Challenge Description

- **Data:**
  - The data consists of atmospheric solar radiation measurements captured by NASA satellites.
  - Specifically, it includes spectral band data representing radiation intensity across 497 different wavelengths.
  - The dataset covers spatial and temporal variations over Earth's surface, with a focus on the Cape Verde region on May 25, 2025.
  - Data is sourced from NASA Earthdata repositories, collected via remote sensing instruments on orbiting satellites.
- **Motivation:**
  - To understand how solar radiation varies across different spectral bands in the atmosphere.
  - To identify which spectral bands receive more or less radiation on average.
  - To visually communicate patterns that help in climate studies, atmospheric science, and satellite sensor evaluation.
  - To simplify complex multidimensional data into intuitive, insightful visualizations.
- **Audience:**
  - Climate scientists, atmospheric researchers, and remote sensing specialists.
  - Educators and students in environmental science and geosciences.
  - Policy makers interested in climate change data and Earth's energy balance.

- Audience characterized by familiarity with scientific data but varying expertise in data visualization.

- **Context:**
  - The visualizations are intended for research presentations, scientific reports, and educational materials.
  - The audience uses the visualizations to compare spectral radiation levels, evaluate sensor performance, and understand atmospheric behavior.
  - The complexity of the data requires clear, concise visual representation to avoid overwhelming users.
  - Design choices favor clarity, simplicity, and highlight critical insights without sacrificing data integrity.

Visualization Exploration

Visualization Design 1: Radial (Polar) Chart of Spectral Radiation

- **Initial design:**
  - Mapped spectral bands as angles around a circle, radiation intensity as distance from center.
  - Advantage: naturally represents cyclical or periodic data.
  - Issue: overcrowding due to large number of bands; small differences hard to see.
- **Iteration:**
  - Reduced bands shown by aggregating nearby spectral bands.
  - Added interactive tooltip to explore specific band values.
  - Result: better readability, improved user engagement.

Visualization Design 2: Heat Map Over Geographic Region

- **Initial design:**
  - Displayed radiation intensity as color gradients over Cape Verde map.
  - Advantage: spatial context clear, easy to identify hotspots.
  - Issue: spectral dimension lost in 2D spatial map.
- **Iteration:**
  - Result: richer data representation, though visualization complexity increased.

Visualization Design 3: Multi-line Spectral Intensity Chart

- **Initial design:**
  - Plotted multiple spectral band intensities as lines over time or wavelength.
  - Advantage: shows trends clearly.
  - Issue: too many overlapping lines caused clutter.
- **Iteration:**
  - Applied filtering to display selected bands.
  - Used smoothing and color coding by wavelength.
  - Result: improved clarity, easier to compare key bands.

Final Design

- **Format: Infographic combining radial chart, heat map, and line chart**
- **Design rationale:**
  - Use a radial chart to summarize average radiation distribution across spectral bands visually.
  - Heat map provides spatial context highlighting regional variation in Cape Verde.
  - Line chart displays temporal or spectral trends for selected bands.
  - Textual annotations and clear titles explain what each visualization shows.
  - Color palettes chosen for accessibility and to reflect physical meanings (e.g., warmer colors for higher radiation).
  - Layout arranged for logical flow: from overall spectral summary to spatial detail, then to detailed trends.
  - Abstract introduces the dataset and key findings in simple language.
  - Explanations clarify unfamiliar terms like "spectral bands" and why satellite data is important.
  - The infographic is sized for A2 poster format to balance detail and readability.

Feedback Report and Reflection

- **Feedback summary from 3 reviewers:**
  - Positive: Clear visuals, intuitive radial chart, helpful annotations.
  - Suggested: More explanation for spectral band concept; improve color contrast.
  - Criticism: Heat map colors too similar, difficult to distinguish some radiation levels.
- **Changes made:**
  - Added a glossary box explaining spectral bands and units.
  - Adjusted color scheme for better contrast and colorblind accessibility.
  - Increased font size for labels and annotations.
  - Simplified some chart elements to reduce cognitive load.

Visualization Tool Critique

Tool 1: Python (Matplotlib)

- **Purpose:**
    - Matplotlib is a widely-used Python library for creating static, animated, and interactive visualizations.
- **Visualizations & Quality:**
    - Supports a broad range of chart types (line, scatter, bar, heat maps, polar/radial charts).
    - Produces publication-quality static images suitable for reports and presentations.
- **Workflow & Interaction:**
    - Code-based plotting; highly customizable via scripting.
- **Skills Required:**
    - Requires basic to intermediate Python programming knowledge.
    - Understanding of plotting concepts and data manipulation with libraries like NumPy or Pandas.
- **Useful Features:**
    - Fine control over plot aesthetics (colors, labels, fonts).
    - Integration with scientific computing stack (NumPy, SciPy).
    - Supports subplots and complex figure layouts.
- **Advantages:**
    - Open-source and free.

    - Mature, stable, and well-documented.
    - Ideal for reproducible research and scripting workflows.
- **Disadvantages:**
    - Interactivity is limited out of the box.
    - More effort required to produce highly stylized or interactive visualizations compared to dedicated tools.
- **Potential Improvements:**
    - Enhanced interactivity without additional libraries.
    - More intuitive APIs for complex plots like radial charts or custom glyphs.
- **Support for Design:**
    - Allowed creation of clear, precise radial charts, heat maps, and line charts.
    - Enabled flexible layout for infographic components and annotations.