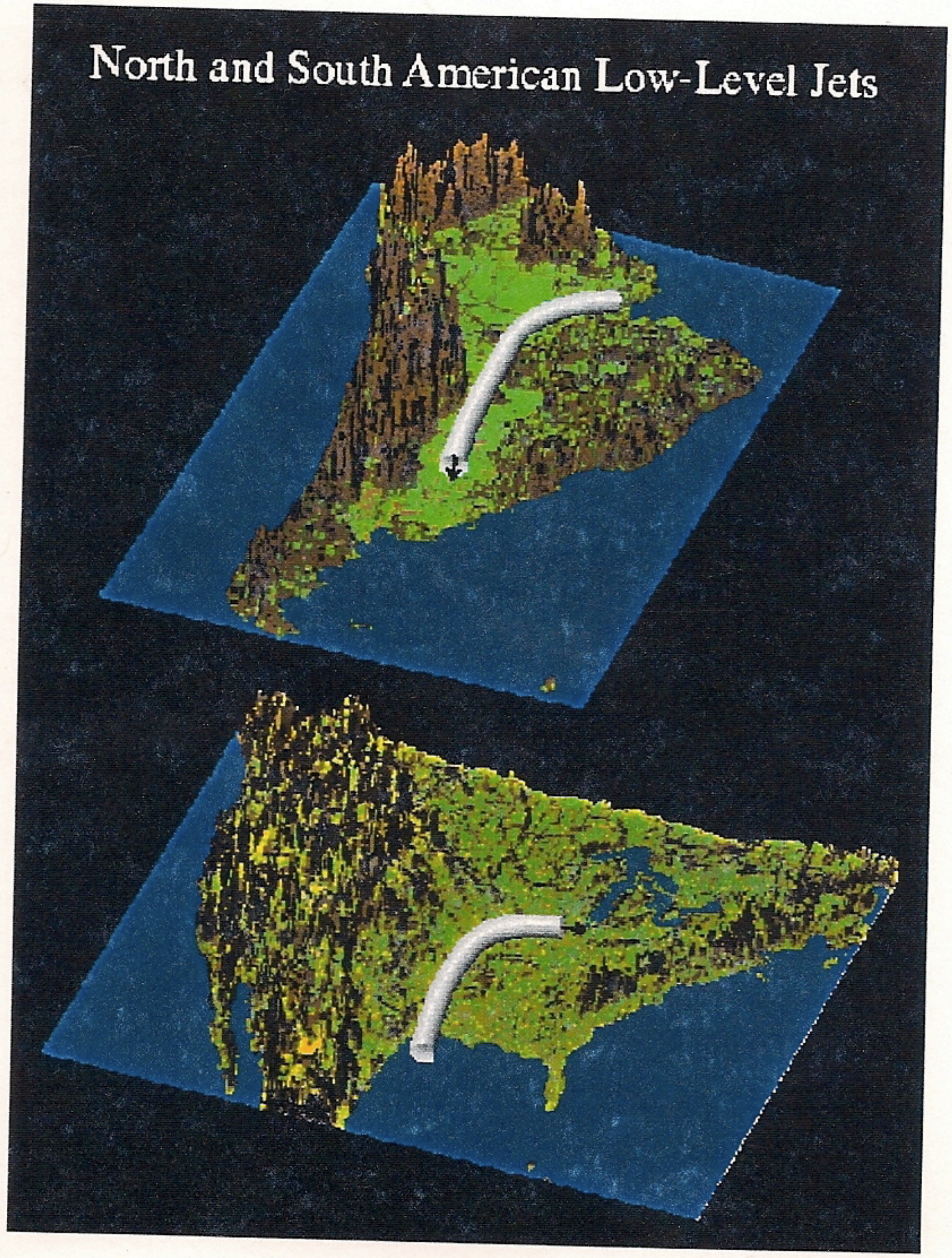
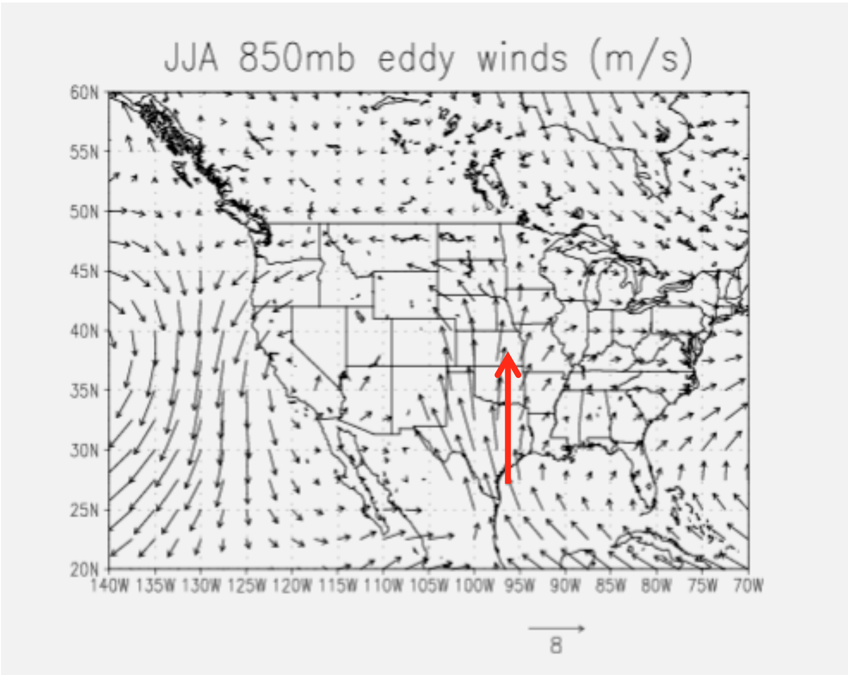
Dependence of Regional Atmospheric Circulations Upon Ambient Wind Fields

Jan Paegle
University of Utah
Lee Byerle
Lt. Col. USAF, Rockville Md

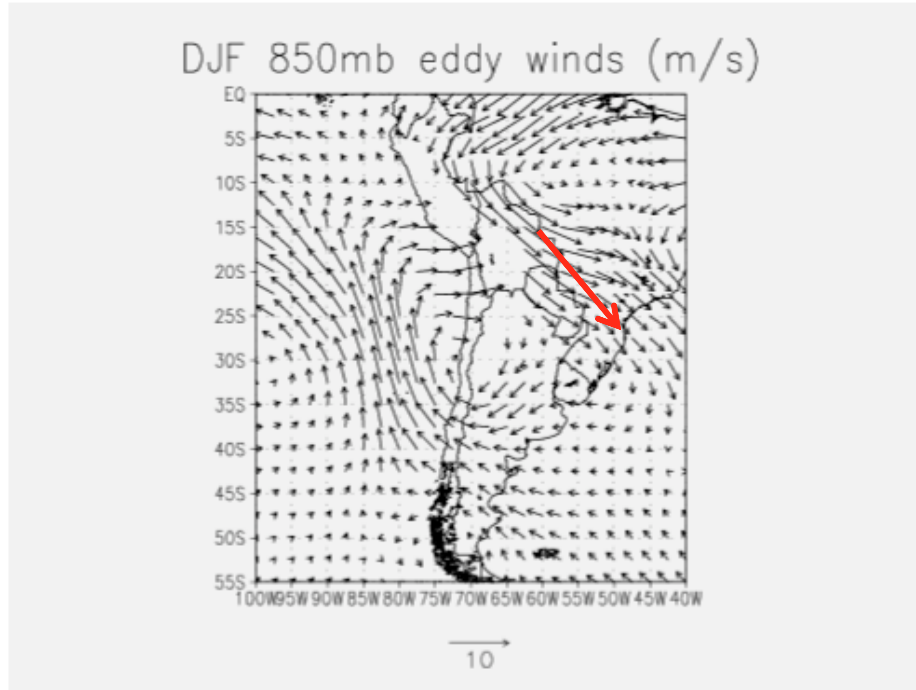


Draft, March 2001

Summer (JJA)



Summer (DJF)

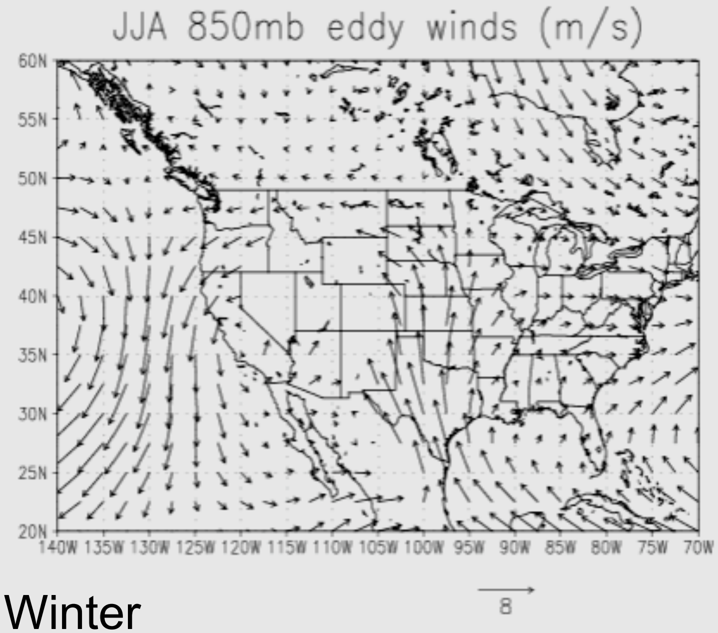


(1951-2000)

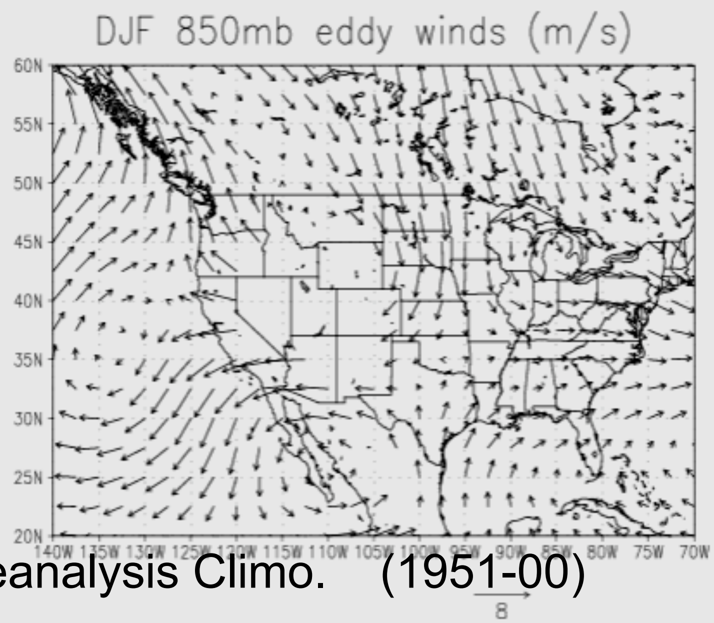
(1951-2000)

850 mb eddy winds (m/s); zonal average removed

Summer

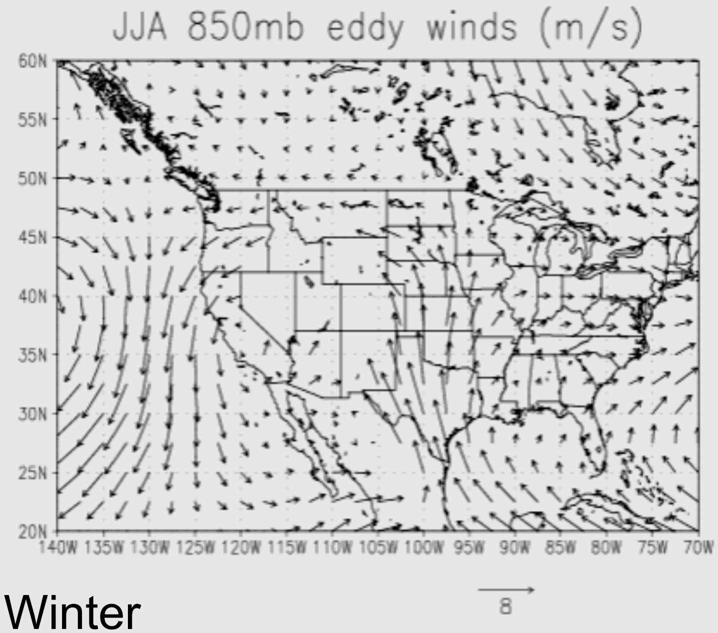


Winter

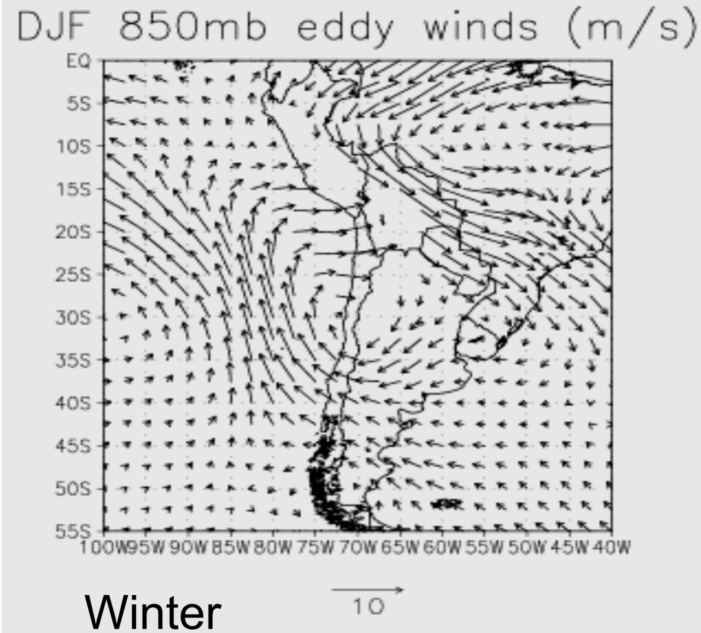


Reanalysis Climo. (1951-00)

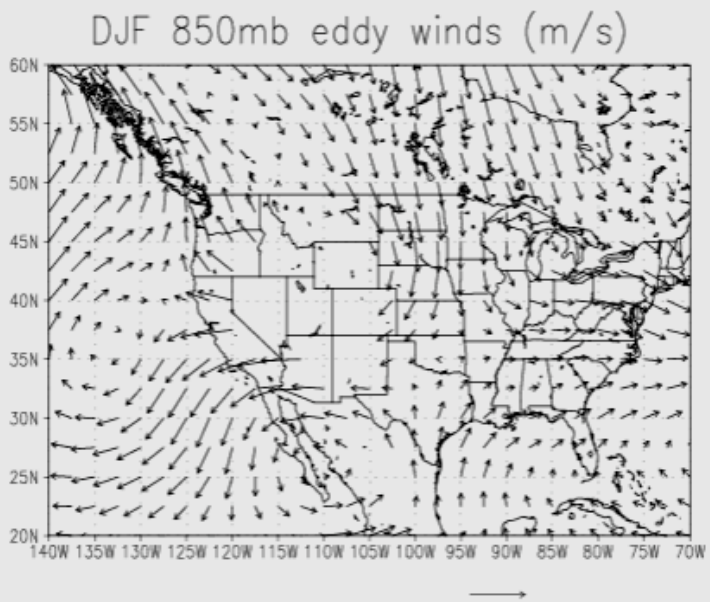
Summer



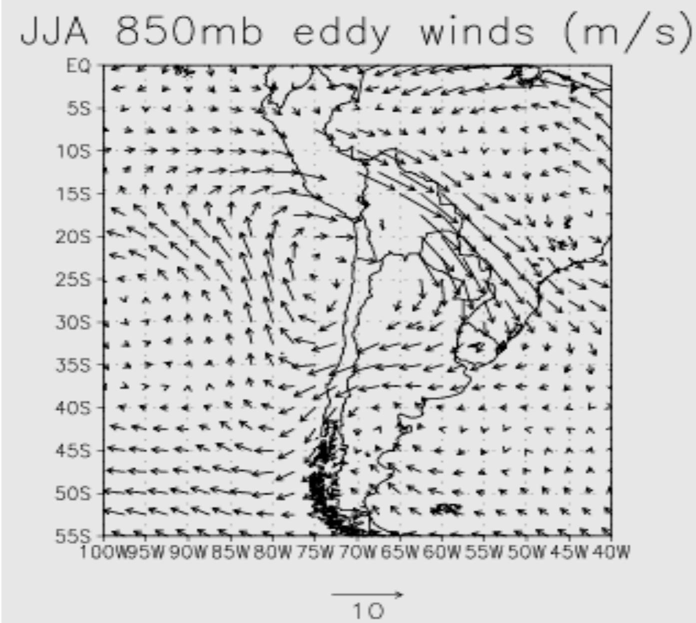
Summer



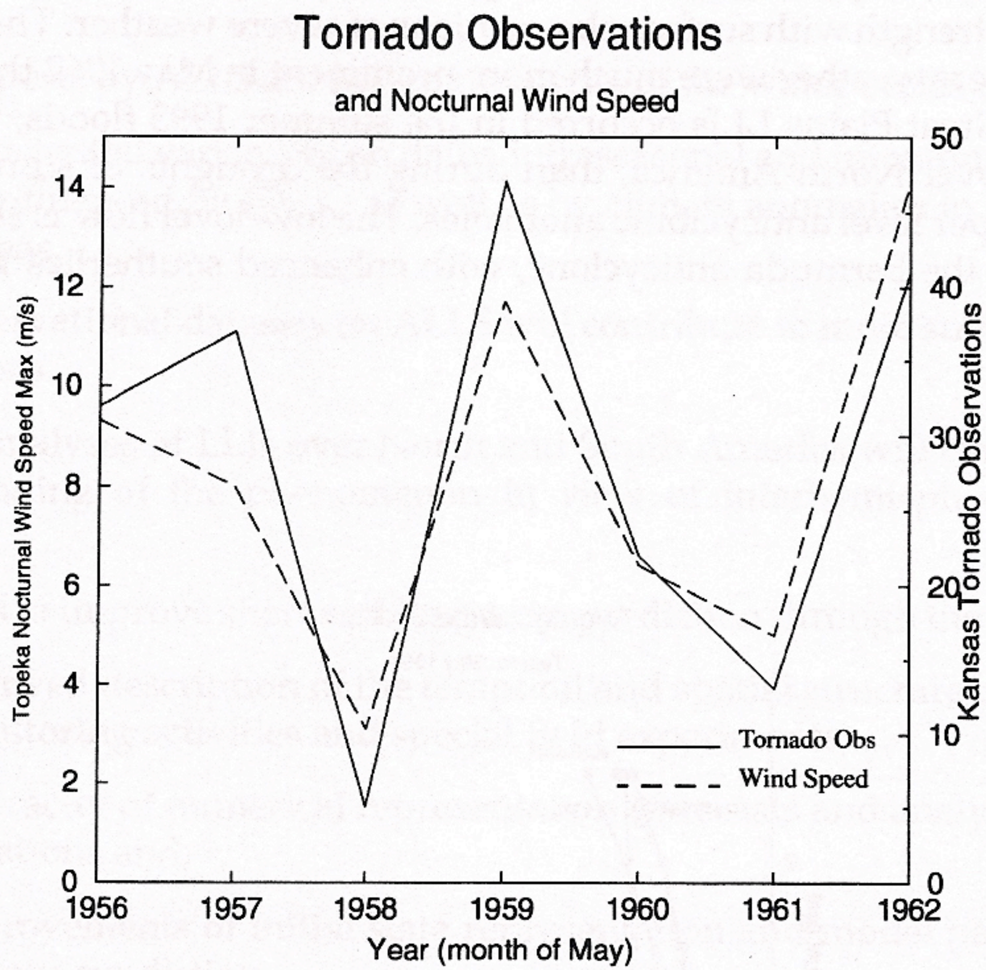
Winter

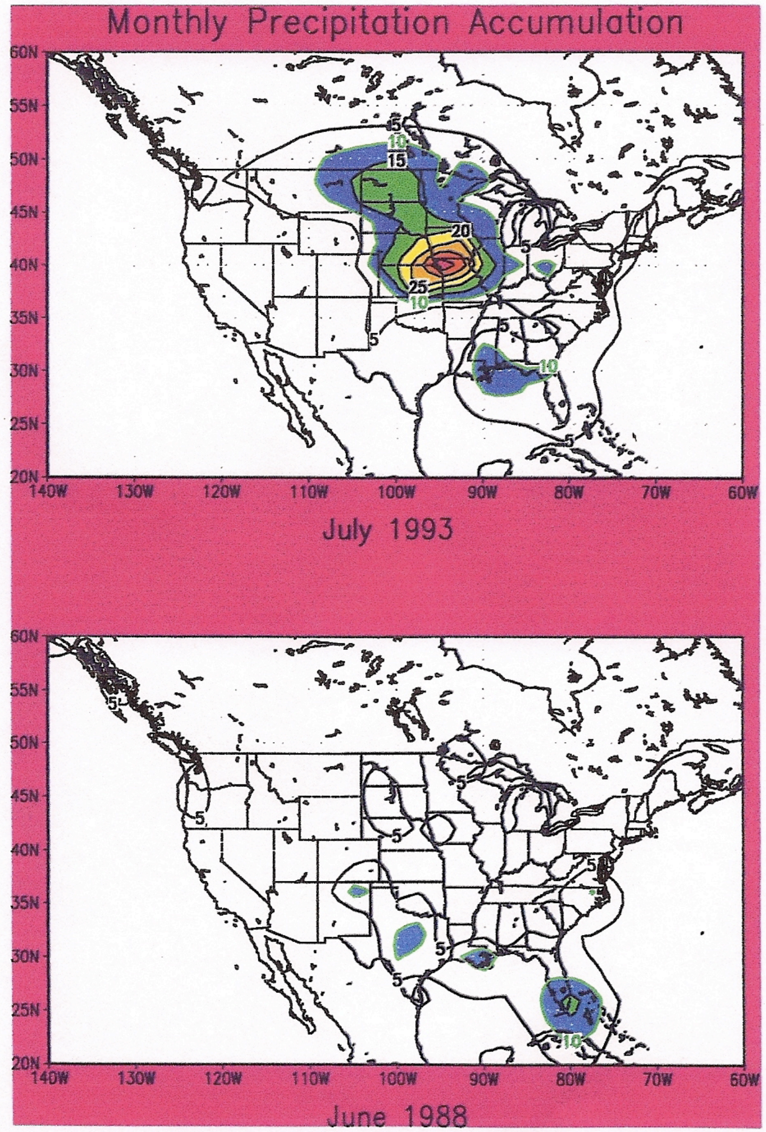


Winter



Reanalysis Climo. (1951-00)


Tornado Observations
and Nocturnal Wind Speed
Topeka Nocturnal Wind Speed Max (m/s)
Kansas Tornado Observations
Year (month of May)
Tornado Obs
Wind Speed
1956
1957
1958
1959
1960
1961
1962


Monthly Precipitation Accumulation
60N
55N
50N
45N
40N
35N
30N
25N
20N
140W
130W
120W
110W
100W
90W
80W
70W
60W
5
10
15
20
25
July 1993
June 1988

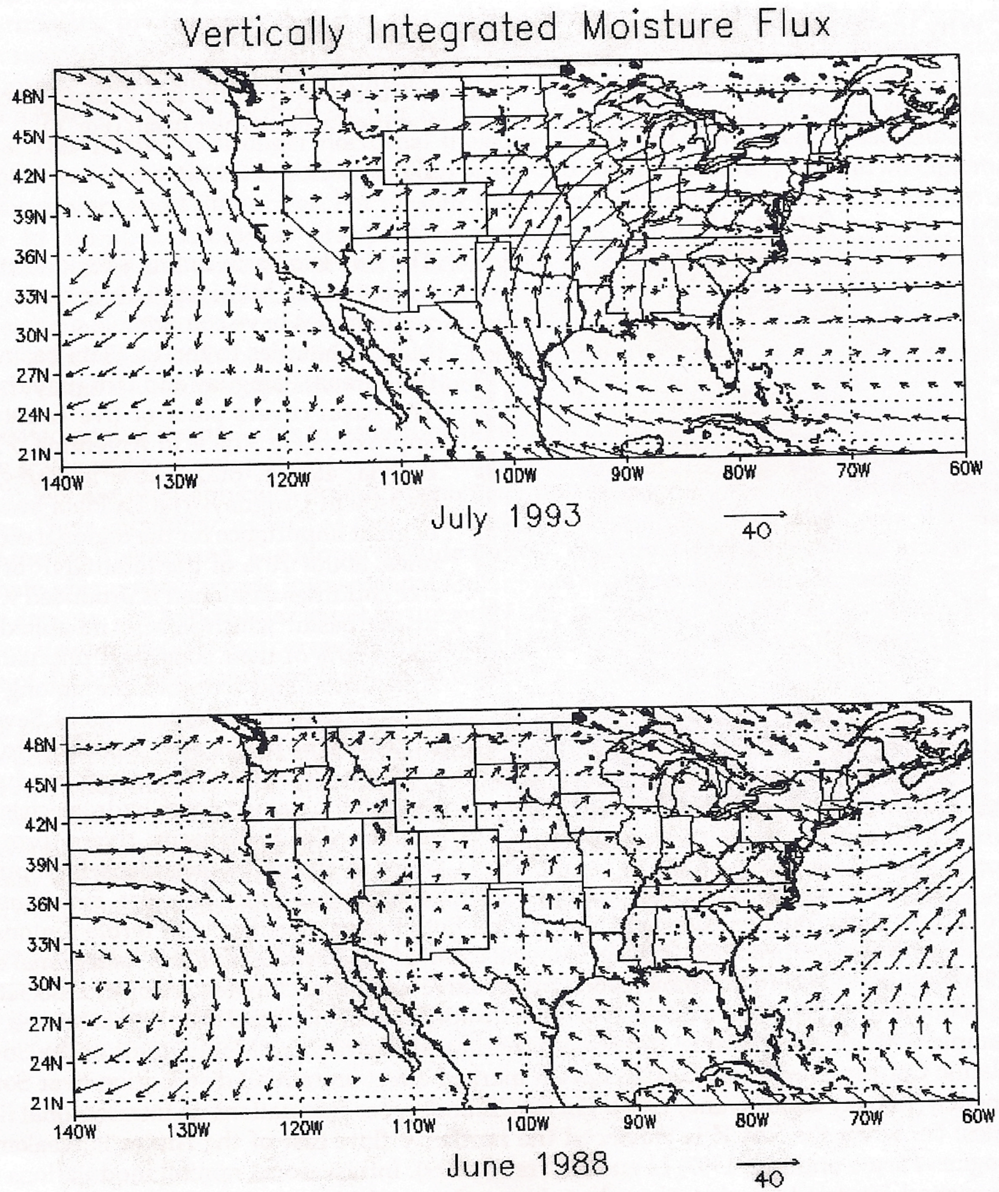
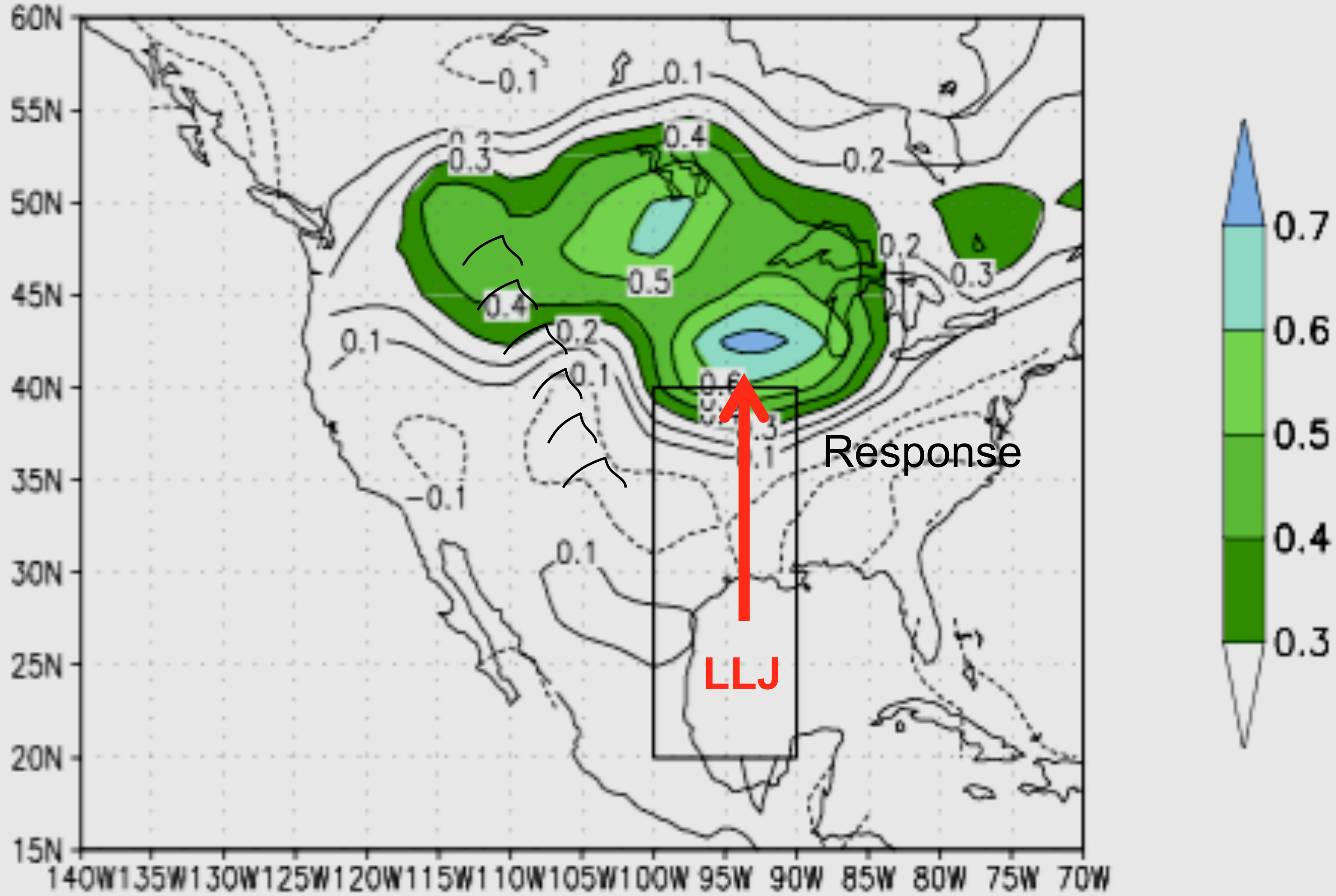


Fig. 3: *Vertically integrated water vapor transport from the NCEP/NCAR reanalysis, for July 1993 (top) and June 1988(bottom). Maximum vector is 50 kg (m/s)*

Precipitation Response to Area-averaged, 850 hPa Meridional Wind in Box Deviations from Climatology



Time correlation coefficients shown (JJA 1951-2000)

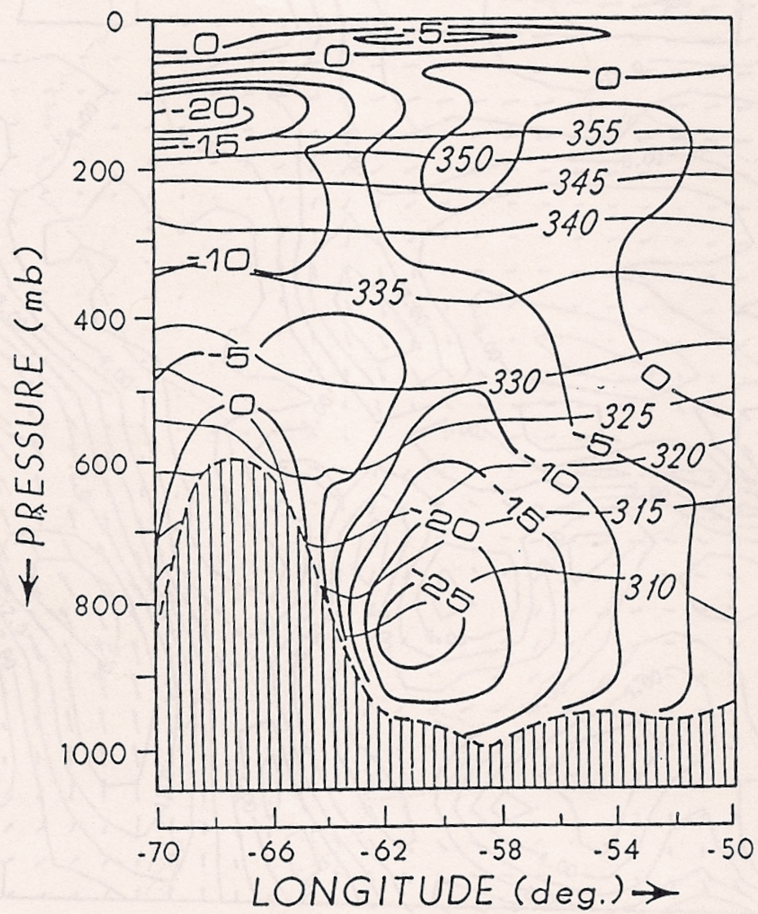
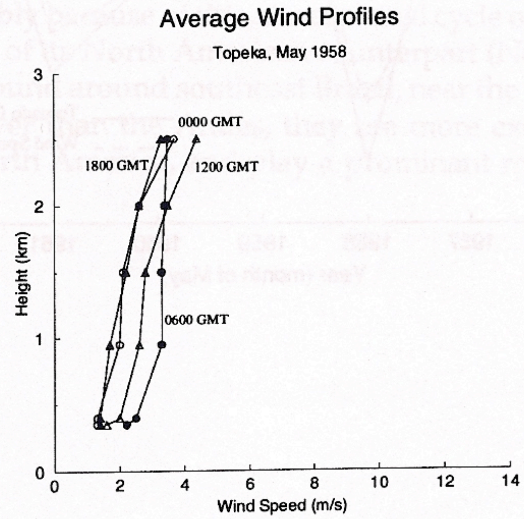
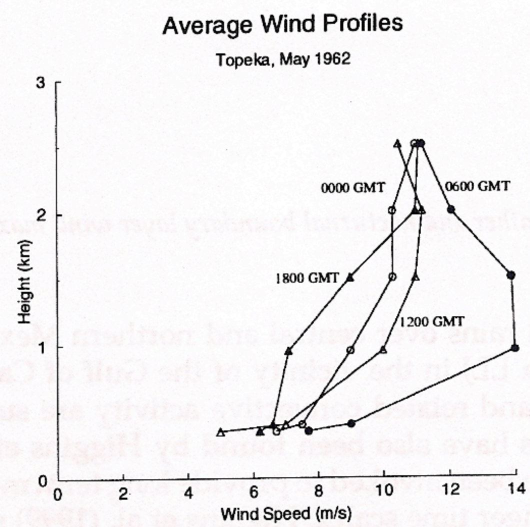


Figure 2b) Vertical cross-section of meridional wind component (m/s) and isentropes (deg. K) along 21 S for 00 UTC, 27 November. These are ECMWF analyses provided by Dr. Heckley.


Average Wind Profiles
Topeka, May 1958
0000 GMT
1800 GMT
1200 GMT
0600 GMT
Height (km)
Wind Speed (m/s)


Average Wind Profiles
Topeka, May 1962
0000 GMT
0600 GMT
1800 GMT
1200 GMT
Height (km)
Wind Speed (m/s)

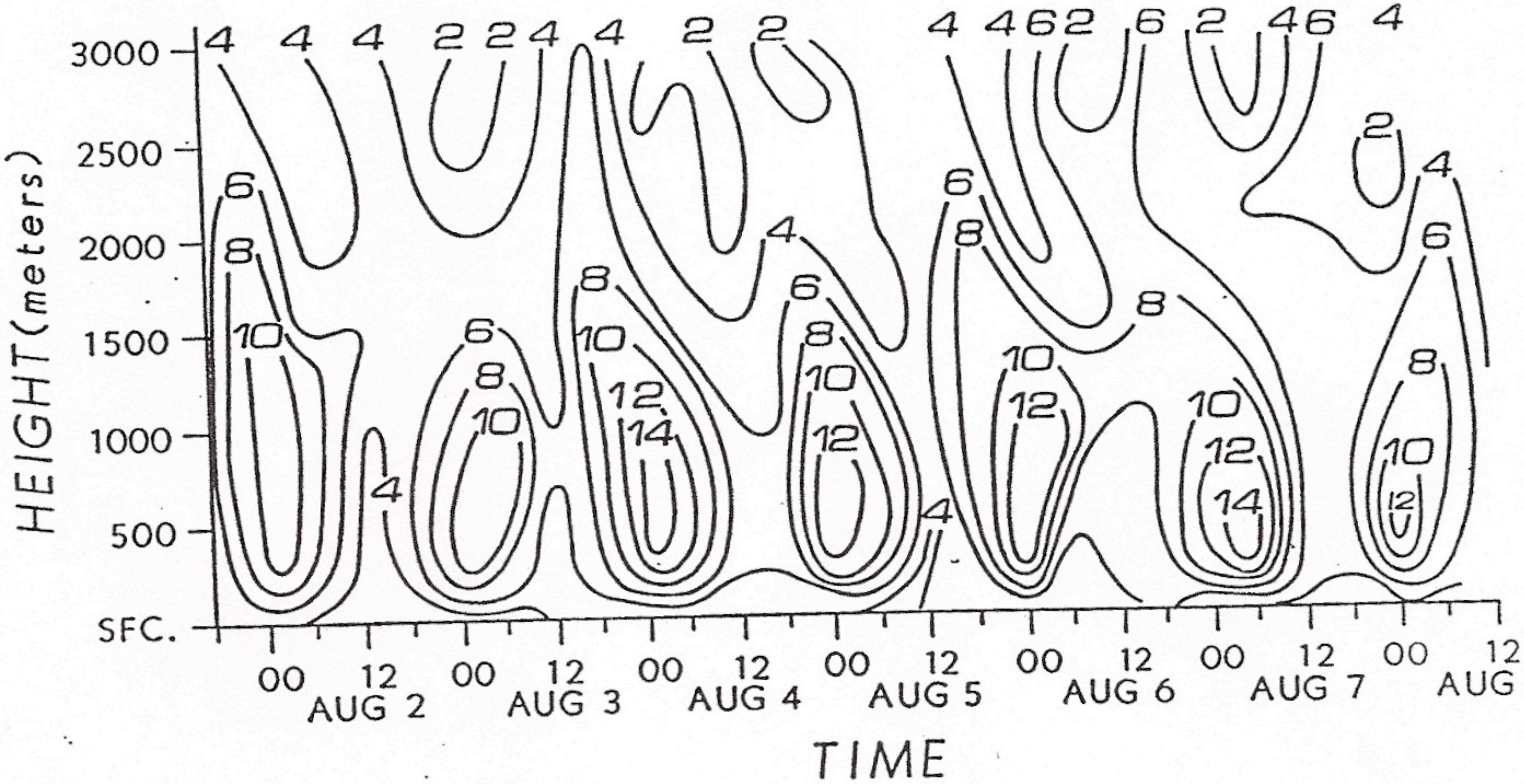


Figure 4) Vertical cross-section of wind speed (m/s) at Ft. Worth, Texas, August 2-8, 1960.

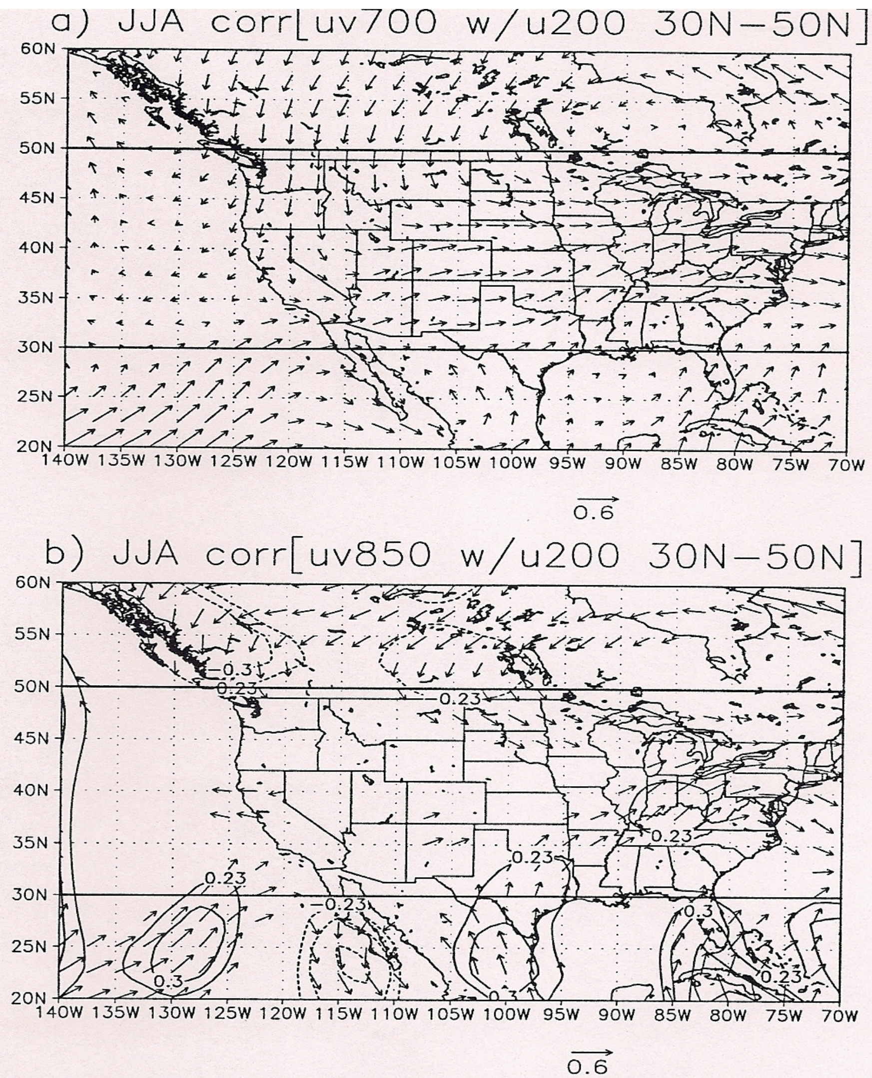
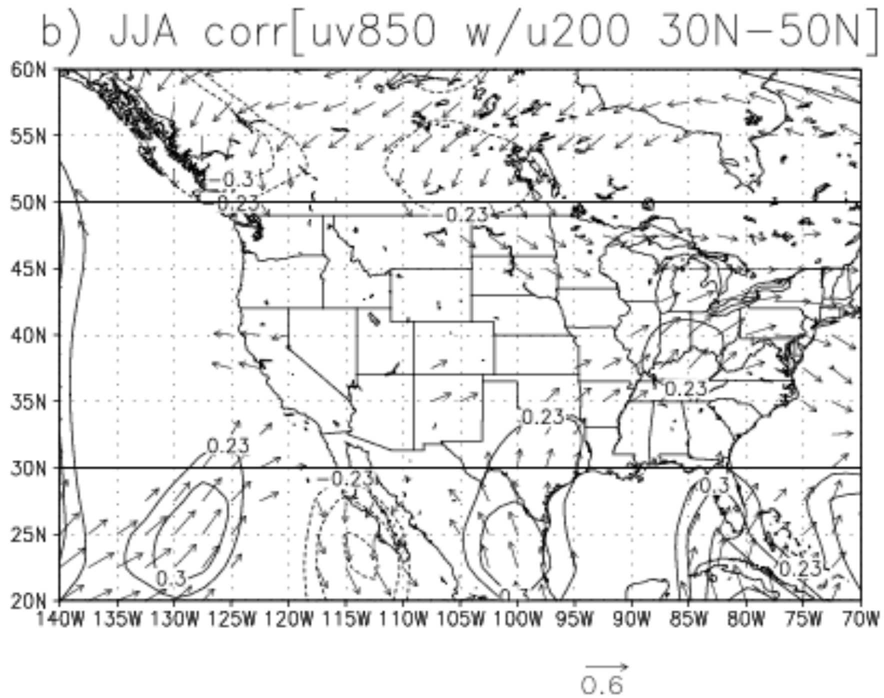
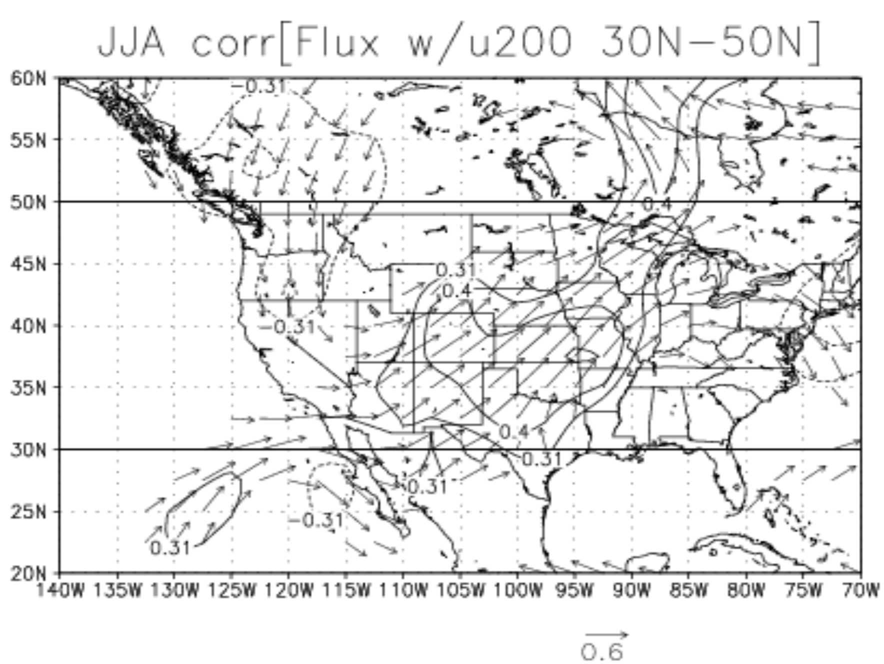
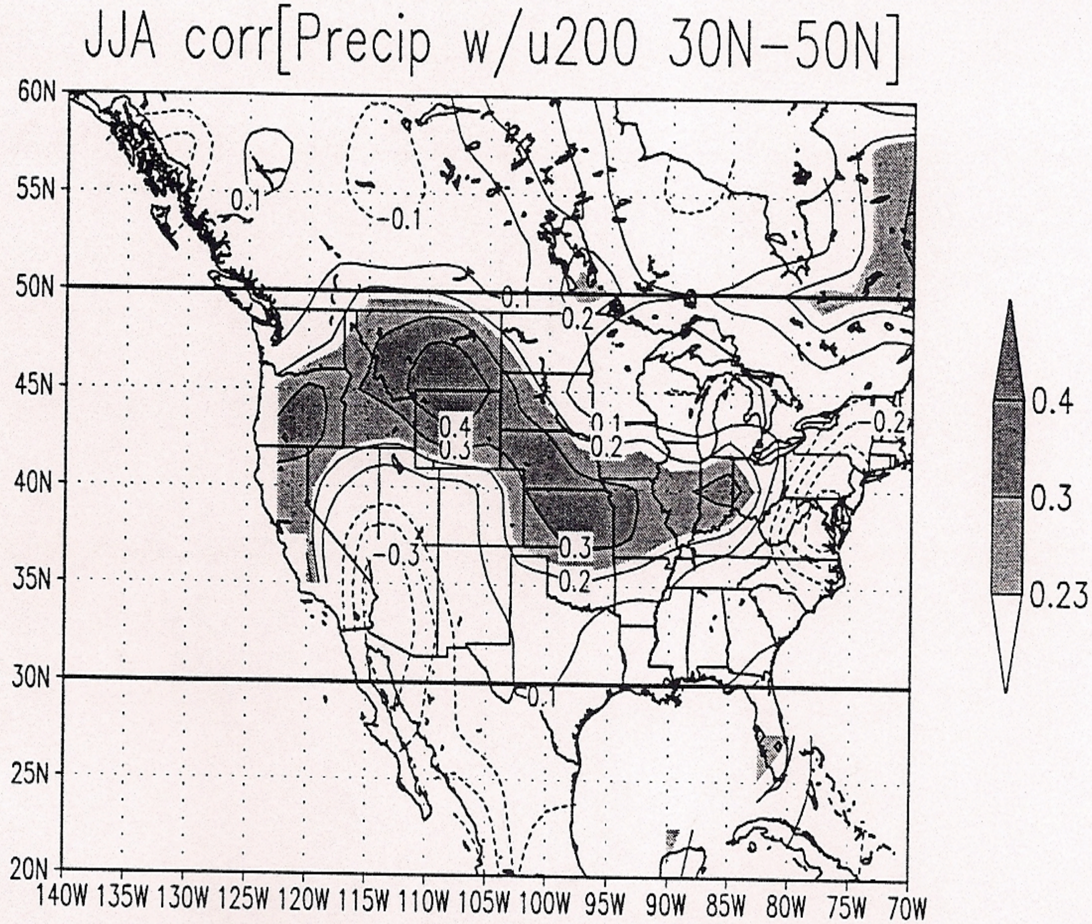


FIG. 4.5. Time correlation over North America (1951-2000) during summer (JJA). (a) Time correlation vectors of the area averaged, 200 mb, zonal wind around the globe from 30°N-50°N (outlined) with 700 mb wind at all locations. (b) Similar to (a), but for 200 mb, zonal wind correlated with vertically integrated moisture flux. The magnitudes of the correlation vectors are indicated at the bottom of each panel. In (b), the meridional components of the correlation coefficients are contoured, and only vector and meridional coefficients meeting the 95% statistical significance criteria (0.23) are shown.

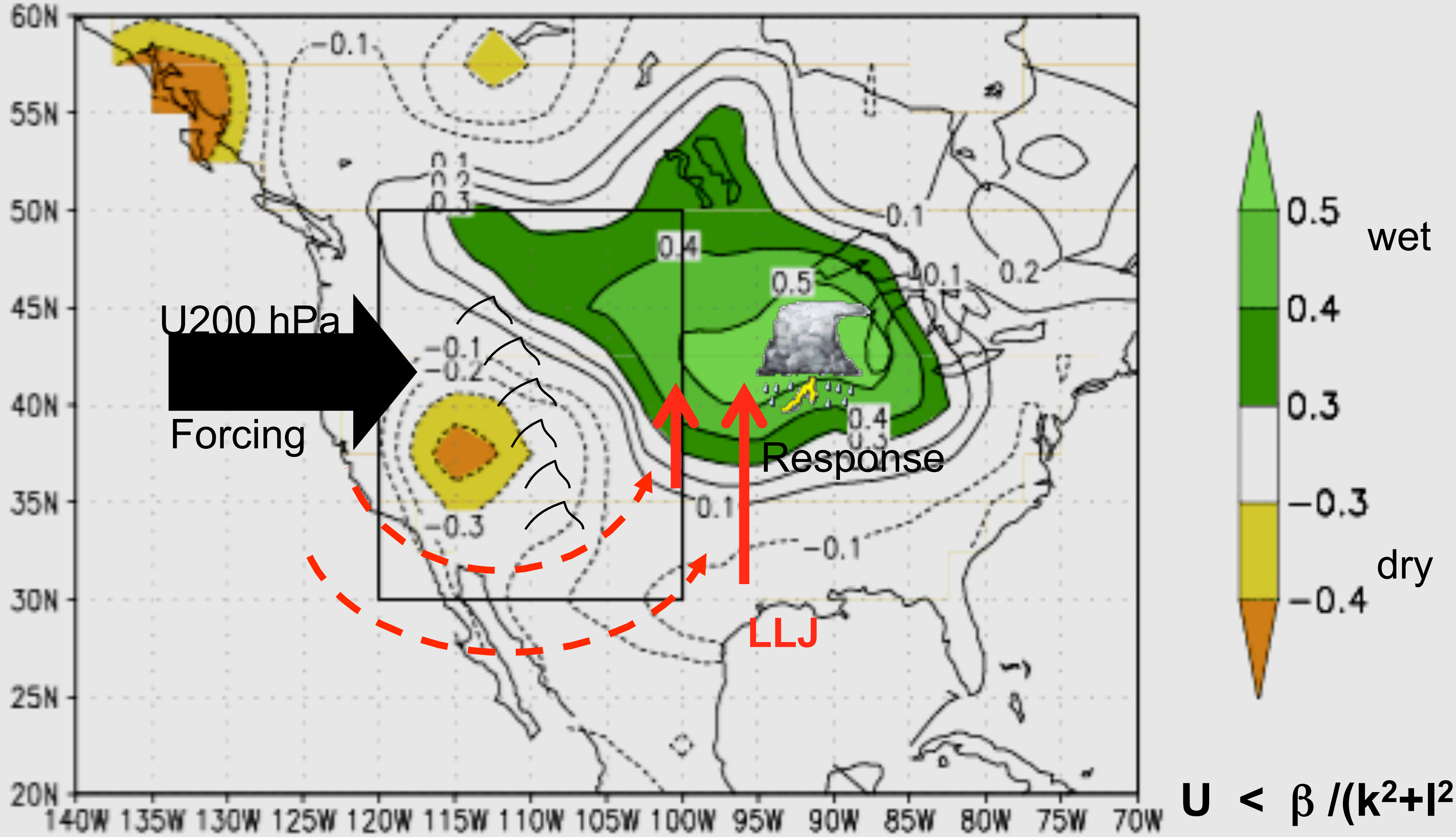

b) JJA corr[uv850 w/u200 30N-50N]
60N
55N
50N
45N
40N
35N
30N
25N
20N
140W 135W 130W 125W 120W 115W 110W 105W 100W 95W 90W 85W 80W 75W 70W
0.6


JJA corr[Flux w/u200 30N-50N]
60N
55N
50N
45N
40N
35N
30N
25N
20N
140W 135W 130W 125W 120W 115W 110W 105W 100W 95W 90W 85W 80W 75W 70W
0.6



JJA corr[Precip w/u200 30N-50N]
60N
55N
50N
45N
40N
35N
30N
25N
20N
140W 135W 130W 125W 120W 115W 110W 105W 100W 95W 90W 85W 80W 75W 70W
0.1
-0.1
0.1
0.2
0.4
0.3
0.1
0.2
-0.3
0.3
0.2
-0.1
-0.2
0.4
0.3
0.23

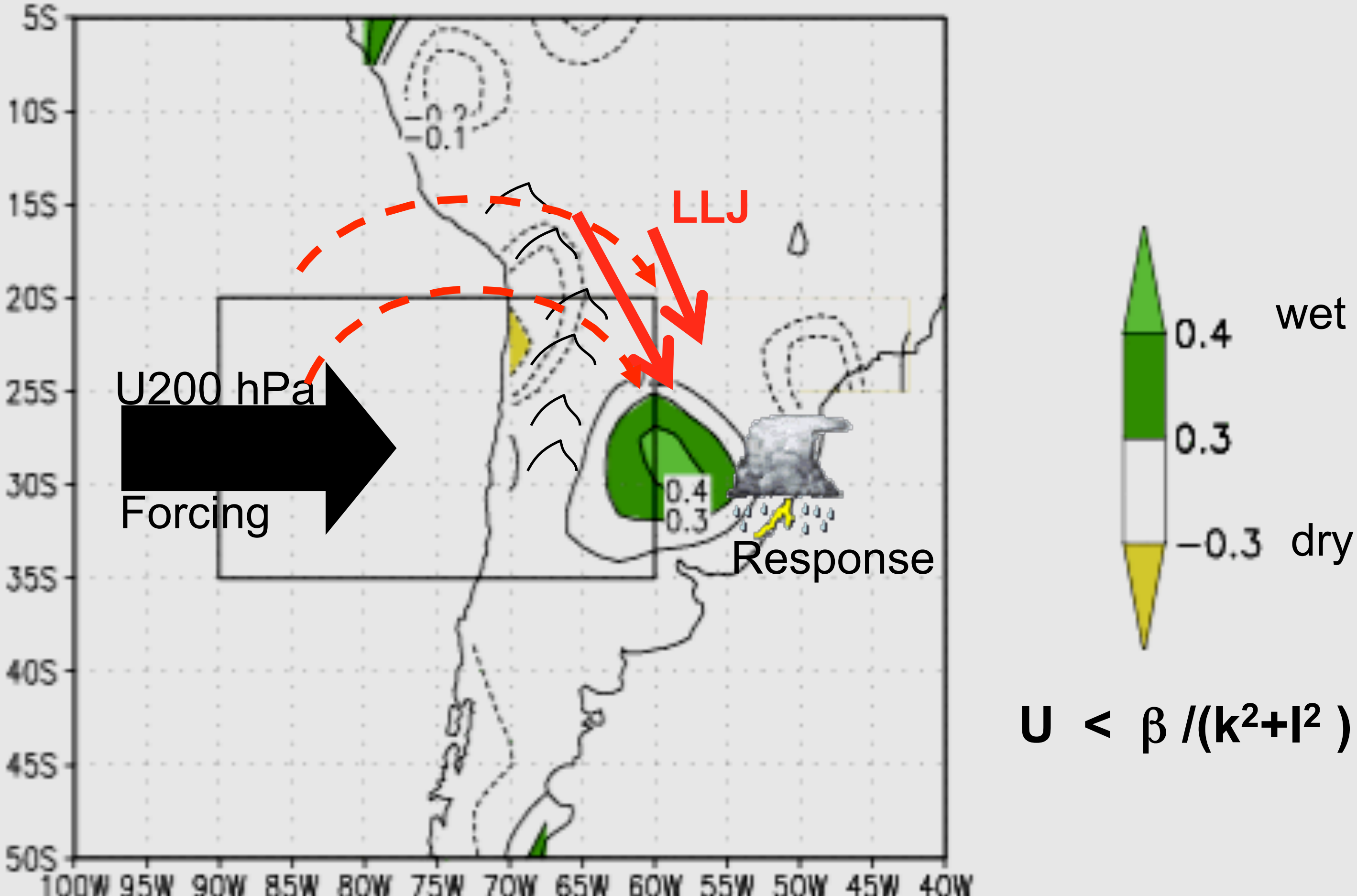
LLJ and Precipitation Response to Ambient Zonal flow and Orography Deviations from Climatology



$$U < \beta / (k^2 + l^2)$$

Time correlation coefficients shown (JJA 1951-2000)

LLJ and Precipitation Response to
Ambient Zonal flow and Orography
Deviations from Climatology



U < β /(k²+l²)

Time correlation coefficients shown (DJF 1951-2000)

(49 deg of freedom)

Summary

. Low-Level Jets modulate severe weather and precipitation

. Detailed vertical, horizontal, and temporal evolution of LLJs might be difficult to detect from space

. Strong correlations of LLJs and related phenomena with upper level, cross-mountain winds could mitigate direct observational difficulties

. Implications for climate impacts: possible weakening of zonal circulations associated with some global warming scenarios and resulting changes of LLJs, moisture fluxes, and regional hydrological cycles

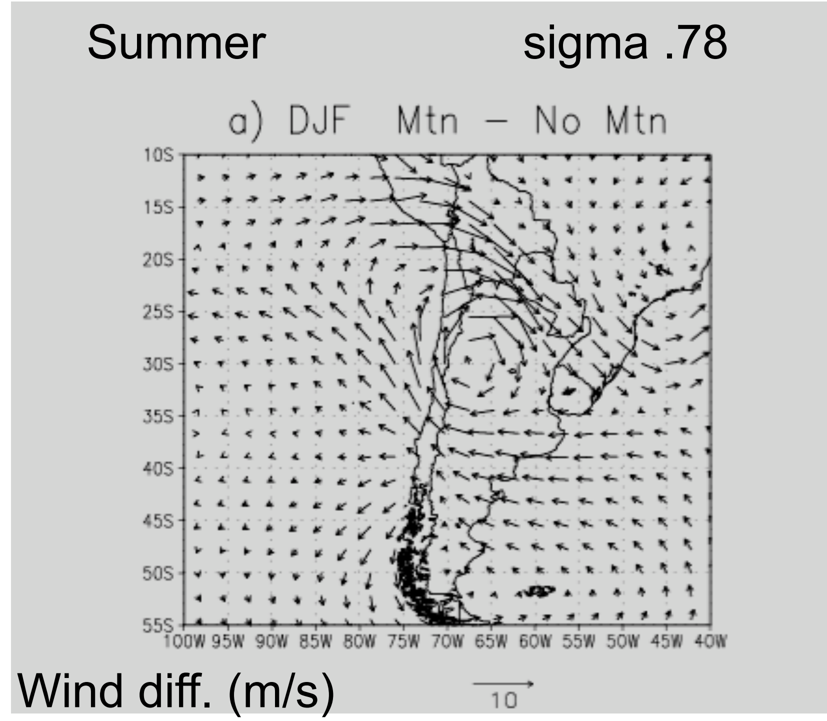
Simulations to test orographic mechanism:

-UGM: hydrostatic; predicts vorticity, divergence, thermal and moisture fields on pressure-based sigma coordinates

-Adiabatic, 20-level primitive eqn version of the UGM, truncated at wavenumber 42, 2º latitude spacing

-Contains full and realistic spectrum of orography and ambient flows

-Zonally averaged portion of the circulation is maintained by relaxation toward the climatology for each season (1951-2000)



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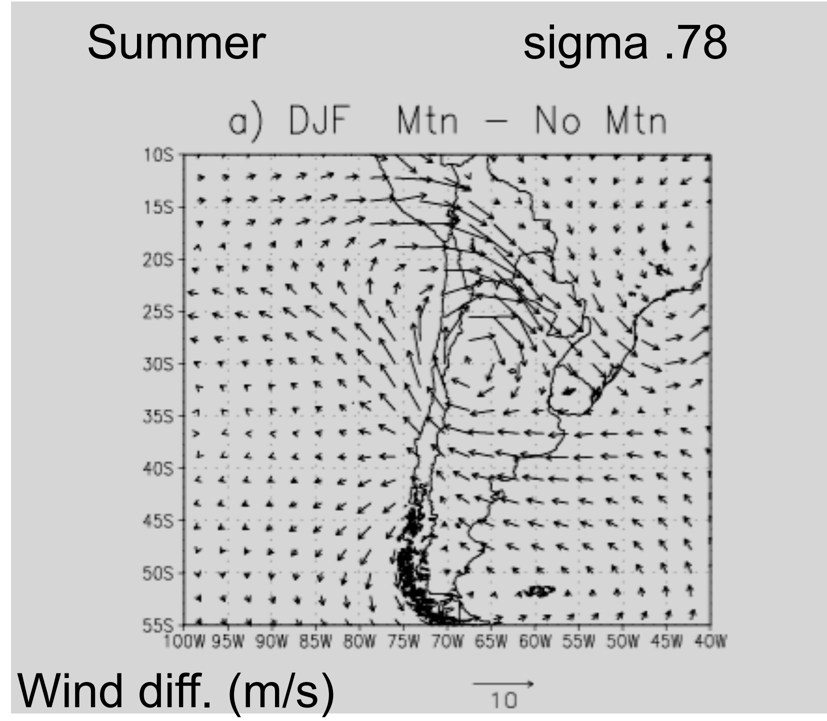

Difference in wind vectors averaged over last 30 days of a 40 day forecast:

(Mountain minus No-Mtn)

Simulations to test orographic mechanism:

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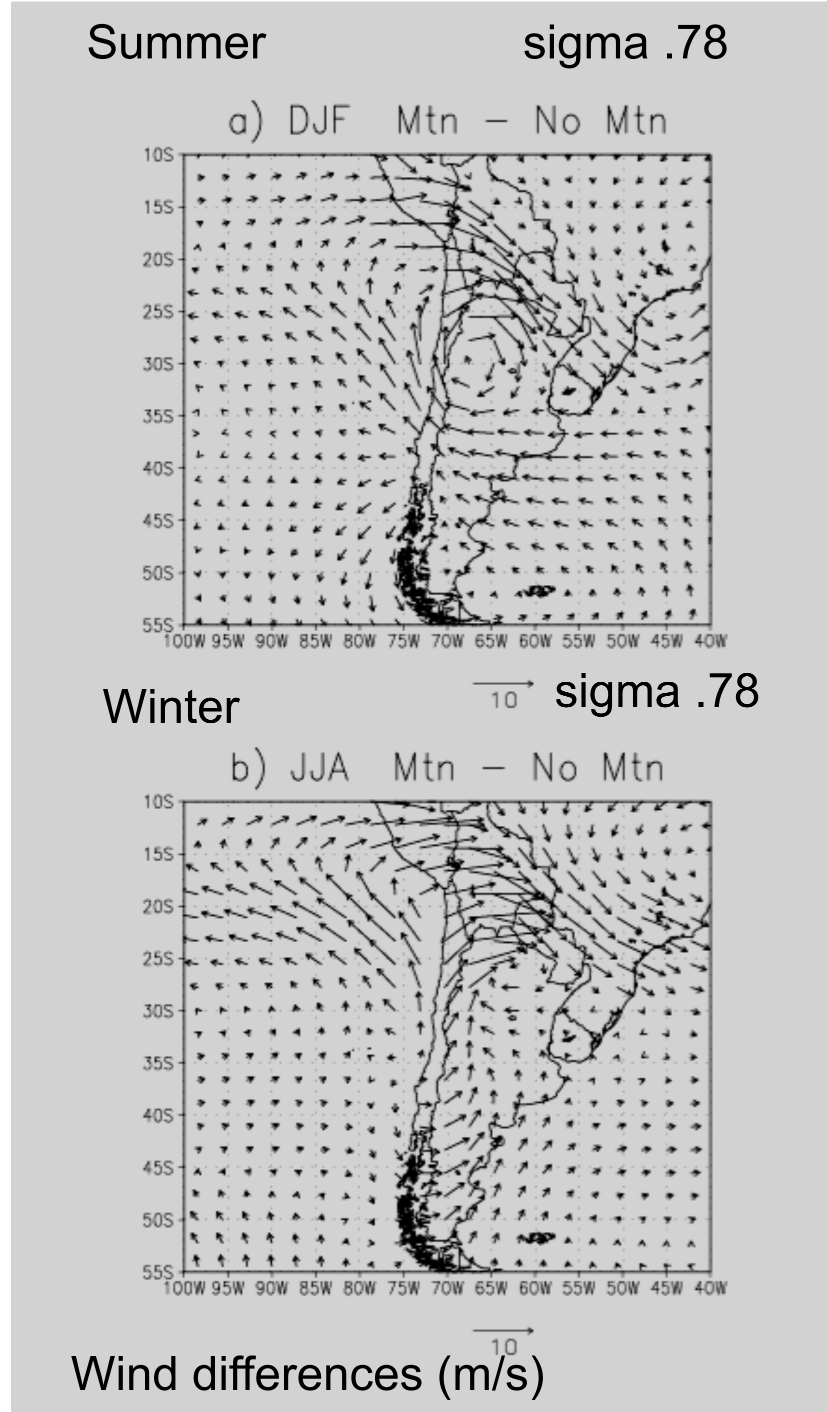
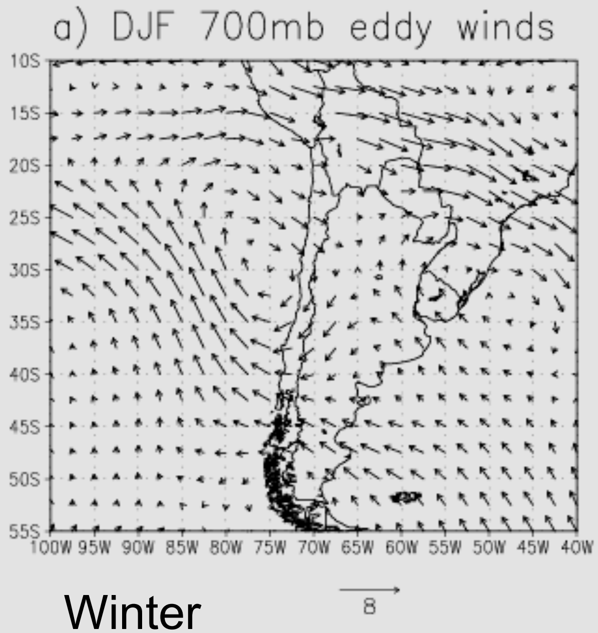
-Orographically bound cyclone over Andes is apparent in both summer and winter difference fields; *partly agrees w/obs*

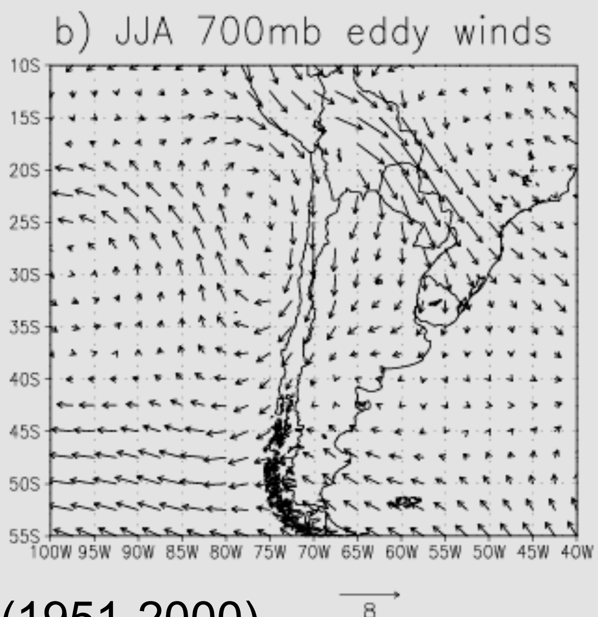


Summer

(m/s)



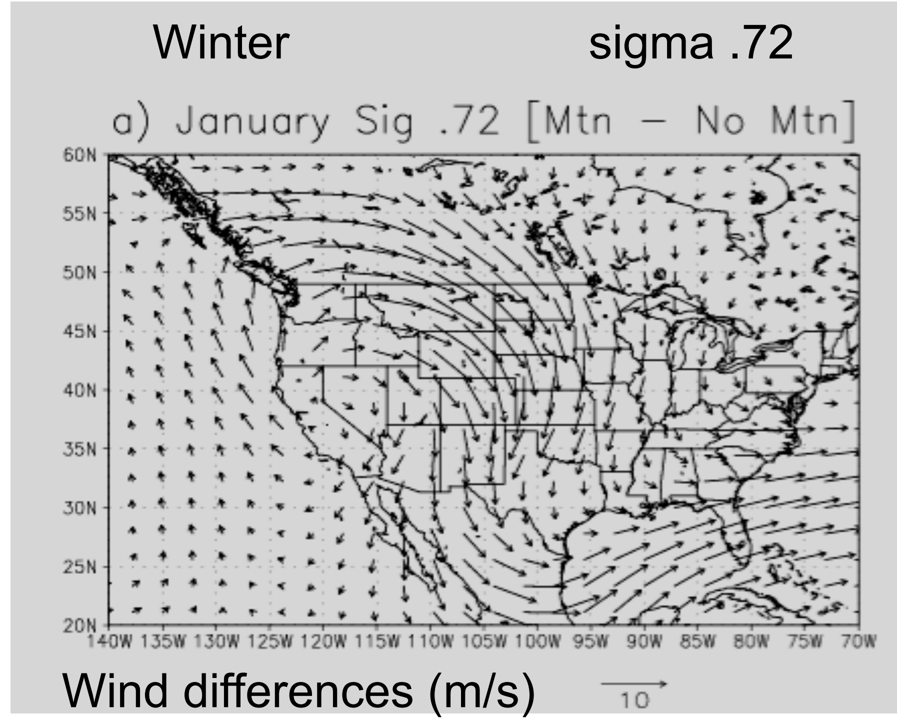
Winter



(1951-2000)

Orographic mechanism over North America:

-During January (top), mtn minus no-mtn effect produces a lower tropospheric anticyclone over the western U.S. and northerly flow east of mtns (extending to MX)



Orographic mechanism over North America:

-During January (top), mtn minus no-mtn effect produces a lower tropospheric anticyclone over the western U.S. and northerly flow east of mtns (extending to MX)

-During July (bottom), orographic effect produces cyclonic curvature within lower troposphere above the south-central Rockies and south-westerly flow east of the mountains over the southern Great Plains

-Qualitatively similar to observed climatologies / partial contribution of mechanical effects