Determining NO_x Emissions from Soil in California Cropping Systems to Improve Ozone Modeling

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Objectives

- Measure NO_x flux in cropping systems of the Sacramento and San Joaquin Valley to provide CARB and the San Joaquin Air Pollution Control District with data that will be useful in improving the predictive capability of O_3 models.

- Study NO_x flux in response to nitrogen fertilization under varying soil moisture and air temperature conditions.

- Supplement on-going N_2O studies
  - ✓*All NOx monitoring sites co-located with N_2O*
  - ✓*Relationship of N_2O and NO_x: any correlation?*

Background

- Study requested by stakeholders
- Proposal reviewed by ARB and San Joaquin Valley Ag Tech Committee
- Significance
  - ✓ Precursor of tropospheric ozone
    - *Harmful to human health*
    - *Cause crop damage*
- Atmospheric process:
  - ✓ NO_x + volatile organic compounds (VOCs) + sunlight interact to generate O_3
  - ✓ NO_x controls O_3 formation if ratio of VOC/NO_x is high, e.g. in rural/ agricultural setting
- Currently no estimates of NO_x emissions from biogenic (non-anthropogenic) sources in the California Emission Inventory Development and Reporting System (CEIDARS)

Previous studies and this research

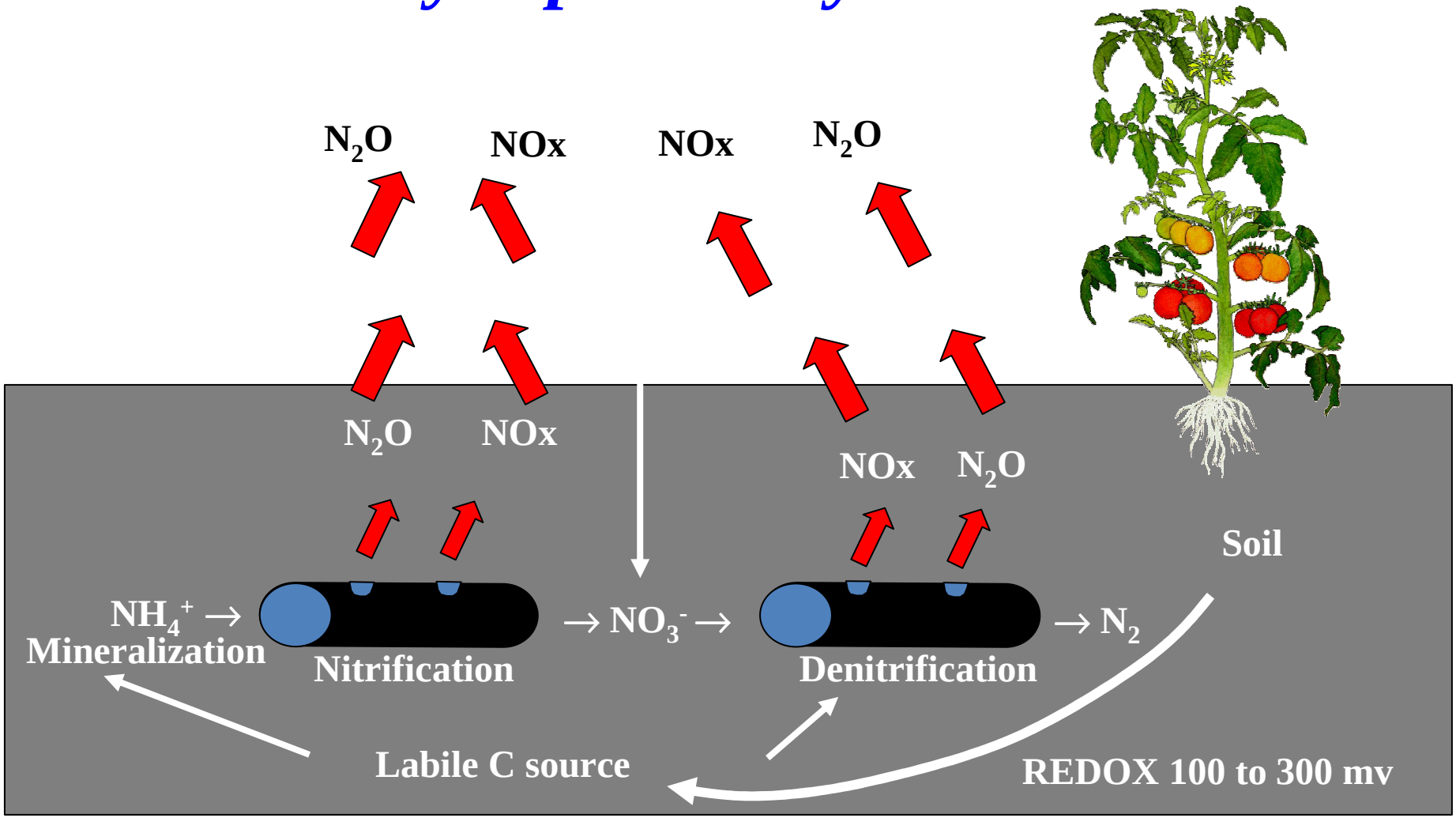
Matson Study (1997):

- NO_x was measured in isolation (sole gas monitored)
- Measurements mainly during middle to late summer, when O_3 concentration is generally highest
- Study design due to Eric Davidson (1991, 1993)

This Study:

- This study will measure N_2O and NO_x simultaneously (monitoring sites collocated)
- Focus on responses to fertilizer and lagoon water application
- Fertilizer applications take place mostly in spring and in early summer
- Rod Venterea's research showing the effect of ammonium on NO_x emission was done after 1995.

N_2O and NO_x Production and Emission - the "Leaky Pipe Theory"



Summary of Tasks

- Open to stakeholders' inputs anytime

- Main tasks:
  - ✓ Select sites for NO_x flux measurements
  - ✓ Measure NO_x flux in response to N fertilization
  - ✓ Assess influence of physical and chemical soil environment on NO_x emissions:
    - *Soil type*
    - *Crops/rotation*
    - *Soil moisture*
    - *Air temperature*
    - *Nitrogen species in soil (ammonium, nitrite)*
    - *Soil pH*
  - ✓ Report

Task 1. Site Selection

- Cropping systems:

Crop	Site	County
Tomato	UCD Research site	Yolo
Wheat	Grower field	Yolo
Alfalfa	Grower fields	Yolo
Corn	Dairy farms	Stanislaus
Almonds	Nickels orchard	Colusa

- Collocated with CARB-funded N_2O monitoring sites

Task 2. Measure NO_x Flux

- Measure flux during summer growing season

- Focus on N fertilizer and irrigation events
  - ✓*N fertilizer rates same as in CARB funded N_2O project*

- Method
  - ✓*Instantaneous analysis in the field*
  - ✓*Chemiluminescence NO_x - analyzer (LMA-3, Scintrex/ Unisearch, Concord. ON, Canada)*
  - ✓*Chamber is connected to analyzer via flow-through system*
  - ✓*Short chamber deployment time (2 to 5 min)*

Task 3. Environmental Variables

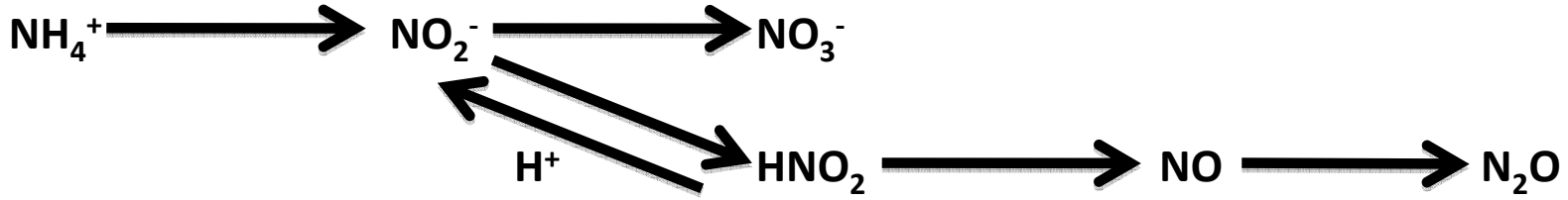
➢**Critical variables controlling NO_x flux**

✓ Soil ammonium (NH_4+) and nitrite (NO_2-) concentration:

Nitrification main process generating NO in soil

Correlation between NO_2- concentration and NO production

✓ pH: Controls formation of HNO_2 (NO precursor)



✓ Soil moisture:

- *Regulates ammonification & nitrification rates*
- *Increasing water-filled pore space increases N_2O production*
- *Soil water content controls diffusion of gases out of the soil*

Task 3 (continued)

- We will compare NO_x flux between plots fertilized at varying N rates at varied moisture content before and after irrigations

- Of particular interest:
  - ✓Ammonium-based fertilizers
  - ✓Plots fertilized with dairy lagoon water

Task 4. Report

- Quarterly progress reports
- Final report
  - ✓Summaries of NO_x flux data
  - ✓Comparisons between NO_x and N_2O emissions
  - ✓Discussion of effects of N fertilizer rates, N fertilizer types, moisture, pH, temperature on NO_x under field conditions
- Stakeholder review
- Research Screening Committee (RSC) review

Timeline (revised, 6 month delay in start time reflected)

Task 1: Select sites
Task 2: Measure NO flux
Task 3: Measure ancillary variables
Task 4: Prepare final report

2010	MONTH	1	2	3	4	5	6	7	8	9	10	11	12
TASK													
1													
2													
3													
4													

2011	MONTH	1	2	3	4	5	6	7	8	9	10	11	12
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2012	MONTH	1	2	3	4	5	6	7	8	9	10	11	12
TASK													
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Task 1 includes chamber modifications, equipment testing and trial runs