Content Creation Guidelines *Updated for SOS 5.1.0+ (08/2016)*

New datasets are always welcome for Science On a Sphere®! Here are a few simple guidelines to assist in the creation of content. The SOS team has significant experience with technical and aesthetic issues when creating content for spherical display systems, and is happy to provide feedback and suggestions during production to ensure quality content.

Part 1 covers useful information for creating content

Part 2 outlines the steps for adding a new dataset to the SOS catalog

Part 1 – Creating New Content

Data Format

There are two basic types of datasets for SOS:

Texture - Single Image

Can be displayed on the sphere and animated, as in a planetary rotation. An example of this is a global image of the Earth's topography and bathymetry. It's a static image that can be manipulated and rotated in real time from the user interface or remote control

Time Series - Image Sequence or MPEG4

Animates through time. An example of this would be a loop of satellite data. For an image sequence, SOS will display the images in sequence and play them like a movie across the entire sphere surface. Image sequences can be of any arbitrary length, limited mainly by disk space and can be animated at frame rates up to 30 frames per second (fps). MPEG4's allow for higher resolution and faster frame rates than image sequences. Transitions, special effects, and other computer graphics techniques can be added to a sequence through the use of off the shelf software like Final Cut Pro.

Map Projection – Equatorial Cylindrical Equidistant Projection

This is a simple latitude/longitude grid with the lines evenly spaced where the image is twice as wide as it is tall. To be consistent with the SOS Data Catalog, it is recommended that the 0° line go through the middle of the map, with the +/-180° lines at the edges.

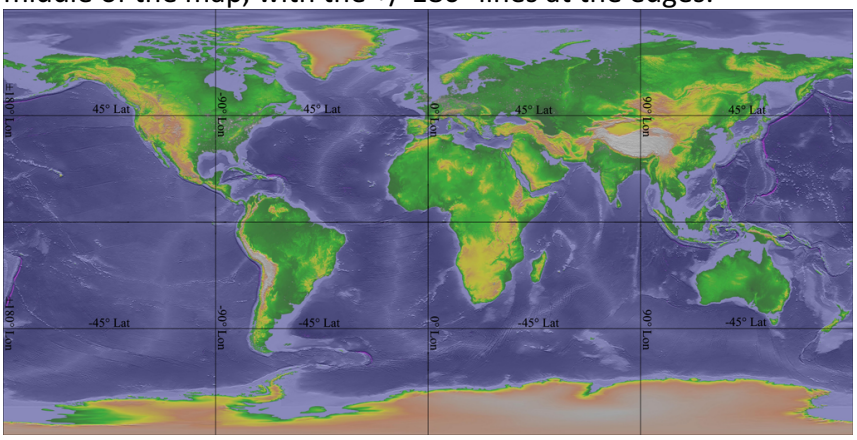


Image Format – JPEG or PNG for single images and image sequences
SOS will accept most common formats (JPEG, PNG, GIF, TIFF, etc.), but JPEG and PNG are preferred.

Video Format – MPEG4
Render the video with the MPEG4 video codec at a minimum of 25 mbps. Just because a file has a .mp4 extension does not mean it will play perfectly on SOS. Be sure to check the codec that was used to render the file. The H.264 codec should not be used because it can cause errors in the SOS software.

Alternative Format – KML
The software also has the ability to display KML (Keyhole Markup Language) files on Science On a Sphere. KML is a popular specification and actively used with Google Earth for displaying data on a sphere. The initial SOS KML capability supports a limited set of the entire specification, which includes many of the commonly used KML features you would typically display in Google Earth. An SOS playlist can reference both KML and the compressed KMZ formats using the layerdata keyword.

Alternative Format – WMS
SOS has an experimental capability to specify and load images directly from an Open GeoSpatial Consortium (OGC) Web Mapping Service (WMS). This feature requires an internet connection and will not work unless the SOS system has access to the internet and the referenced WMS Server. A WMS provides a service allowing users to request data through URLs using specific key value pairs defining terms such as the width, height, image type, etc. A unique feature of the WMS standard allows users to request subsets of imagery by defining a bounding box using a lower left and upper right latitude and longitude coordinates. The combination of these features allows users to host very large high resolution imagery and users can request smaller versions or subsets of the original imagery. SOS takes advantage of this functionality through the magnifying glass, allowing users to see more detail as you increase the zoom level on the sphere. A tutorial specifically for using WMS with SOS can be found here: http://sos.noaa.gov/Docs/WMS-tutorial.pdf .

Audio Format – MP3, MPEG4, WAV, OGG, AIF…
The audio player for SOS is fairly versatile and most common formats will work with SOS. The audio file can either be a standalone file or embedded in the same MPEG4 file as the video.

Resolution – 2048x1024 for animations, 4096x2048 for textures
Those are the recommended resolutions, though other 2x1 resolutions, such as 3000x1500 will work. Higher resolutions are possible for the animations, but not all SOS systems in the SOS Users Collaborative Network are able to animate at 30 frames per second for higher resolutions. Make sure to render the videos with square (1:1) pixels for proper playback. If possible, the highest resolution of the animation that is generated should also be provided, in addition to the 2048x1024 file, so that it is available in the future as the computers, software and projectors improve. If an image sequence is provided, it will be rendered into a MPEG4 file

that is 2048x1024 unless there is a specific reason to keep the animation as an image sequence. For single images, resolutions above 4096x2048 are possible, though load time increases with resolution size.

As of release 5.0, the SOS software is capable of running higher resolution 4K projectors. If you wish to create higher resolution images and movies to take advantage of the higher resolution quality of 4K projection, the same 2:1 ratio rules apply. Movies with 4096x2048 resolution will work on such systems, although decreased fps rates may be necessary and the load time will be longer. Single images of 8192x4096 will display well on 4K projectors and images as large as 16384x8192 should still work, although resolutions above 8192x4096 will result in only slightly increased quality. We recommend that you test any high resolution images and movies you create on a full 4K projector system to ensure they will display as you expect.

Content Considerations

File Names – Based on Resolution, Time Stamp, and Content
Single images are typically named for their resolution, such as 4096.jpg. Image sequences are kept in folders that are named for their resolution, and the images themselves should be named to sort in ascending order from earliest to latest. This can either be done with a time stamp in the file name, or a frame number in the file name with a sufficient number of leading zeros in ensure proper sorting, shown in the example below. Videos should be named based on content and resolution, such as hurricanes_2048.mp4. By including the resolution in the file names, SOS users are able to easily determine what is available and appropriate for their system. Linux and the SOS software do not handle spaces and special characters in file names well. *Do not use spaces and special characters in file names!*

Named by date

```
snow_ice_2048_20110730.png
snow_ice_2048_20110731.png
snow_ice_2048_20110801.png
snow_ice_2048_20110802.png
snow_ice_2048_20110803.png
snow_ice_2048_20110804.png
snow_ice_2048_20110805.png
```

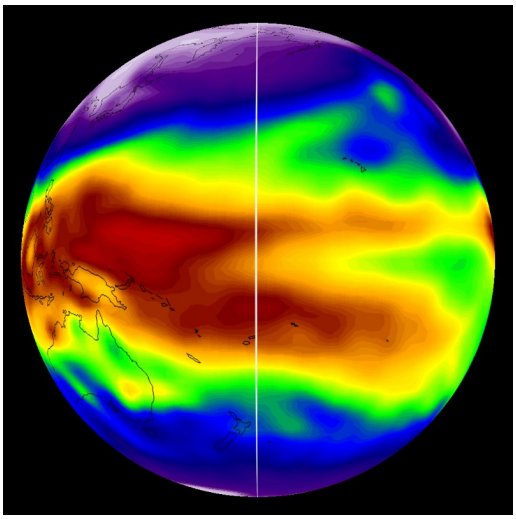
Named by frame count

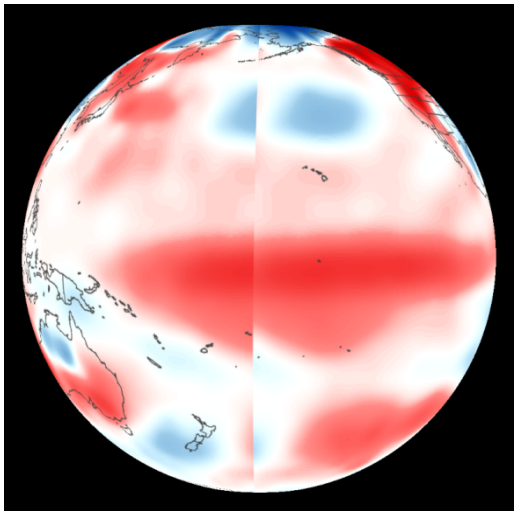
```
sos_jpl_4096.0001.jpg
sos_jpl_4096.0002.jpg
sos_jpl_4096.0003.jpg
sos_jpl_4096.0004.jpg
sos_jpl_4096.0005.jpg
sos_jpl_4096.0006.jpg
sos_jpl_4096.0007.jpg
```

The data should take up the whole image, with no borders or extra space around the edges. Even a pixel border will show up as a seam! In most cases, a simple 1% stretch in the horizontal will fix the problem. The data should match up at the edges of the image. If it doesn't, a seam will appear where the mismatch happens and it won't look seamless on the sphere. Examples of seams problems are shown below.

In addition to making sure that the data fills the entire frame, from 180° West to 180° East, also make sure that the data fills the entire frame from 90° South to 90° North. If there is missing data at the poles, fill in the area with a solid color or a basic land/ocean background to ensure that the dataset wraps properly around the sphere without stretching vertically.

Examples of Seams – A problem to be avoided





Labels – Identifying the dataset

Labels and legends are important. For every dataset that needs a timestamp, a file called labels.txt should be generated that contains one line for each frame in the animation. A labels.txt file cannot be used with a single image. Typically the labels include the date, but can contain any desired information, as seen below.

```
07/24/2004 06:45
07/24/2004 07:15
07/24/2004 07:45
07/24/2004 08:15
07/24/2004 08:45
07/24/2004 09:15
07/24/2004 09:45
07/24/2004 10:15
07/24/2004 10:45
07/24/2004 11:15
07/24/2004 11:45
07/24/2004 12:15
```

```
SSEC 08/31/2005 Katrina
SSEC 08/31/2005 Katrina
SSEC 08/31/2005 Katrina
SSEC 08/31/2005 Katrina
SSEC 08/31/2005 Maria Katrina
SSEC 09/01/2005 Maria
SSEC 09/01/2005 Maria
SSEC 09/01/2005 Maria
SSEC 09/01/2005 Maria
SSEC 09/01/2005 Maria
SSEC 09/01/2005 Maria
SSEC 09/01/2005 Maria
```

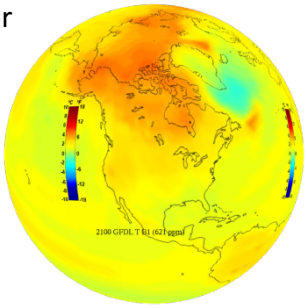
Labels should not be "burned in" the images themselves due to warping. Also, when labels are "burned in" they can be rotated out of view and tilted at odd angles when a presenter is interacting with the sphere. The position of the labels that appear from the labels.txt file remains stationary as the sphere is rotated. While the position and color of the labels can be adjusted in the playlist.sos file, the font and size cannot be adjusted.

In addition to using the labels.txt file, there are other ways of labeling the content that is on the sphere. Colorbars and legends can be added using the picture-in-a-picture feature. As with the timestamps, do not "burn in" colorbars and legends. Make sure to test the size and fonts of colorbars and legends on the sphere to ensure legibility. It seems that most colorbars and legends are too small and have to be increased in size when actually displayed on the sphere. Also make sure to test the size to ensure that the colorbars aren't so large that they hinder the audience from seeing the underlying dataset.

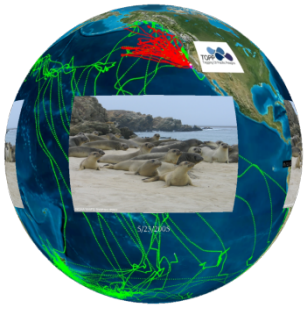
The purpose of adding labels to the sphere is to aid the visitor in understanding the dataset. Consider using pictographs for scales because they have been found to be intuitive and beneficial for visitor understanding. Also, using country or city labels can help visitors orient themselves in a global context. Another suggestion is to use vertical temperature colorbars because that is how most visitors are accustomed to reading thermometers. Size, orientation and placement of colorbars and legends are important for improving the visitor's understanding of the dataset.

Picture-in-a-Picture – Enhancing the dataset

A Picture-in-a-Picture, or PIP, can be used to enhance an existing dataset or provide supplementary documentation. Logos, images, colorbars and legends are added as PIPs. When used for a colorbar, a PIP can help label a dataset, as seen at right. As with the labels, it is not recommended to "burn in" the PIPs. Leave it as an additional image file that can be added in the playlist.sos file. This gives the user complete control over the position and size of the PIP. In general, nothing should be "burned in" to the frames for a dataset because PIPs provide a better way of labeling the dataset.



A PIP can also be used to provide a close-up view of a region or give the viewer additional context for what they are seeing. In the example at right, the underlying dataset shows the tracks of elephant seals in red, and the PIP is a picture of actual elephant seals. Multiple PIPs can be shown at the same time, or staggered to create a slideshow effect. Make sure to consider the placement of the PIP in order to not block information in the underlying dataset, especially if the PIP is displayed for an extended period of time.



By using PIPs that are PNG's with a transparent background, many different shapes can be projected on the sphere with the underlying dataset as a background. PIPs can be set to display in specific locations on the sphere as markers, as seen at right. Here each pushpin is a PIP that identifies the location of a SOS installation.

Standard PIPs shouldn't be any larger than 1024x1024 in resolution size. However, PIPs that are set to wrap around the entire sphere can be up to 4096x2048. Be aware that overlapping and warping can occur if the display size of a PIP is set too large. Make sure to test each dataset before distributing it to other sites, checking the PIP size, placement and timing. The display size can be adjusted using pipheight and pipwidth. PIPs can also be MPEG4 files or image sequences.

A PIP can also be set to be a Shared PIP, which means the PIP will remain active across multiple datasets in a presentation playlist. In addition, a real-time video feed can be played in a PIP. This feature may be useful for sites receiving SphereCasts, where, instead of needing a separate

display in the SOS room to show video of the host site's presenter, the video can be shown directly onto the sphere. This feature may also be useful if a site wants to show a real-time video feed of a remote presenter onto their sphere for a particular in-house presentation.

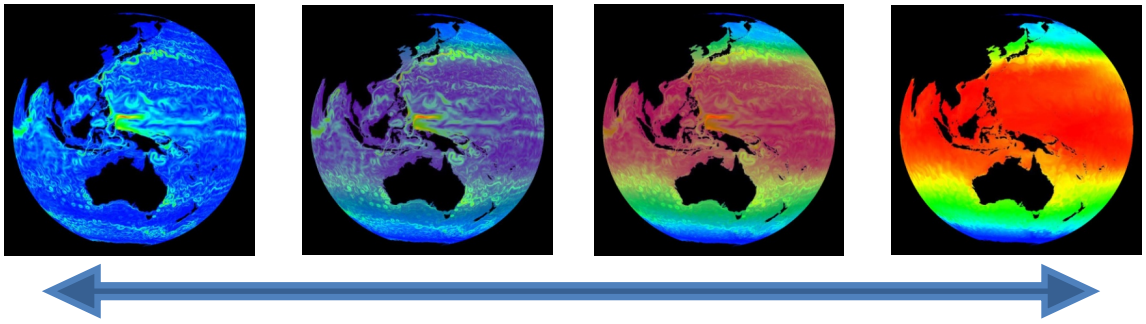
Full documentation of the PIP options can be found in the Playlist Format: http://sos.noaa.gov/Docs/Playlist.html .

Annotation and Icons – Interactively labeling datasets

The SOS Remote app, through the annotation feature, gives presenters the ability to draw on the sphere and place icons on the sphere. There is a set of default icons that come with the SOS Remote app. In addition, sites have the ability to create custom icons. If you would like to create your own icons, use a transparent PNG with a minimum resolution of 256x256. To the right is an example of one of the default icons. Custom icons can either be specified for specific datasets, or made available in the default icon library.

Layers – Adding flexibility to the dataset

The layering capability in SOS allows presenters to dynamically turn layers on and off. A multi-layer display can be created either statically in the dataset definition, or interactively using SOS Remote. By using the new Layers tab in SOS Remote, the user can toggle individual layers on and off, adjust the level of transparency of each layer, or delete a layer. Any labels or PIPs associated with a clip are now automatically placed in dedicated layers named Labels and PIPs. These can be interactively manipulated like any other layer. There is an overlays directory that includes commonly used layers, such as country borders. Below is an example of adjusting the transparency between two layered datasets.



Warping – Something to be aware of

When working with a spherical surface, warping is always something to consider. The least amount of warping occurs near the equator, while the most warping occurs at the poles. Because of this, it is recommended that any text and labels are placed near the equator. Supplementary text, labels and images that are displayed as PIPs don't warp if their position is set with the pipcoords keyword in the playlist. Datasets can be tested for warping issues using CC Sphere in Adobe After Effects or 3D Sphere in Photoshop. There are some plugins for After

Effects such as Cycore Effect's Sphere Utilities that can also help with spherical warping. In addition, these programs can be used to check for seams.

Color Suggestions

A color scale can dramatically change the emphasis and message of a dataset. Because of this, the Science On a Sphere Users Collaborative Network has had many discussions on the color scales that are used for SOS datasets. The goal is to create datasets with well-chosen color scales that are meaningful, intuitive, and scientifically accurate. Several conclusions are the result of these discussions:

1. It can be confusing to users when the same color scheme and their associated color bars are used for two completely unrelated datasets.
2. The same color should not be used to represent more than one thing. i.e. if ice is shaded white, then white should not also be used for areas of missing data.
3. Using rainbow-colored legends and color schemes is often confusing to the audience and hard to parse. Instead, consider using shades of green to represent phytoplankton, and blue and red gradations to represent temperature anomalies. i.e. use "meaningful" colors
4. Avoid using full sphere backgrounds that are completely or pre-dominantly white. The seams between projectors become more apparent when using solid white/bright backgrounds. If using bright background colors, consider adding some noise/texture to them. Same goes for PIPs, especially those displayed at the seams between projectors.

Tools Used – To create Science On a Sphere® visualizations

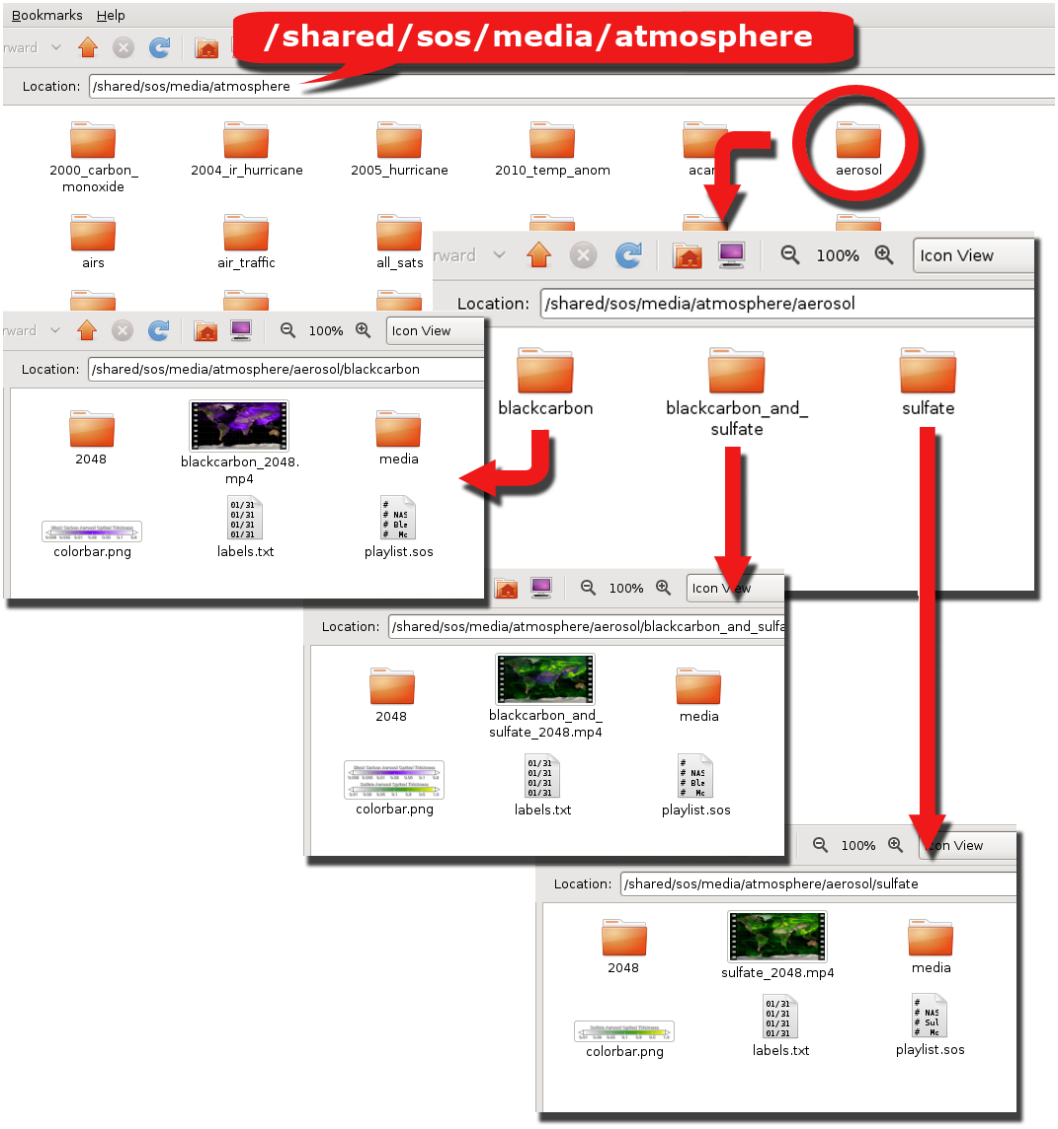
- Because Science On a Sphere® uses basic image formats like JPEG, and PNG as its main input format, there are many tools available for creating SOS datasets. Common examples are Photoshop®, ImageMagick®, GIMP, etc.
- The SOS system comes with a script called "convert2mpeg4" to convert an image sequence to an MPEG4
- For creating MPEG4 files with transitions, special effects and narration, programs such as FinalCut Pro® and Adobe After Effects® are useful.
- Tools like IDL, AWIPS, McIDAS, and other image analysis applications are typically used to create imagery from scientific data sets. Graphics designers can use a 3D modeling applications, like 3D Studio®, to create advanced visualizations.
- GIS programs such as ArcGIS or Quantum GIS can be used to create maps. A tutorial for creating SOS datasets with Quantum GIS is available here: http://sos.noaa.gov/Docs/qgis_tutorial.pdf .

Part 2 – Adding a Dataset

Content Materials

Every dataset that is added by the user to the SOS Data Catalog should be in its own individual folder in the directory */shared/sos/media/site-custom*. All datasets provided by NOAA will be in the directories organized by category. **Do not put your site-created content into the folders created by NOAA.** Complimentary or similar datasets can be grouped together in a folder that contains individual folders for each dataset. Each folder, at very minimum should contain a playlist.sos file and either an image, image sequence or video. In addition to those required pieces, folders can also contain:

- Image, Image Sequence or Video ***– required***
- Playlist.sos file ***– required***
- Labels and colorbars
- Audio file
- Picture-in-a-Picture images, image sequences, and/or videos
- Scripts or supplementary materials
- Media folder with thumbnails and videos (typically created by the SOS team)

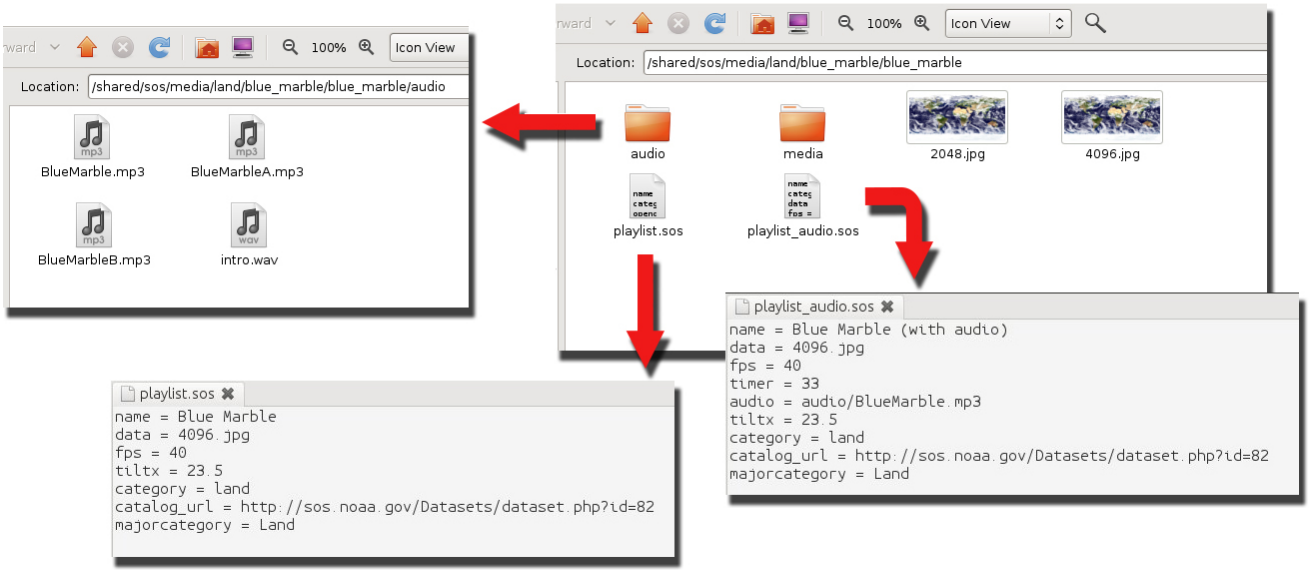


In the above example of a NOAA provided dataset, there are three datasets that are related and all from the same source. To keep them together, a folder was created in the atmosphere category called aerosol. In the aerosol folder, each dataset was given its own folder: sulfate, blackcarbon, and blackcarbon_and_sulfate. **Notice that there are no spaces in the names!** In each of the individual dataset folders there is an image sequence named for the resolution of the frames, a MPEG4 video, a media folder with thumbnails, a colorbar, labels, and a playlist.sos.

Playlist.sos File

Every dataset folder must contain at a minimum a file that is named "playlist.sos". Playlist.sos files can be generated using a text editor, such as Notepad or gedit. There can be multiple playlist.sos files in the same folder, such as playlist.sos and playlist_audio.sos, as long as they reference the same dataset. When working with multiple datasets, they should each be in their own folder with their own playlist.sos file, as shown in the aerosol example. **No playlist.sos file should point to multiple datasets.**

In this blue_marble example, there are two playlist.sos files in the folder for the blue_marble



dataset, playlist.sos and playlist_audio.sos. Both playlists point to the same data, and the only difference is that one includes audio and a timer and the other doesn't. The playlist.sos filename must start with playlist and end with .sos, but anything can be added between, such as _audio or _with_PIPs. Notice that the audio files have been put into their own folder. If there are multiple audio files or PIPs, a folder can be created in the dataset folder that contains those files. While this isn't required, it helps to keep the folder uncluttered.

When files that are referenced in the playlist.sos aren't in the same directory as the playlist.sos, the path to the file needs to be included. Take note in the playlist_audio.sos file how the audio points to audio/BlueMarble.mp3 since the mp3 file isn't in the same directory as the playlist.sos. Either relative paths (audio/BlueMarble.mp3) or full paths (/shared/sos/media/land/blue_marble/blue_marble/audio/BlueMarble.mp3) can be used in the playlist.sos files. Be careful to avoid typos, as the dataset won't work if anything is wrong!

There are many optional settings that can be included in the playlist.sos file. For a dataset added by a site into the site-custom folder, at minimum the playlist.sos file should contain the following elements:

name = My Custom Dataset
data = 4096.jpg
creator = My Museum
subcategory = land
keywords = land, Earth, My Museum
description = {{ A description for my dataset that will appear on the iPad. The description is allowed to span multiple lines and must use be enclosed with the braces characters. }}

The playlist.sos file should be formatted according to the specifications found here: http://sos.noaa.gov/Docs/Playlist.html.

In order for a new dataset to show up in the site-custom library on the local SOS computer, make sure to update the library by clicking "Library" > "Update Library…" in the SOS Stream GUI. After you have updated the library, you have to click the "Update Now" button in the Settings tab of the iPad in order for it to show up on the iPad. It will not appear on the iPad if it is not stored in the site-custom folder on the computer. In the Data Catalog tab of the iPad you will be able to find the new dataset in the subcategory that you assigned under the site-custom main category. You can create as many different subcategories as you like within site-custom.

Note: In your site-custom dataset folder, if you have a dataset playlist.sos file AND variation dataset playlists, such as playlist_audio.sos, the subcategory keyword is ignored for variation playlists. You must include the subcategory keyword in the playlist.sos file if you want this dataset and its variations to be displayed in a particular Sub Category of the Site-Custom Major Category on the iPad. Without the subcategory keyword in the playlist.sos file, this dataset and any of its variations contained in its folder will appear under the "Uncategorized" Sub Category of the Site-Custom Major Category on the iPad.

A complete list of the NOAA-created categories, subcategories and keywords can be found here: http://sos.noaa.gov/_downloads/docs/main-categories-subcategories-sos.pdf . If you want to contribute datasets to the NOAA catalog, you must select categories and subcategories from this list. Additional keywords can be added to the list as necessary.

A site can also add their own custom thumbnails to a custom dataset. Simply create a folder called media and put it in the same folder where the dataset's playlist.sos file is located. The media folder should contain two images in the .jpg format with the following names and resolutions:

thumbnail_small.jpg (128x128)
thumbnail_big.jpg (800x800)

Custom Overlay Datasets

The SOS Data Catalog includes a number of Overlay datasets, such as City Names, Country Borders and Atmospheric General Circulation. Overlays are datasets with transparent

backgrounds that contain foreground data used to augment other SOS datasets. Overlays can help provide context for your audience and make the datasets easier to understand, as well as provide information that may be useful to illustrate related global ideas.

In version 5.1+ of the SOS Remote App, you can now have your custom overlays appear in the Overlays dialog of the iPad app just as the NOAA-managed overlays appear for easy, dynamic layering. To do this:

1. In your playlist.sos file, add the following keyword-value pair (this is optional; it allows your overlay to show up in the overlays category in SOS Stream GUI's Library menu): **category = overlays**
2. In your playlist.sos file, add the following keyword-value pair (this is what makes your overlay appear in the iPad app's Overlays dialog): **subcategory = Overlays**
3. On the SOS computer's SOS Stream GUI application, select the Library menu > Update Library menu option to update the Data Catalog with your new overlay dataset. Once this is complete, on the iPad app's Settings tab, select the Update Now button, and your overlay dataset will appear in the Overlays dialog of the iPad.

Note that Overlays may also be pre-programmed into a dataset's playlist.sos file by using the **layer** keywords.

Written Material

In addition to the above material, a written description of the dataset, a list of "Notable Features," and a list of credits are also requested. All of this documentation is used to create an entry in the SOS Dataset Catalog, as seen at right. The written description should be a simple overview of the dataset that highlights the source of the data, whether it is modeled or measured, what it shows, and why it's important. It should be a non-technical description that is easily understood. The "Notable Features" is a bulleted summary of the highlights from the description that presenters can use when showing the dataset to viewers. The credits are used to fill in the column on the right-hand side. The credits listed are:

- Dataset Source
- Dataset Developer
- Dataset Visualization Developer
- Contact (optional)

These can be the same for each listing, or all different and can include links to the original sources. For examples, visit the SOS Dataset Catalog: http://sos.noaa.gov/Datasets/index.html.

Presentation Playlists

To group multiple datasets together, create a playlist, such as hurricanes.sos, that points to each individual playlist.sos file with the full path included. These playlists are to be stored in /home/sos/sosrc or /home/sosdemo/sosrc . Here is an example playlist that groups multiple datasets together:

```
include = /shared/sos/media/land/blue_marble/playlist.sos

include = /shared/sos/media/atmosphere/carbon_tracker/playlist.sos

include = /shared/sos/media/astronomy/mars/playlist.sos
```

Presentation playlists that group multiple datasets together can be named anything as long as they end with .sos. Playlists can either be typed by hand, or created using the Playlist Editor on the SOS computer, the Playlist Builder on the website, or the Playlist Builder on the iPad. In order to see new datasets in the Playlist Editor, the update the library in the SOS Stream GUI.

A new feature for 4.3.0 is the ability to add presenter notes to your playlists. Presenter notes are accessed from the iPad's SOS Remote app's Presentation tab, and can be edited either from the app's Playlist Builder tab, or manually using a text editor. If editing a playlist file manually, each line that is to be a presenter note should begin with "#>".

Presenter note lines should go at the very bottom of the presentation playlist as shown here:

```
include = /shared/sos/media/land/blue_marble/blue_marble/playlist.sos

include = /shared/sos/media/astronomy/mars/original/playlist.sos

#> Features to note about blue marble:
#> - Shading done in true color: gives Earth's appearance from space
#>
#> Features to note about mars:
#> - Olympus Mons: highest point in the solar system at 88,500 feet
```

More Information on Visualization Considerations

The following article, researching the public understanding of science content, was written by SOS Users Collaborative Network members:

Phipps, M. and Rowe, S. (2010) Seeing satellite data Public Understanding of Science. doi:10.1177/0963662508098684