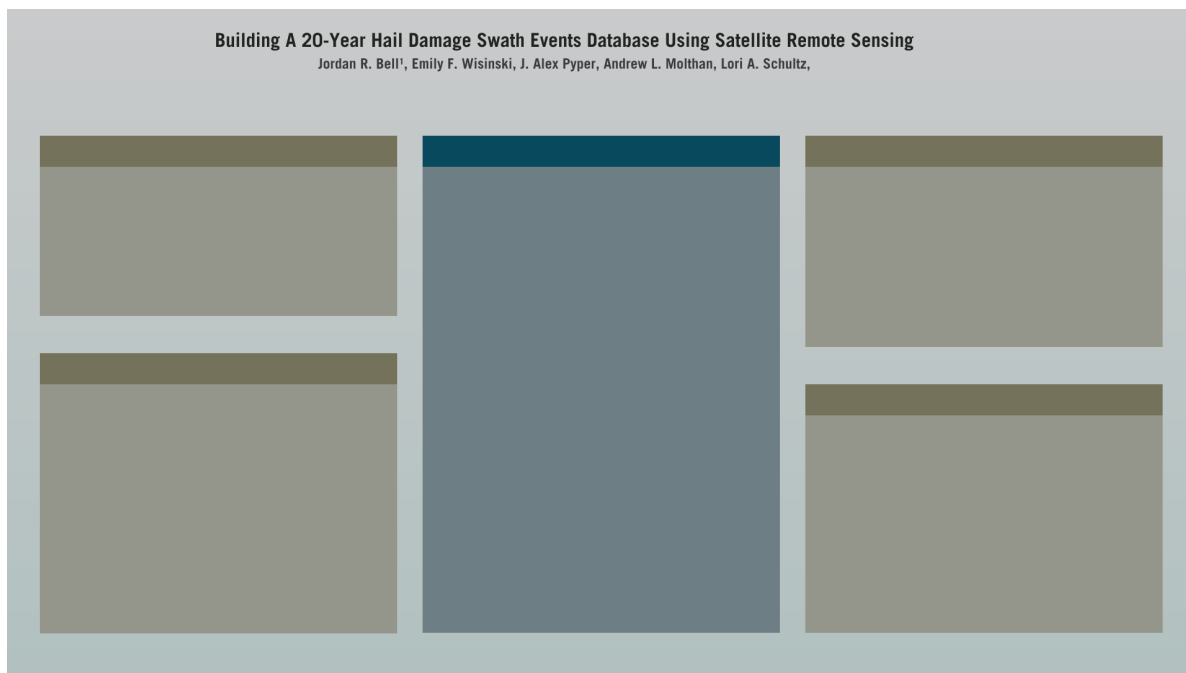


Building A 20-Year Hail Damage Swath Events Database Using Satellite Remote Sensing

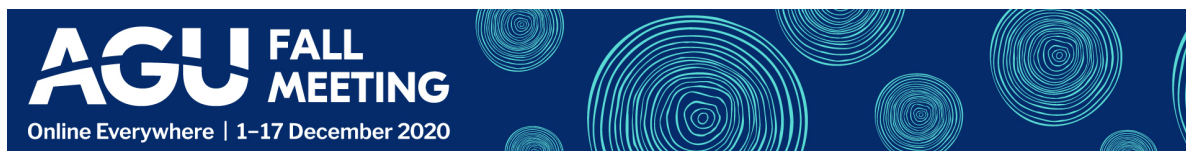


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PRESENTED AT:



BACKGROUND AND MOTIVATION

- Each year intense thunderstorms move over agricultural areas during the prime growing seasons, bringing with them damaging winds, large hail and tornadoes.
- Intense thunderstorms annually cause in excess of 580 million dollars in damage (Changnon 2009).
 - The 2020 Iowa Derecho which had winds in excess of 100 mph and hail mixed, caused an estimated 4 to 8 billion dollars in damage to agricultural crops (Henson 2020).
- In some instances intense thunderstorms will leave behind large swaths of damage, some of which can be several hundreds of kilometers long and tens of kilometers wide.
- Depending on when these "hail damage swaths" occur in the growing season, they can be visible upwards of weeks.



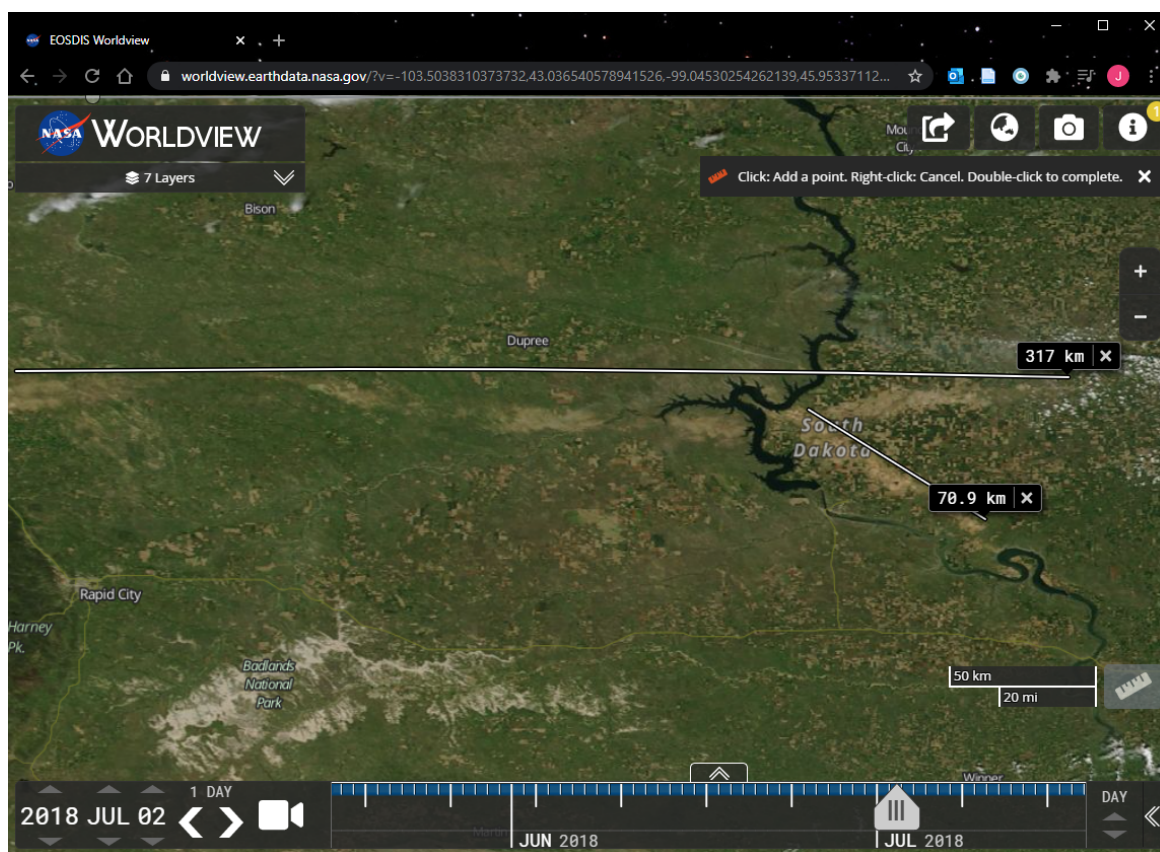
25 August 2011 Terra MODIS True Color image showing numerous hail damage swaths from severe thunderstorms that occurred on 18 August 2011.

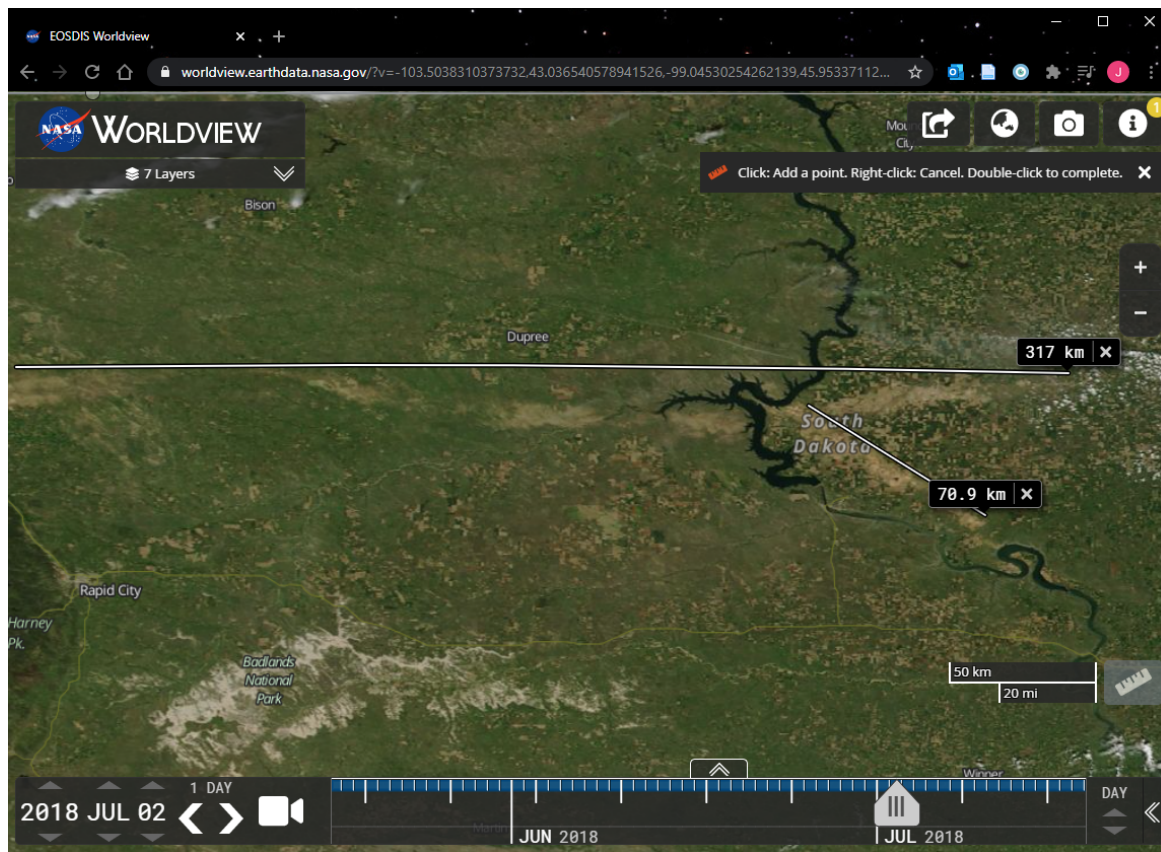
- Despite numerous costly hail damage swaths occurring throughout the Central United States and Great Plains every year, there is no database or archive of these events.
- Because a majority of these hail damage swaths are visible from satellite remote sensing platforms (Gallo et al. 2012, Molthan et al. 2013, Bell and

Molthan 2016, and Bell et al. 2020), this study aims to utilize several of those platforms to build a 20 year hail damage swath events database.

BUILDING THE DATABASE--PHASE I

- The Moderate Resolution Imaging Spectroradiometer (MODIS) instrument aboard the satellite Terra began a daily repeat of the globe in 2000 and a second MODIS instrument aboard Aqua began daily collects in 2003.
- Using the data collected from these two MODIS instruments, daily True Color images were reviewed in NASA's Worldview Portal to identify suspected hail damage swaths
 - The search for hail damage swaths was conducted during the primary growing season (1 May to 30 September) annually in the Central United States and Great Plains, the primary agricultural region.
 - Each suspected hail damage swath was cataloged with additional information such as when the scar first appeared in satellite imagery and potential date of occurrence using the NOAA/NWS Storm Prediction Center's storm reports database.

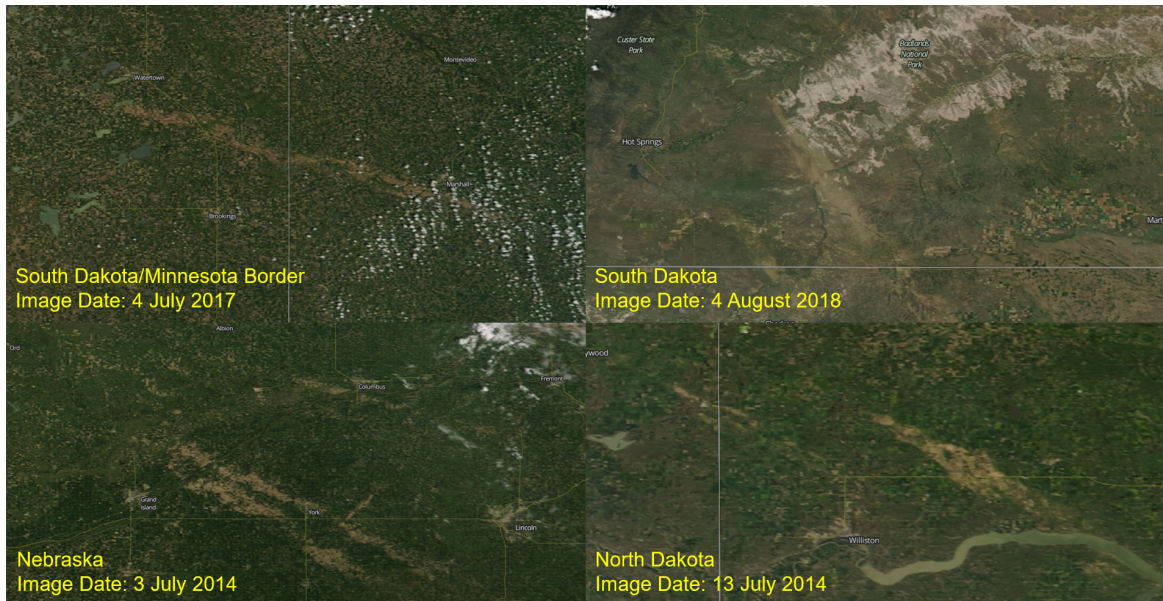




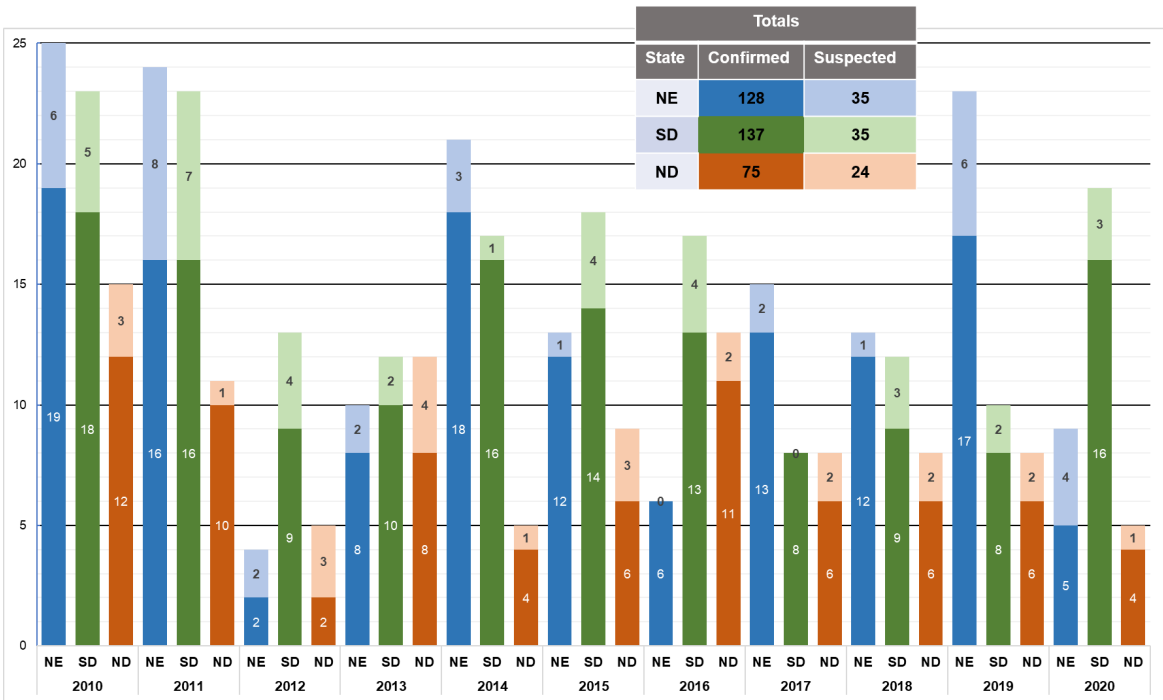
Hail damage swaths observed from NASA Terra MODIS instrument in the NASA Worldview portal. These damage swaths occurred in South Dakota from two different late June 2018 severe thunderstorm events.

PRELIMINARY FINDINGS

Examples of Various Hail Damage Swaths Found To Date



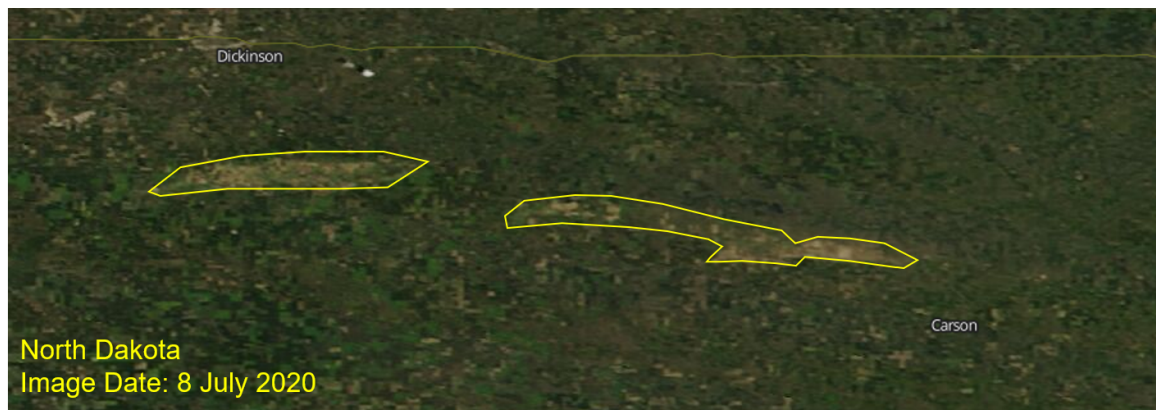
2010 - 2020 Preliminary Hail Damage Swaths Count for Three States



- Confirmed cases are easily identifiable and visible hail damage swaths in MODIS True Color imagery and an event date can be easily determined using SPC Storm Reports.
- Suspected cases may be what looks to be visible hail damage swaths may but may be lacking in storm reports in and around the area or sky conditions may be limiting good views of the surface by satellite imagery.

BUILDING THE DATABASE--PHASE II

- After constructing and validating an extensive list of events through the use of NASA Worldview, geographic metadata will need to be created.
- This will require every identified hail damage swath to have a basic outline of the swath created.
- Using these outlines, the study will be able generate length and width of each hail damage swath, as well as area impacted.



Prototyping of how the geospatial outlining process will look on each hail damage swath.

FUTURE WORK & ACKNOWLEDGEMENTS

- Upon completing Phase I & II for full 20 years of the database the following analysis will be performed:
 - Construct monthly and annual heat maps will be constructed to look for geographic trends.
 - Identify potential correlations and connections between geographic trends and long term climatological variables (ENSO, NAO, etc).
 - Start looking at expanding the events database to include international regions including Canada, Argentina, Europe, and South Africa.
 - Investigate using machine learning techniques to continue building the database

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ABSTRACT

Each growing season, intense thunderstorms can produce damaging winds and large hail across agricultural areas. In certain cases, these intense thunderstorms leave behind visible swaths of damage, sometimes, hundreds of kilometers long and tens of kilometers wide over near mature agricultural crops. Unlike, tornadoes in the United States, where formal ground surveys are conducted to confirm the number of, the length, width, and other statistics of the damage; there is no formal database or climatology of hail damage swaths. Because hail is one of the costliest natural disasters, especially for agricultural crops, the need for a dataset is that can help to inform stakeholders on past events, as well as potentially provide information for about risk planning and the annual threat to agricultural areas going forward. Because hail damage swaths are frequently visible from outer space, satellite remote sensing instruments are frequently used to observe them over the last few decades. Many of these instruments have extensive periods of records, making it possible to go back into time to assemble a database of hail damage swaths.

Using NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) instrument, work is underway to start developing a 20-year hail damage swath events database for the Central United States. This database will initially provide associated metadata for when the damage swath appeared relative to the intense storms that produced the damage, with additional information about atmospheric conditions that may reveal clues about annual variability. This presentation will focus discussing the methodology for creating, populating the database, and initial analysis of the database. The presentation will close with highlighting the work that is still left to be done to complete the database.