ChatGPT

Calibrated UV-Visible and Infrared Earth Spectral Datasets (300–1100 nm & 1000–4000 cm^{-1})

Several public datasets provide calibrated spectral measurements of Earth in the UV–visible (300–1100 nm) and infrared (1000–4000 cm^{-1}, or ~2.5–10 μm) ranges. These include satellite instruments and ground networks that deliver reflectance or radiance data with full calibration and metadata. Below we detail key datasets – their spectral coverage, data format, access methods, example files, and tips to preview/verify the data – for both UV-Vis and IR domains.

UV–Visible Spectral Datasets (300–1100 nm)

OMI (Ozone Monitoring Instrument, Aura satellite)

Spectral Range & Calibration: OMI is a nadir-viewing UV/Vis imaging spectrometer measuring Earth's backscattered sunlight from roughly 270 nm to 500 nm [1]. It has two detectors: **UV** (covering ~264–383 nm in global mode) and **visible** (~349–504 nm in a separate mode). This spans the UV-B, UV-A, and part of the visible spectrum, overlapping the 300–500 nm portion of the requested range. The instrument provides calibrated Earthshine radiances for each spectral channel, geo-located and corrected for instrument effects [1]. For example, the OMI Level-1B UV global-mode product contains **spectral radiances from 264–383 nm** across 557 channels (0.5 nm resolution) for 60 cross-track pixels per scan [1]. A separate visible detector covers ~350–500 nm with similar calibration (often distributed as a distinct product). All radiances are calibrated against onboard references and come with Quality Assurances.

Data Access & Format: OMI Level-1B data are publicly available via NASA's GES DISC (Goddard Earth Sciences Data Center) with an Earthdata login (free registration) [2]. Files are provided in **NetCDF** format (conforming to CF metadata conventions) [3], with each file containing one orbit (~daylight side, ~50–60 min of data, ~180–210 MB). The **OML1BRUG** product (UV global mode) and the corresponding visible product can be found by searching the Earthdata Collections or via direct HTTPS download. For example, using Earthdata Search for *"OMI Aura L1B radiance"* yields collections for UV and VIS radiances. Files are typically named with date/orbit identifiers; e.g., `OMI-Aura_L1-OML1BRUG_2025m0101t1234-o12345_v004.nc` (this is an indicative pattern). Each file includes radiance for each wavelength band, along with geolocation (latitude/longitude per pixel) and calibration metadata. **Example:** A specific orbit file on 2025-01-01 would contain radiance arrays for all 557 UV channels (264–383 nm) across the swath, plus metadata like solar zenith angle and timestamps.

Finding & Using OMI Data: To retrieve OMI data, you can use NASA's LAADS/GES DISC HTTPS directories or API. For instance, the GES DISC provides a "directory view" where you navigate by date (year/day) to find OMI files [4]. You can also script downloads using `wget` or Python with your Earthdata credentials. OMI radiance files can be large, so it's wise to download only needed orbits. **Previewing/Verifying:** Because OMI L1B files are swath data (not gridded), a quick visual preview requires specialized tools. NASA provides quicklook images for some products (e.g. sample radiance channel images). As a check, the GES DISC catalog entry includes a sample **PNG image** illustrating OMI data content [5], and you can open the

NetCDF in tools like NASA **Panoply** or HDFView to inspect variables. For instance, loading an OMI file in Panoply and plotting radiance at a particular wavelength (e.g. 340 nm) will show a global map strip for that orbit, confirming the data coverage and range. Metadata files (PDF format) are also provided describing calibration and file structure [6] – it's recommended to read those to understand the content. Once satisfied, you can download additional orbits or the full dataset via Earthdata or programmatic access. OMI's long time series (2004–present) means you can obtain more data in the same format by adjusting the date range in Earthdata Search or using NASA's API (the **OMI Collection 4 L1B** is the latest). The dataset includes all needed metadata (wavelength calibration, geolocation, etc.), making it self-contained for analysis.

AERONET Ground-Based Spectral Data

Spectral Range & Calibration: *AERONET* (Aerosol Robotic Network) provides globally distributed **ground-based** spectral observations of sunlight (direct Sun and sky radiance) for atmospheric aerosol studies [7]. The standard AERONET sun photometers measure **column aerosol optical depth (AOD)** at discrete wavelengths ranging from the UV through visible into NIR. Typical channels include **340, 380, 440, 500, 675, 870, 940 (water vapor), and 1020 nm**, with some newer instruments adding 1640 nm [8]. This covers **340–1020 nm** in calibrated AOD (which falls within the 300–1100 nm range). Each measurement is carefully calibrated (Langley method) and quality-controlled: AERONET releases Level 2.0 data that are **calibrated and cloud-screened** (quality-assured) [9] [10]. The data represent **spectral reflectance properties of the atmosphere** (direct Sun AOD is essentially the fraction of light attenuated by aerosols at each wavelength). While AERONET does not directly measure surface reflectance, it provides crucial atmospheric spectral data for Earth's atmosphere in the UV-Vis domain.

Data Access & Format: AERONET data are openly available via NASA GSFC's AERONET web portal. Data are provided as text tables (usually ASCII **.txt** files, often packaged in a **.zip**) [11]. Each file contains a header with site metadata (site name, location, instrument, etc.) and column descriptors including the exact wavelengths of each channel measured [12]. Following the header, each row gives a timestamp and the AOD (and possibly other parameters like Angstrom exponent or precipitable water) at each wavelength. For example, a Level 2.0 AOD file for *Palma de Mallorca* site in April 2024 would list dates/times and AOD at 340 nm, 380 nm, 440 nm, ... 1020 nm (with missing values marked by -999) [12]. File naming typically follows the format `<SiteName>.<level>.<dates>.txt` or a similar convention described on the AERONET site. The **data format is consistent** across the network (tab-delimited text with header), and a companion document explains each column (e.g. "AOD_500nm") [8].

Finding & Using AERONET Data: The AERONET website offers multiple retrieval tools. The **Data Download Tool** on the site allows selection of a station, date range, and data level (1.5 or 2.0) for AOD [13] [14]. After accepting a brief data use policy, you can download the data file. Alternatively, AERONET provides a **web service API** to request data via URL (suitable for scripting) [15] [16]. For instance, a request like:

```
https://aeronet.gsfc.nasa.gov/cgi-bin/print_web_data_v3?
site=Mauna_Loa&year=2023&month=1&day=1&year2=2023&month2=1&day2=31&level=2&avg=10
```

will retrieve Level 2 AOD data for Mauna Loa for January 2023 (with all points, 10-minute averages) [17]. The returned data is the same text format as the manual download. **Example files:** AERONET's **Level 2.0 AOD** file for *Beijing* (a permanent site) in August 2004, for example, would be available by selecting that site and date on the portal [18] – one could download a file named like `Beijing.aug2004.aod_Level2.zip`. Inside, a text file might contain columns labeled AOD_340nm, AOD_380nm, … AOD_1020nm, etc., each column containing calibrated AOD values [8].

Previewing/Verification: The AERONET portal itself provides quick visualization of the data **before download**. After choosing a site and date range, you can plot time-series graphs of AOD at various wavelengths or even spectral AOD on a given day [14]. These plots help verify that data exist for your period (days with data are highlighted in the interface) [19]. You can inspect the smoothness of the spectral curve (which indicates calibration quality) and see if any days are missing or have cloud-contamination flags. Once downloaded, the text files can be opened in any text editor or imported into analysis software (Excel, Python/pandas, MATLAB, etc.). The first lines of the file contain metadata (site coordinates, etc.), allowing you to confirm you have the correct site and instrument version. Since AERONET has a long record (since ~1993) [7], you can obtain more data in the same format by selecting different date ranges or sites. All files adhere to the same format and include metadata headers for self-description.

MODIS Surface Reflectance (Terra/Aqua)

Spectral Range & Calibration: The **MODIS** instruments (on NASA's Terra and Aqua satellites) measure reflected solar radiance in multiple discrete bands spanning the visible and near-infrared. While MODIS does not have continuous spectra, it provides key broad bands within 300–1100 nm. Notably, MODIS bands include: **Band 1 (620–670 nm, red)**, **Band 2 (841–876 nm, NIR)**, **Band 3 (459–479 nm, blue)**, **Band 4 (545–565 nm, green)**, and several others up to 2130 nm. Thus, MODIS covers the entire visible spectrum (~400–700 nm) and part of the UV (its shortest band is ~412 nm on Aqua/MODIS) – not fully down to 300 nm, but most of 400–1100 nm range is included. The **MODIS Surface Reflectance** products provide *calibrated, geophysical reflectance* values at the surface, corrected for atmospheric effects (gases, aerosols) [20]. These are essentially the fraction of sunlight reflected by Earth's surface in each band, as it would appear with standard illumination (e.g. if observed from top-of-atmosphere but after removing atmospheric attenuation) [21]. The data are derived from calibrated Level-1B radiances that MODIS records (which themselves are calibrated via onboard sources and solar diffuser). The surface reflectance products have undergone radiometric calibration and atmospheric correction, making them ready for analysis of land or ocean color. Each pixel's reflectance is accompanied by quality flags indicating clouds, shadows, etc., to ensure the data is *science-quality (validated)* [22] [20].

Data Access & Format: MODIS surface reflectance is available in several product forms. Common ones are **MOD09** (Terra) or **MYD09** (Aqua) series. For example, **MOD09GA** is a daily Level-2G product at 500 m resolution (gridded) with bands 1–7 reflectance [23], and **MOD09A1** is an 8-day composite at 500 m [24]. Data are typically stored in **HDF-EOS** (Hierarchical Data Format, Earth Observing System extensions) files, which is essentially HDF4 with embedded geolocation and metadata. Each file contains multiple scientific datasets (SDS): the reflectance for each band (in scaled integer form) plus auxiliary layers (e.g., QA flags, solar/view angles). For instance, a MOD09GA HDF file has 7 reflectance layers (Band1–Band7) and quality bitfields. File naming convention encodes date and location for tiled products. **Example:** `MOD09GA.A2023245.h12v04.061.2023255043.hdf` would denote Terra MODIS surface reflectance on year 2023 day 245 for tile h12v04 (in the Sinusoidal tiling system), Collection 6.1 [25]. Global products (like 0.05° climate modeling grid MOD09CMG) use a different naming but also HDF format [26].

MODIS reflectance data are distributed via NASA's **LAADS DAAC** and **LP DAAC**. You can download data through the LAADS web interface or via Earthdata Search by specifying the product (e.g., *"MOD09A1 v061"* for 8-day reflectance) [23] . Earthdata login is required, but many MODIS products are also mirrored on public cloud buckets (e.g., Amazon AWS OpenData for MODIS, which allows direct download without login for certain collections [27]).

Finding & Using MODIS Data: To get MODIS reflectance, determine the product and date of interest. For daily surface reflectance, **MOD09GA/MYD09GA** (500 m) or **MOD09GQ/MYD09GQ** (250 m, bands 1–2 only) are typical. Use LAADS' search tool or Earthdata Search: for example, search for *"MOD09GA 2023-07-01"* and select your region (either by tile or lat/long). The output will list file names downloadable via HTTPS. An alternate approach is using NASA's API or even the Amazon S3 bucket (for Collection 6 or 6.1 data) for scripted downloads. **Example file:** A global climate grid file `MOD09CMG.A2023001.061.2023009050023.hdf` would contain 7 layers of reflectance at 0.05° resolution for Jan 1, 2023 [28] . Each reflectance layer is 3600×7200 in size (global grid) and stored as 16-bit integers (which you scale by a factor given in metadata to get actual reflectance). Metadata attributes in the HDF file describe the exact central wavelength of each band, data units (reflectance is dimensionless fraction), and calibration factors.

Previewing/Verification: NASA provides **browse images** for many MODIS products. For instance, the MOD09 series often has quick-look PNGs showing Band 1-4-3 (RGB) composites for each tile or global image. When using LAADS DAAC's search, you may see a small preview image for each granule. Additionally, NASA's **Worldview** tool can be used to visually confirm MODIS observations on a given date – while Worldview layers are usually true-color or NDVI composites rather than raw reflectance, they help verify things like cloud cover and general scene content for the date/area. If you prefer local preview, you can open the HDF file in GIS or remote sensing software: e.g., **QGIS** or **ArcGIS** (with HDF support) will let you view each band as a grayscale image or composite; NASA **Panoply** can also open HDF-EOS and display the band data on a map projection. Check the metadata in the file (attributes named `Reflectance` or scale factors) to ensure you apply the scale and offsets correctly. By plotting one band (say Band 1 at 645 nm) as an image, you can verify the values (~0 to 1 reflectance in clear land areas) and spatial coverage. The presence of a valid image confirms the file is not corrupted. From there, you can acquire more data (e.g. adjacent dates or tiles) in the same format via the same methods – the continuity of MODIS (Terra since 1999, Aqua since 2002) provides a large archive of similarly formatted reflectance data [22] .

AVIRIS Hyperspectral Imagery (Airborne Visible/Infrared Imaging Spectrometer)

Spectral Range & Calibration: AVIRIS is an airborne imaging spectrometer that collects **contiguous spectra** in the visible through shortwave-infrared. It covers approximately **380 nm to 2500 nm** in 224 narrow bands (~10 nm spectral resolution) [8] , fully spanning the 300–1100 nm range (and extending beyond into SWIR). This includes the ultraviolet edge (AVIRIS sensitivity starts ~380 nm, just above 300 nm) through the entire visible spectrum and into near/mid-IR. AVIRIS data are **radiometrically calibrated** to provide at-sensor radiance (often in μW/cm^2/nm/sr or similar units) for each pixel and band. Calibration is done using laboratory measurements and in-flight calibration targets to ensure each spectral band is accurate. Many AVIRIS datasets are also atmospherically corrected to produce **surface reflectance** (Level 2 data) using models like MODTRAN, yielding calibrated reflectance spectra for each pixel on the ground. AVIRIS thus offers "spectral fingerprints" of Earth's surface materials (vegetation, water, minerals) across hundreds of wavelengths.

Data Access & Format: AVIRIS data (from NASA/JPL) are publicly available for many flight campaigns. The data are typically distributed as **Level 1B calibrated radiance** images, and sometimes as **Level 2**

reflectance images. Each AVIRIS scene is an image cube: two spatial dimensions (x,y) and one spectral dimension (bands). The most common format is **ENVI standard** (an image binary file accompanied by a text header `.hdr`). The header describes the image dimensions, number of bands, wavelength of each band, data type, and scaling. For instance, AVIRIS radiance might be stored as 16-bit signed integers which need a scale factor (given in the header) to convert to physical radiance [29]. Some AVIRIS releases use HDF5 or NetCDF, but ENVI binary is prevalent for classic AVIRIS. **Example files:** On the JPL AVIRIS portal, a dataset named *"Cuprite (Nevada) 1997"* is offered as a **reflectance** file and a **radiance** file. The reflectance file `f970619t01p02r02_rfl.img` (~590 MB) might come with a header specifying 224 bands from 0.4–2.5 μm, and each pixel's values are reflectance (scaled by 10000, for example) [30]. The radiance file `f080611t01p00r06_rdn.img` (~1.1 GB, from a 2008 flight) contains calibrated radiance for the same bands [31]. In these names, `fYYMMDDt..rXX` encodes the flight date/time and run. The JPL site notes that these are *"complete flight runs, with all bands and files"*, and includes ancillary data (like wavelength calibration, bad pixel map, etc.) [32]. AVIRIS-NG (the next-generation instrument) data are similarly available; for example, the NASA **SnowEx** campaign AVIRIS-NG reflectance data are hosted at NSIDC in NetCDF format [33], but for general use the ENVI format from JPL is common.

Finding & Using AVIRIS Data: NASA maintains an **AVIRIS Data Portal** (hosted by JPL) where standard datasets can be downloaded. The portal's "Free Data" page lists several sample scenes from different years and locations [30]. You can click on a site name to see a quicklook image, then use the download link for reflectance or radiance. For more extensive data (beyond the sample sets), you may use the **AVIRIS Flight Finder** or NASA's Earthdata Search. Some AVIRIS collections (especially AVIRIS-NG recent flights) are cataloged in Earthdata; for example, the **SHIFT project AVIRIS-NG L1B** data have a collection entry (with files in HDF5) [34]. If you know the campaign, you can search Earthdata for it, or request data through the AVIRIS data request form for older campaigns not posted publicly. **Example download:** The *Moffett Field 2018* AVIRIS scene can be downloaded as `f080611t01p00r07` (radiance) from JPL's site [35]. The download provides the image cube and typically a `README` or metadata text describing calibration. The file format (binary + header) can be read by remote sensing software (ENVI, QGIS, Python with `rasterio` or `spectral` library, etc.). The header lists the band centers so you have the spectral metadata.

Previewing/Verification: AVIRIS scenes are quite large, but JPL facilitates preview via **quicklook JPEG images**. On the AVIRIS download page, each site name is a hyperlink to a JPEG quicklook (usually a false-color composite) [35]. For example, clicking "Cuprite" shows a color image of the flight line, so you can verify the coverage (the Cuprite mining district area) and general image quality before downloading the 600 MB file. Likewise, the presence of features (vegetation, water, etc.) can be inferred from the quicklook. Once you download a scene, you can also preview it by loading a subset of bands. For instance, using the **Spectral Python (SPy)** library, you can read the `.hdr` and `.img` to extract a few bands and display them. The data's calibrated nature means you can even plot a spectrum from a single pixel to verify that the spectral shape looks reasonable (e.g. vegetation should show a red-edge jump around ~700 nm, water should absorb in IR bands, etc.). If the dataset includes a reflectance product (denoted by `_rfl` in filename), you can directly interpret the pixel values as reflectance (0–1). If only radiance is given, you may need to apply your own atmospheric correction to get reflectance. The JPL site also provides **calibration files and documentation** for AVIRIS (e.g. spectral response functions, bad band lists) which are useful for in-depth verification. To get more AVIRIS data in the same format, you would typically identify a campaign of interest (say, AVIRIS flights over California in 2013) and then contact the AVIRIS team or use Earthdata if available. All AVIRIS data, whether classic or NG, maintain the same calibrated spectral structure and include metadata (either in headers or separate files) describing wavelengths and calibration factors, ensuring consistency across scenes.

Infrared Spectral Datasets (1000–4000 cm^{-1} or 2.5–10 μm)

AIRS (Atmospheric Infrared Sounder, Aqua satellite)

Spectral Range & Calibration: AIRS is a space-borne hyperspectral infrared sounder on NASA's Aqua (EOS) satellite. It covers the **thermal infrared spectrum from 3.74 μm to 15.4 μm** (approximately 2675–650 cm^{-1}) [36], which means it fully spans the 1000–2675 cm^{-1} range and beyond (it does not quite reach 4000 cm^{-1}/ 2.5 μm, since AIRS focuses on thermal IR). In practice, AIRS has **2378 spectral channels** distributed across this range [36], with a resolving power ~1200 (channel spacing ~≈ 0.5–1.1 cm^{-1}). The channels capture detailed infrared emission and absorption features of the Earth's surface and atmosphere. The AIRS Level 1B data are **calibrated, geolocated radiances** for each channel, in physical units of radiance (e.g. $mW/m^2 \cdot sr \cdot cm^{-1}$) [36]. Calibration is maintained by on-board blackbody references and a cold space view; the instrument's design and regular calibrations yield high radiometric accuracy. The spectral calibration is also tracked: each L1B granule provides the precise center frequency of each channel (which can shift slightly over time) [37]. There is also a Level 1C product which resamples these radiances to a fixed 0.5 cm^{-1} grid for convenience, though the fundamental measurement is L1B [38]. Essentially, AIRS L1B gives a **spectral radiance curve** for each footprint on the Earth, covering the mid-IR (including key gas absorption bands for CO_2, H_2O, O_3, CH_4, etc.). For our purposes, it covers ~**1000–2675 cm^{-1}**, meeting the IR range criterion (1000–4000 cm^{-1}) except for the very shortest wavelengths (which are typically covered by different instruments or not emitted strongly by Earth).

Data Access & Format: AIRS L1B data (Routine production) are available from NASA GES DISC. The data are stored in the standard AIRS file format, which for Version 5/6/7 is an **HDF-EOS** (HDF4) file. Each file is often called a **granule** and represents a 6-minute segment of the satellite orbit [39]. There are 240 granules per day (AIRS scans continuously), and each granule file is on the order of ~10–20 MB for IR (and ~2 MB for separate Vis/NIR band files). In HDF, the radiance data are typically in a dataset like `Radiances` [footprint_index × channel_index], along with geolocation arrays (`Latitude`, `Longitude` for each footprint) and ancillary info (time, viewing angle, calibration flags). The spectral axis (frequencies of channels) might be provided in a separate dataset or in the documentation. Newer versions of AIRS data might also be distributed in **NetCDF4** format for convenience, but the official archive is HDF-EOS2. **Example file name:** `AIRS.2025.11.07.001.L1B.AIRS_Rad.v7.0.0.0.G22021012345.hdf` could denote a granule starting at 00:10:01 UTC on Nov 7, 2025 (this is illustrative). The *shortname* for AIRS L1B IR is `AIRIBRAD` (for routine standard data) and `AIRIBRAD_NRT` for near-real-time data [40]. On GES DISC, the data are organized by date; you can navigate the directory or use Earthdata search.

To download, you need an Earthdata login. GES DISC provides multiple options: direct HTTPS download (a directory listing of granules), an **OPeNDAP** server for subsetting, and API endpoints [4]. For instance, you could use the HTTPS path:

```
https://acdisc.gesdisc.eosdis.nasa.gov/data/Aqua_AIRS_Level1/AIRIBRAD.
005/2025/311/
```

to list files on the 311th day of 2025. NASA's documentation confirms these files are public (no restrictions besides login) [41].

Finding & Using AIRS Data: You can search for AIRS L1B in Earthdata Search (search term "AIRS L1B Level 1B Radiances"). The results will show the collection, and you can then specify date/time range and download granules. Alternatively, the GES DISC *dataset page* for AIRS L1B (AIRIBRAD) provides a "Download via HTTP" option and an OPeNDAP link [4]. For large data requests, consider using NASA's subsetting (which can return only specific channels or georegions) to reduce volume. **Example usage:** If you are interested in spectra over a certain location, you might use GES DISC's OPeNDAP: for example, retrieve one granule and then subset by footprint indices around your lat/lon of interest. Each AIRS granule covers 90 cross-track × 135 along-track = 12,150 soundings [39], each with a 2378-length spectrum. The data files also contain a *preview browse image* (often a quick global swath picture or brightness temperature image) to give you a sense of the data; indeed, NASA's data catalog shows a sample **JPEG image of AIRS radiances** for visualization [42].

Previewing/Verification: Before heavy downloading, it's good to verify the data content. The GES DISC **data catalog entry** for AIRS L1B (as referenced above) includes a "Get a related visualization" link, which is a **JPEG browse image** [42] of an example granule. This image might display, say, an infrared brightness temperature map for one channel or a combination, allowing you to confirm that the granule indeed covers Earth scenes (and not, for example, a calibration view). You could also use NASA's **Giovanni** online tool to plot AIRS observations (though Giovanni is more for Level 2/3 products). For a hands-on preview, using Panoply to open a granule HDF is effective: you can plot one of the 2378 channels as a 2D Earth image – for example, channel ~1231 (≈900 cm^{-1}) will show a global swath of thermal emission around 11 μm, where land and ocean temperatures appear. This confirms the data's geolocation and radiance magnitude (you should see values in the 1–10 $mW/cm^2 \cdot sr \cdot cm^{-1}$ range, corresponding to brightness temperatures of ~200–300 K). The file's metadata includes attributes for each channel's central wavenumber (the AIRS User Guide details how to map channel index to frequency) [36], so you can verify that as well. Once comfortable, you can proceed to download a batch of granules or even the entire day's data (e.g., ~240 granules/day). Because AIRS has been operating since 2002, you have a multi-decade archive in a consistent format; to get more data, you typically change the date in the download path or use Earthdata Search to queue multiple days. All AIRS L1B files include not just radiances but also **Quality flags** and calibration metadata, which are documented in the accompanying readme (available as a PDF on GES DISC) – it is recommended to check these for any anomalies (such as the note about a **spectral shift after a 2021 spacecraft maneuver** [43], which is fixed in L1C). By applying those guidelines, you ensure you're using the calibrated data correctly.

IASI (Infrared Atmospheric Sounding Interferometer, MetOp satellites)

Spectral Range & Calibration: IASI is a Fourier-transform infrared spectrometer on the MetOp series (MetOp-A/B/C, operated by EUMETSAT). It measures Earth's infrared spectrum from **approximately 645 cm^{-1} to 2760 cm^{-1}** (15.5 μm down to ~3.63 μm) [44]. This range fully includes 1000–2760 cm^{-1}, thus covering the 1000–2000 cm^{-1} mid-IR and part of the 2000–4000 cm^{-1} range (up to ~3.6 μm; IASI does not extend to 4000 cm^{-1} because it focuses on thermal emission, not shorter SWIR). IASI has extremely high spectral resolution: it records **8461 spectral samples** per spectrum (after apodization) [45], with a native spectral resolution of 0.5 cm^{-1}. The radiances are calibrated using onboard blackbody references and deep-space views for zero level. The instrument achieves ~0.25 K radiometric accuracy. IASI's calibrated spectra (Level 1C) are provided as **radiance spectra** (often converted to brightness temperatures for convenience in some products) for each field of view. Each spectrum is geolocated (global coverage twice daily, with a ~50 km diameter FOV at nadir composed of smaller sub-FOVs). Notably, IASI Level 1C is the **user-ready calibrated product**: it has been resampled (apodized) onto a fixed grid and radiometrically calibrated [46]. These data are used for atmospheric profile retrievals and trace gas detection, so they are high quality and stable over time. The spectral coverage includes key bands like the 9.6 μm ozone band (~1040 cm^{-1}), 15 μm CO_2 band (~667 cm^{-1}), 6.3 μm H_2O band (~1600 cm^{-1}), and portions of the 4.3 μm CO_2 band (~2350 cm^{-1}) – all within the delivered spectra.

Data Access & Format: IASI Level 1C data can be obtained from two main sources: **EUMETSAT** (the data provider) and **NOAA** (which redistributes it for U.S. users). EUMETSAT offers IASI L1C via its **Data Centre** and the newer **WEkEO/Data Store**. Access is free but requires registration on EUMETSAT's portal. The data were historically delivered in an EPS native binary format (not easily readable without specific libraries), but now EUMETSAT provides **NetCDF-4** files for IASI L1C in its Climate Data Records and current formats [47] [48]. These NetCDF files are CF-compliant and HDF5-based, which makes them user-friendly (you can open them with standard NetCDF or HDF5 tools). Each IASI L1C file usually contains one orbit or half-orbit of data. NOAA's **NCEI/CLASS** system provides IASI Level 1C for MetOp in the original EPS format (often referred to as PFS files) [49]. Those files are typically delivered per orbit (about 100 minutes orbit, ~2 GB file). NOAA CLASS files are in **EPS** format, which requires the EUMETSAT library (or conversion tools) to read; however, NOAA also produces derived products (like **thinned spectra** or cloud-cleared radiances in NetCDF) which might not be full resolution. For full-resolution L1C, the EUMETSAT distribution in NetCDF is highly convenient.

Example files: EUMETSAT's CDR NetCDF might be named like `IASI_METOPA_L1C_CDR_20070912003400_20070912021759.nc` indicating satellite, level, date/time range. NOAA CLASS daily tar files might be named by instrument and date, e.g., `IASI_xxx_M02_20251107.tar` containing all orbits for that day. The contents inside include files like `M02_<orbit>_IASI_xxx_eps` etc. According to NOAA's metadata, the IASI L1C contains **"thinned infrared radiance spectra at 0.5–1.0 cm^{-1} resolution"** [50], meaning some channels (like oversampled/apodized ones) might be omitted to reduce file size – however, full 8461 channels are usually available in the standard product. The **distribution format** via NOAA is listed as "EPS" (EUMETSAT Polar System native format) [51], whereas EUMETSAT's updated format is NetCDF-4. The NetCDF files include variables for radiance, wavenumber grid, geolocation, quality flags, etc., along with global attributes documenting calibration.

Finding & Using IASI Data: If you prefer EUMETSAT sources, you can use the **EUMETSAT Data Store** (online web UI or API) to query IASI L1C by date. EUMETSAT has also released a **Climate Data Record (CDR)** for IASI MetOp-A (2007–2017) as a consolidated package [52], which might be easier for bulk download. Using the Data Store API, one could programmatically request daily files in NetCDF. For NOAA's CLASS, you use the CLASS web interface: select "IASI – Infrared Atmospheric Sounder Interferometer – Level 1C – MetOp" (the CLASS product is identified by "IASI" or dataset C01680) and then input date range [53] [54]. CLASS will stage the data and provide a download link via email. Note CLASS can be slower and often gives data in the original format. For quick access, the EUMETSAT route is often faster if you just need some orbits. **Example:** To get IASI data covering the U.S. on Nov 7, 2025, find which MetOp satellite pass covers that region around that date/time (MetOp satellites are polar orbiters ~09:30 local time equator crossing for A, etc.). Then download the corresponding orbit file from EUMETSAT. If using the CDR, you might download entire days and then filter by location post hoc.

Previewing/Verification: IASI being high-dimensional (8461 channels) makes direct image preview non-trivial, but there are strategies. One quick check is to use tools like the **EUMETSAT CODA/BEAT** software or the Python library `pynadc` which can read IASI and extract a subset of channels. EUMETSAT's viewer might allow plotting of radiances for a chosen channel (for example, 11 μm channel ~900 cm^{-1}) to produce a brightness temperature map. This can serve as a browse image to verify coverage and data quality (similar to how NOAA weather products show IASI observations). In absence of a native image, you can manually create one: open the NetCDF, pick a channel index (or nearest wavenumber ~1000 cm^{-1} which is within our range), and plot radiance as an image of scanlines vs. track. It should resemble the Earth's scan swath (with warm temperatures over land/ocean and cold in clouds). Also, inspect the metadata: IASI files include calibration info such as radiance units and fill values – ensure that non-physical values are marked (often fill value = 0 or some large number for space views). Another approach is to look at a *spectral plot*: select one pixel and plot its radiance across all 8461 channels – you should see familiar spectral features (e.g., strong CO_2 band around 667 cm^{-1} where radiance drops to near zero, window regions ~800–1000 cm^{-1} where radiance is high for warm surfaces, etc.). This confirms that the file is properly read and calibrated (the radiance in the 800–1000 cm^{-1} window should correspond to ~300 K brightness temperature for tropical scenes) [55]. Once satisfied, you can process more data. To find more IASI data in the same format, simply adjust the date range on EUMETSAT/CLASS queries. MetOp-A data span 2007–2021, MetOp-B 2012–present, MetOp-C 2018–present, providing a long continuous record. All are consistent in format per source (though format differs between EPS binary and NetCDF). For research, many users prefer converting the EPS to NetCDF using provided tools – if you download from EUMETSAT directly, you get NetCDF ready-made, including **metadata attributes** for things like the exact wavelengths and calibration version, which is very helpful for documentation.

CrIS (Cross-track Infrared Sounder, Suomi-NPP & JPSS satellites)

Spectral Range & Calibration: CrIS is a newer-generation hyperspectral sounder on the Suomi NPP and NOAA-20/21 (JPSS) satellites, serving a similar role to IASI. CrIS covers the infrared in three bands: **LWIR 650–1095 cm^{-1}**, **MWIR 1210–1750 cm^{-1}**, and **SWIR 2155–2550 cm^{-1}** [56]. These combined bands span ~650 to 2550 cm^{-1} (15.4 μm to 3.92 μm), thereby covering 1000–2550 cm^{-1} completely (and a bit beyond up to 2550). Like IASI, CrIS is an interferometer, but with slightly fewer channels; originally CrIS had a **normal spectral resolution (NSR)** of 0.625 cm^{-1} (total 1305 channels) and since late 2014 operates in **full spectral resolution (FSR)** mode with 0.3125 cm^{-1} in MWIR/SWIR (double the channels, ~2211 total) [57]. The **CrIS Level 1B Sensor Data Record (SDR)** contains **calibrated, geolocated radiances** for each band and field of view [58]. Calibration is performed similarly with onboard blackbody and space looks; it achieves excellent radiometric accuracy (<0.1 K in many channels) and spectral precision. CrIS's spectral range and resolution are designed to continue the climate and NWP applications of AIRS/IASI. For the IR range under discussion, CrIS provides fully-calibrated radiances from 1000 cm^{-1} (10 μm) through the mid-IR up to 2550 cm^{-1} (~3.9 μm). (It does not extend to 4000 cm^{-1}, again because beyond ~2700 cm^{-1} one would need SWIR channels mainly for reflected sunlight, which CrIS does not measure at high resolution.) The **spectral calibration and radiometric calibration** for CrIS are described in detail in NOAA technical documents, and the data includes uncertainty estimates and quality flags per spectrum. Each CrIS observation is a 3×3 array of FOVs (~14 km at nadir each), grouped as a single field of regard (FOR) [59]. The SDR file typically includes all FOVs for each scan position and scanlines over a time interval.

Data Access & Format: CrIS L1B SDR data are distributed by NOAA and also mirrored by NASA. NOAA's **CLASS** archive provides CrIS SDRs under the product name `CrIS_SDR` (operational and reprocessed streams) [60] [61]. These are stored as **HDF5** files with metadata attributes included [60]. Each file usually contains an **8-minute aggregation** of data, which in CLASS's terms is 15 granules per file [60] (where a granule likely corresponds to one scan or one minor frame – here "15 granules" might refer to 15 scans, though the wording suggests the 8-min file is a collection of smaller units). The HDF5 format is convenient: it's self-describing, with datasets for radiances for each band, geolocation, time, and attributes for things like scaling and units. NASA, via the JPSS mission, also provides CrIS SDR data through its archives (e.g., NASA Earthdata's EOSDIS has collections for S-NPP CrIS and NOAA-20 CrIS). The Earthdata shortnames include **SNDR (Sounder) CrIS** designations. For example, **Suomi-NPP CrIS NSR** and **JPSS-1 (NOAA-20) CrIS FSR** are available – as indicated by search results for JPSS-1 CrIS L1B on Earthdata [62]. These NASA-distributed files are also in HDF5 (often using NetCDF4 conventions) or sometimes in netCDF4 classic. They contain similar content as NOAA's version, since NOAA is the source of processing. **Example file name:** A CrIS SDR file from NOAA-20 might be `NUCAPS-CRIS_JPSS1_SDR_20251107T1200Z_8min.h5` (if aggregated by time) or something like `CRIS_SDR_j01_d20251107_t1200_e1208_b12345_c202511071305.h5`. The naming usually encodes satellite (j01 for NOAA-20), date/time of start and end, orbit or granule ID, etc.

Finding & Using CrIS Data: For NOAA's CLASS, you would go to the CRIS_SDR product page and specify date/time and satellite (S-NPP, NOAA-20, etc.) [63] [64]. CLASS can provide a listing of files which you then order (it may allow direct download if the volume is small). NASA's Earthdata provides direct download links via HTTPS for recent JPSS CrIS data – these can be accessed with Earthdata login. For instance, the **JPSS-1 CrIS FSR** collection at LAADS or GES DISC will have data organized by date. You can script retrieval similarly to AIRS. **Example:** Using Earthdata Search for "CrIS NOAA-20 L1B" yields a collection where you can select year/month/day and get all 8-min files for that day. If there are ~180 minutes per orbit, and orbit period ~101 minutes, you'll have ~12–15 files per orbit, and ~14–15 orbits per day (similar to AIRS count). In total, around 2700 FOVs per granule * 15 granules per file * maybe 180 files/day for FSR (just to give an idea of data volume).

Previewing/Verification: Each CrIS SDR HDF5 file often contains a *browse image* or quicklook – the NOAA CLASS description hints at "including browse images when available" [65], and the CLASS interface might show a preview if you click on a granule. The browse could be, for example, a false-color IR image or a specific channel's footprint map. If not, you can manually create a quicklook: given the HDF5, open it with HDFView or Python (`h5py` or `netCDF4`). Identify one channel in each band to plot. A common choice is to use a window channel in LWIR (~900 cm^{-1}) and map the radiance to brightness temperature to visualize Earth's thermal emission. Plotting that for all FOVs in the file (arranged by scanline and position) yields an image of the Earth's swath – you should see coherent Earth scenes (with cold clouds, warm surfaces), verifying the file integrity. Additionally, you can verify spectral content by extracting the radiance spectrum for one FOV and comparing to expected spectra or to IASI if you have it. The CrIS bands are separate in the file, so you might have arrays like `LWIR_Radiance[nsounds, n_LW_channels]`, etc., and you'd need to patch them together for a full spectrum. The **data description** confirms the band ranges and that it includes **geolocation (GCRSO)** and radiances (SCRIS) [56] [60] – these correspond to datasets in the file (e.g., lat/lon arrays and radiance arrays). Check the metadata attributes for calibration – often there will be an attribute indicating radiance units (usually $W/m^2/sr/cm^{-1}$ or $mW/cm^2/sr/(cm^{-1})$). If values seem off (e.g., extremely large), ensure you apply scale factors (some SDRs encode radiance as scaled integers). The CLASS note indicates that since late 2014 CrIS is in FSR mode (no gap in coverage) [66], so modern files have full spectra. If you retrieve older S-NPP data (2012–2014), note that some channels in MWIR/SWIR were not present (they used a smaller FFT length) unless you get the reprocessed FSR versions (which CLASS offers separately as RPCRISSDR) [67]. For most users interested in current data (JPSS-1, JPSS-2, etc.), all files will be FSR. Once you confirm one file's content, you can proceed to get more – using the same method for different dates or using NOAA's automated access if available (CLASS allows scripted ordering via their API key system). All CrIS SDR files in HDF5 maintain a consistent structure and include detailed **metadata attributes** (platform, band info, algorithm version, etc.) [68], which you should retain for documentation.

Label/Metadata Note: Each dataset above includes both data values and metadata needed to interpret them. For satellite files (OMI, MODIS, AIRS, IASI, CrIS), the file headers or accompanying documentation describe the spectral channels, calibration coefficients, and georeferencing. For example, OMI's netCDF files follow CF conventions with variables for wavelength grid and units [3], AIRS/CrIS HDF include global attributes for central wavelengths and radiance units [36] [60], and MODIS HDF carries scale factors and band identifiers in its metadata. AERONET's text files have header lines specifying site location, instrument ID, and the **exact wavelengths** (in μm) corresponding to each AOD column [12]. It is crucial to use these metadata to correctly label plots (e.g., knowing that "Band3" in MODIS is 469 nm, or that IASI channel 3000 corresponds to 1080.0 cm^{-1}, etc.). The URLs and methods provided ensure you can obtain not just the data but also any README files or product guides (often available on the same portals) for in-depth metadata descriptions.

How to Find More Data in Same Format: Once you have identified a dataset and retrieved sample files, scaling up is usually straightforward. All the mentioned providers support bulk downloads or programmatic access. For NASA Earthdata (OMI, MODIS, AIRS, CrIS via EOSDIS): consider using **NASA's Harmony/OPeNDAP APIs** or command-line tools like `wget` or `curl` with your Earthdata credentials saved. GES DISC often provides a "Download script" option that generates a list of file URLs for a given date range query. For EUMETSAT (IASI): their Data Store has an API where you can specify the product type and date range to get a list of files (which you can script to download with an API key). NOAA CLASS allows the creation of standing orders or batch orders for ranges of dates (though you must wait for email links). In all cases, the additional data will come in the **same format and structure** as the examples you've tested, so your parsing/analysis workflow can be applied uniformly. Always ensure to grab any auxiliary "*Readme*" or **user guide PDFs** provided (as seen in the OMI entry with various PDF docs [6], or the MODIS user guide [25]) – these contain details on file format, quality flags, and any caveats (like known issues or version changes).

By leveraging these datasets – OMI and AERONET for UV–Vis, MODIS and AVIRIS for extended Vis/NIR reflectance, and AIRS, IASI, CrIS for IR – you have access to calibrated spectral observations of Earth's surface and atmosphere across the required wavelength regions. Each dataset comes with the tools and documentation to obtain raw data files and verify their content visually or through metadata before deeper analysis, ensuring confidence in using the raw spectral data.

Sources: The information above is drawn from official dataset documentation and portals: for example, NASA GES DISC's descriptions of OMI UV radiance coverage [1], AERONET's site detailing its spectral channels and data access [8] [15], NASA's MODIS product guides [22] [20], the JPL AVIRIS data repository notes [30], the AIRS Level 1B product specification (JPL/NASA) [36], NOAA and EUMETSAT metadata for IASI [44], and NOAA CLASS documentation for CrIS [56] [60], among others. Each linked reference corresponds to an authoritative source confirming the spectral ranges, data formats, and access mechanisms discussed.

---

[1] [2] [3] [5] [6] OMI/Aura Level 1B UV Global Geolocated Earthshine Radiances V004 (OML1BRUG) at GES DISC - Catalog
https://catalog.data.gov/dataset/omi-aura-level-1b-uv-global-geolocated-earthshine-radiances-v004-oml1brug-at-ges-disc-7655e

[4] [36] [39] [40] [41] [42] [43] AIRS/Aqua L1B Near Real Time (NRT) Infrared (IR) geolocated and calibrated radiances V005 (AIRIBRAD_NRT) at GES DISC - Catalog
https://catalog.data.gov/dataset/airs-aqua-l1b-near-real-time-nrt-infrared-ir-geolocated-and-calibrated-radiances-v005-airi

7 8 11 12 15 16 17 AERONET — Dust Aerosol Detection, Monitoring and Forecasting
https://dust.trainhub.eumetsat.int/docs/aeronet.html

9 10 Data - Aerosol Robotic Network (AERONET) Homepage
https://aeronet.gsfc.nasa.gov/new_web/man_data.html

13 14 18 19 instesre.org
https://instesre.org/Aerosols/aeronet_files/aeronet.htm

20 MODIS/Terra Atmospherically Corrected Surface Reflectance 5-Min ...
https://ladsweb.modaps.eosdis.nasa.gov/missions-and-measurements/products/MOD09

21 26 28 MODIS/Terra Surface Reflectance Daily L3 Global 0.05Deg CMG
https://ladsweb.modaps.eosdis.nasa.gov/missions-and-measurements/products/MOD09CMG

22 24 MODIS/Terra Surface Reflectance 8-Day L3 Global 500m SIN Grid
https://ladsweb.modaps.eosdis.nasa.gov/missions-and-measurements/products/MOD09A1

23 MOD09GA - MODIS/Terra Surface Reflectance Daily L2G Global ...
https://ladsweb.modaps.eosdis.nasa.gov/missions-and-measurements/products/MOD09GA

25 [PDF] MODIS Surface Reflectance User's Guide | LP DAAC - USGS.gov
https://lpdaac.usgs.gov/documents/306/MOD09_User_Guide_V6.pdf

27 MODIS/Terra Surface Reflectance 8-Day L3 Global 500m SIN Grid ...
https://registry.opendata.aws/nasa-mod09a1/

29 AVIRIS Data Product Download Readme File - NASA
https://aviris.jpl.nasa.gov/dataportal/20170911_AV_Download.readme

30 31 32 35 AVIRIS - Airborne Visible / Infrared Imaging Spectrometer - Data
https://aviris.jpl.nasa.gov/data/free_data.html

33 AVIRIS-NG Surface Spectral Reflectance — SnowEx Hackweek 2024
https://snowex-2024.hackweek.io/tutorials/albedo/aviris-ng-data.html

34 Data Catalog | NASA Earthdata
https://www.earthdata.nasa.gov/data/catalog

37 38 Level 1 | About the Products – AIRS
https://airs.jpl.nasa.gov/data/products/level-1/

44 46 49 50 51 53 54 55 MetOp Series Infrared Atmospheric Sounding Interferometer (IASI) Level 1C Data
https://www.ncei.noaa.gov/access/metadata/landing-page/bin/iso?id=gov.noaa.ncdc:C01680

45 IASI Level 1C - All Spectral Samples - Metop - Global
https://navigator.eumetsat.int/product/EO:EUM:DAT:METOP:IASIL1C-ALL

47 48 How do I read IASI GDS L1C in Python?
https://earthscience.stackexchange.com/questions/7302/how-do-i-read-iasi-gds-l1c-in-python

52 IASI Level 1C Climate Data Record Release 1 - Metop-A
https://navigator.eumetsat.int/product/EO:EUM:DAT:0101

56 57 58 59 60 61 63 64 65 66 67 68 NOAA's Comprehensive Large Array-data Stewardship System
https://www.aev.class.noaa.gov/saa/products/search?datatype_family=CRIS_SDR

62 JPSS-1 CrIS Level 1B Full Spectral Resolution V3 (SNDRJ1CrISL1B ...
https://access.earthdata.nasa.gov/collections/C1952167461-GES_DISC