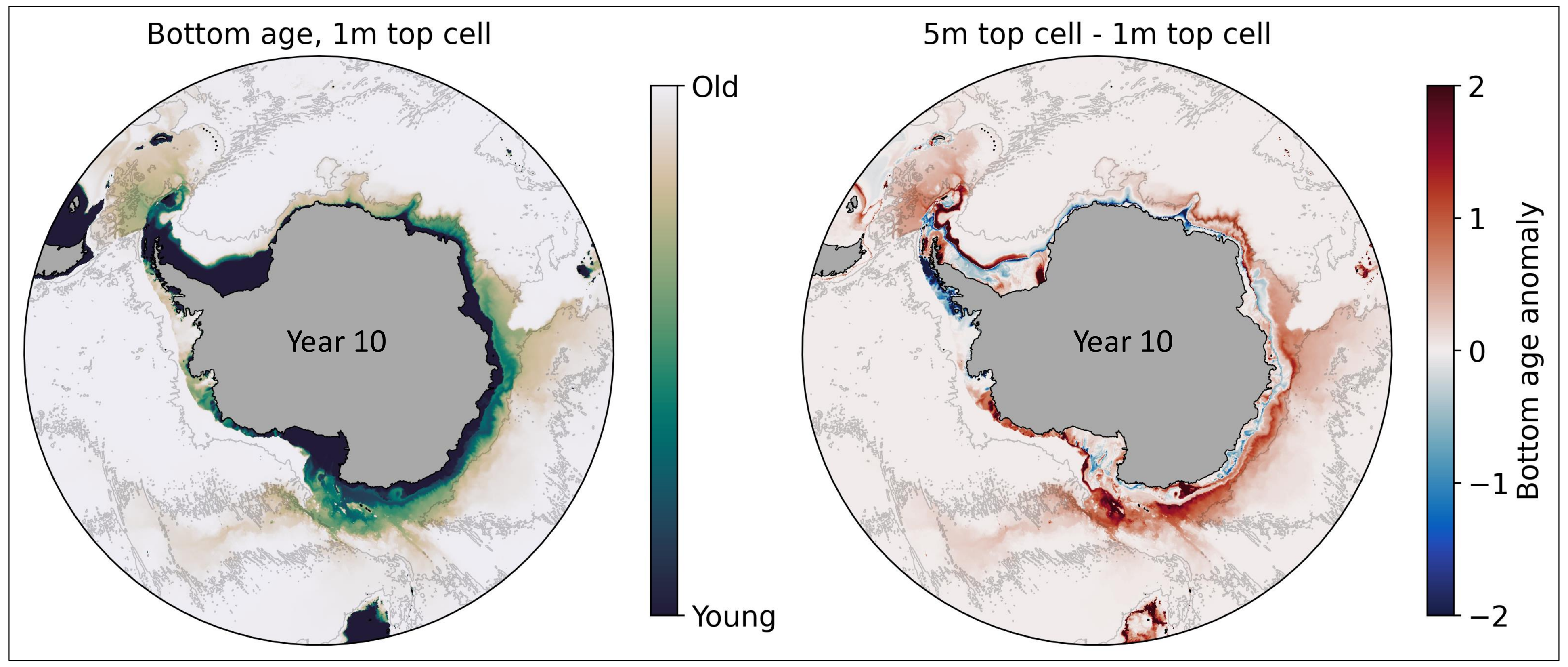
Strong sensitivity of Antarctic dense water formation to surface vertical resolution

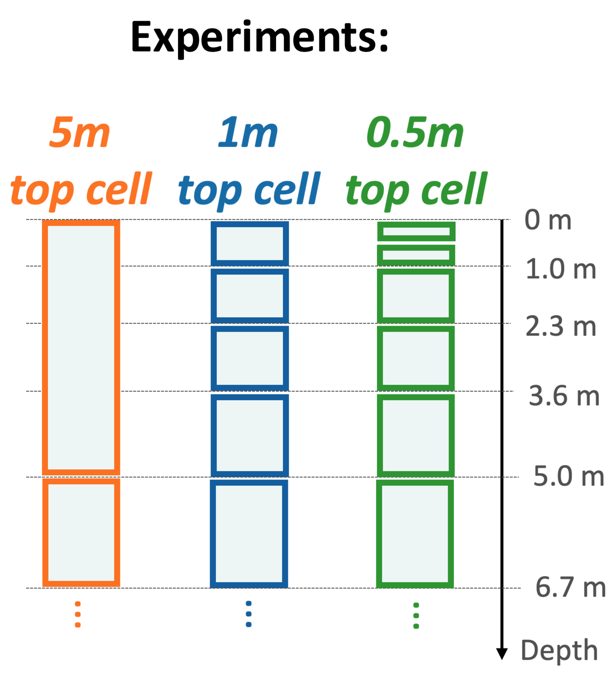
Wilton Aguiar, **Adele Morrison**, David Hutchinson, Paul Spence, Wilma Huneke, Andy Hogg, Fabio Dias

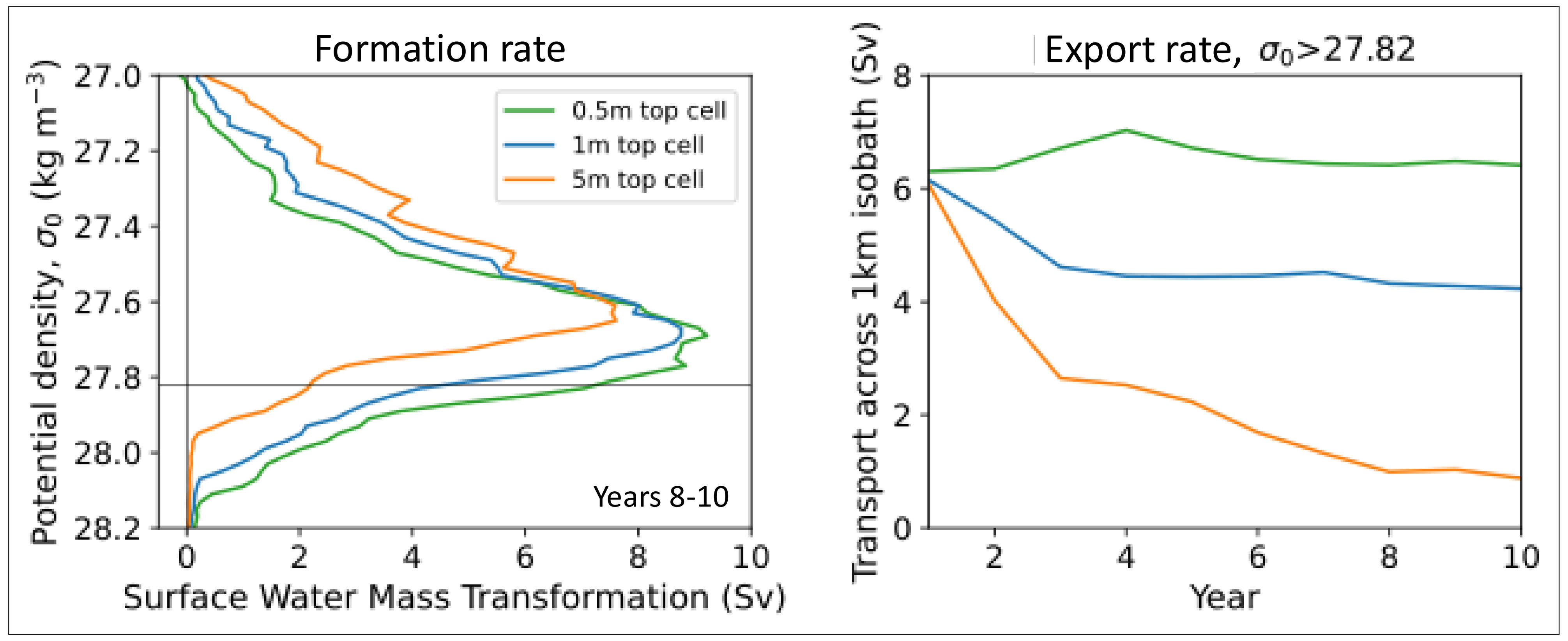
Consortium for Ocean-Sea Ice Modelling in Australia

Australian National University

Increasing vertical resolution at the surface enhances Antarctic dense water formation and overflow







- **ACCESS-OM2-01** (global 0.1° MOM5-CICE5 model) produces dense waters on the Antarctic continental shelf that flow into the abyss.
- Abyssal ventilation decreases going from 5m → 1m thickness of top cell.

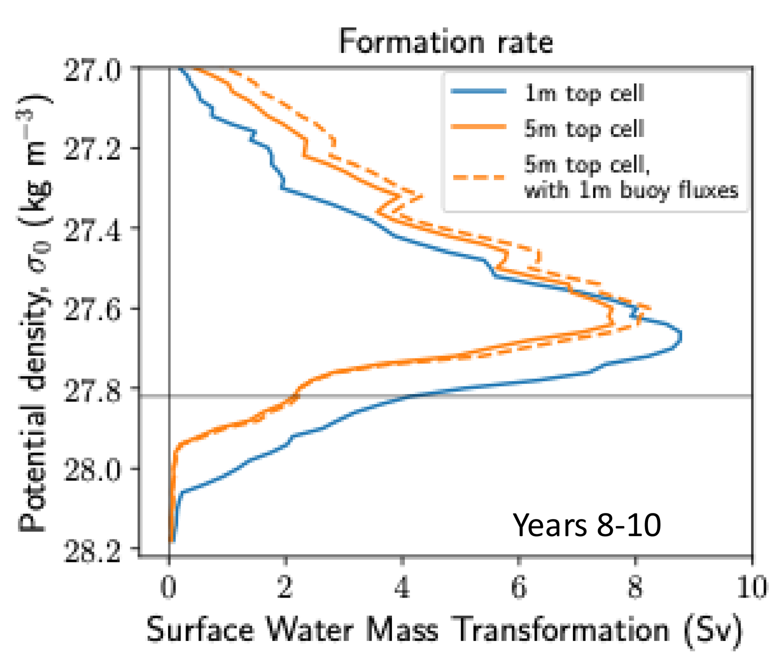
Reduction of top cell thickness from 5m → 1m results in:

- 48% decrease in dense water formation (SWMT at σ_0 = 27.82).
- 77% decrease in dense water transport across shelf break (σ_0 > 27.82).

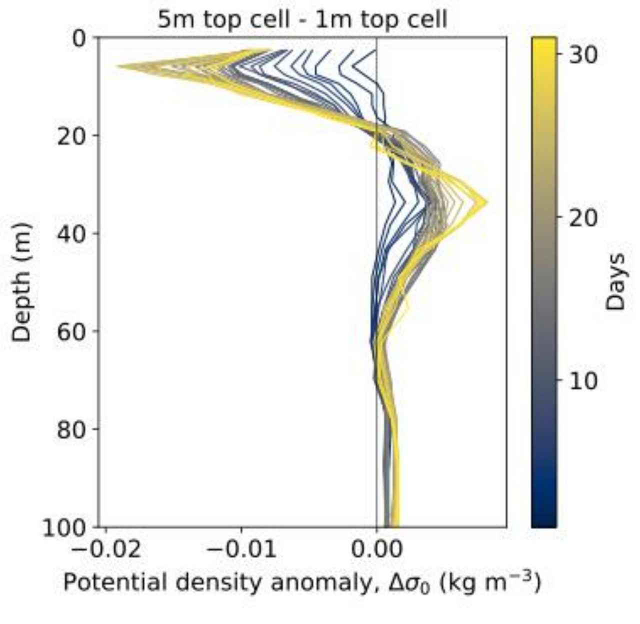
Decreased formation is due to reduced surface density, not altered surface buoyancy flux

The dashed orange line shows the surface water mass transformation calculated using surface density from the 5m top cell simulation (orange), but with surface buoyancy fluxes from the 1m top cell simulation (blue).

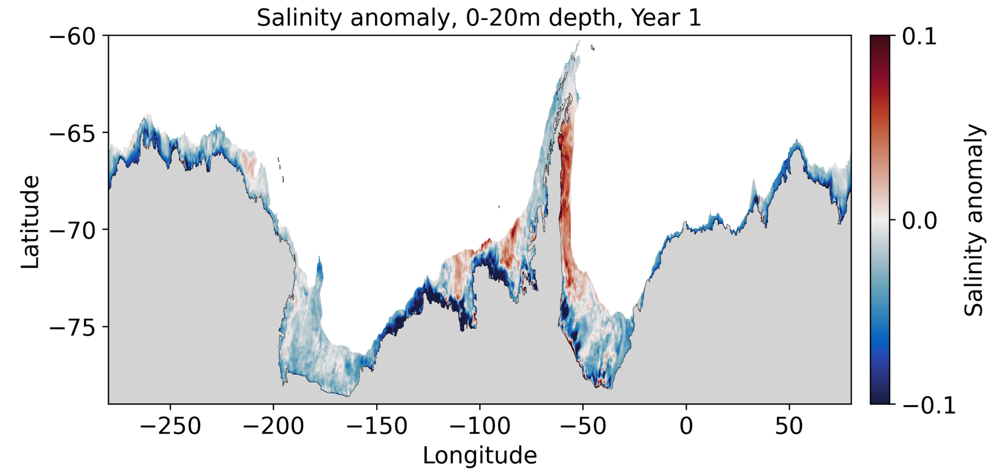
Therefore the driver of reduced dense water formation is surface density change, not buoyancy flux change.



Ocean surface freshening

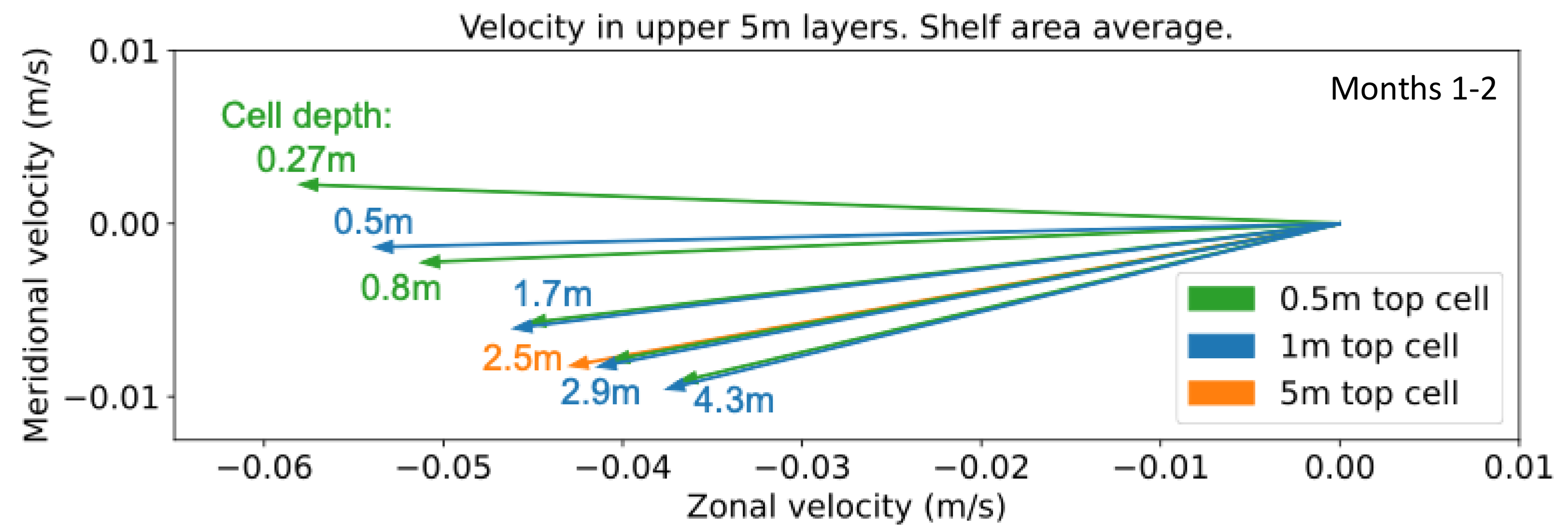


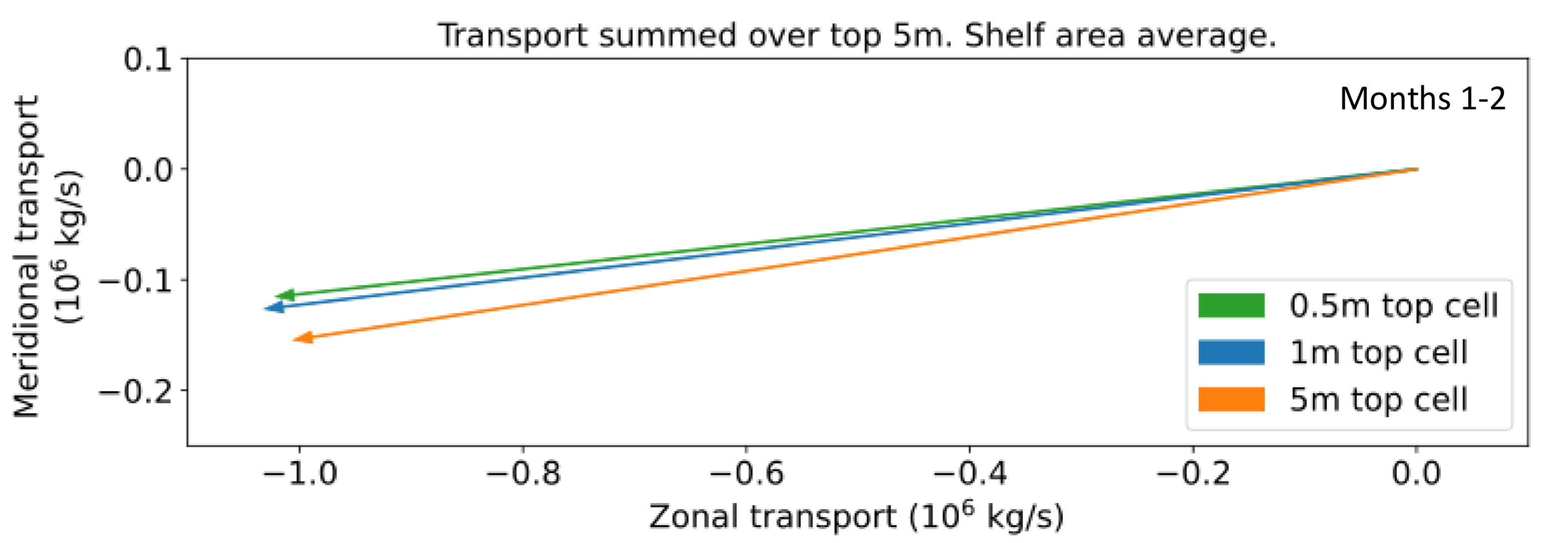
The upper 20m over the continental shelf begins freshening within days, and this fresh bias builds up over the first year.



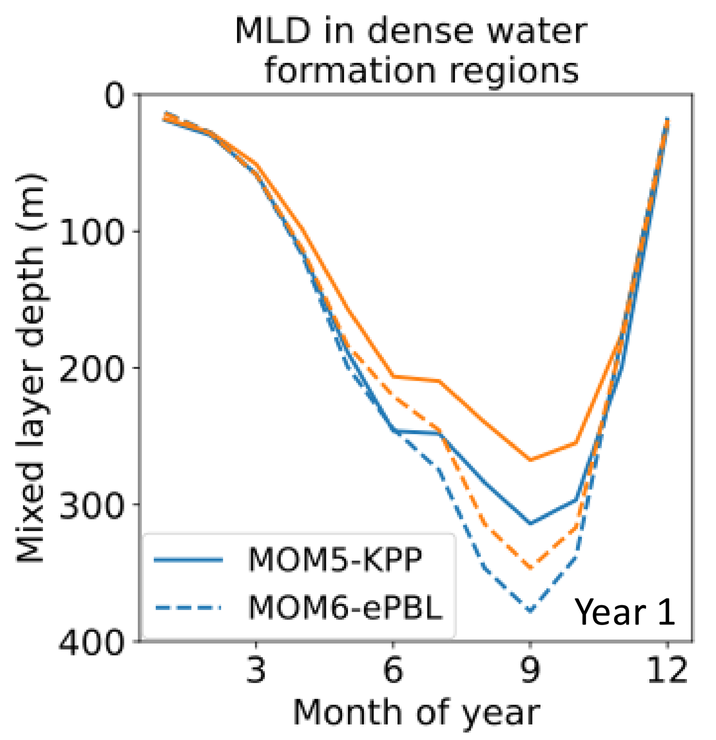
Freshening is due to rotated Ekman transport

In the configurations with thinner upper layers (green), the Ekman transport is less rotated (to the left) in the near-surface cells. Therefore the surface transport is more southward in the simulation with 5m top cell thickness (orange), causing fresh waters to pile up at the surface over the continental shelf.





Independent of boundary layer mixing scheme



A regional 0.1° MOM6-SIS2 circumpolar model with the ePBL parameterisation (dashed lines) shows the same sensitivity to surface vertical resolution as the ACCESS-OM2-01 (MOM5) configuration with KPP boundary layer mixing (solid lines).