Evaluating the Impacts of NASA/SPoRT Daily Greenness Vegetation Fraction on Land Surface Model and Numerical Weather Forecasts

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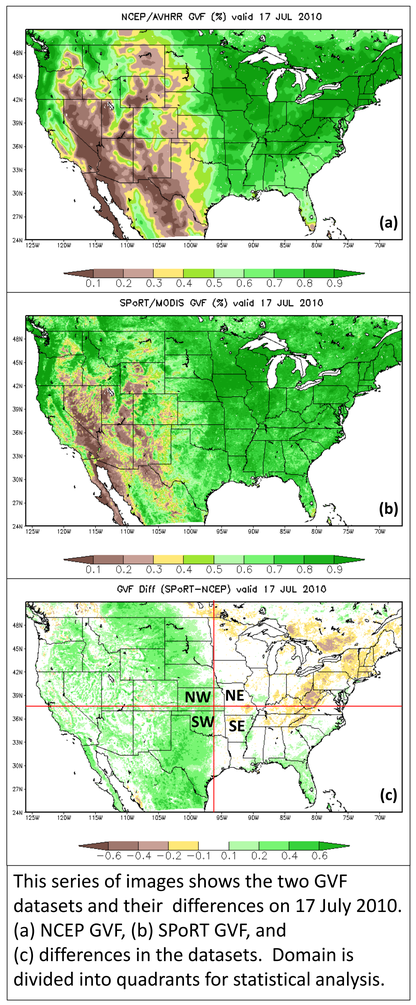
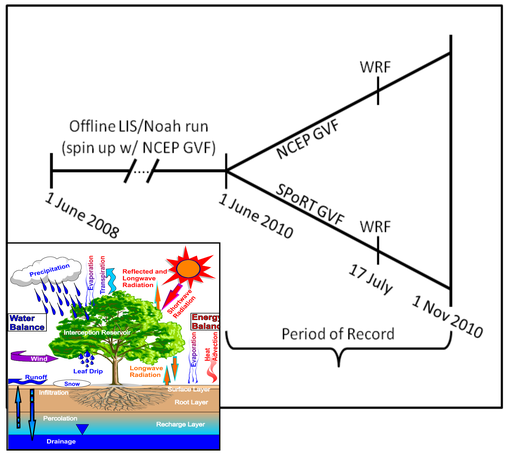
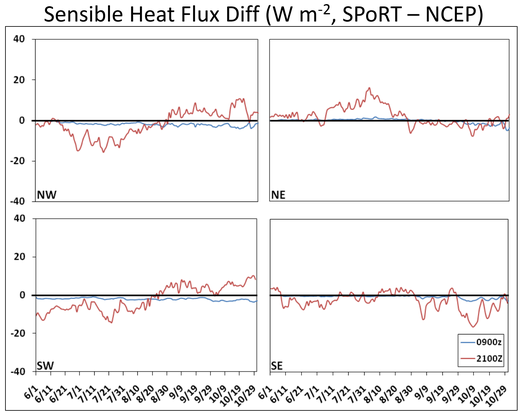
Background and Methodology

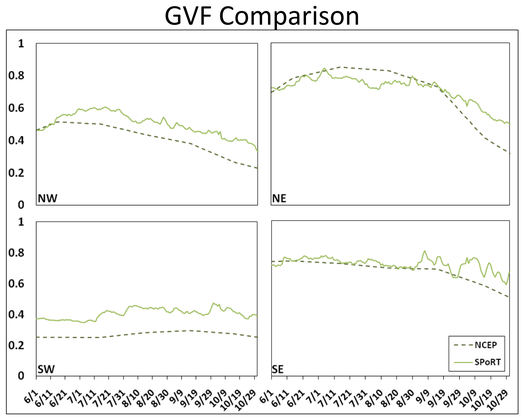
- The NASA SPoRT Center has developed a daily real-time Greenness Vegetation Fraction (GVF) dataset using high-resolution data from the Moderate Resolution Imaging Spectroradiometer (MODIS).
- Climatology versus SPoRT GVFs
  - Current operational weather forecast models use a 20-year-old static database, which depicts vegetation in the same manner from year to year.
  - The SPoRT GVF is updated each day to capture real-time changes in vegetation (e.g. urbanization, wildfires), as well as vegetation responses to weather anomalies (e.g. hard freezes, droughts, extreme temperature/moisture).
  - SPoRT GVF is ~15 times higher spatial resolution.
- This project has two objectives
  - Compare SPoRT/MODIS GVF to the National Centers for Environmental Prediction (NCEP) climatology GVF during the 2010 warm season (1 June – 31 Oct).
  - Examine impacts on Weather Research and Forecasting (WRF) prediction model for a case study.
- Methodology
  - NASA Land Information System (LIS) used to quantify the impacts on the Noah land surface model.
  - Two WRF model simulations were made using the NCEP GVF and the SPoRT GVF datasets, respectively.

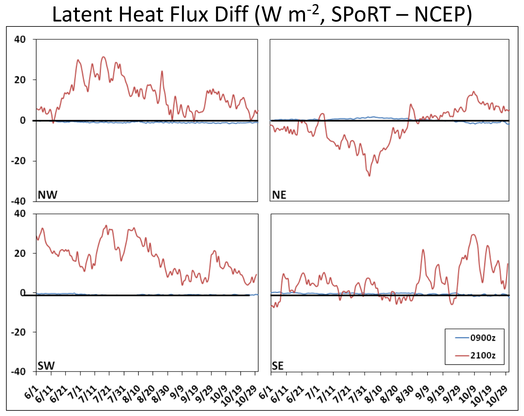


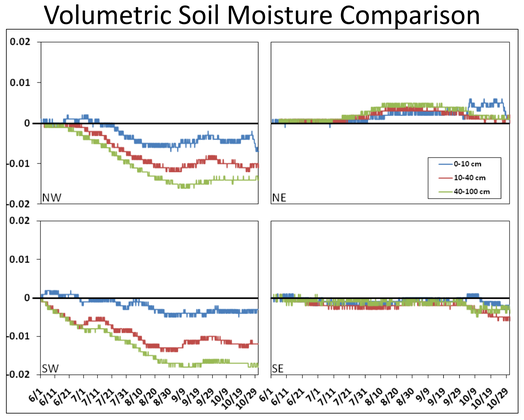
This series of images shows the two GVF datasets and their differences on 17 July 2010. (a) NCEP GVF, (b) SPoRT GVF, and (c) differences in the datasets. Domain is divided into quadrants for statistical analysis.









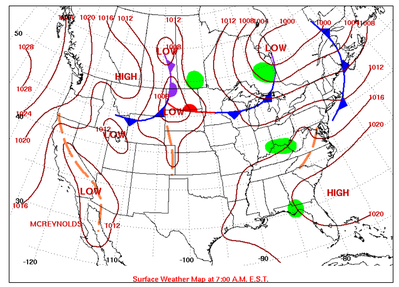


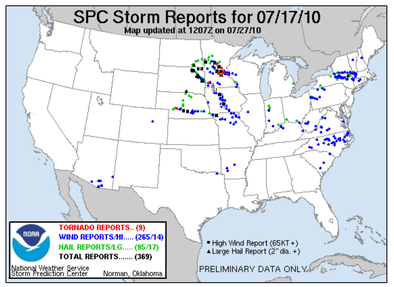
Analysis of Land Surface Model Results

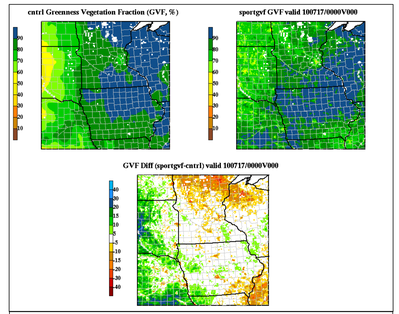
- The latent heat flux is directly related to the GVF. Higher GVF results in greater evapotranspiration (ET), leading to a higher latent heat flux.
- The western half of U.S. had higher SPoRT GVF values than the NCEP climatology.
  - This initially led to higher (lower) mean latent (sensible) heat fluxes.
  - Both the sensible and latent heat fluxes were higher in the SPoRT GVF model run by late summer.
  - This higher vegetation coverage extracts moisture from the soil more rapidly through higher ET.
- The Northeast U.S. experienced a lower GVF during the middle of the warm season, and higher GVF in the early Autumn in the SPoRT model run.
  - Translated to a lower latent heat flux in mid-summer.
  - The lower latent heat flux caused the soil moisture to dry at a slower rate.
  - Higher GVFs in the Autumn led to slightly larger latent heat fluxes.
- The Southeast U.S. had a SPoRT-GVF closest to the NCEP climatology for most of the warm season.
  - The end of the warm season had the greatest difference, where the SPoRT GVF was higher than the NCEP climatology, leading to higher (lower) latent (sensible) heat fluxes.

Summary and Conclusions

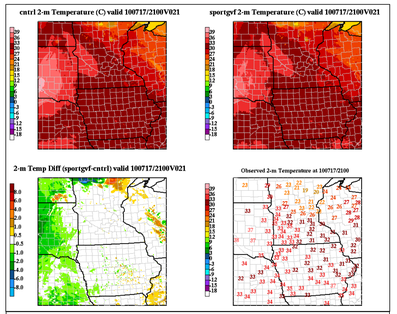
- Consistently higher SPoRT GVFs in the western U.S. and Mexico led to greater moisture transport into the atmosphere and a more rapid soil drying in the Noah land surface model integration.
- A model run using SPoRT GVFs showed some improvement on the 17 July severe weather case.
- Because vegetation patterns of the U.S. have changed since the NCEP dataset was derived, further exploration is needed to see if a real-time dataset would enhance forecast model accuracy.



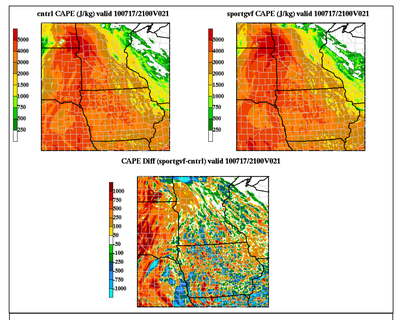




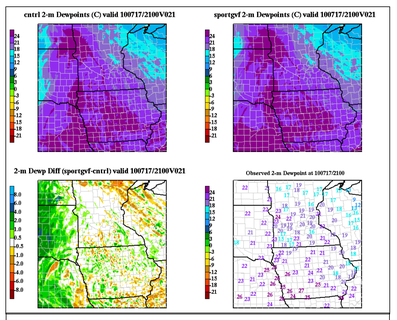
- Areas upstream of where convection develops has higher GVFs.
- Urban areas can be resolved much better by the SPoRT GVF.



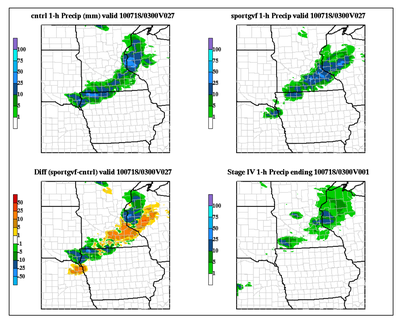
- The higher SPoRT GVFs in the western portion of the domain lead to lower forecast temperatures.
- Lower NCEP GVF leads to an increase in sensible heat flux, leading to higher forecast temperatures.

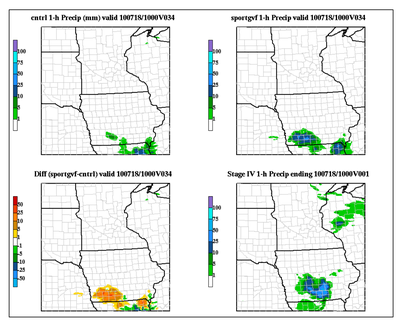


- Higher 2-m dewpoints in the SPoRT/WRF run leads to CAPE increases up to +1000 J kg^{-1} over NCEP run.



- Higher GVF values lead to higher 2-m dewpoints.





- One-hour precipitation, 27-hour forecast:
  - Both runs tend to develop a line of convection with embedded heavier storms.
  - Both depict similar placement of convection.
  - The analyzed precipitation (NCEP Stage IV) shows a mode of discrete cells in a line.
  - SPoRT/WRF suggests more discrete cells over the NCEP WRF run (seen in other hours, too).
- One-hour precipitation, 34-hour forecast:
  - The models have diverged quite a bit in timing and placement of the convection.
  - The NCEP/WRF has the convection moving into Missouri much faster.
  - The SPoRT/WRF has the placement of the convection more in-line with the analysis.
  - The SPoRT/WRF run slightly under-estimated intensity of the precipitation.

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