

# **Severe ozone air pollution in the Persian Gulf region**

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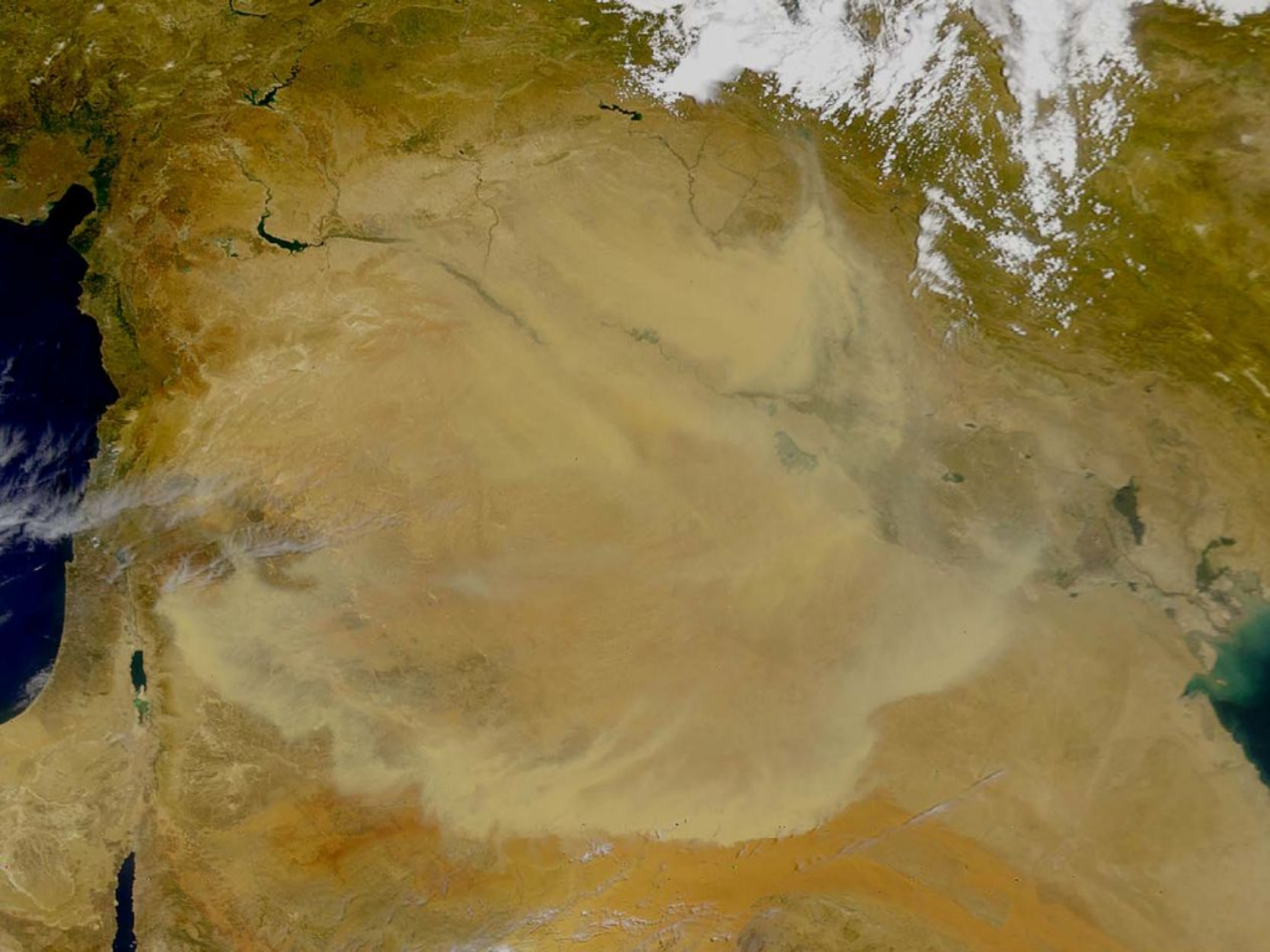
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<sup>3</sup> Observatoire Midi-Pyrénées, Toulouse, France



Neolithic settlements in  
the 8th millenium BC  
The cradle of civilization



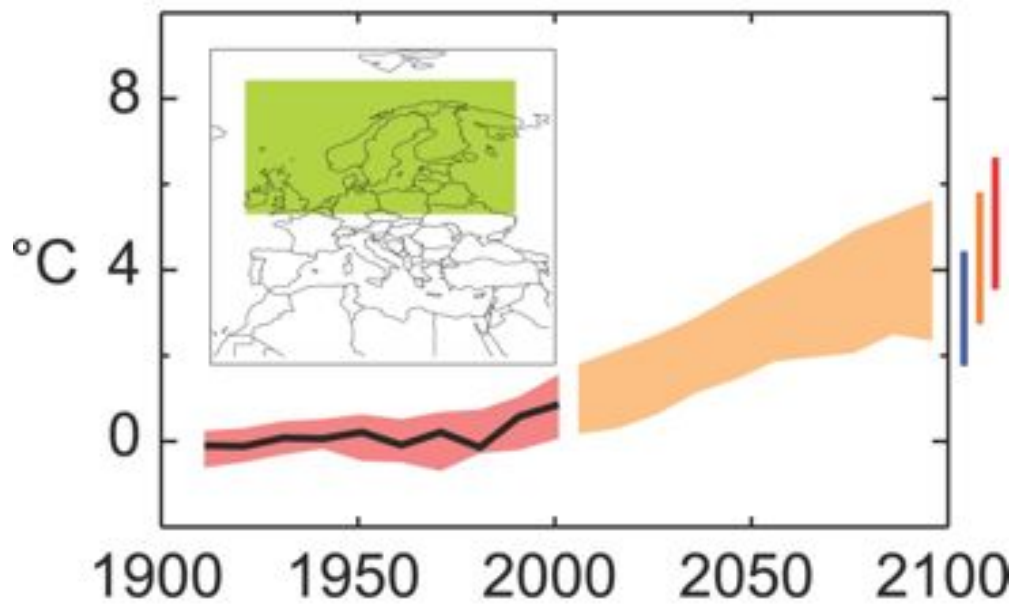


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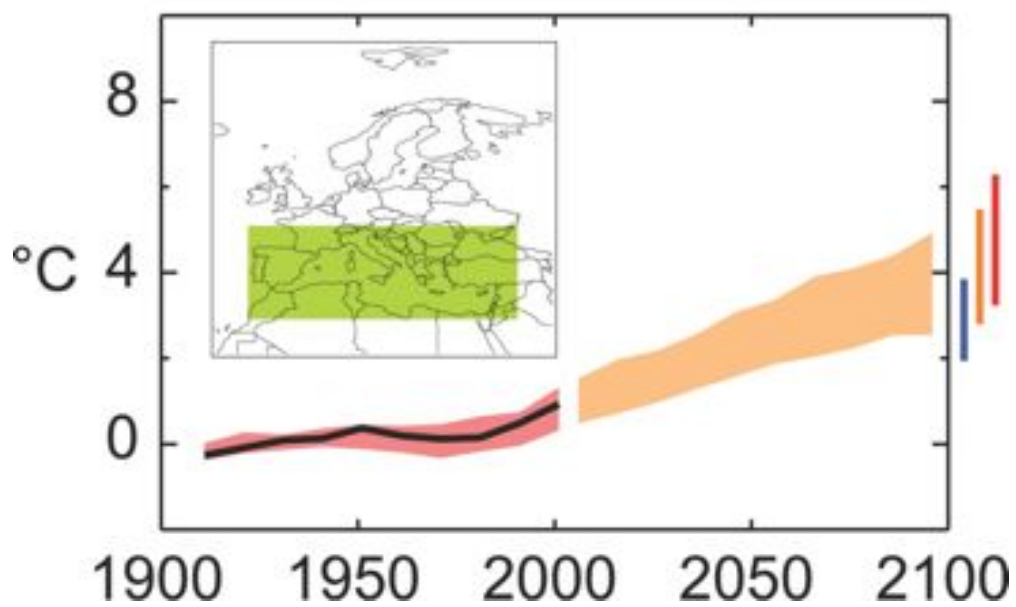


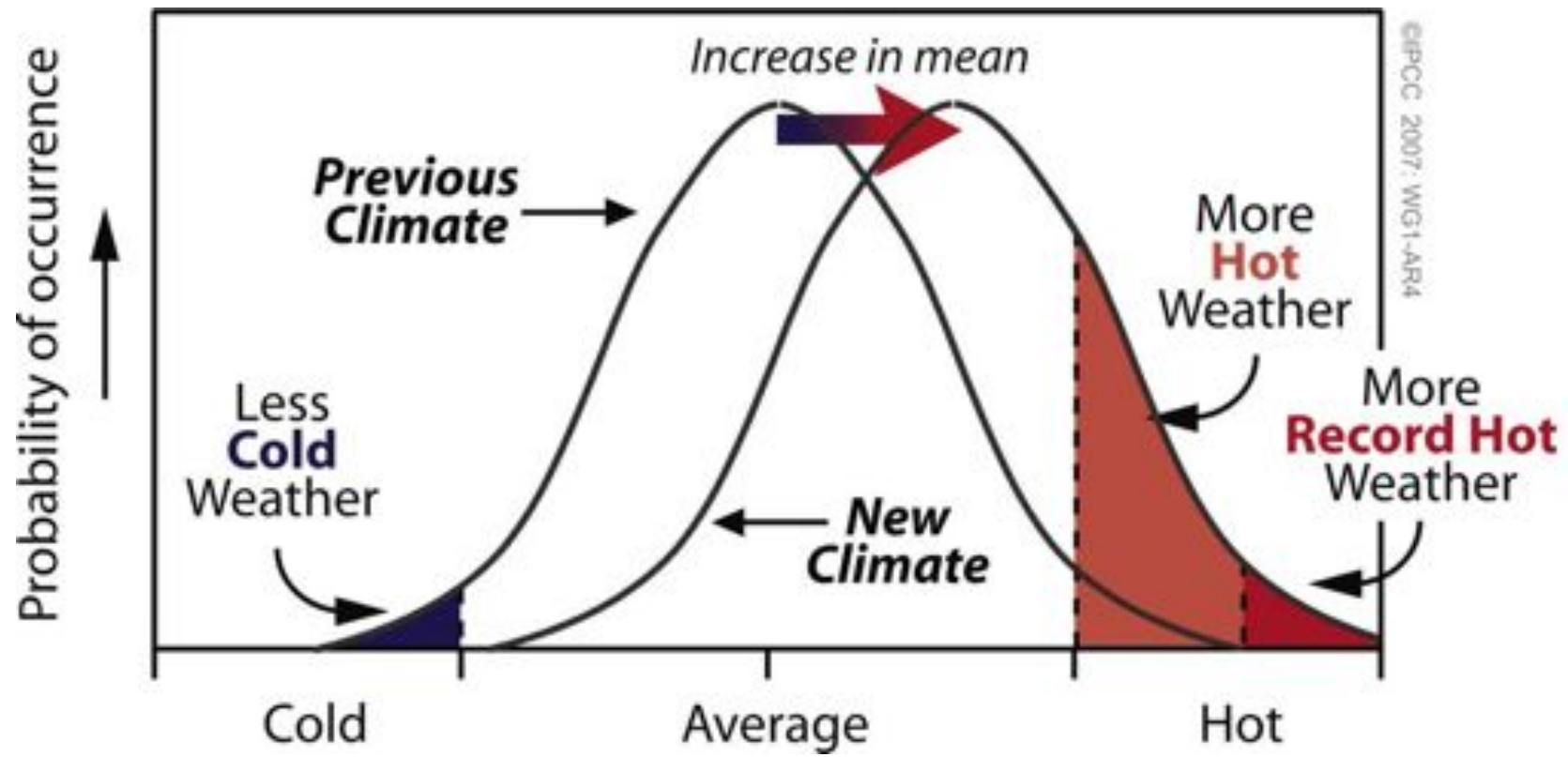
Middle East by night

# NEU



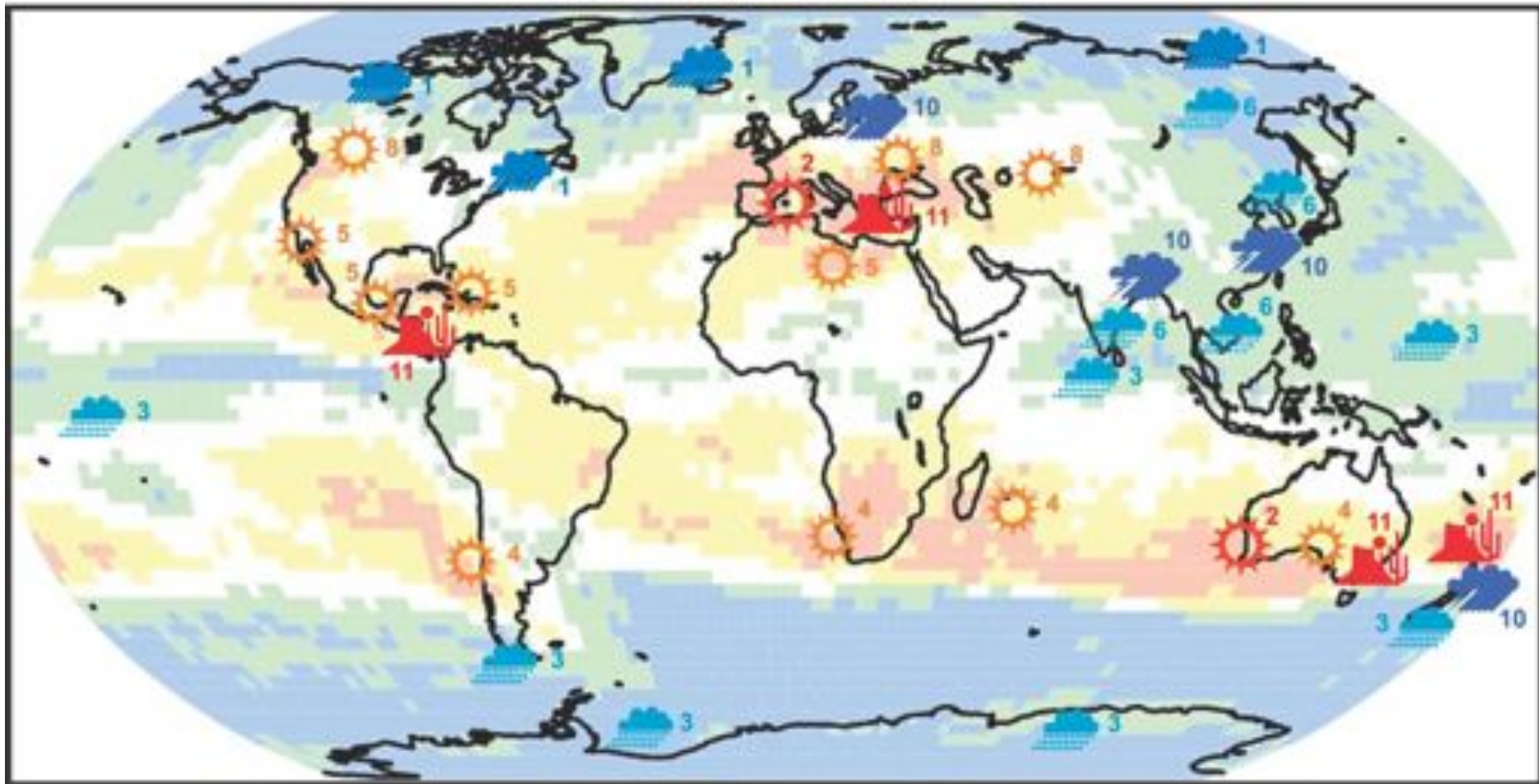
# SEM





©IPCC 2007: WG1-AR4

# June–July–August (JJA)



Based on regional studies assessed in chapter 11:

Precipitation increase in  $\geq 90\%$  of simulations



Precipitation decrease – very likely



Precipitation extreme increase – likely

Precipitation increase in  $\geq 66\%$  of simulations



Precipitation decrease – likely



Increased drought – likely

Precipitation decrease in  $\geq 66\%$  of simulations



Precipitation increase – very likely



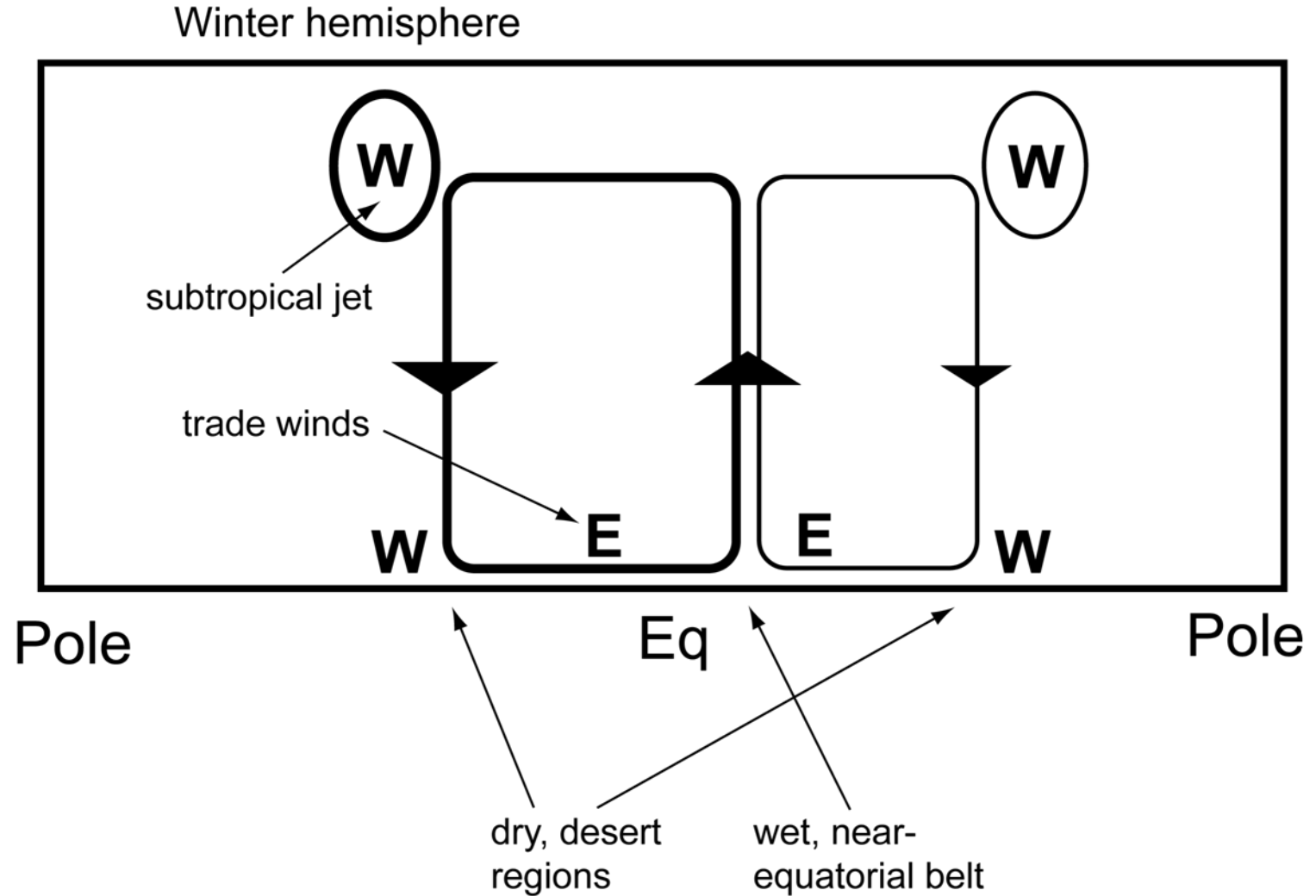
Less snow – very likely

Precipitation decrease in  $\geq 90\%$  of simulations



Precipitation increase – likely

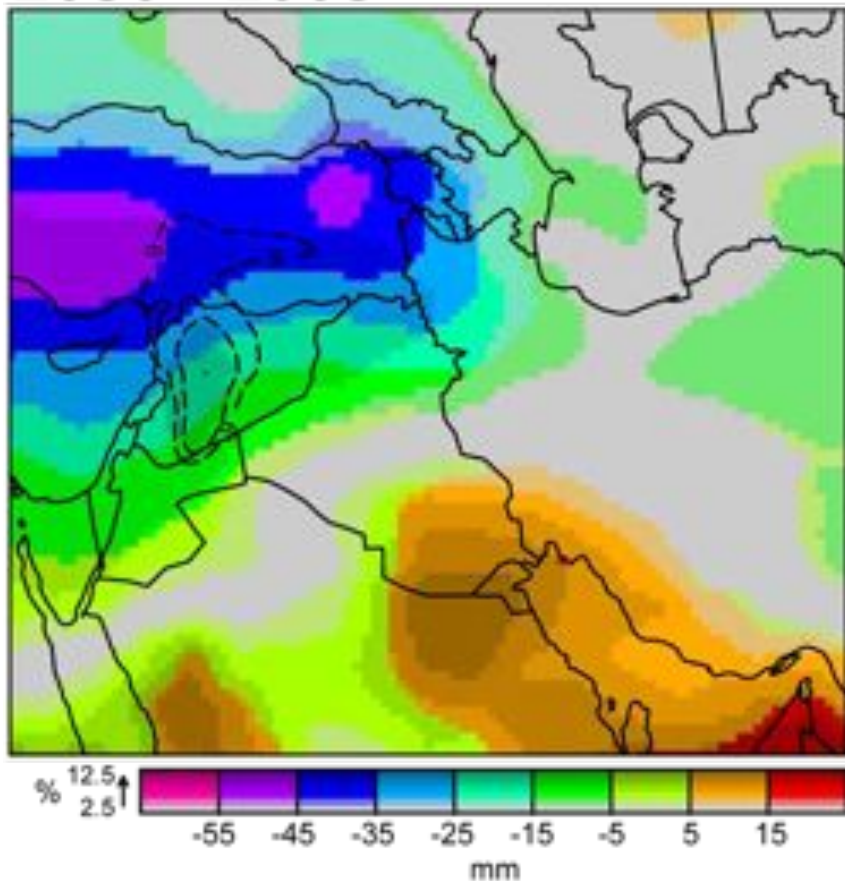
# Hadley cell circulation



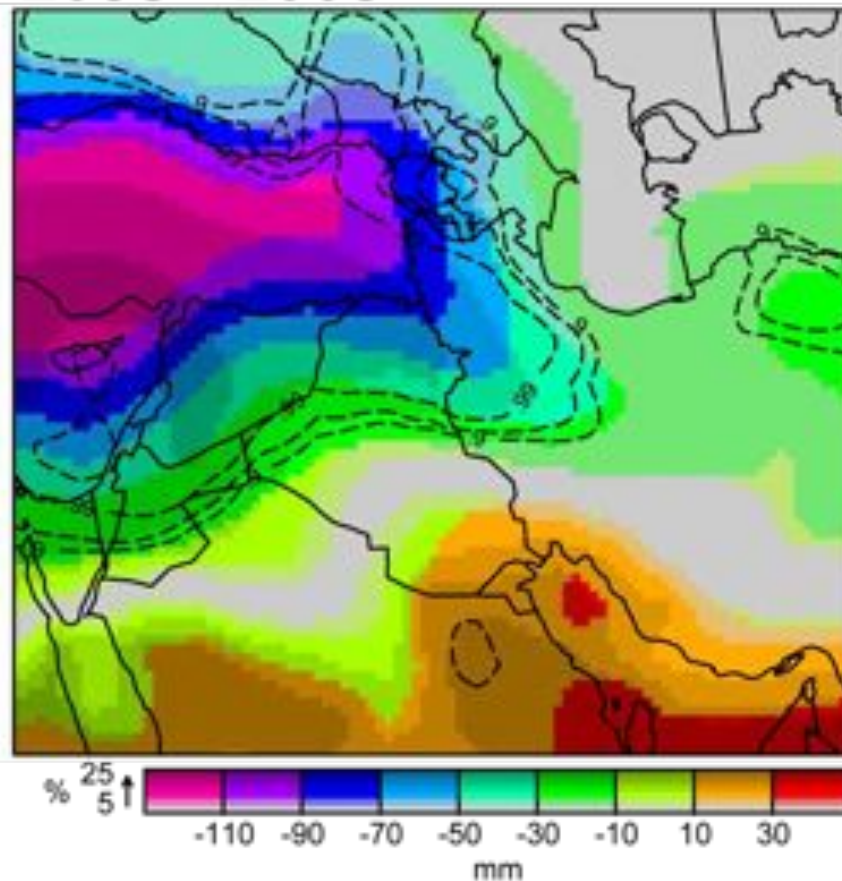
# 500 hPa vertical motion (JJA)



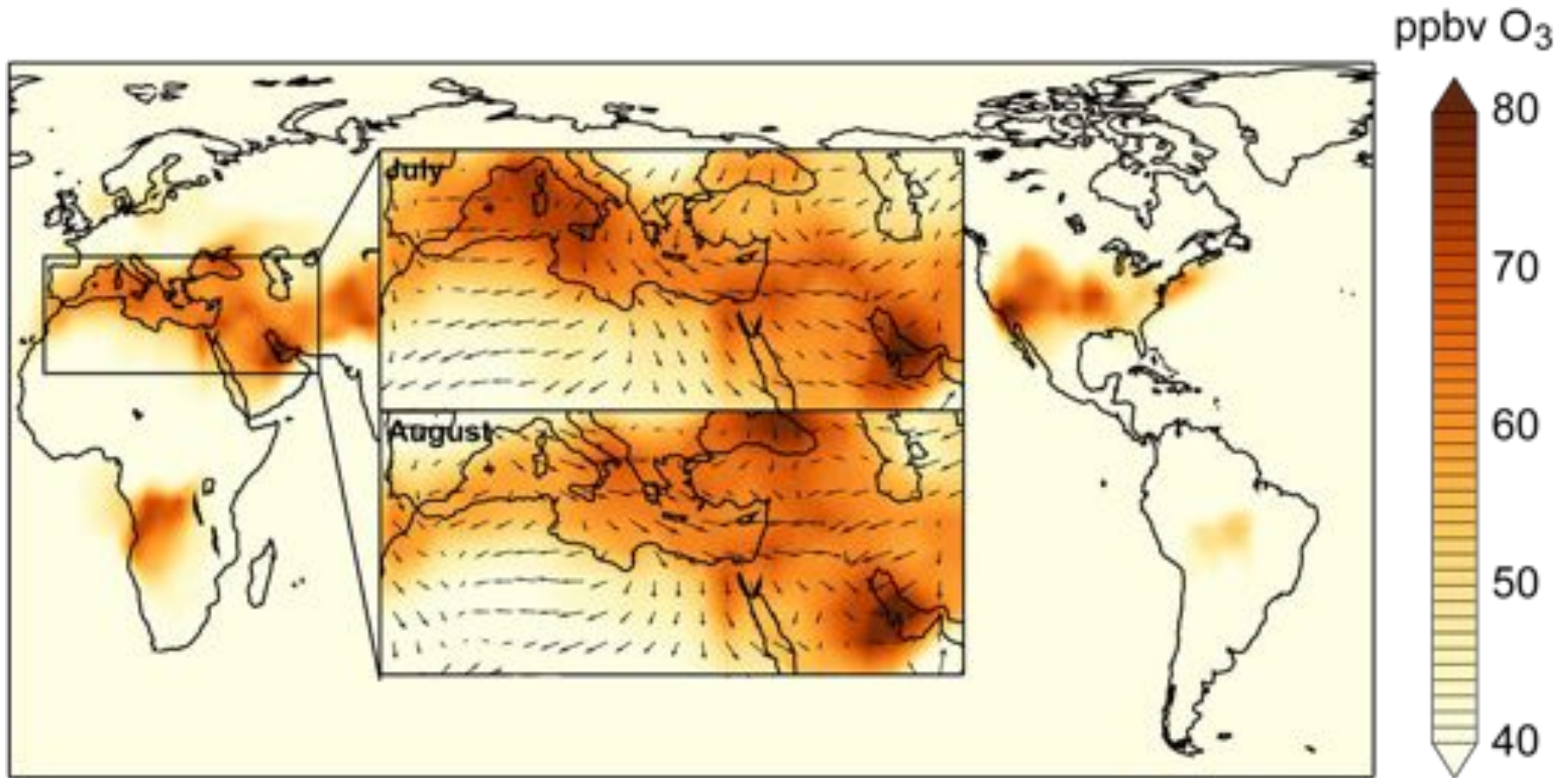
2050 - 2005



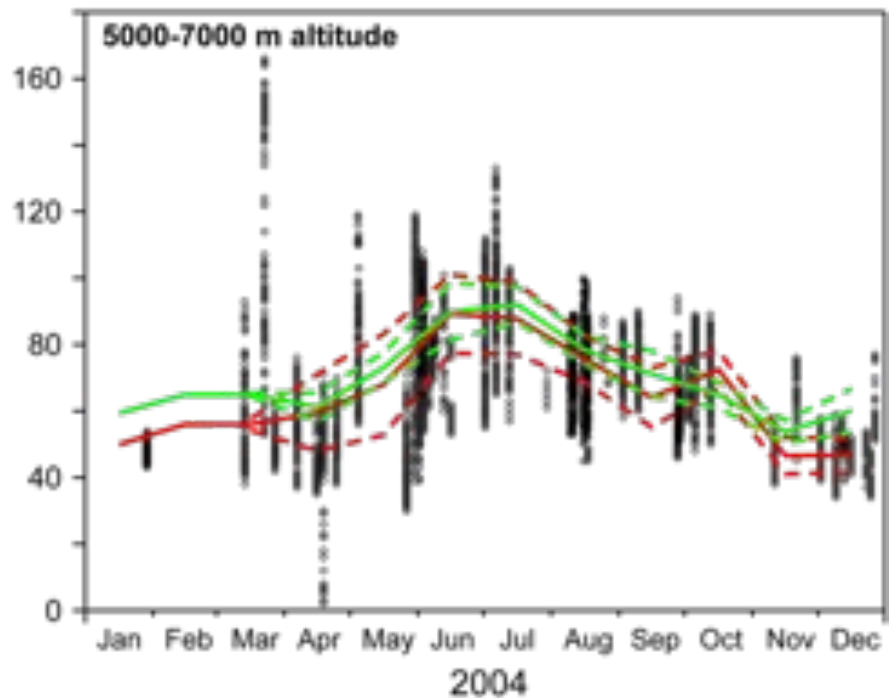
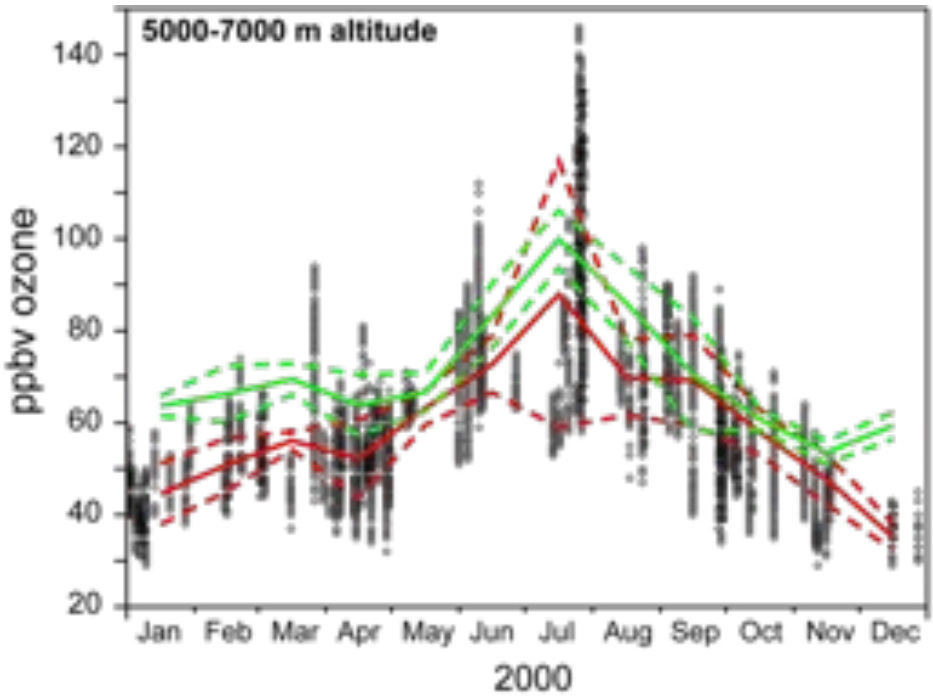
2095 - 2005



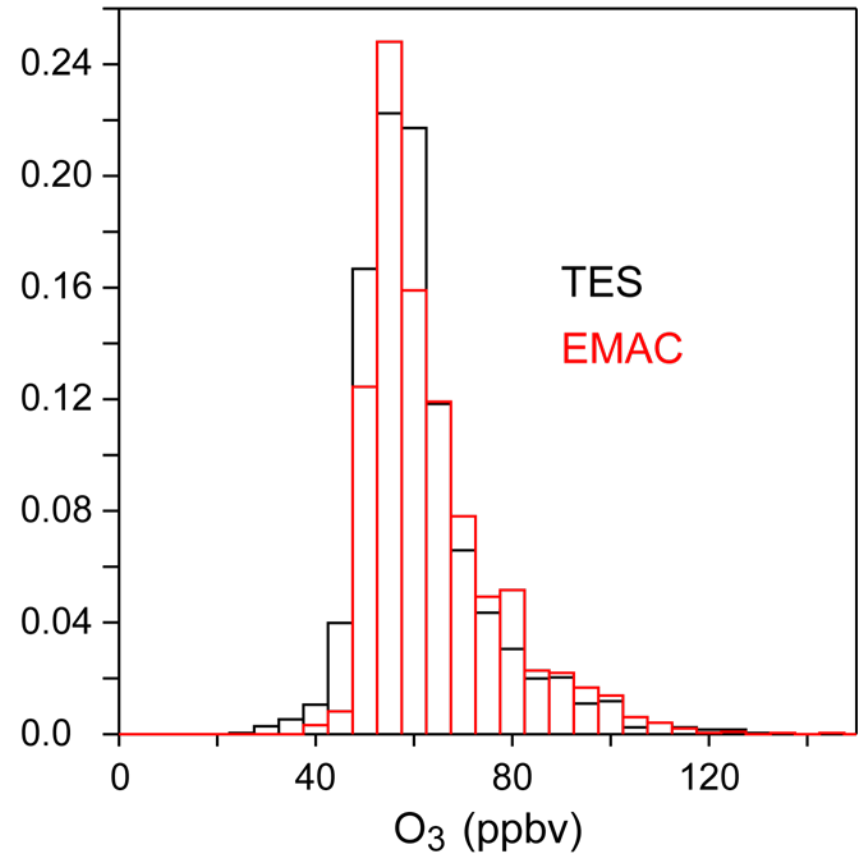
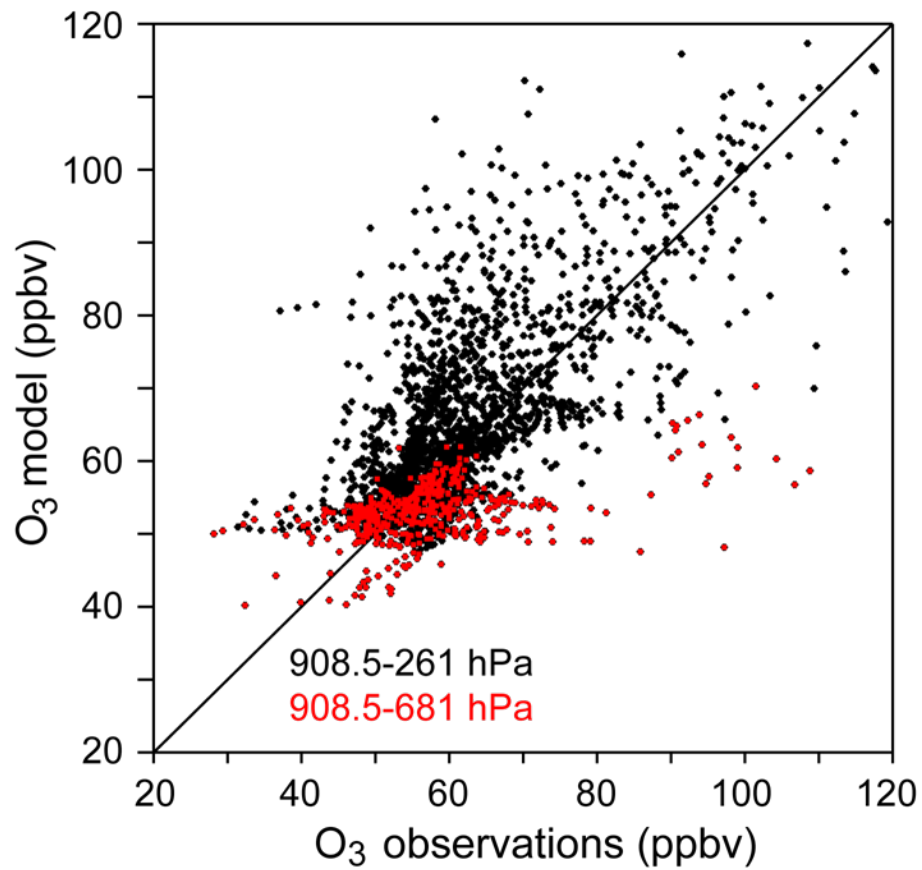
Annual precipitation change based on 18 climate models (IPCC–AR4)  
(J.P. Evans, *Clim. Change*, 2009)



Near surface ozone in July - August 2006  
calculated with the EMAC chemistry-climate model

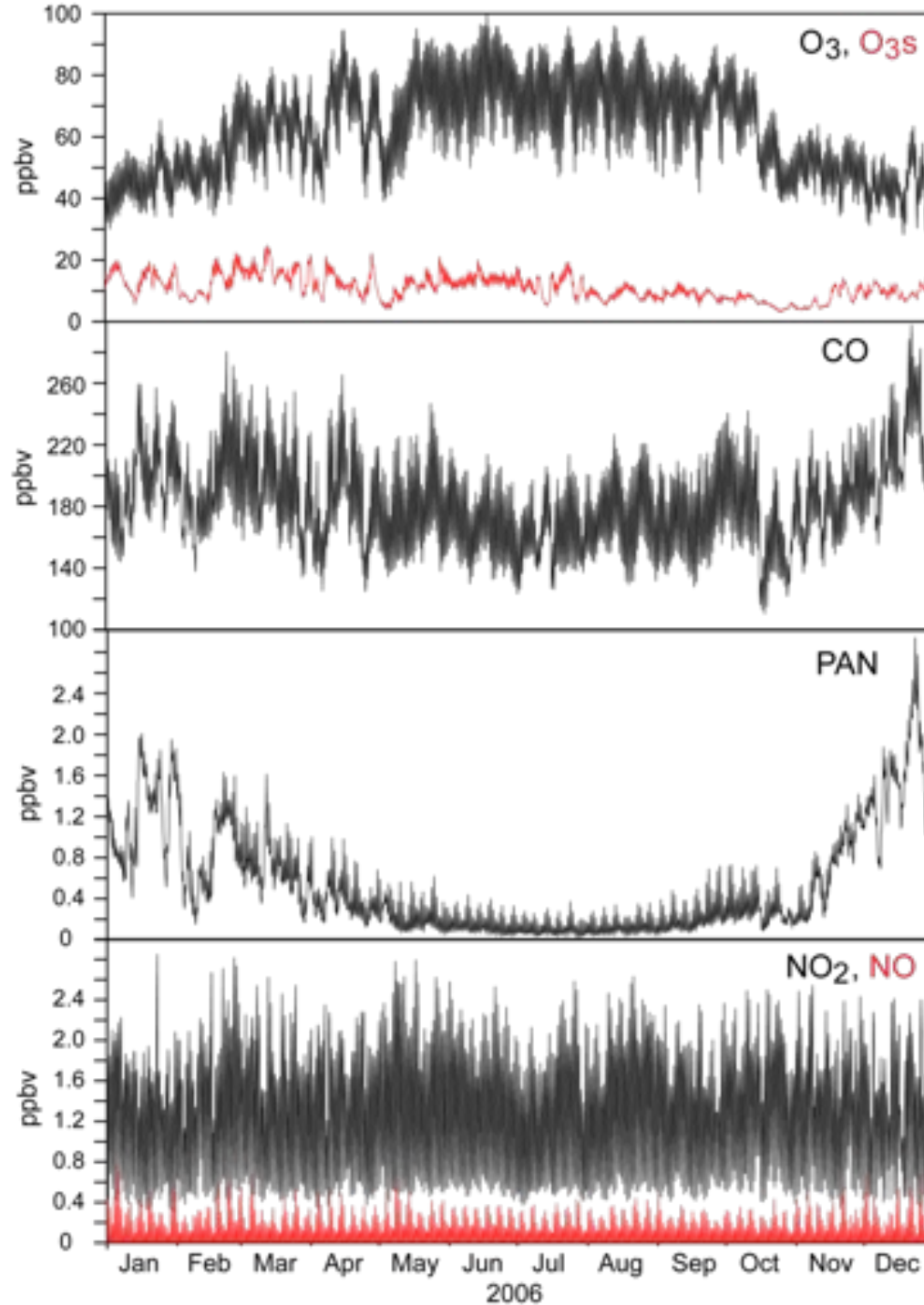


Mean and SD of O<sub>3</sub>, model (green) and MOZAIC measurements (red)

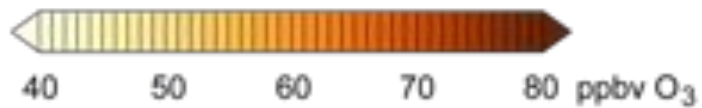
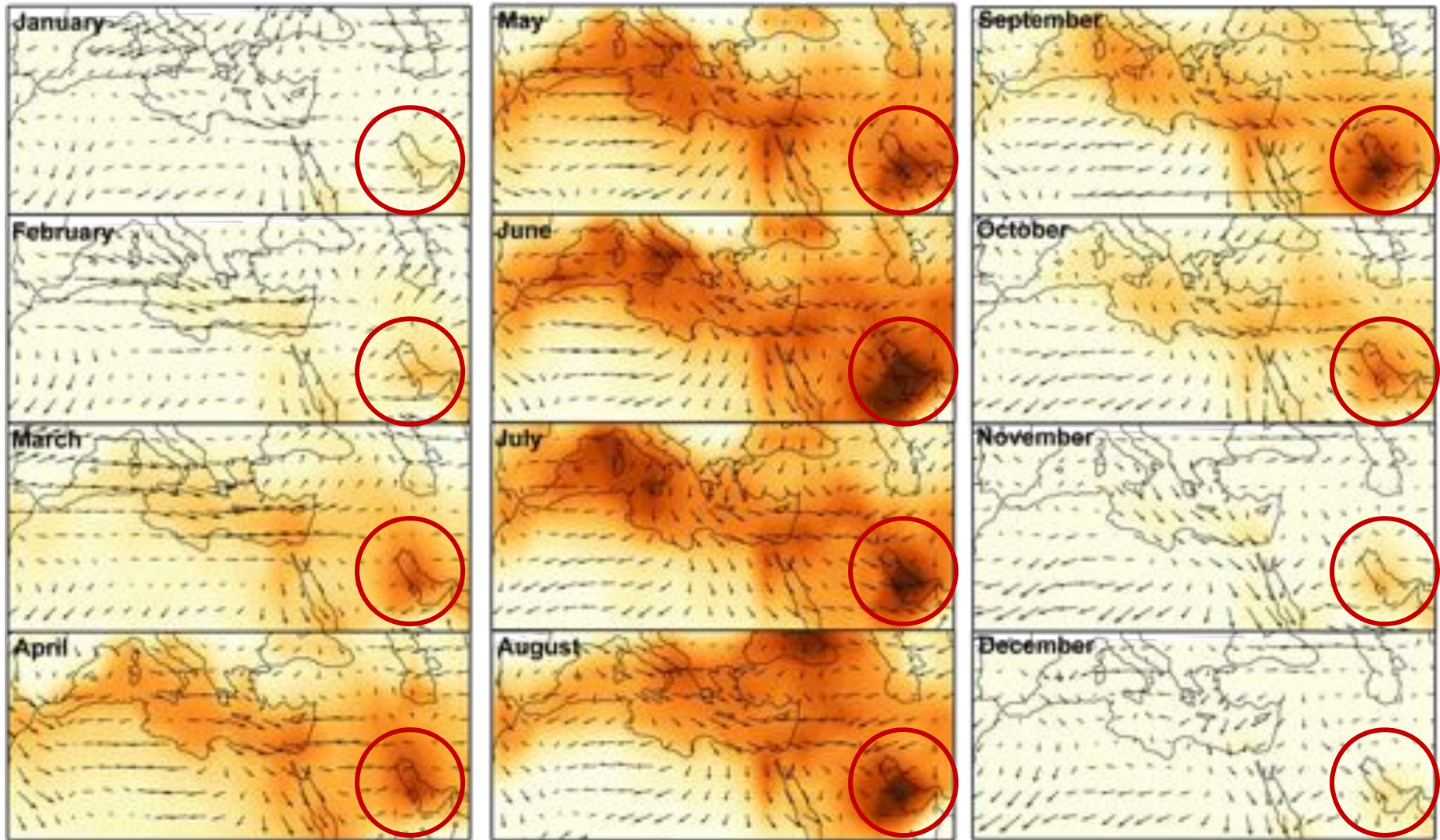


TES satellite data (black) and model results (red)  
(25°-30°N, 45°-55°E)

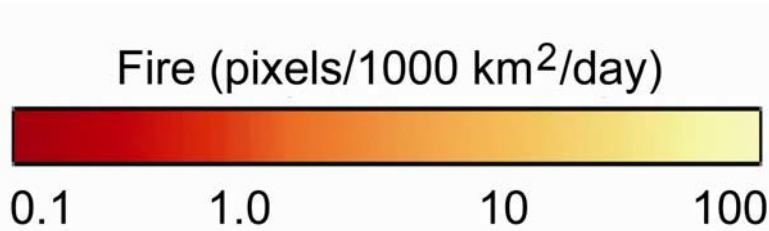
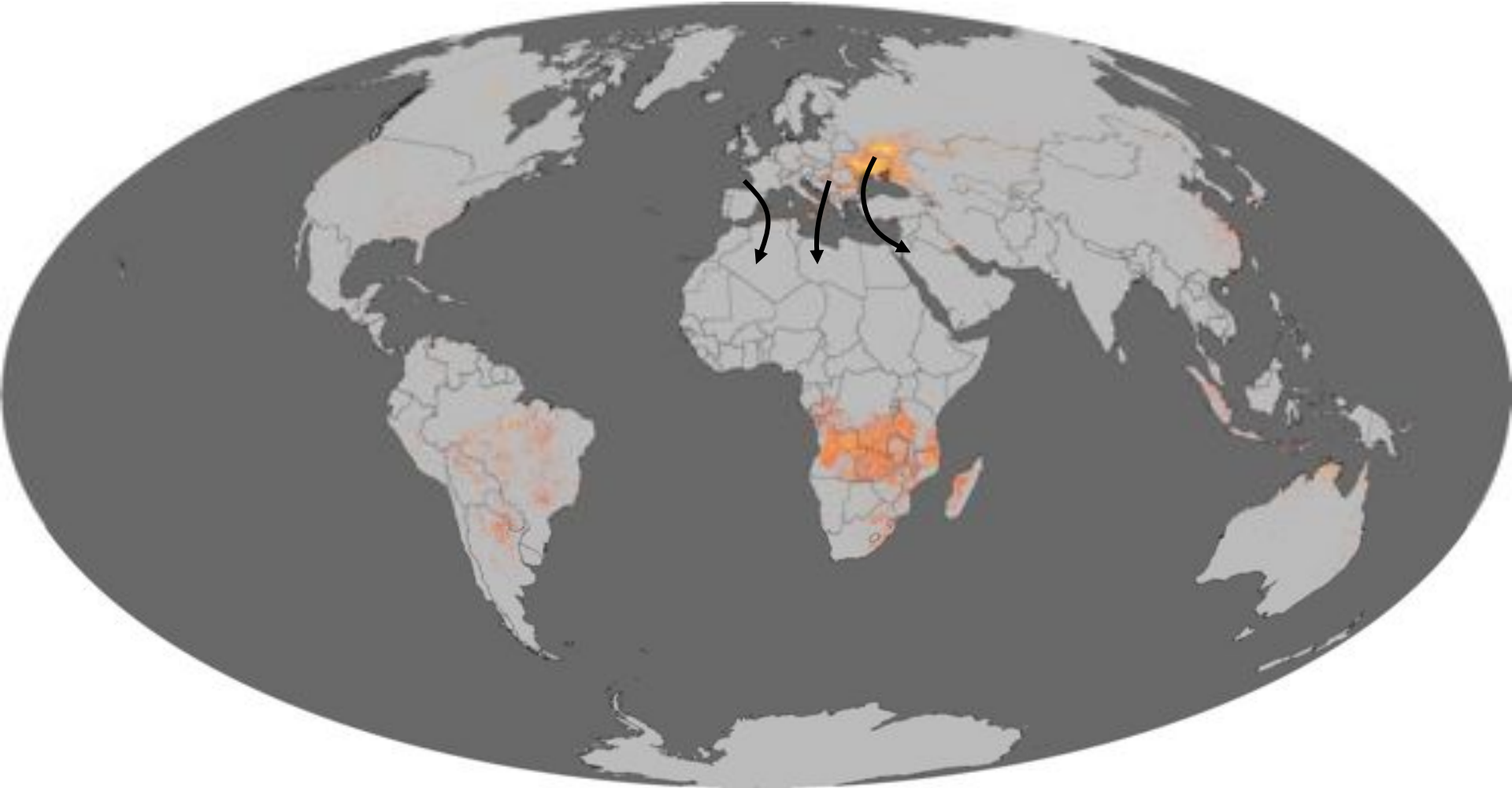
EMAC surface VMRs  
(25°-30°N, 45°-55°E)

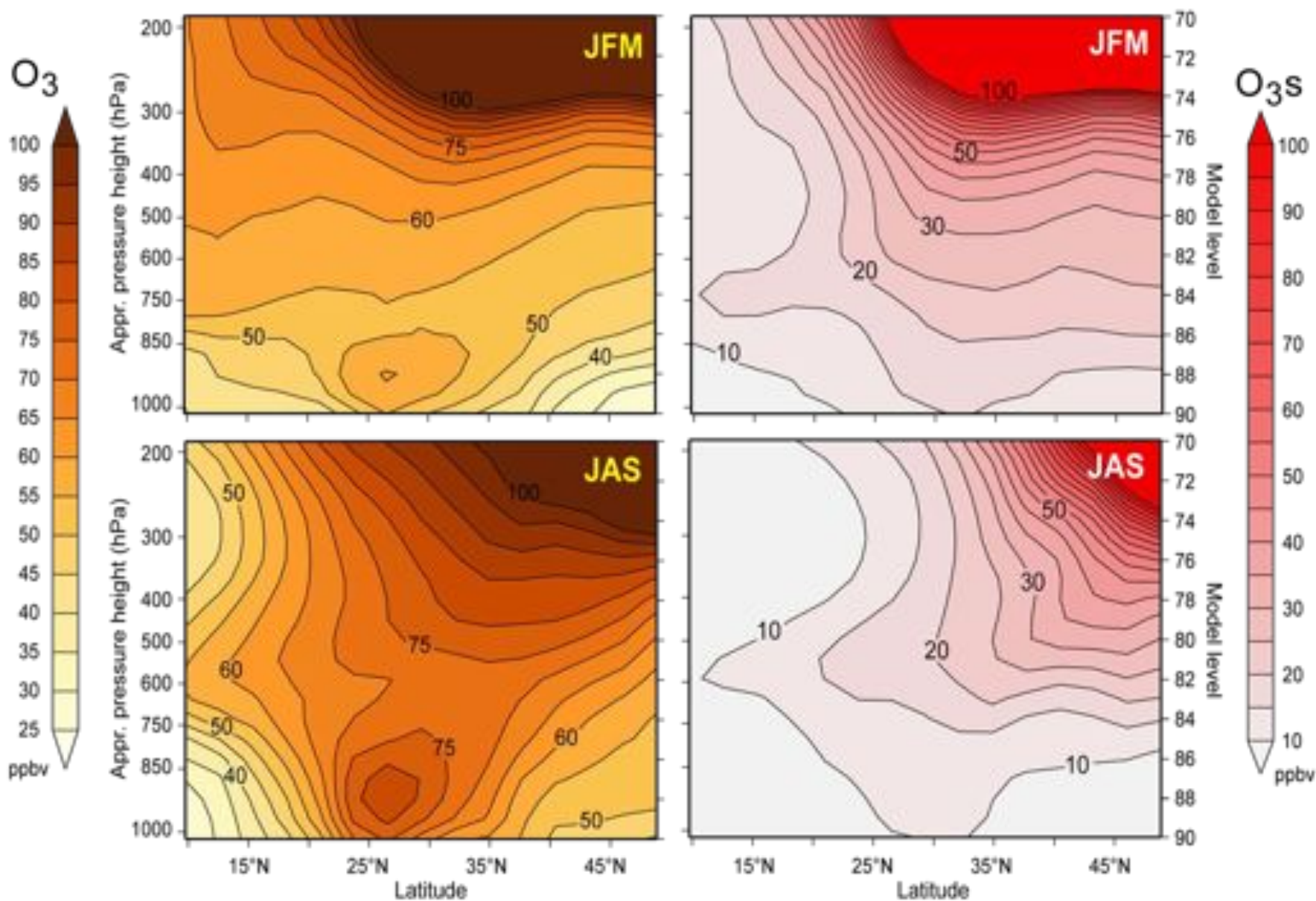


# Monthly mean near-surface ozone



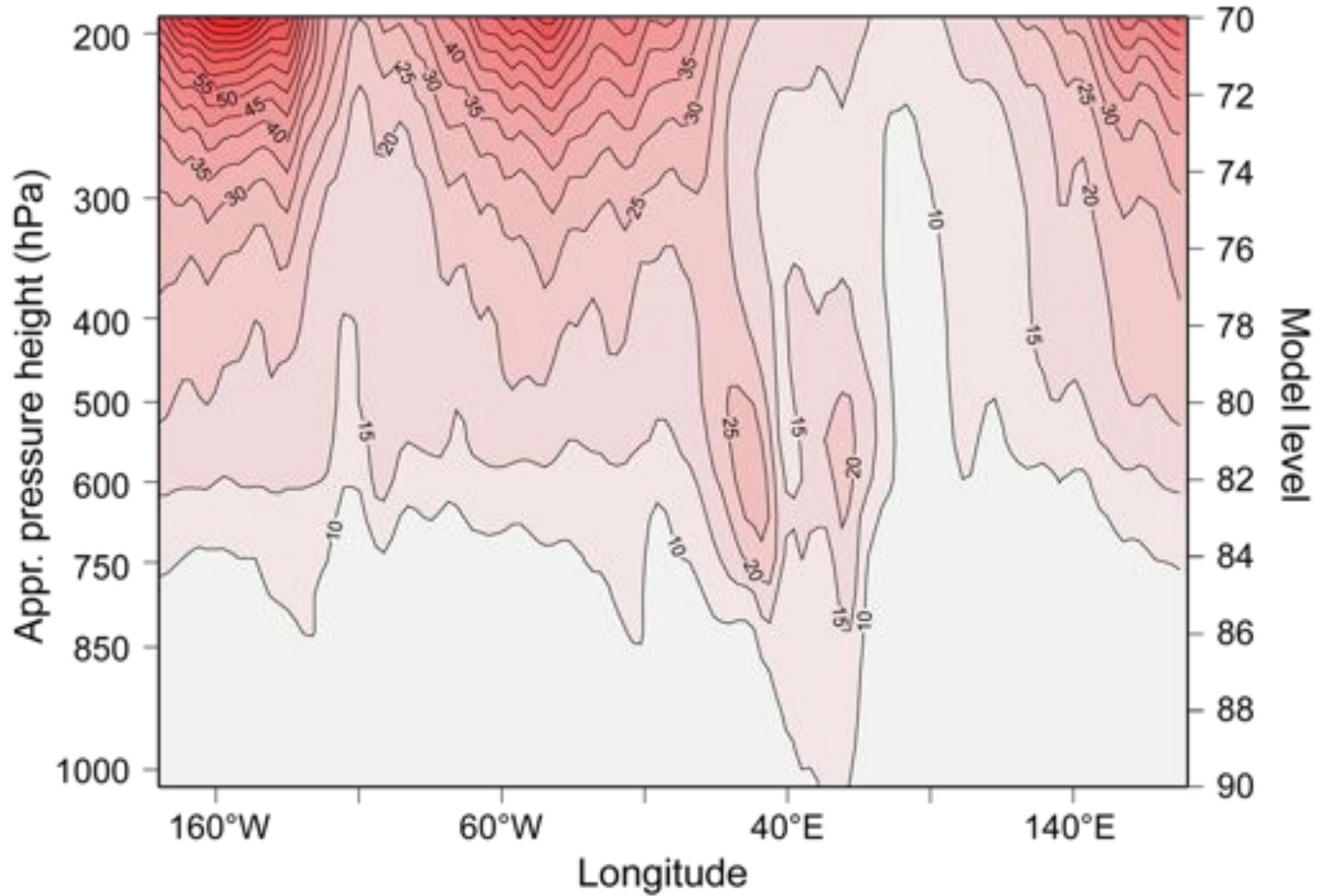
# MODIS fire counts in August 2008





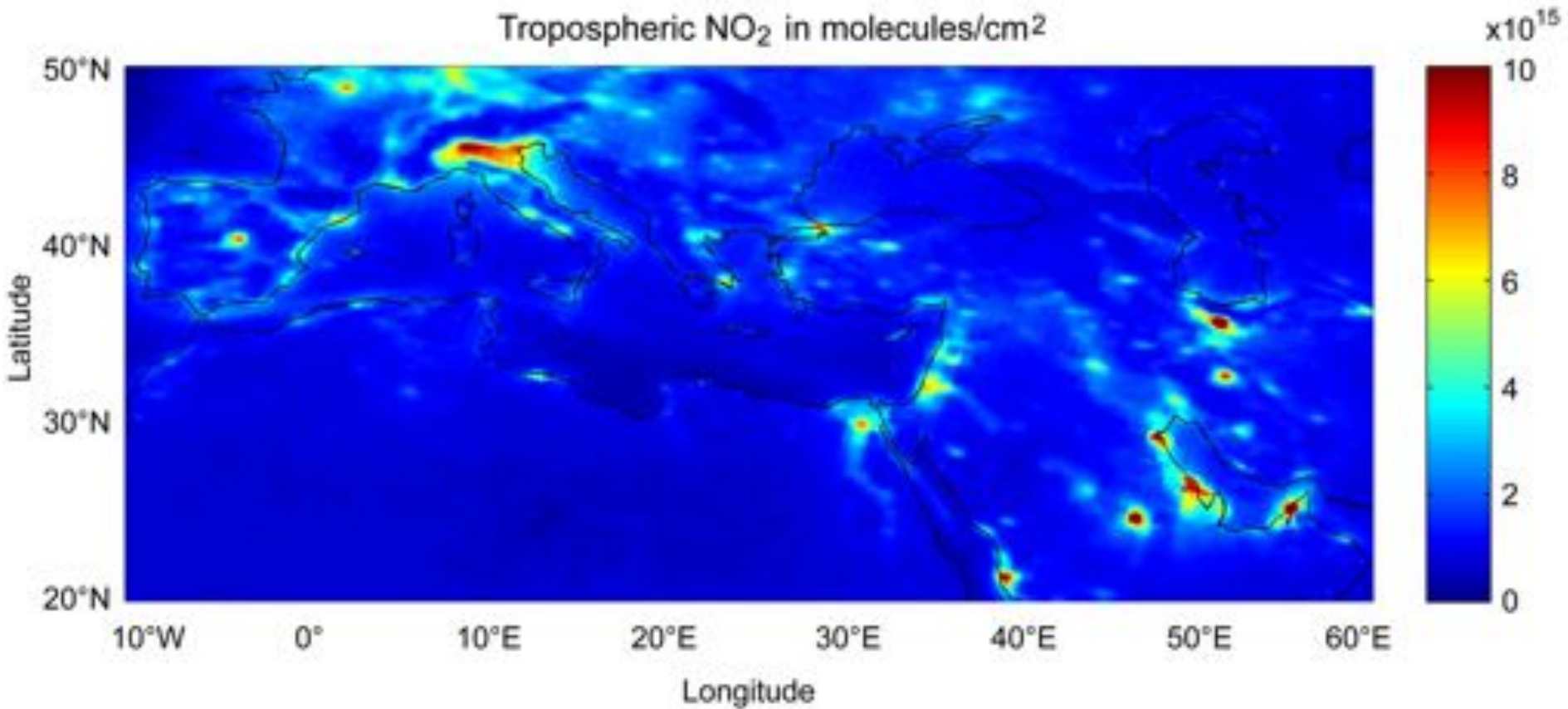
EMAC modeled ozone and  $O_3$  from the stratosphere ( $O_{3s}$ )

# O<sub>3</sub>s (ppbv) 25°-30° North, JAS 2006

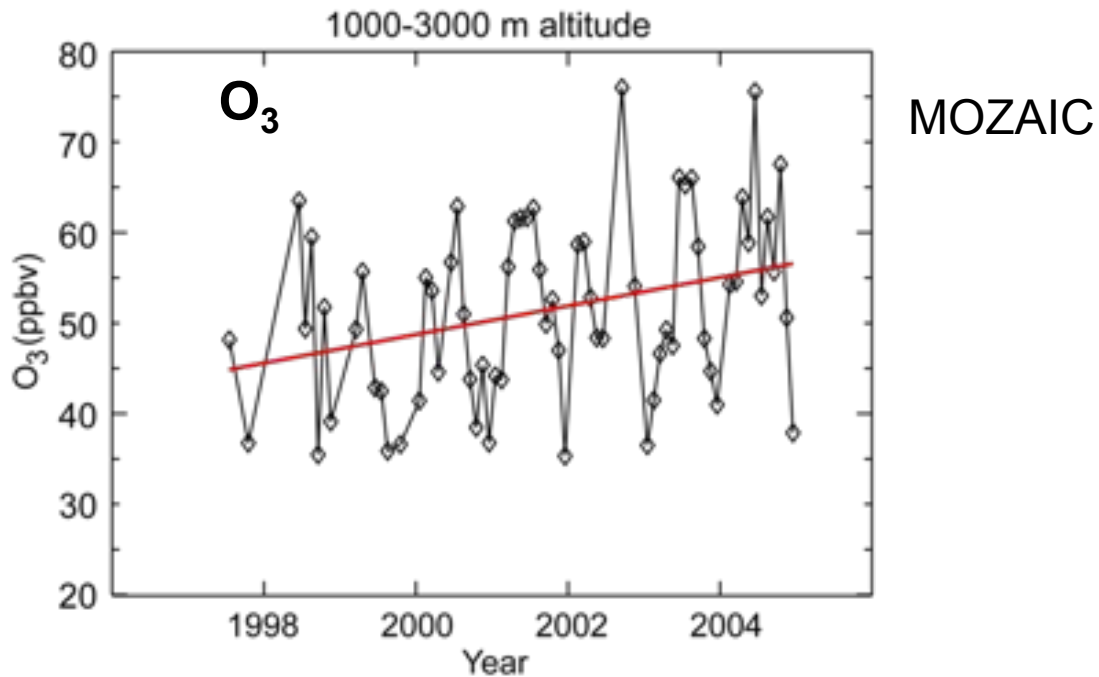
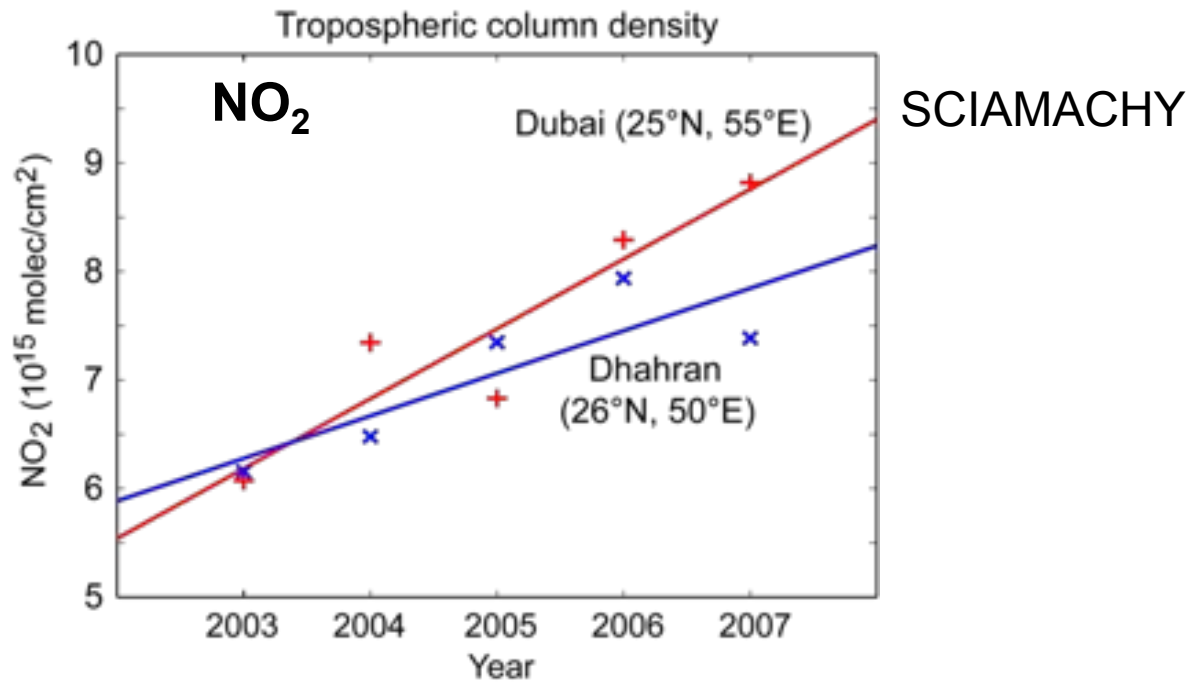


EMAC model calculated O<sub>3</sub> from the stratosphere (O<sub>3</sub>s)

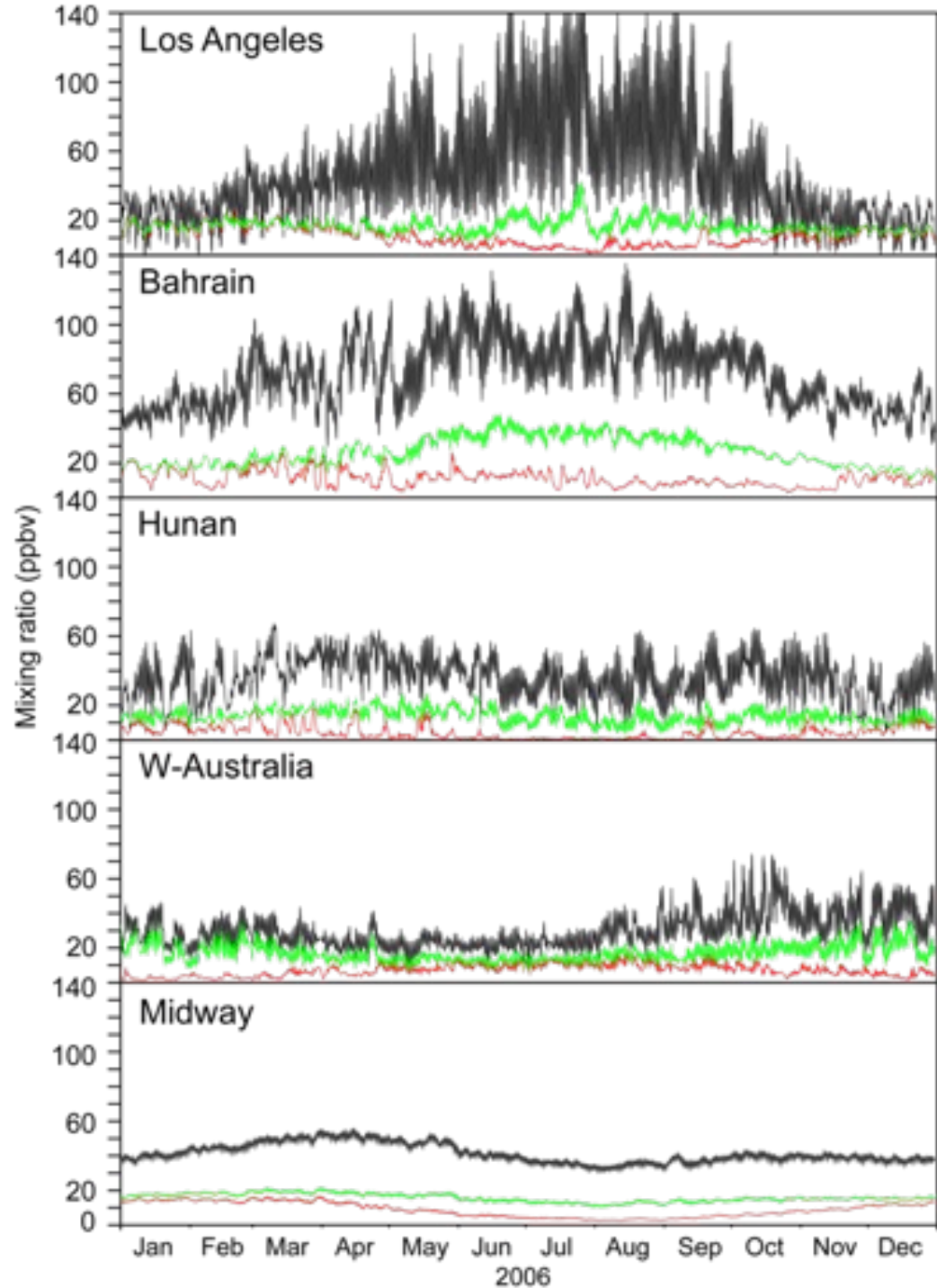
Tropospheric NO<sub>2</sub> in molecules/cm<sup>2</sup>



SCIAMACHY satellite measurements 2003 - 2007



EMAC surface  $O_3$  and  $O_3s$   
In green  $O_3$  without  
anthropogenic emissions



## Conclusions

- Ozone hot spot over the Persian Gulf region
- Long-distance transport of air pollution (eastern Med)
- Influence by  $O_3$  from the stratosphere
- Strong (rapidly growing) local  $NO_x$  sources
- Highly favorable conditions for photochemistry  
(aggravated by climate change?)
- From near-neutral (natural) to strong  $O_3$  export region
- Need for measurements within the region!

Thank you