nature climate change

SUPPLEMENTARY INFORMATION

DOI: 10.1038/NCLIMATE1628

Emerging *Vibrio* risk at high latitudes in response to ocean warming

Supplementary Fig. 1. Warming trends in the Baltic region. A, maximum (red) and average (blue) summer SST from 1982 and the corresponding linear regression lines. B, monthly linear regression slopes for SST calculated using a 10-year step since 1854 showing a strong warming signal for analysis comprising a higher percentage of recent SST fields.

Supplementary Fig. 2. Histogram of observed distribution of *vibrio* infections observed annually. Solid line shows best fit prediction based on a negative binomial distribution, k = shape parameter, mu = average number of cases.

Supplementary Fig. 3. Remote sensing analysis of the Baltic during an 'at risk' period: A: 27th July 2006: SST field over the Baltic Sea region. Peak temperatures in the region were maximum during this month and B: average conditions for that date between 1982-2010. C: SST anomaly map showing the high, abnormal temperatures in the Baltic during this period, and D: corresponding daily risk analysis.

Supplementary Fig. 4. Risk maps showing the highest (summer) values for selected years over the period 1988-2010. The risk model for *V. vulnificus* infections was constructed based on observed SST and salinity. Low salinity areas (< 25 ppt NaCl) allows to delineate the region suitable for the occurrence of *V. vulnificus,* while SST acts as a predictor of risk, which is defined from the number of cases in relation to changes in SST according to the GLM model.

Supplementary Fig. 5. Average sea surface salinity conditions in the Western Atlantic and Euro-Asiatic border obtained from the World Ocean Atlas (NOAA/NODC). Salinity fields are based on average decadal (1955-2006) datasets that include salinity profile data from multiple sources, such as bottle samples, ship-deployed Conductivity-Temperature-Depth (CTD) sensors, profiling floats, and moored and drifting buoys.

Supplementary Table 1.

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Cases ~ Year + Maxtemp, family = quasipoisson, link function = ln)
Deviance Residuals:
   Min       1Q         Median      3Q          Max
-2.901      -1.34       -0.41       0.91        3.87

Coefficients:
              Estimate  exp(Estimate)     Std. Error  t value     Pr(>|t|)
Intercept    -187.47    3.83e-82          41.64       -4.50       0.0001
Year           0.09     1.09              0.02         4.23       0.0003
Max SST        0.66     1.93              0.13         5.15       2.54e-05

Dispersion parameter for quasipoisson family taken to be 3.65
Null deviance: 402.08  on 27  degrees of freedom
Residual deviance:  69.72  on 25  degrees of freedom
Reduction in deviance = 332, Df = 2, P(>|Chi|) <2.2e-16
Number of Fisher Scoring iterations: 5
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Supplementary Table 1. GLM results investigating the relationship between observed wound associated *Vibrio* infections in the Baltic Sea region and maximum SST and time (years).

Supplementary Table 2

Year	Countries reporting cases	Number of cases	Species of infections
1985-1993	Finland, Denmark, (Netherlands, Belgium)	9	*V. vulnificus, V. cholerae* (non O1)
1994	Germany, Sweden, Denmark, Finland	21	*V. vulnificus, V. cholerae* (non O1), *V. alginolyticus*
1995	Denmark, Finland, Estonia	8	*V. vulnificus, V. cholerae* (non O1)
1996	Denmark, Finland	2	*V. cholerae* (non O1)
1997	Sweden, Finland, Denmark	21	*V. vulnificus, V. cholerae* (non O1), *V. alginolyticus, V. damsela*
1998	Finland, Denmark	6	*V. cholerae* (non O1)
1999	Finland	8	*V. cholerae* (non O1), *V. fluvialis*
2000	Finland	5	*V. cholerae* (non O1), *V. parahaemolyticus*
2001	Finland, Sweden	11	*V. cholerae* (non O1), *V. parahaemolyticus*, *V. vulnificus*
2002	Germany, Finland	10	*V. cholerae* (non O1), *V. vulnificus*
2003	Finland, Germany, Sweden	19	*V. cholerae* (non O1), *V. vulnificus*
2004	Finland, Sweden	6	*V. cholerae* (non O1), *V. parahaemolyticus*, Vibrio spp*
2005	Finland, Sweden	9	*V. cholerae* (non O1), *V. parahaemolyticus*, Vibrio spp*
2006	Germany, Denmark, Sweden, Poland, Finland, Estonia, (Netherlands)	67	*V. vulnificus, V. cholerae* (non O1), *V. alginolyticus* *V. parahaemolyticus*, Vibrio spp*
2007	Finland, Sweden	14	*V. cholerae* (non O1), Vibrio spp*
2008	Sweden, Finland, (Netherlands)*	13	*V. vulnificus,* Vibrio spp*
2009	Finland, Sweden, Germany, (Netherlands)	15	*V. cholerae* (non O1), *V. parahaemolyticus*, *V. alginolyticus,* Vibrio spp.
2010	Finland, Sweden, Germany, (Netherlands)	36	*V. cholerae* (non O1), *V. parahaemolyticus*, *V. alginolyticus, V. vulnificus* Vibrio spp*.

Supplementary Table 2. *Vibrio* cases reported per year in the Baltic Sea region, 1985-2010.

Supplementary Table 3

Year	Countries reporting cases	Number of fatalities	Species responsible
1994	Germany, Denmark,	2	*V. vulnificus,*
1997	Sweden	2	*V. vulnificus,*
2003	Finland, Germany	2	*V. cholerae* (non O1), *V. vulnificus*
2006	Sweden, Germany	5	*V. cholerae* (non O1), *V. vulnificus*
2009	Germany	1	*V.alginolyticus*/*V. parahaemolyticus*
2010	Germany	2	*V. cholerae* (non O1), *V. vulnificus*

Supplementary Table 3. Reported fatalities in the Baltic Sea region associated with vibrios, 1994-2010

Figure S1

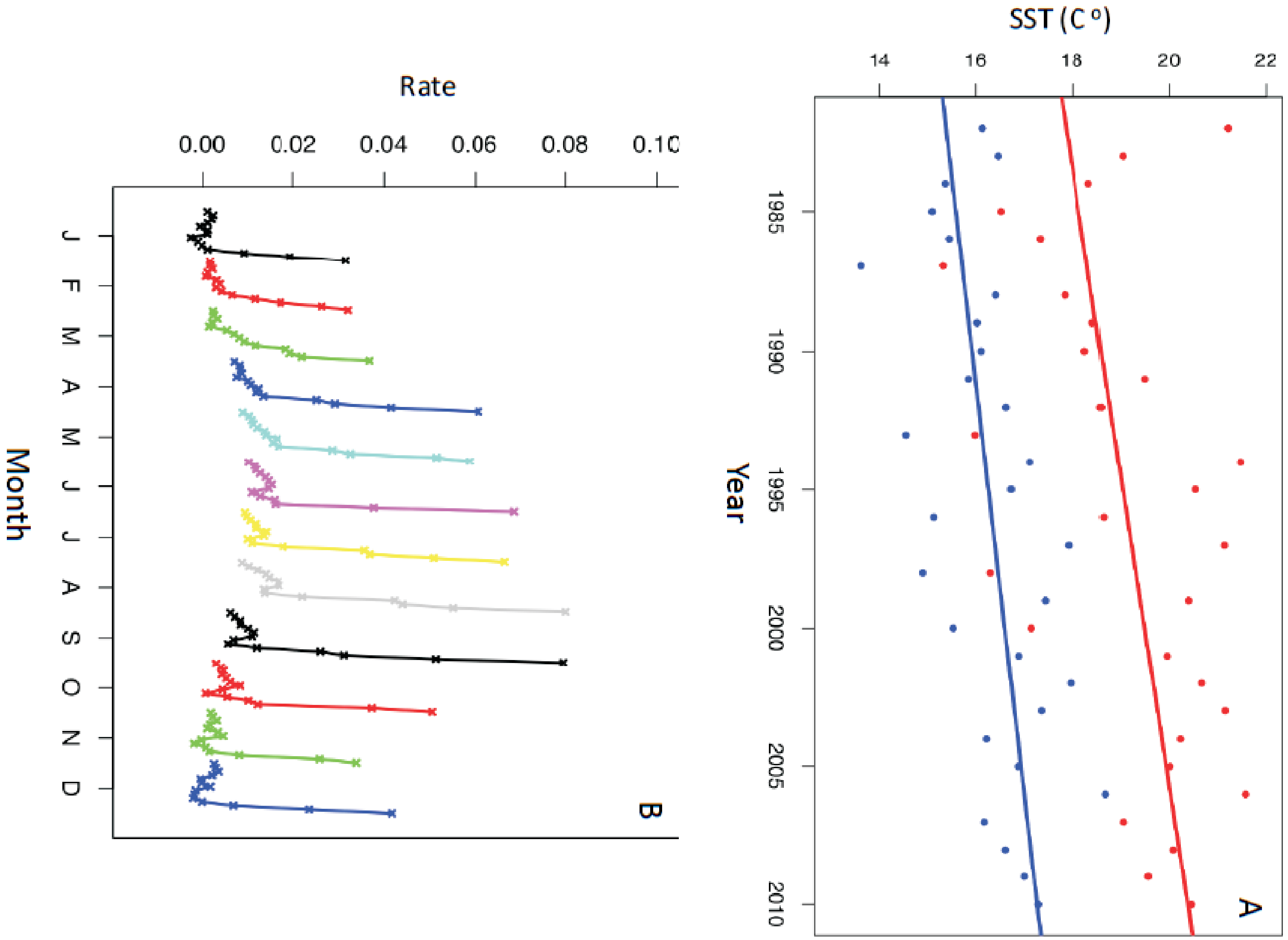

SST (C °)
14
16
18
20
22
Year
1985
1990
1995
2000
2005
2010
A
Rate
0.00
0.02
0.04
0.06
0.08
0.10
Month
J
F
M
A
M
J
J
A
S
O
N
D
B

Figure S2

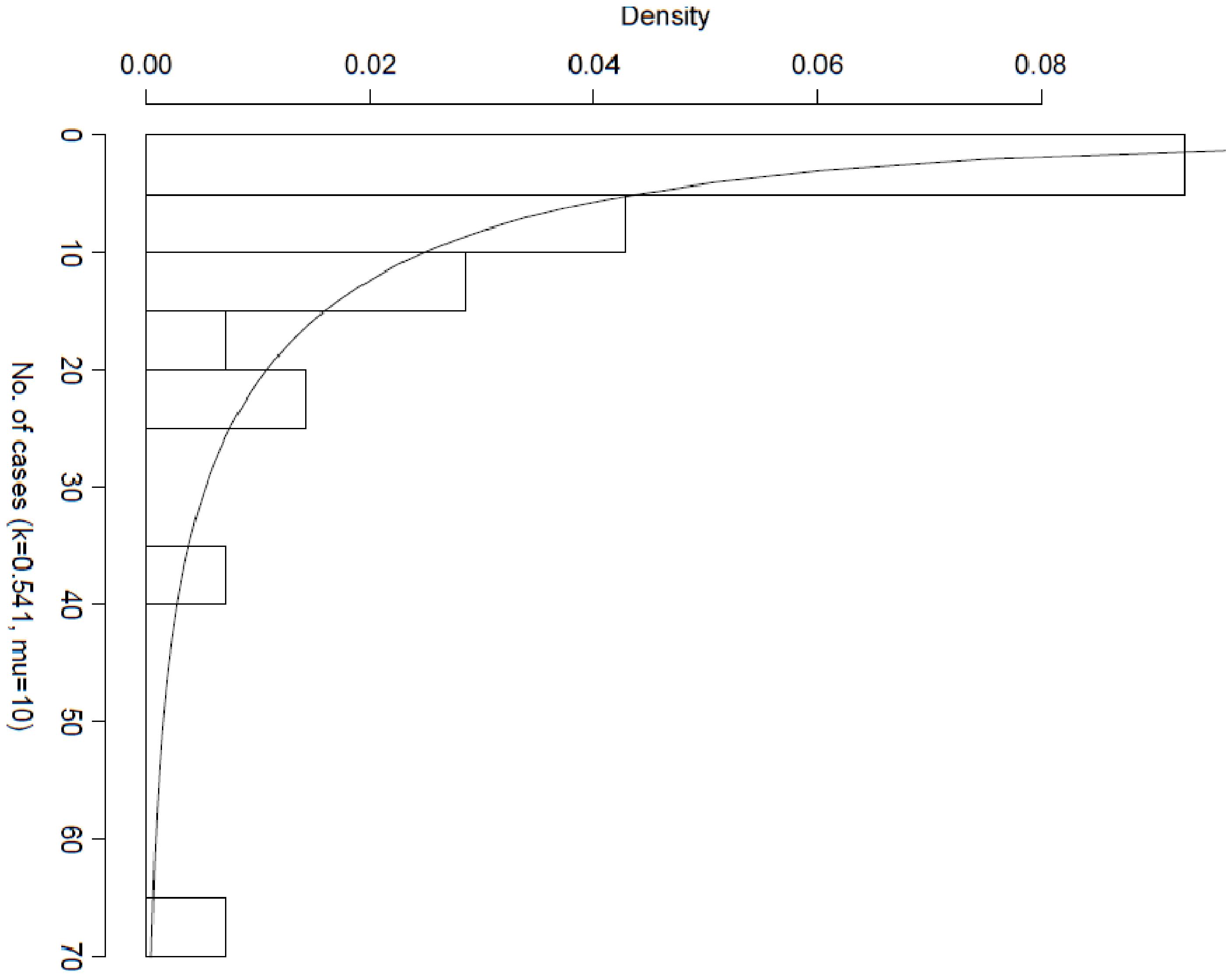
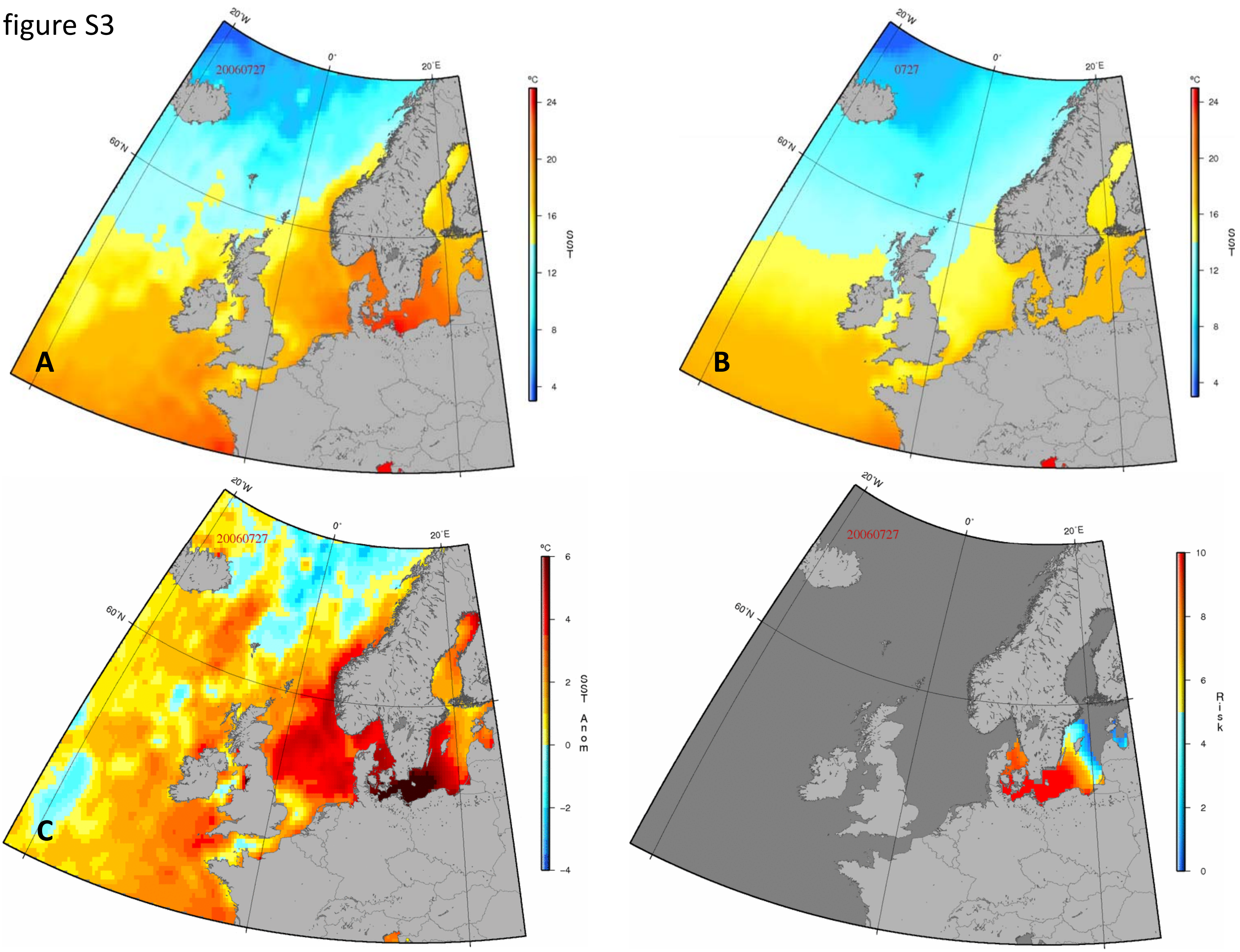

Density
0.00
0.02
0.04
0.06
0.08
0
10
20
30
40
50
60
70
No. of cases (k=0.541, mu=10)

figure S3


20°W
0°
20°E
60°N
20060727
°C
24
20
16
12
8
4
SST
A
20°W
0°
20°E
60°N
0727
°C
24
20
16
12
8
4
SST
B
20°W
0°
20°E
60°N
20060727
°C
6
4
2
0
-2
-4
SST Anom
C
20°W
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60°N
20060727
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6
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0
Risk

figure S4

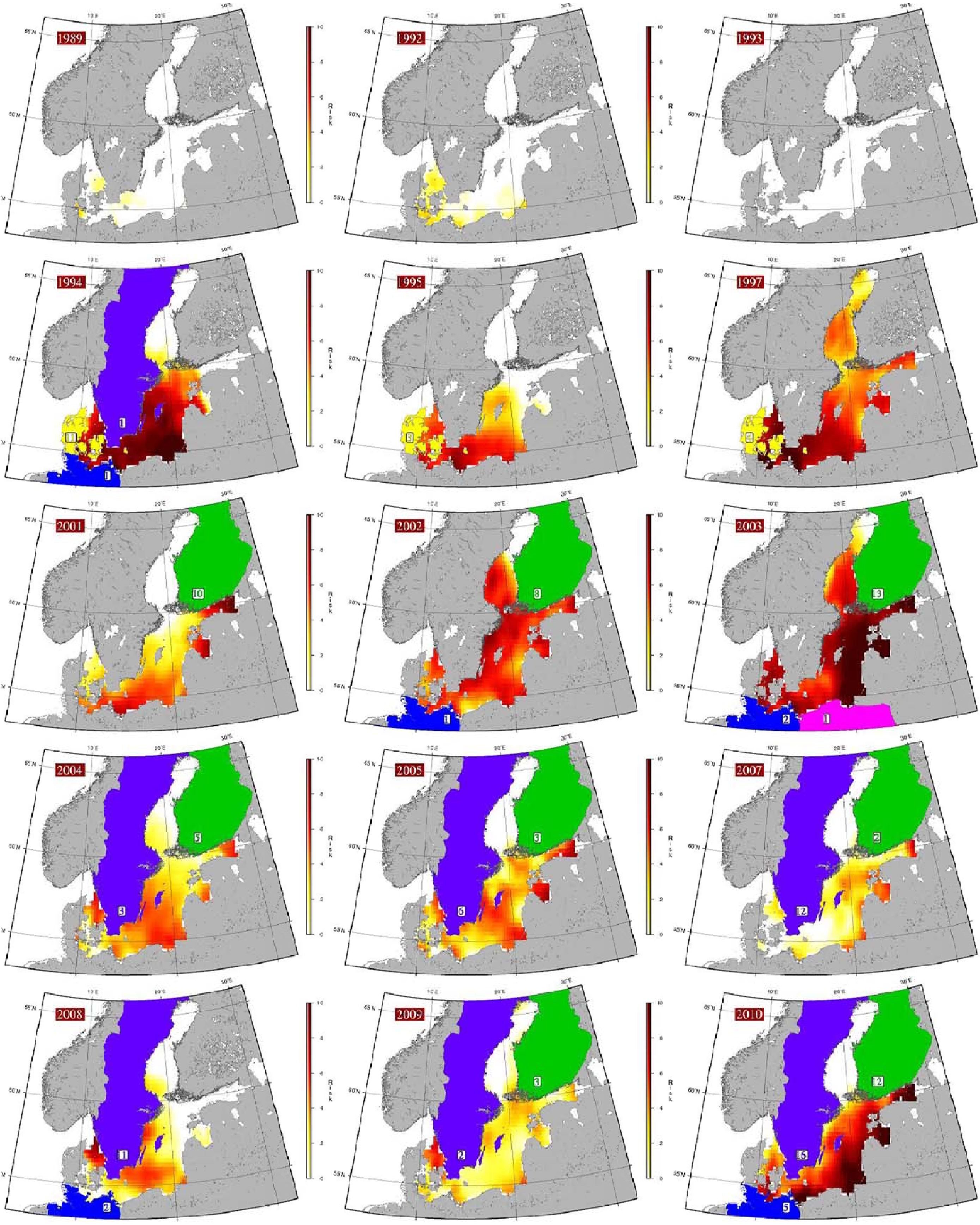
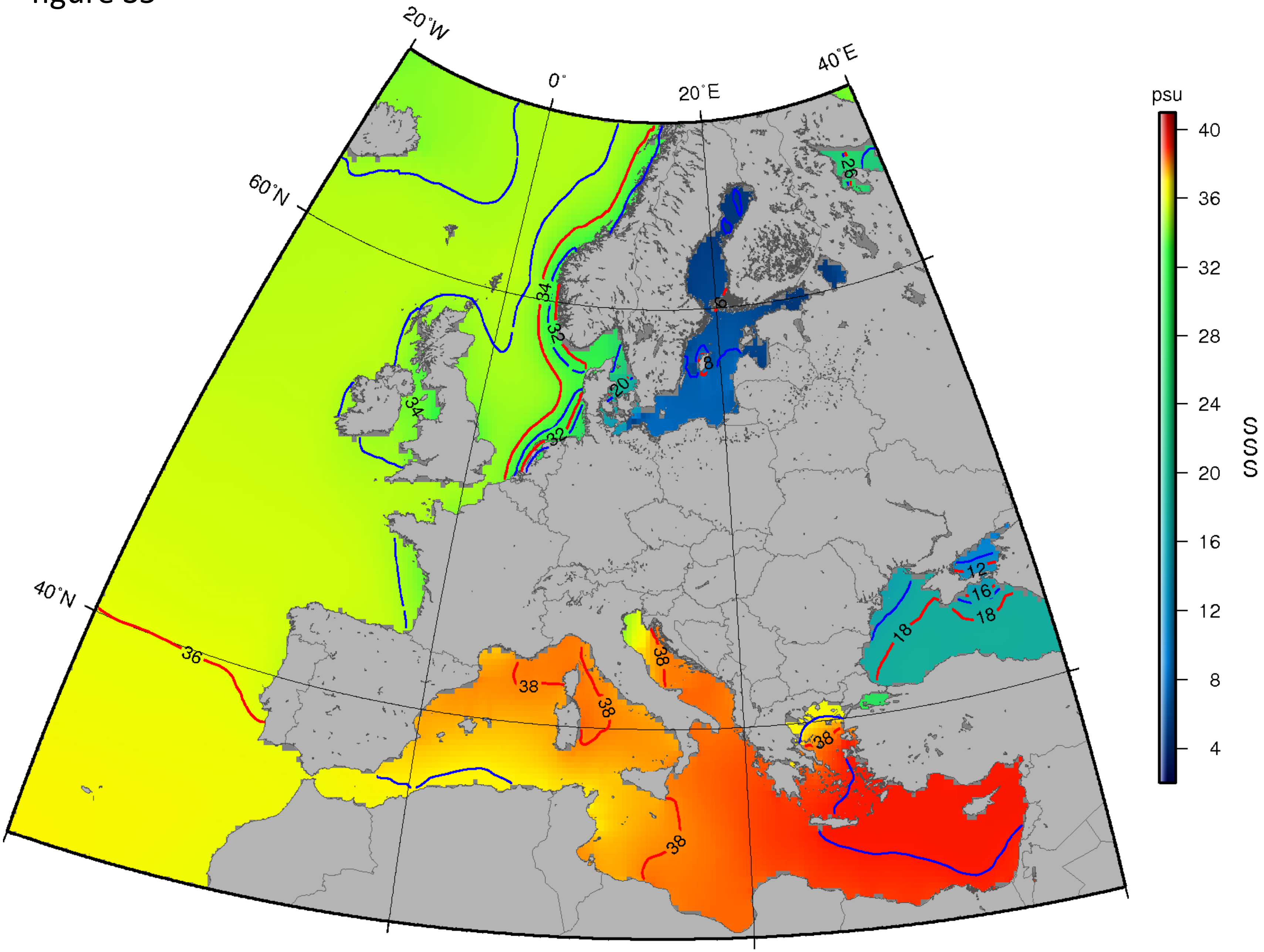

1989
1992
1993
1994
1995
1997
2001
2002
2003
2004
2005
2007
2008
2009
2010
10°E
20°E
30°E
55°N
60°N
65°N
Risk
0
2
4
6
8
10
1
1
10
8
1
2
13
1
3
5
6
6
12
2
11
2
2
3
16
5
12

figure S5



20°W
0°
20°E
40°E
60°N
40°N
psu
40
36
32
28
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8
4
SSS
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