Report for new course GW1876: Applied Groundwater Model Calibration and Uncertainty Analysis.

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Location: Portland Oregon (OR Water Science Center)
Dates: February 6-10, 2017

Overview

The first offering of GW1876 in its current form took place in Portland on February 6-10, 2017. We, the instructors, greatly appreciated the generous support from Office of Groundwater in preparing for and delivering this course material. The goal of this document is to report back to OGW and to the new WMA Office of the Chief Operating Officer Earth Systems Processes and Integrated Modeling and Prediction Divisions to report results of this course offering and propose a future path for the course under the new structure starting in FY18.

We feel that the course was a great success and are confident that the participants left with an appreciation for the importance of purpose-driven modeling (e.g. not modeling for modeling's sake, but modeling in response to a forecast of interest), the value of forecast and model uncertainty throughout the process, and familiarity with free and open-source tools available to implement these important concepts. We have included the course syllabus with this document; the course focused heavily on applications of sophisticated tools. However, to arm attendees with understanding of the underlying theory and assumption, we purposefully presented the theory of parameter estimation and uncertainty analyses within interactive exercises; an approach we feel was very successful.

The course in the end had 20 participants – several more had registered but had to drop for various reasons. It was a lively and engaged group spanning a large range of experience which was excellent.

We have provided as a separate PDF document the complete survey responses from a post-class survey with 17 of 20 participants responding. In the remainder of this document we provide some highlights from the survey and end with recommendations for future directions based on our experience and feedback from the participants.

Summary of Feedback from Participants

We were very pleased to move the needle in terms of participants' familiarity with PEST++ prior to the class compared with after the class.

How confident were you using PEST/PEST++ *prior* to the class? (17 responses)   How confident are you with PEST/PEST++ now *after* the class? (17 responses)
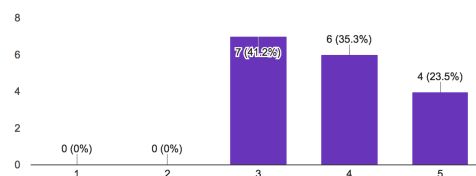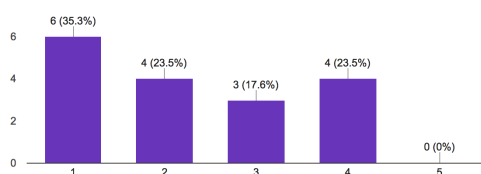
We appear to have struck a good balance between theory and applications

What balance would you like between theory and applications? (17 responses)   How was the mix of lectures and activities? (17 responses)
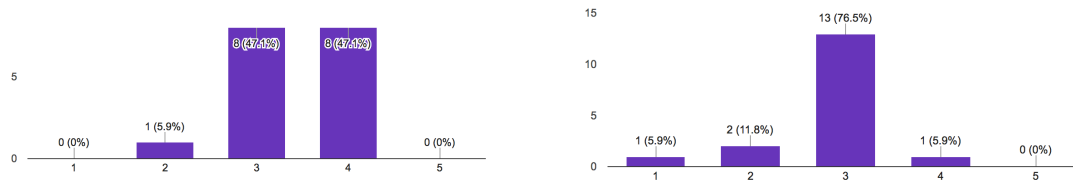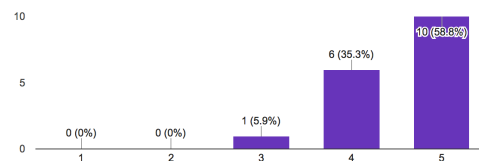

We may have gone through some of the logistics for setting up PEST++ to run on specific models a little bit too fast

Given a couple of hours how comfortable would you feel hooking up an existing model to PEST++?
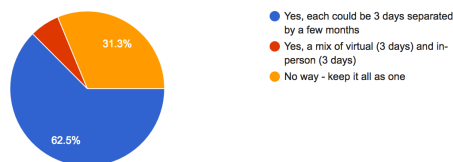(17 responses)
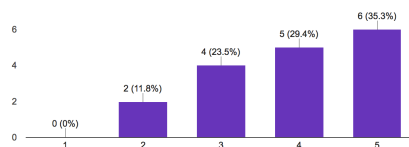
Most students reported they would incorporate PEST++ into their future work

How likely are you to incorporate PEST++ into your work? (17 responses)

A majority of the students would like to split the class into two 3-day sections: one for beginners, and one for advanced.

Would you think it better to split into a basic and advanced class? (16 responses)

- Yes, each could be 3 days separated by a few months
- Yes, a mix of virtual (3 days) and in-person (3 days)
- No way - keep it all as one

Here are a few narrative highlights in the words of the students:

- "For a novice, I really enjoyed the class and making connections with other USGS scientists to collaborate on projects in the future. I thought the instructors were well informed and played to the masses despite various skill levels. I would recommend any class that incorporates calculus as the method behind the madness."
- "I found this class the be excellent, and one of the best I have attended in the last several years. My only recommendation--which appears to already be discussed--is to break the class into two distinct sessions, so things can proceed a bit slower in each session."
- "great class. thank you all. one thought - if the class is broken into two, 3 day parts - for the first class - could use monday morning for travel/afternoon for python installation/background issues. then have tues-thurs for class - (but include teaser information for advanced class)."

- "My overall impression was that you guys had already taught this class several times before. The instructors passion and enthusiasm was clearly evident. I'm sure there could be areas for improvement--always is--but I really can't think of any."
- "The heavy emphasis on APPLIED parameter estimation was the right choice and the source of most of the value of the class. That said, the instructors explained the theory and mathematics of parameter estimation as well as I have ever seen it done."
- "AMAZING. YUGE. Honestly, the class was the BEST I've taken at USGS. Perfect mix of historical context and current issues, old and new, 20% theory, 80% application of theory and lots of discussion of what ifs and explanations of potential problems and lessons learned. Very energetic lectures; kept students engaged, dynamic presentations. Thank you Jeremy Mike and Randy!"
- "The class was terrific, and I am telling people that it is a must-have class for all USGS groundwater modelers."

Recommendations for Future Direction

Based on our experience teaching the class and the feedback summarized here, we feel that the general curriculum and approach are on track and we can make use of much of what we prepared for this initial offering. Our main recommendations for the future are:

1. Split into two 3-day courses to be offered roughly 6 months apart.
2. The funding from OGW combined with tuition income got us close to fully funding the class. Future fine tuning should be largely self-sustaining from tuition income alone if we charge a similar rate and continue to have sufficient participation.
3. Some cost savings could be obtained by holding at least some classes in Madison, WI where two of the three of us instructors are based, cutting down on travel.
4. We are very open to offering the class at locations where multiple students want to attend to help cut down on student costs again.
5. We are committed to the curriculum structure we came up with in general and hope to build upon it for the future.
6. We relied to a large degree on the Python programming language and tools for model construction, uncertainty analysis, and parameter estimation. Combined with the popular GW1774 Python programming class and perhaps incorporating Python into the basic MODFLOW curriculum would provide a common basis for modeling and analysis among all new and hopefully most already established groundwater modelers in USGS. As future planning in WMA goes forward, we are interested in integration into the bigger picture of groundwater curriculum at USGS.

Conclusion

Thanks, again, for the support in initiating this important course! We are happy to talk more about details of this iteration and plans for the future. This class was focused on groundwater applications, but we also recognize the value in other fields (we have all dabbled in collaboration outside groundwater and these techniques and approaches are typically met with much enthusiasm). Branching out to other mission areas is also something we should consider for the future. We hope to start planning future classes soon.