Best Practices: Technical Paper Final Draft

Fall 2019

Elements of a Scientific Research Paper

Experimental Process Question	Section of Paper
What did I do in a nutshell?	Abstract
What is the problem?	Introduction
How did I solve the problem?	Materials & Methods
What did I find out?	Results
What does it mean?	Discussion & Conclusion
Who helped me out?	Acknowledgments
Whose work did I refer to?	Literature Cited
What extra information could be beneficial to include?	Appendices

Things to Remember

You are making an argument - support it!

When in doubt, refer back to your **objectives**.

Use the power of **topic sentences**!

Use **past tense** throughout!

Be specific. Remember who, what, when, where, why, & how!

Introduction Section

Your introduction must include information regarding:

- The problem being investigated
  - Any background necessary to explain the problem
- Project partners
  - End users & collaborators
- Project objectives
- Study area with a map
- Study period
- Related previous DEVELOP work (*2nd or 3rd term projects only*)
- Scientific basis of your methods
  - 5 references from peer-reviewed literature

Methodology Section

Explain your steps in **chronological order**.

Be specific. Give your reader enough details that they can understand and replicate your research. Make sure the “why” and “how” behind data acquisition, processing, and analysis is clearly understood by the reader.

Remember: use past tense & an active voice throughout!

Methodology Section: Data Acquisition

- What data did you get?
- What level products are they?
- For what dates did you get the images?
- Where did you get the images from?

Methodology Section: Data Tables

Table 1. List of Sensors and Data Products

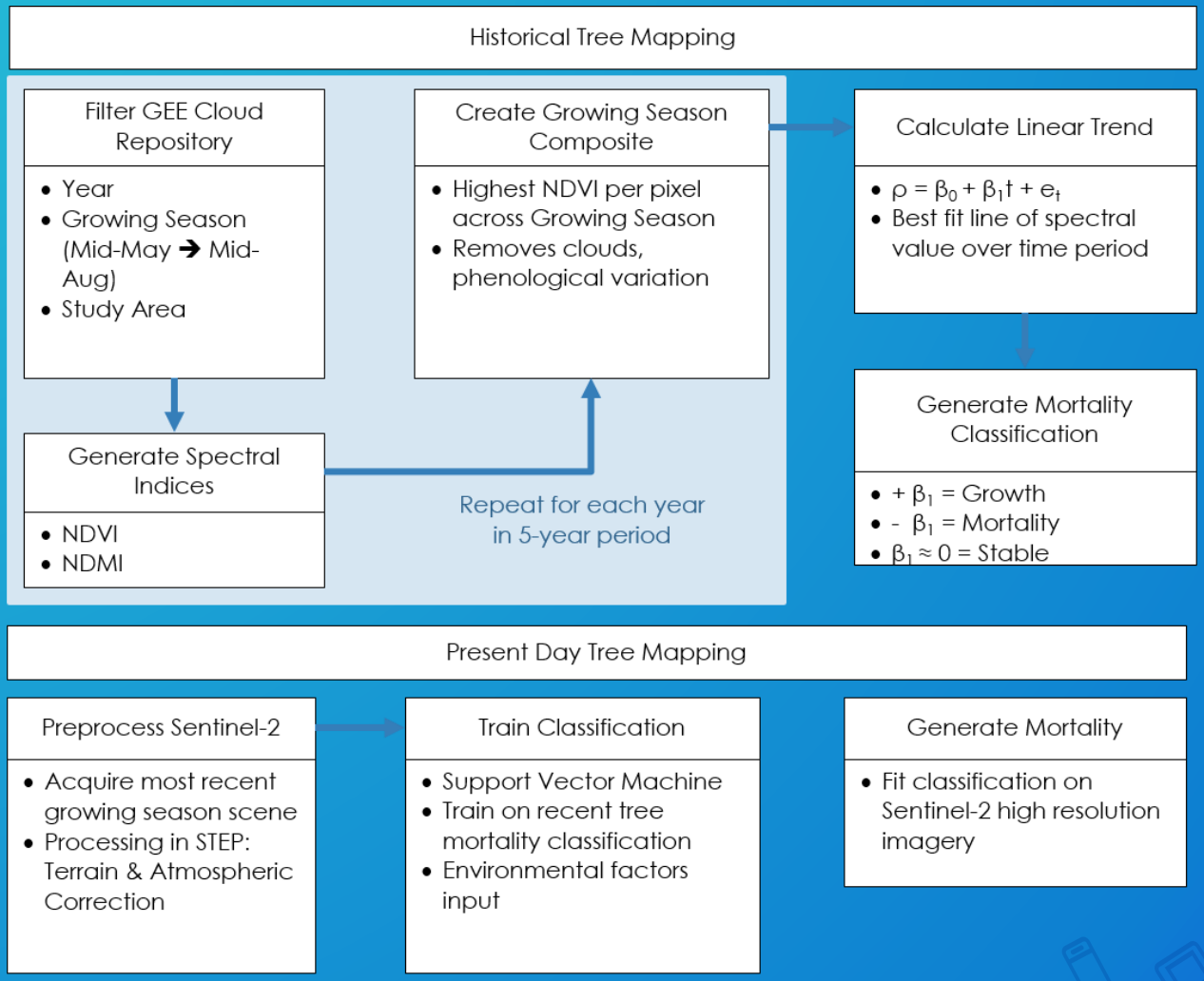
Platform and Sensor	Data Product	Dates/Availability	Acquisition Method
Landsat 8 OLI	Collection 1, Tier 1 Raw and TOA Reflectance (Orthorectified) scenes	April 2013 - present	Google Earth Engine
Sentinel-1 SAR	C-band Synthetic Aperture Radar Ground Range Detected, Level-1C	October 2014 - present	Google Earth Engine
Sentinel-2 MSI	Multispectral Instrument, Level-1C	June 2015 - present	Google Earth Engine
SRTM	SRTM Digital Elevation Data 30m	February 2000	Google Earth Engine
NAIP Airborne Multispectral Imagery	NAIP digital ortho quarter quad tiles	2011, 2014, 2016	Google Earth Engine

Credit: Kristen Dennis, Anson Colds, Timothy Mayer, Gary Olds, Utah Water Resources, 2018

Methodology Section: Data Processing

- What did you do to the data?
- Were there conversions needed to be able to analyze it?
- Did you have to mosaic or composite images?
- What software, scripting, or modeling did you utilize?
- Did you run an NDVI calculation, change detection, etc.?

Methodology Section: Flowcharts



Credit: Josh Verkerke, Anna McGarrigle, John Dilger of the Lassen Volcanic National Park Disasters Summer 2017 Team

Methodology Section: Data Analysis

- How did you analyze the data – statistical analysis, validation, etc.?

Many teams continued writing data processing steps in the data analysis section! Try not to mix them up!

Results vs. Conclusions

Report findings without interpreting them… yet

Results Section: Figures & Tables

When reporting results, use Figures & Tables to help showcase your findings:

- Make sure your figures add to the content of your paper, and do not detract from what you are reporting.
- Know when to use an appendix vs. in-line figures.
  - Reference figures and tables in the text
- Turn on Ruler, Grid Lines, Navigation Pane in the View section of MS Word.
- Caption and label figures in a separate text box. All text should be legible.
  - Captions and labels should be descriptive and able to stand on their own.

Results Section: Be Quantitative & Specific

When reporting differences, directionality, and magnitude, provide useful details:

“Groups A and B were significantly different”

“Group A individuals were 23 percent larger in volume than those in Group B”

Avoid devoting whole sentences to reporting a statistical outcome:

"Males (180.5 ± 5.1 cm; n=34) averaged 12.5 cm taller than females (168 ± 7.6 cm; n=34) in the AY 1995 pool of Biology majors (two-sample t-test, $t = 5.78$, 33 d.f., $p < 0.001$),"

Results Section

Final Tips:

- Vary sentence structure when reporting your results.
- When reporting significance, a common mistake is the overuse of the word “significant”.
- Don’t leave out negative results - they are also important!
- Include possible errors and limitations

Conclusion Section

Fundamental questions to answer in this section include:

- Did you answer the hypothesis or questions posed?
- How does your study compare to past studies?
- Did you describe any new insights to the problem?
- What future work could come from this project?
- How could your end users use your products for decision-making?

Results vs Conclusion

Order Matters! Discuss each section (and topic) in the same sequence as presented in Results.

Methods	Results & Discussion	Conclusion
A) NDVI time series 1) NDVI Formula 2) …	A) NDVI time series 1) Image of NDVI 2) X% of veg lost	A) NDVI time series 1) More area lost than expected 2) Possible cause…
B) Land Surface Temperature 1) Locate hotter/cooler regions	B) Land Surface Temperature 1) Cooler at higher elevations	B) Land Surface Temperature 1) MODIS LST differs from weather stations by X amount
C) Artichoke suitability map 1) Factors and weights 2) …	C) Artichoke suitability map 1) X region more suitable 2) Show map	C) Artichoke suitability map 1) Farmers will have to move by XX year

Citation Notations

How to properly cite your data so readers know that you're legitimate.

Knowing Your Data

EARTHDATA Data Discovery DAACs Community Science Disciplines

Earthdata Wiki Spaces Forums Support Log

Digital Object Identifiers - DOIs for EOSDIS

Pages

CHILD PAGES

- Digital Object Identifiers (DOIs) fo...
- EOSDIS DOIs Status and Listing
  - ASDC DAAC
  - ASF DAAC
  - CDDIS
  - FIRMS
  - GES DISC
  - GHRC DAAC
  - LAADS
  - LANCE AMSR2
  - LANCE MODIS
  - LPDAAC
  - LPVS
  - NSIDC DAAC
  - OB.DAAC
  - Ozone PEATE
  - PO.DAAC
  - PPS

Space tools

Pages / Digital Object Identifiers (DOIs) for EOSDIS

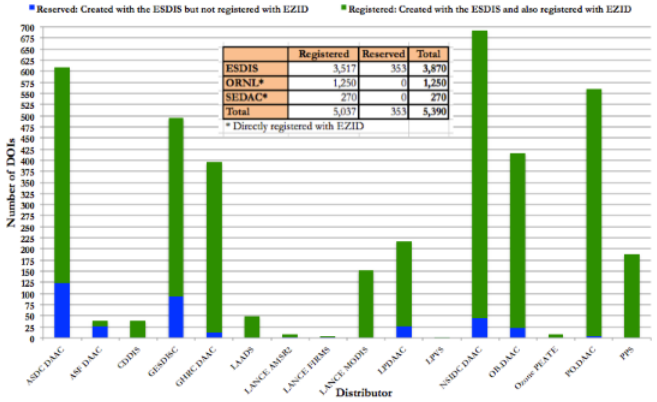
EOSDIS DOIs Status and Listing

Created by Beth Stolte, last modified on Feb 08, 2017

Many EOSDIS components have created DOIs and registered or reserved them using our help. The following missions and projects have begun the process of creating and registering DOIs. The chart below shows the registered/reserved DOIs by Data Provider. The table below gives a status of each mission's DOIs. The links go to the mission page where there is information about the DOIs they have begun to create.

- DOI Background Information
- ESDIS DOI Process
- DOI Submission Process
- DOI Landing Page
- Contact Information
- EOSDIS DOIs Status and Listing
- DOI Documents
- ESDSWG Recommendations
- FAQs
- References and Links

Status of Digital Object Identifiers (DOI) Created with the ESDIS by the Data Providers as of 6 March 2017



	Registered	Reserved	Total
ESDIS	3,517	353	3,870
ORNL*	1,250	0	1,250
SEDAC*	270	0	270
Total	5,037	353	5,390

* Directly registered with EZID

Data Discipline	DOI Provider	Registered	Reserved	Total DOIs
ASDC DAAC	ASDC DAAC	486	123	609
	ASF DAAC	12	26	38
CDDIS	CDDIS	39	0	39
GES DISC	GES DISC	401	94	495
GHRC DAAC	GHRC DAAC	383	12	395
LAADS	LAADS	48	0	48
LANCE AMSR2	LANCE AMSR2	6	1	7
LANCE FIRMS	LANCE FIRMS	2	1	3
LANCE MODIS	LANCE MODIS	152	0	152
LP DAAC	LP DAAC	191	27	218
LPVS	LPVS	1	0	1
NSIDC DAAC	ICESat SIPS	21	0	692
	NSIDC DAAC	627	44	
OB.DAAC	OB.DAAC	394	22	416
Ozone PEATE	Ozone PEATE	7	0	7

Data Digital Object Identifiers (DOIs)

What is a data DOI? [edit]

Digital Object Identifiers, or DOIs, are unique alphanumeric strings used to identify a digital object and provide a permanent link online

Why use DOIs?

- To provide persistent identification for easier access to research data
- To find definitive documentation & creation of the data
- To increase verification and validation of scientific results
- NASA DAACs use DOIs in the published literature to track the use and relevance of their data products

-doi:[prefix]/[suffix]

Prefix - 10.[number] where number identifies registrant agent

5067 - NASA
5066 - USGS

Suffix - uniquely identifies the data item and its format is assigned and managed by the registrant agent

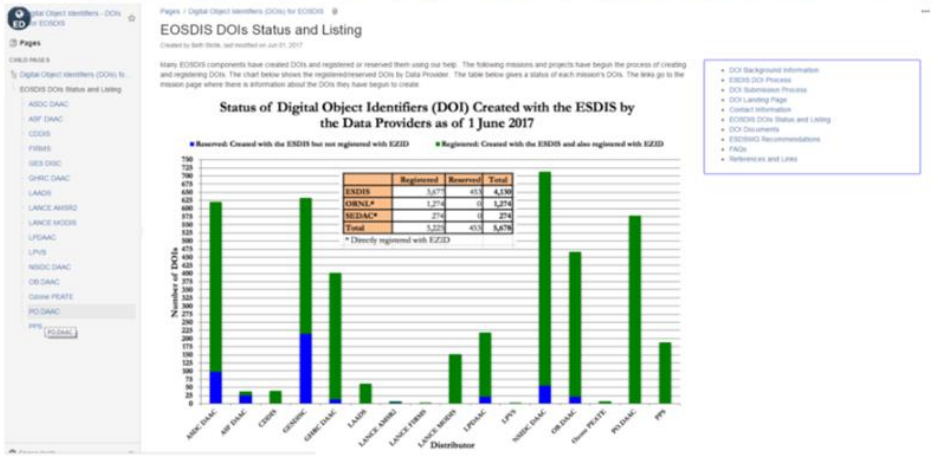
How do I find a DOI for my NASA Data products?? [edit]

1. Look for identifying information

What NASA Distributed Active Archive Center (DAAC) holds the data?
What is the product title?
What is the product shortname?

2. Checkout NASAs EOSDIS DOIs Status and Listing page here!

This is your best resource for NASA product DOIs. Once you know one piece of identifying information listed above, you can find everything you need to correctly cite your data - DOI, product title, creator, distributor, & publication year.



ASDC DAAC

Created by Beth Stolte, last modified on Sep 14, 2015

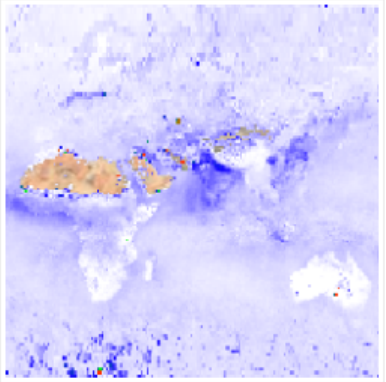
ASDC_Wiki.xlsx

DOI	Product Title	Shortname	Creator	Distributor	P Y
10.5067/CALIOP/CALIPSO/CAL_LID_L1-ValStage1-V3-40	CALIPSO LID L1 ValStage1 HDF File - Version 3.40	CAL_LID_L1-ValStage1-V3-40	Winker, David	NASA Langley Atmospheric Science Data Center DAAC	20
10.5067/CALIOP/CALIPSO/CAL_LID_L2_PSCMask-Prov-V1-10	CALIPSO LID L2 PSCMask Prov HDF File - Version 1.10	CAL_LID_L2_PSCMask-Prov-V1-10	Winker, David	NASA Langley Atmospheric Science Data Center DAAC	20
10.5067/CALIOP/CALIPSO/CAL_LID_L3_APro_AllSky-Standard-V3-10	CALIPSO LID L3 Apro AllSky - Standard HDF File - Version 3.10	CAL_LID_L3_APro_AllSky-Standard-V3-10	Winker, David	NASA Langley Atmospheric Science Data Center DAAC	20
10.5067/CALIOP/CALIPSO/CAL_LID_L3_APro_CloudFree-Standard-V3-10	CALIPSO LID L3 Apro Cloud Free - Standard HDF File - Version 3.10	CAL_LID_L3_APro_CloudFree-Standard-V3-10	Winker, David	NASA Langley Atmospheric Science Data Center DAAC	20
10.5067/CALIOP/CALIPSO/CAL_LID_L3_APro_CloudySkyOpaque-Standard-V3-10	CALIPSO LID L3 Apro Cloudy Sky Opaque - Standard HDF File- Version 3.10	CAL_LID_L3_APro_CloudySkyOpaque-Standard-V3-10	Winker, David	NASA Langley Atmospheric Science Data Center DAAC	20
10.5067/CALIOP/CALIPSO/CAL_LID_L3_APro_CloudySkyTransparent-Standard-V3-10	CALIPSO LID L3 Apro Cloudy Sky Transparent - Standard HDF File - Version 3.10	CAL_LID_L3_APro_CloudySkyTransparent-Standard-V3-10	Winker, David	NASA Langley Atmospheric	20

Earth Engine Data Catalog

HOME | VIEW ALL DATASETS | BROWSE BY TAGS

MOD08_M3.006 Ter
Product



```
ee.ImageCollection("MODIS/006/MOD08_M3")
```

Tags

atmosphere | temperature | geophysical | modis | mod08 | mod08-m3 | monthly | global | terra

DESCRIPTION | BANDS | TERMS OF USE | CITATIONS | DOI(S)

- http://dx.doi.org/10.5067/MODIS/MOD08_M3.006

Google Earth Engine

Search Places or Keywords... | Send feedback | Sign in

Explorer | Data Catalog | Workspace

Data

MCD12Q1.006 MODIS Land Cover Type Yearly...

Add data

MCD12Q1.006 MODIS Land Cover Typ...

2007 2008 2009 2010 2011 2012 2013 2014 2015 2016

2016 Jump to date

Visualization

1 band (Grayscale) | 3 bands (RGB)

LC_Type1

Range

1.0 – 17.0 Custom

Opacity 1.00

Gamma | Palette

Save | Apply | Cancel

Map | Satellite

Indian Ocean

Google

Map data ©2018 500 km Terms of Use

Landsat 7 Enhanced Thematic Mapper Plus (ETM+) Level-2 Data Products - Surface Reflectance

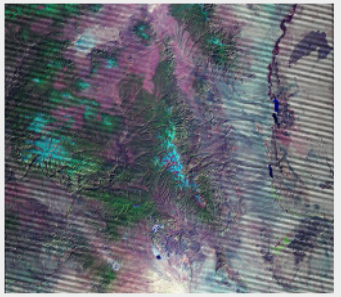
The U.S. Geological Survey (USGS) offers on-demand production of Landsat 7 Enhanced Thematic Mapper Plus (ETM+) Surface Reflectance data through EarthExplorer. Surface Reflectance products provide an estimate of the surface spectral reflectance as it would be measured at ground level in the absence of atmospheric scattering or absorption. The Surface Reflectance products are generated at the Earth Resources Observation and Science (EROS) Center at a 30-meter spatial resolution. The EROS Science Processing Architecture (ESPA) on-demand interface corrects satellite images for atmospheric effects to create Level-2 data products. Landsat Ecosystem Disturbance Adaptive Processing System (LEDAPS), a specialized software originally developed through a National Aeronautics and Space Administration (NASA) Making Earth System Data Records for Use in Research Environments (MEaSUREs) grant by NASA Goddard Space Flight Center (GSFC) and the University of Maryland (Masek et al., 2006), applies radiometric calibration and atmospheric correction algorithms to Level-1 Landsat data products. Specific details about Landsat 7 Surface Reflectance can be found in the Landsat 4-7 Surface Reflectance Product Guide.

The following date ranges apply to the availability of the Landsat archive for Surface Reflectance processing:

- Landsat 7 ETM+: July 1999 to Present

Most Landsat 7 Collection 1 Level-1 scenes in the USGS archive can be processed to Surface Reflectance. Please note the following caveats:

- Surface Reflectance is not run for a scene with a solar zenith angle greater than 76°.
- Users are cautioned against processing data acquired over high latitudes (> 65º) to Surface Reflectance.
- Due to missing auxiliary input data and/or necessary thermal data, Landsat 7 ETM+ scenes processed May 30 through June 12, 2016, cannot be processed to Surface Reflectance. The order status will be updated with this action and the remaining scenes will continue processing.
- Landsat 7 ETM+ inputs are not gap-filled in the surface reflectance production. Users can refer to the quality assurance (QA) layers for pixel-level condition and validity flags.
- Efficacy of Surface Reflectance correction will be likely reduced in areas where atmospheric correction is affected by adverse conditions:
  - Hyper-arid or snow-covered regions
  - Low sun angle conditions
  - Coastal regions where land area is small relative to adjacent water
  - Areas with extensive cloud contamination



Landsat 7 ETM+ Surface Reflectance acquired February 24, 2017 (Path 34, Row 37).

Landsat 7 Enhanced Thematic Mapper Plus (ETM+) Level-1 Data Products

The Landsat Enhanced Thematic Mapper Plus (ETM+) sensor onboard the Landsat 7 satellite has acquired images of the Earth nearly continuously since July 1999, with a 16-day repeat cycle. Landsat 7 images are referenced to the Worldwide Reference System-2.

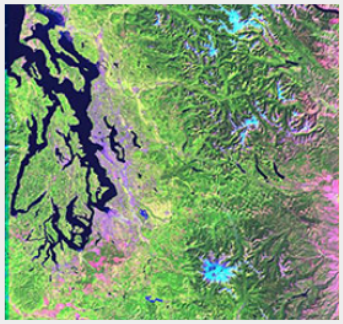
All Landsat 7 scenes collected since May 30, 2003 have data gaps due to the Scan Line Corrector (SLC) failure. Landsat 7 scenes acquired after this date are categorized as SLC-off. This page describes the details of the SLC-off data, and provides established methods to fill the scenes: https://landsat.usgs.gov/using-landsat-7-data.

Landsat 7 ETM+ images consist of eight spectral bands with a spatial resolution of 30 meters for bands 1 to 7. The panchromatic band 8 has a resolution of 15 meters. All bands can collect one of two gain settings (high or low) for increased radiometric sensitivity and dynamic range, while Band 6 collects both high and low gain for all scenes. Approximate scene size is 170 km north-south by 183 km east-west (106 mi by 114 mi).

Standard Processing Parameters

All Landsat 7 ETM+ products are processed through the Level 1 Product Generation System (LPGS) with the following parameters applied.

Product Type	L1T Terrain Corrected*
Resampling Method	Cubic Convolution (CC)
Map Projection	UTM – WGS 84 Polar Stereographic for the continent of Antarctica.
Image Orientation	Map (North Up)
Distribution	HTTPS Download Only
Delivery Time	Within 24 hours of new acquisitions; 1 to 3 days for processing requests for already-archived data



Landsat 7 ETM+ SLC-on acquired September 7, 1999 (Path 46, Row 27)

* While most Landsat scenes are processed with the Standard Terrain Correction (Level 1T), some scenes do not have the ground-control or elevation data necessary to perform these corrections. In these cases, the best level of correction is applied. (See Landsat Processing Details for details on correction levels.)

Specific Level 1T scenes are available for most of the globe under the Global Land Surveys (GLS) collections of 1975, 1990, 2000, 2005, and 2010. These datasets can be found on EarthExplorer or the USGS Global Visualization Viewer (GloVis).

Mandatory ESA Sentinel Citation

“This material contains modified Copernicus Sentinel data (yyyy i.e. 2017), processed by ESA”

- If more than ESA is used, we are obliged to give rights credits to those organizations as well.

Example:

“Copyright contains modified Copernicus Sentinel and Landsat data (2015–16), processed and analysed by Humboldt University Berlin/P. Griffiths (ESA Living Planet Research Fellow). Data preprocessing: NASA and Harmonized Landsat–Sentinel initiative.”

Tips for In-Text Citations

- **All in-text citations should directly relate to the information in the preceding sentence(s).**
  - Common Errors:
    - Using citations in unnecessary places
    - Including citations that are not discussed in the text of the tech paper

- **Text should actively engage with citations.**
  - Common Error: Citing one or many sources without writing about their findings
    - Example: Many studies have been completed on the topic with varying results (Johnson & Abel, 2016; Dennis, 2018; Lawrence, Friedrich, & Smith).

Writing Tips

Here are some things to look out for and ways to avoid submitting errors in your final drafts!

Professional Writing Tips

Be precise.

- "We saw a slight increase in precipitation."
- "Precipitation increased by 3%."

Be direct. Avoid jargon.

- commenced vs. began
- subsequent vs. next

Eliminate unnecessary words.

Do not use contractions.

Keep related words together.

- "The agency must be able to estimate **early each year** the amount of corn that will be harvested."
- "**Early in each year,** the agency must be able to estimate the amount of corn that will be harvested."

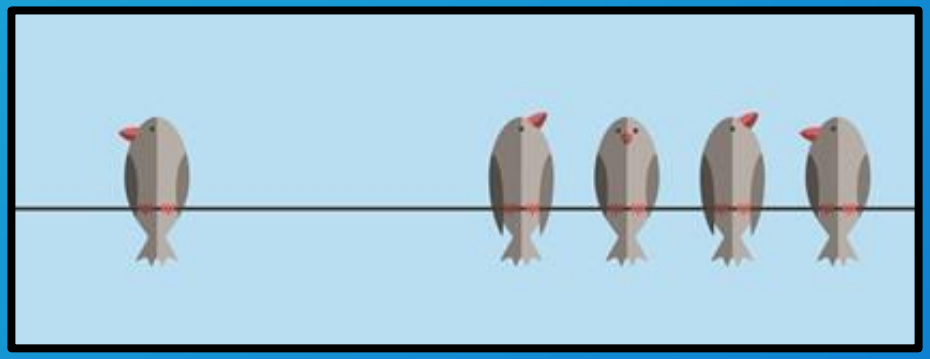
Professional Writing Tips

Organizations are single entities:

- single verbs: “It has...” vs. “They have...”
- possessive pronouns: “Its findings...” vs. “Their findings...”

The individual leaders can be groups:

- “The CheeseFactory directors reached out to us directly. They want to learn to use remote sensing technologies.”



Professional Writing Tips

Organizations are single entities:

- *San Francisco Solar* – They have limited familiarity with NASA Earth observations and has not implemented remotely sensed data in their work before. This project will assist the partner in building their capacity in remote sensing applications and enhance their existing GIS skills.
- *San Francisco Solar* – The end user has limited familiarity with NASA Earth observations and has not implemented remotely sensed data in its work before. This project will assist the partner in building the organization's capacity in remote sensing applications and enhance San Francisco Solor's existing GIS skills.

Professional Writing Tips

1. Adding A Comma Before “That” In A Clause

- Incorrect: The car, that sat in the driveway was old.
- Correct: The car that sat in the driveway was old.

2. Not Using a Comma Between Two Independent Clauses That Are Connected By A Coordinating Conjunction

- Incorrect: I played chess but I could not win any competition.
- Correct: I played chess, but I could not win any competition.

3. Comma Splice and Run-On Sentence

- Incorrect: I opened the door, I fell on the ground.
- Correct: I opened the door. I fell on the ground.

- Incorrect: After I finished my work I went out for a break.
- Correct: After I finished my work, I went out for a break.

Professional Writing Tips

4. Using A Comma in An Essential Adjective Clause

- Incorrect: It is the place, that I always aspired to visit in my lifetime.
- Correct: It is the place that I always aspired to visit in my lifetime.

5. Using A Comma Before a Subordinate Conjunction

- Incorrect: I was cold, because I went outside.
- Correct: I was cold because I went outside.

Professional Writing Tips

Data = Plural

"The data are" NOT "the data is"

Checklist to Complete Before Submission

1. **Go through your word doc alongside the unedited template & deliverables checklist:**
   - tables/equations or headers are properly formatted
   - necessary sections are included

1. **Use find function (ctrl + f) to look for common mistakes:**
   - acronyms
   - correct verbage for “data”
   - figures, tables, & appendix references in text
   - reference usage
   - repeated phrases

1. **Do one last read through to make sure your paper is in past tense.**

1. **Have someone else read it:**
   - science advisor
   - node fellow
   - other node team

Checklist to Complete Before Submission

You're not off the hook for edits when you submit on November 21, 2019!