

MEETING SUMMARIES

ENHANCING THE TEACHING AND LEARNING OF BIOMETEOROLOGY IN HIGHER EDUCATION

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This meeting was the result of a 2015 proposal to the Tromp Foundation (foundation for biometeorological research) within the International Society of Biometeorology (ISB) where opportunities were identified for gaining critical insight into the prospects of the incorporation of biometeorology into higher education. Specific topics were highlighted regarding how to effectively integrate biometeorological concepts, learning modules, and pedagogical techniques into undergraduate and graduate courses and curricula worldwide—and to learn the best practices by which to do so.

ENHANCING THE TEACHING AND LEARNING OF BIOMETEOROLOGY IN HIGHER EDUCATION

WHAT: The Students and New Professionals (SNP) group within the International Society of Biometeorology (ISB) held an international workshop to explore the use of biometeorological concepts in interdisciplinary teaching and learning in higher education.

WHEN: 28 July–1 August 2016

WHERE: Norfolk, Virginia

AFFILIATIONS: PERKINS—George Mason University, Fairfax, Virginia; VANOS—Texas Tech University, Lubbock, Texas; FUHRMANN—Mississippi State University, Mississippi State, Mississippi; ALLEN—Old Dominion University, Norfolk, Virginia; KNIGHT—Virginia Polytechnic Institute and State University, Blacksburg, Virginia; LEE AND SHERIDAN—Kent State University, Kent, Ohio; LEES—University of Queensland, St. Lucia, Queensland, Australia; LEUNG—University of Toronto, Toronto, Ontario, Canada; LUCAS—University of Birmingham, Birmingham, United Kingdom; MEHDIPOOR—University of Twente, Enschede, Netherlands; TAVARES NASCIMENTO—Universidade Estadual de Maringá, Maringá, Paraná, Brazil; SPENCER—University of Akron, Akron, Ohio

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BACKGROUND. The field of “biometeorology” has been uniquely interdisciplinary since 1956 with its formalized beginnings in the International Society of Biometeorology (ISB). The term *biometeorology* is inherently interdisciplinary as a compound word integrating *biology* and *meteorology* with the ultimate goal of describing interactions between living organisms (i.e., humans, plants, animals) and the atmospheric environment. Or, as phrased in the original language by Solco W. Tromp in 1956 at a symposium during which the International Society of Biometeorology was founded, “Biometeorology can be defined briefly as ‘the study of the relations between meteorological factors, physico-chemical systems and living organisms.’” (International Society of Biometeorology 1975, unpublished material)

Within the ISB, biometeorology today is composed of four “commissions” that serve as active

research groups: phenology, climate tourism and recreation, animal biometeorology, and climate and human health. Spanning all these areas of research, the Students and New Professionals (SNP) group is composed of an international representation of graduate students and those who are either within 5 years of completing graduate study or are under 35 years of age.

A primary goal of the SNP group is to integrate biometeorology into both research and teaching. Given the challenges of integrating biometeorology as a stand-alone curriculum and the opportunities of using biometeorology as an interdisciplinary-science-based foundation for experiential applied learning, a natural research inquiry surfaced: how do we enhance the teaching and learning of biometeorology in higher education to both promote the discipline and elicit deeper learning into common meteorological, climatological, and biological concepts? As a result of this inquiry, the second international workshop held by the ISB's SNP group sought to tackle this very issue.

Transforming core tenants of biometeorology and education into collaborative initiatives on an international scale was a key goal of the workshop. Additionally, understanding the true interdisciplinary nature of the actors within the biometeorology community and combining areas of expertise (e.g., climate concepts with human health) into varying forms of higher-education integration are a high priority for advancing the field of biometeorology.

Those involved in the meeting were invited as a result of 1) involvement in the ISB, 2) current status as a SNP member, and 3) successful completion of a competitive application process that was designed to ensure consistency across international representation, disciplinary perspectives, and gender. In total there were two graduate students, two postdoctoral associates, seven assistant professors, one mentor, and one evaluator in attendance. There was also a great wealth of diversity in backgrounds within the biometeorological subfields of animal biometeorology and physiology, human biometeorology, tourism biometeorology, geography and geographic information science (GIS), phenology, and applied synoptic climatology. Another goal of international collaboration was met as participants hailed from the United States (6), Canada (2), England (1), Australia (1), Brazil (1), and the Netherlands (1).

WORKSHOP AGENDA. The workshop was organized both to facilitate collaboration prior to

the event and to encourage future development of projects resulting from the workshop. Prior to the beginning of the workshop, participants collected and tracked classroom assessments; reviewed research literature involving interdisciplinary research and advancing education; and brought current syllabi, best practices, and assessments for lively discussion. A preworkshop survey was also administered. From these preparations participants were able to discuss and exchange their knowledge and personal teaching experiences around the world and among institutions of higher education.

Workshop participants collaborated through a mix of presentations, practical sessions, and interactive group discussions, applying active learning techniques throughout. Individuals presented on personal expertise, further contributing to learning.

The workshop schedule was organized thematically to build upon concepts and to develop creative momentum. The first day began with a general review of the current state of geoscience education. This was followed by focused presentations of unique research methodologies implemented within the differing subfields of biometeorology. Once each of these subfields was given an effective definition, all participants engaged in an "interdisciplinary collaboration brainstorm" meant to explore ways to integrate specific aspects of biometeorology into a widely encompassing biometeorology curriculum.

The second day built upon day 1 through integrative classroom-oriented activities and the development of learning modules to be used within varying curricula that would effectively teach biometeorological concepts in classroom or laboratory settings. Concepts such as service learning, the use of modern technological teaching pedagogy, experiential design, and geospatial analysis were presented and discussed.

Days 3 and 4 served as collaborative "working days" to set up future development and postworkshop continuity. These days were focused on practical working groups, grant writing for future project funding, and the importance of publication when disseminating workshop findings and future research objectives.

FUTURE DEVELOPMENT. As a result of this workshop and its creative collaboration, the participants initiated new research and applications based on both the set objectives within the initial proposal and the findings learned as a result of the workshop. These outcomes have been developed with a goal

of completion over the next several years, many of which are scheduled to take form and presentation at the 21st International Congress of Biometeorology (ICB) at Durham University in the United Kingdom in September 2017. The following list identifies many of the goals and objectives from the workshop:

Biometeorology curriculum modules and assignments

- Participants will develop modules, laboratories, and assignments and apply them when possible in their own curricula to integrate biometeorology-based topics within existing classes/curricula at the university level. The SNP group will then develop educational standards and distribute these lesson plans for more widespread implementation among all ISB members.

Biometeorology education concept paper

- Participants will write a concept article for the international journal of biometeorology's 60th anniversary special issue regarding the future of biometeorology—both in research and in the classroom.

Early-career education workshop at ICB

- Participants will plan and organize an education workshop to continue biometeorological education outreach for students and new faculty at the next ICB.

Website on biometeorology and education

- Participants will work on developing a website (<http://biomet-education.net/>) to promote research, information, educational materials, and promotion of biometeorology education in the twenty-first century. The website will also promote the biometeorology discipline in general through newsletters, research publications, outreach, and sharing of best practices.

Survey of all members of ISB

- Participants will develop and administer a survey to better understand the needs of the biometeorology community for the advancement of biometeorology education. The survey will address the research aspects of those involved in biometeorology worldwide and query opinions and suggestions regarding the promotion of biometeorology education in the future.

Technology and biometeorology

- Participants will contribute knowledge of the latest technical innovations in the field of biometeorology to author a short communication in the *International Journal of Biometeorology*.

Biometeorology in the twenty-first century

- Participants will author a paper reviewing biometeorology as an integrative and

interdisciplinary field and how the subfields of biometeorology can contribute to addressing twenty-first century global issues.

Education-focused funding proposal development (long term)

- Participants will develop an education-based grant proposal regarding the integration of biometeorology into postsecondary curricula.

Edited volume on biometeorology education: "Introduction to biometeorology" (long term)

- Participants will develop an "introduction to biometeorology" edited-volume textbook aimed at covering varying aspects of biometeorology. Plans are to include informational text, laboratory manuals, and curriculum modules for use across a wide variety of interdisciplinary courses.

CONCLUDING THOUGHTS. The workshop, "Enhancing the Teaching and Learning of Biometeorology in Higher Education" was a great success, both facilitating collaboration and illuminating a path toward biometeorology in interdisciplinary physical and social science education on an international scale in the future.

The post-course workshop survey attested to the networking benefits and academic advancements of the workshop. Participants indicated (Fig. 1) that the workshop helped them in their development as a professional in academia. In particular, areas relating to self-improvement and personal knowledge scored highest in terms of positive outcomes from the workshop activities. Participants expressed agreement or strong agreement that they developed as a scholar and gained insights that will allow them to better understand biometeorology and subsequently share insights with their students, community, and colleagues. There were also changes in personal teaching pedagogies and outlooks as a result of the workshop (Fig. 1). In a comparison of pre- and postworkshop differences in respondents' instructional approaches, participants developed greater intentions to implement experiential education tools through the use of hands-on activities, group projects, site visits, and community service outreach.

Concluding, our colleague from Brazil summarized the positive experience gained from the workshop:

"I'm Brazilian and the experience at the workshop for me was extremely valid, mainly due to the interaction with other young professionals from around the world and the possibility to share experiences and to

To what extent do you agree that the workshop helped you:



Use of Instructional Approaches

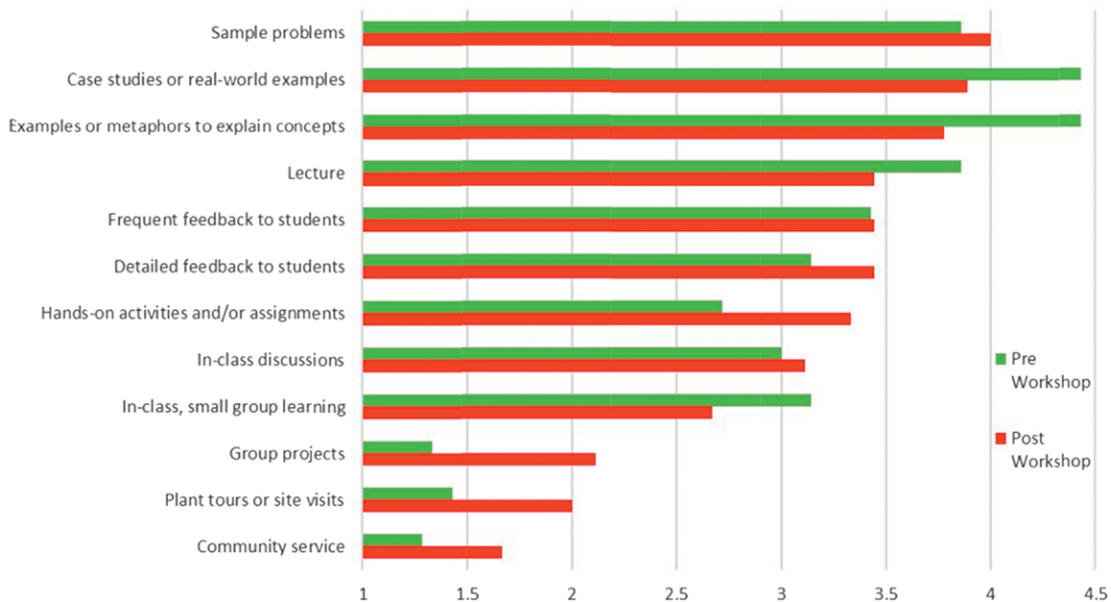


FIG. 1. Workshop outcomes.

learn from colleagues from Australia, USA, Canada, Holland, England. I noticed that the recurring problems to us young professionals are quite similar, such as the challenges of early career teachers and how to balance both careers in the universities as teachers and as researchers.”

“I brought in my luggage back to Brazil a unique experience, and I am sure that our ISB Students and New Professionals group has the competence to carry

out the importance of our International Society to the world, continuing the work started 60 years ago.”

We look forward to continuing the great momentum produced in this workshop for future research and teaching endeavors.

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