

The World Avoided by the Montreal Protocol

Martyn Chipperfield

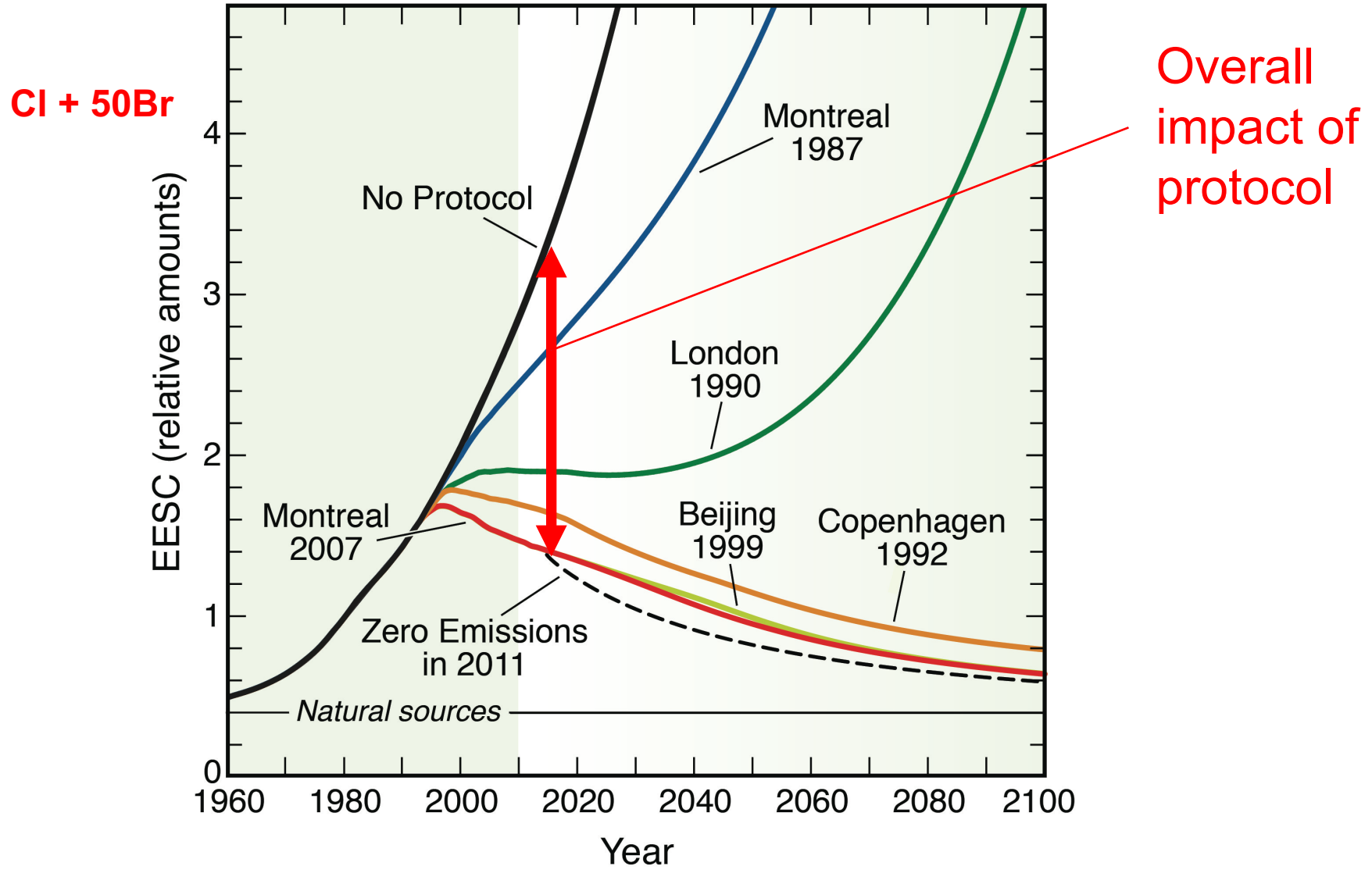
Model simulations of world without Montreal Protocol:

- World avoided so far (CTM simulations)
- Middle of this century (CCM simulations)

Observed/Predicted Stratospheric Chlorine Loading

Effect of the Montreal Protocol

Long-term changes in equivalent effective stratospheric chlorine (EESC)



ARTICLE

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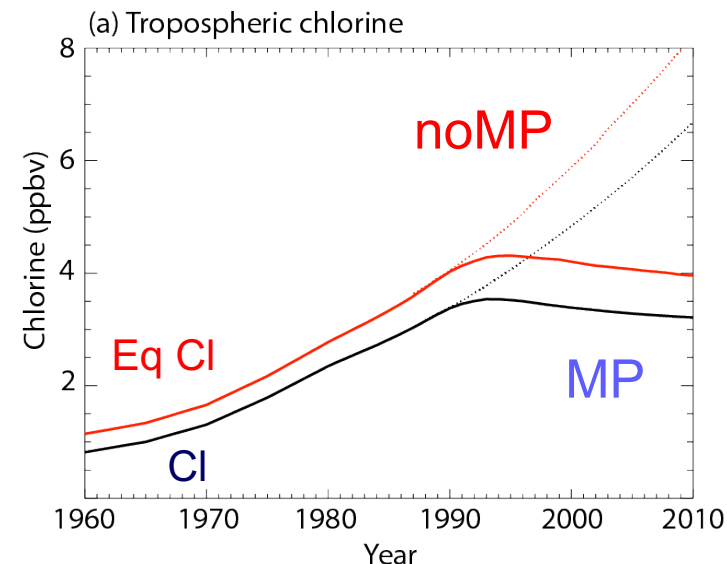
OPEN

Quantifying the ozone and ultraviolet benefits already achieved by the Montreal Protocol

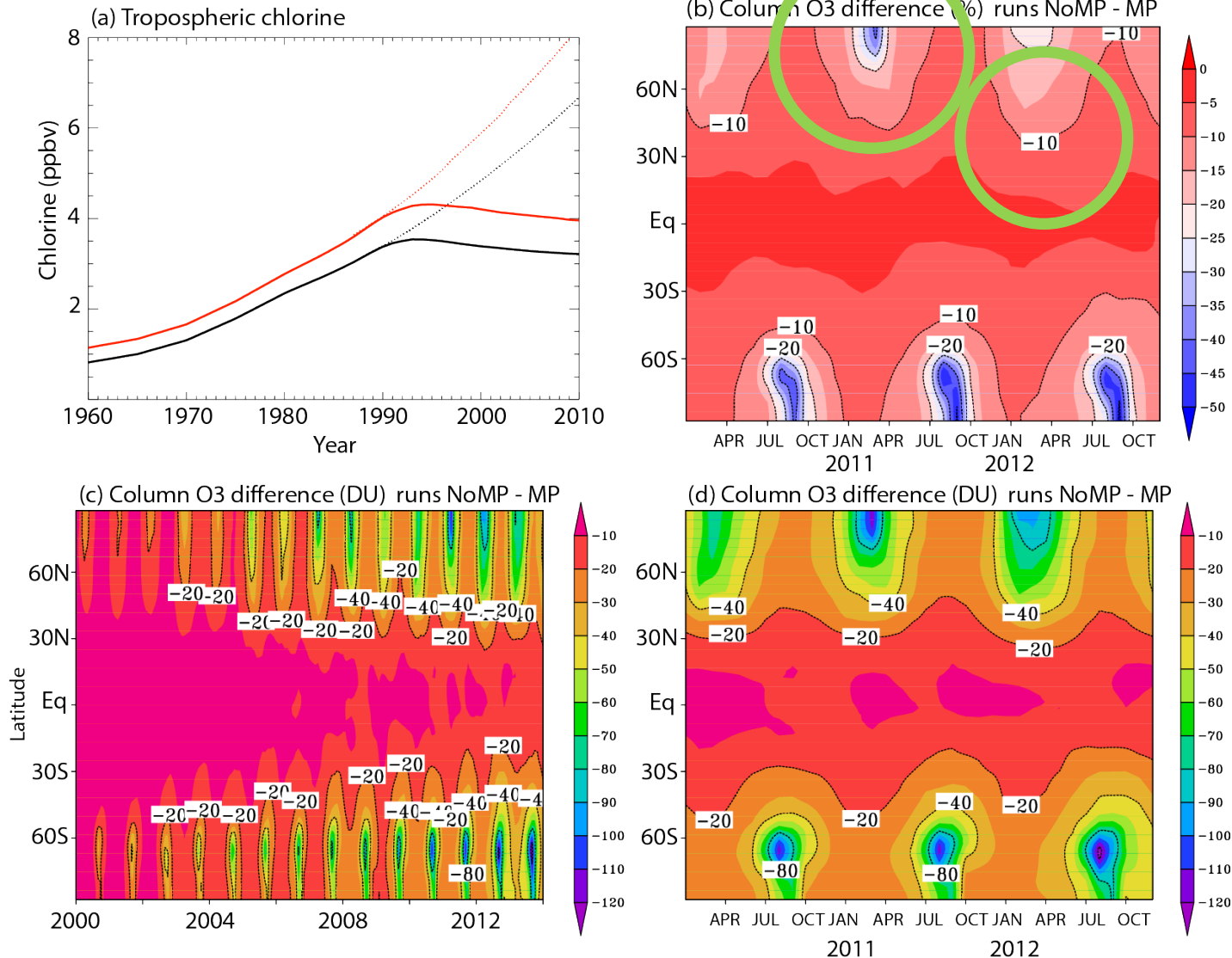
M.P. Chipperfield^{1,2}, S.S. Dhomse^{1,2}, W. Feng^{1,3}, R.L. McKenzie⁴, G.J.M. Velders⁵ & J.A. Pyle^{3,6}

Two simulations:

- **MP.** Forced by observed surface mixing ratios of long-lived ODSs (CFCs, HCFCs, solvents, CH₃Cl...)
- **noMP.** Increasing ODS emissions at 3%/yr from 1987.



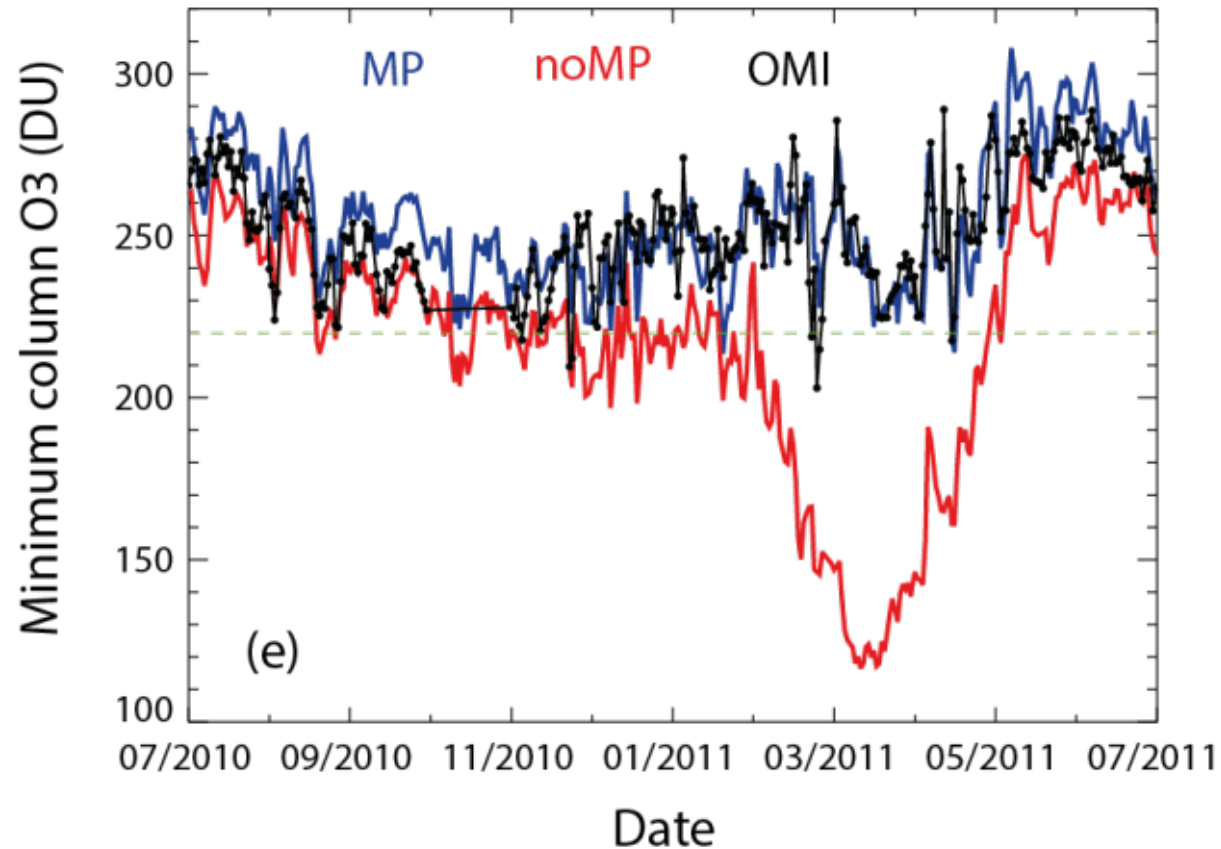
CTM – Column Ozone Difference (noMP – MP)



%

DU

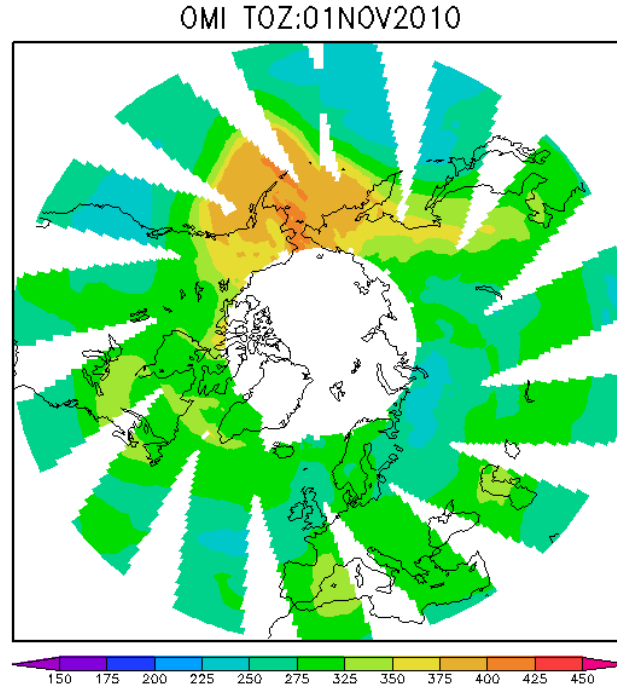
Arctic Ozone 2010/11



Arctic Column Ozone 2010/11

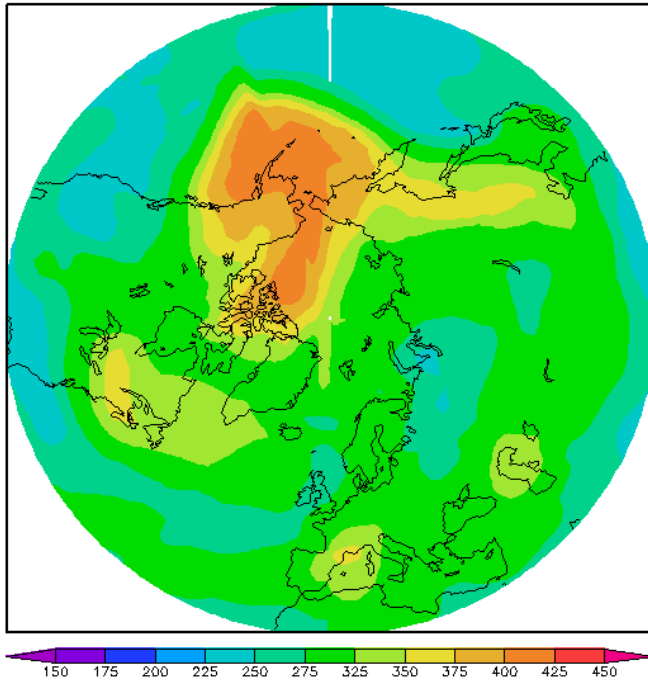
With
Montreal
Protocol

OMI observations

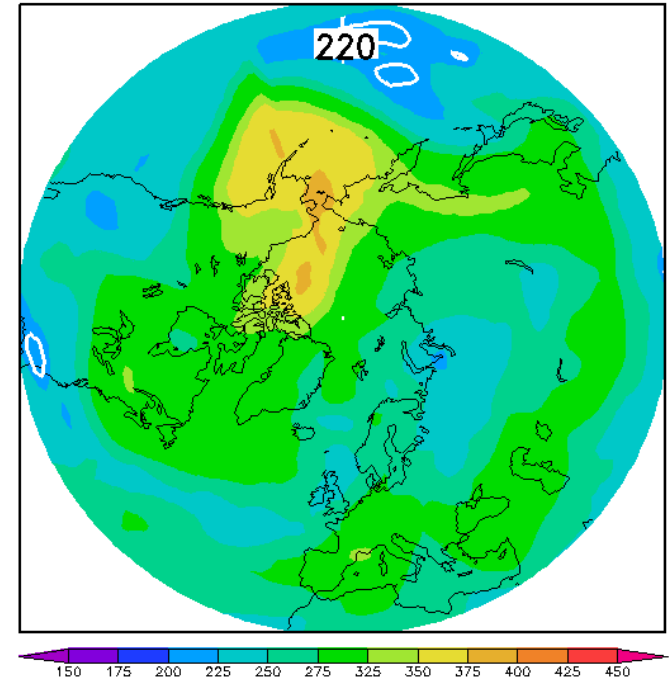


No
Montreal
Protocol

MP TOZ:01NOV2010

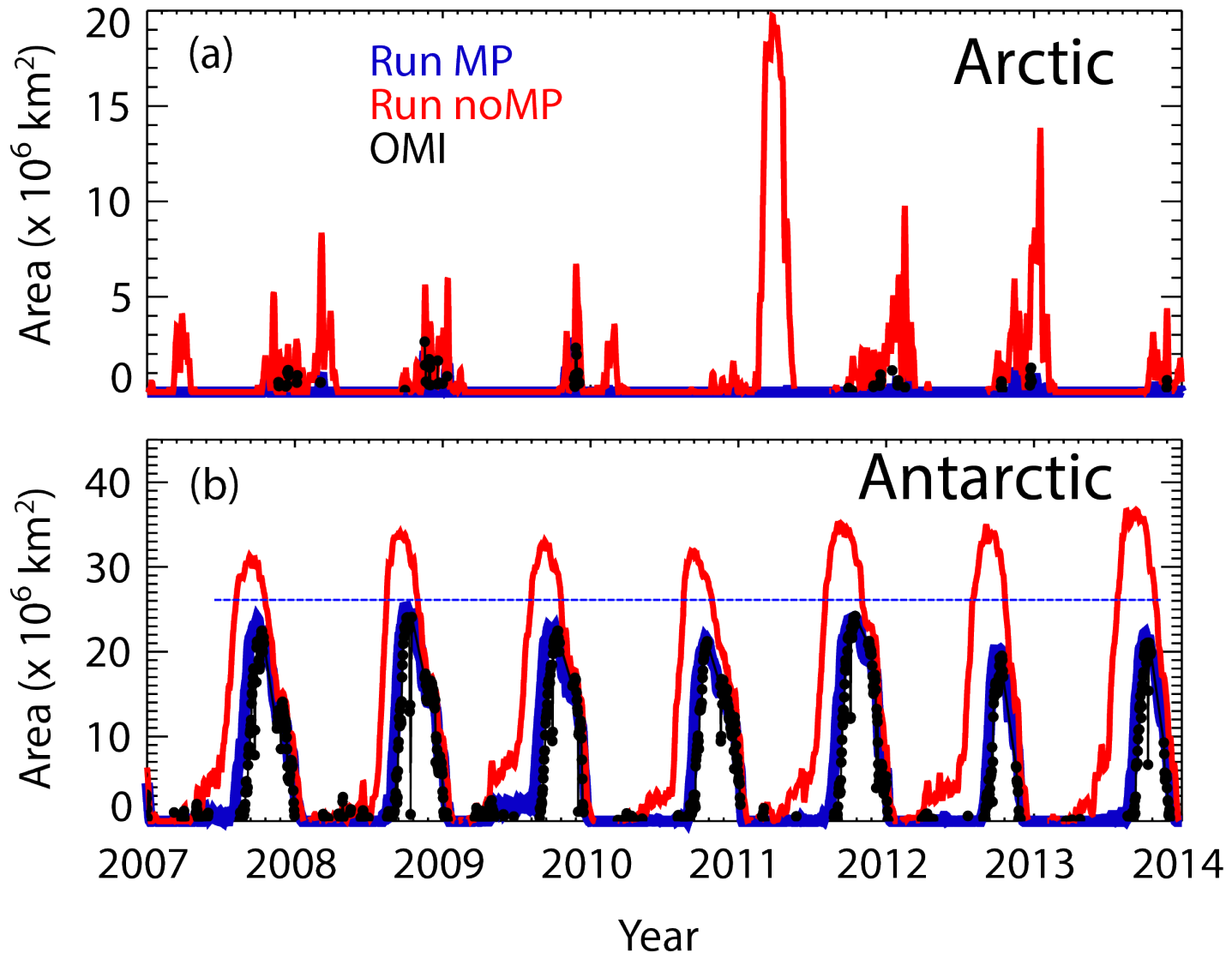


NoMP TOZ:01NOV2010



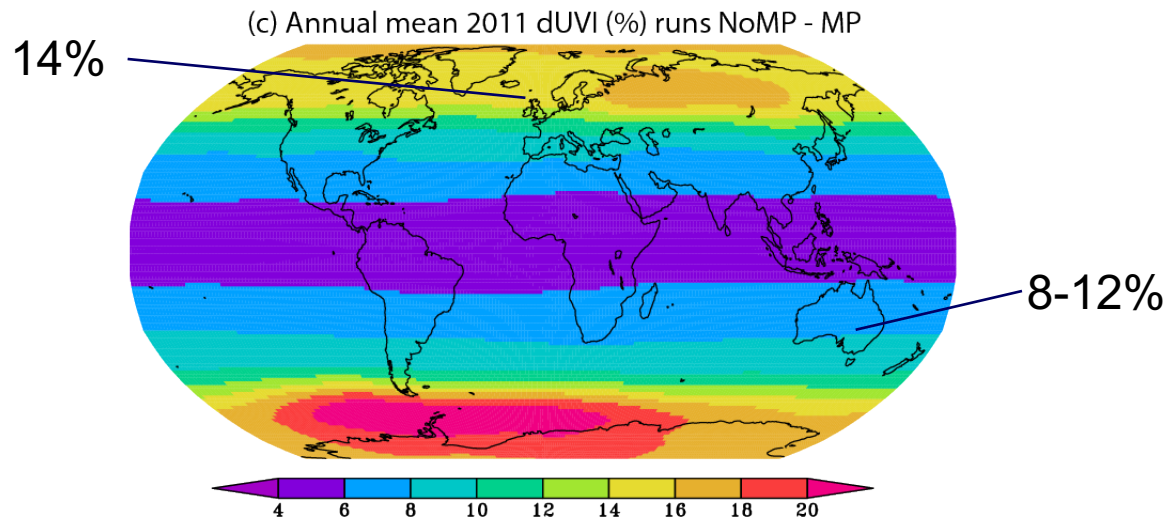
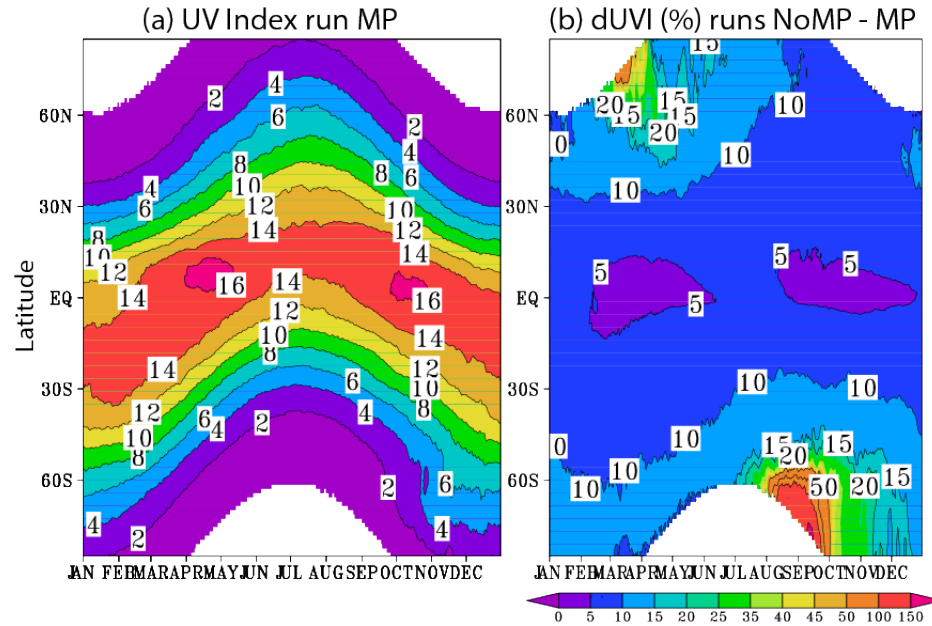
Area of 'Arctic' and Antarctic Ozone Holes

Area within 220 DU contour



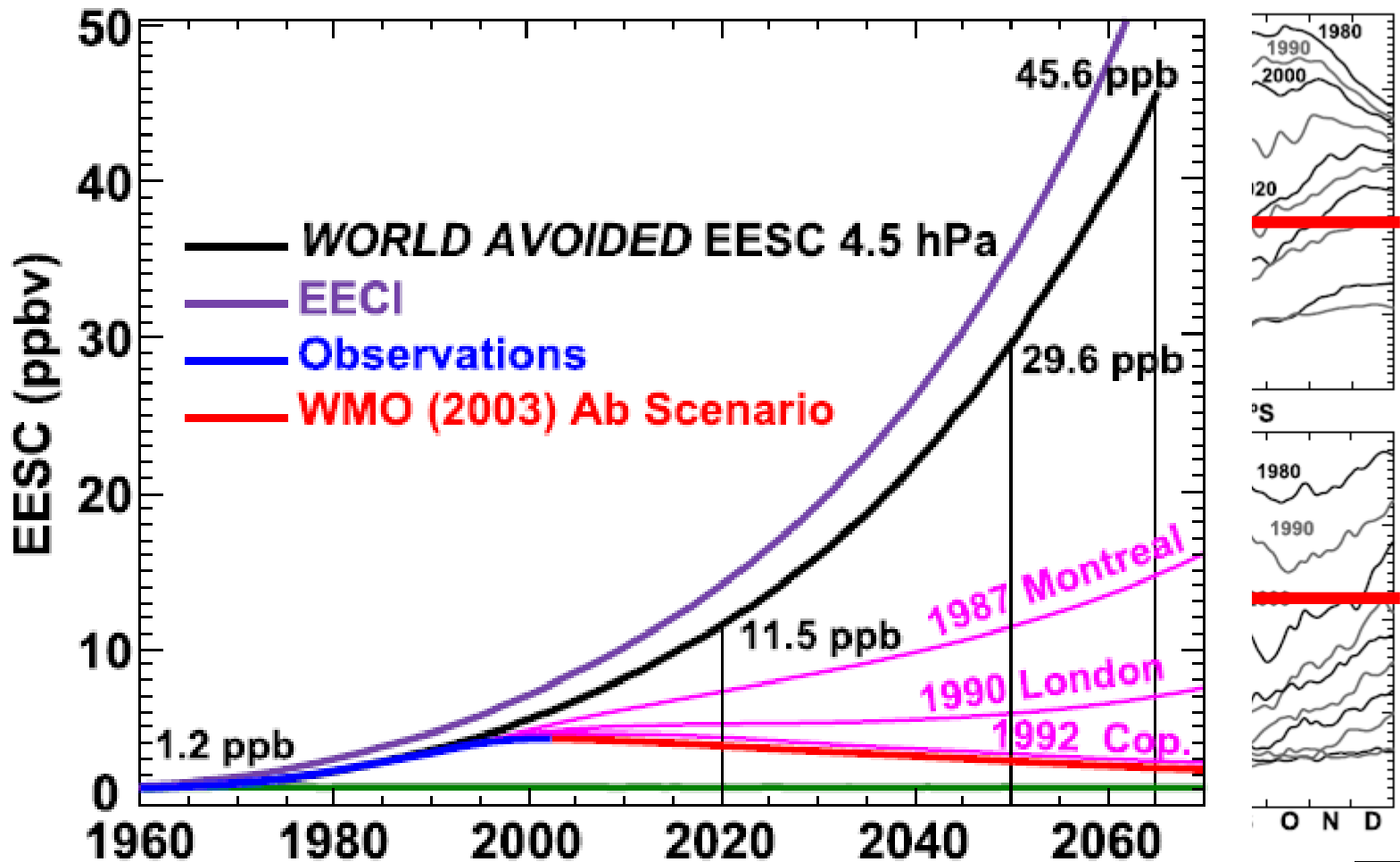
Impact on UV Index

5% increase in sunburning UV could cause increases of: 15% (squamous) and 8% (basal) cell carcinomas (Longstreth et al. 1998).



World Avoided – Into the Future

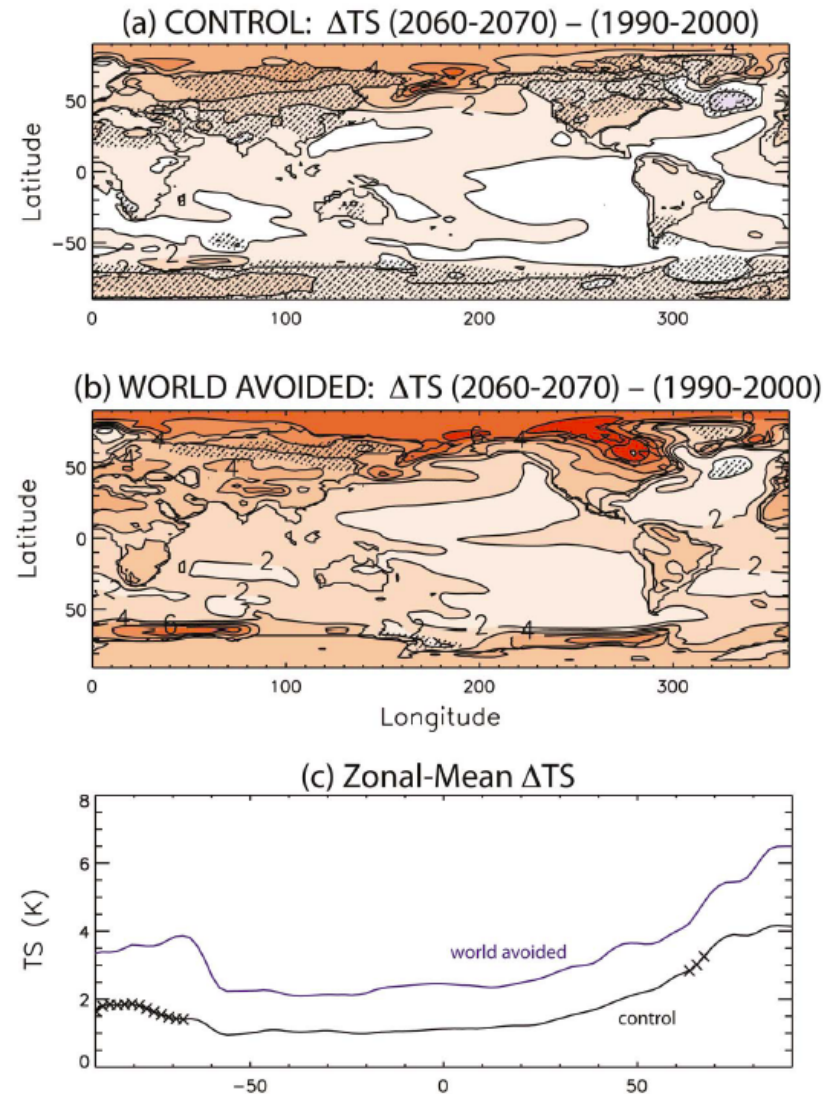
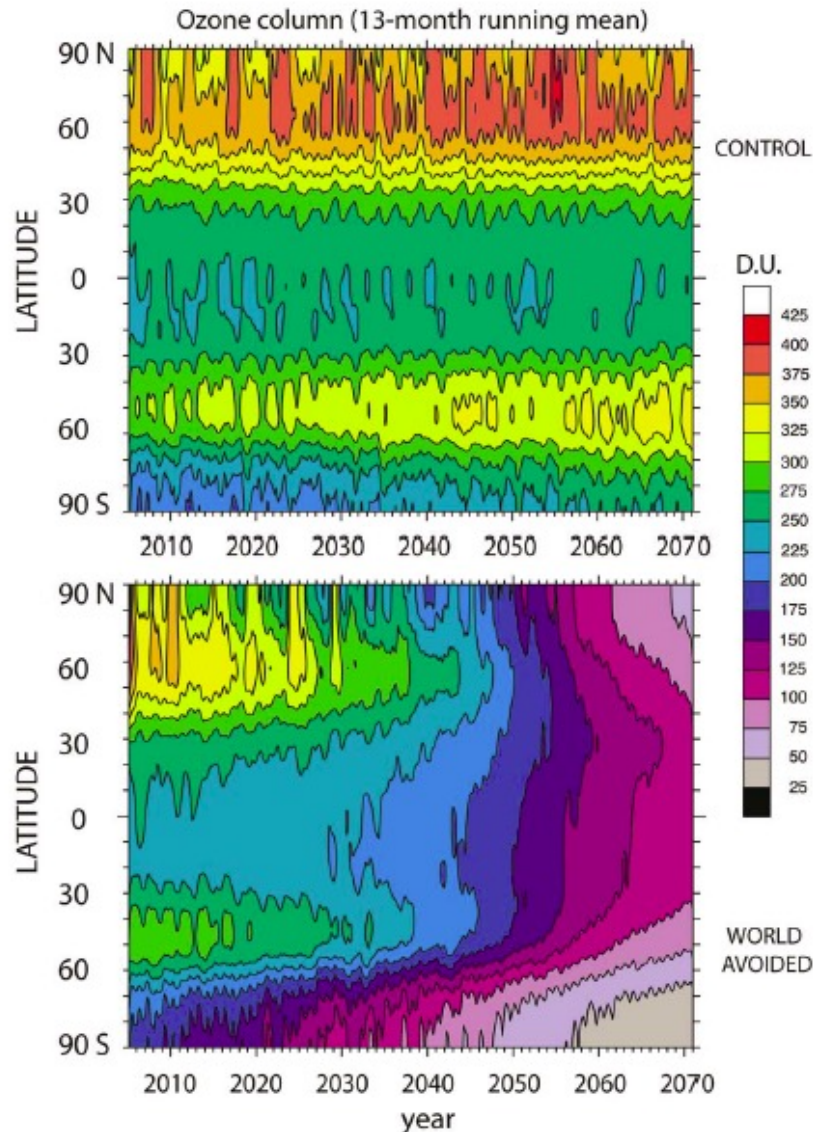
Based on CCM simulations through 2035-2065 – e.g. Newman et al (2009)



World Avoided – Into the Future

Garcia et al (2012) – Ozone loss, climate impact and recovery

ODS RF 4 Wm⁻² by 2070

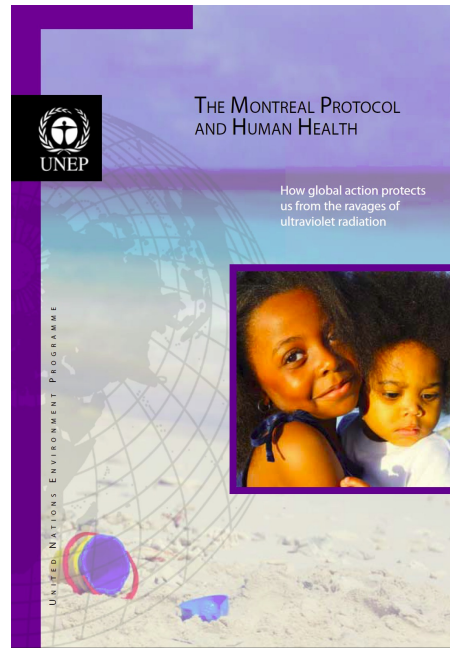


Summary

Montreal Protocol has already had significant benefits (e.g. would have seen 'Arctic ozone hole').

Protocol will have avoided possible catastrophic ozone loss later this century – with related impacts on surface uv, climate, human health etc.

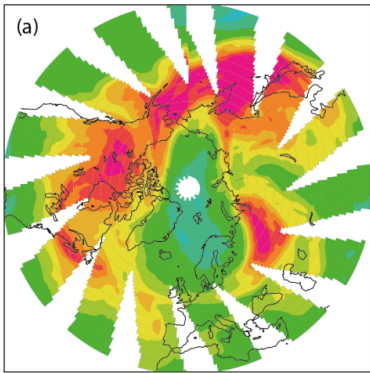
Available in
foyer



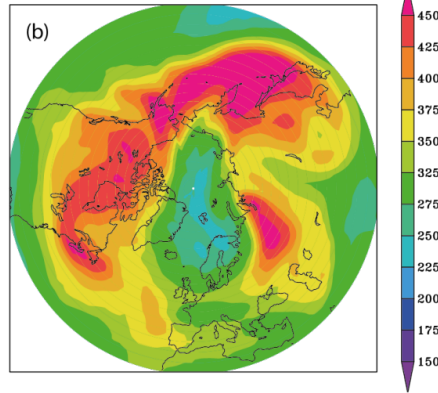


Arctic Ozone 2011

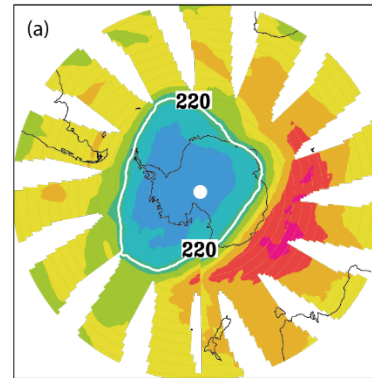
Column ozone OMI March 26, 2011



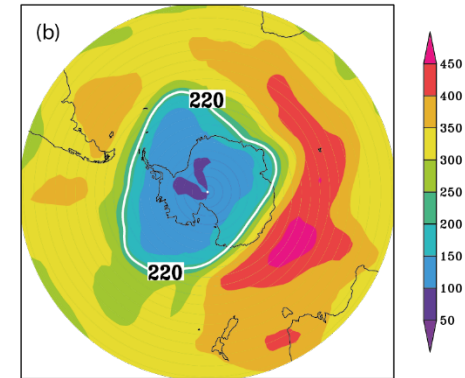
Model run MP March 26, 2011



Column ozone OMI October 2, 2011



Model run MP October 2, 2011



International Agreement to Control ODS Emissions

UNITED NATIONS ENVIRONMENT PROGRAM (UNEP)



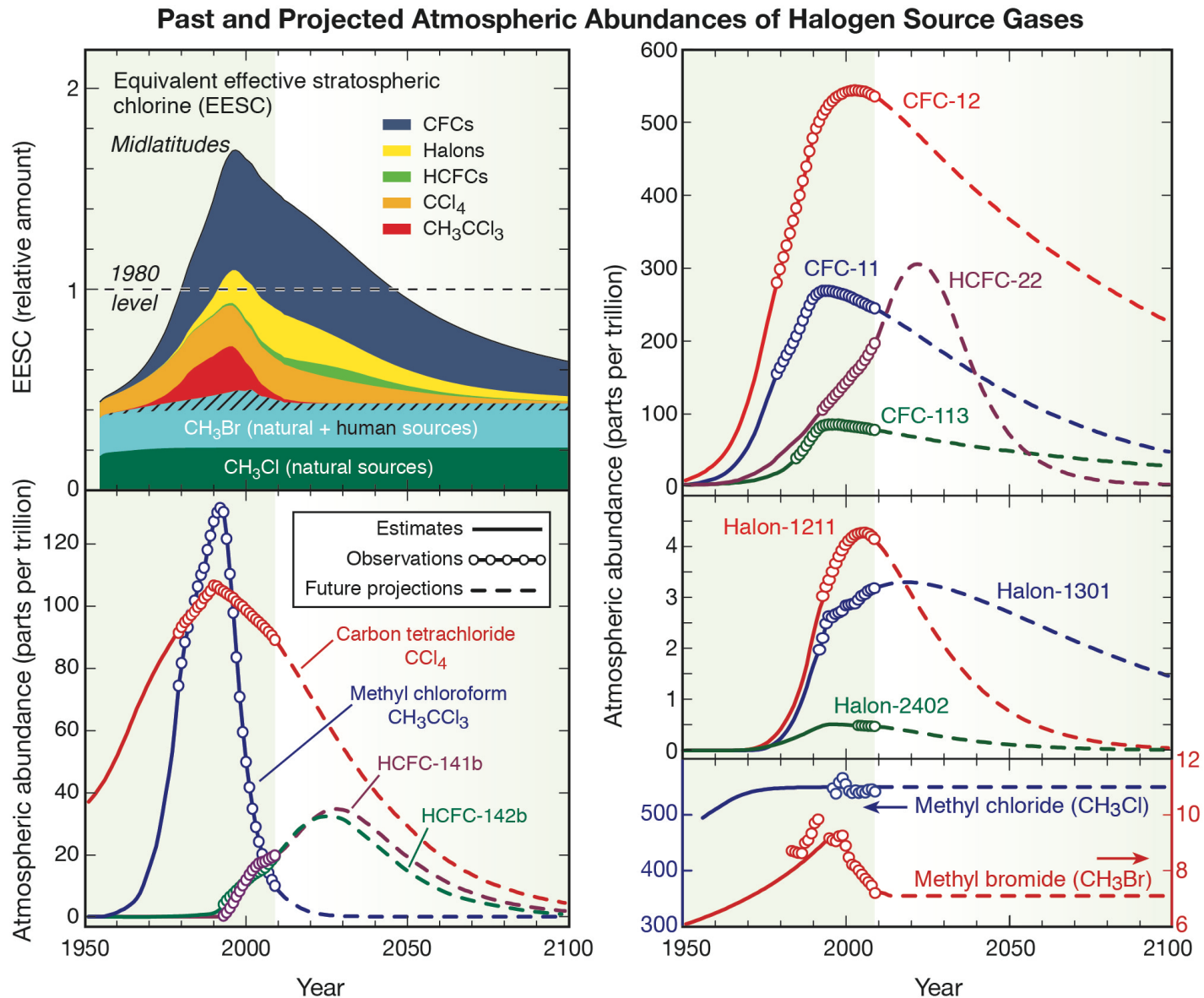
MONTREAL PROTOCOL ON SUBSTANCES THAT DEplete THE OZONE LAYER

FINAL ACT

1987

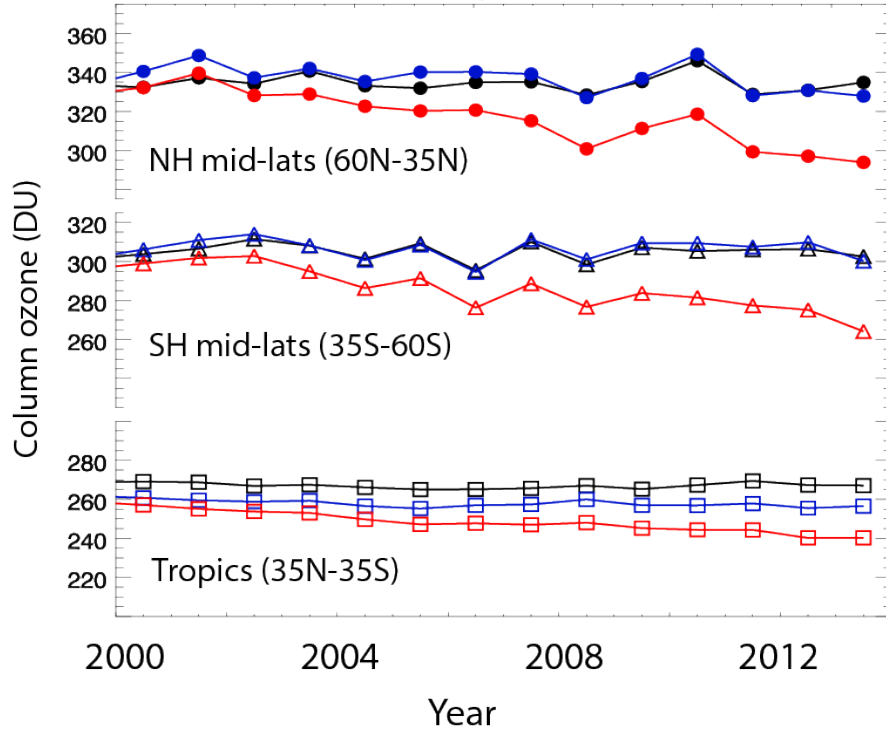


Past/Future Trends in Ozone-Depleting Substances

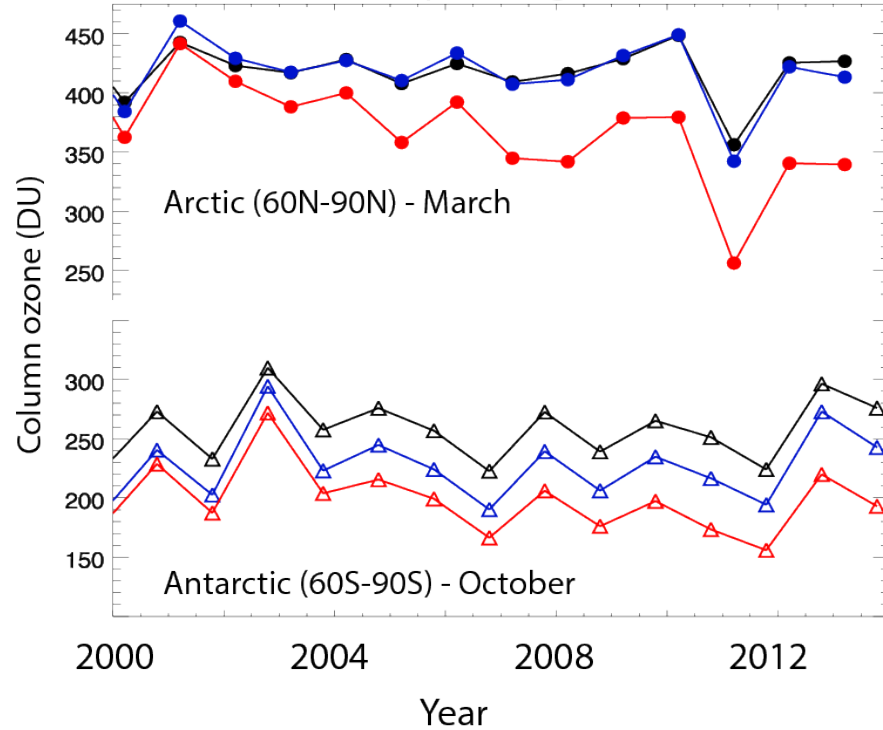


CTM World Avoided Simulations

(e) Column ozone - tropics and mid-latitudes

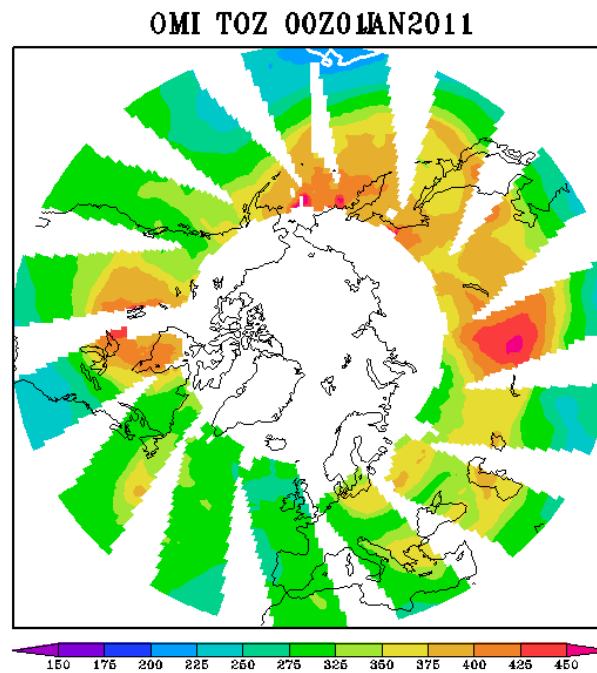


(f) Column ozone - polar regions



Arctic Column Ozone 2010/11

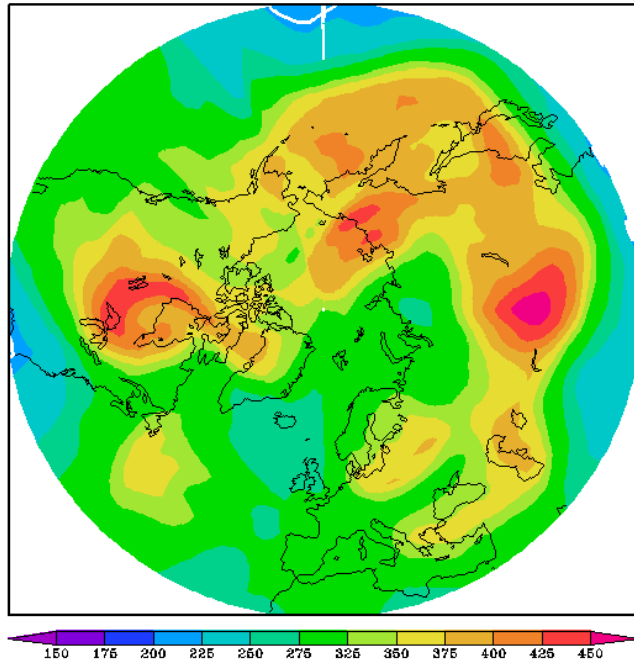
With
Montreal
Protocol



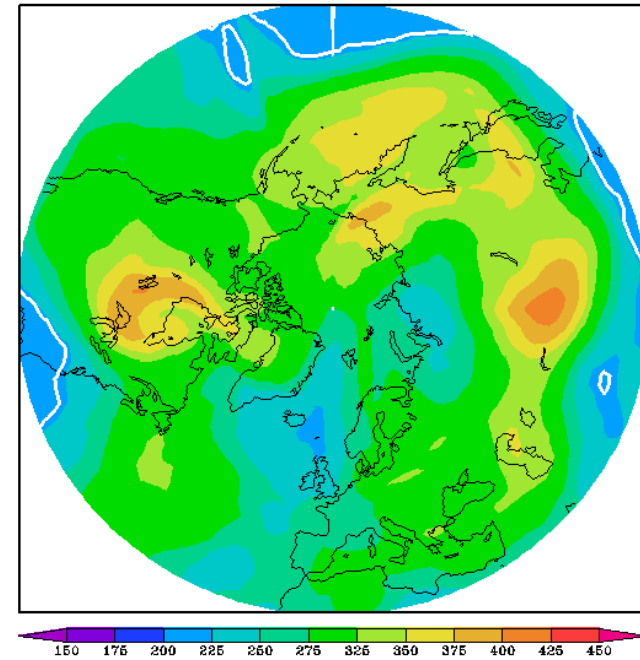
OMI observations

No
Montreal
Protocol

Montreal Protocol (MP) TOZ 00Z01AN2011

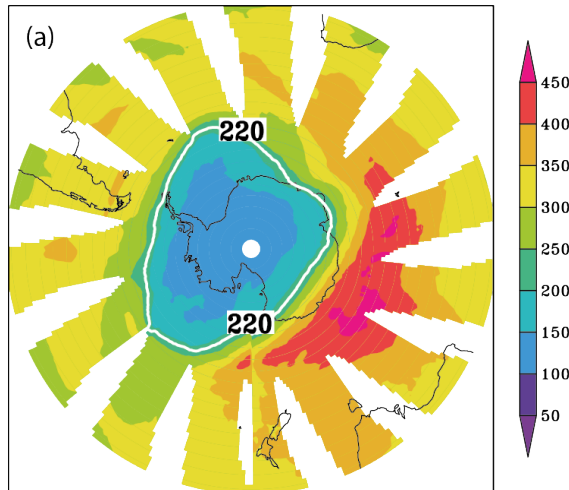


Without MP(NoMP) TOZ 00Z01AN2011

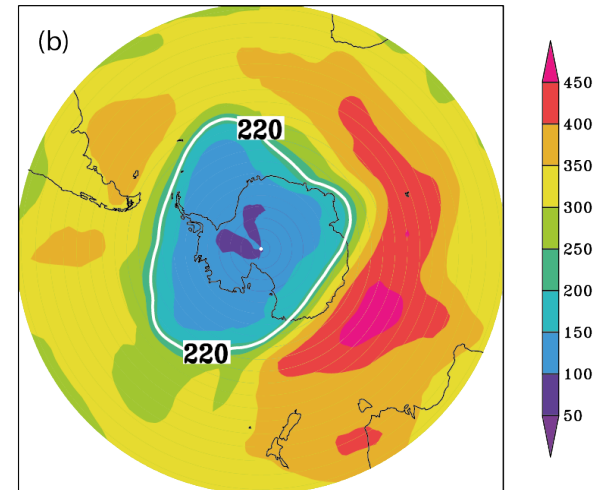


Antarctic Ozone 2011

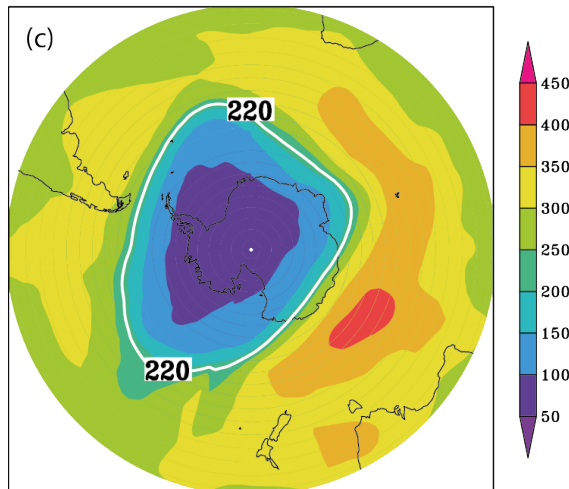
Column ozone OMI October 2, 2011



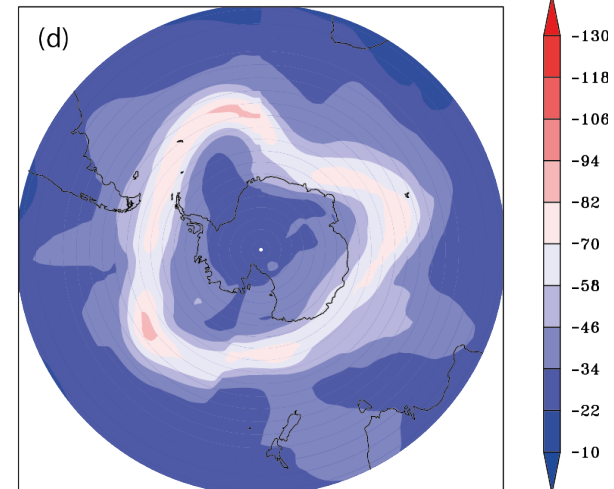
Model run MP October 2, 2011



Model run NoMP October 2, 2011



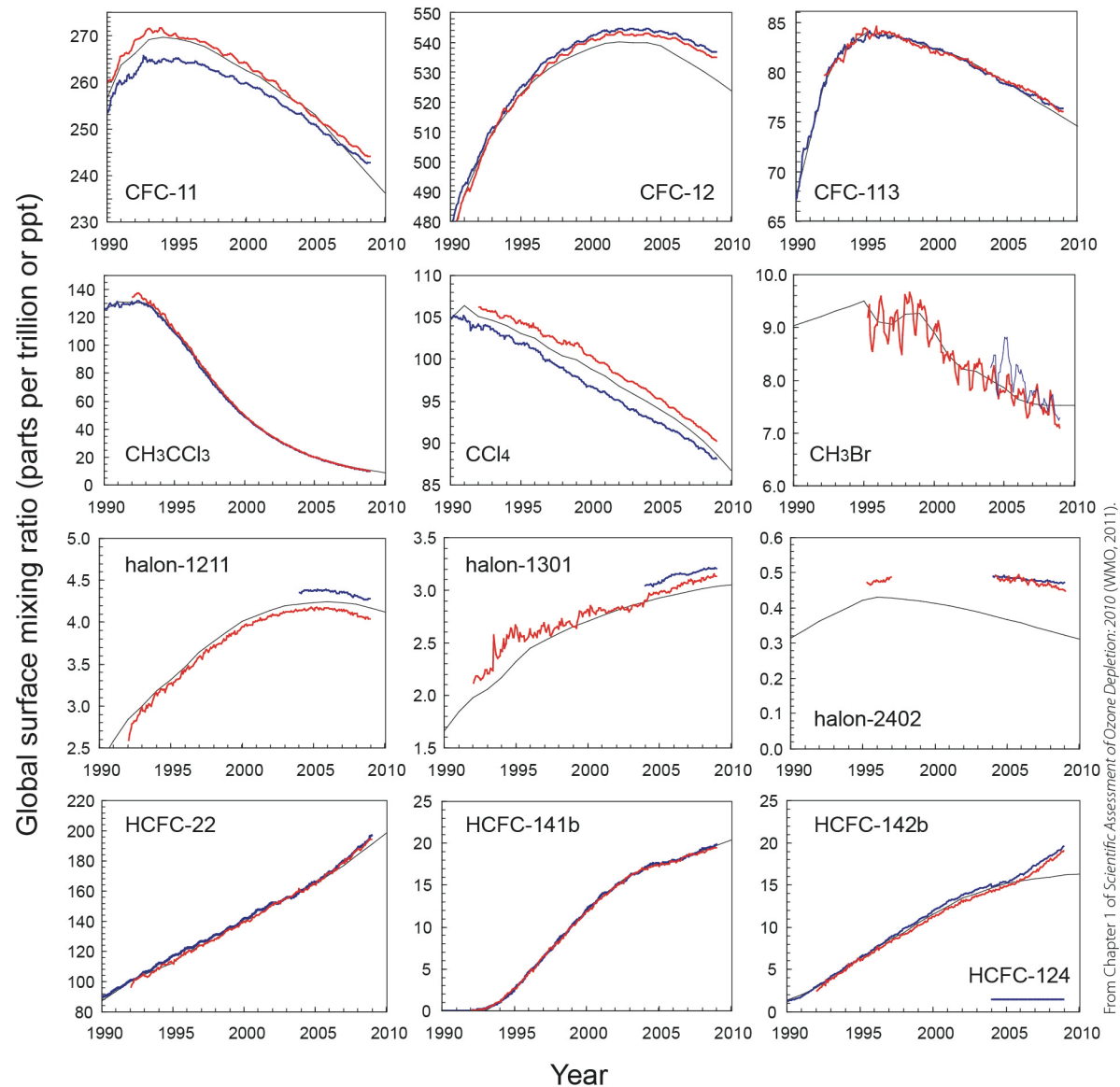
Column O3 difference runs NoMP - MP



Impact of Montreal Protocol (and Amendments)

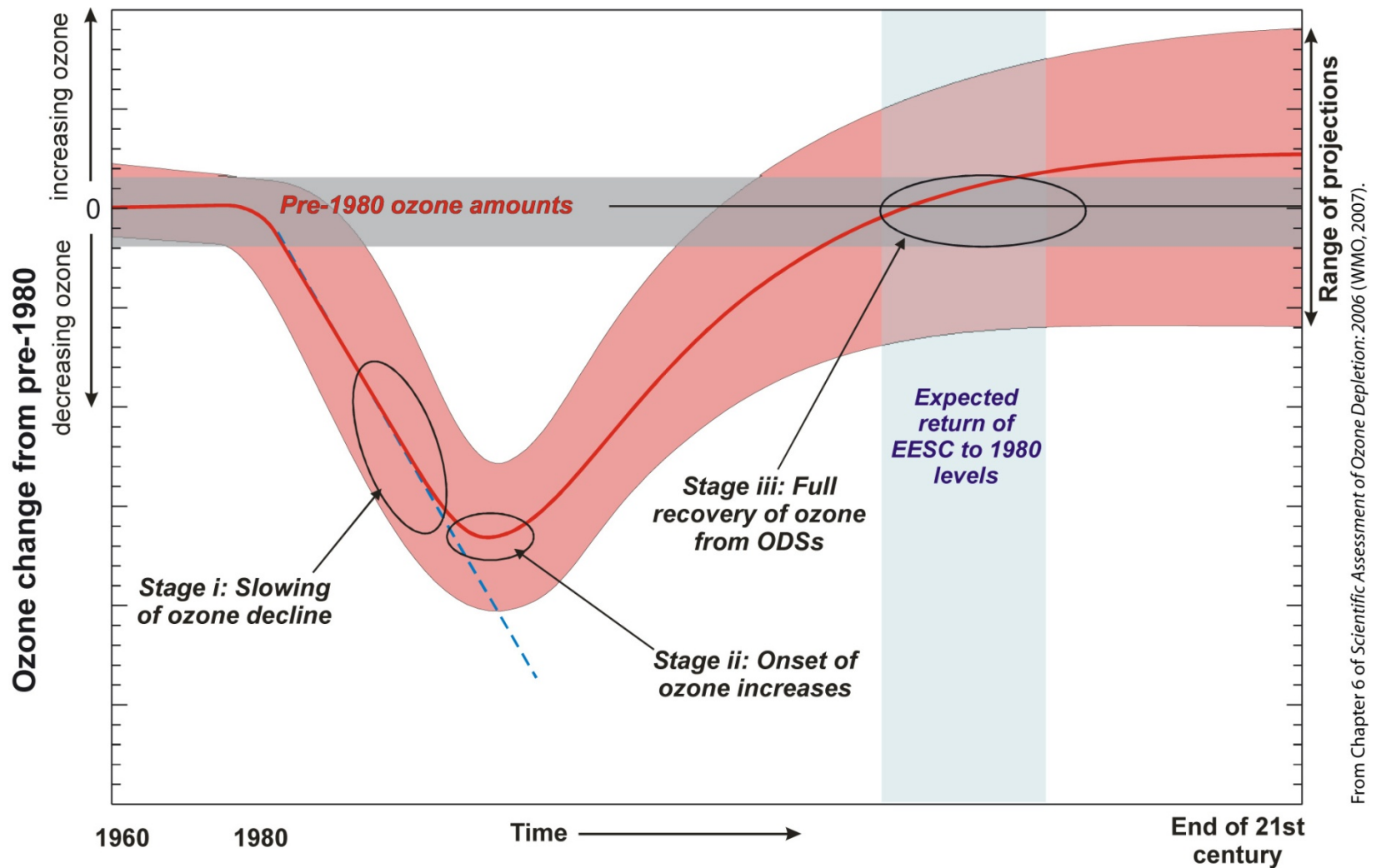
Observations of
Cl source gases
from surface
monitoring
network
i.e. **NOAA**,
AGAGE

In stratosphere all
source gases
release Cl which
forms the main
reservoir HCl



From Chapter 1 of Scientific Assessment of Ozone Depletion: 2010 (WMO, 2011).

Recovery of the Ozone Layer



Observed/Predicted Stratospheric Chlorine Loading

Effect of the Montreal Protocol

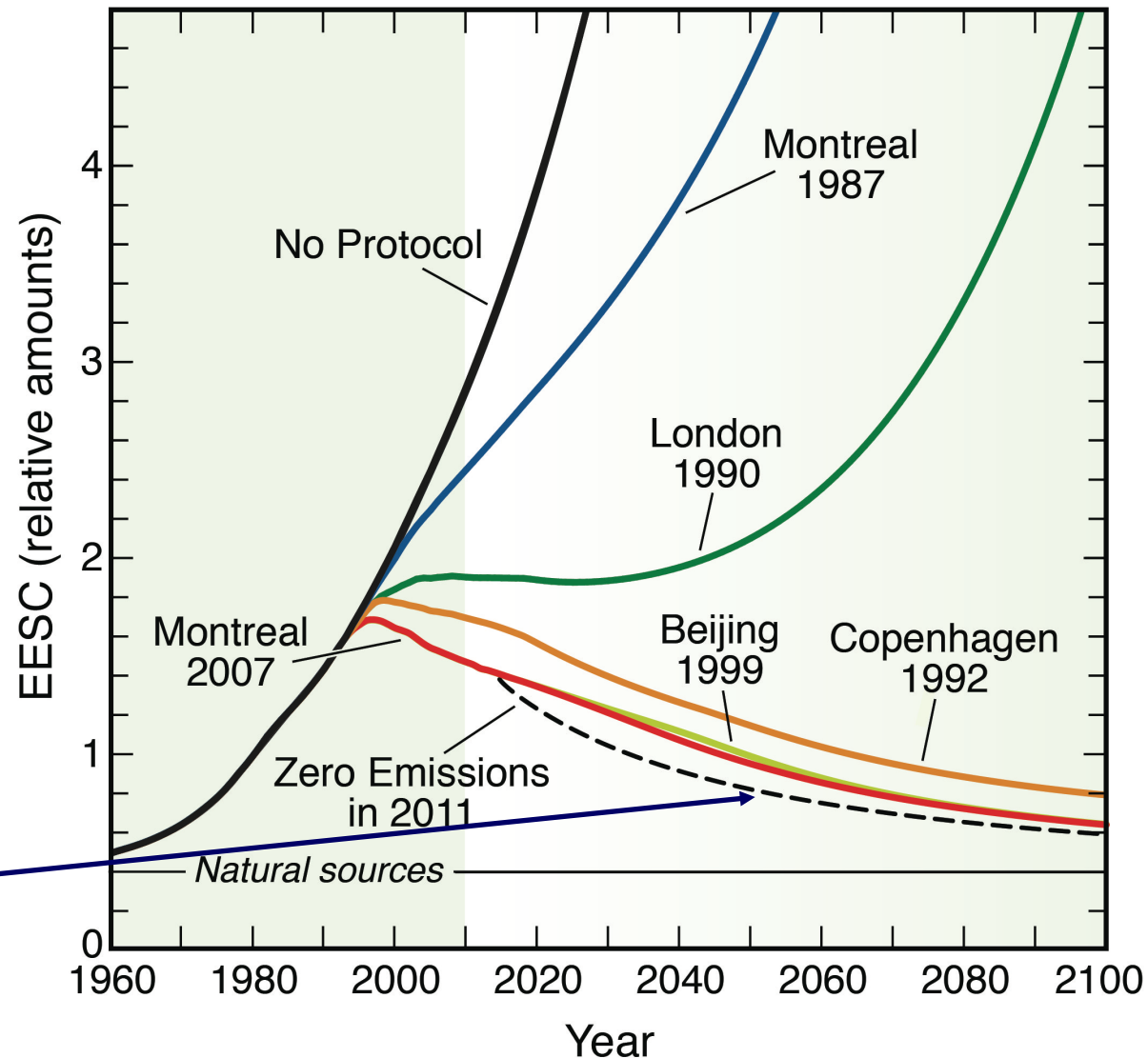
Long-term changes in equivalent effective stratospheric chlorine (EESC)

Cl + 50Br

In 1987 Montreal Protocol placed first limits on use of CFCs. (Based on 'precautionary principle')

Later amendments strengthened control of Cl/Br source gases.

Now expect Cl loading to return to 1980 values (pre Antarctic O₃ hole) by 2050.



Past and Projected Atmospheric Abundances of Halogen Source Gases

