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THE TURN TOWARDS GEOPHYSICS IN HISTORIC RESEARCH AND THE CHANCES IT OFFERS FOR THE STUDY OF WEATHER MODIFICATION IN GEORGIA

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Abstract: *This paper aims to inform the participants of the conference „Modern problems in Geophysics" about ongoing historic research on Geophysics and thereby enable interdisciplinary exchange. First, it is given an overview of selected scientific literature from fields such as the history of science and knowledge, environmental history and Cold War history. This literature illustrates the significantly grown interest in the history of Geophysics, in quantity and diversity alike. Then, drawing on the example of weather modification, the opportunity for such a history of Geophysics in Georgia is outlined from a historical perspective.*

Key words: *History of science, history of Geophysics, Georgia, weather modification.*

Introduction

Writing in 2003 and 2009, the historian of science Ronald Doel identified an imbalance between the historic research in biological and physical Earth sciences. Although physical Earth sciences such as oceanography, atmospheric science or hydrology have shaped the Cold War by their dramatic expansion in these decades, it was mainly the biological sciences which dominated public perception, as well as new research directions such as environmental history. Since Rachel Carson's *Silent Spring* (1962), ecological thinking has influenced the perception of the planet and the history of human interaction with it [1].

This diagnosis, however, was already accompanied by a rising interest in Geophysics among historians of various subdisciplines. Therefore, it is not surprising that, when reviewing new books in 2019, the historian Dania Achermann already finds a "New Diversity in the History of Meteorology and Climate Science" [2].

New historic literature on Geophysics

Although the reasons for such a new interest are numerous, climate change clearly stands out as the single most important influence. The ever-rising awareness for the world's changing climate, its anthropological cause and its fundamental impacts on societies resulted in an increased need for an understanding of how this today's knowledge historically arose. Closely connected to this, the concept of the *Anthropocene,* which describes humans as a force that changes the physical Earth, challenged but also stimulated research in the history of human – planetary interaction [3]. Finally, a new understanding of knowledge further drove the interest in the history of Geophysics. Knowledge, it had been highlighted, is not an absolute and ahistorical thing that simply exists, but rather historically produced and shaped by the cultural and political context in which it is developed [4].

One of the main results of the new historical interest in Geophysics were numerous studies, in which scholars such as Paul Edwards or Kristine Harper traced the genesis of numeral models in meteorology and climatology [5]. They showed how computer modelling not only transformed the disciplines itself, but has become an essential and inevitable part of today's understanding of the physical environment of the planet. Hélène Guillemot, on the other hand, underlined the flaws and uncertainties which are still part of climate models today despite enormous progress in computing and observation [6]. The historical interest, however, has not stopped there. Historians, such as James Fleming, wrote the history of meteorology in the United

States in the 19th and 20th centuries [7]. Such long-term analysis have been accompanied by regionally and thematically focused studies. Fleming himself, for example, wrote biographies of individual scholars such as Guy Stewart Callendar and Joanne Simpson [8]. In *Imperial Weather*, Fiona Williamson discussed the closely connected histories of meteorology and colonialism in Malaya [9]. By the example of meteorology in Victorian Britan, Katharine Anderson showed how the early science of weather prediction became drawn into the public discourse [10]. Deborah Coen, in turn, explored the influence of the complex structure of the Habsburg Empire on conceptional thinking in the 19th century's climatology [11] as well as the contribution of land empires such as Austria-Hungary and the Russian Empire to the early history of this discipline [12]. Jonathon Oldfield, finally, outlined the contributions to global climate science by the important Soviet climatologist Mikhail Budyko [13].

Although meteorology and climatology have attracted most of the attention, they are by far not the only geophysical disciplines studied by historians in the last years. It is oceanology that reveals one of the central objects of this historical investigation: the influence of the state, the military or economic actors on the production of geophysical knowledge. Jacob Hamblin in *Oceanographers and the Cold War* and Naomi Oreskes in *Science on a Mission: How Military Funding Shaped What We Do and Don't Know about the Ocean* [14] have shown how American oceanography gained funding and enormous new research opportunities as part of the military-industrial complex of the Cold War. Whether sea-launched nuclear missiles or vast amounts of data on the oceans, oceanography had much to offer for the scientific race between the United States and the Soviet Union.

Researchers like Julia Lajus, Sverker Sörlin, Lif Lund Jacobsen and Irina Fedorova did not only extend the historic study to further disciplines but helped as well to include the Soviet Union and the international circulation of knowledge into the history of Geophysics. Lif Lund Jacobsen, Irina Fedorova and Julia Lajus showed how seismographs became diplomatic objects as the United States and the Soviet Union exchanged these scientific instruments during the Cold War [15]. By the example of Arctic research, Julia Lajus and Sverker Sörlin examined how personal contacts enabled exchange between Scandinavia and the Soviet Union despite the East-West divide [16].

Finally, one can add that research in the Earth sciences has also reached literary studies. *Literary meteorology*, a concept introduced by Michael Gamper in 2014, understands weather in the broader context of knowledge and studies the contribution of literature to such knowledge [17].

Currently ongoing research projects in the history of Geophysics focus, for example, on the history of the Second Polar Year in the context of rising political instability, due to the Great Depression and the rise of Hitler in Germany [18], and Soviet glaciology in Central Asia, aiming to stimulate an interdisciplinary exchange between natural and social sciences [19].

My own research project deals with the history of weather modification in the Soviet Union in a regional and an international context. The most important prospects of this approach for the history of Geophysics in Georgia are outlined in the following:

Weather Modification – an opportunity for the history of Geophysics in Georgia

From the perspective of much of the literature and the projects discussed above, in particular the two aspects of international and regional context seem prosperous for future examination. As science in the 19th and 20th centuries was often embedded in transnational networks, studying these international links is vital for the understanding of a discipline's development. Even when there is no direct interaction, researchers are aware of being part of larger processes. On the other hand, however, the concrete conditions, such as the existing scientific and knowledge infrastructure, the political framework and the physical environment are determined by the concrete regional context in which research is conducted. Three approaches might be taken in order to write the history of weather modification as an example of the history of Geophysics in Georgia in an international and a regional perspective:

Firstly, the long tradition of geophysical observation and research in Georgia and the Caucasus region must be put into context. Ranging from the early 19th century and the Tsarist Empire over the Soviet Union in the 20th century to the independent Georgia in the 21st century, Geophysics in Georgia has been embedded and shaped by the various domestic and international influences. Historic research can closely analyse these

conditions and influences in order to determine their particular effect on the development of Geophysics in Georgia. The anti-hail research and activities can serve as an important case for this: having first been tried during the late Tsarist period, they were renewed and peaked in the post-war Soviet Union. While the transformation period of the 1990s led to the end of this Soviet-time work, anti-hail measures were reapplied under the now different conditions of the independent Georgia [20-22].

Secondly, including biographical elements in the study of a scientific field has proved to be highly beneficial. This is not only because individual actors and researchers developing new methods and perspectives are often vastly influential for the advancement of their fields. Rather, biographies often reveal larger processes formative for an entire generation or region, but hard to detect from a bird's-eye perspective. Moreover, they can tighten often abstract research questions and structures to personal experiences and decisions. Here, weather modification again offers numerous examples, such as the life and work of Georgi Sulakvelidze, Amiran Kartsivadze or Vasil Lominadze. Considering their professional development in Georgia, but as well their interactions with other Soviet scientists and with their Western counterparts can open a window in the complex, but formative context of Georgian Geophysics and weather modification. Sulakvelidze, for example, was also well-known and highly recognized among American researchers [23-26].

Finally, as researchers like Deborah Coen have shown, approaching the history of research in fields like meteorology, climatology or hydrology through different scales can offer important insights. Evaluating theories, experiments and findings against the background of global and local challenges and particularities sharpens awareness of the causes of success and failure. For the history of weather modification in Georgia, this especially means that the anti-hail systems developed in the Caucasus, on the one hand, can be seen as a response to local needs such as the protection of vineyards. They most importantly had to prove effective for this purpose. On the other hand, however, such specifically local conditions existed in other parts of the world, where anti-hail systems were developed as well. Nevertheless, the specific actors, interests, and goals differed from case to case and success in one case might be seen a failure in another.

Conclusion

My project aims to write the history of weather modification through such shared, but nevertheless variating local experiences and as part of a global history. It thus enables to understand the history of Geophysics in Georgia within both its global and its regional framework. Thereby, it contributes to an increasingly richer literature on the history of Geophysics.

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