The impact of Super El Nino on the Global Electrical Circuit

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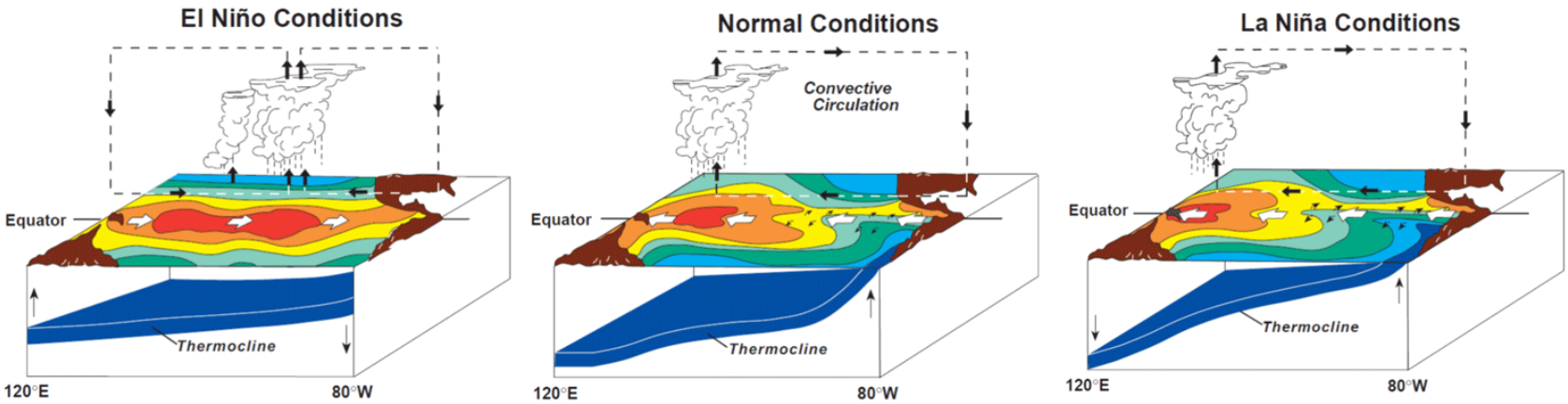
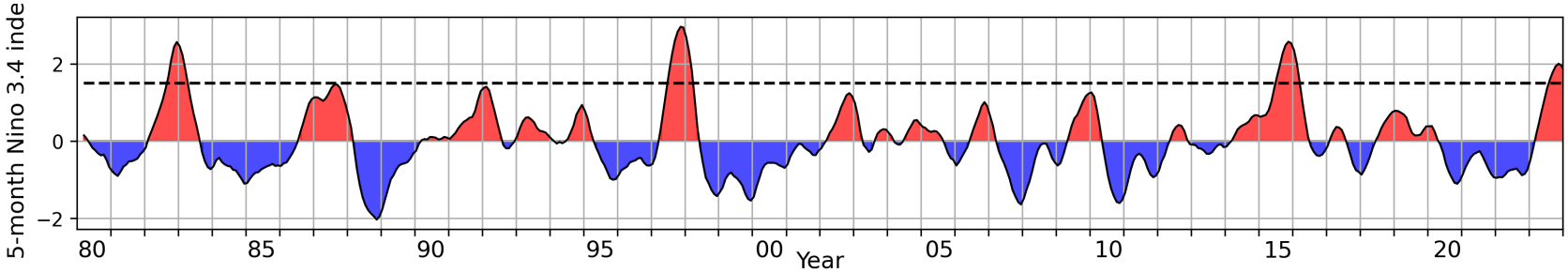
El Niño Southern Oscillation

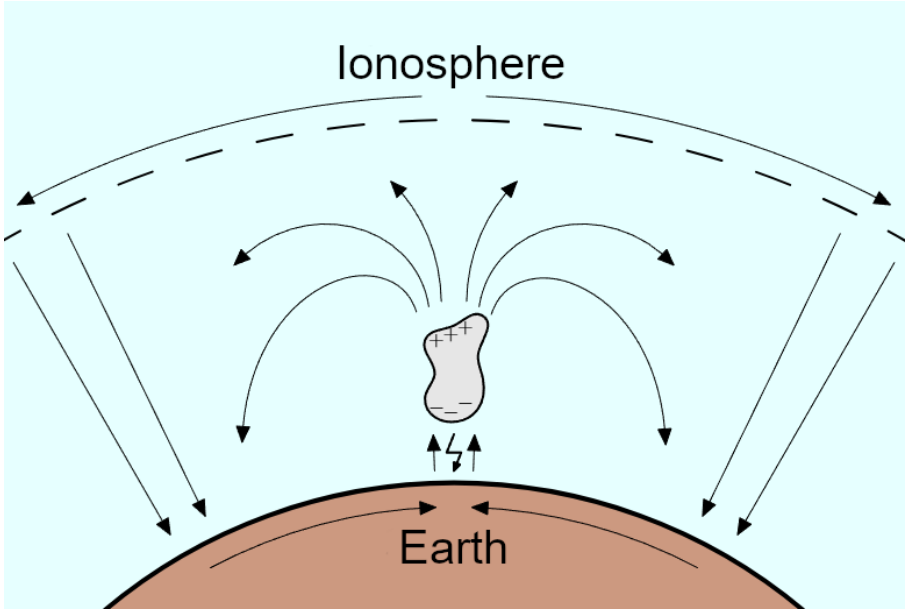


The El Niño—Southern Oscillation (ENSO) is the large cause of climate variations on Earth. The ENSO cycle is made up of a warm phase (El Niño) and a cold phase (La Niña), when the sea surface temperatures in the central and eastern equatorial Pacific Ocean heat/cool by a few degrees for 12–18 months respectively.



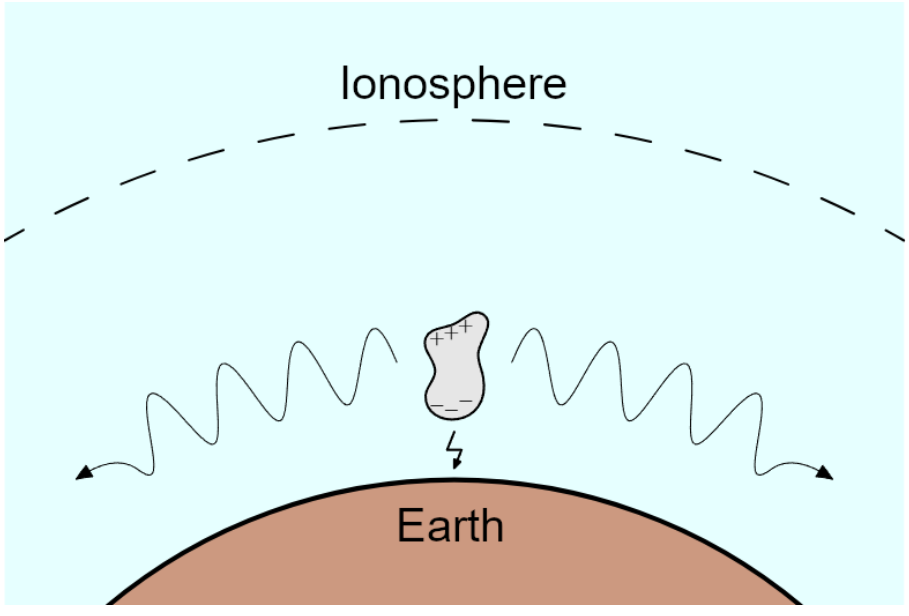
Global electric circuit

DC global electric circuit



The global distribution of charging currents in clouds with a developed electrical structure maintains a quasi-stationary current throughout the atmosphere

AC global electric circuit



The global distribution of lightning discharges supports oscillations in the Earth—ionosphere resonator (first of all, Schumann resonances)

Parametrization

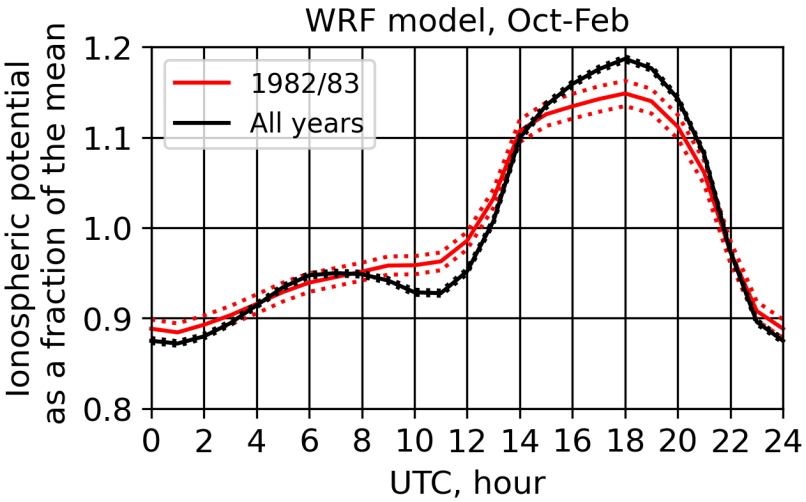
$$V = \int \int \frac{j_z^s(z, \lambda, \psi)}{S_E \sigma(z)} \, dz \, dS$$

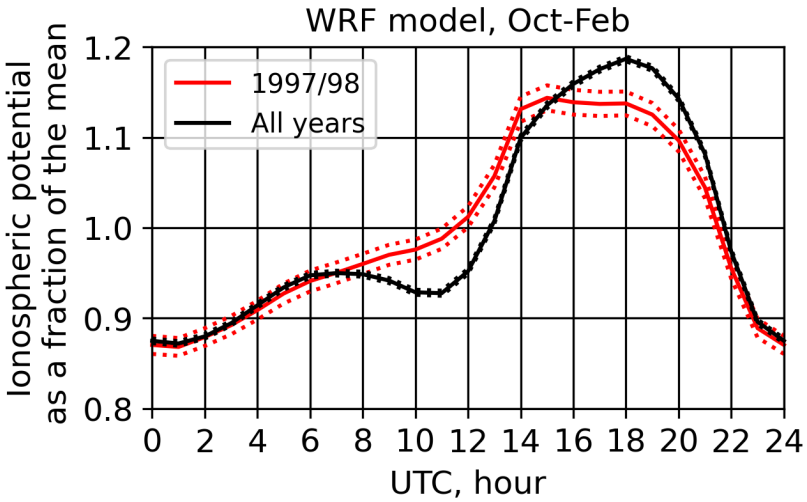
Following parametrization of the IP is used:

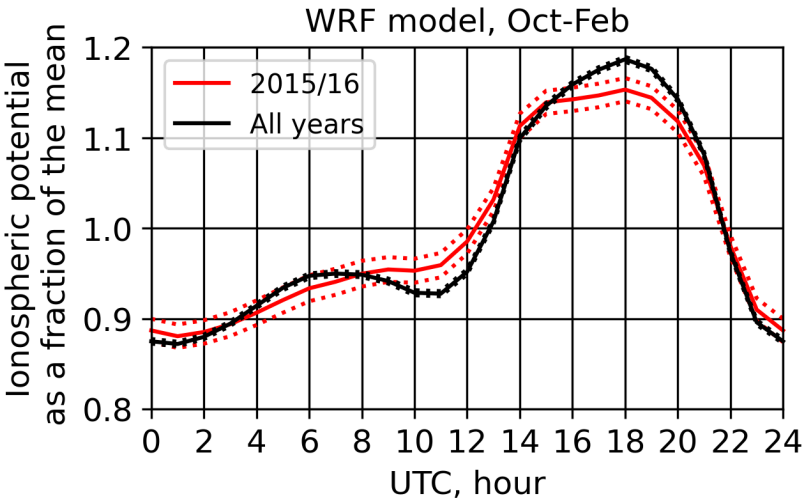
$$V = \sum_i \frac{j_0 H S_i}{\sigma_0 S_E} \frac{P_i}{W_i} \left(exp\left(-\frac{z_i^l}{H}\right) - exp\left(-\frac{z_i^u}{H}\right) \right) \times \begin{cases} 0, & \varepsilon_i < \varepsilon_0 \\ 1, & \varepsilon_i \geq \varepsilon_0 \end{cases}$$

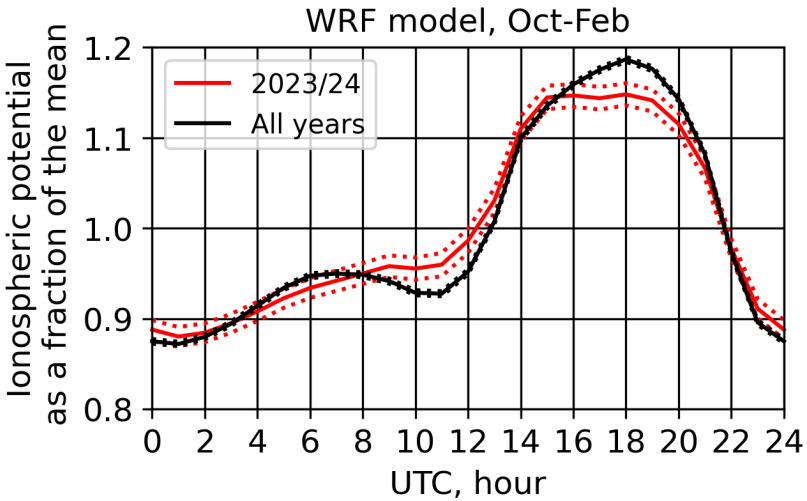
where S_i is the area covered by the i-th model grid column, W_i is the total amount of precipitable water stored in this column, P_i is the amount of precipitation in this column totalled over a symmetric 2 h interval, z_i^l and z_i^u is the heights of the 0 °C and -38 °C isotherms and ε_i is the maximum convective available potential energy (CAPE) averaged over the same column.

Influence of El Niño events on the IP

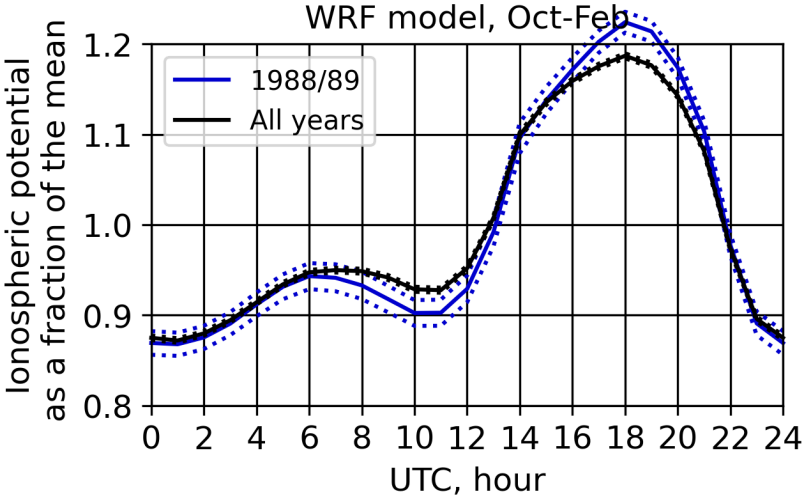


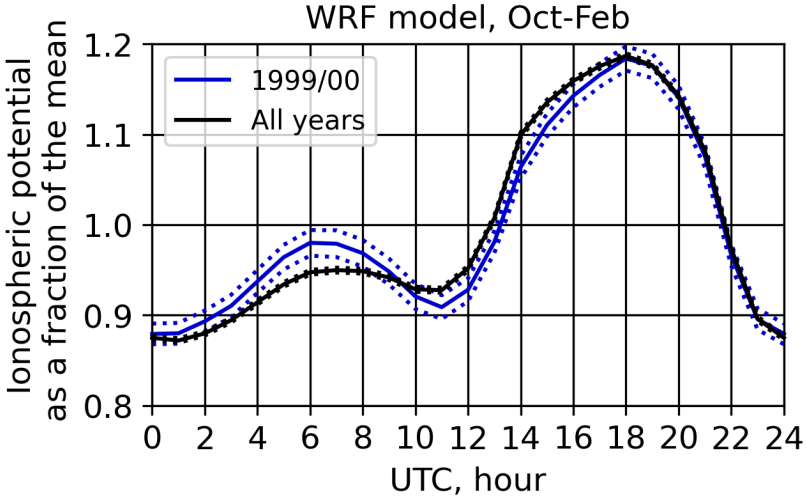


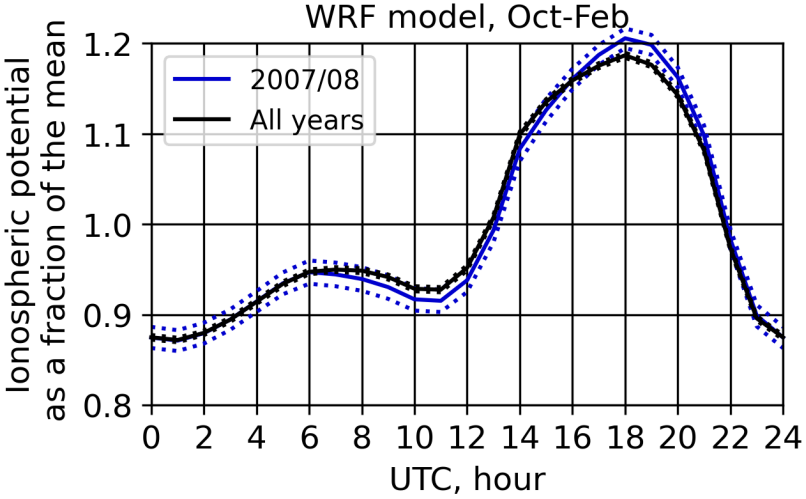


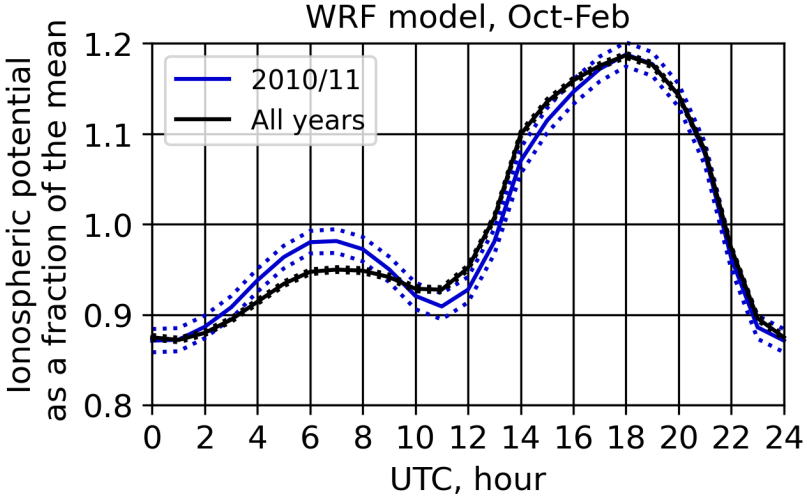


Influence of La Niña events on the IP

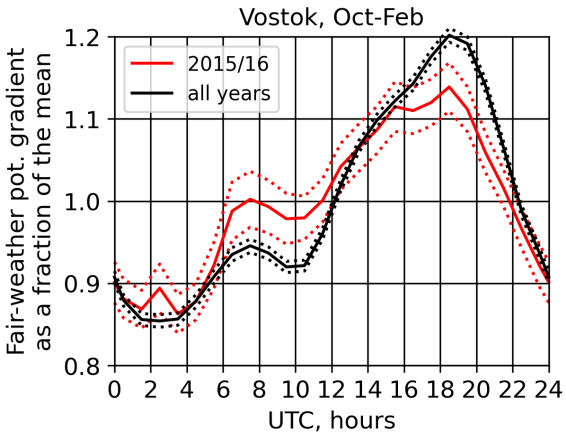


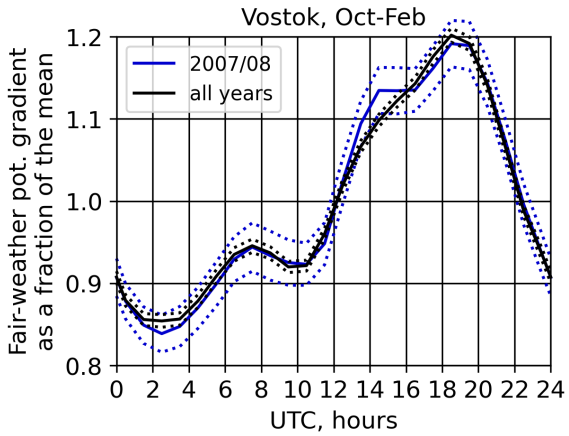


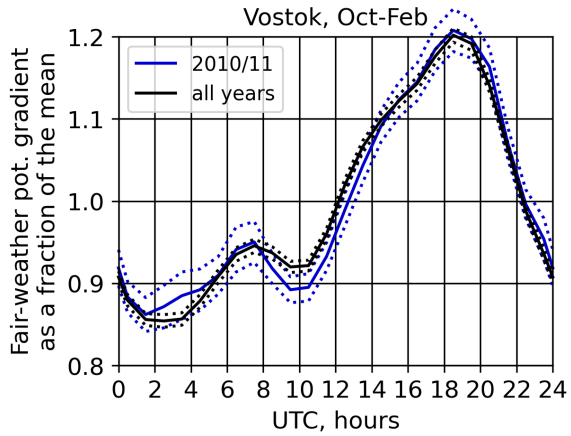




Influence of El Niño and La Niña events on the PG





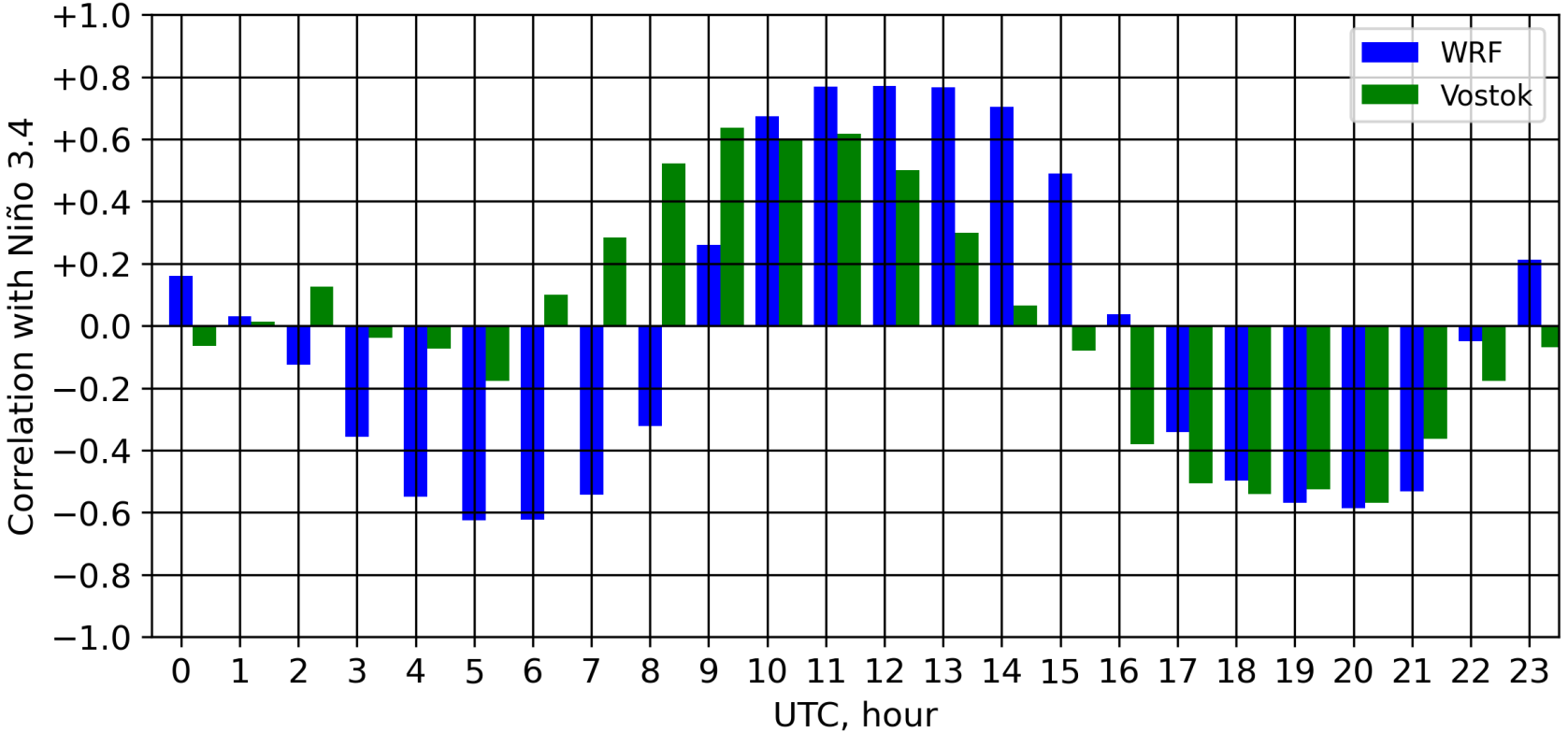


- The days with incomplete/absent hourly data have been excluded
- The days with negative/zero hourly PG values have been excluded
- The days with hourly PG values exceeding 300 V/m have been excluded
- Among the remaining days only those have been retained for which the diurnal peak-to-peak amplitude does not exceed 150% of the diurnal mean

Correlations between ENSO and GEC

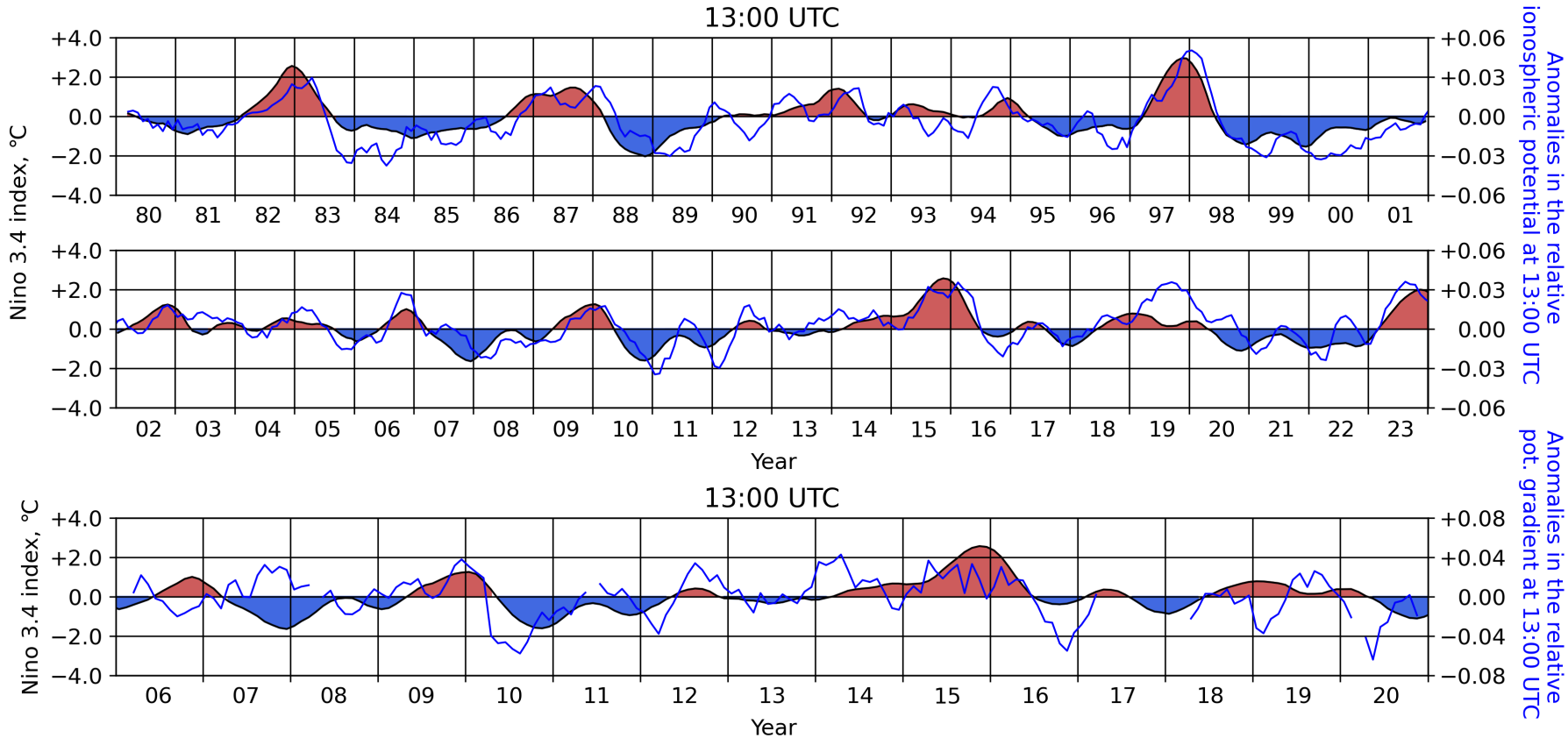
Anomalies of the Niño 3.4 index: $AV(m,y) = \hat{V}(m,y) - \hat{V}(m)$

Anomalies of IP: $AV[h](m,y) = \frac{\hat{V}(m,y;h)}{\langle \hat{V}(m,y;h) \rangle} - \frac{\hat{V}(m;h)}{\langle \hat{V}(m;h) \rangle}$



Temporal variations of ENSO and the GEC at 13:00 UTC

The correlation coefficient between Niño 3.4 SST and relative IP has a maximum of 0.78 at 13:00 UTC.



Temporal variations of ENSO and the GEC at 21:00 UTC

The correlation coefficient between
Niño 3.4 SST and relative IP has a minimum of -0.83 at 21:00 UTC.