A comparison of PCB congener, organochlorine pesticide, and industrial compound burdens in firn and ice cores from Antarctica and Svalbard

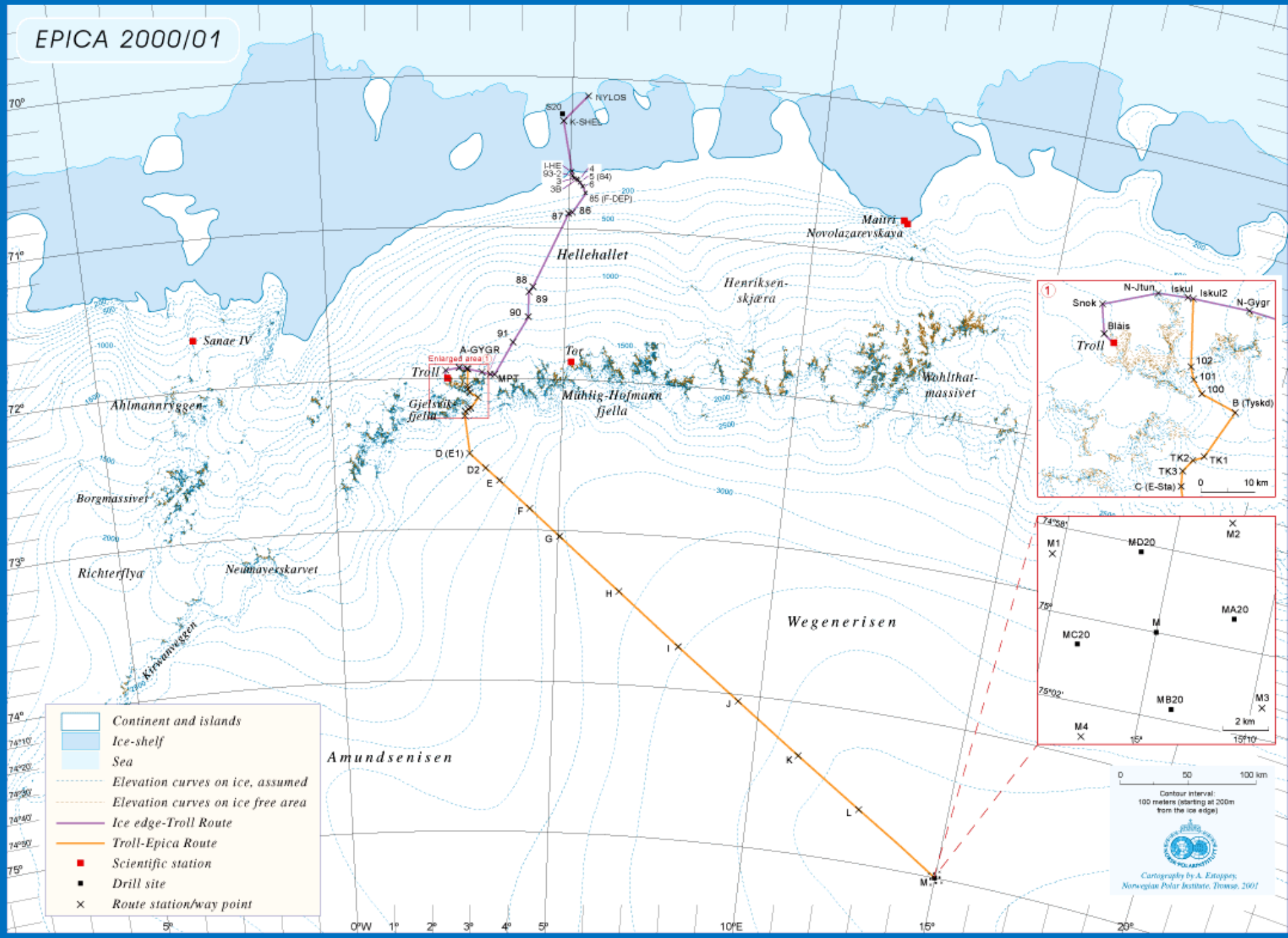
Mark H. Hermanson[1], Elisabeth Isaksson[2], Richard Hann[3], Rachel M. Ruggirello[4], Camilla Teixeira[5], Derek C. G. Muir[5]

[1]Hermanson & Associates LLC, Minneapolis, USA
[2]Norwegian Polar Institute, Tromsø
[3]Norwegian University of Science & Technology, Trondheim
[4]Washington University in St. Louis, USA
[5]Environment and Climate Change Canada, Burlington

The Site M core was a composite of firn cores drilled at the terminal site (M) of the Norwegian Antarctic Traverse in 2000-2001, part of the European Program for Ice Coring in Antarctica (EPICA).

The Site M composite was one sample covering 1958-2000.

The Site M elevation is ~3450 m a.s.l.

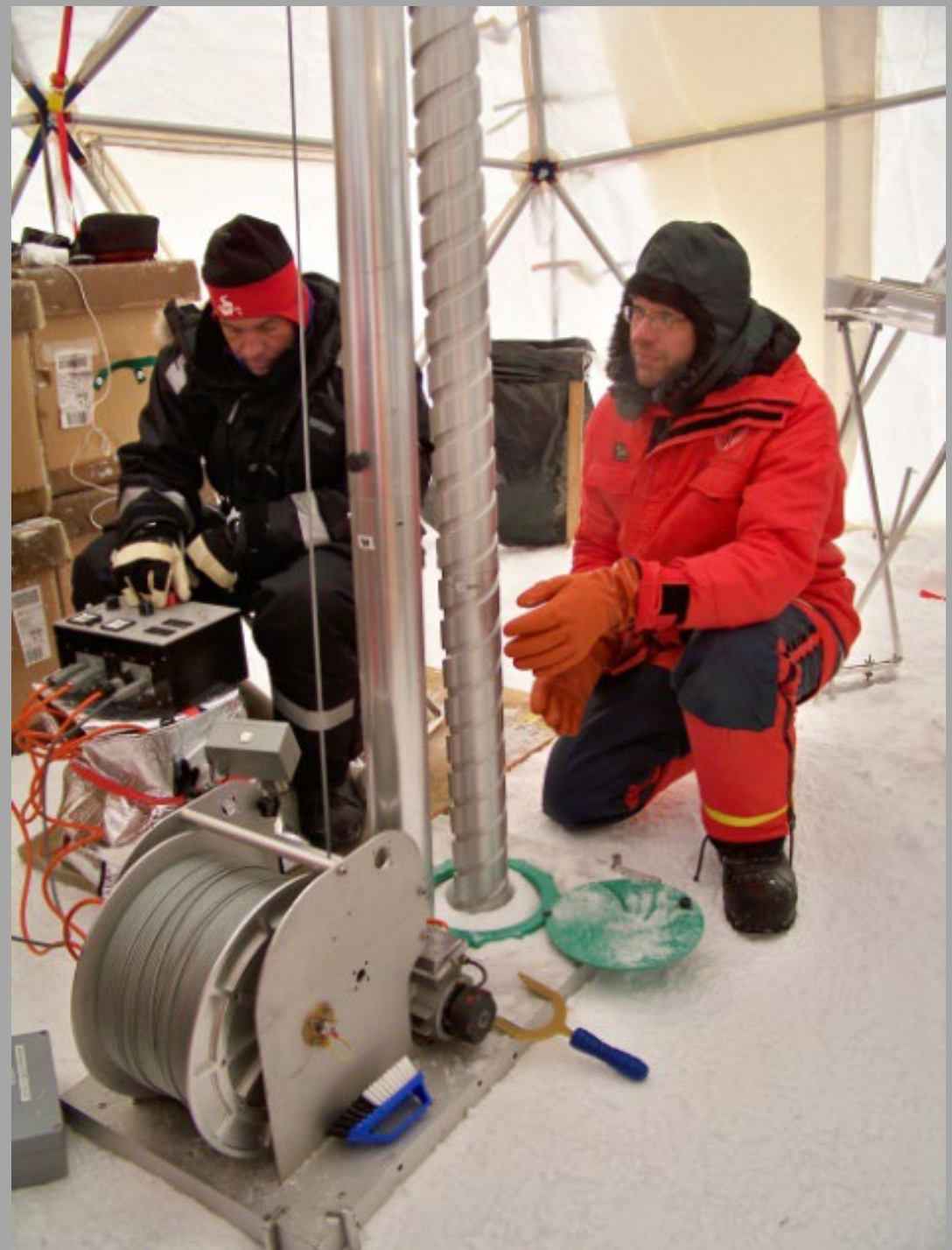


The Site M drill was a PICO (Polar Ice Coring Office) hand augur, used to drill a series of firn cores to a depth of 20 m.

The Holtedahlfonna site is among the highest elevation glaciers on Svalbard (1100 m a.s.l.). It is above the tropospheric boundary layer all year. The core was drilled in 2005.

For this study, the PCBs, OCPs and OHICs at Holtedahlfonna core were calculated as a whole core amount for comparison to Site M.

At Holtedahlfonna, an electro-mechanical drill system was used to drill a core dating to the 1800s. The top 35 meters, from 1953, were analyzed for OC contaminants.



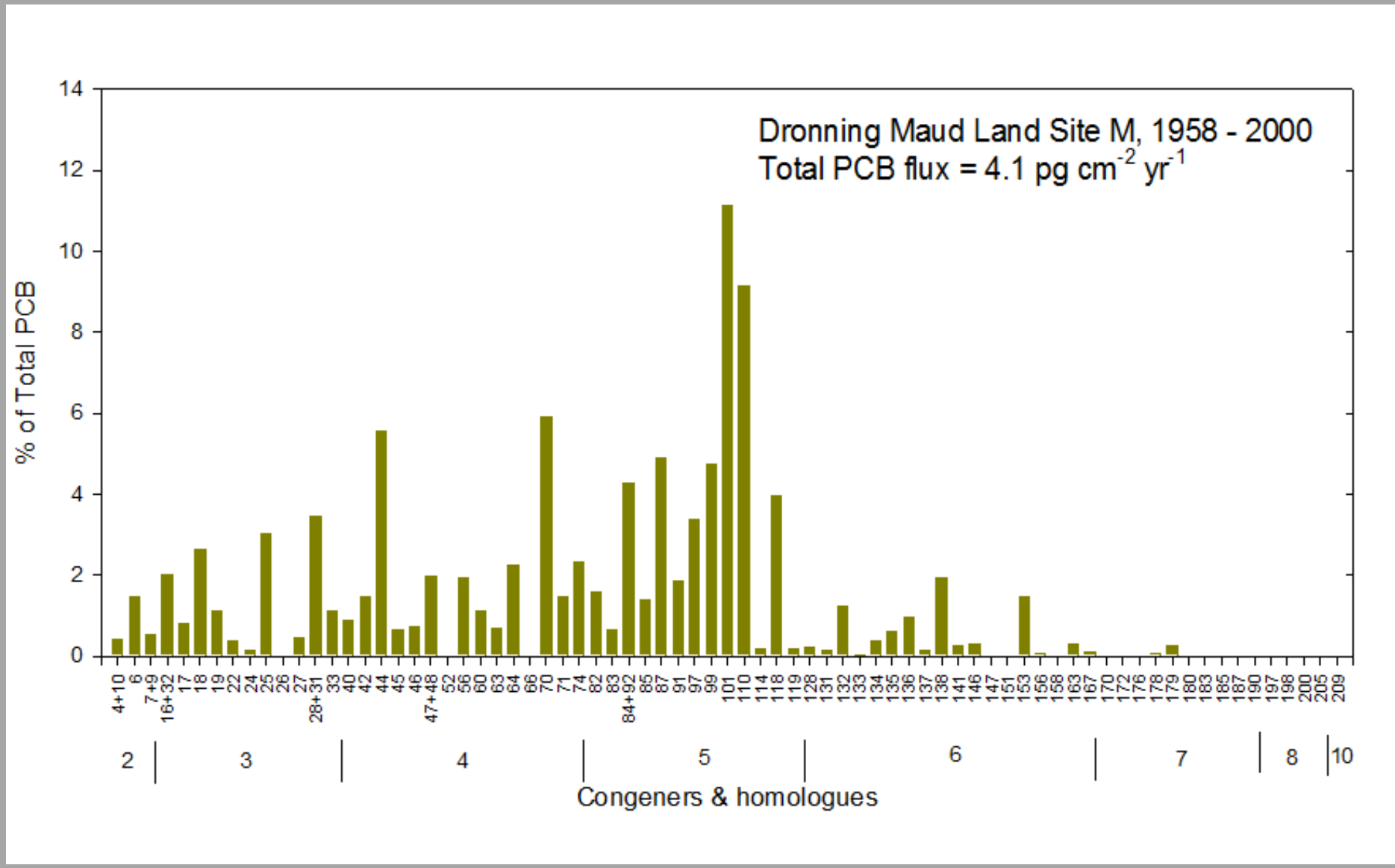
Dronning Maud Land, **Site M** PCB distribution

Top 5 PCB congeners:
101, 110, 70, 44, 87

Pentachloro homologue dominates.

Missing common congeners: 52, 66

Total PCB burden:
172 pg cm^{-2}



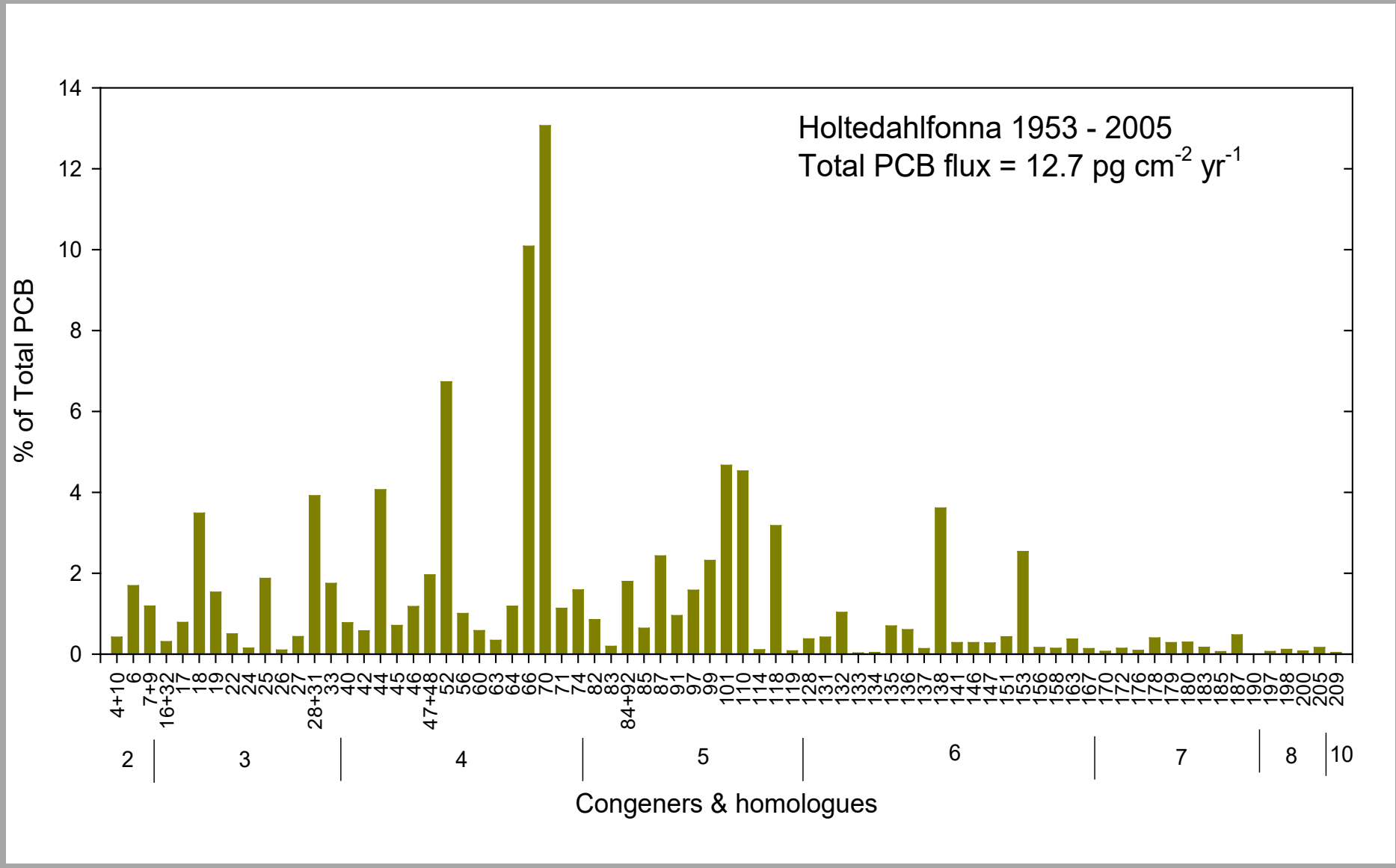
Holtedahlfonna, Svalbard PCB distribution

Top 5 PCB congeners:
70, 66, 52, 44, 87

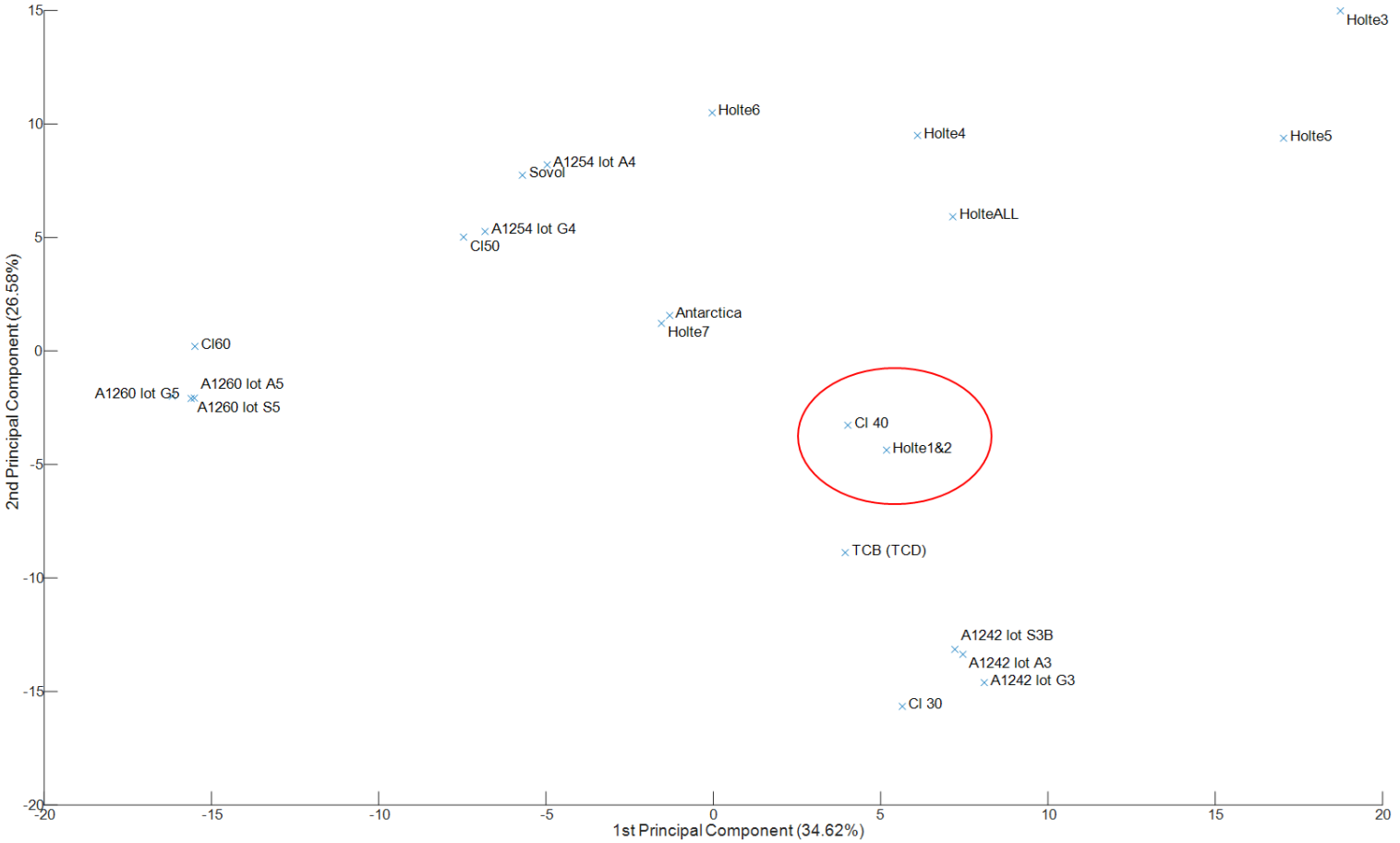
Tetrachloro homologue dominates.

PCB-52 and PCB-66 are ~16% of PCB.

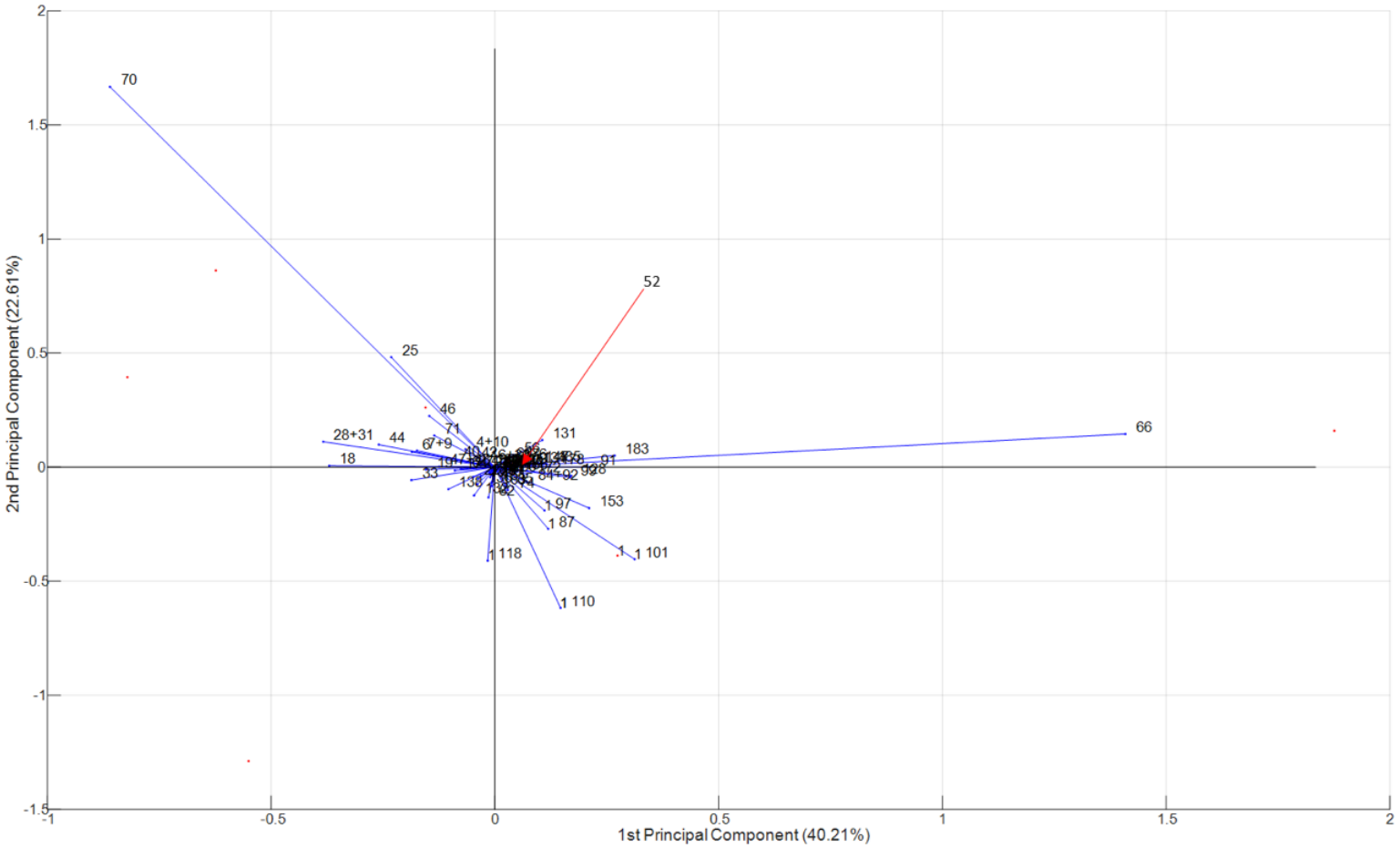
Total PCB burden:
658 pg cm^{-2}



A PCA of the PCB variance in the Holtedahlfonna whole core, core segments and Antarctica Site M shows close association with German PCB product Clophen 40 for the surface sample at Holtedahlfonna.



A PCA biplot of PCB congeners in all samples shows highest variance for PCB-66 and PCB-70 but little for PCB-52 (noted with red line) because it had little down-core variance at Holtedahlfonna.



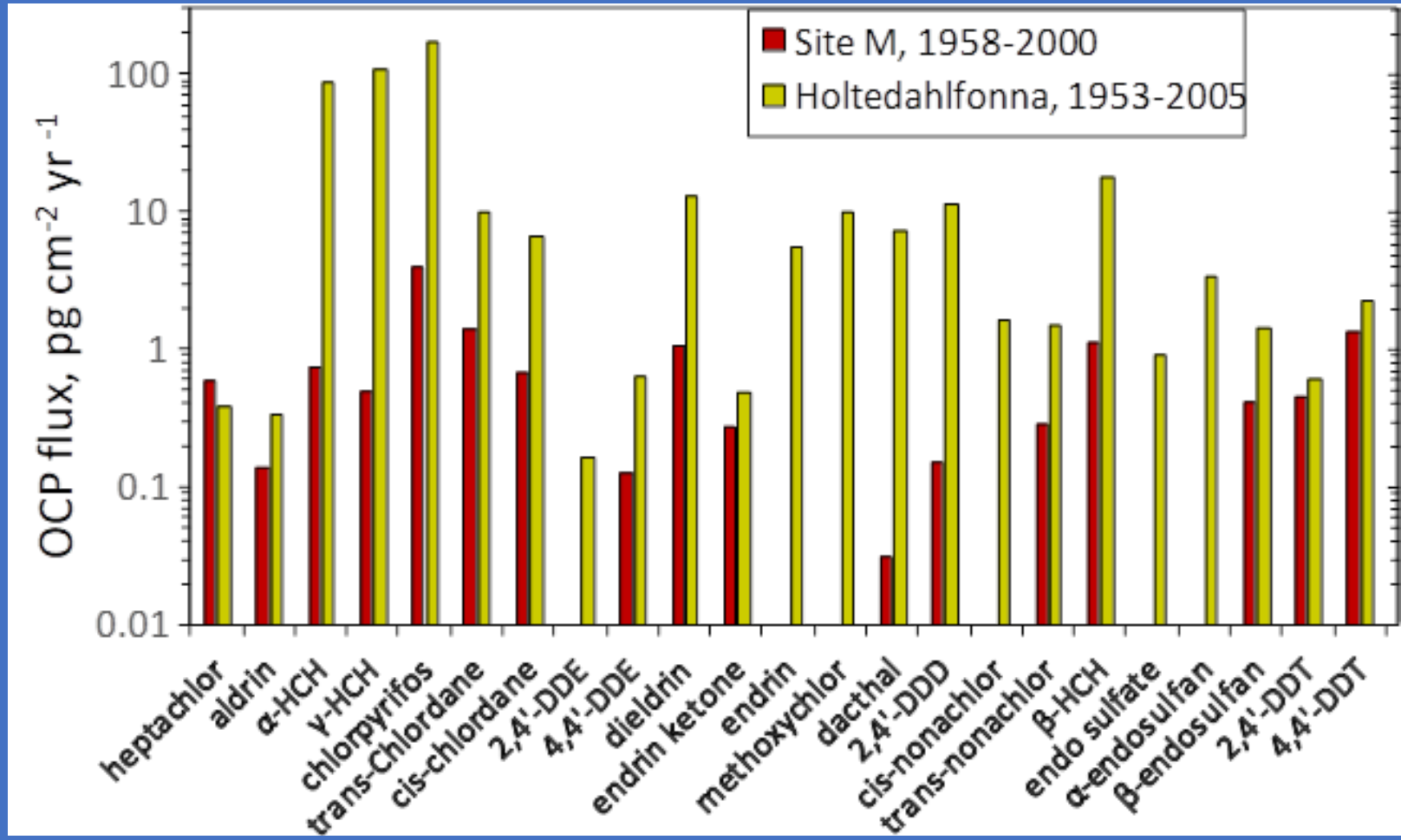
OCPs at Site M and Holtedahlfonna

The 23 OCPs found above detection at Holtedahlfonna arranged by vapor pressure, high to low.

Total burden of 17 OCP at Site M was 556 pg cm^{-2}

Total burden of 23 OCP at Holtedahlfonna was 24 300 pg cm^{-2}

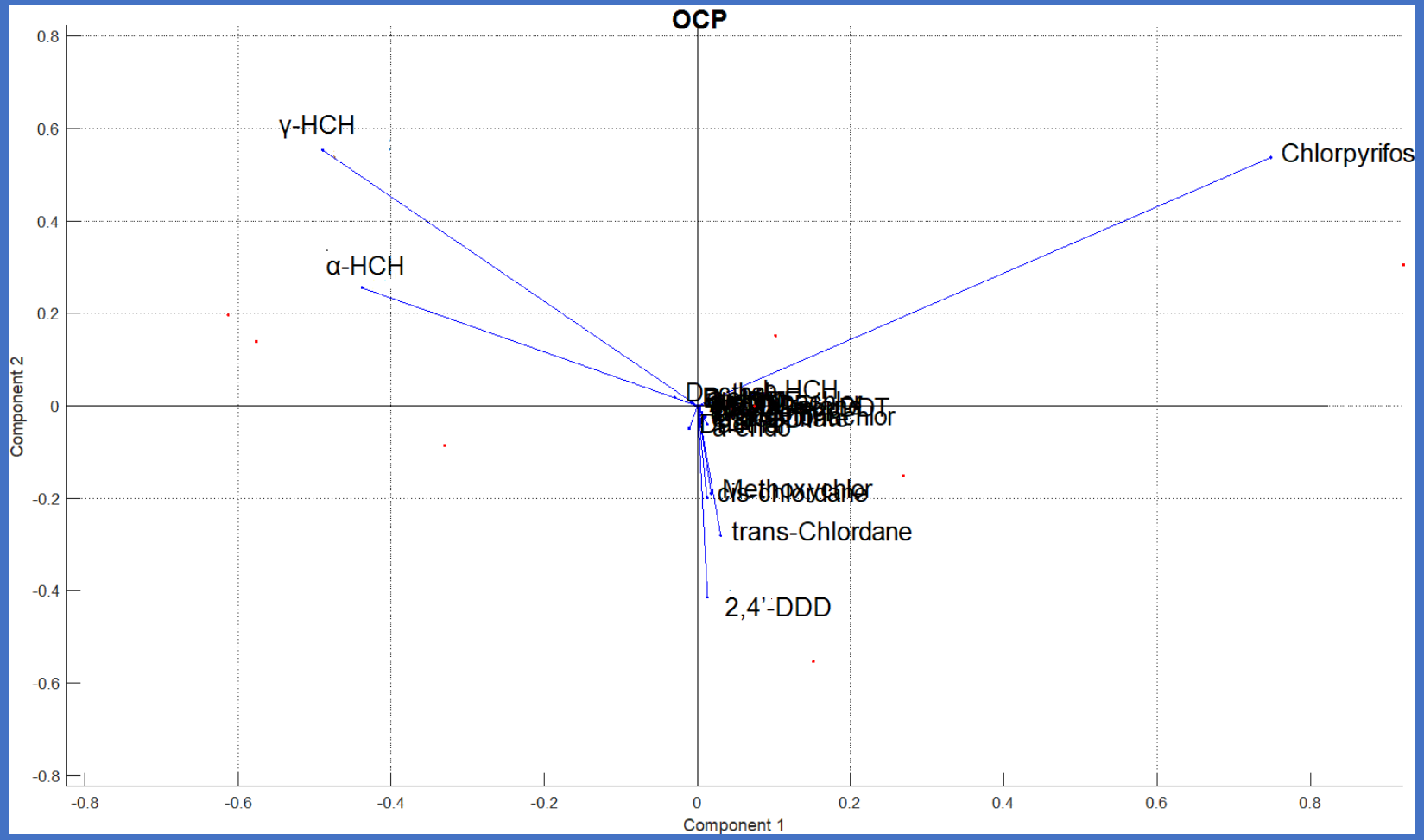
The highest burden to both sites was chlorpyrifos, but at a factor of 50 difference.



Principal components analysis (PCA) biplot showing which OCPs vary most among Site M and Holtedahlfonna whole-core and core segments.

Chlorpyrifos is highest at both sites, but varies by a factor of 50.

α-HCH and γ-HCH are second and third most abundant at Holtedahlfonna, but are sixth and seventh at Site M.



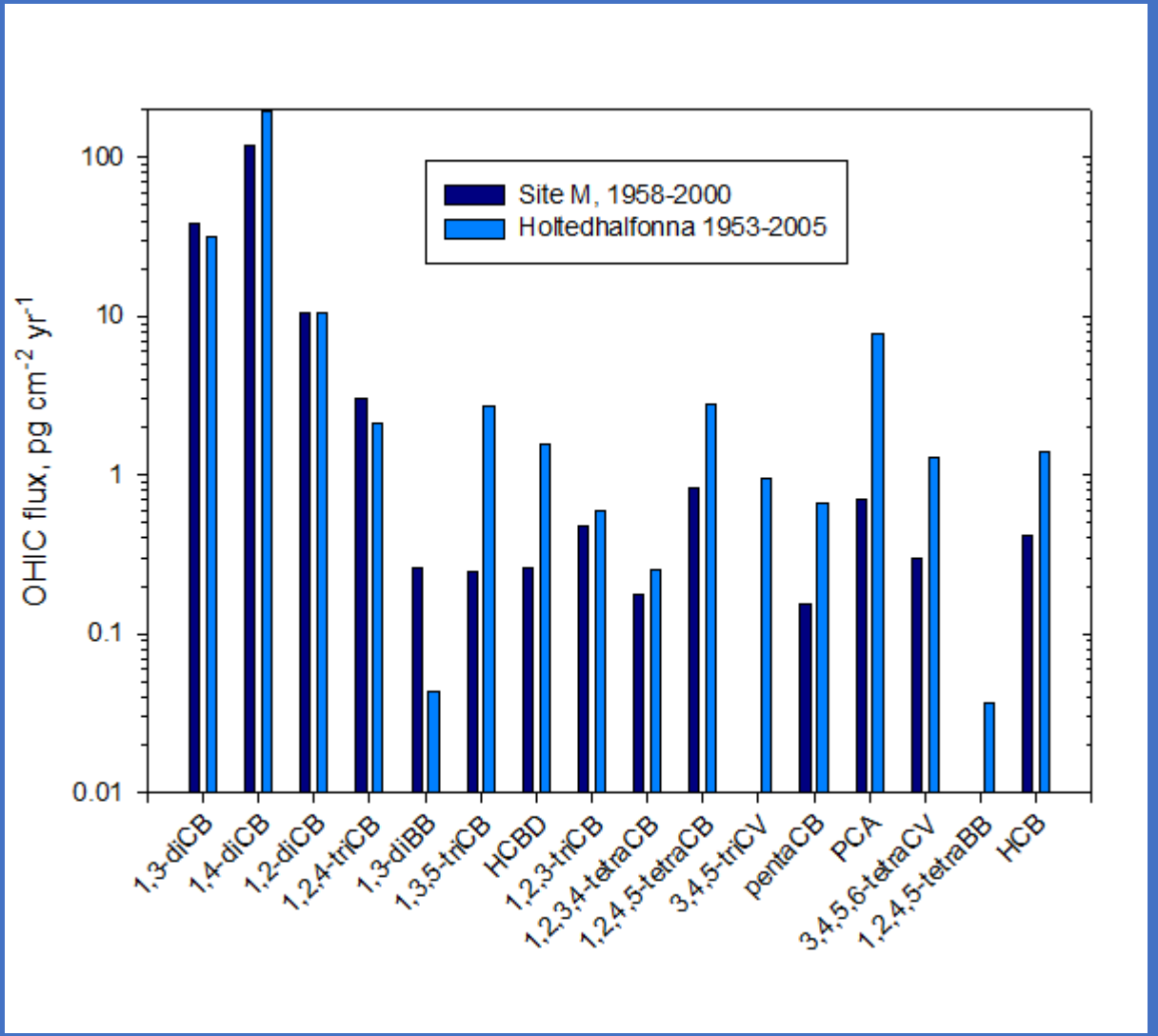
OHICs at Site M and Holtedahlfonna

The OHICs at both sites are mostly dichlorobenzenes, particularly 1,4-diCB.

1,3-diCB at Site M is greater than whole-core Holtedahlfonna, showing that diCBs are present throughout the global atmosphere.

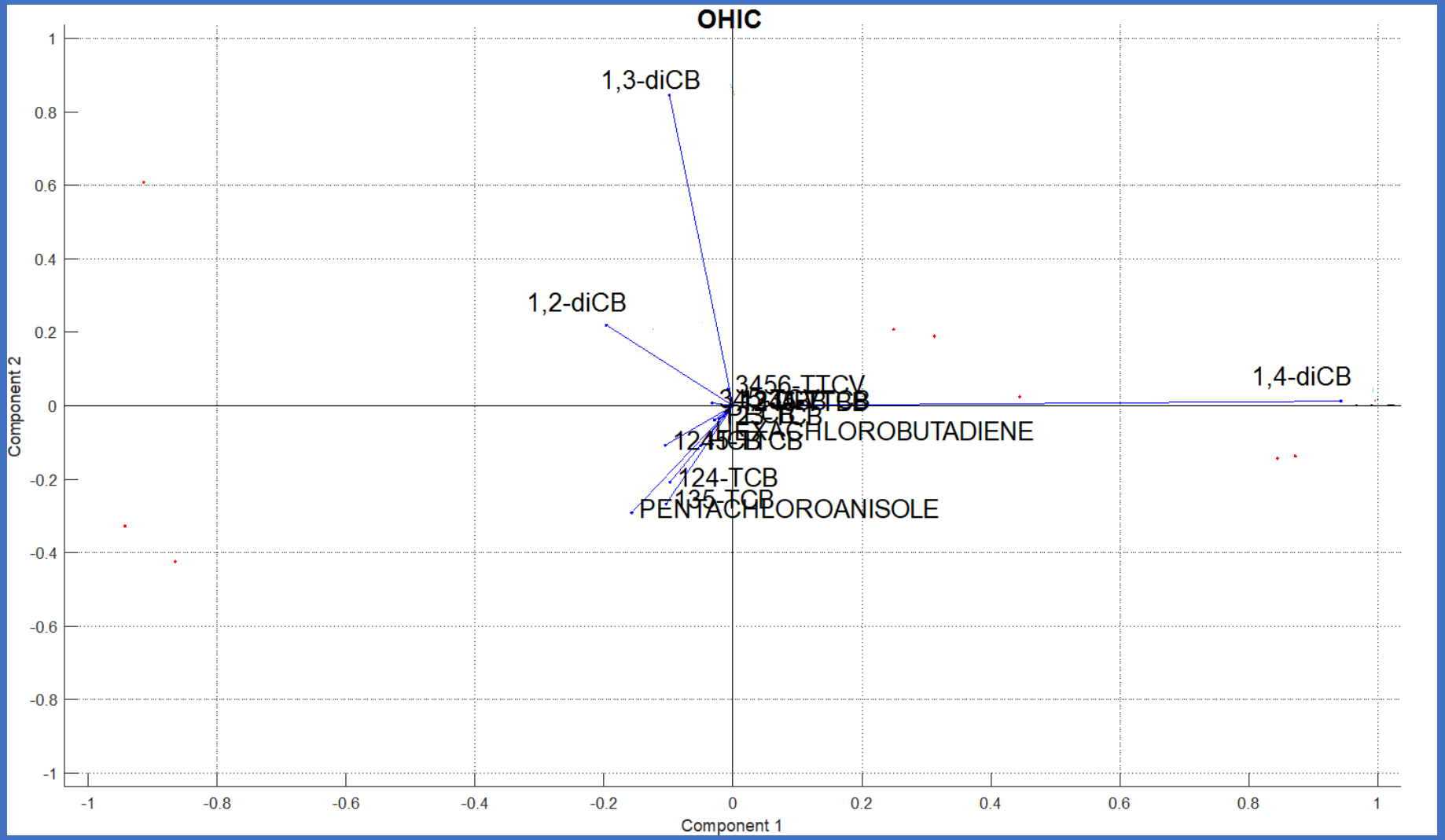
At Holtedahlfonna, the 4th most concentrated was pentachloroanisole (PCA), often observed as a major contaminant in Svalbard glaciers.

Total Site M OHIC burden: 7 300 pg cm^{-2}
Total Holtedahlfonna OHIC burden:
13 500 pg cm^{-2}



A PCA biplot of the Site M and Holtedahlfonna whole core and down-core segment OHIC data shows highest variance among the diCBs.

The result reflects that the diCB are above detection in 50% of the core segments from Holtedahlfonna.



Conclusions

The largest difference in core burden of contaminant was for OCPs, 44 times greater at Holtedahlfonna than at Site M. PCBs were 3.8 times higher at Holtedahlfonna, OHICs 1.8 times higher at Holtedahlfonna.

The PCBs were mostly tetraCB and pentaCB at both sites: Site M was mostly penta, while Holtedahlfonna was mostly tetra.

The OCPs were dominated by chlorpyrifos at both sites, but there were large differences between sites with α-HCH and γ-HCH.

The OHICs were mostly diCB at both sites showing global distribution.

Acknowledgements:

Support for field work was provided by the Norwegian Polar Institute.

Analytical work was by Environment Canada, supported by the Norwegian Polar Institute.