Exploring the possible meridional temperature gradient of Early Eocene Climatic Optimum with an energy balance model

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- **Early Eocene Climatic Optimum** (EECO, ~53-51 million years) high CO_2 concentrations (~900-2500 ppmv)
- Weaker **meridional temperature gradient** relative to pre-industrial values.
- Models are challenged to reproduce the stronger than present day **polar amplification** signal.
- Does **transport** has a positive or negative contribution to polar amplification?
- What **changes** in the meridional heat transport in a high CO_2 climate state?
- DeepMIP, **CESM 1.2** (Zhu et al. 2019)
  - Preindustrial Control
  - 6xCO_2

Partitioning the meridional heat transport with monthly mean data

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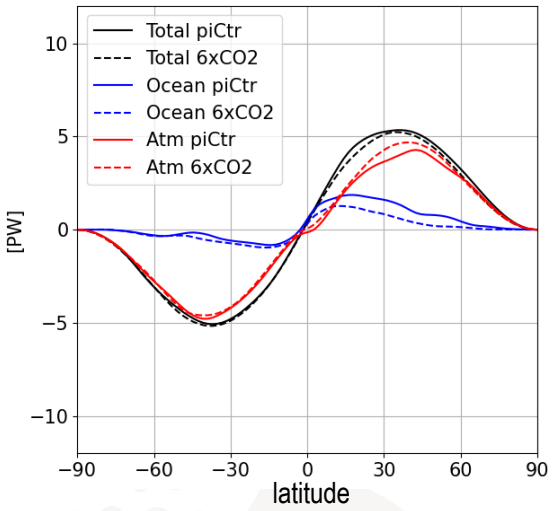
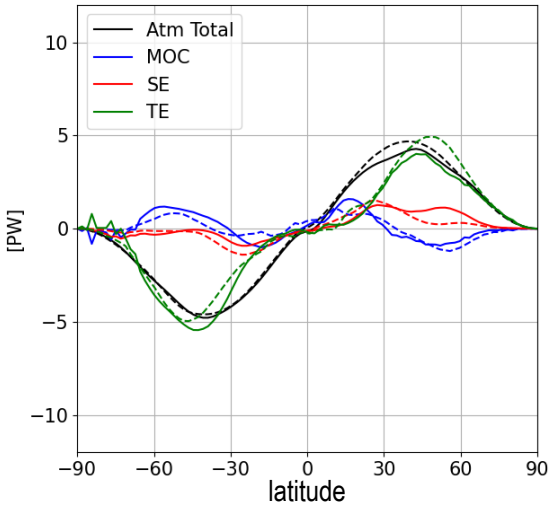
Methodology from Donohoe et al. (2020)

Meridional Heat Transport = Oceanic Heat Transport + Atmospheric Heat Transport

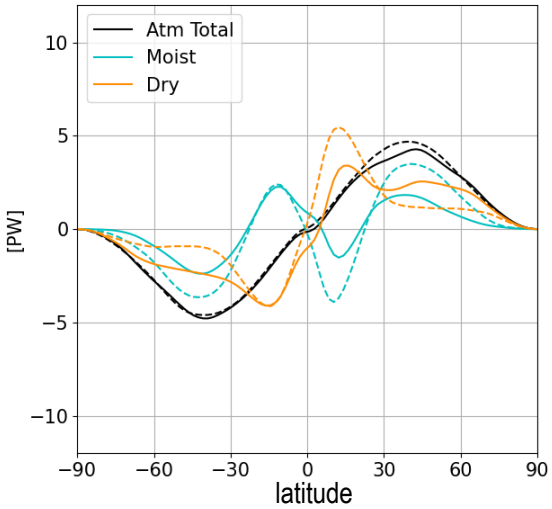
Meridional Overturning Circulation | Stationary Eddies | Transient Eddies



- TOA net radiation budget is stable
- Change mostly in Northern Hemisphere
- ATM increase towards North
- OC decrease towards North

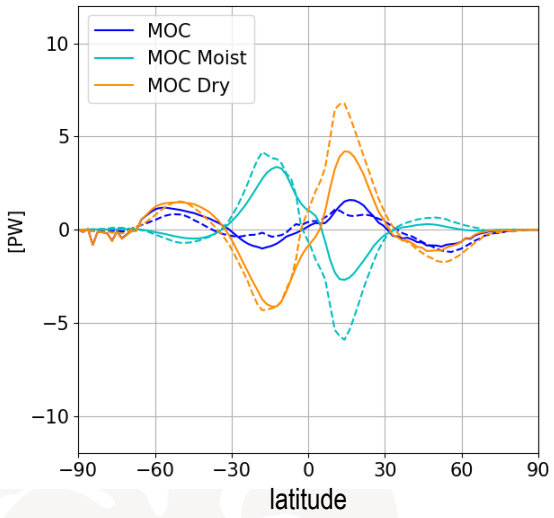


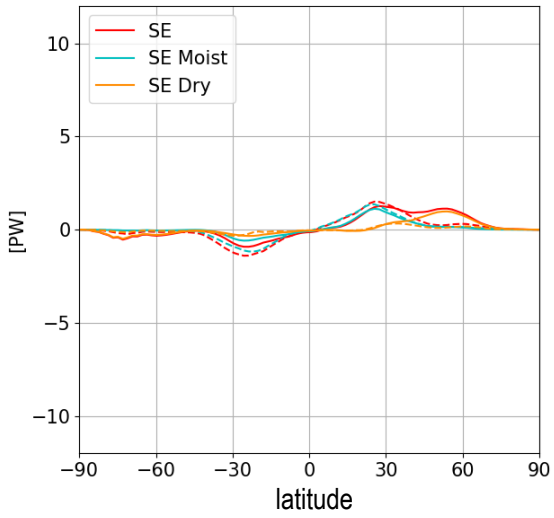
- TE midlatitudes increase towards North, decrease towards South

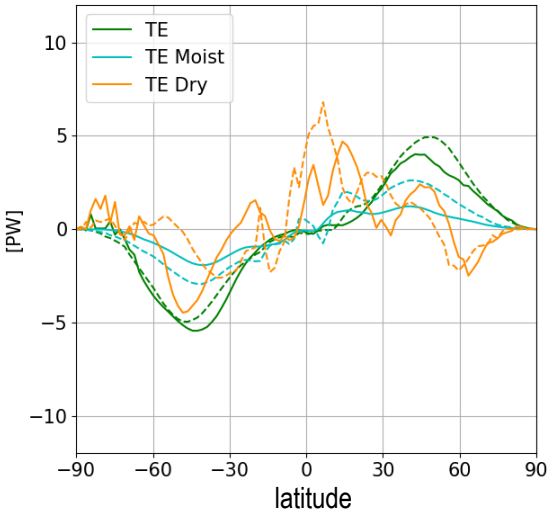


- At midlatitudes increased poleward moist transport

Partitioning the atmospheric heat transport







- MOC, Hadley cell more intense
- SE decrease in North midlatitudes, blocking?
- SE increase in South subtropics, monsoon
- TE midlatitudes mainly moist eddies, increased storm activity

The partitioning of meridional heat transport shows the changes in the different processes but also the compensating mechanisms, which in the end achieve that the net TOA radiation is so stable that the annual meridional heat transport is almost invariant even in a high CO_2 climate state.

References

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