

Remote Sensing B & C

2026 Region 7 Science Olympiad Tournament

Agenda

- Fundamental concepts
- Division B event overview
- Division C event overview
- Additional learning resources
- Questions



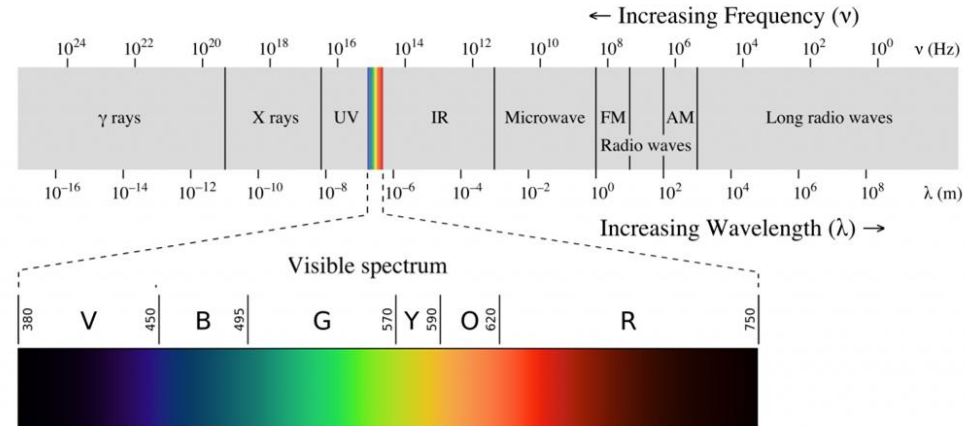
Fundamental concepts

What is remote sensing?

- **Remote sensing** is the process of detecting and monitoring the physical characteristics of an area from a distance, typically from a satellite or aircraft.
- The information collected during remote sensing is typically electromagnetic radiation (light). But the information can also be in other forms, like the strength of the gravitational field at some location.
- Intro learning materials:
 - [Tracking change over time—Understanding remote sensing](#)
 - [What is remote sensing and what is it used for?](#)

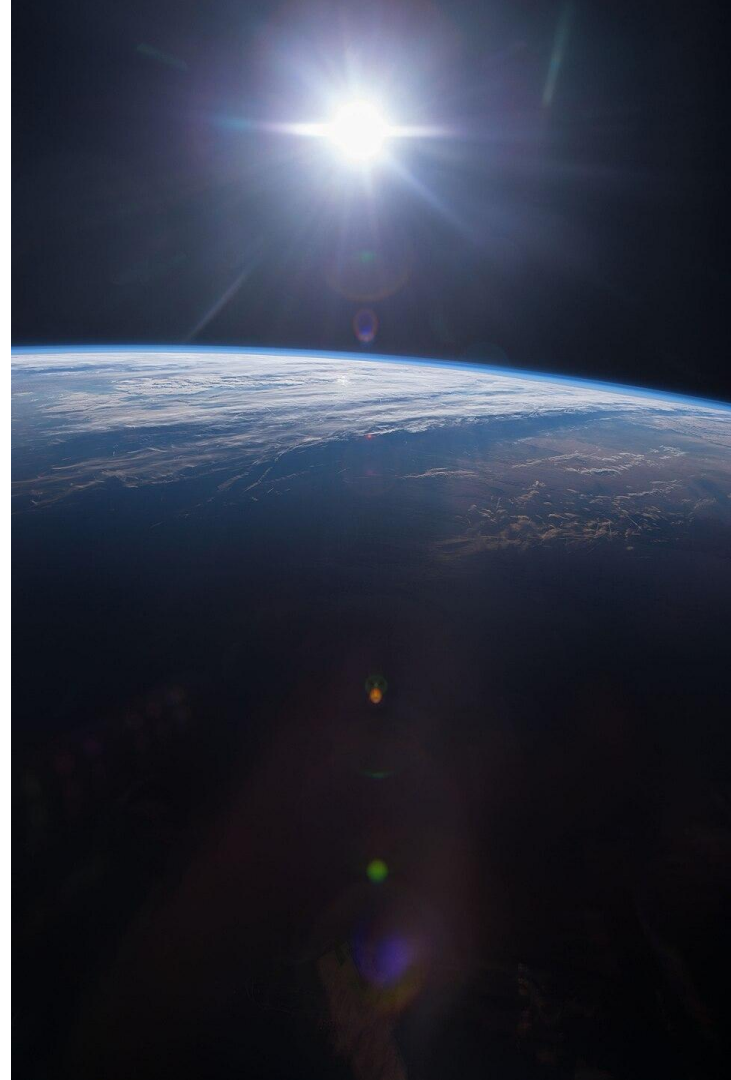
Electromagnetic radiation

- Humans eyes can detect visible light. But visible light is only a small portion of the broader **electromagnetic (EM) spectrum**.
- Different bands of the EM spectrum are emitted and interact with different Earth materials in different ways, making them useful for remote sensing.
- Intro learning materials:
 - [The electromagnetic spectrum](#)
 - [Electromagnetic waves](#)



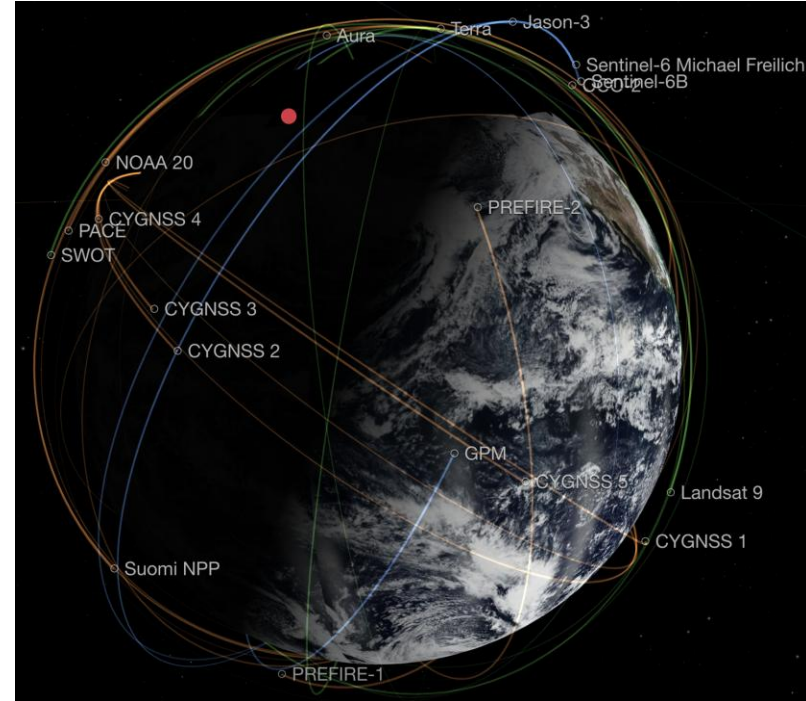
EM radiation from the Sun

- The Sun, like all stars, emits a continuous spectrum of EM radiation. The exact spectrum emitted by the Sun is related to its temperature. This is called **blackbody radiation**.
- The Sun's spectrum reaches Earth and interacts with Earth's different materials, including the different gases in our atmosphere, clouds, vegetation, rocks, surface water, and ice.
- Different parts of the Sun's spectrum are **absorbed**, **emitted**, or **scattered** differently by these materials, allowing us to distinguish between them from a distance.
- Intro learning materials:
 - [Atomic spectra](#), [Blackbody radiation](#), [The greenhouse effect](#)



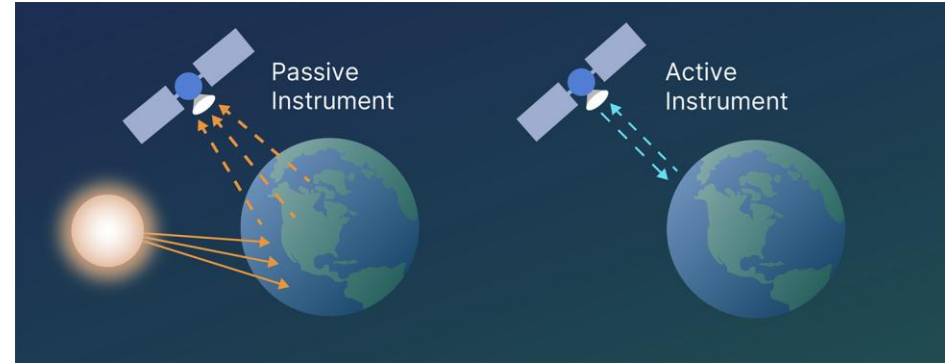
Satellites and orbits

- Remote sensing **satellites** follow specific paths called **orbits** in the space around Earth. Earth satellites are held in orbit by Earth's gravity.
- The exact orbit a satellite is placed into depends on what the satellite is designed to observe.
- Types of orbits include low earth orbit (LEO), medium earth orbit (MEO), high earth orbit (HEO), geostationary, and geosynchronous.
- Intro learning materials:
 - [NASA remote sensing](#)
 - [NASA Eyes on the Earth](#)



Sensors

- Remote sensing satellites contain sensors that can detect various bands of the EM spectrum.
 - **Passive sensors** do not emit radiation of their own. They detect EM radiation that is naturally reflected or emitted by objects. The Sun is the primary source of energy for most passive systems.
 - **Active sensors** emit their own EM radiation or other energy. They measure the portion of that radiation that returns after interacting with the target.
- Intro learning materials:
 - [NASA remote sensing](#)



Data processing, image creation, and interpretation

- The raw data collected by sensors must be **processed** into a usable form. This includes reducing noise in the data.
- Once the data has been processed, it can be represented in various ways. One useful way is to represent the data as an **image**.
- For data collected outside of visible light, this means presenting what would normally be invisible to us in visible colors.
- Finally, we can **analyze and interpret** the image to see what it tells us about an area. Analyzing a map image requires using map features like scales and legends. Interpretation requires connecting info in the image to your knowledge of Earth science and human activities to make sense of the story.
- Intro learning materials:
 - [NASA remote sensing](#)



Division B event



REMOTE SENSING B

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.



1. **DESCRIPTION:** Participants will demonstrate an understanding of the basic principles of remote sensing and interpret imagery, data, and maps related to human interactions with land on Earth.

TEAM OF UP TO: 2

APPROXIMATE TIME: 50 minutes

CALCULATOR: Class II

2. **EVENT PARAMETERS:**

- a. Each team may bring one three-ring binder of any size containing information in any form and from any source attached using the available rings. Sheet protectors, lamination, tabs and labels are permitted. If the event features a rotation through a series of laboratory stations where the participants interact with samples, specimens, or displays; no paper may be removed from the binder throughout the event.
- b. Each team may bring two protractors, two rulers, and two Class II calculators.

3. **THE COMPETITION:** Participants will be given one or more tasks presented as an exam and/or timed stations. The event will consist of questions and activities testing concepts related to the collection and use of remote sensing data to observe and study human interactions with the Earth. Questions will address the following topics:

- a. Remote sensing concepts (25-35% of total points)
- Properties of light: electromagnetic spectrum, reflection, refraction, absorption, scattering, polarization, irradiance/radiance
 - Types of sensors, limited to: active vs. passive, UV, visible light, infrared, radar
 - Types of satellite orbits and their purposes, limited to: low earth, medium earth, high earth, polar/non-polar, geostationary, geosynchronous
 - Image characteristics: spatial, temporal, radiometric (calculations limited to signal-to-noise ratio/sensitivity), spectral
 - Instrumentation, limited to: scanning systems, multispectral imaging systems, optical and infrared imagers, radiometers, radar altimetry
- b. Interpretation and analysis of remote sensing images and data sets (65-75% of total points), limited to the types of sensors listed in 3.a.ii., from the following satellites only: different spectral combinations from Landsat 5-9 (TM, ETM, OLI), Sentinel-1A/1B, Sentinel-2A/2B, Terra (limited to: MODIS, ASTER), Shuttle Radar Topography Mission (SRTM). Questions will focus on the following:
- Fundamentals of mapping as applied to topographic maps, satellite maps, aerial photographs, and other maps generated by remotely sensed data
 - Marginal information
 - Symbology and cartographic design: location, scale, legend, symbols, contours
 - Measurements, limited to:
 - Distance between features, perimeter, area
 - Azimuths and bearings
 - Latitude and longitude in degrees, minutes, seconds, and decimal degrees
 - Altitude and elevation
 - Land usage and monitoring in relation to society and human impact
 - Identification and classification of physical phenomena, including but not limited to
 - Absorption and scattering by aerosols and their effect on data collection
 - Refraction, albedo, surface temperature, reflectance, and other properties of natural and engineered materials and their uses for classifying land areas
 - Elevation or subsidence changes of buildings over time using radar altimetry
 - Vegetation changes (e.g., forests, agriculture) using multispectral images over time
 - Geohazards, limited to: volcanoes, landslides, flooding, wildfires
 - Land Cover Classification Systems
 - Supervised and Unsupervised classification maps
 - National Land Cover Database (NLCD/CONUS) Land Cover Change Index
 - Implications for habitat loss, land cover change, urbanization, deforestation, damage assessment



REMOTE SENSING B (CONT.)

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.



4. **SCORING:**

- High score wins.
- Points will be awarded for the quality and accuracy of responses.
- Selected questions may be used as tiebreakers.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries a variety of resources to purchase; other resources are available on the Event Pages at soinc.org.

This event is sponsored by the IEEE Geoscience and Remote Sensing Society (GRSS).

B

Division B event overview

- Team of up to 2
- 50 minutes
- May bring one three-ring binder of reference information
- Bring a Class II calculator, ruler, and protractor
- The event will be paper (not computer) based. It will consist of questions and activities related to the collection and use of remote sensing data to observe and study **human interactions with Earth**.
 - *Remote sensing concepts (25-35% of total)*
 - *Interpretation and analysis of remote sensing images and data sets (65-75% of total)*
- Refer to the previous slide for the detailed list of concepts and skills you should practice

Class II - Stand-alone non-programmable, non-graphing calculators look like the calculator to the right or simpler. There are hundreds of calculators in this category but some common examples include: CASIO FX-260, Sharp EL-501, and TI-30X.



Division C event



REMOTE SENSING C - CLIMATE CHANGE

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.



1. **DESCRIPTION:** Participants will use remote sensing imagery, data, and computational process skills to complete tasks related to climate change processes in the Earth system.

A TEAM OF UP TO: 2

APPROXIMATE TIME: 50 minutes

CALCULATOR: Class II

2. **EVENT PARAMETERS:**

- a. Each team may bring one three-ring binder of any size containing information in any form and from any source attached using the available rings. Sheet protectors, lamination, tabs and labels are permitted. If the event features a rotation through a series of laboratory stations where the participants interact with samples, specimens, or displays; no material may be removed from the binder throughout the event.
- b. Each team may bring two protractors, two rulers, and two Class II calculators.

3. **THE COMPETITION:**

- a. The event will consist of questions and activities testing concepts related to the collection and use of remote sensing data to observe and study climate change processes and their effects on Earth systems.
- b. The test should be divided so that approximately 25% focuses on topics under 3.e., 35% focuses on topics under 3.d., 20% focuses on topics under 3.e., and 20% focuses on topics under 3.f. **Students should not be expected to know or use calculus to answer any questions.**

c. Remote sensing instrumentation and physics.

- i. Active vs. Passive sensors
- ii. Optical and infrared imagers, radiometers, LIDAR, **space-based gravimetry**
- iii. Radar Altimetry, precipitation radar, **Doppler radar (ground, airborne, and satellite-based)**
- iv. Reflection, refraction, attenuation, transmission, and scattering of light by the atmosphere, aerosols, water, vegetation
- v. **Spectroscopy, including regions of the electromagnetic spectrum, basic types of spectra (continuous, emission, and absorption), usage in identifying composition (atmospheric gases, etc.)**
- vi. Characteristics of blackbody radiation (Wien's Law, Stefan-Boltzmann Law, Rayleigh-Jeans Law)
- vii. **Orbital properties, including Kepler's Laws, types of orbits (LEO, MEO, GEO, geosynchronous, geostationary, polar, sun-synchronous)**
- viii. **Imaging fidelity/quality, including satellite altitude or semi-major axis and angular resolution, instantaneous field of view, ground sample distance, field of view; revisit period vs. orbital period vs. framerate to cover a swath**

d. Interpretation of images and datasets from only the listed satellites and instruments, as relevant to the topics of this event. **Appropriate context (e.g. sensors, bands, etc.) should be provided as necessary for satellite imagery.**

- i. Optical, infrared, and Doppler radar imagery of clouds, precipitation, and extreme weather events (**MODIS on Aqua, CALIPSO, CloudSat, GOES, Suomi NPP, GPM**)
- ii. Sea level rise and surface waves (**PACE, JASON, GRACE**)
- iii. Distributions and radiative effects of greenhouse gases, trace atmospheric gases, and aerosols (**OCO-2, Aura, MODIS on Aqua, GOES, Suomi NPP, CALIPSO, PACE**)
- iv. Atmospheric and sea surface temperatures (**MODIS on Aqua, ECOSTRESS, ATMS, GOES, CrIS on Suomi NPP**)
- v. Radiative energy flux (**CERES on Suomi NPP, PACE**)

e. Climate processes.

- i. Atmospheric concentrations and distributions of greenhouse gases, trace gases, and aerosols (**CO₂, H₂O, CH₄, N₂O, SO₂, Ozone, CFCs, HFCs, NH₃, Halogenated gas**), and relevant influencing factors (e.g. solar activity, volcanic activity, Earth's orbit and seasons, atmospheric and ocean circulation)
 - ii. **El Niño-Southern Oscillation and its effects on regional climate**
 - iii. **Carbon cycle and Nitrogen cycle**, the impacts of natural phenomena and anthropogenic activity on these cycles, and relevance of these cycles to climate processes
 - iv. **The effects of climate change on existing weather processes (e.g. clouds and rainfall, flooding, sea level rise, heat waves, atmospheric effects of wildfires)**
 - v. **Ecological impacts, such as on vegetation and biome distributions**
- f. Energy balance modeling and climate change.



REMOTE SENSING C (CONT.)

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.



- i. The effects of atmospheric and surface conditions (e.g. clouds, aerosols, surface albedo) on climate change, including radiative forcing and climate feedback loops
- ii. Blackbody radiation (using the Stefan-Boltzmann Law) absorbed by the Earth from the Sun, and emitted from the Earth.
- iii. Albedo-based reflection by surface, ice, and clouds
- iv. Modeling planetary equilibrium temperature as a result of the interaction between incoming and outgoing radiation, and changes to equilibrium temperature due to atmospheric and surface conditions
- v. **Changes in heating and cooling rates over time using linear, piecewise-linear, and exponential functions**

4. **SCORING:**

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- Team of up to 2
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- May bring one three-ring binder of reference information
- Bring a Class II calculator, ruler, and protractor
- The event will be paper (not computer) based. It will consist of questions and activities related to the collection and use of remote sensing data to observe and study **climate change processes and their effects on Earth systems**.
 - *Remote sensing instrumentation and physics (25% of total)*
 - *Interpretation of images and data sets (35% of total)*
 - *Climate processes (20% of total)*
 - *Energy balance modeling and climate change (20% of total)*
- Refer to the previous slide for the detailed list of concepts and skills you should practice

General preparation tips

General preparation tips

1. Start by exploring the **intro learning materials** linked on the previous slides.
2. Read through the rules for your event (B or C). Break the listed topics into a **schedule** for yourself. **Explore each topic one-at-a-time** using resources on the following slides, plus any additional resources.
3. As you learn, compile **key factual information** into the three-ring binder you may bring to the event. Organize your binder wisely so you can actually use it as reference during the event.
4. Focus not only on learning and compiling factual information, but also applying **interpretation and analysis skills**. Practice making sense of remote sensing data yourself.



Additional learning resources

Additional learning resources

- [NASA space-based platforms](#)
 - Search and learn about the different satellites
- [NASA Applied Remote Sensing Training Program \(ARSET\) slides](#)
 - Helpful slide deck overview
 - Additional self-guided ARSET trainings available [here](#)
- [Fundamentals of remote sensing](#)
 - Long document, but covers a lot of the relevant information

Additional learning resources

- [JetStream—An online school for weather](#)
 - Lots of helpful info. The units titled “The Atmosphere” and “Satellites” are especially relevant.
- [The greenhouse effect and global energy budget](#)
- [USGS Image of the Week](#)
 - Collection of changes on Earth’s surface, each with a short explanatory video and interactive map
- For teachers/coaches to use with students: [Guided Mapmaker lessons](#)



Questions?