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# **Clear-sky OLR Bias and Water Vapor Drift in CAM – A CAPT Evaluation (Update)**

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***With contribution from***

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# Three model versions examined under CAPT

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- CAM3.5 = CAM3-5-35 (CAMRT + MG Microphysics + HB PBL+Hack ShCu)
- CAM3.6= CAM3-6-15dev07 (RRTM + MG Microphysics + UW PBL/ShCu) (*Reported by Steve Klein at Spring AMWG meeting*)
- CAM4 = CAM3-6-26dev21 (RRTM + MG Microphysics + UW PBL/ShCu)

No major parameterization differences between CAM3.6 and CAM4, but many minor fixes and adjustments

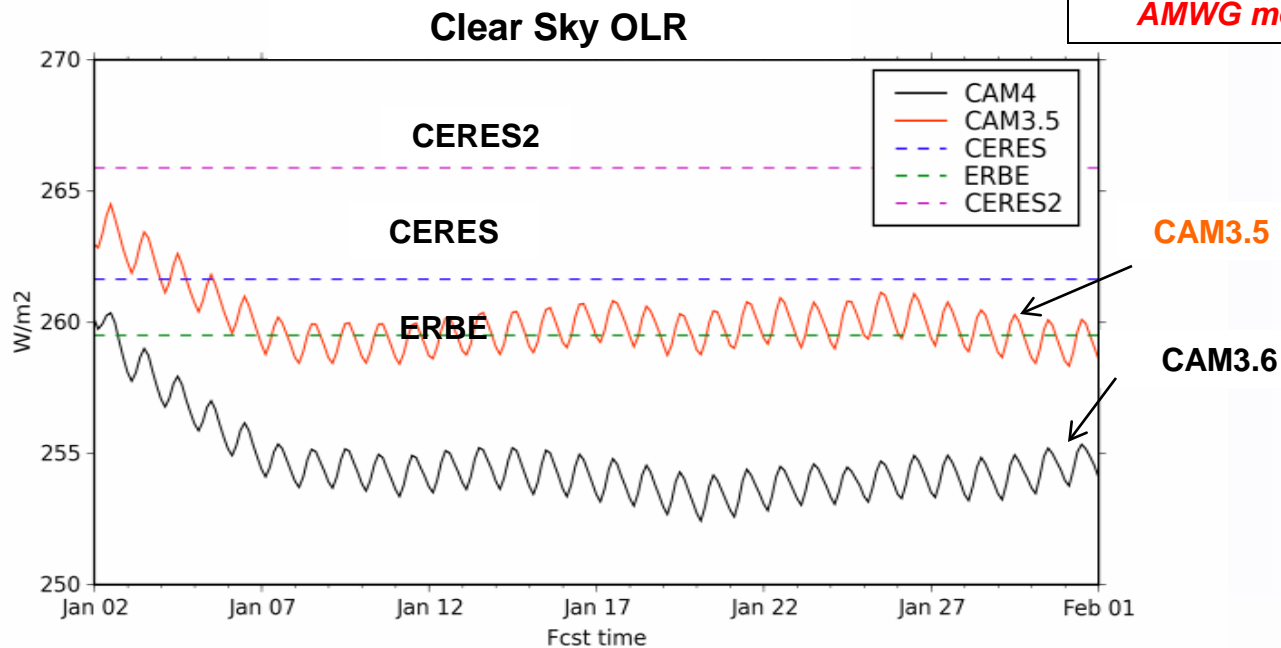
*Weather forecasts are initiated every day at 00Z from 1 Jan to 28 Feb 2006 with the ECMWF operational analysis*



# Background

- ***CAM3-6-15dev07 (CAM3.6) has a low bias in clear-sky OLR***

## Global Means 30 Day Forecast for January 2006 from ECMWF Initial Conditions



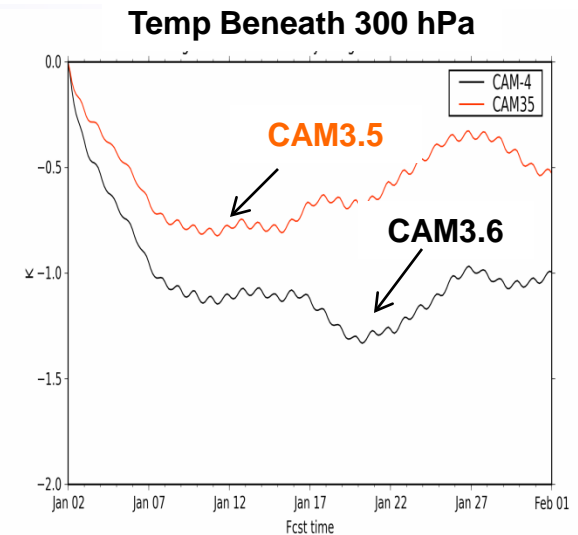
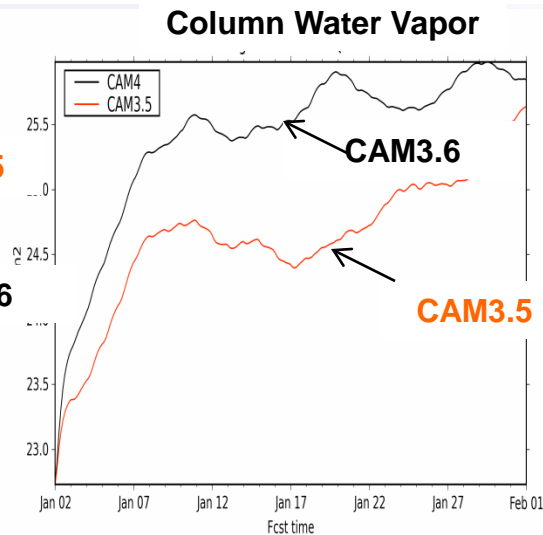
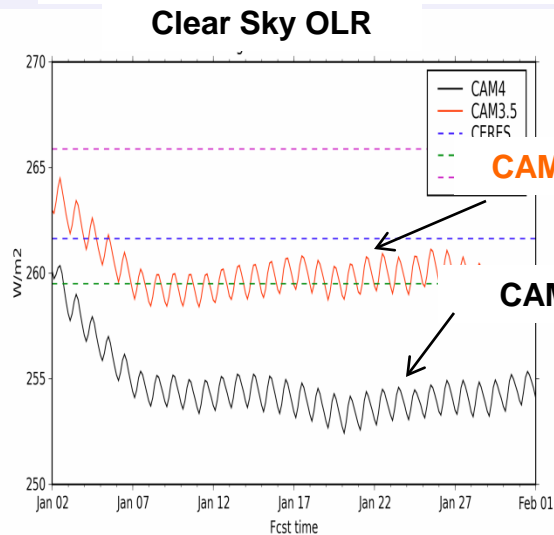
- ***CAM3.6 has smaller OLR than CAM3.5 even at the initial state – the bias of CAMRT and RRTM***
- ***Drift to ‘climate’ occurs over ~ 5 days***

# Background



- ***Our earlier work shows that the bias in clear-sky OLR is associated with drifts in middle & lower tropospheric water vapor (moist) and temperature (cold)***

## Global Means 30 Day Forecast for January 2006 from ECMWF Initial Conditions



**By Klein (2009 Spring AMWG meeting)**



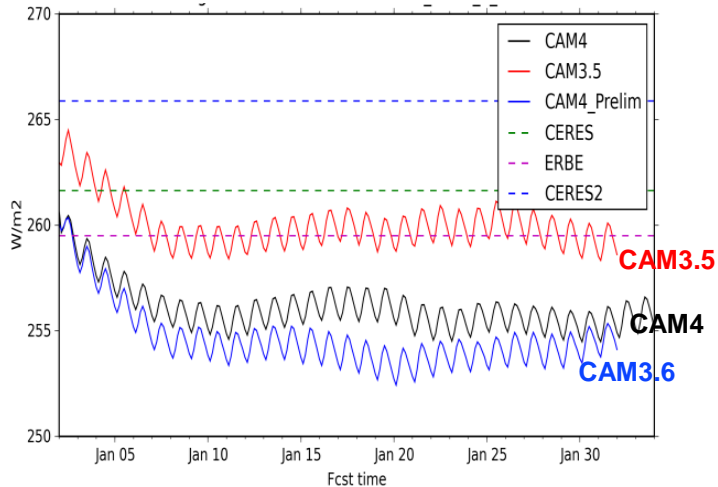
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***Are there similar drifts in the latest version  
of CAM - CAM3-6-26dev21 (CAM4)?***

# Global Means 30 Day Forecast for January 2006

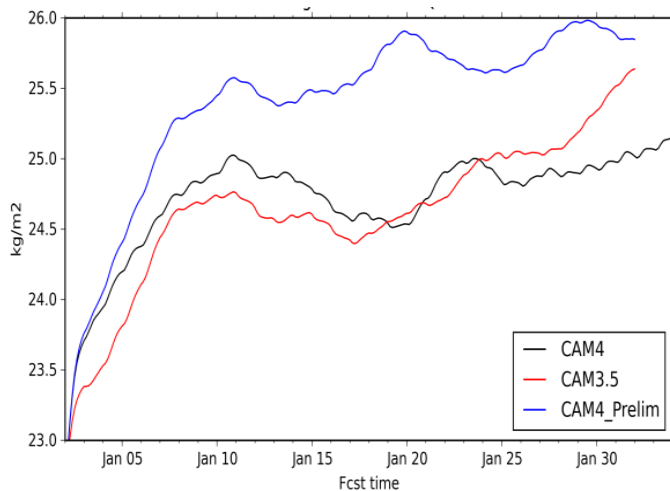


### Clear-Sky OLR

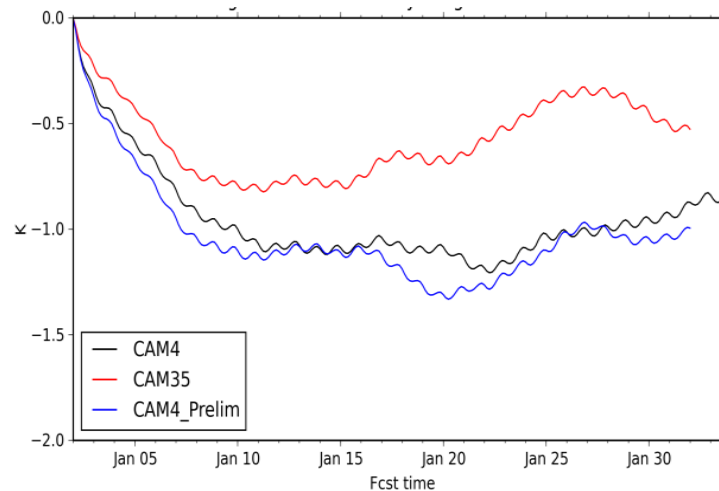


- **No clear drift in CAM4 clear-sky OLR as that shown in CAM3.6.**
- **Difference in clear-sky OLR between CAM4 and CAM3.5 is consistent with offline comparisons of CAMRT and RRTM.**
- **CAM4 is comparable to CAM3.5 w.r.t. the PW bias.**
- **CAM4 still shows a cold drift similar to CAM3.6.**

### Column Water Vapor



### Temp Beneath 300 hPa

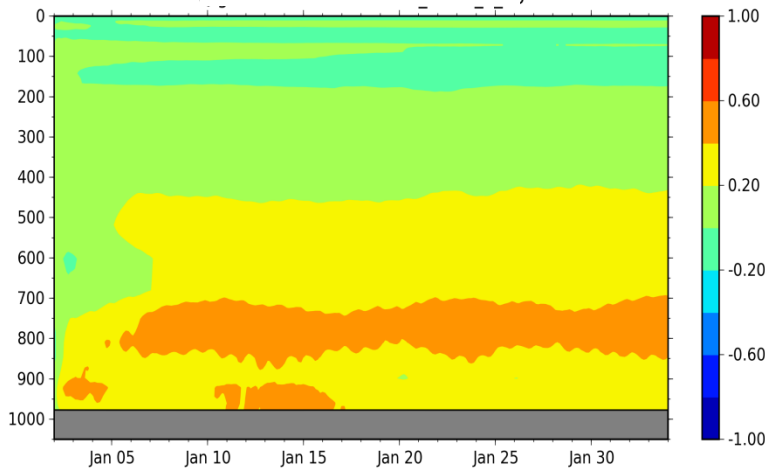


# Vertical Profiles of Water Vapor Drift

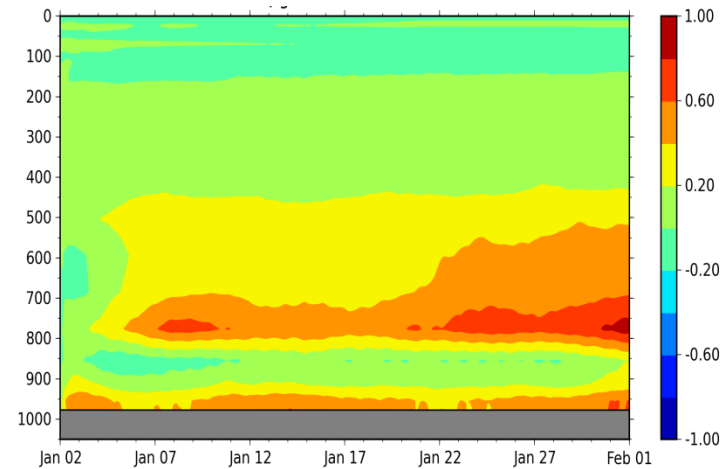


## Global Means 30 Day Forecast for January 2006

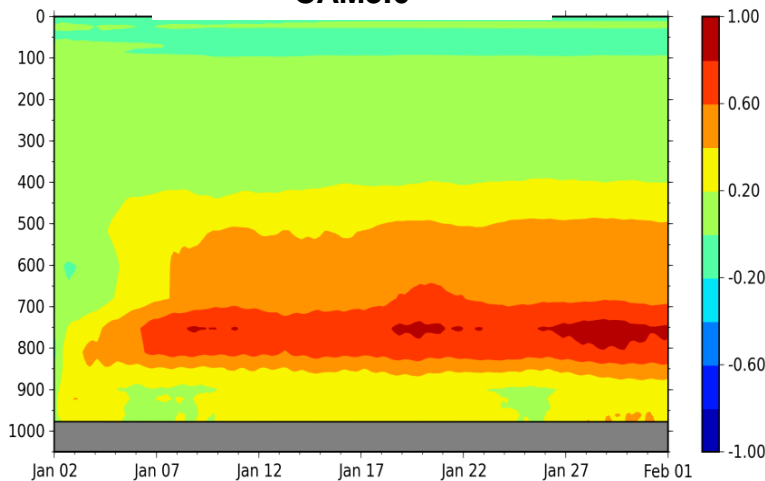
CAM4



CAM3.5



CAM3.6



**Drift = Forecasts – Initial Values**

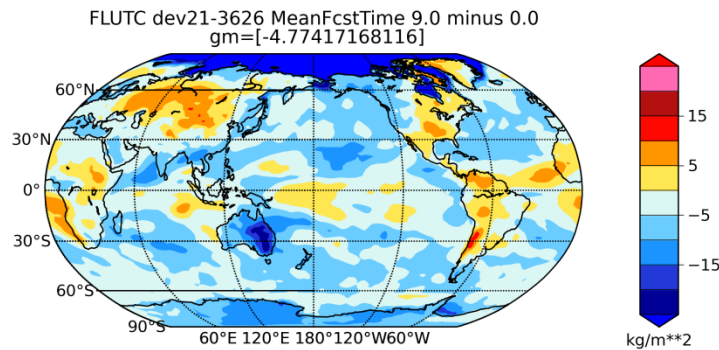
- *The drift in CAM3.6 significantly reduced in CAM4.*
- *The largest moist bias is still near 800 hPa.*
- *Overactive PBL/ShCu?*

# Global Distribution of the Drift

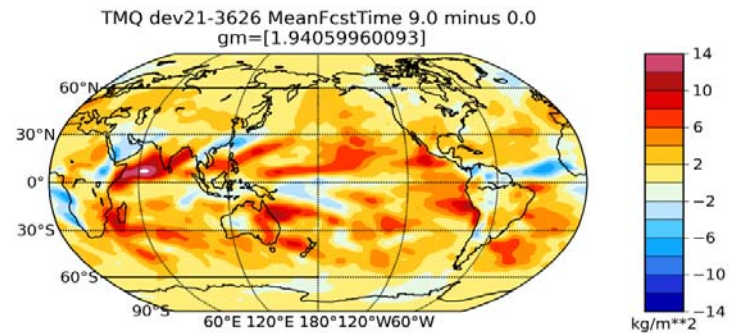


## CAM4 drift from initial values over Day 9 ensemble forecasts

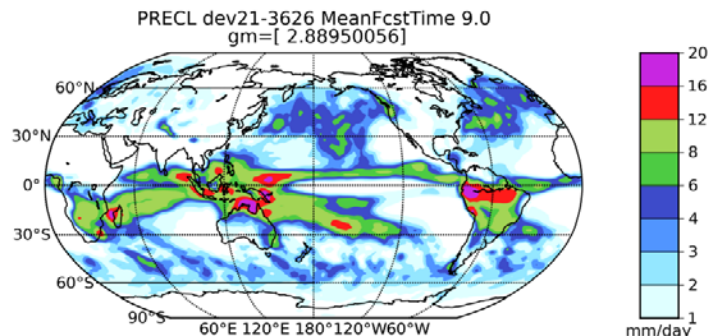
### Clear Sky OLR



### Column Water Vapor



### Precipitation



- **Similar to CAM3.5 and CAM3.6 .**
- **Clear-sky OLR drifts are co-located with large drifts in column water vapor.**
- **Drifts are prominent in tropical regions adjacent to the deep convection regions → Again point to PBL/ShCu processes.**

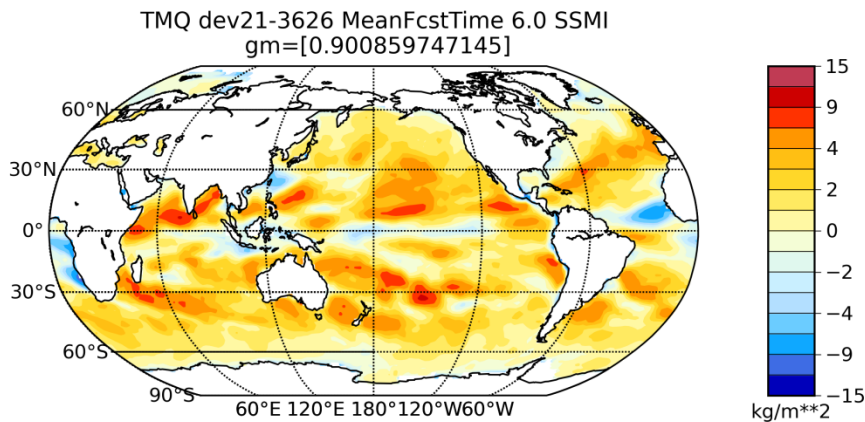


# Global Distribution of the Drift

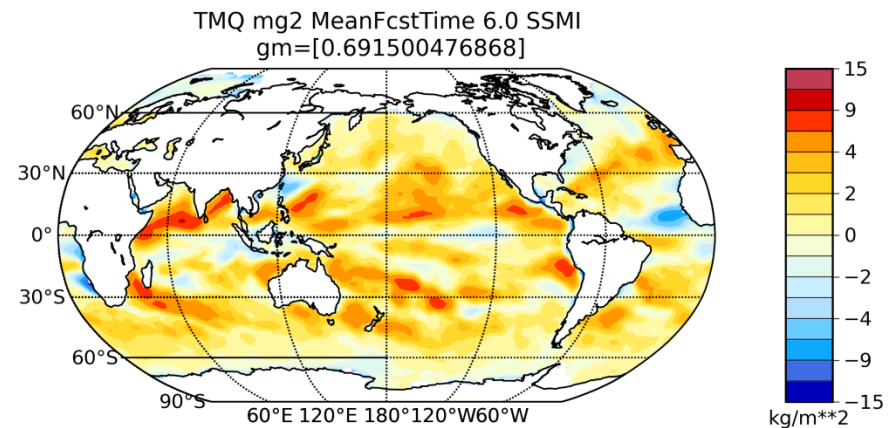


Water vapor drift from SSM/I Wentz retrievals over Day 6 ensemble forecasts

CAM4



CAM3.5



*PW drifts in CAM4 and CAM3.5 are very similar although they have different PBL/ShCu schemes*

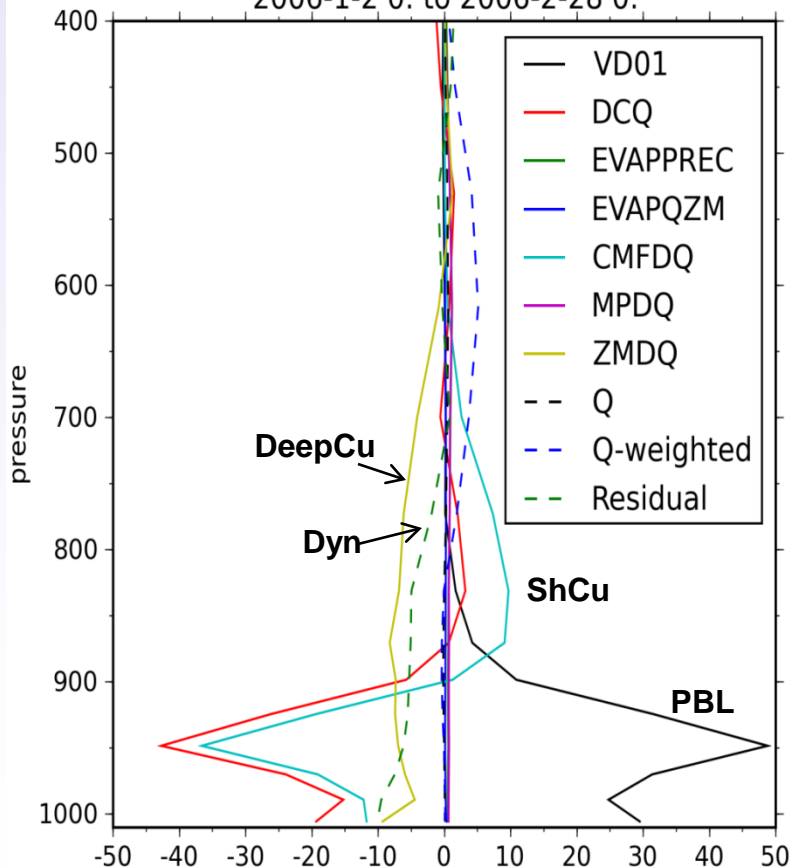
*→ Not due to the change of PBL/ShCu schemes, but they might be still overactive.*

# Budget diagnosis might give us some hints



## CAM4 Water budget over North Tropical Pacific (0-30N, 125-235E)

Over FcstDay 2.0 To 9.0 0.00 to 30.00 125.00 to 235.00  
2006-1-2 0: to 2006-2-28 0:



- *PBL is the dominant process that transports water from surface to lower troposphere below 900 mb.*
- *ShCu then transports water from lower troposphere to middle troposphere.*
- *Deep convection and large-scale advection dry the middle atmosphere.*

*More detailed analysis needs to be done to understand which process is responsible for the moist bias.*

# Conclusions

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- *The water vapor drift seen in CAM3.6 has been substantially reduced in CAM4 and now comparable to CAM3.5.*
- *The larger clear-sky OLR errors in CAM4 compared to CAM3.5 are due to the fact that the RRTM calculates a lower OLR than CAMRT when given identical atmospheres.*
- *To reduce the drift in the OLR, one needs to reduce the moist drift in water vapor or the cold drift in the temperature beneath 300 hPa, which is a bit worse than it was in CAM3.5*
- *Budget diagnosis is a useful tool, but carefully designed sensitivity tests and in-depth analysis are needed to identify which specific physical process responsible for the remaining bias.*