Towards a Continous Cenozoic Arctic Climate Record – A Challenge for IODP Expedition 377 in 2021

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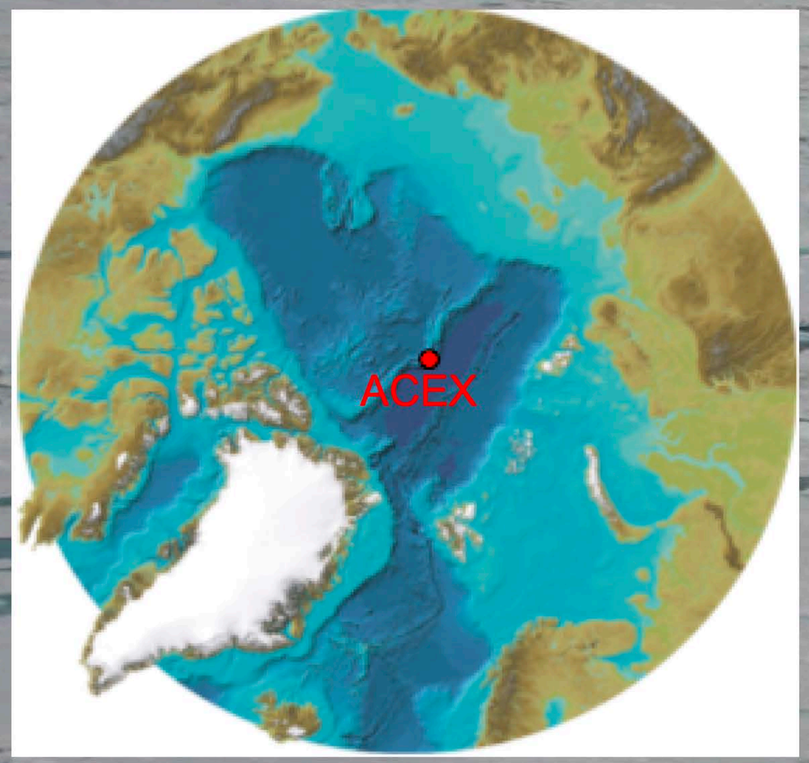
IODP INTERNATIONAL OCEAN DISCOVERY PROGRAM
Achievements & perspectives in scientific ocean & continental drilling – EGU2020-4886 (EGU Vienna, 4-8 May 2020)
ECORD European Consortium for Ocean Research Drilling

IODP Expedition 302 (2004): The Arctic Coring Expedition (ACEX)

(Backman, Moran, McInroy et al., 2006)



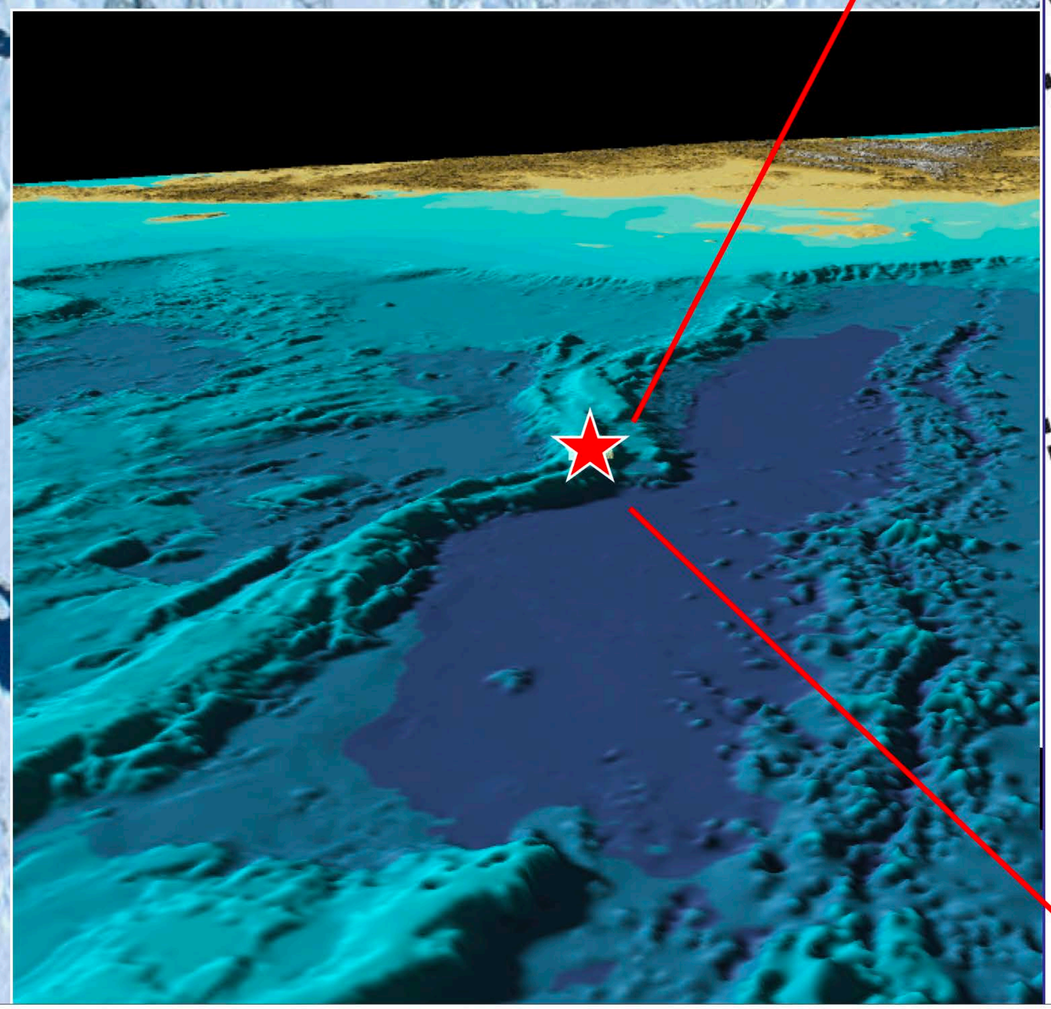
Sovetskiy Soyuz

Oden

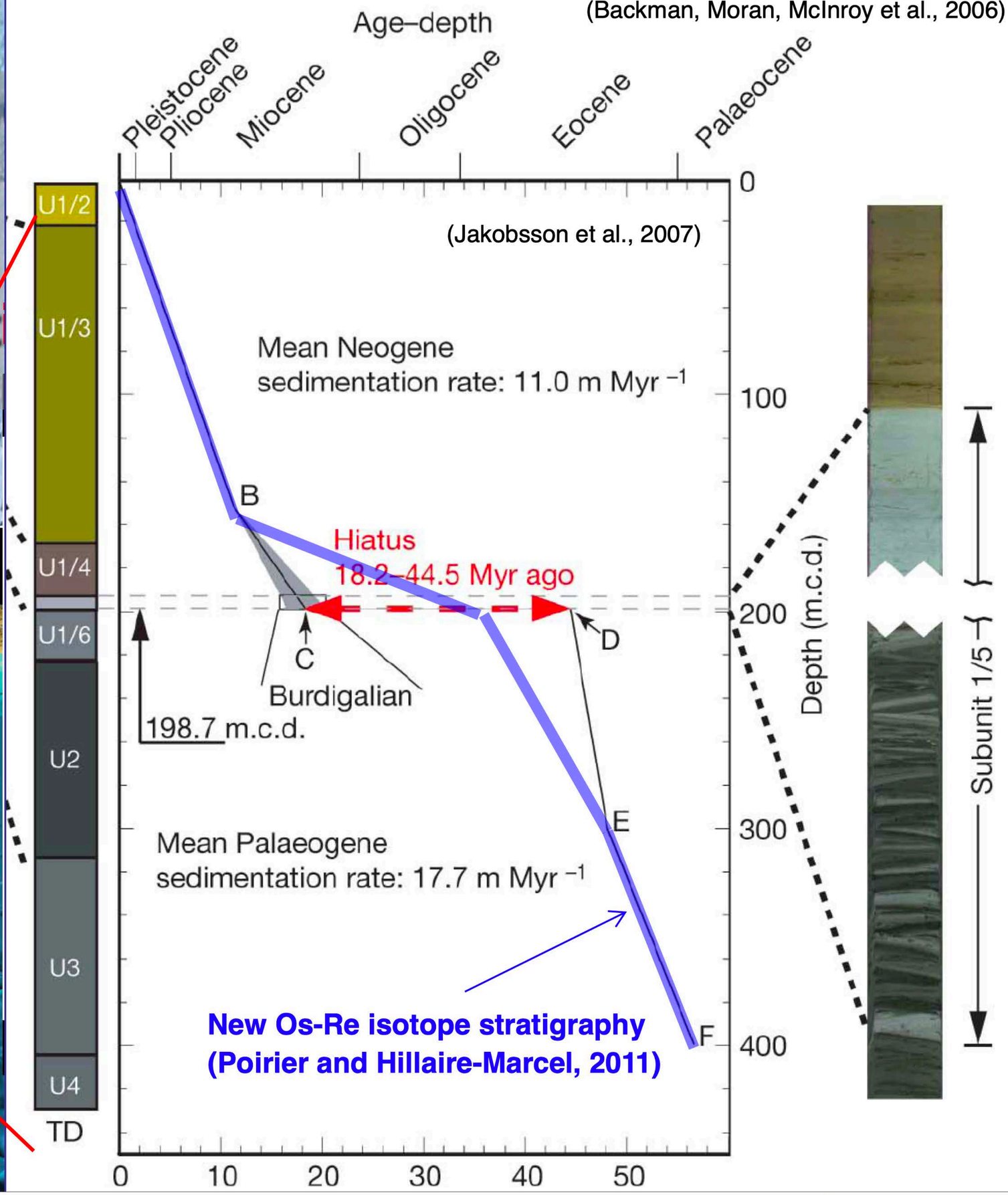
Vidar Viking

The Break-Through in Arctic Ocean Research: ACEX - The 1st Scientific Drilling in the central Arct

(Backman, Moran, McInroy et al., 2006)



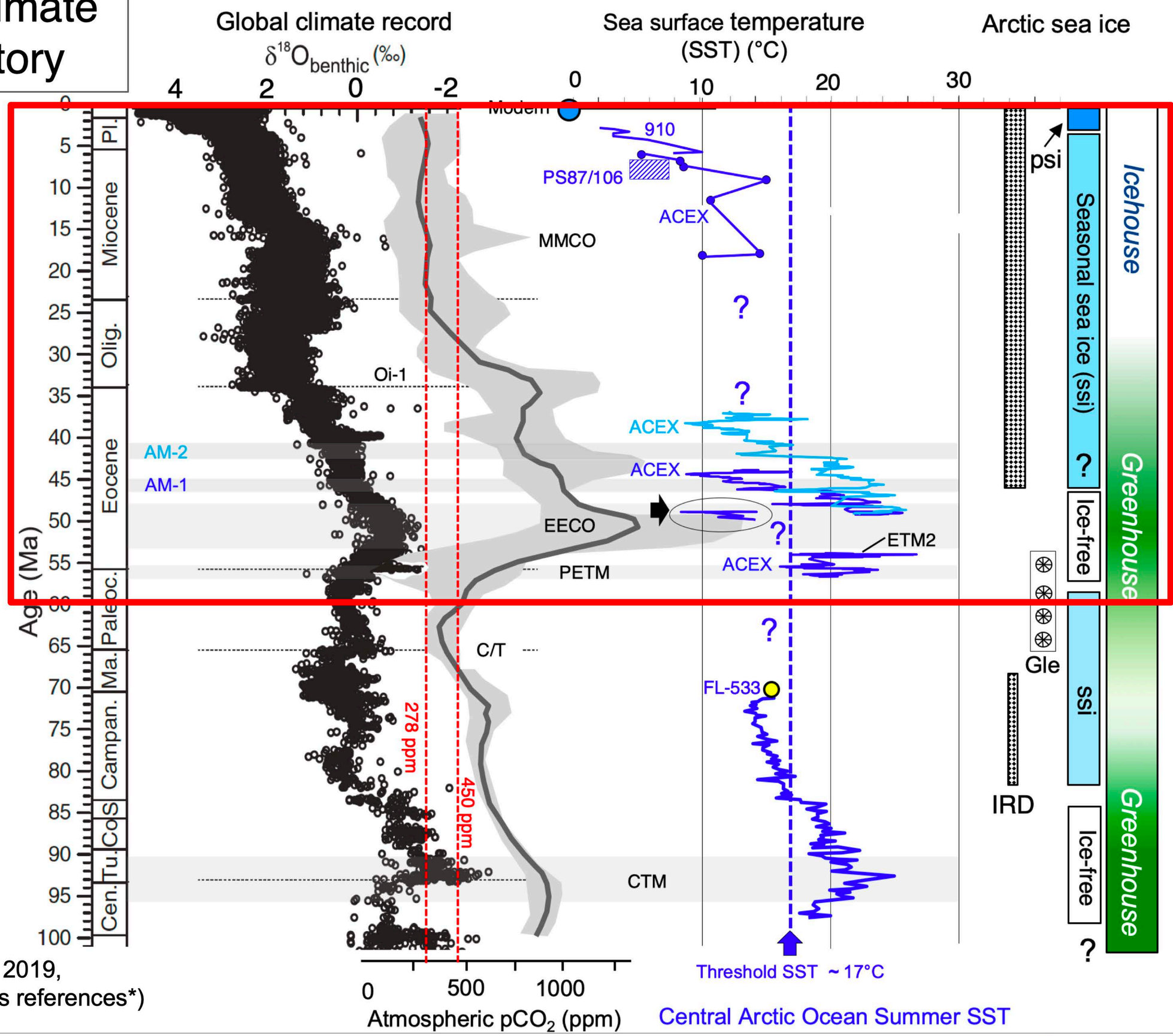
(Backman, Moran, McInroy et al., 2006)



The poorly known Arctic Ocean

Arctic Ocean climate & sea ice history

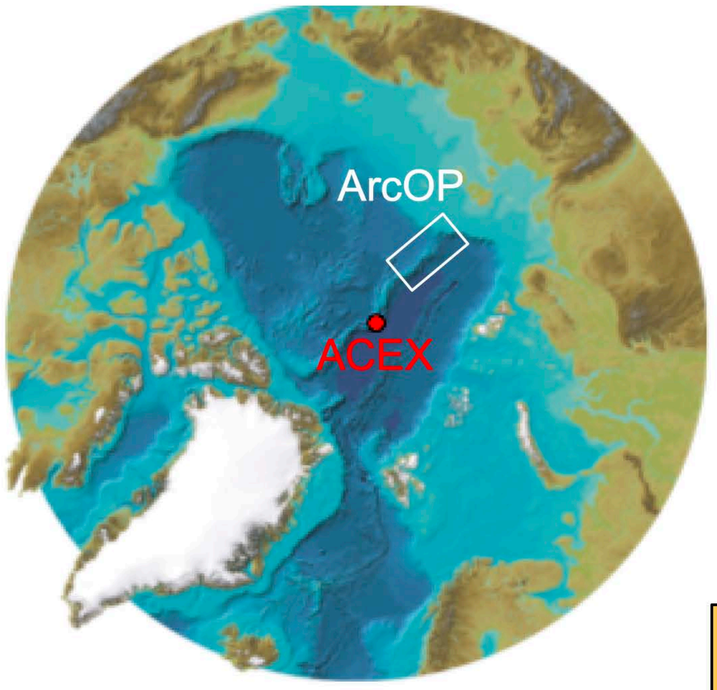
ArcOP



* References

Jenkyns et al., 2004
Brinkhuis et al., 2006
Sluijs et al., 2006
Pearson et al., 2007
Sangiorgi et al., 2008a
Sangiorgi et al., 2008b
Sluijs et al., 2008
St. John, 2008
Weller & Stein, 2008
Davies et al., 2009
Sluijs et al., 2009
Spielhagen & Tripati, 2009
Stickley et al., 2009
Knies et al., 2014
Stein et al., 2014
Stein et al., 2016

(Figure from Stein, 2019, based on numerous references*)



IODP Expedition 377 (Proposal 708):

Arctic Ocean Paleoceanography: Towards a Continuous Cenozoic Record from a Greenhouse to an Icehouse World

Proponents: R. Stein[1], W. Jokat[1], E. Weigelt[1], H. Brinkhuis[2], L. Clarke[3], B. Coakley[4], M. Forwick[5], M. Jakobsson[6], A. Krylov[7], J. Matthiessen[1], S.-I. Nam[7], F. Niessen[1], M. O´Regan[6], C. Stickley, K. St. John[9]

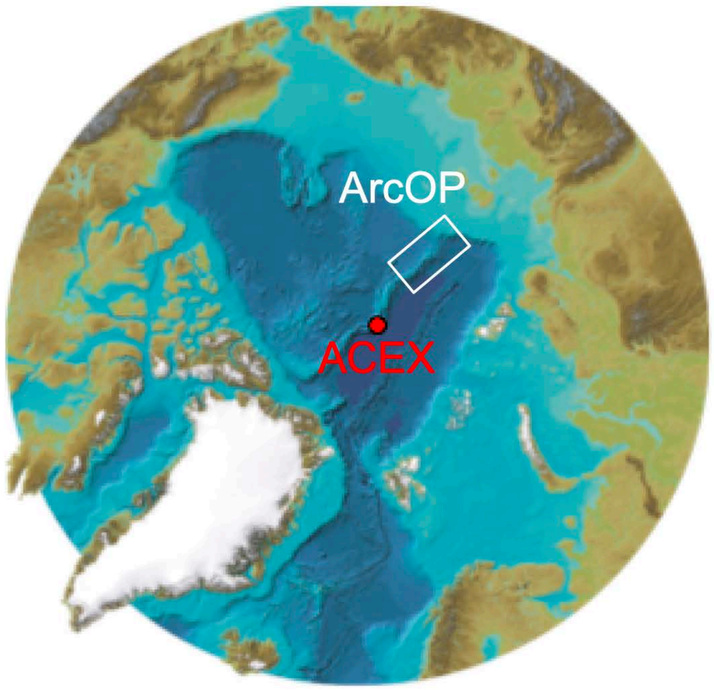
History (I)
708-Pre1 (2006)
708-Pre2 (2009)
708-Full1 (2013)

Overall Goal:
Recovery of a complete (composite) stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continous long-term Cenozoic climate history of the central Arctic Ocean

Involved institutions:

[1]Alfred Wegener Institute (AWI) for Polar and Marine Research, Bremerhaven, Germany
[2]Institute of Environmental Biology, Utrecht University, Utrecht, The Netherlands
[3]School of Science and the Environment, Manchester Metropolitan University, Manchester, UK
[4]Geophysical Institute, University of Alaska, Fairbanks, USA
[5]Institute of Geology, University of Tromsø – The Arctic University of Norway, Tromsø, Norway
[6]Department of Geological Sciences, Stockholm University, Stockholm, Sweden
[7]St. Petersburg University and VNIIOceanologia, St. Petersburg, Russia
[8]Korea Polar Research Institute (KOPRI), Incheon, Korea
[9]Department of Geology & Environmental Science, James Madison University, Virginia, USA

IODP Expedition 377
– Arctic Ocean Paleoceanography (ArcOP) –

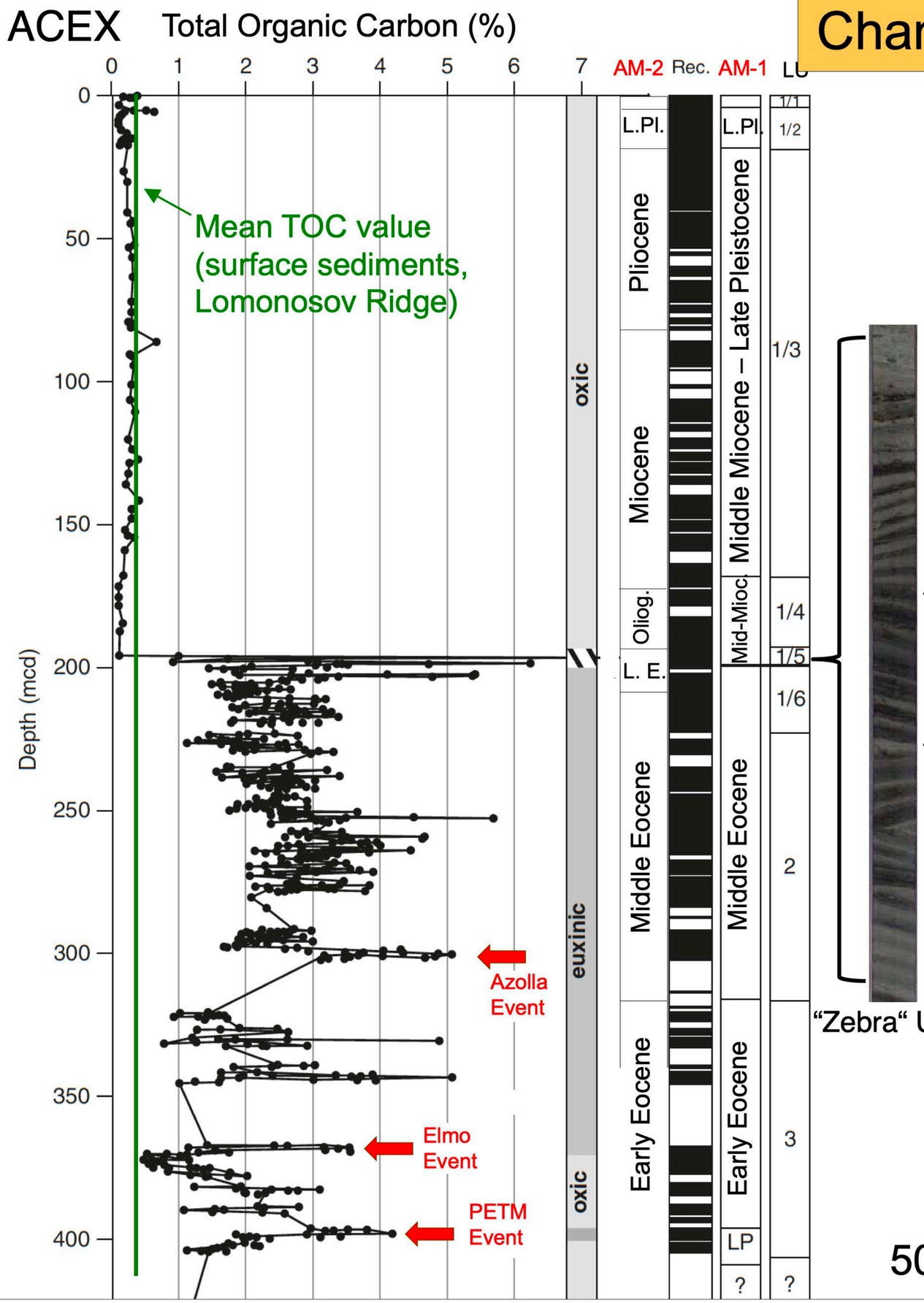


<u>377 Co-chief scientists:</u>
Ruediger Stein (AWI & Bremen University/Germany)
Kristen St. John (Harrisonburg/USA)

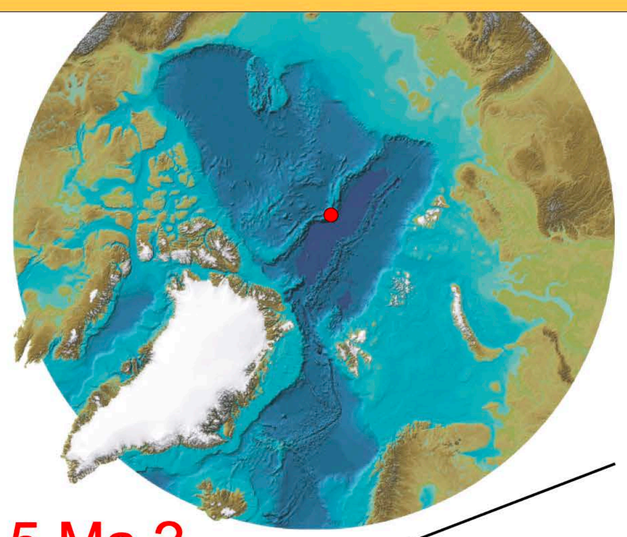
About 50 days between mid-August and mid-October 2021

Key objectives

Change from an euxinic to an oxic ocean



"Zebra" Unit

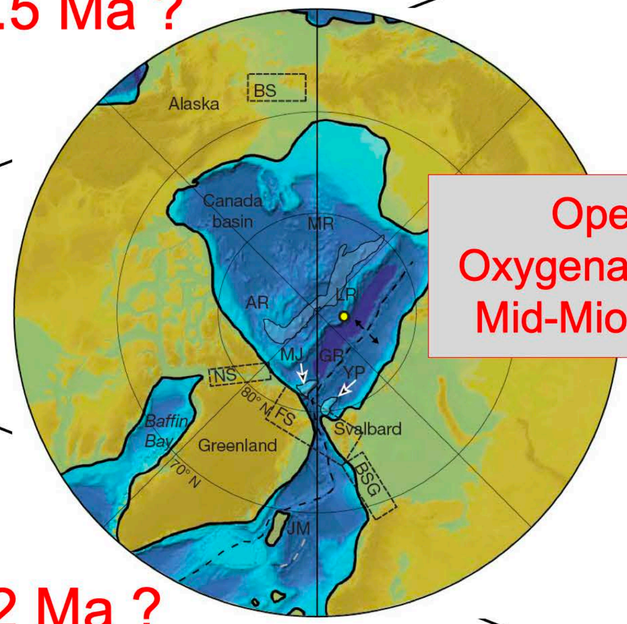


Modern Arctic Ocean

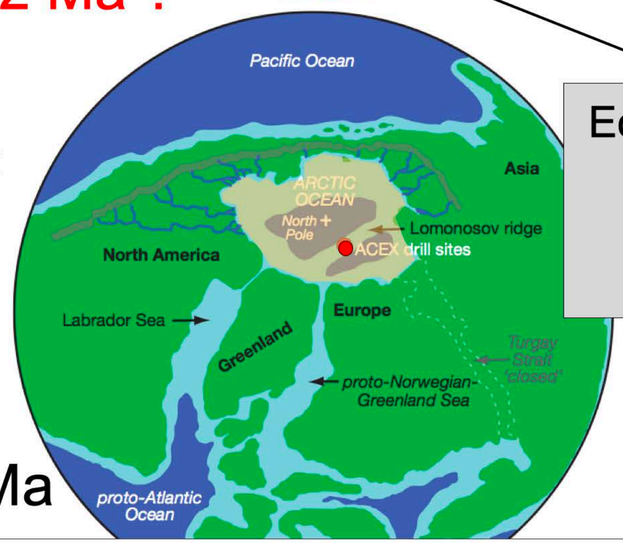
Oxic conditions

17.5 Ma ?

?



32 Ma ?



50 Ma

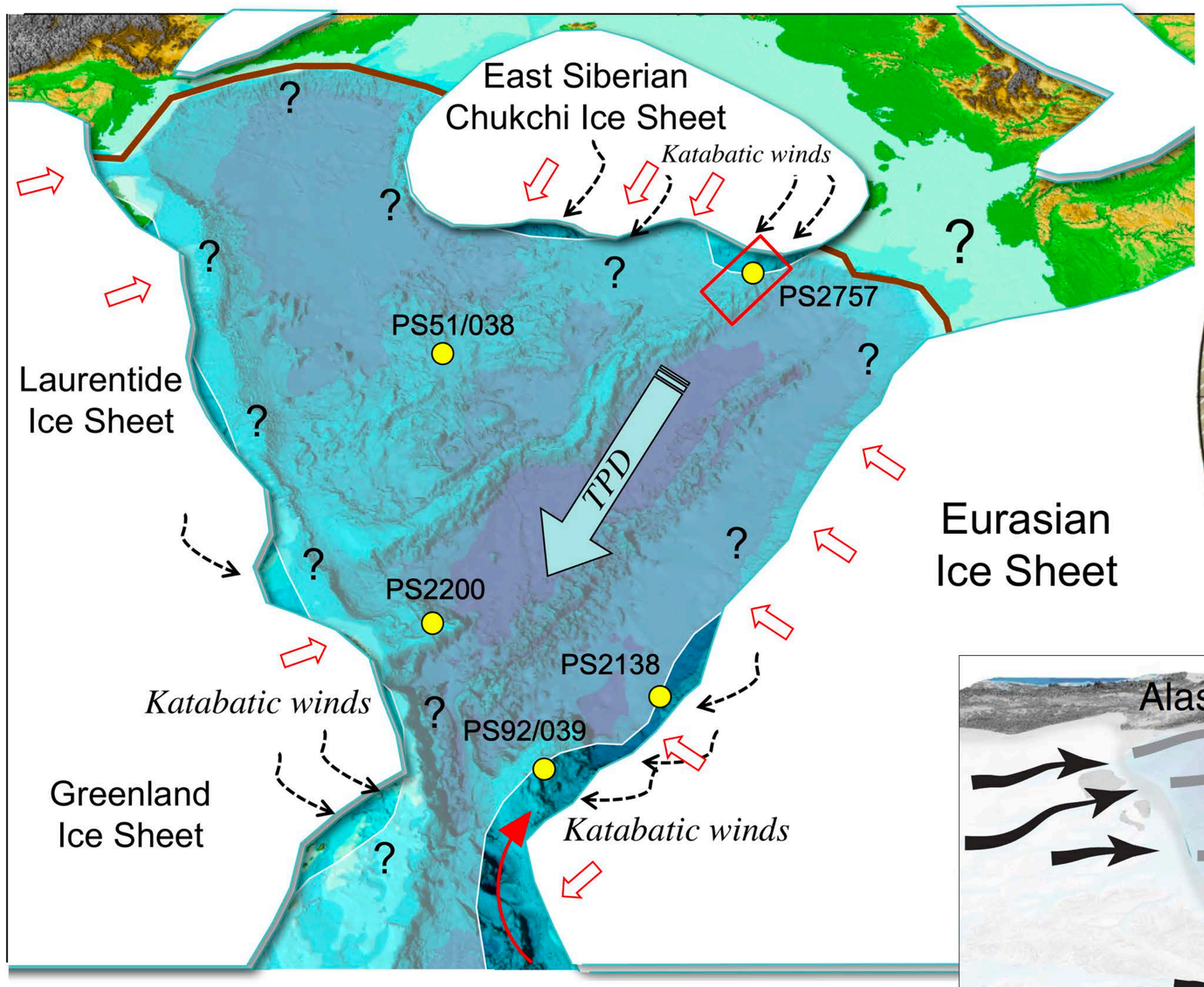
Opening of Fram Strait &
Oxygenation of Arctic deep basins:
Mid-Miocene vs. Early Oligocene

Eocene paleogeography

Euxinic conditions

(Stein, 2017, based on Backman et al., 2006; Brinkhuis et al., 2006; Stein, 2007; Stickley et al., 2009; Stein et al., 2015)

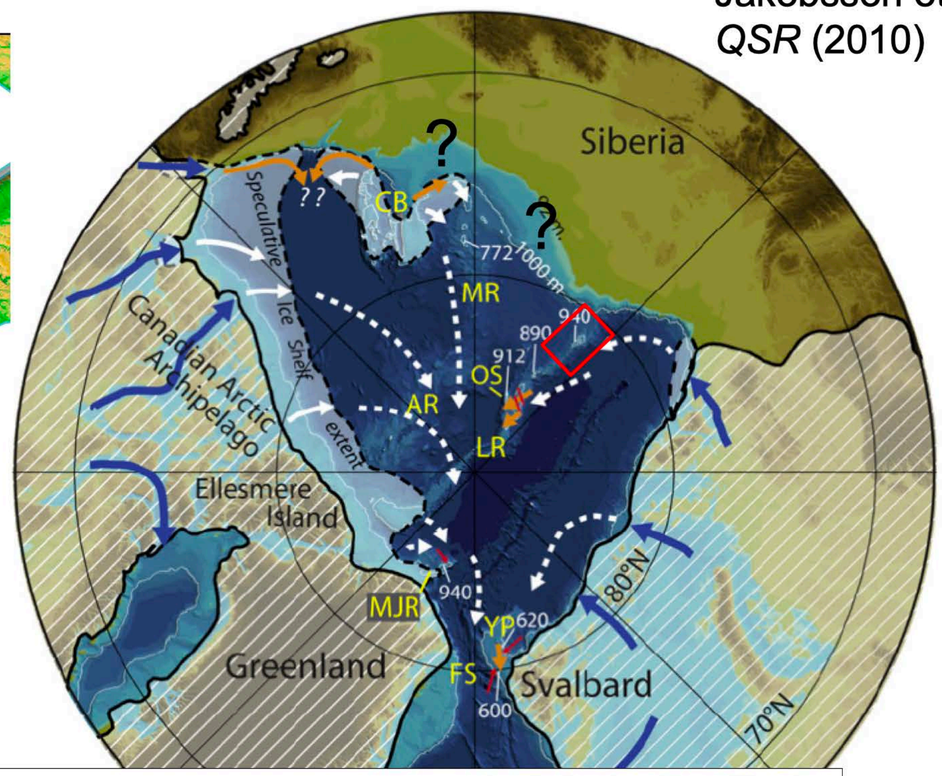
Extent & Timing of (Neogene-) Quaternary Circum-Arctic Glaciations

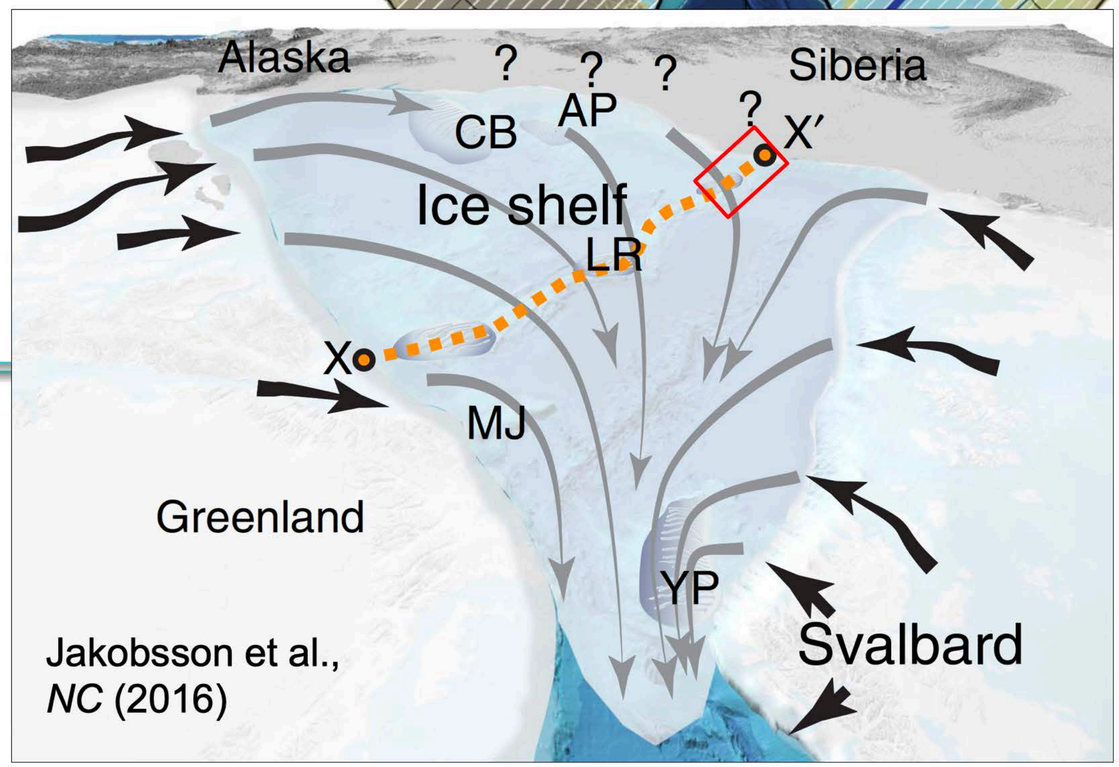


Stein et al., *NC* (2017)

Eurasian
Ice Sheet

Jakobsson et al.
QSR (2010)



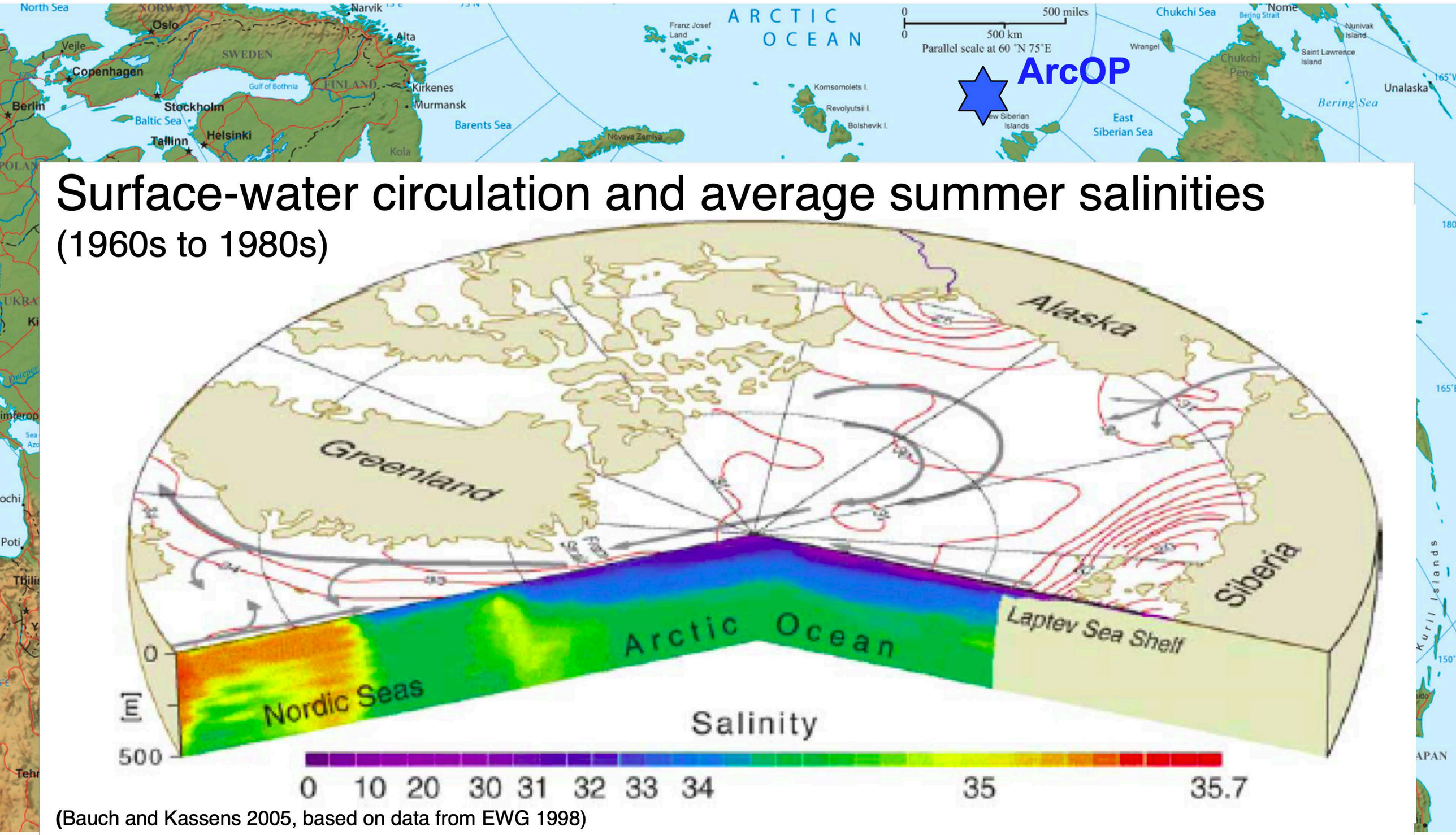


Jakobsson et al.,
NC (2016)

History of circum-Arctic glaciations

History of Siberian River Discharge

? ? ?

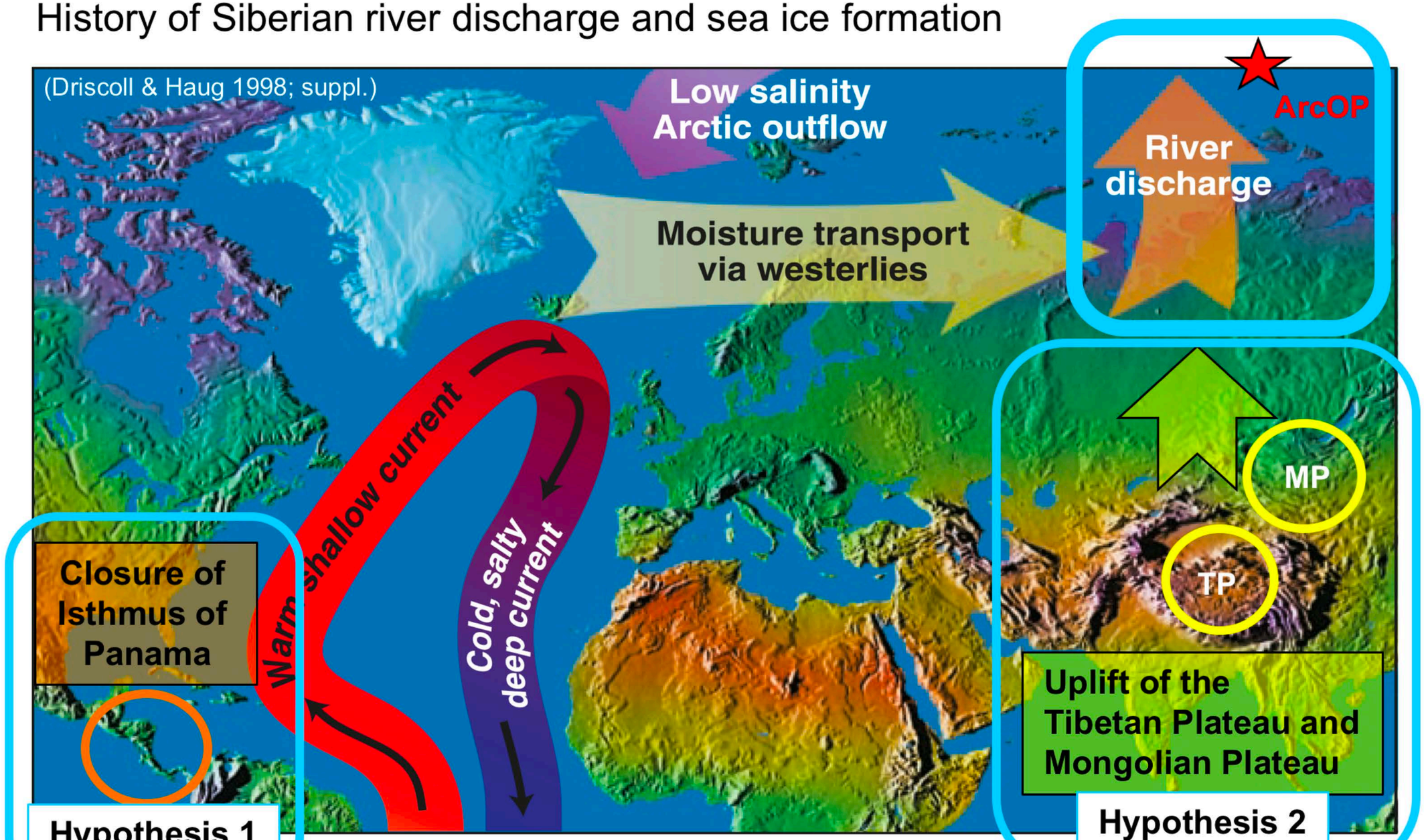


(Bauch and Kassens 2005, based on data from EWG 1998)

History of Siberian River Discharge

? ? ?

History of Siberian river discharge and sea ice formation



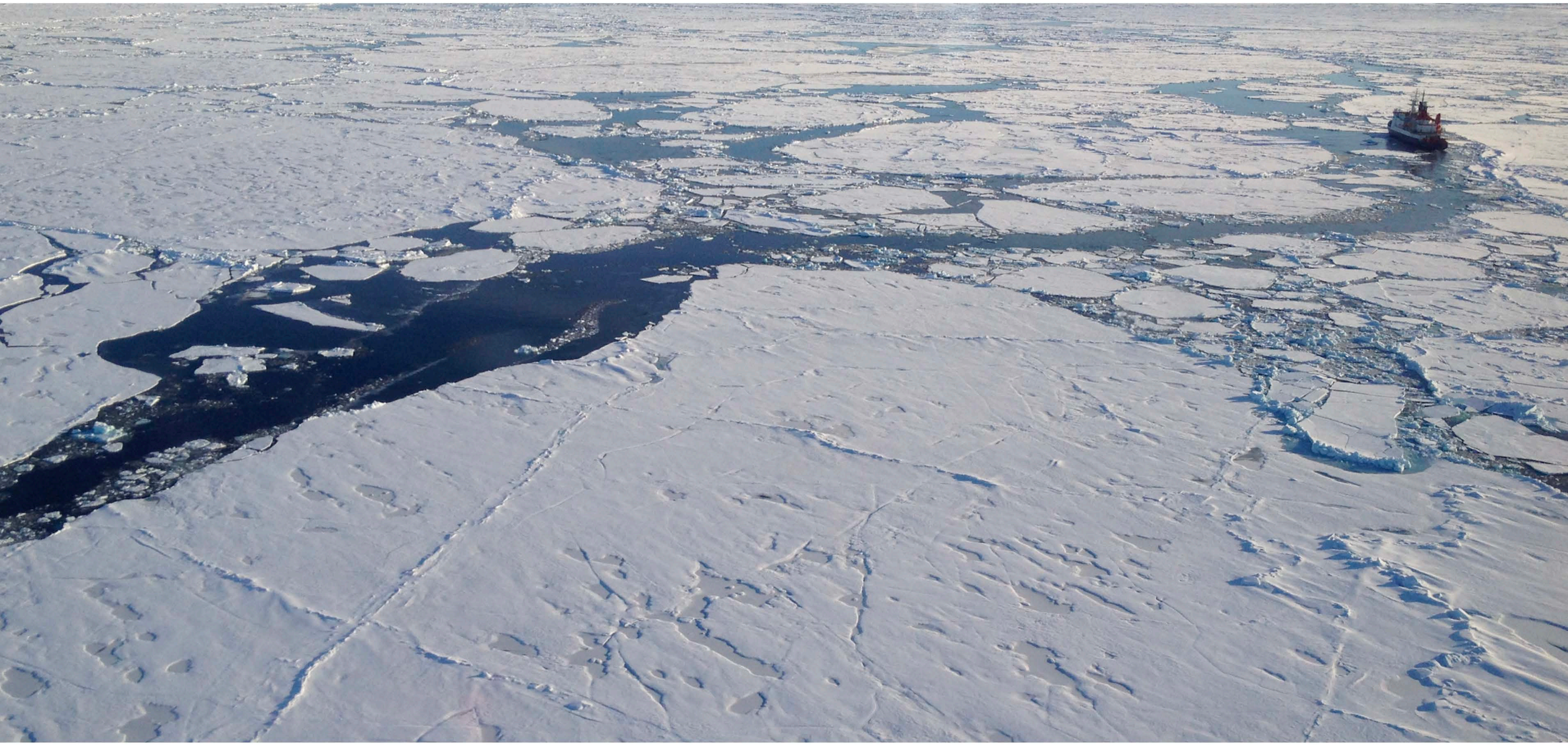
(Driscoll and Haug, 1998)

(Figure from Stein, 2019)

(Wang, 2004)

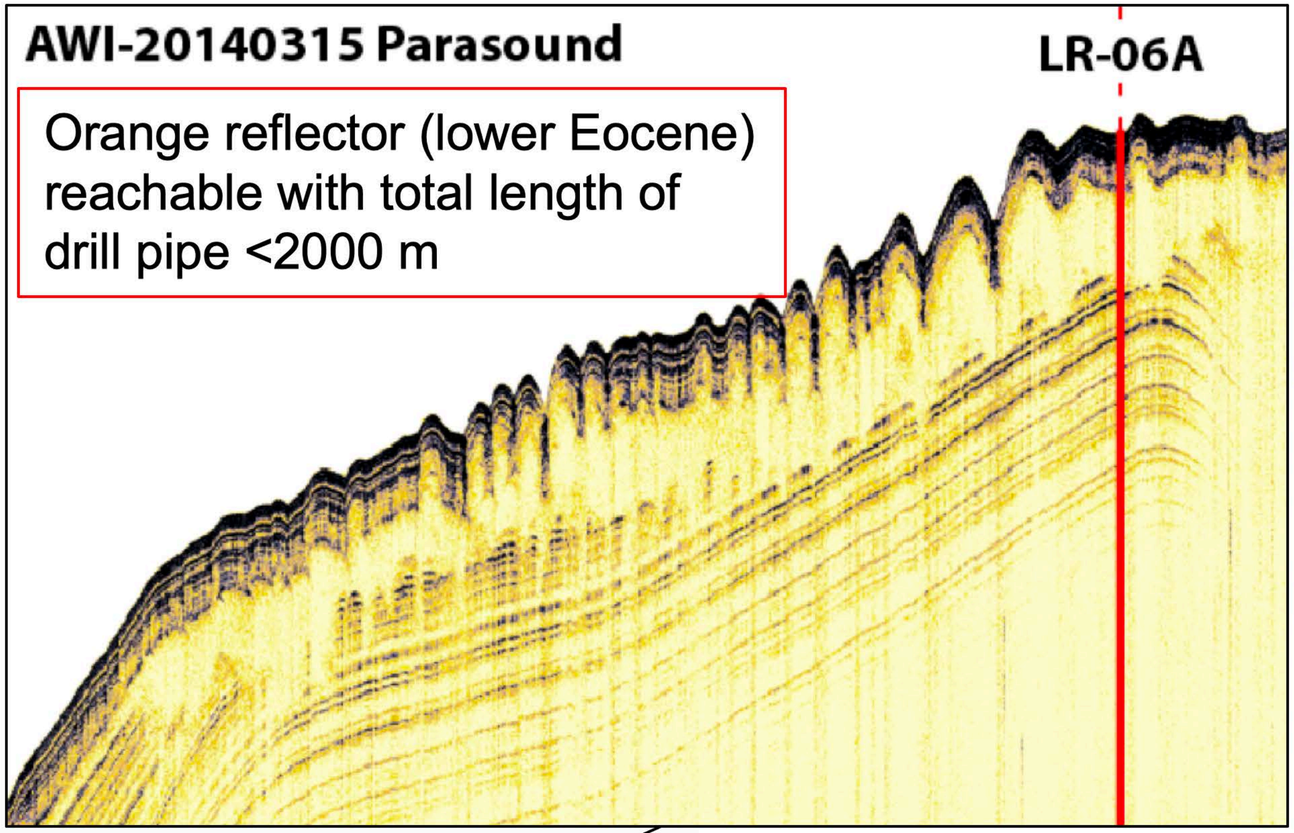
History of Arctic Sea-Ice Cover

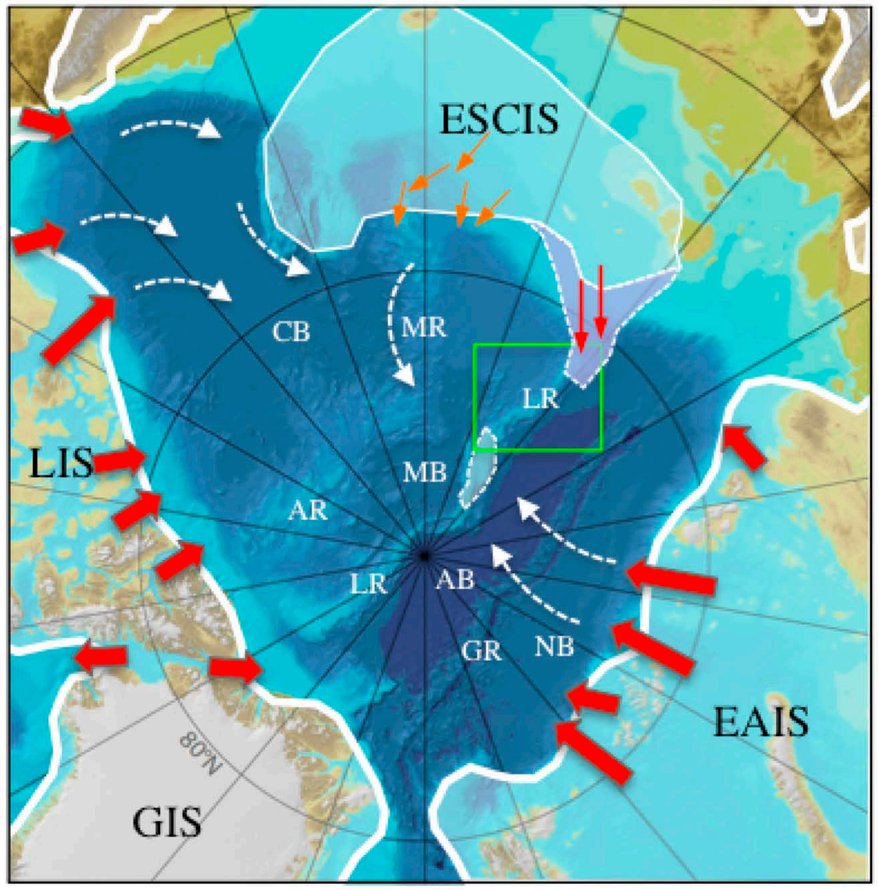
- Onset of sea-ice formation
- Seasonal sea ice vs. perennial sea ice
- Short-term variaility

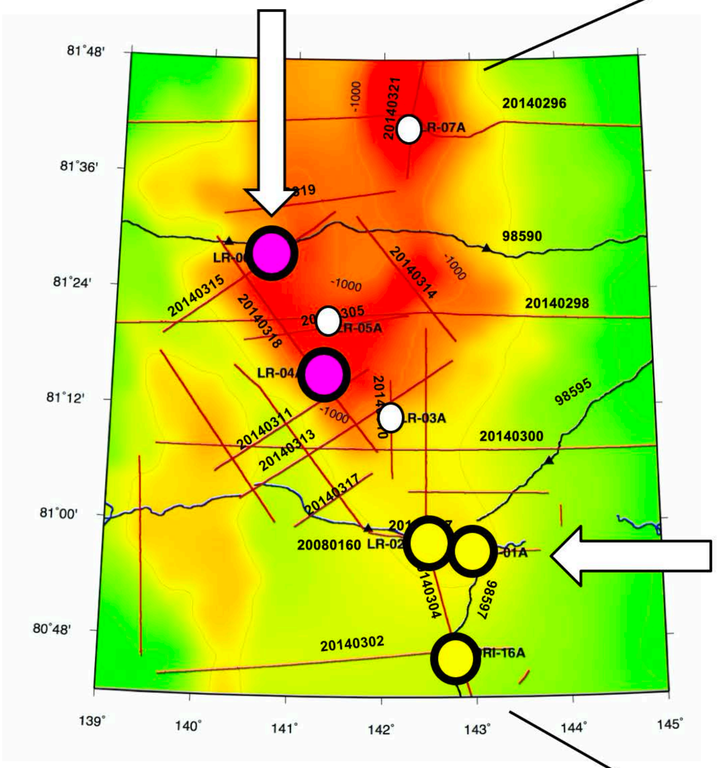


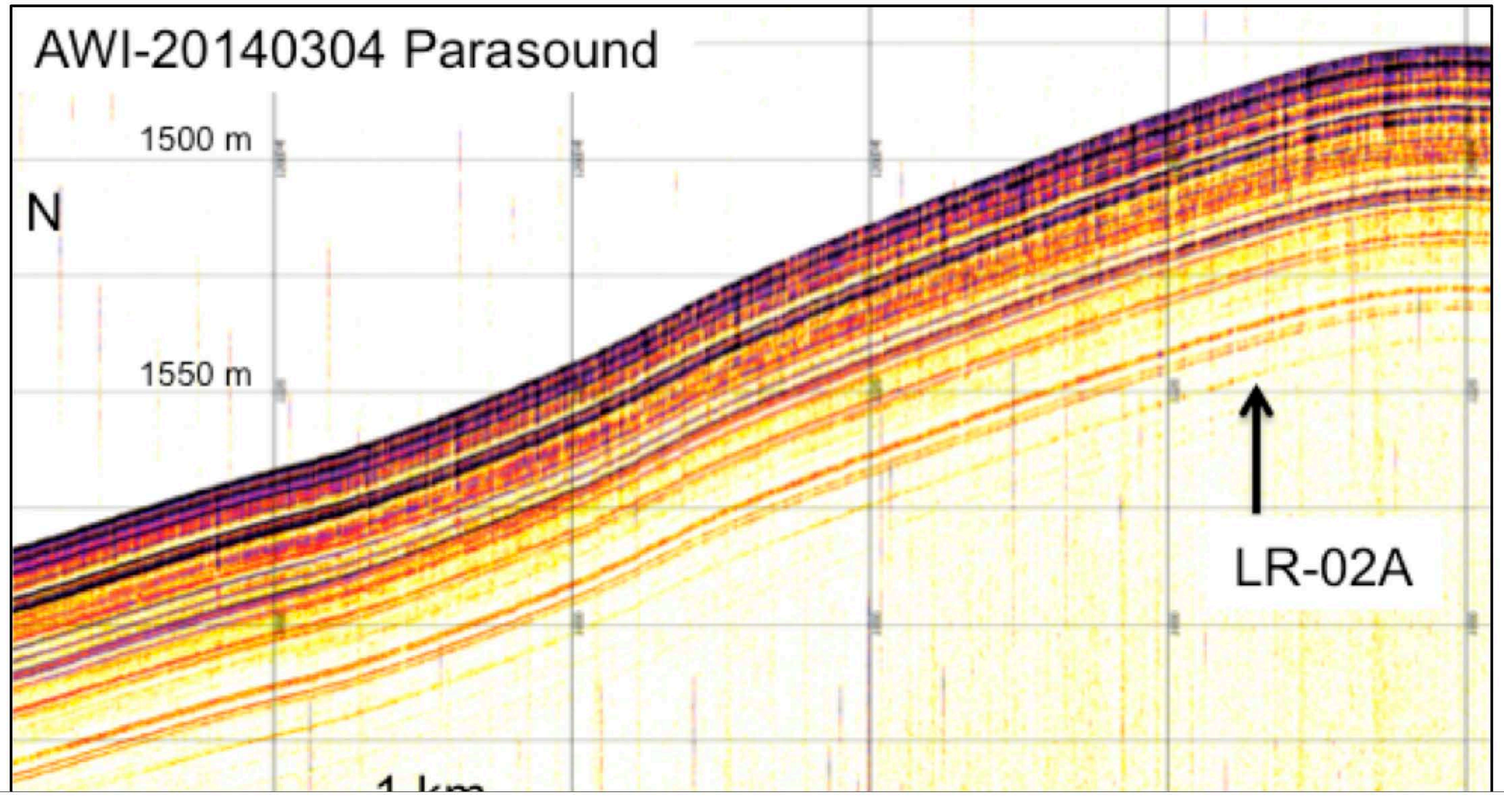
Marine vs. terrestrial climate records: the last 3.5 Ma

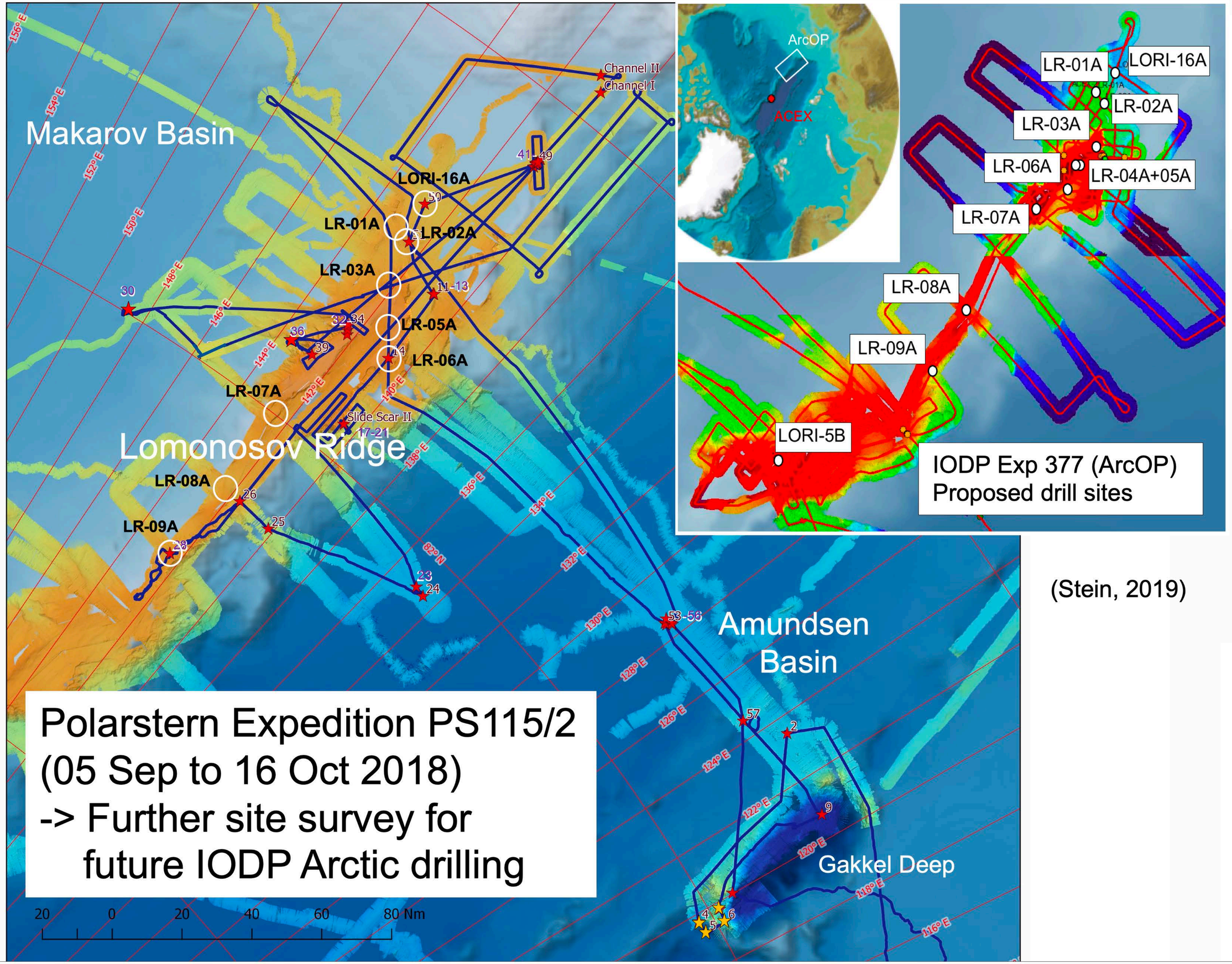
Two-sites approach










Makarov Basin
Lomonosov Ridge
Amundsen Basin
Gakkel Deep
Channel II
Channel I
Slide Scar II
LORI-16A
LR-01A
LR-02A
LR-03A
LR-05A
LR-06A
LR-07A
LR-08A
LR-09A
41-49
50
11-13
30
32-34
36
39
14
17-21
26
25
28
23
24
53-56
57
2
9
4
5
6
156° E
154° E
152° E
150° E
148° E
146° E
144° E
142° E
140° E
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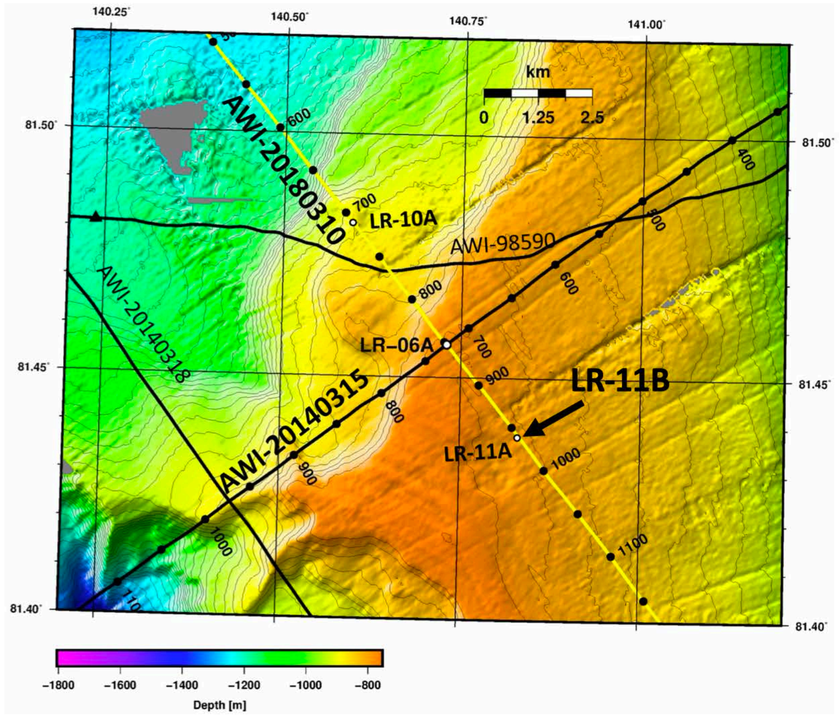
134° E
132° E
130° E
128° E
126° E
124° E
122° E
120° E
118° E
116° E
82° N
20 0 20 40 60 80 Nm
ArcOP
ACEX
LR-01A
LORI-16A
LR-02A
LR-03A
LR-06A
LR-04A+05A
LR-07A
LR-08A
LR-09A
LORI-5B
IODP Exp 377 (ArcOP)
Proposed drill sites
Polarstern Expedition PS115/2
(05 Sep to 16 Oct 2018)
-> Further site survey for
future IODP Arctic drilling

(Stein, 2019)

(Stein, Weigelt and Niessen, July 2019/January 2020)

Site Summary Form 6: IODP Proposal 708 Site LR-11B

Bathymetry and Seismic Line AWI-20180310 (yellow) annotated using CDP numbers



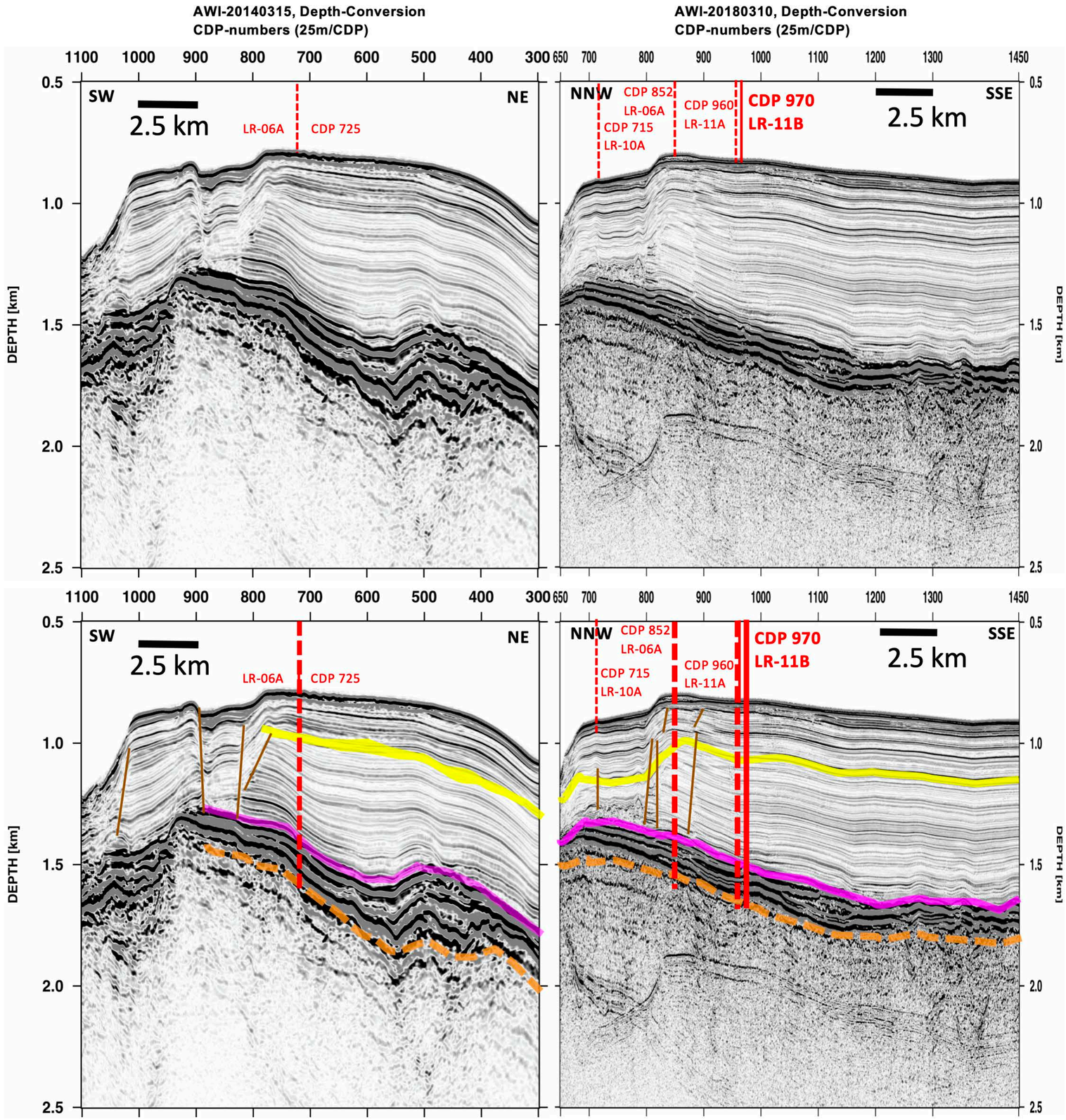
Site:	LR-11B CDP 970	LR-11A CDP 960
Latitude:	81.4365°N	81.4381 °N
Longitude:	140.8405°E	140.8320°E
Water-depth:	800 m	815 m
Top Miocene (yellow):	245 mbsf	230 mbsf
Top Oligocene (pink):	680 mbsf	690 mbsf
Lower Eocene (orange):	880 mbsf	890 mbsf
Proposed Penetration:	900 mbsf	900 mbsf
Penetration total:	1750 m	1750 m

Remarks:

- Seismic images are depth converted migrations

SSDB locations of these graphics and supporting data:

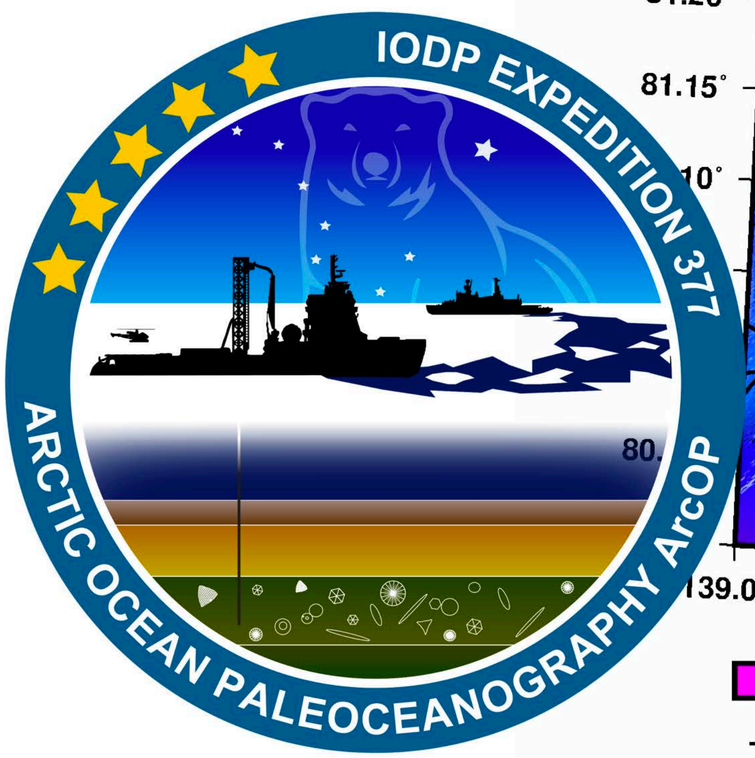
- Figure: Form6-LR-11B_line_AWI-20180310.pdf
- Seismic-SEGY data: 20180310_migrate.segy, 20180310_depcon.segy
- Navigation data: 20180310_cdplocs.txt
- Bathymetry: LR-03A-11B_bathy2018_50m.grd
- Velocity information: Table_LR-11B_20180310_20140315.pdf
- Seismic subbottom profiles: LR-06A-10A-11B_20180310Parasound.segy, *.jpg

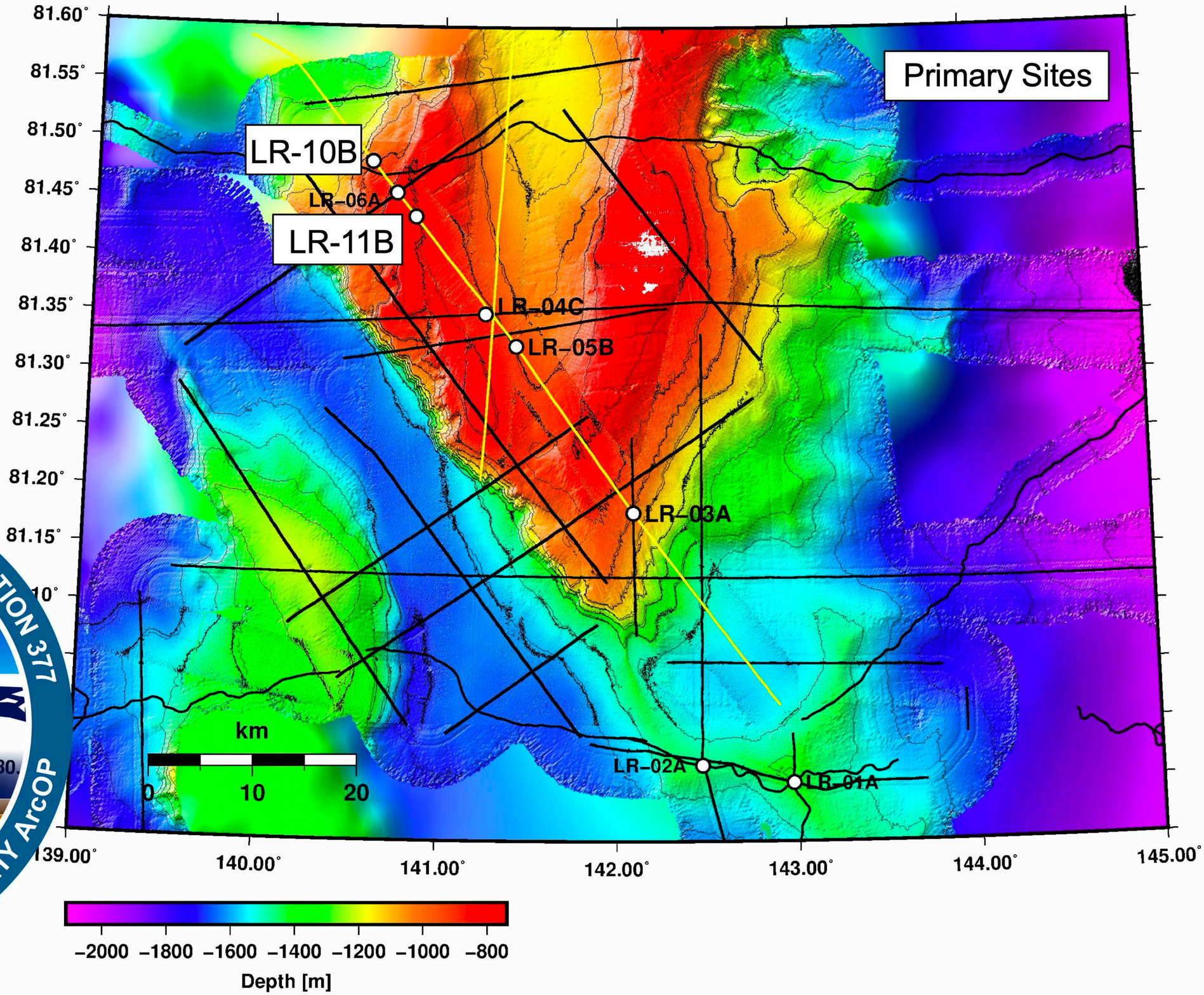


IODP Expedition 377

Arctic Ocean Paleoceanography - ArcOP

Final approval by EPSP (18 Feb 2020)





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About 50 days between mid-August and mid-October 2021

- **Call for applications open now!!**
- **Deadline to apply: 19 June 2020**
- **Information webinar on 26 May 202**
- **To register for webinar go to:**
- **http://wwwsurveymonkey.co.uk/r/IODP377_2021**
- **Further information on Exp377 web page:**
- **http://www.ecord.org/expedition377/**