Interactions between South Atlantic Stratus and the Meridional Mode

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Atlantic Meridional Mode

Chiang and Vimont 2004 (J Clim)
Long term mean low cloud cover and Regression of 10m winds onto the AMM

Tanimoto and Xie (2002)
Solar contribution to $\frac{dSST}{dt}$
Three records of low cloud cover
1000 - 600hPa

1) PATMOSx: AVHRR (vis+ir), polar orbiting, monthly climatology from 1x daily observations, 1982–2010.

2) ISCCP: GOES (vis+ir), geostationary, monthly climatology from 8x daily observations, 1983–2008.

Long term mean low cloud cover

- PATMOSx
- ISCCP
- CAM+SOM
Low clouds regressed onto AMM

\[
AMM(t) = \sum \left( SST_{\text{monthly}}(x,y) \times AMM(x,y) \right)
\]
Dust contamination in NH?

Evan and Mukhopadhyay (2010) *JAMC*

Evan et al. (2005) *IJRS*
Low clouds regressed onto AMM

\[ AMM(t) = \sum \left( SST_{\text{monthly}}(x,y) \times AMM(x,y) \right) \]
Cross-correlation function of low cloud cover and the “observed” AMM (SH-only)

\[ \text{AMM}(t) = \sum (\text{SST}_{\text{monthly}}(x,y) \times \text{AMM}(x,y)) \]

\[ \text{CLD}_{\text{AMM}}(t) = \sum (\text{CLD}_{\text{monthly}}(x,y) \times \text{AMM}(x,y)) \]
Low cloud forced change to SST
Future work

1) Examination of CMIP5 models to determine which reproduce observed relationship between low clouds and the AMM

2) Develop a method to estimate the surface forcing from satellite observations (CALIPSO)

3) Model experiments to evaluate relevance of cloud forcing for excitation of meridional mode
Atlantic Meridional Mode

\[ \frac{\partial \tilde{u}}{\partial t} = \beta y \hat{k} \times \tilde{u} - \nabla (\phi - \Gamma \kappa T) - \varepsilon_u \tilde{u} \]

\[ \frac{\partial \phi}{\partial t} = -c_{RG}^2 \nabla \times \tilde{u} - \varepsilon_\phi (y) \phi \]

\[ \frac{\partial T}{\partial t} = \alpha_{WES} (y) u - (\varepsilon_T - \gamma \nabla^2) T \]

Xie 1999 (J Clim)
Kossin and Vimont 2007 (BAMS)
Surface forcing & stochastic MLD model

\[ F_{sfc} = -0.88 \times LCC' \]

\[ \rho C_p \frac{dHT}{dt} = F_{sfc} - \lambda T + (\rho C_p W_e) (T - T_b) \]

\[ \text{Fairall et al. 2008 (J Clim)} \]

\[ \text{Deser et al. 2003 (J Clim)} \]
PIRATA mooring at 10°S, 10°W
Low cloud anomalies should be out of phase with the AMM

Stratocumulus

- SW

+ LW

Net negative surface forcing