (2)

Section C 15/15 points

16. Atmosphere (1) (1)
17. Parts per million (1) (1)
18. 395 to 400 ppm (2) (2)
19. Passive (1) (1)
20. Water vapor (2) (2)
21. Water vapor is common in the atmosphere(1) and varies greatly (1) (2)
22. Dry season (1) resulting in wildfires (1) which removes carbon from vegetation (1) (3)
23. Oxygen (1) (1)
24. 466 (2) (2)

Section D 10/10 points

25. Temperature (2) (1)
26. Clouds (2) (2)
27. Clouds trap some outgoing longwave (2) (2)
28. Water has a higher specific heat (2) so it doesn't heat up as much as land (1) and emits less longwave radiation (1) (4)
29. Top of atmosphere (1) (1)

Section E 20/20 points

30. 62 to 64 MW/m^2 (4) (4)
31. 45000 to 47000 (3) (3)
32. 127 to 128 Tm^2 (4) (4)
33. 4 (3) (3)
34. It is also the ratio of shortwave flux divided by longwave flux (4) (4)
35. Decrease (2) (2)

Section F 20/20 points

36. Millimeters (1) (1)
37. Average sea surface height (2) (2)
38. Sea surface temperature (2) (2)
39. Warmer water is less dense/expands (2) which means warmer oceans rise slightly (2) (4)
40. Active (1) (1)
41. Time (1) between emission and detection (2) (3)
42. Satellite position/orbit (2) (2)
43. El Niño (2) (2)
44. Weaker than usual (3) (3)