MapMaker History

How we got to what we have now

before MapMaker

- July 2009 workshop, Boulder, CO, USA
  - included training on tools to access, analyze and display climate model data
- September 2009 workshop, Mexico City, MEXICO
  - same as above
- August 2010 workshop, Panama City, PANAMA
  - same as above, with added exercises on using these tools
- May 2012 workshop, Panama City, PANAMA
  - same as above, with modifications
- September 2012 workshop, Cuernavaca, MEXICO
  - same as above, with modifications
- January 2013 workshop, Guatemala City, GUATEMALA
  - same as above, with modifications

something needed to change!

- after 3½ years and 6 workshops, it had become clear that we could not teach participants to use these tools in less than one week

- needed tools that would allow participants to ***use*** the data more easily and get initial results quickly

- initial development of MapMaker over Summer 2013
  - added basic capability to download WRF monthly output files
  - separate web portal for model verification

Original MapMaker Development

- MapMaker was originally developed to allow workshop participants to view downscaled climate and climate change simulation output
- Development goals:
  - No programming required
  - No need to understand netCDF format
  - Easy-to-use web-based interface
  - Basic mapping capability with presentation/publication quality graphical output
  - Access to monthly model output

MapMaker rollout

- first used at 2nd Guatemala workshop (November 2013)
  - participants were able to quickly create maps and other plots to illustrate climate change in different regions of Guatemala for specific impacts (hydrological, agricultural, natural resources)
  - downloaded data were also imported into ArcGIS

MapMaker use and evolution

- have used MapMaker (and its friends, the verification and data download pages) at workshops in Guatemala, Honduras, Bolivia, and Lincoln
- Improvements:
  - "zooming" to specific regions
  - on-the-fly calculation of relative humidity
  - access to underlying datasets
  - multiple month (including annual) averaging
  - additional graphics output options

MapMaker limitations

- features and improvements have developed in an *ad hoc* fashion as needs arose (*e.g.*, relative humidity added *during* 3rd Guatemala workshop, at user request)
- this has resulted in multiple versions and much "ugly" software coding that is difficult to maintain
- separate webpage for each project
  - requires "kludges", as projects are added, to handle different numbers of domains, different time periods, etc.

> kludge [klooj]
> noun, Computer Slang.
> 1. a software or hardware configuration that, while inelegant, inefficient, clumsy, or patched together, succeeds in solving a specific problem or performing a particular task.

MapMaker limitations

- With one exception, limited to post-processed, monthly data from UNL WRF downscaling runs
  - exception: gridded monthly temperature and precipitation observations for Bolivia (M. Andrade)

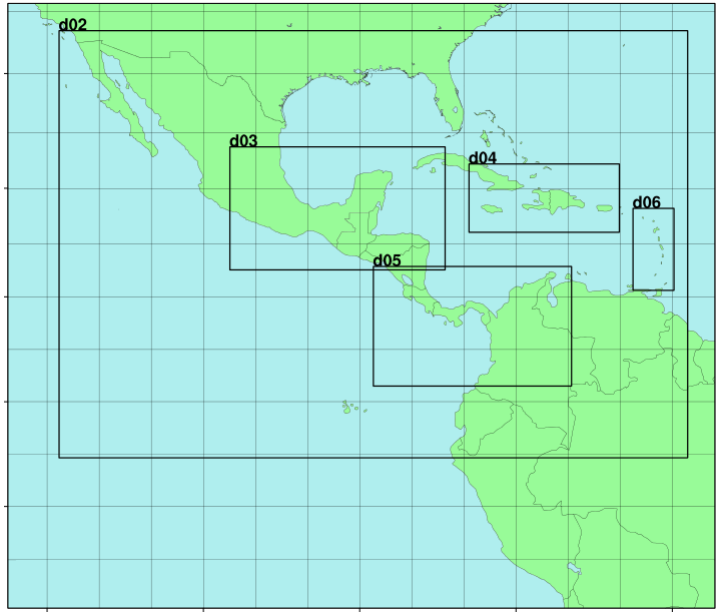
Sideline developments

- Model verification with observations
  - Graphical and statistical output
- Requires pre-processing of observed and model data
  - Uses Global Summary of Day (GSOD) observations
    - Reports to World Meteorological Organization (WMO) from individual countries
    - Problems with missing data and limited number of stations reporting for many regions
  - Difficult to incorporate observations from other sources

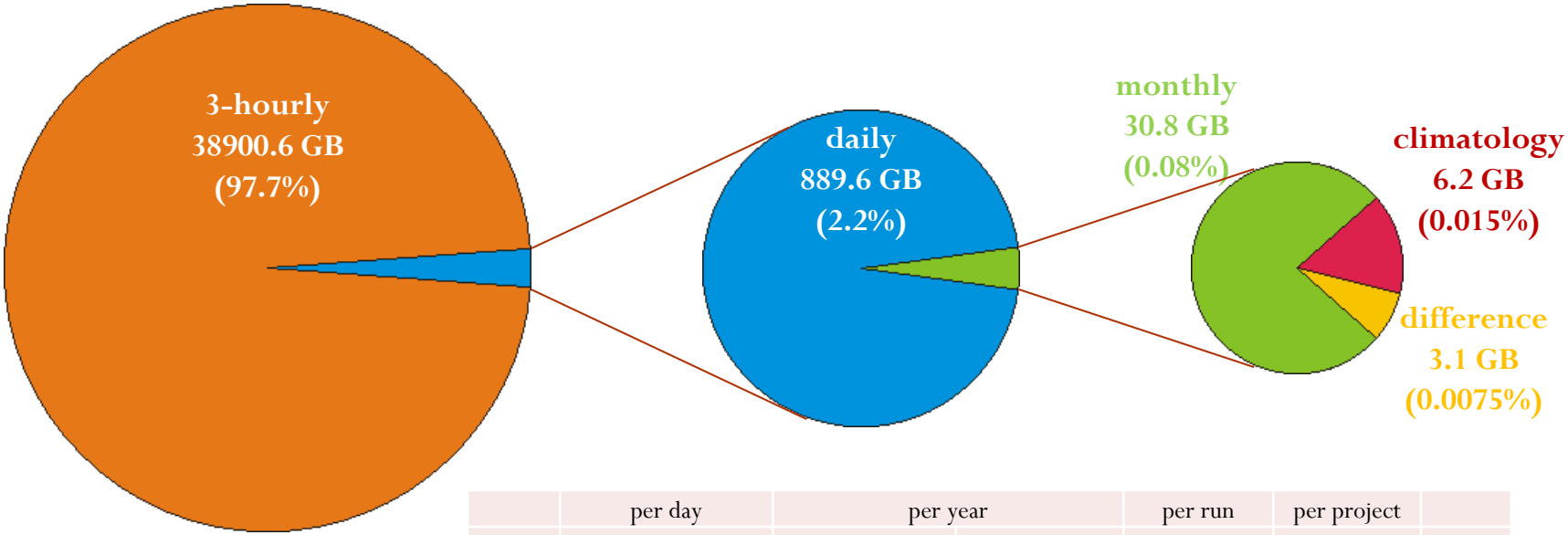
it all starts with WRF …

- 3-hourly output from downscaling (reanalysis or global climate model)
  - → daily averages and totals
  - → monthly averages and totals
  - → climatologies (and climate change differences)

- 30+ variables available for mapping, some at multiple levels in the atmosphere or multiple layers in the soil



Domain	Size NS x WE	Resolution (km)	Center Latitude	Center Longitude
1	178 x 208	36	9.00°N	90.00°W
2	376 x 553	12	14.77°N	88.85°W
3	322 x 565	4	18.02°N	92.57°W
4	178 x 394	4	18.75°N	72.62°W
5	307 x 529	4	6.89°N	79.40°W
6	211 x 103	4	13.98°N	62.08°W



	per day	per year		per run	per project	
Domain	3-hr	daily	monthly	climatology	difference	
1	621852844	5188950560	179396296	179396296	179396296	
2	3511759852	29315475380	1013483752	1013483752	1013483752	
3	3071502124	25639586660	886403176	886403176	886403176	
4	1180412332	9851364200	340582408	340582408	340582408	
5	2694416524	22491374060	777565096	777565096	777565096	
6	363659212	3033635780	104884072	104884072	104884072	
Total	11443602888	95520386640	3302314800	3302314800	3302314800	bytes
	10.66	88.96	3.08	3.08	3.08	GB
TOTAL	41769150541200	955203866400	33023148000	6604629600	3302314800	bytes
	38900.55	889.60	30.76	6.15	3.08	GB
GRAND TOTAL	38.90	TB				

2 runs x 5 years x 365 days
= 3650 days

Dimension Variables

VARIABLE	DESCRIPTION	UNITS	DIMENSIONS
TIME	Ttime	YYYYMMDD	time
PRES_LEV	Mandatory pressure levels	hPa	pres_lev
DZS	Thicknesses of soil layers	m	soil_layers
XLAT	Latitude, south is negative	°N	time, S_N, W_E
XLONG	Longitude, west is negative	°E	time, S_N, W_E

Original MapMaker Variables

VARIABLE	DESCRIPTION	UNITS	DIMENSIONS
LU_INDEX	Land use category		time, S_N, W_E
LANDMASK	Land mask (1 for land, 0 for water)		time, S_N, W_E
IVGTYP	Dominant vegetation category		time, S_N, W_E
ISLTYP	Dominant soil category		time, S_N, W_E
VEGFRA	Vegetation fraction		time, S_N, W_E
LAI	Leaf area index	$m^2\ m^{-2}$	time, S_N, W_E
HGT	Terrain height	m	time, S_N, W_E
ALBEDO	Albedo		time, S_N, W_E
ALBBCK	Background albedo		time, S_N, W_E
EMISS	Surface emissivity		time, S_N, W_E
XLAND	Land mask (1 for land, 2 for water)		time, S_N, W_E
T	Temperature	K	time, level, S_N, W_E
Z	Height	m	time, level, S_N, W_E
Q	Water vapor mixing ratio	$kg\ kg^{-1}$	time, level, S_N, W_E
U	X-wind component	$m\ s^{-1}$	time, level, S_N, W_E

Original MapMaker Variables

VARIABLE	DESCRIPTION	UNITS	DIMENSIONS
V	Y-wind component	$m\ s^{-1}$	time, level, S_N, W_E
W	Z-wind component	$m\ s^{-1}$	time, level, S_N, W_E
CLD	Cloud fraction		time, level, S_N, W_E
PSFC	Sfc pressure	hPa	time, S_N, W_E
PMSL	Sea level pressure	hPa	time, S_N, W_E
T2	Temp at 2 m	K	time, S_N, W_E
T2_MIN	Min temp at 2 m	K	time, S_N, W_E
T2_MAX	Max temp at 2 m	K	time, S_N, W_E
Q2	Qv at 2 m	$kg\ kg^{-1}$	time, S_N, W_E
U10	U at 10 m	$m\ s^{-1}$	time, S_N, W_E
V10	V at 10 m	$m\ s^{-1}$	time, S_N, W_E
PRCP	Daily total precipitation	mm	time, S_N, W_E
TSLB	Soil temperature	K	time, layer, S_N, W_E
SMOIS	Soil moisture	$m^3\ m^{-3}$	time, layer, S_N, W_E
SNOW	Snow water equivalent	$kg\ m^{-2}$	time, S_N, W_E

UNL RCMF MapMaker

weather.unl.edu/RCM/IDB_AR5/maps/

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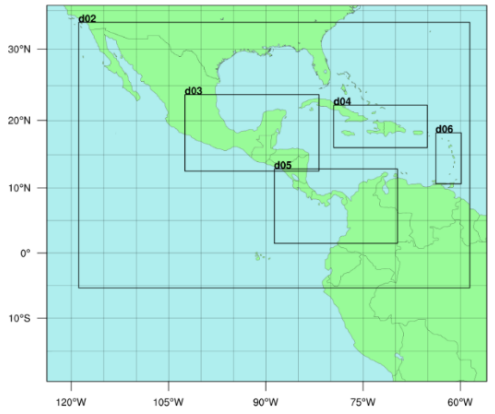
UNL Regional Climate Modeling Facility
MapMaker

MapMaker is an interactive tool for drawing maps from the output of regional climate model runs. Various surface and atmospheric variables can be plotted and overlaid on each other. Currently, monthly average data from three separate simulations are available:

- **NCEP:** a three-year simulation (1991-1993) using NCAR/NCEP global reanalysis data for initial and boundary conditions. This run is used to verify the model performance against observational data.
- **AR5 Present-day:** a five-year simulation (nominally 2006-2010) using NCAR CESM4 IPCC RCP8.5 scenario (business-as-usual) for initial and boundary conditions. It is important to remember that, although this run is labeled with actual dates, it does not correspond to the actual weather of this period. It should, however, represent conditions that are similar, in a climatological sense, to those experienced at the beginning of the 21st century.
- **AR5 Mid-century:** a five-year simulation (nominally 2056-2060) using NCAR CESM4 IPCC RCP8.5 scenario (business-as-usual) for initial and boundary conditions. This run should represent conditions that are similar, in a climatological sense, to those expected in the middle of the 21st century, should the RCP8.5 scenario hold true.
- **AR5 2050s-2000s:** the monthly-average differences between the two CCSM climatologies.

Each simulation was performed for a set of 6 nested domains, as defined below and shown at right:

- **d01** - 36km transitional domain
- **d02** - 12km regional domain
- **d03** - 4km northern MesoAmerican domain
- **d04** - 4km Greater Antilles domain
- **d05** - 4km southern MesoAmerican domain
- **d06** - 4km Lesser Antilles domain

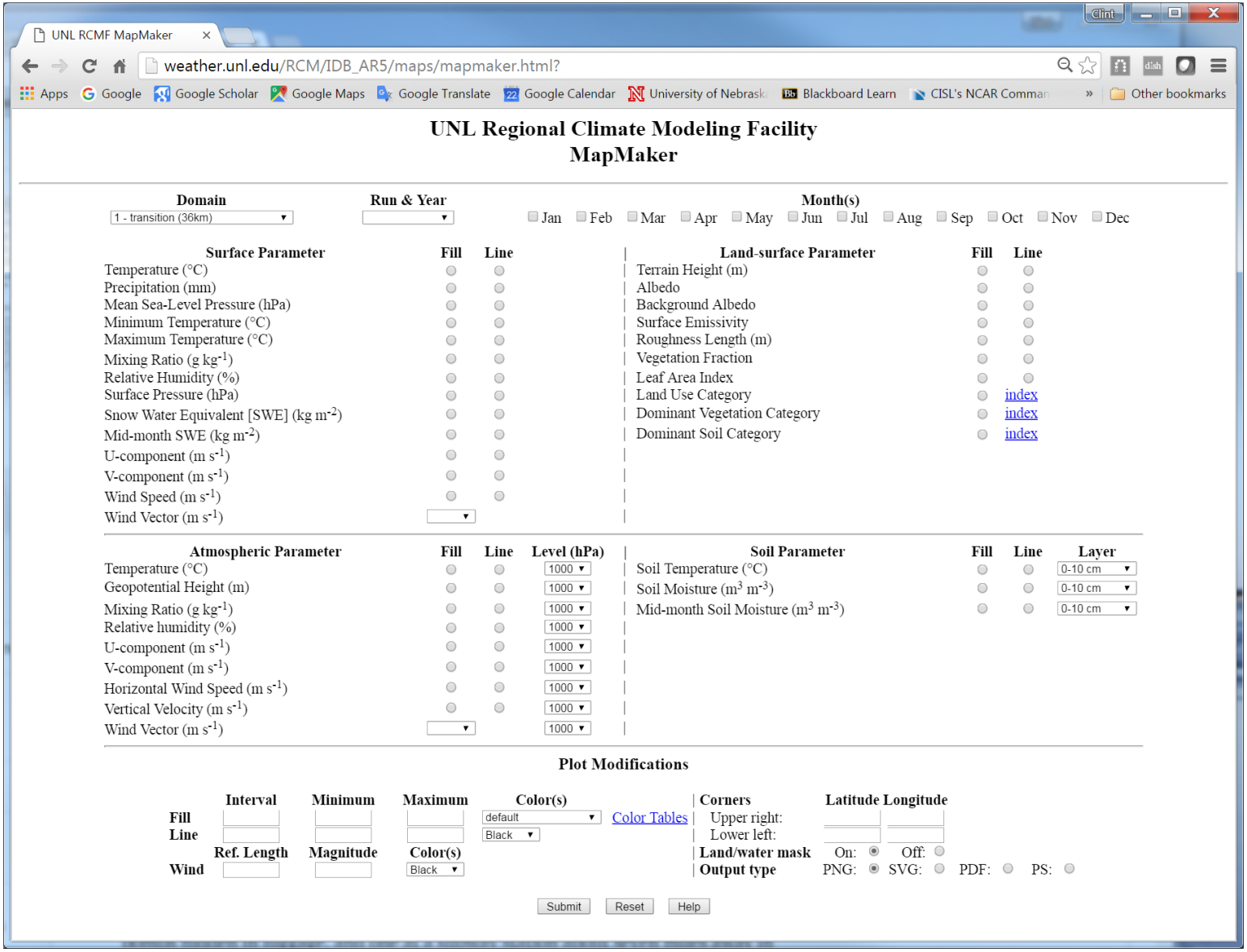


MapMaker allows the user to select one or more variables (from a single simulation over a single domain) to map. One variable can be contoured with color fill between contour levels (similar to terrain elevation at right), a second variable can be contoured without color fill, and winds at the surface and one level in the atmosphere can be plotted as arrows or standard meteorological barbs. Of course, plotting 4 variables (two contoured fields and two winds) will likely lead to an uninterpretable map, so the user must exercise judgment in their choice of variables to map.

All mapping options have default values, either pre-selected by the developer of MapMaker or based on the data to be plotted. Users can change these, although we suggest using the default values as a starting point.

MapMaker does not have the ability to plot multiple maps in a single browser window. The user, however, may open multiple browsers and start MapMaker in each one, if they want to display more than one map at a time. Alternatively, the output from MapMaker can be saved and printed or pasted into another application.

Start MapMaker | MapMaker Help | Access Data


UNL RCMF MapMaker
weather.unl.edu/RCM/IDB_AR5/maps/mapmaker.html?
Apps
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Other bookmarks
UNL Regional Climate Modeling Facility
MapMaker
Domain
1 - transition (36km)
Run & Year
Month(s)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Surface Parameter
Fill
Line
Temperature (°C)
Precipitation (mm)
Mean Sea-Level Pressure (hPa)
Minimum Temperature (°C)
Maximum Temperature (°C)
Mixing Ratio (g kg-1)
Relative Humidity (%)
Surface Pressure (hPa)
Snow Water Equivalent [SWE] (kg m-2)
Mid-month SWE (kg m-2)
U-component (m s-1)
V-component (m s-1)
Wind Speed (m s-1)
Wind Vector (m s-1)
Land-surface Parameter
Terrain Height (m)
Albedo
Background Albedo
Surface Emissivity
Roughness Length (m)
Vegetation Fraction
Leaf Area Index
Land Use Category
Dominant Vegetation Category
Dominant Soil Category
index
Atmospheric Parameter
Level (hPa)
Geopotential Height (m)
Relative humidity (%)
Horizontal Wind Speed (m s-1)
Vertical Velocity (m s-1)
1000
Soil Parameter
Layer
Soil Temperature (°C)
Soil Moisture (m3 m-3)
Mid-month Soil Moisture (m3 m-3)
0-10 cm
Plot Modifications
Interval
Minimum
Maximum
Color(s)
Fill
Line
default
Black
Color Tables
Ref. Length
Magnitude
Wind
Corners
Latitude
Longitude
Upper right:
Lower left:
Land/water mask
On:
Off:
Output type
PNG:
SVG:
PDF:
PS:
Submit
Reset
Help

Directory Listing of /RCM/

weather.unl.edu/RCM/IDB_AR5/data/

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UNL RCM IPCC AR5 RCP8.5 Scenario Output

These directories contain the processed output files from the simulations done by the University of Nebraska Regional Climate Modeling Task Force under contract to the Interamerican Development Bank. Raw model output from the WRF regional climate model (every three hour or 8 times per day) have been processed to create daily, monthly and climatological averages for the available simulation periods. Additionally, atmospheric variables were interpolated from model levels to mandatory pressure levels.

Three separate simulations were completed and are contained in separate directories. A fourth directory contains climatological differences.

- **NCEP**: a three-year simulation (1991-1993) using NCAR/NCEP global reanalysis data for initial and boundary conditions. This run is used to verify the model performance against observational data.
  - **month**: monthly averages: one year per file per domain
  - **climo**: monthly climatological averages: one file per domain
- **CONT** (control): a five-year simulation (nominally 2006-2010) using NCAR CCSM4 IPCC RCP8.5 for initial and boundary conditions. It is important to remember that, although this run is labeled with actual dates, it does not correspond to the actual weather of this period. It should, however, represent conditions that are similar, in a climatological sense, to those experienced at the beginning of the 21st century.
  - **month**: monthly averages: one year per file per domain
  - **climo**: monthly climatological averages: one file per domain
- **CHNG** (change): a five-year simulation (nominally 2056-2060) using NCAR CCSM4 IPCC RCP8.5 for initial and boundary conditions. This run should represent conditions that are similar, in a climatological sense, to those expected in the middle of the 21st century, should the A2 scenario hold true.
  - **month**: monthly averages: one year per file per domain
  - **climo**: monthly climatological averages: one file per domain
- **DIFF** (difference): the monthly-average differences between the two CCSM4 climatologies.
  - **climo**: monthly climatological average differences: one file per domain

Directory Listing of /RCM/IDB_AR5/data/

home

File	Size	Last Modified
CHNG/	-	Apr 21 2016 12:35:53 PM
CONT/	-	Apr 21 2016 12:35:42 PM
DIFF/	-	May 23 2012 07:06:17 PM
NCEP/	-	Nov 15 2013 01:15:10 PM

Directory Listing Script ©2008 Evoluted, Web Design Sheffield.

In linux, to download entire directories, consider using ***wget***. For example, to download all the NCEP climatology files into a "climo" directory created in the current directory, use

```
wget -r -nH -np -c --cut-dirs=3 --reject "index.html*" http://weather.unl.edu/RCM/data/NCEP/climo/
```

Station selector

weather.unl.edu/RCM/verify/MesoAm.html

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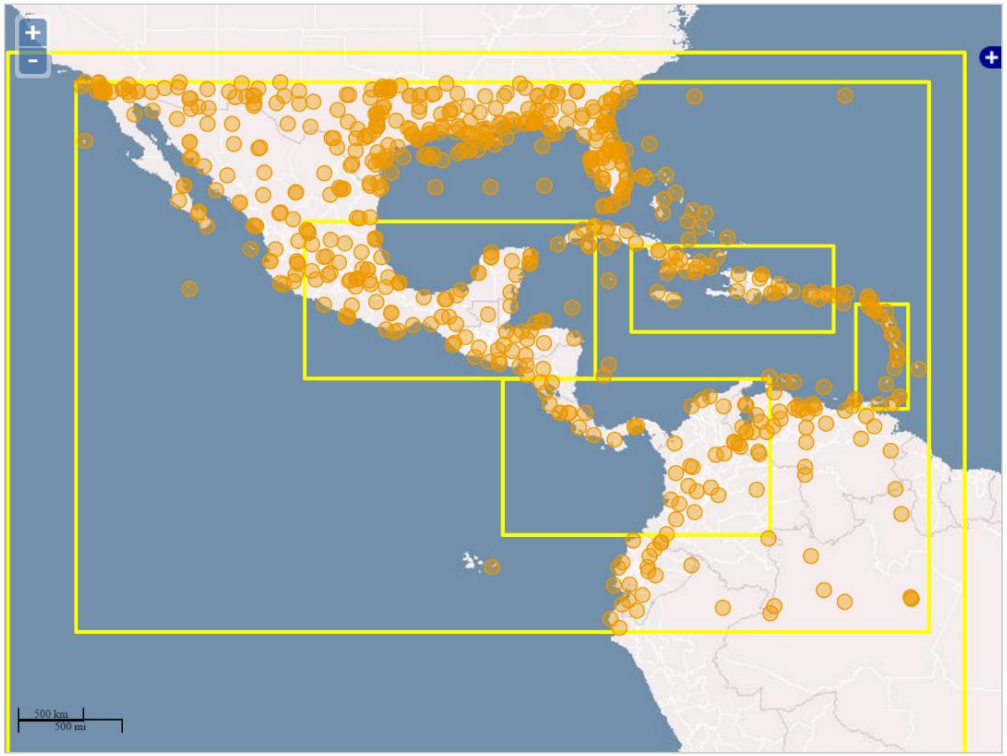
Station Selector

Point to station to identify



Plot selections

Domain

☑ 36km ☑ 12km ☑ 4km

Parameter

◉ Temperature ○ Precipitation
○ Sea-level Pressure ○ Station Pressure
○ Wind Speed

Plot Type

◉ Scatterplot ○ Time Series
○ Ranked Series ○ Taylor plot

Plot Modifications

X min: X max:
Y min: Y max:
Smoothing: ○ data ◉ plot

Output

◉ PNG ○ PDF ○ PS

Submit Reset Help

Live demonstrations

- MapMaker
  - http://weather.unl.edu/RCM/IDB_AR5/maps/
- Data download
  - http://weather.unl.edu/RCM/IDB_AR5/data/
- Verification
  - http://weather.unl.edu/RCM/verify/MesoAm
- Open your favorite browser and follow along …