METRICS FOR EVALUATING CLIMATE AND CO-BENEFITS OF SLCP MEASURES

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**Why are Metrics Important?**

• Metrics allow *quantification of impacts and benefits* of SLCP mitigation. E.g. changes in warming (short and long term); benefits related to human health; ecosystem structure and function, i.e. agriculture & forest yield; Includes both physical benefits and valuation of these;
• Metrics can help *standardize reporting* on activities and actions;
• Metrics can *measure progress* towards a goal;
• Metrics can be used to *compare* between two or more climate pollutants or enable comparisons among pollutants, sources, or measures.

The choice of a metric depends greatly on the policy goal. Science cannot provide information on which value choices to make. The interaction between science and politics is critical for selecting appropriate metrics for specific situations.
The SLCP Challenge

SLCPs are responsible for a substantial fraction of near term climate change, with a particularly large impact on sensitive regions of the world, and have significant detrimental health, agricultural, and environmental impacts.

CLIMATE AND AIR POLLUTION IMPACTS

- **Climate**: Contribute to global warming, Disrupt weather patterns, Accelerate melting

- **Human Health**:
  - 3.5 MILLION/Yr Premature Deaths from Indoor Air Pollution
  - 3.2 MILLION/Yr Premature Deaths from Outdoor Air Pollution

- **Crop Yields**:
  - 110 MILLION TONNES/Yr Crop Losses from 4 Major Staples

Regional share of annual global premature deaths and crop losses due to air pollution.
The SLCP Opportunity
Benefits of Control Measures

A number of available mitigation options have been identified that if rapidly implemented have the potential to deliver rapid multiple benefits for human well-being by improving air quality and reducing near-term global warming.

**ANNUAL BENEFITS**

- **Climate:**
  - Avoided warming
  - Reduced disruption of weather patterns
  - Reduced rate of melting

- **Health:**
  - 2.4 MILLION avoided premature deaths annually from outdoor air pollution

- **Crops:**
  - 52 MILLION tonnes of avoided crop losses from 4 major staples/year

**AVOIDED WARMING**

- N. America and Europe: 0.01°
- Latin America and Caribbean: 0.03°
- Africa: 0.05°
- S. W. and Central Asia: 0.07°
- NE. SE Asia and Pacific: 0.09°
- Global: 0.2°

**FROM 16 MEASURES UP TO 0.5°C TOTAL AVOIDED WARMING**

**FROM HFCs MEASURES UP TO 0.1°C ADDITIONAL AVOIDED WARMING**
How do you compare SLCPs and LLGHGs?

“Analysis of the temperature response to current emissions shows that black carbon and methane emissions cause the greatest amount of warming during the first decade, whereas emissions of CO$_2$ dominate at longer timescales. This highlights the importance of controlling emissions of both the SLCPs and CO$_2$ in order to reduce warming in both the near- and long-term as well as the limitations of any comparison between SLCPs and CO$_2$ at a single point in time.”  (CCAC SAP, 2014)

SPD2 (March 2016) – SAP asked to evaluate existing SLCP metrics and recommend new metrics

Ottawa Metrics Workshop (March 2017)
Meeting Summary: Climate Metrics

• **Agreed that long-term goals and metrics should be those of the UNFCCC** - Paris set temperature goals: 2°C and 1.5°C

• Agreed that **we need a near-term temperature metric**, complementary to long-term temperature targets to emphasise benefits of action to reduce near-term warming and describe pathways to Paris goals

• **AGTP metric can be used** to provide:
  - Temperature in a given future year (°C) – e.g. 25 years from present day e.g. T°C in 2040 under baseline and mitigation
  - % change in temperature in a given year
  - Mean temperature change (°C) or mean % change over 25 years

• In addition the mean AGTP25 was suggested as a metric that can compare strategies
MEETING SUMMARY: HEALTH METRICS

• The widely used metric of *premature mortality* (or mortality attributed to air pollution) from exposure to PM$_{2.5}$ and ozone, is useful to use to compare strategies for CCAC - and also YLL – Years of Life Lost

• The *methods* to calculate these should follow agreed approaches by the main developers of these – *the WHO and GBD communities*

• In addition, calculating non-fatal outcomes of air pollution in physical terms (e.g. non-fatal heart attacks or strokes) could be next step

• Valuation methods using ‘disability weightings’ can be used to assess the significance of these physical impacts to derive Years Lived with Disability (YLD) which can then be used to estimate DALYS (with YLL)
MEETING SUMMARY: AGRICULTURE METRICS

• Metric for use is *yield loss for crops* where we have robust concentration-response relationships with ozone concentrations
  - Total yield loss in Tonnes
  - Relative yield loss in %
  - Robust relationships currently for rice, wheat, soybean and maize

• Work needed to identify further robust CRFs for further crops and forest species so they can also be included in the benefit analysis

• We need ozone concentrations from models or monitoring
MEETING SUMMARY: ECONOMIC METRICS

• Value of impacts can be estimated that cover Direct and Indirect costs.
• Direct costs include direct health costs, forgone output, cost of yield loss.
• Indirect costs can use different methods such as those based on “willingness to pay” approaches such as “Value of a Statistical Life” which indicates the cost that people are willing to pay to avoid a small risk of dying due to air pollution. Climate change impacts can use the social cost of carbon.
• Economic costs can be summed to give an overall valuation of benefits of a strategy, whilst making clear the uncertainties.
## Summary of recommended metrics for evaluating impacts

<table>
<thead>
<tr>
<th>Metrics Parameter</th>
<th>Climate [Stabilization]</th>
<th>Climate [Rate of Change]</th>
<th>Health</th>
<th>Agriculture and Vegetation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Emissions</strong></td>
<td>Tonne/yr [CO$_2$; tonnes of each emitted substance affecting climate]</td>
<td>Tonne/yr [CO$_2$; CH$_4$; BC; OC; SO$_2$; HFCs; NOx; CO; N$_2$O; NH$_3$; nmVOC]</td>
<td>Tonne/yr [PM$_{2.5}$ / O$<em>3$ and precursors – of PM$</em>{2.5}$ include BC, OC, mineral dust, NOx, SO$_2$, NH$_3$]</td>
<td>Tonne/yr [O$_3$ precursor emissions – NOx, nmVOC, CH$_4$, CO]</td>
</tr>
<tr>
<td><strong>2. Exposure</strong></td>
<td>GWP</td>
<td>Mean AGTP25</td>
<td>Population weighted annual average µg/m$^3$ PM2.5</td>
<td>M7 M12 AOT40 Ozone flux</td>
</tr>
<tr>
<td></td>
<td>GWP*</td>
<td>Mean Temperature Increase</td>
<td>Mean daily maximum 1-hour O3 concentration aver. over 6 months; OR annual average daily maximum 8 hour concentration</td>
<td></td>
</tr>
<tr>
<td><strong>3. Response impact and benefits (domestic/global public good)</strong></td>
<td>Temperature (°C)</td>
<td>Temperature (°C) 25 years out</td>
<td>Equivalent Attributable Deaths &amp; Illness</td>
<td>Tonnes of yield loss/yr for four staple crops, and other crops, vegetation types for which there are agreed CRFs</td>
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<tr>
<td></td>
<td></td>
<td>Mean Temperature (°C) over 25-yr</td>
<td>Attributable deaths</td>
<td></td>
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<td></td>
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<td>Temperature (°C) by region/latitude bands</td>
<td>Years of Life Lost (YLL)</td>
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<tr>
<td><strong>4. Economic valuation (domestic: global public goods)</strong></td>
<td>Social Cost of Carbon</td>
<td>Social Cost of Methane</td>
<td>DALY = YLL+YLD</td>
<td>USD/Tonne of each staple (and other crops as appropriate)</td>
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<tr>
<td></td>
<td>Social Cost of Methane</td>
<td>Social Cost of Black Carbon</td>
<td>Cost of Illness</td>
<td></td>
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<td></td>
<td>Social Cost of Atmospheric Release</td>
<td>Social Cost of Atmospheric Release</td>
<td>Willingness to Pay (WTP)</td>
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<td><strong>5. Finance (Price)</strong></td>
<td>SDG 13: &lt;2°C in 2100</td>
<td>1.5 - &lt;&lt;2.0°C in 2100 25-year rate of warming target</td>
<td>Value of a Statistical Life (VSL)</td>
<td>Will be set by regulations and market</td>
</tr>
<tr>
<td><strong>6. Policy objectives</strong></td>
<td>SDG 3</td>
<td>SDG 2</td>
<td>Will be set by regulations and market</td>
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<td>WHO AQ Guidelines</td>
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“[W]e recognize the importance of improving our understanding of the contribution of sources of black carbon emissions in order to prioritize actions and to track progress. The following Coalition State Partners resolve to commence development of or continue to refine by the end of 2017 black carbon inventories and projections including, as a first step, strengthening our capacities and efforts to do so (taking into account the guidelines under the United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution), and to share information on existing or planned black carbon mitigation actions with the Coalition”

Australia, Bangladesh, Benin, Canada, Central African Republic, Chad, Chile, Colombia, Cote d’Ivoire, Denmark, Dominican Republic, Finland, Germany, Guinea, Ireland, Italy, Japan, Kenya, Luxembourg, Mali, Mexico, Moldova, Morocco, Netherlands, New Zealand, Nigeria, Norway, Paraguay, Peru, Philippines, Poland, Rwanda, Sweden, Switzerland, Togo, United Kingdom, United States, Uruguay
MEETING SUMMARY: EMISSION INVENTORIES

• To estimate impacts of methane and black carbon sources and mitigation strategies using the recommended metrics, all co-emitted substances from a particular emission source need to be reported as individual species.

• CCAC can build on existing approaches and methodologies including Convention on LRTAP Task Force on Emission Inventories and Projections; and countries can use LEAP-IBC to develop emissions and scenarios for all required substances for impact assessment.

• Work is needed to evaluate quality of available emission factors and improve estimates for activity data needed for emission inventories appropriate for developing countries.
NEXT STEPS

• CCAC SAP will ‘road test’ proposed near-term climate metric with interested countries and institutions

• CCAC will form a policy task force on the pathway proposal and metrics
Thank you!

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