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Climate of the Past Discussions

Interactive comment on "Extratropical cyclone statistics during the last millennium and the 21st century" *by* Christoph C. Raible et al.

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Dear Reviewer

Please find below our reply to your review in the discussion process of our manuscript. Please note that this reply is not the comprehensive point-to-point response which will be due in a later stage of the review process (depending on the editor's decision). Thus, we concentrate on the major comments and try to show how we will deal with the helpful suggestions and questions raised.

'The reviewer suggests to redo the analysis by using SLP instead of Z1000. The main reason is that the reviewer thinks we have used the in-line 1000hPa geopotential (Z1000) as a variable (versus calculating Z1000 using the hybrid coefficients

and topography). Actually we have calculated Z1000 offline from the 3-dimensional geopotential height field (See ncl script below). Comparing the Z1000 with the SLP averaged for the period 1980-2009 we still see a small positive difference over the center of Greenland (Fig 1, reply, below). However, this difference between Z1000 and SLP does not affect the two regions where CESM overestimates cyclones (see manuscript Fig. 2), namely in the Hudson Bay and in between Iceland and Spitzbergen. We additionally made a visual test (movie of Z1000 field) and see that CESM simulates more cyclones traveling to these two regions than ERA interim. So there are no stationary cyclones in these regions which may be a hint that the interpolation of Z1000 leads to some artificial cyclones. Note also the effect of the slightly coarser resolution of ERA interim (here 1.5 degree) which lead to a less pronounced meridional pressure gradient in the North Atlantic. So some of the bias might be due to weak cyclones (we will give more arguments for this in the revised version), but certainly CESM also overestimates cyclones. We will be more clear on this fact in the revised version.

Furthermore, we will take care on the minor comments and add the literature, in particular concerning the subgrid physics and give some reasoning on the use of basin wide storm track measure and how the can be interpreted. The main reason is that we focus here on the broader picture and certainly plan to perform a regional focus on regions in Europe in a next publication.

Thank you again for the helpful comments which certainly will improve our manuscript.

Sincerely yours,

Christoph Raible

on behalf of the author team

NCL script:

;**********

; This script interpolates sigma to pressure coordinates

```
; in outputs the geopotential height (for all plevs chosen)
;*********************************************
load "$NCARG_ROOT/lib/ncarg/nclscripts/csm/gsn_code.ncl"
load "$NCARG_ROOT/lib/ncarg/nclscripts/csm/gsn_csm.ncl"
;*********************************************
begin
;*************************************************
; read in data
;*************************************************
;******only years
;******year has to be given with the function call: 'for a in { }; do ncl
;******year=... Interpolation_... ;done'
path1="/BPRD_trans/atm/hist/BPRD_trans.cam2.h1.$yy-01-01-00000.4.nc"
in = addfile(path1,"r")
;---------------------------------------------------
; read needed variables from file
;---------------------------------------------------
Z3 = in->Z3 ; select variable to be converted
P0mb = 1000.
hyam = in->hyam ; get a coefficiants
hybm = in->hybm ; get b coefficiants
```



```
PS = in->PS ; get pressure
TBOT = in->TS ; get temperature at lowest layer (closest to surface)
dims = dimsizes(Z3)
nlevs= dims(1)
PHIS = Z3(:,nlevs-1,:,:)*9.81 ; get geopotential [m^2/s^2] at the bottom (lowest layer)
;---------------------------------------------------
; define other arguments required by vinth2p
;---------------------------------------------------
; type of interpolation: 1 = linear, 2 = log, 3 = loglog
interp = 2
; is extrapolation desired if data is outside the range of PS
; extrap = False
extrap = True
; A scalar integer indicating which variable to interpolate: 1 = temperature,
; -1 = geopotential height, 0 = all others.
varflg = -1
; create an array of desired pressure levels:
plevs =(/ 1000.0 /)
plevs!0 = "plevs"
plevs&plevs = plevs
plevs@long_name = "Pressure"
```

```
plevs@unit = "hPa"
intVar_PS = vinth2p_ecmwf(Z3,hyam,hybm,plevs,PS,interp,P0mb,1,extrap,varflg,TBOT,PHIS
intVar_PS!0 = "time"
intVar_PS!1 = "lev"
intVar_PS!2 = "lat"
intVar_PS!3 = "lon"
intVar_PS&time = in->time
intVar_PS&lev = plevs
intVar_PS&lat = in->lat
intVar_PS&lon = in->lon
intVar_PS@units = "m"
intVar_PS@long_name = "Geopotential Height (above sea level)"
;system("echo saving")
;setfileoption("nc","Format","NetCDF4Classic")
;fileout=getenv("FZ")
fileout="BPRD_trans.cam2.h1.$yy-01-01.z1000.nc"
system("rm " + fileout) ; remove any pre-existing file
fout=addfile(fileout,"c")
fout->Z3 = intVar_PS ; write into new file
system("echo new file for GPH") ; print path and new file to screen as confirmation
```


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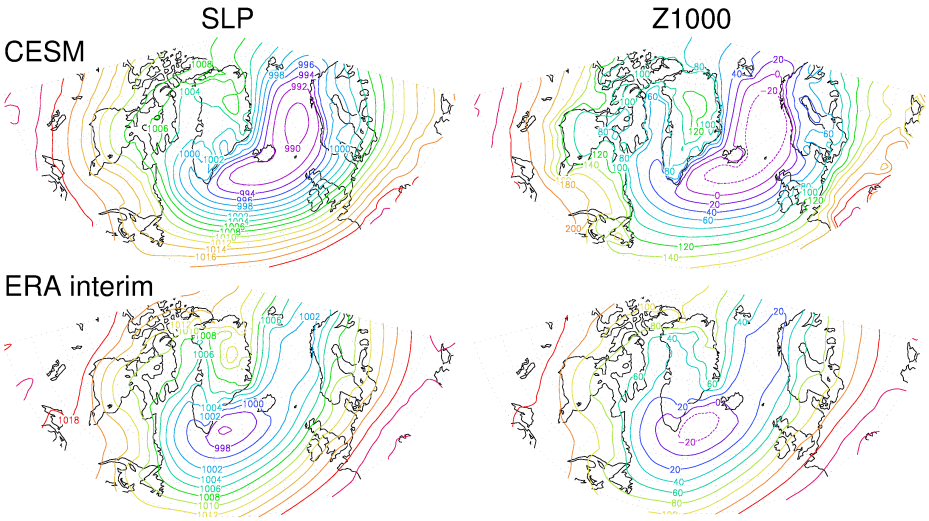

Fig. 1. Comparison of mean SLP and Z1000 field for winter DJF for the period 1979 to 2009: (top) CESM, (bottom) ERA interim.