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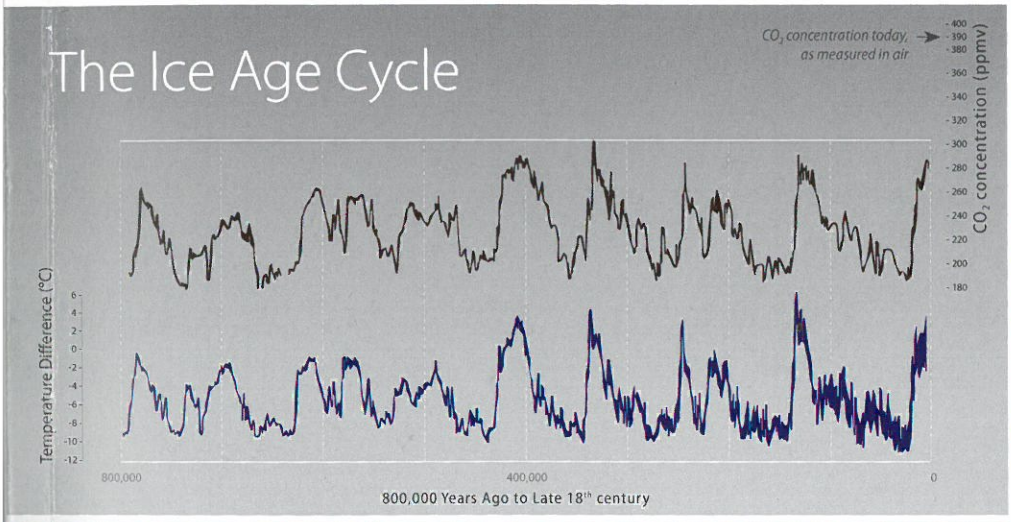

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PON Books

Establishing a Geoengineering Protocol

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Introduction: The Case for Geoengineering

The case for geoengineering our way out of the climate challenge may be getting stronger by the day. The global community is unable to mitigate greenhouse gas emissions even as the IPCC's predictions for impacts from a changing climate are gaining credence (Scherer, 2012). Furthermore, the need to counteract the rise in impending emissions is also becoming clear. More of the world's energy poor will have to move beyond basic minimum energy access needs — much of which, for the coming decades, will be from some mix of fossil fuels that risks blowing our carbon budget. Perhaps the most interesting case for geoengineering to emerge is that a protocol for controlled authorized management of such projects might help strengthen global environmental governance and elevate science's waning authority to inform the multilateral environmental process.

The recently concluded negotiations of the 18th Conference of Parties (COP) under the United Nations Framework Convention on Climate Change (UNFCCC) reveal that the pace of political action to avert the dangerous impacts of climate change is inadequate. Twenty years of negotiation aimed at pushing along the lagging process have launched "roadmaps,"[1] "pillars,"[2] "platforms,"[3] and now a "gateway."[4] Meanwhile, scientists have repeatedly shown that we must control emissions to prevent a global average temperature increase of more than 2°C (IPCC, 2007) in order to avoid a catastrophic change in the global climate system. And while 2°C is the politically agreed-upon upper limit, there are many studies supporting a lower upper limit — something well below 2°C (Hansen et al., 2008; Krause et al., 1989). The more stringent 1.5°C target, advocated by the planet's "most vulnerable" nations, makes the gargantuan task of mitigating climate change even more sobering.

A scientific study conducted by Meinshausen et al. suggests that "limiting cumulative CO_2 emissions over 2000–50 to 1,000 Gt CO_2 yields a 25% probability of warming exceeding 2°C" (2009). Futhermore, the study states that based on the emissions budget consumed by 2006 of 234 Gt CO_2, "less than half the proven economically recoverable oil, gas, and coal reserves can still be emitted up to 2050 to achieve such a goal." This will be a challenge as countries are realizing the untapped potential of formerly irrecoverable

[1] The 2007 COP 13 decision launched the "Bali Road Map" which included the various decisions on tracks for negotiation under a "Bali Action Plan."

[2] The Bali Action Plan rests on four pillars of action under the Ad Hoc Working Group on Long Term Cooperative Action (AWG-LCA) negotiation track.

[3] The Durban Platform was launched at COP 17 in Durban, South Africa. It included a proposal to launch a new negotiation track to establish a new legally binding treaty by 2015.

[4] The plan of action resulting from the recently concluded COP 18 in Doha, Qatar has been termed as the "gateway to greater ambition and action on climate change."

sources of fossil fuels, especially shale oil and gas. Furthermore, some fossil fuels are unavoidable to ensure that the planet's 2.7 billion energy poor have access to energy to reduce poverty and sustainably improve livelihoods (IEA, 2011). While some reports (PA 2009; IEA, 2010; Sanchez, 2010) may argue that meeting all needs of the energy poor will have a minimal impact on global emissions, the basis of their energy consumption threshhold could be disputed (Pachauri et al., 2003; Singh, 2012). The situation is clear: we are not only failing to reduce global carbon emissions, and we are still on a path that is highly dependent on fossil resources. Here is where geoengineering can help address the challenge of reducing poverty in a climate-constrained world, and perhaps buy humanity time and atmospheric carbon space.

Even as the UNFCCC failed to achieve its "ultimate objective" of "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system," (UNFCCC, 1992) the challenges faced by the Convention are symptomatic of the larger problem facing global environmental governance. Najam et al. outline several key challenges to effective global environmental governance (2006), including the lack of coordination and cooperation among existing Intergovernmental Organizations (IGOs) on the many Multilateral Environmental Agreements (MEAs). There is low priority afforded to a coordinated and comprehensive approach to dealing with transboundary environmental challenges. The work of the weak United Nations Environment Program (UNEP) overlaps with much stronger institutions like the United Nations Development Program (UNDP), the World Trade Organization (WTO), and the international development banks. The result, Najam et al. argue, is resource inefficiency and lack of compliance, implementation, and enforcement. Furthermore, in an era when the role of non-state actors is increasingly important, global environmental governance mechanisms are not appropriately suited to engaging this sector as a partner in solving global challenges. Non-state actors, including research institutions, advocacy groups, industries, civil society organizations, and youth must be involved in informing the decision-making process as well as monitoring and implementing the outcomes of multilateral negotiations (Gemmill, 2002). Indeed in many of the least-developed countries and island states, they act as important capacity builders for governments who are ill-equipped to deal with the multitudes of MEAs.

Finally, the fragmentation of global environmental governance is also affected by the "thinning influence of science" and its role in the international governance processes. Najam et al. state that "science needs to be credible and to cross political barriers to influence policy," but its influence has been "spread thin through multiple scientific bodies" that fail to look at the interconnections between the myriad environmental issues (2006). This is not the time for science to lose its influence — geoengineering could be a mechanism to give science the authority it once had in influencing global environmental policy. Furthermore, the threat posed by unauthorized geoengineering provides an opportunity to draw linkages between MEAs and strengthen global environmental governance mechanisms. An examination of the controversy of geoengineering projects

executed without consent reveals how these linkages can be made and ultimately yield multiple gains for global environmental governance while mitigating climate change.

The Challenge of Geoengineering

Geoengineering is the "deliberate large-scale intervention of the Earth's climate system, in order to moderate global warming" (Shepherd, 2009). The tools used to undertake these interventions are called "climate engineering technologies" (CETs) by Parsons and Ernst (2012). These technologies can be used in two broad categories of techniques: carbon dioxide removal (CDR) and solar radiation management (SRM). CDR techniques "seek to alter the global carbon cycle by manipulating natural biological, geophysical and chemical processes, on land or in the oceans, to remove carbon dioxide from the atmosphere" (Strong, 2011). While large reforestation projects may be considered geoengineering, Strong states that the best known form of CDR is, in fact, ocean fertilization, "which proposes to sequester carbon in the deep oceans through the application of $FeSO_4$ to ocean areas in which iron is a limiting nutrient" (2011). The other category, solar radiation management (SRM) techniques, are meant to cool down the planet. Various SRM techniques have been proposed including placing mirrors in outer space, deploying reflecting aerosols or metal flakes in the atmosphere, manipulating cloud cover, enhancing land albedo, or simply painting roofs white (Schellnhuber, 2011).

The challenge of geoengineering does not stem simply from the fact that it initiates a process that deliberately attempts to alter the global climate in order to mitigate what human activity has already thrown off balance. Instead the challenge is the lack of clarity in existing international laws relating to the regulation of the global environment that may jeopardize how such projects may be carried out with full transparency and in a safe and controlled manner. No existing conventions have been established specifically to address geoengineering. Existing conventions that may affect geoengineering research or implementation are ambiguous as to what constitutes sovereignty of airspace over a country that may be used for dumping of matter (as is the case with the 1965 Long Range Transboundary Air Pollution Treaty (CLRTAP) and the 1985 Convention on the Ozone), or they lack robust governance structures (as is the case with the 1967 Outer Space Treaty). Furthermore, in the absence of clear guidelines for what constitutes a "large-scale" or "small-scale" intervention in the global ecosystem, not only is pertinent scientific research impeded, but the authority of the science of climate change is undermined as it is given spotty direction to address geoengineering under many different international conventions.

Two recent geoengineering projects shed light on this weakness and also support the urgent need for a proper governance structure for geoengineering. In July 2012, entrepreneur Russ George executed the "world's largest geoengineering project" by dumping 100 tons of iron sulfate off the northwestern coast of Canada (Banerjee, 2012). George claimed he was enriching the ocean ecosystem to boost the salmon population on which the local Haida Native Americans depend for their livelihood. The impacts of his experiment are still unknown, and allegations fly as to how he may have tricked

the Canadian and American governments into allowing him to undertake this project. Everyone is alarmed at the number of international laws that George may have violated. This case shows that existing MEAs are weak in dealing with geoengineering.

The UN Convention on Biological Diversity (CBD) guidelines on climate engineering that were adopted in 2010 exempt "small scale" scientific experiments in "coastal waters" (CBD, 2010). The London Convention and Protocol against Dumping passed a resolution on ocean fertilization in 2008. Unfortunately this Convention exempts "legitimate scientific research" and does not define "other activities" (CPMP, 1972). The lack of clarity on what is considered "legitimate scientific research" and the fact that multiple MEAs are attempting to deal with a complex issue suggest that George may not have violated any law. This is coupled with the fact that these treaties are non-binding and that they do not hold an individual accountable — they are only meant for nation states. In this case then, would Canada, the nation of the Haida tribe, be responsible? Or would it be George, who is a United States citizen? Furthermore, could geoengineering projects cause conflict if carried out unauthorized and unmonitored? Boyd rightly points out the need to minimize "the potential for conflict between nations as a result of geoengineering... when considering the focus of future research" (Boyd, 2009).

The other case supporting the need for better governance structure for geoengineering is LOHAFEX, the joint Indo-German venture. In 2009, an experiment was carried out in the South Atlantic as a result of the ambiguity in existing international law on geoengineering. Amidst great opposition, scientists managed to inject 20 tons of iron into a suitable eddy on the open ocean that they claimed was similar to "coastal waters" due to the composition of the nutrients in the waters (Nature, 2009). They further claimed that their experiment was "small-scale" and for the purposes of "legitimate" scientific research, the results of which they are now monitoring. In the aftermath, the German Federal Ministry of Environment expressed its regret at approving the project, further alienating the scientific community and begging the question of who is truly in control when it comes to regulation of geoengineering.

Regulating Geoengineering

The failure of the existing MEAs to adequately address dangerous anthropogenic-induced climate change poses an interesting dilemma that supports creating a mechanism to regulate geoengineering. If humans are already geoengineering the planet by augmenting the greenhouse gas cycle, then why should we not attempt to solve the problem through direct, controlled, and intentional climate change? At the very least, we do not have the ability to conduct experiments, regardless of the scale, to ascertain the impacts of geoengineering as a tool to avert a climate change disaster. Perhaps geoengineering techniques could help avert the Arctic "death spiral" which has exceeded the scientific projections of ice melting in the region (Wadhams, 2012). Despite continued resistance against geoengineering among scientists, environmentalists, and governments, support for geoengineering governance has steadily been on the rise.

Rayner et al. argue the need to establish a framework for geoengineering research (Rayner, 2009). This framework would be guided by the following "Oxford Principles," which emphasize a governance structure before deployment:

1. Geoengineering to be regulated as a public good
2. Public participation in geoengineering decision-making
3. Disclosure of geoengineering research and open publication of results
4. Independent assessment of impacts
5. Governance before deployment

These principles could allay many fears about the threats of unregulated and unauthorized projects if enshrined in a governance structure for geoengineering. In 2010, a conference was organized for the global scientific community to establish norms and guidelines for controlled experimentation on climate engineering techniques. Scientists convening for the conference agreed upon many of the principles that had elements of cooperation in climate-engineering research "within a framework that has broad international support." They also called for the need for governments to "clarify responsibilities for, and when necessary create new mechanisms for the governance and oversight of large-scale climate engineering research activities" (Alisomar, 2010). Transparency and public participation were also stressed in the Alisomar principles.

Governments are listening and the funds are beginning to flow. In 2011 in the United States, the Bipartisan Policy Center's Task Force on Climate Remediation called for federal funding for geoengineering research (BPC 2011). While their report cautioned that climate remediation could not be substituted for mitigation and adaptation, it would be unwise to not invest in technologies that may someday help avert ecological tipping points. This report followed another report released by the Chairman of the United States House Committee on Science & Technology that stressed the need to begin "consideration of climate engineering research now to better understand which technologies or methods, if any, represent viable stopgap strategies for managing" climate change (2010). Furthermore, the report states that "the impact of a moratorium on research should be carefully weighed against the importance of promoting scientific freedom and accountability," echoing the sentiment of many scientists around the world.

A Protocol Approach

If federal funding is beginning to flow towards geoengineering research, and there is a growing sense that research and testing is inevitable in the wake of inadequate progress to address climate change under the UNFCCC, surely the time has come to establish a governance structure for geoengineering research and implementation. Strong supports the need for creating a Convention on Geoengineering (2011), though the process to put it together would be long and cumbersome. But it is important to expedite this process of establishing a governance structure since experiments are

already underway that may have dramatic impacts on the global ecosystem. I propose a geoengineering Protocol under the existing UNFCCC — it would be easier to establish and would have additional benefits. First, it would strengthen the flagging UNFCCC by adding strong compliance mechanisms for climate change; it could also add revenue streams to be funneled towards climate mitigation and adaptation projects. And by establishing linkages with existing MEAs and their associated scientific bodies, it would also elevate the authority and influence of science in the decision-making process.

The Protocol would be defined by three key objectives:

1. No unauthorized geoengineering projects would be allowed
2. A process for authorizing geoengineering research and experimentation of projects would be established (by limiting size, scope, etc.)
3. A process for authorizing geoengineering actions that have been demonstrated to work effectively would be established

These last two objectives, the process of authorizing, would strengthen the existing UNFCCC. A menu of scientifically pre-approved CETs could be included in the annex of the protocol that would ensure that only technologies considered safe at certain scales would be allowed. The CDR and SRM techniques could be used to categorize the technologies in the menu. If large-scale afforestation is considered, linkages could be made with the existing REDD (Reducing Emissions from Deforestation and Degradation) plus negotiations under the UNFCCC. (Though large-scale reforestation projects may not be considered as geoengineering because they are meant to restore forest ecosystems that used to exist.) Other CDR mechanisms that may be considered for authorization include projects that enhance coral growth, or increase carbon storage capacity of agricultural or rangeland soils. Projects designed to address removal of other non-carbon-based GHGs may be placed in the same menu as the CDR technologies with the global warming potential of the gases used to estimate the level of mitigation required.

The same process currently used by the Clean Development Mechanism (CDM) for authorizing projects could be employed. A Board of Scientists could be formed for this Geoengineering Execution Mechanism (GEM) and would be responsible for approving projects. This Board structure would be similar to the recently formed Technology Executive Committee (TEC) under the Technology Transfer Mechanism of the UNFCCC. An ad hoc working group could be established to undertake the process of collecting information to ensure that the best level of relevant expertise is represented on the Board. The makeup of the Board would have an appropriate panel of experts to provide independent, sound, balanced, and useful scientific and technical advice. Furthermore, Board members would represent each of the geographic regions in question, similar to the makeup of Boards and Executive Committees in other mechanisms under the UNFCCC. Projects would be consistently monitored and evaluated, and their impacts on global carbon levels would be informed by the IPCC and the existing subsidiary bodies under the COP. This would give scientists greater authority in deeming projects safe for execution and allow for

independent apolitical evaluation. A Geoengineering Fund could also be established with money from both public and private sources. In the event that an authorized or executed geoengineering project repeatedly poses a threat to any party or to the global ecosystem, an "off switch" would be required to halt action. The decision to halt the action would have to be supported by evidence and endorsed by the Board of scientists of the GEM through a simple majority vote. In the case of a tied vote or abstentions, de-authorizing an action could be undertaken through a majority vote of the COP.

Intellectual Property Rights (IPRs) currently pose a barrier for the transfer of climate friendly technologies, but may be less of an issue in the transfer of CETs given that simply executing these projects will allow technology innovators to test their innovations. In fact, countries that would be willing to host climate engineering projects would conceivably bear no financial burden, and could potentially sell carbon off-sets in a global market. This would be a major selling point for the ratification of the Protocol itself. Companies and governments that reap financial rewards from selling these carbon off-sets would be taxed (just as CDM projects currently are) in order to fund adaptation projects, but in this case would also apply towards mitigation using clean energy technologies. Finally, because geoengineering poses some serious risks, strong compliance, enforcement, and dispute resolution measures would be the foundations of the Protocol. Linkages for dispute resolution and violation of compliance could be made at the International Court of Justice (ICJ). Liability for failure to comply would include not only nation states, but also individuals and private companies.

Details of the Protocol may be further refined in the process of negotiation, but the key aspect of this Protocol is that it is designed to share the *opportunities* associated with solving climate change — not the burden, something that has plagued negotiations of the existing Framework. In doing so, this Protocol would not only strengthen global environmental governance by creating linkages between existing MEAs, but would also manage geoengineering, address climate change, and elevate the authority of science in informing the decision making.

Geoengineering Protocol to the United Nations Framework Convention on Climate Change (Draft)

The Parties to this Protocol,
Being Parties to the United Nations Framework Convention on Climate Change, hereinafter referred to as "the Convention",
In pursuit of the ultimate objective of the Convention as stated in its Article 2,
Recalling the provisions of the Convention,
Being guided by Article 3 of the Convention,
Taking note of the Decisions adopted at the by the United Nations Convention on Biological Diversity, and relevant Resolutions of the United Nations Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter,
Recalling also the Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification, 1977,

Recalling further the Vienna Convention for the Protection of the Ozone Layer, 1984, and the Montreal Protocol on Substances that Deplete the Ozone Layer, 1987, as adjusted and amended on June 29, 1990,
Recognizing the provisions of the Convention on Long Range Transboundary Air Pollution Treaty, 1979, and the Outer Space Treaty, 1965,
Have agreed as follows:

Article 1: Definitions

Some of the terms that should be defined by this Protocol are below. Additional terms could be added as deemed necessary during the negotiation process.

1. Geoengineering
2. Large-scale
3. Small-scale
4. Legitimate scientific research
5. Coastal waters
6. Climate engineering technologies (CET)
7. Carbon dioxide removal (CDR)
8. Solar radiation management (SRM)

Article 2: Objectives

1. No **unauthorized** small-scale or large-scale geoengineering projects affecting the hydrosphere, stratosphere, lithosphere, and biosphere of planet Earth will be permissible by the Parties of this Protocol.
2. For the purposes of scientific research and experimentation, geoengineering projects may be authorized under the guidance of the bodies established by this Protocol but limited based on their size and scope, and carried out in a manner that does not jeopardize the stability of the global ecosystem.
3. Authorized geoengineering projects that are assured to mitigate the impacts of global warming will be allowed under the supervision of institutions and through the use of instruments established by this Protocol.

Article 3: Principles

The principles that would guide this Protocol could come from the existing Oxford Principles as well as those established at the Alisomar Conference of 2010.

Article 4: Implementation

This section would establish the Geoengineering Execution Mechanism (GEM) and institute that Parties can only choose from the menu of CETs under the two categories as defined in the Annex.

Article 5: Finance

Creative finance mechanisms including a new Fund will be defined in this section. In addition, it will be important to draw linkages to the existing efforts to fund mitigation through the adoption of clean energy technologies, as well as adaptation under the UNFCCC.

Article 6: Monitoring and Evaluation

Here the role of the IPCC as well as the existing Subsidiary bodies would be defined in the process of monitoring and evaluating geoengineering projects and their impacts. Parties may choose to launch an independent global expert group as well as an additional subsidiary body to continue to inform the Meeting of the Parties on emerging CETs and geoengineering research.

Article 7 : Compliance and Dispute Resolution

This section will be critical to establishing that not only all parties to the Protocol but also individuals and companies based anywhere in the world are liable for failing to comply. This treaty will be binding on all parties and their citizens. Dispute resolution and compliance will be handled by the ICJ. Disputes will be informed by the bodies responsible for monitoring and evaluation as defined above.

Article 8: Public Participation

Public participation will be crucial to keeping the process open to all actors (as stated in the principles), both state and non-state in informing, evaluating, and implementing the projects. Therefore, this section will outline the role and extent to which public participation will be allowed and encouraged at the various stages of geoengineering research projects and implementation.

Conclusion

While not too long ago, geoengineering may have seemed like science fiction, unabated greenhouse gas emissions have resulted in a climate that is changing much faster than scientists previously anticipated. Even development agencies such as the World Bank are now preparing for scenarios for a planet that is 4°C warmer than pre-industrial levels (2012). Given that geoengineering may provide some answers, and experiments may continue to be undertaken without appropriate guidance and authorization, a global mechanism must be created to authorize and monitor geoengineering research, experiments, and actions. A geoengineering protocol may be better suited to strengthen the UNFCCC by reiterating the environmental and sustainable development principles that it contains. Such interlinkages are required as part of a larger need to strengthen global environmental governance (Najam et al., 2006).

The process of creating and launching a geoengineering protocol will not be easy. The protocol building activity should be put on the global agenda through a coalition of

scientists who can inform interested civil society, businesses, and governments about the process. Indeed, those who are interested in global environmental governance reform or strengthening of the climate change regime might be persuaded to push for a new protocol that not only addresses climate change and spurs technology innovation, but also provides more carbon space and time for development that is required for poverty eradication. Groups who oppose a geoengineering protocol will likely feel that there are great risks in attempting to alter ecosystems on such large scales. Furthermore, they may say that geoengineering takes away from the urgent task of mitigating greenhouse gases.

I have several arguments in favor of establishing such a protocol as a rebuttal. First, an outright ban on geoengineering research hinders innovation. Technological revolutions come in waves, and in the interim, incremental innovation makes up the bulk of knowledge creation. Research on innovation has revealed that a continuous buildup of knowledge through research and development are essential for companies and governments alike to drive economic growth and create entrepreneurial wealth (Arrow, 1962; Brooks, 1995; Ruttan, 2000; Deeds, 2001). Geoengineering research and experimentation may provide avenues for breakthroughs in technological innovation that could address climate change and be applicable for other needs. Banning research and experimentation may hinder the buildup of knowledge in a field that is yet to be fully explored. The debate is parallel to that of stem cell research, which may yield medical breakthroughs despite being considered unethical by opponents.

Finally, if we are driven by fears of what geoengineering might unlock and what could happen by removing the focus from mitigation, we must consider a second protocol under the UNFCCC. Moomaw and Papa argue that the problem of climate change is that it has been misdiagnosed as a pollution problem instead of a sustainable development problem (2012). They conclude that this has led to the creation of a process based on burden-sharing instead of opportunity-sharing, and they suggest we reframe the discussion on the basis of a mutual gains approach that focuses on delivery of clean energy services. Such an approach would begin mitigating greenhouse gases while furthering development goals and could only happen through the creation of a protocol on clean energy services. This could be supported by the recently launched United Nations Sustainable Energy for All, a program which seeks to address the need to expand energy access and provision of modern cooking energy services to 1.6 and 2.7 billion people around the world respectively (AGECC, 2010). Details of a protocol on clean energy services could be the subject of a different paper, but it is important to note here that these protocols would go a long way towards strengthening a weakened UNFCCC and a global environmental governance regime that requires deeper interlinkages in order to meet many of the existing and emergent environmental challenges that we face.

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