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Benthic diatom response to changing environmental conditions

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Preliminary remarks

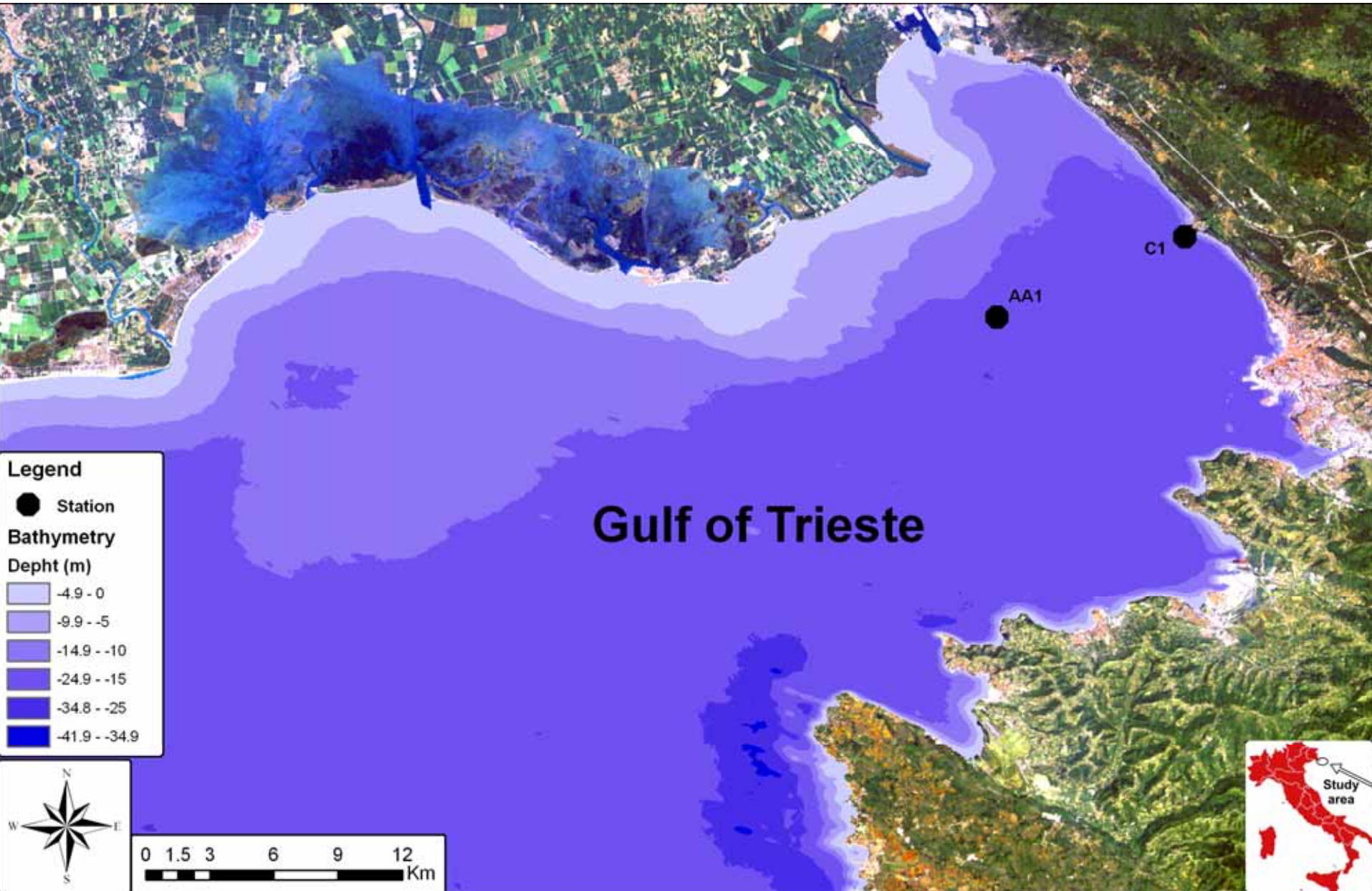
- **The Gulf of Trieste (northern Adriatic Sea, Italy) is a semi-enclosed water basin with a maximum depth of 25 m and therefore the response to any kind of environmental variation should be rapid and easy to detect.**
- **The gulf conditions have changed in the last years: from 1991 to 2003 temperature has shown a positive trend up to 0.23 °C year^{-1} in summer and up to 0.10 °C year^{-1} in winter at 10 m depth (Malačič et al. 2006), i.e. about one order of magnitude higher than the Intergovernmental Panel on Climate Change (IPCC) estimates (IPCC 2001).**
- **Salinity showed a most pronounced positive trend up to 0.34 year^{-1} at 10 m depth (Malačič et al. 2006).**

Aims of the study

Following the variations of temperature, salinity, freshwater inflow and nutrient concentrations that occurred in the last two decades in the Gulf of Trieste, we expected to detect a change also in the benthic diatom community.

- **The main goal of this survey was to study benthic diatom assemblages with respect to physical parameters (temperature and salinity).**
- **We made predictions of possible variations that may occur within the benthic diatom community in the future.**

Study site

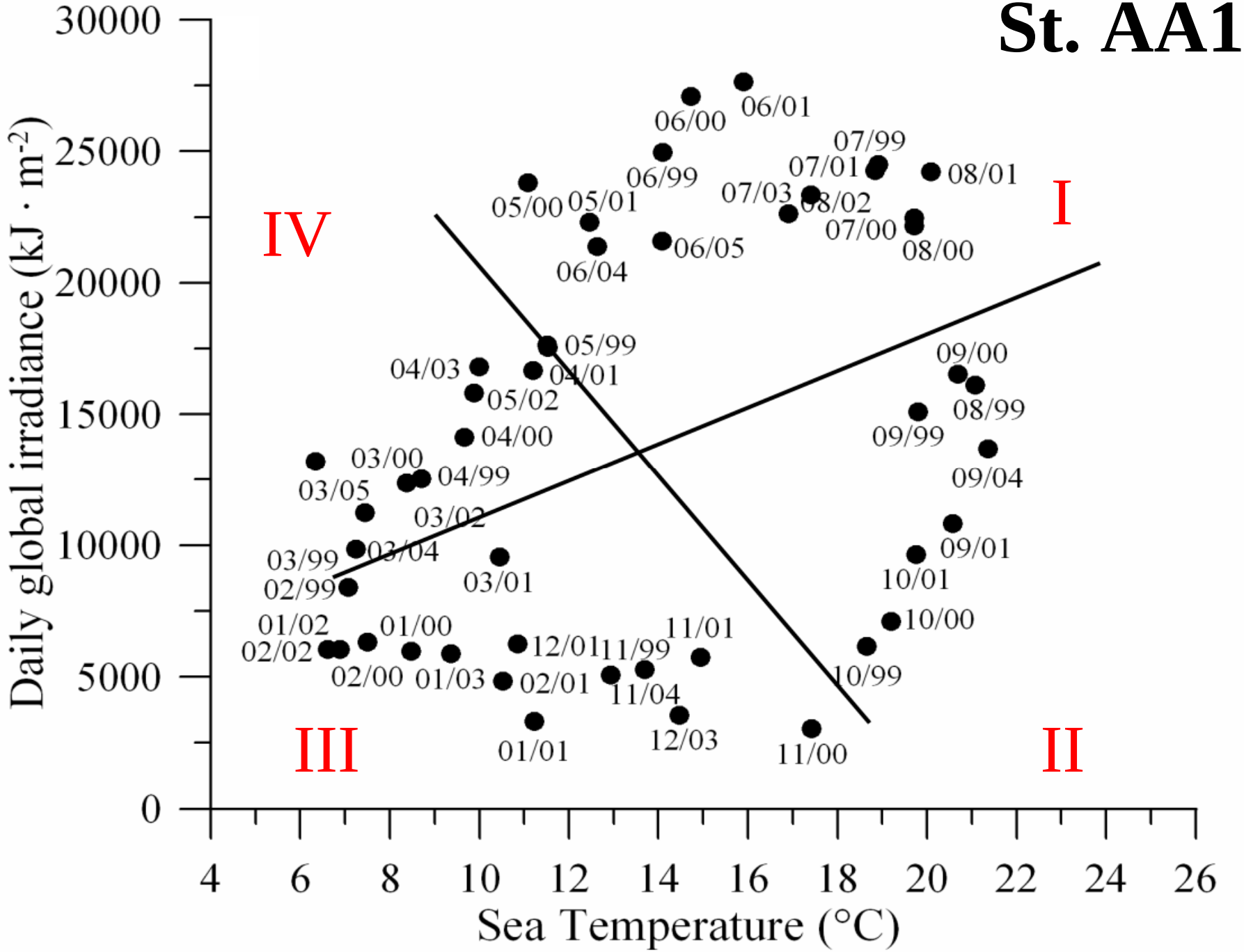

C1
AA1
Gulf of Trieste
Legend
Station
Bathymetry
Depht (m)
-4.9 - 0
-9.9 - -5
-14.9 - -10
-24.9 - -15
-34.8 - -25
-41.9 - -34.9
N
W
E
S
0 1.5 3 6 9 12
Km
Study area

Sampling by KC HAPS bottom corer (I.D. 13.3 cm)

Benthic diatom abundance (cells cm^{-3}) estimated by an inverted light microscope (Utermöhl, 1958) using a 32X objective

Statistical analyses

- The abundance of diatom genera was reduced performing a ranking of the genera according to their decreasing specific variance (%SV) (Orloci 1978).
- Since the environmental noise markedly affected the measurements, a bin-average analysis was used to obtain a more precise picture of the actual relation between temperature or salinity and abundance. Both temperature and salinity measurements were gathered into equally-spaced bins, with a bin interval of 2°C for temperature and 0.2 for salinity; then, bin-averaged temperature or salinity data were put into correlation with the corresponding averages of abundance data.


St. AA1
Daily global irradiance (kJ · m-2)
Sea Temperature (°C)
30000
25000
20000
15000
10000
5000
0
4
6
8
10
12
14
16
18
20
22
24
26
I
II
III
IV
06/01
06/00
07/99
06/99
07/01
08/01
05/00
05/01
07/03
08/02
07/00
08/00
06/05
06/04
05/99
04/03
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10/01
02/99
03/01
01/02
01/00
11/01
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01/03
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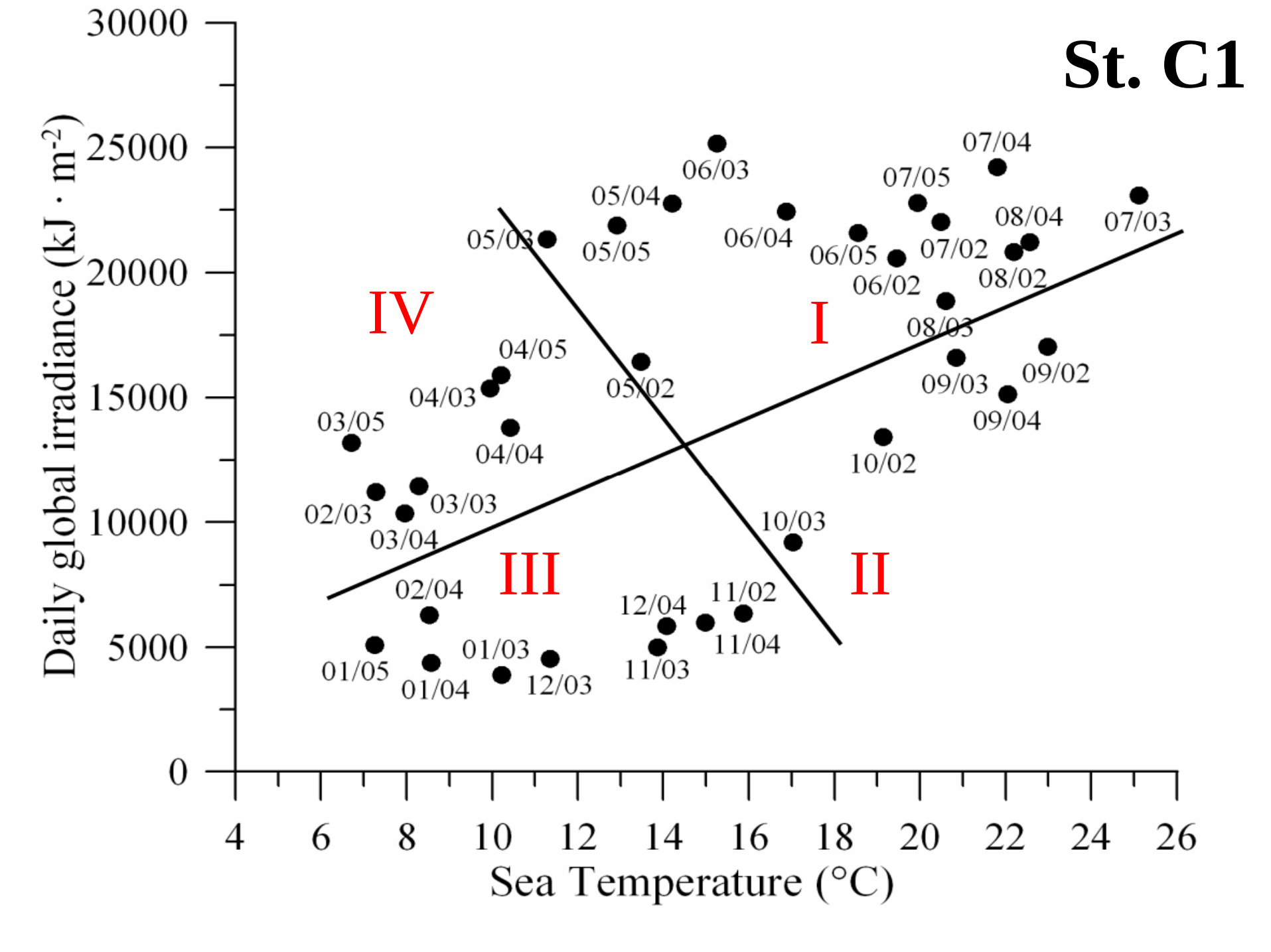
11/04
01/01
12/03
11/00


St. C1
Daily global irradiance (kJ · m-2)
Sea Temperature (°C)
30000
25000
20000
15000
10000
5000
0
4
6
8
10
12
14
16
18
20
22
24
26
I
II
III
IV
07/04
06/03
07/05
05/04
08/04
07/03
05/03
05/05
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08/03
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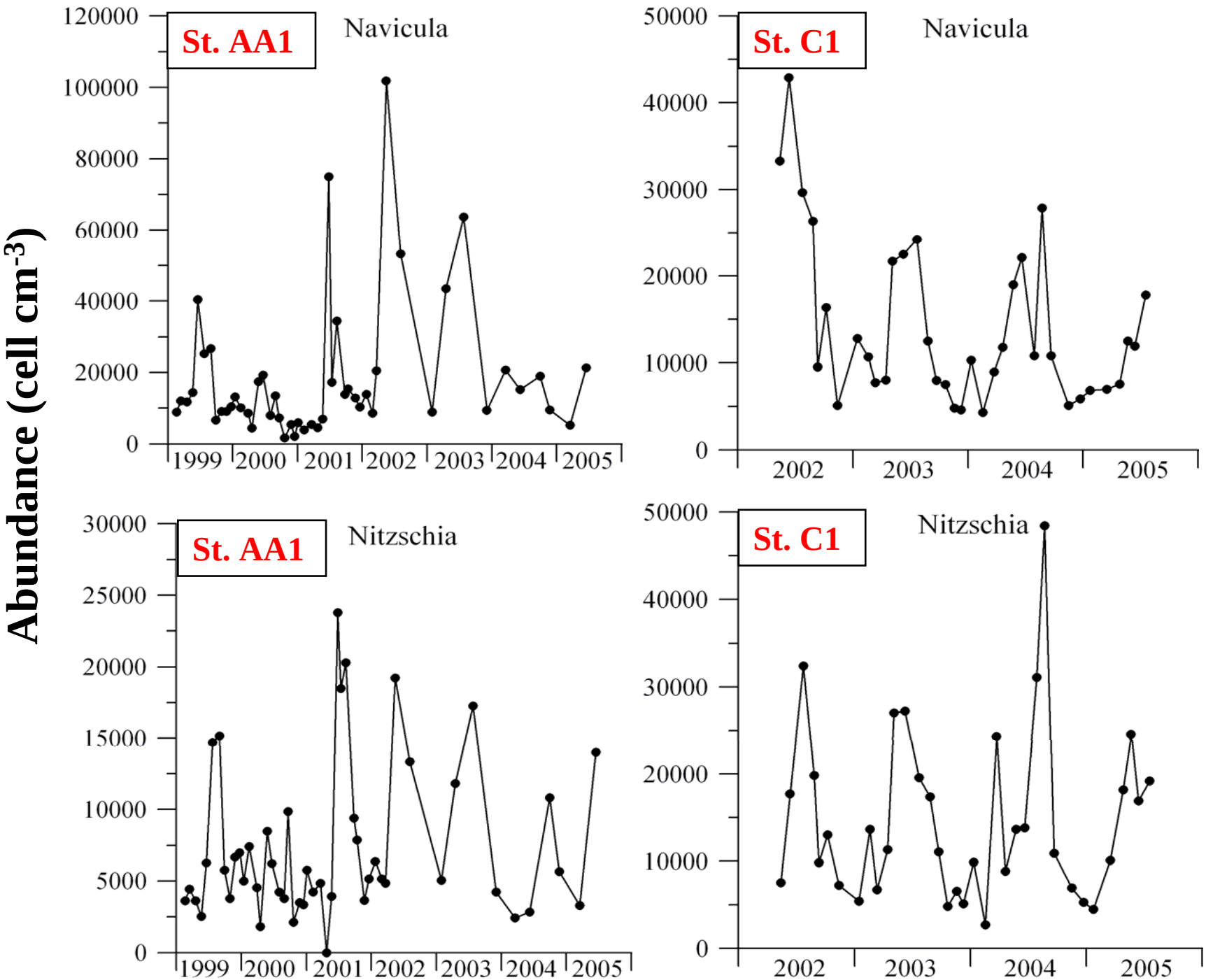
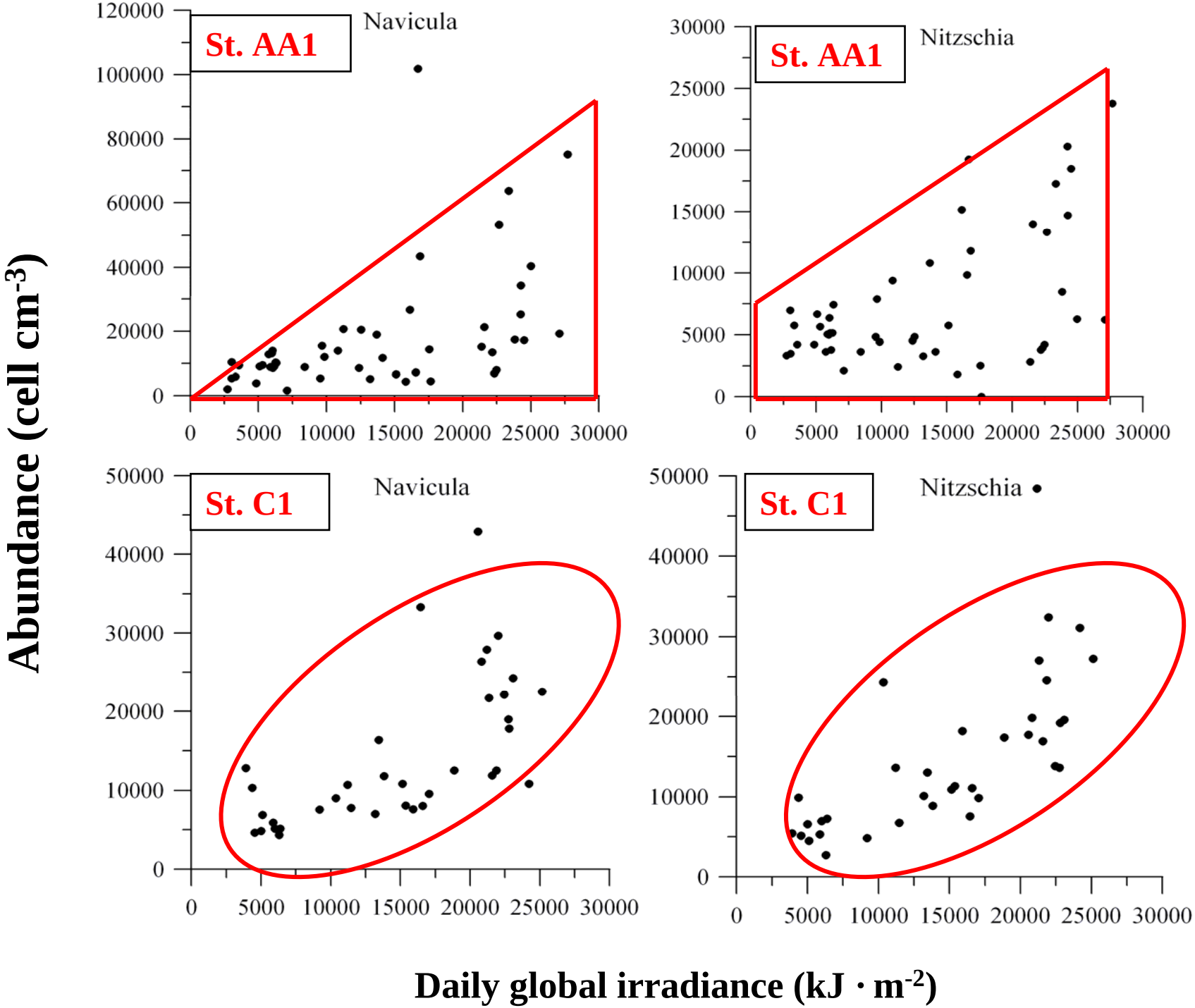
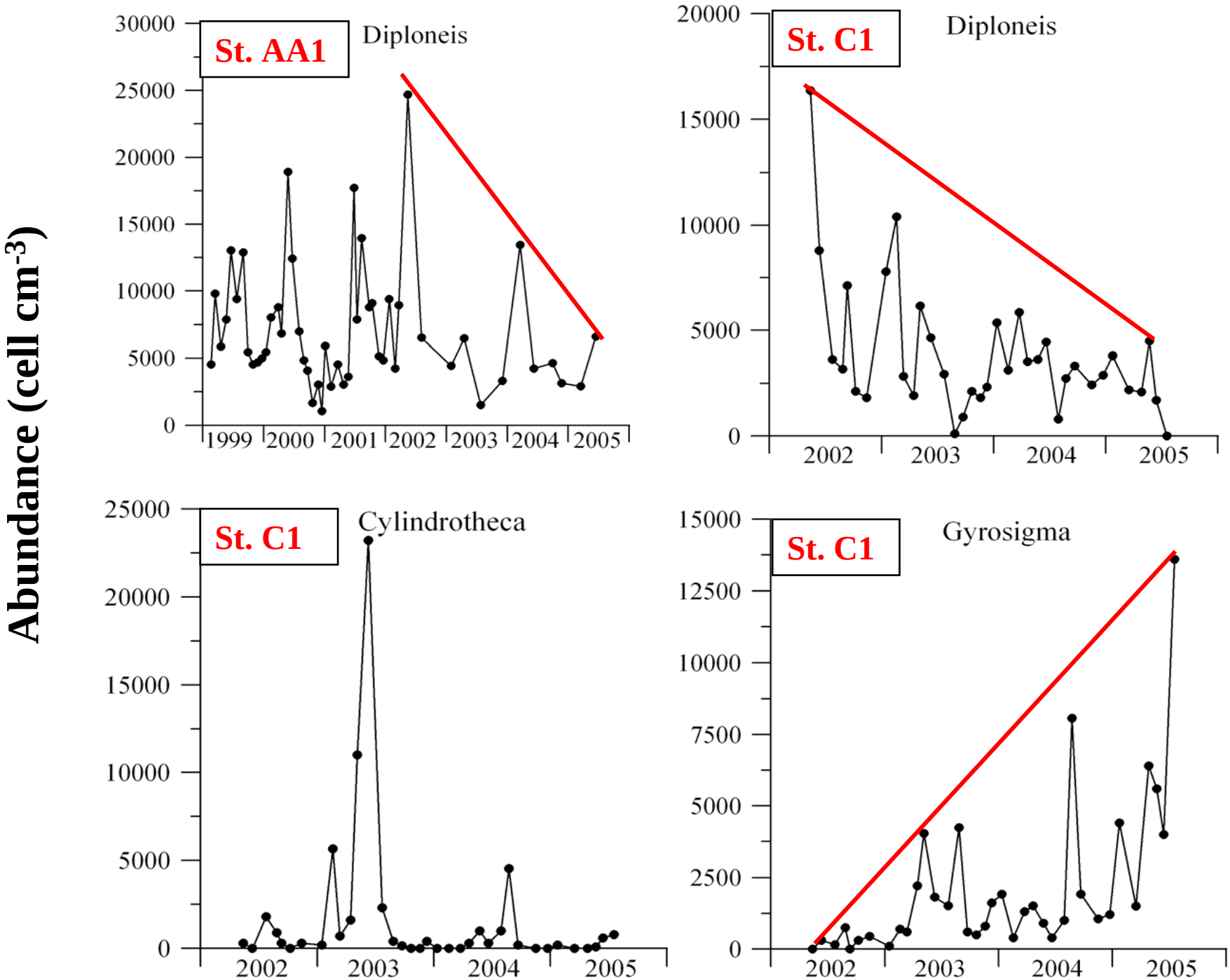
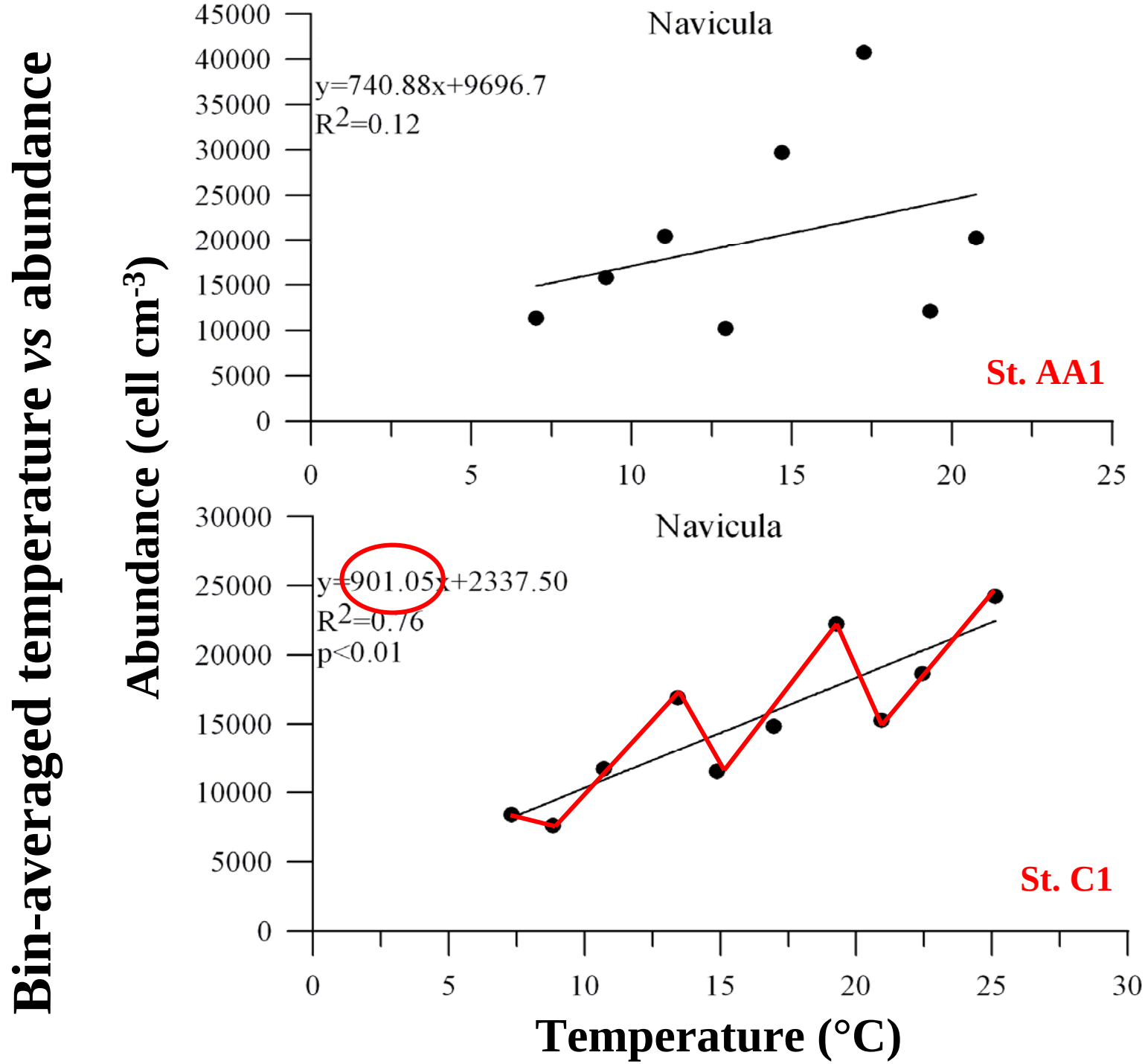
01/04
12/03

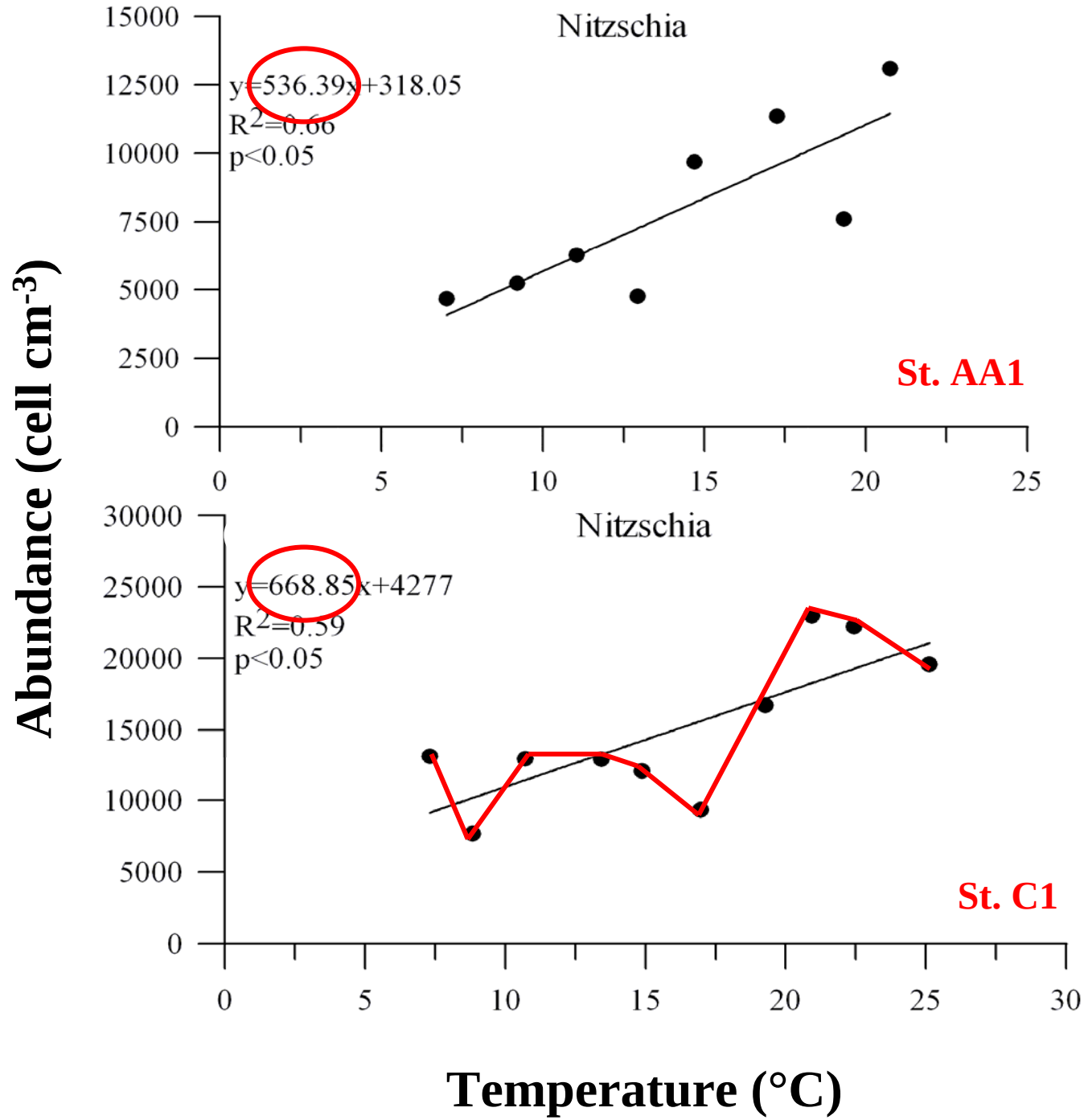

Abundance (cell cm-3)
St. AA1
Navicula
120000
100000
80000
60000
40000
20000
0
1999
2000
2001
2002
2003
2004
2005
St. C1
Navicula
50000
40000
30000
20000
10000
0
2002
2003
2004
2005
St. AA1
Nitzschia
30000
25000
20000
15000
10000
5000
0
1999
2000
2001
2002
2003
2004
2005
St. C1
Nitzschia
50000
40000
30000
20000
10000
0
2002
2003
2004
2005


St. AA1
Navicula
St. AA1
Nitzschia
St. C1
Navicula
St. C1
Nitzschia
Abundance (cell cm-3)
Daily global irradiance (kJ · m-2)

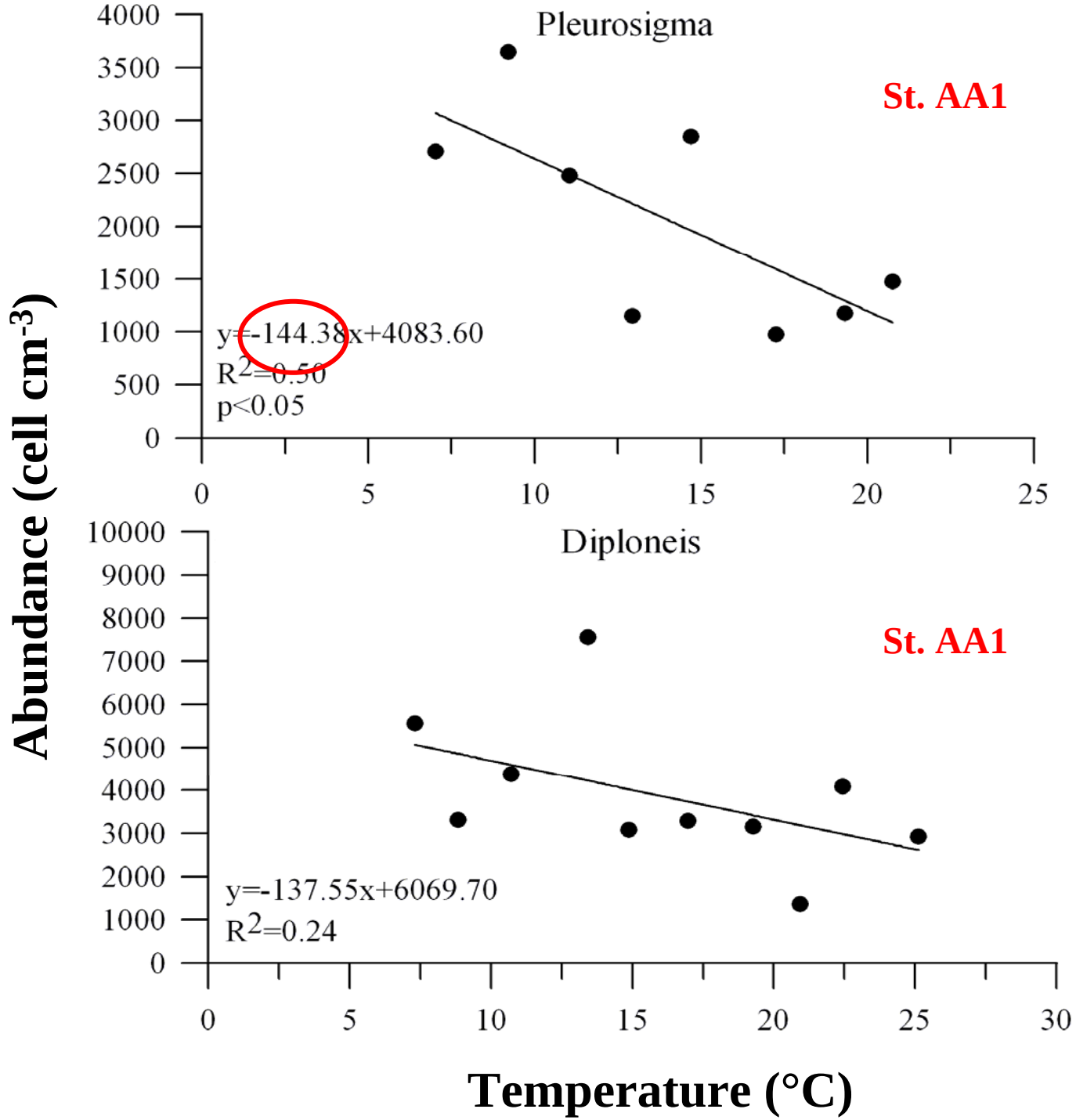

Abundance (cell cm-3)
St. AA1
Diploneis
30000
25000
20000
15000
10000
5000
0
1999
2000
2001
2002
2003
2004
2005
St. C1
Diploneis
20000
15000
10000
5000
0
2002
2003
2004
2005
St. C1
Cylindrotheca
25000
20000
15000
10000
5000
0
2002
2003
2004
2005
St. C1
Gyrosigma
15000
12500
10000
7500
5000
2500
0
2002
2003
2004
2005


Bin-averaged temperature vs abundance
Abundance (cell cm-3)
Navicula
y=740.88x+9696.7
R2=0.12
St. AA1
Navicula
y=901.05x+2337.50
R2=0.76
p<0.01
St. C1
Temperature (°C)

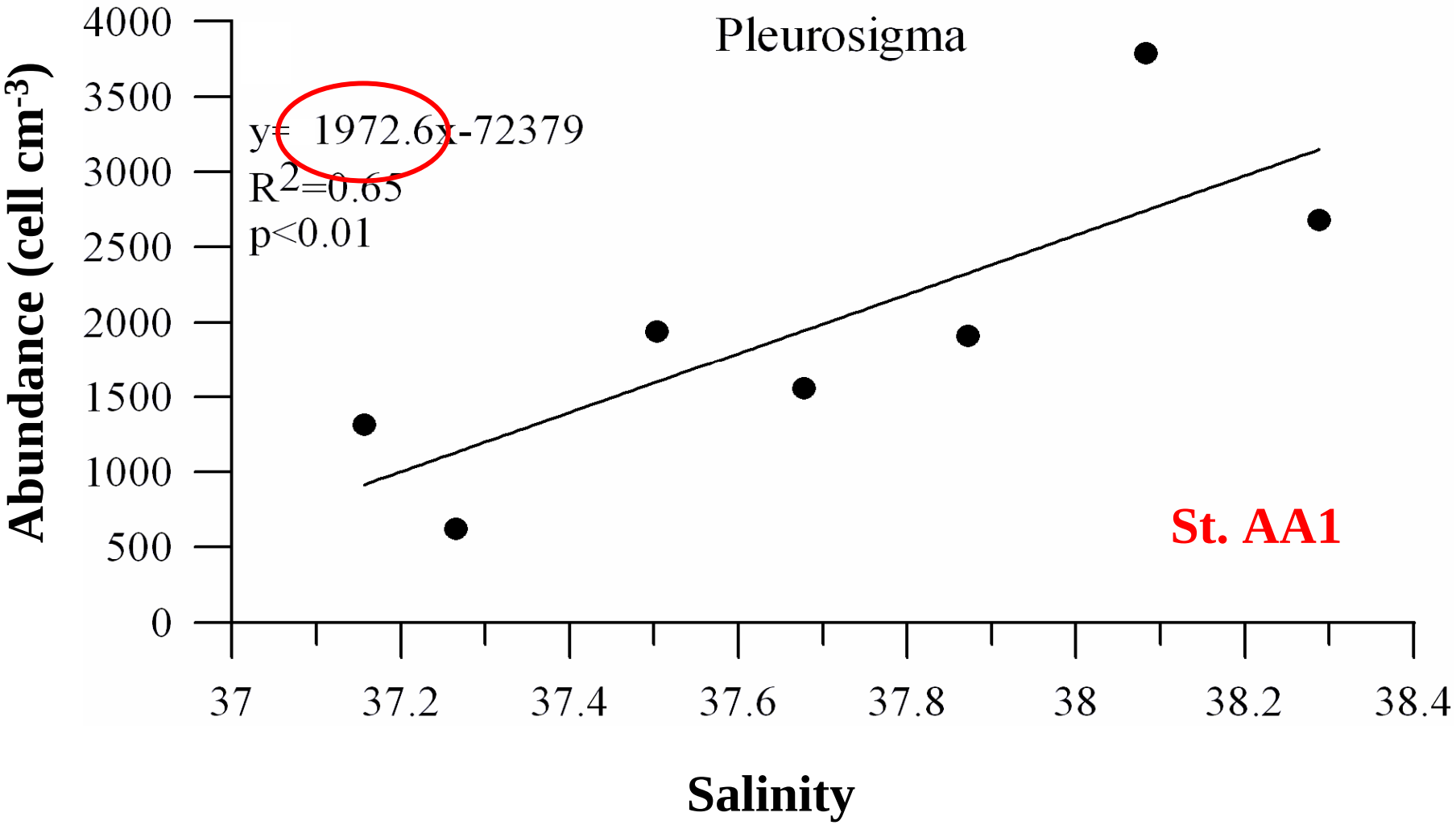
Bin-averaged temperature *vs* abundance



Bin-averaged temperature *vs* abundance



Bin-averaged salinity *vs* abundance



Conclusions (1)

- Although our observational period covers only seven years, we found that the benthic diatom community has already shown some variations in its composition, responding to the modified abiotic conditions.
- According to the increasing trend of temperature and salinity observed by Malačič et al. (2006) in the Gulf and to the scenarios predicted by IPCC (2001), it is likely that a marked increase of temperature and salinity will occur in the next future. We infer that in this future scenario also the benthic diatom community will shift.
- As temperature rises in the future, the abundance of genera is expected to shift according to their thermal tolerance and ability to adapt (Harley et al. 2006).

Conclusions (2)

• *Diploneis* could disappear from the community and be replaced by *Gyrosigma*.

• *Navicula* and *Nitzschia* could markedly increase becoming the dominant genera.

• In highly saline conditions we could expect a rise of *Pleurosigma* abundances and frequent *Cylindrotheca* blooms.

• All these changes in the specific composition of the benthic diatom community are likely to be reflected also in benthic primary production variations.

• Since the Gulf of Trieste could be considered a natural megacosm due to its geomorphologic characteristics, the benthic diatoms response to changing environmental conditions observed in this site could be extended beyond the geographical limits of this particular ecosystem. In the next future similar changes in the benthic diatom community are likely to occur also in deeper basins.

Acknowledgments

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Thanks for your attention!