Transient development of the double-ITCZ bias in CESM1 and its sensitivity to convective parameterization

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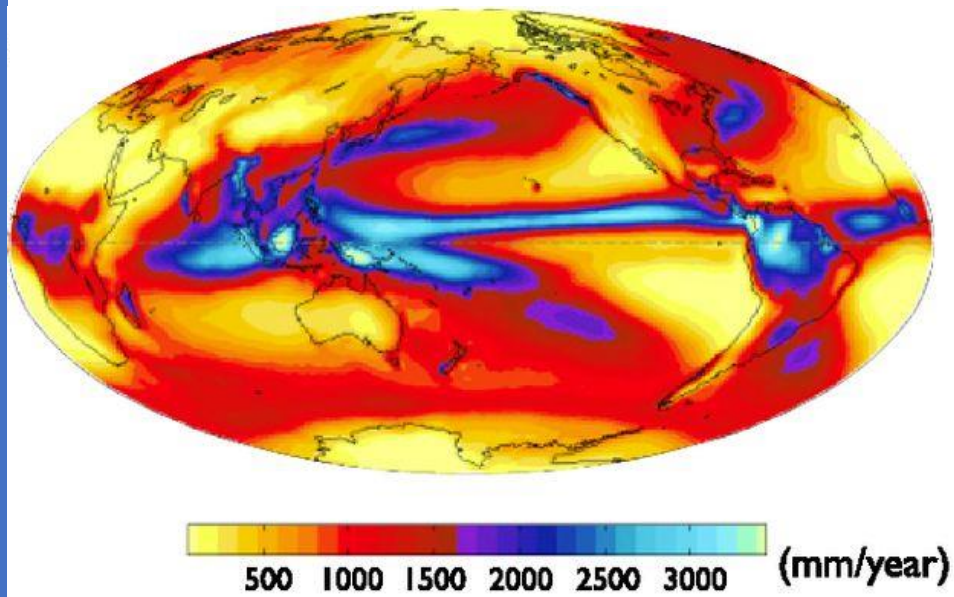
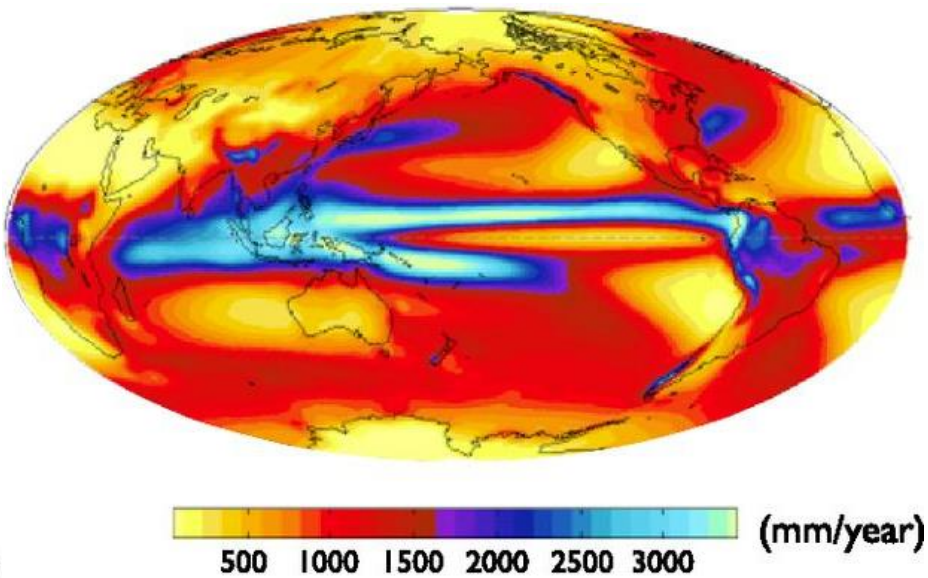
Intertropical Convergence Zone (ITCZ)



GPCP

(observations)

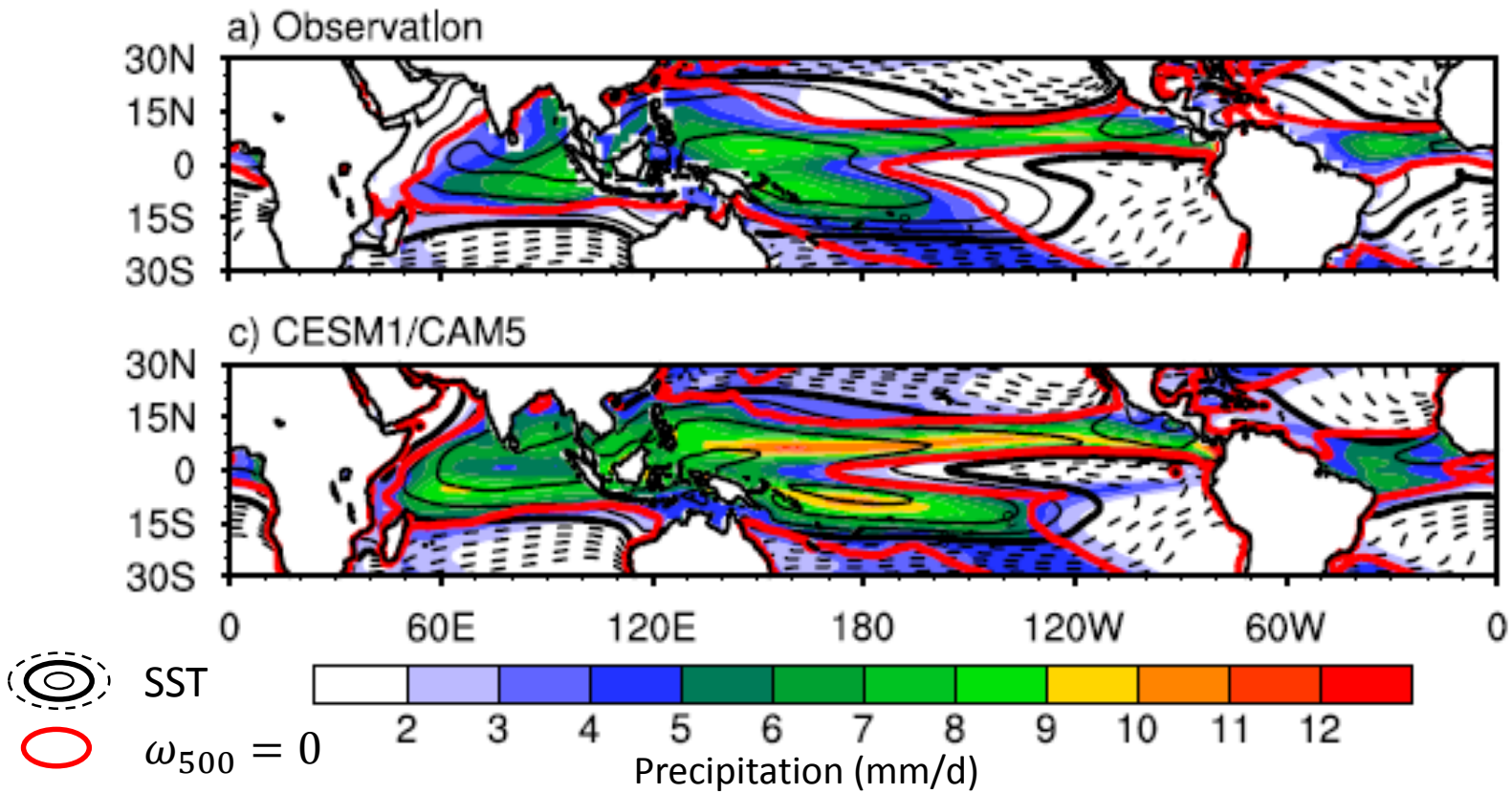


CMIP5

(models)

Hwang and Frierson (2013)

Double-ITCZ Bias in CESM1



- Excess precipitation in southern tropics
- Too cool SSTs over equator

Wang et al. (2015)

Theories for the double-ITCZ bias

- Extratropical controls
  - e.g. Hwang and Frierson (2013)
- Inadequate convective parameterization
  - e.g. Song and Zhang (2009), Oueslati and Bellon (2015)
- Coupled ocean-atmosphere feedbacks
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If convection plays a key role in coupled tropical feedbacks related to the double-ITCZ bias, **perturbations to convective parameterization should influence the development of the double-ITCZ bias.**

Experimental Design

Experimental Design

[1] Spin up model components

Ocean/Sea Ice
(CORE2 Forced;
Large and Yeager, 2009)

[1]

Atmosphere IC
(ERA Interim)

Land
(*CAS Atmo. Forcing*;
Qian et al., 2006)

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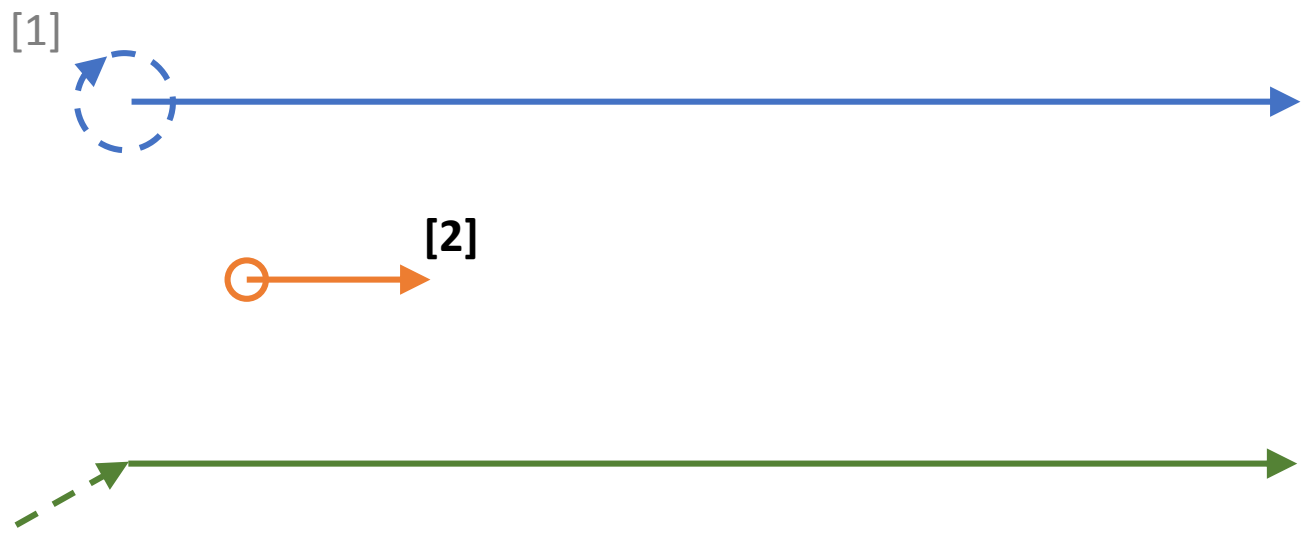

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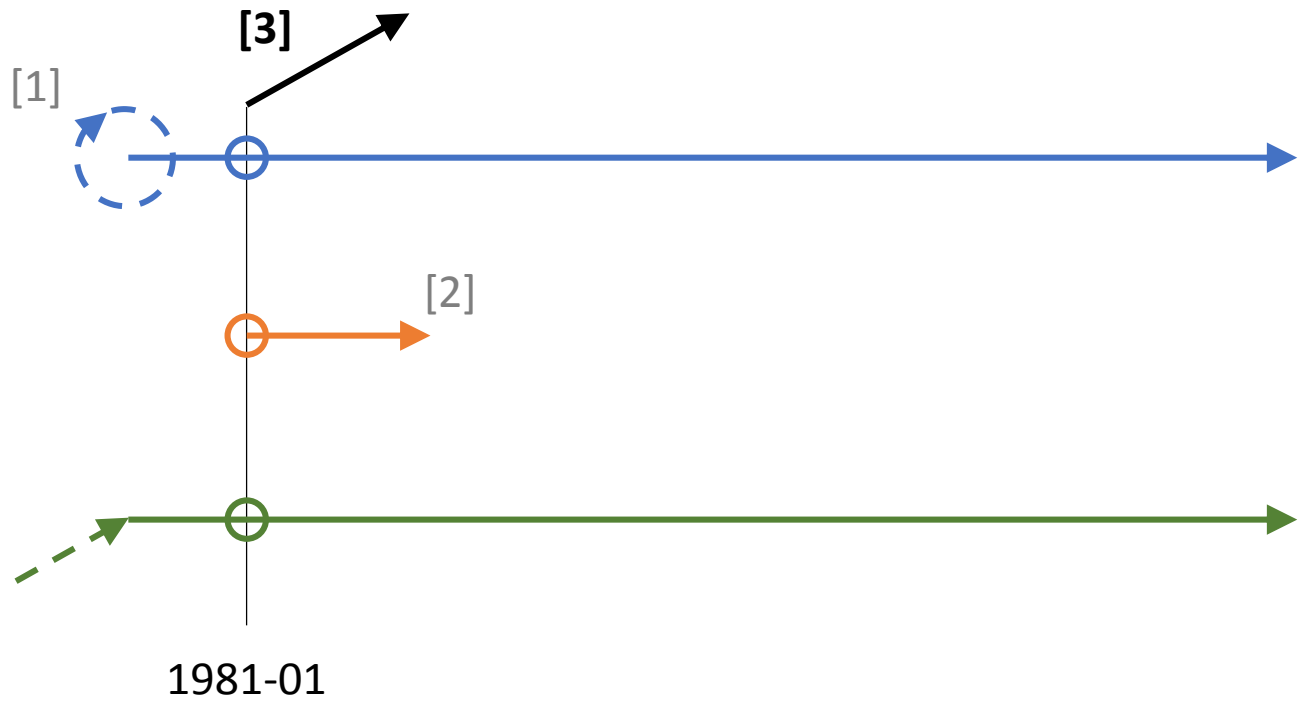

○ Initial conditions for coupled run taken from this point

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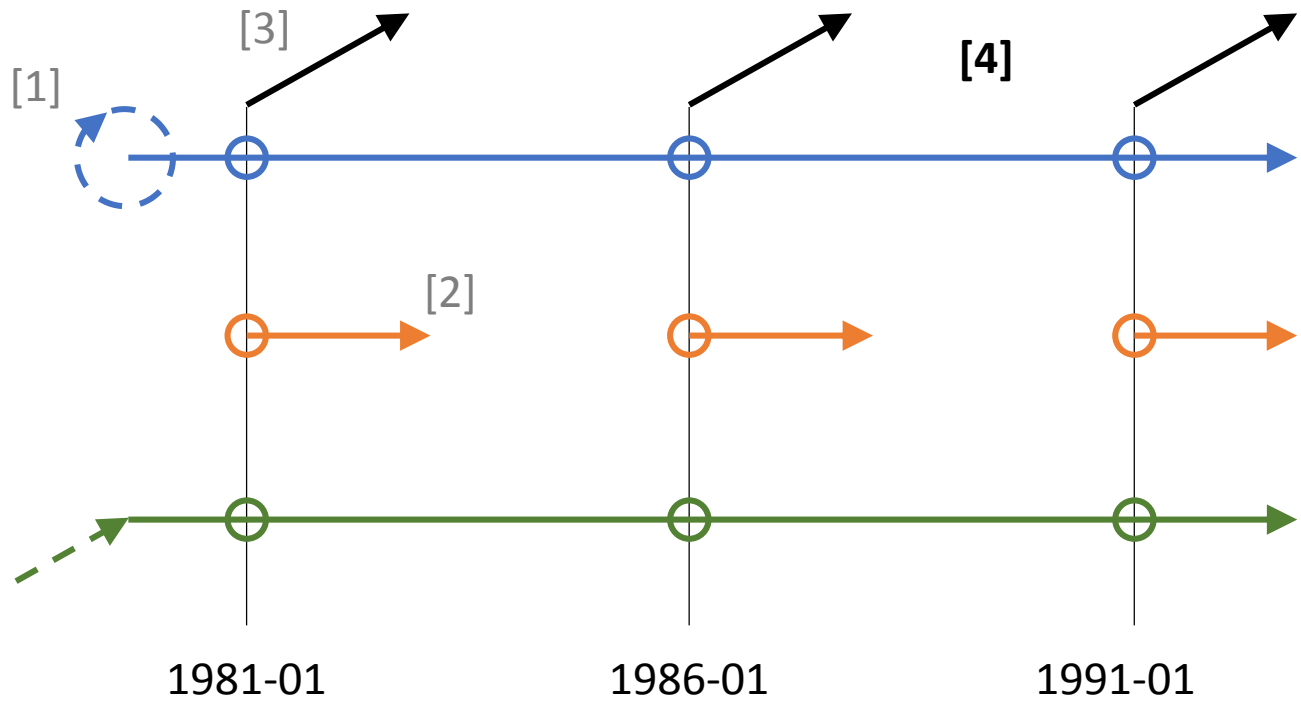

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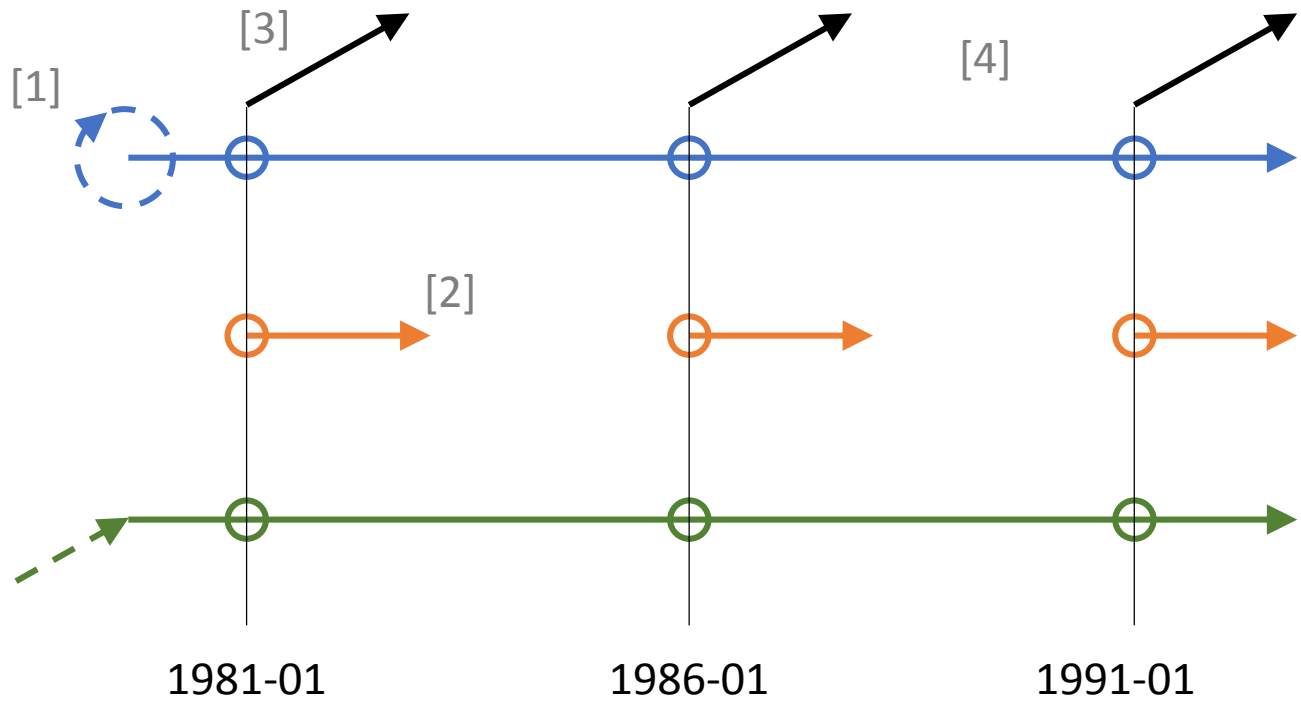

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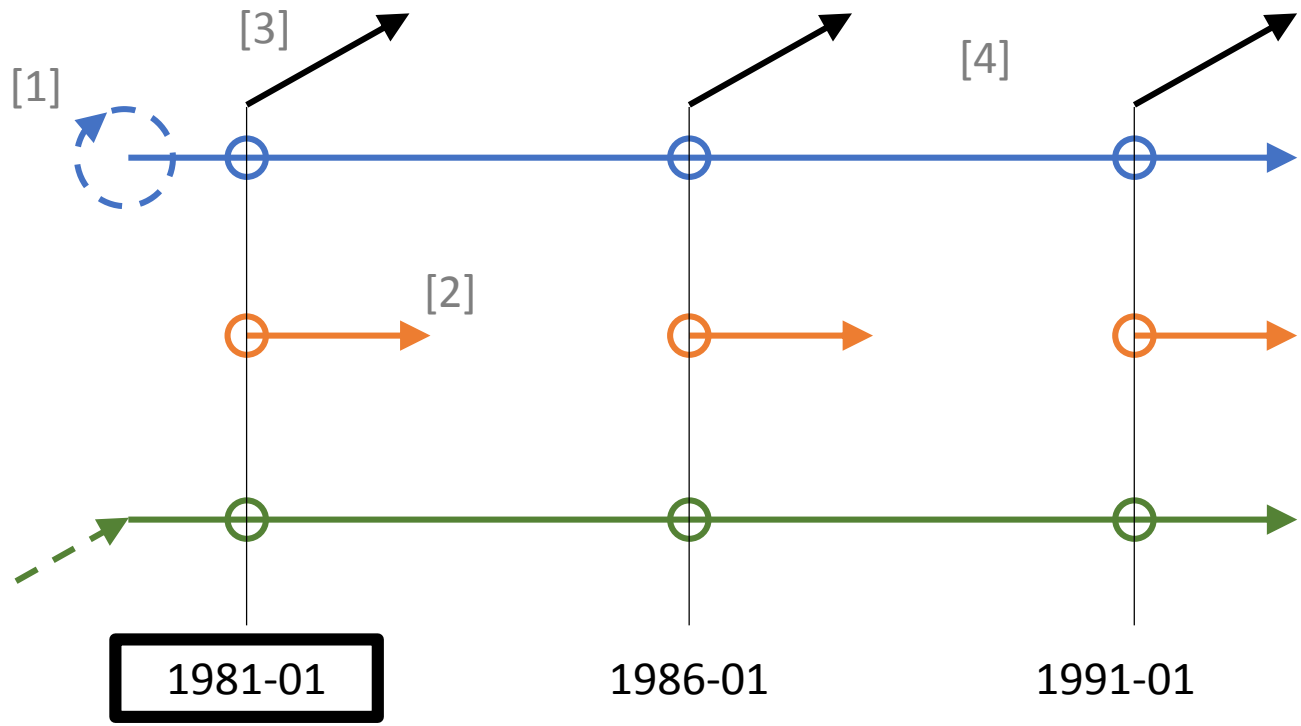

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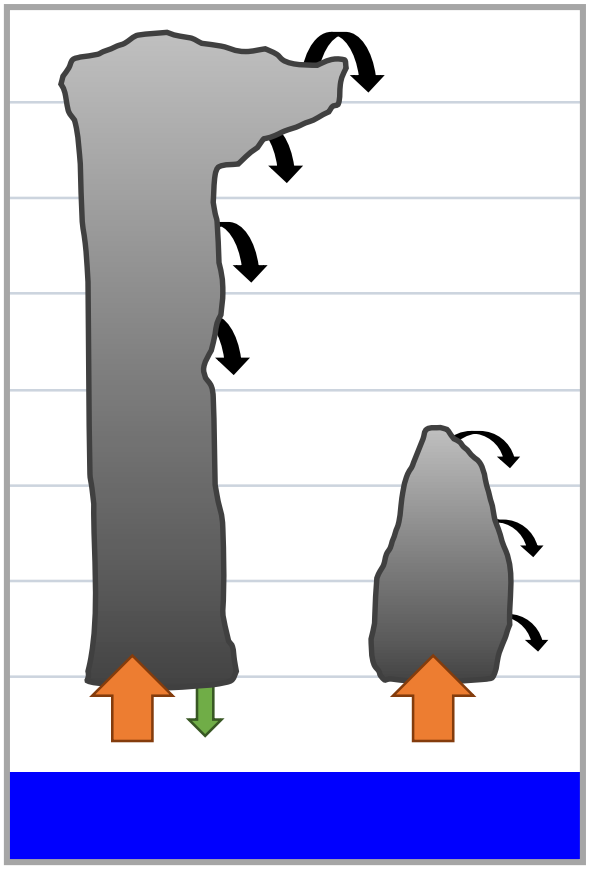
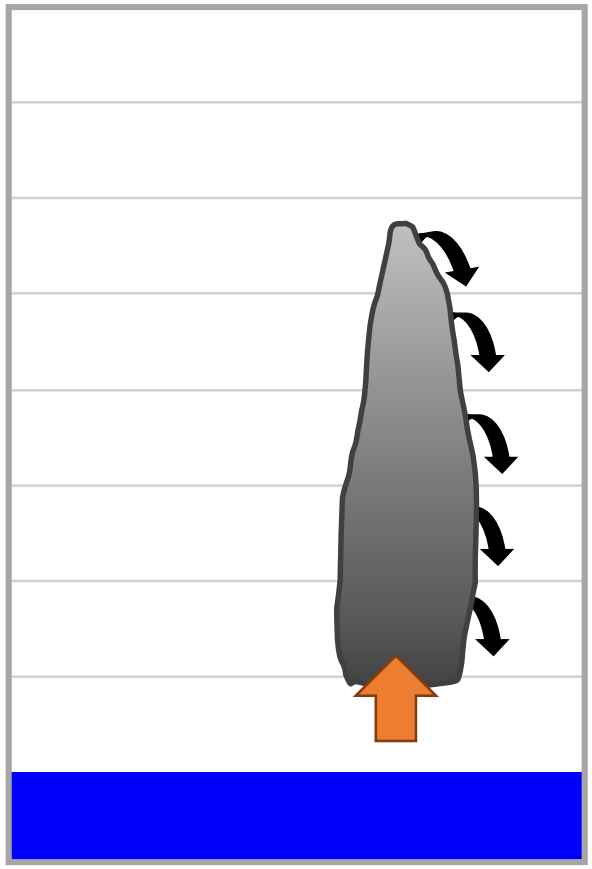
Convective parameterizations



CTRL & NOSP

- UW shallow convection (Park and Bretherton, 2009)
- ZM deep convection (Zhang and McFarlane, 1995)



NODC

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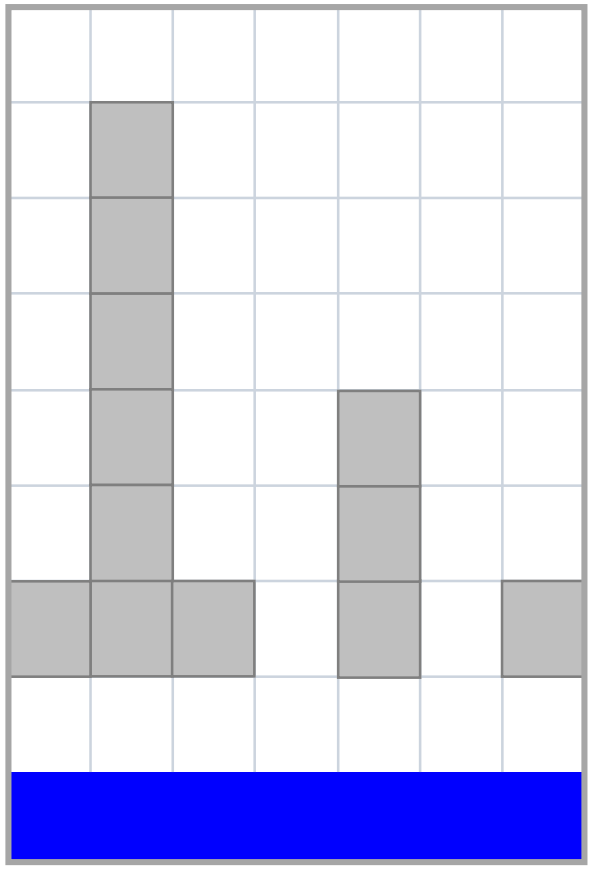
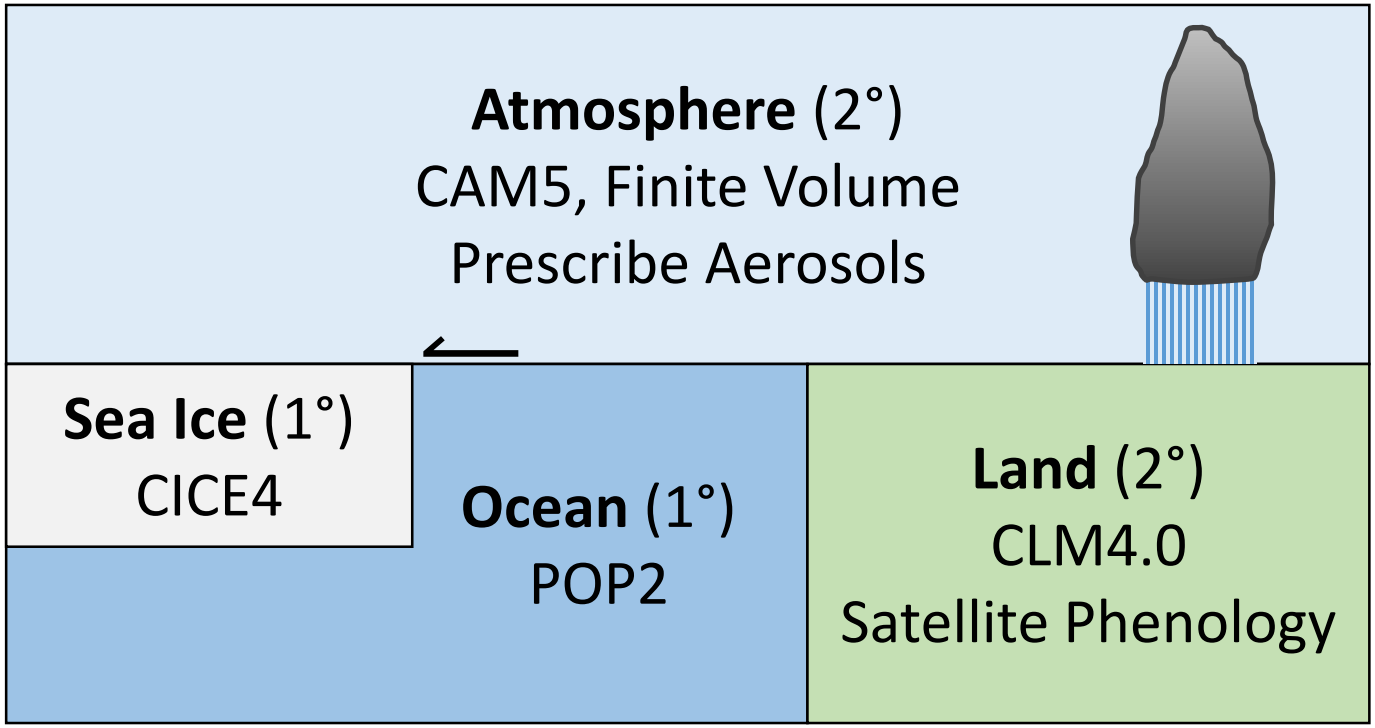


SP

- Embedded 2D cloud-resolving model (Grabowski, 2001)

Other model details

- CTRL and NODC use CESM1.2.2
- NOSP and SP built from CESM1.1



Comparison datasets

SODA – Carton and Geiss (2008)

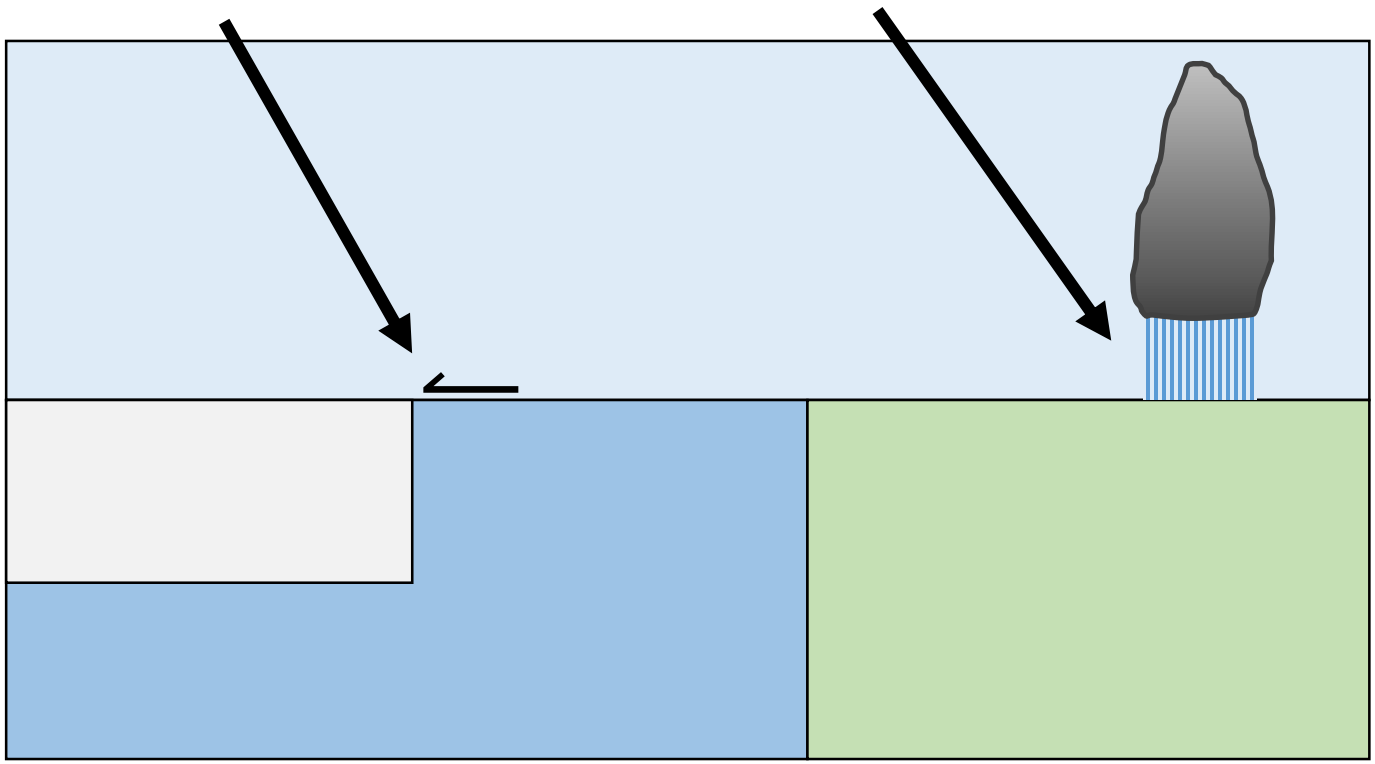
Sea surface temperature (SST)

Surface wind stress (τ)

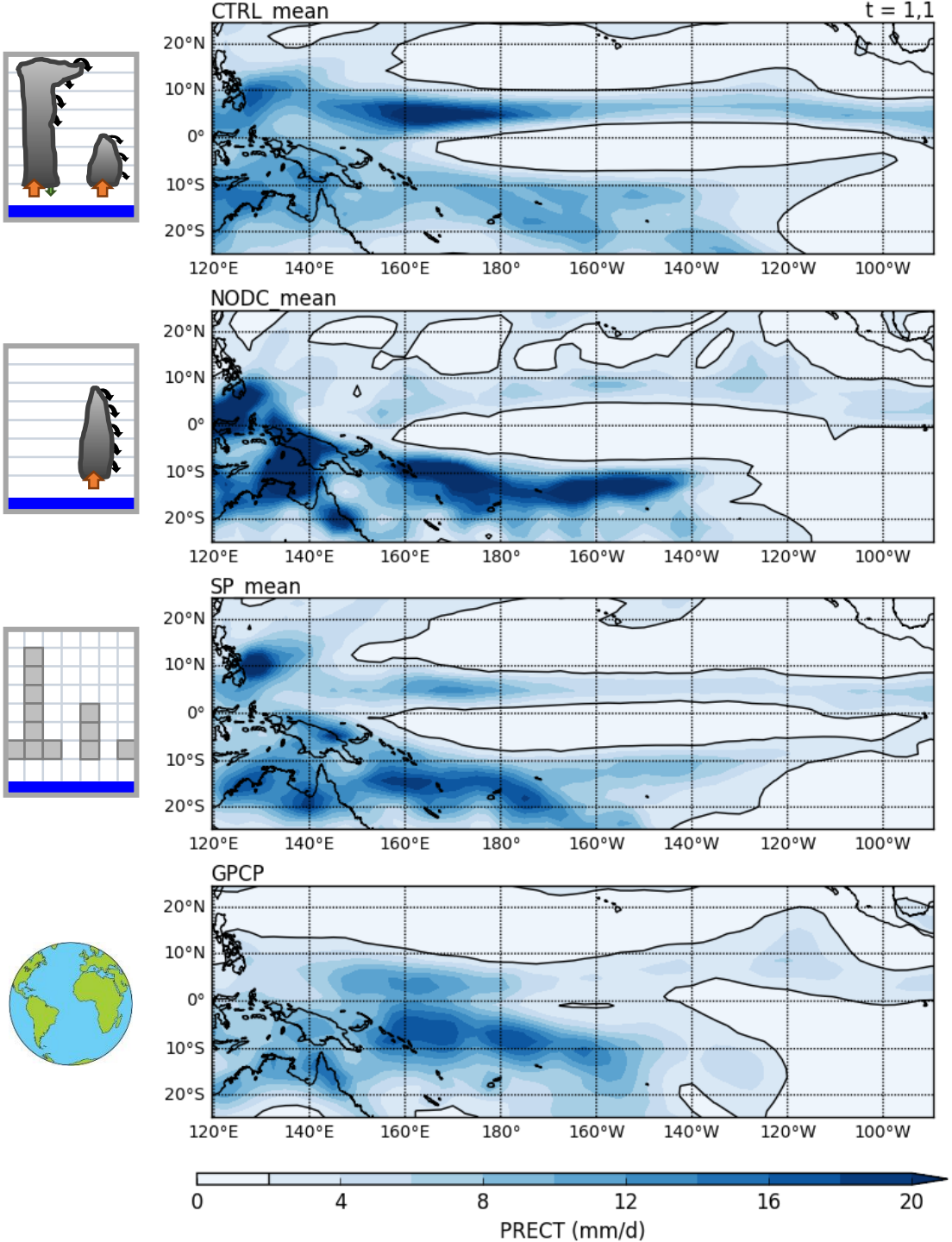
Ocean velocities

GPCP – Huffman et al. (2009)

Precipitation

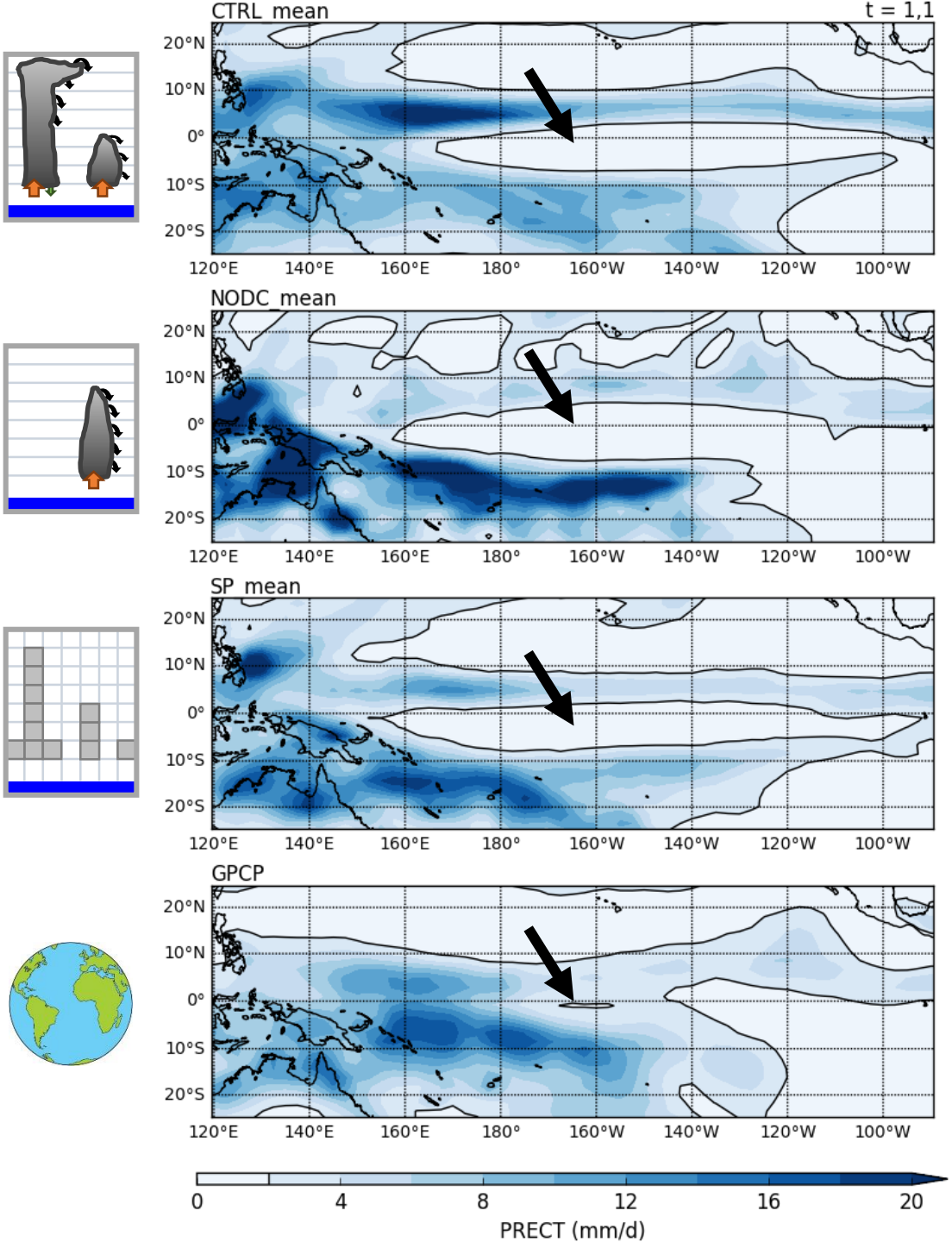


Precipitation Feb. 1981



Precipitation Feb. 1981

- Dry bias over equator in all simulations



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- Dry bias over equator in all simulations
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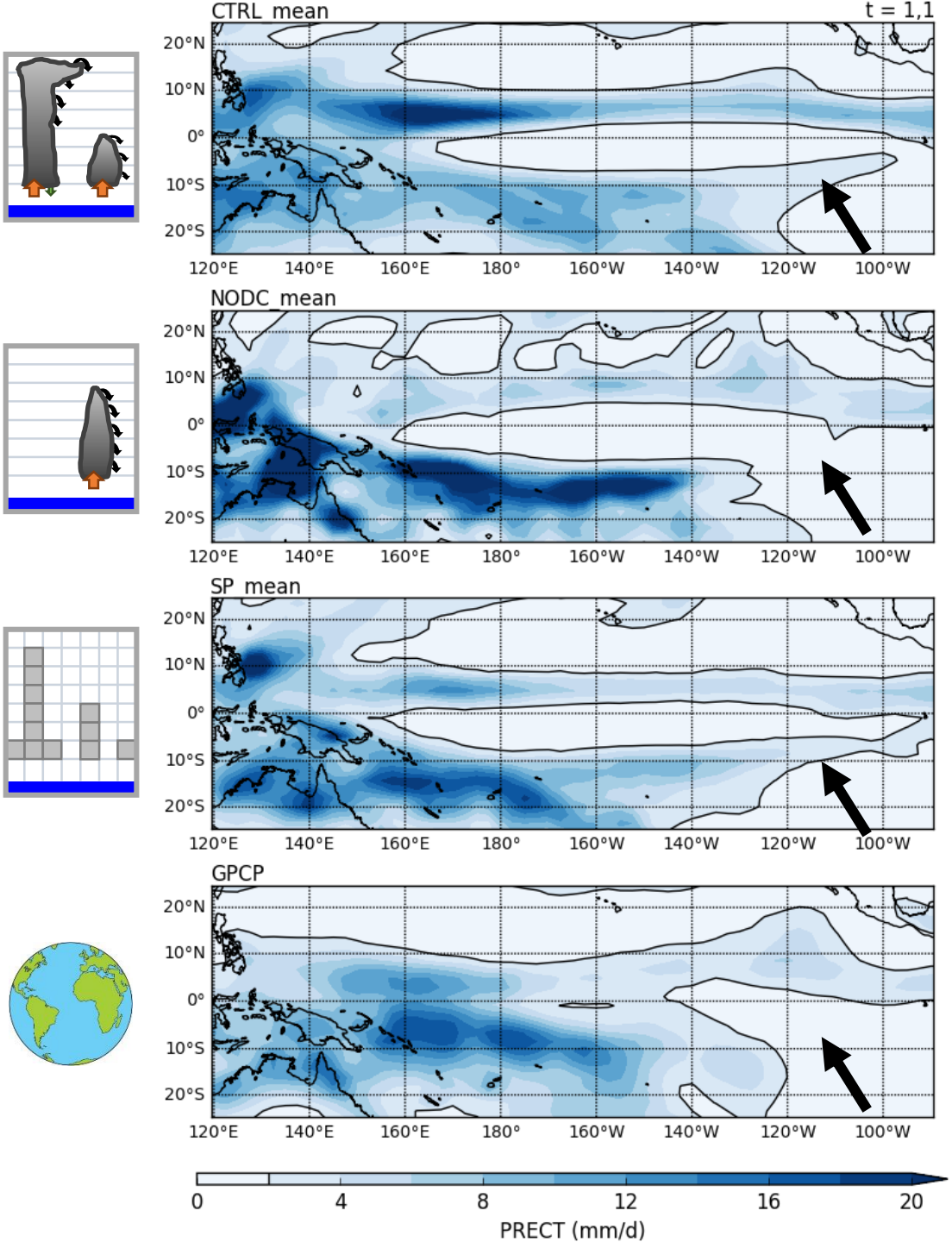

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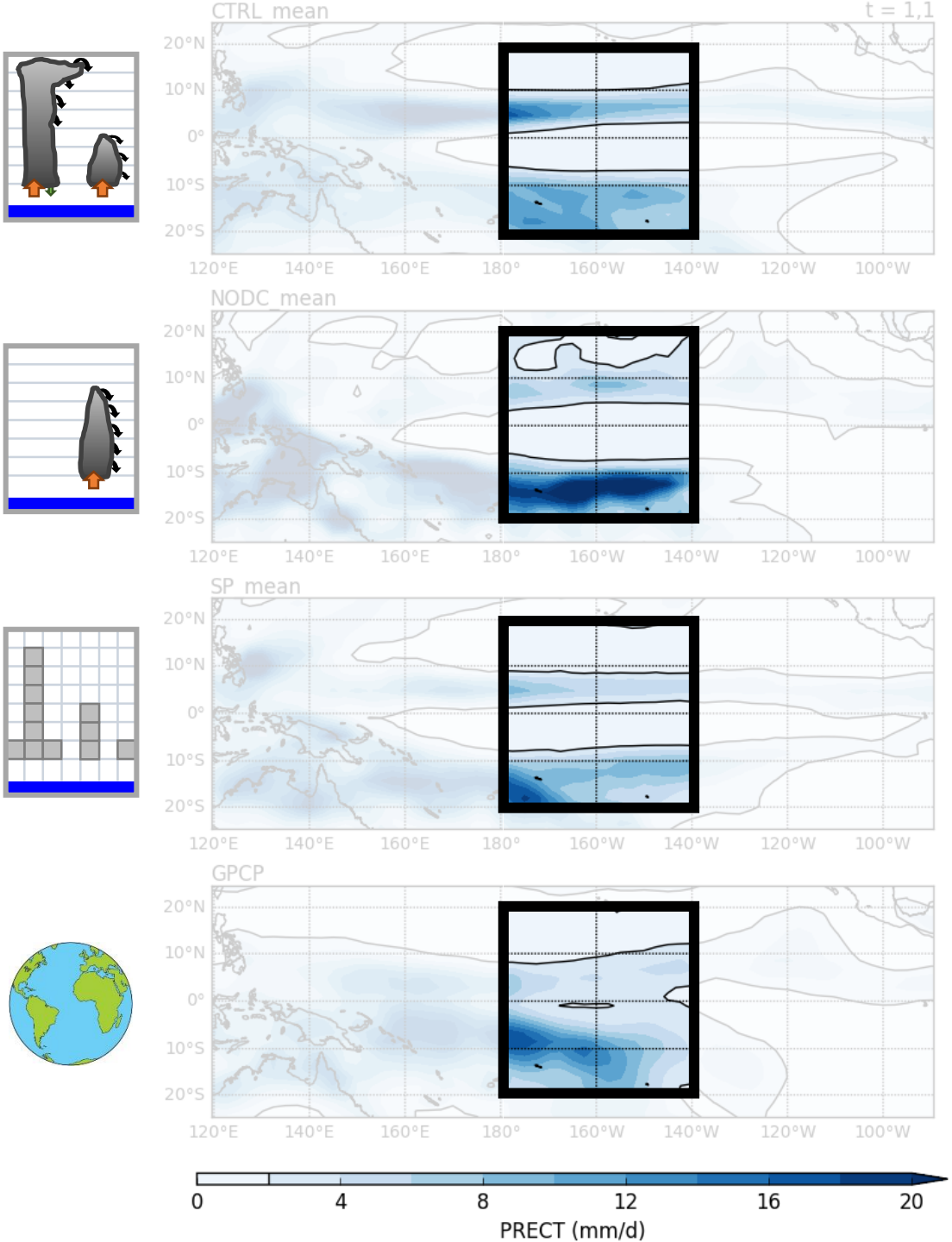
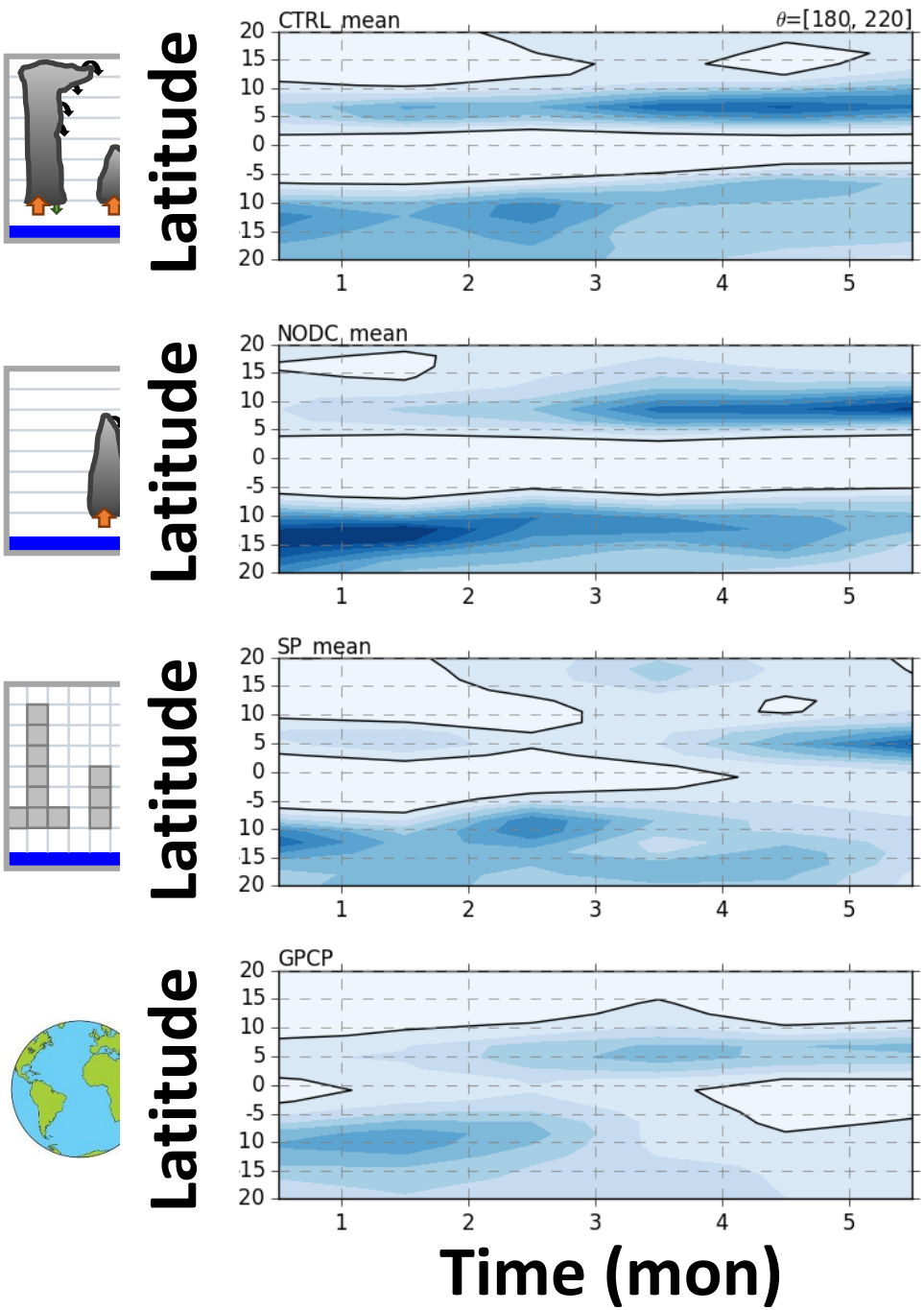
Take zonal mean over central Pacific (180-220°E)



Precipitation Hovmoller (180-220°E)



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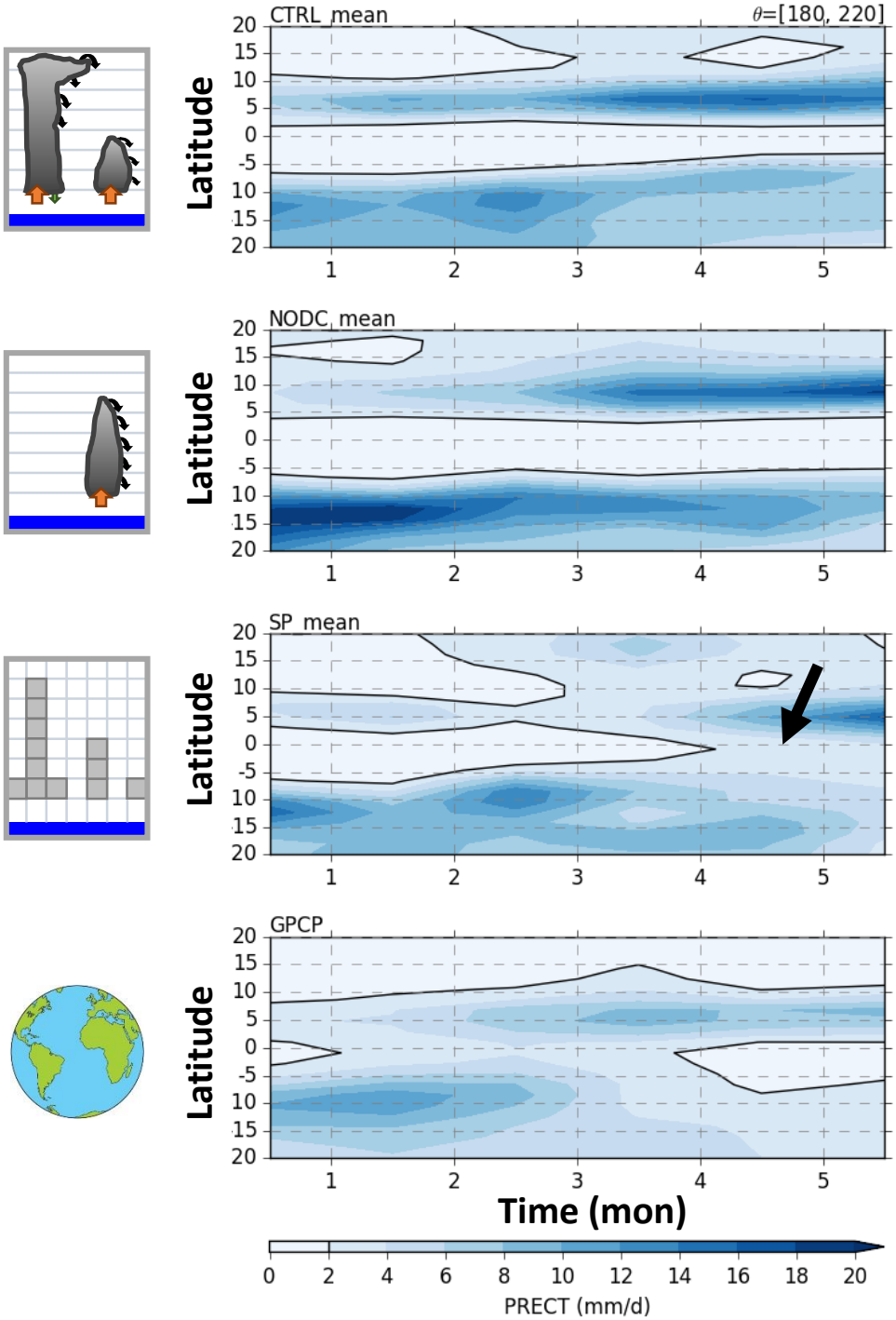
- SP able to produce precipitation over the equator



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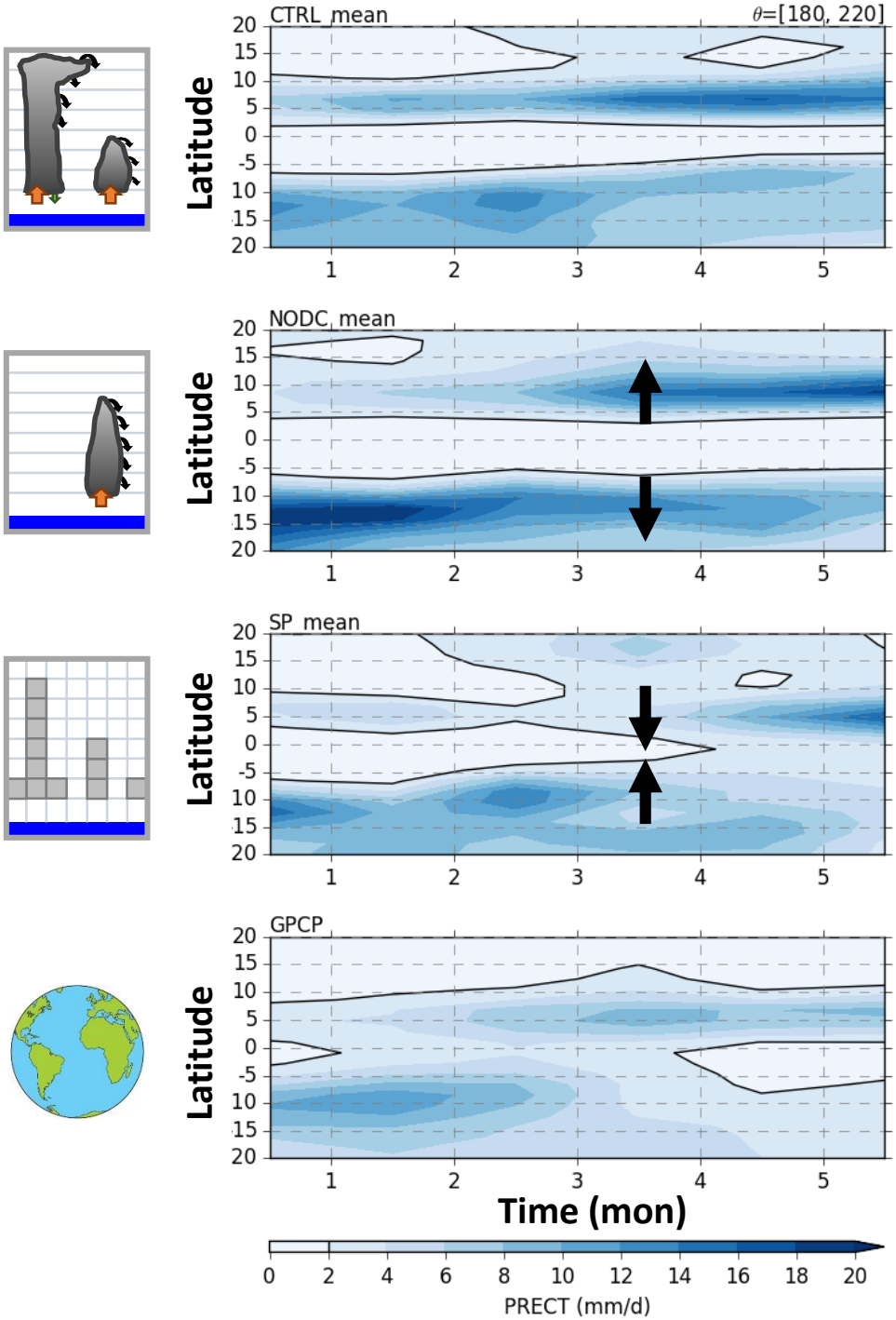
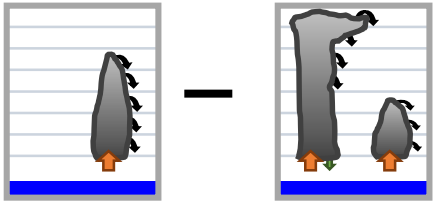
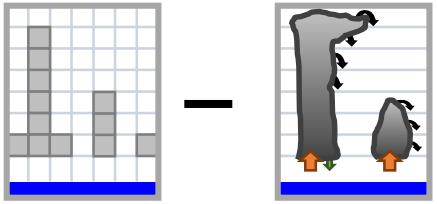
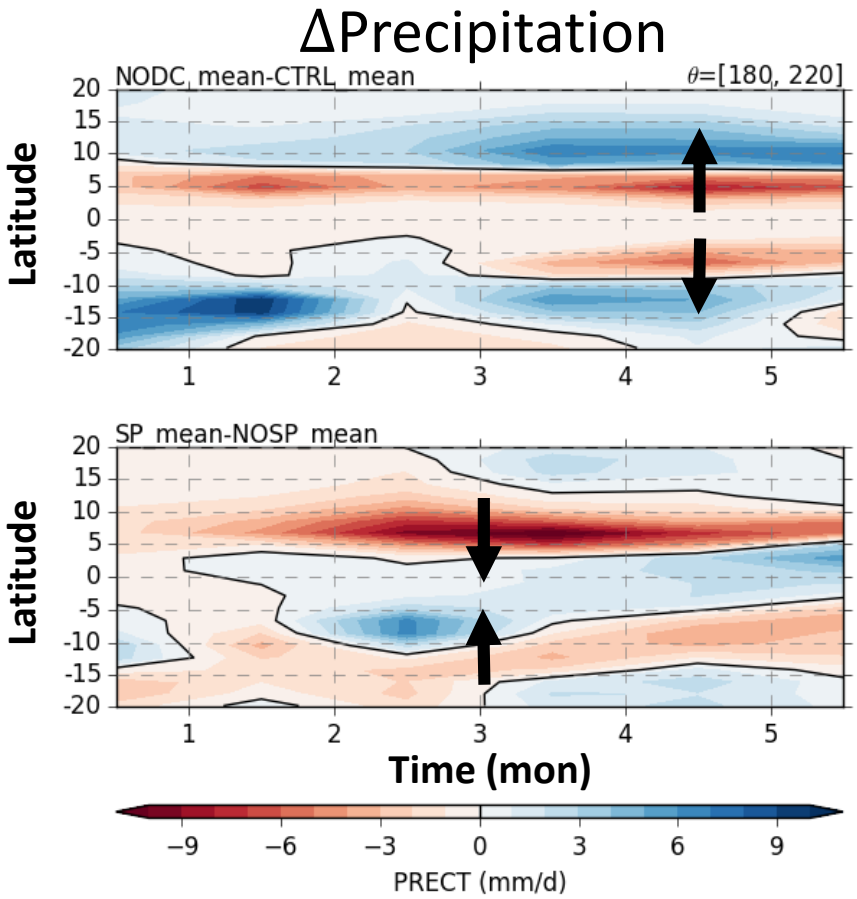
- SP able to produce precipitation over the equator
- ITCZ shifts: poleward in NODC and equatorward in SP



Effect of ΔConv. Parameterization







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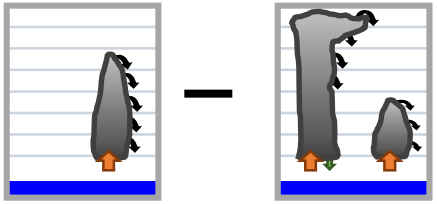
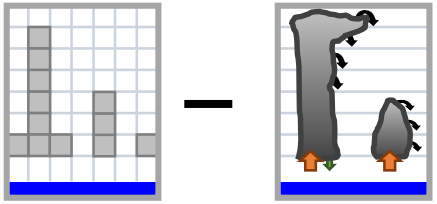
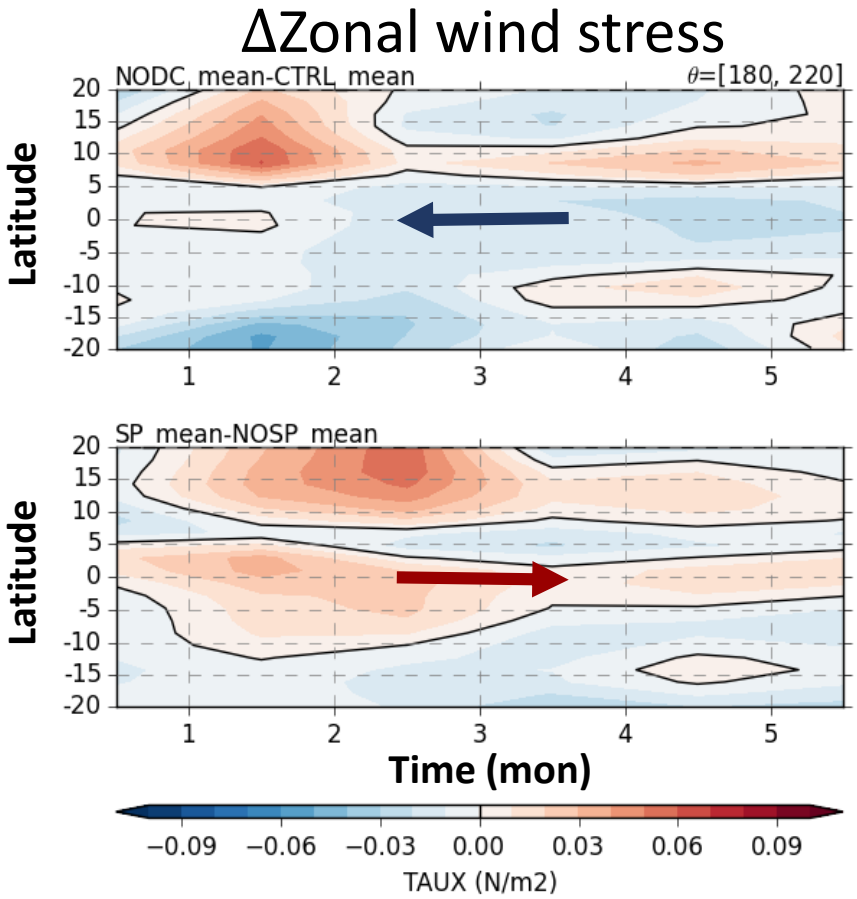
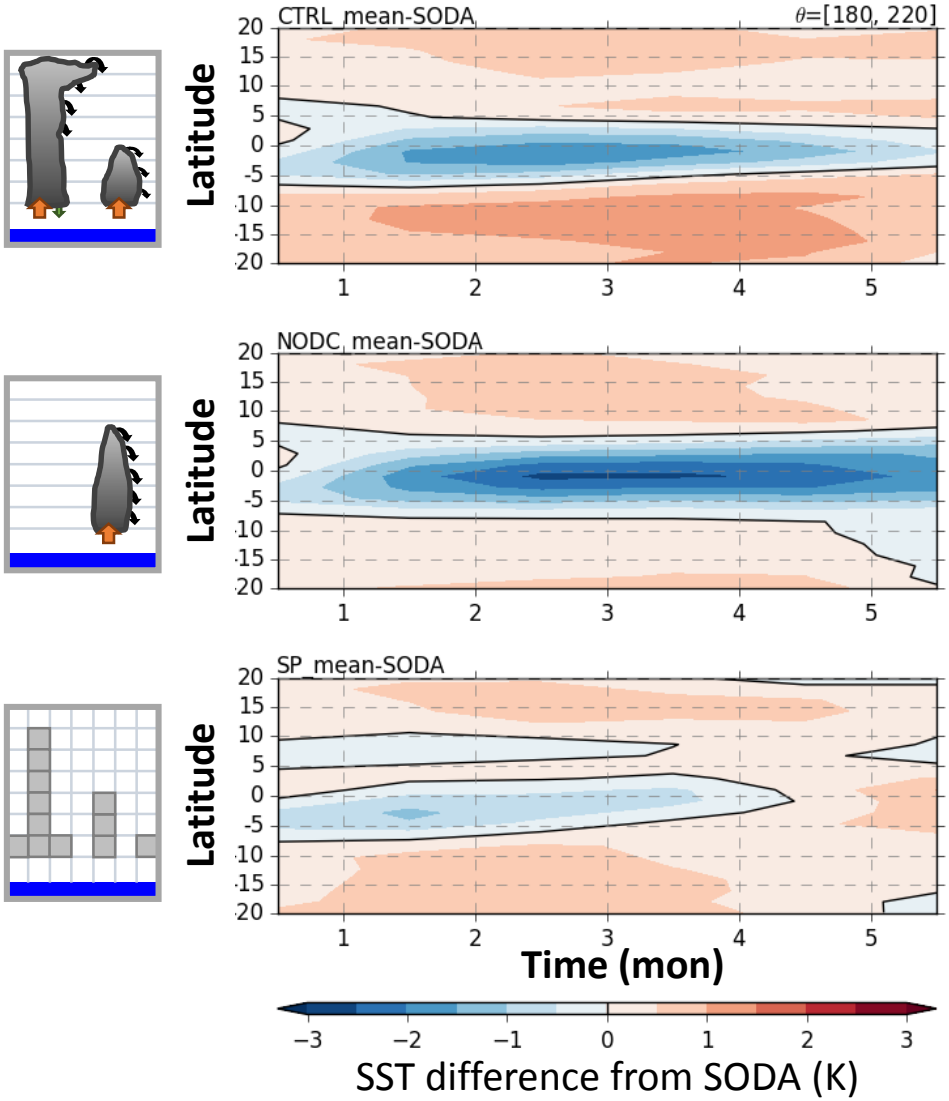






SST-Obs Hovmoller (180-220°E)



Carton and Geiss (2008)

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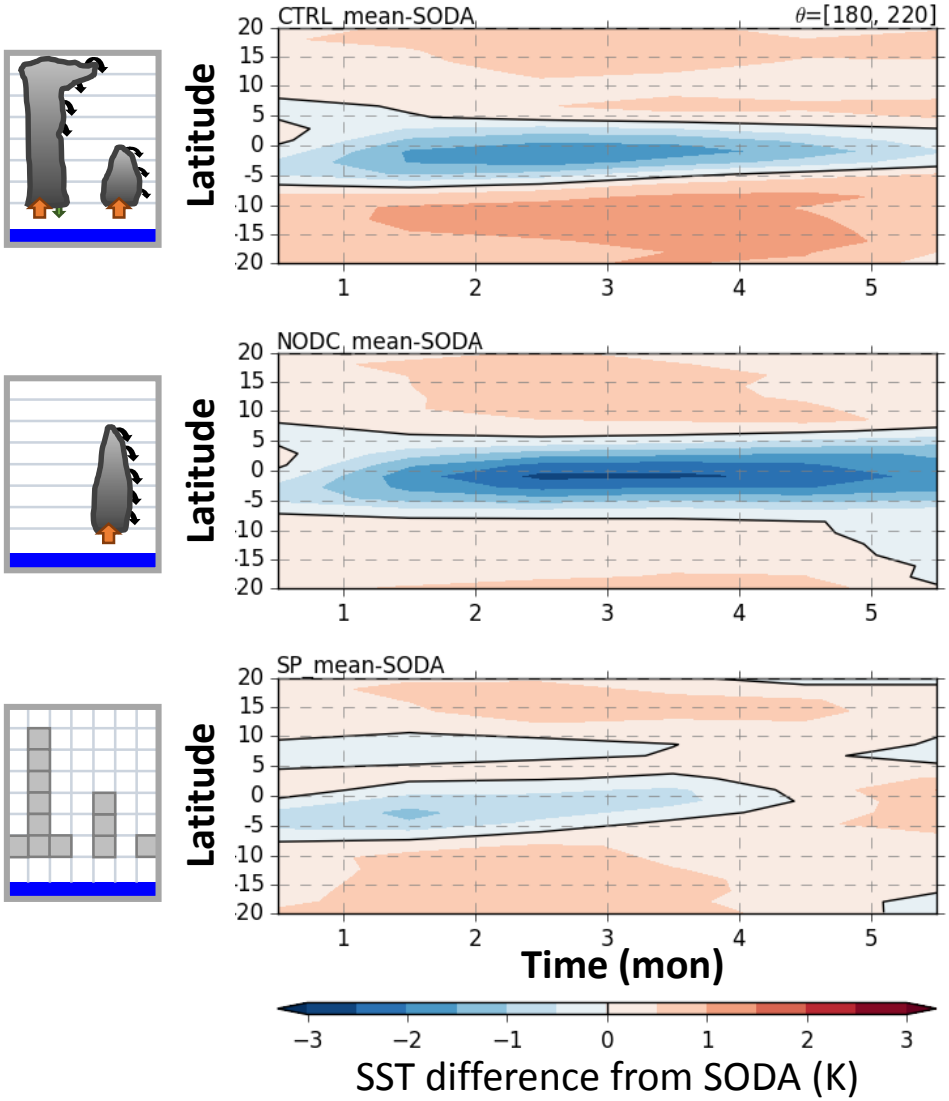
Cold tongue bias:

- Develops rapidly with amplitude of 1.5 K by month 2 in CTRL



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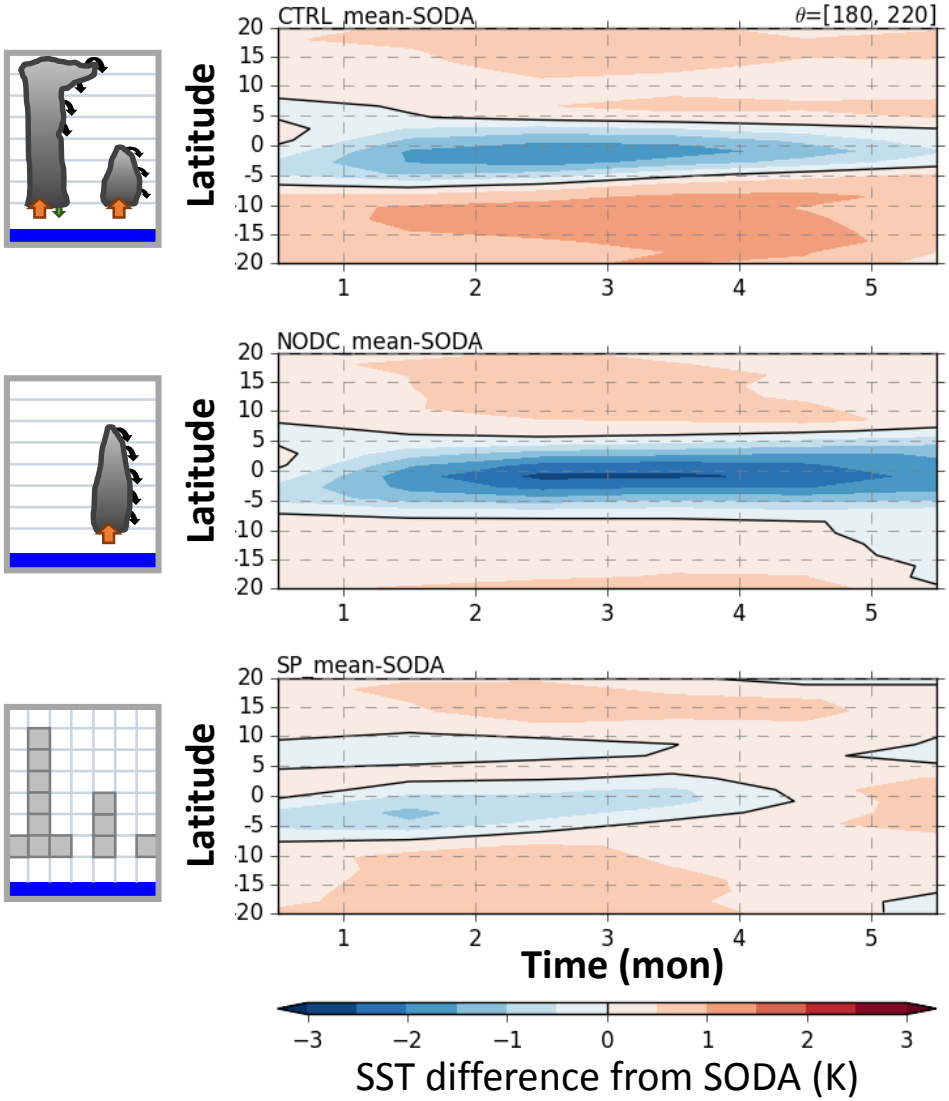

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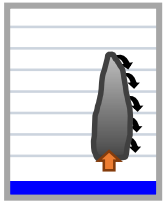

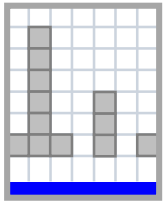

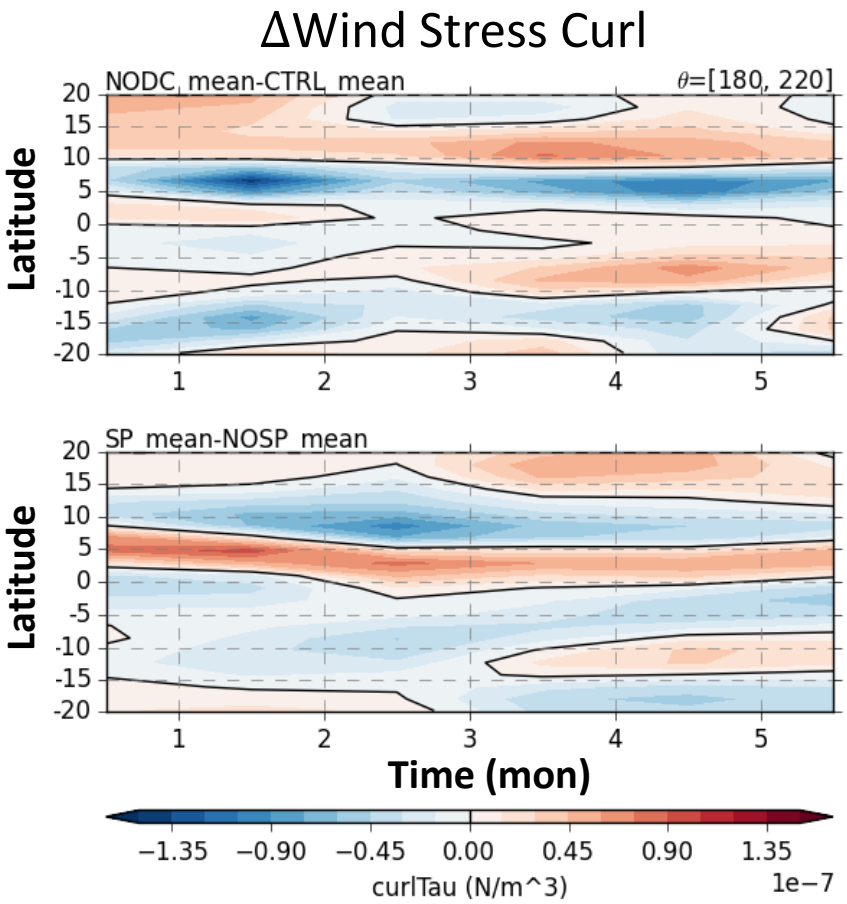

Cyclonic vorticity shifts

- Poleward in NODC
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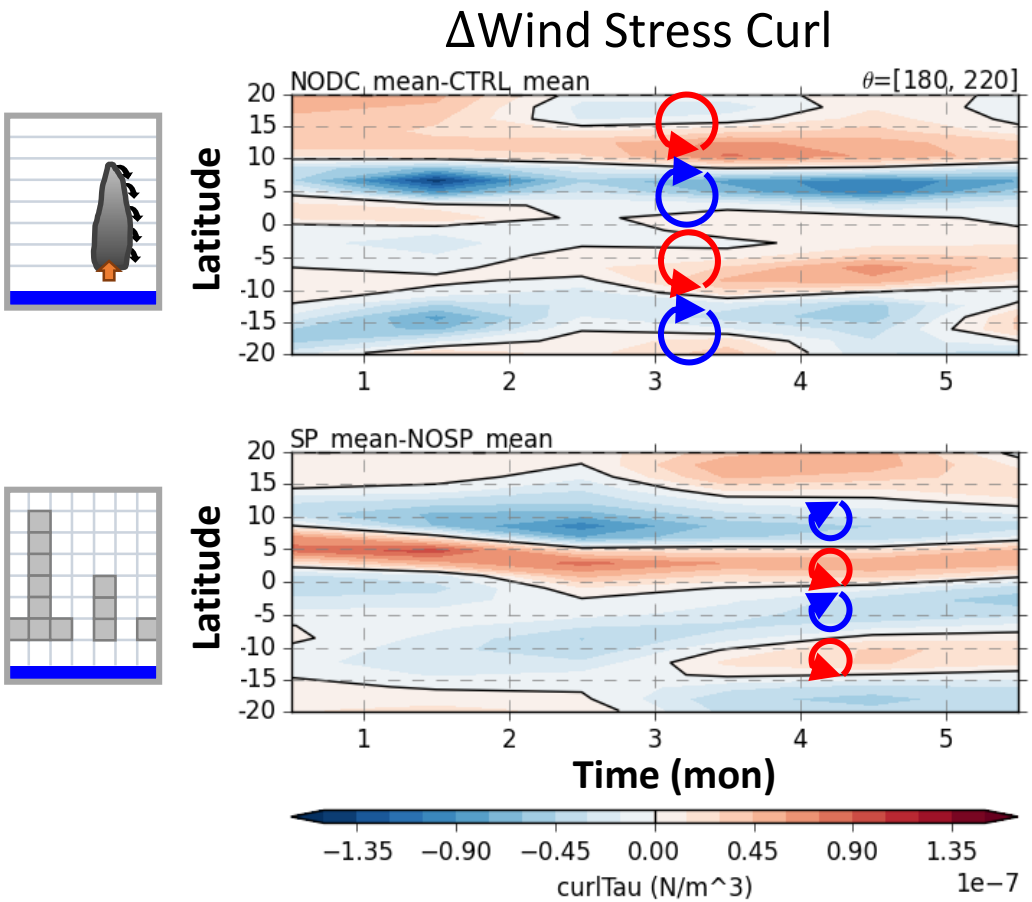

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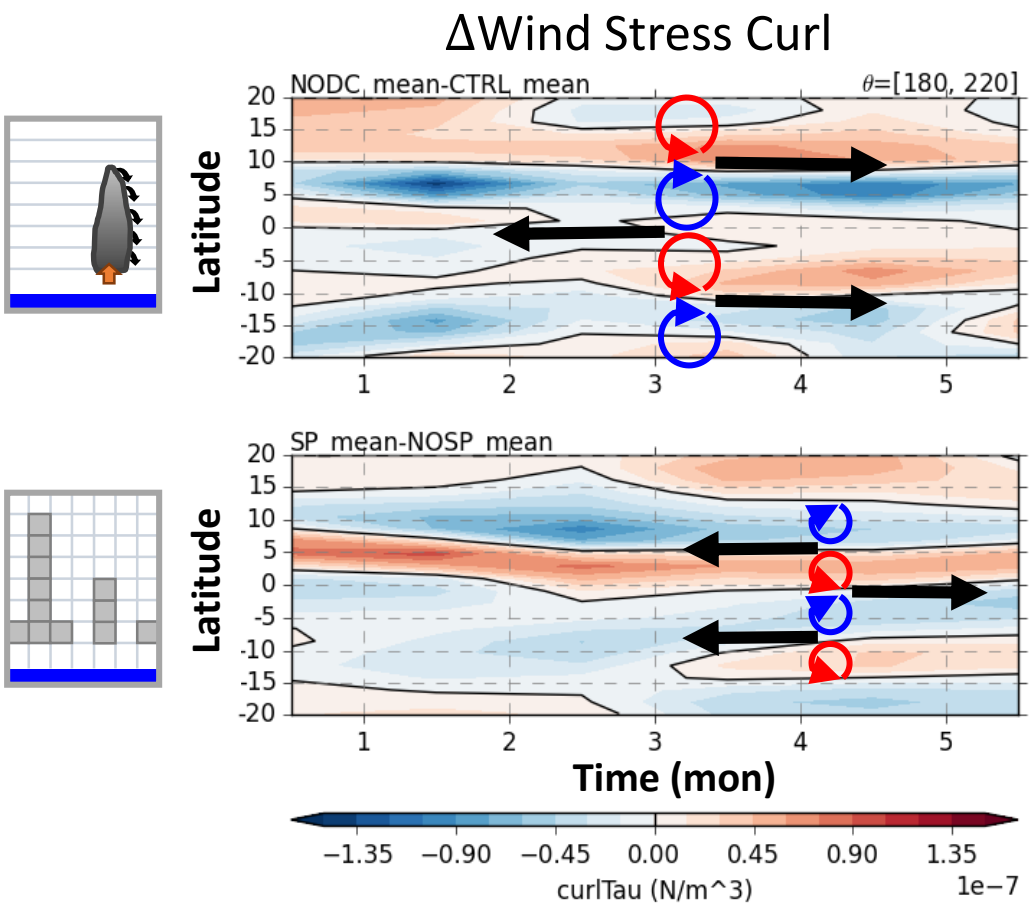

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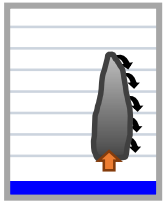

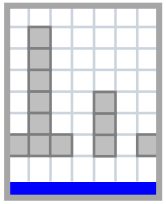

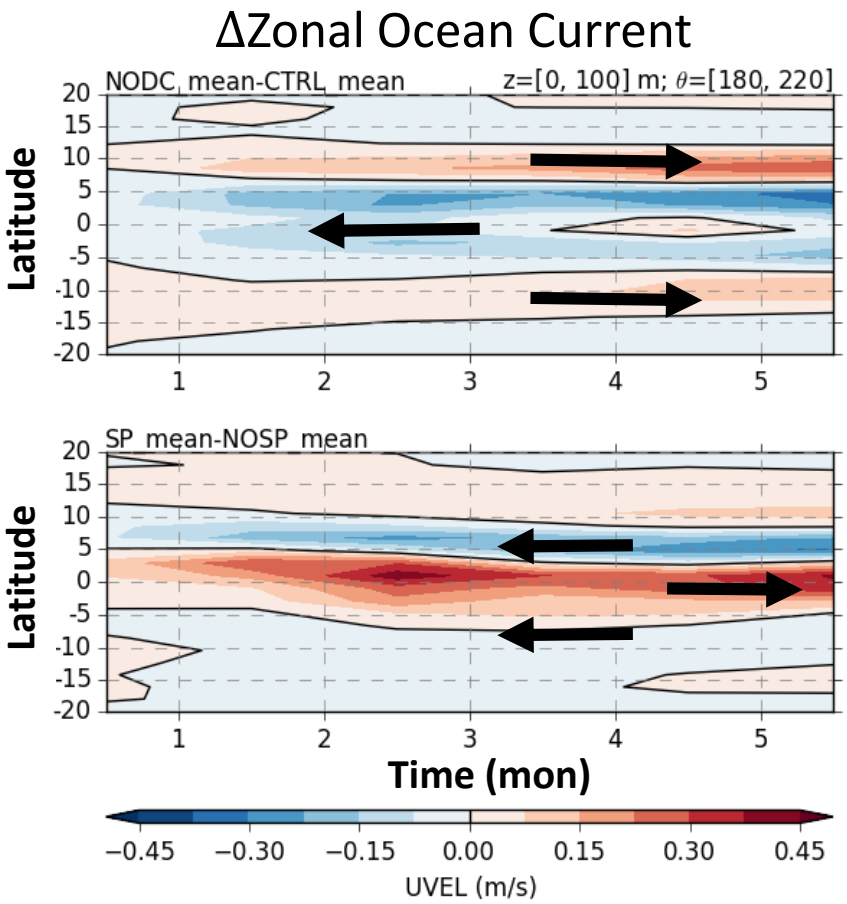

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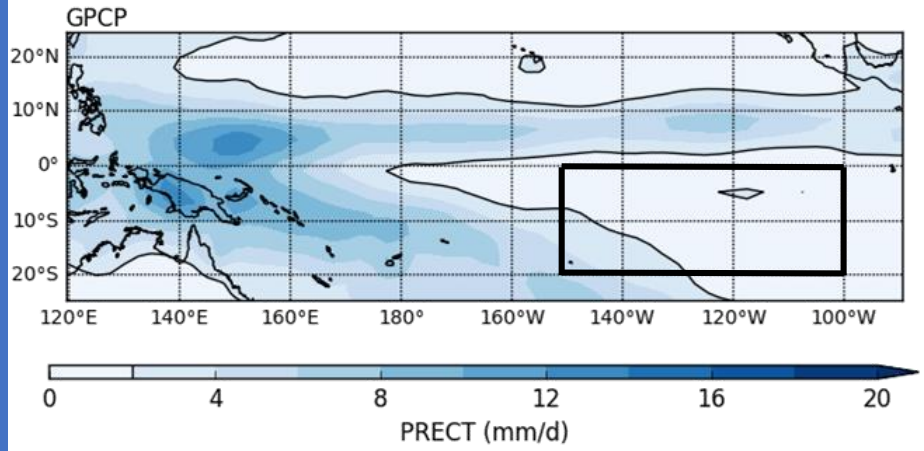

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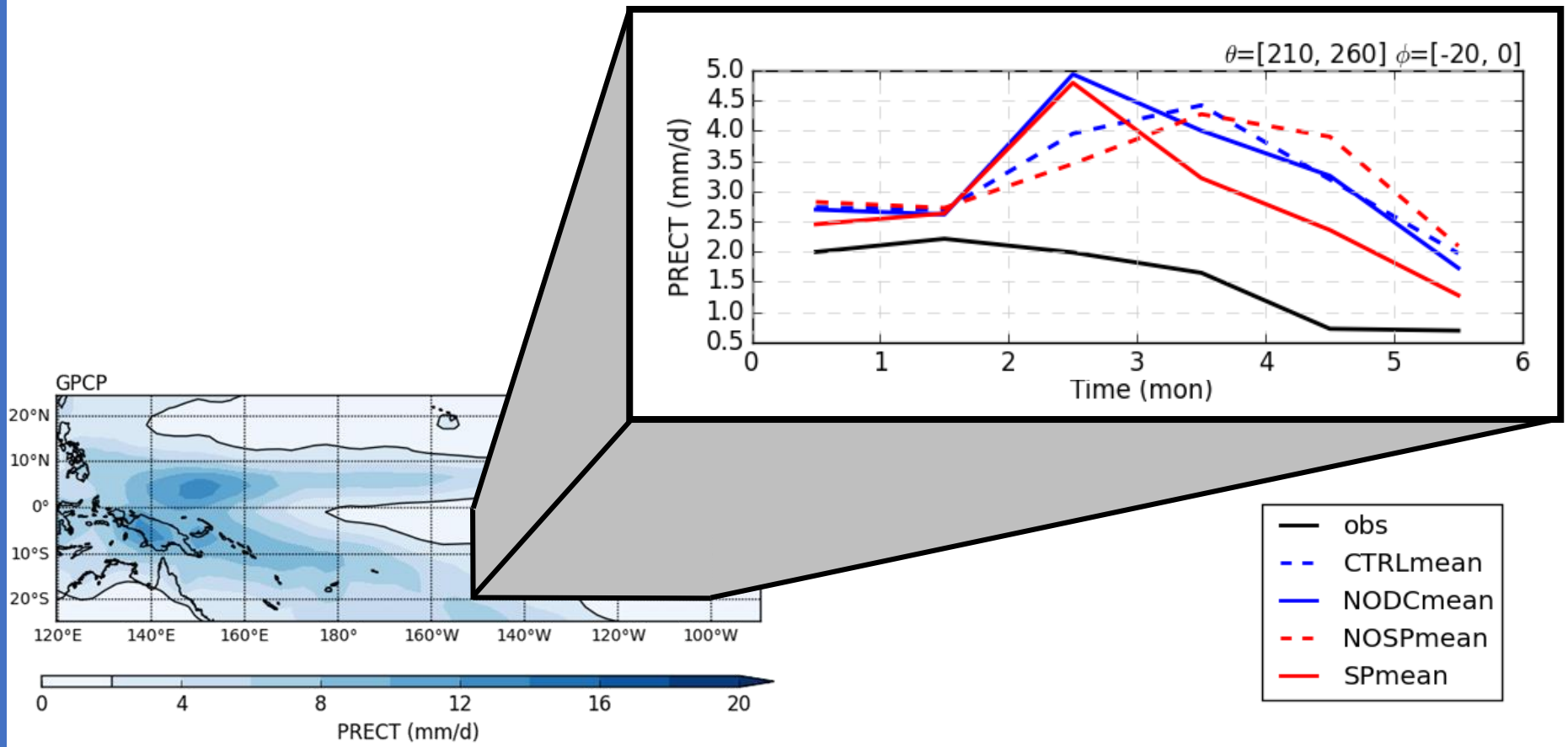
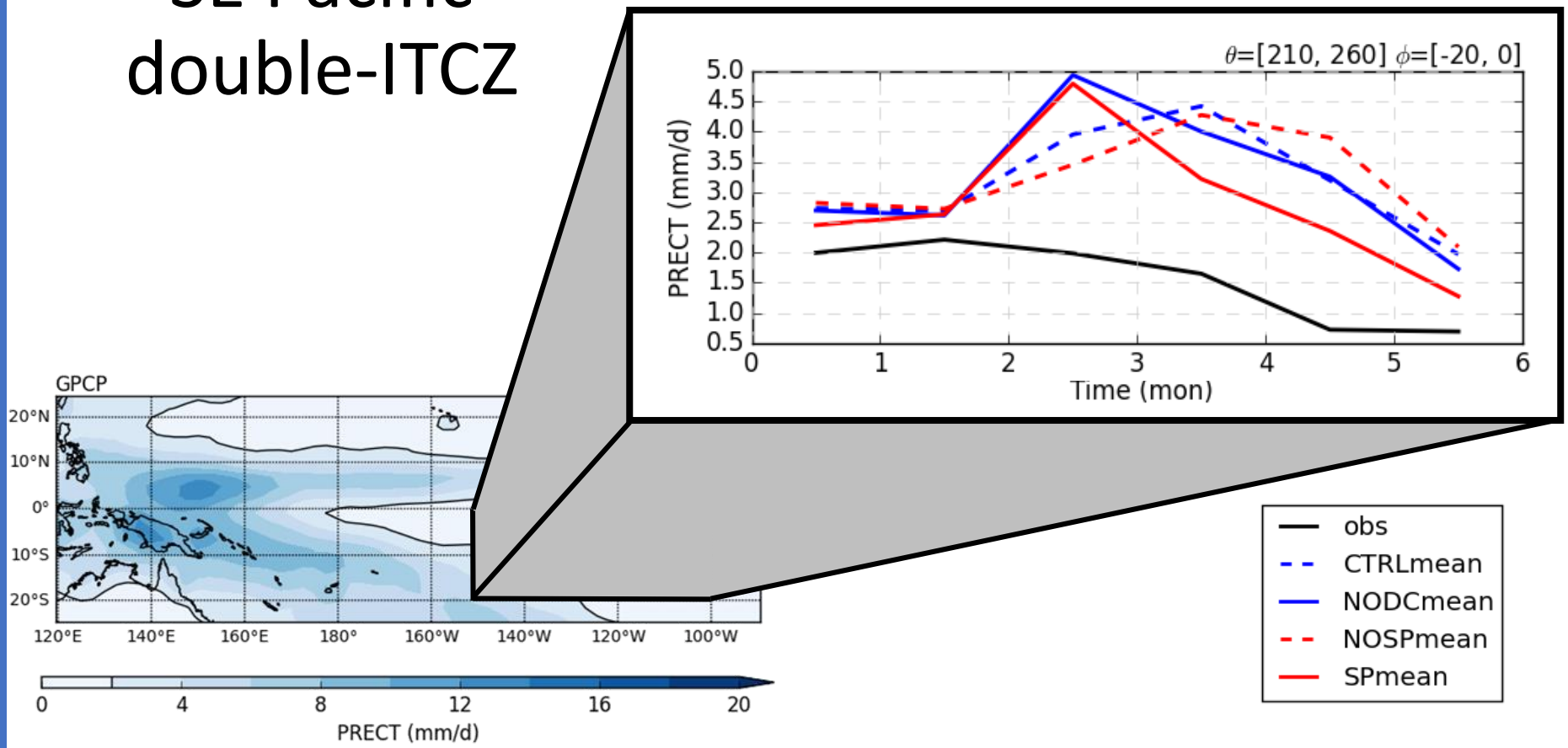


But what about the SE Pacific?

Little change in SE Pacific double-ITCZ



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