

THE IMPROVEMENT OF HDO/ H₂O ISOTOPE EFFECTS IN THE TES VERSION 5 DATASET

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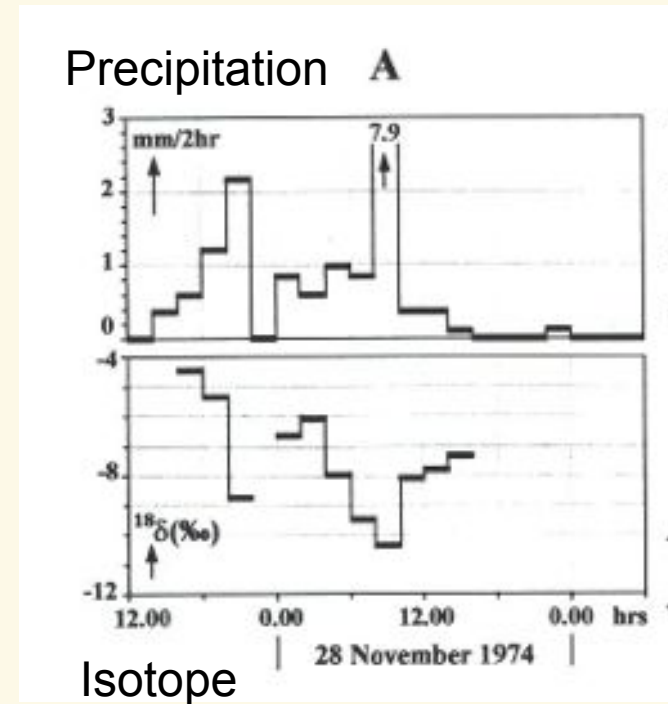
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THE MAIN ISOTOPE EFFECTS

- **Temperature Effect** – Water Vapor becomes more depleted in heavy isotope at lower temperatures ($\delta^{18}\text{O} + 0.5 \text{ ‰}/^\circ\text{C}$ in precipitation)
- **Amount Effect** – linear anti correlation between precipitation and isotope (more precipitation more depleted in heavy isotope)
- **Altitude Effect** – WV becomes More depleted in heavy isotope with increasing elevation
- **Continental Effect** – WV becomes progressively depleted in heavy isotope inland from moisture source



OBJECTIVE

- Comparison of atmospheric isotopologues measurements from TES version 5, TES version 4, SCIAMACHY, and ECHAM 4 model regarding:
 - Geographic distribution
 - Seasonal variability
 - Interannual variability (ENSO)



METHODS

$$X_m^n = X_a + A_{TES}[X_m - X_a]$$

$$A_{TES} = \begin{bmatrix} A_{DD} & A_{DH} \\ A_{HD} & A_{HH} \end{bmatrix}$$

$$X_n^D = X_a^D + A_{DD}(X_m^D - X_a^D) + A_{DH}(X_m^H - X_a^H)$$

$$X_n^H = X_a^H + A_{HH}(X_m^H - X_a^H) + A_{HD}(X_m^D - X_a^D)$$

TES version 4 has high sensitivity at 850-500 hPa

TES version 5 is more sensitive even to near surface layers , ie 925-450 hPa

$$\delta = \frac{R_{\text{sample}}}{R_{\text{VSMOW}}} - 1$$

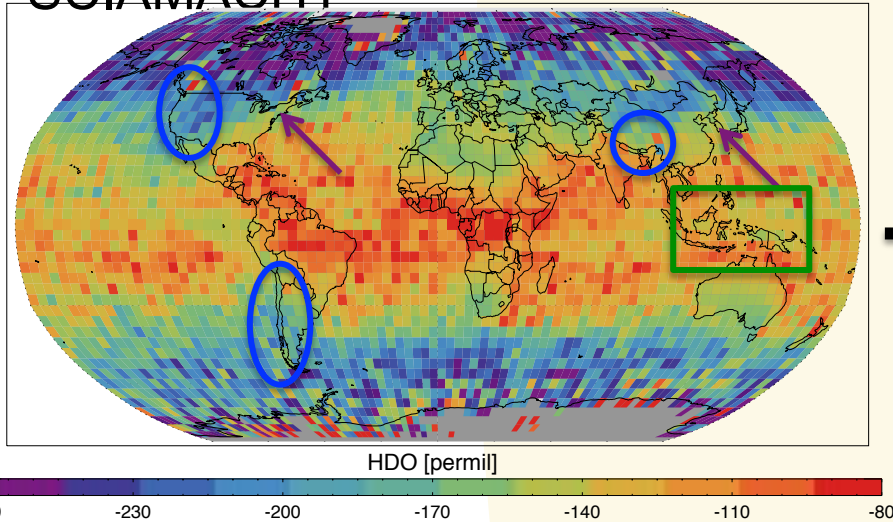
We applied bias correction of 5% for v4, no bias correction for v5 since it is already bias corrected by 6.5%.

SCIAMACHY was bias corrected by -5‰ and -10‰



GEOGRAPHIC DISTRIBUTION

SCIAMACHY



Strong latitudinal effect.

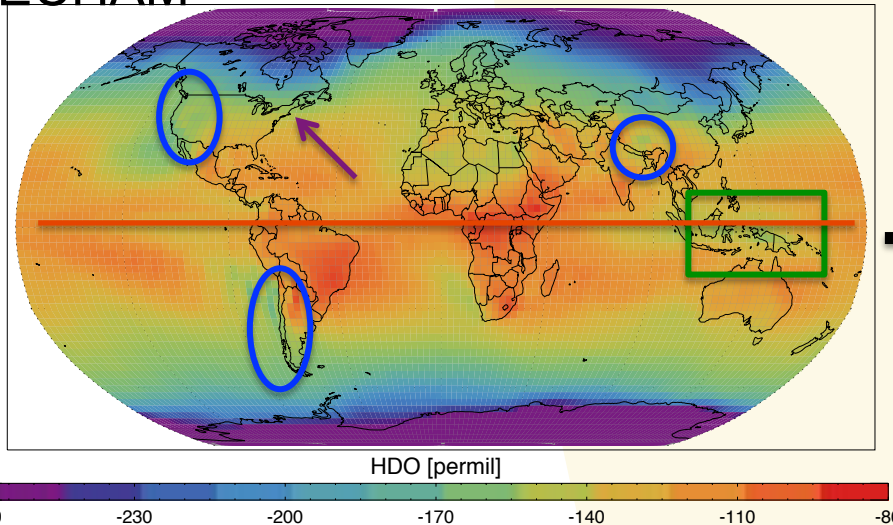
Altitude effect.

Continental effect.

Amount effect.

ICTZ line is clearly visible.

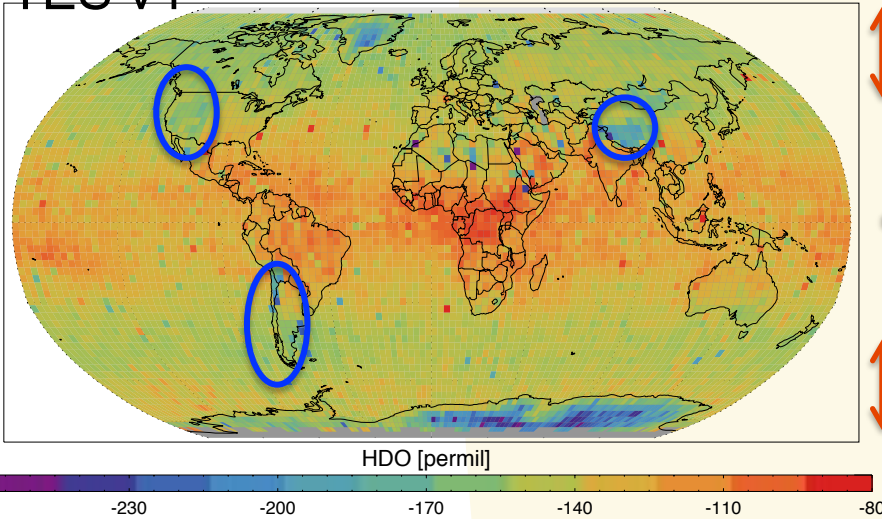
ECHAM



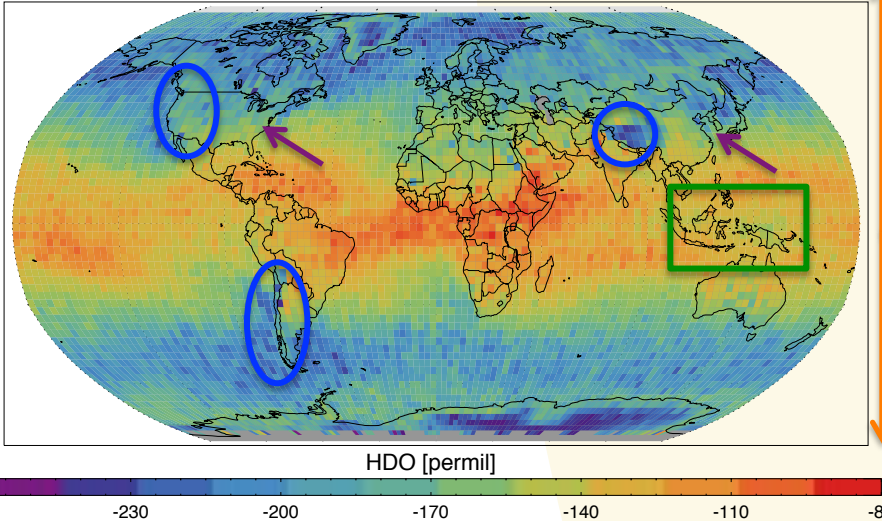
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GEOGRAPHIC DISTRIBUTION

TES v4



TES v5

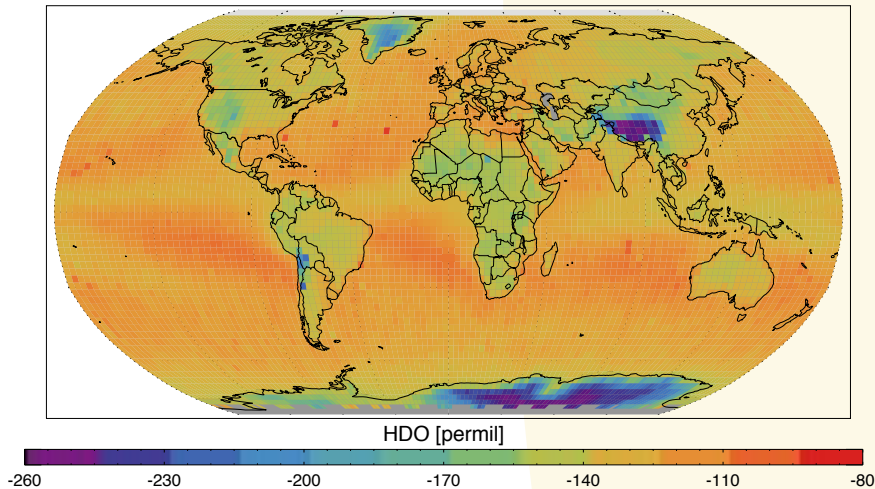


High latitudes are far too enriched (v4).
Strong latitudinal effect (v5 improved).
Strong Altitude effect.
Continental effect.
Amount effect.

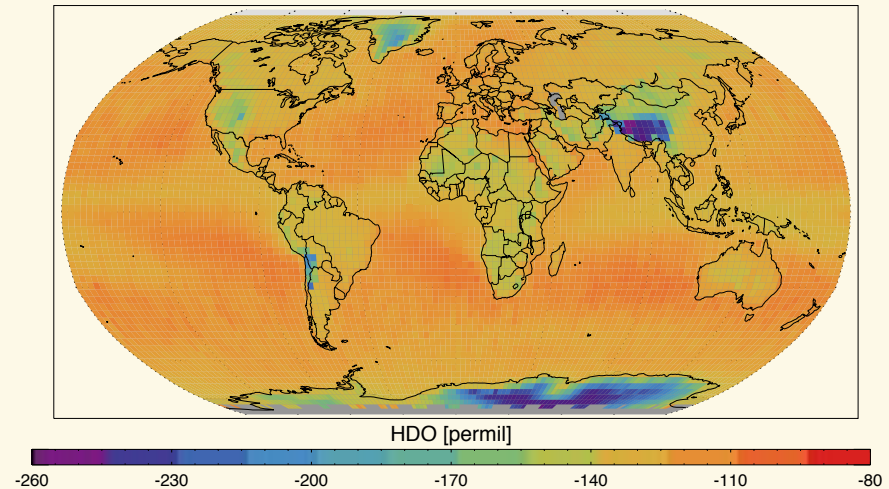


GEOGRAPHIC DISTRIBUTION

TES prior v4



TES prior v5

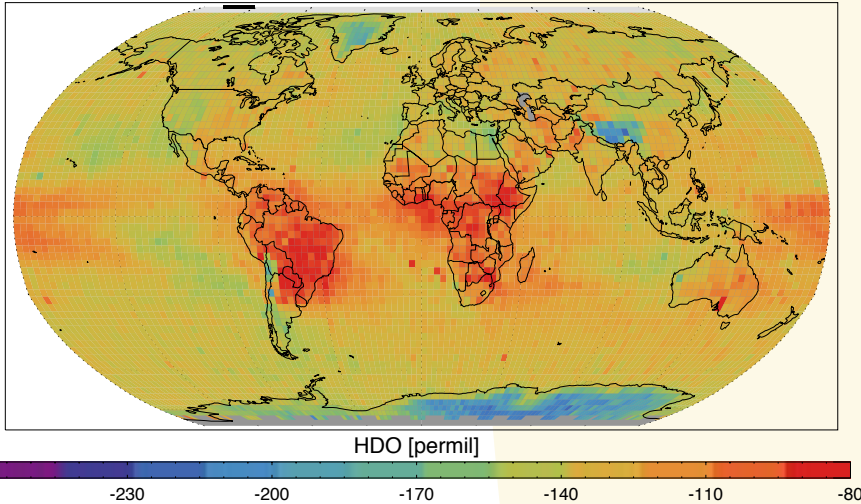


The TES HDO/H₂O prior is a single fixed value representative of the tropics calculated from a run of the NCAR-CAM

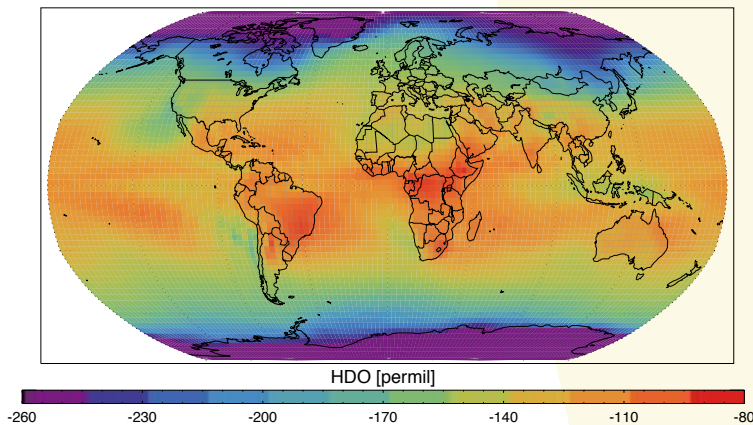


GEOGRAPHIC DISTRIBUTION

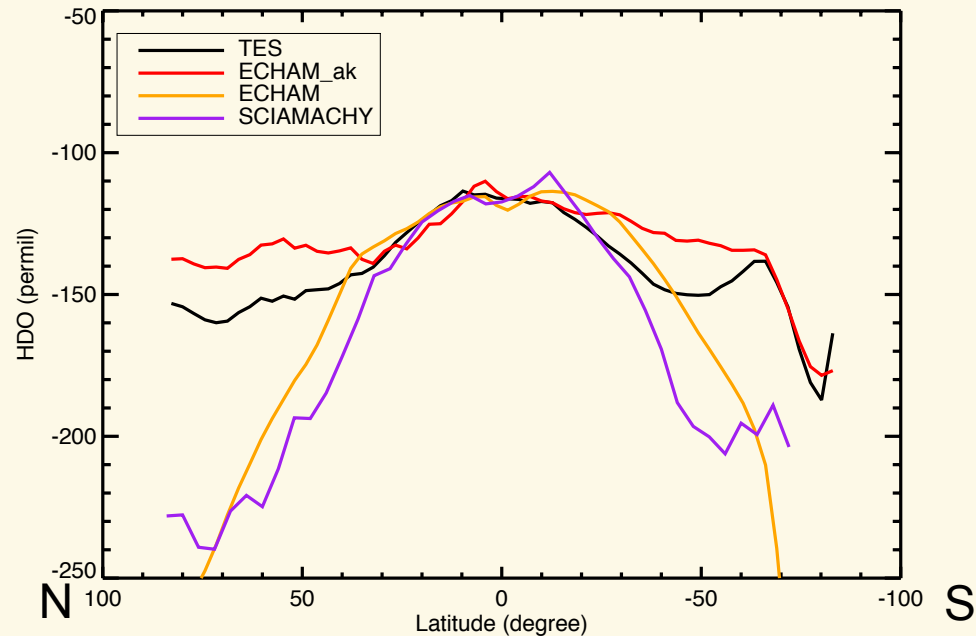
ECHAM_ak v4



ECHAM



Less latitudinal effect.
High latitudes are completely dominated by the prior.
Some regions (the Himalayas) show exactly **like a priori**.
ITCZ line is clearly visible.



GEOGRAPHIC DISTRIBUTION

Strong latitudinal effect.

The result is more **like ECHAM** in the Tropics.

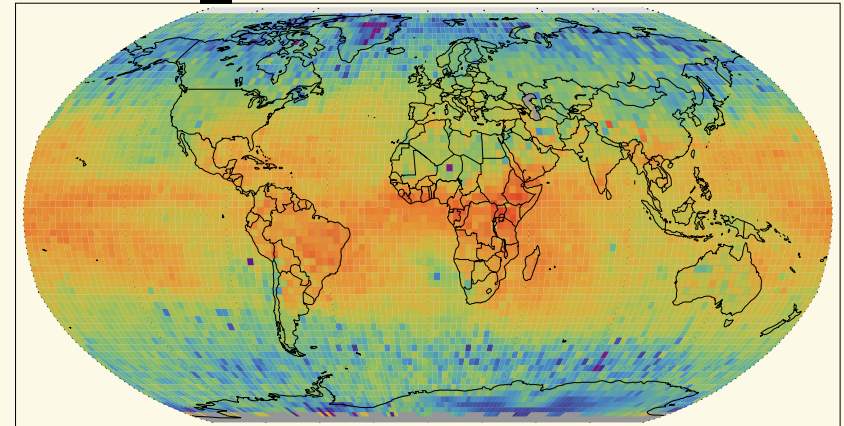
Exaggerated altitude effect in the Himalayas disappears.

Amount effect.

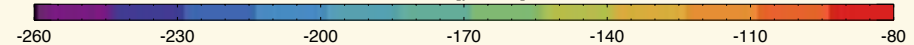
ICTZ is visible.



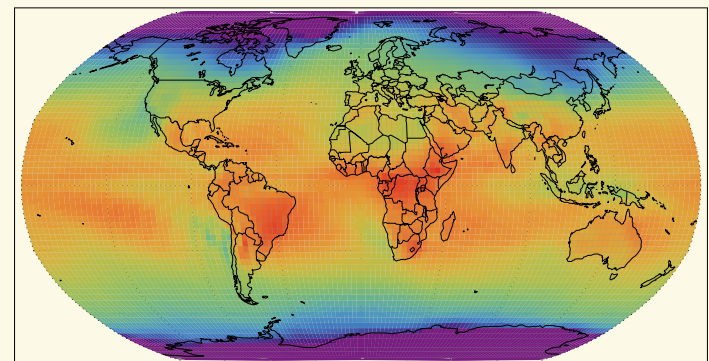
ECHAM_ak v5



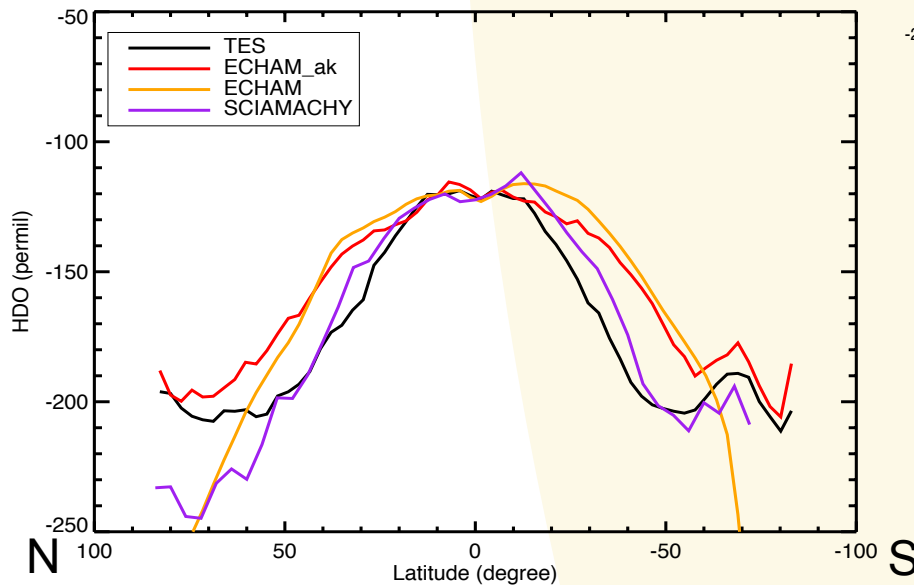
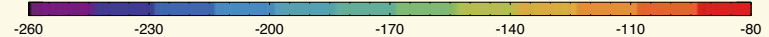
HDO [permil]



ECHAM

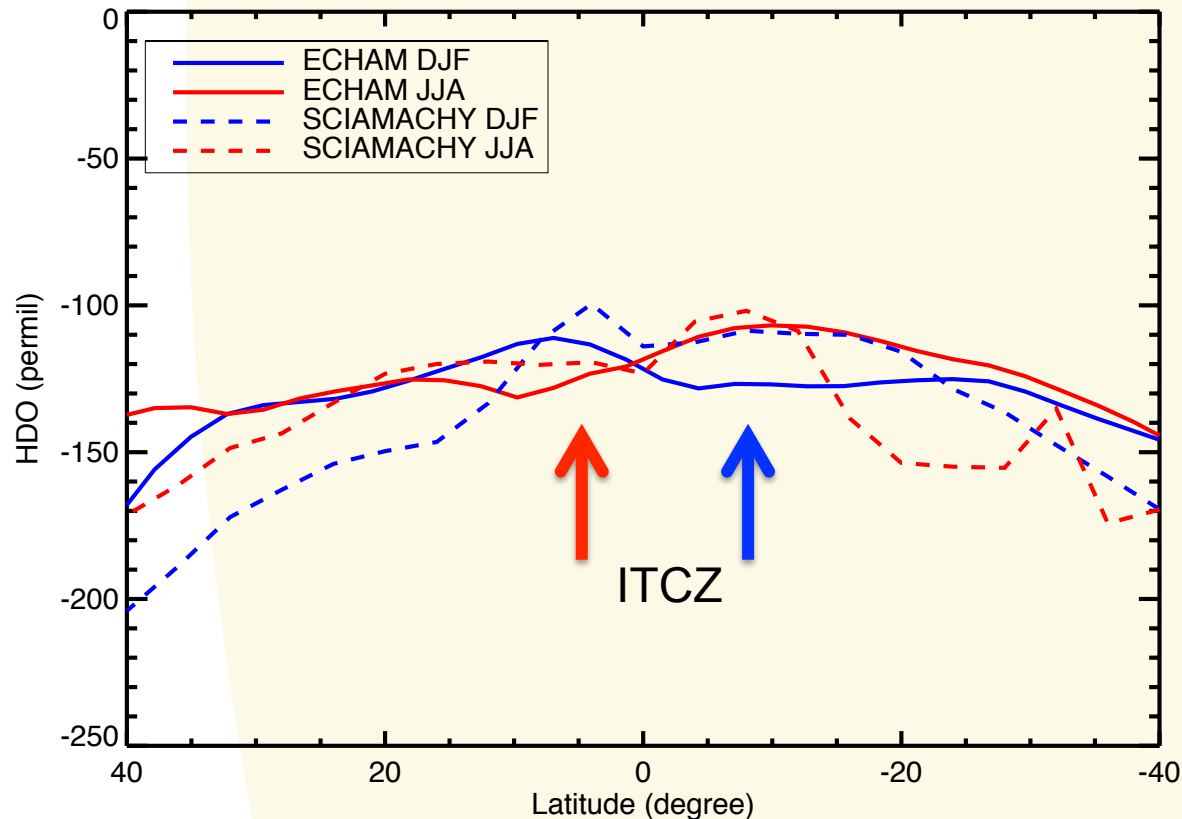


HDO [permil]



SEASONAL VARIABILITY

ECHAM & SCIAMACHY



Red=Summer

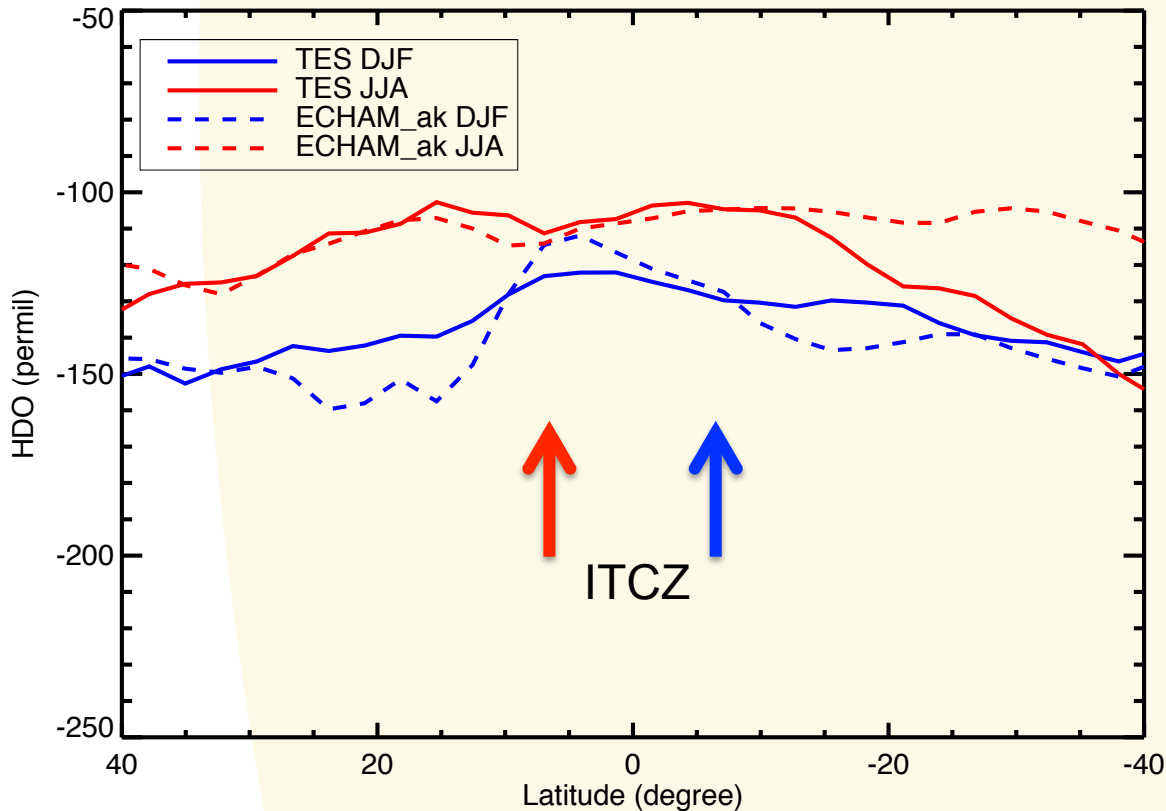
Blue=Winter

ECHAM and SCIAMACHY show quite realistic seasonality in the tropics, e.g. relatively small variations around the annual mean, DJF and JJA in agreement with movements of the ITCZ and the isotopic amount effect.



SEASONAL VARIABILITY

TES & ECHAM_ak v4



Red=Summer

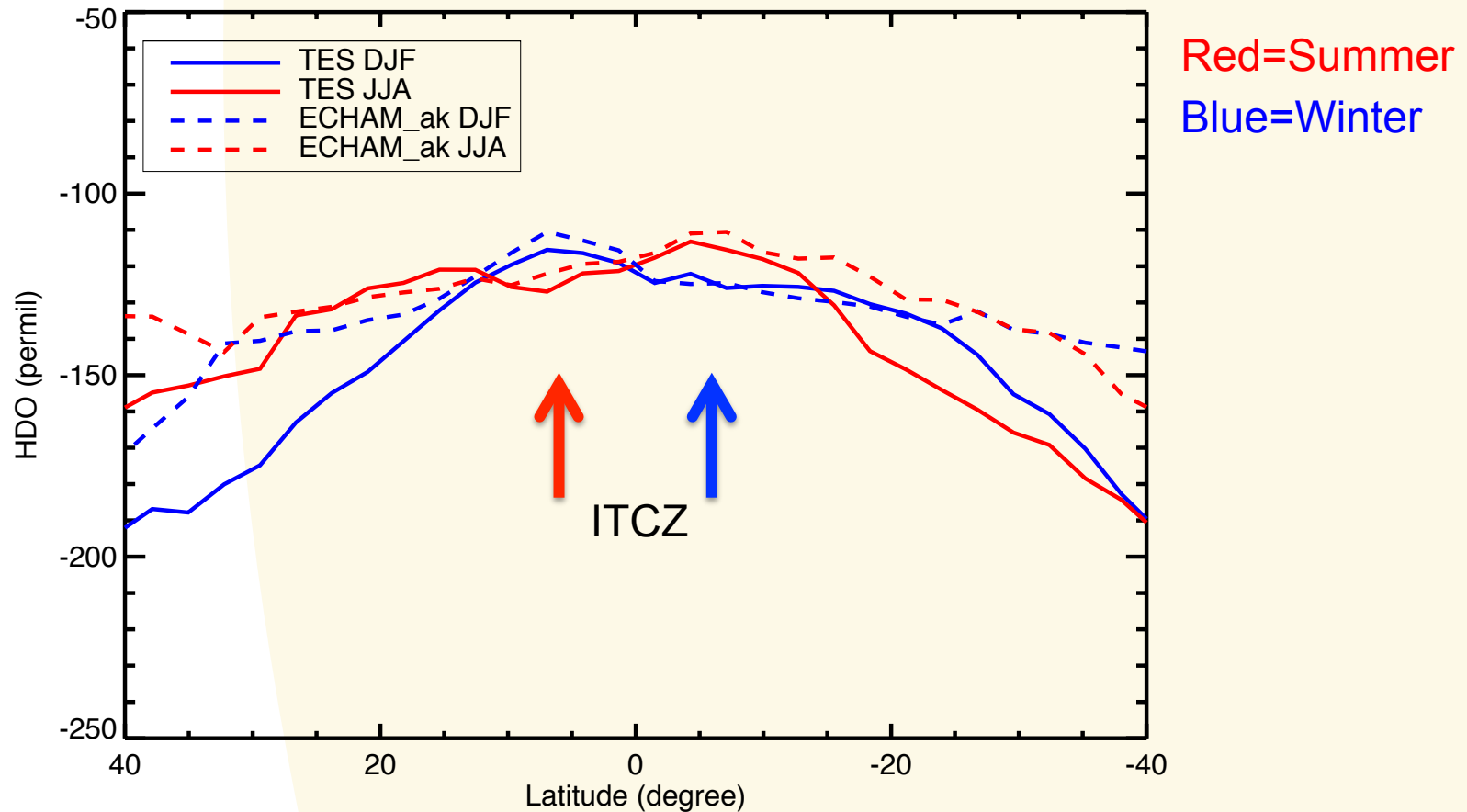
Blue=Winter

Applying the AK on the GCM result destroys the seasonality features in the model. During summer, HDO values are always higher than winter.



SEASONAL VARIABILITY

TES & ECHAM_ak v5

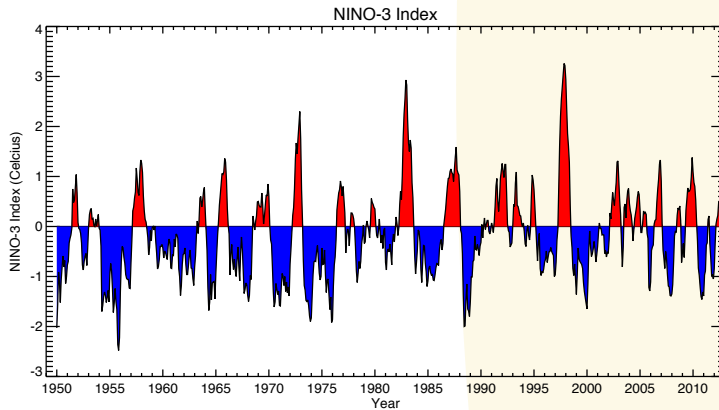


This seasonality feature is seen in version 5



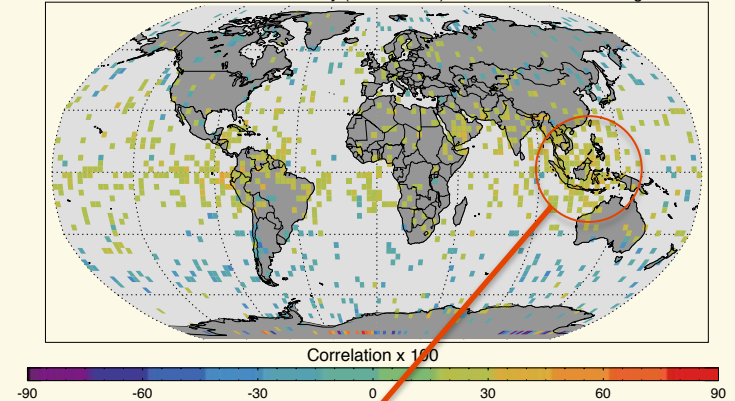
INTERANNUAL VARIABILITY

NINO-3 INDEX



TES v4

Correlation of Nino3 Index on HDO anomaly (850-500hPa) from TES V4 with 10% significance level



Indonesia

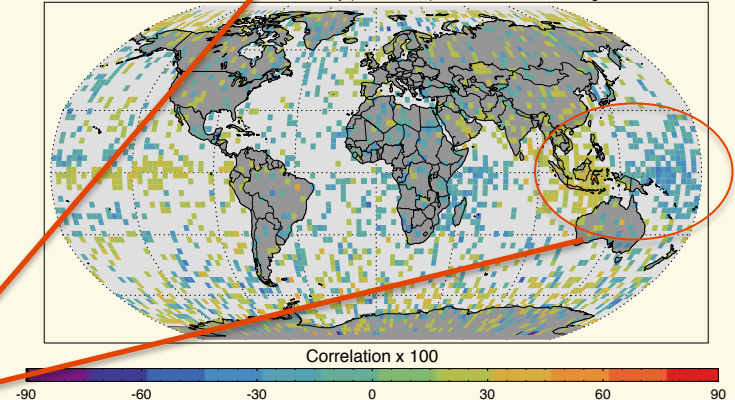


West Pacific



TES v5

Correlation of Nino3 Index on HDO anomaly (925-450hPa) from TES V5 with 10% significance level



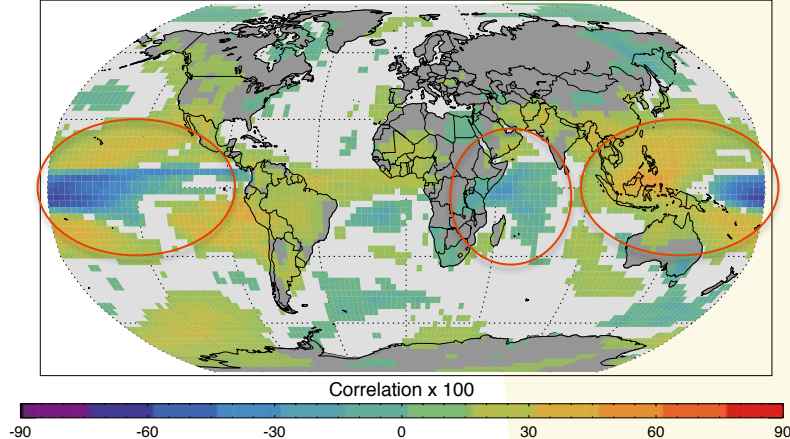
More clear ENSO pattern from TES v5 in the West Pacific Ocean



CHANGES IN ENSO VARIABILITY

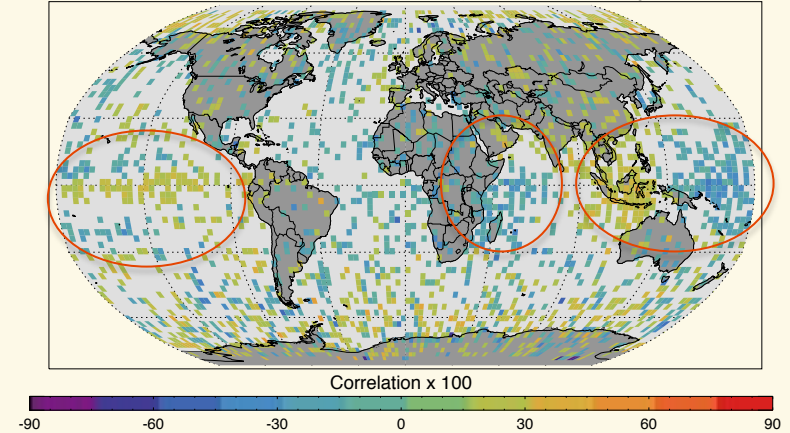
ECHAM 1000 hPa

Correlation of Nino3 Index on HDO anomaly at 1000hPa (x100) with 10% significance level



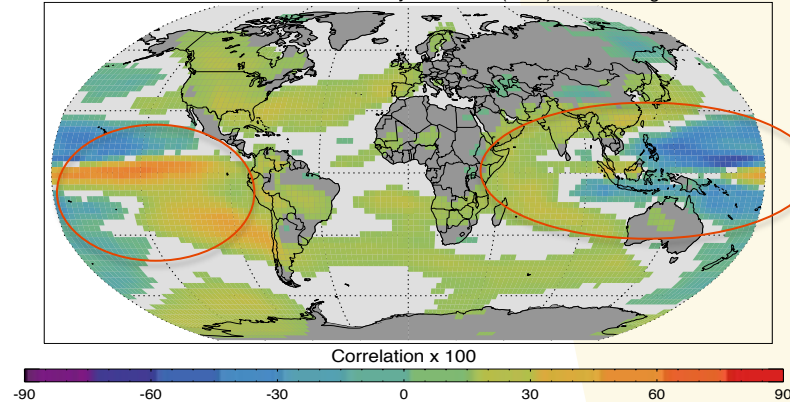
TES 925-450 hPa

Correlation of Nino3 Index on HDO anomaly (925-450hPa) from TES V5 with 10% significance level



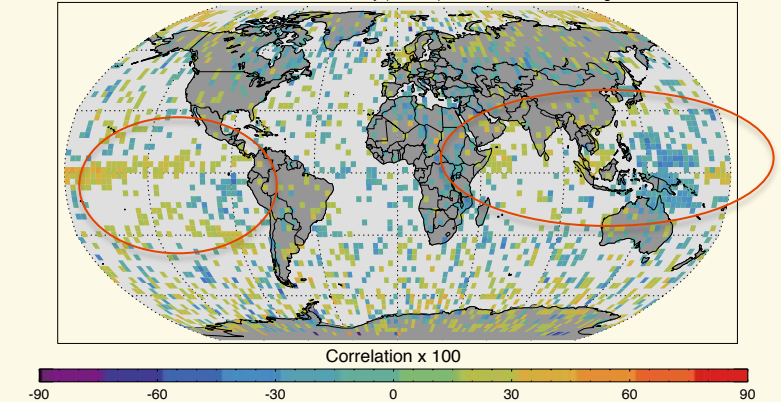
ECHAM 500 hPa

Correlation of Nino3 Index on HDO anomaly at 500hPa (x100) with 10% significance level



TES 500 hPa

Correlation of Nino3 Index on HDO anomaly (500hPa) from TES V5 with 10% significance level



TES at 500 hPa captured the changes in ENSO variability



CONCLUDING REMARKS

- A number of strong isotope effects are clearly seen in the TES v5, e.g. more realistic the latitudinal gradient, the continental effect and the amount effect.
- The TES v5, ECHAM and SCIAMACHY show quite realistic seasonality in the tropics.
- The effect of ENSO in the Indian Ocean and in the West Pacific Ocean is clearly seen in TES v5.



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