Climate-Aquatics Blog #14: Is 10 Years of Stream Temperature Monitoring Enough to Predict 100 Years of Change?

Hi Everyone,
This week we're back to the last of a couple stream temperature/climate posts before transitioning to the hydrology/climate module...

So even as it's become easy in recent years to monitor & organize stream temperature data for various climate-related purposes (blog posts 3, 4, 7, 8, & 9), it's also become apparent that long-term (i.e., > 20 years) monitoring records are relatively rare & oftentimes nonexistent in many parts of the world. If we have to wait 20 – 40 years until sufficiently long time-series from new monitoring efforts provide accurate trend descriptions, it will be too late to be anything other than passive observers to the ways in which climate change is altering stream ecosystems.

Short-term sensitivity analyses wherein changes in temperatures at multiple stream sites across a few climate years are examined will be useful for understanding relative sensitivities to climate forcing (blog post 9). However, it will also be necessary to understand the rates & total amounts of temperature changes within individual streams to properly understand the biological consequences of warming. Techniques for accurately reconstructing long-term, historic trends in stream temperatures from short-term records are necessary, and are also relatively straightforward to apply. In the attached paper by Moatar & Gailhard, the authors use a 27 year time-series of river temperatures from stations along the River Loire in France to calibrate regression models with air temperature and flow as predictors. Because air temperatures & flows were monitored since 1881 in this part of France, the regression model developed from the shorter-term time series could then be used to reconstruct river temperatures over a 122 year period.

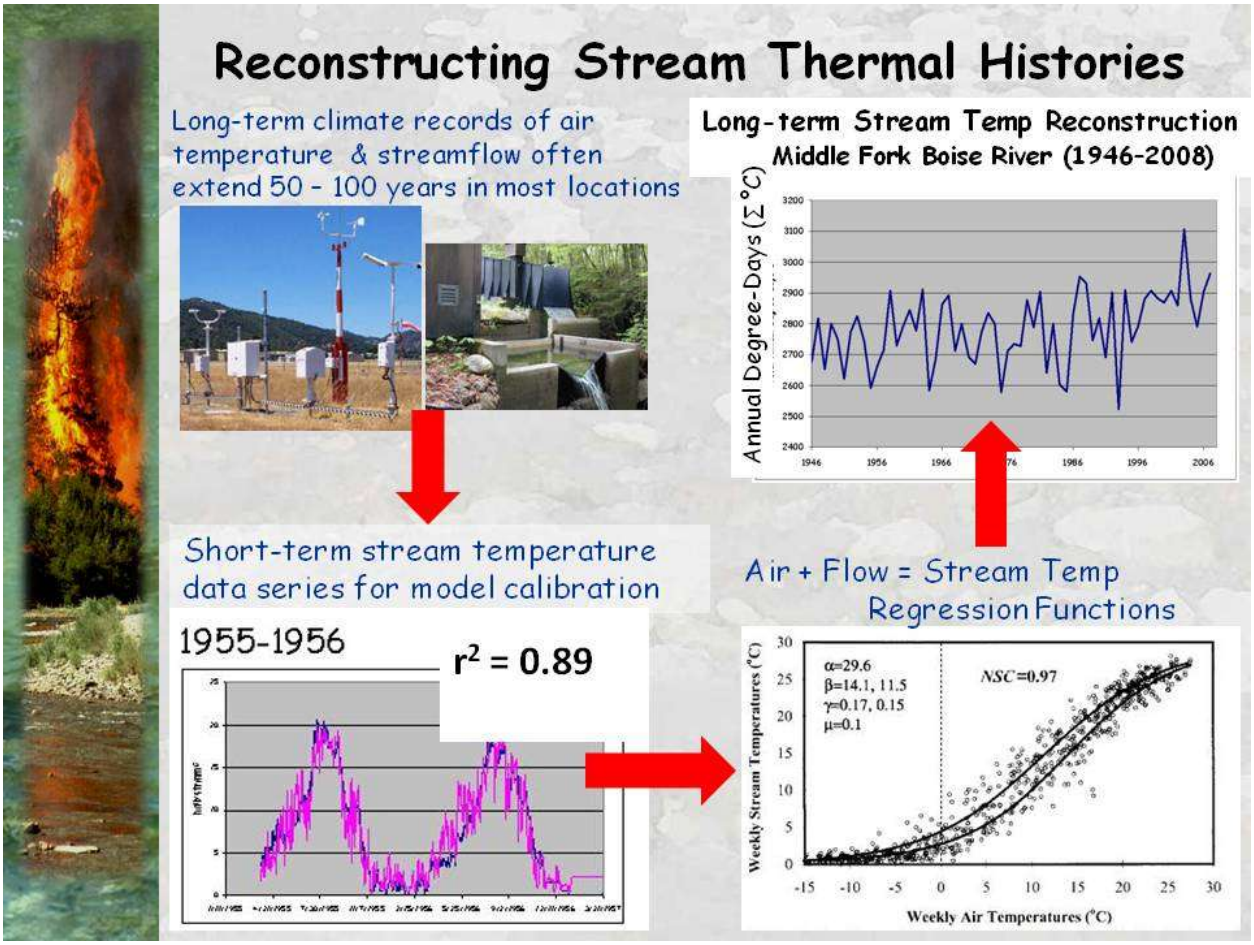
In a related paper, Van Vliet et al. recently linked daily temperature measurements from 157 global river stations to local air temperature and flow measurements over a 20 year period to assess the relative importance of these factors in river warming. Because Van Vliet's models predict river temperatures at daily timesteps, they also have utility for describing short-term extremes in thermal conditions like those that might occur during heat waves and be of particular ecological relevance.

Both are great papers & there are several others that could have been highlighted with regards to describing/reconstructing historical patterns, but one thing that has to be tackled yet is some basic validation work to determine the minimum amount of stream temperature data required to reconstruct historical patterns accurately. In both Moatar & Van Vliet's studies, they had the luxury of relatively long monitoring time-series from which their models could be developed, but this will be a rare in most instances. Determining whether 2, 5, 10, or 20 years of stream temperature monitoring at a site is necessary before those data can be reliably leveraged into something longer would be a very useful contribution for a young, aspiring stream climatologist to make. Once that minimum data requirement is known, it will be possible to describe site-specific warming rates with confidence everywhere a monitoring record of sufficient length exists (and recall that there are thousands of sites now where stream temperature monitoring has recently been initiated (blog post #4)). That, in turn, will allow us to make much more precise

predictions regarding anticipated biological effects, determination of which provides its own set of challenges that we'll discuss in later posts.

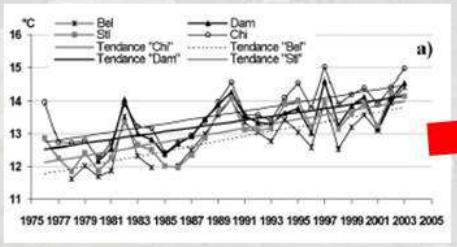
Until next time, best regards,

Dan

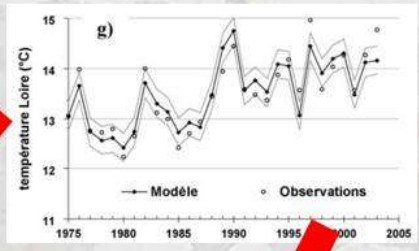


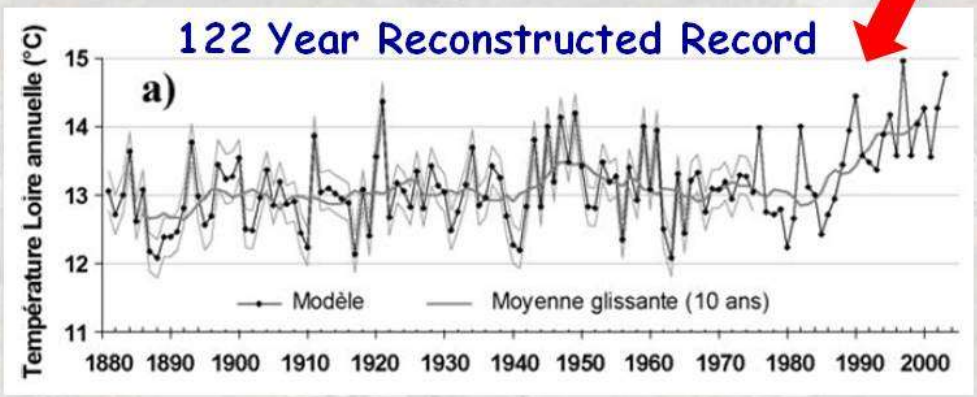
An Example in France's River Loire

Observed 27 year monitoring record….

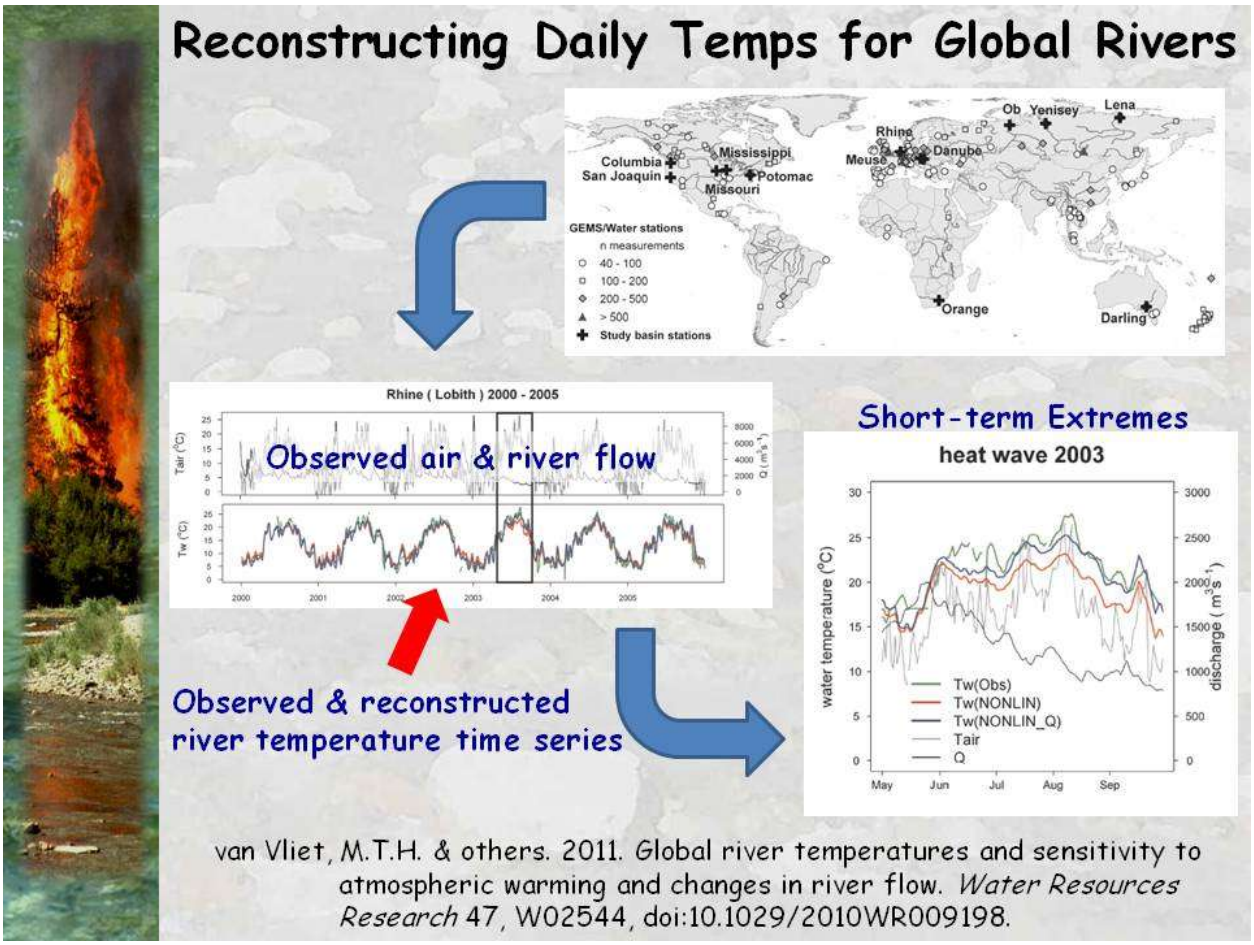


Observed vs reconstructed river temperature record (r^2 ~ 0.80)





Moatar, F., and J. Gailhard. 2006. Water temperature behaviour in the River Loire since 1976 and 1881. *C. R. Geoscience* 338: 319-328.



Previous Posts

Climate-Aquatics Overviews

Blog #1: Climate-aquatics workshop science presentations available online

Blog #2: A new climate-aquatics synthesis report

Climate-Aquatics Thermal Module

Blog #3: Underwater epoxy technique for full-year stream temperature monitoring

Blog #4: A Google Map Tool for Interagency Coordination of Regional Stream Temperature Monitoring

Blog #5: Massive Air & Stream Sensor Networks for Ecologically Relevant Climate Downscaling

Blog #6: Thoughts on monitoring air temperatures in complex, forested terrain

Blog #7: Accurate downscaling of climate change effects on river network temperatures through use of inter-agency temperature databases and application of new spatial statistical stream models

Blog #8: Thoughts on monitoring designs for temperature sensor networks across river and stream basins

Blog #9: Assessing climate sensitivity of aquatic habitats by direct measurement of stream & air temperatures

Blog #10: Long-term monitoring shows climate change effects on river & stream temperatures

Blog #11: Long-term monitoring shows climate change effects on lake temperatures
Blog #12: Climate trends & climate climate cycles & weather weirdness
Blog #13: Tools for visualizing local historical climate trends

Future topics…
Climate-Aquatics Hydrology Module
Climate-Aquatics Biology Module
Climate-Aquatics Management Module

Instructions for joining the group discussion: After clicking on the link, you should be able to see the discussion thread text, but to post comments & read those of others you'll first have to join the Climate-Aquatics Group (you'll only have to do this the first time). To join, follow these steps: 1) on the right side of the page, click on "Join this group" 2) Create your account information with Google user name & password, 3) Add your "nickname", 4) Pick one of the four available options for how you'll read this group (I'd advise against the bottom one that sends a new email every time a comment is added to a discussion thread), 5) Select "Join this group" at the bottom of the page, and 6) Click on the discussion topic hyperlink and you should now be able to post comments to the discussion thread.

The intent of the discussion group is to provide a means for the 1,900 (& growing) field biologists, hydrologists, students, managers, and researchers currently on this mailing list across North America, Europe, and Asia to more broadly and rapidly discuss topical issues associated with aquatic ecosystems and climate change. Messages periodically posted to this blog will highlight new peer-reviewed research and science tools that may be useful in addressing this global phenomenon. Admittedly, many of the ideas for future postings have their roots in studies I and my colleagues have been a part of in the Rocky Mountain region, but attempts will be made to present topics & tools in ways that highlight their broader, global relevance. Moreover, I acknowledge that the studies, tools, and techniques highlighted in future missives are by no means the only, or perhaps even the best, science products in existence on particular topics, so the hope is that this discussion group engages others doing, or interested in, similar work and that healthy debates & information exchanges will occur to facilitate the rapid dissemination of knowledge among those most passionate about climate change and its effects on aquatic ecosystems.

If you know of others interested in climate change and aquatic ecosystems, please forward this message and their names can be added to the mailing list for notification regarding additional science products on this topic. If you do not want to be contacted regarding future such notifications, please reply to that effect and you will be removed from this mailing list.