Developing Satellite-derived Estimates of Surface Moisture Status

Nemani, RR, L Pierce, and SW Running. 1992. Journal of Applied Meteorology. 32: 548-557

Study Goals

- Build on previous study by applying relationship between temperature and NDVI to other areas
- Hypothesis that in dry conditions, an increase in green foliage will increase NDVI and surface temperature emissions will decrease
  - During wet conditions there is a flat relationship because of ET from the soil

Methods

- Start with a 300x300 km region over MT
  - Rocky Mountains, grasslands, coniferous forests, also crop land
  - Growing season from April – October
  - Natural vegetation is moisture limited during the summer
- Used NOAA-9/ AVHRR at 14:30 again for 3 days
  - Normalized data by comparing reflectance to Flathead Lake
- Calculated NDVI

$$\mathrm{NDVI} = \frac{\mathrm{NIR} - \mathrm{RED}}{\mathrm{RED} + \mathrm{NIR}}$$

- Calculated Temperature (Ts)

$$\mathrm{Ts} = \mathrm{Tb4} + 3.3(\mathrm{Tb4} - \mathrm{Tb5}).$$

Methods

- Selected one day (July 14th) and compared Ts/NDVI for 3 different vegetation types
  - Agriculture
  - Grassland
  - Forest
  - Also used lake and snow pixels to display contrast

Methods

- Need to automate determining slope of ts/NDVI but estimating the line is difficult with mixed pixels or clouds
- Build a process that searches for the most accurate pixels to determine the relationship of the slope
  - Given similar conditions surface temperature varies with canopy cover and density (latent heat)
  - Could cover will skew the image leaving a tail on the distribution
  - Most accurate pixels will be at the other end of the distribution
  - Similar logic for shaded vs sunlit areas and viewing angles

Methods

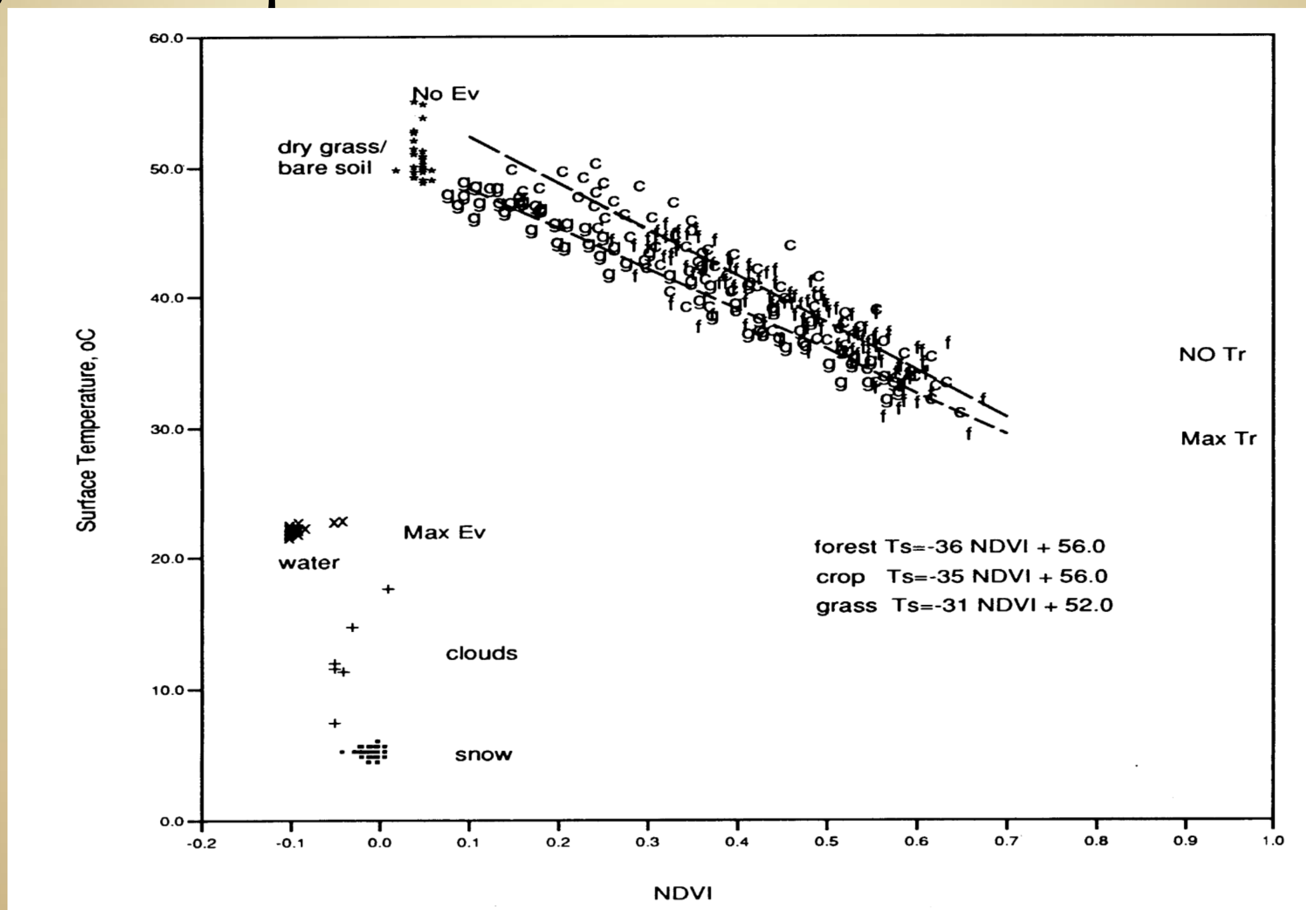
- For automated slope determination you also need to determine ideal pixel size
  - Uniform vegetation gives poor range in NDVIs
  - Examined the relationship between Ts and NDVI using different ‘window’ sizes
    - Same pixel size
    - Different number of pixels compared

Methods

- Regionally surface moisture was compared between 2 days and 3 vegetation types using the Ts/NDVI relationship
- Continentally
  - Used EROS EDC 1km resolution data
    - Bi-weekly composites
    - Chose 2 composites representing late spring and early summer
    - Used previous calculations to determine Ts and NDVI
    - Tested accuracy by comparing 20 climate zones to Crop-moisture index (National Weather Service and USDA)
    - Did not try to standardize Ts or NDVI for weather conditions due to compositing

Results

- Regional slope of Ts vs NDVI



Results

- Four domains of influence
- Low Ts and Low NDVI
  - Flat head lake, high evaporation
- High Ts and Low NDVI
  - Bare soil, low evaporation
- Low Ts and High NDVI
  - Complete vegetation high transpiration
- High Ts and High NDVI
  - Complete vegetation and low transpiration

Results

- Moisture Status did not vary with pixel size used
- However, vegetation types required different window sizes to get an accurate slope
  - Crops 10x10 pixels
  - Grasslands 50x50
    - However, required irrigated land to be accurate
  - Forests 30x30 pixels
    - May be effected by elevation/temp

Results

- Regionally
  - Relationship between Ts and NDVI did not change between wet and dry days for crops or grasslands but did change for forests
  - For grasses and crops you can use NDVI alone to determine surface resistance
- Continentally
  - Strong correlation (R2=0.83) between CMI and the slope of Ts/NDVI for the zones tested
    - There is scatter around the relationship
    - Possible caused by frequency of data collection, number of data collection points, compositing

Conclusions

- The given method appears to be an accurate and useful way to determine Surface Moisture Status even at a large scale
- Size of target area should be determined by vegetation and topography
  - Less topography requires greater window size to get enough variation to determine slope accurately
- At a continental scale the slope of Ts/NDVI is related to moisture availability making it a useful tool for large scale modeling