Levels of Data Processing

Data Processing Levels

NASA's Earth Observing System Data and Information System (EOSDIS) data products are processed to various levels ranging from Level 0 to Level 4. Level 0 products are raw data at full instrument resolution. At higher levels, the data are converted into more useful parameters and formats that include error correction and interpolation of missing data pixels. The levels are summarized here:

Remote Sensing Data Processing Levels	
Data Level	**Description**
Level 0	Raw, unprocessed instrument and payload data at full resolution.
Level 1A	Level 0 with added time-reference and annotations for ancillary information
Level 1B	Level 1A processed to sensor units (not all sensors have Level 1B)
Level 2	Level 1 with derived geophysical variables at the same resolution and location
Level 3	Level 2 with variables mapped on uniform space-time grid scales with some completeness and consistency
Level 4	Model output or results from analyses of lower-level data (e.g., variables derived from multiple measurements)

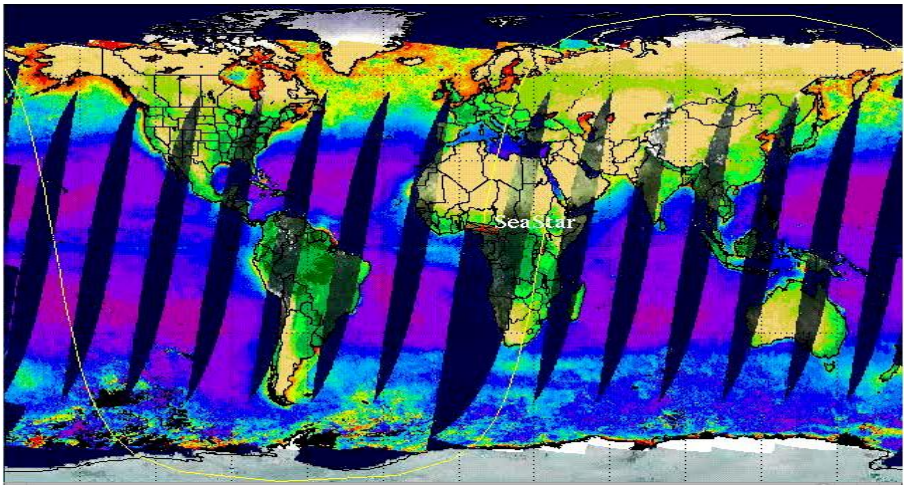
As more agencies recognize and apply these processing levels, greater consistency between the data archives of different agencies is achieved. Most of the remote sensing products K-12 learners will encounter are Level 2 or Level 3, and some may be Level 4. Data issued from a database processed to Level 2 or 3 is time-referenced, error corrected, interpolated, georeferenced (each pixel is correlated with latitude and longitude), and displayed in a gridded map image with false color keyed to a data range legend.

Time Series Data

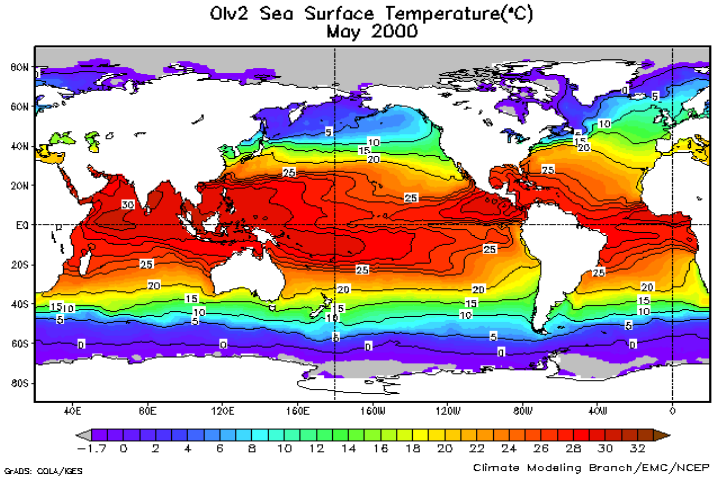
Encourage K-12 learners to use **time series** (time-averaged or interpolated) imagery instead of single pass data for two reasons: (1) the difficulty in discovering change over time in single images and (2) the width of scan swathes.

NASA's Earth Observatory and NOAA's Environmental Visualization Laboratory regularly publish single images of significant events accompanied by appropriately detailed descriptions and explanations. The archived images and accompanying documentation are newsworthy and informative – and the views of the Earth from space are, more often than not, spectacular! While single images are attractive and interesting, K-12 learners have little basis for comparison when viewing them. Research questions often require multiple images of the same area at specific intervals in order to discover trends of change over time. This need is addressed when the investigator finds data sets that include scans of the same area at different times. Data images are especially useful when they have already been processed to display at the same geographic orientation and scale.

The scan swathe is the ground trace of the actual scan by the remote sensor. In a single day, the scan swathe of a sensor on a polar-orbiting satellite generally does not overlap the swathe traced by the last orbit. There are gaps between swathes that widen towards the equator as shown here.



Because of the satellite's orbital period and inclination, the scan swathes of the next day are offset from, and slightly overlap, the previous day swathes. It takes several days of constant scanning to cover the entire surface of the Earth. Once sequential single day data are collected, the data are averaged over 5 or 8 days as well as monthly and even annually. In these time-averaged data sets, missing data are interpolated from existing data in surrounding pixels (Level 2). Very often, the data sets are also georeferenced with latitude and longitude and overlaid with a gridded map and color coded (Level 3).



The resulting image, like the one above, is easier for K-12 learners to relate to and analyze in the classroom. Even though the data are averaged, trends of change over time can be discovered from multiple images at intervals of a week, month or year. Unless the particular research requires otherwise, the use of averaged and interpolated data is recommended.

Metadata

A metadata file is archived with every data set. Metadata are data about the data. A metadata file contains information about the image data, how they were obtained, how they were processed, who processed them and who archives them, their geographic orientation, and the pixel values of specific items such as a land mask, ice, and missing data pixels, and sometimes an equation for calibrating pixel value to an external parameter like temperature. The pixel values (brightness) of the original image vary from 0 to 255 in an 8-bit image. That's 256 possible gray tones for each pixel and the original image is gray tone. As learners color enhance, analyze, and interpret an image, questions may arise that can only be answered by looking up the metadata.