Impact of Extreme Climatic Differences on the Net Ecosystem Carbon Dioxide Exchange of a Sitka Spruce Forest

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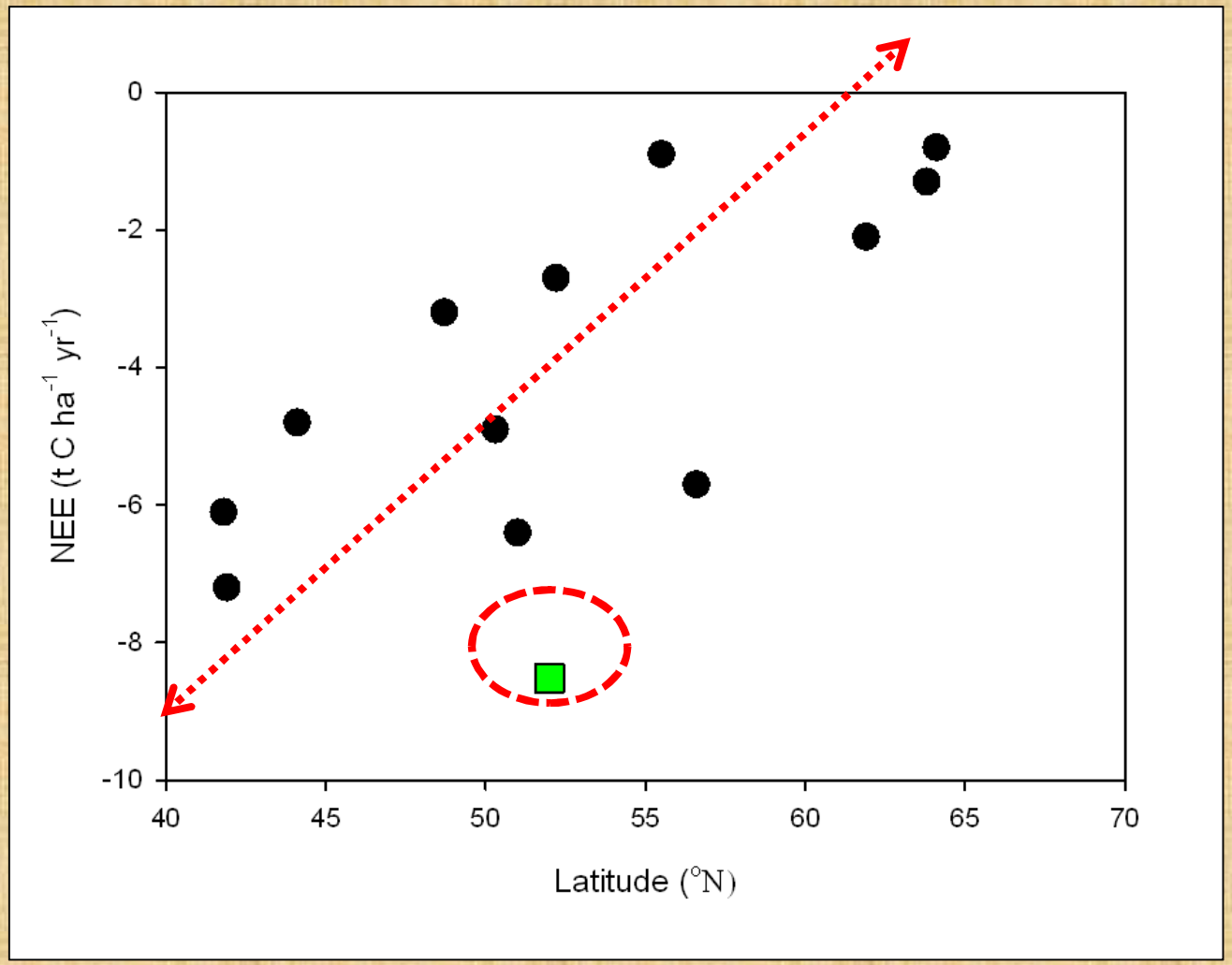
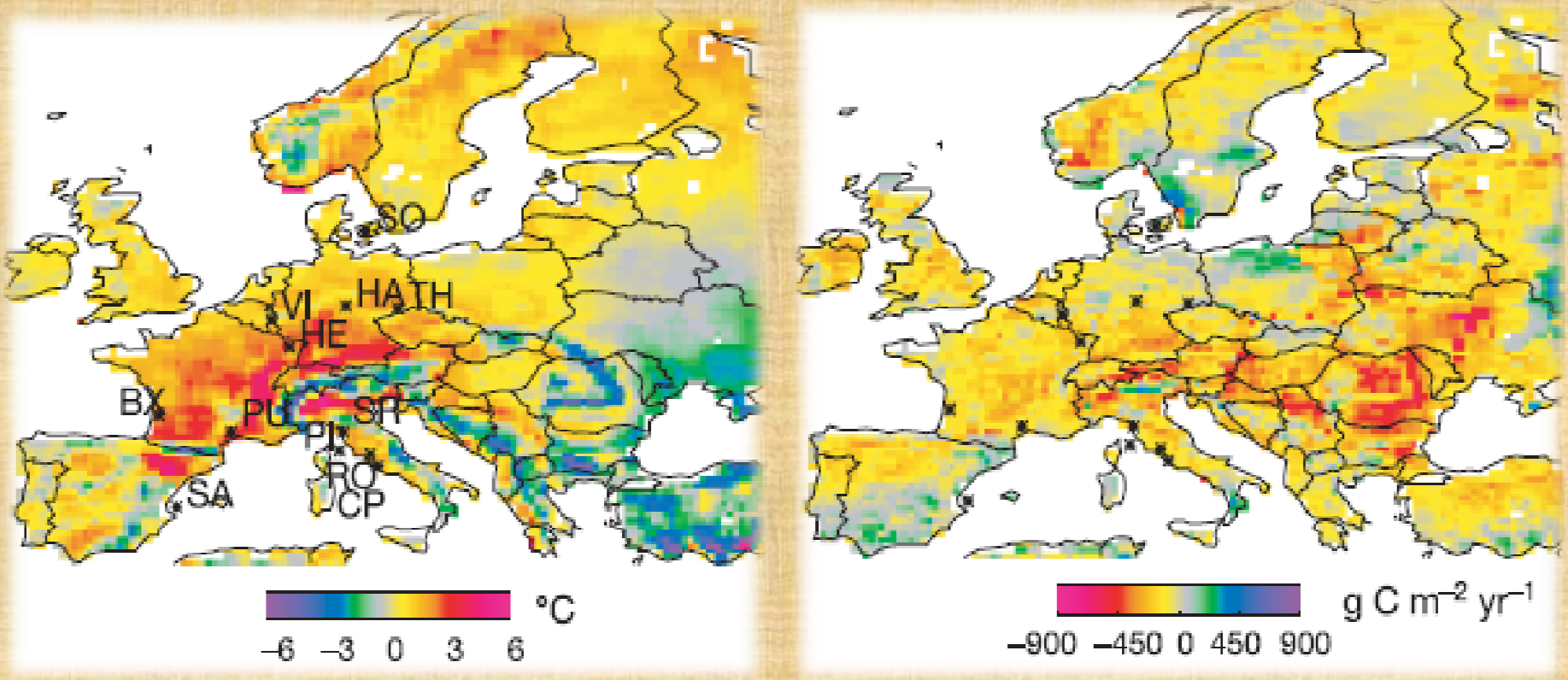
Latitudinal Gradient of Forest Productivity in the EU



Van Dijk *et al.*, 2004

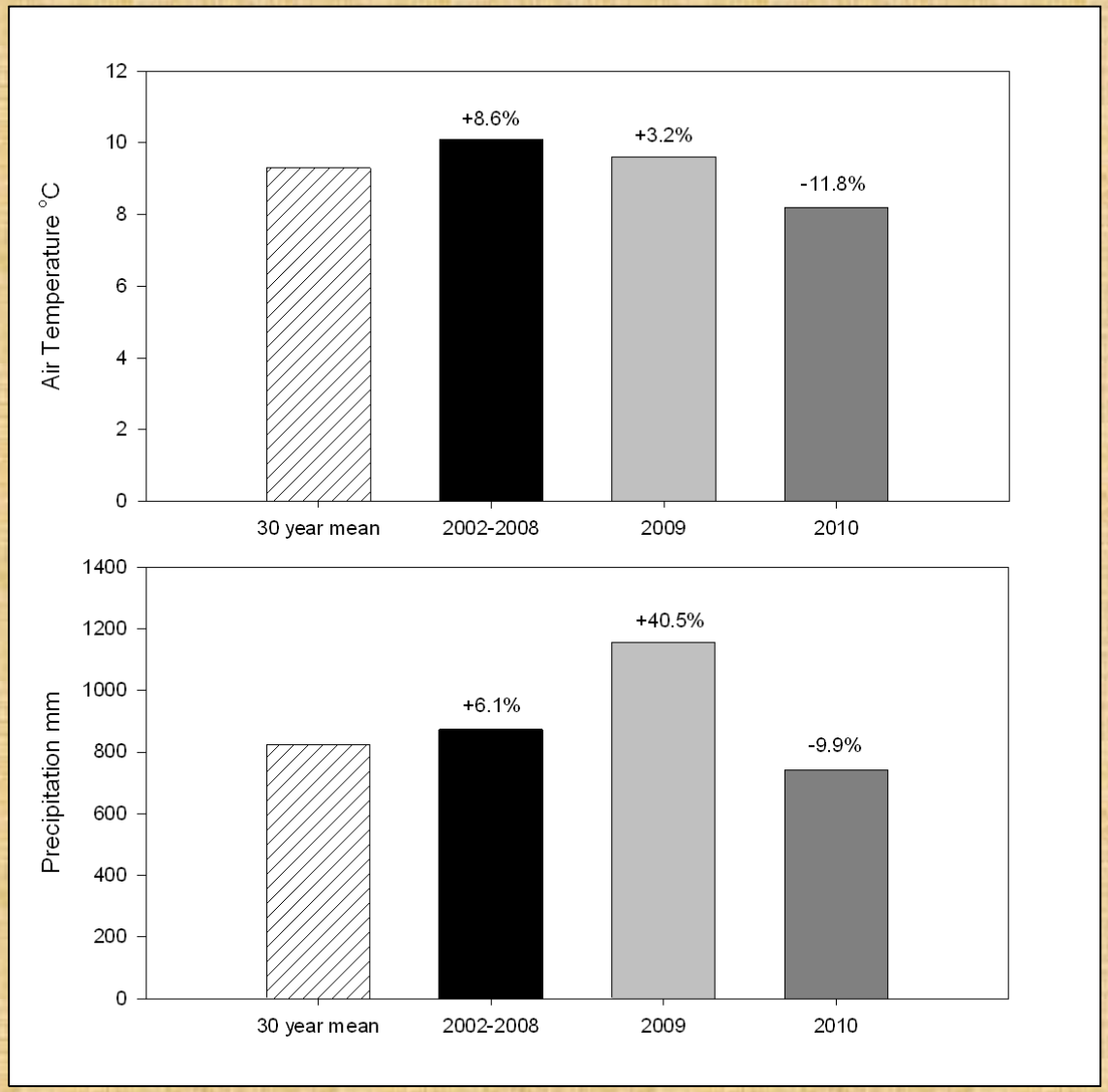
2003 Summer Heat-Wave



- 30% reduction in GPP observed leading to a net carbon loss of 0.5 Pg C yr^{-1}.

Cias *et al.* (2005)

Annual Temperature and Precipitation Extremes



Key Questions

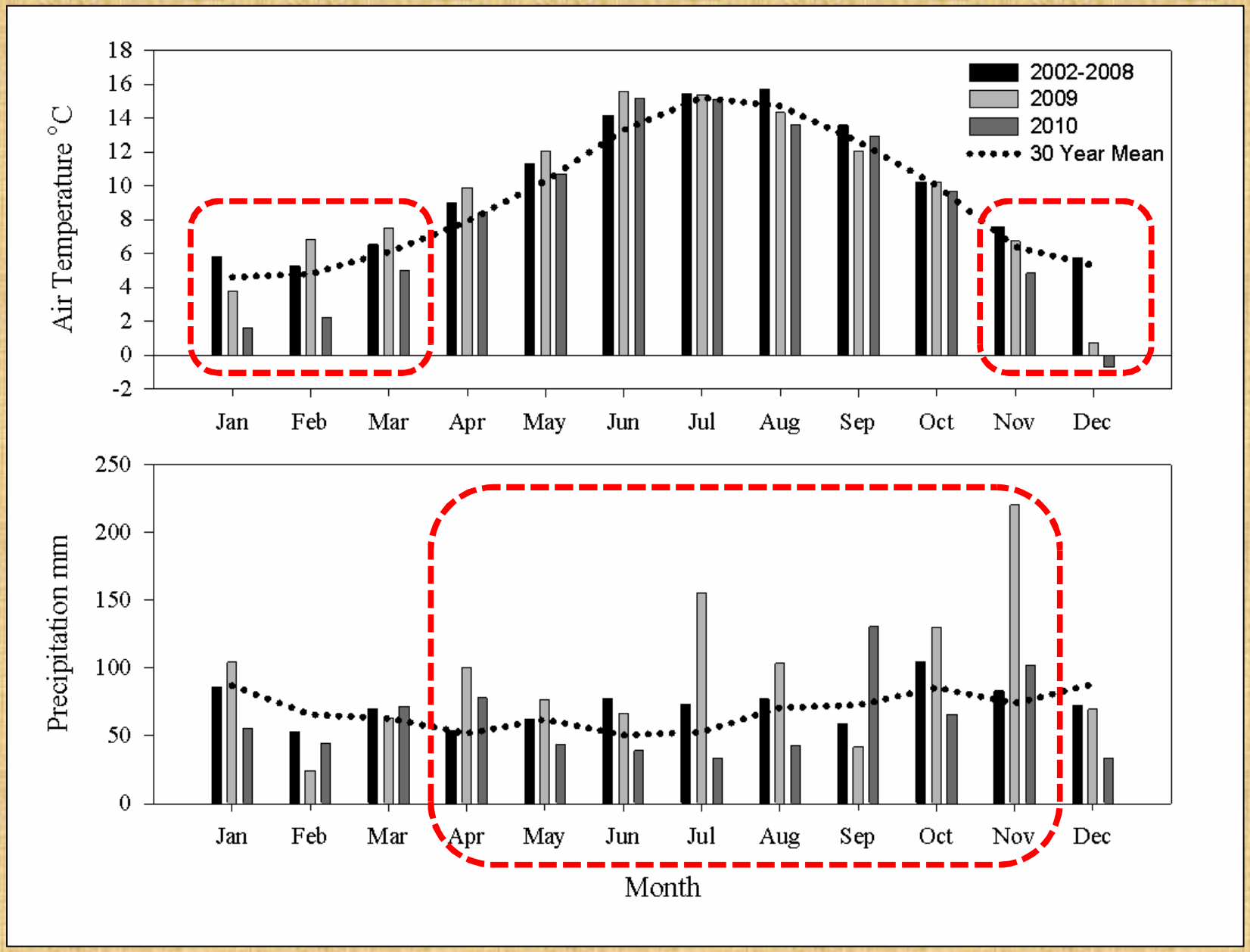
- **How is the carbon budget of a Sitka spruce forest influenced by:**

  - Extreme variations in soil water content?

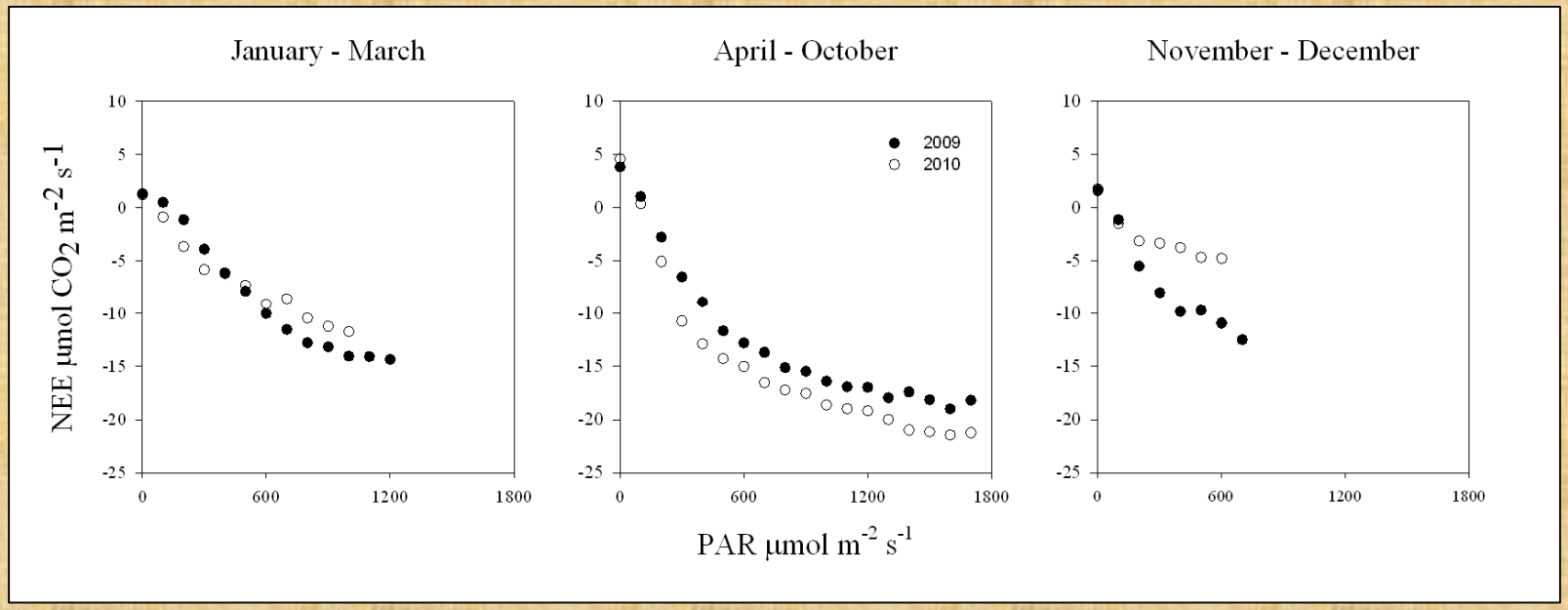
  - Magnitude of low-temperature events?

  - Duration of low temperature events?

Seasonal Climatic Variation

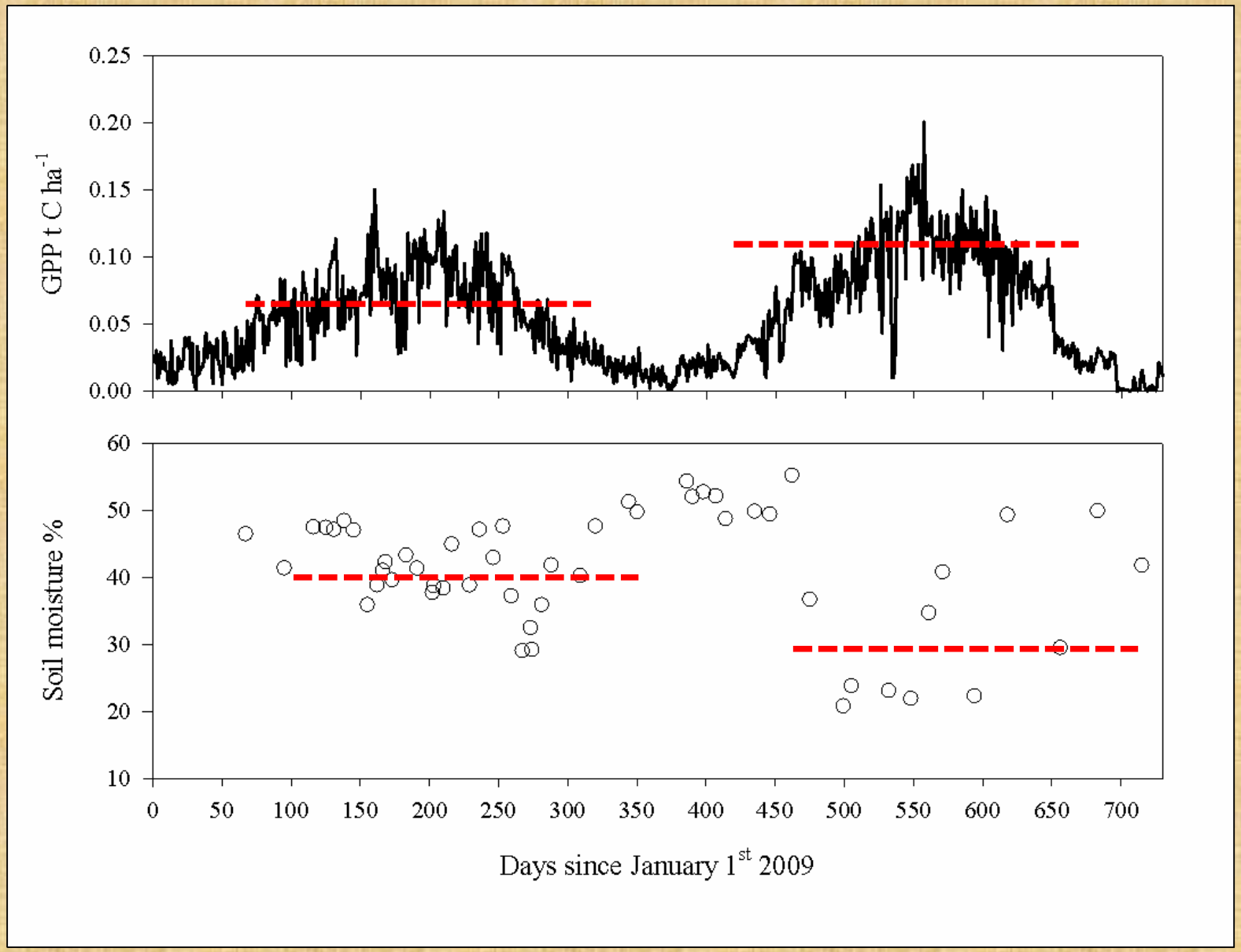


Eddy Covariance Measurements

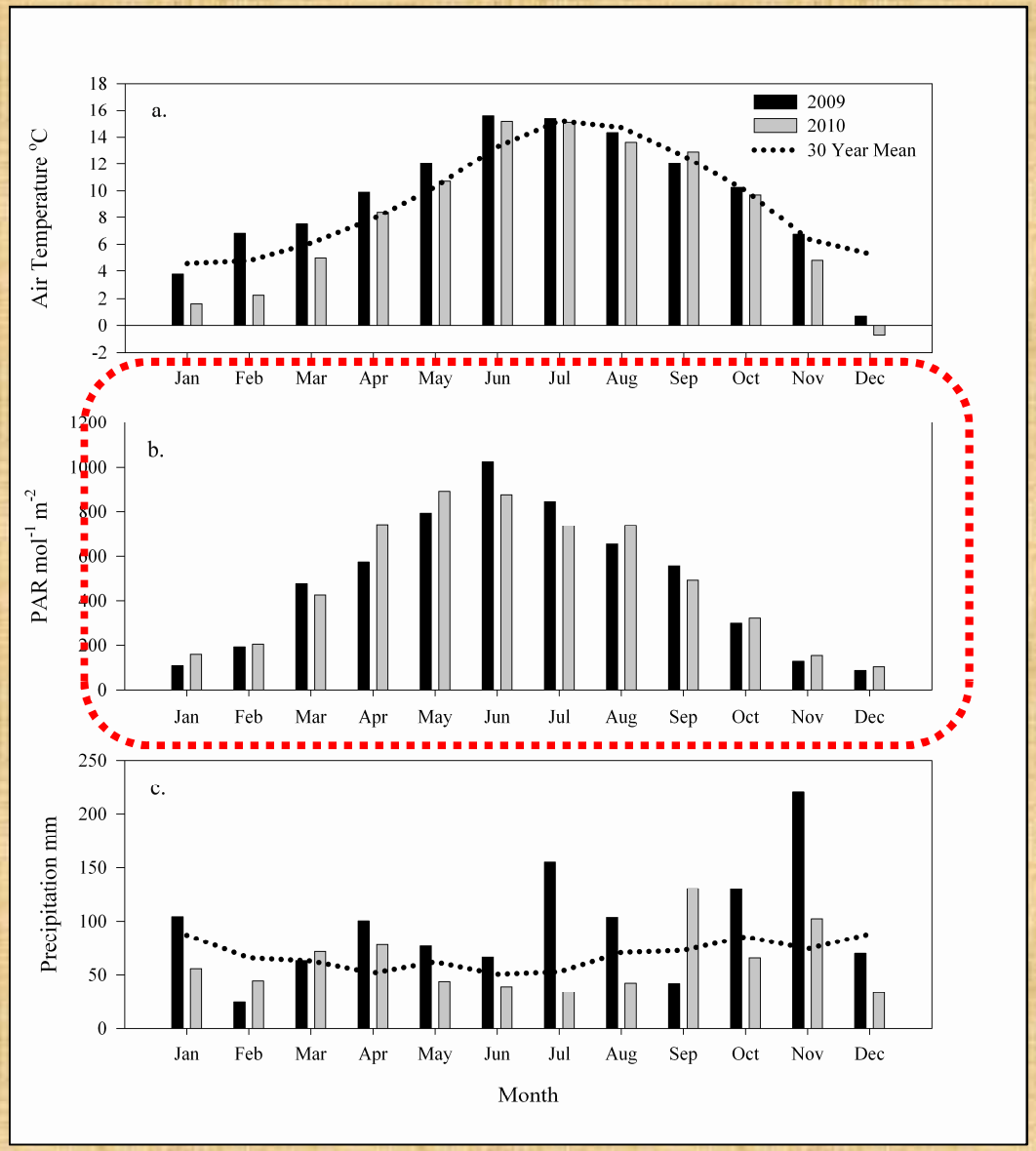


Year	Period	Mean Temperature (ºC)	Mean Soil Water Content (%)	α (mol CO_2 mol PAR)	NEE_{sat} (µmol CO_2 m^{-2} s^{-1})	GPP (t C ha^{-1}) [%]
2009	Jan-Mar	6.3	46.5	0.03	35.3	2.63 [13.8]
	Apr-Oct	11.6	40.9	0.05	41.9	15.21 [79.9]
	Nov-Dec	6.0	47.3	0.05	25.2	1.20 [6.3]
2010	Jan-Mar	3.1	51.4	0.03	22.1	2.16 [9.7]
	Apr-Oct	12.5	32.7	0.06	43.3	19.41 [87.0]
	Nov-Dec	-0.1	45.9	0.04	12.1	0.74 [3.3]

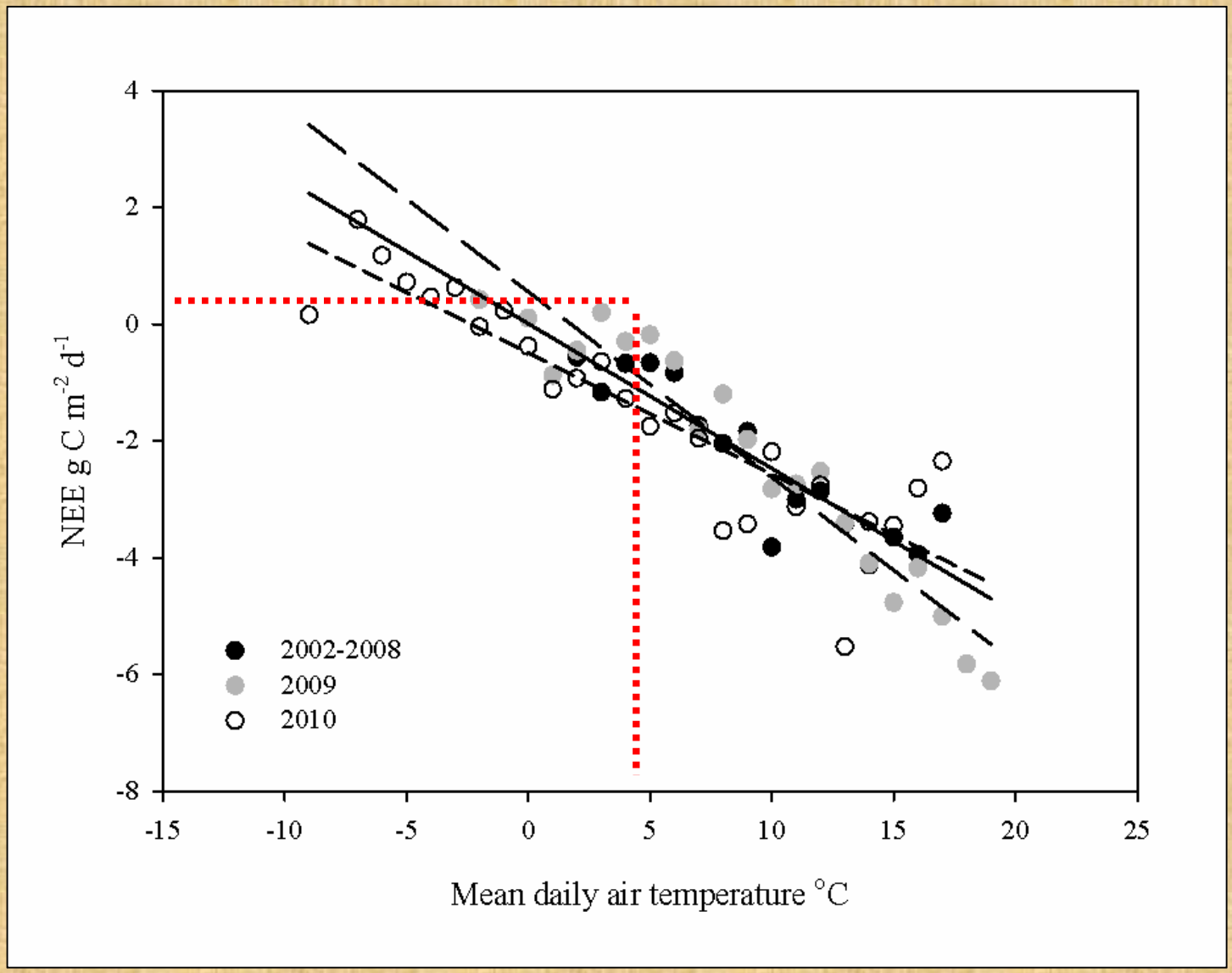
GPP and Soil Moisture Content



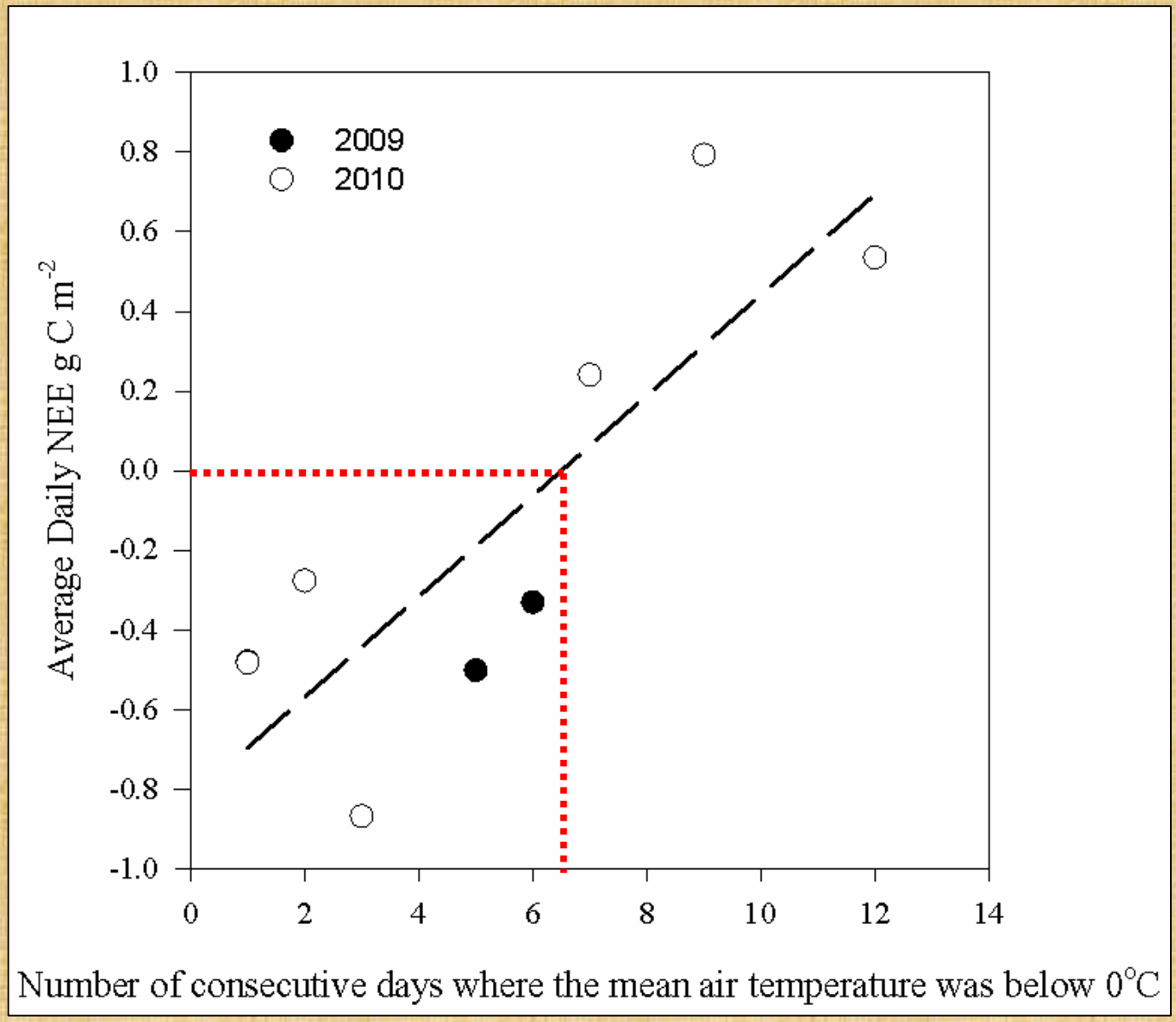
Radiation, Temperature and Precipitation



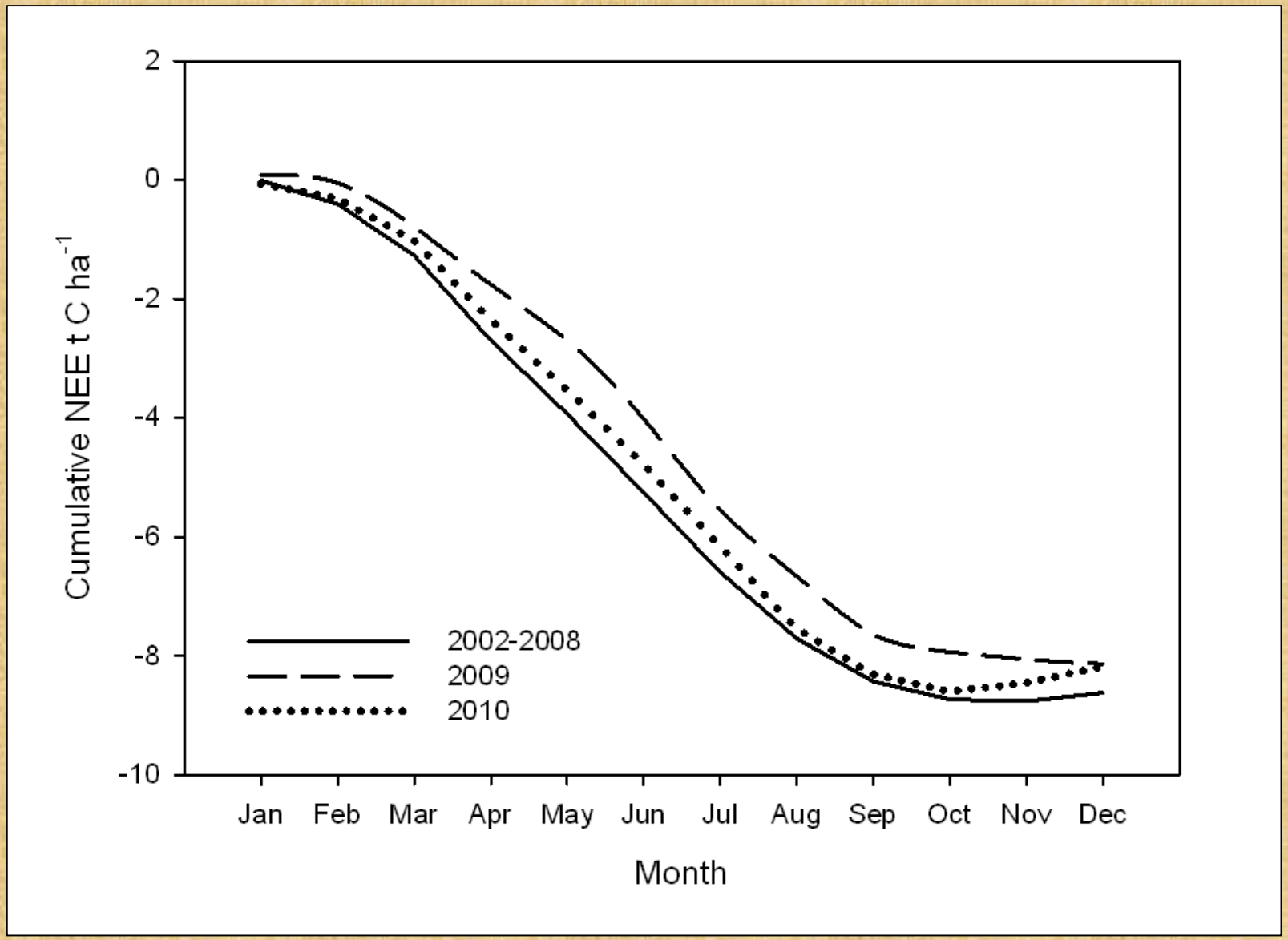
Temperature and NEE Relationship



Impact of Consecutive Freezing Events



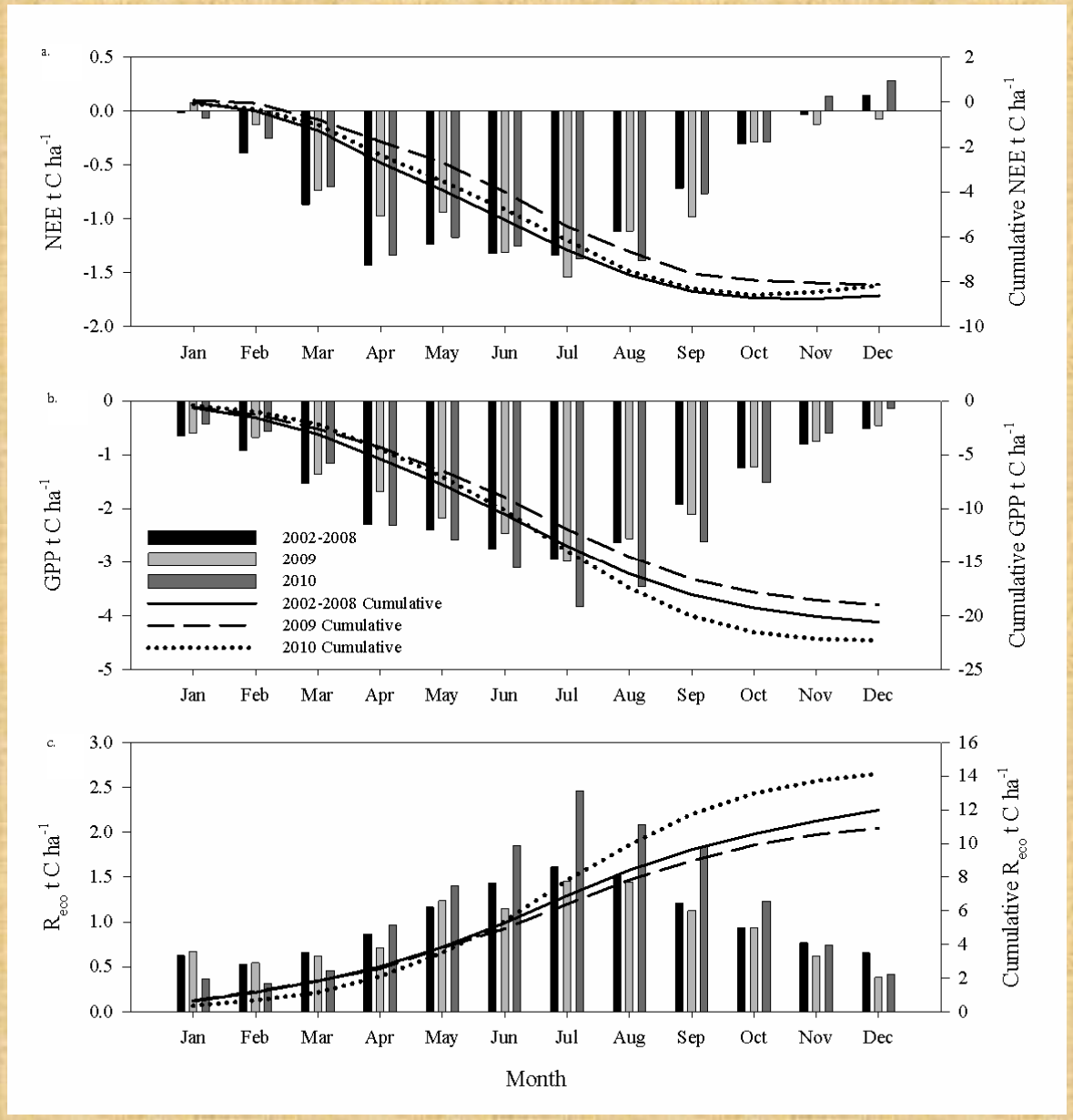
Net Carbon Budget



Summary

- **Extreme** inter-annual **climatic variability** observed in 2009 (precipitation) and 2010 (temperature).
- **Increased** precipitation and **soil water content** during growing season **reduced GPP-**major impact?
- **Below ~2°C** the forest switches to a **carbon source**.
- Where the **sub-zero temperatures** lasted for **>6 days** the forest became a **C source**.
- **Annual carbon sequestration potential not significantly compromised** under these extreme climatic conditions.

Acknowledgements.


a.
NEE t C ha-1
Cumulative NEE t C ha-1
0.5
0.0
-0.5
-1.0
-1.5
-2.0
2
0
-2
-4
-6
-8
-10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
b.
GPP t C ha-1
Cumulative GPP t C ha-1
0
-1
-2
-3
-4
-5
0
-5
-10
-15
-20
-25
2002-2008
2009
2010
2002-2008 Cumulative
2009 Cumulative
2010 Cumulative
c.
Reco t C ha-1
Cumulative Reco t C ha-1
3.0
2.5
2.0
1.5
1.0
0.5
0.0
16
14
12
10
8
6
4
2
0
Month