Overview

Day 1
• Introduction
• What is Climate Data Rescue and Its Importance
• Climate Data in Jordan and Palestine
• Climate Data Rescue Methods
• Practicum

Day 2
• International Activities
• CDMP-Forts
• Metadata
• Practicum

Day 3
• Homogenization
• Practicum
• Climate Data Rescue in Jordan and Palestine
• Conclusion
Metadata – from CDMP

- Image – Source and Processing
- Keying / QC
  - Thus far:
    - Station name, id, lat, long, elev., Period of Record, Variables (Elements), instrumentation, observer name, time zone
    - Tests applied
    - Corrections and Flags
- Thus far, documentation to correctly reproduce observations
Documentation of Data Processing

- Document source, data transfer steps
- Document formats variables in files
- Document meanings of Flags/codes
- Document units / conversion factors
- Document QC applied (yes/no for tests)
- Document observing practices; site information
Metadata Use

• Are changes in climate data due to climatic changes or non-climatic changes?

• Best tool, to document observing practices and site characteristics that also change over time

• Exact dates of changes in instrumentation, changes in observer, of site relocation, of date calibrations, of new instrumentation
Non-climatic Factors to Document

- Station Identifiers
  - Local code
  - WMO code
  - Names, Aliases
  - Region code
  - Network code

- Site Characteristics
  - Local Environment
  - Geographical Data

- Instrumentation
  - Placement / exposure
  - Type
  - Maintenance

- Observing Practices
  - Observer info
  - Elements
  - Units, Observation times

- Historical Events
  - Changes in social institutional, political environment
  - Daylight savings time

- Communications
  - General correspondence can provide information on quality observations
  - Data transmission issues, particularly for hourly data
Site: Geographic Data

• Latitude, Longitude
  o At least 0.001 to the thousands in accuracy within a few 100 meters
  o Decimal form or Minutes/Seconds
  o N/S E/W or +/-

• Elevation about sea level within a few meters

• Elevation of the pressure reference level, as the barameter is not usually in the station enclosure

• Instrument moves
Site: Local Characteristics

• Basic Requirements:
  o MesoScale region map (1:100,000) (1 cm on map = 100,000 earth (1km))
  o TopoScale map, updated annually (1:5000)
  o Radiation horizon mapping, updated annually
  o Photos, from all points of the compass, from ~5m, ~20 m, of the enclosure, of the instrument position outside of the enclosure, updated upon significant changes
  o MicroScale map of the instrument enclosure, (1:500) updated when instruments are relocated or other significant changes.
Enviroment Scales

- **MicroScale**: < 300 m
  - Frost hollows affect minimum temperature
  - Surface Energy Exchange affected by wetness and thermal conductivity of soil
  - Reliable radiation measurements depend on obstacle free environment [trees, buildings]

- **TopoLcale / Local Scale**: 300 m - 1 km
  - Observations influenced by terrain slope, forests, crops, and other roughness, by nearby obstacles: trees, houses, airplanes

- **Mesoscale**: 1 to 30 km
  - Climate is affected by proximity and size of large water surface, urbanized areas, deep valleys and mountain ranges
Frost Hollow

- **Frost hollow** (or frost pocket) is the name for low-lying area (e.g. a valley bottom or a smaller hollow) where frosts occurs more frequently than in the surrounding area. This is normally as after a dry, clear and cold night cold air drains down neighboring slopes into a localized pocket from which it is slow (or unable) to escape.

- Frost hollows of larger scale (a valley or basin) are also known as **cold pools**. Cold pools are areas where cold air is trapped under an inversion under calm winter weather conditions.
- MicroScale
- From WMO/TD 1186 page 24
Macro View

- CIMO-Guide Template for documenting metadata at the toposcale. The example shows an imaginary station.
- (From WMO/TD 1186, page 7).
Land Use Cover Class

- Artificial surfaces
- Agricultural surfaces
- Natural vegetation and open areas
- Wetlands
- Water bodies
- Urban, suburban, rural
Next Slides Define these classes

Could be used in description of site characteristics
Artificial Surfaces

- continuous urban cover;
- discontinuous urban cover;
- industrial and commercial areas;
- transportation infrastructures;
- harbor areas;
- airports,
- mines, dumps, areas under construction;
- artificial green areas (non-agricultural)
Agricultural Surfaces

- Non-irrigated crops
- Irrigated crops
- Rice fields and other inundated crops
- Grasslands
- Mixed crops
- Agricultural / forest systems
Natural Vegetation

- Deciduous Forests
- Evergreen Forests
- Mixed Forest
- Scrub vegetation
- Mixed scrub and forest
- Natural Grasslands and prairie
- Desert
Wetlands

- Swamp areas
- Peat lands
- Marshes
- Inter tidal flat areas
Water Bodies

- Rivers, streams, other natural water courses
- Artificial water courses, channels
- Lakes, lagoons
- Reservoirs, Estuaries
- Seas, Oceans
Site characteristics

- Root top vs ground level
- On a hill? [wind effects]
- Over grass, bare ground, concrete
- Near buildings / Trees
- Land use type (urban, suburban, rural)
- At airport
- Near water
- By field where crops can reach higher than instruments during growing season
- Proximity to irrigation; to water body
- Skyline diagram and site map - valuable
Changing Site Characteristics: Urban vs Urbanizing, Vienna

From WMO/TD 1186)
Instrument Exposure/Location

• MicroScale (here = < 100 m)

  obstacles and ground cover can impact instruments

  enclosure surroundings: tree, fence, wall, house, or other buildings
Precipitation Data, Croatia, 35% decrease (WMO/TD 1186, page 19)
Wind Impacts from Site Characteristics

- Correction of shelter effects can be made with roughness estimates
  - (Davenport Class)
  - Azimuth-dependent analysis of observed gustiness data (Verkaik, 2002)
<table>
<thead>
<tr>
<th>No.</th>
<th>Class Name</th>
<th>Roughness length (m)</th>
<th>Landscape description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Very Rough</td>
<td>0.5</td>
<td>Intensively cultivated landscape with large farms, orchards, bushland, $x \approx 8 , H$; low well-spaced buildings and no high trees ($x \approx 3-7 , H$)</td>
</tr>
<tr>
<td>7</td>
<td>Skimming</td>
<td>1.0</td>
<td>Full similar-height obstacle cover with interspaces $\approx H$, e.g. mature forests, densely-built town area</td>
</tr>
<tr>
<td>8</td>
<td>Chaotic</td>
<td>$\geq 2$</td>
<td>Irregular distribution of very large elements: high-rise city centre, big irregular forest with large clearings</td>
</tr>
<tr>
<td>No.</td>
<td>Class Name</td>
<td>Roughness length (m)</td>
<td>Landscape description</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------</td>
<td>----------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>Sea</td>
<td>0.0002</td>
<td>Open water, featureless flat plain, fetch $&gt; 3$ km</td>
</tr>
<tr>
<td>2</td>
<td>Smooth</td>
<td>0.005</td>
<td>Obstacle-free land with negligible vegetation, marsh, ridge-free ice</td>
</tr>
<tr>
<td>3</td>
<td>Open</td>
<td>0.03</td>
<td>Flat open grass, tundra, airport runway, isolated obstacles separated by $&gt;50$ obstacle heights $H$;</td>
</tr>
<tr>
<td>4</td>
<td>Roughly Open</td>
<td>0.10</td>
<td>Low crops or plant cover, occasional obstacles separated by $\geq 20$ $H$;</td>
</tr>
<tr>
<td>5</td>
<td>Rough</td>
<td>0.25</td>
<td>Crops of varying height, scattered obstacles with separation $x \approx 12-15$ $H$ if porous (shelterbelts) and $x \approx 8-12$ $H$ if solid (buildings)</td>
</tr>
</tbody>
</table>
“Rural” station

From WMO/TD 1186, pg 9)
CCPN Gage 2 move; 6/8/2012

• Winnetka Park District was preparing to expand their parking lot to the south which required us to move the gauge.
• Moved the gauge 0.4 km @ 260°.
• New location is on top of a hill created by dredge material from their irrigation ponds.
• The nearest trees are 10 m to the east at 10 meters above the gauge.
• This location has unobstructed exposure. It also has good solar exposure, but we may need to watch the voltage in November & December due to Southern trees.
Convenient to document instrument information
Aside, project camera

- Camera used to take pictures of sites;
- Also good for documenting mishaps at the instrument site

- February 2011; large increase in bucket weight on a clear and sunny day; not observed elsewhere; previous event in line with other gages.
Snowplow cleared parking lot
Other Information (by variable)

- Temperature and Humidity: Screen (type and size) and ventilation
- Wind direction: time and method of azimuth alignment
- Wind speed: response time of anemometer and recording chain, and how these were determined
- Radiation: wavelength length range transmitted to the dome
- Sunshine: thresholds for automatic sunshine recorders
- Evaporation: cover applied to evaporation pan
Ground Cover

- Properties of the surface underlying instruments can impact measurements – concrete, vegetation, soil type down to 1 m.
- Surface properties:
  - Albedo
  - Roughness
  - Thermal capacity
  - Wetness
  - Thermal conductivity
- Evapotranspiration computations affected by vegetation type / non-vegetation
Instrumentation

• Manufacture
• Model number – manufacturer leaflets often incomplete; can search for other information
• Modifications to instrument
• Output type and sensitivity
• Transducer type (if applicable)
• Response time (if applicable)

• Helpful for inter-comparison studies of instruments
Instrument Placement / Type

- Sheltered / ventilated / near building?
- Maintenance / Replacement (run in parallel)
- Precipitation – gage type tipping bucket / weighing bucket, non-recording
  (Some gages measure snow/ heavy rain better than others)
- Temperature - thermometer and shelter type
Network change in US

- Temperature – Max / Min thermometer changes, 1980s-1990s
  - From liquid-in-glass max/min thermometers in wooden Cotton Region Shelters
  - To Thermistor-based Max/Min Temperature System housed in a smaller plastic shelter ~400 stations daily average min T change, +0.3 C
  - Daily average max T change -0.4 C (Quayle et al., 1991, BAMS)
Aggregated differences in mean monthly maximum temperature between stations that switched to thermistor sensors at time 0 and neighboring stations that continued to use liquid in-glass thermometers (from Quayle et al., 1991)
Other Gage Information

• Precipitation –
  o Gage rim diameter;
  o Rim height above ground,
  o Presence of overflow storage,
  o Presence of a nipher screen or Alter shield or other airflow modifying feature
  o Presence of heating or other means to deal with solid precipitation
  o Exposed or sheltered
  o Chart or potentiometer and data logger
Note Observing Practices:

• Observer name, agency, level of training
• List of observed elements
• Observing times for max / min T
  o 7 am or 5 pm, close to min or max,
    • could double count
    • AM observers tempted to shift date)
• Observing times for precipitation
  • Hour, AM, PM, midnight,
    • important for inter-comparison of stations
• Corrections made by observer (time shifters)
More Observing Practices

- Units, example Peterson et al, 1998) degrees Kelvin erroneously corrected, (From WMO/TD 1186, Page 14.)

- Instructions
- Routine Maintenance Operations
Changes in Institutional/Social Environment

- Army Surgeons ->
- Smithsonian Volunteers -> US Civil War ->
- Dept War – Army Signal Corps & volunteers ->
- Dept Agriculture, Weather Bureau & volunteers ->
- Airlines ramp up ->
- move from urban areas to airports ->
- Hourly observations ->
- Dept of Commerce, National Weather Service - automated observations- ->
- Improved automated observations ..... 
- Daily observations – Cooperative Network
Mount Tamboura Eruption 1815; Year Without a Summer 1816; 1820 observations began.

US Army Surgeon General Network --> Smithsonian Institute Volunteers --> US Army Signal Corps (Dept War) --> US Weather Bureau (1892; Dept Ag)

Westward expansion of US

Civil War

US Weather Bureau

Number of Months with Keyed Data

Mount Tamboura Eruption 1815; Year Without a Summer 1816; 1820 observations began.

Year

1780 1800 1820 1840 1860 1880 1900
Network Differences

- Hourly observations – NWS employees or contract employees; often at airports;

- Daily observations – volunteers; often in backyards or fields
  - 6000 stations across the US;
    - daily max/min T,
    - Precipitation
    - Snowfall, snow depth

- Climate - Reference Network (CRN) ~ 125 stations
  - 1 minute, 5 minute, hourly observations
Station Histories

- CDMP – Forts
  - Text descriptions for 70 stations
  - Written primarily by emeritus-climatologists, or an occasional state climatologist
  - Gathered and presented pictures, descriptions of the site through time, whatever information they could find.
Histories of Weather Observation at Selected Locations

In association with the CDMP project to digitize the 19th Century weather data, the Station Histories Project is striving to collect information about the location of the weather stations and their observing practices. This information may be found in national or local archives, libraries, or in private collections. The information for a station is gathered together into a written report describing the historical development of weather observations at the site. Station histories for over 70 stations are currently available. (Click here for citation format.)

These histories are in Adobe PDF format. You must have PDF reader on your computer to view them. Histories with an asterisk (*) after their name are quite large (over 15 MB), and not recommended for dial-up users.

List of available histories - click on the station name:

| AL - Mobile                  | KS - Manhattan     | OH - Cincinnati* |
| AL - Mount Vernon           | KY - Bowling Green | OH - College Hill |
| AZ - Fort Huachuca*         | KY - Louisville*   | OH - Jacksonburg |
| AZ - Fort Verde*            | KY - Newport Barracks* | OH - Mount Auburn |
| AZ - Wickenburg*            | LA - Fort Jesup    | OK - Fort Gibson |
| CA - Los Angeles            | LA - Shreveport    | OK - Fort Washita |
| CA - Presidio of San Francisco | MA - Nantucket  | OR - Portland |
| CA - Sacramento*            | ME - Portland      | SC - Aiken       |
Urbana IL
1888 to 1963
schematic of 4 campus locations
FIGURE 6. CAMPUS WEATHER STATION INSTALLATION IN 1932, LOOKING SOUTHWEST. THIS WAS THIRD SITE OF SHELTER, BUT ONLY SECOND SITE OF RAINAGE. ENCLOSURE FOR SOIL THERMETERS LIES BETWEEN SHELTER AND RAINAGE.
Where to find Metadata

- Met. Office for current observation practices, and for as long as the Met. Office has been active
- Publications from prior Met. Offices
- Other scientific institutions. (Agricultural / hydrological / geographical)
- Current and former observers / climatologists / other local experts
- Data forms
- Meteorological Site (mapping, photographing)
- Libraries / archives / newspapers / Journal articles
- Web
- Instrument manufacturers
Metadata

• The details and history of local conditions, instruments, operating procedures, data processing algorithms can help us verify data and interpret data.

• Help us identify non-climatic “breakpoints” in trends
Document everything so that non-climatic changes can be identified.