Direct Flux Mapping: Towards Impartial and Scalable Atmospheric Measurement, Reporting and Verification

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Background/Objectives. At the 2021 Glasgow Climate Summit, the US committed to reducing net greenhouse gas emissions by 50-52% below 2005 levels in 2030. In addition to decarbonizing the US economy, two principal carbon sequestration sectors are envisioned for implementing this commitment: intensive abiotic sequestration such as Battelle's Carbon Capture, Utilization and Storage (CCUS) and extensive biotic sequestration such as Nature-based Climate Solutions (NbCS). Measuring, reporting and verifying (MRV) the true climate benefits across these mitigation actions is a pivotal challenge that requires balancing robustness and scalability. Here, we explore a dialogue between academia and industry in pursuit of an impartial MRV across carbon sequestration sectors, scale, regulatory requirements, and acceptable level of uncertainty. Key applications include: industry leak detection such as for CCUS; NbCS and precision agriculture; biophysical and permafrost feedbacks; emission inventory validation and urban air quality.

Approach/Activities. Eddy-covariance flux towers provide one of the few direct observations of net carbon, water, and heat exchanges between the earth's surface and its atmosphere. This has led to their advent as the de facto gold-standard for basic research in hectare-scale urban and natural settings such as at National Ecological Observatory Network sites. Flux towers also address existing regulatory requirements such as for CCUS near-surface atmospheric monitoring to detect potential CO_2 release, e.g. California Air Resource Board Low Carbon Fuel Standard. However, the rich information provided by flux towers is rarely accessible to market-ready MRV, owing to cost and complexity in data interpretation. Here, we present progress towards turnkey Direct Flux Mapping that overcomes these historical challenges through interfacing flux towers with simultaneously available ground-based, airborne and spaceborne observations. These patent-pending, space- and time explicit systems and methods aim to harness the benefits and overcome the limitations of the individual observational assets.

Results/Lessons Learned. Direct Flux Mapping produces carbon, water and heat flux maps at half-hourly and decameter resolutions over 1 km^2 to 100 km^2 mitigation project domains. The near-real time spatialization enables continuous MRV, precise problem tracking and resolution for underperforming locations, and ultimately provides robust information for mitigation action. An initial sensitivity study shows that Direct Flux Mapping can reduce the MRV cost per unit area by at least one order of magnitude compared to current industry practices. Implementing such cost savings can increase the accessibility and economic attractiveness of carbon sequestration, and accelerate widespread adoption. We expect to further specify Strengths, Weaknesses, Opportunities and Threats (SWOT) from applying EODAS to the CHEESEHEAD19 (https://doi.org/10.1175/BAMS-D-19-0346.1) 100 km^2 high-density dataset.