Assimilation of TIMED wind and temperature measurements into a tide-mean flow model

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Data Assimilation in the MLT
## Short list of problems that must be solved

- Asynoptic data sampling

    - Preprocess data and model over an interval of time

- Unbalanced dynamics

    - Notions of the "slow manifold" does not apply

- Vertically propagating forced waves

    - Dynamical model must have "tunable" forcing

    - Initialization alone is not sufficient

- Unknown damping (eddy diffusion, etc.)

- Wave interactions, especially gravity waves

Asynoptic analysis method

Time series of temperatures at each altitude and track grid

An infinite set of 2D modes (lon,time) are aliased with each single Fourier component of the 1D time series

Salby method is not sufficient if more than two aliased waves are present

Mean component, ascending node
Zonal mean+migrating tides

Mean component, descending node

Diurnal component, ascending node
Modes with wavenum + freq = 1

Diurnal component, descending node

(real part)
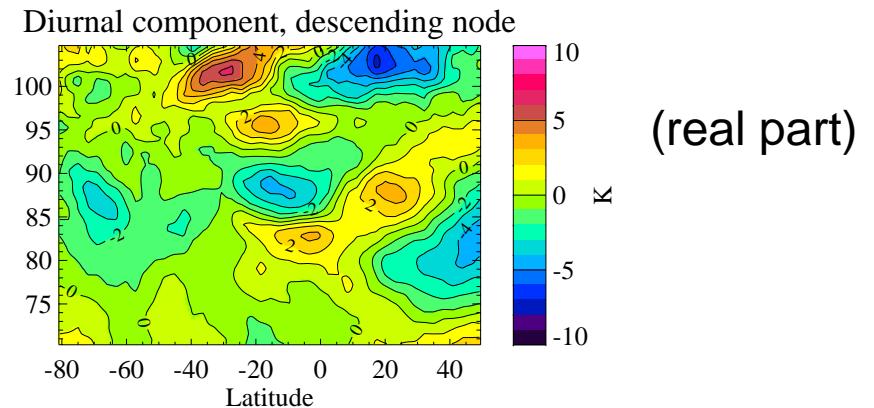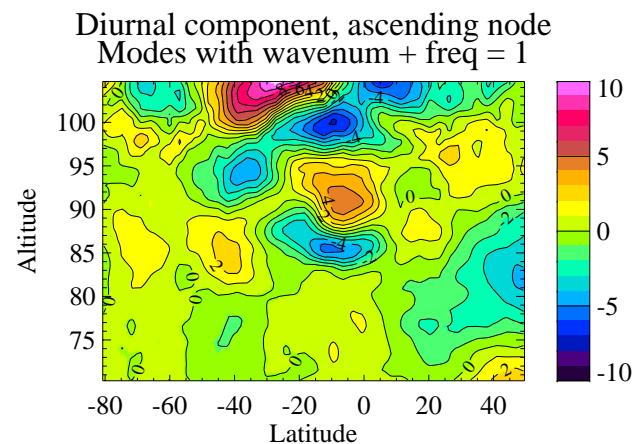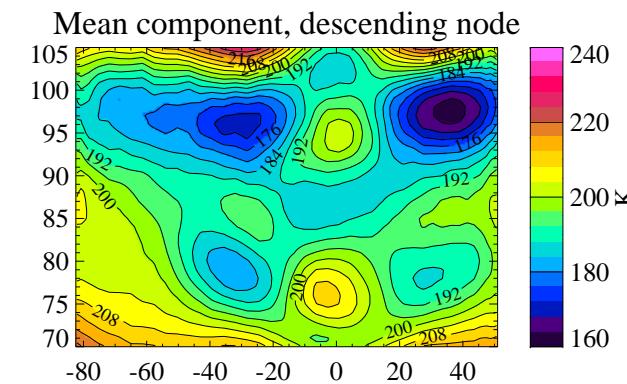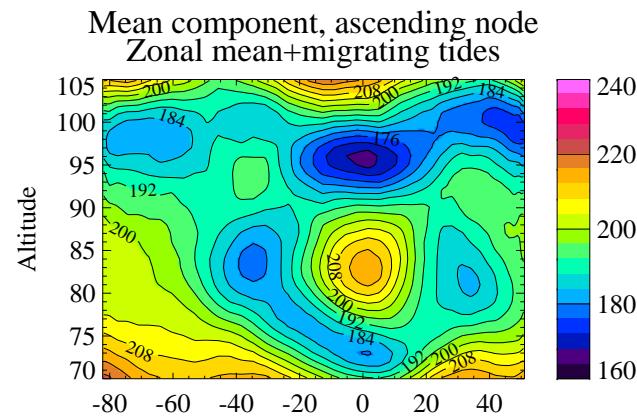
Assimilation model

- Model supplies constraints that enable separation modes (mean flow and tides)
- Assume waves are vertically propagating through nonzero mean flow, and near steady state
- Model parameters adjusted during fit:
  - Forcing strength (Hough mode decomposition of forcing)
  - Damping parameters (eddy diffusion profile)
  - GW parameterization
- Results give mean flow and tide estimates on a daily basis. Contrast with diurnal harmonic fitting techniques, which require a full yaw cycle (61 days)
- These fitting results could serve as part of an initialization step in a time-dependent assimilation scheme

Fitting results
compare harmonic fit to assimilation
SABER temperatures
## Jan 14-Mar 15 2006 average
results shown at longitude=0, UT=0
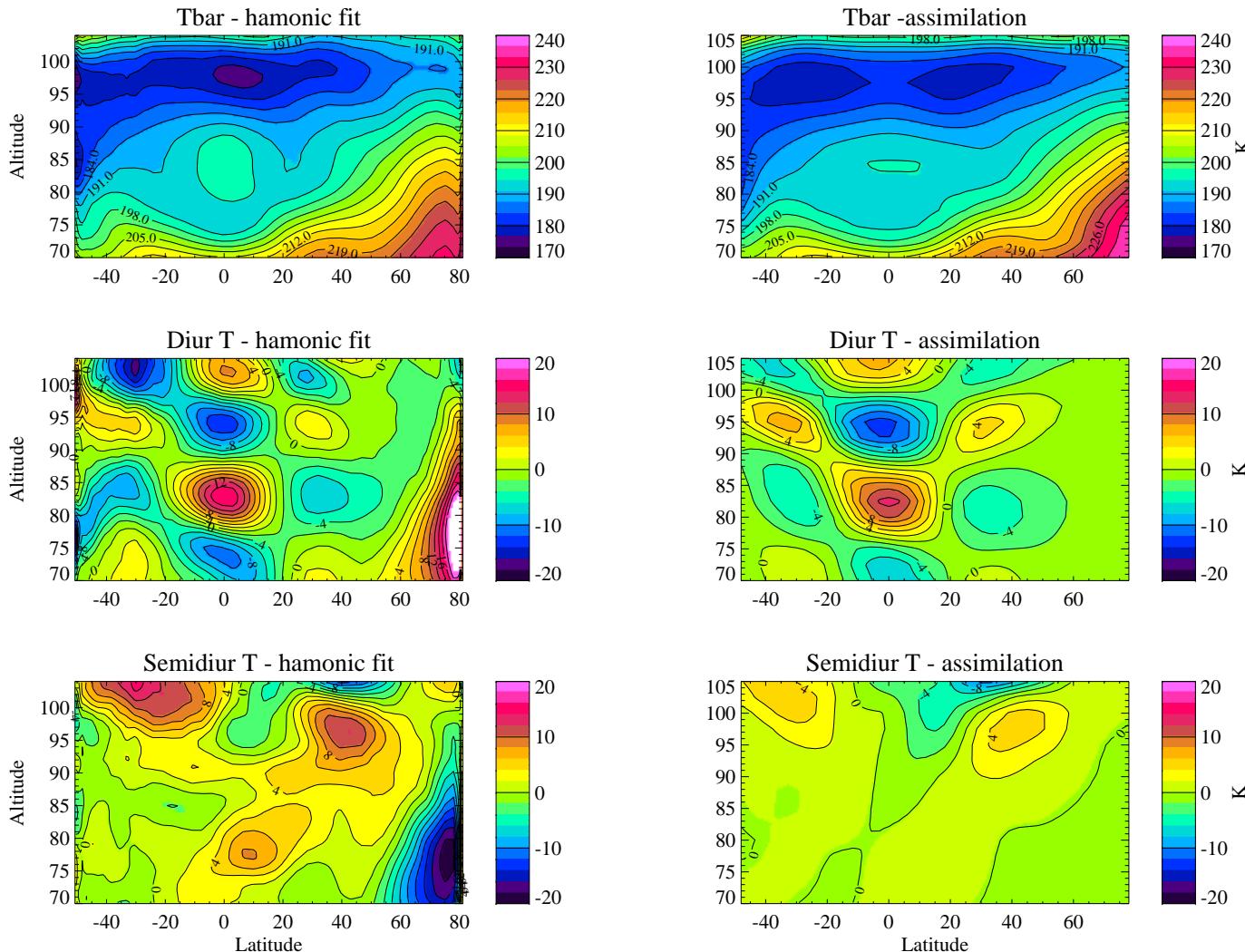
Fitting results
TIDI zonal wind
harmonic fit has difficulty with data gaps and transience
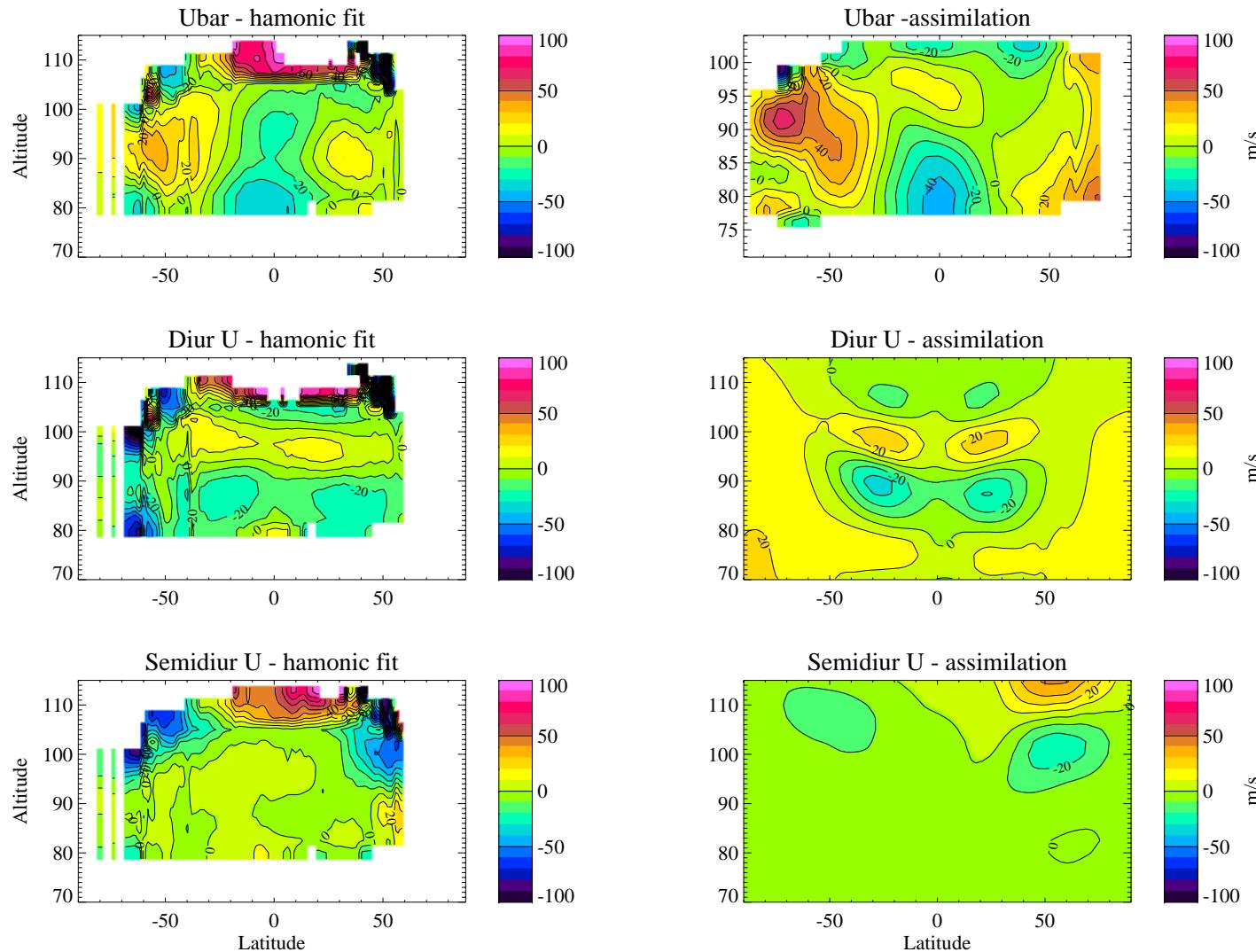
Fitting results
## TIDI meridional wind
### only fit diurnal and semidiurnal tide
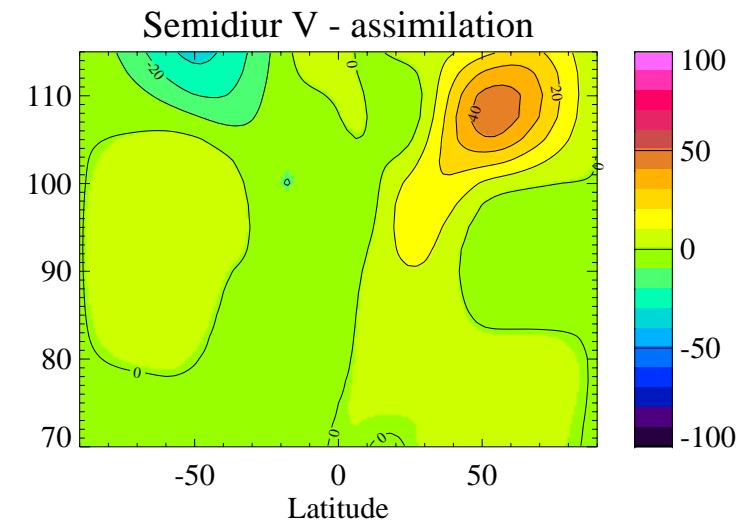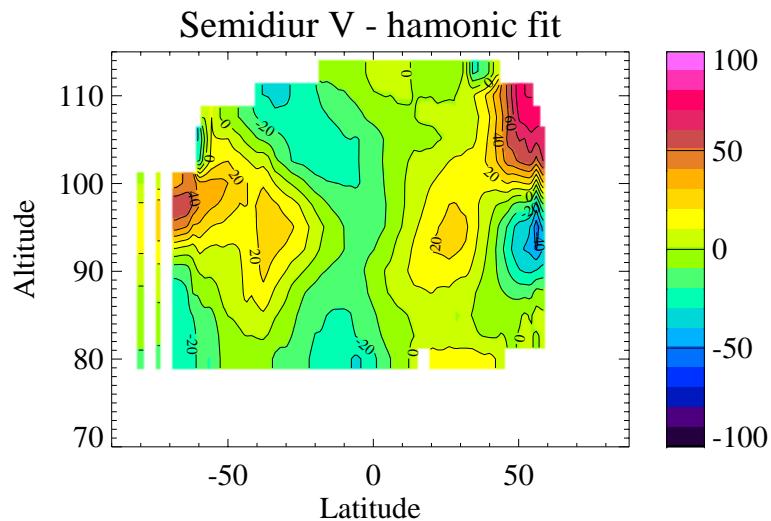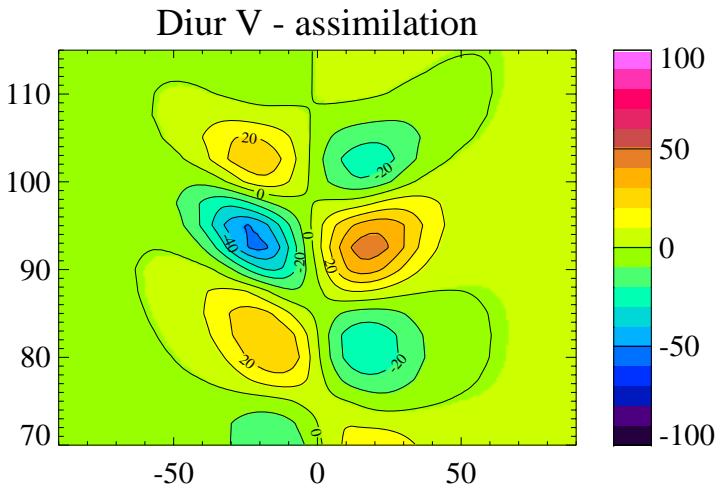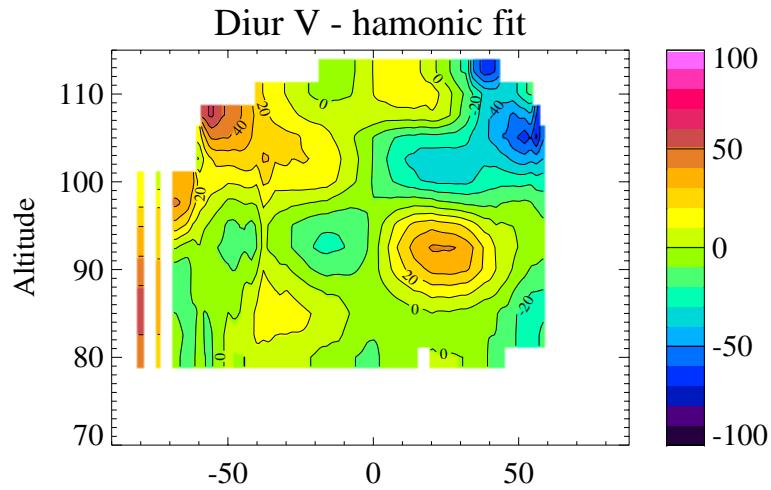
Compare fits

Harmonic fit cannot determine mean flow or tidal variability over a yaw cycle
temperature 80 km
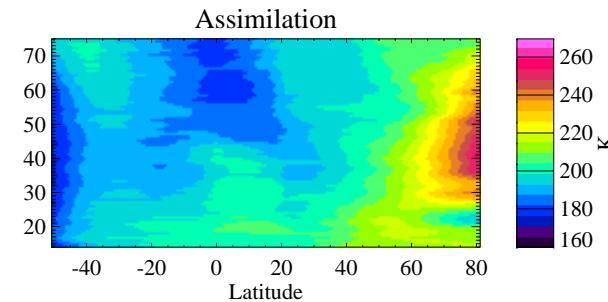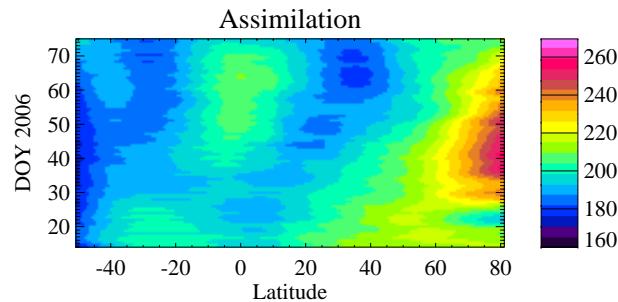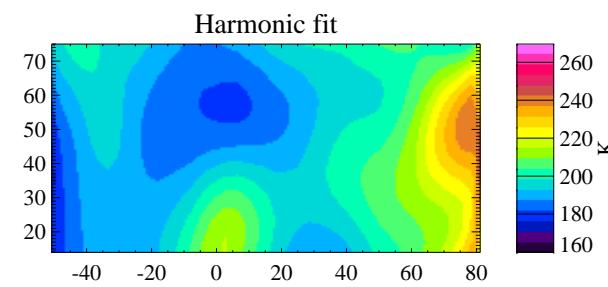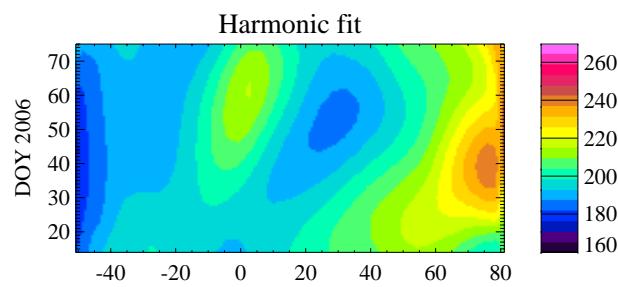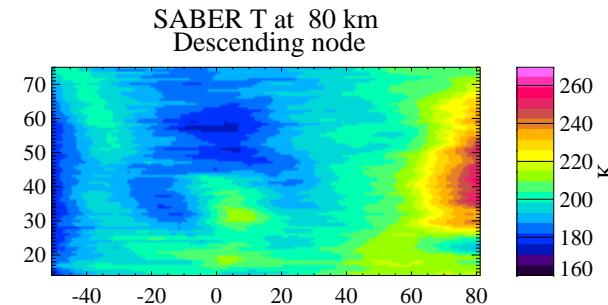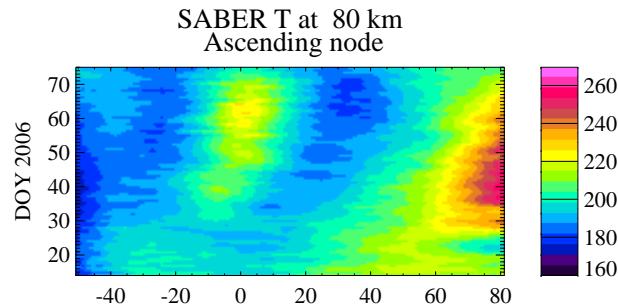
Compare fits

temperature 95 km
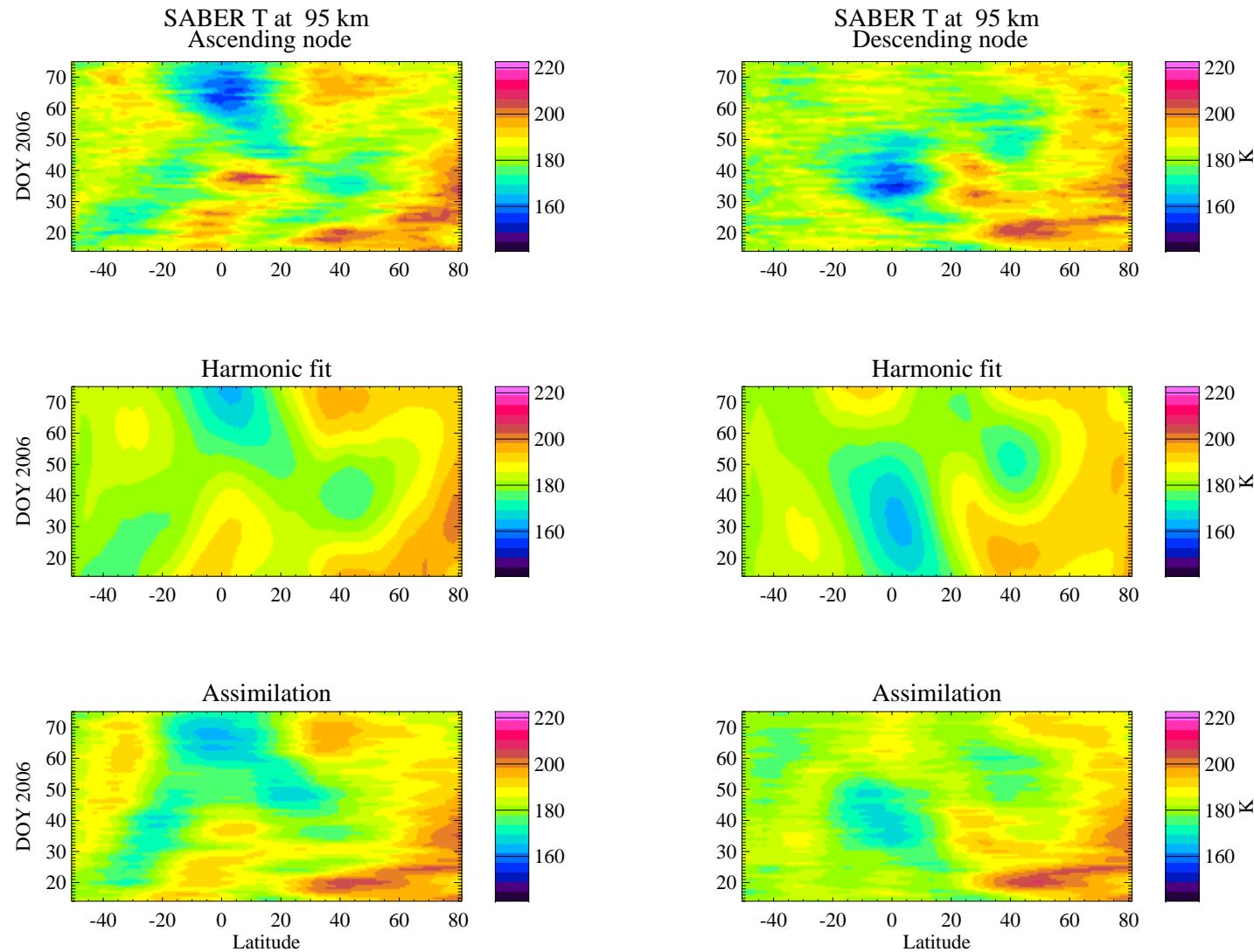
SABER temperature at 100 km
subtract zonal mean from temperature
## decompose into diurnal and semidiurnal tide
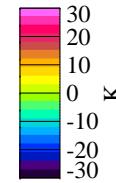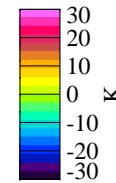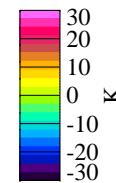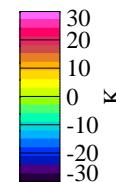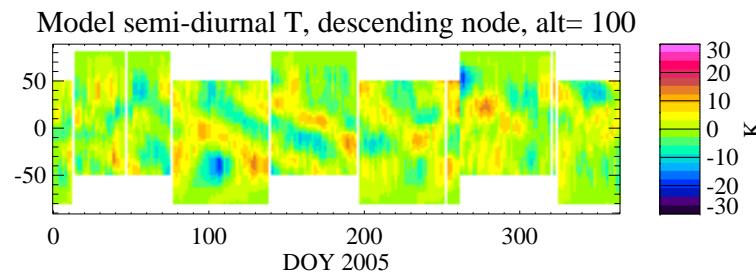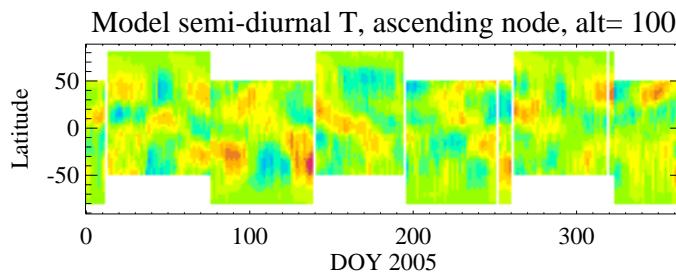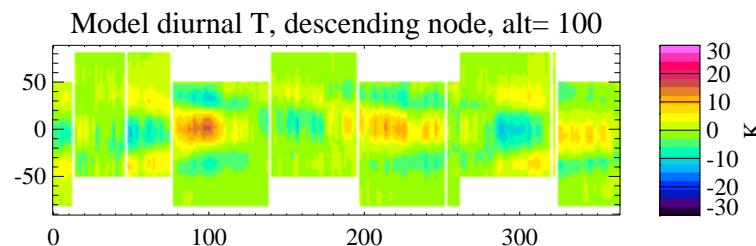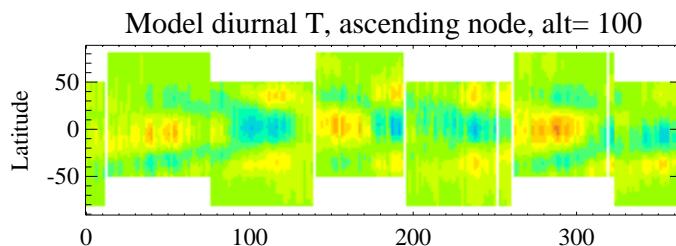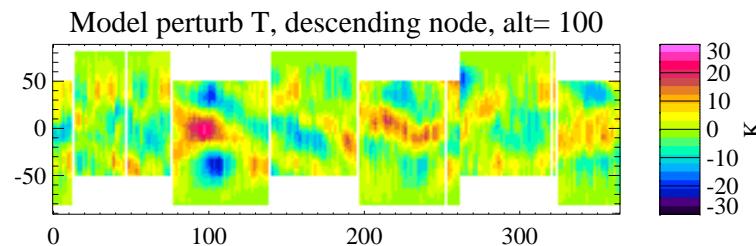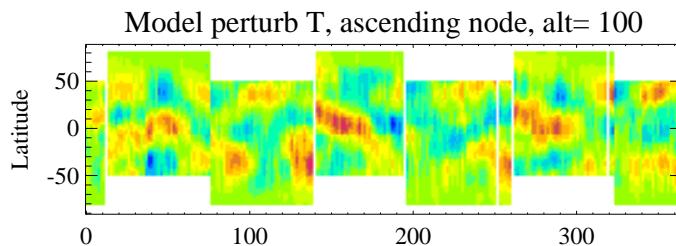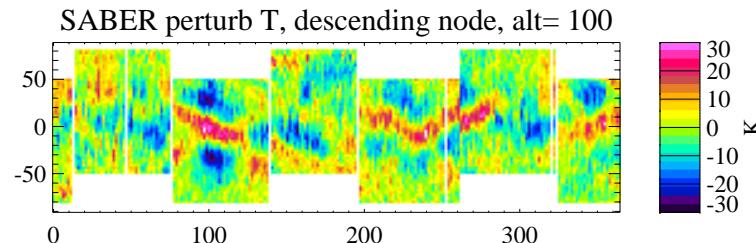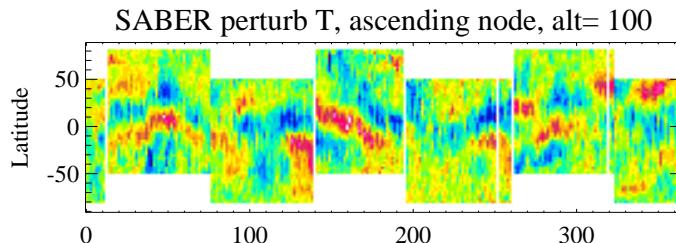
TIDI Zonal wind at 90 km
## Compare view from 2 tracks x 2 nodes with the assimilation model fit
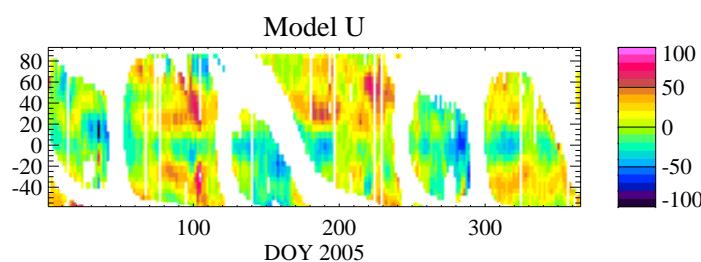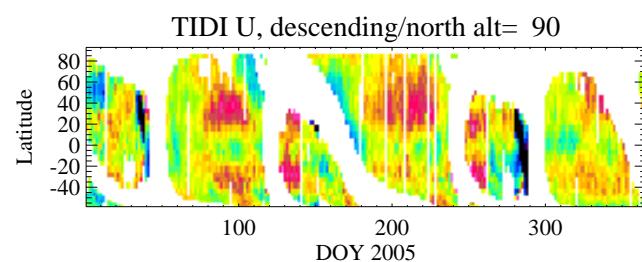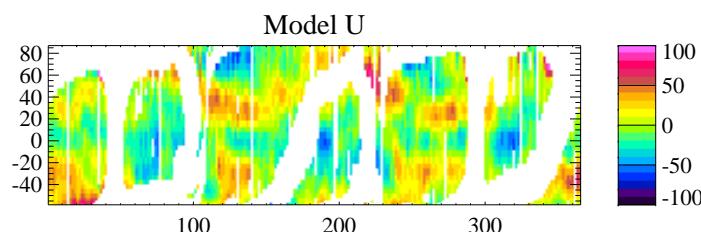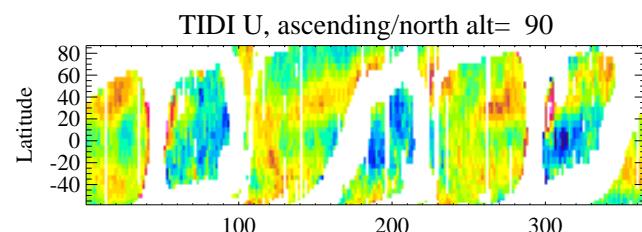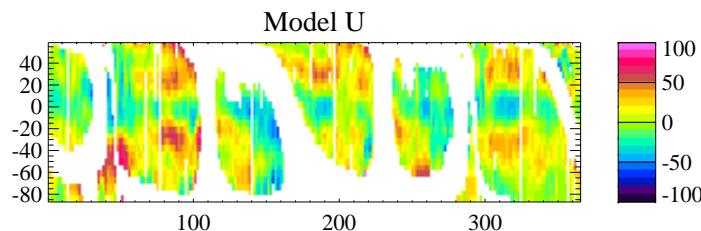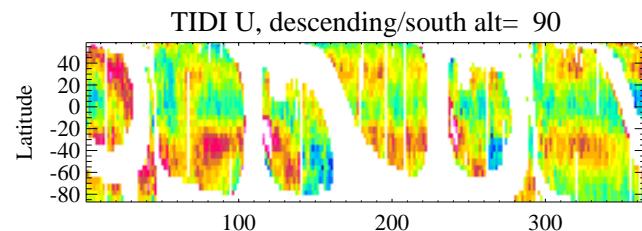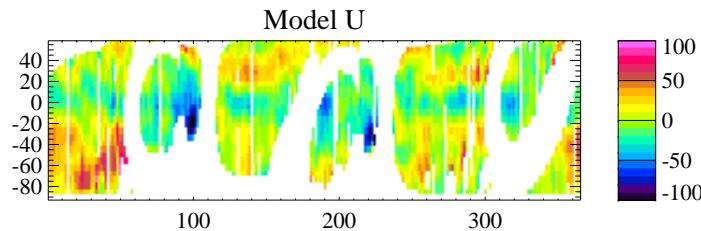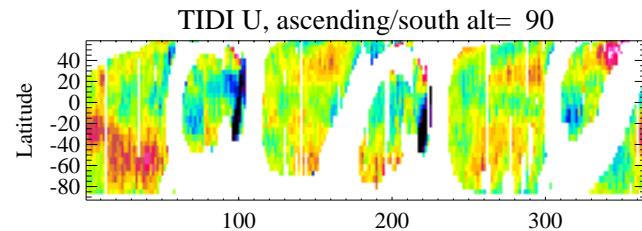
TIDI Meridional wind at 90 km

## Compare view from 2 tracks x 2 nodes with the assimilation model fit
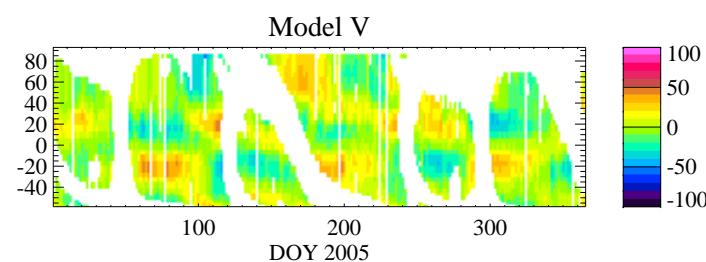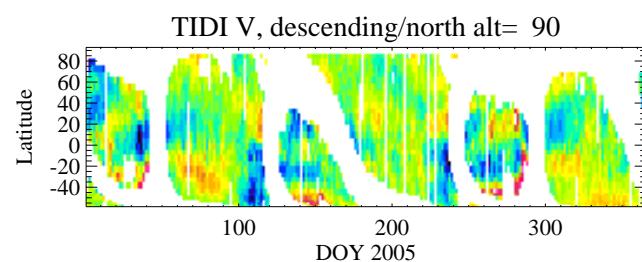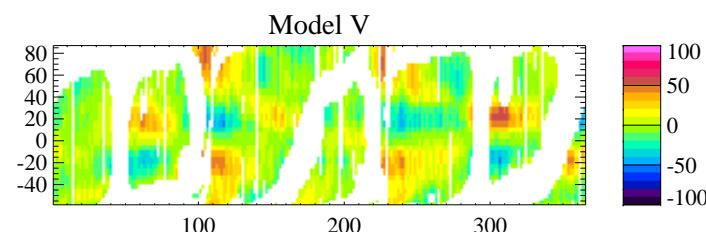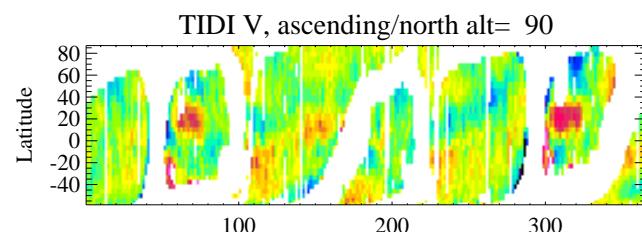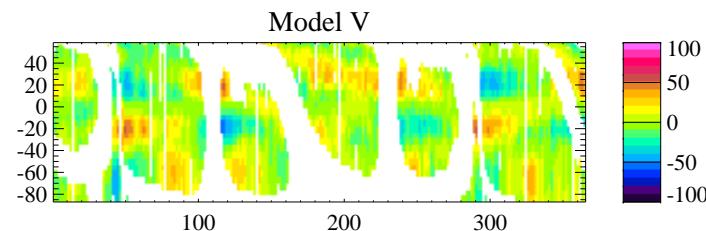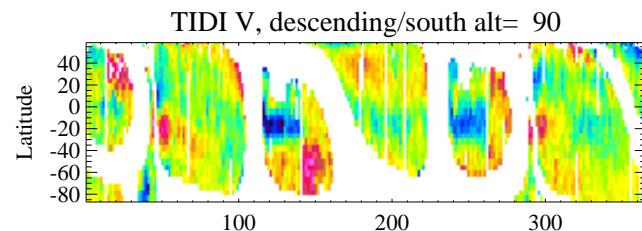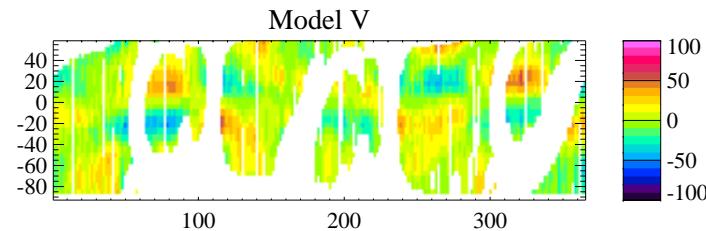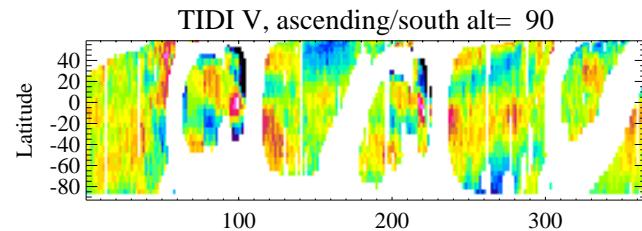
TIDI Meridional wind at 110 km

## Compare view from 2 tracks x 2 nodes with the assimilation model fit
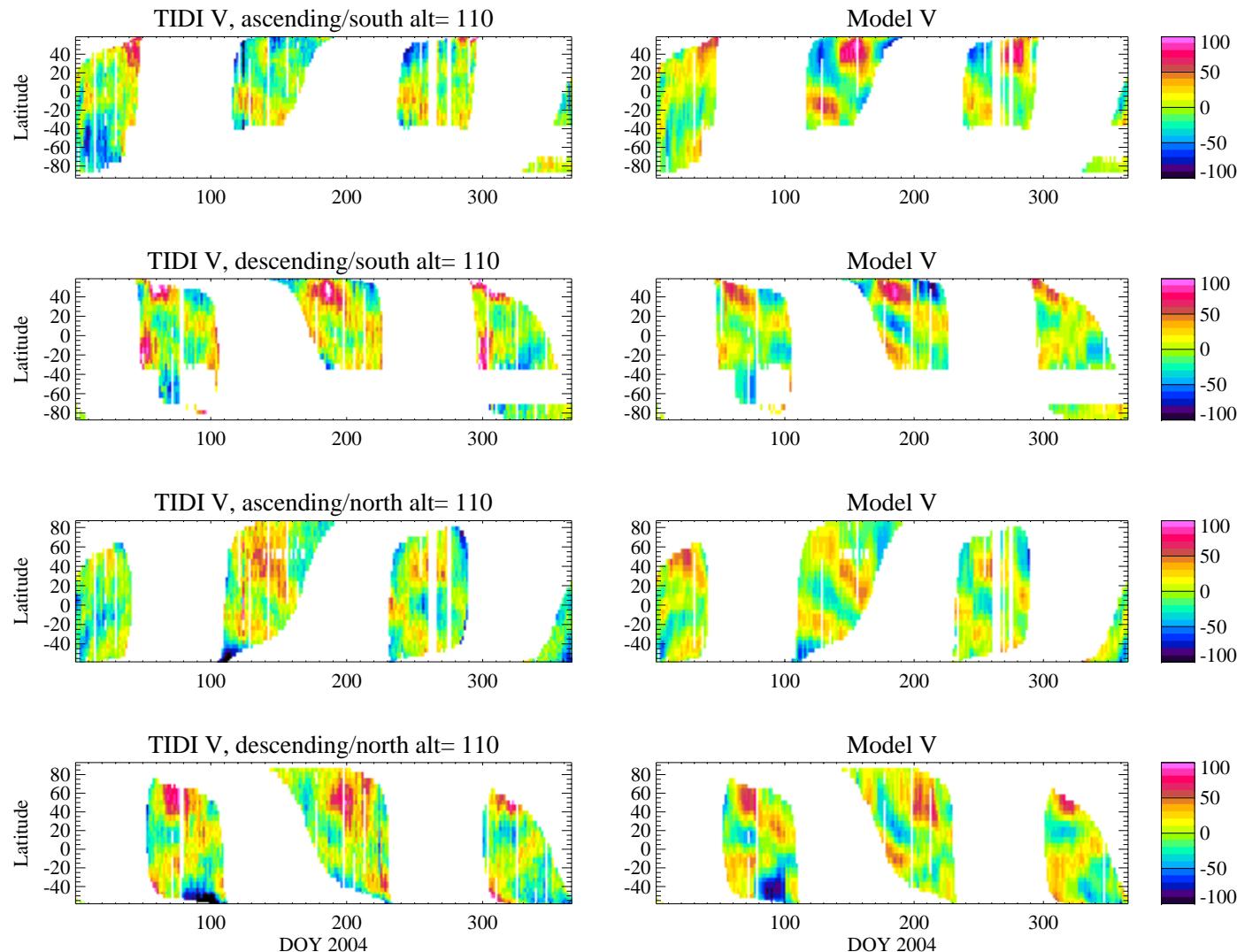
Zonal wind climatology
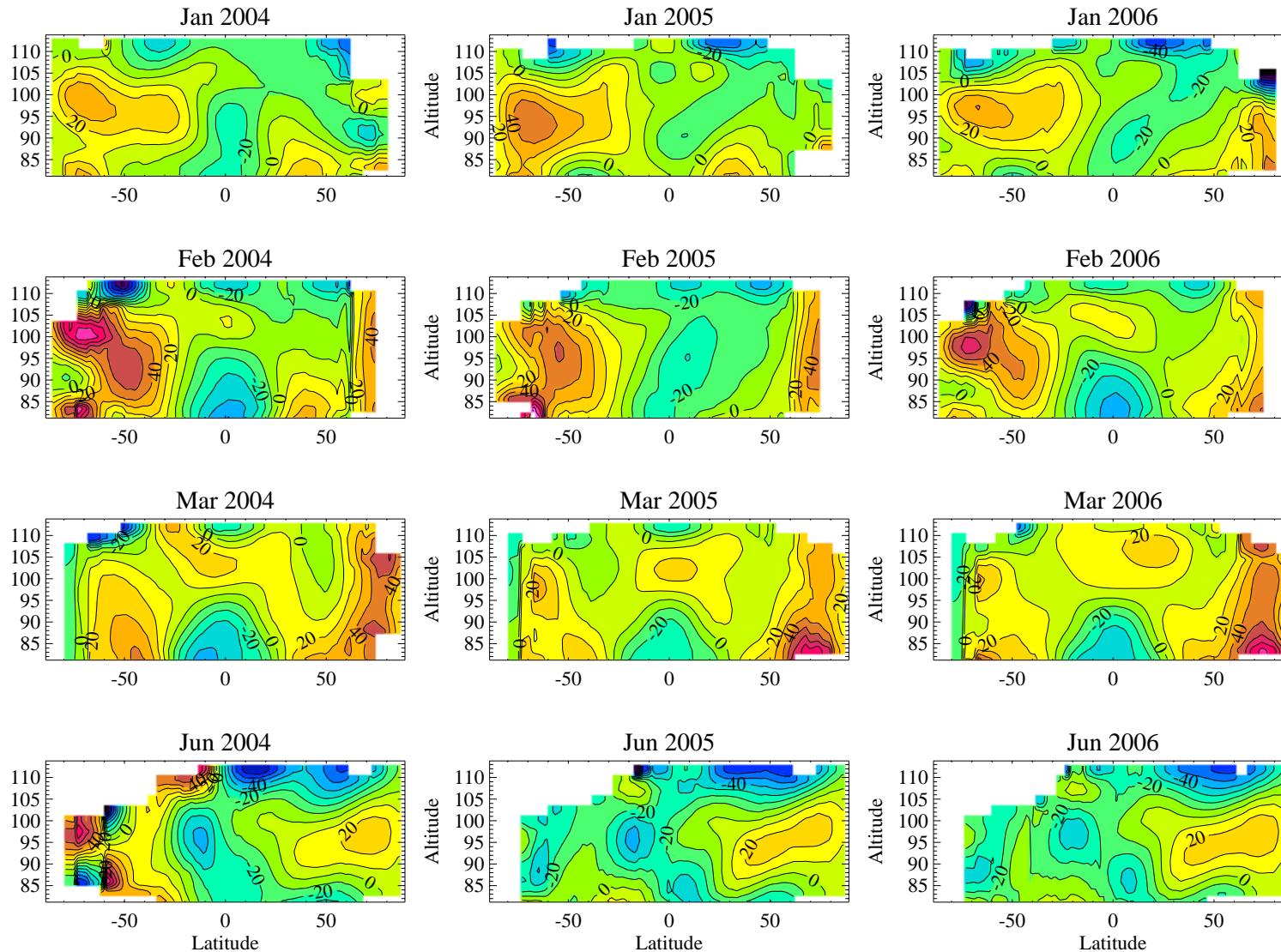
# Zonal mean zonal wind in 2004, 80-100 km
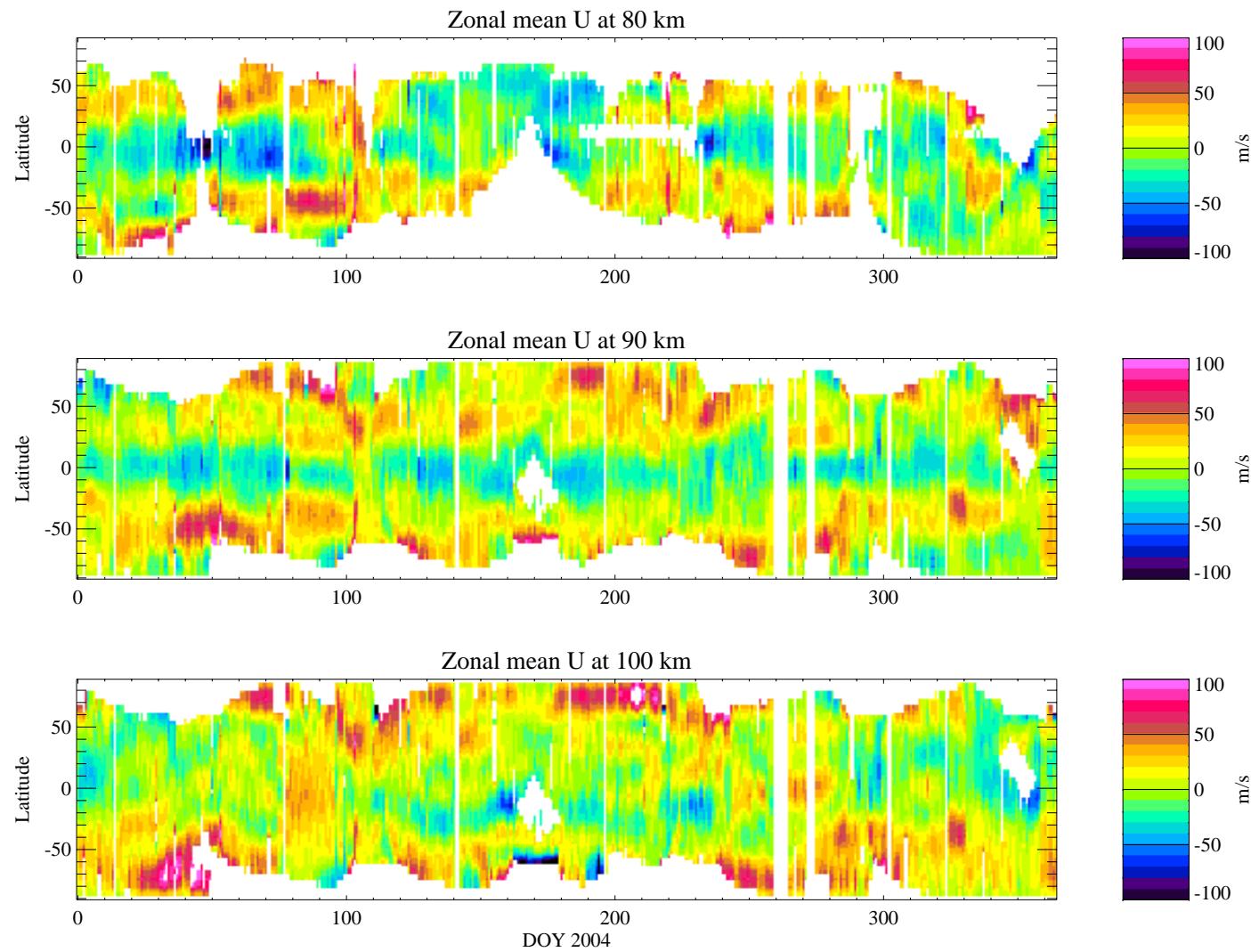
# Zonal mean temperature in 2005, 80-100 km
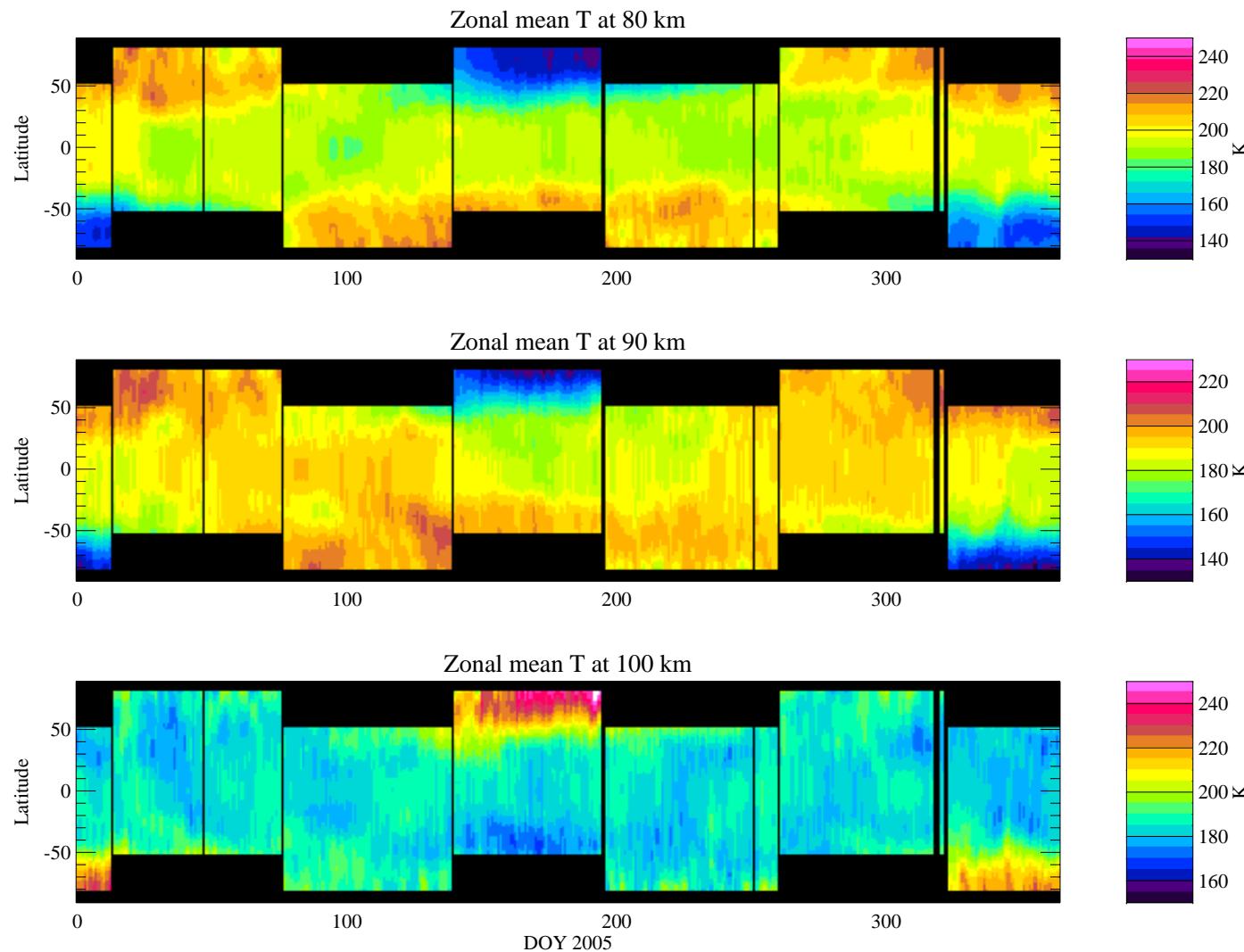
Zonal mean temperature in 2006, 80-100 km
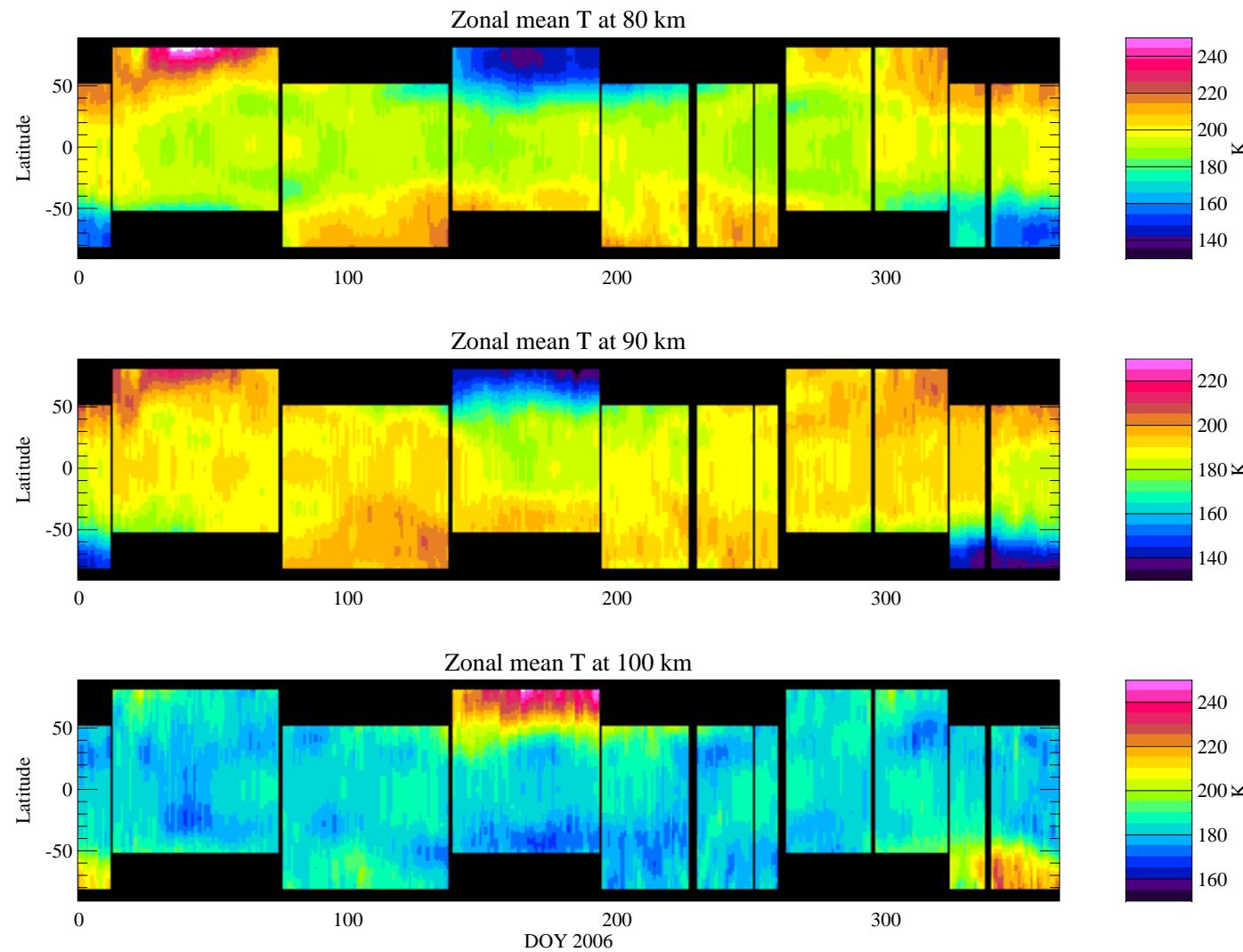
Amplitude of diurnal tide at 95 km, 20N
meridional wind
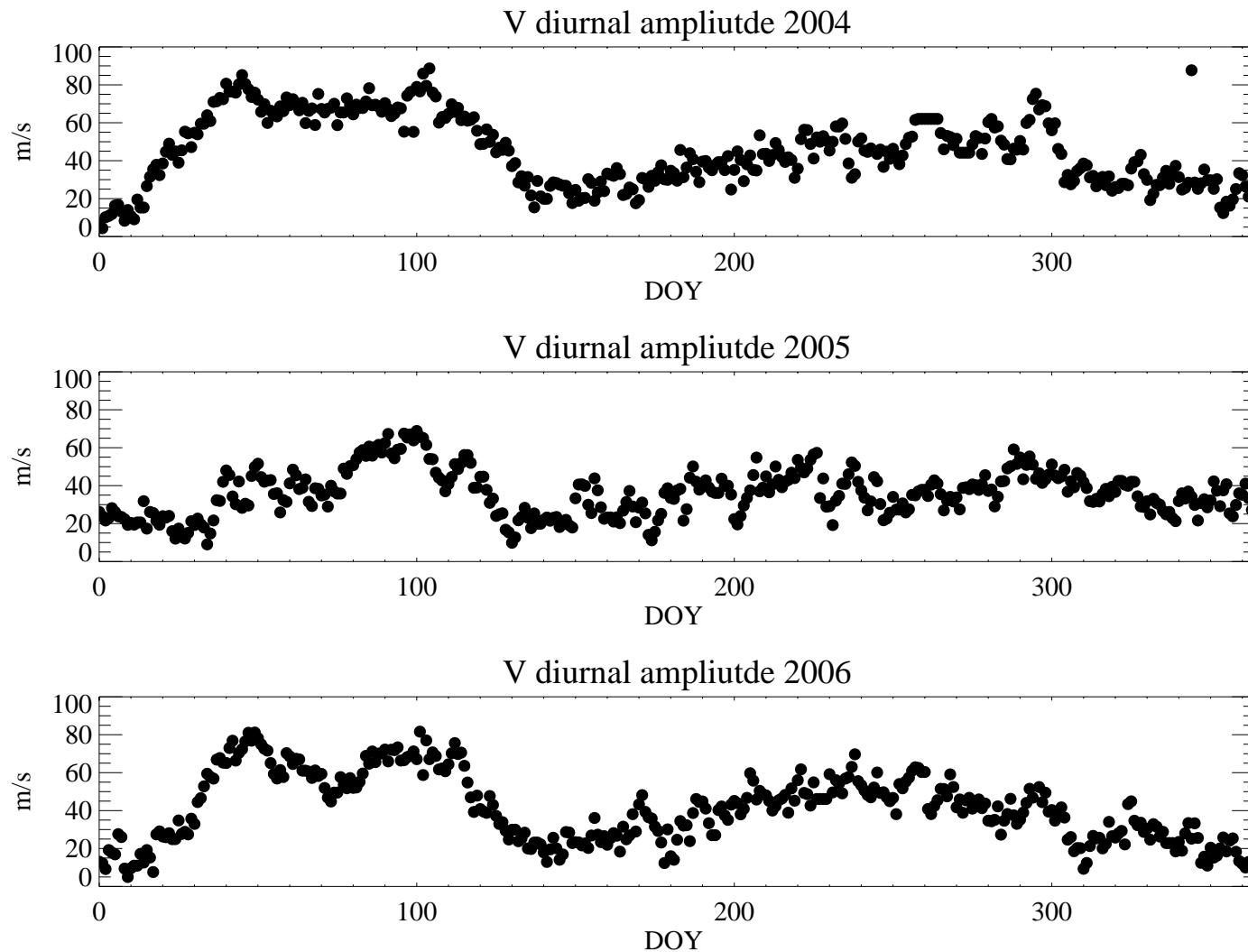
Amplitude of the semi-diurnal tide in temperature and wind at 100km

T semidiurnal amplitude at 100 km

U semidiurnal amplitude

V semidiurnal amplitude

DOY 2005
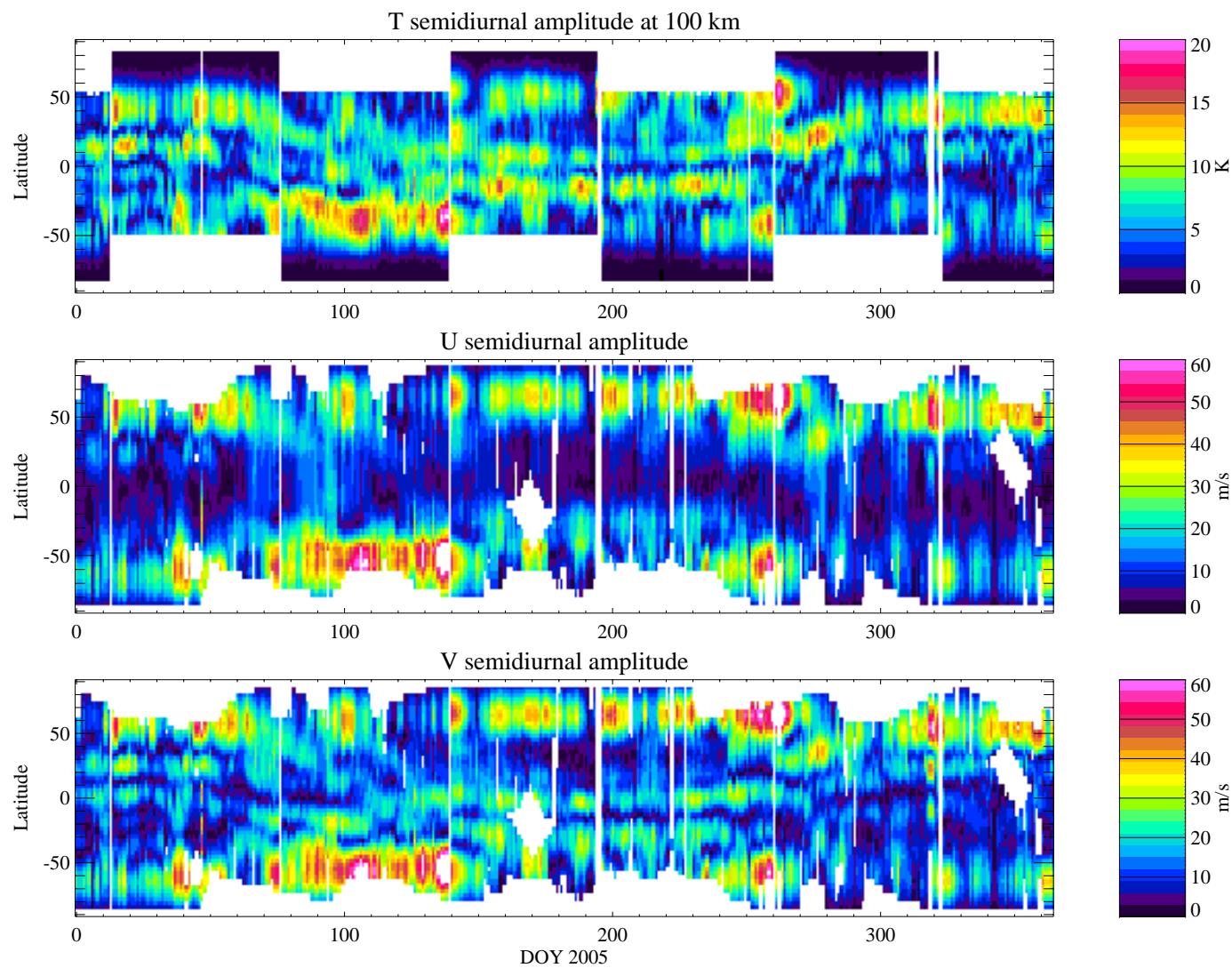
Amplitude of the semi-diurnal tide in temperature at 100km, 2004-2006