

# An Introduction to VegOut

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# What is VegOut?

National Drought Mitigation Center–RMA Partnership Agreement Projects



## Vegetation Outlook (VegOUT)

Dr. Brian Wardlow, Dr. Tsegaye Tadesse, Dr. Michael Hayes, and Mark Svoboda, NDMC/UNL; Jun Li, NDMC/HPRCC; Ian Cottingham, CSE/UNL; and Karin Callahan, CALMIT/UNL

**A new experimental tool to provide future outlooks of general vegetation conditions (seasonal greenness) based on an analysis of information that integrates climate, satellite, biophysical, and oceanic data.**

- the term suggested by Mark Svoboda, Climatologist at NDMC



## ***VegOut Products:***

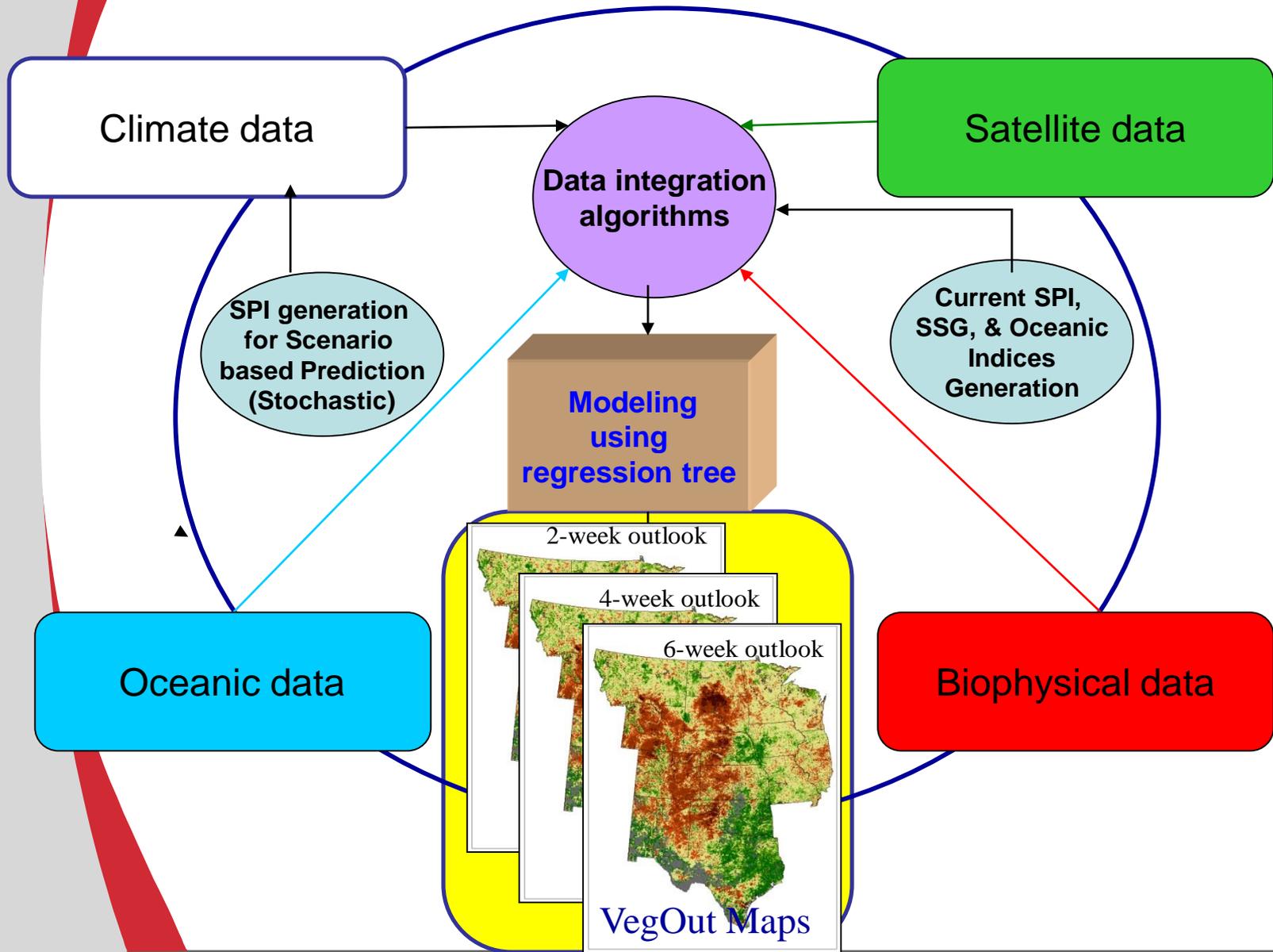
Series of maps depicting future outlooks of general vegetation conditions at a 1-km<sup>2</sup> spatial resolution that are updated every 2 weeks.

- 1) 2-week Vegetation Outlook map
- 2) 4-week Vegetation Outlook map
- 3) 6-week Vegetation Outlook map

\* Release of initial semi-operational VegOut products is planned to be in Spring 2009.



# Methodological approach



# Input data

- **Climate indices**
  - PDSI and SPI
- **Satellite data**
  - SG, PASG, & SSG
- **Biophysical variables**
  - land cover type,
  - ecoregion type,
  - irrigation status, and
  - soil available water capacity
  - Elevation (DEM)

## Eight oceanic indices

1. Multivariate ENSO Index (MEI)
2. The Southern Oscillation Index (SOI)
3. Sea Surface Temperature Anomaly (SST)
4. The Pacific Decadal Oscillation (PDO) Index
5. North Atlantic Oscillation (NAO) Index
6. Pacific/North American (PNA) index
7. Atlantic Multidecadal Oscillation (AMO)
8. The Madden-Julian Oscillation
  - MJO\_RMM1(Real-time Multivariate MJO)

# Types of Vegetation Outlooks

1) Historical-pattern (time-series relationships) – outlooks based on series of historical records

*EX - if the current climate, vegetation, and oceanic conditions are similar to previous drought years (e.g., 1989, 2002, etc), then the following 2-, 4-, and 6-week would have similar drought patterns as those drought years.*

2) Scenarios - outlooks based on implementation of the model using percentage(s) of precipitation expected over the specific outlook period.

*EX. – 50% of normal precipitation over the next 2 week period used to calculate the 2-week VegOut map*

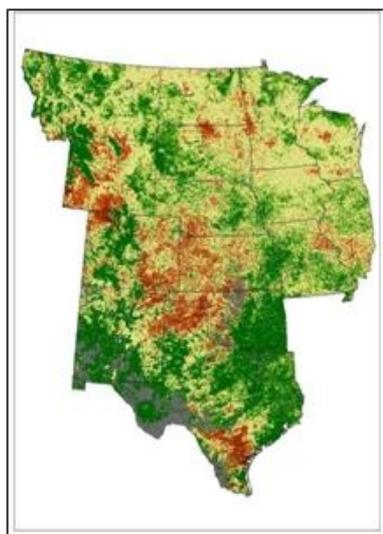
- Multiple scenarios using different %
  - 0%, 50%, 100%, and 150% of normal precipitation
- Scenarios can be done over the different time intervals
  - 2-weeks, 4-weeks, and 6-weeks



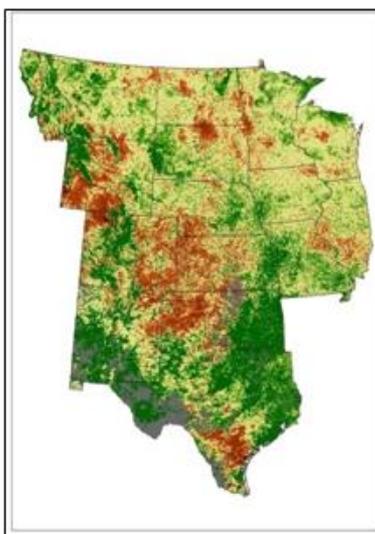
# Time-series relationship model (Historical Pattern)

## Model

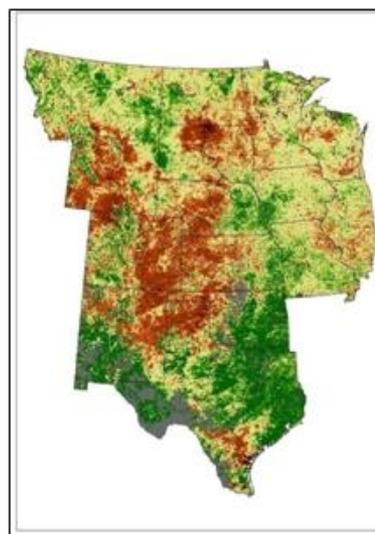
- Method: Given the current independent variables listed, what would be the value in the following 2 week based on the historical pattern? (the next 4 and 6 week?)
- **The original VegOut modeling approach:**
  - $\text{VegOut}_{t=2 \text{ wk}} = f_{t=0}(\text{SSG}) + f_{t=0}(\text{SPI}, \text{MRLC}, \text{Eco\_R}, \text{Per\_Irrig}, \text{AWC}, \text{SoS\_anom},) + f_{t=\text{priorMonth}}(\text{MEI}, \text{MJO\_RMM1}, \text{NAO}, \text{PDO}, \text{SOI}, \text{AMO}, \text{SSTA}, \text{PNA})$



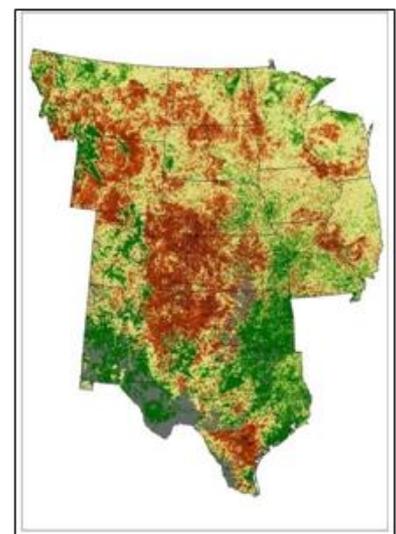
(a) Observed SSG for  
15 May, 2006



(b) 2-week SSG prediction  
for May 29

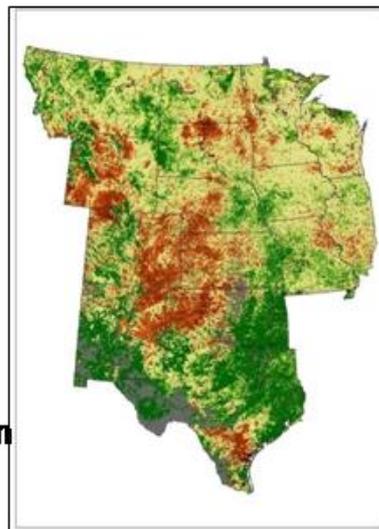


(c) 4-week SSG prediction  
for June 12

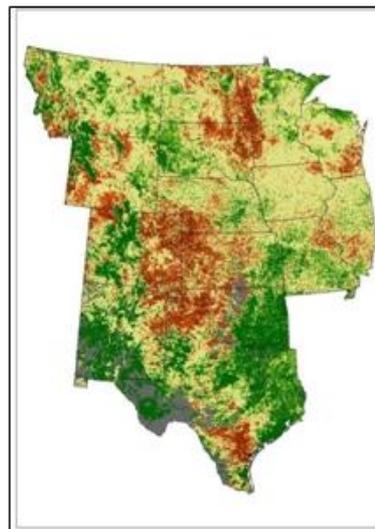


(d) 6-week SSG prediction  
for June 26

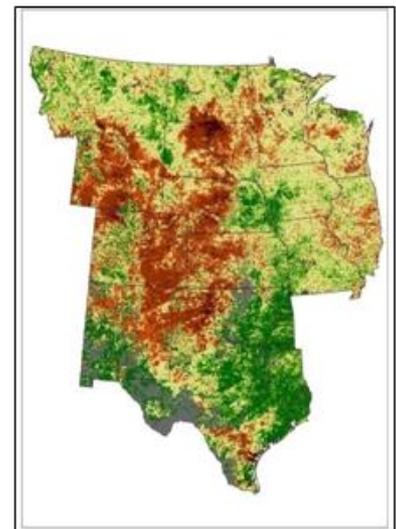
### Vegetation Condition



(e) Observed SSG for  
May 29



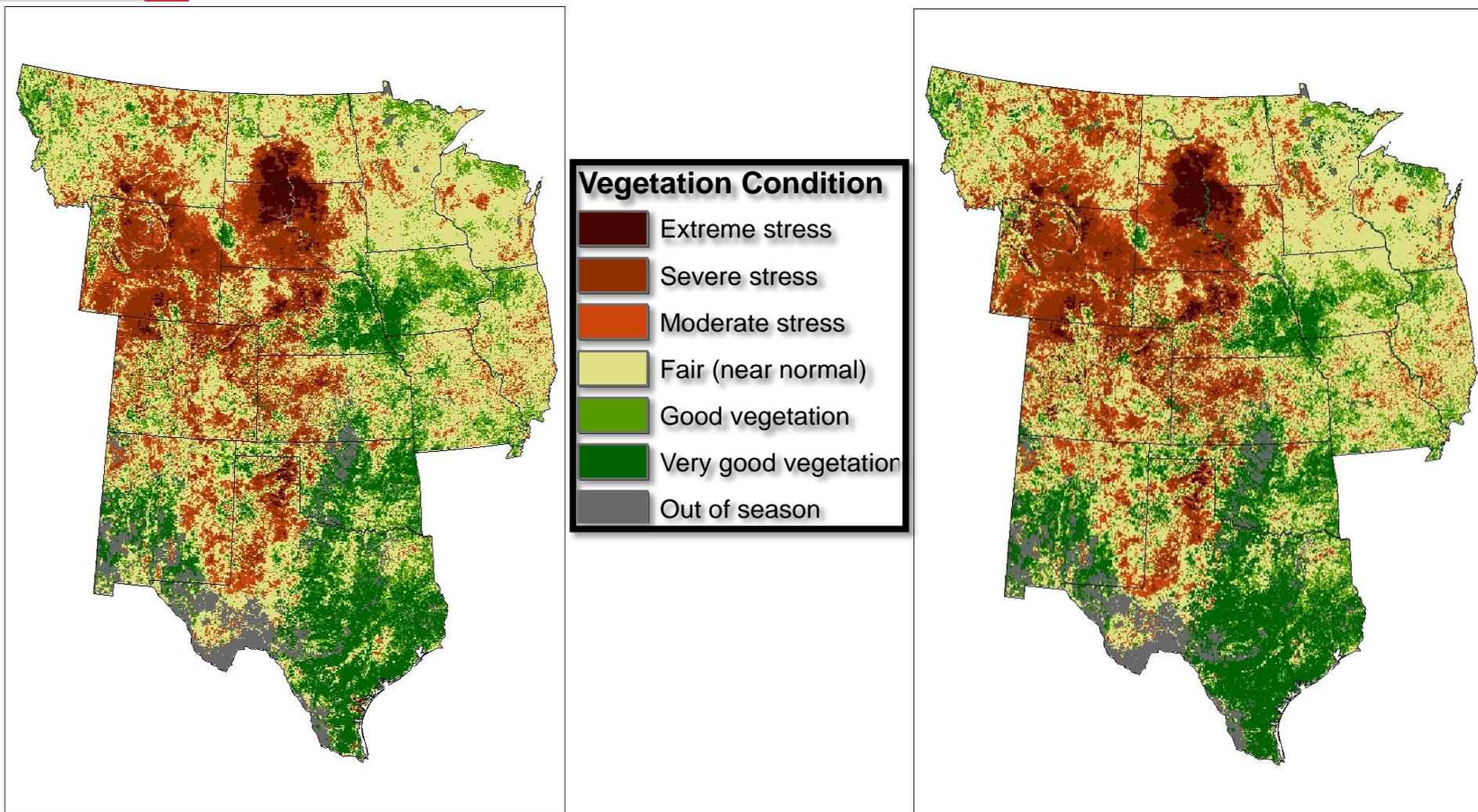
(f) Observed SSG for  
June 12



(g) Observed SSG  
for June 26

**Figure.** The observed standardized seasonal greenness observed from satellite (a) is presented for May 15, 2006 over a 15-state region of the central United States. Maps (b) to (d) show the predicted SSG patterns in the 2-, 4-, and 6-week Vegetation Outlook (VegOut) maps calculated on May 15. Map (e) to (g) present the SSG patterns observed from satellite for the dates corresponding to the three Vegetation Outlooks, respectively.

# Evaluation: Comparison of Two-week Outlook & Observed SSG

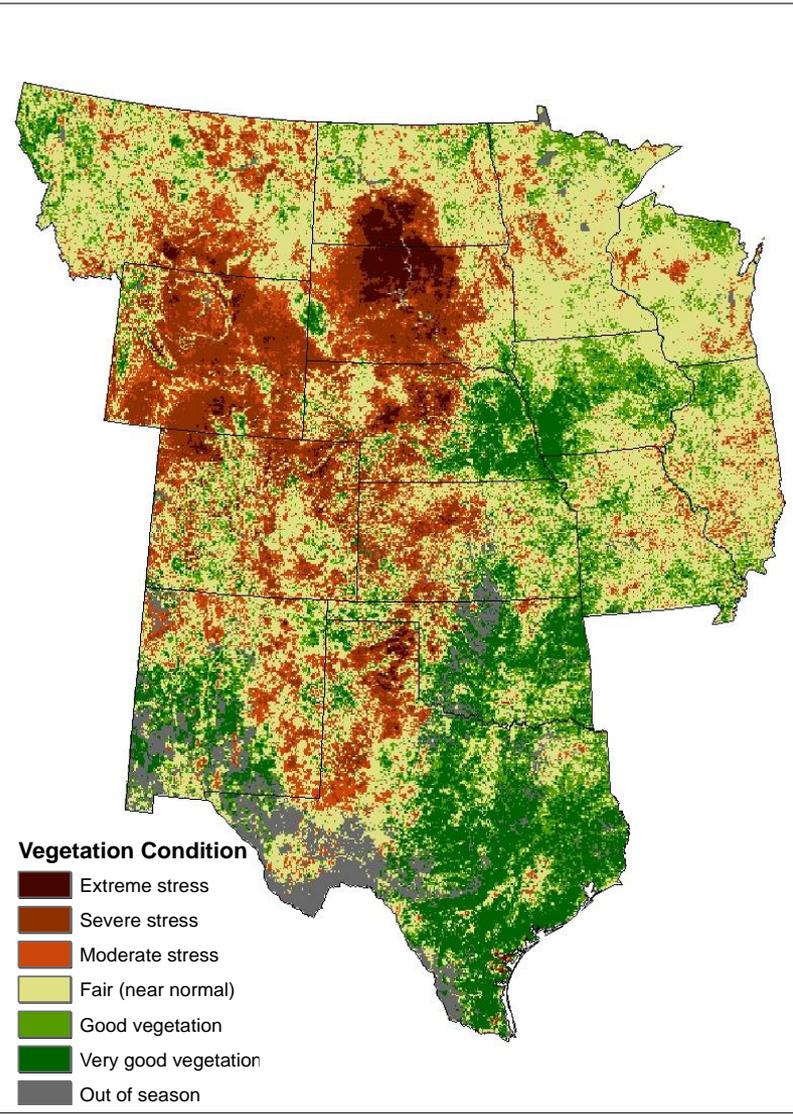


(a) 2-week outlook (for September 4)

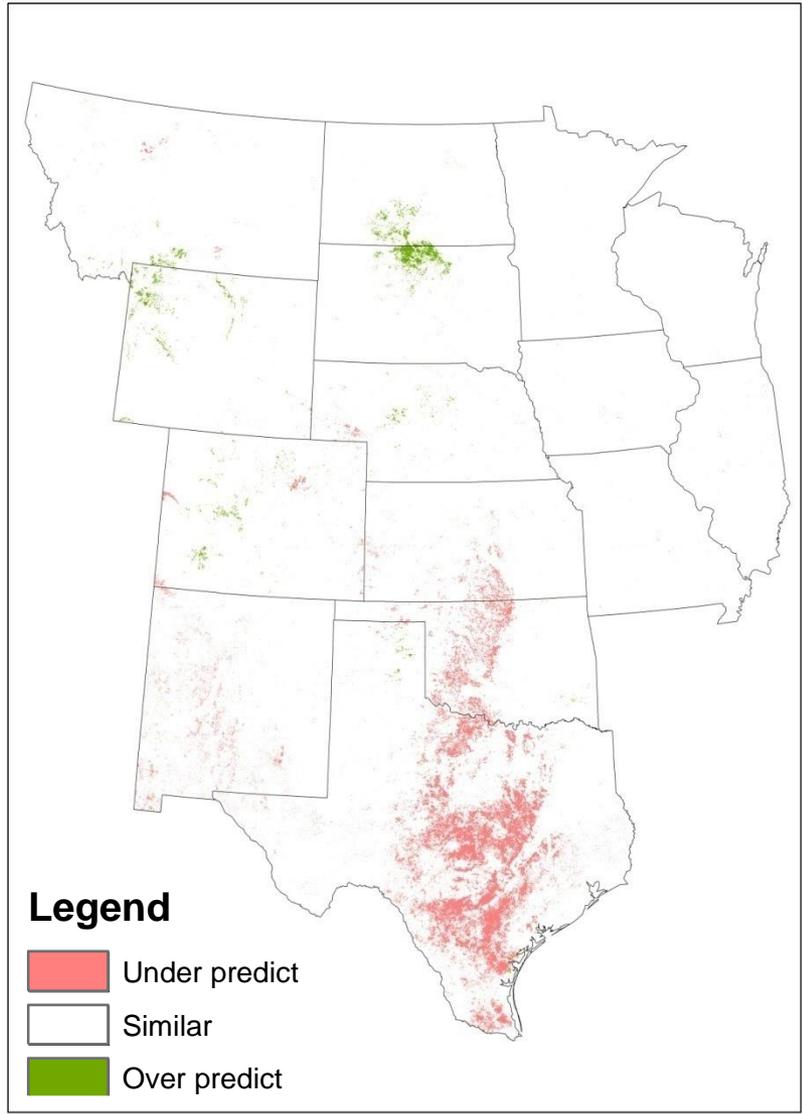
(b) Observed SSG (September 4)

Figure . (a) Two-week Vegetation outlook (VegOut) map that was predicted for the period ending September 4, 2006; (b) Bi-weekly Standardized Seasonal Greenness (SSG) observed for the period ending September 4, 2006.

# The Difference Map: Comparing two-week outlook with actual observation (VegOut minus the observed SSG)



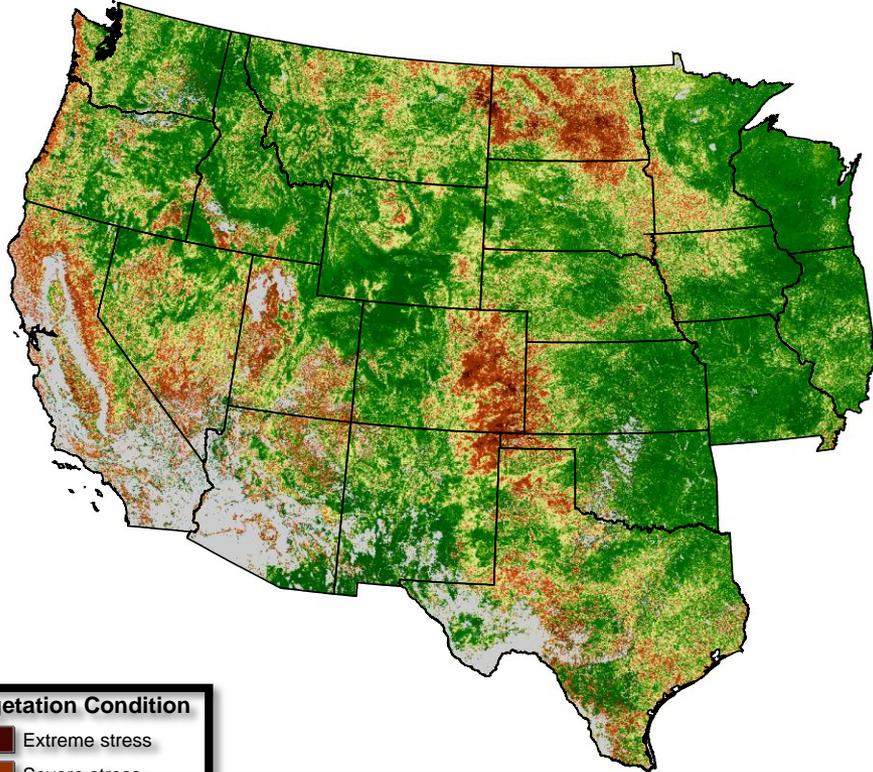
(a) VegOUT (2-week outlook for September 4, 2006)



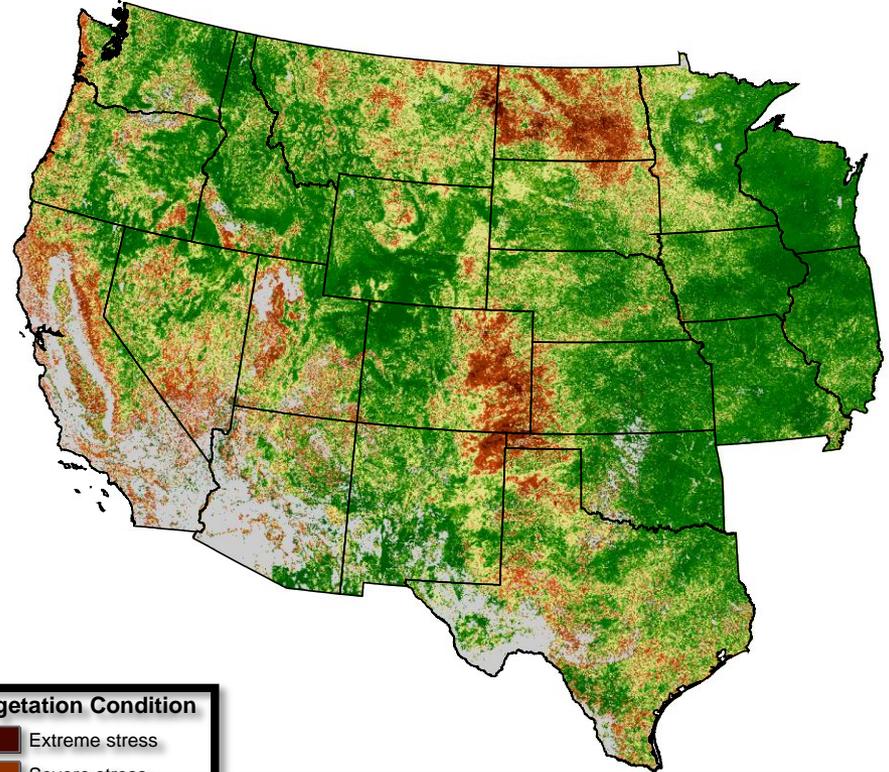
(b) Difference Map of 4 Sep, 2006

# Evaluation: Comparison of Two-week Outlook & Observed SSG

## Central and western U.S.



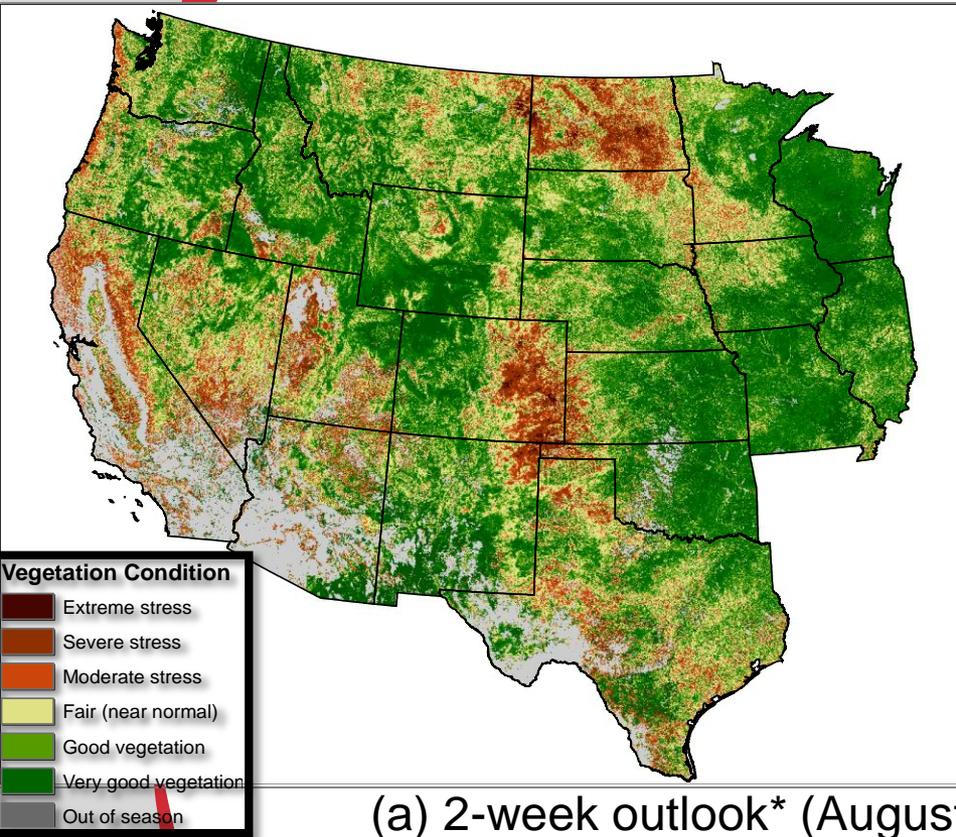
(a) 2-week outlook (for August 11)



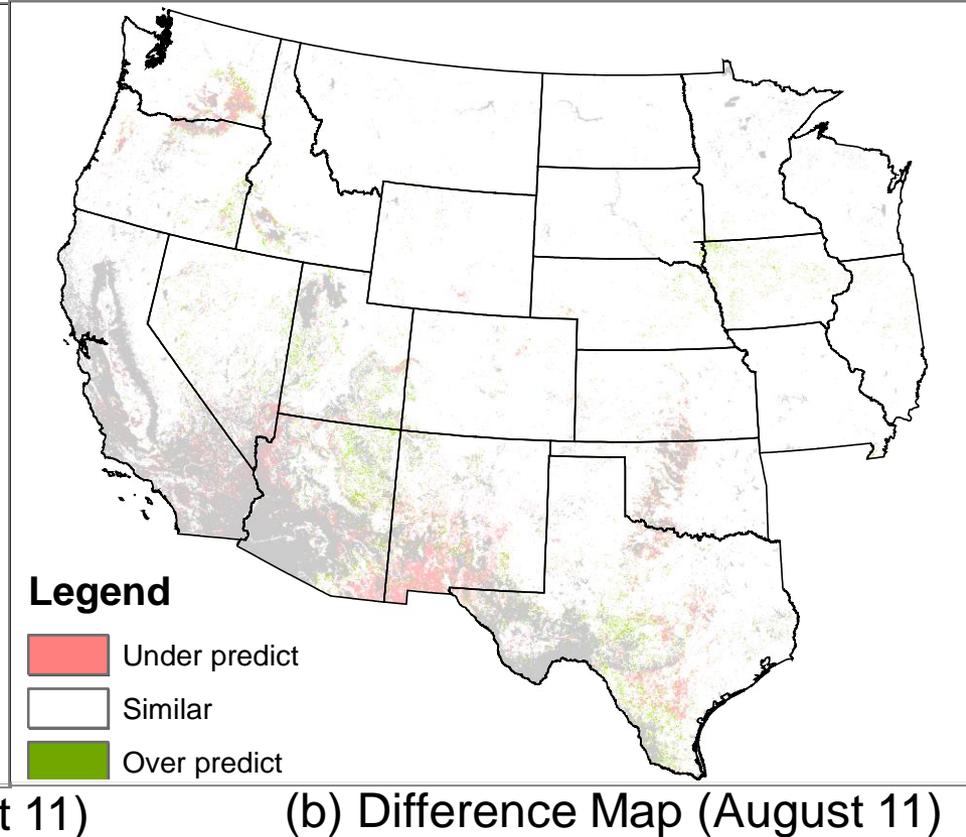
(b) Observed SSG (August 11)

Figure . (a) Two-week Vegetation outlook (VegOut) map that was predicted for the period ending August 11, 2008; (b) Bi-weekly Standardized Seasonal Greenness (SSG) observed for the period ending August 11, 2008.

# The Difference Map: Comparing two-week outlook with actual observation (VegOut minus the observed SSG)



(a) 2-week outlook\* (August 11)

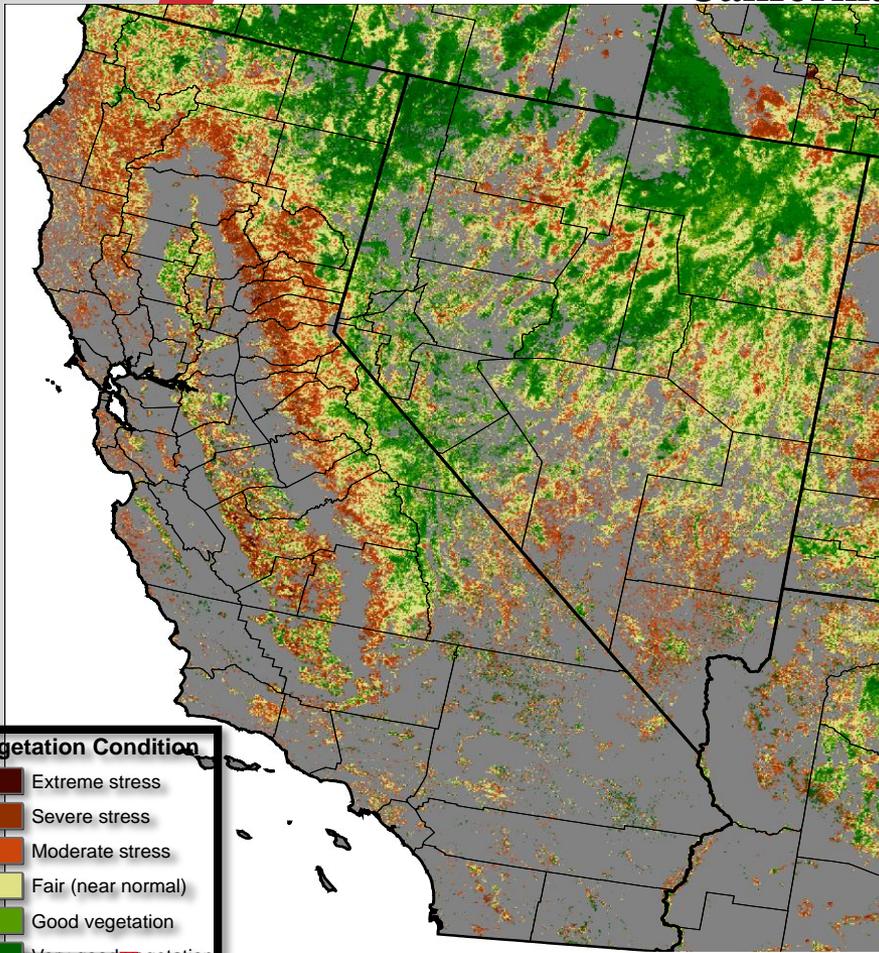


(b) Difference Map (August 11)

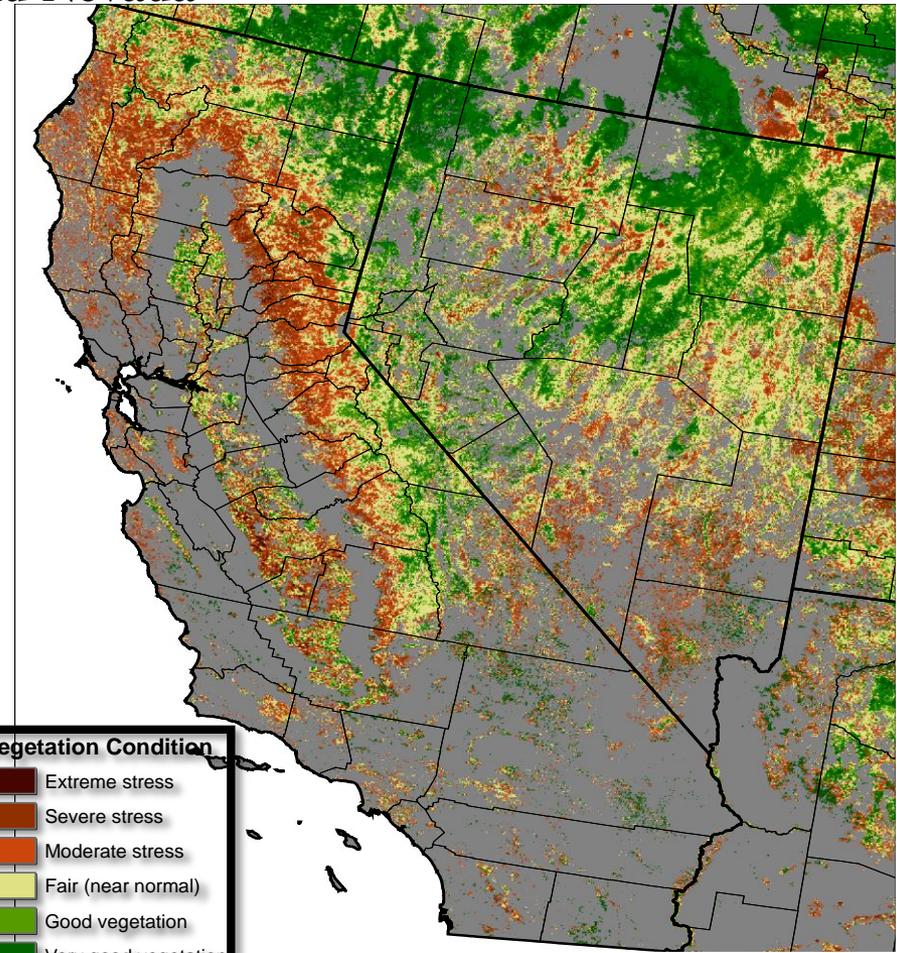
\*VegOut (2-week outlook for 11 Aug, 2008 based on 28 Jul, 2008 observed variables)

# Evaluation: Comparison of Two-week Outlook & Observed SSG

## California and Nevada



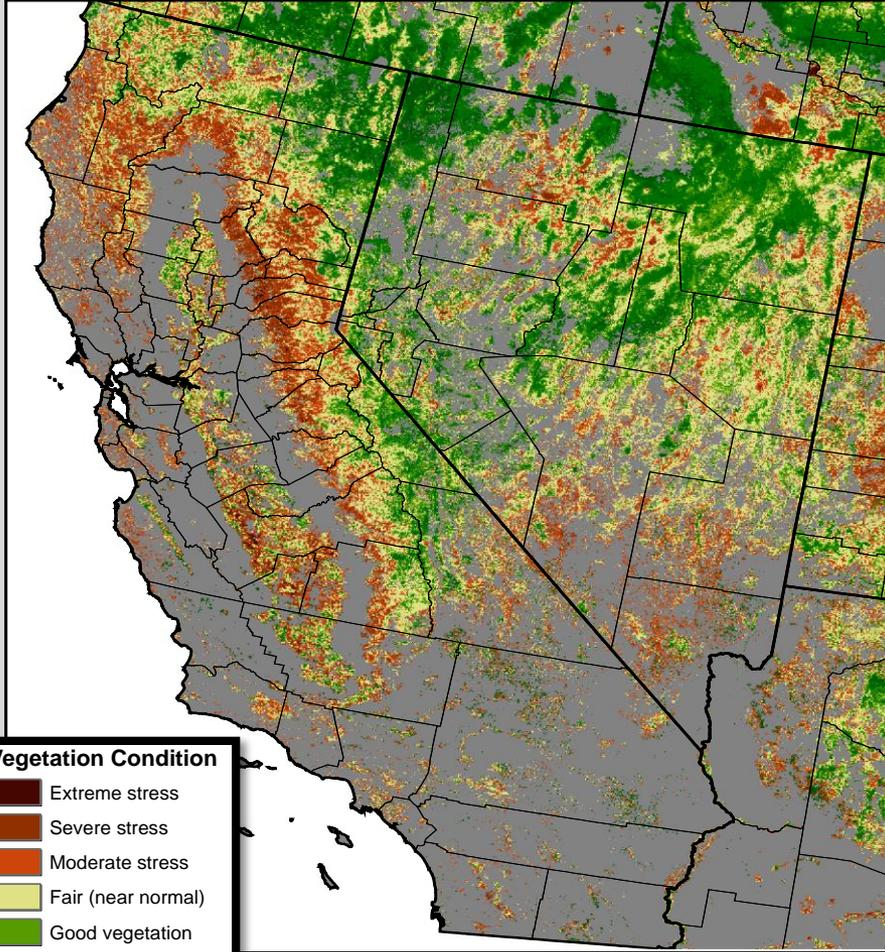
(a) 2-week outlook (August 11)



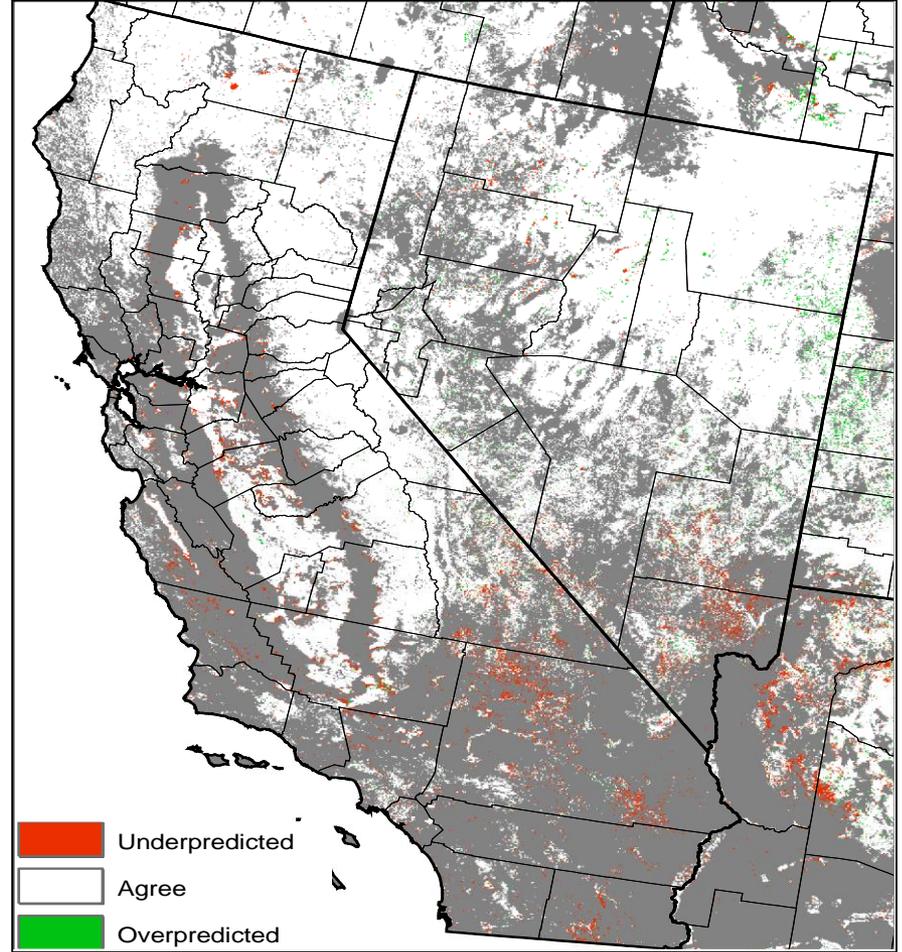
(b) Observed SSG (August 11)

Figure . (a) Two-week Vegetation outlook (VegOut) map that was predicted for the period ending August 11, 2008; (b) Bi-weekly Standardized Seasonal Greenness (SSG) observed for the period ending August 11, 2008.

# The Difference Map: Comparing two-week outlook with actual observation (VegOut minus the observed SSG) California and Nevada



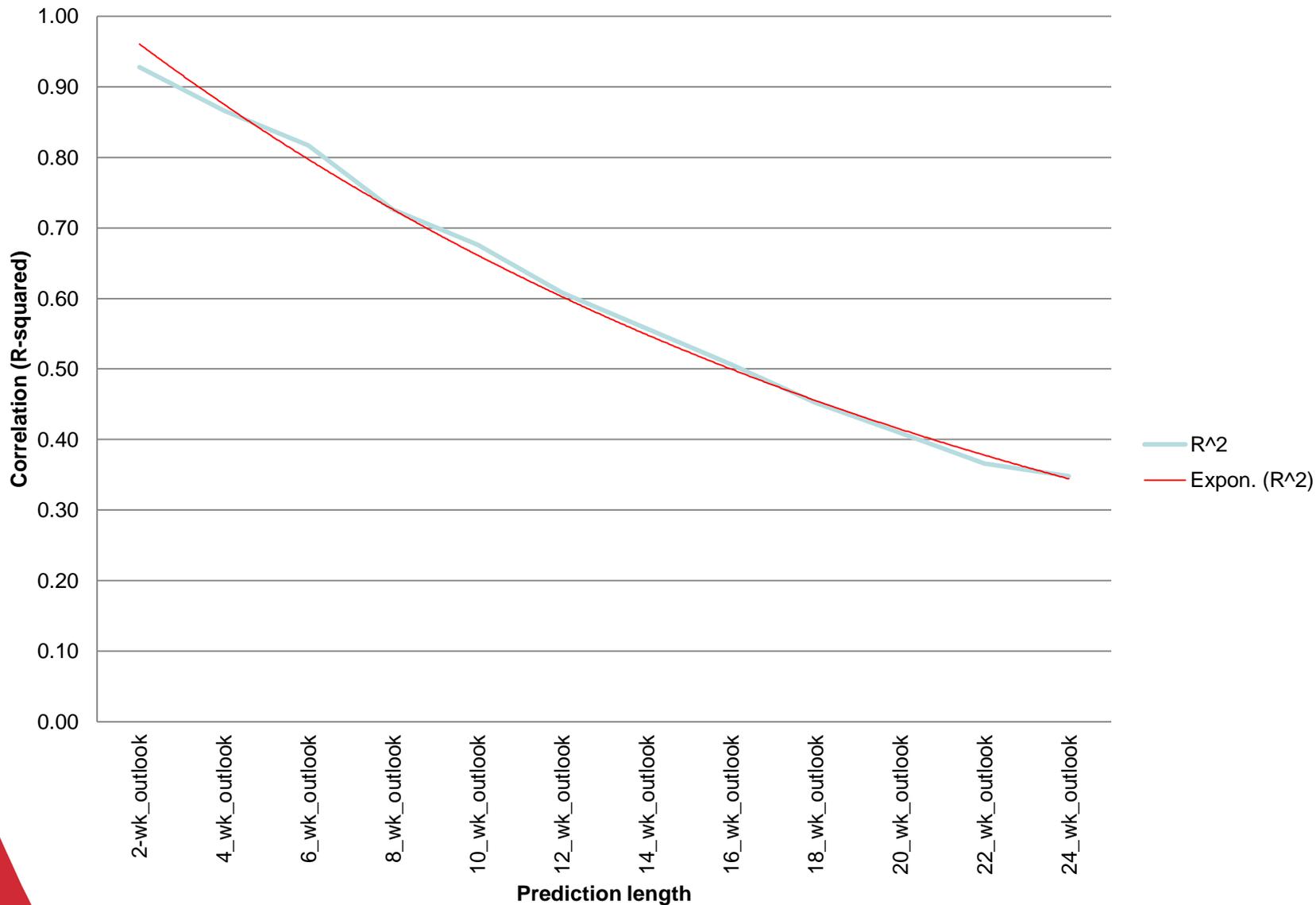
(a) 2-week outlook\* (August 11)



(b) Difference Map (August 11)

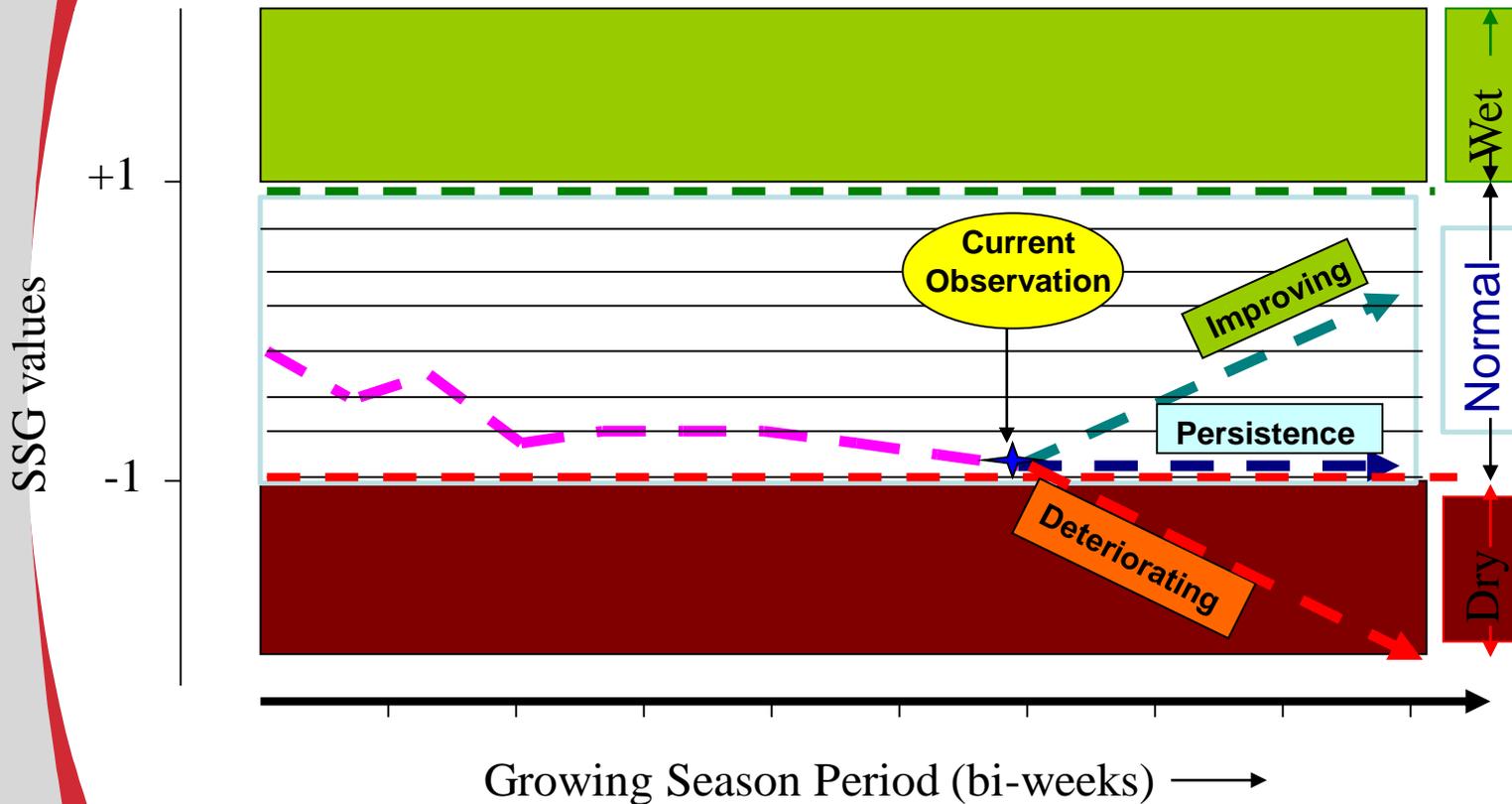
\*VegOut (2-week outlook for 11 Aug, 2008 based on 28 Jul, 2008 observed variables)

# The average correlation (R-squared) of Vegout models (predicted vs observed)



# E.g., Projected Trends of Vegetation Conditions

## VegOut Trends (“Whisk-broom” method)



# VegOut- Scenario model

## Model

- Method: Given the current independent variables listed, what would be the value in the following 2 week based on the dry, wet, and normal precip scenarios?
- $$\text{VegOut}_{t=2 \text{ wk}} = f_{t=0}(\text{SSG, MRLC, Eco\_R, Per\_Irrig, AWC, SoS\_anom}) + f_{t=\text{bestCorrelated}}(\text{MEI, MJO\_RMM1, NAO, PDO, SOI, AMO, JAM, ONI, PNA}) + f(\text{SPI}_{t=2\text{wk\_scenario}})$$
- Where  $\text{VegOut}_{t=2 \text{ wk}}$  is two-week prediction of SSG based on the historical pattern identified by the regression tree model;
- $\text{SPI}_{t=2\text{wk\_scenario}}$  is:
  - a) **Scenario 1 (dry)**: e.g., precipitation expected to be less than 50 % of normal
  - b) **Scenario 2 (near normal)**: e.g., precipitation expected to be between 50 & 150 %
  - c) **Scenario 3 (wet)**: e.g., precipitation expected to be more than 150 % of normal



# Climate Outlooks Resources

- Expert knowledge
- Climate Prediction Center
  - <http://www.cpc.ncep.noaa.gov/index.htm>
- National Drought Mitigation Center
  - <http://www.drought.unl.edu/dm/forecast.html>



# How do we improve the VegOut model?

- Assess temporal and spatial relationships between
  - Climate & vegetation dynamics
  - Oceanic dynamics & climate
  - Spatial variability of drought indices
- Use these relationships to determine which variables to integrate in modeling the VegOut to improve its accuracy
- Evaluation based on feedback from users & potential users (e.g., ranchers, university extension agents, and managers)

# Future Activities

- Experimental maps will be posted online
- Semi-operational maps planned for the 2009 growing season
- Evaluation needed
  - Expert assessments
  - Users feedback



# Thank You!

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