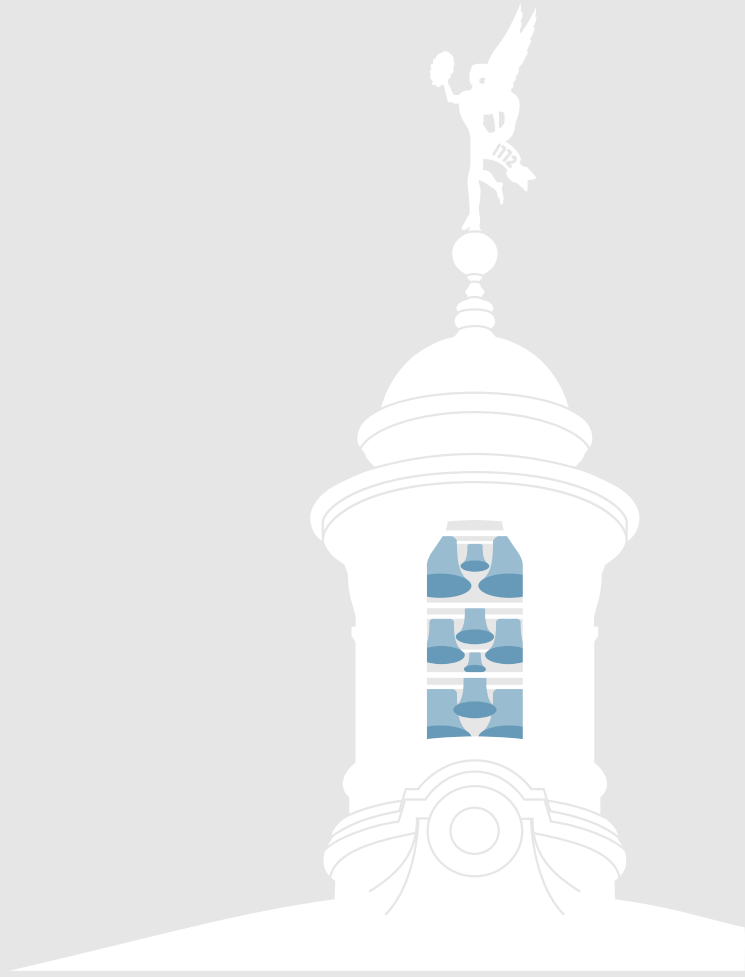
Tracing Tasman Leakage on Broken Ridge (Indian Ocean) since the Middle Miocene

09.05.2022

Jing Lyu
Supervisor: David De Vleeschouwer



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Working Group Earth System Science / Erdsystemforschung
Institute of Geology and Paleontology
Westfälische Wilhelms-Universität (WWU) Münster

Content

- **What** what is Tasman Leakage (TL)
- **Why** is it important to study Tasman Leakage
- **How** to detect the onset of Tasman Leakage
- **Work** that has been done during the first year of my phD

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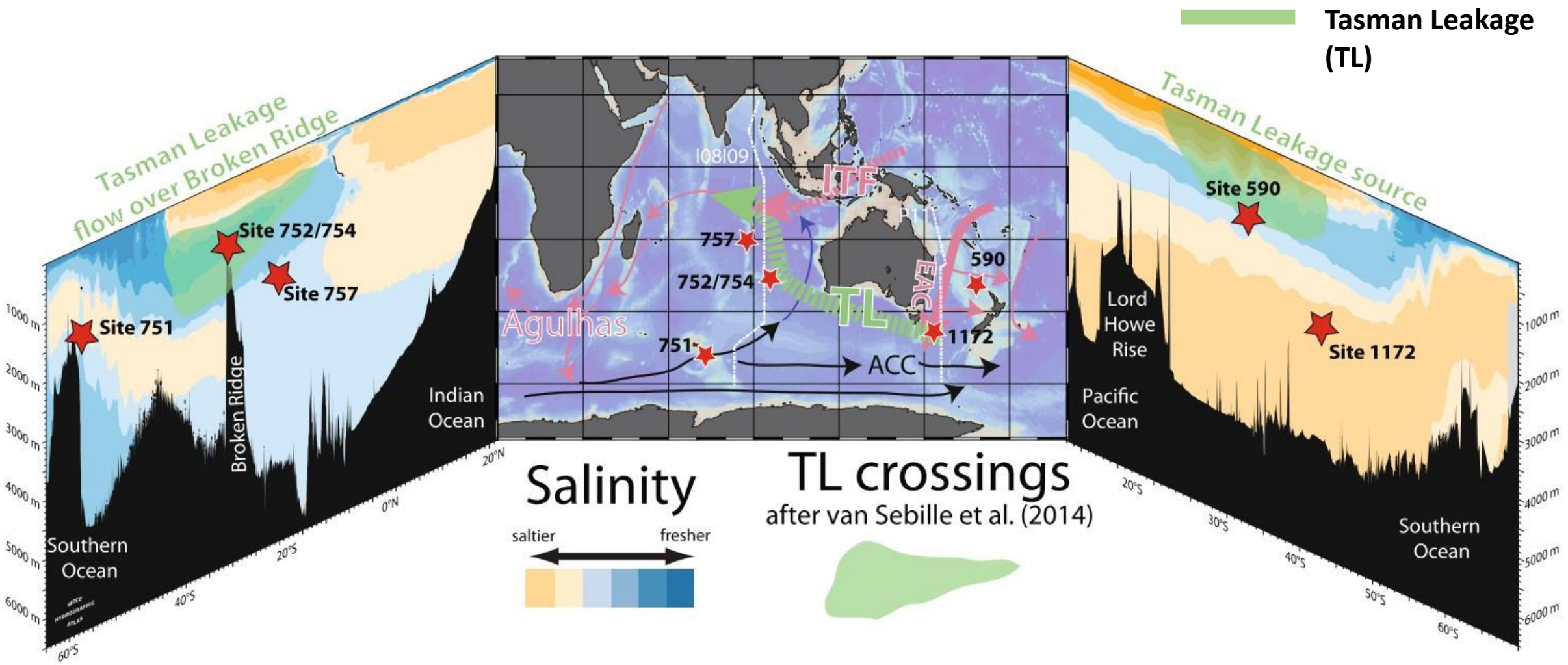
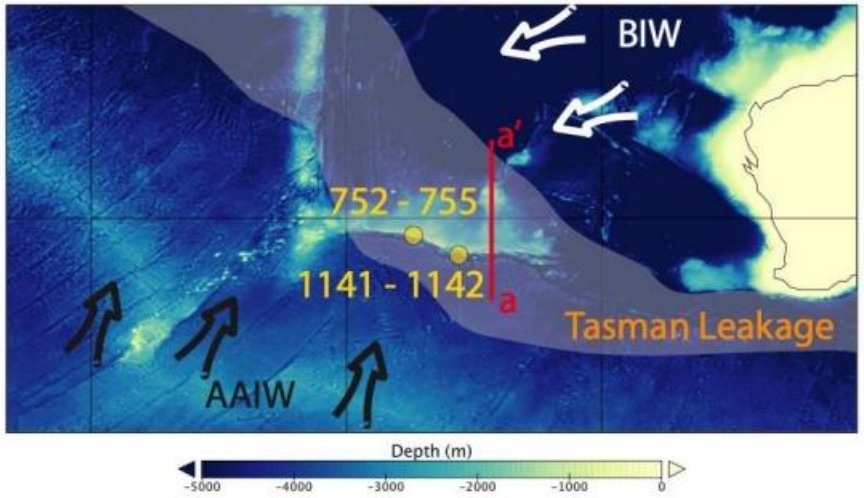
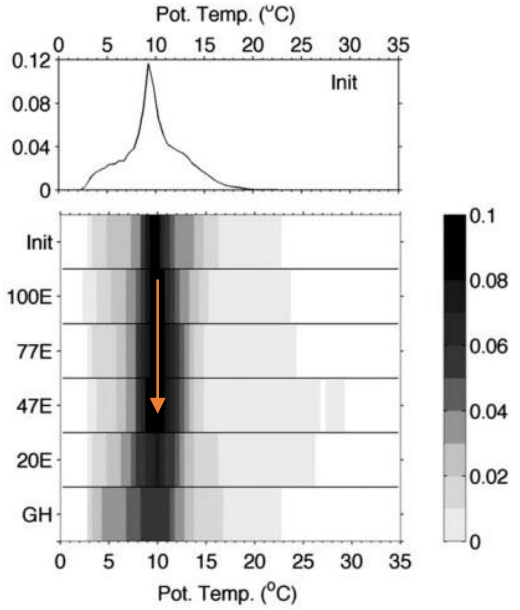
Tasman Leakage links the Pacific and Indian Ocean, south of Australia, at **intermediate water** depth.

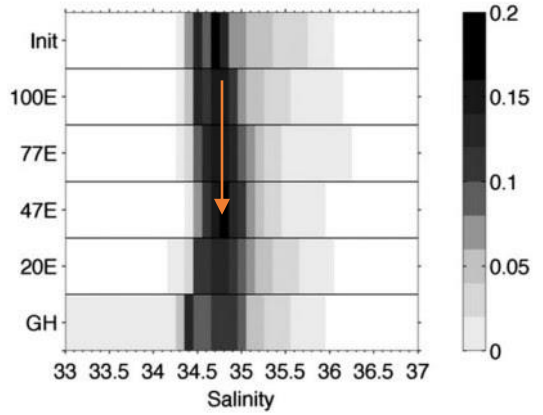


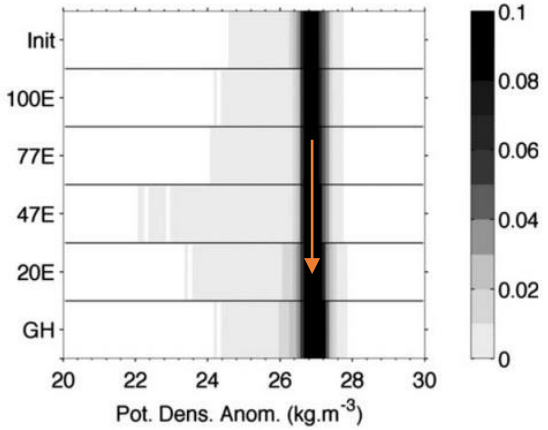
TL **maintains its water properties** and undergoes little mixing with surrounding waters when moving through the Indian Ocean

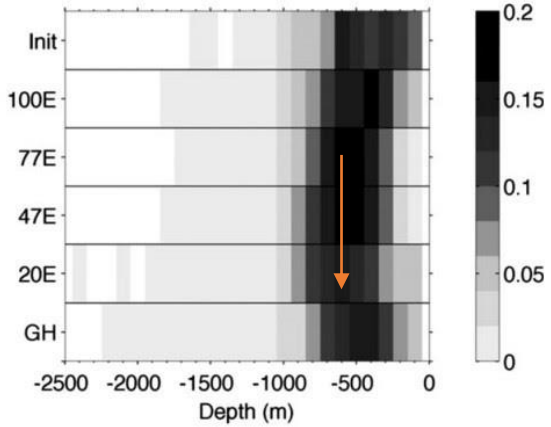




Water flow direction







Durgadoo et al., 2017

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GEOPHYSICAL RESEARCH LETTERS, VOL. 39, L06601, doi:10.1029/2012GL051004, 2012

Tasman leakage in a fine-resolution ocean model

Erik van Sebille,[1] Matthew H. England,[1] Jan D. Zika,[1] and Bernadette M. Sloyan[2,3]

Received 18 January 2012; revised 27 February 2012; accepted 27 February 2012; published 24 March 2012.

AGU PUBLICATIONS

JGR

Journal of Geophysical Research: Oceans

RESEARCH ARTICLE
10.1002/2013JC009525

Pacific-to-Indian Ocean connectivity: Tasman leakage, Indonesian Throughflow, and the role of ENSO

Erik van Sebille[1], Janet Sprintall[2], Franziska U. Schwarzkopf[3], Alex Sen Gupta[1], Agus Santoso[1], Matthew H. England[1], Arne Biastoch[3], and Claus W. Böning[3]

[1]ARC Centre of Excellence for Climate System Science & Climate Change Research Centre, University of New South Wales, Sydney, New South Wales, Australia, [2]Scripps Institution of Oceanography, La Jolla, California, USA, [3]GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel, Kiel, Germany

Key Points:
- Pacific and Indian Oceans are connected through ITF and Tasman leakage
- Both pathways are important for global circulation but are not correlated
- A Lagrangian analysis of pathways

GEOPHYSICAL RESEARCH LETTERS, VOL. 29, NO. 10, 1416, 10.1029/2001GL014586, 2002

Tasman leakage: A new route in the global ocean conveyor belt

Sabrina Speich and Bruno Blanke
Laboratoire de Physique des Océans, Brest, France

Pedro de Vries and Sybren Drijfhout
Royal Netherlands Meteorological Institute, De Bilt, The Netherlands

Kristofer Döös
Meteorologiska Institutionen, Stocholms Universitet, Stockholm, Sweden

Alexandre Ganachaud
Institut de Recherche pour le Développement, Laboratoire d'Études en Géophysique et Océanographie Spatiale, Toulouse, France

Robert Marsh
James Rennell Division for Ocean Circulation and Climate, Southampton Oceanography Centre, European Way

GEOPHYSICAL RESEARCH LETTERS, VOL. 40, 5456–5460, doi:10.1002/2013GL057797, 2013

Tasman Leakage of intermediate waters as inferred from Argo floats

Miquel Rosell-Fieschi,[1] Stephen R. Rintoul,[2,3,4,5] Jeröme Gourrion,[1] and Josep L. Pelegrí[1]

Received 26 August 2013; revised 4 October 2013; accepted 6 October 2013; published 23 October 2013.

AGU PUBLICATIONS

JGR

Journal of Geophysical Research: Oceans

RESEARCH ARTICLE
10.1002/2016JC012676

Indian Ocean sources of Agulhas leakage

Jonathan V. Durgadoo[1], Siren Rühs[1], Arne Biastoch[1], and Claus W. B. Böning[1]

[1]GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany

Key Points:
- A study of pathways, timescales, and water transformations of Indian

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RESEARCH LETTER
10.1029/2021GL095036

Late Miocene Onset of Tasman Leakage and Southern Hemisphere Supergyre Ushers in Near-Modern Circulation

Beth A. Christensen[1], David De Vleeschouwer[2], Jorijntje Henderiks[3], Jeroen Groeneveld[4,5], Gerald Auer[6], Anna Joy Drury[7], Boris Theofanis Karatsolis[3], Jing Lyu[2], Christian Betzler[5], Gregor P. Eberli[8], and Dick Kroon[9]

Key Points:
- Benthic $\delta^{13}C$ time-series from the southwestern Pacific and eastern Indian Ocean suggest onset of Tasman Leakage at 7 Ma
- Latitudinal movement of the

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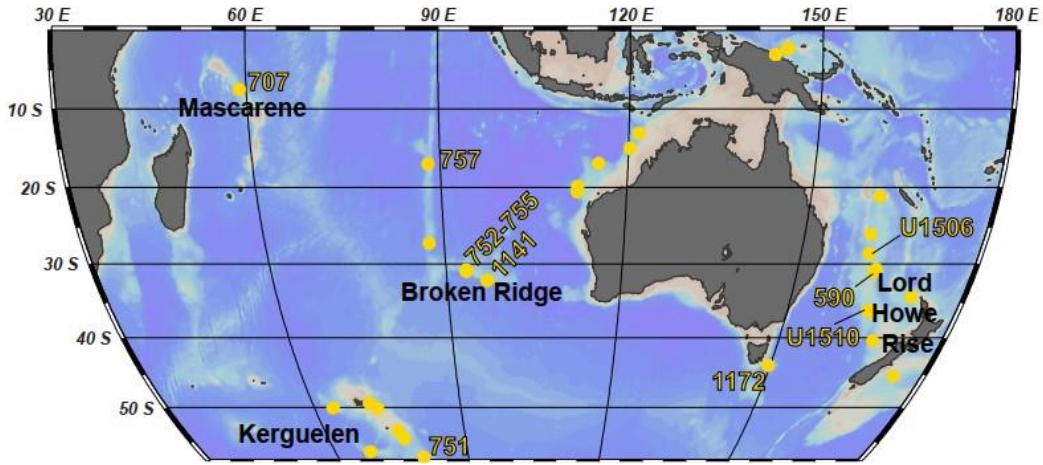
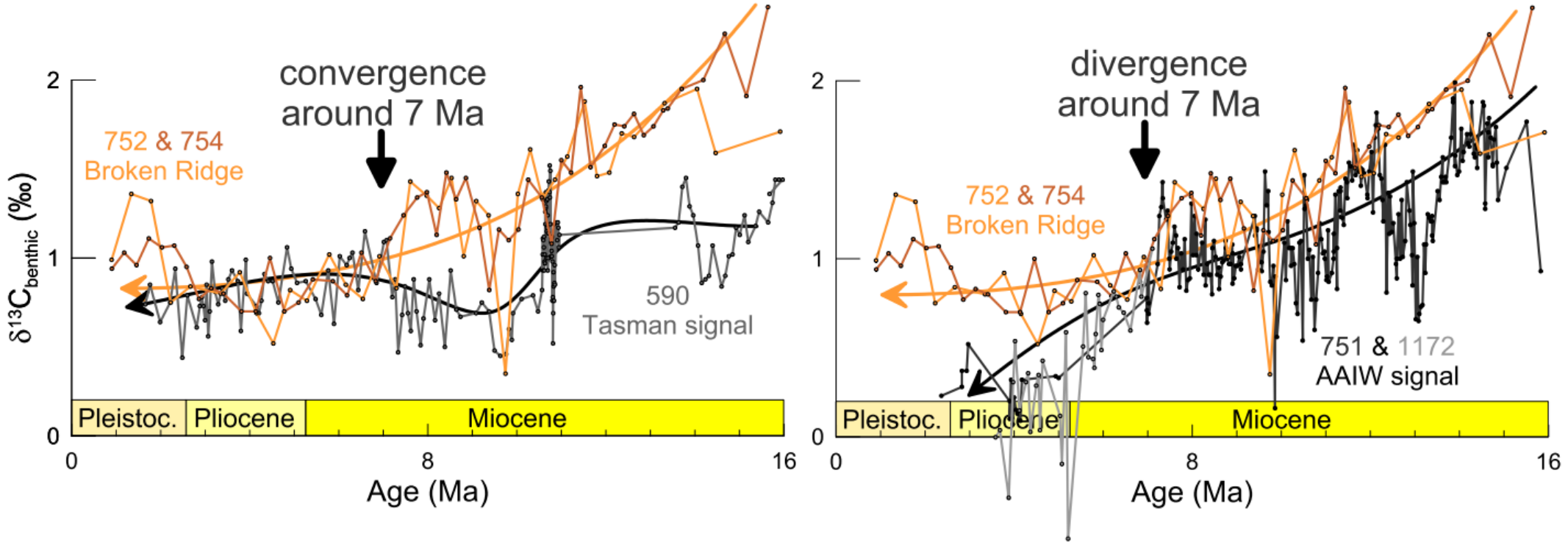
Legacy $\delta^{13}C$ data indicate TL onset at ~7 Ma





Christensen et al., 2021. Site 590: Kennett, 1986; Site 752/754: Rea et al., 1991; Site 751: Mackensen et al., 1988; Site1172: Diester-Haass et al., 2006

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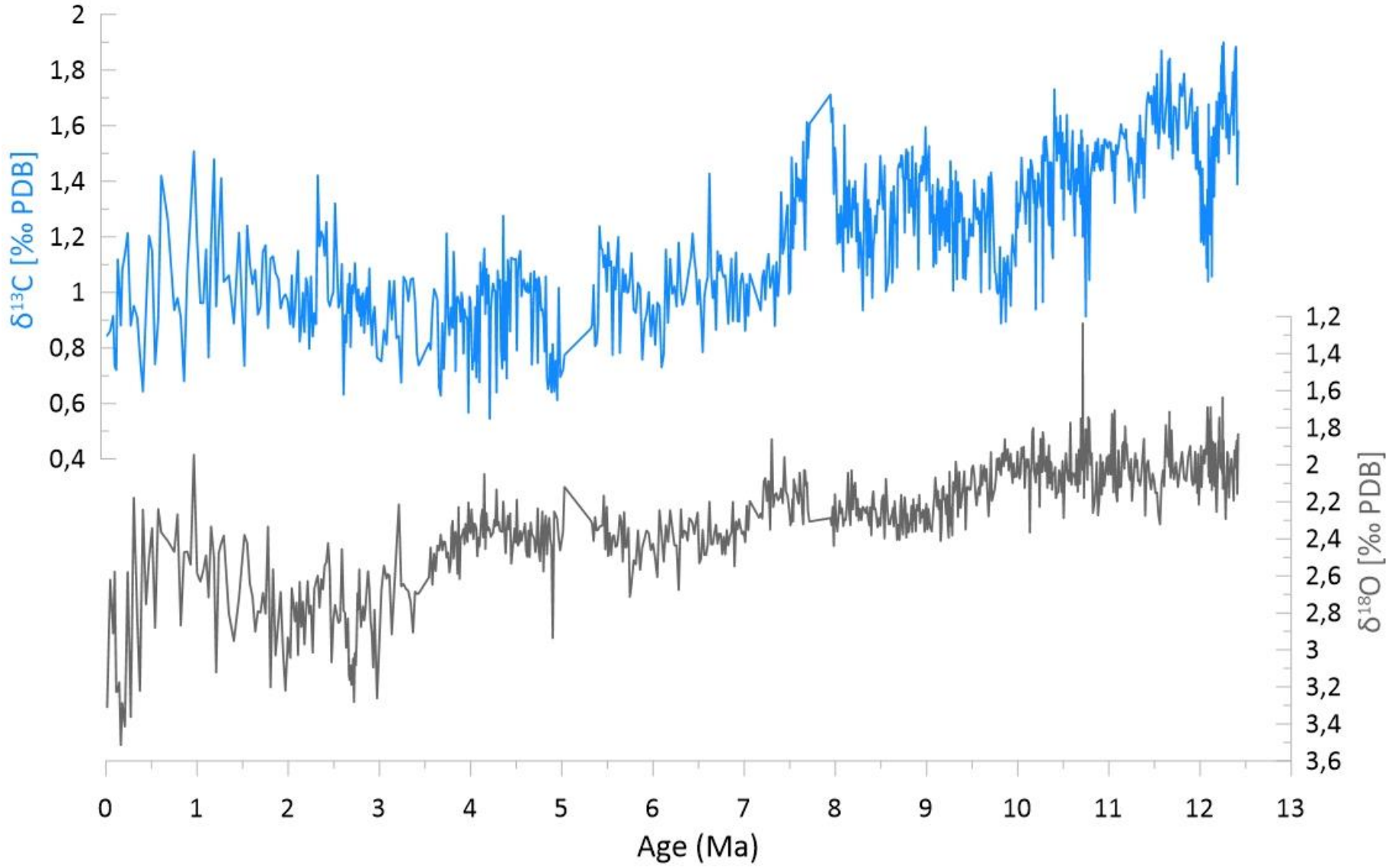
Scientific objective

- Pinpoint the onset of Tasman Leakage in geological time
- Main factor(s) that control TL behaviors
  climatic (subtropical front), and/or
  tectonic (northward motion of Australia)

- To differentiate between TL and AAIW

	TL	AAIW
Temperature	~10 °C	2-5 °C
Salinity	34.5-35 psu	~34.4 psu
$\delta^{13}C$	~1.2 ‰	~0.5 ‰
εNd	Less depleted	depleted

Site 752 benthic carbon and oxygen stable isotopic records in the orbital resolution



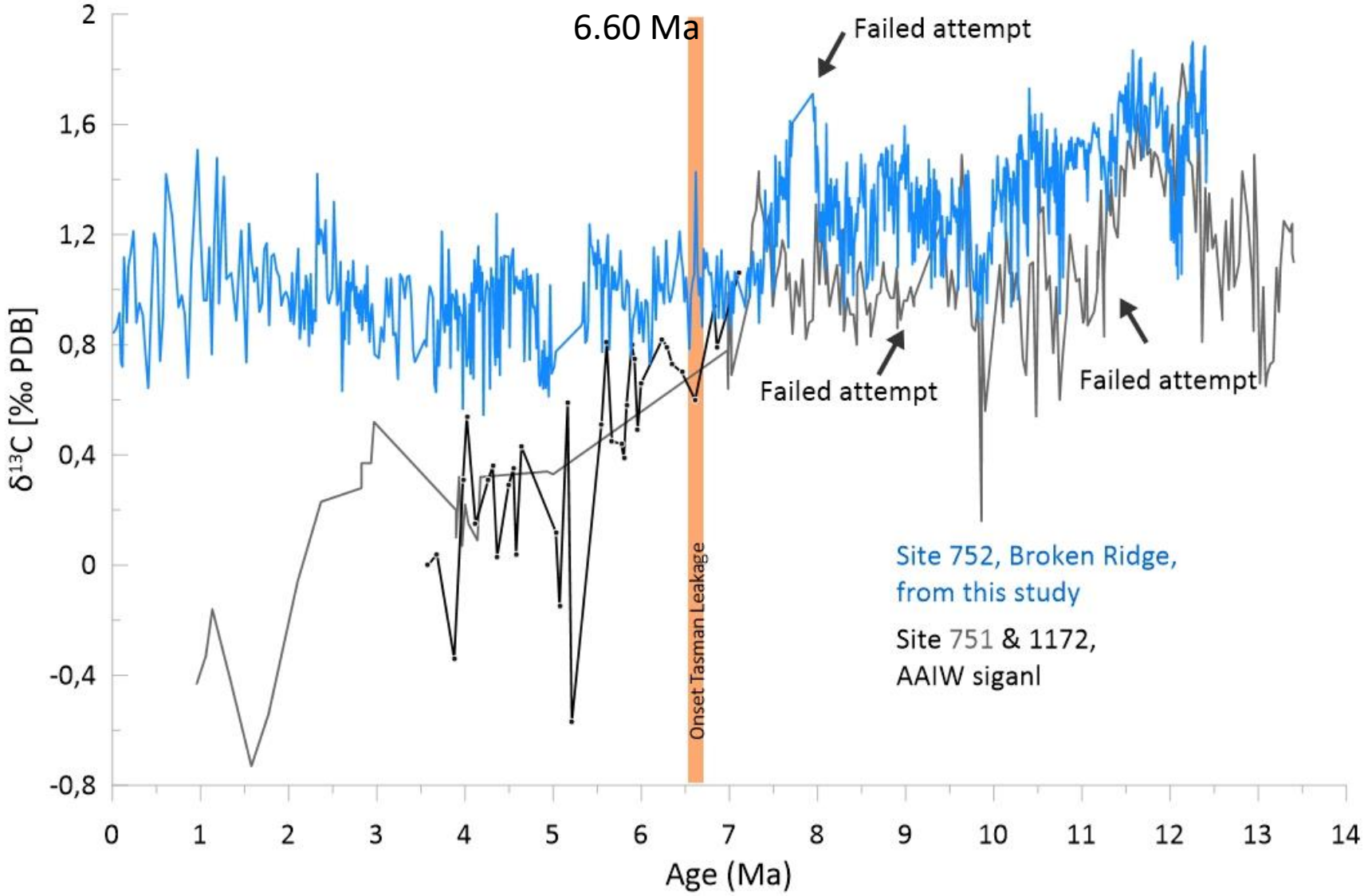
Cibicidoides mundulus, Oridosalis umbonatus, and C. wuellerstorfi. Values were corrected to C. mundulus

Stable isotopes were measured at MARUM, University of Bremen

The isotopic divergence between Broken Ridge and the AAIW sites is at 6.60 Ma

Benthic d^{13}C

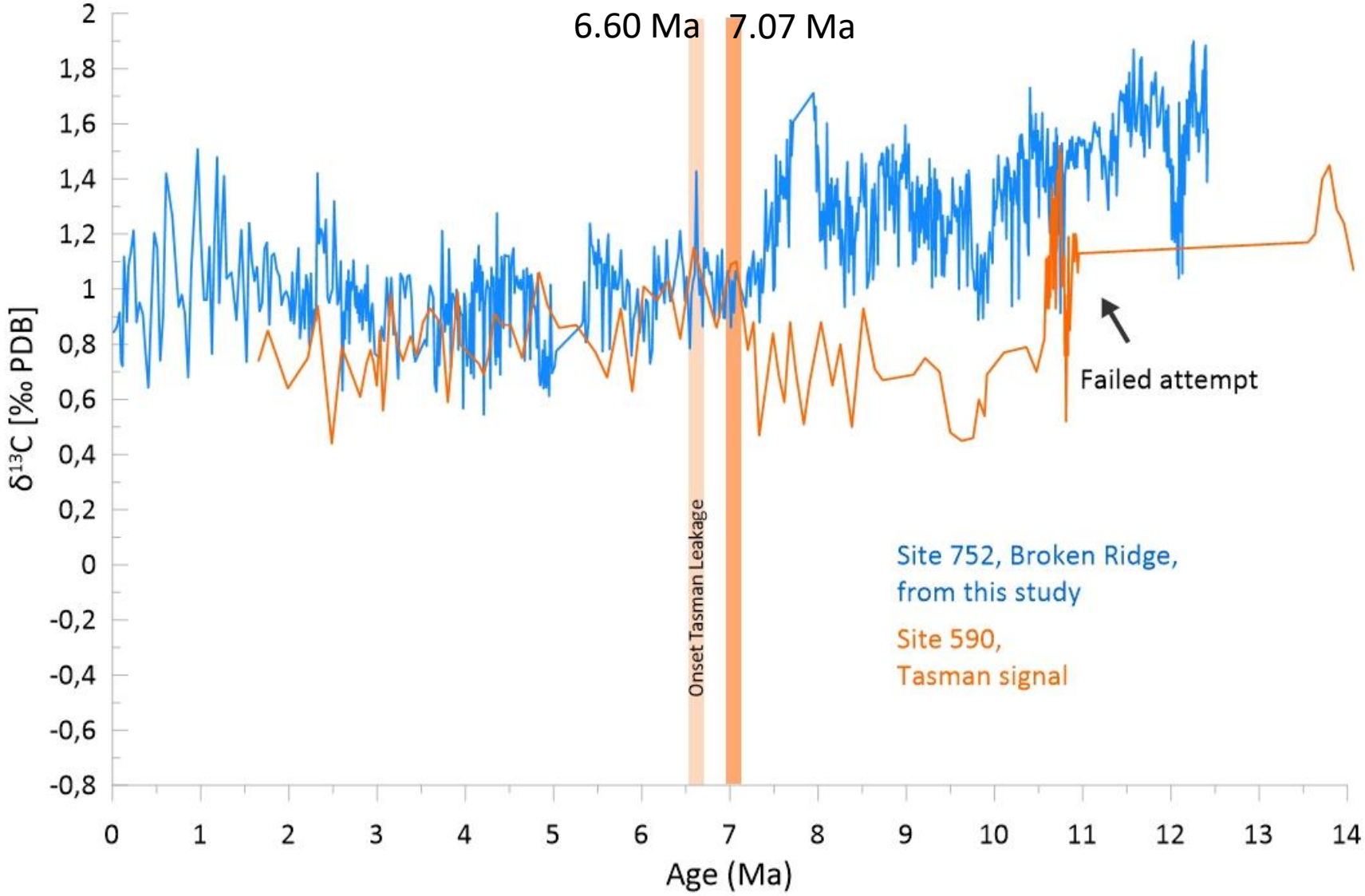
Cibicidoides mundulus, Oridosalis umbonatus, and C. wuellerstorfi. Values were corrected to C. mundulus



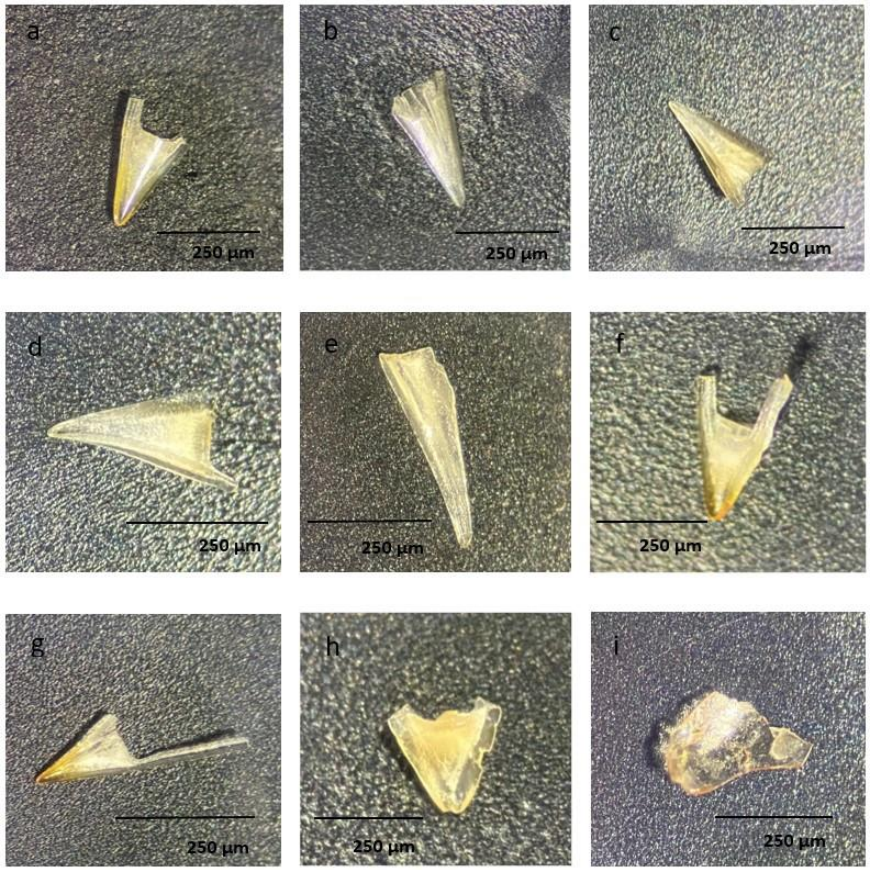
The isotopic convergence between Broken Ridge and the Tasman site is at 7.07 Ma

Benthic d^{13}C

Cibicidoides mundulus, Oridosalis umbonatus, and C. wuellerstorfi. Values were corrected to C. mundulus



Neodymium isotope (εNd) as an additional proxy to trace TL



Fish teeth and bone debris from ODP Site 752, photos by J. Lyu

- Fossil fish debris from a variety of marine environments preserves a reliable and robust record of deep seawater Neodymium isotopic compositions (ε_{Nd}) from the time of deposition (Martin and Scher, 2004).

- ε_{Nd} serves as a water mass tracer

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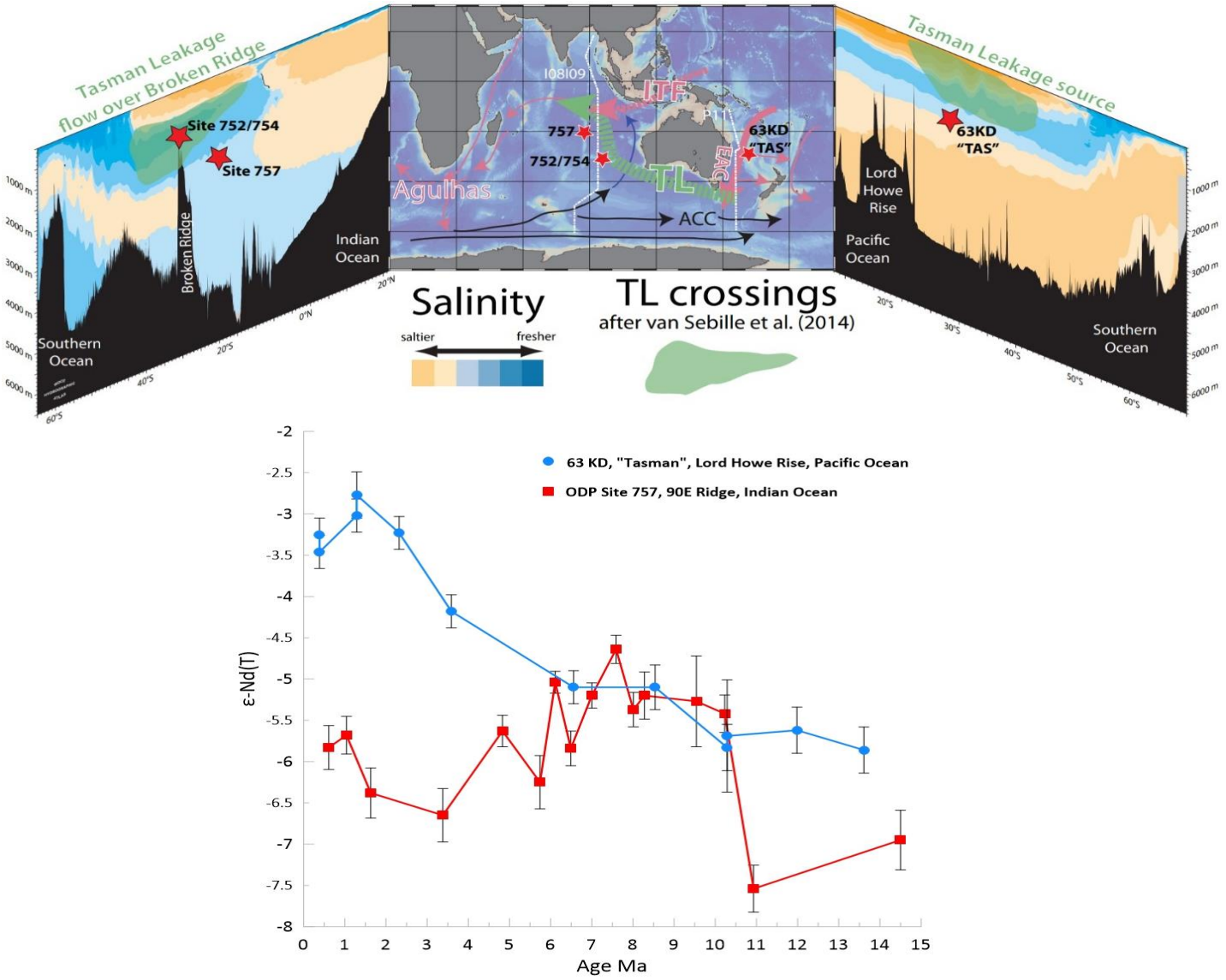
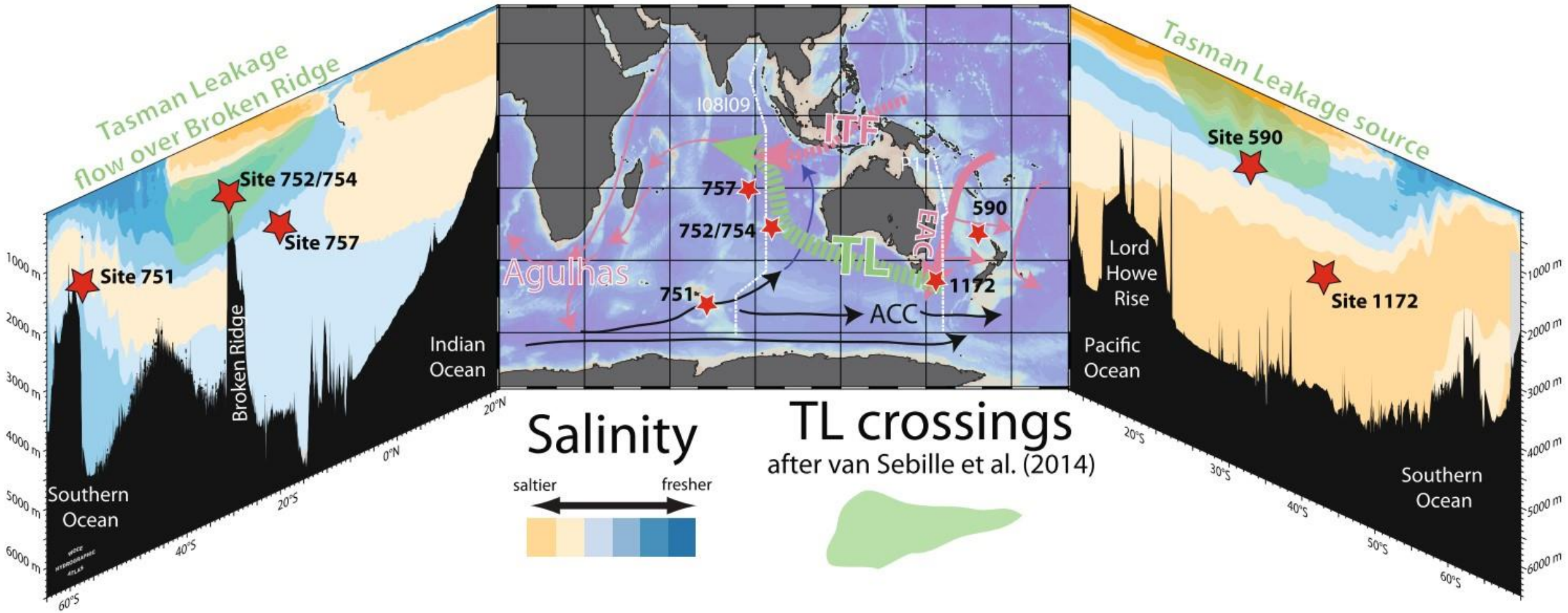
Neodymium isotope (εNd)

- Constructing an ε_{Nd} record will allow testing whether the Sites (752/754) were bathed in AAIW or Tasman Leakage, and therefore, to determine the timing of a switch.



"Tasman", 63KD: van de Flierdt, et al., 2004, Site 757:Martin and Scher, 2006

Take home



Christensen et al., 2021

Thank you for your attention!

Any further comments and/or questions→

j.lyu@uni-muenster.de / 5th floor, room 520

Benthic foraminiferal specimens
from Site 752, 3H-1, 10-12