Soil Moisture influence in the occurrences of Wildfires in the Southeast of United States

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MISSISSIPPI STATE UNIVERSITY

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Objective

Analyze the influence that soil moisture content (SW) has over:

- Occurrences of wildfires (WF)
- Wildfire size (WFS).

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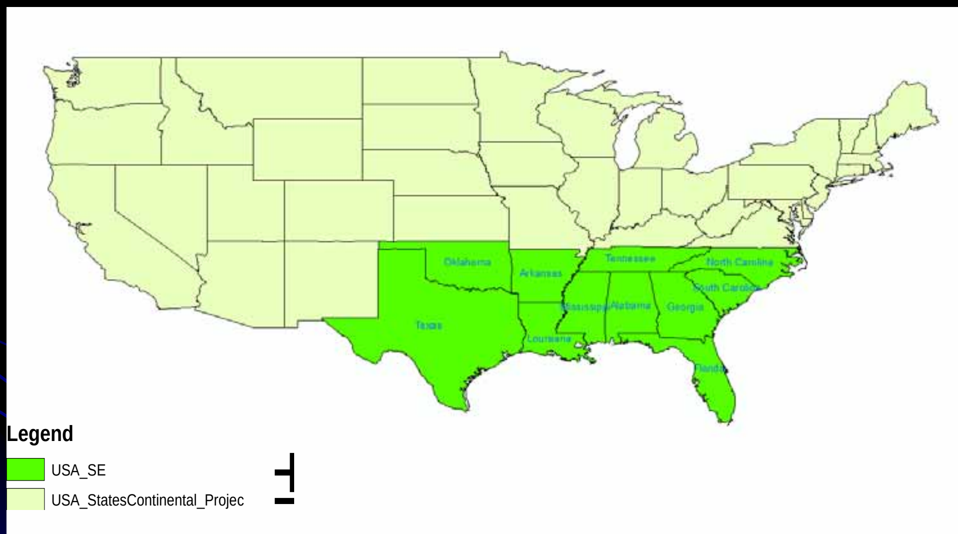
Study area : Southeast united States (SE-US)

Temporal scale: 1992- 2009 (May - November)



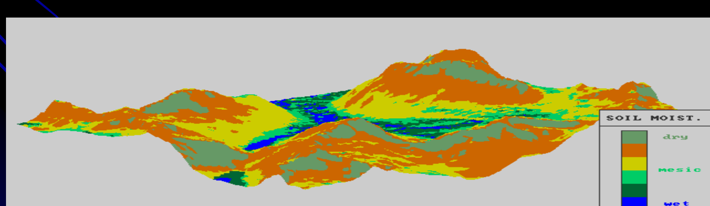
RESEARCH (2 Levels of analysis)

- Land Data Assimilation Systems (NLDAS) — Coarse analysis, 1/8th degree resolution
- Watershed Assessment — Localized analysis, 30 m resolution

General aspects

Soil Moisture (SW)

- SW is the water that is held in the spaces between soil particles.
- Compared to other components of the hydrologic cycle, the volume SW is small.; nonetheless, it is of fundamental importance to many hydrological, biological and biogeochemical processes.
- Soil moisture is a key variable in controlling the exchange of water and heat energy between the land surface and the atmosphere through evaporation and plant transpiration.
- Soil moisture information can be used for reservoir management and early warning of droughts.



Wildfire (WF)

- A Wildfire is any uncontrolled fire in combustible vegetation that occurs in the countryside or a wilderness area such grassland, bushland, scrubland, and other wooded areas that act as a source of fuel, or combustible material.

Wildfire Size (WFS)

- The number of acres burned in a WF-event

Wildfire Size Categories

US Wildfire Size Categories	
WF Category	WF Size range (acres)
A	0 – 0.25
B	0.25- 9.9
C	10 - 99
D	100 - 299
E	300 – 999
F	1000 – 4999
G	5000 - Larger

WF >= 15 acres ➔ Large WF

US Wildfire Size Categories	
WF Category	WF Size range (acres)
A	0 – 0.25
B	0.25- 9.9
C	10 – 99
D	100 - 299
E	300 – 999
F	1000 – 4999
G	5000 - Larger

DATA and METHODS

DATA

- *Soil Moisture*
- *Wildfires*

Soil Moisture Content Data

(1992-2009)

Land Data Assimilation Systems (NLDAS)

GES DISC Goddard Earth Sciences Data and Information Services Center

Data Type (Short Name)	Description	FTP	GDS	Mirador Navigation	Mirador Search	Giovanni * (Visualization)
NLDAS-1, 0.125 degree, North America						
NLDAS_FOR0125_H.001	Hourly forcing	✓	✓	✓	✓	✓
NLDAS-2, 0.125 degree, North America						
NLDAS_FORA0125_H.002	Hourly primary forcing	✓	✓	✓	✓	✓
NLDAS_FORB0125_H.002	Hourly secondary forcing	✓	✓	✓	✓	✓
NLDAS_MOS0125_H.002	Hourly Mosaic	✓	✓	✓	✓	✓
GLDAS-2, 1.0 degree, Global						

L I S software

Uses observations not affected by Numerical Predictions-NP (Avoid biases generated of NP)

- High-resolution Vegetation and Soil coverages
- Pp gauges observations
- Satellite data
- Radar Pp measurements

Land Data Assimilation Systems (NLDAS) → 1979-Present

The accuracy of Data is high

GRI Geoportal

Mosaic
Gridded Binary (GRIB)

1992
1993
2003
2004
2006
2007
2008
2009
2010

1992

001
002
003

363
364
365

1 day file

001

NLDAS_MOS0125_H.A19950104.0000.002	GRB File
NLDAS_MOS0125_H.A19950104.0000.002....	XML Document
NLDAS_MOS0125_H.A19950104.0100.002	GRB File
NLDAS_MOS0125_H.A19950104.0100.002....	XML Document
NLDAS_MOS0125_H.A19950104.0200.002	GRB File
NLDAS_MOS0125_H.A19950104.0200.002....	XML Document
NLDAS_MOS0125_H.A19950104.2300.002	GRB File
NLDAS_MOS0125_H.A19950104.2300.002....	XML Document

24 GRIB FILES (1 file /hour)

Gridded Binary

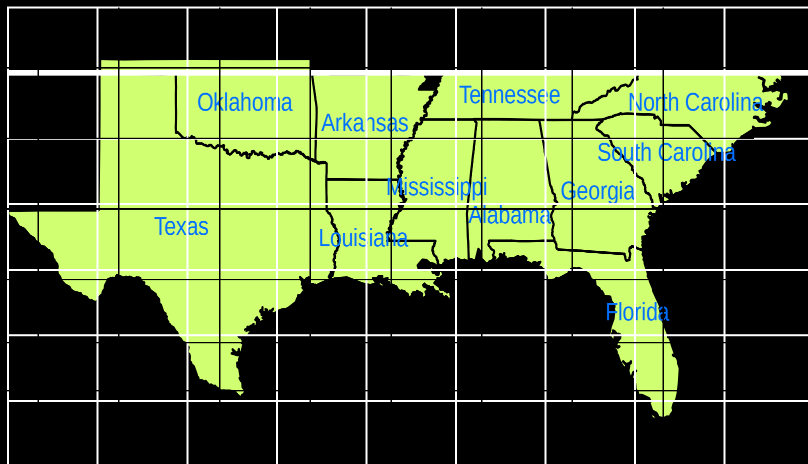
GRIB FILE Arrays

NLDAS_MOS0125_H.A19950104.2300.002 GRB File
NLDAS_MOS0125_H.A19950104.2300.002.... XML Document

(1 File / hour)

464 columns

224 rows



33 Layers-Parameters

Grid size=1/8th degree resolution

NLDAS_MOS0125_H.A19910101.0000.002 11/14/2011 6:11 PM GRB File 5,628 KB

Array:

[464 col * 224 rows * 33 Layers]

GRIB - Parameters data

33 Layers (Parameters)

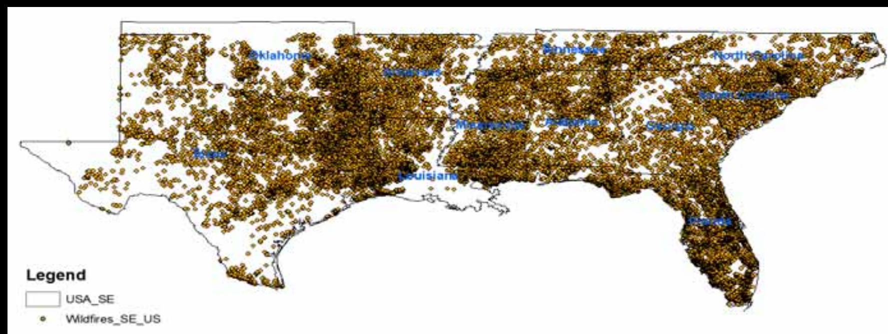
North America Land Data Assimilation System Phase 2 (NLDAS-2) Products README

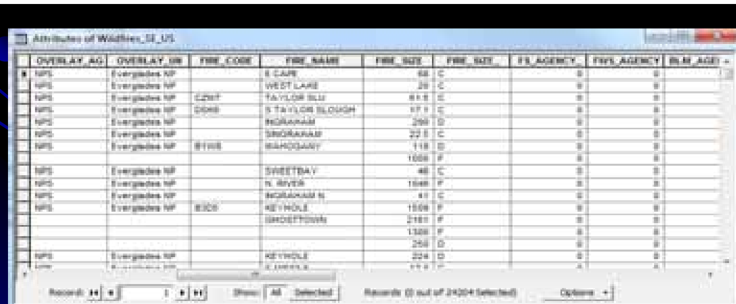
	✓	203	Minimal stomatal resistance	s/m	Hourly backward-averaged
	✓	250	Root zone soil moisture	kg/m^2	Hourly backward-averaged
✓	✓	198	Sublimation (evaporation from snow)	W/m^2	Hourly backward-averaged
✓	✓	122	Sensible heat flux	W/m^2	Hourly backward-averaged
✓	✓	66	Snow depth	m	Hourly instantaneous
✓	✓	229	Snow phase-change heat flux	W/m^2	Hourly backward-averaged
✓	✓	99	Snow melt	kg/m^2	Hourly backward-accumulated
✓	✓	238	Snow cover	%	Hourly instantaneous
✓	✓	86	0-10 cm layer 1 Soil moisture content	kg/m^2	Hourly instantaneous
✓	✓	86	0-100 cm top 1 meter Soil moisture content	kg/m^2	Hourly instantaneous
✓	✓	86	0-200 cm total column Soil moisture content	kg/m^2	Hourly instantaneous
✓	✓	86	10-40 cm layer 2 Soil moisture content	kg/m^2	Hourly instantaneous
✓	✓	86	40-100 cm layer 3 Soil moisture content	kg/m^2	Hourly instantaneous
✓	✓	86	100-200 cm layer 4 Soil moisture content	kg/m^2	Hourly instantaneous
✓	✓	235	Surface runoff (non-infiltrating)	kg/m^2	Hourly backward-accumulated
✓	✓	210	Transpiration	W/m^2	Hourly backward-averaged

MATLAB NetCDF/GRIB reader

Wildfire Data (1992 – 2009)
Summer season

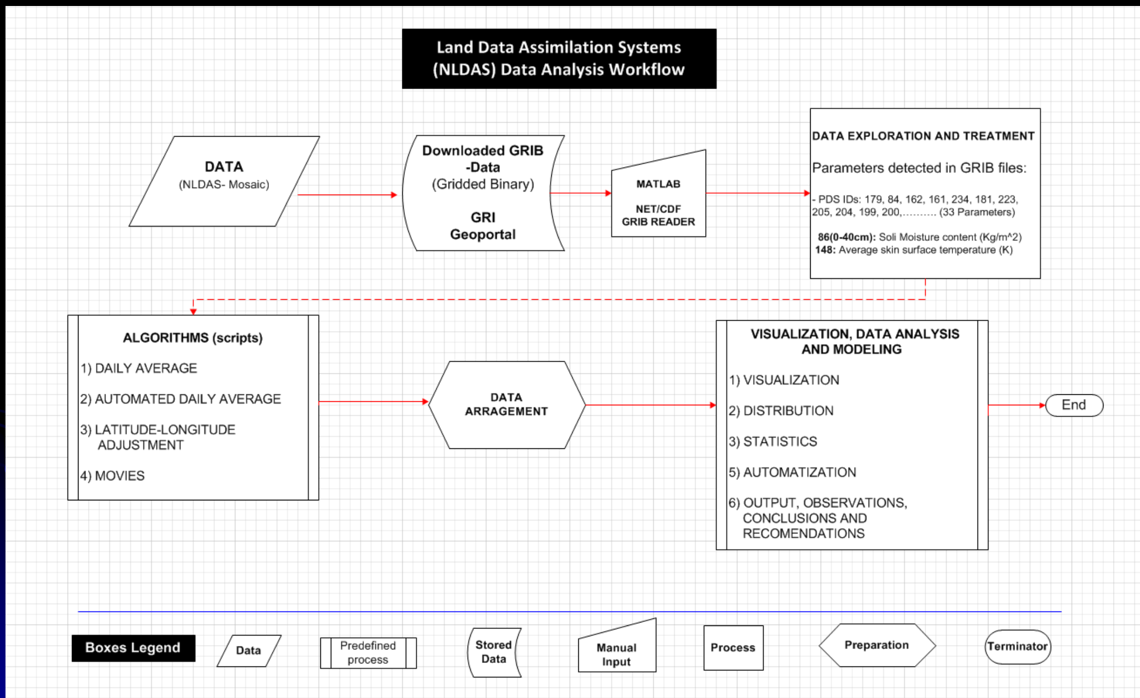
24,064 WF >= 15 acres

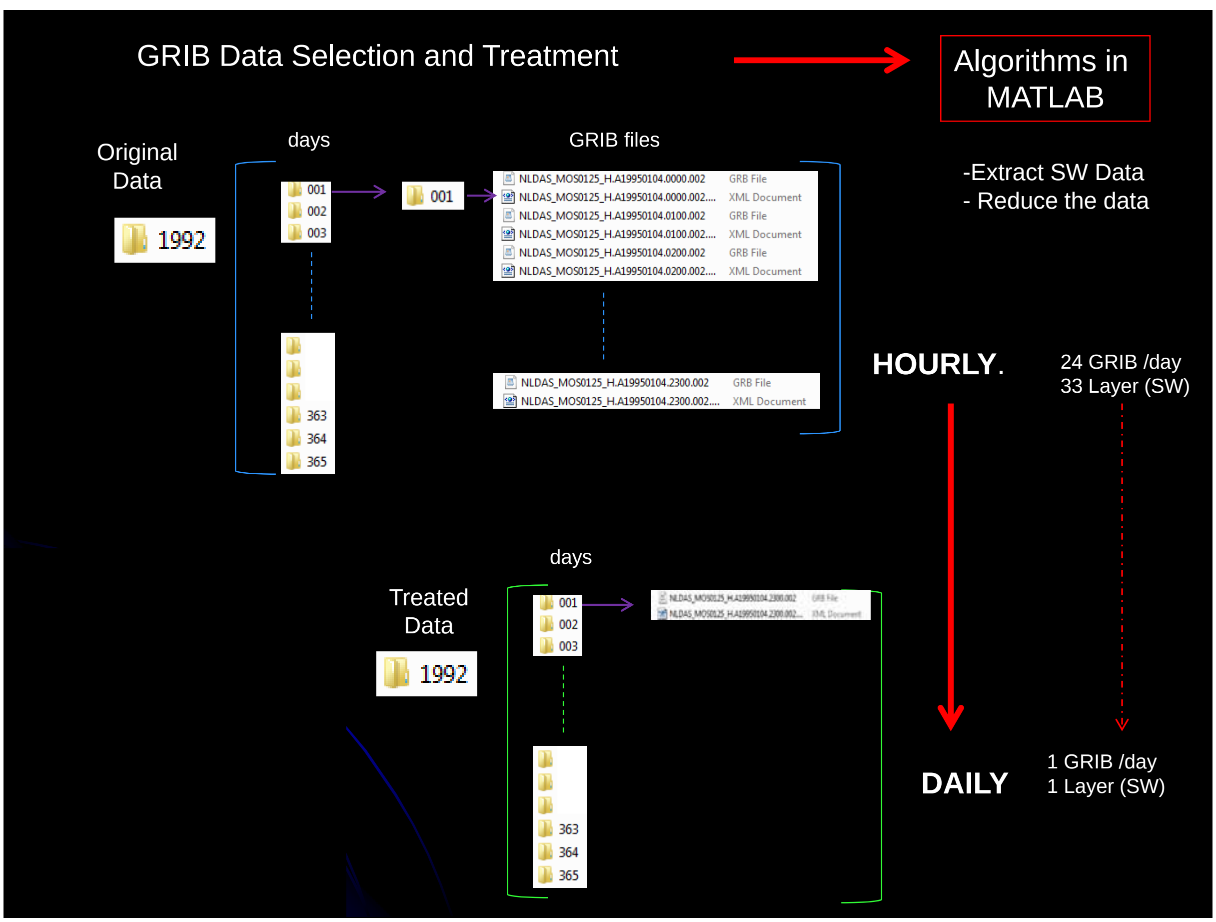




METHODS

METHODS


Land Data Assimilation Systems
(NLDAS) Data Analysis Workflow
DATA
(NLDAS- Mosaic)
Downloaded GRIB -Data
(Gridded Binary)
GRI
Geoportal
MATLAB
NET/CDF
GRIB READER
DATA EXPLORATION AND TREATMENT
Parameters detected in GRIB files:
- PDS IDs: 179, 84, 162, 161, 234, 181, 223, 205, 204, 199, 200,.......... (33 Parameters)
86(0-40cm): Soli Moisture content (Kg/m^2)
148: Average skin surface temperature (K)
ALGORITHMS (scripts)
1) DAILY AVERAGE
2) AUTOMATED DAILY AVERAGE
3) LATITUDE-LONGITUDE ADJUSTMENT
4) MOVIES
DATA ARRAGEMENT
VISUALIZATION, DATA ANALYSIS AND MODELING
1) VISUALIZATION
2) DISTRIBUTION
3) STATISTICS
5) AUTOMATIZATION
6) OUTPUT, OBSERVATIONS, CONCLUSIONS AND RECOMENDATIONS
End
Boxes Legend
Data
Predefined process
Stored Data
Manual Input
Process
Preparation
Terminator


GRIB Data Selection and Treatment
Algorithms in MATLAB
Original Data
1992
days
001
002
003
363
364
365
GRIB files
001
NLDAS_MOS0125_H.A19950104.0000.002 GRB File
NLDAS_MOS0125_H.A19950104.0000.002.... XML Document
NLDAS_MOS0125_H.A19950104.0100.002 GRB File
NLDAS_MOS0125_H.A19950104.0100.002.... XML Document
NLDAS_MOS0125_H.A19950104.0200.002 GRB File
NLDAS_MOS0125_H.A19950104.0200.002.... XML Document
NLDAS_MOS0125_H.A19950104.2300.002 GRB File
NLDAS_MOS0125_H.A19950104.2300.002.... XML Document
-Extract SW Data
- Reduce the data
HOURLY.
24 GRIB /day
33 Layer (SW)
Treated Data
1992
days
001
002
003
363
364
365
DAILY
1 GRIB /day
1 Layer (SW)

dailyAverage.m

```
function dailyAverage(dataSubFolder, dataDate, varName, varLevel)

dataSubFolder1 = strcat(dataSubFolder,'/');
mosiacDataPrefix = 'NLDAS_MOS0125_H.';
hourString = ['0000';'0100';'0200';'0300';'0400';'0500';...
              '0600';'0700';'0800';'0900';'1000';'1100';...
              '1200';'1300';'1400';'1500';'1600';'1700';...
              '1800';'1900';'2000';'2100';'2200';'2300'];

dataDate1 = strcat('A',dataDate,'.');
data_version = '002';
file_ext = '.grb';

[m,n] = size(hourString);

gridSize = 0.125;
longitudeBoundingBoxWest = -125.0;
longitudeBoundingBoxEast = -67.0;
latitudeBoundingBoxNorth = 53.0;
latitudeBoundingBoxSouth = 25.0;
jEnd = abs(longitudeBoundingBoxWest-longitudeBoundingBoxEast)/gridSize;
iEnd = abs(latitudeBoundingBoxNorth-latitudeBoundingBoxSouth)/gridSize;

longitudeBoundingNodeWest = -(gridSize/2.0)+longitudeBoundingBoxWest;
longitudeBoundingNodeEast = longitudeBoundingBoxEast+(gridSize/2.0);
latitudeBoundingNodeNorth = (gridSize/2.0)+latitudeBoundingBoxNorth;
latitudeBoundingNodeSouth = latitudeBoundingBoxSouth-(gridSize/2.0);


lon = (longitudeBoundingBoxWest-(gridSize/2.0)):gridSize:(longitudeBoundingBoxEast-(gridSize/2.0));
lat = (latitudeBoundingBoxSouth+(gridSize/2.0)):gridSize:(latitudeBoundingBoxNorth-(gridSize/2.0));



temp = zeros(jEnd,iEnd);

for k = 1:1:m

    dataSource = strcat(dataSubFolder1, mosiacDataPrefix,...
                        dataDate1, hourString(k),'.',...
                        data_version, file_ext);
    data1 = zeros(jEnd,iEnd);
    dataSource = char(dataSource);
    data2 = ndi_readfield(dataSource, '', varName);
    data1 = data2(:,:,varLevel);
    data1 = purgeData(data1(:,:));
    clear data2

    for j = 1:1:jEnd
        for i = 1:1:iEnd
            if ( isnan(data1(j,i)) == 0 )
                temp(j,i) = temp(j,i) + data1(j,i);
            end
        end
    end

    clear data1
    if ( k == 24 )
        temp = (1.0/24.0)*temp;
    end
end

mkdir(dataSubFolder1,'INFO')
%plotData(temp,'var86', varLevel);
disp(' ')
disp(strcat('=======> Writing out average of year and day: ',strcat(' A',dataDate)));
disp(' ')


disp('=======> Writing out average of points...');
disp(' ')
filename2 = strcat(dataSubFolder1,'INFO/', mosiacDataPrefix, dataDate,'_points.txt');
cfileName2 = char(filename2);
fileID2 = fopen(cfileName2, 'w');
fprintf(fileID2, '%d \n', temp(j,1) );
fprintf(fileID2, '%d \n', temp(273,57) );
fprintf(fileID2, '%d \n', temp(280,60) );
fprintf(fileID2, '%d \n', temp(274,59) );
fprintf(fileID2, '%d \n', temp(272,61) );
fprintf(fileID2, '%d \n', temp(279,59) );
fprintf(fileID2, '%d \n', temp(279,59) );
fprintf(fileID2, '%d \n', temp(272,55) );
fprintf(fileID2, '%d \n', temp(282,50) );
fprintf(fileID2, '%d \n', temp(280,53) );
fprintf(fileID2, '%d \n', temp(279,59) );
fprintf(fileID2, '%d \n', temp(281,52) );
fclose(fileID2);



myLongitudeTemp = longitudeBoundingNodeWest;
myLatitudeTemp = latitudeBoundingNodeNorth;

filename1 = strcat(dataSubFolder1,'INFO/', mosiacDataPrefix, dataDate, '_',varName,'_',int2str(varLevel),
fileID1 = fopen(filename1,'w');
for j = 1:1:jEnd
    myLongitudeTemp = myLongitudeTemp+gridSize;
    for i = 1:1:iEnd
        myLatitudeTemp = myLatitudeTemp-gridSize;
        if( j == 1 && i == 1 )
            fprintf(fileID1, 'Longitude\t Latitude\t Value\n');
        end
        fprintf(fileID1, '%d\t %d\t %d\t \n', myLongitudeTemp, myLatitudeTemp, temp(j,i) );
    end
    myLatitudeTemp = latitudeBoundingNodeNorth;
end

disp(' ')
disp('=======> Writing averaged lon && lat points...');


%collecting specified data
fileID3 = fopen('coordinates.txt', 'r');
fileData = textscan(fileID3, '%n %n');
[fileColumnLength, n] = size(fileData{1});

filename3 = strcat(dataSubFolder1,'INFO/', mosiacDataPrefix, dataDate, '_',varName,'_',int2str(varLevel),'_coordin
cfileName3 = char(filename3);
fileID4 = fopen(cfileName3, 'w');
for k = 1:1:fileColumnLength
    % location 1 in fileData for longitude, 2 for latitude
    if( k == 1 )
        fprintf(fileID4, 'Longitude\t Latitude\t Value\n');
    end

    %round array location up if needed
    j = int16(abs(longitudeBoundingNodeWest-(fileData{1}(k)))/gridSize);
    i = int16(abs(latitudeBoundingNodeNorth-(fileData{2}(k)))/gridSize);
    fprintf(fileID4, '%d\t %d\t %d\t \n', fileData{1}(k), fileData{2}(k), temp(j,i) );
end
disp('=======> done...');
disp(' ')

fclose(fileID3);
fclose(fileID4);
fclose(fileID1);
clear
end
```

automatedDailyAveragePerYear.m

```
function automatedDailyAveragePerYear(dataYearFolder, varriableOfInterest, varLevel)
%automatedDailyAveragePerYear('E:/LIS_DATA_2/2010', 'var86',1)

[a,b] = size(dataYearFolder);
dataYear = str2num(dataYearFolder(b-3:b)); %#ok<ST2NM>

if(mod(dataYear,400) == 0)
    feb = 29;
elseif(mod(dataYear,100) == 0)
    feb = 28;
elseif(mod(dataYear,4) == 0)
    feb = 29;
else
    feb = 28;
end

month = [31,feb,31,30,31,30,31,31,30,31,30,31];

    function returnString = strPrefix(value)
        if (value <= 9)
            returnString = strcat('0',int2str(value));
        else
            returnString = int2str(value);
        end
    end

% Possible stop (skip date without data)
for i = 1:1:sum(month(:))

    if ( i <= 9 )
        intString1 = int2str(i);
        intString2 = strcat('00',intString1);
        day = char(intString2);
    elseif(i <= 99)
        intString1 = int2str(i);
        intString2 = strcat('0',intString1);
        day = char(intString2);
    else
        intString2 = int2str(i);
        day = char(intString2);
    end

    if ( i <= sum(month(1:1)) )
        strMonth = '01';
        strDay = strPrefix(i);
    elseif(i > sum(month(1:1)) && i <= sum(month(1:2)) )
        strMonth = '02';
        strDay = strPrefix(i-sum(month(1:1)));
    elseif(i > sum(month(1:2)) && i <= sum(month(1:3)) )
        strMonth = '03';
        strDay = strPrefix(i-sum(month(1:2)));
    elseif(i > sum(month(1:3)) && i <= sum(month(1:4)) )
        strMonth = '04';
        strDay = strPrefix(i-sum(month(1:3)));
    elseif(i > sum(month(1:4)) && i <= sum(month(1:5)) )
        strMonth = '05';
        strDay = strPrefix(i-sum(month(1:4)));
    elseif(i > sum(month(1:5)) && i <= sum(month(1:6)) )
        strMonth = '06';
        strDay = strPrefix(i-sum(month(1:5)));
    elseif(i > sum(month(1:6)) && i <= sum(month(1:7)) )
        strMonth = '07';
        strDay = strPrefix(i-sum(month(1:6)));
    elseif(i > sum(month(1:7)) && i <= sum(month(1:8)) )
        strMonth = '08';
        strDay = strPrefix(i-sum(month(1:7)));
    elseif(i > sum(month(1:8)) && i <= sum(month(1:9)) )
        strMonth = '09';
        strDay = strPrefix(i-sum(month(1:8)));
    elseif(i > sum(month(1:9)) && i <= sum(month(1:10)) )
        strMonth = '10';
        strDay = strPrefix(i-sum(month(1:9)));
    elseif(i > sum(month(1:10)) && i <= sum(month(1:11)) )
        strMonth = '11';
        strDay = strPrefix(i-sum(month(1:10)));
    elseif(i > sum(month(1:11)) && i <= sum(month(1:12)) )
        strMonth = '12';
        strDay = strPrefix(i-sum(month(1:11)));
    end
    srtMonthDay = strcat(strMonth,strDay);
    dataSubFolder1 = strcat(dataYearFolder,'/',day);
    try
        dailyAverage(dataSubFolder1, strcat(int2str(dataYear),srtMonthDay), varriableOfInterest, varLevel);
    catch
        continue
    end
    disp('Last Evaluated Day is:')
    disp(srtMonthDay)
end
disp(strcat('Done with',dataYear));
end
```

AGGREGATED DATA = [Soil Moisture & Wildfires]

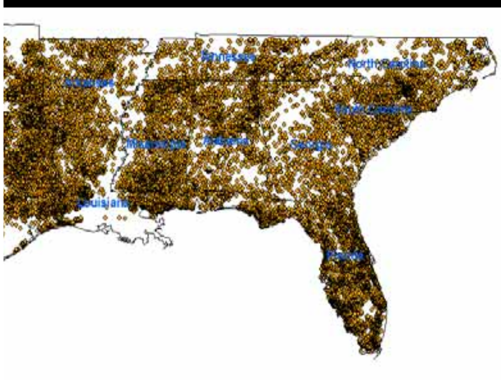
FIRE_SIZE	FIRE_SIZE_	FIRE_YEAR	DISCOVERY_	DISCOVERY1	DISCOVER	TAT_CAUS	STAT_CAU	FPU_NAM	LATITUDE	LONGITUDE	Lon_adj	Lat_adj	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
68.00	C	2000	7/25/2000	207	1500	1	Lightning	South Flo	25.21706500000	-81.10447600000	-81.0625	25.1875	148.73	148.73	148.84	149.02	149.12	149.14	149.14
20.00	C	1997	7/13/1997	194	1530	1	Lightning	South Flo	25.23735900000	-80.77741100000	-80.8125	25.1875	148.09	148.09	148.17	148.33	148.40	148.42	148.42
61.50	C	2006	7/17/2006	198	1800	1	Lightning	South Flo	25.28849600000	-80.64918500000	-80.6875	25.3125	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.10	C	2007	7/20/2007	201	1520	1	Lightning	South Flo	25.28890000000	-80.65360000000	-80.6875	25.3125	0.00	0.00	0.00	0.00	0.00	0.00	0.00
290.00	D	2003	7/25/2003	206	1525	1	Lightning	South Flo	25.29923000000	-80.72845000000	-80.6875	25.3125	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22.50	C	2002	9/1/2002	244	1615	1	Lightning	South Flo	25.32450500000	-80.72266400000	-80.6875	25.3125	0.00	0.00	0.00	0.00	0.00	0.00	0.00
118.00	D	2005	7/23/2005	204	1715	1	Lightning	South Flo	25.32730600000	-80.80923900000	-80.8125	25.3125	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1000.00	F	2000	6/7/2000	159		1	Lightning	South Flo	25.33810000000	-80.51690000000	-80.5625	25.3125	0.00	0.00	0.00	0.00	0.00	0.00	0.00
46.00	C	2002	9/1/2002	244	1615	1	Lightning	South Flo	25.34247800000	-80.78235300000	-80.8125	25.3125	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1046.00	F	1997	8/7/1997	219	1630	1	Lightning	South Flo	25.34506800000	-80.87228100000	-80.8125	25.3125	0.00	0.00	0.00	0.00	0.00	0.00	0.00
41.00	C	1998	6/30/1998	181	1100	1	Lightning	South Flo	25.34788400000	-80.71615900000	-80.6875	25.3125	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1509.00	F	2005	8/6/2005	218	1530	1	Lightning	South Flo	25.34952300000	-80.76003800000	-80.8125	25.3125	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2161.00	F	2003	8/18/2003	230	1430	1	Lightning	South Flo	25.35242900000	-80.55102300000	-80.5625	25.3125	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1300.00	F	2003	8/19/2003	231		1	Lightning	South Flo	25.35277998900	-80.54945002500	-80.5625	25.3125	0.00	0.00	0.00	0.00	0.00	0.00	0.00
250.00	D	2004	6/14/2004	166		7	Arson	South Flo	25.35277998900	-80.42055998400	-80.4375	25.3125	0.00	0.00	0.00	0.00	0.00	0.00	0.00
224.00	D	2001	6/22/2001	173	1700	1	Lightning	South Flo	25.35643400000	-80.73824400000	-80.6875	25.3125	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.80	C	1999	6/22/1999	173	1600	1	Lightning	South Flo	25.35889500000	-80.66756700000	-80.6875	25.3125	0.00	0.00	0.00	0.00	0.00	0.00	0.00
113.00	D	2000	9/7/2000	251	1515	1	Lightning	South Flo	25.35909000000	-80.87771100000	-80.9375	25.3125	0.00	0.00	0.00	0.00	0.00	0.00	0.00
81.00	C	1998	8/11/1998	223	1630	1	Lightning	South Flo	25.36431700000	-80.69783800000	-80.6875	25.3125	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1947.00	F	2000	6/7/2000	159	1630	1	Lightning	South Flo	25.36472000000	-80.51400500000	-80.5625	25.3125	0.00	0.00	0.00	0.00	0.00	0.00	0.00
500.00	E	2004	6/8/2004	160		1	Lightning	South Flo	25.36695000500	-80.40418999300	-80.4375	25.3125	0.00	0.00	0.00	0.00	0.00	0.00	0.00
322.00	E	1998	9/4/1998	247	1430	1	Lightning	South Flo	25.36847800000	-80.79411800000	-80.8125	25.3125	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1631.30	F	2005	8/21/2005	233	1245	1	Lightning	South Flo	25.37668500000	-80.79931900000	-80.8125	25.4375	0.00	0.00	0.00	0.00	0.00	0.00	0.00
300.00	D	2000	10/28/2000	302		2	Equipmer	South Flo	25.38000000000	-80.52000000000	-80.5625	25.4375	0.00	0.00	0.00	0.00	0.00	0.00	0.00
234.00	D	2007	6/24/2007	175	1614	1	Lightning	South Flo	25.38500000000	-80.73690000000	-80.6875	25.4375	0.00	0.00	0.00	0.00	0.00	0.00	0.00
337.00	E	2007	7/20/2007	201	1453	1	Lightning	South Flo	25.38940000000	-80.62880000000	-80.6875	25.4375	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22.00	C	2002	8/6/2002	218	1400	1	Lightning	South Flo	25.39209200000	-80.88634300000	-80.8125	25.4375	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20.00	C	2004	6/5/2004	157		9	Miscellan	South Flo	25.39639001600	-80.54945002500	-80.5625	25.4375	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24.00	C	1998	6/7/1998	158	1600	1	Lightning	South Flo	25.39709900000	-80.59271900000	-80.5625	25.4375	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35.00	C	2006	8/16/2006	228	1630	1	Lightning	South Flo	25.39823400000	-80.76648700000	-80.8125	25.4375	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50.00	C	1997	8/15/1997	227		1	Lightning	South Flo	25.40000000000	-80.52000000000	-80.5625	25.4375	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20.00	C	1996	11/29/1996	334		9	Miscellan	South Flo	25.40000000000	-80.52000000000	-80.5625	25.4375	0.00	0.00	0.00	0.00	0.00	0.00	0.00
210.00	D	1996	6/12/1996	164	1600	1	Lightning	South Flo	25.40022600000	-81.07151600000	-81.0625	25.4375	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20.00	C	2004	7/11/2004	193	1630	1	Lightning	South Flo	25.41544400000	-80.84112500000	-80.8125	25.4375	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100.00	D	2007	10/9/2007	282	1706	0		South Flo	25.41610000000	-80.56280000000	-80.5625	25.4375	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Data Size Reduction -→ Improve computation efficiency and storing

```
%% TUNING THE DATASET
%% 1. NOMINAL ARRAYS
% Four fields (UNIT_NAME, FIRE_SIZE_,
% STAT_CAU_1, FPU_NAME) have repeated categorical data. Then doing NOMINAL
% arrays should be will save space and create more efficiency at storing
% the repeated data and also the processess will be much faster for
% indexing and searching purposes.

datafull.UNIT_NAME = nominal(datafull.UNIT_NAME);
datafull.STAT_CAU_1 = nominal(datafull.STAT_CAU_1);
datafull.FPU_NAME = nominal(datafull.FPU_NAME);
% datafull variable ORIGINAL size is 18148094 bytes
% datafull variable NEW size is now 8410832 bytes (53.6% ORIGINAL size)

%% 2. ORDINAL ARRAYS
% It supplies the rating scale for "Wildfire Categories (C,D,E,F and G)"
% from lowest to highest (alphabetical order)

ratingScale = ...
    {'C','D','E','F','G'};
datafull.FIRE_SIZE_=ordinal(datafull.FIRE_SIZE_, [],ratingScale);

% datafull variable NEW size is now 6353762 bytes (68.5% ORIGINAL size)

%% CHANGE DATES into MATLAB numbers
 datafull.DISCOVERY_ = datenum(datafull.DISCOVERY_);

% datafull variable NEW size is now 2747004 bytes (84.86% ORIGINAL size)
```

STATISTICS & COMPUTATIONS OF INTEREST

-At each WF-event location
- Period: 1992-2009



- Mean, Median, Mode
- S.D.
- Water Deficit & Surplus
- SW Deficit
- SW lag values
- …
- Etc.

Example

1992

* WF event on day 234

* Location:
Latitude X
Longitude Y

SW mean

Day 233
1 1991
1 1992
1 1993
1 2009

Day 234
2 1991
2 1992
2 1993
2 2009

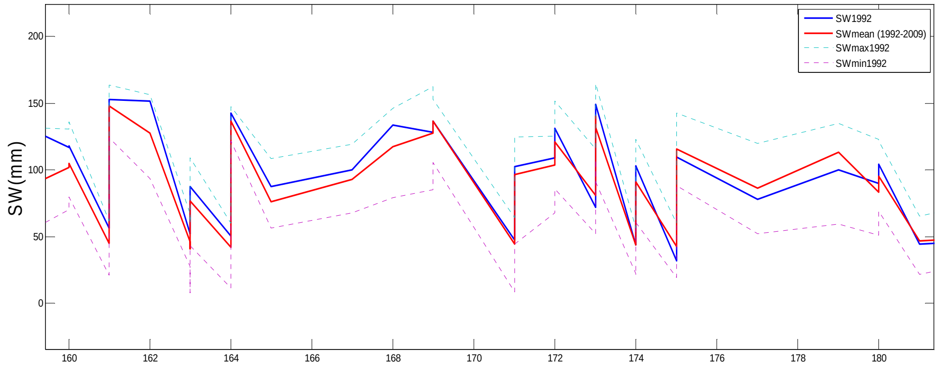
1991-2009

SW- value of Day 234 1992

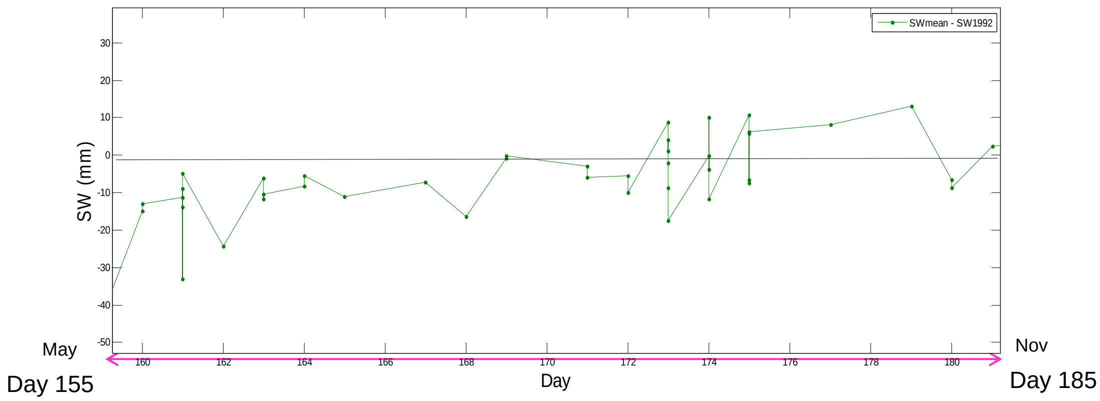
↔

SW – mean of day 234 1992-2009

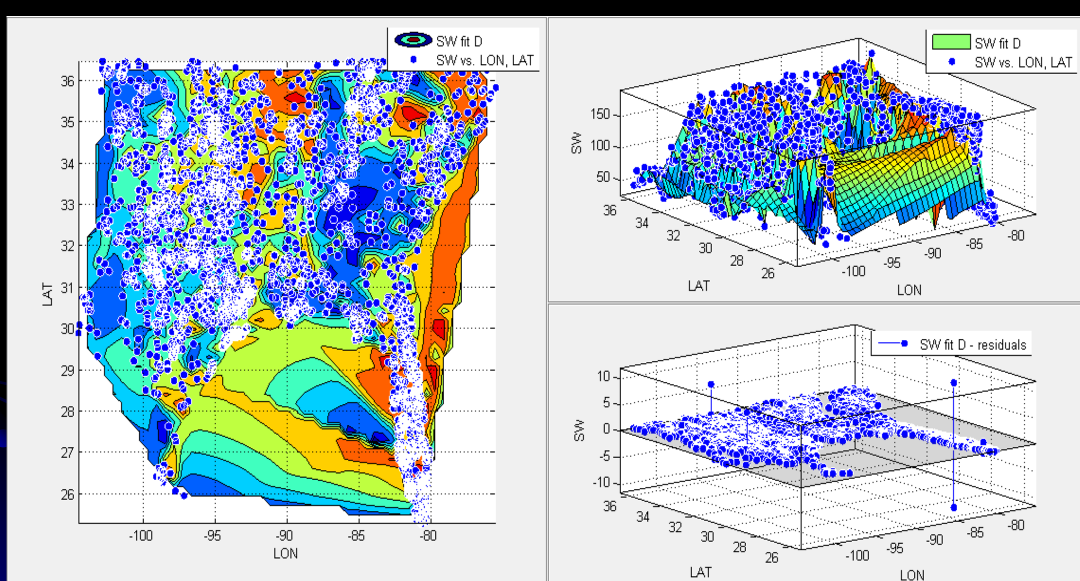
SW-1992 vs. SW-mean (1992:2009)



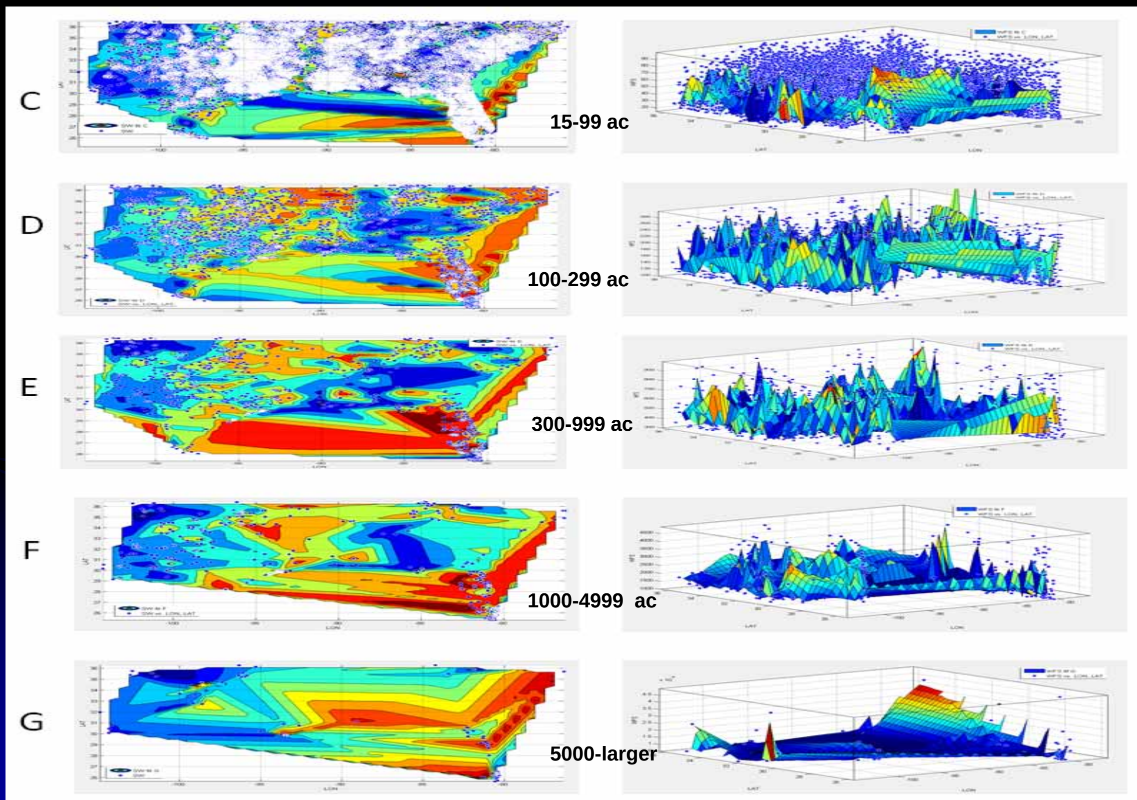
SW-1992 Deficit and Surplus

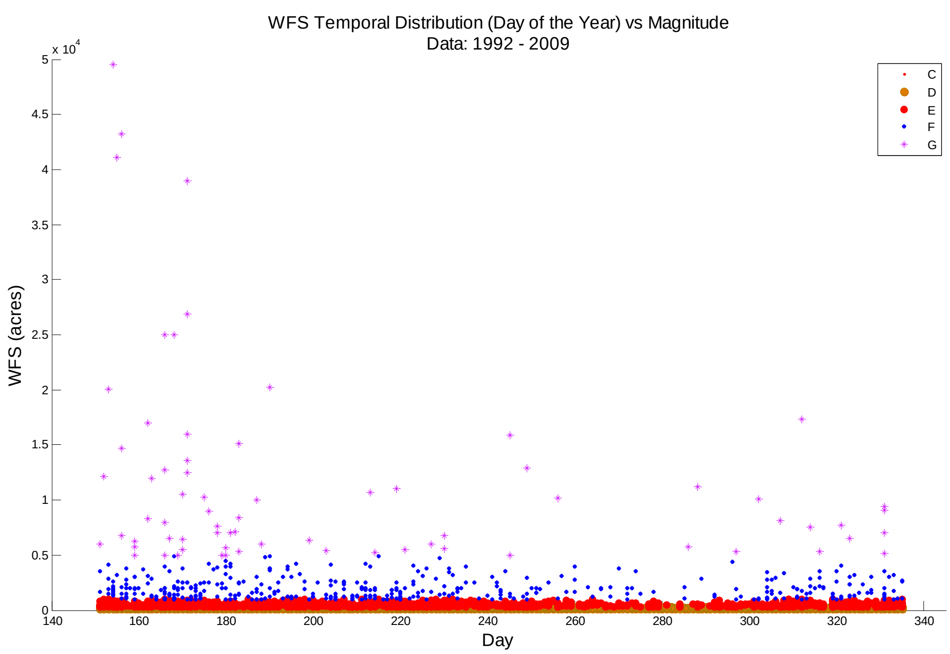


WF-events and Soil Moisture (SW) : 1992-2009
WFS-Category: D

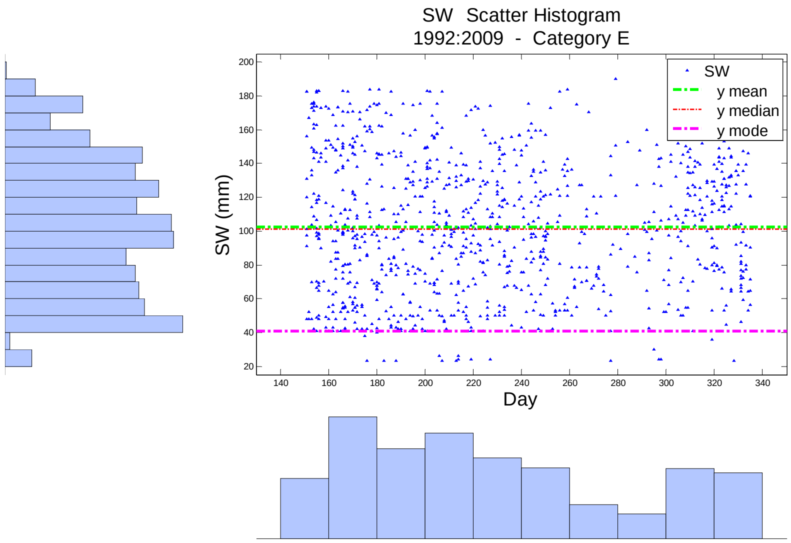


WF Events Location 1992-2009 WFS (acres)



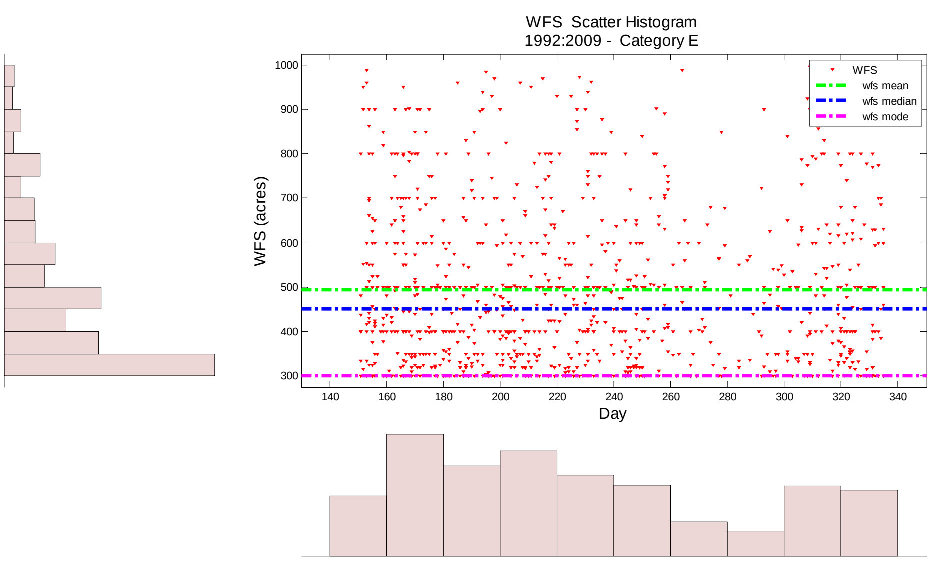


Soil Moisture (SW) mm

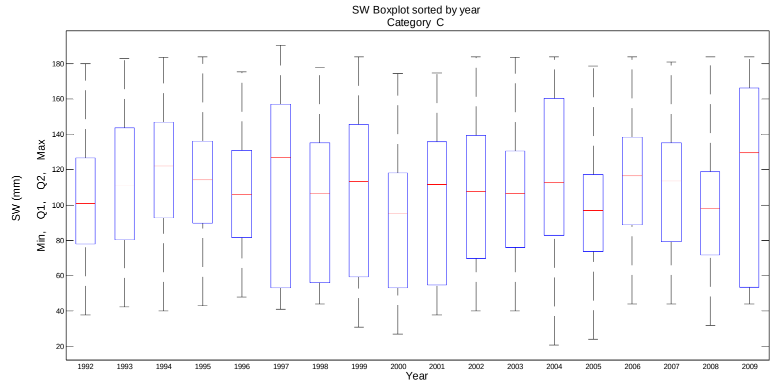


- In all Categories the SW-mode is significant lower than the mean and median those are relatively close.
- Most of the WF occurred when SW-level was low.

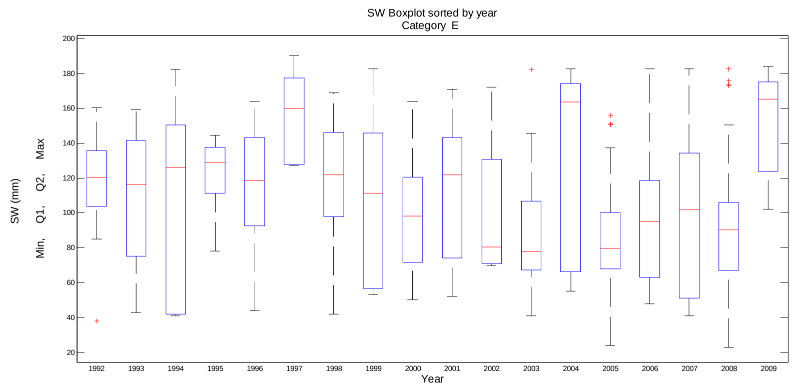
Wildfire Size (WFS) acres



SW Boxplots

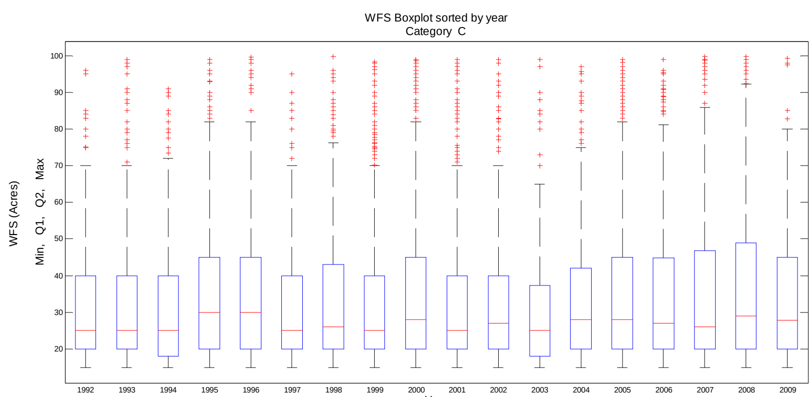


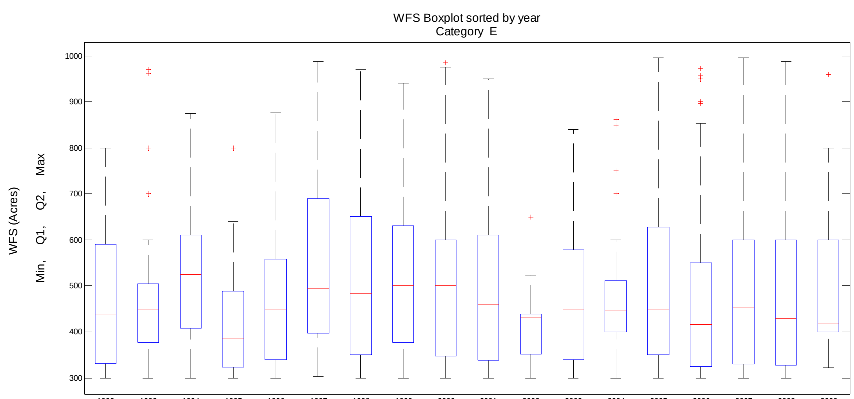
C



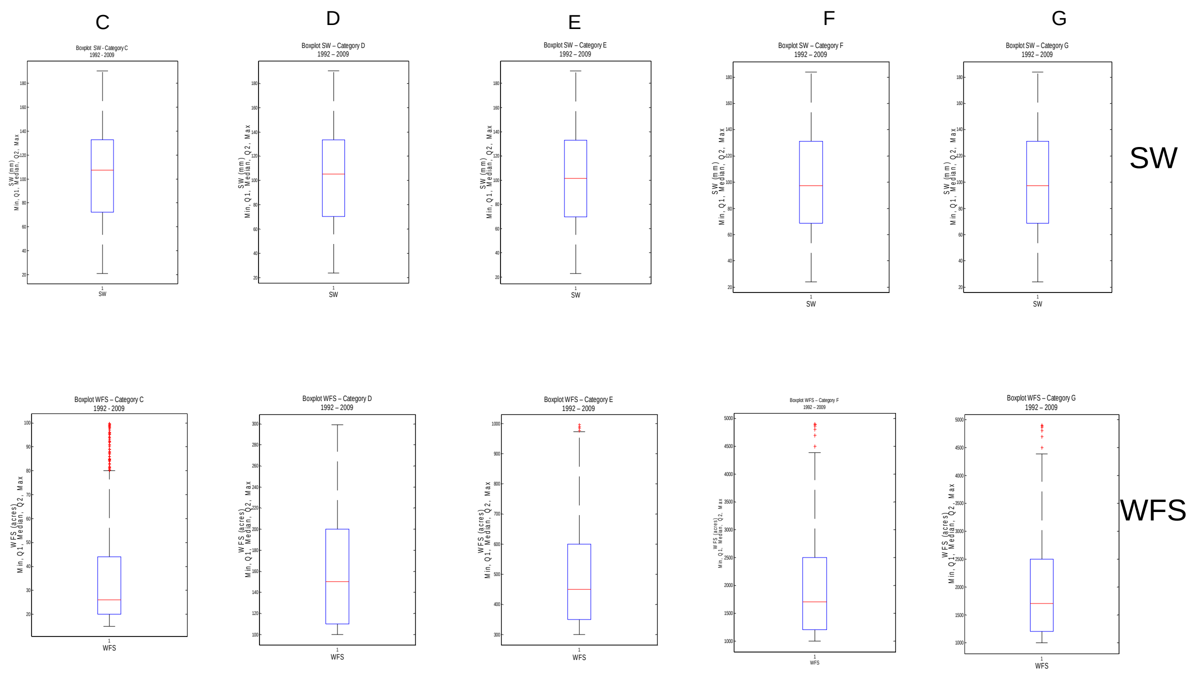
E

WFS Boxplots

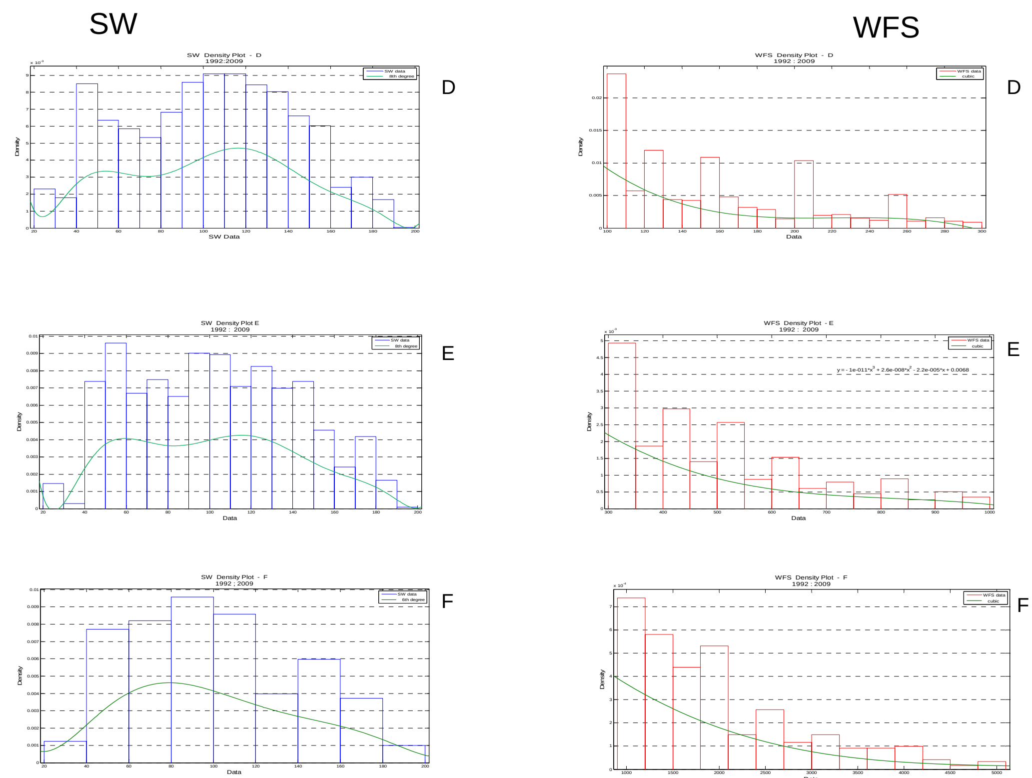




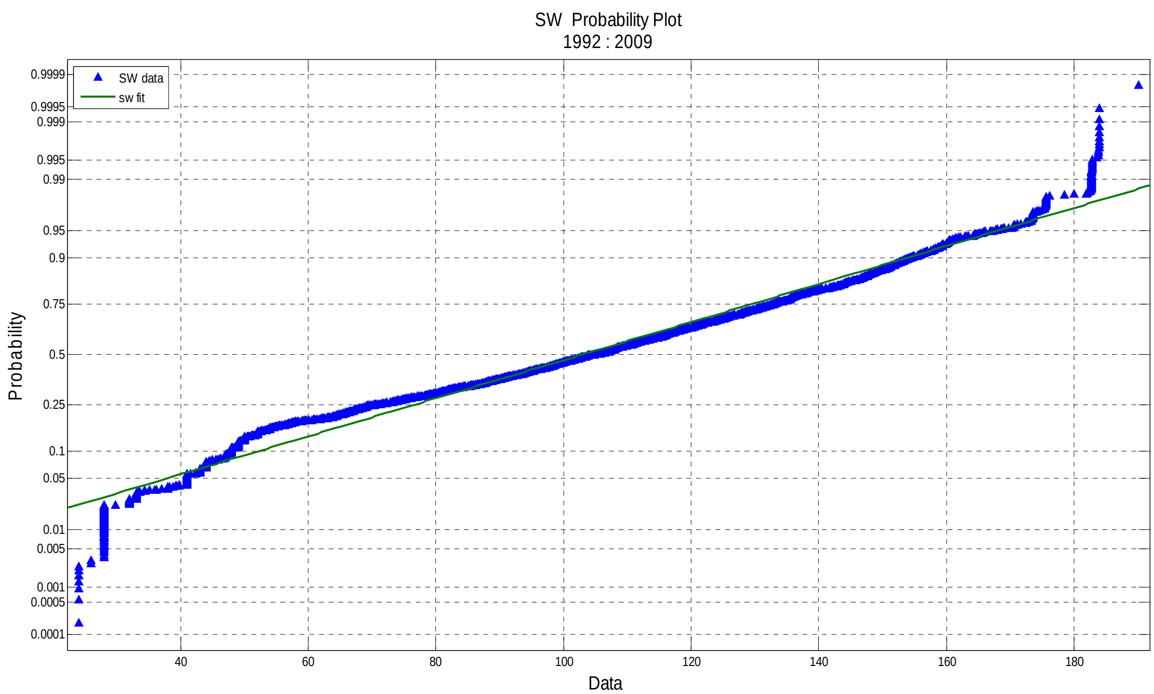
SW and WFS
Box plots (Data:1992-2009)



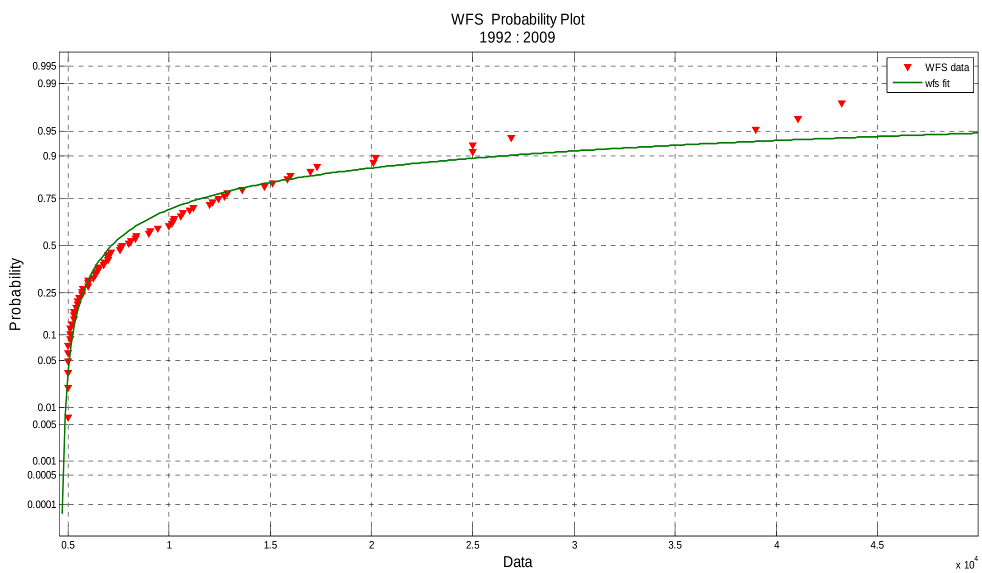
Density Plots Tendency



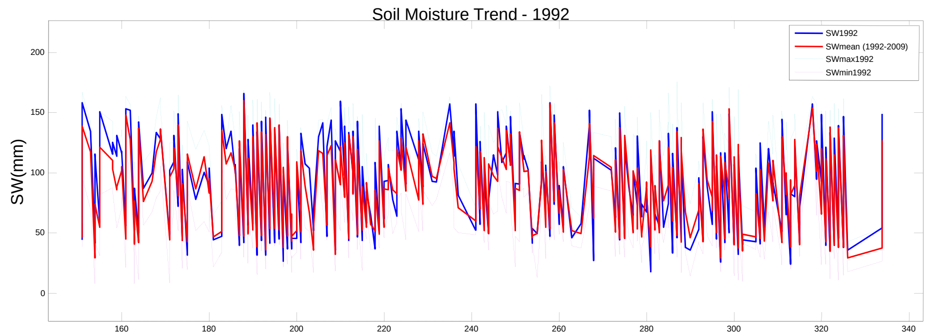
SW Probability Plot – Category C



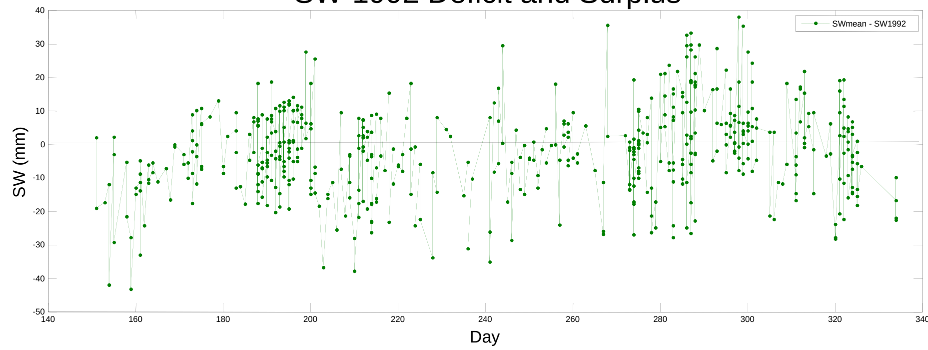
WFS Probability Plot - Category E



SW-1992 vs. SW-mean (1992:2009)



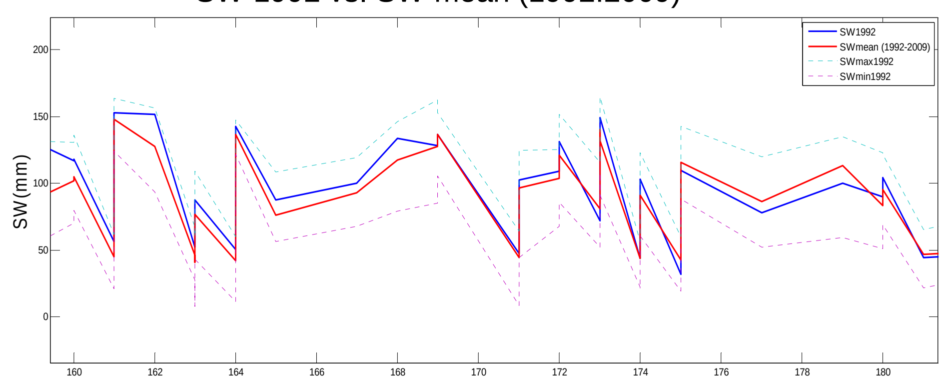
SW-1992 Deficit and Surplus



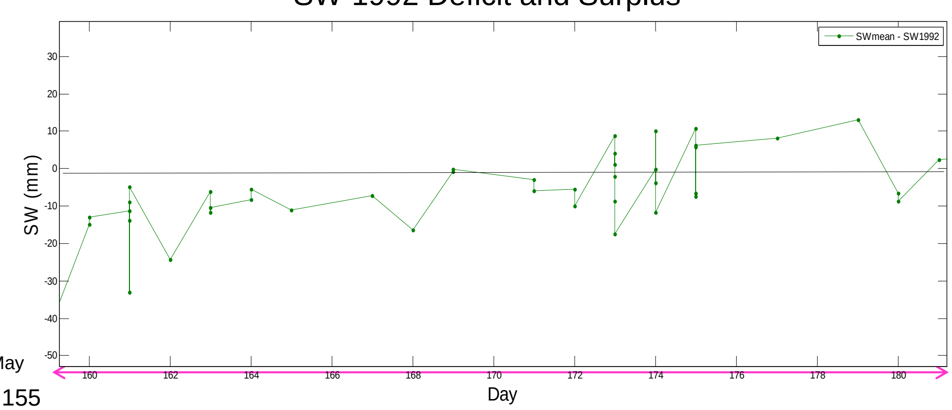
May
Day 140

Nov
Day 340

SW-1992 vs. SW-mean (1992:2009)

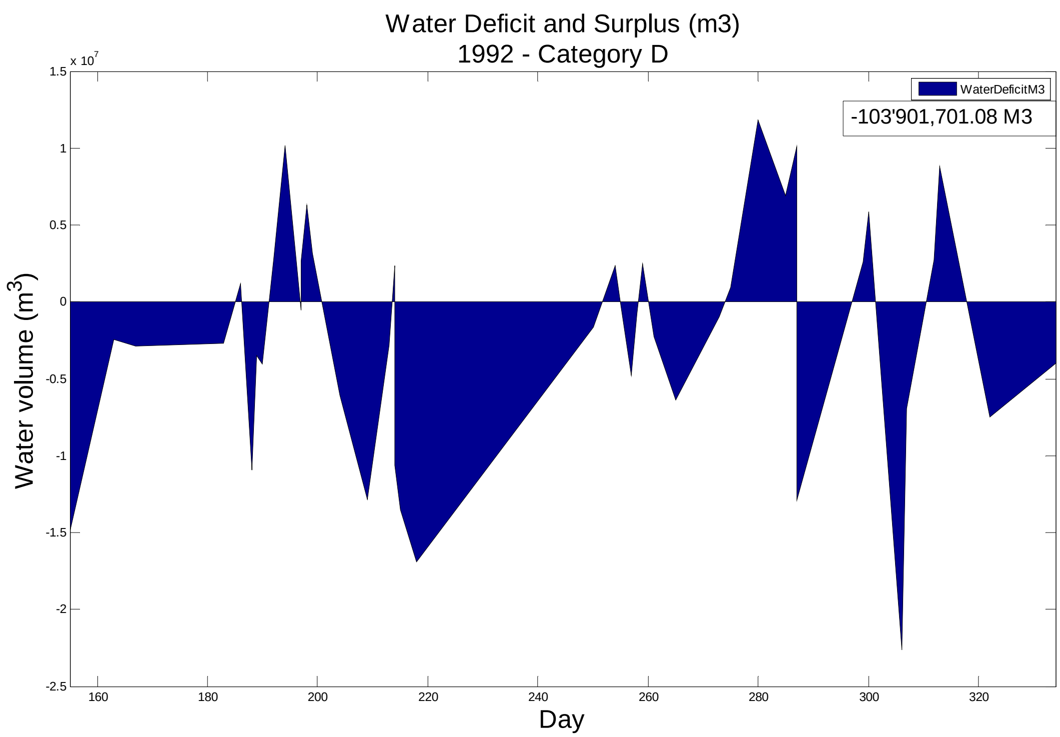


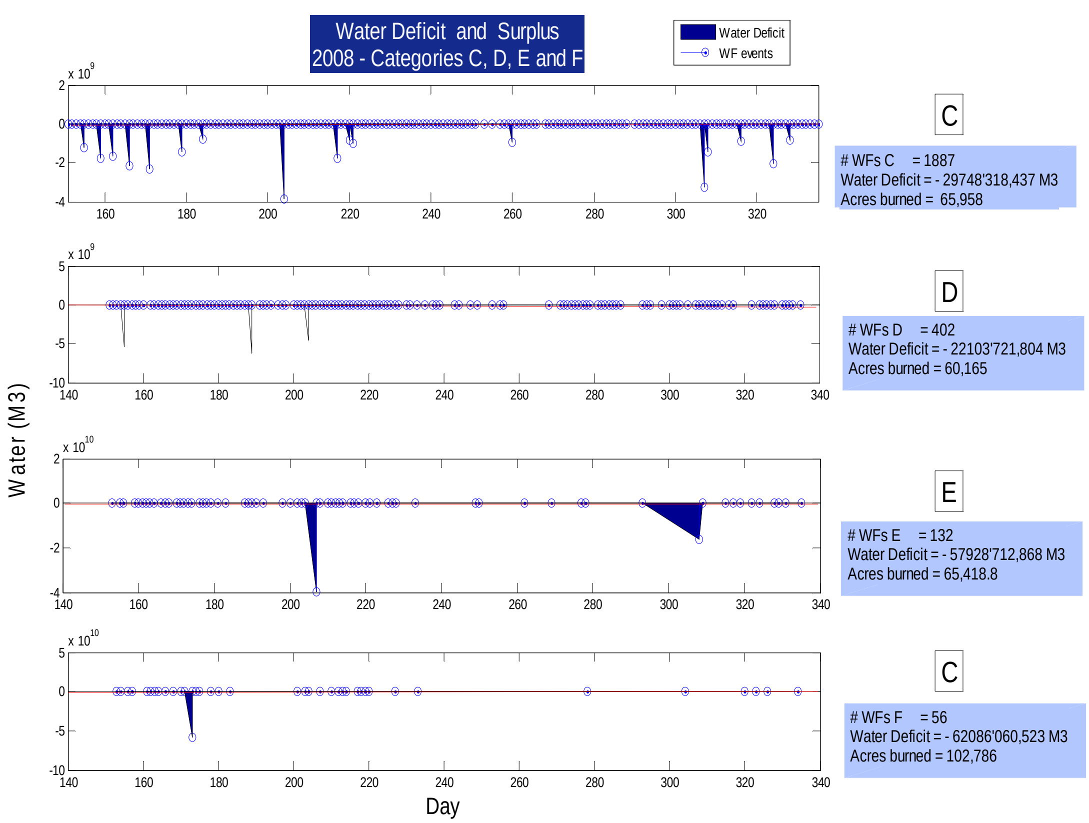
SW-1992 Deficit and Surplus



May
Day 155

Nov
Day 185


Water Deficit and Surplus (m3)
1992 - Category D
WaterDeficitM3
-103'901,701.08 M3
Water volume (m3)
x 10^7
Day


Water Deficit and Surplus
2008 - Categories C, D, E and F
Water Deficit
WF events
Water (M3)
Day
C
WFs C = 1887
Water Deficit = - 29748'318,437 M3
Acres burned = 65,958
D
WFs D = 402
Water Deficit = - 22103'721,804 M3
Acres burned = 60,165
E
WFs E = 132
Water Deficit = - 57928'712,868 M3
Acres burned = 65,418.8
C
WFs F = 56
Water Deficit = - 62086'060,523 M3
Acres burned = 102,786

Soil Moisture -SW- (mm) -1992:2009							
Category	*Min*	*max*	*mean*	*median*	*mode*	*std*	*range*
C	21.0	190.2	102.3	107.6	44.0	41.0	169.2
D	24.0	190.0	103.0	105.2	28.0	39.6	166.2
E	23.0	190.2	102.2	101.0	41.0	39.5	167.2
F	24.0	183.0	100.0	97.3	44.0	39.5	159.9
G	42.5	182.5	95.7	85.7	84.0	34.8	140.0

Wildfire and Wildfire-size -WFS (acres) - 1992:2010									
Category	*Min*	*max*	*mean*	*median*	*mode*	*std*	*range*	*No Wildfires*	*Acres burned*
C	15.0	99.7	34.0	26.0	15.0	19.8	84.7	19965.0	678728.0
D	100.0	299.0	156.0	150.0	100.0	52.5	199.0	2737.0	427950.0
E	300.0	995.0	493.0	450.0	300.0	177.1	695.0	1030.0	508229.0
F	1000.0	4900.0	1955.0	1700.0	1000.0	92939.0	3900.0	402.0	785838.0
G	5000.0	49500.0	11320.0	7680.0	5000.0	9279.0	44500.0	73.0	355648.0

What's Next [SW-GRIB + WF] analysis?

- Aggregate Soil data to current data to evaluate the relationship among SW, WF and soil characteristics (soil type, hydrologic groups, etc)
- Aggregate Landcover data to current the relationship among Landcover vigor, SW and WF-events.

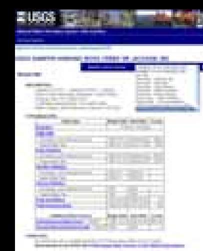
WATERSHED ASSESSMENT OVERVIEW

WATERSHED ASSESSMENT

D E M

Weather

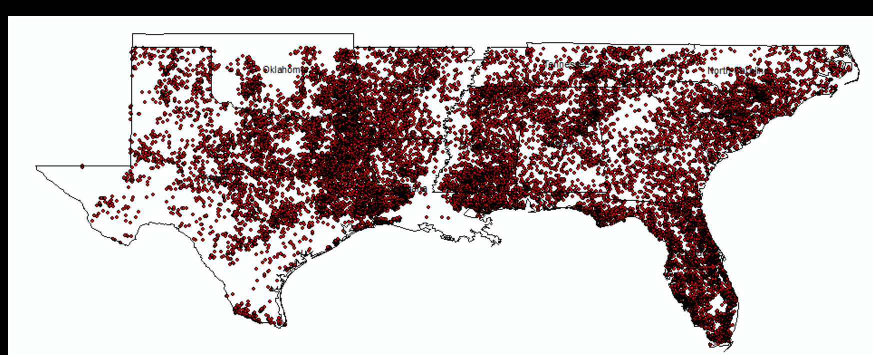
Landcover



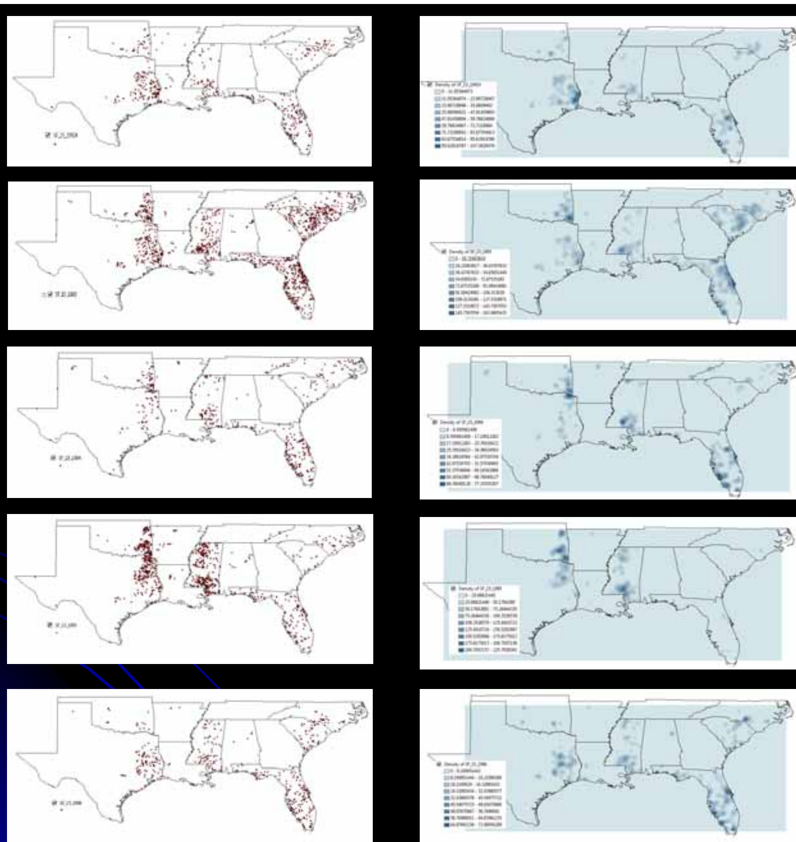
Soil

Water Drainage (gauges)

Criteria to select the Areas to evaluate



WF-events Density maps



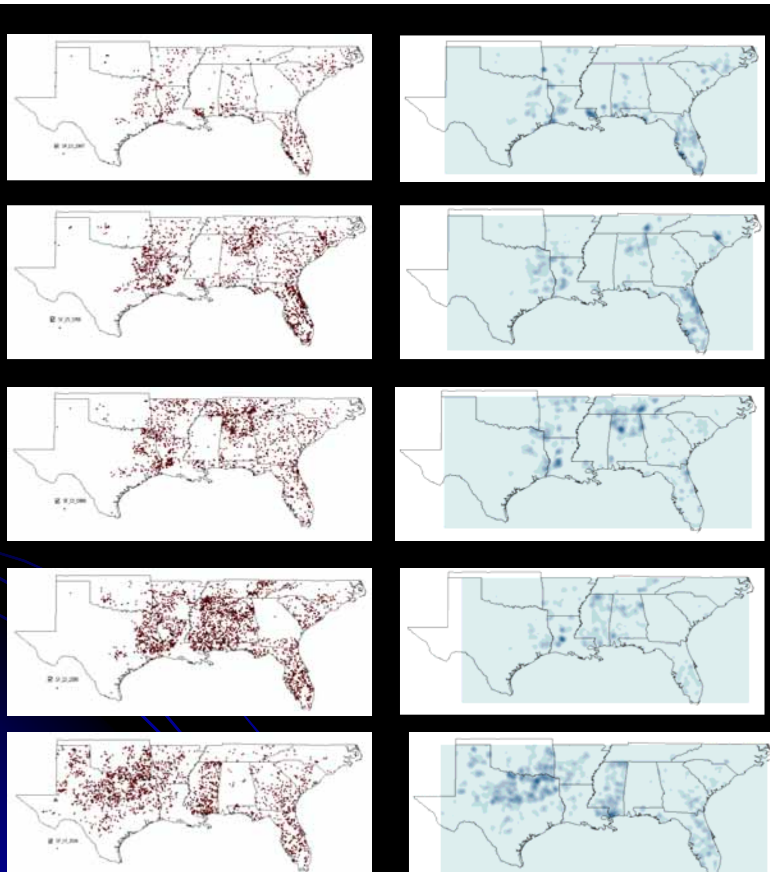
1992
471 WF

1993
1386 WF

1994
456 WF

1995
1070 WF

1996
476 WF



1997
819 WF

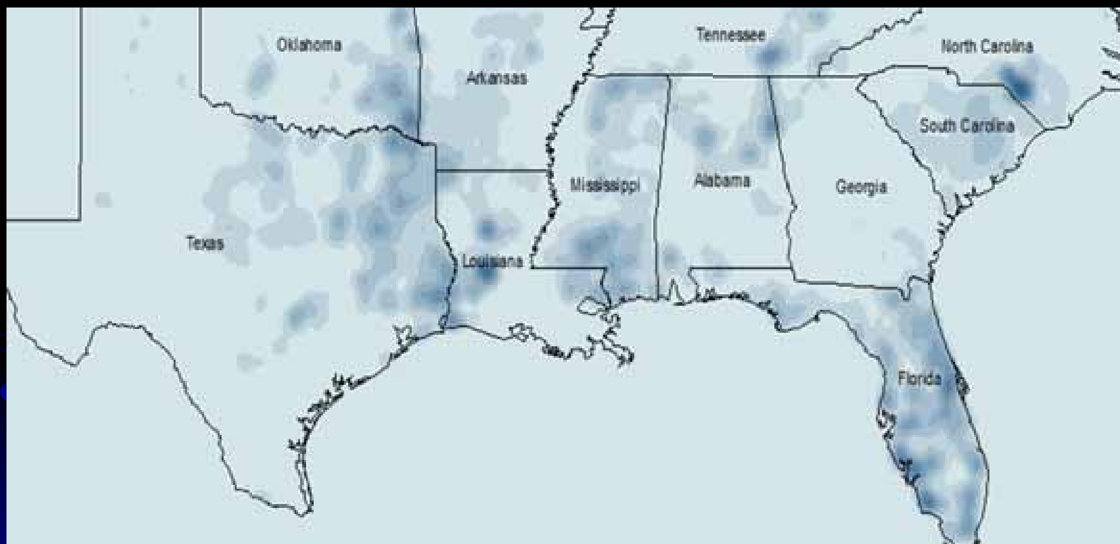
1998
2050 WF

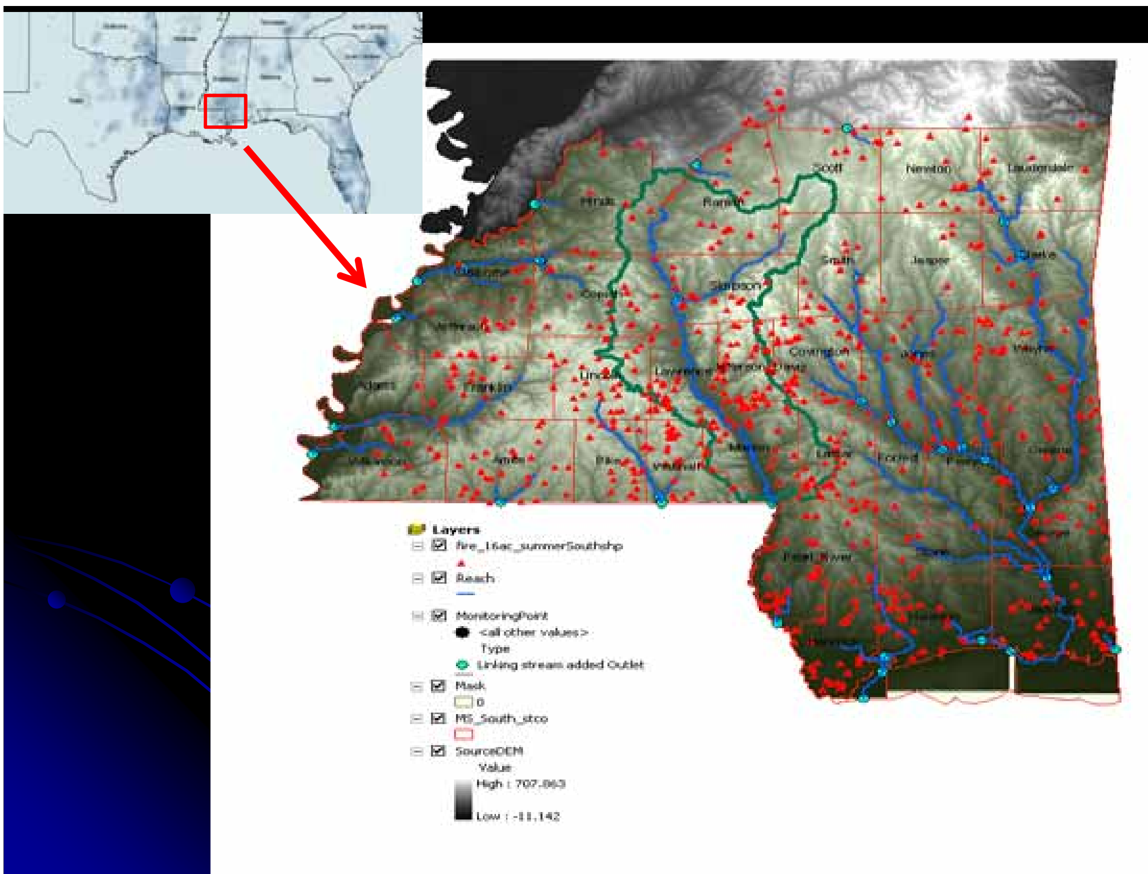
1999
1966 WF

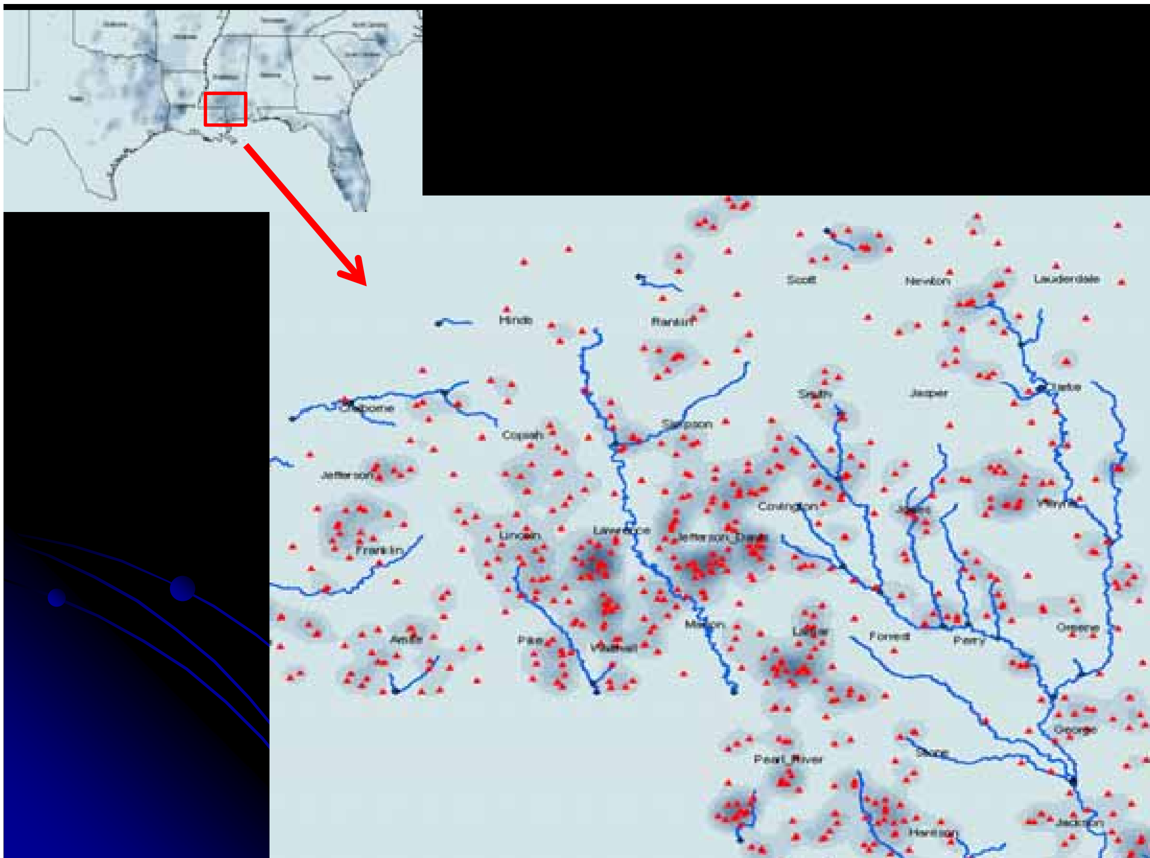
2000
3176 WF

2006
2723 WF

Wildfire-events Density Plot (1992-2009)



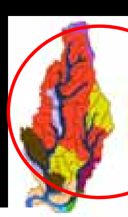


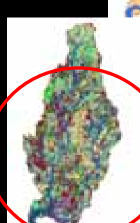


Watershed Parameter Computations

INPUT

SOIL





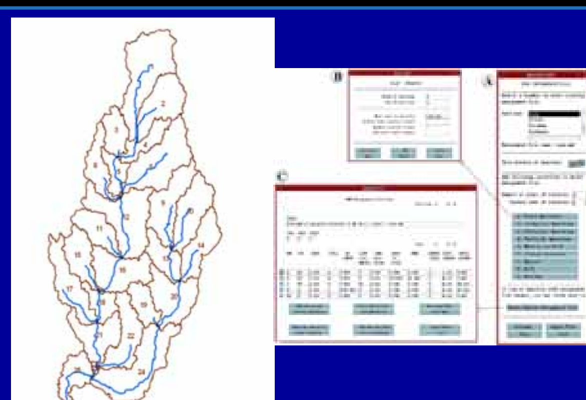
LANDCOVER

WEATHER

DEM

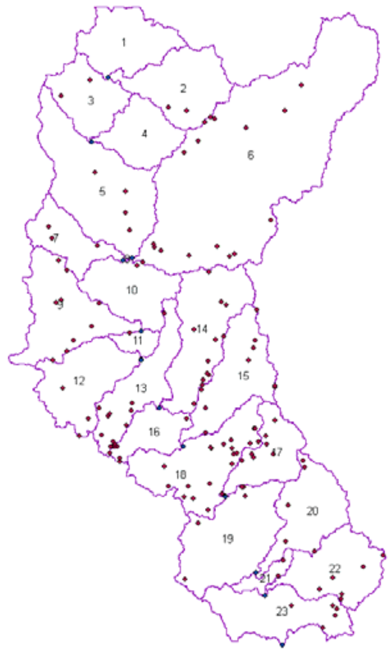
Soil & Water Assessment Tool SWAT

OUTPUT



Eduardo Arias

Summer Wildfires>= 15 ac and Subbasins
Temporal scale: 1992 - 2009



HYDROLOGICAL PARAMETERS COMPUTED	
Variable name	**Definition**
SUB	Subbasin number.
GIS	GIS code reprinted from watershed configuration file (.fig). See explanation of subbasin command.
MON	Daily time step: the julian date, Monthly time step: the month (1-12), Annual time step: 4-digit year, Average annual summary lines: number of years averaged together
AREA	Area of the subbasin (km2).
PRECIP	Total amount of precipitation falling on the subbasin during time step (mm H2O).
SNOMELT	Amount of snow or ice melting during time step (water-equivalent mm H2O).
PET	Potential evapotranspiration from the subbasin during the time step (mm H2O).
ET	Actual evapotranspiration from the subbasin during the time step (mm).
SW	Soil water content (mm). Amount of water in the soil profile at the end of the time period.
PERC	Water that percolates past the root zone during the time step (mm). There is potentially a lag between the time the water leaves the bottom of the root zone and reaches the shallow aquifer. Over a long period of time, this variable should equal groundwater
SURQ	Surface runoff contribution to streamflow during time step (mm H2O).
GW_Q	Groundwater contribution to streamflow (mm). Water from the shallow aquifer that returns to the reach during the time step.
WYLD	Water yield (mm H2O). The net amount of water that leaves the subbasin and contributes to streamflow in the reach during the time step. (WYLD = SURQ + LATQ + GWQ – TLOSS – pond abstractions)
SYLD	Sediment yield (metric tons/ha). Sediment from the subbasin that is transported into the reach during the time step.
ORGN	Organic N yield (kg N/ha). Organic nitrogen transported out of the subbasin and into the reach during the time step.
ORGP	Organic P yield (kg P/ha). Organic phosphorus transported with sediment into the reach during the time step.
NSURQ	NO3 in surface runoff (kg N/ha). Nitrate transported by the surface runoff into the reach during the time step.
SolP	Soluble P yield (kg P/ha). Phosphorus that is transported by surface runoff into the reach during the time step.
SEDP	Mineral P yield (kg P/ha). Mineral phosphorus attached to sediment that is transported by surface runoff into the reach during the time step.

Summer Wildfires>= 15 ac and Subbasins
Temporal scale: 1992 - 2009

HYDROLOGICAL PARAMETERS COMPUTED	
Variable name	**Definition**
SUB	Subbasin number.
GIS	GIS code reprinted from watershed configuration file (.fig). See explanation of subbasin command.
MON	Daily time step: the julian date, Monthly time step: the month (1-12), Annual time step: 4-digit year, Average annual summary lines: number of years averaged together
AREA	Area of the subbasin (km2).
PRECIP	Total amount of precipitation falling on the subbasin during time step (mm H2O).
SNOMELT	Amount of snow or ice melting during time step (water-equivalent mm H2O).
PET	Potential evapotranspiration from the subbasin during the time step (mm H2O).
ET	Actual evapotranspiration from the subbasin during the time step (mm).
SW	Soil water content (mm). Amount of water in the soil profile at the end of the time period.
PERC	Water that percolates past the root zone during the time step (mm). There is potentially a lag between the time the water leaves the bottom of the root zone and reaches the shallow aquifer. Over a long period of time, this variable should equal groundwate
SURQ	Surface runoff contribution to streamflow during time step (mm H2O).
GW_Q	Groundwater contribution to streamflow (mm). Water from the shallow aquifer that returns to the reach during the time step.
WYLD	Water yield (mm H2O). The net amount of water that leaves the subbasin and contributes to streamflow in the reach during the time step. (WYLD = SURQ + LATQ + GWQ – TLOSS – pond abstractions)
SYLD	Sediment yield (metric tons/ha). Sediment from the subbasin that is transported into the reach during the time step.
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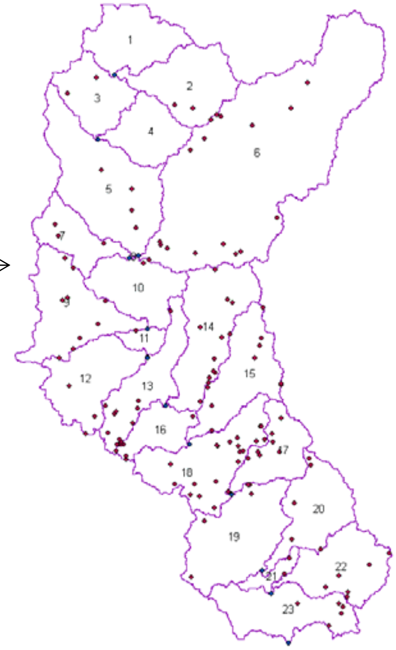
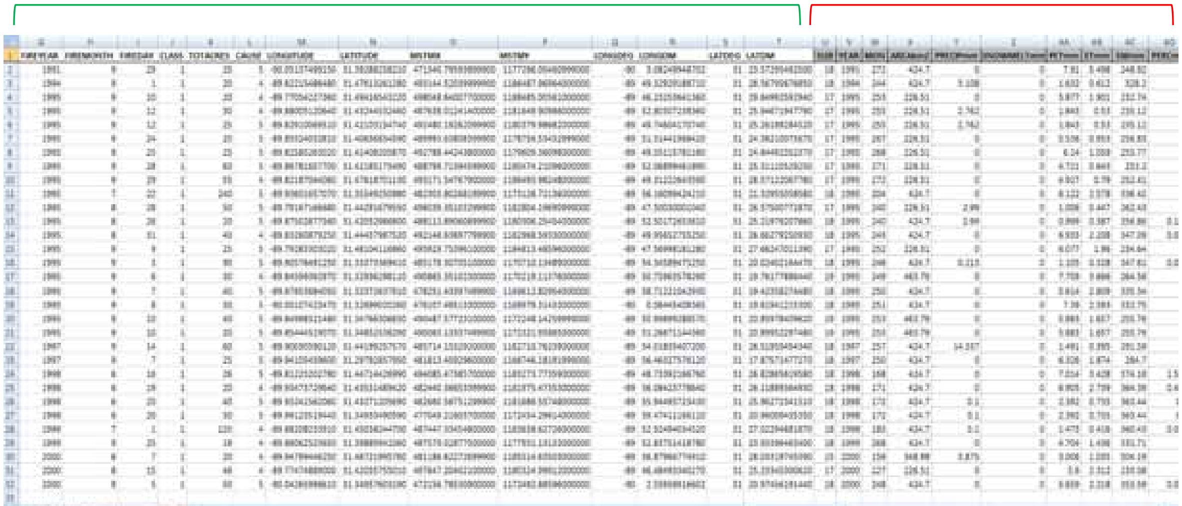


Aggregated Data

Wildfire data:

SW -SWAT output:
Concatenated by Date and Subbasin

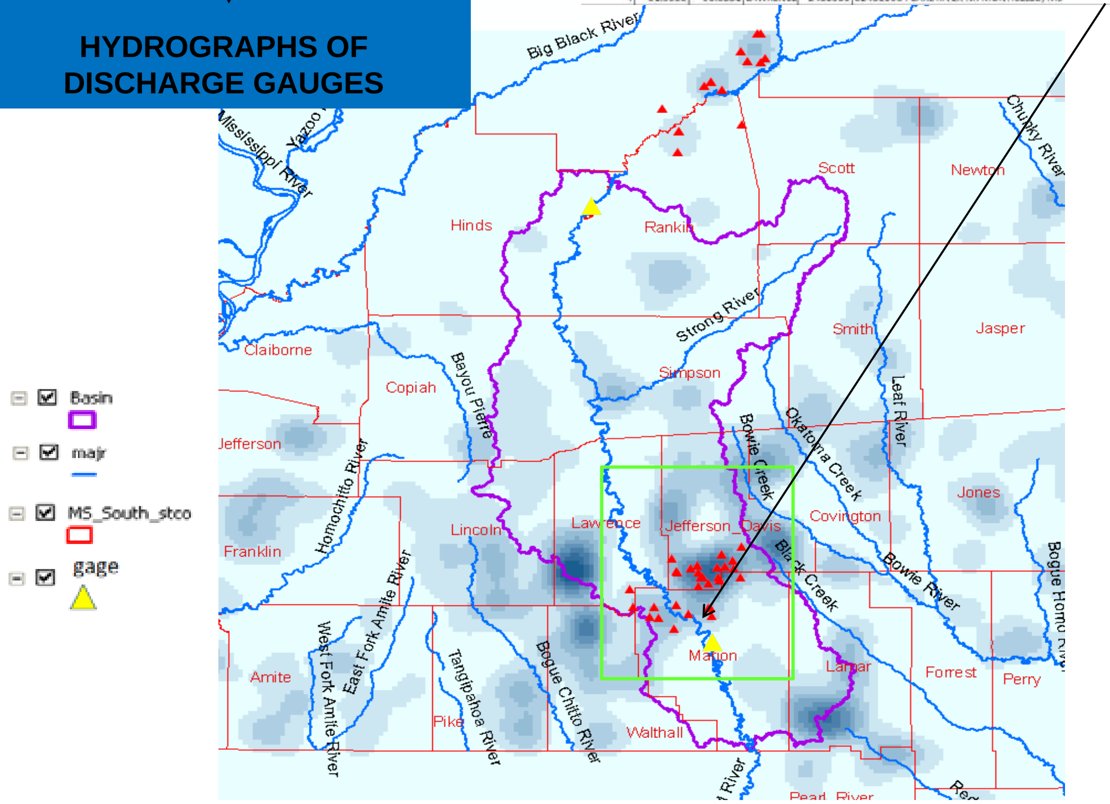


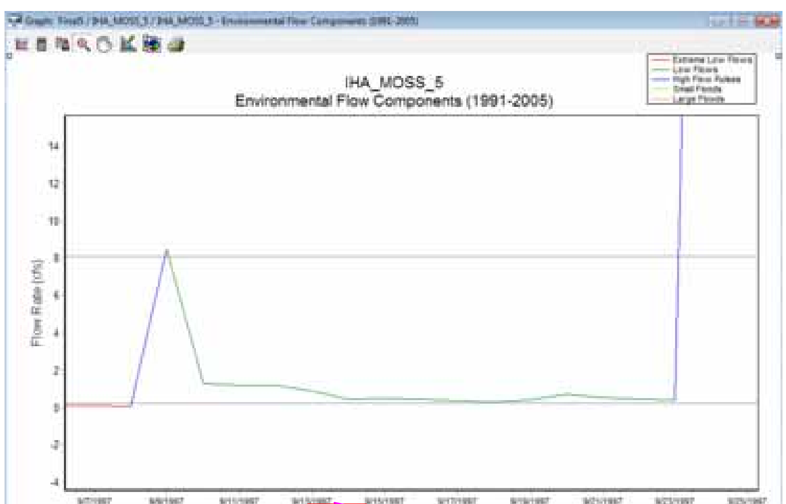
Indicators Hydrology Alterations

↓

HYDROGRAPHS OF DISCHARGE GAUGES

FID	X	Y	COUNTY	INFO	GAGE NAME
1	32.365	-90.1447	HINDS	2485700	02485700HANGING MOSS CREEK NR JACKSON, MS
2	32.2847	-90.215	HINDS	2486100	02486100 LYNCH CREEK AT JACKSON, MS
3	31.2378	-89.8469	MARION	2489000	02489000 PEARL RIVER NR COLUMBIA, MS
4	31.5533	-90.0881	LAWRENCE	2488500	02488500 PEARL RIVER NR MONTICELLO, MS

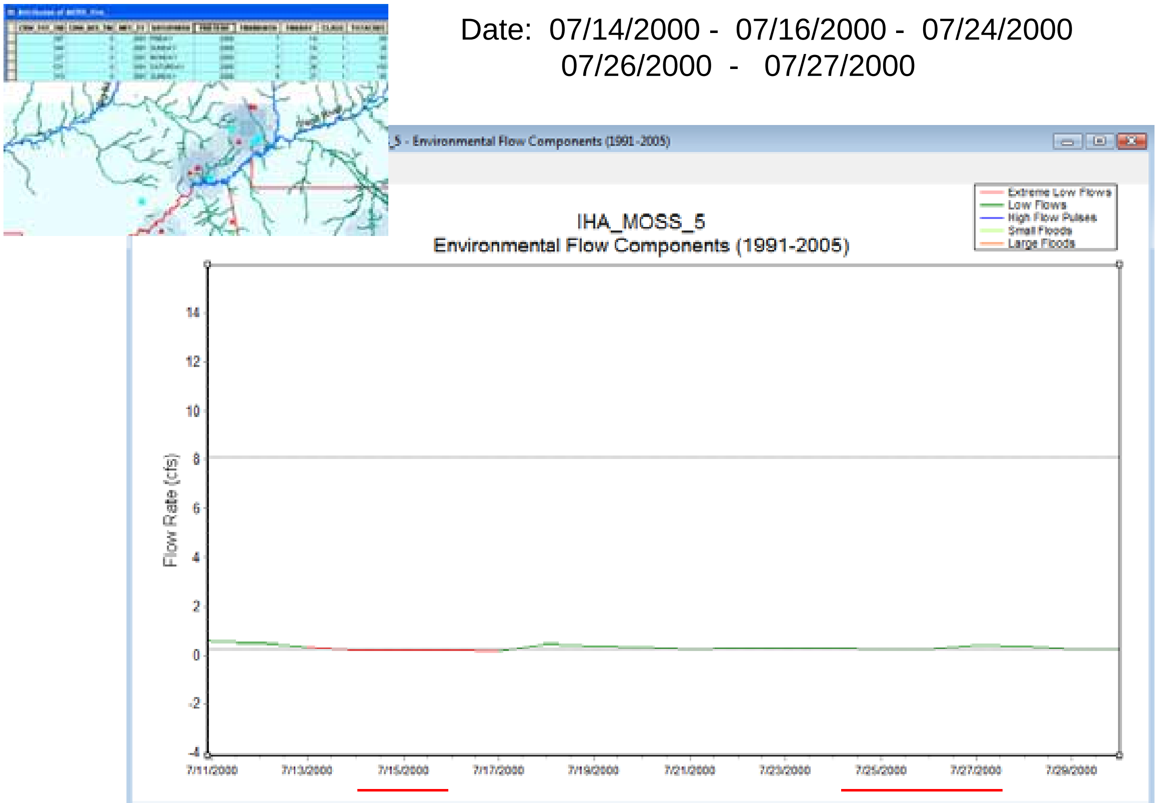




Date: 09/14/1997

Wildfire location

Date: 07/14/2000 - 07/16/2000 - 07/24/2000
07/26/2000 - 07/27/2000



Preliminary Conclusions

- Soil moisture content (SW) have significant influence in the occurrences of wildfires/
- SW does not have direct influence in the wildfires size; the values of SW do not vary significantly at any of the WFS categories.
- The number of “small wildfires” (WF) occurrences is significantly larger than the number of “large WF” but the summation of acres-burned and damage generated by large WF regularly is larger than smaller WF.
- The frequency of “small” WF-event is larger than the frequency of “large” WF-event in all of the WFS-categories (C, D, E, F and G).

- Hydrographs and Environmental flow components show that most of the WF occurred after a decreasing SW-lag period.

- The standard deviation observed during the period study show that the values at each WF-location do not vary significantly.

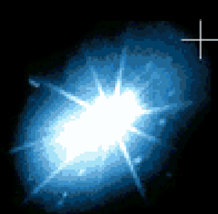
Further study

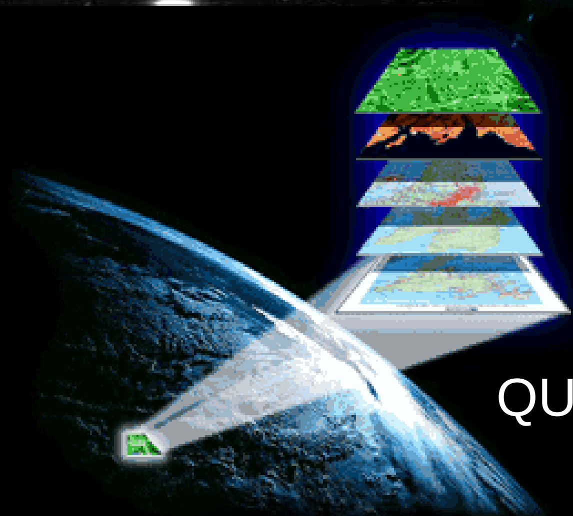
- Complete a watershed assessment at high, middle and low WF-activity regions.

- Calibrate the model and complete sensitivity analysis to predict SW-activity.

DEDICATION

My father





QUESTIONS ?

Soil Moisture influence in the occurrences of Wildfires in the Southeast of United States

Thank you

Eduardo Arias