

Wetter subtropics and Hadley/Walker circulation in mid-Pliocene simulated by an atmospheric general circulation model

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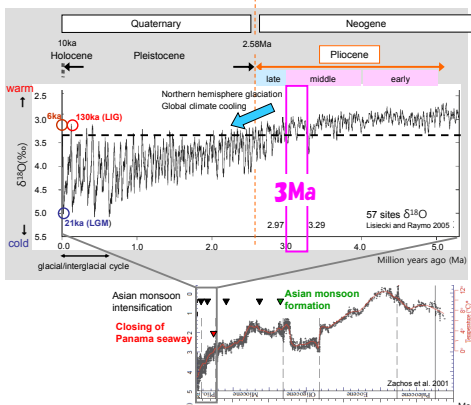
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Middle Pliocene (3Ma) • most recent sustained warm period
• land-sea distribution is near to the present

Intensification of Gulf stream → water vapor transport → high latitude glaciation
Global cooling & drying
Formation of the western Pacific warm pool & eastern Pacific cooling

High atmospheric CO₂ concentration
Closure of Panama seaway
Warmer & wetter climate (etc. subtropics)
Permanent El Niño
Small ice sheet on Greenland and Antarctic



Purpose

simulating atmospheric general circulation and hydrological cycle with boundary conditions reconstructed by proxy data

Model

AGCM in MRI-CGCM2.3.2 Yukimoto et al. (2001, 2006)

T42L30 (~280km grid)

land process 3-layer SiB (Sellers et al. 1986)
convection scheme prognostic Arakawa-Schubert (Randall and Pan 1993)
planetary boundary layer Mellor-Yamada level 2 (Mellor and Yamada 1974)

Experimental design

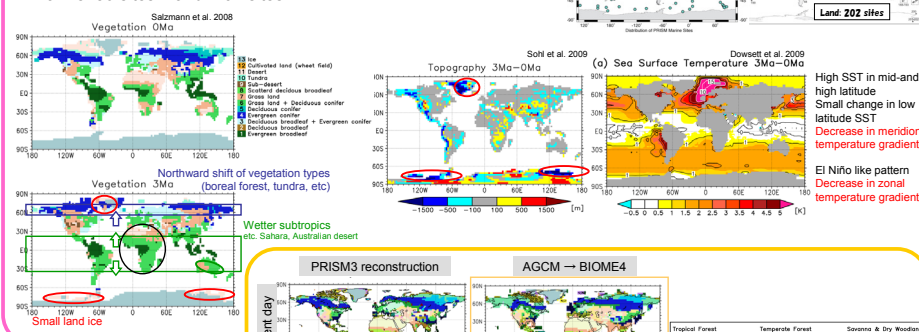
"Experiment 1" in PlioMIP Haywood et al. (2010)

run	0Ma	3Ma
CO ₂	280ppmv	405ppmv
CH ₄	760ppbv	760ppbv
N ₂ O	270ppbv	270ppbv
SST, sea ice	Dowsett et al. 2009	
Topography	Sohl et al. 2009	
Vegetation	Salzmann et al. 2008	
No change in orbital forcing and land-sea distribution		
Spin-up: 10 years		
Integration: 50 years		

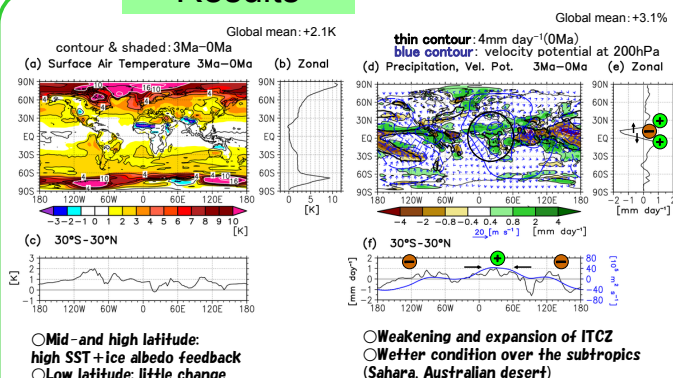
Boundary condition

USGS PRISM3 U.S. Geological Survey
Pliocene Research, Interpretation and Synoptic Mapping Project

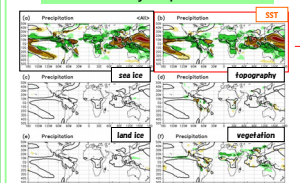
Marine: 86 sites Land: 202 sites



Results

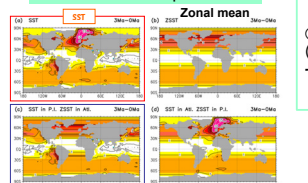


Sensitivity experiments



○ SST is the main factor (in low-latitude)

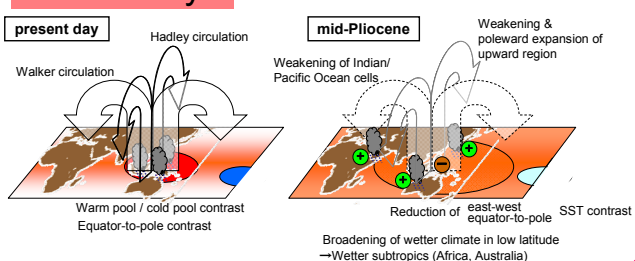
Idealized SST experiments



○ Zonally asymmetric SST pattern in the Indian / Pacific Ocean → east-west atmospheric circulation (Warm SST in upwelling region)

○ Zonally asymmetric SST in Atlantic Ocean (Weakening of Walker circulation)

Summary



Acknowledgment

Kamae, Y., H. Ueda, and A. Kitoh, 2011: Hadley and Walker circulation in mid-Pliocene simulated by an atmospheric general circulation model. *J. Meteor. Soc. Japan*, submitted.

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