Mass sinking of individual species populations during an iron fertilization experiment in the Southern Ocean (EIFEX)

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I. The European Iron Fertilization Experiment (EIFEX), conducted in the Polar Frontal Zone of the Southern Ocean, induced a large phytoplankton bloom in the deeply mixed surface layer (Fig. 1). In the final week of the experiment the bloom crashed as indicated by decreasing chlorophyll concentrations.

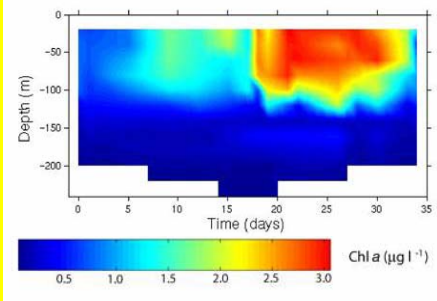

Fig. 1: Temporal and vertical evolution of the iron-induced bloom over the course of EIFEX.

II. *Chaetoceros* populations crashed within days of each other at the surface (Fig. 2a) and sank out successively (Fig. 2b).

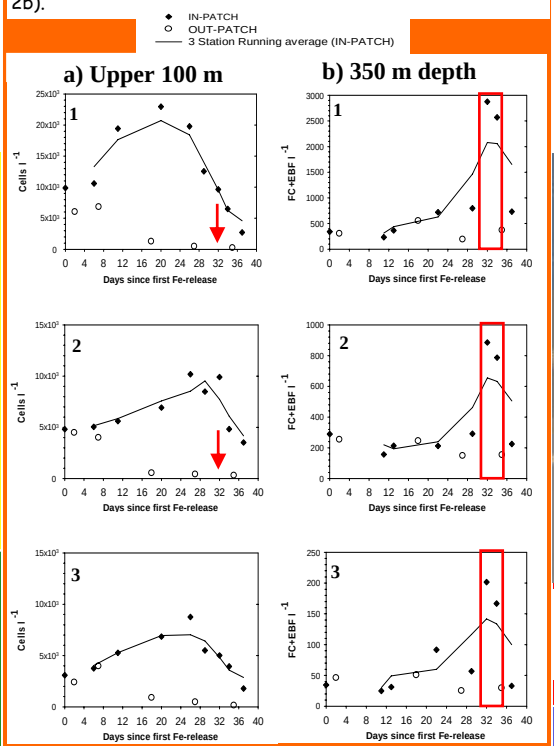

Fig. 2: a) Average mixed layer (upper 100 m) abundance of full cells over the course of EIFEX: 1) *Chaetoceros dichaeta*, 2) *C. atlanticus* and 3) *C. convolutus*.
b) Abundance of full cells (FC) + empty and broken frustules (EBF) in 350 m depth over the course of EIFEX: 1) *Chaetoceros dichaeta*, 2) *C. atlanticus* and 3) *C. convolutus*. Framed area indicates the sinking event.

III. On day 32 of the experiment the autofluorescence signal of intact chains of *Chaetoceros dichaeta* faded (Fig. 3a+b), indicative of a dying population. Whereas *C. atlanticus* that crashed later in the experiment still showed a viable autofluorescence signal (Fig. 3c).

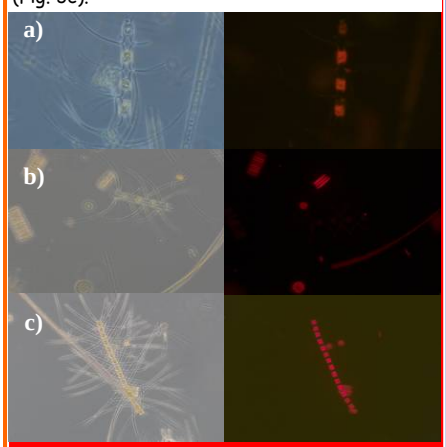

Fig. 3: Light (left row) and epifluorescence (right row) micrographs of a+b) *Chaetoceros dichaeta* and c) *C. atlanticus* chains. Micrographs were taken on day 32 of the experiment (indicated with red arrow in figure 2a1 + 2a2).

IV. Full, empty and broken cells and chains of e.g. *Chaetoceros dichaeta* sank down the deep water column (Fig. 4) and reached the sea floor at ca. 3700 m depth within 2 weeks after disappearance in the surface (Fig. 5).

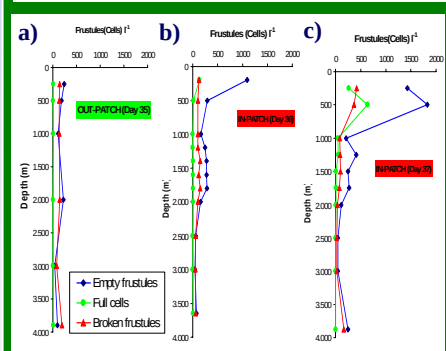

Fig. 4: Deep profiles (200 - ~3700 m) of full cells, empty and broken frustules of *Chaetoceros dichaeta* at one out-patch (a) and two in-patch (b + c) stations towards the end of EIFEX.

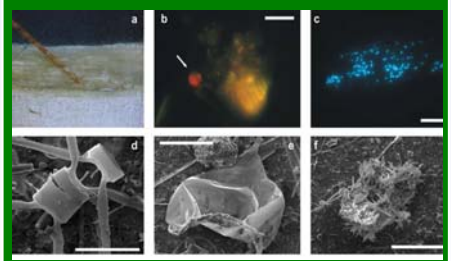

Fig. 5: Evidence of freshly deposited material underneath the EIFEX area (a-f): a) Sediment core with a 5 mm thick fluff layer. b) Chl-a fluorescence (arrow) of an intact dinoflagellate cell in ~3600 m; scale bar: 50 µm. c) High bacterial activity on a colonised cell of *Corethron* sp. in the fluff layer; scale bar: 50 µm. d) SEM micrograph of an intact chain of *Chaetoceros atlanticus*; scale bar: 20 µm. e) Lorica of the tintinnid ciliate *Cymatocylis* sp.; scale bar: 50 µm. f) fecal pellet containing diatom debris; scale bar: 100 µm.

Conclusions. During EIFEX the fate of an iron-induced bloom was followed in detail. For the first time the massive sinking event down the water column to the sea floor, in the aftermath of the iron-induced bloom, was examined from an ecological viewpoint at the species population level. The findings confirm similarity between oceanic and coastal blooms but raise intriguing questions concerning the evolutionary ecology of phytoplankton populations.

V. Other species that responded later to iron addition, continued growth in the surface layer (Fig. 6). So the bloom continued after the sinking event.

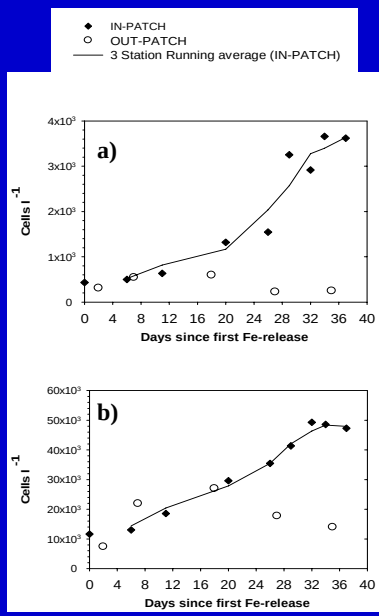

Fig. 6: Average mixed layer (upper 100 m) abundance of full cells over the course of EIFEX: a) *Corethron inerme*, b) *Thalassionema nitzschioides*.