Downscaling a weather event over South Africa using WRF Model

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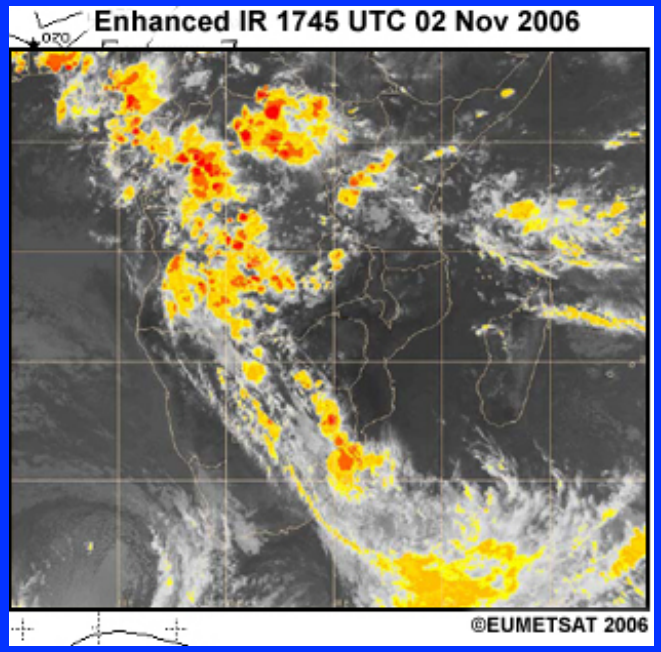
Tropical Temperature Trough (TTT)

Tropical Temperature Trough (TTT) are troughs that connect westerlies with tropical disturbances and brings heavy rainfall to southern Africa.



A channel of warm, moist air and associated deep convection extends from the NW to the SE along South Africa.

One of the signatures of the TTT is strong inflow of tropical moisture by a low-level jet at 850 hPa along the southern African coast.

Washington and Todd (1999)

Todd and Washington (1999)

TTT system contributes 40 % of annual rainfall over the central interior of South Africa. Harrison (1984)

Example of TTT: 22-24 January 1981

Trough

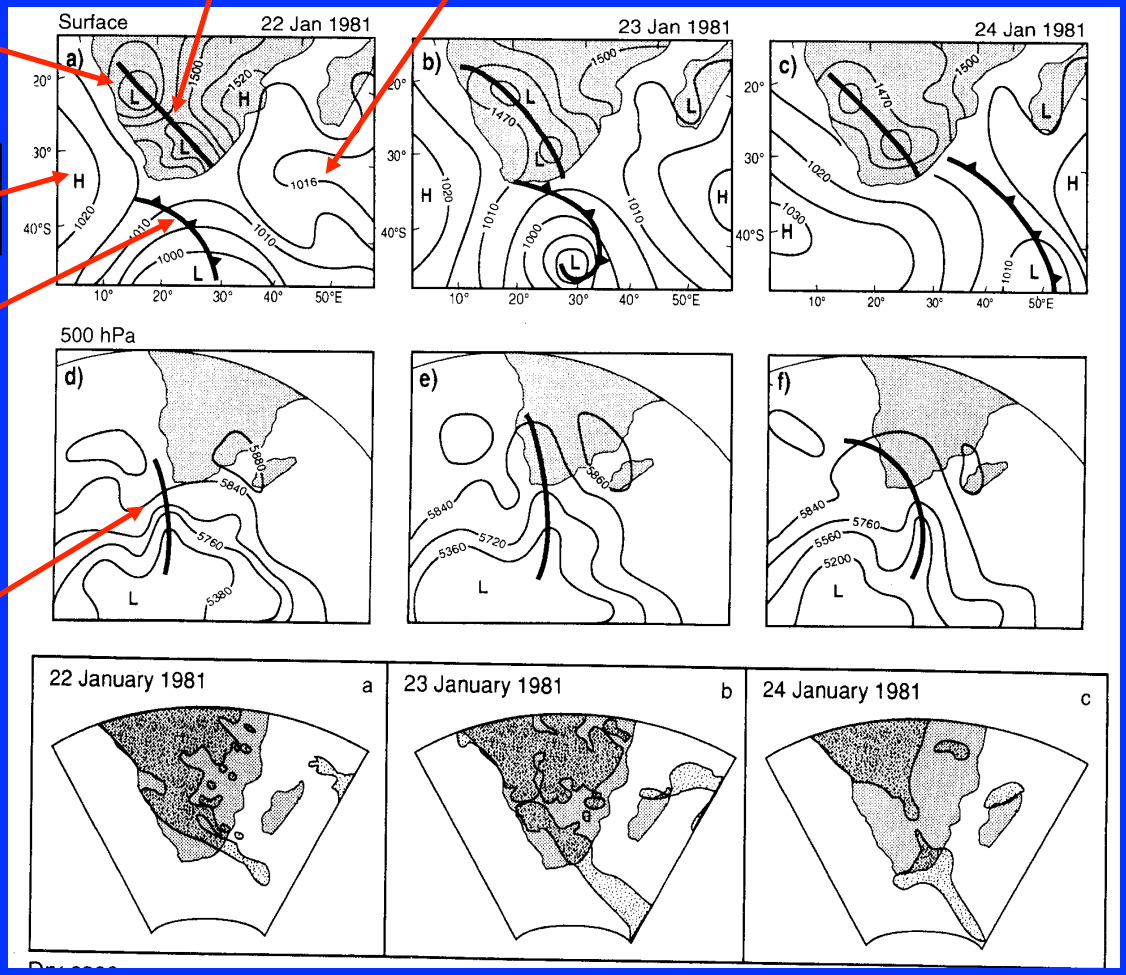
South Indian Anticyclone

Low

South Atlantic Anticyclone

Cold Front

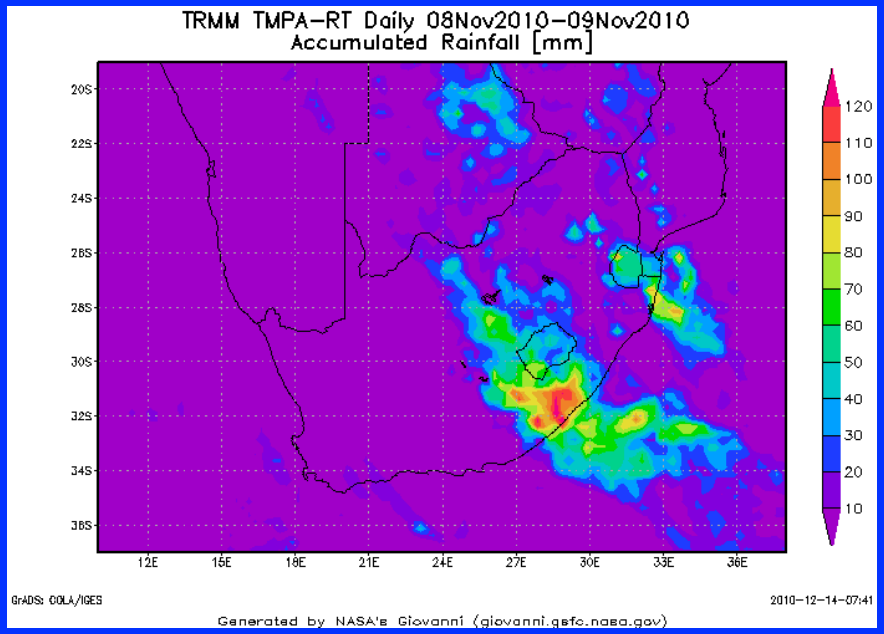
Westerly wave



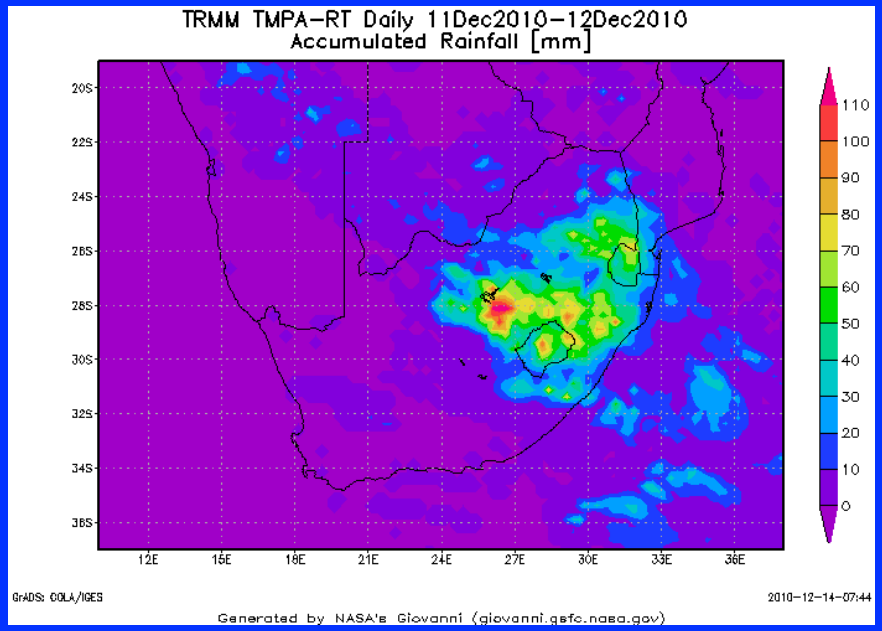
Van den Heever et al. (1997)

Two recent heavy rainfall events over South Africa

8-9 November 2010



11-12 December 2010



Case Study

Two extreme rainfall events:

(i) 31 December 1997 - 2 January 1998

(ii) 5 January 1998 – 7 January 1998

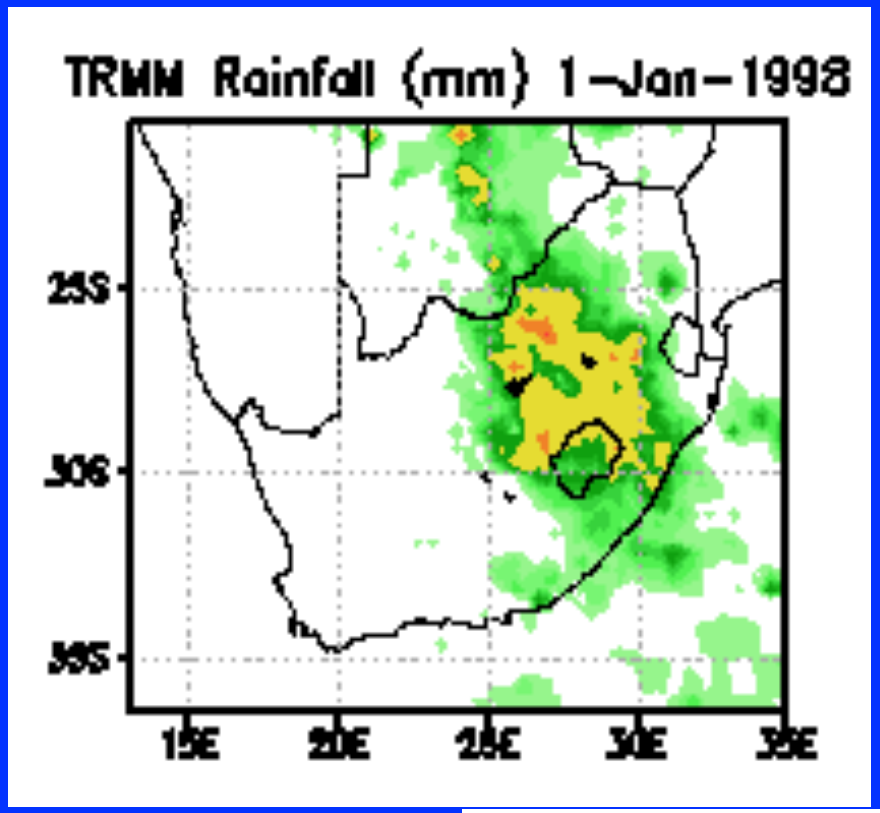
(Chosen based on study by Hart et al. 2010)

Successive two events with in the 10 days period caused heavy rainfall over many parts of South Africa.

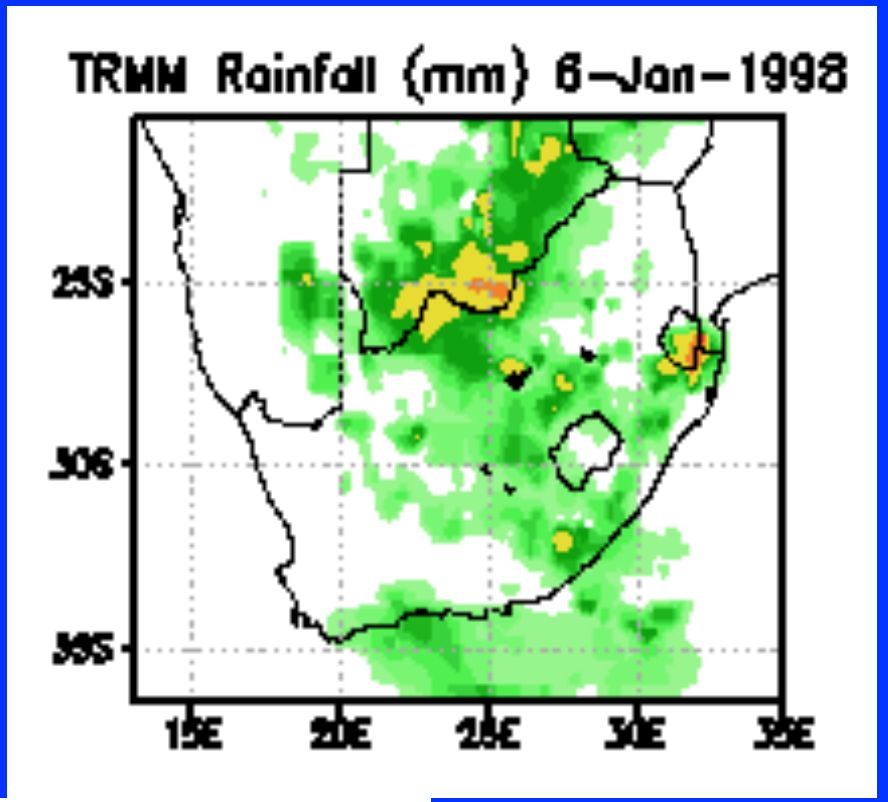
This wet spell contributed to 40 % of NDJF (1997/1998) rainfall for South Africa.

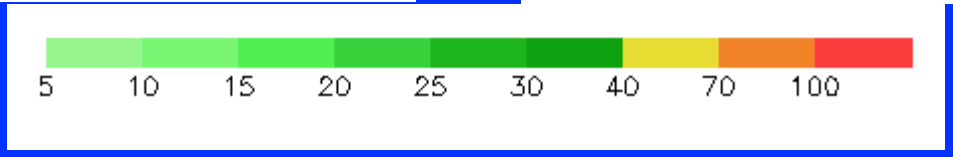
Rainfall during TTT events

31 December 1997 - 2 January 1998



5 January 1998 – 7 January 1998

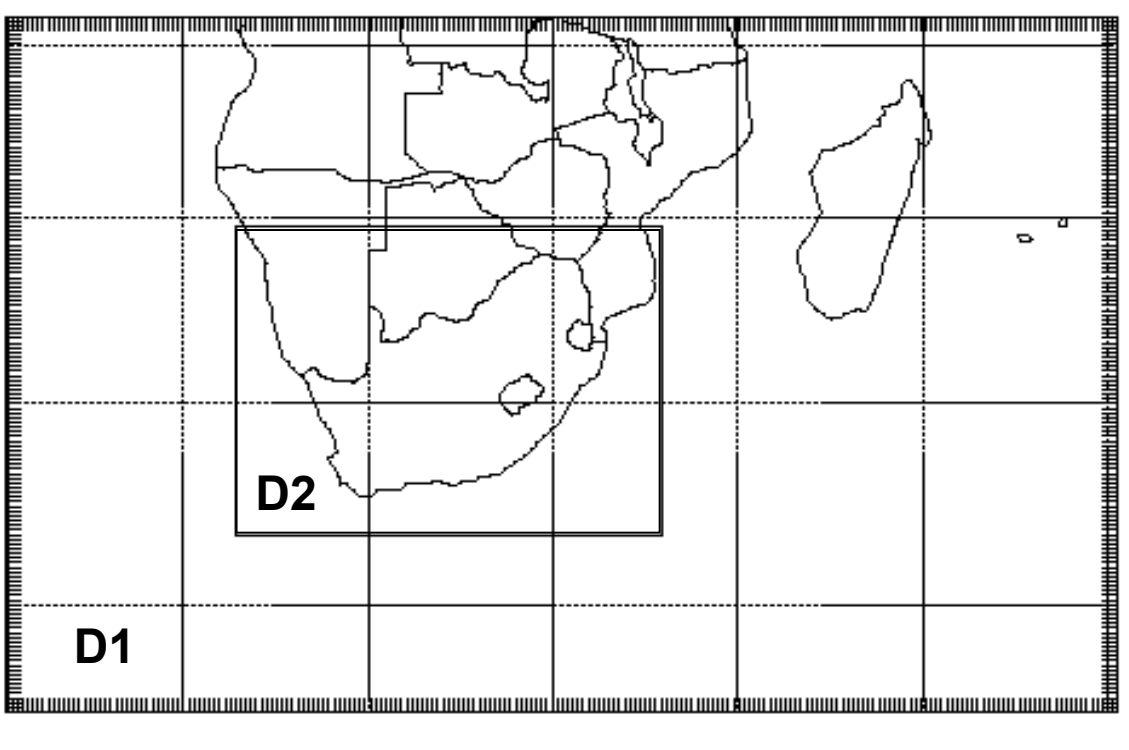




Model Configuration

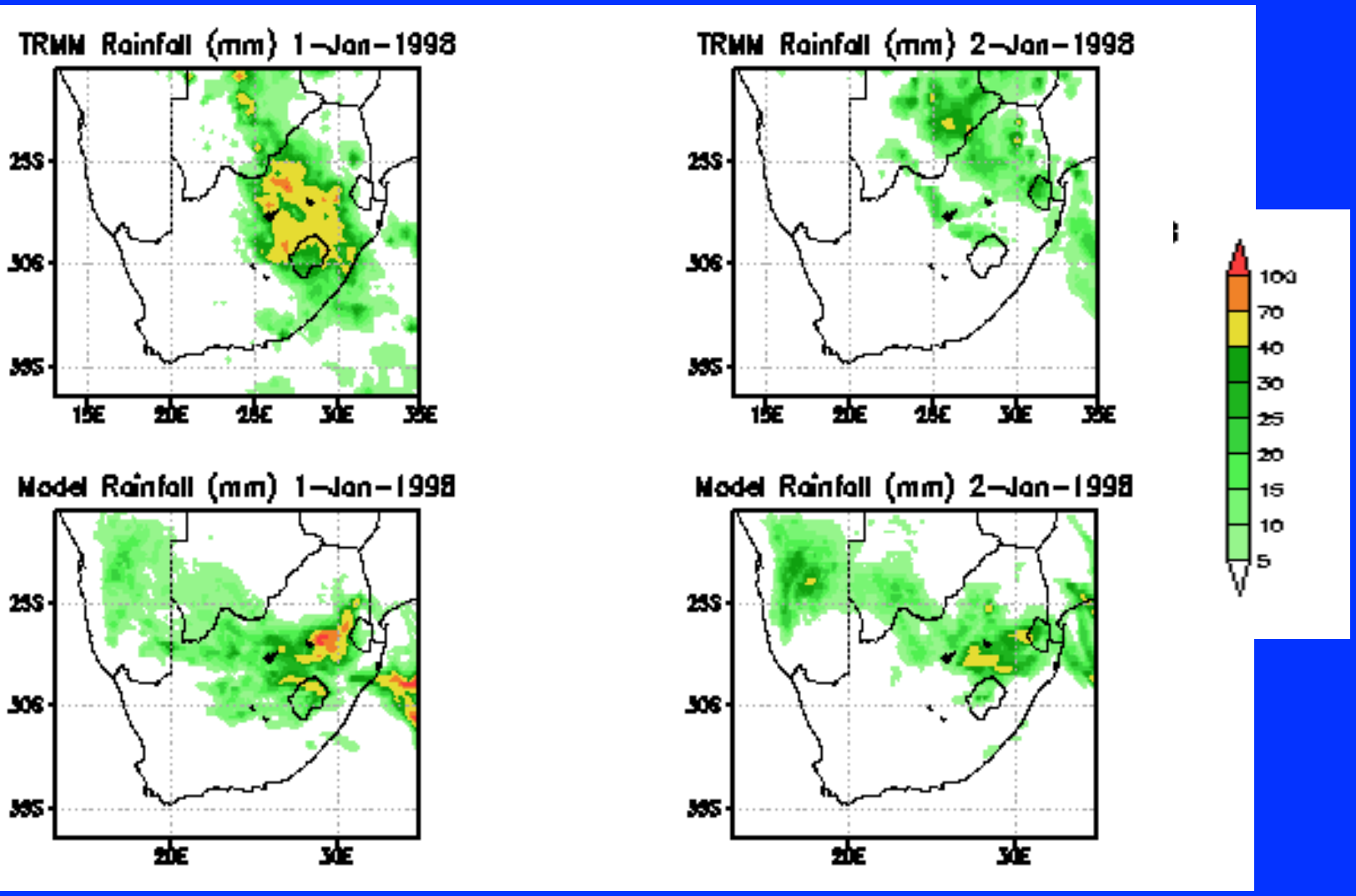
Model:	WRF v3.2.1
Domain:	2-way interactive two nested domain (27 km, 9 km)
Simulation Period:	00 UTC 30 December – 00 UTC 9 January 2002
Initial boundary condition:	NCEP Reanalysis2
Model Physics	
Convection	Kain-Fritsch
Microphysics	Simple Ice WSM-3 class
PBL	YSU scheme
Land Surface	Noah
Radiation	Short wave (Dudhia); Long wave (RRTM)

Model Domain

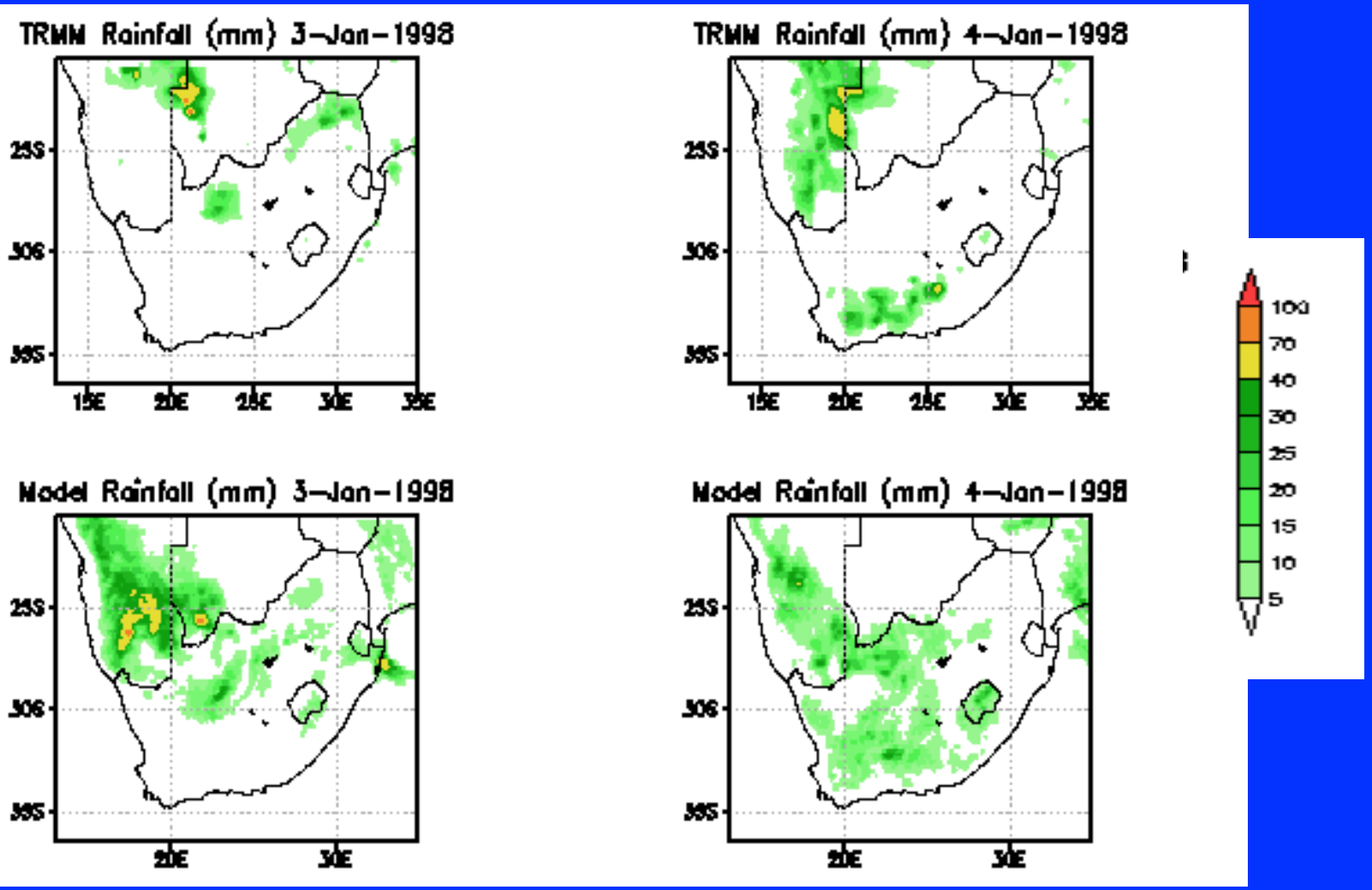


Domain	D1	D2
Horizontal resolution	27 km	9 km
Grid point (E-W)	215	247
Grid point (N-S)	150	199
Topography resolution	30 s	30 s

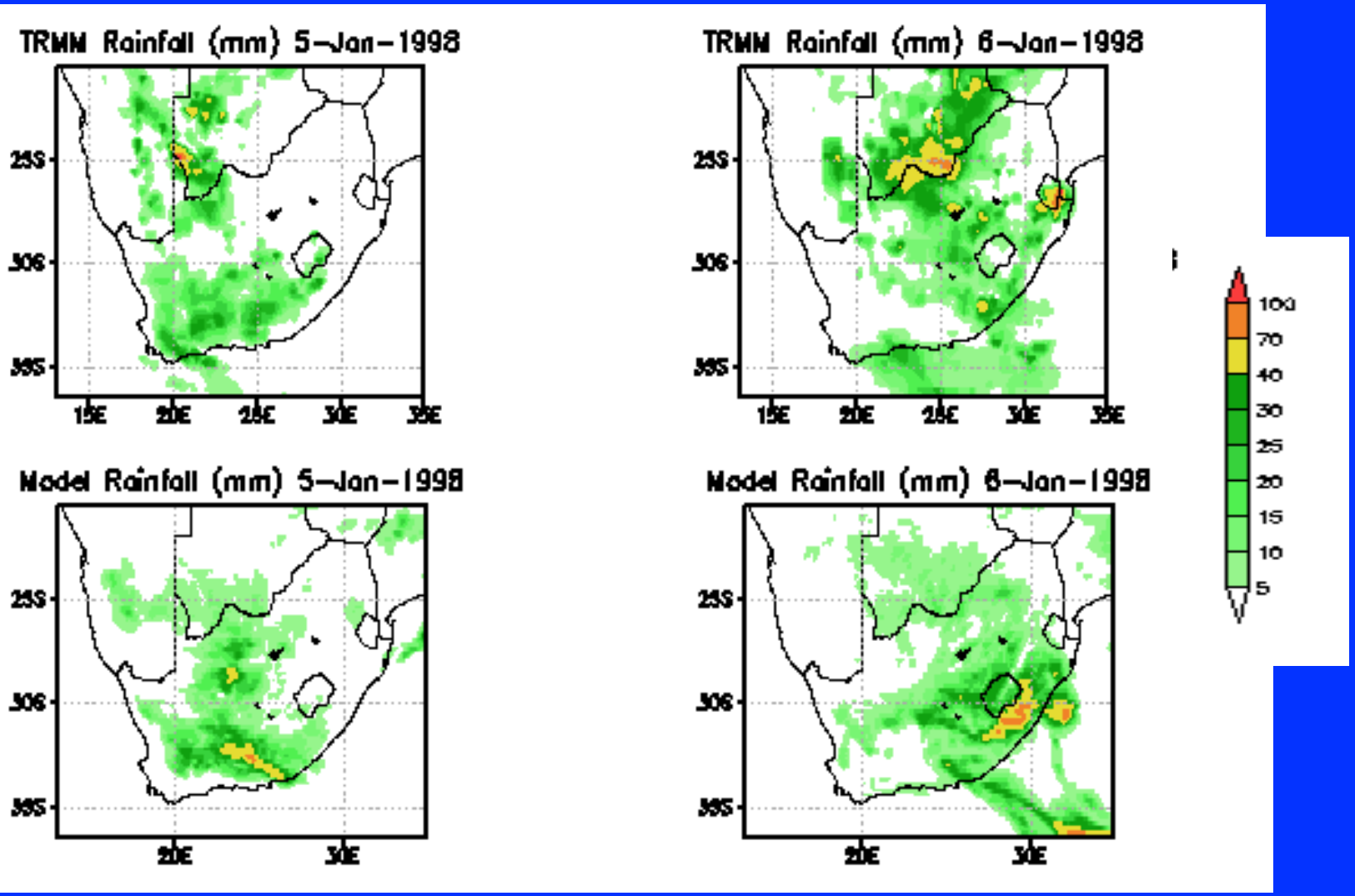
Model (9 km) simulated and TRMM rainfall (mm)



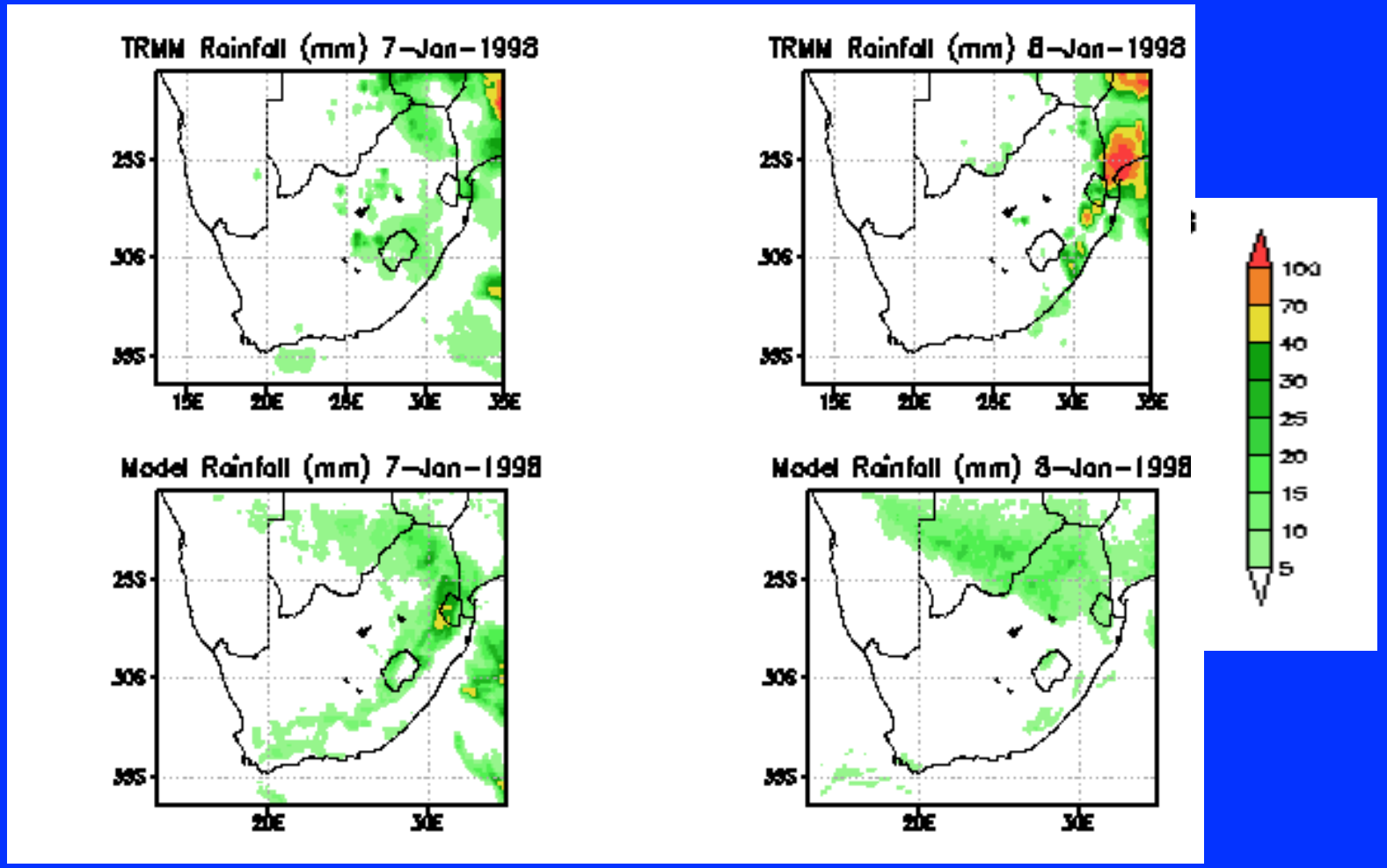
Model (9 km) simulated and TRMM rainfall (mm)



Model (9 km) simulated and TRMM rainfall (mm)

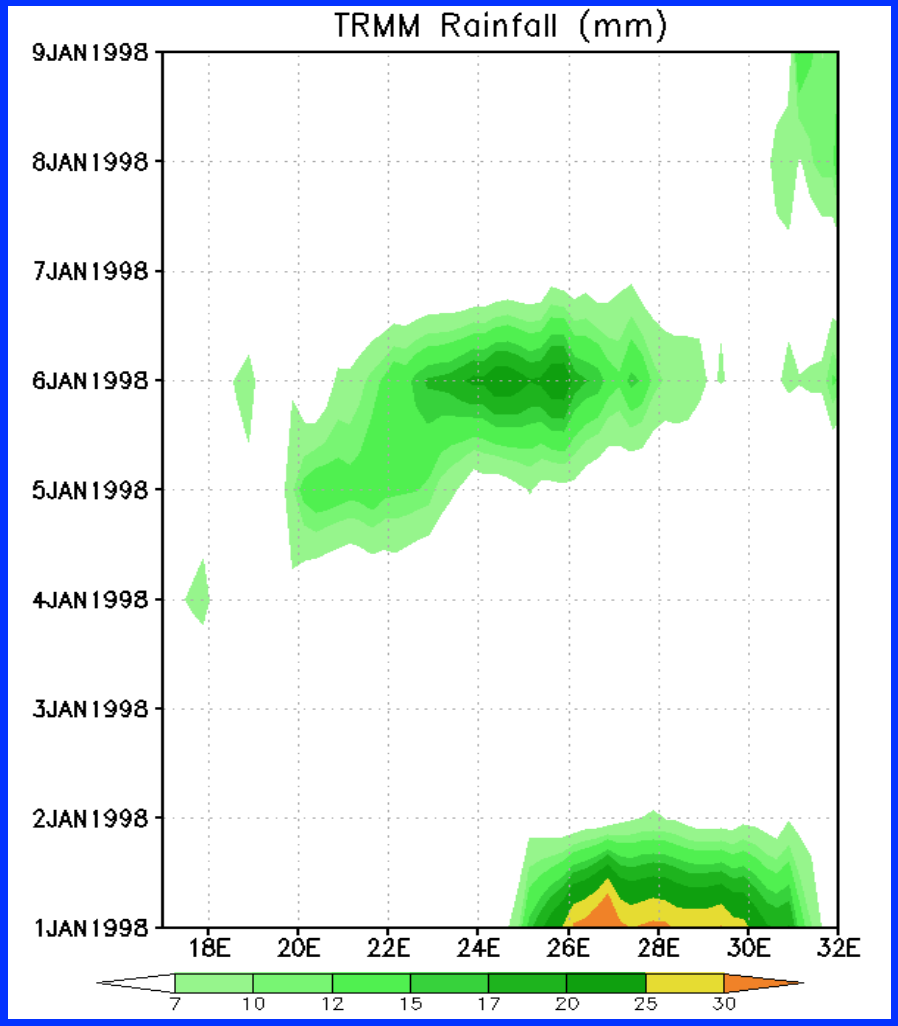


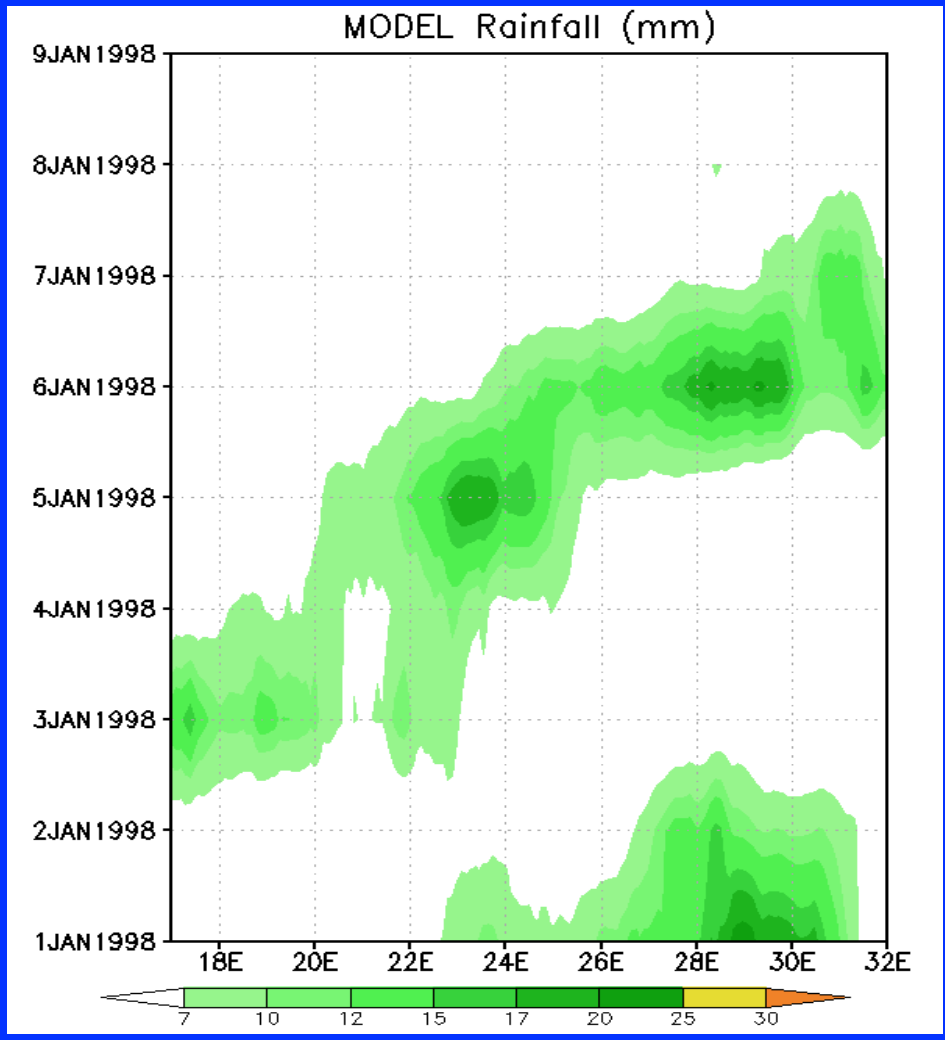
Model (9 km) simulated and TRMM rainfall (mm)



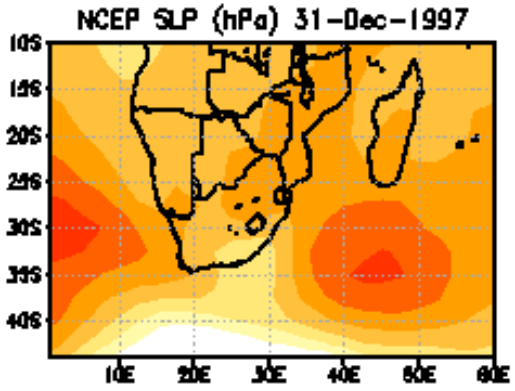
Model (9 km) simulated and TRMM rainfall (mm)

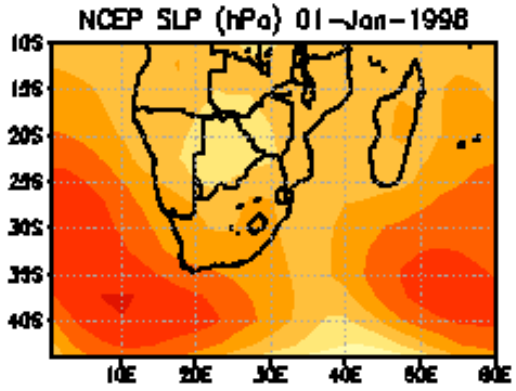
(Averaged over South Africa Latitudes)

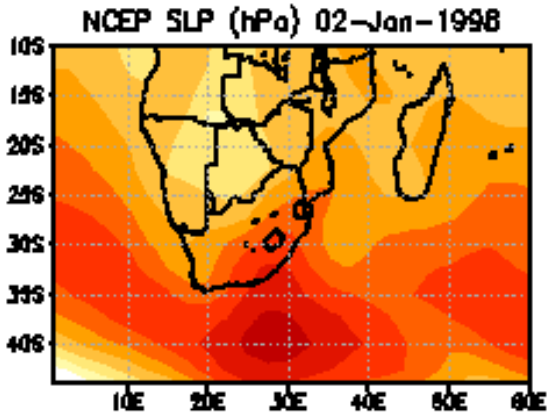


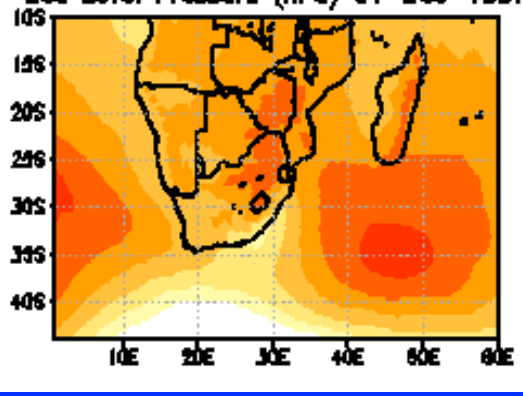


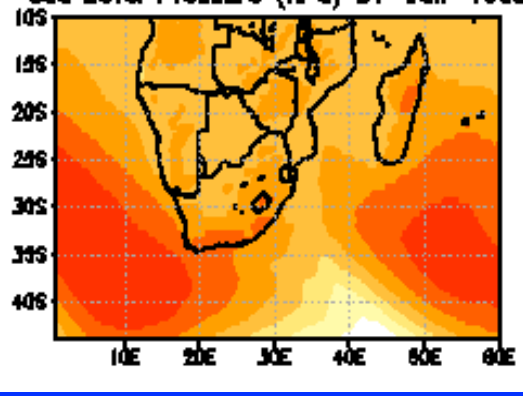
Sea Level Pressure (hPa)

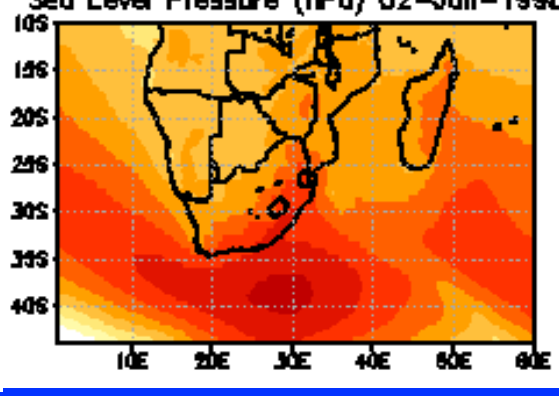




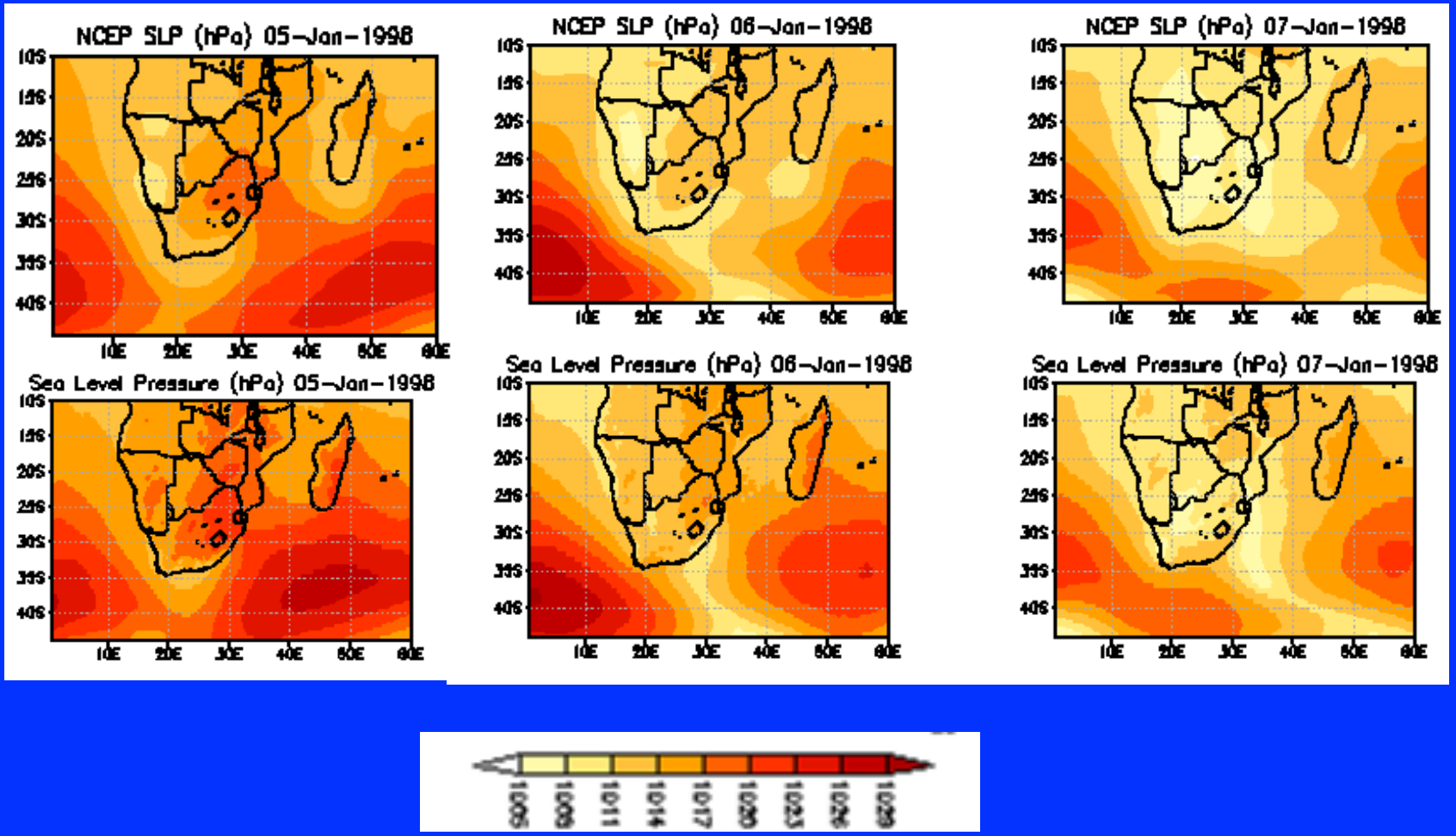




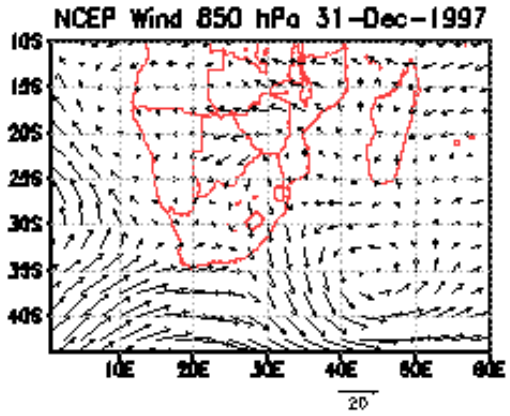


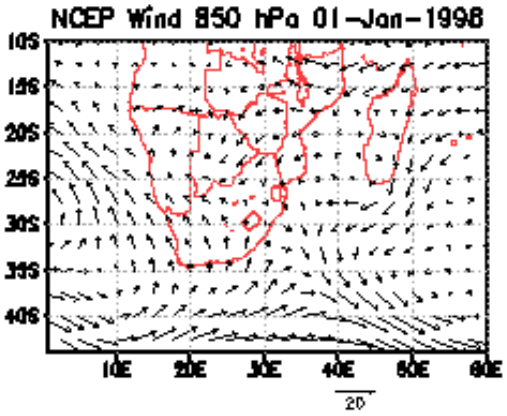


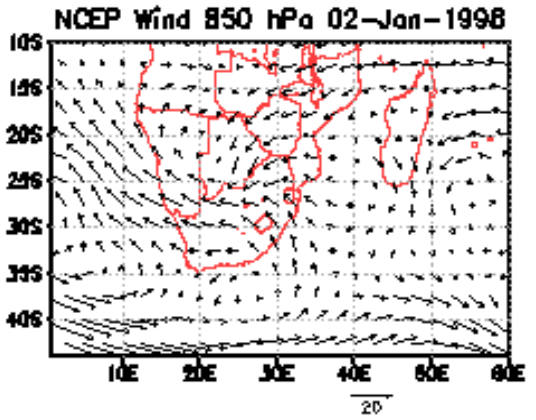
Sea Level Pressure (hPa)

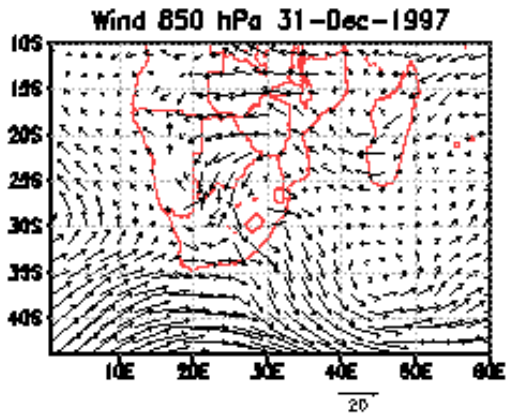


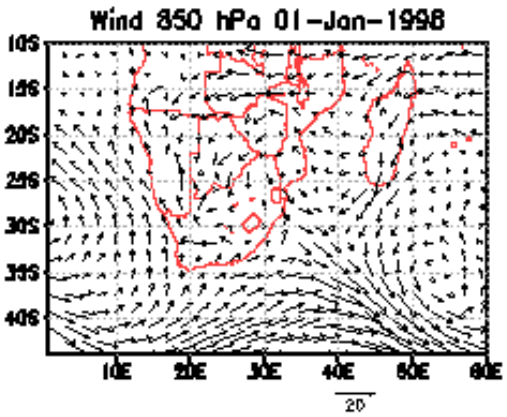
Wind (m/s) 850 hPa

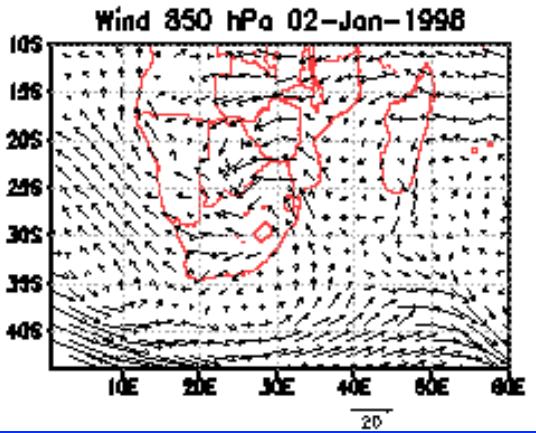




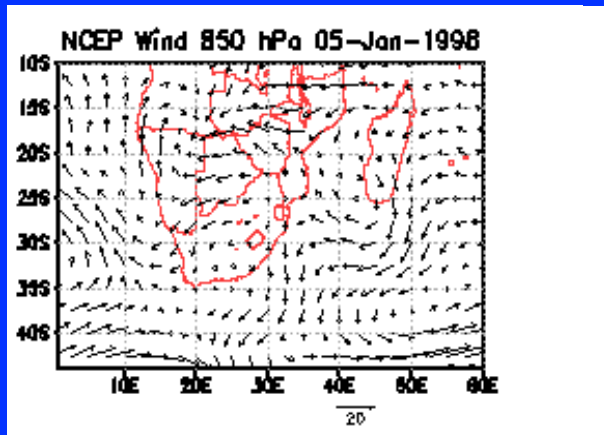


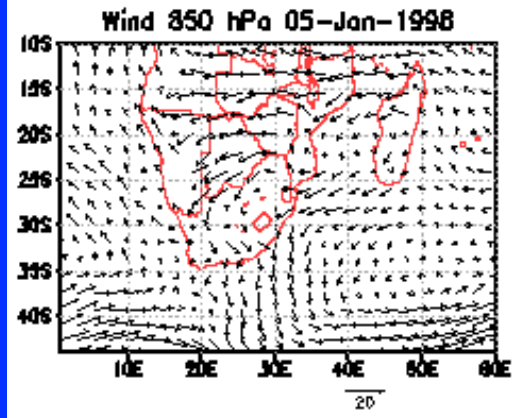


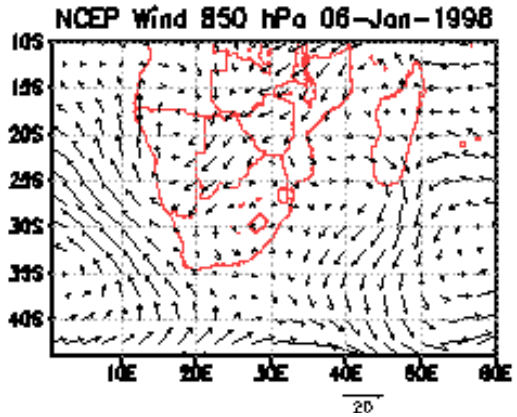


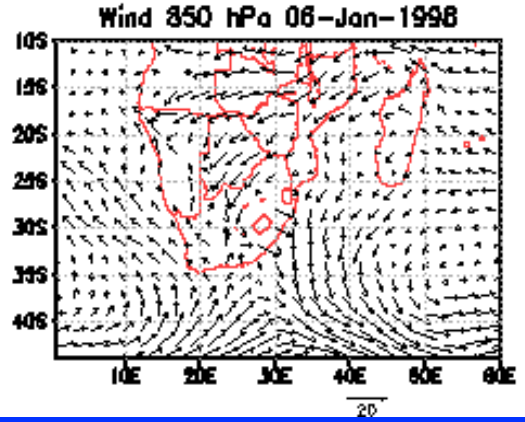


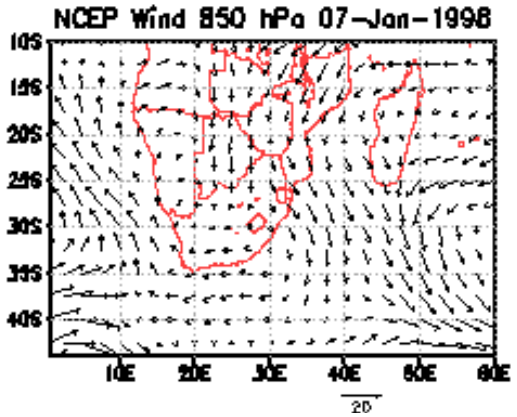
Wind (m/s) 850 hPa

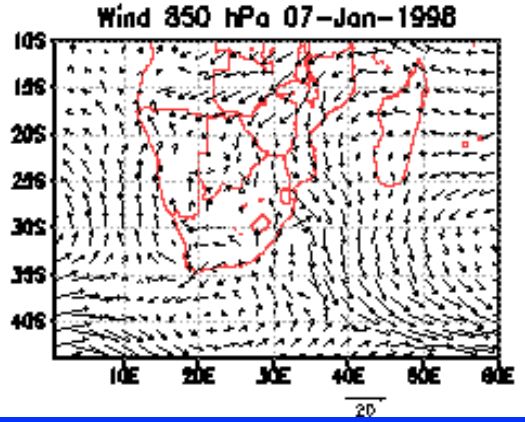




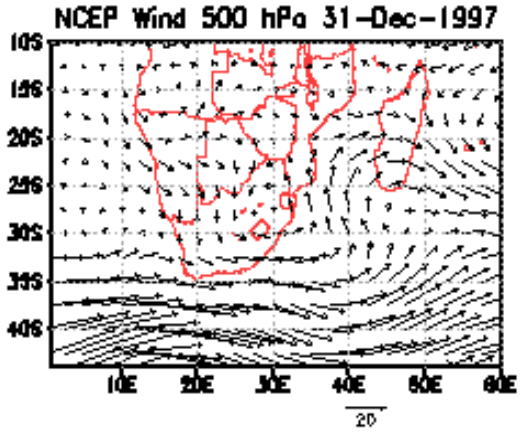


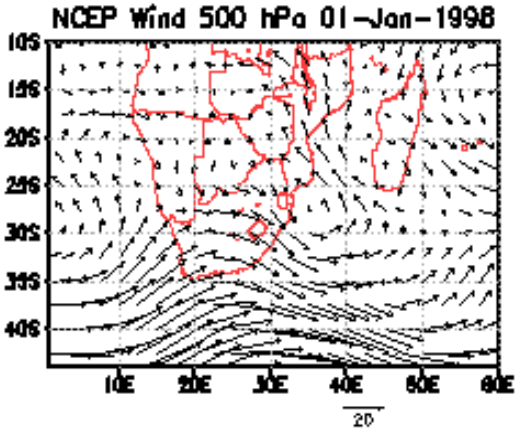


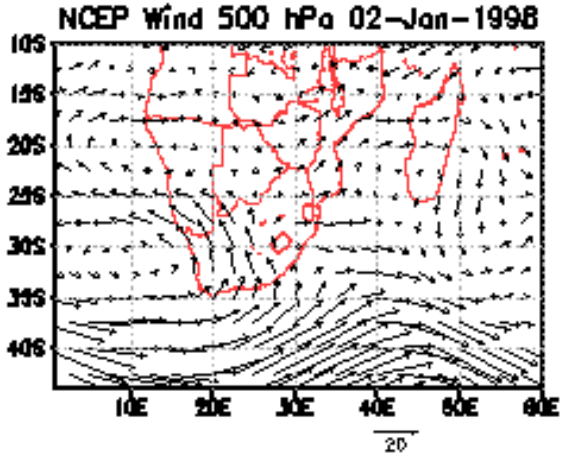


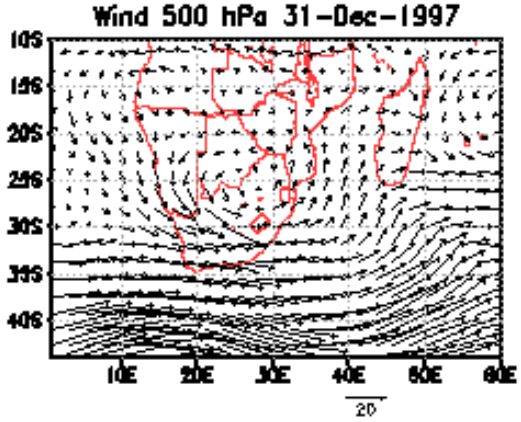


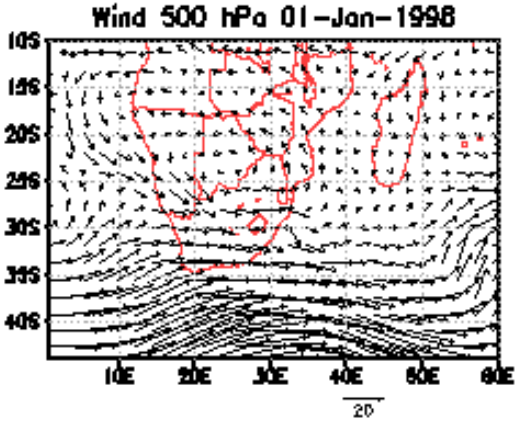
Wind (m/s) 500 hPa

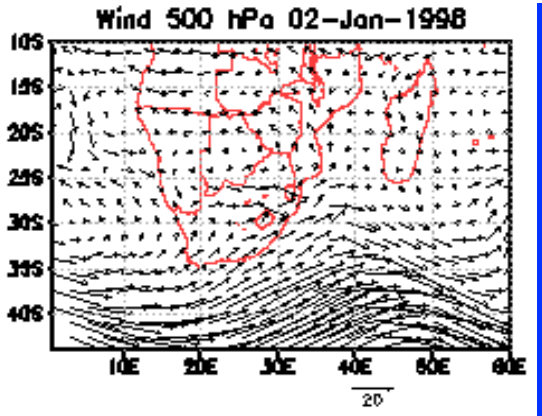




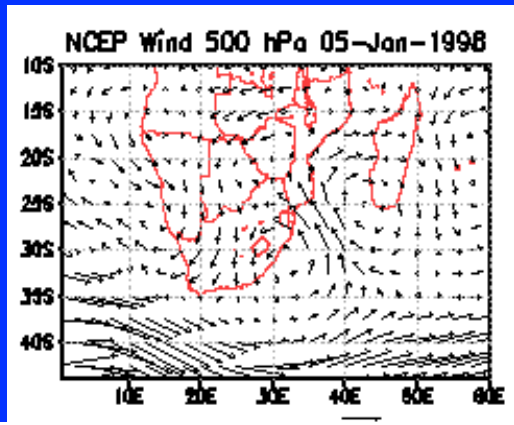


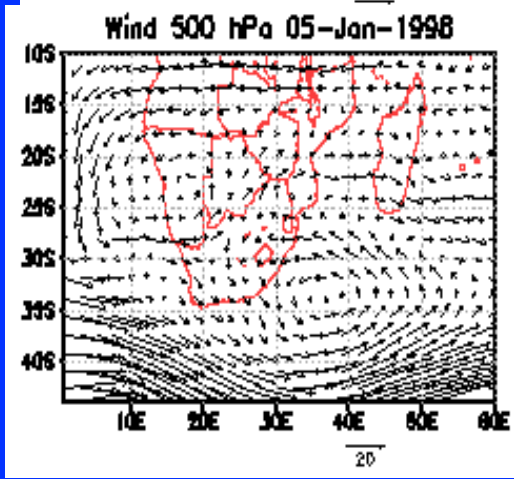


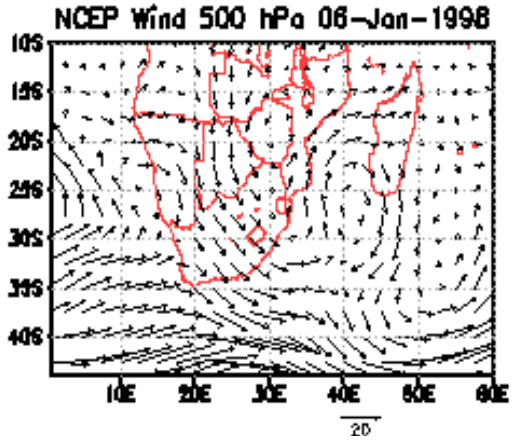


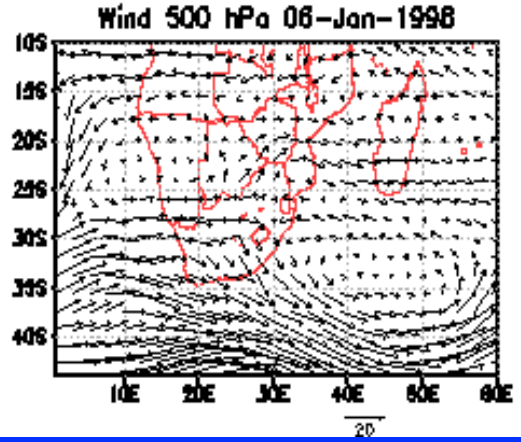


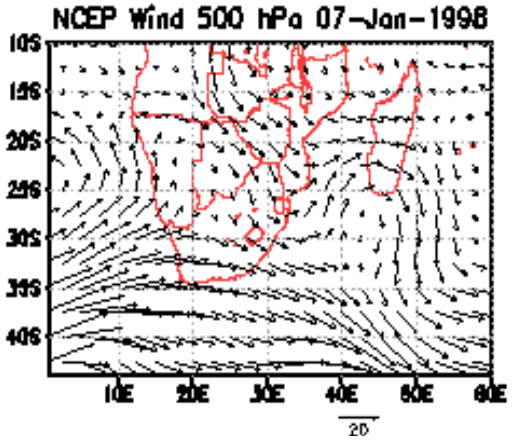
Wind (m/s) 500 hPa

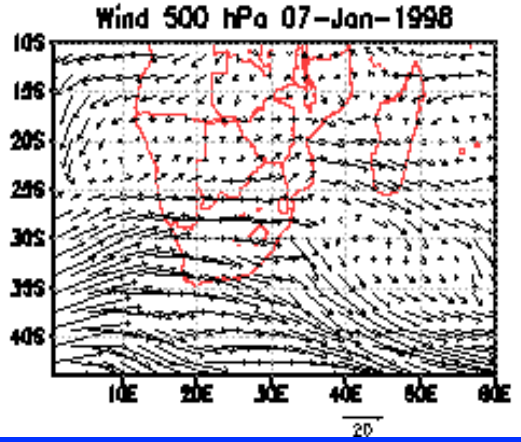




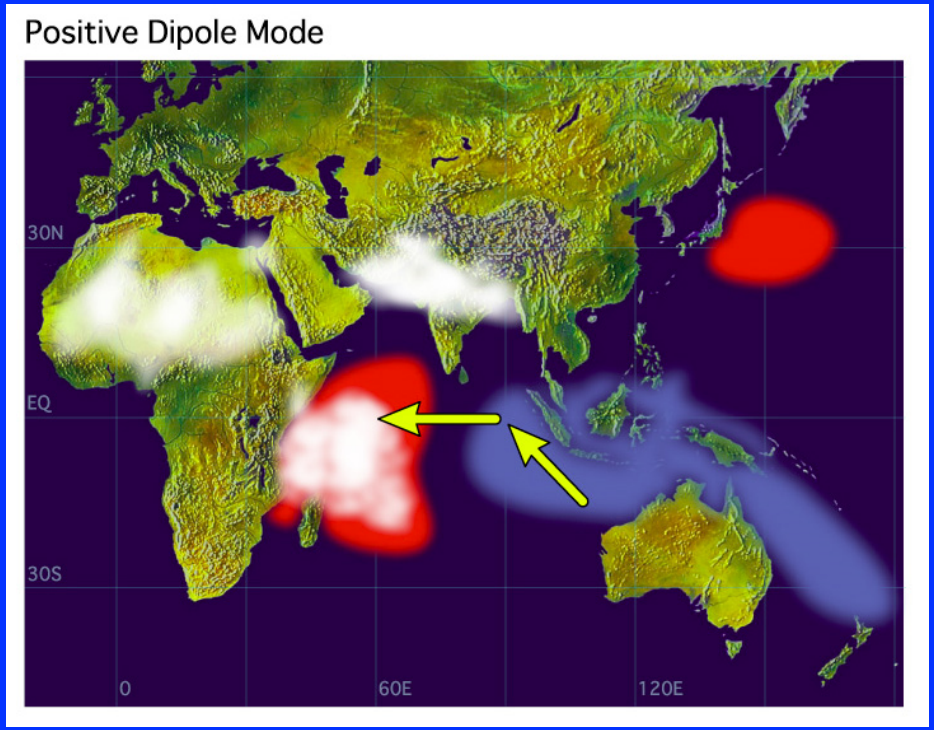


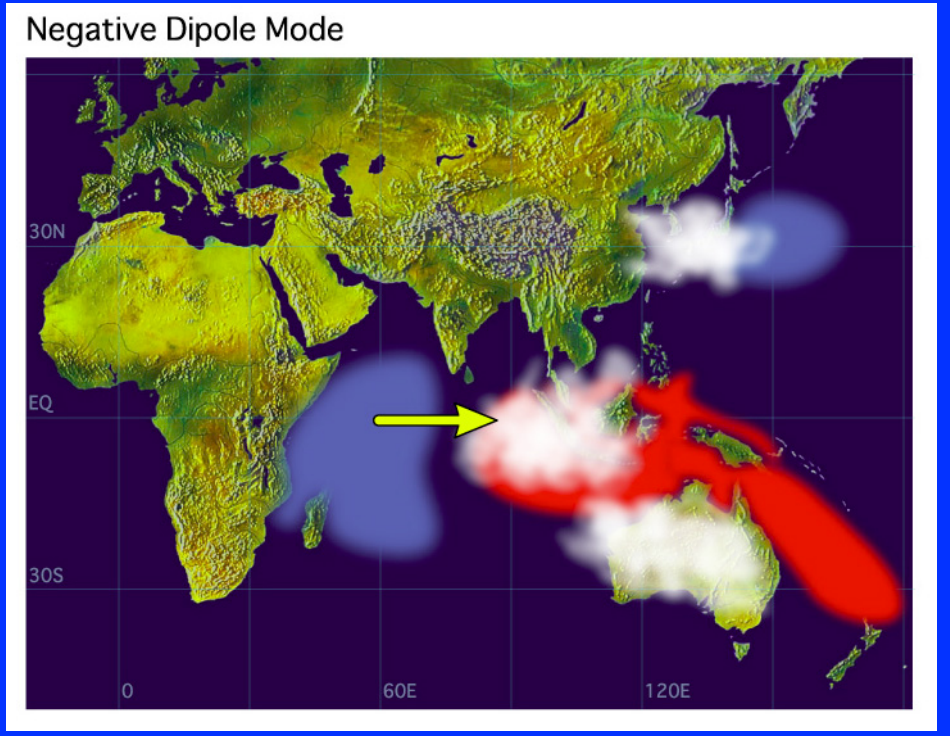




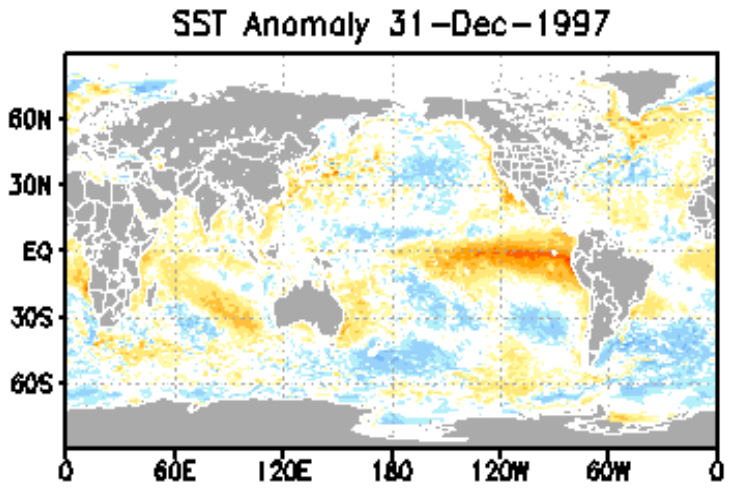


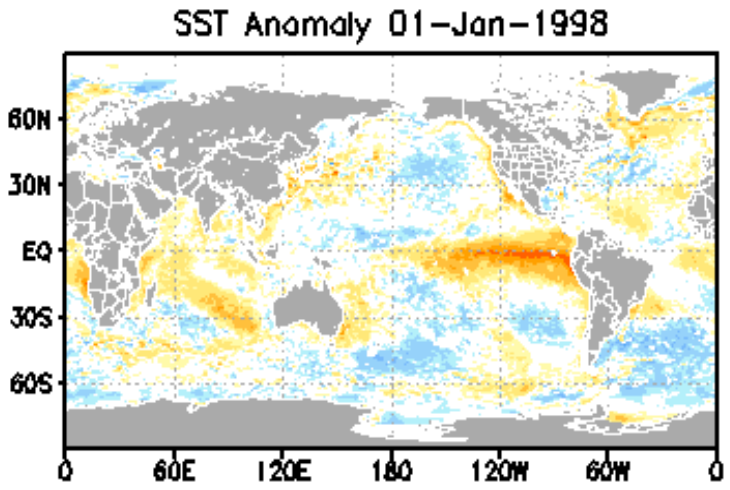
Indian Ocean Dipole

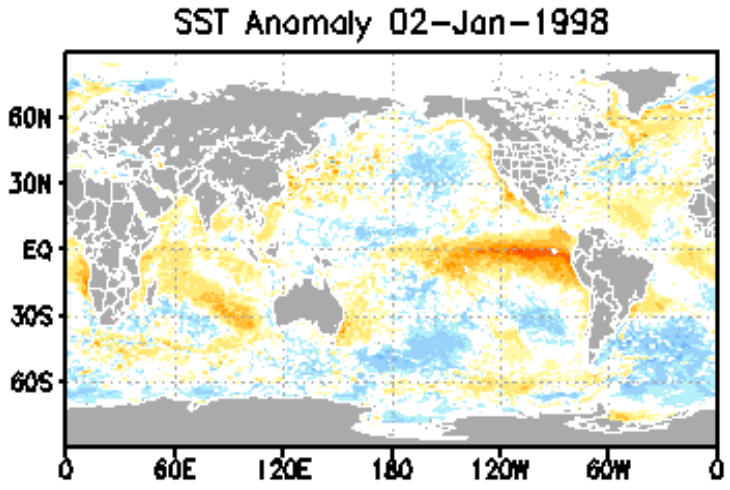


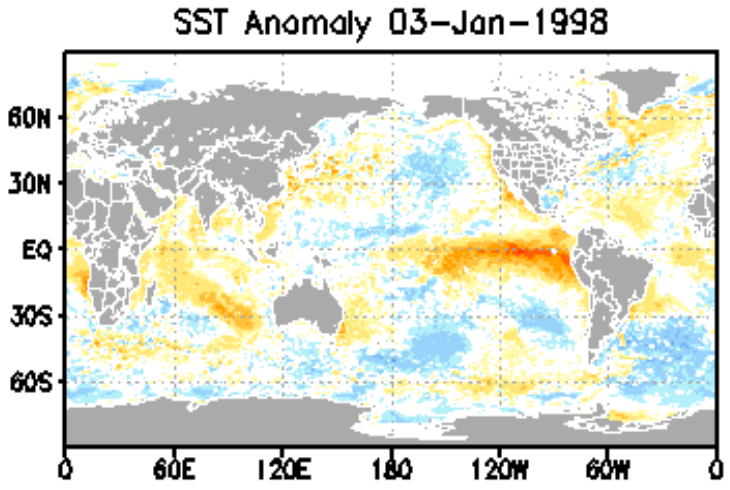


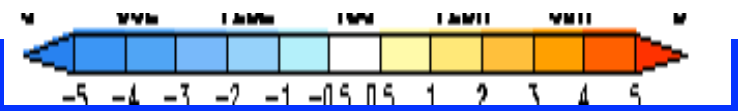
SST Anomaly


SST Anomaly 31-Dec-1997
60N
30N
EQ
30S
60S
0
60E
120E
180
120W
60W
0

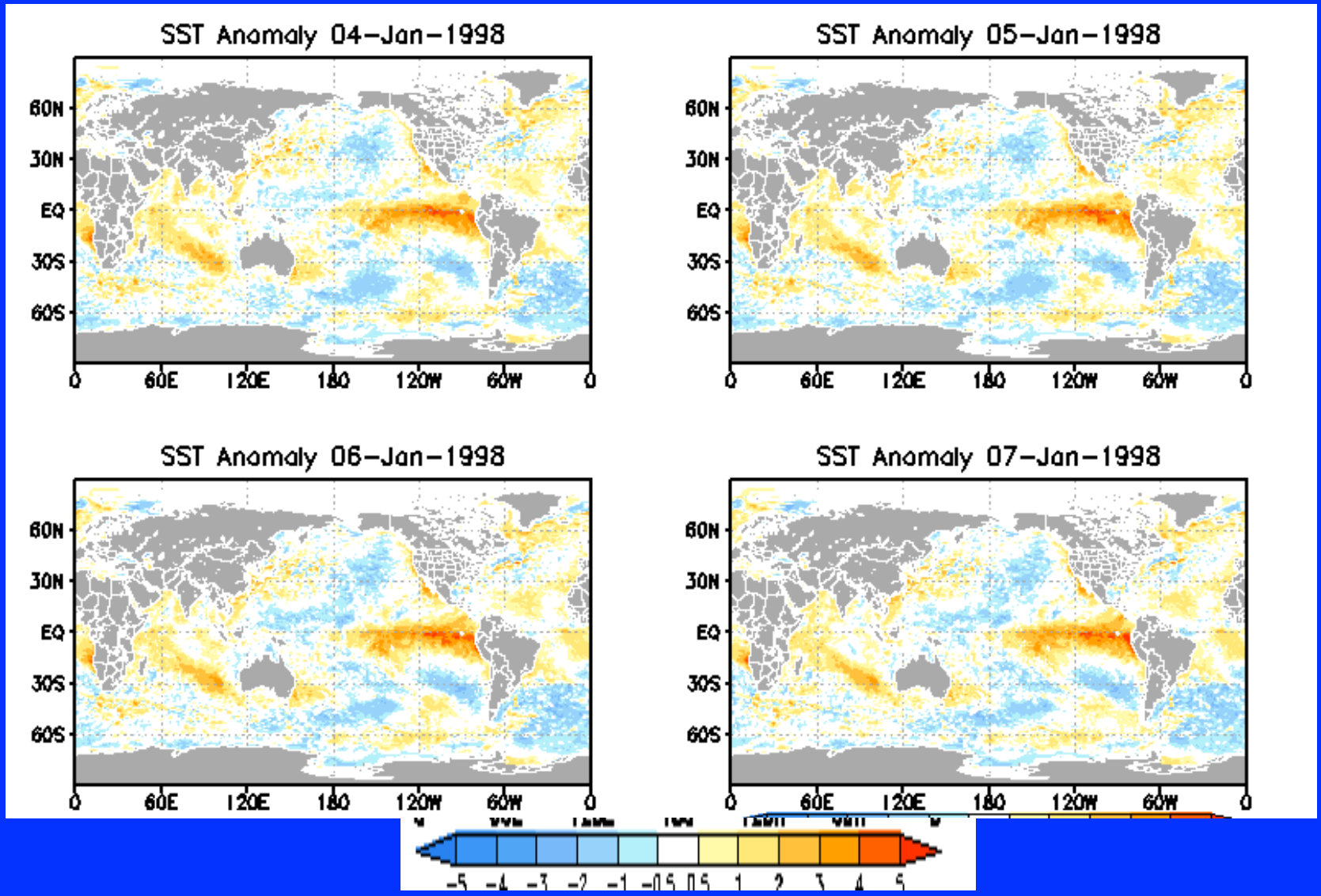

SST Anomaly 01-Jan-1998
60N
30N
EQ
30S
60S
0
60E
120E
180
120W
60W
0


SST Anomaly 02-Jan-1998
60N
30N
EQ
30S
60S
0
60E
120E
180
120W
60W
0


SST Anomaly 03-Jan-1998
60N
30N
EQ
30S
60S
0
60E
120E
180
120W
60W
0

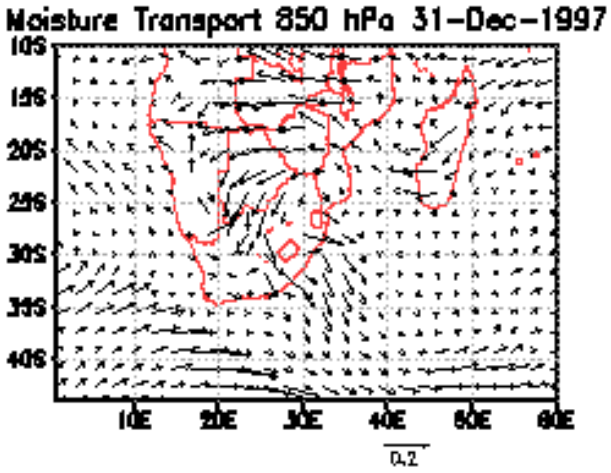

-5
-4
-3
-2
-1
-0.5
0.5
1
2
3
4
5

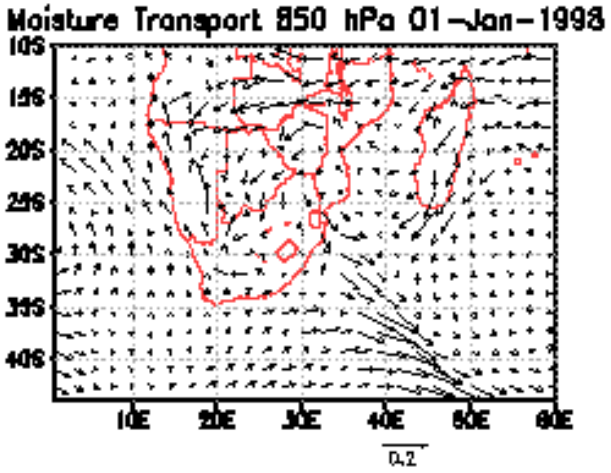
SST Anomaly

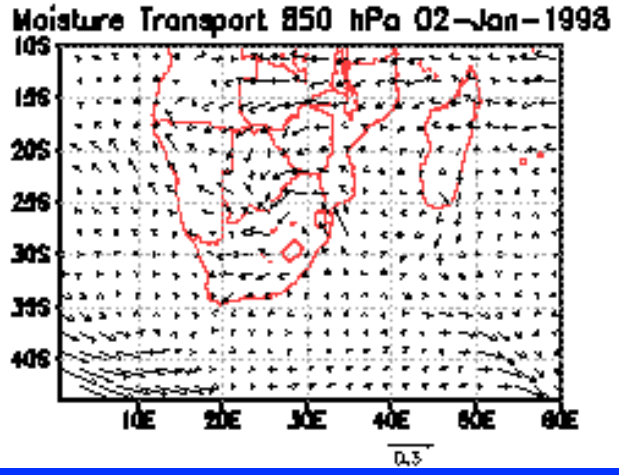

SST Anomaly 04-Jan-1998
SST Anomaly 05-Jan-1998
SST Anomaly 06-Jan-1998
SST Anomaly 07-Jan-1998
60N
30N
EQ
30S
60S
0
60E
120E
180
120W
60W
-5
-4
-3
-2
-1
-0.5
0.5
1
2
3
4
5

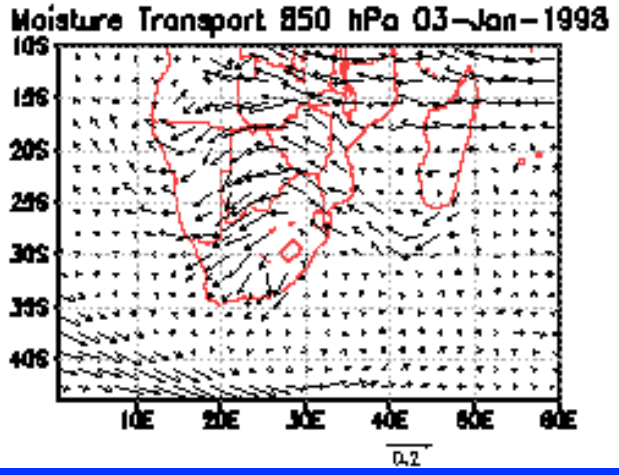
Model simulated

Moisture Transport (g $kg^{-1}s^{-1}$) 850 hPa



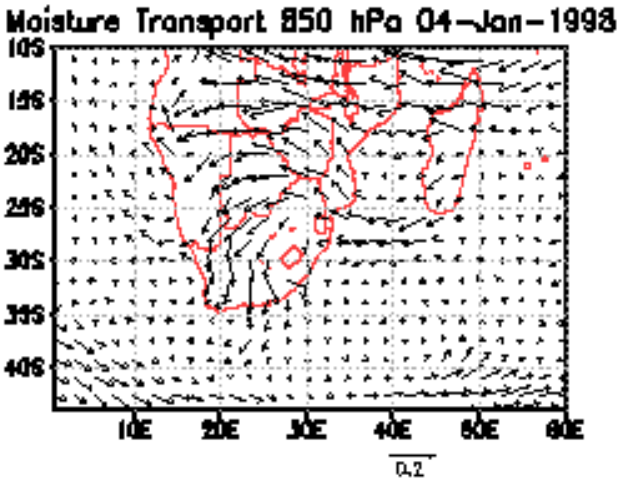


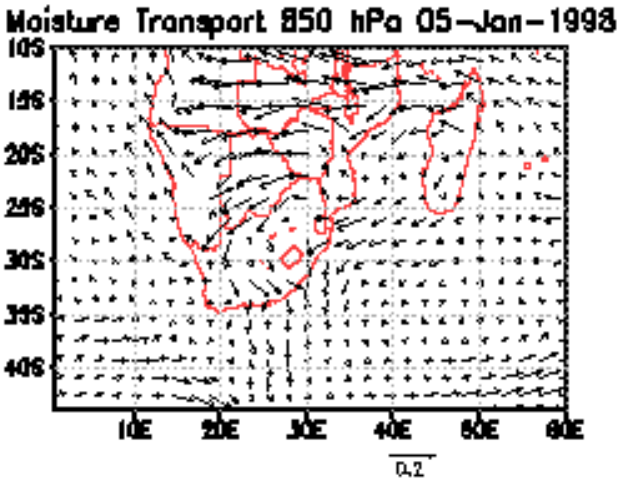


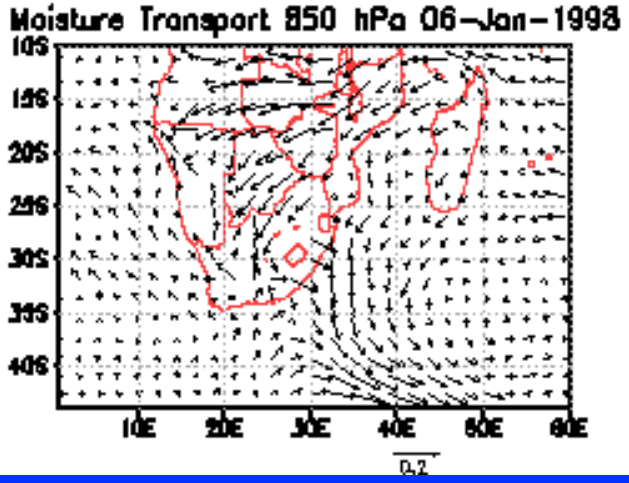


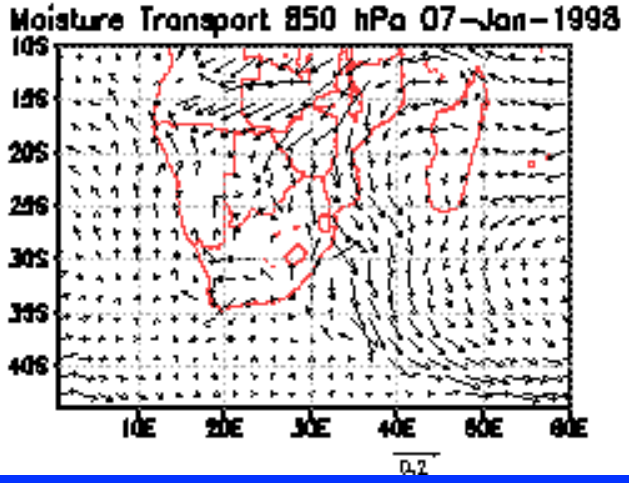
Model simulated

Moisture Transport (g $kg^{-1}s^{-1}$) 850 hPa









Summary

WRF model is able to reproduce the tropics-temperate link and associated rainfall over Southern Africa.

Model simulated active and weak phases of the rainfall system agrees well with the observations.

Thank You