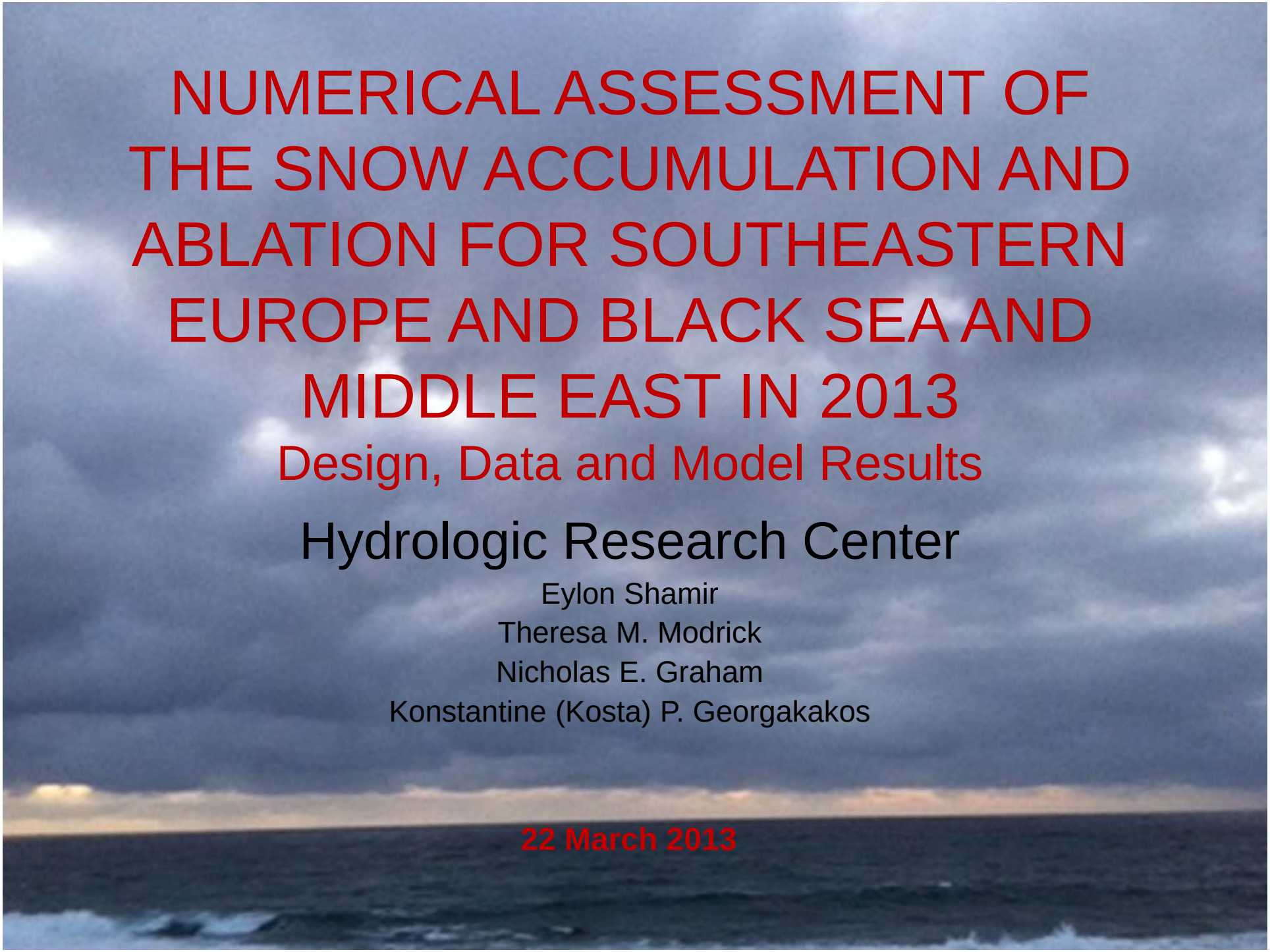


NUMERICAL ASSESSMENT OF THE SNOW ACCUMULATION AND ABLATION FOR SOUTHEASTERN EUROPE AND BLACK SEA AND MIDDLE EAST IN 2013

Design, Data and Model Results

Hydrologic Research Center

Eylon Shamir

Theresa M. Modrick

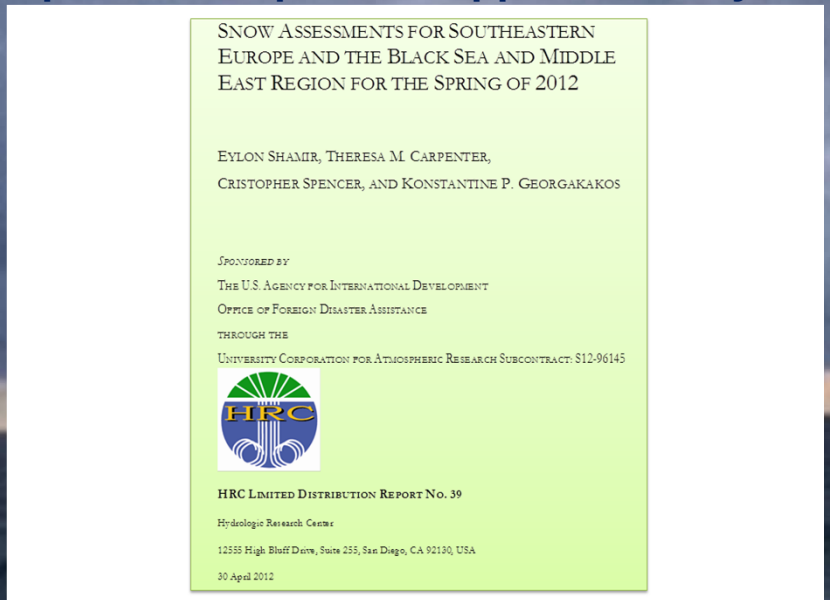
Nicholas E. Graham

Konstantine (Kosta) P. Georgakakos

22 March 2013

ASSESSMENT AND OUTLOOK FOR 2012

1. **Winter of 2012 was unusual in the large cover extent for southeastern Europe**
2. **In most countries this winter follows a dry 2011**
3. **By February 15, 2012 most significant snowfall events had occurred and in some regions significant melt also had occurred**
4. **No significant regional flood risk from snowmelt was estimated by the numerical analysis and consensus discussion at the Ankara Workshop on 29 March 2012, although some local quick melt episodes appeared likely in a small number of cases**



SNOW ASSESSMENTS FOR SOUTHEASTERN EUROPE AND THE BLACK SEA AND MIDDLE EAST REGION FOR THE SPRING OF 2012

EYLON SHAMIR, THERESA M. CARPENTER,
CRISTOPHER SPENCER, AND KONSTANTINE P. GEORGAKAKOS

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THE U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT
OFFICE OF FOREIGN DISASTER ASSISTANCE
THROUGH THE
UNIVERSITY CORPORATION FOR ATMOSPHERIC RESEARCH SUBCONTRACT: S12-96145

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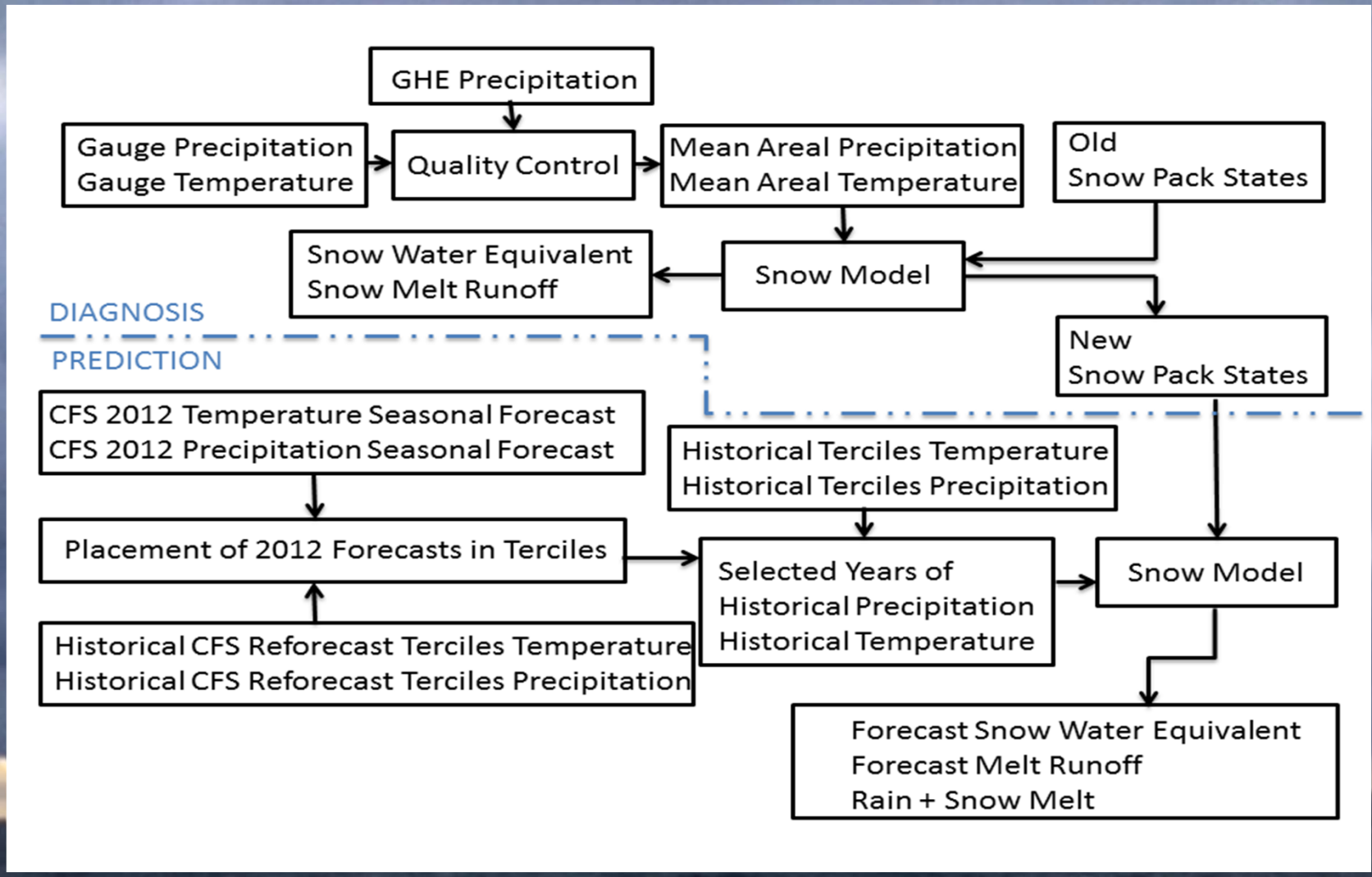
30 April 2012

DIAGNOSIS AND PREDICTION



GOALS AND METHODS

A. ESTIMATE PRESENT SNOW STATE (DIAGNOSIS)

- Bias adjusted satellite data (precipitation) + station data (temperature) (2007-2013) (Current phase for SEE: 11/2012 – 3/2013)
- Model runs for basins that cover the SEE and BSME regions (parameter estimation based on spatial data)
- Adjustments to parameters based on few available snow depth, snow water equivalent, and snow cover observations (determined: 2012)

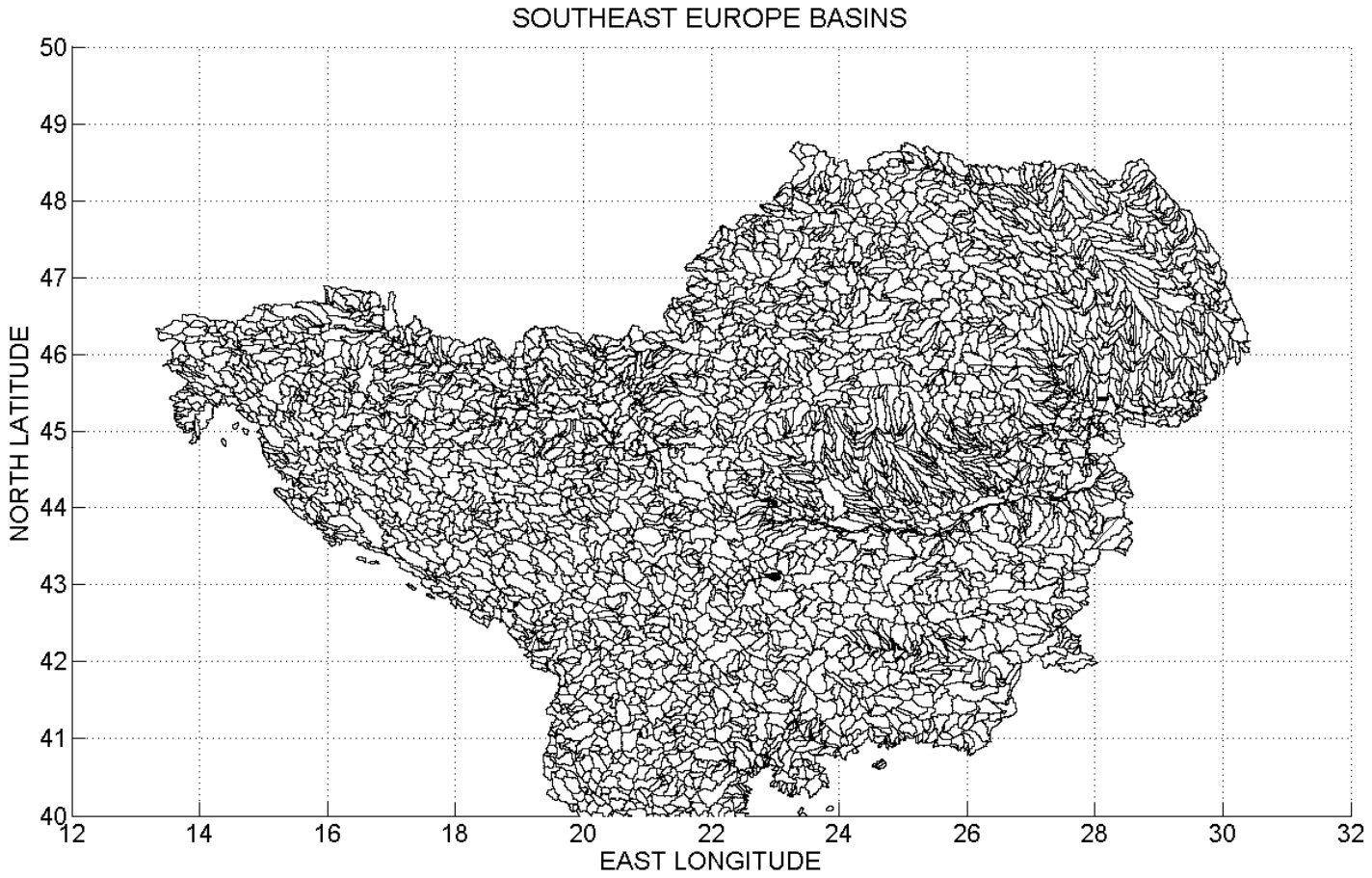
GOALS AND METHODS

B. ESTIMATE PLAUSIBLE EVOLUTION IN THE NEXT MONTHS (OUTLOOK)

- Climate Forecast System (CFS) ensemble forecasts of precipitation and temperature and large-scale snow water equivalent
- Determine the current precipitation and temperature forecast placement in the tercile of its distribution for April/May 2013 with initial time in March 2013
- Select from the historical years and for each station the years that belong to the same tercile of their distribution as the current climate forecast tercile
- Run the snow model using the historical year station input, interpolated in space and with model initial condition in March 2013

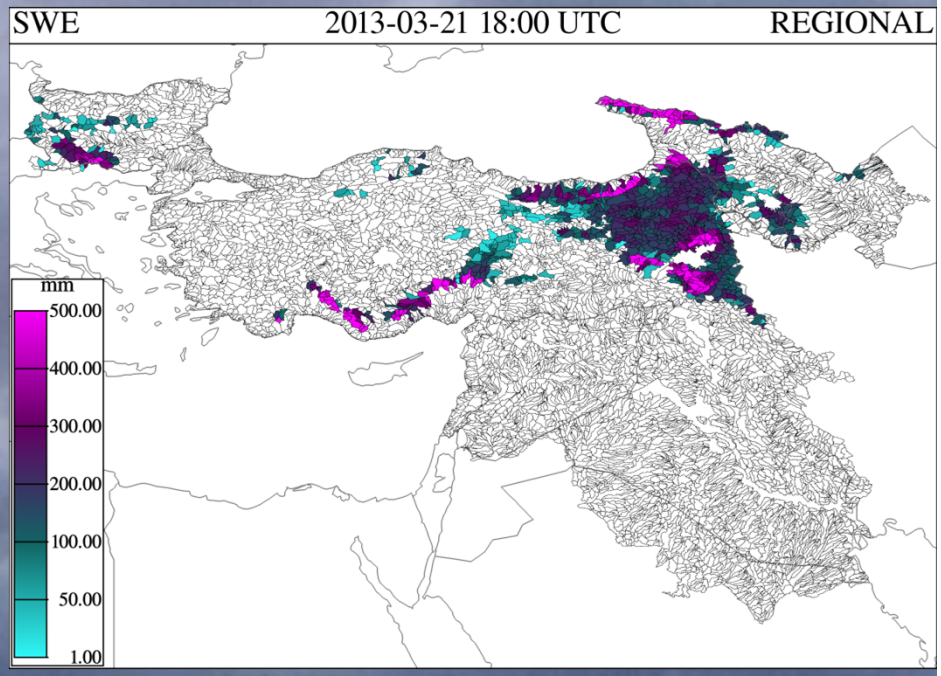
BASIN APPROACH FOR SNOW MODEL

DIVIDE THE DOMAIN IN DRAINAGE BASINS (AREA ~ 100 KM^2)



COUNTRY DATA

SLOVENIA
(10/2012 – 3/2013)
Six-hourly Precipitation Accumulation
Six-hourly Temperature
Twelve-hourly Snow Water Equivalent
and Snow Depth



SERBIA
(1981 – 2010)
Daily Precipitation Accumulation
Mean Daily Temperature
Five-day Snow Depth

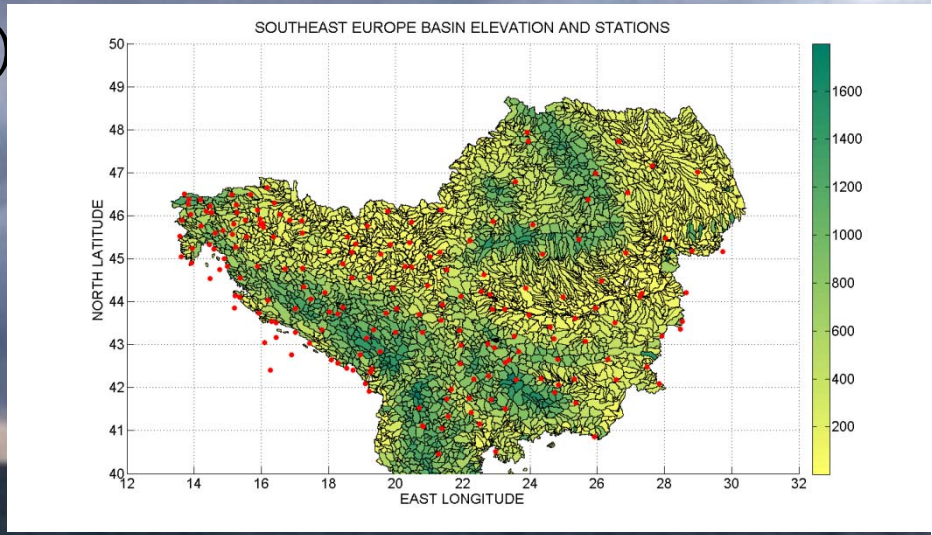
TURKEY
BSMEFFG system precipitation and temperature data

FOR DIAGNOSTICS

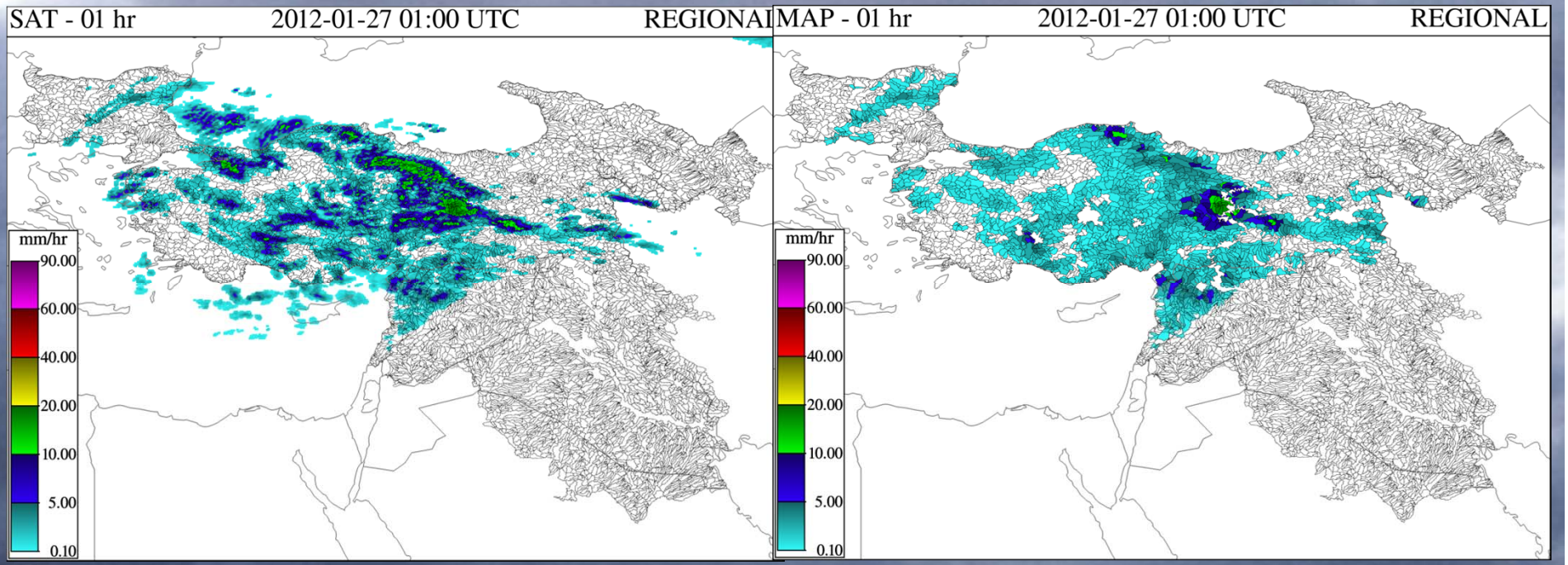
SNOW MODELING USING OPERATIONAL US NWS SNOW17 AND ALL AVAILABLE DATA

ARCHIVES OF SATELLITE GLOBAL HYDROESTIMATOR DATA (NESDIS) (1/2007 – 3/2013)
Six-hourly Precipitation Accumulation (~ 4km x 4km)

ARCHIVES OF STATION DATA (NCDC) (1/1998 – 3/2013) (1/2007 – 3/2013)
Six-hourly Precipitation Accumulation
Six-hourly Temperature Average
Six-hourly Snow Depth
Six-hourly Snow Water Equivalent



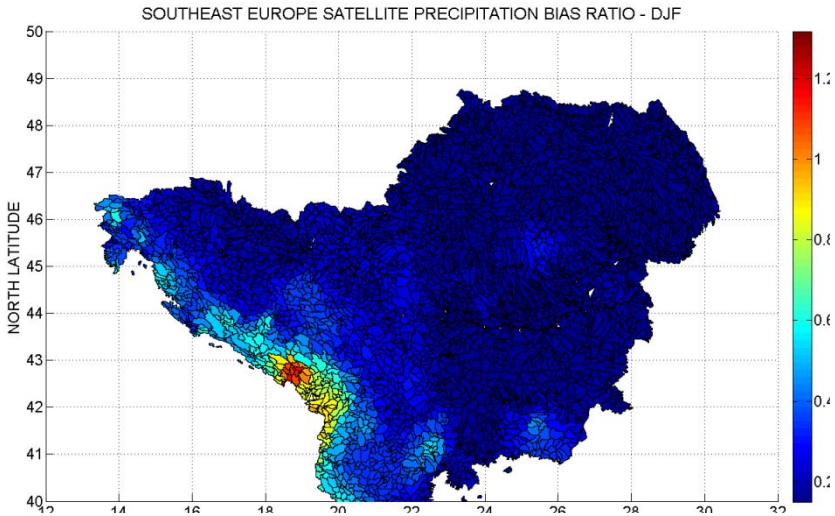
GLOBAL HYDROESTIMATOR PRECIPITATION

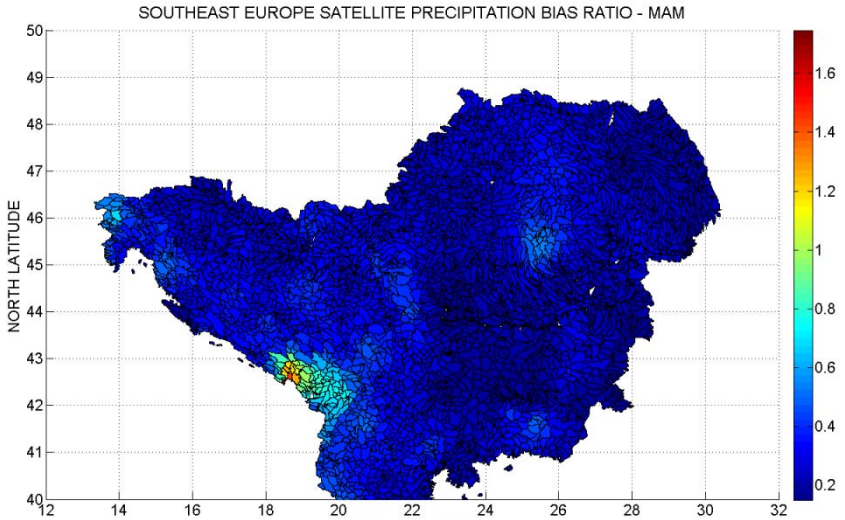


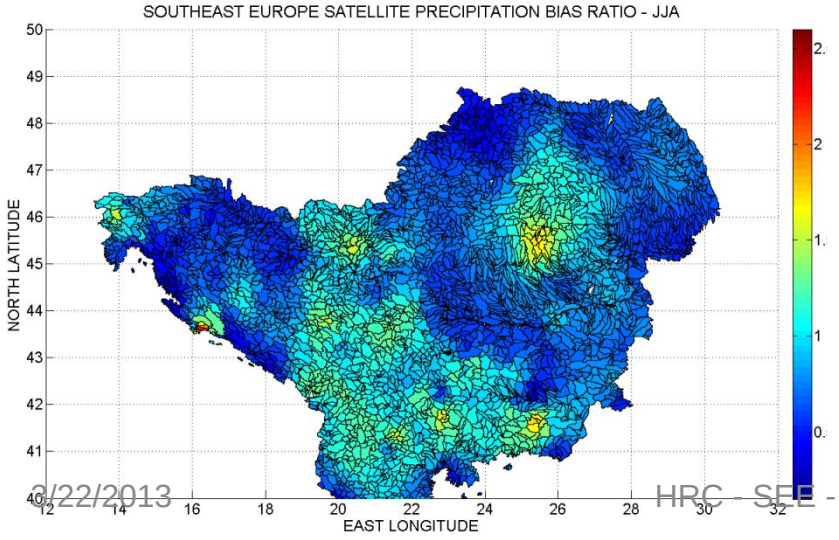
IR BASED FOR CLOUD-TOP TEMPERATURE
LOW LATENCY (4KMX4KM; HOURLY)
BETTER FOR STRONG CONVECTION

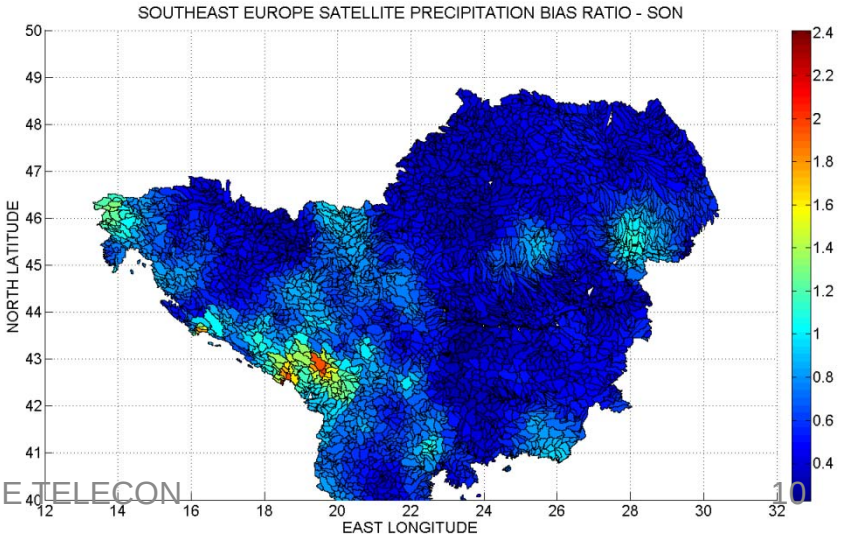
SATELLITE AND STATION DATA

GHE BIAS ADJUSTMENT (2007-2012)
BIAS RATIO: sum(STATION)/sum(GHE PIXEL)



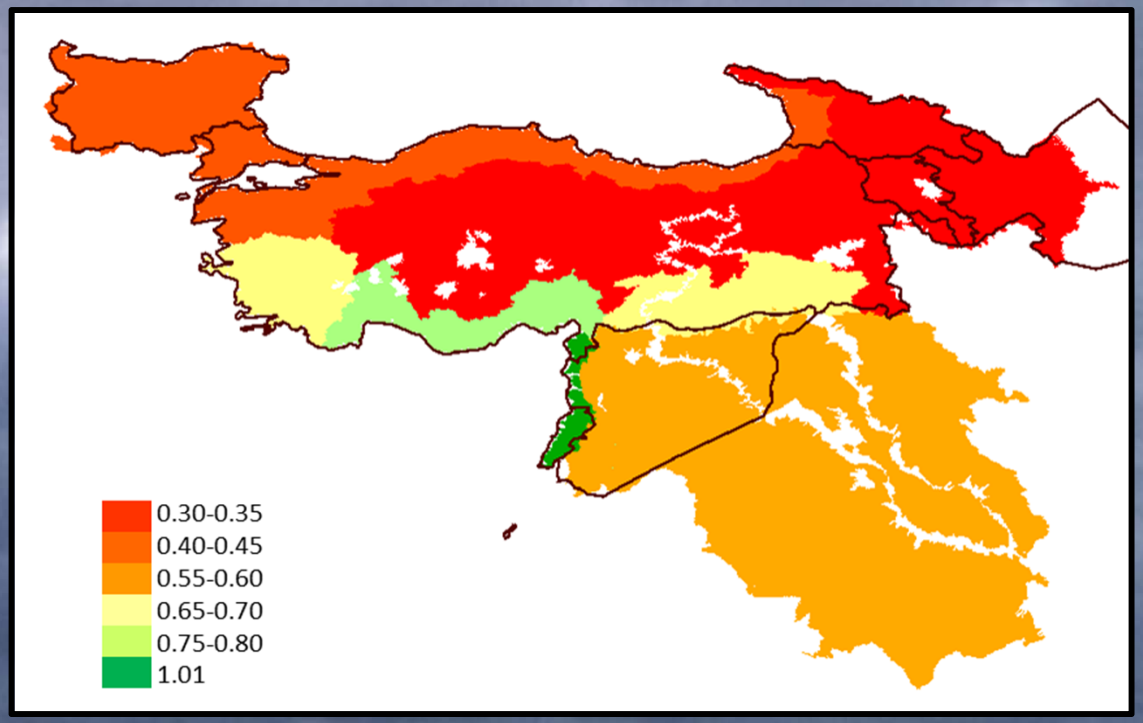






SATELLITE BIAS ADJUSTMENT BSMEFFG

FEBRUARY



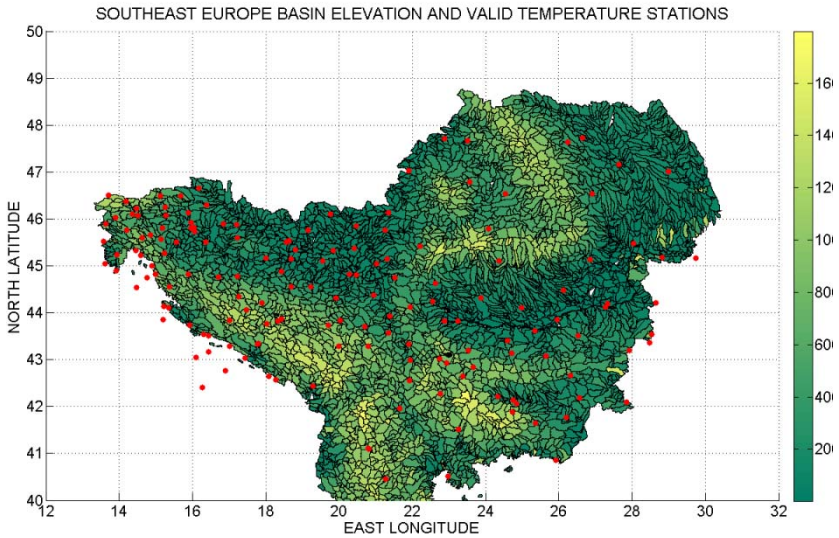
GHE BIAS ADJUSTMENT (2008-2010)
BIAS RATIO: sum(STATION)/sum(GHE PIXEL)

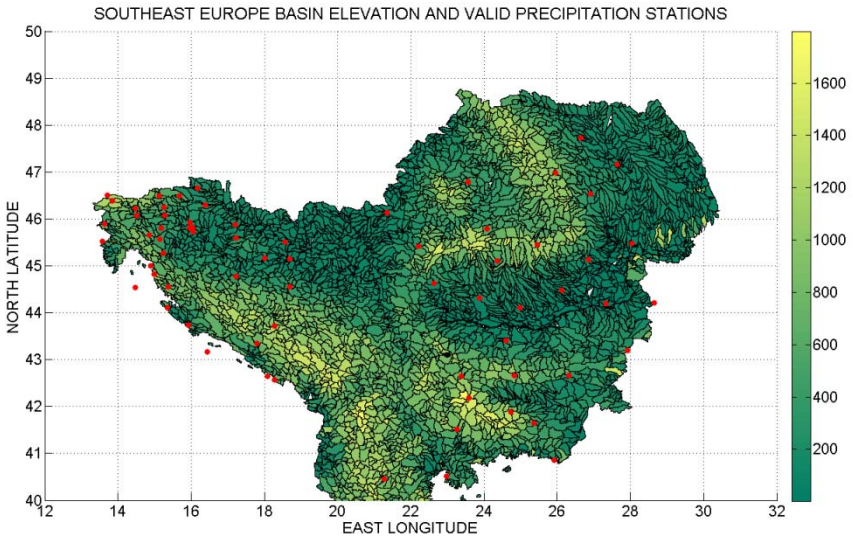
STATION DATA ISSUES

MANY STATIONS HAD NO DATA FOR SEVERAL YEARS IN THE NCDC DATABASE

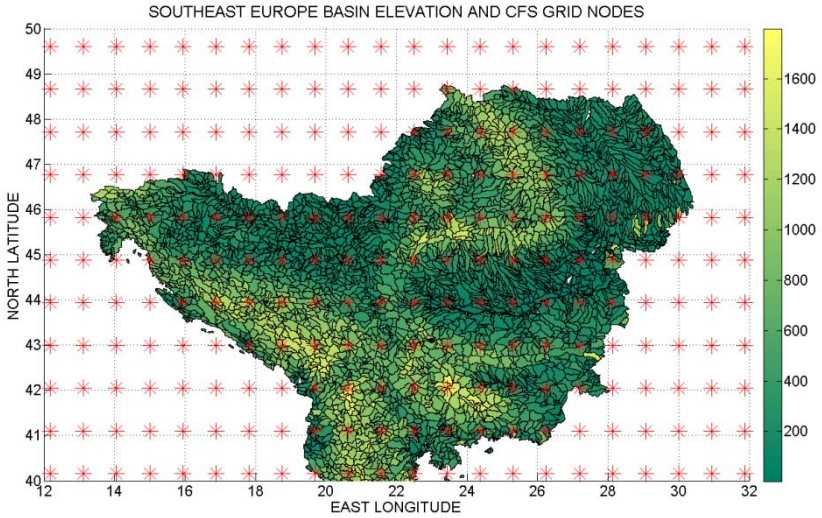
FROM A TOTAL OF 569 STATIONS FOR THE REGION:
179 HAD REASONABLY GOOD DATA FOR TEMPERATURE AND
79 HAD REASONABLY GOOD DATA FOR PRECIPITATION (1998-)

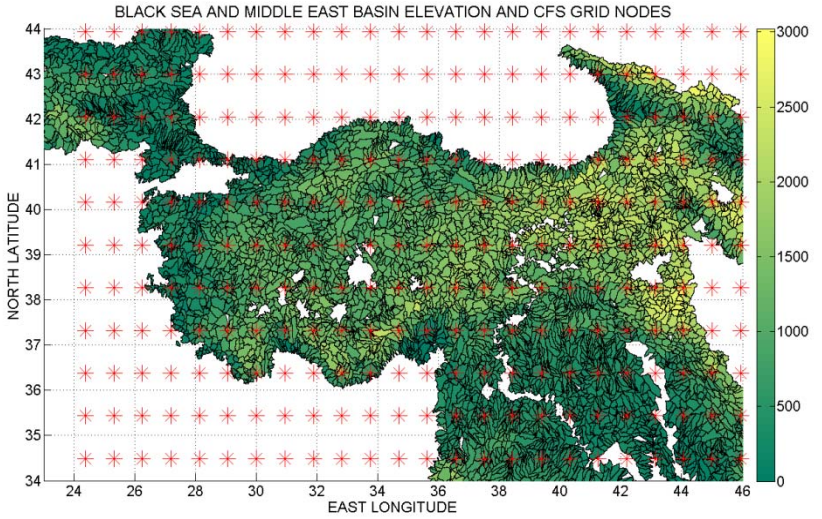
MOST STATIONS ONLY RARELY REPORTED SNOW DEPTH





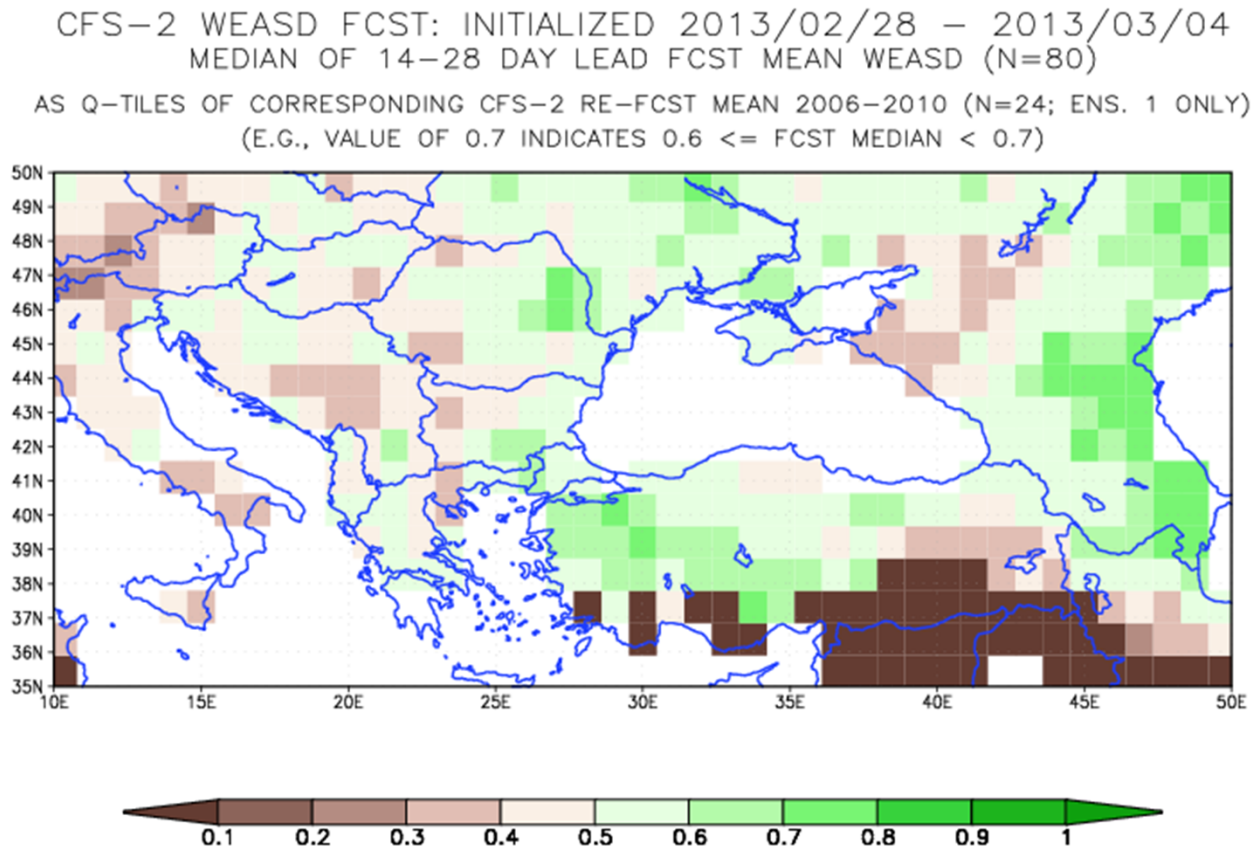
CFS NODES AND SEE DOMAIN





REFORECAST SINCE 1982 (5 DAY STARTS)
REAL-TIME 4 TIMES DAILY SEASONAL FORECASTS (NCEP)

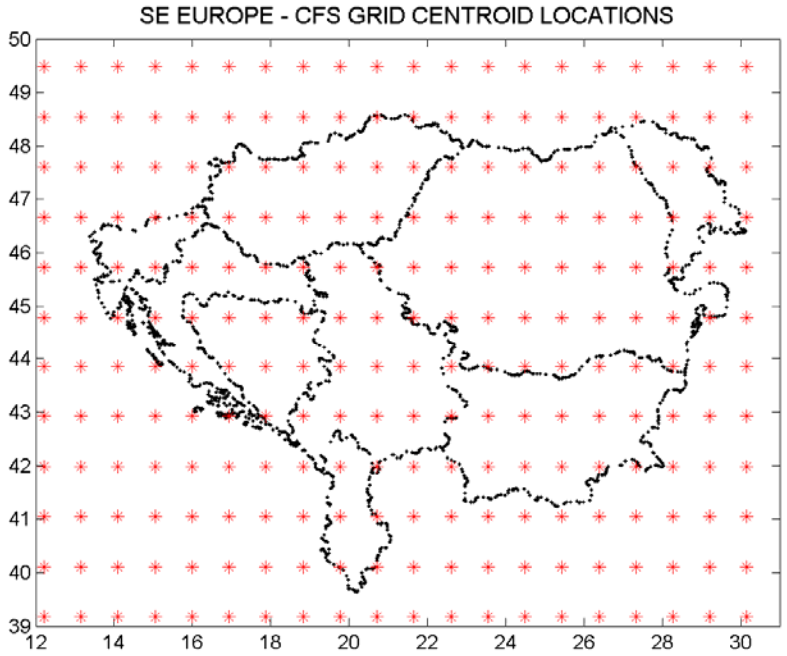
CFS SWE OUTLOOK

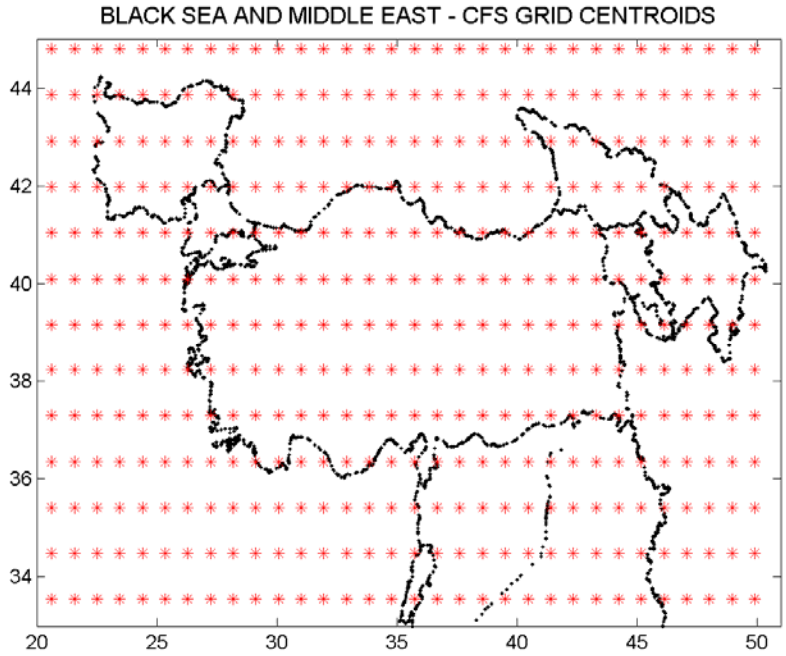


CFS OUTLOOK FOR APRIL, MAY 2013

- Climate Forecast System (CFS) ensemble forecasts of precipitation and temperature for forecast dates of 3/10-13/2013 with 4 ensembles per day.
- Aggregate forecast to monthly precipitation volume and average monthly temperature on grid basis for April and May 2013.
- Compare current forecasts with CFS Reforecast for same forecast period (mid-March) and given forecast months of April and May.
- Regional assessment of current CFS forecast and placement in tercile distribution of reforecast.
- Select corresponding years from historical observation record in appropriate tercile of historical distribution to provide input to force snow model.

CFS OPERATIONAL FORECAST AND REFORECASTS





OPERATIONAL (REAL-TIME) SEASONAL FORECASTS:

4 FORECASTS PER DAY

6 HOURLY RESOLUTION

REFORECASTS:

MONTHLY RESOLUTION

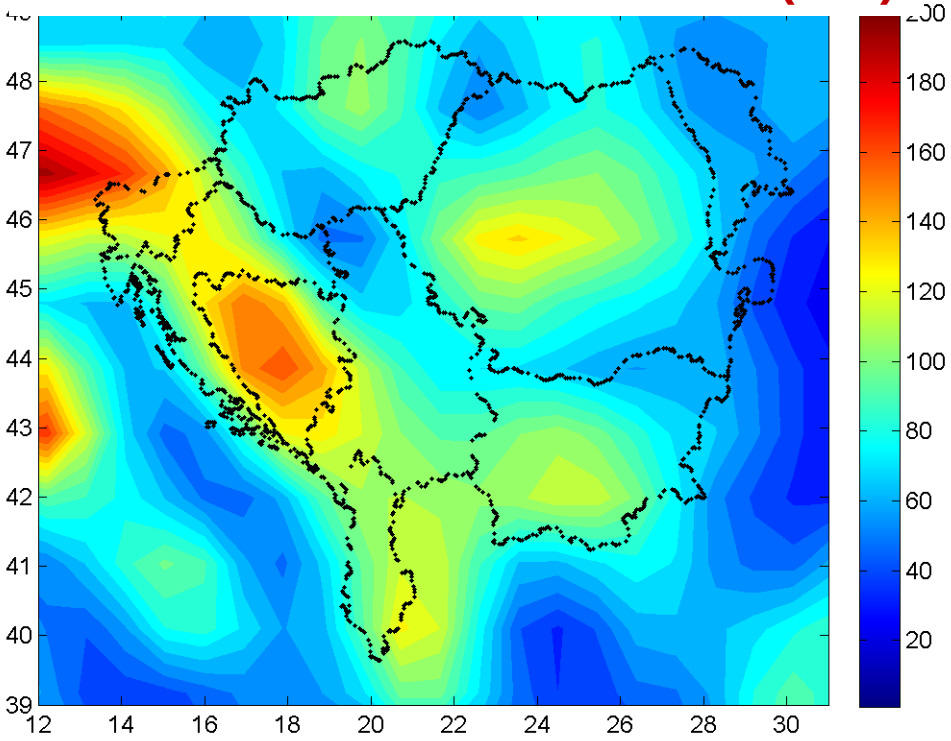
REFORECAST STARTS EVERY 5 DAYS

1982 - 2010

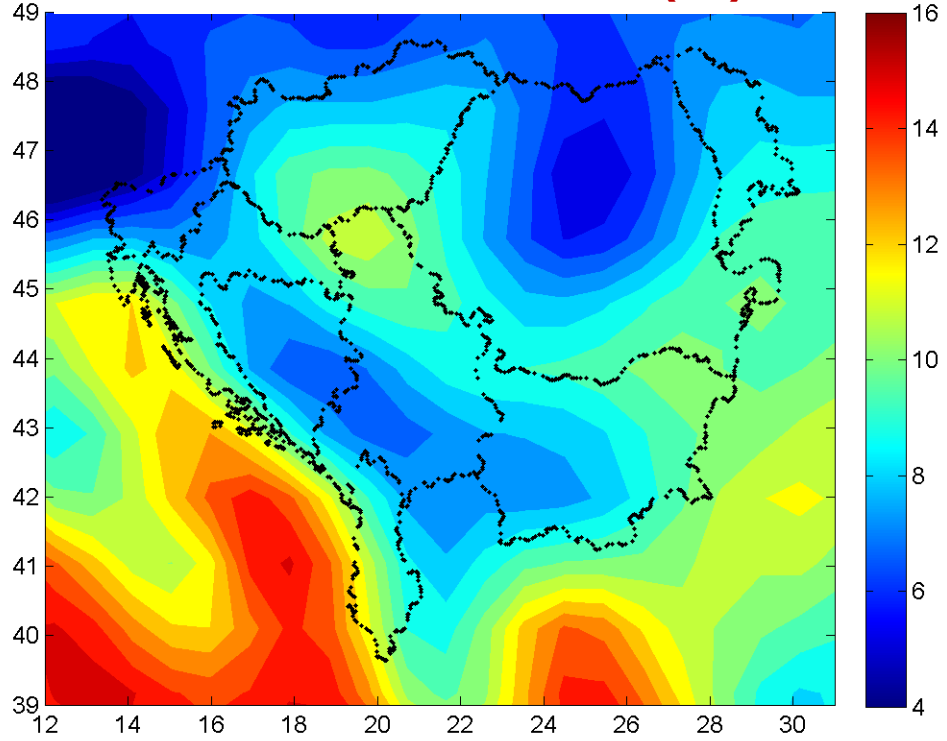
CFS FORECAST FOR APRIL
SE EUROPE

FORECAST DATES OF 3/10, 11, 12, 13 with 4 FORECASTS EACH DAY

MEAN PRECIPITATION VOLUME (mm)



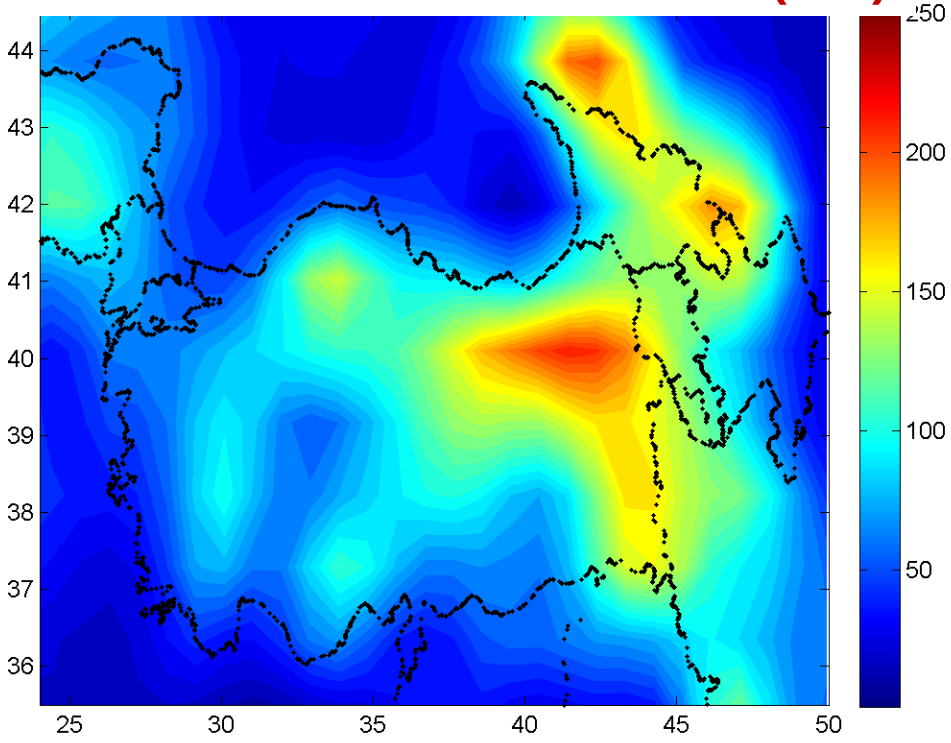
MEAN TEMPERATURE (ºC)



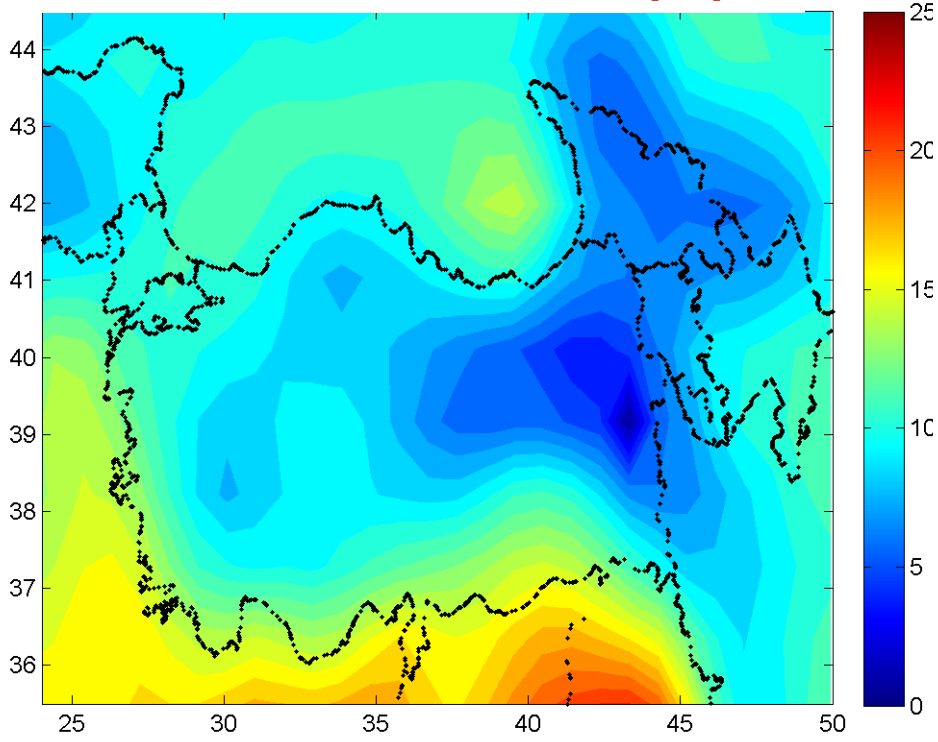
CFS FORECAST FOR APRIL
BLACK SEA/MIDDLE EAST

FORECAST DATES OF 3/10, 11, 12, 13 with 4 FORECASTS EACH DAY

MEAN PRECIPITATION VOLUME (mm)

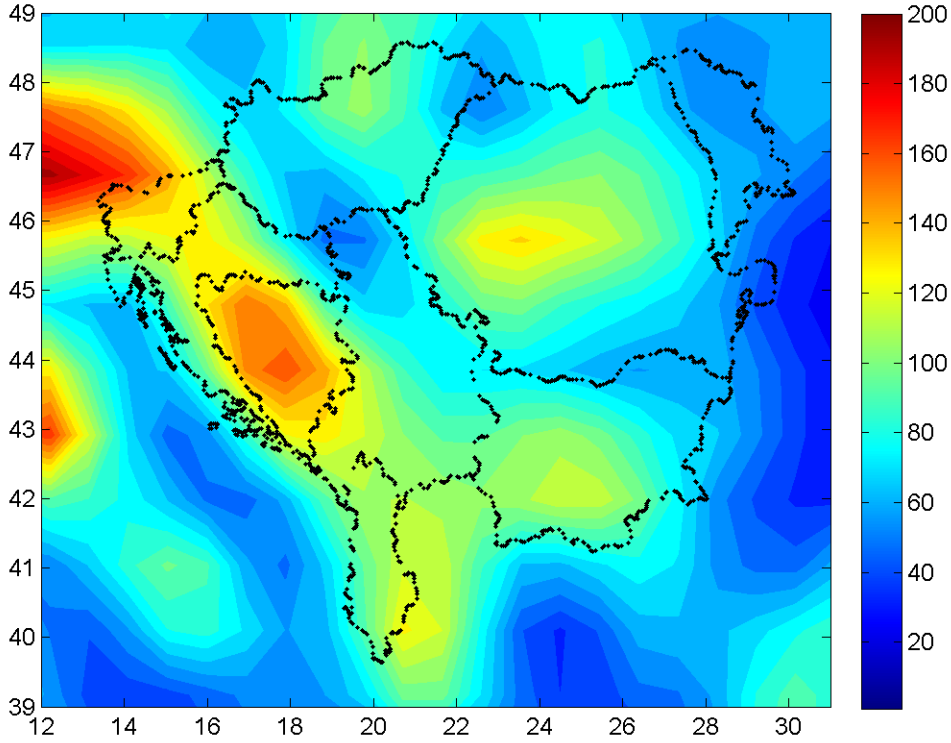


MEAN TEMPERATURE (°C)

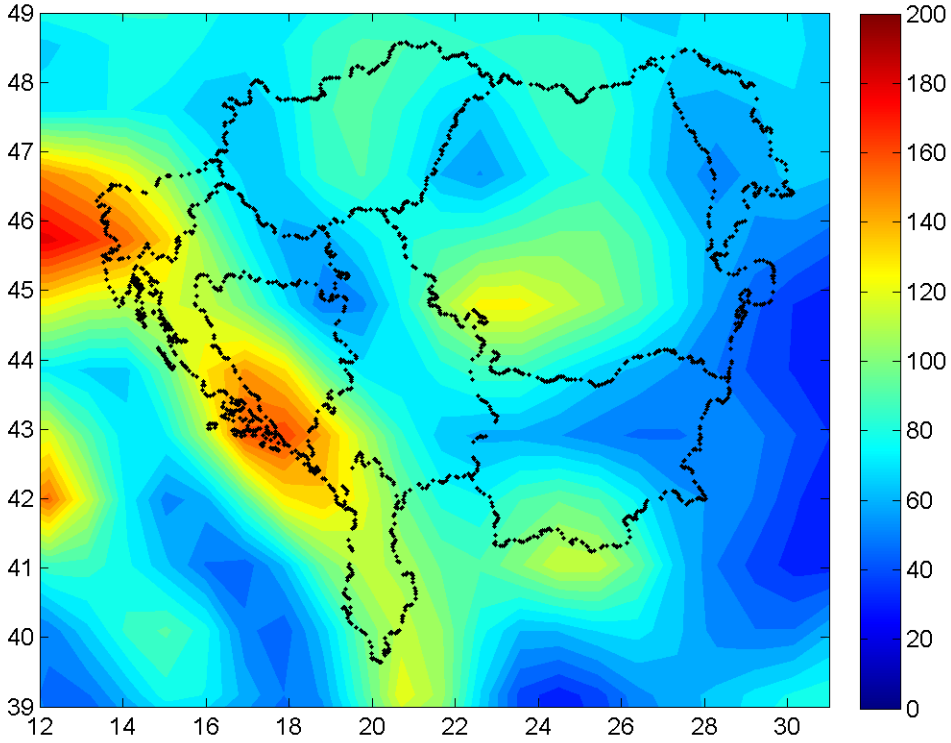


HOW DOES CURRENT FORECAST COMPARE WITH MODEL CLIMATOLOGY?

FORECAST MEAN APRIL PRECIP (mm)



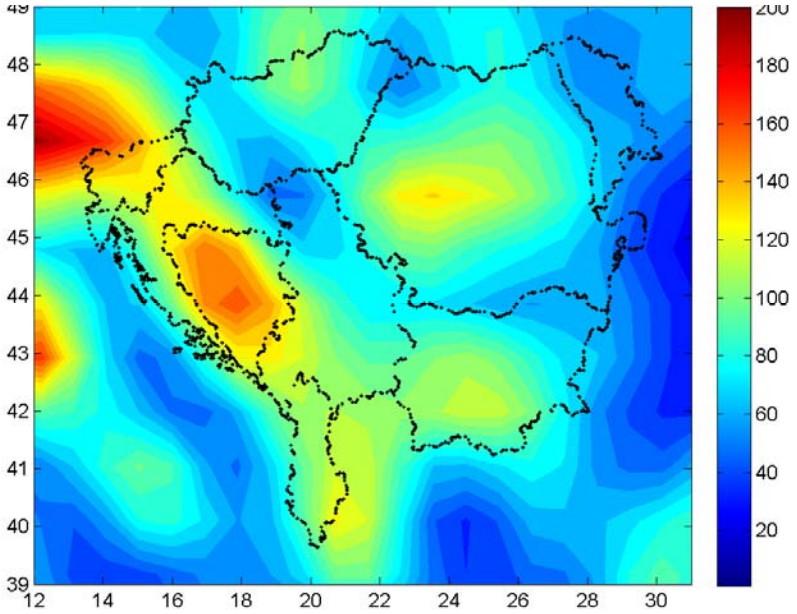
CLIMATOLOGICAL APRIL PRECIP (mm)



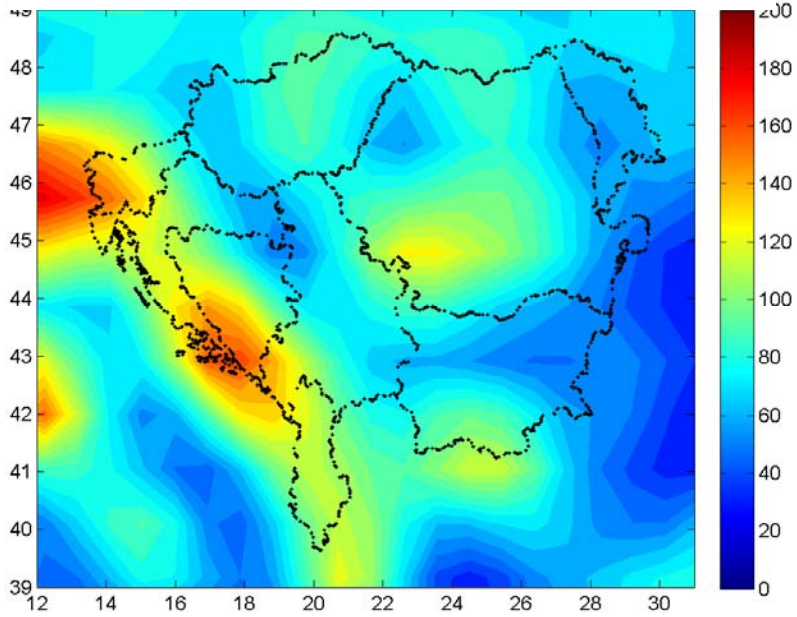
16 FORECASTS (4 DAYS X 4 PER DAY)

INCLUDED DATES OF 3/7, 12, and 17
4 REFORECASTS PER DAY
29 YEARS (1982-2010)

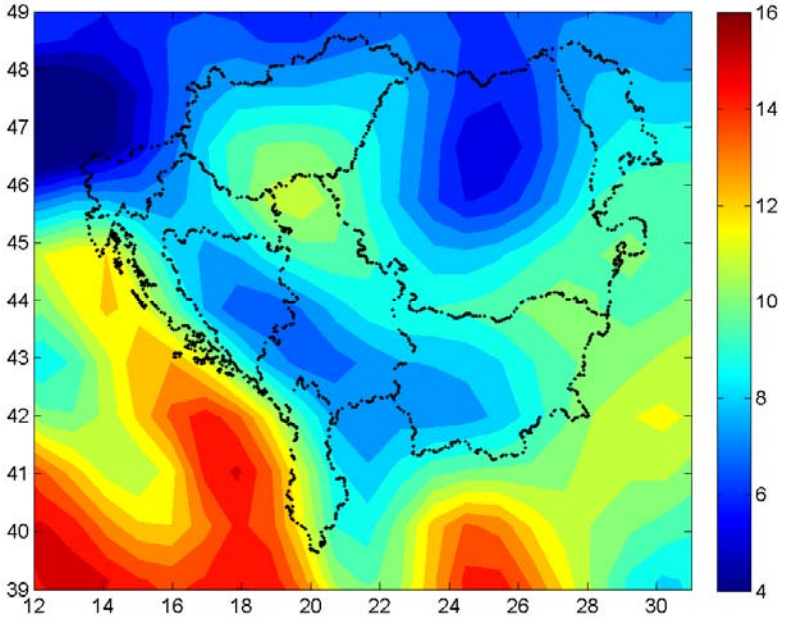
FORECAST MEAN APRIL PRECIP (mm)



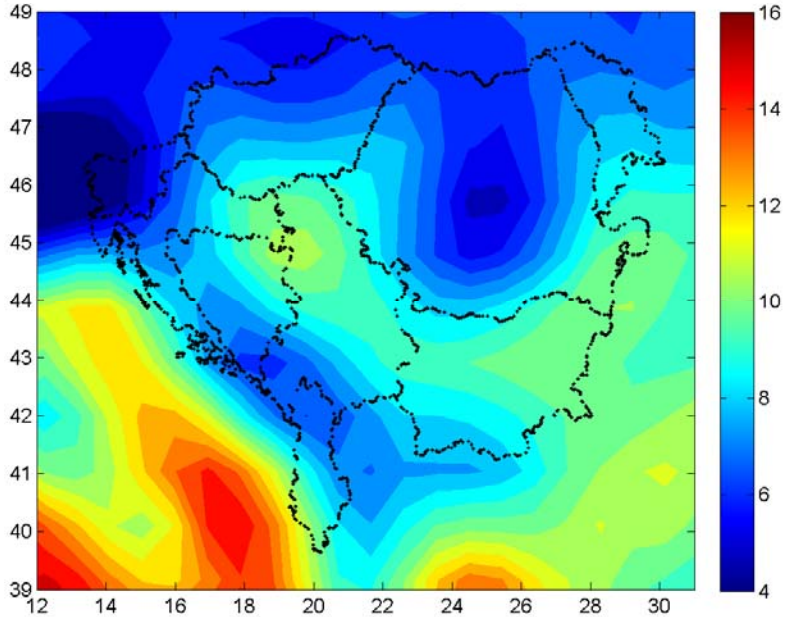
CLIMATOLOGICAL PRECIP



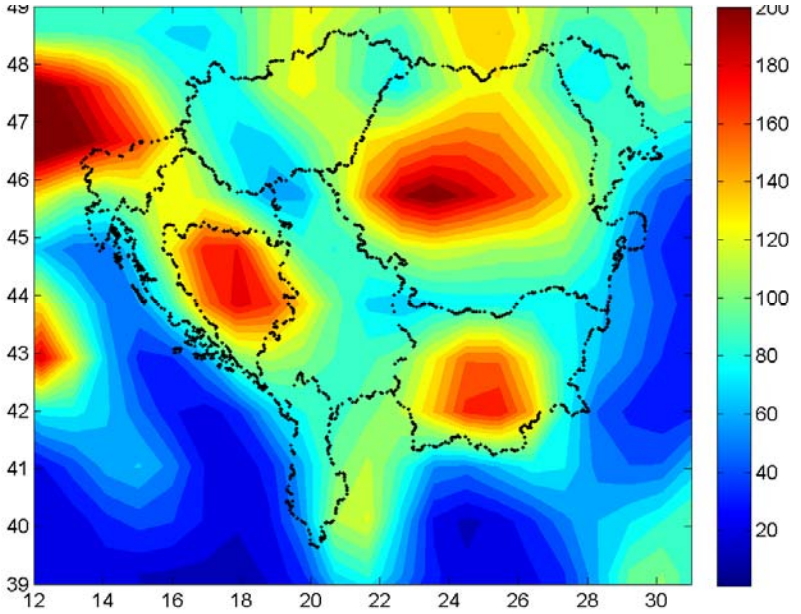
FORECAST MEAN APRIL TEMP (ºC)



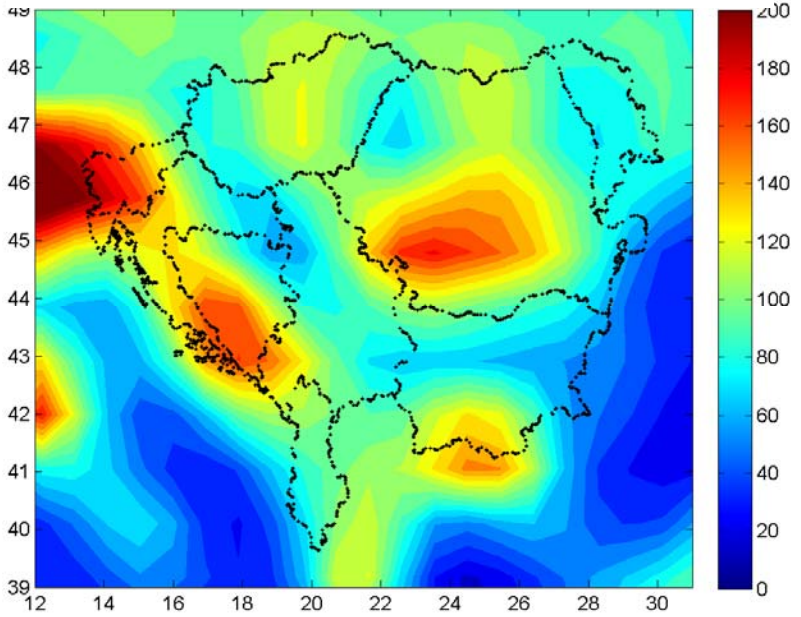
CLIMATOLOGICAL TEMP



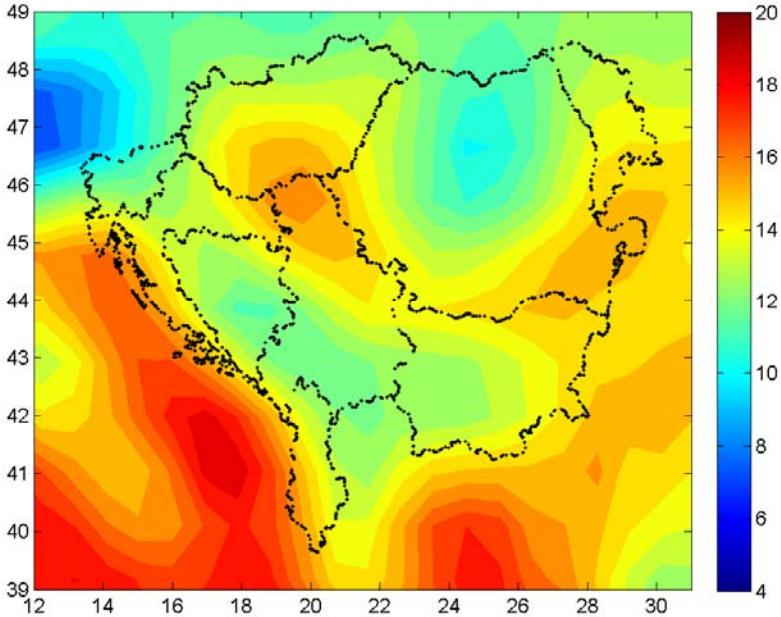
FORECAST MEAN MAY PRECIP (mm)



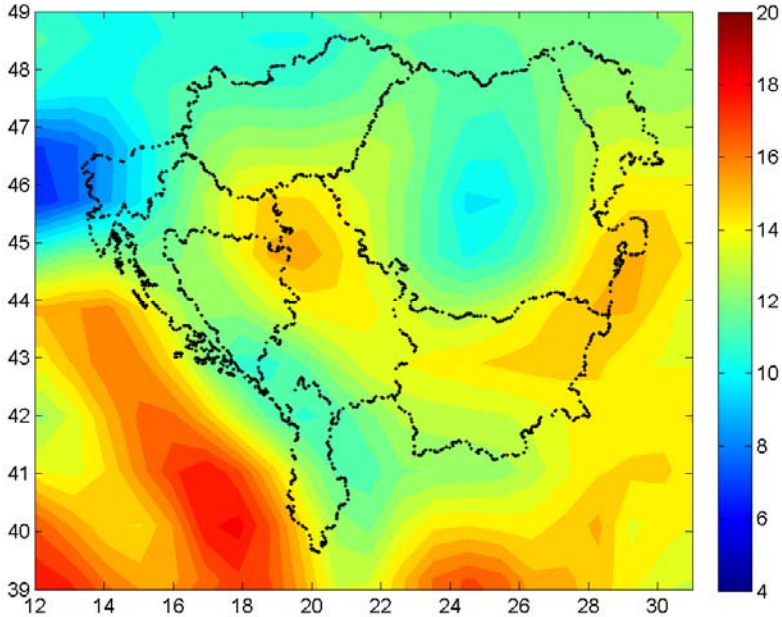
CLIMATOLOGICAL PRECIP



FORECAST MEAN MAY TEMP (ºC)

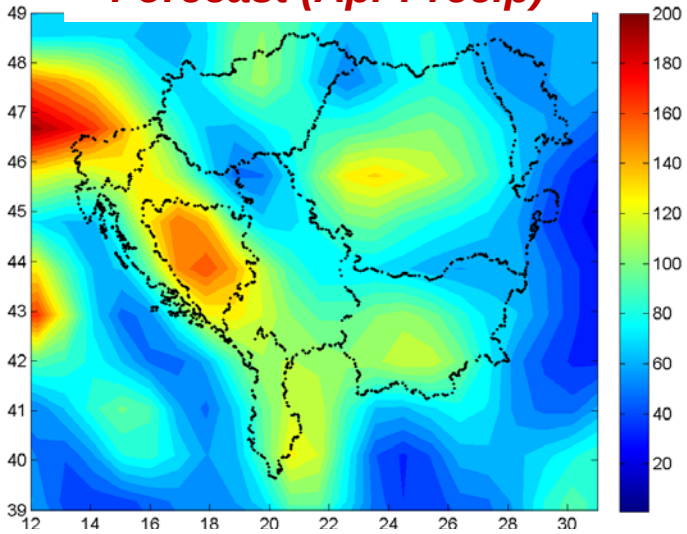


CLIMATOLOGICAL TEMP

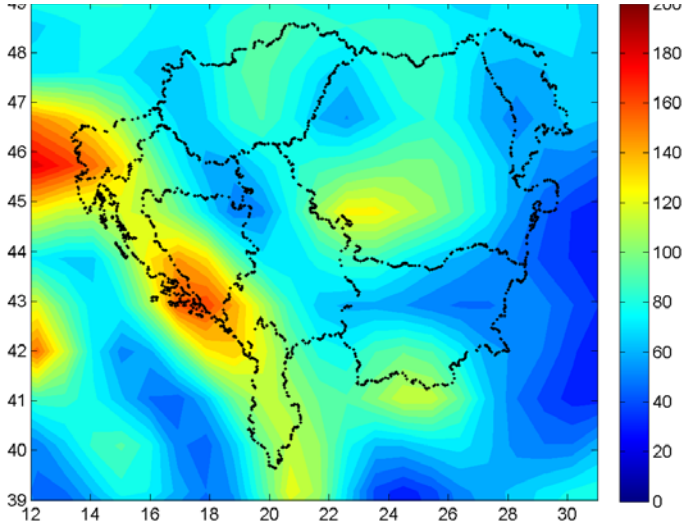


QUANTITATIVE COMPARISON

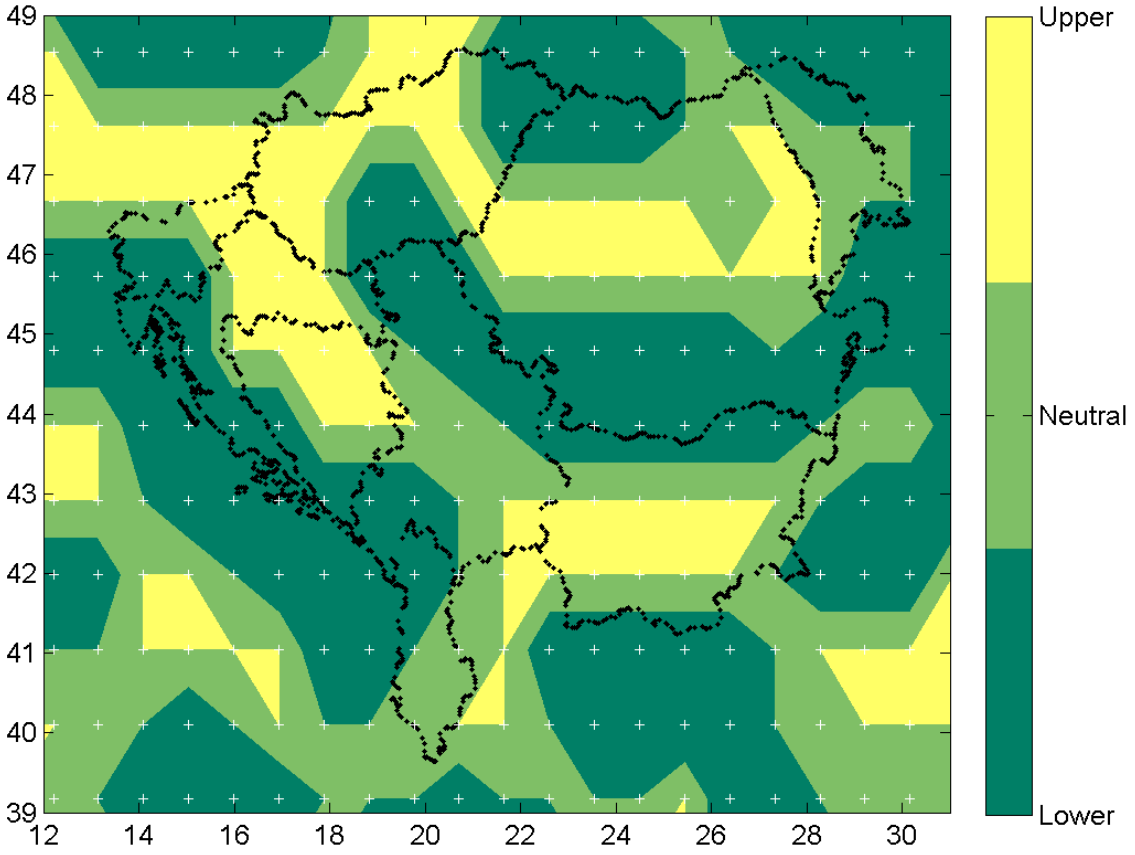
Forecast (Apr Precip)



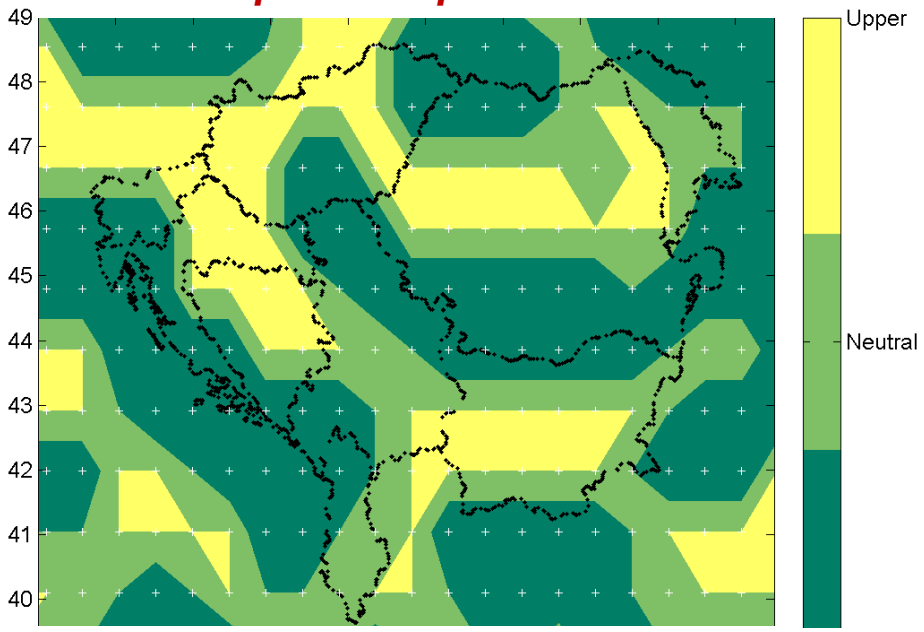
Reforecast Tercile (Upper/Lower)



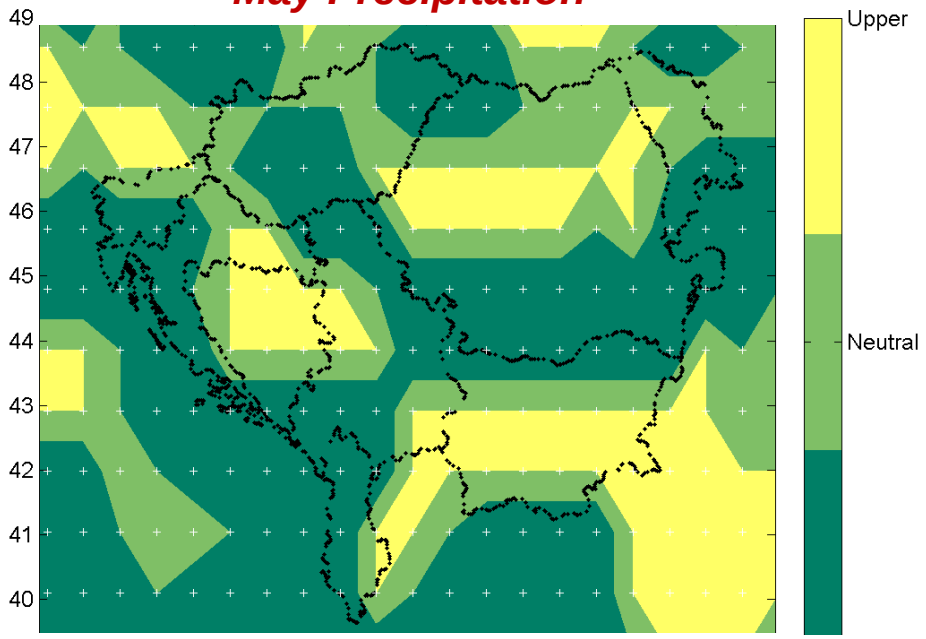
SE EUROPE - APRIL PRECIPITATION FORECAST FROM CFS
Based on Reforecast Dates of 3/7, 3/12, 3/17



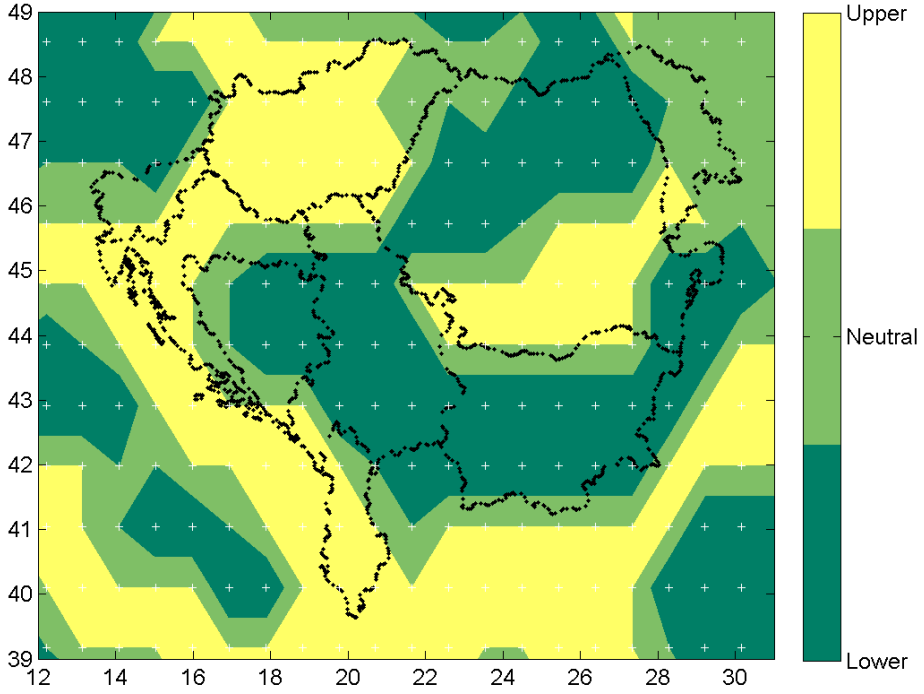
April Precipitation



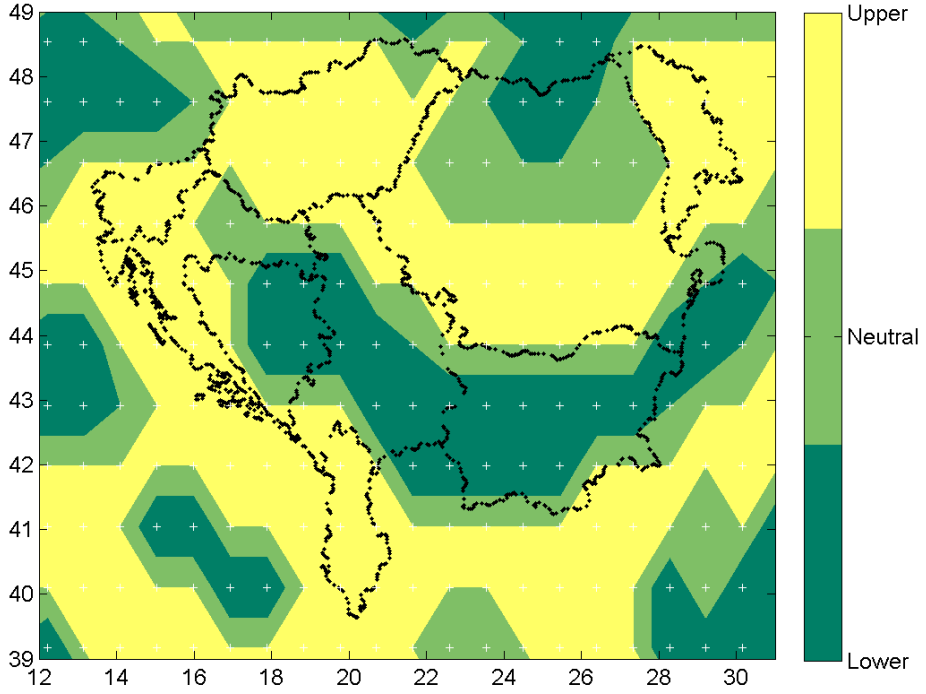
May Precipitation



April Temperature

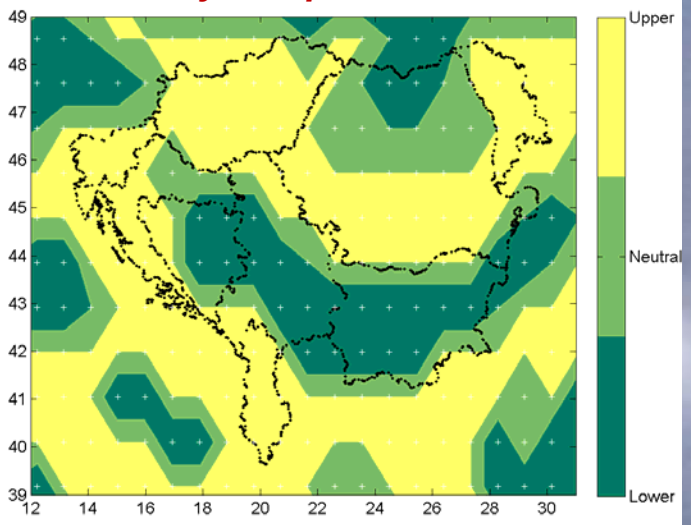


May Temperature

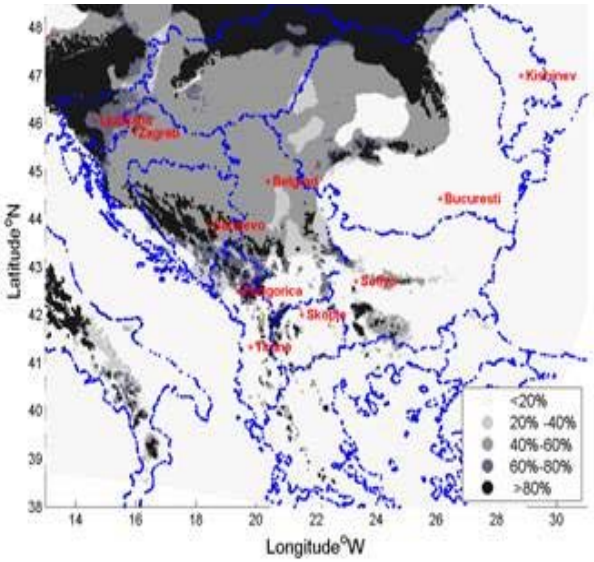


USING THE CFS COMPARISON TO SELECT HISTORICAL YEARS FOR MODEL RUNS

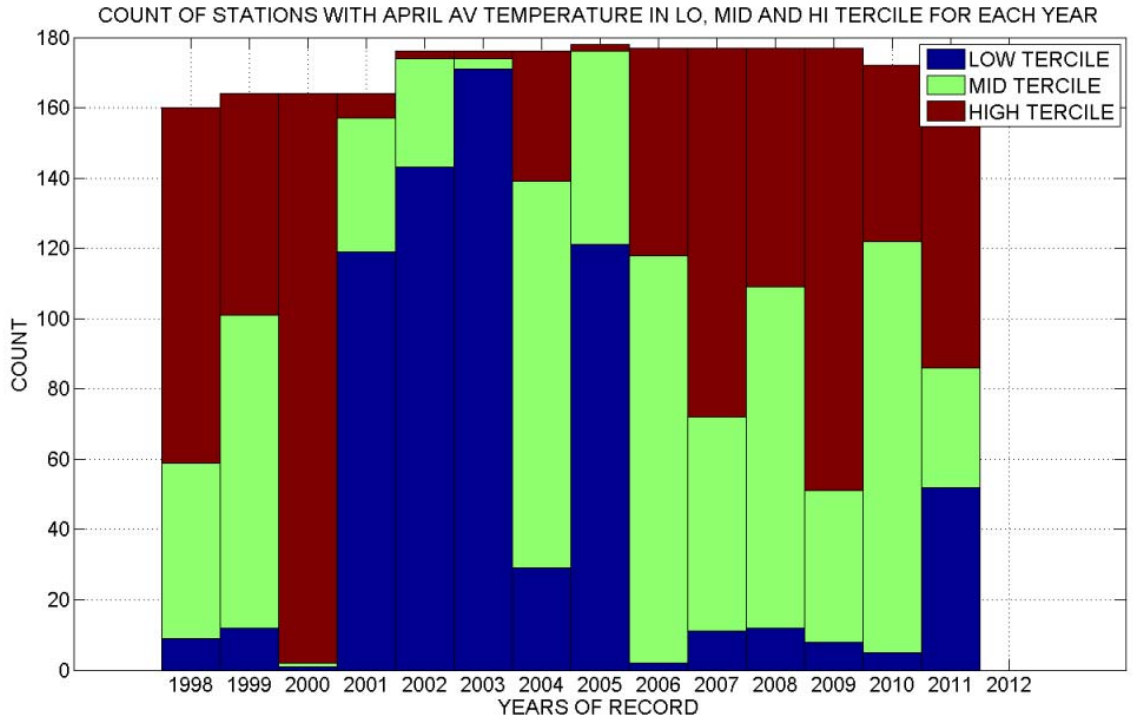
May Temperature



Snow Cover Frequency (~3/15/2013)



HISTORICAL OBSERVATIONS: NUMBER OF STATIONS IN GIVEN TERCILES FOR EACH YEAR

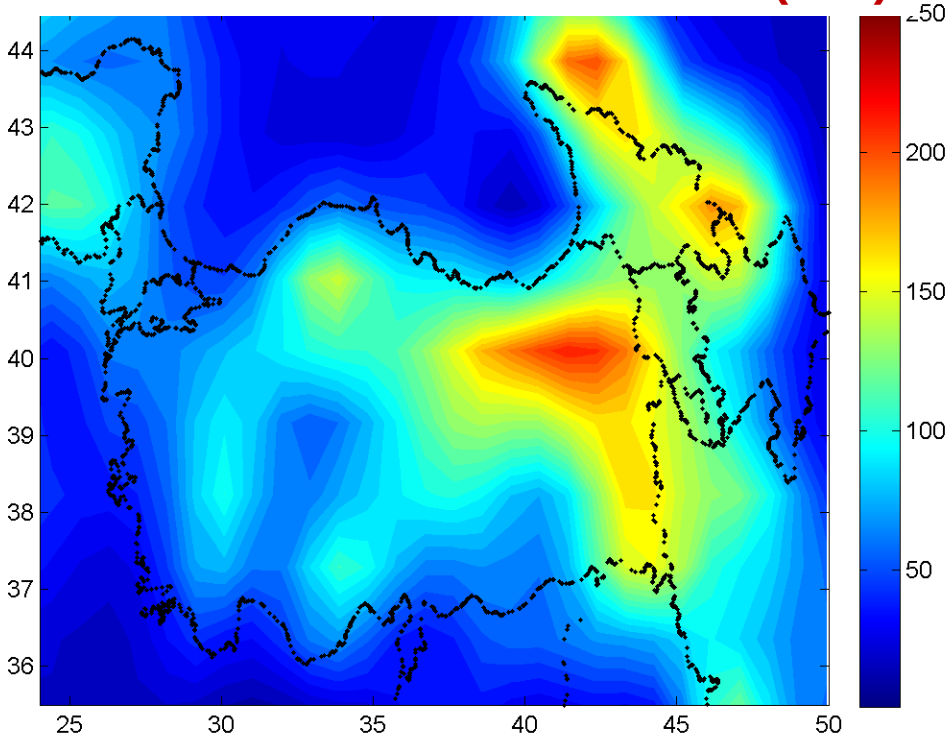


YEARS WITH TEMPERATURE IN UPPER TERCILE: 1998, 2000, 2007, 2009, 2011

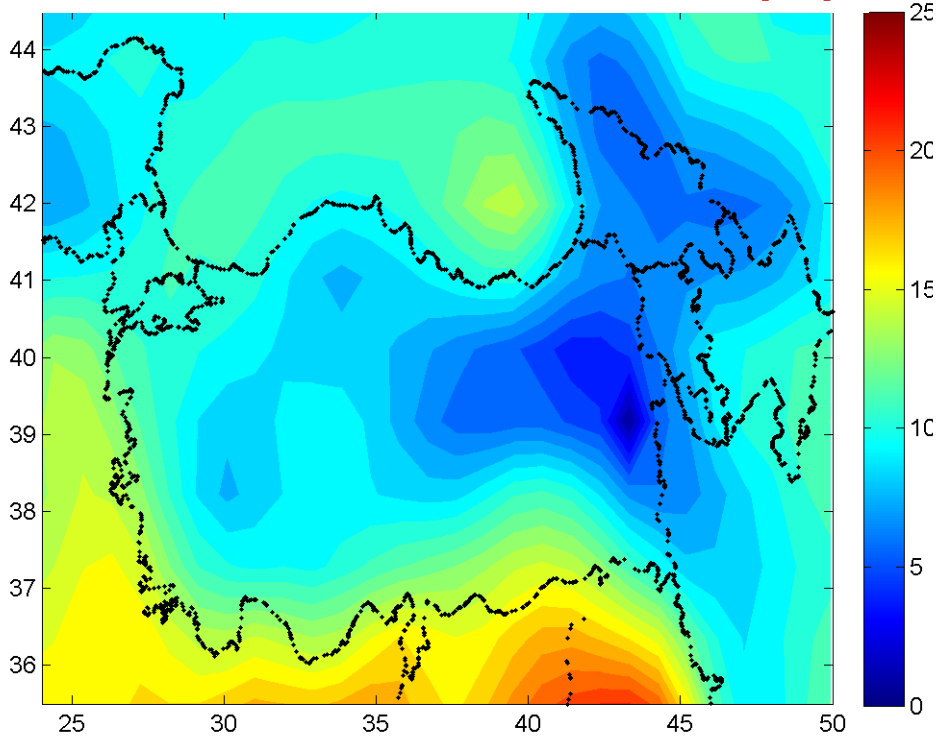
CFS FORECAST FOR BLACK SEA/MIDDLE EAST

NOTE: BSME SNOW MODEL DRIVEN BY BSMEFFG SYSTEM PRECIPITATION AND TEMPERATURE - ONLY HISTORICAL RECORD FOR 2007 - 2013

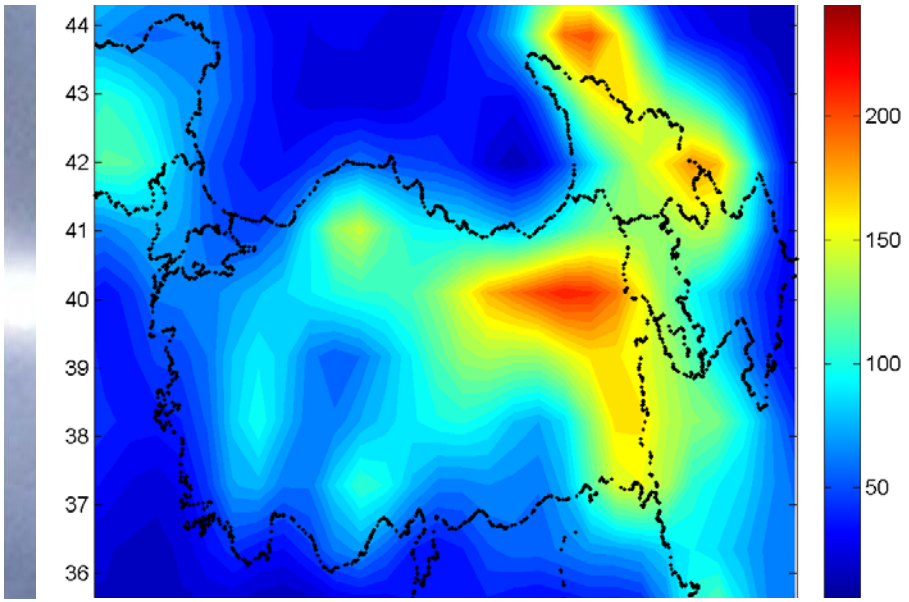
APRIL PRECIPITATION VOLUME (mm)



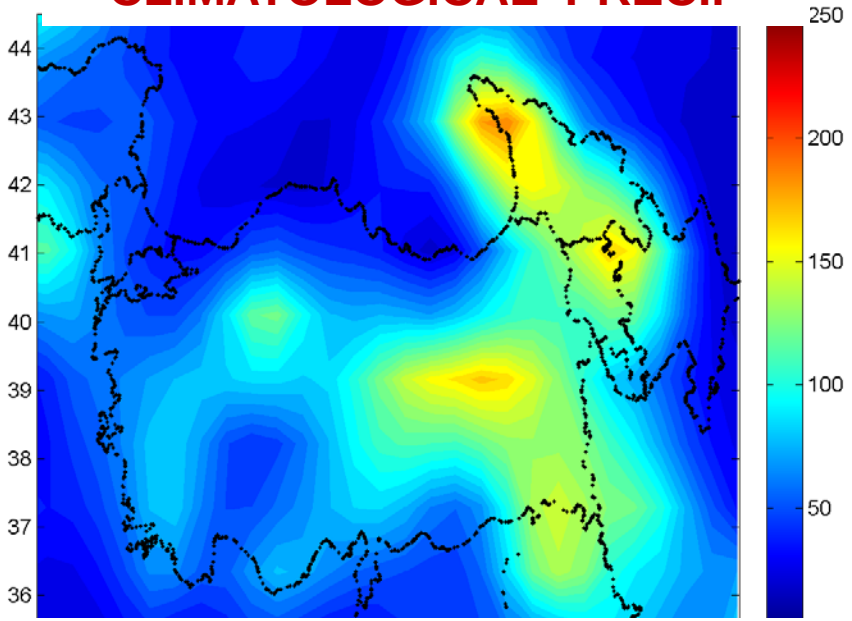
APRIL MEAN TEMPERATURE (ºC)



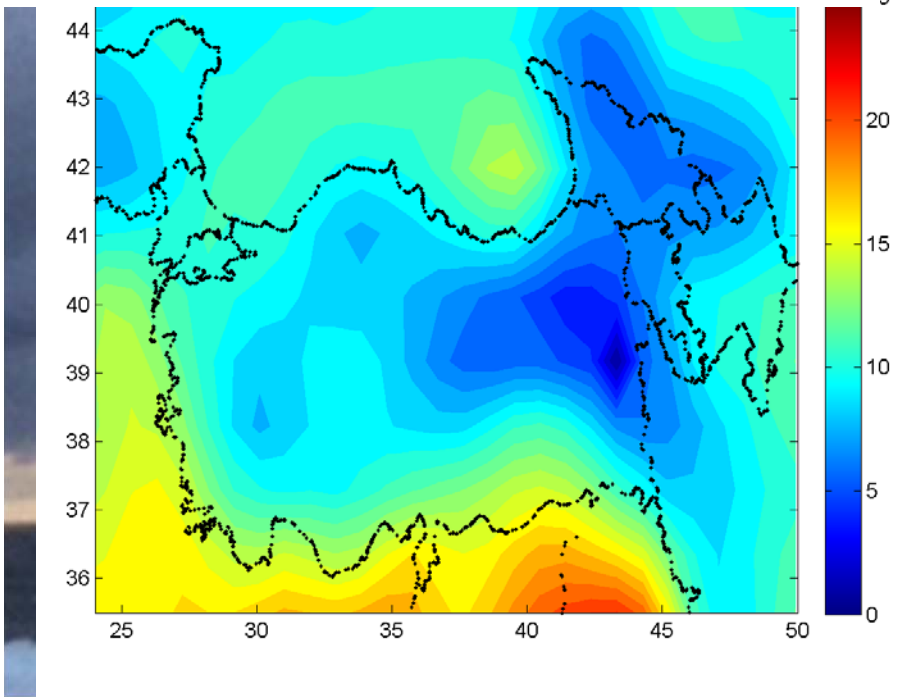
FORECAST MEAN APRIL PRECIP (mm)



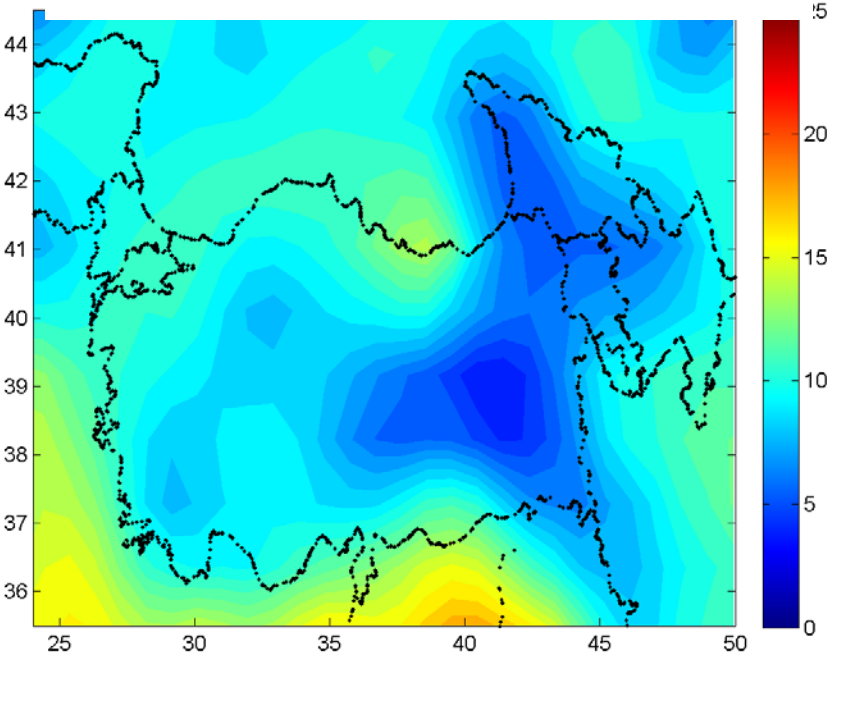
CLIMATOLOGICAL PRECIP



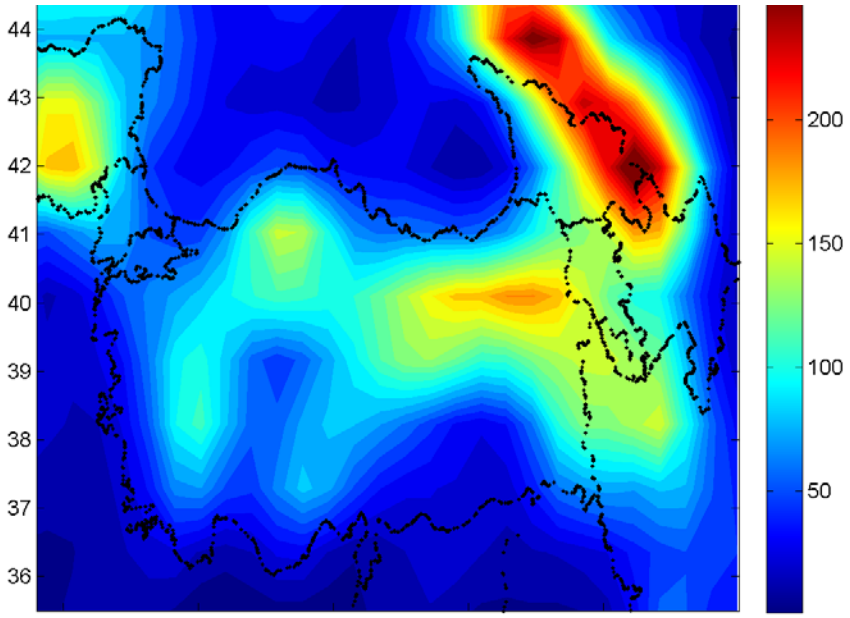
FORECAST MEAN APRIL TEMP (°C)



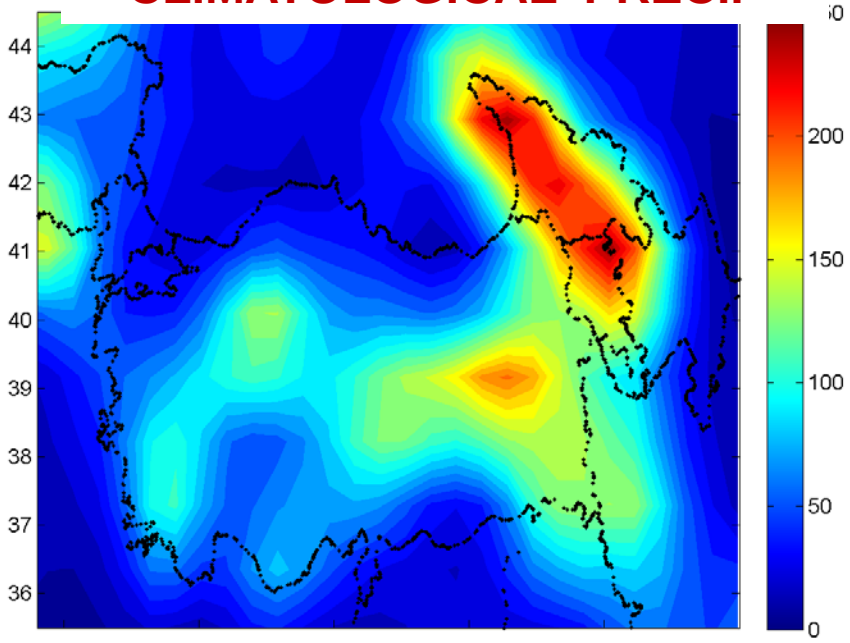
CLIMATOLOGICAL TEMP



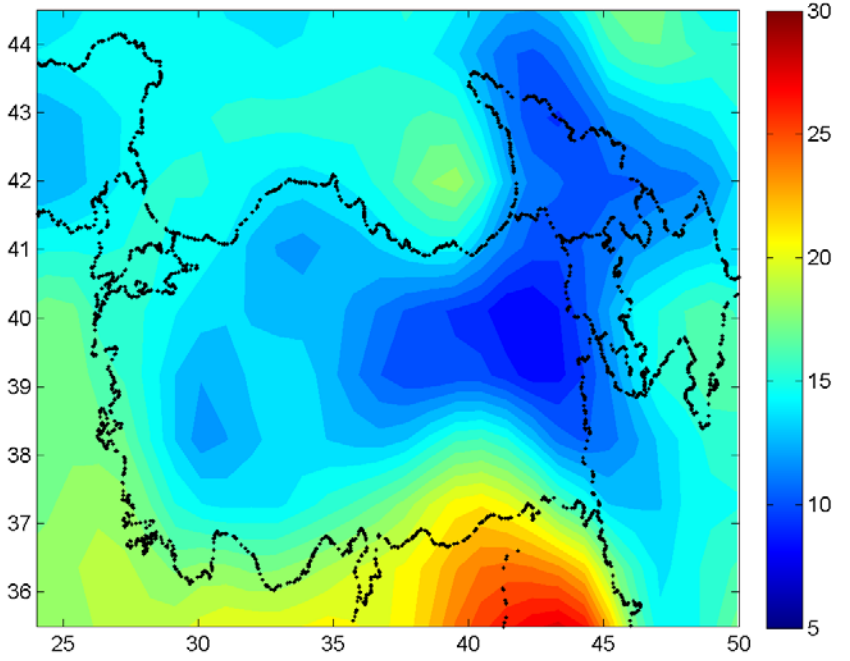
FORECAST MEAN MAY PRECIP (mm)



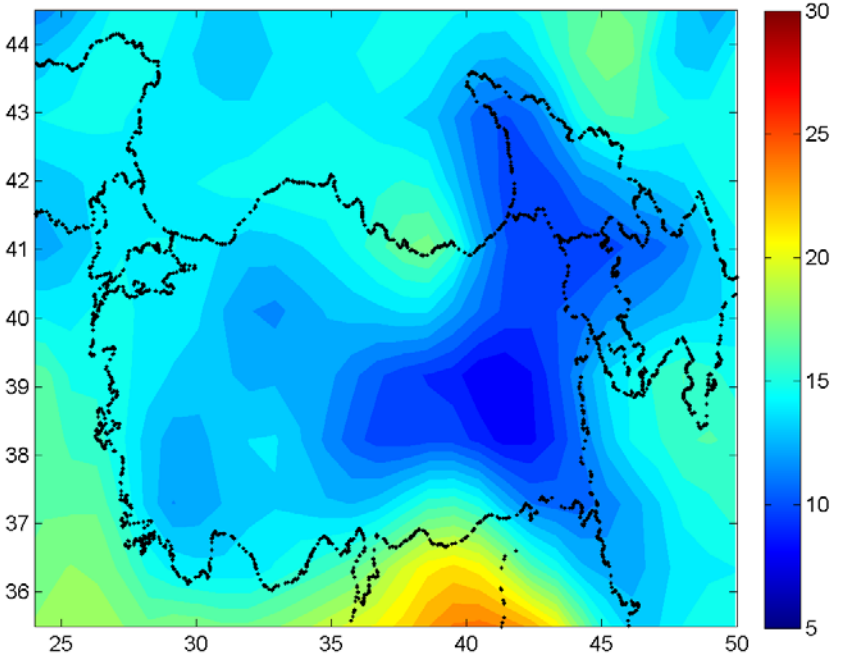
CLIMATOLOGICAL PRECIP



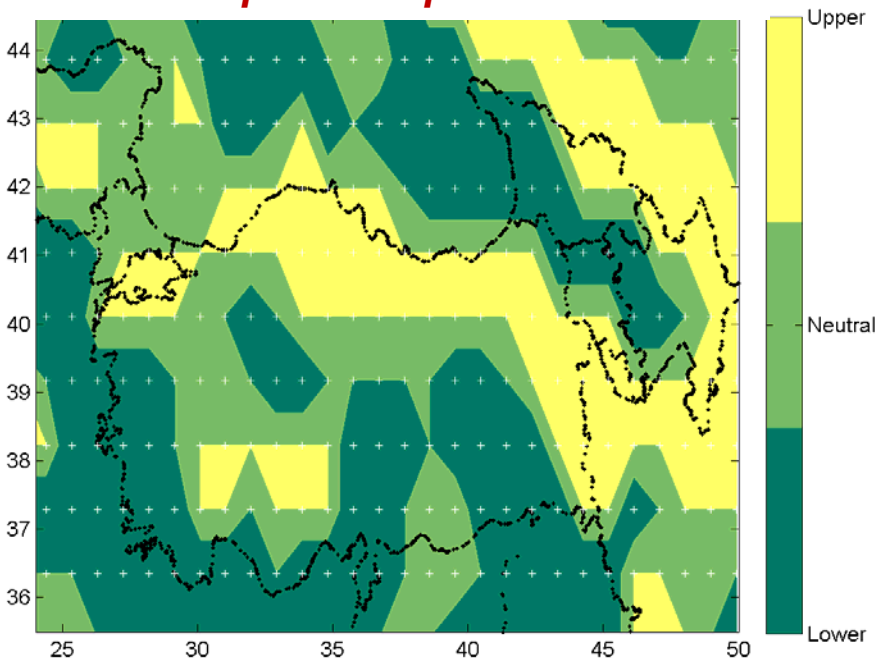
FORECAST MEAN MAY TEMP (ºC)



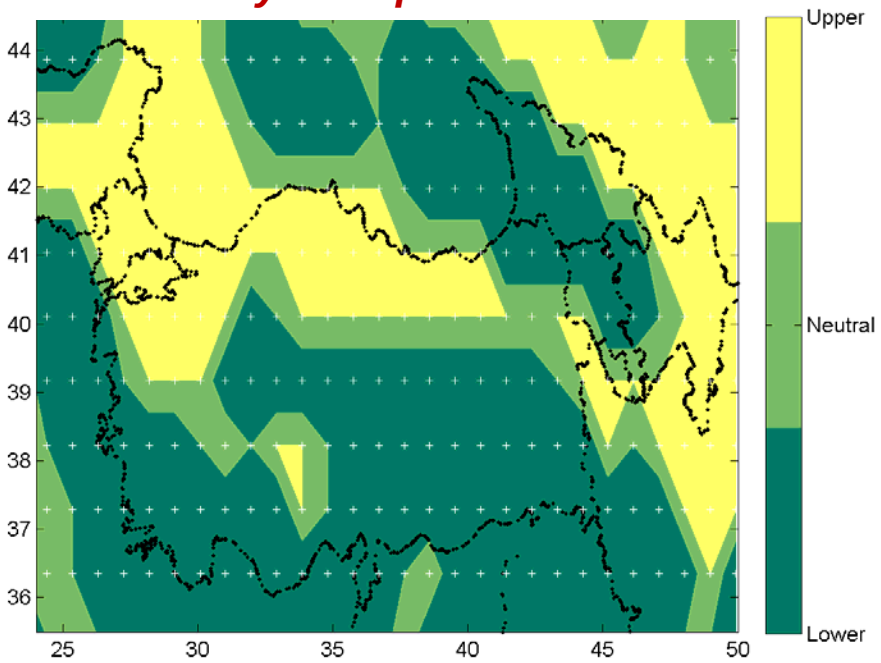
CLIMATOLOGICAL TEMP



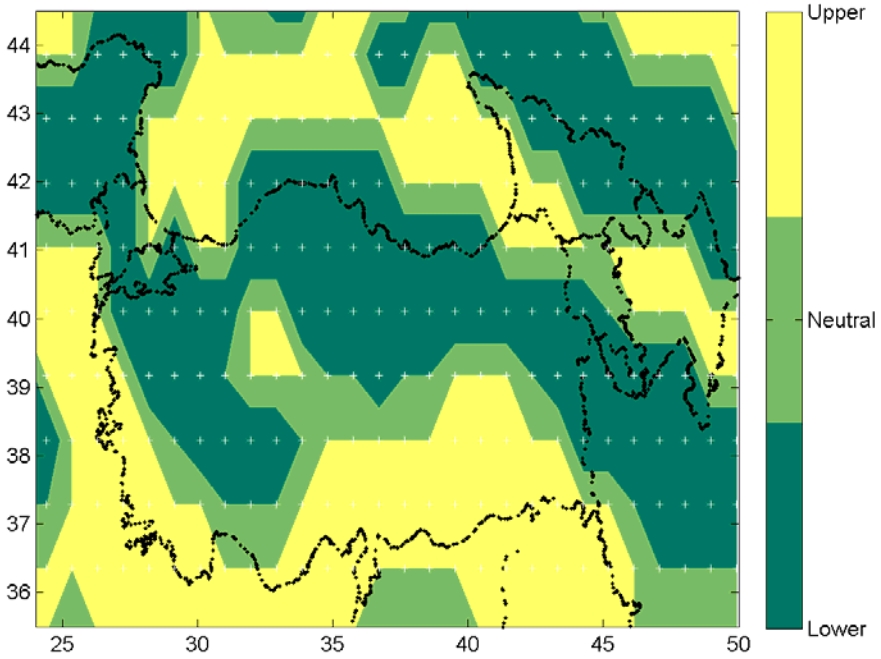
April Precipitation



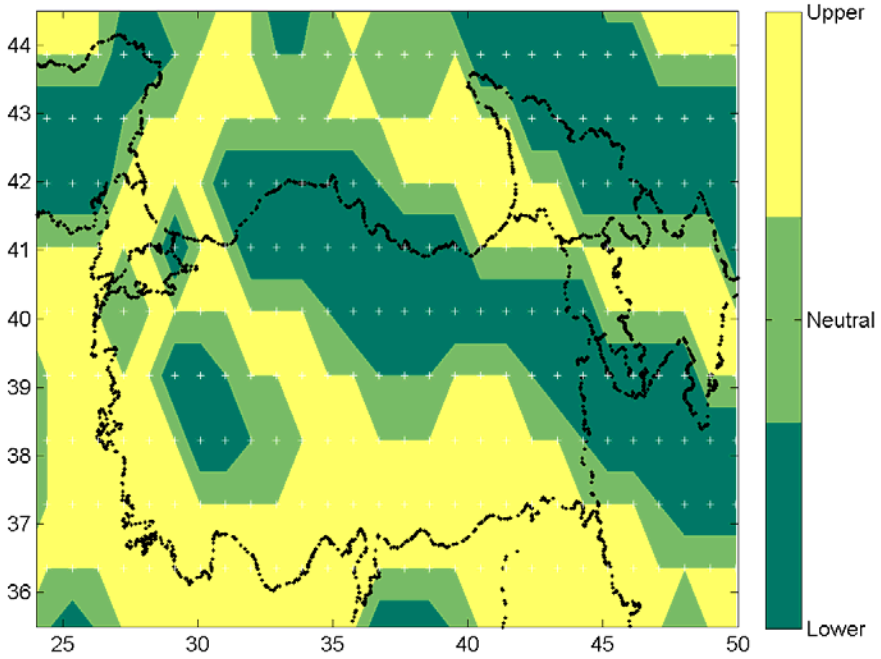
May Precipitation



April Temperature

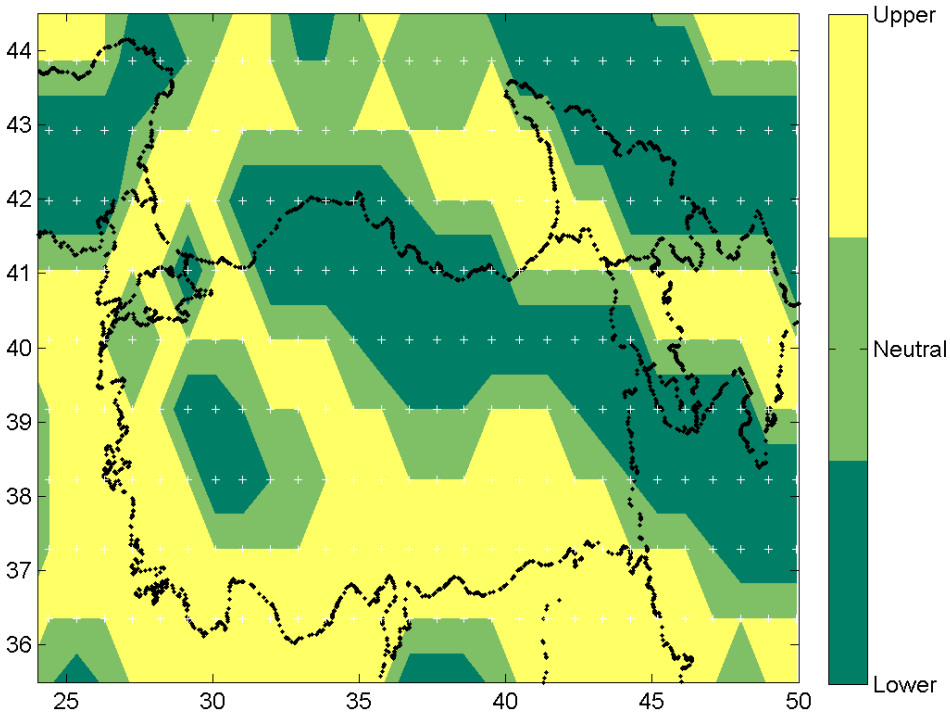


May Temperature

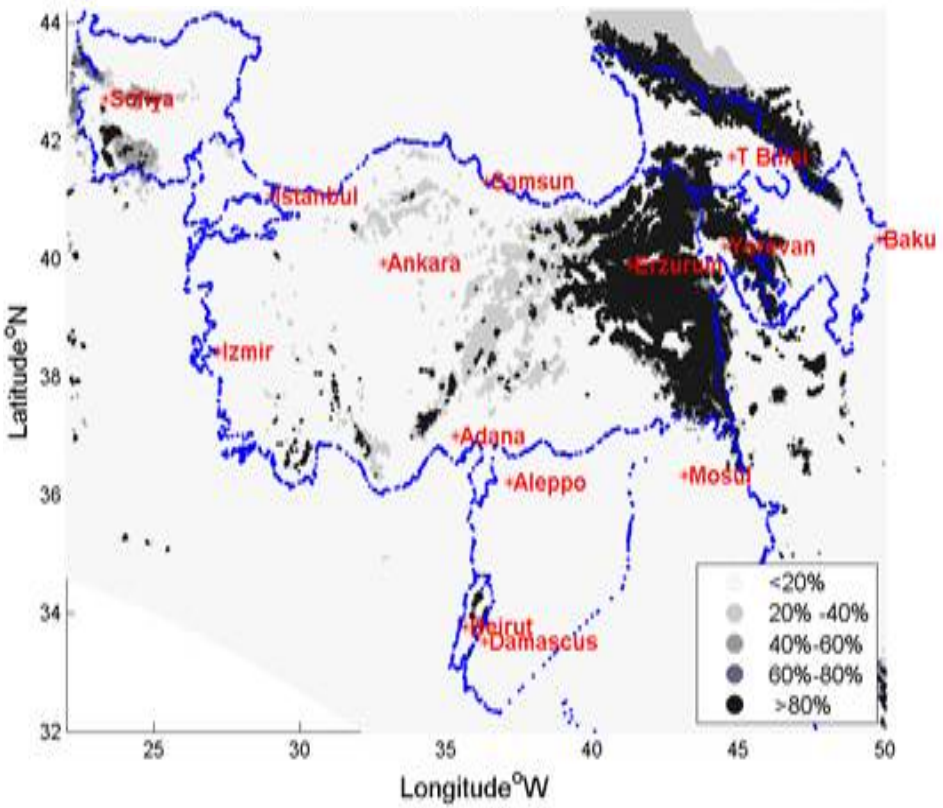


CFS FORECAST ASSESSMENT FOR BLACK SEA/MIDDLE EAST

May Temperature



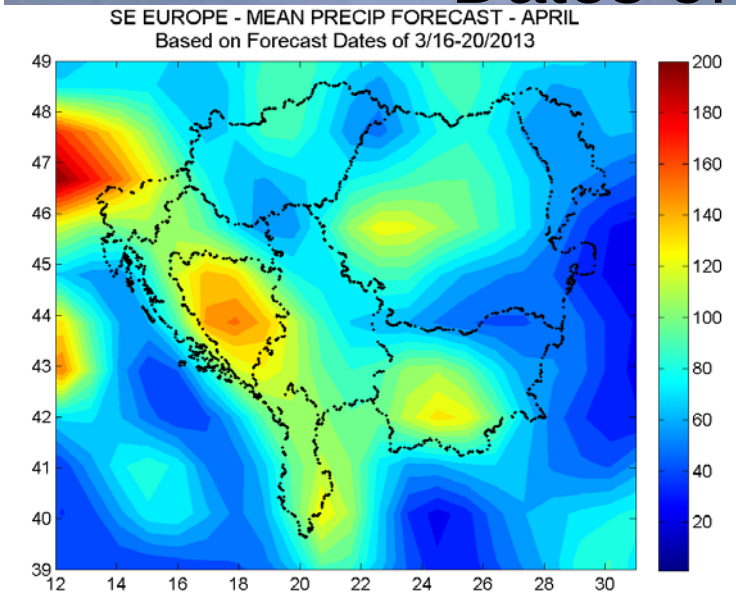
Snow Cover Frequency (~3/15/2013)

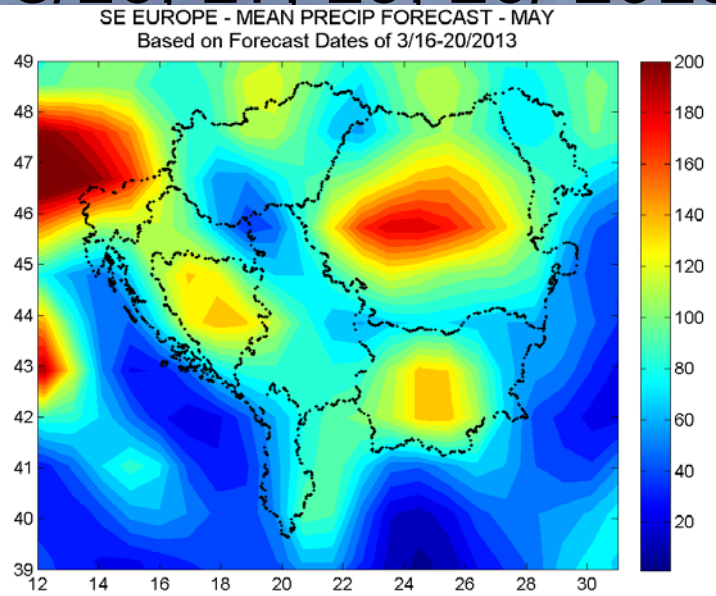


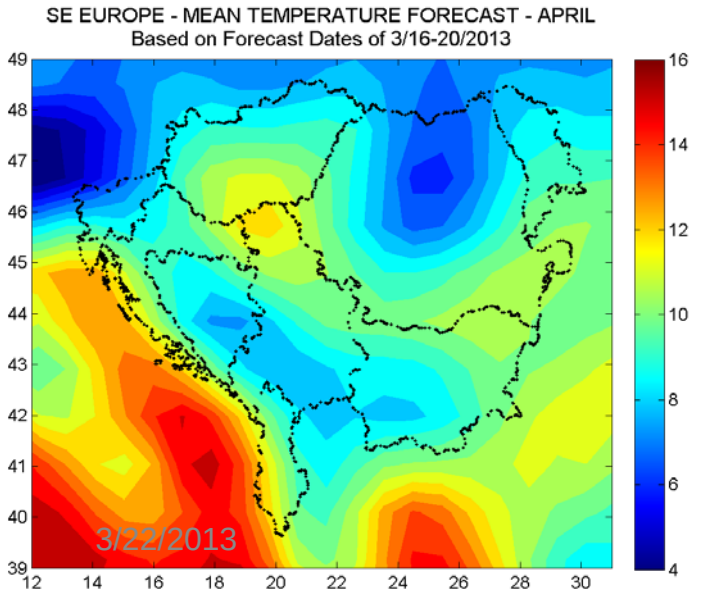
CFS FORECAST OVER BSME REGION SHOWS MIXED REGIONAL SIGNAL IN TERMS OF PRECIPITATION/TEMPERATURE IN TERCILE DISTRIBUTION.

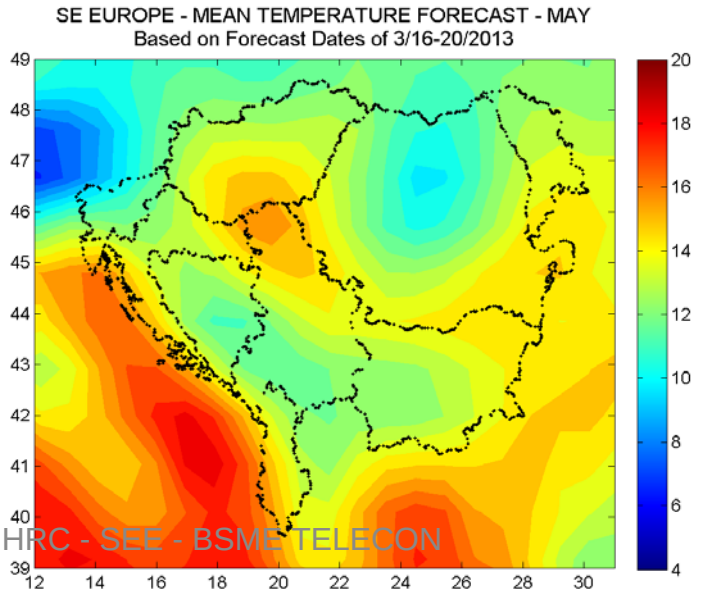
CFS Forecast Update

Dates of 3/16, 17, 19, 20/ 2013









RELATIVE TO 3/10-13 FORECAST

APR PREC DECR IN B-H, ROM (~20 mm @ peak)

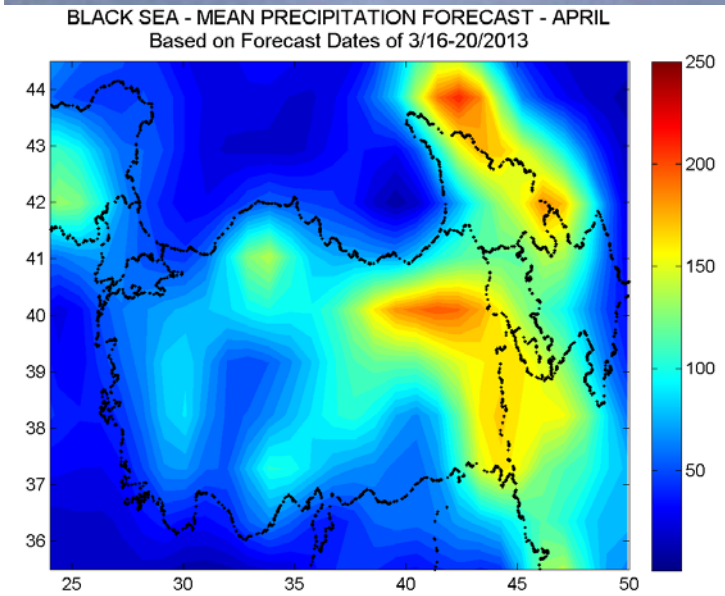
MAY PREC DECR IN B-H, ROM, BUL (~ 40 mm)

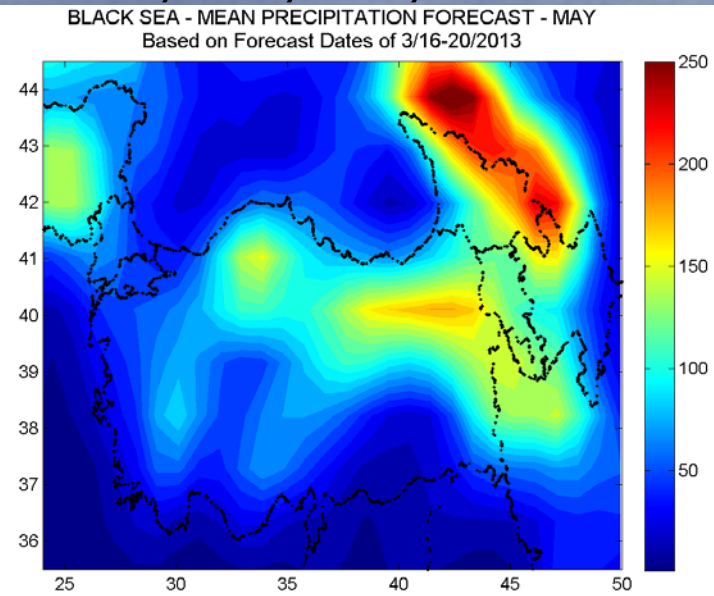
APR TEMP INCR GENERALLY (1-2º)

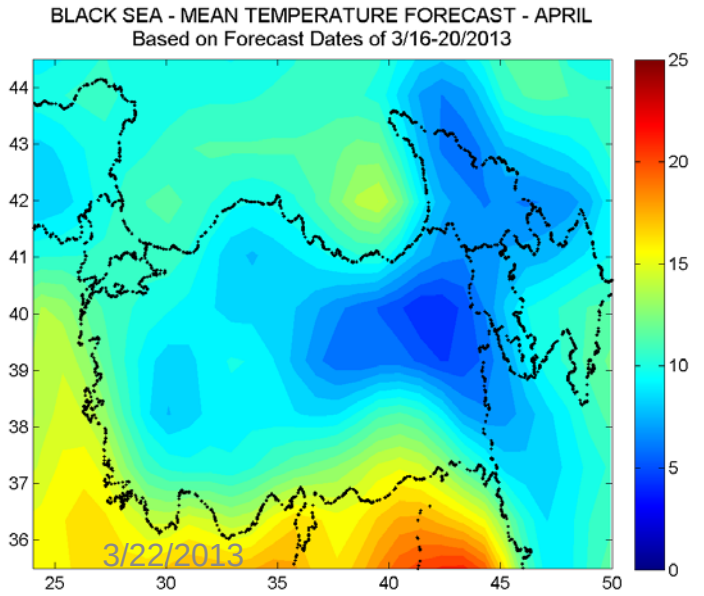
MAY TEMP DECR IN EAST, e.g., ROM (~1º)

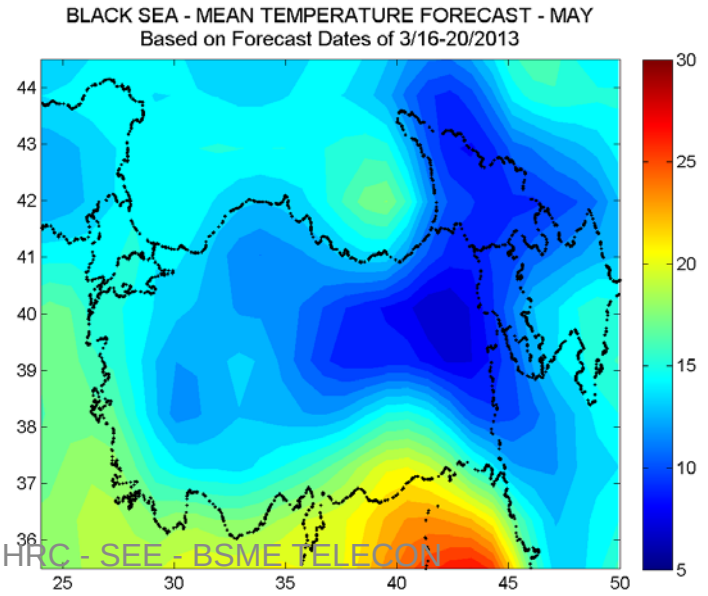
CFS Forecast Update

Dates of 3/16, 17, 19, 20/ 2013









RELATIVE TO 3/10-13 FORECAST

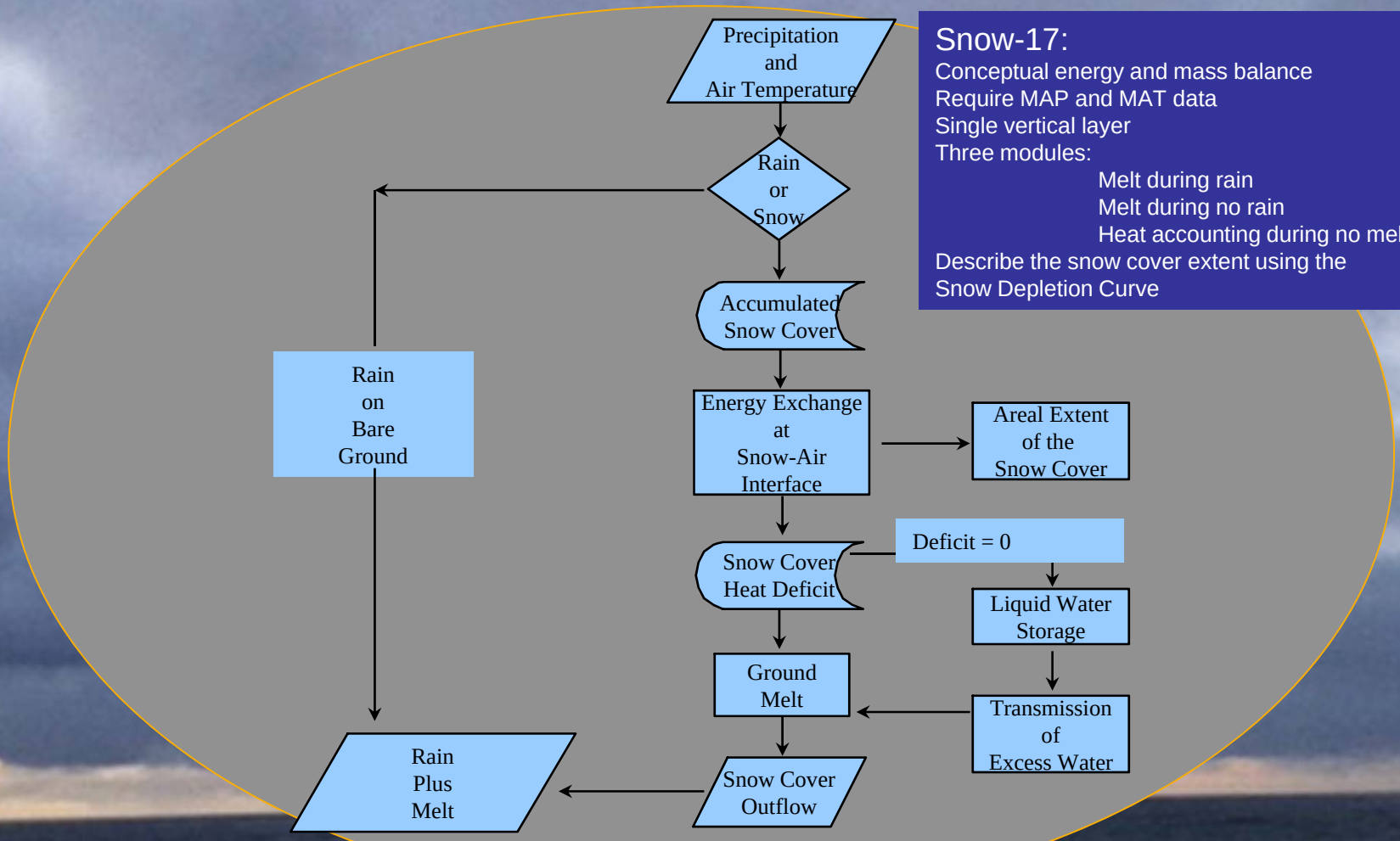
APR PREC DECR IN TURKEY (~20 mm @ peak)

MAY PREC DECR IN BULG, GEO (~ 40 mm max)

APR TEMP SIMILAR

MAY TEMP DECR GENERALLY (1-2°)

NWSRFS Accumulation and Ablation Snow model (Anderson 1976)



Snow-17:

Conceptual energy and mass balance
Require MAP and MAT data
Single vertical layer
Three modules:
- Melt during rain
- Melt during no rain
- Heat accounting during no melt

Describe the snow cover extent using the Snow Depletion Curve

Snow Model Data Requirements

- Surface Air Temperature
  - Index for the pack energy balance and determine the form of precipitation (rain or snow)
- Precipitation
  - determine amount of snowfall and amount of rain-on-snow (PXTEMP)
  - SCF - Multiplying factor that adjusts precipitation data for gage catch deficiencies during periods of snowfall
- Other Data (when available)
  - Snowfall
  - Snow course and/or snow sensors (water-equivalent)
  - Areal extent of snow cover (satellite)

Snow Model Variables

States

- SWE - Snow water equivalent
- Liquid content – PLWHC parameter (vertical transmission through the pack)
- Heat Deficit - Energy required to bring the snowpack to isothermal 0º C
- ATI – Antecedent Temperature Index
- Snow Pack Depth – (Optional)
- SCA - Snow Cover Area

Output

- Rain plus Melt

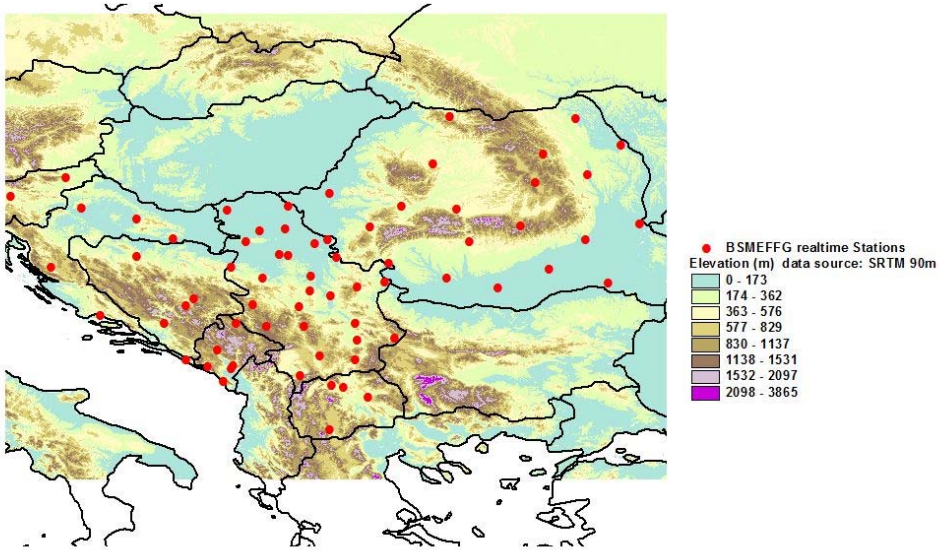
South East Europe (SEE)
4344 basins ~150 km²

GTS DATA AVAILABLE AT HRC

GTS Mean Areal Temperature (MAT)

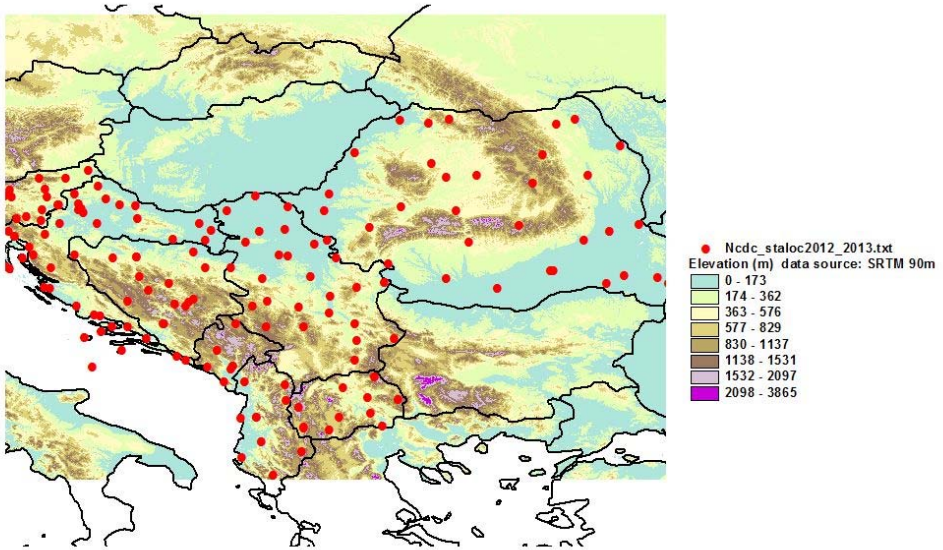
STATION DATA

Real Time Data Available from BSMEFFG (74 stations)



National Climatic Data Center /NOAA

NCDC (172 stations)

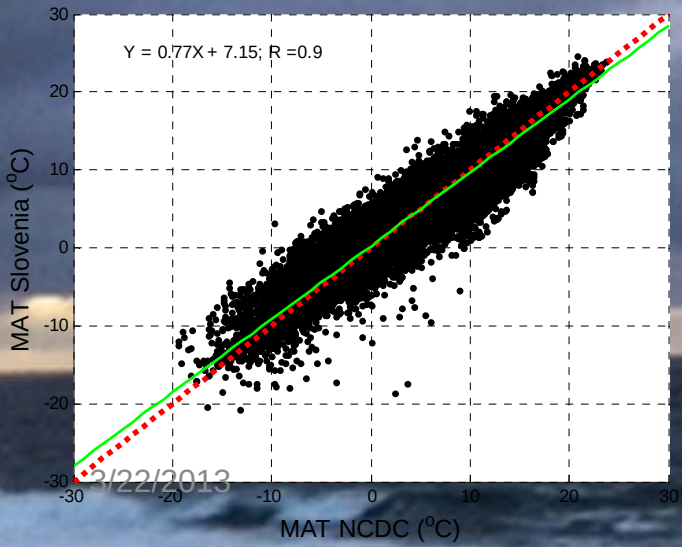


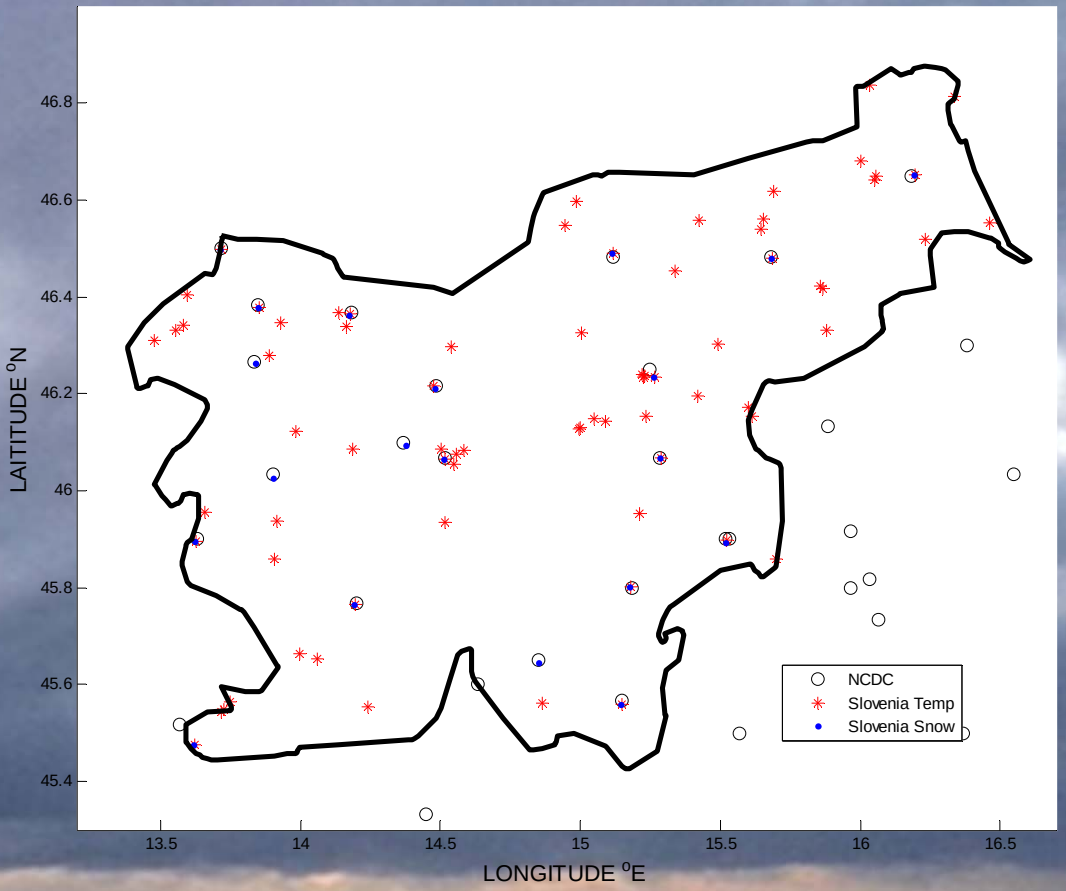
NCDC 1/11/2012 - 2/25/2013 ~170 gauges

GTS 2/25/2013 – 15/3/2013 ~74 gauges

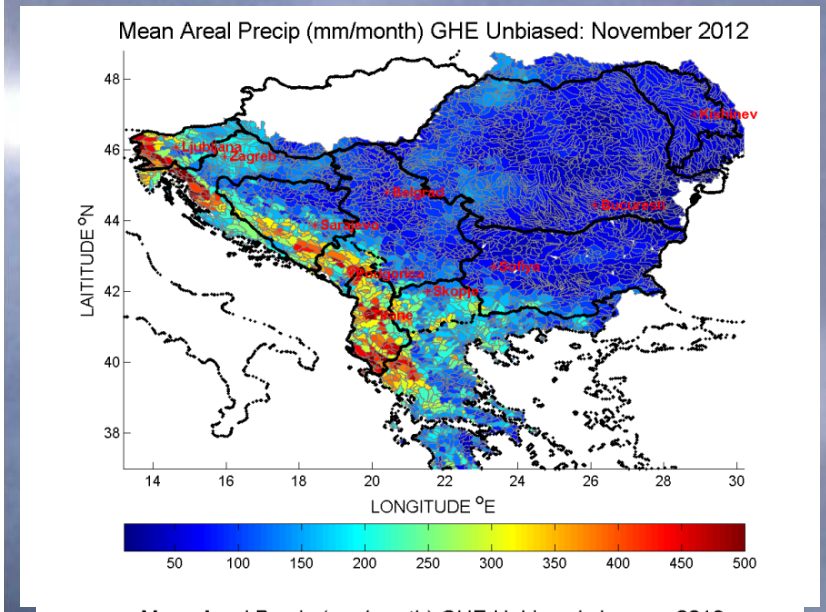
Slovenia Local Dataset ~70 gauges

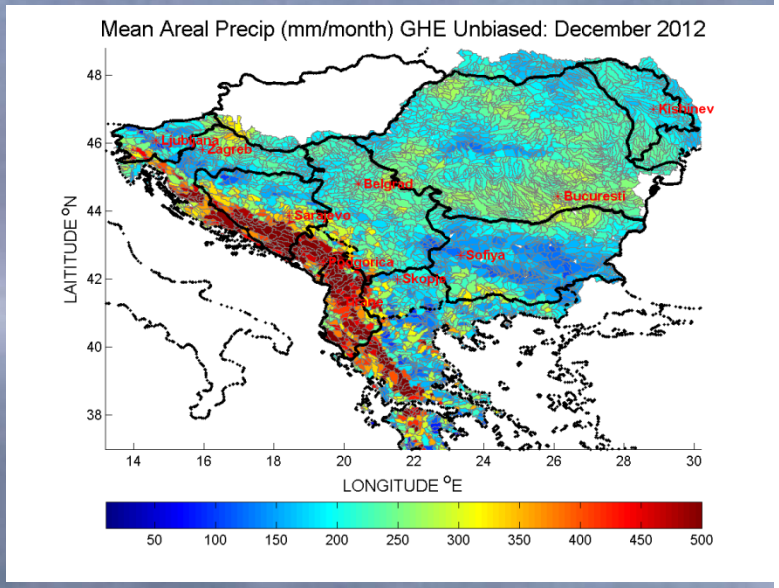
Data from Slovenia

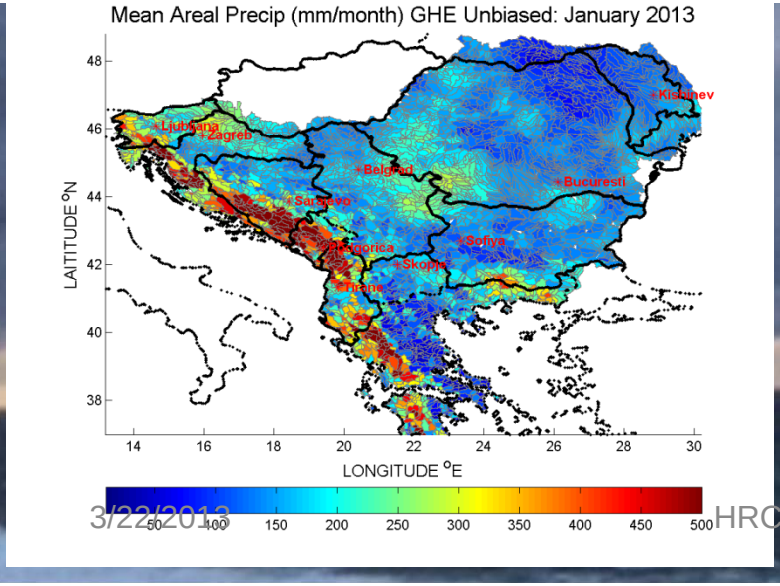


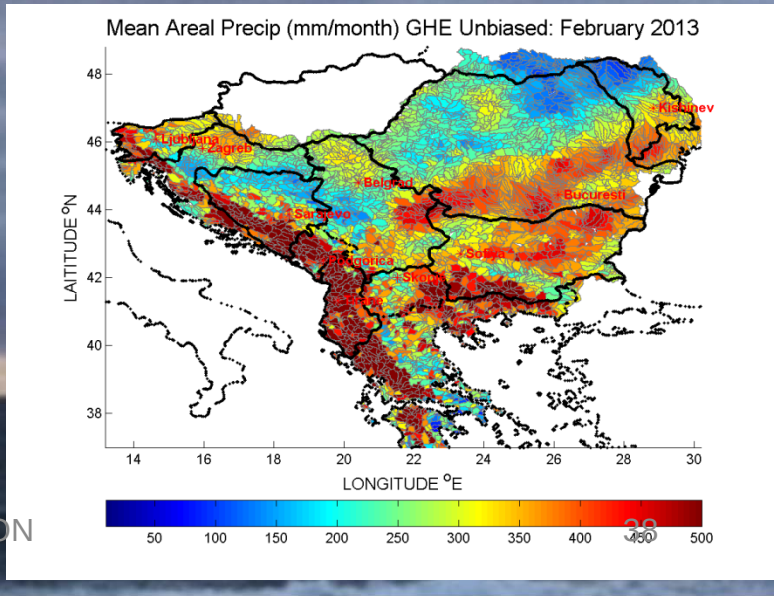


Mean Areal Precipitation
Bias Adjusted Hydro-Estimator



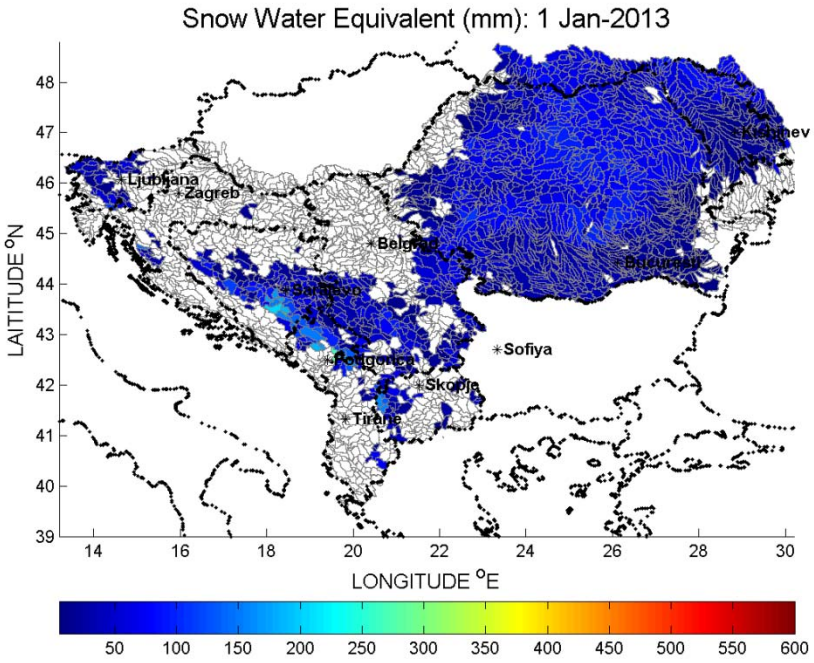


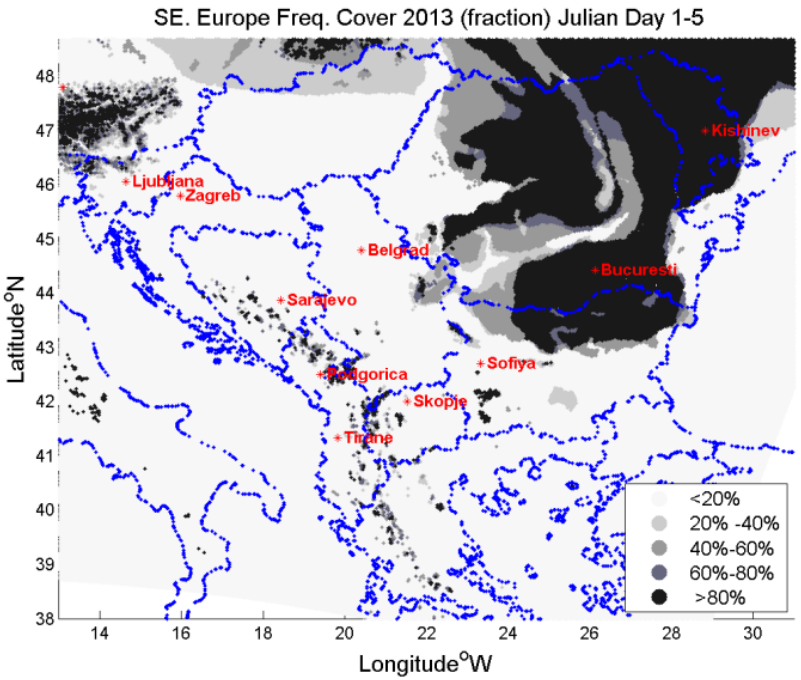


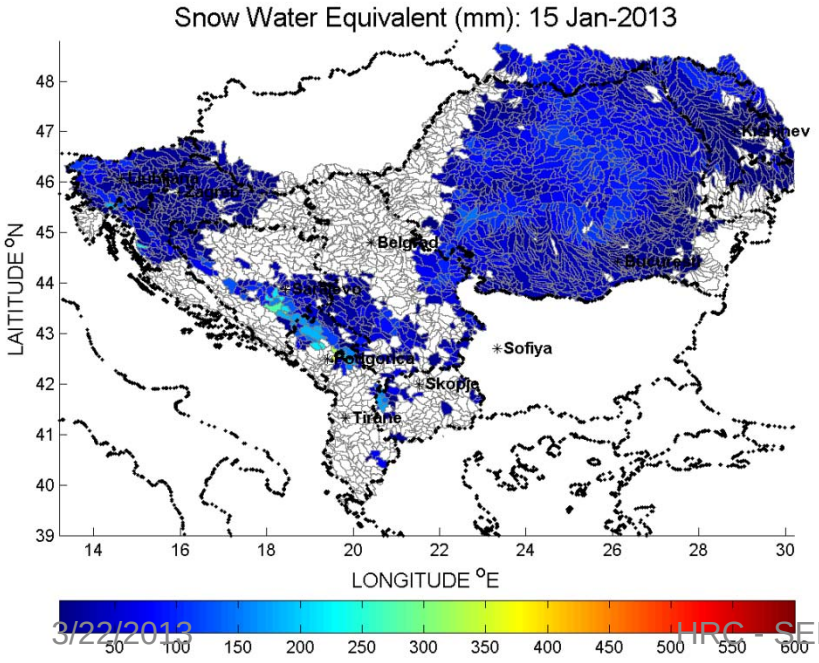


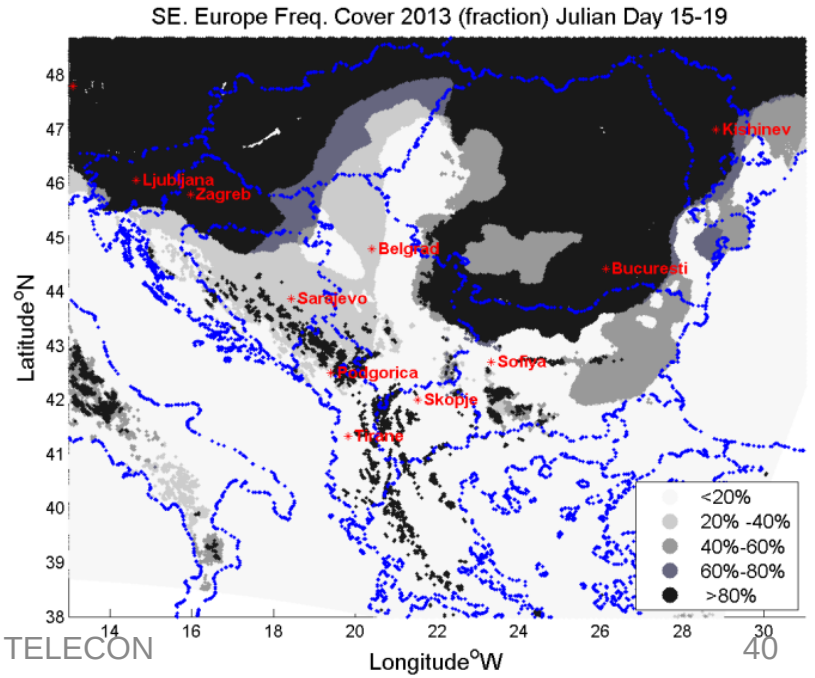
Satellite Snow Covered Area –IMS

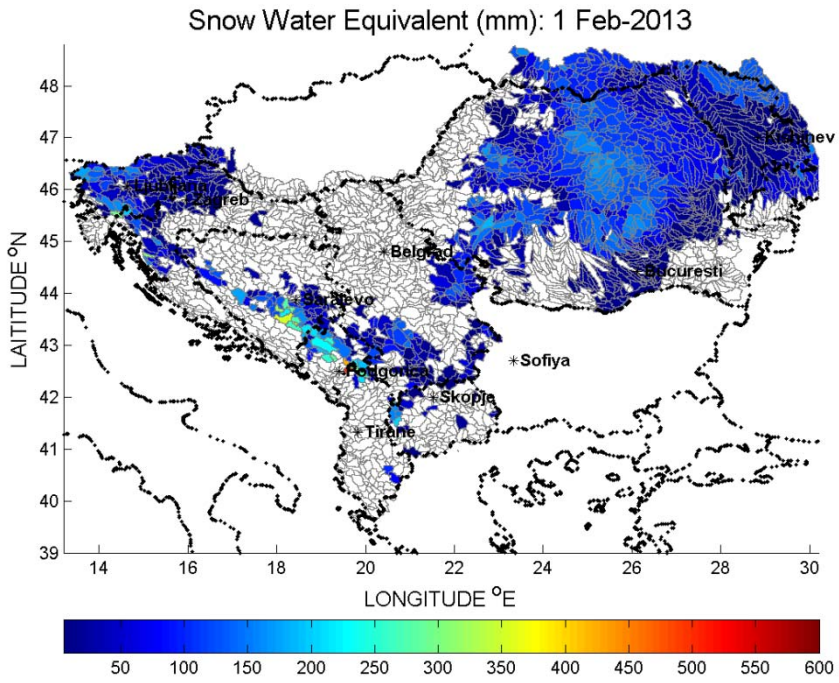
- Interactive Multisensor Snow and Ice Mapping System (IMS), made available through National Snow and Ice Data Center, NOAA. http://nsidc.org/data/docs/noaa/g02156_ims_snow_ice_analysis/index.html
- Daily (23:00 GMT) snow cover based on summary of multiple satellites at 4km x 4km resolution.
  - Geostationary satellites
  - Polar orbiter: MODIS, AVHRR & Microwave
  - Assisted by modeling , climatological maps, and personnel expertise
- Generally available within 1 day (often within several hours) following date of observation
- 4km product is Operational since 2006-2011 (movie)
- **Helfrich et al., 2007 Hydrological Processes**

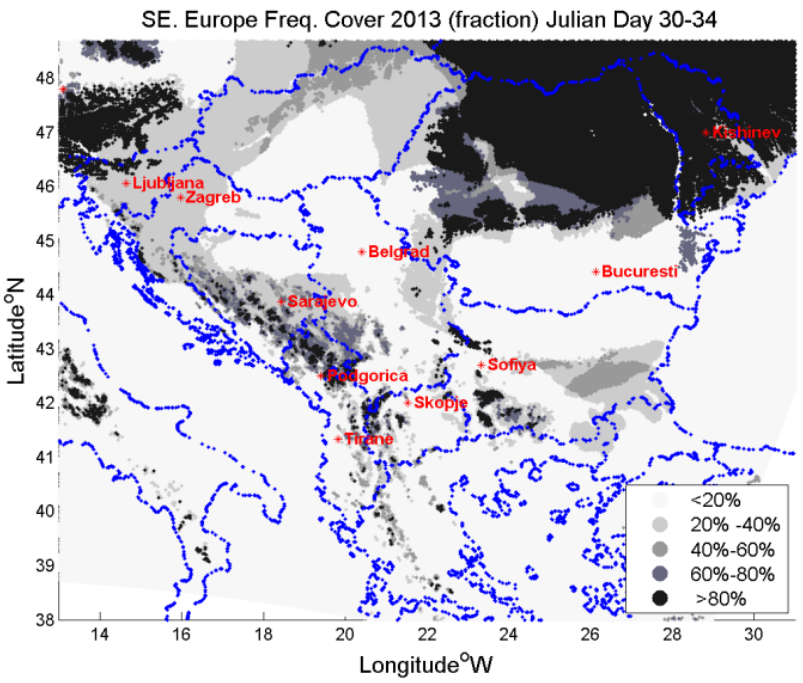

Snow Water Equivalent (mm): 1 Jan-2013
LAITITUDE °N
LONGITUDE °E
Ljubljana
Zagreb
Belgrad
Bucuresti
Sofiya
Podgorica
Skopje
Tirane
50 100 150 200 250 300 350 400 450 500 550 600

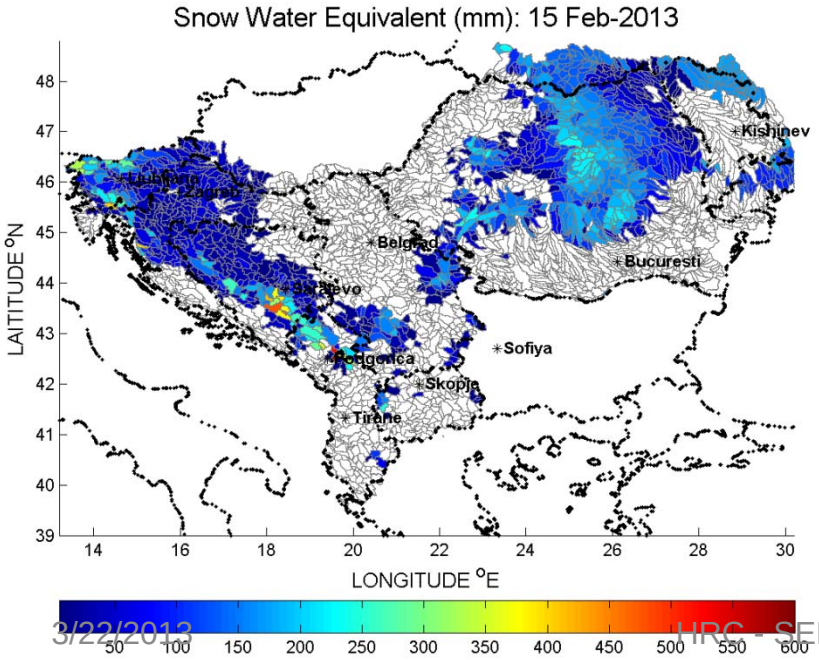

SE. Europe Freq. Cover 2013 (fraction) Julian Day 1-5
Latitude°N
Longitude°W
Kishinev
Ljubljana
Zagreb
Belgrad
Bucuresti
Sofiya
Podgorica
Skopje
Tirane
<20%
20% -40%
40%-60%
60%-80%
>80%

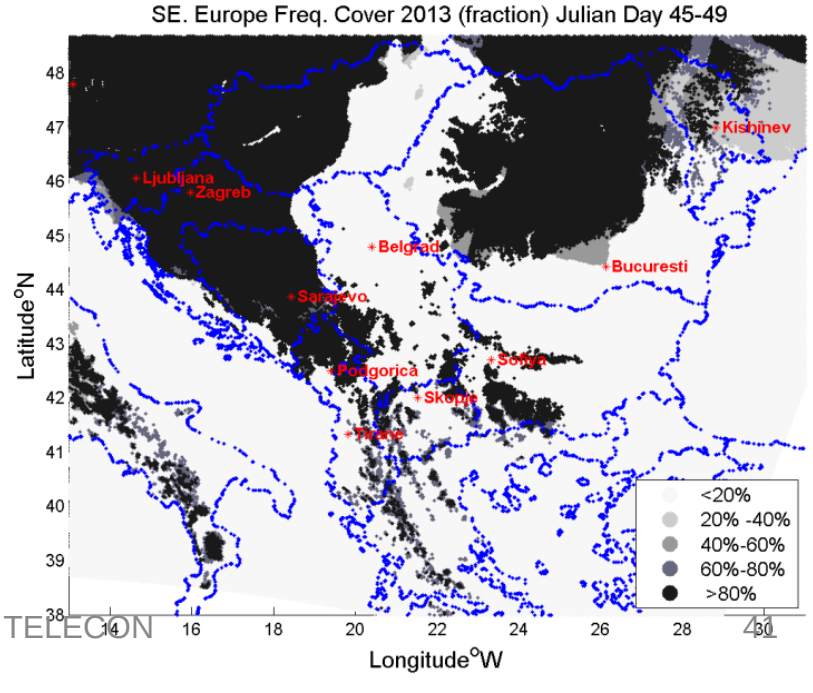

Snow Water Equivalent (mm): 15 Jan-2013
LAITITUDE °N
LONGITUDE °E
Belgrad
Bucuresti
Sofiya
Podgorica
Skopje
Tirane
50 100 150 200 250 300 350 400 450 500 550 600

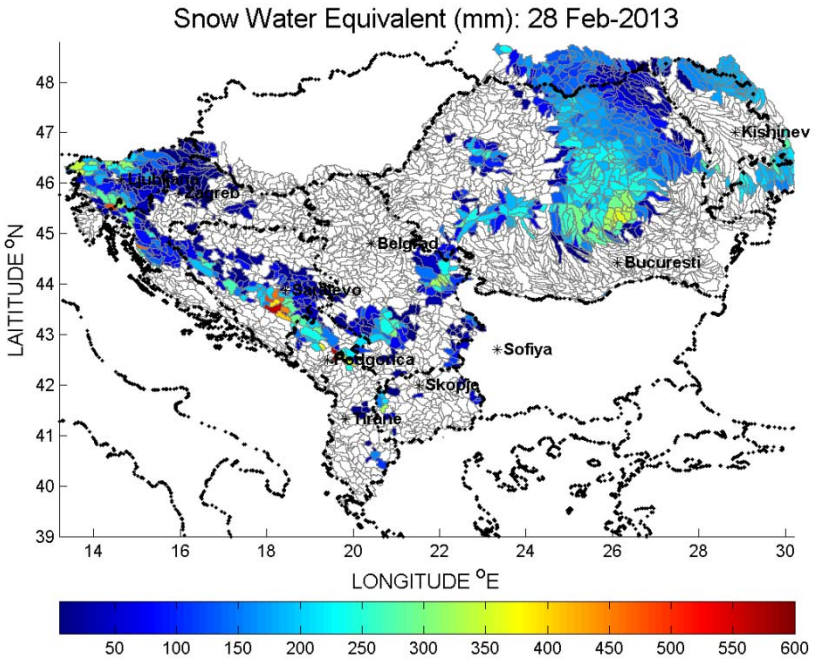

SE. Europe Freq. Cover 2013 (fraction) Julian Day 15-19
Latitude°N
Longitude°W
Kishinev
Ljubljana
Zagreb
Belgrad
Bucuresti
Sofiya
Podgorica
Skopje
Tirane
<20%
20% -40%
40%-60%
60%-80%
>80%

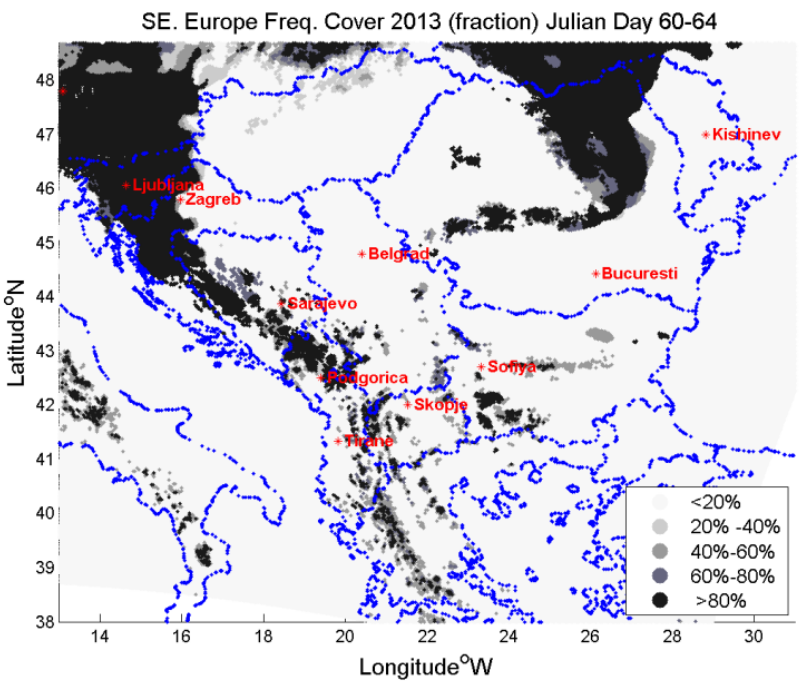

Snow Water Equivalent (mm): 1 Feb-2013
LAITITUDE °N
LONGITUDE °E
Kishinev
Ljubljana
Zagreb
Belgrad
Bucuresti
Sarajevo
Sofiya
Podgorica
Skopje
Tirane
50 100 150 200 250 300 350 400 450 500 550 600

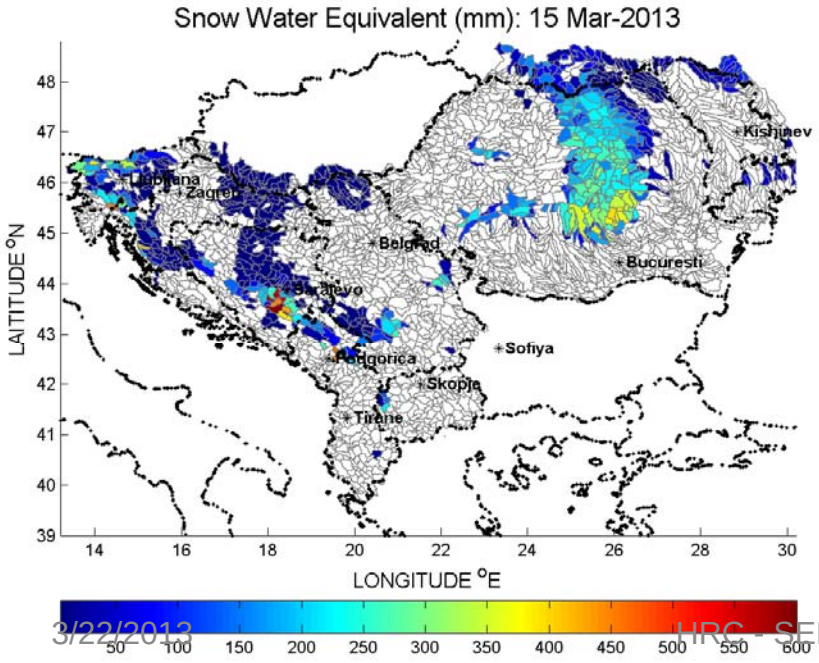

SE. Europe Freq. Cover 2013 (fraction) Julian Day 30-34
Latitude°N
Longitude°W
Kishinev
Ljubljana
Zagreb
Belgrad
Bucuresti
Sarajevo
Sofiya
Podgorica
Skopje
Tirane
<20%
20% -40%
40%-60%
60%-80%
>80%

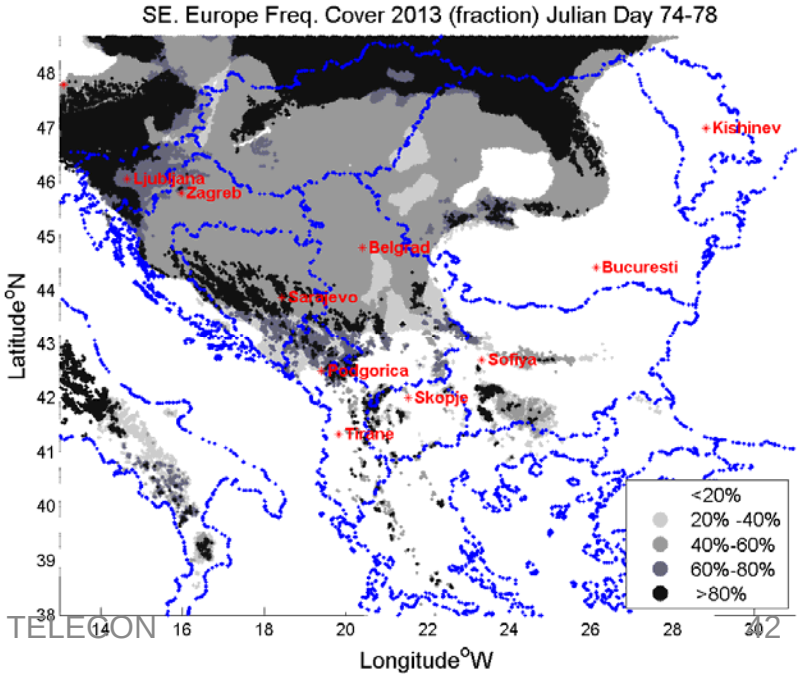

Snow Water Equivalent (mm): 15 Feb-2013
LAITITUDE °N
LONGITUDE °E
Kishinev
Ljubljana
Zagreb
Belgrad
Bucuresti
Sarajevo
Sofiya
Podgorica
Skopje
Tirane
50 100 150 200 250 300 350 400 450 500 550 600


SE. Europe Freq. Cover 2013 (fraction) Julian Day 45-49
Latitude°N
Longitude°W
Kishinev
Ljubljana
Zagreb
Belgrad
Bucuresti
Sarajevo
Sofiya
Podgorica
Skopje
Tirane
<20%
20% -40%
40%-60%
60%-80%
>80%

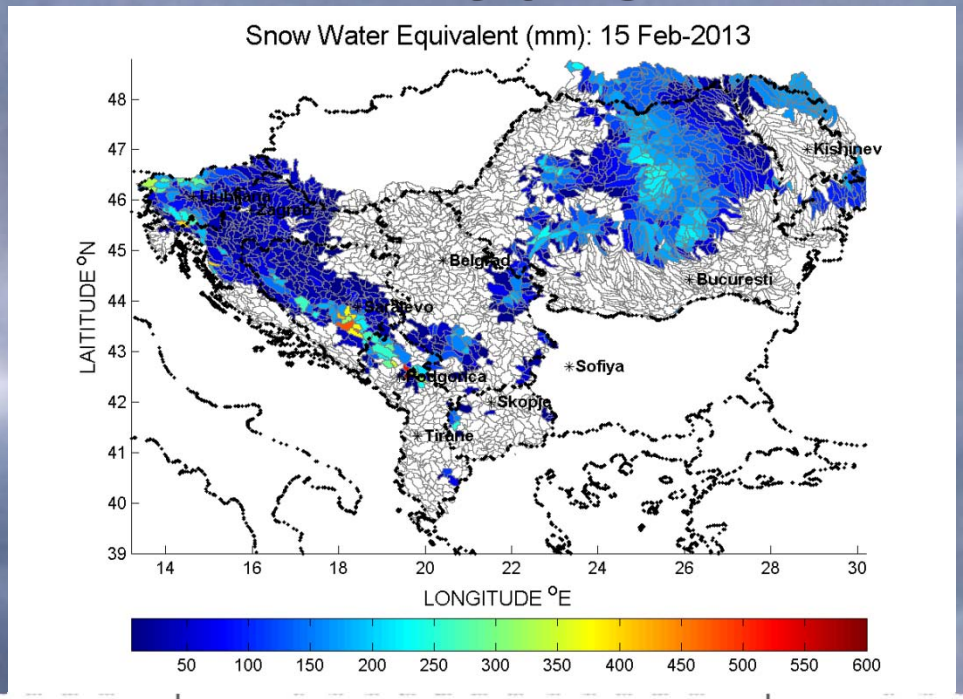

Snow Water Equivalent (mm): 28 Feb-2013
LAITITUDE °N
LONGITUDE °E
Kishinev
Ljubljana
Zagreb
Belgrad
Bucuresti
Sarajevo
Podgorica
Sofiya
Skopje
Tirane
50 100 150 200 250 300 350 400 450 500 550 600

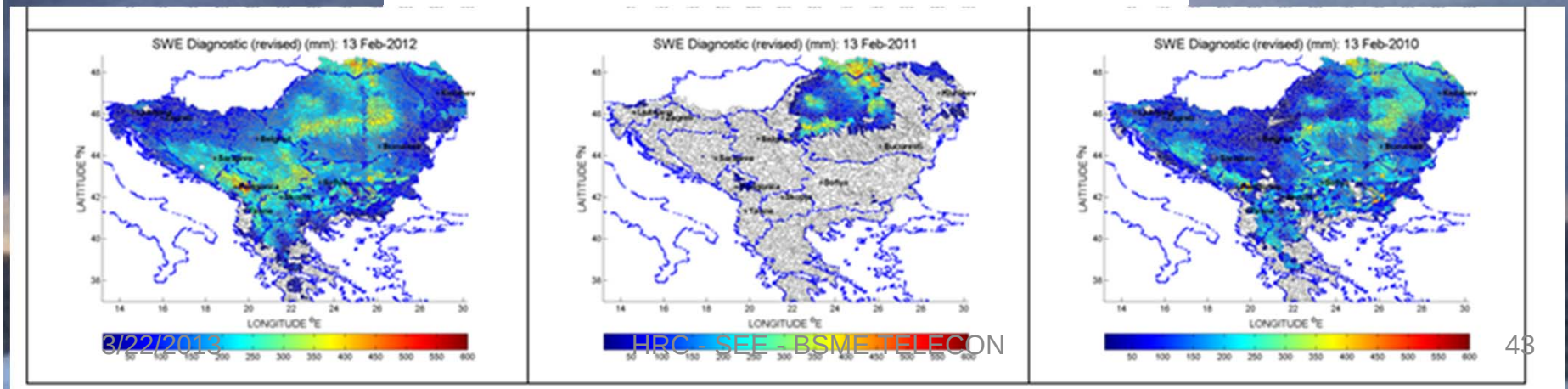

SE. Europe Freq. Cover 2013 (fraction) Julian Day 60-64
Latitude °N
Longitude °W
Kishinev
Ljubljana
Zagreb
Belgrad
Bucuresti
Sarajevo
Podgorica
Sofiya
Skopje
Tirane
<20%
20% -40%
40%-60%
60%-80%
>80%


Snow Water Equivalent (mm): 15 Mar-2013
LAITITUDE °N
LONGITUDE °E
Kishinev
Ljubljana
Zagreb
Belgrad
Bucuresti
Sarajevo
Podgorica
Sofiya
Skopje
Tirane
50 100 150 200 250 300 350 400 450 500 550 600


SE. Europe Freq. Cover 2013 (fraction) Julian Day 74-78
Latitude °N
Longitude °W
Kishinev
Ljubljana
Zagreb
Belgrad
Bucuresti
Sarajevo
Podgorica
Sofiya
Skopje
Tirane
<20%
20% -40%
40%-60%
60%-80%
>80%

Comparison of SWE with previous Years

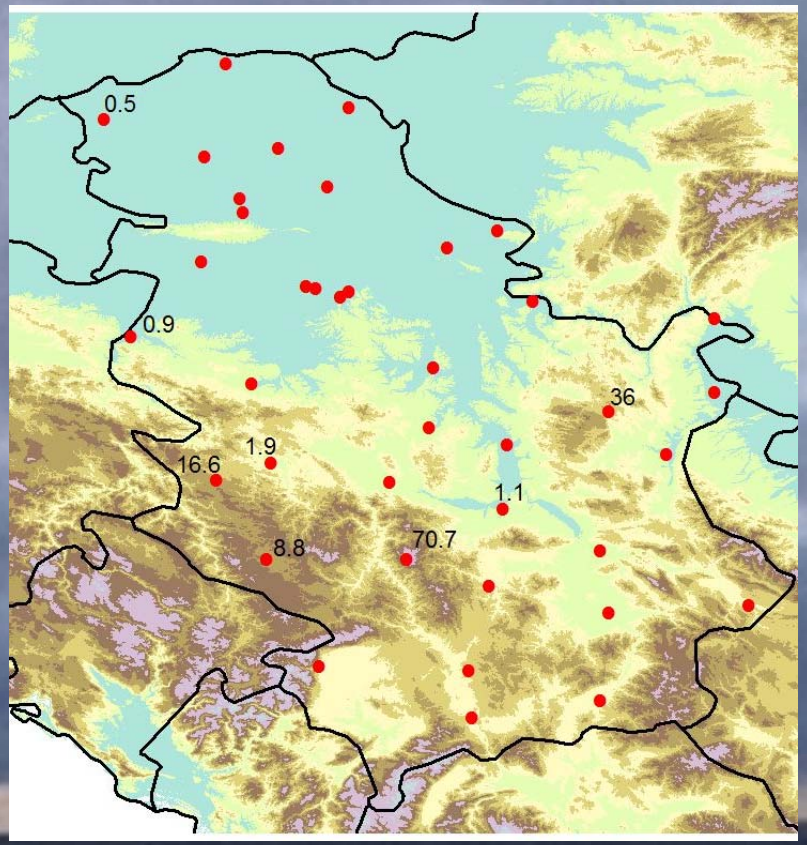




Serbia: Comparison of SWE to climatology of Snow depth

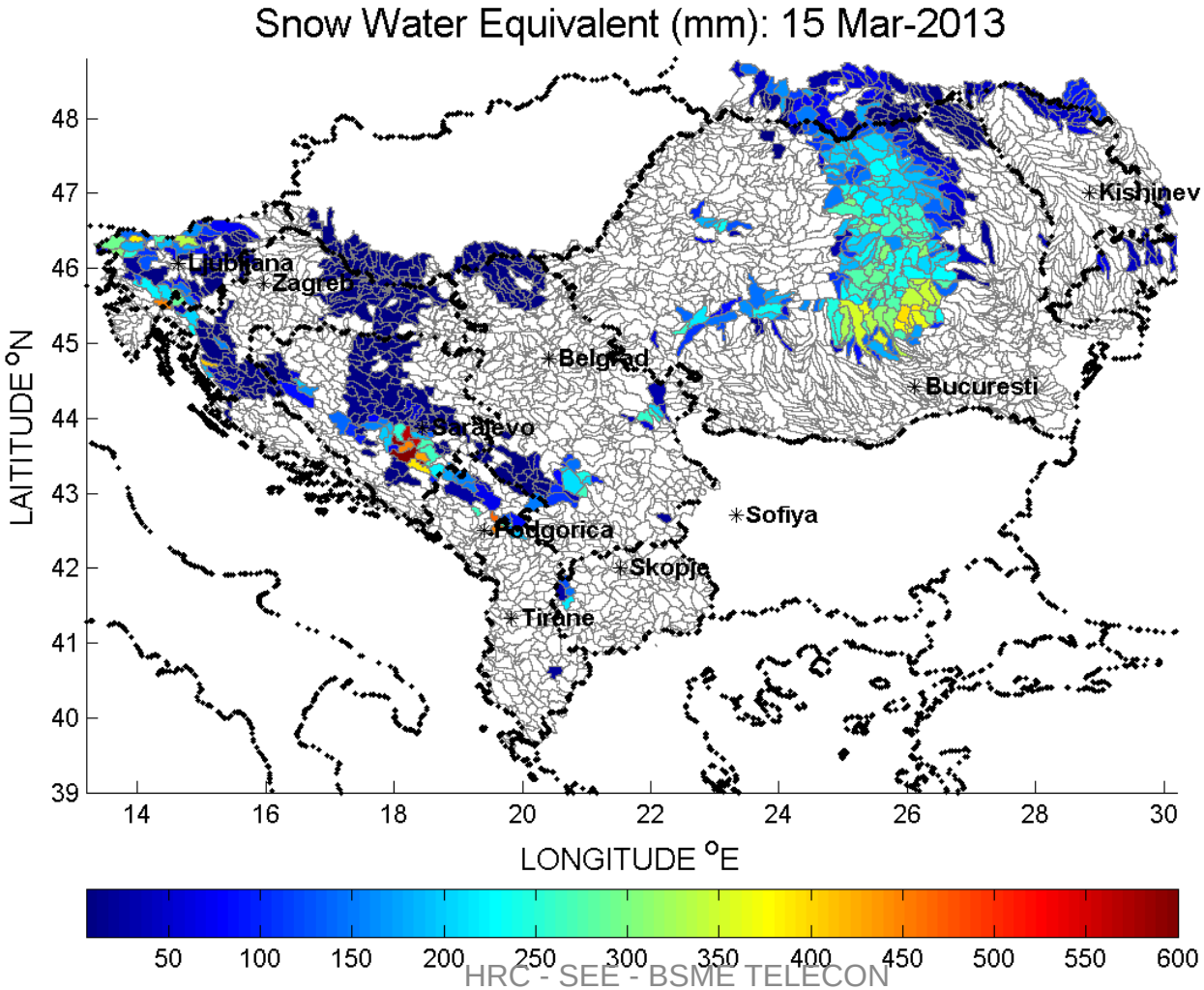
SWE 15 March 2013

Average Snow Depth (cm) March 15



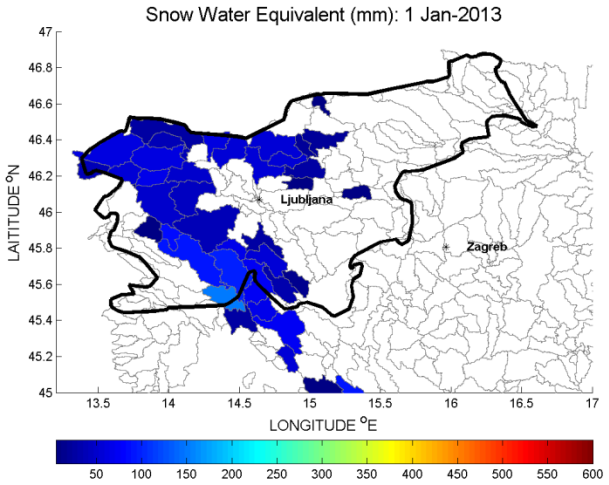
Climatological data 1980-2010 from Serbia

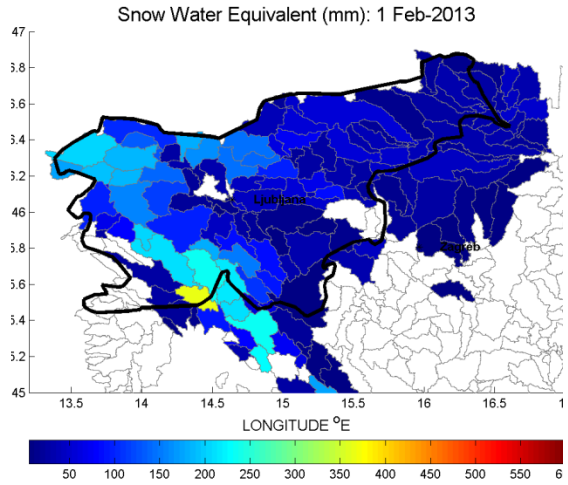
Outlook: Snow Water Equivalent Baseline

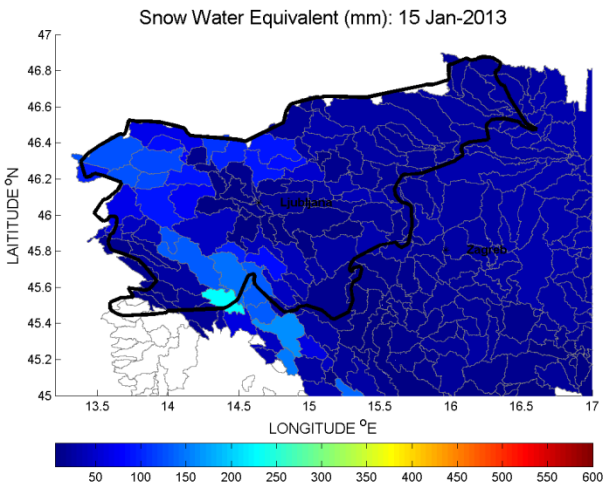


Slovenia: Comparison of SWE using different sources of Temperature data

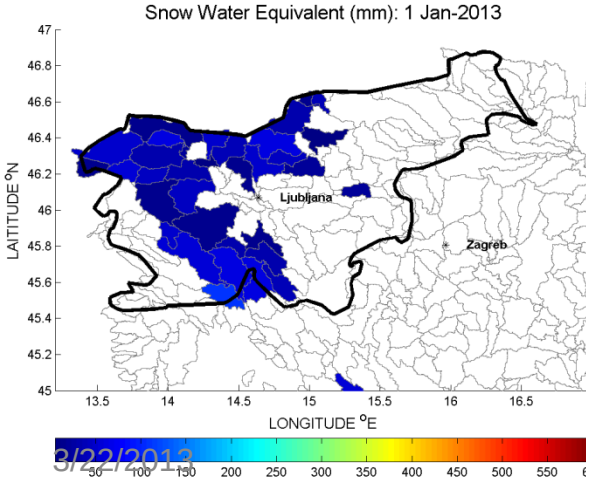
GTS Reports

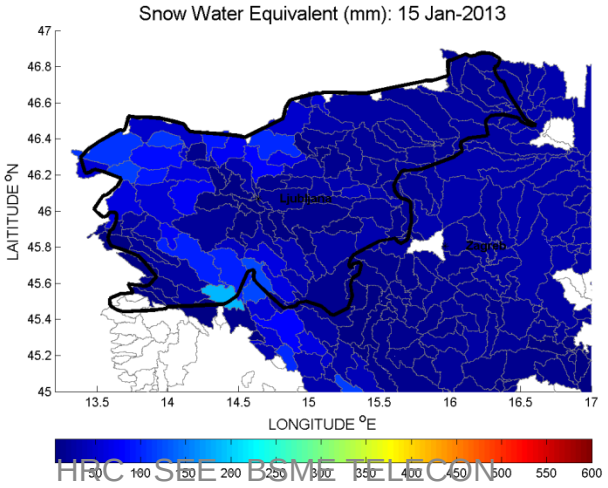


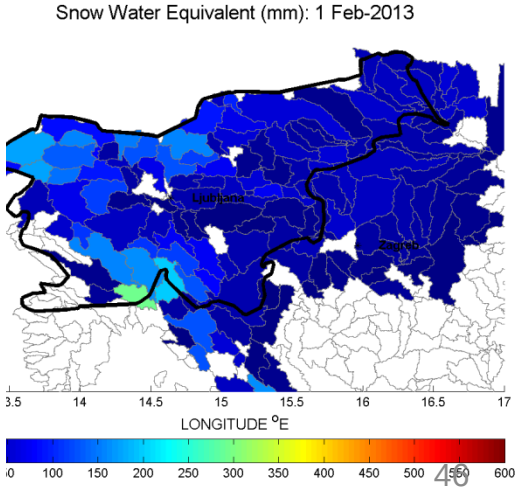




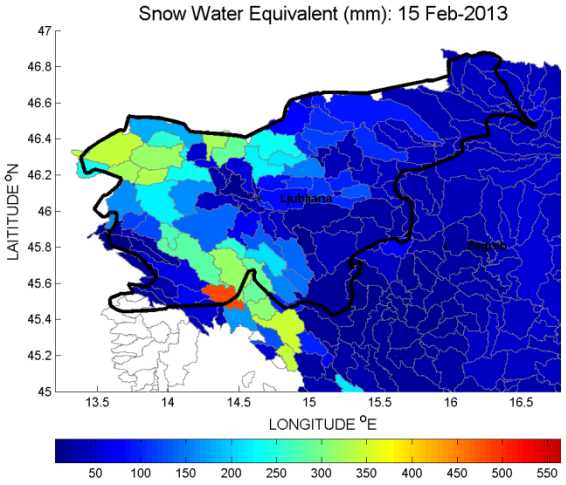
IMPACT OF LOCAL DATA

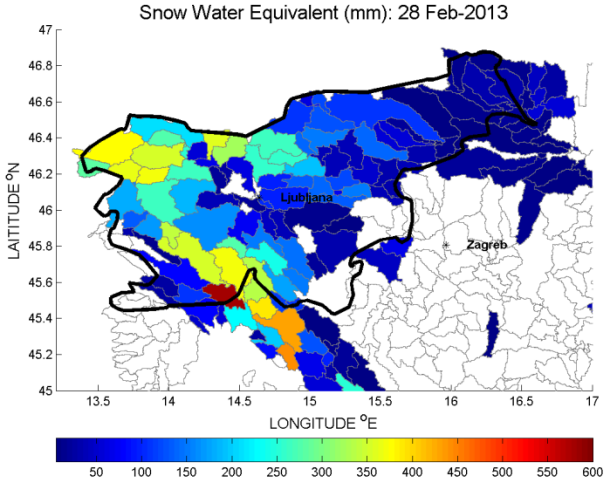


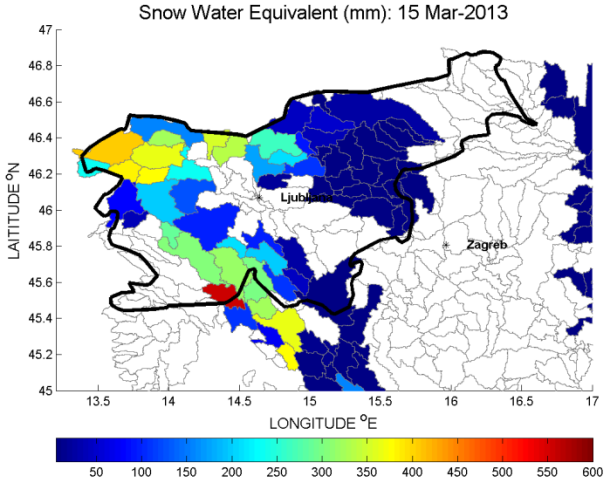




GTS Reports







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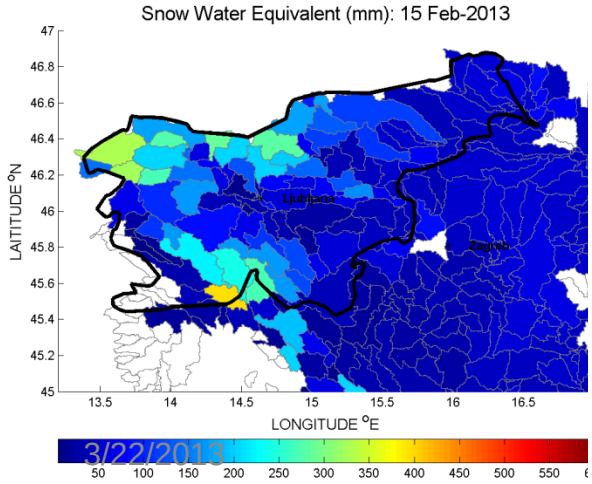
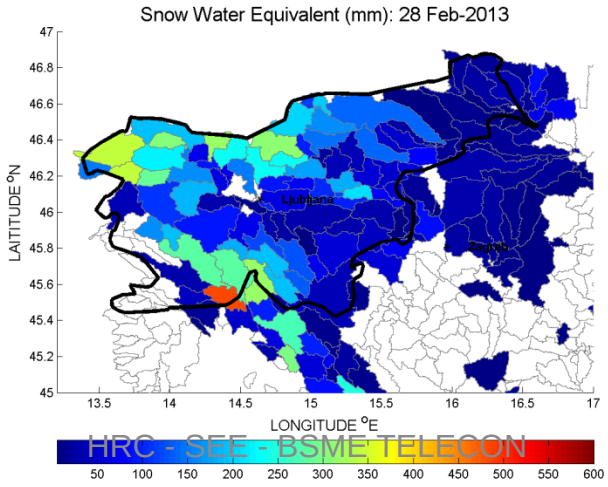
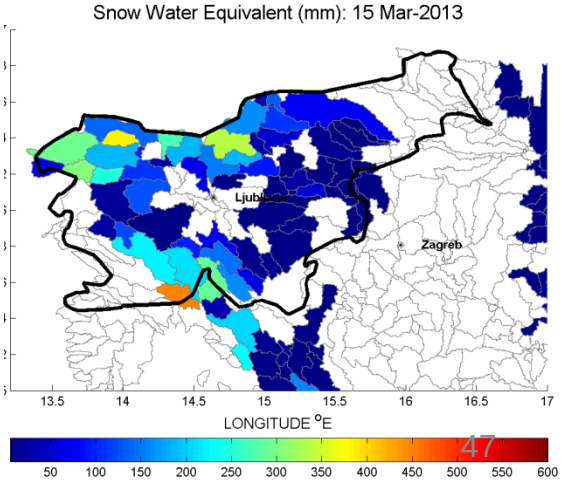
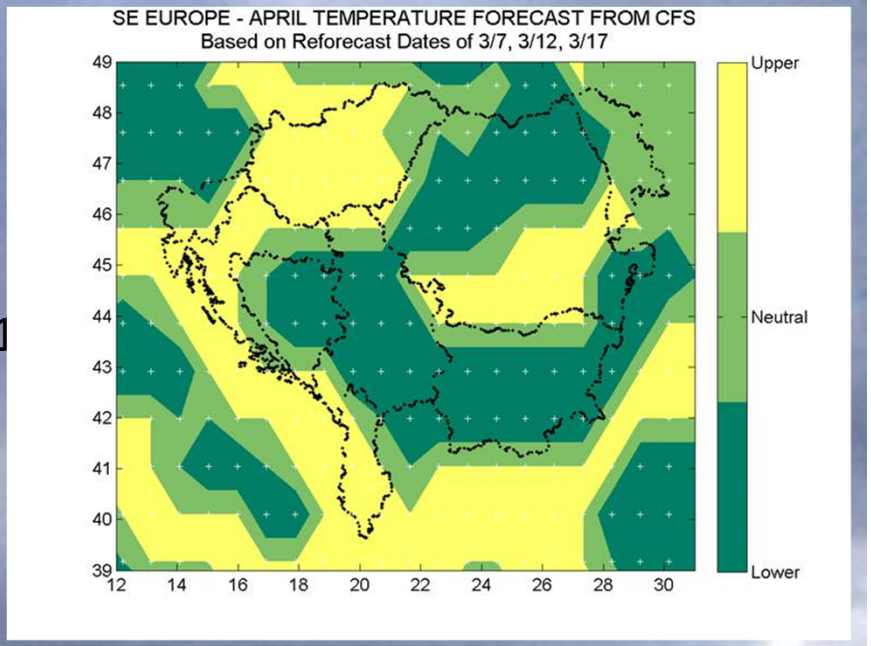




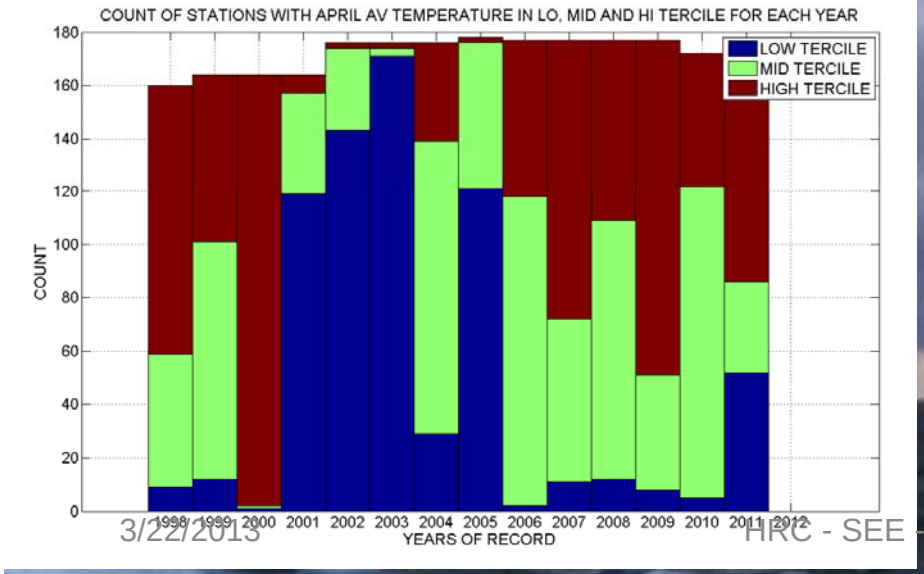


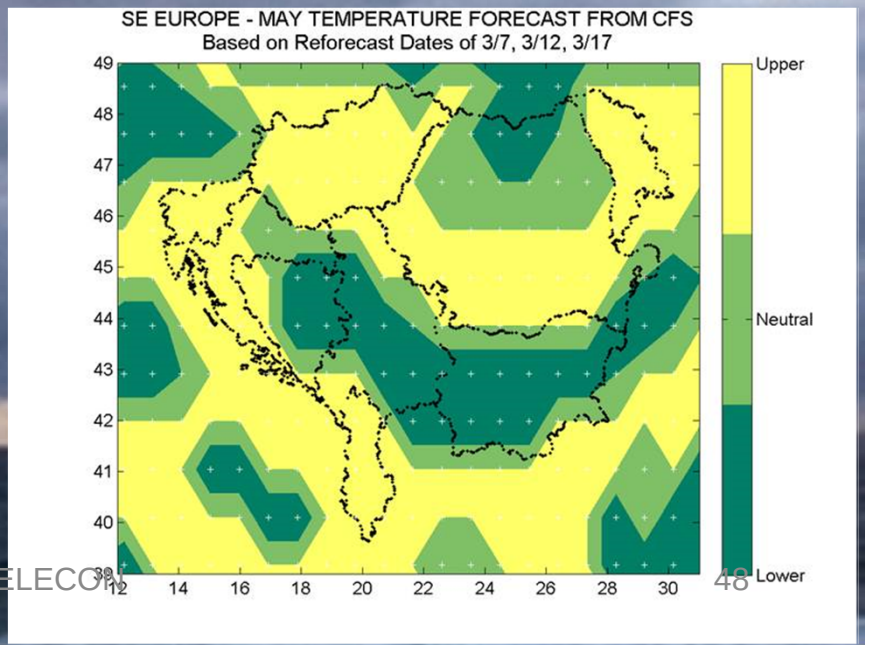
SEE OUTLOOK:

- Selected Years: 1998, 2000, 2007, 2009, 201
- MAT: NCDC gauge data
- MAP: NCDC gauge data
- Snow Base line: 15 March 2013

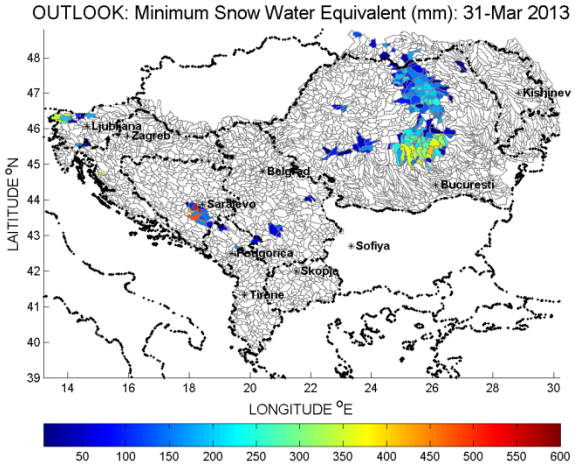


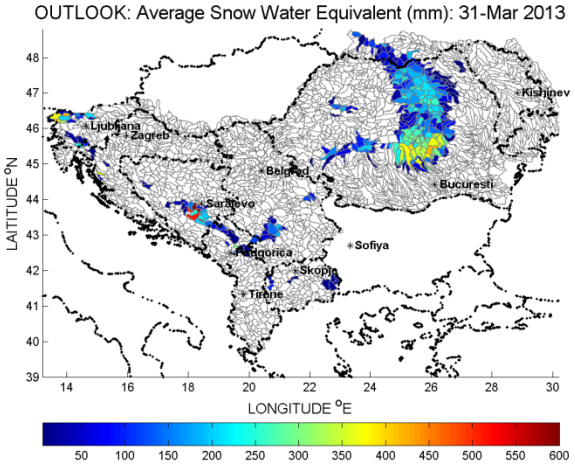
APRIL HISTORICAL TERCILES TEMPERATURE

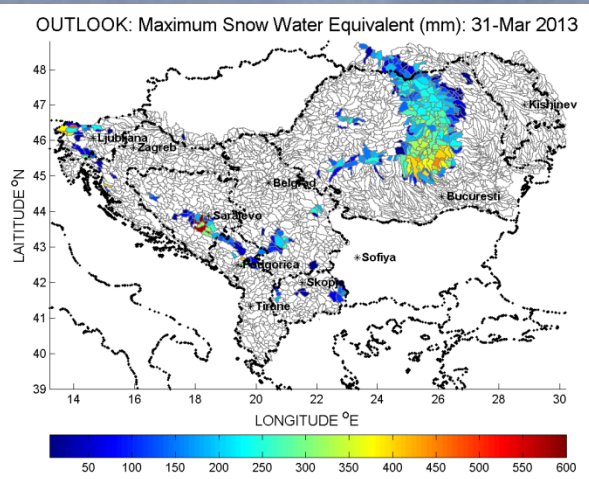


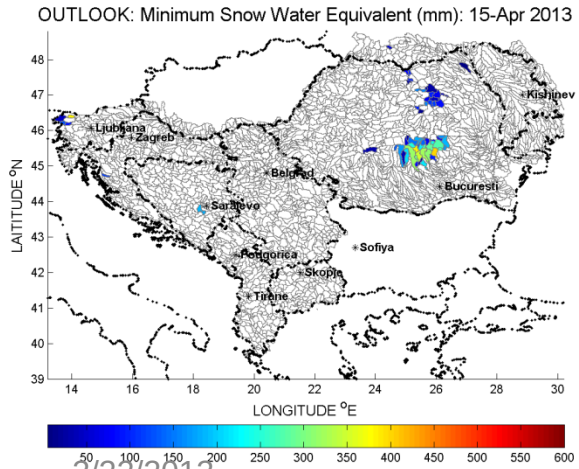


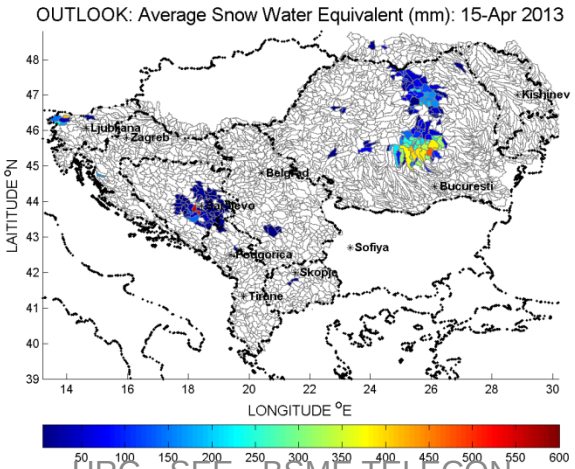
SEE: OUTLOOK: SWE

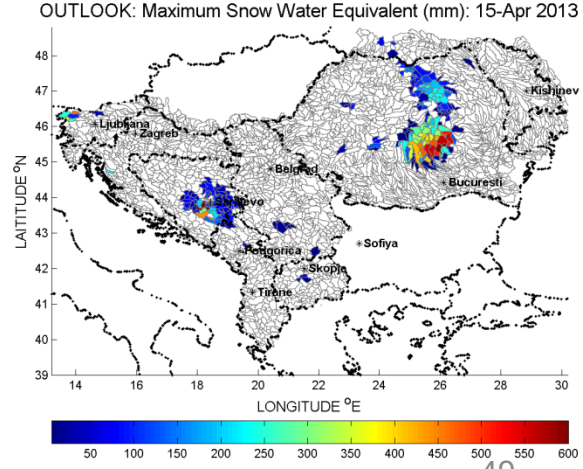




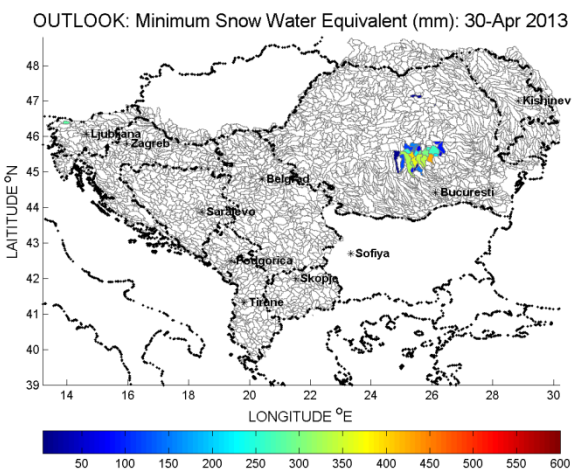


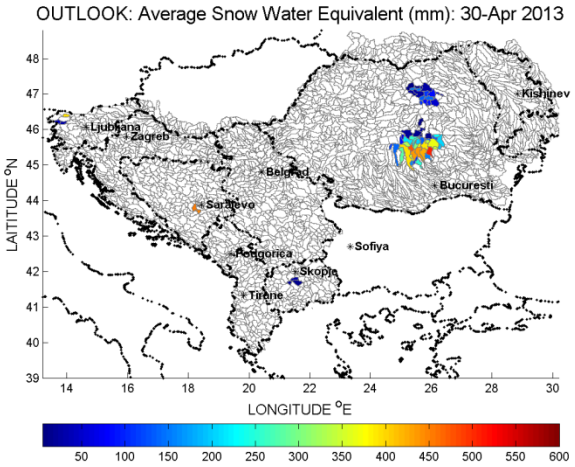


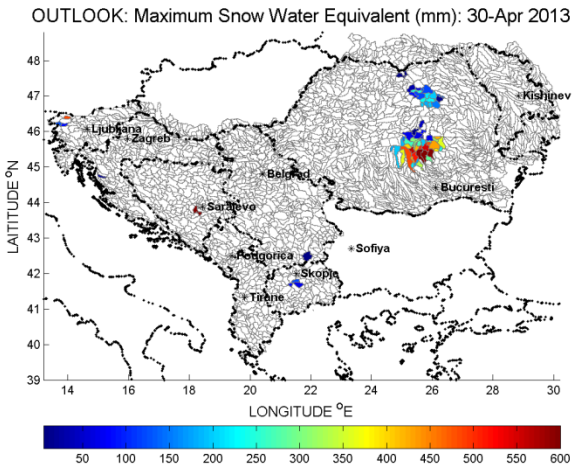


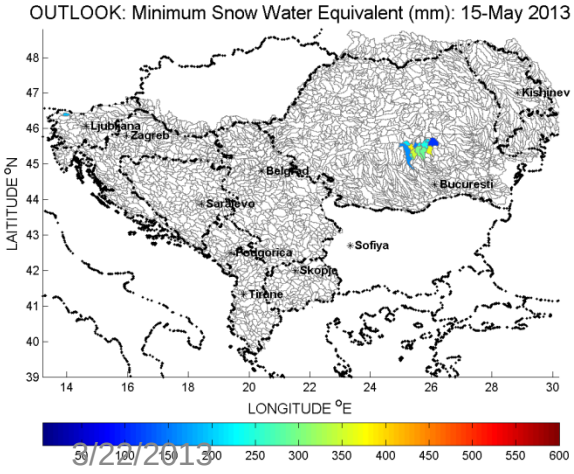


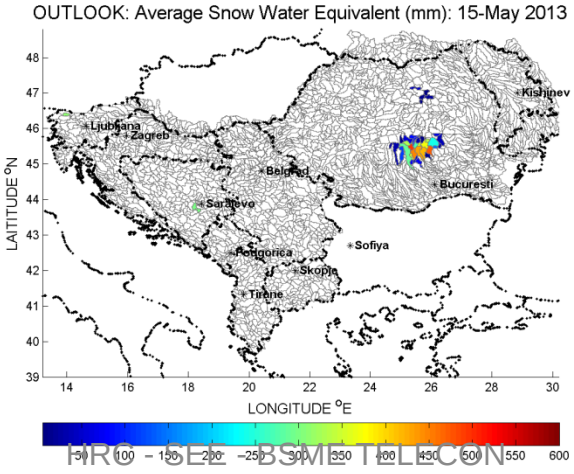
SWE Outlook Cont.

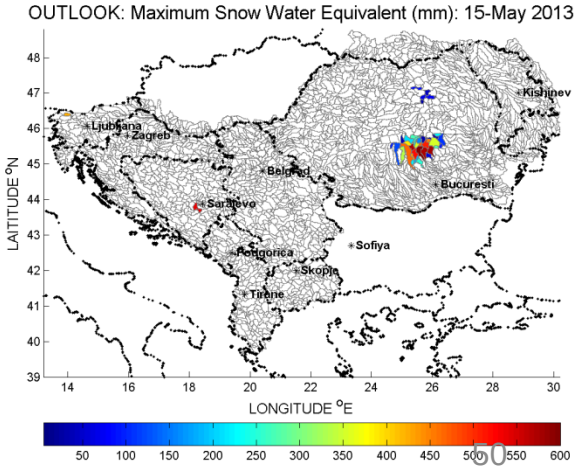




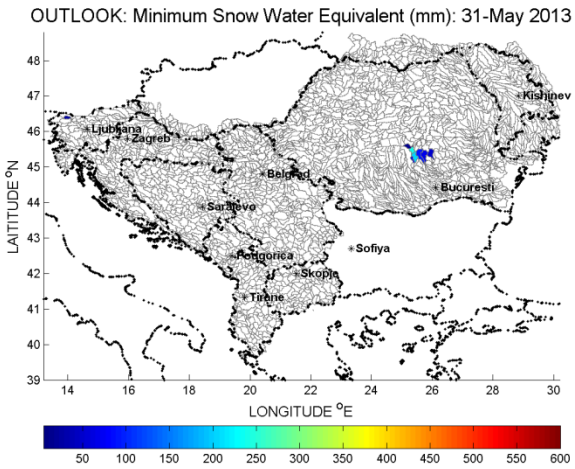


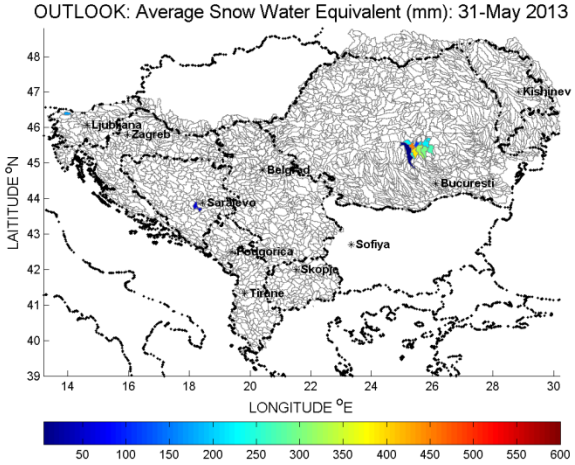


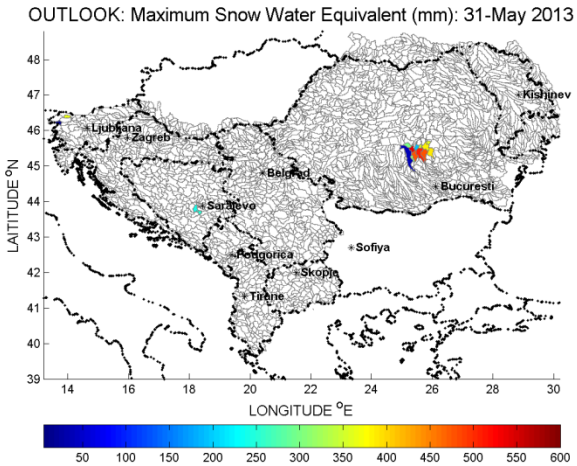




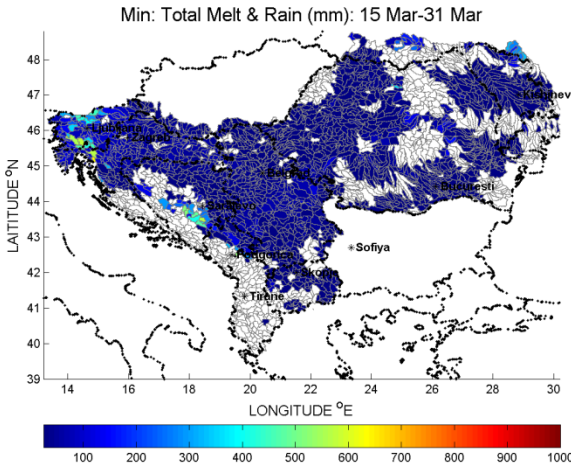
SWE Outlook Cont.

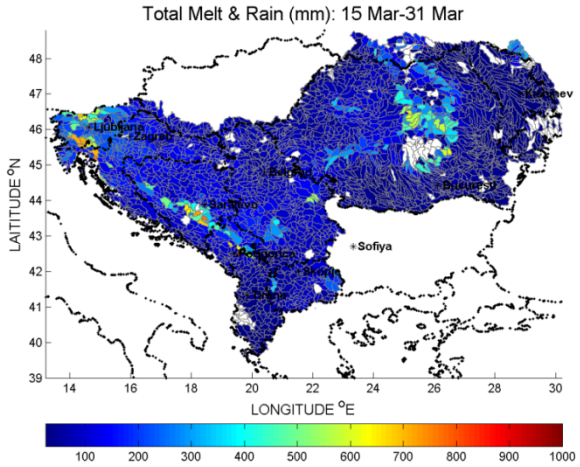


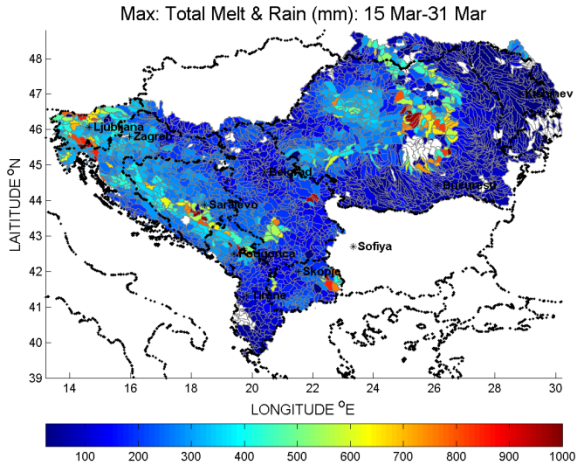


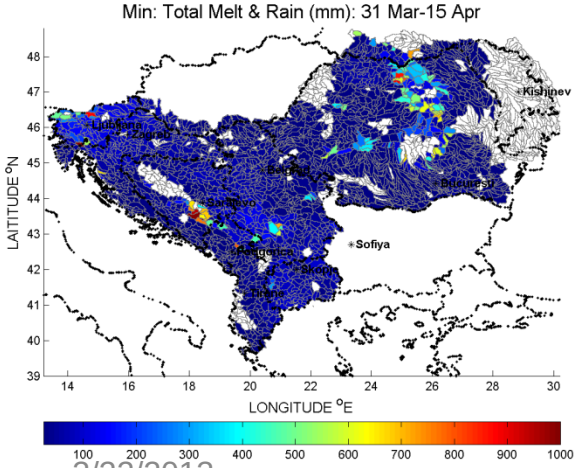


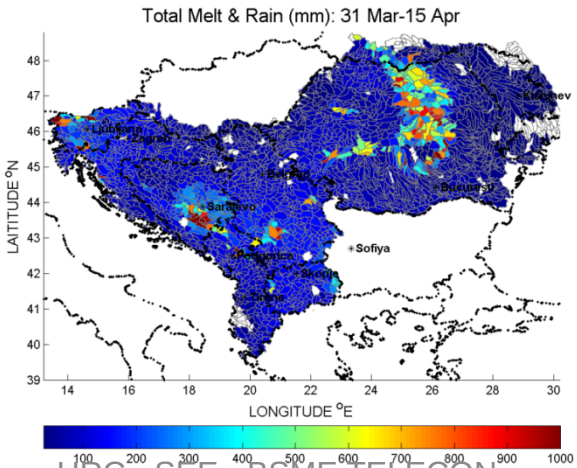
Runoff Volume Outlook: Minimum, Average and Maximum

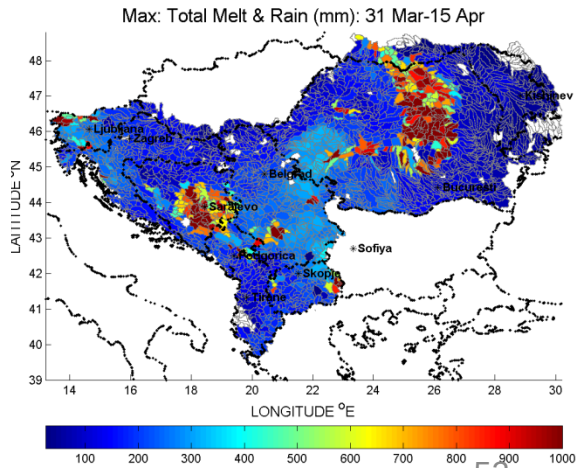




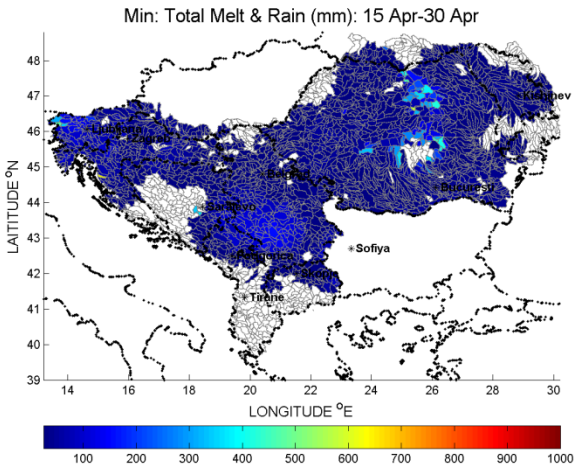


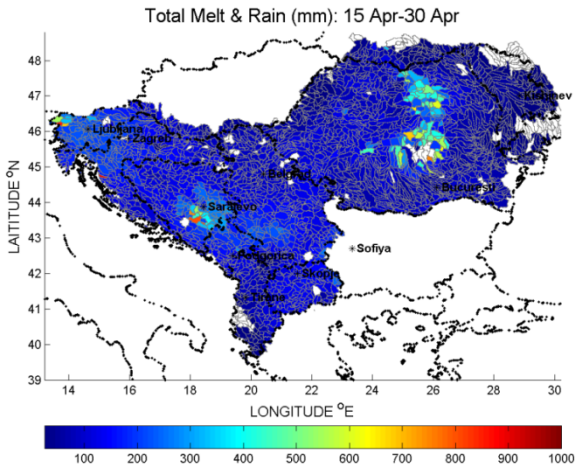


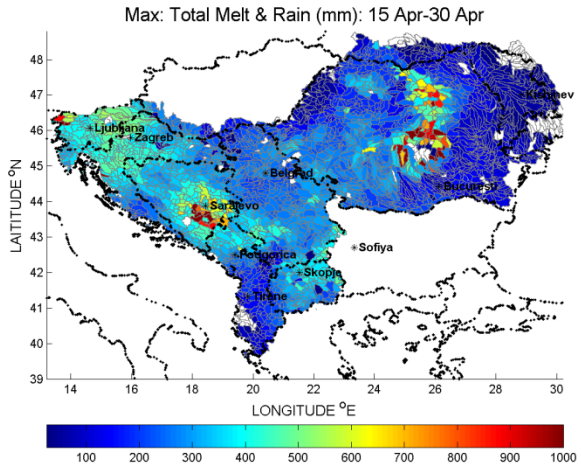


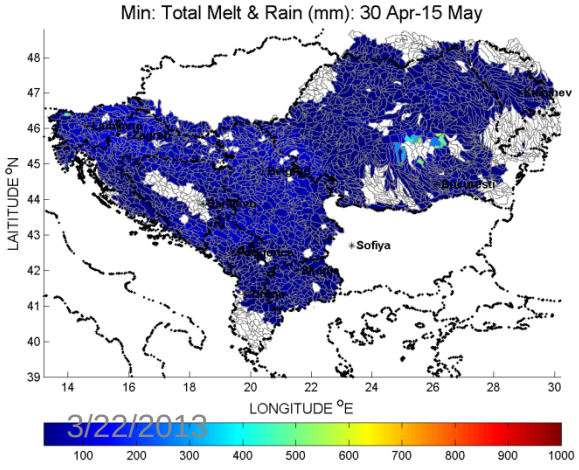


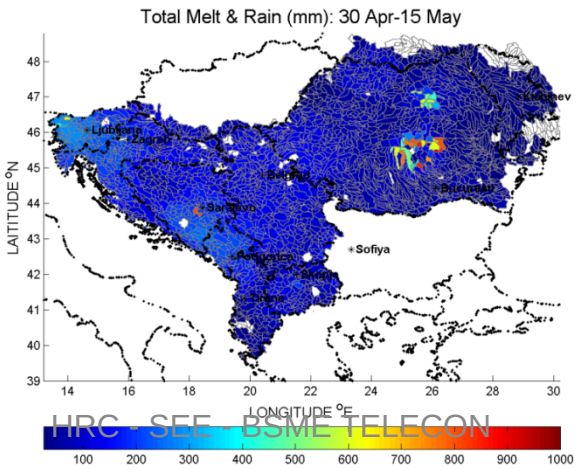
Runoff Volume Outlook: Minimum, Average and Maximum

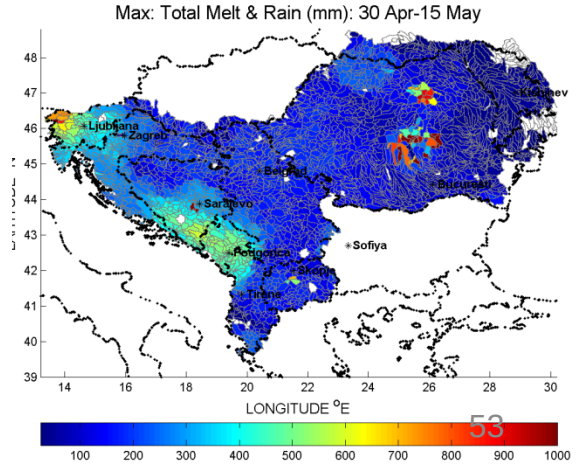




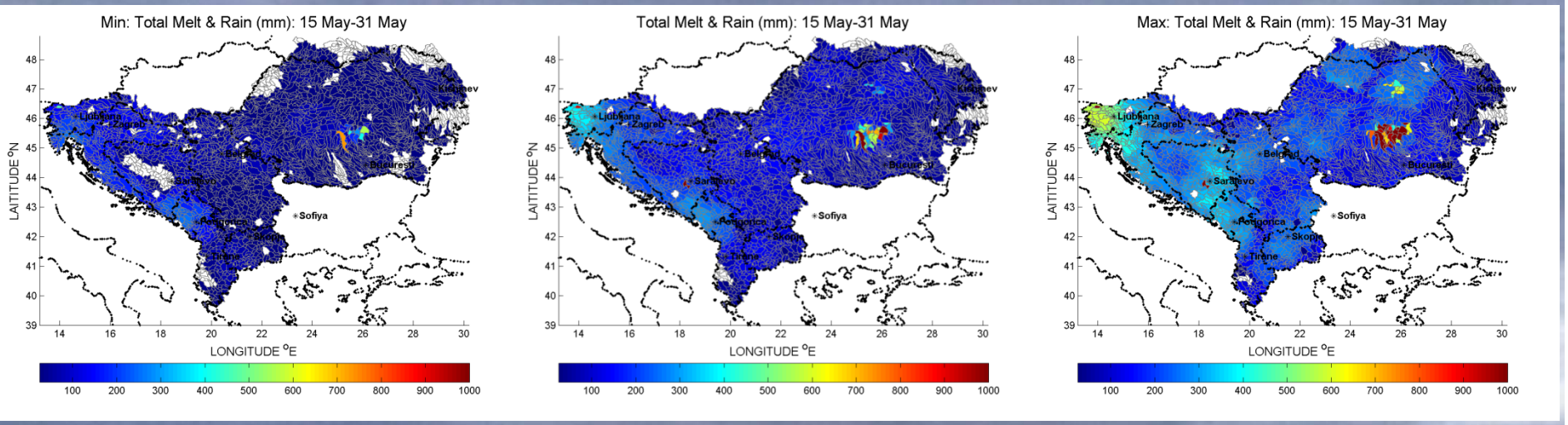




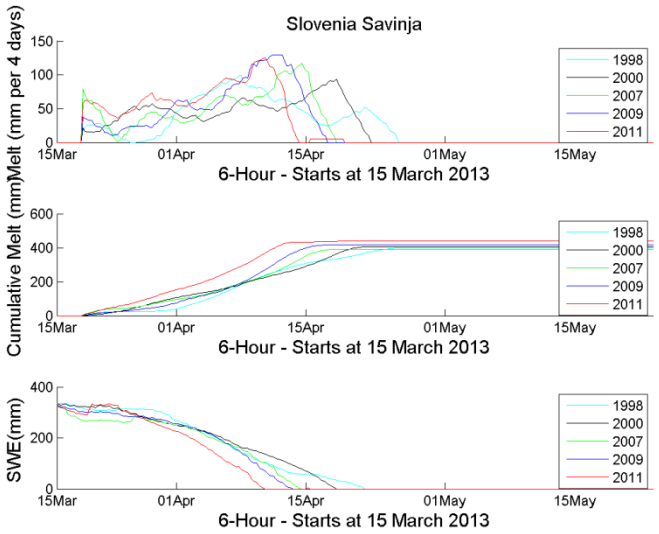


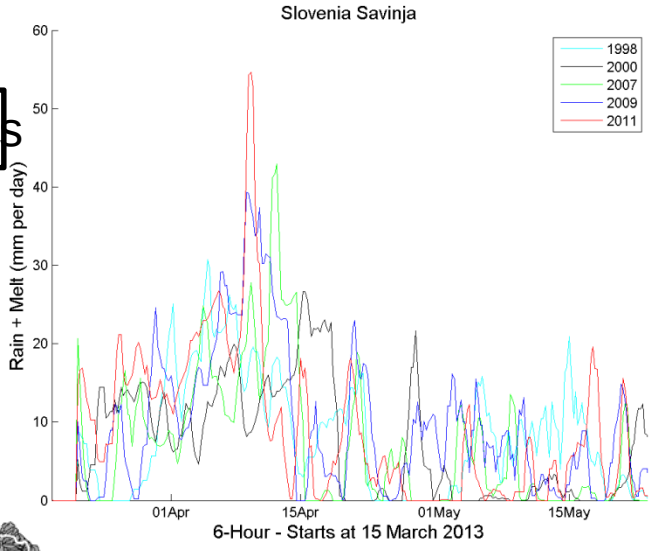


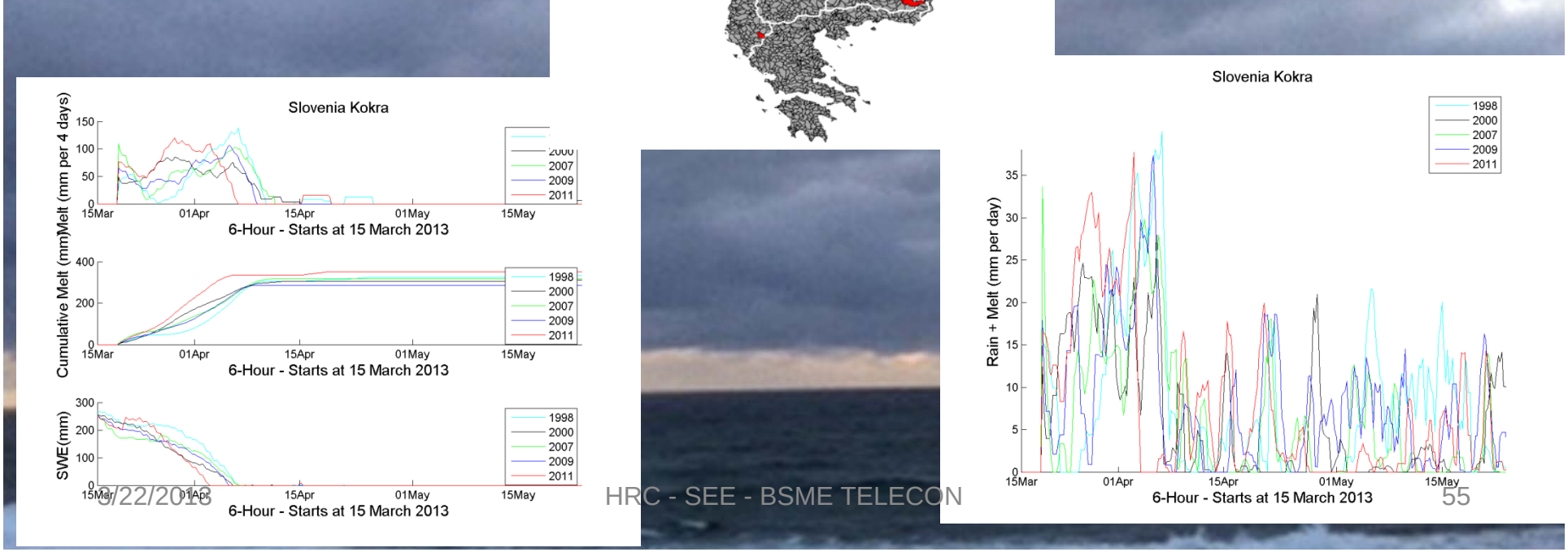
Runoff Volume Outlook: Minimum, Average and Maximum



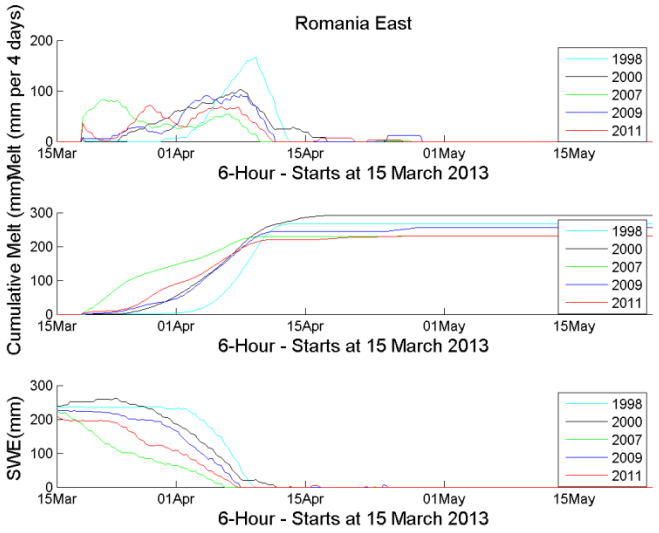
Time Series Analysis

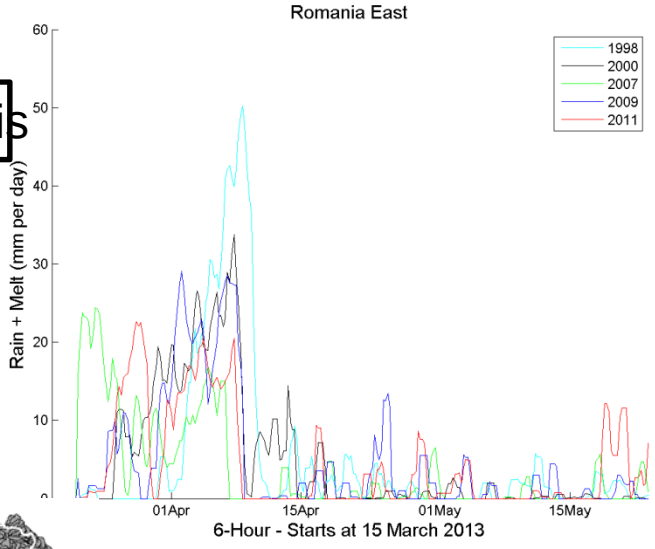


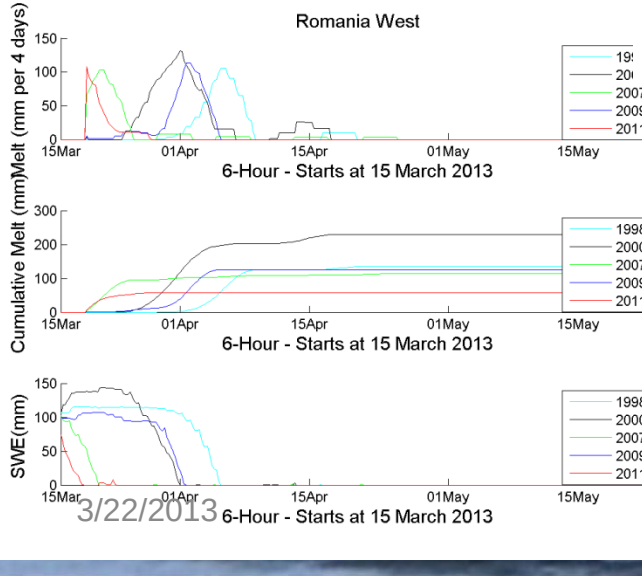


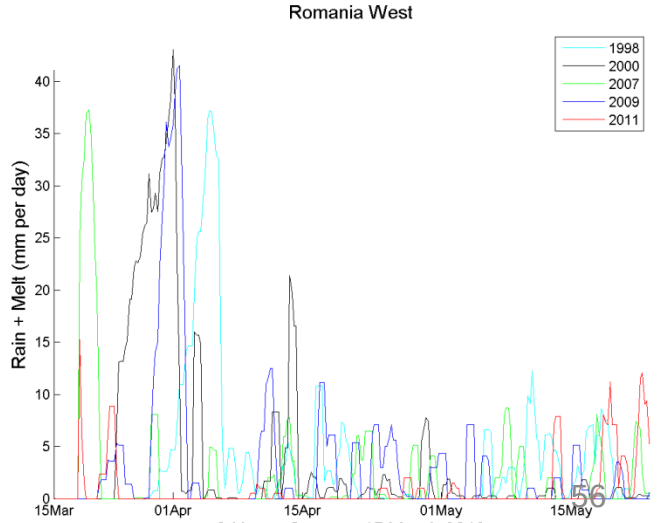


Time Series Analysis

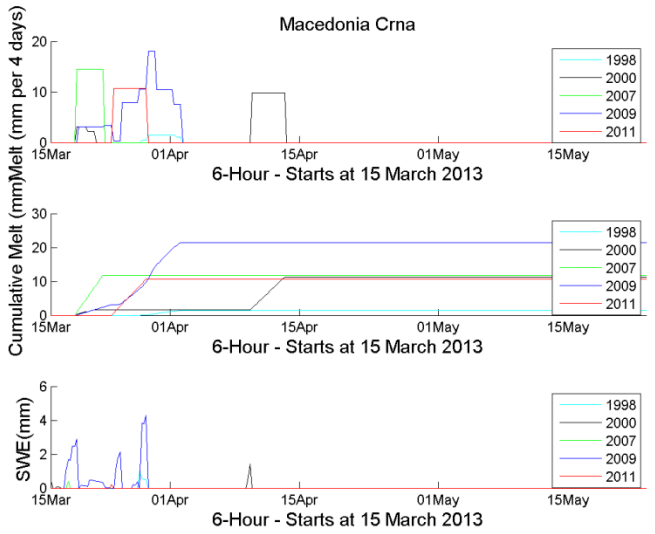


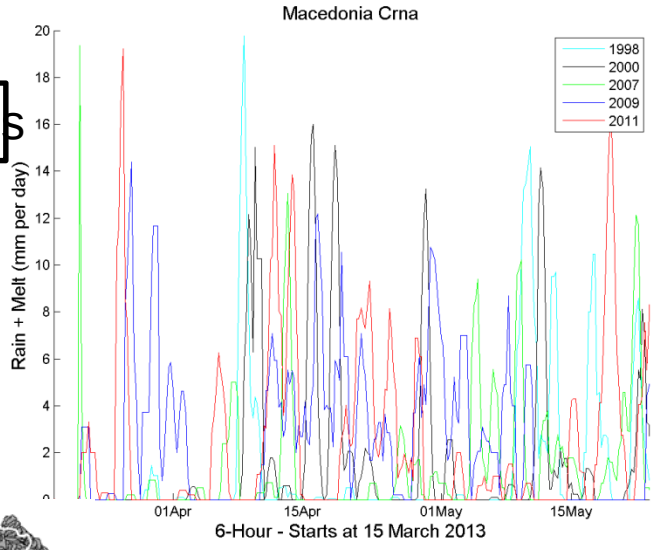


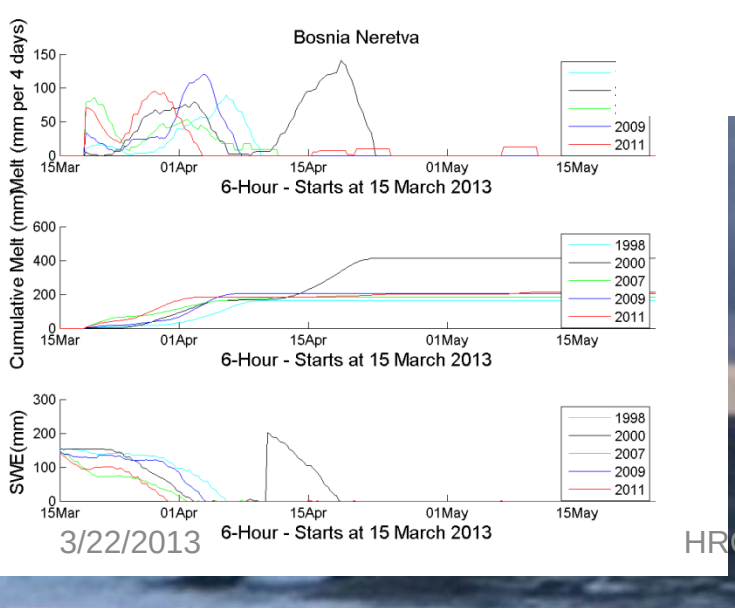


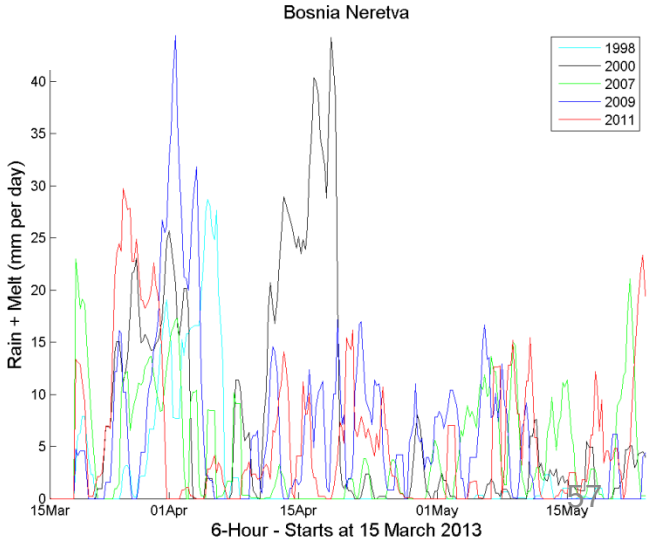


Time Series Analysis

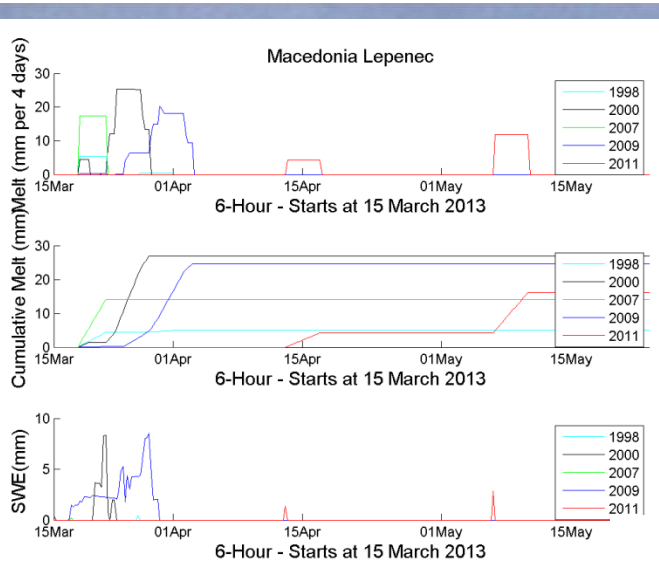


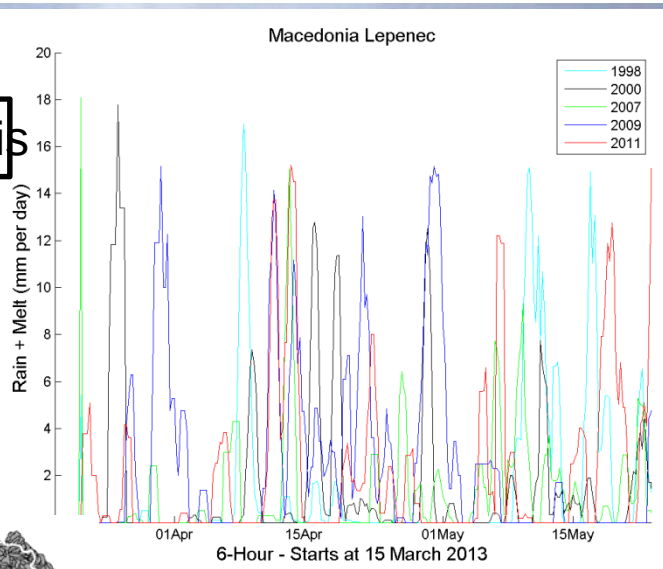


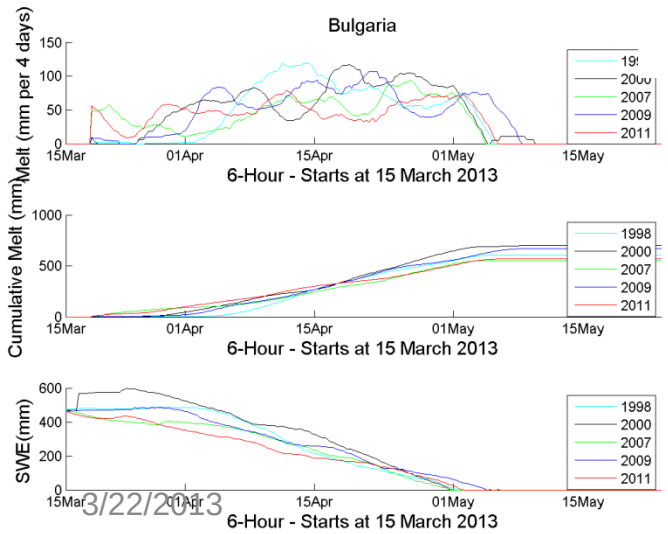


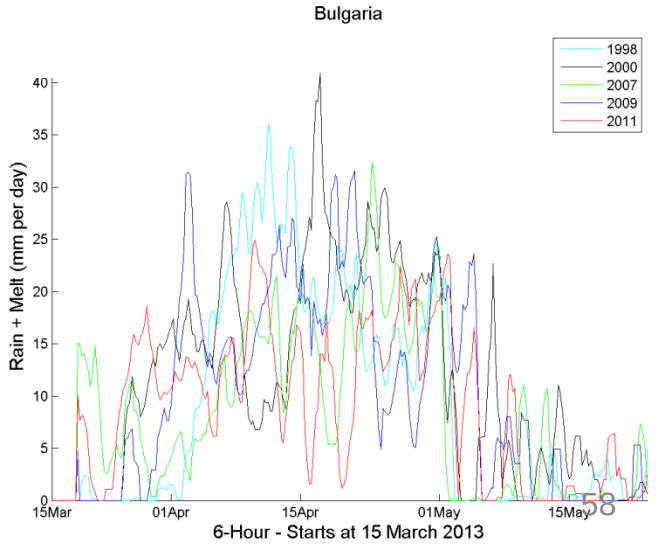


Time Series Analysis

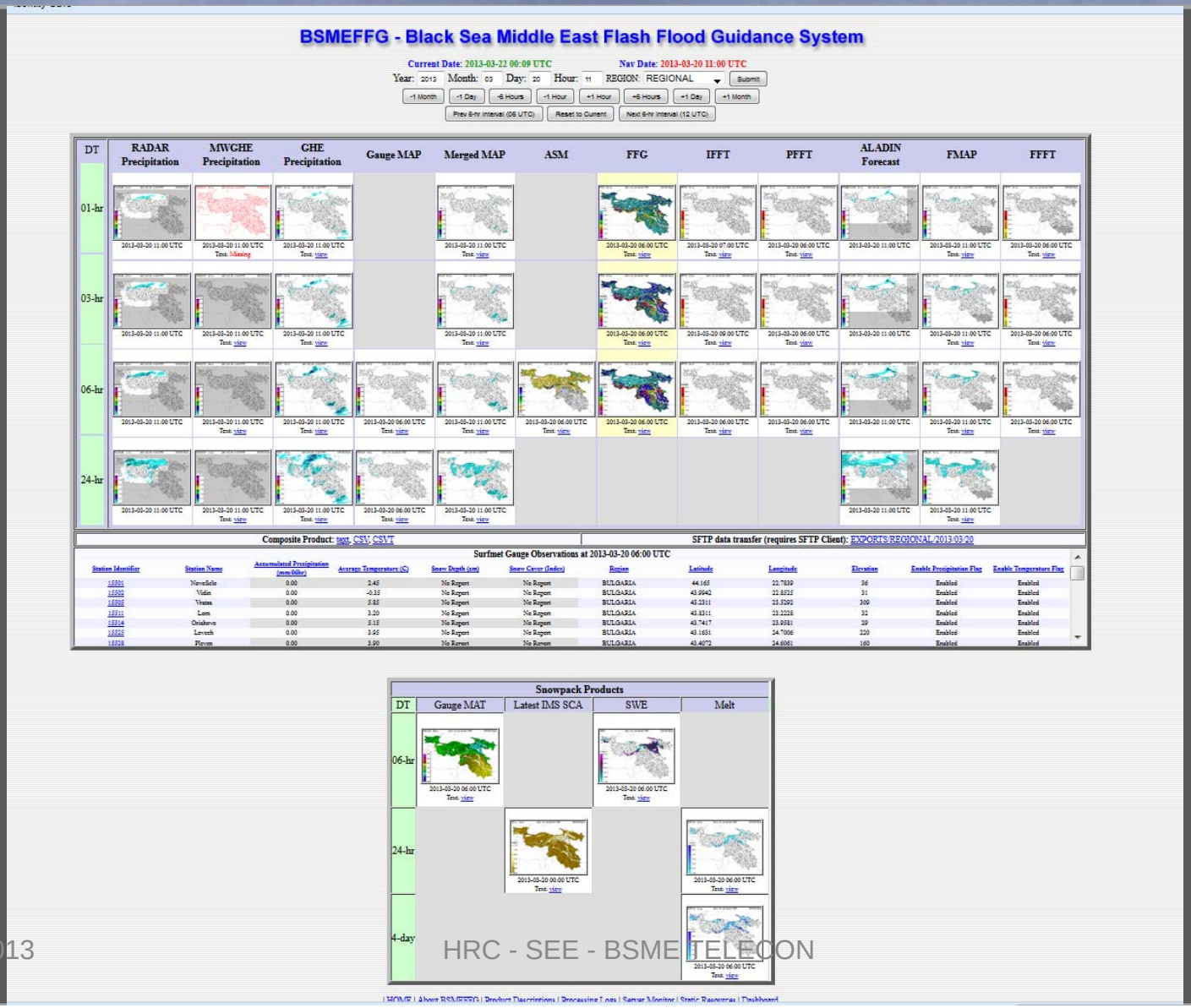




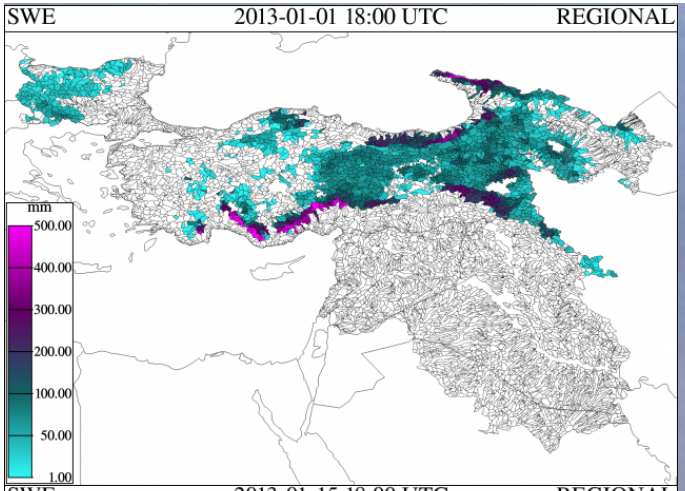


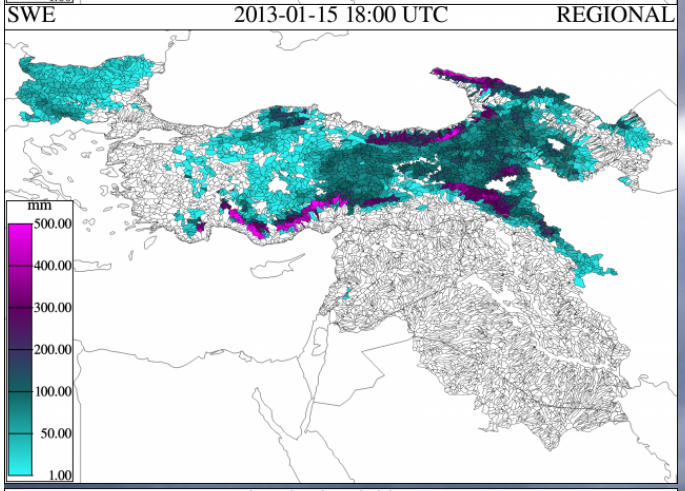


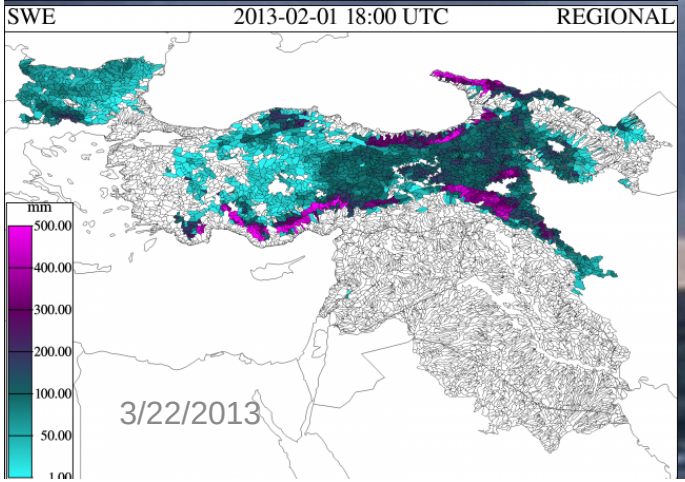
BSMEFFG Operational System

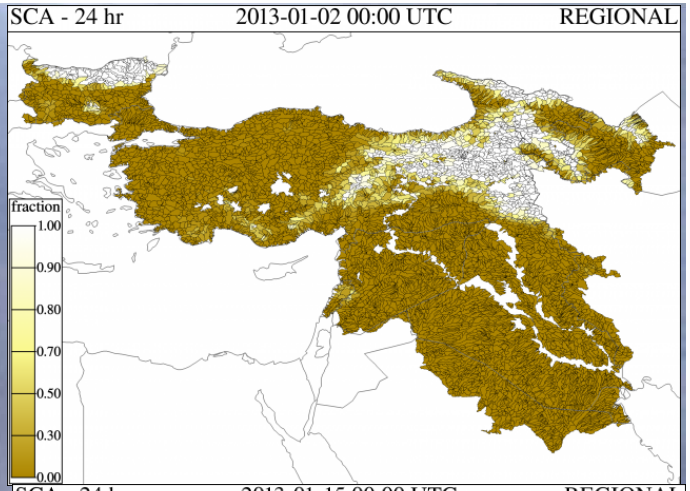


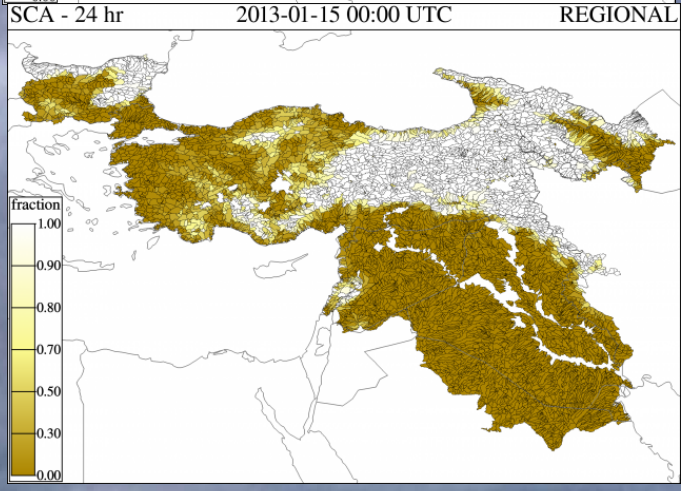
BSMEFFGS
SNOW SIMULATION

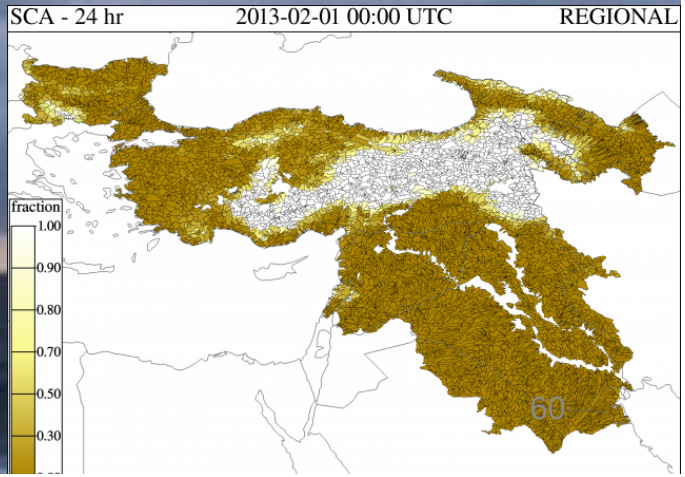




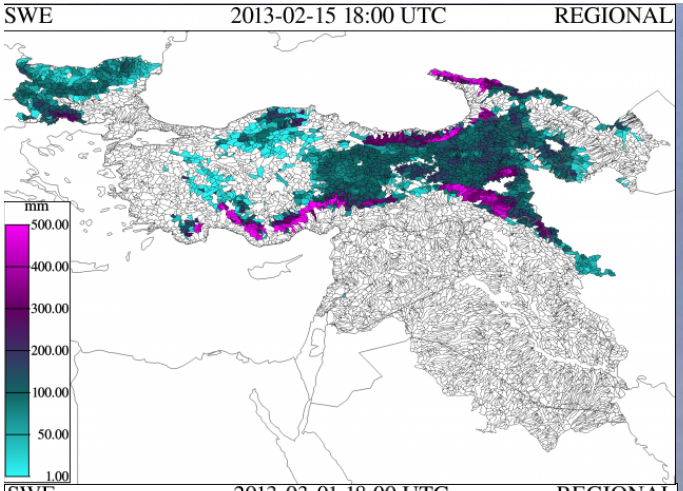


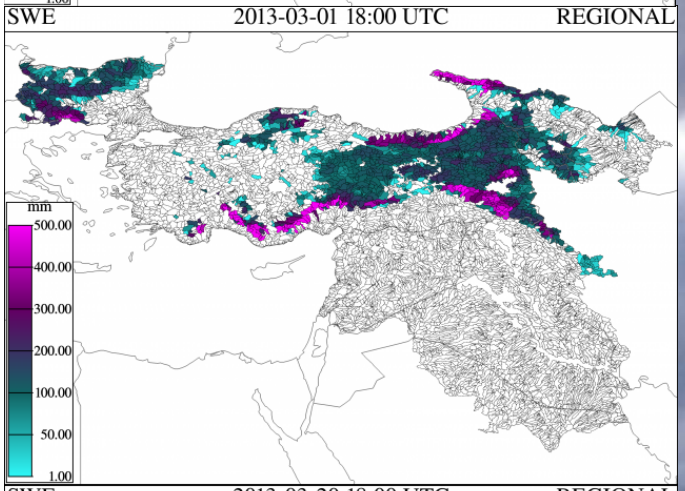


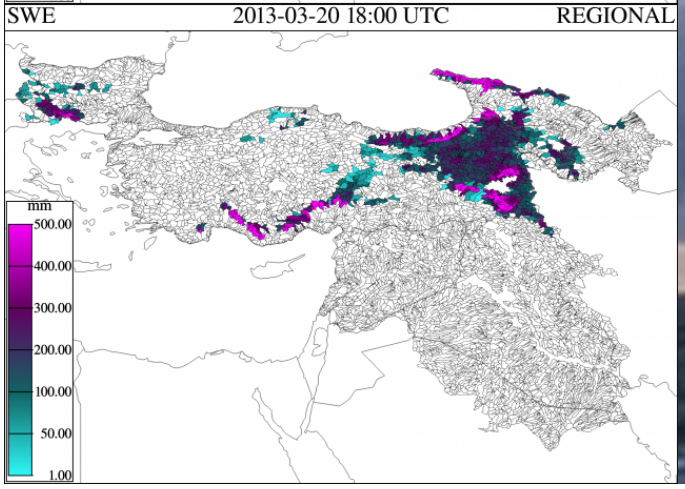


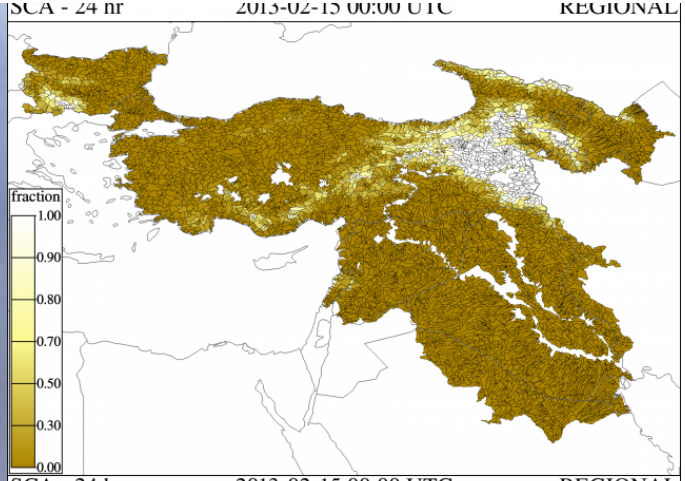


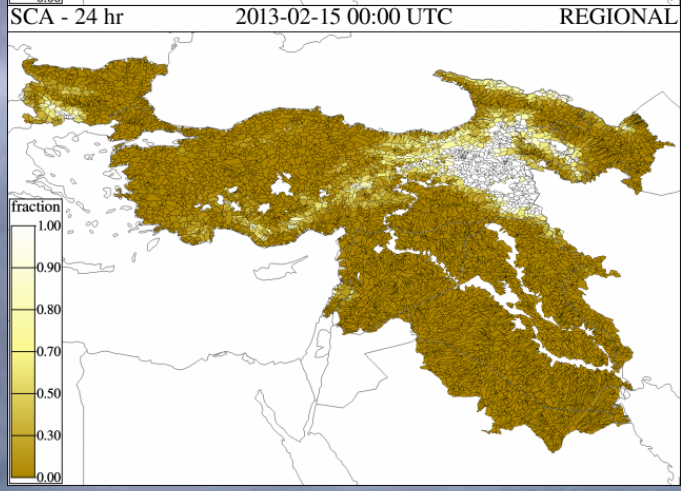
BSMEFFGS
SNOW SIMULATION

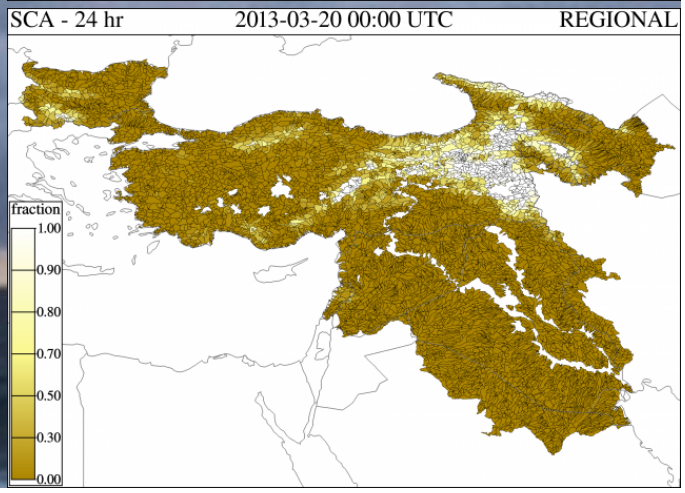




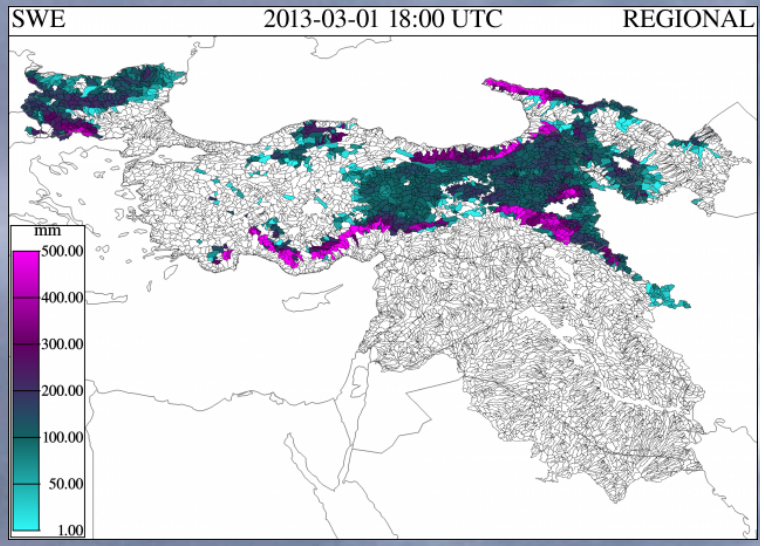


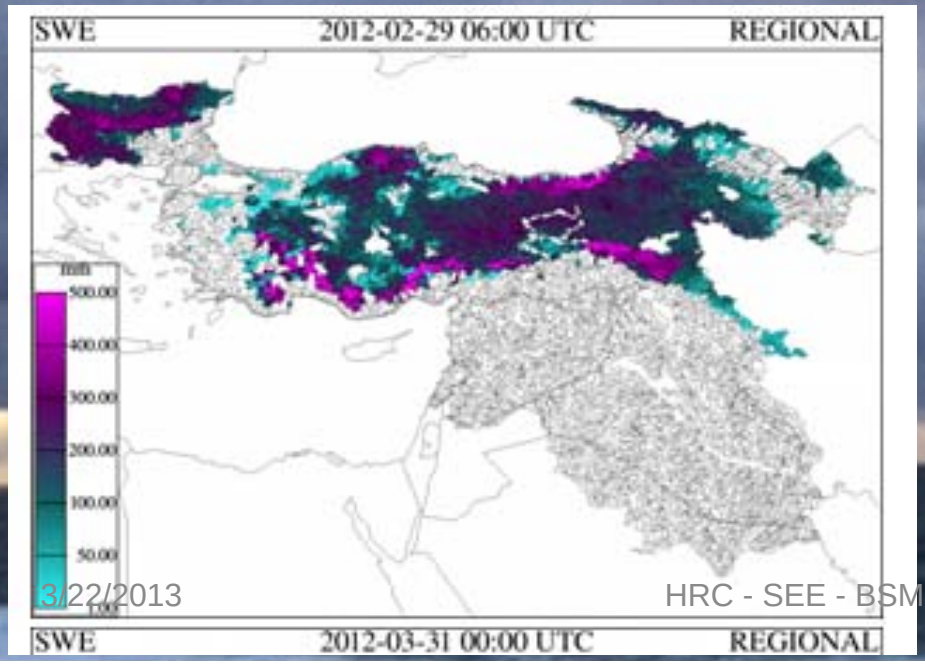






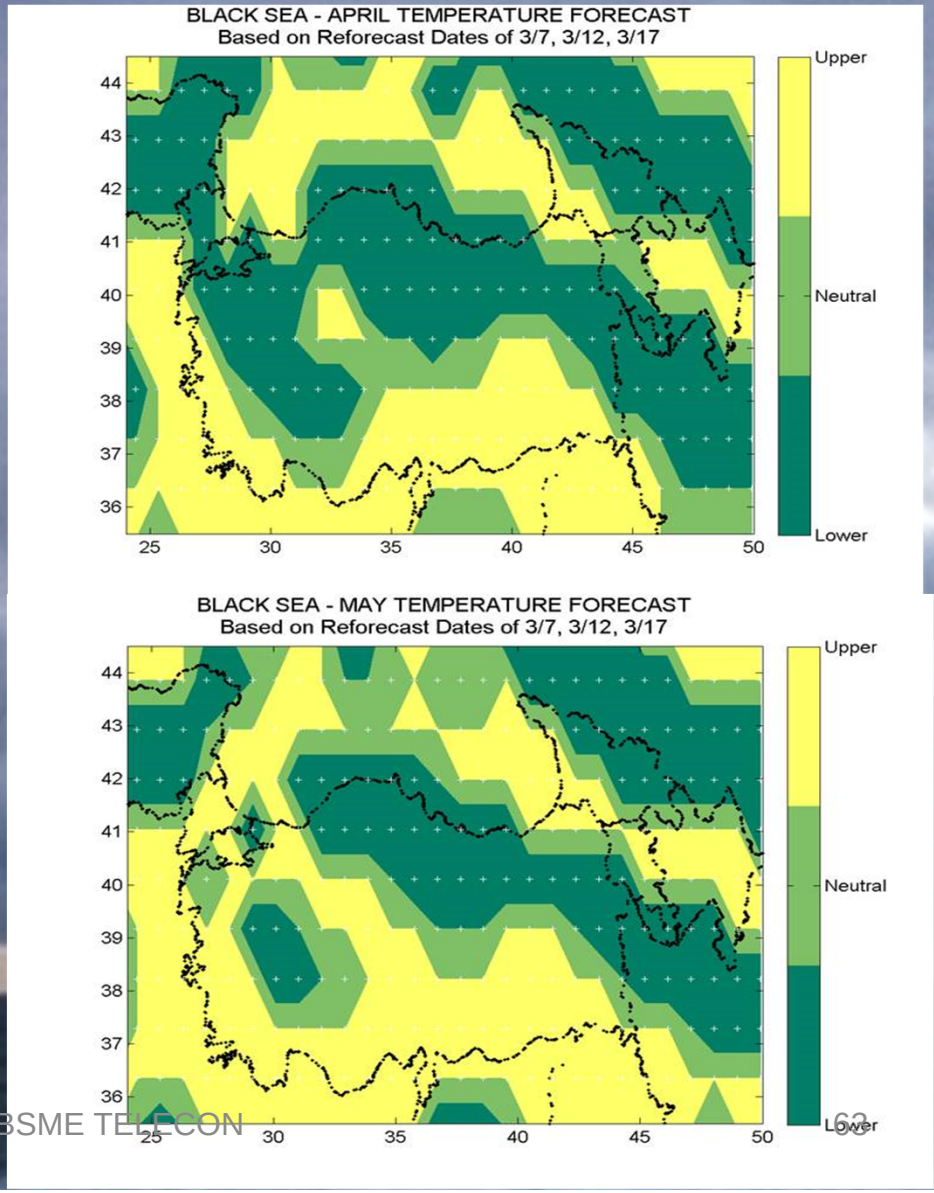
Comparison between 2012 and 2013



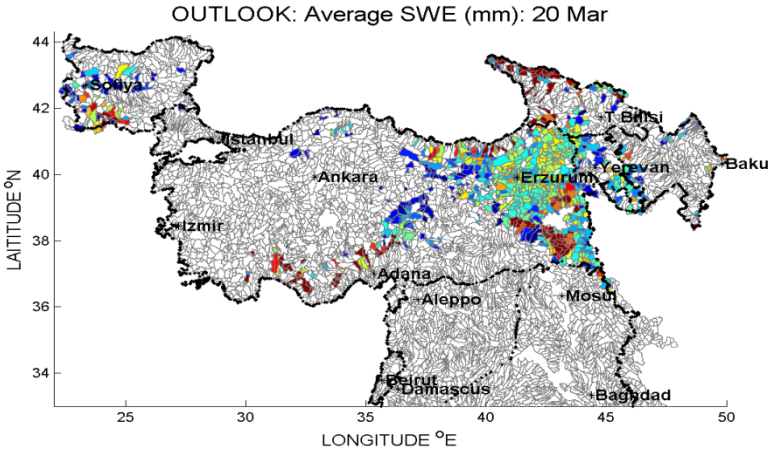


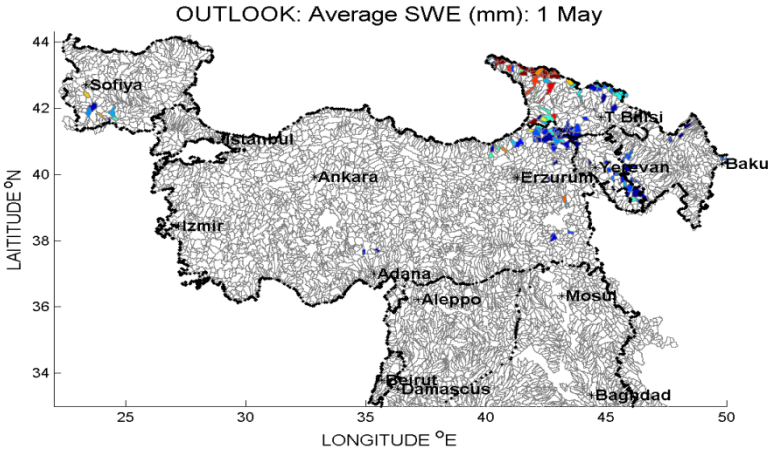
BSME Snow Outlook 2013

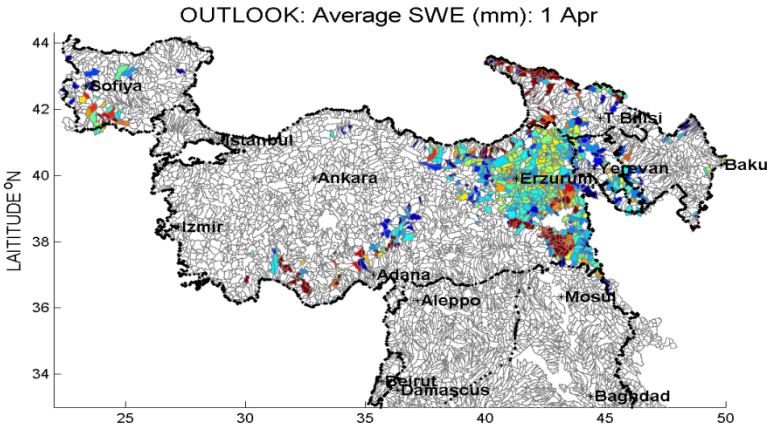
- Years used for Outlook 2007, 2008, 2009, 2010, 2011, and 2012
- MAT: interpolated from GTS reports to BSMEFFGS
- Initial Base line March 20, 2013
- MAP Bias Adjusted Hydro Estimator

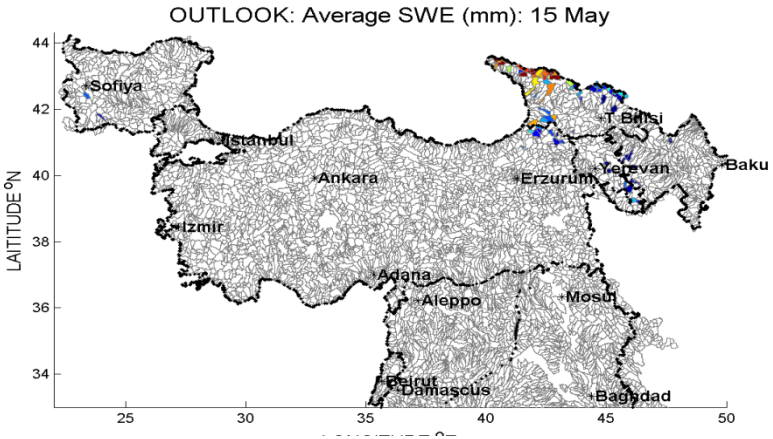


Average


OUTLOOK: Average SWE (mm): 20 Mar
Sofiya
Istanbul
Ankara
Erzurum
T. Bilisi
Yerevan
Baku
Izmir
Adana
Aleppo
Mosul
Beirut
Damascus
Baghdad
LAITITUDE °N
LONGITUDE °E


OUTLOOK: Average SWE (mm): 1 May
Sofiya
Istanbul
Ankara
Erzurum
T. Bilisi
Yerevan
Baku
Izmir
Adana
Aleppo
Mosul
Beirut
Damascus
Baghdad
LAITITUDE °N
LONGITUDE °E


OUTLOOK: Average SWE (mm): 1 Apr
Sofiya
Istanbul
Ankara
Erzurum
T. Bilisi
Yerevan
Baku
Izmir
Adana
Aleppo
Mosul
Beirut
Damascus
Baghdad
LAITITUDE °N


OUTLOOK: Average SWE (mm): 15 May
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Istanbul
Ankara
Erzurum
T. Bilisi
Yerevan
Baku
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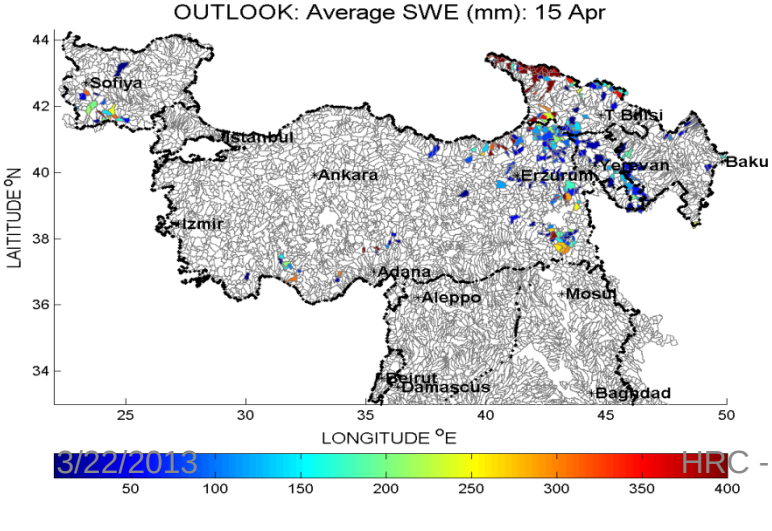
Beirut
Damascus
Baghdad
LAITITUDE °N


OUTLOOK: Average SWE (mm): 15 Apr
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Istanbul
Ankara
Erzurum
T. Bilisi
Yerevan
Baku
Izmir
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Aleppo
Mosul
Beirut
Damascus
Baghdad
LAITITUDE °N
LONGITUDE °E
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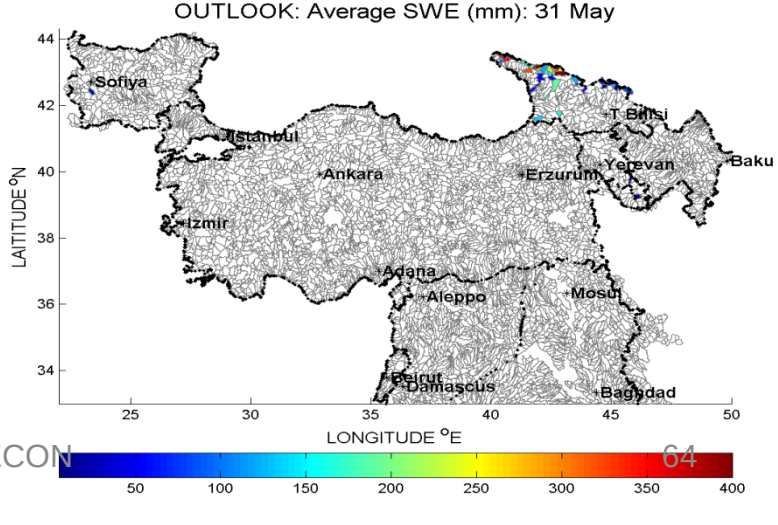
OUTLOOK: Average SWE (mm): 31 May
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Ankara
Erzurum
T. Bilisi
Yerevan
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Mosul
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Damascus
Baghdad
LAITITUDE °N
LONGITUDE °E
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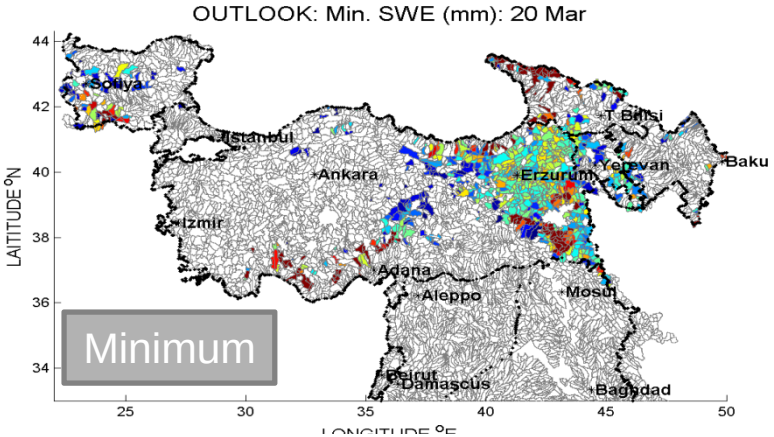
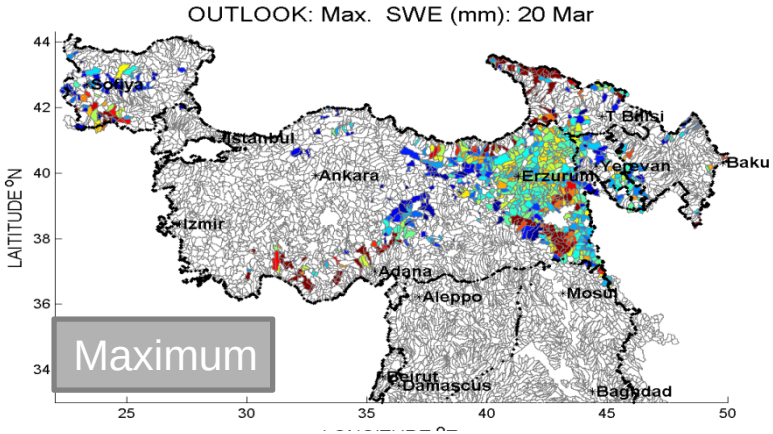

OUTLOOK: Min. SWE (mm): 20 Mar
Minimum
Sofiya
Istanbul
Ankara
Izmir
T Bilisi
Yerevan
Baku
Erzurum
Adana
Aleppo
Mosul
Beirut
Damascus
Baghdad
LAITITUDE °N
LONGITUDE °E


OUTLOOK: Max. SWE (mm): 20 Mar
Maximum
Sofiya
Istanbul
Ankara
Izmir
T Bilisi
Yerevan
Baku
Erzurum
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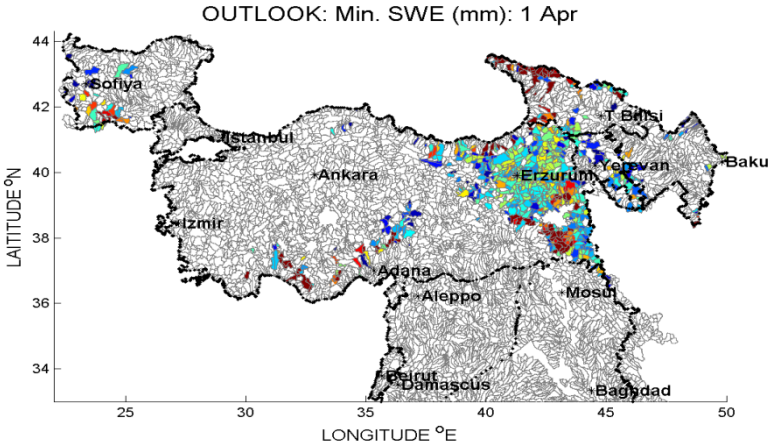
Aleppo
Mosul
Beirut
Damascus
Baghdad
LAITITUDE °N


OUTLOOK: Min. SWE (mm): 1 Apr
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Istanbul
Ankara
Izmir
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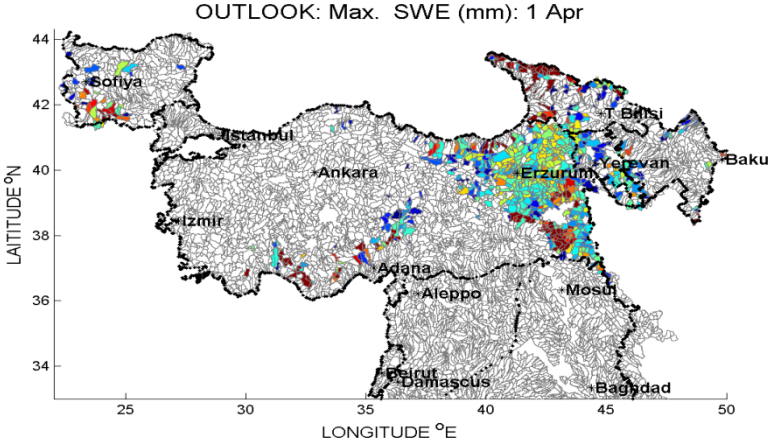
Baghdad
LAITITUDE °N
LONGITUDE °E


OUTLOOK: Max. SWE (mm): 1 Apr
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Erzurum
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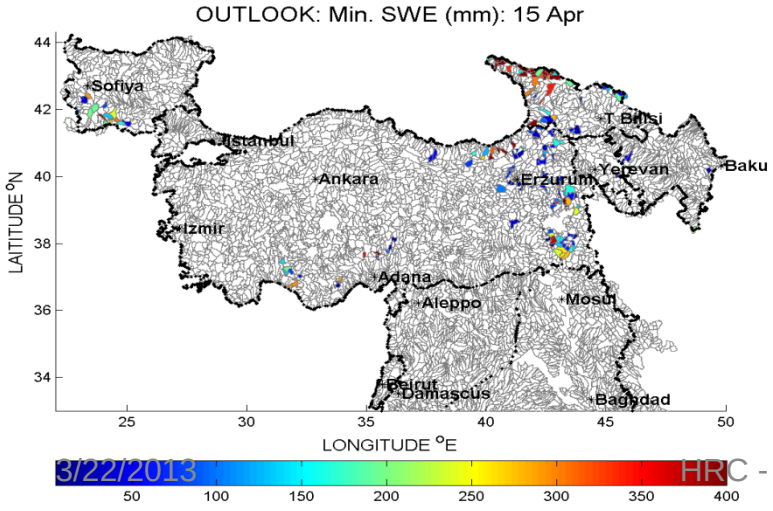
Beirut
Damascus
Baghdad
LAITITUDE °N
LONGITUDE °E


OUTLOOK: Min. SWE (mm): 15 Apr
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Ankara
Izmir
T Bilisi
Yerevan
Baku
Erzurum
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Aleppo
Mosul
Beirut
Damascus
Baghdad
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LONGITUDE °E
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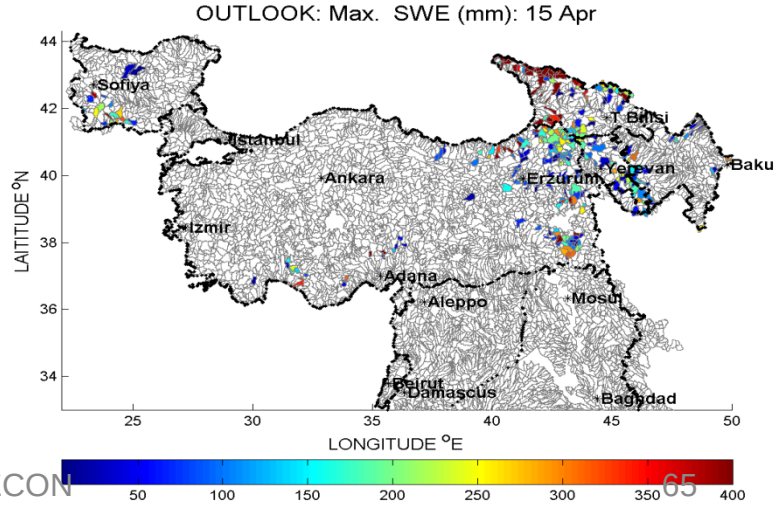
OUTLOOK: Max. SWE (mm): 15 Apr
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Ankara
Izmir
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Yerevan
Baku
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Damascus
Baghdad
LAITITUDE °N
LONGITUDE °E
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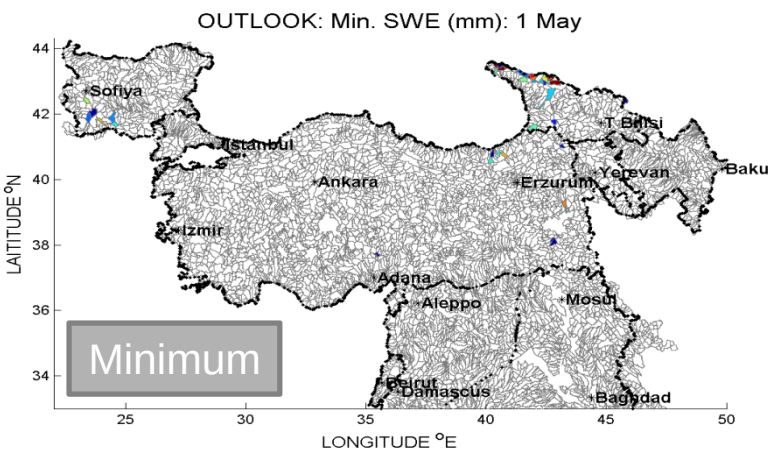
OUTLOOK: Min. SWE (mm): 1 May
Minimum
Sofiya
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T Bilisi
Ankara
Erzurum
Yerevan
Baku
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Aleppo
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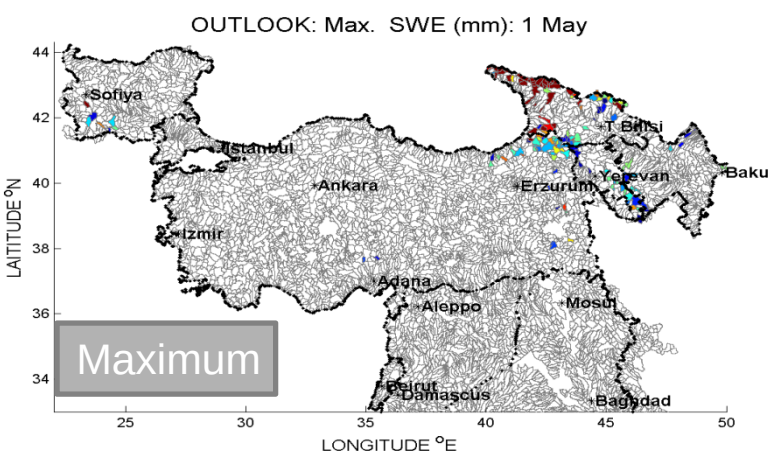
Damascus
Baghdad
LAITITUDE °N
LONGITUDE °E


OUTLOOK: Max. SWE (mm): 1 May
Maximum
Sofiya
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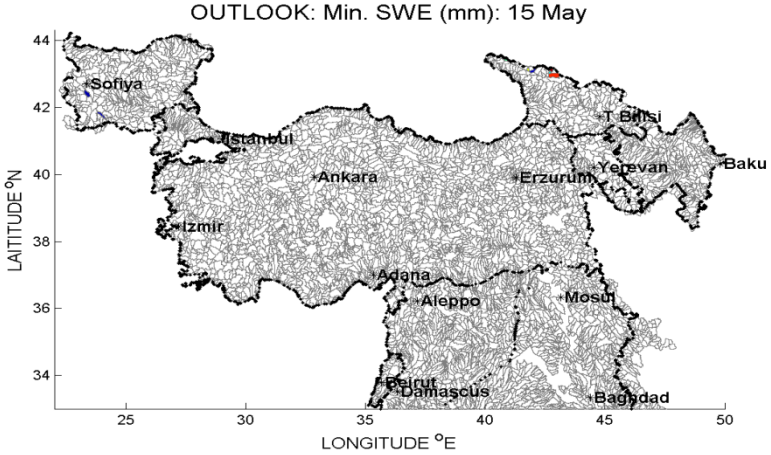
LONGITUDE °E


OUTLOOK: Min. SWE (mm): 15 May
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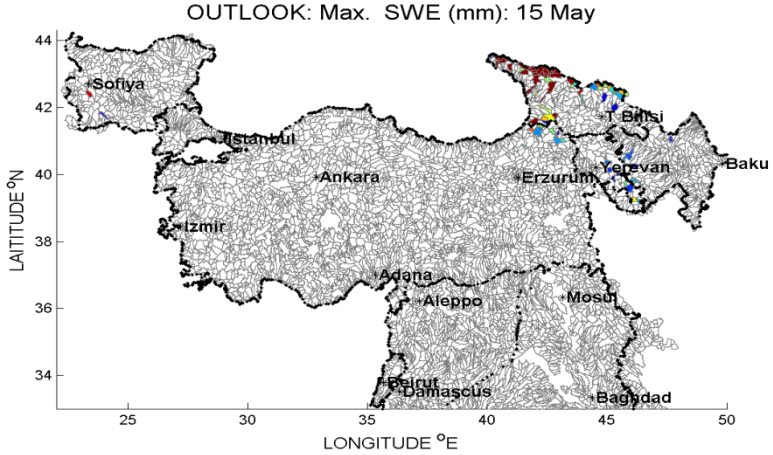
LAITITUDE °N
LONGITUDE °E


OUTLOOK: Max. SWE (mm): 15 May
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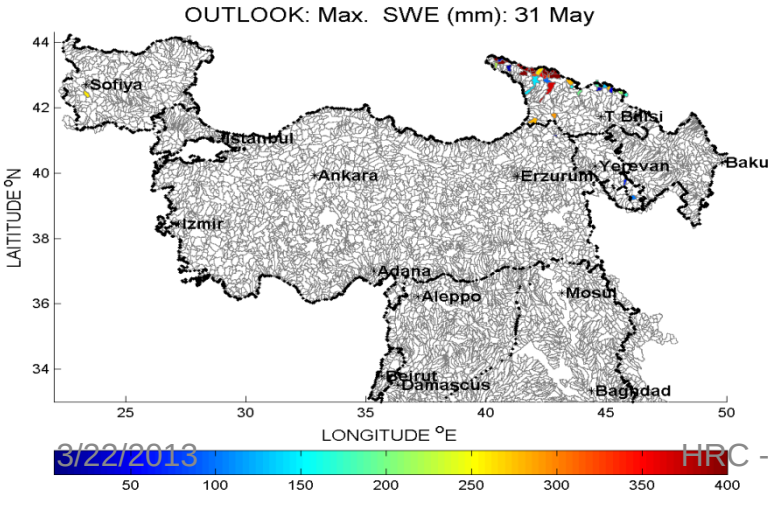
LAITITUDE °N
LONGITUDE °E


OUTLOOK: Max. SWE (mm): 31 May
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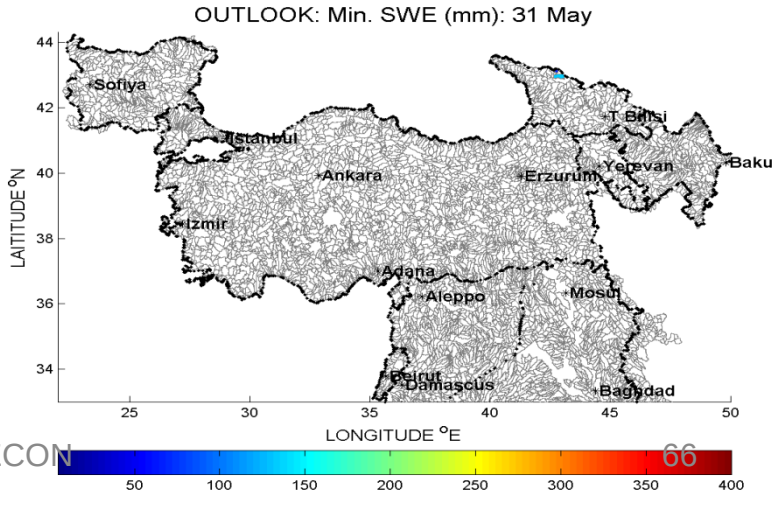
OUTLOOK: Min. SWE (mm): 31 May
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Aleppo
Mosul
Beirut
Damascus
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LONGITUDE °E
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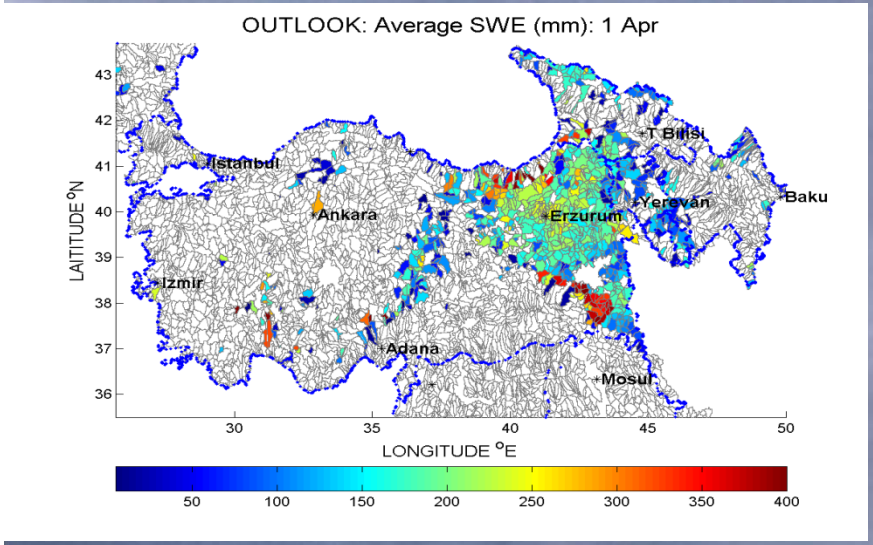
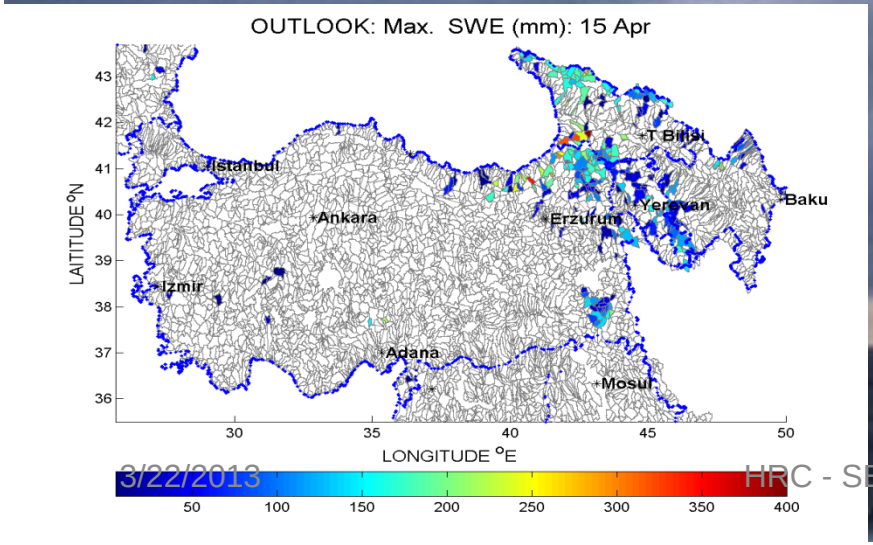
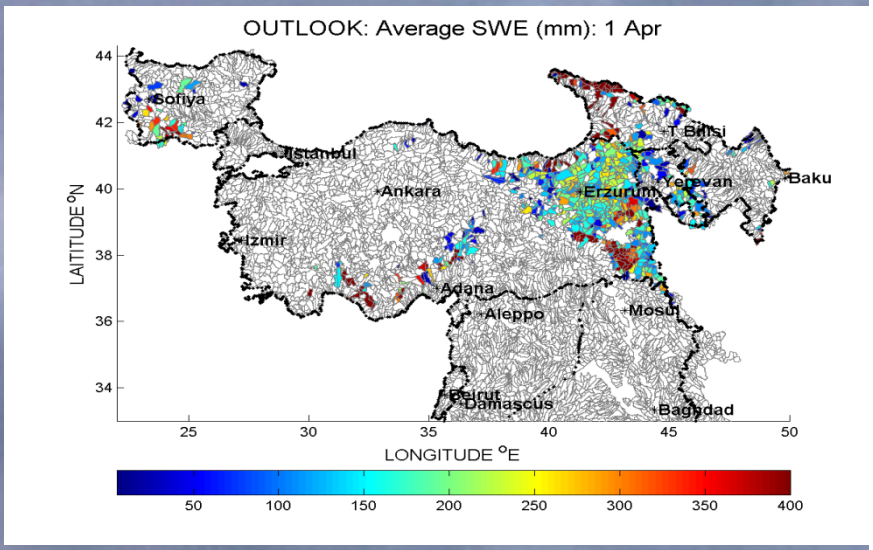
Comparison between April outlook for 2012 and 2013

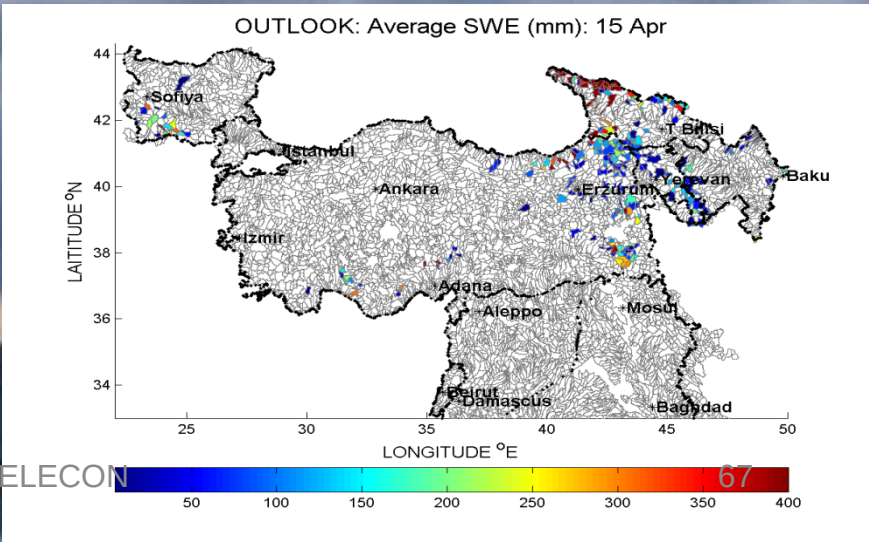
Outlook 2012



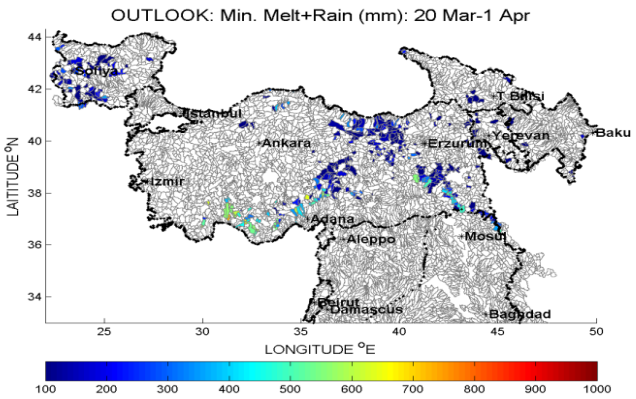


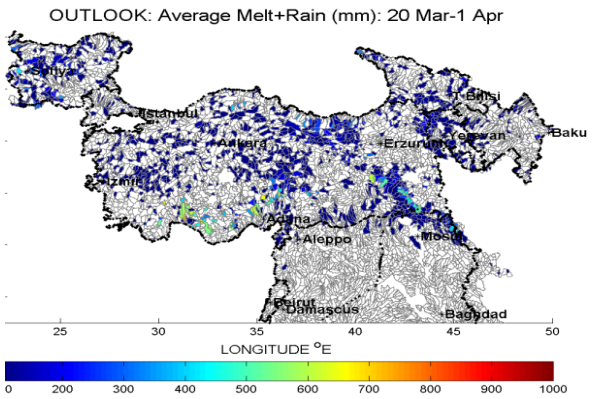
Outlook 2013

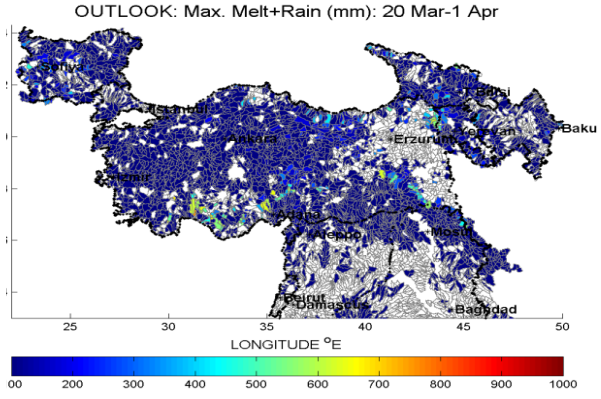


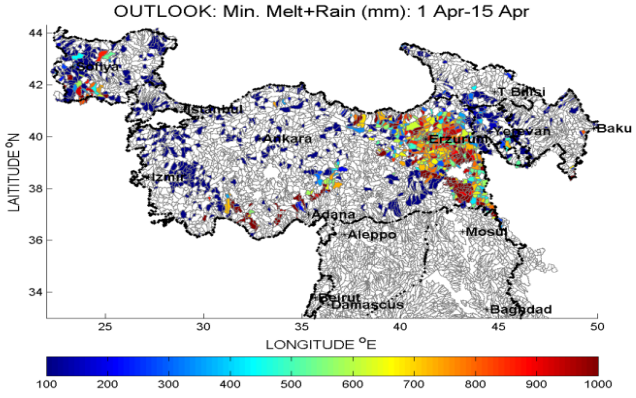


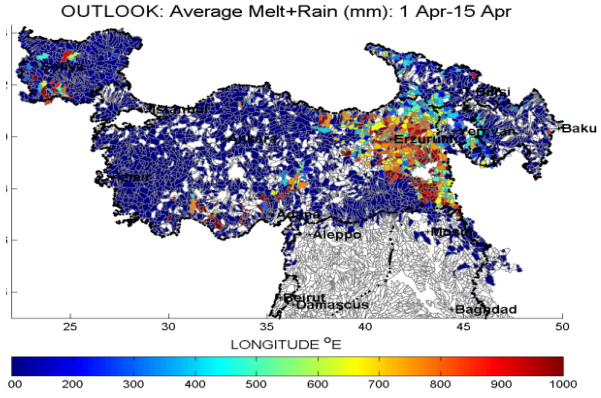
Runoff Volume Outlook: Minimum, Average and Maximum

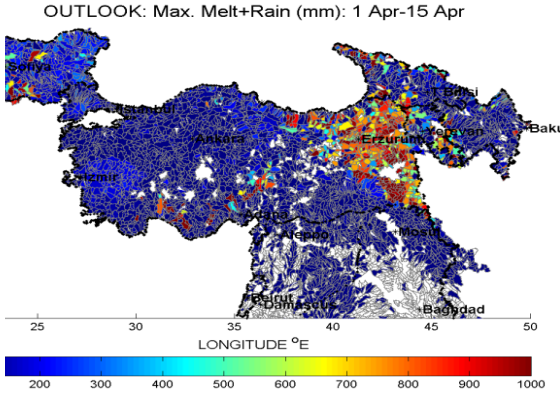




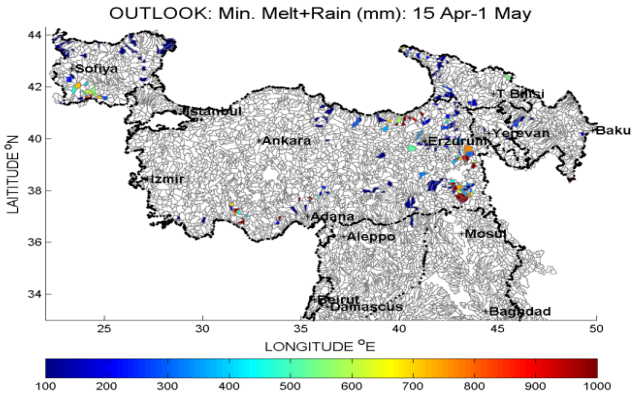


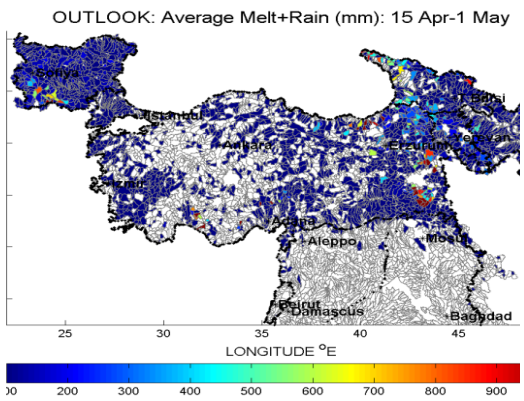


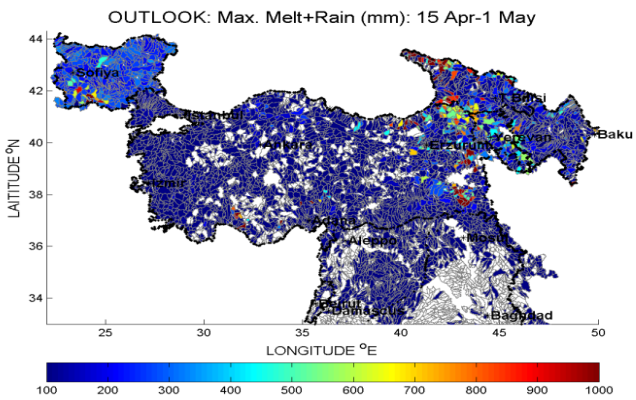


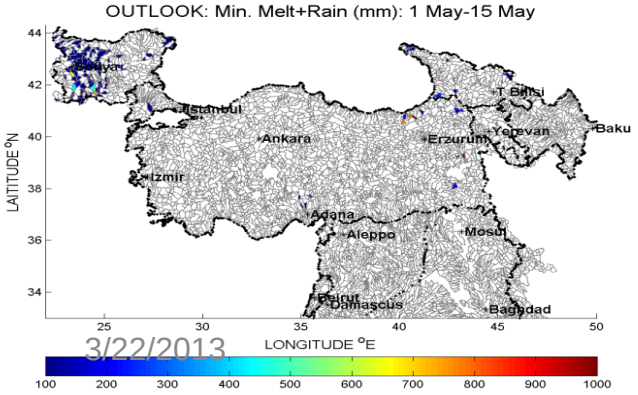


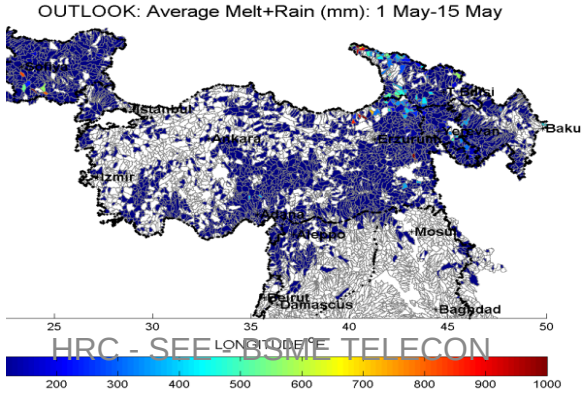
Runoff Volume Outlook: Minimum, Average and Maximum

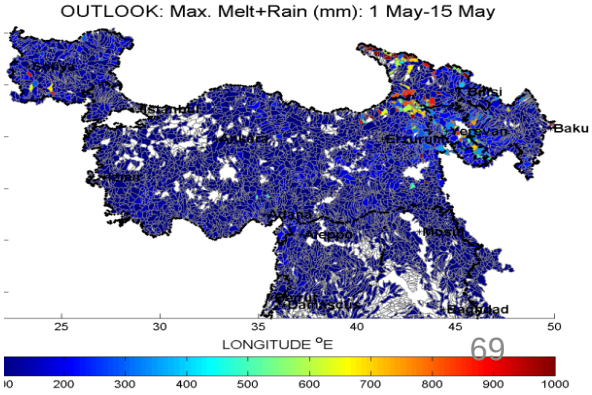




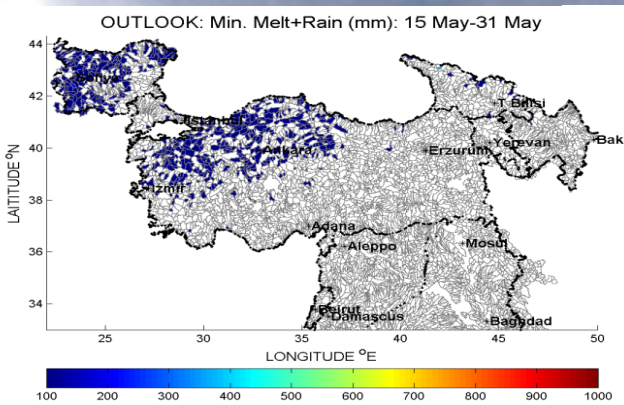


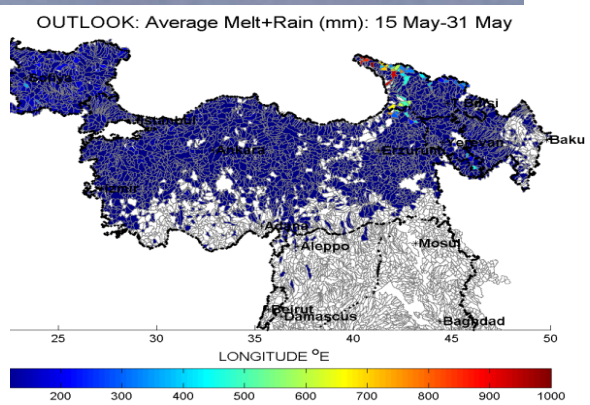


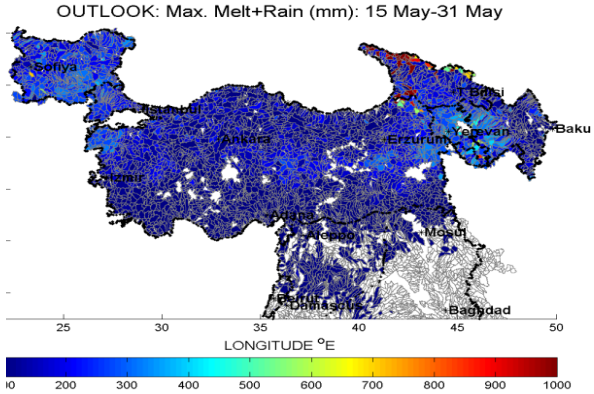




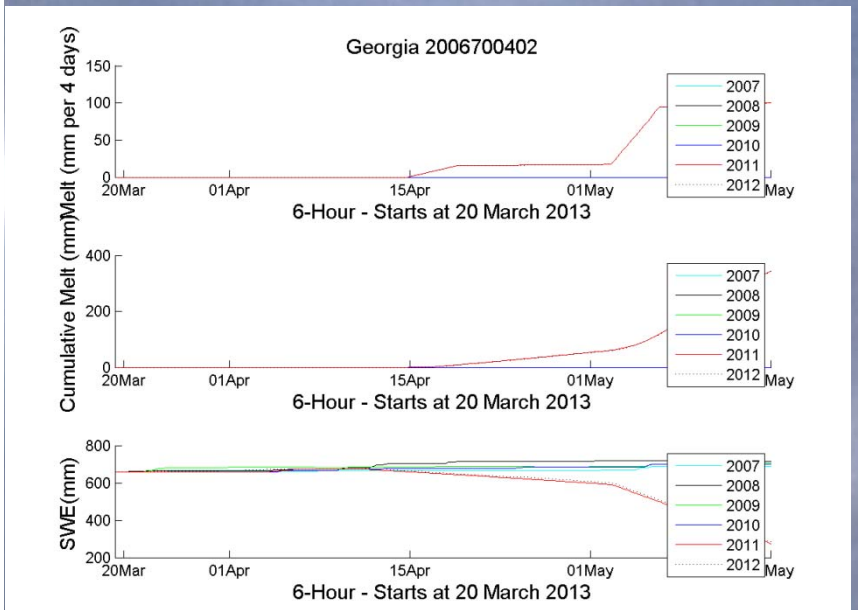
Runoff Volume Outlook: Minimum, Average and Maximum

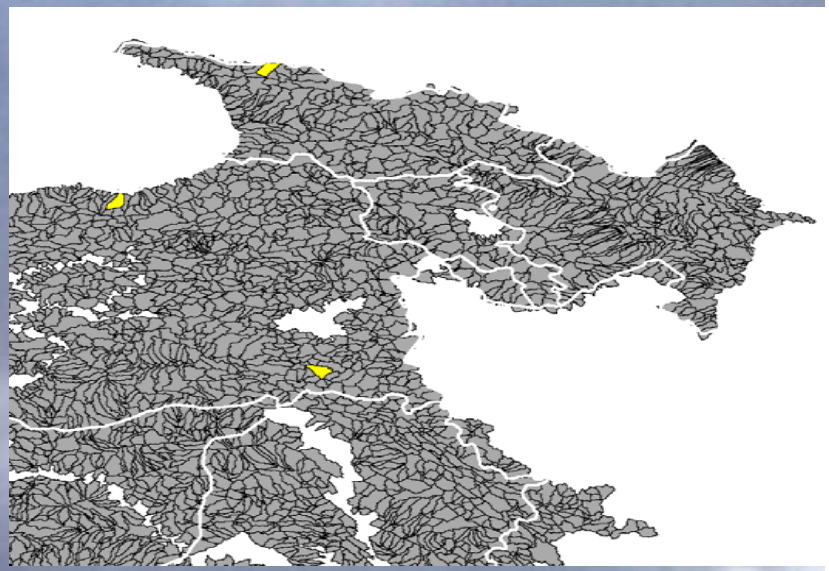


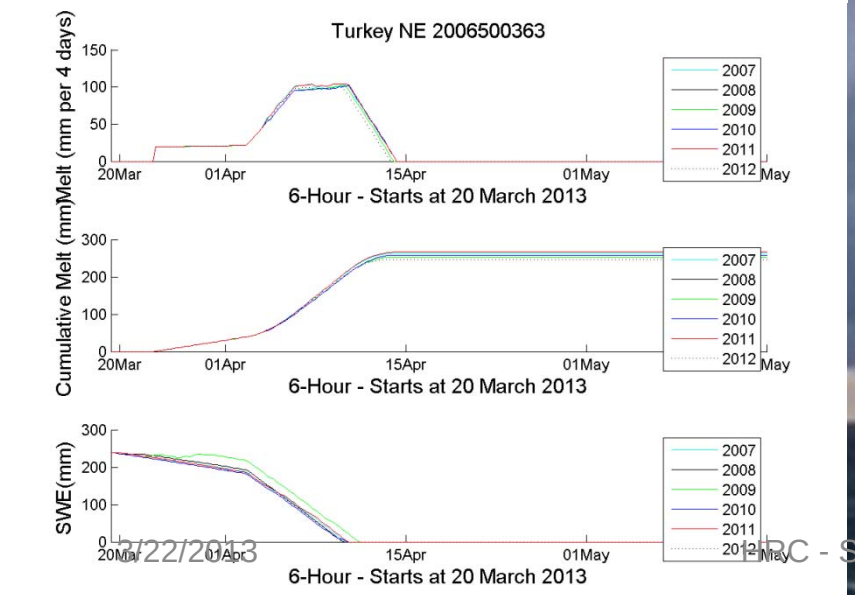


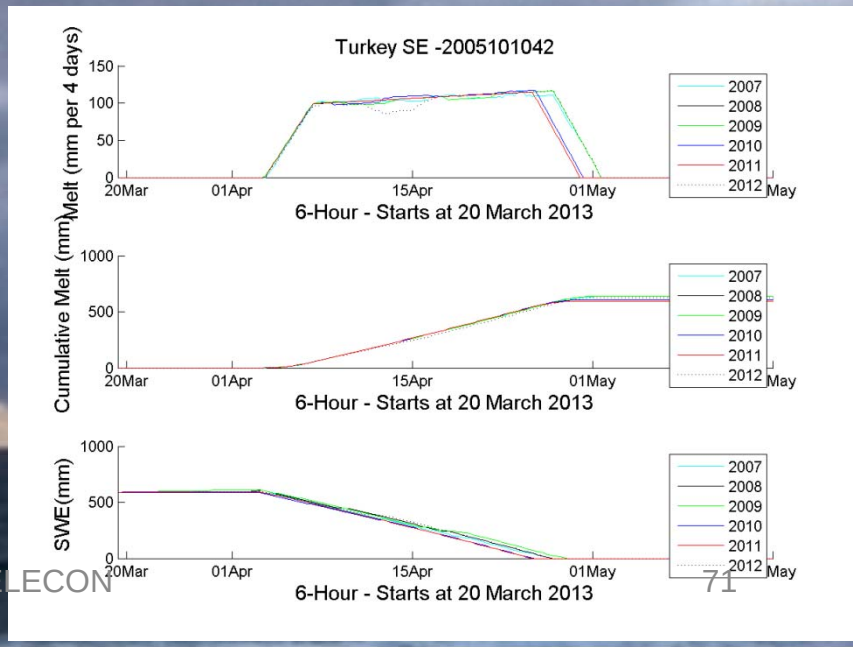


Time Series from Specific Basins









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