REMOTE SENSING C - CLIMATE CHANGE

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 writing utensils.
   b. Each team may bring two Class II calculators
   c. Each team can bring two protractors and two rulers.
   d. 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.
3. **THE COMPETITION:**
   a. The event will consist of questions and activities testing **the principles of remote sensing data collection, and the usage and interpretation of data from the specified satellites and instruments** 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.c., 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), band ratios, usage in identifying spectral composition (atmospheric gases, **atmospheric interactions with the terrestrial biosphere**, etc.)
      vi. Characteristics of blackbody radiation (Wien's Law, Stefan-Boltzmann Law)
      vii. Orbital properties, including Kepler's Laws, types of orbits (LEO, MEO, HEO, 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. frame rate to cover a swath, types of resolution
   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, **Tropomi on Sentinel-5P, ASTER on Terra)**
      iv. Atmospheric and sea surface temperatures (MODIS on Aqua, ECOSTRESS, **ASTER on Terra**, GOES, CrIS on Suomi NPP)
      v. Radiative energy flux (CERES on **Aqua**/Suomi NPP, PACE)
   e. Climate processes.
      i. Atmospheric concentrations and distributions of greenhouse gases, trace gases, and aerosols (CO_2, H_2O, CH_4, NO_2, SO_2, Ozone, CFCs, HFCs, NH_4, 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. Earth's energy balance.

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. **Interpreting changes in planetary and atmospheric heating and cooling rates over time (linear, piecewise-linear, and exponential)**

4. **SCORING:**

a. High Score wins.

b. Points will be awarded for the quality and accuracy of responses.

c. Preselected questions will be used as tiebreakers.

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