Subject: Direction of Wind Vectors: A bug?
Posted by David Fanning on Wed, 18 Feb 2015 18:32:42 GMT
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Folks,

Someone was harassing my retirement reveries this morning by claiming that cgDrawVectors was drawing vectors incorrectly, in the wrong directions. He cited as evidence the output of the lovely NASA program, PartVelVec.

Upon looking into this, I discovered that the two programs produce vectors in exactly the same direction if the the plot they are being output on has the same scale in the X and Y direction. (Other things, such as vector length and whether the location specifies the end of the vector or the middle, etc, are different, but irrelevant here.)

If the scale is different on the output plot, the two programs calculate the end-point of the vector differently. As it happens (maybe you saw this coming), I believe cgDrawVectors is doing things right and PartVelVec is doing things wrong.

You will need a recent version of cgDrawVectors to test this. You can download the latest here:

http://www.idlcoyote.com/programs/cgdrawvectors.pro

Unfortunately, I am only about 75% convinced cgDrawVectors is right. I need reassurance from some IDL experts. God only knows how many papers have been written using output from PartVelVec as supporting evidence!

Here is my thinking. Suppose you tell me at some spot on the Earth, the wind is blowing 10 mph in the X direction and 10 mph in the Y direction. Clearly, if I place, say, an arrow at that location, I will have to point it at a 45 degree angle to the location I am standing on to indicate the wind vector direction at that location.

OK, see, my confidence has already eroded to less than 50%, just by writing what I have so far! :-(

As you can see from the test program below, cgDrawVectors preserves this instantaneous vector angle (45 degrees) no matter what the plot scale, while PartVelVec does not. But, I can also see someone explaining PartVelVec by saying, "Look, forget the angle of the vector for a moment. Walk from the starting point of this vector to the end of this vector, and note the coordinates of the two points. Calculate the angle from that. It is 45 degrees, even though it doesn't look like it on the plot because the scale is screwed up."

So, here is my question. Are both of these programs "right"? If not, why not? And, which would convey the "true wind direction" more convincingly on a plot?

Here is the test program.

```
;************************************************************ *****
Pro Vector_Bug
   cgdisplay, wid=1, aspect=1.0, Title='Scale Same in XY'
   cgplot, [-180, 180], [-180, 180], /NoData
   partvelvec, [10,10], [10,10], [-45, -45], [50,-50], $
      /over, veccolor='red', length=.5
   cgdrawvectors, [10,10], [10,10], [-45, -45], [50,-50], $
      /over, veccolor='blue', length=0.1

   cgdisplay, wid=0, aspect=1.0, Title='Scale Different in XY'
   cgplot, [-180, 180], [-90, 90], /NoData
   partvelvec, [10,10], [10,10], [-45, -45], [50,-50], $
      /over, veccolor='red', length=.5
   cgdrawvectors, [10,10], [10,10], [-45, -45], [50,-50], $
      /over, veccolor='blue', length=0.2
END
;************************************************************ *****
```

Cheers,

David

--
David Fanning, Ph.D.
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Coyote's Guide to IDL Programming: http://www.idlcoyote.com/
Sepore ma de ni thue. ("Perhaps thou speakest truth.")

Subject: Re: Direction of Wind Vectors: A bug?
Posted by wlandsman on Wed, 18 Feb 2015 19:23:23 GMT

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On Wednesday, February 18, 2015 at 1:32:50 PM UTC-5, David Fanning wrote:

> So, here is my question. Are both of these programs "right"? If not, why
> not? And, which would convey the "true wind direction" more convincingly
> on a plot?

I'd vote for the partvelvec.pro approach where the angle -- like everything else on the map -- is distorted by the unequal projections.

However, in a similar case I chose the opposite approach -- in my tvcircle.pro I have the comment

"TVCIRCLE always draws a circle --- even when in data coordinates and the X and Y data scales are unequal. (The X data scale is used to define the circle radius.) If this is not the behavior you want, then use TVELLIPSE instead."

In any case, the behavior of the program should be documented (which partvelvec.pro currently isn't), and perhaps a keyword could be added to let the user choose which approach he wants.

--Wayne

Subject: Re: Direction of Wind Vectors: A bug?
Posted by David Fanning on Wed, 18 Feb 2015 19:44:14 GMT
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wlandsman writes:

>
> On Wednesday, February 18, 2015 at 1:32:50 PM UTC-5, David Fanning wrote:
>
>> So, here is my question. Are both of these programs "right"? If not, why
>> not? And, which would convey the "true wind direction" more convincingly
>> on a plot?
>
> I'd vote for the partvelvec.pro approach where the angle -- like everything else on the map -- is distorted by the unequal projections.
>
> However, in a similar case I chose the opposite approach -- in my tvcircle.pro I have the comment
>
> "TVCIRCLE always draws a circle --- even when in data coordinates and the X and Y data scales are unequal. (The X data scale is used to define the circle radius.) If this is not the behavior
> you want, then use TVELLIPSE instead."
>
>
> In any case, the behavior of the program should be documented (which partvelvec.pro currently isn't), and perhaps a keyword could be added to let the user choose which approach he wants.

I'm having a hard time wrapping my head around whether both approaches
are "right", or are they both "wrong." Or, maybe there is some other
combination. It would be easier (and maybe the right approach) to draw a
"stream line" instead of a vector. Then, at least you could visually see
the distortion.

In any case, I can't quite see where I would introduce the actions of
the proposed keyword. And, then, adding a real map projection is just...
Whew! I need another bottle of Tylenol. :-(

Cheers,

David
--
David Fanning, Ph.D.
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Sepore ma de ni thue. ("Perhaps thou speakest truth.")

Subject: Re: Direction of Wind Vectors: A bug?
Posted by natha on Wed, 18 Feb 2015 20:04:24 GMT
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I saw this problem in the routine VELOVECT. I had to rewrite the code taking into account the aspect ratio of the output plot.

```
  ra=(clip[3]-clip[1])/(clip[2]-clip[0])

  x_step=0.01
  y_step=0.01 * ra
```

I had to do the same in your routine windbarb. I assume that you are having the same problem here...

Subject: Re: Direction of Wind Vectors: A bug?
Posted by David Fanning on Wed, 18 Feb 2015 20:09:18 GMT
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nata writes:

> I saw this problem in the routine VELOVECT. I had to rewrite the code taking into account the aspect ratio of the output plot.
>
> ra=(clip[3]-clip[1])/(clip[2]-clip[0])
>
> x_step=0.01
> y_step=0.01 * ra
>
> I had to do the same in your routine windbarb. I assume that you are having the same problem here...

And you are just telling me about this now, after I've retired! Sigh...

Cheers,

David
--
David Fanning, Ph.D.
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Subject: Re: Direction of Wind Vectors: A bug?
Posted by Paul Van Delst[1] on Wed, 18 Feb 2015 20:25:44 GMT
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On 02/18/15 15:09, David Fanning wrote:
>
> And you are just telling me about this now, after I've retired!
> Sigh...

To paraphrase Inigo Montoya: I do not think retired means what you think
it means.

cheers,

paulv

Subject: Re: Direction of Wind Vectors: A bug?
Posted by David Fanning on Wed, 18 Feb 2015 20:46:44 GMT
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Paul van Delst writes:

> To paraphrase Inigo Montoya: I do not think retired means what you think
> it means.

Trying to find the Like button to hit. (I've had plenty of time to learn
how to use Facebook lately.)

Dave
--
David Fanning, Ph.D.
Fanning Software Consulting, Inc.
Coyote's Guide to IDL Programming: http://www.idlcoyote.com/
Sepore ma de ni thue. ("Perhaps thou speakest truth.")

> I'm having a hard time wrapping my head around whether both approaches
> are "right", or are they both "wrong." Or, maybe there is some other
> combination. It would be easier (and maybe the right approach) to draw a
> "stream line" instead of a vector. Then, at least you could visually see
> the distortion.
>
> In any case, I can't quite see where I would introduce the actions of
> the proposed keyword. And, then, adding a real map projection is just...
> Whew! I need another bottle of Tylenol. :-(

OK, I've finally convinced myself Wayne was right all along. I can hear the big sigh from NASA astronomy programmers from here in Colorado! :-)

With the help of the Arrow command to give me a better idea of which direction I should be pointed in, I have revamped cgDrawVectors to essentially point in the "data" direction. Now this is more or less compatible with PartVelVec. I haven't tested this thoroughly with map projections yet, but it appears it might even be slightly better than PartVelVec with map projections. Or, maybe it's just my glazed eye outlook on the subject.

In any case, I recommend everyone who cares about this kind of thing get a new version of the cgDrawVectors program. You can find it here:

http://www.idlcoyote.com/programs/cgdrawvectors.pro

Here is my test program so you can see what the two programs are doing. Be sure to download the new program before running it.

```
;************************************************************ ***
Pro Vector_Bug
   cgdisplay, wid=1, aspect=1.0, Title='Scale Same in XY'
   cgplot, [-180, 180], [-180, 180], /NoData
   partvelvec, [10,10], [10,10], [-45, -45], [50,-50], $
      /over, veccolor='red', length=.5
   cgdrawvectors, [10,10], [10,10], [-45, -45], [50,-50], $
      /over, veccolor='blue', length=0.1
   cgArrow, -45, 50, -25, 70, /Data, Color='Grn6', Thick=3
   cgArrow, -45, -50, -25, -30, /Data, Color='Gold', Thick=3

   cgdisplay, wid=0, aspect=1.0, Title='Scale Different in XY'
   cgplot, [-180, 180], [-400, 400], /NoData
   partvelvec, [10,10], [10,10], [-45, -45], [50,-50], $
      /over, veccolor='red', length=.5
   cgdrawvectors, [10,10], [10,10], [-45, -45], [50,-50], $
```

```
      /over, veccolor='blue', length=0.2
   cgArrow, -45, 50, -25, 70, /Data, Color='Grn6', Thick=3
   cgArrow, -45, -50, -25, -30, /Data, Color='Gold', Thick=3

   cgdisplay, wid=2, aspect=1.0, Title='Scale Different in XY on Map'
   cgMap_Set, /Miller_Cylindrical, $
      Position=[0.1, 0.1, 0.9, 0.9], LIMIT=[-70, -180, 70, 180]
   ;cgMap_Grid, /label
   partvelvec, [10,10], [10,10], [-45, -45], [50,-50], $
      /over, veccolor='red', length=.5
;    cgArrow, -45, 50, -25, 70, /Data, Color='Grn6', Thick=3
;    cgArrow, -45, -50, -25, -30, /Data, Color='Gold', Thick=3

   mapCoord = Obj_New('cgMap', 118, xrange=[-180, 180], $
      yrange=[-70, 70], $
      Position=[0.1, 0.1, 0.9, 0.9], /LatLon_Ranges)
   mapCoord -> Draw
   cgMap_Continents, Map=mapCoord, Color='grn5'
   cgdrawvectors, [10,10], [10,10], [-45, -45], [50,-50], $
      /over, veccolor='blue', length=0.2, Map=mapCoord
    xy = mapCoord -> Forward([-45, -25], [50,70])
    cgArrow, xy[0,0], xy[1,0], xy[0,1], xy[1,1], /Data, $
      Color='grn6, Thick=3
    xy = mapCoord -> Forward([-45, -25], [-50,-30])
    cgArrow, xy[0,0], xy[1,0], xy[0,1], xy[1,1], /Data, $
      Color='grn6, Thick=3
END
;*************************************************************
```

Cheers,

David

P.S. See you next year! ;-)

--
David Fanning, Ph.D.
Fanning Software Consulting, Inc.
Coyote's Guide to IDL Programming: http://www.idlcoyote.com/
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Subject: Re: Direction of Wind Vectors: A bug?
Posted by Fabzi on Wed, 18 Feb 2015 22:27:21 GMT

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On 18.02.2015 20:23, wlandsman wrote:
> On Wednesday, February 18, 2015 at 1:32:50 PM UTC-5, David Fanning wrote:

>
>>> So, here is my question. Are both of these programs "right"? If not, why
>>> not? And, which would convey the "true wind direction" more convincingly
>>> on a plot?
> I'd vote for the partvelvec.pro approach where the angle -- like everything else on the map -- is distorted by the unequal projections.

I agree with Wayne. But this is realy just for equirectangular maps, I guess...

Fabien

Subject: Re: Direction of Wind Vectors: A bug?
Posted by David Fanning on Wed, 18 Feb 2015 22:44:58 GMT
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Fabien writes:

> I agree with Wayne. But this is realy just for equirectangular maps, I
> guess...

Well, I don't think Wayne is doing anything special for maps. I know cgDrawVectors works "properly" for polar stereographic projections of the poles, but this relies on using the cgMap object to set up the map projection space. (Really simple, but people still tell me they won't use or learn objects, so...)

Cheers,

David
--
David Fanning, Ph.D.
Fanning Software Consulting, Inc.
Coyote's Guide to IDL Programming: http://www.idlcoyote.com/
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Subject: Re: Direction of Wind Vectors: A bug?
Posted by David Fanning on Mon, 23 Feb 2015 15:28:03 GMT
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David Fanning writes:

> Someone was harassing my retirement reveries this morning by claiming
> that cgDrawVectors was drawing vectors incorrectly, in the wrong
> directions. He cited as evidence the output of the lovely NASA program,

> PartVelVec.

Having decided Wayne was doing the right thing, and still a bit dissatisfied with how my cgDrawVectors algorithm was working, I spent the weekend (the reason I retired!) completely gutting and rebuilding cgDrawVectors. It now takes into account the scale of the plot in the X and Y directions. What took me a while to work out is that the scale of the plot on a map projection should always be 180x360, no matter what portion of the map you are showing in the plot.

Making these changes, I can duplicate the PartVelVec results on every test I've made, including tests with map projections using Map_Set and the Map_Proj_Init methods (as implemented in cgMap_Set and cgMap). I've tried various map projections, and all seems to be working correctly, although additional testing on ALL map projections is probably warranted.

While I was tearing things up, I decided to fix the code in cgArrow (which was drawing the vectors) to make it more flexible and faster by moving the code closer to the machine. You can now pass a vector of colors to cgArrow, as well as a vector of arrows to draw, and you should see significant speed-up of its vector drawing capability. Both programs should be downloaded, as cgDrawVectors depends on cgArrow.

You can find the two new programs here:

http://www.idlcoyote.com/programs/cgarrow.pro
http://www.idlcoyote.com/programs/cgdrawvectors.pro

Cheers,

David
--
David Fanning, Ph.D.
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