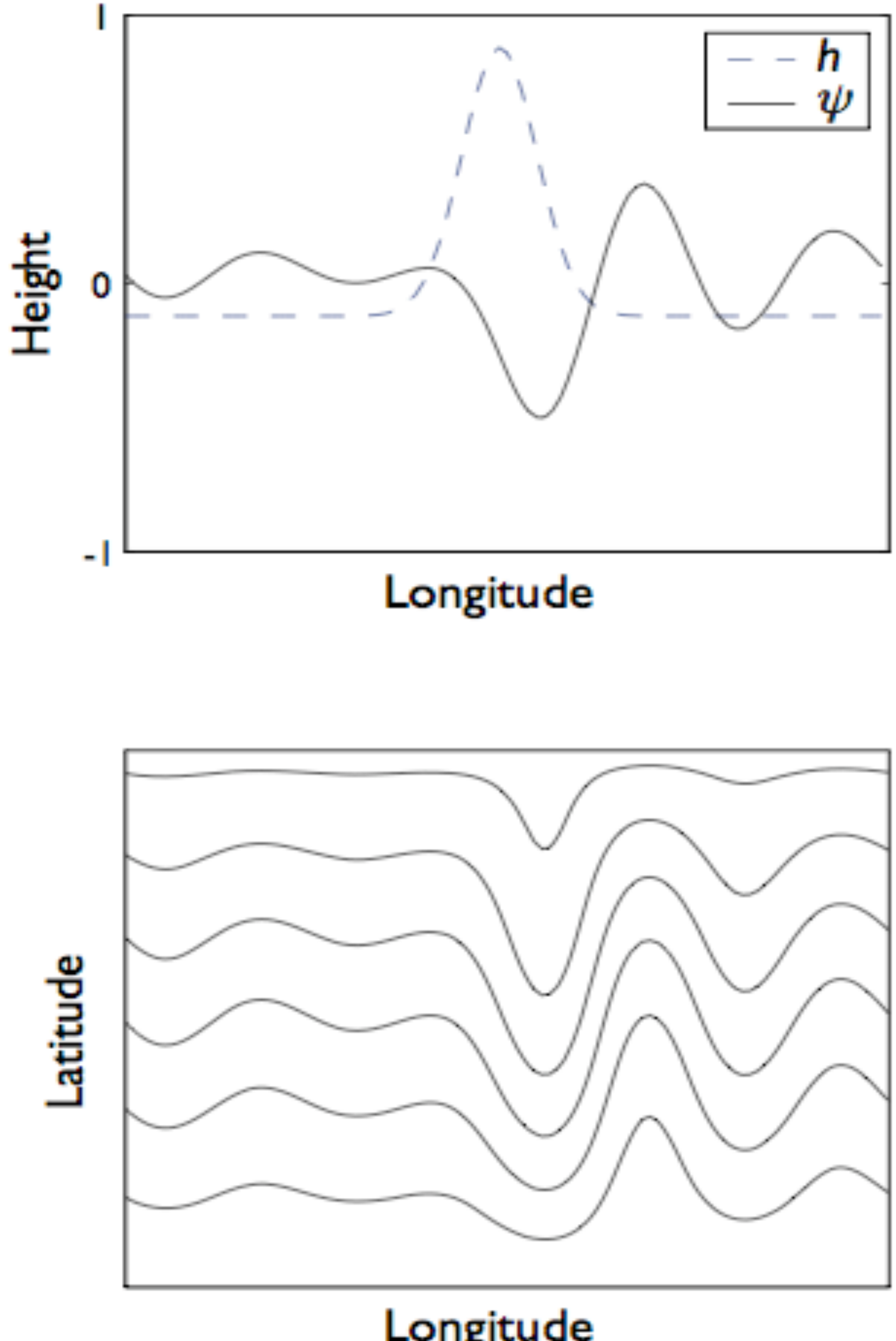
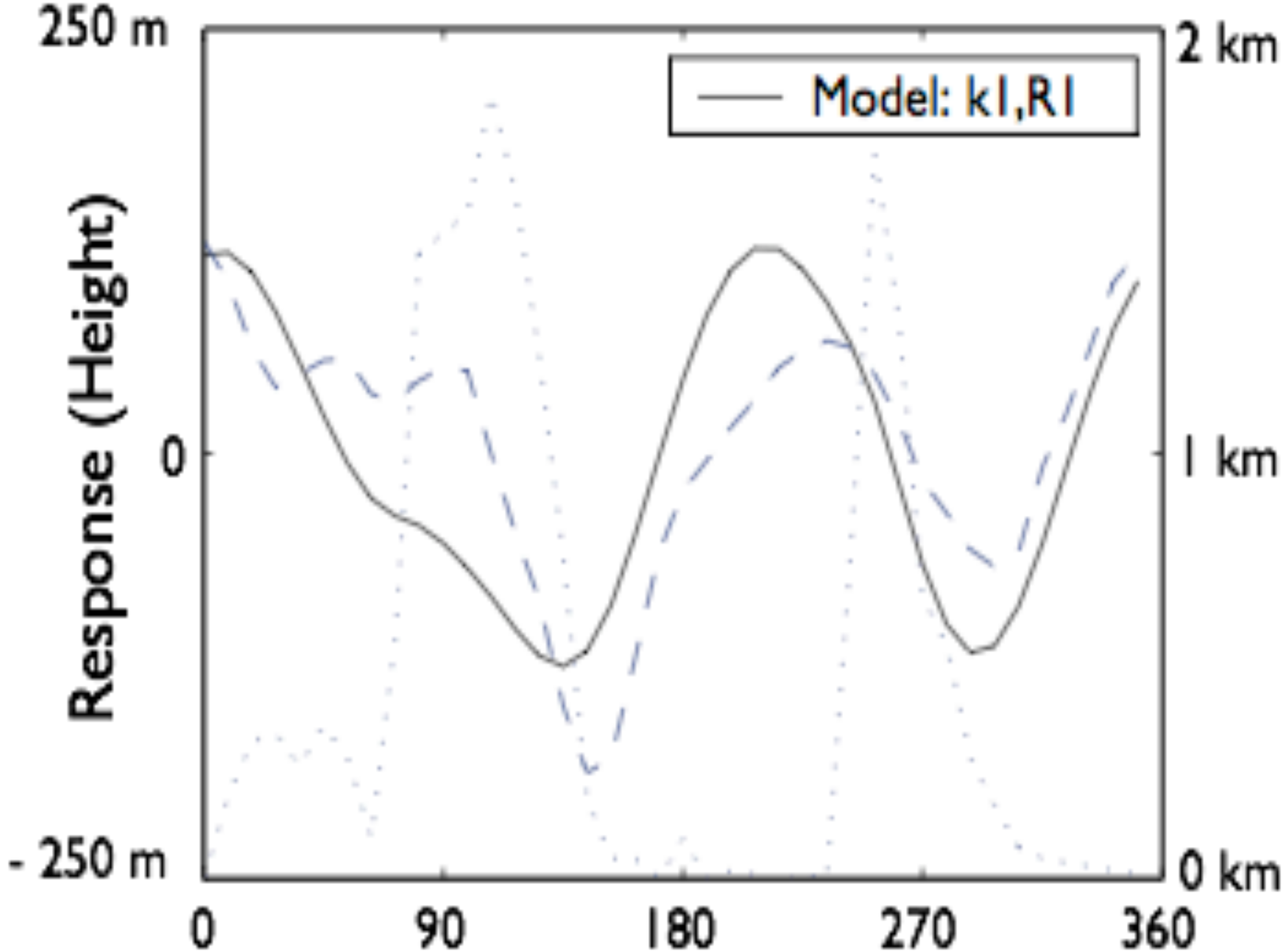
ATM 622
General Circulation

7. Planetary Waves



Vallis (2006)

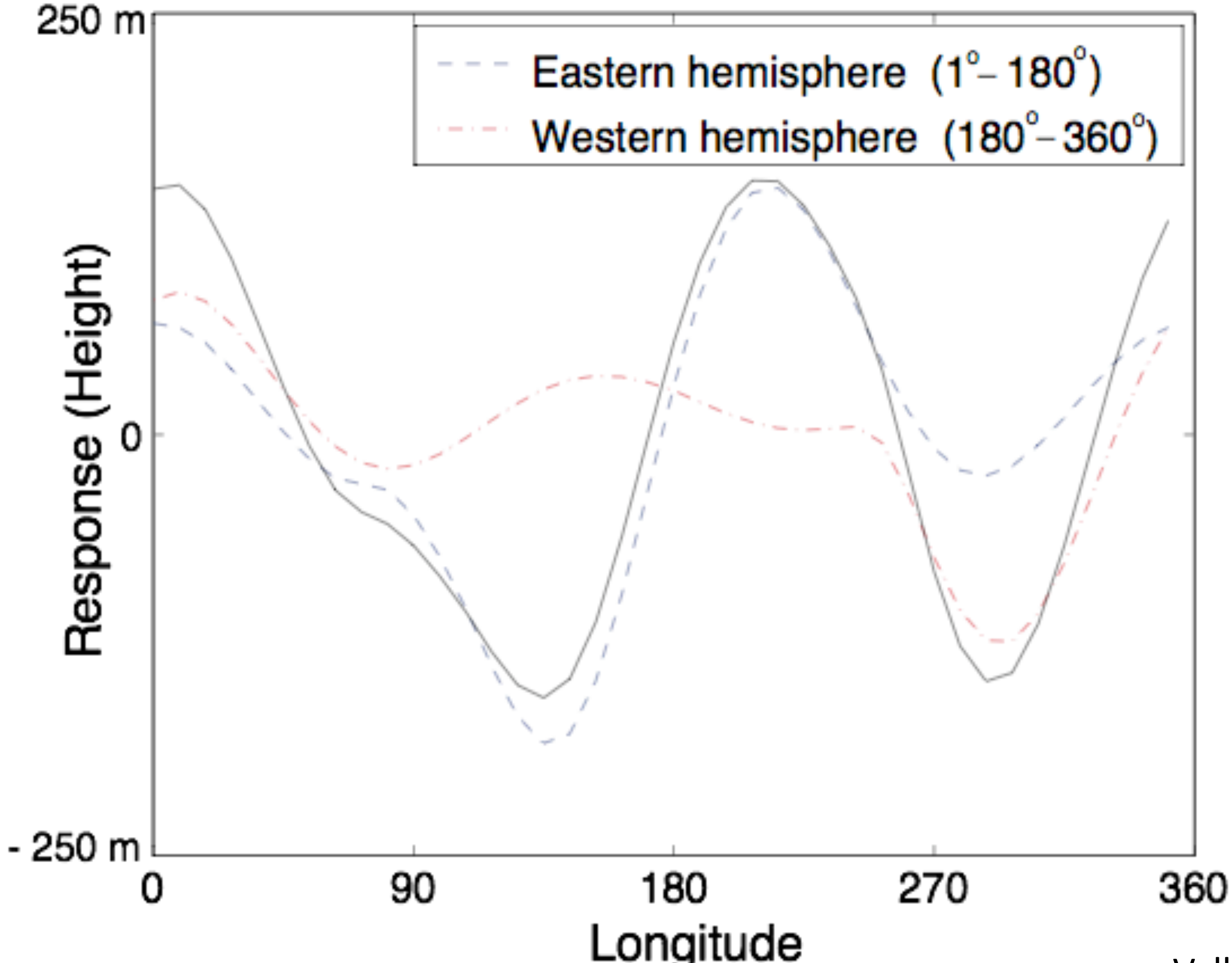


Vallis (2006)

theoretical solution

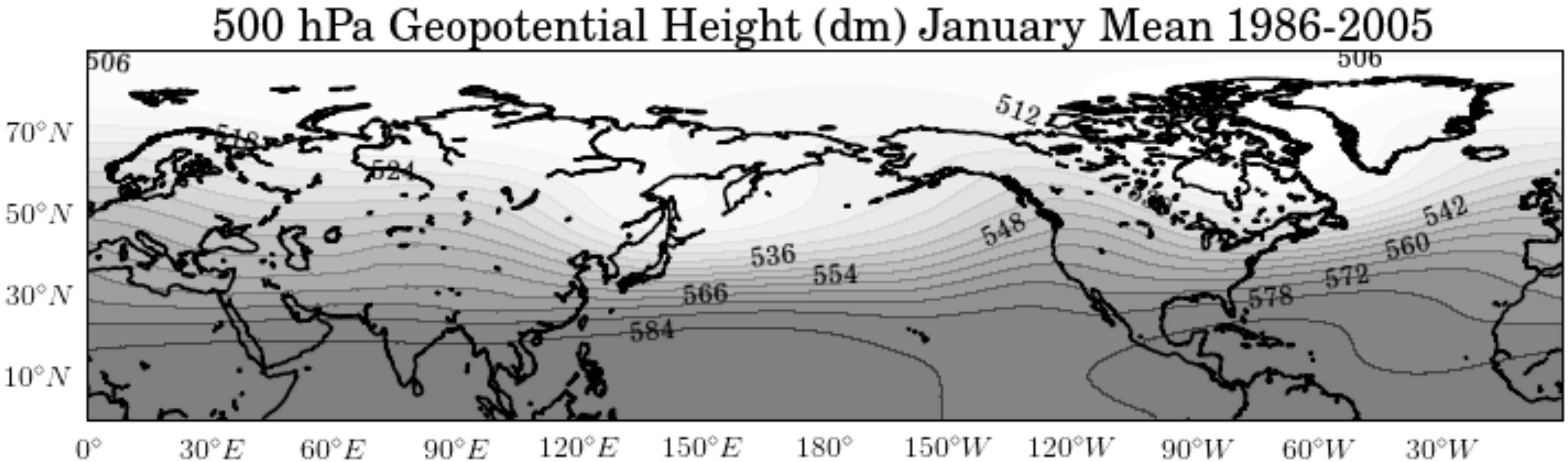
500-hPa time avg. height perturbations at 45°N in Jan.

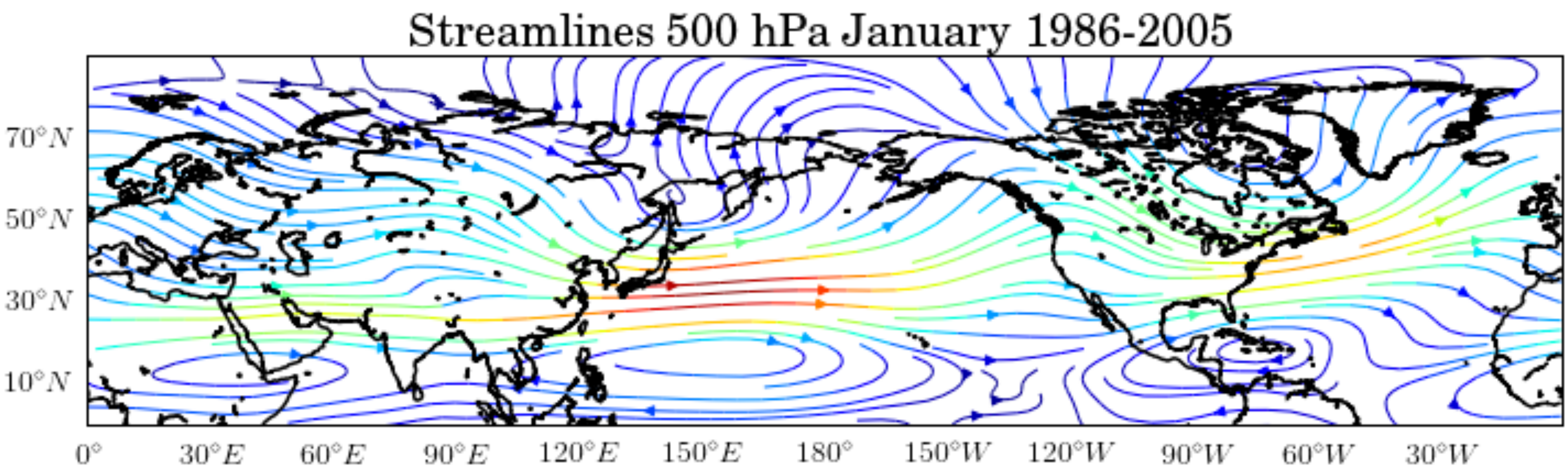
topography used in theoretical calculation (45°N)



theoretical solution
Solution using only E Hemisphere topography
Solution using only W Hemisphere topography

Vallis (2006)


500 hPa Geopotential Height (dm) January Mean 1986-2005
70°N
50°N
30°N
10°N
0°
30°E
60°E
90°E
120°E
150°E
180°
150°W
120°W
90°W
60°W
30°W
506
512
518
524
536
542
548
554
560
566
572
578
584


Streamlines 500 hPa January 1986-2005
70°N
50°N
30°N
10°N
0°
30°E
60°E
90°E
120°E
150°E
180°
150°W
120°W
90°W
60°W
30°W

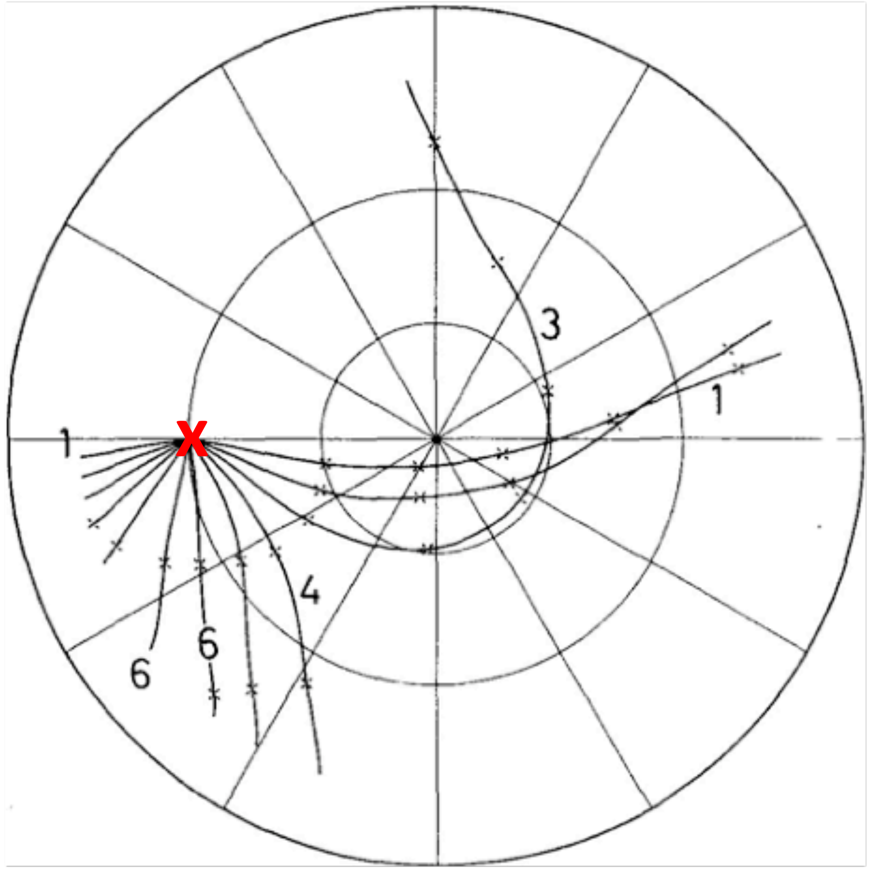
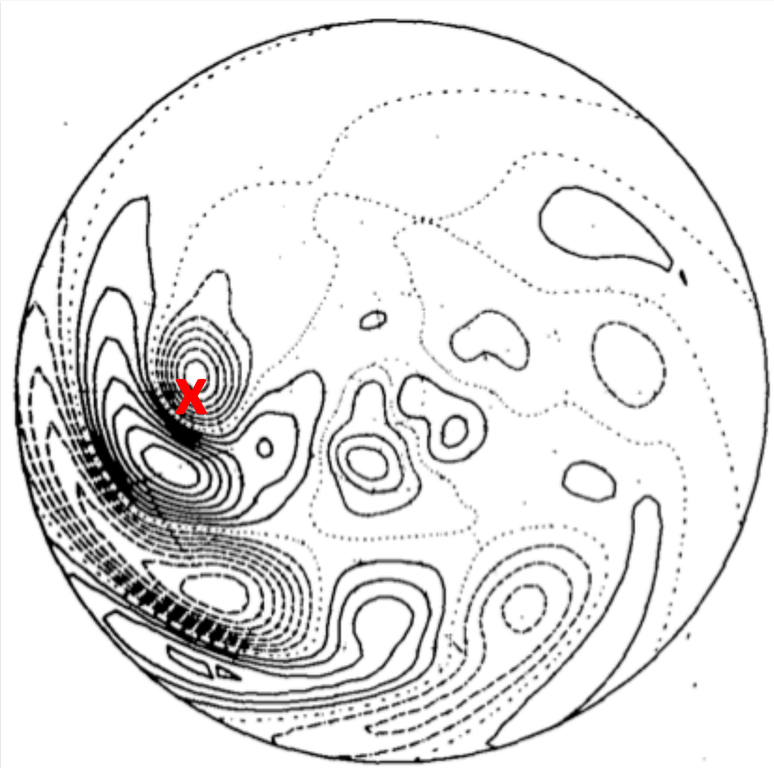


Fig. 13.5 The rays emanating from a point source at 30° N and 180° (nine o'clock), calculated using the observed value of the wind at 300 mb.[1] The crosses mark every 180° of phase, and mark the positions of successive positive and negative extrema. The numbers indicate the zonal wavenumber of the ray. The ray paths may be compared with the full linear calculation shown in Fig. 13.6.

Vallis (2006)

ζ^*



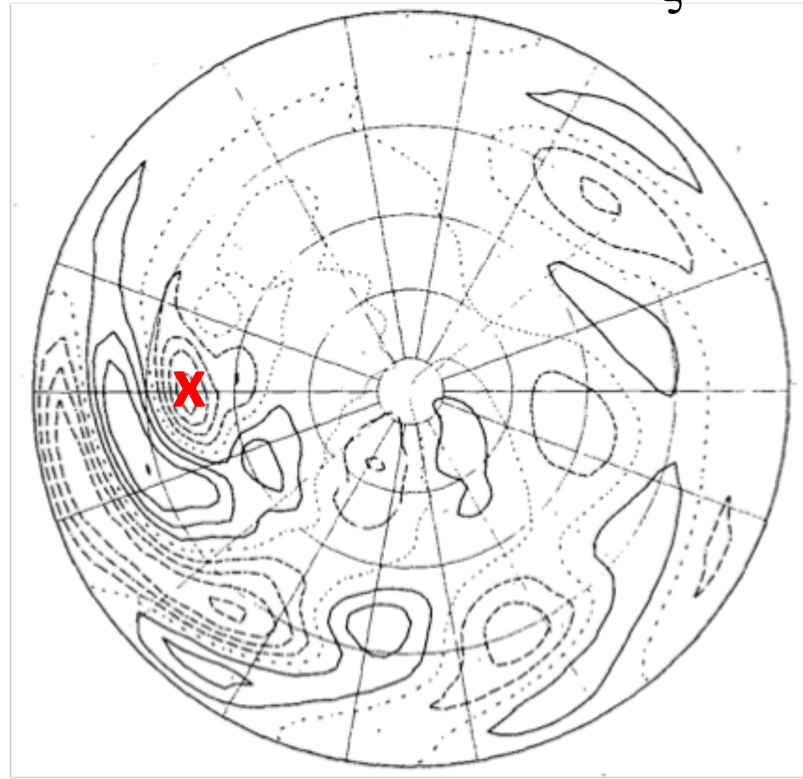
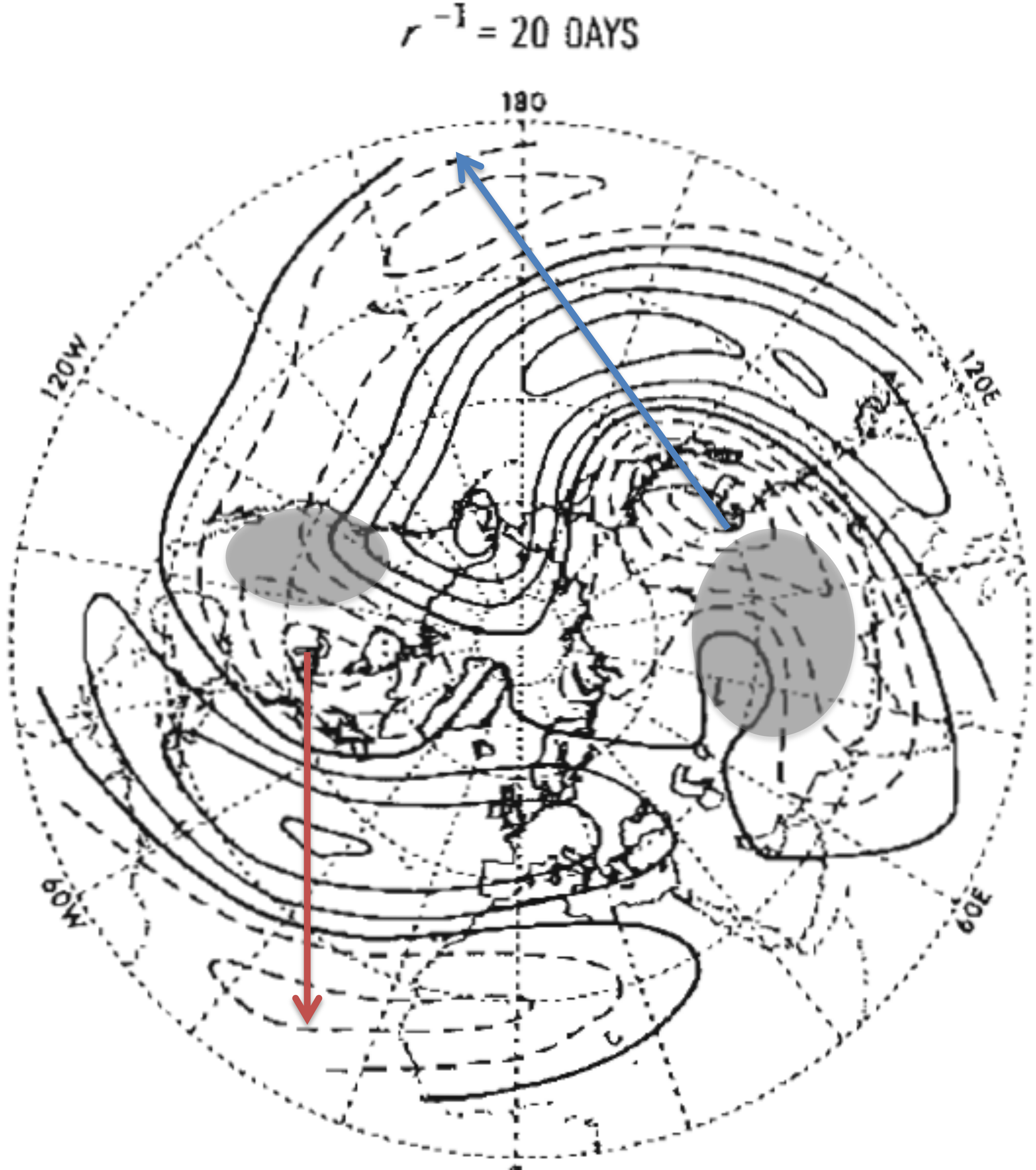


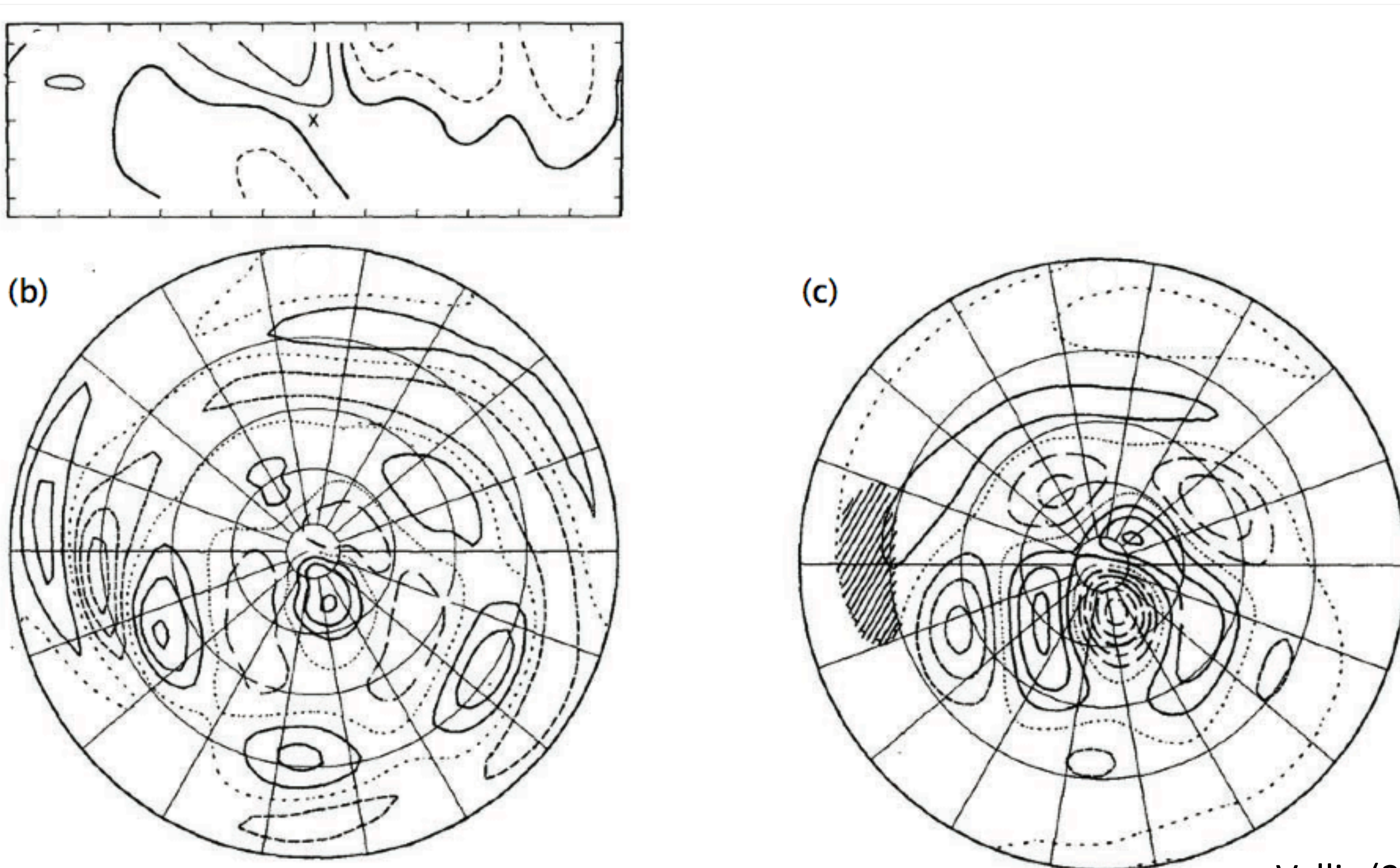
Fig. 13.6 The linear stationary response induced by circular mountain at 30° N and at 180° longitude (nine o'clock). The figure on the left uses a barotropic model, whereas the figure on the right uses a multi-layer baroclinic model.[2] In both cases the mountain excites a low-wavenumber polar wavetrain and a higher-wavenumber subtropical train.

Vallis (2006)



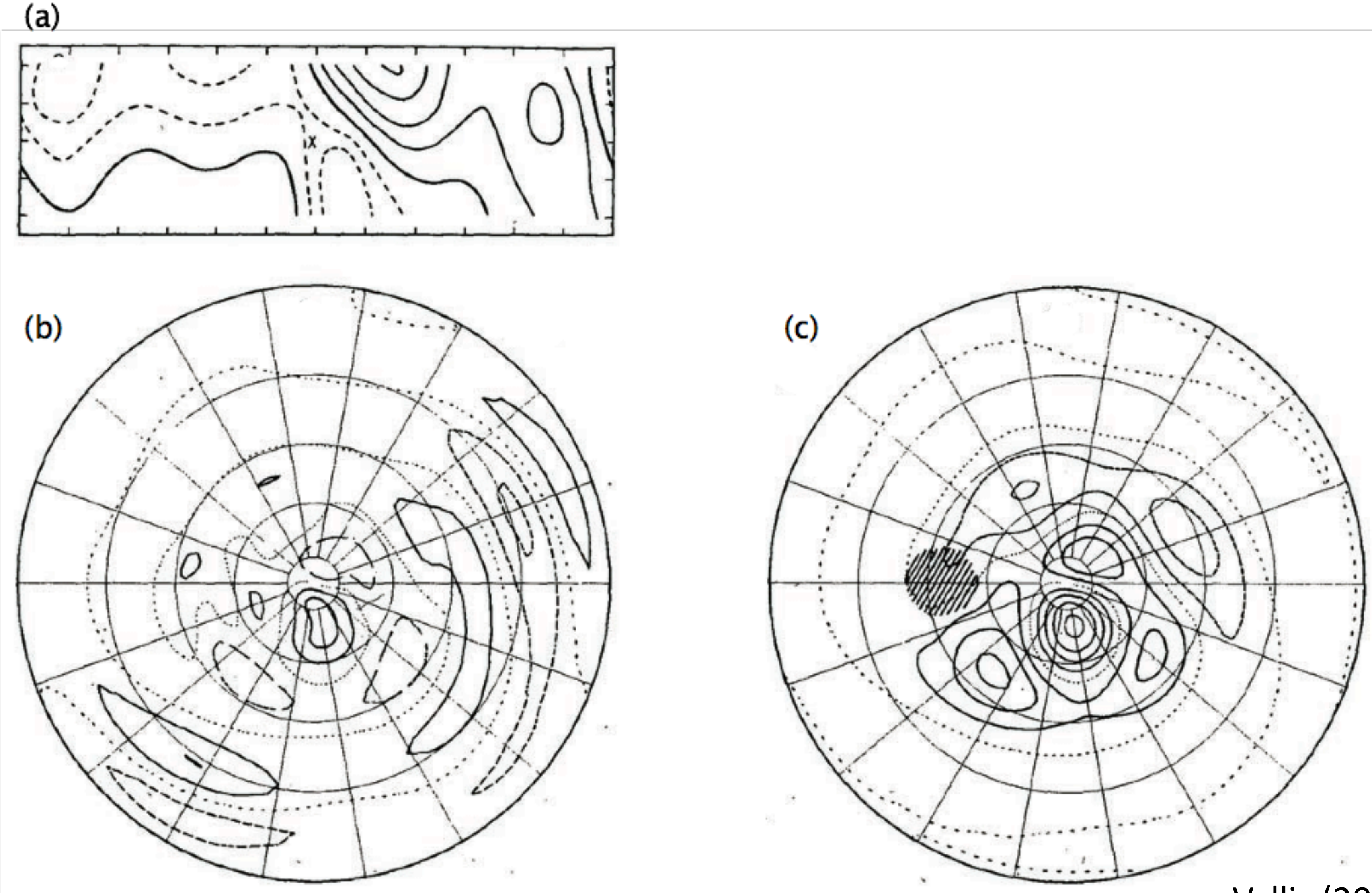
ψ^*

Held (1983)



Vallis (2006)

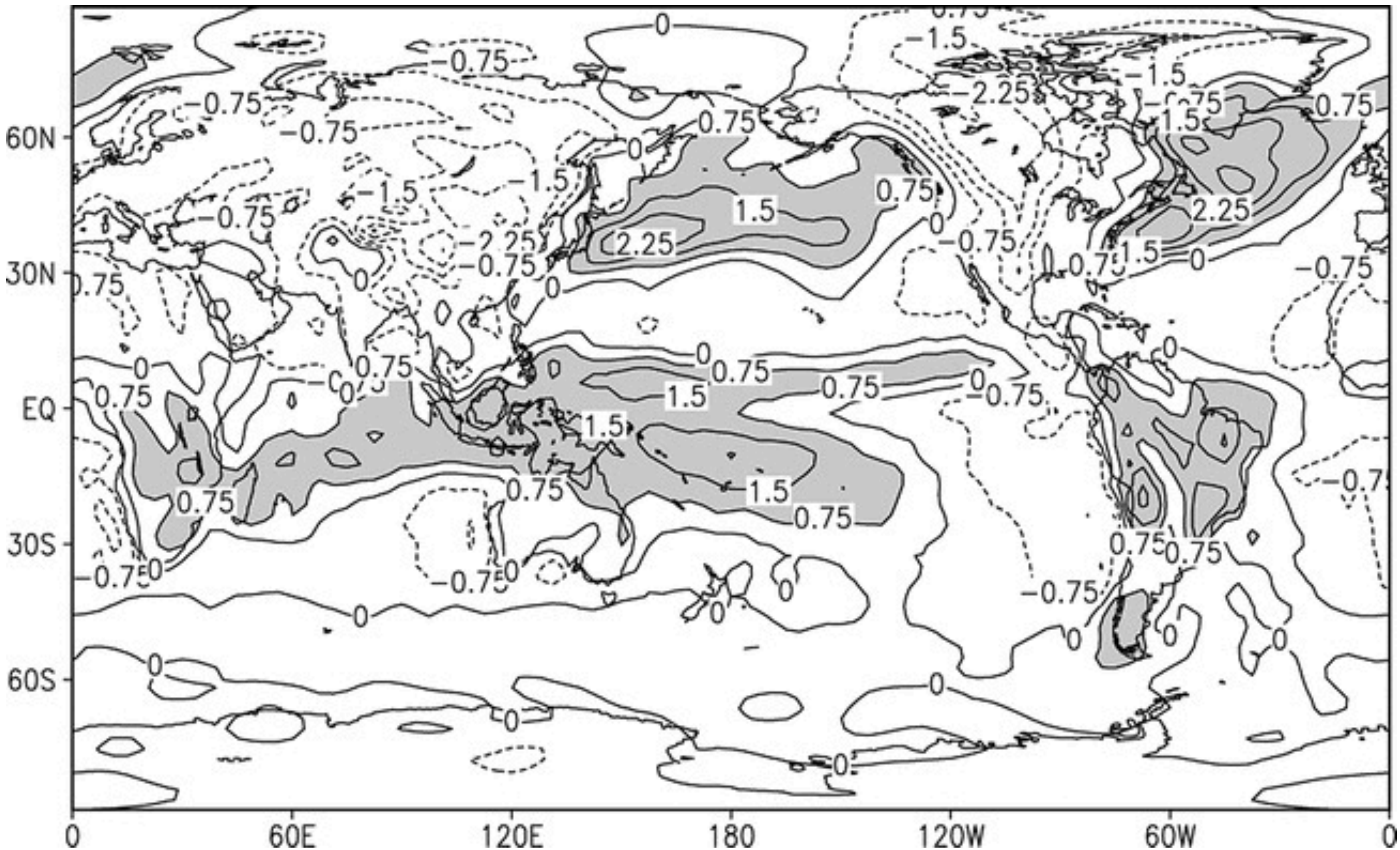
Fig. 13.8 Numerical solution of a baroclinic primitive equation model with a deep heat source at 15° N and a zonal flow similar to that of northern hemisphere winter. (a) Height field in a longitude height at 18° N (vertical tick marks at 100, 300, 500, 700 and 900 mb); (b) 300 mb vorticity field; (c) 300 mb height field. The cross in (a) and the hatched region in (c) indicate the location of the heating.[3]



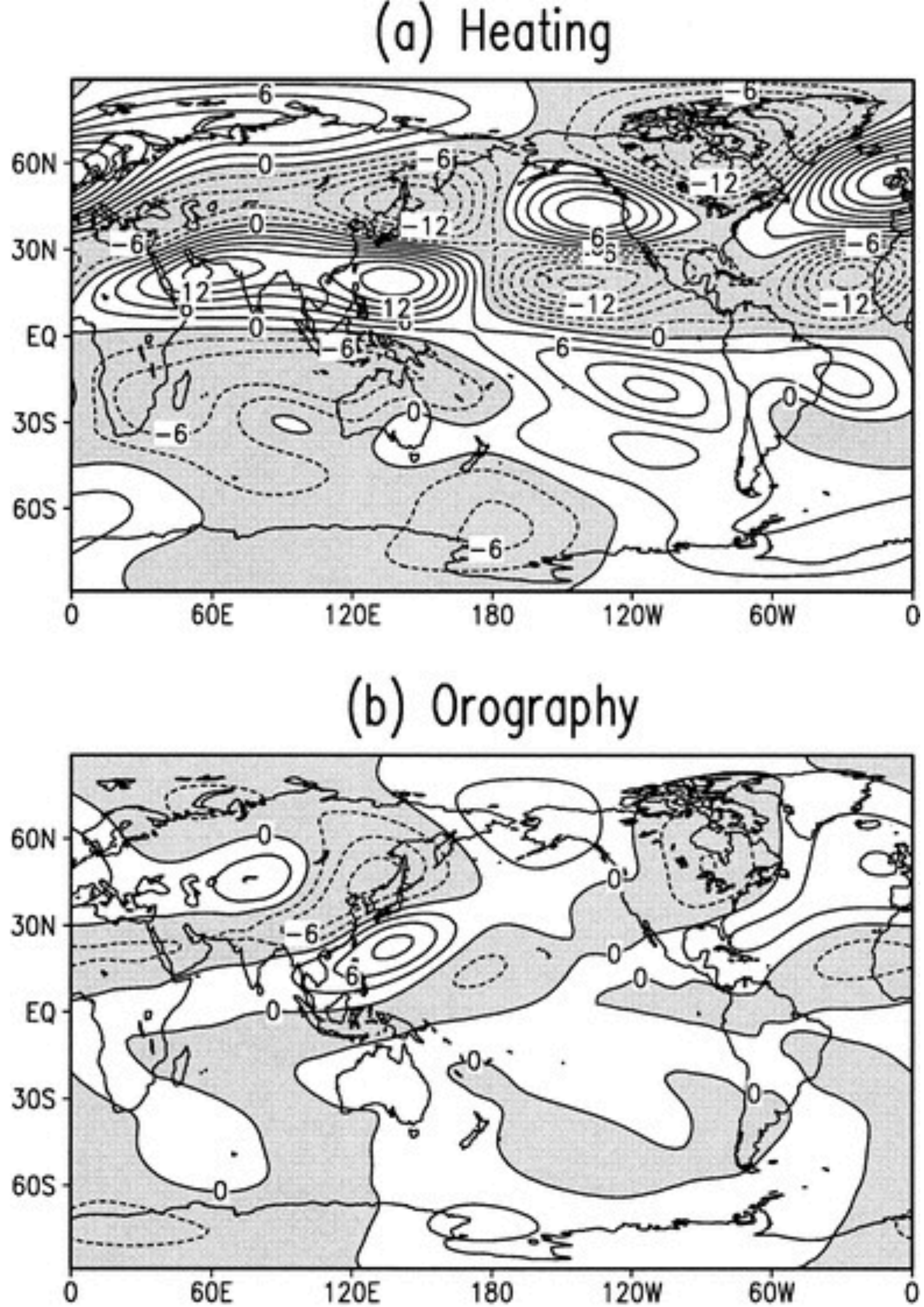
Vallis (2006)

Fig. 13.9 As for Fig. 13.8, but now the solution of a baroclinic primitive equation model with a deep heat source at 45°N. (a) Height field in a longitude height at 18°N; (b) 300 mb vorticity field; (c) 300 mb height field. The cross in (a) and the hatched region in (c) indicate the location of the heating.[4]

The column-averaged diabatic heating field in Jan. (NCEP-NCAR Reanalysis) [K/day]



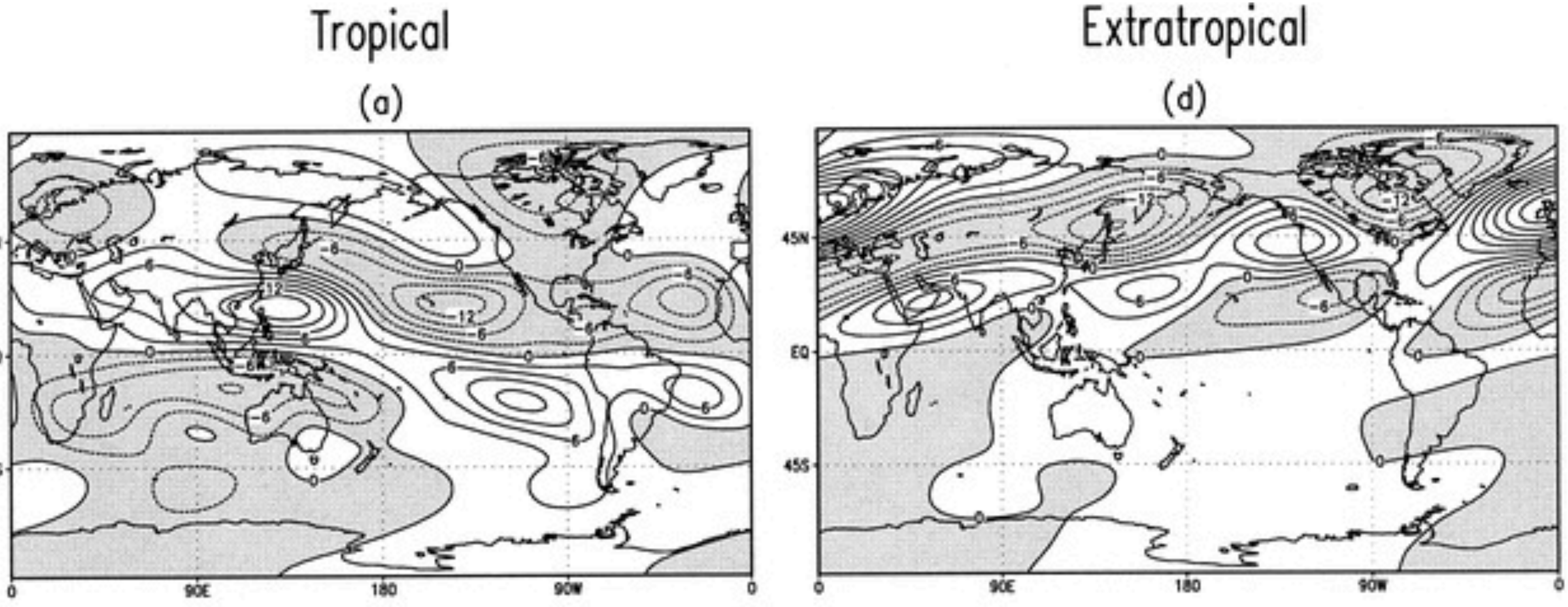
Held et al. (2002)



Streamfunction decomposition of the total linear response at 300 mb in Jan. into parts forced by (a) heating plus transient eddy heat fluxes (b) orography.

Contour interval is 3×10^6 $m^2\ s^{-1}$

Held et al. (2002)



The 300-mb eddy streamfunction for the (a) linear response to NH tropical heating in Jan; the analogous (d) linear response to extratropical heating. Contour interval is 3×10^6 m^2 s^{-1}

Held et al. (2002)

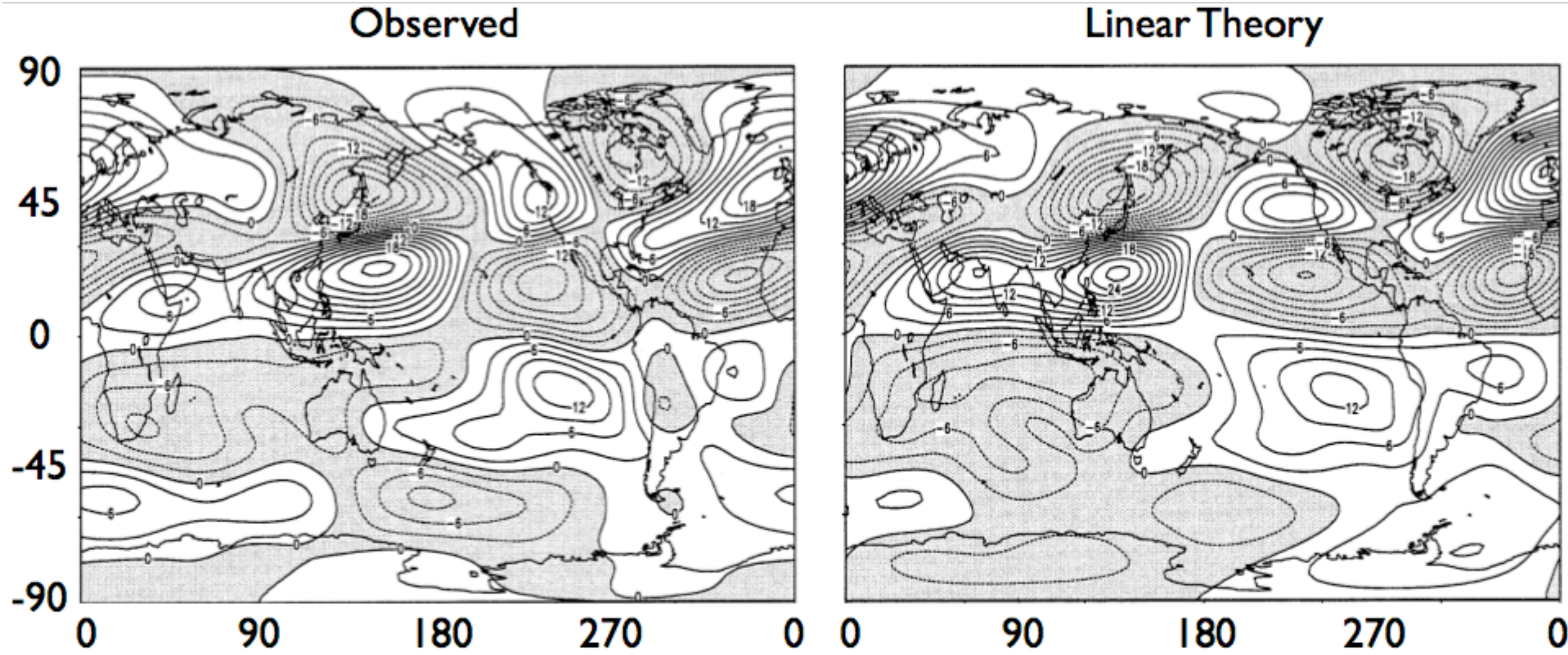


Fig. 13.10 Left: the observed stationary (i.e., time-averaged) streamfunction at 300 mb (about 7 km altitude) in northern hemisphere winter. Right: the steady, linear response to forcing by orography, heat sources and transient eddy flux convergences, calculated using a linear model with the observed height-varying zonally averaged zonal wind. Contour interval is $3 \times 10^6\ m^2\ s^{-1}$, and negative values are shaded. Note the generally good agreement, and also the much weaker zonal asymmetries in the southern hemisphere.[5]

Vallis (2006)