Southampton Oceanography Centre
UNIVERSITY OF SOUTHAMPTON AND NATURAL ENVIRONMENT RESEARCH COUNCIL

Max-Planck-Institut für Meteorologie
Max Planck Institute for Meteorology

A low resolution coupled aquaplanet simulation with the FORTE OAGCM

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Ein Institut der Max-Planck-Gesellschaft
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NATURAL ENVIRONMENT RESEARCH COUNCIL

Summary

- Model
- WaterWorld
- Ocean heat transport experiments

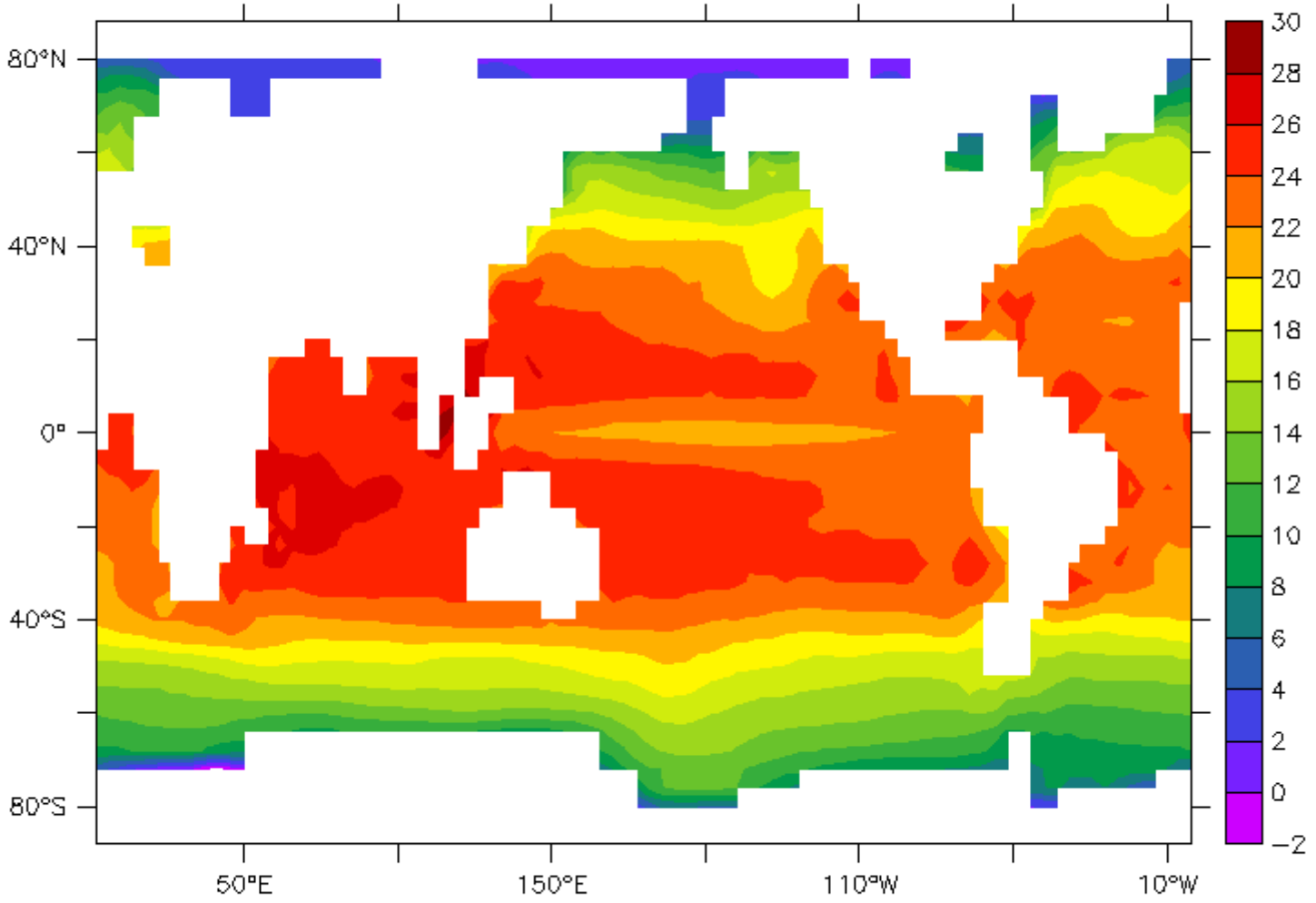
Motivation

- Part of series of idealised coupled climate experiments
- Influence of basin configuration on ocean heat transport => climate
- Some paleo-applications, partly theoretical
- Curiosity!

Model: FORTE

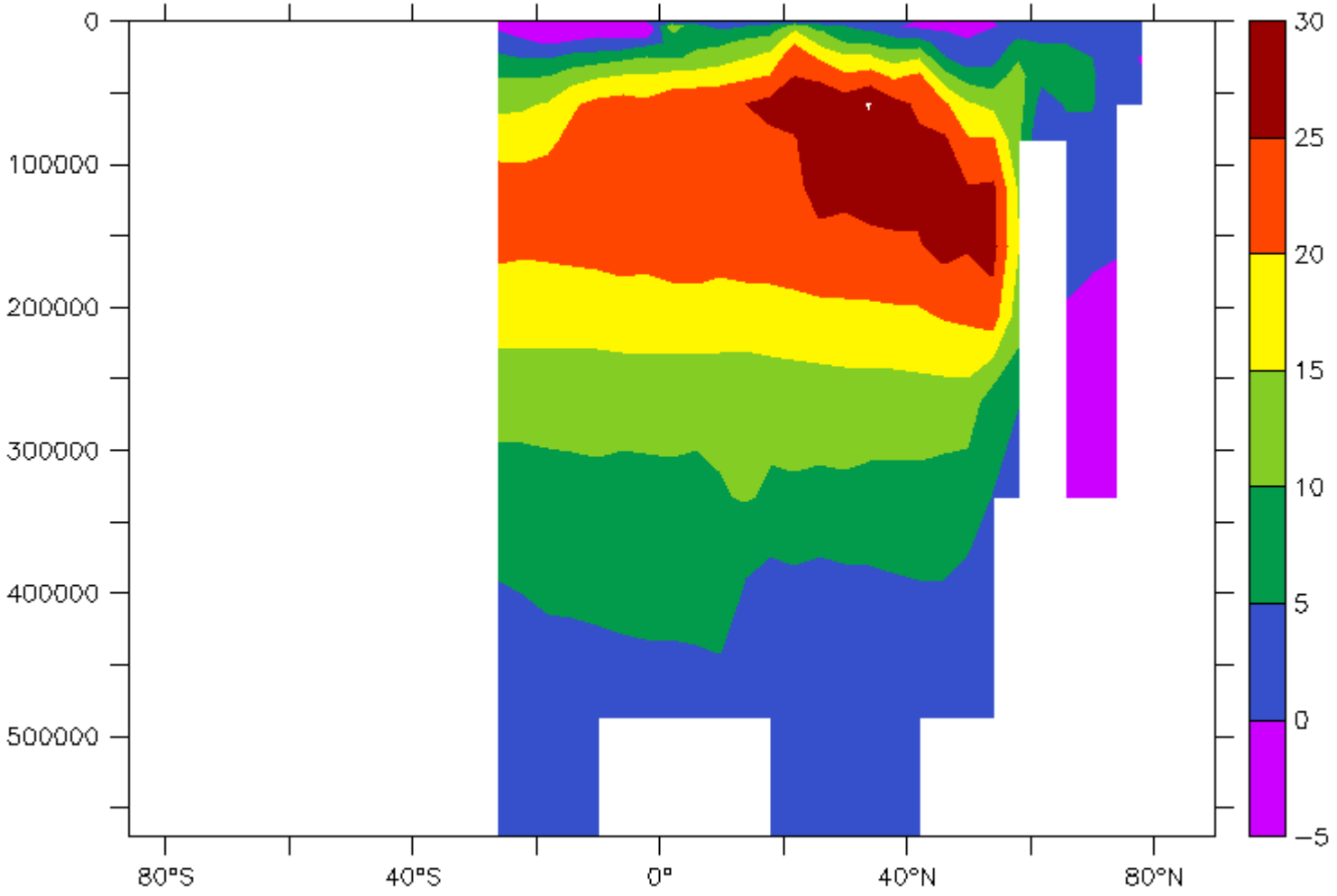
- MOMA [Webb '96]
  - Free surface, simple mixing con
  - Primitive equation, z-coordinate
- IGCM3 [Forster '00]
  - T21 spectral model, 22 vertical layers
  - Explicit convective adjustment, 4 distinct cloud layers
- OASIS [Terray, '99]
- Additional features
  - Runoff
  - Sea-ice
  - Coastal tiling
  - Periodic Coupling

Model: Modern reference climate



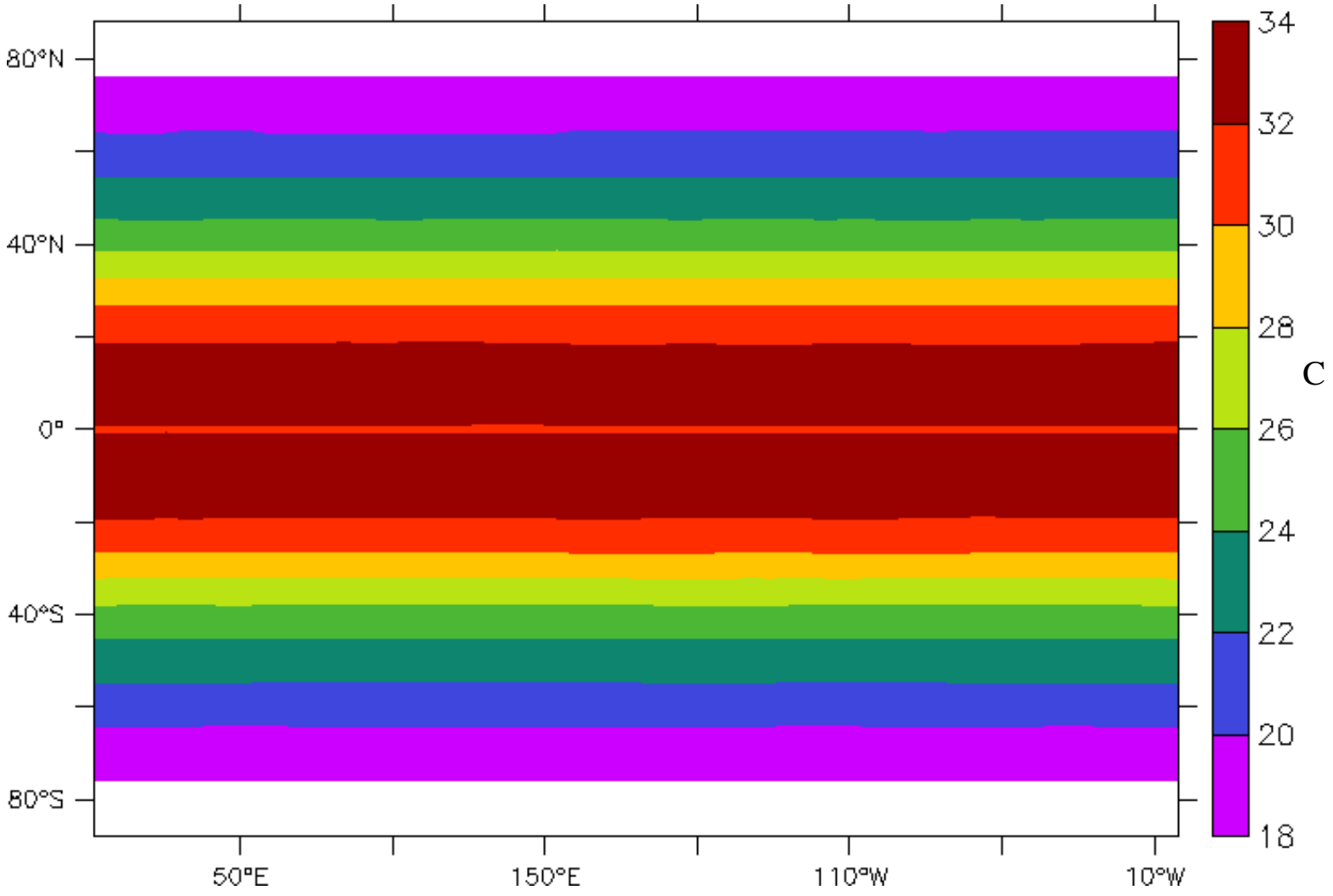
Annual average SST (C) for the modern reference

Model: Modern reference climate



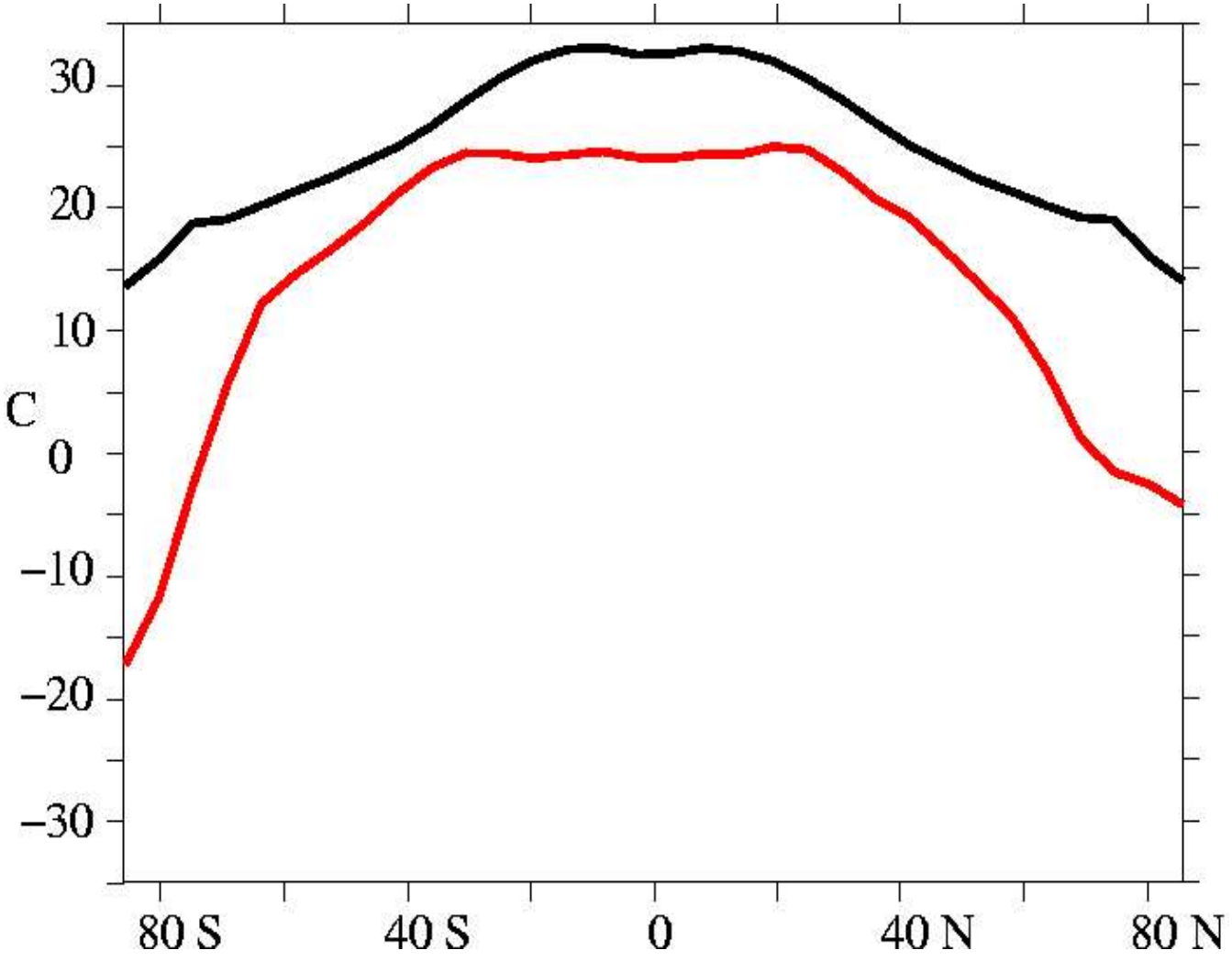
Annual average Atlantic overturning (Sv) for the modern reference

WaterWorld: Surface Climate



Annual mean SSTs (C)

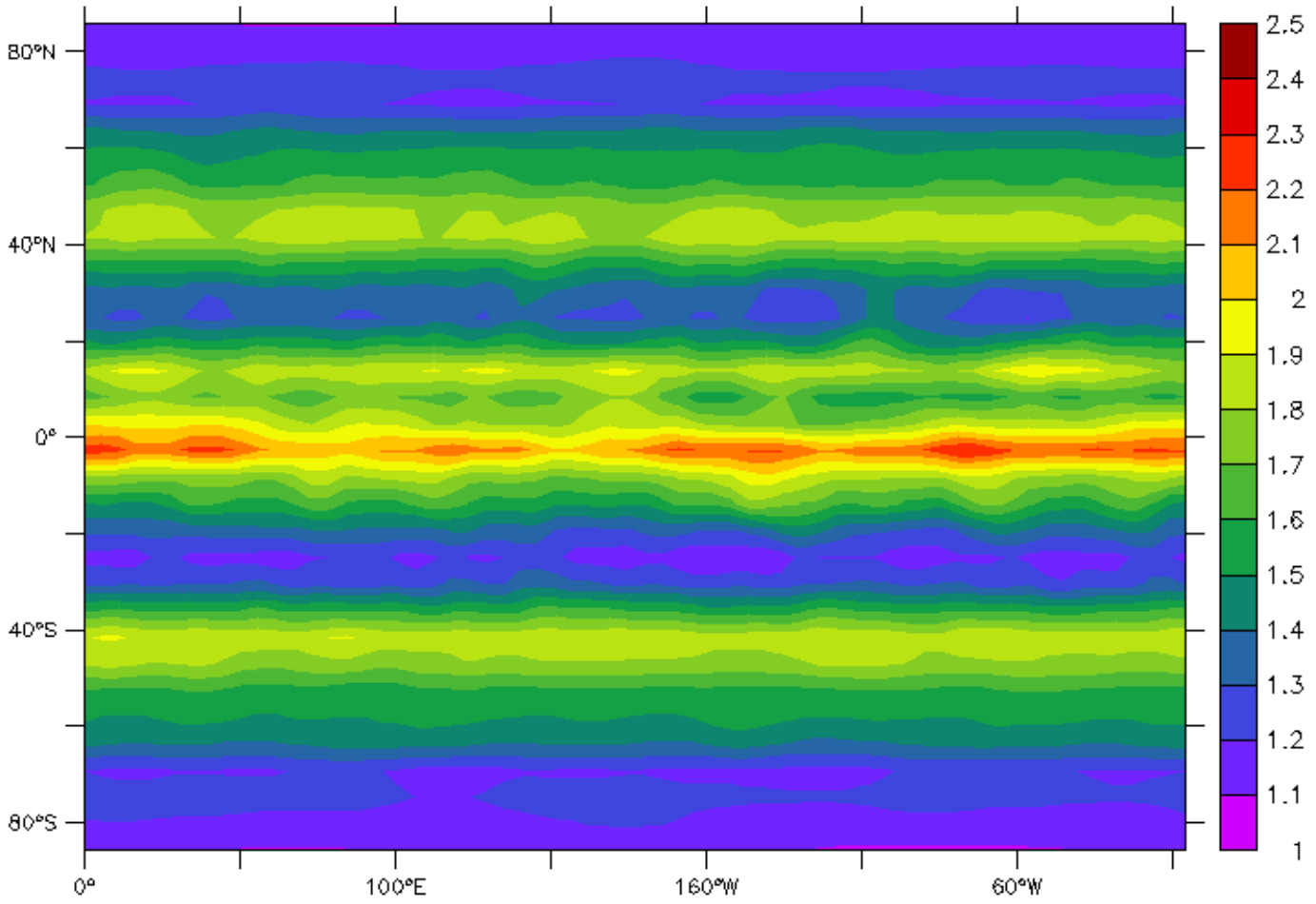
WaterWorld: Surface Climate



Zonal, annual mean Air Surface Temperatures (C)

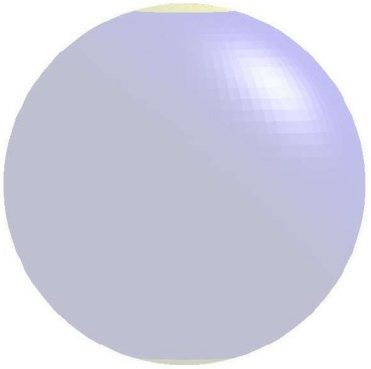
Red: modern ref.
Black: WaterWorld

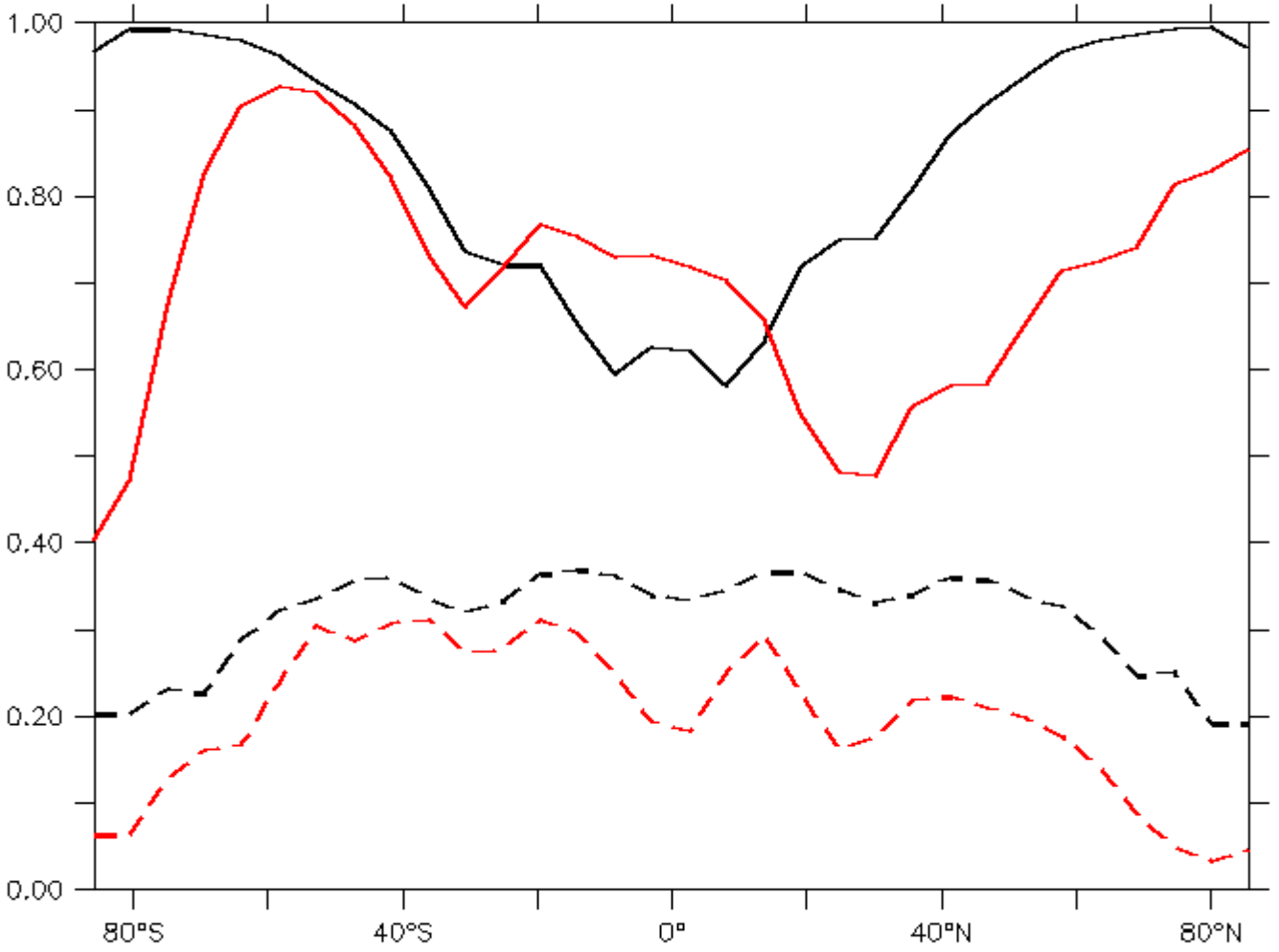
WaterWorld: Surface Climate



Annual mean precipitation (m/year)

WaterWorld: Surface Climate

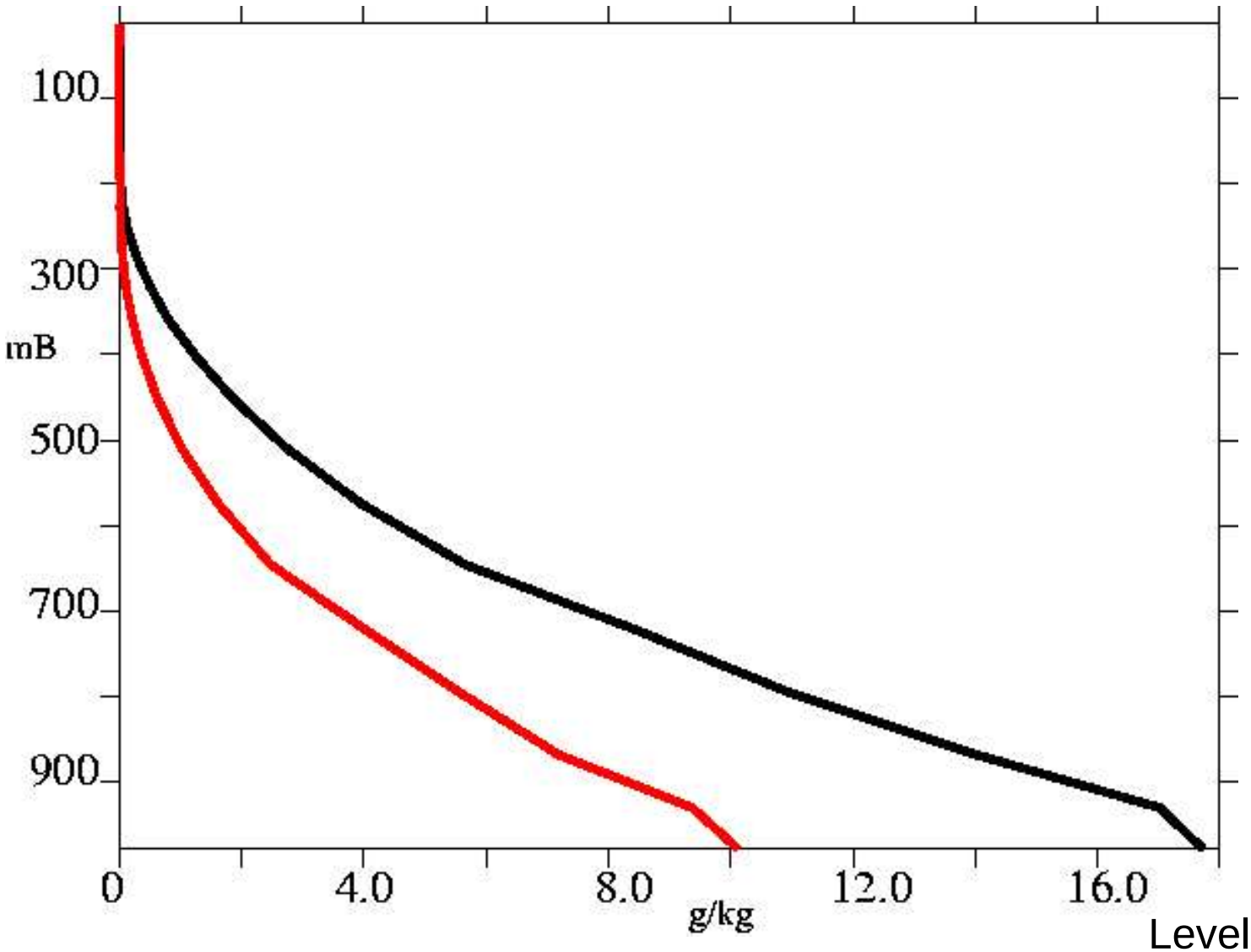




Zonal, annual mean cloud cover fraction

Solid: low cloud
Dashed: convective cloud
Red: modern reference
Black: WaterWorld

WaterWorld: Atmospheric water vapour

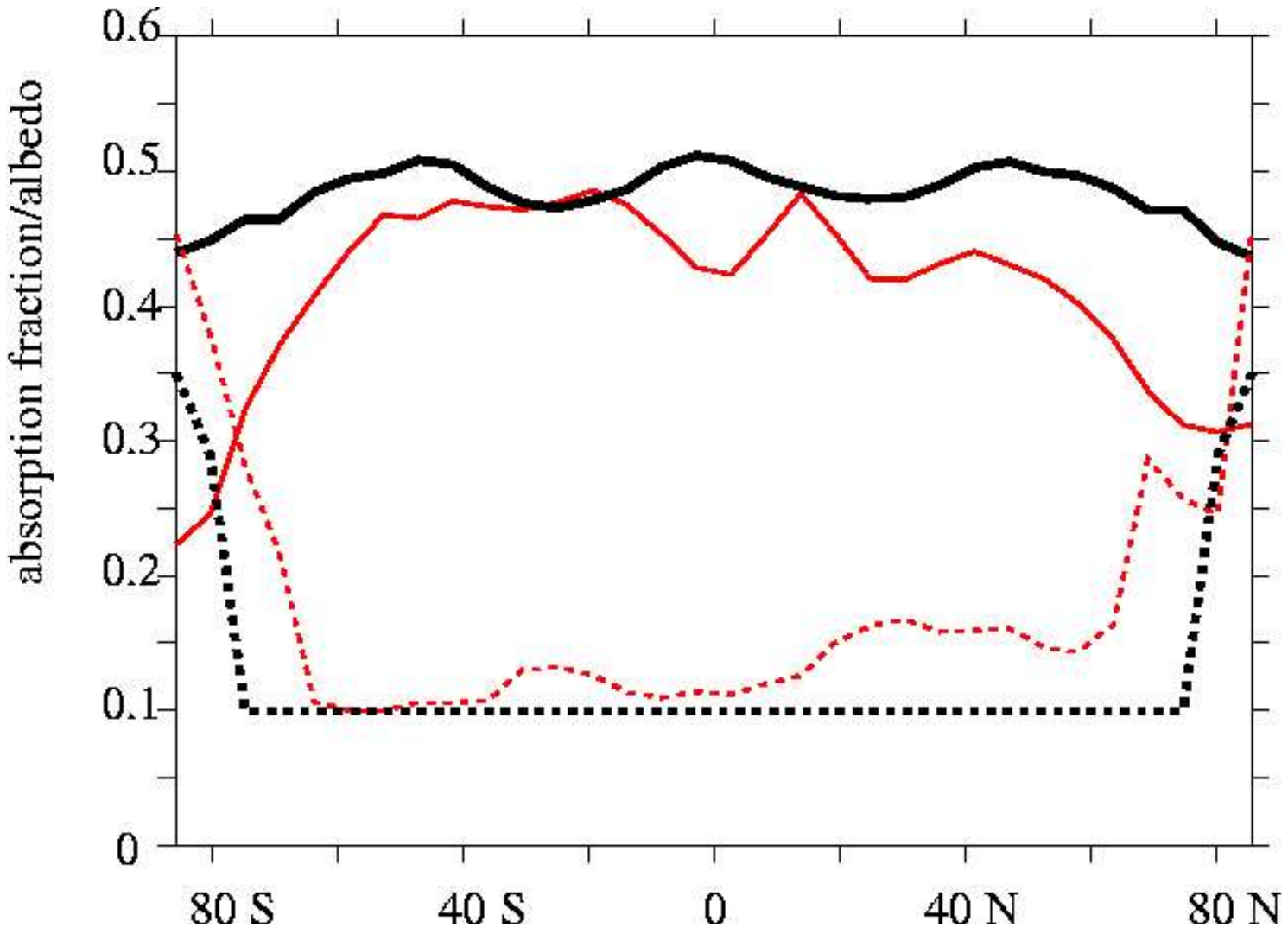


Level mean, annual mean specific humidity

Red: modern ref.

Black: WaterWorld

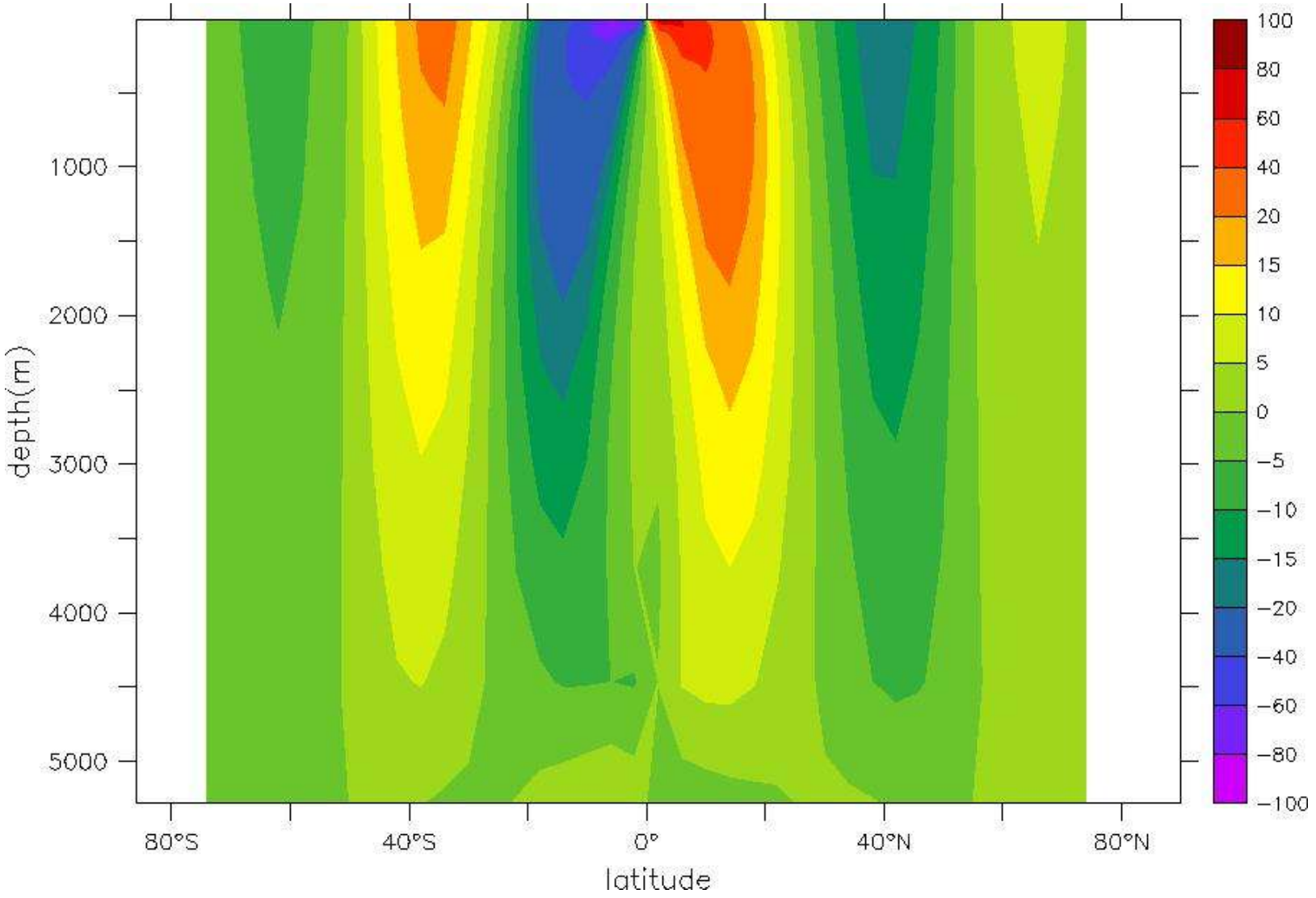
WaterWorld: Atmospheric water vapour



Zonal, annual mean longwave absorption fraction (solid) and surface albedo profile (dashed)

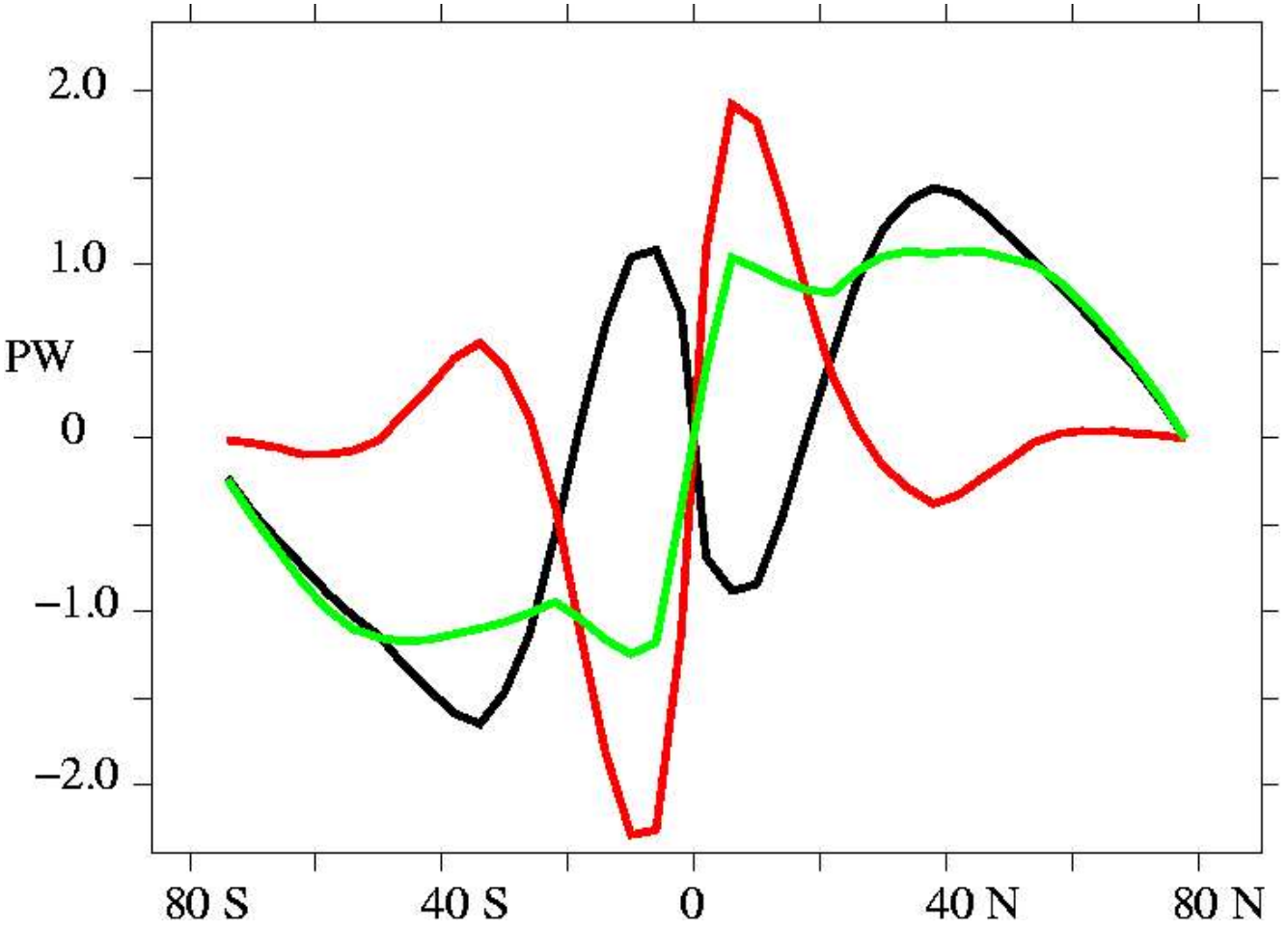
Red: modern ref.
Black: WaterWorld

WaterWorld: Meridional overturning



Global oceanic meridional overturning (Sv)

WaterWorld: Heat transport



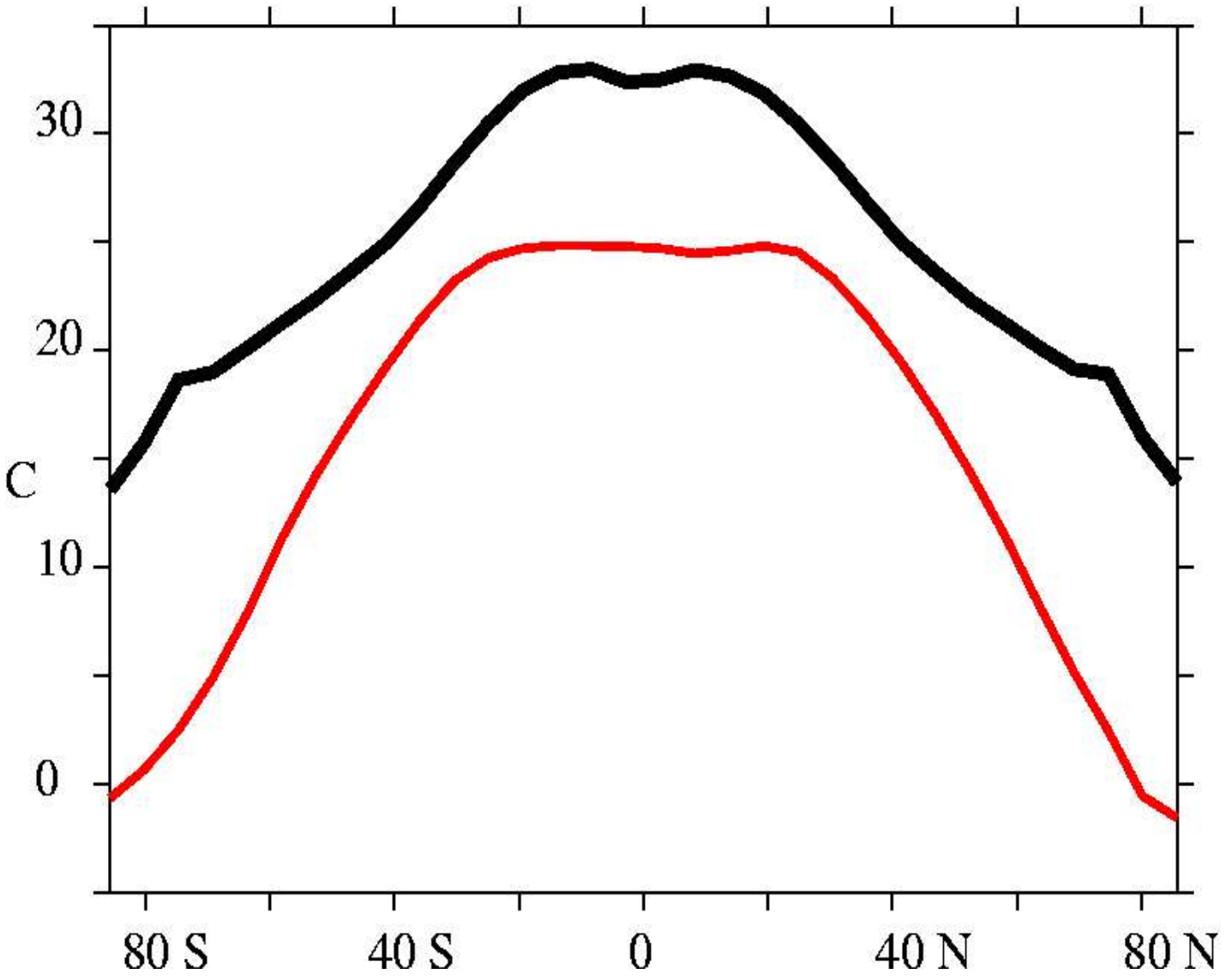
Global oceanic heat transport (PW)

Red: advected

Black: diffused

Green: Total

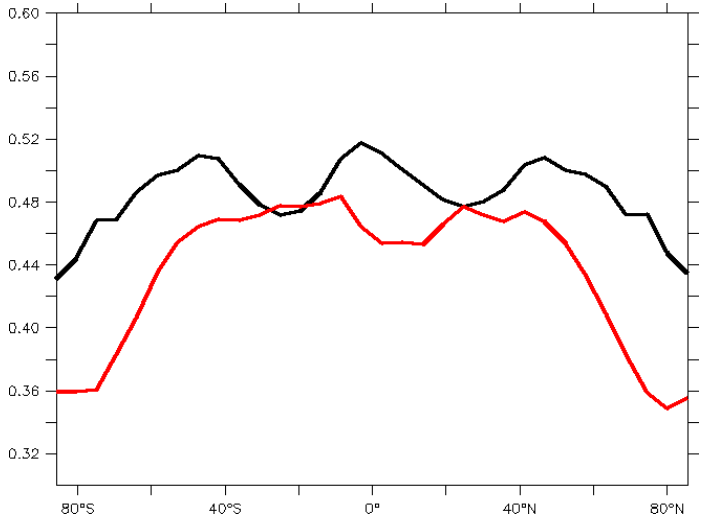
WaterWorld: inhibited ocean heat transport

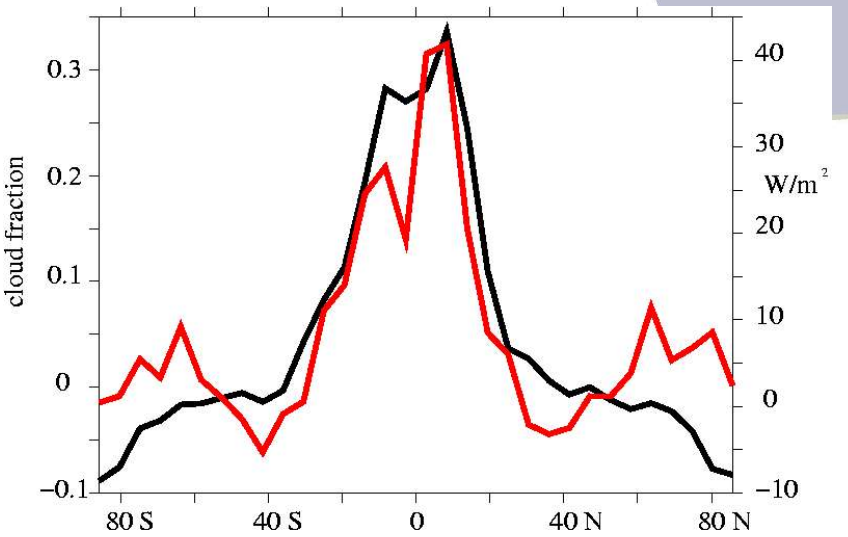


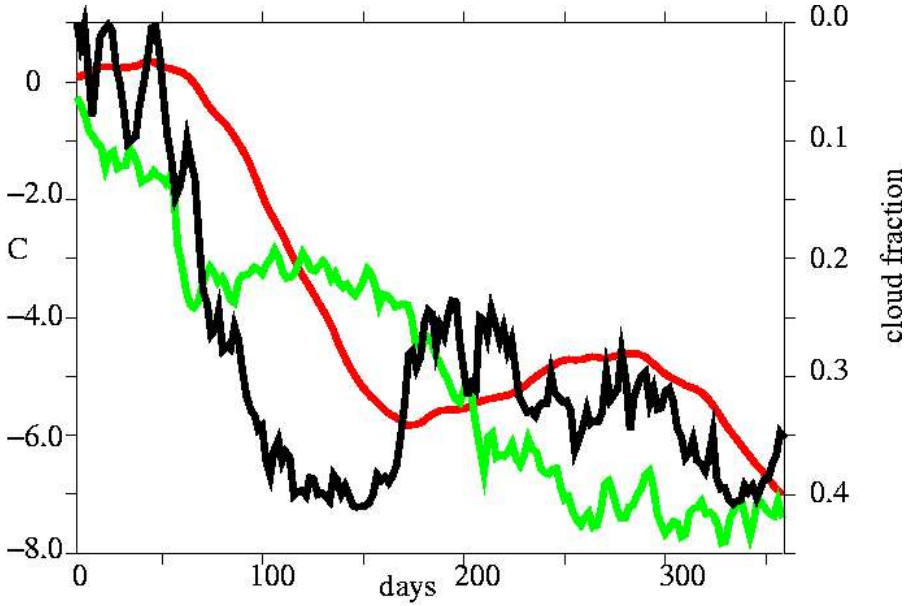
Zonal, annual mean air surface temperature (C)

Red: swamp WW
Black: coupled WW

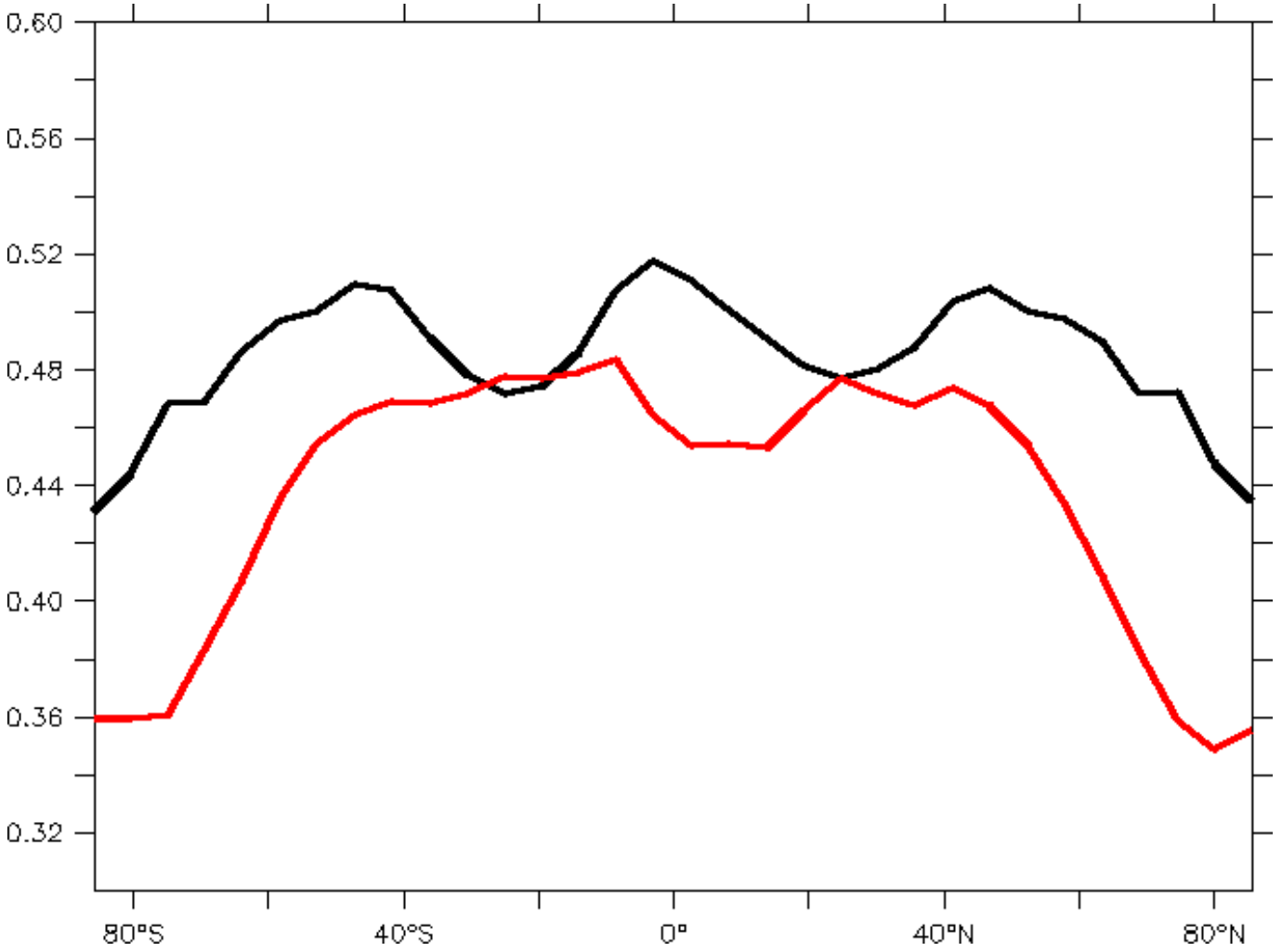
WaterWorld: inhibited ocean heat transport







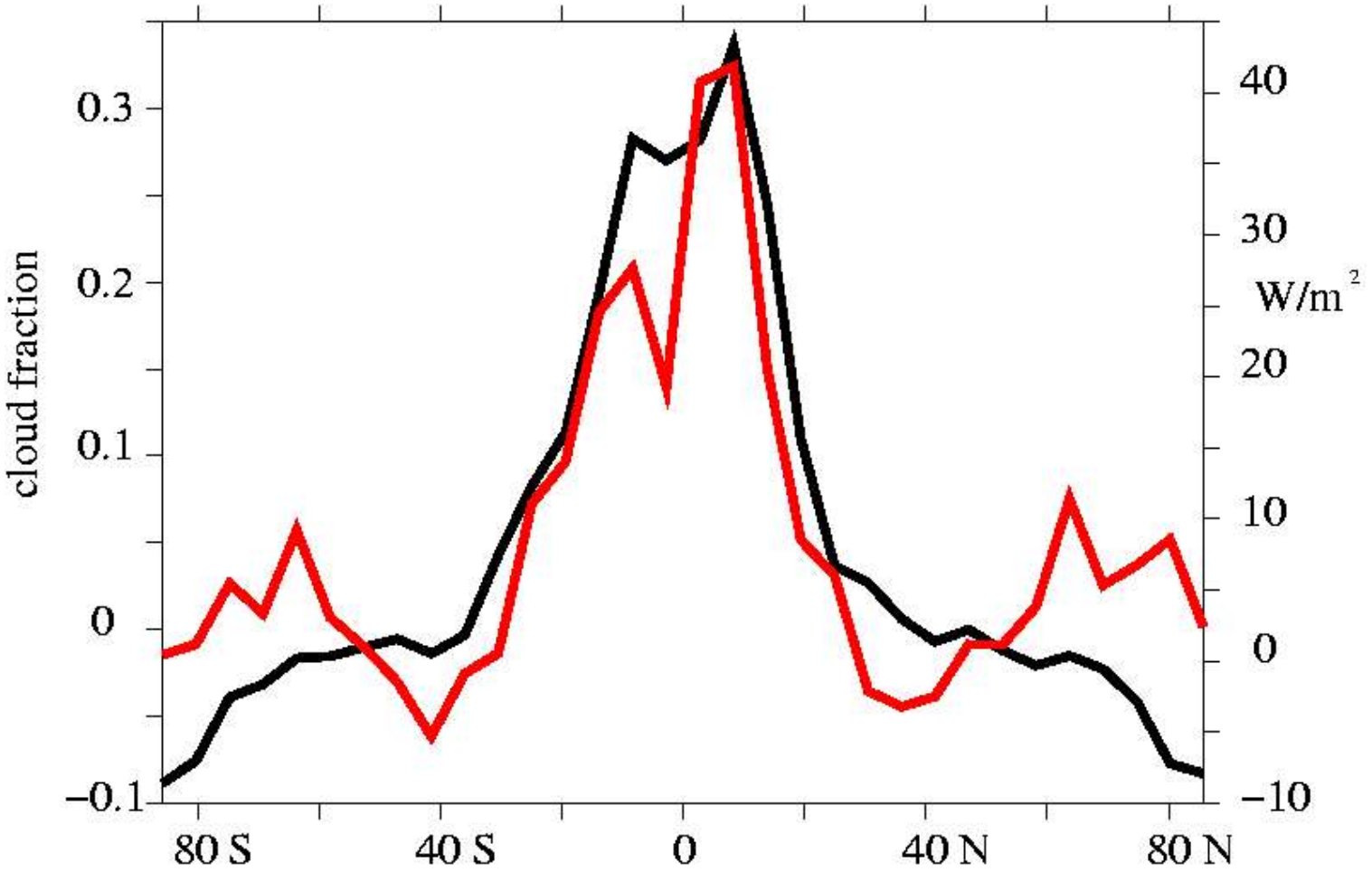
WaterWorld: inhibited ocean heat transport



Zonal average longwave absorption fraction

Red: swamp WW
Black: coupled WW

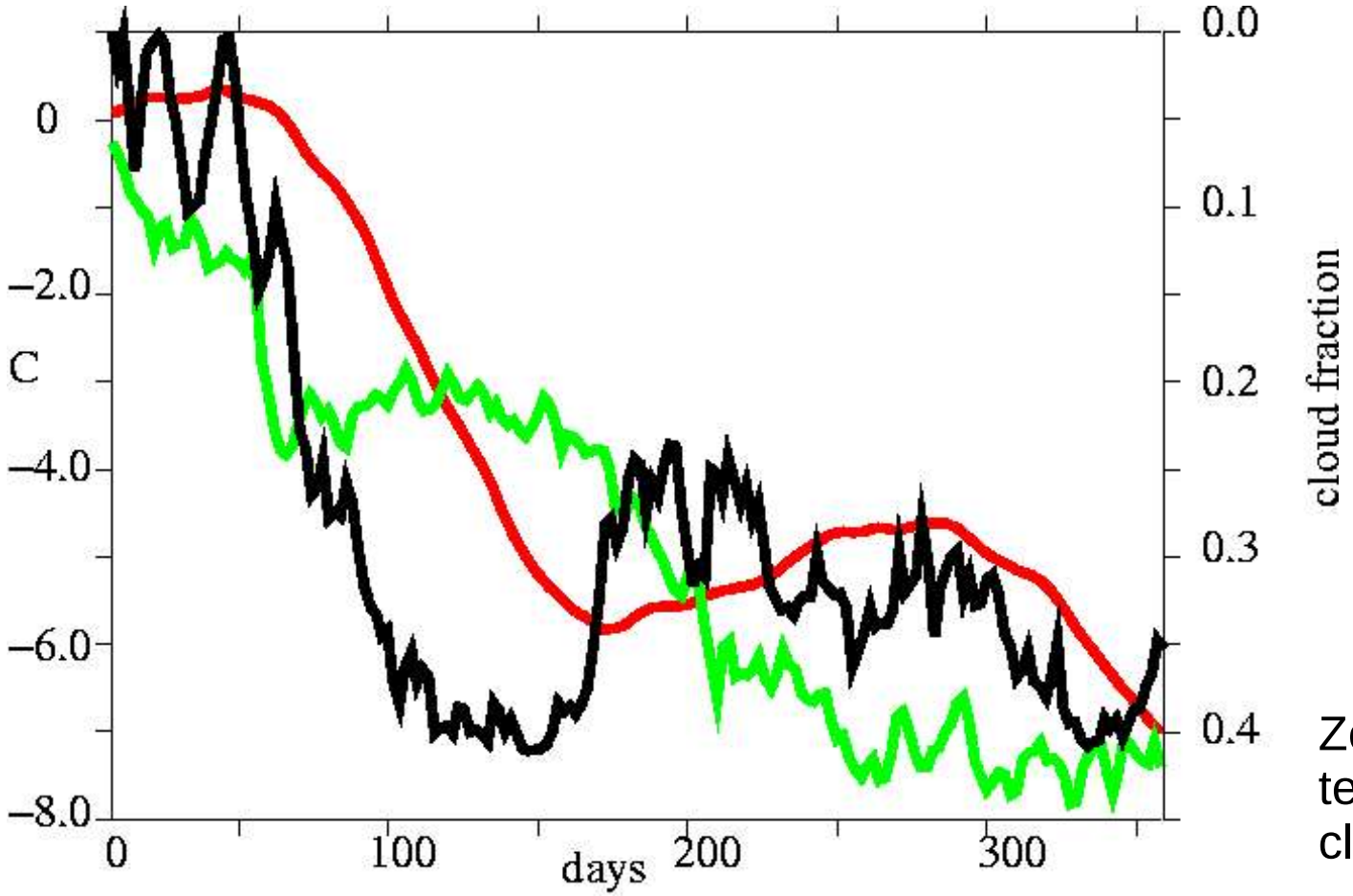
WaterWorld: inhibited ocean heat transport



Zonal average changes in shortwave emission at TOA and low level cloud

Red: shortwave emission, right
Black: low cloud, left

WaterWorld: inhibited ocean heat transport



Zonal average changes in temperature (left) and low cloud (right)

Red: low latitude AST
Green: high latitude AST
Black: low latitude low cloud fraction

Conclusions

- Stable coupled climate achieved
- Very humid, warm greenhouse
- Similar system heat transport to 'realistic' reference
- High non-advective (eddy?) heat transport in the ocean
- Major global impact of inhibited ocean heat transport through atmospheric feedbacks