SNODAS Assimilation from ~~2003~~ 2004-2014: Qualifications as a Reference Analysis

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SNODAS Introduction

- SNODAS = SNOw Data Assimilation System
- Provides an operational, near-real-time snow analysis (and short term forecasts) at 1 km, 1 hour resolution for the coterminous U.S. and southern Canada.
- Has been in operation since October 2004.
- Core of NOHRSC operations and basis for various products collectively known as the National Snow Analysis.

SNODAS consists of:

1. A forcing data engine that prepares analysis and forecast fields from NOAA numerical weather prediction (NWP) systems (RR and NAM) for the SNODAS domain;
2. A snow mass and energy balance model;
3. An assimilation system which adjusts snow model states using ground-based, airborne, and satellite observations of the snowpack.

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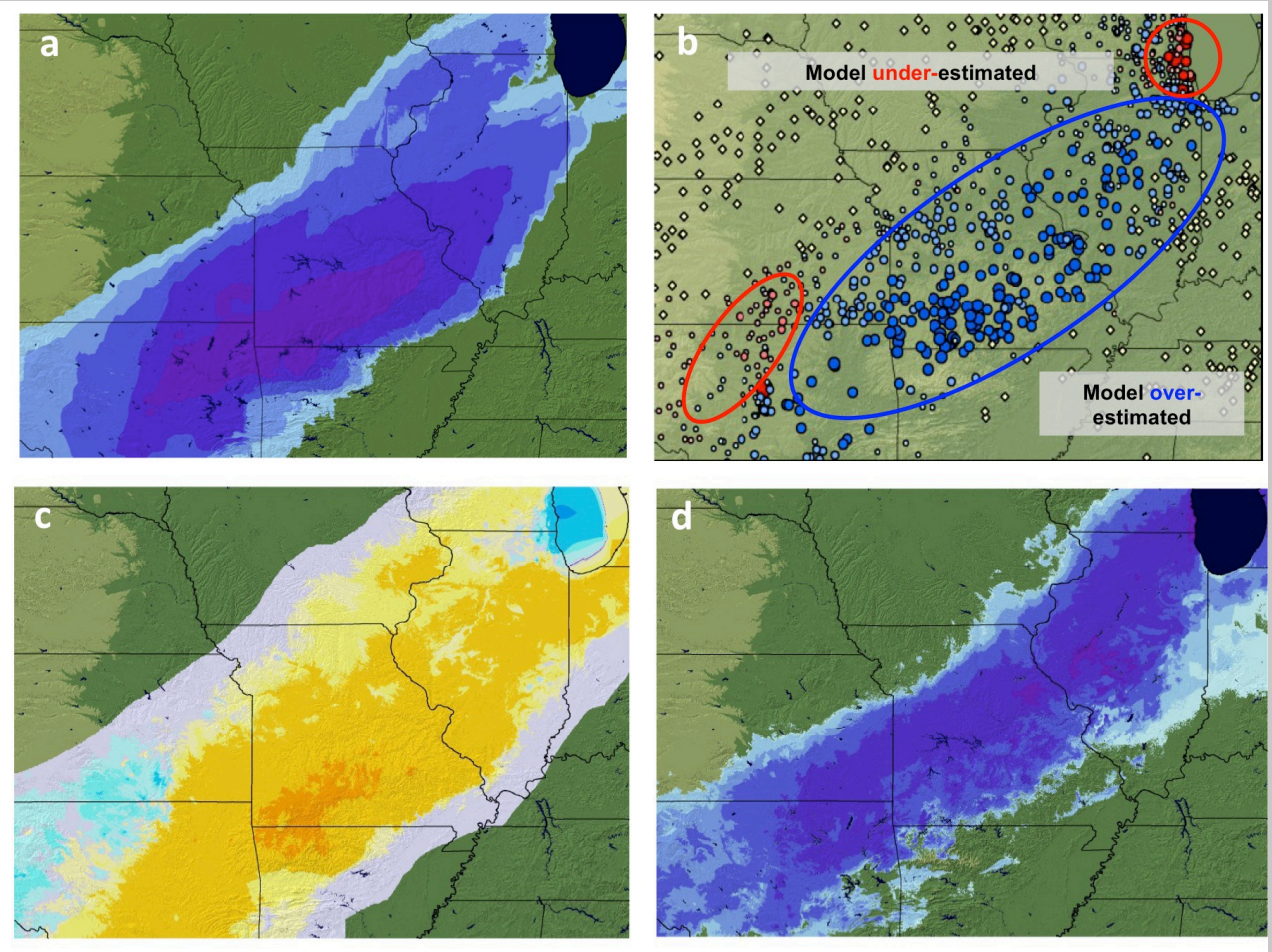
Sources of Uncertainty and Error

- Data
  - NWP model analyses and forecasts (forcing data)
  - Observed forcing data
  - Observed snow information
  - Station metadata (e.g. site location)
  - Input parameter data (e.g. forest cover density)
  - Process parameters (e.g. snow emissivity)
- Processes
  - Forcing data downscaling and correction methods
  - Point-to-pixel representativeness errors
  - Model physics
  - Model simplifications and parameterizations

Assimilation Process

1. Generate daily deltas between model states and ground-based and airborne SWE and snow depth observations.
2. Examine daily MODIS imagery for binary snow cover.
3. Manually select/reject assimilation points, adding pseudo-zeroes to delineate satellite-based snow line.
4. Generate model nudging fields via IDW with an additional weighting factor based on elevation differences.
5. Rerun most recent six-hour model cycle with nudging.

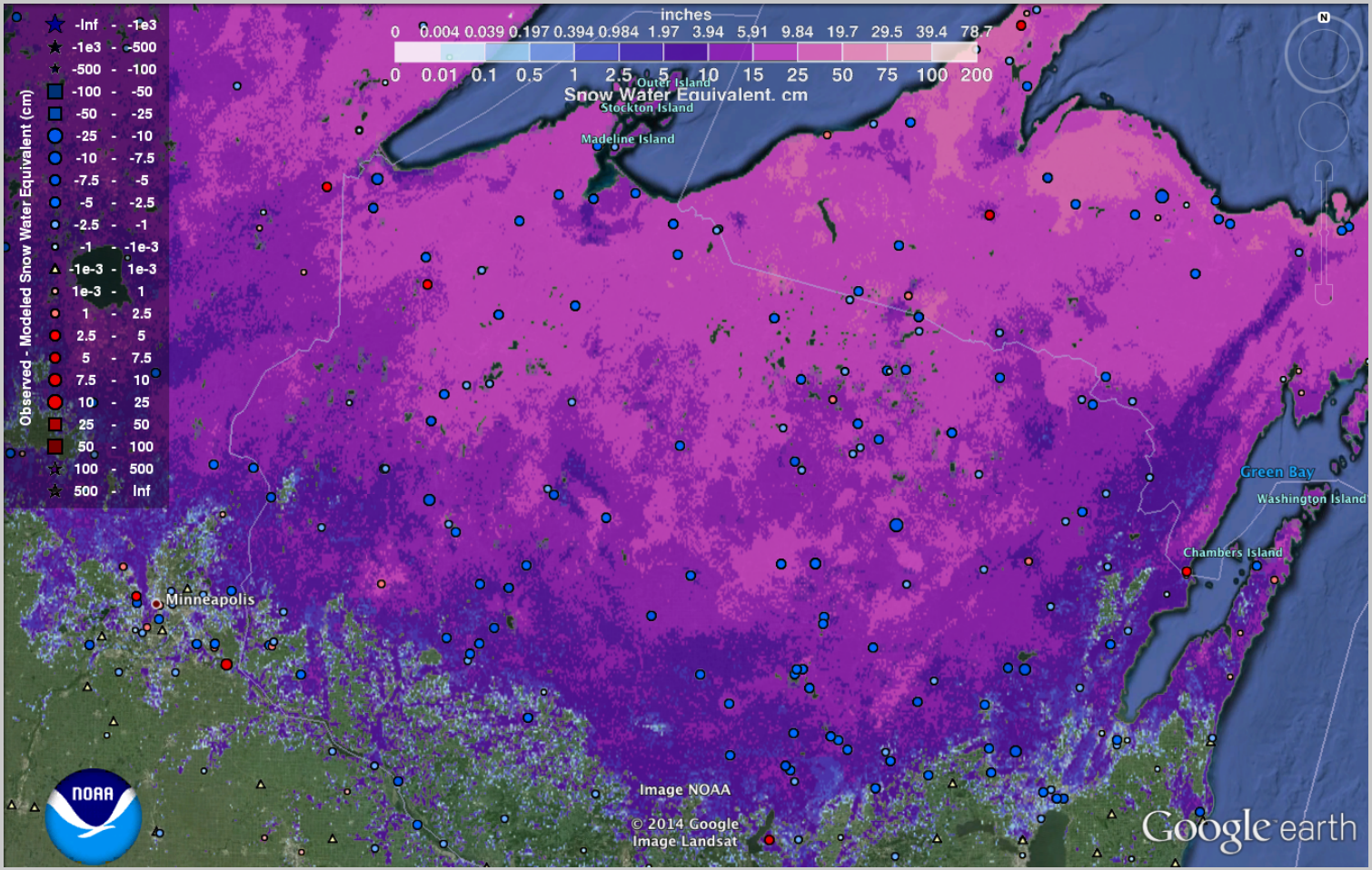
Assimilation Example



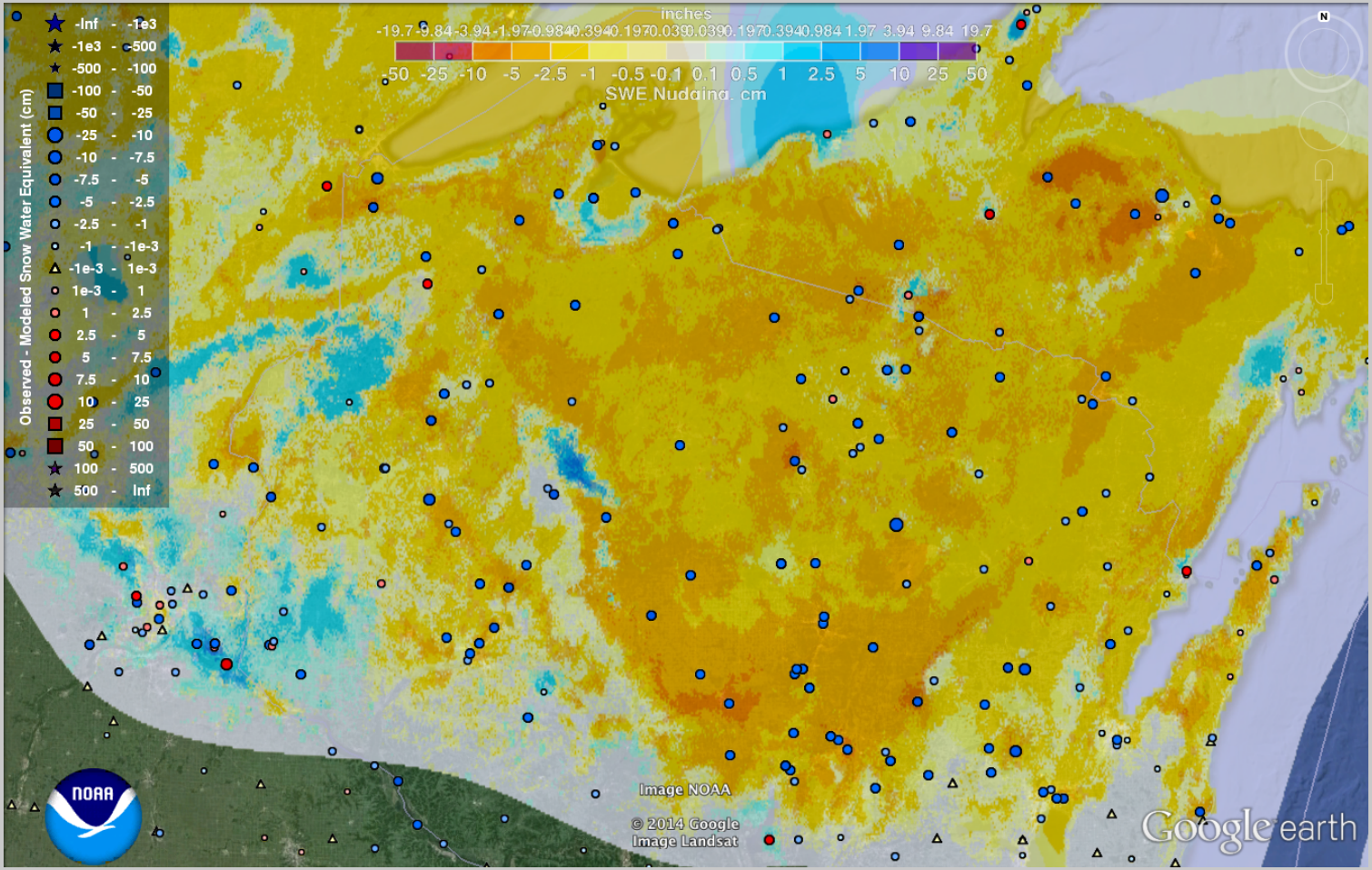
Factors Impacting Decision to Assimilate

- Daily assimilation is expected/assumed.
- Spatial correlation in deltas
- Sufficient coverage in observations
- Satellite imagery
- Presence of precipitation
- Snowpack stability
  - A stable (i.e., cold) snowpack allows large time window for observations
  - Rapid increase in modeled snowpack density during melt leads to high uncertainty when comparing observed and modeled snow depth
- Scheduling and timing of surveys (ground-based and airborne)
- Staffing

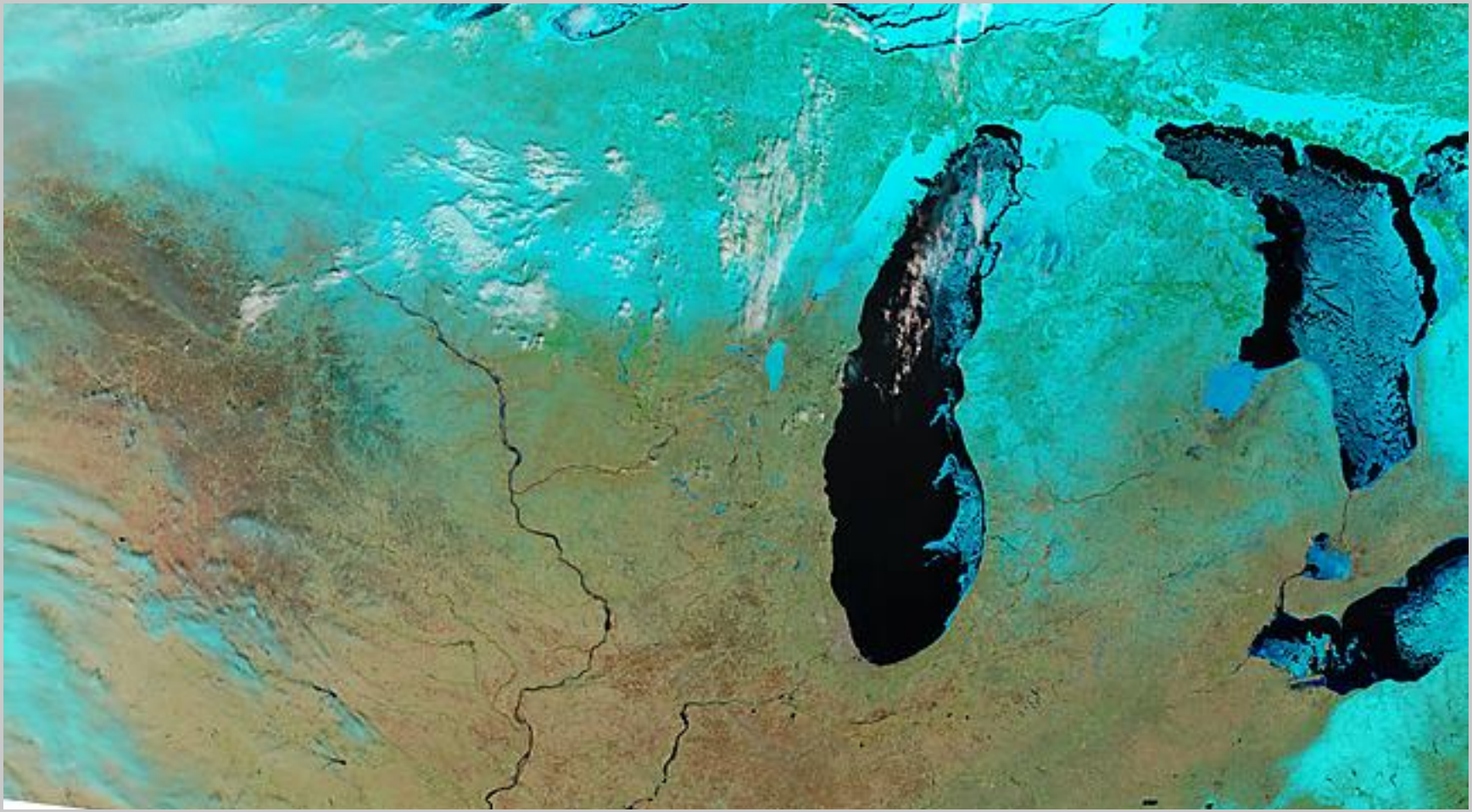
SNODAS SWE w/Deltas, 2014-03-31



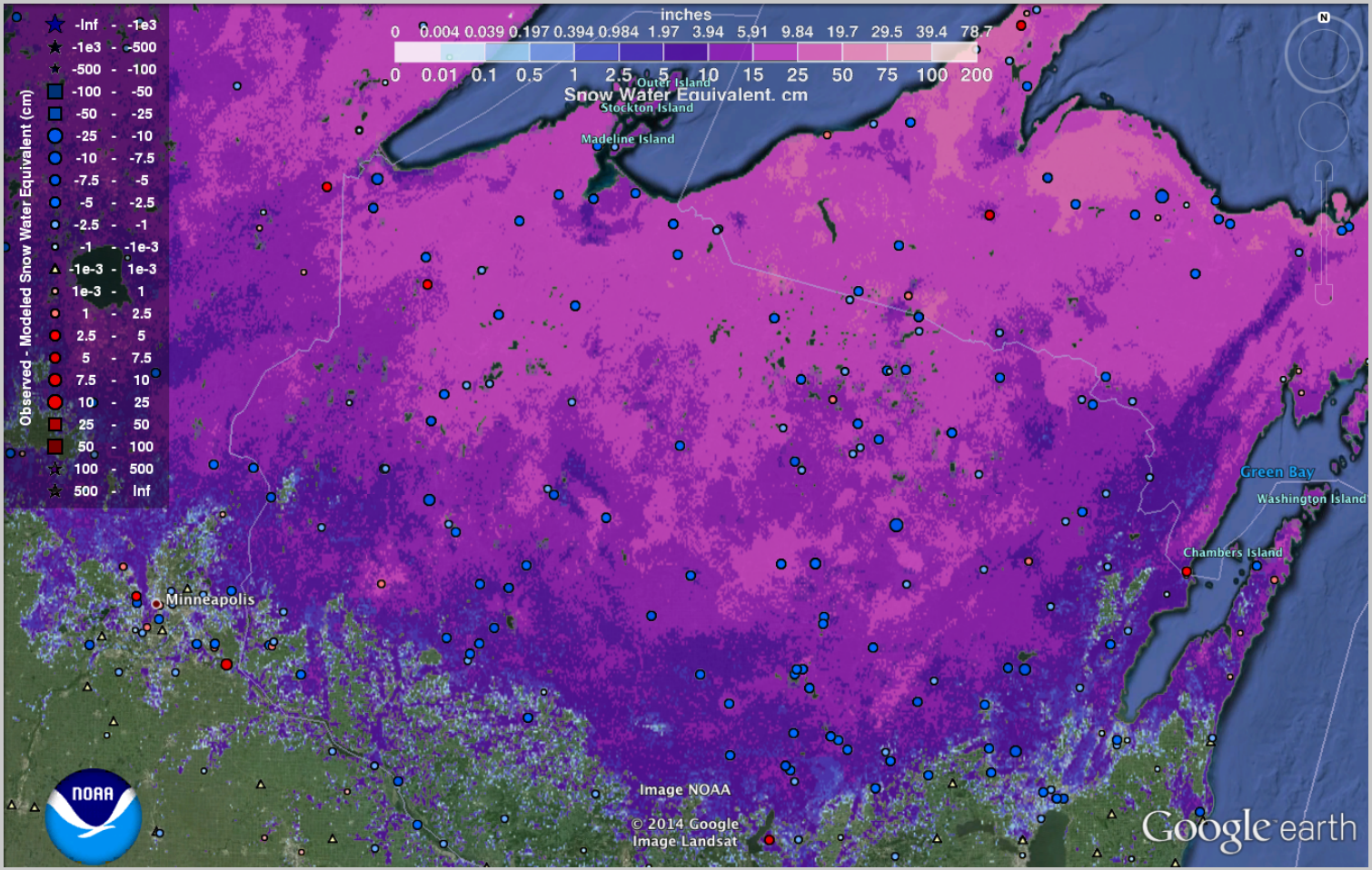
SNODAS SWE Nudging w/Deltas, 2014-03-31



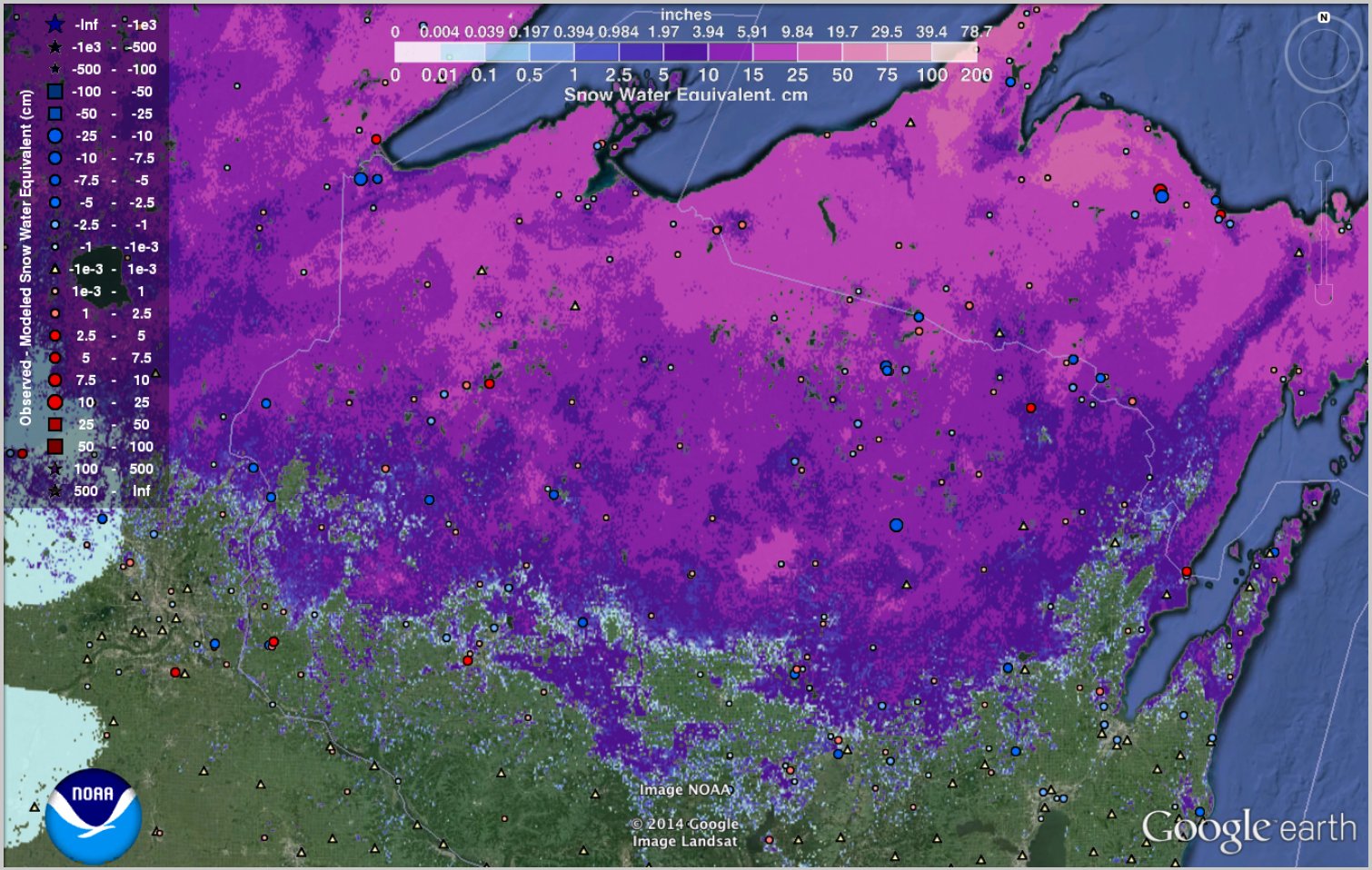
MODIS MYD09 Surface Reflectance, 2014-03-30



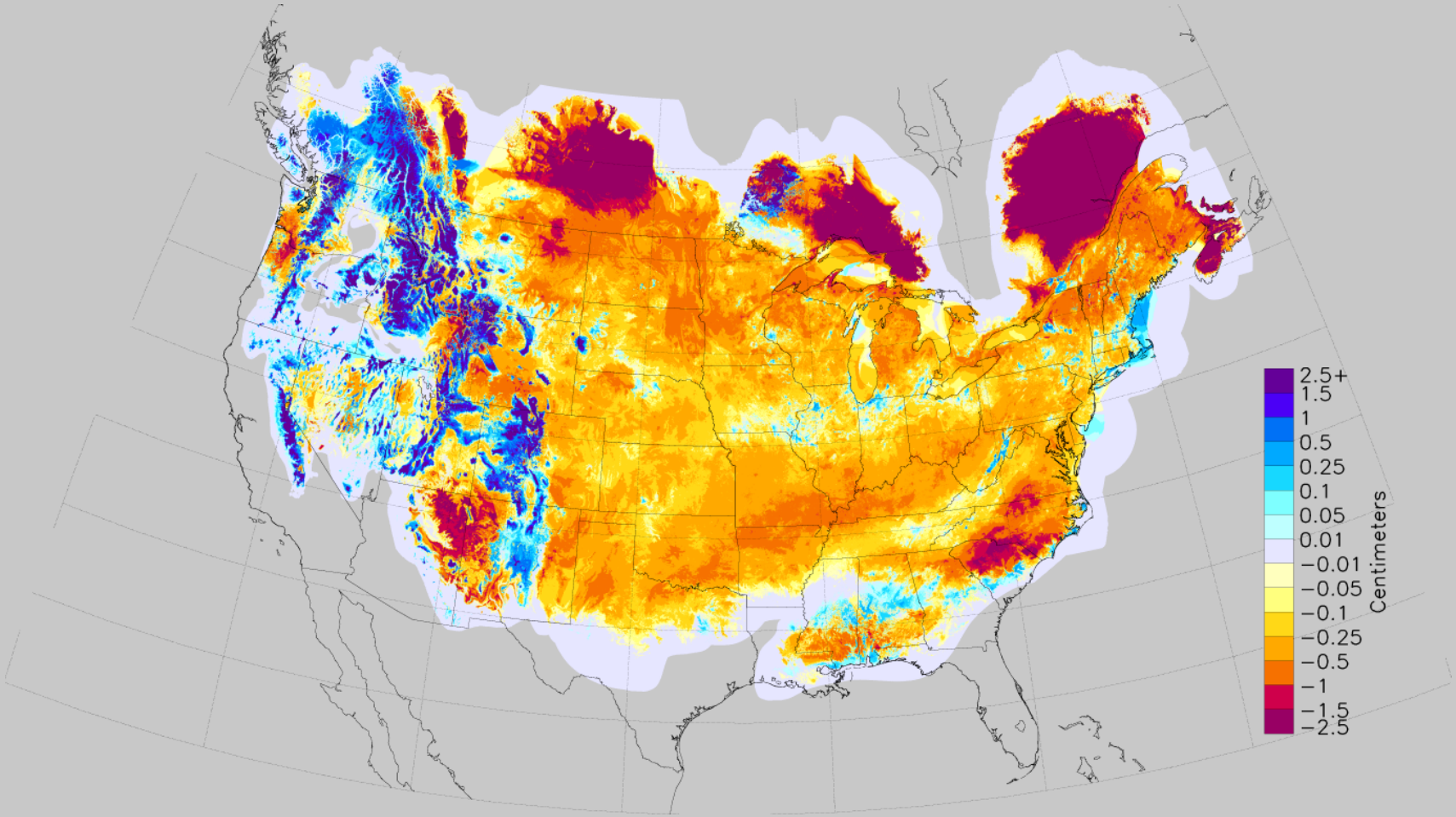
SNODAS SWE w/Deltas, 2014-03-31



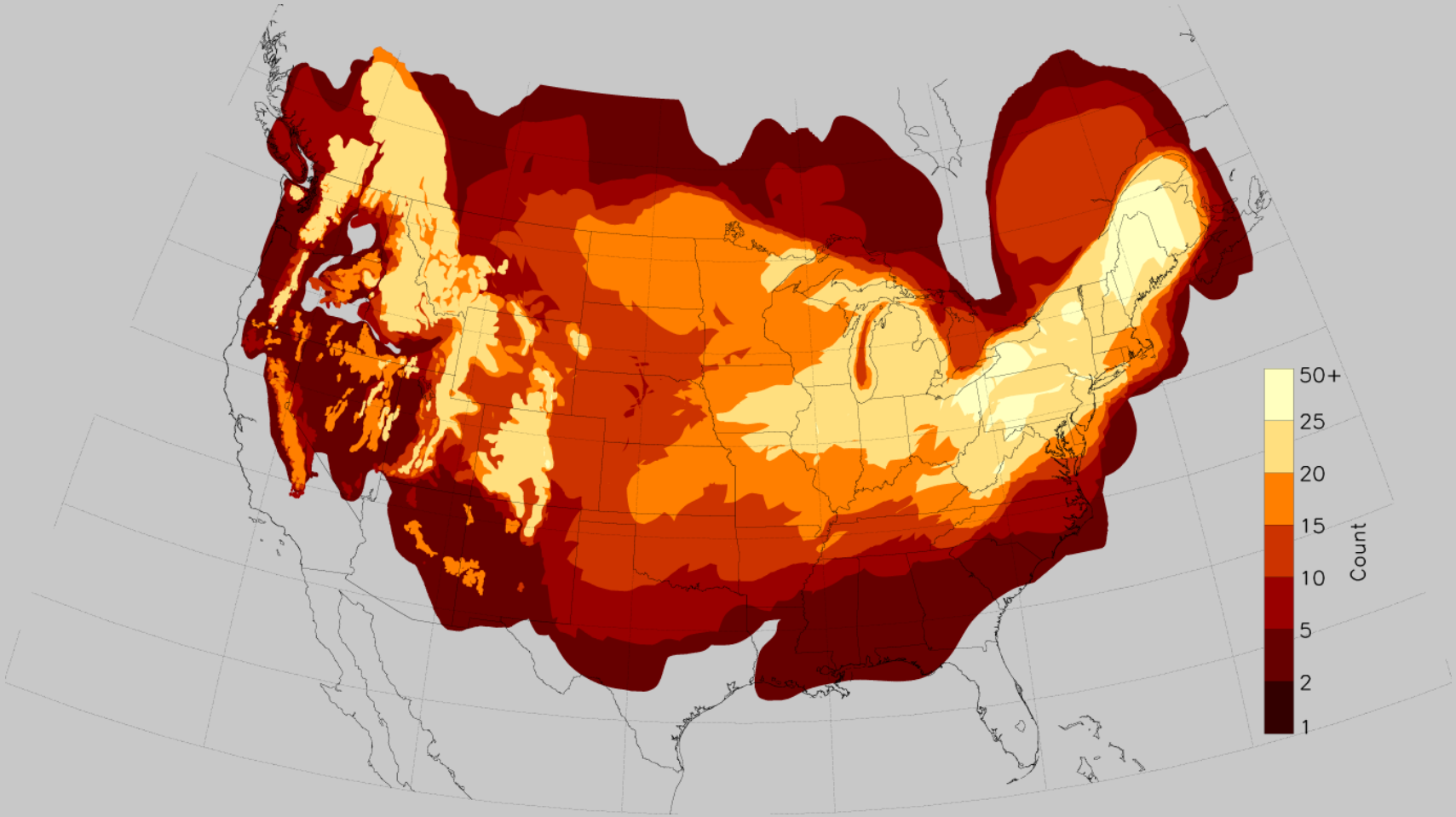
SNODAS SWE w/Deltas, 2014-04-01



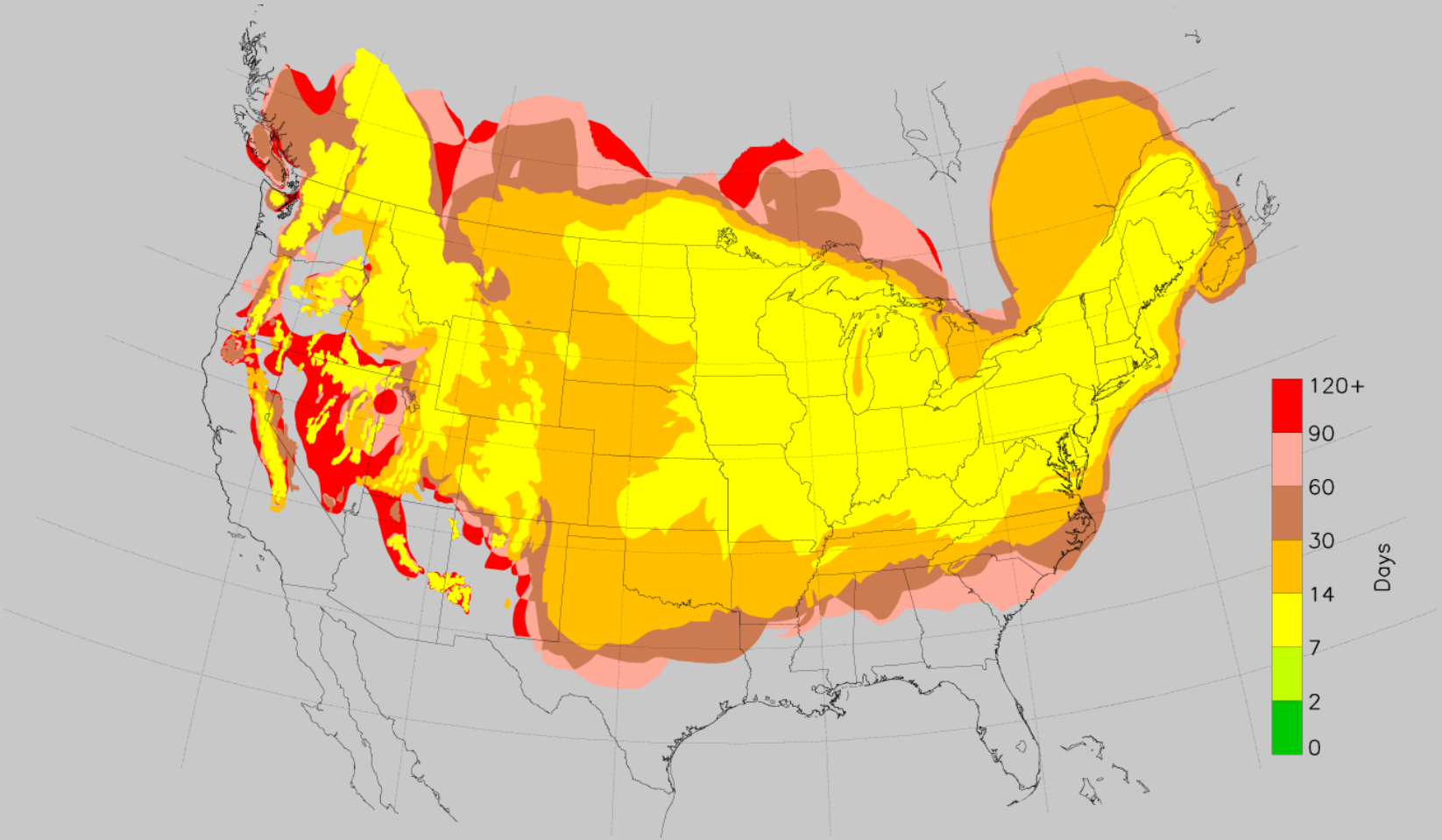
Average SNODAS Assimilation
2013-10-01 to 2014-05-31 (50 performed)



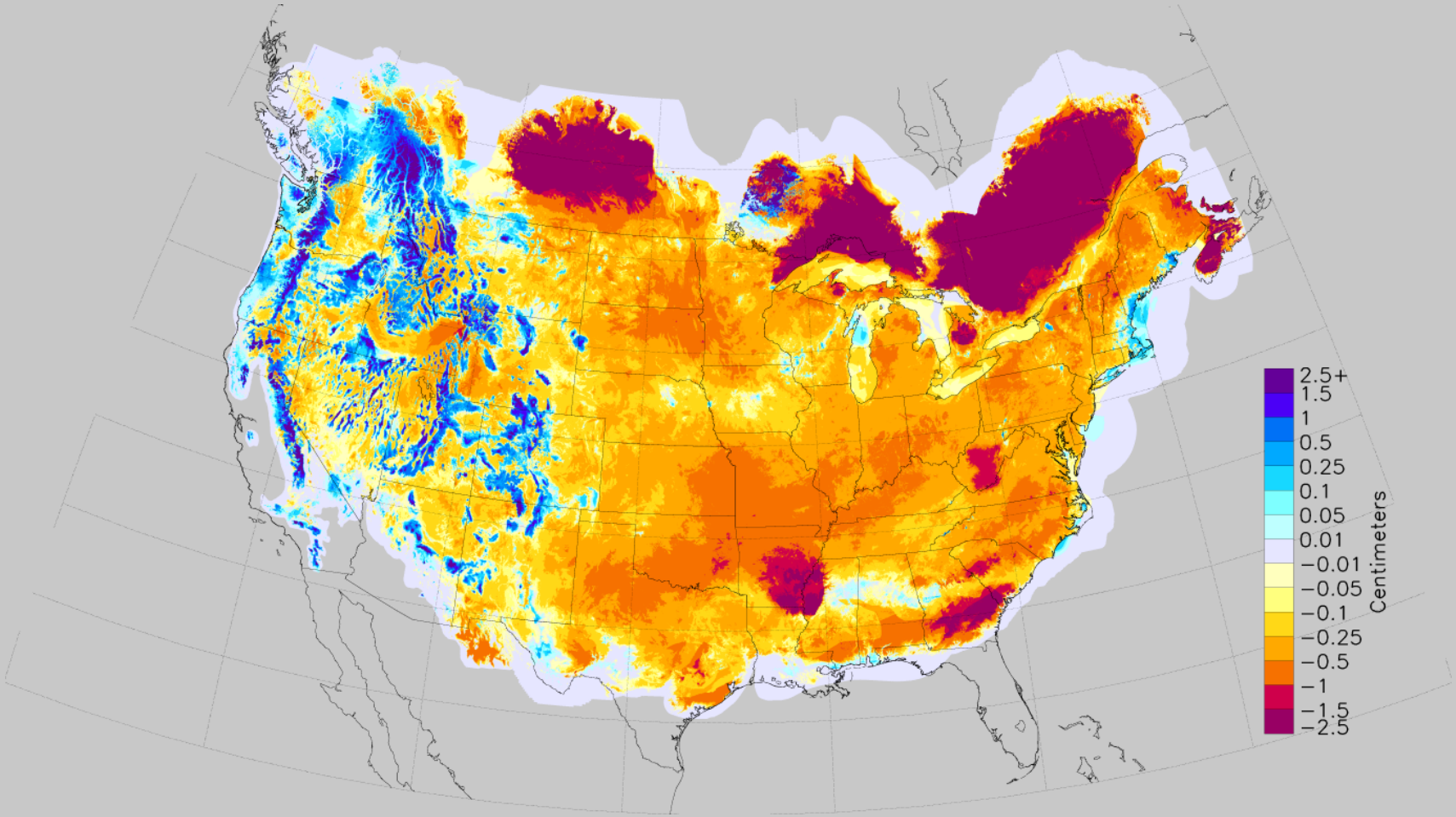
Number of SNODAS Assimilations
2013-10-01 to 2014-05-31 (50 performed)



Average time between SNODAS Assimilations 2013-10-01 to 2014-05-31 (50 performed)



Average SNODAS Assimilation
2004-10-01 to 2014-05-31 (760 performed)



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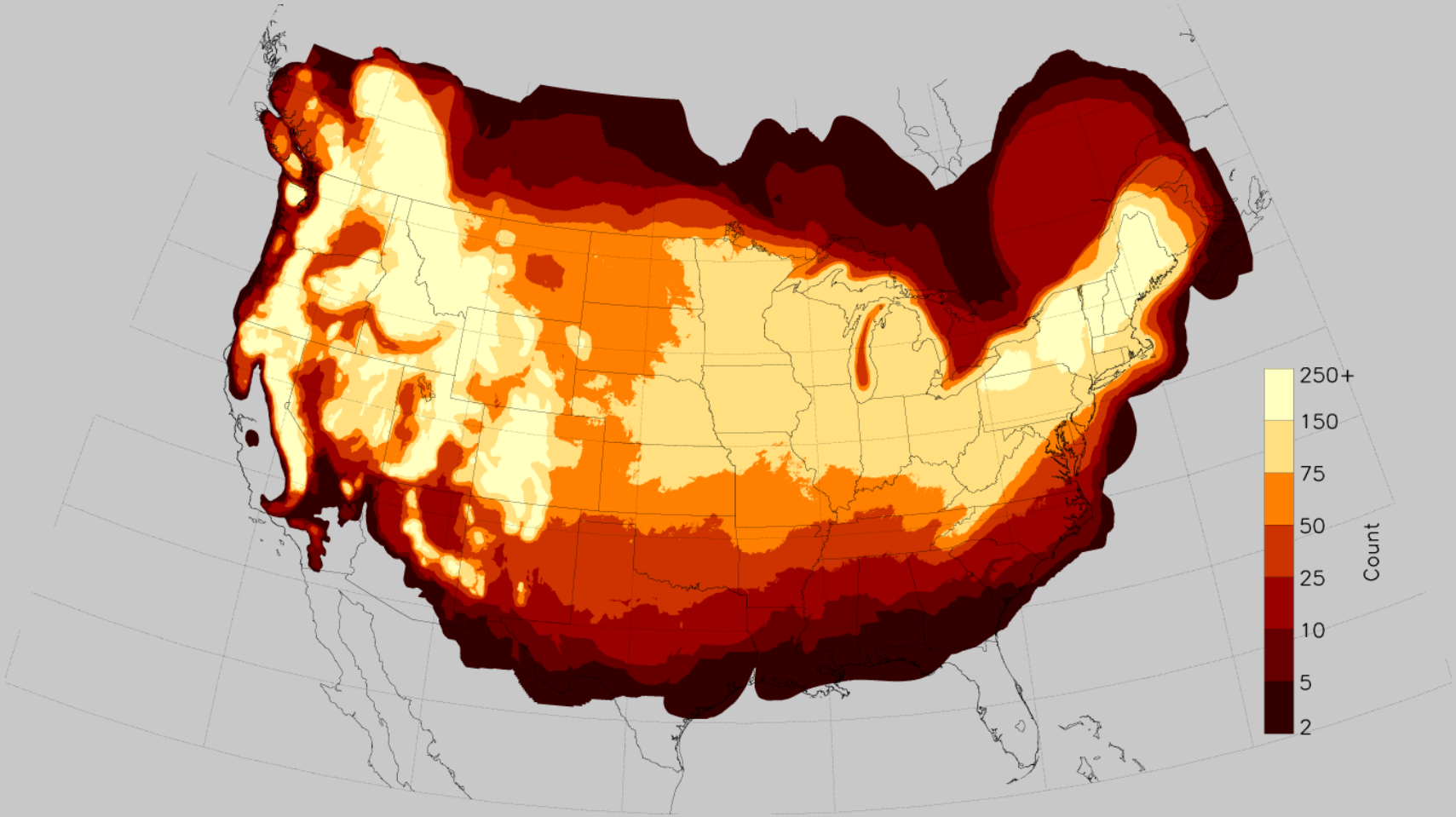

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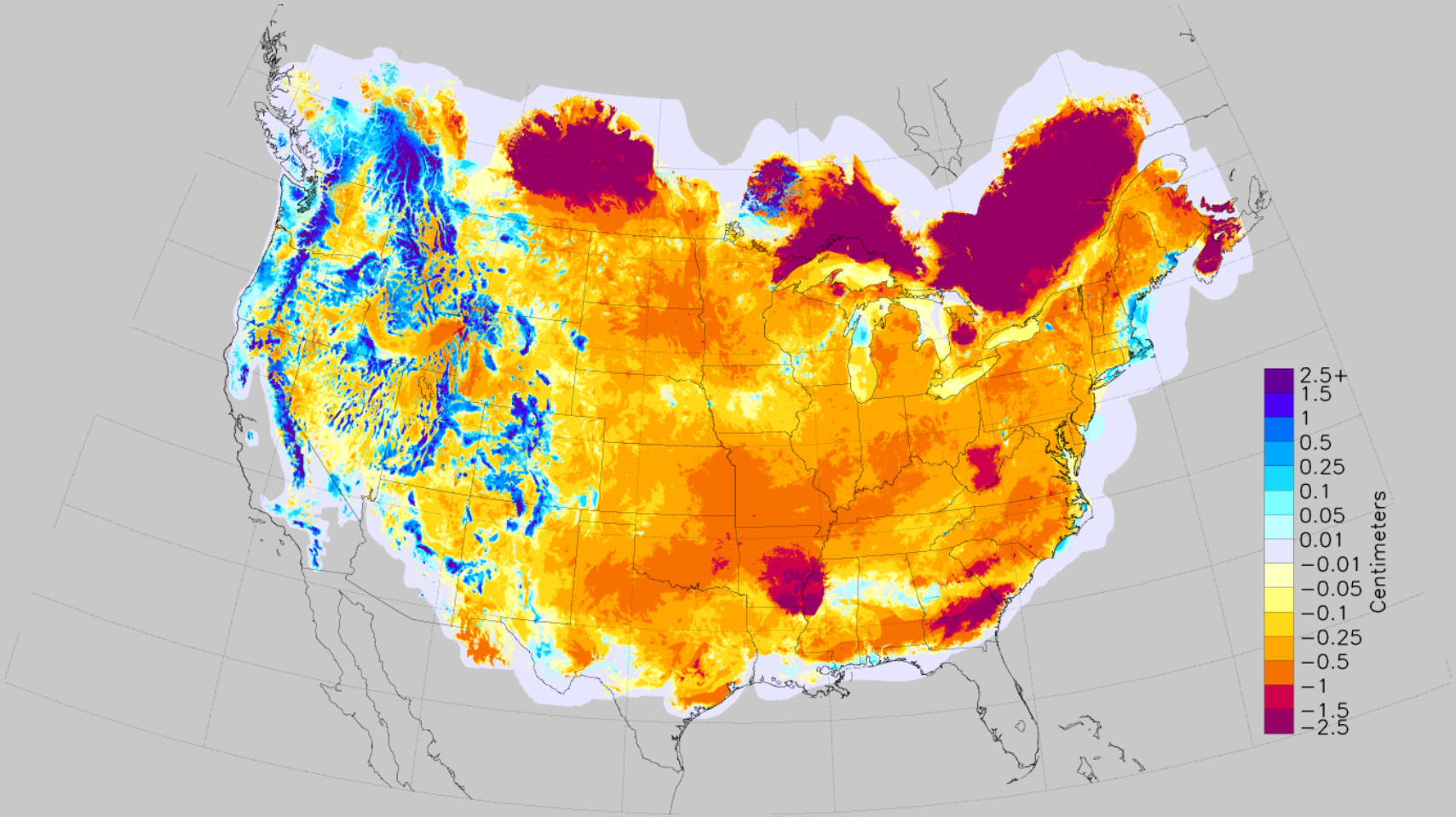
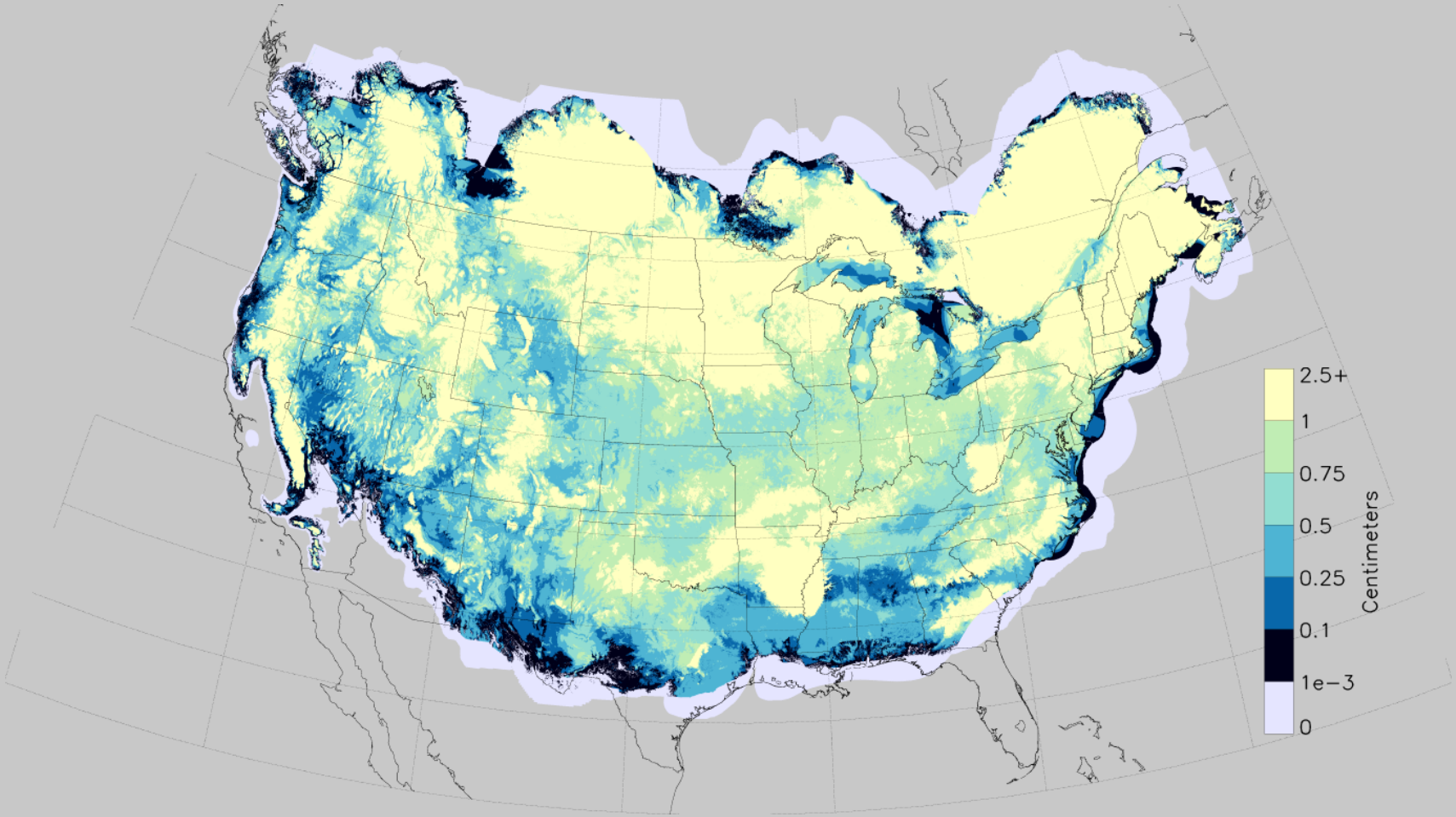
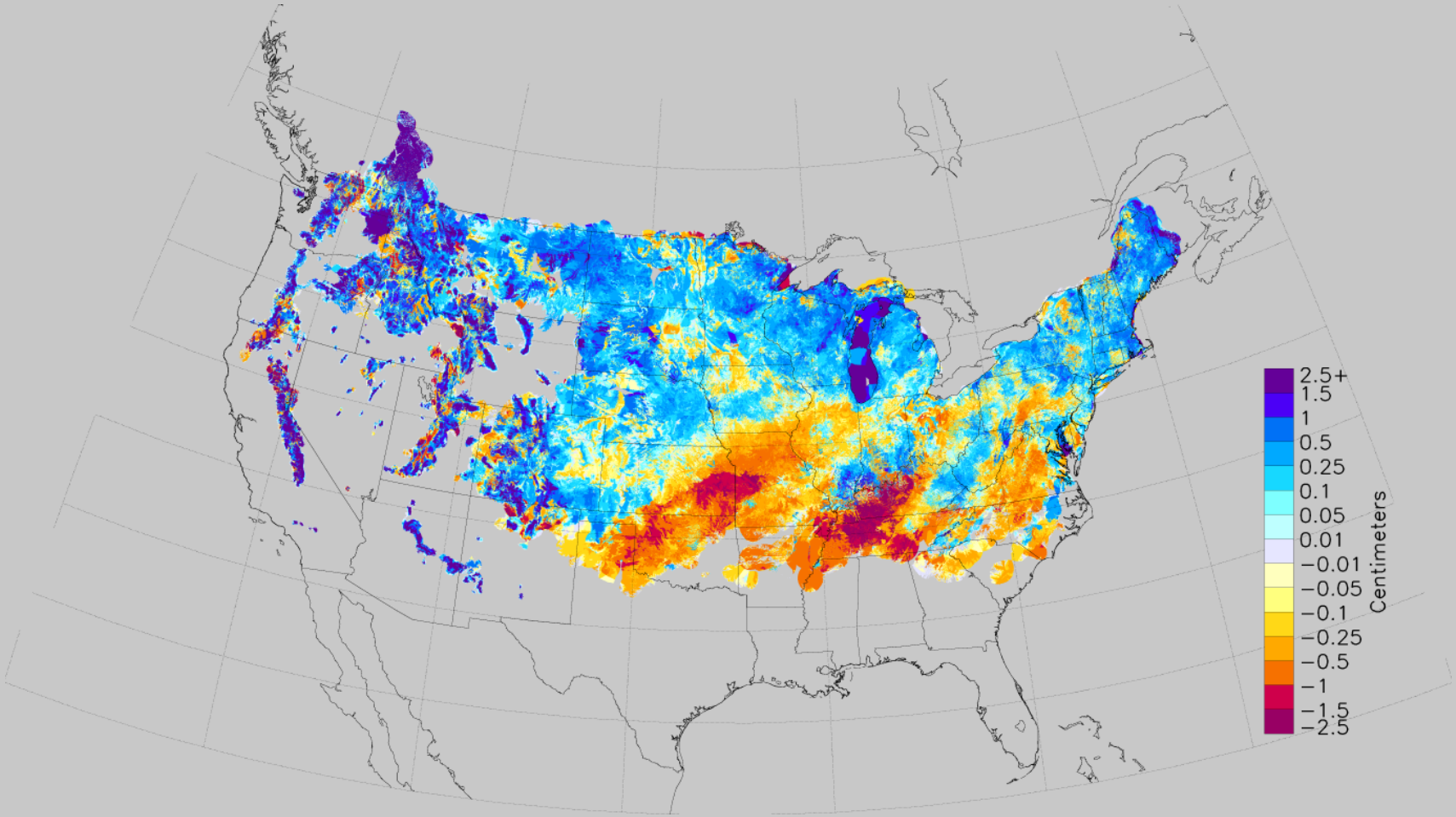


SNODAS Assimilation Standard Deviation 2004-10-01 to 2014-05-31 (760 performed)



Average SNODAS Assimilation
2004-10-01 to 2005-05-31 (92 performed)



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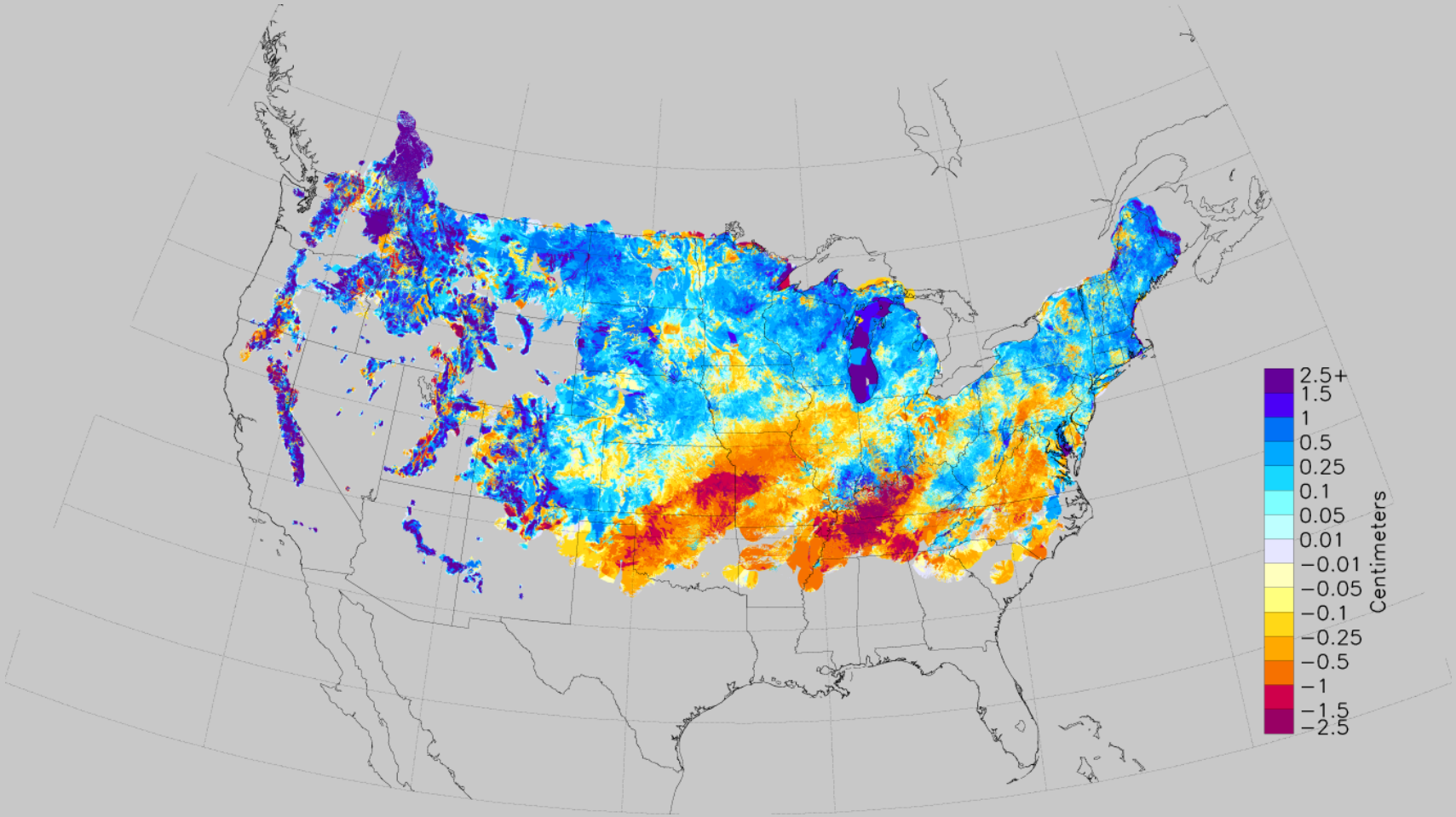
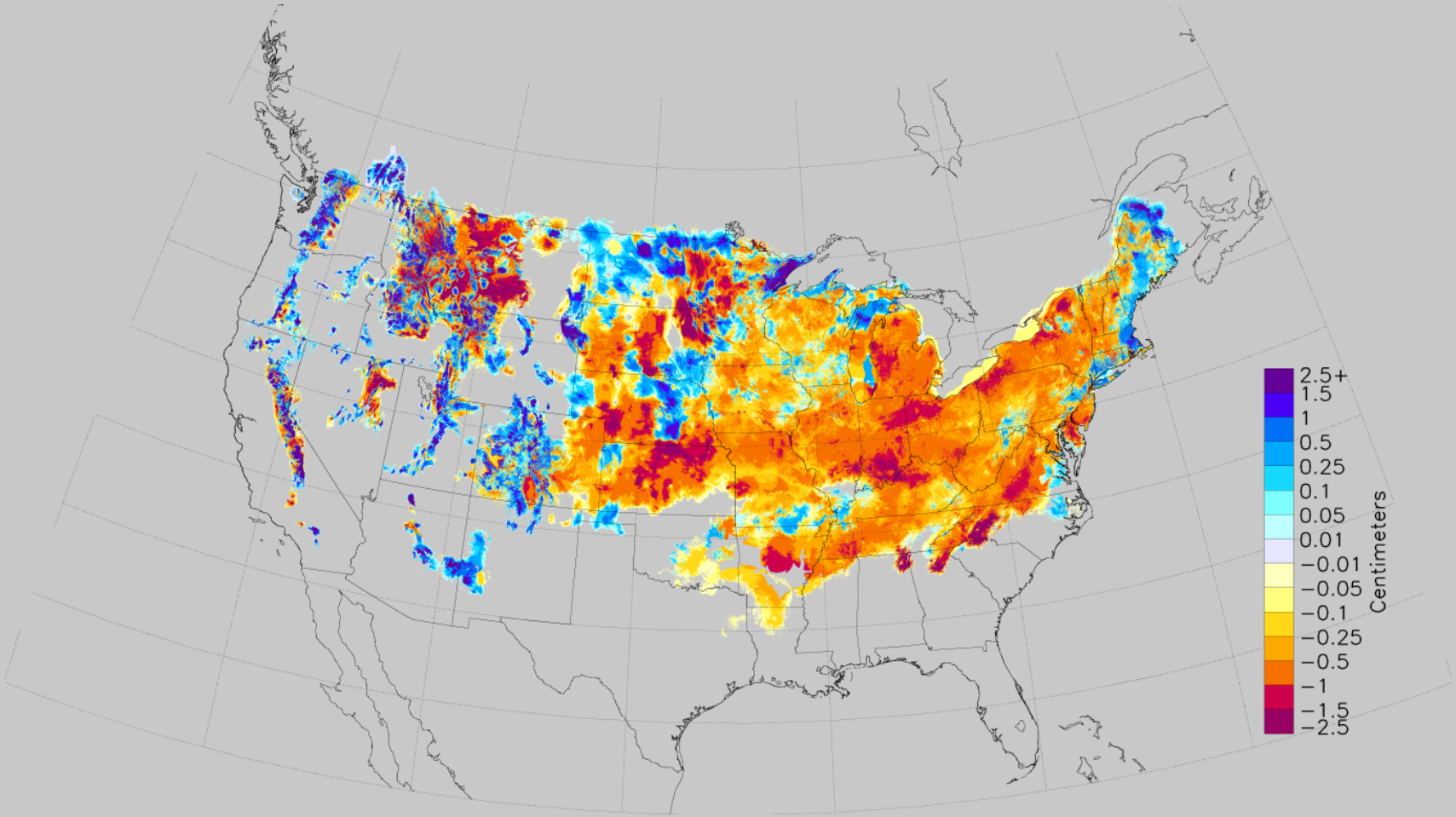
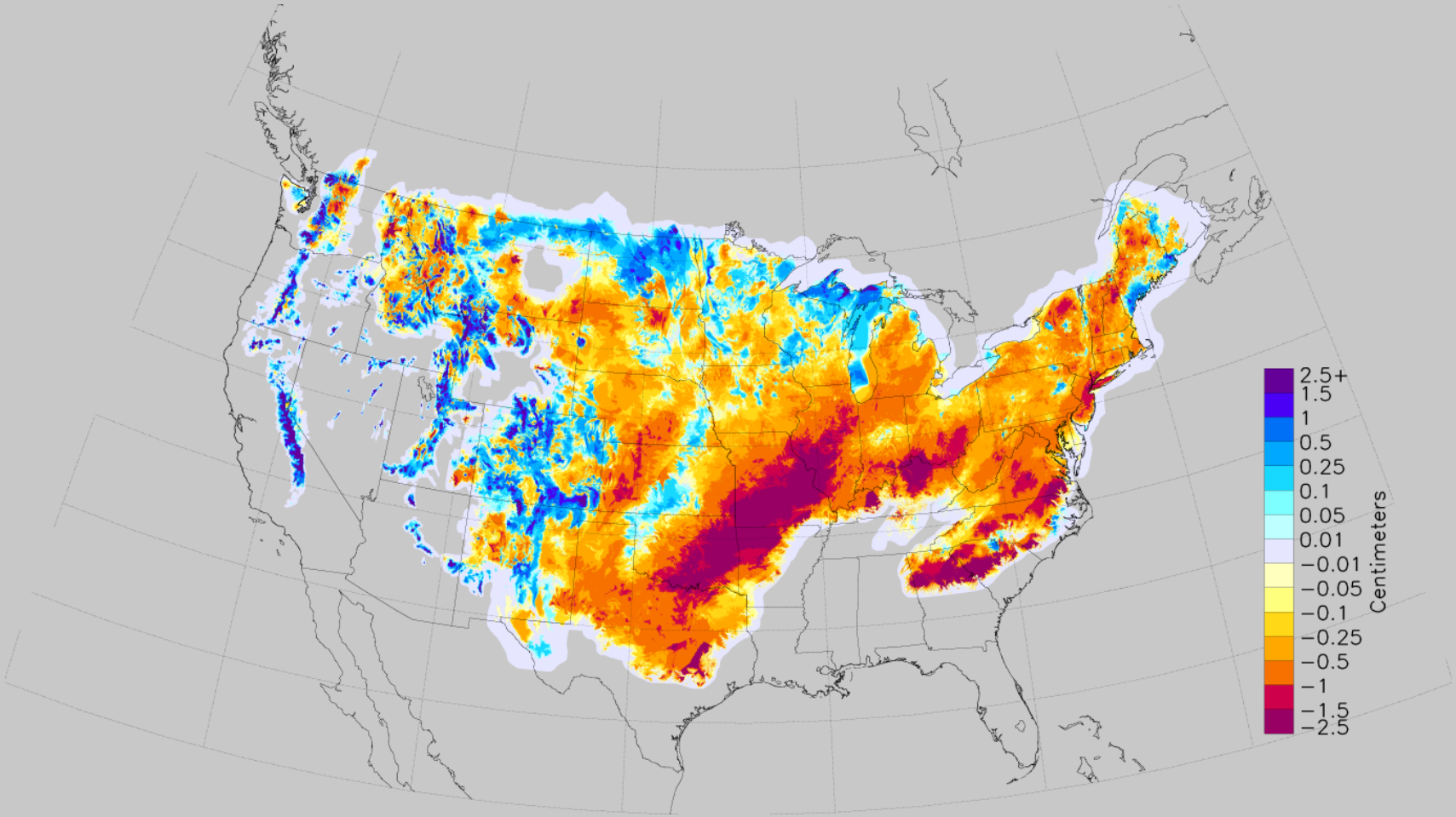


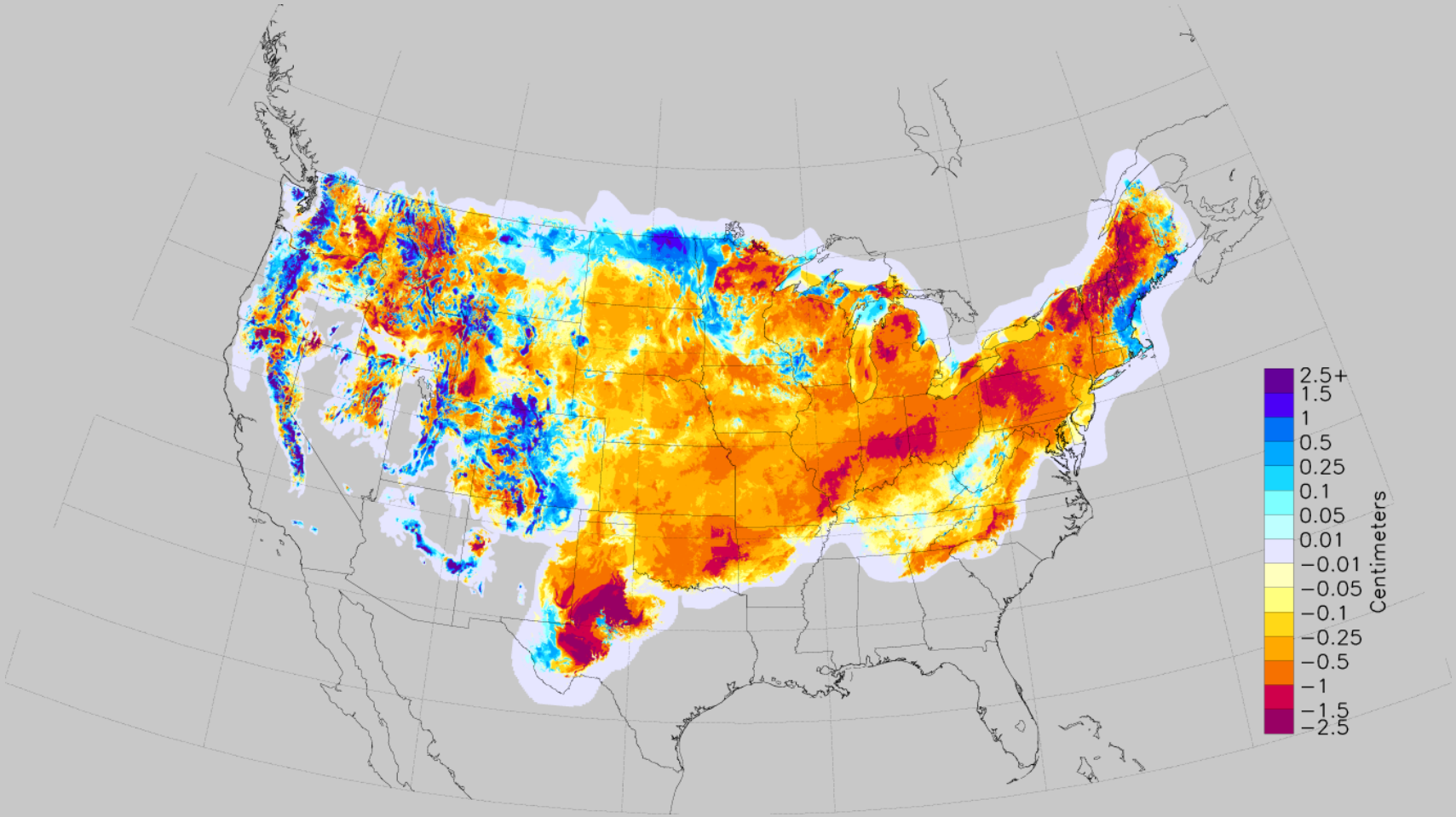
Average SNODAS Assimilation
2005-10-01 to 2006-05-31 (64 performed)



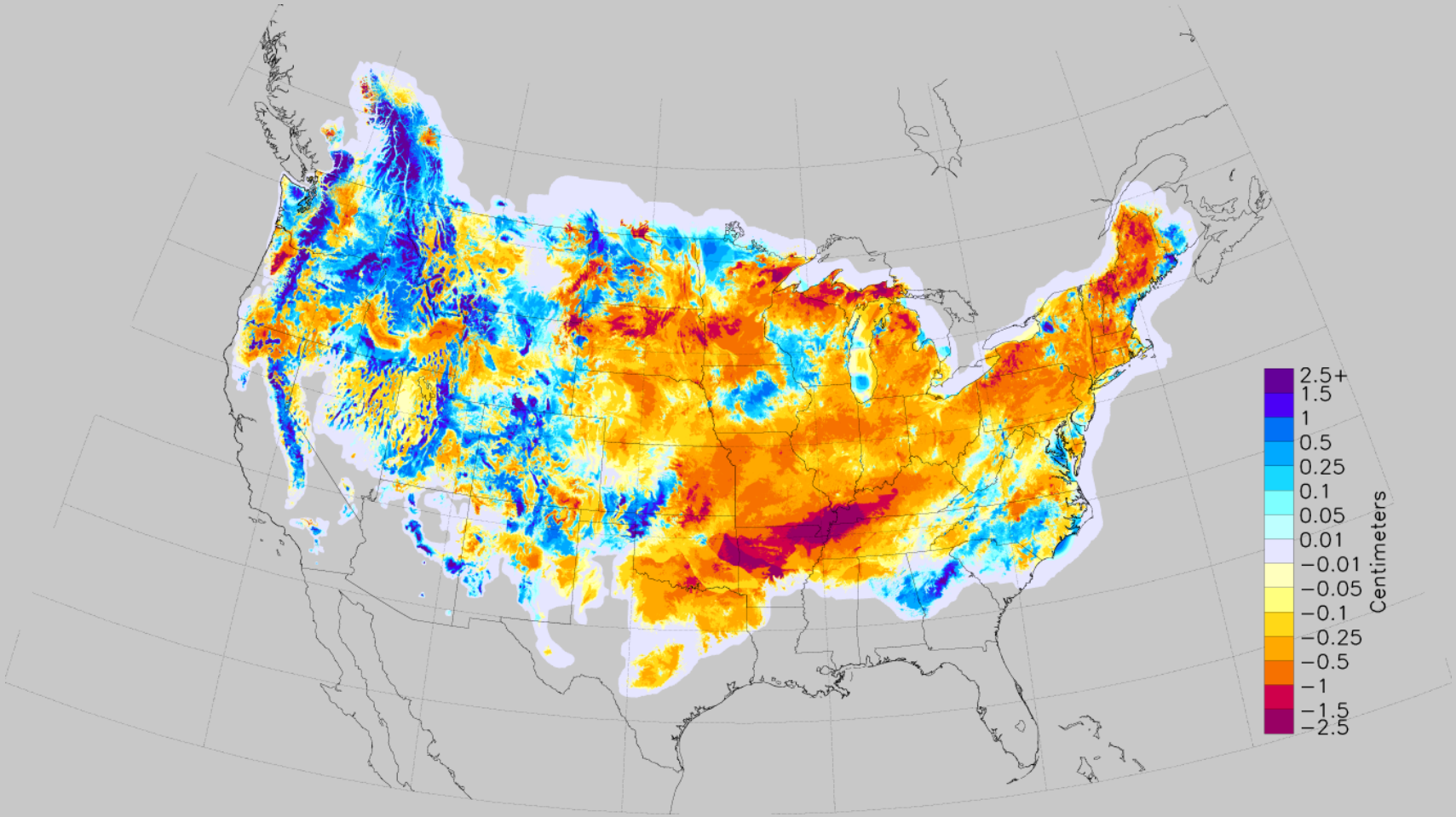
Average SNODAS Assimilation
2006-10-01 to 2007-05-31 (72 performed)



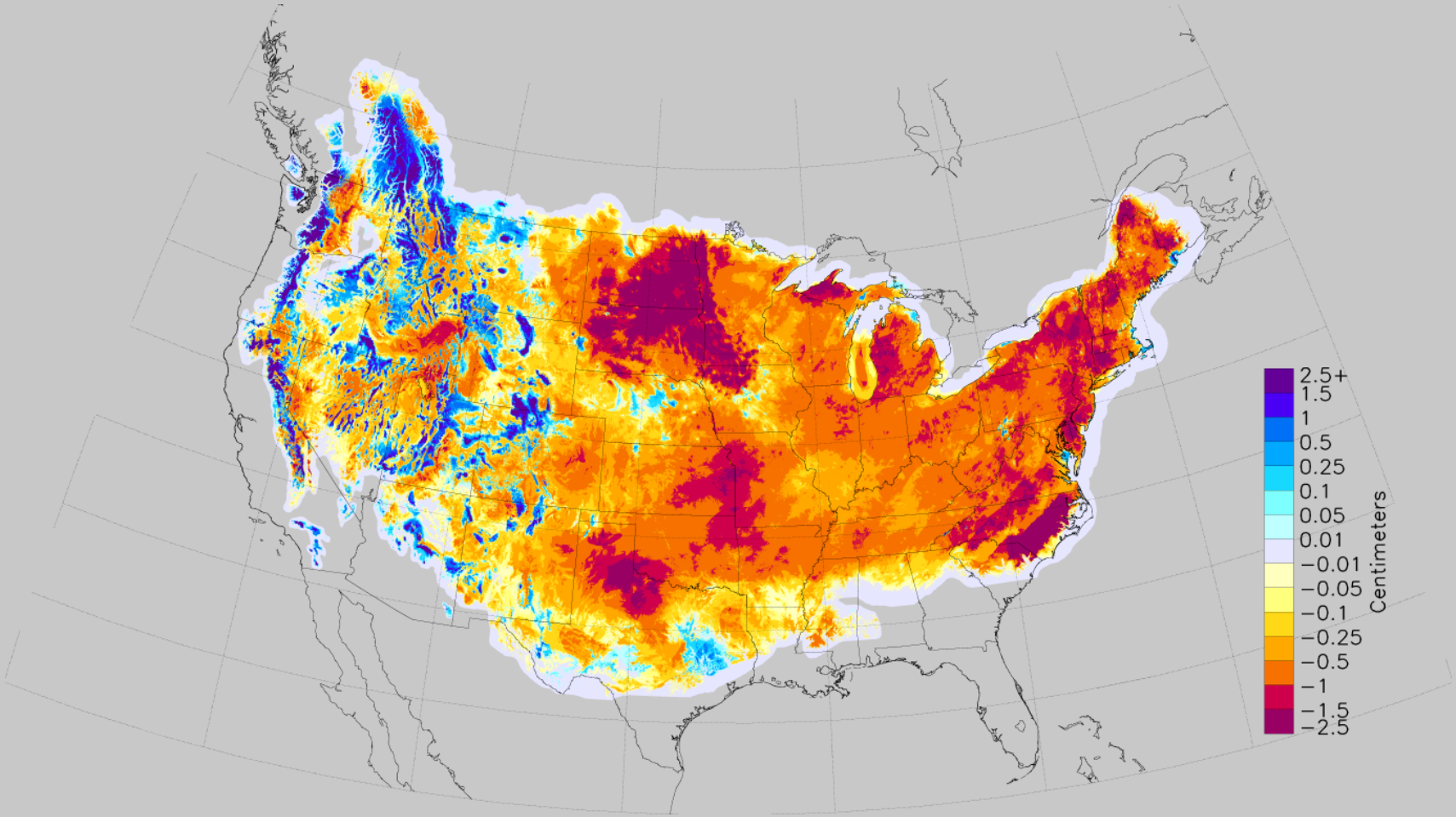
Average SNODAS Assimilation
2007-10-01 to 2008-05-31 (54 performed)



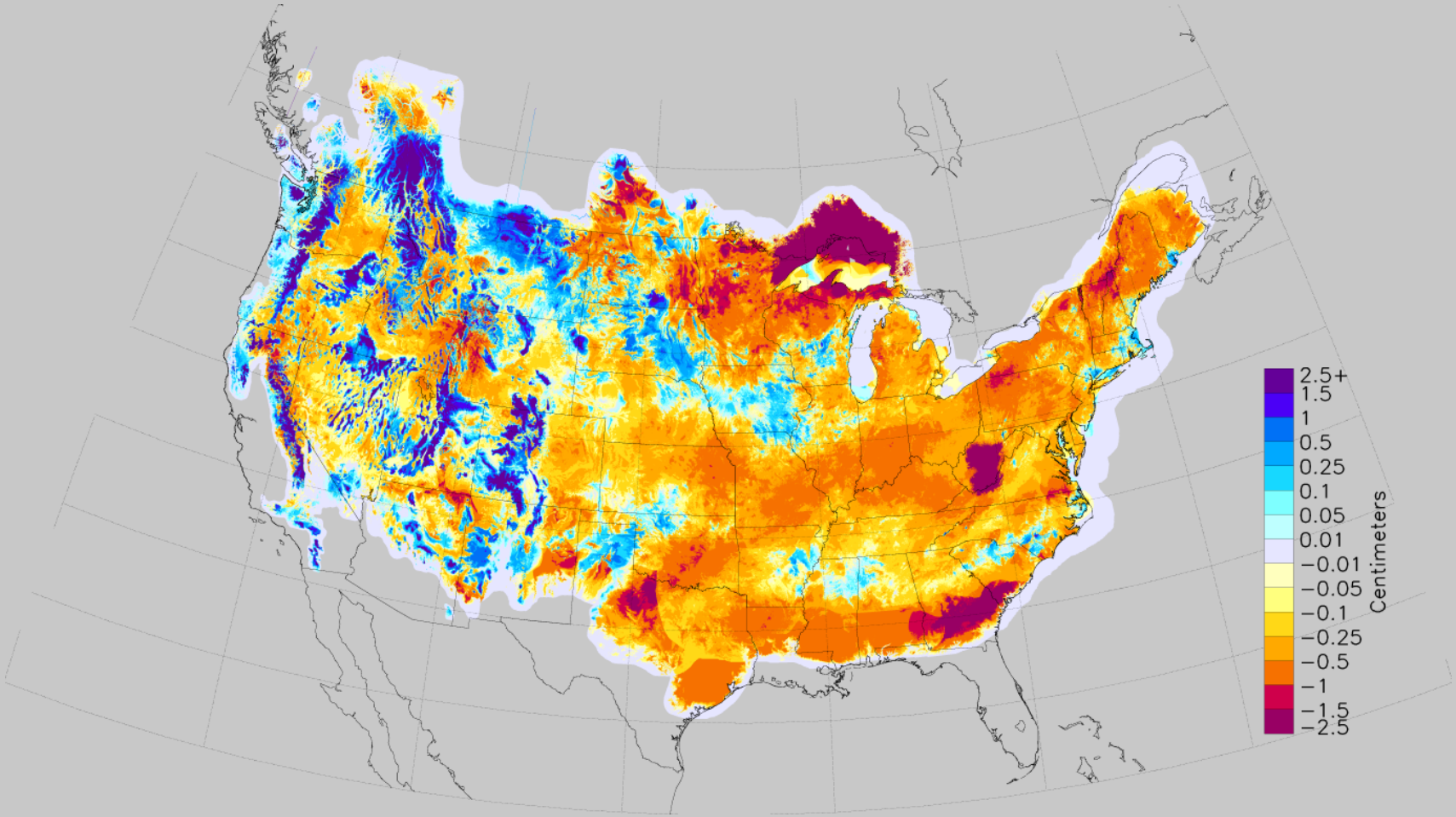
Average SNODAS Assimilation
2008-10-01 to 2009-05-31 (69 performed)



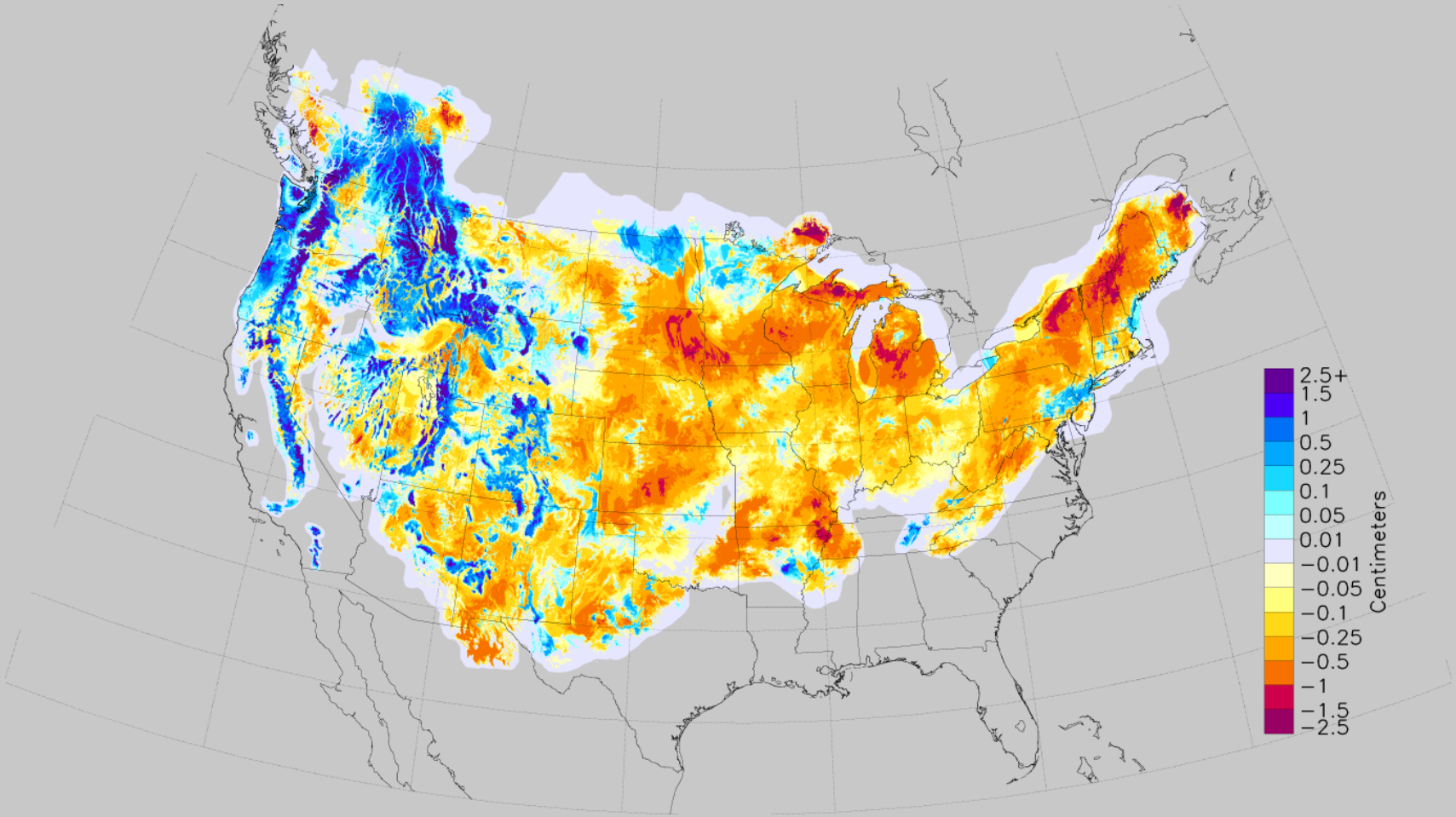
Average SNODAS Assimilation
2009-10-01 to 2010-05-31 (86 performed)



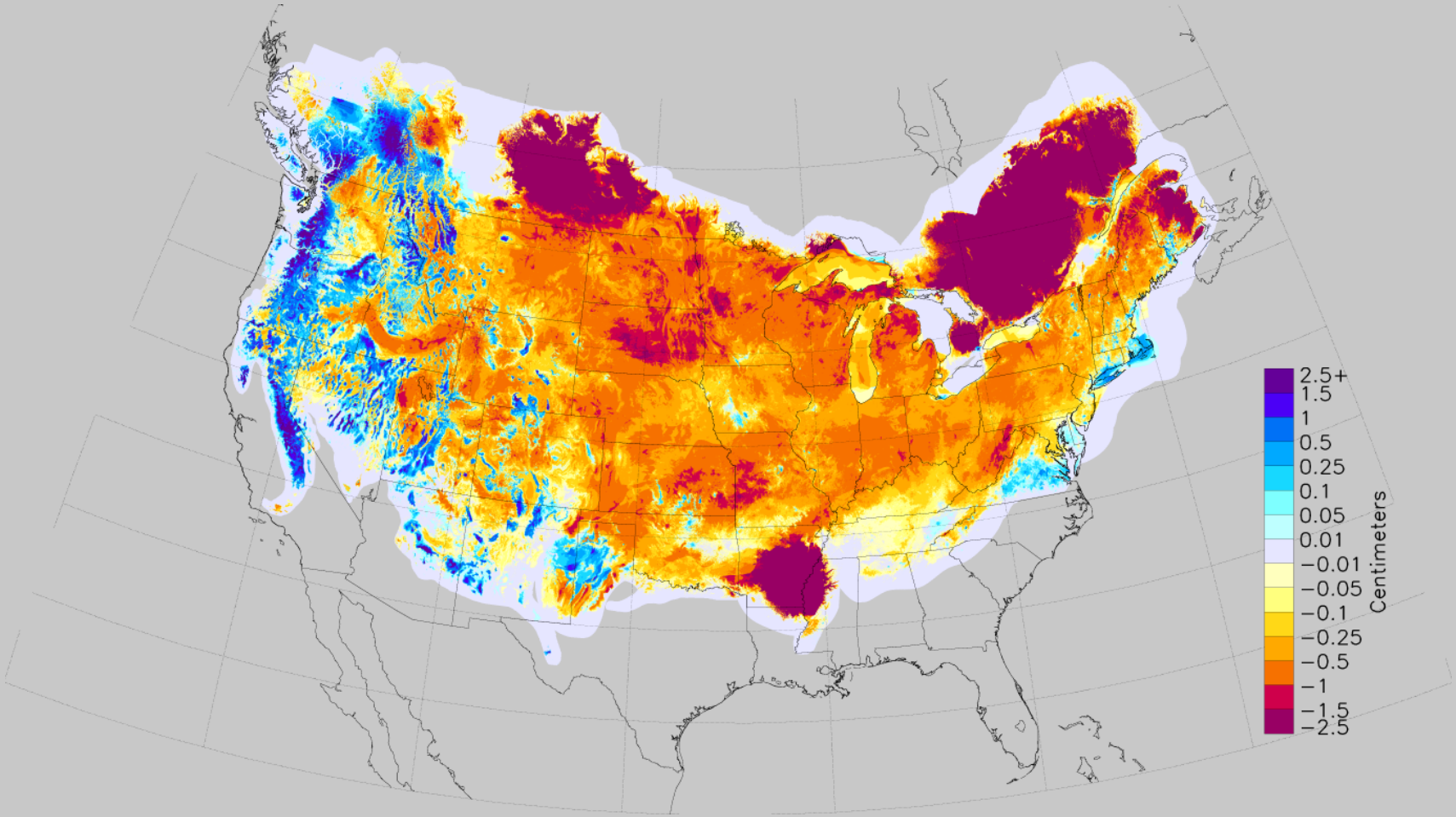
Average SNODAS Assimilation
2010-10-01 to 2011-05-31 (94 performed)



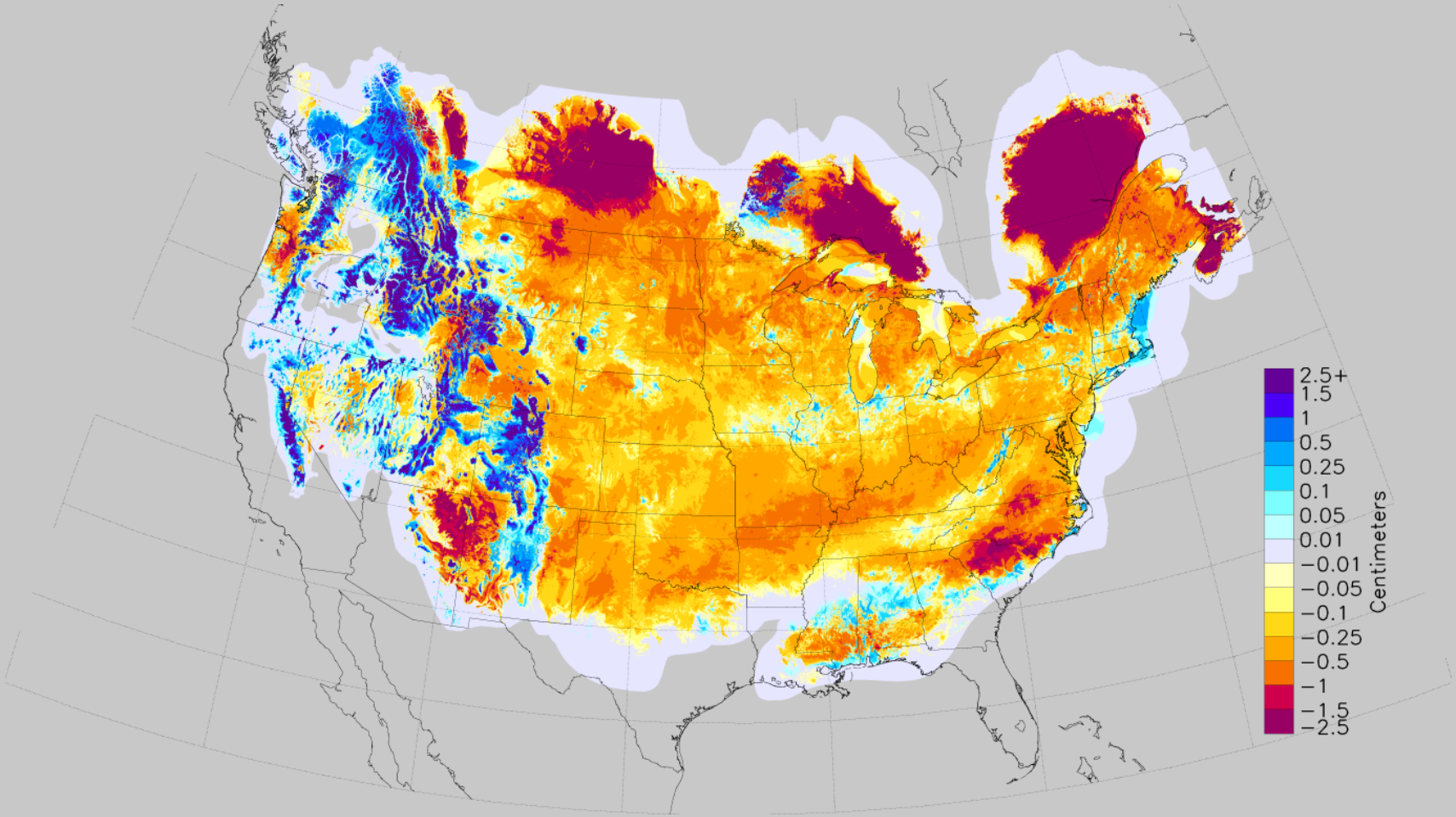
Average SNODAS Assimilation
2011-10-01 to 2012-05-31 (70 performed)



Average SNODAS Assimilation
2012-10-01 to 2013-05-31 (53 performed)



Average SNODAS Assimilation
2013-10-01 to 2014-05-31 (50 performed)



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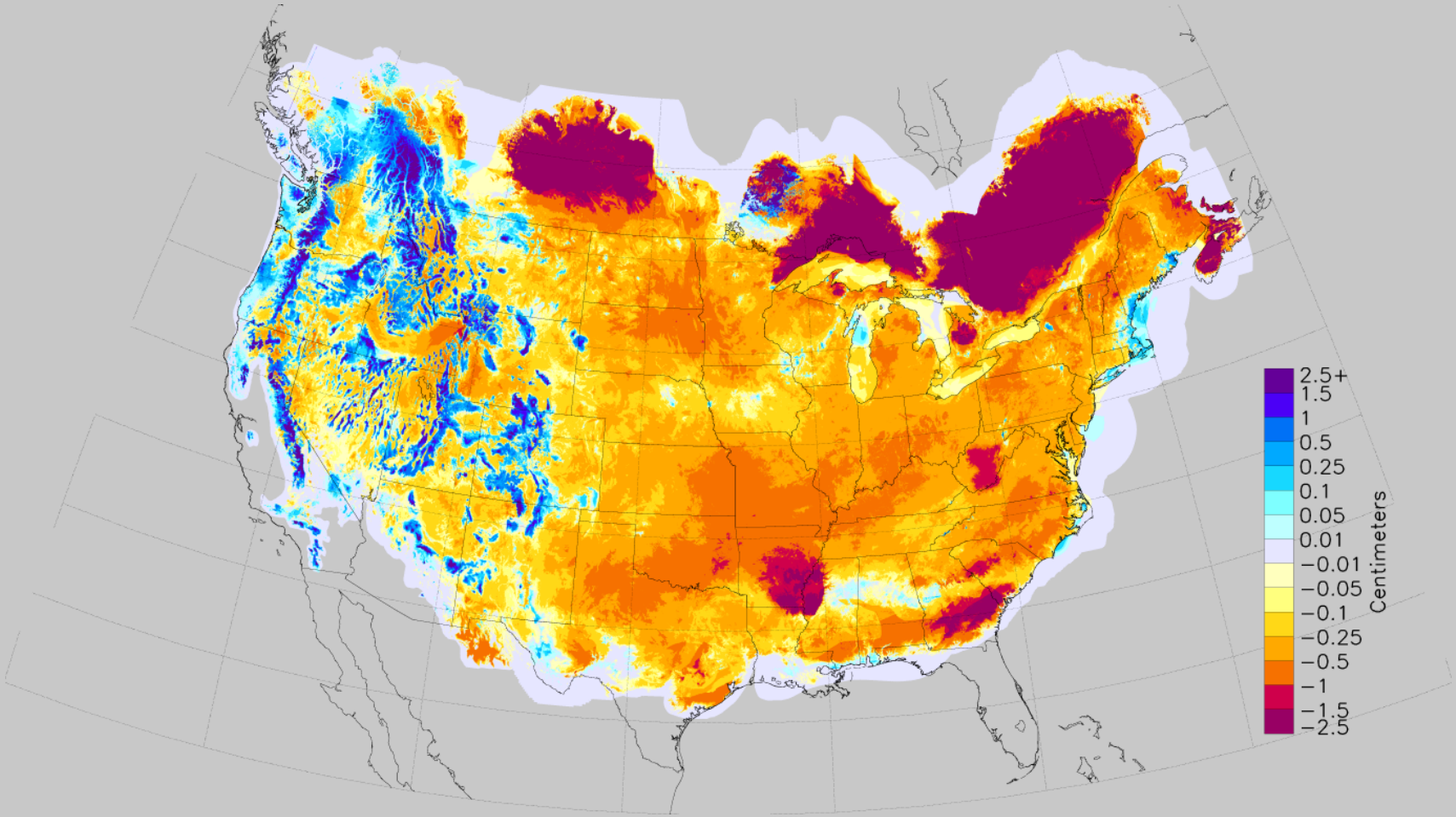
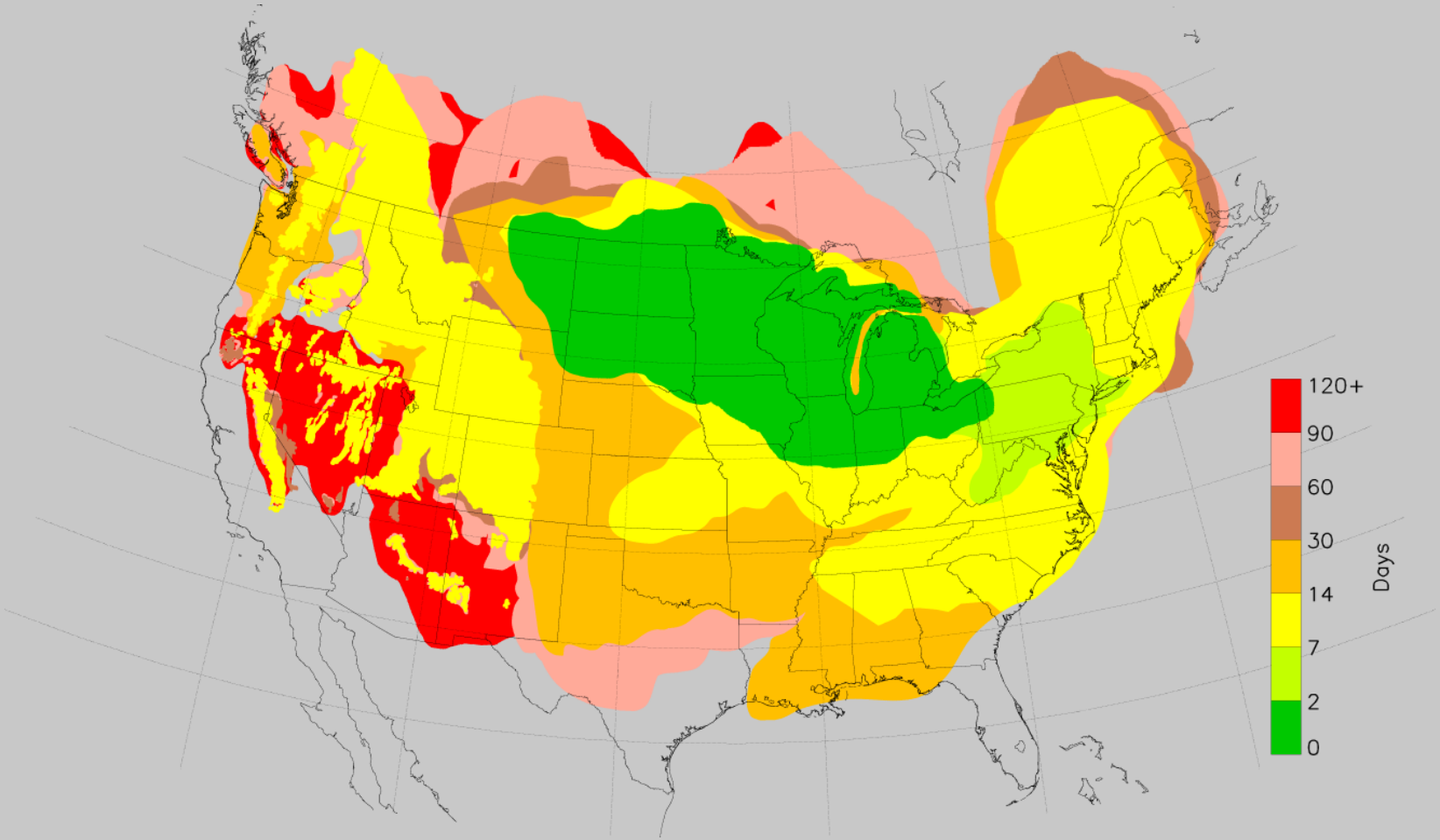


Days Since SNODAS Assimilation
2014-02-26



Conclusions

- Sensitivity analysis is needed to rank sources of error.
- Need improved precipitation engine to bias-correct forcings and reduce categorical (e.g. storm placement) errors.
- Temporal gaps in assimilation can be large at a given location, and this information is relevant to SNODAS users.
- “Days since assimilation” graphic may be a good start.