Issues from the WMO 2010 Assessment

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SPARC/IOC/WMO-IGACO workshop:
Past Changes in the Vertical Distribution of Ozone

Geneva, 25-27 January 2011

Introduction

Scientific Assessment of Ozone Depletion: 2010 was just released:

http://ozone.unep.org/Assessment_Panels/SAP/Scientific_Assessment_2010/

including

Chapter 2: Stratospheric Ozone and Surface Ultraviolet Radiation (*Anne Douglass and Vitali Fioletov*)

While on the whole our understanding of global ozone continues to grow, several key issues standout as requiring immediate attention

Issues

- Ozone “recovery” trend magnitudes are 2-3 times smaller than ozone decline trends.
- Different satellite instruments measure “different” ozone and it is not obvious how to combine them.
- Satellite instruments measure ozone profiles in different units and vertical-coordinates.

Issues: magnitude of recovery trends

- Ozone "recovery" trend magnitudes are 2-3 times smaller than ozone decline trends. It is more difficult to detect them.

Northern mid-latitude ozone trends

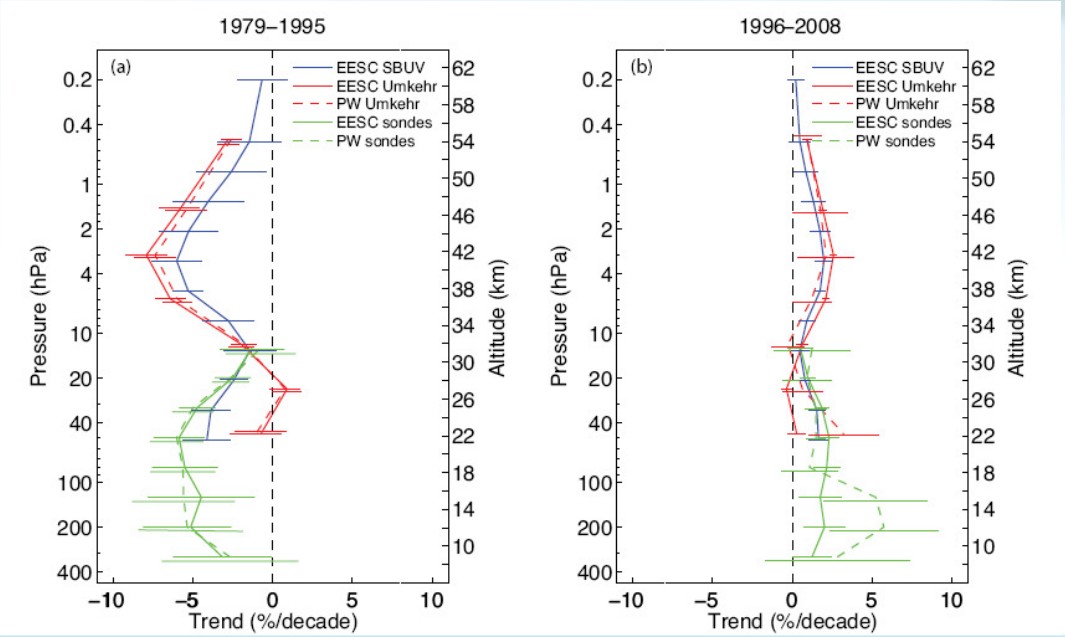

Figure 2-7, WMO, 2010

Issues

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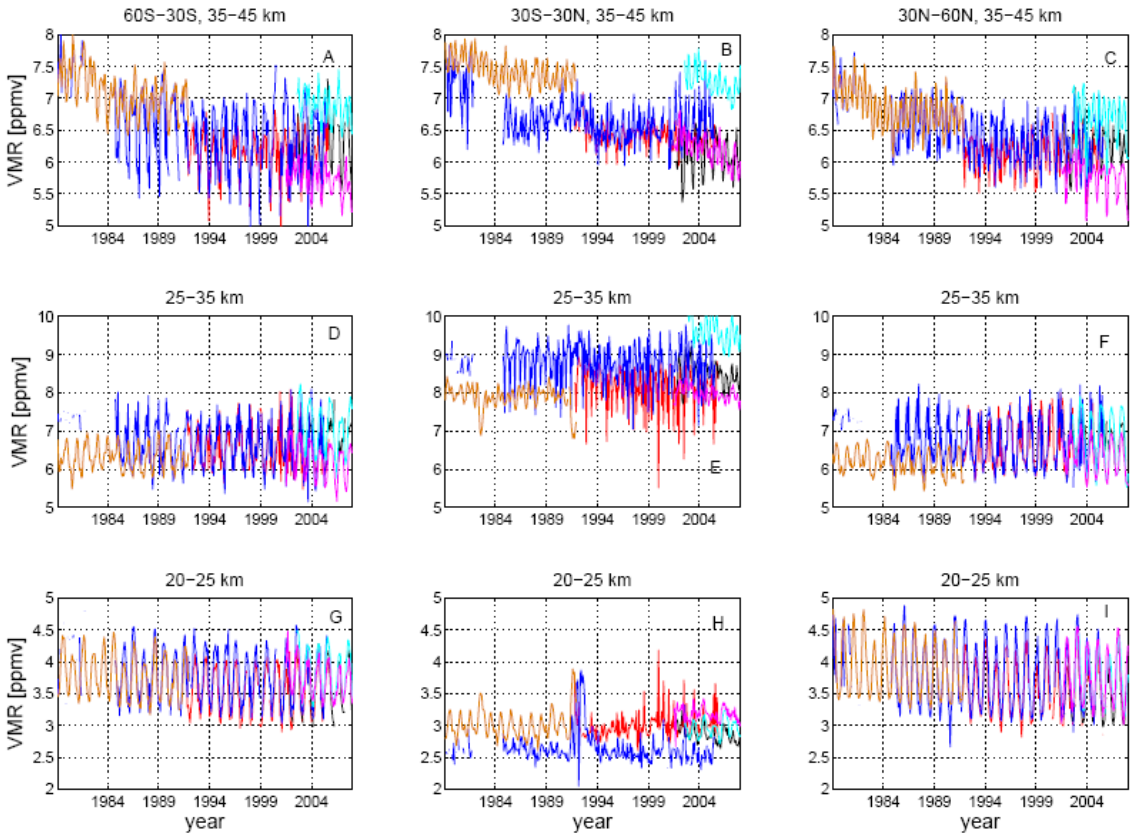
Issues: combining ozone data

- Different satellite instruments measure "different" ozone. It is not obvious how to combine them; the difference is not just a simple bias or annual cycle.
- Several newer satellites measure O_3 profiles: Odin (9+ years), Envisat (8+), SciSat (7+), Aura (6+)
- To consider: vertical resolution, spectral region, native units, repeat times, drift, p & T profiles, …

Shows several sources of ozone: SAGE, SBUV, HALOE, SCIAMACHY, SMR, OSIRIS, MLS, …

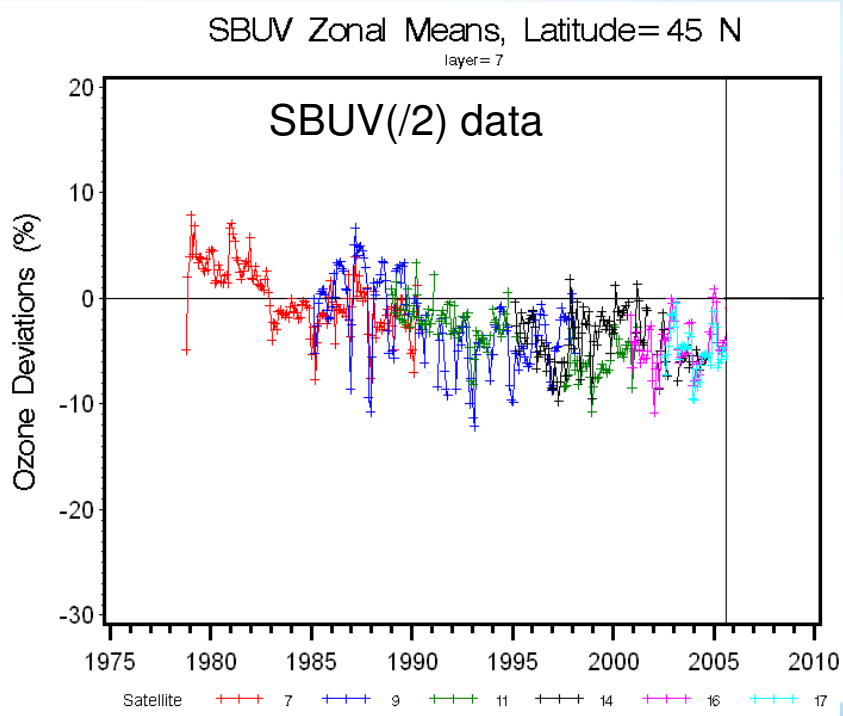
Jones et al., ACP, 2009

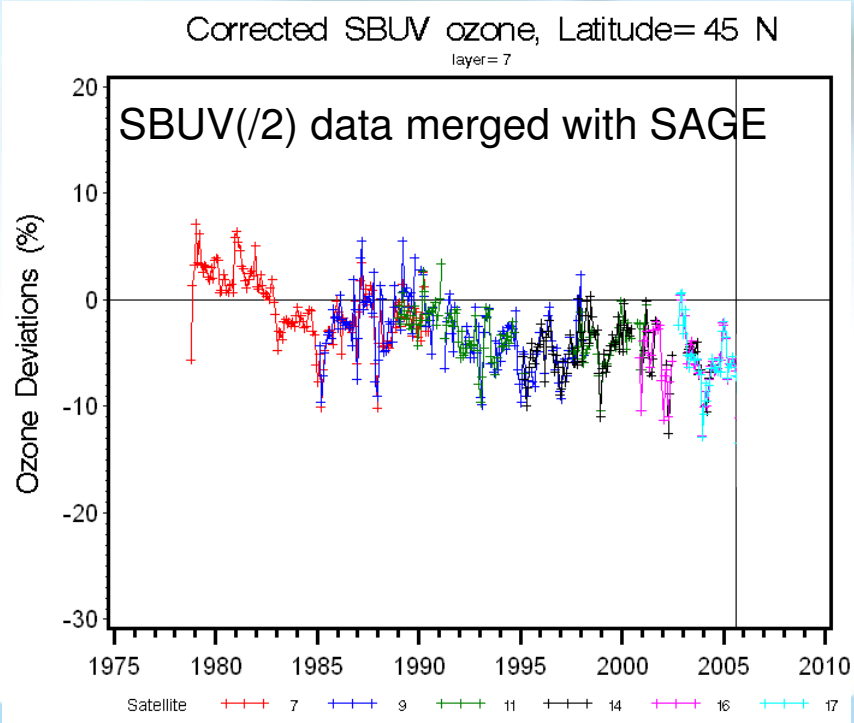


Issues: combining ozone data

The “SAGE-corrected SBUV” dataset removes inter-SBUV biases using comparisons with SAGE I+II

→ Need to make SAGE data look like SBUV data

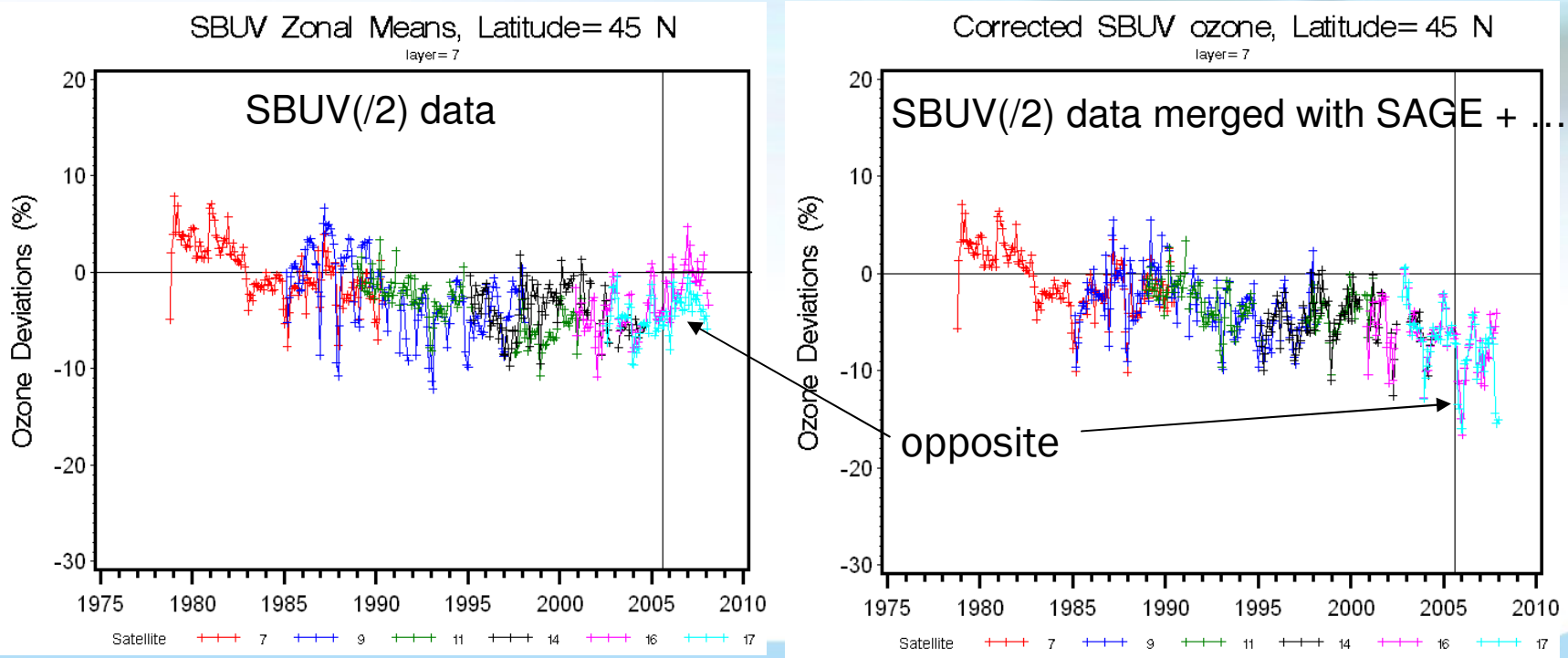




Issues: combining ozone data

Time series can be extending this past 2005 using another ozone source (in-lieu of SAGE II) after correcting for SAGE II – instrument X biases

→ But which way is the ozone going?



Issues

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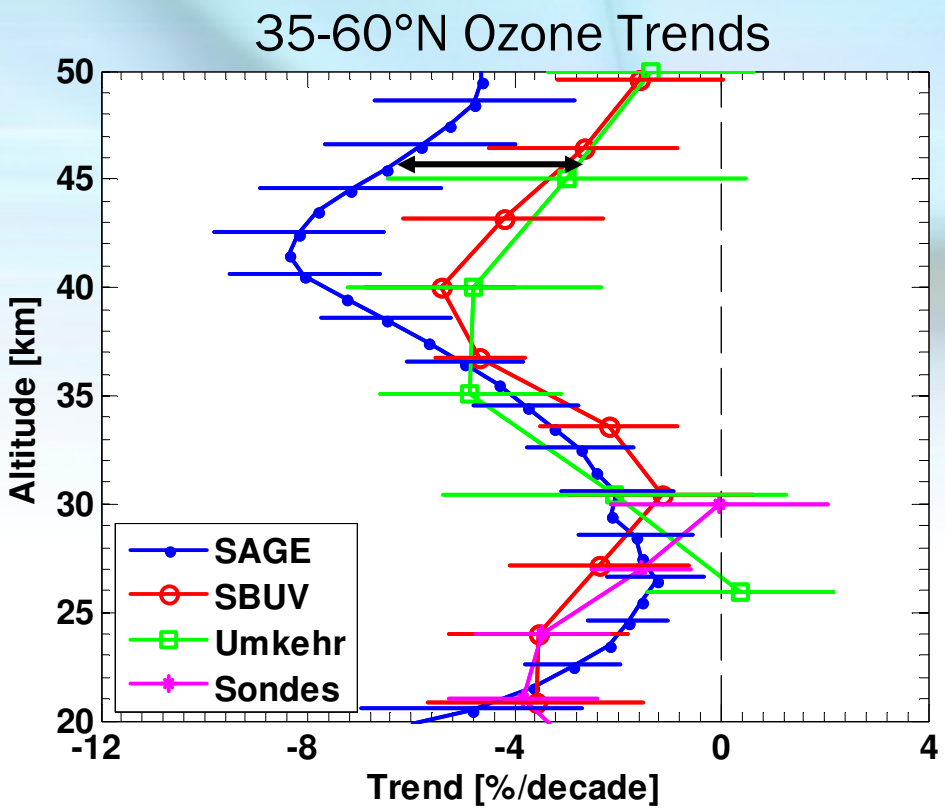
Issues: ozone units and co-ordinates

SAGE: number density as a function of altitude

SBUV: partial column as a function of pressure

How does the greenhouse-gas induced stratospheric cooling, impact ozone trends derived from different units?

Or: How much of this ~4%/decade SAGE-SBUV differences is due to units / vertical co-ordinates?



adapted from WMO, 2006, Figure 3-8

Issues: O_3 units and co-ordinates

Consider a climatological atmosphere defined by T(z) and ozone vmr(z) and observed T-trend

If vmr(z) is held constant what are the effective trends in ozone in other units?

vmr ≡ volumne mixing ratio

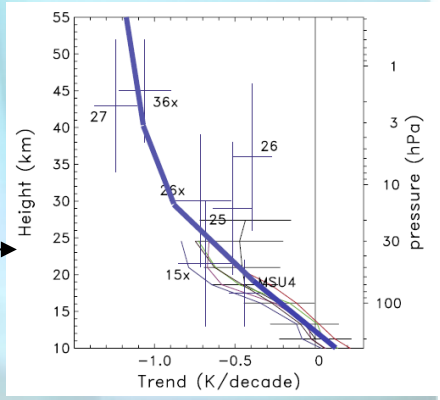
nd ≡ number density

pcol ≡ partial column

z ≡ altitude

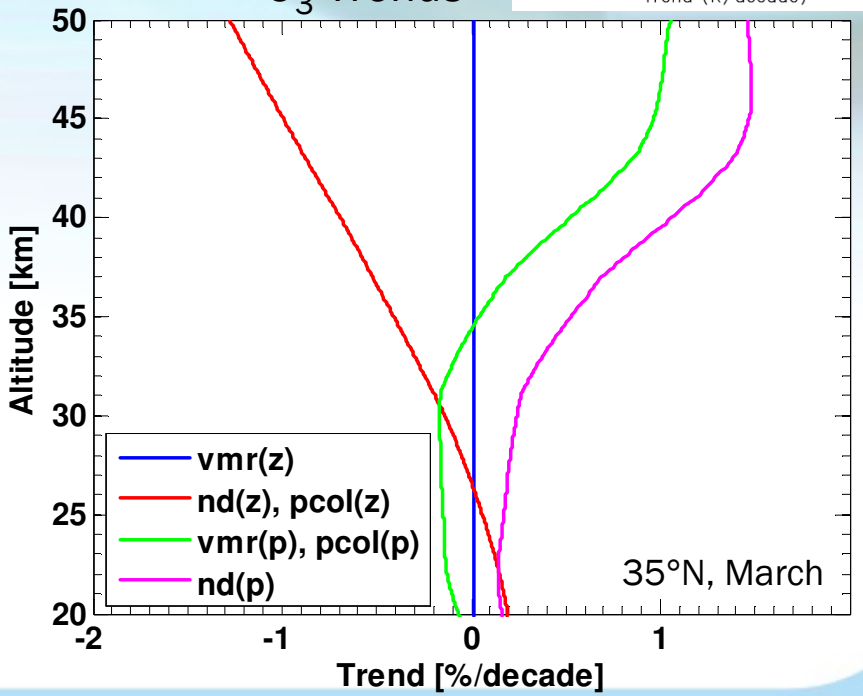
p ≡ pressure

Randel et al., 2009, Figure 19



T-trend →

O_3 Trends

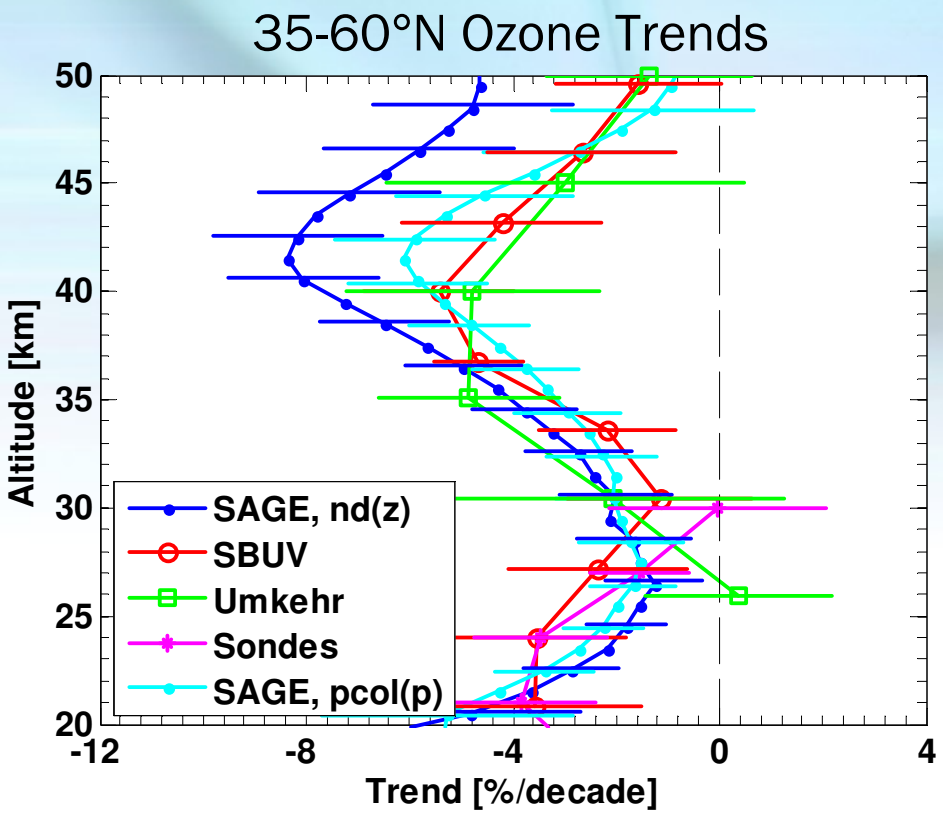


Issues: O_3 units and co-ordinates

When each SAGE profile is converted to SBUV-units (partial column between pressure levels):

The conversion was done using a T-climatology with the observed trend imposed on top:

$$T(Y) = T_{clim} + T_{trend} (Y-Y_{ref})$$

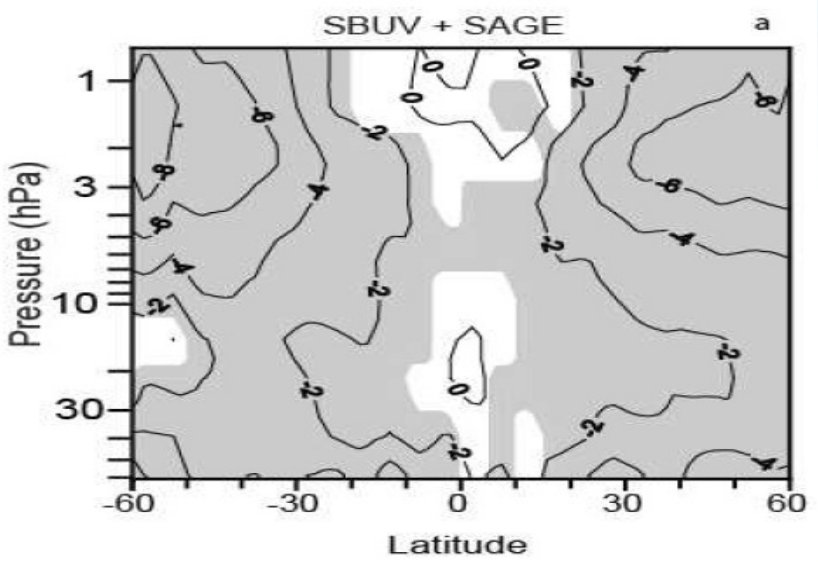


adapted from WMO, 2006, Figure 3-8

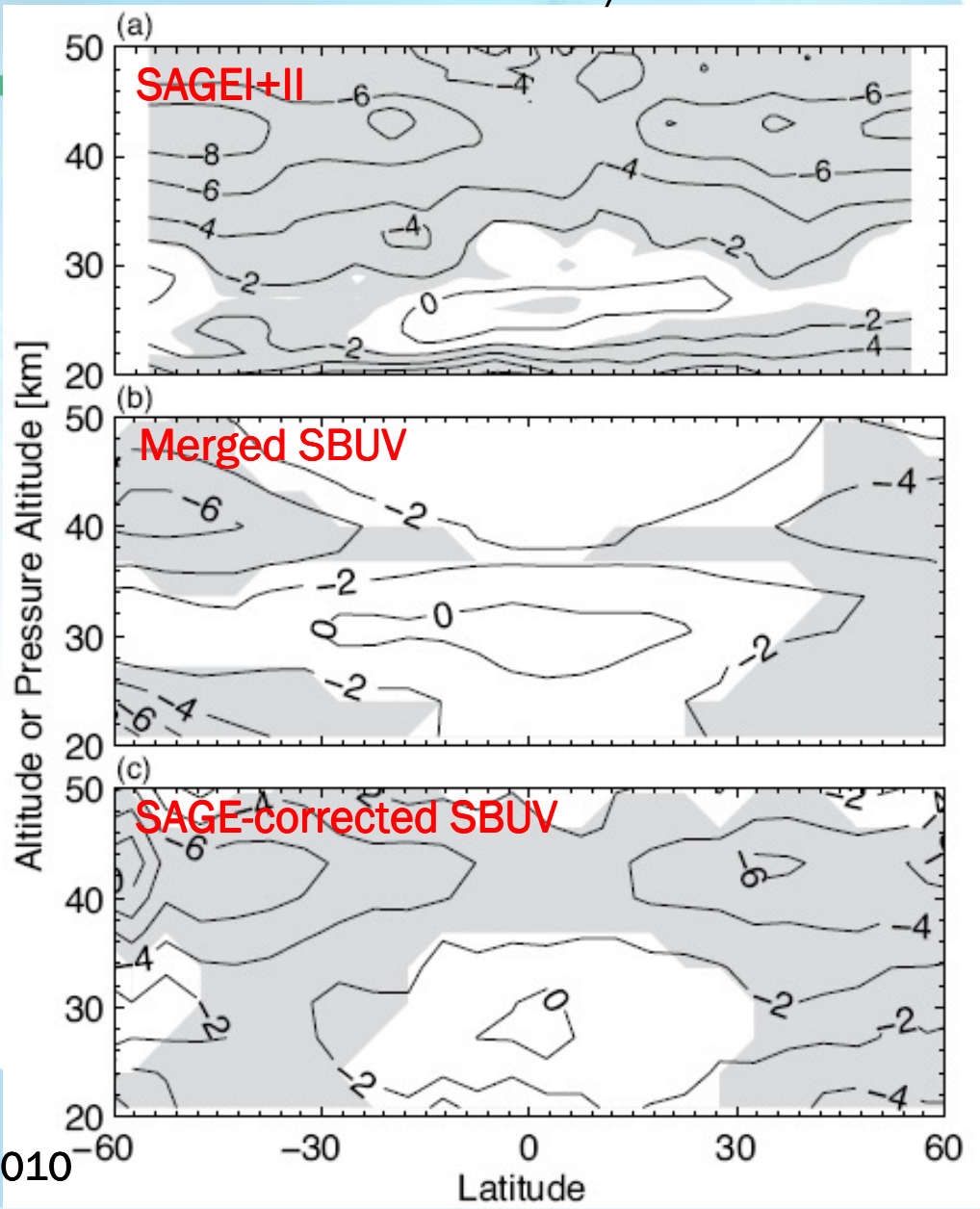
Issues: O_3 units

Three different trend evaluations (using EESC basis function)

old SAGE-corrected SBUV:



Ozone trends in %/decade



Environment Canada Environnement Canada

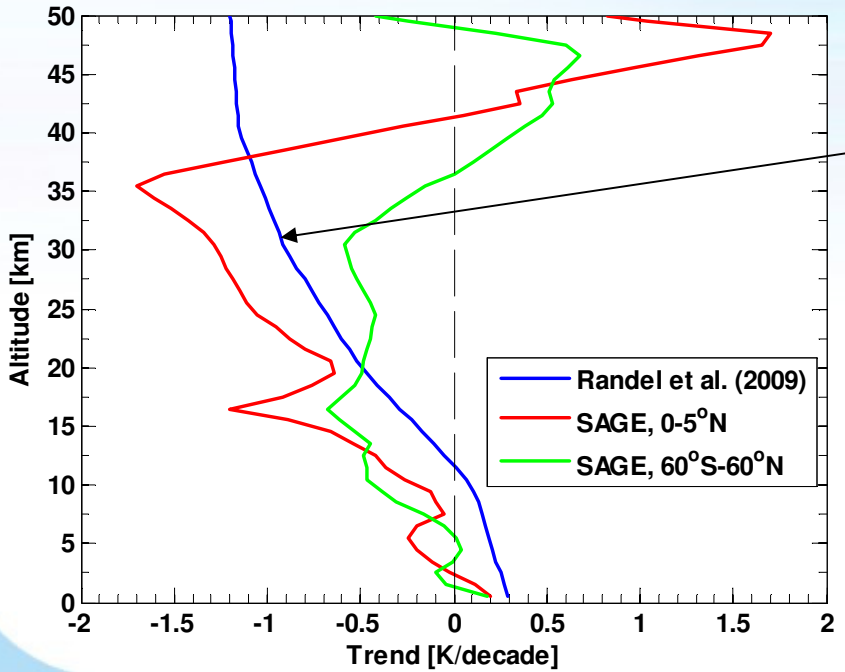
Figure 2-4, WMO, 2010

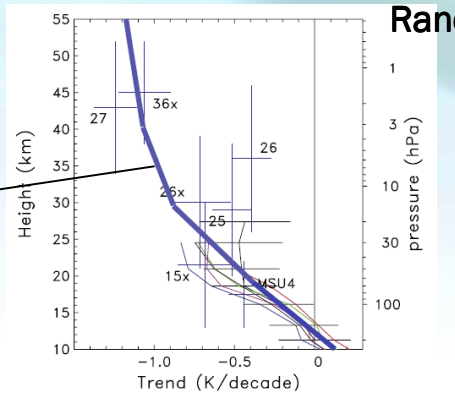
Issues: O_3 units and co-ordinates

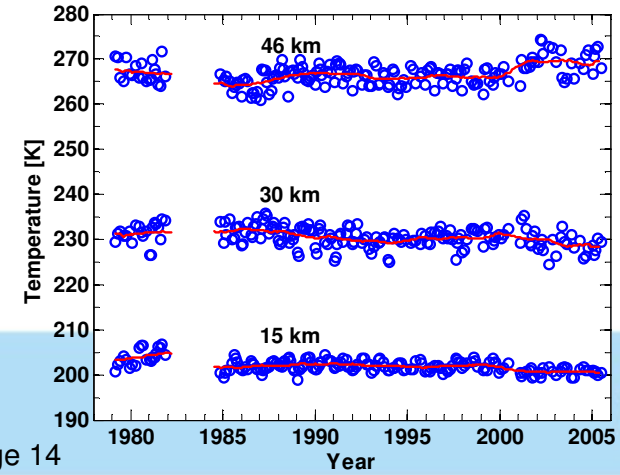
- Reliable temperature data are required in order to compare and combine ozone measured in different units and co-ordinates them

→ T profiles in SAGE data files do not possess realistic long-term trend

Randel et al., JGR, 2009, Figure 19

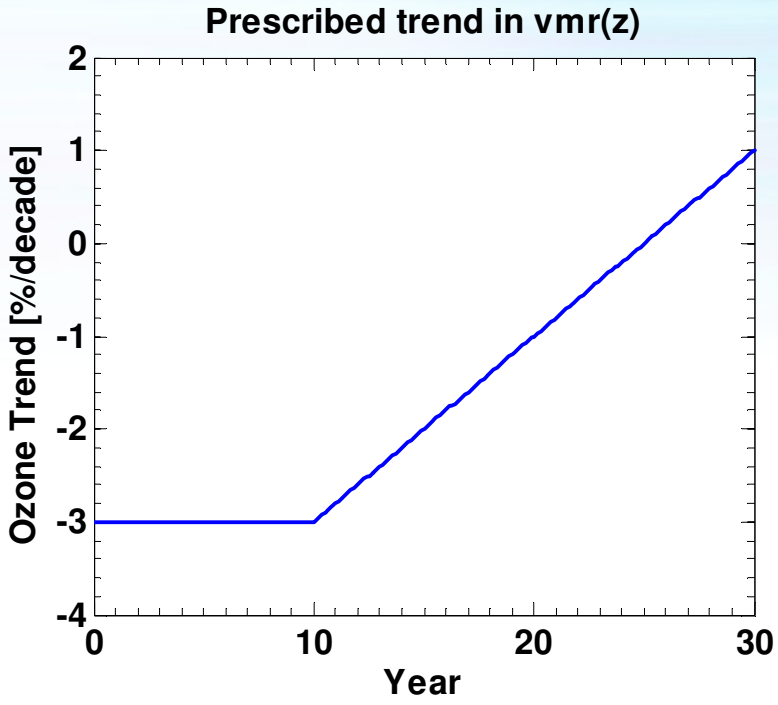


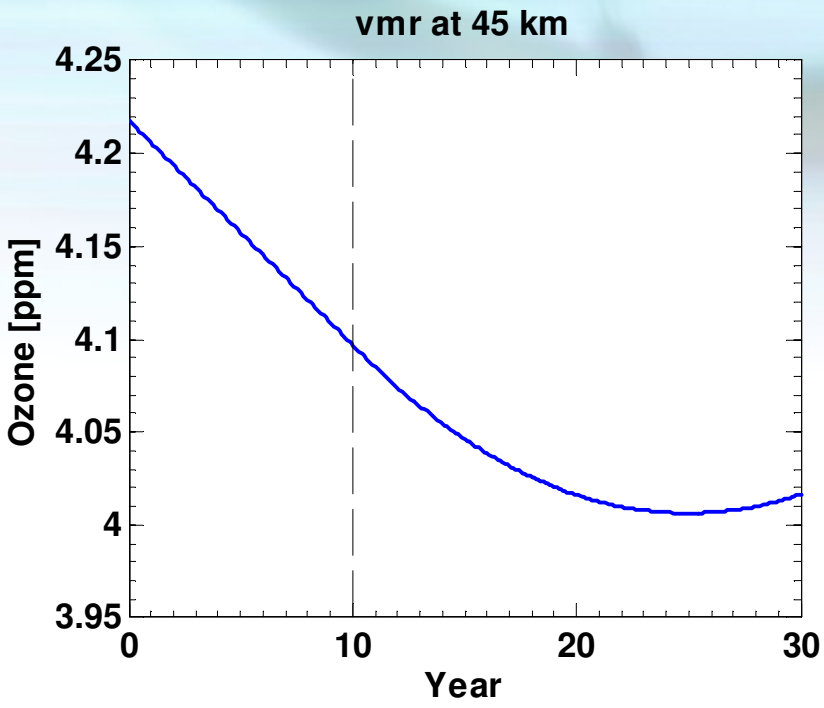




Issues: O_3 units and co-ordinates

What might this mean for identifying ozone turnaround?

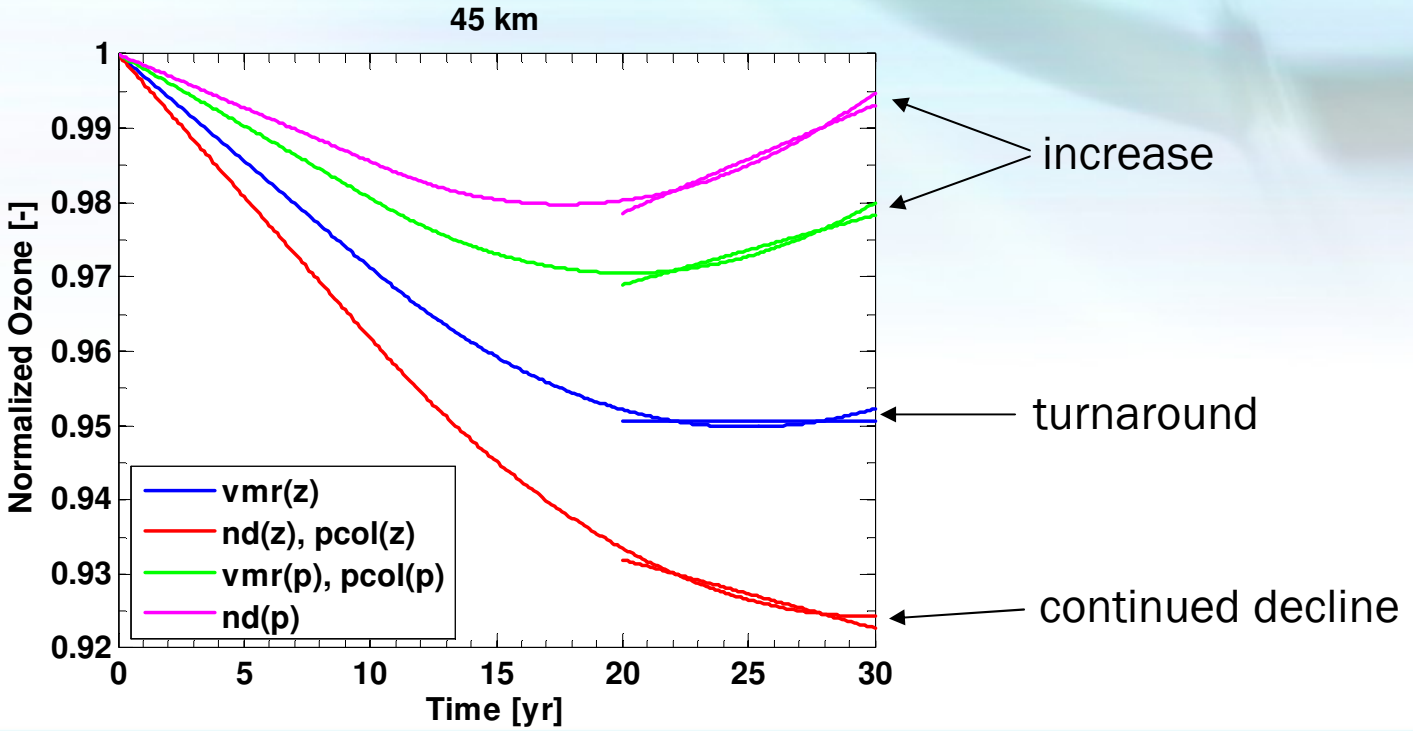




Issues: O_3 units and co-ordinates

Onset of recovery will depend on the native units of the measurements

→ In this example, turnaround will occur 10-year earlier for a pcol(p) timeseries (SBUV-like) than a nd(z) timeseries (SAGE-like)



Summary

- Trends are expected to be relatively small, 1-3%/decade, and thus more difficult to detect
- Extending the ozone limb-profile timeseries past 2005 will require data from the Odin-Envisat-SciSat-Aura cohort
- Instruments measure “different” ozone thereby complicating the addition
- One of these “differences” is the native units and vertical co-ordinates
- Reliable temperature data are required in order to compare and combine ozone measured in different units and vertical co-ordinates
- Onset of recovery will depend on the units / vertical co-ordinates

Thank you!