

N₂O Emissions from Application of Fertilizers in Agricultural Soils

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Background

Need to quantify and reduce amount of N₂O emissions and uncertainty around estimates of agricultural N₂O emissions at multiple spatial and temporal scales

Accurate assessments of annual N₂O budgets need detailed, event-related N₂O flux measurements to calibrate and validate biogeochemical models for prediction of daily, seasonal, and annual N₂O emissions from agriculture.

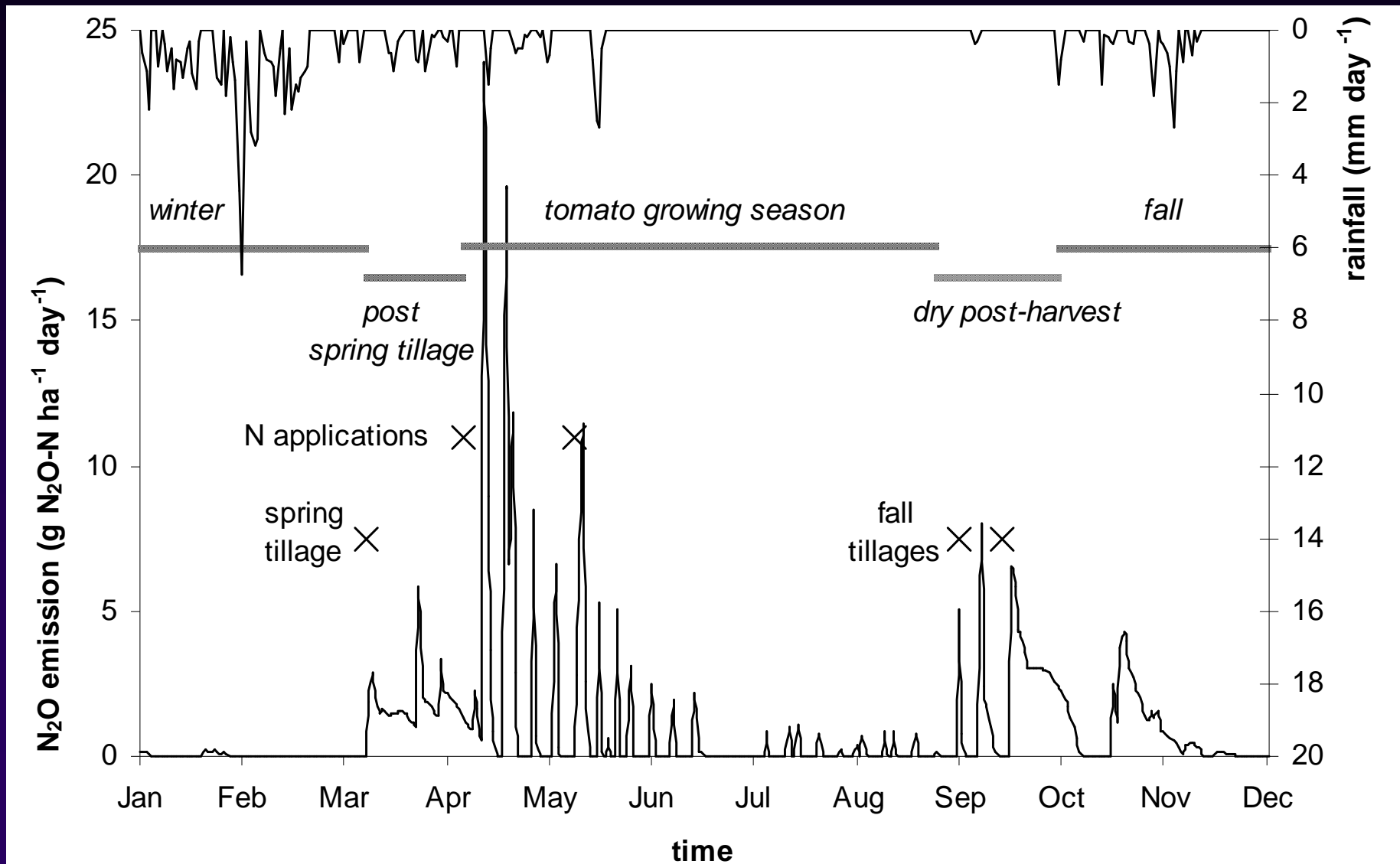
Objectives

To combine event-related N₂O measurements at multiple spatial and temporal scales with field information and soil measurements to develop a database ideal for calibration and validation of biogeochemical models used to estimate GHG budgets of current and future conventional and alternative CA cropping systems.

Tasks

- 1) determine detailed time series of N₂O fluxes and underlying factors at crucial management events (irrigation, fertilization, etc.) in representative agroecosystems in California.
- 2) assess N₂O emissions at the spatial scale of farmer management
- 3) use the intensive and extensive data on N₂O fluxes to initialize the calibration and validation of DNDC.

N₂O emissions: highly variable

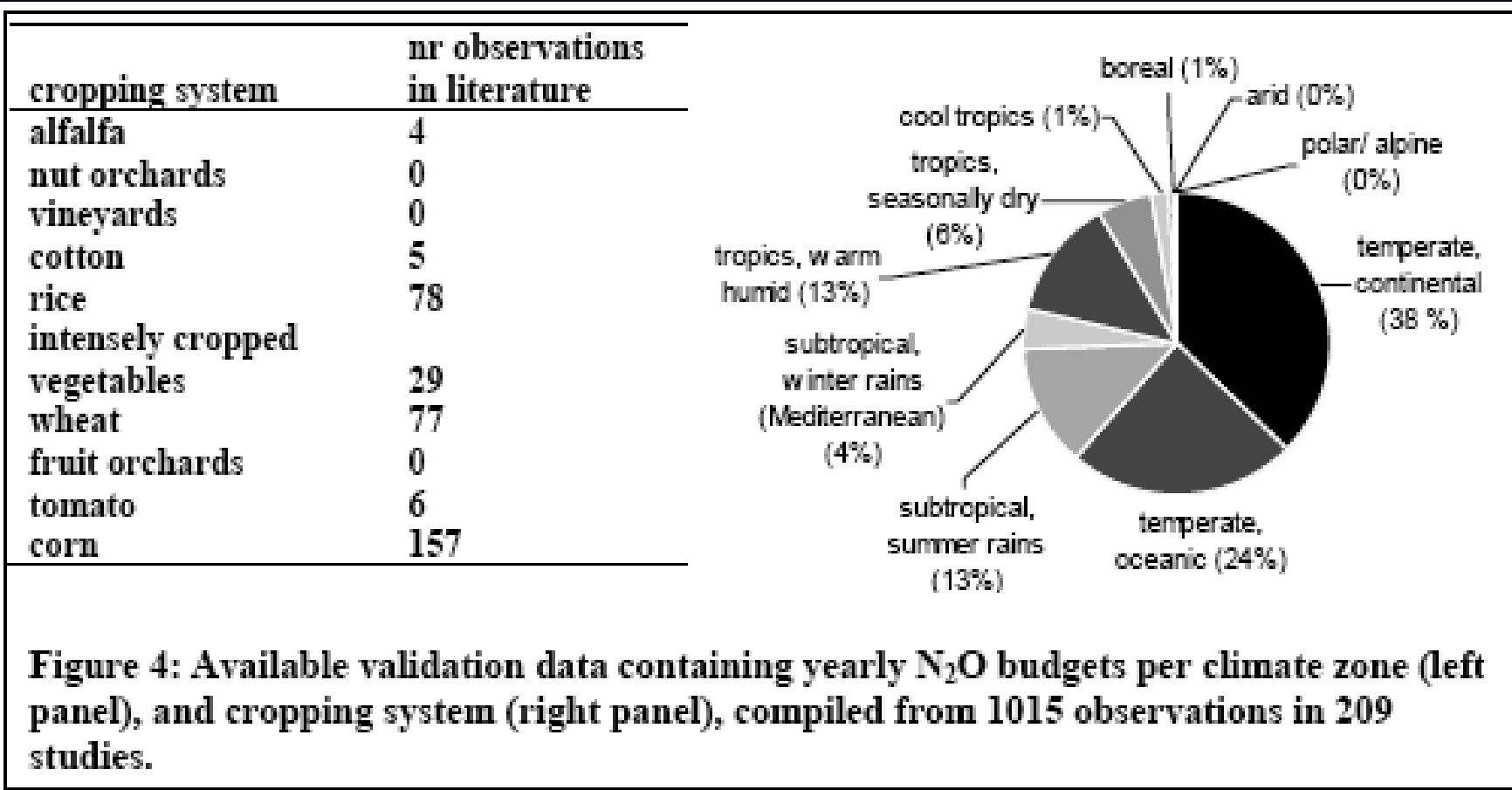


Ranking of California crops

Table 2: California's 10 most important crops, area wise, and their economic value (California Department of Food and Agriculture)

area rank	crop	area (1000 acres)	economic value (\$million)	economic rank
1	hay (mainly alfalfa)	1550	1141	6
2	nuts (almonds, walnuts and pistachios)	900	3454	1
3	grapes	800	3166	2
4	cotton	657	625	11
5	rice	526	408	13
6	intensely cropped vegetables (lettuce, broccoli, carrots, celery, and peppers)	496	2920	3
7	wheat	369	104	>15
8	fruit trees (oranges, plums, lemon, peaches)	359	1292	5
9	tomatoes	307	942	9
10	corn	110	52	>15

Status of N₂O budgets



Note: Since proposal writing, one paper on vineyards has been published: Steenwerth & Belina. 2008. Applied Soil Ecology 40:370-380.

Field sites

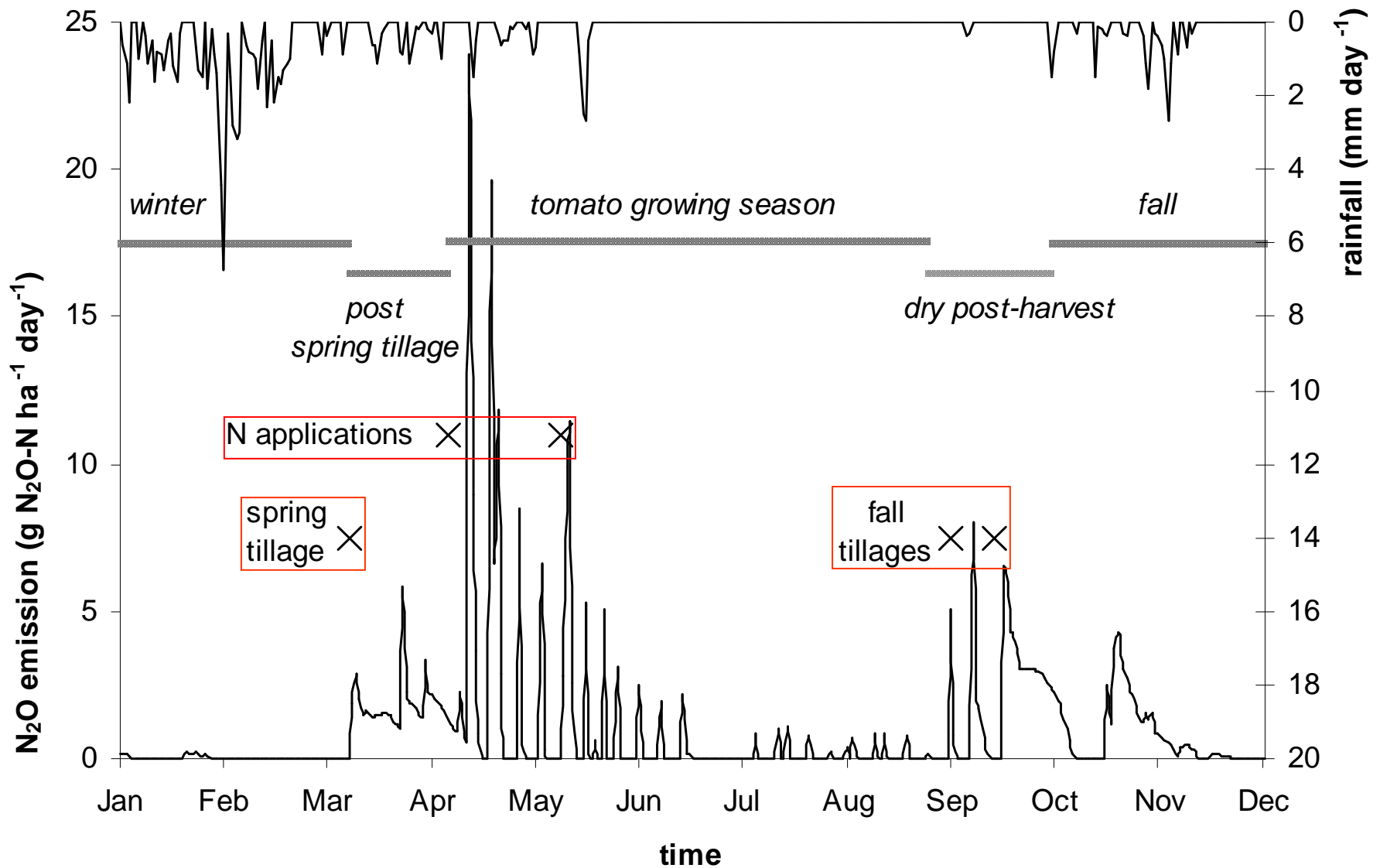
Russell Ranch--University of California research farm for controlled field experiments in tomato/wheat systems (5 fertilizer rates)

Farmers fields--alfalfa (2X), orchards (2X), vineyards (2X), corn (1X) and vegetables (1)

Sampling for gas fluxes will be:

- **event-related: continuous measurements (1 wk) after critical events such as irrigation, fertilization**
- **non event-related: 10 manual measurements**

N₂O monitoring requires targeted measurements



Chamber measurements

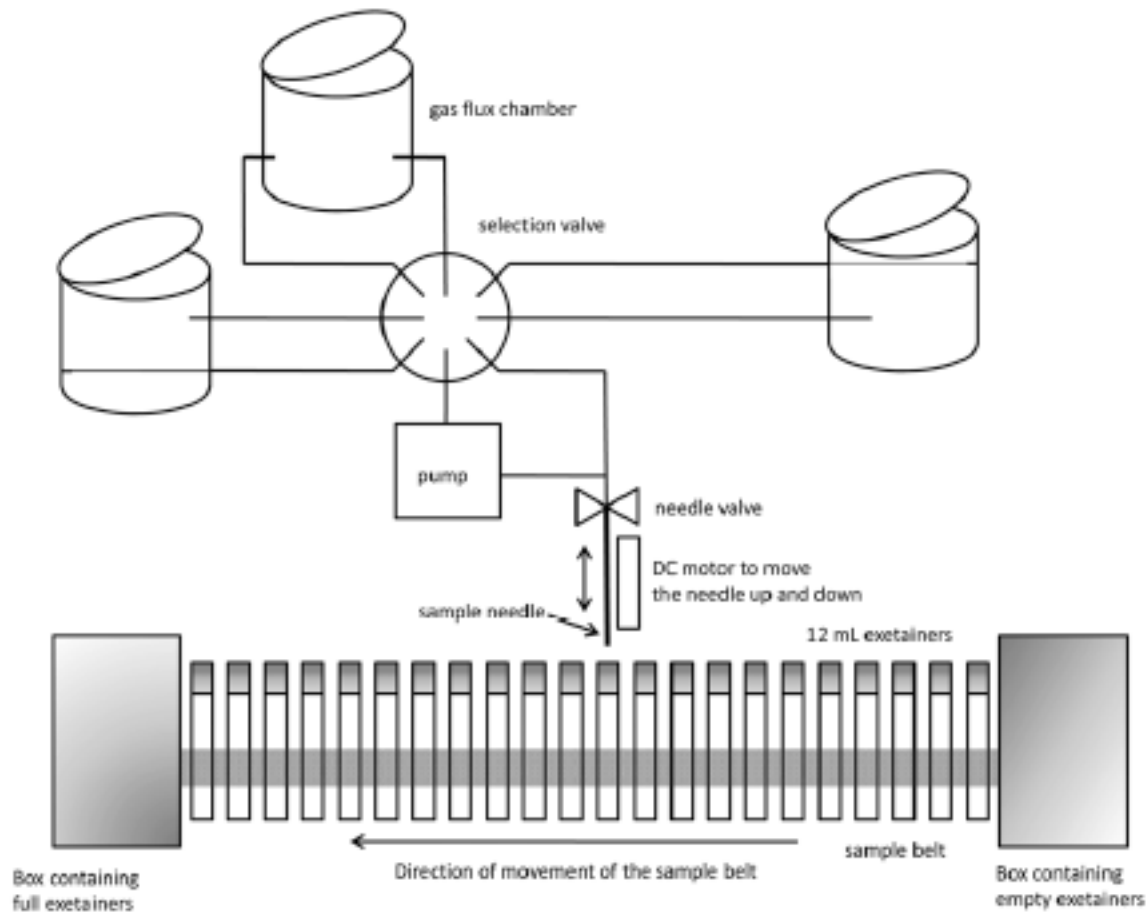


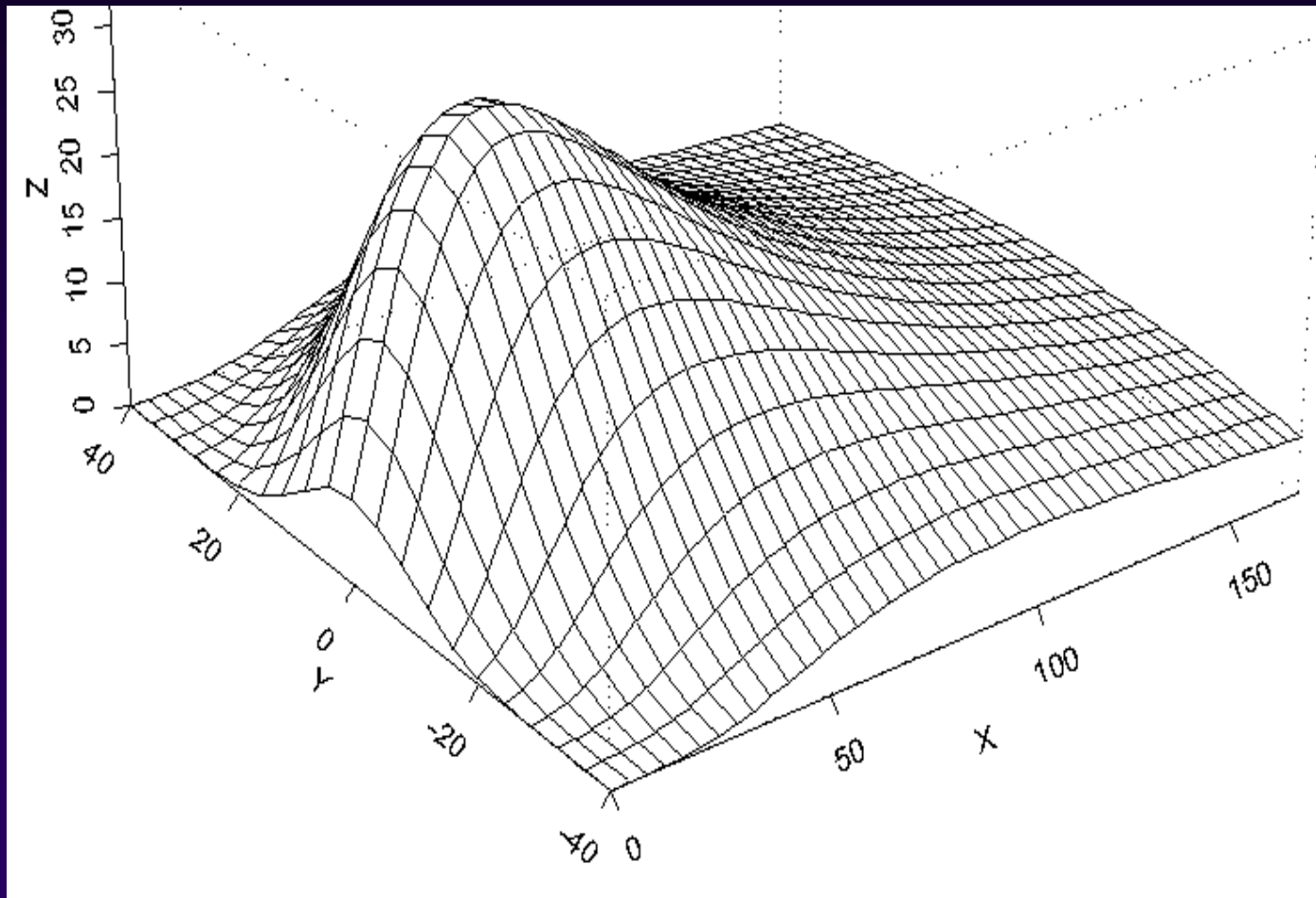
Figure 6: Drawing of the proposed mobile gas autosampler for continuous measurements in the field

Continuous measurements for event sampling with 3 reps

Manual measurements for non-events with 6 reps

Eddy covariance (TDL / QCL)

N_2O flux footprint



100 to 10,000
 m^2
resolution

30 min
sampling freq

Yr 1: 2 fields
Yr 2: 4 fields
combined with
chambers

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LBL

Modeling

DNDC model includes:

- **soil climate, plant growth and decomposition sub-models**
- **biogeochemical process sub-models**

Calibration and validation of the soil water and N cycle module

Model will then be used for scenario and trade-off analyses of potential ag practices to minimize GHG emissions

Collaborations and cost-sharing

- *Evaluating the Potential for California Almond Orchards to Sequester Carbon and Mitigate Greenhouse Gas Emissions and Conservation Tillage of Cover Crops as a Means of Improving Carbon Storage in California Vineyard Soils and Mitigating GHG Emissions:* The Almond Board of California (ABC), the American Vineyard Foundation (AVF), the California Competitive Grants Program for Research in Viticulture & Enology (CCGPRVE) and the USDA Viticulture Consortium (USDA VC) funds for preliminary N₂O emissions assessments to D.R. Smart.
- *Field carbon data collection for vineyard and orchard crops* funded by Natural Resources Conservation Service, to set up monitoring sites in orchards and vineyards to collect time series of soil C and production, with the immediate purpose of calibrating and validating the model for orchards and vineyards.
- *Assessing the Carbon Budget of Almond Trees and Developing a 3-D Computer Simulation Model of Almond Tree Architectural Growth and Dry Matter Partitioning.* Dr. T. De Jong and Dr. J. Six funded by Almond Board.
- Additional matching funds will be sought through the California State University (CSU) Agricultural Research Initiative (ARI). External grants can be matched up to \$150,000 per year for up to 3 years.
- The N₂O eddy covariance measurements are made possible for a minimal cost because the Lawrence Berkeley National Laboratory supported development of the instrument (\$115,000 for instrumentation and \$200,000 labor effort) for ammonia flux measurements. This proposal is hence leveraged by an approximately \$300,000 investment in instrumentation and intellectual capability.
- *Establish Baseline N₂O Emissions from Nitrogen Fertilizer use Based on Field-Derived California Specific N₂O Emission Factors* project, submitted to the California Air Resource Board (CARB) and California Department of Food and Agriculture (CDFA).
- Kearney Foundation of Soil Science
- Agricultural Sustainability Institute (ASI) Russell Ranch experimental farm