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NOTE TO EILEEN AND KATIE FROM DAN
RE: TODAY'S IWG MEETINGS
3/29/93

Just a quick update on the two IWG meetings I attended today: Antarctica; and Forests. In each meeting, we reviewed text for the IWG report.

Antarctica

- o The 3/26 draft paper we reviewed focused almost exclusively on the implementation of the Protocol on Environmental Protection to the Antarctic Treaty.

- o To this end, the paper contrasts the relative merits of two bills introduced this session to implement the provisions of the Protocol:

    1) introduced by Rep. Boucher, Chair of the Subcommittee of Science of the Committee on Science, Space and Technology (based on a proposal by the Bush Administration)

    2) introduced by Rep. Studds, Chair of the Committee on Merchant Marine and Fisheries (reintroducing former chair Jones' bill from last session)

- o In general, Studds' bill goes further than Boucher's. The biggest difference between the bills regards agency responsibilities and oversight. In both bills, NSF would continue to run the US Antarctic Program, but Studds' bill would give most of NSF's regulatory functions to NOAA.

- o I asked whether this is the full extent of the scope of this issue, and if it is the only issue, to be reviewed.

    + The response from State (Tucker Scully) is that other upcoming issues and meetings (e.g., leading up to Japan in 1994)are not ripe to be discussed. I suggested that we could at least flag any additional upcoming issues in the paper.

    + NOAA suggested, and State agreed, that we should have a separate section on the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR)

Forests

- o We reviewed the 3/28 draft paper in detail. One of the biggest (and most immediate) issues in the paper is on the ITTA renegotiations. I raised several points:

  - + it would be helpful to lay out clearly who the different groups are on this issue and what exactly they want

    - - this is actually tougher than it sounds because several issues are easily confused: whether there should be a commodity agreement for temperate/boreal timber; whether there should be forest management principles (e.g,. Target 2000) for temperate/boreal forests; and whether the ITTA renegotiations are the appropriate vehicle for anything other than improving the ITTA in its current function regarding tropical timber

    - - it is especially tough because the ITTA is itself neither a true commodity agreement nor a true forests management agreement, instead it has elements of both: it is supposed to be a commodity agreement, but it doesn't address pricing or supply issues (only data/transparency issues) <u>and</u> the ITTO funds projects toward a sustainable management target

    - - thus, if someone says they want to expand the ITTA to all timber, it is not necessarily clear what they mean (a commodity agreement or a forest management agreement) For example, LDCs say they want to expand ITTA to all timber, but what do they mean? They have insisted vehemently that they don't want any global forest management principles, but what possible stake/interest could they have in a temperate/boreal "commodity" agreement? It seems like a diversionary tactic whose bluff could be called by saying "OK we expand the ITTA 'commodity' agreement to cover all timber, but we also expand it to fully embrace the global forest management principles agreed at Rio"

  - + it would also be helpful to include any factual data on the levels of timber production and trade in both producer and consumer countries

  - + that OEP/NSC should be involved in the USTR working group on the ITTA renegotiations

    - - I talked to Duane Sams and Jennifer Havenkamp, who promised to include me in the group

- Another issue that came is the Forest for the Future Initiative (FFI).

  + CEA pushed to remove the option to abandon FFI after meeting the $16m FY93 commitment because $30m in FY94 is included in Clinton's "A Vision for Change" package.

  + I resisted, saying that the point of the review is to have all the options on the table, and that it was not good government to have a single preliminary funding decision drive the discussion on the entire issue

  + However, there seemed to be consensus in the group to drop it and I didn't want to impede progress, but I emphasized that it is dangerous to assume that something is a fait accompli just because it is in the proposed package

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URGENT -- PLEASE DELIVER ASAP

To: Katie McGinty
Eileen Claussen

From: Scott A. Hajost
International Counsel

Date: March 3, 1993

Just in case you haven't seen it, the following is an LA Times piece on the Antarctic NEPA issue. Thanks for the opportunity to meet today.

Scott

... Drinlinger, a rescue mission ... Drinlinger said. "They were extremely glad to see us."

"They were in some of the most avalanche prone terrain in Colorado, but if you ...

... of waiting friends.

Researcher Ann Rovin in the Denver bureau contributed to this story.

U.S. Law's Scope at Issue in Antarctica Case

■ Environment: A court of appeals overturns doctrine, finds that waste cannot be incinerated at McMurdo Sound without an impact statement.

By RUDY ABRAMSON
TIMES STAFF WRITER

WASHINGTON—A U.S. Court of Appeals ruling, triggered by the National Science Foundation's incineration of waste at its McMurdo Sound research station in Antarctica, has reignited a debate over the overseas application of the United States' most sweeping environmental law.

The dispute over the 23-year-old National Environmental Policy Act, which established the environmental impact statement review process, is to be put before the National Security Council within the next few days, sources said Tuesday.

Environmental activists are looking at the outcome as perhaps the first test of what they contend was a Bill Clinton campaign promise about the environment.

The three-week-old court ruling overturned a long-standing doctrine that U.S. laws do not apply outside the United States. The decision applies only to so-called "global commons," the Antarctic, the oceans and space.

But government officials and environmental lawyers said the decision opens the door to the interpretation that the law applies to U.S. government projects in any foreign country as well. Critics contend that such a requirement would be expensive and invite prolonged delays and litigation.

But environmental activists argue that Congress intended to require international application of the National Environmental Policy Act when it was written in 1970. That interpretation has been resisted by many federal agencies, including the State Department, on grounds that enforcement and litigation of environmental issues could interfere with foreign policy activities.

Democratic lawmakers have introduced amendments making clear a requirement for international enforcement, but both the Ronald Reagan and George Bush administrations threatened a veto if such a measure were adopted.

The issue flared again after a three-judge panel of the federal Court of Appeals for the District of Columbia ruled in a suit filed against the National Science Foundation by the Environmental Defense Fund.

The case arose after the National Science Foundation began using incinerators to dispose of its waste at McMurdo Sound. The Environmental Defense Fund had threatened to sue the foundation, which had been burning waste in open pits, alleging a violation of the Resources Conservation and Recovery Act.

But when the incinerators were installed, the Environmental Defense Fund filed suit on grounds that no environmental impact statement had been prepared, as required by the National Environmental Policy Act.

Sources said the only strong government support for the court's opinion comes from the Environmental Protection Agency, the National Oceanic and Atmospheric Administration and the White House Council on Environmental Quality.

Environmentalists contend that President Clinton endorsed international application of the law when the issue was ra[ised] by the League of Conservation Voters during the 1992 election campaign.

Clinton's answer seems ambiguous, however, because it came in the context of a question about the Endangered Species Act, not the National Environmental Policy Act. Asked whether he favored extending the protection of the Endangered Species Act to U.S. projects overseas, he replied:

"I support legislation to apply the National Environmental Policy Act to federal actions overseas. As President, I would issue new regulations restoring protection for all listed species from sanctions by U.S. agencies. The protection of species, particularly those listed as endangered or threatened, is a responsibility of citizens and government. U.S. agencies should be required to protect listed species overseas, just as they are required to do so in this country."

Environmentalists believe that his reference to the National Environmental Policy Act in that context was not a slip of the tongue.

Aspin Still in Hospital; Date for Work Return Uncertain

By ART PINE
TIMES STAFF WRITER

WASHINGTON—Defense Secretary Les Aspin remained in a hospital Tuesday for a third consecutive night, with aides saying it was not yet clear how soon he might be able to resume a full workload as the nation's highest-ranking defense official.

Pentagon officials said that Aspin, 54, who was taken to the hospital late Sunday for shortness-of-breath problems related to a previous heart condition, had improved significantly and could be discharged as early as today or another week.

[...] is the only top defense official who has been confirmed by Congress and installed in office. Next in line, should Aspin be unable to function, is James R. Locher III, a holdover from the George Bush Administration who is serving as acting undersecretary of defense for policy.

In a development unrelated to Aspin's illness, the White House formally announced the nomination of two top Defense Department ...

The Pentagon announced Tuesday that officials had installed a secure telephone line to Aspin's hospital room and that he is continuing to do some work by phone. He also has conferred with key members of his staff, department officers said.

But sources said the secretary is receiving antibiotics intravenously and clearly is tired and in need of recuperation. Aspin reportedly has been pushing to get back to work quickly but his physicians are urging further rest.

Aspin first learned of his heart problem in 1991, when he had similar symptoms during a skiing vacation in ...

3/5/93

Katie:

Enclosed is a comparison between NEPA and the Antarctic Protocol Environmental Impact Assessment requirements. It simply confirms what was stated at the interagency meeting today - that is, the United States has already made the commitment to do at least as much as NEPA requires (note that the protocol applies to non-governmental activities as well as federal actions). The protocol requirements are a major step for the National Science Foundation which has hitherto been slow to comply with even the executive order, and very reluctant to involve the interested public. The one big difference remaining between it and NEPA, of course, is judicial enforceability. Let me know if you need more detail or want this in a different format.

Also enclosed is information related to the most recent and dramatic environmental accident in Antarctica. As you can see, even an NSF lawyer stated that "we should be more deliberate in conducting an environmental assessment, whenever possible".

I am working on the analysis we discussed and also identifying environmental impacts of typical naval activities in the high seas, and if possible, any specific "incidents". I will have both for you Sunday evening or Monday morning, but if you need anything in the meantime, don't hesitate to call. I should be easily reachable at either home (291-7273) or office (5754).

Dariah

COMPARISON OF ENVIRONMENTAL IMPACT ASSESSMENT PROVISIONS IN NEPA/CEQ REGULATIONS AND THE ANTARCTIC PROTOCOL/ANNEX 1

PURPOSE/PRINCIPLES

NEPA: Basic national charter for protection of the environment. To ensure environmental information is available to public officials and citizens before decisions are made, and before actions are taken. The NEPA process is intended to help public officials make decisions based on an understanding of environmental impacts, and take actions that protect, restore and enhance the environment.

PROTOCOL: To ensure that the protection of the Antarctic environment and dependent and associated ecosystems are fundamental considerations in the planning and conduct of all activities in the Antarctic Treaty area. Accordingly, activities in Antarctica shall be planned and conducted on the basis of information sufficient to allow prior assessments of, and informed judgments about, their impacts on the Antarctic environment.

APPLICABILITY

NEPA: Applies to federal actions, including plans, policies, rules, regulations.

PROTOCOL: Applies to both governmental and non-governmental actions, including those pursuant to scientific research programs and tourism

SCOPING

NEPA: Provides for scoping process at an early stage in the process to identify significant environmental issues, and to deemphasize insignificant issues

PROTOCOL: Does not articulate scoping process (presumably because the Antarctic Treaty Parties recognized the particulars of EIA implementation would be drafted by each individual Party)

2-Part Process (EA/EIS-- IEE/CEE)

NEPA: Environmental Assessment (EA) prepared to determine whether federal action may have a significant impact on the environment; if so, then the more comprehensive Environmental Impact Statement (EIS) is required in both a draft and final form

PROTOCOL: Requires preparation of an Initial Environmental Evaluation (IEE) for any proposed action that may have at least a "minor or transitory" impact on the environment; if so, then preparation of a Comprehensive Environmental Evaluation (CEE) is required in both a draft and final form

THRESHOLD STANDARDS

NEPA: EA prepared to determine whether an action might have a significant impact on the environment; if there is a finding of no significant impact, the action may proceed, as no EIS is required

PROTOCOL: IEE to determine whether action may reasonably be expected to have a significant impact; if IEE indicates that the action is likely to have no more than a minor or transitory on the environment, then the activity may proceed, as no CEE is required

DOCUMENTATION

NEPA AND PROTOCOL: EIS and CEE to include, inter alia, a description of the proposed activity, including alternatives to that activity; a description of the character of the likely impacts of the proposed activity; consideration of indirect and cumulative impacts; identification of measures, including monitoring, to mitigate impacts and detect unforeseen impacts; identification of unavoidable impacts

PUBLIC INVOLVEMENT

NEPA: Requires public involvement in preparation of EA; requires public involvement for the preparation of draft and final EIS

PROTOCOL: Does not address public involvement in preparation of IEE; requires public involvement in preparation of draft and final CEE

CIRCULATION OF, COMMENT ON, DOCUMENTS

NEPA: Requires EA, draft and final EIS be made available to the public for comment. Final EIS must address comments received on draft EIS, and must be circulated for at least 45 days before the commencement of the proposed activity

PROTOCOL: Does not address circulation/comment regarding IEE; requires draft and final CEE be circulated to all Parties for comment, and at the same time forwarded to the Committee for Environmental Protection. Final CEE is to address and include or summarize comments received, and shall be circulated to all Parties at least 60 days before the commencement of the proposed activity

EMERGENCIES

NEPA: Where emergency circumstances make it necessary to take an action with significant environmental impacts without observing NEPA and CEQ regulations, then federal agency should consult with the Council on Environmental Quality about alternative arrangements. These arrangements would be limited to actions necessary to control the immediate impact of the emergency

PROTOCOL: Provides exception to EIA process in cases of emergency relating to the safety of human life or of ships, aircraft or equipment and facilities of high value, or the protection of the environment. Immediate notification of activities undertaken in such circumstances is required, and subsequently a full explanation of those activities

LEGAL RECOURSE

NEPA: No criminal or civil penalties. Pursuant to tenets of administrative law, citizens may file lawsuits where agencies do not comply with NEPA and CEQ regulations

PROTOCOL: Obligates Parties to take appropriate measures within their competence, including the adoption of laws and regulations, administrative actions and enforcement measures, to ensure compliance with the Protocol and Annexes.

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Briefing material for meeting c̄ Walter Oechel is fairly successful for a variety of liquids over extended pressure, compression and viscosity ranges, and yields physically reasonable predictions.

The empirical Vogel-Tammann-Fulcher (VTF) equation, $\log \eta = A + B/(T - T_0)$, is an excellent representation for the temperature-dependent viscosity data of glycerol over 12 orders of magnitude[22], where T_0 is roughly the Kauzmann temperature[23] (at which the liquid and crystal are isentropic). A modified form of the VTF equation, in which T_0 is assumed to depend linearly on P, has been used to fit high-pressure conductivity[24,25] and Brillouin scattering data[26] but does not describe our viscosity data. Following the assumption that the parameters A and B are constants[24,25], independent of both pressure and temperature, then the isothermal high-pressure viscosity data can be used with the VTF equation to calculate $T_0(P)$. Applying the ambient-pressure result[22] that $T_g - T_0 = 55$ K, we obtain $T_g(P)$ as shown in Fig. 4. This plot has several important features. First, the resulting $T_g(P)$ are nonlinear with pressure and agree with estimates from high-pressure measurements of heat capacity and dielectric constant[6,8]. Such nonlinearity is not widely recognized but was theoretically predicted[32] and has been seen for other liquids[27]. We do, however, find a linear relationship between T_0 and volume (inset to Fig. 4).

Alternatively, one can assume that A and the ratio B/T_0 are constant, as found for methanol over a limited pressure range[28]. This leaves unaltered the nonlinear behaviour of $T_0(P)$, but now $T_g - T_0$ must increase with pressure to agree with experimental data. The nearly linear relationship between T_0 and volume is preserved. The key difference between these two models is whether the fragility parameter B/T_0 (ref. 20) is independent of pressure. This parameter is related to the rate of structural breakdown in the liquid above T_g and is used for the classification of glass-forming liquids. But past studies have not addressed its pressure dependence. Evaluation of this requires variable-temperature, high-pressure data, and the single available viscosity point for glycerol[9] suggests that B/T_0 is independent of pressure. This suggests that the combined effects of temperature and pressure on glycerol are such that an isothermal crossing of T_g, at any pressure, would yield a constant configurational entropy change. Further data are clearly required to clarify this issue.

Received 9 October, accepted 24 December 1992

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ACKNOWLEDGEMENTS. We acknowledge useful discussions with P. Dixon, G. Grest, D. Herschbach and E. Herbolzheimer and the technical assistance of L. Wenzel.

Recent change of Arctic tundra ecosystems from a net carbon dioxide sink to a source

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ARCTIC tundra has been a net sink for carbon dioxide during historic and recent geological times[1-4], and large amounts of carbon are stored in the soils of northern ecosystems. Many regions of the Arctic are warmer now than they have been in the past[5-10], and this warming may cause the soil to change from a carbon dioxide sink to a source by lowering the water table[11,12], thereby accelerating the rate of soil decomposition (CO_2 source)[3,13-15] so that this dominates over photosynthesis (CO_2 sink). Here we present data indicating that the tundra on the North Slope of Alaska has indeed become a source of carbon dioxide to the atmosphere. This change coincides with recent warming in the Arctic, whether this is due to increases in greenhouse gas concentrations in the atmosphere or to some other cause. Our results suggest that tundra ecosystems may exert a positive feedback on atmospheric carbon dioxide and greenhouse warming.

The current, recent and future carbon flux of terrestrial ecosystems is controversial[16,17], and at present, the carbon budget does not balance, implying uncertainty as to the current terrestrial carbon flux. It may be that over the past 30–40 years, the terrestrial biosphere has been a net sink for carbon[11,18] large enough to account for the 'missing carbon' injected into the atmosphere and not accounted for in oceanic uptake or atmospheric storage[19,20]. Analyses by Tans *et al.*[17] concluded the likelihood of a net terrestrial sink with high-latitude CO_2 sources to the atmosphere.

Northern ecosystems contain up to 455 Gt (petagrams) of C in the soil active layer and the upper levels of the permafrost, or up to ~60% of the ~750 Gt C currently in the atmosphere as CO_2 (refs 1–4). Arctic tundra ecosystems alone contain more than 50 Gt C below ground as dead organic matter. In the historic and recent geological past, rates of carbon accumulation in tundra worldwide have been ~0.1–0.3 Gt C per year[2-4,21,22]. Tussock tundra is estimated to have accumulated carbon at the rate of 23 g C m^{-2} yr^{-1} (0.02 Gt C per year worldwide), wet tundra at the rate of 27 g C m^{-2} yr^{-1} (0.03 Gt C per year worldwide[2,4]) to 40–120 g m^{-2} yr^{-1} (refs 24, 25).

High-latitude ecosystems are expected to undergo the greatest increases in surface temperature with a doubling of atmospheric CO_2. Surface temperature increases of 4 °C in summer and as much as 17 °C in winter have been predicted for high northern latitudes[5,23], providing the potential for large absolute and relative increases in temperature in arctic regions. The importance of permafrost, ice and snow in controlling arctic ecosystem processes also makes the Arctic particularly sensitive to warming[24].

Regional warming of surface air temperatures[7,9] and permafrost temperatures[6,10] has been experienced over arctic Alaska and Canada and/or central Siberia over the past century. In Alaska, ...

* To whom correspondence should be addressed.

Barrow[26], regional summer warming over the past 70 and 20 years at Barrow and Prudhoe Bay, respectively, seems to be reflected in their temperature records (Fig. 1) and agrees with the general trend in global temperature deviations[27-29]. But although the direction of the change observed on the north slope of Alaska is that predicted by general circulation models and climate reconstructions, the temperature rise cannot definitely be ascribed to greenhouse warming[30].

Here we report measurements of whole-ecosystem CO_2 flux measured over five seasons (1983-1985, 1987, 1990) at Toolik Lake and along a latitudinal transect in 1990, from the Arctic Ocean at Prudhoe Bay to Toolik Lake, Alaska (Fig. 2). The initial measurements (1983-1985, 1987) were made at Toolik Lake using a closed, CO_2 and long-term temperature-controlled, null-balance greenhouse chamber (CO_2LT chamber) system[31]. During the summer of 1990, we made diurnal and seasonal measurements of ecosystem CO_2 flux along a north-south transect from the Arctic Ocean at Prudhoe Bay to Toolik Lake, 200 km to the south, using a portable ecosystem cuvette and gas exchange system[32].

The repeated summer measurements of diurnal CO_2 flux at Toolik Lake made between 1983 and 1987 indicated a loss of CO_2 from the tussock tundra of 0.72-3.9 g C m^{-2} d^{-1} (Table 1). If we assume a nominal active season of 125 days, these annual rates of CO_2 efflux varied from 53 to 266 g C m^{-2} yr^{-1}, reflecting the year-to-year variability in environmental conditions (Table 1). We may have slightly underestimated CO_2 loss by missing some periods of soil and plant respiration in early spring and late autumn (S. A. Zimov, personal communication).

Diurnal and seasonal patterns of carbon flux were dominated by periods of carbon loss to the atmosphere. For example, Happy Valley shows a seasonal increase in the rate of loss of carbon at 'night' from early season to peak season. This increase is presumably due to increasing soil temperatures, soil aeration and depth of thaw over this period. Peak net ecosystem carbon uptake also increases from early to mid-season, but on no days measured is the carbon balance positive, and soil decomposition and plant respiration always exceed photosynthetic uptake for the diurnal period. By mid-season, despite increases in midday rates of carbon uptake, carbon loss has increased more than has photosynthetic uptake, and the net loss of carbon has increased compared to early season rates. The measurement period was extended in 1991 to cover almost the entire snow-free period, reducing the extrapolation necessary (W.C.O., unpublished data). The results support those presented here and confirm the carbon loss from spring snow melt to autumn freeze-up along the transect measured.

Net seasonal carbon loss to the atmosphere was found at all sites measured. Carbon loss to the atmosphere during the 1990 season generally increased from north to south (Fig. 2), and on the drier areas within a site (Fig. 2, Table 1). The site closest to the coast, Prudhoe Bay Wet, was the wettest site measured (Table 1). The southern tussock tundra sites, Toolik Lake and Happy Valley, were better drained, and had greater thaw depths

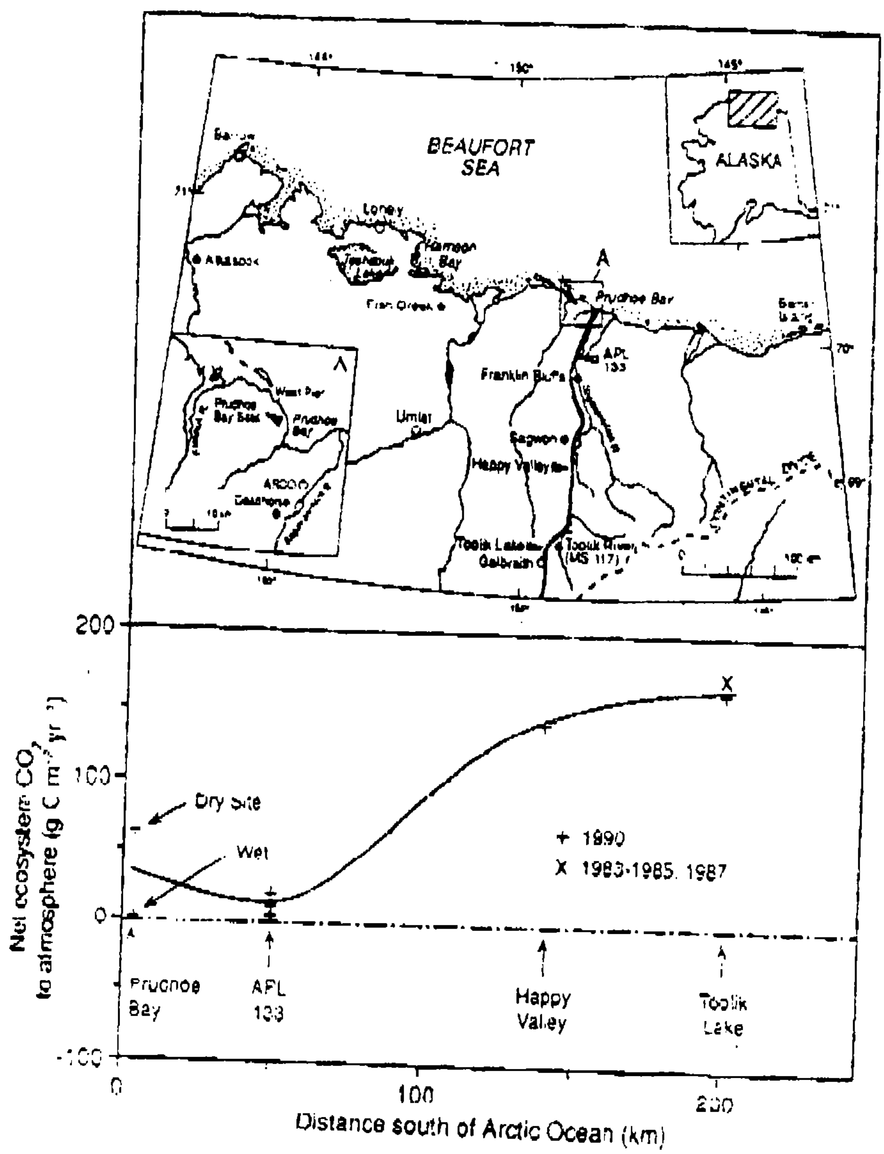


FIG. 1 Mean annual summer (June through August) temperatures from 1921 to 1990 at Barrow, Alaska and from 1970 to 1990 at Prudhoe Bay, Alaska. Represented are 3-yr sliding mean values ... US Weather Service for Barrow, Alaska ... ARCO for the ARCO airport tower at Prudhoe Bay, Alaska.

TABLE 1 Characteristics of research sites and measured CO_2 fluxes

Site	Latitude	Longitude	Distance (km)	Elevation (m)	Tundra type	Moisture	Year	Average summer temperature* (°C)	Summer precipitation* (mm)	[illegible]
Prudhoe Bay wet	70° 22'	148° 45'	2.5	3	Wet sedge	Wet	1990	6.5¶	49§	[illegible]
Prudhoe Bay moist	70° 22'	148° 45'	2.5	3	Wet sedge	Moist	1990	6.5¶	49§	[illegible]
APL-133 control	69° 50'	148° 45'	50	80	Wet/moist sedge	Moist	1990	10.0‡	69‡	[illegible]
APL-133 flooded	69° 50'	148° 45'	50	80	Wet/moist sedge	Wet	1990	10.0‡	69‡	[illegible]
APL-133 drained	69° 50'	148° 45'	50	80	Wet/moist sedge	Moist	1990	10.0‡	69‡	[illegible]
Happy Valley	69° 08'	148° 50'	140	366	Tussock	Moist	1990	13.1†	50†	[illegible]
Toolik Lake	68° 38'	149° 35'	200	732	Tussock	Moist	1990	9.3‡	160‖	[illegible]
Toolik Lake							1983	6.9#	N.D.**	[illegible]
Toolik Lake							1984	N.D.**	264‖	[illegible]
Toolik Lake							1985	7.5‡-6.5#	213‖	[illegible]
Toolik Lake							1987	9.2§	246‖	[illegible]

Positive values of flux indicate CO_2 loss to the atmosphere. Daily CO_2 flux measurements are calculated from diurnal measurements and the integrated seasonal ... averaged to provide an average daily flux for the period of biological activity.

* Summer months from June–August.

† This study, missing 22 days of data.

‡ Toolik River, MS-117 (D. Kane, personal communication).

§ This study.

‖ Toolik River, MS-117 (R. J. McClure, personal communication).

¶ National Climatic Data Center, Asheville, NC computed from the mean minimum and mean maximum recorded temperatures.

\# Toolik River, MS-117 (R. H. Haugen, personal communication).

** N.D. Not Determined.

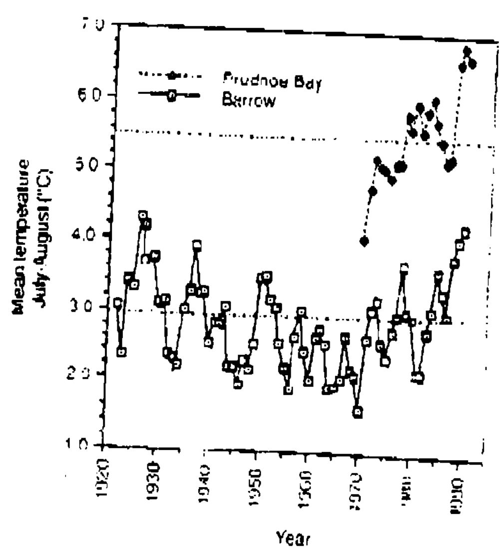
and lower water tables. The average rate of annual CO_2 loss for the tussock tundra sites in 1990 was 156 g C m^{-2} yr^{-1}, whereas carbon loss for the wet coastal tundra sites (Prudhoe Bay and APL 133-3) was ~34 g C m^{-2} yr^{-1} (Table 1). The results for the tussock tundra ecosystems during the 1990 sampling season agree well with the initial measurements made between 1983 and 1987 (Table 1) and with subsequent measurements made in 1991 and 1992 (W.C.O., unpublished data). These data indicate a change in carbon balance of the tundra with respect to the atmosphere, in response to the trend in climate warming for the north slope of Alaska.

We feel that the change from carbon accumulation to carbon loss in these ecosystems is not caused directly by the increase in temperature but indirectly, by enhanced drainage and soil aeration, and a decrease in the water table[11,12]. Decomposition of the soil organic layer in northern peatlands is controlled much more by drainage, and consequently soil aeration, than by temperature[5,13-15]. Warmer periods in the past that resulted in peat accumulation in the Canadian sub-arctic and Alaskan arctic[33], where there is no evidence of current carbon accumulation[3], are thought to reflect the combination of warmer and wetter conditions.

FIG. 2 Site locations on the north slope of Alaska. From north to south: Prudhoe Bay, APL-133, Happy Valley, Toolik Lake (upper panel). Seasonal carbon dioxide flux (as carbon) along a latitudinal gradient from Prudhoe Bay to Toolik Lake, Alaska in 1990 (+), and for four additional years of measurement at Toolik Lake (1983–1985, 1987; ×). The line represents an interpolation of values for 1990. Mean flux for 1983–85 and 1987 is 175 ± 62 g C m^{-2} yr^{-1} (mean ±1 s.e.). Site differences in soil moisture are noted at Prudhoe Bay and APL 133. The three values at APL 133 represent the three areas of differing moisture availability (drained, control and impounded) studied which resulted in higher, medium and lower CO_2 efflux from the tundra to the atmosphere respectively. For the initial measurements (1983–85, 1987), there were three replicate control chambers running under ambient conditions. Measurements were made every 3 minutes, and averaged and recorded every 6 minutes throughout the day and the season. For 1990, measurements were made from shortly after snow melt to shortly before soil freeze-up in the autumn at each site on each of six replicate plots roughly once every 1.5 h throughout the 24-h measurement period. Seasonal flux was extrapolated to zero at the time of snow melt in the spring and of soil freeze-up in the autumn. The net seasonal flux for each site was determined as the integral under the curve of the seasonal pattern of daily fluxes. There was little variability in daily CO_2 flux rates among the replicates at each site on any day. Because these measurements were made only during the snow-free summer period, they underestimate the seasonal carbon loss to the atmosphere by the presumably small amount of soil and plant respiration that occurs under snow during the unmeasured winter period.

Given the general pattern of warming for the north slope of Alaska and the Canadian arctic[6-10,34], the patterns observed along this transect in Alaska may be widespread and the carbon loss huge. If the average rate of loss in tussock tundra of 156 g C m^{-2} yr^{-1} is typical for circumpolar tussock tundra, the loss of carbon to the atmosphere in 1990 from the 0.90×10^6 km² of tussock tundra worldwide[2] would be 0.14 Gt C per year. Similarly, if the 34 g C m^{-2} yr^{-1} of CO_2 evolution from wet tundra is applied to the 1.00×10^6 km^2 of wet coastal tundra, another 0.03 Gt C is lost annually to the atmosphere. Adding 0.02 Gt C for efflux from arctic tundra lakes and rivers[35] results in a total estimated annual loss of 0.19 Gt C from these three circumpolar arctic surface types. This combined efflux can be compared to the 0.2–0.7 Gt C calculated to be lost to the atmosphere from high-latitude ecosystems[17]. Given the large belowground stores of carbon in arctic, boreal forest and high-latitude bogs, these high-latitude ecosystems could provide a considerable positive feedback on increasing atmospheric CO_2 and global warming.

There are many uncertainties in predicting the long-term effect of global change on arctic ecosystems. The initial response to warming and drying may be a loss of carbon from the system.



whereas at longer intervals, invasion by shrub and tree species may result in increased above-ground carbon storage. Other compensatory processes include cooling of the soil surface (following increased insulation from drying of the soil surface and litter or biomass accumulation from elevated CO_2 and, or other climatic effects). Currently there is no evidence that these compensatory processes are acting or will act quickly. Field and laboratory experiments indicate little or no stimulation of photosynthesis in the Arctic by elevated atmospheric CO_2 (ref. 36). It is likely that global warming will lead to significant outgassing of carbon from wet and moist tundra before other processes reincorporate this carbon into arctic areas. Global warming could accelerate the rate of carbon loss in arctic tundra ecosystems by increasing the depth of thaw, increasing soil drainage and aeration, and increasing rates of soil decomposition and plant respiration more than gross primary productivity.

The recent climate patterns may be part of the normal climate variation or an early indication of greenhouse warming. In either case, it is clear that they have affected the current carbon flux from the arctic ecosystem, and that arctic and boreal forest ecosystems could provide a strong positive feedback on atmospheric carbon dioxide concentration. □

Received 27 April; accepted 21 December 1992.

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ACKNOWLEDGEMENTS. Supported by the CO_2 Research Program of the Office of Health and Environmental Research of the U.S. Department of Energy. We thank W. Lawrence and T. Prudhomme for assistance in developing the CO_2/T greenhouse system, S. Cowles for data analysis, and B. Stocker, I. Fung, S. Wofsy, F. S. Chapin III, G. Shaver and W. D. Billings for reviewing an earlier draft of this manuscript. Accommodation and support provided by the North Slope Borough, Department of Industrial Development and ARCO Department of Environmental Compliance at Prudhoe Bay and by the University of Alaska at Toolik Lake are gratefully acknowledged.

The transient response of terrestrial carbon storage to a perturbed climate

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MODEL simulations suggest that at equilibrium, global warming driven by higher atmospheric concentrations of greenhouse gases will lead to increased terrestrial carbon storage[1,2], implying a negative feedback between the global vegetation/soil system and the atmospheric CO_2 concentration. But changes in vegetation and soil type that result in a net release of CO_2 to the atmosphere (such as those caused by wildfires) could be more rapid than changes that result in a net increase in terrestrial carbon storage (such as species immigration and soil formation), so that in its transient response to climate change, the terrestrial vegetation/soil system could be a net source of carbon to the atmosphere. Here we use two general circulation models[3,4] to estimate the transient response of the terrestrial surface to a step doubling of atmospheric CO_2. We find that vegetation and soil changes could prove to be a significant source of CO_2 in the first 50–100 years following a climate warming, increasing the atmospheric CO_2 concentration by up to a third of the present level.

Several estimates have been made for the carbon reserves of the terrestrial surface[5,6]. These estimates are obtained by classifying the vegetation and soils, and then multiplying area estimates for each classification category by the carbon concentration of soil and vegetation in research sites typical of that category. Vegetation and soil classifications have also been related to climate variables and used in assessments of possible global responses to climate changes[1,2,7], for example to estimate changes in potential terrestrial carbon storage. Such calculations presumably estimate a long-term equilibrium response to a climate change. In the case of a 'greenhouse gas' climate warming, the long-term response of the terrestrial surface is to store more carbon[1,2].

Here we extend the methodology used by Smith *et al.*[2] to estimate the transient terrestrial surface response to a step change in climate. In brief, the method of determining present and future carbon reserves was this. (1) Expected current global distributions of vegetation were mapped at a $0.5° \times 0.5°$ (latitude and longitude) resolution using the Holdridge life-zone classification[8] and a climate database of monthly precipitation and temperature[9]. (2) Estimates of carbon storage per unit area for each Holdridge life zone[2] were derived for above-ground biomass using data from Olson *et al.*[5] and for soil carbon from Post *et al.*[10]. These estimates were applied to the map produced in step 1 to obtain global terrestrial-surface carbon pools[2]. (3) Simulations of current ($1 \times CO_2$) and $2 \times CO_2$ climates from the general circulation models developed by the Goddard Institute for Space Studies[3] and the Geophysical Fluid Dynamics Laboratory[4] were used to construct climate change schemes[2]. (4) The climate database was altered according to the changes implied by the climate change schemes, and steps 1 and 2 (above) were repeated to obtain estimates of carbon storage (presumably after a long period of equilibration) for the altered climate conditions.

To obtain an estimate of the change in source–sink relations between the terrestrial surface and the atmosphere, we developed a simple compartment model of terrestrial carbon reserves (above-ground biomass and soils) and applied this model to the globally mapped vegetation changes in response to the two climate-change schemes. The compartment model used in this analysis parallels the approach used in current

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Statement by the Department of Justice on EDF v. Massey

WASHINGTON, D.C. -- In declining to seek a rehearing in this case today, the administration has decided not to challenge the Court's precise holding -- namely, that the National Environmental Policy Act applies to the National Science Foundation's activities in Antartica described in the opinion. However, the administration does not embrace language in the opinion which may be interpreted to extend beyond this holding.

# # #

93-070

Katie McGinty - well done! A good piece of work (or, sometimes the good guys win one!)

Thanks again for a job well done

Tim

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2B

Absence of evidence for greenhouse warming over the arctic ocean in the past forty years

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ATMOSPHERIC general circulation models predict enhanced greenhouse warming at high latitudes[1] owing to positive feedbacks between air temperature, ice extent and surface albedo[2-4]. Previous analyses of Arctic temperature trends have been restricted to land-based measurements on the periphery of the Arctic Ocean[5,6]. Here we present temperatures measured in the lower troposphere over the Arctic Ocean during the period 1950–90. We have analysed more than 27,000 temperature profiles, measured by radiosonde at Russian drifting ice stations and by dropsonde from US 'Ptarmigan' weather reconnaissance aircraft, for trends as a function of season and altitude. Most of the trends are not statistically significant. In particular, we do not observe the large surface warming trends predicted by models; indeed, we detect significant surface cooling trends over the western Arctic Ocean during winter and autumn. This discrepancy suggests that present climate models do not adequately incorporate the physical processes that affect the polar regions.

According to general circulation model (GCM) studies, both with and without coupled ocean model components, high-latitude warming in response to increasing greenhouse gas concentrations should occur rapidly both at the surface and at higher elevations in the troposphere[1]. In one simulation[7], Arctic surface air temperatures for the 1980s were predicted to increase by 2 °C relative to 1958 levels. There is marked disagreement, however, among simulations of the present-day Arctic climate. Walsh and Crane[8] found significant differences among five GCMs in reproducing basic meteorological fields, including sea-level pressure and surface air temperature. As the causes for the large intra- and interannual differences in the Arctic circulation and hence tropospheric temperatures are still poorly understood[9], it is not surprising that the interannual variability in tropospheric temperatures may be poorly simulated. In addition, many GCMs lack thermodynamic sea-ice model components which are obviously of great importance in the polar regions.

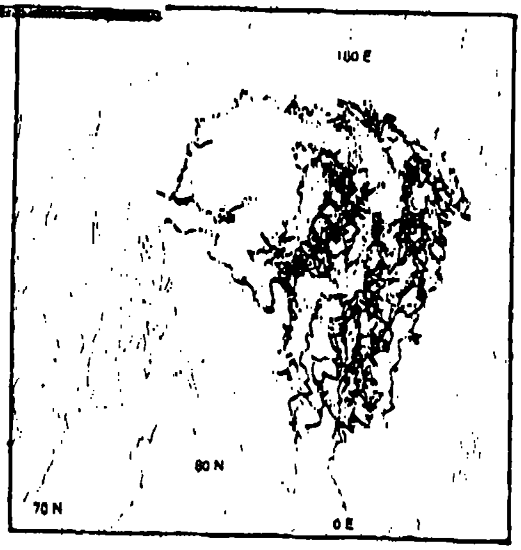

FIG. 1 Locations of 16,850 temperature profiles measured by radiosonde at Russian drifting ice stations during 1954–1990. The stations drift with the prevailing winds and surface currents in the Arctic Ocean, typically moving ~100 km each month. Taken together, the measurements provide reasonably complete coverage over the Arctic ice cap. At any given time, however, data are only available at locations along the drift path.

As predicted by theory, Arctic surface temperatures have shown accelerated warming trends during the past century[5,6]. Temperatures above the surface, however, have shown little evidence of enhanced warming during the past several decades[10-12]. Tropospheric cooling has even been detected in some regions of the Arctic[13]. So far analyses of Arctic temperature trends have focused on measurements at land-based weather stations located along the periphery of the nearly uninhabited Arctic Ocean. Here we analyse temperature measurements made over the Arctic Ocean during the period 1950–1990.

Two independent meteorological databases were assembled for analysis. The first consists of 16,850 lower tropospheric temperature profiles measured at the 'North Pole' series of

TABLE 1 Temperature trends over central and western Arctic Ocean

Season	Surface Trend	Surface N	Surface s	850 hPa Trend	850 hPa N	850 hPa s	700 hPa Trend	700 hPa N	700 hPa s	850-700 hPa layer Trend	850-700 hPa layer N	850-700 hPa layer s
Central Arctic Ocean												
Winter	0.81	30	0.30	**2.41**	30	0.98	2.14	30	0.94	**2.30**	30	0.99
Spring	0.02	26	0.00	1.06	27	0.36	2.33	26	0.78	3.26	26	0.91
Summer	0.41	26	0.62	0.81	26	0.60	0.12	26	0.09	1.31	26	0.80
Autumn	−2.50	29	0.79	−0.02	29	0.01	−0.07	29	0.04	0.71	29	0.42
Western Arctic Ocean												
Winter	**−4.40**	20	0.97	**3.42**	20	0.97	**2.84**	20	0.96	**3.74**	20	0.99
Spring	1.56	20	0.27	2.39	20	0.54	2.51	20	0.65	2.45	20	0.59
Summer	−0.23	23	0.19	−0.49	23	0.38	−0.21	22	0.20	0.18	22	0.14
Autumn	**−4.90**	21	0.96	−1.14	21	0.48	−1.34	21	0.66	−1.06	21	0.51

Temperature trends (°C per 40 yr) over the central and western Arctic Ocean, along with the length of the data record in years (*N*) and the confidence level (s). Bold entries are significant at the 95% confidence level or greater. Note that most trends are not significant, and that significant warming in surface air temperatures is not observed.

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TABLE 2 Temperature trends over Arctic Ocean

Season	Surface Trend	Surface N	Surface s	850 hPa Trend	850 hPa N	850 hPa s	700 hPa Trend	700 hPa N	700 hPa s	850–700 hPa layer Trend	850–700 hPa layer N	850–700 hPa layer s
Winter	**−2.44**	38	0.95	**2.30**	38	0.97	1.74	38	0.94	**2.77**	38	0.99
Spring	0.70	36	0.19	2.08	36	0.77	2.12	36	0.84	2.68	36	0.90
Summer	0.00	38	0.01	−0.11	38	0.11	−0.21	38	0.24	0.64	38	0.59
Autumn	**−4.14**	37	0.99	−1.07	37	0.77	−1.19	37	0.85	−0.62	37	0.52

Temperature trends (°C per 40 yr) over the Arctic Ocean, along with the length of the data record in years (N) and the confidence level (s). Bold entries are significant at the 95% confidence level or greater. Results are shown for all available measurements. Most trends are not significant, and significant cooling in surface air temperatures is observed during winter and autumn.

Russian drifting ice stations during the period 1954–1990 (Fig. 1). Temperature profiles were measured 1–2 times daily by radiosondes (balloon-borne meteorological instrument packages). Portions of this database have been used previously in investigations of the thermal structure over the Arctic Ocean[14–16], convection heights above leads[17] and Arctic temperature fluctuations[18]. The second database contains 10,326 dropsonde temperature soundings measured during the 'Ptarmigan' air weather reconnaissance missions conducted by the United States Air Force during the period 1950–1961 (ref. 19) (Fig. 2). The dropsondes, meteorological instrument packages carried by parachutes, provided temperature profiles throughout the lower troposphere.

Temperatures at the surface, the 850 hPa (~1.4 km) and 700 hPa (~2.8 km) pressure altitudes, and mean virtual temperatures within the 850–700 hPa layer were extracted from each profile and subjected to quality-control procedures[20,21]. Virtual temperature is the temperature that dry air would have if it had the same density as moist air at the same pressure. Mean virtual temperature is a convenient quantity for monitoring climate change, as it characterizes an atmospheric layer and may be calculated from pressure and height data. It is a useful surrogate for temperature in the Arctic where moisture levels are low. Seasonal mean temperatures for each level or layer, based on a minimum requirement of 10 values per season, were calculated with seasons defined as winter (December–February), spring (March–May), summer (June–August) and autumn (September–November). Trends were computed by linear regression on seasonal anomalies for the 41-year period 1950–1990.

Statistical significance levels (for rejecting the null hypothesis that there is no trend) were determined through a bootstrap procedure[22] as follows. The anomaly time series were first detrended by subtracting the linear regression values from the N anomalies, where N is the number of points (years) in the time series. Bootstrap anomaly series were then obtained by drawing N values at random from the detrended anomaly series, allowing values to be drawn multiple times. The trend given by the linear regression was then added to the bootstrap anomaly series, and a new trend was subsequently calculated. This procedure was repeated 10^4 times for each season, level and layer, yielding gaussian frequency distributions of simulated trends with mean μ and standard deviation σ. The significance level, the probability that the trend is significantly different from zero, was obtained by determining the number of standard deviations between μ and zero (μ/σ) and integrating over the range $\mu \pm \mu/\sigma$.

Our analysis focused on two regions (Fig. 2): the 'central Arctic Ocean' (82–90° N) and the 'Western Arctic Ocean' (73–82° N and 90–180° W). These regions were defined through an iterative process in which we tried to optimize the number of annual observations within each region, while keeping the regions as small as possible. Possible sources of bias arising from the spatial and temporal inhomogeneity of the database will be discussed below.

The calculated temperature trends are shown in Table 1. For the central and western Arctic Ocean respectively, 26–30 and 20–23 years are represented in the anomaly time series analysed. Most of the trends are not significant at the 95% confidence level. Winter trends are mostly positive and significant, particularly at above-surface levels in the western Arctic Ocean, although the large surface warming predicted by GCMs is not found in either region. Rather, a large, statistically significant surface cooling (negative) trend is found in the western Arctic during winter and autumn.

We conducted tests to assess the sensitivity of the computed trends to three possible sources of bias arising from the spatial and temporal non-uniformity of the data base: (1) the large degree of spatial anisotropy in the 'Ptarmigan' soundings (Fig. 2); (2) the temporal non-uniformity of the data base, as more observations were available for analysis during the years 1954–1961 (when both 'Ptarmigan' and Russian ice station soundings were available) than during other years; and (3) the selection of analysis regions. The first two sources of possible bias were investigated by excluding the 'Ptarmigan' soundings from the trend analyses. Without this portion of the database, the measurements were considerably more uniform in both space (Fig. 1) and time. The results were similar to those shown in Table 1. We addressed the third possible source of bias by computing trends for the entire Arctic Ocean using all available soundings including those outside the central and western Arctic Ocean analysis regions (Figs 1, 2). The results of this latter analysis (Table 2) are again similar to those shown in Table 1.

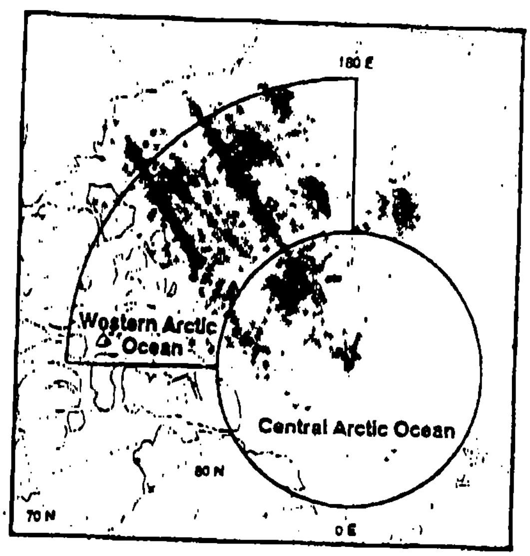

FIG. 2 Locations of 10,326 temperature profiles measured by dropsonde from U.S. Ptarmigan weather reconnaissance aircraft during 1950–1961. The aircraft typically flew diamond-shaped patterns extending from central Alaska to the North Pole. Portions of the flight paths are visible as 'streaks' of dropsonde positions. Drops were often made at pre-determined locations, with as many as 500 soundings made at specific points. More than 100 soundings were made at the North Pole. The 'Central Arctic Ocean' and 'Western Arctic Ocean' analysis regions are identified.

Few of the trends are significant, large surface warming trends are not observed, and like the Western Arctic Ocean analysis in Table 1, significant surface cooling trends are found during winter and autumn. Significant warming trends are observed at the 850 hPa level and the 850–700 hPa layer during winter, in agreement with GCM simulations, but the surface trend is negative. The trends presented in Table 2 are more representative temporally, as they use 36–38 years out of a possible 41, as compared with 20–30 years in the regional analysis (Table 1). On the basis of these tests, we feel that any possible bias introduced by the non-uniform database is small.

The lack of widespread significant warming trends leads us to conclude that there is no strong evidence to support model simulations of greenhouse warming over the Arctic Ocean for the period 1950–1990. Our results, combined with the inconsistent performance of model simulations of Arctic climate[6], indicate a need to understand better the physical processes that affect the polar regions, especially atmosphere–ice–ocean interactions, ocean heat transfer and cloud radiative effects, and to incorporate thermodynamic sea-ice components into future models. We consider the retrieval of temperature profiles from satellite sounding instruments to be an important means of further resolving the spatial and temporal gradients in Arctic air temperatures. □

Received 23 July; accepted 21 December 1992.

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ACKNOWLEDGEMENTS. Portions of this work were sponsored by the NOAA's Climate and Global Change Program, the Electric Power Research Institute, and the NSF Division of Polar Programs. The project was conducted as part of the US-Russia Joint Committee on Cooperation in Environmental Protection, the Influence of Environmental Change on Climate (Working Group VIII). Helpful comments were provided by A. A. Tsonis.

Detection of crustal deformation from the Landers earthquake sequence using continuous geodetic measurements

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THE measurement of crustal motions in tectonically active regions is being performed increasingly by the satellite-based Global Positioning System (GPS)[1,2], which offers considerable advantages over conventional geodetic techniques[3,4]. Continuously operating GPS arrays with ground-based receivers spaced tens of kilometres apart have been established in central Japan[5,6] and southern California to monitor the spatial and temporal details of crustal deformation. Here we report the first measurements for a major earthquake by a continuously operating GPS network, the Permanent GPS Geodetic Array (PGGA)[7–9] in southern California. The Landers (magnitude M_w of 7.3) and Big Bear (M_w 6.2) earthquakes of 28 June 1992 were monitored by daily observations. Ten weeks of measurements, centred on the earthquake events, indicate significant coseismic motion at all PGGA sites, significant post-seismic motion at one site for two weeks after the earthquakes, and no significant preseismic motion. These measurements demonstrate the potential of GPS monitoring for precise detection of precursory and aftershock seismic deformation in the near and far field.

The PGGA, established in southern California (Fig. 1) in the spring of 1990, is a network of five continuously operating GPS receivers providing an uninterrupted record of crustal motion in near real-time. At each site there is a precise P-code GPS receiver with its antenna mounted on a geodetic monument. Twenty-four hours of data are automatically collected from each site once a day; the operational analysis provides the site position averaged over the day (0–24 h Universal Time Coordinated, UTC), although finer resolution is possible. The precision of the daily relative position between any two sites in the network, based on long-term scatter of nearly 2 years of measurements, is ~5 mm in the horizontal and 10–20 mm in the vertical. To obtain this precision, and to achieve near-real-time solutions, we compute orbits for all GPS satellites, using data collected by a globally distributed network of about 25 permanent tracking stations[10] (Fig. 1), and corrections to tabulated predictions[11] of the orientation of the Earth's rotation axis (polar motion). The worldwide tracking network defines a global reference frame in which coordinates for the PGGA stations, in unstable southern California, can be computed with respect to rigid plate interiors (for example, the North American plate).

Here we report measurements of seismically induced displacements of the PGGA stations due to the Landers (M_w 7.3, 11:58 UTC, 34.22° N, 116.43° W) and Big Bear (M_w 6.2, 15:07 UTC, 34.21° N, 116.83° W) earthquakes of 28 June 1992. We examined the series of PGGA station positions in the 10-week period centred on the day of the earthquakes using a Kalman-filter formulation[12] to analyse the daily 24-hour PGGA solutions. For the day of the earthquakes, we computed the station positions separately from the 12 hours of data before the Landers earthquake and the 9 hours of data after the Big Bear event. The global tracking network was fairly extensive as the 3-month International GPS Service campaign[13] began on 21 June (Fig. 1). Displacements of the PGGA sites, listed in Table 1, were determined by examining the variation in the positions before and after the earthquakes with respect to a global reference frame defined by the coordinates of the tracking network stations. The horizontal displacements of the PGGA sites are

There is nevertheless good evidence that neuromuscular activity influences the morphogenesis of body-wall synapses, at least when assayed in the larva. Where electrical excitability is increased using potassium channel mutants, there is a corresponding elaboration of the size and complexity of the motor endings[10].

The new paper by Broadie and Bate[1] looks at the effects of total body-wall denervation on the muscle cells. Embryos mutant for the *prospero* gene have extensive errors in the CNS, with many efferent neurons failing to exit the CNS. The *prospero* product is localized to the nuclei of neural precursor cells, and is involved in establishing the appropriate cell lineages. The mutation was used to separate genetically those events in synaptogenesis that are induced by motor neurons from those that occur intrinsically in the musculature. It turns out that innervation plays no part in the normal accumulation of either fasciclin III or connectin to synaptic sites, or in the initial expression of glutamate receptors. Nevertheless, the localization of the receptors to the predicted synaptic sites did not occur in the absence of the innervating motor neuron, and the second wave of receptor expression which normally follows innervation was also disrupted in the denervated *prospero* muscle fibres. When the few developing motor neurons in *prospero* mutants occasionally established connections on ectopic sites, receptors accumulated at those locations. In *Drosophila*, glutamate receptors accumulate at ectopic innervation sites even when native motor neurons have made functional connections at their correct locations, as is seen for ectopic neuromuscular synapses in the *bithorax* mutant[11].

Events involved in the expression and localization of *Drosophila* neurotransmitter receptors are reminiscent of those occurring at vertebrate neuromuscular junctions, raising the possibility that common mechanisms may be at work. Many questions are raised by the observations made in the fruit fly. Is the receptor expression and localization activity dependent? Does the motor neuron release receptor-inducing activities, resembling the vertebrate ARIAs? Are there molecules involved that organize receptors, similar to vertebrate agrin? In a system using multiple neurotransmitters, how do the appropriate receptors associate with the correct presynaptic processes? *Drosophila*, with its beautifully patterned array of body-wall synapses is just the organism for tackling these and other questions, where hypotheses about development can often be phrased in terms of single neurons and single genes. □

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CLIMATE CHANGE

The elusive Arctic warming

John E. Walsh

TEMPERATURE data obtained from drifting ice stations and aircraft over the Arctic Ocean provide no evidence of surface warming in the region over the past four decades. This finding, reported by Kahl *et al.* on page 335 of this issue[1], apparently runs counter to the grain of the greenhouse-induced climate changes projected by global climate models. Experiments with climate models have indicated that the greenhouse warming will be amplified in the polar regions, at least during the winter half of the year[2]. The new results are all the more striking because they indicate a statistically significant decrease in surface temperatures in the western Arctic Ocean (70–80° N, 90–180° W) during winter and autumn of the 1950–90 period. Interesting, the winter temperatures at 1–1.5 km altitude have apparently warmed by 3.4 °C over 40 years, while the surface has cooled by 4.4 °C, thereby increasing the strength of the temperature inversion over this range by a striking 7.8 °C.

When viewed in a broader context, these findings (apart from the inversion) are not necessarily at odds with climate-model projections. The drifting ice stations, from which were launched the balloon-borne radiosondes that provided all authors' temperature profiles for 1962–90, are logistically constrained to be sited on the thick pack ice of the central Arctic Ocean. So they do not sample the potentially sensitive marginal ice zone, where the ice retreat generally results in the greatest warming in CO_2-doubling experiments of climate models[3].

The broad latitudinal range of many model-derived Arctic warming patterns is attributable to the seasonal migration of the boundary of a reduced ice cover: a model's newly created open water typically extends a few degrees north of the present ice edge in winter, but it extends well into the central Arctic Ocean (or even to the pole) during summer. The distribution of Russian drifting station tracks in Kahl *et al.*'s Fig. 1 (see page 335) indicates that only one track extends as far south as 75° N in the Western Arctic domain, and one other track extends as far south as 75° N in Fram Strait. Many of the dropsonde profiles were obtained from the climatologically warmer marginal ice zone of the western Arctic, but all these measurements were made in the first 12 years of the 40-year study period.

The contrast between the central Arctic Ocean and the subarctic assumes greater significance when one examines the temperature trends derived from other data sources[4]: land-station and marine-ship reports. From such data, we have found[5] a high-latitude warming over the past 30 years, but primarily over the northern land areas[5] (see figure). The few areas of noteworthy oceanic warming (north of Svalbard, Kara-Laptev Seas) are south of the ice-station and dropsonde data. Interestingly, according to the 1992 Supplementary Report of the Intergovernmental Panel on Climate Change[6], CO_2-doubling experiments with some of the more advanced coupled atmosphere-ocean climate models (UK Meteorological Office, Geophysical Fluid Dynamics Laboratory, Princeton) project a pattern similar to that emerging from all the data: strongest warming over land, weaker warming over the subpolar oceans, and little warming (or even a cooling) over the climatically delicate North Atlantic Ocean near southern Greenland. As is the case in the recent (1961–90) data, the projected warming over land is stronger in winter than in summer. Indeed, the summer trends must be negligible over ice-covered oceans, where the summer surface temperatures are constrained to 0 °C by melting snow and ice. The land–sea contrast of the recent warming is consistent with a forced variation of climate.

Data-based indications of high-latitude warming are not limited to the past few decades. Tree-ring chronologies from high-latitude sites have been used to reconstruct annual temperatures for an "Arctic zone" and for the Northern

NEWS AND VIEWS

RÉSUMÉ

Hemisphere[7]. The low-frequency variations are similar in the Arctic and hemisphere time series, and the Arctic variations generally appear as amplifications of the latter. Interestingly, the Arctic temperatures deduced from the tree rings show a century-scale warming interrupted by a cooling from the 1940s to approximately 1970; the instrumental temperatures indicate that the warming over the high-latitude land areas was most pronounced after the late 1960s.

A highly relevant model experiment has recently been performed by Oglesby and Saltzman[8] as a part of MECCA (Model Evaluation Consortium for Climate Assessment). A short-term climate simulation using CO_2 concentrations that increased from 330 to 342 parts per million (corresponding approximately to the increase from 1973 to 1983) showed no significant warming in the Arctic, even in winter. However, when the model was run with CO_2 prescribed to increase from 330 to 450 parts per million (the change projected for 2048), significant warming occurred in the Arctic. The implication is that natural variability will overwhelm the greenhouse signal in the Arctic over the decadal timescale, but that the Arctic warming is detectable as a statistically significant signal in a model simulation of 70–100 years.

These studies indicate that climate model results are not necessarily at odds with recent temperature variations in high latitudes. One may also point to compatibilities between precipitation data of recent decades and model projections of an increase of high-latitude precipitation as greenhouse-gas concentrations increase. Wetter conditions in high latitudes are quite plausible if the greenhouse scenario includes surface warming, higher evaporation rates, and a greater moisture-holding capacity of the warmer atmosphere. Recent data analyses have shown an increase of precipitation in the northern extratropics during the twentieth century[9,10], and the increase over northern Canada and Alaska during the past few decades is especially large[11].

One may conclude that the greenhouse projections of climate models are consistent, in several respects, with high-latitude data from the past few decades. ing of the wintertime temperature inversions reported by Kahl *et al.* from over the Arctic Ocean. Subtleties in the model formulations of Arctic boundary-layer processes (including cloud/radiative interactions) may well be at the root of this discrepancy. Certainly, the vertical resolution of current models is inadequate. Alternatively, the changing spatial and temporal distributions of the temperature data relative to the climatological spatial pattern may contribute to the apparent discrepancy. As the breakdown of the near-surface temperature inversion contributes substantially to the polar amplification of the greenhouse warming projected by models, the resolution of this discrepancy deserves high priority. One possible approach to resolving the discrepancy is a replication of Kahl *et al.*'s sampling strategy, both spatially and temporally, using output from a climate model run with the changing CO_2 concentrations of the period 1950–90. □

Trends of annual temperature (°C per decade) for 1961–90 based on land-station and marine-ship reports. Data from the Arctic Ocean are not included. The analysis was obtained by spatially filtering local trends using a 400-km radius of influence. All points in black area at centre are more than 400 km from locations for which data were consistently available. (From ref. 5.)

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ATTACHMENT A

COMPARISON OF ENVIRONMENTAL IMPACT ASSESSMENT PROVISIONS IN NEPA/CEQ REGULATIONS AND THE ANTARCTIC PROTOCOL/ANNEX 1

PURPOSE/PRINCIPLES

NEPA: Basic national charter for protection of the environment. To ensure environmental information is available to public officials and citizens before decisions are made, and before actions are taken. The NEPA process is intended to help public officials make decisions based on an understanding of environmental impacts, and take actions that protect, restore and enhance the environment.

PROTOCOL: To ensure that the protection of the Antarctic environment and dependent and associated ecosystems are fundamental considerations in the planning and conduct of all activities in the Antarctic Treaty area. Accordingly, activities in Antarctica shall be planned and conducted on the basis of information sufficient to allow prior assessments of, and informed judgments about, their impacts on the Antarctic environment.

APPLICABILITY

NEPA: Applies to federal actions, including plans, policies, rules, regulations.

PROTOCOL: Applies to both governmental and non-governmental actions, including those pursuant to scientific research programs and tourism

SCOPING

NEPA: Provides for scoping process at an early stage in the process to identify significant environmental issues, and to deemphasize insignificant issues

PROTOCOL: Does not articulate scoping process (presumably because the Antarctic Treaty Parties recognized the particulars of EIA implementation would be drafted by each individual Party)

2-Part Process (EA/EIS-- IEE/CEE)

NEPA: Environmental Assessment (EA) prepared to determine whether federal action may have a significant impact on the environment; if so, then the more comprehensive Environmental Impact Statement (EIS) is required in both a draft and final form

PROTOCOL: Requires preparation of an Initial Environmental Evaluation (IEE) for any proposed action that may have at least a "minor or transitory" impact on the environment; if so, then preparation of a Comprehensive Environmental Evaluation (CEE) is required in both a draft and final form

THRESHOLD STANDARDS

NEPA: EA prepared to determine whether an action might have a significant impact on the environment; if there is a finding of no significant impact, the action may proceed, as no EIS is required

PROTOCOL: IEE to determine whether action may reasonably be expected to have a significant impact; if IEE indicates that the action is likely to have no more than a minor or transitory on the environment, then the activity may proceed, as no CEE is required

DOCUMENTATION

NEPA AND PROTOCOL: EIS and CEE to include, inter alia, a description of the proposed activity, including alternatives to that activity; a description of the character of the likely impacts of the proposed activity; consideration of indirect and cumulative impacts; identification of measures, including monitoring, to mitigate impacts and detect unforeseen impacts; identification of unavoidable impacts

PUBLIC INVOLVEMENT

NEPA: Requires public involvement in preparation of EA; requires public involvement for the preparation of draft and final EIS

PROTOCOL: Does not address public involvement in preparation of IEE; requires public involvement in preparation of draft and final CEE

domestic or intl?

CIRCULATION OF, COMMENT ON, DOCUMENTS

NEPA: Requires EA, draft and final EIS be made available to the public for comment. Final EIS must address comments received on draft EIS, and must be circulated for at least 45 days before the commencement of the proposed activity

PROTOCOL: Does not address circulation/comment regarding IEE; requires draft and final CEE be circulated to all Parties for comment, and at the same time forwarded to the Committee for Environmental Protection. Final CEE is to address and include or summarize comments received, and shall be circulated to all Parties at least 60 days before the commencement of the proposed activity

public comment or just parties??

EMERGENCIES

NEPA: Where emergency circumstances make it necessary to take an action with significant environmental impacts without observing NEPA and CEQ regulations, then federal agency should consult with the Council on Environmental Quality about alternative arrangements. These arrangements would be limited to actions necessary to control the immediate impact of the emergency

PROTOCOL: Provides exception to EIA process in cases of emergency relating to the safety of human life or of ships, aircraft or equipment and facilities of high value, or the protection of the environment. Immediate notification of activities undertaken in such circumstances is required, and subsequently a full explanation of those activities

LEGAL RECOURSE

NEPA: No criminal or civil penalties. Pursuant to tenets of administrative law, citizens may ~~file lawsuits~~ where agencies do not comply with NEPA and CEQ regulations

PROTOCOL: Obligates Parties to take appropriate measures within their competence, including the adoption of laws and regulations, administrative actions and enforcement measures, to ensure compliance with the Protocol and Annexes.

file

STATEMENT

BY THE

NATIONAL SCIENCE FOUNDATION

DR. FREDERICK BERNTHAL
DEPUTY DIRECTOR

BEFORE THE

SUBCOMMITTEE ON SCIENCE

ON

FEBRUARY 23, 1993

Thank you, Mr. Chairman, for this opportunity to discuss Antarctic research, and the Protocol on Environmental Protection to the Antarctica Treaty.

The Protocol, signed by the United States at Madrid on October 4, 1991, and given the advice and consent of the Senate on October 7, 1992, designates Antarctica as a natural reserve, devoted to peace and science, and establishes a comprehensive environmental protection regime governing activities undertaken there. The National Science Foundation whole-heartedly supports its basic goal of according priority to research, while requiring that all activities, including scientific research, be undertaken in a manner that preserves the Antarctic environment.

Antarctic research has made many important scientific contributions, and is critical to our understanding of global ecological and environmental problems. Most recently --

- o Antarctic researchers observed the lowest ozone levels and the largest ozone "hole" during the 1992-1993 season. Despite the Montreal Protocol curbing CFC production, the chemical destruction of ozone continues unabated due to the atmospheric reservoir to chlorine compounds from global, not Antarctic, sources.

o A four-station Antarctic UV monitoring system provides a continent-wide perspective on the scope of increased levels of ultraviolet radiation associated with the Antarctic ozone hole. Recent results suggest that marine productivity is reduced six to twelve percent during the time of maximum ozone depletion.

o South Pole measurements of microwave background radiation are helping astrophysicists understand the evolution of the universe. Because of extremely clear atmospheric conditions at the South Pole, the quality of data collected there is unsurpassed.

o Scientists at a joint US-Russian ice camp in the Weddell Sea took the first ever coordinated set of measurements of interactions of ice, ocean and atmosphere in the region. Early discoveries include algae that are biologically active in the winter, new sources of bottom water formation, and the accurate location of the continental shelf. These fundamental findings are essential to a better understanding of the effects of the Antarctic ocean on global change.

Antarctica is an unmatched natural laboratory for scientific research, in large part, because the Antarctic environment is relatively unaffected by human activity there. The National

Science Foundation (NSF) is committed to protecting the Antarctic environment, and, to that end, has implemented a series of environmental protection measures. These include improvements in U.S. Antarctic Program (USAP) waste handling procedures; development and implementation of oil spill prevention and spill management plans; and commencement of routine monitoring of ambient air and water quality at McMurdo station so as to gather baseline information to detect unforeseen impacts of USAP activities. USAP has also ceased open burning of waste at all of its stations, has instituted comprehensive waste minimization and recycling programs, has worked towards the prevention of fuel spills by replacing rubber fuel bladders with steel tanks, and old, short-length fuel hoses with new, long-length "dry-break" connections.

The list of NSF's environmental stewardship activities goes on, and environmental practices continue to improve. Attached to this testimony are descriptions of some of the environmental actions undertaken by NSF during the past three Antarctic seasons. Although the Protocol is not yet in force, NSF already conducts its Antarctic activities in a manner largely consistent with its requirements, and will soon publish final Antarctic waste management and waste disposal regulations that, among other things, require U.S. citizens to comply with the Protocol's waste management and waste disposal requirements.

The Clinton Administration is establishing a new interagency working group to review U.S. policy for Antarctica. That review will include the question of legislation to implement the Protocol on Environmental Protection to the Antarctic Treaty. H.R. 964, which was introduced on February 18th by you, Mr. Chairman, and co-sponsored by Reps. Brown, Walker, Boehlert, Valentine, Barcia, Johnson, and Minge will be carefully considered by the interagency working group. As soon as the review is completed, the Administration will advise you of the outcome.

Testimony of

Alan D. Hecht
Acting Assistant Administrator
Office of International Activities
U.S. Environmental Protection Agency

Before the

Subcommittee on Environment and Natural Resources
Committee on Merchant Marine and Fisheries
The U.S. House of Representatives

February 25, 1993

The Environmental Protection Agency (EPA) greatly appreciates this opportunity to present its views on U.S. efforts to promote the export of U.S. environmental goods and services. While we defer to views of the Department of Commerce and other Federal agencies on clear-cut matters of export promotion, we would like to present here a brief overview of the global market for environmental goods and services and the commercial opportunities this market presents. We would also like to describe some of EPA's many export-*related* activities which, while not directly promoting trade, provide the opportunity for U.S. vendors to identify and fill environmental needs across the globe. Because EPA's international programs foster unique follow-on opportunities for U.S. environmental businesses to help solve environmental problems worldwide, EPA can make a significant contribution to overall U.S. export assistance efforts.

The Growing Global Market for Environmental Goods and Services

The global market for environmental technologies, currently estimated at $200 billion a year, is projected by the Organisation for Economic Cooperation and Development (OECD) to reach nearly $300 billion by the year 2000. This unprecedented growth is believed to result from a number of factors. First, as countries around the world seek to reduce the risks and costs imposed by pollution, governments are enacting stringent environmental regulations and committing the resources necessary to enforce them. Second, companies themselves are recognizing that cleaner manufacturing processes not only mitigate waste but heighten cost-savings and competitiveness. As a result, industry increasingly has been adopting *voluntarily* cleaner technologies, and new market opportunities have developed in result. Third, non-governmental and multilateral lending and development organizations are insisting that protection of the environment pre-condition their assistance and lending activities. Together, these factors are offering U.S. firms an unprecedented opportunity to meet new and burgeoning international needs.

The international market for environmental goods and services is currently dominated by demand for "end-of-pipe" pollution control equipment. The OECD projects that the markets for both pollution control equipment and services will increase steadily through the end of the century, with demand for equipment projected to grow at 5% per annum. The demand for services is expected to grow even faster as pollution control technologies are more fully integrated into industrial products and processes. [See Tables A and B.] In response to these bright prospects, the United States and a number of other countries have begun to position themselves to take advantage of the lucrative business opportunities.

The United States has long been a leader in providing environmental protection products and services at home. Our aggressiveness in setting and enforcing environmental standards established U.S. environmental goods and services firms as front runners early on. However, as other nations have adopted and enforced stronger laws over time -- particularly laws utilizing quality standards and laws that emphasize preventive, rather than end-of-pipe, solutions -- overseas environmental firms have also become very competitive. Japan, for example, has had strict emissions standards in place since the early 1970s, and is generally considered the world leader in air pollution control technologies. The same can be said for Germany and water pollution control technologies. While the Environmental Protection Agency (EPA) is aware of no comprehensive, technology-specific evaluation of U.S.

strengths, the literature does identify U.S. firms to be market leaders in waste technologies and to be well-positioned in general environmental services.

EPA's Role in Promoting U.S. Environmental Exports

In pursuing its environmental protection objectives worldwide, EPA lays important groundwork for a thriving market for U.S. environmental technologies, goods, and services. Under the U.S.-Asia Environmental Partnership, the Support for Eastern European Democracy Act (SEED), the Freedom Support Act, and other programs, EPA is engaged in a comprehensive effort to strengthen or build environmental institutions and capabilities throughout the developing world -- thereby creating potential commercial opportunities for U.S. business and industry.

Other trade-nurturing activities EPA contributes to include the U.S. Environmental Training Institute (USETI), which coordinates U.S. corporate-sponsored environmental training courses for overseas public- and private-sector executives in order to give key decision makers exposure to U.S. technologies and approaches that can be incorporated into their local industries and governments. EPA is also working on a "reverse" trade mission this Spring for Brazilian officials to meet with U.S. public and private sector officials on the clean-up of Brazil's Tiete River. Among other things, this project will allow Brazilian industrial and political leaders to visit U.S. cities that have enacted similar river clean-ups and, showcasing U.S. technologies, will lay the foundations for future environmental partnerships. EPA's technical assistance and capacity-building programs ~~[to help]~~ enhance worldwide demand for environmental technologies and expertise, thereby creating potential commercial opportunities for U.S. business and industry.

On the supply side, EPA is a national and international leader in the research and development of innovative technologies. The development of these new technologies can only enhance the competitive position of U.S. suppliers. The Superfund Innovation Technology Evaluation (SITE) Program, now in its sixth year, is a good example of this kind of program. The U.S. Federal Technology Transfer Act (FTTA) vests EPA with considerable authority to cooperate with industries and universities in developing new and innovative environmental technologies, and through the SITE program, EPA has promoted the development and use of alternative clean-up methods for hazardous waste sites. EPA now participates in over 30 cooperative research and development (CRADA) and licensing agreements.

EPA is also promoting the establishment of an inter-agency initiative called "U.S. Technology for International Environmental Solutions" (U.S. TIES). Led by EPA, U.S. TIES will be directed at improving the international competitiveness of U.S. pollution prevention and end-of-pipe technologies by fostering the development and international dissemination of credible data and information on these technologies. This will require the active involvement of other Federal agencies, the national laboratories, and universities and other private sector groups. Elements of the program currently under discussion include technology or product evaluation; development of testing protocols and a peer review process for performance data; technology profiles; technology demonstrations; and research and commercialization of new and innovative solutions. This program is critical to long-term competitiveness. Programs such as SITE and U.S. TIES put EPA in an excellent position to showcase U.S. technology and know-how.

Building on the success of these programs, EPA can play a much larger and more direct role within overall U.S. environmental export assistance efforts. We can, for example, improve cooperation with the Department of Commerce in a number of areas, including environmental training for U.S. and Foreign Commercial Service personnel; guidance and co-chairmanship of an Environmental sub-group to the Trade Promotion Coordinating Committee or some other inter-agency coordinating body; and establishment of environmental business centers in Russia and the Newly Independent States. We can also improve export-related cooperation with States, business groups, and other outside organizations. The National Association of State Development Agencies (NASDA), for

Concluding Statement

The $200 to $300 billion global market for environmental goods and services presents lucrative commercial opportunities for U.S. business and industry. Other countries are evolving long term views toward the opportunities that pollution remediation and prevention and cleaner process design offer industry and national competitiveness. The more successful foreign programs differentiate between export *promotion* programs -- which offer supply-side services but do not help companies identify and penetrate new markets and do not clearly link promotion to sales -- and export *assistance* programs -- which develop markets and offer demand-driven services that lead to long-term export capacity by identifying, anticipating, creating, and responding to emerging overseas markets or market niches for both existing and future products. Export assistance, with a small amount of export promotion services, is what the successful foreign programs attempt to provide.

EPA strongly believes that a carefully targeted program to coordinate environmental export promotion and assistance activities of U.S. federal agencies, including those of EPA, would be a "win-win" situation both for EPA and the United States. Effective dissemination of proven, cost-effective U.S. technologies and services would help EPA achieve its own environmental objectives. It would also enhance U.S. competitiveness and trade.

EPA believes it can and should be a major player within overall U.S. export assistance efforts. EPA is *the* most respected environmental regulatory organization anywhere in the world. We hear again and again from business groups that when an American company, or German company, or Japanese company seeks to sell a particular product or service abroad, they are inevitably asked: Does this product or service meet U.S. EPA standards? Not German standards, not Japanese standards, but U.S. EPA standards. EPA also has the most extensive network of contacts throughout the international environmental community, as well as the most detailed understanding of environmental needs and conditions worldwide. We need to bring this information and these contacts to bear on behalf of both the environment and the U.S. economy.

Mr. Chairman, this concludes our statement. We will be pleased to answer any questions you might have.

TABLE A
Forecasts of World Market Trends for the Environment Industry
(in billions US$)

Environmental Sector	1990	2000	Growth Rate
EQUIPMENT	$ 152	$ 220	5.0%
Water Treatment	60	83	4.0
Waste Management	40	63	6.4
Air Quality Control	30	42	4.4
Other	22	32	5.1
SERVICES	48	80	7.4
Total	200	300	5.5

Source: OECD, "The OECD Environment Industry: Situation, Prospects, and Government Policies," (Paris: OECD, 1992).

example, is currently working with EPA to organize a conference for States on environmental business opportunities in Eastern Europe.

Thus, in promoting U.S. environmental exports, EPA is most interested not in replicating what is the traditional purview of the Department of Commerce, but in expanding cooperative programs with these agencies and with other public and private sector organizations. Two important considerations underlie this approach. First, legal considerations preclude EPA, a regulatory agency, from promoting or endorsing specific products, services, or enterprises. Second, because States, local governments, international organizations, and countries throughout the world look to EPA for guidance on setting environmental standards, developing policy and management guidelines, and establishing the scientific and technical underpinnings for environmental programs, it is important that EPA do nothing to jeopardize its international credibility and reputation for objectivity.

Volunteer Environmental Services Corps

The Committee has expressed interest in establishing a volunteer services corps to provide U.S. environmental expertise to developing nations. At EPA, we have found that our international technical assistance activities tend to generate overseas interest in U.S. environmental products and methods. We believe the same would hold true for any successful U.S.-sponsored technical assistance initiative, and as such, we would recommend your proposal for further consideration.

U.S. Industry Assistance to Mexico - NAFTA Side Agreement

The Committee has also expressed interest in the potential for U.S. companies to assist Mexico in environmental capacity building as part of a side agreement to the North American Free Trade Agreement (NAFTA). EPA anticipates that there will be ample opportunity and cause for U.S. companies to assist Mexico in building environmental capacity in that country. We would recommend that all potential avenues be explored.