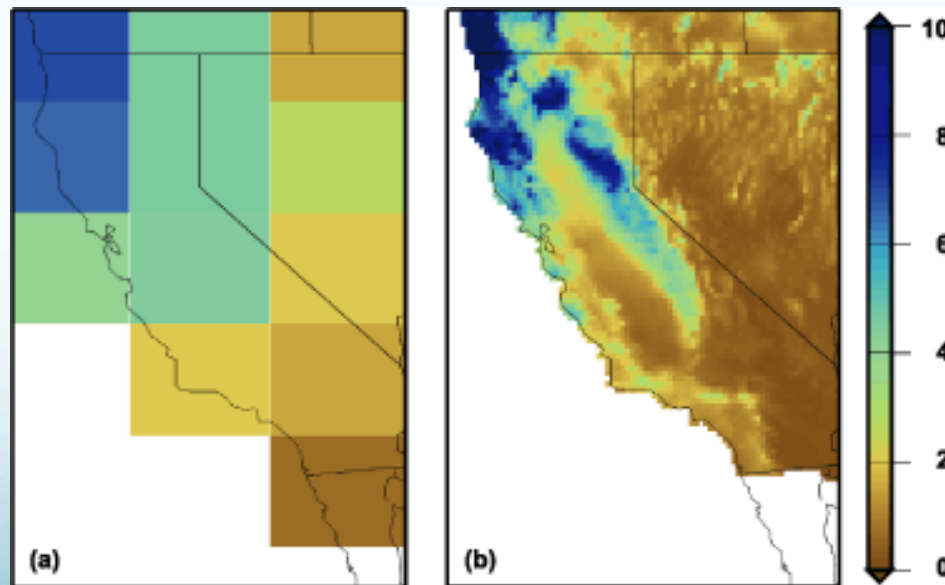


# Proposed Area of Excellence and Cluster Hire in Climate and Sustainability Studies

Walter Oechel (Biology; Co-Point of Contact),  
Samuel Shen (Math and Stats; Co-Point of Contact),  
Trent Biggs (Geography),  
Chun-Ta Lai (Biology),  
Matthew Lauer (Anthropology)

# Climate change is one of the major challenges of the century

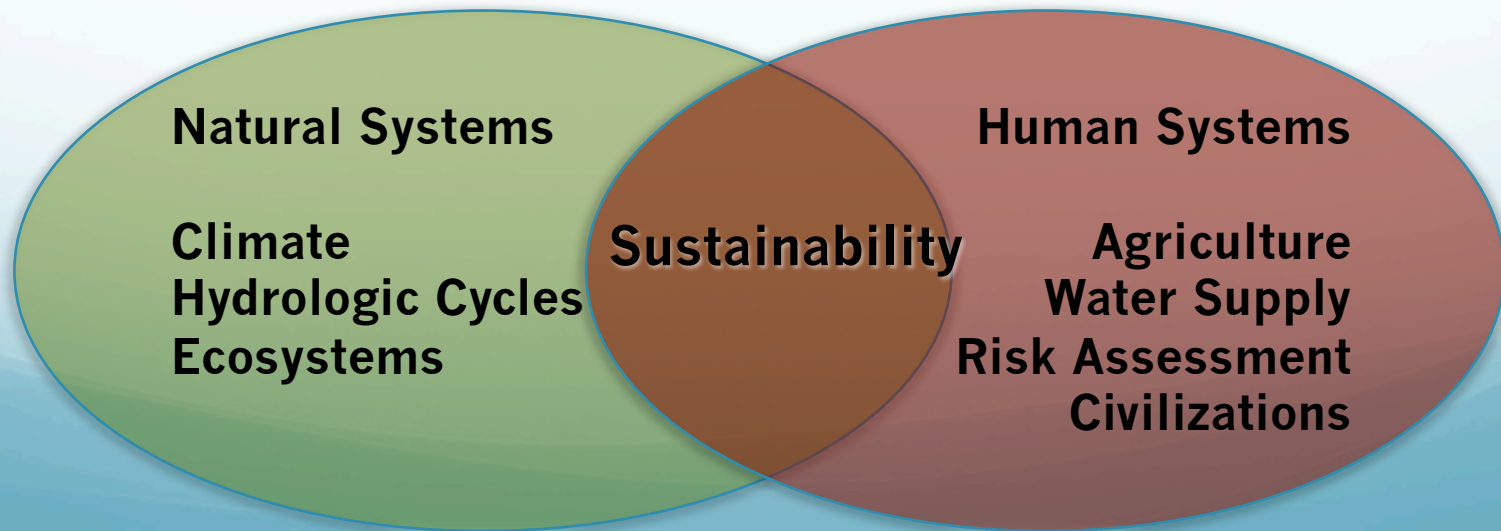
- We know that climate is changing, but we do not know the regional impacts.
- Appropriate scale is critical
- Current GCMs operate at a scale too coarse (50-100 kms) to inform policy and conservation.



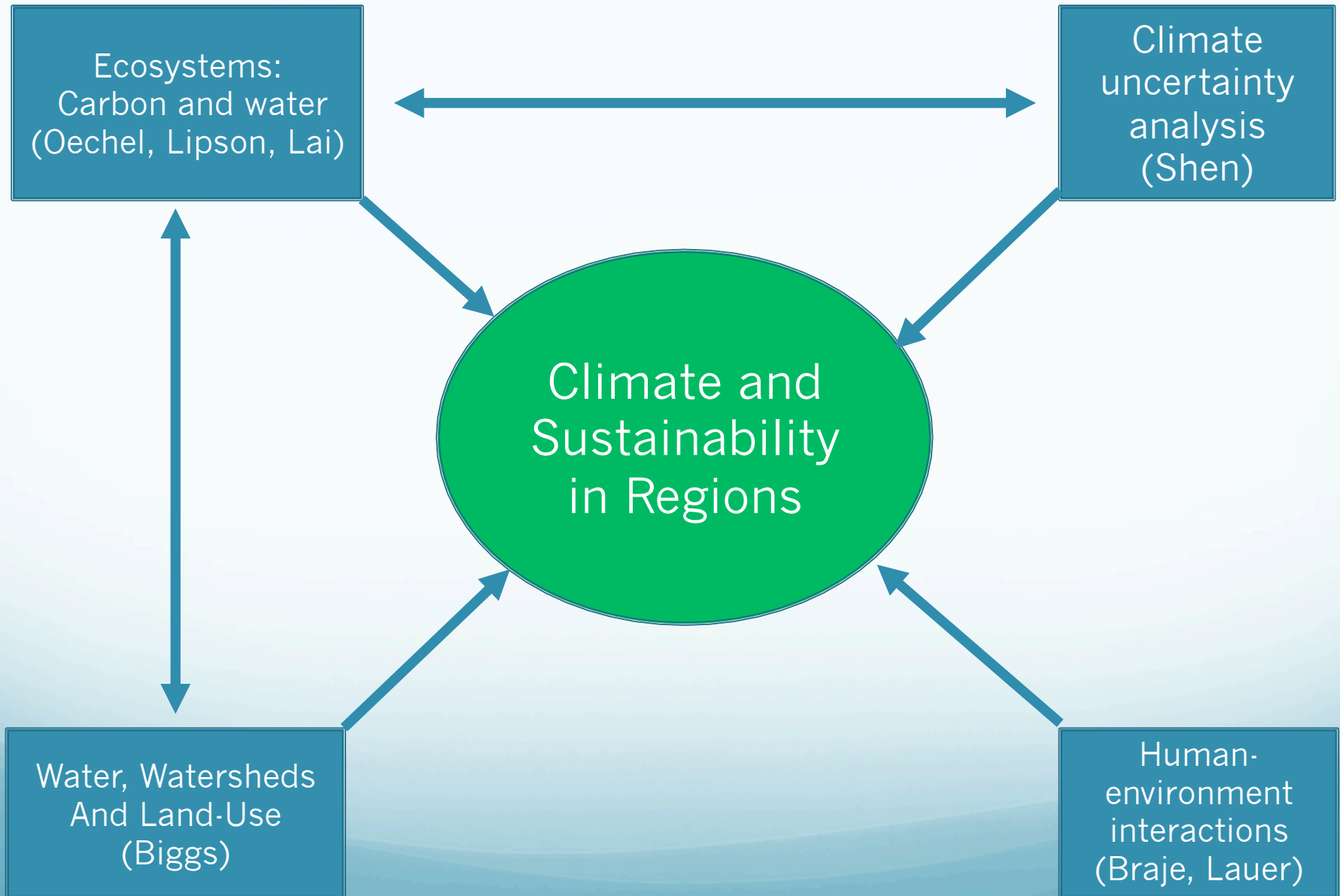
Simulated precipitation over California in 2070–2099 (mm/day)

# Objectives and Central Questions

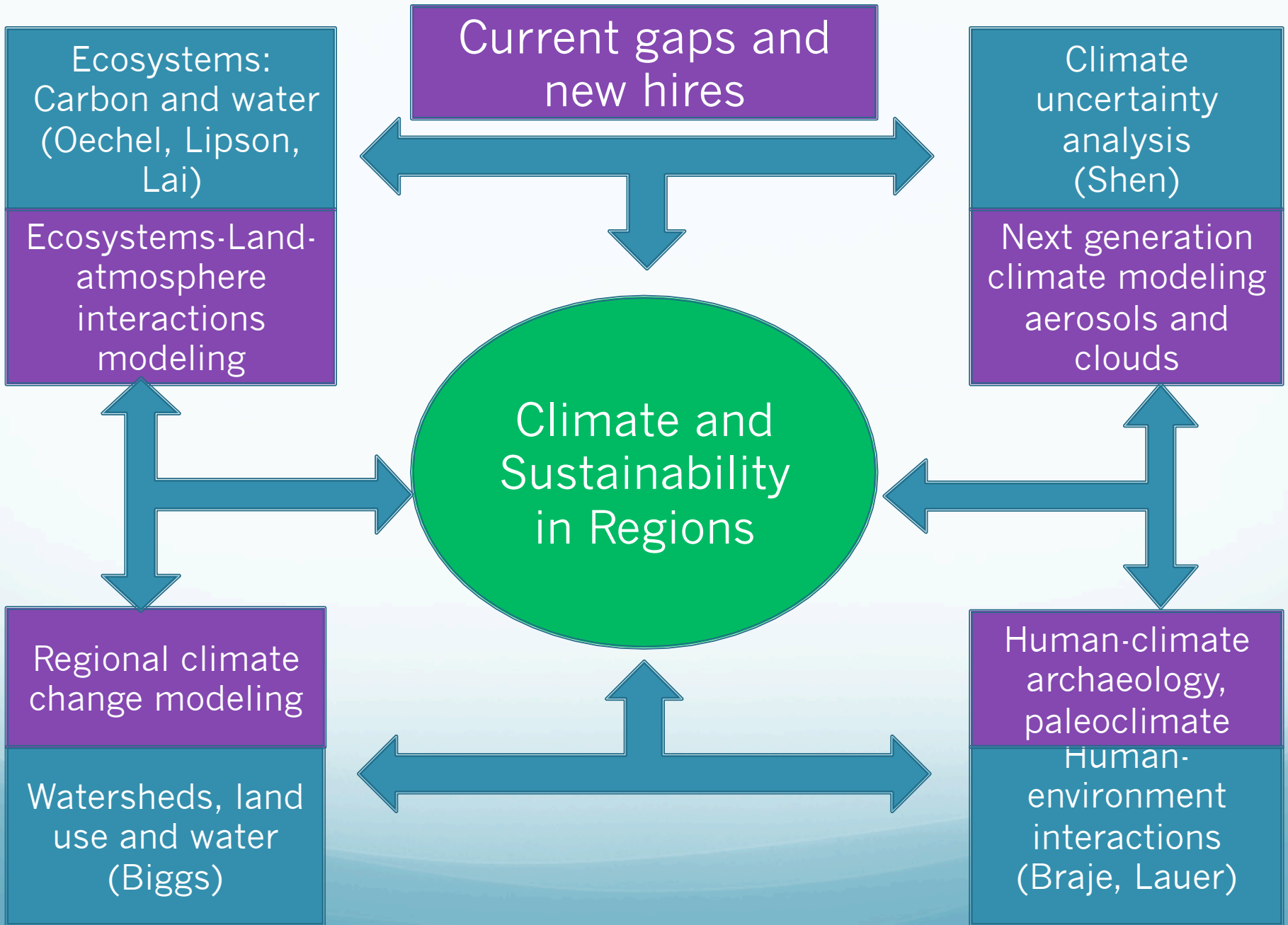
- **Objective:**
  - To become a world-class, interdisciplinary center in climate and sustainability studies.
- **Central questions:**
  - How will the climate change in specific regions?
  - How will ecosystems and humans be impacted by climate change?
  - How will ecosystems and humans feedback and impact climate change?



# Existing strengths and links



# Existing strengths and links



# Increased funding opportunities

The hires enable our group to build on current expertise and apply for substantial funding, such as:

- **NSF EaSM, IGERT, ARCSS**
  - (Earth system modeling program), \$2m for 5 years.
  - (Integrative Graduate Education and Research Traineeship Program) \$1.5 M for 5 years.
  - (Arctic System Science) \$2.0 for 5 years.
- **DOE Center Grant:**
  - **(Mathematical Multifaceted Integrated Capability Centers)**  
\$2.5m for 5 years
- **NASA Arctic ABoVE program** (Arctic-Boreal Vulnerability Experiment) \$2.2m for 5 years

**Goal: to double funding to \$5m/y**

# Communication and Coordination

**This Area of Excellence collaborates through a new Center for Climate and Sustainability Studies (C<sup>2</sup>S<sup>2</sup>) with:**

- **A Stakeholder and Expert Advisory Board to meet annually**
- **Steering Committee from C<sup>2</sup>S<sup>2</sup> faculty**
- **Monthly Seminars and hosting International conferences and meetings**
- **Monthly project meetings, frequent meetings on funding opportunities**
- **Joint supervision of Graduate Students (Ph.D. and M.Sc.)**
- **Support for SDSU Programs including the Sustainability Major and Environmental Sciences Major**

# C<sup>2</sup>S<sup>2</sup> will support SDSU's strategic plan of regional and international outreach

- **New: Stakeholder round table on climate and sustainability** (policy makers, regulators, NGOs, business, utilities, educators)
- **Enhance: Current K-12 Education.** (e.g. NSF, County Office of Education)
- **Enhance: Collaboration with CICESE in Ensenada, BC Mx** (Center for Scientific Research and Higher Education)
- **Enhance: The SDSU IRIP Program Development** (including with Mexico, Italy, France, U.K., and China) (International Research Internship Program)



# C<sup>2</sup>S<sup>2</sup>'s unique regional distinction

- Our goal is that C<sup>2</sup>S<sup>2</sup> be equal in reputation to, but distinct from, climate studies at Scripps Institution of Oceanography (SIO)
- We are distinct in the following areas:
  - Impacts of climate change on ecosystems
  - Ecosystem feedbacks on climate change
  - Uncertainty quantification of climate change
  - Risk assessment
  - Human-Climate Interactions

**In summary, C<sup>2</sup>S<sup>2</sup> will bring  
increased regional and international  
recognition to SDSU in the area of  
Climate and Sustainability Studies**

**and**

**Will solve critical issues facing humankind**




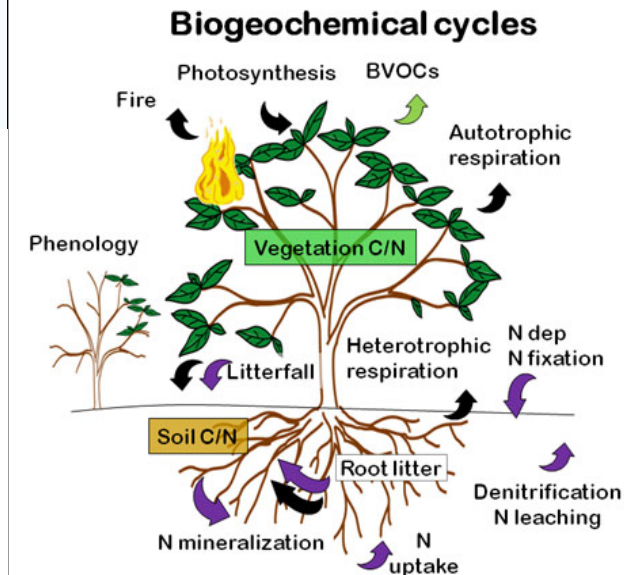
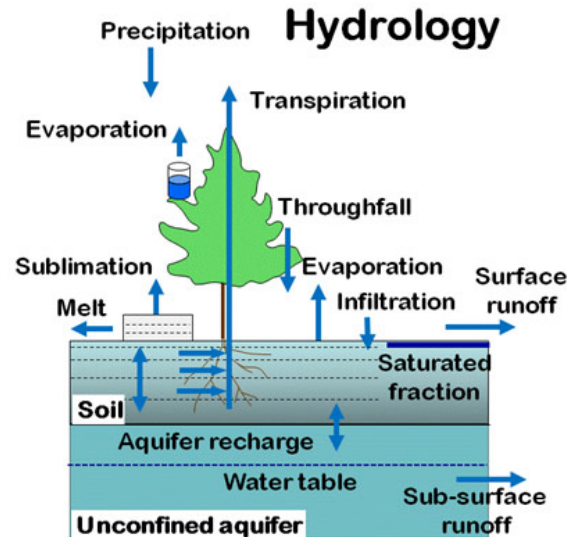
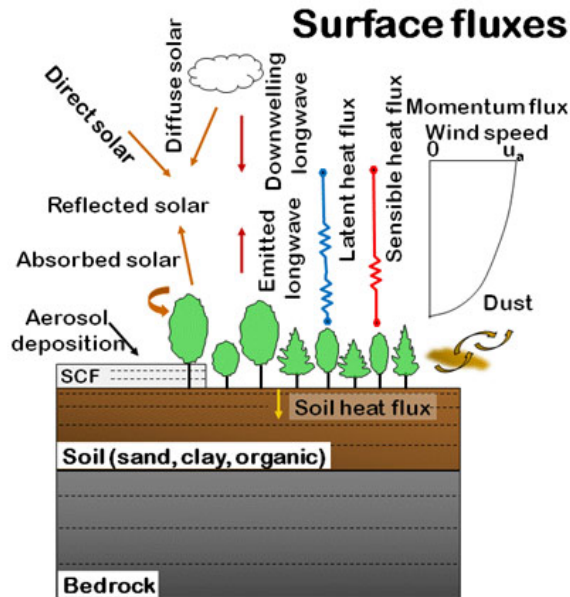
# Hire in Biology: Ecosystem Land Surface Modeler

- Use Regional Climate model output to predict
  - Greenhouse Gas Fluxes and Feedbacks
  - Vegetation, biodiversity, reserve areas
  - Water use and yield
  - Agricultural Productivity, incl. vineyards
- Highly desirable to funding agencies: including NSF, NASA, DOE, USDA

Surface Energy Balance

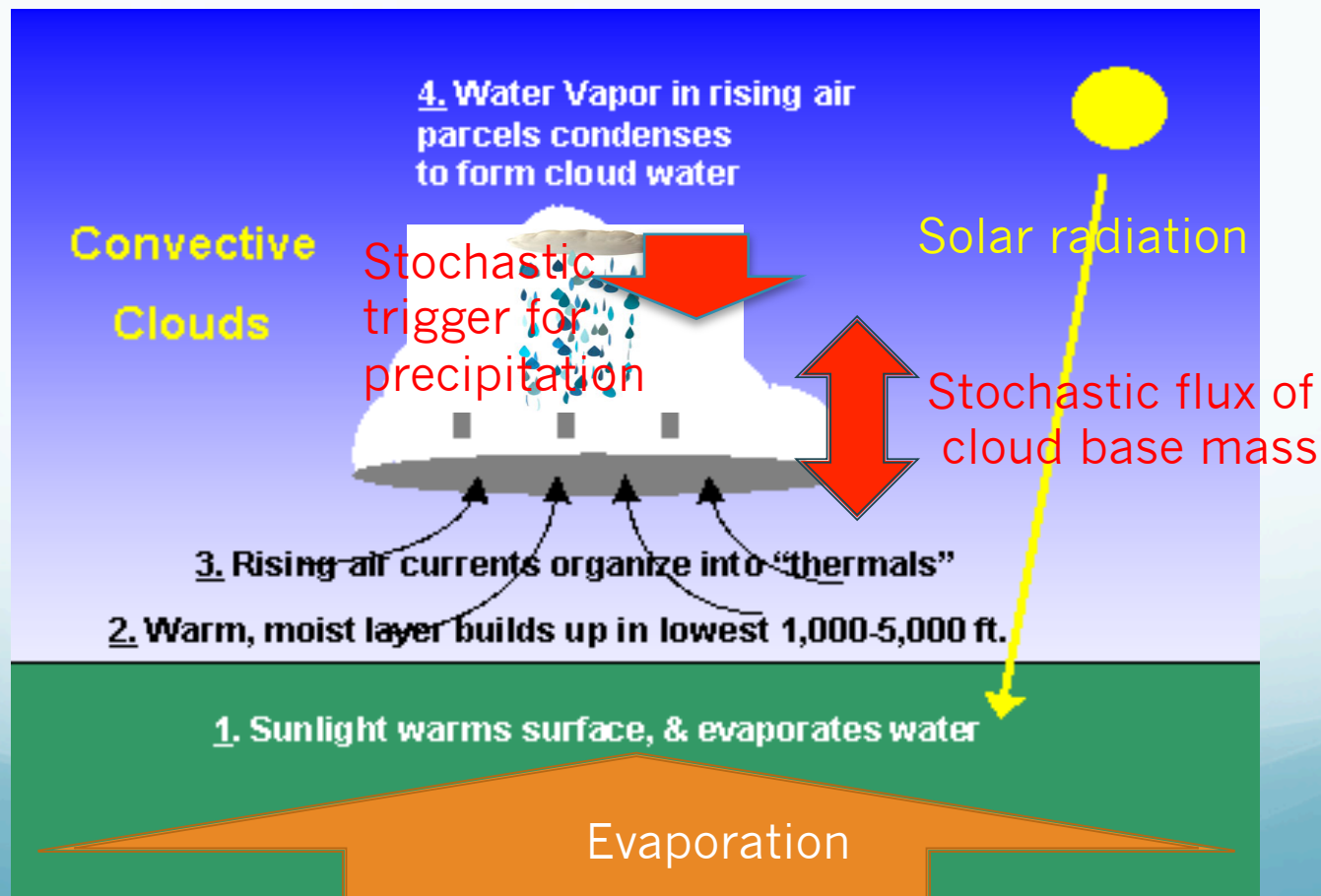
Water Yield, Drought

GHGs  
CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O

# Hire in Mathematics: Climate mathematician for the next generation of cloud-resolving models

- Random cloud, precipitation, and aerosol
- Uncertainty principle in climate models
- Ecological and human-climate dynamics
- NSF EaSM and DOE MMICC Center programs



# **Hire in Anthropology: Archaeologist of Human-Environmental Dynamics**



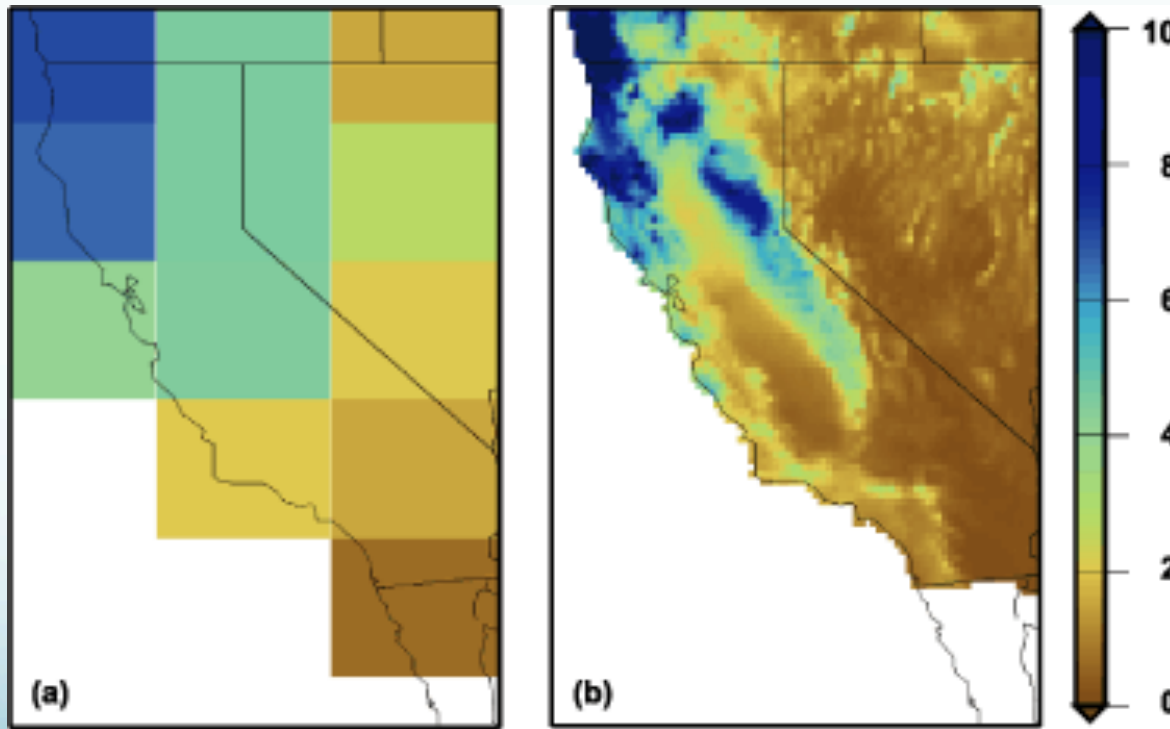
Maya Collapse

**Will Expand Anthropology with focus on:**

- **Ancient Human->Climate and Climate->Human impacts and Interactions**
- **Remote sensing, GIS modeling, isotopic analysis**
- **Examples of Human->Climate and Climate->Human Interactions and Feedbacks**
- **Funding: NSF Coupled Natural and Human Systems**

# Hire in Geography: Regional climate modeler

- Impact assessment requires regional climate simulations
  - Topography is important
  - Ocean-land interaction is important



Precipitation over California in 2070–2099 (mm/day) (Maurer, 2012)

# Potential Research Collaborations

Walter Oechel

C2S2

February 17, 2017



SAN DIEGO STATE  
UNIVERSITY



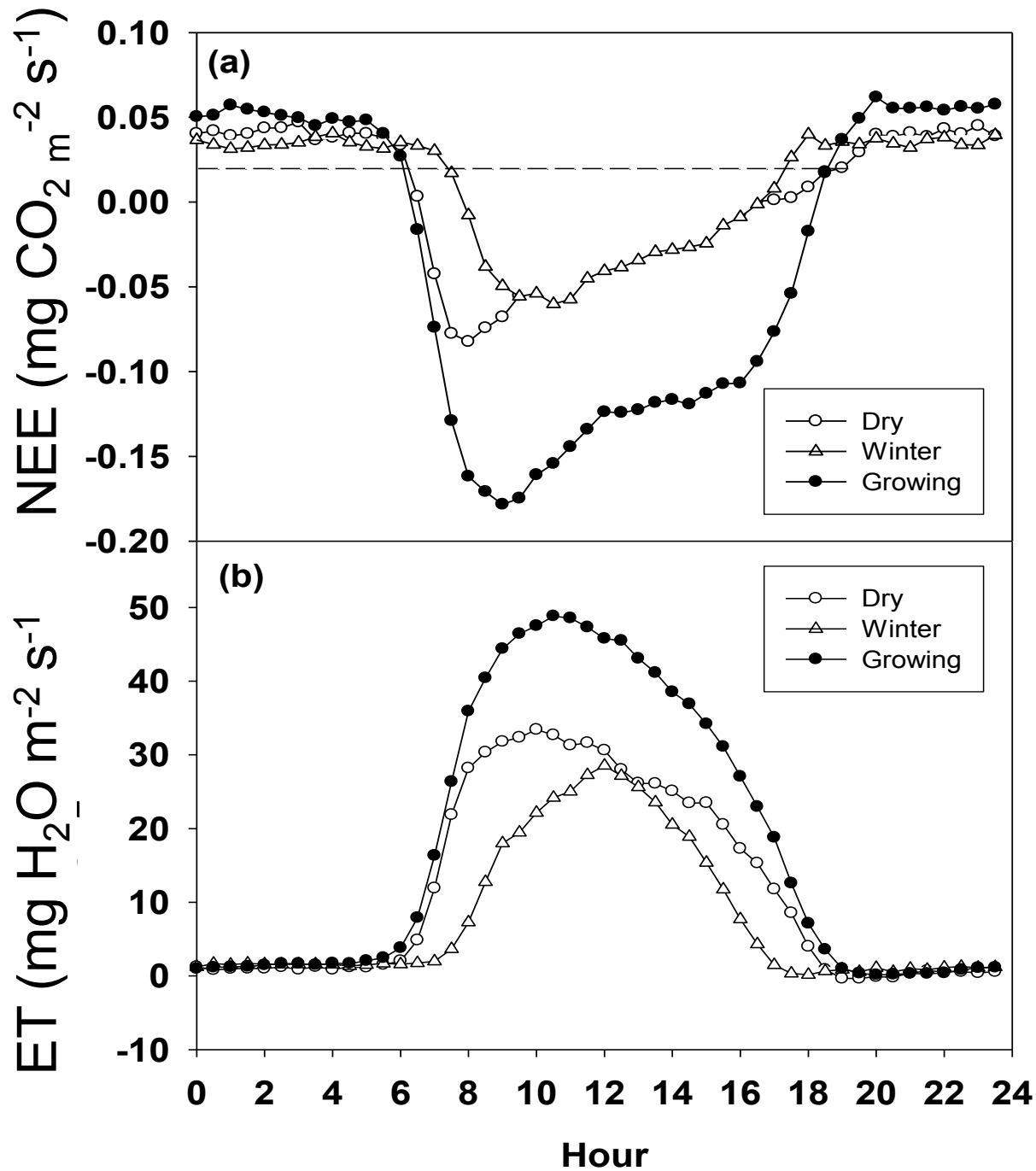


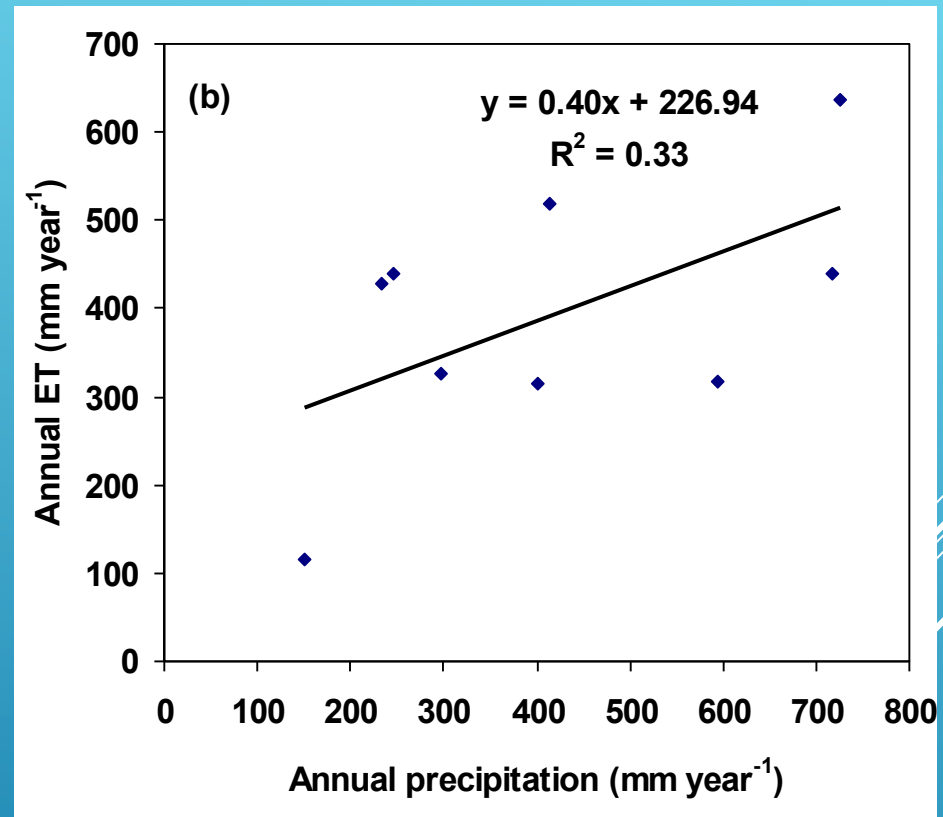
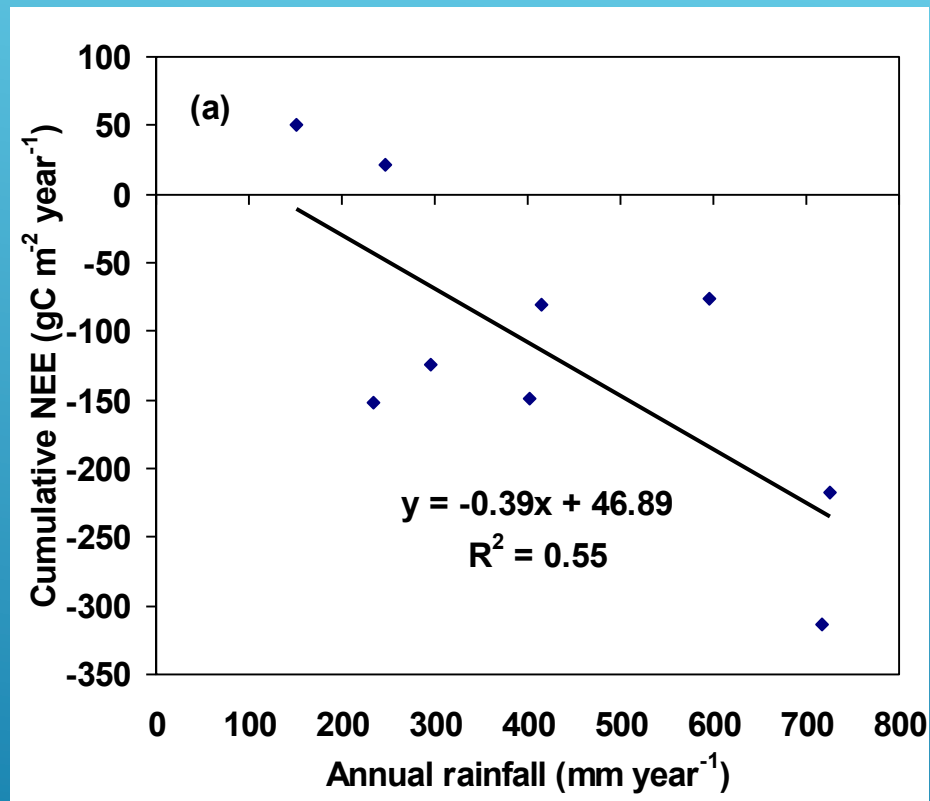




Sky Oaks Old Stand  
1997-Current  
(Burned 2003)

Continued in 2003 after the fire....

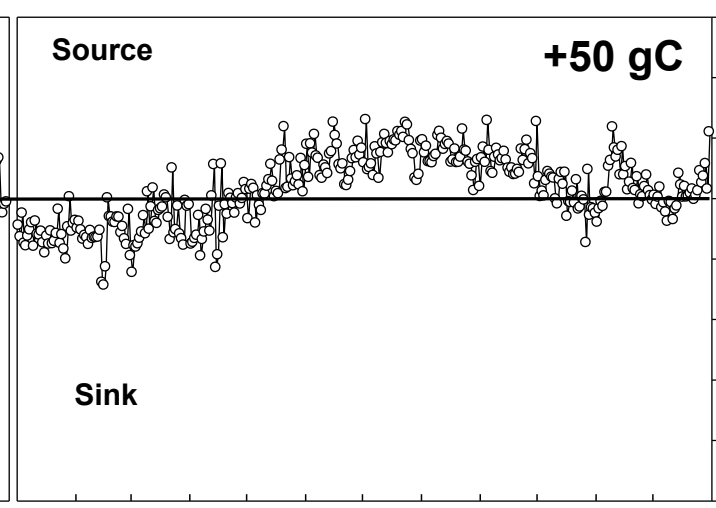
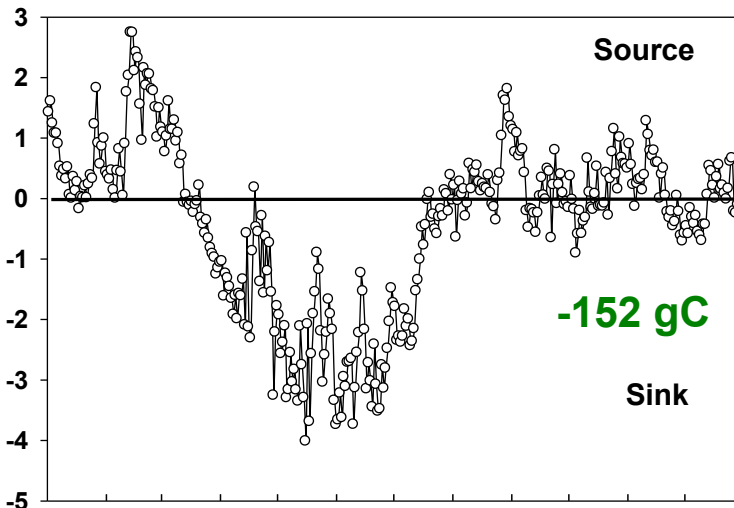




2000 (typical year)

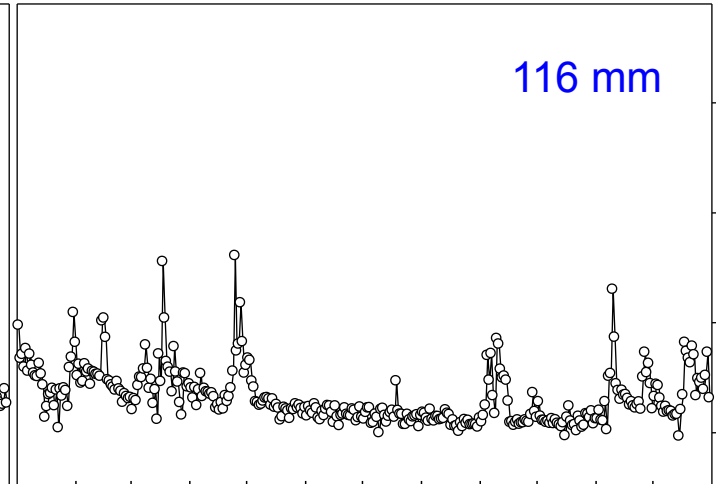
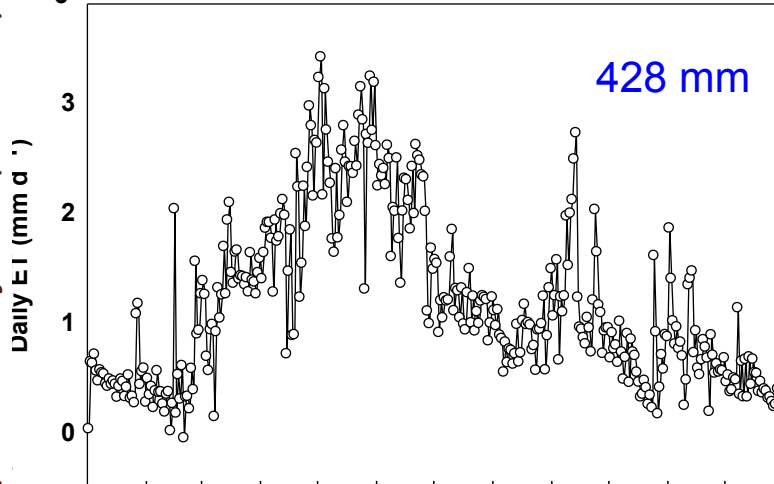
2002 (drought year)

Daily NEE ( $\text{gC m}^{-2} \text{d}^{-1}$ )



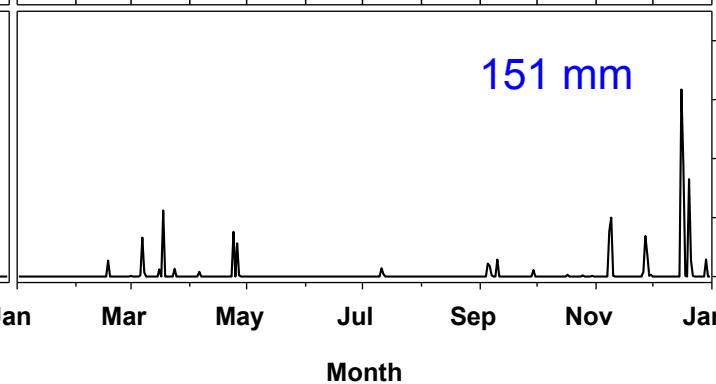
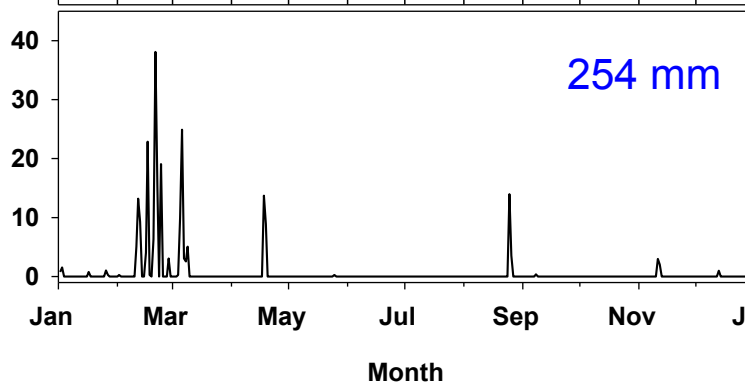
Daily NEE ( $\text{gC m}^{-2} \text{d}^{-1}$ )

Daily ET ( $\text{mm d}^{-1}$ )



Daily ET ( $\text{mm d}^{-1}$ )

Daily ppt ( $\text{mm d}^{-1}$ )

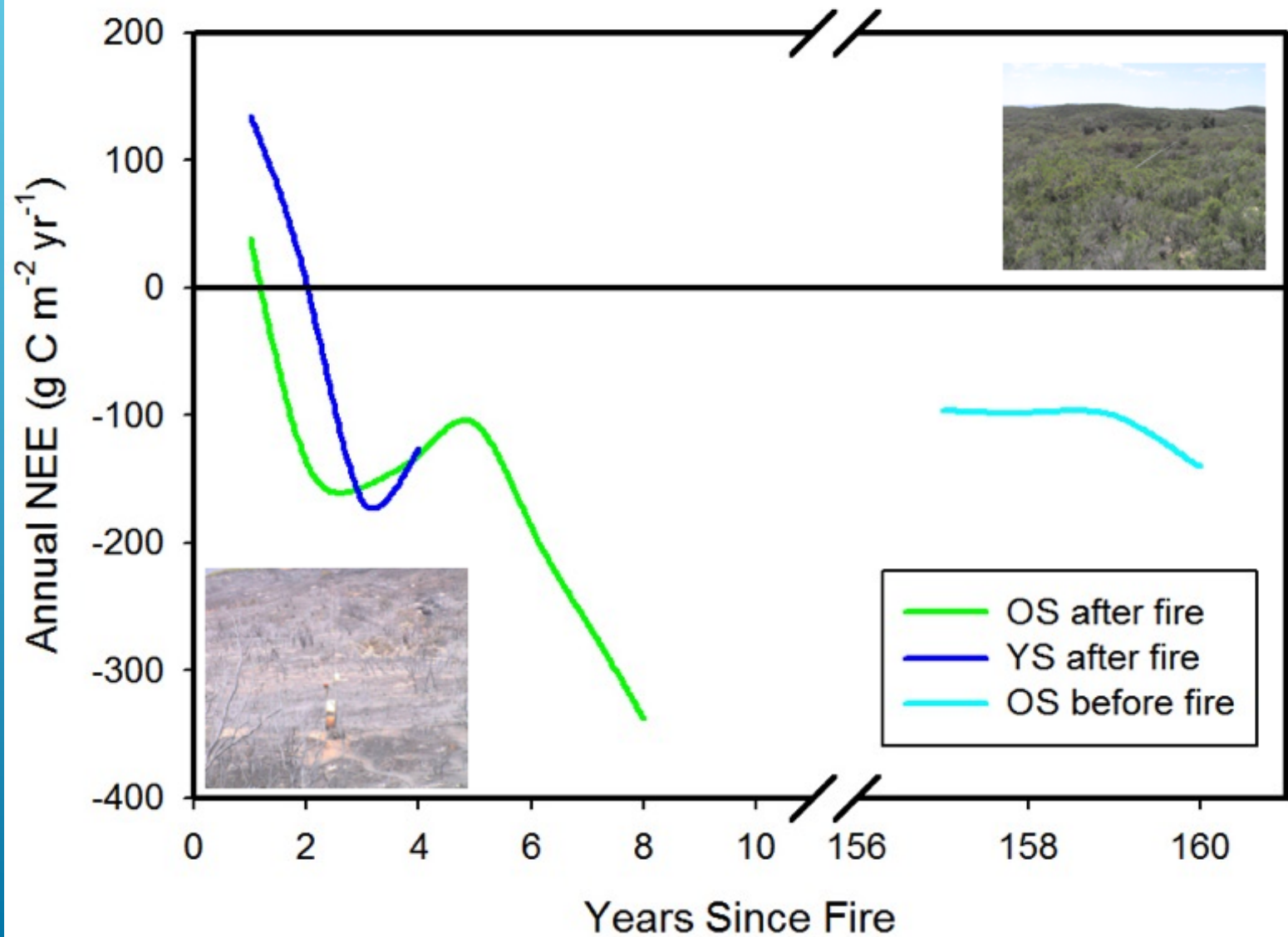


Daily ppt ( $\text{mm d}^{-1}$ )

Month

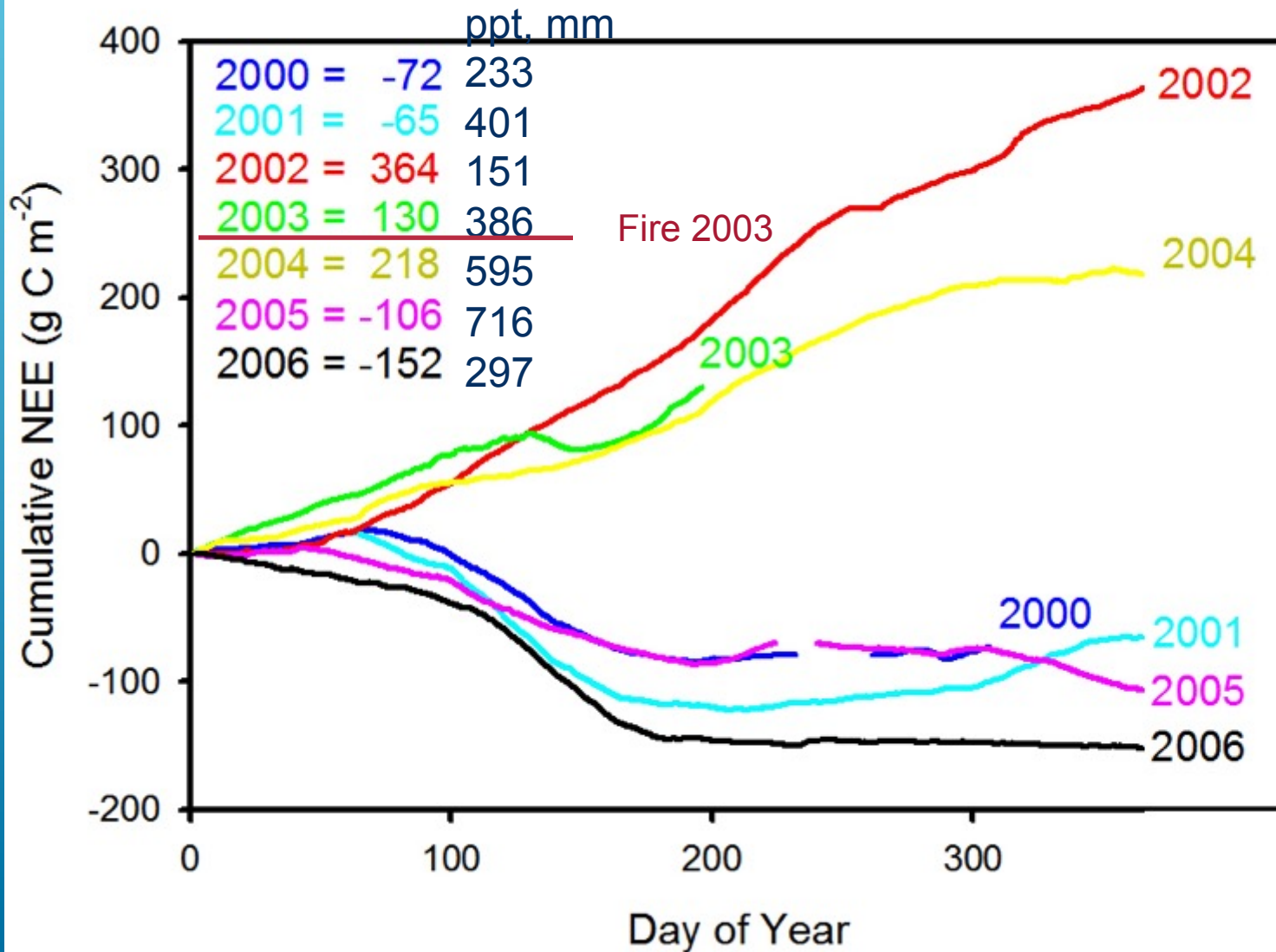
Daily precipitation ( $\text{mm d}^{-1}$ )

# Annual Chaparral NEE with time after fire



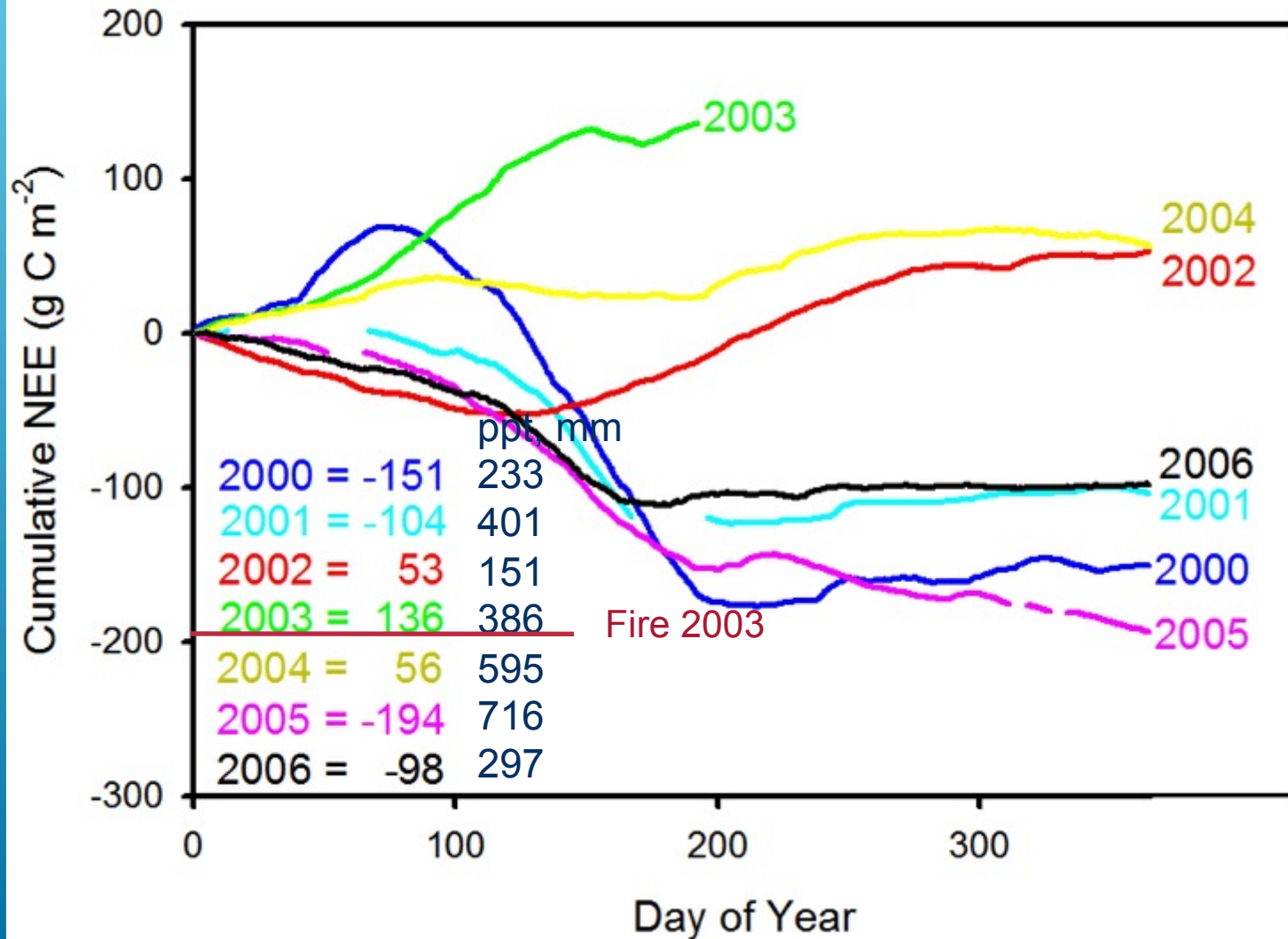


# Young Stand (0-8 years old) Cumulative CO<sub>2</sub> uptake 2000-2006





# Old Stand (> 150 years old) Cumulative CO<sub>2</sub> uptake 2000-2006



- ▶ Chaparral ecosystems are a significant CO<sub>2</sub> sink
- ▶ Old stands can be maintained for carbon sequestration and wildlife habitat
- ▶ Even though chaparral will periodically burn, it can still act as a net CO<sub>2</sub> sink.

TERRESTRIAL CARBON FLUX



- ▶ Decreased runoff
- ▶ Increased drought
- ▶ Increased wildfire frequency and/or intensity (Increased fuels, increased fire weather, increased climate variability (wet and then dry))
- ▶ Reduced utility of MSCP and conservation reserves (without major redesign)
- ▶ Decreased Biodiversity
- ▶ Increased summer monsoons
- ▶ Increased climate variability

## LIKELY REGIONAL OUTCOMES OF GLOBAL CHANGE



# EFFECTS OF ANTECEDENT PRECIPITATION, STAND AGE, AND FIRE ON THE RESPONSE OF ECOSYSTEM FUNCTIONING TO DROUGHT IN ARID AND SEMI-ARID ECOSYSTEMS OF NORTH AMERICA

Walter C Oechel<sup>1</sup>, Thomas Bell<sup>2</sup>, Kristen Freeman<sup>1</sup>, Beniaminio Gioli<sup>3</sup>, Hiroki Ikawa<sup>1</sup>, Aram Kalhori<sup>1</sup>, William Lawrence<sup>4</sup>, Patrick Murphy<sup>1</sup>, Alessandra Rossi<sup>1</sup>

<sup>1</sup>San Diego State University, United States of America; <sup>2</sup>University of California, Santa Barbara, United States of America; <sup>3</sup>IBIMET, CNR, Florence, Italy; <sup>4</sup>Bowie State University, United States of America



# LA PAZ



# La Paz Study Site Climate



- Hot Arid Climate
  - Köeppen' s Climate Classification System
- Average Precipitation
  - 176.1 mm with majority during late summer monsoon events
- Average Temperature
  - 23.6 °C with summertime highs >40 °C

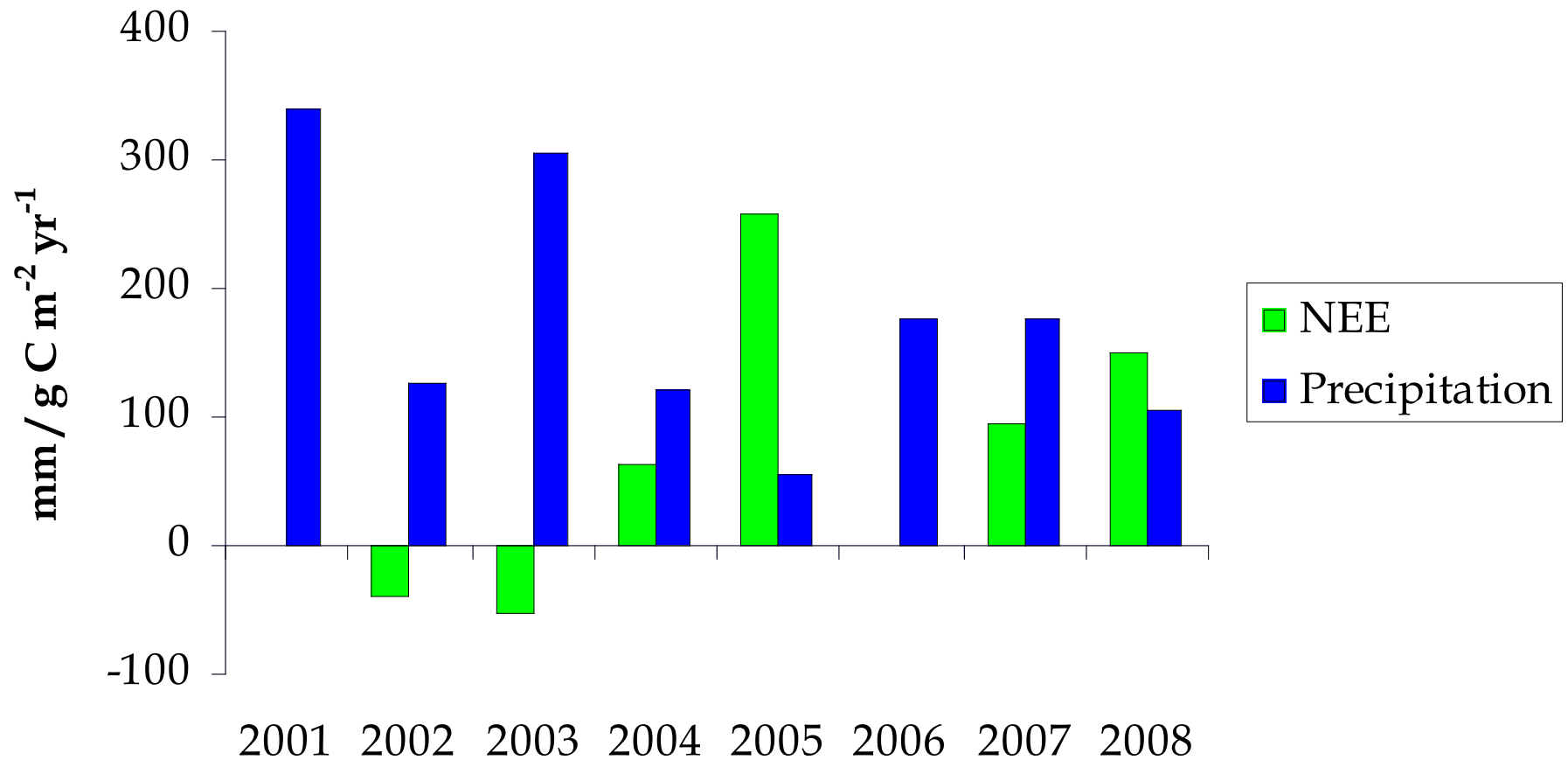


# *Cardon Larrea desert*

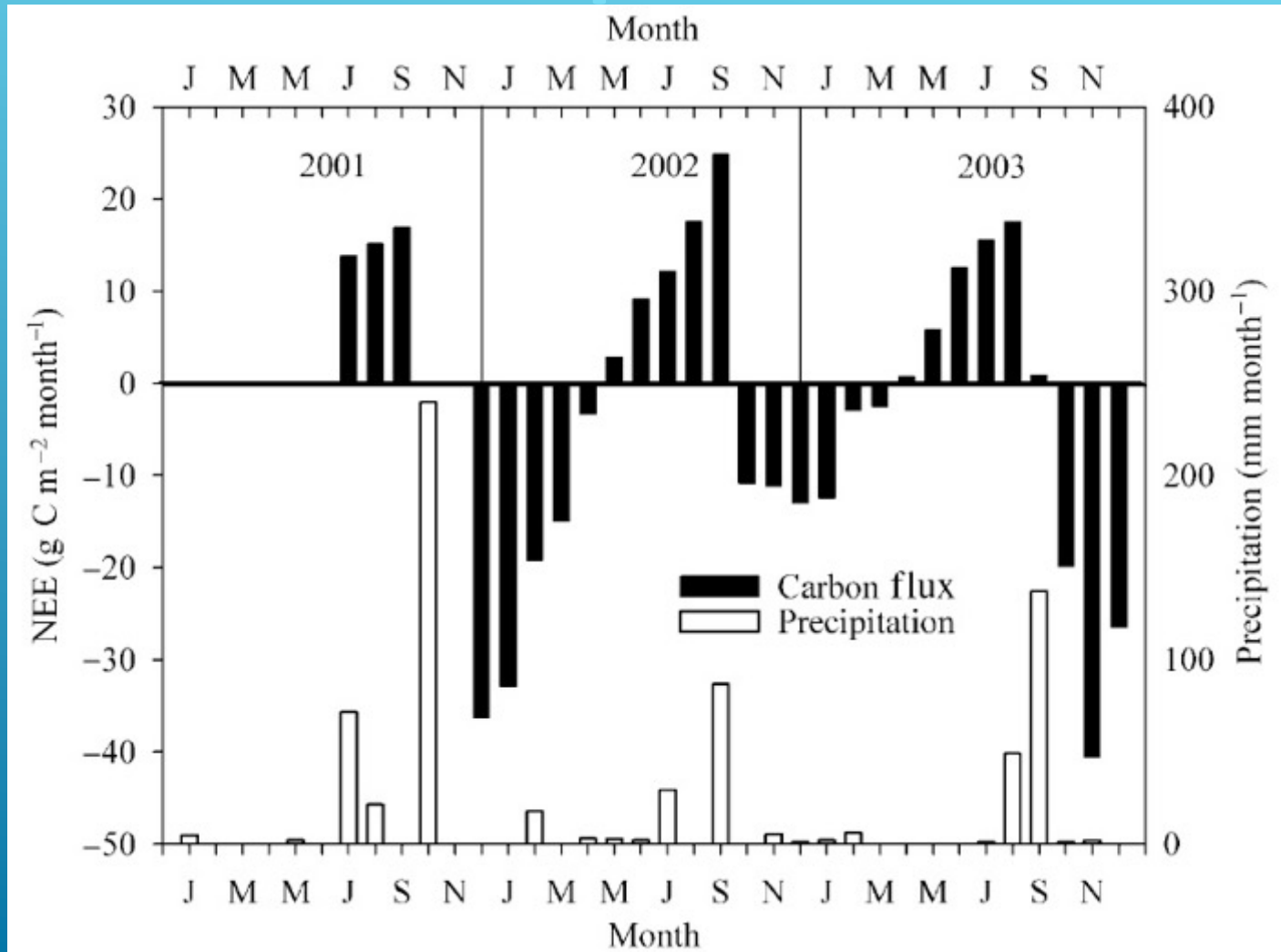




# Inter-annual Variability of NEE with Precipitation



# Seasonal Variability of NEE with Precipitation



# CLIMATE CHANGE EFFECTS ON VINES AND WINES

Molly Clemens, jDPE  
David Lipson  
Walt Oechel



# SALIENT RESEARCH QUESTIONS

- ▶ Investigate the role of rising atmospheric carbon dioxide and temperature on wine quality
- ▶ How can we work with vineyard owners on sustainable viticulture
  - ▶ Water use
  - ▶ Carbon sequestration
  - ▶ Temperature tolerance





- ▶ Greenhouse project currently funded and underway
  - ▶ Using temperature gradient and CO<sub>2</sub> enrichment
- ▶ Necessary to assess berry quality long term
- ▶ Measurements to be taken:
  - ▶ rates of evapotranspiration, soil salinity, berry salinity, xylem embolism
- ▶ Dry irrigation is a possibility for the future, many vineyards are switching to this more sustainable method

PAIRED WITH GREENHOUSE  
EXPERIMENTS



Year	Cost	Offset	Anticipated Direct Costs Covered	Yield	Anticipated Indirect Benefits	Total Direct Cost/Productivity:
2016	40,900	0				-\$40,900
2017	8,200	0				-\$8,200
2018	8,200	0				-\$8,200
2019	8,660	3,000		+		-\$5,660
2020	8,890	4,800	A	+		\$4,090
2021	9,120	12,600	A	+	B, C, D	\$3,480







# Anomaly

EXPERIMENTAL WINE  
CARBON ENRICHED VARIETALS  
AUGMENTED VERAISON

SUSTAINABLE WINE OF THE FUTURE

13% ALC

SAN DIEGO

STATE UNIVERSITY

SUSTAINABLE

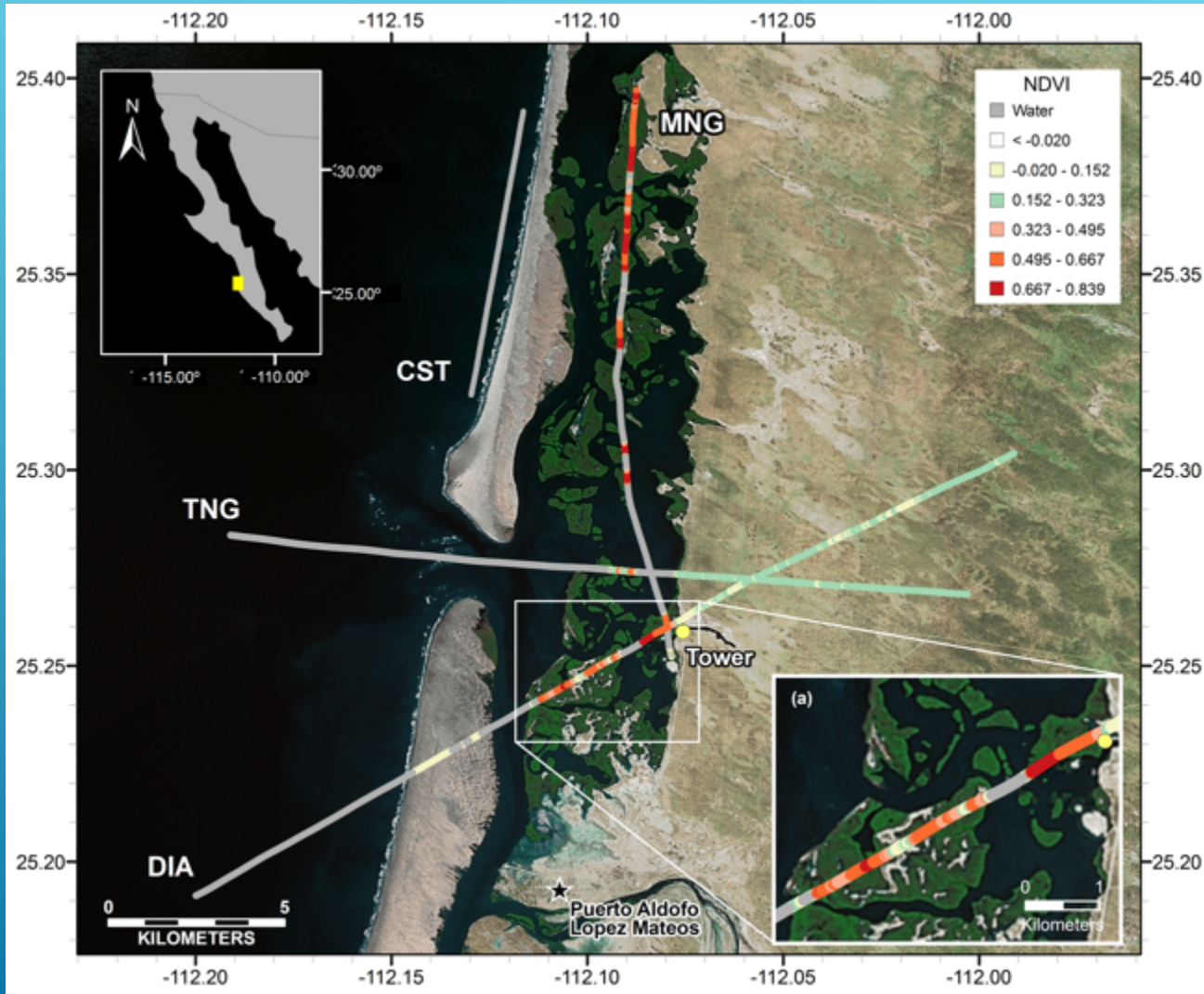
VITICULTURE

# Regional scale

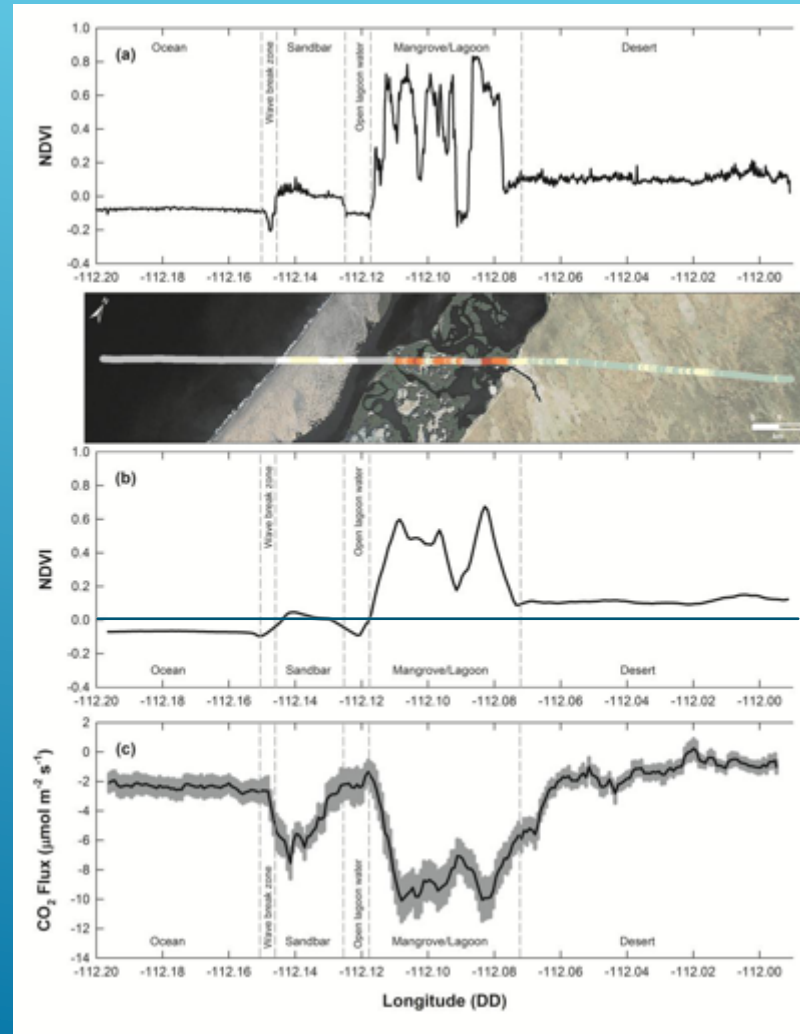
## FLUX AIRCRAFT TO MEASURE REGIONAL CO<sub>2</sub> AND CH<sub>4</sub> FLUXES (MOBILE FLUX PLATFORM CAN BE TRANSFERRED)



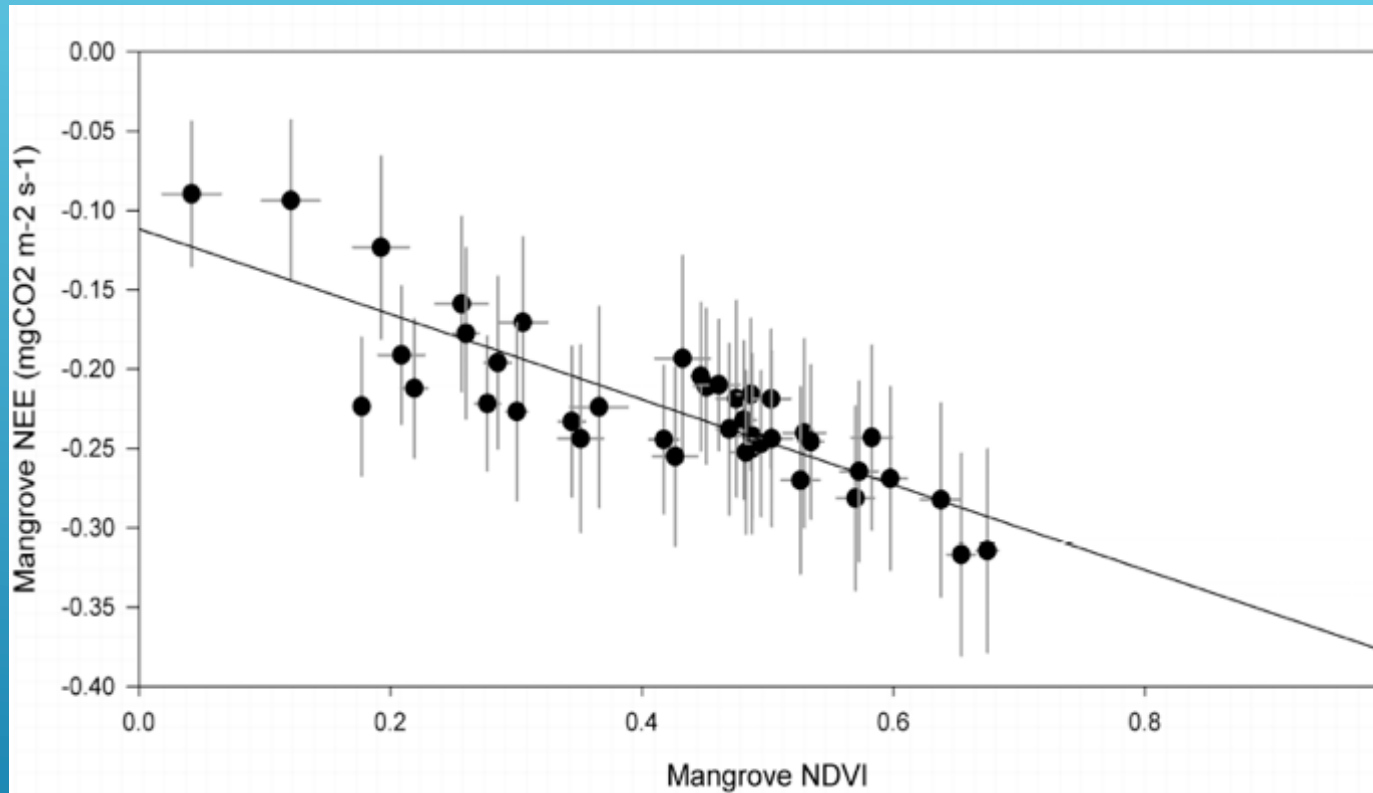
# MAGDALENA BAY STUDY AREA



# AIRCRAFT NDVI (LEAF AREA), CO<sub>2</sub> SEQUESTRATION



# MANGROVE CO<sub>2</sub> SEQUESTRATION VS NDVI (LEAF AREA)



# SCRIPPS PIER, SAN DIEGO





# BOAT BASED FLUX MEASUREMENTS, SAN DIEGO

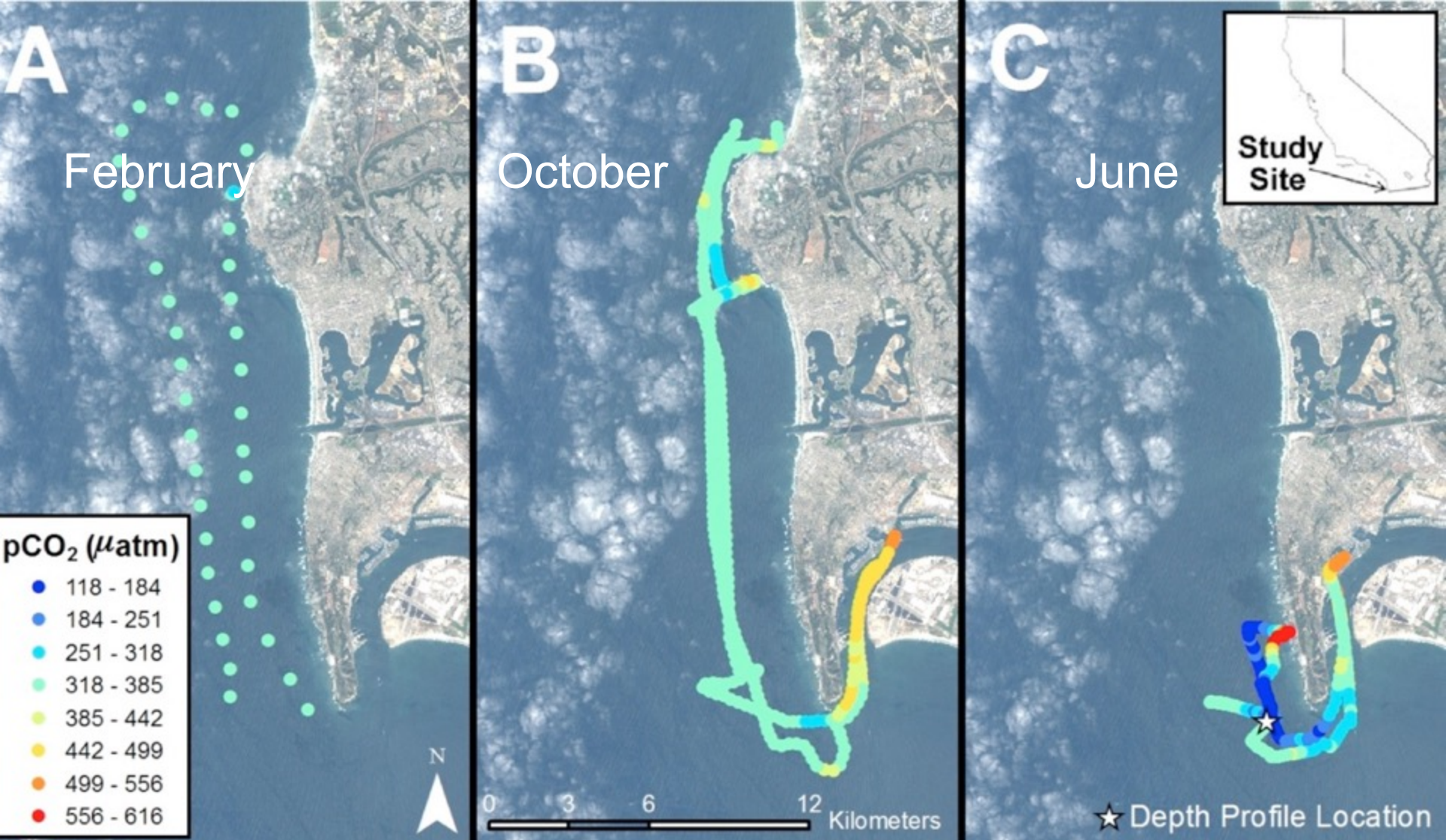






Figure  
Sampling path  
across San  
Diego Bay and  
the CO<sub>2</sub>  
concentrations  
measured

Alexander  
Carsh JPDE

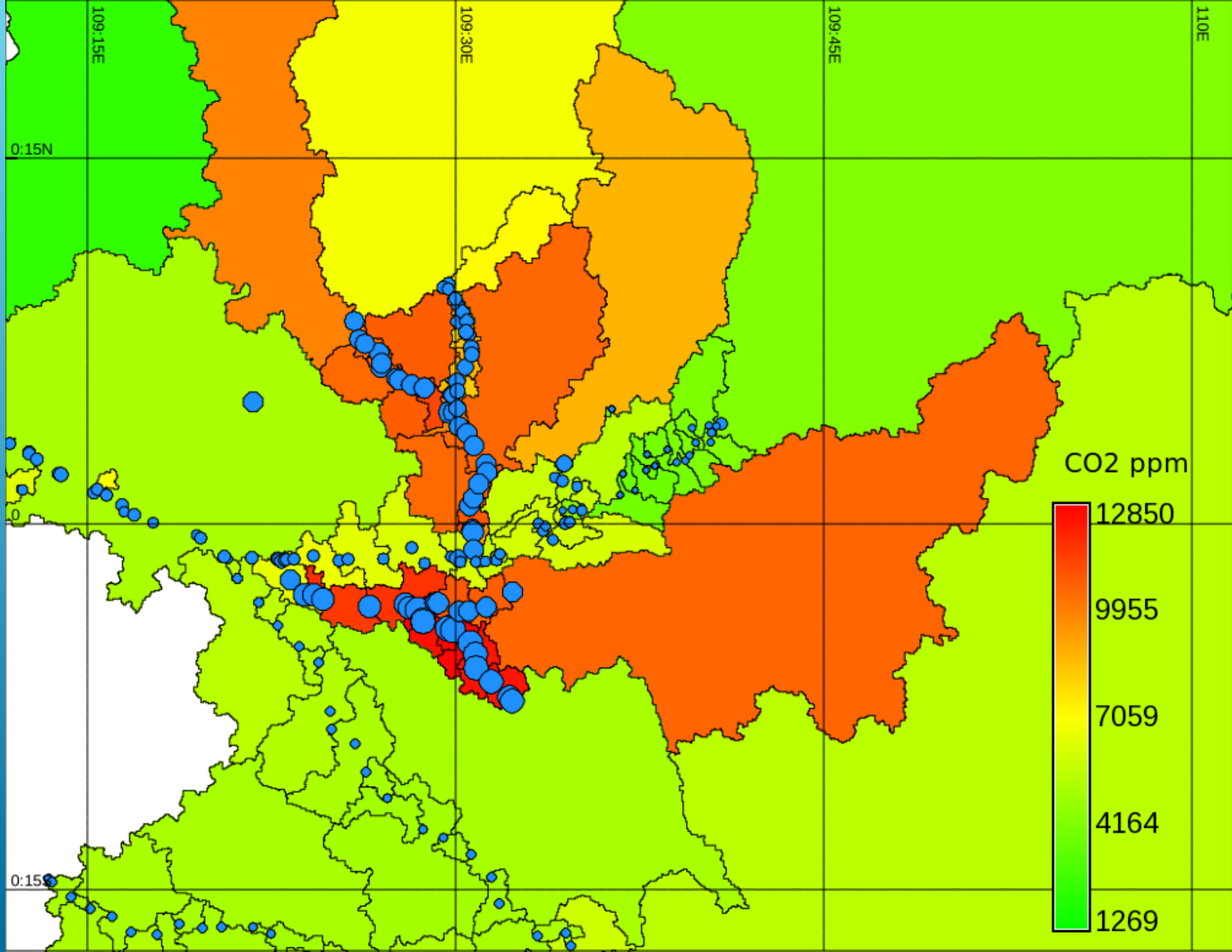


08/09/2010

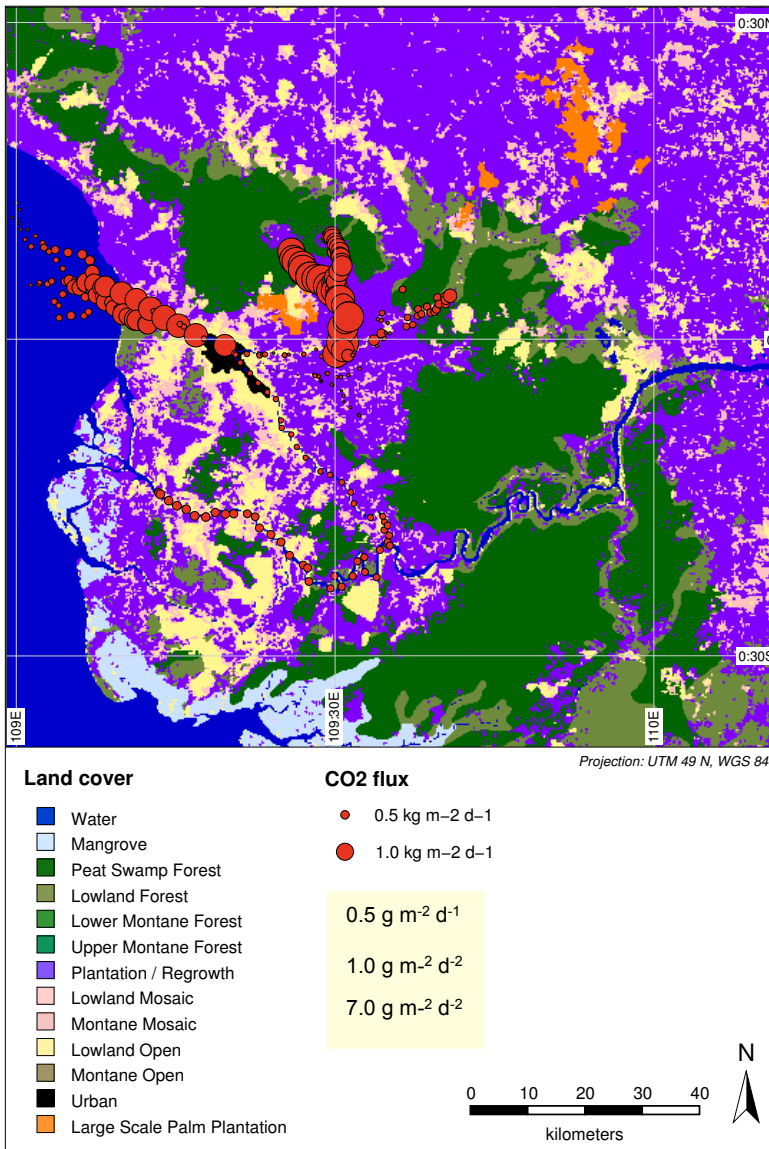
# Tributary of the Kapuas River, Borneo



08/09/2010



# CO<sub>2</sub> Flux In Kapuas River, Tributaries, and Estuary August 2010 0:30°S-0:30°N lat. 109°E-110°E long





08/09/2010