

**Table 3.** Summary of Nordic Miocene Zones (NM) and bioevent calibrations for the Nordic Atlantic region. Bioevent ages are organised from south to north according to latitudinal region. Ages are according to the calibrations in this study, except for the low-latitude ages in the "Time scale" column which are according to the Astronomically Tuned Neogene Time Scale (ATNTS04) of Lourens et al. 2004. Bioevent codes: CN= Calcareous Nannofossil; PF= Planktonic Foraminifera; BF= Benthic Foraminifera; BO= Bolboforma; DC= Dinoflagellate cyst or acritarch. Standard zones/chrons: C-Subchrons = Cande & Kent (1995); Lourens et al. (2004); Nannoplankton Zones: CN = Okada & Bukry (1980); NN = Martini (1971); Planktonic foraminiferal Zones: N of Blow (1969). Zonal boundaries are indicated by a "/", eg. NN3/NN4. Bioevent acronym: LO = Last uphole Occurrence; FO = First uphole Occurrence. For "Age by region" columns, the per region age range is in brackets (See Appendix 1). Preceding this is the youngest age extreme (youngest possible age for LO's) or oldest age extreme (oldest possible age for FO's) from this range. Bold highlighted age extremes are considered most reliable ages. Where these region age extremes occur closely together in time, they are grouped into a "boundary event cluster". These boundary event clusters define a zonal boundary (first column). For details of individual age calibrations per ODP/DSDP hole, see Appendix 1.

<b>Age of boundary event cluster (Ma)</b>		<b>Nordic Miocene Zone</b>			<b>Bioevent(s)</b>	<b>Calibration</b>	<b>Calibration sites</b>	<b>References</b>						
		<b>Age by region (Ma)</b>												
<b>5.3-5.4</b>	NPO/ NM10	PF14	5.445-5.548 (M)		M = E. Med.; A = S. Atl.	MIS TG12-TG9; NN12	Atlantic Morocco tuned section ii) 918D	Hilgen et al. (2007) ii) Spezzaferri and Spiegler (1998) + Wei (1998) + Fukuma (1998)						
		DC18			Mid - High North Atl.				LO Hystrichosph aeropsis pontiana	C3r	Mudie (1989), Bleil (1989)			
					High North Atl.							LO common/ consistent N. acostaensis and/or N. humerosa	i) MIS TG3, ii) C3An.1n, iii) (C3An.1r)	i) Flower (1999 + Hoddell et al. (2001) + This study; ii), iii) Spiegler and Jansen (1989) + Bleil (1989)
					Nordic Seas & North Sea									

6.1-6.3	5.9	5.8	5.8	5.7-5.8	5.5-5.6	5.5-5.6
NM10						
BO7	BO6b	BO6a	MDS8	PF15*	MD7	DC
				6.08 (A)		
	<b>6.0</b> (5.95-8.53)			5.7 (5.50-5.65)		
<b>6.1-6.3</b> (6.11-6.32)	<b>5.9</b> (5.38-5.86)	(4.95) <b>5.76</b>		<b>5.8</b> (5.78-6.37)	<b>5.6</b> (5.59)	<b>5.5</b> (5.47-5.51)
		(4.86) 5.60-5.65	<b>5.8</b> (5.74-5.91)		5.5 (5.50-5.52)	5.6 (5.61)
Upper Miocene acme of smooth Bolboforma cysts	LO common Bolboforma intermedia	FO Bolboforma costairregularis variabilis	FO Thalassiosira jacksoni	FO Globorotalia margaritae	FO abundant Thalassiosira spp.	LO Cristadinium diminutivum
Top=MIS TG39/40 Base="C3An glacial"	i) MIS TG30; ii) NN12; iii) N17, NN11	i) TG20; ii) NN12/13, iii) C3r, iv) (C3n.3n)	C3r	i) MIS TG20-TG22	i) NN11/NN12; ii) C3r	i) lower NN12; ii) C3r
982B	i) 982B; ii) 408; iii) 404	i) 982B, ii) (116), iii) 642C, iv) (642B)	i) 907A; ii) 642B	i) 982B	i) 552A; ii) 642B	i) 646B; ii) 987E
Spiegler (1999); Hodell et al. (2001); Hilgen et al. (2007)	i) Spiegler (1999); Hodell et al. (2001); Hilgen et al. (2007); ii) Spiegler and Müller (1992); iii) Müller et al. (1985)	i),ii) Spiegler (1999) + Hoddell et al. (2001) + Hilgen et al. (2007); iii),iv) Qvale and Spiegler (1989) + Bleil (1989)	i) Koc and Scherer (1996) + Channell et al. (1999); ii) Boden (1992) + Bleil (1989)	i) Flower (1999)+ Hilgen et al. (2007)	i), ii) Boden (1992) + Bleil (1989)	i) Head et al. (1989a) + Knüttel et al. (1989); ii) Channell et al. (1999)

7.7			7.3	6.6-7.6	6.6
0/NM9					
PF17 b	PF17a	PF16 b	PF16a *	www vw	MD9
7.89 (M)			6.52 (M)		
~8.0 (~7.98)	? 4.6 (4.11-4.56)	7.4 (7.36-9.27)	6.5 (6.45-6.50)		
7.7 (7.66-7.69)	7.6 (7.59)	7.5 (7.40-7.51)	7.3 (6.77-7.30)	6.6-7.6	
		7.3 (7.07-7.28)			6.6 (5.06-6.63)
FO Globorotalia miotumida (conomiozea) group	FO Globorotalia cf. crassula	D-S Neogloboquadrina atlantica coiling change (?Disap. N. atlantica (d))	LO Globorotalia miotumida (conomiozea) group	<b>DISSOLUTION INTERVAL (global carbon shift)</b>	FO Thalassiosira oestrupii
i) orbitally tuned isotope record; ii) C3Br.2r-C4n.1r	i) orbitally tuned isotope record; ii) (C3n.2n)	i) C3Br.2r; ii) orbitally tuned isotope record; iii) C3An.2n- C3Bn	i) C3An.2n; ii) C3Ar; iii) orbitally tuned isotope record	orbitally tuned isotope record	i) C3An.2n; ii) C3An.4n
i) 982B; ii) 611C, 610E	i) 982B; ii) (609)	i) 610E; ii) 982B; iii) 642C	i) 609,609B; ii) 611C; iii) 982B	982	i) 907A; ii) 642C
i) Flower (1999) + Hodell et al. (2001); ii) Weaver and Clement (1986)+ Clement and Robinson (1986)	i) Flower (1999) + Hodell et al. (2001); ii) Weaver and Clement (1986)+ Clement and Robinson (1986)	i),ii) Weaver and Clement (1986)+ Clement and Robinson (1986); iii) Flower (1999) + Hodell et al. (2001); iii) Spiegler and Jansen (1989) +Bleil (1989)	i),ii) Weaver and Clement (1986)+ Clement and Robinson (1986); iii) Flower (1999) + Hodell et al. (2001)	Diester-Haass et al. (2005) + Hodell et al. (2001)	i) Koc and Scherer (1996) + Channell et al. (1999); ii) Boden (1992) + Bleil (1989)

		8.4	7.9	7.5		
		NM9		NM1		
BO9c	BO9b	PF19	PF18*	DC19 <sub>c</sub>	DC19 <sub>b</sub>	DC19 <sub>a</sub>
	9.6 (7.82–9.6)			7.7 (7.65–7.66)	7.7 (7.65–7.66)	7.7 (7.66–9)
	<b>8.8</b> (8.77)	<b>8.4</b> (8.42)	<b>7.9</b> (7.86–7.96)		?7.6 (7.07–7.56)	?9.7 (9.70)
					8.9 (8.56–9.13)	7.7 (7.72)
Decrease Bolboforma laevis	FO Bolboforma intermedia	Base acme dominant Globigerina	LO Globorotalia juanai	LO Spiniferites pseudofurcatus	LO Hystricosphaeropsis obscura	LO Labyrinthodinium truncatum
re-calibrated oxygen isotope record	i) orbitally tuned isotope record; ii) lower NN10 or NN11	orbitally tuned isotope record	orbitally tuned isotope record	C4n	i) C4n; ii) NN11	i) C4n; ii) Tor 2 maximum flooding surface of Hardenbol et al. (1998), same level as DC19b
608	i) 982B; ii) 608	982B	982B	905A	i) 905A; ii) 555	i) 905A; ii) onshore Netherlands boreholes
Spiegler and Müller (1992)+This study	i) Spiegler (1999) + Hodell et al. (2001); Spiegler and Müller (1992)	Flower (1999) + Hodell et al. (2001)	Flower (1999) + Hodell et al. (2001)	de Verteuil and Norris (1996), de Verteuil (1996) + Gartner and Shyu (1996)	i) de Verteuil and Norris (1996), de Verteuil (1996) + Gartner and Shyu (1996); ii) Edwards (1984) + Backman (1984)	i) de Verteuil and Norris (1996), de Verteuil (1996) + Gartner and Shyu (1996); ii) Munsterman and Brinkhuis (2004) + Ogg and Lugowski (2008)

9.5	9.5	9.4	8.9-9.4	<b>8.8-8.9</b>	
				NM9/ NM8b	
PF21 b	PF21a *	PF20	www vw	DC20	BO9a
	9.69 (A)				
				<b>8.9</b> (8.92–8.95)	9.5
?9.5 (9.52)	9.5 (9.46)	<b>9.4</b> (9.35)	8.9–9.4	?7.7 (7.46–8.02)	<b>8.8</b> (8.77–8.99)
		10.8 (10.70–10.79)		?10.2 (9.80–10.61)	8.7 (8.68–8.71)
FO Neogloboquadrina humerosa	FO (consist.) Globorotalia juanai	LO consistently common Neogloboquadrina acostaensis	<b>DISSOLUTION INTERVAL/ HIATUS</b>	LO Paleocystodinium golzowense	LO (consistent) Bolboforma metzmacheri
Strontium ( <sup>87</sup> Sr/ <sup>86</sup> Sr) isotope record	Orbitally tuned oxygen isotope record	Orbitally tuned oxygen isotope record	i) orbitally tuned oxygen isotope record; ii) Strontium ( <sup>87</sup> Sr/ <sup>86</sup> Sr) isotope record	i) C4An; ii) near NN10/NN11	i) re-calibrated oxygen isotope record; ii) orbitally tuned isotope record; iii) C4r.2r
918D	982B	982B	i) 982B; ii) 918D	i) NW Italy onshore; ii) 905A	i) 608; ii) 982B; iii) 643A
Spezzaferri (1998) + Israelson & Spezzaferri (1998)+ McArthur et al. (2001)	Flower (1999) + Hodell et al. (2001) + Shipboard Scientific Party (1996) + This study	Flower (1999) + Hodell et al. (2001) + This study	i) Flower (1999) + Hodell et al. (2001) + This study; ii) Spezzaferri (1998) + Israelson & Spezzaferri (1998)+ McArthur et al. (2001)	i) Munsterman & Brinkhuis (2004) + Zevenboom (1995); ii) De Verteuil & Norris (1996) + Gartner & Shyu (1996)	i) This study ii) Spiegler (1999) + Hodell et al. (2001); iii) Qvale and Spiegler (1989) + Bleil (1989)

10.5	10.5	10.2	10.2	9.9
NM8b				
PF23a	BO	BO10 <sub>b</sub>	BO10 <sub>a</sub>	PF22
10.57 (M)				
	10.1 (10.07–10.18)	10.0 (9.97–10.03)	?10.0 (9.7–10.03)	
<b>10.5</b> (10.00–10.48)	10.5 (10.49–10.50)	10.2 (10.04–10.17)	10.2 (8.88–10.17)	9.9 (9.86)
<11 (<11.01)			?8.9 (7.75–8.91)	
FO Neogloboquadrina acostaensis	LO Bolboforma robusta	LO Bolboforma capsula	FO Bolboforma metzmacheri	Disap. N. pachyderma (dextral)
i) Strontium ( <sup>87</sup> Sr/ <sup>86</sup> Sr) isotope record; ii) orbitally tuned oxygen isotope record	i) mid–NN9; ii) lower–NN9; iii) orbitally tuned oxygen isotope record	i) re–calibrated oxygen isotope record; ii) orbitally tuned oxygen isotope record; iii) mid to upper NN9	i) re–calibrated oxygen isotope record; ii) orbitally tuned oxygen isotope record; iii),iv) mid–NN9 to NN10/NN9	Orbitally tuned oxygen isotope record
i) 918D; ii) 982B	i) 608; ii) 116; iii) 982B	i) 982B; ii) 608; iii) 116	i) 982B; ii) 608; iii) 555; iv) 116	982B
i) Spezzaferri (1998) + Wei (1998); ii) Flower (1999) + Hodell et al. (2001) + Shipboard Scientific Party (1996)	i) Spiegler & Müller (1992) + Baldauf et al. (1986); ii) Spiegler & Müller (1992); iii) Spiegler (1999) + Hodell et al. (2001)	i) Spiegler & Müller (1992); Spiegler (1999) + Hodell et al. (2001); ii) Spiegler & Müller (1992) + re–calibrated age model (this study); iii),iv) Spiegler & Müller (1992)	i) Spiegler & Müller (1992); Spiegler (1999) + Hodell et al. (2001); ii) Spiegler & Müller (1992) + re–calibrated age model (this study); iii),iv) Spiegler & Müller (1992)	Flower (1999) + Hodell et al. (2001) + Shipboard Scientific Party (1996) + This study

..0			10.6
18a			
BO11 b	BO11 a	BO	PF23 b
11.5 (11.35–11.57)	10.6 (10.64–10.70)	10.4 (10.35–10.45)	
<b>10.9</b> (10.88–10.98)	<b>10.9</b> (9.47–10.88)	<b>10.9</b> (10.86–10.93)	10.6 (10.07–10.59)
9.3 (9.23–9.27)	9.4 (9.37–9.39)		9.8 (8.91–9.79)
LO Bolboforma fragori	LO Bolboforma subfragoris	FO Bolboforma capsula	FO N. atlantica (dextral)
i) re-calibrated oxygen isotope record; ii) (near NN7/NN8); iii) near NN8/NN9	i) N15–N16; ii),iii) near NN8/ NN9; iv) (C4Ar.1n)	i) lower NN9; ii) NN8/NN9; iii) orbitally tuned oxygen isotope record	i) NN9; ii) orbitally tuned oxygen isotope record; iii) (C4An)
i) 608; ii) (982B); iii) 918D	i) Palazzolo Section, Acreide, Sicily; ii) 608; iii) 918D; iv) (643A)	i) 608,116; ii) 918D; iii) 982B	i) 918D; ii) 982B; iii) (643A)
i) Spiegler & Müller (1992) + this study; Spiegler (1999) + Shipboard Scientific Party (1996); iii) Spezzaferri and Spiegler (1998) + Wei (1998)	i) Spezzaferri et al. (2001); ii) Spiegler and Mueller (1992) + Baldauf et al. (1986); iii) Spezzaferri & Spiegler (1998) + Israelson & Spezzaferri (1998) + McArthur et al. (2001); iv) Qvale & Spiegler (1989) + Bleil (1989)	i) Spiegler & Müller (1992) + Baldauf et al. (1986); ii) Spezzaferri (1998) + Wei (1998); iii) Spiegler (1999) + Hodell et al. (2001) + Shipboard Scientific Party (1996)	i) Spezzaferri (1998) + Wei (1998); ii) Flower (1999) + Hodell et al. (2001) + Shipboard Scientific Party (1996); iii) Spiegler & Jansen (1989) + Bleil (1989)

11.1	<b>10.9-11</b>		
	NM8b/NM		
DC	DC21	BO12	PF*
	<b>11.0</b> (10.89–11.04)	12.5 (12.41–12.52)	
		<b>11.0</b> (11.02–11.13)	11.0 (11.03–13.31)
11.1 (10.95–11.14)	?11 (?11–11.8)	9.2 (9.06–9.22)	(16.71)
LO Palaeocystodinium sp. A of Costa and Downie (1979)	LO Cannosphaeropsis passio	LO common B. compressispinosa	LO Globigerinoides trilobus
C5n.2n–C5r.2r	i) C5n.2n/C5r.1r; ii) NN7–NN8 and N14; iii) in TST above Ser4/Tor1 global sequence boundary	i), iv) near NN7/NN6; ii) NN7–NN8; iii) lower NN7	NN7
643A	i) Mazzapiedi section, NW Italy; ii) 905A; iii) onshore Netherlands boreholes	i) 982B; ii) 608; iii) 555; iv) 918D	918D
Mudie (1989) + Manum et al. (1989) + Bleil (1989)	i) Zevenboom (1995); ii) de Verteuil and Norris (1996); de Verteuil (1996); Shipboard Scientific Party (1994); Munsterman and Brinkhuis (2004) + Hardenbol et al. (1998) + Ogg and Lugowski (2008)	i) Spiegler (1999) + Shipboard Scientific Party (1996); ii) Spiegler & Mueller (1992) + Baldauf et al. (1986); Spiegler & Mueller (1992)+ Backman (1989); iv) Spezzaferri & Spiegler (1998) + Wei (1998)	Spezzaferri (1998) + Wei (1998) + this study



	11.3	10.6-11.5	11.1	11.1
	NM8a			
PF25	BO13	vvvvv	DC	PF
11.47 (A)				
	13.3 (13.34)			
>10.8 (>10.08-10.79)	<b>11.3</b> (11.32-12.06)	10.6-11.5	11.1 (10.52-11.14)	10.1 (10.06-10.08)
>11.3 (>10.97-11.33)	10.2 (10.22-10.45)		11.1 (10.27-11.05)	11.1 (10.93-11.13)
LO Paragloborotalia mayeri	LO abundant Bolboforma badenensis	HIATUS	FO Invertocysta lacrymosa	FO N. praeumerosa
Below (10.6-11.5) hiatus	i) upper NN6; ii) NN6; iii) NN7; iv) C5n.2n	i) Absence of NN8; ii) Absence of N15	i) NN7-NN8; ii) C5n.2n	i) (NN9); ii) ?C5r.2r
i)982B; ii) 918D; iii) 642B	i) 608; ii) 982B; iii) 918D; iv) 642B, 642C	i) 116; ii) 918D	i) 555; ii) 643A	i) 918D; ii) 642B
i) Flower (1999) + Hodell et al. (2001) + Shipboard Scientific Party (1996) ii) Spezzaferri (1998) + Wei (1998); iii) Spiegler & Jansen (1989)	i) Spiegler and Mueller (1992) + Baldauf et al. (1986); Spiegler (1999) + Shipboard Scientific Party (1996); Spezzaferri and Spiegler (1998) + Wei (1998); iv) Qvale & Spiegler (1989) + Bleil (1989)	i) Spiegler (1999); ii) Spezzaferri (1998)	i) Edwards (1984) + Backman (1984), Berggren et al. (1995); ii) Manum et al. (1989) + Bleil (1989)	i) Spezzaferri (1998) + Wei (1998); ii) Spiegler & Jansen (1989)

		12.3	<b>11.6-11.8</b>			
		NM7	NM8a/NM7			
BO15 <sup>a</sup>	PF27	PF26	BO14 <sup>b</sup>	DC22	BO14 <sup>a</sup>	DC
			9.6 (9.56-10.88)	<b>11.6</b> (11.6-12.0)	13.0 (11.63-12.97)	12.1 (11.9-12.10)
<b>12.7</b> (12.51-12.72)	<b>12.7</b> (12.24-12.66)	<b>12.3</b> (12.27-12.30)	6.7 (6.65)		<b>11.6</b> (10.93-11.57)	
			~11.8		10.4 (10.12-10.42)	<b>11.6</b> (10.66-11.61)
Acme Bolboforma atlantica	Acme Neogloboquadrina group	Reappearance Globorotalia ex gr. praescitula-zealandica	Disappearance Bolboforma clodiusi	LO Cerebrocysta poulsenii	FO Bolboforma subfragoris	FO Achomosphaera andalousiensis
NN6	NN6	NN6	i) near NN7/NN8; ii) upper NN9	C5r.3r	i) MIS CM7, at FO Globoturborotalita nepenthes; ii) upper NN6; iii) NN7	i) upper C5An; ii) NN7-?NN8 and N14
982B	982B	918D	i) 982B; ii) 116	onshore NW Italy	i) Palazzolo section, Sicily; ii) 608; iii) 982B	i) onshore NW Italy; ii) 905A
Spiegler (1999) + Shipboard Scientific Party (1996)	Flower (1999) + Shipboard Scientific Party (1996)	Spezzaferri (1998) + Wei (1998)	i) Spiegler (1999) + Shipboard Scientific Party (1996); ii) Spiegler (1999) + Loughton et al. (1975)	Zevenboom (1995)	i) Spezzaferri et al. (2001); ii) Spiegler and Mueller (1992) + Baldauf et al. (1986); iii) Spiegler (1999) + Shipboard Scientific Party (1996)	i) Zevenboom (1995); de Verteuil and Norris (1996); de Verteuil (1996) + Shipboard Scientific Party (1994)

?	?	<b>12.6-12.7</b>	
		NM7/ NM6	
DC	DC	BO15 <sub>c</sub>	BO15 <sub>b</sub>
13.5 (13.53-14.91)	12.8 (12.77-13.53)	13.5 (13.45-13.46)	12.7
	12.9 (12.94-13.26)	<b>12.7</b> (12.65-13)	<b>12.7</b> (12.11-12.65)
?13.0 (11.20-12.99)	?13.5 (11.6-16.0)	10.5 (10.51-10.93)	
LO Distatodinium paradoxum	LO Unipontidinium aquaeductum	LO Bolboforma reticulata group	Acme Bolboforma danielsi
i) ?upper NN5; ii) C5r.2r-C5Ar.3r	i) C5An.1n/C5Ar.2r; ii) NN6 and N10-N11	i),ii) NN6; iii) C5n.2n	i),ii),iii) NN6
i) 903C; ii) 643A	i) onshore NW Italy; ii) 905A	i) 982B; ii) 608; iii) 642B, 642C	i) 982B; ii) 608; iii) 555
i) de Verteuil and Norris (1996) +(1996) + Shipboard Scientific Party (1994); ii) Manum et al. (1989)	i) Zevenboom (1995); ii) de Verteuil and Norris (1996) +(1996) + Shipboard Scientific Party (1994)	Spiegler (1999) + Shipboard Scientific Party (1996); ii) Spiegler & Müller (1992); iii) Qvale & Spiegler (1989)	Spiegler (1999) + Shipboard Scientific Party (1996); ii) Spiegler & Müller (1992); iii) Murray (1984) + Backman (1984) + Berggren et al. (1995)

?13.7	13.5	13.3	13.3
NM6			
DC	BO16	PF29a	DC23
	13.9 (13.71-14.06)		13.4 (13.41-13.53)
	<b>13.5</b> (13.46-13.53)	<b>13.3</b> (13.3-13.86)	13.5 (13.48)
13.7 (13.34-14.12)	11.2 (11.19-11.76)		<b>13.3</b> (13.33)
LO Cribroperidinium giuseppei	FO common B. reticulata group	Top acme Globigerina praebulloides	LO Cleistosphaeridium placacanthum
C5AAr-C5ACr	i),iii),iv) NN5/NN6; ii) NN4; v) ?C5r.3r	NN5	i) (C4r.1r/C4n.2n); ii) NN6 and N10-N11; iii) NN6; iv) near C5AAr/C5ABn
643A	i) 608; ii) 982B; iii) 408; iv) 555; v) 642B	982B	i) (Mazzapiedi section, NW Italy); ii) 905A; iii) 555; iv) 643A
Manum et al. (1989) + Bleil (1989)	i),iii) Spiegler and Mueller (1992) + Baldauf et al. (1986); ii) Spiegler (1999) + Shipboard Scientific Party (1996); iv) Spiegler and Mueller (1992) + Backman (1989); v) Qvale & Spiegler (1999) + Bleil (1989)	Flower (1999) + Shipboard Scientific Party (1996) + Berggren et al. (1995) + Ogg and Lugowski (2008) + This study	i) Zevenboom (1995); ii) de Verteuil and Norris (1996) +(1996) + Shipboard Scientific Party (1994); iii) Edwards (1984) + Backman (1984); iv) Mudie (1989) + Bleil (1989)

14.9	14.9	14.7	14.2	<b>13.8-13.9</b>		
NM5				NM6/ NM5		
DC24	DC	PF31a	BO	PF30e	PF30d	PF30c
						13.73 (A)
14.9 (13.53-14.91)	14.9 (14.91)					
		<b>14.7</b> (14.61-14.68)	<b>14.2</b> (14.22-14.35)	<b>14.0</b> (13.96-14.12)	<b>13.9</b> (13.86-13.99)	<b>13.8</b> (13.80-14.24)
<b>14.9</b> (14.94-15.08)	?13.3 (13.25-13.31)					
LO Apteodinium spiridoides	LO Cousteaudinium aubryae	FO Globigerina bulloides	LO Bolboforma reticulata s.str.	LO Praeorbulina glomerosa	Influx Globorotalia miozea	LO (consistent) Globorotalia ex gr. praescitula-zealandica
i) upper NN5; ii) C5Bn.1r	i) base C5Bn.1n; ii) NN5; iii) (C5AAr)	NN5	NN5	NN5	NN5	i) NN5; ii) NN5 and near N8/N9
i) 903C; ii) 643A	i) Cortemilia section, NW Italy; ii) 903C; iii) 643A	982B	982B	918D	982B	i) 982B; ii) 918D
i) de Verteuil and Norris (1996) + de Verteuil (1996) + Shipboard Scientific Party (1994); ii) Manum et al. (1989) + Bleil (1989)	i) Zevenboom (1995); ii) de Verteuil and Norris (1996); Shipboard Scientific Party (1994); iii) Manum et al. (1989) + Bleil (1989)	Flower (1999), Shipboard Scientific Party (1996)	Spiegler (1999) + Shipboard Scientific Party (1996)	Spezzaferri (1998), Wei (1998)	Flower (1999), Shipboard Scientific Party (1996)	i) Flower (1999) + Shipboard Scientific Party (1996); ii) Spezzaferri (1998) + Wei (1998)

15.4-18.3	<b>15.2-15.5</b>		?15.0	15.0
	NM5/ NM4			
vvvv vv	DC25	PF32	DC	DC
?(13.7-14.4)	15.2 (14.91-15.16)		18.8	15.0 (15.03-15.16)
15.4-18.3	~14.9	<b>15.2</b> (15.18-15.22)		
	<b>15.5</b> (15.51)	9.0 (8.78-9.03)	15.0 (14.94-15.08)	?11.2 (11.20-12.99)
<b>HIATUS (MID-MIO. UNCONF.)</b>	FO Labyrinthodinium truncatum	FO N. pachyderma (sinistral)	LO Cribroperidinium tenuitabulatum	FO Unipontidinium aquaeductum
i) ?upper NN5; ii) NN4; iii) NN4-NN5; iv),v) NN4-NN3	i) lower C5Bn.2n; ii) lower NN5; iii) "Langhian 1" maximum flooding surface of Hardenbol et al. (1998)	i) near NN4/NN5; (C4An)	i) Strontium ( <sup>87</sup> Sr/ <sup>86</sup> Sr) isotope ratio of 0.708525; ii) C5Bn.1r-C5Bn.2n	i) upper C5Bn.2n; ii) (C5r.2r-C5Ar.3r)
i) 608; ii) 982B; iii) 116; iv) 408; v) 918D	i) Cessole section, NW Italy; ii) 903C; iii) onshore Netherlands boreholes (Breda Fm)	i) 918D; ii) (643A)	i) ACGS-4 borehole, US East Coast; ii) 643A	i) Cessole section, NW Italy; ii) (643A)
i) Spiegler and Mueller (1992) + Baldauf et al. (1986); ii) Spiegler (1999) + Shipboard Scientific Party (1996); iii),iv) Spiegler and Müller (1992); v) Spezzaferri (1998) + Israelson & Spezzaferri (1998)+ McArthur et al. (2001)	i) Zevenboom (1995); ii) de Verteuil and Norris (1996) + de Verteuil (1996) + Shipboard Scientific Party (1994); iii) Munsterman and Brinkhuis (2004) + Hardenbol et al. (1998) + Ogg and Lugowski (2008)	i) Spezzaferri (1998) + Wei (1998); ii) Spiegler and Jansen (1989) + Bleil (1989)	i) de Verteuil and Norris (1996) + Sugarman et al. (2001); ii) Manum et al. (1989) + Bleil (1989)	i) Zevenboom (1995); ii) Manum et al. (1989) + Bleil (1989)

?17.3	17.2	16.3	16.3	16.2	16.1	?15.7
NM4						
DC	PF	BO17	PF33 b	DC	DC	DC
		17.5 (17.46)				20.6
	<b>17.2</b> (17.18–17.23)	<b>16.3</b> (15.95–16.32)	<b>16.3</b> (16.19–16.32)			
?17.3 (17.28–17.72)	?(15.15)			16.2 (16.22–16.24)	16.1 (16.03–16.18)	15.7 (15.52–15.90)
LO Distatodinium craterum	LO Paragloborotalia nana	FO Bolboforma reticulata s. str.	Influx common Sphaeroidinellopsis disjuncta	LO Cordosphaeridium minimum	LO Lophocysta sulcolimbata	LO Apteodinium australiense
C5Dr.1n	i) NN4; ii) (C5Bn.2n)	i,ii) mid–NN4; iii) upper N8	mid–NN4	near C5Cn.1n/C5n.1r	C5Cn.1n	NN4
643A	i) 918D; ii) (643A)	i) 608; ii) 982B; iii) 918D	982B	643A	643A	982B
Manum et al. (1989) + Bleil (1989)	i) Spezzaferri (1998) + Wei (1998); ii) Spiegler & Jansen (1989) + Bleil (1989)	i) Spiegler and Mueller (1992) + Baldauf et al. (1986) + This study; ii) Spiegler (1999) + Shipboard Scientific Party (1996); iii) Spezzaferri & Spiegler (1998) + Spezzaferri (1998)	Flower (1999) + Shipboard Scientific Party (1996)	Manum et al. (1989) + Bleil (1989)	Manum et al. (1989) + Bleil (1989)	Spiegler (1999) + Shipboard Scientific Party (1996)

17.5-17.7			17.3
NM4/ NM3			
BO18 <sup>a</sup>	DC26	PF35 <sup>d*</sup>	DC
	17.5 (17.53-18.82)		
17.6 (17.50-17.76)		17.5 (17.07-17.48)	
	17.5 (17.54-17.83)	?(11.76)	17.3 (17.28-17.72)
LO Bolboforma rotunda	LO Tityrosphaeridium cantharellus	Influx Globorotalia peripheroronda	LO Evittosphaerula paratabulata
NN4	i) near C5Dn/C5Dr.1r; ii) Strontium (87Sr/86Sr) isotope ratio of 0.708525; iii) NN2 and N5; iv),v) ?C5En (as LO consistent); vi) within the "Bur3" sequence	i) NN4; ii) (?C5r.3r)	near C5Dn/C5Dr.1r
982B	i) Cortemilia section, NW Italy; ii) ACGS-4 borehole, onshore US E. Coast; iii) 902D; iv) 643A; v) 642D; vi) onshore Netherlands boreholes (Breda Fm)	i) 918D; ii) 642B	643A
Spiegler (1999) + Shipboard Scientific Party (1996)	i) Zevenboom (1995); ii) de Verteuil and Norris (1996) + Sugarman et al. (1993) + McArthur et al. (2001); iii) de Verteuil and Norris (1996) + Shipboard Scientific Party (1994); iv),v) Manum et al. (1989) + Bleil et al. (1989) + Goll (1989); Munsterman & Brinkhuis (2004) + Hardenbol et al. (1998) + Ogg & Lugowski (2008)	i) Spezzaferri (1998) + Wei (1998); ii) Spiegler & Jansen (1989) + Bleil (1989)	Manum et al. (1989) + Bleil (1989)



<b>19.0-19.2</b>		18.3			
NM3/ NM2		NM3			
PF37 b	PF37a	BO19	PF36*	BO18 b	
17.54 (A)					
		14.3 (14.15-14.36)		? 14.2 (14.15-14.36)	
<b>19.0</b> (19.00-19.20)	<b>19.0</b> (18.96)	<b>18.3</b> (18.2-18.3)	<b>17.7</b> (17.71)	<b>17.6</b> (17.63-17.95)	
				? 9.2 (9.18-9.21)	
LO Catapsydrax dissimilis	LO (consistent) Sphaeroidinellopsis disjuncta	LO Bolboforma spiralis	LO Cassigerinella chipolensis	LO Bolboforma spinosa	
strontium (87Sr/86Sr) isotope record	strontium (87Sr/86Sr) isotope record	i) NN5; ii) NN3; iii) ?NN3/NN2 - NN1; iv) NN4 - NN5	NN3/NN4	i) (?mid-NN5); ii) lower NN4; iii) ?N7; iv) (C4Ar.1r)	
918D	918D	i) 608; ii) 982B; iii) 116; iv) 918D	918D	i) 608; ii) 982B; iii) 918D; iv) (643A)	
Spezzaferri (1998) + Israelson and Spezzaferri (1998) + McArthur et al. (2001)	Spezzaferri (1998) + Israelson and Spezzaferri (1998) + McArthur et al. (2001)	i) Spiegler and Mueller (1992) + Baldauf et al. (1986); ii) Spiegler (1999) + Shipboard Scientific Party (1996); iii) Spiegler and Mueller (1992); iv) Spezzaferri & Spiegler (1998) + Wei (1998)	Spezzaferri (1998) + Wei (1998)	i) Spiegler & Müller (1992) + Baldauf et al. (1986); ii) Spiegler (1999) + Shipboard Scientific Party (1996); iii) Spezzaferri & Spiegler (1998); iv) Qvale & Spiegler (1989) + Bleil (1989)	

<b>.4-20.6</b>			?20.1	
12/ NM1			NM2	
DC	DC	PF39	DC	PF38
20.6	20.6		20.1 (20.06–20.86)	
		<b>20.4</b> (20.38–20.48)		<b>19.2</b> (19.20–19.28)
LO Homotryblium vallum	LO Ectosphaeropsis burdigalensis	LO (consistent) Catapsydrax unicavus	LO Impagidinium aculeatum	LO Catapsydrax unicavus
i) strontium ( <sup>87</sup> Sr/ <sup>86</sup> Sr) isotope date; ii) NP25 (top), and possibly NN1 to lower NN2; iii) (C4An–C4Ar.2r)	strontium ( <sup>87</sup> Sr/ <sup>86</sup> Sr) isotope date	strontium ( <sup>87</sup> Sr/ <sup>86</sup> Sr) isotope record	i) At FO Globigerinoides altiapertura; ii) strontium ( <sup>87</sup> Sr/ <sup>86</sup> Sr) isotope date and NN2 and N5	strontium ( <sup>87</sup> Sr/ <sup>86</sup> Sr) isotope record
i) Anciennes carrieres Section, Leognan, France; ii) 902D; iii) (643A)	Anciennes carrieres Section, Leognan, France	918D	i) Lemme–Carrosio section, NW Italy (= base Aquitanian GSSP); ii) Anciennes carrieres Section, Leognan, France	918D
i) Londeix and Jan du Chene (1998) + Cahuzac et al. (1997); ii) de Verteuil and Norris (1996) + Shipboard Scientific Party (1994); iii) Manum et al. (1989) + Bleil (1989)	Londeix and Jan du Chene (1998) + Cahuzac et al. (1997)	Spezzaferri (1998) + Israelson and Spezzaferri (1998) + McArthur et al. (2001)	i) Zevenboom (1996) + Iaccarino et al. (1996) + Berggren et al. (1995); ii) Londeix and Jan du Chene (1998) + Cahuzac et al. (1997) + Pognant and Pujol (1978) + Mueller and Pujol (1979)	Spezzaferri (1998) + Israelson and Spezzaferri (1998) + McArthur et al. (2001)

21.4	21.2	<b>20</b>	
		NM	
BF18	DC28	DC27	DC
	22.8 (22.8–23.1)	<b>20.6</b> (20.6–21.12)	<b>20.6</b> (20.6–21.12)
~21.4 (20.9–21.8)	<b>21.2</b> (21.24–22.26)	27.8 (27.54–27.99)	27.2 (26.97–27.46)
LO Spirosigmoinella compressa	LO Caligodinium amiculum	LO Thalassiphora pelagica	FO Apteodinium spiridoides
Between LO Thalassiphora pelagica and LO Caligodinium amiculum	i) NN1; ii) interpolation between C5Dr.2r/C5En and LO Enneadocysta	i) strontium ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) isotope date and NN2 and N5; ii) interpolation between C5Dr.2r/C5En and LO Enneadocysta pectiniformis	i) strontium ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) isotope date and NN2 and N5; ii) interpolation between C5Dr.2r/C5En and LO Enneadocysta pectiniformis
Well Alma-1X (Central North Sea, of shore Denmark)	i) Marche region (Central Italy); ii) 643A	i) Anciennes carrieres Section, Leognan, France; ii) 643A	i) Anciennes carrieres Section, Leognan, France; ii) 643A
Schiøler (2005)	i) Biffi and Manum (1988); ii) Manum et al. (1989) + Bleil (1989) + Van Simaey (2004)	i) Londeix and Jan du Chene (1998) + Cahuzac et al. (1997) + Poignant and Pujol (1978) + Mueller and Pujol (1979); ii) Manum et al. (1989) + Bleil (1989) + Van Simaey (2004)	i) Londeix and Jan du Chene (1998) + Cahuzac et al. (1997) + Poignant and Pujol (1978) + Mueller and Pujol (1979); ii) Manum et al. (1989) + Bleil (1989) + Van Simaey (2004)

22.8	<b>22.0-22.2</b>		21.6-21.8
	NM1/ NM0		NM1
DC	DC30	MD12	DC29
<b>22.8</b> (22.8-23.1)	19.9 (19.88-22.82)		23.3 (22.7-23.25)
?28.0 (28.03-28.50)	<b>22.2</b> (21.7-22.7)	(>21.8, <22.2)	~ <b>21.6-21.8</b> (<22.2)
LO Deflandrea phosphoritica	LO Chiropteridium spp.	LO Aulacodiscus insignis var. aemulans	FO Ectosphaeropsis burdigalensis
i) NN1; ii) NN2-NN1; iii) interpolation between C5Dr.2r/C5En and LO Enneadocysta pectiniformis	i) C6r; ii) lower NN2; iii) NP25 (top), and possibly NN1 to lower NN2; iv) Above LO common Deflandrea phosphoritica and below FO Ectosphaeridium burdigalensis	Midway between the dinoflagellate cyst LO Caligodinium amiculum and LO Chiropteridium galea	i) near C6Cn.1r/C6Cn.1n; ii) base C6Cn.2r; iii) Above LO Chiropteridium spp and below LO Homotryblium plectilum, probably correlates with a warm 180 peak following Mi1 glaciation
i) Lemme-Carrosio Section, NW Italy (base Neogene stratotype section); ii) 903C; iii) 643A	i) Contessa Valley composite section (Gubbio, Italy); ii) Lemme-Carrosio section, NW Italy (= base Aquitanian GSSP); iii) 902D; iv) Frida-1 well, of shore Denmark	Well Alma-1X (Central North Sea, of shore Denmark) (Lark Formation)	i) Contessa Valley composite section; ii) Lemme-Carrosio Section, NW Italy (base Neogene stratotype section); Frida-1 well, of shore Denmark (North Sea)
i) Powell (1986); ii) de Verteuil and Norris (1996) + Shipboard Scientific Party (1994); iii) Manum et al. (1989) + Bleil (1989) + Van Simaey (2004)	i) Montanari et al. (1997); ii) Powell (1986); iii) de Verteuil and Norris (1996) + Shipboard Scientific Party (1994); iii) Dybkjær and Rasmussen (2007)	Schiøler (2005)	i) Montanari et al. (1997) + McArthur et al. (2001); ii) Zevenboom (1996); Ogg and Lugowski (2008) + Gradstein et al. (2004); iii) Dybkjær and Rasmussen (2007)

	25.9	22-26	23?
		vvvvvv	
DC	DC	vvvvv	DC31
			21.7 (21.69–21.77)
		~22–26	
27.1 (26.89–27.23)	25.9 (25.60–25.90)		23? (22.2–28.3)
LO Chiropteridium lobospinosum + Major abundance decrease in dinocysts	FO Invertocysta tabulata	<b>HIATUS (BASE NEOG. UNCONF.)</b>	LO common Deflandrea phosphoritica
interpolation between C5Dr.2r/C5En and LO Enneadocysta pectiniformis	interpolation between C5Dr.1r/C5Dr.1n and LO Enneadocysta pectiniformis	Absence of upper N3 to lower N4, between FO G. dehiscens and LO P. opima (possibly as Ch4/Aq1 global sequence boundary of Hardenbol et al. (1998))	i) CAAr.3r; ii) Above LO D. biffii and below LO Chiropteridium spp.
643A	643A	918D	i) i) Lemme–Carrosio Section, NW Italy (base Neogene stratotype section); ii) Frida–1 well, of shore Denmark
Manum et al. (1989) + Bleil (1989) + Van Simaey (2004)	Manum et al. (1989) + Bleil (1989) + Van Simaey (2004)	Spezzaferri (1998)	i) Zevenboom (1996) + Steininger et al. (1997); ii) Dybkjær and Rasmussen (2007) + Zevenboom (1996)

?27.8	<b>27.1-27.3</b>	
	Base NM0	
DC	MD13	DC
		23.7 (23.38-24.04 )
27.8 (27.39-27.78)	~27.3 (26.71-27.83)	<b>27.1</b> (26.79-27.30)
FO Impagidinium aculeatum	LO Aulacodiscus insignis var. quadrata	LO Distatodinium biffii
interpolation between C5Dr.2r/C5En and LO Enneadocysta pectiniformis	Between LO Svalbardella cooksoniae and below 'Upper Oligocene/basal Neogene unconformity'	i) within C6Cr and between the GSSP for the Neogene and the FO Paragloborotalia pseudokugleri and Globigerinoides primordius; ii) interpolation between C5Dr.2r/C5En and LO Enneadocysta pectiniformis
643A	Well Alma-1X (Central North Sea, of shore Denmark)	i) Lemme-Carrosio Section, NW Italy (base Neogene stratotype section); ii) 643A
Manum et al. (1989) + Bleil (1989) + Van Simaey (2004)	Schiøler (2005) + Van Simaey (2004)	i) Zevenboom (1996) Iaccarino et al. (1996) + Berggren et al. (1995); ii) Manum et al. (1989) + Bleil (1989) + Van Simaey (2004)