**Excerpt on Reaching Beyond the Averaged Global Warming Metric and Net-Zero Emissions**

Section 2: The Need for COP Policy to Reach Beyond Averaged Global Warming Metric and Net-Zero Emissions, from: Addressing the Urgent Need for Direct Climate Cooling: Rationale and Options, *Oxford Open Climate Change* 2024 forthcoming. Aug. 17, 2024, preprint.

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1. **The Need for COP Policy to Reach Beyond Averaged Global Warming Metric and Net-Zero Emissions**

The IPCC “Average Global Warming” metric, central to setting and publicizing policies dealing with climate change, is inadequate and misleading. Defined as “an increase in combined surface air and sea surface temperatures averaged over the globe and over a 30-year period,” the metric yields an approximation to global average temperature increase that is time-lagged by a decade behind the current level of warming [30]. This smoothing of data aims to provide a scientifically rigorous metric for determining when the Paris Accord peak-temperature goals are exceeded. However, by suppressing variability the metric defers recognizing essential thresholds that would indicate crossing of tipping points [10].

Though useful as a summary metric (as in figure 1), the Average Global Warming metric fails to convey the significance of the warming taking place in real time or reveal regionally important vulnerabilities. The oceans, which cover 71% of the Earth’s surface, have a very large heat capacity that keeps its average warming well below the increase occurring over land surfaces. Averaging ocean and land surface temperatures together understates the rapidly increasing impacts on people and the terrestrial biosphere [31].

In the Northern Hemisphere’s high latitudes, polar amplification is resulting in warming that is more than three times the global average, accelerating permafrost thawing, loss of sea ice, and loss of mass from the Greenland ice sheet [32]. In mid-latitudes, measures of the increases in extreme precipitation and duration of heat waves would better characterize the pace and significance of weather disruption [33]. The heat and discomfort index is a much more appropriate metric for indicating the significance of global warming in hot, humid regions [34]. Extremes in precipitation can cause the worst impacts on those living in wet, tropical regions where increased ocean evaporation leads to more intense rain and flooding [35]. Current events and observations are making it clear that short-term weather extremes [36] are increasing at a rate far faster than the slowly rising multi-decadal average of the global temperature increases.

Use of the global average warming metric, even with projections out to 2100, provides no direct insight into the ongoing and committed amounts of sea level rise. Paleoclimatic analyses suggest an equilibrium sea level sensitivity exceeding 12 meters per degree change in global average temperature [37]. The present rate of warming is at least 10 times greater than the average during the multi-millennial deglaciation following the Last Glacial Maximum. Sea level rise then averaged more than a meter per century for 100 centuries while the average temperature in Antarctica was rising at an average rate of one degree every 10 centuries [38].

The IPCC assurances that the rise in sea level by 2100 would be less than a meter [39] are questionable given the destabilization and increasing rate of flow of glacial streams from the Greenland and Antarctica ice sheets [40]. Geological evidence makes clear that ice sheet decay occurs much more rapidly than ice sheet formation and that melting is very hard to stop once it starts [41]. NOAA estimates in a 2021 technical report that even if net-zero GHG emissions were rapidly achieved, sea level rise along the US coast by 2100 would exceed half a meter [42], threatening destruction of all low-lying infrastructure. There is virtually no public understanding of committed future sea level rise and the impacts it will have on future generations [43].

The scientific community may view the global average warming metric, properly interpreted, as a suitable public and policy surrogate for climate change, but its use leaves many members of the public, most business leaders, and many lawmakers ill-informed about the urgency of effective climate action. Most citizens, and even political leaders, do not have access to expert climate advisors. A variety of more meaningful metrics and a revised approach to communicating the urgency of incorporating credible cooling research and responsible deployment into global climate change policy are needed.

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