



COUP-9

2019 Southern Hemispheric SSW triggered Q6DW-Tide-GW interactions observed by meteor radars at 30° S



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Introduction & Motivation

- 2019 SH Sudden Stratospheric Warming (SSW) is a rare SH SSW (NH SSWs occur ~6 times per decade);
- Quasi-6-Day Wave (Q6DW) are greater than the average in Sep., globally observed in the MLT region and ionosphere;
- Motivation:** Does this strong Q6DW activity impact on tides and Gravity Waves (GW) propagation?

Data & Methodology

Instruments

Table 1. Specs of two meteor radars used in this work.

	Radar Specs	Site, lat, long, Height	Status during SSW
CONDOR	Freq: 35.15MHz High power (48kW) & high detection rate (30,000/day/site)	ALO, 30° S, 71°W, 2520m	From 06/26/2019
		SCO, 31° S, 70°W, 1140m	From 07/14/2019
		LCO, 29° S, 71°W, 2339m	From 02/20/2020
Buckland Park MR	Freq: 55Mhz Power: 18kW	Main, 35°S, 139°E, 302m	ST mode not MLT
		Remote, 35°S, 138°E, 2m	10 days of wind used

Methodology

Input: Meteor radar observations with high temporal & spatial resolution

bipolar distribution coefficient D_α

Line-of-sight velocity

Temperature gradient model [Hocking et al. 1999]

$$T_{radar} = S \cdot \log_{10} \left[e \left(2 \frac{dT}{dz} + \frac{mg}{k} \right) \right]$$

$$\frac{dT}{dz} \approx -1.2, \frac{mg}{k} \approx 33.2$$

Note that S is the slope of D_α at peak height.

3DVAR: GW dynamics on regional scales [Stober et al., 2021]

$$\Lambda = \Sigma \left((v'_{rad})^2 - (v'_{radm})^2 \right)^2$$

Minimize Λ

Get Partially differentiated $u^2, v^2, w^2, u'v', u'w', v'w'$

Compare with SD-WACCM-X simulations

Time averaged Eliassen-Palm flux

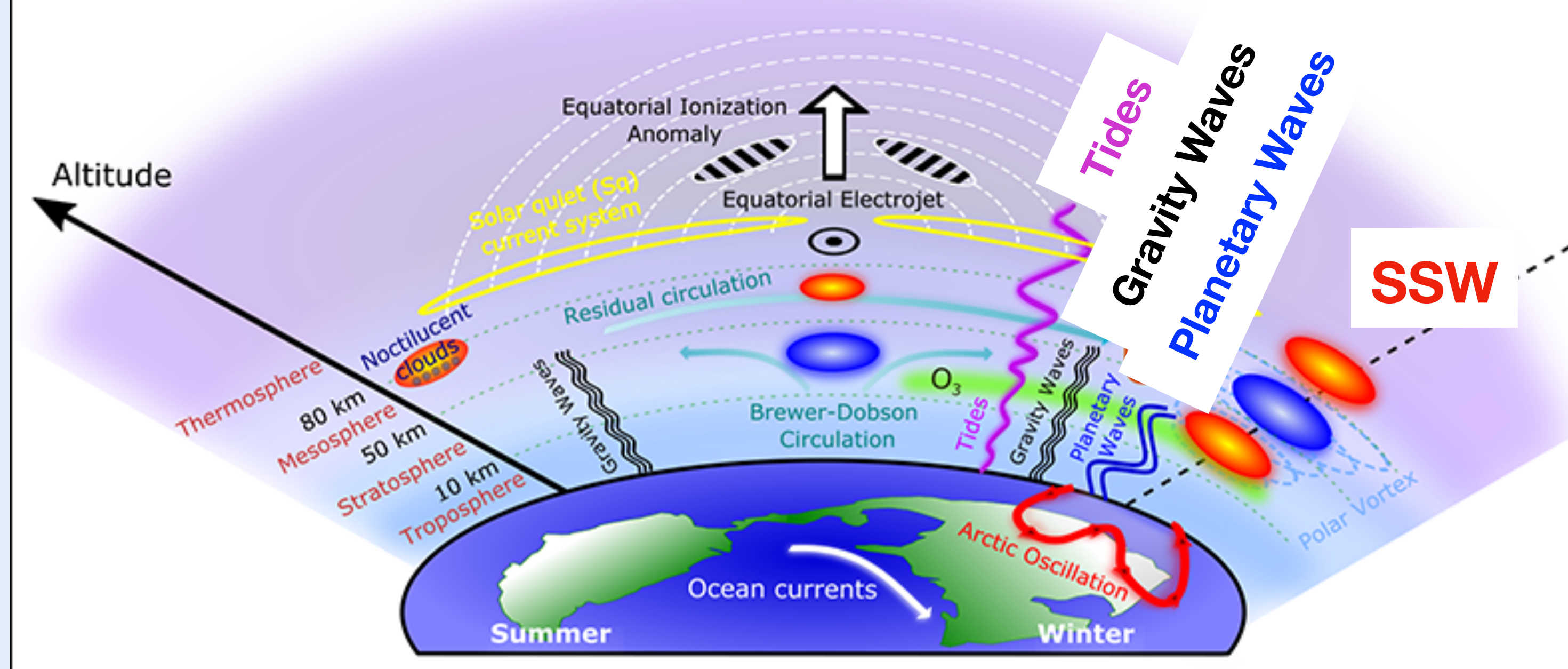
$$\mathbf{F} = \hat{\mathbf{j}}F_y + \hat{\mathbf{k}}F_z$$

$$F_y = -\overline{u_0 v'_0} = -\frac{1}{2} \Re \{ \tilde{u}_{Q6DW} \tilde{v}_{Q6DW}^* \}$$
 Momentum flux

$$F_z = \frac{gf}{N^2} \frac{\overline{\theta_0 v'_0}}{\theta_s} = \frac{gf}{N^2} \frac{\Re \{ \tilde{\theta}_{Q6DW} \tilde{v}_{Q6DW}^* \}}{2\theta_s}$$
 Heat flux

E-P flux indicates the energy propagation of PWs
Divergence of E-P flux suggests the energy source/sink.

Coupling processes during SSW. [Pedatella et al., 2018]



Result 1: Q6DW Diagnosis

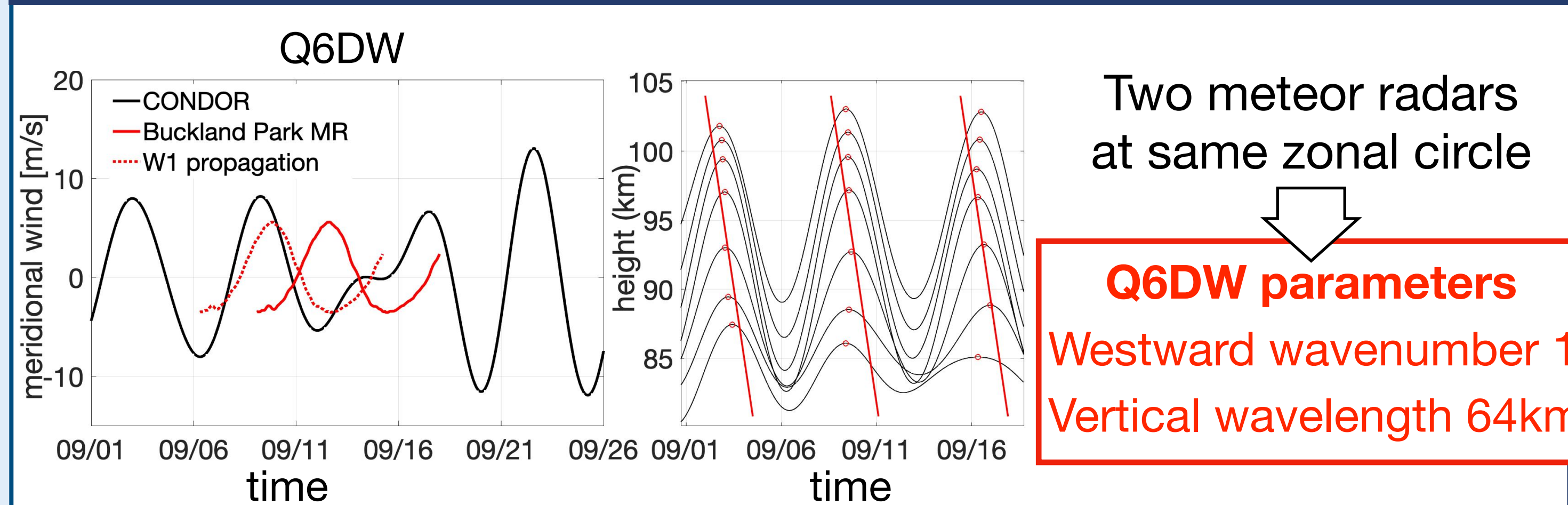


Figure 1. 151.75° longitudinally spaced CONDOR and Buckland Park meteor radar winds are combined to diagnose the parameters of Q6DW.

Result 3: Radar & Model Q6DW E-P flux

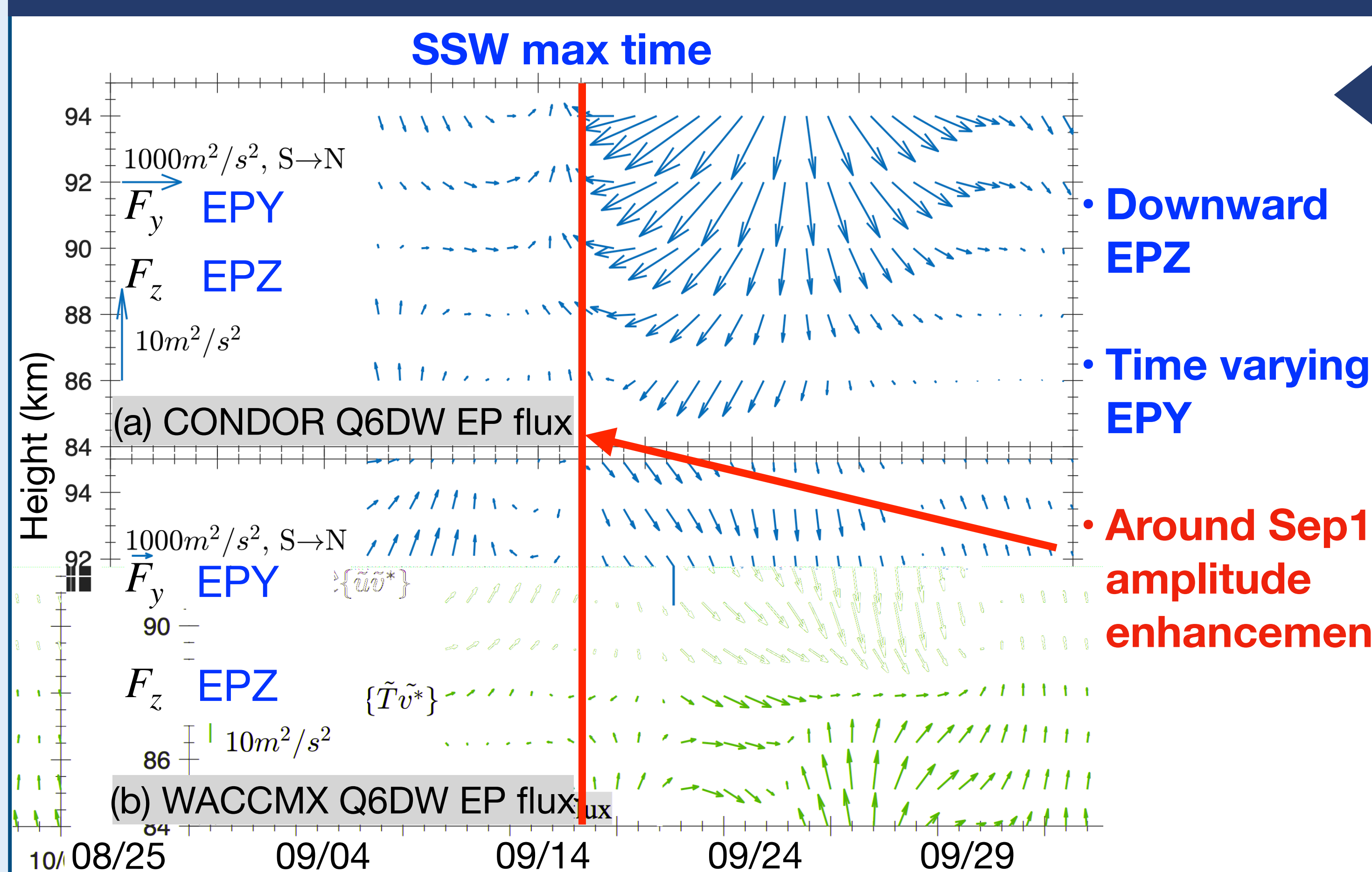


Figure 3. Q6DW E-P flux vectors derived from (a) CONDOR observation and (b) SD-WACCM-X simulation.

- First result of meteor radar observed Q6DW E-P flux exhibits a good agreement with simulation.
- Enhancement of the E-P flux suggests potential energy/momentum deposition in the background atmosphere.

Result 2: Q6DW-Tide-GW interactions

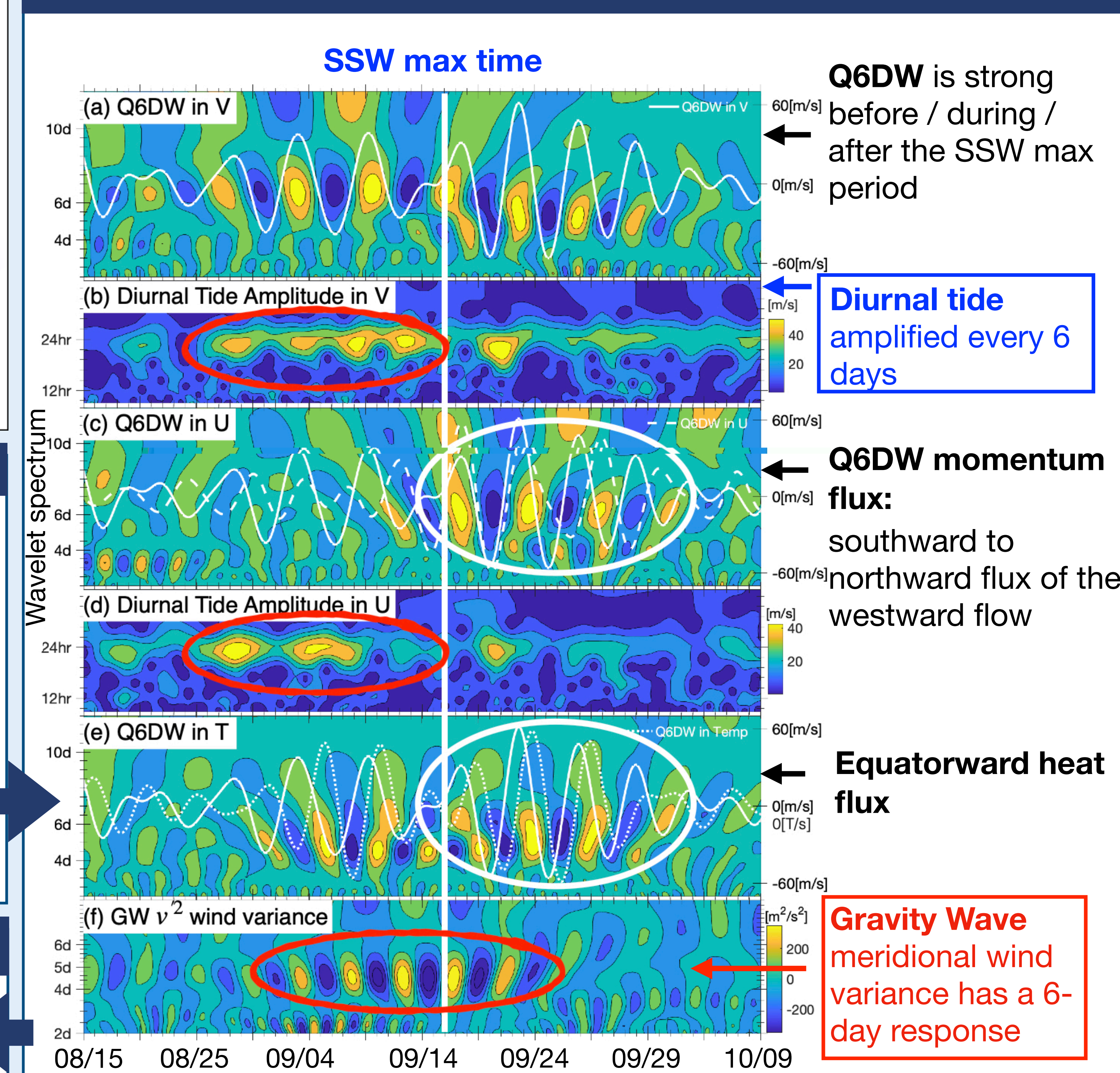


Figure 2. Morse wavelet spectrum of Q6DW in (a) V, (c) U, (e) T; diurnal tide amplitude in (b) V and (d) U; (f) GW variance in meridional wind at 90km.

Conclusion

- A strong W1 Q6DW activity associated with the rare 2019 SH minor SSW is determined by two meteor radars at 30° S.
- Both GW wind variance and diurnal tide amplitude indicate a strong, clear quasi-6-day periodicity in meridional winds.
- First result of meteor radar observed Q6DW E-P flux is presented and exhibits a good agreement with SD-WACCM-X simulation, indicating equatorward heat flux and time varying momentum flux.
- Q6DW-Diurnal Tides-GW interactions in the MLT region may contribute to the reported ionospheric 6-day variability [Yamazaki et al., 2020].
- The manuscript related to this poster is to be submitted to GRL.

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