Submission to the AWG-LCA and to the Chair's Note summarizing "Ideas and proposals on paragraph 1 of the Bali Action Plan"

The Federated States of Micronesia offer this submission as a contribution to discussions within the AWG-LCA on an appropriate shared vision, including a long-term global goal for emission reductions, as well as on appropriate mitigation commitments by all Annex I countries to the Convention. It focuses on selected aspects of the Chair's Note entitled "Ideas and proposals on paragraph 1 of the Bali Action Plan".

I. SCOPE, NATURE AND ELEMENTS OF A SHARED VISION FOR LONG-TERM COOPERATIVE ACTION

The Bali Action Plan calls for a shared vision for long-term cooperative action for the "full, effective and sustained implementation of the Convention … now, up to and beyond 2012".

The context of a shared vision (paragraph 13)

The Bali Action Plan calls for a shared vision of long-term cooperative action for the implementation of the Convention commencing "now" and continuing "up to and beyond 2012". We note that action commencing "now" is an urgent priority for the Federated States of Micronesia and for other least developed and small island developing countries. The need for timely action to address climate change is also established as part of the UN Framework Convention on Climate Change's ultimate objectives in Article 2, which calls for action to avoid dangerous anthropogenic interference with the climate system:

> …within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner (Article 2).

The scientific basis of a shared vision (paragraph 14)

The IPCC has made a tremendous contribution to our understanding of the causes of climate change, as well as the challenges facing all countries of mitigating and adapting to climate change. We acknowledge the value in particular of the AR4 and its contribution to our deliberations. We must, at the same time, recognize the evolving nature of scientific endeavor as well as the areas not covered by the IPCC report, notably:

- **Consideration of recent studies.** The process for the consideration of scientific studies is lengthy and including a deadline for submissions two years before publication of reports.[1] Consequently, information in the AR4 is based principally on studies that are now three years or older, presenting opportunities to introduce new findings as important context for ongoing UNFCCC discussions.
- **Consideration of relevant phenomena.** In some places, the analysis explicitly limits consideration of certain phenomena including rapid dynamical changes in ice flows as well as climate-carbon cycle feedbacks. For example, the report notes that certain risks

relating to "large scale singularities" may be larger than projected because "because ice dynamical processes seen in recent observations but not fully included in ice sheet models assessed in AR4 could increase the rate of ice loss".[2]

Our efforts within the AWG-LCA – including our discussions of a shared vision including a long-term global goal for emission reductions – must therefore be brought up to date in light of the most recent scientific information including findings on:

- **Arctic sea loss.** Arctic sea ice loss is running decades ahead of the projections of the IPCC in AR4. Experts predict that summer sea ice could make its first full retreat as early as late summer 2013, based on the substantial melting in 2007 and 2008.[3] As the Arctic ice cap disappears in summer, surface waters absorb more solar radiation, creating a positive feedback, leading to faster melting and warming of the entire Arctic region.[4]
- **Thawing permafrost.** Thawing of permafrost in the Arctic tundra and the release of methane and carbon stores as the Arctic region warms presents a major risk associated with rapid Artic temperature increases.[5]
- **Greenland Ice Sheet thinning.** This is attributed in part to sea surface temperature increases.[6] IPCC models do not explain recent observed changes on the Greenland Ice Sheet[7] nor do they fully address ice dynamics.[8]
- **Sea level rise.** Sea level is rising twice as fast as previously predicted. This is partly based on higher-than-projected contributions from the Greenland Ice Sheet.[9] At the current rate of sea level rise, an increase 1.4 meters above 1990 levels is expected over the next century - more than double the amount projected by the AR4.[10]
- **Rapid retreat of alpine glaciers.** Warming as well as the deposition of black carbon, or soot, on glaciers is contributing to rapid glacial retreat in areas such as the Hindu-Kush-Himalayan-Tibetan glaciers, threatening regional food and water security.[11]
- **Intensification of regional weather phenomena.** Intensification of El Niño-Southern Oscillation and future of amplified, "super El Niños."[12] This would cause extreme weather events around the world, including Australasia, Africa and the Americas.[13]
- **Drought and rainfall patterns.** Drought in Amazon Rainforest due to rising in sea surface temperate, particularly in El Niño years.[14] Decreases in Indian Summer Monsoon rainfall, a north-south shift in rainfall over China, and increased surface ozone.[15]
- **Ocean acidification and potential methane escape.** Links are being identified between ocean acidification and coral/marine organism bleaching finding that added to warming, CO_2 can exacerbate bleaching.[16] Methane hydrate deposits on sea floor could escape to the surface with deep-ocean warming.[17]

In the view of Federated States of Micronesia, recent scientific findings on these and other phenomena should be explicitly considered in discussions of the scientific basis of a shared vision including a long-term global goal for emission reduction, as well as for discussions of mitigation commitments for Annex I Parties.

The principles of a shared vision (paragraph 17)

The Bali Action Plan states that the shared vision is for long-term cooperative action commencing "now" and continuing "up to and beyond 2012". The emphasis in the Bali Action Plan on action commencing "now" is complemented by the principle of precaution as set out in Article 2 of the Convention, which states:

> Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures…

II. A LONG-TERM GLOBAL GOAL FOR EMISSION REDUCTIONS

The nature, principles and quantification of a long-term global goal (paragraphs 26-29)

As stated by AOSIS in its comments on the Chair's Note, the avoidance of climate change impacts on SIDS must be one of the key benchmarks for assessing the appropriateness of any long-term goal. AOSIS therefore sees the long-term target as a stabilization of GHG gas concentrations well below 350 ppm CO2e and temperature increases limited to well below 1.5ºC above the pre-industrial level

A 2ºC increase compared to pre-industrial levels would have devastating consequences on SIDS due to resulting sea level rise, coral bleaching, coastal erosion, changing precipitation patterns, increased incidence and re-emergence of climate related diseases and the impacts of increasingly frequent and severe weather events.

A number of Parties have called for efforts to limit global average temperature increase to 2ºC above pre-industrial levels. They have drawn on figures included in the AR4[18] as the basis for defining and quantifying appropriate further mitigation commitments for Annex I Parties and an appropriate long-term global goal for emission reductions in the context of a shared vision. In evaluating these proposals, it is important to understand the basis of the figures presented by the IPCC in AR4:

- **Likelihood of remaining below 2 degrees C.** The figures (presented in the Box 13.7 on page 776) are based on an analysis of six published studies. These studies used diverse emissions pathways with stabilization levels ranging from 400 ppm CO2-eq to 450 ppm CO2. Only two of the studies estimated the likelihood of the pathways staying below 2ºC. Pathways aiming at 450 ppm CO2-eq assume a period of overshoot, increasing the likelihood of exceeding 2ºC at least temporarily to over 50 percent. It is thus not accurate to suggest these scenarios as a whole "aim to limit global temperature increase to 2ºC."[19]
- **Establishing emissions allowances or rights.** The 25-40 percent range for Annex I emission reductions could be characterized as the creation of emissions allowances or rights, which may be substantially above what should ultimately be required of them on the basis of equity, historical responsibility and common but differentiated responsibility.

Given these Annex I allocations, emissions allocations to the non-Annex I countries representing "substantial deviations from baseline" would be required by 2020, according to the IPCC figures.[20]

- **Assumptions about burden sharing.** The IPCC figures say nothing about where physical emissions reductions need to be made, but rather reflect the burden-sharing assumptions reflected in the studies summarized by the IPCC. The burden sharing implications of the figures is therefore unclear and should be clarified by those proposing the figures.[21] Burden sharing – including through actual emissions and through the provision of financing, technology and other forms of support – is a political not merely a scientific question and has significant distributional impacts that should be explicitly discussed by Parties to the Convention.
- **Evaluating historical responsibility.** The IPCC figures include no explicit evaluation of the historical responsibility of developed countries. As noted by the Convention, the largest share of historical emissions has originated in developed countries and that "per capita emissions in developing countries are still relatively low and that the share of global emissions originating in developing countries will grow to meet their social and development needs" (preamble). Any allocation of emissions allowances within a carbon constrained world should take into account the aggregate historical emissions and not merely current emissions of Parties.
- **Scenarios for more ambitious Annex I mitigation commitments.** The 40 percent figure is not the maximum level of Annex I reductions described in the scenarios reviewed by the IPCC. Two of the studies summarized in the table include scenario variants in which Annex I reductions reach 47 percent and 50 percent below 1990 levels respectively. In the IPCC summary these were effectively treated as "outliers" and discarded.[22] These and other more ambitious scenarios for Annex I countries should be considered, particularly in light of concerns about equity and historical responsibility. To the extent that Annex I Parties would not be able to meet such scenarios (e.g. for technical reasons) then other means for satisfying their historical responsibility including financing, compensation or liability could be considered.

In the view of the Federated States of Micronesia, these factors call for efforts to complement use of the AR4 with additional and updated scientific and technical information in the development of a shared vision including a long-term global goal for emission reductions, with the goal of achieving the limits on global temperature and greenhouse gas concentration increases put forward by AOSIS.

The contribution by different groups of countries to achieving a global goal (paragraph 30)

The allocation of emissions allowances (or emissions rights) within a global goal is a distributional question that must be considered in light of considerations of equity as well as effectiveness. It must take into consideration issues of historical responsibility as well as current emissions. It must recognize that the initial allocation of rights (inherent in the setting of Annex I assigned amount units) within a global goal will affect the distribution of resources and wealth on Planet Earth. In particular, we suggest that the current and unsustainable emissions pathways of the Annex I countries should not be "grandfathered"

into a new agreement through allowances or "emission rights" that are inconsistent with principles of effectiveness (based on the emerging science) and equity (based on an equitable effort sharing arrangement).

III. MITIGATION COMMITMENTS BY ALL DEVELOPED COUNTRIES

To be consistent with the goals set out by AOSIS and to avoid further serious climate change impacts, Annex I countries, as a group, would need to reduce their GHG emissions by more than 40% to 1990 levels by 2020, and more than 95% by 2050.

To achieve these goals, we call for action commencing "now" to rapidly reduce emissions in all developed countries, bearing in mind the risks of tipping points and the importance of avoiding the potential for near-term, rapid and non-linear climate changes. Particularly important are efforts by Annex I Parties to fully implement their emission reduction commitments under the Kyoto Protocol, and their commitments under the Convention, particularly those relating to mitigation, adaptation, financing and technology transfer to developing countries.

Deep emissions reductions through action commencing now is particularly important when viewed in light of the risks associated with abrupt, non-linear changes to the climate system. The paleoclimate records show that past climate changes have included both steady, linear changes as well as abrupt, non-linear changes, where small increases in global warming produced large and irreversible impacts once tipping points were passed.

Climate scientists now warn that anthropogenic greenhouse gas emissions are pushing the planet's climate system toward such tipping points sooner than previously expected, and that impacts could be catastrophic.[23] Among potential impacts of passing climate tipping points are:

- Disappearance of Arctic summer sea ice;
- Disintegration of the Greenland Ice Sheet;
- Collapse of the West Antarctic Ice Sheet;
- Shutdown of the Atlantic Thermohaline Circulation;
- Retreat of alpine glaciers (e.g. Hindu-Kush-Himalayan-Tibetan glaciers); and
- Dieback of Amazonian and boreal forests.[24]

As noted in discussion above, many of these phenomena are already experiencing levels of change significantly greater than predicted by existing climate models, including those identified in the AR4 which has been proposed by some Parties as a basis for identifying appropriate ranges for further commitments by Annex I Parties, and for the development of a long-term global goal for emission reductions.

The catastrophic impacts from these events – should they materialize – would include many meters of sea level rise, water shortages, megadroughts, and famine, and could lead to political instability and resource wars.[25] Other impacts include release of methane and other

global warming gases from permafrost and ocean hydrates, which could set off runaway feedbacks. These and other non-linear events or "singularities" increase the risks associated with climate change, particularly to those countries most vulnerable to climate change.

To help reduce these risks, and on the basis of the principles of precaution, equity, historical responsibility and common but differentiated responsibility and respective capabilities, we call for a much higher levels of ambition by Annex I Parties to the Convention than reflected in any of the ranges for emissions so far proposed in the negotiations – including through the enhancement by Annex I countries of sinks on their territories.

We call on Annex I Parties to be ready to go well beyond reducing 100% of their 1990 levels of emissions over the longer term, in order to provide sufficient atmospheric resources or carbon space for the full realization by developing countries of the Right to Development, and to provide an adequate and predictable basis for the provision of financing and technology, as well as for compensation for restricted development opportunities and for adaptation impacts.

Action commencing now to implement the Convention

In light of these considerations, the Federated States of Micronesia believes that action to reduce emissions commencing "now" as set out in the Bali Action Plan is essential – particularly in order to safeguard the survival and prosperity of least developed countries, small island developing states and other vulnerable countries. In particular, early and rapid action to reduce emissions:

Regardless of the levels of ambition set in the negotiations, action commencing now offers a range of benefits:

- Speeds up efforts to mitigate climate change;
- Buys valuable time to adapt to the effects of climate change;
- Demonstrates leadership in modifying longer term trends in emissions;
- Reduces the risks of "tipping points" for abrupt climate change;
- Builds experience and confidence in the UNFCCC; and
- Fulfils the requirements of the Bali Action Plan for enabling action "now".

Action commencing now also provide a practical way of linking discussions of mitigation and adaptation, as early action to mitigate greenhouse gas emissions both achieves mitigation goals and reduces the future costs associated with adapting to climate change. Consequently, there is considerable value to all Parties in focusing on measures that can secure early emissions reductions.

With respect to Bali Action Plan – in particular paragraphs 1(b)(ii)-(iii), 1(d)(i)-(iii), and 1(e)(v) – additional efforts are needed to promote "fast start" strategies with existing technologies to mitigate climate change in the immediate near-term. These strategies should include those

that can start immediately, are effective and efficient, and have strong co-benefits for public health, local communities, and competitiveness, including:

- **Technology transfer and deployment.** Expanding investment and speeding deployment of energy efficient technologies, improving energy efficiency [26] and expanding renewables, especially wind, can produce fast mitigation,[27] as can improving urban albedo.[28]
- **Reducing carbon soot.** Promoting strategies to reduce black carbon, or soot, which may be the second largest contributor to climate warming, but which has an atmospheric lifetime of only days to weeks, so reducing it may offer the fastest mitigation.[29]
- **Reducing powerful greenhouse gasses.** Reducing other short-lived forcers such as methane and tropospheric ozone precursors.[30]
- **Enhancing sequestration.** Promoting bio-char carbon sequestration as a near-term carbon mitigation and storage strategy, which removes carbon from the carbon cycle by drawing down atmospheric concentrations of CO_2 in a carbon-negative process and provides near permanent carbon storage while also improving soil productivity and reducing the need for fossil fuel-based fertilizer.[31] (Carbon mitigation and storage, including through enhanced coral reef growth, also should be expanded.)
- **Accelerating efforts under other treaties.** Accelerating efforts under the Montreal Protocol on Substances that Deplete the Ozone Layer to reduce ozone-depleting substances, most of which are powerful climate gases.[32] (In November 2008, the 193 Parties to the Montreal Protocol unanimously agreed for the second year in a row to strengthen their treaty to provide additional protection for both the ozone layer and the climate system.[33])

These and other near-term strategies often have strong co-benefits, such as public health benefits from black carbon reductions, soil enhancement from biochar, and increased energy security from efficiency and renewables, providing further incentives to act now to forestall tipping points visible on the horizon.

Early action to address climate change will also help to build the confidence and trust required to secure an effective outcome in Copenhagen. Parties to the Climate Convention are mandated by the Bali Action Plan to commence action "now, up to and beyond 2012". Notably, this action – including action commencing "now" – is foreseen by the Bali Action Plan as necessary "in order to reach an agreed outcome and adopt a decision at its fifteenth session".

Importantly, efforts to implement the Convention commencing now will help reduce the risks of climate change to all countries, and particularly those who are vulnerable to the effects of climate change. A focus on fast-action strategies offers great advantages particularly to LDCs, small island states and other states vulnerable to extreme weather events and flooding.

We therefore call on all Parties to the UNFCCC to consider what actions they can take commencing "now" to implement the Bali Action Plan's objective of ensuring the full, effective and sustained implementation of the Convention.

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[1] Hans Joachim Schellnhuber, *Global Warming: Stop worrying, start panicking?*, 105 Proc. of the Nat'l Acad. of Sci. 14239, 14239 (2008) ("The IPCC format, perfected by the late Bert Bolin, is a painstaking self-interrogation process of the pertinent scientific community. In this process, virtually every stone in the cognitive landscape is turned and the findings, however mundane or ugly, are synthesized into encyclopedic accounts. Unfortunately, such an approach is inherently tuned for burying crucial insights under heaps of facts, figures, and error bars."). DAVID SPRATT & PHILIP SUTTON, CLIMATE CODE RED: THE CASE FOR A SUSTAINABILITY EMERGENCY 1 (2008) ("The IPCC's four-year schedule for producing reports requires a deadline for scientific papers that is often more than two years prior to the report's final release. What happens if there is significant new evidence or events that dramatically change [sic] our understanding of climate science in the gap between the science reporting deadline and publication? They don't get a mention, so the IPCC report is out of date before it hits the presses, and in the rapidly changing world of global warming that is a serious problem because it is widely viewed as the climate change Bible.").

[2] *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE [IPCC], *Summary for Policymakers*, *in* CLIMATE CHANGE 2007: SYNTHESIS REPORT 8, tbl. SPM.1, 20 (2007).

[3] WORLD WILDLIFE FUND, CLIMATE CHANGE: FASTER, STRONGER, SOONER (2008) [hereinafter WWF, CLIMATE CHANGE], *available at* http://assets.panda.org/downloads/wwf_science_paper_october_2008.pdf ("It is currently forecast that summer sea ice could completely disappear somewhere between 2013 and 2040 – a state not seen on planet Earth for more than a million years."). On September 16, 2007, the Arctic sea ice coverage decreased to 4.13 million square kilometers, its lowest area on record, compared to the previous record low of 5.32 million square kilometers in 2005. National Snow and Ice Data Center [NSIDC], Arctic Sea Ice News Fall 2007, http://nsidc.org/news/press/2007_seaiceminimum/20070810_index.html ("The minimum for 2007 shatters the previous five-day minimum set on September 20–21, 2005, by 1.19 million square kilometers (460,000 square miles), roughly the size of Texas and California combined, or nearly five United Kingdoms."). On September 12, 2008, deemed the low point for summer 2008, the ice measured the second-lowest on record at 4.52 million square kilometers, making it clear that the Arctic is now headed toward full sea ice loss very quickly. NSIDC, Arctic Sea Ice News and Analysis, http://nsidc.org/arcticseaicenews/2008/091608.html ("The Arctic sea ice cover appears to have reached its minimum extent for the year, the second-lowest extent recorded since the dawn of the satellite era. While above the record minimum set on September 16, 2007, this year further reinforces the strong negative trend in summertime ice extent observed over the past thirty years . . . . On September 12, 2008 sea ice extent dropped to 4.52 million square kilometers (1.74 million square miles). This appears to have been the lowest point of the year, as sea has now begun its annual cycle of growth in response to autumn cooling. The 2008 minimum is the second-lowest recorded since 1979, and is 2.24 million square kilometers (0.86 million square miles) below the 1979 to 2000 average minimum."). *See also* SPRATT & SUTTON, *supra* note 1, at 3 ("Dr Wieslaw Maslowski of the Naval Postgraduate School, whose research utilizes US military submarine mapping of the Arctic sea-ice over many decades and focuses on modelling the processes of Arctic sea-ice loss, projected a blue Arctic Ocean free of sea-ice by the summer of 2013, the main reason being that the modelled thickness and volume appear to be decreasing at a much faster rate than the satellite-derived ice extent. Maslowski's work suggests the sea-ice is significantly being thinned by the northward heat flux of warm summer Pacific and Atlantic waters, not just higher air temperatures.") (citations omitted); *id.* at 4 ("The central point is that Arctic is now irreversibly headed to total summer sea-ice loss very quickly and way beyond the expectation of the IPCC, whose Arctic scenarios are no longer credible, and of most scientists' views only two to three years ago.").

[4] *See* Timothy Lenton, Hermann Held, Elmar Kriegler, Jim Hall, Wolfgang Lucht, Stefan Rahmstorf & Hans Joachim Schellnhuber, *Tipping elements in the Earth's climate system*, 105 PROC. OF THE NAT'L ACAD. OF SCI. 1786, 1788 (2008), *available at* http://www.pnas.org/content/105/6/1786.full.pdf ("As sea-ice melts, it exposes a much darker ocean surface, which absorbs more radiation–amplifying the warming.").

[5] MARTIN SOMMERKORN, WWF, A CLOSING WINDOW OF OPPORTUNITY – GLOBAL GREENHOUSE REALITY 2008, at 7 (2008) ("This additional heat absorbed by the surface waters is warming the Arctic Ocean and the arctic atmosphere (Steele et al., 2008; Serreze & Francis, 2006), feeding it into the global climate system, where it contributes to more global warming. There is concern that the additional heat will unleash carbon cycle effects that accelerate global warming at an earlier date than previously assumed. The Arctic holds vast stores of carbon that are vulnerable to regional warming and could be partially released to the atmosphere as methane or carbon dioxide, or both."); *see also* David M. Lawrence et al., *Accelerated Arctic land warming and permafrost degradation during rapid sea ice loss*, 35 GEOPHYS. RES. LETT. L11506 (2008) ("We find that rapid sea ice loss forces a strong acceleration of Arctic land warming in [a climate model] . . . which can trigger rapid degradation of currently warm permafrost and may increase the vulnerability of colder permafrost for subsequent degradation under continued warming. Our results also suggest that talik [a layer of perpetually unfrozen ground that

forms above the permafrost table] formation may be a harbinger of rapid subsequent terrestrial change. This sea ice loss – land warming relationship may be immediately relevant given the record low sea ice extent in 2007."). Warming in northern latitudes is also predicted to lead to the drying out of peat bogs, which typically act as effective carbon sinks, and the release of significant amounts of carbon into the atmosphere over time. *See* Takeshi Ise, Allison L. Dunn, Steven C. Wofys & Paul R. Moorcroft, *High sensitivity of peat decomposition to climate change through water-table feedback*, 1 NATURE GEOSCIENCE 763, 763 (2008) ("We conclude that peatlands will quickly respond to the expected warming in this century by losing labile soil organic carbon during dry periods.").

[6] Lenton et al., *supra* note 4, at 1789; *see also* SOMMERKORN, *supra* note 5, at 8 ("The reason for the accelerated losses is accelerated glacier flow, partly attributed to observed regional sea surface temperature increases.").

[7] Lenton et al., *supra* note 4, at 1789 ("[E]xisting ice-sheet models are unable to explain the speed of recent changes. These changes include melting and thinning of the coastal margins and surging of outlet glaciers, which may be contributed to by the intrusion of warming ocean waters.").

[8] SOMMERKORN, *supra* note 5, at 8 ("IPCC 4AR had excluded ice dynamics from estimates of sea level increase because the limited understanding of these processes did not allow adequate representation in models.").

[9] Lenton et al., *supra* note 4, at 1789; *see also* Anders E. Carlson et al., *Rapid early Holocene deglaciation of the Laurentide ice sheet*, 1 NATURE GEOSCIENCE 620, 623 (2008), *available at* https://mywebspace.wisc.edu/aecarlson/web/Carlson_Publications_files/carlson_2008_nat_geo.pdf ("The modern GIS is also ~3 times smaller than the [Laurentide ice sheet (LIS)] at the start of the Holocene, but the LIS was similar in size ~8 kyr BP. At present, ablation, ice streaming and calving control GIS mass loss. However, ice streaming and calving will decrease or cease if the GIS retreats inland, making it more analogous to the LIS. Nevertheless, predictions of the rate of sea level rise from the GIS by the end of this century in the [AR4] are 6–40 times smaller than the estimated rate of LIS mass loss in the early Holocene. Given the similar summer [surface air temperature] responses for these two periods, and the geologic evidence for rapid early Holocene LIS retreat, current projections of GIS melt rates for the coming century may be only minimum estimates even without considering positive feedbacks from ice-sheet dynamics.").

[10] Stefan Rahmstorf, *A Semi-Empirical Approach to Projecting Future Sea-Level Rise*, 315 SCIENCE 368, 368 (2007), *available at* http://www.pik-potsdam.de/~stefan/Publications/Nature/rahmstorf_science_2007.pdf ("A semi-empirical relation is presented that connects global sea-level rise to global mean surface temperature. It is proposed that, for time scales relevant to anthropogenic warming, the rate of sea-level rise is roughly proportional to the magnitude of warming above the temperatures of the pre–Industrial Age. This holds to good approximation for temperature and sea-level changes during the 20th century, with a proportionality constant of 3.4 millimeters/year per °C. When applied to future warming scenarios of the Intergovernmental Panel on Climate Change, this relationship results in a projected sea-level rise in 2100 of 0.5 to 1.4 meters above the 1990 level."); *see also* WWF, CLIMATE CHANGE, *supra* note 3 ("Since 1990, global sea level has been rising one and a half times faster than forecast in the IPCC's Third Assessment Report (published in 2001) (Rahmstorf et al 2007). In addition to this, new studies have projected global sea level rise by the end of the century to reach up to more than double the maximum estimate of 0.59m presented in the Fourth Assessment Report (Rahmstorf 2007, Rohling et al 2008). More than 1.2m sea level rise would put vast coastal areas at risk, in Europe and around the world.").

[11] V. RAMANATHAN ET AL., UNITED NATIONS ENVIRONMENT PROGRAMME, ATMOSPHERIC BROWN CLOUDS: REGIONAL ASSESSMENT REPORT WITH FOCUS ON ASIA 2 (2008), *available at* http://www.unep.org/pdf/ABCSummaryFinal.pdf ("[I]ncreasing amount of soot, sulphates and other aerosol components in atmospheric brown clouds (ABCs) are causing major threats to the water and food security of Asia and have resulted in surface dimming, atmospheric solar heating and soot deposition in the Hindu Kush-Himalayan-Tibetan (HKHT) glaciers and snow packs.").

[12] James Hansen, Makiko Sato, Reto Ruedy, Ken Lo, David W. Lea & Martin Medina-Elizade, *Global temperature change*, 103 Proc. of the Nat'l Acad. of Sci. 14288, 14290 (2006) ("The 1983 and 1998 El Niños were successively labeled 'El Niño of the century,' because the warming in the Eastern Equatorial Pacific (EEP) was unprecedented in 100 years. We suggest that warming of the Western Equatorial Pacific (WEP), and the absence of comparable warming in the EEP, has increased the likelihood of such 'super El Niños.'").

[13] Joëlle L. Gergis & Anthony M. Fowler, *A history of ENSO events since A.D. 1525: implications for future climate change*, 89 CLIMATIC CHANGE (forthcoming 2008), *available at* http://www.springerlink.com/content/2242tp4610562j55/fulltext.pdf ("ENSO influences extreme weather events such as drought, flooding, bushfires and tropical cyclone activity across vast areas of the Earth, adversely affecting hundreds of millions of people in agriculturally important areas of Australasia, Africa and the Americas.") (citations omitted); *see also* Daniel C. Nepstad et al., *Interactions among Amazon land use, forests and climate: prospects for a near-term forest tipping point*, 363 Phil. Trans. R. Soc. B 1737, 1740 (2008), *available at* http://journals.royalsociety.org/content/d7330302566g25u3/fulltext.pdf ("Rainfall tends to decline in the Amazon when sea surface temperatures rise along the Pacific coast of northern South America through El Niño episodes."); SPRATT & SUTTON, *supra* note 1, at 27 ("[I]n 1998 El Nino-generated forest fires in a drying Amazon poured almost half a billion tonnes of carbon into the air . . . .").

[14] Nepstad et al., *supra* note 13, at 1740 ("A more likely near-term shift in Amazon climate may be associated with changes in sea surface temperature that are usually associated with Amazon drought. Rainfall tends to decline in the Amazon when sea surface temperatures rise along the Pacific coast of northern South America through El Niño episodes."); *see also* Peter M. Cox et al., *Increasing risk of Amazonian drought due to decreasing aerosol pollution*, 453 NATURE 212, 212 (2008) ("We show that reduction of dry season (July–October) rainfall in western Amazonia correlates well with an index of the north–south SST (sea surface temperature) gradient across the equatorial Atlantic.").
[15] RAMANATHAN ET AL., *supra* note 11, at 2 ("[Effects of ABCs] have given rise to major areas of concern, some of the most critical being observed decreases in the Indian summer monsoon rainfall, a north-south shift in rainfall patterns in eastern China, the accelerated retreat of the HKHT glaciers and decrease in snow packs, and the increase in surface ozone. All these have led to negative effects on water resources and crop yields.").
[16] K. R. N. Anthony et al., *Ocean acidification causes bleaching and productivity loss in coral reef builders*, 105 PROC. OF THE NAT'L ACAD. OF SCI. 17442, 17444-45 (2008), *available at* http://www.pnas.org/content/105/45/17442.full.pdf ("The observation that CO_2 triggers bleaching in synergy with warming under high light, and thereby partly drives patterns of net productivity, indicates that predictions of survival thresholds for reef builders under climate change must take account of acidification–warming interactions in the integrated biological and biogeochemical response.").
[17] David Archer, *Methane hydrate stability and anthropogenic climate change*, 4 BIOGEOSCIENCES 521, 521 (2007), *available at* http://geosci.uchicago.edu/~archer/reprints/archer.2007.hydrate_rev.pdf ("If the dissolved methane concentration reaches the saturation value for hydrate formation at the local temperature and pressure conditions, methane and water will freeze together into methane hydrate or clathrate deposits."); *see also* David Archer, Bruce Buffett & Victor Brovkin, *Ocean methane hydrates as a slow tipping point in the global carbon cycle*, 105 PROC. OF THE NAT'L ACAD. OF SCI. (forthcoming 2008), *available at* http://www.pnas.org/content/early/2008/11/18/0800885105.full.pdf ("The hydrates could be vulnerable to melting with a deep ocean warming of a few degrees Celsius (3–6), which is obtainable given the available inventories of fossil fuel carbon for combustion.").
[18] In particular, reference has been made to the figures included in Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Technical Summary, pages 39 and 90, and Chapter 13, page 776 (as noted in footnote 1 to the Bali Action Plan)
[19] *See* Paul Baer, Exploring the 2020 global emissions mitigation gap (Dec. 4, 2008) (unpublished, updates available at www.globalclimatenetwork.com).
[20] *Id.*
[21] *Id.*
[22] *Id.*
[23] V. Ramanathan & Y. Feng, *On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead*, 105 PROC. OF THE NAT'L ACAD. OF SCI. 14245, 14245 (23 September 2008). (calculating that greenhouse gas [GHG] emissions as of 2005 have committed the planet to warming of "2.4ºC above the preindustrial surface temperatures," which is within the range of predicted tipping points).
[24] Lenton et al., *supra* note 4, at 1790 ("Dieback of the Amazon rainforest has been predicted to occur under ≈ 3-4ºC global warming . . . ."); *id.* at 1791 ("Under climate change, increased water stress, increased peak summer heat stress causing increased mortality, vulnerability to disease and subsequent fire, as well as decreased reproduction rates could lead to large-scale dieback of the boreal forests, with transitions to open woodlands or grasslands.") (footnotes omitted).
[25] *Id.* at 1788; PETER SCHWARTZ & DOUG RANDALL, AN ABRUPT CLIMATE CHANGE SCENARIO AND ITS IMPLICATIONS FOR UNITED STATES NATIONAL SECURITY (2003), http://handle.dtic.mil/100.2/ADA469325.
[26] Group of Eight Summit, Heiligendamm, Ger., June 6-8, 2007, *Growth and Responsibility in the World Economy: Summit Declaration*, ¶ 46 (June 7, 2007) ("Improving energy efficiency worldwide is the fastest, the most sustainable and the cheapest way to reduce greenhouse gas emissions and enhance energy security.").
[27] The IPCC has predicted that renewable energy sources, which have "a positive effect on energy security, employment and on air quality," will be able to provide 30-35% of the world's electricity by 2030. IPCC, *Summary for Policymakers*, *in* CLIMATE CHANGE 2007: MITIGATION 13 (B. Metz et al. eds., 2007). The IPCC has also found that "wind is the fastest growing energy supply sector." IPCC, IPCC SCOPING MEETING ON RENEWABLE ENERGY SOURCES 4 (Olav Hohmeyer & Tom Trittin eds., 2008); *see also* GREENPEACE & GLOBAL WIND ENERGY COUNCIL, GLOBAL WIND ENERGY OUTLOOK 2006, at 38 (2006) ("Under the Advanced wind energy growth projection, coupled with ambitious energy saving, wind power could be supplying 29.1% of the world's electricity by 2030 and 34.2% by 2050."). In its most recent report, the International Energy Agency concludes "[p]reventing catastrophic and irreversible damage to the global climate ultimately requires a major decarbonisation of the world energy sources . . . . The energy sector will have to play the central role in curbing emissions – through major improvements in efficiency and rapid switching to renewable and other low-carbon technologies . . . ." *See* INTERNATIONAL ENERGY AGENCY, WORLD ENERGY OUTLOOK 37-38 (2008).
[28] *See* Hashem Akbari, Surabi Menon & Arthur Rosenfeld, *Global Cooling: Increasing Worldwide Urban Albedos to Offset CO_2*, CLIMATIC CHANGE[0] (forthcoming 2008) (If 100 large urban areas switched their roofs and pavement to highly reflective materials, the authors calculate this would "induce a negative radiative forcing of $4.4x10^{-2}$ Wm^{-2} equivalent to offsetting 44

Gt of emitted CO_2. A 44 Gt of emitted CO_2 offset resulting from changing the albedo of roofs and paved surfaces is worth about $1100 billion. Assuming a plausible growth rate of 1.5% in the world's CO_2-equivalent emission rate, we estimate that the 44 Gt CO_2-equivalent offset potential for cool roofs and cool pavements would counteract the effect of the growth in CO_2-equivalent emission rates for 11 years."); *see also* Hashem Akbari, Leader, Heat Island Group, Presentation at the Fifth Annual California Climate Change Conference: Global Cooling: Increasing World-wide Urban Albedos to Offset CO_2 (Sept. 9, 2008), *available at* http://www.climatechange.ca.gov/events/2008_conference/presentations/2008-09-09/Hashem_Akbari.pdf. In California, which sets strict energy budgets for new construction, residential and some non-residential buildings can receive energy credits toward their energy budgets for installing "cool roofs." Cool roofs can lower roof temperatures up to 100 degrees Fahrenheit, reducing energy use for air conditioning and associated urban heat islands and smog. CAL. CODE REGS. tit. 24 § 118 (2007). Cool roof and reflective pavement are two of California's early action measures implementing California Assembly Bill Number 32, the Global Warming Solutions Act. *See* AIR RESOURCES BOARD, CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY, EXPANDED LIST OF EARLY ACTION MEASURES TO REDUCE GREENHOUSE GAS EMISSIONS IN CALIFORNIA RECOMMENDED FOR BOARD CONSIDERATION, at C-14 (2007).

[29] V. Ramanathan & G. Carmichael, *Global and regional climate changes due to black carbon*, 1 NATURE GEOSCIENCE 221, 222 (2008) ("The BC forcing of 0.9 W m^{-2} (with a range of 0.4 to 1.2 W m^{-2}) . . . is as much as 55% of the CO_2 forcing and is larger than the forcing due to the other GHGs such as CH_4, CFCs, N_2O or tropospheric ozone."); *see also* Mark Jacobson, *Control of Fossil-Fuel Particulate Black Carbon and Organic Matter, Possibly the Most Effective Method of Slowing Global Warming*, 107 J. GEOPHYS. RES. D19 (2002); *see also* Jane Qiu, *The Third Pole*, 454 NATURE 393, 396 (2008) ("Reducing emissions of greenhouse gases and black carbon should be the top priority," according to Xu Baiqing of the Institute of Tibetan Plateau Research.).

[30] *Role of Black Carbon on Global and Regional Climate Change: Hearing on the role of black carbon as a factor in climate change Before H. Comm. on Oversight and Gov't Reform*, 110th Cong. 4 (2007) (testimony of V. Ramanathan).

[31] Johannes Lehmann, John Gaunt & Marco Rondon, *Bio-char Sequestration In Terrestrial Ecosystems – A Review*, 11 MITIGATION AND ADAPTATION STRATEGIES FOR GLOBAL CHANGE 403, 404 (2006).

[32] *See* Guus J. M. Velders, Stephen O. Andersen, John S. Daniel, David W. Fahey & Mack McFarland, *The importance of the Montreal Protocol in protecting climate*, 104 PROC. NAT'L. ACAD. SCI. 4814, 4814-19 (2007), *available at* http://www.pnas.org/cgi/content/abstract/104/12/4814 (From 1990 to 2010, the Montreal Protocol will have reduced climate emissions by a net of 135 billion tonnes of CO_2-eq., delaying climate forcing by up to 12 years. This is ~ 13% of the forcing due to accumulated anthropogenic emissions of CO_2 and several times the reductions sought under the first phase of Kyoto Protocol.). In 2007, the Montreal Protocol was further strengthened to accelerate the phase-out of HCFCs; that adjustment has the potential to produce mitigation up to 16 billion tones of CO_2-eq. *See* U.S. EPA 2008 Climate Award Winners, Team Award Winners, http://www.epa.gov/cppd/awards/2008winners.html ("The U.S. EPA estimates that, through 2040, the HCFC agreement could reduce emissions by up to 16 billion metric tonnes of carbon dioxide-equivalent. This is equal to the greenhouse gas emissions from the electricity use of more than 70 million U.S. households over the next 30 years."); TECHNOLOGY AND ECONOMIC ASSESSMENT PANEL [TEAP], UNITED NATIONS ENVIRONMENT PROGRAMME, RESPONSE TO DECISION XVIII/12, REPORT OF THE TASK FORCE ON HCFC ISSUES (WITH PARTICULAR FOCUS ON THE IMPACT OF THE CLEAN DEVELOPMENT MECHANISM) AND EMISSIONS REDUCTIONS BENEFITS ARISING FROM EARLIER HCFC PHASE-OUT AND OTHER PRACTICAL MEASURES 8 (2007) [hereinafter TEAP RESPONSE], *available at* http://ozone.unep.org/teap/Reports/TEAP_Reports/TEAP-TaskForce-HCFC-Aug2007.pdf.

[33] At the 20th Meeting of the Parties to the Montreal Protocol, the Parties agreed to begin collecting and destroying unwanted ODSs in existing stockpiles and discarded products and equipment. *See* The Eighth Meeting of the Conference of the Parties to the Vienna Convention and the Twentieth Meeting of the Parties to the Montreal Protocol, Doha, Qatar, Nov. 16-20, 2008, *Advance Report*, at Decision XX/7 (Nov. 27, 2008) [hereinafter *Advance Report*], *available at* http://ozone.unep.org/Meeting_Documents/mop/20mop/MOP-20-9E.pdf. Without immediate action to prevent emissions of ODSs from banks, these sources will release 6 billion tonnes or more of CO_2–eq. into the atmosphere before 2015 and a further 15 billion tonnes of CO_2–eq. thereafter, and will otherwise cancel the hoped for gains of the current climate treaty. *See* TEAP RESPONSE, *supra* note 32, at 12, 27; *see also* IPCC & TEAP, *Technical Summary*, *in* SPECIAL REPORT ON SAFEGUARDING THE OZONE LAYER AND THE GLOBAL CLIMATE SYSTEM: ISSUES RELATED TO HYDROFLUOROCARBONS AND PERFLUOROCARBONS [SPECIAL REPORT] 9 (2005), *available at* http://arch.rivm.nl/env/int/ipcc/pages_media/SROC-final/SpecialReportSROC.html. The Parties also decided to start discussions on moving hydrofluorocarbons, or HFCs, from the climate treaty to the stricter Montreal Protocol, where HFCs with high global warming potential could be phased-out. *See Advance Report*, *supra*, at Decision XX/8. HFCs have global warming potentials hundreds to thousands of times that of CO_2 and are one of the six GHGs included in the Kyoto Protocol; they are used primarily as a replacement for ODSs phased-out under the Montreal Protocol. *See* IPCC & TEAP, *Summary for Policy Makers*, *in* SPECIAL REPORT, *supra*, at 3. The Parties also provided USD $490 million over three years to assist developing countries to meet their commitments, including the commitment last year to accelerate the phase-out of HCFC, which has the potential to prevent up to 16 billion tonnes of CO_2-eq. emissions if the Parties ensure climate friendly alternatives are used, and not high GWP HFCs. *See id.*; *see also* TEAP RESPONSE, *supra* note 32.