

Title:	Mapping Global Carbon Dioxide Concentrations Using AIRS
Product Type:	Curriculum
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Target audience:	Undergraduate
Format:	Tutorial (pdf document)
Software requirements* :	ArcMap 9 or higher (ArcGIS Desktop)
Data:	All data required are obtained within the exercise.
Estimated time to complete:	2 hrs.
Learning objectives:	<ul style="list-style-type: none"> • Learn about infrared sensing and the Atmospheric Infrared Sounder (AIRS) instrument • Download and import data from the AIRS instrument • Make a map of monthly worldwide carbon dioxide data in ArcGIS

*Tutorials may work with earlier versions of software but have not been tested on them



Mapping Global Carbon Dioxide Concentrations Using AIRS

Objective:

- Learn about infrared sensing and the Atmospheric Infrared Sounder (AIRS) instrument
- Download and import data from the AIRS instrument
- Make a map of monthly worldwide carbon dioxide data in ArcGIS

The Atmospheric Infrared Sounder, AIRS, monitors temperature, humidity, and greenhouse gases in the atmosphere using infrared channels. Greenhouse gases absorb heat emitted from the earth's surface, and radiate it back out at a lower temperature. AIRS has 2,378 infrared detectors ranging in wavelength from 3.74 μm to 15.4 μm to detect the outgoing infrared radiation from the earth's atmosphere and allow scientists to derive the concentration of the greenhouse gases which absorb radiation in this spectral region.

AIRS also measures the atmospheric pressure at 24 different pressure levels. These range from 1000 millibars (mb) in pressure at the surface to 1 mb of pressure at the top of the atmosphere.

AIRS works in conjunction with microwave sensors, the Advanced Microwave Sounding Unit (AMSU) and the Humidity Sounder for Brazil (HSB), to collect data when cloud cover is present and to monitor water vapor. Clouds block infrared waves, but microwaves can penetrate clouds. Together AIRS, AMSU, and HSB collect data on greenhouse gases (like carbon dioxide and water vapor), global climate change and the weather. The accuracy of these instruments is comparable to data collected from weather balloons. AIRS, AMSU, and HSB are onboard the Aqua satellite and have been collecting data since 2002. AIRS/AMSU/HSB provide daily, 8-day composite and monthly data. AIRS has a swath width of 1650 km (1025.26 mi or 49.5°) and provides daily global coverage.

AIRS TOTAL PRECIPITABLE WATER VAPOR (millimeters) 20120711-20120713

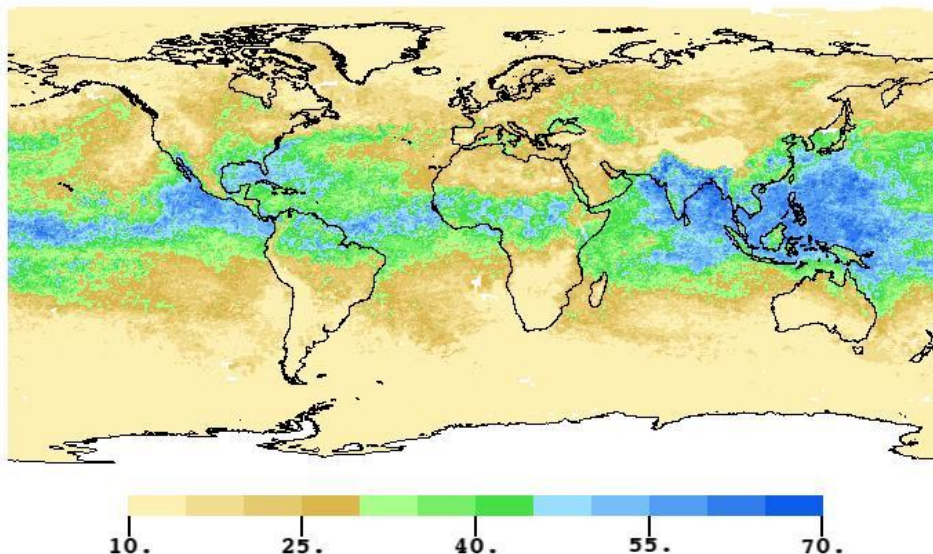


Figure 1. Global water vapor. Sample of 3-day composite from AIRS. From:
http://airs.jpl.nasa.gov/maps/satellite_feed/water_vapor_total_column/water_vapor_total_column.html

1. Download AIRS CO₂ data

Visit the AIRS website <http://airs.jpl.nasa.gov/> to download Monthly CO₂ data (AIRX3C28)

Click on the Data tab > on the webpage select Get AIRS Carbon Dioxide Data

Select Data access via Mirador to the Level 3 CO₂ (daily, 8-day, monthly) Data Products. **Select Monthly data.**

Mirador is a data search and order tool. Level 3 data will be downloaded.

Access to AIRS Tropospheric Carbon Dioxide Products

The AIRS CO₂ product files may be freely downloaded from the Goddard Earth Sciences (GES) Data and Information Services Center (DISC). The links listed below will give you access to all the AIRS carbon dioxide data products.

A web page with links to all methods of access to AIRS Data Products:

<http://disc.sci.gsfc.nasa.gov/AIRS/data-holdings>

Links on this web page may be used to search for and subset all AIRS data products by type, geospatial location, and time and to download them via ftp or directly via links on web pages.

Data access via Mirador to the Level 2 (standard, support) CO₂ Data Products:

<http://mirador.gsfc.nasa.gov/cgi-bin/mirador/collectionlist.pl?keyword=airx2stc>

<http://mirador.gsfc.nasa.gov/cgi-bin/mirador/collectionlist.pl?keyword=airx2spc>

Data access via Mirador to the Level 3 CO₂ (daily, 8-day, monthly) Data Products:

Daily: <http://mirador.gsfc.nasa.gov/cgi-bin/mirador/collectionlist.pl?keyword=airx3c2d>

8-Day: <http://mirador.gsfc.nasa.gov/cgi-bin/mirador/collectionlist.pl?keyword=airx3c28>

Monthly: <http://mirador.gsfc.nasa.gov/cgi-bin/mirador/collectionlist.pl?keyword=airx3c2m>

Corresponding links for data access via the Web Portals:

http://disc.sci.gsfc.nasa.gov/AIRS/data-holdings/by-data-product/airsL2_Stc

http://disc.sci.gsfc.nasa.gov/AIRS/data-holdings/by-data-product/airsL2_Spc

<http://disc.sci.gsfc.nasa.gov/AIRS/data-holdings/by-data-product/AIRX3C2D>

<http://disc.sci.gsfc.nasa.gov/AIRS/data-holdings/by-data-product/AIRX3C28>

<http://disc.sci.gsfc.nasa.gov/AIRS/data-holdings/by-data-product/AIRX3C2M>

The sample L2 swath and L3 grid data readers provided with the AIRS V5 documentation package are available here:

<http://disc.sci.gsfc.nasa.gov/AIRS/documentation>

AIRS/ Aqua Level 3 Monthly CO₂ in the free troposphere (AIRS + AMSU) (AIRX3C2mM) is returned.

The free troposphere is the mid to upper portion of the troposphere at an altitude where concentrations are not influenced by local topography. (The troposphere extends from sea level up to approximately 18 km at the equator and 7 km at the poles.)

Click View Files> Find the month you are interested in and click OPeNDAP

Mirador
Data Access Made Simple

You are here: [Keyword Search](#) » [Data sets from air3c2m search](#) » [File Listing of air3c2m](#) » Service Selection » Your Cart » Checkout

AIRS Version 4 Retirement 2011-09-16
In anticipation of Aqua AIRS Version 6 data products coming on line plans are underway to remove AIRS Version 4/Collection 3 data from the online archive when Version 6 becomes available. Version 6 data are expected to be released to the public in the Fall 2011. Versions 5 and 6 represent significant improvements in data quality and will continue to be available in the on line archive. [more info...](#)

Keyword Projects Science Areas

Results 1 - 15 for air3c2m (1 second)

AIRS/Aqua Level 3 Monthly CO2 in the free troposphere (AIRS AMSU) [info](#)

The following services are available for the data set(s). Whenever you add files to the shopping cart, you will be presented with options for selecting these services.

Download via HTTP

<input checked="" type="checkbox"/> Select All in Page <input type="checkbox"/> File Names/Descriptive File Names	Start Time
<input checked="" type="checkbox"/> AIRS.2012.01.01.L3.CO2Std031.v5.9.14.12.X12039173547.hdf (0.49 MB) One Click Download: HDF (FTP) HDF (HTTP) OPeNDAP	2012-01-01 00:00:00 Metadata
<input checked="" type="checkbox"/> AIRS.2011.12.01.L3.CO2Std031.v5.9.13.37.X12011124909.hdf (0.49 MB) One Click Download: HDF (FTP) HDF (HTTP) OPeNDAP	2011-12-01 00:00:00 Metadata
<input checked="" type="checkbox"/> AIRS.2011.11.01.L3.CO2Std030.v5.9.13.37.X12011123522.hdf (0.49 MB) One Click Download: HDF (FTP) HDF (HTTP) OPeNDAP	2011-11-01 00:00:00 Metadata
<input checked="" type="checkbox"/> AIRS.2011.10.01.L3.CO2Std031.v5.9.13.37.X12011122529.hdf (0.49 MB) One Click Download: HDF (FTP) HDF (HTTP) OPeNDAP	2011-10-01 00:00:00 Metadata
<input checked="" type="checkbox"/> AIRS.2011.09.01.L3.CO2Std030.v5.9.12.18.X11297090518.hdf (0.49 MB) One Click Download: HDF (FTP) HDF (HTTP) OPeNDAP	2011-09-01 00:00:00 Metadata
<input checked="" type="checkbox"/> AIRS.2011.08.01.L3.CO2Std031.v5.9.9.1.X11263082049.hdf (0.49 MB) One Click Download: HDF (FTP) HDF (HTTP) OPeNDAP	2011-08-01 00:00:00 Metadata

OPeNDAP stands for Open Source Project for a Network Data Access Protocol. It distributes the same data as FTP and HTTP, but OPeNDAP data is used because it is georeferenced.

The OPeNDAP Server Dataset Access Form page opens. Leave the default setting as they are and click Get as NetCDF. A hdf.nc file will download.

OPeNDAP Server Dataset Access Form

Action:

Data URL:

Global Attributes:

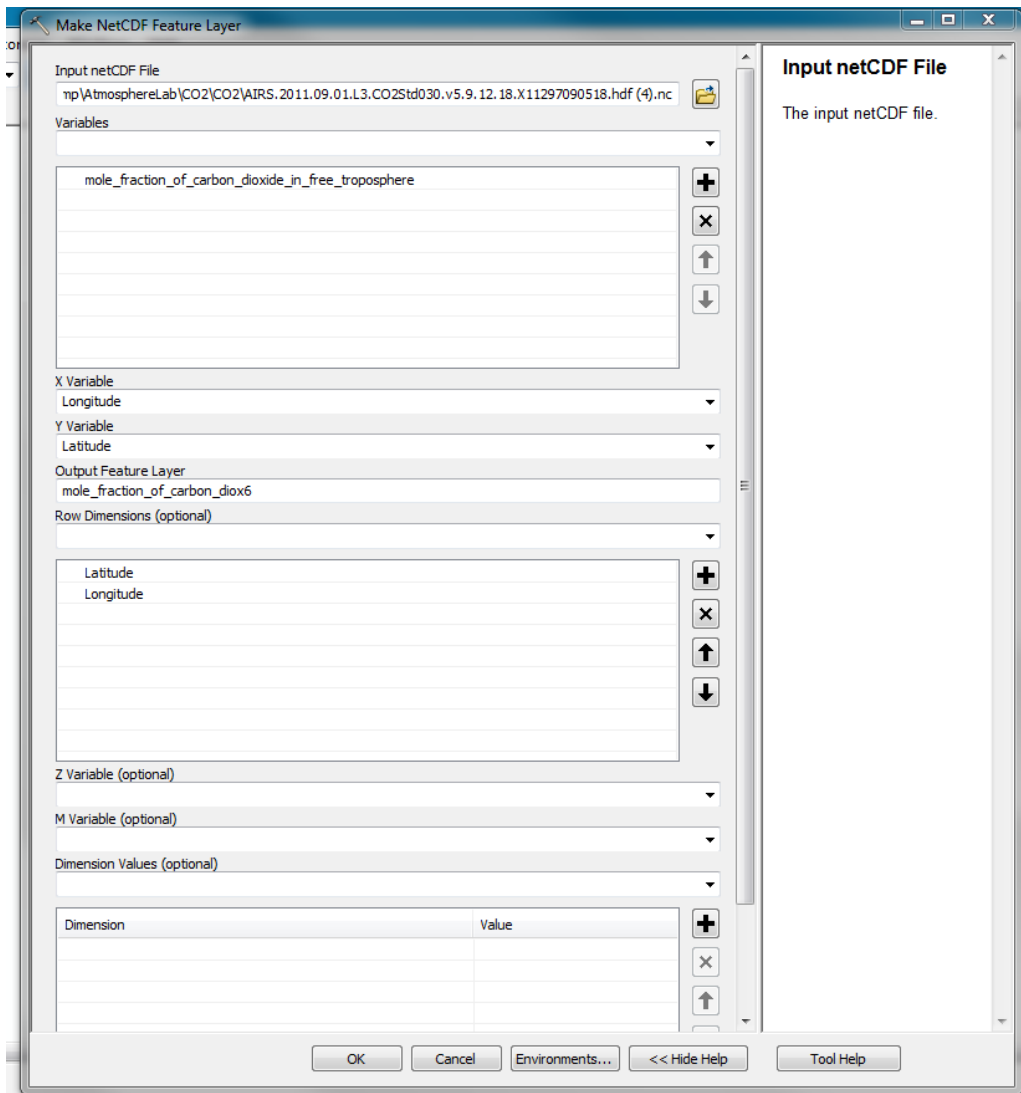
```
coremetadata.INVENTORYMETADATA.GROUPTYPE: MASTERGROUP
coremetadata.INVENTORYMETADATA.ECSDATAGRANULE.LOCALGRANULEID.NUM_VAL:
1
coremetadata.INVENTORYMETADATA.ECSDATAGRANULE.LOCALGRANULEID.VALUE:
"AIRS.2012.01.01.L3.CO2Std031.v5.9.14.12.X12039173547.hdf"
```

Variables: **Latitude:** Array of 32 bit Reals [Latitude = 0..90]

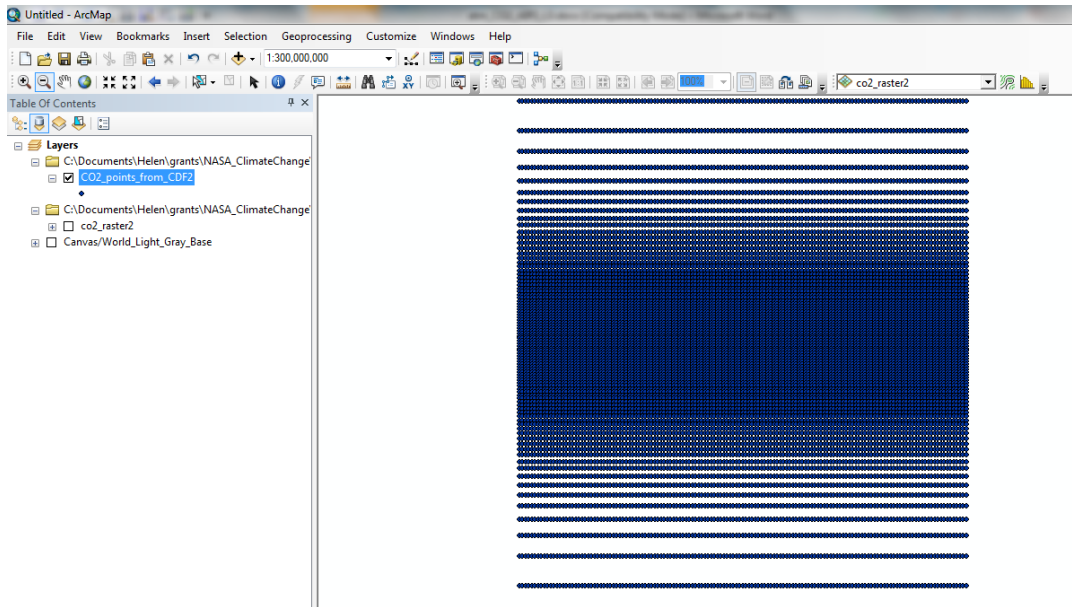
NetCDF stands for Network Common Data Form. This file format can store many layers of data such as CO₂, temperature, or ozone data in one file.

Open ArcMap. Do not add the downloaded layer to the map yet. Instead use the tools search box to find the Make NetCDF Feature Layer tool. This will make a point layer from the downloaded file. For some data, the Make NetCDF Raster Layer tool can be used however this requires that the data be evenly spaced. In our case the ground pixels are not evenly spaced so the Feature Layer tool must be used followed by interpolation to generate a raster.

Drag the downloaded layer into the tools input box. In the variables box select Mole_fraction_of_carbon_dioxide_in_free_troposphere click OK. (Mole fraction of CO₂ reports the amount of CO₂ in the atmosphere as a relative amount (fraction of air molecules).)

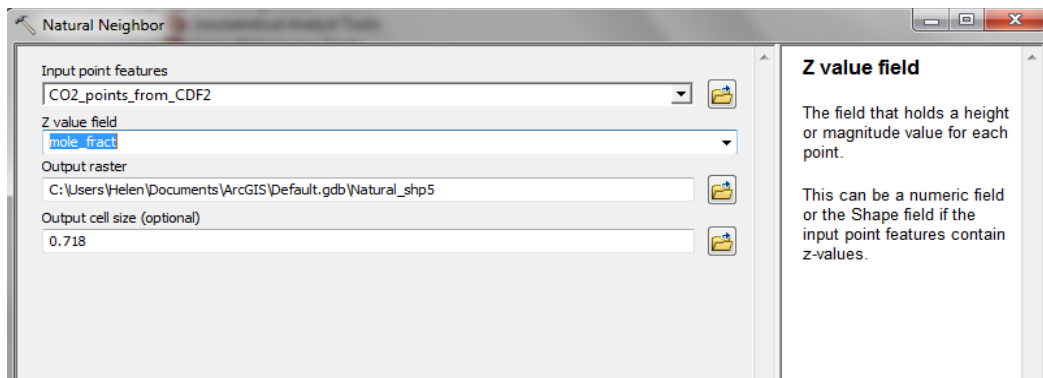


Make sure the X variable is set to “Longitude” and the Y variable to “Latitude”. Set the Row Dimension to Latitude and Longitude. This will force the feature layer to create a point for each unique value (in our case each latitude and longitude cell).



Right click on this layer. Choose Data -> Export Data and Save this layer as a Shapefile. (In this example it is named "CO2_points_from_CDF2".)

Now the points will have to be interpolated to produce a raster. This can be done using Spatial Analyst. Open up Spatial Analyst in your toolbox and select Natural Neighbor.

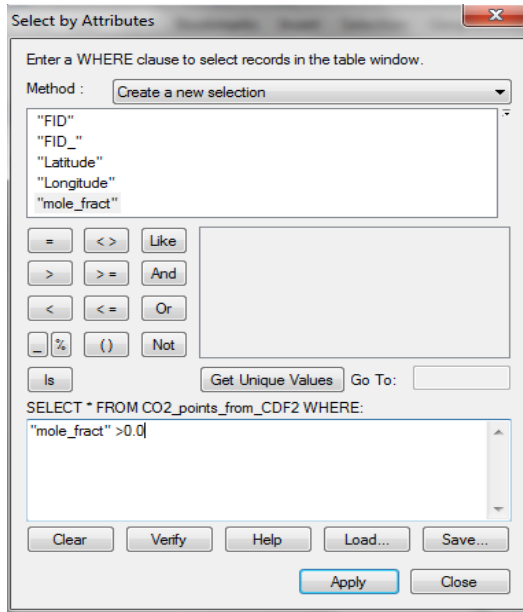


Select the point layer as your input features. Select mole fract. as the z-value (this is the CO₂ concentration). Choose the location and name for your output raster.

Add a Light Gray Canvas base map, Shaded Relief map, or similar to see the CO₂ distribution on a map. Set the transparency on the CO₂ raster layer to see the map beneath it.

At high latitudes fill values (-9999) are used where there is no data. To avoid these displaying and dominating the symbology coloring scheme it is best to remove these from the point layer before interpolating. The simplest way to do this is to use the Select by Attribute tool to create an expression where only positive values are selected. Right click on your points layer, Open the Attribute Table, Select by Attribute, type in the expression "mole_fract" >0 and click on Apply. This will select the appropriate records from the attribute table. While these are selected open Spatial Analyst and repeat the Natural

Neighbor interpolation using this layer again. This time the interpolation will use only the positive values of CO₂ concentration (and eliminate the -9999 fill values) in creating the raster layer.



Change the output CO₂ classification to 10 classes, choose an appropriate color scheme and change the transparency to 50% or so. Examine the CO₂ results in relation to the base map.

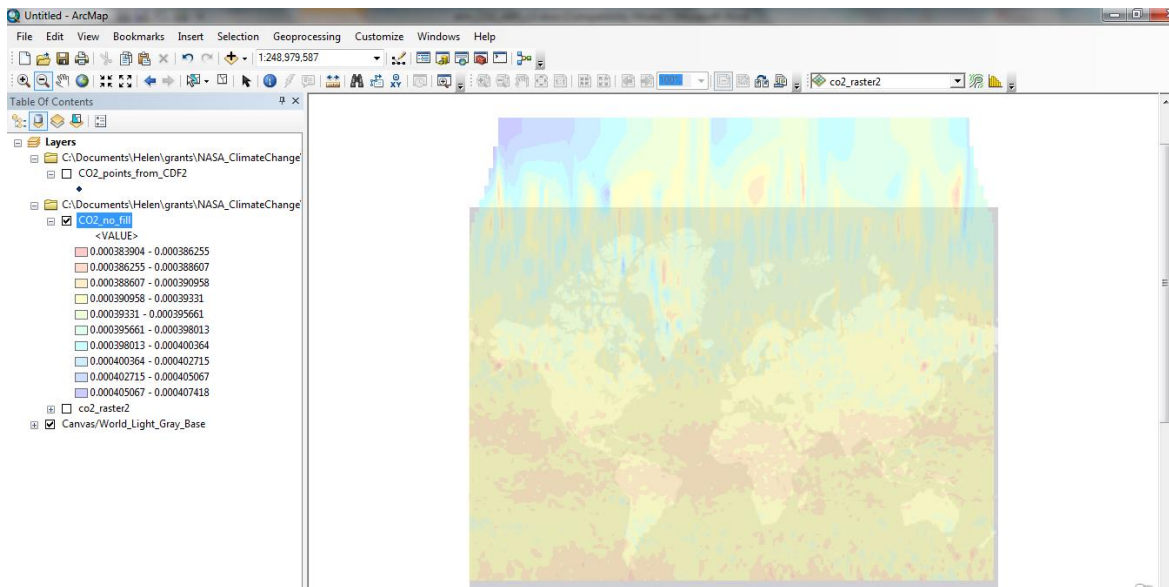


Figure2. CO₂ monthly average data in mole fraction for February 2012. Data is for mid-troposphere and collected at 1:30 pm local time.

The data shows the monthly CO₂ averages at the middle troposphere gridded into 2° x 2.5" cells and measured in fraction of atmosphere. To convert to parts per million (ppm), multiply values by a million (10⁶).