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Catalysing virtual collaboration: the experience of the remote TIES working groups

Meis, M.*[1] | Pirani, M.[2] | Euan, C.[3] | Castruccio, S.[4] | Simmons, S.[5] | Stroud, J.R.[6] | Blangiardo, M.[2] | Wikle, C.K.[7] | Wheeler, M.[8] | Naumova, E.[9] | Bravo, L.[10] | Miller, C.[11] | Gel, Y.[12]

[1]Departamento de Ciencias de la Atmósfera y los Océanos. Universidad de Buenos Aires. Centro del Mar y de la Atmósfera, UBA-CONICET Argentina
[2]MRC Centre for Environment and Health, Department of Epidemiology and Biostatistics, Imperial College, London, UK
[3]Department of Mathematics and Statistics, Lancaster University, Lancaster, UK
[4]Department of Applied and Computational Mathematics and Statistics, University of Notre Dame, Indiana, USA
[5]Institute for Advanced Analytics, North Carolina State University, North Carolina, USA
[6]McDonough School of Business, Georgetown University, Washington, DC, USA
[7]Department of Statistics, University of Missouri, Missouri, USA
[8]Biostatistics & Computational Biology Branch, National Institute of Environmental Health Science, USA
[9]The Gerald J. and Dorothy R. Friedman School of Nutrition Science and Policy, Tufts University, Boston, MA., USA
[10]College of Liberal Arts Sciences. Department of Statistics., University of Illinois, Urbana-Champaign, USA
Statistics School of Mathematics and Statistics, University of Glasgow, Glasgow, UK
[12]Department of Mathematical Sciences, University of Texas, Dallas, USA

Correspondence
*Melanie Meis, Intendente Guiraldes 2160. Pabellón cero más infinito. Email: mmeis@at.fcen.uba.ar

Present Address
Intendente Guiraldes 2160. Pabellón cero más infinito

Abstract

During the COVID-19 pandemic, the idea of collaboration and scientific exchange between members of the scientific community was enhanced by technology. Virtual meetings and work platforms have become common resources to continue generating research, partially replacing instances of joint in-person work before, during or after a conference. The idea of teleworking played a fundamental role in remote collaboration groups within The International Statistical Society (TIES), a community of interdisciplinary scientists such as statisticians, mathematicians, meteorologists, and biologists, among others working on quantitative methods to enhance solutions to environmental problems. In 2021 the Society launched three working groups with the aim of improving networking across the Society's members and develop creative collaboration, while advancing statistical and computational methods motivated by real-world driven applications in environmental research. Here, we provide insights from this virtual collaborative initiative.

KEYWORDS:
remote; working groups; scientific environmental research

1 | INTRODUCTION

Within The International Environmetrics Society (TIES)'s community, multidisciplinary collaborations have always been at the heart of the Society. During the COVID-19 pandemic, the scientific community experienced lack of conferences or in-person meetings and workshops, and in the absence of encounters to generate new challenges, research was affected. It was urgent to propose a new working method that would be successful for the scientific community in this new reality, which initially did not show an end date. In this sense this new method for the community could be categorized as an "enforced experiment", term considered by a recent work, Gifford (2022), associated to being remote work the only way that most of the working lines should adopt due to pandemic. In this scenario, the TIES Membership Committee debated developing a strategy to keep research collaborations and networking moving within the society.

There is well documented research about remote work in companies, specially the technological ones, which have reported various businesses adopting the hybrid or mostly remote format even before the pandemic. However, in academia remote work for a research group has not been the first option of work before COVID-19, especially when most or, if not all, the people involved are located in different parts of the world. In this sense, in Hunter (2019) the authors suggested that remote work for career science results easily when people have at least a first meeting in person.

Many workers are accustomed to working remotely, whether it is for a company or other types of work, however, a recent study at a technology company in the United States suggests that remote work leads to a deficiency in communication among workers Yang et al. (2022). In addition, the same study encourages other companies or different types of line's work to document the results obtained in remote work due to the potential bias that their work might have. On the other hand, the study of Felstead (2022) suggests that the generation of successful remote work is based on focusing on objectives.

Within this challenging scenario, the TIES created a new opportunity of networking for its members establishing virtual working groups (WGs) with the overreaching goal of generating creative collaboration. In this sense, an open call for participation was made through the TIES and the International Statistical Institute (ISI). This resulted in the formation of three WGs, one led by Matthew Wheeler (National Institute of Environmental Health Science); a second group headed by Marta Blangiardo (Imperial College London); and the third group lead by Christopher Wikle (University of Missouri). The focus of these WGs was respectively in the areas of (i) Bayesian methods for complex environmental systems, (ii) Bayesian modeling to apportion ultra-fine particles into their sources, and (iii) artificial intelligence in environmental statistics. Moreover, the workflow of the WGs involved regular virtual meetings between the members, tasks delegation, and finally, writing at least one manuscript. It is important to highlight that only a few or none of the members of the WGs knew each other before this initiative.

This article establishes specific steps for successful virtual collaboration among multidisciplinary groups with a common scientific goal. Success was measured by completing a research project, including disseminating the outcomes through scientific papers and conference presentations. In the following sections, we first present the feedback from the group leaders, then we list certain guidelines for finalizing a manuscript, afterwards we present the results from a semi-structured questionnaire that we run among the group members after the completion of the research activities, which helped us to evaluate the proposed strategy and draw conclusions and suggestions for the future.

2 | THE EXPERIENCE OF THE WGS' LEADERS

2.1 | Statistical Methods for Large Geospatial Datasets

This working group was led by Matthew Wheeler. After a distinct learning curve, in which the leader learned to manage the needs, abilities, and interests of the group members, the WG collectively forged a research path. Specifically, the leader wanted the team to help dictate the direction; this was difficult for some who wanted a more structured, defined problem to which they could contribute. Because of this, there was some early attrition in group membership. Another issue centered around the availability of general code bases that could be used in independent high performance computing (HPC) environments. The research proposed involved Gaussian process approximation for large data sets. It is the case that just because one person has access to and knowledge of a software solution (e.g., high-performance BLAS libraries), not all team members are equally knowledgeable. Thus, each team member shared their knowledge to conduct the analysis relative to other members' HPC environments. This process took time. Finally, the team made progress on the combined goal when these issues were resolved, and the group

will have multiple high-quality publications (currently a paper is under review). Also, the members are discussing the possibility of further collaborations.

2.2 | Statistical Methods for Source Apportionment

The experience of working in a remotely-runned group has been positive. Every member has been proactive and keen in engaging with the others, even to work on a topic they did not know much about at the beginning. While the group was led by Marta Blangiardo, the support provided by two tutors (also members of the group) has been invaluable in making sure meetings were set and run smoothly. All the components of the group discussed and agreed on a set of rules during the first meeting, related to meeting recurrences, paper authorship, task splitting. These were particularly useful as it made clear who was in charge of the main draft writing and who would contribute more on commenting and editing. This project was based on a real-world applied problem, which required statistical modelling; the WG had a brainstorming session which enabled all the group members to propose ideas on the type of statistical approach to be considered. This has resulted in two main directions which have resulted in a published paper (Baerenbold et al. (2023) and in one currently under review. Similarly to the other groups, using resources which enabled sharing easily, such as Overleaf and Github, was a key point, which made the interaction across the group members easy to manage.

2.3 | Artificial Intelligence in Environmental Statistics

It worked very well for this working group to have a team of three leaders to help organize the working group. Chris Wikle was the primary content leader, but two tutors (also members from the WG) were integral in helping to lead the group as well. With such a group, it was not overwhelming for any one person and if one of the leaders could not make a particular meeting, another could fill in easily. It was important to the success of the group that the leaders were very open to ideas from all participants and worked to ensure that all voices were heard, regardless of previous experience in the topic area. Indeed, having a good mix of senior and junior-level researchers was crucial. The leaders expressed that they would have liked to have more graduate student participation, but the postdoctoral participation was very good. In addition, it was important to this group that the leadership team communicated goals and deadlines explicitly. Finally, it was essential for this WG having an organized data and document storage system, and working together through Overleaf to write the paper. The group has one paper published (Wikle et al. (2023) and another submitted as a discussion paper. A couple of things were less than ideal. First, it was impossible to find a meeting time that worked for everyone across the globe and the WG lose a few potential group members early on due to the vast time zone differences. Lastly, for the first paper the WG tried a communal writing approach where each member submitted their results and wrote up their relevant sections – with the leaders writing the introduction, conclusion, and substantially editing the document. Although this had some advantages, the disadvantages of having to smooth over different writing and presentation styles was a substantial burden. In the second paper, they have taken a more leader-centric writing approach, which has proven to be more efficient.

3 | STRATEGIES FOR AN EFFECTIVE REMOTE WG AND FOR A SUCCESSFUL COLLABORATIVE WRITING

In this section, we summarise the key steps for an effective virtual collaboration and the strategies to achieve a scientific publication, based on the experience of the TIES WGs.

3.1 | Steps to achieve an effective remote WG:

1. *Leadership*. Identify a WG leader who possesses conviction and a clear vision for the project, and facilitate the group activities through:

    - Articulate a general objective in specific objectives to support it;
    - Leverage the strengths and weaknesses of team members;
    - Delegate tasks effectively while establishing schedules and deadlines.

2. *Communication and collaboration*. It is key for the WG to:
    - Establish a common programming language if required;
    - Set clear milestones and deadlines to guide the research's progress;
    - Organise subgroups to fulfill specific tasks.
3. *Logistics and coordination*. It is effective for the WG to:
    - Assign one or two members to manage logistics, such as: scheduling meetings, find the requested dates and times for attendance, and maintain control of the schedule;
    - Identify a useful platform for communication and quick chats for timely exchanges of ideas, doubts, and results;
    - Implement a collaborative writing and revision platform, which is critical for cohesive document creation.

3.2 | Strategies to achieve writing and completing a manuscript:

- Write the manuscript collaboratively, dividing the group into subgroups based on members expertise and level of involvement in the project;
- Determine which part each person would be qualified to contribute to, from abstract, introduction, methods, results, discussion and conclusions;
- Establish a process for reviewing drafts, incorporating feedback to refine the manuscript;
- Reach a consensus on authorship order, reflecting each contributor's level of involvement and contribution to the project.

4 | FEEDBACK FROM THE MEMBERS OF THE TIES WGS

In the following, we report the feedback provided by 13 members of the TIES WGs, which was obtained through a semi-quantitative questionnaire run at the end of the collaborative activities.

4.1 | The participants opinion on the performance of the WGs

Most of the WGs' participants (92%) concluded that the groups were a success. Some interesting opinions on the value of this collaborative experience are shown below:

- "The group was full of enthusiasm, and we also got a publication out of it. I learned a lot of new concepts and interacted with more people than otherwise, I would have done during these challenging years."
- "The group allowed for collaboration from individuals from differing fields. The group produced publications."
- "The group has helped me to expand my network, and it has given me a space to work in a collaborative team."

4.2 | Suggestions for future editions

Being the first occurrence of an experience of this kind, different actions could be taken into account to enhance the results of the future editions. In particular, some suggestions have been made among the participants:

- "Well balanced academic career groups." We acknowledge that, in general, doctoral or postdoctoral students were involved in fewer projects, so in this sense we would like to encourage more students to participate in different projects proposed by the community and resulting in a core essential in their development.
- "If there is more than one WG, the members should contribute in only one of them." The participation in more than one group should not be encouraged in the future editions, as it might implicate less dedicated time per project.

5 | WHY DID THE WGS WORK?

The WGs' leaders role was of vital importance for establishing clear work guidelines in the research process, as well as recognizing the strengths and weaknesses of each member to achieve a published manuscript. Furthermore, the support of tutors was essential to assist the leader in the logistics for the virtual meetings, make good use of platforms to organize work events and follow deadlines closely. Finally, but not least, the commitment and enthusiasm of each member to collaborate, attend meetings and perform the required tasks was crucial for the success of the WGs.

5.1 | Interdisciplinarity

All the members agreed that the WGs provided an ideal atmosphere, as they proved to be a friendly environment to work and discussion. Nonetheless, a suggestion from one member of the WGs highlighted the importance of acknowledging the complexities inherent in interdisciplinary collaboration, pointing out that "we should consider a slight warning regarding the pitfalls of multidisciplinary work would not come amiss". This feedback underscores the key role of leadership in preempting unforeseen challenges, fostering a shared language among participants, as well as enhancing mutual understanding and collaboration.

5.2 | Challenges

The path to innovation and collaboration between the members of the TIES WGs was not without its hurdles. This section explores the nuanced challenges encountered by the members of the WGs, shedding light on the delicate balance required to foster a productive, inclusive, and forward-thinking research environment. In particular, we align the following points:

- *Scheduling for active and inclusive participation*. Identify a proper time that could work for all the members of the WGs presented some challenges in relationship to diverse time zones. In fact, opening the door to virtual collaborations allowed people worldwide to join the TIES WGs, so keeping the meeting agenda adequate was difficult for some groups.

- *Leveraging diverse expertise*. Flexible new collaborations resulted in having a WG of members with different backgrounds and experiences. In this sense, it was crucial to understand the team's dynamics and enhance collaboration by harnessing each member's strengths.

- *Managing virtual contributions*. Being hold in a virtual setting, it was not easy keeping track of collaborations and contributions as there was no physical pressure of accomplishment. However, ensuring that each member was accountable for specific tasks fostered a sense of responsibility and commitment to the group's goals, thereby supporting the research development.

6 | CONCLUSION

The first edition of the TIES WGs has successfully shown the significant potential of transnational collaboration in advancing statistical methods for environmental science, uniting researchers of diverse expertise and career stages. This experience stands as a compelling example for the scientific community, underscoring the benefits of fostering remote collaboration and supporting young scientists in joining active research groups. Furthermore, considering participants' suggestions for future editions might bring out excellent opportunities to work across countries and disciplines. Finally, we expect early career researchers to experience TIES as a committed Society to facilitate new research collaborations through the TIES WGs.

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References

Baerenbold, O., Meis, M., Martínez-Hernández, I., Euán, C., Burr, W. S., Tremper, A., … Blangiardo, M. (2023). A dependent bayesian dirichlet process model for source apportionment of particle number size distribution. *Environmetrics*, *34*(1), e2763.

Felstead, A. (2022). *Remote working: A research overview*. Routledge.

Gifford, J. (2022). *Remote working: Unprecedented increase and a developing research agenda* (Vol. 25) (No. 2). Taylor & Francis.

Hunter, P. (2019). Remote working in research: An increasing usage of flexible work arrangements can improve productivity and creativity. *EMBO reports*, *20*(1), e47435.

Wikle, C. K., Datta, A., Hari, B. V., Boone, E. L., Sahoo, I., Kavila, I., … Chang, W. (2023). An illustration of model agnostic explainability methods applied to environmental data. *Environmetrics*, *34*(1), e2772.

Yang, L., Holtz, D., Jaffe, S., Suri, S., Sinha, S., Weston, J., … others (2022). The effects of remote work on collaboration among information workers. *Nature human behaviour*, *6*(1), 43–54.