II. The Outputs of the Iterative Process

Part One has described what one might consider to be the "inputs" of the iterative process: the textual provisions in the Initial Enactments that govern the frequency and subject matters of the parties' formalized interactions over time. Part One concluded that the drafters of these initial ozone treaties crafted the relevant provisions with a thorough-going, though not theoretically maximal, concern for iteration. With respect to the higher-level choices involved in the ozone treaties—the choice of a treaty as the form of international legal cooperation, and the employment *vel non* of a convention-protocol approach—Part One argued that the drafters of the initial ozone treaties actually chose the maximally iterative approach.

Part Two examines what one might consider the "outputs" of the iterative process over time: the textual changes in the Revisions, the expressions of formal consent from nation-states, the degree to which the actual behavior of nation-states has comported with the rules of the ozone treaties, the meetings of the Conference and the MoP through the years, and so on. Because of the particular structure of treaty law and of the ozone treaties themselves, one may examine many of these outputs in clear and quantifiable form.

This clarity and quantifiability provides at least two advantages over the more typical and undifferentiated arguments that the ozone treaties are a "success." First, for those generally interested in the evolution of cooperation, one may unpack "the" success of the ozone treaties into a variety of components and examine the evolution of each component over time. For example, the number of ozone-depleting substances regulated by the ozone treaties increased by literally an order of magnitude in roughly five years, although the number of chemically distinct groups regulated increased "only" four-fold.[1] The rules governing the chemicals first regulated by the original Protocol required a number of iterations before eventually imposing a ban on those chemicals[2], while certain of the chemicals first regulated by the Copenhagen Revisions were almost immediately allocated an Allowable Percentage of 0%.[3] The rules governing the parties' response to non-compliance by one of their number, in contrast, have evolved at a pace so tentative and stately as to be vaguely reminiscent of the post-Jurassic reptiles.

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[1] See Table Three, *infra*, at __.

[2] Montreal Protocol on Substances That Deplete the Ozone Layer, Sept. 16, 1987, art. 2, 26 I.L.M. 1550 (entered into force Jan. 1, 1989) [hereinafter Montreal Protocol].

[3] Montreal Protocol on Substances That Deplete the Ozone Layer, Adoption of Adjustments and Amendment by the Fourth Meeting of the Parties at Copenhagen, Nov. 25, 1992, art. 2G, 32 I.L.M. 875 (entered into force Jun. 14, 1994) [hereinafter Copenhagen Revisions].

Second, there are some generalized conclusions about the success and dynamics of the ozone-treaty regime that one can draw much more confidently for having examined, in sometimes numbing detail, the specifics of that regime. The degree of cooperation effected through the ozone treaties is quite impressive. The number of regulated chemicals has grown dramatically since the Initial Enactments.[4] The number of parties to the regime has mushroomed.[5] The Revisions have tinkered with the exceptions to the core regulatory scheme. Even the non-compliance provisions of the regime are innovative when measured against the backdrop of the vast majority of treaty regimes.

The aggregation of details concerning the evolution of cooperation in the ozone-treaty regime produces not only a sense of impressively broad success but also a sense that the regime has matured. The Copenhagen Revisions have failed to garner the burst of initial assents associated with the immediately prior London Revisions, though the London Revisions had outpaced the rate of adoptions associated with their immediate predecessor (the original Protocol).[6] The parties created the first three versions of the Protocol in five years, increasing the number of regulated chemicals from 0 to 88[7]; in the five years since the adoption of that third version of the Protocol, only one new version has issued forth, and it does not add a single new chemical to the list of regulated substances.[8] Given the broad spectrum of chemicals regulated after the Copenhagen Revisions and the number of outright bans in place after the enactment of the Montreal Revisions, the ozone-treaty regime may well have achieved about all it can by way of rapid expansion of its jurisdiction. Consolidation of the extant successes under existing textual authority—chiefly in implementing the regime's redistributive mechanisms in order to persuade the currently unregulated developing nations to comply when they too become fully constrained by the substantive limits of the regime, and in dealing with non-compliance by Russia or others—is presumably the order of the new day. One hopes, at least, that the most relevant post-expansionist parallel will prove to be the United States in the decades after the closing of the frontier rather than the Macedonian Empire after Alexander's final conquests.

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[4] See Table Three, *infra*, at __.
[5] See Table 14, *infra*, at __; Chart One, *infra*, at __.
[6] See Table 14, *infra*, at __; Chart One, *infra*, at __.
[7] See Table Three, *infra*, at __.
[8] Montreal Protocol on Substances that Deplete the Ozone Layer, Adoption of Adjustments and Amendment by the Ninth Meeting of the Parties at Montreal, Sept. 17, 1997, UNEP/OzL.Pro.9/12 [hereinafter Montreal Revisions]; see Table Three, *infra*, at __.

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This Part examines, in essentially the same order as Part One examined the inputs, the outputs of the iterative process instantiated in the ozone treaties: meetings, textual changes, membership, and interpretation and compliance.

First, however, one should note that virtually all of these various outputs are the result of an overarching series of nested iterations stemming from the particular implementation of the general law of treaties in the text of the Initial Enactments. The text of the initial ozone treaties sets forth the procedural mechanisms by which a CoP or MoP can adopt new text and by which (if necessary) the parties later individually indicate their full consent to that new text. With respect to each enactment, then, the three iterations generally applicable with respect to treaties—negotiations leading to an authoritative text, adoption of that text, and the expression of full consent to that text—occur. The parties to the ozone treaties have chosen to effect a series of such three-iteration enactments, thus creating the opportunity for parties to cooperate or defect at another level of interaction. The "convention-protocol" approach inherently involves no more inter-instrument iteration than occurs with a convention and a subsequent protocol, i.e., the Initial Enactments. The parties, however, have additionally created nearly half a dozen Revisions, and thus generated an ongoing opportunity for inter-instrument iteration.

The parties have thus sustained a complex network of iteration and meta-iteration through a mixture of mandatory general obligations (e.g., the duty of a ratifying member to observe in good faith all terms of an adopted text ratified by the requisite number of parties); mandatory specific obligations (e.g., the duty of any adopting member to observe in good faith any adjustment adopted by consensus); contemplated but non-mandatory activities (e.g., the Convention's explicit consideration of how to modify the text of subsequent protocols once the parties choose to enter into them); and entirely discretionary activities (e.g., the decision to propose text for adoption). If iterations are a prerequisite to the success of a cooperative endeavor in a decentralized system in which the parties face a Prisoner's Dilemma (i.e., the international political milieu), as is well established, and if the density of iterative opportunities is likely to be correlated positively with the success of such an endeavor, as I have argued elsewhere at some

length, then one can conclude, even in advance of the examination of the specific outputs of that iterative process that I now undertake, that the ozone treaties were destined for some success.

A. Meetings

The mere occurrence of meetings is unlikely by itself to convince many observers of a powerful relationship between iteration and cooperation. Meetings without more, after all, need not even attempt to accomplish anything of substance, as those who have watched the modern political perversion of "town meetings" can attest. The Initial Enactments do not in fact set forth particularly onerous requirements.

Nonetheless, a brief description of the meetings relating to the ozone treaties is in order. First, if *no* meetings had occurred under the Initial Enactments, then one might take non-compliance with such a minor obligation to be a strong indicator that the parties were unlikely to comply with more burdensome requirements. Second, the meetings that have in fact occurred are sufficiently frequent and varied to indicate not merely perfunctory compliance by the parties with their meeting-related obligations under the ozone treaties, but also some significant efforts by the parties to nurture their international legal regime beyond the Initial Enactments. Third, the parties to the ozone treaties have not met merely to enjoy the vocal stylings of the Helsinki Children's Choir (the first undertaking at the first MoP). The parties have also met to adopt a host of important Revisions. A description of the time, date, and place of the parties' meetings can thus, when supplemented with a brief description of the textual changes effected at those meetings, serve as an indication of the parties' compliance with both the letter and the spirit of the Initial Enactments, and as a précis of the more extended discussion undertaken immediately hereafter of the growth in the length, breadth, depth, and coverage of the ozone treaties over time.

The Convention and the original Protocol entered into force within a few months of one another (September 22, 1988, and January 1, 1989, respectively). The parties convened the first Conference and the first MoP just a few months later, in late April and early May, respectively, of 1989. Since that first gathering, the parties have held a MoP every year, with the Conference occasionally preceding the MoPs. In London in 1990, the MoP adjusted the main body of the Protocol, and amended both the main body and

the annexes of the Protocol.[9] A 1991 MoP in Nairobi added an essentially hortatory annex.[10] In 1992, the MoP was held in Copenhagen, and (as in 1990) both adjusted and amended the main body of the Protocol and amended the annexes.[11] In 1994, the parties returned to Vienna (where the Convention had been signed) to adjust the main body of the Protocol and to change one ODP.[12] In 1997, the parties returned to Montreal (where the original Protocol had been signed) to adjust and amend the main body of the Protocol.[13] With what one assumes was a certain feeling of symmetry, the parties closed the meeting by thanking the World Children's Choir of Washington, DC, for donating 1000 copies of its compact disk to the UN Environment Program.

TABLE TWO -- THE COPS AND MOPS

	1989	1990	1991	1992	1993	1994	1995	1996	1997
Convention	Met		Met		Met			Met	
Protocol		Amend-ments (sig-nificant)	Amend-ments (minor)	Amend-ments (sig-nificant)					Amend-ments (sig-nificant)
	Met	Adjust-ments		Adjust-ments	Met	Met	Adjust-ments	Met	

Throughout this procession of meetings, the parties refrained from modifying the text of the Convention, although, as mentioned just above, the parties did sometimes precede a MoP with a meeting concerned specifically with the Convention as a separate instrument. In each year in which the parties did not adopt the original Protocol or its

[9] Adjustments to the Montreal Protocol on Substances That Deplete the Ozone Layer, Jun. 29, 1990, 30 I.L.M. 539 [hereinafter London Revisions].
[10] Annex D to the Montreal Protocol on Substances That Deplete the Ozone Layer, Jun. 21, 1991, DEP'T ST. BULL. No. 93-145.
[11] Copenhagen Revisions, *supra* note __.
[12] Montreal Protocol on Substances That Deplete the Ozone Layer, Adoption of Adjustments and Amendments by the Seventh Meeting of the Parties at Vienna, Dec. 7, 1995, UNEP/OzL.Pro.7/12 (1995) [hereinafter Vienna Adjustments].
[13] Montreal Revisions, *supra* note __.

Revisions, they nonetheless held a MoP at which they discussed various matters of administration, finance, non-compliance, and future textual revisions.[14]

From this bare outline of the meetings, one might make at least a few observations about the contours of the evolution of cooperation in the ozone treaties.

First, the Protocol is the focus of whatever dynamism exists in the ozone-treaty regime. Meetings on the Protocol have occurred every year; meetings on the Convention have occurred much less often. Meetings on the Protocol have led to textual changes in the original Protocol on five occasions; meetings on the Convention, in contrast, have yet to lead to any textual changes in the main body of that document. Given the clearly more specific obligations of the Protocol in comparison to the Convention, one must conclude that the parties are grappling more seriously with the more substantive part of the convention-protocol pairing.

Second, if one accepts for the moment my assessment of which amendments or adjustments are "significant," then one might well conclude that these meetings reflect an energetic regime of international cooperation. The parties have met every year. One of every three MoPs (London, Copenhagen, and Montreal) has involved significant amendments; another meeting (Vienna) involved significant adjustments; and a fifth meeting (Nairobi) involved minor amendments. Roughly every other meeting thus involves some significant textual modifications. Especially in light of the fact that each meeting on a given instrument in a given year has run just three or four consecutive days,[15] this seems a lively pace.

Third, the parties have never been able to effect significant textual changes in consecutive meetings, but the parties have only once held two meetings in a row without adopting a Revision.[16] An alternation of a meeting presently concerned with textual

[14] *Report of the Parties to the Montreal Protocol on the Work of their First Meeting at Helsinki*, UNEP/OzL.Pro.1/5 (1989); *Report of the Fifth Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer at Bangkok*, UNEP/OzL.Pro.5/12 (1993); *Report of the Sixth Meeting of the Parties to the Montreal Protocol on Substances That Deplete the Ozone Layer at Nairobi*, UNEP/OzL.Pro.6/7 (1994); *Report of the Eighth Meeting of the Parties to the Montreal Protocol on Substances That Deplete the Ozone Layer at San José*, UNEP/OzL.Pro.8/12 (1996).

[15] *See, e.g.*, *Report of the Second Meeting of the Parties to the Montreal Protocol on Substances That Deplete the Ozone Layer at London*, UNEP/OzL.Pro.2/3 (1990) (meeting held 27-29 June 1990); *Report of the Third Meeting of the Parties to the Montreal Protocol on Substances That Deplete the Ozone Layer at Nairobi*, UNEP/OzL.Pro.3/11 (1991) (meeting held 19-21 June 1991); *Report of the Fourth Meeting of the Parties to the Montreal Protocol on substances That Deplete the Ozone Layer at Copenhagen*, UNEP/OzL.Pro.4/15 (1992) (meeting held 23-25 November 1992); *Report of the Seventh Meeting of the Parties to the Montreal Protocol on Substances That Deplete the Ozone Layer at Vienna*, UNEP/OzL.Pro.7/12 (1995) (meeting held 5-7 December 1995); *Report of the Ninth Meeting of the Parties to the Montreal Protocol on substances That Deplete the Ozone Layer at Montreal*, UNEP/OzL.Pro.9/12 (1997) (meeting held 15-17 September 1997).

[16] See Table Two, *supra*, at __.

revisions, and then one focused on implementation or on the most preliminary consideration of future changes, seems to be the natural rhythm of the meeting iterations. Anyone hoping for MoP after MoP to produce significant textual changes is probably asking too much.

Fourth, the parties have, with one exception, never effected Revisions during a year that also includes a meeting on the Convention. (The Nairobi Revisions, a hundred words without immediate substantive impact, are the exception.) Without more evidence, however, one may plausibly assume either direction for the casual arrow. The parties may be unable, in the limited time available to them, both to address the Convention and the Protocol; even though a Conference has never actually amended the main body of the Convention, such gatherings have adopted various Convention annexes and discussed the budget of the secretariat serving both the Convention and the Protocol. Alternatively, it may be that the parties know in advance that no important issues are immediately on the horizon in a given year, and so they schedule both Conference and MoP almost simultaneously to allow exclusive attention in the next year to important changes to the Protocol.

B. Textual Changes

The degree of cooperation associated with a treaty is clearly a function of more than simply the number of meetings that the parties to that treaty undertake. This sub-section examines the rigor of the rules embodied in the ozone treaties over time.

As a result of the particular scheme persistently adopted by the parties to the Protocol, there are two readily quantifiable dimensions of those rules: the number of chemicals (or groups of chemicals) subject to regulation of any kind, and the Allowable Percentage for a given group of chemicals in a given year. I call the number of regulated chemicals or groups of chemicals an indication of the "breadth" of the ozone-treaty regime, while I call reductions in the Allowable Percentage an indication of the "depth" of that regime's rules. These dimensions are not only readily quantifiable but also readily associated with judgments about the direction of their impact on the ozone layer. Each increase in the number of regulated chemicals, and each decrease in the Allowable Percentage, reflects greater cooperation with respect to preservation of the ozone layer. One may argue about how much actual impact each change has, and about whether each change produces benefits greater than its costs, and of course about whether parties will comply with each change in the rules, but one would be hard pressed to argue that

regulating fewer chemicals or increasing their usage aids in preservation of the ozone layer. (I assume here, and it is an assumption borne out by the facts surrounding the text of the ozone treaties, that additions of chemicals and decreases in Allowable Percentages are both what one might call "unmitigated"—that is, that chemicals are added to the list of those regulated but no other chemicals are simultaneously eliminated, and that Allowable Percentages are reduced or remain constant, but never increase.)

Next, with some hesitation as to the net utility of the endeavor, I discuss data concerning the number of words in a treaty regime's texts as a measure of the success of the iterative process. The availability of treaties in on-line form, combined with the word-counting features of computer software, now makes the calculation of the length of a treaty text relatively straightforward. (There are still some definitional issues. Even the calculations themselves involved some effort. In my experience, the only thing that *truly* happens "at the touch of a button" is—eventually—the appearance of an elevator.) That such calculations actually mean anything may strike many as counter-intuitive. In my view, however, it is worthwhile at least to develop the relevant data, as well as to explore the arguments on each side of the proposition that such calculations are useful.

Finally, I explore a broader, more subjective phenomenon reflected in the ozone regime, which I call its "approaches." If one were to describe the fundamental approaches to the problem of ozone depletion embodied in the ozone treaties, one can discern a certain proliferation. One might, for example, assert that the Convention embodies promises of general substantive cooperation and specific promises concerning the procedures to be used in creating future promises. The original Protocol adds the core regulatory approach. One may discuss these approaches in a fashion very roughly similar to the breadth and depth of regulatory rigor described above—although the much more subjective nature of determining the boundaries of an "approach," in contrast to measurements of breadth or depth or length, imposes some distinct limitations on the analysis.

1. Breadth

The core regulatory approach of the ozone treaties' substantive rules involves the regulation of anthropogenic ozone-depleting chemicals. The original Montreal Protocol and its subsequent revisions list various ozone-depleting chemicals in their annexes. For each chemical, the relevant annex lists its ODP, a scientifically based estimate of the harm to the ozone layer caused by a molecule of the given chemical. With respect to most chemicals, the annexes then gather together several particular chemicals into "groups" sharing the same general chemical structure. (Occasionally there is only one

chemical in a so-called "group.") For example, "Group I" of Annex A consists of five chlorofluorocarbons, a kind of chemical compound containing atoms of chlorine and fluorine and carbon (but no other constituents).[17] Three halons, which all contain atoms of chlorine and fluorine and bromine (but no other constituents), are aggregated into "Group II" of Annex A.[18] It is the sum of the ODP-weighted consumption or production of all the chemicals in a group that one uses, in conjunction with the Allowable Percentage, to determine the allowable consumption or production each year.[19]

Whether measured in terms of individual chemicals or of "groups" of chemicals, the breadth of the ozone treaties' regulations has increased (or remained the same) with each new document in the series. Table 3 summarizes these changes. The Convention did not require reductions in the production or consumption of *any* chemicals.[20] The original Protocol listed two separate groups of chemicals, the five chlorofluorocarbons and three halons mentioned in the paragraph above.[21] The London Revisions retained intact the groupings and chemicals of the original Protocol; but added another group of chlorofluorocarbons (consisting of nine different chemicals) as well as two one-chemical groups (for carbon tetrachloride and methyl chloroform).[22] The Copenhagen Revisions retained all of the previously assigned chemicals and groupings, while adding one group of 40 different hydro*chloro*fluorocarbons, one group of 34 hydro*bromo*fluorocarbons, and one "group" consisting only of methyl bromide.[23] The post-Copenhagen enactments have left intact the list and groupings of chemicals effected by the original Protocol, the London Revisions, and the Copenhagen Revisions.[24]

[17] Montreal Protocol, *supra* note __, annex A, 26 I.L.M. at 1561.
[18] *Id.*
[19] Montreal Protocol, *supra* note __, art. 3, 26 I.L.M. at 1554.
[20] Vienna Convention for the Protection of the Ozone Layer, Mar. 22, 1985, art. 2(2)(c), 26 I.L.M. 1529 at 1530 (entered into force September 22, 1988) [hereinafter Vienna Convention] (limiting the parties' general obligations as, *inter alia*, cooperation "in the formulation of agreed measures, procedures and standards for the implementation of this Convention, with a view to the adoption of protocols and annexes").
[21] Montreal Protocol, *supra* note __, art. 2, 26 I.L.M. at 1552.
[22] London Revisons, *supra* note __, art. 2D, 2E, 30 I.L.M. at 544-45.
[23] Copenhagen Revisions, *supra* note __, art. 2F, 2G, 2H, 32 I.L.M. at 879-81.
[24] Vienna Adjustments, *supra* note __.

TABLE THREE—CHANGES IN GROUPS AND CHEMICALS REGULATED BY THE OZONE TREATIES

Document	Total Groups Regulated	Total Chem-icals Regulated	Range of ODPs in Added Groups
Vienna Convention	0	0	---
Montreal Protocol	2	8	0.6-1.0 (CFCs) 3-10 (halons)
London Revisions	5	20	1.0 (more CFCs) 1.1 (carbon tetrachloride) 0.1 (methyl chloroform)
Nairobi Addition	5	20	---
Copenhagen Revisions	8	95	0.14 or less (HCFCs) 0.3 - 14.0 (HBFCs) 0.7 (methyl bromide)
Later Enactments	8	95	---

The breadth of the ozone-treaty regime thus involves a period of intense growth bracketed by periods of perfect inactivity. The Convention regulates no chemicals.[25] The enactments between 1988 and 1992 are responsible for all the changes in breadth. After the Montreal Protocol breaks the ice, as it were, the London Revisions and Copenhagen Revisions together quadruple the original Protocol's breadth on a per-group basis and increase the original Protocol's breadth by more than ten times on a per-chemical basis.[26] The post-1992 enactments do not add a single chemical.[27]

Simply counting the number of chemicals and groups implies that all ozone-depleting substances are created equal. One might wonder, however, if early enactments picked unimportant targets to be sure of hitting something. In fact, the original Protocol regulated those substances thought to be the most threatening to the ozone layer, as measured in terms of a combination of volume of production and ODP. The CFCs were used in great volume, while the halons were used in significant volume and possess very high ODPs. Subsequent enactments regulated the HCFCs largely because they were thought to be viable substitutes for CFCs, which were by that time scheduled to be banned. The scientific data showing that bromine, the crucial component of the last-regulated HBFCs and methyl bromide, is a catalyst of ozone-depleting reactions became available much later than that showing the catalytic role of chlorine. One may therefore conclude that, given the state of scientific knowledge, the parties regulated the most worrisome substances first.

One might also note that the incorporation of chemicals and groups displays a ratchet effect: no chemical or group, once regulated, has been de-regulated.[28]

Speaking both from a purely quantitative and from a partly qualitative perspective, then, the changes over time in the breadth of the ozone-treaty regime are most consistent with what one might call "a matured evolution of cooperation." The first enactment regulates no chemicals, followed by a phase of three enactments over four

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[25] Vienna Convention for the Protection of the Ozone Layer, Mar. 22, 1985, art. 2(2)(c), 26 I.L.M. 1529 at 1530 (entered into force September 22, 1988) [hereinafter Vienna Convention] (limiting the parties' general obligations as, *inter alia*, cooperation "in the formulation of agreed measures, procedures and standards for the implementation of this Convention, with a view to the adoption of protocols and annexes"). **[if previously cited, cite as: *Supra* note __ (20)]**

[26] See Table Three, *supra*, at __.

[27] *See generally* Vienna Adjustments, *supra* note __; Montreal Revisions, *supra* note __.

[28] London Revisions, *supra* note __, art. 2, 30 I.L.M. at 542-45; Copenhagen Revisions, *supra* note __, art. 2, 32 I.L.M. at 878-81; Vienna Adjustments, *supra* note __; Montreal Revisions, *supra* note __.

years in which the breadth of the system grows rapidly in both numerical terms and effectiveness, followed in turn by a phase of at least as many years in which no further expansion occurs. (An analogy from human development—although I am not claiming it as an example of either iteration or cooperation—might be the development of language. The initial period involves an inability to employ much in the way of words at all, followed by a period of rapid growth in vocabulary and articulation, followed in turn by a period of relative stasis.)

2. Depth

a. Summary

The particulars of the regulatory scheme adopted by the ozone treaties lend themselves to a quantitative examination of the changes over time in the rigor of their strictures, which I call their "depth." For each group of chemicals within the scope of a given document's regulations, there is a reduction in the Allowable Percentage associated with each particular year in the future of the regime. For example, the original Protocol specifies that, in 1999, each nation's Allowable Percentage of the five CFCs in Group I of Annex A shall be 50% of that nation's aggregate, ODP-weighted consumption or production of those chemicals in the baseline year.[29] Moreover, for many chemicals, subsequent enactments specify *additional* reductions in the Allowable Percentage over time.[30]

One may therefore examine the changes over time in the relevant percentages in two different ways: within a given document and across documents. Along both dimensions, there is a monotonic decrease over time in the Allowable Percentage for every group of chemicals addressed. In any given enactment, the Allowable Percentages always decrease (or remain constant) over time for each group of chemicals[31]; across relevant enactments for a given group of chemicals, the Allowable Percentages likewise

[29] Montreal Protocol, *supra* note __, art. 2(4), 26 I.L.M. at 1552-53.
[30] For example, the London Revisions quicken this timetable, specifying that in 1997 each nation's Allowable Percentage of the chemicals in Group I of annex A shall be 15% of that nation's calculated levels of consumption or production in the baseline year. London Revisions, *supra* note __, art. 2, para. 4, 30 I.L.M. at 539. The Copenhagen Revisions further accelerate the reduction by specifying that beginning in 1996 the Allowable Percentage of these same chemicals shall be reduced to zero. Copenhagen Revisions, *supra* note __, art. 2(4), 32 I.L.M. at 876.
[31] See Table Four, *infra*, at __; Table Five, *infra*, at __; Table Six, *infra*, at __; Table Seven, *infra*, at __; Table Eight, *infra*, at __; Table Nine, *infra*, at __; Table Ten, *infra*, at __.

always decrease (or remain constant) over time.[32] The intra-enactment trend is consistent with a belief by the parties at a given time that future iterations promise greater cooperation (in the form of stricter standards in later years); the inter-enactment trend reflects the realization of greater cooperation by the parties (in the form of stricter standards in a subsequent enactment) in future iterations.

b. Specific Chemical Groups

As mentioned above, the original Montreal Protocol addressed two groups of chemicals: five CFCs (known somewhat unimaginatively as CFC-11, CFC-12, CFC-113, CFC-114, and CFC-115), and three halons (described with equal pragmatism as halon-1211, halon-1301, and halon-2402).[33]

The Original CFCs. With respect to the five "original" CFCs, the original Protocol left them unregulated until "the twelve-month period commencing on the first day of the seventh month following the date of entry into force of this Protocol."[34] (Entry into force was contemplated by the drafters of the treaty as, and proved in fact to be, January 1, 1989.)[35] For that first regulated twelve-month period, and for all subsequent twelve-month periods, the Allowable Percentage for the five CFCs constituting Group I of Annex A was 100%.[36] (One might call this a "freeze" on consumption and production, although the aggregation of chemicals within a group allowed parties some flexibility to vary levels of production and consumption of chemicals within the group.) For the period from mid-1993 through mid-1994, the relevant Allowable Percentage was reduced to 80%[37]; by the twelve-month period commencing in mid-1998 (and for all subsequent twelve-month periods), the relevant Allowable Percentage dropped to 50%.[38]

The London Revisions tightened this regulatory scheme, and the Copenhagen Revisions tightened the regulation of the five original CFCs still further. For the period spanning mid-1996 through mid-1997, for example, the original Protocol specified the Allowable Percentage for the five original CFCs at 80%[39]; the London Revisions further

[32] *Id.*
[33] Montreal Protocol, *supra* note __, annex A, 26 I.L.M. at 1561.
[34] Montreal Protocol, *supra* note __, art. 2(1), 26 I.L.M. at 1552.
[35] Montreal Protocol, *supra* note __, art. 16, 26 I.L.M. at 1559.
[36] Montreal Protocol, *supra* note __, art. 2(1), 26 I.L.M. at 1552.
[37] Montreal Protocol, *supra* note __, art. 2(3)., 26 I.L.M. at 1552.
[38] Montreal Protocol, *supra* note __, art. 2(4)., 26 I.L.M. at 1552.
[39] Montreal Protocol, *supra* note __, art. 2(3)., 26 I.L.M. at 1552.

reduced the relevant Allowable Percentage to 50% for 1996[40]; and the Copenhagen Revisions specified 0% as the relevant Allowable Percentage for that year.[41] (One might call a 0% Allowable Percentage a "ban" on the consumption and production of the relevant substances, although the treaty in fact sets forth some exceptions to the Allowable Percentages that operate to permit some continuing consumption and production of the five original CFCs today without violating the treaty.)[42] Table 4 sets forth the relevant Allowable Percentages for all periods covered by each ozone enactment. (Post-Copenhagen documents did not further reduce the Allowable Percentage for CFCs[43]; by the time that such documents could have entered into force, the Copenhagen Revisions already mandated a 0% Allowable Percentage.)

TABLE FOUR—GROUP I OF ANNEX A (ORIGINAL CFCS)

Document	Initial Period	1993	1994	1995	1996	1997	1998	1999	2000 and each later year
Montreal Protocol	100%	80%	80%	80%	80%	80%	50%	50%	50%
London Revisions	100%	80%	80%	50%	50%	15%	15%	15%	0%
Copenhagen Revisions	100%	80%	25%	25%	0%	0%	0%	0%	0%

Note: For the original Montreal Protocol, the year shown above designates an annum beginning on July 1st of the year shown and continuing until June 30th of the subsequent calendar year. For the London Revisions and the Copenhagen Revisions, the year shown above designates an annum beginning on January 1st of the year shown and continuing until December 31st of that same calendar year.

[40] London Revisions, *supra* note __, art. 2(3), 30 I.L.M. at 539.
[41] Copenhagen Revisions, *supra* note __, art. 2A(4), 32 I.L.M. at 876.
[42] Montreal Protocol, *supra* note __, art. 2(5), 26 I.L.M. at 1553 (industrial rationalization); Montreal Protocol, *supra* note __, art. 5, 26 I.L.M. at 1555-56 (basic domestic needs of developing nations).
[43] *Compare* Vienna Adjustments, *supra* note __, *and* Montreal Revisions, *supra* note __, *with* Copenhagen Revisions, *supra* note __, art. 2A(4), 32 I.L.M. at 876.

The Halons. Three chemicals—halon-1211, halon-1301, and halon-2402—comprise Group II of Annex A.[44] The regulation of halons did not begin as quickly as did the regulation of the original CFCs[45], and the Allowable Percentage in a given year for halons was typically greater than the Allowable Percentage for CFCs in that same year.[46] Nonetheless, the trend towards stricter regulation, with an ultimate reduction in the Allowable Percentage to 0%, encompasses not only the original CFCs but also the halons.[47] Table Five shows the Allowable Percentages for the halons in the original Protocol, the London Revisions, and the Copenhagen Revisions. Again, there is no need to display post-Copenhagen enactments because such enactments did not modify the regulation of halons.

TABLE FIVE—GROUP II OF ANNEX A (HALONS)

Document	Initial Period	Three Years After Initial Period	1992	1993	1994	1995	1996	1997	1998	1999	2000 and each later year
Montreal Protocol	Not reg-ulated	100%	---	---	100%	100%	100%	100%	100%	100%	100%
London Revisions	---	---	100%	100%	100%	50%	50%	50%	50%	50%	0%
Copenhagen Revisions	---	---	---	100%	0%	0%	0%	0%	0%	0%	0%

Note: For the original Montreal Protocol, the year shown above designates an annum beginning on July 1st of the year shown and continuing until June 30th of the subsequent calendar year. For the London Revisions and the Copenhagen Revisions, the year shown above designates an annum beginning on January 1st of the year shown and continuing until December 31st of that same calendar year.

[44] Montreal Protocol, *supra* note __, annex A, 26 I.L.M. at 1561.
[45] Montreal Protocol, *supra* note __, art. 2(2), 26 I.L.M. at 1561.
[46] *Id.*; London Revisions, *supra* note __, art. 2B, 30 I.L.M. at 540; Copenhagen Revisions, *supra* note __, art. 2B, 32 I.L.M. at 876.
[47] *Compare* Montreal Protocol, *supra* note __, art. 2(2), 26 I.L.M. at 1561, *with* London Revisions, *supra* note __, art. 2B, 30 I.L.M. at 540, *and* Copenhagen Revisions, *supra* note __, art. 2B, 32 I.L.M. at 876.

The "Follow-on" CFCs. The London Revisions added ten CFCs—CFC-13, CFC-111, CFC-112, and CFCs -211 through -217—to the list of regulated chemicals.[48] These ten newly regulated CFCs constituted Group I of Annex B, which I call the "follow-on" CFCs. The London Revisions stated that, beginning in 1993, the Allowable Percentage for follow-on CFCs would be 80%; beginning in 1997, the relevant Allowable Percentage was to be 15%; beginning in 2000, the relevant Allowable Percentage was to be 0%.[49] The Copenhagen Revisions retained the London Revisions' 80% ceiling for 1993.[50] For 1994 and 1995, however, the relevant Allowable Percentage was reduced from 80% to 25%.[51] Beginning in 1996, the relevant Allowable Percentage was to be 0%.[52] Practically speaking, no post-Copenhagen enactments could have entered into force before the 0% Allowable Percentage, and post-Copenhagen amendments leave in place the Allowable Percentages set forth in the Copenhagen Revisions.[53]

Table Six sets forth the relevant Allowable Percentages. Note that, because the original Protocol did not regulate these substances, only two enactments regulate the relevant chemicals, not three.

TABLE SIX—GROUP I OF ANNEX B (FOLLOW-ON CFCS)

Document	Before 1993	1993	1994	1995	1996	1997	1998	1999	2000 and each later year
London Revisions	Not regulated	80%	80%	80%	80%	15%	15%	15%	0%
Copenhagen Revisions	Not regulated	80%	25%	25%	0%	0%	0%	0%	0%

[48] London Revisions, *supra* note __, annex B, 30 I.L.M. at 552.
[49] London Revisions, *supra* note __, art. 2C, 30 I.L.M. at 543-44.
[50] Copenhagen Revisions, *supra* note __, art. 2C(1), 32 I.L.M. at 877.
[51] Copenhagen Revisions, *supra* note __, art. 2C(1), 32 I.L.M. at 877.
[52] Copenhagen Revisions, *supra* note __, art. 2C(2), 32 I.L.M. at 877.
[53] *See* Vienna Adjustments, *supra* note __; Montreal Revisions, *supra* note __.

Carbon Tetrachloride and Methyl Chloroform. The London Revisions added carbon tetrachloride, a compound familiar to domestic environmental regulators as an important dry-cleaning solvent, to the list of regulated ozone-depleting substances as the only chemical in "Group" II of Annex B.[54] Those Revisions likewise added methyl chloroform as the only chemical in "Group" III of that Annex.[55] Following a pattern that may now seem familiar, the Copenhagen Revisions further tightened the Allowable Percentages for each chemical, including a reduction to 0% effective soon after the Copenhagen Revisions entered into force[56], and post-Copenhagen enactments in the ozone treaties have left in place the Allowable Percentages set forth in the Copenhagen Revisions.[57] See Tables 7 and 8.

TABLE SEVEN—GROUP II OF ANNEX B (CARBON TETRACHLORIDE)

Document	Before 1993	1993	1994	1995	1996	1997	1998	1999	2000 and each later year
London Revisions	Not reg-ulated	Not reg-ulated	Not reg-ulated	15%	15%	15%	15%	15%	0%
Copenhagen Revisions	Not reg-ulated	Not reg-ulated	Not reg-ulated	15%	0%	0%	0%	0%	0%

[54] London Revisions, *supra* note __, annex B, 30 I.L.M. at 552.
[55] London Revisions, *supra* note __, annex B, 30 I.L.M. at 553.
[56] Copenhagen Revisions, *supra* note __, art. 2D, 2E, 32 I.L.M. at 877-78.
[57] *See* Vienna Adjustments, *supra* note __; Montreal Revisions, *supra* note __.

TABLE EIGHT — GROUP III OF ANNEX B (METHYL CHLOROFORM)

Document	Before 1993	1993	1994	1995	1996	1997	1998	1999	2000 through 2004 (per year)	2005 and each later year
London Revisions	Not reg-ulated	100%	100%	70%	70%	70%	70%	70%	30%	0%
Copenhagen Revisions	Not reg-ulated	100%	50%	50%	0%	0%	0%	0%	0%	0%

HCFCs. These 34 chemicals, added to the substances regulated by the ozone treaties with the Copenhagen Revisions, do not fit the typical pattern of progressive tightening over time. The Copenhagen Revisions set up a progressively tighter Allowable Percentage for HCFCs, but no later enactments further reduce those Allowable Percentages despite the fact that the Copenhagen Revisions do not mandate a 0% Allowable Percentage until 2030.[58] The relevant Allowable Percentages are 65% from 2004 to 2009, 35% from 2010 to 2014, 10% from 2015 to 2019, 0.5% from 2020 to 2029, and 0% thereafter.[59] This Allowable Percentage, it should be noted, is to be applied against a baseline measuring the 1989 Allowable Percentage for the 34 HCFCs *plus* 3.1% of the 1989 Allowable Percentage for the five original CFCs. (Consistent with the fact that a nation employing more CFCs in 1989 is by this formula allowed to use more *H*CFCs in later years, the HCFCs are viewed as a transitional substitute for CFCs.)

HBFCs. The HBFCs are the international environmental equivalent of every second-stringer's nightmare: they enter into play only late in the game, and then they are immediately and permanently banished from the field. The Copenhagen Revisions, which entered into force in mid-1994, are the first enactment to treat the HBFCs, and those Revisions impose a 0% Allowable Percentage, beginning in 1996.[60] Like HCFCs, therefore, they deviate to some degree from the model of repeated tightenings of the Allowable Percentages that characterizes the treatment by the ozone treaties of the

[58] *Compare* Copenhagen Revisions, *supra* note __, art. 2F(6), 32 I.L.M. at 880 (delaying complete ban until 2030), *with* Vienna Adjustments, *supra* note __ *and* Montreal Revisions, *supra* note __.
[59] Copenhagen Revisions, *supra* note __, art. 2F, 32 I.L.M. at 879-80.
[60] Copenhagen Revisions, *supra* note __, art. 2G, 32 I.L.M. at 880.

original CFCs, the halons, the follow-on CFCs, carbon tetrachloride, methyl chloroform, and, as discussed immediately below, methyl bromide.

Methyl Bromide. The Copenhagen Revisions are the first document to regulate methyl bromide, a commonly used soil fumigant and a by-product of both biomass burning and internal combustion using leaded gasoline. In contrast to the other chemicals first regulated by the Copenhagen Revisions, however, methyl bromide is also the subject of stricter regulation in subsequent Revisions. The Copenhagen Revisions simply place a freeze on the consumption and production of methyl bromide with respect to the baseline-year consumption or production in 1991.[61] The Vienna Adjustments retain this freeze through the end of the twentieth century, but then begin to ratchet down the Allowable Percentages for methyl bromide through 75% (from 2001-2004) and 50% (from 2005-2009) on the way to a final reduction to 0% in 2010.[62] The Montreal Revisions begin the sub-100% ratcheting two years earlier and impose a 0% Allowable Percentage by 2005. Table 9 compares the depth of regulation in the various documents.

One might also note that methyl bromide is an exception to the usual special treatment accorded developing countries by the ozone treaties. A developing country consuming fewer than 0.3 kilograms per capita of ozone-depleting substances may indefinitely delay its compliance with the particulars of the Allowable Percentage-reduction scheme of the treaties so long as its consumption continues to be fewer than 0.3 kilograms per capita.[63] As of the entry into force of the Vienna Adjustments, however, even a developing nation must abide in a given year by specified Allowable Percentages for methyl bromide.[64] (The timetable is different from that adopted for developed nations, however.) The Montreal Revisions further tighten these regulations, moving up the initiation of a 0% Allowable Percentage by a full quarter of a century.[65] Table 10 summarizes these regulations (including the non-regulations of the Copenhagen Revisions, in order to allow the most directly parallel comparison between the regulation of methyl bromide in developed countries, as shown in Table 9, and in developing countries).

TABLE NINE—ANNEX E (METHYL BROMIDE)—
BASIC REGULATION (DEVELOPED NATIONS)

[61] Copenhagen Revisions, *supra* note __, art. 2H, 32 I.L.M. at 880-81.
[62] Vienna Adjustments, *supra* note __, art. 2H(1)-(4).
[63] Montreal Protocol, *supra* note __, art. 5(1), 26 I.L.M. at 1555.
[64] Vienna Adjustments, *supra* note __, art. 5, para. 8 ter.

Enactment	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005 and each year later	2010 and each later year
Copenhagen Revisions	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Vienna Adjustments	100%	100%	100%	100%	100%	100%	75%	75%	75%	75%	50%	0%
Montreal Revisions	100%	100%	100%	100%	75%	75%	50%	50%	30%	30%	0%	0%

Note: The baseline year for the relevant calculation is 1991.

TABLE TEN—ANNEX E (METHYL BROMIDE)—BASIC REGULATION (DEVELOPING NATIONS)

Document	1995 to 2004	2005 to 2014	2015	2016 to 2039	2040 and each later year
Copenhagen Revisions	No regs apply	No regs apply	No regs apply	No regs apply	No regs apply
Vienna Adjustments	No regs apply	No regs apply	No regs apply	100% of 2015 consumption	0%
Montreal Revisions	No regs apply	80% of 1995-1998 Average of production and consumption	0%	0%	0%

[65] Montreal Revisions, *supra* note __, art. 5, para. 8 ter (d)(iii).

Over and over, and with respect to both aspects of regulatory depth, one sees the same pattern. In a given enactment, the Allowable Percentage either remains constant over time or decreases over time. From enactment to enactment, the Allowable Percentage in a given year likewise either remains constant or decreases. Such a system would seem to involve increasing or constant cooperation under most reasonable definitions thereof.

These two trends have certainly combined to create an extremely strict set of Allowable Percentages for the relevant substances. For every regulated group of chemicals in the ozone-treaty regime, the most recent enactment changing that group's Allowable Percentages sets an Allowable Percentage of 0% for some year. For six of the eight groups of chemicals regulated by the ozone-treaty regime, that year is 1996.[66] For methyl bromides, that year is 2005[67]; for the CFC-substitute HCFCs, the earliest year with a 0% Allowable Percentage is 2030.[68]

As with the measurement of temperature in degrees Kelvin, "zero" is about as low as one may go in specifying Allowable Percentages. If the ratchet-like quality of the depth of regulation in the ozone-treaty regime persists, furthermore, then the specification of an Allowable Percentage of 0% in a given year specifies both a theoretically and permanently maximal degree of cooperation for that year. If the current year is already a year in which the Allowable Percentage for a group is 0%, then one must judge the treatment of that group of chemicals to have matured. As with breadth, then, the ozone-treaty regime must in some sense now be considered "mature" with respect to the depth of six of the eight groups of chemicals that it currently regulates.

One may use the dynamics of cooperation with respect to those six groups to make a prediction about the remaining two groups: they do not appear likely to be subject soon to the maximum possible depth of regulation.

For seven of the eight groups regulated by the Protocol, either the first enactment regulating the group set the Allowable Percentage to 0% in the very near future, or the immediately subsequent enactment imposed further reductions on the Allowable Percentages for that group.[69] The exception to this rule is the HCFCs. The Copenhagen Revisions were the first enactment regulating HCFCs; those Revisions do not set a 0%

[66] See Table Four, *supra*, at __; Table Five, *supra*, at __; Table Six, *supra*, at __; Table Seven, *supra*, at __; Table Eight, *supra*, at __.
[67] See Table Nine, *supra* at __.
[68] Copenhagen Revisions, *supra* note __, art. 2F(6), 32 I.L.M. at 880.
[69] See Tables Four through Nine, *supra* at __.

Allowable Percentage for HCFCs until 2030[70]; and neither of the Revisions following the Copenhagen Revisions addresses HCFCs.[71] With respect to this group, no repeated interactions with a steady (and ratcheted) increase in the depth of cooperation appears to be underway.

Methyl bromide is the other group of chemicals with respect to which an Allowable Percentage of 0% is not already in place. The Copenhagen Revisions were the first enactment to regulate methyl bromide. (See Table 9.) They set an Allowable Percentage of 100% for methyl bromide for each year from 1995 on.[72] The immediately subsequent Vienna Revisions imposed an Allowable Percentage of 75% beginning in 2001 and an Allowable Percentage of 0% in 2010.[73] The Montreal Revisions in turn moved up the first 75% AP to 1999; the first 0% AP was set at 2005.[74] Methyl bromide thereby achieved a distinction indicating a certain intractability in its control, at least compared to other substances regulated by the ozone-treaty regime: methyl bromide is the only substance to be the subject of more than one enactment that, by the third enactment, has not had its Allowable Percentage reduced to 0% within a few years of that enactment's adoption. In contrast to the situation with HCFCs, however, the parties have been willing to revisit the Allowable Percentages regulating methyl bromide in enactments subsequent to the initial enactment regulating the group, so perhaps the *fourth* time will be the "charm" for the near-term-0%-Allowable Percentage regulation of methyl bromide.

3. Length

In the most banal sense, the output of a treaty process consists of words on paper. The re-conversion of those words from ink-on-paper to electrons allows one to count this output with relative ease, although some definitional questions are likely to remain with any treaty (which language to use, whether to count the words in the captions of articles, and so forth) even after one has found a suitable on-line version of the text and a computer capable of counting words. I set forth a variety of measurements of the length of the ozone treaties and then discuss a variety of arguments addressed to the question of whether such a mechanical measurement is of any actual utility.

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[70] Copenhagen Revisions, *supra* note __, art. 2F(6), 32 I.L.M. at 880. **[or: *Supra* note __ (71)]**
[71] Vienna Adjustments, *supra* note __; Montreal Revisions, *supra* note __.
[72] Copenhagen Revisions, *supra* note __, art. 2H, 32 I.L.M. at 880-81.
[73] . Vienna Adjustments, *supra* note __, art. 2H(2), (4).
[74] Montreal Revisions, *supra* note __, art. 2H(2), (5).

In English, the Vienna Convention is about 5800 words long, including roughly 1500 words contained in two annexes that elaborate upon the particulars of scientific research and cooperation described in the main text. The original Protocol is roughly 4400 words in length, with roughly 100 of those words contained in an annex listing a handful of ozone-depleting substances and their ozone-depleting potential.

The proper treatment of Revisions in the ozone series is, even with respect to the relatively mechanical measurement of the number of words therein, somewhat ambiguous. In contrast to the Initial Enactments, the Revisions cannot stand on their own; they instead consist of amendments or adjustments to the original Protocol. Each of these Revisions (with the exception of the Nairobi Addition) contains both some passages of text designed to replace previously enacted provisions and some passages that are purely additive. For example, the London Revisions contain some text that effects the stricter regulation of the original CFCs, which were already regulated in the original Protocol, as well as some text that sets forth rules on a Multilateral Fund (for technology transfer), an entity completely absent from the original Protocol.

One obvious response to such a situation is to count not the length in words of each enactment but rather the length in words of the composite document that results from incorporating the changes and additions of the latest enactment into the previously existing version. With a bit of work, one can certainly create such a composite document. "Mere" replacement text then disappears for counting purposes, while "true" additions continue to show up as additional text.

There is nonetheless some appeal to a quantification that simply counts the words in each enactment, replacements, additions, preamble, and all. First, such an approach is a measure of the actual, treaty-text output of the various meetings of the parties; the drafters of the London Revision needed to agree upon the language of all the words in the enactment, for example, even for those passages that "merely" replaced pre-existing language.

This simple-counting approach also has some appeal as a valid measurement of the textual richness of the ozone treaties in another sense. A party may join any sub-set of the ozone treaties so long as that party joins the Convention and does not "skip" subsequent enactments. For example, a party may consent fully to the Convention, the original Protocol, and the Copenhagen Revisions, but refrain from expressing any consent with respect to the later-enacted London Revisions, Nairobi Addition, Vienna Adjustments, and Montreal Revisions. (A great many nations have in fact fully consented to some but not all of the versions of the Protocol, as I discuss in more detail below.) Each enactment therefore makes a permanent contribution to the possible

regulations governing a potential party, even if still-later enactments override the earlier enactments for those parties joining all enactments. In terms of quantifying the variety of options presented to a nation currently unbound by any enactment, the simple-counting approach is a better measure than the composite-creation approach.

TABLE 11—ENACTMENT LENGTH AND COMPOSITE LENGTHS OF DOCUMENTS IN THE OZONE TREATIES

Document	Year of Enactment	Length in Words of Enactment	Length in Words of Enactment without Annex(es)	Length in Words of Composite Document	Length in Words of Composite Document without Annex(es)
Vienna Convention	1985	5800	4300	5800	4300
Montreal Protocol	1988	4400	4300	4400	4300
London Revisions	1990	6200	6000	7800	7600
Nairobi Addition (Annex D)	1991	100	0	7900	7700
Copenhagen Revisions	1992	5500	4800	9900	9200
Vienna Adjustments	1995	4200	1300	10,700	10,000
Montreal Revisions	1997	3400	1500	11,000	10,700

Note: The "composite document" is the text of the original Montreal Protocol with the changes specified by the various Revisions incorporated into a single, non-redundant document. For example, if the London Revisions provided a paragraph to replace a pre-existing paragraph in the original Montreal protocol, only the replacement paragraph would appear in the composite document (and thus only the replacement paragraph would count towards the length of the composite document). One might also think of the composite document as the "latest potentially governing text."

Table 11 reflects both the simple-counting and the composite-creation approaches. The column headed "Length in Words of Enactment" simply counts the words in each separate "road map" of changes and additions produced by a MoP. The column headed "Length in Words of Composite Document" counts the words in the document that results from beginning with the original Protocol and then incorporating *seriatim* any changes and additions resulting from the later enactments. The entry for the Copenhagen Revisions, for example, results from counting the words in the document that results from beginning with the text of the original Protocol, incorporating the changes and additions of the London Revisions and Nairobi Addition, and then in turn

incorporating the changes and additions made by the Copenhagen Revisions to the Nairobi-Addition composite document. The table also shows changes including and excluding annex text; text in the annexes is still part of the treaty, but the prevalence of chemical and numerical information in many of the annexes reduces somewhat the reliability of the counting. (Is the phrase "0.1 - 0.4" for an ODP estimate one word or three, for example?)

Assuming for the moment that these quantifications correspond in some rough way to the output of the parties' cooperative efforts respecting the subject matter of the ozone treaties—an assumption that I examine in more detail shortly—then what can one glean from an examination of these word counts?

(As discussed above in connection with the meetings of the parties, there seems to be a two-year cycle of enactment and quiescence. I therefore use two-year intervals as the relevant period. I also assume that the parties will not break this pattern by adopting an enactment in 1998 after having also done so in 1997.)

The parties to the ozone-treaty regime have produced a steady flow of verbiage to guide them in their endeavor. Five of the seven two-year intervals from 1985–86 through 1997–1998 have led to exactly one enactment. (There were two enactments of 1991–92 and none in 1993–94.) Each enactment has consisted of between 3400 and 6200 words. The Protocol has much more than doubled in composite length, from its initial length of 4400 words to its current 11,000 words.

One may recall the "ratchet" effect of the breadth and depth of the regulations in the ozone-treaty regime: once included as a subject of regulation, no chemical is de-regulated, and once a group is assigned an Allowable Percentage for a given year, that Allowable Percentage is never increased. It is not possible to observe a precisely analogous ratcheting with respect to the words in the treaty themselves: some phrases appearing in an enactment are later replaced. The length of both texts in the ozone-treaty regime does either increase or remain the same over time, however. The Convention has not been modified and thus remains at its original length, while the length of each composite Protocol increases steadily throughout the series.

Despite the relative steadiness of this output, one may divide the parties' linguistic products into two six-year periods surrounding the 1991-92 interval containing the Copenhagen Revisions. In the six-year period from 1985 to 1990, the parties produced a total of more than 16,000 words in the enactments that effected the Convention, the original Protocol, and the London Revisions. In the six-year period from 1993 to 1998,

in contrast, the parties produced a total of fewer than 8000 words in the enactments effecting the Nairobi Addition, the Vienna Revisions, and the Montreal Revisions.

The difference is even more dramatic if one examines the change in the length of composite documents rather than the enactments, and even if one omits the never-amended Convention from the analysis to focus on the Protocol. The Protocol grew from 0 words to 13,700 words in the period between 1985 and 1990, and then increased by only 1,100 words in the period between 1993 and 1998. (This measure omits the Copenhagen Revisions at the "pivot.")

If one ignores not only the Convention but also the original Protocol to focus exclusively on the Revisions, then there is a similar division between an early period of verbal proliferation and a later period of relative restraint. The Protocol was 5600 words longer after the London Revisions, the Nairobi Addition, and the Copenhagen Revisions, while the three subsequent Revisions increased the composite length of the Protocol by only an additional 1000 words.

The assumption that all of these quantifications of treaty length actually mean anything, of course, is subject to some doubt. Simply counting up the words in a treaty, or comparing the lengths in a series of enactments, seems more the task of a simple scrivener than ink for the wells of the analytically inclined. Certainly the connection between substance and verbal output is not to be taken for granted: one can construct prolixities of virtually no meaning, as well as profundities of great pith. The Agreement on the Conservation of Polar Bears is roughly 1,000 words long[75], while the Charter of the United Nations is under 10,000 words[76], but one imagines that the Charter is much more than ten times as important to international politics than the Agreement (unless one is a polar bear, presumably). Indeed, the ozone-treaty set presents an example of a similar phenomenon: the 5800 words of the Convention impose essentially no substantive obligations whatsoever on the parties thereto, while the original Protocol uses fewer words to set forth some highly concrete obligations.

Nonetheless, one should also not be too hasty to dismiss the rough correlation between word counts and some useful measure of the output of a treaty process. In the context at hand, one is not comparing polar bears with peacekeeping, but rather one treaty

[75] Agreement on the Conservation of Polar Bears, Nov. 15, 1973, 27 U.S.T. 3918, 13 I.L.M. 13.
[76] Charter of the United Nations, 1 UNTS xvi.

addressed to the regulation of anthropogenic ozone-depleting substances with another treaty addressed to the regulation of anthropogenic ozone-depleting substances. Furthermore, once one moves away from a comparison of the Convention to the original Protocol in favor of comparing one version of the Protocol with another, then the level of specificity evoked by the relevant obligations does seem fairly constant from document to document. One might also note that the post-Copenhagen enactments are associated not only with a diminution in the rate at which additional words are added to the Protocol but also with, as discussed earlier, a cessation in the addition of new chemicals to the groups regulated by the regime and a cessation in the further deepening of regulation (with the exception of stricter regulations for methyl bromide in both the Vienna Revisions and the Montreal Revisions).

One might also defend the usefulness of measuring the length in words of legal enactments at a more general level. Certainly, lengthier verbal formulations can be correlated with more rules or with more precisely specified rules. Academics criticized by the lay public for their wordiness or multi-syllabism frequently reply that precise speech is both necessary and necessarily lengthy. (A counter-argument would be that those academics are simply fortifying their intellectual barriers to entry, but one might at least ponder whether such a counter-argument is as applicable to a conversation among, say, physicians or physicists as it is to a conversation among, say, professors of law or literature.) The length of treaties may similarly bear some relationship to their content. As with the elaboration and interpretation of rules derived from the common law or statutes or constitutions, one might argue that the interpretation of rules derived from treaties requires an increase in the length of some relevant authoritative texts, and subsequent treaty text tends to be just the repository of such clarifications in an international legal system that does not reliably produce authoritative judicial decisions.

Additionally, one must note that nations are likely to pay a price for longer texts in terms of increased transactions costs of inter- and intra-national negotiations, and that nations should be unwilling to pay that price unless the increase in length yields benefits. To negotiate longer textual passages requires, by definition, the formulation of more words, and the formulation of texts in international negotiations is rarely costless. The formulation of a treaty typically involves the commitment of significant governmental resources, in the form of on-site negotiators, inter-agency coordination of the national negotiating position, and (in at least some nations) interactions between the executive and legislative branches. Treaties of greater textual length seem likely to require a greater commitment of such resources. If nations are the rational, self-interested actors that IR theorists so often assume them to be, then rational nations should be willing to pay the price of longer texts only if the rewards from doing so are at least commensurate.

4. Approaches

Both the breadth and the depth of the ozone treaty regulations seem to be susceptible of relatively objective measurement and to be clearly correlated to the degree of underlying international cooperation that nations seek to effect by participating in the ozone treaties—at least so long as nations comply with those increasingly broad and deep formal obligations. As nations place more and more chemicals within the ambit of the ozone treaties' regulations, and as that regulation requires a given chemical to be consumed and produced in smaller and smaller quantities, the ozone-treaty regime clearly becomes more and more effective in the pursuit of a more robust ozone layer. The particular nature of the ozone-treaty regime means that the characterization of a particular change as effecting the regulation of "more and more chemicals" and "smaller and smaller quantities" thereof is a highly objective evaluation.

The length of the ozone-treaty regulations is likewise a highly objective evaluation, but the regime's verbiage does not seem so reliably correlated with the degree of cooperation embodied in the regime. Nonetheless, given the relative ease with which one may calculate the relevant measures and given a number of arguments that do support some relationship between length and the degree of cooperation embodied in the regime, I have an undertaken an examination of the length in words of the ozone treaties.

The final topic of this sub-section—the "approaches" manifested in each enactment in the set of ozone treaties—may strike some as rankly subjective. The fundamental idea is to one of aggregation: to attempt to identify some higher-level approaches implicit in the myriad of particular provisions in the ozone treaties. I have already referred to the "core regulatory approach" of the ozone treaties—the aggregation of ozone-depleting chemicals into various groups with the limitation, by group, of ODP-weighted production and consumption in each year according to an Allowable Percentage of a baseline year.

One might first note that there is nothing magical, nor magically permanent, about this weighted-quota, percentage-reduction approach. Other treaties with an environmental focus have adopted, *inter alia*, unweighted quotas, immediate bans, quotas ranked by weight rather than by environmental harm, licenses, and admonition. Indeed, the International Convention for the Regulation of Whaling (ICRW) and the Convention on International Trade in Endangered Species have each adopted more than one of these approaches simultaneously, and the ICRW has tried and then entirely abandoned certain approaches.[77] The fact that the core regulatory approach of the ozone treaties has remained constant throughout the various enactments following the Convention is itself worthy of note.

The core regulatory approach of the ozone treaties is not the only approach that one might identify within this set of treaties. Certainly there are provisions in the treaty on other topics. One or more of the enactments in the ozone treaties provide that richer nation-parties are required to pay 100% of the poorer nation-parties' costs of compliance with the treaty[78]; that each nation-party is required to ban the import of controlled substances from any non-party nation[79]; and that there are five languages in which the text of the treaty has been translated with equal authenticity.[80] Some of these provisions, or some combinations of them, seem sufficiently related and sufficiently important to rise to the level of an "approach" that one might use as a short-hand description of a significant aspect of the treaty regime. The judgment about which provisions combine to represent an "approach" is a subjective determination, but I pursue it here as a potentially fruitful way to examine both the statics and the dynamics of the enactments in the ozone treaties.

Table Twelve summarizes the approaches embodied in the ozone treaties. These approaches are largely cumulative—that is, an approach adopted in one treaty carries through unmodified to all later treaties, unless otherwise noted. For the sake of conciseness, therefore, Table Twelve shows the approaches newly embodied in each of the enactments in the set of ozone treaties.

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[77] With respect to quotas and bans, see International Convention for the Regulation of Whaling, December 2, 1946, art. 5(1), 161 U.N.T.S. 72, 80 [hereinafter ICRW] (authorizing "regulations with respect to the conservation and utilization of whale resources, fixing protected and unprotected species, . . . size limits for each species, . . . and catch returns"); Convention on International Trade in Endangered Species of Wild Fauna and Flora, Mar. 3, 1973, art. 2(4), 12 I.L.M. 1085, 1089 [hereinafter CITES] (forbidding parties from trading in specimens of species included in certain appendices except in accordance with various provisions).

[78] London Revisions, *supra* note __, art. 10, 30 I.L.M. at 550 (establishing Multilateral Fund to enable compliance of parties operating under paragraph 1 of Article 5).

[79] Montreal Protocol, *supra* note __, art. 4, 26 I.L.M. at 1554-55.

[80] Montreal Protocol, *supra* note __, art. 20, 26 I.L.M. at 1560. **[Montreal Protocol lists 6 languages, subsequent versions omit French. Find out where exactly this occurred.]**

TABLE TWELVE—ENACTMENTS AND APPROACHES IN THE OZONE TREATIES

Enactment	New Approaches
Vienna Convention	General Cooperation Scientific Cooperation Procedures for Future Enactments
Montreal Protocol	Core Regulatory Approach Exceptions to Core Regulatory Approach (Industrial Rationalization for All, and Basic Domestic Needs for Developing Countries) Trade Bans Developing-Nation Delay
London Revisions	Multilateral Fund {Exceptions to Core Regulatory Approach (Basic Domestic Needs for Developing Countries)}
Nairobi Revisions	None
Copenhagen Revisions	{ Exceptions to Core Regulatory Approach (Essential Domestic Uses for Developed Nations Once Allowable Percentage is 15% or Below) }
Vienna Revisions	None
Montreal Revisions	Export Ban for Non-Complying Parties Licensing for Imports and Exports

Note: Curly brackets {} indicate a significant modification to an already-existing approach.

The Convention appears to involve roughly four approaches: (1) vague promises of general cooperation among nations; (2) some moderately concrete specifications of the scientific agenda (as set forth in the annexes) with respect to which the parties are to co-ordinate their research; (3) a set of rules governing the status of the Convention itself (such as when it enters into force, how it is to be amended, when and how parties may withdraw from it); and (4) a promise also to use those rules with respect to the texts of any *future* "protocols" building on the Convention. The third approach—specifying when the Convention will be partly and fully binding on nation-parties, and how to amend its text—is common to all treaties and will not be discussed further for any treaties in the ozone set. The other approaches—a vague promise of general cooperation, the specification of a cooperative scientific agenda, and the adoption of a convention-protocol approach—are sufficiently distinct from the approaches of a large number of other treaties to keep in mind.[81]

It is clear that the original Protocol adds at least four more approaches to those set forth in the Convention. The first is the core regulatory scheme, discussed in exhaustive detail above, in which parties promise to reduce their production and consumption of regulated chemicals in accordance with the Allowable Percentages specified in the treaties. The second is the specification of exceptions to this core regulatory scheme. For purposes of "industrial rationalization," and with respect to production only (not consumption), a party may exceed its Allowable Percentage by a specified amount (typically 10%, but occasionally 15%).[82] For developing countries, production for "basic domestic needs" may also contribute to the specified-percentage excess.[83] The third clear addition of the Montreal Protocol is a promise not to engage in trade in regulated substances with nations that are not party to the Protocol.[84] The fourth clear additional approach in the original Protocol is a statement that a developing nation may delay by ten years its obligations under the core regulatory scheme of the Protocol, so long as its ODP-weighted consumption and production of controlled substances does not exceed 0.3

[81] For example, the first set of strategic arms-control agreements focused on substance. "While the Ozone Convention sets forth a number of organizational and procedural rules for future agreements, the SALT I agreements make no explicit effort to lay down procedural provisions governing future treaties and specify only a bare minimum of organizational arrangements." John K. Setear, *An Iterative Perspective on Treaties: A Synthesis of International Relations Theory and International Law*, 37 HARV. INT'L L.J. 139, 224 (1996). Likewise, "[w]hile the London and Copenhagen Revisions to the Montreal Protocol make clear their huge debt to the Protocol itself, later strategic arms-control agreements rarely make explicit reference to a previous treaty in the series." *Id.*

[82] Montreal Protocol, *supra* note __, art. 2(5), 26 I.L.M. at 1553.

[83] Montreal Protocol, *supra* note __, art. 5, 26 I.L.M. at 1555-56.

[84] Montreal Protocol, *supra* note __, art. 4, 26 I.L.M. at 1554-55. **[or *Supra* note (82)]**

kilograms per capita.[85] The original Protocol thus adds four approaches to those of the Convention: the core regulatory scheme, exceptions to the core regulatory scheme allowing a percentage overage for industrial rationalization or (for developing nations) basic domestic needs, a ban on trade with non-parties, and a blanket ten-year delay for developing nations maintaining relatively minimal usage levels.

The London Revisions, as discussed in more detail above, significantly increase the breadth and depth of the core regulatory scheme of the original Protocol.[86] But for present purposes, this does not constitute a new approach. The numbers change, but the basic structure—percentage reductions for ODP-weighted groups of chemicals in comparison to a baseline year—does not.

The London Revisions do clearly adopt one new approach, however. The original Protocol, essentially tracking the vague promises of the Convention, states that, "taking into account in particular the needs of developing countries, [the parties shall] co-operate in promoting technical assistance to facilitate participation in and implementation of this Protocol."[87] The London Revisions, in contrast, bring so much specificity to the question of technical assistance, including financial transfers therefor, that one must, in my view, call it a whole new approach. The relevant assistance is so clearly to include financial assistance that the relevant article, called "Technical Assistance" in the original Protocol, is renamed "Financial Mechanism."[88] That mechanism is to include a "Multilateral Fund."[89] The purpose of the relevant financial and technical assistance is to "meet all agreed incremental costs" of compliance with the Protocol incurred by less-developed nations.[90] Only developed nations are obliged to contribute to the financial mechanism (although all parties are "encouraged" to contribute), and they are to do so in the proportions *inter se* already established for the assessment of UN costs generally.[91] The London Revisions also provide some organizational details concerning the Fund—the creation of an executive committee, the naming of some advisory bodies (e.g., the World Bank and UNEP), and some voting rules.[92]

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[85] Montreal Protocol, *supra* note __, art. 5(1), 26 I.L.M. at 1555.
[86] See discussion, *supra*, at __.
[87] Montreal Protocol, *supra* note __, art. 10(1), 26 I.L.M. at 1557.
[88] London Revisions, *supra* note __, art. 10, 30 I.L.M. at 550.
[89] London Revisions, *supra* note __, art. 10(2), 30 I.L.M. at 550.
[90] London Revisions, *supra* note __, art. 10(1), 30 I.L.M. at 550.
[91] London Revisions, *supra* note __, art. 10(6), 30 I.L.M. at 551 (stating that the Multilateral Fund shall be financed by contributions from Parties not operating under paragraph 1 of Article 5 and encouraging contributions by other Parties).
[92] London Revisions, *supra* note __, art. 10(5), 30 I.L.M. at 550-51 (establishing an Executive Committee "selected on the basis of a balanced representation", to discharge its duties "with the co-operation and assistance of the [World Bank], the United Nations Environment Programme, the United Nations Development Programme or other appropriate agencies depending on their respective areas of expertise").

Additionally, the London Revisions eliminate the industrial-rationalization exception to production reductions, though those Revisions leave intact the basic-domestic-needs exception for developing countries. For present purposes, I consider this to be an important modification of an already-existing approach, rather than the addition of a new approach.

Finally, the London Revisions do elaborate upon the definition of "production" so as to subtract from that number both any substances destroyed (in ways approved by the parties) and any substances used entirely as "feedstock" in the manufacture of other chemicals. I do not consider this change to rise to the level either of a new approach or an important modification to an existing approach.

As with the London Revisions, the Copenhagen Revisions modify the exceptions to the core regulatory scheme: in a number of instances, exceptions for "essential domestic uses" are allowed once the Allowable Percentage for a given group of chemicals reaches 0%.[93] (The Copenhagen Revisions also increase the breadth and depth of the core regulatory scheme, as described in more detail above, while leaving its general approach intact.)[94]

The Vienna Adjustments, as adjustments, cannot affect the approaches taken in the treaty regime. Adjustments can only change the ODPs or allowable aggregate ODP-weighted percentages of already-regulated substances, which does not constitute a change in "approach" in my terminology.[95]

The Montreal Revisions arguably involve two new approaches. First, a new Article, 4A, is added to the Protocol, which states:

> 1. Where, after the phase-out date applicable to it for a controlled substance, a Party is unable, despite having taken all practicable steps to comply with its obligation under the Protocol, to cease production of that substance for domestic consumption, other than for uses agreed by the Parties to be essential, it shall ban the export of used, recycled and reclaimed quantities of that substance, other than for the purpose of destruction.
>
> 2. Paragraph 1 of this Article shall apply without prejudice to the operation of Article 11 of the Convention and the non-compliance procedure developed under Article 8 of the Protocol.[96]

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[93] Copenhagen Revisions, *supra* note __, art. 2A, 2B, 2C, 2D, 2E, 32 I.L.M. at 876-878.
[94] *Supra*, at **[33-49]**.
[95] Montreal Protocol, *supra* note __, art. 2(9), 26 I.L.M. at 1553-54.
[96] Montreal Revisions, *supra* note __, art. 4A.

Parties violating their obligation to phase-out entirely a group of chemicals (except for essential uses) are thereby obliged not to export chemicals in that group (except to have them destroyed), a violation that applies without prejudice to the operation of the DRM or NCP described above in more detail. These provisions may be drafted somewhat inartfully—the first paragraph could be read to imply that parties *not* having taken all practicable steps towards compliance have *no* obligation to ban exports—but they are intriguing nonetheless. The explicit discussion in a treaty of the permissible responses to breach of that treaty is, as mentioned above, taboo. This provision not only breaks the taboo, but attempts to impose particular obligations upon the breaching party (i.e., the export ban) rather than validating particular responses within the control of the non-breaching parties (e.g., the ability to suspend its own performance under the treaty). The imposition of additional promises upon a party, contingent upon a breach of that party's other promises, should not look especially surprising to those familiar with liquidated-damages or acceleration clauses in domestic contracts, but such an approach in international treaties is an almost-startling innovation.

The Montreal Revisions also set up a licensing scheme for the import and export of controlled substances.[97]

In a very broad sense, the changes over time in the number of approaches embodied in the ozone treaties are consistent with the changes over time in breadth, depth, and length: an initial period of great change precedes a period of lesser change. After the first three enactments, the treaty regime embodies eight approaches; the five subsequent enactments added only two more approaches (and modified one of the pre-existing approaches).

Nonetheless, an examination of approaches yields a somewhat different perspective on the dynamics of the ozone treaties than these other measures. With respect to breadth, the increase begins only with the Montreal Protocol, continues with the London Revisions and the Copenhagen Revisions, and then ceases. With respect to depth, an evaluation aggregated across each agreement is more difficult to construct, but the picture is similar. The Montreal Protocol begins a period of a rapidly deepening regime; by the time of the Copenhagen Revisions, six of the eight regulated groups included 0% Allowable Percentages in the out years, though the subsequent Vienna Revisions and Montreal Revisions both continued to increase somewhat the depth of the overall regime.

[97] Montreal Revisions, *supra* note __, art. 4B.

With respect to length, the relevant measurement takes on a non-zero value from the beginning, with the regime at the time of the Copenhagen Revisions attaining about 90% of its current length in words.

The approaches embodied in the regime likewise begin with the Vienna Convention rather than, as with breadth and depth, in the Montreal Protocol. In contrast to the three other measurements, however, the regime appears in one sense to have matured by the time of the London Revisions rather than the later Copenhagen Revisions. Eight approaches are in place with the enactment of the London Revisions, while the Copenhagen Revisions do nothing more than modify one of the pre-existing approaches. Additionally, the number of approaches in the treaty regime not only involves an initial burst of activity that comes to a close more rapidly than in the case of breadth or depth or length, but also involves a second burst of activity with the Montreal Revisions, which added two new approaches—an export ban with respect to non-complying parties and a licensing scheme for all imports and exports. Neither length nor breadth nor depth displays such a second burst of activity.

C. Membership (Coverage)

Given the consensual nature of international legal mechanisms for effectuating cooperation, one must consider not only the breadth and depth of the rules embodied in the ozone treaties, but also the extent of membership in a treaty regime. A treaty embodying an outright ban on the production of every ozone-depleting substance known to humankind might be of relatively limited value if only one nation fully consented to that treaty. One advantage of studying treaties is that the same formalism and structure that makes the treaty process generally iterative means a good deal of data is also readily available with respect to the breadth of formal membership in the treaty regime.

I would readily admit that formal adherence can be both under- and over-inclusive as a proxy for true participation in the treaty scheme. A nation could fail to sign or ratify a treaty, yet behave in a way consistent with all of that treaty's terms. Such a phenomenon implies a number of interesting questions, such as the balance between a nation's reaping the favorable publicity from joining a treaty regime and that nation's constraining its freedom of action in the future. I ignore such questions, however. Alternatively, and perhaps of greater concern, formal adherence might be an over-inclusive proxy for cooperation: a nation could agree formally to be fully bound by a

treaty but violate every one of its terms. I account, at least in part, for this latter possibility in a later discussion of "compliance."

Here, however, I simply assume that the degree of a nation's formal adherence is a useful if imperfect proxy for its degree of cooperation with the ozone treaties, and proceed actually to examine formal national consents to the ozone treaties.

For the sake of terminological uniqueness, I call the extent of membership in a treaty regime its "coverage." (I am tempted to refer to the "breadth" of membership, but that term, alas, is already taken in my schema.)

1. Entry

The most basic aspect of coverage, at least with respect to enactments that have entered into force, is presumably the number of nations fully bound by the enactment at issue. Table 13 below provides that information for the first four enactments in the treaty set requiring a separate expression of full consent: the Convention, the original Protocol, the London Revisions, and the Copenhagen Revisions. (The Montreal Revisions, the final document in the set requiring a separate expression of full consent, were adopted too recently to make coverage data meaningful.) Table 13 expresses that coverage expressed in terms both of absolute numbers of nation-states fully bound and as a percentage of all nations in the world under two definitions of "all nations in the world."

TABLE THIRTEEN—COVERAGE OF OZONE TREATIES EXPRESSED IN TERMS OF NATIONS FULLY BOUND AS OF DECEMBER 31, 1997

Document	Number of Nations Fully Bound	As a Percentage of All Nations per US Department of State Listing (190 Nations)	Number of UN Members Fully Bound	As a Percentage of UN Members (185), and excluding from Nations Fully Bound those non-UN Members
Vienna Convention	164	86	161	87
Montreal Protocol	161	85	158	85
London Revisions	115	61	114	62
Copenhagen Revisions	72	38	71	38

Note: The U.S. Department of State listing is of "independent states" defined as "a people politically organized into a sovereign state with a definite territory recognized as independent by the US." The list includes all members of the United Nations except the Federal Republic of Yugoslavia (which has been deprived of its seat in the UN General Assembly but has not been expelled from the United Nations). The Department of State listing includes five nations not members of the UN: the Holy See, Nauru, Switzerland, Tonga, and Tuvalu.

One might compare these figures with some other environmental treaties. As of the end of 199**6**, there were roughly 140 nations fully bound to the Convention on International Trade in Endangered Species of Flora and Fauna[98], roughly 90 nations fully bound to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal[99], and roughly 40 nations fully bound to the International Convention for the Regulation of Whaling.[100] (As with the other environmental treaties discussed here, this last is not limited in its membership to any geographical or functional—i.e., whaling—sub-grouping of nations. Switzerland is a member of the whaling convention despite what one assumes is a limited history of, or direct economic interest in, whaling.)

A listing of the degree of participation of particular nations provides a useful overview with somewhat more detail. The ozone treaties are progressive in the sense that full consent to an enactment expressly or impliedly full consent to prior enactments. (A nation need not express its full consent to the *latest* enactment in order to express its full consent with respect to any enactment, however, as was mentioned above in the discussion of treaty lengths.) One may therefore determine the degree of participation in the ozone-treaty regime without much difficulty. Table 14 lists the degree of participation of nations in the treaty regime respecting the same treated above in Table 13.

[98] Consortium for International Earth Science Information Network (CIESIN), Environmental Treaties and Resource Indicators (ENTRI) (last modified Mar. 1, 1997) <http://sedac.ciesin.org/entri/> [hereinafter CIESIN].
[99] *Id.*
[100] *Id.*

TABLE FOURTEEN — DEGREE OF PARTICIPATION IN OZONE TREATY SET

None {26}	Exactly One (Convention) {3}	Exactly Two (Convention and Original Protocol) {46}	Exactly Three (Convention through London Revisions) {43}	All Four Major Enactments Between 1988 and 1996 {72 Nations}
Afghanistan	Equatorial Guinea	Benin	Algeria	Antigua & Barbuda
Albania	Belize	Bosnia & Herzegovina	Bahrain	Argentina
Andorra	Tajikistan	Brunei	Bangladesh	Australia
Angola		Bulgaria	Belarus	Austria
Armenia		Burundi	China	Azerbaijan
Bhutan		Central African Republic	Comoros	Bahamas
Cambodia		Chad	Cote d'Ivoire	Barbados
Cape Verde		Costa Rica	Cyprus	Belgium
Congo (Kinshasa)		Cuba	Dominica	Brazil
Djibouti		Dominican Republic	Fiji	Bolivia
Eritrea		El Salvador	Gambia	Botswana
Guinea-Bissau		Estonia	Ghana	Burkina Faso
Haiti		Ethiopia	Grenada	Cameroon
Iraq		Gabon	Guinea	Canada
Kazakhstan		Georgia	India	Chile
Kyrgyzstan		Guatemala	Indonesia	Colombia
Laos		Guyana	Lebanon	Congo (Brazzaville)
Nauru		Honduras	Maldives	Croatia
Oman		Kirbati	Mali	Czech Republic
Palau		Latvia	Malta	Denmark
Rwanda		Lesotho	Monaco	Ecuador
San Marino		Libya	Myanmar [Burma]	Egypt
Sao Tome & Principe		Lithuania	Namibia	Finland
Sierra Leone		Macedonia	Nepal	France
Somalia		Madagascar	Niger	Germany
Tonga		Mauritania	Papua New Guinea	Great Britain
		Micronesia	Paraguay	Greece
		Moldova	Peru	Hungary
		Nicaragua	Philippines	Iceland
		Nigeria	Portugal	Iran
		North Korea	Romania	Ireland
		St. Lucia	Russia	Israel
		Solomon Islands	Senegal	Italy
		St. Kitts & Nevis	Singapore	Jamaica
		Sudan	Slovakia	Japan
		Suriname	Slovenia	Jordan
		Swaziland	South Africa	Kenya
		Syria	Tanzania	Kuwait
		Togo	Turkmenistan	Liberia
		Trinidad & Tobago	Uganda	Liechtenstein
		Tuvalu	Ukraine	Luxembourg
		United Arab Emirates	Venezuela	Malawi
		Uzbekistan	Zambia	Malaysia
		Western Samoa		Marshall Islands
		Yemen		Mauritius
		Yugoslavia		Mexico
				Mongolia
				Morocco
				Mozambique
				Netherlands
				New Zealand
				Norway
				Pakistan
				Panama
				Poland
				Qatar
				St. Vincent & the Grenadines
				Saudi Arabia
				Seychelles
				South Korea
				Spain
				Sri Lanka
				Sweden
				Switzerland
				Thailand
				Tunisia
				Turkey
				United States
				Uruguay
				Vanuatu
				Viet Nam
				Zimbabwe

[I omit an analysis of this data, though I undertake an analysis of the same data in Part III in connection with hypotheses unconnected with the iterative perspective. I also omit the analysis of a number of other coverage measures, such as the number of parties initially adopting each enactment, the length of time that each enactment took to enter into force, and so on. The basic idea is a picture of steadily increasing cooperation, and cooperation that continues to seem "youthful" rather than "mature," as the relevant rates are continuing to increase (in contrast to, e.g., the measures of regulatory depth, which inevitably slow down when an Allowed Percentage of 0% is adopted).]

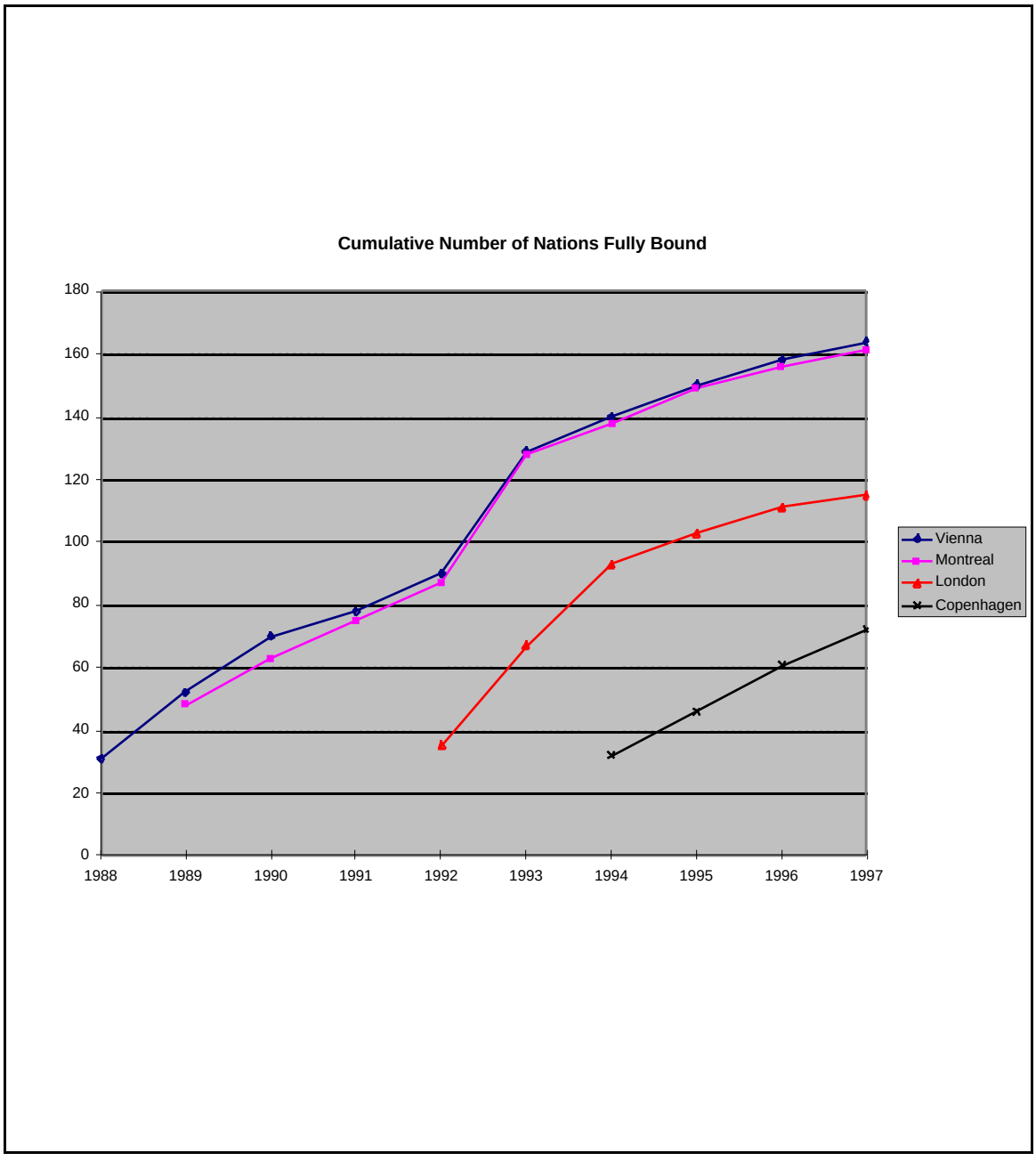
From the point of view of evaluating the growth over time in international cooperation with a treaty regime, the fundamental formal measure is presumably the number of nations with respect to which each treaty is in force. Table 15 shows the cumulative number of nations with respect to which each treaty is in force at the end of each calendar year from 1988 (the year that the Convention first entered into force) and 1997.

TABLE FIFTEEN — CUMULATIVE NUMBER OF NATIONS FULLY BOUND BY EACH DOCUMENT IN THE OZONE TREATY SET AT THE END OF EACH CALENDAR YEAR

	1988	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*
Vienna	31	52	70	78	90	129	140	150	158	164
Montreal		48	63	75	87	128	138	149	156	161
London					35	67	93	103	111	115
Copenhagen							32	46	61	72

Chart 1 presents the same data in graphical form. This presentation emphasizes the closely parallel coverage of the Convention and the original Protocol, supporting the notion that parties have treated the Initial Enactments as a linked pair of documents after a brief period in which many nations joined the Convention but not the original Protocol. (Thirty-one nations were fully bound by the Convention by the end of 1988, at which point the original Protocol had barely been adopted; seven nations were fully bound by the Convention but not the original Protocol at the end of 1990; and after that the differential is never more than three nations.)

CHART ONE—NATIONS FULLY BOUND BY EACH OF THE FOUR DOCUMENTS IN THE OZONE TREATY SET



This presentation also emphasizes the dramatic growth in the coverage of the ozone regime from 1992 through 1994, with a subsequent maturation afterwards. In the space of just two years, 1993 and 1994, the coverage of the Initial Enactments increased by more than 50% over its coverage in 1992; the nations joining the Initial Enactments during those two years in fact represent more than 25% of all the nations in the world. Between 1992 and the end of 1994, the coverage of the London Revisions also increased dramatically: it entered into force during 1992 and had entered into force with respect to 93 nations by the end of 1994. With the broad coverage of the London Revisions and the entry into force in 1994 of the Copenhagen Revisions, the effective depth and breadth of the regime had also increased substantially. After 1994, one can see that the coverage of all of the first four enactments in the ozone-treaty regime grew only slowly. The Copenhagen Revisions did not garner the same burst of fully bound adherents as the London Revisions, for example: the Copenhagen Revisions had entered into force for fewer nations after four years than the London Revisions had garnered in two years. (One should note that the Copenhagen Revisions were adopted in November while the London Revisions were adopted in June, however, so the adoption of the end of the calendar year as the point of measurement places the Copenhagen Revisions at a half-year disadvantage.)

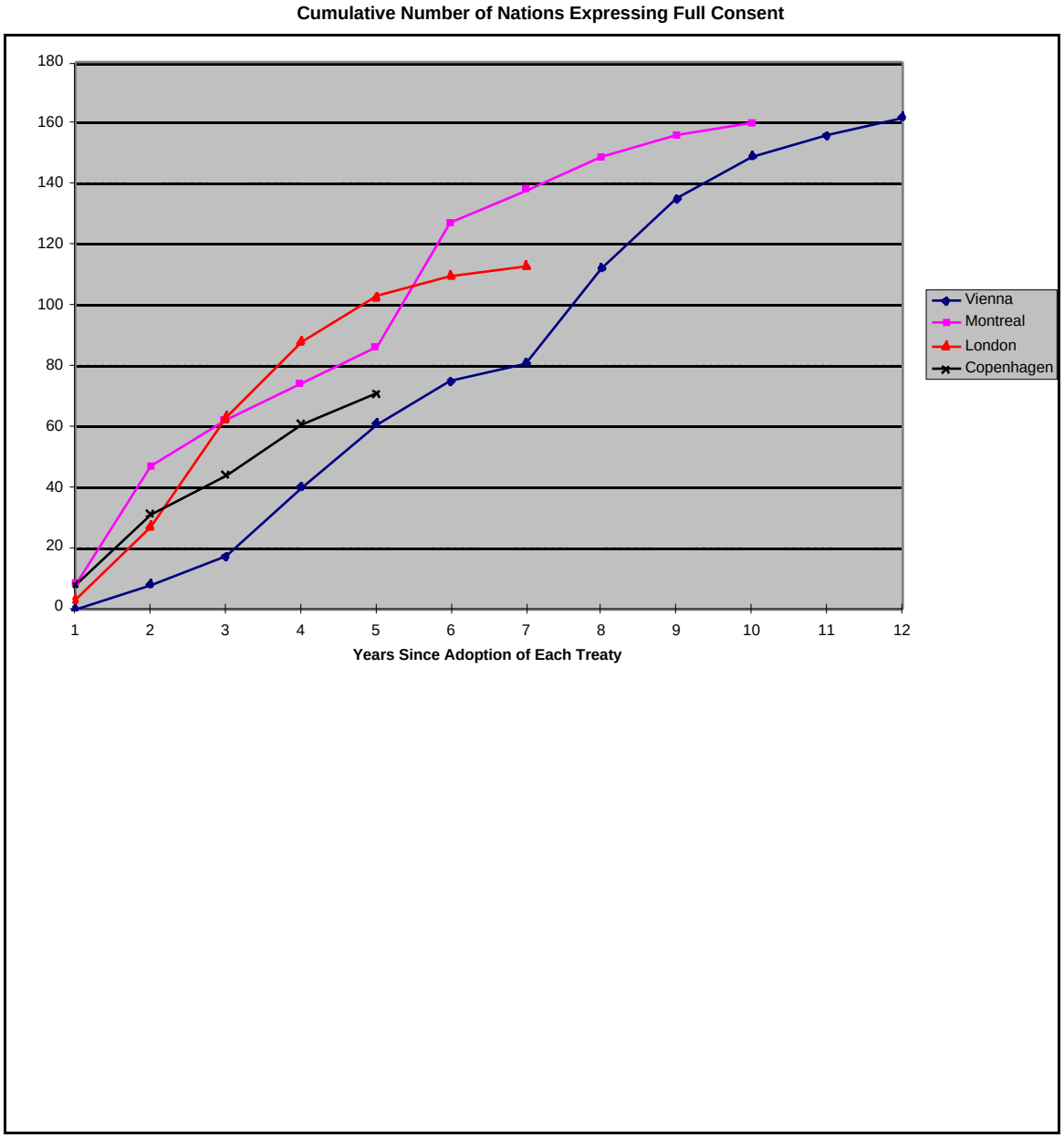
If one desires a measurement of the rate at which coverage accrues that focuses on inter-enactment comparisons, one might examine the accumulation of expressions of full consent within a particular period after the adoption of each enactment. Such a measure also places more emphasis on national intentions, rather than on the national obligations measured by entries into force. Focusing on expressions of full consent rather than on entry into force avoids the boundary effect created by the triggering entry into force (which triggers the entry into force for *all* nations previously expressing full consent) and so allows an examination of pre-initial-entry-into-force activity. Table 16 shows the numbers of full consents accumulated for a given enactment within each 365-day period following the document's adoption; Chart 2 presents the same data in graphical form.

TABLE 16 — CUMULATIVE NUMBER OF NATIONS EXPRESSING FULL CONSENT WITHIN A GIVEN 365-DAY PERIOD

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
Vienna	0	8	17	40	61	75	81	112	135	149	156	162
Montreal	8	47	62	74	86	127	138	149	156	160		
London	3	27	63	88	103	110	113					
Copenhagen	8	31	44	61	71							

Note: Column headings are number of 365-day periods since adoption.

CHART TWO -- NATIONS EXPRESSING FULL CONSENT TO EACH OF THE FOUR DOCUMENTS IN THE OZONE TREATY SET



The broad message is as before: the ozone-treaty regime has steadily accumulated adherents to all of its enactments. This measurement does allow a ready comparison of one document to another, however. One may thus see somewhat more clearly the appeal of the original Protocol: in all but three 365-day periods after its adoption, the Protocol has garnered more additional adherents than any other enactment in the comparable passage of time after that other enactment's own adoption. The exception is the London Revisions during the third, fourth and fifth years after its adoption (by margins of 1 nation, 14 nations, and 17 nations, respectively); this exception re-emphasizes the extraordinary popularity of the London Revisions during 1993 and 1994.

This measurement of coverage also allows one more readily to conclude that the Copenhagen Revisions are not keeping pace with earlier enactments relating to the Protocol.

2. Exit

As discussed briefly in Part One above, any nation that has been bound for four years by the Convention or Protocol may release itself from its obligations under the Convention or Protocol, respectively, simply by giving notice and allowing a year to lapse from the date of the receipt of that notice by the depository.[101] No nation has ever done so, however. This is obviously the most enthusiastic possible testament, with respect to this variable, to the strength of the endeavor's success in sustaining international cooperation.

Nations do on occasion withdraw, or threaten to withdraw, from treaties, including international environmental treaties. Belize, Brazil, Canada, Dominica, Ecuador, Egypt, Iceland, Jamaica, Mauritius, the Netherlands, Norway, Panama, the Philippines, the Solomon Islands, Sweden and Uruguay have all withdrawn from the International Convention for the Regulation of Whaling (ICRW).[102] (Indeed, in a history that goes Richard Burton and Elizabeth Taylor one better, the Netherlands pledged itself to the ICRW in 1948, severed its formal relationship with the ICRW in 1958, re-joined the ICRW in 1962, withdrew again in 1968, and finally re-joined the ICRW for good—so far—in 1977.)[103] Japan served notice of withdrawal from the ICRW but withdrew that notice before it took effect[104]; Norway (once) and Panama (twice) gave notice of

[101] Vienna Convention, *supra* note __, art. 19, 26 I.L.M. at 1535.
[102] CIESIN, *supra* note __.
[103] **[Where is this info found?]**
[104] **[Where is this info found?]**

withdrawals that were themselves withdrawn before taking effect, although Norway and Panama eventually left in place later notices of withdrawal.[105] And the ICRW's membership at its peak was barely more than 40 nations (41 in 1985–1987)[106], less than a quarter as many potentially disgruntled nations as are currently parties to both the Convention and Protocol. The ICRW may be unusual in the contentiousness associated with its ever-stricter mandates, but one can be confident that few international environmental treaties will involve fewer exits than the ozone treaty's zero departures.

D. Implementation and Compliance

This sub-section first examines textual changes and then assays the degree of conformity between obligations and actual behavior.

No textual changes directly respecting implementation and compliance have occurred in the treaties themselves. As mentioned briefly in part I, however, the parties did charge themselves with the adoption of a "non-compliance procedure" at their first conference.[107] This they did not do, at least not in the time—one meeting—allotted to them by the original Protocol. The first MoP resulted in a draft non-compliance procedure (NCP)[108]; the second MoP resulted in the provisional adoption of the draft[109]; the third MoP identified some areas of concern to the parties regarding the provisional NCP, with a delegation to an expert group to address those concerns[110]; and the fourth MoP finally adopted a re-drafted, nominally final version of the NCP.[111]

Like the arbitration rules or the rules of procedure governing the parties' meetings, the NCP is not part of the formal text of the treaty, and its specifications state explicitly that it "shall apply without prejudice to the operation of the" dispute-resolution mechanism set forth in the Vienna Convention.[112] The NCP does create an Implementation Committee with one member from each of ten nations (chosen in

[105] **[Where is this info found?]**
[106] CIESIN, *supra* note __.
[107] *Report of the Parties to the Montreal Protocol on the Work of their First Meeting at Helsinki*, UNEP/OzL.Pro.1/5 (1989).
[108] *Id.*
[109] *Report of the Second Meeting of the Parties to the Montreal Protocol on Substances That Deplete the Ozone Layer at London*, UNEP/OzL.Pro.2/3 (1990).
[110] *Report of the Third Meeting of the Parties to the Montreal Protocol on Substances That Deplete the Ozone Layer at Nairobi*, UNEP/OzL.Pro.3/11 (1991).
[111] *Report of the Fourth Meeting of the Parties to the Montreal Protocol on substances That Deplete the Ozone Layer at Copenhagen*, UNEP/OzL.Pro.4/15 (1992).
[112] *Report of the Fourth Meeting of the Parties to the Montreal Protocol on substances That Deplete the Ozone Layer at Copenhagen*, annex IV, UNEP/OzL.Pro.4/15 (1992) [hereinafter Non-Compliance Procedure].

rotation), however, and this Committee has met some twenty times.[113] In the formal sense, at least, the NCP is vibrant.

The specificity and scope of the NCP on paper is an innovation in treaty compliance. First, it creates a body devoted exclusively to concerns of implementation and compliance, whereas most treaties rely on meetings of the parties to do so. Second, the report of the Implementation Committee regarding a particular allegation of non-compliance may be the basis for a decision by the Parties to "call for steps to bring about full compliance with the Protocol, including measures to assist the Parties' compliance with the Protocol."[114] A further "Indicative List of Measures That Might Be Taken by a Meeting of the Parties in Respect of Non-Compliance with the Protocol," adopted by the same MoP that adopted the final NCP, includes not just appropriate assistance, but the issuing of cautions and even "[s]uspension, in accordance with the applicable rules of international law concerning the suspension of the operation of a treaty, of specific rights and privileges under the Protocol, whether or not subject to time limits."[115]

Parties to treaties have thought about non-compliance and, simply by specifying the conditions of compliance, have even implicitly acknowledged the possibility that non-compliance will occur. The Convention on the Law of Treaties includes provisions addressed specifically to a non-breaching party's ability legally to suspend or terminate its own treaty obligations in responses to a breach by another party[116]; these provisions are presumably the "applicable rules of international law concerning the suspension of the operation of a treaty" mentioned in the Indicative List.[117] As a result, it is unclear exactly what *new* rights or procedures are contemplated by the Indicative List. But, in contrast to the general law of treaties, however, a treaty on a particular substantive matter rarely acknowledges this possibility explicitly. Even formally to award near-textual status to such a procedure at a meeting of parties is apparently unprecedented and has been taken by many to represent an important innovation.

One must characterize the actual operation of the implementation-oriented portions of the treaty and closely associated text as rather more disappointing than the potential implicit in the text itself.

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[113] Non-Compliance Procedure, *supra* note __, para. 5.
[114] Non-Compliance Procedure, *supra* note __, para. 9.
[115] *Report of the Fourth Meeting of the Parties to the Montreal Protocol on substances That Deplete the Ozone Layer at Copenhagen*, Annex V, UNEP/OzL.Pro.4/15 (1992) [hereinafter Indicative List].
[116] The Law of Treaties prescribes certain "rules of release" which revolve around the concept of material breach. With respect to multilateral treaties, material breach is necessary but not sufficient for unilateral release. In order to justify release, the material breach must also either lead all non-breaching parties to agree that their simultaneous release is appropriate, or specially affect a party seeking release only from its obligations to the breaching state, or radically affect the future performance obligations of all parties. Vienna Convention on the Law of Treaties, *opened for signature* May 23, 1969, art. 60(2), 1155 U.N.T.S. 331, 346 (entered into force Jan. 27, 1980); John K. Setear, *Responses to Breach of a Treaty and Rationalist International Relations Theory: the Rules of Release and Remediation in the Law of Treaties and the Law of State Responsibility*, 83 Va. L. Rev. 1, 15-24 (1997).
[117] Indicative List, *supra* note __, para. C.

I can find no report of any instance in which any party used the dispute-resolution mechanism (DRM) specified in Article 11 of the Vienna Convention. Pessimists may draw their own conclusions (as they are wont to do in any case). Optimists might suggest that Article 11's DRM is designed to resolve disputes about the correspondence between behavior and obligation only when such disputes stem from differences in the interpretation of the treaty's meaning. On this reading, which is plausible though hardly compelled, the absence of resort to the DRM simply indicates a well-drafted treaty. Additionally, one might argue that the parallel existence of the NCP makes resort to the DRM unnecessary. Or perhaps nations have been so diligent in complying with their obligations that there is no dispute about compliance or non-compliance to resolve.

There is actually some support for this last proposition in the meetings of the Implementation Committee of the NCP. One looks in vain through the **recent** reports of the Implementation Committee for signs of a classic interpretive dispute. Very occasionally, a nation makes a request for treatment that seems clearly inconsistent with the text. One might think of this as an interpretive dispute, although the flavor of these discussions actually seems closer to a plea for special treatment. In any case, the vast majority of topics discussed by the Implementation Committee involve nations offering excuses for their non-compliance, rather than nations arguing that their activity is in fact consistent with the ozone treaties as those texts should properly be interpreted. Descriptively, the Implementation Committee's activity seems much closer to the plodding development of a *modus vivendi*, which the compliance-oriented school would expect, than to the confrontational *sturm und drang* of judgment and punishment, for which the enforcement-oriented school might hope. The Committee notes an instance of non-compliance, and the offender states that it is already making some progress and expects to be in compliance eventually; a meeting or two later, the problem has diminished somewhat; eventually, the situation is in fact resolved.

This is the entire story in kind, but not in degree. The countries occupying the eastern portion of the European continent appear to constitute virtually all of the nations that have come in for criticism of their compliance record with respect to the substantive phase-out provisions of the treaties.[118] With the exception of the Russian Federation, and

[118] For example, at the seventh meeting of the Implementation Committee Under the Non-Compliance Procedure, Belarus "could not confirm . . . that [it] would be able to meet all the 1994 reduction targets for controlled substances as mandated by the Protocol." *Report of the Implementation Committee Under the Non-Compliance Procedure for the Montreal Protocol on the Work of its Seventh Meeting*, para. 15, UNEP/Ozl.Pro/ImpCom/7/2 (November 1993). The tenth meeting of the Committee noted that the then Russian Federation presented a particular problem in terms of its access to controlled substances. *Report of the Implementation Committee under the non-Compliance Procedure for the Montreal Protocol on the Work of its Tenth Meeting*, para. 32, UNEP/OzL.Pro/ImpCom/10/4 (August 1995). Later, the Committee noted that, beginning in 1996, Belarus would have difficulties complying with the Protocol as a result of the economic problems that were facing countries with economies in transition, *Report of the Implementation Committee under the Non-Compliance Procedure for the Montreal Protocol on the Work of its Eleventh Meeting*, para. 15, UNEP/OzL.Pro/ImpCom/11/1 (August 1995), and forsaw non-

to a lesser extent Latvia and Lithuania, all of these difficulties appear to have been resolved to the satisfaction of the Implementing Committee.[119]

Russia, however, presents several troubling and still-unresolved difficulties. It is a major producer of ozone-depleting substances. It has not only violated its obligations with respect to internal consumption or production, but also with respect to trade with other nations.[120] Finally, Russia has a large stockpile of ozone-depleting substances already in existence, which implies that it will need either to destroy a hefty tonnage of economically valuable material or to sell those stocks in violation of its treaty obligations. The good news is that Russia is the recipient of international aid aimed specifically at addressing some of these difficulties, and that the Russians' outward attitude, at least, is one of conciliation.

Finally, there is a set of persistent treaty violations stemming from the failure of developing nations to file the proper reports.[121] (Much of the Implementation Committee's output, by the way, consists of what one might call "literal formalism"—reproductions of the proper reporting forms, discussions of what words should go in which box on the forms, and so on.) The problem has diminished over time, however. One should also note that the developing nations as a group currently account for only a very small share of the global consumption or production of ozone-depleting substances. The pessimist will note that even the filing of papers is a task beyond the ability of the international legal system to compel; the optimist will note that, unless impoverished countries have succeeded in the past few years in making the clandestine production of refrigerants and flame retardants a high priority, the failure to file these forms is of fairly limited impact.

One might also take note of three factors that may not be apparent from the relatively straight-forward recitation above of the (non-)activities undertaken under the DRM and the activities of the Implementation Committee under the NCP.

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compliance by Ukraine, *id*., para. 20. These problems persist throughout the Implementation Committee reports.

[119] *See Report of the Implementation Committee under the Non-Compliance Procedure for the Montreal Protocol on the Work of its Seventeenth Meeting*, UNEP/OzL.Pro/ImpCom/17/3 (April 1997); *Report of the Implementation Committee under the Non-Compliance Procedure for the Montreal Protocol on the Work of its Eighteenth Meeting*, UNEP/OzL.Pro/ImpCom/18/3 (June 1997); *Report of the Implementation Committee under the Non-Compliance Procedure for the Montreal Protocol on the Work of its Nineteenth Meeting*, UNEP/OzL.Pro/ImpCom/19/3 (September 1997).

[120] *Report of the Implementation Committee under the Non-Compliance Procedure for the Montreal Protocol on the Work of its Seventeenth Meeting*, para. 25(b), (d), UNEP/OzL.Pro/ImpCom/17/3 (April 1997) (noting that Russia was in non-compliance with the Protocol for 1996 and "had exported both new and reclaimed substances to, and also imported ODS from, many Parties operating under Article 5 and those Parties not operating under that Article").

[121] Most of the Implementation Committee Reports contain sections devoted to assessing compliance with the reporting requirements of Article 7 of the Protocol and the production of data thereunder.

First, there have been no accusations of non-compliance involving any of what were once called "First World" nations—the highly developed, free-market democracies of the OECD. These are the nations that produced the lion's share of ozone-depleting substances when the relevant problem came to light, and their current production capacities still dwarf those of other nations.

Second, all the instances of non-compliance with substantive standards by what were once called "Second World" nations, and all the instances of non-compliance with reporting requirements by what were once called "Third World" nations, stem from voluntary reporting by those nations of their own behavior.[122] The self-reporting of a violation by an accused criminal is often the subject of derision ("THE COURT: What is the defendant's occupation? —DEFENDANT: Burglar," being a classic example) or pity (in the case of many confessions). The self-reporting of a violation by a previously unaccused nation seems an extraordinary testament to the power of international legal norms. The incentive-oriented analyst would note that the presence of funding to reduce non-compliance with the ozone treaties may have something to do with such non-reporting. The pessimist will wonder what violations are occurring that are not reported at all.

An ideal solution might be the devotion of hundreds of millions of dollars, rather than tens of millions, to aid aimed at monitoring compliance with the ozone treaties, along with the devotion of hundreds of millions of dollars to monitoring efforts. Even if one believes that the threat from cheating on the ozone treaties justifies that sort of expenditure, however, there are domestic political realities with which to contend. In the United States, at least, voters typically overestimate foreign aid's percentage of the budget by roughly an order of magnitude, and only nuclear arms-control treaties have ever been the recipient of hundreds of millions of dollars in effort for their verification.

Finally, there is at least one market-oriented indicator that the ozone treaties are having an important effect on the consumption and production of ozone-depleting substances: you can now reliably buy those substances on a "black market," and you will pay a premium of some 1000% to do so.[123] One may lament that such substances are available at all, but their high price on the black market indicates at least that some combination of reductions in the sources of supply and governmental efforts to prosecute those engaged in that market have had an impact.

[122] Montreal Protocol, *supra* note __, art. 7, 26 I.L.M. at 1556.

[123] *See, e.g.*, Frederick Poole Landers, Jr., Note, *The Black Market Trade in Chlorofluorocarbons: The Montreal Protocol Makes Banned Refrigerants a Hot Commodity*, 26 Ga. J. Int'l & Comp. L. 457, 472-73 (1997) (noting that "a 30 pound cylinder of CFCs can be purchased [from countries operating under Article 5] for less than $35, and then resold sans excise tax for over $500 in the United States").