China Carbon Forum | 中国碳论坛

An independent platform to foster trust and cooperation among China's stakeholders for climate action

Advancing Greenhouse Gas Emissions Estimations and Reporting in China and the World

Executive Summary

On April 24th, 2018, the China Carbon Forum together with the Commonwealth Scientific and Industrial Research Organisation (CSIRO), co-organised an event titled ***"Advancing Greenhouse Gas Emissions Estimations and Reporting in China and the World"***.

The event featured welcome remarks by Ms Jan Adams, Australian Ambassador to China and Mr Xu Huaqing, Director of the National Center for Climate Change Strategy and International Cooperation, followed by a keynote address from Dr Helen Cleugh, Research Director of the Climate Science Centre at CSIRO. Mr Xu and Dr Cleugh then joined a distinguished expert panel to share insights on the challenges and opportunities in applying 'top down' approaches to improve GHG estimation and reporting in China and internationally, including Dr Yao Bo, Chief Scientist for Greenhouse Gas Measurement at the Chinese Meteorological Association and Mr Knut Alfsen, Special Advisor to CCICED and a Senior Researcher at CICERO. The panel was moderated by Mr Dimitri de Boer, Vice Chairman of China Carbon Forum.

Welcome remarks

Ms Jan Adams AO PSM, Australian Ambassador to China

The Ambassador thanked the China Carbon Forum for bringing together the top thinkers on climate change issues, as well as the organisations represented at the event, including:

- CSIRO (the Commonwealth Scientific and Industrial Research Organisation), is Australia's largest, oldest and most-trusted scientific research organisation, and largest patent holder;

- The National Center for Climate Change Strategy and International Cooperation (NCSC), is a pioneer in climate change research, and takes a leading role in the Australia-China climate change partnership;
- The China Meteorological Association, a premiere institution in China, with strong links to Australian institutions;
- CICERO, also with a fine history of important research on climate change.

The Ambassador commended China for putting the environment at the centre of its policy priorities, as one of three major challenges that President Xi Jinping has identified for China in the coming years. Australia's Prime Minister has also acknowledged the leadership role that China played in bringing the Paris Agreement in to being. The Ambassador was in Hainan recently for President Xi's Boao Forum speech, where he once again reiterated china's commitment to work with others on the environment and climate change.

Australia and China are natural partners, including on implementation of the Paris Agreement, and a long-standing Ministerial Dialogue on environment and climate change since 2008. Research collaborations include 6,500 co-authored research papers, and Australia hosting about 180,000 Chinese students each year, including in science, engineering and other areas relevant to climate change. Australia-China collaboration is characterised by pragmatism, as seen in the recent free trade negotiations, and reflected in the two countries' climate change engagement. Practical engagement on MRV (Monitoring, Reporting and Verification) is a good example of that.

Those involved in negotiations know that reliable measurements are the backbone of the process. It is needed for political confidence in meaningful commitments.

Mr Xu Huaqing, Director, National Center for Climate Change Strategy, NDRC

Director Xu noted that Australia and China have been conducting effective cooperation on climate change for many years. **In relation to the reporting and accounting of greenhouse gas emissions, this has involved very good exchanges and discussions with the relevant Australian agencies including the Department of Environment and Energy.**

China is also aware that Australia has a very good national system for companies to publicly report relevant data, with strong legal requirements. This provides the legal framework for controlling company emissions, and responding to climate change.

China also places great importance on this work. In 2009, the State Council Standing Committee set a goal for limiting greenhouse gas (GHG) emissions by 2020, and established the requirement for a clear system for measuring, reporting and verifying emissions statistics.

After many years of hard work and research, China released a proposal for strengthening GHG statistics collection in 2013. The government borrowed from existing statistical collection and survey systems that could inform the preparation of a GHG inventory, as well as the GHG accounting system for companies at the local level. The system was needed to support effective control of emissions at the company level, helping to fulfil China's international commitments in controlling emissions.

At the same time, relevant departments, such as the Ministry of Science and Technology (MoST), the Chinese Academy of Sciences and the China Meteorological Administration, have also conducted research work using satellite data to map the temporal and spatial distribution of GHGs in China, and in December 2016, China launched a satellite to monitor GHG emissions. These efforts help to monitor the concentration of GHGs, both at the global and regional level, as well as the trends in emissions.

Seminars such as the one today will help us to increase the reliability of reporting and verification, and promote effective international communication. In order to improve the transparency of China's GHG data, standardization of management and scientific approaches needs further support. Given China's demonstrated implementation of its international commitments, we will continue to contribute to such exchanges.

Keynote Speech

A keynote speech was provided by Dr Helen Cleugh from CSIRO. Below is a summary of the key points discussed during the presentation.

- As we are all aware, climate change driven by human emission of GHGs is disrupting the earth's climate system. Through an enormous global research collaboration over at least three decades, the IPCC's 5th Assessment Report concluded in 2013 that the evidence was clear that human GHG emissions are causing changes in the climate system that are unprecedented on millennial time scales. Climate science research shows that old patterns are shifting and records are being broken. Phenomena that affect our year-to-year climate variability like the monsoon or the El Nino southern oscillation, are changing because of climate change. This means that the past can no longer be a reliable guide to the future.

- **China and Australia have a long and strong history of adapting to a variable climate, and climate science is needed now more than ever, to enable us to be prepared, resilient and productive in the face of climate and environmental change.**

- The Paris Agreement is very relevant to this event, because it demonstrates the importance of excellent science in providing the evidence basis for decisions and policies. It also demonstrates the power of global scientific collaboration. The agreement provides some pointers for climate science. For example, it acknowledged the need for adaptation planning, to better manage the risks and opportunities of climate change that is already in train. It spoke to the need to continue to understand how the climate will change in the future under different GHG emission scenarios. Furthermore, the commitment to limit global warming to 2 degrees has sent a strong signal to the business community such that climate change is now seen not just as an environmental risk, but as a financial risk and opportunity.

- All this means that there is a continued demand for information about how the climate is changing and what it will look like in the future. In summary, global climate change research is needed just as much now as it was in the decades leading up to the Paris Agreement.

- CSIRO is Australia's national research agency, with a record of scientific excellence over 100 years. It is ranked in the top 1% of research globally in fifteen research fields, including its work on oceans, climate and atmospheric science. CSIRO partners extensively with industry and other

agencies, both in Australia and globally. It receives funding from both the public and private sectors, and analysis has shown that it delivers significant value, with an estimated return on investment of around five to one.

- CSIRO is expected to apply its deep scientific expertise to significant challenges. Its goal is to make a difference to the environment, society and economy, using its expertise across a range of scientific domains, including agriculture, energy, manufacturing, data, astronomy and education. This means that CSIRO can build multi-disciplinary teams with skills that are needed to address significant research questions, and to facilitate and deliver solutions.

- The Climate Science Centre (CSC), is housed within CSIRO's Oceans & Atmosphere Division. It was established in 2016 and brings together all the physical climate change research capabilities in CSIRO. The scientists work on observations and simulations of climate, the atmosphere and the oceans. Its strengths include world-leading expertise, a commitment to scientific excellence and provision of key national research infrastructure, including laboratories and simulation models that others use. It has a strong commitment to public good research and delivers research which is relevant and useful (applied).

- The Centre for Southern Hemisphere Oceans Research (CSHOR) sits within the CSC, and is a collaboration between CSIRO, the Qingdao National Laboratory for Marine Science and Technology, the University of New South Wales and the University of Tasmania. It was launched in May 2017, and was one a series of initiatives that coincided with the CSC's establishment. Its goal is to study how the southern hemisphere oceans moderate the climate in Australia, China and around the planet. It is an excellent example of CSIRO's global outreach, because the data, knowledge and insights that CSIRO receives from this collaboration will benefit climate change science in China, Australia and internationally.

- CSC is part of several global atmospheric observing networks. CSIRO has a facility at Cape Grim in northwest Tasmania which captures the cleanest air on the planet after travelling across thousands of kilometres of ocean, with no local anthropogenic influence. With over 40 years of measurements, CSIRO is able to track changes in the atmospheric GHG concentrations that are causing changes in our climate. CSIRO's measurements capture changes in time from 1700 through to the present, of methane, carbon dioxide, nitrous oxide and the synthetic GHGs. The data back to 1700 comes from ice cores in collaboration with other research agencies, where the air bubbles are analysed for the concentration of GHGs.

- CSC samples the properties of the oceans through a global observing network. Australia joins with many other countries, including China, to run an array of ocean floats that provide regular measurements of the physical properties of the oceans. By analysing this data, CSIRO can plot a time series from the 1970s to the present showing that over 90% of the extra energy resulting from greenhouse warming is going in to the oceans, meaning that oceans are moderating the rate of climate change. This is important for our understanding of future climate. In the past, the uncertainty of such measurements was high, but this has reduced significantly in recent years due to advances in technology for ocean observations.

- Predicting future climate requires the use of global climate models. CSIRO has been developing and using such models, and contributing to the IPCC climate change assessments since 1990. By the early 2000s it was clear that global climate models were becoming so complex that the expertise required exceeded any one organisation's capacity. CSIRO therefore joined with the Bureau of Meteorology and Australian universities to build a global weather, climate and earth systems model. This model is called ACCESS. It provides weather forecasts for Australia, as well as seasonal outlooks, i.e. what is the weather going to be like in the next 3-6 months? What is the fire risk? How much rain will fall? It has also been developed to be a climate change model. By incorporating atmospheric chemistry and the carbon cycle in to the simulation model, the CSC can explore the interactions of future climate with the carbon cycle and air pollution.

- The CSC partners with others across CSIRO who can provide additional and complementary skills to help deliver an effective pathway to impact. To provide solutions and adaptation pathways, more than just models and observations are required. Decision support systems, impact and risk frameworks, multiple future scenarios are all needed. For example, the CSIRO water division can talk about future water resources management, the agriculture division can talk about food security, other areas work on energy, construction, infrastructure and buildings that all require climate adaptation efforts.

- The CSC also has expertise on climate change mitigation, with observations and models of GHG concentrations, emissions, carbon sources and sinks, but also of air pollution, smoke, dust and other things that affect human health. Solutions must deliver air quality outcomes, tracking global GHG emissions and helping to set global agreements. CSIRO has expertise on renewable energy, efficient grids and smart agriculture that can help develop mitigation strategies. CSIRO can work on issues like negative emissions, bioenergy and fugitive emissions, for example

CSIRO can measure the risk of fugitive emissions and assess how to manage landscapes so that they sequester as much CO_2 as possible.

- For CSC's global networks and collaborations, the Cape Grim facility (run by the Bureau of Meteorology) and CSIRO's laboratory in Melbourne are able to provide high-quality long-term records of all of the gases that affect the earth's climate. Some of CSC's observations are taken in-situ, some in flasks, and some from on-board the RV Investigator, a marine research facility which is used for ocean observations and atmospheric research. From this, along with air extracted from ice cores, CSC constructs time series that take us back 2000 years, showing human-caused changes that have not been seen in millennia. CSC converts the concentration of GHGs to the radiative forcing that affects the Earth's climate, helping identify the mitigation challenge that the world faces.

- As with Chinese colleagues, CSIRO is excited about the next big climate science challenge, which is to estimate GHG emissions in urban areas using atmospheric observations and modelling. **CSIRO think that this top-down approach can complement existing emissions MRV methods that are based on formulae in emissions inventories, and that the two together can add rigour to the estimates of emissions, particularly for cities.** There is already work going on in China in this regard. It requires new science, multiple observations from ground sensors, remote sensing from satellites, and perhaps from sensors mounted on towers, combined with modelling. It is a great but important challenge, because with the Paris Agreement comes a focus on the ability of nations to report on progress towards their nationally determined commitments. Cities are an important focus because they are centres of population, and where emissions are concentrated. A focus on better quantifying emissions from cities can help achieve our mitigation goals.

- With knowledge of the baseline, CSC can then use this methodology to track emissions and trends into the future, and can contribute to protocols, methods and capacity building. From CSIRO's perspective, achieving this grand challenge will require collaboration across the scientific community. Meeting this challenge would lead to highly complementary methods to strengthen the estimates that come from the world's inventory-based methods, improving the transparency and accuracy of estimates of GHGs in urban settings, where the emission sources are diffuse and difficult to capture through an inventory method. **An atmospheric-based approach complements the inventory-based approach.**

- An example from CSIRO's work at Cape Grim is for synthetic GHGs, which are an important driver of climate change. CSC looked at a time series from 2005-2015 of emissions of hydrofluorocarbons (HFCs), mostly from the aluminium sector, based on the best inventory method, tested and developed by scientists. When comparing it with what CSC infers from its measurement of HFCs concentrations, there is a divergence from 2011. **This identifies an area for future research to understand why, and comparing these two methods can improve the estimates of emissions.** This example is a reliable one, given the HFCs are a synthetic gas with no biological factors involved.

Record of Discussion

The following is an edited synthesis of discussion that took place at the event among panellists (around 55 minutes) and open Q&A with participants (20 minutes). As per convention, individual's comments are not attributed.

The panel noted that important foundational work regarding the effective management of emissions data at the company level has been carried out in China, as well as capacity building for enterprises. In the past ten years, the Chinese government has identified this work as a priority. Agencies including the NCSC have been supporting the central government, especially given that the NDRC's climate change department has been getting established, and establishing the statistical accounting, reporting, monitoring and assessment system is a relatively large challenge. To date, the basic data collection system has been enhanced and verification systems. Guidelines have been issued for the preparation of company inventories and assessment carried out of GHG controls at the provincial-level, as well as beginning work on GHG accounting and preparation of inventories at the city level, especially for CO_2. In addition, key GHG accounting and reporting methodologies have been issued, and GHG accounting work has begun in those industries which will be covered by the carbon market.

The panel also noted that China's use of satellite measurement of GHGs will help to improve the understanding of spatial and temporal distribution of GHG emissions sources. This research work is directed at the central level, and is supported by various research institutions. The ability to track trends by region will allow us to judge appropriate responses, and target the areas that demand it. There is much to do to refine this work, and build useful simulations and models, but this should be completed quickly.

The panel discussed the background of China's work on climate research, noting that the China Meteorological Administration (CMA) established China's first background atmospheric monitoring station in the early 1990s, and it how has now been collecting data for 30 years. In the last decade, the CMA's GHG monitoring network has developed well. Six regional atmospheric stations have been established during this century. The CMA monitors the seven major GHGs (CO_2, CH_4, N_20, SF_6, HFC, PFC and NF_3), that have a large Global Warming Potential (GWP). CFCs and HCFCs which are covered by the Montreal Protocol are also monitored by this network.

However, China currently has a relatively low resolution of monitoring capability, achieving 100 km X 100 km. The panel noted that because 'low-carbon cities' has become a popular topic in China, many people are wondering how greenhouse gas emissions from the city and provincial level can be connected directly to atmospheric GHG concentrations. Unfortunately, the current monitoring network cannot yet make that link. Therefore, China's Ministry of Science and Technology is supporting a group of cities for demonstration carbon monitoring projects, along with more than twenty relevant agencies, including the CMA's National Satellite Meteorological Centre and Meteorological Observation Center, NDRC's Energy Research Institute and the National Institute of Meteorology. This effort will draw on both the domestic and international scientific community, including the CMA's carbon monitoring satellite, CAS's high-altitude satellites, as well as those of the United States and Japan. In the 'Jing-Jin-Ji region (Beijing, Tianjin, Hebei), there are currently six high-precision monitoring stations, plus 200 low-medium stations. At the same time, China is using a range of techniques, including laser radar (LIDAR), aircraft and other cutting-edge technology, to build a more comprehensive monitoring system. Eventually, the aim is to achieve monitoring at hourly intervals with resolution of one square kilometer.

The panel suggested that although climate change is a global issue, it has to be solved with local action. To facilitate this, citizens at the local level need information, in order to identify the problem and its solutions. However, inventory-type approaches to greenhouse gases typically have larger levels of uncertainty at the local level, making it harder to engage with people.

The panel also suggested that the challenge of dealing with climate change comes down to finance, i.e. how do you compensate those affected, who should pay and who should get paid? In this respect, work such as advising investors on the reliability of 'green bonds' becomes important, which could include water treatment, emission reductions, green transport or housing. About 10 years ago, the World Bank initiated the first green bonds, but the financial market did not have the knowledge and capacity to adequately consider such bonds. In recent years, the green bond has expanded

quickly, making the verification and assessment increasingly important. The reliability of green bonds can also be underpinned by reliable estimates of GHGs, by independent parties.

The panel made the point that reliable GHG estimates are also critical for the success of the UN climate change negotiation process, as they can create trust and make the negotiating environment more efficient and easier.

The panel noted the long history of using top-down/inverse methods, including for use in Australian coal mining regions to measure diffuse methane emissions. However, it was suggested that **cities are where these techniques will make the most significant difference.** Not only are cities concentrated in population and emission sources, but it is also where significant action is taking place to reduce emissions, for example through local government efforts. In order to introduce measures, government will want to see results, and that requires information at the relevant scale. There is an enormous amount of technology innovation occurring in cities regarding the creation of smart cities, new transport systems and renewable energy technologies. It makes sense, therefore, for top-down emissions estimation to focus on cities.

In addition, monitoring of GHG emissions can happen in parallel with that of air pollution, given that they often share the same sources. The panel suggested that this monitoring approach will allow for more coordinated efforts at dealing with air pollution and GHGs, helping to achieve co-benefits for both areas. By improving the accuracy of GHG measurements, the need to adjust the energy and industrial structure of China's economy will become even clearer, focusing attention on reducing coal consumption rather than simply treating pollutants with filters etc. This will inevitably have a positive impact on air pollution.

The panel discussed the costs associated with the technology required for these innovative approaches. **While the upfront cost for instruments may be high, the programs are not expensive over the long-term. Internationally, low-cost sensors are increasingly being utilized which bring a lot of information at relatively low cost.** In countries such as Norway, individual residents are also invited to build their own measuring stations, increasing data availability for scientists. This bring multiple benefits, including increased interest in science, especially among young people. Low-cost sensors for air quality are very common in Beijing, and perhaps this may expand to the use of carbon sensors in the future. Such technology is under development in China.

The panel expressed the view that, regardless of cost, the new approach to monitoring can help to improve accuracy where real world emissions do not match closely with the boundaries of the existing inventory method. This can be especially useful in areas such as agriculture for example.

An example was shared regarding the scientific assessment of the Montreal Protocol, in relation to Ozone Depleting Substances (ODS). One of the ODS is carbon tetrachloride (CCl_4), for which there was a very large imbalance between the source and sinks globally, meaning that the top-down and bottom-up approaches did not match. Scientists from around the world worked together on this issue. In China, it was found that the top-down estimates of CCI_4 were three times higher than the inventory approach. So, the CMA undertook top-down mapping of emission sources, identifying some places with concentrated emission sources which were not captured by the models. Working together with those responsible for the inventories, samples were taken of some factories that found a huge level of emissions. Similar findings were made in Europe and the US, which were not supposed to be producing CCI_4 but were in practice. The panel suggested that both approaches may have error, and this shows that the bottom-up and top-down approaches need to work together to resolve the uncertainty.