Evaluation:
Tromp Foundation-Sponsored Enhancing the Teaching and Learning of Biometeorology in Higher Education Workshop

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1. **Purpose**

The purpose of this report is to present an evaluation of a workshop focused on enhancing teaching and learning of biometeorology in higher education. This evaluation will determine the extent to which attending the workshop influenced participants' attitudes and knowledge about teaching as well as their plans for subsequent teaching activities.

Findings are being delivered to the workshop leader who is welcome to pass along findings to participants, the Tromp Foundation, or any other relevant stakeholders. Findings may also be used in future publications and funding proposals.

This evaluation was charged to:
1) Determine the impact of the workshop in meeting the overarching goals of the program;
2) Illuminate the professional experiences and opportunities related to teaching and learning that were enabled because of the workshop;
3) Identify how specific elements of the workshop contributed to professional development;
4) Explore participants’ perceptions of the usefulness of the workshop;
5) Make recommendations for improving similar workshops for the future.

2. **Approach to the Evaluation**

To complete the evaluation, data were drawn from multiple sources. In reporting a profile of the participants, workshop organizers provided the evaluator with rosters of workshop attendees. Summary data are reported in aggregate as opposed to identifying individual participants in this report. All data collected in the evaluation are eligible to be published; the evaluation plan was approved by Virginia Tech’s Institutional Review Board. Participants signaled informed consent of the evaluation and agreed to its potential to publish results by answering a question at the start of the survey.

Approximately one and a half months before the workshop, all participants were invited via email to complete a pre-workshop survey as a part of the evaluation. The first participation request was sent by email on June 14, 2016, and a follow-up was sent on July 12, 2016. The link to the survey remained live through the start of the workshop. Summaries of the pre-workshop survey results are included in this evaluation. Results were shared with the workshop leaders and were used to guide early discussions during the workshop as the participants helped set goals for their time together.

The evaluator attended the workshop and took observational field notes to be able to report about activities that took place during the event. These observations informed the development of a post-workshop survey, which was sent to workshop participants on August 18, 2016, approximately two and a half weeks following the workshop. Participants had received a “head’s up” email about the survey from the workshop leader and were asked to respond to the post-workshop survey by August 26, 2016.

Pre-workshop (see Appendix A) and post-workshop surveys (see Appendix B) contained both quantitative and qualitative survey items.
3. Participants in the 2016 Workshop
11 individuals participated in the workshop, either in-person or virtually.

Institutions represented by the workshop participants varied internationally as well as in size, mission, and type. Program participants were from the following institutions:

<table>
<thead>
<tr>
<th>George Mason University, USA</th>
<th>University of Akron, USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kent State University, USA</td>
<td>University of North Carolina-Greensboro, USA</td>
</tr>
<tr>
<td>Mississippi State University, USA</td>
<td>University of Queensland, Australia</td>
</tr>
<tr>
<td>Old Dominion University, USA</td>
<td>University of Toronto, Canada</td>
</tr>
<tr>
<td>State University of Maringá, Brazil</td>
<td>University of Twente, Netherlands</td>
</tr>
<tr>
<td>Texas Tech University, USA</td>
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</table>

10 of the 11 participants (91%) responded to the pre-workshop survey, and 10 responded to the post-workshop survey. Two participants reported having a Master’s degree as the highest degree, and the remainder reported a doctorate as the highest degree. The year in which the highest degrees were earned ranged from 2010–2016.

Participants represented a variety of disciplines, including the following (note: disciplines of current position):
- Animal Biometeorology
- Animal science
- Atmospheric science
- Exercise and environmental physiology
- Geography
- Geo-information analysis and modeling
- Geosciences
- GIS and remote sensing

Current roles of participants included the following:
- 2 Graduate students
- 7 Faculty/postdoc: Research and teaching
- 1 Faculty/postdoc: Research only
- 1 Faculty/postdoc: Teaching only

The average time participants had been in these roles was 2.7 years (range: 1 to 6 years).

In summary, on the whole the participants truly were early career academics. The group had a great deal of international and disciplinary diversity and represented a range of kinds of academic positions.
4. Pre-Workshop Survey

A. Goals for the Workshop

One section of the survey asked participants in advance what they hoped to gain from participating in the workshop. When asked why they decided to participate, the following themes emerged across participants:

- Discuss current state of higher education in biometeorology
- Determine how to best communicate the discipline of biometeorology
- Broaden personal views of biometeorology
- Develop course content for biometeorology
- Discuss or improve instructional strategies
- Engage with other professionals working through processes like tenure and navigating the job market
- Produce a grant proposal that could receive external funding

Participants were also asked to provide input on what they felt should be the ultimate goal of the workshop. Much of the previous themes re-appeared, with more concrete deliverables, however there are noticeable differences in identified goals across the program participants, which was discussed at the start of the workshop:

- Develop a working definition of biometeorology within the undergraduate context
- Develop guide for new instructors on how to develop curricula (i.e., a working model) and implement active learning in biometeorology courses
- Write a workbook of lesson plans or modules
- Write a textbook or some form of a publication (e.g., IJB article, lab manual)
- Improve teaching strategies
- Recognize that institutional types differ in goals and faculty expectations
- Produce a funding proposal
- Share knowledge and technology about biometeorology studies
- Create an opportunity for original research

Participants also indicated what they hoped to learn at the workshop. Many of the similar themes emerged, but new topics included how to write education-focused funding proposals, innovative use of technology for biometeorology research, resource and idea exchanges for teaching biometeorology, and learning new research methods.

Finally, participants hoped to learn about the following teaching techniques:

- Case studies
- Service learning
- Practical, hands-on learning
- How to motivate students
- Teaching at the grad and undergrad level
B. Pre-Workshop Survey: Teaching Biometeorology

Since one of the major goals of the workshop was to explore potential ways to change biometeorology curricula, participants were asked several open-ended questions to get a sense of its current placement in curricula.

We started broadly by asking participants to describe advice that they would give to an undergraduate who was seeking help at strategizing how to become a biometeorologist. Broad findings are as follows:

- **Course-based**: Take an array of courses across departments; Take a research course in biometeorology; Take statistics courses; Learn human physiology
- **Co-curricular**: Engage with research groups; Get field experience;
- **Individually driven**: Read journal articles; Attend conferences; Think through existing technology and data sets; Connect with professional society; Talk to a biometeorologist; Enroll in a graduate program.

In summarizing responses, it appears as if there are no clear pathways currently in place for students to pursue biometeorology. Most of the responses required individually driven students who would be able to string together a set of courses across departments, complete academic work not tied to courses, and get involved in research opportunities. It appears as if a useful contribution of the workshop could be identifying clear pathways for interested students to navigate to this field (e.g., course planning, co-curricular planning, set of recommended individual tasks).

Perhaps one of the challenges for this field is the wide array of classes in which biometeorology topics currently reside. Participants listed the following broad courses: Geography; Atmosphere and Weather; Climatology; Cartography; Maps and Map Reading; Hazards; Environmental Issues; Climate Change Impact Assessment; Climate Data Analysis; Wind; Thermal Adaptations of Animals; Introduction to the Biophysical Environment; Introduction to Atmospheric Science; Animal Biometeorology; Animal Behaviour and Welfare; Precision Livestock Farming; Physiology. We also asked about the topics or concepts related to biometeorology in classes, summarized in the word cloud:
Participants also described challenges they face in bringing biometeorology topics into courses. These challenges are summarized as follows:

- Finding time to schedule topics or develop modules within courses
- Insufficient background knowledge of students, especially because it requires such an interdisciplinary foundation
- Introductory courses do not enable advanced modelling or math required for in-depth biometeorology discussion
- Challenge to make incorporate biometeorology into current events
- Lack of control over teaching assignments
- Insufficient time to prepare sufficiently for activity-based learning or field trips
- Lack of student interest

Finally, participants were asked to brainstorm freely about how they might enhance biometeorology in the curriculum if they had decision-making authority and did not have to be worried about resources:

- Develop several courses (or sequence of courses at lower- and upper-level) in biometeorology following an interdisciplinary curriculum of fundamental courses
- Develop service or experiential learning components for biometeorology courses
- Install a properly functioning weather station or instrumentation for teaching demonstrations
- Revamp existing courses or add modules to existing courses to adjust foci
- Incorporate field trips
- Expand teaching assistant support
- Have students conduct field work (both quantitative and qualitative data collection)

C. Pre-Workshop Survey: Teaching Practices and Views of Teaching

The final section of the survey asked participants to report on their teaching practices and training on how to teach. In planning future steps beyond the workshop, it is important to take into account the wide variation in teaching loads across participants, which ranged from 1 course each semester to 3 courses each semester to 24 hours per week.

To anchor responses on the following questions, we asked participants to report on a single class that they are assigned to teach most frequently. These classes ranged in size from 20 students to 120 students—thus, it is very important in the workshop to not take a “one size fits all approach” when developing educational materials. The activities that can be dropped into relative small classes will not be effective for larger classes. Moreover, taking into account who is enrolled in the courses is another important consideration. Two-thirds of the classes reported on by respondents were required departmental classes for students, and one-third of the classes were electives (most of those elective courses were taken by students outside of the department).
As shown in the following figure, common instructional strategies included drawing on case studies or examples, sample problems, and lectures. Less common pedagogies included in-class group learning exercises, in-class discussions, and hands-on activities. Rarely did participants include field trips, group projects, or community service as instructional strategies, although we know from previous responses that some participants hoped to develop ways to expand those pedagogies during the workshop.

<table>
<thead>
<tr>
<th>In that course, how often do you use:</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Case studies or real-world examples</td>
<td>4.4</td>
</tr>
<tr>
<td>Examples or metaphors to explain concepts</td>
<td>4.4</td>
</tr>
<tr>
<td>Sample problems</td>
<td>3.9</td>
</tr>
<tr>
<td>Lecture</td>
<td>3.9</td>
</tr>
<tr>
<td>Frequent feedback to students</td>
<td>3.4</td>
</tr>
<tr>
<td>Detailed feedback to students</td>
<td>3.1</td>
</tr>
<tr>
<td>In-class, small group learning</td>
<td>3.1</td>
</tr>
<tr>
<td>In-class discussions</td>
<td>3.0</td>
</tr>
<tr>
<td>Hands-on activities and/or assignments</td>
<td>2.7</td>
</tr>
<tr>
<td>Plant tours or site visits</td>
<td>1.4</td>
</tr>
<tr>
<td>Group projects</td>
<td>1.3</td>
</tr>
<tr>
<td>Community service</td>
<td>1.3</td>
</tr>
</tbody>
</table>

1: Never; 2: Sometimes; 3: About half the time; 4: Most of the time; 5: Always

Why might some of these high-impact practices receive less attention? Although many workshop participants are being asked to educate undergraduates, they have received fairly limited training in teaching. As the following figure shows, over a third had no formal teaching training prior to their current role. Others participated in a program for graduate students to teach, which generally vary widely and sometimes only include a half day training.
We also asked participants about their experiences with respect to teaching and learning activities. Less than half engaged in major course improvement in the past 12 months. Only about one-quarter read literature on teaching and learning, and fewer attended education-focused workshops or conferences or wrote teaching and learning focused publications.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Made a significant effort to improve your teaching or one of your courses</td>
<td>45%</td>
</tr>
<tr>
<td>Read journals/books on teaching, learning, or assessment</td>
<td>27%</td>
</tr>
<tr>
<td>Attended an education-focused conference</td>
<td>9%</td>
</tr>
<tr>
<td>Attended a workshop on teaching, learning, or assessment</td>
<td>9%</td>
</tr>
<tr>
<td>Wrote a paper, article, or chapter on teaching, learning, or assessment</td>
<td>0%</td>
</tr>
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</table>

We asked about other education-related activities. Despite the interdisciplinary nature of biometeorology, only about one-third of participants had experience with team-teaching within their department and a smaller percentage team-taught with a faculty member in a different department. About one-third had experience developing a new course—which could be a deliverable from this workshop—and less than one-fifth had served as an investigator on a grant supporting curriculum development or reform.
The small percentage of participants who engaged in these activities can be explained by institution’s reward systems. As shown by the following figure, education-related scholarship was weighted on the lower end of the scale relative to discipline-specific activities. The one exception was end-of-course evaluations. These institutional values need to be considered when setting realistic expectations for participants after the workshop.

<table>
<thead>
<tr>
<th>In general, how much do the following &quot;count&quot; for promotion and tenure?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discipline-specific research publications</td>
</tr>
<tr>
<td>Discipline-specific research grants</td>
</tr>
<tr>
<td>End-of-course evaluation results</td>
</tr>
<tr>
<td>Discipline-specific conference presentations</td>
</tr>
<tr>
<td>Curriculum or course development</td>
</tr>
<tr>
<td>Advising a student organization</td>
</tr>
<tr>
<td>Education research grants</td>
</tr>
<tr>
<td>Writing textbooks</td>
</tr>
<tr>
<td>Education research publications</td>
</tr>
<tr>
<td>Education conference presentations</td>
</tr>
<tr>
<td>Helping recruit women and underrepresented students</td>
</tr>
</tbody>
</table>

1: Not at all; 2: Slightly; 3: Moderately; 4: A good deal; 5: A great deal

Finally, we asked participants about various views of teaching, which provides a sense of the kinds of activities that may be feasible coming out of this workshop (without shifting participants' attitudes about roles) (see Figure on the following page). More classroom-specific activities received higher values, and program-level activities received lower values. One surprising finding was the preparation for graduate school item, especially given participants' responses to the earlier question about recommendations for undergraduates who are interested in pursuing biometeorology. There appeared to be misalignment between the role of the participants and their sense of the academic pathways to biometeorology.
Do you agree or disagree that as a teacher it is your responsibility to:

- Create a classroom environment that is respectful of all students: 4.8
- Make your expectations for students' performance clear: 4.7
- Help students connect their prior knowledge and experience to what's being learned: 4.6
- Make concepts and principles relevant to students: 4.6
- Motivate students to learn: 4.4
- Prepare students for the role of citizen: 4.2
- Help students consider the world from multiple perspectives: 4.2
- Help students succeed, rather than weed them out: 4.1
- Prepare students for the workforce: 4.1
- Ask students to make connections across the disciplines: 3.9
- Encourage students to reflect on their values and how these might influence their work: 3.9
- Help students understand the value of a liberal education: 3.8
- Understand the value of diversity in its many forms: 3.6
- Prepare students for graduate school: 3.2

1: Strongly disagree; 2: Disagree; 3: Neither agree nor disagree; 4: Agree; 5: Strongly agree
5. Workshop Details and Outcomes

A. Schedule of activities

Michael Allen of Old Dominion University’s Department of Political Science and Geography hosted the workshop in Norfolk, VA from July 28-July 31, 2016. He worked with Jennifer Vanos of Texas Tech University and Jeremy Spencer of the University of Akron in planning and facilitating the workshop. The following tables encompass the intended schedule—some items shifted due to changing travel schedules, but for the most part each listed activity took place at some stage during the workshop.

Day 1: Thursday July 28th, 2016

<table>
<thead>
<tr>
<th>Time</th>
<th>Thursday</th>
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</table>
| 8:30 to 10:00 | Logistics: Mike A.  
9am: Welcome – Francis Adams, Chair Department of Political Science and Geography  
9:10-10:00: Introductions by each person ~3min each |
| 10:00-10:15   | BREAK                                                                    |
| 10:15 to 11:00| 10:15–11:00: Why We are Here & Setting the Tone  
Jenni (20min)  
- The Proposal  
- Conference Goals  
- Workshop Plan  
- Background on the SNP  
- Four day plan |
| 11:00 to 12:00| 11:00-11:45: David Knight: Pre-workshop Surveys, Evaluations, etc.       |
| 11:45 to 12:45| Lunch (on own – campus)                                                  |
| 12:45 to 14:30| 12:45–13:30: Icebreakers & breakout session                             |
| 14:30–14:45   | Break                                                                    |
| 14:45 to 16:00| Types of Biometeorology & Links to Teaching/Student Engagement  
14:45–15:00: Tourism Biometeorology (D.J)  
15:00–15:15: Human Biometeorology in the classroom (Chris)  
15:15–15:30: Plant Biometeorology Teaching Techniques (Hamed)  
15:30–15:45: Animal Biomet & Teaching (Sheila) |
| 16:00 to 17:00| Breakout Groups: What is biometeorology? What is Biometeorology Education? Strengths, weaknesses? Etc.  
16:45 Logistics for evening, next day. |
| Evening       | Activities                                                               |
|               |                                                                          |
Day 2: Friday July 29, 2016

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
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</thead>
<tbody>
<tr>
<td>8:30 to 10:00</td>
<td>Reiterate Goals of Workshop, Module Development (Jenni)</td>
</tr>
</tbody>
</table>

**Developing Class Materials**

8:45 – 9:30: Group Session looking through syllabi together, teaching reviews, in class activities, reflections from own teaching. e.g., Syllabus, Assignments, Labs, etc. and Reflection of Teaching.

9:30-10:00 - Establishing Student Learning Objectives/Outcomes

| 10:00-10:15 | BREAK |

10:15 to 11:00 | Evaluating Student Learning in areas within Biomet |

**Roundtable: Biometeorology in the Classroom?** (What is the current state at each of our Universities? What are some of the implementation difficulties we will encounter?)

11:00 to 12:00 | Guidelines for Developing Course Materials / Potential discussion on Curriculum Development (Jeremy) (+ discussion)

| 12:00 to 13:00 | Lunch (on own – campus) |

13:00 to 14:30 | **Experiential Learning in the Classroom:** 15min each |

1) “Beyond Lecturing” (Mike)
2) Geospatial Technology Use in the Classroom (Jeremy)
3) Technology for Biometeorology (Jenni)
4) Examples of In-class Exercises (Jeremy)

14:00-14:30 – **Roundtable on Experiential Learning.** Everyone brainstorm/write down the best examples.

| 14:30-14:45 | BREAK |

14:45 | **14:45 – 15:15: Dr. Emily Eddins,** Assistant Director of Service-Learning Leadership and Student Involvement (Old Dominion University) - brief talk on SL aspects of learning and student engagement with community partners.

15:15 – 16:15: Create out of classroom learning exercise.

| 16:15 to 17:00 | **Roundtable:** Group discussion on *Internationalizing* the SNP & Biometeorology – Lead by Becky |

- What is needed internationally for education?
- Differences between institutions, teaching, and funding worldwide??
- etc.

| Evening Activities | Social with food and drink at the Allen Household 7:00-9:00pm. Leave hotel at 6:45pm. |
Day 3: Saturday July 30th, 2016

<table>
<thead>
<tr>
<th>Time</th>
<th>Saturday</th>
</tr>
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</table>
| 8:30 to 10:00 | 8:30-10:00am Scott Sheridan & Springer  
8:30 – 9:00: Brief history of the ISB, Biometeorology as a discipline and how it evolved (Scott)  
9:00 – 9:30: Springer call.  
9:30 – 10:00: Textbook and Proposal writing (Scott) |
| 10:00-10:15  | BREAK                                                                    |
| 10:15 to 11:00 | Group Discussion/Breakouts on next steps & fulfilling proposal deliverables  
Explore proposals/ideas/book info/lab manuals online: open time |
| 11:00 to 12:00 | Create working Groups (examples):  
1) Textbook group  
2) Proposal Group  
3) Lab Manual  
4) Modules  
5) etc. |
| 12:00 to 13:00 | Lunch (on own – campus)                                                  |
| 13:00 to 14:30 | Writing in Working Groups                                               |
| 14:30–14:45  | BREAK                                                                    |
| 14:45 to 16:00 | Free time to work or explore or rest  
See Norfolk guide and folder in bag for ideas. |
| Evening Activities | Dinner at restaurant downtown? (TBD)                                   |
Day 4: Sunday July 31, 2016

<table>
<thead>
<tr>
<th>Time</th>
<th>Sunday</th>
</tr>
</thead>
</table>
| 8:30 to 10:00 | **8:45-9:15 - The Bridge from Introductory Classes to Research**  
  - Teaching with the aim of student publishing (Scott).  
  - Teaching at the Graduate Level / Research Framing (Cameron, Scott)  
  IJB Publication (Scott Sheridan) **15min background** – 60-year IJB edition  
  **30min discussion on what a paper might look like from this workshop.** |
| 10:00-10:15 | **BREAK**                                                              |
| 10:15 to 12:00 | **Practical Group Work/Breakout Sessions/writing**                    |
| 12:00 to 13:00 | **Lunch (on own – campus)**                                           |
| 13:00 to 14:30 | **Practical Group Work/Breakout Sessions/writing**                    |
| 14:30-14:45 | **BREAK**                                                              |
| 14:45       | **Groups Present informally where they are at in their work.**  
  **Active & Iterative** – will develop final summary & next steps for last session of  
  workshop  
  - Develop timelines for deliverables |
| 16:00 to 17:00 | **Final thoughts, summary by Jenni V. & David Knight**  
  Next Steps. Online Evaluation, etc.  
  Working groups |
| Evening Activities | **TBD**                  |
B. Workshop Outcomes and Next Steps

Throughout the workshop participants jointly developed a “Next steps and Outcomes” document shared among participants via a Google drive. Participants committed to completing certain tasks following the workshop to continue the momentum around teaching and learning biometeorology. These initiatives include the following:

1. Biometeorology curriculum modules to share experiential learning ideas
2. Education-focused funding proposal
3. Edited volume (Introduction to Biometeorology)
4. BAMS workshop summary
5. Biometeorology concept article for IJB Special Issue
6. SNP Report (IJB special issue)
7. SNP early career education workshop
8. Website/social media work to include biometeorology glossary
9. Biometeorology survey of members of IJB
10. 21st Century biometeorology (technology-focused) – IJB special issue

6. Post-Workshop Survey

A. Why Others Should Engage in Such Workshops and Activities

The first section of the post-workshop survey asked participants why other students and new professionals should engage in similar teaching and learning focused workshops. The following themes emerged in looking across responses:

- Engagement with colleagues face-to-face in a motivating atmosphere
- Excellent brainstorming and discussion around enhancing students’ experiences with respect to biometeorology
- Opportunity to learn about new ways to teach biometeorology subjects and classroom management strategies more generally
- Opportunity to integrate with other areas of biometeorology and network with peers in the profession
- Opportunity to develop an awareness of variation in education globally and across different institutional types
- Development of educational research ideas and how discipline-specific research can be brought into teaching

Participants were also asked—based on this workshop and others—why students and new professionals should engage in SNP activities. The following themes emerged:

- Chance to share early career experiences and opportunities
- Collaboration opportunities for research, publications, and teaching
- Opportunity to strengthen and renew the ISB and the field of biometeorology more broadly
- Opportunity to understand the challenges that biometeorology can address
- Method to stay informed about the state-of-the-art of biometeorology
- Opportunity to demonstrate leadership in a professional society
B. Evaluation of specific workshop activities and experiences

The next section of the survey asked participants to indicate the extent to which each workshop activity was helpful. Averages across all activities were on the positive side of the scale, so it appears as if participants on the whole found the workshop worthwhile. Time set aside to enable informal connections (i.e., evenings and meals) appeared to be particularly beneficial, as were the sessions more focused on biometeorology topics. The sessions that did not have a clear biometeorology focus (e.g., more generalized education sessions) did not appear to be as beneficial but were still on the positive side of the scale. The call with Springer was the lowest rated activity, and some participants specifically pointed to this activity as being a poor use of time. Additionally, there was a mixed review of the aspects of the session focused on the ISB and IJB, as multiple participants thought those activities were outside the scope of this particular workshop. Two participants voiced concerns that they believed too little time was spent workshopping ideas, while the rest of the participants thought the allotted time was about right.

![Bar chart showing the extent to which sessions and activities were helpful to participants.](image)

1: Strongly disagree; 2: Disagree; 3: Neither agree nor disagree; 4: Agree; 5: Strongly agree
C. Development as a Professional

Participants also answered questions about how they felt the workshop helped them develop professionally. Several activities were rated, on average, in the agree-to-strongly agree range, including understanding education research, items related to teaching and scholarship, awareness of education funding opportunities, and understanding differences across institutional contexts. Although still on the positive side of the scale, some of the more advanced educational research and “doing activities”—like how to write education-focused funding proposals—were not rated as highly.

It was clear in participants’ responses that this professional development would not have been able to happen had the travel support from the Tromp Foundation not been in place. Only 3 participants indicated that they would have attended the workshop had the funding not been in place, and 4 noted that they would not have been able to attend. All other respondents were unsure how their attendance would have been influenced. Thus, it is reasonable to claim that this grant directly enabled professional development of early career academics within the field that would not have otherwise occurred.

Participants also described how their participation in the workshop may influence how they incorporate biometeorology into their courses or how they may change their teaching practices more generally. The following themes emerged:

- Use specific modules as labs but focus them within the context of biometeorology.
- Incorporate the topic in a survey-type approach of what the field encompasses.
- Talk about the intersection of animals, plants, and humans in an interdisciplinary manner.
- Give students preliminary data to bring the topic to life.
- Use experiential learning techniques in which students collect data (e.g., ibuttons) and use tools such as GIS.
- Incorporate ideas from modules brainstormed at the workshop, but they need to be more fully developed before they can be implemented.
- Search for ways to incorporate service learning into classes.
More generally, participants noted the following:

- They feel better about integrating biometeorology into existing courses.
- They intend to find ways to boost students’ hands-on experiences and bring greater variety to classroom learning experiences.
- They intend to focus on processes (i.e., learning) rather than outcomes (i.e., what students may actually produce).
- They intend to think about more authentic assessment strategies.

Such statements were corroborated when they are compared to pre- and post-test differences in respondents’ use of and future plans to use different instructional approaches. While we saw slightly lower averages for frequency of using case studies, examples, and lecture, we saw gains in hands-on activities, detailed feedback, group projects, site visits, and service learning. Because the scale is a frequency scale, we would not anticipate gains on every item—gains on certain items would have to be balanced out by losses on other items if participants were answering these questions carefully, which is what we observed. It is encouraging that the kinds of high-impact instructional approaches emphasized during the workshop were the practices that showed gains from the pre- to the post-test, although the anticipated frequency of their use was still lower relative to other “easier” practices to implement. Given the other demands on participants’ time (e.g., research) that became apparent during the workshop, the lower frequency for some activities was not surprising.

![Use of Instructional Approaches](image-url)

1: Never; 2: Sometimes; 3: About half the time; 4: Most of the time; 5: Always
D. Critiques of the Workshop and Recommendations for the Future

Participants were also asked to offer constructive criticism of the workshop, which can be taken on board for future workshop planning. Although several participants thought nothing was missing from the workshop schedule, some ideas with respect to what was missing that emerged from these open-ended responses are as follows:

- Try to build in sufficient time to have concrete tasks completed before participants leave the workshop. It may be difficult to build momentum on plans as opposed to building it around deliverables.
- Try to ensure that educational discussions remain grounded within the context of biometeorology instead of being pitched more generally.
- Incorporate more hands-on sessions to the workshop so that participants can gain familiarity with tools, sensors, and software.
- Reduce the number of and time spent in lectures. Instead of being so Powerpoint heavy, offer opportunities to participate in sessions guided by alternative teaching practices.
- Include focused sessions on how to put together education proposals.

Specific recommendations for future similar workshops include the following:

- Reduce the daily schedule length.
- Ensure topics are applicable to all participants given the diversity in participants from graduate students to faculty.
- Incorporate a focus on grant writing.
- Use the breakout sessions more effectively and ensure that such workshops produce actual products.
- Ensure invitations to such workshops are extended to other sub-fields in biometeorology.
- Consider holding Skype meetings prior to the workshop or sharing resources in advance so the time can be better spent accomplishing tasks instead of brainstorming potential tasks.
- Make sure workshops remain focused on intended goals instead of being side-tracked (e.g., the IJB manuscript was not relevant yet took significant time).

Participants also offered ideas for themes for future SNP workshops:

- Societal applications of biometeorology
- Public-private partnerships using biometeorology
- Writing scientific papers
- Internationalization and technology in the 21st century
- Role of citizen science and technology studying biometeorology
- Expanding traditional views of biometeorology to include medical professionals, national security experts, and K-12 educators (far beyond academics)
- Professional development for early career academics.
7. Summary and Future Work

This workshop focused on teaching and learning within the context of biometeorology and involved students and new professionals from around the globe. Participants came together in Norfolk, Virginia for four days to share experiences incorporating biometeorology in the classroom and brainstorm potential ways to share resources so that the field reaches more undergraduates using student-centered teaching practices. Data collected in this evaluation provide evidence that participants thought the workshop met its overarching goals and indicated it supported their professional development in a variety of areas. Importantly, those professional development opportunities would not have been feasible for most participants without the travel support from the Tromp Foundation. Comparing the relative efficacy of different kinds of activities, coupled with specific ideas and critiques from participants, can guide future workshop planning.

One of the last questions of the post-workshop survey asked participants to summarize their own take-home messages following the workshop. These summaries included the following:

- The workshop offered an opportunity for individual professional development.
- Biometeorology can help to analyze, model and solve many of challenges posed by the impact of the change in weather and climate and can be relevant to everyone.
- There is still enthusiasm for teaching among colleagues in the field.
- Focusing on educational development in biometeorology can be a key point that both enhances teaching while simultaneously resulting in research publications.
- A curriculum in biometeorology is attainable but needs to account for rapid advancements in technology and needs to be global in scale.
- There is great diversity between universities and countries on teaching expectations and practices.
- There is a need for a formal platform to share biometeorology resources.

Finally, we asked participants to report on the next steps following the workshop about which they are most excited. SNP organizers could leverage these ideas as they continue to build momentum following the workshop:

- Excitement about collaborative publication opportunities, website development, and conference presentations (note: this theme was most popular across participants).
- Excitement about brainstorming, developing, and using class modules in labs.
- Excitement about continuing to share resources online.

In taking those next steps one observation that continued to come up in the surveys and during the workshop should be taken under serious consideration in scoping future work—the bulk of the participants pointed to publications and traditional academic dissemination as being the most exciting next steps. Such activities are likely valued by many institutions, in particular research-focused institutions, and fall within the “wheelhouse” of many participants, but those activities do fall outside the scope of influencing students directly from a teaching and learning perspective. In taking next steps, it is highly recommended to focus on activities that will be valued by participants’ home institutions as these new professionals navigate institutional processes such as promotion and tenure and scope activities so that they may be completed within the constraints on participants’ available time. Following that approach will enable the greatest likelihood for success.
Default Question Block

Evaluation of Enhancing the Teaching and Learning of Biometeorology in Higher Education Workshop

You are invited to participate in an evaluation of the Enhancing the Teaching and Learning of Biometeorology in Higher Education Workshop, which was sponsored by the Tromp Foundation. The purpose of this evaluation is to report on your experiences during the workshop, the activities that occurred during the workshop, and the impact of the workshop on your knowledge and beliefs about teaching and interdisciplinarity as well as on subsequent actions with respect to biometeorology education. Your participation in the pre-workshop survey will contribute to a better understanding of how such workshops can be improved in the future. If you choose to consent to participate in the research study as well, your responses will also contribute to future academic publications and funding proposals. You must be at least 18 years old to participate.

If you agree to participate in the research study:

Below you will indicate your informed consent to allow your survey responses to be used for academic publications and funding proposals. No time or effort are required for participation beyond completing the pre-workshop survey and post-workshop survey, which are also part of the workshop evaluation.

Risks, Benefits, & Confidentiality of Data

Risks associated with participation are expected to be minimal. You may benefit from the self-satisfaction of knowing that this evaluation may lead to future publications or funded proposals to support education in the field within which you teach. Findings may also support your own teaching—and indirectly your students—in the future.

Other than including a list of workshop participants in the evaluation report, identifying
information will be stripped from surveys for reporting and publication purposes, and responses will be reported in aggregate. The evaluator, Dr. David Knight, will be the only individual who has access to responses with individually identifying information.

**Participation or Withdrawal**

Your participation in the research study is voluntary. You may decline to answer any question and you have the right to withdraw from participation at any time. Withdrawal will not affect your participation in the workshop in any way. If you do not want to continue participating, simply email me at dbknight@vt.edu and I will remove your survey responses from the research dataset. They will be used for your participation and the workshop evaluation.

Thank you!

Should you have any questions about the study or your participation, please feel free to contact:
Dr. David Knight  
Assistant Professor, Department of Engineering Education  
dbknight@vt.edu  
540-231-2563

Should you have any questions about your rights as human research participants, please contact Dr. David Moore at moore@vt.edu or 540-231-4991.

This question specifically asks for your consent to willingly participate and have your responses included in this research study.

Do you consent to have your responses to this pre-workshop survey be used as part of this research study?

☐ Yes, I choose to participate in this research study. I understand that my consent can be withdrawn or that I may withdraw from the study at any time.

☐ No, I choose not to participate in this research study.

**Section 1. Participant Background Information**
What is your first and last name?  
(Used for response tracking purposes, not for reporting purposes)

What is your highest degree?

- Bachelor's
- Master's
- Ph.D.; MD
- Other

In what year did you receive your highest degree?

From what institution did you receive your highest degree?

In what discipline did you receive your highest degree?

What is your current institution?

What is your current discipline?

What is your current role?

- Graduate student
Section 2. Workshop Questions

Please list three reasons why you decided to participate in this workshop.

What do you feel should be the ultimate goal of this workshop?

What do you hope to learn at this workshop?

What teaching techniques would you like to learn about at this workshop?

How many years have you been in this role at your current institution?

Postdoc
Faculty (Research and teaching)
Faculty (Research only)
Faculty (Teaching only)
Other
Section 3. Biometeorology Questions

What would be your advice to an undergraduate in your department who is seeking help with strategizing to become a biometeorologist?

In what classes have you or your colleagues taught biometeorology topics?

What specific topics or concepts related to biometeorology have you taught in your classes?

What challenges do you face in bringing biometeorology topics into your classes?

If you had unlimited resources and were free to make decisions in your own department, what would you do to enhance biometeorology in the curriculum?

Section 4. Interdisciplinary Competence Questions

Do you agree or disagree?
<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>If asked, I could identify the kinds of knowledge and ideas that are distinctive to different fields of study.</td>
<td>o</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I recognize the kinds of evidence that different fields of study rely on.</td>
<td>o</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I'm good at figuring out what experts in different fields have missed in explaining a problem or proposing a solution.</td>
<td>o</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I value reading about topics outside of my field.</td>
<td>o</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I enjoy thinking about how different fields approach the same problem in different ways.</td>
<td>o</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not all problems have purely technical solutions.</td>
<td>o</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In solving problems I often seek information from experts in other academic fields.</td>
<td>o</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Given knowledge and ideas from different fields, I can figure out what is appropriate for solving a problem.</td>
<td>o</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I see connections between ideas in my field and ideas in the humanities and social sciences.</td>
<td>o</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can take ideas from outside my field and synthesize them in ways to better understand a problem.</td>
<td>o</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can use what I have learned in one field in another setting or to solve a new problem.</td>
<td>o</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Section 5. Teaching Questions (final section)

What is your typical teaching load?


What courses have you taught or are you scheduled to teach?


What formal training in teaching did you have before your current role? Check all that apply.

- No formal training
- Attended a program for graduate students on how to teach
- Took course(s) in college teaching
- Completed a teaching certificate during graduate program
- Had K-12 (secondary school) teaching experience
- Other (please specify)

Have you: (Check all that apply)

- Team-taught a course with a faculty member from within your department
- Team-taught a course with a faculty member from outside your department
- Served as PI or co-PI on a grant supporting undergraduate curriculum development or revision
- Led a major curriculum reform project in your department or college
- Developed a new course

To answer the following questions, think about one undergraduate course that you teach most often (skip these if you only teach graduate level courses or do not teach in your role).

What is the name of that course?
Is this course:

- Lower division (primarily first-/second-year students)
- Upper division (primarily third-/fourth-/fifth-year students)

On average, approximately how many students enroll in this course?

Which category best describes this course? (check all that apply)

- Fundamental science or math course
- Required course in your department
- Elective typically taken by students in your department
- Elective typically taken by students outside of your department
- Capstone course

Is this course:

- A stand-alone laboratory course
- A lecture with a lab component
- A lecture only course
- None of the above

In this course, how often do you use the following instructional approaches?

<table>
<thead>
<tr>
<th>Instructional Approach</th>
<th>Never</th>
<th>Sometimes</th>
<th>About half the time</th>
<th>Most of the time</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>In-class discussions</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>In-class, small group learning</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Group projects</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Hands-on activities</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
During the past 12 months, have you: (check all that apply)

☐ Taken a class or worked in industry to enhance your knowledge or skills
☐ Attended an education-focused conference
☐ Made a significant effort to improve your teaching or one of your courses
☐ Attended a workshop on teaching, learning, or assessment (not including this one)
☐ Read journals/books on teaching, learning, or assessment
☐ Wrote a paper, article, or chapter on teaching, learning, or assessment

In general, how much do the following "count" in promotion and tenure reviews in your department?

<table>
<thead>
<tr>
<th>Education research grants</th>
<th>Not at all</th>
<th>Slightly</th>
<th>Moderately</th>
<th>A good deal</th>
<th>A great deal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education research publications</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Education conference presentations</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Discipline-specific research grants</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Discipline-specific research publications</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Discipline-specific conference presentations</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>End-of-course</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
Final question: Do you agree or disagree that as a teacher it is your responsibility to:

<table>
<thead>
<tr>
<th>Make your expectations for students' performance clear.</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivate students to learn.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Create a classroom environment that is respectful of all students.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Encourage students to reflect on their values and how these might influence their work.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Prepare students for graduate school.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Ask students to make connections across the disciplines.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Prepare students for the workforce.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Help students consider the world from multiple perspectives.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Make concepts and principles relevant to students.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Help students connect their prior knowledge and experience to what's being learned.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Prepare students for</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
the role of citizen.

Understand the value of diversity in its many forms (e.g., ideas, cultures, gender).

Help students understand the value of a liberal education.

Help students succeed, rather than weed them out.
Default Question Block

**Evaluation of Enhancing the Teaching and Learning of Biometeorology in Higher Education Workshop**

The purpose of this evaluation is to report on your experiences during the workshop, the activities that occurred during the workshop, and the impact of the workshop on your knowledge and beliefs about teaching and interdisciplinarity as well as on subsequent actions with respect to biometeorology education. Your participation in the post-workshop survey will contribute to a better understanding of how such workshops can be improved in the future.

**Risks, Benefits, & Confidentiality of Data**

Risks associated with participation are expected to be minimal. You may benefit from the self-satisfaction of knowing that this evaluation may lead to future publications or funded proposals to support education in the field within which you teach. Findings may also support your own teaching—and indirectly your students—in the future.

Other than including a list of workshop participants in the evaluation report, identifying information will be stripped from
Based on your experiences at this workshop, please list three reasons why other students and new professionals should engage in similar teaching and learning workshops.

Based on your experiences at this and similar workshops, please list three reasons why other students and new professionals should engage in SNP activities.

Please indicate the extent to which you agree or disagree that the following sessions and
How did you find the amount of time allotted to engage in workshopping ideas (i.e., moving things like curriculum modules or papers forward)?

- Too little
- About Right
- Too Much

What should have been removed from the schedule to allow more time for workshopping?

What should have been added to the schedule in place of time allotted for
Become more capable of publishing research
Share insights within the community
Improve your work as a teacher in the classroom
Improve your ability to teach biometeorology, specifically
Provide mentoring as an early career faculty member
Bolster your self-esteem as a faculty member
Gain a better understanding of education research
Develop professional relationships
Understand differences in education across national and institutional contexts
Enhance your awareness of education-focused funding opportunities
Enhance your ability to write education-focused funding proposals

What specific topics or concepts related to biometeorology may you include in your classes in the future?
<table>
<thead>
<tr>
<th>Activity</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-class, small group learning</td>
<td></td>
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<tr>
<td>Group projects</td>
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<tr>
<td>Hands-on activities and/or assignments</td>
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<tr>
<td>Frequent feedback to students</td>
<td></td>
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<tr>
<td>Detailed feedback to students</td>
<td></td>
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<td></td>
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<tr>
<td>Examples or metaphors to explain concepts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case studies or real-world examples</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant tours or site visits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community service</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

What was missing from this workshop that you believe should have been included?
What "next step" from this workshop are you most excited and optimistic about?

How would you sum up your take-away message from this workshop in a single sentence?

**Final question**: Do you agree or disagree that as a teacher it is your responsibility to:
the workforce. Help students consider the world from multiple perspectives.

Make concepts and principles relevant to students.

Help students connect their prior knowledge and experience to what's being learned.

Prepare students for the role of citizen.

Understand the value of diversity in its many forms (e.g., ideas, cultures, gender).

Help students understand the value of a liberal education.

Help students succeed, rather than weed them out.