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## High off-season nitrous oxide emissions negate potential soil C-gain from cover crops in boreal cereal cropping

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Enhancing carbon storage in managed soils through increased use of cover and catch crops in cereal cropping is at the heart of a carbon-negative agriculture. However, increased C storage by additional biomass production has a nitrogen cost, both in form of increased N fertilizer use and by potentially increasing nitrous oxide (N<sub>2</sub>O) emissions when cover crops decay. Frost-sensitive, N-rich aboveground biomass may be a particular problem during wintertime, as it may fuel off season N<sub>2</sub>O emissions during freezing-thawing cycles, which have been shown to dominate the annual N<sub>2</sub>O budget of many temperate and boreal sites. Here we report growing season and winter N<sub>2</sub>O emissions in a plot experiment in SE Norway, testing a barley production system with seven different catch and cover crops (perennial and Italian ryegrass, oilseed radish, summer and winter vetch, phacelia and an herb mixture) against a control without cover crops. Cover crops were either undersown in spring or established after harvesting barley. While ryegrass undersown to barley marginally reduced N<sub>2</sub>O emissions during the growing season, freeze-thaw cycles in winter resulted in significantly larger N<sub>2</sub>O emissions in treatments with N-rich cover crops (oilseed radish, vetch) and Italian ryegrass. N<sub>2</sub>O budgets will be presented relative to aboveground yield and quality of cover crops and compared to potential soil organic carbon gains.