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The Global Science Factor V. 1.1: A New System for Measuring and Quantifying Quality in Science

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ABSTRACT

There are currently very few measures used globally to measure the impact of science, but most often, the Impact Factor (IF), a Thomson Reuters product, is erroneously equated with quality, extrapolating beyond the confines of quality. Although the IF reflects a strength in its ability to integrate information from a range of sources and data-bases, thus creating one number, a simple ratio of two integers, the truth of the matter is that the IF is now clearly being used and abused by scientists, research institutes and is serving as the *de facto* role model of quality control to evaluate "quality". The IF is also increasingly being used commercially to reward scientists through improved positions, salaries, research grants or other direct benefits based heavily, or even exclusively, on the IF. This is dangerous not only because the IF represents a marketing tool owned by a large media corporation with clear vested interests and conflicts of interests, but because the quality of science should not be monetized and judged by a single parameter. If so, it is open to fraud and abuse, as is increasingly currently taking place around the globe. This paper does not examine the merits and demerits of the IF, but does view it as, at minimum, grossly insufficient, and overly praised and thus serves as a spring-board for necessary change. Thus, to provide a simple, free, open access and useful parameter to assess the true impact and standing of a scientist, journal, publisher or university, I have coined a new system, the Global Science Factor, or GSF. Using equations that are open to the scientific public for use as they see fit, but primarily as a performance index that is based on concrete and publically available facts, I am of the opinion that the GSF could prove more useful than the IF because it represents a path of openness and transparency that can be freely verified by any person within the scientific community and does not represent a behind-closed-doors tool for abuse. The GSF does not claim that the IF is redundant, also because it relies on the IF to be calculated. However, it would allow the weighting of the IF to be blunted in the light of other important factors that should be taken into account when trying to assess the quality of a scientist, journal, publisher or university. The GSF is an open system, an open parameter, not meant to derive profit, but meant to serve the scientific community. The GSF, as a new cumulative index, is far more balanced than the IF or the H-Index because it measures the value and quality of a scientist using variables other than publications only.

Keywords: Impact Factor, H-Index, metrics, openness, the "Minority Report" syndrome, transparency
Abbreviations: ARS, arbitrary relative score; **GSF**, Global Science Factor; **IF**, Impact Factor; **MF**, multiplicative factor; **PFQ**, parameter, facet, or quality; **PI**, performance index

WHY IS THERE A NEED TO QUANTIFY SCIENCE OR ITS QUALITY?

We live in a world where everything is becoming increasingly quantified. Regrettably, we are already in a world where quantification is no longer sufficient, but where hypothecation, re-hypothecation and predictions are made in an attempt to foresee future events, trends and outcomes with a desperate desire to look into the future and try to understand an event before it is about to take place, the "Minority Report" syndrome, as I like to call it. Unfortunately, most of these policies are being used in banking, money markets, politics and power struggles to secure future socio-economic and geo-political positions far into the future. And science is not exempt from these trends, nor is it immune from the effects of such actions. Although the original initial objectives of the Impact Factor (IF), a Thomson Reuters product, and brainchild of Eugene Garfield, may have been noble, the current use of the IF is now of limited nobility. This paper does not aim to explore the pro's and con's of the IF, nor does it mean to explore the alternative indices that currently exist, *sensu stricto* or *sensu lato*. These issues will be discussed separately in another paper. Rather, even though it is based on a fundamental criticism of the IF and its unintended (negative) consequences on science and the scientific community, this paper serves almost exclusively to put forward a new system, a new parameter, a new means by which "quality" can be measured in science, of a scientist, based on a wide range of factors that would influence the quantitative measurement of a scientist's worth. This new parameter, which could serve as an open, transparent and free means to assess quality, depends somewhat on truth, but can also be used to test truth. I have decided to coin a term for this parameter, the Global Science Factor, or GSF. Along with the IF and other currently existent parameters used to measure the impact, quality or success of science, journals or scientists, the GSF simply provides one more alternative performance index (PI), but could potentially be the most balanced and transparent form currently available. The GSF does not claim that the IF is redundant, also because it relies on the IF to be calculated, but it would allow the impact of the IF to be somewhat blunted in the light of other important factors that should be taken into account when trying to assess the quality of a scientist, journal or publisher. The GSF score, which can be calculated using the parameters listed and quantified in **Table 1**, could be used by university staff to assess a candidate for a new position, evaluate a scientist's performance to qualify for a raise, increased research funding, or position. At a wider scale, it could be used by a ministry of education to evaluate the performance of individual scientists within a public university, or to, collectively, assess the collective performance of many scientists within a department or university and to compare it with other departments or universities, for example. The GSF can also be used to independently verify the performance of a scientist by any member of the scientific community based on publically available facts, or by facts made

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Research Note

Table 1 How to calculate the Global Science Factor, or GSF.

Parameter, facet, or quality (PFQ)#	Arbitrary relative score (ARS)[1]	Multiplicative factor (MF)
1. Professional qualification and development		
1.1. Academic education and qualifications		
High school diploma	1	
Bachelor of Science (BSc, 3-year)	1	
Bachelor of Science (BSc Hons.)	1	
Other degrees or diplomas	1	
Master of Science (MSc)	2	
Doctorate (DSc or PhD)[2]	3	
1.2. Work experience (non-science related)		
Menial	1	× number of years
Managerial	2	× number of years
1.3. Work experience (science related)		
Menial office work	1	× number of years
Lab, field or greenhouse work (non-post doc)	2	× number of years
Post-doc	3	× number of years
Sabbatical	4	× number of years
Principal investigator	4	× number of years
Managerial	5	× number of years
1.4. Academic position (university)		
Associate professor	4	× number of years
Assistant professor	5	× number of years
Full professor	6	× number of years
Active emeritus professor	4	× number of years
Head of department	7	× number of years
Head of faculty	8	× number of years
Head of university (e.g., vice-president or president)	9	× number of years
1.5. Academic position (research institute)		
Lab assistant	1	× number of years
Junior research assistant	2	× number of years
Research assistant	3	× number of years
Senior research assistant	4	× number of years
Junior researcher	3	× number of years
Senior researcher or project leader	4	× number of years
Management	6	× number of years
Vice-director or director	7	× number of years
2. Academic responsibilities		
2.1. Teaching, tutoring, etc.		
Teaching, lecturing and/or tutoring (40 h a week)	1	× number of years
Number of successful MSc students supervised	1	× number of graduated candidates supervised
Number of successful PhD students supervised	2	× number of graduated candidates supervised
2.2. Research funding and collaboration projects (successful applicant)		
Nationally funded project (< 50,000 US$)	1	× number of project years
Nationally funded project (> 50,000 US$)	2	× number of project years
Internationally funded project (< 50,000 US$)	3	× number of project years
Internationally funded project (> 50,000 US$)	4	× number of project years
National collaboration groups	1	
International collaboration groups	2	× number of countries
2.3. Membership and/or role of officially registered professional affiliations and societies*		
National peer society (member)	0.1	× number of membership years
International peer society (member)	0.5	× number of membership years
National peer society (secretary)	0.1	× number of membership years
International peer society (secretary)	0.5	× number of membership years
National peer society (organizing committee or academic board)	0.1	× number of membership years
International peer society (organizing committee or academic board)	0.5	× number of membership years
National peer society (upper management)	0.2	× number of membership years
International peer society (upper management)	1	× number of membership years
National peer society (vice-president or president)	0.5	× number of membership years
International peer society (vice-president or president)	2	× number of membership years
3. Academic achievements		
3.1. Academic awards or prizes (officially recognized)*		
National award	1	
International award	3	
3.2. Publications, i.e., authorship		
3.2.1. English[3,4]		
Short paper or other publication (non peer reviewed)	0.1	5 $
Short paper or other publication (peer reviewed)	1	5 $
Conference proceedings (national, non peer reviewed)	0.1	5 $
Conference proceedings (national, peer reviewed)	0.5	5 $
Conference proceedings (international, non peer reviewed)	0.1	5 $
Conference proceedings (international, peer reviewed)	1	5 $
Original research paper (non peer reviewed)	0.1	5 $
Original research paper (peer reviewed)	2	5 $

Table 1 (Cont.)

Parameter, facet, or quality (PFQ)#	Arbitrary relative score (ARS)[1]	Multiplicative factor (MF)
3.2.1. English[3,4] (Cont.)		
Review paper (non peer reviewed)	0.1	[5 $]
Review paper (peer reviewed)	2	[5 $]
Book chapter (non peer reviewed or non-indexed)	0.1	
Book chapter (peer reviewed and/or indexed)	2	
Book (non peer reviewed or non-indexed)	1	
Book (peer reviewed and/or indexed)	4	
Other publications (popular magazines, etc.)	0.5	
3.2.2. Any other language[3,4]		
Short paper or other publication (non peer reviewed)	0.05	[5 $]
Short paper or other publication (peer reviewed)	0.5	[5 $]
Conference proceedings (national, non peer reviewed)	0.05	[5 $]
Conference proceedings (national, peer reviewed)	0.25	[5 $]
Conference proceedings (international, non peer reviewed)	0.05	[5 $]
Conference proceedings (international, peer reviewed)	0.5	[5 $]
Original research paper (non peer reviewed)	0.05	[5 $]
Original research paper (peer reviewed)	1	[5 $]
Review paper (non peer reviewed)	0.05	[5 $]
Review paper (peer reviewed)	1	[5 $]
Book chapter (non peer reviewed or non-indexed)	0.05	
Book chapter (peer reviewed and/or indexed)	1	
Book (non peer reviewed or non-indexed)	0.5	
Book (peer reviewed and/or indexed)	2	
Other publications (popular magazines, etc.)	0.25	
3.2.3. Publications and academic offenses		
Retractions or any other officially reported ethical infractions	-5	× number of retractions, independent of the reason)
3.3. Peer reviewing functions[6]		
Peer reviewer (any language, non-IF journal)	0.1	× number of manuscripts
Peer reviewer (any language, book chapter)	0.2	× number of chapters
Peer reviewer (any language, IF ≤ 2 journal)	0.3	× number of manuscripts
Peer reviewer (any language, IF > 2 journal)	0.4	× number of manuscripts
3.4. Editorial functions[6]		
Editor (any language, non-IF journal)	0.1	× number of journals
Editor (any language, book chapter)	0.2	× number of chapters
Editor (any language, IF ≤ 2 journal)	0.5	× each journal
Editor (any language, IF > 2 journal)	1.0	× each journal
Managing editor or editor-in-chief	1.5	× each journal
3.5. Attendance in symposia, congresses or peer-related meetings*		
National	0.2	
International	0.5	
3.6. Organization of symposia, congresses or peer-related meetings[7]		
National	0.3	
International	0.6	
3.7. Patents (any) or qualified varieties (plant, animal, microorganisms)		
National	0.5	
International	1	
3.8. Refereed activities (dissertations, journal manuscripts, research proposals, etc.) at national or international level		
National	0.1	
International	0.5	
4. Others		
4.1. Charitable actions*		
Involvement in local/national charities	0.1	× number of years
Involvement in international charities	0.2	× number of years
4.2. Data-base listings (abstracting and/or indexing)		
Top data-bases[8]	0.1	
Other data-bases	0.05	
4.3. Science-related indexes or data-bases[9]		
H-Index (Google)	1	× Google H-Index
H-Index (Elsevier Scopus)	0.5	× Elsevier Scopus H-Index
Other indexes	0.1	
Author indexing and/or publications repositories[10]	0.1	
4.4. Social and web-related parameters[11]		
Social media page (e.g., Facebook, Twitter, etc.)	0.5	
Wikipedia page	2	
Number of hits in first 10 pages (Yahoo)	0.05	× each hit
Number of hits in first 10 pages (Google)	0.1	× each hit

[1] The lowest possible score that can be attributed is 0 (except for retractions), with no upper value. The arbitrary value is observed based on a relative weighting relative to all other factors in **Table 1**. In factors such as societies or awards, the point refers to EACH one.

[2] The attribution of a PhD or DSc will differ from country to country, and the length of time to achieve it or the requirements to obtain it will clearly differ, but the impact of these cultural differences will most likely be balanced out when considering the number of publications since most PhD require international publications in peer reviewed or IF journals in order to graduate.

[3] This includes proceedings papers from meetings, conferences or symposia.

Table 1 (Cont.)

[4] In general, a journal that does not conduct peer review is not considered to be scholarly, thus all non peer reviewed publications are given a very low arbitrary score of 0.1 (to emphasize their non-academic nature). However, it would not be fair to give them a zero score because they still reflect some academic achievement, and if in the open access medium, a wider audience and reach, hence a MF of × 1.1 (see [5]). The low score obtained for publishing in non peer reviewed journals (see Case 1 below) should thus serve as a decentivation to publish in such journals or books.

[5] The IF of a journal is still an important factor, as is the open access nature of a journal (see # below). The multiplicative factor (MF) for publications has two cases: Case 1 (IF < 1.00) and Case 2 (IF ≥ 1.00). For Case 1, the MF is × √IF × OA. In contrast, for Case 2, the MF is × IF × 1.1. The 1.1 part of the MF is explained in detail below (#) and is related to the OA nature. Consequently, the final equations for calculating Case 1 and Case 2 are:

Case 1 (IF < 1.00) = ARS × √IF × OA

Case 2 (IF ≥ 1.00) = ARS × IF × OA

[6] Peer reviewing and editorial functions should only be considered valid when proof can be shown of such an activity, not simply a web-site listing of a name. Thus, only showing a screen-shot of a name on a journal's or publisher's web-site is insufficient. Actual copies of reviewed manuscripts must be provided as proof upon request.

[7] The organization of a congress has been given a higher relative score than attendance because of the amount of effort and time usually required to organize a congress.

[8] The top 10 data-bases (in no particular order), include: NIH's PubMed, Elsevier's Scopus, Scirus and/or sciencedirect.com, Springer's SpringerLink, Taylor and Francis (Routledge) CATS system, CABI, Thomson Reuter's data-bases (any) including ISI Web of Knowledge, Wiley-Blackwell, Google Scholar.

[9] The H-Index or the Hirsch Index is "an index that attempts to measure both the productivity and impact of the published work of a scientist or scholar. The index is based on the set of the scientist's most cited papers and the number of citations that they have received in other publications. The index can also be applied to the productivity and impact of a group of scientists, such as a department or university or country, as well as a scholarly journal." As defined by Wikipedia. However, some factors overlap with those assessed by the GSF, and to blunt this overlap, the H-Index has been given a low score. Since the Google H-Index and the Elsevier Scopus H-Index tend to focus on quite different publications, they are both listed, although the Elsevier H-Index tends to be more narrow and thus is considered to have a less impact than the Google H-Index. Scientists should read Wikipedia to learn more about the dangers, risks and limitations of using the H-Index. Very likely more indexes will emerge, similar to the H-Index, but with different names, as powers within the publishing world seek control over the quantification of quality and achievement. This will be a strong influence, no doubt, on future versions of the GSF.

[10] Many science-related or -unrelated companies have set up web-sites that allow scientists to register themselves and their CVs or publications, usually freely, in a bid, in most cases, to generate profits through advertising. Although the author is of the opinion that such sites do not reflect authoritative academic quality, but are rather exploratory and even predatory marketing practices and tools, one cannot deny their existence or weighting, as well as increased exposure to a scientist and their work, and are thus given a score, within a separate category. Among others, the ones most currently visible are: Academic Search (Microsoft), Academiccorner.com, Arxiv.org, Authormapper.com, Biomedexperts (ELS), DeepDyve, Labome.org, LinkeD, Nrcpb.org, ORCID, Research Gate, Scirp.org, Skillpages.com, etc. This will be a strong influence, no doubt, on future versions of the GSF, particularly ORCID, which has seen an aggressive campaign starting in late 2012 and early 2013.

[11] Social media can be extremely important in rapidly and effectively networking with peers and to spread a message or a result that is academic, and thus has been given a strong arbitrary score relative to a non-peer reviewed publication, for example. One of the primary objectives of a scientist is to increase visibility of their profile and work so that others can use their results or ideas. If, at the time the ASF for a social media page is calculated, that page is not active (e.g., a person had a Facebook account, but not the account has been terminated), then no score should be assigned. The logic behind this rule is that such web-pages, sites and accounts reflect a real-time impression, unlike books or journal manuscripts that have a historical value through longevity.

The terms used are in English and understandably might not reflect the exact terminology used in each country, although similar or parallel systems could exist. To create country-specific GSFs, there could be a collaboration at national levels to implement such a system, and to adjust the GSF to suit a specific country, region, or culture (See **Q&A8**).

* For all such parameters, valid certification must be available.

$ The open access (OA) nature of a publication can not be ignored and should thus be taken into consideration vs. print medium. It is obvious that an OA paper or chapter will likely be viewed (i.e., actual or potential viewership) more times than a non-OA paper, and thus used more in research or referenced more. Thus, it has a greater weighting and relative POTENTIAL importance. However, the OA movement is still relatively new and rapidly evolving. Thus, until we see how important the OA movement is over the next 2-3 years, especially taking into consideration predatory OA and how that pans out, for now, the only thing can be said is that OA is slightly more important than print, thus a × 1.1 factor (i.e., 10% more important than print) has been included. As more quantitative data on the use and importance of the OA evolves, so too will the GSF evolve into version 1.2., etc.

Abbreviations: ARS, arbitrary relative score; **IF**, Impact Factor; **MF**, multiplicative factor

available by that scientist, providing thus a more honest, open and transparent form of regulating and monitoring fraud. With the GSF, the scientist is forced to become fully transparent about their achievements and their past, i.e., it literally forces a scientist to be fully open and transparent about their academic and professional CV without any veils or masks. Although this new measure may appear a little complex at first, it can reflect a real-time measure of true quality and can be extrapolated to reflect the quality of a manuscript, a journal, or a publisher in increasing levels of complexity, provided that the basal data is available for each level. This is exemplified as two hypothetical examples (Cases) in which a relatively unproductive scientist with limited experience would have a GSF of 31.500 while a dedicated scientist with considerable experience would have a GSF of 166.350 (**Table 2**). GSF values should always be presented with three decimal places. The exact time period used to evaluate the GSF depends entirely on the needs of the user. Therefore, a GSF score can easily be calculated for a 1-year period, a 10-year period or an entire career period simply because all past parameters and achievements are fixed parameters, and not subject to change, and thus the use of the GSF depends on the end user. An evaluation of Case 2 indicates that the greatest emphasis is on publications, which makes sense since the ultimate objective of a scientist is to publish research results as scientific papers. In horticulture, for example, one exception to this ultimate objective would be the need for new varieties to be patented for national or international release, thus emphasizing the need for patents more than publications. Consequently, giving equal recognition of research data for academia and for industry, both publications and patents are given almost equal weighting in **Table 1**. Furthermore, using the basal GSF in **Table 1**, GSFs for authors (GSF_A), manuscripts (GSF_M), journal issues (GSF_{Ji}), journals (GSF_J) and publishers (GSF_P) can be subsequently calculated based on a cumulative index (**Fig. 1**).

The following factors are not taken into consideration when calculating the GSF, since these would appear to be biased and clearly unrelated to a candidate's scientific merit: age, gender, religion, culture, race, creed, socio-political affiliations or ranks, economic status or other personal qualities. An aspect such as age would be considered to reflect experience over time, but age is itself not an important factor, since that experience over time is already factored into the GSF in **Table 1**.

WHAT IS STILL REQUIRED TO IMPROVE THE GSF?

The GSF and associated factors are only truly useful if they remain free. In the same manner in which I have introduced this new concept freely for use (or abuse) by the scientific community, to serve as a transparent and open form to assess quality within science, there is still a great need for improvement, hence my term in the title V 1.1 (i.e., version 1.1). This implies that as technologies, journals and publishers evolve and as some become redundant while others become relevant, the GSF will also need to evolve dynamically to meet the challenges of these changes. The evolution of the GSF lies in the hands of scientists and therefore the concept has not been patented, even though Global Science Books holds the copyright, to allow for a free flow and evolution of ideas. Indeed, the following unknowns exist about the GSF at present:

1) A simplified, automatic system to quantify the GSF is required using mathematical models and computer-generated algorithms. This may be as simple as an Excel file or using more complex programming languages such as Fortran, C++, or others. This will require a level of altruism.

2) An independent web-site needs to be created that allows the GSF to be calculated freely, with 24/7/365 access so that a GSF score can be assessed real-time by any scientist around the world. This will also require a level of altruism.
3) There needs to be some sort of a conversion factor between GSF v 1.1. and later versions, almost like an inflation/deflation calculator, to make an outdated GSF compatible with weightings of factors in subsequent versions. This will likely be strongly influenced by the objective nature of what an individual considers to be important, assigning different relative weightings to value parameters, currently listed in **Table 1** as arbitrary units to give an arbitrary relative score (ARS), but all viewed in a relative sense.
4) How to resolve the objective-subjective balance? The GSF score is based on objective facts, eliminating most or a considerable amount of the bias or subjectivity, but the relative ranking of factors that could be considered to be important to a scientist would differ from scientist to scientist and between different scientific fields, reflecting subtle (subjective) differences in culture, religion, gender, or other differentiating socio-cultural, religio-ethnic and economic variables.
5) How can plagiarism be factored into the GSF? Although retractions (broadly) are factored into the equation, they may or may not reflect retractions based on plagiarism.
6) How can cultural or regional differences be taken into account by the GSF? See **Q8** below.
7) Several, if not most parameters used to assess the quality of a scientist are calculated by the scientist themselves. For example, only a scientist will know their full history, but that history can be verified by independent sources. However, the first step is for a scientist to make their full academic CV freely and openly available to the public.

Q&A's REGARDING THE GSF

Q1: Age will affect the final result. It is not the same if someone is 28 years old or 56 years old regarding almost all activities described in **Table 1**.
A1: Of course, a 28-year old will almost never have the same GSF as a 58-year old! This is fairly obvious, even when IF is used to assess scientists. However, it is understandable that a young person with a high GSF could be either productive or excellent, and this is the power of the GSF! It can be used for realistic and for unrealistic comparisons between scientists, journals, publishers or universities. This depends on the person who is calculating and using the GSF.

Q2: Wouldn't a journal with a large number of papers or authors reflect an unfairly high GSF_J relative to a journal with fewer papers or authors?
A2: Exactly! In essence, a large team of scientists who are valid authors (i.e., no guest authors, but including young and old, inexperienced and experienced scientists) would in theory reflect a stronger research project and thus the expected GSF_M and GSF_J will be higher than a manuscript or journal with few authors. The assumption is that the number of authors in any manuscript and journal is a random parameter and is not fixed, thus with an increase in volume

Table 2 Application of the GSF to two hypothetical cases: Case 1 (relatively unproductive) and Case 2 (highly productive).

Case 1		
Parameter, facet, or quality (PFQ)	**Arbitrary relative score × number of PFQs**	**GSF (sub-totals)**
Academic education and qualifications		
High school diploma	1 × 1	1
Bachelor of Science (BSc, 3-year)	1 × 1	1
Bachelor of Science (BSc Hons.)	1 × 1	1
Master of Science (MSc)	2 × 1	2
Doctorate (DSc or PhD)	3 × 1	3
Work experience (science related)		
Menial office work	1 × 3 years	3
Lab, field or greenhouse work (non-post doc)	2 × 1	2
Post-doc	3 × 1	3
Academic responsibilities (incl. teaching, tutoring, etc.)		
Teaching, lecturing and/or tutoring (40 h a week)	1 × 1	1
Research funding and collaboration projects		
National collaboration groups	1 × 2	2
Membership of officially registered professional affiliations and societies		
National peer society	0.1 × 2	0.2
Academic awards or prizes (officially recognized)		
National award	1 × 1	1
Publications*		
Short paper or other publication (non peer reviewed)	0.1 × 4	0.4
Short paper or other publication (peer reviewed)	1 × 1	1
Original research paper (non peer reviewed)	0.1 × 2	0.2
Original research paper (peer reviewed)	2 × 1	2
Review paper (non peer reviewed)	0.1 × 2	0.2
Review paper (peer reviewed)	2 × 1	2
Book chapter (non peer reviewed)	0.1 × 1	0.1
Other publications (popular magazines, etc.)	0.5 × 3	1.5
Attendance in symposia, congresses or peer-related meetings*		
National	0.2 × 5	1
International	0.5 × 1	0.5
Data-base listings (abstracting and/or indexing)		
Top data-bases	0.1 × 5	0.5
Other data-bases	0.05 × 5	0.25
Social and web-related parameters		
Social media page (e.g., Facebook, Twitter, etc.)	0.5 × 3	1.5
Number of hits in first 10 pages (Yahoo)	0.05 × 1	0.05
Number of hits in first 10 pages (Google)	0.1 × 1	0.1
	TOTAL GSF SCORE	31.500

Table 2 (Cont.)

Case 2		
Parameter, facet, or quality (PFQ)	**Arbitrary relative score × number of PFQs**	**GSF (sub-totals)**
Academic education and qualifications		
High school diploma	1 × 1	1
Bachelor of Science (BSc, 3-year)	1 × 1	1
Bachelor of Science (BSc Hons.)	1 × 1	1
Master of Science (MSc)	2 × 1	2
Doctorate (DSc or PhD)[2]	3 × 1	3
Work experience (non-science related)		
Menial	1 × 2	2
Managerial	2 × 1	2
Work experience (science related)		
Lab, field or greenhouse work (non-post doc)	2 × 2	4
Post-doc	3 × 2	6
Principal investigator	4 × 2	8
Academic position		
Assistant professor	5 × 2	10
Full professor	6 × 2	12
Academic responsibilities (incl. teaching, tutoring, etc.)		
Teaching, lecturing and/or tutoring (40 h a week)	1 × 2	2
Number of successful MSc students supervised	1 × 2	2
Number of successful PhD students supervised	2 × 6	12
Research funding and collaboration projects		
Nationally funded project (< 50,000 US$)	1 × 1	1
Internationally funded project (< 50,000 US$)	3 × 1	3
National collaboration groups	1 × 2	2
International collaboration groups	2 × 4	8
Membership of officially registered professional affiliations and societies		
National peer society	0.1 × 3 × 1 year each	0.3
International peer society	0.5 × 5 × 5 years each	1.25
Academic awards or prizes (officially recognized)		
National award	1 × 1	
International award	3 × 1	
Publications*		
Short paper or other publication (peer reviewed)	1 × 2	2
Original research paper (non peer reviewed)	0.1 × 2	0.2
Original research paper (peer reviewed)	2 × 20	40
Review paper (peer reviewed)	2 × 5	10
Book chapter (peer reviewed)	2 × 3	6
Retractions	-5 × 1	-5
Attendance in symposia, congresses or peer-related meetings		
National	0.2 × 15	3
International	0.5 × 8	4
Patents		
International	1 × 1	1
Charitable actions		
Involvement in local/national charities	0.1 × 1	0.1
Data-base listings (abstracting and/or indexing)**		
Top data-bases	0.1 × 45	4.5
Other data-bases	0.05 × 10	0.5
Social and web-related parameters		
Social media page (e.g., Facebook, Twitter, etc.)	0.5 × 2	1
Wikipedia page	2 × 1	2
Number of hits in first 10 pages (Yahoo)	0.05 × 18	0.9
Number of hits in first 10 pages (Google)	0.1 × 26	2.6
	TOTAL GSF SCORE	166.350

* In all options and for both Cases, an IF = 1.0 was assumed (for simplicity and for uniformity)
** This reflects the number of entries, so each manuscript listed in a data-base would be considered as a single entry. The scoring or counting is the entire responsibility of the scientist, but can be easily verified by any member of the scientific community, the public, or any university or government official, if necessary.
[1] Case 1 scientist holds a PhD, has 3-5 years of experience, is not part of any societies, nor has won any prizes but has published a few papers, mainly locally, but with a few international papers.
[2] Case 2 excels in all efforts related to science and attempts to be highly active in as many ways as possible.

over several years, it could be expected that the total number of authors would tend towards some equilibrium level. This needs to be tested, of course.

Q3: How can the GSF be used to evaluate a scientist within a specific period of time? For example, can the GSF be used to assess the productivity of a scientist from January, 2012 to December, 2012?
A3: Of course. This is another power of the GSF. It can be used to assess productivity provided that all information is fully available and provided by the scientist. Therefore, the productivity of a scientist can be easily calculated by entering values into **Table 1** for this 12-month period only, and it could be referred to as the 2012 GSF or GSF_{2012} for that scientist. This is one idea.

Q4: Who should use the GSF?
A4: At first, scientists should calculate their own GSF. It could form part of their CV as a formal "quality" parameter. This would be useful for job applications or for project funding evaluations, for example. This would correspond to Application 1 in **Fig. 1**, corresponding to self-evaluation or

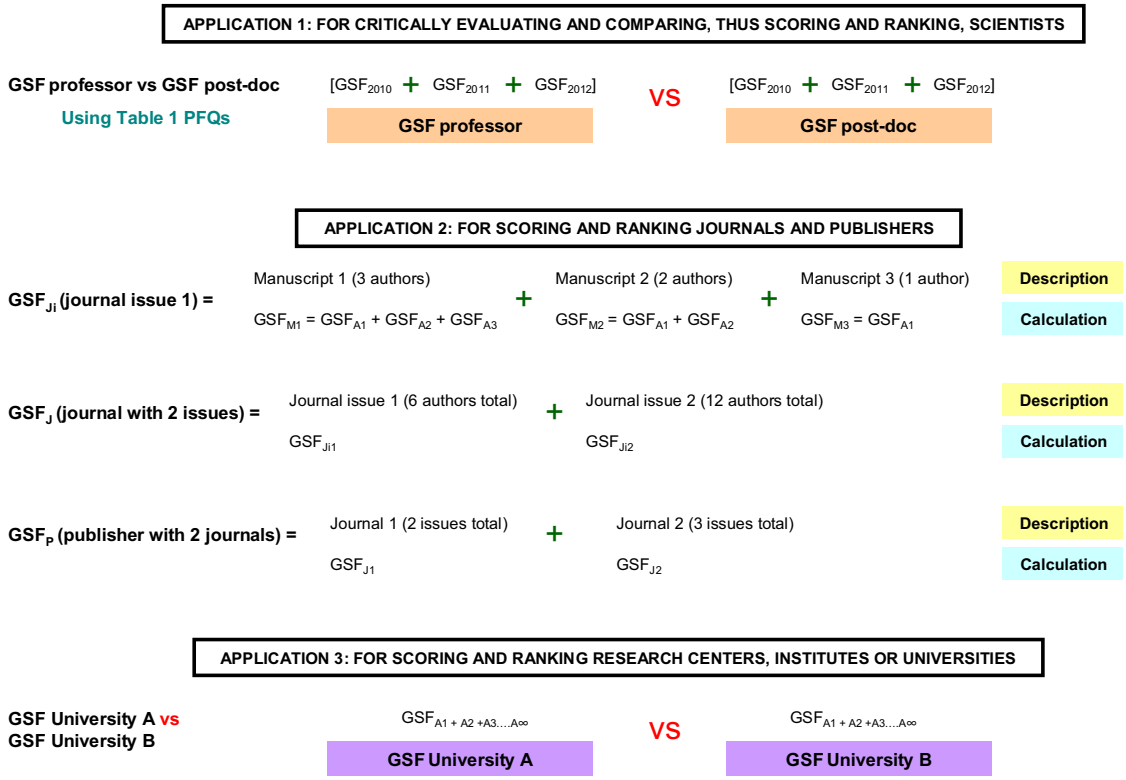

Fig. 1 How can the Global Science Factor (GSF) can be expanded outwards to measure the quality of other science-related parameters and what are some potential applications? Three broad and possible applications are described, but there may be more depending on the end need of the user. Application 1: There may be interest in comparing the academic and professional performance between a professor with 20 years' experience and a post-doc with 5 years' experience over a 3-year period, e.g., 2010-2012. In this case, only PFQs (parameters, facets, or qualities) that were obtained or achieved in this 3-year time period are valid. No other back history is considered at all. This allows the GSF to be used "fairly" and "objectively" without career influence. Application 2: The GSF for each author (GSF_A) within a manuscript can be calculated according to **Table 1**. The cumulative total of all GSF_A within one manuscript would give the GSF of a manuscript (GSF_M), journal issue (GSF_{Ji}), journal (GSF_J) and publisher (GSF_P) when calculated in a pyramid-type manner. This diagram indicates that in fact the scientist is the most fundamentally important aspect of the publishing process and upon which the quality of a journal issue, a journal and a publisher's quality is ultimately based. Application 3: Ministries of education may be interested in comparing the academic and professional performance between universities in order to be able to reward research grants. Subscripts: M = manuscript; A = author; Ji = journal issue; J = journal; P = publisher; ∞ = infinity.

independent evaluation by any third party (provided that the CV is publically available). It could also be used by departmental faculty or the human resources department to assess, for example, a year-by-year productivity of the scientist. The GSF could then be used to objectively calculate salary increases, research funding allocation, travel funds, bonuses, or promotions. This would correspond to Application 2 in **Fig. 1**, corresponding to non-biased independent evaluation by any third party (provided that the CV is publically available). The GSF is currently the most balanced evaluation system available for scientists and the system by which scientists hold the most control of the system.

Q5: Is the GSF up to date?
A5: 100% yes. It is always aup to date, unlike the IF, which is always one year behind. For example, in 2012, only 2011 IF's are available, and 2012 IF's will only be available in 2013, most likely near June. Unlike the IF, the GSF is always a real-time assessment of quality at that time, but for any period of time. Even if the IF is delayed, the GSF reflects the reality of the IF, i.e., even if the IF is delayed, the GSF is always up to date.

Q6: If a scientist has plagiarized or committed ethical violations, should they have a GSF?
A6: Until the point where a scientist committed an ethical violation, that scientist may have been ethical. The level and seriousness of plagiarism (including self-plagiarism) is also a debatable issue and is currently being hotly debated and regulated, but without uniform consensus. Thus, plagiarism and ethical violations could be factored into **Table 1**, although I suspect that a department or university might not hire or contract a scientist if they have too many ethical violations. Finally, the history of a scientist is a fixed parameter and cannot be changed or altered. Thus, the GSF for any period of time for any scientist should, in theory, not change, independent of ethical violations. Once calculated it should remain fixed. A scientist who presents a GSF with altered values for the same period of time has either calculated the GSF incorrectly (which is not possible if an automatic system is created), or has concealed facts. A scientist with an excessively high GSF as a result of ethical violations is an off-shoot of the intended use of the GSF.

Q7: Should some activities be valued only in a specific examined period such as an academic qualification which should only be valued if it was gained during this period, or should previous achievements also be considered?
A7: This is related to Q3 above and is one of the strengths, flexibilities and advantages of the GSF. The GSF of that candidate can be calculated for any specified amount of time. Thus, if the candidate obtained a full professorship in 2008, for example, and the GSF of the entire candidate's career is examined (e.g., 1980-2012), then absolutely all parameters in **Table 1** apply. If, however, an academic committee simply wants to calculate that candidate's GSF for 2012 (GSF_{2012}), i.e., the achievements in only one year (2012), this can easily be done, by excluding a score for any other parameter that was not achieved in 2012, such as the full professorship, which had been obtained in 2008. Thus, the career GSF will reflect the ARS derived from the 2008 professorship, but the GSF_{2012} will not. In addition, a quarter-by-quarter GSF can be calculated, even within one year. For example, $GSF_{2012\ Q1} = GSF_{2012\ Q2} + GSF_{2012\ Q3} +$

$GSF_{2012\ Q4}$ where Q = quarter.

Q8: How can cultural or regional differences be taken into account by the GSF?
A8: This is one of the most important features of the GSF. The GSF, which can be calculated through **Table 1**, applies very broadly and would cover most countries in both Eastern and Western hemispheres that share a higher education system. However, the author recognizes that there are fine-scale regional or even country-by-country differences in research institutes and even in the work place, and if there are sufficient differences, then a slightly modified GSF can be created, using the terms of agreement indicated below, together with the author, to develop a modified system, for example, the GSF_{Japan}, GSF_{Brazil} or $GSF_{Australia}$. Also see **Q18**.

Q9: How should GSF data be presented and represented?
A9: It would be useful for a scientist to add a GSF score to their CV. The GSF score (as for all ARS scores used to calculate it) should be represented as three decimal places always (see text and **Table 2**).

Q10: Why is the GSF not called the Global Science Score?
A10: A score would only represent a number whereas the term "factor" represents "variability" or even "uncertainty" in terms of change. To reflect the influence of various parameters, variables, or factors on the actual score, it is termed the GSF and not the GSS.

Q11: Why is the GSF not divided by the number of years to provide a "per year" score?
A11: Use (and abuse) of the GSF lies within the hands of the user, and not the creator. Thus, how the user uses it or interprets it is totally at the discretion of the user. It would not be correct, as the founder of this system, to force how the GSF should or could be used. For example, it would not make sense to divide a GSF by the total number of years that a person is professionally active, for two reasons: a) when does one consider a person to be "professionally active", if studies and education are also part of the process? b) Obviously, each year will have a different weighting, so a GSF can easily be calculated for a single year, as explained above, to reflect the strengths (or weaknesses) within a single year. See **Fig. 1**, Application 1.

Q12: Is not comparing a scientist with a 20-year experience and thus (in theory) a high GSF with one that has a 5-year experience and thus (in theory) a low GSF the same as com-paring rabbits with turtles?
A12: Understandably, a person with a longer career will have a higher GSF than one with a shorter career. This is basic common sense. However, in any moment in time, the GSF of an "experienced" researcher can be compared to one of a "novice" researcher using the GSF of a single year, or between a researcher of country A with another of country B. As already indicated in **Q11**, each year will have a different weighting, so a GSF can be calculated for a single year, e.g. GSF_{2011}, GSF_{2012}, or GSF_{2013}. Of course, GSF_{2013} can only be calculated in 2014 once the academic or calendar year is complete. For example, the US, Canada and most EU systems (including the UK), China and 70% of the world's education systems (university) use a September (start) calendar, the Anglosaxonic system (e.g. Australia, New Zealand or South Africa) would use a January (start) calendar while the Japanese system uses an April (start) calendar. Thus comparing the GSF_{2012} of the "experienced" researcher versus that of the "novice" researcher would be fair, balanced, and comparable, independent of the country or education system. See **Fig. 1**, Application 1.

Q13: Can the GSF_A (i.e., GSF of an author) for a past year (e.g., 2011) change?
A13: In theory, no. This is one of the strengths or benefits of the GSF, which reflects a fixed value in any space in time. Thus, a scientist's 2011 academic and professional achievements (i.e., PFQs) are *fait acompli*, i.e., past events that cannot be altered. A scientist who presents two GSF_{2011} values has either made an error or attempted to conceal some facts. The only exception to this truth would be where the latest IF scores have been updated since IF scores for one year are only released in the following year. So, a GSF_{2012} score would reflect all academic achievements up to and including 2012, even though the 2012 IF scores will only be available in about mid-2013. Thus, it is realistically possible that the GSF_{2012} score calculated at the end of 2012 (when only 2011 IF scores are available) and that calculated at the end of 2013 (when 2012 IF scores are already available) will be different. Here, it is the responsibility of the scientist to ensure that the GSF scores be updated and reflect the most accurate and up-to-date data available, indicating clearly up to what year the IF includes.

Q14: How is the IF or the open access (OA) nature of a paper factored into the GSF and what are their weightings?
A14: This is an important aspect, exemplified below in the three examples. The scientific community (whether proponents or opponents of the IF) cannot ignore the IF, or its relative importance. In addition, a paper that is published as OA is more likely to be read (and consequently referenced) than a paper hidden behind a publisher's security screen. This is why, under the Publications section of **Table 1**, i.e., **3.2.**, both the IF and the OA nature of a paper are taken into consideration. Please read the footnote in **Table 1** about the logic of the relative weighting of the OA. Also, in footnote 5, some explanation is given about why two Cases are required for calculating the IF score of a paper, although three clear examples here, to justify the use of both Cases.

Q15: Can a scientist know how good or bad their GSF score is relative to another scientist in the same institute, in a different institute or even in a different country?
A15: Indeed, scientists always like to know their relative "weighting", or measure of importance or influence among peers in a national and international setting, so this question is and will be valid for a long time to come. The GSF provides a way to do precisely this. As for any other nascent concept, time is required for the idea to be tested and used (or abused) by the scientific community. Time will tell, although, as I advocate above, the GSF can be added to a CV as one more parameter to "quantify" a scientists' achievements. Over time, the hope would be that a database be established and that public records of scientists be available for open, fair and transparent uses and comparisons.

Q16: The IF scores in **Table 1** are not normalized or standardized across disciplines. Why not?
A16: This is an excellent question (and criticism) about the IF and one that many scientists across the globe are asking. I recommend that scientists direct this question to the owner and manager of the IF, Thomson Reuters. However, I can advance that, in principle, one would not be comparing a heart surgeon with a plant biotechnologist for a university position, i.e., in this scenario apples would not be compared with frogs, so in practical uses of the GSF, inter-disciplinary comparisons would be unlikely, although this lack of standardization could be problematic when looking at the GSF of a publisher, which would take into consideration the GSF of several inter-disciplinary journals. That said, the excessively high IFs observed for some areas of study, such as medical journals, might be much higher than, for example, horticulture-related journals. This imbalance in IF values and consequently a potential skewing of the GSF, for example in applications for project funding is, admittedly, a potential problem or weakness, but one for which there is no apparent immediate solution on the horizon provided that Thomson Reuters continues to hold the reigns of con-trol over the IF. The only way to "buffer", reduce or blunt the impact of the IF in terms of its cross-disciplinary imbalances is precisely by using the GSF, which considers,

among many other PFQs, the IF.

Q17: Explain more about criteria used to factor books into the GSF.
A17: The following are true about books: 1) except for books that are used as text-books, i.e. that get a wide audience through a ministry-supported programme, in general books carry less weighting than journals. 2) There is no IF for books or book chapters (yet), automatically reducing the weighting of either. 3) A book has a greater weighting than a book chapter. These three facts have been considered when considering the GSF score related to books in **Table 1**. To simplify the equation, indexing and peer review are considered equally ranked. Thus, a book that appears on Amazon.com or on SpringerLink, for example, would be considered with equal weighting. However, marketing channels, despite their importance in disseminating information, are not taken into account by the GSF because these are factors that are not in the control of the scientist to whom a GSF is being assigned. Also related to books, should the GSF of writing or editing a book be equal? In general, I have used the assumption that writing a manuscript or book chapter will require considerably more time and effort than editing a journal manuscript or book chapter. Consequently, these tow factors have been considered separately in **Table 1** as **3.2.** and **3.3.**, respectively.

Q18: How is language factored into the GSF?
A18: Fortunately or unfortunately, depending on the viewpoint, English is now considered to be the primary (i.e., main) and thus most important form of reporting science in the global literature, even though Chinese, Spanish, Portuguese, Arabic, French, German and a few other languages also command great absolute numbers. However, when considering publications in **Table 1**, language cannot be ignored, and thus publications are divided into two separate categories, English (**3.2.1.**) and non-English (**3.2.2.**). This might be perceived as a "punishment" for not publishing in English, but the GSF is based on facts, and not on emotions, thus it is a fact that a paper or book published in English will *most likely* be viewed by a wider readership than a non-English audience (if a global audience is taken into consideration).

Q19: Should the GSF be commercialized?
A19: There are two possible interpretations to this question. The first implies that the GSF should be turned into a capitalistic, business model for generating profits. This is **NOT** the objective of the GSF and goes against the intended use by the author of the GSF and thus the GSF, at least under this name which is copyright property of Global Science Books, should not be commercialized. The GSF is meant to be a free and open measure of quality and performance of authors, journals, books and publishers but always with the basic assumption that the most important contributor is the author. The second interpretation of the question might have a surprisingly opposite answer. If the GSF is used to draw comparisons between scientists, universities, research projects and any other situation in which there is competition for funding, a salary or a budget, the GSF is one excellent score or value that could be taken into consideration precisely because of its *minutiae* of PFQs considered in **Table 1**.

EXAMPLES

Two rules apply for all examples:
Case 1 (IF < 1.00) = ARS × √IF × OA
Case 2 (IF ≥ 1.00) = ARS × IF × OA

Example 1 (with explanation)

In Case 1, where the IF is < 1.00, let's imagine a scientist has published three papers (all in English): one peer reviewed short communication (OA) with an IF = 0.25 and two peer reviewed original research papers (non-OA) with IF = 0.345 and 0.786. The total arbitrary relative score (ARS) for these three papers would be, using the equation for Case 1:

$1 \times \sqrt{0.25} \times 1.1 = 0.550$
+
$2 \times \sqrt{0.345} = 1.175$
+
$2 \times \sqrt{0.786} = 1.773$

The publication's ARS grand total for these three papers would be 3.498 (i.e., 0.550 + 1.175 + 1.773).

Example 2 (with explanation)

In Case 2, where the IF is ≥ 1.00, let's imagine another scientist that has also published three papers (all in English): one peer reviewed short communication (OA) with an IF = 2.85 and two peer reviewed original research papers (non-OA) with IF = 1.612 and 1.105. The total ARS for these three papers would be, using the multiplicative factor (MF) for Case 2 (× IF × 1.1):

$1 \times 2.85 \times 1.1 = 3.135$
+
$2 \times 1.612 = 3.224$
+
$2 \times 1.105 = 2.210$

The publication's ARS grand total for these three papers would be 8.569 (i.e., 3.135+3.224+2.210).

Example 3 (with limited explanation)

This scientist that has 7 publications (P) (all in English), using a mixture of Case 1 and Case 2 equations:

P1 = a short communication, non-peer reviewed, non-OA, with no IF;
P2 = a short communication, peer reviewed, OA, with an IF = 0.85;
P3 = an original research paper, peer reviewed, OA, with an IF = 1.45;
P4 = an original research paper, peer reviewed, non-OA, with an IF = 0.68;
P5 = an original research paper, peer reviewed, OA, with an IF = 0.345;
P6 = a review paper, peer reviewed, non-OA, with an IF = 4.23;
P7 = a book chapter, peer reviewed, non-OA.

The total ARS for these 7 publications would be:

P1 = 0.1 = 0.100
P2 = $1 \times \sqrt{0.85} \times 1.1 = 0.922$
P3 = $2 \times 1.45 \times 1.1 = 3.190$
P4 = $2 \times \sqrt{0.68} = 1.649$
P5 = $2 \times \sqrt{0.345} \times 1.1 = 1.292$
P6 = $2 \times 4.23 = 8.46$
P7 = 2 = 2.000

The publication's ARS grand total for these 7 publications would be 17.613.

Notes for examples

a) In all examples, the publication's ARS is not equal to the GSF, since the GSF includes many factors in **Table 1**, i.e. any ARS is one subset of the GSF.

b) It is highly likely that a scientist will publish papers that fall under both Cases 1 and 2, i.e. with an IF < 1 and also ≥ 1. Thus, in those cases, the ARS of both categories of papers will need to be calculated separately, depending on the IF of each paper. This is what happens, more realistically, in Example 3.
c) Remember, the × 1.1 part of the MF only applies when the journal is OA.
d) The ARS calculated for Examples 1-3 pertain ONLY to section **3.2.** of **Table 1** related to publications. The GSF of each scientist in all three Examples would still require the ARS to be calculated for all other aspects in **Table 1** related to that scientist.
e) In all three Examples, the first value when calculating the ARS of each paper/publication equals the value in the ARS column in **Table 1**.

ULTIMATE PRE-REQUISITE FOR CALCULATING THE GSF

A publically available CV/resume showing the entire professional history (i.e., reflecting all the aspects listed in **Table 1**). Ideally, this should appear as an official entry on the scientist's official university or research institute website since online sites with similar services are automatically generated by search bots and do not reflect the full CV of a scientist. One excellent format for the full academic profile of a scientist is as is shown by Brazilian scientists through the Lattes system (http://lattes.cnpq.br) of the CNPq (Centro Nacional de Desenvolvimento Científico e Tecnológico), or National Center of Scientific and Technological Development. This indicates that the scientist is fully responsible for declaring all scientific activities and achievements, while being monitored by a higher academic and government authority. Thus, it is only in the interests of scientists to fully declare all publications, activities, websites, etc. in order to gain a higher GSF score.

WEAKNESSES, LIMITATIONS AND HOW TO COUNTER THEM

As indicated above, the reliance on external factors (the PFQs that give the ARSs) such as the IF, Google's H-Index, publisher-controlled indices such as Elsevier's Scopus, or others can give the impression of imperfection and reliance on factors that are beyond the control of the scientist. The criticism is perfectly valid because aspects (PFQs) like work experience are factual and totally in control by the scientist. However, externally controlled factors are extremely important and realistic factors nonetheless, and independent of personal criticisms, should be considered in the GSF. One fact about the GSF is true, however: those who do not declare something have clearly something to hide. Thus, implementation of a government or ministry of education-regulated system like the Brazilian Lattes explained above, would put pressure on scientists to ensure that ALL PFQs are fully, openly, and publically declared. Thus, the GSF serves not only as a means to measure quality, but to enforce transparency through fair and responsible exposure of a scientist's PFQs.

REQUIREMENTS AND CODES OF CONDUCT FOR USE AND RE-CALCULATION OF THE GSF

The GSF represents an intellectual achievement by the author of this paper. And although the use is free for the entire scientific community, its relative scores or rating cannot be altered under the name of the GSF without the permission of the author. Any GSF that needs to be re-calculated or re-assessed should be done in conjunction with the author and should/could be published in an open access medium as an updated version, e.g., v 1.2, provided that this is done so in collaboration with the author and with the knowledge of the author. It is recommended that the GSF v 1.1. not be used for any official purposes until a window of time has passed to allow for scientists, publishers and journals to test it and to allow for changes to the equations. Realistically, testing could take between 6-12 months with the launch of GSF v 1.2 in late 2013 or early 2014. GSF v 1.2, tested and tweaked, could be then used for official purposes, such as in CVs, project proposals, funding competitions, raises, bonuses, or promotions. The GSF must not be commercialized in any way, form or format.

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