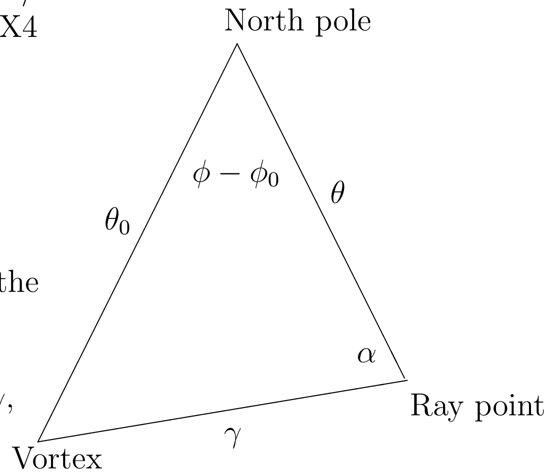
FORM TO SPECIFY INPUT DATA FOR WIND/CURRENT PERTURBATION MODEL VVORTX4



$v_r = v_{r0}$, $v_\theta = v_{\theta 0} - v_H \sin\alpha$, $v_\phi = v_{\phi 0} + v_H \cos\alpha$,

$v_H = \frac{c_1 U_0 \gamma_0}{\gamma}\left(1 - e^{-c_2\gamma^2/\gamma_0^2}\right) e^{-\left(\frac{h-h_{max}}{w_H}\right)^2}$,

v_{r0}, $v_{\theta 0}$, and $v_{\phi 0}$ are the background wind,

$c_1 = 1 + \frac{1}{2c_2}$, c_2 is a solution of the transcendental equation $e^{c_2} = 2c_2 + 1$, which has the approximate solution $c_2 = 1.256431209$,

$\cos\gamma = \sin\lambda_0 \cos\theta + \cos\lambda_0 \sin\theta \cos(\phi - \phi_0)$,

$\cos\alpha = [\sin\theta\cos\theta_0 - \sin\theta_0\cos\theta\cos(\phi - \phi_0)]/\sin\gamma$,

$\sin\alpha = \sin\theta_0 \sin(\phi - \phi_0)/\sin\gamma$,

$h = r - r_e$, $\theta_0 = \pi/2 - \lambda_0$

This model represents the wind/current velocity of a vortex with a viscous core and a Gaussian intensity profile in the vertical. The axis of the vortex is vertical and may be positioned above any geographic latitude and longitude. The vortex rotates anticlockwise looking down. The core (inside γ_0) is essentially a solid-rotating fluid, while outside γ_0, $|v|$ falls off as the inverse radius.

Specify–

the model check for VVORTX4 = ______3.0______ (w125)

the input data-format code = ____________ (w126)

an input data-set identification number = ____________ (w127)

an 80-character description of the model with parameters:

____

and the model values:

λ_0, latitude of the vortex center ____________ rad, deg, km (w128)

ϕ_0, longitude of the vortex center ____________ rad, deg, km (w129)

U_0, maximum tangential wind speed ____________ km/s, m/s (w130)

γ_o, radius of the vortex core ____________ rad, deg, km (w131)

h_{max}, height of the vortex ____________ km, m (w132)

w_H, Gaussian width in height of the vortex ____________ km, m (w133)

Non-zero to print labels on the plot of projections on the ground ____________ (w134)

X position to print columns 1-20 of above 80-character description ____________ (w135)

Y position (if non-zero) to print columns 1-20 of above description ____________ (w136)

X position to print columns 21-40 of above 80-character description ____________ (w137)

Y position (if non-zero) to print columns 21-40 of above description ____________ (w138)

X position to print “De-focusing” on the raypath plots ____________ (w139)

Y position (if non-zero) to print “De-focusing” on the raypath plots ____________ (w140)

X position to print “Focusing” on the raypath plots ____________ (w141)

Y position (if non-zero) to print “Focusing” on the raypath plots ____________ (w142)

X position to print “Virtual Source” on the raypath plots ____________ (w143)

Y position (if non-zero) to print “Virtual Source” on the raypath plots ____________ (w144)

Non-zero to draw a circle around core of vortex on raypath plot ____________ (w145)

OTHER MODELS REQUIRED: Any background wind/current velocity model.

Definitions:

FORTRAN variable	Variable name	Definition
LAMBDA0	λ_0	Latitude of vortex
PHI0	ϕ_0	Longitude of vortex
U0	U_0	Maximum tangential wind speed
GAMMA0	γ_0	radius of the vortex core
Hmax	h_{max}	height of the vortex
EARTHR	r_e	Radius of the Earth
SING0SQ	$\sin^2 \gamma_0$	
SINLAM0	$\sin \lambda_0$	
TH0	θ_0	Co-latitude of vortex
COSTH0	$\cos \theta_0$	
COSLAM0	$\cos \lambda_0$	
SINTH0	$\sin \theta_0$	
HmSQ	h_{max}^2	
C1	$c_1 = 1 + \frac{1}{2c_2} = 1.397952547$	
C2	$c_2 = 1.256431209$	
C3	$c_1 U_0 \gamma_0$	
C4	c_2/γ_0^2	
VH	$v_H = A * B * C$	Horizontal component of wind velocity
A	$A = c_3/\gamma$	
B	$B = 1 - D = 1 - e^{-c_4\gamma^2}$	
C	$C = e^{-((h-h_{max})/w_H)^2}$	
D	$D = e^{-c_4\gamma^2}$	
DENOM	$1/w_H^2$ if $w_H \neq 0$, otherwise, zero.	
PAPG	$\partial A/\partial\gamma$	
AG	$\partial A/\partial\gamma$	
AGG	$\partial^2 A/\partial\gamma^2 = 2A/\gamma^2$	
PBPG	$\partial B/\partial\gamma$	
BG	$\partial B/\partial\gamma$	
BGG	$\partial^2 B/\partial\gamma^2 = -2c_4 D + 2c_4\gamma\partial B/\partial\gamma$	
PCPR	$\partial C/\partial r$	
CR	$\partial C/\partial r$	
CRR	$\partial^2 C/\partial r^2 = -2C/w_H^2 - 2(h - h_{\mathrm{max}})\partial C/\partial r$	
R	r	Distance from center of Earth to ray point
H	h	Height of ray point above sea level
TH	θ	Co-latitude of ray point
COSTH	$\cos\theta$	
SINTH	$\sin\theta$	
PH	ϕ	Longitude of ray point
COSPH	$\cos(\phi - \phi_0)$	
SINPH	$\sin(\phi - \phi_0)$	
GAM	γ	Great circle angle between

		vortex and ray point
COSGAM	$\cos\gamma$	
SINGAM	$\sin\gamma$	
SINGSQ	$\sin^2\gamma$	
SGPGTH	$-\partial\cos\gamma/\partial\theta = \sin\gamma\partial\gamma/\partial\theta$	
SGPGPH	$-\partial\cos\gamma/\partial\phi = \sin\gamma\partial\gamma/\partial\phi$	
PCOSGAMTH	$\partial\cos\gamma/\partial\theta = -\sin\gamma\partial\gamma/\partial\theta = -\cos\theta_0\sin\theta + \sin\theta_0\cos\theta\cos(\phi-\phi_0)$	
PCOSGAMPH	$\partial\cos\gamma/\partial\phi = -\sin\gamma\partial\gamma/\partial\phi = -\sin\theta_0\sin\theta\sin(\phi-\phi_0)$	
PCOSGAMTHTH	$\partial^2\cos\gamma/\partial\theta^2 = -\cos\gamma$	
PCOSGAMPHTH	$\partial^2\cos\gamma/\partial\phi\partial\theta = -\sin\theta_0\cos\theta\sin(\phi-\phi_0)$	
PCOSGAMPHPH	$\partial^2\cos\gamma/\partial\phi^2 = -\sin\theta_0\sin\theta\cos(\phi-\phi_0)$	
PSINGAMTH	$\partial\sin\gamma/\partial\theta = -\cot\gamma\partial\cos\gamma/\partial\theta$	
PSINGAMPH	$\partial\sin\gamma/\partial\phi = -\cot\gamma\partial\cos\gamma/\partial\phi$	
PSINGAMPHTH	$\frac{\partial^2\sin\gamma}{\partial\phi\partial\theta} = -\left(\cos\gamma\left(\frac{\partial^2\cos\gamma}{\partial\phi\partial\theta}\right) + \left(\frac{\partial\sin\gamma}{\partial\phi}\right)\left(\frac{\partial\sin\gamma}{\partial\theta}\right) + \left(\frac{\partial\cos\gamma}{\partial\phi}\right)\left(\frac{\partial\cos\gamma}{\partial\theta}\right)\right)/\sin\gamma$	
PSINGAMTHTH	$\frac{\partial^2\sin\gamma}{\partial\theta^2} = -\left(\cos\gamma\left(\frac{\partial^2\cos\gamma}{\partial\theta^2}\right) + \left(\frac{\partial\sin\gamma}{\partial\theta}\right)^2 + \left(\frac{\partial\cos\gamma}{\partial\theta}\right)^2\right)/\sin\gamma$	
PSINGAMPHPH	$\frac{\partial^2\sin\gamma}{\partial\phi^2} = -\left(\cos\gamma\left(\frac{\partial^2\cos\gamma}{\partial\phi^2}\right) + \left(\frac{\partial\sin\gamma}{\partial\phi}\right)^2 + \left(\frac{\partial\cos\gamma}{\partial\phi}\right)^2\right)/\sin\gamma$	
VH	v_H	horizontal component of wind velocity
	α	azimuth angle of vortex counter-clockwise from North as viewed from ray point
SINALP	$\sin\alpha$	
SINALPSQ	$\sin^2\alpha$	
COSALP	$\cos\alpha$	
COSALPSQ	$\cos^2\alpha$	
COS2ALP	$\cos 2\alpha$	
VTH	v_θ	Southward component of wind velocity
VPH	v_ϕ	Eastward component of wind velocity
PVHR	$\partial v_H/\partial r$	
PVTHR	$\partial v_\theta/\partial r$	
PSINALPTH	$\partial\sin\alpha/\partial\theta$	
PSINALPPH	$\partial\sin\alpha/\partial\phi$	
PCOSALPTH	$\partial\cos\alpha/\partial\theta$	
PCOSALPPH	$\partial\cos\alpha/\partial\phi$	
PSINALPPHTH	$\frac{\partial^2\sin\alpha}{\partial\phi\partial\theta} = -\left(\sin\alpha\left(\frac{\partial^2\sin\gamma}{\partial\phi\partial\theta}\right) + \left(\frac{\partial\sin\alpha}{\partial\phi}\right)\left(\frac{\partial\sin\gamma}{\partial\theta}\right) + \left(\frac{\partial\sin\gamma}{\partial\phi}\right)\left(\frac{\partial\sin\alpha}{\partial\theta}\right)\right)/\sin\gamma$	
PSINALPTHTH	$\frac{\partial^2\sin\alpha}{\partial\theta^2} = -\left(\sin\alpha\left(\frac{\partial^2\sin\gamma}{\partial\theta^2}\right) + 2\left(\frac{\partial\sin\alpha}{\partial\theta}\right)\left(\frac{\partial\sin\gamma}{\partial\theta}\right)\right)/\sin\gamma$	
PSINALPPHPH	$\frac{\partial^2\sin\alpha}{\partial\phi^2} = -\left(\sin\alpha\left(\frac{\partial^2\sin\gamma}{\partial\phi^2}\right) + 2\left(\frac{\partial\sin\alpha}{\partial\phi}\right)\left(\frac{\partial\sin\gamma}{\partial\phi}\right) + \sin\theta_0\sin(\phi-\phi_0)\right)/\sin\gamma$	
PCOSALPPHTH	$\frac{\partial^2\cos\alpha}{\partial\phi\partial\theta} = -\left(\cos\alpha\left(\frac{\partial^2\sin\gamma}{\partial\phi\partial\theta}\right) + \left(\frac{\partial\cos\alpha}{\partial\phi}\right)\left(\frac{\partial\sin\gamma}{\partial\theta}\right) + \left(\frac{\partial\sin\gamma}{\partial\phi}\right)\left(\frac{\partial\cos\alpha}{\partial\theta}\right)\right.$ $\left.+\sin\theta_0\sin\theta\sin(\phi-\phi_0)\right)/\sin\gamma$	
PCOSALPTHTH	$\frac{\partial^2\cos\alpha}{\partial\theta^2} = -\left(\cos\alpha\left(\frac{\partial^2\sin\gamma}{\partial\theta^2}\right) + 2\left(\frac{\partial\cos\alpha}{\partial\theta}\right)\left(\frac{\partial\sin\gamma}{\partial\theta}\right)\right.$ $\left.+\cos\theta_0\sin\theta - \sin\theta_0\cos\theta\cos(\phi-\phi_0)\right)/\sin\gamma$	
PCOSALPPHPH	$\frac{\partial^2\cos\alpha}{\partial\phi^2} = -\left(\cos\alpha\left(\frac{\partial^2\sin\gamma}{\partial\phi^2}\right) + 2\left(\frac{\partial\cos\alpha}{\partial\phi}\right)\left(\frac{\partial\sin\gamma}{\partial\phi}\right)\right.$ $\left.-\sin\theta_0\cos\theta\cos(\phi-\phi_0)\right)/\sin\gamma$	

PVHPG	$\partial v_H / \partial \cos\gamma = -1/\sin\gamma \partial v_H / \partial\gamma$
PVHTH	$\partial v_H / \partial\theta$
PVHPH	$\partial v_H / \partial\phi$
PVTHTH	$\partial v_\theta / \partial\theta$
PVTHPH	$\partial v_\theta / \partial\phi$
PVPHR	$\partial v_\phi / \partial r$
PVPHTH	$\partial v_\phi / \partial\theta$
PVPHPH	$\partial v_\phi / \partial\phi$
VSQ	$\lvert v\rvert^2$
V	$\lvert v\rvert$
PVTH	$\partial\lvert v\rvert / \partial\theta$
PVPH	$\partial\lvert v\rvert / \partial\phi$
PVR	$\partial\lvert v\rvert / \partial r$
VHpp%r%r	$\frac{\partial^2 v_H}{\partial r^2} = AB\frac{\partial^2 C}{\partial r^2}$
VHpp%r%th	$\frac{\partial^2 v_H}{\partial r\partial\theta} = \frac{\partial v_H}{\partial\theta}\frac{1}{C}\frac{\partial C}{\partial r}$
VHpp%r%ph	$\frac{\partial^2 v_H}{\partial r\partial\phi} = \frac{\partial v_H}{\partial\phi}\frac{1}{C}\frac{\partial C}{\partial r}$
VHpp%th%ph	$\frac{\partial^2 v_H}{\partial\theta\partial\phi} = \left(\frac{1}{\sin^2\gamma}\frac{\partial^2 v_H}{\partial\gamma^2}\right)\left(\sin\gamma\frac{\partial\gamma}{\partial\theta}\right)\left(\sin\gamma\frac{\partial\gamma}{\partial\phi}\right) - \left(-\frac{1}{\sin\gamma}\frac{\partial v_H}{\partial\gamma}\right)\left(\sin\gamma\frac{\partial^2\gamma}{\partial\theta\partial\phi}\right)$
VHpp%th%th	$\frac{\partial^2 v_H}{\partial\theta^2} = \left(\frac{1}{\sin^2\gamma}\frac{\partial^2 v_H}{\partial\gamma^2}\right)\left(\sin\gamma\frac{\partial\gamma}{\partial\theta}\right)^2 - \left(-\frac{1}{\sin\gamma}\frac{\partial v_H}{\partial\gamma}\right)\left(\sin\gamma\frac{\partial^2\gamma}{\partial\theta^2}\right)$
VHpp%ph%ph	$\frac{\partial^2 v_H}{\partial\phi^2} = \left(\frac{1}{\sin^2\gamma}\frac{\partial^2 v_H}{\partial\gamma^2}\right)\left(\sin\gamma\frac{\partial\gamma}{\partial\phi}\right)^2 - \left(-\frac{1}{\sin\gamma}\frac{\partial v_H}{\partial\gamma}\right)\left(\sin\gamma\frac{\partial^2\gamma}{\partial\phi^2}\right)$
VHGamGam	$\left(\frac{1}{\sin^2\gamma}\frac{\partial^2 v_H}{\partial\gamma^2}\right)$
GamThPh	$\left(\sin\gamma\frac{\partial^2\gamma}{\partial\theta\partial\phi}\right)$
GamThTh	$\left(\sin\gamma\frac{\partial^2\gamma}{\partial\theta^2}\right)$
GamPhPh	$\left(\sin\gamma\frac{\partial^2\gamma}{\partial\phi^2}\right)$
wind1%th%pp%r%r	$\frac{\partial^2 v_\theta}{\partial r^2} = \frac{\partial^2 v_H}{\partial r^2}\sin\alpha$
wind1%th%pp%th%r	$\frac{\partial^2 v_\theta}{\partial\theta\partial r} = -\frac{\partial^2 v_H}{\partial\theta\partial r}\sin\alpha - \frac{\partial v_H}{\partial r}\frac{\partial\sin\alpha}{\partial\theta}$
wind1%th%pp%ph%r	$\frac{\partial^2 v_\theta}{\partial\phi\partial r} = -\frac{\partial^2 v_H}{\partial\phi\partial r}\sin\alpha - \frac{\partial v_H}{\partial r}\frac{\partial\sin\alpha}{\partial\phi}$
wind1%th%pp%th%ph	$\frac{\partial^2 v_\theta}{\partial\theta\partial\phi} = -\frac{\partial^2 v_H}{\partial\theta\partial\phi}\sin\alpha - \frac{\partial v_H}{\partial\phi}\frac{\partial\sin\alpha}{\partial\theta} - v_H\frac{\partial^2\sin\alpha}{\partial\theta\partial\phi} - \frac{\partial v_H}{\partial\theta}\frac{\partial\sin\alpha}{\partial\phi}$
wind1%th%pp%th%th	$\frac{\partial^2 v_\theta}{\partial\theta^2} = -\frac{\partial^2 v_H}{\partial\theta^2}\sin\alpha - 2\frac{\partial v_H}{\partial\theta}\frac{\partial\sin\alpha}{\partial\theta} - v_H\frac{\partial^2\sin\alpha}{\partial\theta^2}$
wind1%th%pp%ph%ph	$\frac{\partial^2 v_\theta}{\partial\phi^2} = -\frac{\partial^2 v_H}{\partial\phi^2}\sin\alpha - 2\frac{\partial v_H}{\partial\phi}\frac{\partial\sin\alpha}{\partial\phi} - v_H\frac{\partial^2\sin\alpha}{\partial\phi^2}$
wind1%ph%pp%r%r	$\frac{\partial^2 v_\phi}{\partial r^2} = \frac{\partial^2 v_H}{\partial r^2}\cos\alpha$
wind1%ph%pp%th%r	$\frac{\partial^2 v_\phi}{\partial\theta\partial r} = \frac{\partial^2 v_H}{\partial\theta\partial r}\cos\alpha + \frac{\partial v_H}{\partial r}\frac{\partial\cos\alpha}{\partial\theta}$
wind1%ph%pp%ph%r	$\frac{\partial^2 v_\phi}{\partial\phi\partial r} = \frac{\partial^2 v_H}{\partial\phi\partial r}\cos\alpha + \frac{\partial v_H}{\partial r}\frac{\partial\cos\alpha}{\partial\phi}$
wind1%ph%pp%th%ph	$\frac{\partial^2 v_\phi}{\partial\theta\partial\phi} = \frac{\partial^2 v_H}{\partial\theta\partial\phi}\cos\alpha + \frac{\partial v_H}{\partial\phi}\frac{\partial\cos\alpha}{\partial\theta} + v_H\frac{\partial^2\cos\alpha}{\partial\theta\partial\phi} + \frac{\partial v_H}{\partial\theta}\frac{\partial\cos\alpha}{\partial\phi}$
wind1%ph%pp%th%th	$\frac{\partial^2 v_\phi}{\partial\theta^2} = \frac{\partial^2 v_H}{\partial\theta^2}\cos\alpha + 2\frac{\partial v_H}{\partial\theta}\frac{\partial\cos\alpha}{\partial\theta} + v_H\frac{\partial^2\cos\alpha}{\partial\theta^2}$
wind1%ph%pp%ph%ph	$\frac{\partial^2 v_\phi}{\partial\phi^2} = \frac{\partial^2 v_H}{\partial\phi^2}\cos\alpha + 2\frac{\partial v_H}{\partial\phi}\frac{\partial\cos\alpha}{\partial\phi} + v_H\frac{\partial^2\cos\alpha}{\partial\phi^2}$