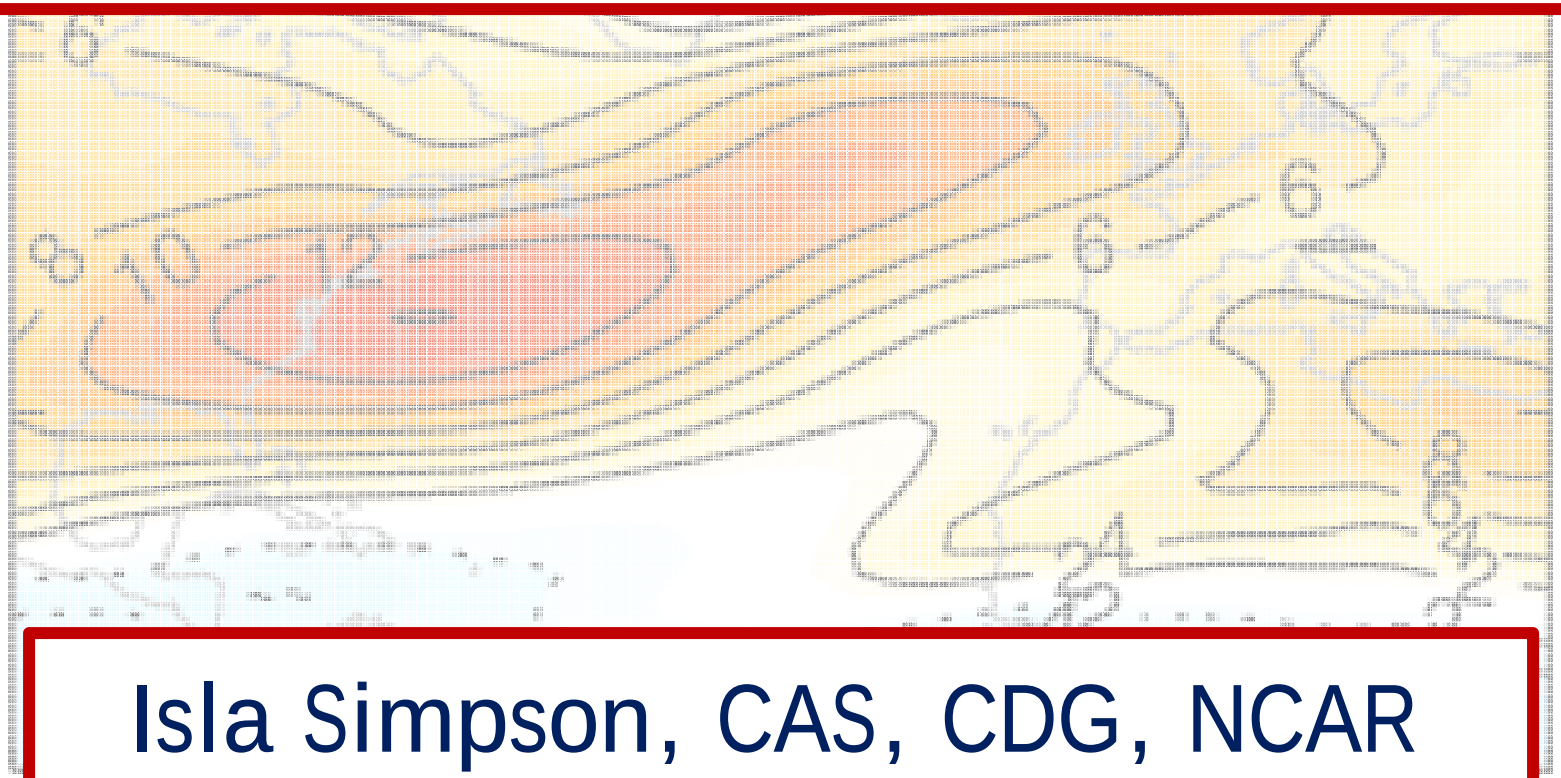
How well do we know the climatological characteristics of the North Atlantic jet stream?



Isla Simpson, CAS, CDG, NCAR

A common bias among GCMs is that the Atlantic jet is too zonal

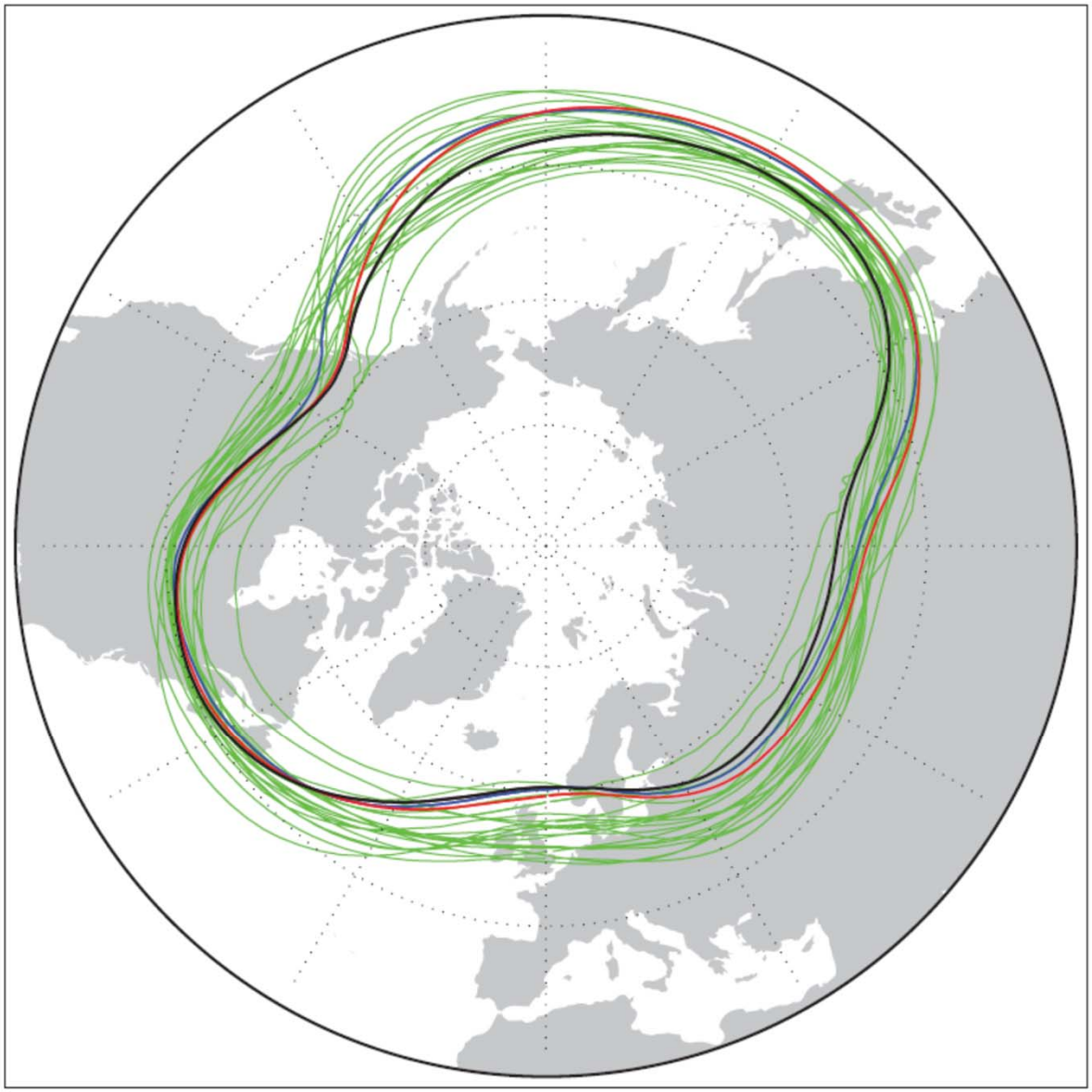
One particular contour of 500hPa geopotential height during DJF →

(Indicates the location of the jet stream)

— ERA-40 1957-2001

— CMIP3

— High resolution models



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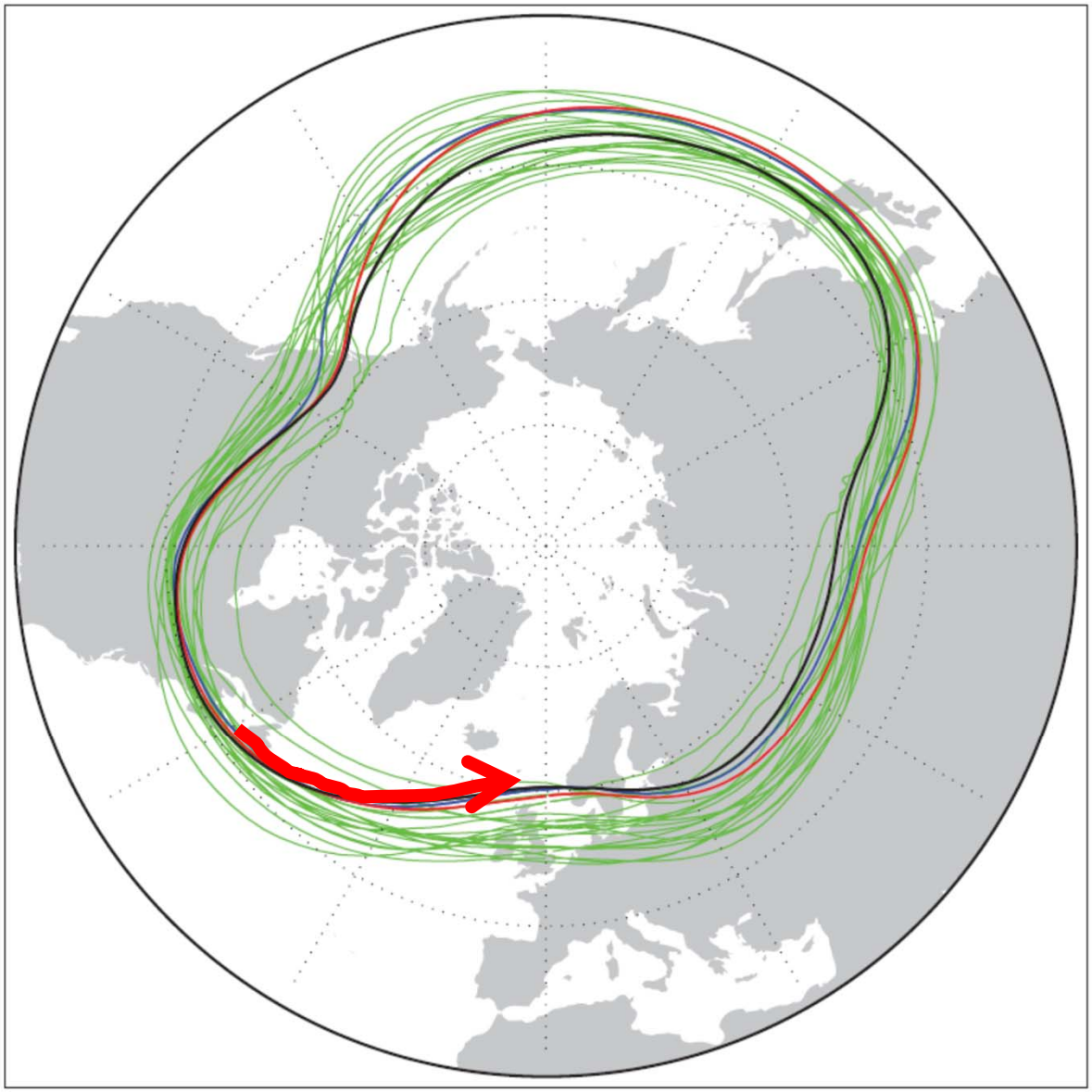

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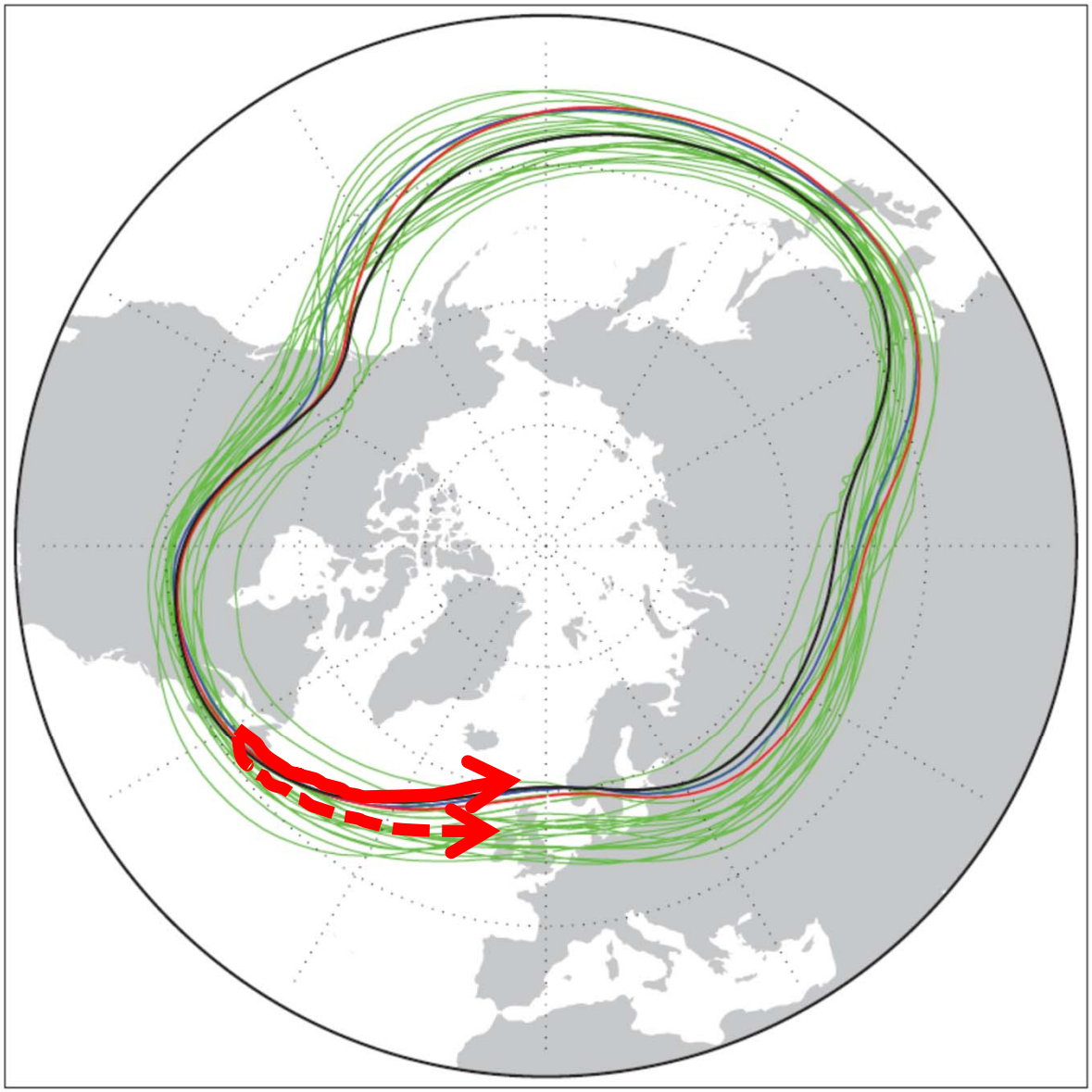

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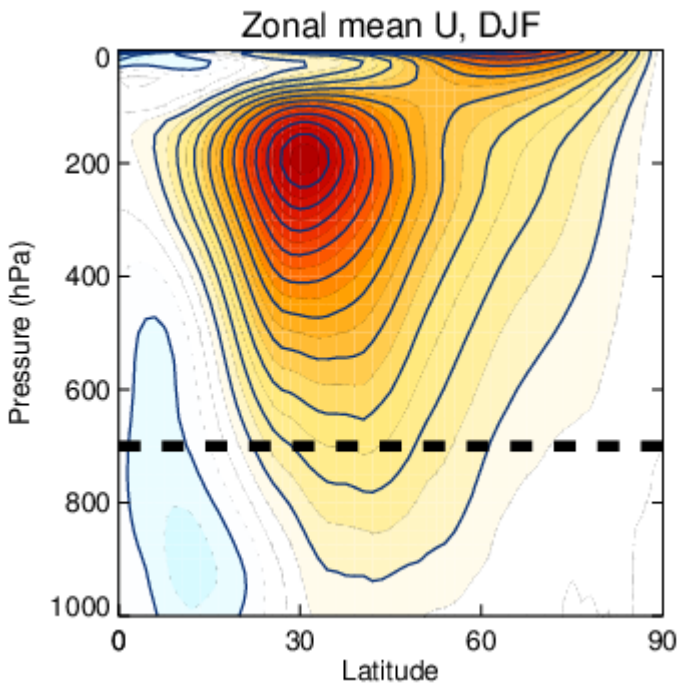
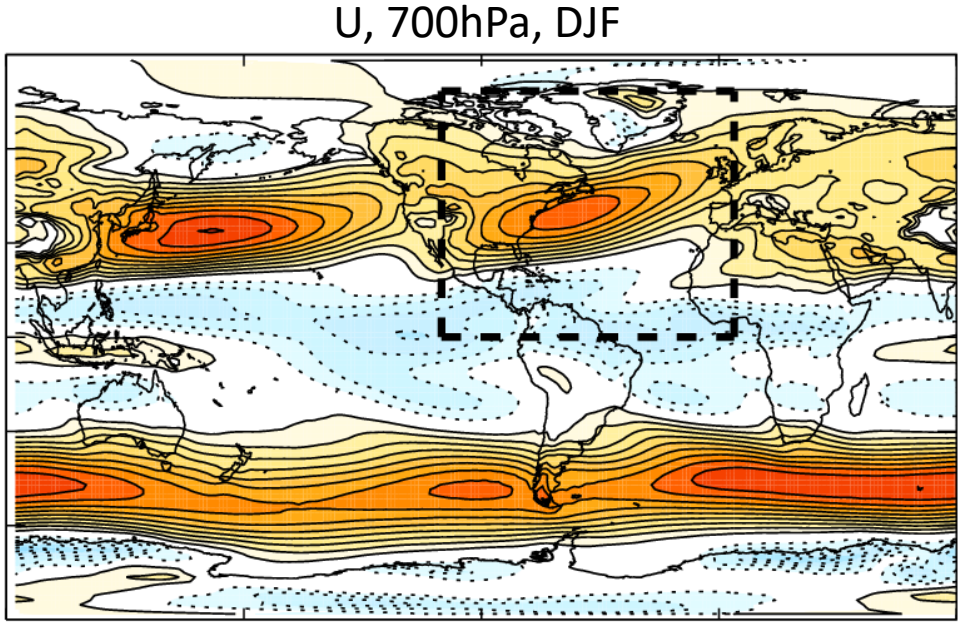
How well do we know the climatological characteristics of the North Atlantic jet stream?

Is the climatology over the satellite record truly representative?

Is this really the climatology that we should be aiming for with our models?

Focused on metrics of jet tilt, latitude and speed at 700hPa in the North Atlantic sector during DJFM





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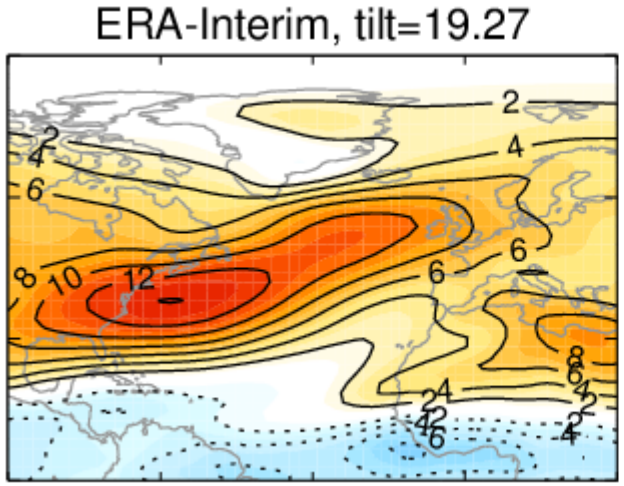

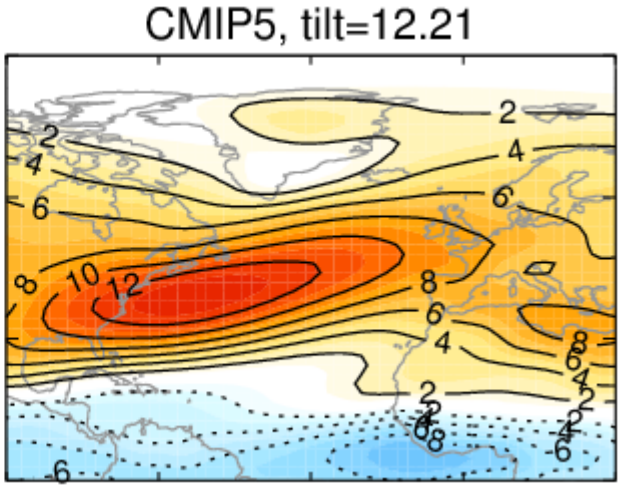

ERA-Interim climatology (1979-2005)

CMIP5 multi-model mean climatology (35 models, 1979-2005)

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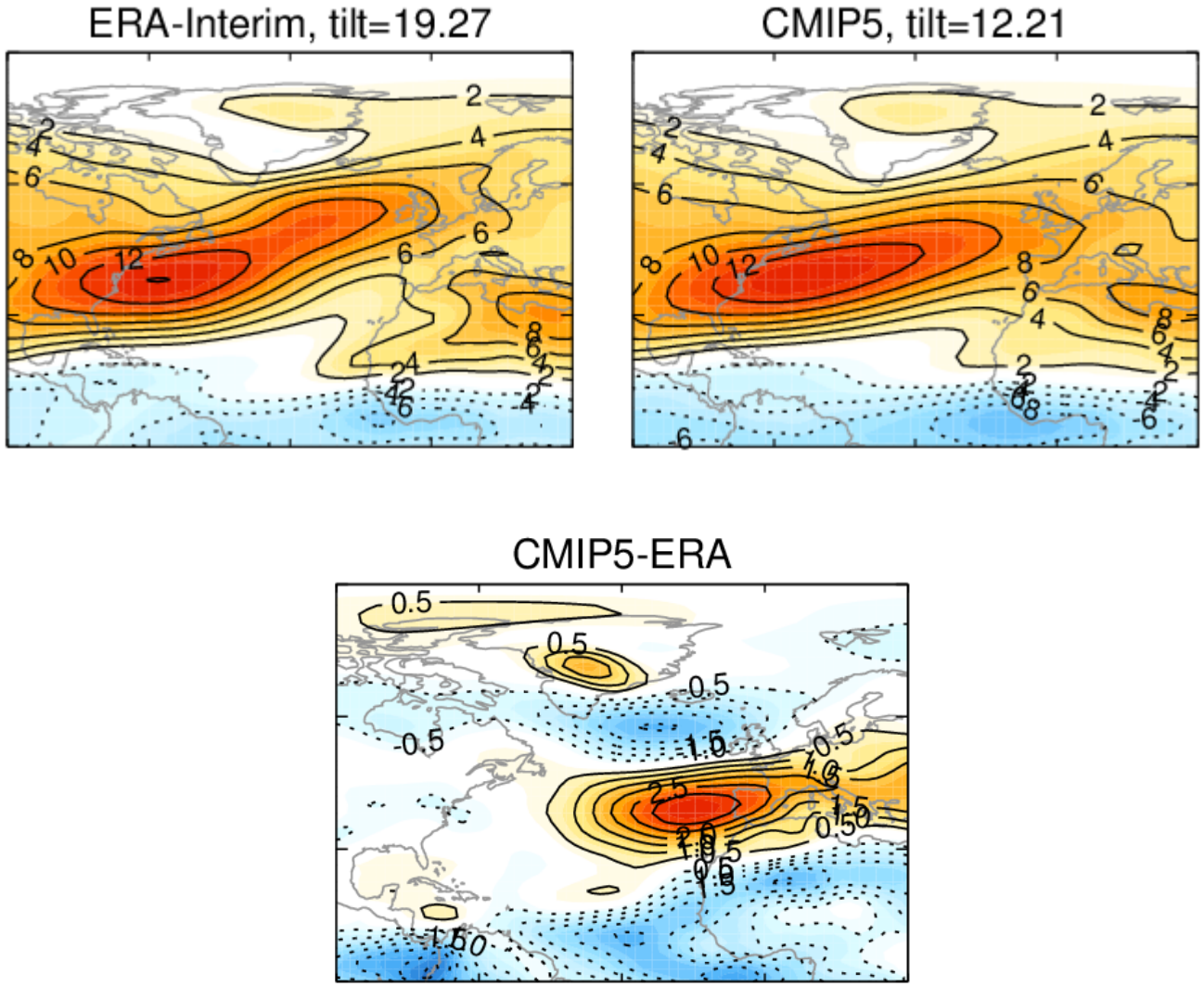

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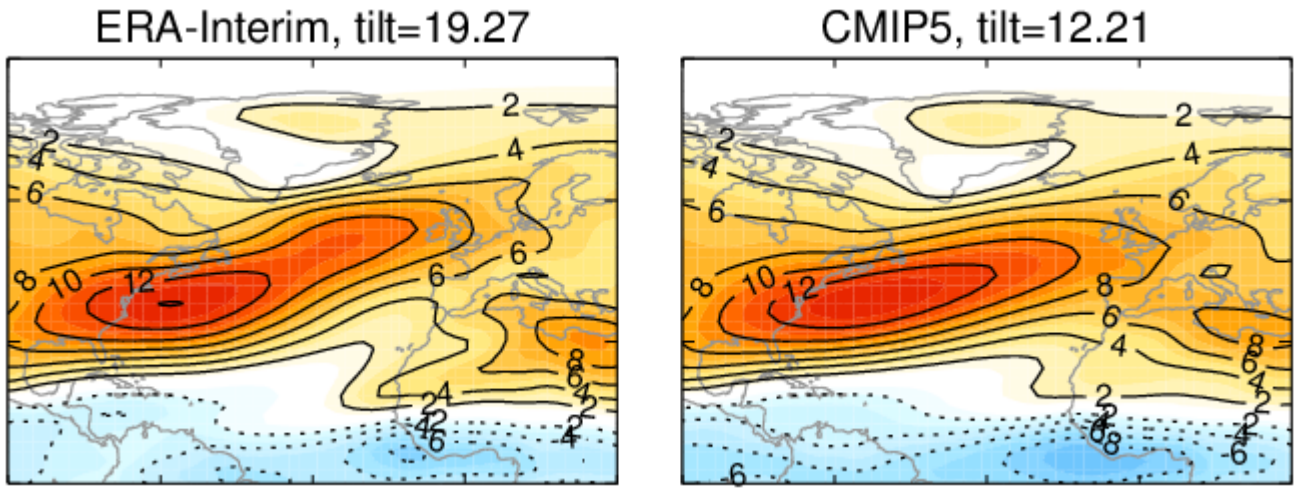

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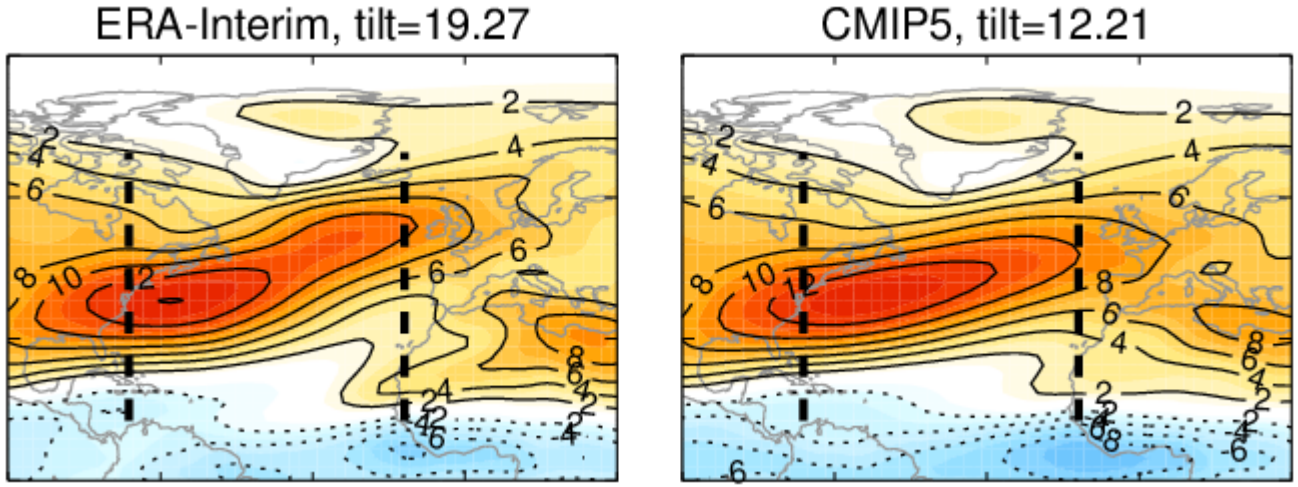

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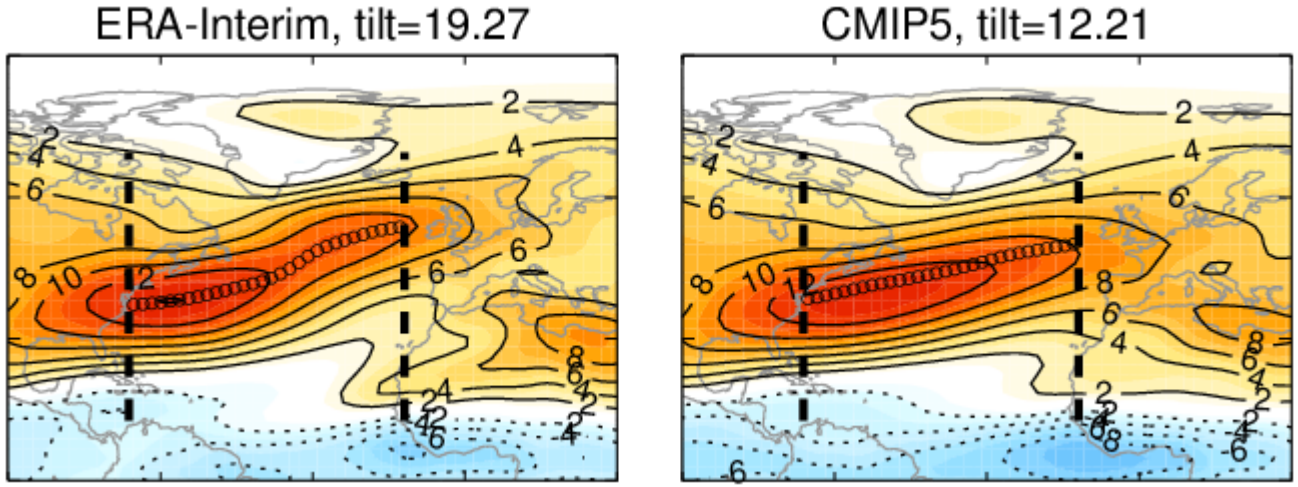

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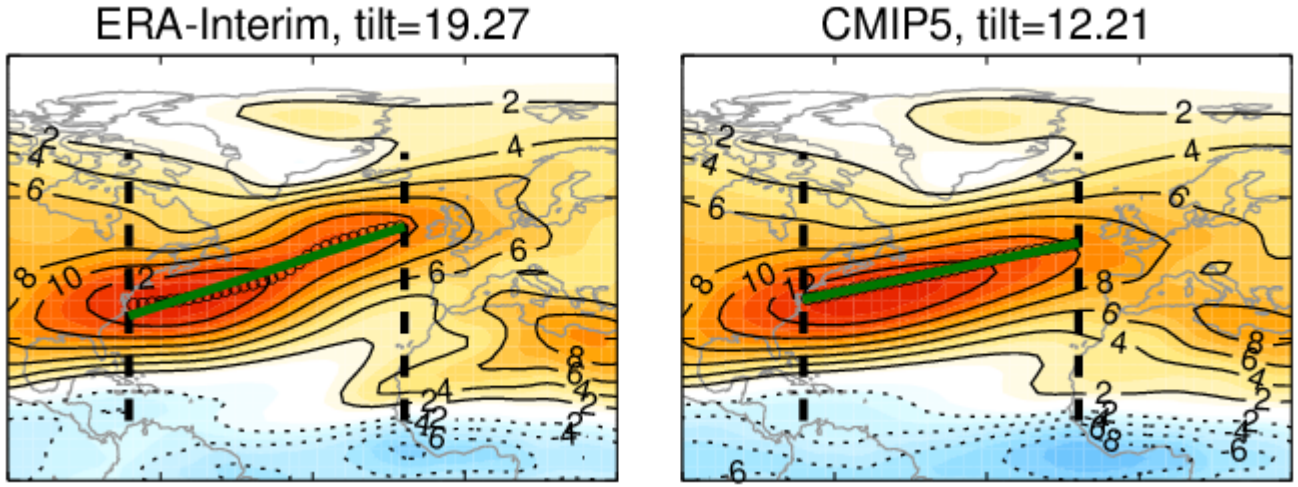

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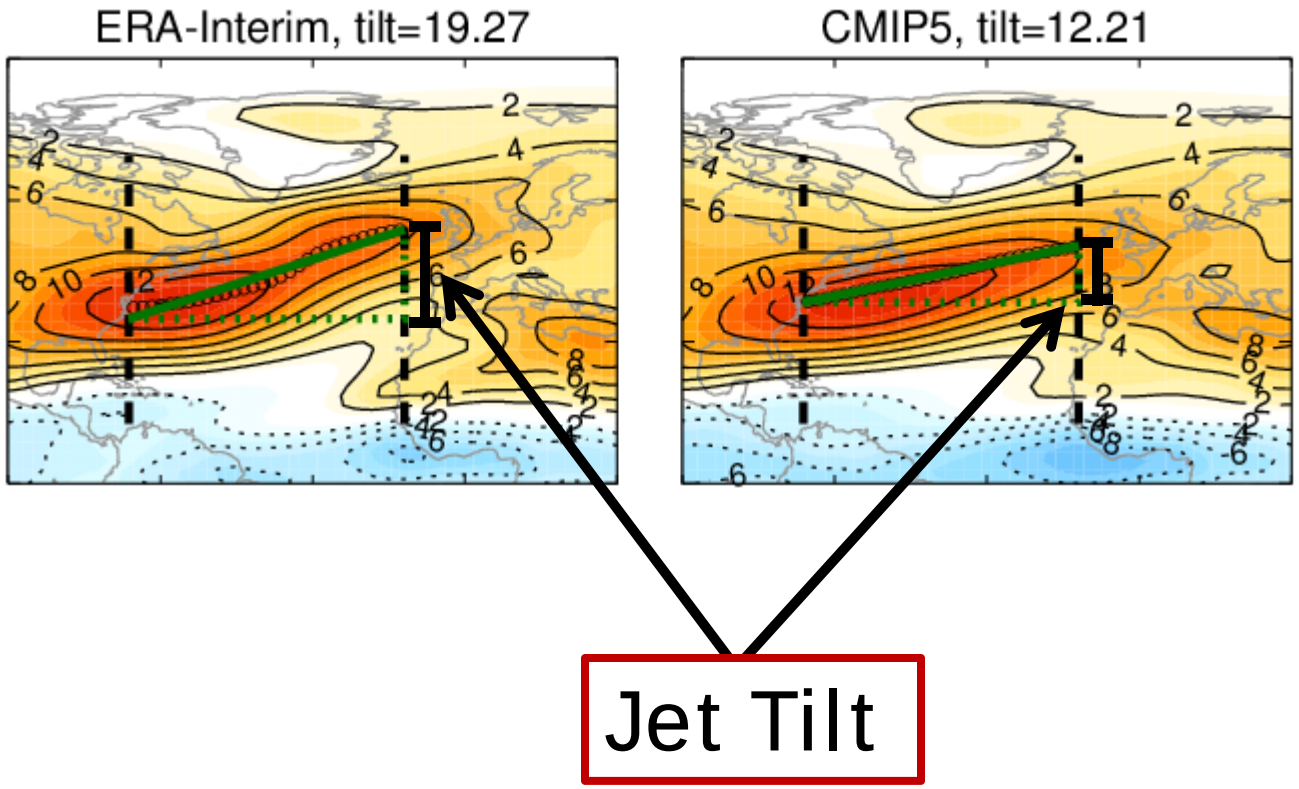

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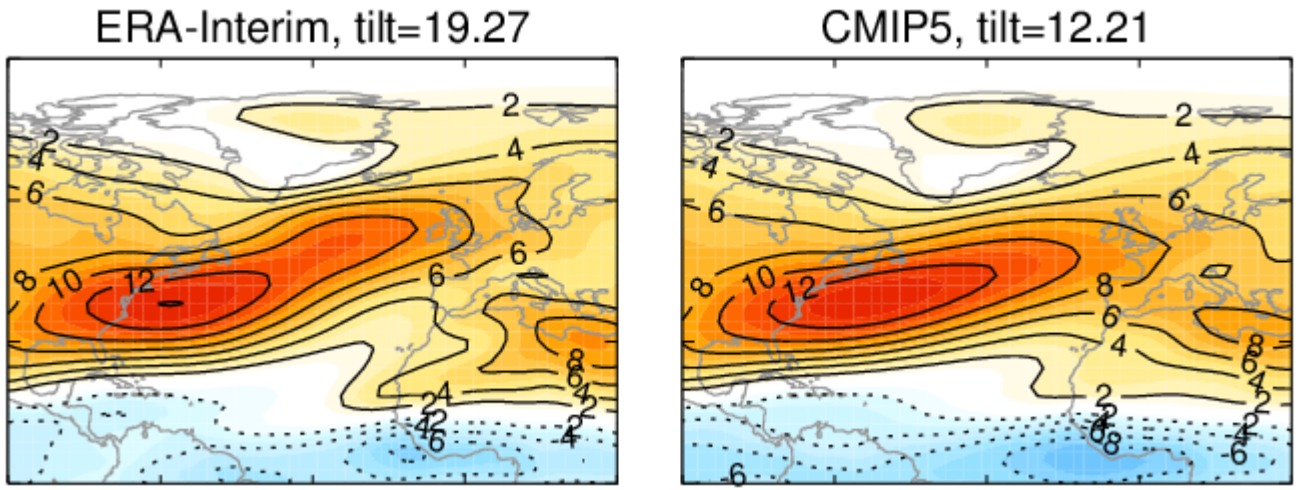
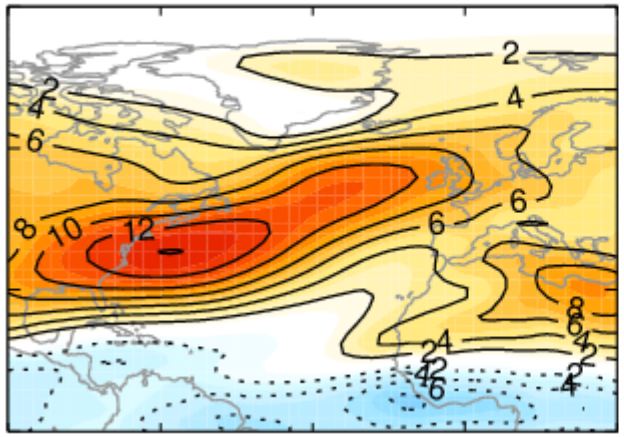
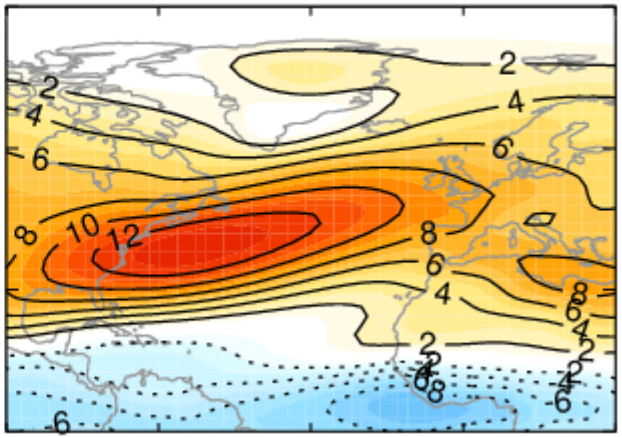


A motivational example…jet tilt in March

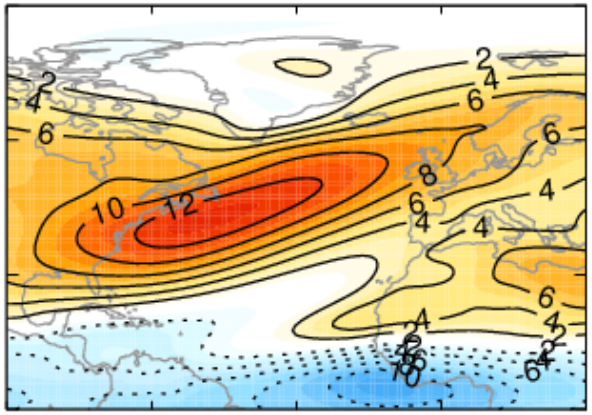
ERA-Interim, tilt=19.27



CMIP5, tilt=12.21



LENS, tilt=16.55



CESM large ensemble
Ensemble mean of 42 members
1979-2005

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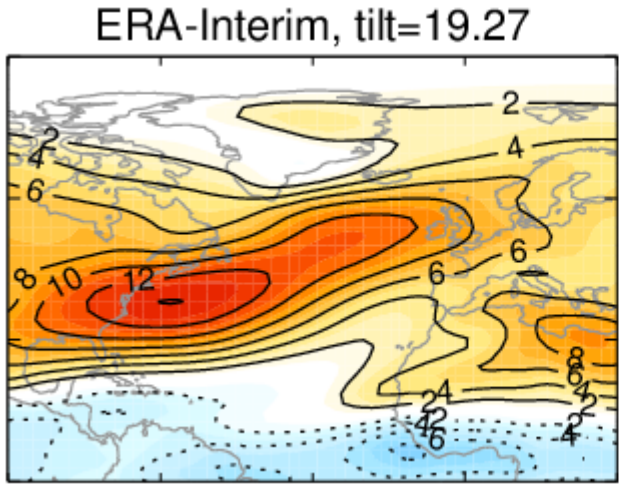

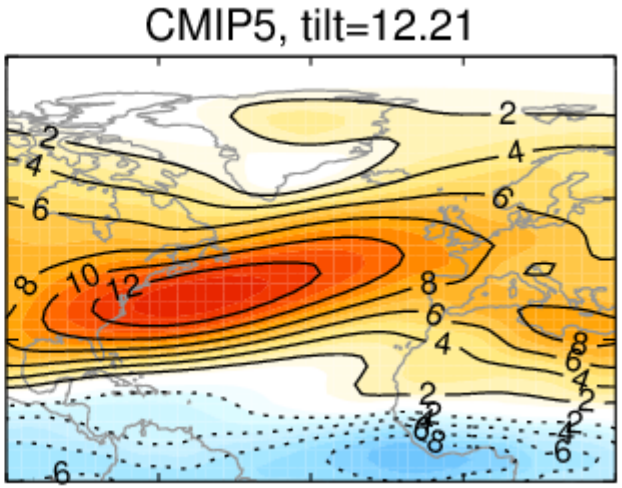

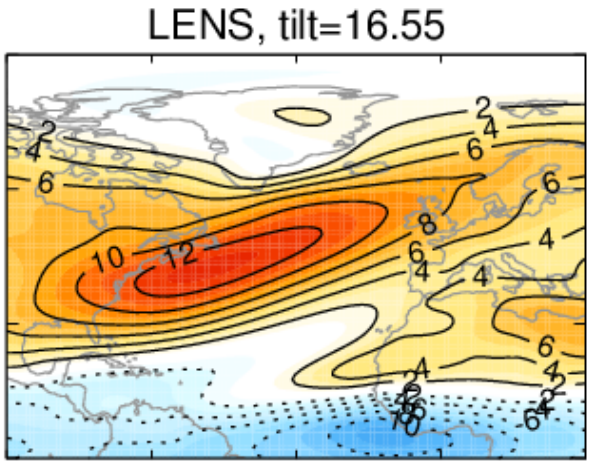

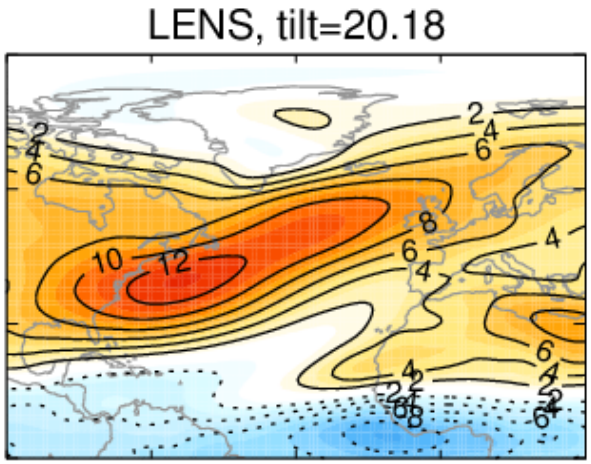

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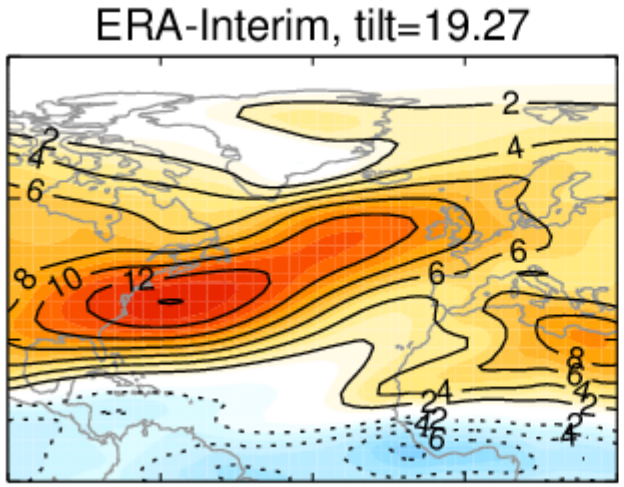

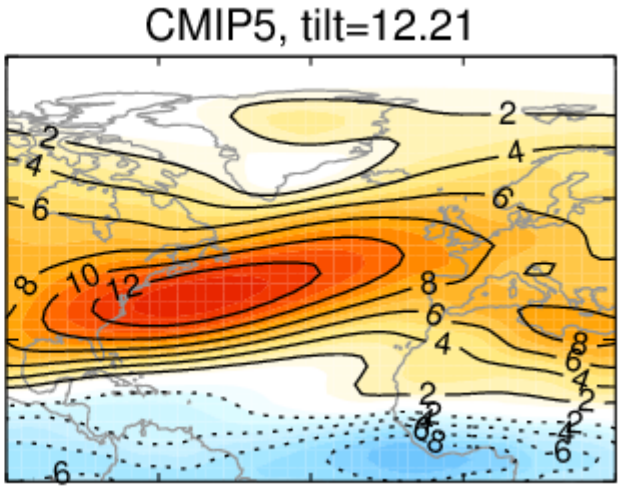

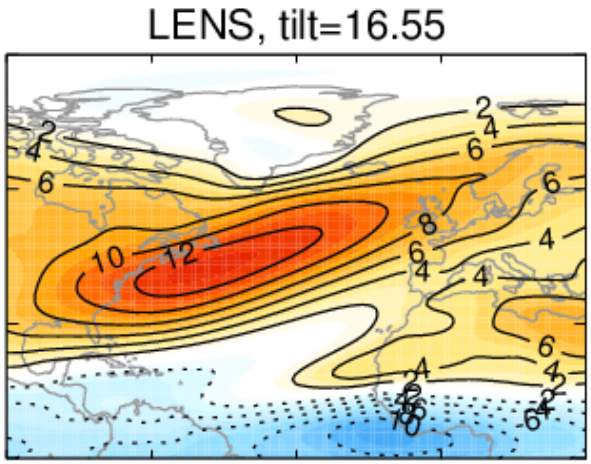

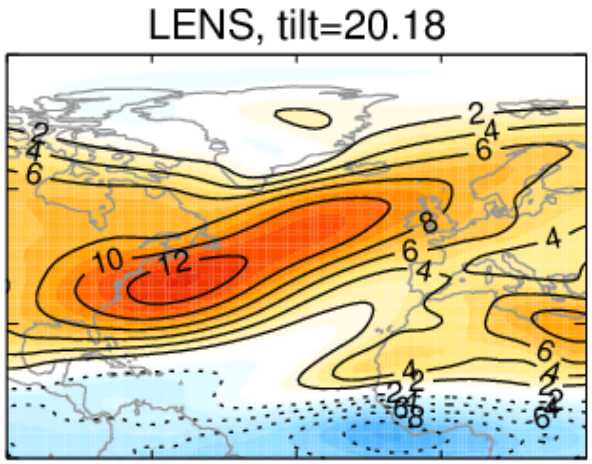

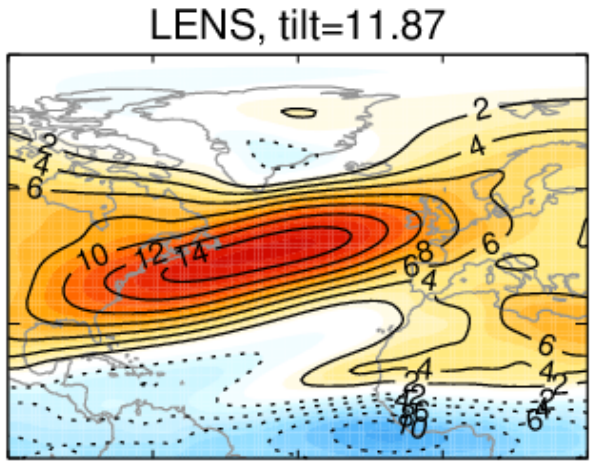

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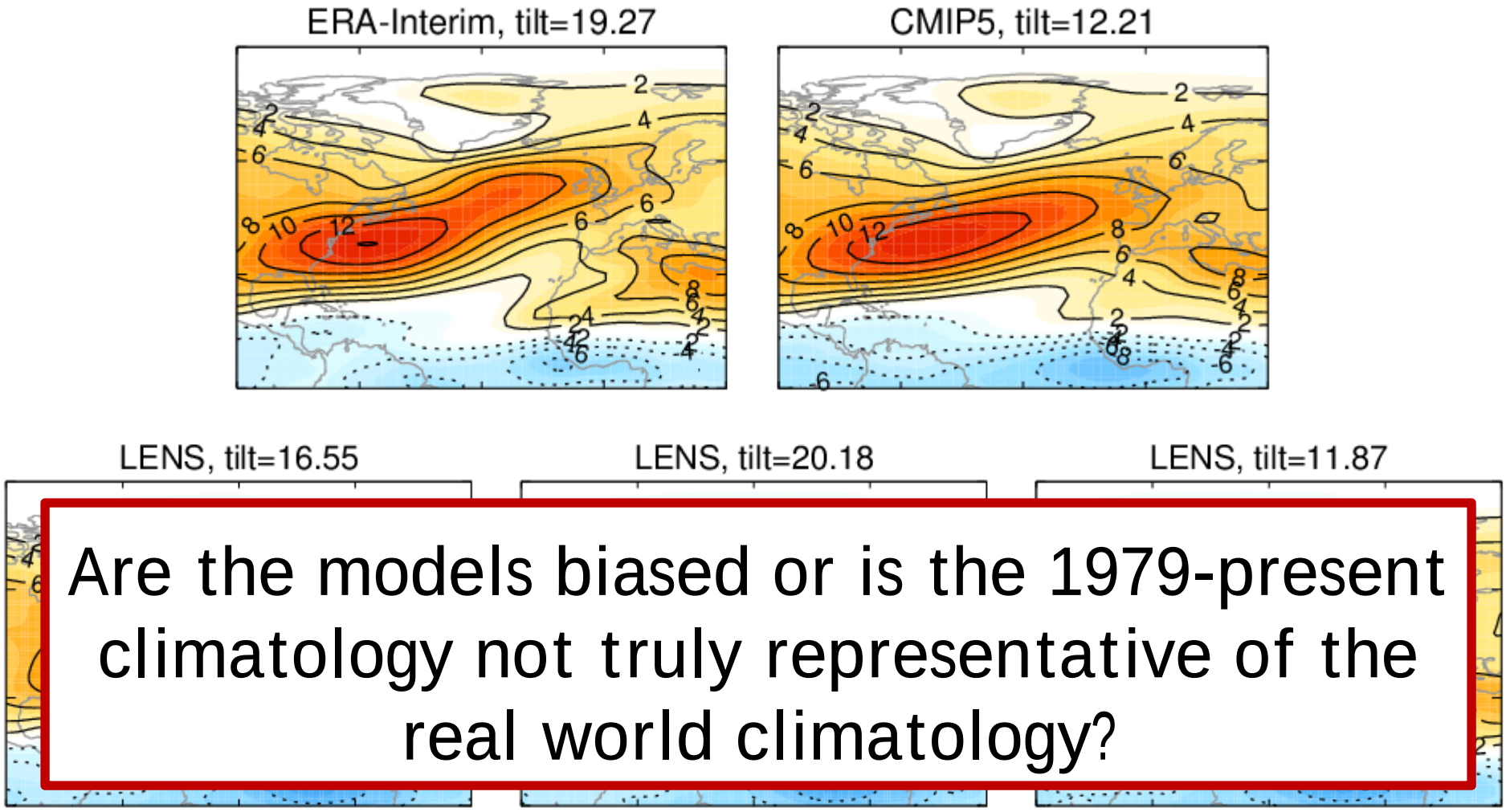

Are the models biased or is the 1979-present climatology not truly representative of the real world climatology?

Can we look at climatologies further back in time?

Over the satellite ERA we have ~37 years of data (1979 – now)

ERA-Interim (1979-now), MERRA2 (1980-now), JRA-55 (using 1979-now)

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Yes, the evolution of long term climatologies are highly correlated during winter in the North Atlantic between the two.

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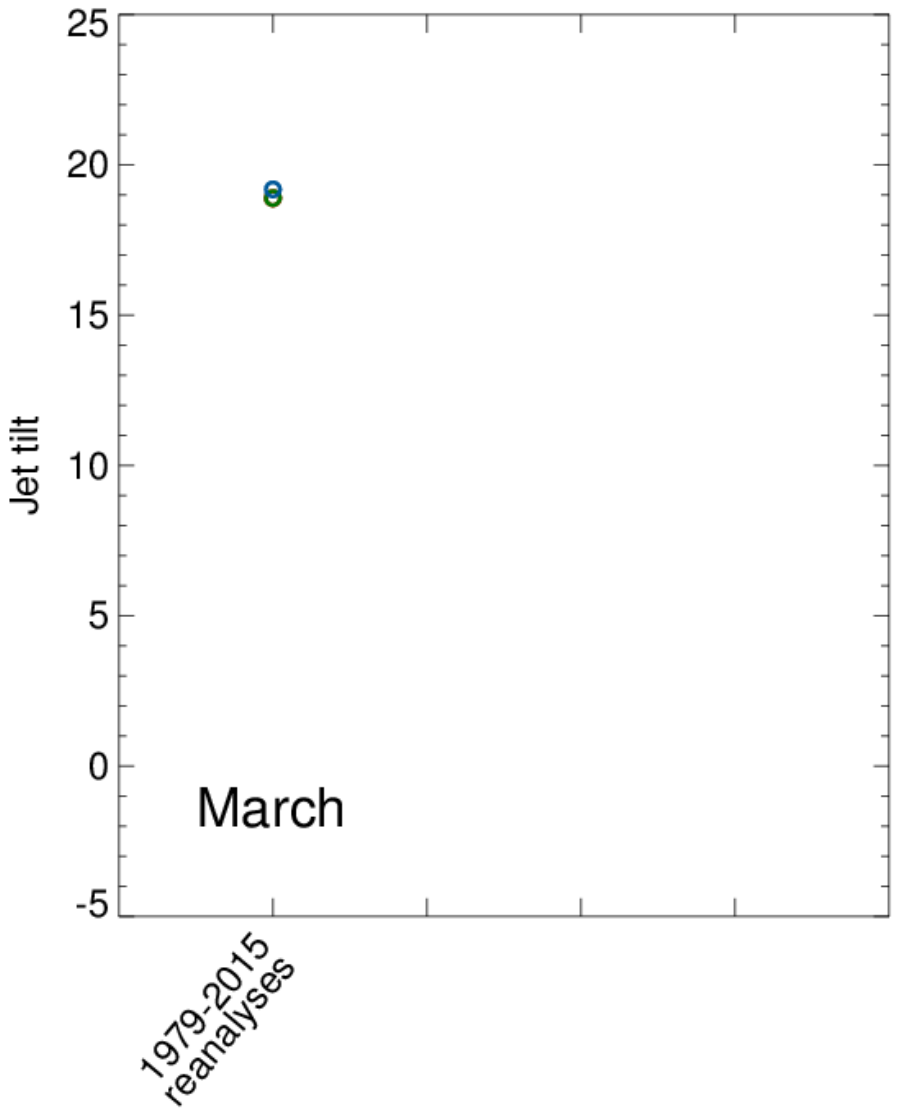
Comparing model climatologies with reanalysis, placing the climatology of the satellite era within the context of the full 20th Century

An example: Jet tilt in March



ERA-Interim MERRA2 JRA-55

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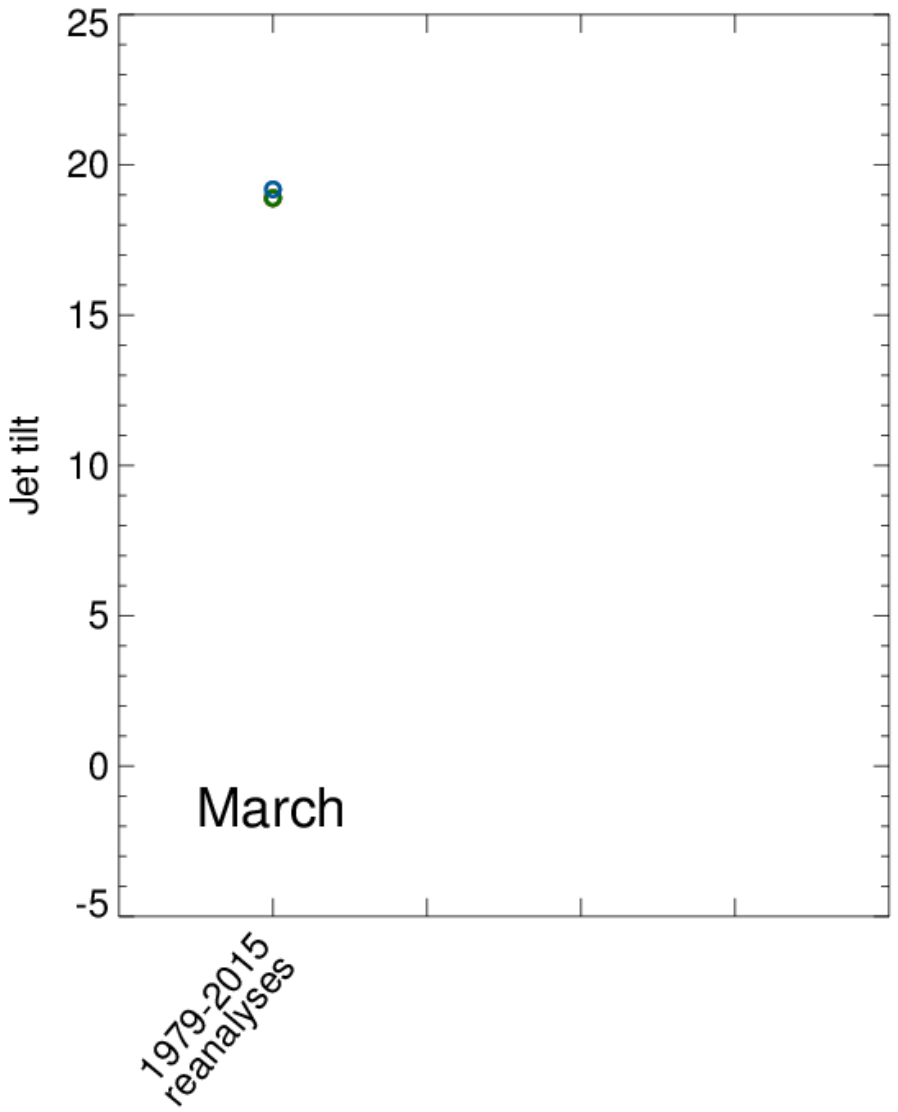
!!Note, March is an extreme example!!



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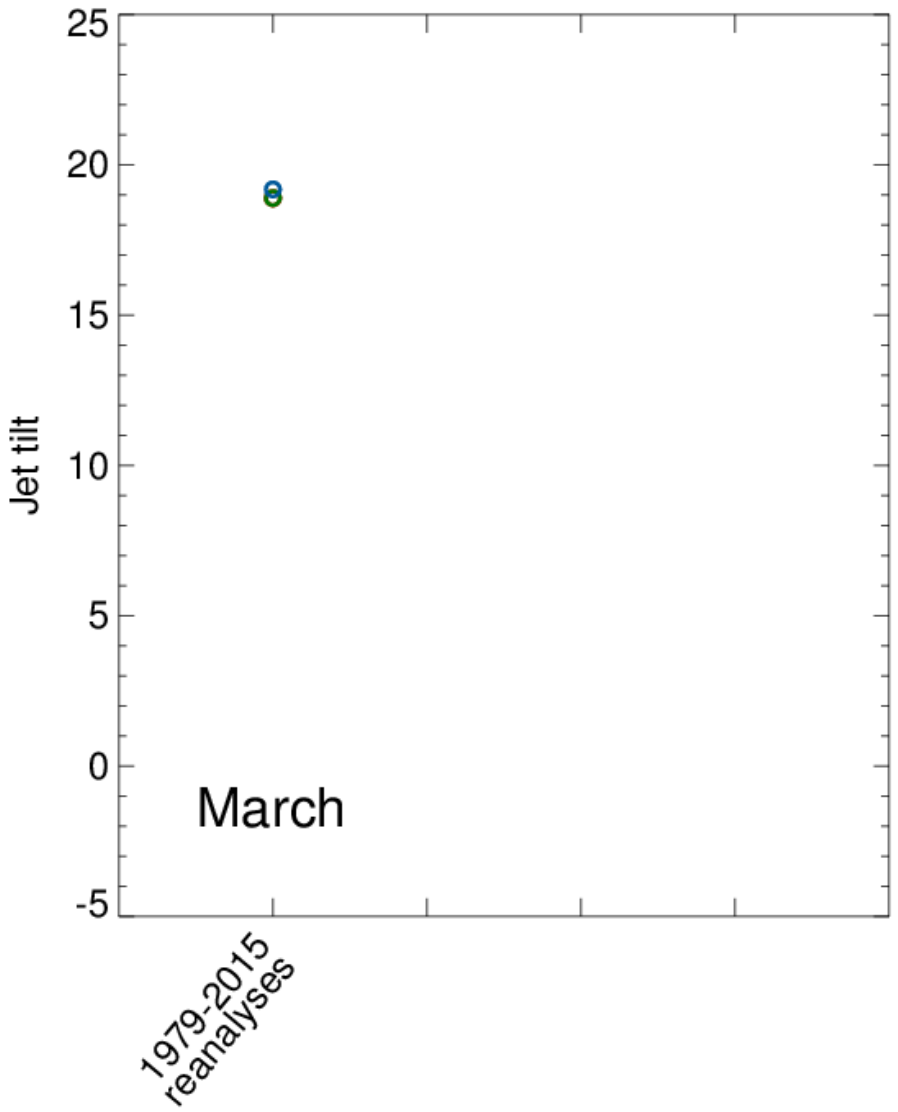

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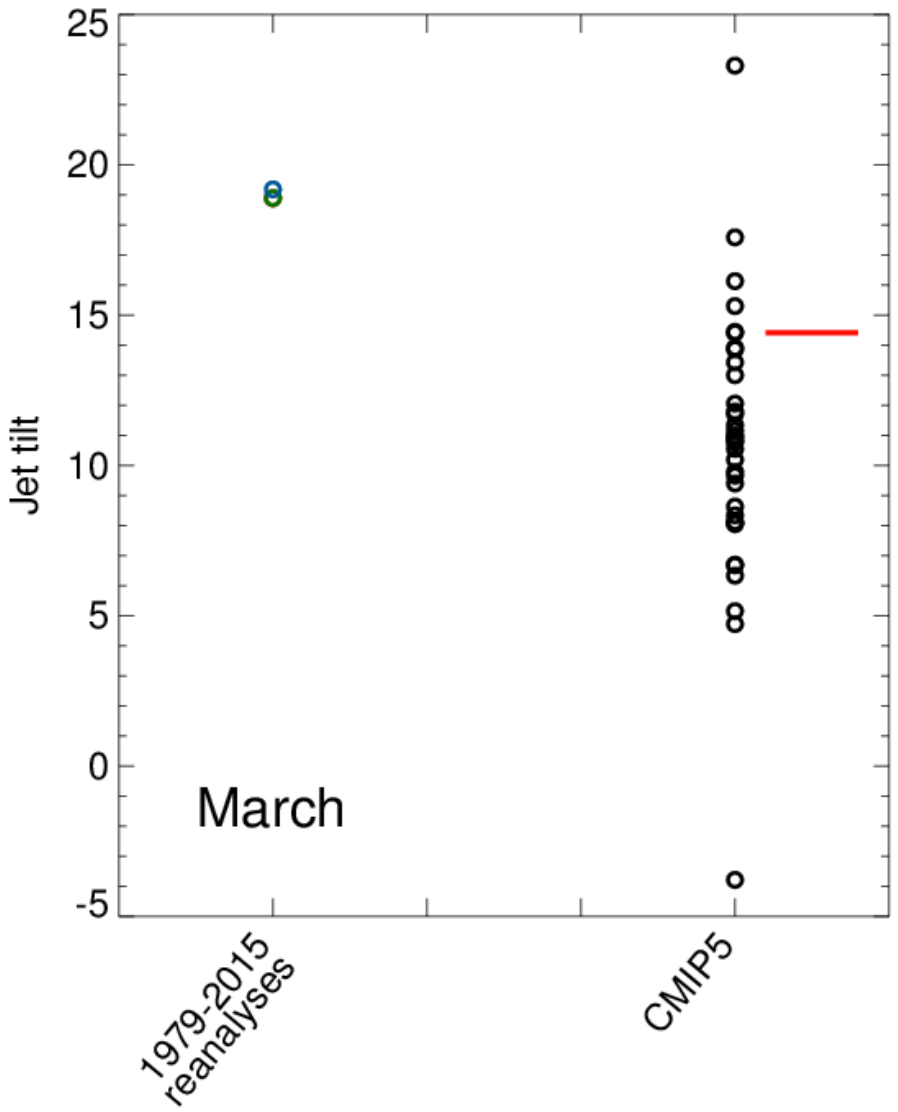

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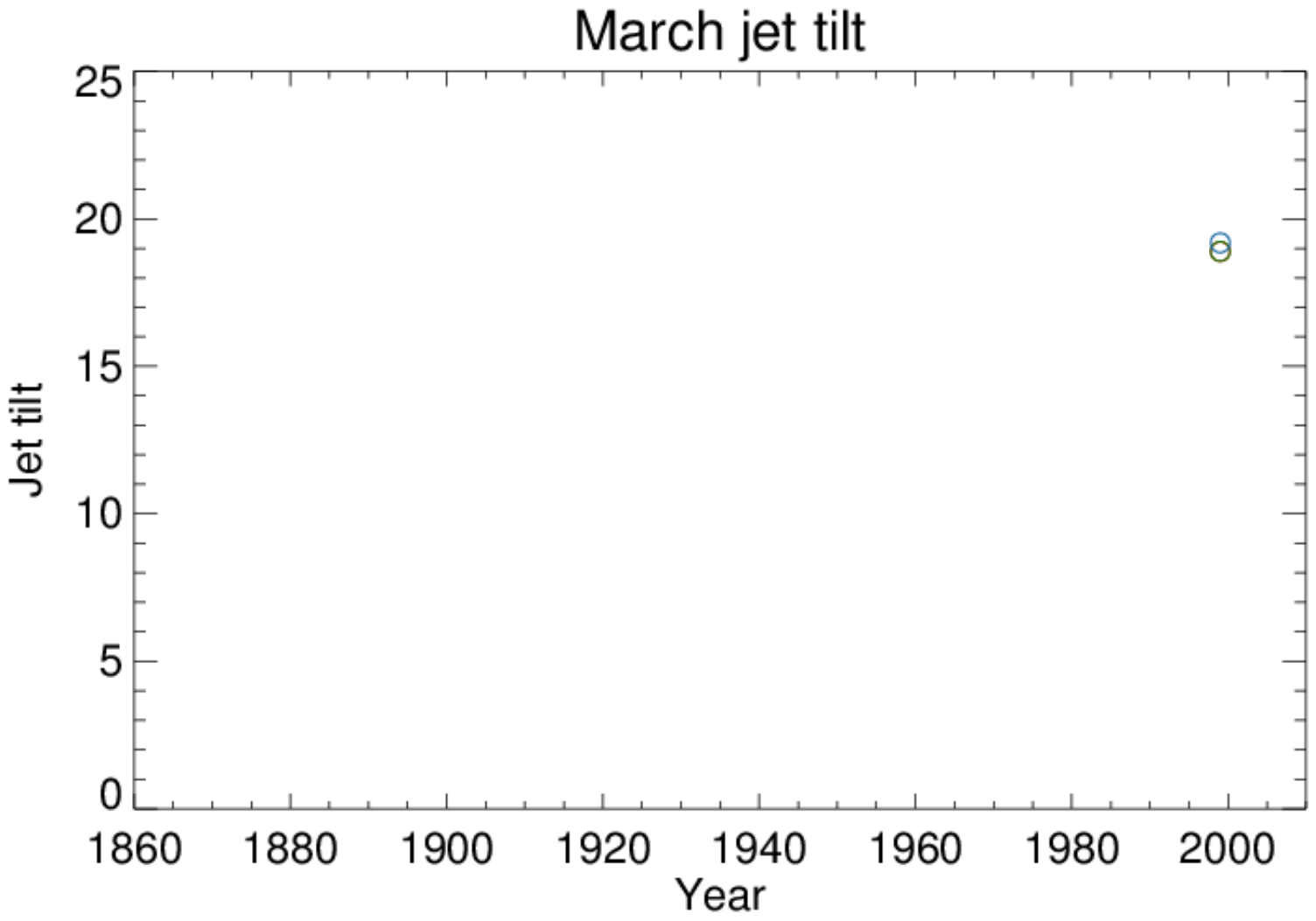
37 year running means of March jet tilt



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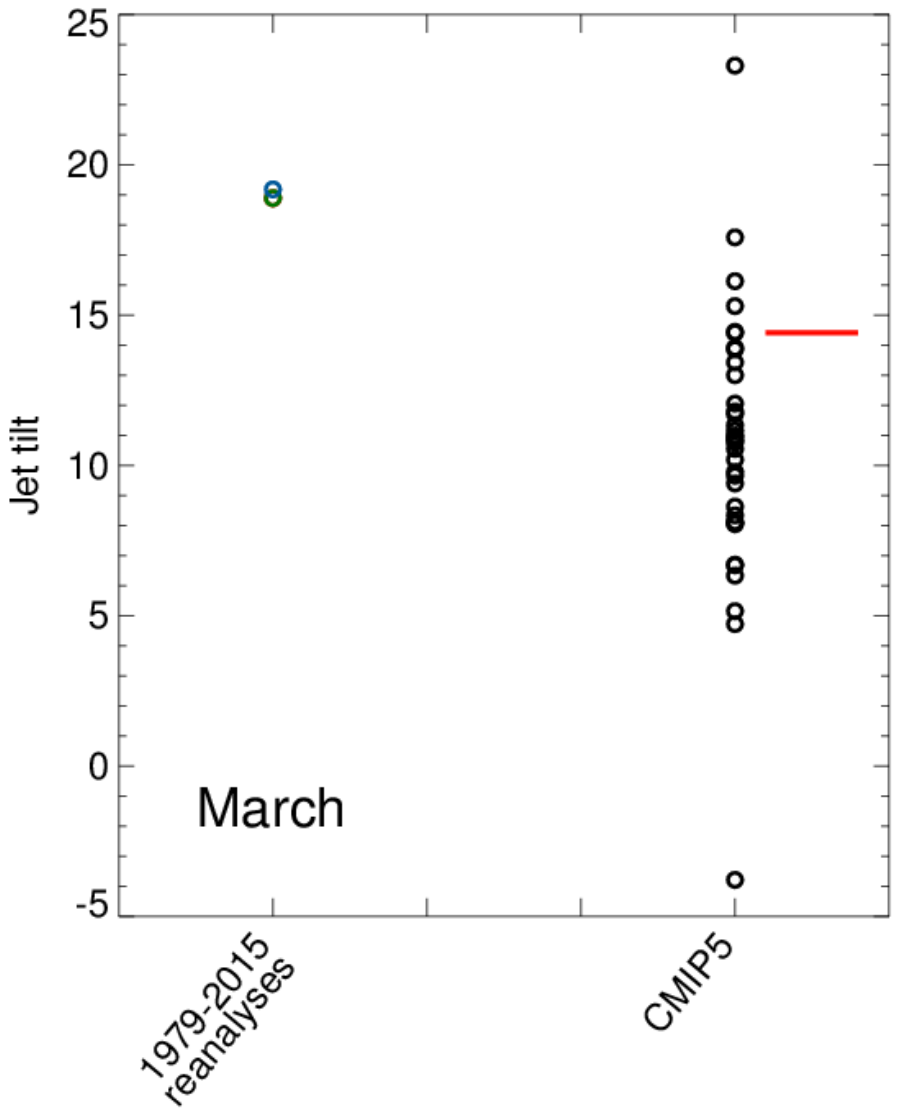

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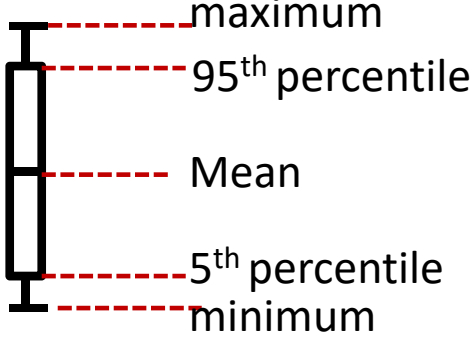

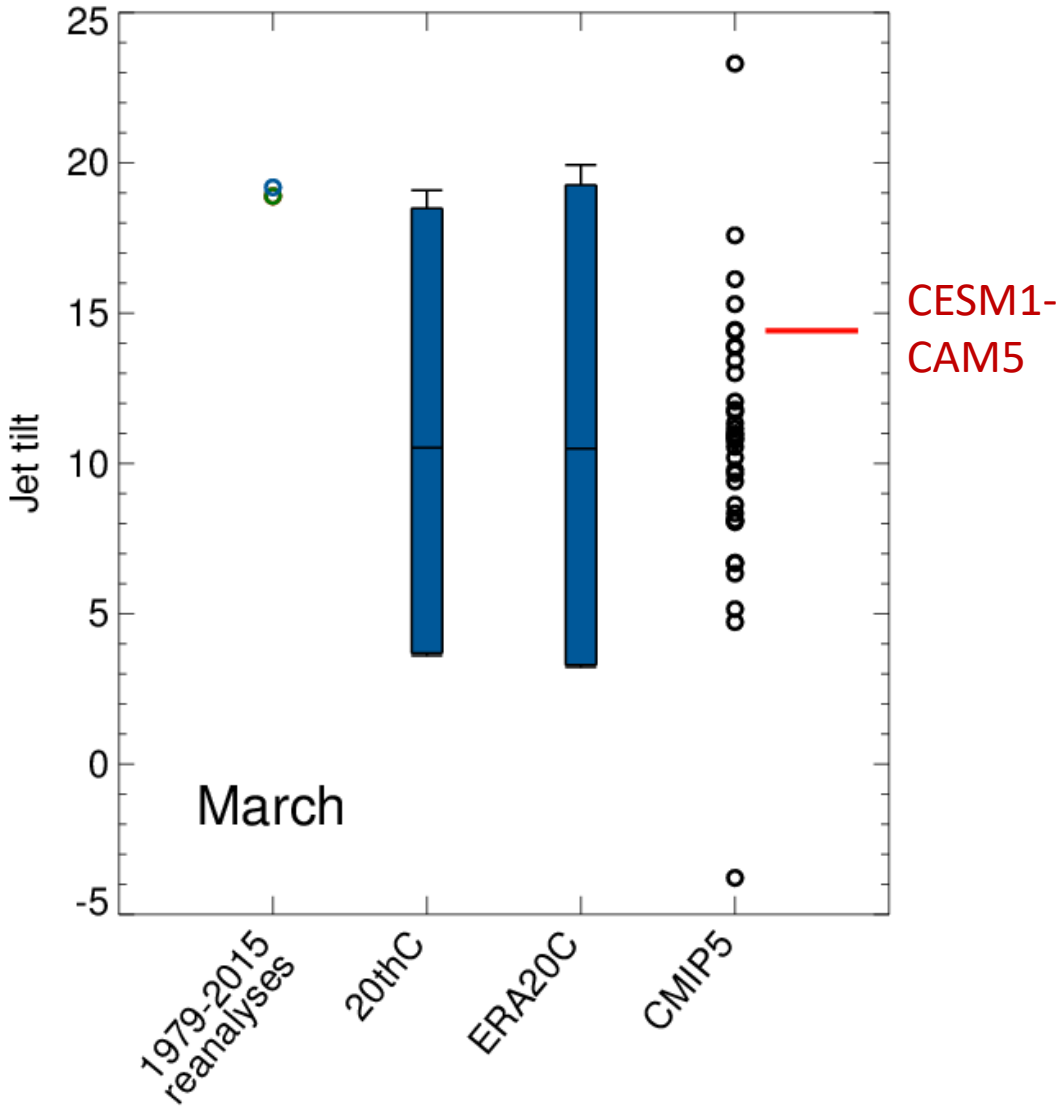

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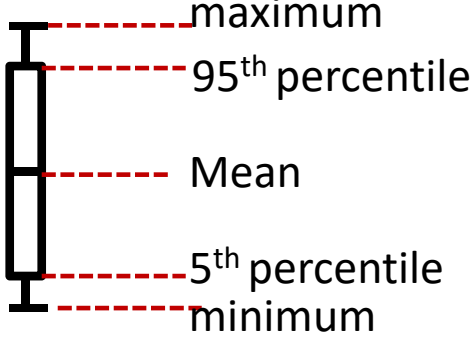
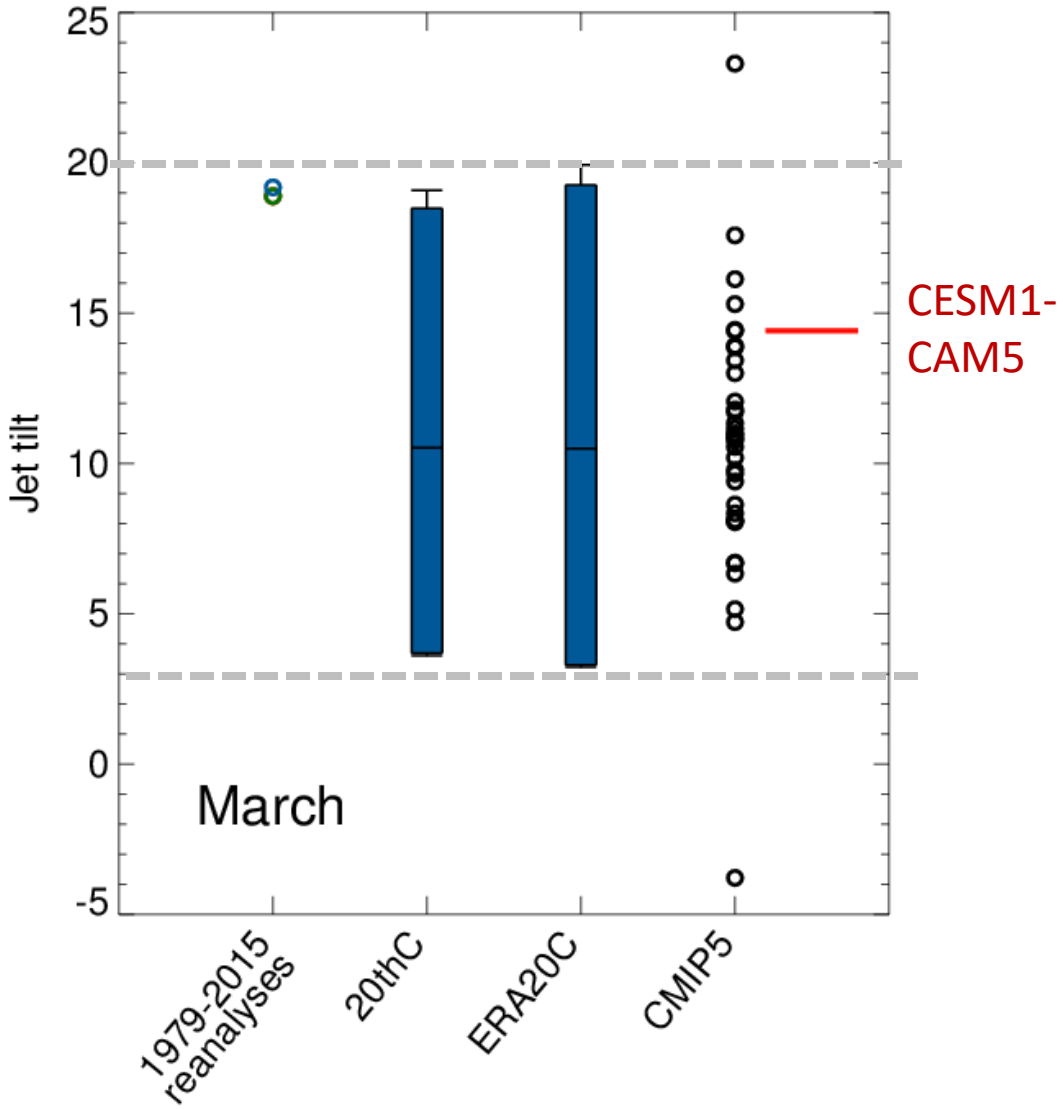
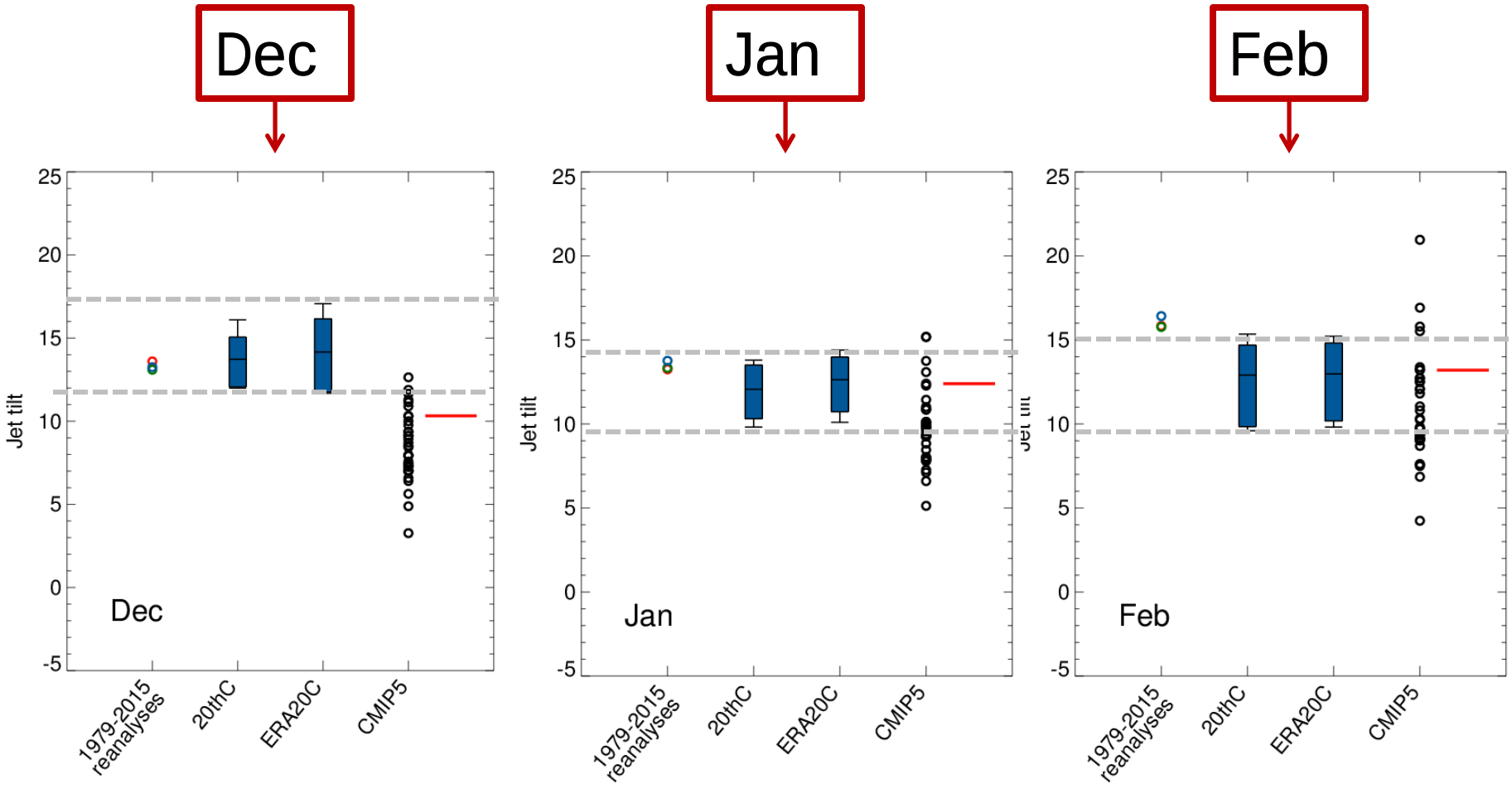




ERA-Interim MERRA2 JRA-55

Other months



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I think yes, because…

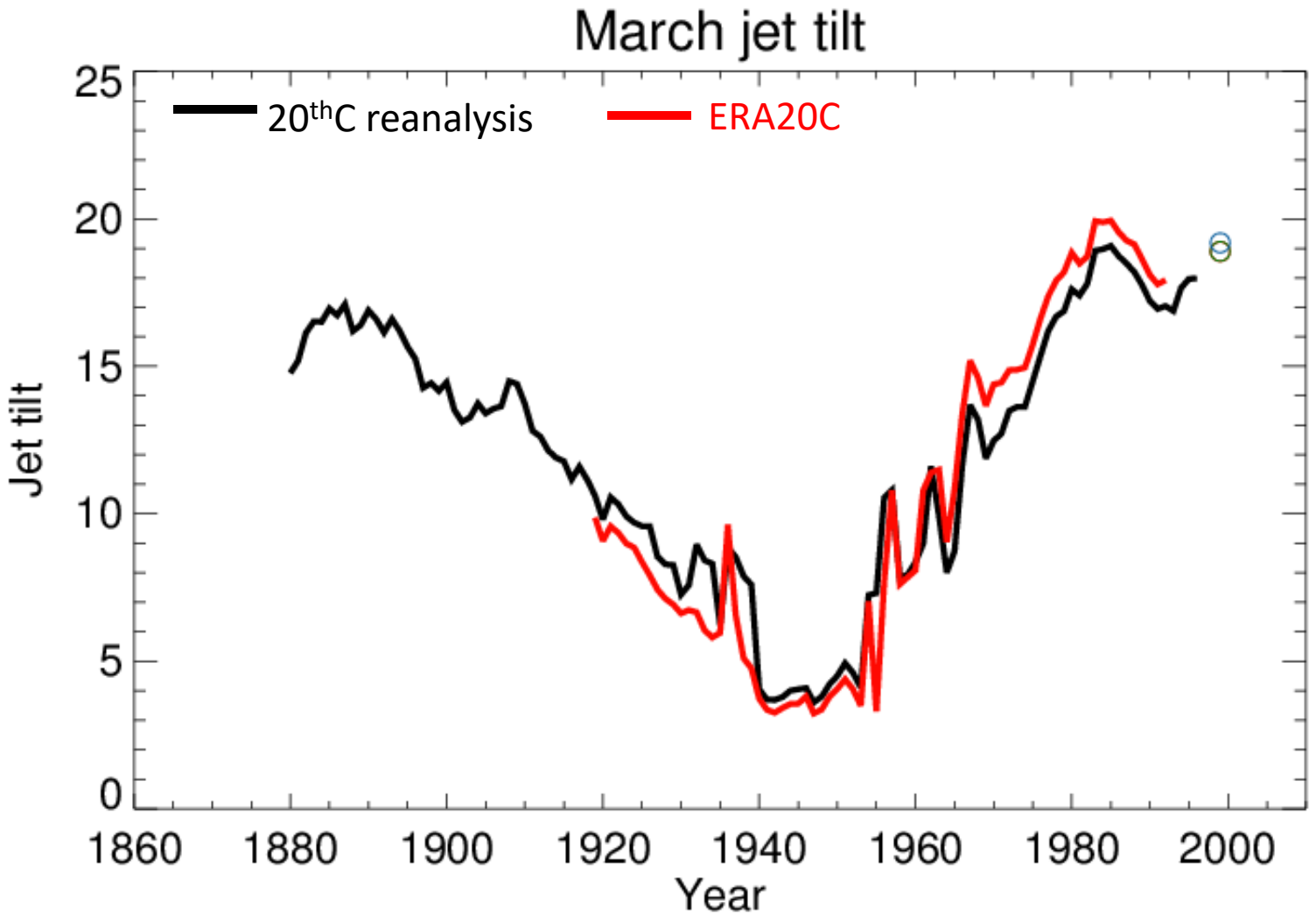
- Variations over the 20th Century are not at all linear (unlikely to be GHG forced)
- 20th Century variations in models forced with observed boundary conditions do not correlated with those observed.
- A similar degree of variability is seen across the LENS members or within unforced control simulations (not True in March = an interesting model vs reanalysis difference)

Summary

- We can use the 20th Century reanalyses to look at variations in the climatology of jet metrics further back in time.
- The 1979-now climatology is not completely representative of the real world climatology
- Substantial long term variability is seen and during January, February, March, the present day climatology is unusually tilted compared to the past.
- These uncertainties on the true climatology of the real world should be considered for model validation.

Extra Slides

37 year running means of March jet tilt

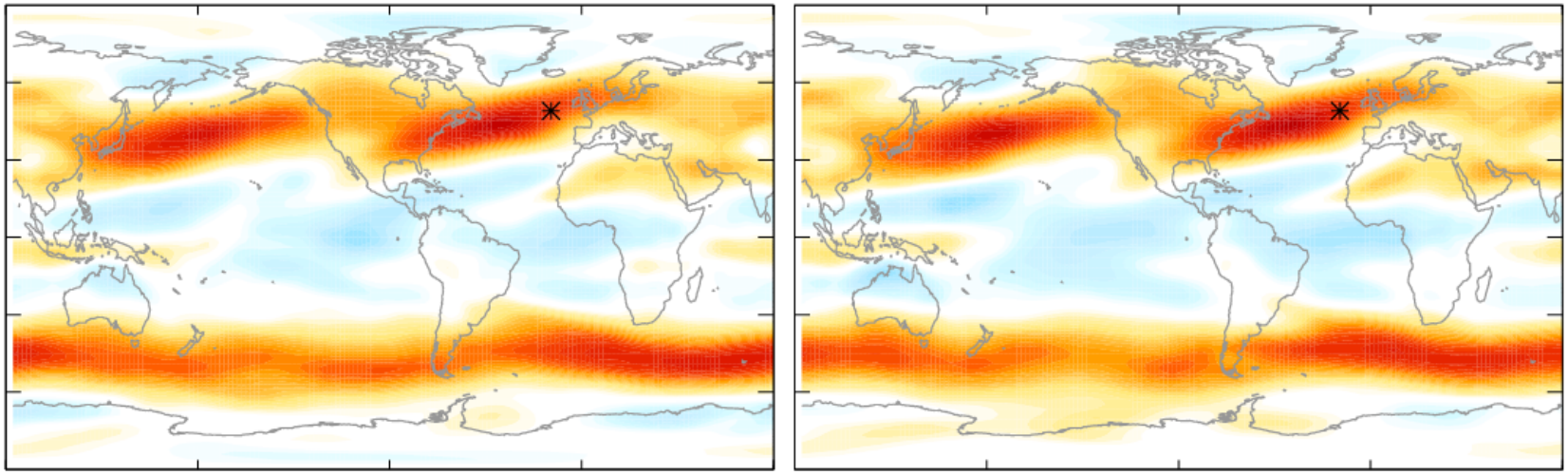


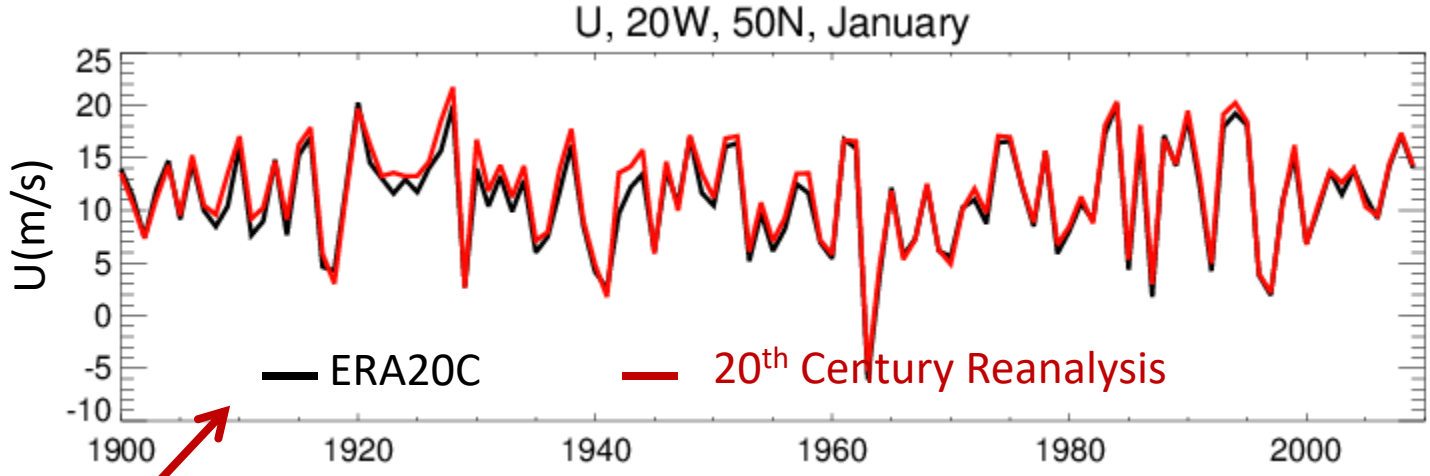
ERA-Interim MERRA2 JRA-55

Example: 700hPa zonal wind at one point in the North Atlantic in January

ERA20C

20th Century Reanalysis

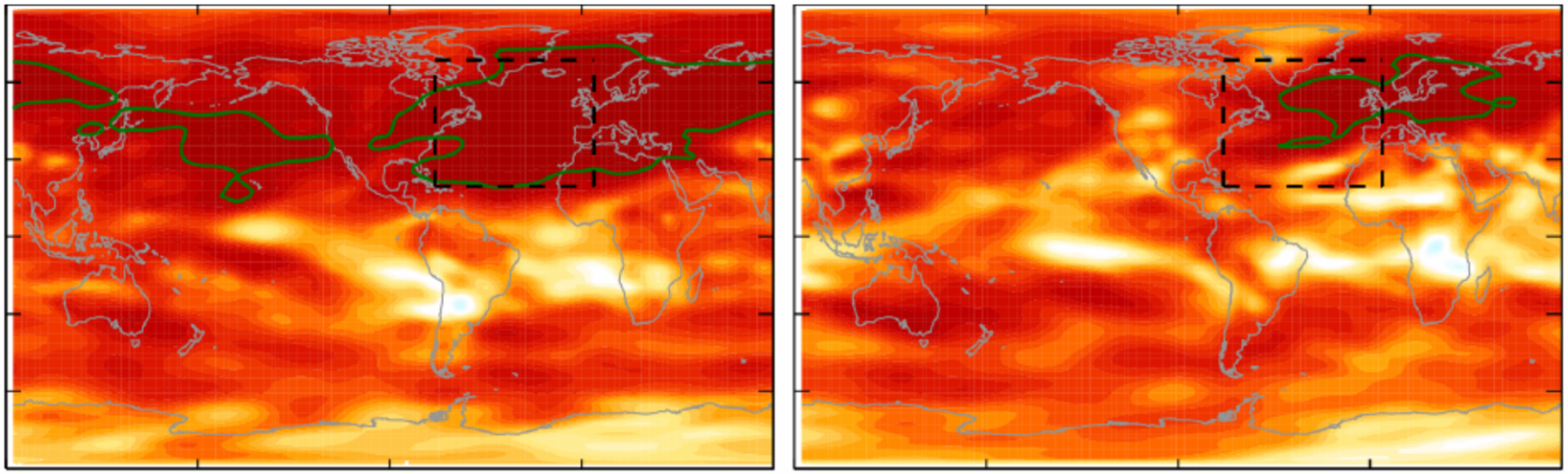




Correlation = 0.94

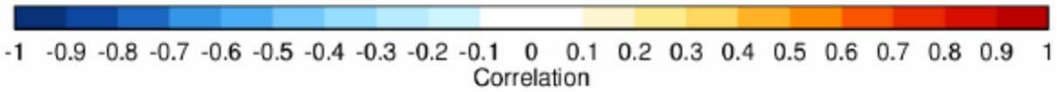
January

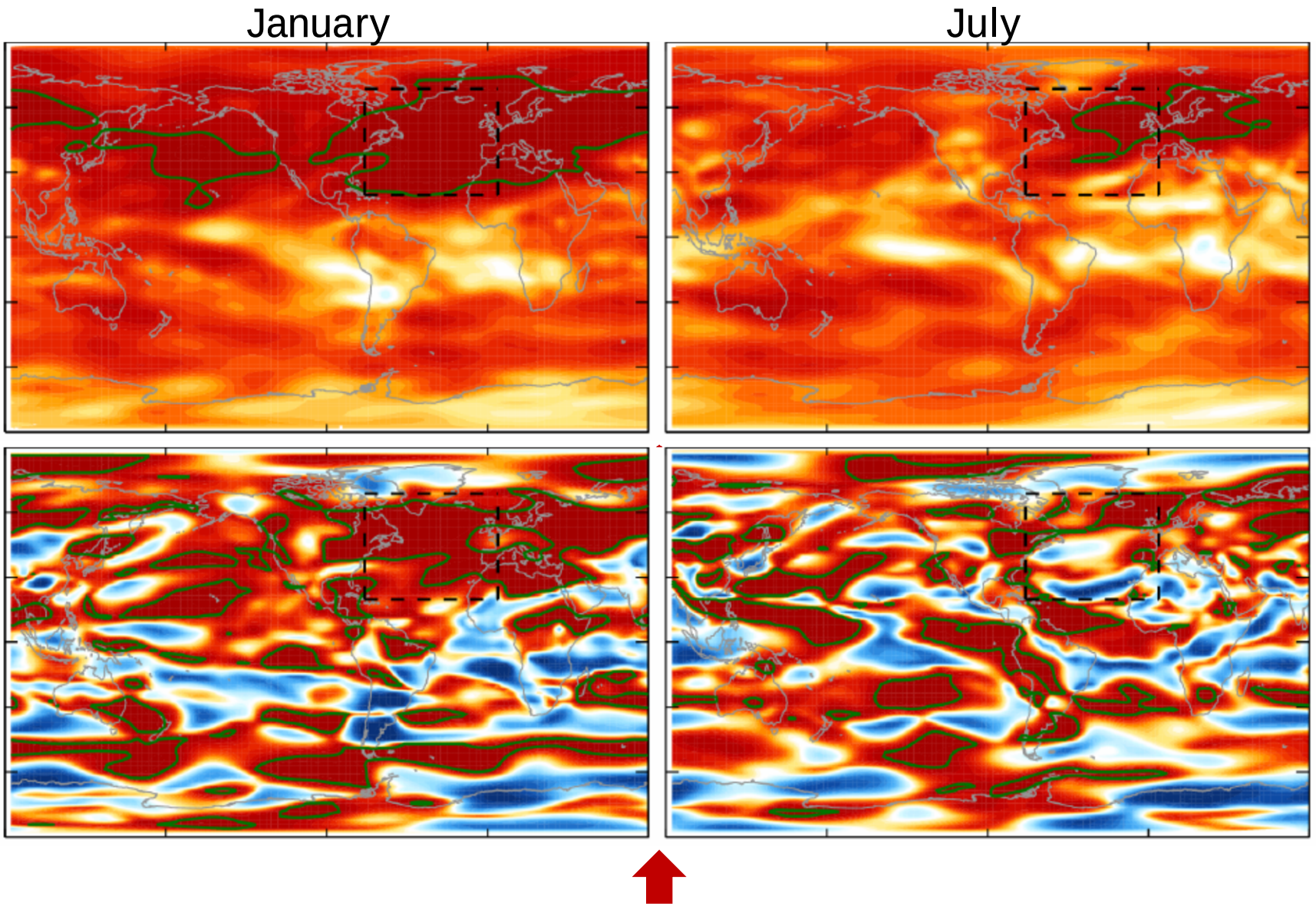
July



Correlation(ERA20C,20thC), Interannual Variability

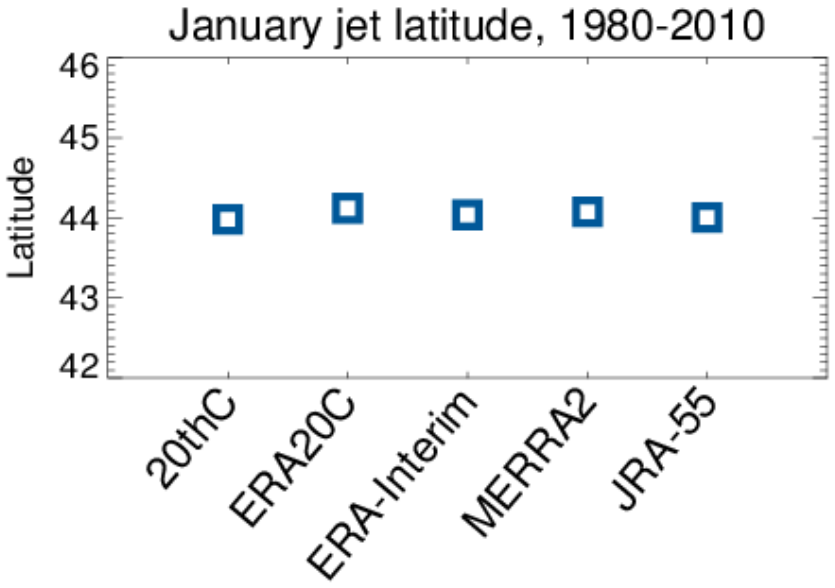
= correlation > 0.9

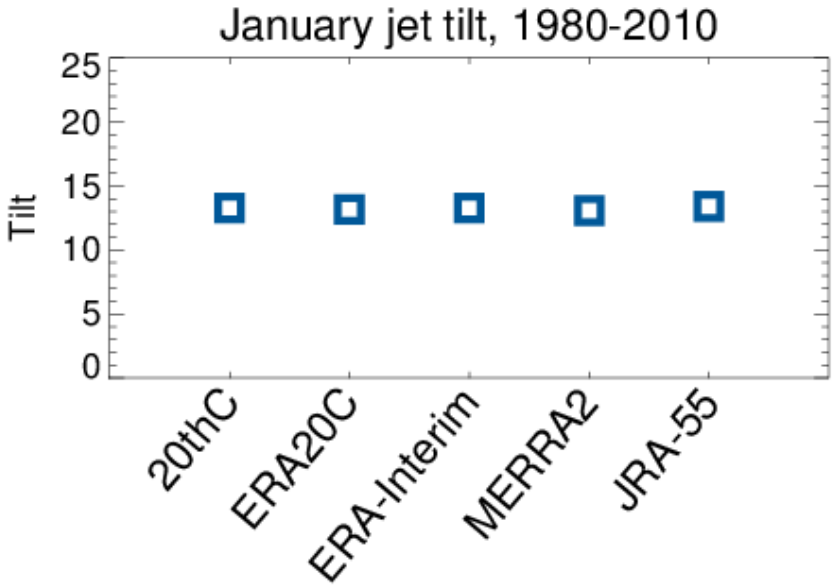


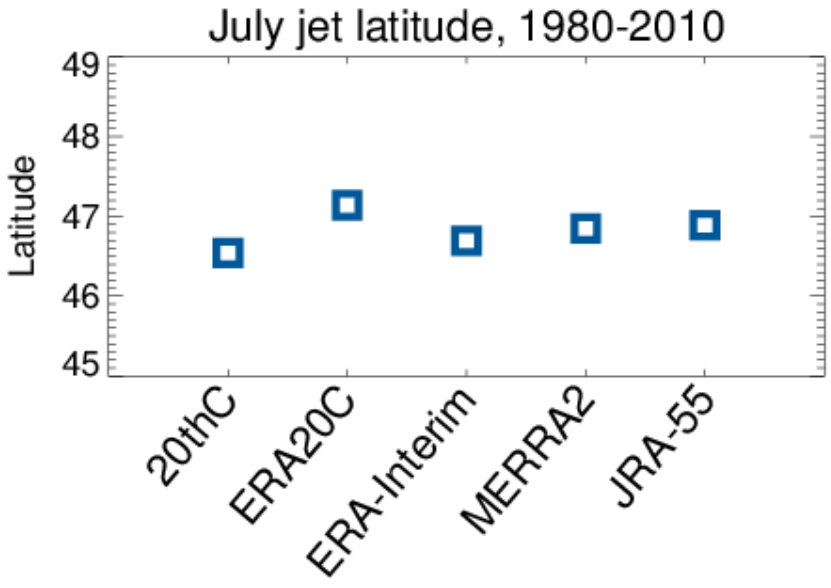


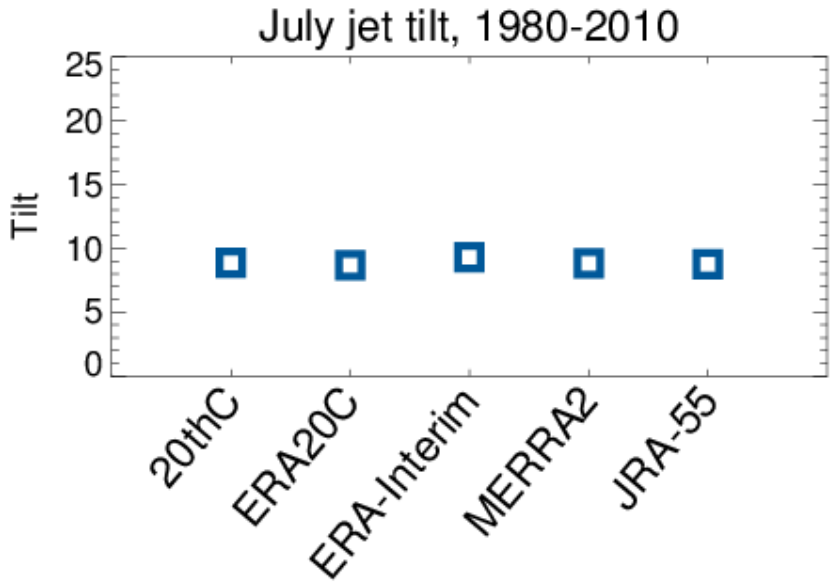
Correlation(ERA20C,20thC), 37 year running means

Do all the reanalyses agree in the climatology of the overlapping time period (1980-2010)?







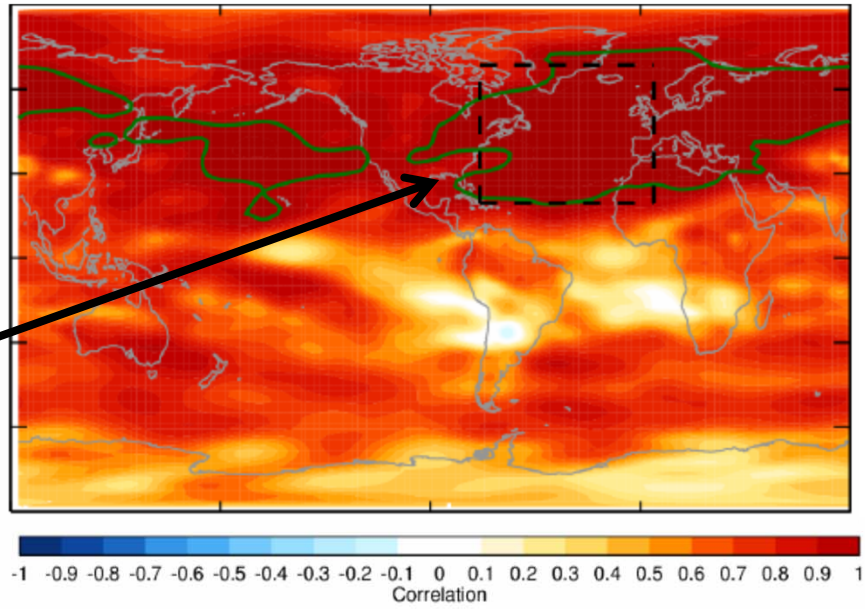


The correlation between ERA20C and 20thC reanalyses

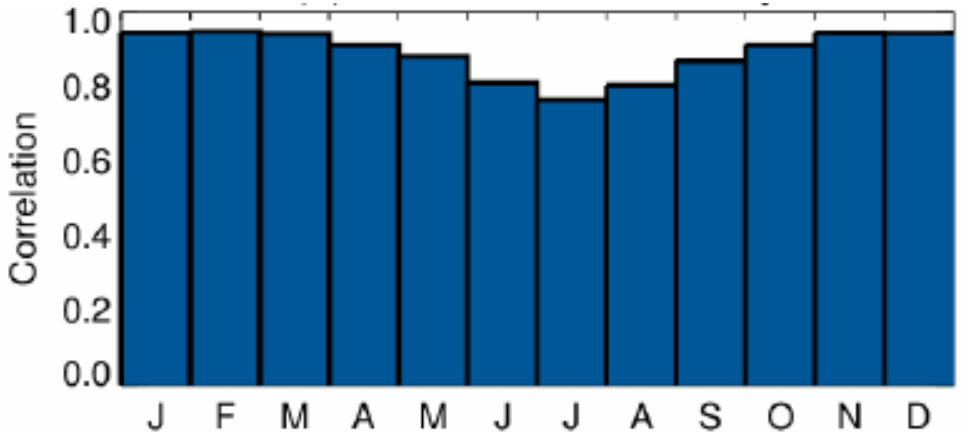
Correlation of interannual variability of monthly means

January Correlation

= correlation > 0.9



Average correlation over Atlantic grid points



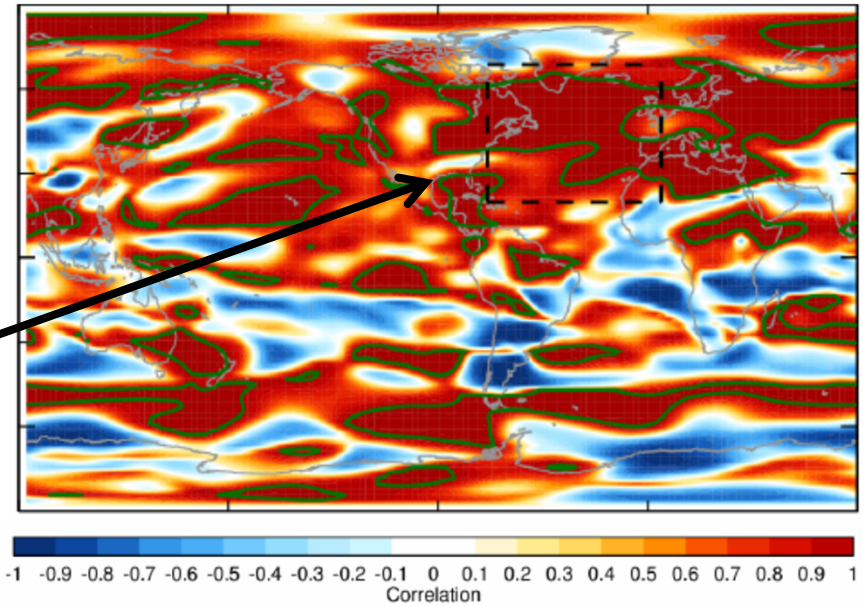
High correlation during winter, lower during summer

The correlation between ERA20C and 20thC reanalyses

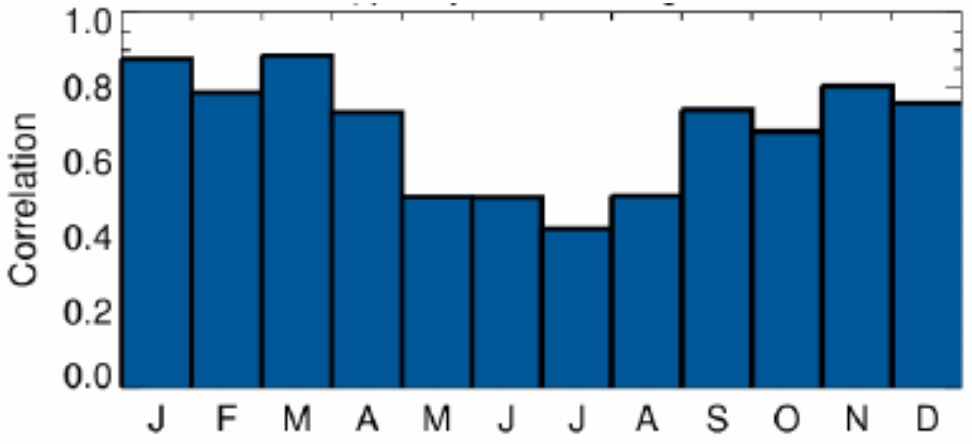
Correlation of 37 year running means of zonal wind

= correlation > 0.9

January Correlation



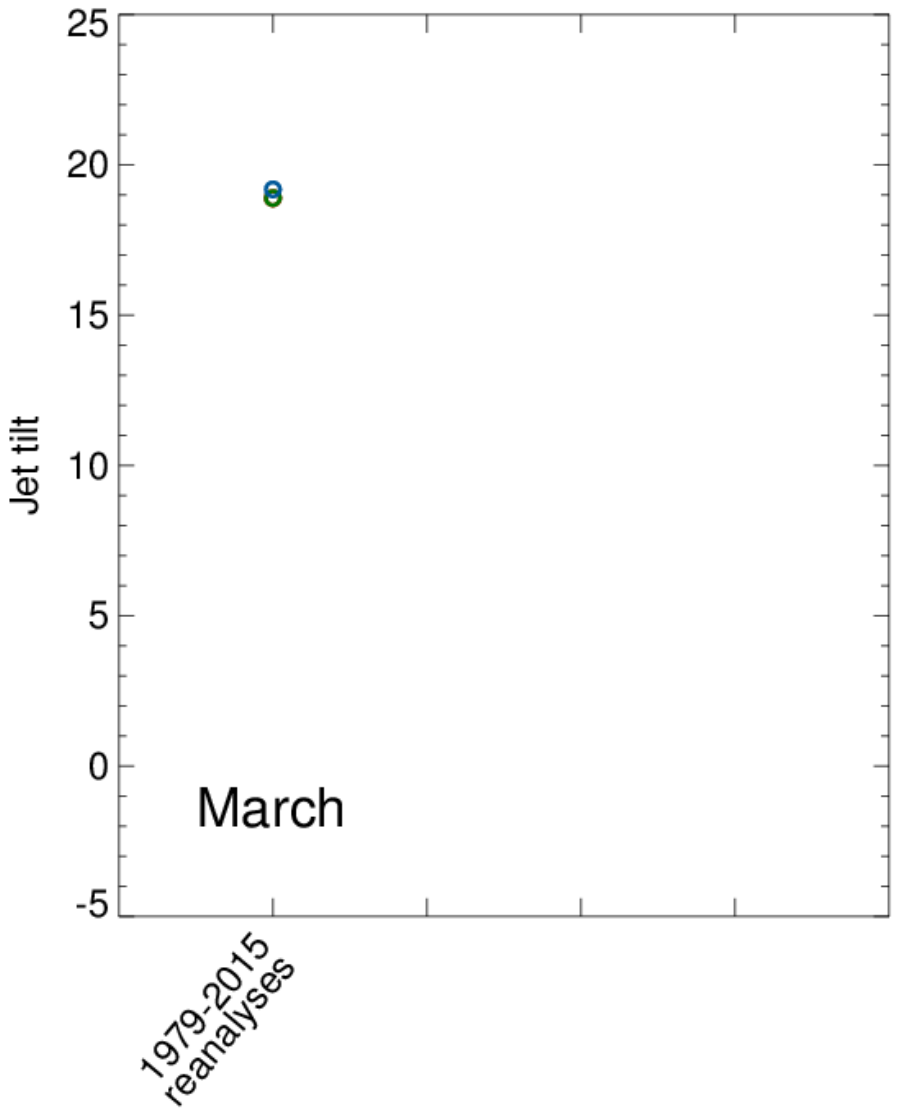
Average correlation over Atlantic grid points



High correlation during winter, lower during summer

Comparing model climatologies with reanalysis, placing the climatology of the satellite era within the context of the full 20th Century

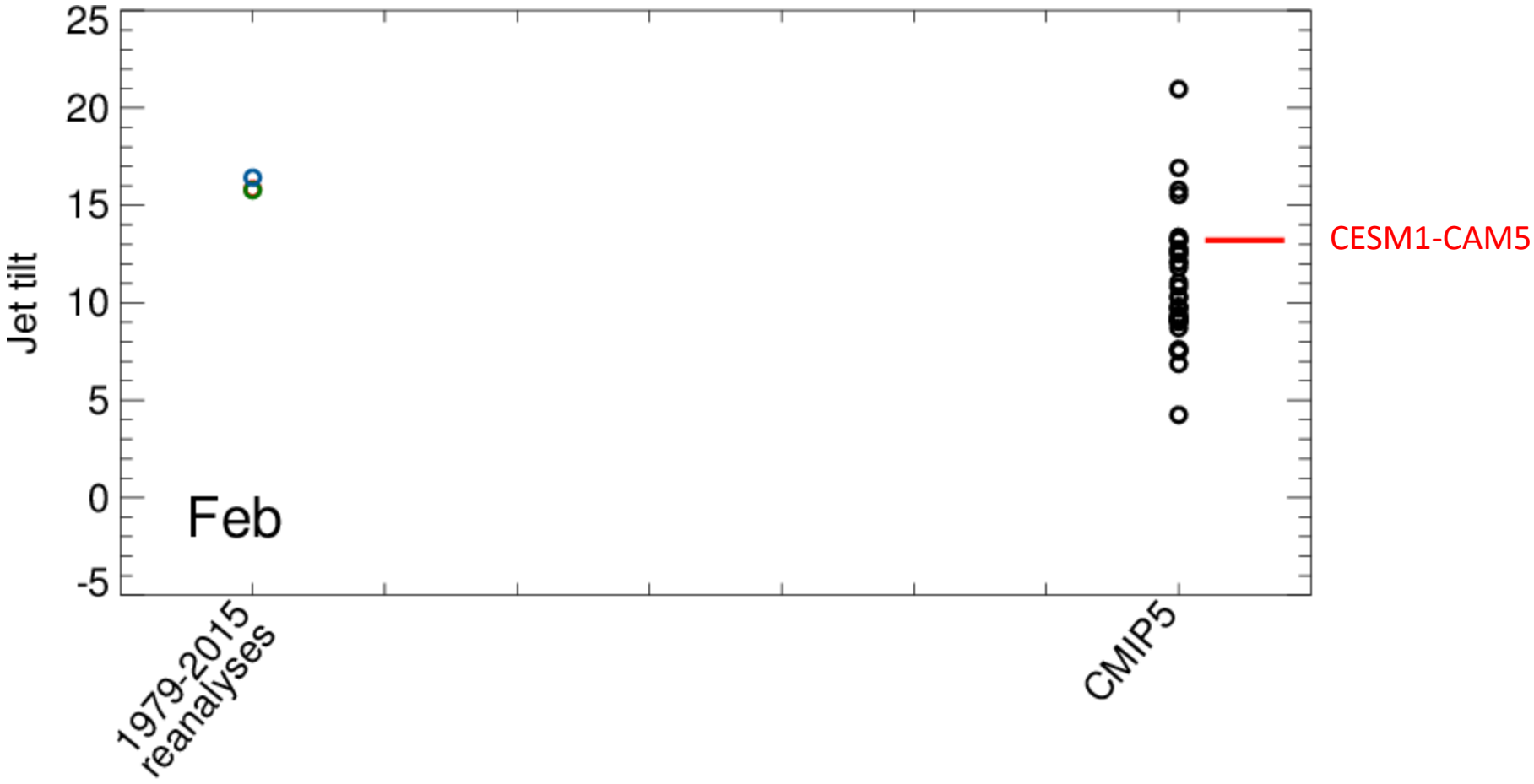
An example: Jet tilt in March



ERA-Interim MERRA2 JRA-55

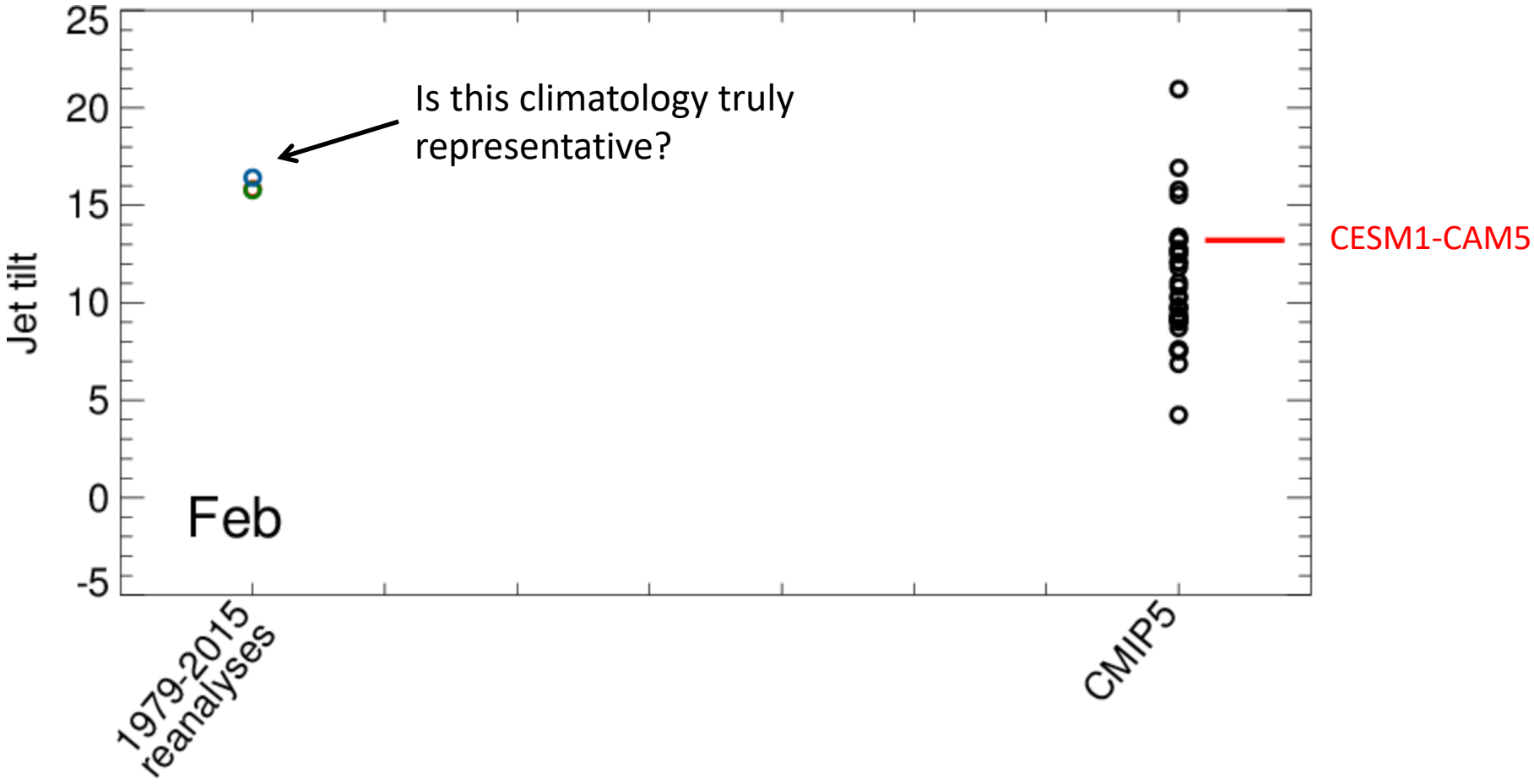
Comparing model climatologies with reanalysis, placing the climatology of the satellite era within the context of the full 20th Century

An example: Jet tilt in February

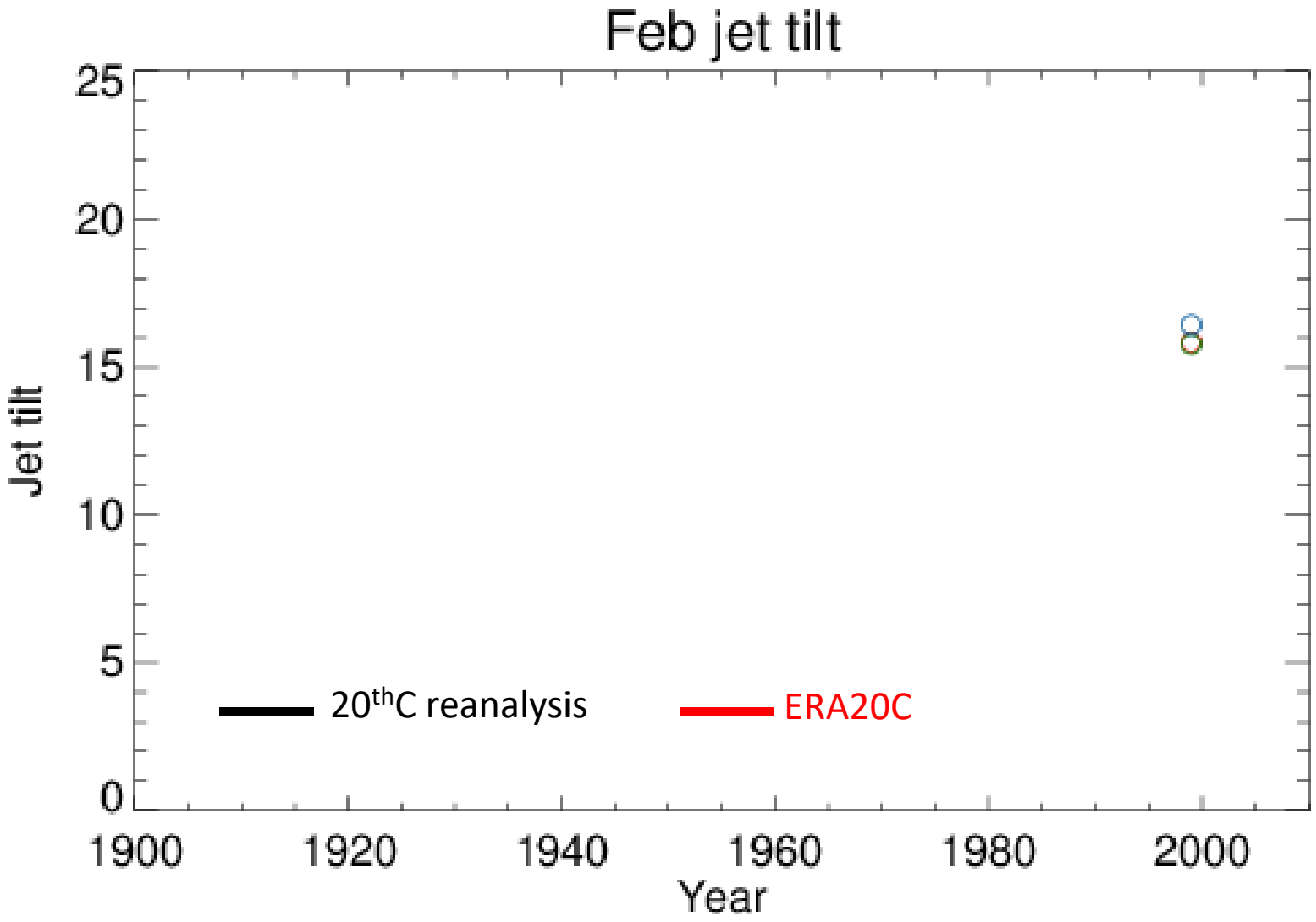


Comparing model climatologies with reanalysis, placing the climatology of the satellite era within the context of the full 20th Century

An example: Jet tilt in February

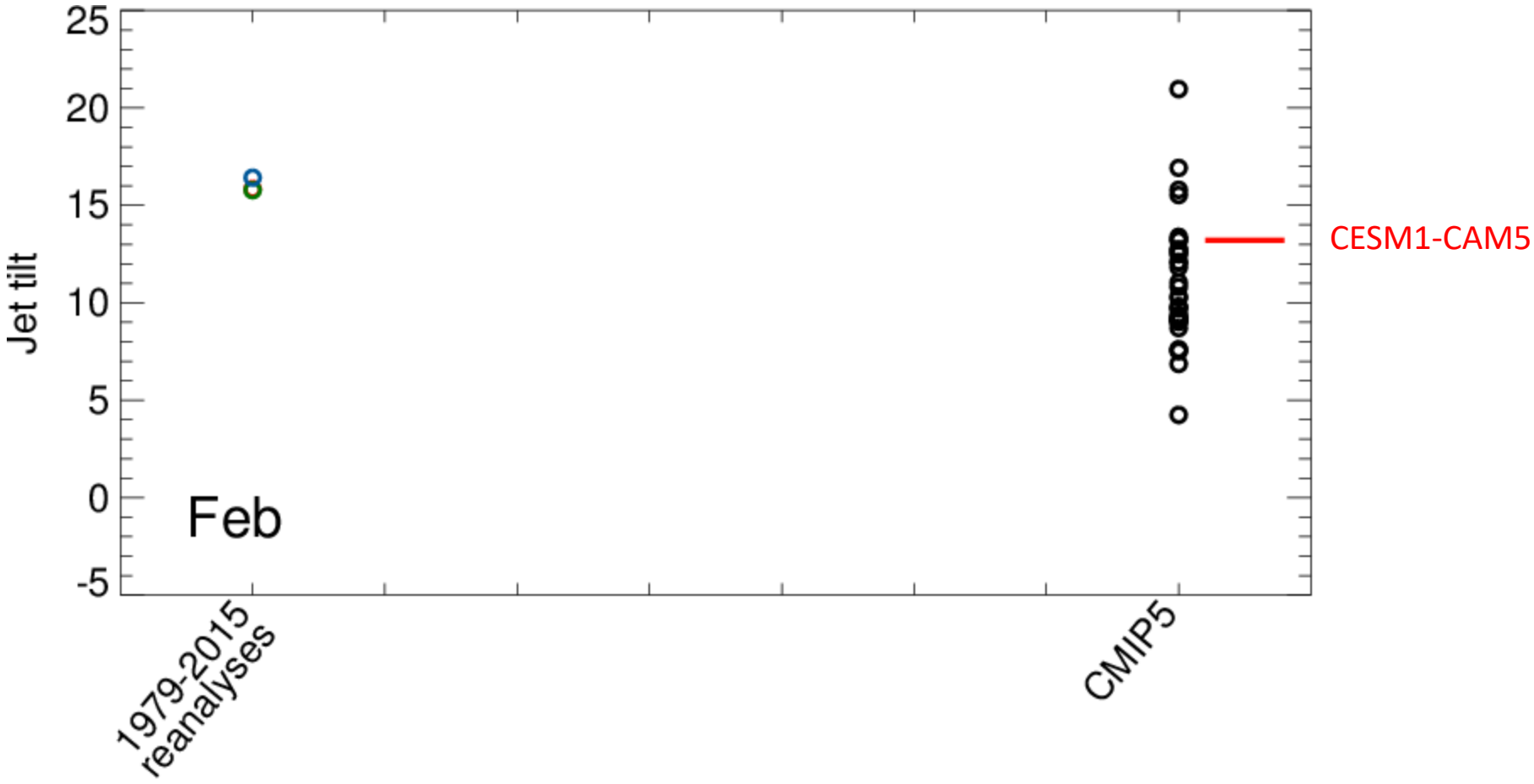


Evolution of 37 year climatologies over the 20th Century



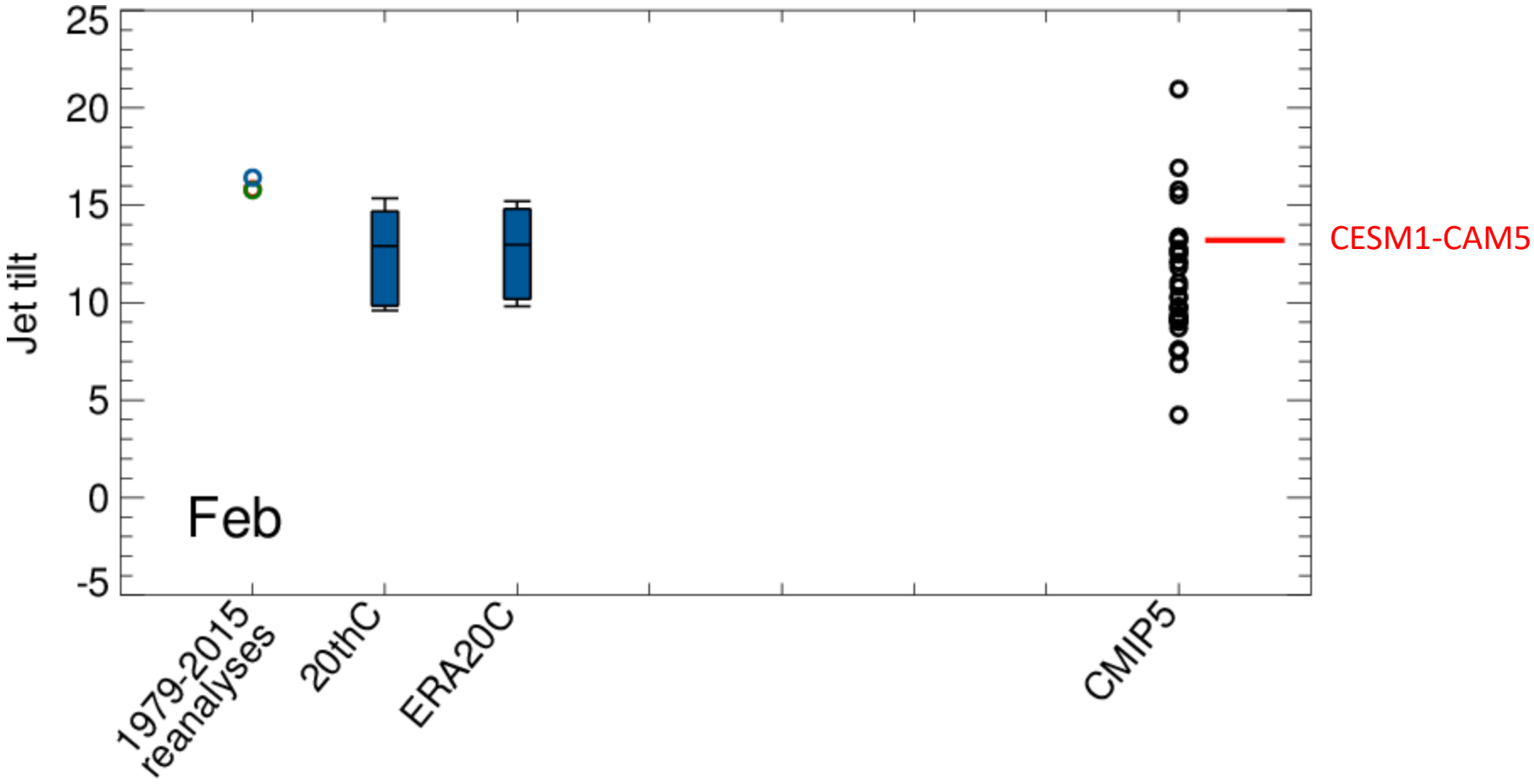
Comparing model climatologies with reanalysis, placing the climatology of the satellite era within the context of the full 20th Century

An example: Jet tilt in February



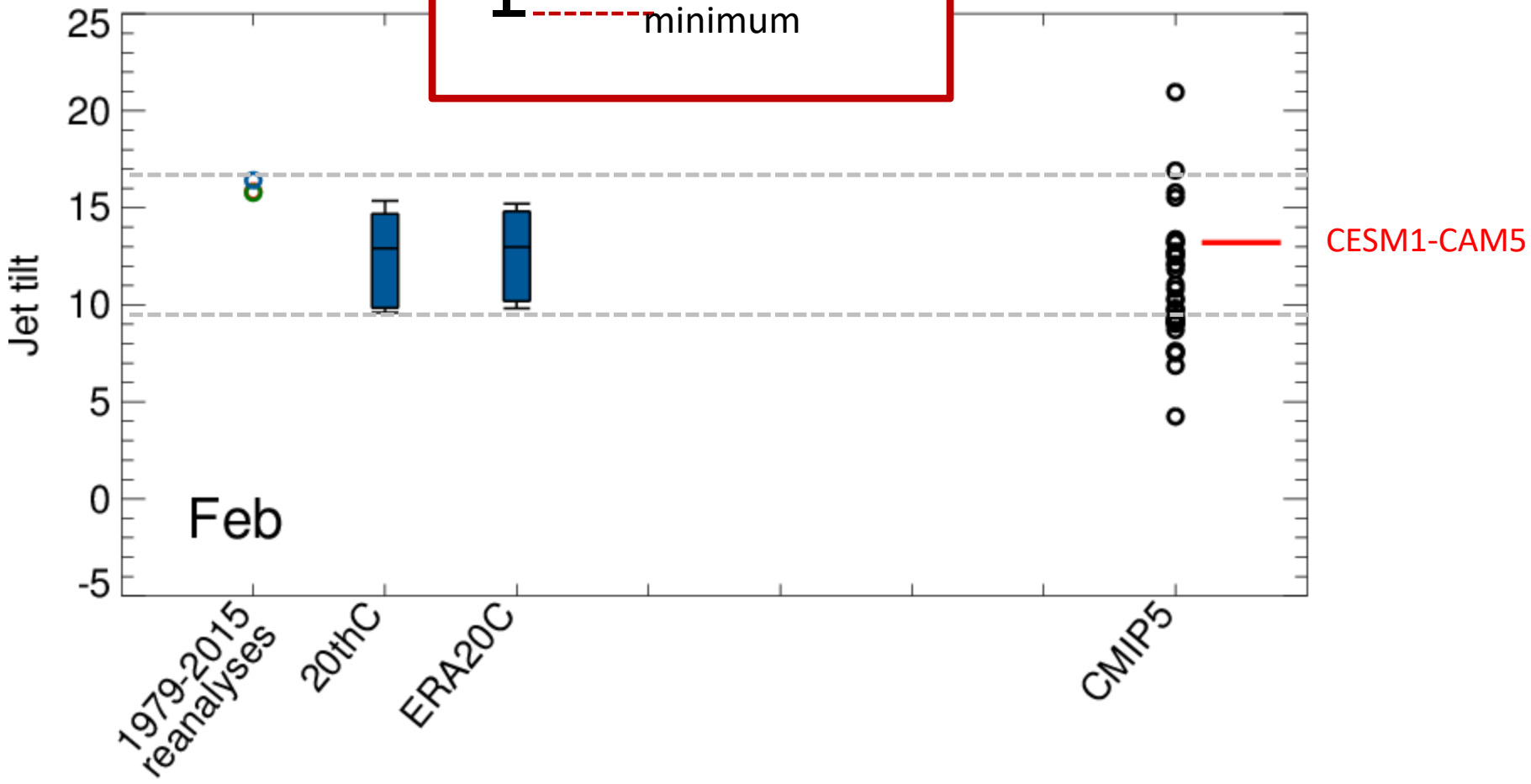
Comparing model climatologies with reanalysis, placing the climatology of the satellite era within the context of the full 20th Century

An example: Jet tilt in February



Comparing mode eanalysis, placing the climatology of the he context of the full

An example: Jet tilt



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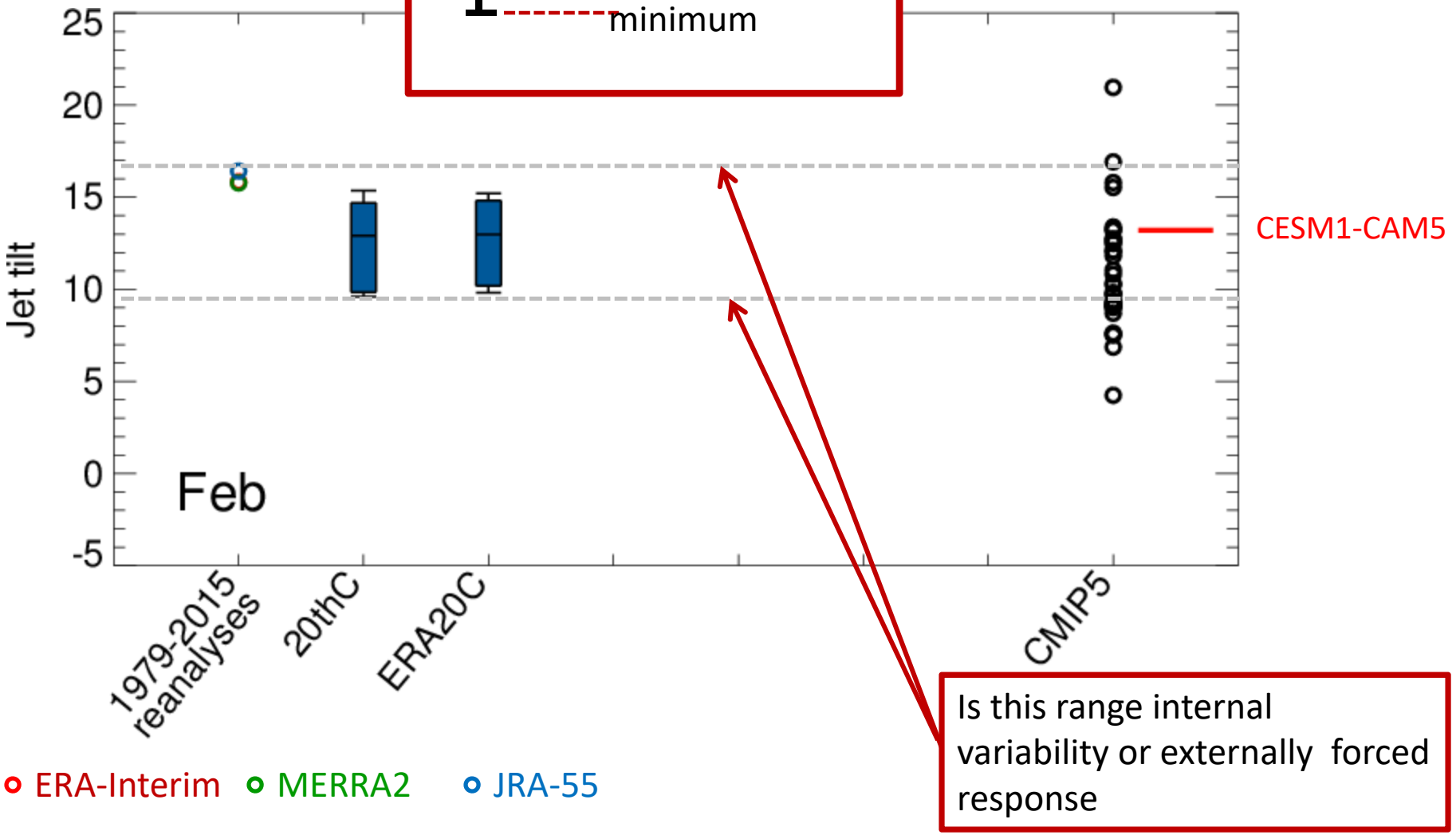

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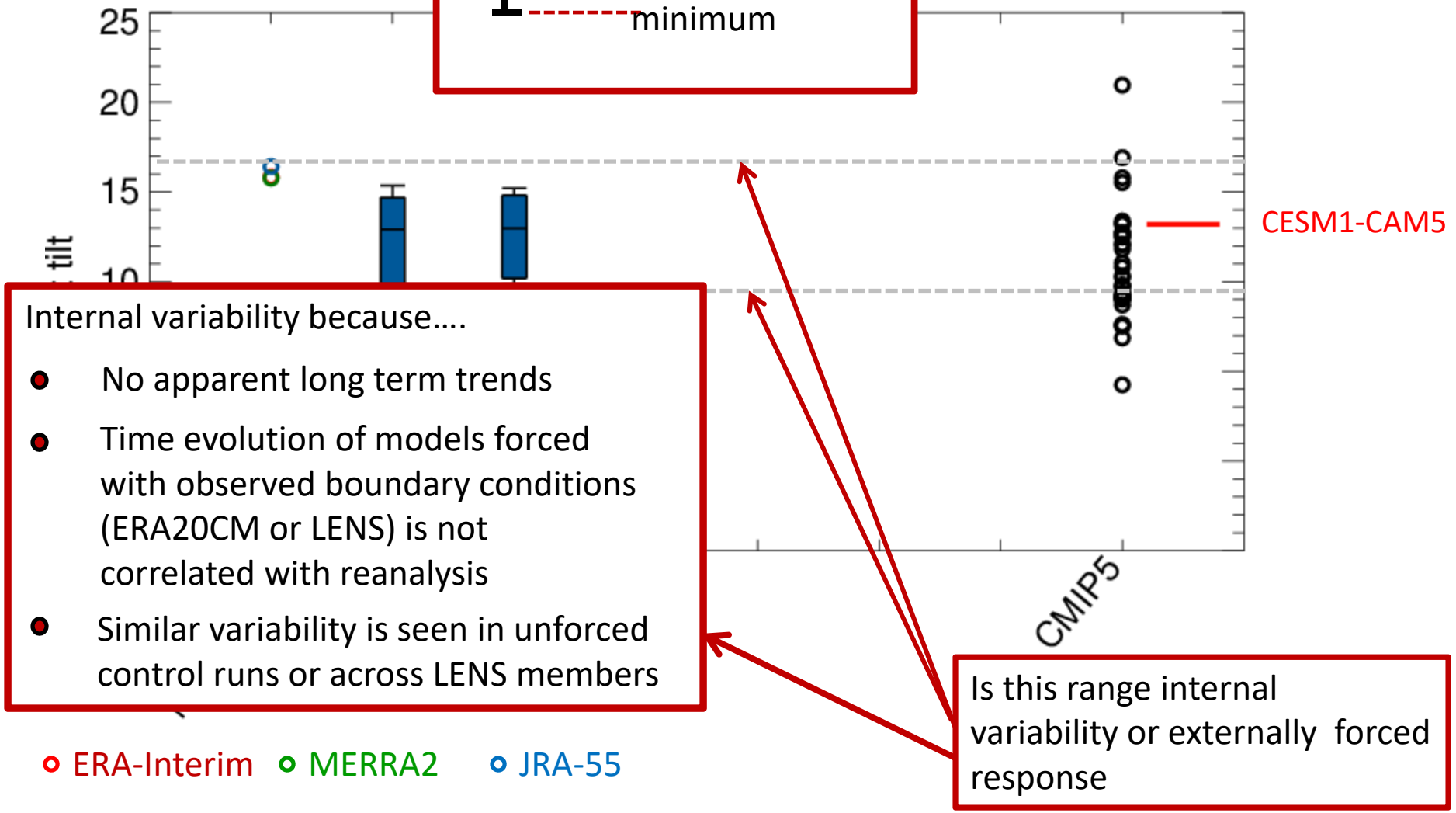
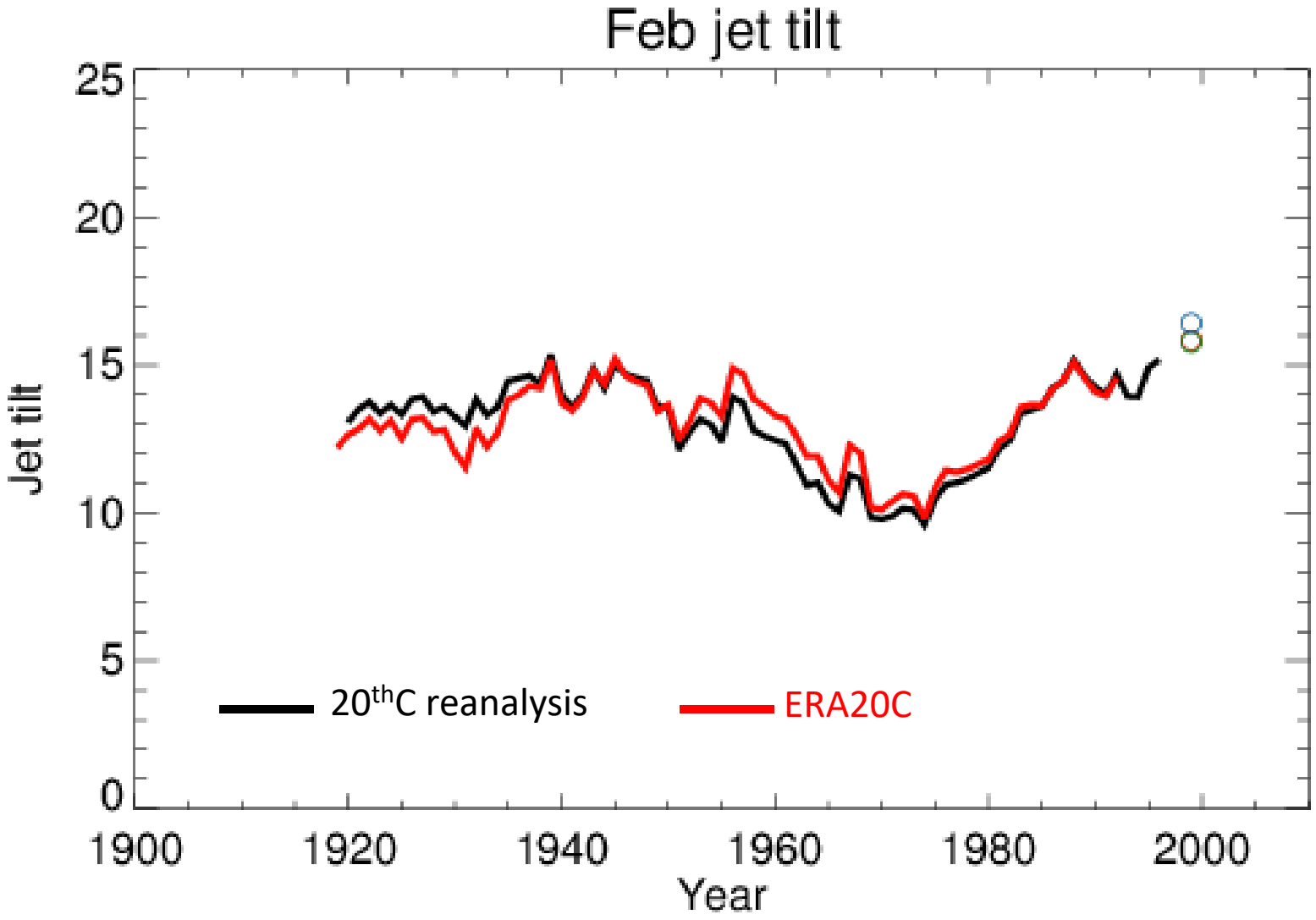


Internal variability because….

- No apparent long term trends
- Time evolution of models forced with observed boundary conditions (ERA20CM or LENS) is not correlated with reanalysis
- Similar variability is seen in unforced control runs or across LENS members

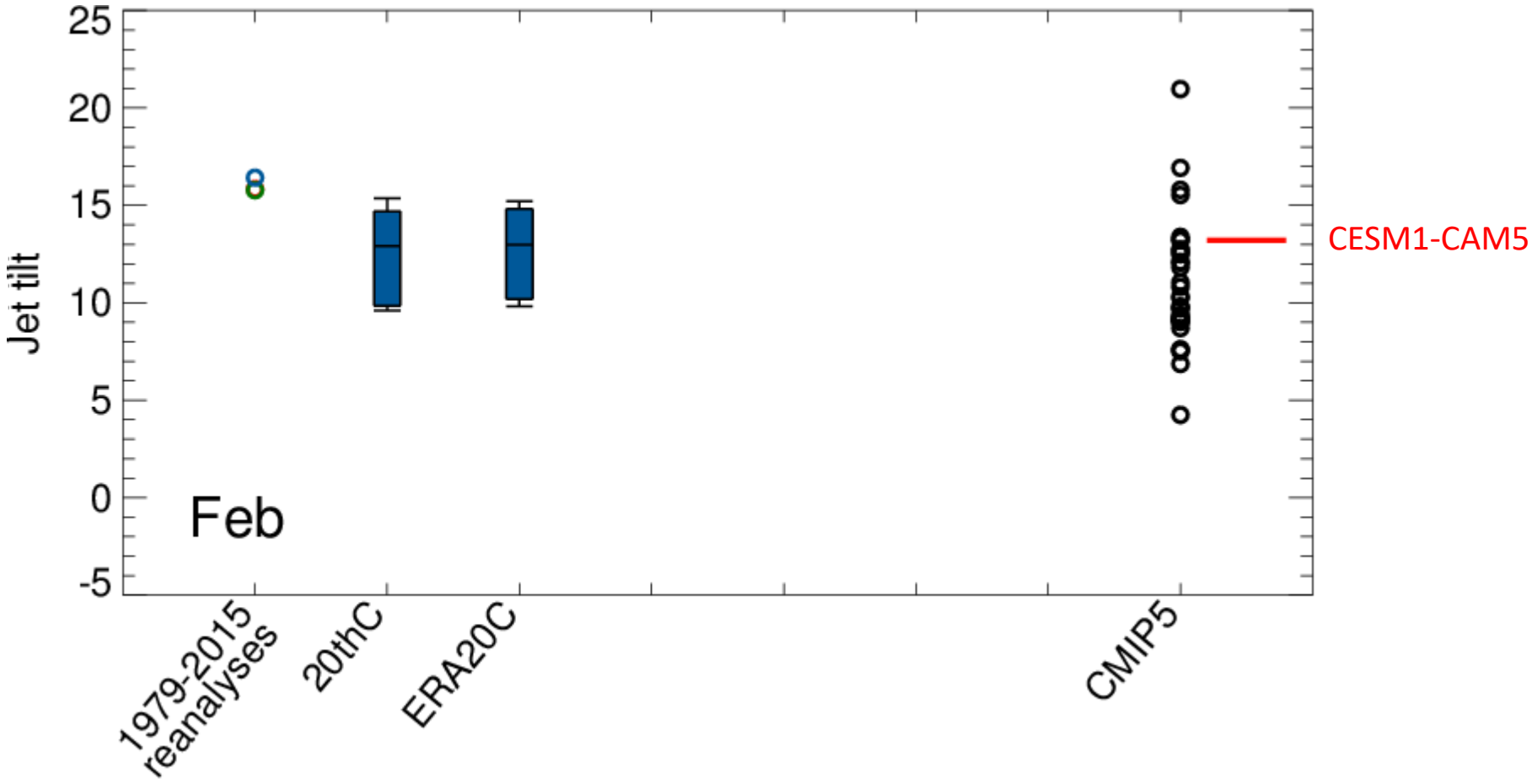
Is this range internal variability or externally forced response

Evolution of 37 year climatologies over the 20th Century



Comparing model climatologies with reanalysis, placing the climatology of the satellite era within the context of the full 20th Century

An example: Jet tilt in February



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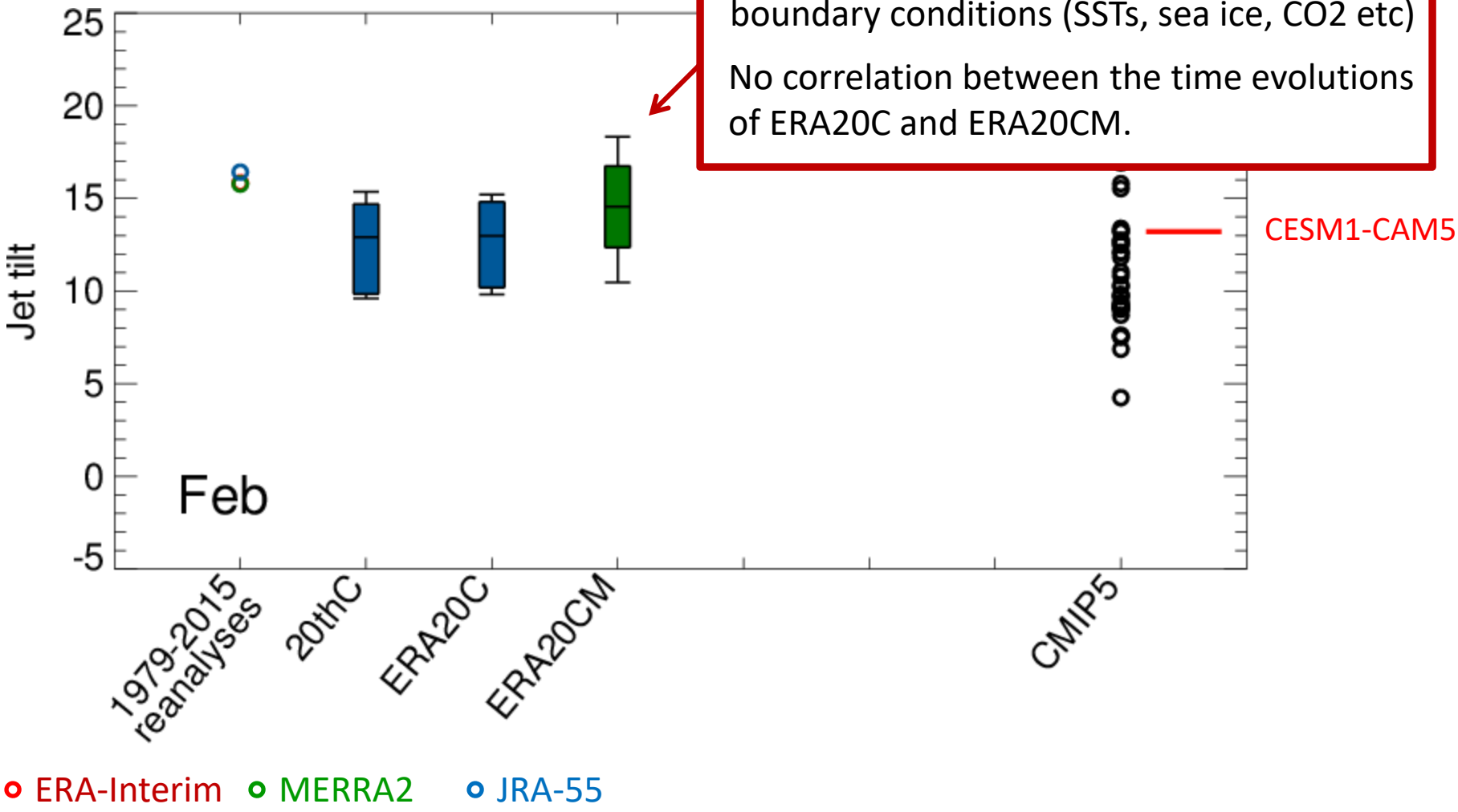

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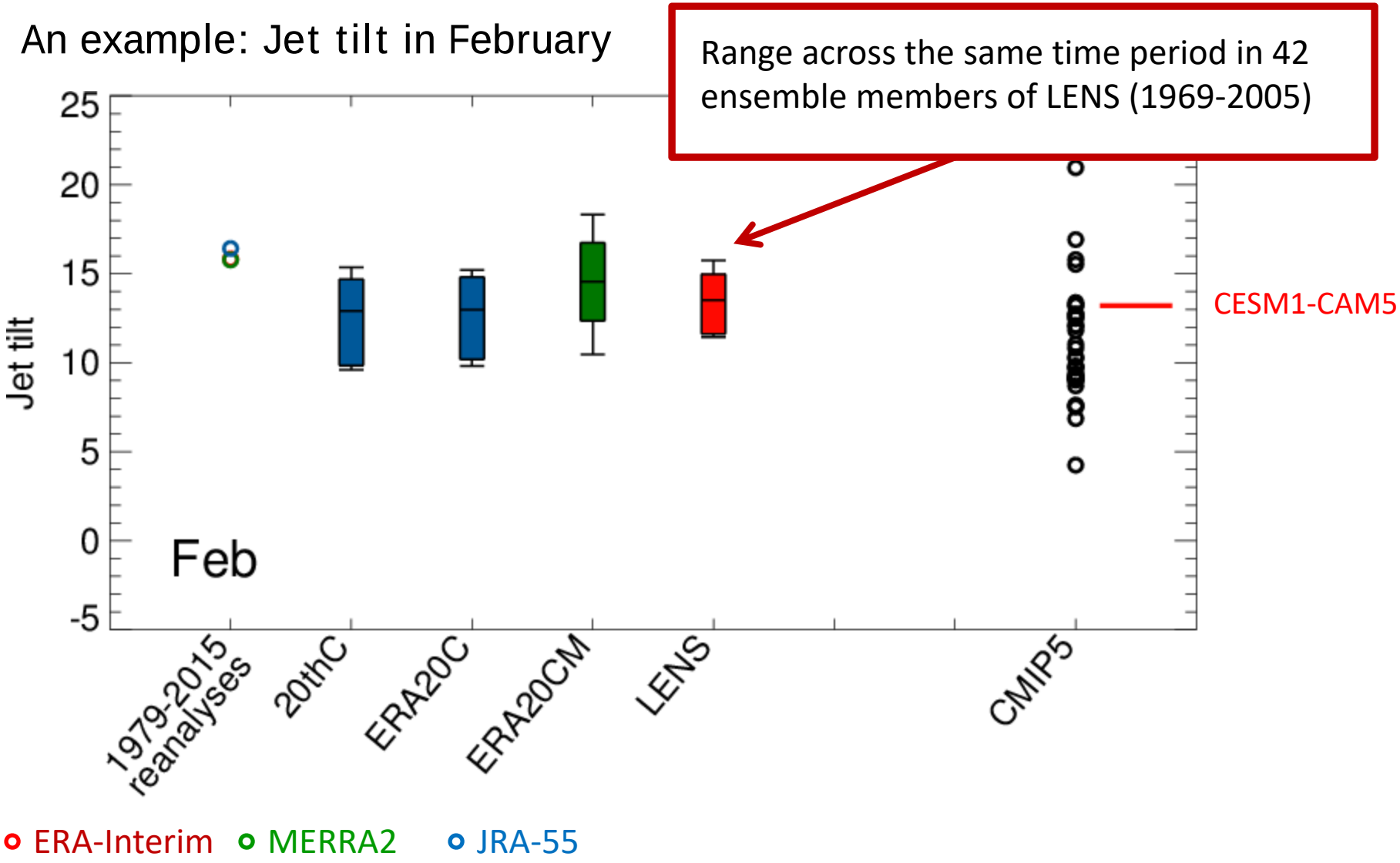

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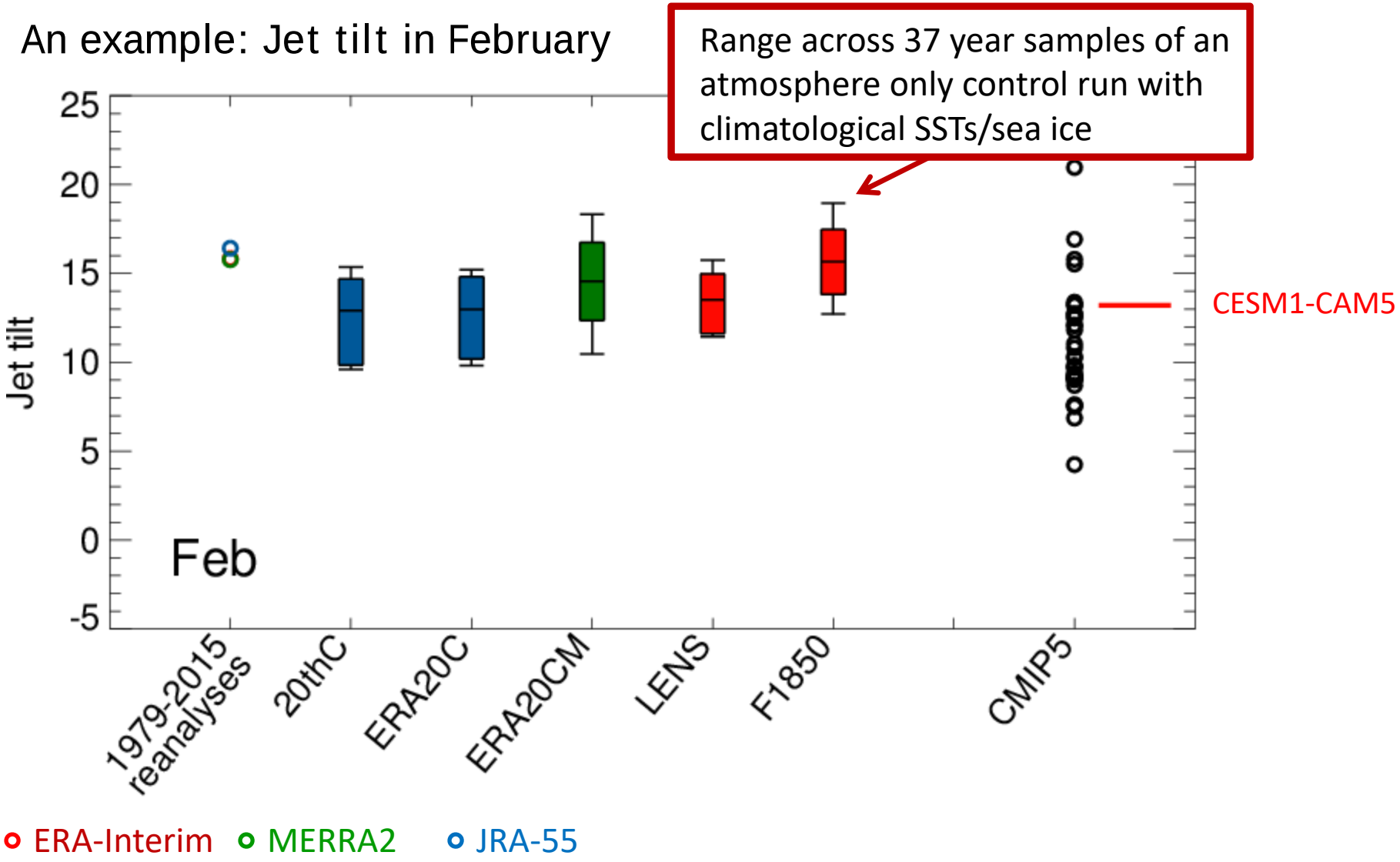

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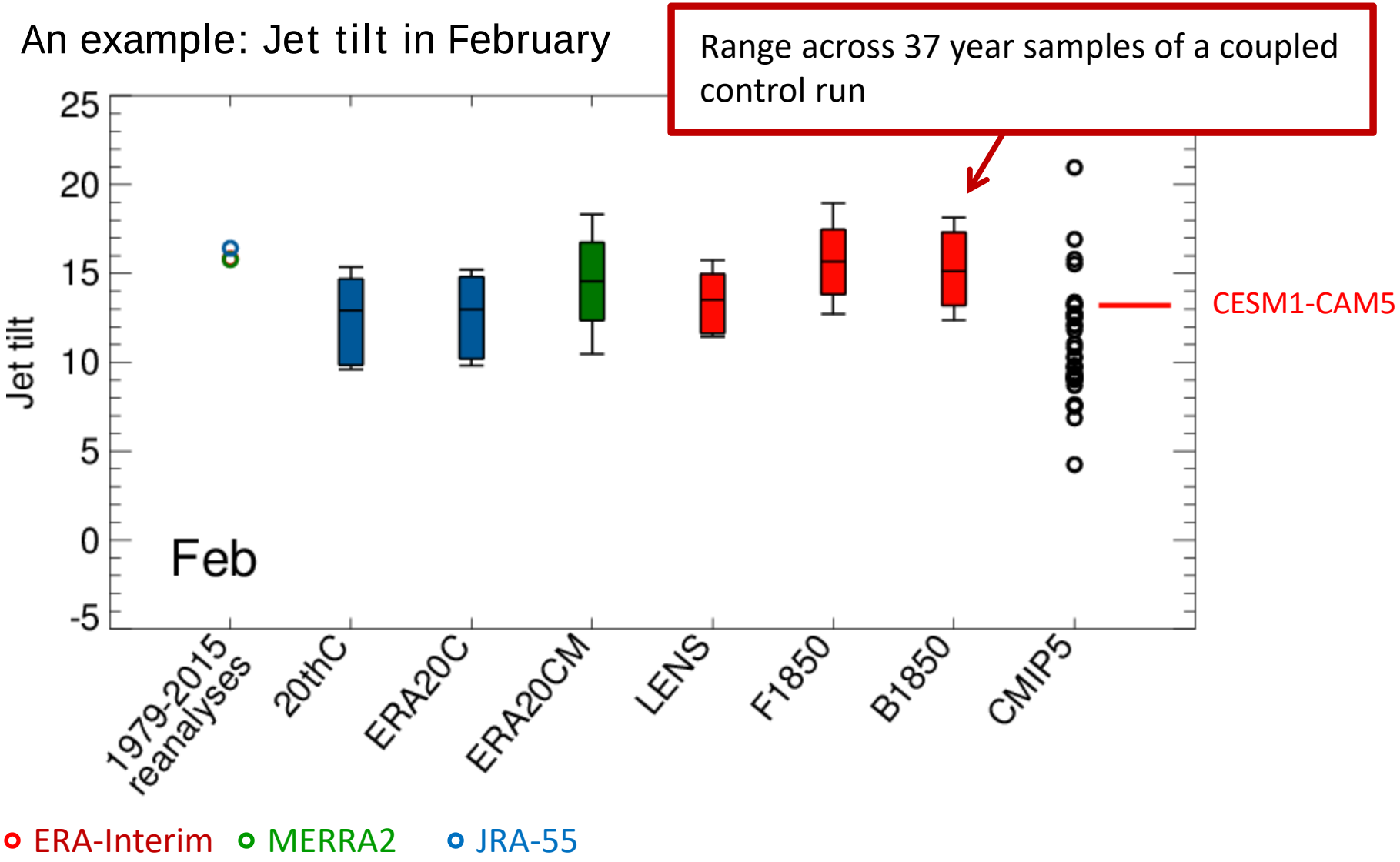

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