

# NSB, a Big Data tool for chronostratigraphic syntheses of the deep-sea sediment record

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05.07.2019



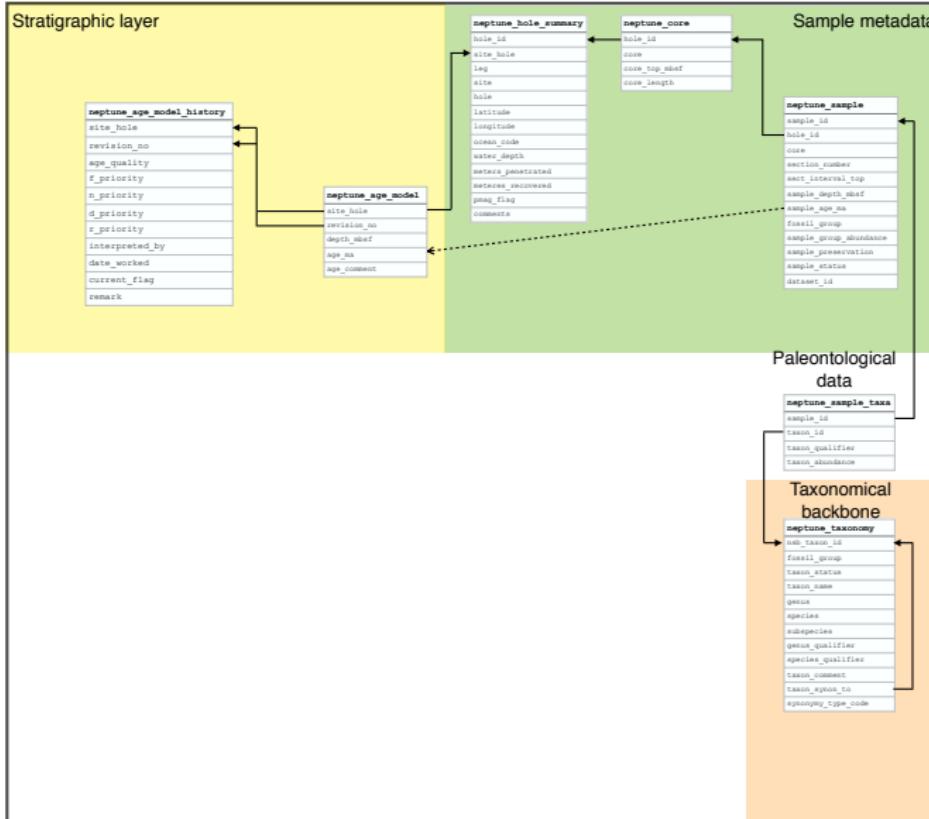
## Outline

- The history of the Neptune Database
- NSB structure and content
- Data quality control
- Web portal
- NSB\_ADP\_wx: tool for exploring NSB age models
- Data provider for Mikrotax, Worms, GBDB
- Summary & Outlook: Future developments

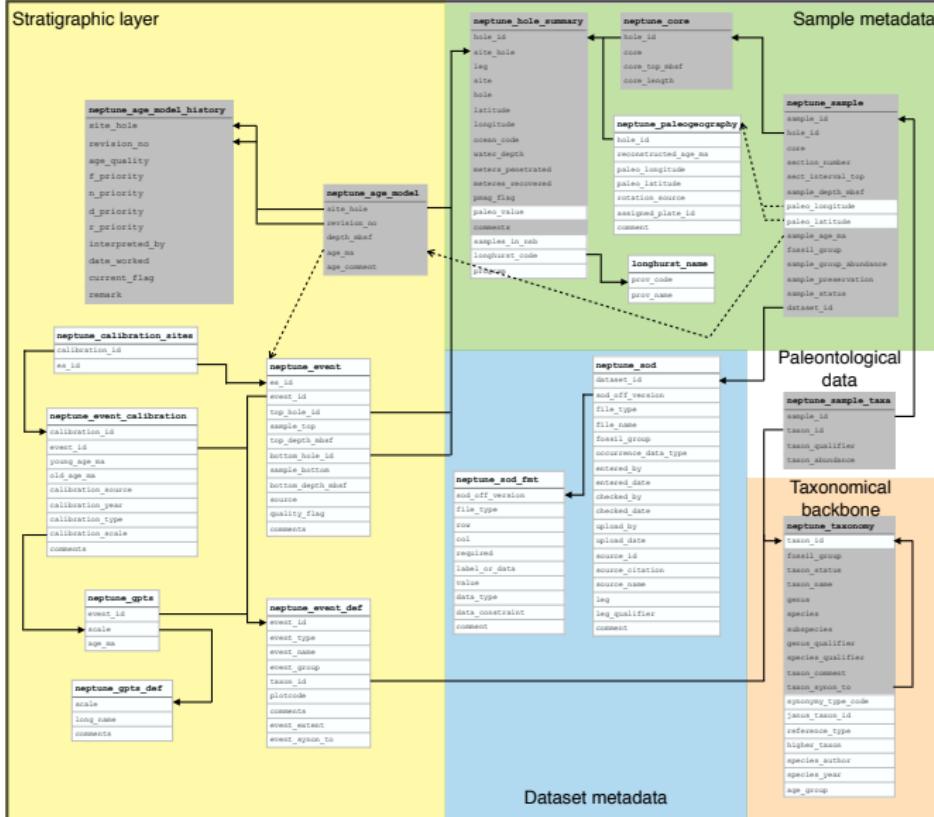
## The Neptune Database

- Started at ETH in Zurich in 1990 as a database of microfossils based on published DSDP and OPD deep-sea drilling data, for paleobiology.
- Put online and updated from 2001 to 2006 as part of NSF-funded Chronos project.
- Salvaged and reopened since 2010 as NSB (Neptune Sandbox Berlin) at the MfN in Berlin.
- since 2014, large ESF-funded effort to update it and expand its stratigraphic capabilities for use in paleoceanography.

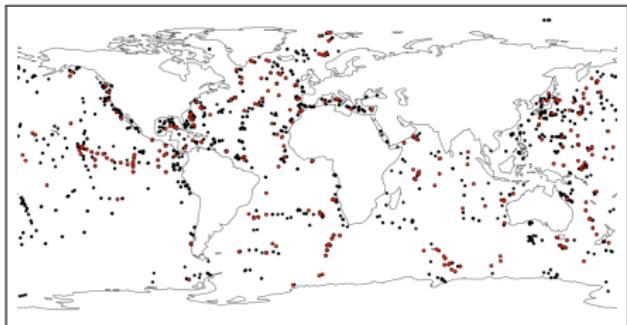
# NSB Structure



# NSB Structure



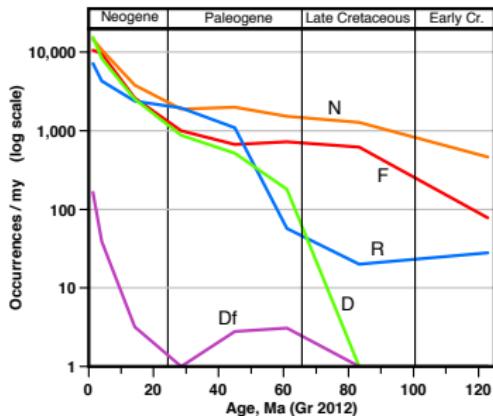
## NSB Content



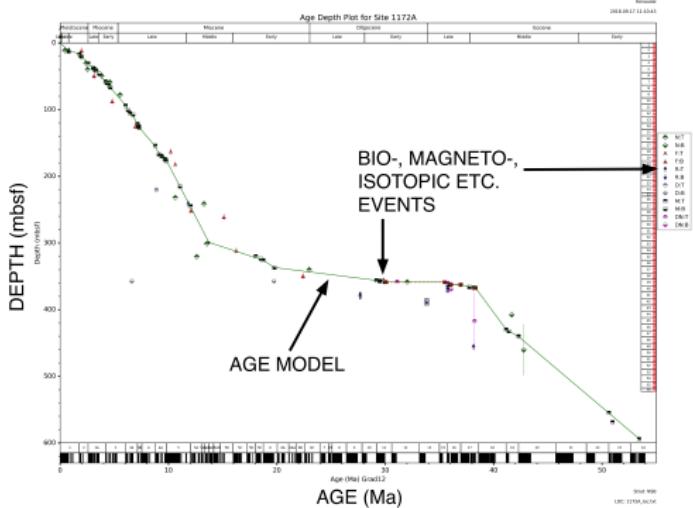
18 859 taxa names  
for 5 microfossil groups  
(R, D, PF, N, DN).

Synonymy resolved using TNL:  
international effort from IODP  
Paleontology Coordination Group.

768 057 occurrences.  
502 deep-sea drilling holes.  
Mostly Cenozoic, but significant  
Cretaceous.  
More carbonate than siliceous  
fossil data so far.



# NSB Content



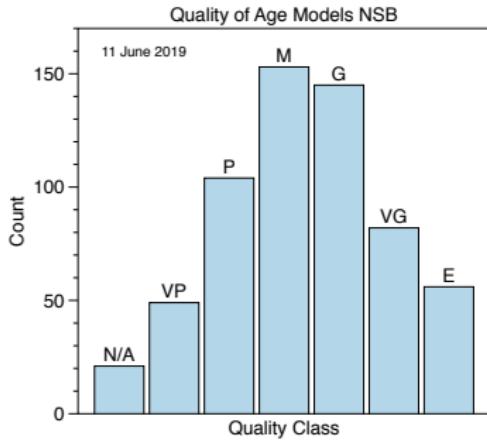
Age model quality vary but most above average.

Website option to ignore poor age models set by default.

Continuous age vs depth functions (age models) for each section

27 608 stratigraphic events (including 2 746 calibrations for them)

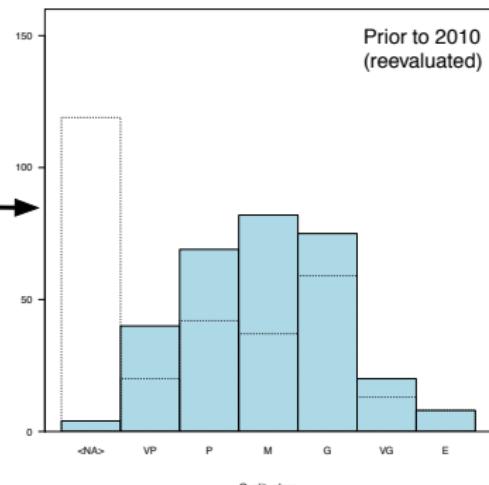
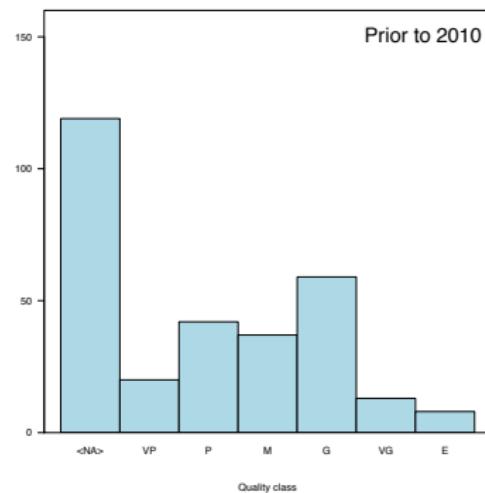
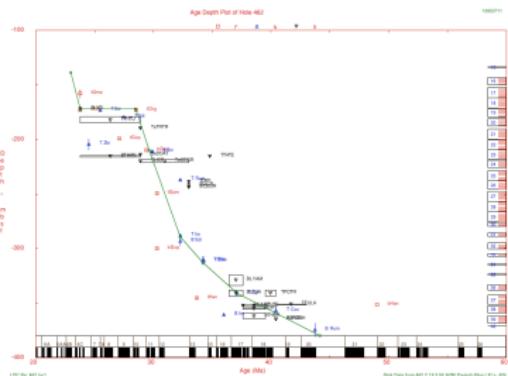
Age models for 463 DSDP, ODP or IODP holes.



# Data quality control

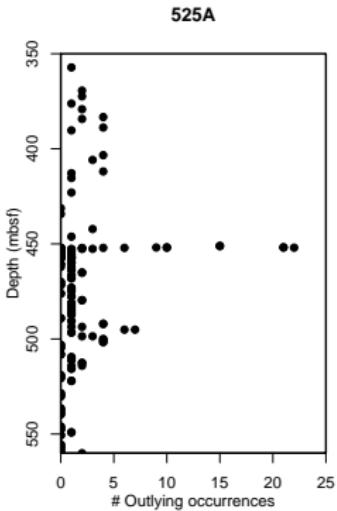
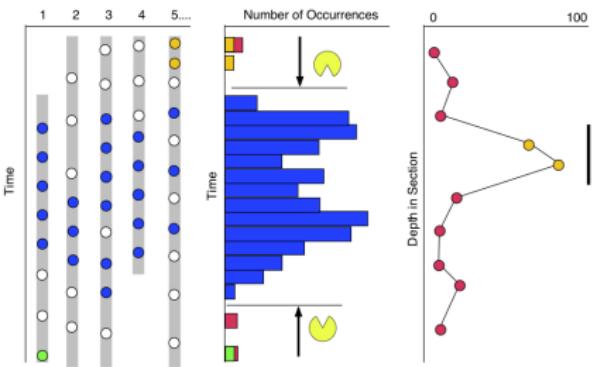
## Age models

- New quality assessment of old Chronos-era age models

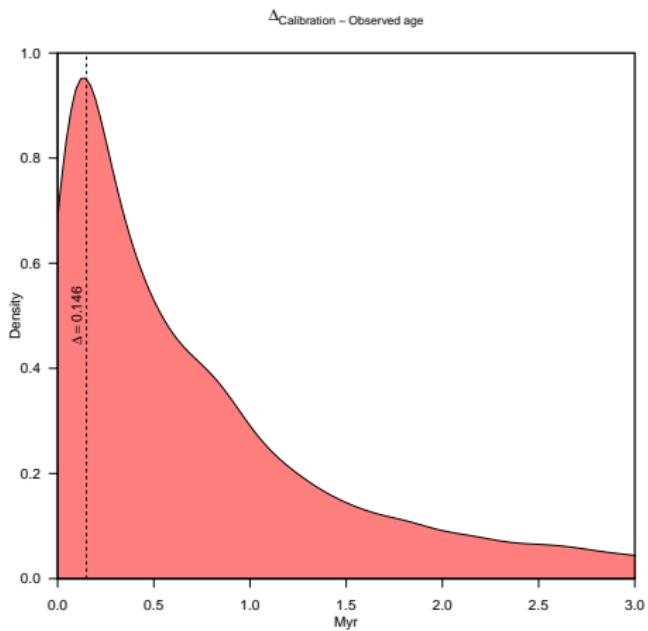


# Data quality control

## Age models

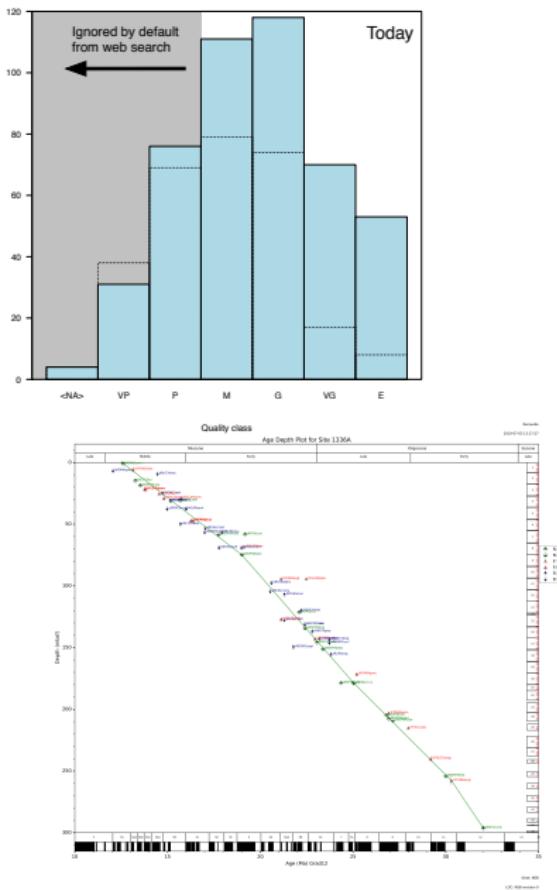


- New quality assessment of old Chronos-era age models
- Outlier detection using e. g. PacMan analysis (Lazarus et al. 2012)



# Data quality control

## Age models

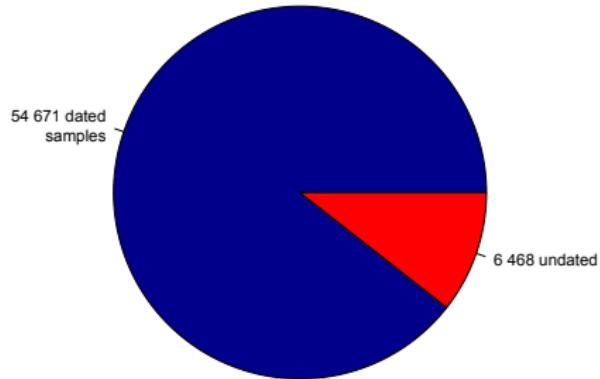
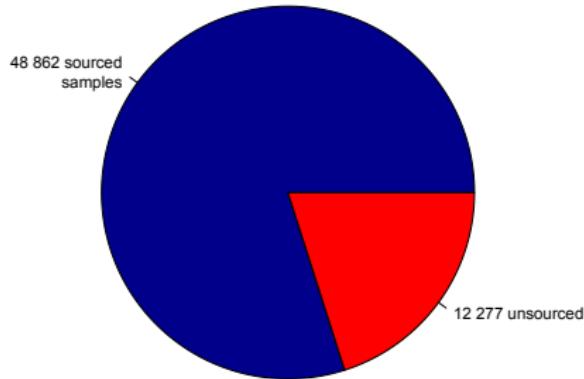


- New quality assessment of old Chronos-era age models
- Outlier detection using e. g. PacMan analysis (Lazarus et al. 2012)
- Selected undated holes containing the larger amount of samples
- Re-did main offenders by using modern calibrations and newly published statigraphic events (including astrochronology)
- Added possibility to filter out datasets with poor age models on the web portal

## Data quality control

### Occurrence datasets

- Sources of datasets entered in Neptune prior to 2010 were backtracked (so far ca. 80% of the ca. 60k samples are sourced)
- Checked that sources matched entered datasets and corrected for discrepancies, cleaned duplicated and added missing samples.



## Neptune Sandbox Berlin

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### About

NSB is the current implementation of the Neptune database (Lazarus, 1994; Spencer-Cervato, 1999). It holds hundreds of thousands of occurrence records for thousands of marine plankton microfossil species from hundreds of deep-sea ocean drilling sections; a taxonomic name management list; age models for all sections; and the geochronologic data used to create these age models. NSB serves several distinct groups of users including microfossil taxonomists, evolutionary (paleo)biologists, and paleoceanographers. A selection of papers that have used Neptune/NSB data is given below, and a full list of all papers using, describing or mentioning the database is given [here](#).

NSB also provides data services to the [Mikrotax](#) community catalog of microfossils and to the [Geobiodiversity Database](#) (GBDB).

NSB is free to use. User accounts are employed to maintain database security and provide feedback on user needs, and can be obtained simply with an email to one of NSB's managers ([see here](#)). The only obligation is to cite the database properly ([references here](#)) in any publications or public presentations.

### Twenty selected papers using NSB

- Lazarus, D. 1994. Neptune: a marine micropaleontology database. *Mathematical Geology*, 26(7):817-832.  
Spencer-Cervato, C., Thierstein, H. R., Lazarus, D. B., and Beckmann, J. P. 1994. How synchronous are Neogene marine plankton events? *Paleoceanography*, 9:739-763.  
Finkel, Z. V., Katz, M. E., Wright, J. D., Schofield, O., and Falkowski, P. 2005. Climatically driven macroevolutionary patterns in the size of marine diatoms over the Cenozoic. *Proceedings of the National Academy of Sciences of the United States of America*, 102(25):8927-8932.  
Allen, A. P., Gillooly, J. F., Savage, V. M., and Brown, J. H. 2006. Kinetic effects of temperature on rates of genetic divergence and speciation. *Proceedings of the National Academy of Sciences of the United States of America*, 103(24):9130-9135.  
Liow, L. H. and Stenseth, N. C. 2007. The rise and fall of species: implications for macroevolutionary and macroecological studies. *Proceedings of the Royal Society B*, 274(1626):2745-2752.  
Muttniak, G. and Kentish, D. 2007. Widespread formation of reefs during the early Eocene climatic optimum. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 253(3-4):348-362.  
Rabosky, D. L. and Sorhannus, U. 2009. Diversity dynamics of marine planktonic diatoms across the Cenozoic. *Nature*, 467:183-187.  
Cermeño, P. and Falkowski, P. G. 2009. Controls on diatom biogeography in the ocean. *Science*, 325:1539-1541.  
Filz, D., Cervato, C., Reed, J., Diver, P., Tang, X., Bohling, G., and Greer, D. 2009. CHRONOS architecture: Experiences with an open-source services- oriented architecture for geoinformatics. *Computators and Geosciences*, 35(6):778-782.

## Occurrence search

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### Search for occurrences

Fossil group

Diatoms

Time span

5

to

0

Ma

Ocean

Southern Ocean

Genus

Longitude

to

0

°

Leg

Site

Species

Latitude

to

0

°

Hole

Ecological Province

### Options

- Resolve taxonomy using TNL.
- Filter out questionable identifications and taxa invalidly included in the fossil group.
- Filter out open-nomenclature taxa.
- Filter out problematic samples/occurrences (reworking, ...)

Choose Age Scale: [Gradstein et al. 2012](#)

- Filter out sites with age quality less than [Good](#)
- Perform pacman trimming (top :  % ; bottom :  %).

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## Taxonomy explorer

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### Search the database

Genus

Species

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Fossil Group	Taxon ID	Taxon Name	Taxon Status	Taxon Synonym to	Synonymy type	Author	Year	ID in Janus DB	Old NSB ID
R	2100165	Piannapus hornbrooki	V			O'Connor	1999		
R	2100166	Piannapus mauricei	V			O'Connor	1999		
R	2100167	Piannapus microcephalus	V			O'Connor	1999		
R	2003804	Piannapus microcephala	S	2100167		(Haeckel) O'Connor	1997		
R	2001115	Dicocolapsa microcephala	S	2100167	OBJECTIVE	Haeckel	1887/2740		RDIC00020
R	2100452	Piannapus sp. A	G						
R	2100052	Dicocolapsa microcephala (q)	Q	2001115					RDIC00021

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## Age models

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Sandbox  
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About

Help

Search the  
database

Downloaded  
datasets

Recent Changes



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occurrences

Search  
taxonomy

Search  
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Search  
stratigraphic events

Search  
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### Search an age model

Hole

1338A

Scale

Gradstein et al. 2012

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#### Revision 0

Interpreted  
by

Age  
Quality

Quest by dbI 6.2.17. Excellent model now avail: Backman et al. 2016 IODP Leg SR

vol online. JR (2015); uses IR magneto; M disagrees with biostrat between 200  
and 300 mbsf

Renaudie

Date

April 15, 2015

Y

Hole	Age (Ma)	Depth (mbsf)	Comment
1338A	0.000000	0.000	None
1338A	0.782725	8.276	None
1338A	1.109405	11.971	None
1338A	1.762765	21.207	None
1338A	2.579465	31.368	None
1338A	3.118487	37.835	None
1338A	3.330829	40.142	None
1338A	3.608507	43.837	None
1338A	4.180197	51.688	None
1338A	4.376205	54.459	None
1338A	5.029564	66.929	None

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## Event calibrations

Neptune  
Sandbox  
Berlin

About

Help

Search the  
database

Downloaded  
datasets

Recent Changes



Search  
occurrences

Search  
taxonomy

Search  
an age model

Search  
stratigraphic events

Search  
event calibrations

### Search an event calibration

Event BOT

Scale

Gradstein et al. 2012

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Event ID	Calib. ID	Type	Event Name	Group	Age min	Age max	Geographical Extent	Source	Calibration Type	Original Scale	Comments
1073	1210	BOT	Emilia nia huxleyi	N	0.5		global	Berggren et al. 1985	M	Berg85	ODP Technical Note 24
1073	174	BOT	Emilia nia huxleyi	N	0.29		global	Backman et al. 2012	O	Grad04	

All ages given here on Gradstein et al. 2012 scale.

This event has been found in the following sites:

Event ID	TOP				BOTTOM				Source event	Comment
	Hole	Sample	Depth (mbsf) (*)	Age	Hole	Sample	Depth (mbsf) (*)	Age		
1073	101_626C	5-1.40	38.90	101_626C	5-CC	48.01	626C_fn_bstrat95			
1073	104_642B	2-6.85	13.15	104_642B	3-2.87	16.67	Donnelly 1989			
1073	104_643A	1-2.50	2.00	0.278	104_643A	1-3.87	3.50	0.31	Donnelly 1989	
1073	104_644A	4-1.50	26.20	104_644A	4-2.50	27.70	644A_mfnr_bstrat95			
1073	105_646A	2-5.102	12.02	0.184	105_646A	2-6.104	13.54	0.207	Baldau et al 1989	
1073	105_646B	12.03	0.182	105_646B	13.55	0.2	Baldau et al 1989			
1073	105_647A	1-6.130	8.80	0.275	105_647A	1-7.14	9.14	0.285	647A_mfnr_bstrat95	
1073	107_651A	8-CC	64.42	107_651A	9-1.69	69.49	651A_mn_bstrat95			

Used for  
calibration  
of the event  
(see  
calibration  
No 174).

1073	107_653A	3-2.60	15.30	107_653A	3-2.120	15.90	Rio et al. 1990			
1073	107_653A	15.60		107_653A	15.60		Glacon et al 1990			
1073	107_655A	1-2.20	1.70	107_655A	1-2.120	2.70	Müller 1990			
1073	108_657A	0.90		108_657A	3.30		657A_fn_bstrat95			
1073	108_658A	34.20	0.275	108_658A	43.70	0.318	Manivit 1989			
1073	108_658B	34.20	0.275	108_658B	43.70	0.318	658A_mfnr_bstrat95			
1073	108_659A	1-5.130	7.50	0.241	108_659A	2-1.38	8.10	0.27	Manivit 1989	



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Search for events in sections

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About

Help

Search the  
database

Downloaded  
datasets

Recent Changes



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Search  
occurrences

Search  
taxonomy

Search  
an age model

Search  
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Search  
event calibrations

Search for stratigraphic events

Hole

320-1333A

Scale

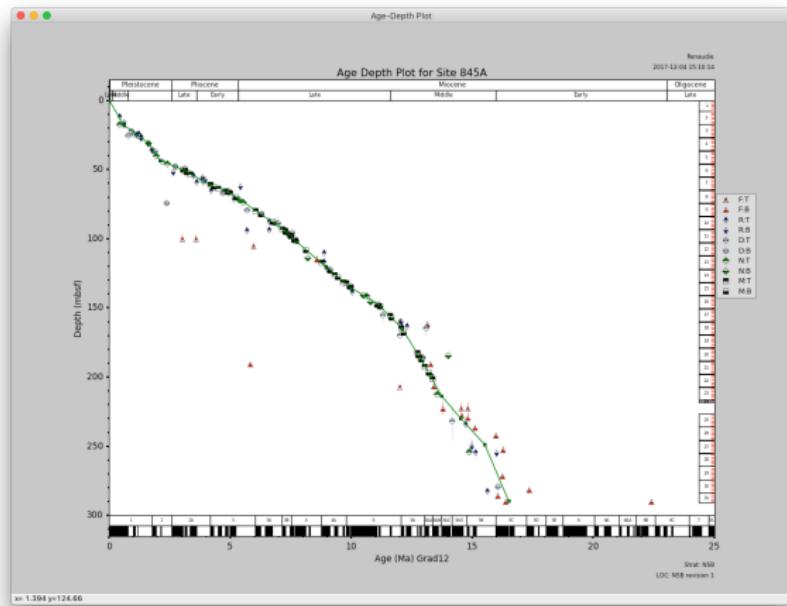
Gradstein et al. 2012

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Type	Event Name	Sample (Top)	Sample (Bottom)	Depth mbsf (Top)	Depth mbsf (Bottom)	Age min	Age max	Source event	Source calibration	Comment
M TOP	C6An.1n	320_1333A-1-1,55	320_1333A-1-1,65	0.55	0.65	20.04		Expedition 320/321 Scientists, 2010	Gradstein et al. 2012	
M BOT	C6An.1n	320_1333A-1-1,10	320_1333A-1-1,15	1.10	1.15	20.21		Expedition 320/321 Scientists, 2010	Gradstein et al. 2012	
M TOP	C6An.2n	320_1333A-1-2,50	320_1333A-1-2,60	2.00	2.10	20.44		Expedition 320/321 Scientists, 2010	Gradstein et al. 2012	
R BOT	Stichocorys delmontensis	320_1333A-1-2,104	320_1333A-1-4,104	2.54	5.54	20.6		Expedition 320/321 Scientists, 2010	Kamikuri et al. 2012	Used for age model revision 0
D DNT	Chikorozia delmontensis	320_1333A-2-6,1	320_1333B-2-10,1	2.6	10.0	20.6		Kamikuri et al. 2012	Kamikuri	Used for

NSB<sub>—</sub>ADP<sub>—</sub>wx

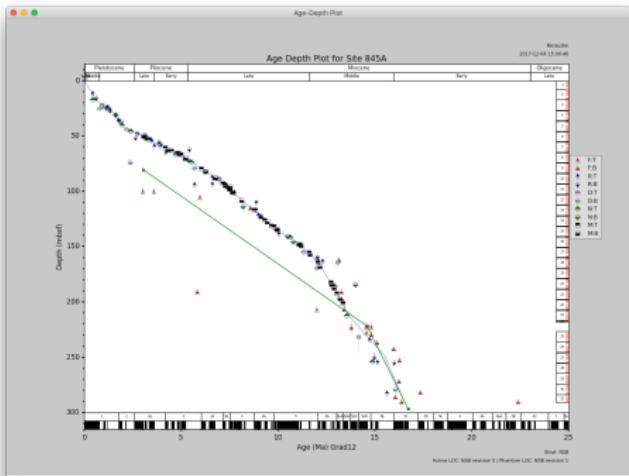
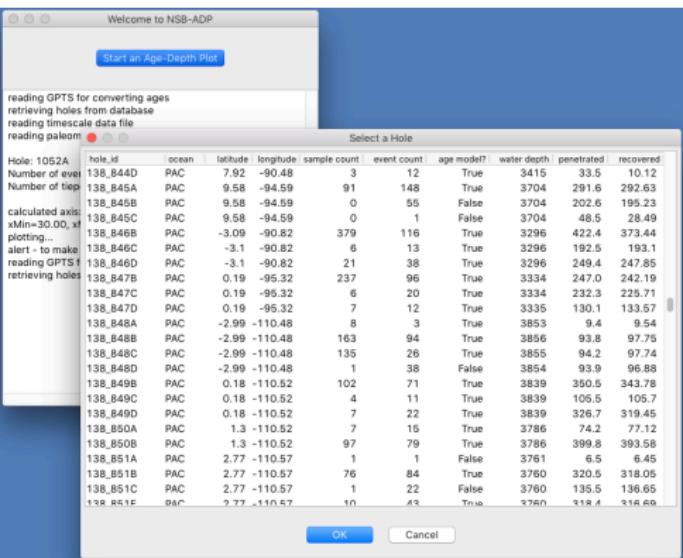
Currently available for Mac OSX 10.12 and higher, or as a python script, at  
[http://github.com/plannapus/nsb\\_adp\\_wx/releases](http://github.com/plannapus/nsb_adp_wx/releases).



## Modernisation of Age-Depth plot software (Lazarus, 1992; Bohling, 2005)

# NSB\_ADW\_wx

Allows users to create an age model, to explore NSB age model and biostratigraphic events library, to modify an existing age model, compare alternative ones, etc.



# NSB as Data provider

## Mikrotax

www.mikrotax.org/Nannotax3/index.php?dir=Coccolithophores

Berlin Weather Google Amazon.de News Apple Berlin External science sites Rad sites MNF sites Professional MNF webmail

Nannotax3 - Coccolithophores - Coccolithophores

About Nannotax Live & Cenozoic Mesozoic Calc-dinos Farinacci Comments Tools Links

taxon search Suppress fossils ?

### Cenozoic and Modern Coccolithophores

Ancestry: Coccolithophores  
Sister taxa: >>>  
Short diagnosis: Extant coccolithophores and Cenozoic calcareous nannofossils - Mesozoic nannofossils are in a separate module

Daughter taxa (blue --> in age window 0-300Ma)				Granddaughter taxa
Reticulofusiform	Reticulofusiform	Reticulofusiform	Reticulofusiform	Heterococcoliths  ISOCHRYSIDALES Motile phases with vestigial haptonema. Heterococcoliths mostly placoliths with R-unit dominant.
Coccolith	Coccolith	Coccolith	Coccolith	COCCOLITHALES  Mostly placolith heterococcoliths, with V-unit forming the distal shield; R-unit the proximal shield.
Calcidiscoid	Calcidiscoid	Calcidiscoid	Calcidiscoid	
Heliocoenoid	Heliocoenoid	Heliocoenoid	Heliocoenoid	ZYGOOSCALES  Heterococcoliths with V-units forming upper/outer cycle of imbricated elements and R-units forming basal plate and central mass of irregular elements
Peritrichoid	Peritrichoid	Peritrichoid	Peritrichoid	
Syracosphaeroid	Syracosphaeroid	Syracosphaeroid	Syracosphaeroid	SYRACOSPHERALES  Coccoliths with radial lath cycle of T-units, and disjunct, often complex, axial structure, coccospores often polymorphic
Acanthocystis	Acanthocystis	Acanthocystis	Acanthocystis	
				NOELAERHABDACEAE PARISIACEAE ISOCHRYSIDAEAE
				COCCOLITHACEAE CALCIDISCACEAE HYMENONADACEAE PLEUROCHRYSIDAEAE
				HELIOSPHERACEAE PONTOSPHERACEAE ZYGOOSCAEAE
				CALCIDOLENIACEAE RHABDOSPHERACEAE SYRACOSPHERACEAE

# NSB as Data provider

## Mikrotax

### menardii lineage

taxon search

Suppress fossils

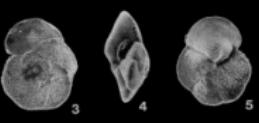
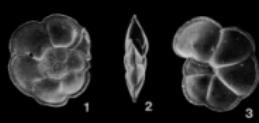
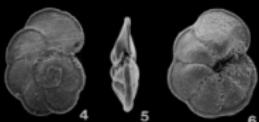
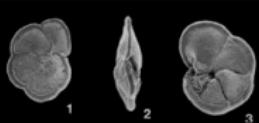
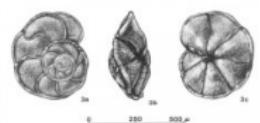
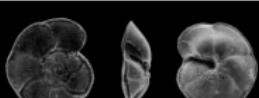
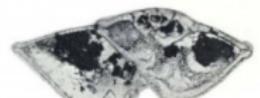


NB TAXA WHICH ORIGINATE IN THE OLIGOCENE ARE NOT INCLUDED YET

Classification: pf\_neogene -> Globorotalidae -> Globorotalia -> menardii lineage

Sister taxa: fohsi lineage, hirsuta lineage, menardii lineage, truncatulinoides lineage, tumida lineage, G. sp.,

Daughter taxa (blue => in age window 0-4500Ma)

			 <i>Globorotalia archeomenardii</i>
			 <i>Globorotalia exilis</i>
			 <i>Globorotalia limbata</i>
		 Keel & thin, laterally compressed shell 250 200 μm	 <i>Globorotalia menardii</i>
			 <i>Globorotalia miocenica</i>

# NSB as Data provider

## Mikrotax

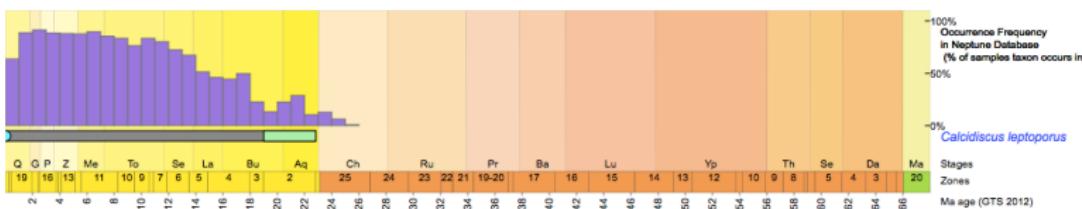
### Geological Range:

Last occurrence (top): Extant Data source: present in the plankton (Young et al. 2003)

First occurrence (base): within NN2 zone (19.00-22.82Ma, base in Aquitanian stage). Data source: Young (1998)

### Plot of occurrence data:

- Range-bar - range as quoted above, pink interval top occurs in, green interval base occurs in.
- Triangles indicate an event for which a precise placement has been suggested
- Histogram - Neptune occurrence data from DSDP and ODP proceedings. Interpret with caution & [read these notes](#)
- Taxon plotted: *Calcidiscus leptoporus*, synonyms included - *Calcidiscus leptoporus*; *Calcidiscus leptoporus f. rigidus*; *Calcidiscus leptoporus hol*; *Calcidiscus leptoporus* subsp. *centrovalis*; *Calcidiscus quadriforatus*; *Cocospaera leptopora*; *Cyclococcolithina leptopora*; *Cyclococcolithus leptoporus*; Parent: *C. leptoporus* group



### References:

Backman, J., (1980). Miocene-Pliocene nanofossils and sedimentation rates in the Hatton-Rockall Basin, NE Atlantic Ocean. *Stockholm Contributions in Geology*, **36**: 1-91.

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*Calcidiscus leptoporus* compiled by Jeremy R. Young, Paul R. Bown, Jacqueline A. Lees viewed: 22-10-2017

Taxon Search:   Advanced Search

AphiaID: 235923 Nomenclatural data on WoRMS

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NSB as Data provider  
Others

NSB also provides taxonomical data to WoRMS and age models to GBDB.

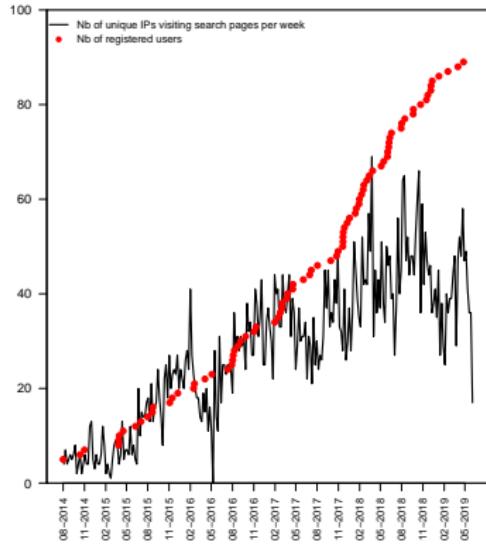
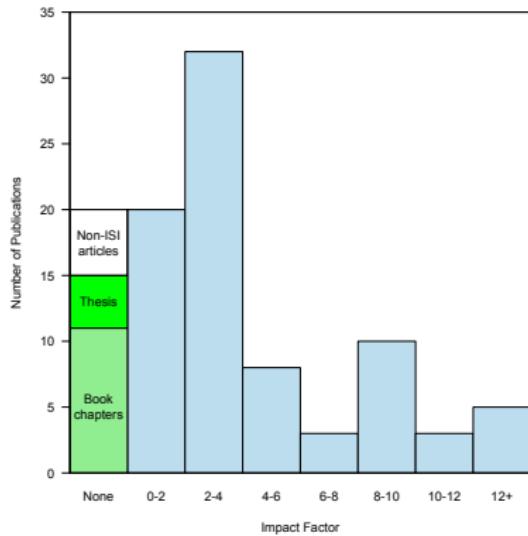


## Geobiodiversity Database

Promoting collaborations based on global and regional database

## Current usage of NSB

- 101 published articles using or about NSB, on marine micropaleontology, stratigraphy, marine sedimentology, paleoceanography, theoretical biology, etc.
- ca. 90 registered users and ca. 45 unique weekly visitors in 2018.



## Summary & Outlook: Future developments

- NSB, together with Mikrotax, provides a rich big-data infrastructure for (marine) micropaleontology and paleoceanography
- Uniquely support detailed, quantitative geochronology and section linked data
- Currently being expanded - goals are better international management and formal participation in national and international science data infrastructure agreements (NFCDI4Earth, DDE, etc.)
- MfN, NSB host, recently got Very Large Grant; small fraction to be dedicated to building data science systems

Thanks for listening.

**And thanks to the many students and volunteers who helped us with the database since 2010:**

Mandy Schmohl, Diana Panning, Simon Boehne, Effi-Laura Drews, Robert Wiese,  
Robert Seeger, Norbert Maier, and the few other Praktikanten whose names were  
forgotten :|

**Access to the Neptune Database website:** <http://nsb-mfn-berlin.de>

Username: guest

Password: arm\_aber\_sexy

**NSB\_ADP\_wx:** [http://github.com/plannapus/nsb\\_adp\\_wx/releases](http://github.com/plannapus/nsb_adp_wx/releases)



Centre for Ecological and Evolutionary Synthesis

