

Title: Training working group: Climate and streamflow seasonal trend analysis at LTER sites  
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### Goals

The objective of this workshop was to train climate information managers and scientists from the LTER Network in (1) climate data homogenization, and (2) climate data trend analysis, in order to provide a basis for LTER Network-wide analysis of climate trends and variability. A third goal accomplished in the workshop was to establish a possible agenda for the LTER Climate Committee, which has not been very active for some years.

The workshop was motivated by the fact that individual LTER sites have published climate trend analyses, but [apart from the Ecotrends book (Peters et al 2011) and Jones et al (2012)] there has been no systematic analysis of long-term LTER climate records. Climate trends and variability are central to research at all sites in the LTER network, and climate records are long enough (>3 decades) at almost all LTER sites to undertake meaningful quantitative analysis for site-level assessment of ecological responses and cross-site comparisons of responses to climate change. Yet despite the availability of climate records from the LTER network in a single, public archive (climDB/hydroDB) since at least 2000, we have barely begun to systematically quantify climate trends and variability across the network.

The climate-training workshop took place June 23-25, 2013, at the LTER Network Office at the University of New Mexico in Albuquerque. The climate training workshop was a follow-up activity to two climate/hydrology synthesis workshops to promote network-wide analysis of climate trends in 2010 and 2011, sponsored by the LNO, which resulted in an overview paper in *BioScience* (Jones et al 2012), and additional synthesis papers are underway (e.g., Creed, in review).

The workshop aimed to promote efforts to estimate and compare climate and streamflow trends across LTER sites by:

- (1) helping sites to identify daily climate and streamflow data suitable for long-term trend analysis (1950-2012 or longer) and to harvest these data into climDB/hydroDB, a web harvester and data warehouse that provides uniform access to common daily streamflow and meteorological data through a single portal;
- (2) training climate information managers and scientists to check climate data collected at LTER sites for discontinuities due to changes in instrumentation, physical surroundings, data collection methods, or data archiving; and
- (3) training climate scientists and information managers to estimate trends in climate and streamflow and share, compare, and interpret these trends across the full collection of LTER sites.

The goals of this working group were to (1) improve climate and streamflow daily data quality for long-term analysis at LTER sites, (2) conduct rigorous, standardized trend analyses, and (3) compare, synthesize and publicize the results.

### Activities

The workshop engaged climate information managers and scientists at participating LTER sites to work with trainers to complete seven steps (Figure 1): (1) select daily datasets for climate and streamflow trend analysis, (2) upload new datasets for 1950-2012 as needed to climDB/hydroDB, (3) homogenize climate data to account for discontinuities (see below), (4) visualize the data to generate hypotheses; (5)

calculate climate and streamflow trends for annual, seasonal and daily data, including averages and extremes, (6) interact with LTER site scientists to interpret these trends, and (7) post corrected data, results, and homogenization, visualization, and trend analysis protocols online.

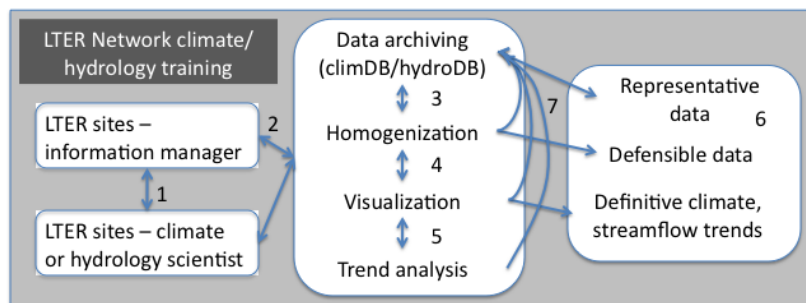


Figure 1. Steps in the training working group on climate and streamflow trend analysis.

A principal focus of Day 1 of the workshop was Step (3): data homogenization and Step (4): data visualization. In addition to climate trends and patterns, raw climate records also contain discontinuities due to changes in instrumentation, physical surrounding of the station, and method of data recording and archiving. Participants were given training in a Matlab program written by Chris Thomas and customized by Fox Peterson. The Matlab program identifies and corrects for these discontinuities using a relative homogenization approach, in which data from a station are compared to artificial reference time series computed from one or more neighboring stations outside of the immediate site domain.

A principal focus of Day 2 of the workshop was Step (5): trend analysis. Trend analysis of daily climate and streamflow data reveals seasonal patterns of climate change and response, crucial for interpreting ecosystem responses. Participants were given training in a Matlab program written by Julia Jones and Chris Thomas and customized by Fox Peterson. The program conducts trend analysis of daily data for temperature, precipitation, and streamflow. All steps are still ongoing; no homogenized data have yet been posted on ClimDB.

### Participants

The climate-training workshop included participants from 13 sites. All sites were invited to send participants, but a number of sites were unable to participate because of (1) conflicts with midterm reviews, (2) lack of long-term climate data, or (3) lack of personnel available and qualified to participate in the workshop.

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Results and recommendations to the LTER Executive Committee  
(and \*possible tasks for a future LTER Network-funded post-doc)

- LTER Exec should
  - Provide a clear statement of the role of climate in LTER (make climate a 'core area')
  - Clarify the role/composition of the Climate Committee. Are we (participants in this climate training workshop) the default LTER Climate Committee?
  - Promote LTER climate data and analyses as a value of LTER, communicate to NSF.
- LTER Network (or Climate Committee) should
  - Stress importance of having a [standardized] method of homogenization with best practices for climate records at all sites \*
  - Accomplish homogenization for sites that did not attend workshop\*
  - Determine what quality control is done at each site
  - Identify standardized quality control measures across sites
  - Address climate data quality, standardization, and inter-site trend analysis at ASM
- Each LTER site should
  - Identify appropriate, homogenized nearby reference climate datasets. At many sites there exists a nearby, already-homogenized reference climate record that is longer than the site record. The site record should be homogenized with this reference record\*
  - Collect and make available documentation about sensors, changes, etc., especially from “old-timers”\*
- CLIM-DB should have
  - Clear oversight by LTER Climate Committee
  - Added section for homogenized data and for detected breaks\*
  - A metadata template for homogenized data that could be downloaded with data
  - Longer-term reference records (homogenized climate data not collected at the site) as possible standard climate records for many sites\*
  - The homogenization tool/trend detection tools as accessible engines on Clim-DB\*
  - Improved capability to visualize datasets

Participants also identified a number of tasks for workshop trainers, which will be pursued in Fall 2013.