長期シミュレーションを用いた成層圏昇温時の大気潮汐変動と電離圏への影響

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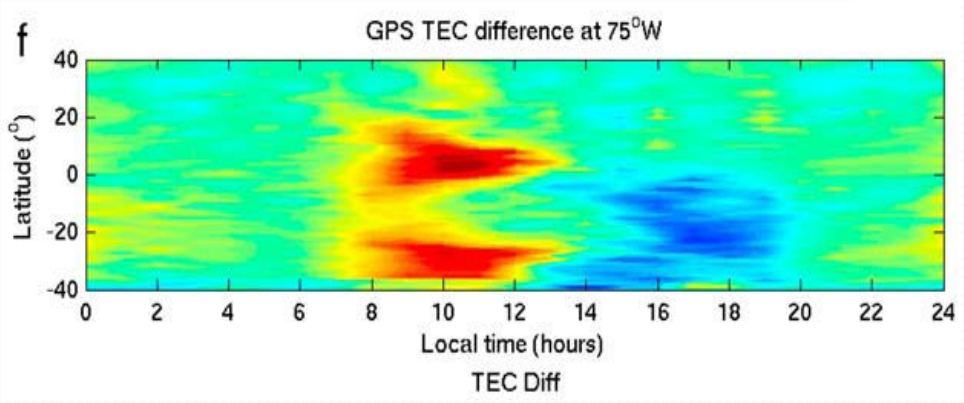
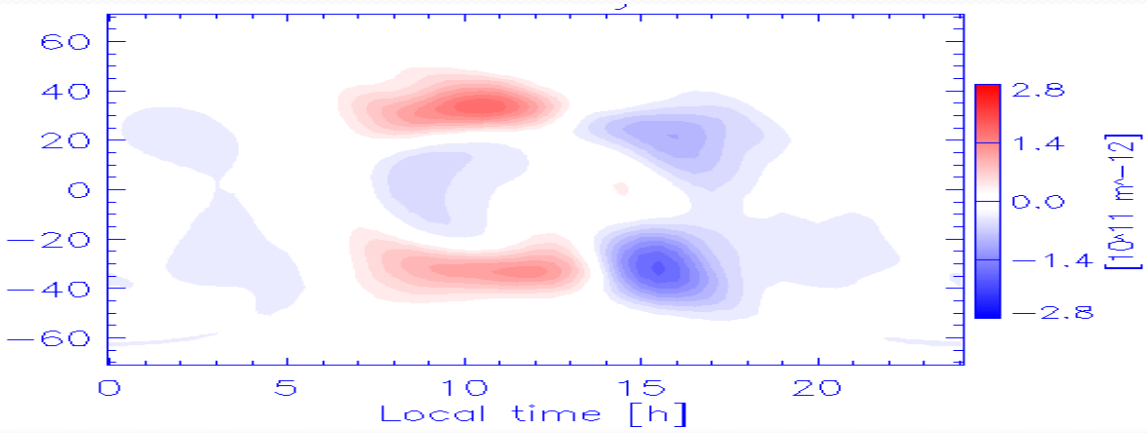
Introduction： Effects of SSW on ionosphere

Observation：
GPS-TEC at 75°W
Difference before and after SSW
[Goncharenko et al., 2010]



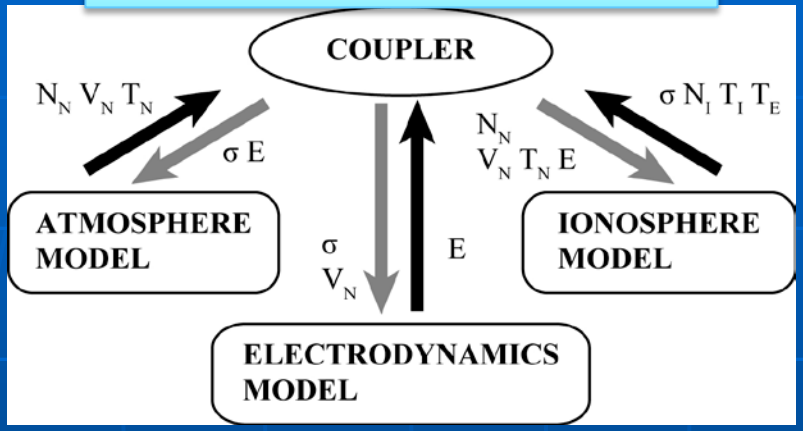
GAIA Simulation：
F region electron density
(zonal mean)
Difference before and after SSW
[Jin et al., 2012]

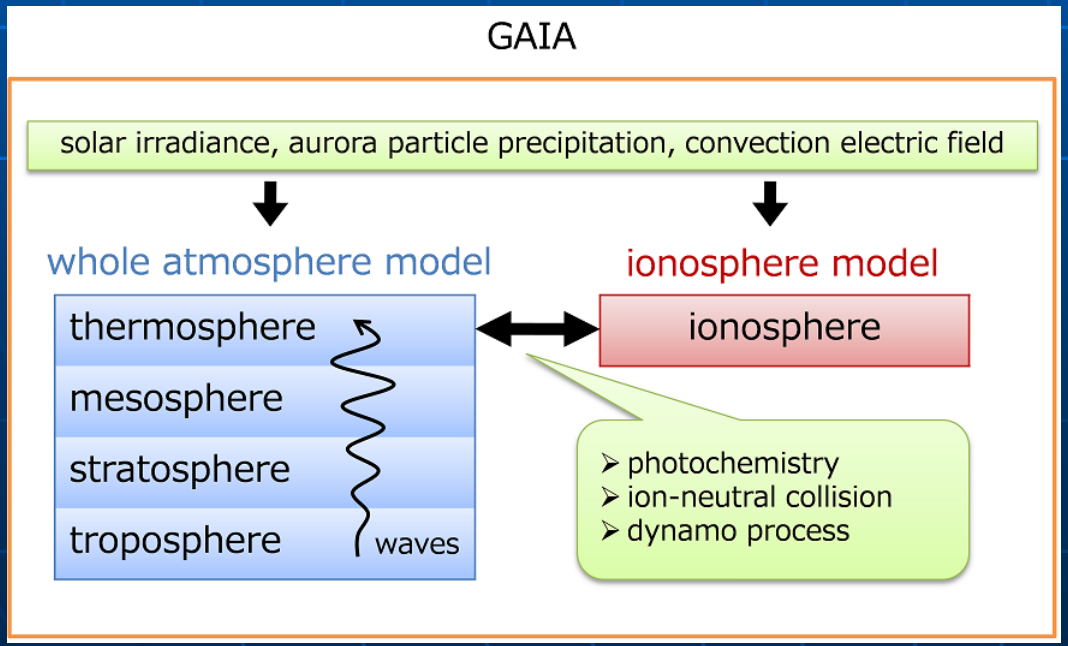


- Recent studies have revealed effect of SSW on ionosphere is significant, and several mechanisms for the lower and upper atmospheric coupling have been proposed.
- Most studies focused on the recent major SSWs (2009/1, 2013/1,,,), but how about other SSWs? What are the general processes? What causes differences?

Ground-to-topside model of Atmosphere and Ionosphere for Aeronomy(GAIA)

Self-consistent coupling





Included

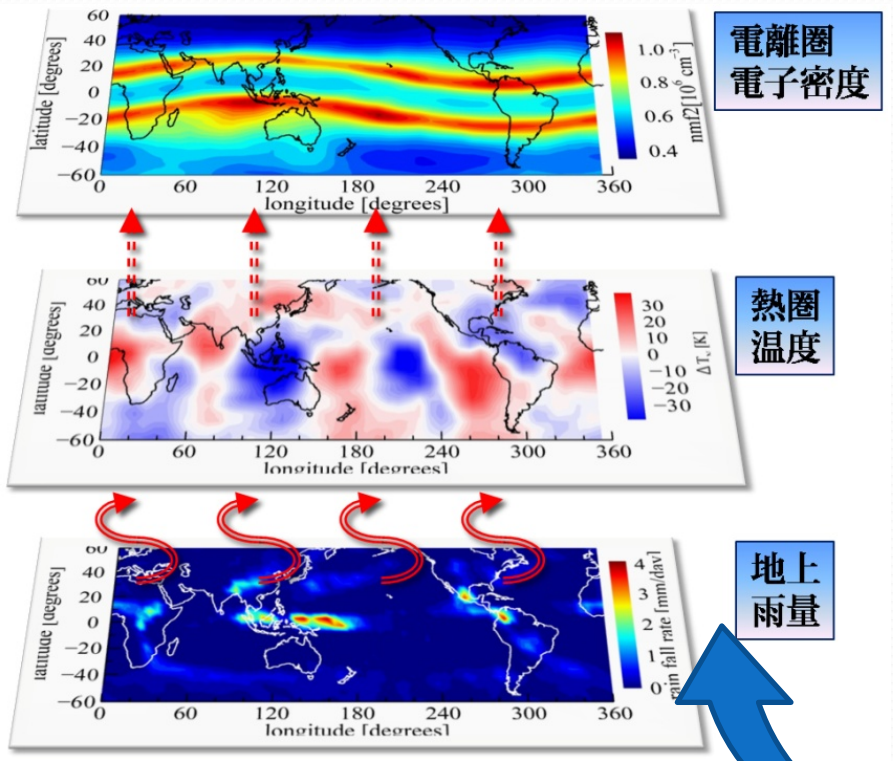
- Seamless neutral atmosphere from ground to topside thermosphere
- Meteorological processes
- Self-consistent interaction between thermosphere-ionosphere
- Spatial Resolution lon-lat 1*1, 2.5*2.5, 5.0*5.0, L75 and L150

Not Included

- Detail chemical reactions in GCM
- Inertia terms in ion momentum equation
  →upper ionosphere, plasmasphere not rigorous
- Tilted dipole magnetic field used
- Realistic Magnetospheric inputs
- Only F10.7 used
- No lunar tide

Realistic whole atmosphere-ionosphere simulation

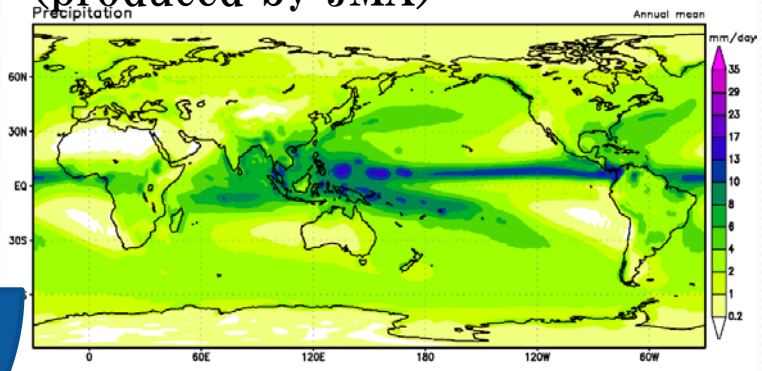
Whole atmosphere-ionosphere model (GAIA)



Realistic input parameters

F10.7 at Penticton

Meteorological Reanalysis data
(produced by JMA)



nudging at 0-30 km altitudes

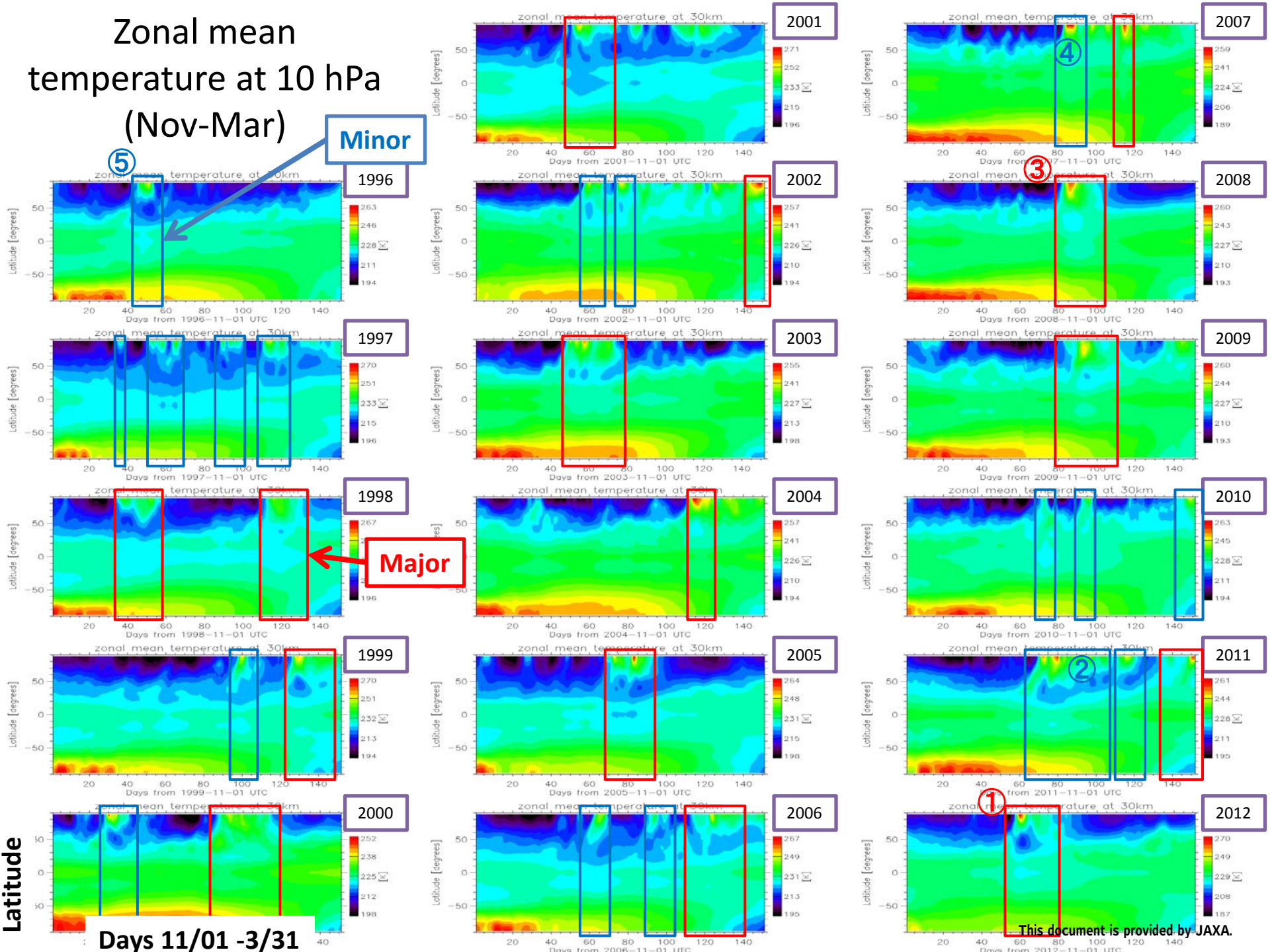
surface temperature and pressure, temperature, zonal and meridional winds, water vapor

- Simulation period: 1996/1 - 2015/6
- magnetospheric inputs are fixed to quiet levels

Database of GAIA long-term run

- All variables (~original output from the model)
  - ✓ Neutral variables: mass ratio (O, O2), Un, Vn, Wn, Tn, z, rain precipitation, …
  - ✓ Ionospheric variables: density (O+, O2+, N2+, NO+, O, O2, N2), **Vn**, Te, Ti, **E**, **J**
- Tidal components: DW1, SW2, TW3, DE3, SW1, …
  extracted by short-term Fourier decomposition
- Data coverage
  - Neutral variables: (2.8 deg * 2.8 deg), vertical 150 layers (0-~700km), 1 hour interval
  - Ionospheric variables: 2.5 deg * 2 deg * 10 km from (0-1800km), 0.5 hour interval
  - 1996/1 – 2015/6
- Format: Netcdf4
- Available from NICT Science Cloud

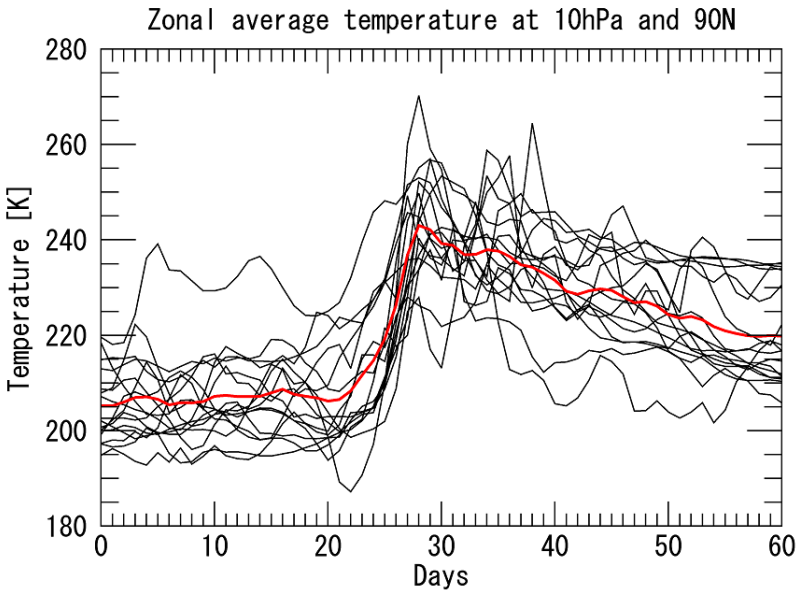
Zonal mean temperature at 10 hPa (Nov-Mar)

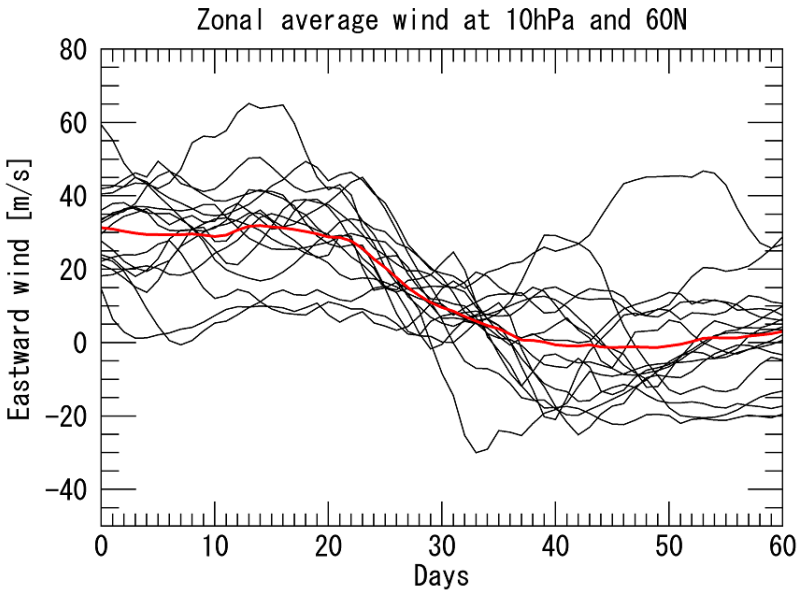


Superposed epoch analysis

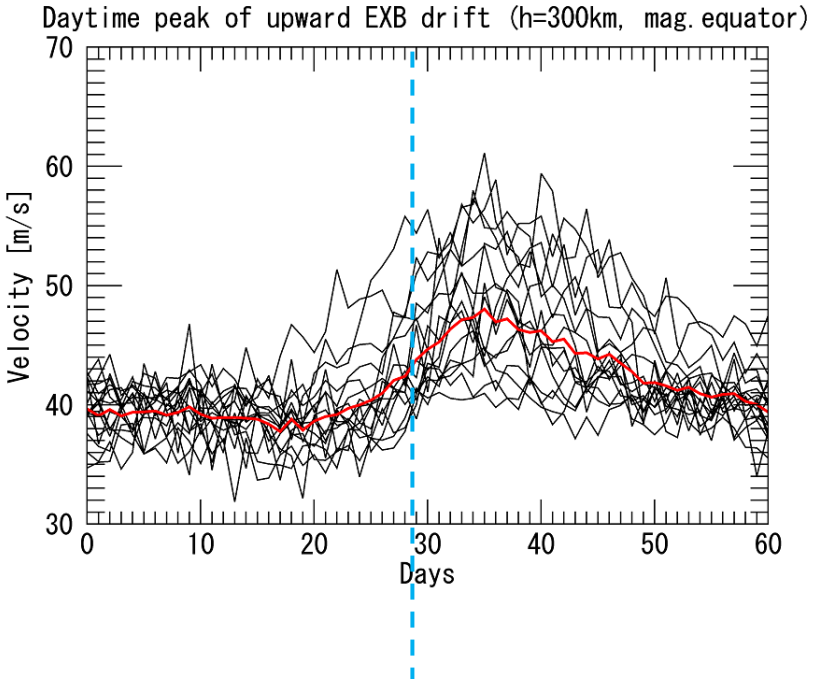
- SSW発生（10Pa高度で1週間以内に25K以上温度増加）が確認された日を基準に前20日、後40日を抽出。
- イベントどうしが30日以上離れているものを選ぶ。

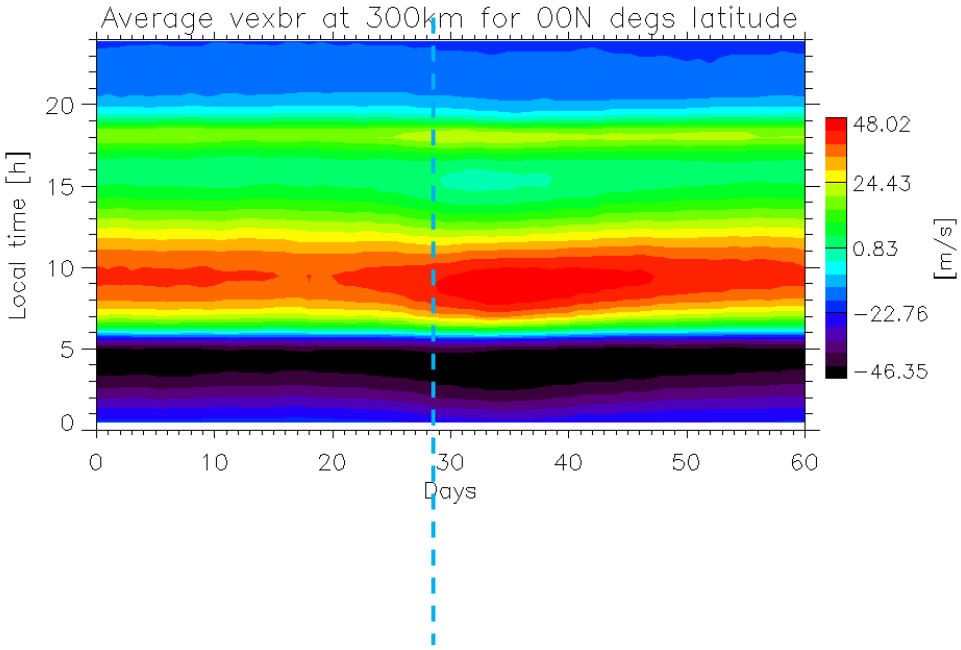
→全部で16イベント





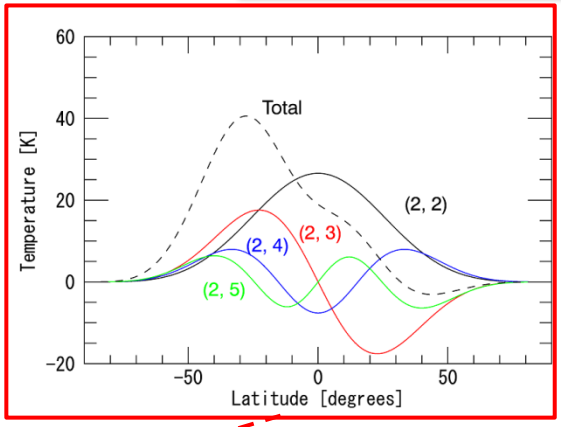
Upward EXB drift during SSW (h=300km, mag.equator)

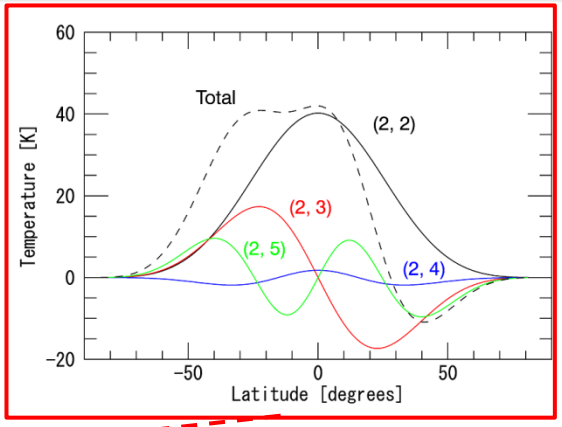




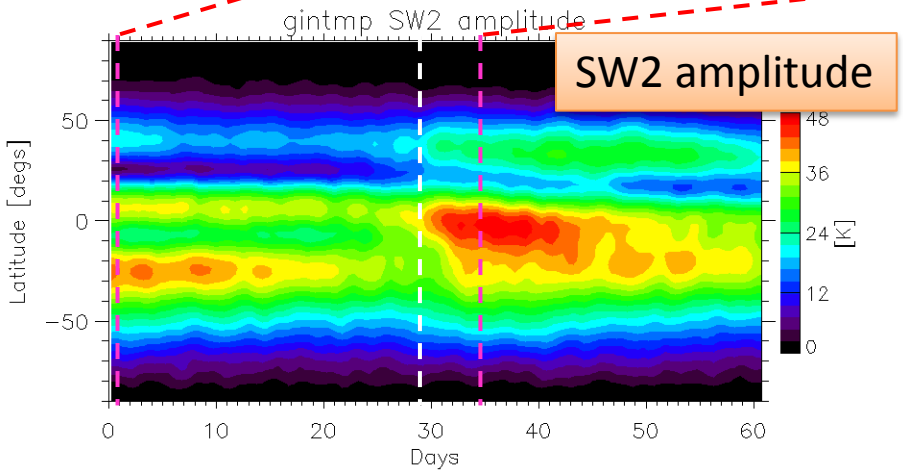
Day of average peak temperature
at North Pole at 10hPa

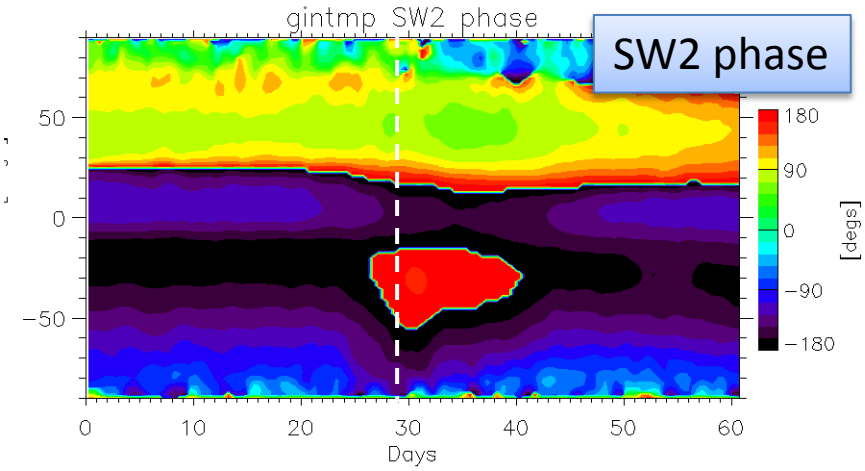
Average tidal variation at 120 km (SW2)

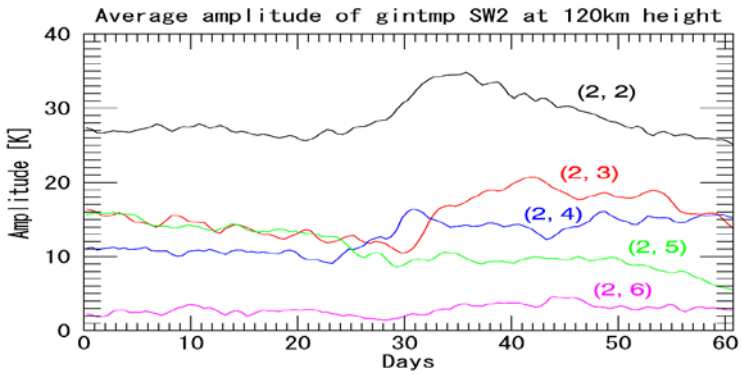


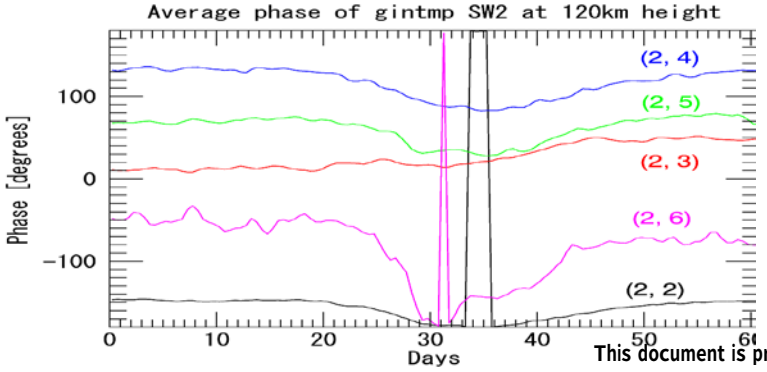


← SW2 temperature (at LT=0)

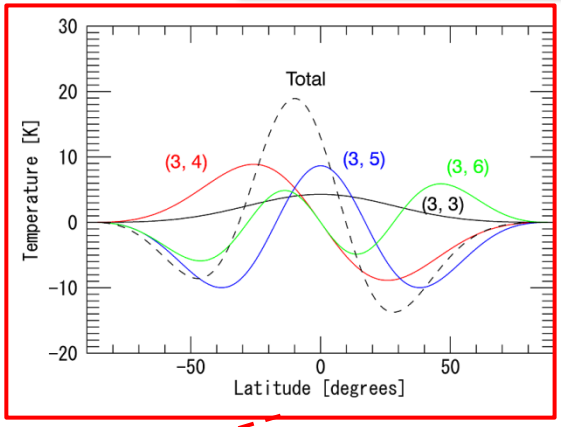


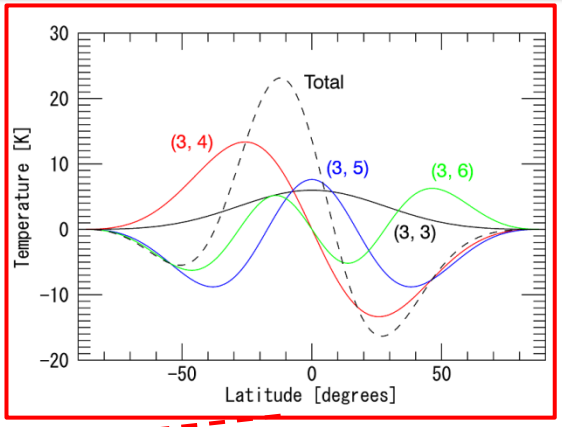




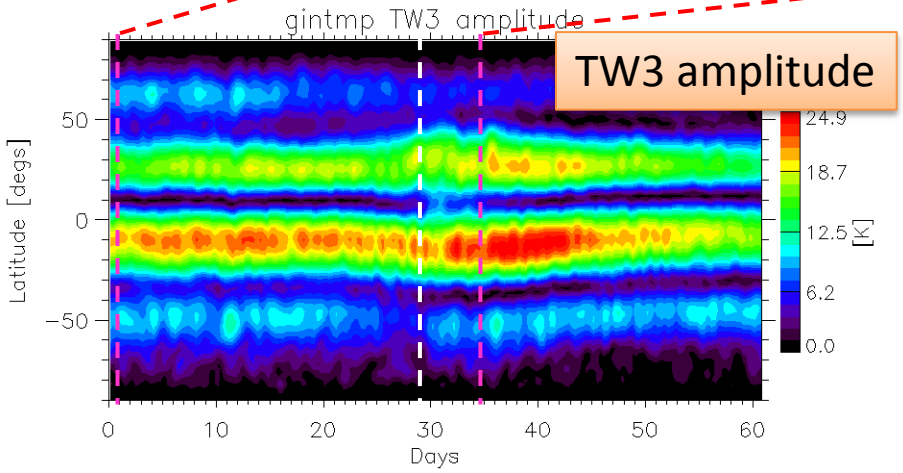


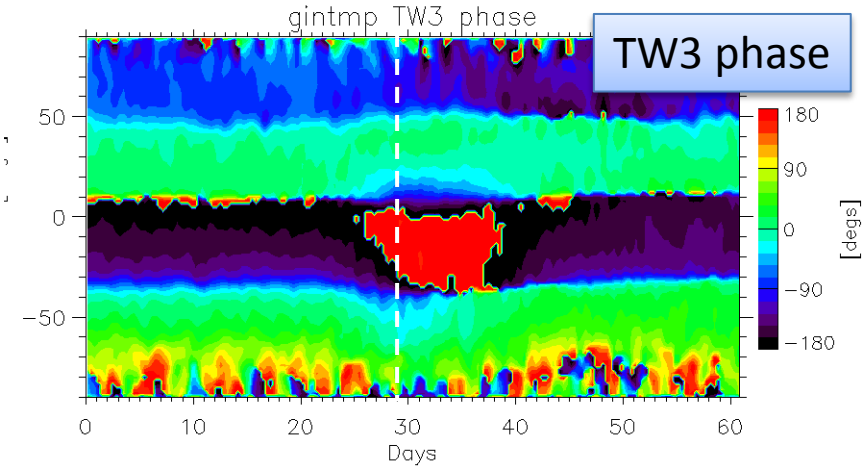
Average tidal variation at 120 km (TW3)

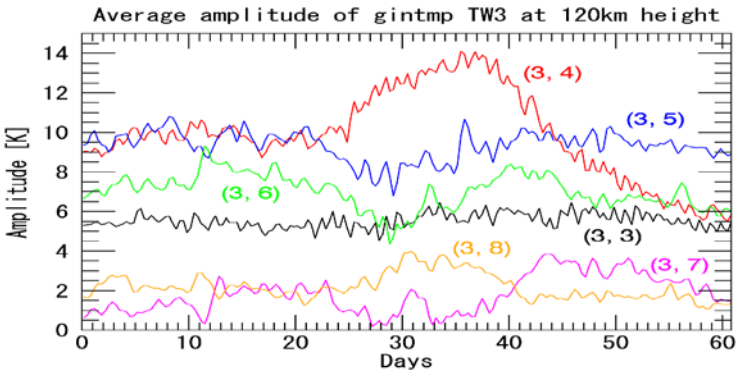


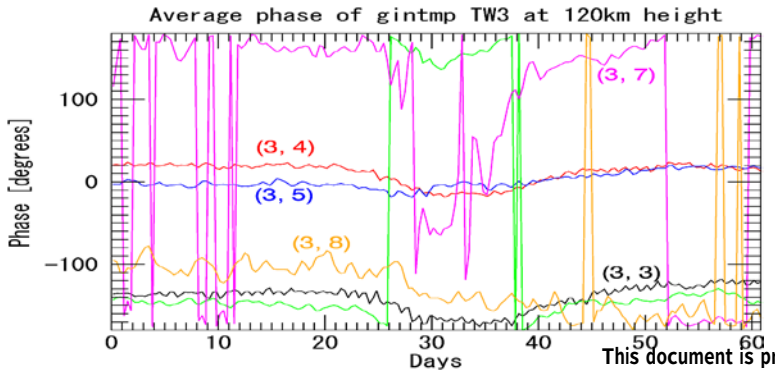


← TW3 temperature (at LT=0)









Conclusion

- Relation between upward VEXB in equatorial ionosphere and polar stratospheric temperature
  - On average large Tn increase leads to large increase of VEXB
  - but not always true (correlation is 0.59)
- Tidal variation at dynamo layer
  - On average, SW2, TW3 and DW1 change in amplitude and phase during SSW periods.
  - Especially, (2,2), (2,3), (2,4), (3,3), (3,4), (1,1)

Future Analysis

- Which changes of amplitude and phase of tidal modes cause the difference of increase in EXB drift?
- Which changes in background middle atmosphere lead to the tidal variabilities in the lower thermosphere?