Local Climate Analysis Tool (LCAT) in Support of Weather and Climate Extremes

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Local Climate Analysis Tool (LCAT)

- Developed to support NWS field offices
- Online interactive tool
- For regional and local climate studies
- State-of-the-art station data
- Best practices for climate analysis
- Applications for assessing climate impacts on severe weather

- Variables beyond average temp and total precip, including extreme events
- Reduce field office time spent on responding to customers’ climate questions
- Provides critical links for forecasters on climate drivers for weather and water events
**LCAT Essentials**

**NOAA Recommended Trend Methods**
- **Hinge**
  - Best fit line (Slope = 0) 1950 – 1976
  - Best fit line 1976 - 2010
- **EWMA**
  - Exponentially Weighted Moving Average
- **OCN**
  - Optimal Climate Normal
- **Ensemble**
  - Average of all trend values

**SMEs**
- NCDC, CPC, NDMC, ESRL, CBRFC, WWA

**Science Advisory Teams**

**Integrated Working Team**

**Requirements Training**

**CSD, OST, Contractors**

**LCAT Development Team**

**Drought Analysis and Impacts**

**Climate Change Impacts**

**Climate Variability Impacts**

**Water Resources Applications**

**Attribution of Extreme Events**


** NIST/SEMATECH e-Handbook of Statistical Methods. 2012**

*** Huang et al, 1996; *J. Climate***

© Requirements pulled from NWS field, RCSDs, stakeholders
LCAT Essentials
Peer review and coordination process

New requirement to IWG, SAT

Development Team

Capability not in LCAT

Field Officer uses LCAT

USER Question

IWP & Climate.gov publication

Study saved in IWP

Local, Regional, SAT review of study

Analysis submitted to LCAT 3-tier review

Documentation/study Option

Question answered
How does LCAT work?

LCAT uses principles of Artificial Intelligence to connect humans with computing capability to apply data and scientific techniques.

How is the temperature in my town changing?

Should we expect floods during La Nina events?

How severe is the drought in my region this year?

Which climate model performs best in my region?

What are the projections for climate in my region?

Data: Homogenized station maximum temperature
Analysis: best practices for trend; rate of change
Output: statistics, plots, metadata

Data: Homogenized precipitation and river flow
Analysis: composites, risk assessment
Output: statistics, plots, metadata

Data: Drought indices
Analysis: time series analysis
Output: statistics, plots, metadata

Data: Reanalysis and GCM fields
Analysis: downscaling, sensitivity tests
Output: statistics, plots, metadata

Data: GCM outputs
Analysis: downscaling
Output: statistics, plots, metadata
LCAT Output

Climate Change Impacts

Data Statistics
- Mean: 80.42 Degrees F
- Median: 80.30 Degrees F
- Mode: 80.20 Degrees F
- Standard Deviation: 1.083

Trend Performance
- Root Mean Square Error
  - Hinge with anchor at 1975: 1.02
  - Exponentially Weighted Moving Average (Alpha=10): 0.88
- CPC Optimal Climate Normal (10-Year Moving Average):
  - Ensemble Performance
    - Ensemble Standard Deviation: 0.17
- Rate of Change
  - Annual Rate of Change: 0.010 Degrees F per year
  - Decadal Rate of Change: 0.1 Degrees F per decade
  - Climatological Rate of Change: 0.3 Degrees F per 30-year period

Climate Variability Impacts

Data Statistics
- Mean: 5.94 Inches
- Median: 5.8 Inches
- Mode: 6.3 Inches
- Standard Deviation: 1.391
- Climatological Mean: 5.92 Inches
- Tercile Low: 5.1 Inches
- Tercile High: 6.3 Inches
- Below Events: 15
- Neutral Events: 32
- Above Events: 14
- Total Events: 61

Anomaly
- Lower Category Anomaly: 0.57 Inches
- Middle Category Anomaly: -0.29 Inches
- Upper Category Anomaly: 0.15 Inches

Climate Division Data:
- Florida Panhandle
  - Total Precipitation (inches)

COOP Data: TALLAHASSEE WSO AP, FL
- Variable: Average Temperature (degrees F)

Link to LCAT Developmental Site
## LCAT Milestones

<table>
<thead>
<tr>
<th>Activity</th>
<th>Date</th>
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<tbody>
<tr>
<td>Complete LCAT Documentation and Training Modules</td>
<td>March 2013</td>
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<tr>
<td><strong>Operational Deployment:</strong></td>
<td>March 2013</td>
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<tr>
<td>• Climate Variability Study (T/P data for station, CPC FR, NCDC CD)</td>
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<tr>
<td>• Climate Change Study (ENSO, T/P data for station, CPC FR, NCDC CD, 20 NCEP R1 fields)</td>
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<td>• Correlation (20 NCEP R1 fields + 20 Climate Variability modes)</td>
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<td><strong>Augmenting Datasets</strong></td>
<td>September 2013</td>
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<td>• ACIS – extremes data</td>
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<td>• NCDC Severe Weather</td>
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<td>• NOS sea level</td>
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<td><strong>DOE Year 1</strong></td>
<td>August 2013</td>
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<td>• User requirements</td>
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<td>• Global gridding</td>
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<td>• Reanalysis data</td>
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<tr>
<td><strong>DOE Year 2</strong></td>
<td>August 2014</td>
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<tr>
<td>• New computational analysis capabilities for DOE applications</td>
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<tr>
<td>• Implement new web design</td>
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<td>• Access CMIP5 data</td>
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LCAT – Learn

• Total of 6.5 h of recorded training:
  – LCAT Utility
  – LCAT Data
  – LCAT Methods
  – LCAT Applications

• Online guidance

• Available in the end of March – April 2013

• Online Help buttons and Dynamic Interpretation will bridge the gaps

• We will rely on CSPMs and SOOs for ensuring proper training and utility of LCAT in operations
LCAT – Share

- LCAT will leverage MDL Innovation Web Portal (IWP, OSIP project 11-002), a common, virtual, dynamic, interactive environment for field developers, meteorologists, other NOAA/NWS personnel, and partners to collaborate, share information, validate needs, exchange innovative ideas, concepts, research/science and technology information

- https://nws.weather.gov/innovate/

- Advantage:
  - Merging Climate Studies into the suite of NWS innovations
  - Use of existing capabilities
  - Located at the same operational server, and
  - Search for climate across broader data
Water Resources Applications and Drought Studies

LCAT capabilities developed in partnership with
- NIDIS
- National Drought Mitigation Center (NDMC)
- NWS Office of Hydrological Development (OHD)
LCAT – Shift of Priorities

• DOE Project – with relevance to NOAA
  • Reanalysis data – CFSR
    • Grid point data
    • Averaging over a region
  • Model data at grid points and regions
    • CMIP / IPCC models – AR5
    • What’s next?
      • CFSv2, FIM
      • 7 models of the NMME

• New LCAT Application
  • Validation/evaluation of climate model output/performance by region
  • Analysis of regional trends in climate models
  • Spatial correlations of climate phenomena
  • Extracting climate signals from model data
LCAT – Shift of Priorities

To enhance the availability and application of DOE environmental information resources for research and research management in DOE and in the broader scientific community.

The project is supported for 1 year, expiration in September 2013, with potential of extension up to 3 years.

Support for:
- Prescient Weather
- NWS Local Climate Specialist

NWS contribution: support for Web development for LCAT integration.
LCAT Future

• Data and analyses for energy industry support
  – What has been the maximum wind speed over the past 30 years?
  – What is the projection for the next 20-50 years?
  – What is the average daily cloud cover in a region during an El Niño winter?
  – What is the average radiation in the North East when the AO is in the negative phase?
LCAT Future

• Weather and Climate Extremes
  – Relative humidity, upper air, storminess, lightning, tornadoes, snow, radiation, large hail, high winds, lightning, winter storms, blizzards, tropical storms and hurricanes, flooding, dust storms, radiation, drought
    • What is the frequency and return period of extreme precipitation?
    • What is hydrologic hazard distribution at a specific watershed?
    • What is the trend in snowfall in the Pacific NW?
    • What is the average speed of the midlatitude jet over Kansas during ENSO neutral years?
    • What is the probability of a greater than average number of hurricanes during a La Niña year?

• Health Applications
  – Mortality, morbidity, vectors, pathogens, contaminants
    • Is the local climatology favorable for spreading the Dengue Fever vector?
    • Will a spring drought increase the chance for spread of West Nile virus?
    • What is the trend in heat-related deaths in Chicago?
    • What is the relationship between severe precipitation events and the spread of contaminants?
LCAT Future

• Coastal Inundation
  – Incorporation of NOS sea level data and analysis techniques for correlations to regional and local climate variability and change
    • What are water level extremes during El Niño or La Niña events?
    • Are there seasonal extremes?

• Marine Ecosystems
  – Support for Healthy Oceans
  – *NOAA Habitat Blueprint: A framework to improve habitat for fisheries, marine life, and coastal communities*
    • Relating climate variables with relevant data sets
      – Fisheries
      – Habitats
      – Iconic species
    • Climate change impacts to the ocean
      – Sea level
      – Acidification
    • Warming Water level (tides, etc.) and climate signals for coastal regions
Final Thoughts

• LCAT is a unique, revolutionary tool for data analysis
• Relieves user of burden of
  – Identifying which data is the most relevant and reliable
  – Identifying which analysis technique to use that is most appropriate and scientifically sound
  – Developing codes for data access and analysis techniques
• LCAT has application for priorities of both Weather-Ready Nation strategy and the Climate Goal objectives
• LCAT potential includes
  – Comprehensive environmental study of climate impacts at regional and local levels
  – National and global applications
  – Historical data out to climate projections
• Partnerships growing
  – State Climatologists – joint proposals for analysis of state climates
  – DOE support for accelerated LCAT development to meet their needs
  – Fisheries for stock analysis
  – Marine Sanctuaries for management of protected areas and climate adaptation planning