Session 3
MODIS NDVI Time Series

Introduction

This exercise uses a web-based tool from the Global Agriculture Monitoring (GLAM) project to derive MODIS NDVI images and to graph the data for any given year. Graphing annual NDVI time series enables you to look at peak green up/green down times for the year. This website also enables you to compare the annual NDVI trend with the long-term average (NDVI Anomalies).

Part 1: NDVI Time Series

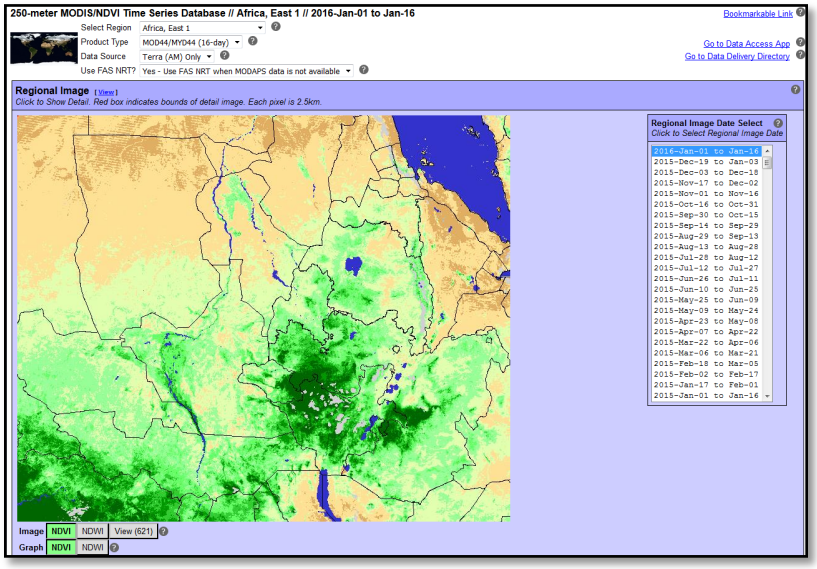
- Go to: http://pekko.geog.umd.edu/usda/test/

First you need to select your region of interest by clicking on the globe, or you can select from the list located at the bottom left of the webpage.

- Using the dropdown menu, Select Africa, East 1

The information at the top of the NDVI viewer includes:

- **Select Region** – The region that you selected, which you can change
- **Product Type** – MOD44/MYD44 is the 16-day NDVI composite and the MOD09/MYD09 is the 8-day composite. We will leave the MOD44/MYD44 product selected.
- **Data source** – You can select data from the Terra or Aqua satellites or both. We will leave the Terra satellite selected.
- **Use FAS NRT?** – This is the Foreign Agricultural Service Near Real-Time data. We will leave this option selected.



The first image you see on the top is the most current NDVI image for the region. On the right within the purple box, you can see the image dates, which you can select and change. You can download the NDVI imagery for each region by clicking on **Go to Data Access App** or **Go to Data Delivery Directory** in the upper right.

- Click on **2015-Aug-13 to Aug-28** to see the NDVI image for that time.
- To view a jpg of the image, click on **View**, right next to the words **Regional Image** at the top of the image. This will bring up the image on a separate web page.

Below the image you can see options of mapping NDVI or NDWI or View (621). NDWI is another vegetation index called the Normalized Difference Wetness Index. The View (621) shows the area in pseudocolor.

- Make sure the NDVI is clicked on for both **Image** and **Graph**.

Below the mapping options you will see the color legend for the map. The values range from 0 (no vegetation) to 1.00 (dense vegetation). The yellow and brown colors represent low NDVI values, and the green colors represent higher NDVI values.

As you continue to scroll down, on the left you will see several ways to mask or edit the image.

- **Image type** – There are many different types of images available. Click on the **?** to see the different types. Right now leave it on **Current Image**.
- **Water and Crop Masks** – You can select different types of masks for both the visual image and the graphs below. By masking out water and/or crops, they will not be included in the processing. Leave the water mask as **Standard (MOD12)**, and the crop mask as **None**.
- **Greeness Threshold** – This allows you to eliminate all NDVI values below 0.125. Leave the greenness threshold off.
- **Palette** – You can select the color palette that you like. Leave the palette as **Color (USDA)**
- **Click Type** – This shows you what will be highlighted when you click on the regional image. This is used to select a detail image. Leave click type as **Box**.

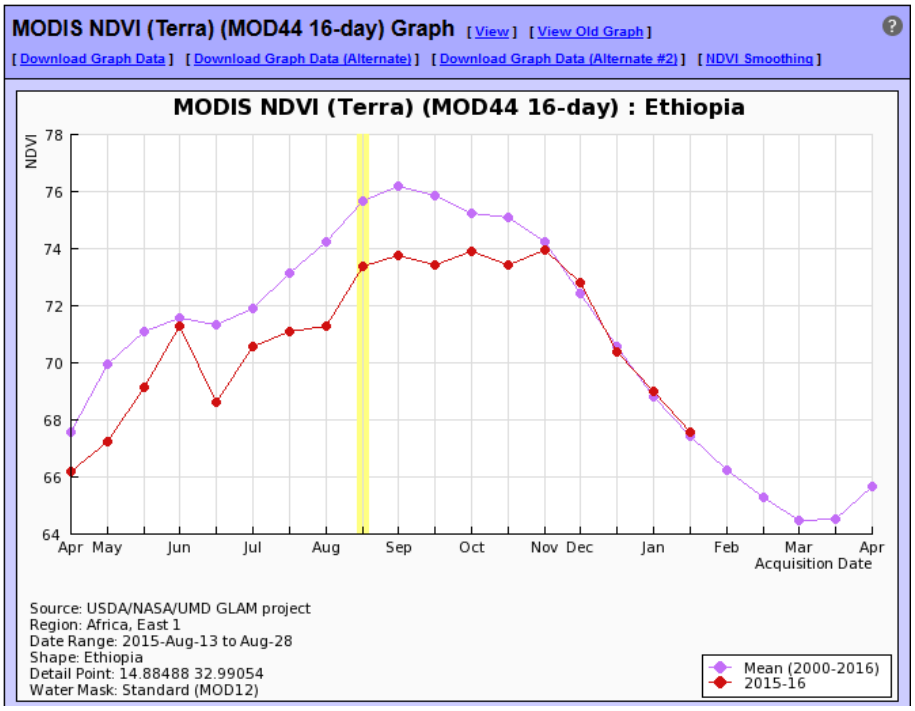
On the right hand side, **Polygon Options** allows you to draw, label and zoom into particular areas. First we will zoom in and get NDVI information for a particular country.

- To the right of Country, make sure **Draw?** is clicked on and Zoom To **Ethiopia**.

You will notice that the **Regional Image** (at the top) now has a red box around Ethiopia. If you scroll down to the **Detail Image** below the **Regional Image**, you

will see the NDVI image for Ethiopia. It tends to be a very large image so you need to scroll around to see the entire image. Alternatively, you can click on **View** next to **Detail Image** to see the whole image as a jpeg on a separate web page.

- Scroll all the way to the right so you can see the MODIS NDVI (Terra) (MOD44 16-day) Graph. You will notice two lines on the graph. One is the Mean (2000-2016) NDVI, in purple, and the other is the Current Year (2015-16) NDVI, in red.

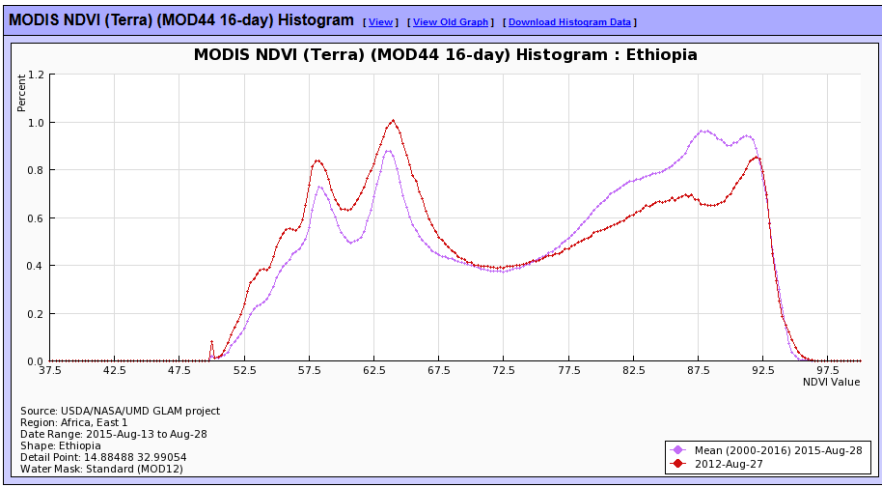


On this graph you can see the peak NDVI values for the 2014 year compared to the long-term mean. You can also see where the 2014 NDVI deviated from the long term mean.

- Scroll down until you see **Detail Box/Point** and **Selected Polygon**.

You can change the year of the NDVI series that you would like to view in the graph by clicking a different year below Selected Polygon.

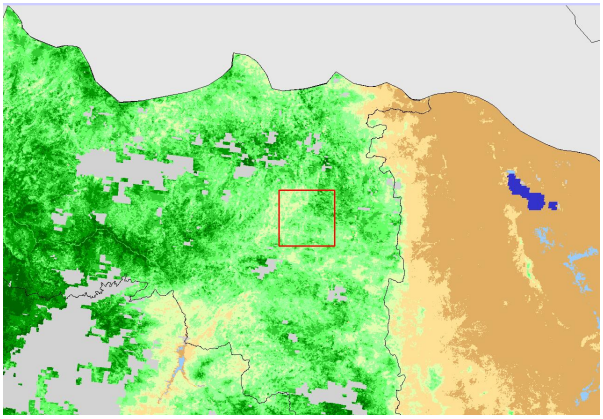
- Click on **Year 2012** under **Selected Polygon** and then click **Update Graphs** (below the tables). You can also check "**Automatic Update?**" on if you would like to look at several different years.
- Scroll back to the left and down below the **Detail Image** until you see the graph "**MODIS NDVI (Terra) (MOD44 16-day) Histogram: Ethiopia**".

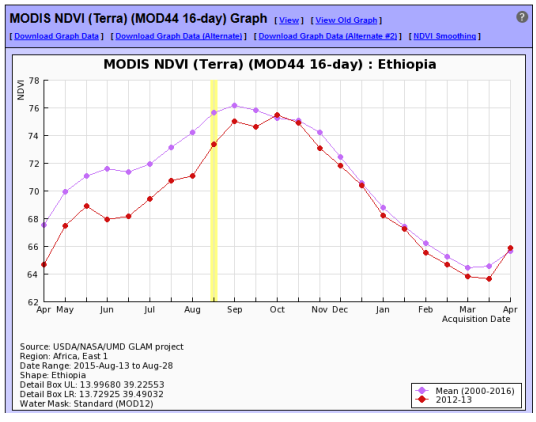


This is the histogram of NDVI values for the year you have selected in the **Detail Image** graph. In this graph compares the 2012 NDVI values to the long-term mean. You can see that there is a higher percentage of lower NDVI values and a lower percentage of higher NDVI values in 2012 when compared to the long-term mean.

In the **Detail Image** area you can select a point or a box of various sizes to get more detailed NDVI information for a particular area.

- Scroll up to just above the Histogram.
- Next to **Click Type**, select **Box 30km** in your Detail Image.
- Now click somewhere in your Detail Image of Ethiopia. Once you do that, a red box will appear on your image and the Time Series graph will update. Note that you are still displaying Year 2012 that you specified previously. You can change the date to look at other NDVI time series for that box.





Part 2: NDVI Anomalies (Web Tool)

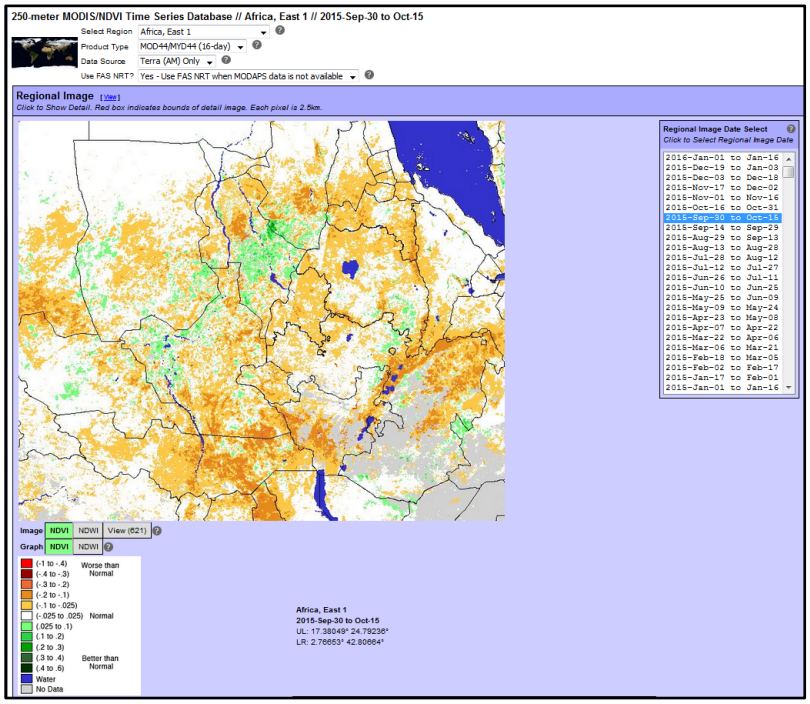
There are two web tools you can use to get NDVI anomalies:

- http://pekko.geog.umd.edu/usda/test/
- http://glam1.gsfc.nasa.gov

Part 2A: NDVI Anomalies – Web Tool 1

We will stay on the same website that we used for the NDVI time series.

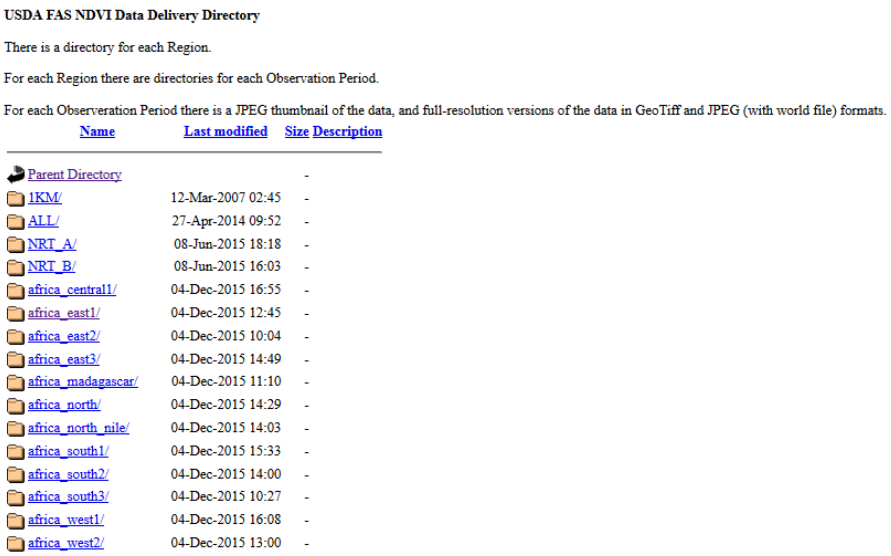
- Go to http://pekko.geog.umd.edu/usda/test/
- Make sure you have selected **Africa, East 1**.
- Scroll to the top of the page so you can see the **Regional Image for Africa, East 1**.
- Select **2015-Sep-30 to Oct-15** in the Regional Image Date Select box.
- Scroll down to just below the legend.
- Next to **Image Type**, select **Anomaly Image (vs. All Years Mean)**
- Click **Update Image**



You will see the Anomaly image appear, with an associated legend below it. The yellow to red colors indicate NDVI values for the specified year are less than the long term mean. Green colors indicate NDVI values for the specified year are greater than the long term mean.

You can download the anomaly images by clicking on **Go to Data Delivery Directory** on the top right of the web page.

- Click on **Go to Data Delivery Directory**



USDA FAS NDVI Data Delivery Directory

There is a directory for each Region.

For each Region there are directories for each Observation Period.

For each Observeration Period there is a JPEG thumbnail of the data, and full-resolution versions of the data in GeoTiff and JPEG (with world file) formats.

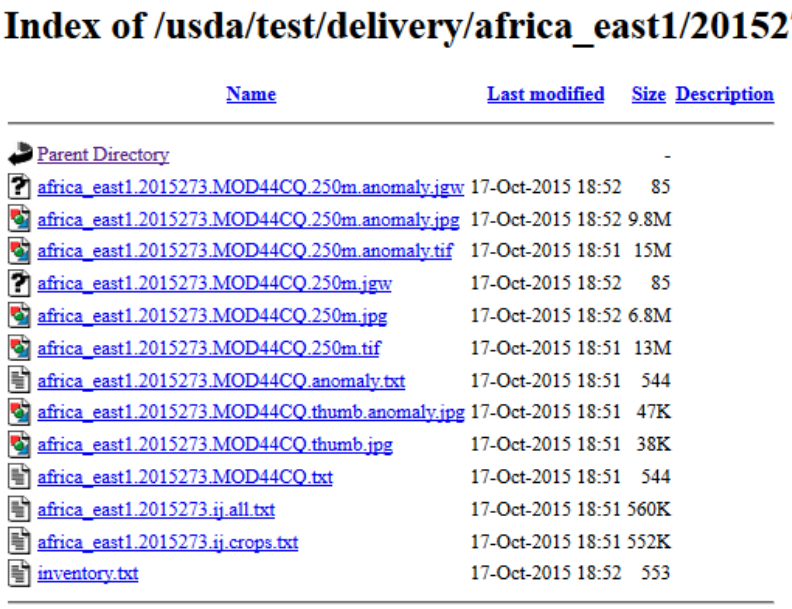
Name	Last modified	Size	Description
Parent Directory		-	
1KM/	12-Mar-2007 02:45	-	
ALL/	27-Apr-2014 09:52	-	
NRT_A/	08-Jun-2015 18:18	-	
NRT_B/	08-Jun-2015 16:03	-	
africa_central1/	04-Dec-2015 16:55	-	
africa_east1/	04-Dec-2015 12:45	-	
africa_east2/	04-Dec-2015 10:04	-	
africa_east3/	04-Dec-2015 14:49	-	
africa_madagascar/	04-Dec-2015 11:10	-	
africa_north/	04-Dec-2015 14:29	-	
africa_north_nile/	04-Dec-2015 14:03	-	
africa_south1/	04-Dec-2015 15:33	-	
africa_south2/	04-Dec-2015 14:00	-	
africa_south3/	04-Dec-2015 10:27	-	
africa_west1/	04-Dec-2015 16:08	-	
africa_west2/	04-Dec-2015 13:00	-	

The data directory looks like this. Click on **africa_east1**. You will see a directory of dates.

Index of /usda/test/delivery/africa_east1

Name	Last modified	Size	Description
Parent Directory		-	
2000049/	26-Aug-2010 13:27	-	
2000065/	07-Aug-2008 18:59	-	
2000081/	07-Aug-2008 19:00	-	
2000097/	07-Aug-2008 19:02	-	
2000113/	07-Aug-2008 19:03	-	
2000129/	07-Aug-2008 19:05	-	
2000145/	07-Aug-2008 19:06	-	
2000161/	07-Aug-2008 19:07	-	
2000177/	07-Aug-2008 19:09	-	
2000193/	07-Aug-2008 19:10	-	
2000209/	07-Aug-2008 19:12	-	
2000225/	07-Aug-2008 19:13	-	
2000241/	07-Aug-2008 19:15	-	
2000257/	07-Aug-2008 19:16	-	

The format of the dates is Year then Julian Day. For example 2000049 means Year 2000, Julian day 049. The Julian Day Calendar can be found at the end of this exercise. If you look on the calendar, Julian day 049 in the year 2000 is February 18, 2000. The date we were just looking at was September 30, 2015, which is Julian date 273. So scroll down and select the date **2015273** in this directory.



Index of /usda/test/delivery/africa_east1/2015273

Name	Last modified	Size	Description
Parent Directory		-	
africa_east1.2015273.MOD44CQ.250m.anomaly.jgw	17-Oct-2015 18:52	85	
africa_east1.2015273.MOD44CQ.250m.anomaly.jpg	17-Oct-2015 18:52	9.8M	
africa_east1.2015273.MOD44CQ.250m.anomaly.tif	17-Oct-2015 18:51	15M	
africa_east1.2015273.MOD44CQ.250m.jgw	17-Oct-2015 18:52	85	
africa_east1.2015273.MOD44CQ.250m.jpg	17-Oct-2015 18:52	6.8M	
africa_east1.2015273.MOD44CQ.250m.tif	17-Oct-2015 18:51	13M	
africa_east1.2015273.MOD44CQ.anomaly.txt	17-Oct-2015 18:51	544	
africa_east1.2015273.MOD44CQ.thumb.anomaly.jpg	17-Oct-2015 18:51	47K	
africa_east1.2015273.MOD44CQ.thumb.jpg	17-Oct-2015 18:51	38K	
africa_east1.2015273.MOD44CQ.txt	17-Oct-2015 18:51	544	
africa_east1.2015273.ij.all.txt	17-Oct-2015 18:51	560K	
africa_east1.2015273.ij.crops.txt	17-Oct-2015 18:51	552K	
inventory.txt	17-Oct-2015 18:52	553	

In this directory you will see the anomaly images in both jpg and tif formats. The jpg images are just thumbnail pictures, while the tif images are the data that can be opened in QGIS or other GIS software. The text files contain the coordinate information for the images.

- To put the image into QGIS, right click on the **africa_east2015273_MOD44CQ_250m_anomaly.tif** image.
- Select Save link as….and save it to a folder on your computer.
- Open QGIS and use the **Add Raster Layer** tool to add the image to the QGIS display.

Julian Day Calendar

Leap years:
(2000, 2004, 2008, 2012, 2016, 2020...)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	32	61	92	122	153	183	214	245	275	306	336
2	2	33	62	93	123	154	184	215	246	276	307	337
3	3	34	63	94	124	155	185	216	247	277	308	338
4	4	35	64	95	125	156	186	217	248	278	309	339
5	5	36	65	96	126	157	187	218	249	279	310	340
6	6	37	66	97	127	158	188	219	250	280	311	341
7	7	38	67	98	128	159	189	220	251	281	312	342
8	8	39	68	99	129	160	190	221	252	282	313	343
9	9	40	69	100	130	161	191	222	253	283	314	344
10	10	41	70	101	131	162	192	223	254	284	315	345
11	11	42	71	102	132	163	193	224	255	285	316	346
12	12	43	72	103	133	164	194	225	256	286	317	347
13	13	44	73	104	134	165	195	226	257	287	318	348
14	14	45	74	105	135	166	196	227	258	288	319	349
15	15	46	75	106	136	167	197	228	259	289	320	350
16	16	47	76	107	137	168	198	229	260	290	321	351
17	17	48	77	108	138	169	199	230	261	291	322	352
18	18	49	78	109	139	170	200	231	262	292	323	353
19	19	50	79	110	140	171	201	232	263	293	324	354
20	20	51	80	111	141	172	202	233	264	294	325	355
21	21	52	81	112	142	173	203	234	265	295	326	356
22	22	53	82	113	143	174	204	235	266	296	327	357
23	23	54	83	114	144	175	205	236	267	297	328	358
24	24	55	84	115	145	176	206	237	268	298	329	359
25	25	56	85	116	146	177	207	238	269	299	330	360
26	26	57	86	117	147	178	208	239	270	300	331	361
27	27	58	87	118	148	179	209	240	271	301	332	362
28	28	59	88	119	149	180	210	241	272	302	333	363
29	29	60	89	120	150	181	211	242	273	303	334	364
30	30		90	121	151	182	212	243	274	304	335	365
31	31		91		152		213	244		305		366

Regular years:
(2001-2003, 2005-2007, 2009-2011, 2013-2015...)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	32	60	91	121	152	182	213	244	274	305	335
2	2	33	61	92	122	153	183	214	245	275	306	336
3	3	34	62	93	123	154	184	215	246	276	307	337
4	4	35	63	94	124	155	185	216	247	277	308	338
5	5	36	64	95	125	156	186	217	248	278	309	339
6	6	37	65	96	126	157	187	218	249	279	310	340
7	7	38	66	97	127	158	188	219	250	280	311	341
8	8	39	67	98	128	159	189	220	251	281	312	342
9	9	40	68	99	129	160	190	221	252	282	313	343
10	10	41	69	100	130	161	191	222	253	283	314	344
11	11	42	70	101	131	162	192	223	254	284	315	345
12	12	43	71	102	132	163	193	224	255	285	316	346
13	13	44	72	103	133	164	194	225	256	286	317	347
14	14	45	73	104	134	165	195	226	257	287	318	348
15	15	46	74	105	135	166	196	227	258	288	319	349
16	16	47	75	106	136	167	197	228	259	289	320	350
17	17	48	76	107	137	168	198	229	260	290	321	351
18	18	49	77	108	138	169	199	230	261	291	322	352
19	19	50	78	109	139	170	200	231	262	292	323	353
20	20	51	79	110	140	171	201	232	263	293	324	354
21	21	52	80	111	141	172	202	233	264	294	325	355
22	22	53	81	112	142	173	203	234	265	295	326	356
23	23	54	82	113	143	174	204	235	266	296	327	357
24	24	55	83	114	144	175	205	236	267	297	328	358
25	25	56	84	115	145	176	206	237	268	298	329	359
26	26	57	85	116	146	177	207	238	269	299	330	360
27	27	58	86	117	147	178	208	239	270	300	331	361
28	28	59	87	118	148	179	209	240	271	301	332	362
29	29		88	119	149	180	210	241	272	302	333	363
30	30		89	120	150	181	211	242	273	303	334	364
31	31		90		151		212	243		304		365

Part 2B: NDVI Anomalies – Web Tool 2

- Go to http://glam1.gsfc.nasa.gov/

This webtool also enables you to display NDVI and NDVI anomaly images. We will display an anomaly image in this exercise.

- Under Select Layers, choose:
  - **Satellite:** Terra
  - **Layer:** NDVI Anomaly (%)
  - **Year:** 2015
  - **Start DOY: MM/DD Range:** 273: 09/30 – 10/07 (the same date as we used in the exercise above)
- Leave the remaining selections the same.

In this image you can see the NDVI Anomaly for the world. The legend on the right indicates the anomalies in terms of percentages. The yellow to red colors represent below normal NDVI values and the green values represent above normal NDVI values. You can also zoom in to a specific area to get more information.

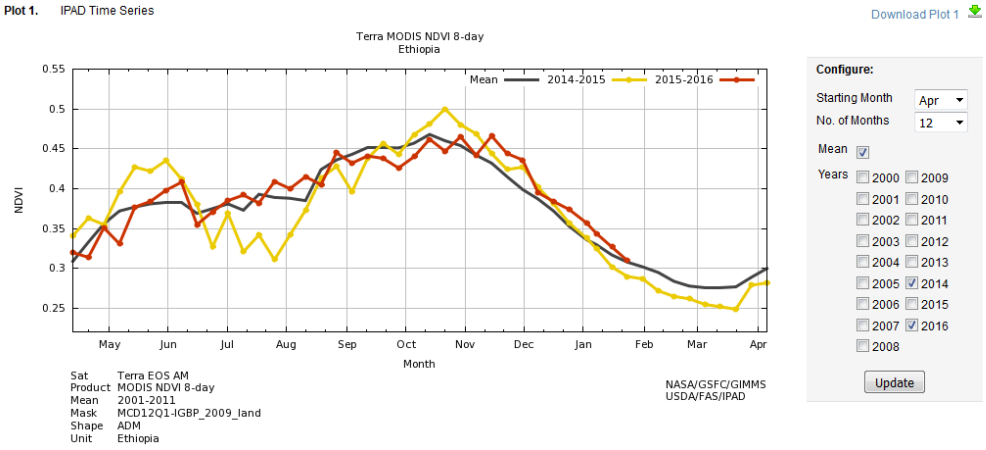
- Zoom in to Eastern Africa by using the zoom tools at the top of the page.

You can get NDVI time series information about a specific country by selecting a polygon and submitting a query.

- Select Ethiopia by first clicking on the Select Shape key  at the top of the page and then clicking somewhere in Ethiopia on the image.
- On the left panel under **Query DB**, you will see **Dataset: NDVI** and **Selected Id's: 28496**. Click **Submit**.

A web page will appear showing **Plot 1. IPAD time series** for the current year compared to the mean. You can change the year on the right hand side.

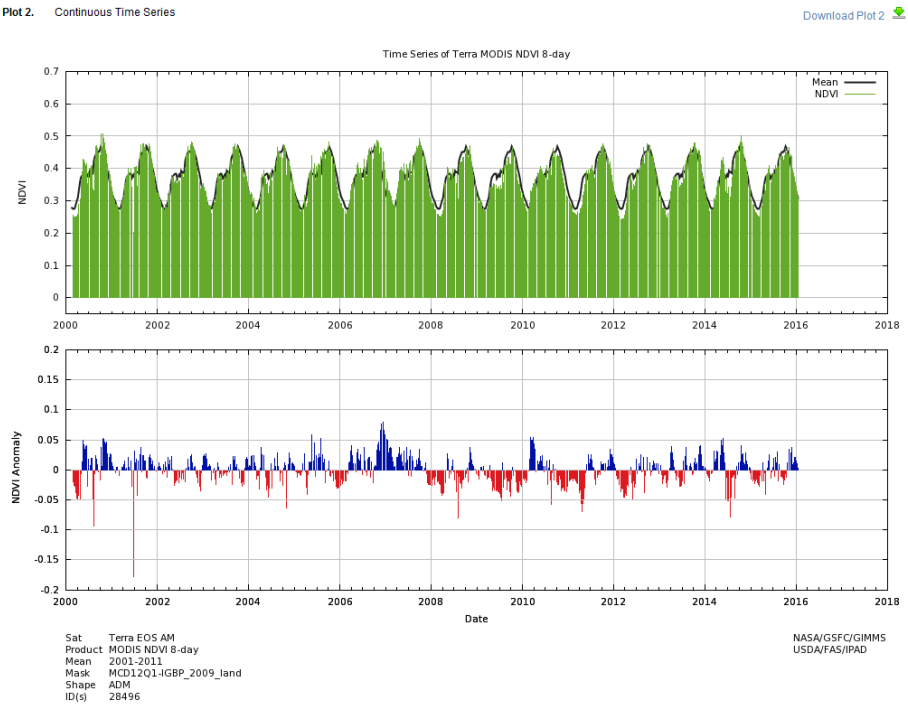
- Click on **2014** and click **Update**.



In this graph you can see that the NDVI values in 2014 were lower in July and August than 2015 and the long term mean. You can also download the data in .csv format by clicking on **Download CSV Table** at the top of the page, or download the graph in a .png format by clicking on the Download Plot 1 to the top right of the graph.

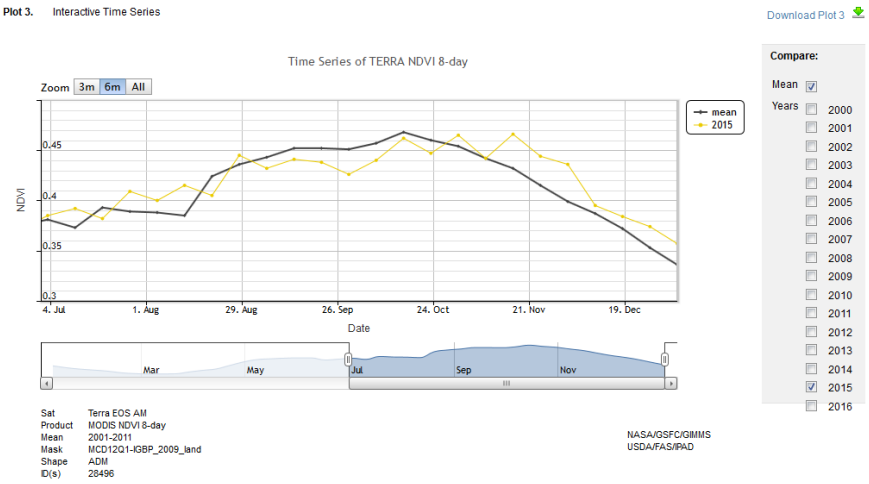
- Scroll down to see more graphs.

Plot 2. Continuous Time Series: Time Series of Terra MODIS NDVI 8-day: This shows the comparison of the NDVI mean for 2000-2016 compared to the 8-day NDVI values. The graph below it shows negative and positive NDVI anomalies for the same dates.



Plot 3. Interactive Time Series: Time Series of TERRA NDVI 8-day is an interactive graph where you can specify whether you can view different time periods.

- Click on **Years: 2015** on the right
- Click on **Zoom: 3m** above the graph. The graph will zoom to October, November and December.
- Click on **Zoom: 6m** above the graph. The graph will zoom to July through December.
- You can specify the time period using the slider bar below the graph.



These websites provide approachable, user-friendly data and figures that can be used to compare NDVI values and anomalies. Next week we will be showing you how to create a MODIS NDVI map in QGIS.