The Changing Antarctic Environment and its Impact on Ecosystems

PCWG Winter Meeting – Mar.3, 2025

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Photo: John Weller

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Teamwork makes the dream work!

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Te Whare Wānanga o Waitaha
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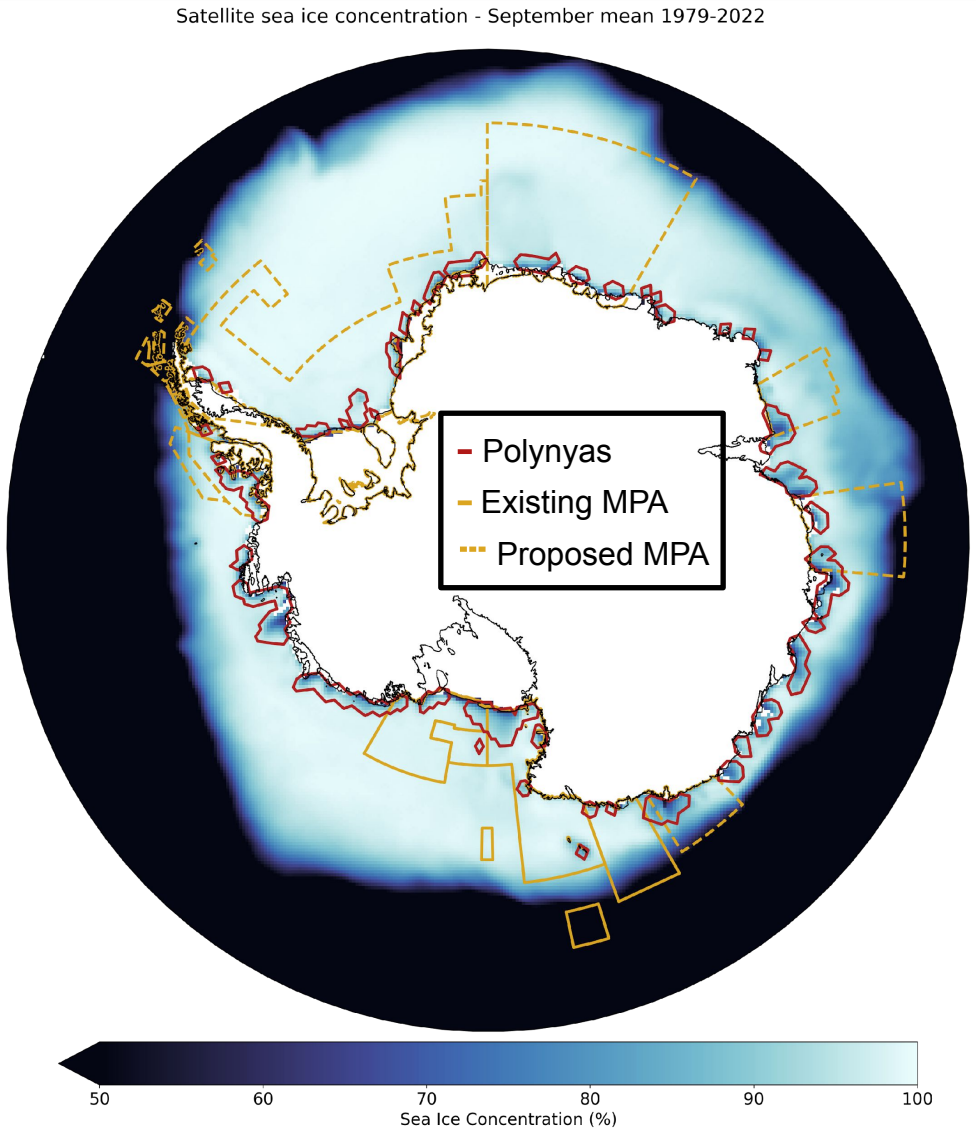
Science questions:

How valuable are polynyas for the Antarctic ecosystem?

How might polynya value impact policy, including for Marine Protected Areas (MPAs)?



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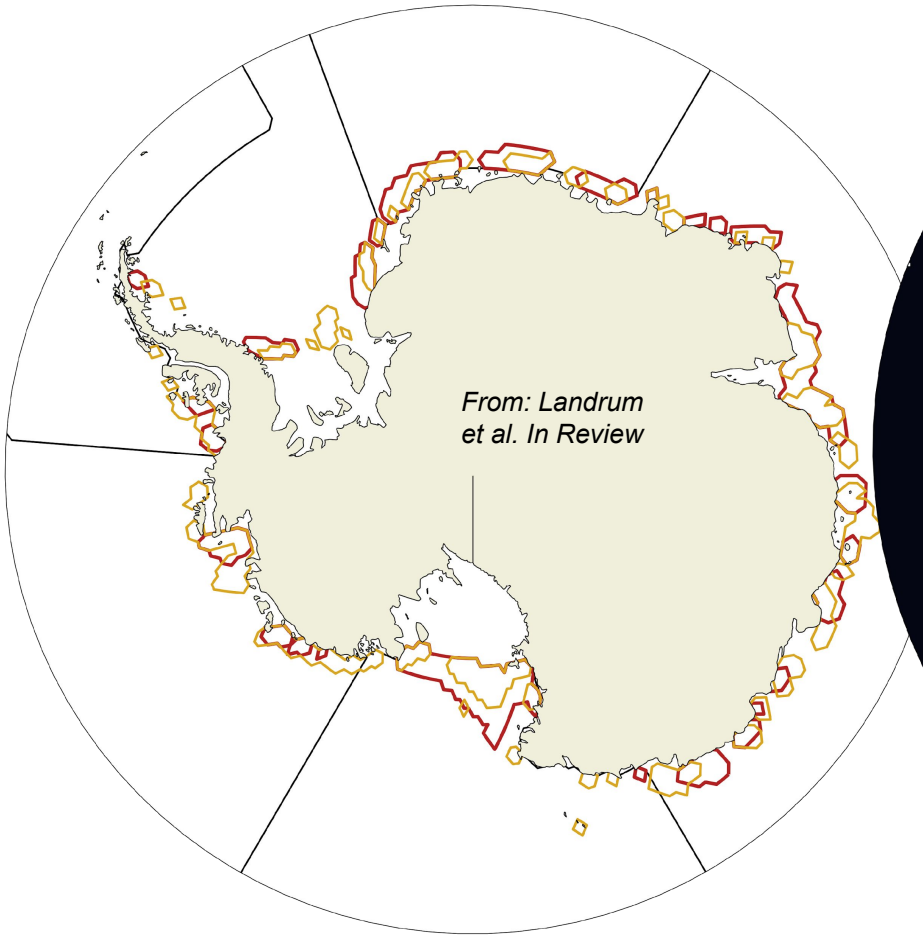
Satellite and CESM2 polynya regions generally match well.

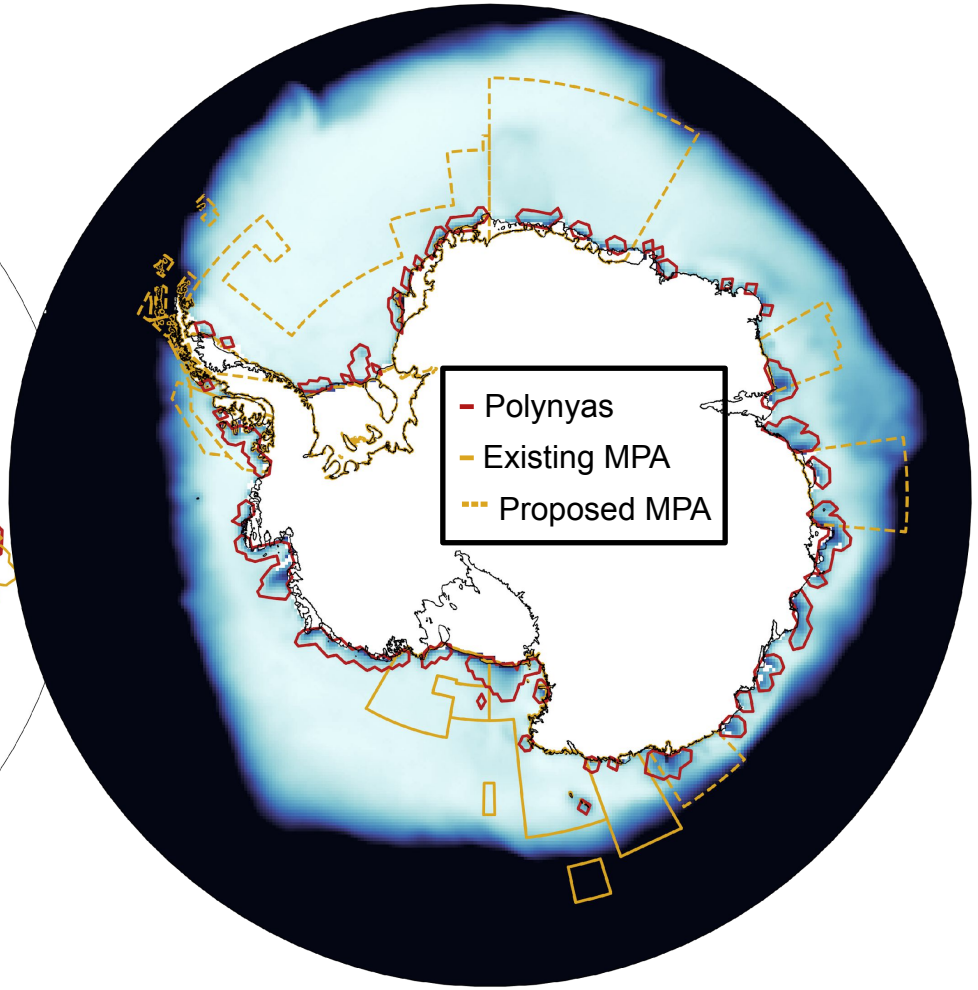
1979-2020 “typical” polynyas
(identified >10% of the year)



satellite (85% SIC threshold)

CESM hindcast (0.4m SIT threshold)

Satellite sea ice concentration - September mean 1979-2022



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How important are polynyas for the Antarctic ecosystem?

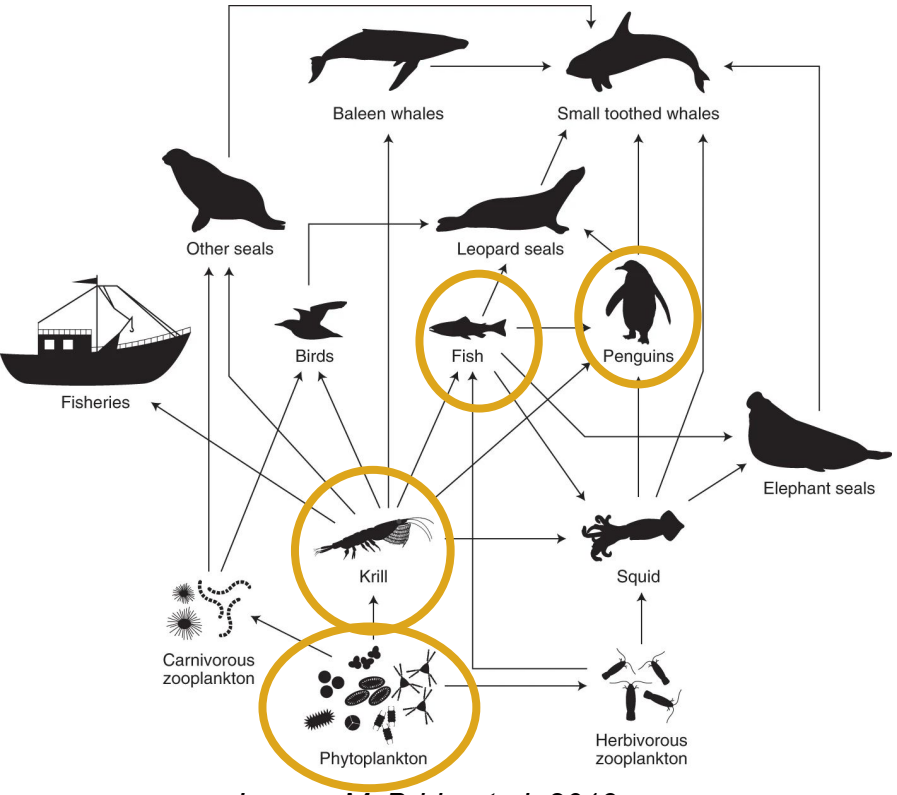

Image: McBride et al. 2019

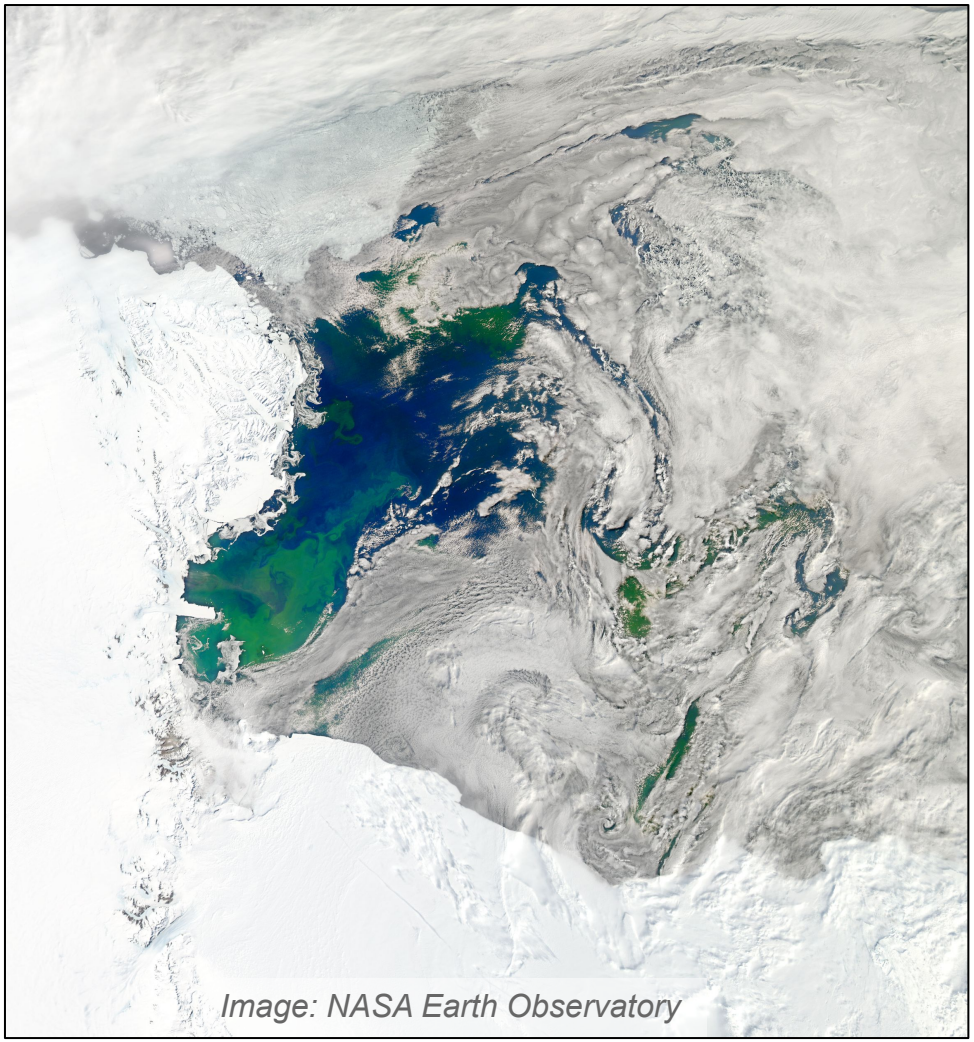

Image: NASA Earth Observatory

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Antarctic Ecosystem Value (AEV) Index

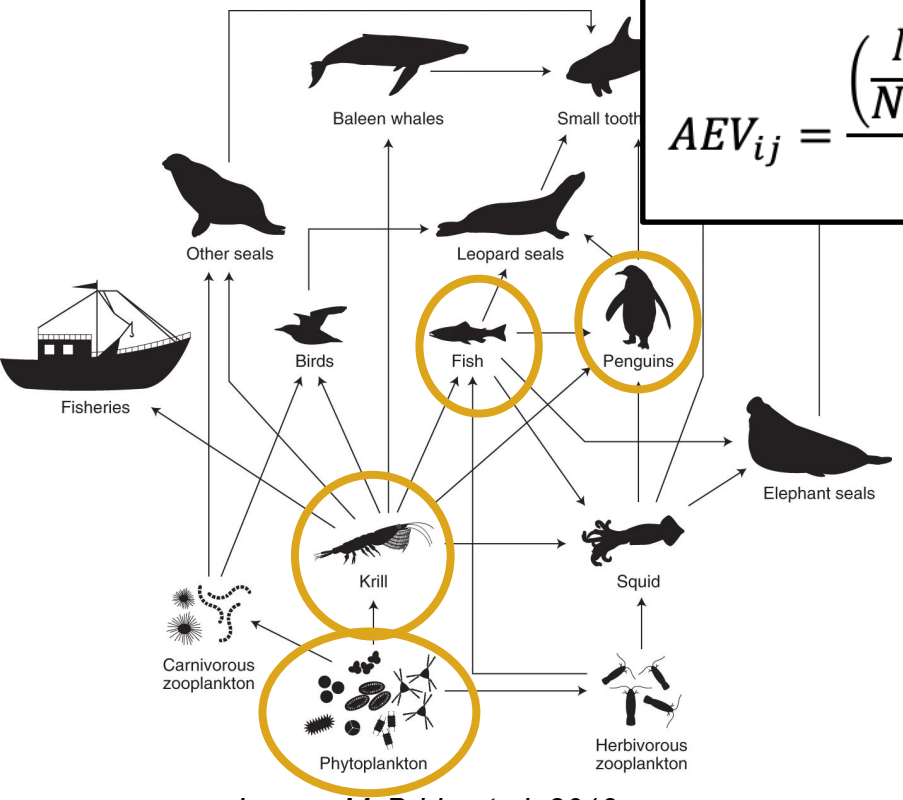
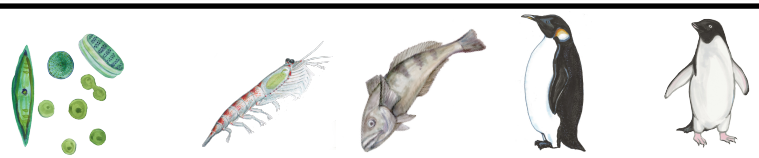


Image: McBride et al. 2019



$$AEV_{ij} = \frac{\left(\frac{NPP_{ij}}{NPP_{max}} + \frac{KGP_{ij}}{KGP_{max}} + \frac{FD_{ij}}{FD_{max}} + \frac{EP_{ij}}{EP_{max}} + \frac{AP_{ij}}{AP_{max}}\right)}{n_i}$$

AEV Index identifies areas of highest value <u>over multiple levels of the Antarctic food web</u>

AEV includes management relevant indicator species for the Ross Sea Region Marine Protected Area (2017):

- Emperor penguin nesting pairs
- Adelie penguin nesting pairs
- Antarctic krill
- Antarctic toothfish

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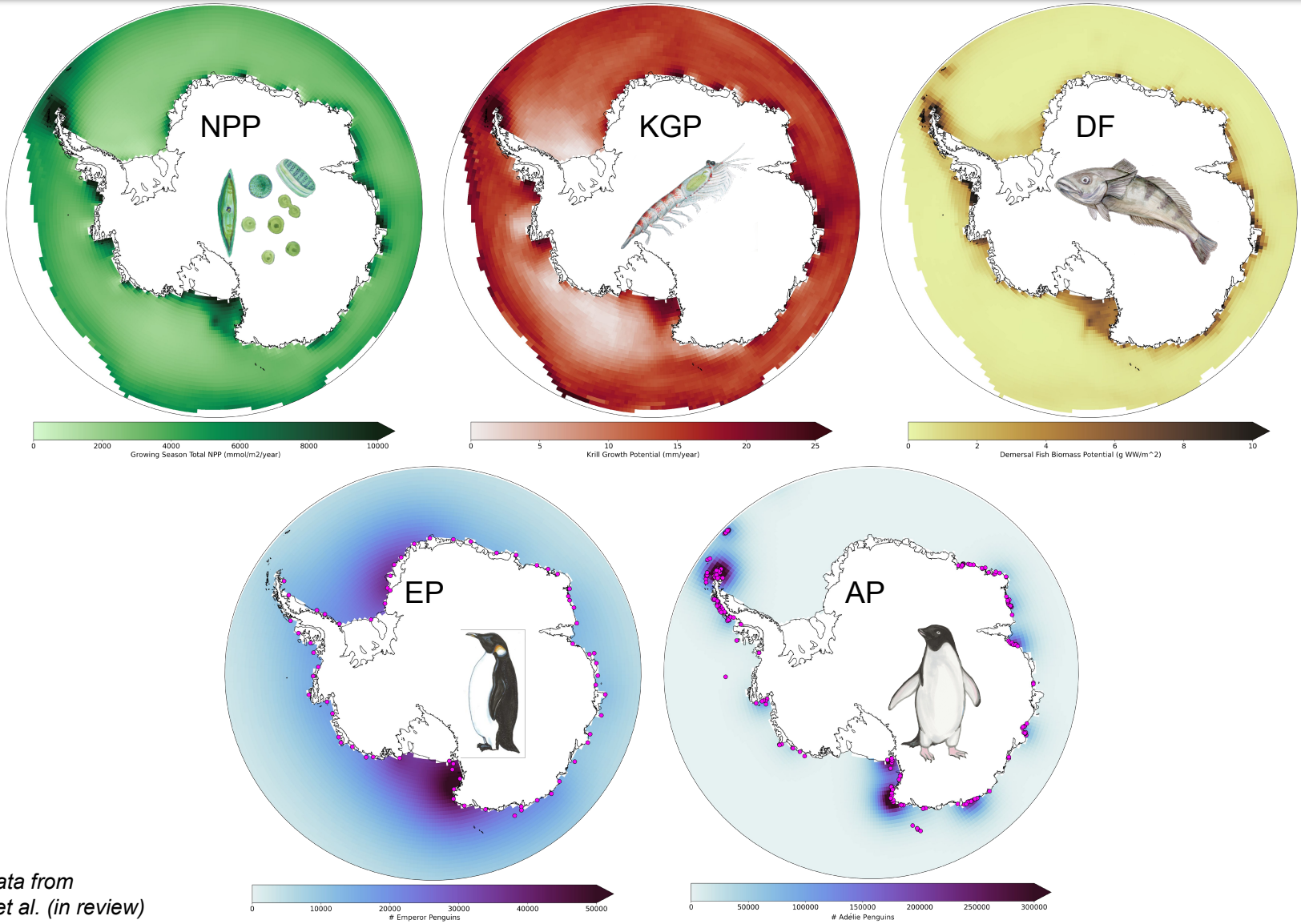
AEV Index input layers – present day



Data from
DuVivier et al. (in review)

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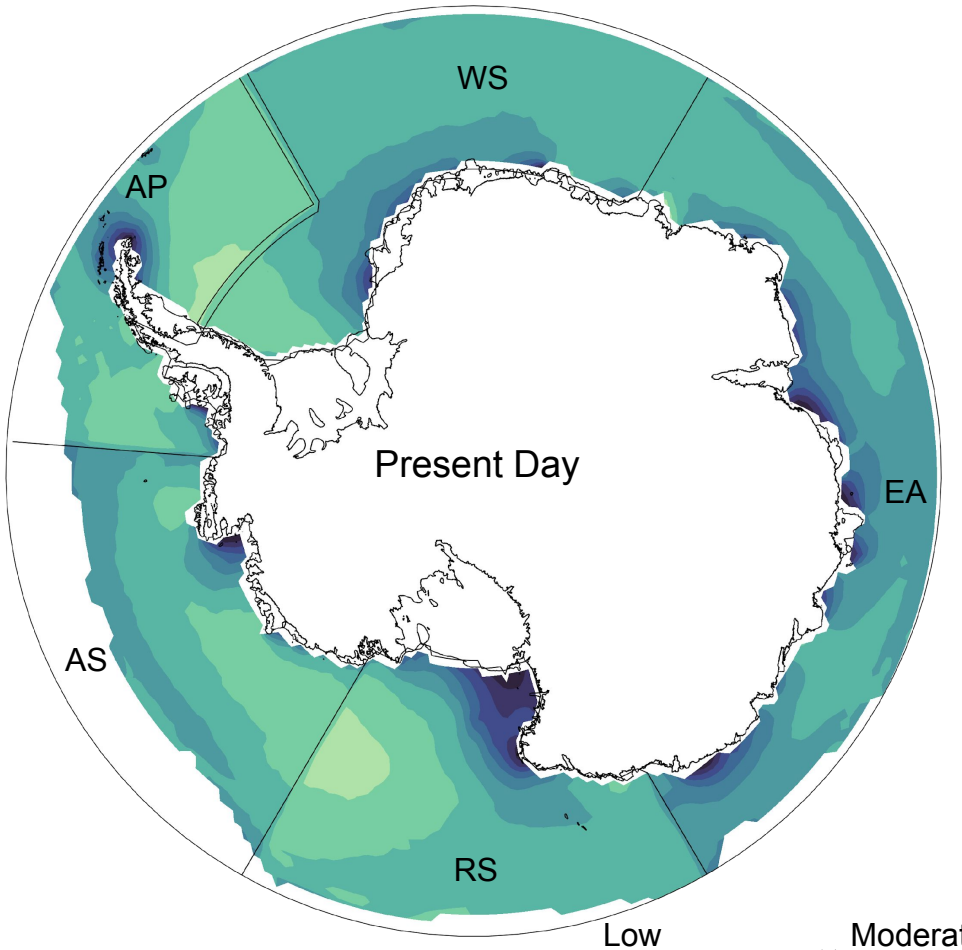
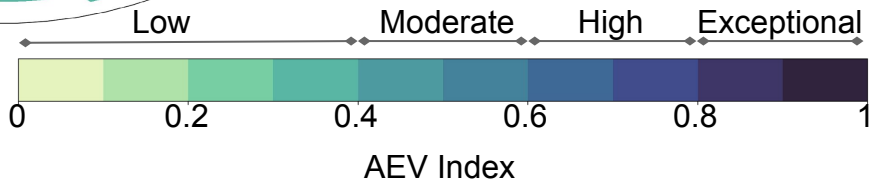
Antarctic Ecosystem Value (AEV) Index – present day





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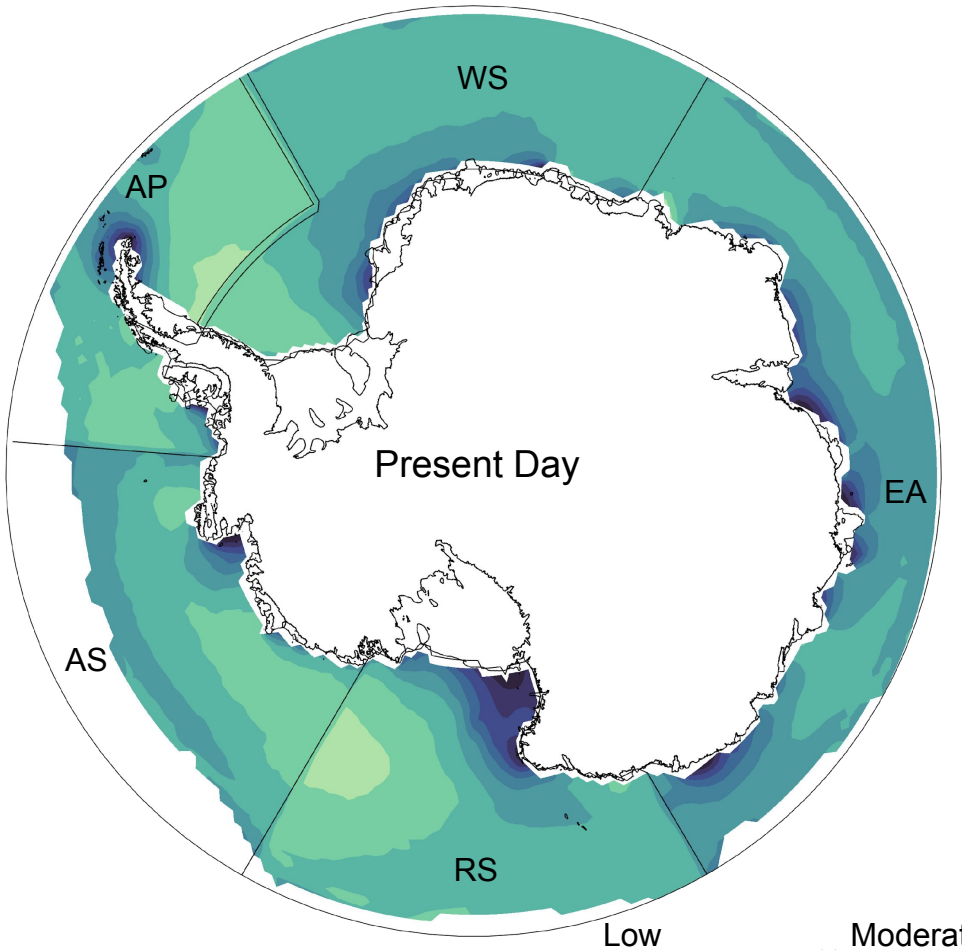
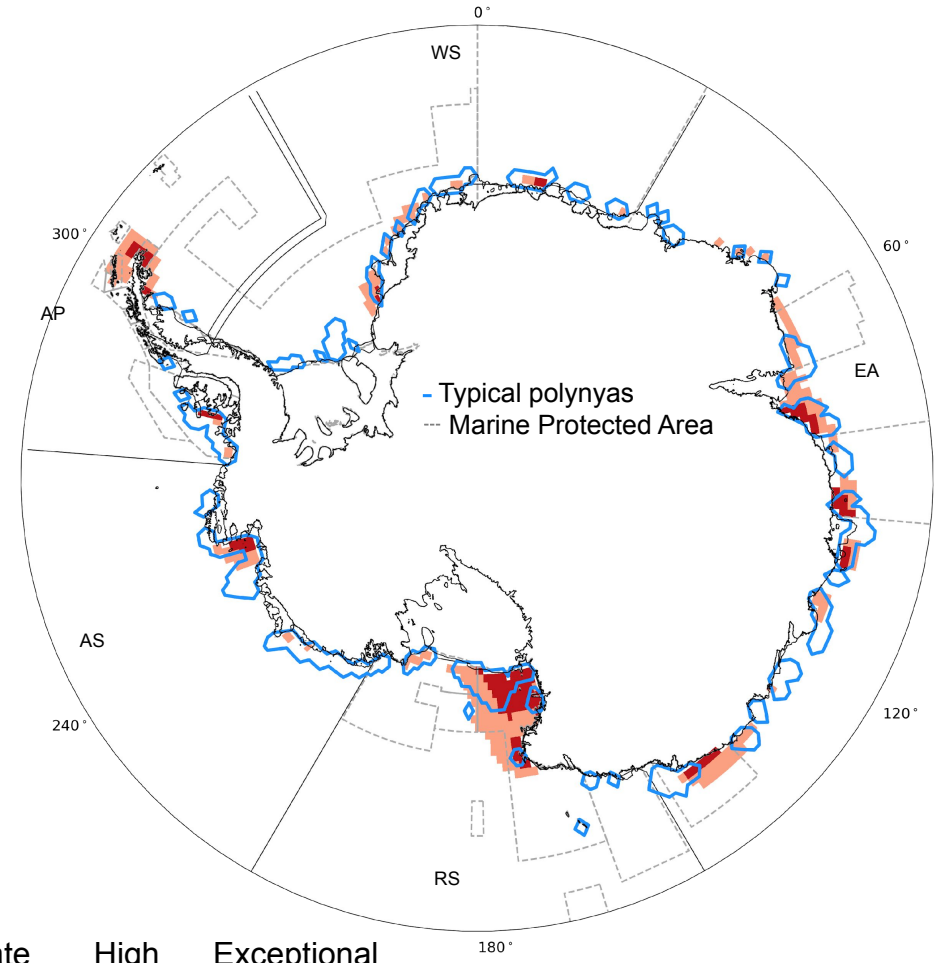
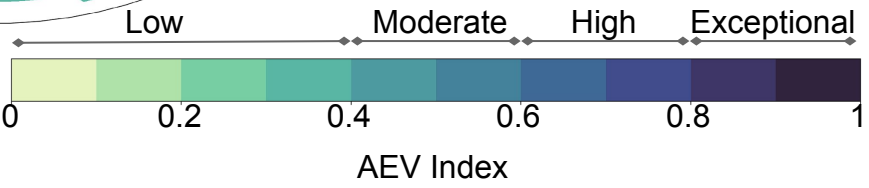
Many polynyas have High or Exceptional AEV Index







Data from DuVivier et al. (in review)

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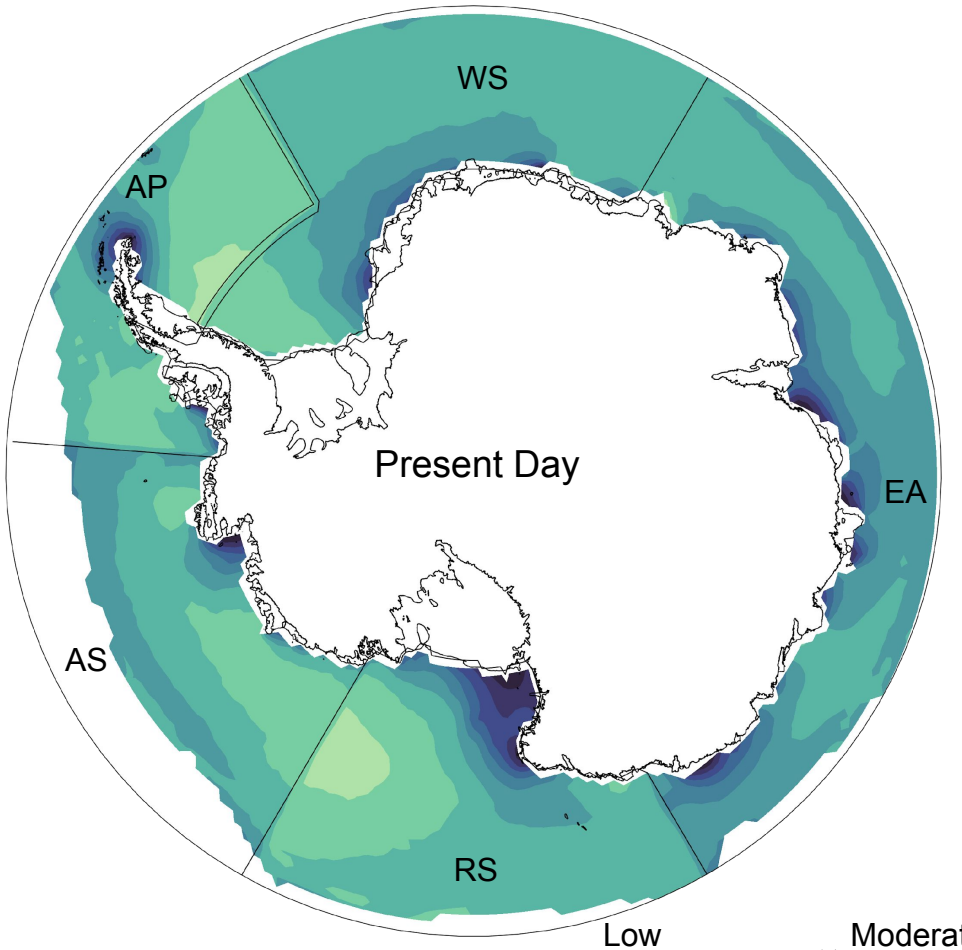
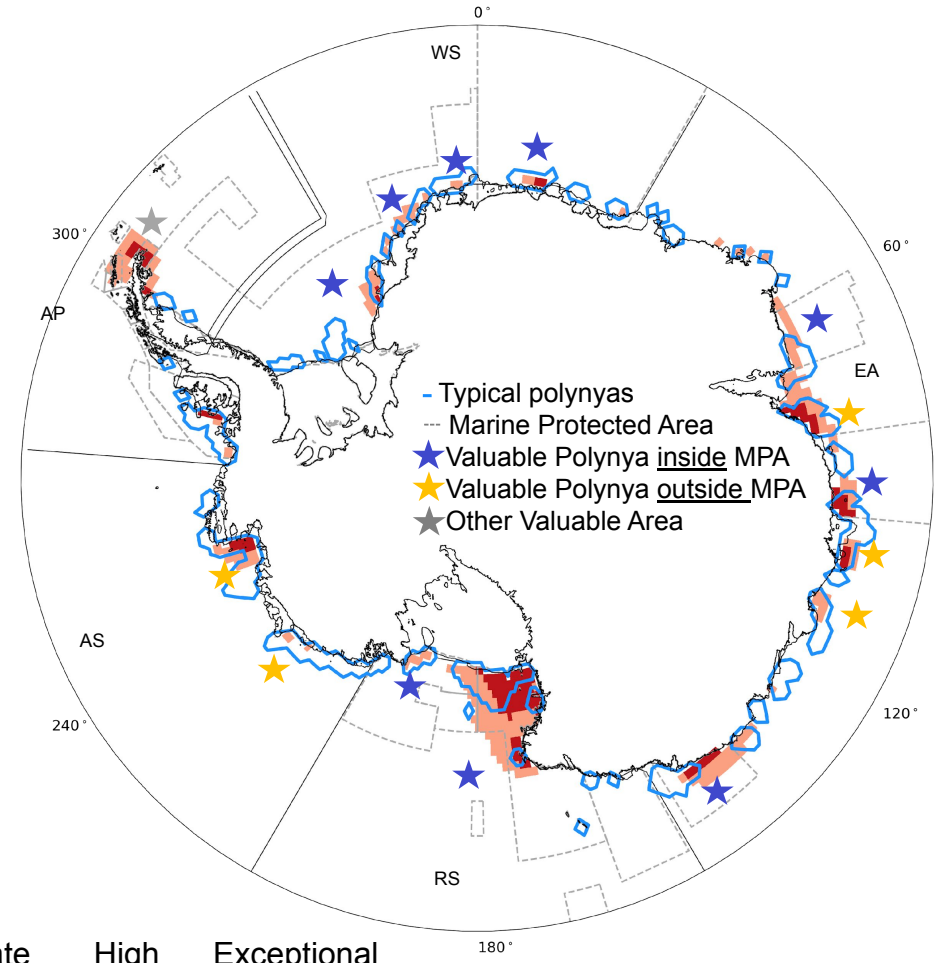
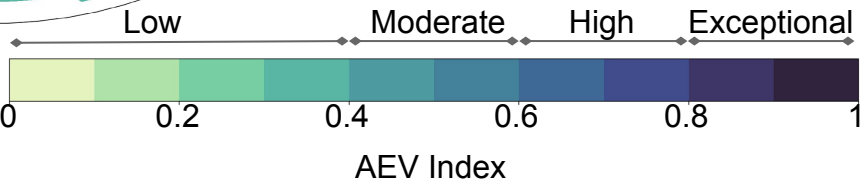
Many polynyas are in MPAs, but several valuable polynyas are opportunities







Data from DuVivier et al. (in review)

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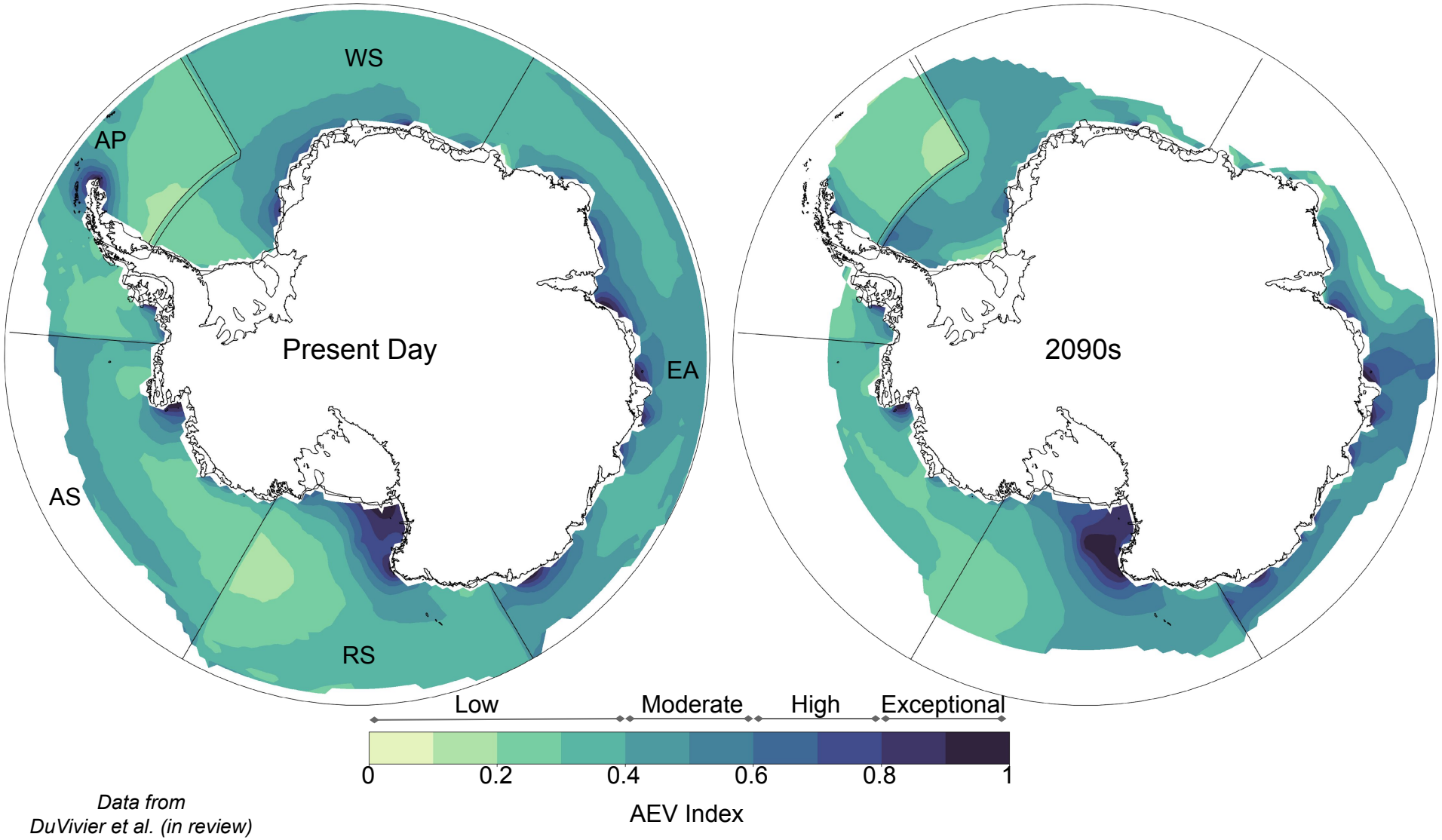
Valuable regions in the present continue to be valuable in the future



Data from
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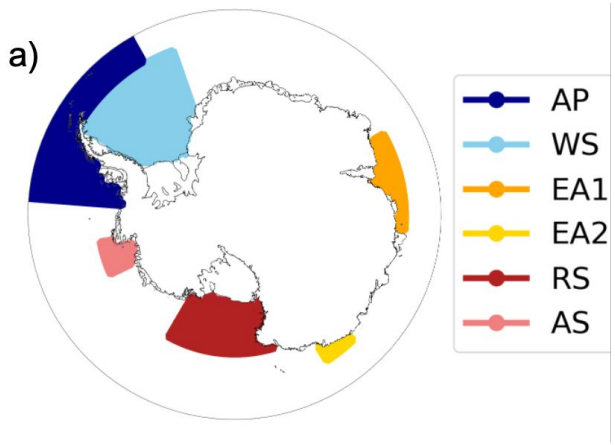
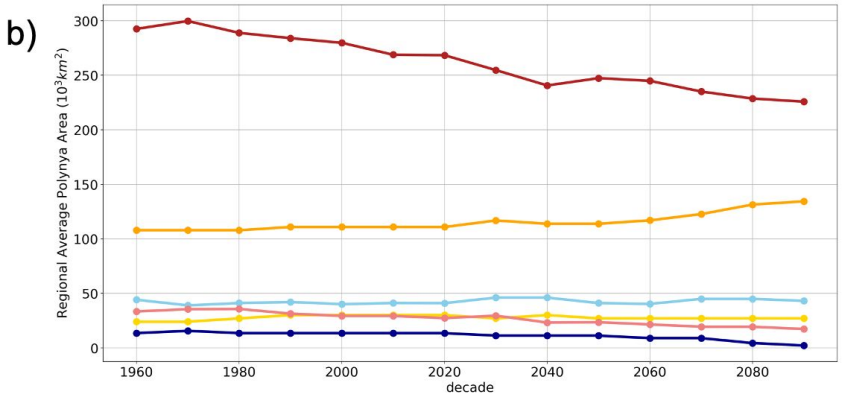
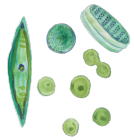
Polynya area stays relatively constant, but there are ecological red flags.





- Less ice and warmer temperatures increase NPP.
- Sea surface temperatures get too warm for krill.
- Deep ocean temperatures get too warm for Antarctic toothfish habitat.
- Most Emperor Penguin colonies become extinct.
- Most Adelie Penguin colonies remain unthreatened.



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Storytelling is critical to the protection process

"For policy making it is important to see the whole … Emotion is important. If we as policy makers, and as a society as a whole, do not understand, do not sense, do not feel what you are talking about, what the impact is and what the dangers are if we don't make decisions for conservation, then we don't take that into the negotiations."

Stephanie Langrock, CCAMLR Commissioner for Belgium
SCAR2024 symposium on co-producing knowledge at the Antarctic science-policy interface in a complex world

Photo: John Weller

Engaging policymakers and the public

Science-Policy-Public Interface

Scientists

NSF | NCAR Operated by UCAR

University of Colorado Boulder

Woods Hole Oceanographic Institution 1930

LOCEAN

THE PEW CHARITABLE TRUSTS

Antarctic and Southern Ocean Coalition

Only One

Decision-makers

CCAMLR

General public

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Working on a webtool with OnlyOne to do visual scientific storytelling and encourage Antarctic protection.

Photos: John Weller

OnlyOne

https://only.one/campaign/antarctica-ecoindex

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Conclusions:

The material is based upon work supported by NASA under award No 80NSSC21K1132. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration

Thanks to NASA for funding!

- Polynyas are highly valuable for Antarctic ecosystems.
- Many polynyas are in proposed MPAs, but several highly valuable polynyas remain opportunities for protection.
- Valuable regions in the present continue to be valuable in the future and could be refugia for Antarctic species if protected.

Questions?

Only One

https://only.one/campaign/antarctica-ecoindex

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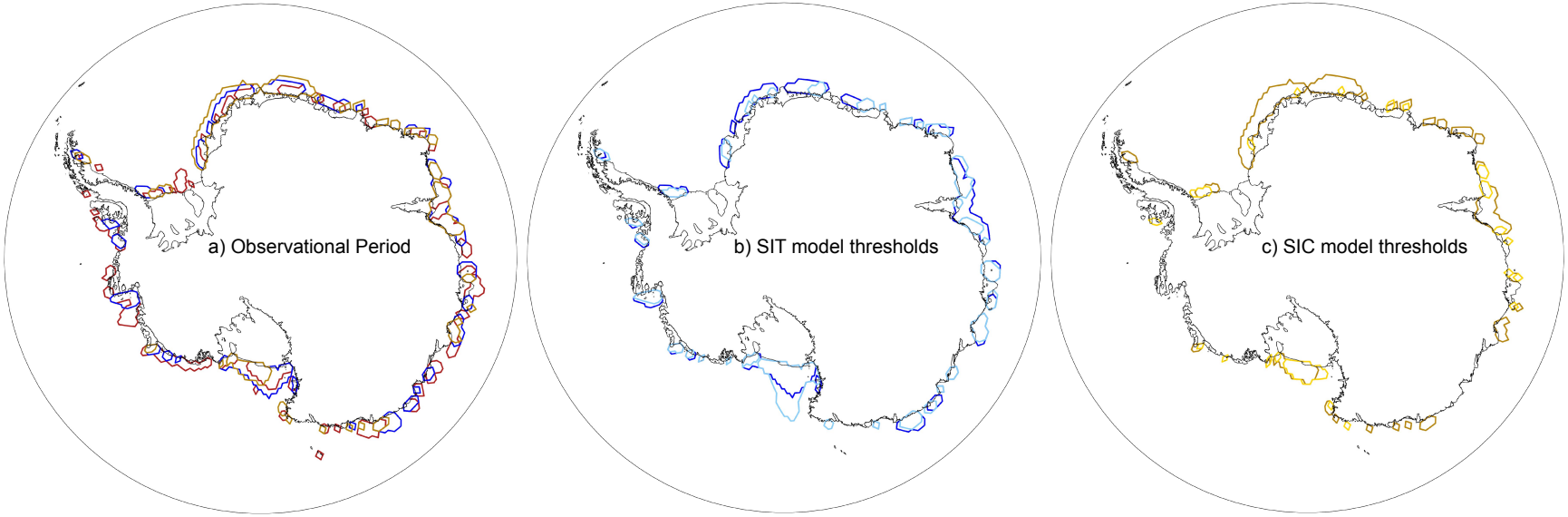
Extra slides



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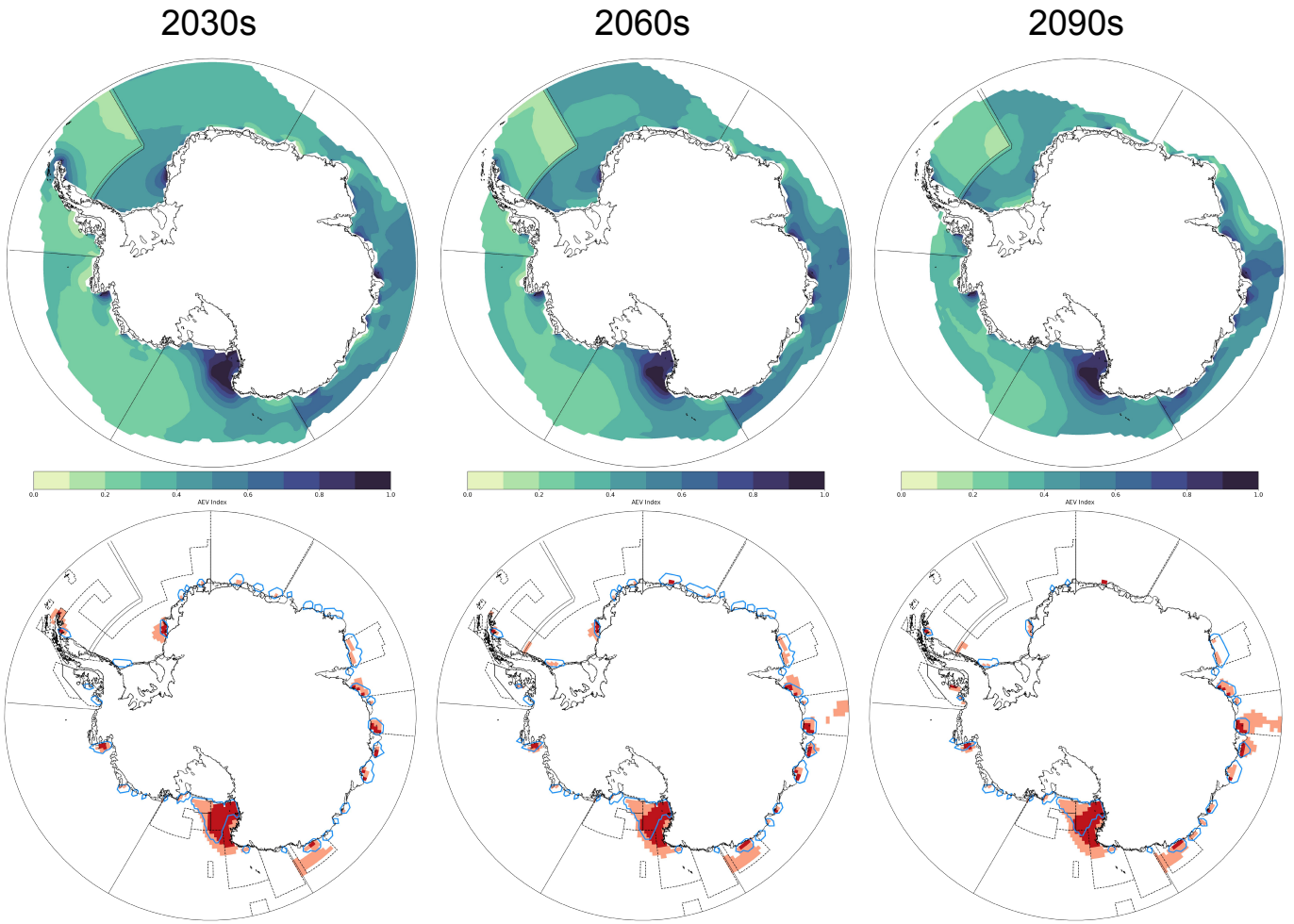

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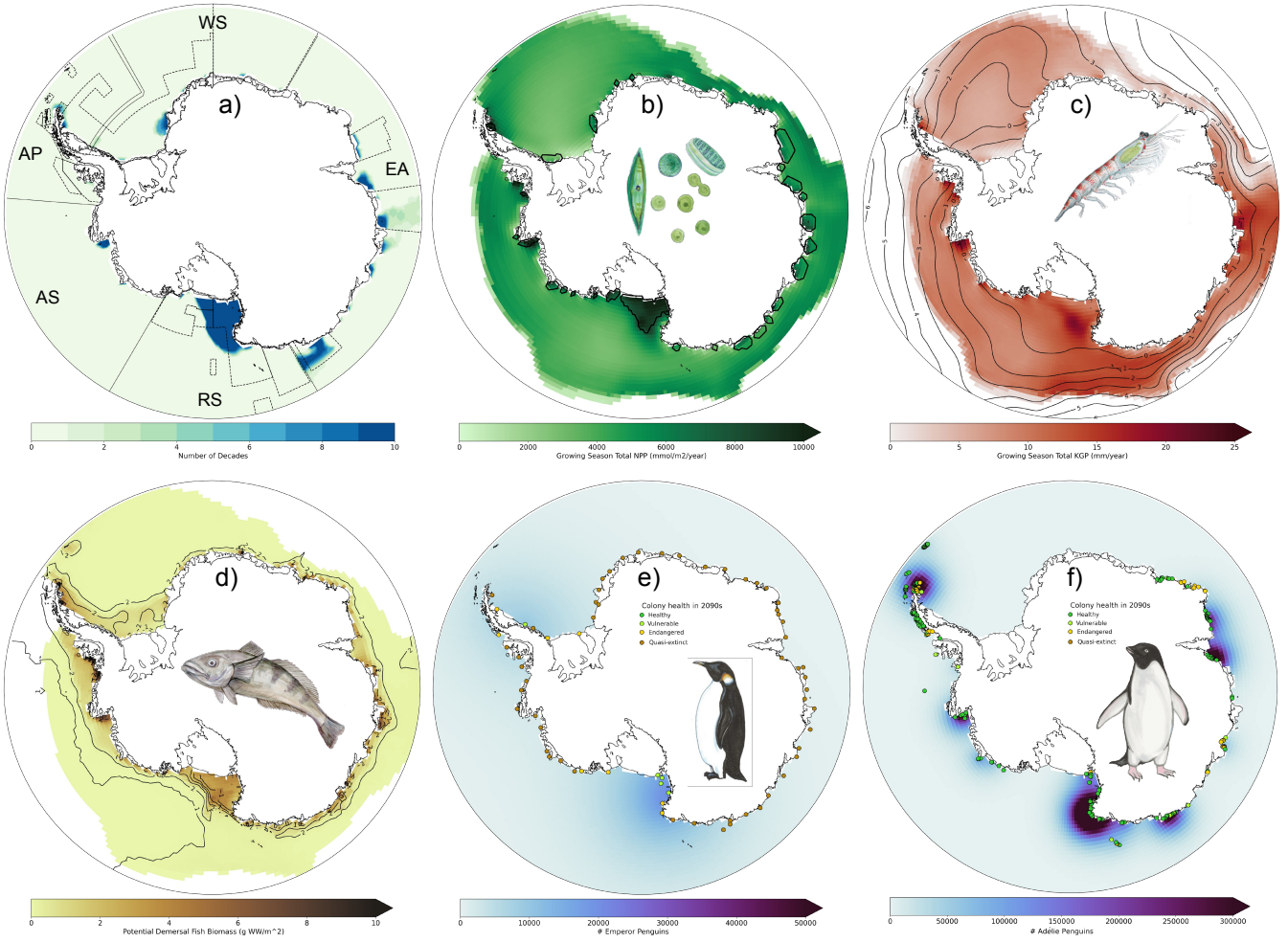

Colony health:

- "healthy" → population decline <30% (dark blue)
- "vulnerable" → population decline of >30% (light blue)
- "endangered" → population decline of >50% (gold)
- "quasi-extinct" → population decline of >90% (red)

Need a baseline. Use 2000s.

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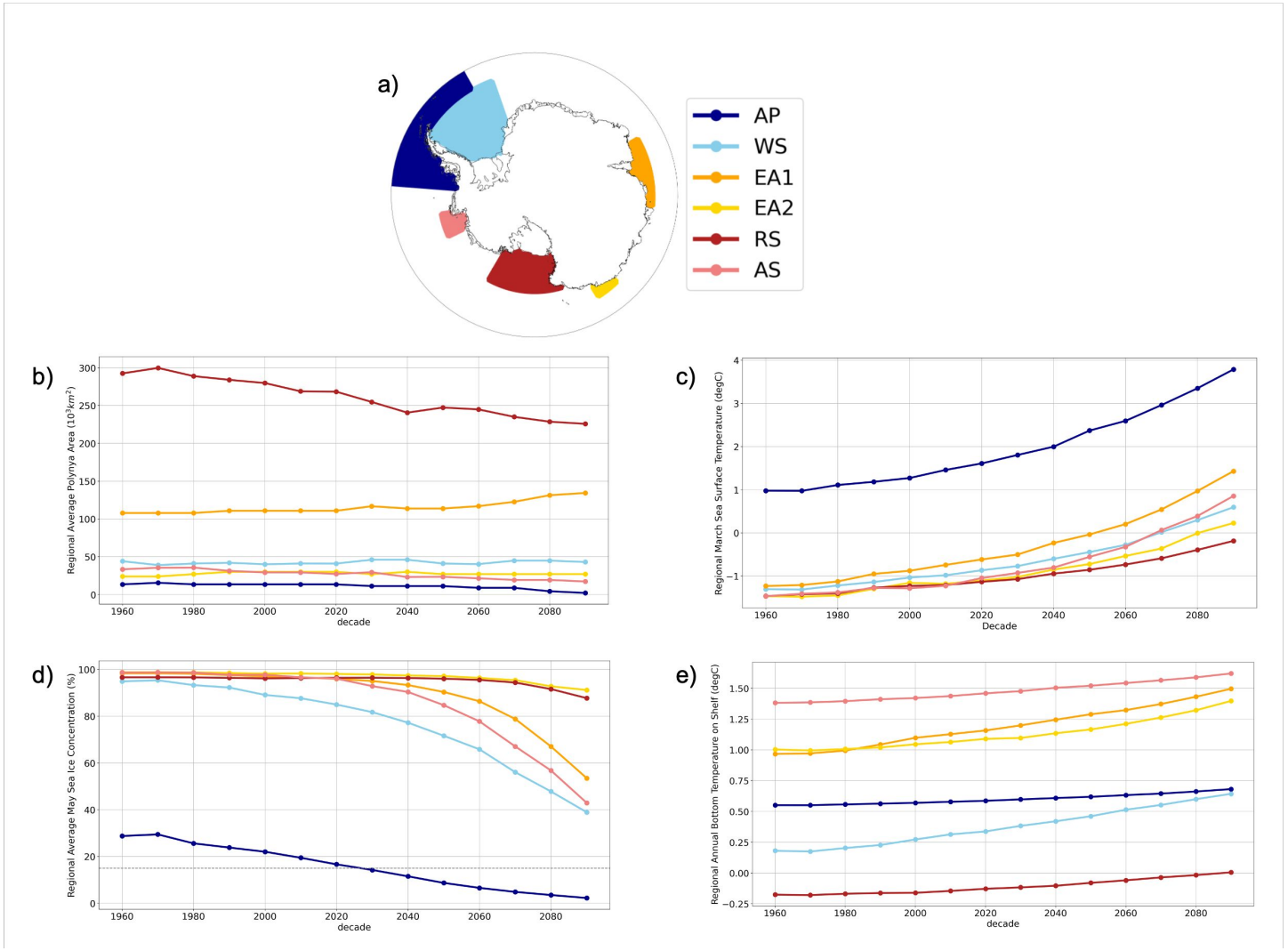

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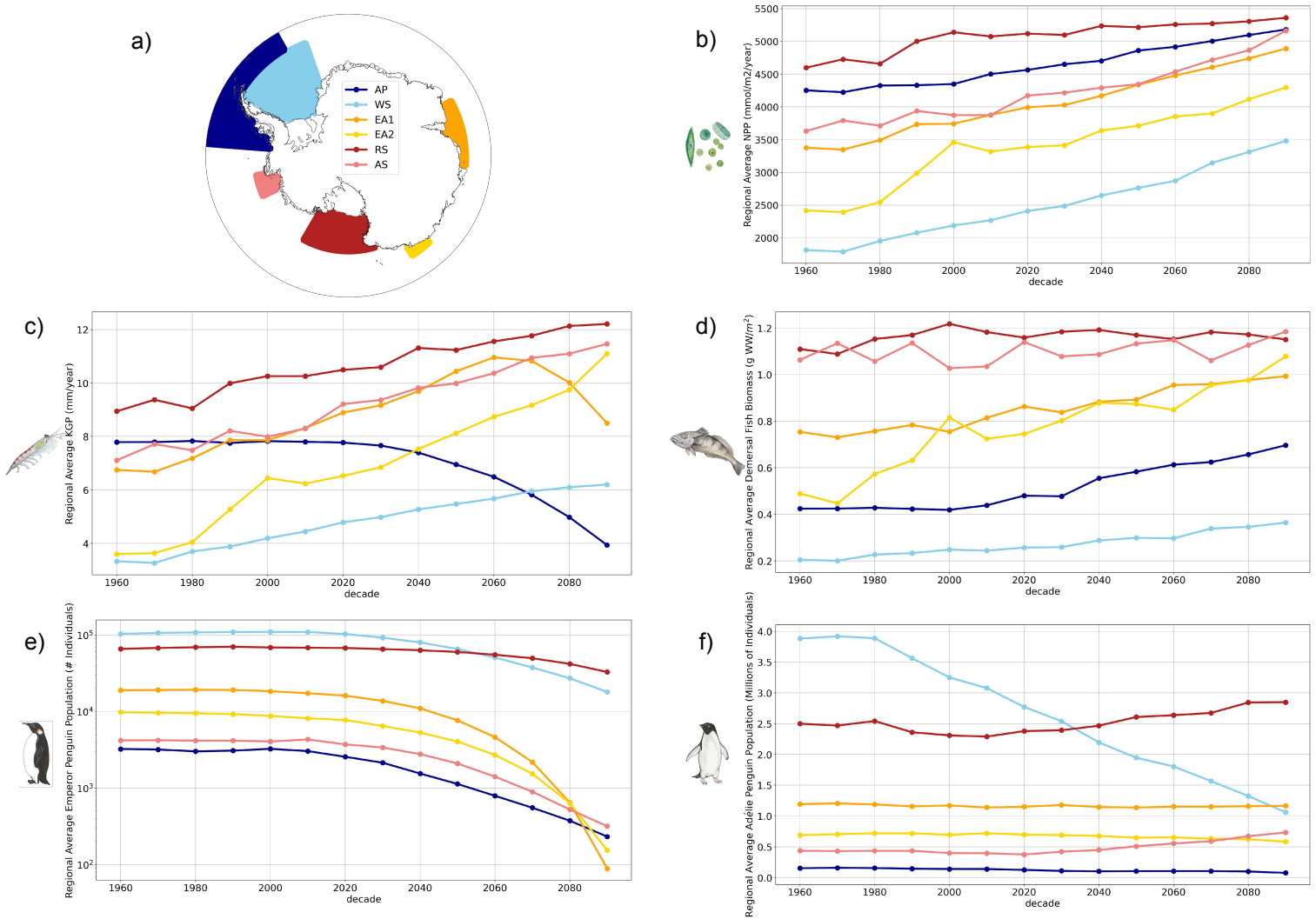
Figure 4



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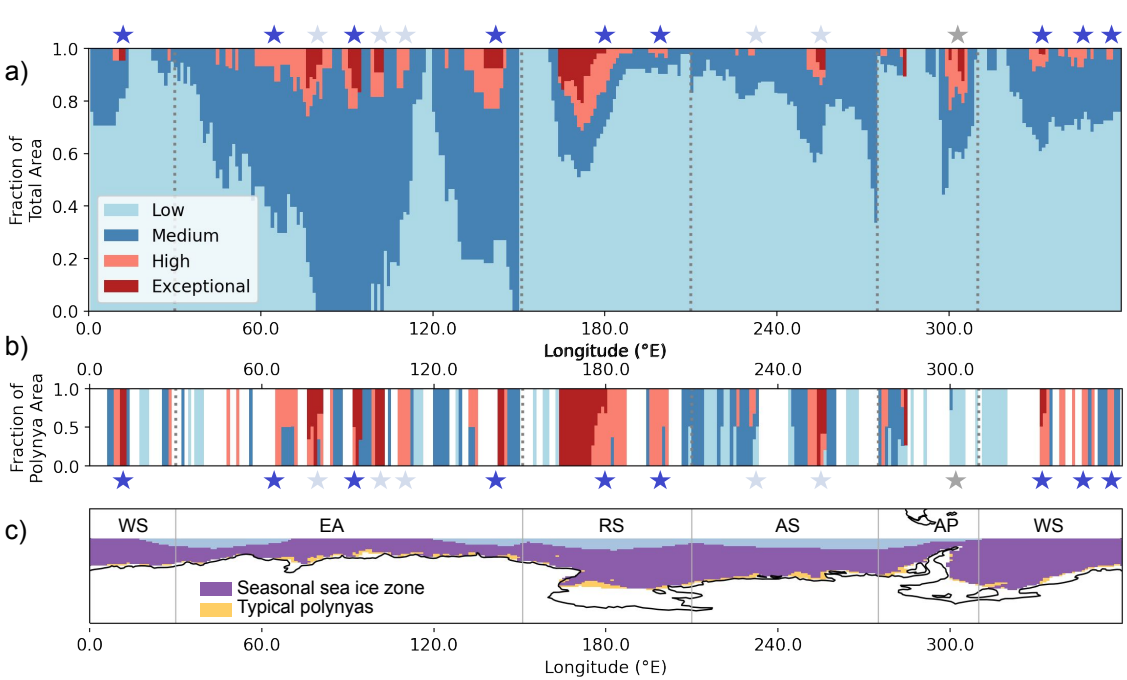
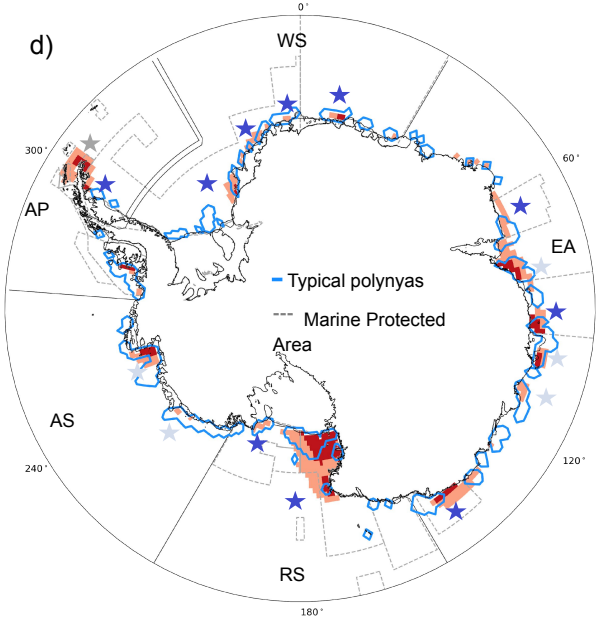
Obs based!





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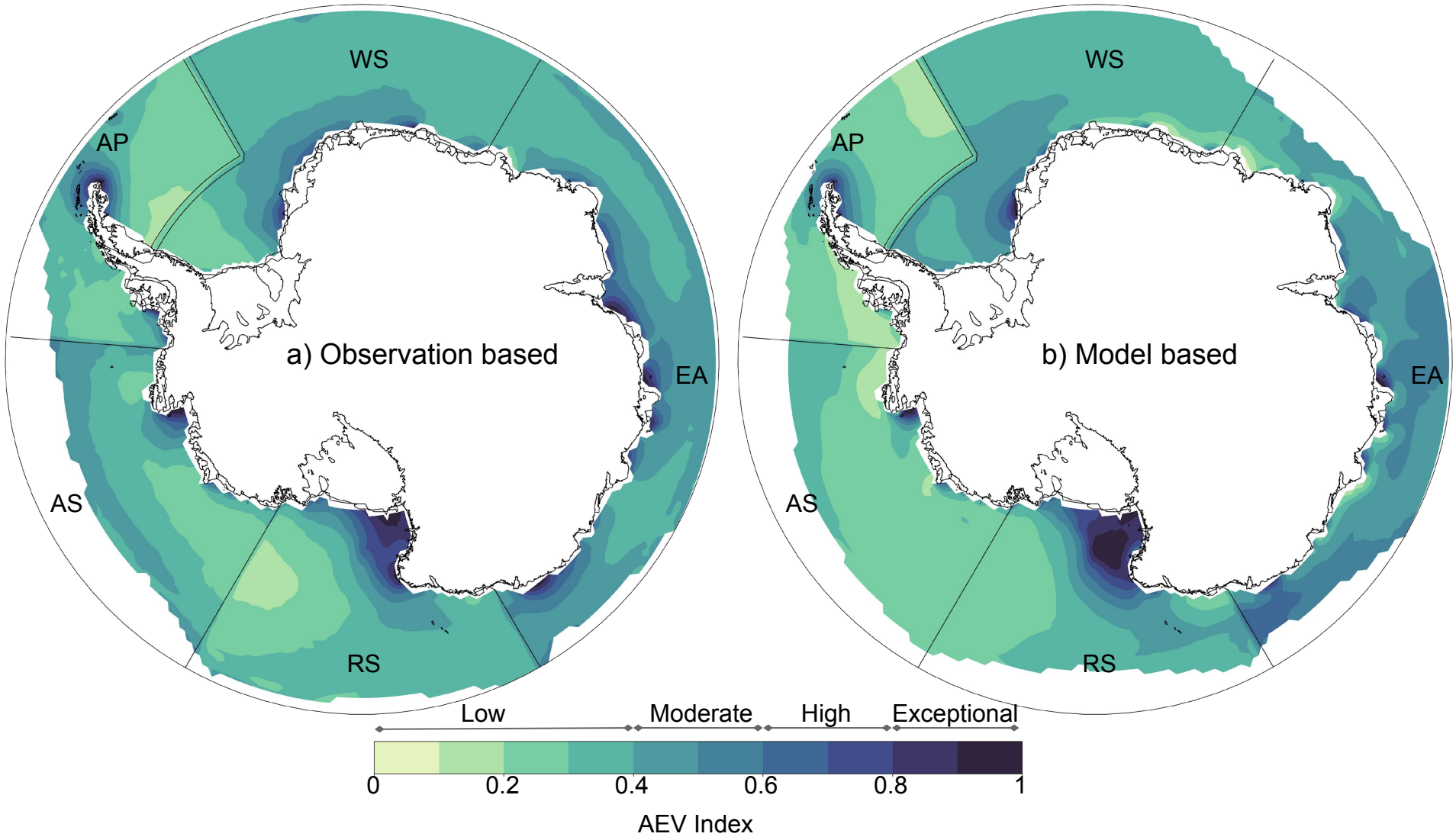

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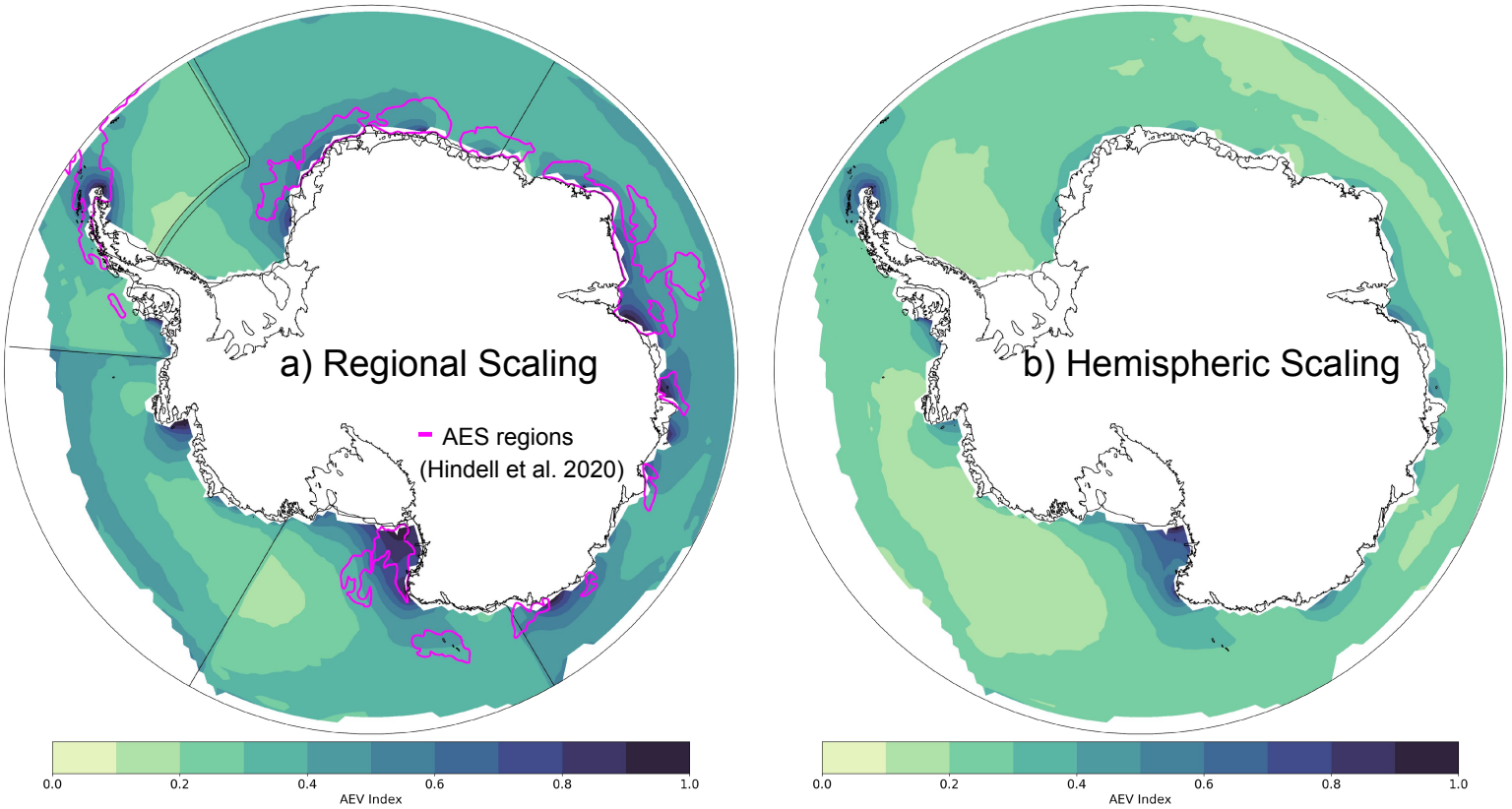

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