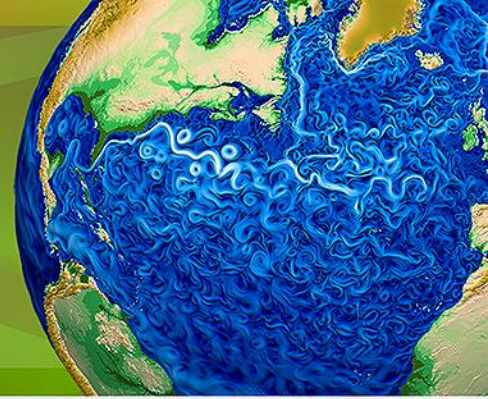




Accelerated Climate Modeling
for Energy



Lessons learned from the “high-res” project: *the importance of atmospheric variability and suggested improved testing*

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May 2015*

Background & the subcycling issue

- ✓ During the analysis of a version of CESM output from “high-res” project, we found that the energetics and the atmospheric variability, including wave activity and some key atmospheric phenomena, are not correct.
- ✓ After an in depth examination, we found the problems is associated with a subcycling issue (time-stepping bug) in the atmosphere.
- ✓ It indicates a serious issue in the atmosphere coupler, which is responsible for the energy conversion between **dynamical** and **physical** processes.

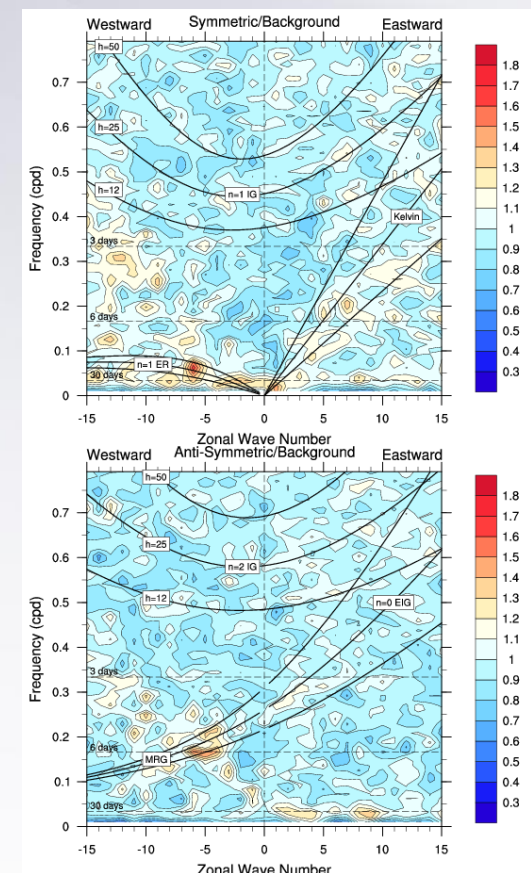
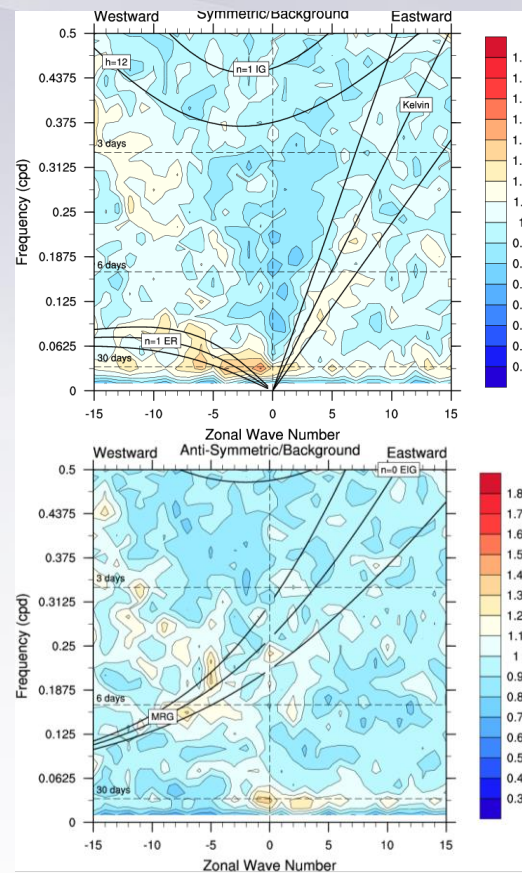
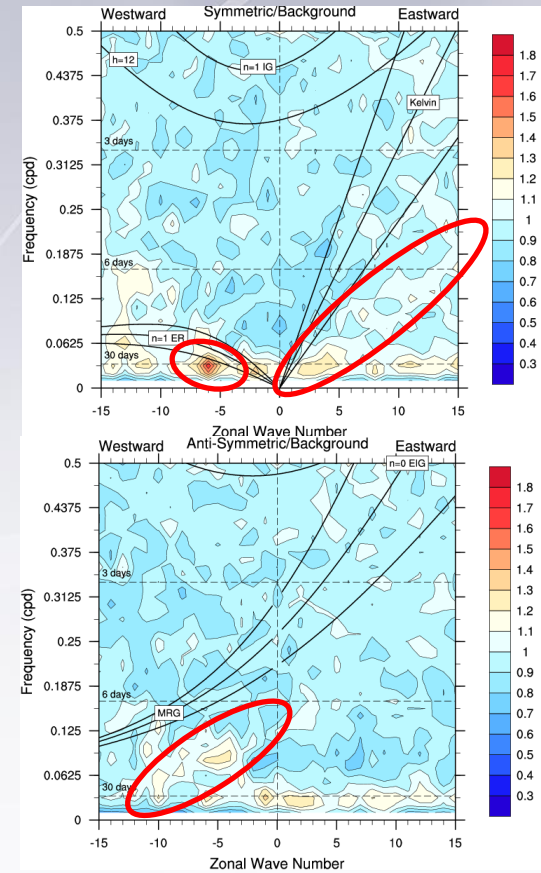
Equatorial Waves

Wheeler-Kiladis diagram

With Subcycling issue

Reanalysis

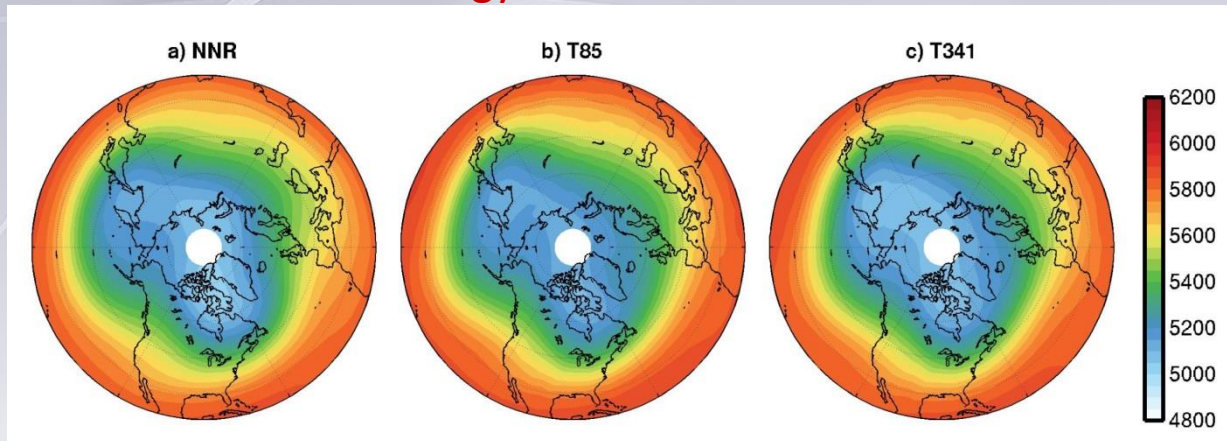
Wrong time-stepping but with "daily=12hrly assumption"



✓ Demonstrated that the tropical dynamics is largely determined by the subcycling due to the heavily parameterized processes in this region (more linear response).

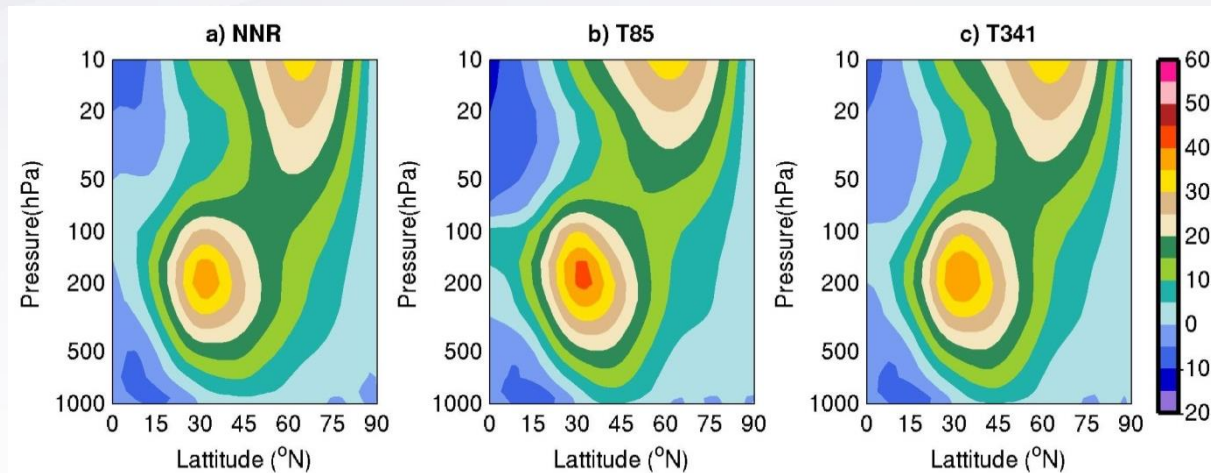
Extratropical circulation?

Z500 Winter Climatology



Difference: <3%

Zonal wind cross section



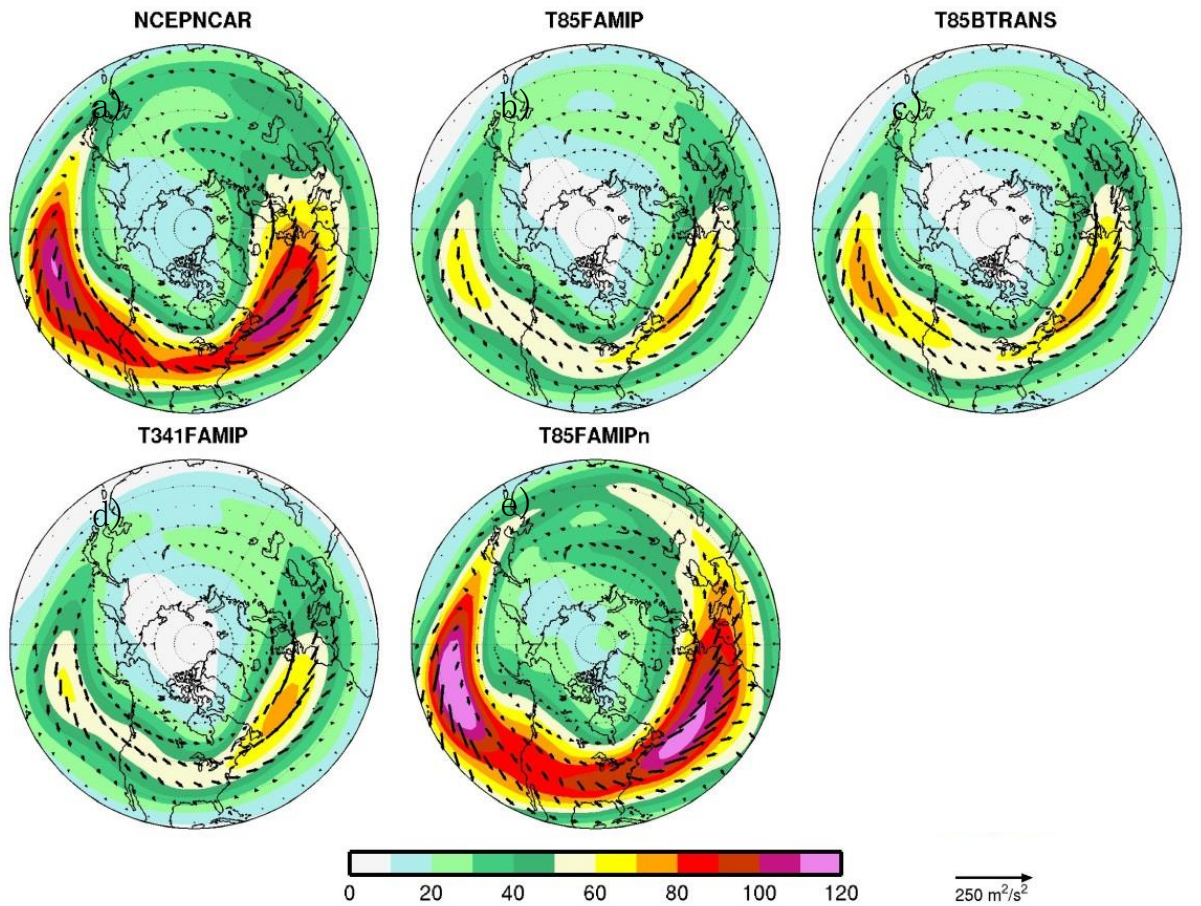
Difference: <10%

The general circulation looks OK?

The synoptic scale variability

Storm tracks: 250 hPa high-passed (<7 days)

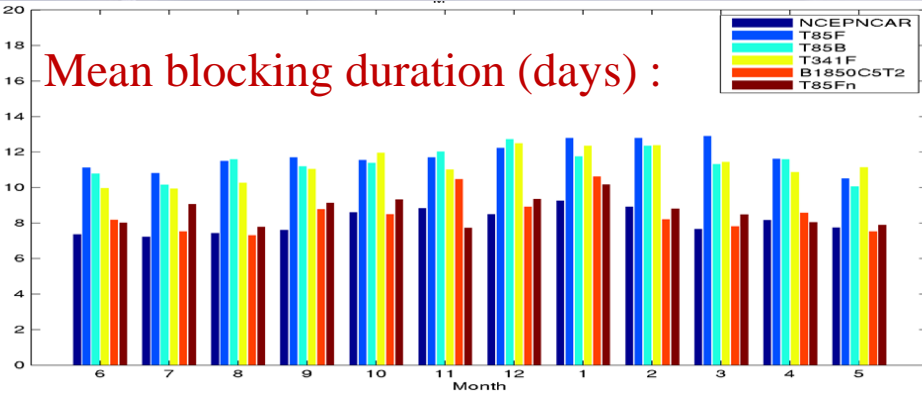
Eddy Kinetic Energy



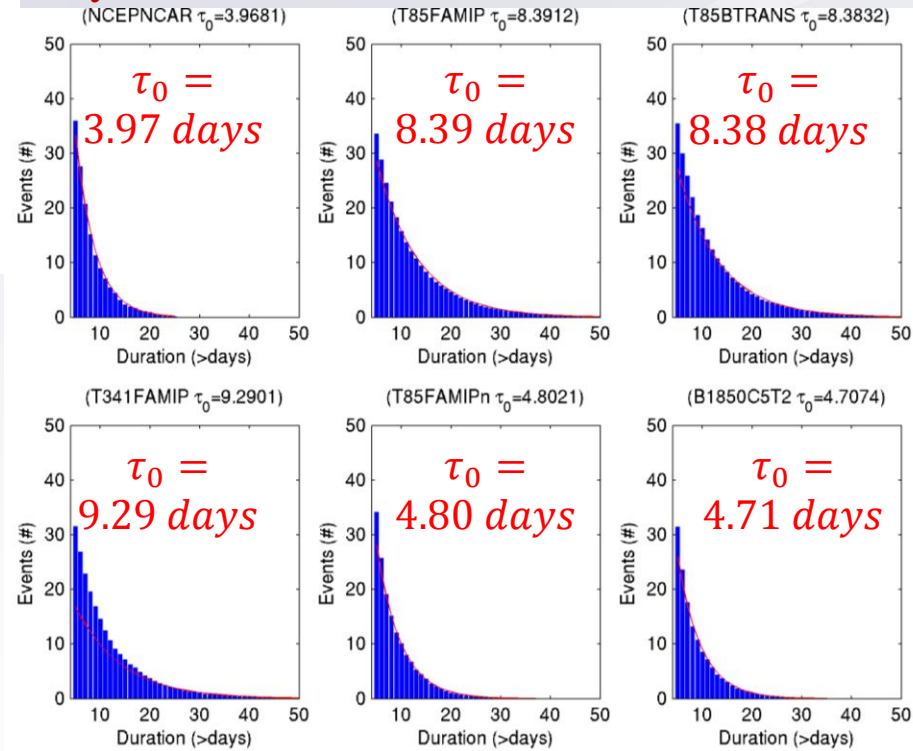
- ✓ The midlatitude stormtracks in high-res runs (b, c and d) is about 2/3 of the amplitude as in the NCEPNCAR reanalysis (a).
- ✓ The stormtrack is more comparable if the subcycloning issue is corrected (e).
- ✓ The much weaker weather scale variability is because the atmosphere flow is perturbed by the baroclinic potential energy generated through subcycloning process.
- ✓ **The ACME model is able to correctly capture this variability in the B1850C5T2 version.**

The impact to a low-frequency atmospheric phenomenon: atmospheric blocking

Atmospheric blocking is a large-scale quasi-stationary extratropical flow regime. It is commonly referred to as the situation when the midlatitude westerly jet is interrupted by strong and persistent (lasting more than 5 days) meridional flow.



Events lasting at least a given number of days :



- The blocking duration is much higher with the inaccurate subcycling.
- The **characteristic timescale** τ_0 is about doubled in T85F, T85B and T341F runs.
- The characteristic timescale indicates the typical **spindown timescale** of the blocking through diabatic decay.
- Because the wrong time-stepping in the model, the **diabatic cooling rate** is only about half of what it should be. So the lifespan of blocking phenomenon is unrealistically long.

Summary

- The subcycling issue contaminates the dynamical processes in most of the high-res runs, but this influence is difficult to detect in the mean circulation.
- We have validated the B1850c5t2 version of ACME model from a dynamical standpoint.
- It is suggested that the testing of high-frequency atmospheric variability and transient eddies need to be included in model validation, especially because we are plugging in more and more components and schemes into the model.