Atmospheric Dynamics

Solutions to Questions on Tutorial Sheet 9

1) $(u + a\Omega\cos\phi)\cos\phi = C$, where C is a constant. The air is at rest at the equator, so $C = a\Omega$, leading to $u = \frac{a\Omega(1-\cos^2\phi)}{\cos\phi} = a\Omega\sin\phi\tan\phi$. Now $a\Omega = 6371 \times 7.292 \times 10^{-5} kms^{-1} = 465 ms^{-1}$, giving

Lat/^{o}N	0	10	20	30	40	**50**
u/ms^{-1}	**0**	**14.2**	**57.8**	**134**	**251**	**424**

2) This is similar to the previous question, but now we have $(u + a\Omega\cos\phi)\cos\phi = (0 + a\Omega\cos 20^{o})\cos 20^{o}$, so that $u = \frac{a\Omega(\cos^2 20^{o} - \cos^2\phi)}{\cos\phi}$

Lat/^{o}N	-10	0	10	20	**30**
u/ms^{-1}	**-41.0**	**-54.3**	**-41.0**	**0**	**71.4**

Note that all the entries except the last are negative, so that in all cases except the last, the wind blows from east to west.

3) Avoiding the approximation means that the constant angular momentum is $(u + (a+z)\Omega\cos\phi)(a+z)\cos\phi = C = (0 + a\Omega)a$ by the terms of the question.

Setting $\phi = 0$ gives $(u + (a+z)\Omega)(a+z) = a^2\Omega$ or $u = \frac{-\Omega[2az - z^2]}{a+z} \sim -2\Omega z$.
Inserting 16km for the height gives

$$u = 2.33 ms^{-1}$$