

# Solar variability in UKCA

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**NIWA**

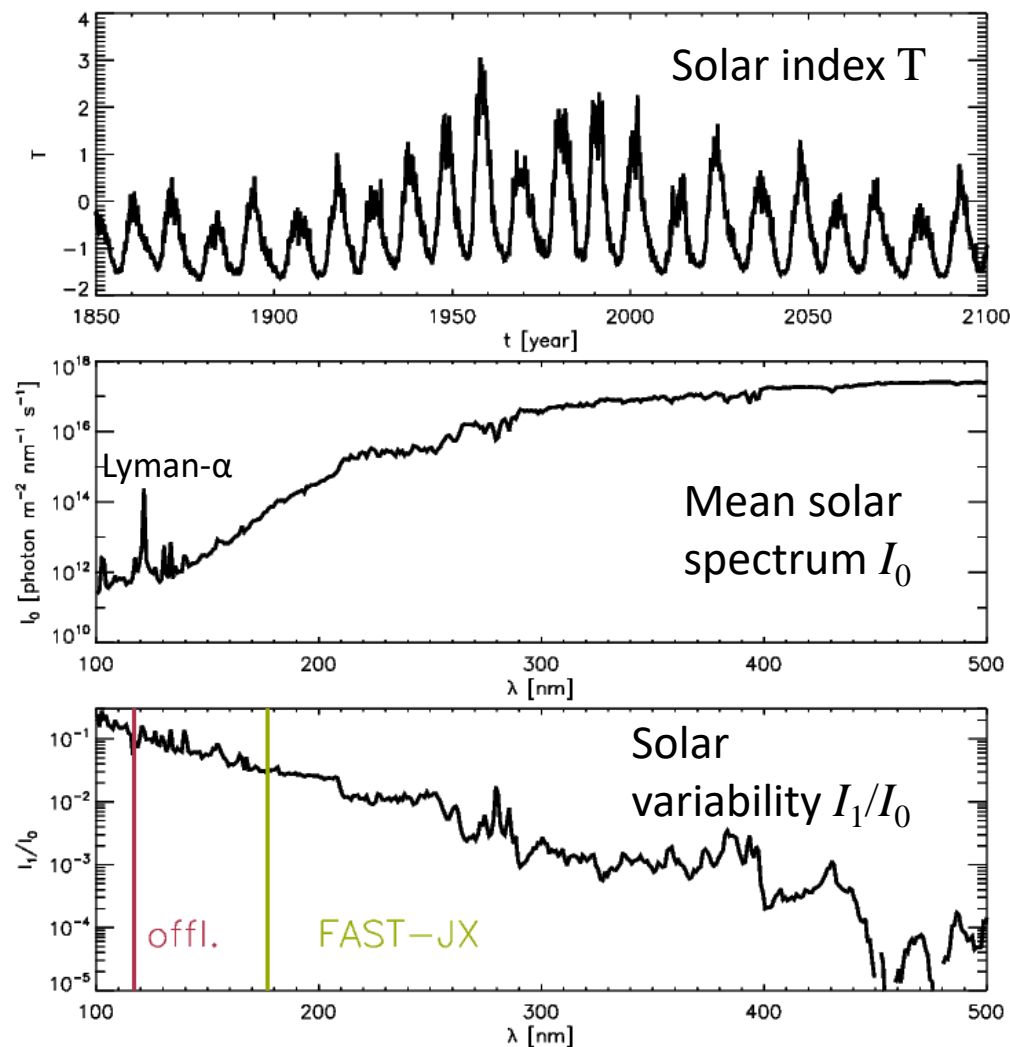
Taihoru Nukurangi

# EOF analysis of solar variability

- Solar irradiation  $I(\lambda, t)$  is decomposed using EOF analysis:

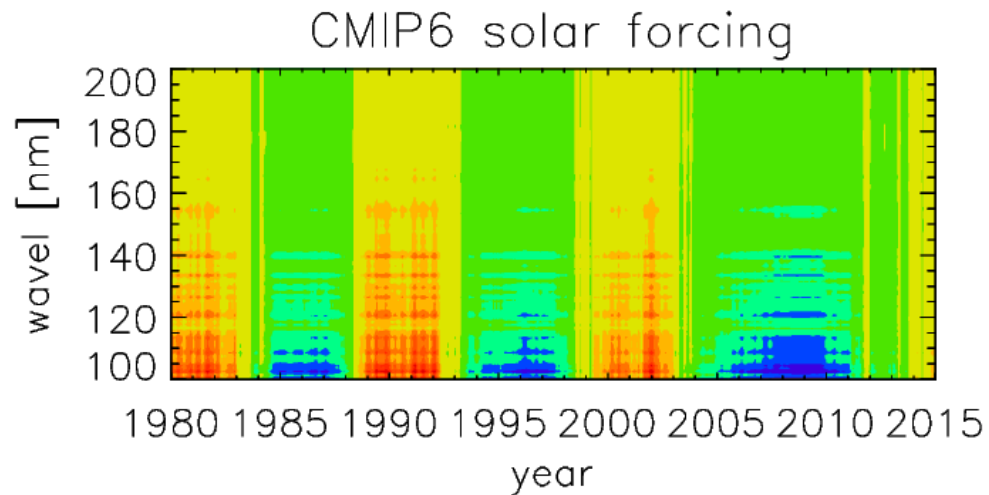
$$I(\lambda, t) = I_0(\lambda) + I_1(\lambda) \cdot T(t)$$

- Normalization:  $\text{mean}(T^2) = 1$
- We express solar variability as  $I_1/I_0$ .



(top)  $T$ , (centre)  $I_0$ , and (bottom)  $I_1/I_0$  for the CMIP6 solar forcing dataset (data from Matthes et al., GMD, 2017)

# Accuracy of SVD decomposition

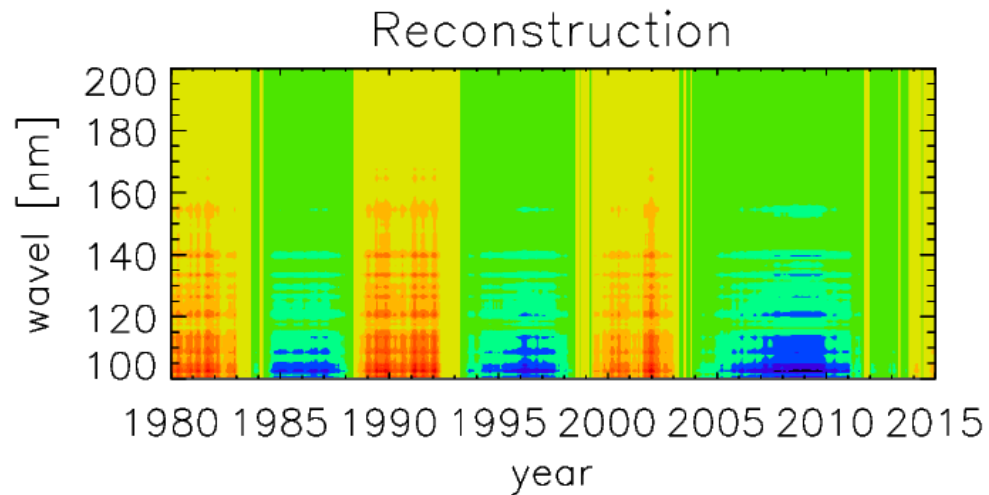


(top) Deviation of original solar forcing dataset from 1850-2300 average (Matthes et al., 2017)

(bottom) First term in SVD decomposition

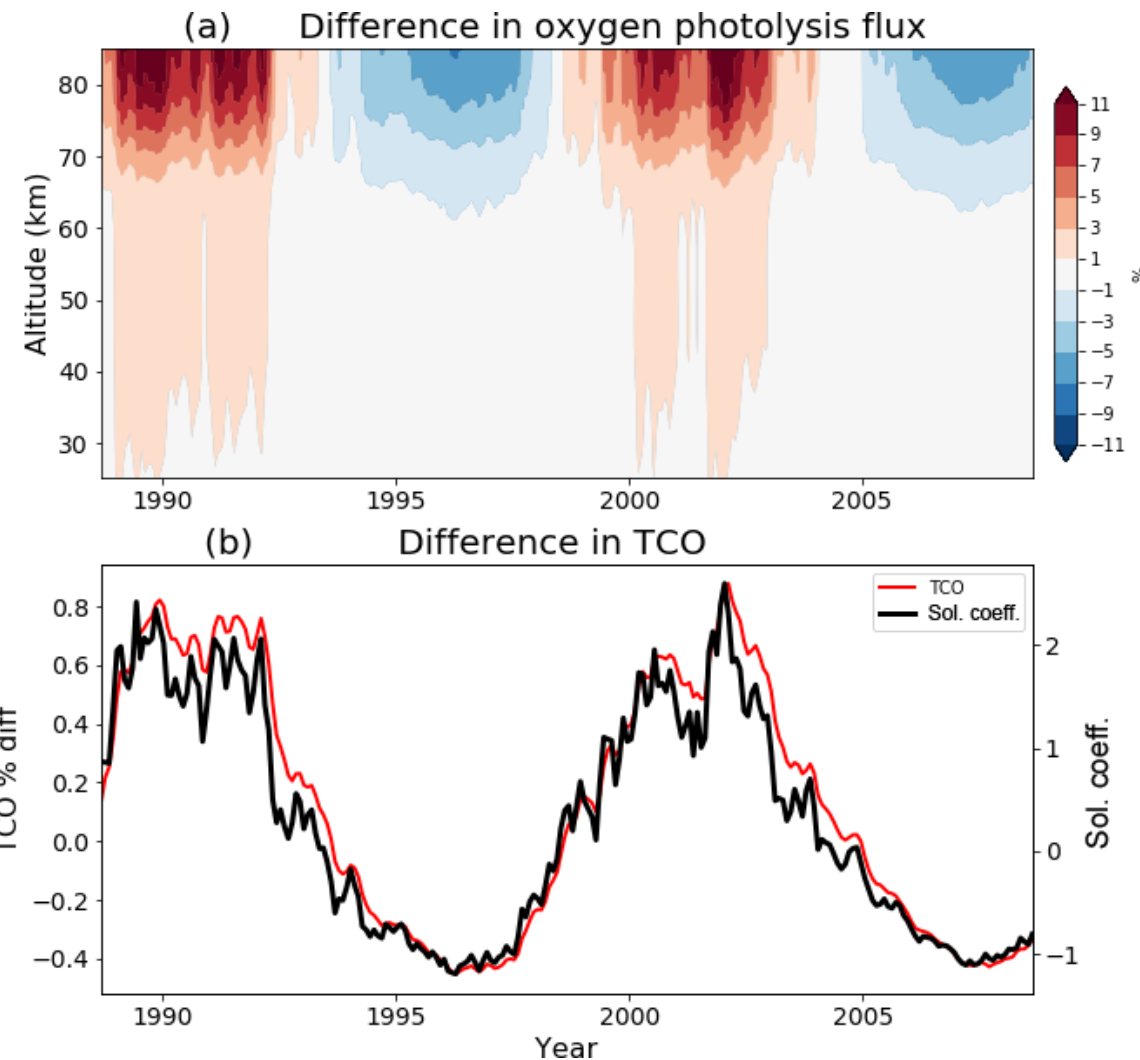
$$I_1(\lambda) T(t)$$

The leading term in the SVD captures practically all the variability in solar forcing.



# Implementation in UKCA

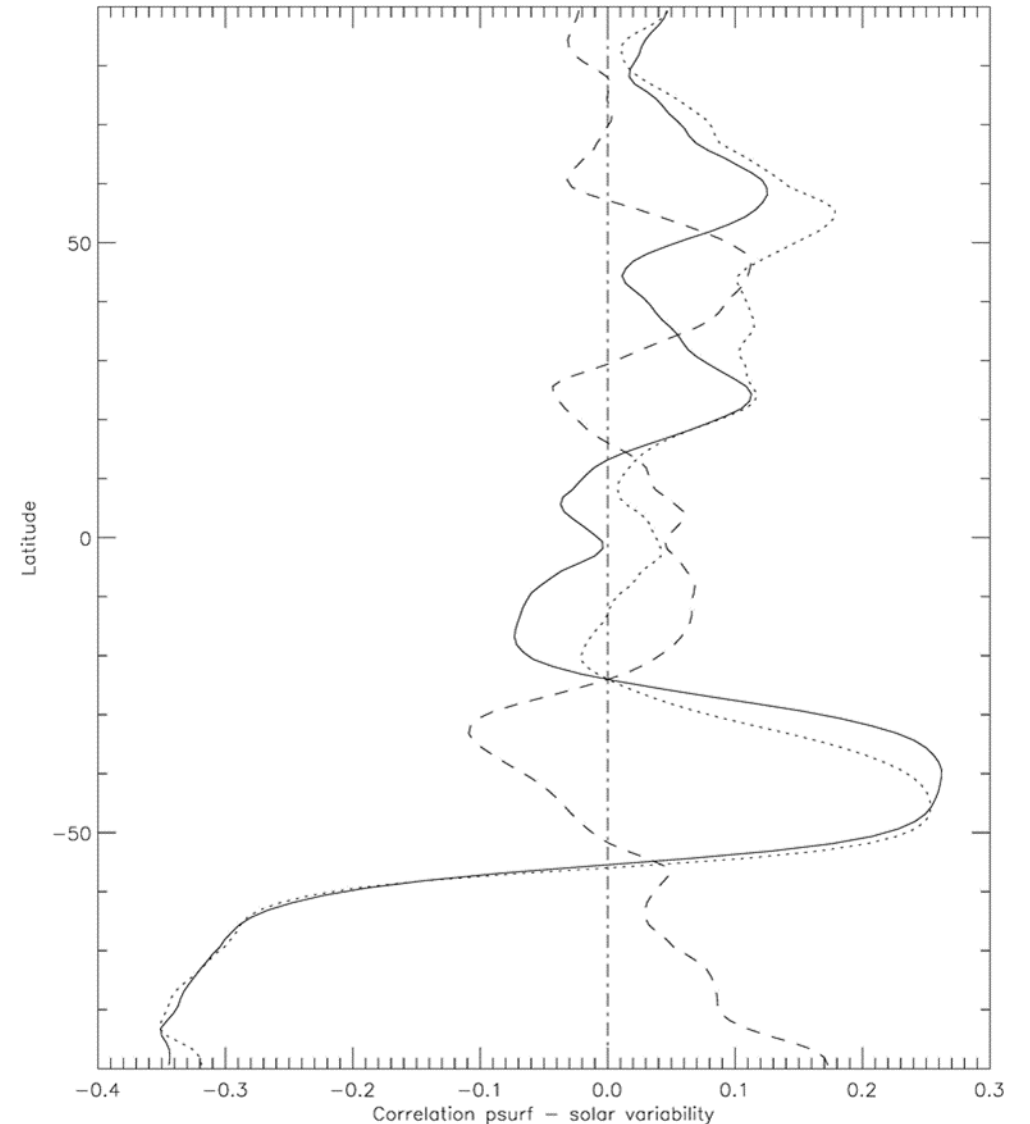
- We have two photolysis schemes:
  - I. Offline: 117-177 nm (Lary and Pyle, 1991), ~1 nm resolution
  - II. FAST-JX: 177-850 nm (Neu et al., 2007); 18 bins.
- In both cases,  $I_1$  is regridded and at every timestep  $I_1 T$  is added to the invariant solar forcing  $I_0$ .
- Much of the impact on ozone comes from the offline scheme.



Relative difference in the  $O_2$  photolysis rate,  $T(t)$ , and  $60^\circ S-60^\circ N$  mean total column ozone (Dennison et al., GMD, 2019)

# Impact of solar variability on dynamics

- Solar variability projects onto the SAM, i.e. in the positive phase of the solar cycle the SAM tends to be stronger (Kuroda, JGR, 2018).
- No such equivalent effect exists in the Northern Hemisphere.
- NZESM simulations exist with and without the solar variation in photolysis. More analysis of the impact is needed.



Correlation of zonal- and annual-mean surface pressure with  $T(t)$  in NZESM “historical” simulation (1950-2014).