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Climate change as an issue of global environmental concern: Emerging debates concerning climate and climate change amongst Soviet geographers, c.1945-1960s

Jonathan Oldfield
Central and East European Studies,
University of Glasgow, Glasgow, UK

Jonathan.Oldfield@glasgow.ac.uk

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Introduction

Russian natural science has a long and rich tradition of work related to weather and climate phenomena sustained, at least in part, by the extremes of such phenomena encountered as travellers and scientists marched eastward during the course of the last two to three hundred years. Climate change as a process resonates strongly with contemporary audiences and is predominantly associated with the deleterious impact of human-induced climatic transformations. Nevertheless, both small- and large-scale manipulations of the climate for human betterment, together with associated theorising of climate and climatic systems, have a long history. In addition, the negative impact of human activity on climate has also been part of wider international scientific discussion for much of the last forty to fifty years. A consideration of the place and role of Russian and Soviet science within this history provides a chief starting point for this paper. *More specifically, this paper explores the range of understandings of climate, climatic processes and climate change that circulated amongst Soviet geographers during the early post-Second World War period. It is argued that these understandings would provide an important basis for later work concerning climate change science as it developed in the Soviet Union during the 1970s-80s*.

This paper's focus on the work of Soviet geographers stems from the disciplinary interests of the author and at the same time recognises the significant role played by Soviet geographers in helping to advance understanding in this area. The focus on the post-1945 period is somewhat arbitrary given the long history of climate thought in Russia; nevertheless, the immediate post-war period coincided with marked developments in both the conceptual and applied aspects of such thinking within geographical circles and it is these which form the main focus of this paper.

In order to examine the associated conceptualisations of climate and climate change evident amongst Soviet geographers, the paper explores a number of discernable conceptual trends within the geographical literature post-1945, although at the same time attempting to remain sensitive to the long history of thought underpinning such trends. Furthermore, in order to structure the analysis, the paper draws predominantly from the work of three influential geographers, namely, L.S. Berg

(1876-1950), A.A. Grigor'ev (1883-1968), and I.P. Gerasimov (1905-1978), as well as the climatologist and geographer M.I. Budyko (1920-2001).

Climate as a dynamic and historical physical-geographical process

As noted above, understandings of climate and associated climatic processes have played a significant role in the history of the Russian natural sciences. Given the constraints of space and time, the work of two individuals is worthy of brief mention in recognition of their subsequent importance to Soviet geography. First, the aforementioned climatologist and geographer *A.I. Voeikov* (1842-1916) was a leading figure in the study of climatology, both in Russia and beyond, during the late tsarist period. He was an active member of the Russian Geographical Society and carried out a vast amount of work dedicated to explaining climatic patterns and processes as well as more localised weather phenomena. His 1884 book Climates of the earth's surface, particularly Russia is typically highlighted as a significant piece of scholarship with its effort to explore the complex processes underpinning climatic patterns and events in Russia as well as more broadly. Grigor'ev (1949, pp. 9-10), writing in the introduction to Voeikov's collected works, noted,

> In this monograph [Climates of the earth's surface…], Voeikov was the first in world science to determine the task to reveal the essence of complex and composite climatic phenomena….While opening up the structure of climatic processes, Voeikov always strove to find the basic, dynamic forces of the development of the studied phenomena (of the researched processes) and as such to determine the proportion and significance of the remaining factors.

More specifically, Voeikov's 1884 work explored a range of climatic relations such as the role of snow cover and atmospheric moisture in the climatic process as well as past climatic change events. Second, the formative role of climate in determining the characteristics of the physical-geographical environment at the earth's surface was advanced strongly by the soil scientist *V.V. Dokuchaev* (1846-1903) during the late nineteenth century and furthered significantly by the work of his school (e.g. via the work of individuals such as G.F. Morozov, R.I. Abolin, G.I. Tanfil'ev, A.N. Krasnov etc.). In addition, it should be noted that the Dokuchaev school is implicated strongly in the development of Russian/Soviet geography during the course of the 20C. While the influence of this school was advanced strongly within the ideological constraints of Soviet geographical historiography, there would appear little doubt that it had an influential role in this regard.

In order to trace the subsequent engagement with climate amongst Russian/Soviet geographers, and mindful of the limitations of space, the following section focuses on the work of the aforementioned geographer A.A. Grigor'ev in addition to that of Lev Semenovich Berg [1876-1950]. Berg's work is particularly helpful in highlighting the central role of climate in Russian geographical thought during the late tsarist and early Soviet periods.

L.S. Berg is most famous for his work concerning landscape science and his associated championing of a largely chorological approach to geographical study grounded on the identification of landscape units within the wider environment (see Berg, 1913; 1915). His methodological work encountered difficulties during the Soviet period not least due to its links with the ideas of the German geographer, Alfred Hettner; and his personal battles with Grigor'ev over the essence of geography have been well-documented (e.g. see Shaw and Oldfield, 2008). Nevertheless, Berg's fundamental conceptualisation of the physical environment, stressing the complex interconnectivity of both organic and inorganic elements, owed much to the earlier work of the Dokuchaev school and also displayed overlap with the work of Grigor'ev. Berg's efforts to detail the Soviet Union's physical-geographic/landscape zones (e.g. Berg, 1938a, pp. 11-12) embodied his understanding of landscape as

> a community of a higher order, combining and unifying in itself from one side communities of organisms...and to a known degree, humankind, and from the other side – complexes of inorganic phenomena: the form of relief, accumulation of water, and climatic factors...'.

Berg identified a range of landscape zones across the Soviet Union (e.g. 1938, p. 14). Each landscape zone was subsequently discussed in terms of a range of interrelated natural factors including that of climate.

Berg's work on climate moved beyond a reflection on its role in the formation of particular types of landscape to include more specific work on climatic zones (Berg, 1958)[1], and this built purposefully on the work of individuals such as the aforementioned Hettner, plus W. Köppen and A. Penck, as well as detailed investigations of climatic processes (e.g. Berg, 1938b). Furthermore, his 1947 book Klimat i zhizn', which was a second, heavily revised, edition of his earlier 1922 publication, reflected on the intimate connections between climate and both organic

[1] Note, the original version of this publication was published in 1925 in the Izvestiya geograficheskogo instituta, No. 5.

and inorganic nature. In the preface to the 1947 edition, Berg stated that the main aim of the book was

…to highlight the influence of a changing climate on relief, vegetation, fauna, soil and, in general, on nature.' (Berg, 1947, p. 4)

He then proceeded to explore a range of themes including the recent warming of the climate in the northern hemisphere, aspects of climate change in the past and the connections between climate change and the level of the Caspian Sea. Berg's opening chapter on the recently observed warming period, notable during the early part of the twentieth century, combined with later chapters on historical patterns of climate change, drew attention to the dynamic nature of climatic phenomena over both the short- and long-term, and indicated the readiness of Soviet geographers to embrace such dynamism as the norm rather than the exception. Berg's reflection on contemporary climate change events was also interesting for its effort to draw from a range of both physical and biological indicators (for example, the movement of fish species) in order to determine the exact nature and consequence of the warming process.[2]

The geographer A.A. Grigor'ev started to work purposefully on a complex approach to the physical geographical environment during the 1930s influenced strongly by the prevailing ideological emphasis on dialectical materialism. Climate inevitably formed a significant and integral element of this work. As with Berg, Grigor'ev traced the conceptual roots of his endeavour to the work of Dokuchaev, in particular. For Grigor'ev, Dokuchaev had provided physical geography with two fundamental laws, namely, the law of 'wholeness and the un-breakability of the geographical environment' and the law of geographical zonality (Grigor'ev, 1957, p. 3). A prime task of Soviet physical geography was therefore to determine the specific processes which underpinned this evident 'wholeness' (*ibid*. p 4) and, linked to this, geographical zonality. Beginning in 1938, Grigor'ev embarked on an ambitious effort to work through the main physical-geographical belts of the earth's surface in order to delineate the nature and intensity of the dominant physical processes flowing through the different belts and to outline the 'typical balance of substances and energy'. The 1938 publication focussed on the earth's equatorial belt and this was followed by the tropical belt, temperate belt and so on, although it was his later work on the sub-

[2] Berg had explored the influence of climatic oscillation on fish migration in a 1935 article published in Problemy fizicheskoi geografii (see Berg, 1962).

arctic region which received most acclaim (1946; 1956).[3] Grigor'ev's analysis of each physical-geographical belt followed a similar approach encompassing key elements of the physical-geographic environment such as flora, fauna and soil formation as well as reflecting on the balance of substances and energy characteristic of each belt.

Thus, for Grigor'ev, climatic processes were integral to an understanding of the nature and character of the physical-geographical processes at the earth's surface. More specifically, he highlighted the formative role of the interplay between incoming heat energy and yearly precipitation levels in determining the distinct zonal patterning advanced by Dokuchaev (see following section). As he noted in the concluding section of the 1956 edition of Subarktika,

> In [the subarctic] belt, just as in the temperate, tropical and equatorial belts of both hemispheres, at the basis of the particularities of the structure, dynamic and development of the geographical environment of the zones lies the magnitude of the yearly radiation balance of the earth's surface and the quantity of the yearly precipitation and correlation between them (the extent of their proportionality). (Grigor'ev, 1956a, p. 205)

Climate and geographical zonality

While the earlier work of Dokuchaev had provided a general starting point from which to consider the character of geographical zonality, it was evident that the precise nature of the boundaries between different geographical-climatic regions required greater attention. In other words, while the latitudinal pattern of distinct zones was evident at a general level, it was proving difficult to account for the more complex patterning evident on the ground (Grigor'ev, 1957, p. 7). Linked to his aforementioned work on the physical-geographical environment, Grigor'ev played an influential role in advancing greater insight here in collaboration with the climatologist M.I. Budyko. According to Grigor'ev,

> The further work of M.I. Budyko showed that the relationship of the yearly radiation balance of the Earth's surface to the quantity of heat necessary for the evaporation of the yearly total of precipitation, represents a climatic index, the isolines of which coincide well with the borders of the main geographical zones. (Grigore'v, 1956b, p. 351)

[3] Grigor'ev, A. A. 1946. Subarktika: Opyt kharakteristiki osnovnykh tipov fiziko-geograficheskoi sredy, Izdatel'stvo akademii nauk SSSR, Moscow/Leningrad

More specifically, the two of them advanced a *radiation index of dryness*[4] (based on the earlier quantitative work of Budyko) which attempted to capture the corresponding interplay between solar radiation and precipitation/moisture. This approach

> …established that the distribution of geographical zones corresponds to the definite gradation of the quantity of heat as a fundamental energetic factor, the quantity of moisture and the correlation of the quantity of heat with the quantity of moisture (Grigor'ev and Budyko, 1956, p. 129).

Furthermore, it suggested that the specific correlation of heat and moisture could result in a similar value for the radiation index of dryness at different latitudes thus giving rise, due to the intimate connections between moisture availability in soil and bedrock and the resulting character of key 'biotic'[5] (organic) components of the geographical environment, to 'periodically' repeated vegetational and soil structures. (Grigor'ev, 1956b, p. 353; see also Grigor'ev and Budyko, 1956).

Heat and water regime of the earth's surface & notions of climate as a modifiable natural phenomenon

The early post-war period was a difficult time for Soviet geography, with the Presidium of the Soviet Academy of Sciences declaring the work of the Institute of Geography as 'unsatisfactory' in 1950, resulting in more emphasis being placed on its applied work (Kotlyakov, 2008, pp. 22-23). The 1955 Congress of the Geographical Society of the USSR provided additional impetus for this initiative and amongst its subsequent recommendations/tasks for Soviet geography was included

> [T]he comprehensive development of scientific research linked with the directed transformation of natural conditions and the all-rounded utilisation of elemental forces of nature in the interests of a further increase in the productivity of the socialist national economy (Gerasimov, 1956, p. 16).

This particular emphasis had earlier encouraged geographical input into work concerning the *Great Stalin Plan for the Transformation of Nature*, with its intention to modify the local and regional climate of the European steppe in order to improve its agricultural potential. As noted by Stephen Brain (2010, p. 2) the Plan represented 'the world's first state-directed effort to reverse human-induced climate change.' This shift in the emphasis placed on Soviet geographical practice, while not radically

[4] Radiation index of dryness – R/Lr. Where R – yearly radiation balance of the earth's surface, L – latent heat of evaporation and r – yearly precipitation (Grigor'ev and Budyko, 1956, p. 129).
[5] See Grigor'ev, 1956b, p. 352.

different from the pre-war situation, nevertheless provides an important backdrop to subsequent developments with respect to both its conceptual and applied work.

For the purposes of this paper, a key development concerns related work on the heat and water balance at the Earth's surface (Kotlyakov, 2008, p. 25). Such work emerged strongly during the course of the 1950s with the general backing of the Academy of Sciences. Furthermore, the earlier work by Grigor'ev on general physical-geographical laws provided a basis for this initiative, although it was noted that the application of his ideas had been undermined by a lack of relevant data (Budyko and Gerasimov, 1959, p. 13).[6] More specifically, work on the heat and water balance at the Earth's surface internalised efforts to develop both a deeper conceptual understanding of the interconnections between natural phenomena together with an emphasis on the applied aspects of the geographical sciences.

In order to advance this key task, Budyko and Gerasimov highlighted the crucial importance of the heat and water regime for understanding the character and nature of the physical-geographical environment,

> The main scientific idea underpinning the problem under discussion is that the heat and water balance of the Earth's surface in the natural geographical environment is as a rule the main mechanism determining the *intensity* and *character* of all other forms of *exchange of energy and matter* between the basic components of the geographical environment i.e. climatic, hydrological, soil-forming, biological etc.

They went on to state that

> Therefore, by studying the mechanism of the exchange of heat and water and purposefully influencing it via the assistance of various natural and artificial measures, it is possible to obtain premeditated and stable transformational changes in the course of the manifold natural processes and phenomena on the earth's surface. (Budyko and Gerasimov, 1959, p.4)

The final part of the paper by Budyko and Gerasimov moved on to reflect on the ways in which a better understanding of the heat and water regime at the Earth's surface could facilitate more effective interventions by society with respect to drainage schemes, irrigation works, shelter-belt planting etc.. Furthermore, they were envisioning large-scale transformative work, mentioning in passing, for example, the possibility of acting on the glaciers of the Arctic Ocean (indeed, this particular issue

[6] An English-language version of this paper can be found in Soviet Geography: Review & Translation, 1961, Vol. II, No. 2, pp. 3-12.

received considerable attention during this period). In a similar vein, Davitaya (1956) had earlier reflected on the various ways in which climate might be modified at the local-scale in order to effect positive improvements in agricultural activity. To some extent, the final section of the Budyko/Gerasimov paper was also a critique of the earlier transformative work linked to such initiatives as the noted *Great Stalin Plan for the Transformation of Nature*. Without mentioning the plan directly, they suggested that many recent proposals to alter the climatic conditions over large areas had lacked the necessary understanding of the heat and water balance thus undermining their overall effectiveness.

Climate and the potential deleterious influence of human activity

The noted developments during the 1950s within Soviet geography therefore revolved generally-speaking around the twin concerns of gaining greater empirical and conceptual insight into the interrelations between natural phenomena at the earth's surface and utilising this knowledge for the benefit of resource utilisation. As such, it echoed in part comparable initiatives in the West evident in the early post-war period linked, for example, to the emergence of ecosystems ecology, which were similarly predicated on the twin objectives of furthering understanding of natural systems in order to facilitate improved resource management (e.g. Oldfield and Shaw, 2013; see also Kwa, 1987). The central importance of geography to the task of ensuring greater understanding of natural processes so as to expedite resource use was underlined in influential publications such as the journal Voprosy filosofii (e.g. Fedorov, 1958, p. 137). Fedorov's 1958 article in this journal is notable for its associated efforts to reflect upon the determined as well as involuntary influence of humankind on weather and climate (Fedorov, 1958, p. 143).[7] As part of this, he highlighted the work of the aforementioned climatologist A.I. Voeikov concerning the (often deleterious) impact of late tsarist society on the wider environment. Fedorov moved on to note the influence of human society on the chemical state and electrical composition of the atmosphere, the former exemplified by a noted increase in the emission of (anthropogenic) CO2 and its associated ability to alter the balance of radiant energy,[8] and the latter linked to the massive release of energy from the hydrogen bomb explosions. Reflecting on this, Fedorov noted,

[7] It is interesting to note that Fedorov refers to the UK's efforts during the Second World War to artificially encourage the dispersion of fog at airports via the heating of the air as an example of previous attempts at influencing weather conditions (Fedorov, 1958, p. 138).

[8] It is also noteworthy that he cites work from the American Journal of Physics to support this point (*ibid.*, p. 143).

> Consequently, human society has already become an involuntary climatological factor. While its influence on climate is currently not great, it is however growing with a quick tempo and it is possible to fear that we risk revealing significant and perhaps undesirable and difficult to amend changes in climate before we learn to anticipate them. (Fedorov, 1958, p. 144)

Fedorov's article appears to be one of the earliest direct engagements with the problems associated with climate change and, more specifically, anthropogenic climate change in the Soviet Union. However, this theme received more concerted discussion and debate from the early 1960s. Two meetings of particular note took place in Leningrad in April 1961 and June 1962, both of which were organised by the Main Geophysical Observatory in tandem with the Institute of Applied Geophysics and the Institute of Geography and brought together a range of Soviet scientists, including geographers, in order to discuss the 'problem of the transformation of the climate' (see Gal'tsov, 1961; Gal'tsov and Cheplygina, 1962). These meetings covered significant ground and included papers on general approaches to climate change, climate change during the quaternary period, the relationship between artificial reservoirs and climate, the melioration of climate, as well as a number of papers on the problem of changes in ice cover and climate and the relationship between the two. The work of M.I. Budyko in particular would further develop understanding in this general area during the 1960s-80s. For example, a 1969 paper entitled Climate change reflected, amongst other things, on the consequences for the global climate system of increased economic activity and growing levels of energy production (and its related heating effect) noting the potential impact on rainfall regimes, loss of polar ice and rising sea levels.

Concluding remarks

In this short paper, I have attempted to highlight the key role of climate in both the conceptual and applied work of Russian/Soviet geographers which would also provide a significant resource for later understandings of climate change as they emerged during the 1960s-80s. The post-1945 period represented a period of significant development in this regard. Four main conceptual trends have been identified during the period 1945-early 1960s and these include: (i)climate as a historical, complex and dynamic process with scope for change over both the short- and long-term, (ii)climate as a determining factor in the spatial/zonal patterning of distinct physical-geographical regions, (iii)climate as a modifiable set of natural processes, and (iv)climate as set of natural processes susceptible to deleterious anthropogenic influence. These trends were rooted in earlier work linked to

individuals such A.I. Voeikov and V.V. Dokuchaev and pointed towards the complex understanding of climate and associated processes held by Soviet geographers during the early post-war period.

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