SBSTA-IPCC SPECIAL EVENT

COMMON METRICS IN ASSESSMENT REPORTS
TO CALCULATE THE CARBON DIOXIDE EQUIVALENCE
OF GREENHOUSE GASES

Historical Overview and Background

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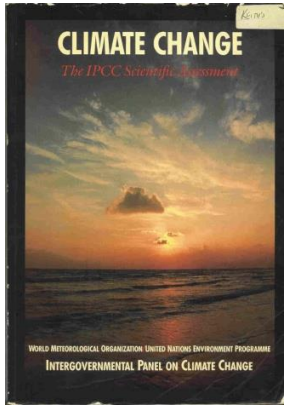
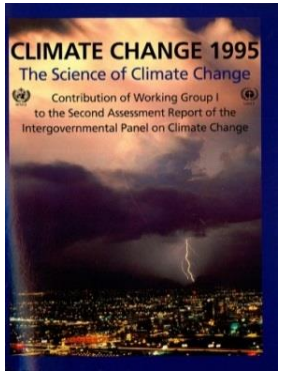
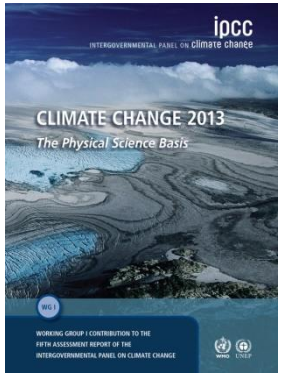
"Pedigree"

- Convening Lead Author, Radiative Forcing: WG1 FAR and SAR
- Therefore: partly "to blame" for both the GWP and for the values of GWP adopted in the first reporting period of Kyoto Protocol
- Also Review Editor (Radiative Forcing) of WG1 AR5







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Why metrics?

- **UNFCCC:**

"…policies and measures should …., be comprehensive, cover all relevant sources, sinks and reservoirs…"

- **Kyoto Protocol**:

a multi-gas approach (or "basket approach") including CO_2, CH_4, N_2O, HFCs, PFCs, SF_6

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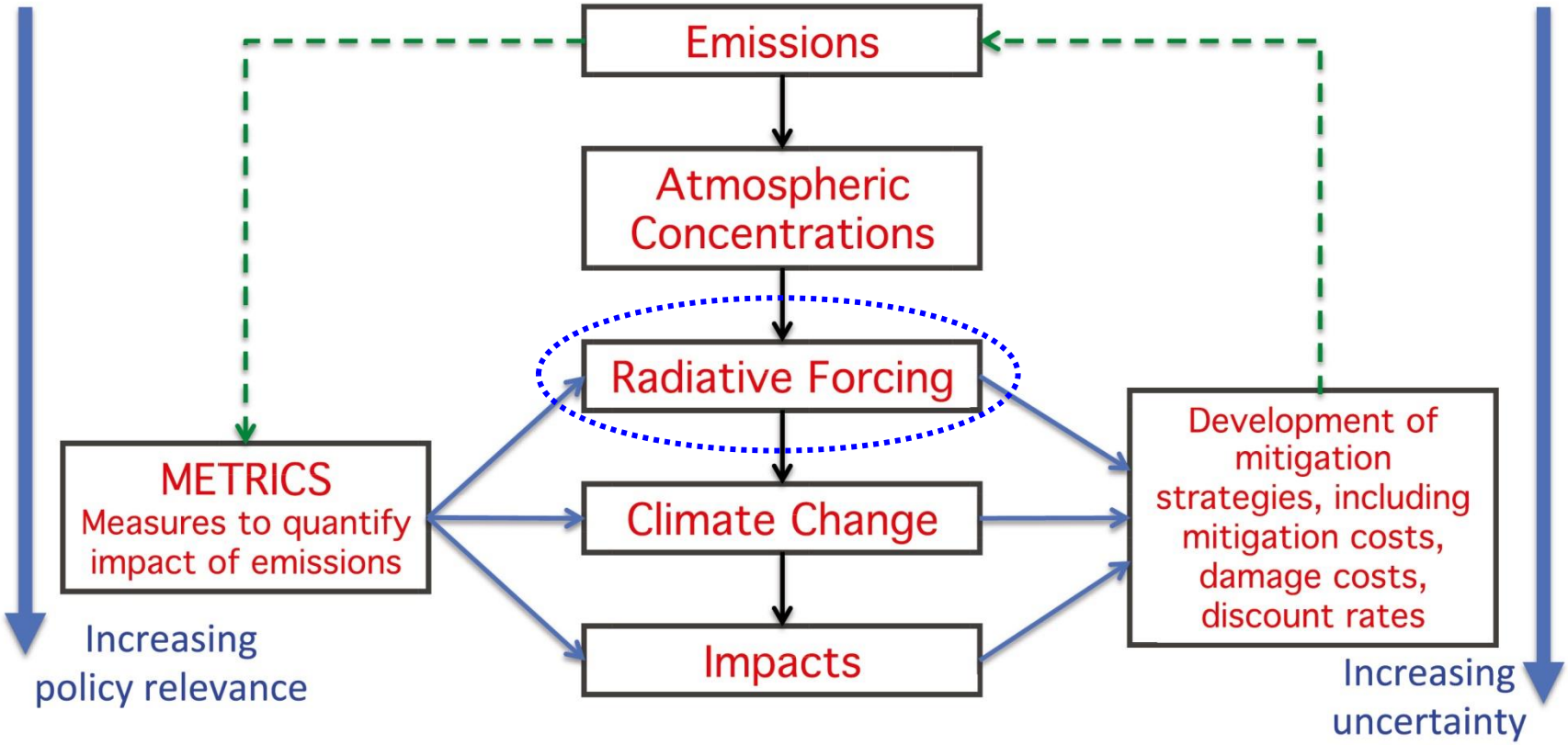
Metric design 1

- The metric provides an "exchange rate" to allow the *climate effect* of emissions of gas x to be compared with emissions of gas y (normally CO_2)
- We can then put emissions of all gases on a common scale ("equivalent CO_2")
- *Ideally*, the same equivalent CO_2 emissions would produce the same climate effect regardless of which gases contribute to that equivalent CO_2

Metric design 2

- An underlying assumption is that metrics should be simple to apply without further science input
- They must be flexible enough to incorporate new knowledge
- Ideally they should provide the user with a measure of uncertainty

Choice of climate impact



IPCC AR5 WG1 Fig 8.27

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Choices for metrics

- What parameter? e.g. radiative forcing, temperature change, sea-level rise, economic impacts, or the rate of change of these?
- What emission? Pulse, sustained,…?
- What time horizon?
- Value at a given time or integrated over a given time horizon, and/or discounted?

The above choices can affect decisions as to whether it is (perceived) to be best to cut short-lived or long-lived gases – ***and the choice of metric depends on the policy that it aims to fulfil***

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Kyoto Protocol use of the Global Warming Potential (GWP)

- The first Kyoto commitment period of Kyoto, uses the *100-year* time-horizon GWP as given in SAR. (AR4 values used in second commitment period)
- *Generally* accepted as an appropriate measure by the user community
- At the time of the Kyoto Protocol, the GWP was the only metric on offer to the policy community, that had been assessed by IPCC
- There has been a sustained and vigorous debate about them in the academic literature (which has been referred to in IPCC assessments)

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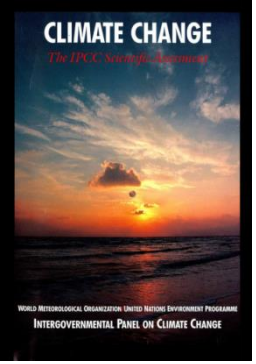

The Global Warming Potential (GWP) - the view from IPCC's First WG1 Assessment Report …

Section 2.2.7: "It must be stressed that there is no universally accepted methodology for combining all the relevant factors into a single (metric) … A *simple* approach [i.e. the GWP] has been adopted here to illustrate the difficulties inherent in the concept …"

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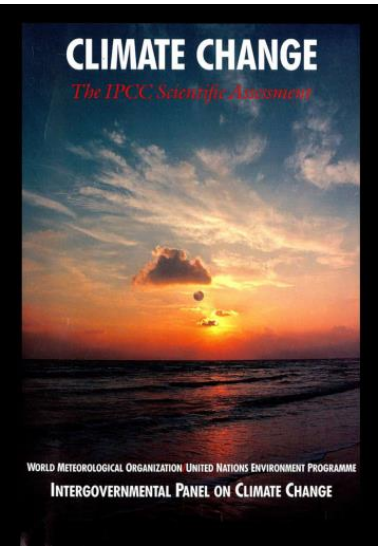
FAR view on climate metrics was based on a very limited literature



Model calculations of the relative effects of CFCs and their replacements on global warming

Donald A. Fisher*, Charles H. Hales*, Wei-Chyung Wang†, Malcolm K. W. Ko† & N. Dak Sze†

* E. I. du Pont de Nemours and Company, Experimental Station, Wilmington, Delaware 19880-0320, USA
† Atmospheric and Environmental Research Inc., 840 Memorial Drive, Cambridge, Massachusetts 02139, USA

Relative contributions of greenhouse gas emissions to global warming

Daniel A. Lashof* & Dilip R. Ahuja†‡

* Natural Resources Defense Council, 1350 New York Avenue, Northwest Washington, DC 20005, USA
† Tata Energy Research Institute, New Delhi 110003, India

IN the past few years, many workers have noted that the c effect on climate of increases in the concentrations of

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 93, NO. D3, PAGES 2423-2428, MARCH 20, 1988

Absolute Infrared Intensities for F-113 and F-114 and an Assessment of Their Greenhouse Warming Potential Relative to Other Chlorofluorocarbons

JERRY D. ROGERS AND ROBERT D. STEPHENS

Beyond CO_2—The Other Greenhouse Gases

Donald J. Wuebbles

Air and Waste Management Association
1989 Annual Meeting

Trace gases and their relative contribution to the greenhouse effect

R G Derwent

January 1990

Modelling and Assessments Group
Environmental & Medical Sciences Division
Harwell Laboratory, Oxfordshire OX11 0RA

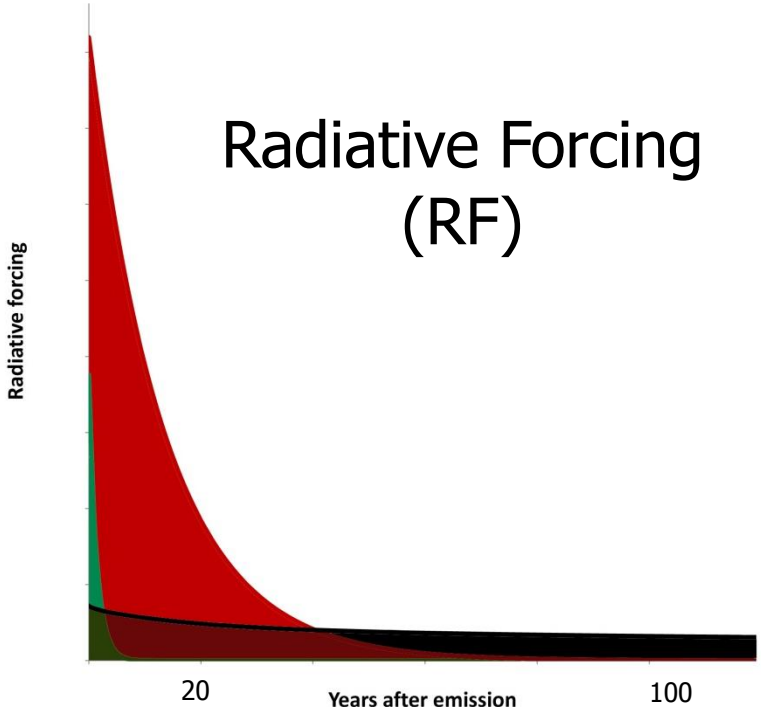
IX. HALOCARBON GLOBAL WARMING POTENTIALS

Relative Effects on Global Warming of Halogenated Methanes and Ethanes of Social and Industrial Interest

D. A. Fisher and Charles H. Hales
E. I. du Pont de Nemours & Company
Wilmington, DE

Wie-Chyung Wang, Malcolm K. W. Ko and N. Dak Sze
Atmospheric and Environmental Research, Inc.
Cambridge, MA

Definition of the GWP



The time-integrated radiative forcing in response to a pulse emission of a gas (relative to the same quantity for a emission of the same mass of CO_2)

$$GWP_i(H) = \frac{\int_0^H RF_i(t)dt}{\int_0^H RF_{CO_2}(t)dt} = \frac{AGWP_i(H)}{AGWP_{CO_2}(H)}$$

where H is the time horizon

GWP has a strong memory of short-lived emissions (often misunderstood; no climate response included)

The GWP *can* be related to temperature change in specific circumstances e.g. the eventual temperature change due to sustained emissions, or the the time-integrated temperature change due to a pulse emission

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What kind of "equivalence" does the GWP give?

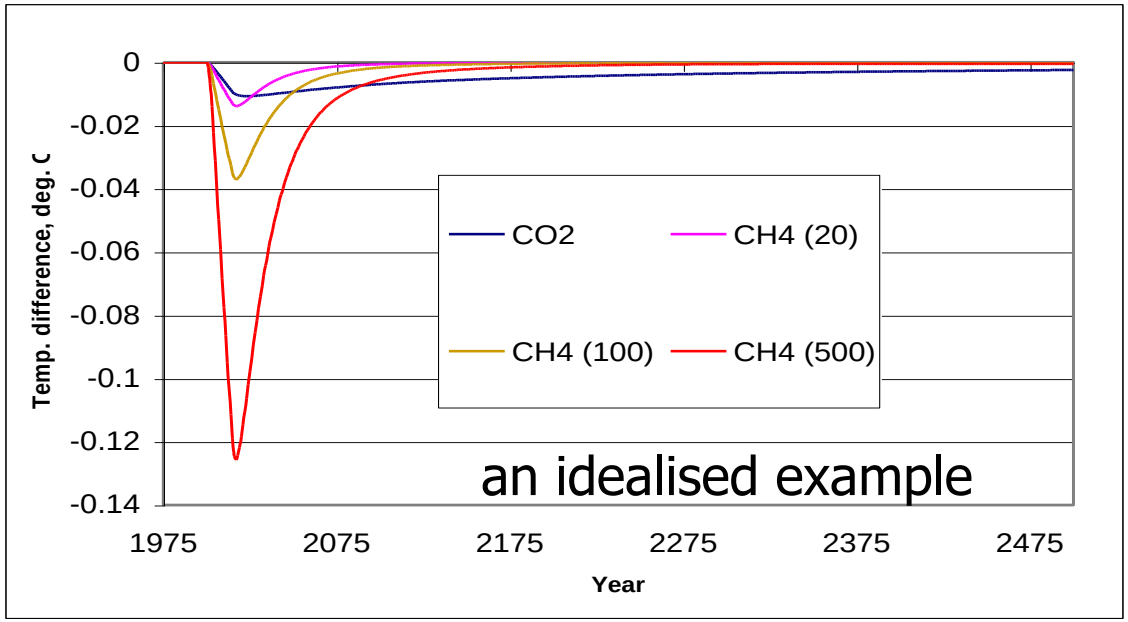

Figure 4. Temperature responses to sustained changes in emissions of CO_2 and CH_4 in terms of 'CO_2-equivalents' for various time horizons. The reductions are assumed to last for 15 years.

Fuglestvedt et al. 2003 *Climatic Change* 58:267-331

Equivalence of emission reductions in GWP terms does not (necessarily) lead to equivalence in temperature change or other climate parameters

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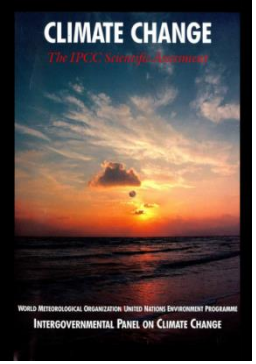

Time horizon

IPCC 1990 presented three time-horizons (20, 100 and 500 yr)…

….'*as candidates for discussion [that] should not be considered as having any special significance*'

SAR	GWP_{20}	**GWP_{100}**	GWP_{500}
CH_4	56	**21**	6.5

No compelling scientific argument for selecting 100 yrs compared with other horizons. Did Kyoto choose the middle value of those available?

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History

- FAR – GWP(20, 100, 500) for about 20 gases; no alternative metrics pursued
- SAR - GWP(20, 100, 500) for about 40 gases; no alternative metrics pursued
- TAR - GWP(20, 100, 500) for about 90 gases; no alternative metrics pursued
- AR4 - GWP(20, 100, 500) for about 100 gases; discussion of an alternative metric, *the Global Temperature-change Potential* (GTP), but no values presented
- AR5 – see next talk!

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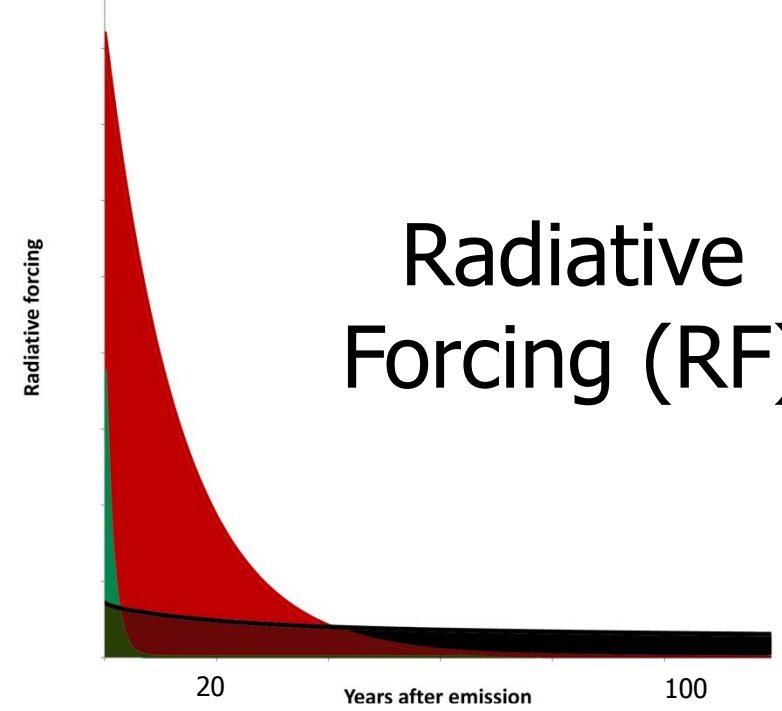
Radiative Forcing (RF)



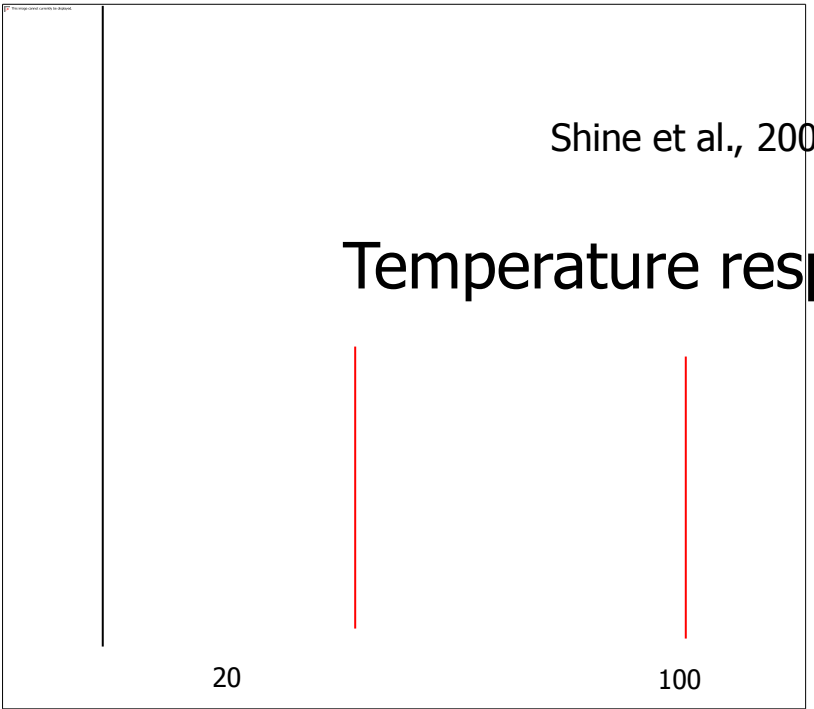
$$GWP_i(H) = \frac{\int_0^H RF_i(t)dt}{\int_0^H RF_{CO_2}(t)dt} = \frac{AGWP_i(H)}{AGWP_{CO_2}(H)}$$

➔ strong memory
(often misunderstood; no climate response included)

Shine et al., 2005:

$$GTP_i(t) = \frac{AGTP(t)_i}{AGTP(t)_{CO_2}} = \frac{\Delta T(t)_i}{\Delta T(t)_{CO_2}}$$

Temperature response



Large differences between GTP and GWP for short-lived components

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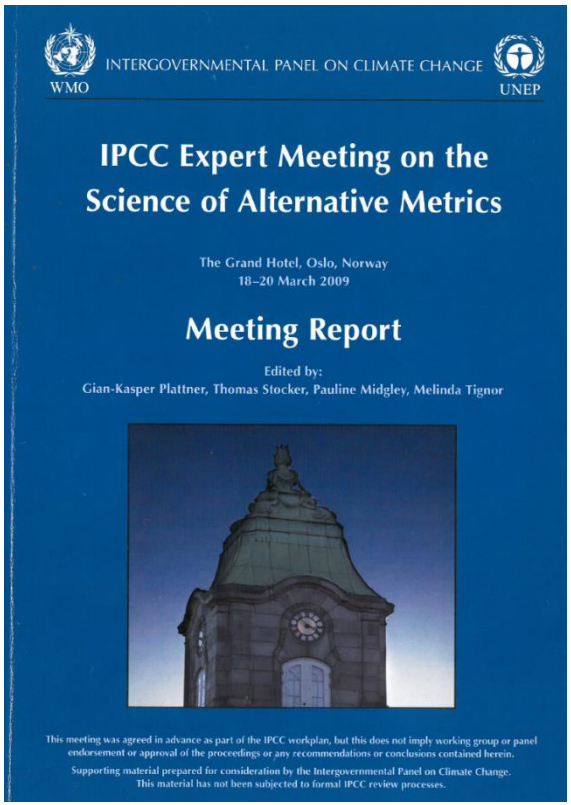
Post-AR4



Key Conclusions and Recommendations to UNFCCC:

1. GWP is a well-defined metric ... that continues to be useful in a multi-gas approach. Shortcomings have been identified ...
2. The effectiveness of the use of a given metric depends on the primary policy goal ... The GWP was not designed with a particular policy goal in mind. Depending on the ... policy goal ... alternative metrics may be preferable ...
3. The GWP with the time horizon of 100 years is used in the Kyoto Protocol. (Its) numerical value ... can depend markedly on the choice of time horizon. The choice of any particular time horizon involves value judgments in terms of future commitment ...
4. Timely information on potential future policy goals would facilitate research on alternative metrics

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Framework Convention on
Climate Change

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- Technology

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- Essential Background
- Kyoto Protocol
- Cooperation & Support
- Science
- Adaptation
- National Reports
- GHG Data
- Methods
- REDD

Workshop on common metrics to calculate the CO2 equivalence of anthropogenic greenhouse gas emissions by sources and removals by sinks

http://unfccc.int/methods/other_methodological_issues/items/6737.php

3 – 4 April 2012
UN Campus, Langer Eugen (Room 1916), Hermann-Ehlers-Str. 10
Bonn, Germany

The Subsidiary Body for Scientific and Technological Advice (SBSTA), at its thirtieth session (2009), initiated its consideration of common metrics to calculate the carbon dioxide equivalence of anthropogenic greenhouse gas emissions by sources and removals by sinks.

The SBSTA at its thirty-fourth session (2011) requested, the secretariat to organize, subject to the availability of resources, a workshop on common metrics, to be held in the first half of 2012, with a focus on four major areas: i) uncertainties; ii) new and refined areas or metrics; iii) policy goals; and iv) relationship between policy frameworks and metrics, with the purpose of providing information for further consideration of the SBSTA at its thirty-sixth session (2012).

Workshop report at: FCCC/SBSTA/2012/INF.2 – no specific conclusions/recommendations

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Some personal conclusions

- There is nothing uniquely good about GWP (100) – arguably it is an "accident of birth" that we use it
- The GWP(100) has enabled multi-gas climate policy and has generally been viewed as allowing a cost-effective approach
- There would be "costs" in moving away from using the GWP(100) to another metric
- The choice of metric depends on the climate policy being pursued. Since Kyoto does not have a specific climate target, the choice of GWP(100) cannot easily be said to be suitable or unsuitable
- Perhaps some "mutual satisfaction" between IPCC and the policymaking community on the suitability of GWP(100) which may have inhibited exploring alternatives?