

Ben Foster <foster@ucar.edu>

TIEGCM geopotential/geometric height

12 messages

Alex Chartier <alex.chartier@outlook.com> Reply-To: alex.chartier@outlook.com To: Ben Foster <foster@ucar.edu> Tue, Jan 20, 2015 at 12:35 PM

Hi Ben,

I'm confused about the geopotential (Z) and geometric (ZG) heights in TIEGCM. In my TIEGCM setup, ZG is coming out smaller than Z, especially for large values, whereas I think the opposite should be the case. I think geometric height, Z, should be larger at high altitudes because geometric height takes account of gravity weakening with increasing distance from Earth, whereas geopotential height, ZG, does not.

Can you shed any light on this? My equation for ZG is as follows (re is Earth's radius):

ZG = -Z re / (Z - re)

Thanks,

Alex

Ben Foster <foster@ucar.edu> To: Alex Chartier <alex.chartier@outlook.com>

Alex, are you looking at ZG from your own equation, or the one calculated in the model by sub calczg (addiag.F)? If you add 'ZG' to secflds, then the addfld call at the end of sub calczg will save it to secondary histories.

--Ben [Quoted text hidden] --Ben Foster National Center for Atmospheric Research (NCAR) High Altitude Observatory (HAO) 303-497-1595

Ben Foster <foster@ucar.edu> To: "Stanley C. Solomon" <stans@ucar.edu>

Stan, can you comment on this? I looked briefly at a history, (where ZG is calculated by sub calczg in addiag.F), and ZG does appear smaller than Z at most pressure levels.

--Ben

[Quoted text hidden]

Ben Foster

Tue, Jan 20, 2015 at 1:09 PM

Tue, Jan 20, 2015 at 1:16 PM

National Center for Atmospheric Research (NCAR) High Altitude Observatory (HAO) 303-497-1595

Alex Chartier <alex.chartier@outlook.com> Reply-To: alex.chartier@outlook.com To: Ben Foster <foster@ucar.edu> Tue, Jan 20, 2015 at 1:28 PM

Hi Ben,

The ZG that looks incorrect to me (i.e. ZG smaller than Z) is in the secondary model output. My equation gives me correct (i.e. ZG larger than Z) values.

I'll send you the file using wetransfer - it's too big to fit as an attachment. I have checked output from TIEGCM 1.95 and the relationship is still ZG < Z in that version. I think geopotential height could only be larger than geometric height if the force of gravity was greater at higher altitudes than at sea level, so either there is a bug or I have misunderstood those two quantities.

Alex

From: foster@ucar.edu Date: Tue, 20 Jan 2015 13:09:14 -0700 Subject: Re: TIEGCM geopotential/geometric height To: alex.chartier@outlook.com [Quoted text hidden]

Stan Solomon <stans@ucar.edu> Tue, Jan 20, 2015 at 5:01 PM To: Ben Foster <foster@ucar.edu>, "alex.chartier@outlook.com >> Alex Chartier" <alexc@ucar.edu>

TIE-GCM uses grav = 870 cm s^-2, which occurs at about 300 km altitude. The geopotential is referenced to this grav. Therefore, for most pressure levels, the actual g is greater than grav, so the geopotential height is greater than the geometric height.

Alex Chartier <alex.chartier@outlook.com> Reply-To: alex.chartier@outlook.com To: Stan Solomon <stans@ucar.edu>, Ben Foster <foster@ucar.edu> Wed, Jan 21, 2015 at 9:06 AM

Hi Stan,

Thanks for the explanation. I think it explains all but the last point on my plot of Z - ZG (attached). The very highest geopotential height is much higher than the highest geometric height (22 km higher). What's going on there?

Alex

> Date: Tue, 20 Jan 2015 17:01:18 -0700

> From: stans@ucar.edu

> To: foster@ucar.edu; alexc@ucar.edu

> Subject: Re: Fwd: TIEGCM geopotential/geometric height

[Quoted text hidden]

geopotential minus geometric height.eps

Stan Solomon <stans@ucar.edu> To: alex.chartier@outlook.com, Ben Foster <foster@ucar.edu> As a general rule, ignore the very top level of the model.</foster@ucar.edu></stans@ucar.edu>	Wed, Jan 21, 2015 at 10:04 AM
I'm not sure if this is the answer, but there is an extrapolation to the top level of ZG in sub calczg:	
zg(lev1,i,j) = 1.5*zg(lev1-1,i,j)-0.5*zg(lev1-2,i,j)	
whereas sub addiag, sets the top level of geopotential Z as follows:	
do i=lon0,lon1 do k=lev0,lev1-1 z(k+1,i,j) = w1(k,i)+z(k,i,j) enddo enddo	
where w1 is defined from lev0 to lev1-1	
Ben [Quoted text hidden] Ben Foster National Center for Atmospheric Research (NCAR) High Altitude Observatory (HAO)	
303-497-1595	
Ben Foster <foster@ucar.edu> To: Alex Chartier <alex.chartier@outlook.com>, Liying Qian <lqian@ucar.edu> Cc: Stan Solomon <stans@ucar.edu></stans@ucar.edu></lqian@ucar.edu></alex.chartier@outlook.com></foster@ucar.edu>	Wed, Jan 21, 2015 at 10:58 AM

Keep in mind that Z and ZG are both calculated on interface levels, as shown in an ncdump of a history file, they are both dimensioned ilev:

float Z(time, ilev, lat, lon) ; Z:long_name = "GEOPOTENTIAL HEIGHT" ; Z:units = "cm" ; Z:missing_value = 1.e+36 ; float ZG(time, ilev, lat, lon) ; ZG:long_name = "Geometric Height ZG" ; ZG:units = "cm" ; ZG:missing_value = 1.e+36 ;

So they should be plotted on the ilev coordinate (ilev):

double ilev(ilev) ;
ilev:long_name = "interface levels" ;
ilev:short_name = "ln(p0/p)" ;

3 of 4

ilev = -7, -6.75, -6.5, -6.25, -6, -5.75, -5.5, -5.25, -5, -4.75, -4.5, -4.25, -4, -3.75, -3.5, -3.25, -3, -2.75, -2.5, -2.25, -2, -1.75, -1.5, -1.25, -1, -0.75, -0.5, -0.25, 0, 0.25, 0.5, 0.75, 1, 1.25, 1.5, 1.75, 2, 2.25, 2.5, 2.75, 3, 3.25, 3.5, 3.75, 4, 4.25, 4.5, 4.75, 5, 5.25, 5.5, 5.75, 6, 6.25, 6.5, 6.75, 7;

--Ben [Quoted text hidden]

Ben Foster <foster@ucar.edu> To: Liying Qian <lqian@ucar.edu> Wed, Jan 21, 2015 at 11:02 AM

Liying,

However, I noticed that we are using tn,o2,o,n2 at midpoints instead of interfaces in sub calczg - since ZG is supposed to be on interfaces, shouldn't we calculate xmas and use tn on interfaces in calczg?

--Ben

------ Forwarded message ------From: **Ben Foster** <foster@ucar.edu> Date: Wed, Jan 21, 2015 at 10:58 AM Subject: Re: TIEGCM geopotential/geometric height [Quoted text hidden] [Quoted text hidden]

Liying Qian <lqian@ucar.edu> To: Ben Foster <foster@ucar.edu> Wed, Jan 21, 2015 at 2:22 PM

Hi Ben,

We calculate gravitational acceleration at mid-points, then use it to calculate geometric scale heights at the mid-points, and then we use these geometric scale heights to get geometric heights at interfaces, so we want to use tn, o1, o2, and n2 at the mid-points. It is correct.

Liying [Quoted text hidden]

Ben Foster <foster@ucar.edu> To: Liying Qian <lqian@ucar.edu>

Great, thanks! [Quoted text hidden] Wed, Jan 21, 2015 at 3:36 PM