

# Inferring photolysis rates from solar radiation measurements at Cape Grim

Stephen Wilson, Centre for Atmospheric Chemistry, School of Chemistry, SMAH.



UNIVERSITY  
OF WOLLONGONG  
AUSTRALIA

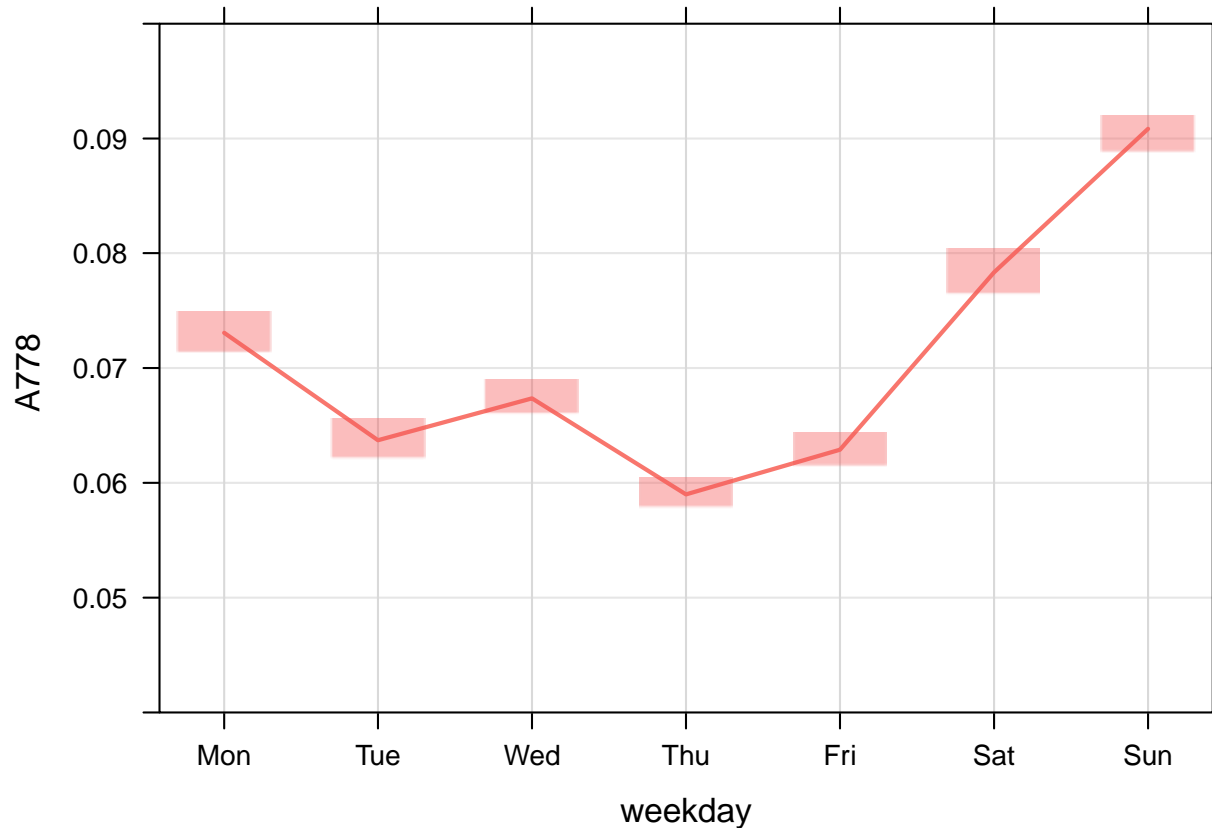
# Cape Grim



- Site chosen for sampling air from the southern ocean

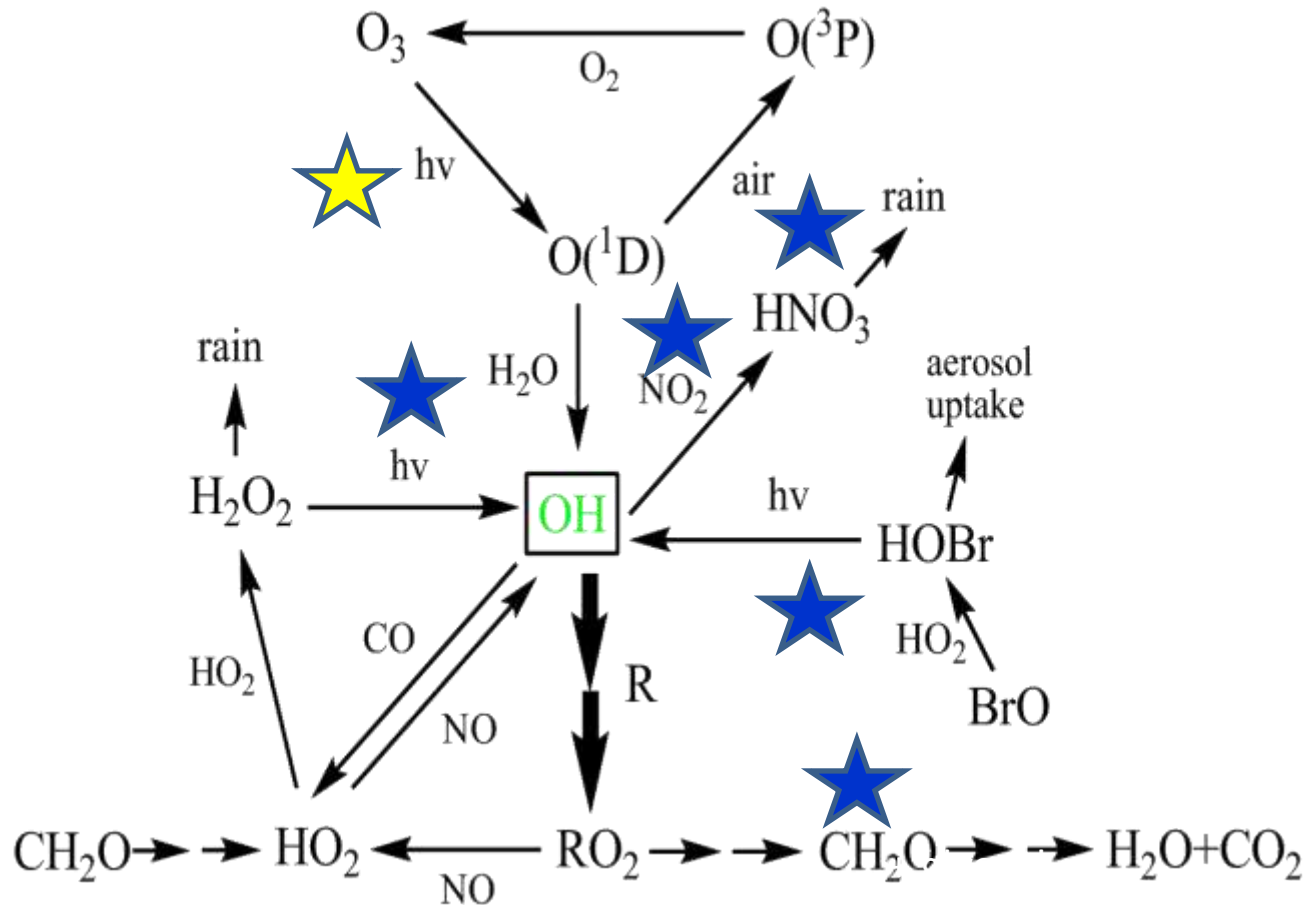


# Instruments cleaned Mon - Fri

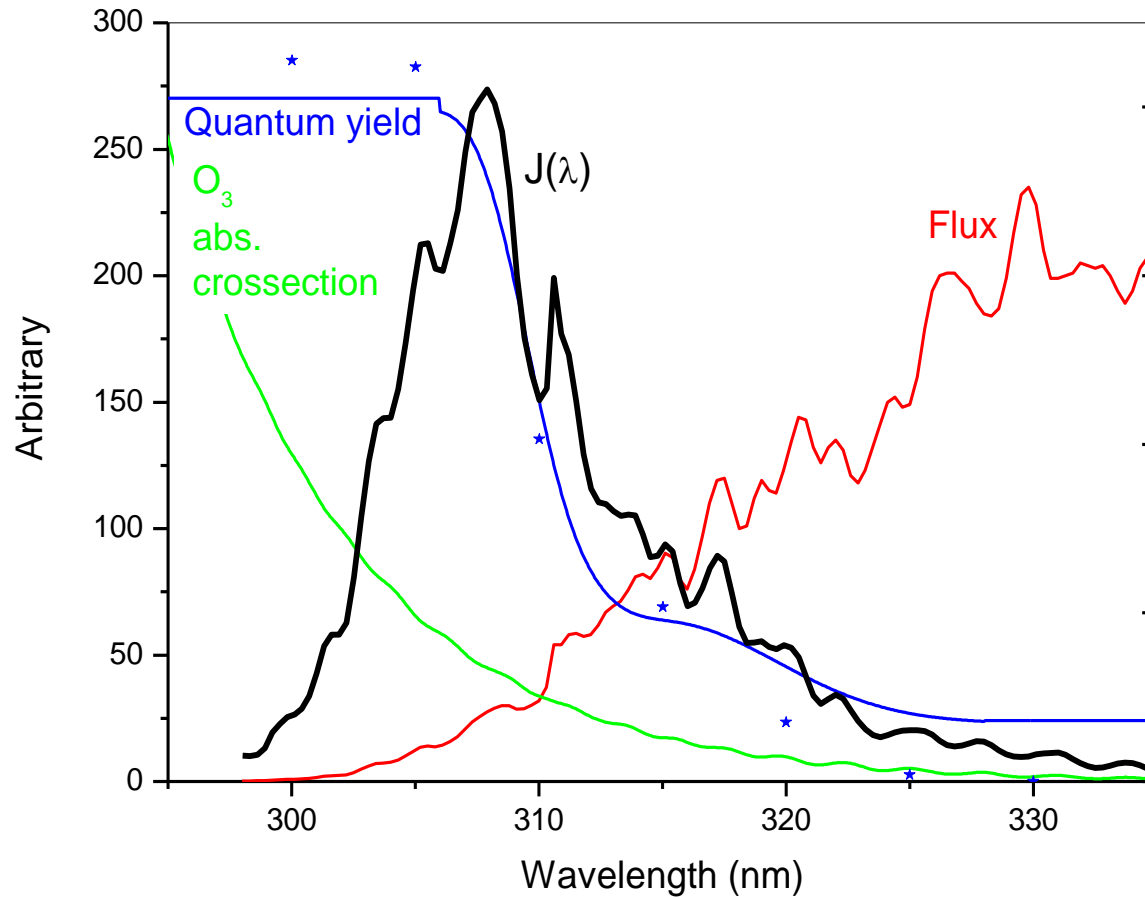


Contamination of front window Sat – Mon morning.  
Data used Monday pm – Friday pm

# Solar Radiation and a bit of atmospheric chemistry

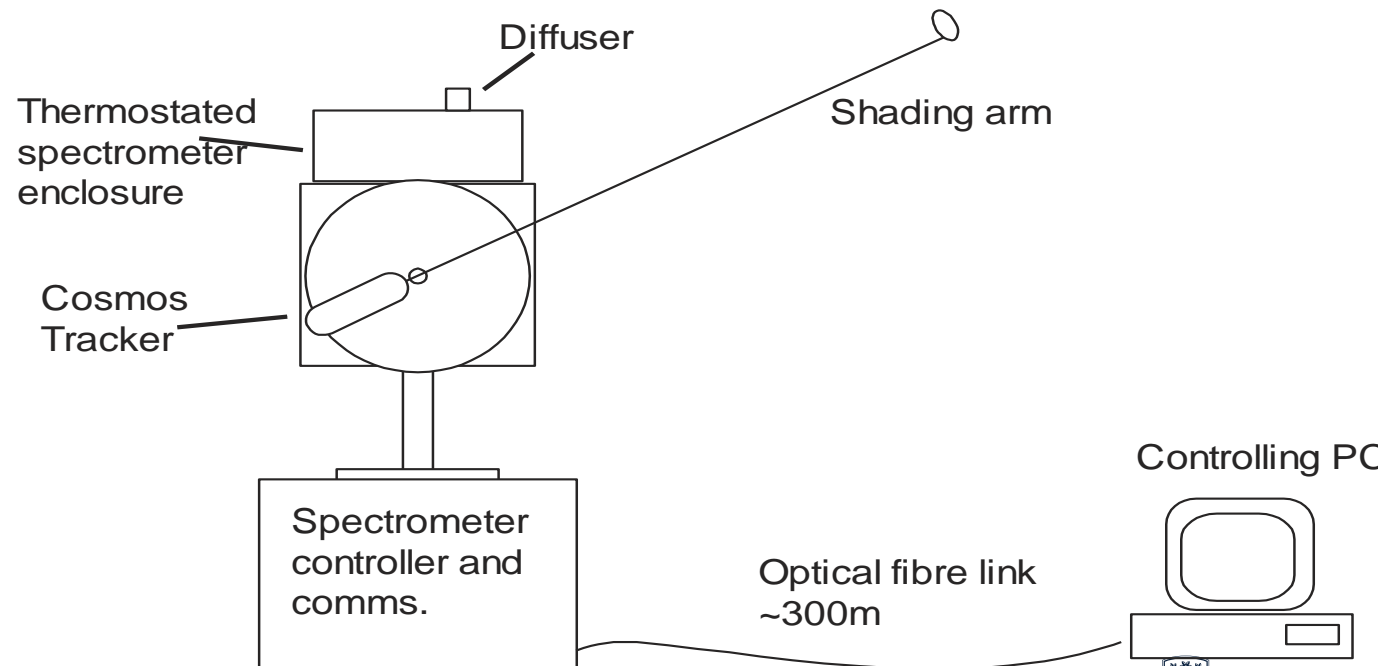


# OH – UV production



# UV-B Instrument

- Automated Scanning Spectral radiometer SRAD (1996-2005)
  - global and diffuse irradiance



# Actinic Flux density (F) estimation from irradiance (E)

direct

diffuse down

diffuse up

$$F = F_0 + F_{\downarrow} + F_{\uparrow} \approx F_0 + F_{\downarrow}$$

$$E = E_0 \cos \theta + E_{\downarrow}$$

$$F \approx E_0 + \alpha E_{\downarrow}$$

$$\alpha = \frac{F_{\downarrow}}{E_{\downarrow}}$$

Low albedo

# Need:

- $E_0$  and  $E_{\downarrow}$ 
  - Measured routinely
- At 305 – 310 nm

$$a \gg 2.01 - \frac{0.052}{\cos q} \quad (\text{clear sky})$$

$$\gg 1.73 \quad (\text{cloud})$$

More relevant for Cape Grim





# From actinic flux $F$ to $J$

Uncertainties

~10%

10%

$$J(O^1D) = \int \tilde{F}(\lambda) S_{O_3}(\lambda) F_{O_3}(\lambda) d\lambda$$

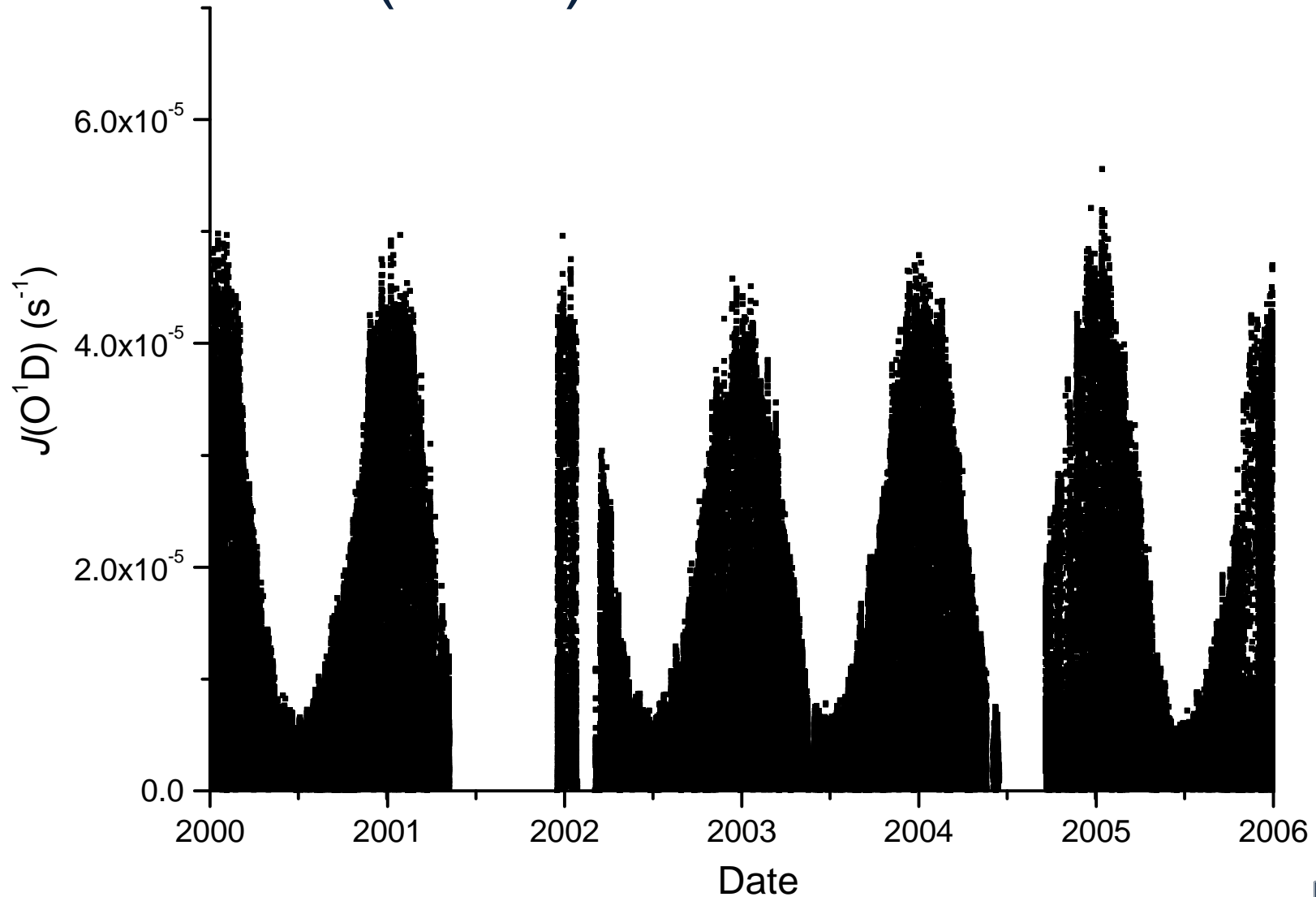
$$\tilde{F}(\lambda) = \frac{\lambda F(\lambda)}{hc}$$

$S_{O_3}(\lambda)$  = ozone absorption cross section

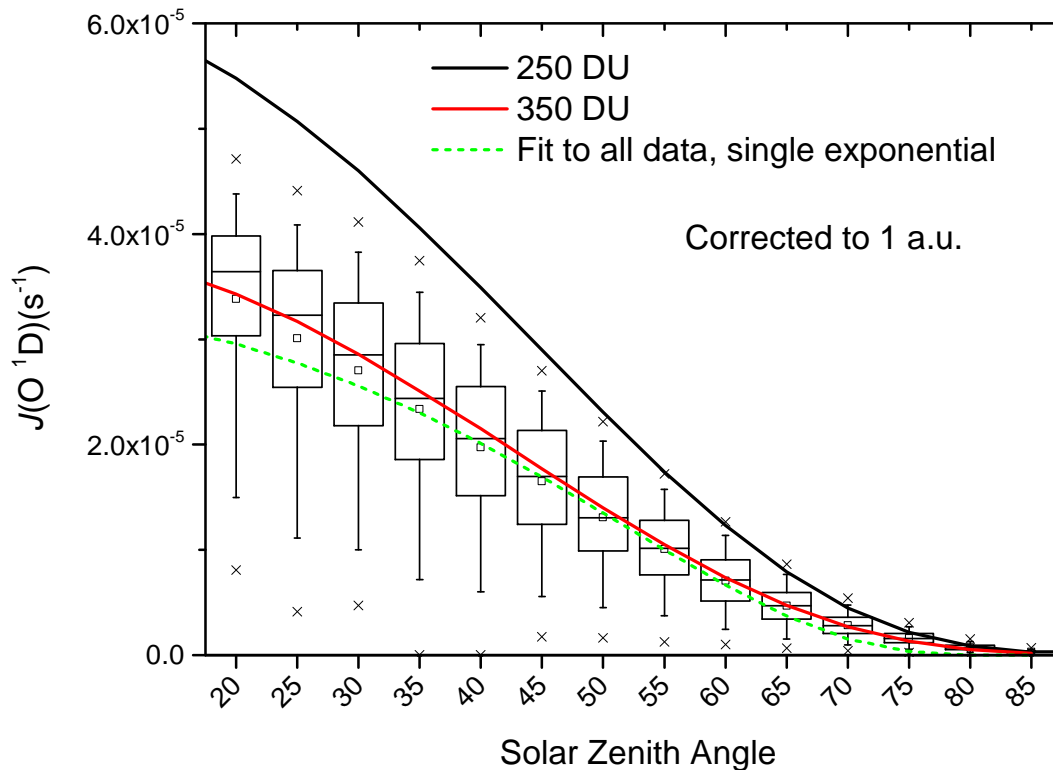
$F_{O_3}(\lambda)$  = Quantum yield of production



# Derived J (O <sup>1</sup>D)



# $J(O^1D)$ – Cape Grim



Model Calcs – clear sky low aerosol  
TUV (Madronich)

$$J(O^1D) = f(sza) * (O_3(col)/300)^{-RAF}$$

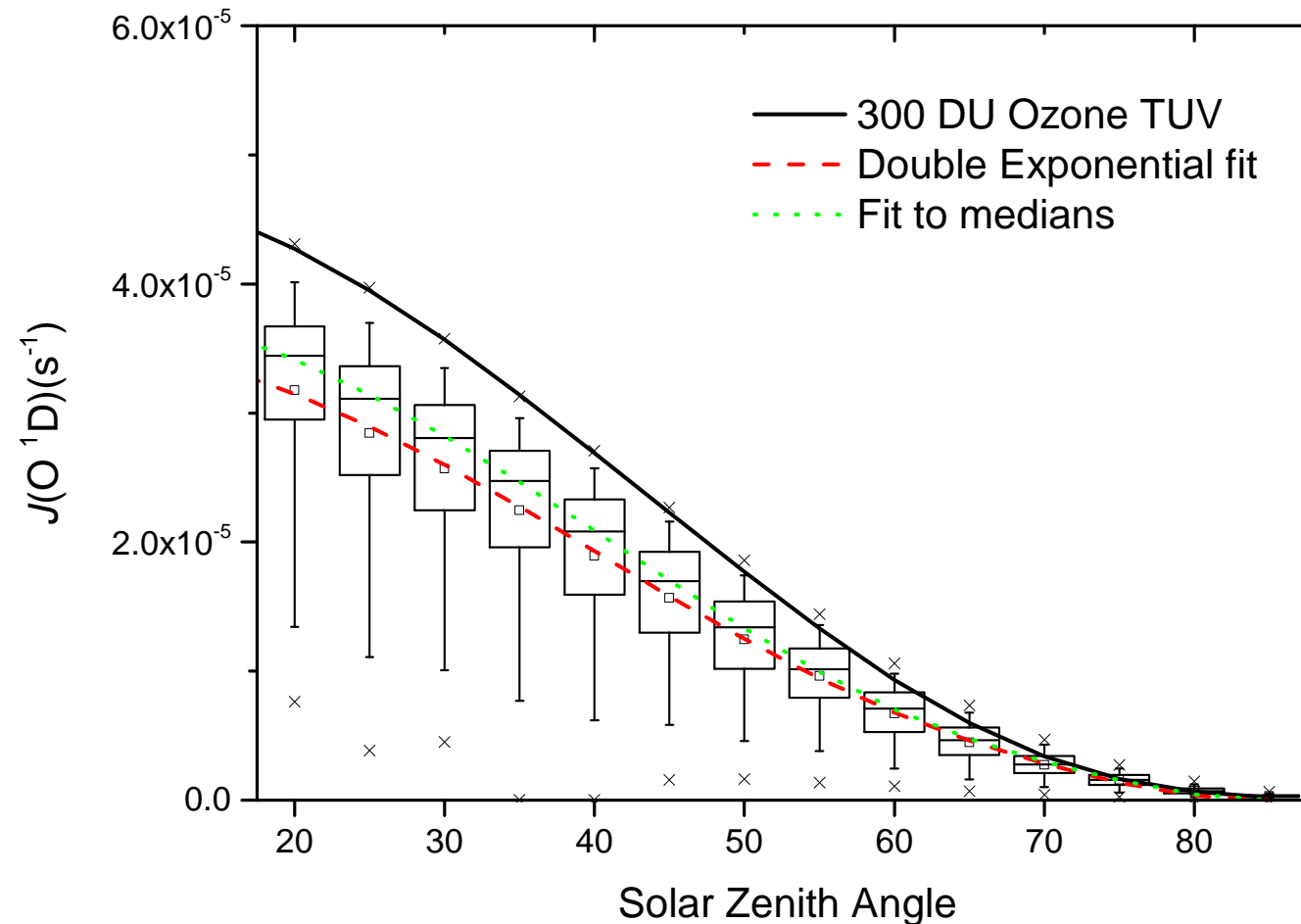
RAF = Radiation Amplification  
Factor

RAF =  $1.43 \pm 0.01$  (all sky)

Models: 1.4 – 1.5 (clear sky)



# Removed O<sub>3</sub> Column Dependence



Wilson, S. R. (2015). Characterisation of  $J(\text{O}^1\text{D})$  at Cape Grim 2000–2005. *Atmospheric Chemistry and Physics*, 15(13), 7337–7349. <http://doi.org/10.5194/acp-15-7337-2015>

- Multiple processes can be estimated (e.g.  $\text{NO}_3^-$  photolysis) from such data sets provided there is appropriate wavelength coverage.
- New system uses a detector array so that all wavelengths are captured simultaneously.



- Thanks to the Cape Grim/ Bureau of Meteorology staff that have made these measurements possible.

U

O

W

Thank you...



UNIVERSITY  
OF WOLLONGONG  
AUSTRALIA

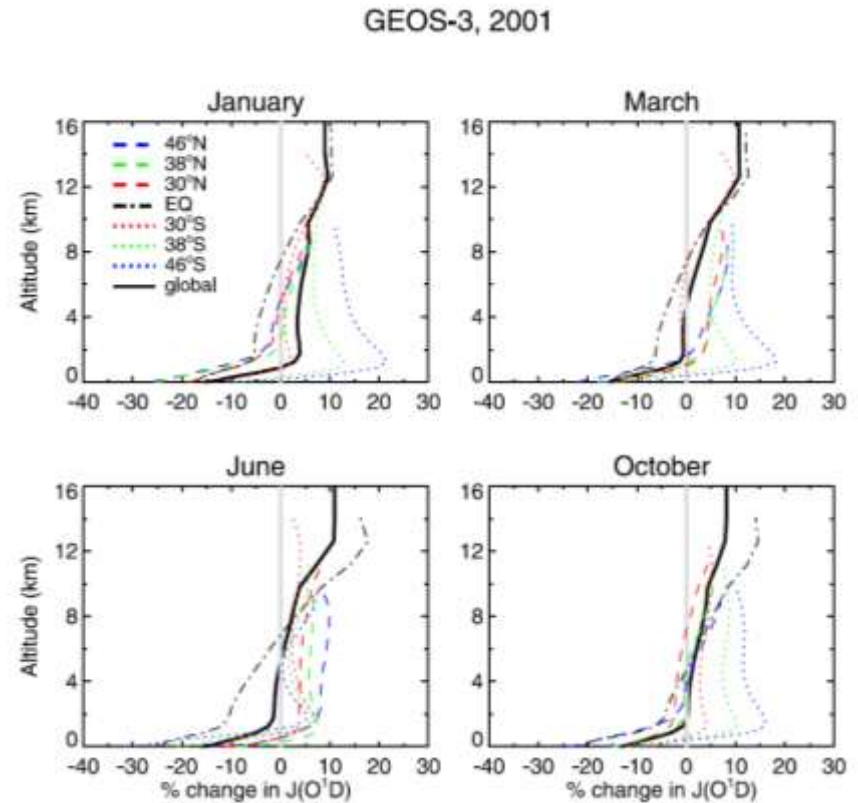
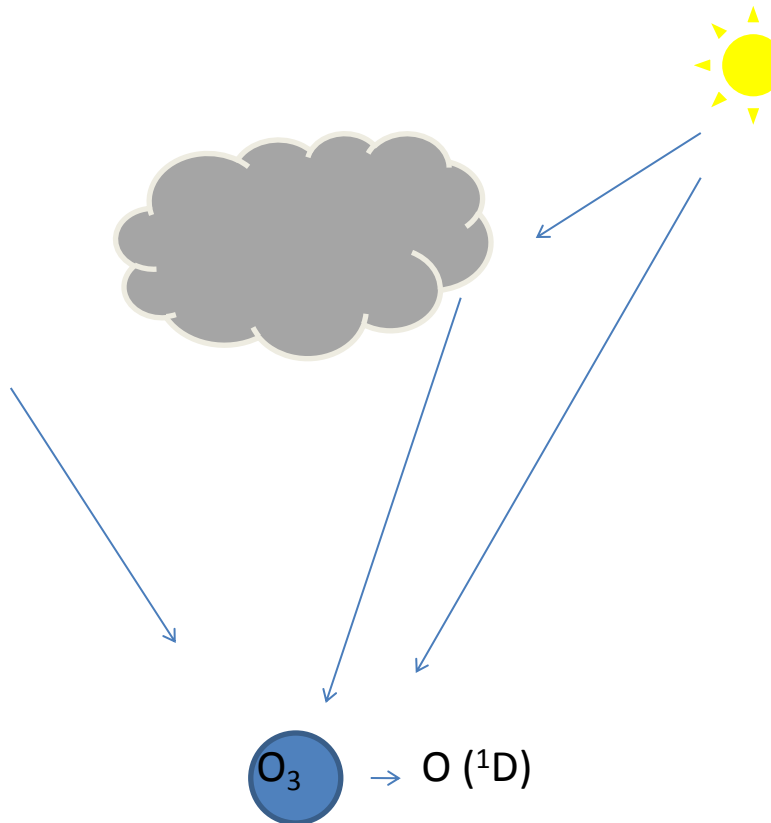
# Centre for Atmospheric Chemistry







# J O(<sup>1</sup>D) and cloud



Modelled cloud impact  
Liu et al, JGR, 2009