School of Chemistry and Physics, University of KwaZulu-Natal, Durban, South Africa

Mesosphere-Lower Thermosphere (MLT) planetary and tidal waves structure over Southern Hemisphere using Super DARN HF radar using SANAE radar (72°S, 3°W)

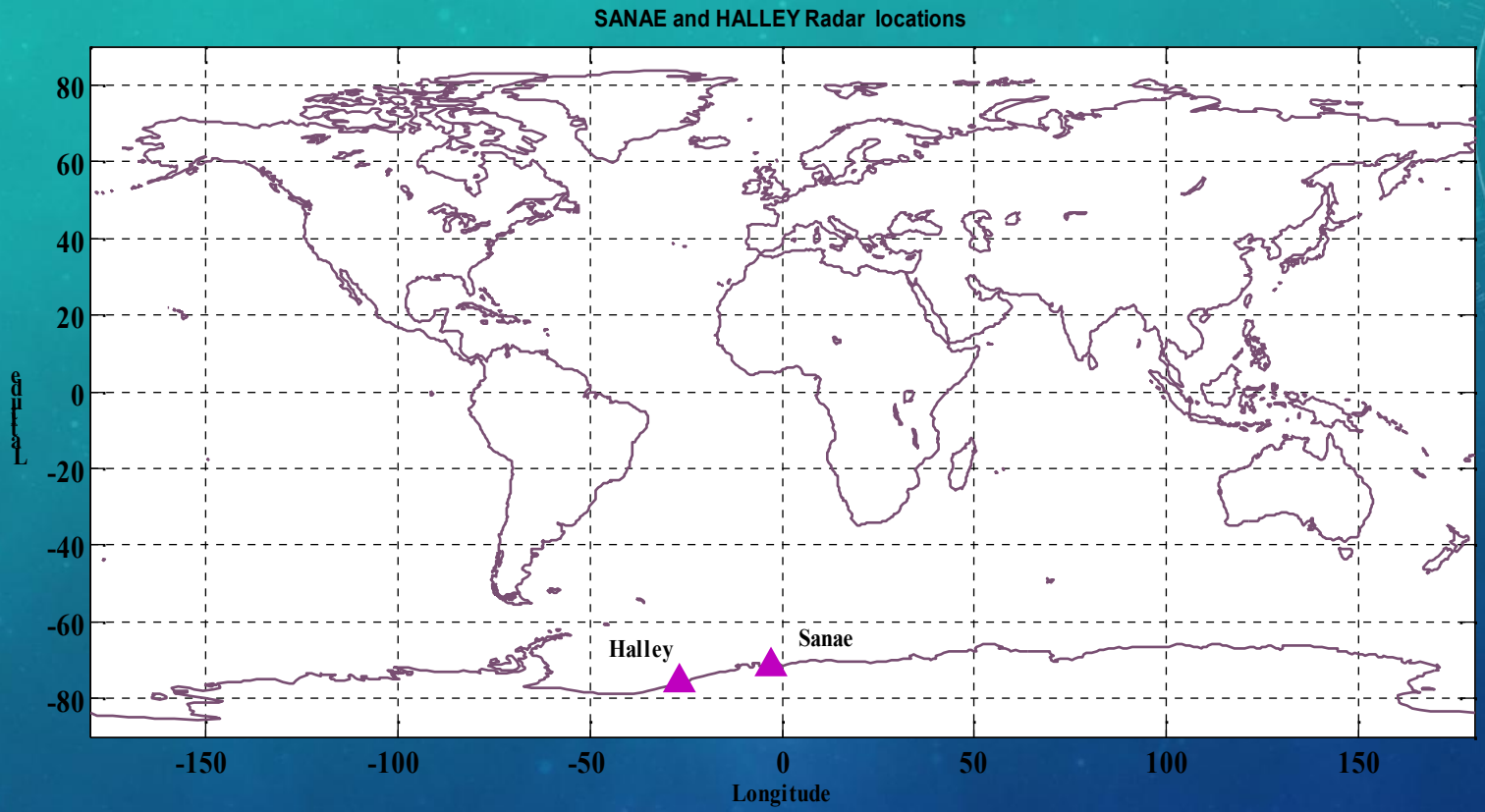
By Perfect Chifoto

Email:perfectpeechifoto@gmail.com

Supervisor: Prof. Sivakumar Venkataraman

Co-supervisor: Dr. Nkanyiso .B Mbatha

Instrumentation



HALLEY (-75.52, -26.63)

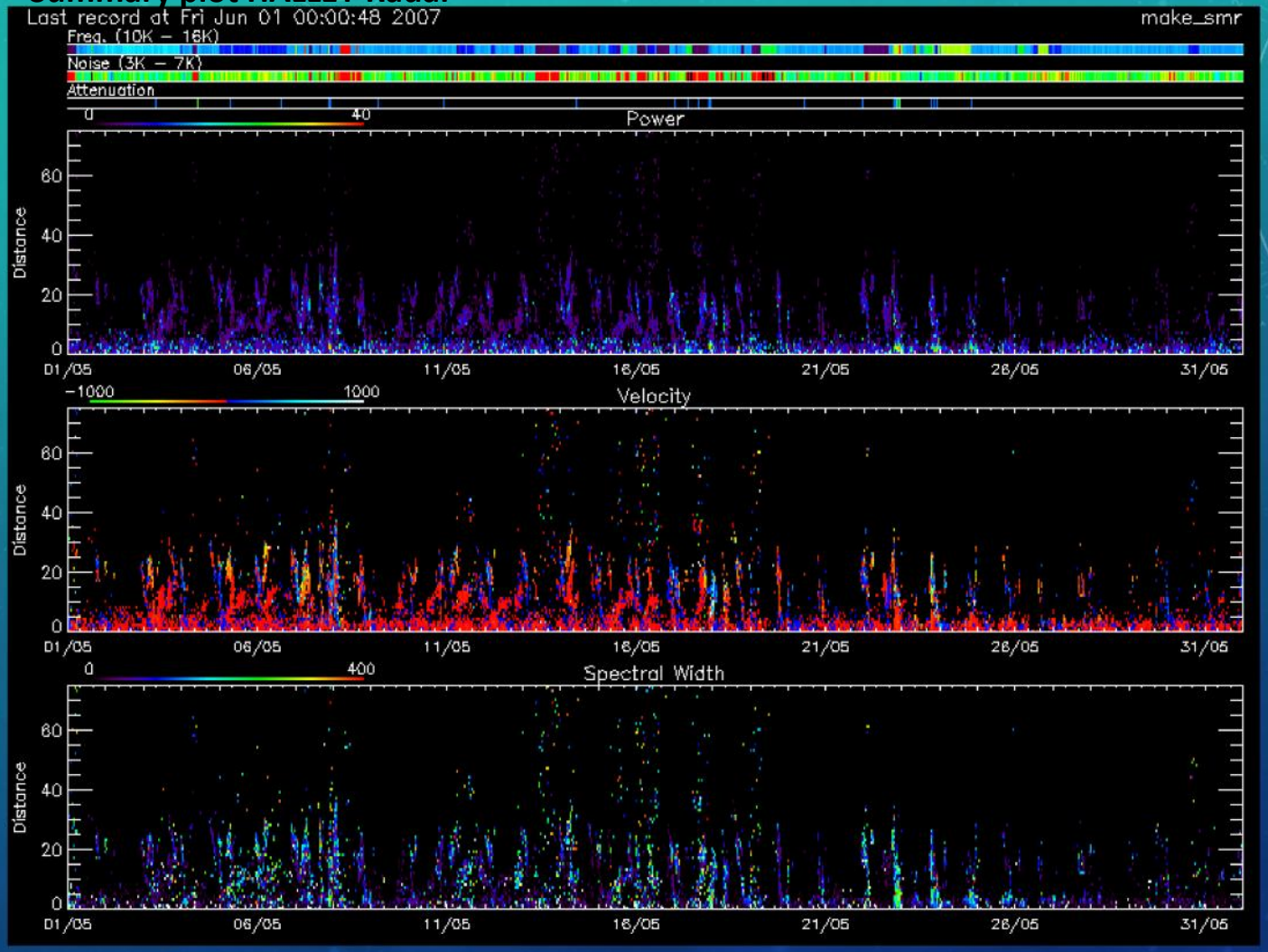
SANAE (-71.68, -2.85)

Instrumentation

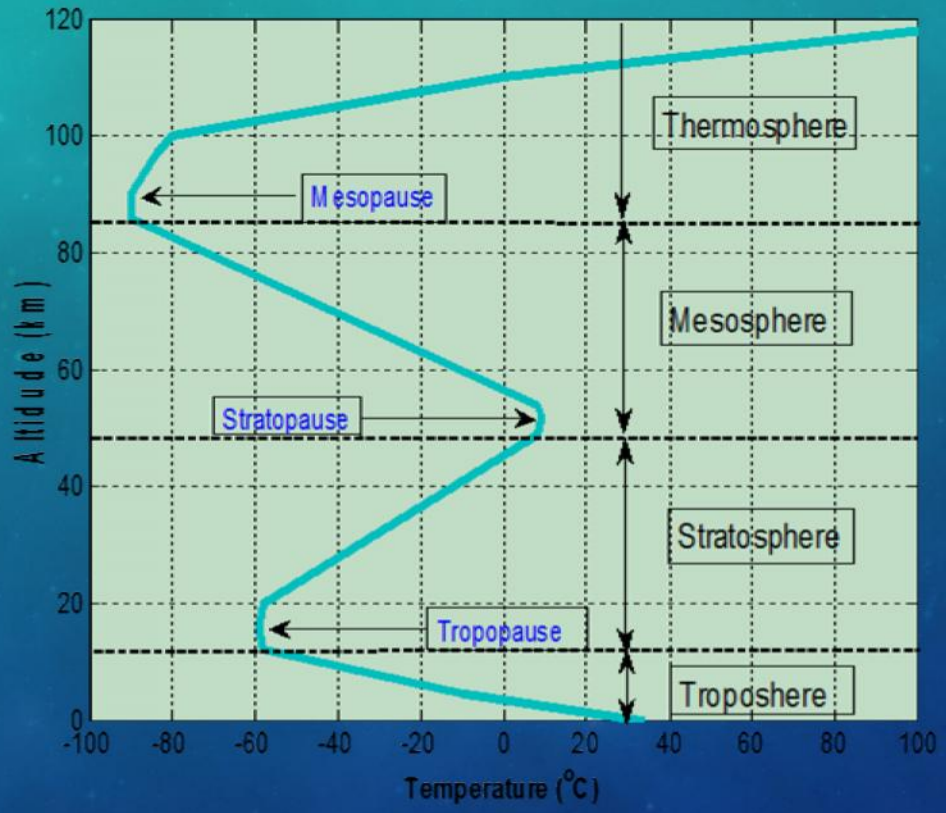
South African National Antarctic Expedition (**SANAE**), (72°S, 3°W) is part of the SuperDARN HF Radar network [Greenwald et al., 1995]

- originally designed to study plasma flow in the high-latitude ionosphere
- It was confirmed that echoes at ranges close to the SuperDARN radars are actually due to scatter from meteor trails near approximately 94 km altitude except periods of high geomagnetic disturbance
- operate at frequencies between 8 and 20 MHz

Summary plot HALLEY Radar



Temperature Profile



BACKGROUND

Planetary waves

- Arise when wind flows over continental scale topography, by continent-ocean heating contrasts, and by nonlinear interactions among transient tropospheric wave disturbances.
- Form in the troposphere around the equator and propagate upward into the stratosphere where they break and deposit momentum and move towards the poles.
- Interaction between planetary waves and the zonal mean flow is known to be the major driver of winter stratospheric dynamics (Andrews, 1987).

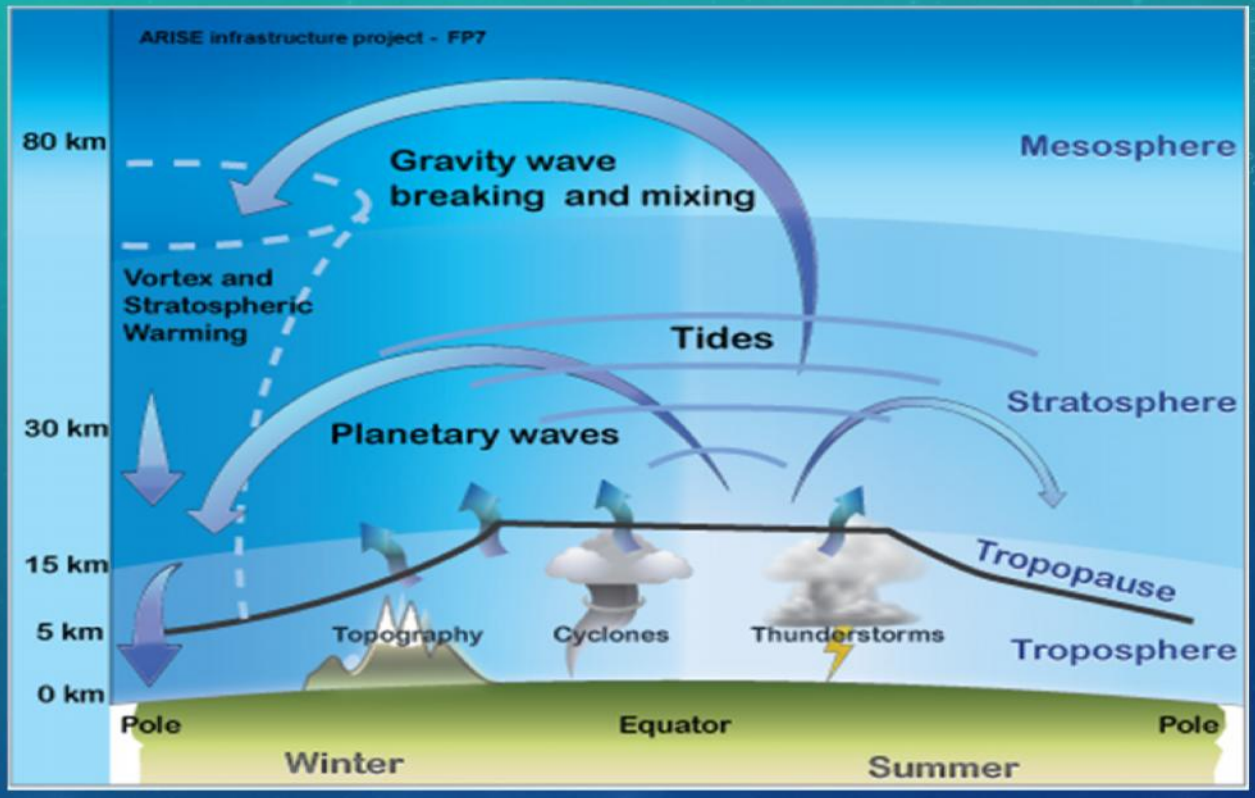
Tidal waves

- Generated because the atmosphere is periodically heated by the Sun.
- Separated into three types, namely (diurnal~24h, semidiurnal~12h tides and terdiurnal~8h).

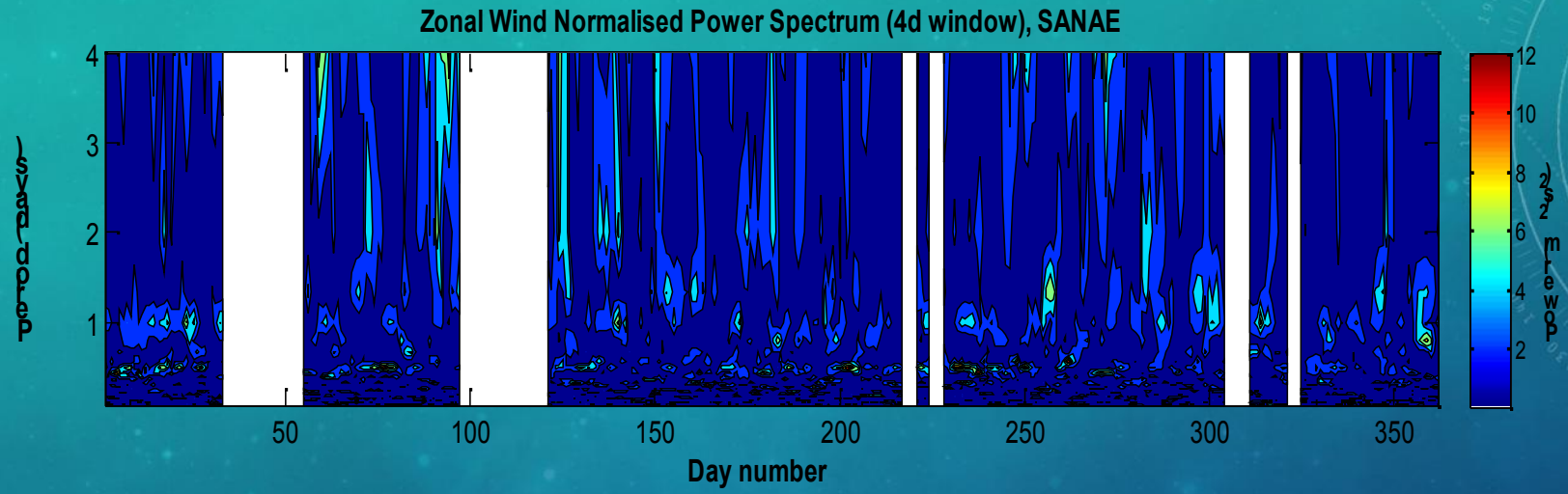
Why studying planetary waves and Tides in MLT

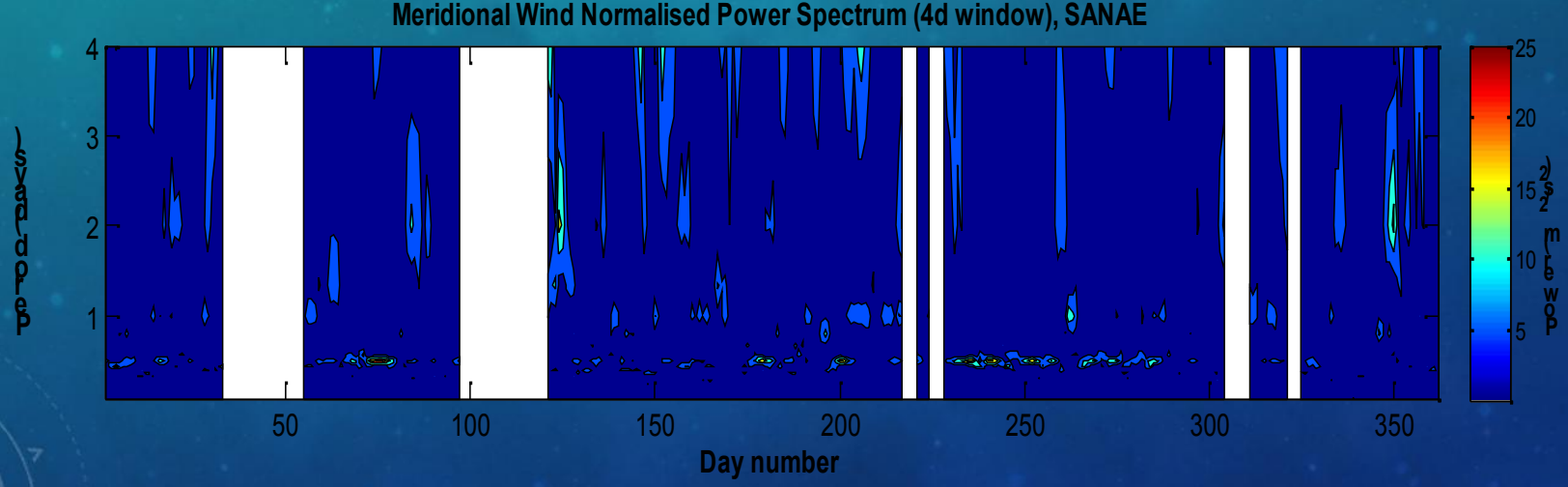
- They contribute much to the atmospheric dynamics and therefore facilitate some periodic, annual and seasonal global climate variations e.g. Sudden Stratospheric Warming (SSW).
- They distribute momentum flux and heat flux as they interact with mean zonal flow and propagate upwards.

Wave Propagation

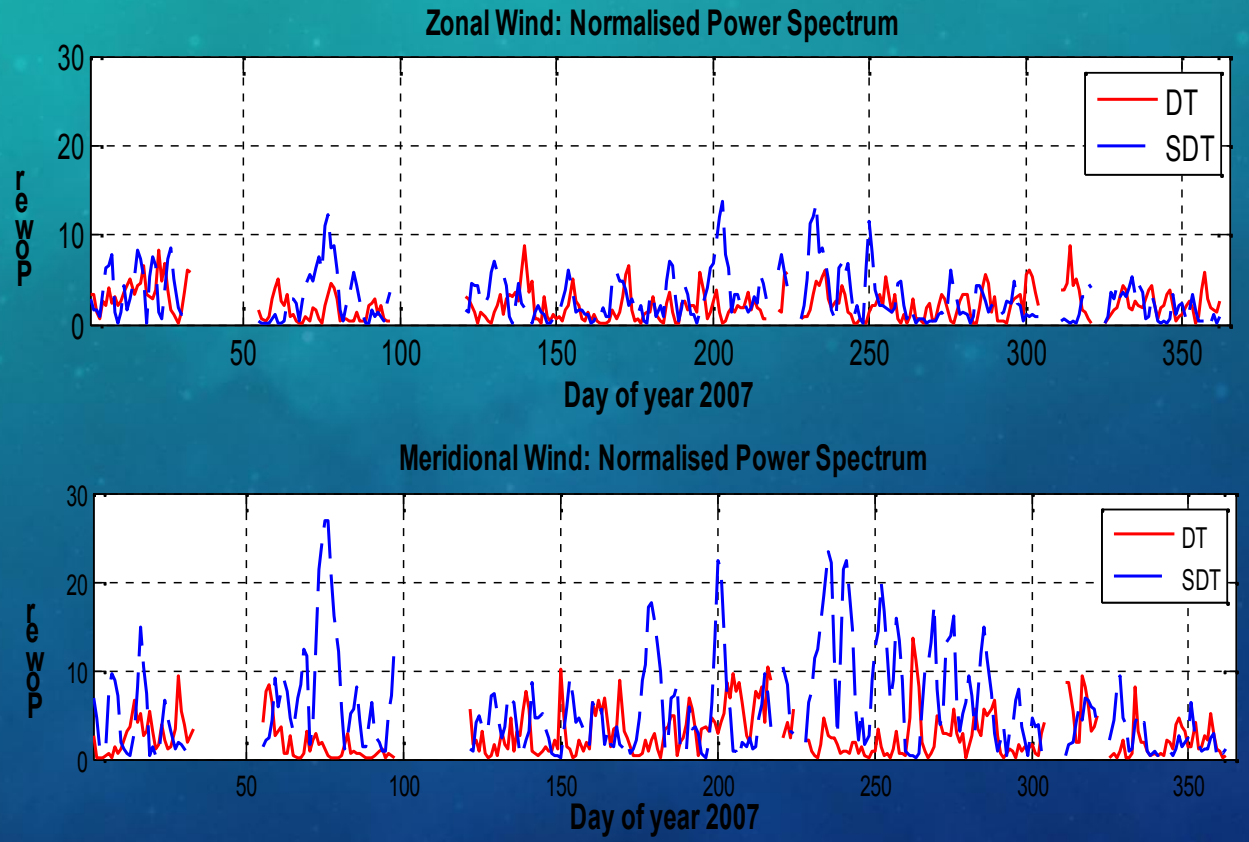


site: http://arise-project.eu/atmospheric-dynamics.php

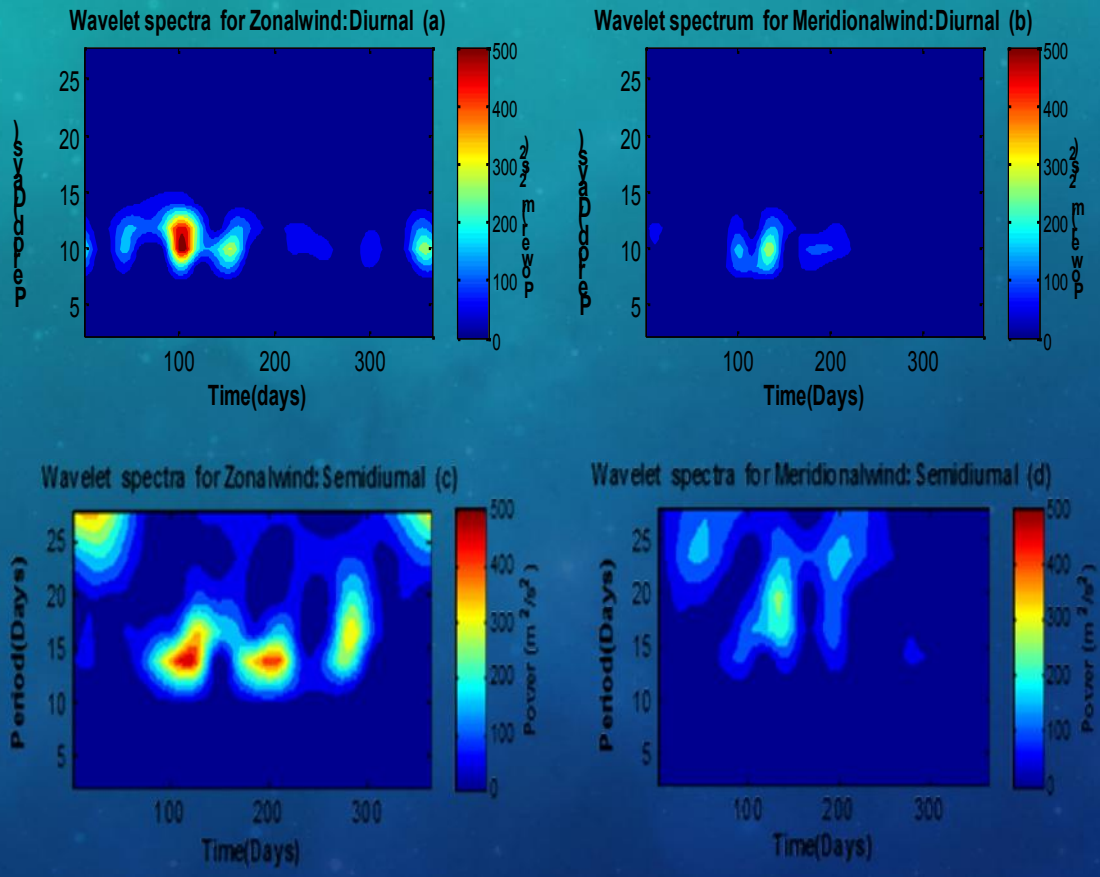

Zonal Wind Normalised Power Spectrum (4d window), SANAE
Cycles per day
Day number
Power (m²s⁻²)


Meridional Wind Normalised Power Spectrum (4d window), SANAE
Cycles per day
Day number
Power (m²s⁻²)

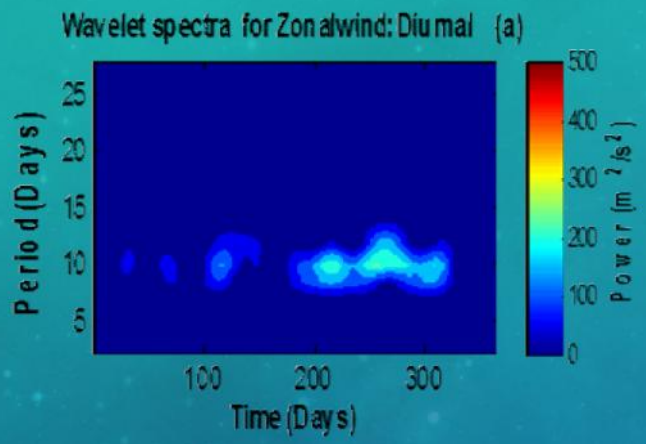
Results and Discussion

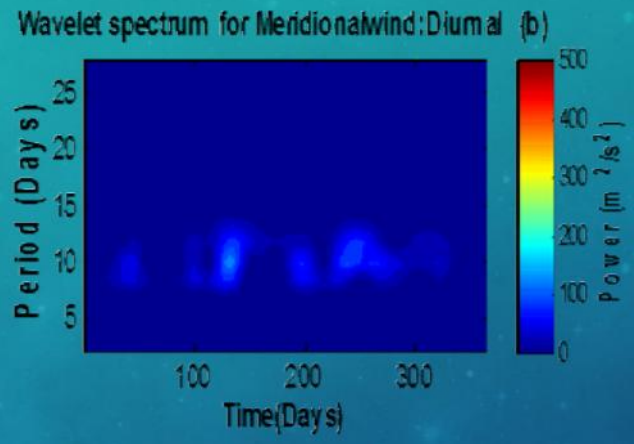


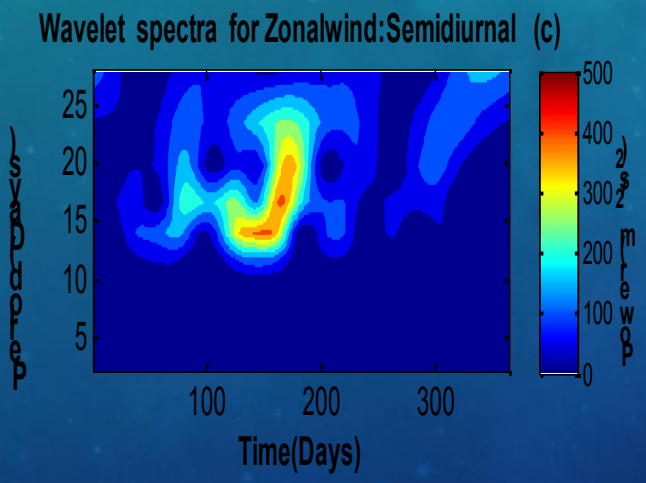
SANAE 2007

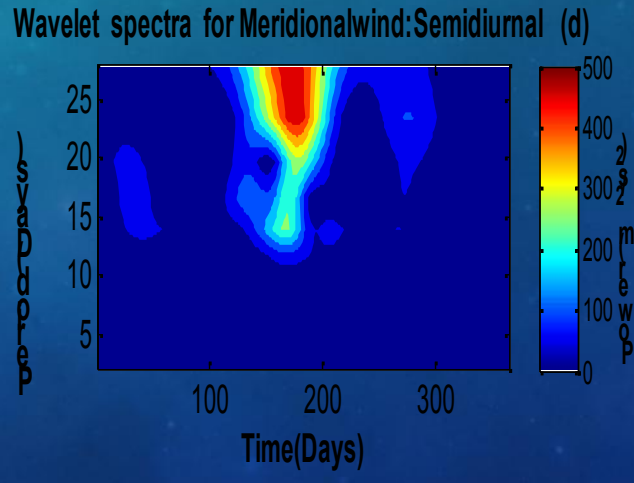

Wavelet spectra for Zonalwind:Diurnal (a)
Wavelet spectrum for Meridionalwind:Diurnal (b)
Wavelet spectra for Zonalwind:Semidiurnal (c)
Wavelet spectra for Meridionalwind:Semidiurnal (d)
Time(days)
Time(Days)
Period(Days)
Power (m²/s²)

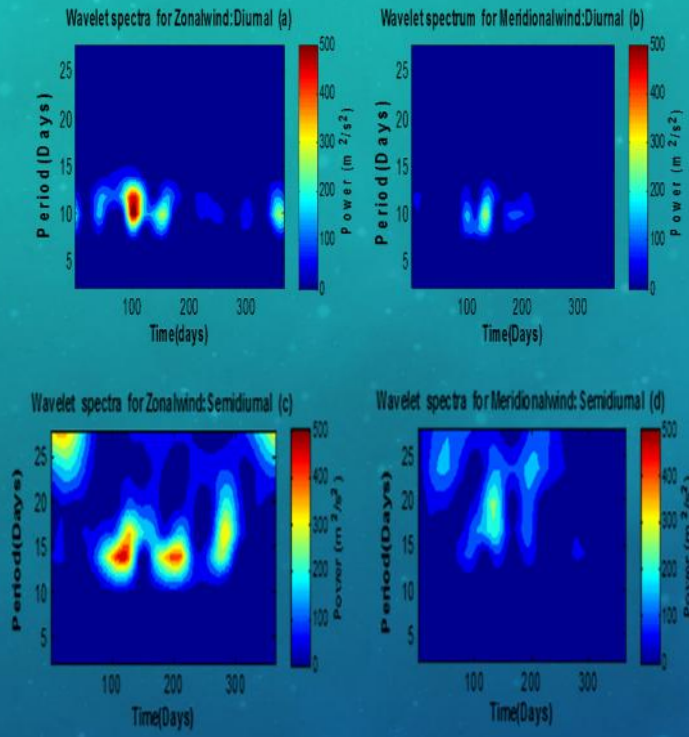
Halley 2007


Wavelet spectra for Zonalwind: Diurnal (a)
Period (Days)
Time (Days)
Power (m²/s²)

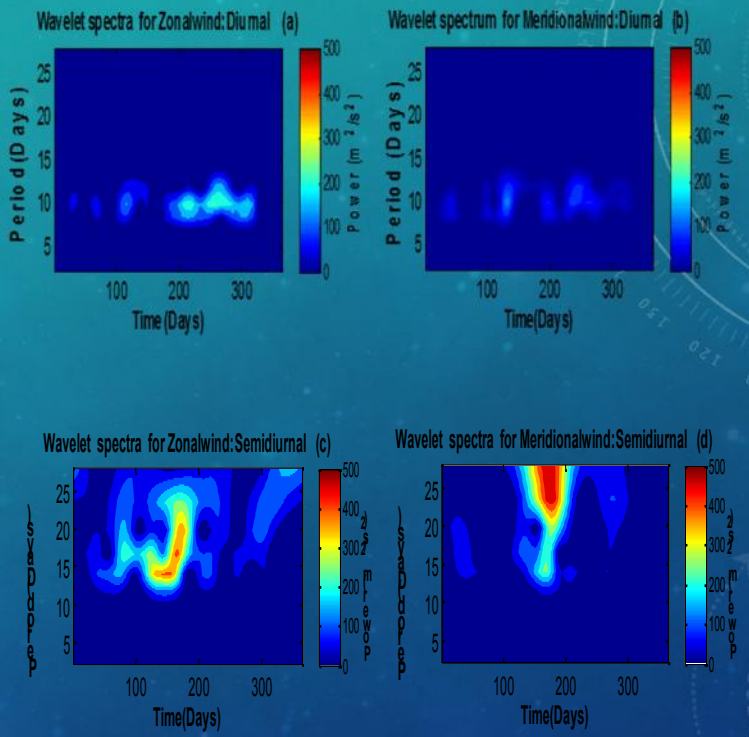

Wavelet spectrum for Meridionalwind: Diurnal (b)
Period (Days)
Time (Days)
Power (m²/s²)


Wavelet spectra for Zonalwind:Semidiurnal (c)
Time(Days)

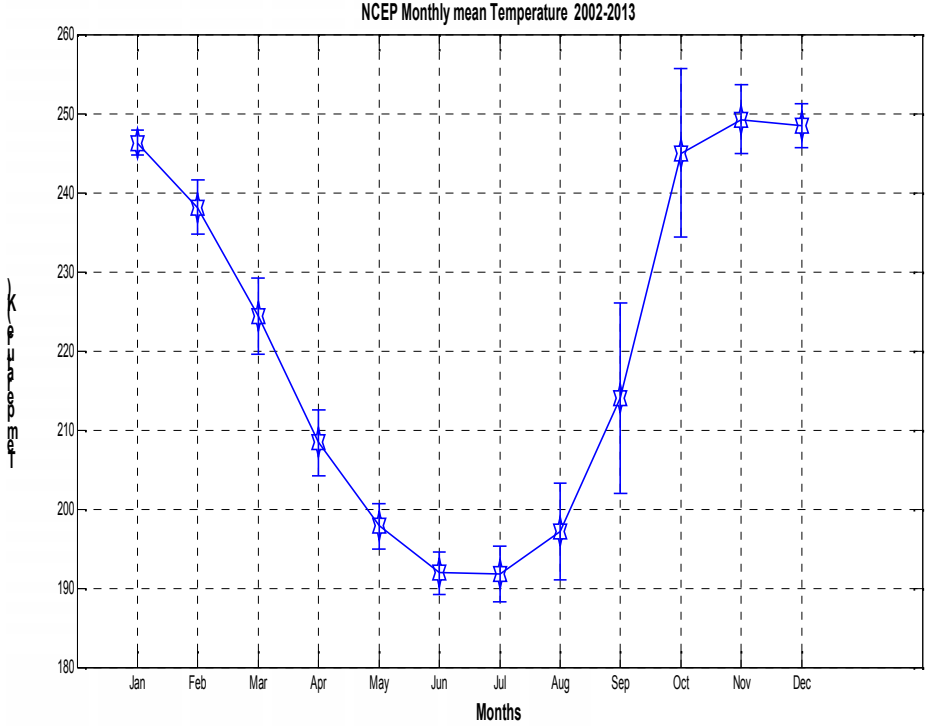

Wavelet spectra for Meridionalwind:Semidiurnal (d)
Time(Days)

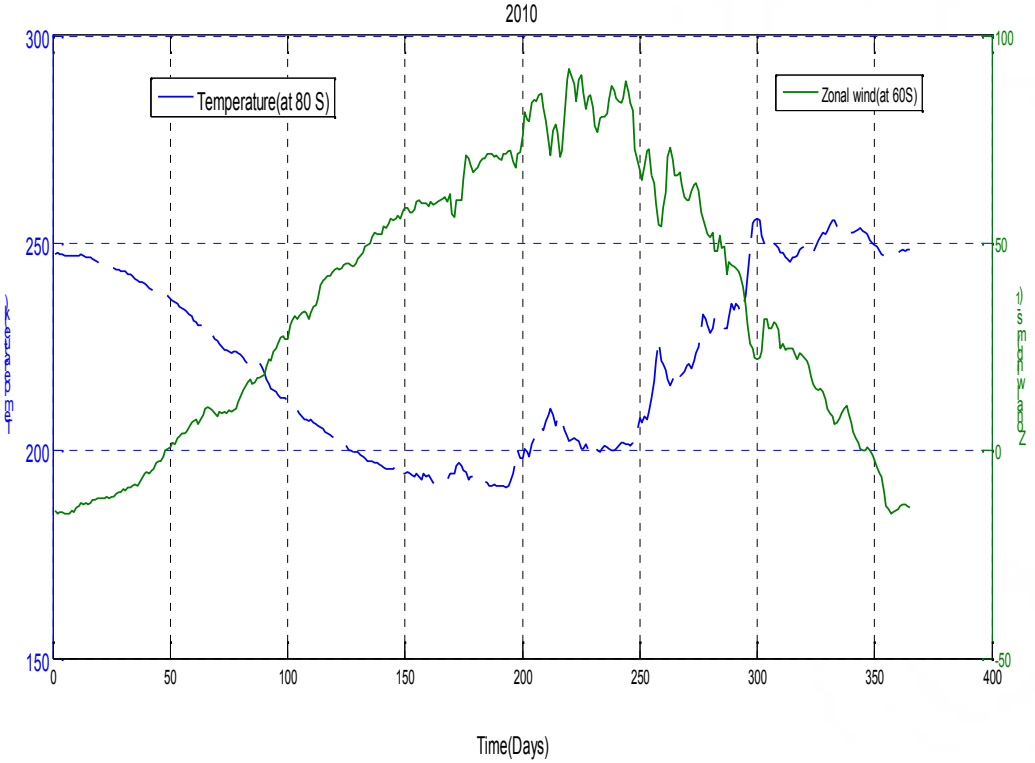


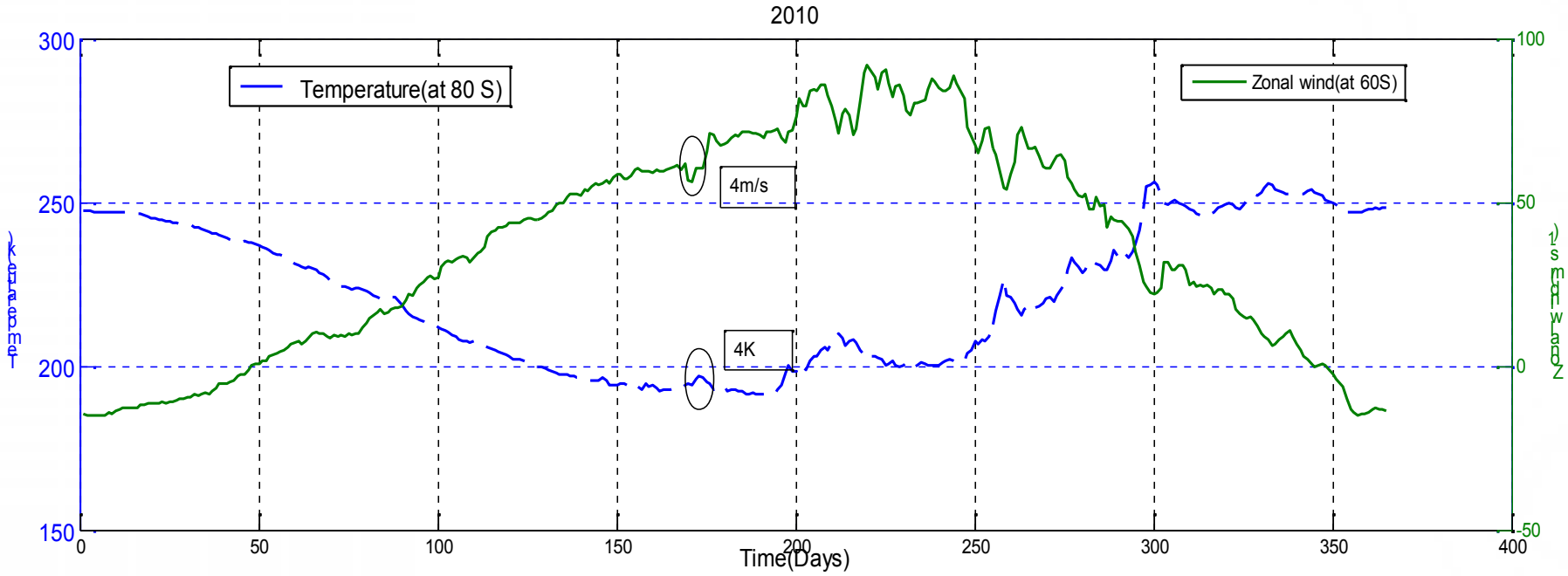
SANAE 2007

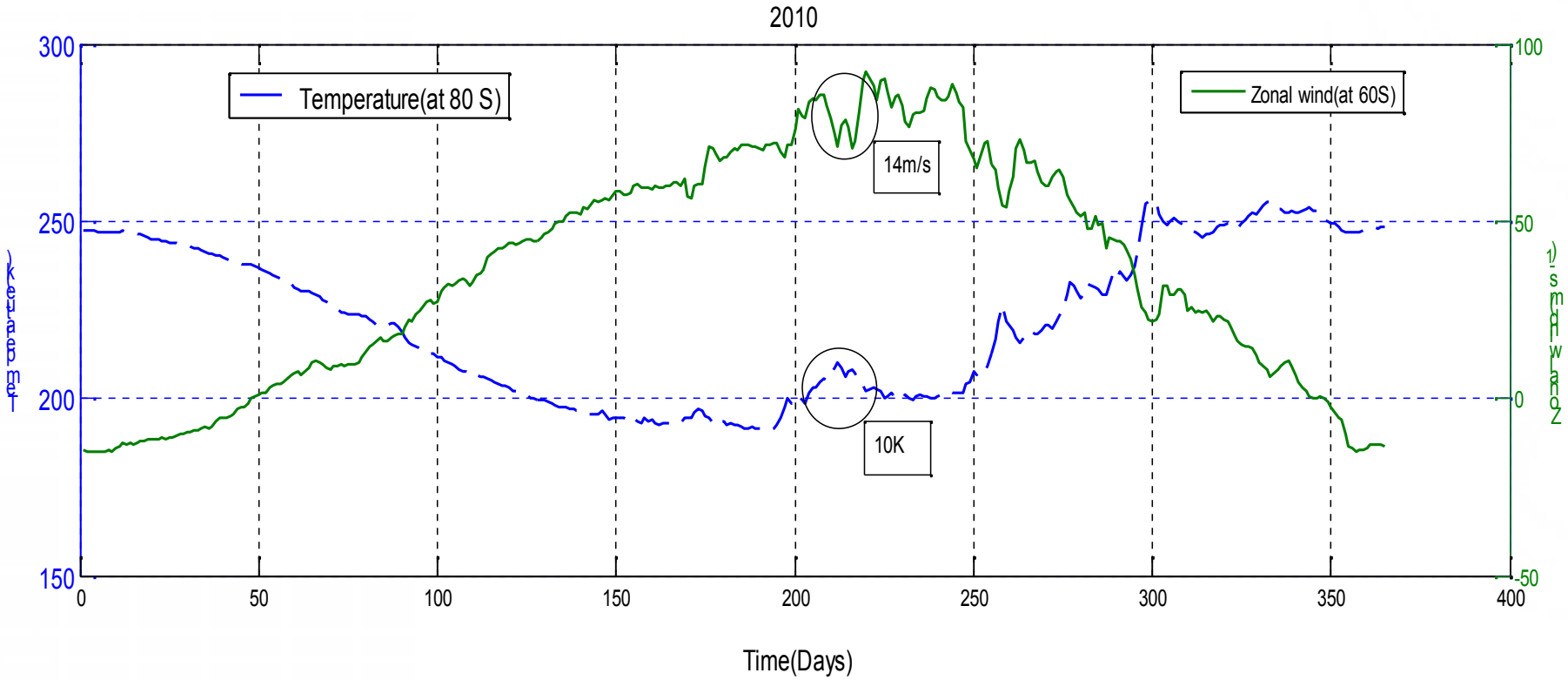


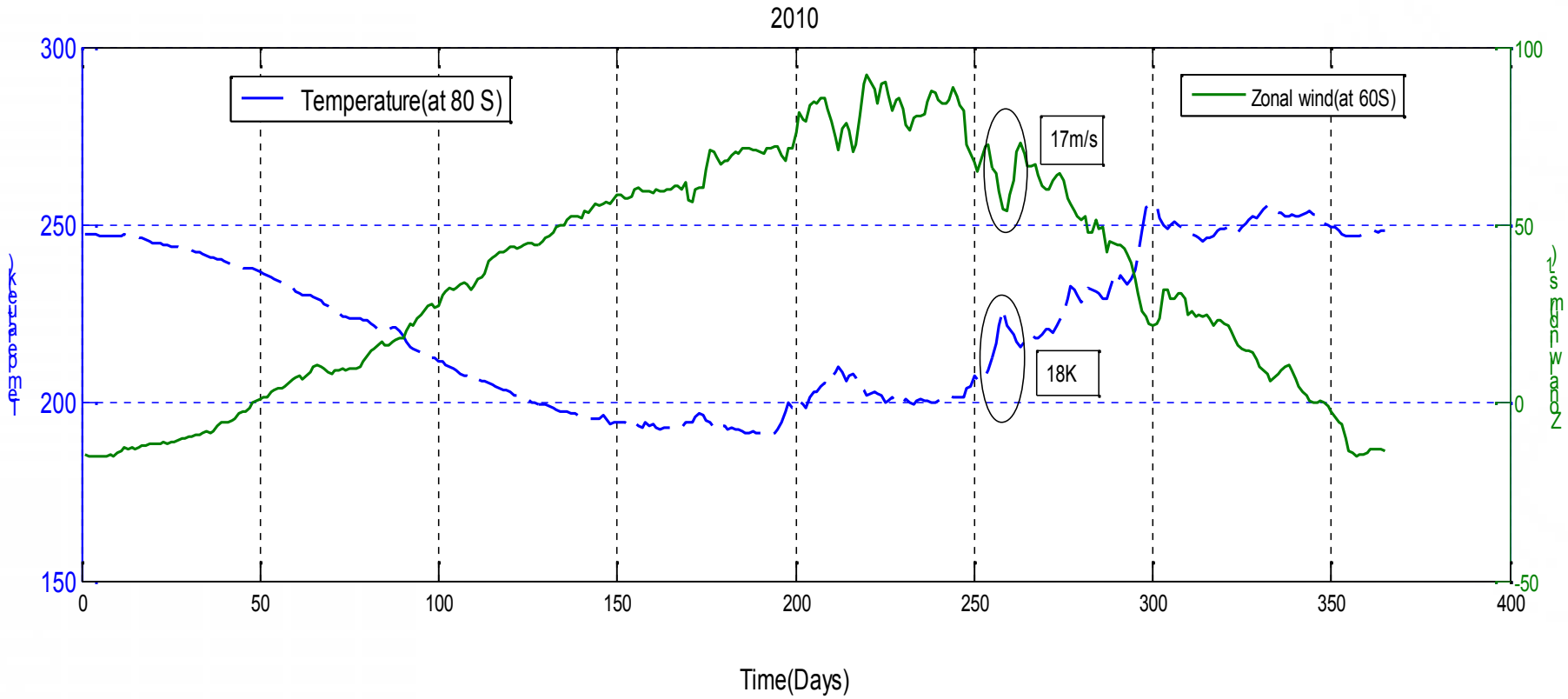
Halley 2007


NCEP Monthly mean Temperature 2002-2013
260
250
240
230
220
210
200
190
180
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Months


2010
Temperature(at 80 S)
Zonal wind(at 60S)
300
250
200
150
100
50
0
-50
0
50
100
150
200
250
300
350
400
Time(Days)


2010
Temperature(at 80 S)
Zonal wind(at 60S)
4m/s
4K
Time(Days)
300
250
200
150
100
50
0
-50
0
50
100
150
200
250
300
350
400


2010
Temperature(at 80 S)
Zonal wind(at 60S)
14m/s
10K
300
250
200
150
100
50
0
-50
0
50
100
150
200
250
300
350
400
Time(Days)


2010
Temperature(at 80 S)
Zonal wind(at 60S)
17m/s
18K
Time(Days)
300
250
200
150
100
50
0
-50
0
50
100
150
200
250
300
350
400

Summary

- HF Radar instrument are very useful in monitoring MLT region though they were initially designed to study plasma flow in the high-latitude ionosphere.

- There is good agreement in SANAE and HALLEY Radar measurements meaning SuperDARN Radar network is efficient in monitoring the field of view of interest.

- SSW is enhanced by interaction of planetary waves and Diurnal and Semidiurnal tidal waves with mean zonal flow.

- Successive MSSWs can occur and at times can lead to MSSW for example in 2002 in the Southern Hemisphere (Mbatha et.al. 2010).

END

THANK YOU!!!!!!!!!!!