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Ideal types and modeling: epistemic bases against "universalistic truths" about global warming

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Abstract: In this text we propose to analyze the epistemic possibilities of the ideal types for use their signification in the practice of numerical climate modeling; we will argue that the scientific concepts and particularly the models and all more the climatic models should have the epistemic status of ideal types. The plan is translate the methodological topic of ideal type into the numerical climate modeling topic to put forward a proposal that disempowers the universalistic pretentions of the cognitive coinages of contemporary science and particularly about the climatic modeling, so that laying down a scientific self-control mechanism synthesizing subjective explanations and objective validation processes becomes feasible. From these reflections, we consider it would be appropriate that the modelers and their institutions assume the climatic modeling keeping a space of scientific self-control allowing epistemological apertures instead of nomological conclusive impossible tasks about global warming.
Key words: ideal type, scientific explanation, objective validation, modeling and simulation, climatic modeling.
Resumen: En este texto nos proponemos analizar las posibilidades epistémicas de los idealtipos para emplear su significación en la práctica de modelación numérica climática; sostendremos que los conceptos científicos y particularmente los modelos y aún más los modelos climáticos deben tener el estatuto epistémico de idealtipos. El plan consiste en traducir el tema metodológico del idealtipo con el de la modelación numérica del clima para intentar avanzar una propuesta que depotencie las pretensiones universalistas de las acuñaciones cognoscitivas de la ciencia contemporánea y en particular de la modelación climática, para que sea factible establecer un mecanismo de autocontrol científico que sintetice explicaciones subjetivas y procesos de validación objetiva. A partir de estas reflexiones, consideramos que sería adecuado que los modeladores y sus instituciones asumieran la modelación climática, guardando un espacio de autocontrol científico que permita aperturas epistemológicas en lugar de imposibles tareas nomológicas concluyentes sobre el calentamiento climático.
Palabras clave: idealtipo, explicación científica, validación objetiva, modelación y simulación, modelación climática.

Introduction[1]

More than one hundred years ago Max Weber was interested in elucidating the particularities of the European occidental culture in his time (by the end of XIX century and early XX), for which he found himself in the need to clarify the working method, its episteme and validity, particular to the science of institutions and human cultural occurrences. To do so, he took inspiration from Jellinek's (1903) work on the ideal types in the analysis of the State, advancing himself in a scientific methodology of elliptic and indirect approach to the empirical phenomena, called ideal types (idealtypus).

Grosso modo, the problematizations of the ideal type concept subject to debate oscillate between nomological and epistemic interpretations. The nomological interpretations of ideal type come from sociological discussions, while the epistemic from gnosiology. In the former the interest has prevailed in founding and establishing the categories that best give an account of the social and cultural phenomena; whereas the greatest concerns in gnosiological research have been the attempts to clarify the ways of scientific explicitness.

For instance, Rogers (1969: 87) indicates that "it is difficult, if not impossible, to build an accurate definition of the ideal type simply because the concept itself is not accurate"; Secher (1962) considers that the ideal type is an instrument to classify and an unsuitable description of social phenomena; Abel (1929) identifies two primary species of ideal type (generalizations and individualizations), but he does not offer a definition as such. Von Schelting (in Rogers, 1969)[2] expressed dissatisfaction with the incomplete and confusing development of ideal types such as the fact of having distinguished a number of concepts under the same term.

Parsons (1968: 714) characterized the Weberian work in the idealistic tradition and Kantian dualism, by placing it in the separatist approach "of natural sciences and the sciences of human action and culture". He accused Weber of limiting research to the concrete description and explanation, and specifically points out that "this stance was formulated saying that historical reality is 'irrational'. The general concepts, on the other side, are rational, so they cannot coincide" (Parsons, 1968: 719).

1 The author is thankful for the comments of Drs. José María Aranda Sánchez and Ismael Ledesma Mateos, as well as those of David Tapia Martínez. A full development of the topic of climate numerical modeling in Mexico will be published in "Historia de la Modelación Climática Mexicana: Estelaridad, Planeación y Subordinación" [History of Mexican climate modeling: prominence, planning and subordination] (Arellano, 2015b).

2 The reference offered by Rogers on Von Schelting is: Von Schelting, Alexander: Die logische Theorie der historischen Kulturwissenschaften von Max Weber und in besonderen sein Begriff des Idealtypus "Archiv für Sozialwissenchaft und Sozialwissenchaft und Sozialpolitik", vol. 49, p. 623 ss., 1922.

Unfortunately, Parsons did not consider the Weberian dissertation on the construction of the objective validity of knowledge, in which it is clear that what cannot agree is reality with the concepts and that irrationality is, in the research of culture, the distance between two types of research, namely: logical-conceptual research and empirical research on reality. Regrettably, he did not study that which is not residual analysis, to assimilate that the ideal type is an epistemological instrument to approach reality by means of empirical research exercises.

Other authors have produced epistemic interpretations of ideal types, helping to understand this notion and facilitating the methodological instrumentation. Among them we find Freund (1965), who makes thorough introduction to the Weberian work and the ideal types, explaining the methodological role performed by the ideal types in building scientific knowledge and its objective validation.

Hempel (1952a), on his own, retook the idea of ideal type for his works on the philosophy of scientific explanation from the standpoint of logical empiricism, recovering in "Ideal Types and Explanation in Social Sciences" three sorts of ideal types: the classificatory, the extreme —which might work as referential points— and the Weberian types. Indeed, in the aforementioned text, Hempel considered that the explanatory possibility of the ideal types is not an attribution specific to social sciences, but it can be applied to the explanatory strategies of natural sciences.

For us, the Weberian perspective contains an unavoidable stance of political epistemology. Scientific knowledge is a cognitive quality exclusive to certain societies and represents a form of value interpretation specific with the world. Hence —as Freund states retaking Weber—, "judgement educated in science shall be equally applied to the objective interpretation of its signification by culture, correctly assessing the scope and limits of knowledge without falling into the exaggerations of scientism or the traps of irrationalism (Freund, 1965: 51). The Weberian political scientific stance is characterized by continuous self-reflection on the scope of scientific knowledge, on the means to accomplish it and on its limitations.

In this article we analyze the epistemic possibilities of the ideal types to use them in the domain of numerical climate modelling. Making use the epistemic qualities of the ideal type and taking them as a lowest common denominator of the equivalence of social natural and political sciences —as weber himself had considered—, we will see that the scientific concepts, models and more so, the climate models can legitimately have the status of ideal type.

The plan is to link and translate the methodological topic of ideal type with that of numerical climate modelling in order to attempt an putting forward a research

proposal that restrains the universalistic pretensions of cognitive coinages of the current numerical climate modelling, so that it is feasible to establish a mechanism of scientific self-control that summarizes subjective explanations and objective validation.

We understand that this exercise to translate ideal types and numerical modelling will be strange for both sociologists[3] and scientists, in general, and numerical modelers, in particular; thus, there is need to recognize as legitimate the epistemological closeness of the methodology of sciences in Weberian culture with those of the climate nature to go on to demonstrate its equivalence and later on, to instrument the analysis of ideal types to numerical climate modeling. This aspect will be applied to the analysis of the practice of numerical climate modeling in Mexico in later works.

To conduct this epistemic translation, we will try to give an account of the matrix-epistemological pertinence of the methodology of ideal types and numerical modeling, making it clear they are part of the same heuristic practice, with the same cognitive possibilities and similar validation problems. Then, we will try to establish the connection and links that allow translating the methodology of ideal types with that of numerical modeling.

The exercise consists in explain very tightly the characteristics of the ideal types showing the characteristics Weber assigns them; namely: objective validity of knowledge, relation between objective truths and value judgments, methodological equality between natural and cultural sciences; as well as the exposition of the method of the ideal types, models and mathematical models. And finally, a reflection on the cognitive and epistemological usefulness of modeling that helps elucidate the question: shall numerical models be valid representations of reality or heuristic elements to acknowledge reality?

Objective validity and axiological neutrality

Weberian sociology promoted the dis-enchantment of the world, as that way to become aware of the demystified social action of idealized interpretations on the world, allegedly endowed with objective validity, impregnated with values of the

3 In his text "Teoría y categorías en Marx, Durkheim y Weber" [Theory and categories in Marx, Durkheim y Weber], Díaz-Polanco (1997) has performed the typical reading that opposing concepts and reality, gives the ideal type the statute of categories devoid of historic content. According to Díaz-Polanco (1997: 71), in Weber "there is no theoretical elaboration of the real-concrete. Conversely, there is a reduction of reality to its essential elements"; suggesting that the ideal type is a reduced category of reality, when in reality Weber did not propose that ideal types were a reduction of reality.

must-be and raised to the statute of norms. In parallel, Weberian epistemology promoted the disenchantment of scientific methodology, by means of criticizing one of the most valued conditions of science: the objective validity of empirical knowledge, and mainly of its production.

Some revealing phrases of this disenchanting proposal of the objective validity and cognitive elaboration evocate the following:

> The objective validity of every empirical knowledge has as a foundation, and only on this: any given reality is ordered according to categories that are subjective in a specific sense, as it represents the presupposition of our knowledge while these categories are linked to the presupposition of the value of truth that only empirical knowledge can provide us with. (…)
> Science (...) can only offer: concepts and judgements which are not the empirical reality, neither do they copy it; however, they allow ordering it by means of thinking in a valid manner (…) in the sphere of social and empirical sciences of culture, the possibility of knowledge full of meaning (…) is linked to the utilization of viewpoints of specific particular character, which ultimately, are oriented according to value ideas (…). The "objectivity" of the knowledge of social sciences heavily depends on this: on the fact that what is empirically given is constantly aligned on value ideas, the only that confer cognitive value; (…). The irrational reality of life and its capability for possible significations are inexhaustible; also, the concrete structure of the relation to values remains fluctuant, subject to the possible variations of the dark becoming of human culture (Weber, 1965a: 213-214).

For Weber, the validity objectivity of scientific knowledge is a value proper to modern society, but one with no universal essence whatsoever, regardless how much scientists speak of universal truths. He was a fervent opponent to axiological neutrality in scientific practice. In his 1917 essay, "Essai sur le sens de la «neutralité axiologique » dans les sciences sociologiques et économiques' (1965)", he pointed out the difficulty of purging axiological from knowledge production and the separation of the empirical verification in relation to the axiological assessment of social practice (Weber, 1965d).

Weber did not want to avoid value judgments in scientific debate, but to submit them to an empirical analysis, considering that criticism should not be stopped before value judgments because of the fact that knowledge is based, ultimately, on certain ideals and on "subjective" elaborations. In any case, the issue was to answer the meaning of scientific criticism of the ideals and value judgments; because of this, in his essay "L'objectivité de la connaissance dans les sciences et la politique sociales" (Weber, 1965), he considered that "scientific method of dealing with value judgments not only limits to understand [verstehen] and relive [nacherleben] the desired objectives and the ideals that work as a foundation; linked to this, he

intended to teach us to present a 'critical' judgment on them" (Weber, 1965a: 154). Indeed, according to him "one of the essential tasks of any science of cultural human life is that of opening intellectual comprehension to 'ideas' for which men have fought and will continue fighting, regardless of the content of reality or of appearance (Weber, 1965a: 155).

Epistemic equality of natural and cultural sciences

As it occurred with the anti-secessionist treatment between objective validity and values, Weber has an anti-separatist stance between natural and political sciences. He alludes to social sciences and sciences of culture as if they were references to natural sciences or properly political, because of the simple reason that for him, these are not distinguished by quantification/qualification nor by the definition of regularities employed in the concept of law.

This inseparability has a substratum its understanding of contents that allow go from natural to cultural sciences without difficulty and mobilize the same epistemic parameters for some and for the others; mainly as adherence to the principle of causal explanation of chaining of singular facts and their signification. For him, "significant" interpretations are mere imputation hypotheses, subject to verification by any means; they are utilizable hypotheses and represent subjectively significant "chains of reasons".

For Weber (1965c: 437-438), comprehension and explanation are not necessarily separated; on the contrary, they are related as follows:

> The causal chains in which the interpretative hypothesis introduce motives oriented in a "rationality by finality" mode are, under determinate favorable circumstances and particularly for all that touches the latter, susceptible to be directly verified by statistics, and in those cases it is possible to offer a (relatively) optimal weighty reason of their validity as "explanations". Contrarily, statistical data (also including the largest amount of data from "experimental psychology"), at least every time they offer indications on the development or the consequences of a behavior that includes elements that can be interpreted by means of comprehension, are not "explained" to us unless, in the concrete case, they are in fact significantly interpreted.

Webber expressly opposed against the deduction of reality and the elaboration of laws as scientific ideal to pursue, uttering the need for causal explanations as a common denominator of all sciences, in the following way:

> The opinion according to which the ideal toward all knowledge tends or might tend, and this comprehends the sciences of culture, even though in a distant future, would consist of a system of propositions from which reality could be "deduced". (…). We know that one of the masters of sciences of nature has deemed it possible to characterize the ideal objective (practically unrealizable) of such elaboration of

> cultural reality as "astronomic" knowledge of the phenomena of life. Although these issues have been the object of intense discussions, we will save the effort of considering it in our turn. To begin with, it is plain to see that the "astronomic" knowledge that we consider is not whatsoever knowledge of laws; on the contrary, she takes from other disciples, mechanics for instance, the "laws" that she uses as presuppositions of her very work. As for astronomy, she is interested in the following aspect: what is the singular effect that the action of these laws produces on a singular constellation, of the fact that these singular constellations are the ones that have importance before our eyes? Each one of these singular constellations, which "explains" to us or that foresees, evidently, is not causally explained, but as a consequence of other antecedent constellation equally singular. Therefore, it is possible for us to date back in the greyish haze of the distant past to the reality which these laws apply to remains equally singular and refractory to a deduction from laws. A cosmic "original state" that did not have a singular nature or that was to a lesser degree than the cosmic reality of the world is obviously a thought stripped of meaning. Well now, in our discipline, do not radical analogue representations insist on the suppositions of the "original states" of economic and social order, stripped of all historical "accident", from which it is inferred, sometimes natural law, sometimes observations verified on the "primitive peoples" (…), from which would come the singular historic development by means of some sort of fall into concrete?
>
> The starting point of our interest in social sciences is indubitably the actual configuration, therefore unique to cultural and social life that surrounds us, when we hold on its universal configuration, which is no less singularly formed and developed from other social conditions of civilization that, of course, are singular in nature. It is clear that we also face the situation we have just commented about astronomy, taking it as a limit case (procedures that the logicians also regularly with the same purpose), and even in specifically more marked proportion. If for the astronomy of celestial bodies are not taken into consideration for our curiosity but for their quantitative relations susceptible to exact measurement, in social sciences, on the contrary, it is the qualitative aspects of the events what concerns us (Weber, 1965a: 173).

For Weber (1965a), the distinction between the sciences of nature and sciences of culture is not to be found in different essences; conversely, the rational study of social reality was born in close relation with the modern development of natural sciences, it keeps close to the former in relation to their way of considering things. This is to say, as they share their considerations both sciences translate the values they carry, the technicities they develop, the world-views they convey and the possibilities of rationalization of reality.

Weber refers to the natural sciences in the sense of natural proper and natural exact. This way, when he refers to the scope of social sciences in relation to the natural ones, he states that "the 'economic laws' with no exception, not of

'laws' in the rigorous sense of exact natural, but of adequate causal connections, expressed in rules and consequently, of an application of the category of 'objective possibility' that we do not have to consider in detail here, do not undermines at all the preceding affirmation" (Weber, 1977: 69).

The only difference that Weber conceded social sciences over the natural refers to the understanding by reviviscence. According to him, "in social sciences, we deal with mental-order phenomena which have to be understood by means of 'reviviscence'. And this last task is specifically different from that of the formulas of the exact knowledge of nature intend or require to solve in general" (Weber, 1965a: 173). But even in this case, only determined disciplines, such as psychology or anthropology, require a reviviscent interpretative position before certain phenomena of natural and collective order.

Emphatically, Weber (1965a: 173) considers that differences between natural and cultural sciences are not fundamental, as he expresses:

> these differences are not as categorical as they seem at first sight. Natural sciences —an abstraction of pure mechanics— cannot do without the notion of quality, besides, we find in our very own dominion an opinion –indeed erroneous- according to which, at least the phenomenon, fundamental for our civilization, of the financial traffic would be quantifiable and because of this reason it would be no longer taken under the shape of "laws". Finally, it would depend on the greater or lesser amplitude of the concept of "law", so that we can include regularities that probably are not susceptible to be numerically expressed, because they are not quantifiable.

In the previous quotation, Weber discusses the significant quality of natural sciences, the quantification and establishment of laws of unquantifiable regularities and he goes on to discuss the de-Cartesian pretension of element decomposition for their simplified analysis applied to the sciences of the spirit, of then tentative to turn psychology into the "chemistry" of psychic foundations of social life.

But the Weberian reasons for distinctionless between the sciences of nature and of culture will be shown in the following argumentation on the ideal types, models and mathematical models. We will use this distinctionless to think that the Weberian epistemology of the ideal types can be applied to numerical modeling.

The concept of ideal type and the empirical study of reality

Weberian sociology proposed "the disenchantment of the world", and accordingly, the methodology of the ideal types would allow opposing the objectivist and rationalist attempts of knowledge. Weber (1965a: 148) was in the need of clarifying "the working method, his way to produce concepts and their validity", particular to the sciences of institutions and cultural human events. To do so, he applied the Jellinekian notion of ideal type, this allowed giving an account of empirical knowledge explained with categories from reason.

This methodology starts with the elaboration of rationally organized subjective explanations; then, there are some heuristic exercises, capable of mediating explicatory hypotheses of empiric cultural phenomena; finally, we approach the distance between those rationally organized explanations in relation to the objects found in empirical researches.

Taking the stances of the "representatives of the historic school" as the object of reflections, Weber criticized their persistence in considering that the ultimate goal of every science:

> Will consist in ordering their matter in a system of concepts, whose content will be progressively establishing and perfecting by means of the observation of empirical regularities, the construction of hypotheses and their verification until (…) from this came out the "perfect" science, in consequence deductive (Weber, 1965a: 209); in which historical and inductive work would be a preceding task.

In like manner, he criticized the a priori assignation of the concepts elevated to the category of representative copies of the "objective" reality. Weber (1965a: 209) wielded all the epistemological tradition from Kant, according to which "the concepts constitute intellectual means oriented to help the spirit take control of empirical data.

And suggested those "representatives" "inverting the meaning of the relation between the concept and the historical work, (and make them understand) the fact that concepts are not the objective, but the means of knowledge of significant relationships under singular viewpoints" (Weber, 1965a: 209).[4]

4 Weber does not follow Dilthey in the project to separate sciences of nature from human; while, he considered the interpretative comprehension of human action important, but he does not release it from the causal explanation of cultural phenomena. In Dilthey, the proposal is clear, to reach the understanding of nature by means of the concept and of the spirit by means of experience. It is not very clear in Webber, nevertheless; as neither is it what sciences of nature are sciences of causes and those of spirit of ends.

From Weber's (1965c: 436) standpoint:

> The objective rationality is useful for the sociology of ideal type in relation to empirical activity; rationality according to ends works as an ideal type in respect that which is significantly comprehensible from the psychological viewpoint; and what is significantly comprehensible works as an ideal type in relation to the activity in which motives are incomprehensible. And, in virtue of the comparison with the ideal type it is possible to determine the irrationalities (in every sense of the term) causally important to the effects of the causal imputation.

The deep Weberian disenchantment of science consists in becoming aware of the limits of the validity of the concepts wielded as scientific truths. For Weber (1965b, 209), it is clear that the content of historical concepts is variable, so it is necessary to formulate them in an accurate manner, according to him,

> due to the unavoidable variation of the ruling value ideas, there cannot be truly definitive historical concepts, susceptible to be considered final and general objectives, admitting that, indeed because we have built rigorous and univocal concepts from the singular perspective that they orient each work, one might become wide aware of the limits of their validity.

Then, part of recognizing the limits of the validity of concepts is due to their subjective construction. The solution to this epistemic challenge, in the historiographic domain, consists in "the need to cautiously maintain the character of ideal type at the time of using them and do not mistake ideal type with history (Weber, 1965b: 209).

The ideal type is an epistemic resource, defined as:

> a conceptual construction for the mediation and systematic characterization of individual connections, this is to say (…) the formation of typical concepts in the sense of excluding the "contingent" finds its own place also in the case of historic individuals (…) those gender concepts we find (…) as elements of historical expositions and of concrete historical concepts can be configured as ideal types by means of abstraction and enhancing some of their essential conceptual elements (Weber, 1977: 89).

For Weber (1977: 83), an ideal type:

> has a concept of purely ideal limit concept, in relation to which reality is measured and compared in views of clarifying certain significant elements of their empirical content. Such concepts are formations in which our fantasy, disciplined and oriented in views of reality, deems adequate. The ideal type is, in particular in this function, the attempt to apprehend, in genetic concepts, historical individuals or their singular elements.

Weber (1965a) intended to design the notion of ideal type as a part of the causal imputation process that is not a hypothesis in itself, but helps producing them. On the other side, it is not an exposition of the real, but proposed to provide the exposition with univocal expression means.

The way to obtain an ideal type is:

> unilaterally stressing one or some viewpoints and chaining a myriad of phenomena in isolation, diffuse and discrete, which on occasions, one finds in large numbers or small numbers and over various places, ordered according to the unilaterally chosen preceding viewpoints to produce a homogenous frame of mind. Nowhere will we empirically find a similar frame in its conceptual purity: it is a utopia. (…). Applying prudently this concept yields a specific purpose that is expected to benefit the research and the clarity (Weber, 1965a: 191).

As for historical work, Weber (1965a: 143-144) states:

> the ideal type is a frame of mind, it not historic reality nor the "authentic" reality, neither does it work as a schema in which reality could be ordered as an example. It has a special significance of purely ideal limit concept, with which reality is "measured" to clarify the empirical concept of some of its important components, and with which it compares with. These concepts are images in which we build relations, using the category of objective possibility that our imagination shaped and oriented according to reality deems adequate.

Weber opposes the idea that knowledge considered objective becomes "must-be" axiologically strong. Here Weber (1977: 84) makes an advantageous use of the confusion between history and theory to explain the confusion between knowledge and must-be, pointing out that either:

> because it is considered fixed in those theoretical conceptual frameworks the "authentic and actual" content, the "essence" of historic reality, or else because they are used as a Procrustean bed in which history has to be forcefully introduced, or because the "ideas" are hypostasized as an "actual" reality that remains in the background of the flowing of phenomena, as "actual forces" that manifest in history.

According to Weber (1977: 90), "the ideal types have a complication introduced by the naturalist prejudice according to which the goal of social sciences must be the reduction of reality to 'laws', with the help of the concept of the 'typical'". The greatest danger he perceived on he relations of ideal types and reality was that they were mistaken for one another and he insisted on invigilating the limits of significance and criticism to conceptual construction. For him, "the value of great tentative of conceptual constructions in our science (social sciences) consisted (…) in evidencing the limits of signification of the viewpoint that supported them"

(Weber, 1965a: 208-209); and "the most considerable progresses in the domain of social sciences are positively linked to the fact that the practical problems of civilization displace and take the form of criticism to the construction of concepts" (Weber, 1965a: 208-209).

For Weber (1965c), the ideal type allows heuristically likening the interpretations of reality and judgments of causal imputation and their possible verification, even in the cases with the most "evidence". The mechanism should submit the significant interpretations to all the possible verifications resorting to the means employed in any hypothesis.

The hypotheses —Weber (1965c: 438) says —:

> Acquire the validity of utilizable hypotheses under the condition that we can have on a variable "opportunity" degree following each particular case, indicating we are in the presence of "chains of (subjectively) significant reasons". The causal chains in which the interpretative hypotheses introduce reasons rationally oriented by finality are under certain circumstances favorable and susceptible to be directly verified by statistics, and in this case it is possible to offer an approving reason (relatively optimal) for their validity as "explanations". Inversely, statistical data (among which numerous data from "experimental psychology"), at least each time they give indications on the development or consequences of a behavior implying elements that can be interpreted by comprehension, are not "explained" in our eyes only under the condition of being, in the concrete case, significantly interpreted.

In the previous quotation, it is clear that for our author causal chains can be statistically verifiable, and inversely the comprehensive interpretation is epistemologically attained on condition of reaching a significant explanation.

Ideal types, scientific concepts and modelling

For the ends of this work, the Weberian approach to the topics in which the use of model has been emblematic is interesting; such is the case of economics and numbered natural sciences. In the essays on the methodology of sciences of culture, Weber freely moves with no boundaries from the sciences of nature to those of culture, in virtue of the matrix from judgments of value and the pretending judgments of objective validity. The following phrase of the first essay ("L'objectivité de la connaissance dans les sciences et la politique sociales") makes this matrix evident, when he considers that the immediate and single objective of the discipline of political economics was the production of value judgments on certain measures of economic policy. And immediately, he comments that this discipline "has been a 'technique', more or less in the way in which clinical disciplines of medical sciences are" (Weber, 1965a: 149).

To dimension the methodological usefulness of the ideal types, Weber (1965a: 143) says:

> There is no other criterion but that of efficacy by the knowledge of the relations between the concrete phenomena of the culture, of their causal conditionality and their signification. Therefore, the construction of abstract ideal types should not be considered as an objective, but only as a means for knowledge.

This was expressed by Webber in the essay "L'objectivité de la connaissance dans les sciences et la politique sociales" (1965a: 192), as follows:

> What is now the meaning of these ideal-type concepts for an empirical science such as we intend to practice it? "To begin with, we would like to insist on the need to rigorously separate the frames of thought we are dealing with here, which are "ideals" in a purely logical sense, of the notion of must-be or of "model". Indeed, it is nothing but constructions of relations that sufficiently justified in the look of our "objectively possible" imagination and that seem suitable for our nomological knowledge.

Weber (1965a: 144) closes the cycle on the usefulness of ideal types supposing their uselessness considering that:

> If the historian (in the broad meaning of the term) opposes the tentative of formulating ideal types excused by the supposition that they are "theoretical constructions", this is to say, useless or superfluous operations for the concrete ends of knowledge, follows a general rule or else applies conscious or unconsciously other analogous constructions without explicitly formulating them and with no logical elaboration, or else remains embedded in the sphere of what was "vaguely felt".

For Weber, the mathematical model is nothing but a particular and limited form of knowledge, this method is not efficacious but in its determinate conditions and in virtue of certain postulations. It does not offer any superiority. On the contrary, mathematical work, as any other scientific work, is endless, it does not have an end; it will be presumptuous to present it as finished, as all who see in the mathematical procedure the methodological ideal have been forced to admit. It is true that a part of the mathematical method or deduction is nothing more than a specific vision of the world, a standpoint; on the other side, it is not reasonable to believe in the possibility of deducing the historic reality or another aspect from a concept or from pretended future general and ultimate laws (Freund, 1965). For Weber (1965a), the construction of ideal-type concepts has the function of becoming aware of the particular nature of the sociocultural phenomena and not of that which is generic.

To be fair on the scope of ideal types, Weber never made any reference to the possibility of using that tool in researching nature; on the contrary, they were used for representing social phenomena.

Hempel (1952b) is owed, from the perspective of logical positivism, the idea of using ideal types in the deductive-nomological explanation of phenomena that summon general covering laws. Hempel recognized the importance of Weber's "ideal type intentional explanations", however he states that explanations of the ideal type can be analyzed in terms of the "covering-laws" (Hempel, 1942 in Suppe, 2000: 206), which are an explanation model, according to which the explanation of an event by referring to another necessarily presupposes an appeal to general laws or presuppositions that correlate event that in order to be explained (explanandum) require events cited as their causes or conditions (explanans) (Encyclopaedia Britannica, http://global.britannica.com/EBchecked/topic/155455/covering-law-model).

The searches for similitudes of Weberian ideal types with the idealized notions of natural sciences lacks, as in the case of the social criticisms seen in the introduction to this text, passion for the search for correspondence between conceptualization and reality, mainly by sociologists, as we have seen in such introduction. However, the reception of ideal types by the epistemology of logical positivism and mainly by Hempel's formulation instrumented in an epistemic model of scientific explanation and continued by other epistemologists up to the appearance of social epistemology.

On his own, Camardi has tried to fully justify the utilization of ideal types in the sciences of nature by means of recognizing theoretical entities that, being part of the domain of idealized identities, approach the Weberian ideal type. Among these entities Camardi cites:

> The entities whose characteristics approach an idealized reference model, counterfactual or not; the theoretical-ideal imperfectly observed entities, theoretical-ideal entities defined in an incomplete manner by means of the intersections between the laws with numerous contour conditions. Science functions legitimately with all these theoretical entities, not only with natural species. And, far from adhering the realism I do not want to validate [written in first person by Camardi], it is necessary to recognize that natural species do not have a sufficient ontological substance to be logically demarcated from other idealized entities. It is not possible to sufficiently clarify its ontological status nor its semantic solidity. Indubitably, its existence is the object of a "presumption" that "implies different levels of commitment" by the scientists. Without this presumption, science would be impossible: scientific vocabulary "has terms whose extension is supposed, by convention, to constitute natural classes" (Bromberger, 1997, in Camardi, 2004: 283). Consequently, these are

> neither logically nor ontologically concepts stable epistemologically, in the sense that their properties are not defined by a valid universal logic, but only by significance and control criteria that are useful for a certain scientific community (Camardi, 2004: 283-284).

Indeed, in scientific activity, the term "ideal" colonizes, somehow, the sciences that take nature as an object; then, one speaks of "ideal gas", vacuum, "ideal conditions", etc. The same occurs when in the sciences of nature limit conditions are utilized to refer to a conceptualized entity that works as an enouncement or abstract referent in studies on realistic conditions, therefore bordering reality. When one talks of scientific model, it is clear we face an epistemic device that, in strict sense, does not have the pretensions to represent reality, but that methodological operates in the design of empirical and conceptual approaches to allude to some phenomenon in reality.

Ideal types and climate modeling

One of the largest mutations of contemporary science has been its synthesis with technologies to integrate technoscience and unfold it in all the spheres of social life, including the very sphere of technical-scientific research. One of the largest displays we can allude to refer to the synthesis of mathematics, algorithmic logic and computing, which can be appreciated in the proliferation of numerical modeling techniques that allow representing schemas and conceptual images with a high degree of "realism". Contemporary intellectual technologies applied to scientific-technological research cannot separate now from heuristic as in abstract representation.

The previous reasons explain why nowadays there are all manner of models in sciences and technologies. With the elaboration of physical models, scientists intend to examine aspects of natural phenomenon; in the mathematical models one tries to analyze relations mathematically formulated in a determinist, probabilistic, stochastic, numerical, simulated manner; in the graphical ones, the intention is to symbolize data by means of any sort of graphs; of analogies intending to project and substitute aspects of various entities; and of the conceptual models or called neuronal on tries to understand relations between concepts and phenomena; scale-models and prototypes can have the stature of models, to the extent that they aspire to accomplish any correspondence between those material models and those which take place in reality as the "scale changes".[5]

5 In the case of our own practice of the modeling techniques known as mapping of socio-technical networks, we have learnt that according to designers and programmers (Mogutov, 1998; Callon, 2001), the epistemological role of such networks is that the images resulting from the software work as heuristic elements to explain the sort and content of the relations that appear in the iconographic figures (Arellano, 2006).

Nowadays, the Weberian and Hempelian discussions on ideal types have mutated due to the advancement in mathematics, algorithmic logic and computing, and to their integration in a bean called numerical modelling and simulation. Both are anchored in the practice of every domain of scientific research. According to Varenne, "in the act of developing a model or using scientific simulation, it is always about manipulating, modifying or building an object, live or not, material or formal, in perspective to respond a certain number of relevant questions of a knowledge query" (Varenne, 2013: 11).

More precisely, a model or simulation have as a function to mediate between the empirical experience and theory (Morgan and Morrison, 1999). This mediation unfolds in the practices of practical knowledge, such as manipulation, know-how, the learning of technical gestures or behaviors; or else, theoretical practices such as the definition of data gathering, formulation of hypotheses and theoretical researches (Varenne, 2013).

The methodological use of modeling and simulation has mutated in recent decades, offering an almost unrecognizable scenario in relation to the Hampelian dissertations on the scientific explanation models; for instance, Varenne has repertoired the particular functions of modeling and simulation in about 20 scientific research specifications. This way, the mediation of a model or simulation is declined in specific performances that work to facilitate empirical research, supply elements for the intelligible formulation of knowledge, strengthen theorization, enable communication and the construction of knowledge and even action and decision.

In spite of the mutations that have occurred in the practice of numerical modeling in general over recent decades, there still persists a deep epistemic battle inherited from Jellinek, Weber and by the authors we have analyzed in the previous sections on the realistic or epistemic statute of ideal types and that nowadays is expressed in the utilization of the modeling term to give an account of the methodological function and particular functions of modeling to establish empirical researches and the simulation term to refer to the equivalence between symbolical representation expressed in the objects of simulation and their correspondence with the actually-occurring situations. Linked to this, it would seem as though the epistemic debates on modeling and simulation will increase, if we take into account the controversies around climate modeling, its procedures, results and cognitive and political uses.

Current climate modeling closely corresponds with the descriptions of debates on the representation of reality and the epistemic use of models and simulation. Indeed, current climate modeling considers the aspects of climate variability as a

rational representation of the climate and those of anthropogenic climate change to represent the changes forecast for human behaviors expressed in CO^2 emission levels, in the case of the scenario of the fourth IPCC report, or the socioeconomic levels associated to determinate CO^2 level, or in RCPs. In both cases it is the rational modeling of human behavior and should work not as representations of reality, but as schemas that allow determining the irrationality of human behavior in relation to climate.

When we refer to climate models the similitude between them and the Weberian ideal type is even clearer. In the practice of modeling, the enouncements are "the simulation of hurricanes by means of 'sowing vortexes'" (Magaña, 2004: 2), the formula of conservation of energy as idea of the atmosphere, the Coriolis Effect expressed in a formulation, etc., even the introduction of parametrizations in the models in an idealization of phenomena such as the increment in heat retention or aggregating a factor, which then can be attributable to the similar behavior of "greenhouse effect", hence it may be supposed that such increment in the temperature of the factor might take up the name of CO^2.

On the other side, the elements of objective validity of Weberian ideal types correspond to that affirmation of the climate modeler Guillemot (2009: 273) when indicating that "the scientific validity and legitimacy of climate numerical models and their predictions on climate changes are based upon the confrontations between simulation and observation data". However, it is closer to what Weber stated on the ideal types when: —Guillemot (2009: 273) says—:

> The assessments of the models by data are the modelers' largest share of work. There is no general methodology to assess the models; one notices a wide variability of practices because no general model is validated, but the capacity of giving account of a particular climate phenomenon.

As Guillemot states, it is how modelers establish their dialogical connections between models and data that do not reduce to the validation of the former by the latter.

Climate modeling is one of the most complicated branches of contemporary techno-science. Its realization has meant a simultaneous challenge for geosciences and logical-mathematical sciences, and also for computing technical development; but more so for the reorganization of knowledge to integrate in a single beam hydrodynamics, climatology, meteorology, thermodynamics, volcanology, algorithmics, computing and technical advancement in computers.

Climate modeling is also one of the most complicated techno-scientific domains because of the temporary and spatial stochastic behaviors of the numerous variables climate comprises; among other, fluctuations in oceans, atmosphere, earth's surface, vegetal coverage, cryosphere, volcanic activity, radiation from the sun and alterations caused by human activity.

In spite of all the noticeable advancements in climate modeling, according to Gutiérrez, climate simulation poses uncertainties along the sequence of the process. This means that despite the noticeable advancement in computing modeling on climate comprehension, the models still are rational arrangements (in spite of the incalculable amount of parametrizations) of physical phenomena that do not faithfully represent the actual climate phenomenon.

Climate modeler Douville has called attention on the pressure exerted by governors to offer better resolutions and new components of numeric climate models. So he calls to question the good balance between complexity, resolution and realism in representing these processes (WCRP, 2011). In like manner, Douville calls attention on the lack of lassitude of IPCC on the dissemination of results, adhering the petition for this organism to be more strict and less consensual when assessing the models and risks associated with global warming (WCRP, 2011).[6]

Epistemologically understand climate modeling requires the analysis of the scientific practice of modeling, and inseparably, of the epistemic function of concepts, cognitive schemas, models and all sort of rational arrangements that allow contrasting the cognitive elaboration with the empirical practice of knowledge. The epistemic notion of ideal types developed by Weber to understand and explain social action can be useful for the comprehension of the staging and epistemic function of the socio-technical practice of modeling, understood as a technical-cognitive social action.

The notion of ideal type will enable, besides, the practice of modeling in agreement with the cognitive and normative role the actors assign to the models. According to the studies by Weber, this role oscillates between realistic and heuristic roles; this is to say, while certain scientists defend their concepts and models as copies of reality, others apply these coinages to empirically approach to the knowledge of phenomena. The comprehension of climate modeling requires a critical apparatus that allows critically analyze the construction of cognitive devices rationally arranged that enable giving an account of the cognitive distance

6 Douville asks for symmetry in a way to prevent the hypocrisy of denouncing the risks inherent to global warming of anthropic origin without rebelling from the weak adaption capabilities of numerous societies in the face of a natural global warming.

of these models from the actual behavior of phenomena. The idea is to apply the development of the sociology of ideal types to the study of the sociality of elaboration of climate models.

Finally, we may say from all the discussion presented in this text, that a climate model should be useful to accomplish the significant comprehension of climate and causal imputation of climate reality, including the notion of global warming. As much as possible climate modeling should not become a must-be or a norm; instead, modeling should be a heuristic tool to develop hypotheses and also a possibility to broaden knowledge on climate and human action, and that modeling should be a research activity that worked as a mechanism of scientific control that summarized the subjective explanations of the creators of the models and simulations with the processes of collective and open discussion for the social validation of objectivity.

From these reflections, we consider that it will be adequate that the modelers and their institutions assumed modeling preserving a self-control scientific space that allows for epistemological openings instead of impossible concluding nomological tasks; considering that climate models cannot mirror reality, but can be powerful heuristic instruments to understand climate; this means that organisms such as the Inter-Governmental Panel on Global Warming or the National Institute of Ecology and Global Warming of Mexico should introduce a vast schema of knowledge and reflection on climate and change, instead of trying to impose a vision of global warming supported on the alleged "objective validity" of the predictions from climate models (Arellano, 2015a).

In this proposal it is worth not rejecting the symmetrical demand of some modelers, such as that of Douville asking for the look of human sciences on the practices of modeling; because as he deems climate modeling with reflection might make it look as a self-centered discipline in which models would become the main object of study, much more than actual climate (Douville, 2012). This claim is feasible because of that lack of distinction between sciences of nature and cultural sciences from Weber's epistemological reflections.

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