# Introduction to TimeSync – A Tool For Landsat Time Series Visualization

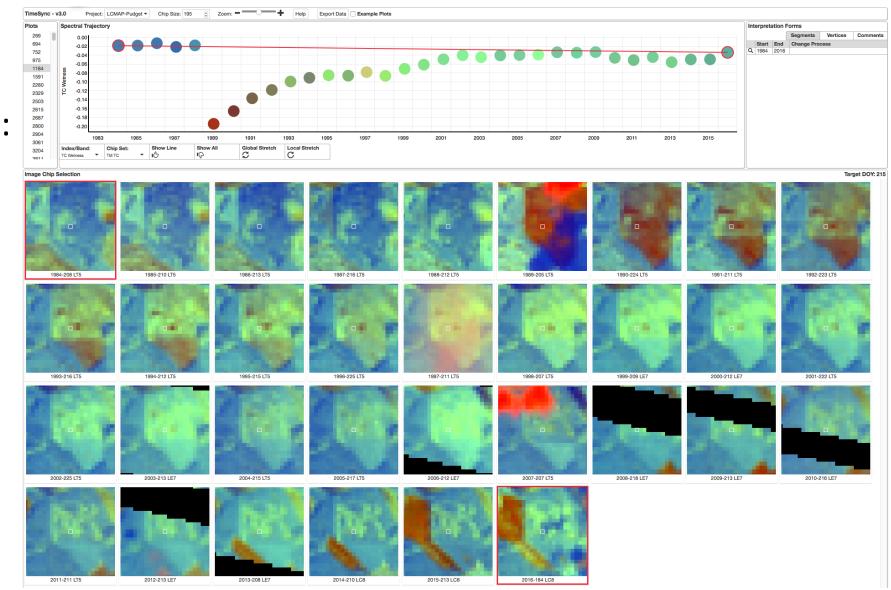
Warren B Cohen, USDA Forest Service Zhiqiang Yang, Oregon State University

#### TimeSync – Introduction

- Landsat time series visualization and change data collection tool
- Designed to evaluate quality of change maps derived from Landsat time series data
- Facilitates any reference data collection sample design based on Landsat data
- Every Landsat observation available to algorithms also available in TimeSync
- Basic human visual image interpretation skills (e.g., airphoto interpretation) applied to Landsat time series

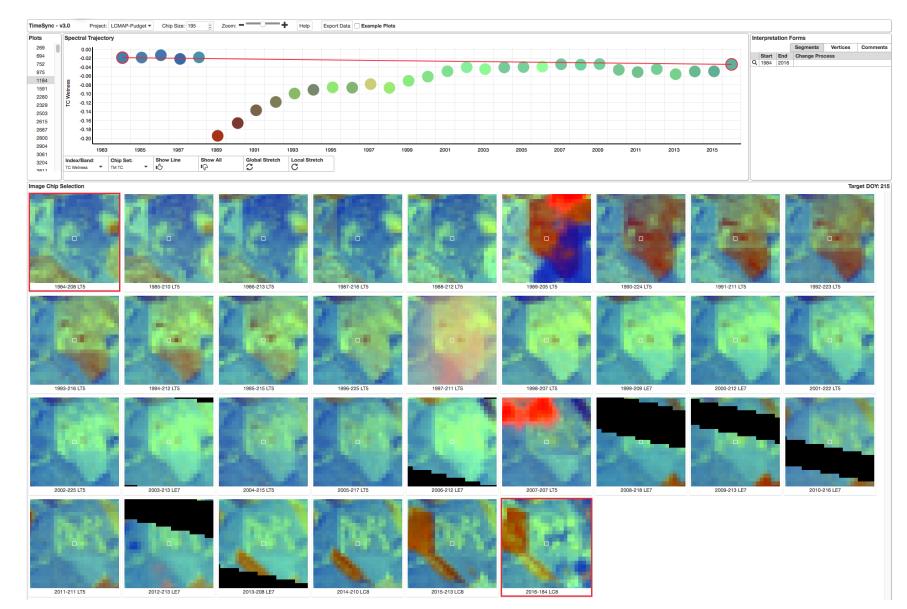
#### TimeSync – Basic Interface & Related Information

- Generic introduction to Version 3.0
- Three main windows: chip, trajectory, data entry



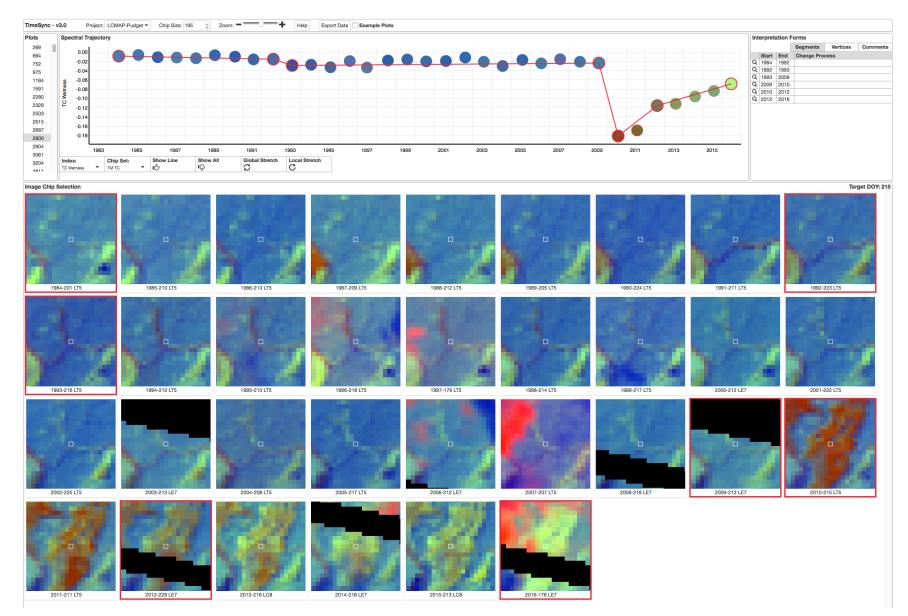
#### TimeSync – Basic Interface & Related Information

• Basic idea is to use TimeSync for temporal segmentation of time series, identifying and documenting when changes happened and what caused the changes



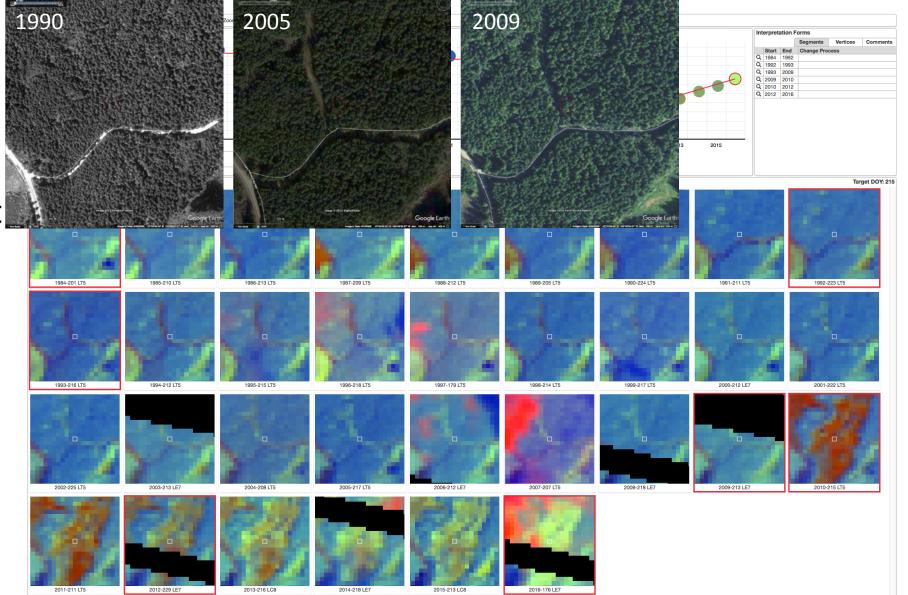
# TimeSync – Temporal Segmentation

- Concept of temporal segmentation
- From chips we see several segments: stable, new road spur, stable, harvest, non-linear spectral response to growth



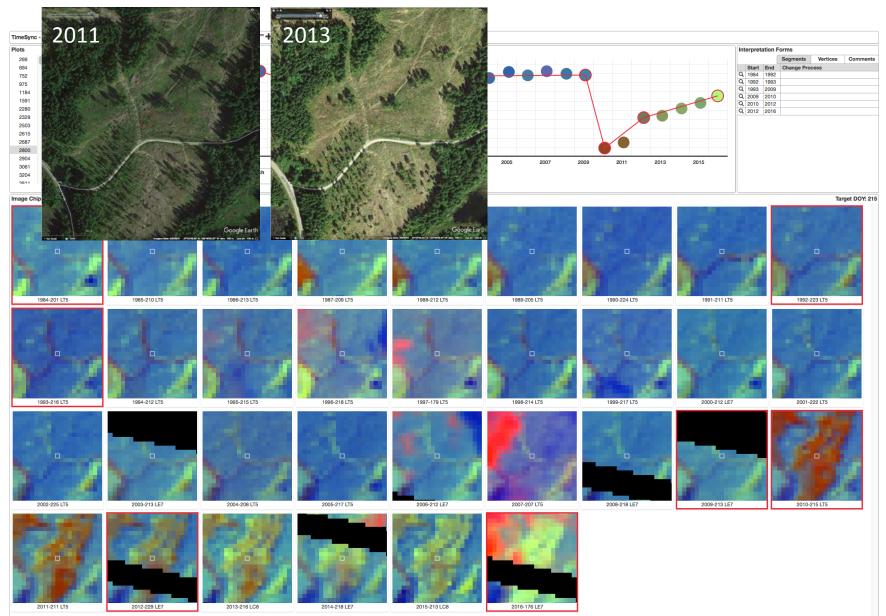
#### TimeSync – Role of Google Earth

- Historic snapshots important, but don't always exist
- GE images (and Landsat images) not always perfectly aligned (2005 v. 2009), so often best to go with most likely reality based on Landsat images (road spur through edge of plot)

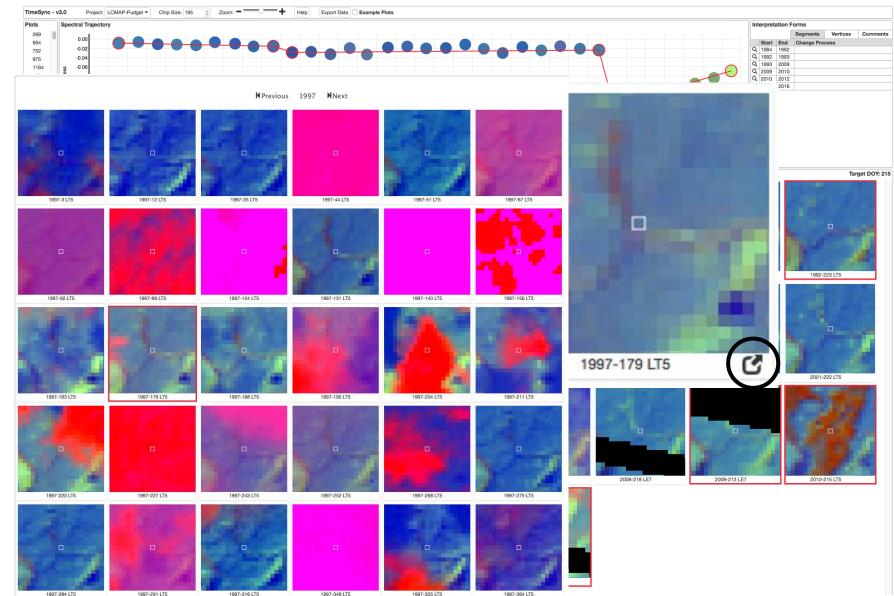


#### TimeSync – Role of Google Earth

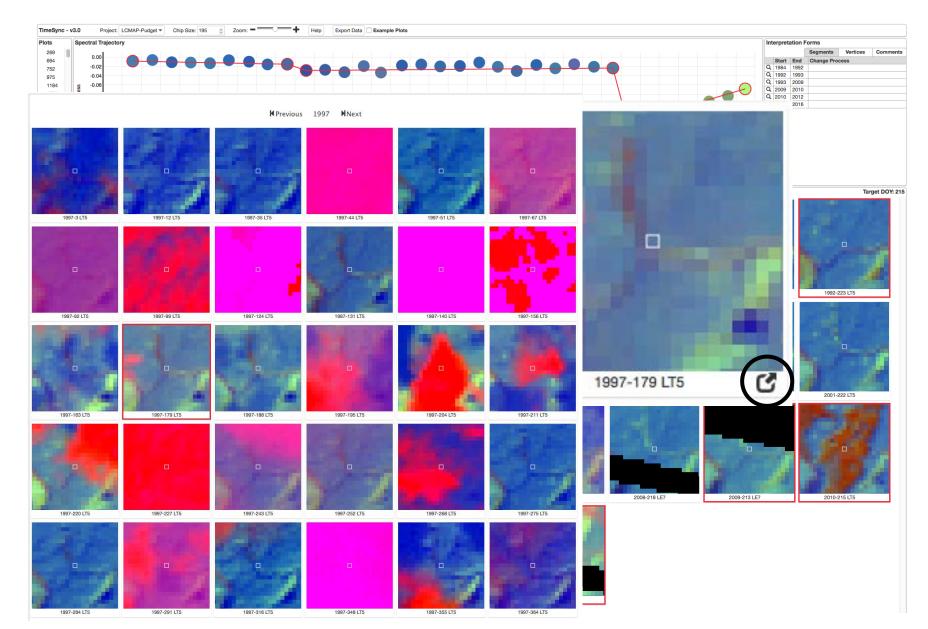
 GE image from 2011 confirms harvest observed in 2010 and that vegetation is beginning to reestablish (also seen in 2013



- Target date & clouds/haze (1997)
- Automatic logic selects single "best" image chip for each year
- Not always best and not always a better choice
- Chip gallery (shows selected chip)

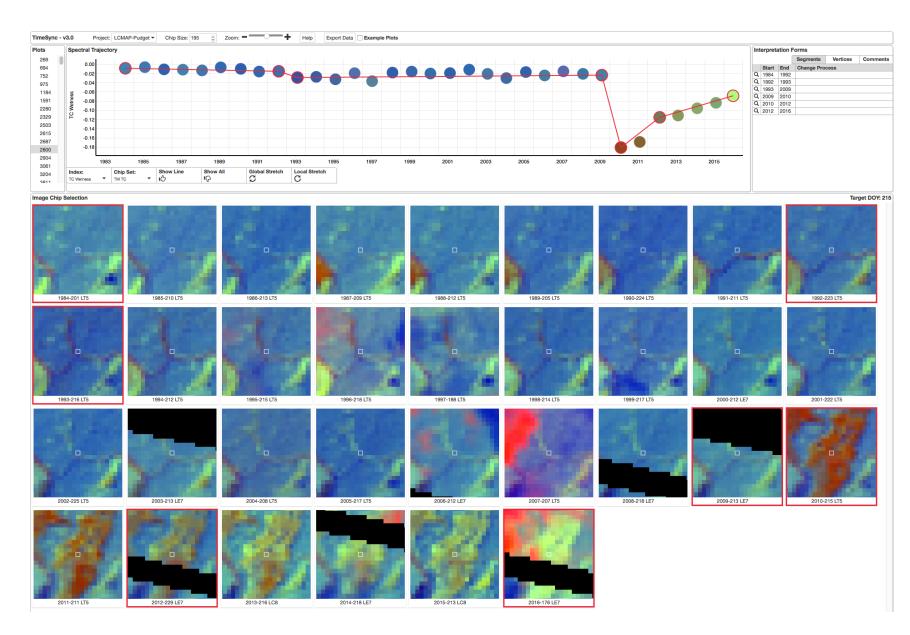


- Goal is clear, high quality image chip for all years at approximately target data (e.g., 215)
- Best choice here is DOY 188 (clear and close enough to target date)
- Note previous and next in gallery window)

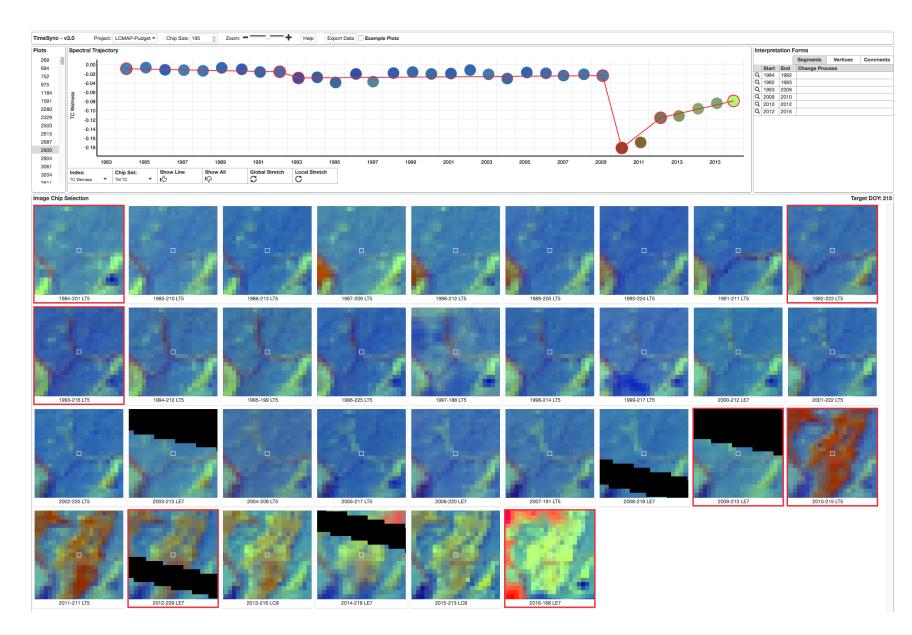


Also cloudy/hazy are 1995, 1996, 2006, 2007, 2016

 Can also remove "no-data" strips from L7 SLC-off (2003, 2008, 2009, 2012, 2014, 2016, if desired; sometimes essential as when plot falls in strip)

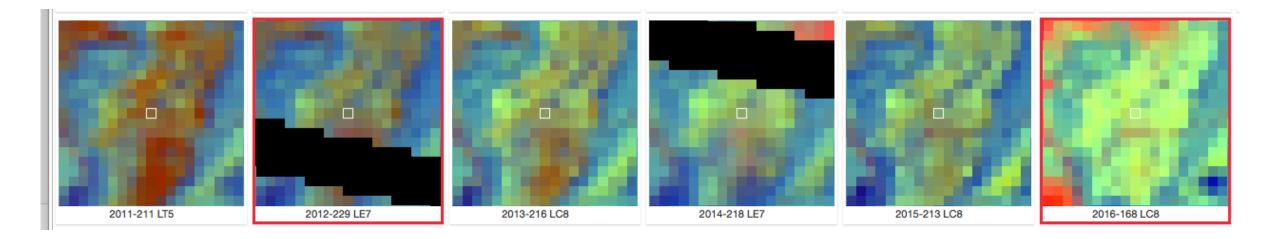


- A final, best selection
- Note that 2016 is DOY 168, but there was no better choice that was clear and closer to target date
- Note SLC-off strip gone for 2016, but left in place for other years because not a problem for interpretation



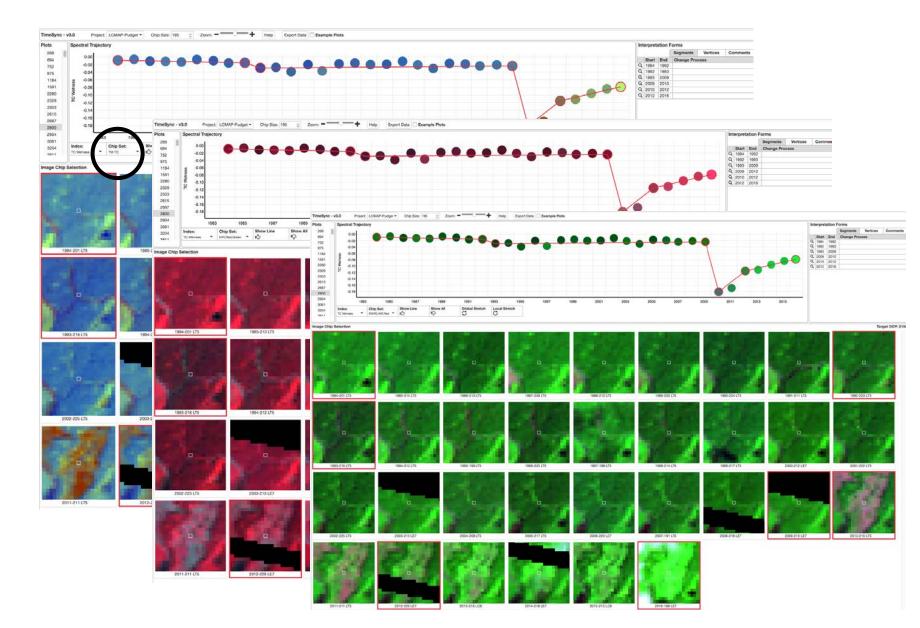
#### TimeSync – Chip Origin

- A given chip comes from a given sensor and a given acquisition date
- This information shown under each chip
- Year, DOY (Day of Year), Sensor
- Sensor e.g., LT5 = Landsat 5 TM, LE7 = Landsat 7 ETM+, LC8 = Landsat 8 Continuity (?) = OLI



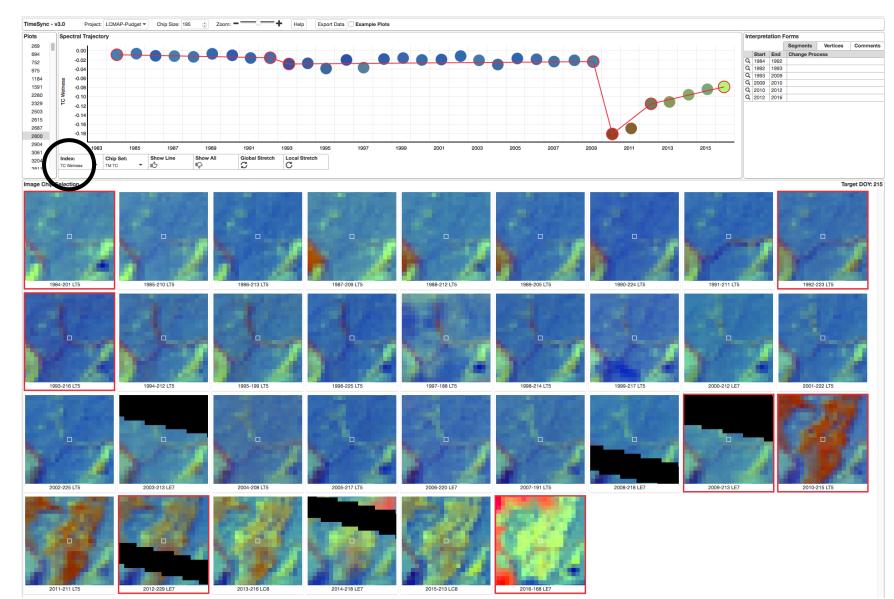
#### TimeSync – Chip Sets

- Three RGB sets
  - TM Tasseled Cap brightness (R), greenness (G), wetness (B) – default
  - NIR (R), Red (G), Green (B)
  - SWIR2 (R), NIR (G), Red (B)



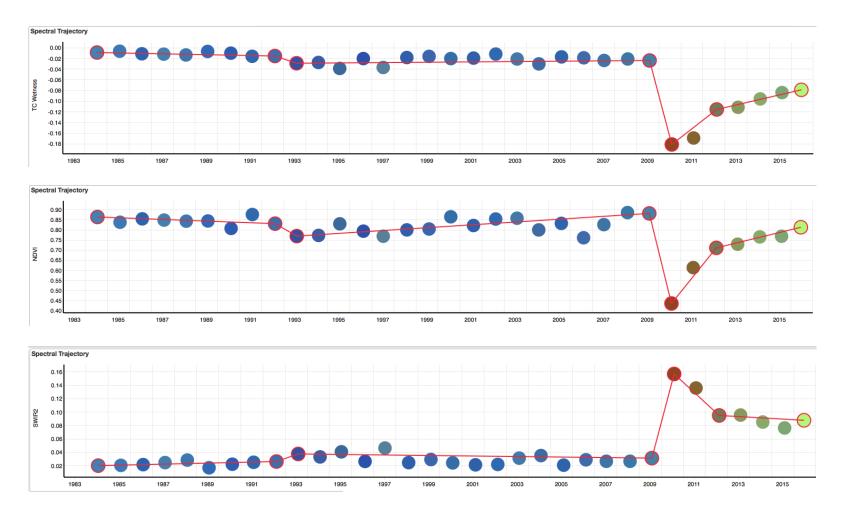
# TimeSync – Band/Index

- Can select any band or available spectral index
- Each one shows how the spectral trajectory looks in given band/index
- Shown here is wetness



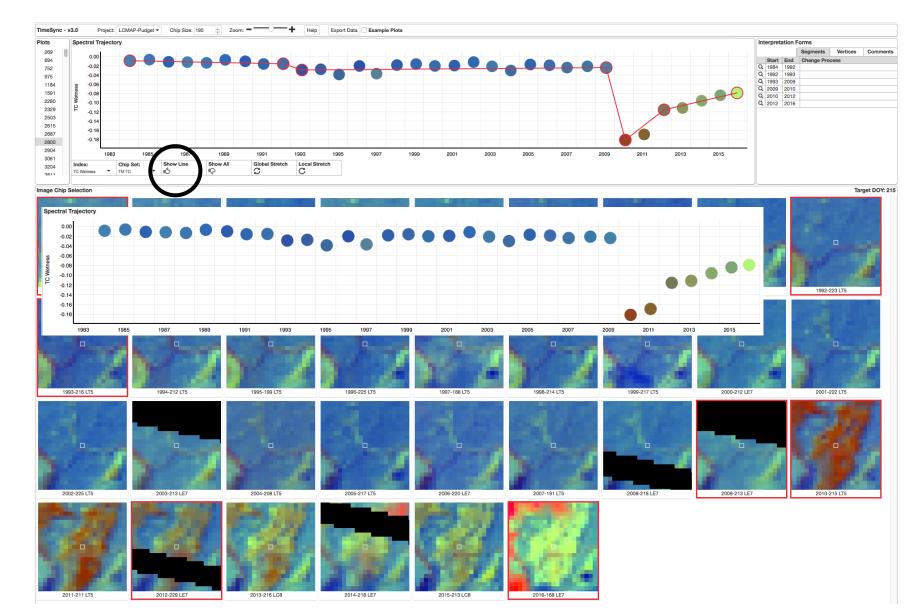
#### TimeSync – Band/Index

- Generally, they are similar, but often opposite direction
- Sometimes they are different enough, that you have to decide whether a different segmentation is more appropriate



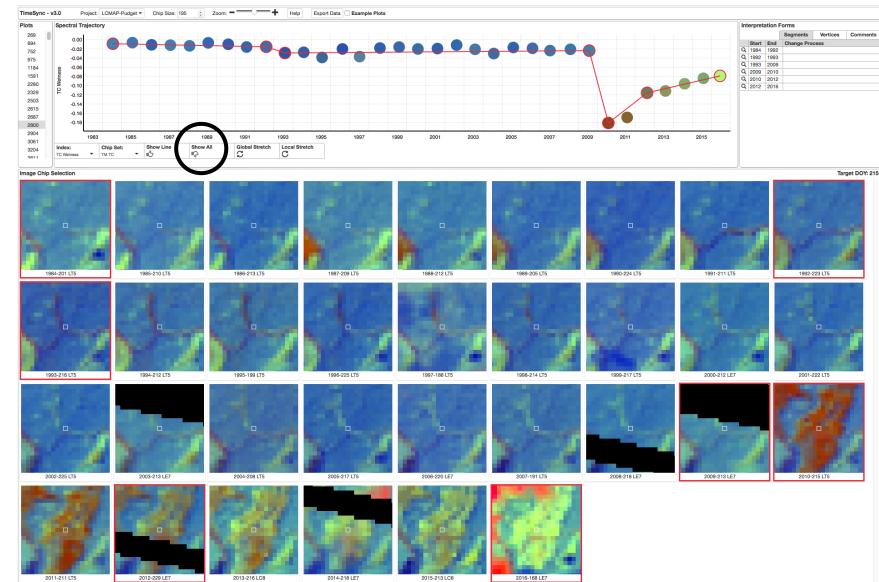
#### TimeSync –Show Line

- Can be a good idea to turn off your segmentation (without losing it) for a reality check
- Often your eye will be falsely guided by your previous decisions



#### TimeSync – Show All

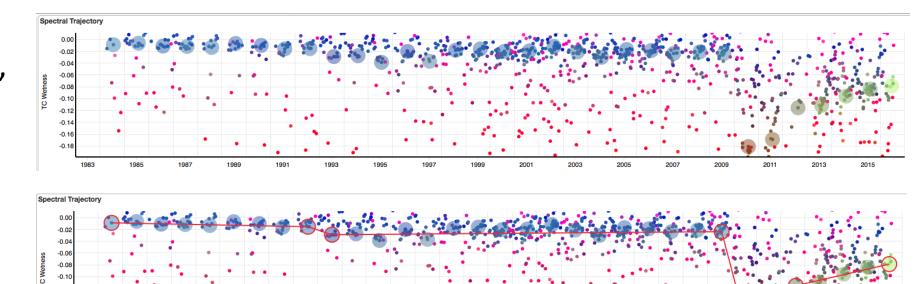
 Default is a single chip data point per year in the trajectory window, based on final selection (default or adjusted using chip gallery)



#### TimeSync – Show All

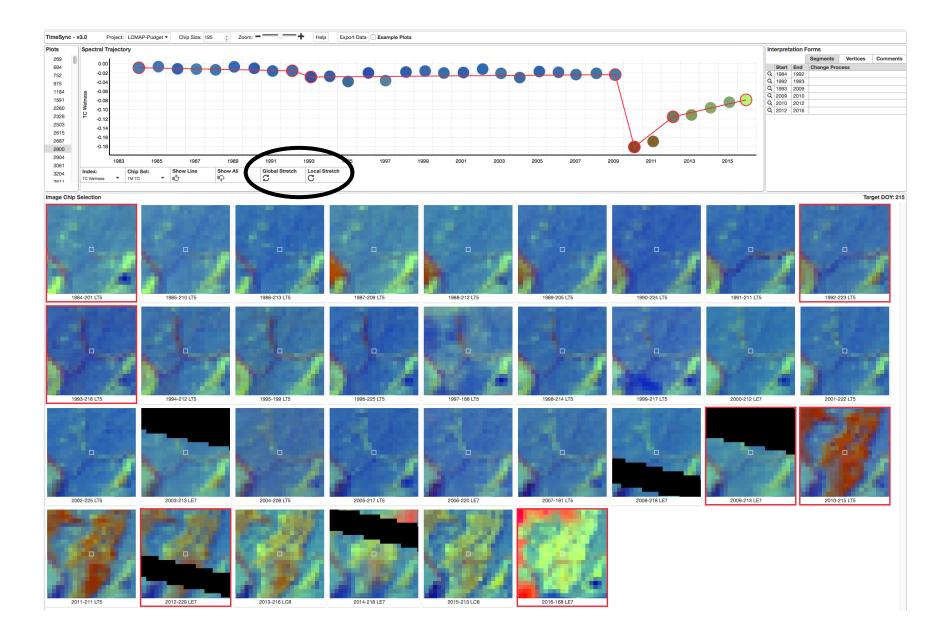
-0.1

- But we can also see all points for all years, as a guide to understanding how the selected annual chips fit in the phenological sequence across years
- This can influence decision about which chip to use for a given year and consequences for choosing a DOY not near target date



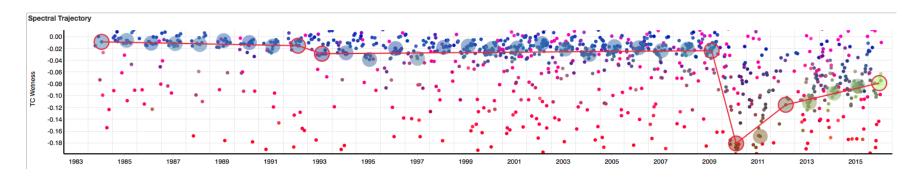
#### TimeSync – Local and Global Stretches

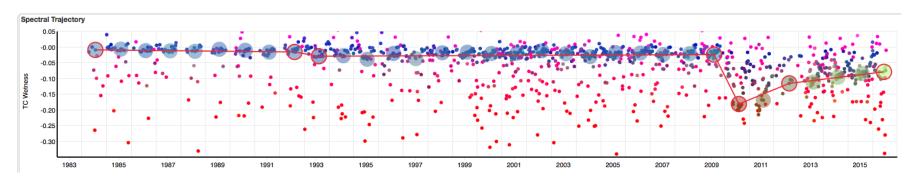
 Default is local, plot-based y-axis stretch



#### TimeSync – Local v. Global Stretch

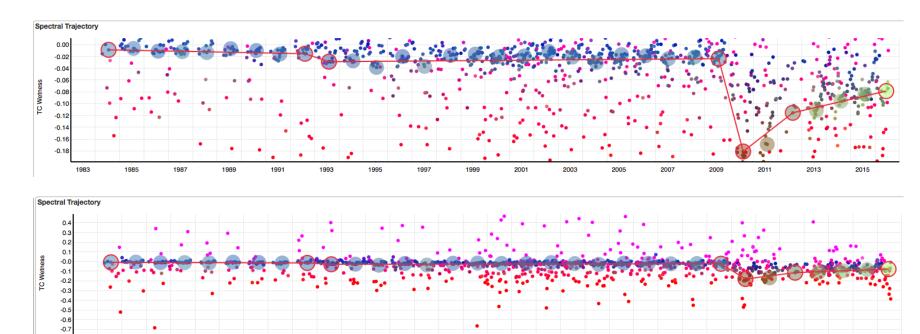
- Local stretch (top) maximizes y-axis stretch for the plot based on selected annual chip set
- Global stretch (bottom) uses more generalized (across plot) stretch so that you can check whether you are zooming in to closely to the noise and thus over-interpreting the data

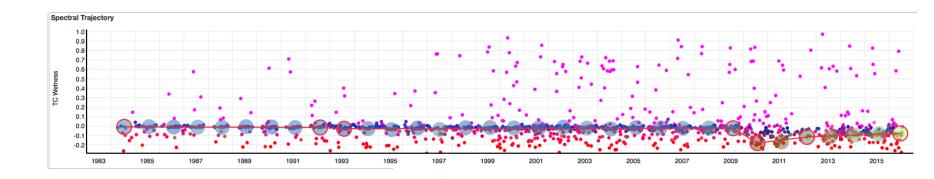




#### TimeSync – Other Stretch Options

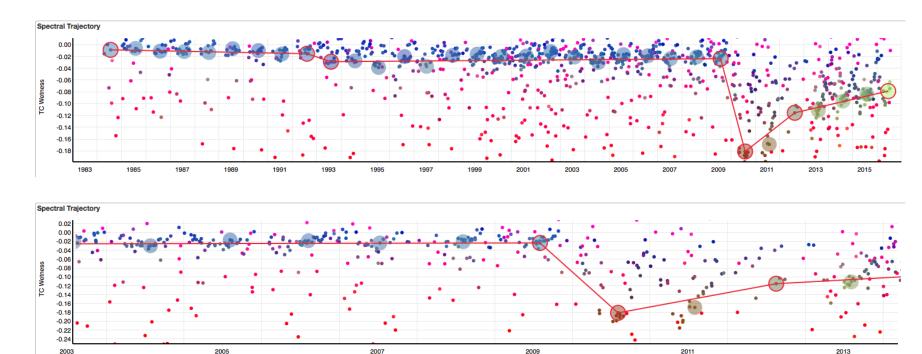
- Shrink y-axis to show all points (including those outside of local stretch)
- And can shift y-axis up and down





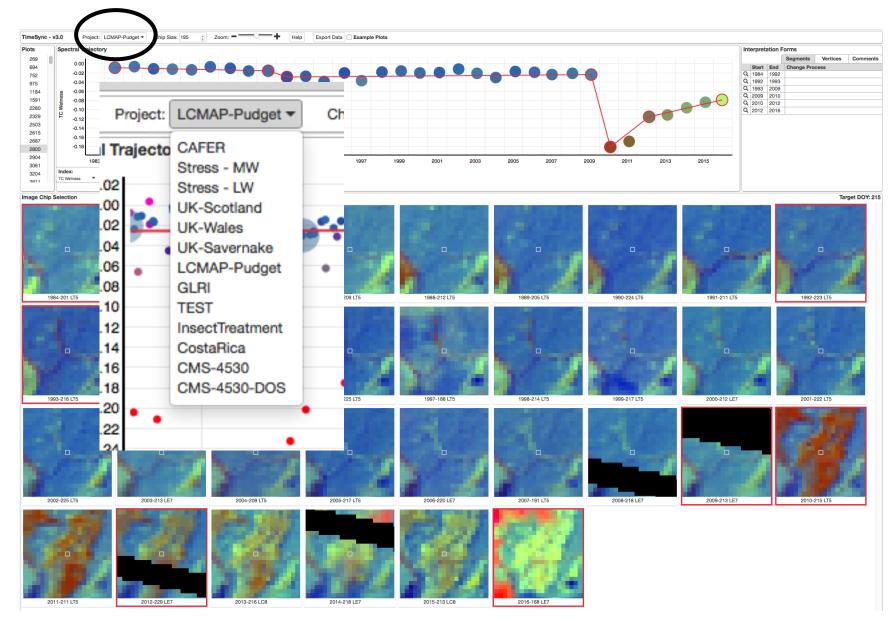
# TimeSync – Other Stretch Options

- Can also zoom and shift x-axis
- Shifting usually not helpful, but sometime necessary



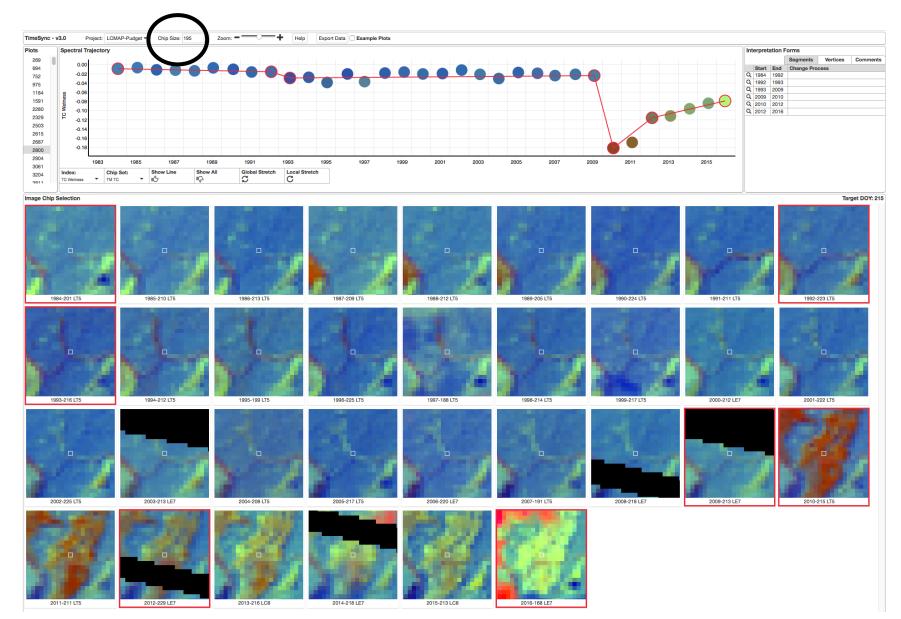
# TimeSync – Projects

- There may be many different projects from which to choose
- Could be different geographic areas, or plot sets within an area for different interpreters, etc.



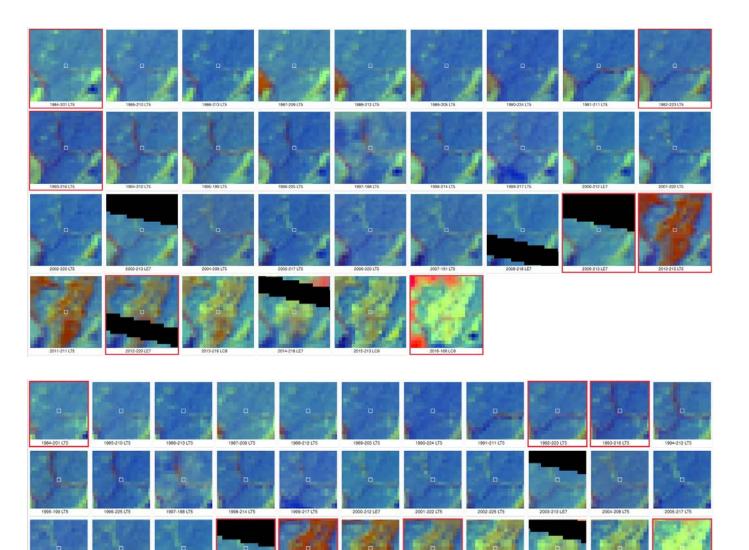
#### TimeSync – Chip Size

- TimeSync works best with ample screen real estate
- But for smaller screens chip size can be changed (default 195 x 195 screen monitor pixels)



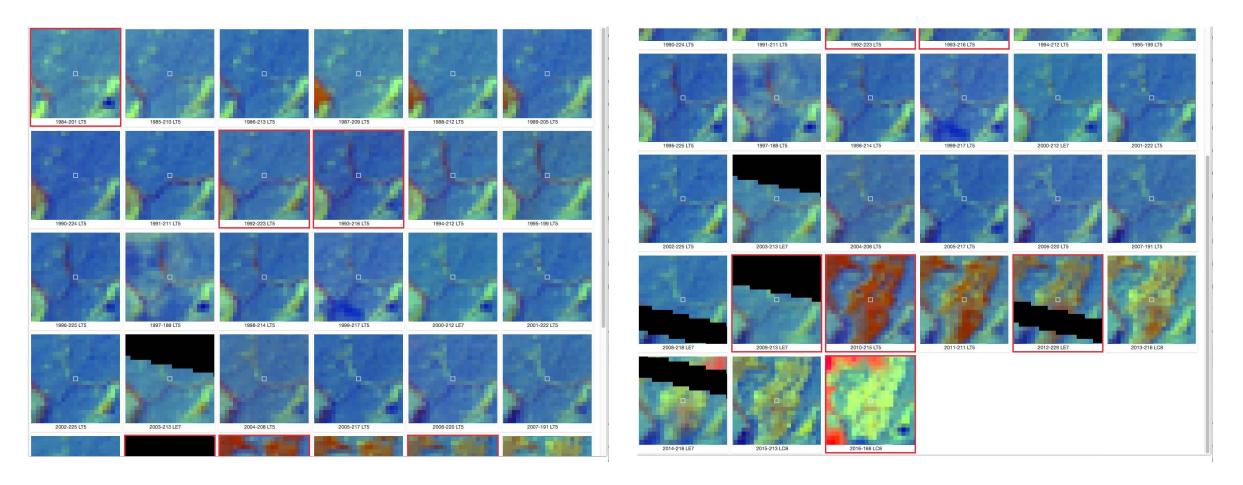
#### TimeSync – Chip Size

• The actual number of Landsat pixels shown does not change, but each chip takes up less space on the monitor



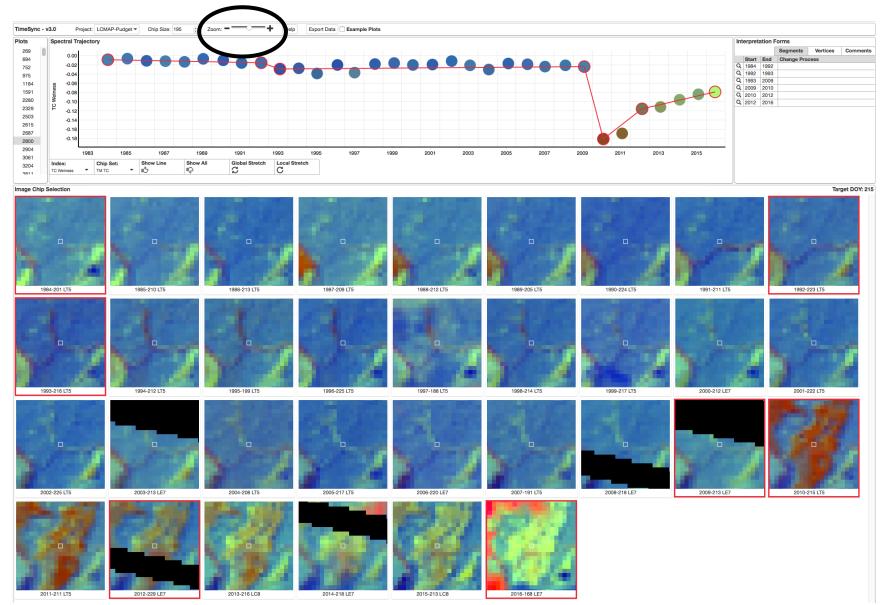
#### TimeSync – Scrolling

- Other option is to keep chip size larger but use scrolling (note scroll bar)
- Left first part of series, right is last part of series



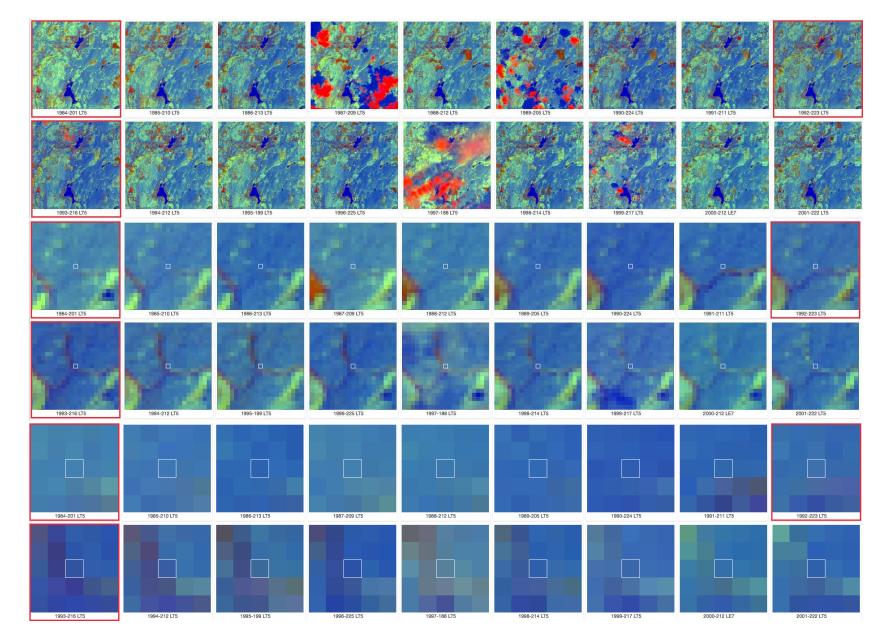
#### TimeSync – Zoom

- Zooming in and out changes the number of Landsat pixels shown, independent of chip size
- Is a good way to get spatial context (zoom out) and spatial detail (zoom in)



#### TimeSync – Zoom

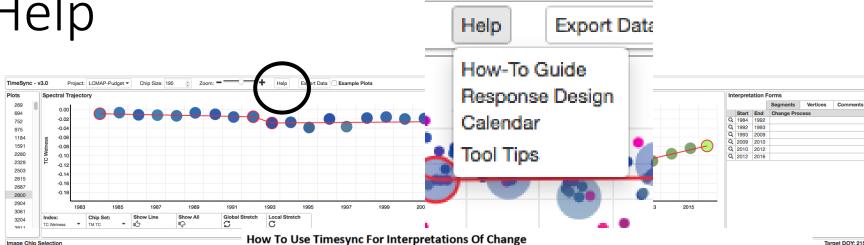
- Zooming in and out changes the number of Landsat pixels shown, independent of chip size
- Is a good way to get spatial context (zoom out) and spatial detail (zoom in)

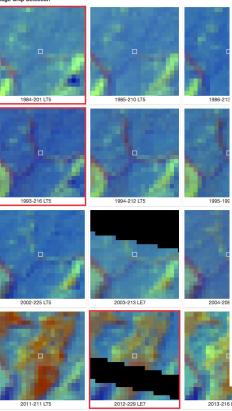


# TimeSync – Help

 How-To Guide opens document that describes the functions described here and other important items

 Also opens response design labeling document (introduced earlier and detailed later)





How To Use Timesync For Interpretations Of Change

TimeSync is a Landsat satellite image time series visualization and data collection tool. It is used to record and describe events and periods in the history of land cover and use as represented by Landsat satellite image pixels. This guide walks through the basic procedure for interpreting a plot. Information about the TimeSync user interface and functionality is available as tool tips activated from the Help button dropdown. When tool tips are active you can hover over most program elements to produce a description of the element and any functionality it has. This document should be used in conjunction with the default "Response Design" available through the Help button. Although a given project may use a different response design, the same basic overview represented in the default version is relevant to your understanding of how to use TimeSync. Some of the detail below is relevant only to the default response design, but the mechanics for all designs are the same.

The basic steps of TimeSync interpretation are as follows:

#### 1. Load a project

2. Load a plot from the project plot list

3. Visually assess the spectral image series points and image chips for change events

4. Set change events as vertices

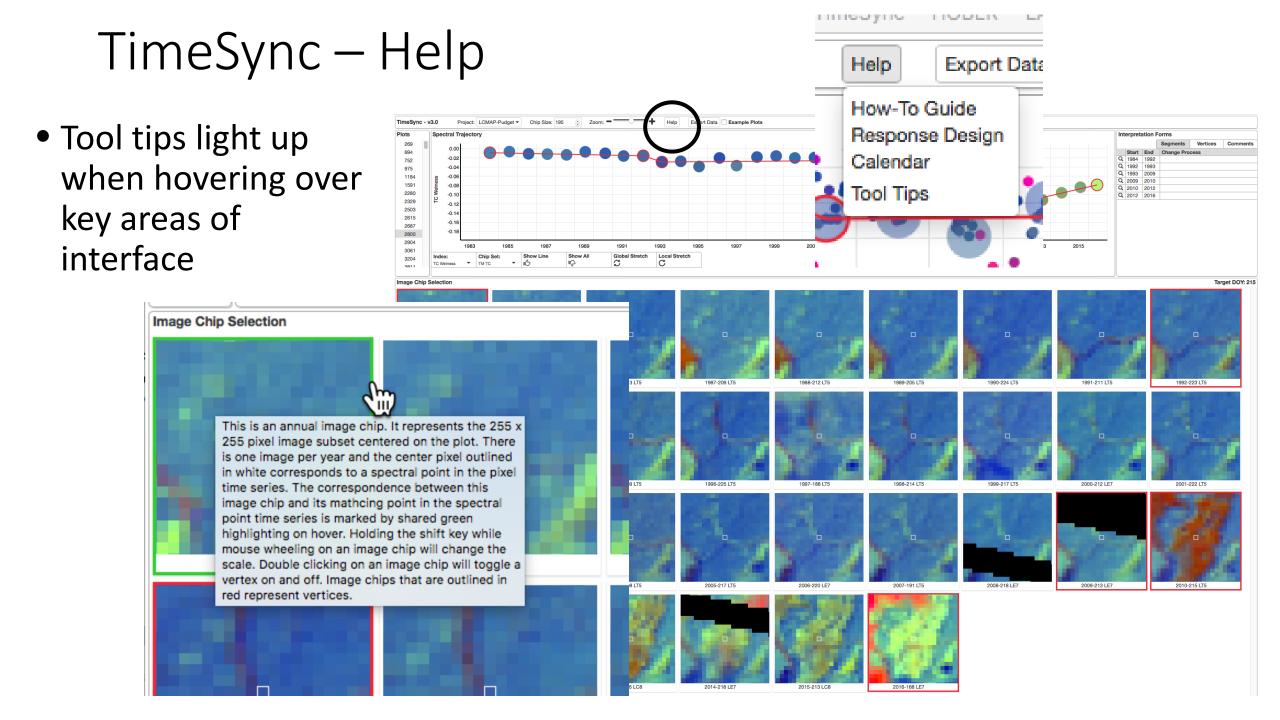
5. Fill out the vertex and segment interpretation forms.

#### TimeSync – Help

- Also opens a calendar for use with DOY chip considerations
- And toggles on and off tool-tips that describe contextspecific functions

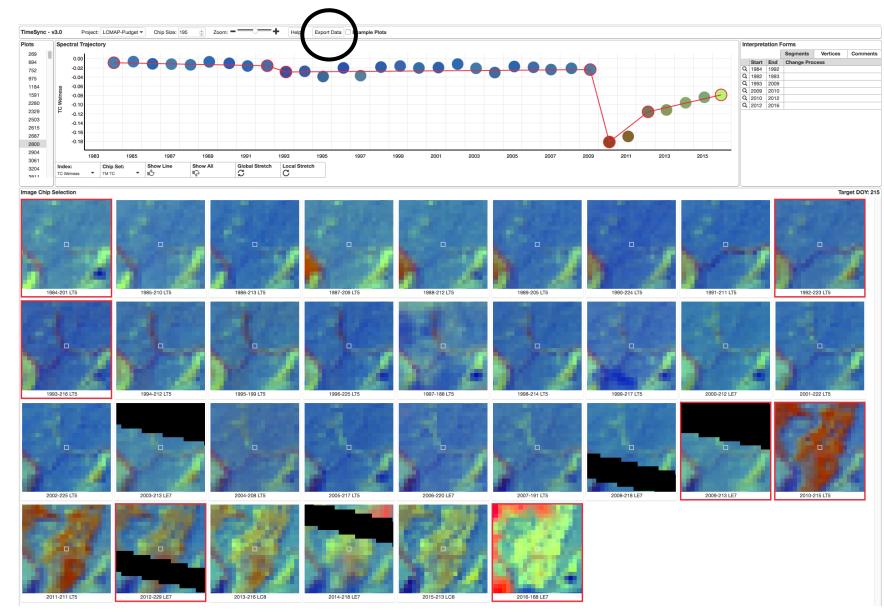
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Norm	пер	Help Export Data
Image: series   Image: series<	TimeSync - v3.0 Project LCMAP-Pudget - Chip Size: 195 © Zoom: - + Help Example Plots	
Image: state stat		Start End Change Process
Image: bin and	975 -0.04	Q 1993 2009
Impute design   Impute design<	2280 8 0.10 2329 0.12 2500 0.14	
Jan     Feb     Mar     Apr     May     Jun     Jun     Aug     Sop     Oct     Nov     Doc       1     1     3     61     92     12     158     124     245     275     306     337     2     33     3     34     63     94     124     155     165     247     277     308     337     3     34     65     65     66     69     127     187     144     55     165     167     187     148     145     245     276     307     337     36     33     46     62     95     125     156     166     17     58     96     126     127     138     126     126     128	2867 2800 2004 3061 3061 3061 3061 3061 3061 1985 (1972, 1976, 1980, 1984, 1988, 1992, 1996, 2000, 2004, 2008, 2012, 2016, 2020 1985 (1972, 1976, 1980, 1984, 1988, 1992, 1996, 2000, 2004, 2008, 2012, 2016, 2020 2024)	), (1973-1975, 1977-1979, 1981-1983, 1985-1987, 1989-1991, 1993-1995, 1997-1999, 2001-2003, 2005-2007, 2009-2011, 2013-2015, 2017-2019,
2     2     3     62     93     123     154     164     215     246     276     307     337     3     61     92     122     153     163     214     245     257     306     336       3     3     3     61     63     64     95     156     166     217     248     276     300     339       104-00 IS     66     66     77     77     38     67     98     128     129     120     210		Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
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18   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     200   20   51   80   111   141   172   202   233   264   294   325   355     200   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   297   328   358     24   24   55   84   115   146   177   208   236   266   296   327   356     25   25   56   85   116   146   177   270		
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22   22   53   82   113   143   174   204   23   26   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   300   30   360   277   276   88   116   146   177   207   238   269   299   300   360     26   26   57   86   117   147   178   208   239   260   237   363   361     27   27   58   87   118   148   179   209   240   231   362   266   257   86   117   147   178   208   239   350     28   28   59   86	<b>20</b> 20 51 80 111 141 172 202 233 264 294 325 355	20 20 51 79 110 140 171 201 232 263 293 324 354
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24   24   25   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   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   29   60   89   120   150   181   211   242   273   303   363     2011:211 LT5   30   30   90   121   151   182   212   243   274   303   363     2011:211 LT5   201   201   211   211   242   273   303   364   365     2011:211 LT5   201   300   30   90   121   151   182   212   243   274   3	2002-225 UT5 22 22 53 82 113 143 174 204 235 266 296 327 357	22 22 53 81 112 142 173 203 234 265 295 326 356
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   343   364     2011:211 LT5   30   30		<b>23</b> 23 54 82 113 143 174 204 235 266 296 327 357
26   26   57   86   117   147   178   208   239   270   300   331   361     27   27   58   87   118   148   179   209   240   271   301   322   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   343   364     2011-211 LT5   30   30		
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     2011:211/15   20   30   30   30   120   121   151   182   212   243   274   303   363     2011:211/15   30   30   30   120   121   151   182   212   243   274   303   363		
28   28   59   88   119   149   180   210   241   272   302   333   363     29   29   60   89   120   150   181   211   242   273   303   363     2011-211/15   30   30   90   121   151   182   212   243   274   304   335   365		
29   29   60   89   120   150   181   211   242   273   303   334   364   29   29   88   119   149   180   210   241   273   363     2011-211/LT5   30   30   90   121   151   182   212   243   274   304   335   365   30   30   89   120   150   181   211   242   273   303   364		
2011-211 LT5 30 30 90 121 151 182 212 243 274 304 335 365 30 30 89 120 150 181 211 242 273 303 334 364		
	20 20 121 151 182 212 243 274 204 235 365	

Target DOY: 215



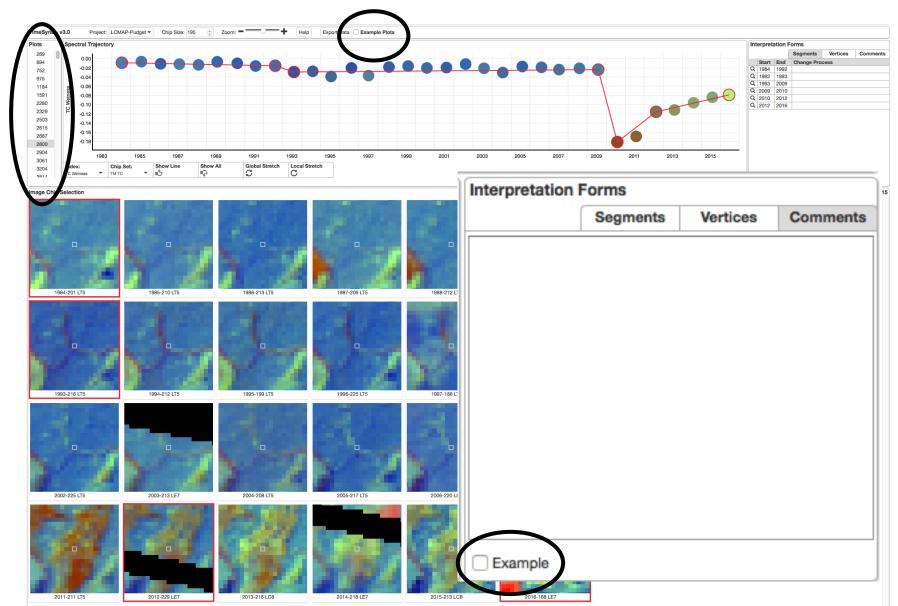
#### TimeSync – Export Data

 Exports interpretations after data is collected



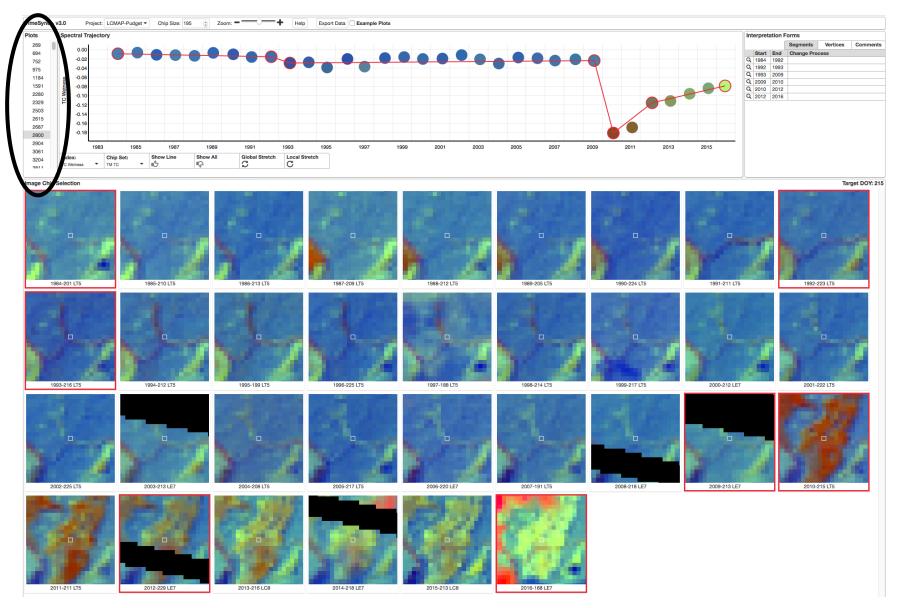
# TimeSync – Example Plots

- Can be useful to easily recall special plots (examples for demonstration, ones that need to be looked at again, etc.)
- Checking this box (top middle) shows, from the full list of plots (top left), only those that were identified as examples in Comments box (bottom)



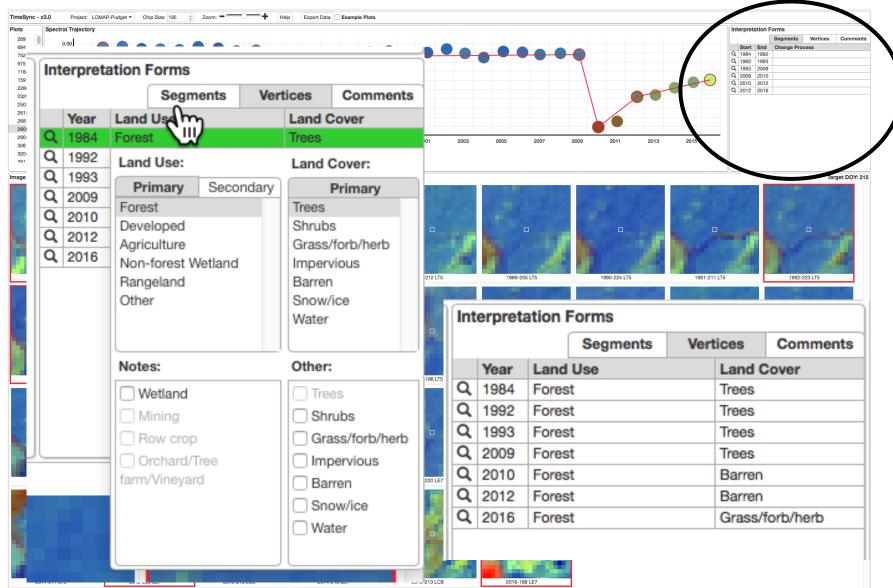
# TimeSync – Plot List

- Each project has a list of plots that can be interpreted
- Generally speaking, a project will belong to a only one person, and that person responsible for all/most/some plots in the list
- Number in a given project usually limited for practical reasons, but there are often extras to facilitate "bad" plots



#### TimeSync – Interpretation Forms

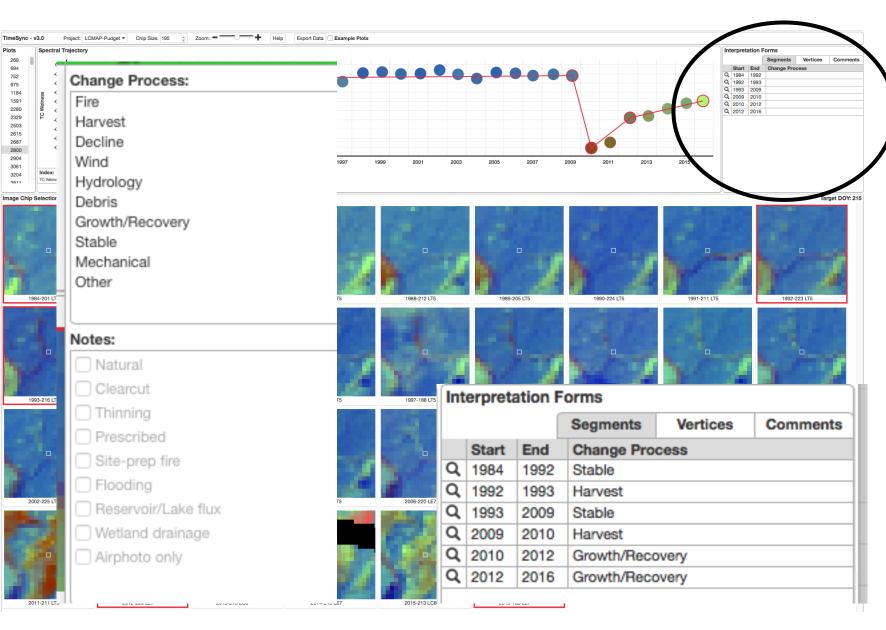
- Segment and vertex labels are specific to a project
- Shown here are the vertex labels chosen for this plot (use and cover), selected from a list that includes secondary use labels and a series of checkboxes relevant to specific choices (notes, other)



#### TimeSync – Interpretation Forms

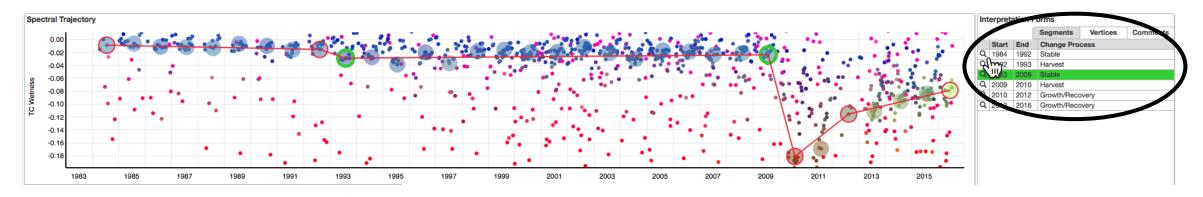
 Shown here are the segment labels chosen for this plot, selected from a list that includes secondary use labels as a series of checkboxes relevant to specific choices

 Comments box for interpreter notes related to plot being interpreted

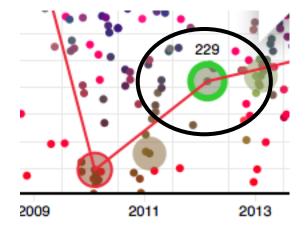


#### TimeSync – Query Button, and DOY "Tip"

- Clicking on query button associated with segments and vertices highlight the relevant vertices in the trajectory window
- For segments there are two relevant vertices



 Hovering over a data point in the trajectory window shows the DOY for that point



#### TimeSync – Data Set-up, Versions, Independence

- There is a process for setting up a project in TimeSync, and it is described, and some people do it themselves, but mostly this currently falls on Yang
- There are two current versions of TimeSync
  - Online version (OLTS, v3.0)
  - Stand alone version (SATS, v1.0)
  - The versions are supposed to have identical functionality, but development occurs on OLTS, with SATS often lagging behind
  - Currently some of the functionality of OLTS is not available in SATS
- Our goal is to have TimeSync software on GitHub (or similar), and let folks run with it
  - This will involve ability to design and load user-specified response design labels, load sample points, and download data