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On the determination of the carbon balance of continents (Vladimir Ivanovich Vernadsky Medal Lecture)

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The carbon balance of regions, the size of continents, can be determined, albeit with significant uncertainty, by combining several bottom up and top down methods. The bottom up methods use eddy covariance techniques, biometric inventory measurements and modeling, while the top down methods use atmospheric observations and inverse models.

There has been considerable progress in the last few years in determining these balances through more or less standard protocols, as highlighted for instance by studies of the REgional Carbon Cycle Assessment and Processes (RECAPP) project of the Global Carbon Project. Important areas where uncertainty creeps in are the scaling of point measurements in the bottom up methods, the sparseness of the observation network and the role of model and other errors in the inversion methods.

Typically these balances hold for periods of several years. They therefore do not resolve the impact of anomalies in weather and climate directly. The role of management in these balances also differs for different continents. For instance in Europe management plays a strong role in the carbon balance, whereas for the Russian continent this is less important. Management in the European carbon balance may potentially override climatically driven variability. In contrast, for Russia, the importance of the role of forest is paramount, but there the vulnerability of the Arctic regions and permafrost is a key uncertainty for future behaviour.

I hope to show the importance of these different aspects of the terrestrial carbon balance by comparing the two continents, and also discuss the significant uncertainty we still face in determining the carbon budgets of large areas. I will argue that we need to get a clearer picture of the role of management in these budgets, but also of the time variability of the budgets to be able to determine the impact of anomalous weather and the vulnerability in a future climate.