**NASA DEVELOP National Program**



NASA Jet Propulsion Laboratory

*Summer 2015*

U.S. Disasters II

Using GRACE-derived water and moisture products as a predictive tool for fire response in the contiguous United States

 **Technical Report**

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Brittany Zajic (Project Lead)

Daniel Jensen

Nick Rousseau

Dr. John T. Reager, NASA Jet Propulsion Laboratory (Science Advisor)

Previous Contributors:

Max Baldridge

# I. Abstract

[Placeholder - do not put anything here until the final draft submission. The abstract in the project summary is where the working draft of the abstract should “live”]

**Keywords**

Insert here 2-8 keywords that relate to your project

Example: Remote Sensing, Drought, Climate, Fire Activity, GRACE, Global Fire Emissions Database, MODIS

# II. Introduction

Including the items listed below; write a synopsis of the following information. Be concise. Word count should be between 200-1000 as one to two pages should suffice.

Material to include:

* Background Information: Relevant information to inform the reader of current status, issues, previous studies, etc.
* Project Objectives: These should be short decisive action items.
* Study Area: Describe the geographic location of the study
* Study Period: Explain the time period of data you are looking at (years and dates of data)
* National Application(s) Addressed: Explain which NASA national application areas this project addresses and how it contributes to them
* Project Partners: Explain who the project partners are, why they are interested in this project, how they will use it, what decision making they have to do and is being addressed with this research and methodologies, etc. How will they benefit from this project and methodology?

Wildfires across the United States have increasingly become larger and more frequent in the last several decades.  Trends contributing to both an increase in the number of wildfires and burned area correlate with increased drought severity, causing severe economic loss, environmental degradation, and property damage (Dennison et al. 2014, Morton et al. 2003).  One of the largest contributing factors to fire danger is fuel moisture content (FMC), a measure that when limited contributes to fire severity in a given area (Verbesselt et al. 2002).  Low FMC means higher fire risk as well as higher potential fire severity, the degree of environmental change caused by a fire, due to plants being more resistant to fire when containing more moisture.  However, drought severity indices generally lack objective soil moisture, root zone moisture, and groundwater conditions and remotely sensed FMC products themselves are generally unavailable at large scales (Houborg et al. 2012).

NASA’s Gravity Recovery and Climate Experiment (GRACE), which is made up of a pair of Earth-observing satellites that measure Earth’s gravity field, is significant due to its ability to derive water stored at all levels. This enables reliable detection of spatio-temporal variations in total terrestrial water storage (TWS) (Houborg et al. 2010, Houborg et al. 2012).  By assimilating these data into the Catchment Land Surface Model, coarse resolution GRACE terrestrial water storage is spatially and temporally disaggregated and vertically decomposed into different water content components (Houborg et al. 2010).  Estimates of terrestrial water storage in the United States are crucial for predicting climate change, weather, and natural hazards, especially wildfires (Tapley et al. 2004). Because biomass is largely built up during wet years and fire risk is greatest during dry years, dry years that are preceded by wet years are of great importance for fire risk assessment. Soil moisture is of particular importance for estimating fire risk through FMC, as well as fire-severity risk based on alternating wet and dry year patterns that have previously been difficult to assess with remotely sensed measurements (Tapley et al. 2004).

With this information in mind, this project analyzed correlations between GRACE assimilated data products and the Global Fire Emissions Database (GFED), which quantify zonal moisture content and burned vegetated area respectively. In doing so, this established the potential predictive capability of GRACE assimilated data products by determining fire risk resulting from accumulated fuel moisture content. Building upon these processes, the project further investigated those relationships by examining various spatial and temporal characteristics. These included investigating the modeled differences between various land cover types as well as the responses in fire severity to deviations from average moisture patterns. This methodology in turn can be used for directing on-the-ground preparedness, mitigation, and response efforts during fire seasons. By proving the feasibility of this approach, this study further established the need to refine the modeling process and results through the incorporation on other Earth observation datasets to more accurately assess fire risk in the United States.

This project worked towards gaining understanding of the relationship between fire severity and regional climate conditions and determining fire risk in novel ways that have previously faced severe limitations. These preliminary fire-risk products provide the project’s partners at the USDA Forest Service Remote Sensing Applications Center (RSAC) and NASA Terrestrial Hydrology Program at Goddard Space Flight Center a predictive tool that enables risk management at a national scale. This will allow these organizations to better employ early decision support to areas of high risk during fire seasons and mitigate the potential impacts fire related disasters before they occur. The partners will have access to over 10 years of assimilated data which has been consolidated, modeled, and input into a scripted Python algorithm, allowing for the study of past trends to inform future fire risk.

# III. Methodology

This should be the focus of the paper - concise, yet explanatory, and highlight the NASA Earth observations utilized and its/their capabilities. Include a paragraph or more for each of the following items. No word cap, but be thoughtful and keep it in the two to six page range.

Content to include:

* Data Acquisition: What data did you get, what level products are they, for what dates did you get images, where did you get the images from, etc.
* Data Processing: What did you do to the data? Were there conversions needed to be able to analyze it? Did you have to mosaic images? Did you have to normalize anything to fit other datasets? Did you run an NDVI, change detection, etc?
* Data Analysis: How did you analyze the data? What methods did you use?

# IV. Results & Discussion

Insert images, graphs, maps, charts, etc. here. Choose the most important results to highlight here. No word cap, but two to six pages is a good range.

Things to discuss:

* Analysis of Results: What can you tell from your graphs, images, etc? What does this mean for your project?
* Errors & Uncertainty: What factors could you not account for, what things didn’t work out like you expected they would, etc.
* Future Work: If this project was to be selected for another term, what would be the focus? What other areas would be of interest?

# V. Conclusions

Final conclusions. Word count: 200-600 (~a page).

# VI. Acknowledgments

We would like to thank our Science Advisor, Dr. John T. Reager (NASA JPL), for his guidance on this project. We would like to thank Mark Finney, Chuck McHugh, and Everett Hinkley from the USDA Forest Service Predictive Services Program for their involvement in providing direction and information pertaining to wild fires in the United States. We would also like to thank Dr. Matt Rodell of the NASA Terrestrial Hydrology Program at Goddard Space Flight Center for his help in attaining and utilizing the assimilated GRACE data

This material is based upon work supported by NASA through contract NNL11AA00B and cooperative agreement NNX14AB60A.

# VII. References

Insert references here. Only include articles/content cited in the body of text above. It’s great if you read many other articles, but they should not all be listed here unless they are being cited in this report.

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# IV. Appendices