Climatology of mesospheric and lower thermospheric diurnal tides over Jicamarca (12°S, 77°W): Observations and simulations

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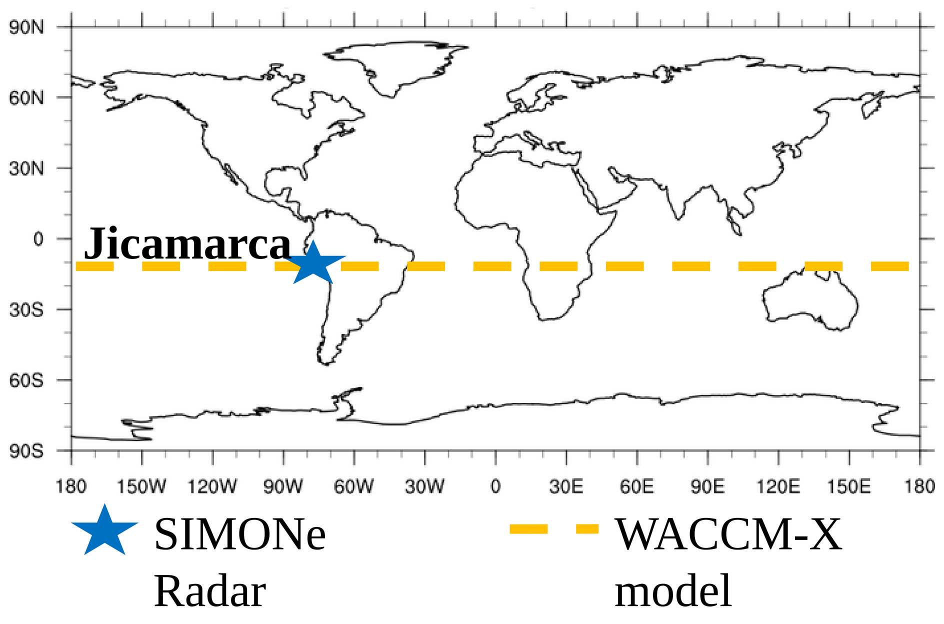
Introduction



- The **M**esosphere and **L**ower **T**hermosphere is the transition region (80-110 km) between our atmosphere and the geospace.
- The diurnal tides (T = 24 h) are the most dominant MLT large-scale oscillation over Jicamarca (12°S, 77°W).
- Diurnal tide could be migrating (DW1) and non-migrating (e.g., DW2 and DE3).

$$A\cos(\omega t - k_1\lambda + \alpha_0) + B\cos(\omega t - k_2\lambda + \beta_0) = A_{tot}\cos(\omega t + \varphi_{tot})$$

Motivation

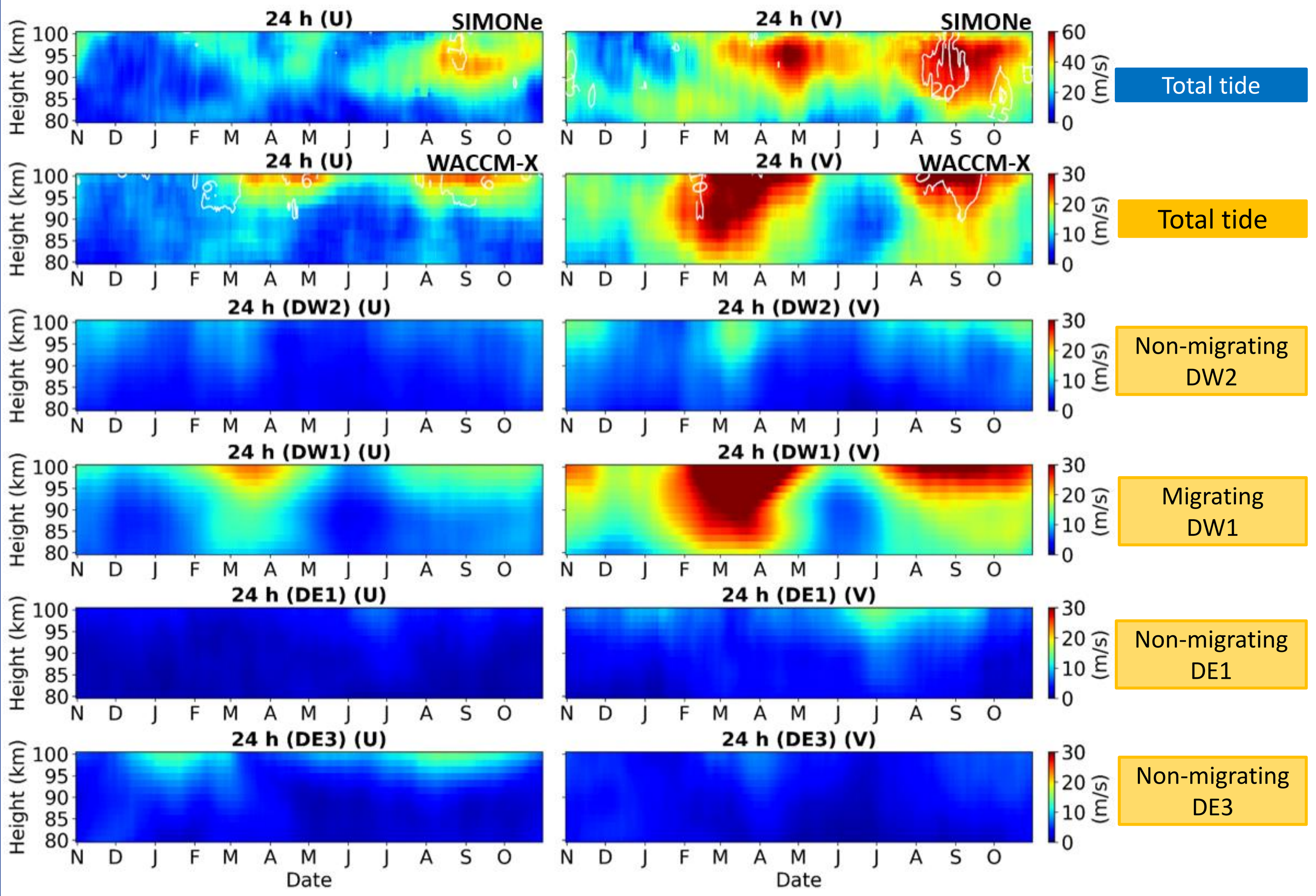
- A single radar only can measure total tides (it can not separate migrating and non-migrating), but it is known that the non-migrating contribution is significant.
- The diurnal tide, as it propagates vertically, could be modulated by different oscillations, which is important to understand the coupling between atmospheric layers.

Objectives

1. Obtain the climatology of the total diurnal tide over Jicamarca.
2. Infer the possible non-migrating contribution to the total diurnal tide.
3. Report the main periods that modulate the total diurnal tide.

Results

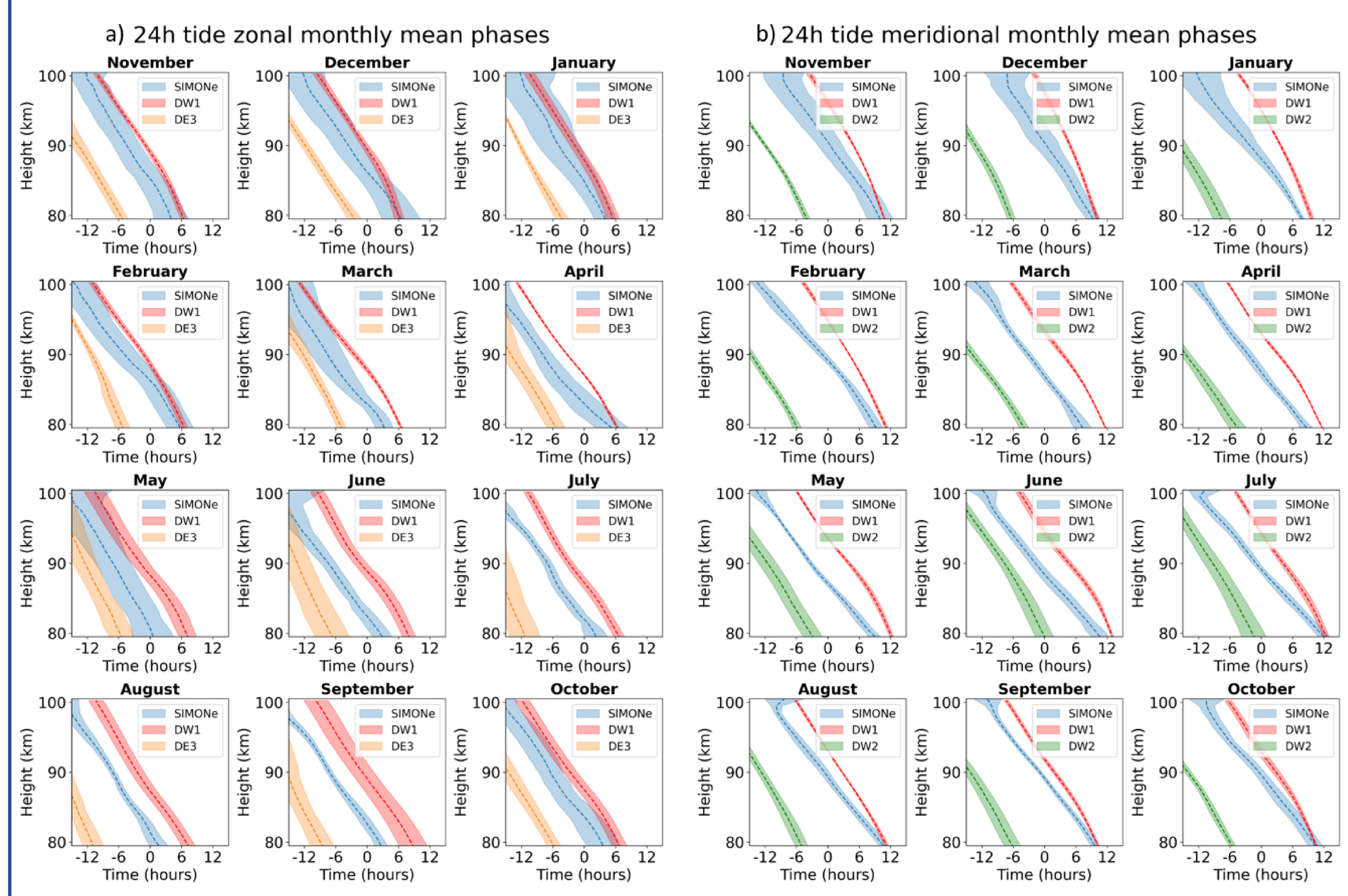
Fig 1. Climatology of the observational total tide (first row), modeled total tide (second row) and DW2, DW1, DE1 and DE3 (from third to sixth row) .



R1a. Observational maxima of the total tide:
Zonal: August-September
Meridional: August-September and April-May

R1b. Dominant wavenumbers:
Zonal: DW1 & DE3 Meridional: DW1 & DW2

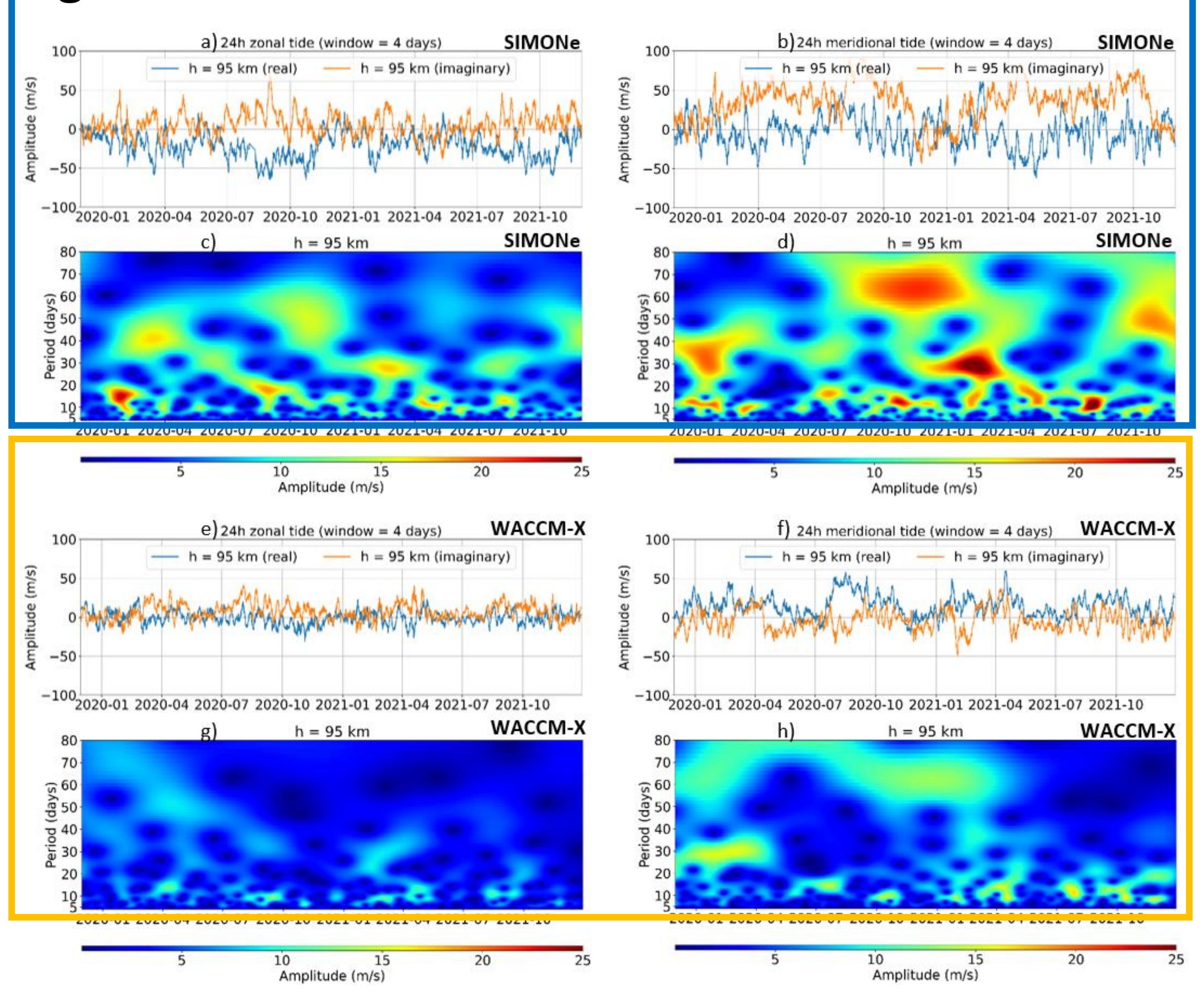
Fig 2. Phase profiles of the zonal (left) and meridional (right) diurnal tides.



R2. Total tide phase profiles are more separated from the migrating DW1 in the component:
Zonal: From June to September
Meridional: From November to July

$$\varphi_{tot} = \operatorname{atan}\frac{A\sin(\alpha) + B\sin(\beta)}{A\cos(\alpha) + B\cos(\beta)}$$

Fig 3. Modulations of the total diurnal tide at 95 km



R3. Observations and Model show modulating signatures from 5-80 days.

$$x(t) = m(t)_{tot}\cos(\omega t + \varphi_{tot})$$

$$m(t) = A_m\cos(\omega_m t + \varphi_m)$$

Discussion

D1a. The observed shifted and asymmetrical maxima could be due to the non-migrating contributions.

D1b. Although the model shows amplitudes twice as small as the observations. We can use the phase profiles as references.

D2. We can infer that:
Zonal: DE3 is most significant from June to September,
Meridional: DW2 is most significant from Nov. to July.
Good agreement with satellite observations [2,3].

D3. Modulations are most likely due to:
- **Planetary Wave**s (5-25 days),
- **Large-scale tropospheric oscillations** (>25 days): e.g. Madden Julian Oscillations [4].

Conclusions and Future Work

- We have obtained the total diurnal tide climatology over Jicamarca, and we have inferred the non-migrating contribution, being the DE3 (DW2) tide significant from June to September (from November to July) for the zonal (meridional) component. Finally, periods between 5-80 days are observed that modulate the total diurnal tides. These modulations might be associated to large-scale tropospheric oscillations.
- We plan to study the longitudinal variability of the large-scale mesospheric dynamics over low latitudes.

References

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[3] Wu et al. (2008). DOI: :10.1029/2007JA012543
[4] Eckermann et al. (1997). DOI: 10.1016/S1364-6826(96)00143-5