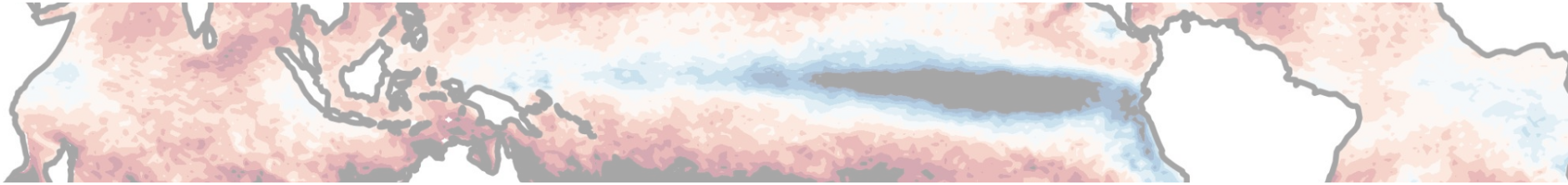
Local drivers of marine heatwaves

A global analysis with an Earth System Model



presented by Linus Vogt
with Friedrich A. Burger, Stephen M. Griffies, Thomas L. Frölicher

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EGU General Assembly 2022

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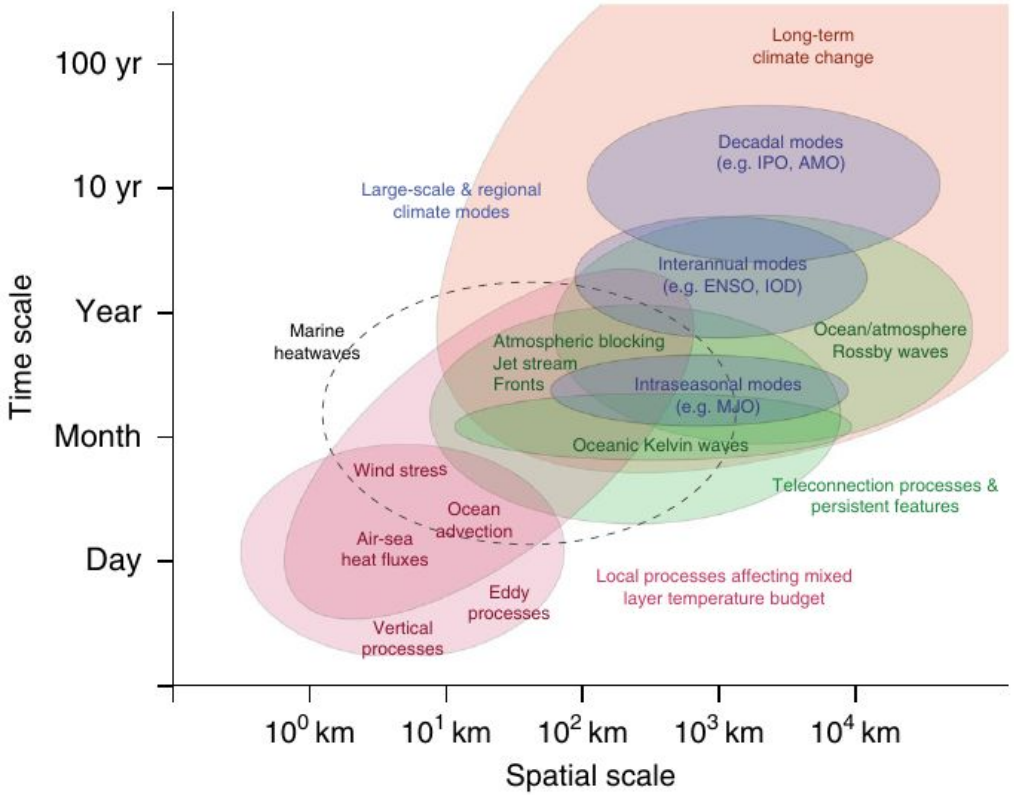
Physical drivers



(Holbrook et al. 2019)

Earth system model

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- GFDL ESM2M, ocean model MOM4p1, 1-degree resolution

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- 500 years of daily-mean preindustrial simulation output

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- Surface ocean heat budget:

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$$\Delta Q_{\text{total}} =$$

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- Surface ocean heat budget:

$$\Delta Q_{\text{total}} = \Delta Q_{\text{sfch}}$$

air-sea heat flux
(SW, LW, latent, sensible)

Earth system model

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- 500 years of daily-mean preindustrial simulation output

- Surface ocean heat budget:

$$\Delta Q_{\text{total}} = \Delta Q_{\text{sfch}} + \Delta Q_{\text{vmix}}$$

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convective vertical mixing
(nonlocal KPP)

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$$\Delta Q_{\text{total}} = \Delta Q_{\text{sfch}} + \Delta Q_{\text{vmix}} + \Delta Q_{\text{vdiff}}$$

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vertical diffusion and mixing (local KPP)

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- Surface ocean heat budget:

$$\Delta Q_{\text{total}} = \Delta Q_{\text{sfch}} + \Delta Q_{\text{vmix}} + \Delta Q_{\text{vdiff}} + \Delta Q_{\text{adv}}$$

air-sea heat flux
(SW, LW, latent, sensible)

convective vertical mixing
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vertical diffusion and mixing (local KPP)

advection
(resolved + parameterized)

Earth system model

- GFDL ESM2M, ocean model MOM4p1, 1-degree resolution
- 500 years of daily-mean preindustrial simulation output

- Surface ocean heat budget:

$$\Delta Q_{\text{total}} = \Delta Q_{\text{sfch}} + \Delta Q_{\text{vmix}} + \Delta Q_{\text{vdiff}} + \Delta Q_{\text{adv}} + \Delta Q_{\text{res}}$$

residual

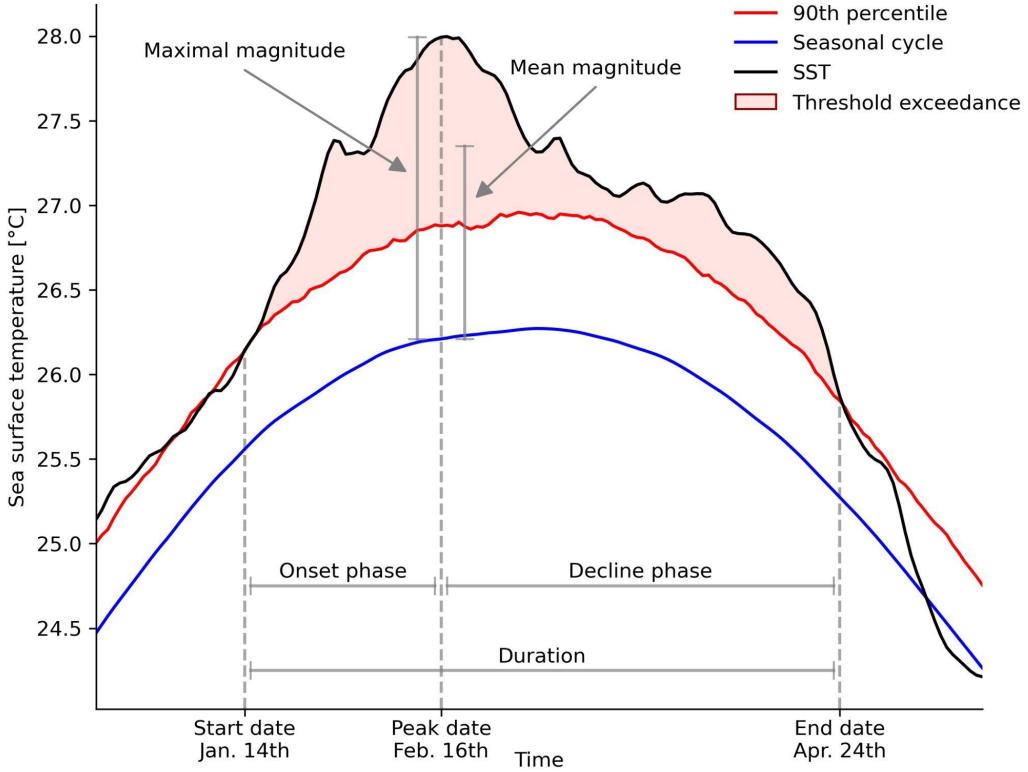
advection
(resolved + parameterized)

air-sea heat flux
(SW, LW, latent, sensible)

vertical diffusion and mixing (local KPP)

convective vertical mixing
(nonlocal KPP)

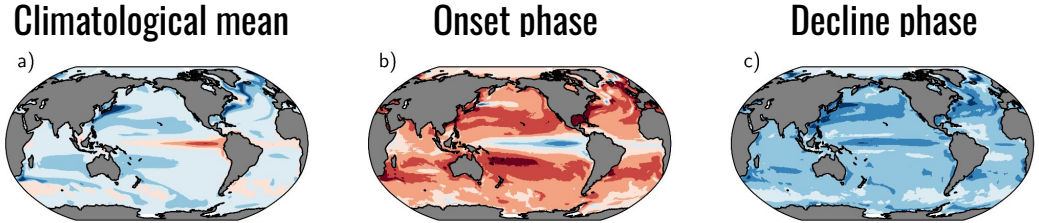
MHW definition

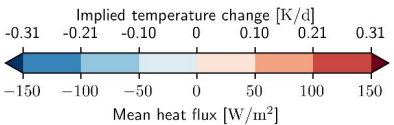


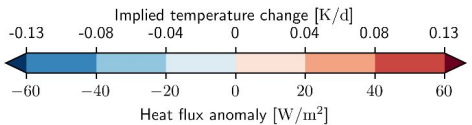
Anomalous heat flux patterns

Anomalous heat flux patterns

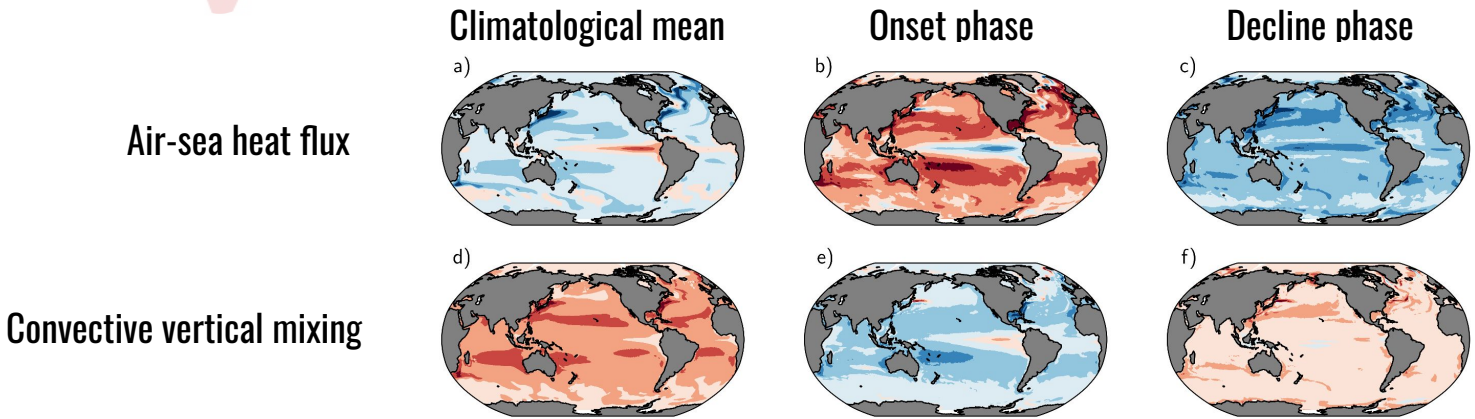
Air-sea heat flux

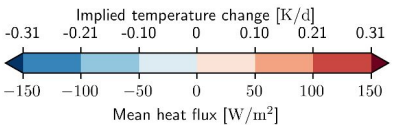


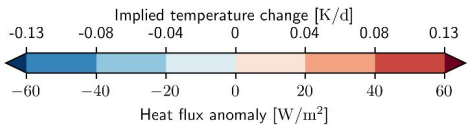




Anomalous heat flux patterns







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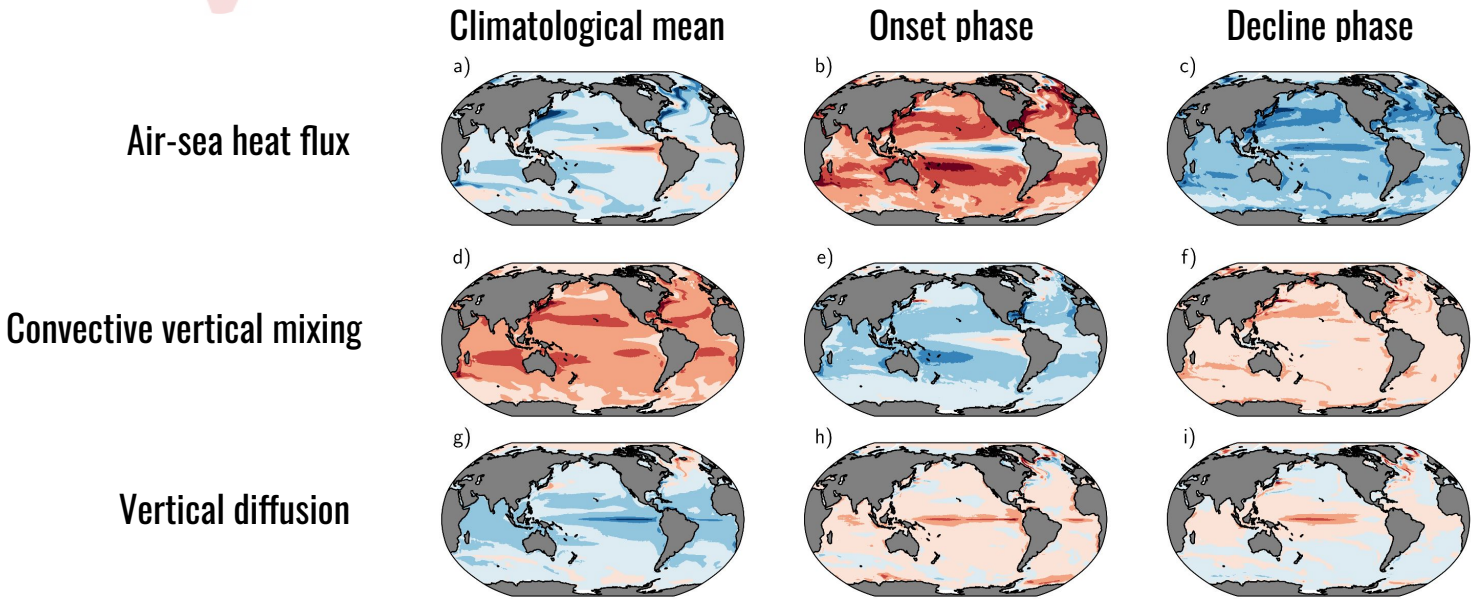

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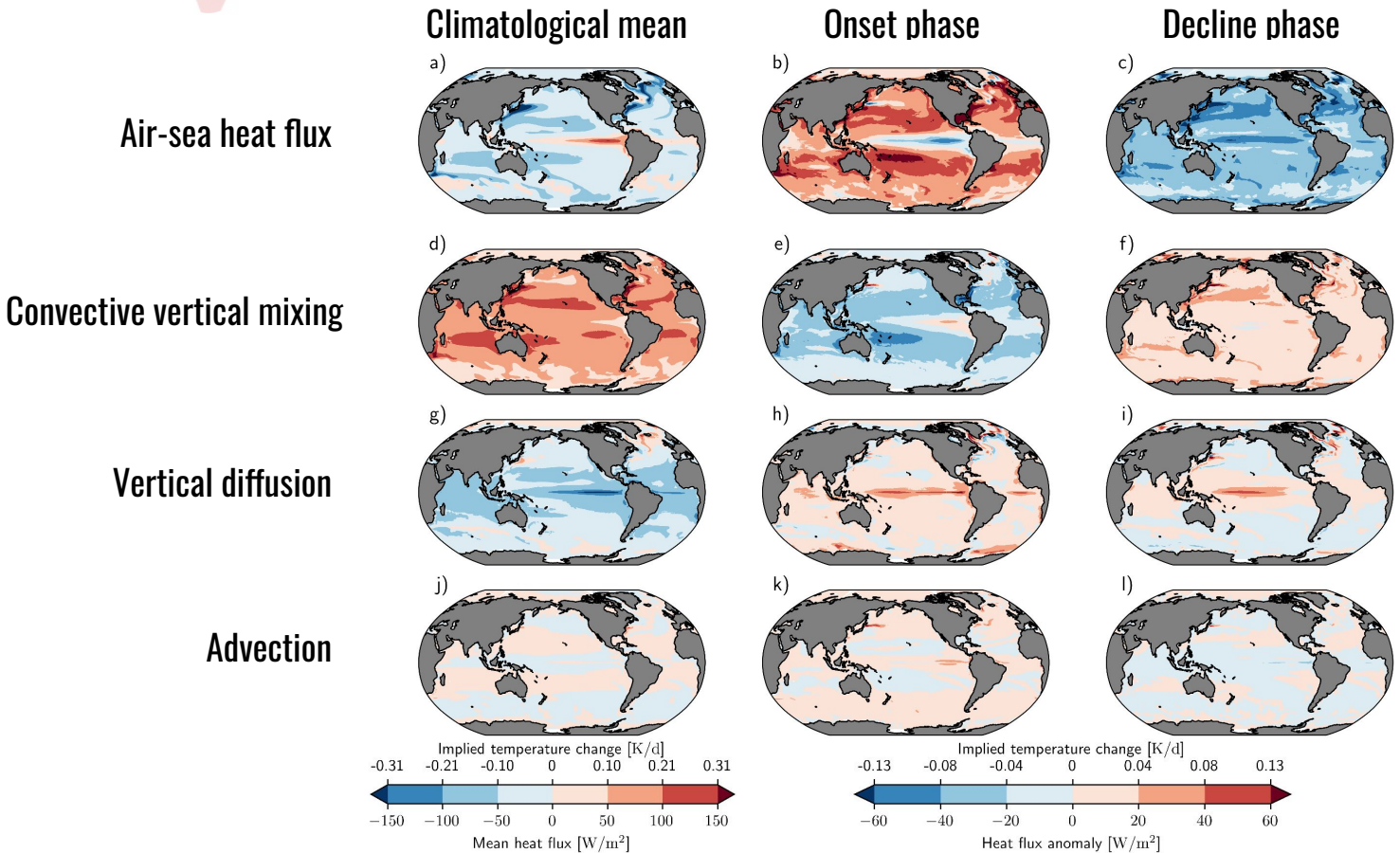


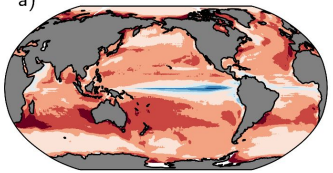
Seasonality of onset phase drivers

Seasonality of onset phase drivers

Air-sea heat flux

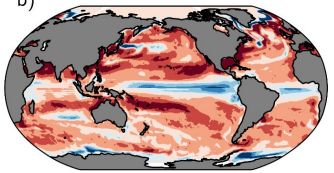
Summer onset phase

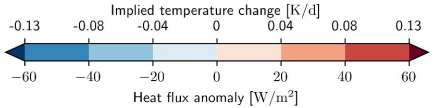
a)



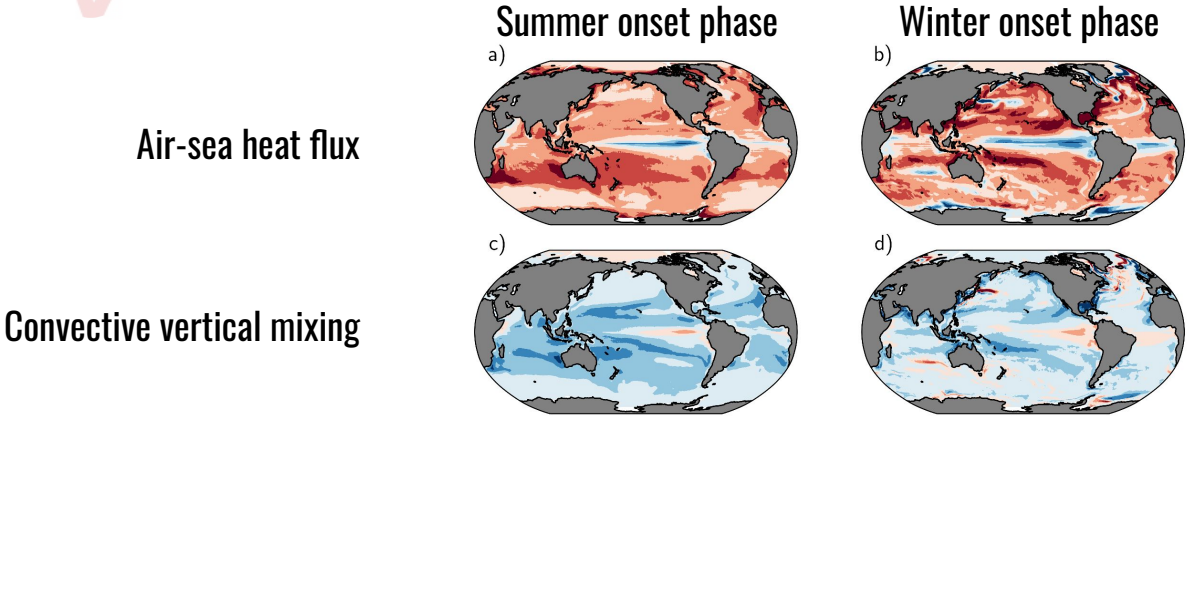
Winter onset phase

b)





Seasonality of onset phase drivers



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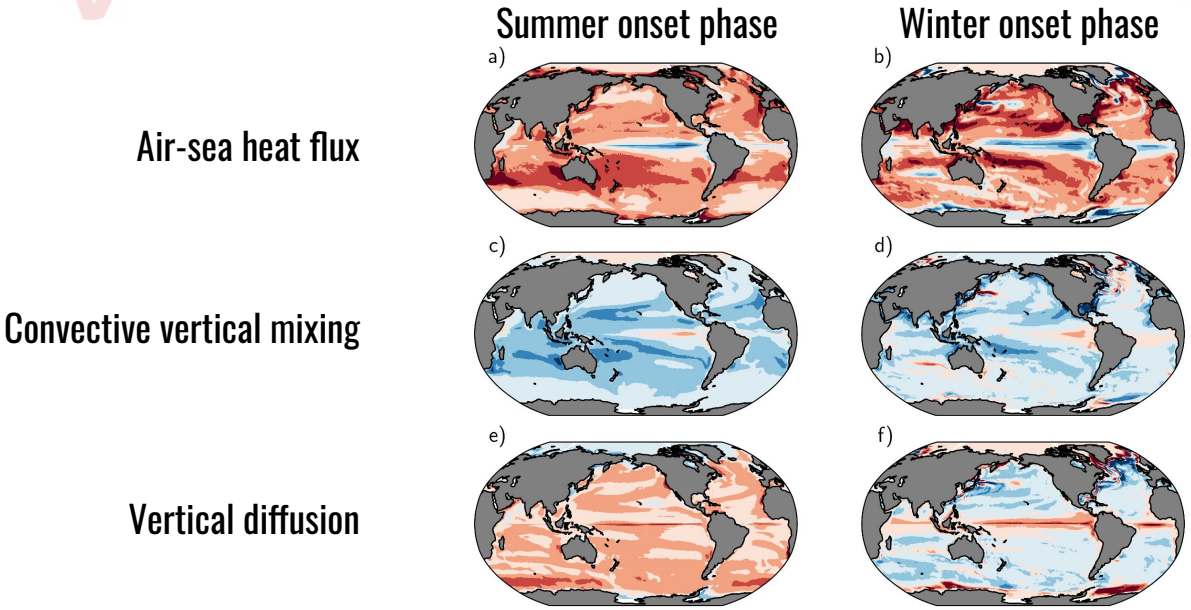

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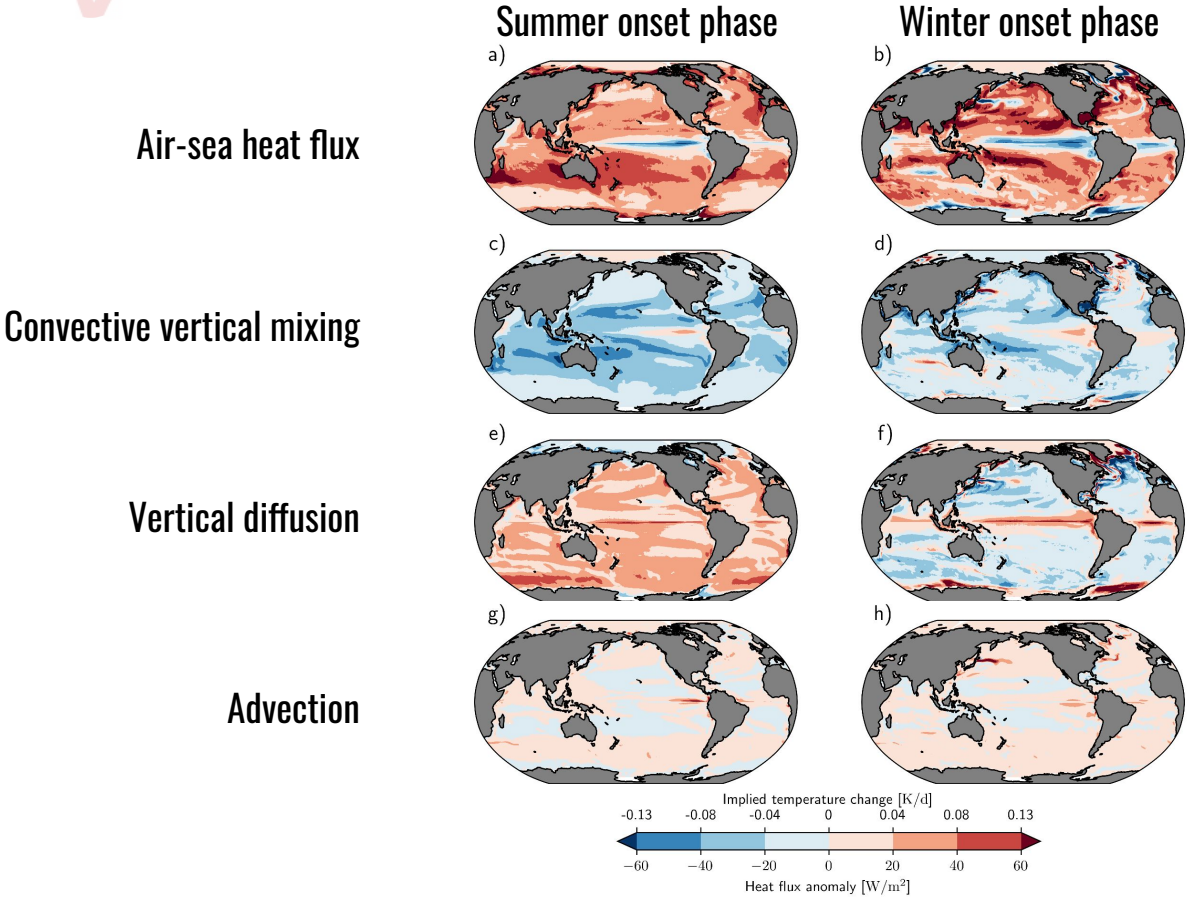

Conclusions

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Thank you!

Conclusions

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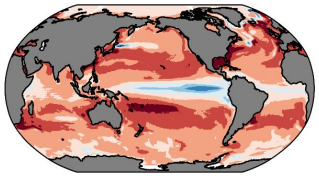
Thank you!

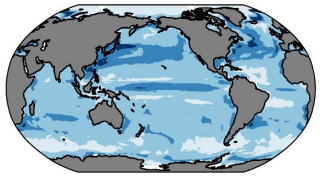
Air-sea heat flux decomposition

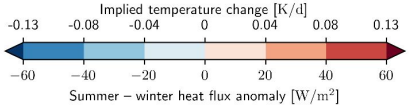
Air-sea heat flux (total)

Onset phase



Decline phase

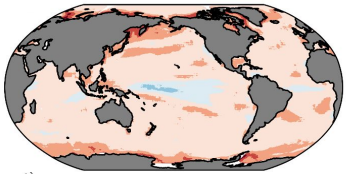


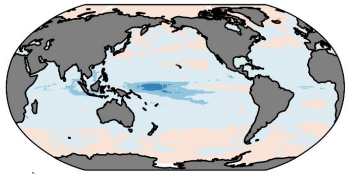


Onset phase

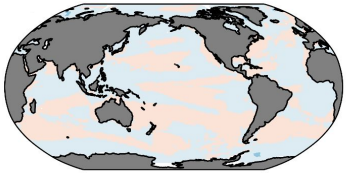
Decline phase

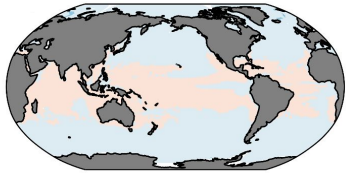
Shortwave radiation



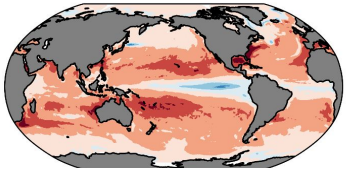


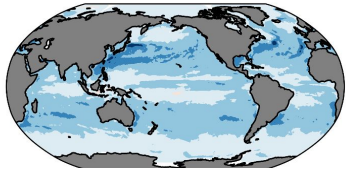
Longwave radiation



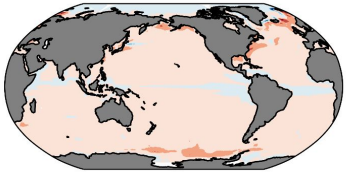


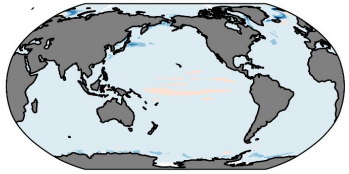
Latent heat flux

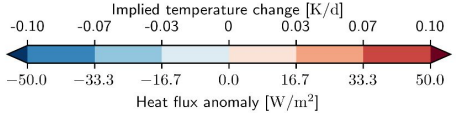




Sensible heat flux





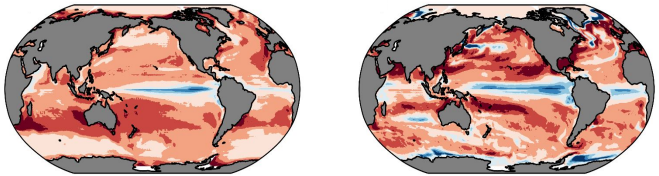


Seasonality of air-sea heat flux

Air-sea heat flux (total)

Summer onset phase

Winter onset phase



Summer onset phase

Winter onset phase

Shortwave radiation

Latent heat flux