A cold tongue without upwelling: how an equatorial continent forces a split ITCZ over a motionless ocean.

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Aiko Voigt (TRACMIP co-conspirator, KIT)

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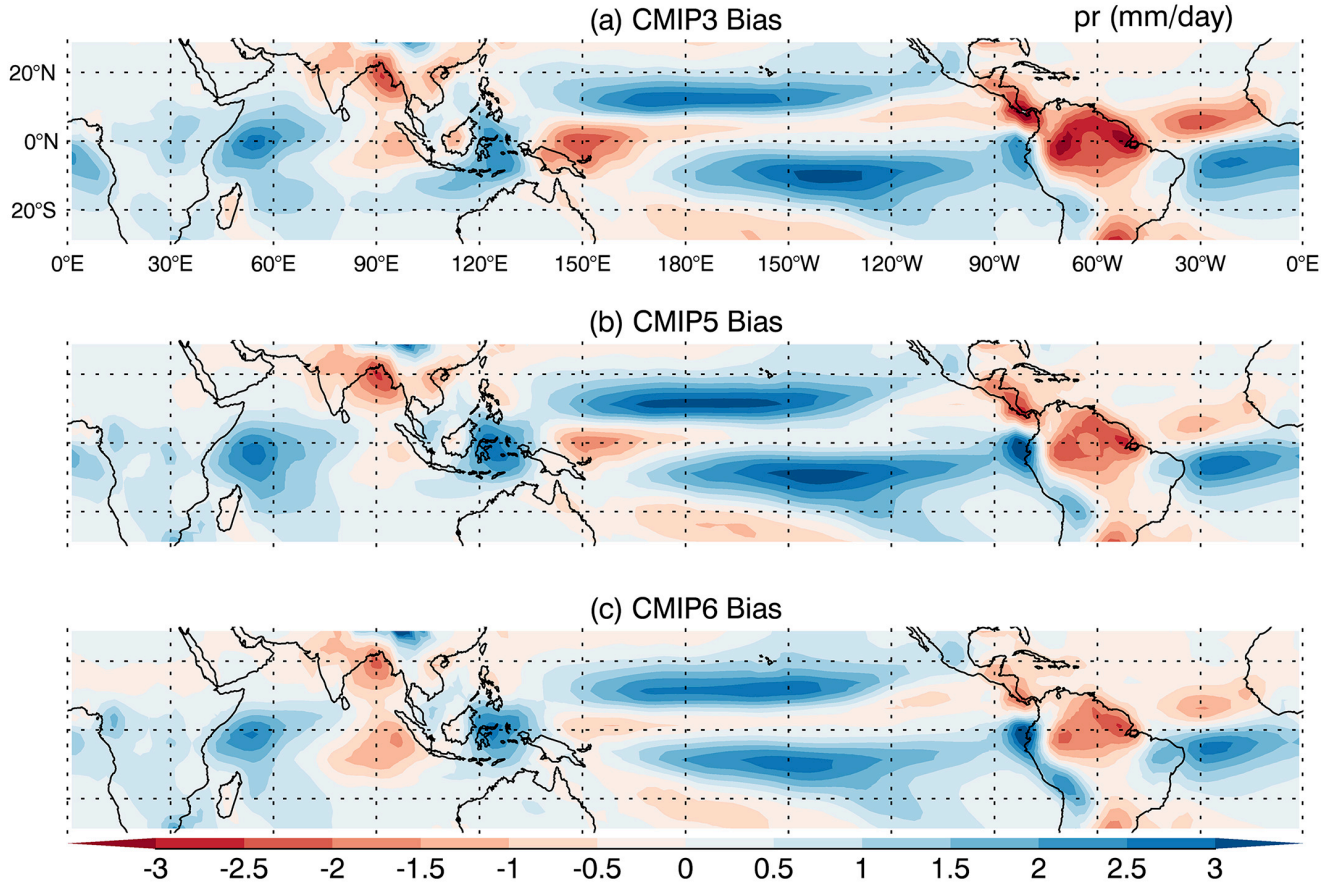
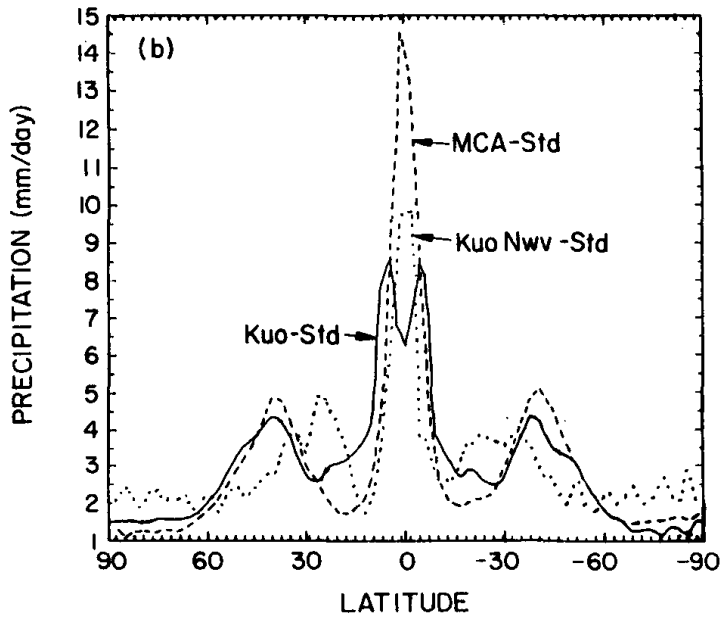
The double ITCZ bias is still an unsolved problem (CMIP6, like CMIP5, like CMIP3…)



https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2020GL087232

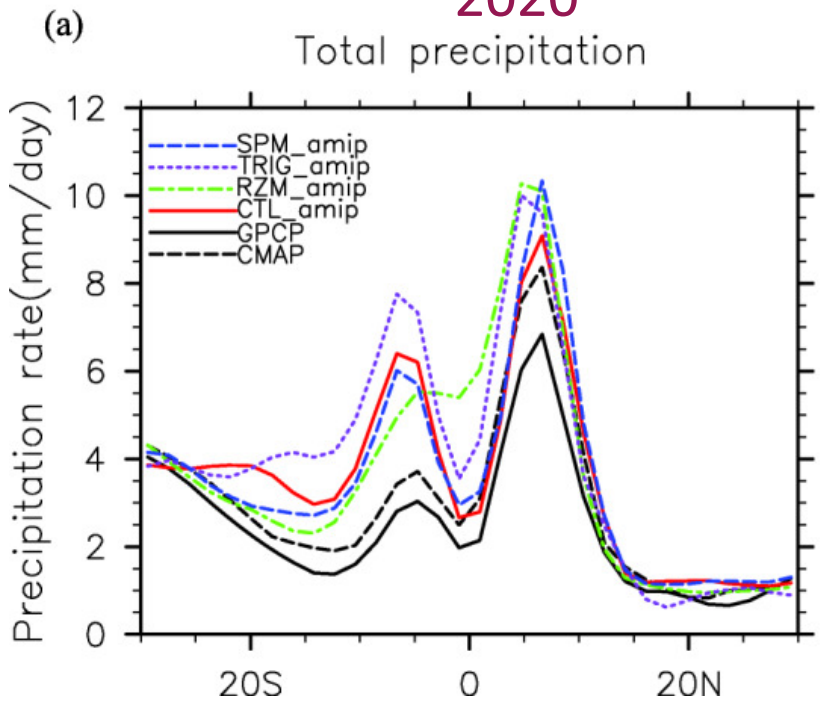
The origin of the double ITCZ bias is in the AGCM: it is sensitive to the representation of convection

1993



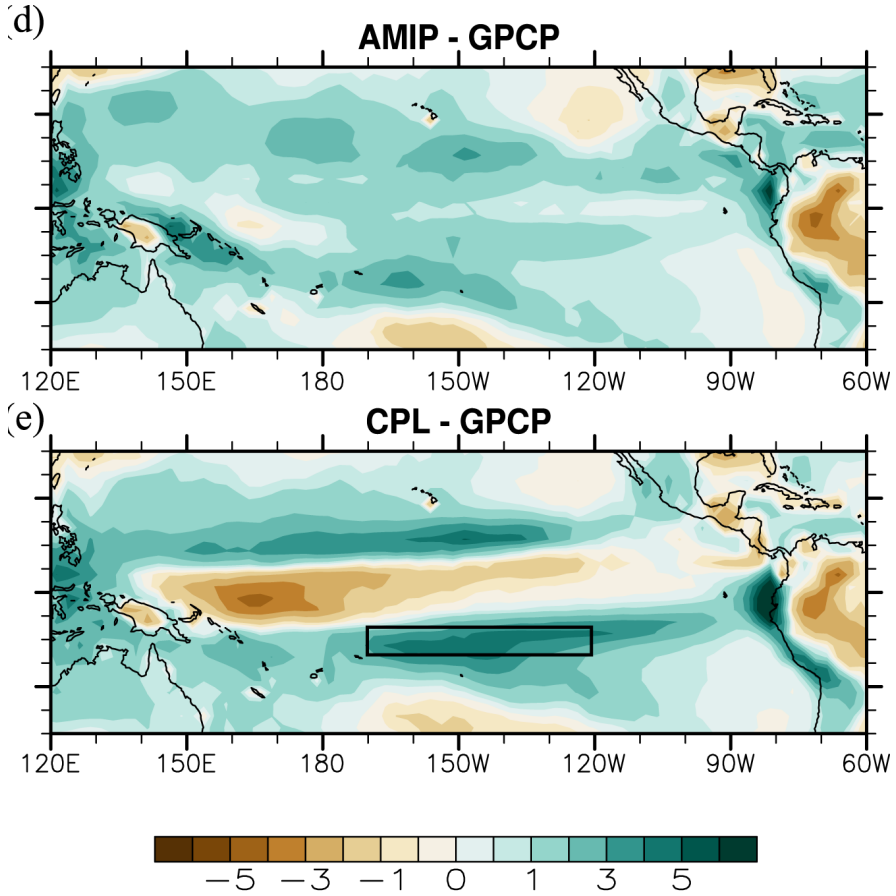
https://doi.org/10.1175/1520-0469(1993)050<0691:MOTICZ>2.0.CO;2

2020



https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2017MS001191

DOUBLE ITCZ: coupling with the ocean worsens the atmosphere-only bias

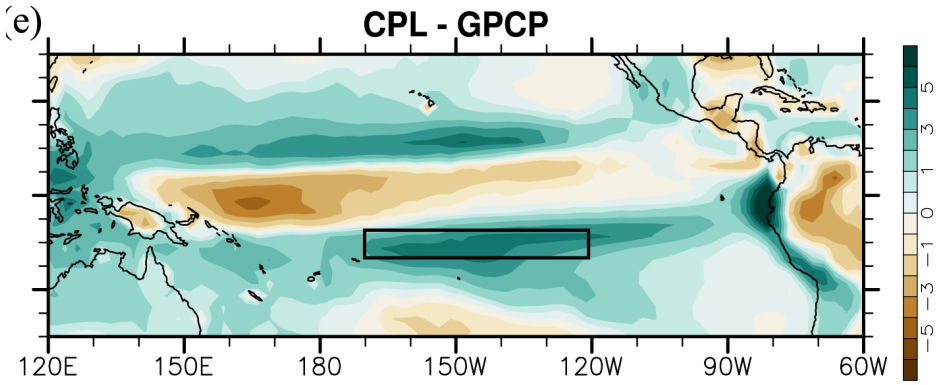


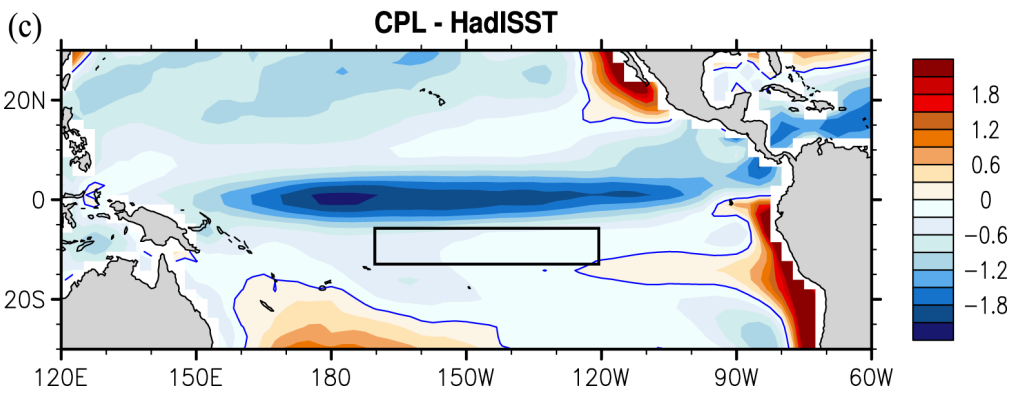
Rainfall bias in the NCAR model with prescribed observed SST

Rainfall bias in the NCAR model with fully coupled ocean

J. Climate. 2020;33(24):10407-10418. doi:10.1175/JCLI-D-20-0141.1

The ITCZ biases are coupled to cold tongue SST biases



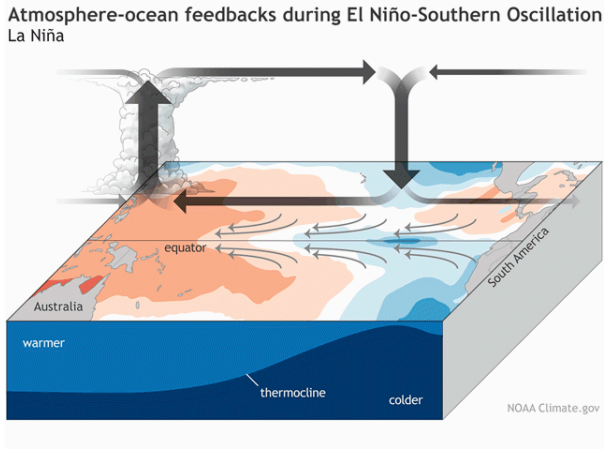


dynamics feedbacks
involving **upwelling**

thermodynamic feedbacks
involving **latent heat fluxes**
and **cloud radiative forcing**

J. Climate. 2020;33(24):10407-10418. doi:10.1175/JCLI-D-20-0141.1

Several ocean-atmosphere processes have been implicated in the ITCZ-Cold Tongue coupling



dynamics feedbacks
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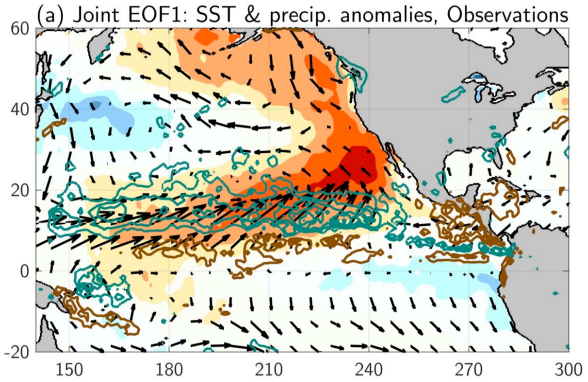
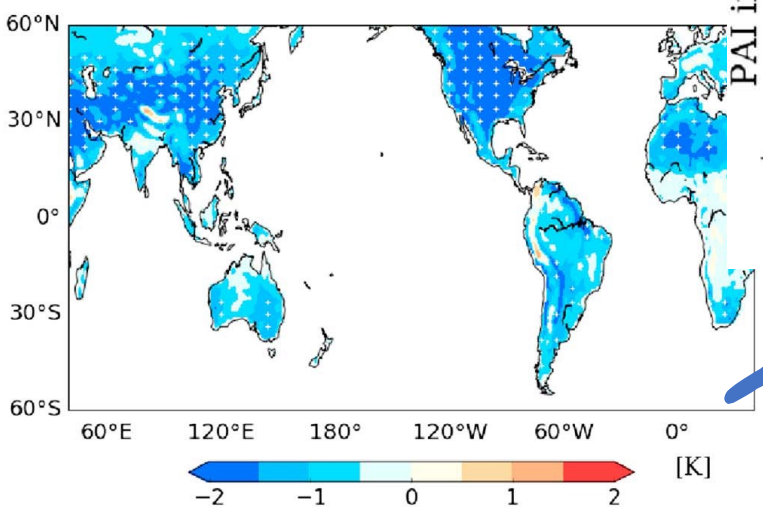
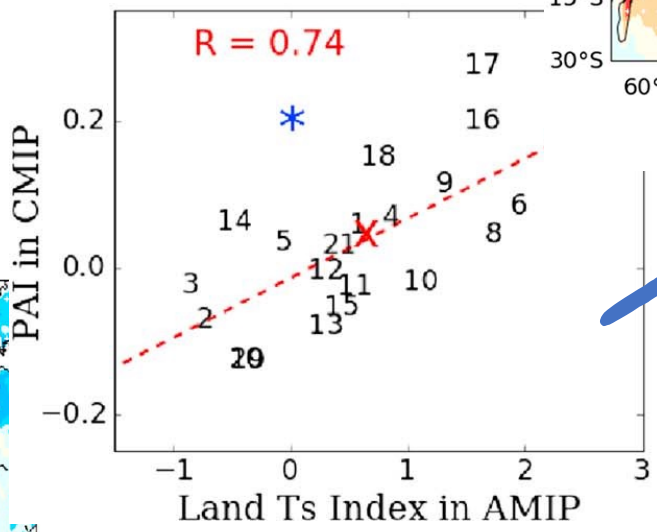


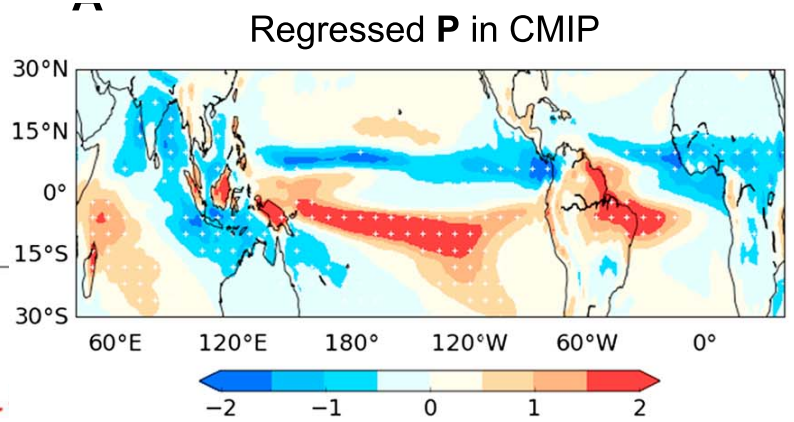
thermodynamic feedbacks
involving **latent heat fluxes**
and **cloud radiative forcing**

There is an additional role for land.

Biases in continental Ts in AMIP correlate with the severity of the double ITCZ bias in CMIP







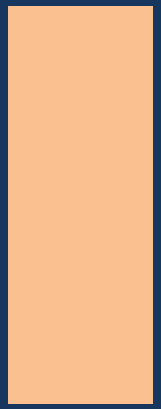
Zhou + Xie, 2017

https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2017GL074377

We use idealized simulations with no ocean dynamics
to show that wintertime continental conditions drive
an annual mean oceanic cold tongue
and a split in the ITCZ

TRACMIP:
Tropical Rain belts with an Annual cycle and Continent Model Intercomparison Project

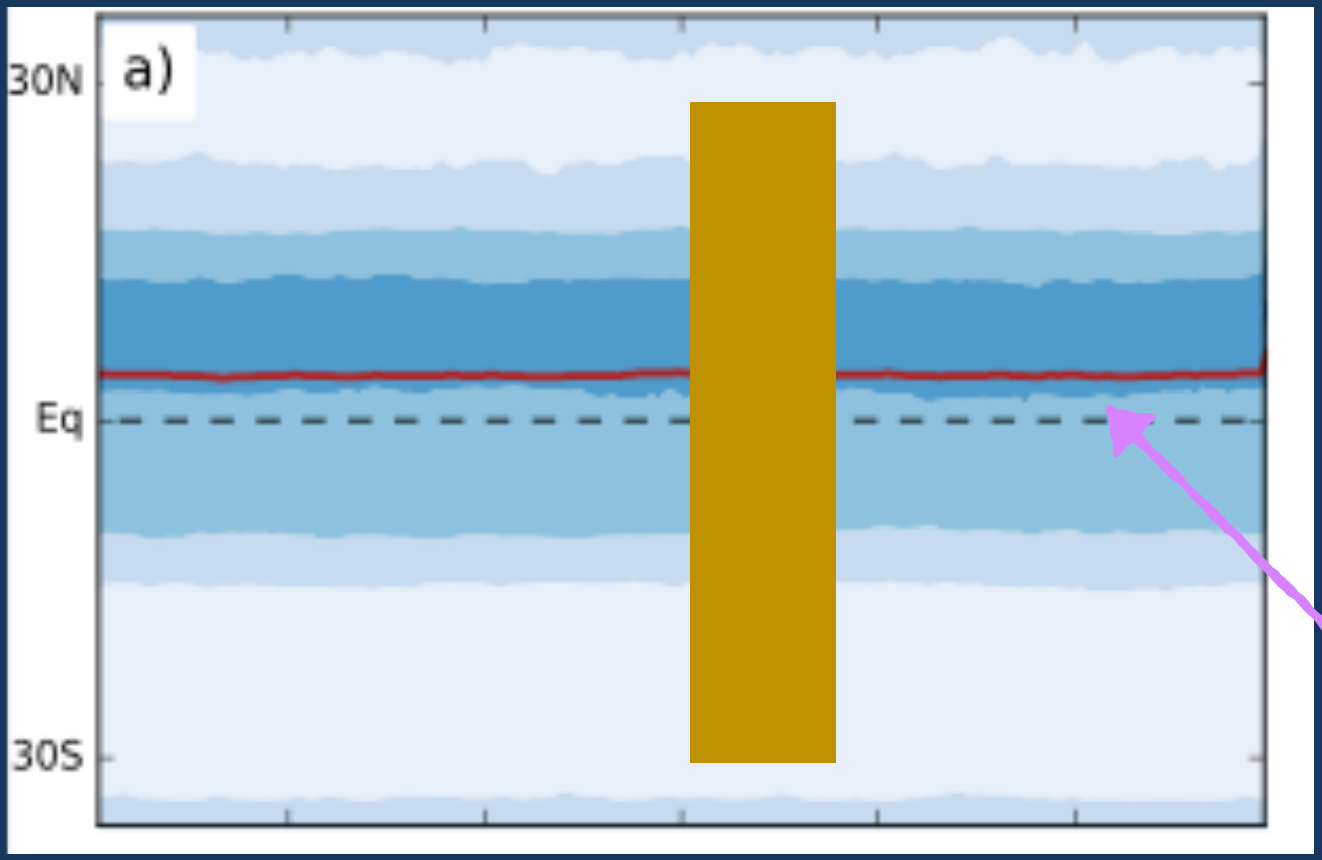
Michela Biasutti and Aiko Voigt (tracmip@gmail.com)



Simulations by: Jürgen Bader, Simona Bordoni, Francis Codron, Ross D. Dixon, Sarah Kang, Nicholas P. Klingaman, Ruby Leung, Jian Lu, Elizabeth A. Maroon, Sonali McDermid, Jong-yeon Park, Romain Roehrig, Brian E. J. Rose, Jeongbin Seo, Thomas Toniazzo, Masakazu Yoshimori, Aiko Voigt

And help from: Jacob Scheff, Brian Mapes, and Lucas R. Vargas Zeppetello

Slab Ocean Aquaplanet = AquaControl

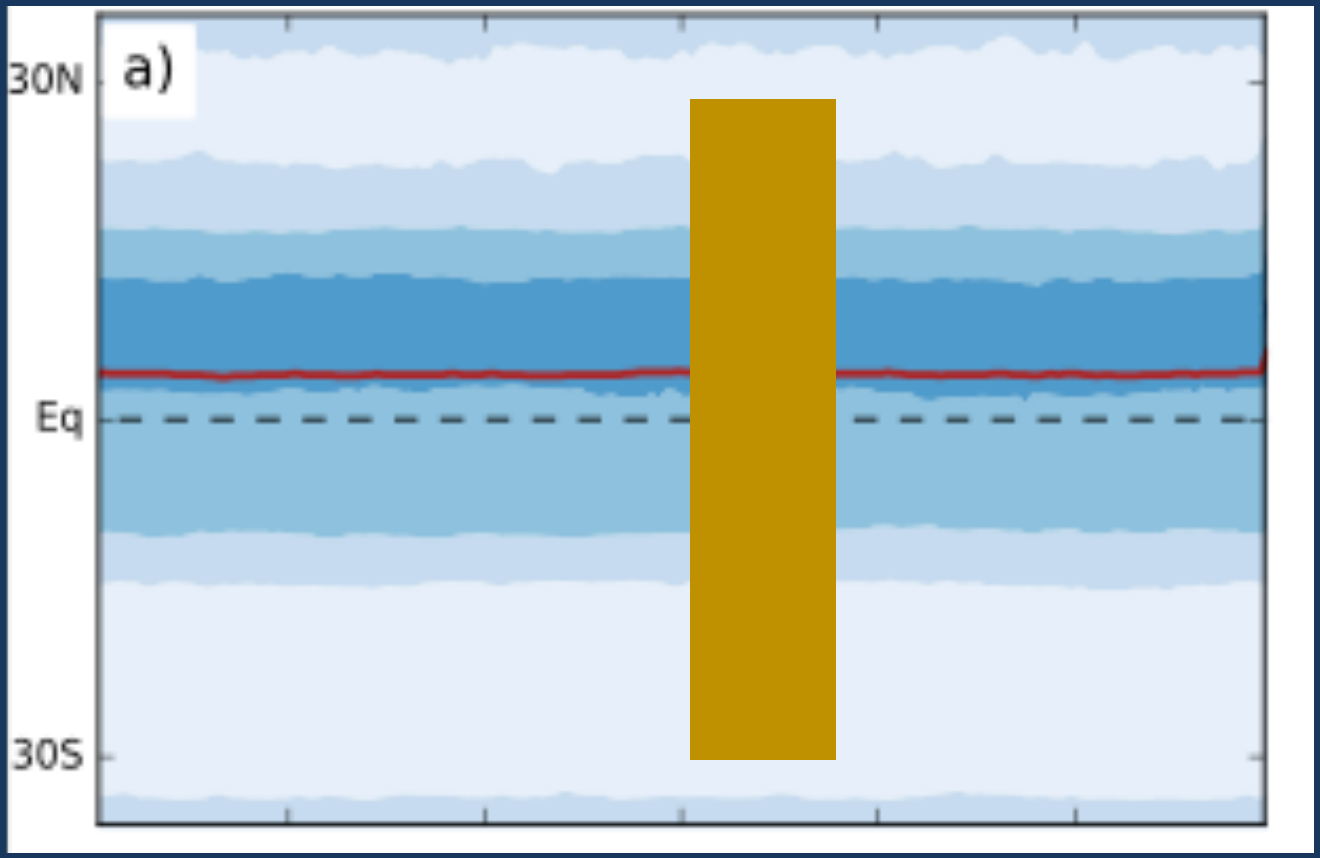


Q-flux warms the NH and pushes the ITCZ north of the equator

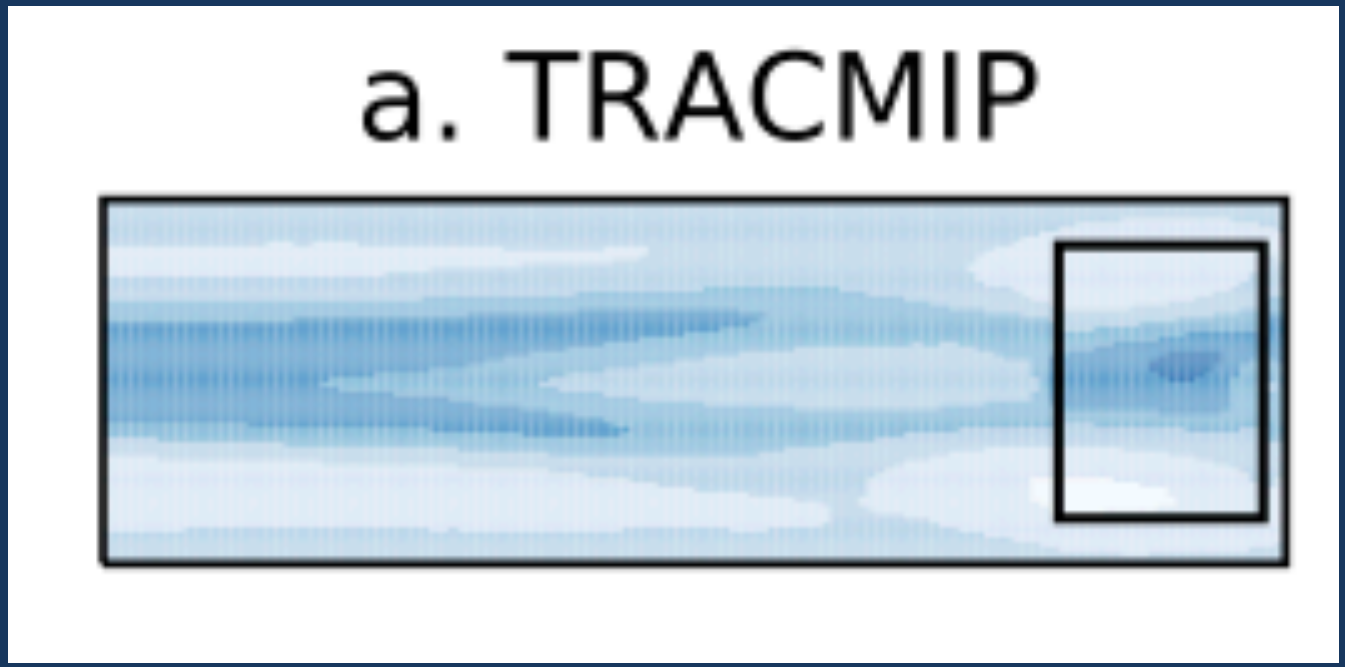
“jell-o” continent

1. Low heat capacity
2. Brighter than water
3. Resists evaporation
4. Does not transport heat

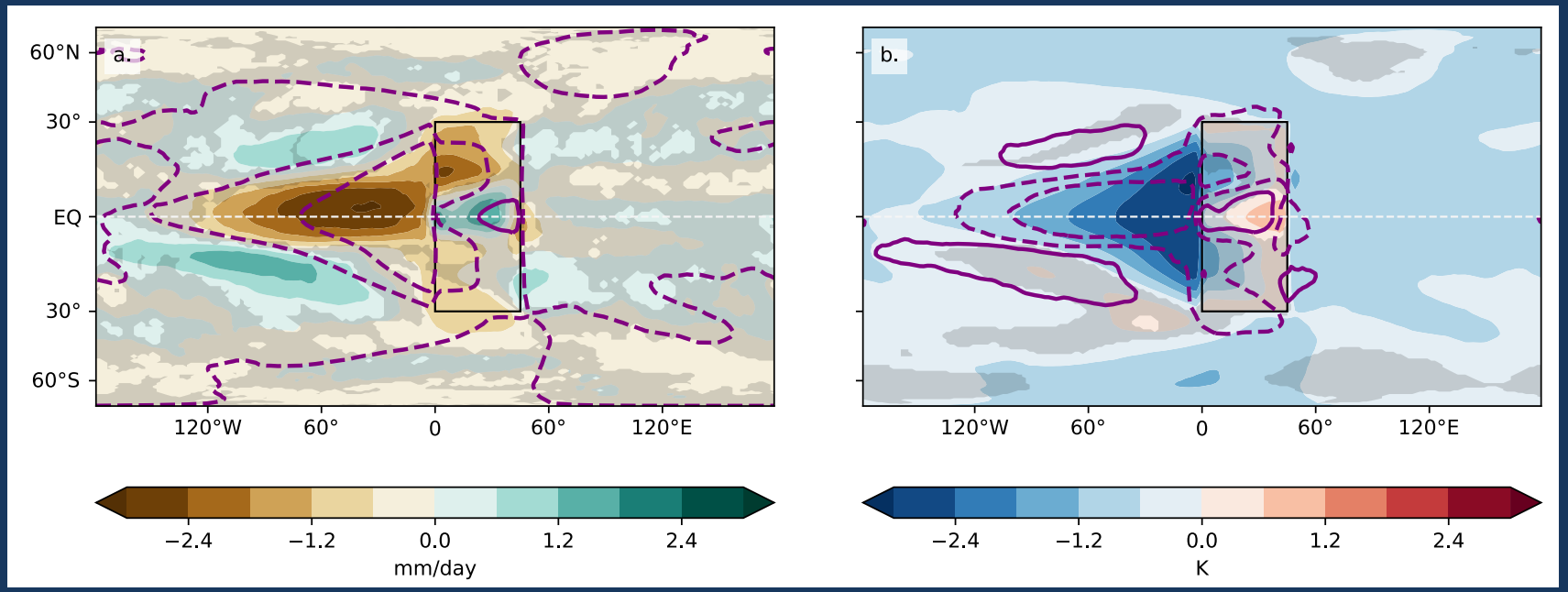
Slab Ocean Aquaplanet = AquaControl
AquaControl + “jell-o” continent = LandControl



The presence of an equatorial continent creates a split in the ITCZ

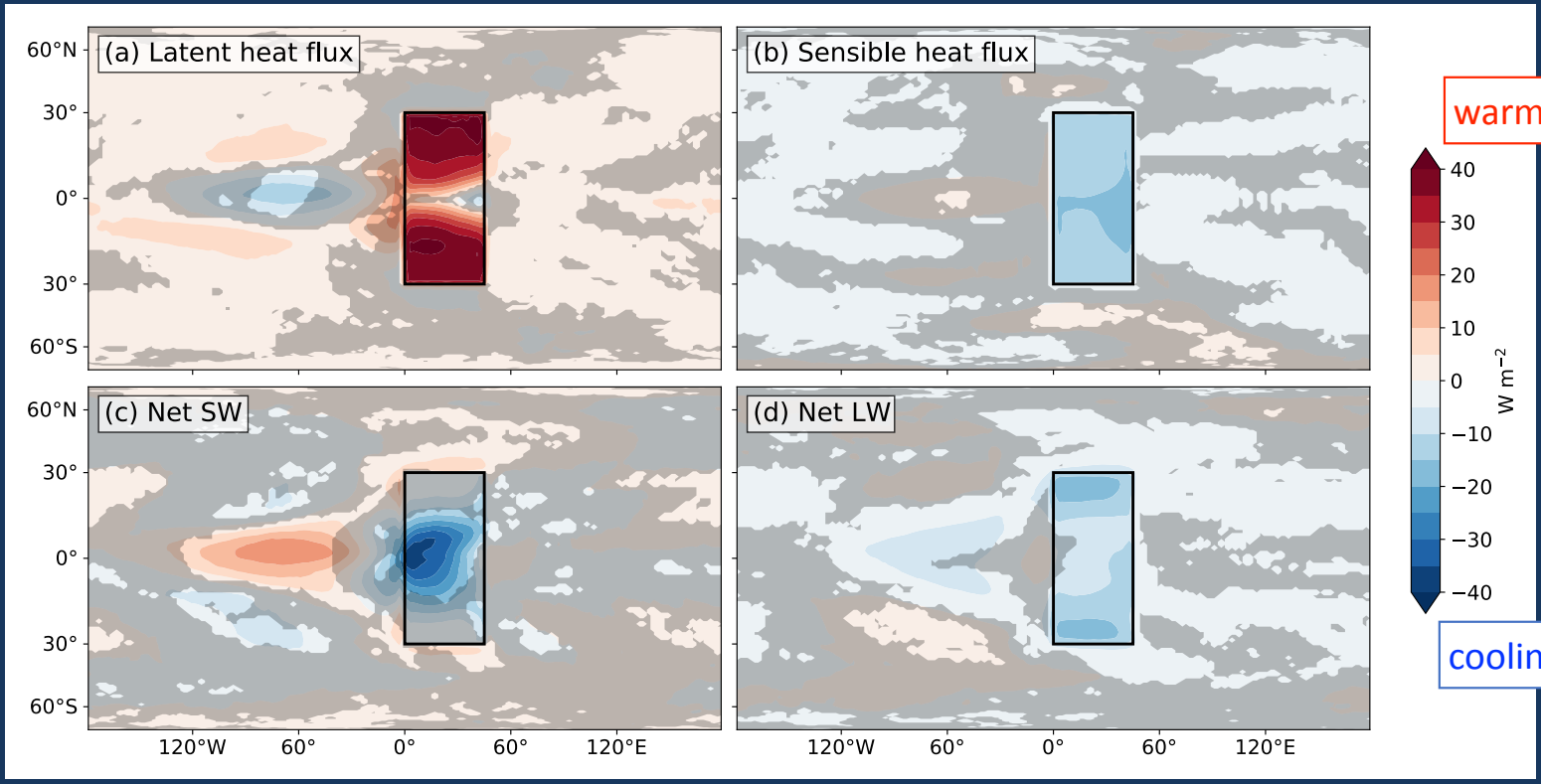


LandControl – AquaControl: the largest anomalies in the annual mean are over the ocean

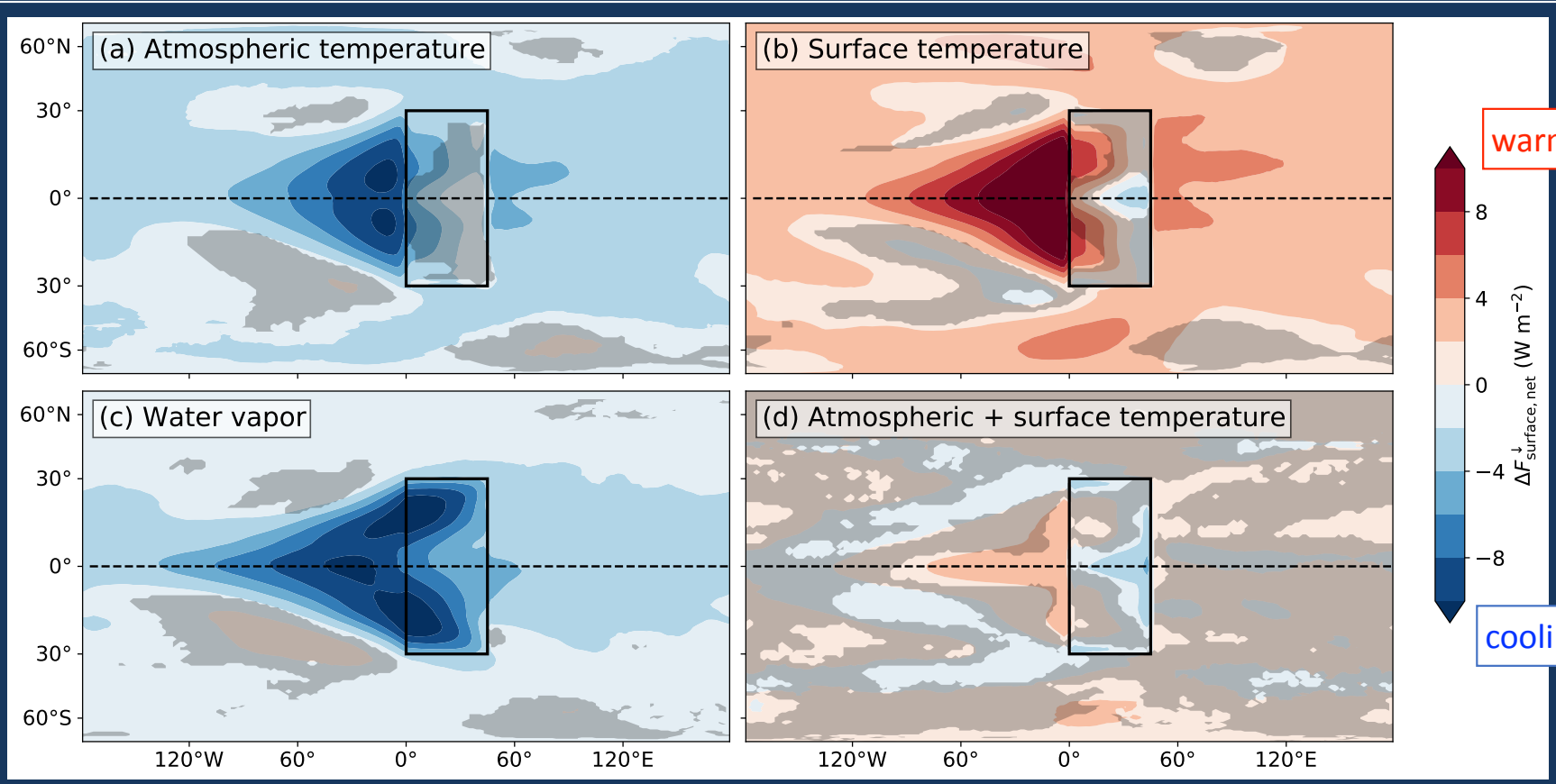


oceanic cold tongue and split ITCZ

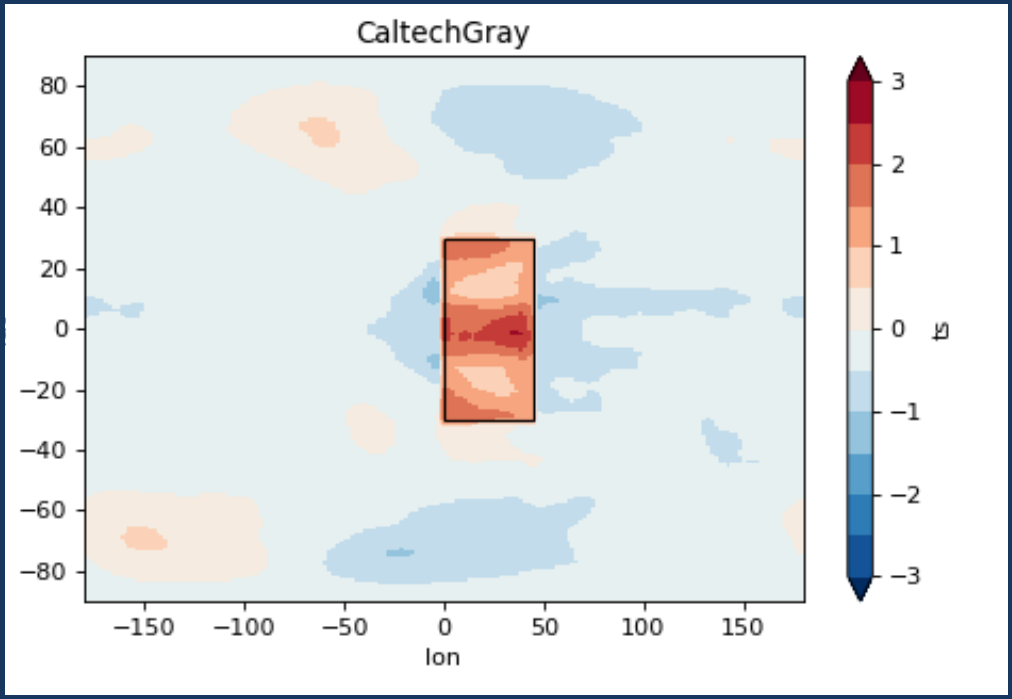
Oceanic cooling is achieved and maintained via changes in evaporation and in LW fluxes



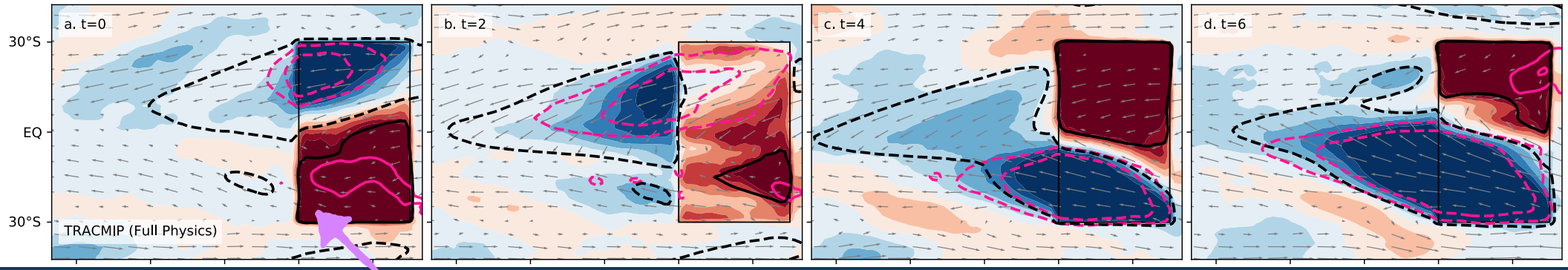
Radiative kernels reveal that changes in the atmospheric humidity are key to the ocean cooling



A model with a grey radiation scheme confirms that changes in the atmospheric humidity are key to the establishment of the cold tongue

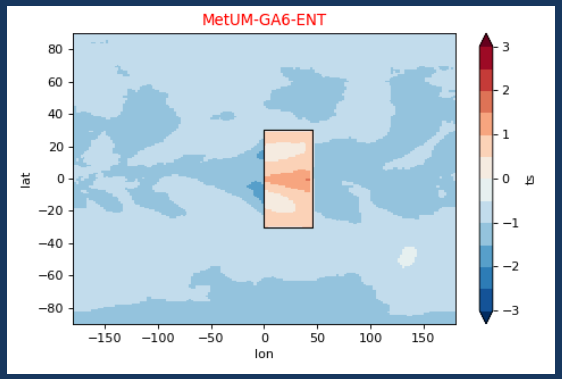


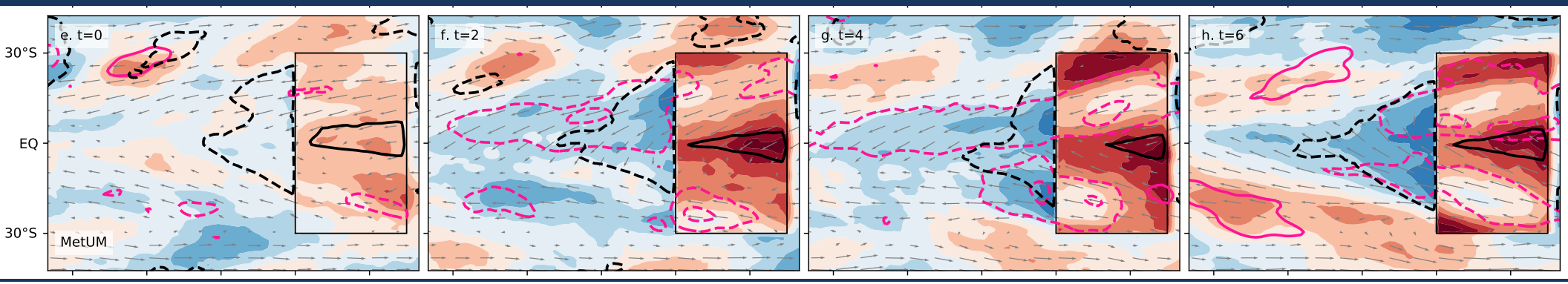
Cooling and drying in the winter portion of the continent initiates the cooling and drying downstream.

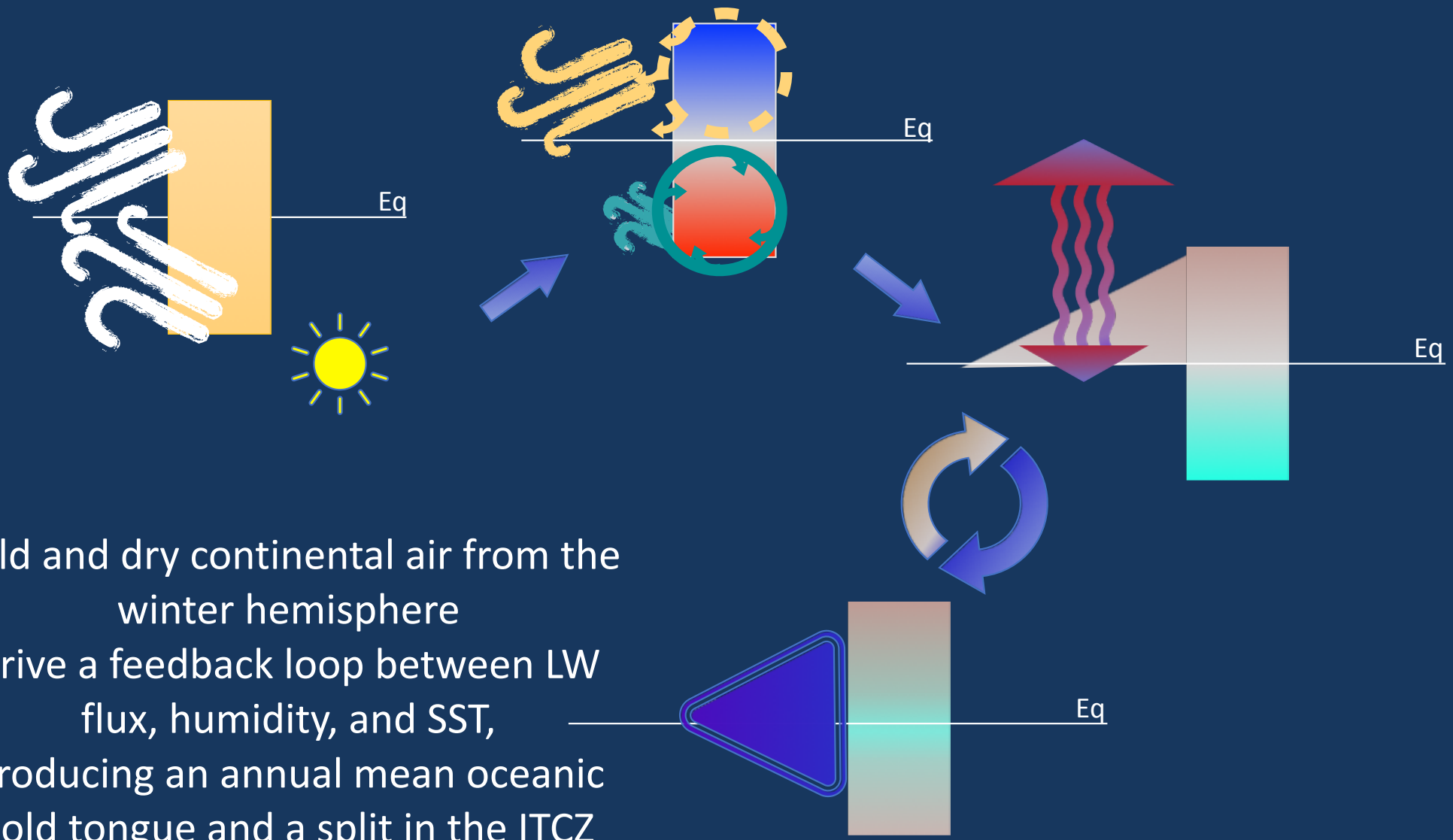


Low-level convergence into the summer continent prevents warm and moist anomalies from spreading to the ocean.

Models with no seasonal cooling/warming over the continent confirm that the cold tongue is due to the rectification of the seasonal signal

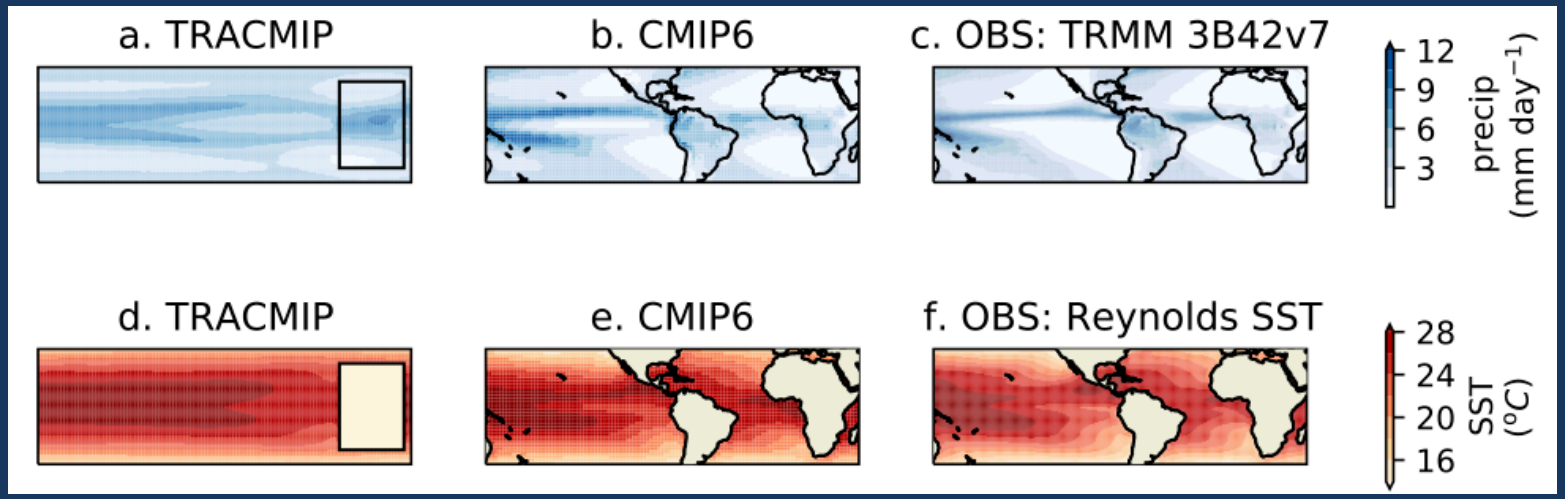






cold and dry continental air from the winter hemisphere
drive a feedback loop between LW flux, humidity, and SST,
producing an annual mean oceanic cold tongue and a split in the ITCZ

wintertime temperature and humidity biases in the tropical continents may contribute to biases in the oceanic cold tongue and the double ITCZ



The Effect of an Equatorial Continent on the Tropical Rain Belt. Part 1: Annual Mean Changes in the ITCZ. *J.Clim 2020 (in revision)*
Michela Biasutti; Rick D Russotto; Aiko Voigt; Charles C Blackmon-Luca.

PANGEO

https://console.cloud.google.com/storage/browser/cmip6/tracmip

https://cmip6-pds.s3.amazonaws.com/index.html#tracmip/

DKRZ ESGF and CoG

https://esgf-data.dkrz.de/search/esgf-dkrz/