A Near Real-time Operational Tool for Monitoring Flash Drought Development Across the United States

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Goals of the U.S. Flash Drought Monitor (US-FDM)

- Provide weekly maps that highlight areas across the United States that are likely to be experiencing rapid drying and flash drought development
- Use a multi-metric, “convergence of evidence” approach to increase confidence in areas designated in flash drought
- Create intuitive maps that translate the complexities of flash drought development into clear risk levels for a broad audience (e.g., researchers, stakeholders, general public, etc.)

Data Used in the US-FDM

- Evaporative Demand Drought Index (EDDI)
  - Measures the atmospheric demand of moisture at the land surface
  - Derived from NLDAS-2
- Precipitation
  - Used from the Climate Prediction Center's Unified Gauge-Based Analysis
- Standardized Evaporative Stress Ratio (SESR)
  - Measures the overall moisture stress on the environment (ratio of ET/PET)
  - Derived from NLDAS-2
- Root zone soil moisture
  - Used from NLDAS-2
- Land Surface Water Index (LSWI)
  - A vegetation index that measures vegetation health from the perspective of moisture content
  - Derived from MODIS aboard NASA's Terra satellite

Methods for Flash Drought Detection in the US-FDM

Categories of US-FDM

- RD1: Initiation of rapid drying
  - 1-2 weeks of rapid drying
  - Drought conditions not reached
- RD2: Extended period of rapid drying
  - 2-3 weeks of rapid drying
  - Drought recently reached (but short duration; less than 1-2 weeks)
- FD1: Flash drought development is established and ongoing
  - 3 or more weeks of rapid drying (and ongoing)
  - Drought conditions present for at least the most recent 3-week period or longer
- FD2: Flash drought is persisting and transitioning to drought
  - Experienced multi-week rapid drought development (but rapid drought intensification no longer occurring)
  - At least 3 weeks of persistent drought conditions following rapid drought intensification

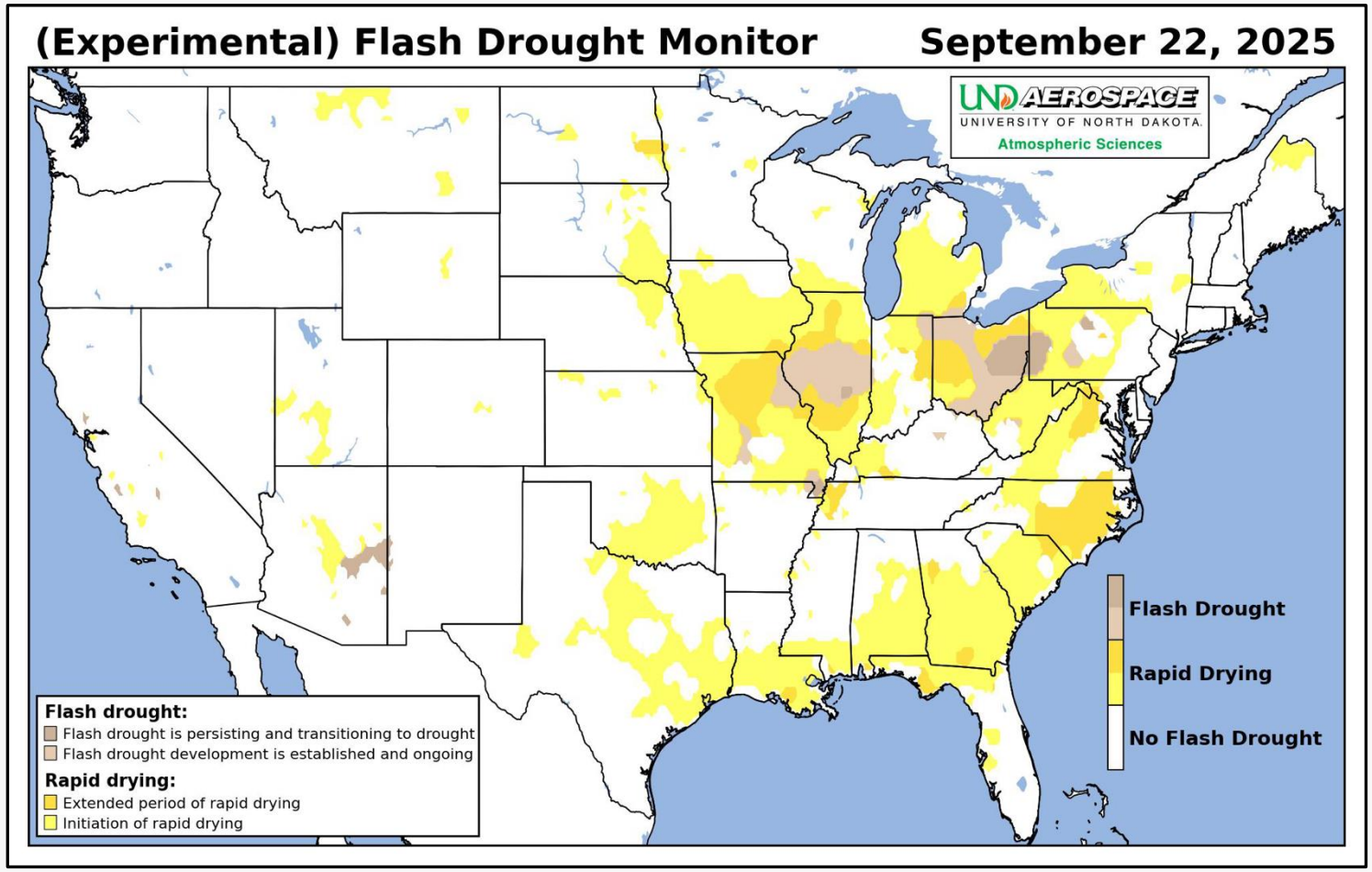
Methods for Flash Drought Detection in the US-FDM

- Evaporative Demand Drought Index (EDDI)
  - Greater than 70th percentile
- Precipitation
  - Lower than 20th percentile
- Standardized Evaporative Stress Ratio (SESR)
  - Rapid drying: ΔSESR less than 25th percentile week over week
  - Drought: SESR less than 20th percentile
- Root zone soil moisture (SM)
  - Rapid drying: ΔSM less than 25th percentile week over week
  - Drought: SM less than 20th percentile
- Land Surface Water Index (LSWI)
  - Rapid drying: ΔLSWI less than 25th percentile week over week
  - Drought: LSWI less than 20th percentile

- For EDDI and precipitation:
  - Consecutive weeks exceeding threshold
  - RD1 – 1 week, RD2 – 2 weeks, FD1 – 3 weeks, FD2 – 4 weeks
- For SESR, SM, and LSWI:
  - RD1: Rapid drying >= 1 Δvariable
  - RD2: Rapid drying >= 2 Δvariable and drought via variable >= 1 week
  - FD1: Rapid drying >= 2 Δvariable, drought via variable >= 3 weeks, and weeks of drought without rapid drying < 3 weeks
  - FD2: Rapid drying >= 2 Δvariable and weeks of drought without rapid drying >= 3 weeks

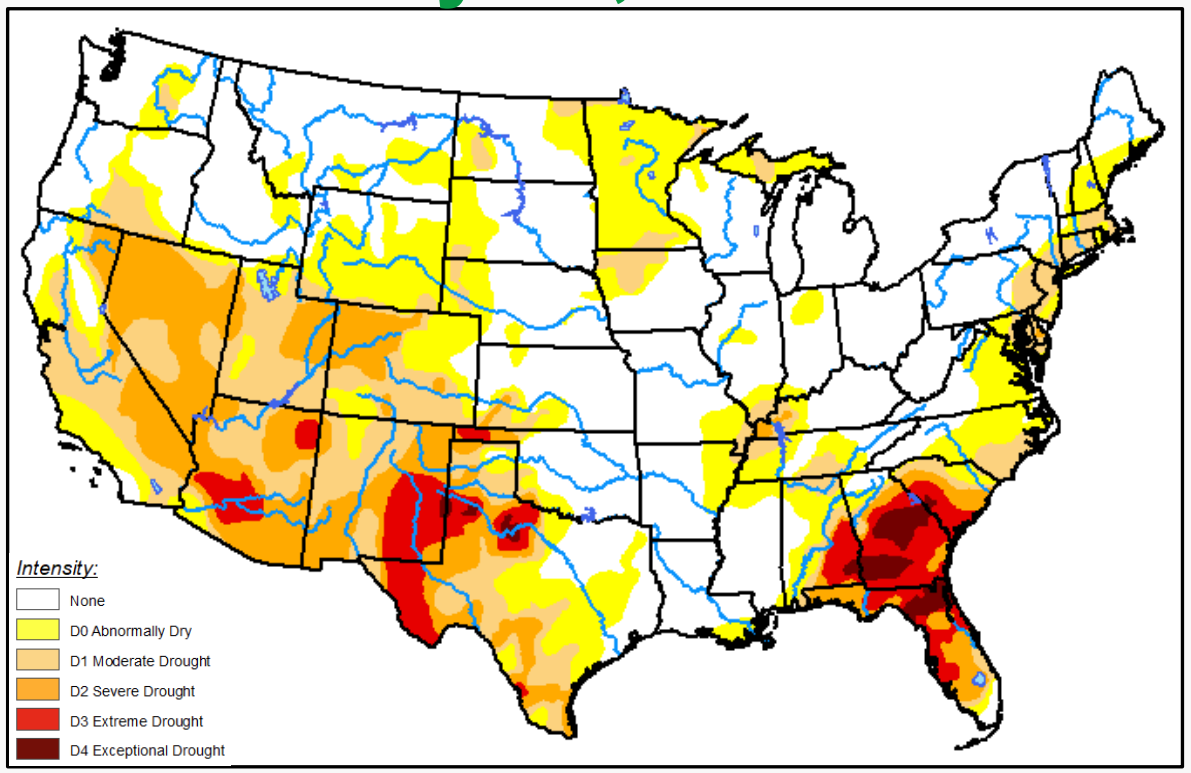
US-FDM

- The US-FDM is updated weekly every Monday morning during the approximate warm/growing season (March through October)
- The US-FDM provides 4 categories for monitoring rapid drought onset and development
  - **Initiation of rapid drying**
  - **Extended period of drying**
  - **Flash drought development is established and ongoing**
  - **Flash drought is persisting and transiting to drought**

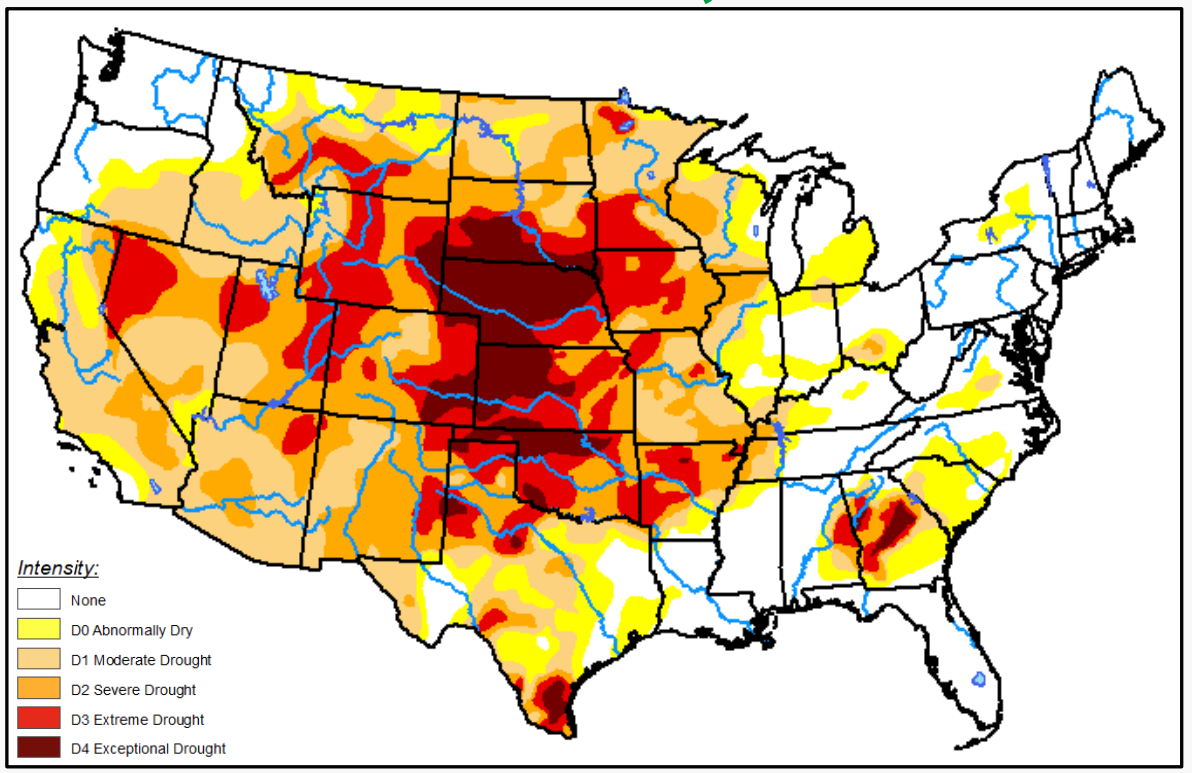


2012 Central US Drought

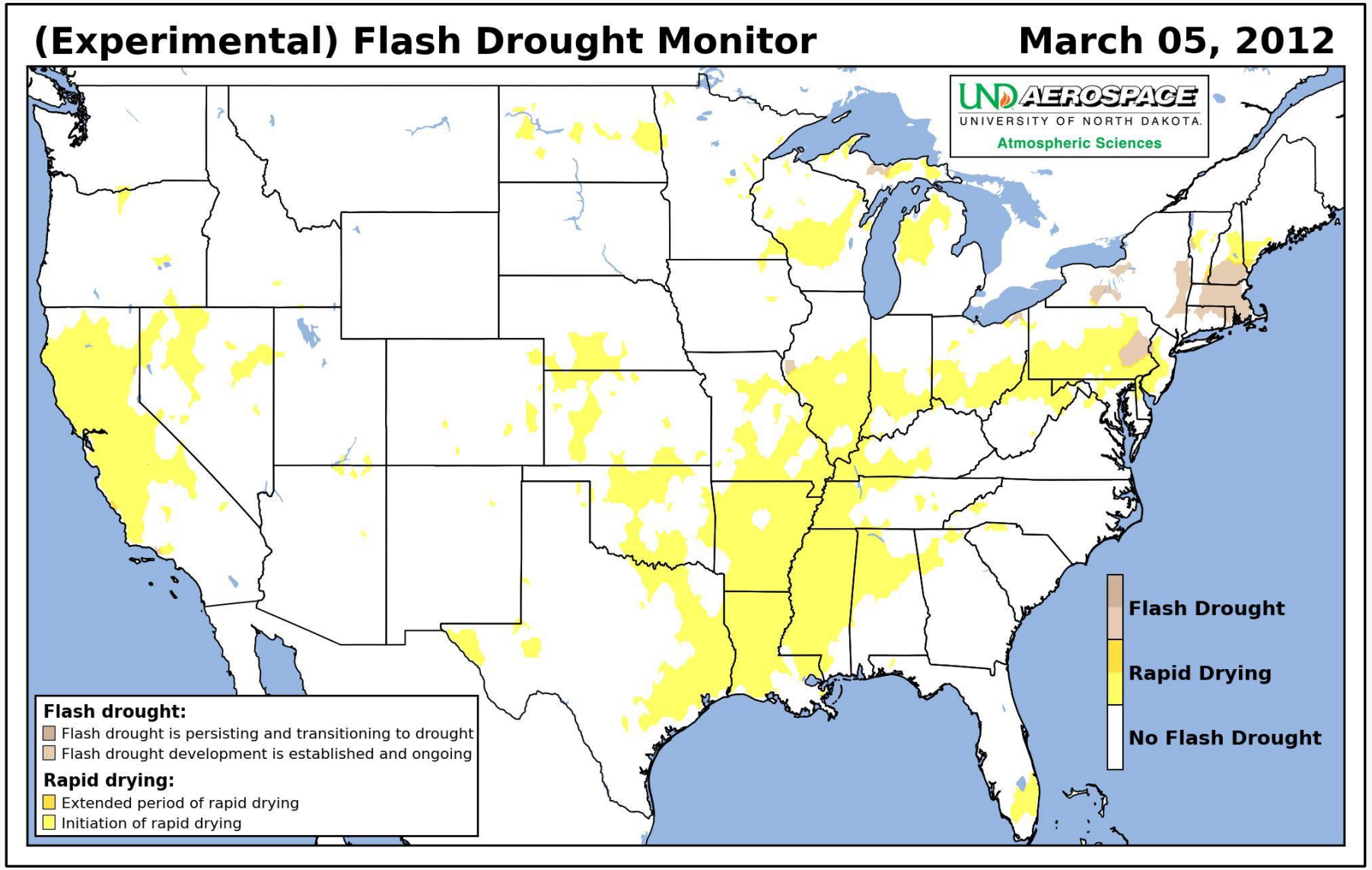
USDM
May 15, 2012



USDM
October 30, 2012



US-FDM Example (2012 flash drought)



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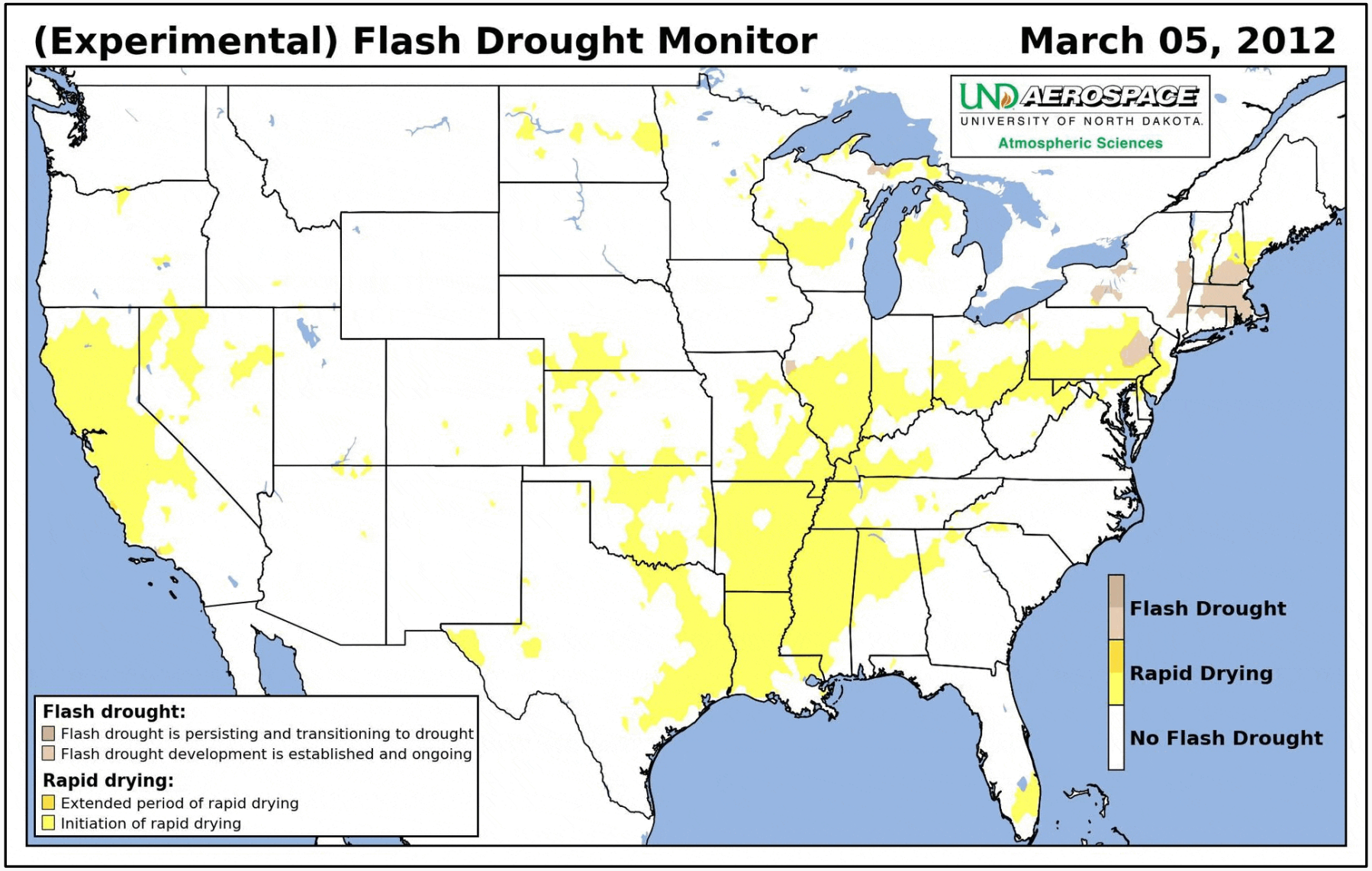
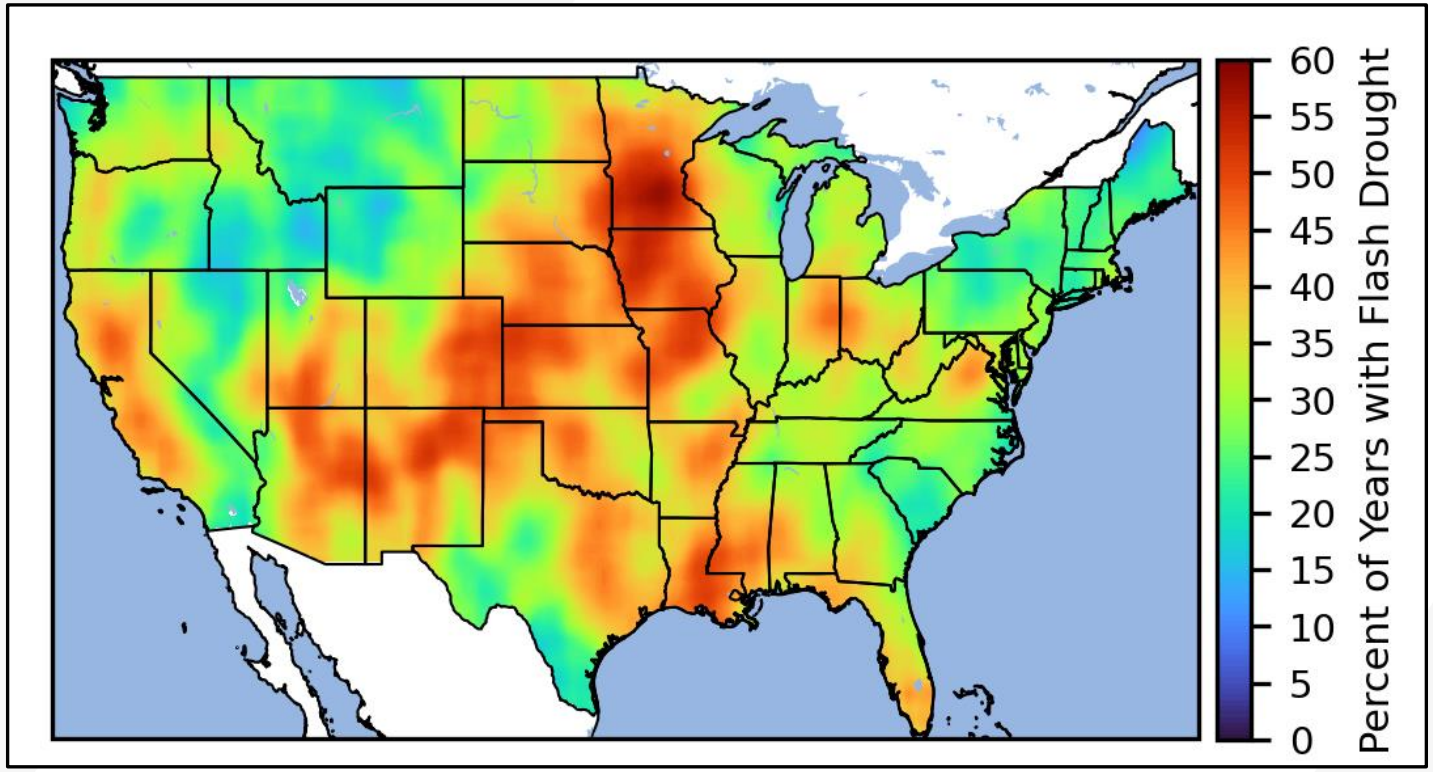
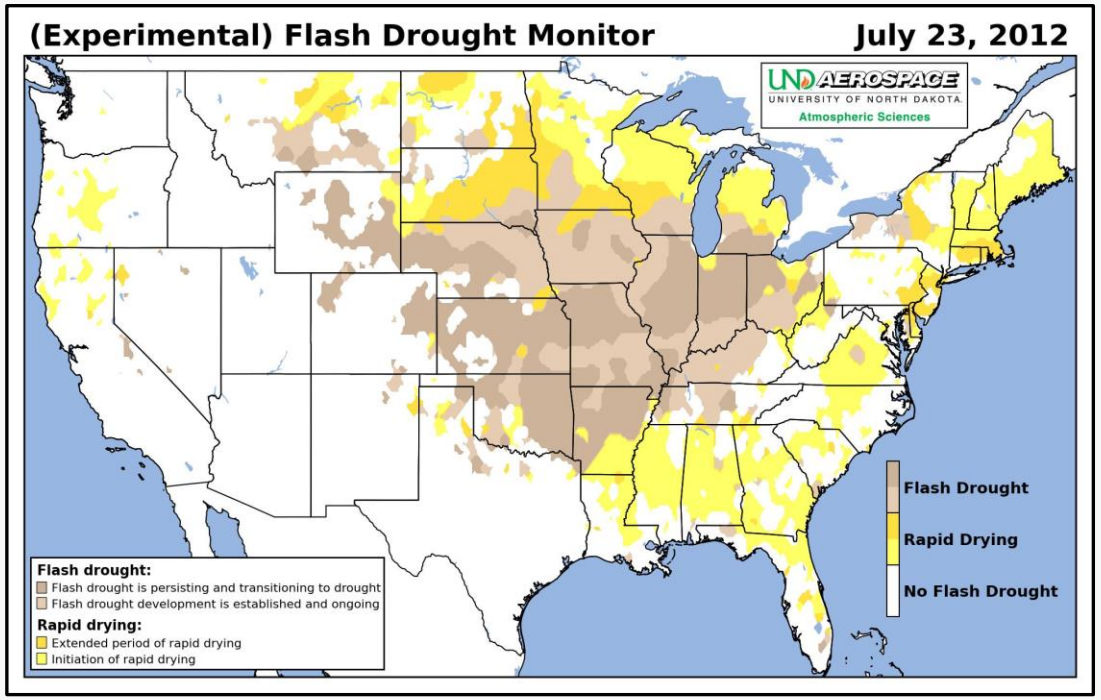


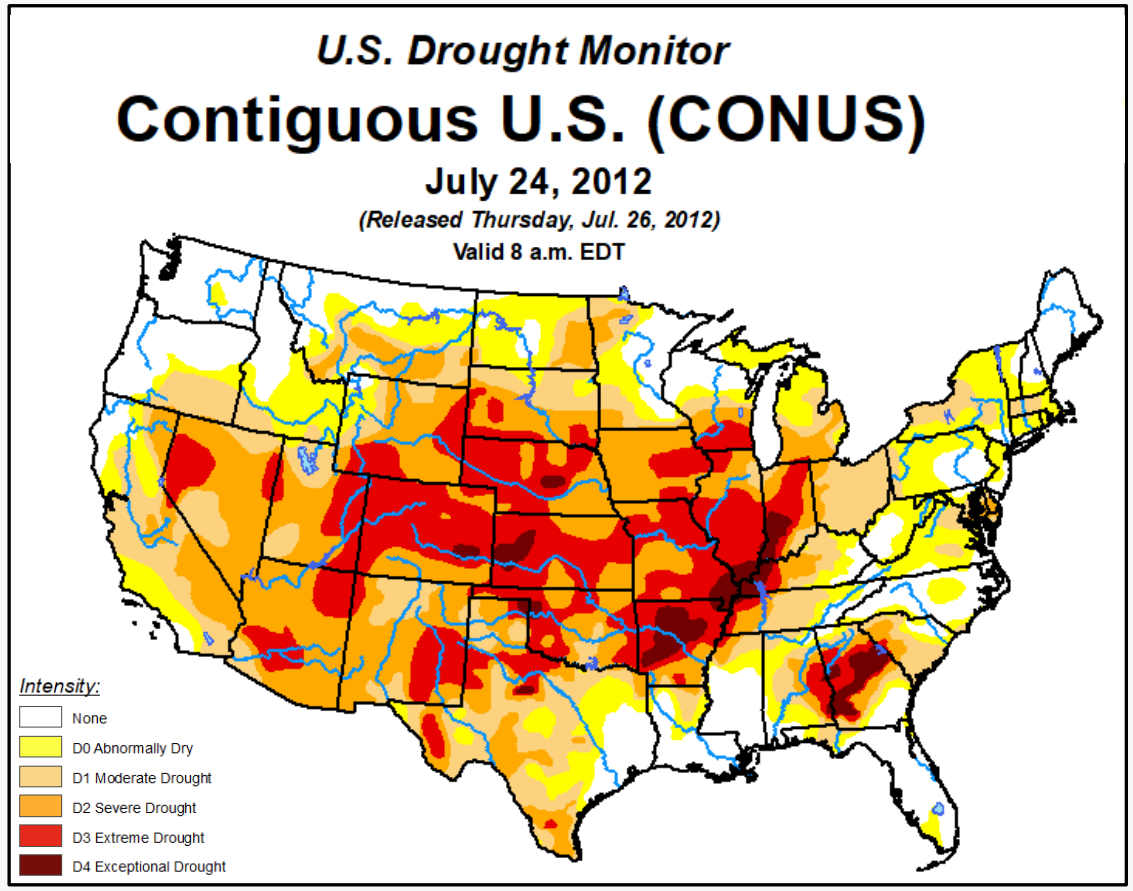
Spatial Hotspots of Flash Drought from US-FDM

- Figure shows the percent of years (between 2000-2024) that experienced a flash drought via the US-FDM
- Higher frequency (flash drought occurrence greater than 2 out of 5 years on average):
  - Midwest
  - Northern Plains
  - Southern Plains
  - Southwest
- Lower frequency (flash drought occurrence less than 1 out of 4 years on average):
  - Rockies (particularly northern Rockies)
  - Pacific Northwest
  - Far south-central US (southern Texas)
  - Northeast
  - Carolinas



Co-Occurrence of US-FDM and USDM



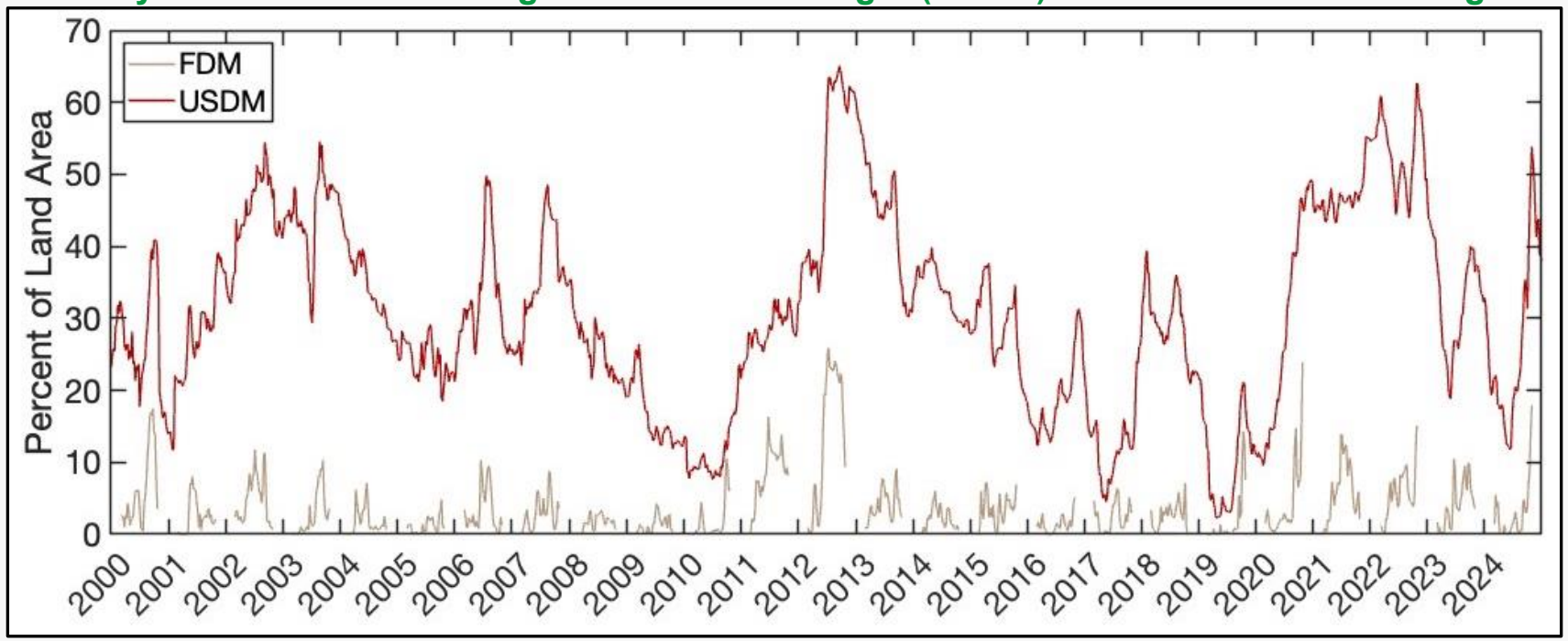


How much flash drought is co-located with drought via the USDM (D1-D4)?

Co-Occurrence of US-FDM and USDM

- Flash drought is a subset of drought
  - In other words, there cannot be more flash drought than drought
- Flash drought is a rare subseasonal phenomenon
  - Flash drought is not a common occurrence (e.g., a flash drought monitor should not be routinely identifying flash drought multiple times during one year or consistently every year for a particular location)

Weekly CONUS Land Coverage from USDM Drought (D1-D4) and US-FDM Flash Drought



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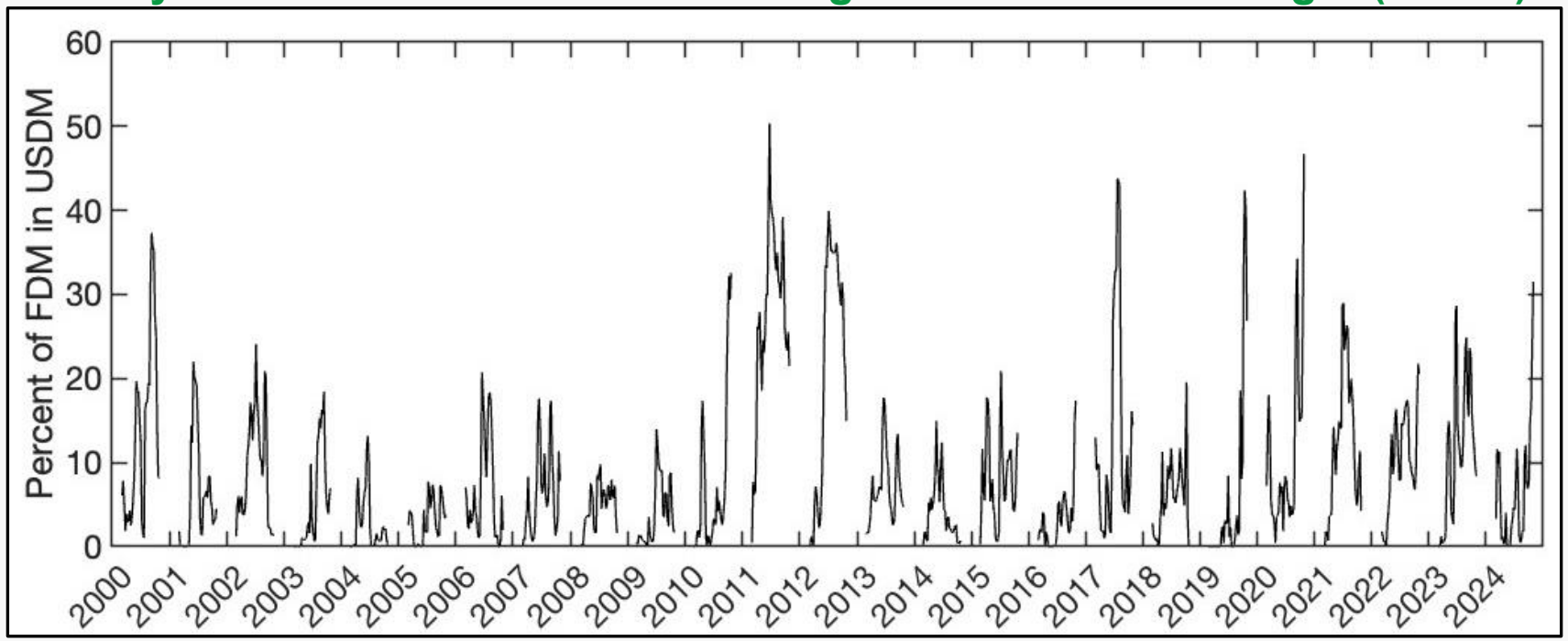
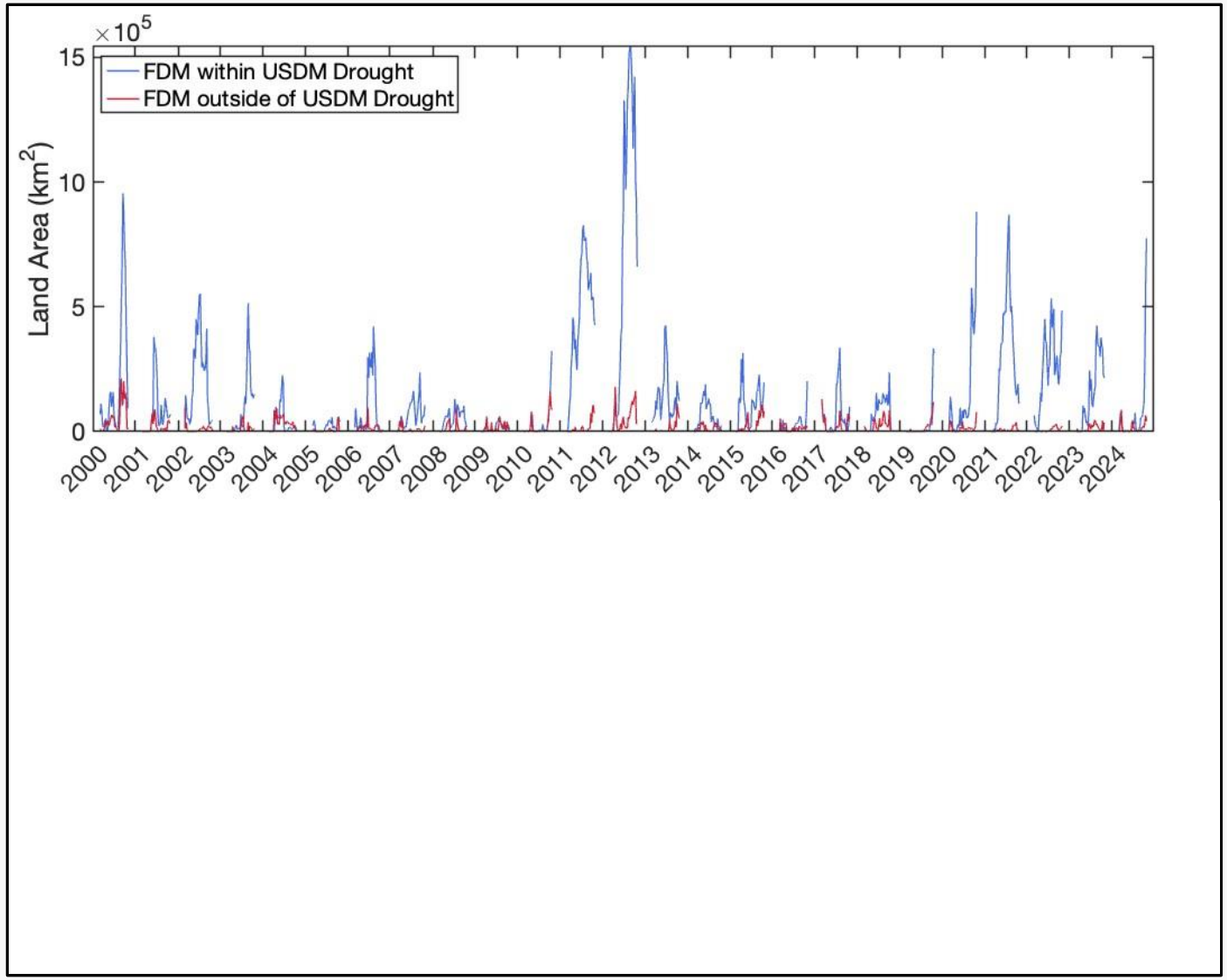
Weekly Percent of US-FDM Flash Drought within USDM Drought (D1-D4)



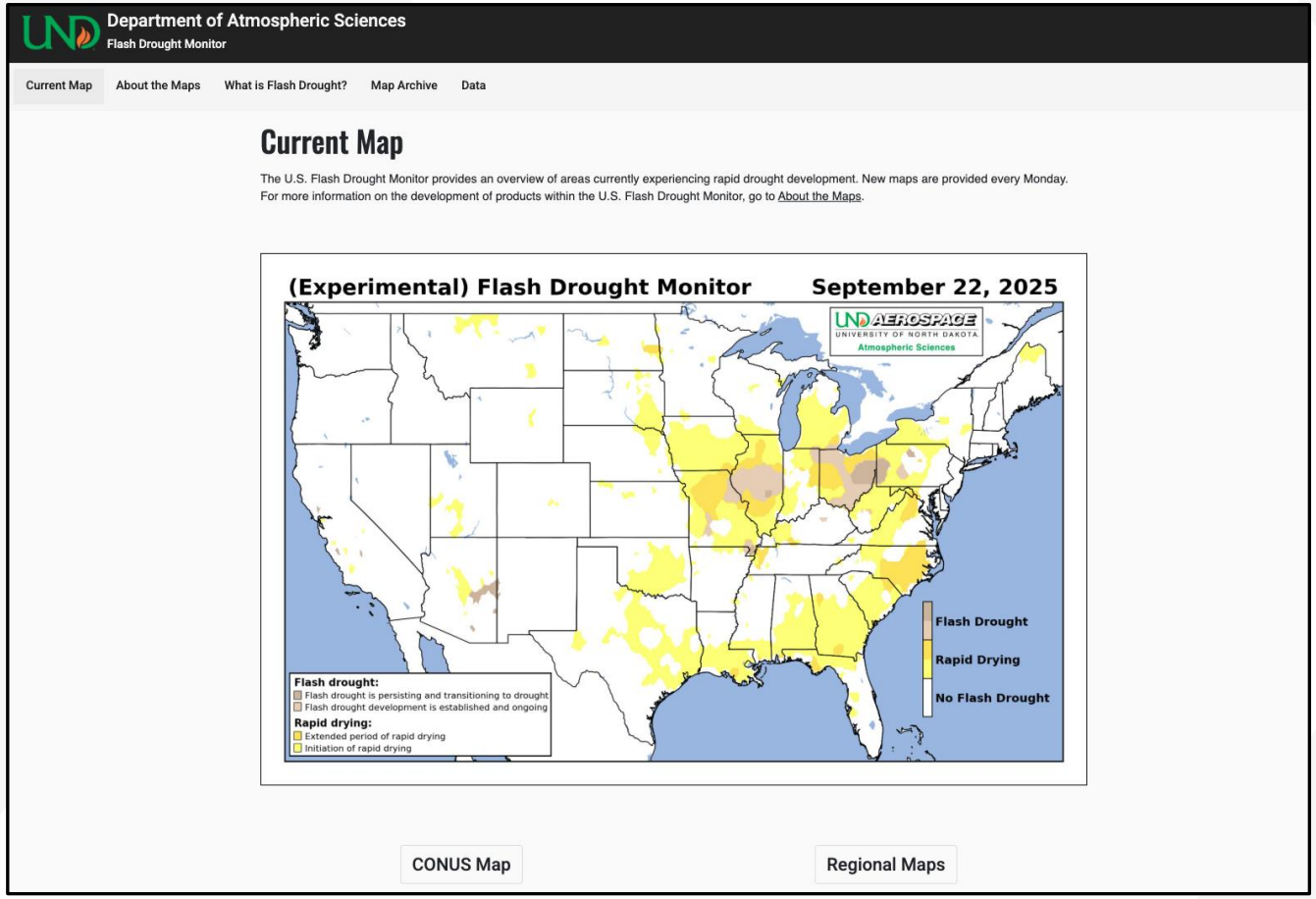
Co-Occurrence of US-FDM and USDM

- Flash drought from the US-FDM is predominantly located in the same areas designated under drought (D1-D4) from the USDM
- Percent of US-FDM flash drought within USDM drought (D1-D4) between 2000-2024:
  - Accumulated land area coverage across all weeks and all years: 88%
  - Median per week: 87%
- Co-occurrence of US-FDM flash drought and USDM drought is regionally dependent
  - US-FDM flash drought was nearly always located in areas designated with UDSM drought in the South Central region (96%)
  - US-FDM flash drought was located in areas designated with UDSM drought less often in the Northeast region (64%)
  - 5 of 6 regions were above 83%



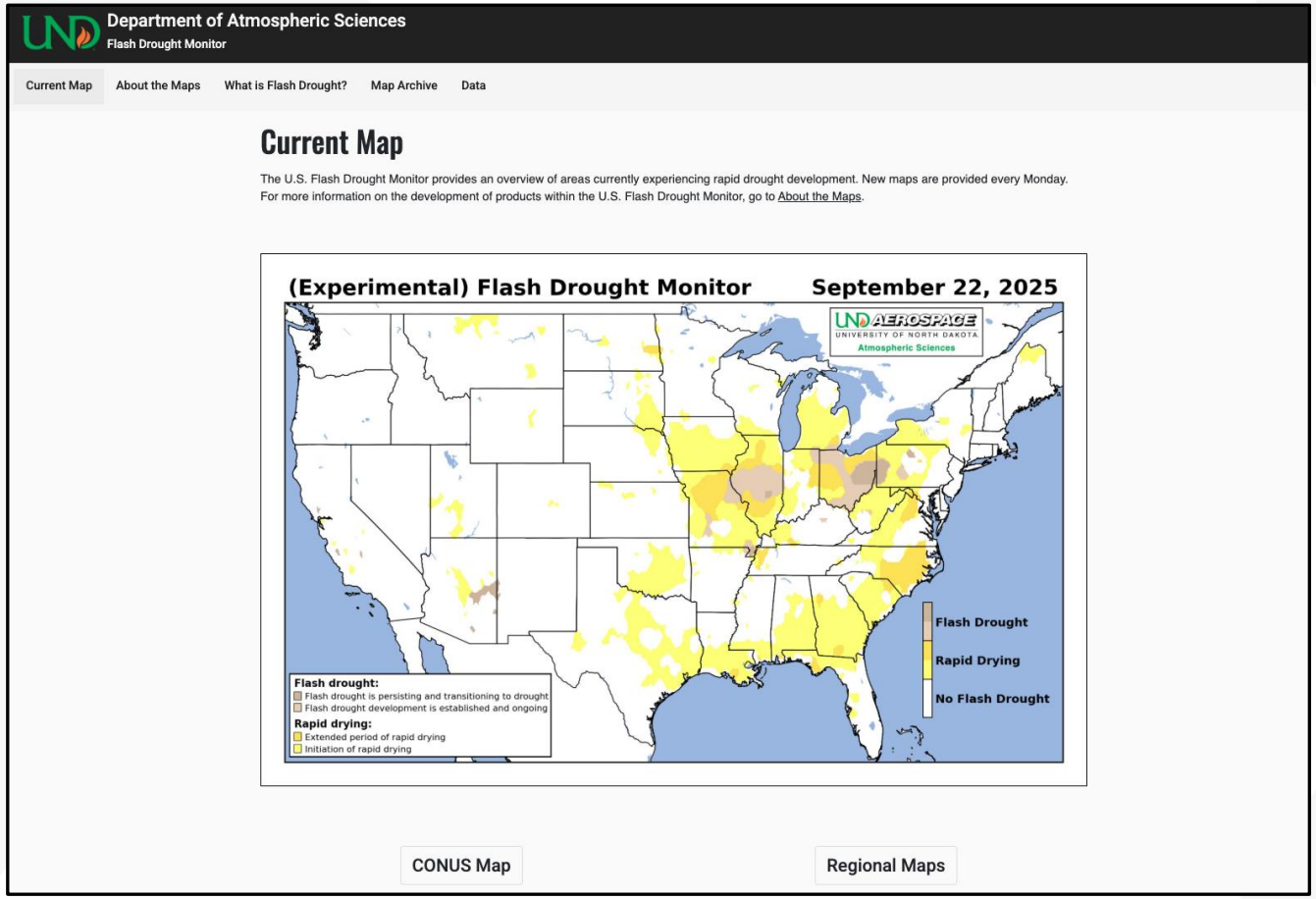
US-FDM Website

- **https://fdm.atmos.und.edu/**
- Website features:
  - Current map
    - View the most recent flash drought conditions
  - About the Maps
    - Discussion of US-FDM interpretation and data
  - What is Flash Drought?
    - Overview of flash drought
    - More info will be added, including a general FAQ page about flash drought and the US-FDM
  - Map Archive
    - Maps of US-FDM dating back to 2000
    - CONUS and regional (county overlayed) maps available
  - Data
    - Research data (SESR)
    - Shapefiles of US-FDM (coming soon)
    - Scripts for downloading data from the website (coming soon)



Future Work

- Continue to update the website text and pages
- Add a few additional metrics to the US-FDM
  - Improves robustness and redundancy in the event of missing data for a specific week
- Add additional maps to the website
  - Intensity maps (rate of change)
  - Timing/duration maps
- Seek input!
  - What text, data, and maps can be added to the website to improve the communication and information provided from the US-FDM?
- Create a global flash drought monitoring system (Global-FDM)



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