Ozone Applications and CDRs

Craig Long & Jeannette Wild*

NOAA/NWS/NCEP

Climate Prediction Center

**Innovim*

Applications of Ozone Data

- Monitoring the health of the stratospheric ozone layer
  - Global ozone depletion through 1990's
  - Annual Antarctic ozone hole and occasional Arctic ozone depletion
  - Montreal Protocol impacts to cease depletion and start recovery
  - Detection of recovery :where, what altitudes
- Assimilation into weather and climate models and reanalyses
  - Needed for proper radiation computations
  - Needed for model to separate out ozone effects in IR channels
  - Ozone forecasts used to generate UV Index forecasts
  - Boundary conditions for AQ models
  - Stratospheric intrusions : AQ in passenger planes / surface

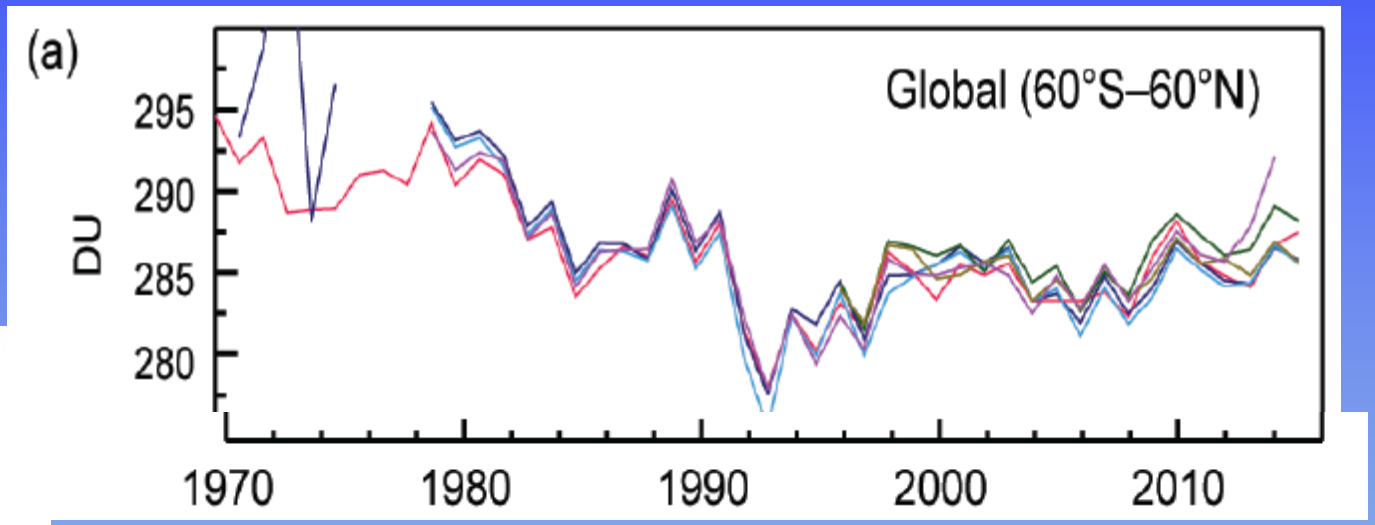
Monitoring

- Short term monitoring
  - Ozone depletion over Antarctica and Arctic during winter/spring months
  - CPC monitoring ozone via SBUV/2, OMPS-NM & NP, LP coming soon
  - CPC provides dynamical context for ozone monitoring
- Multiple long term ozone data sets
  - WOUDC – ground based; Brewer, Dobson, SAOZ, and filter spectrometers
  - SBUV v8.6 – NASA & NOAA - Nadir
  - GOME / SCIAMACHY / GOME-2 – Univ of Bremen & ESA/DLR - Nadir
  - GOZCARDS – occultation and limb
  - SAGE II + OSIRIS– occultation and limb
- Total and Profile trends published in recent papers.
- WMO Ozone Assessments
- 2015 State of the Climate: Stratospheric Ozone (Weber et al)

Continued monitoring

- Where should we be looking for changes in climate and ozone recovery?
  - In a changing climate it is expected that tropical upwelling will increase and thus ozone will continue to decline (Zubov et al. 2013; WMO 2014).
  - The most recent ozone assessment (WMO 2014) and studies (Nair et al. 2015; Harris et al. 2015) indicate that the clearest signs of significant ozone increases should occur in the upper stratosphere (2%–4% decade−1 at ~2 hPa or 40 km)
- Proper trend analysis needs to be preformed with an auto-regressive model taking into account the effects of atmospheric and solar oscillations:
  - Solar cycle
  - QBO
  - ENSO
  - Arctic Oscillation / Antarctic Oscillation

Global Total Ozone

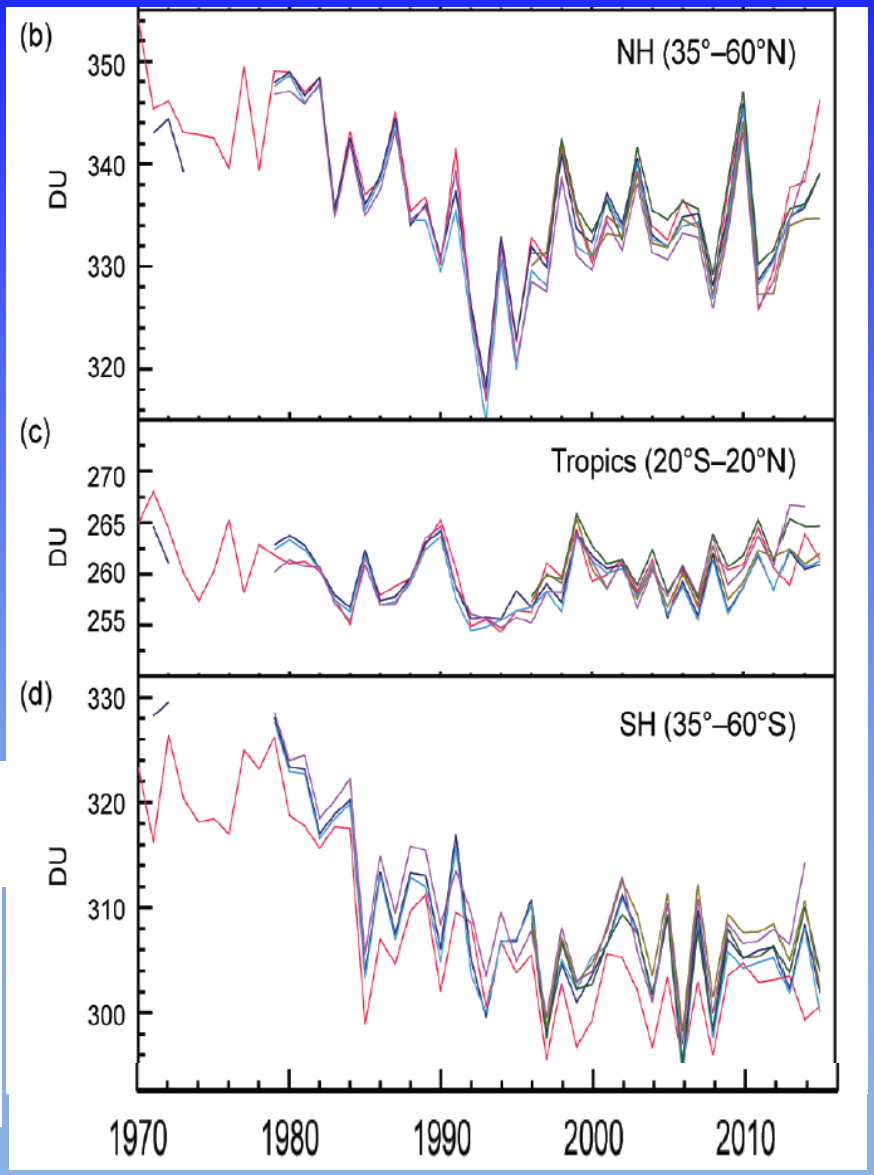


WOUDC
SBUV V8.6 NASA
SBUV V8.6 NOAA
GOME/SCIA GSG
GOME/SCIA/OMI GTO
MSR2

From State of the Climate, 2015

Very good agreement among data sets except for last couple years

Total Ozone – NH, Tropics, SH

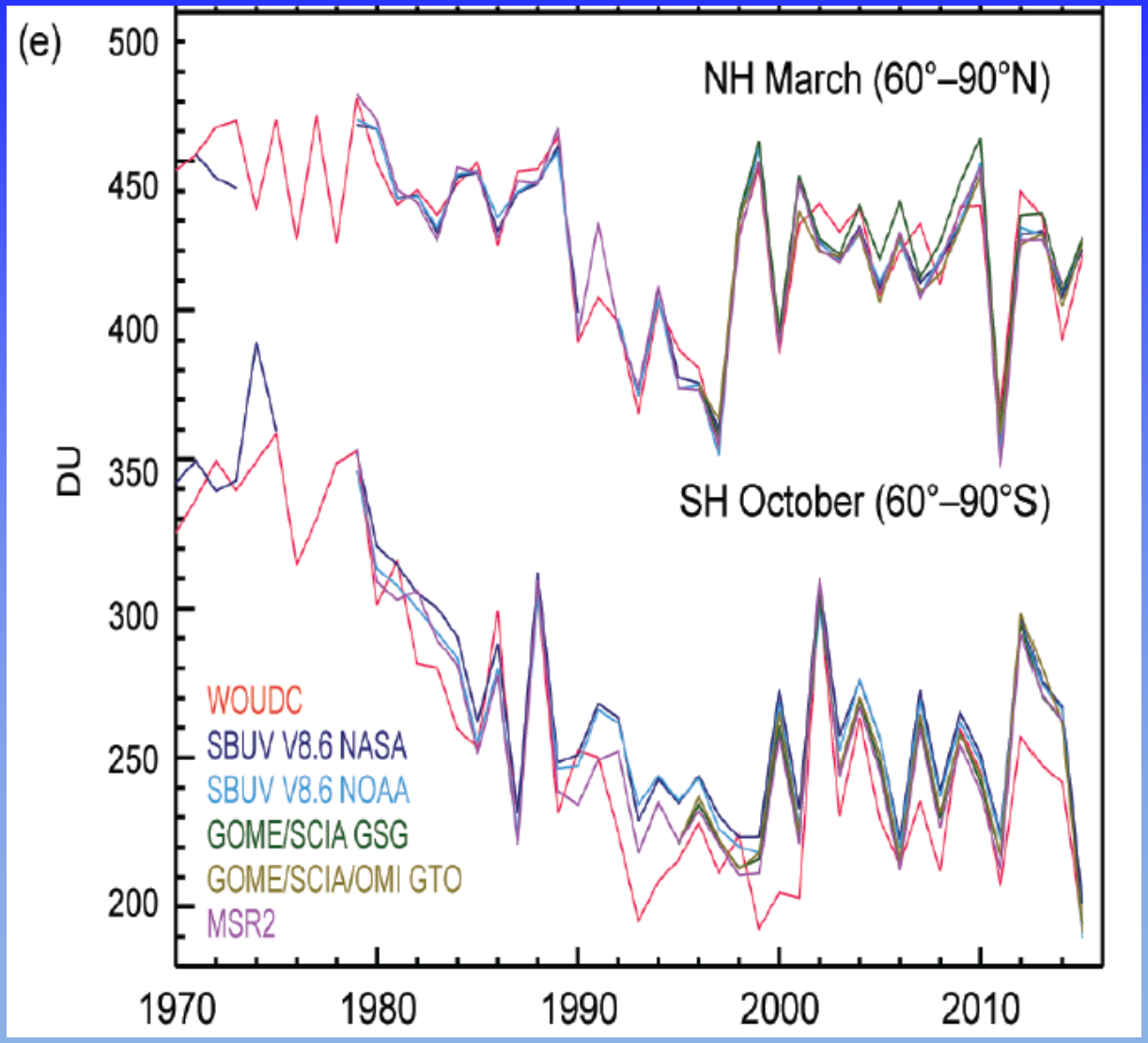


WOUDC
SBUV V8.6 NASA
SBUV V8.6 NOAA
GOME/SCIA GSG
GOME/SCIA/OMI GTO
MSR2

Very good agreement among data sets in NH and Tropics except for last couple years.
SH has greater disagreement especially with WOUDC. Could be do to sparse observation sites.

From State of the Climate, 2015

Total Ozone – NH,SH Polar Latitudes

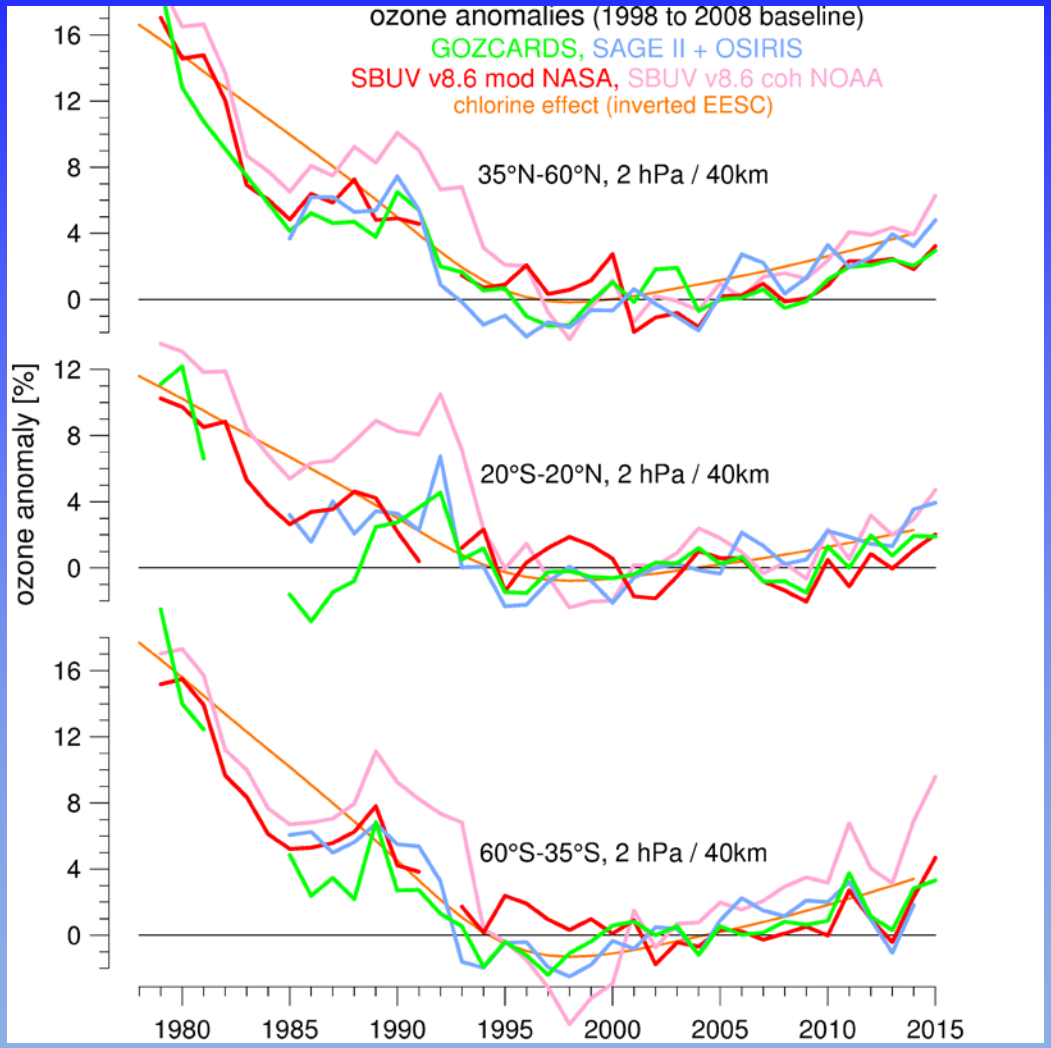


NH March shows period in the 1990's of repeated low ozone years due to cold (noWarmings) conditions. 2010/2011 cold winter also shows up.

SH October shows monthly mean drop from 350 to 220 DU from 1970 to late 1990's. High ozone years of 1986, 88, 02, 12-14 are seen. But large variability since 1999.

From State of the Climate, 2015

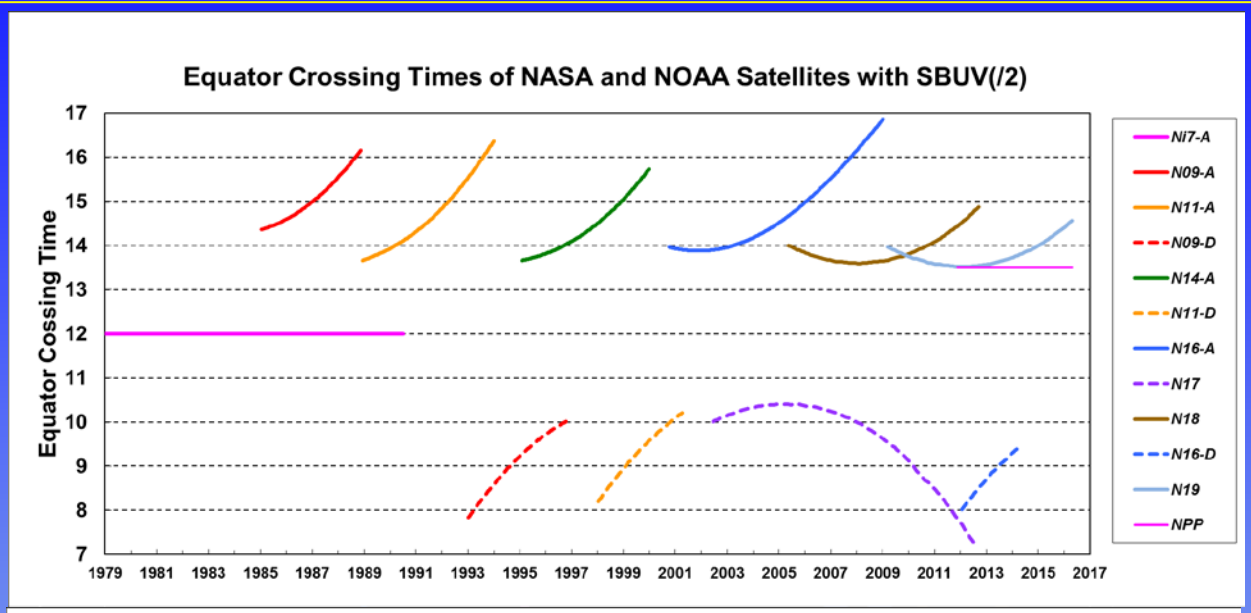
2 hPa Ozone Anomalies

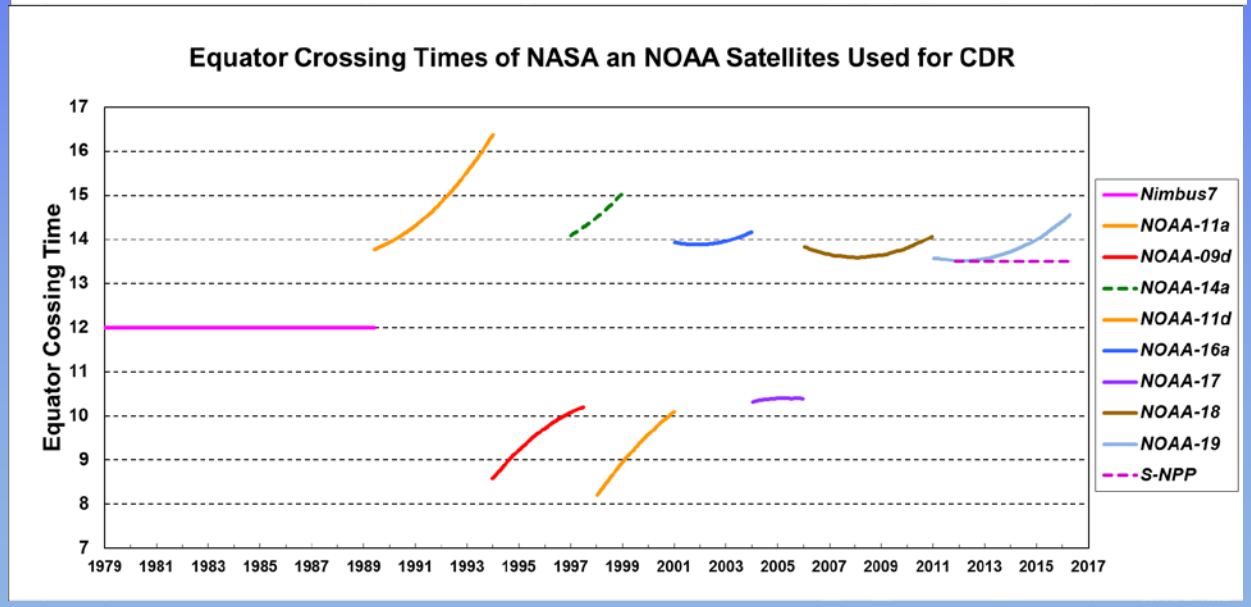


From State of the Climate, 2015

Plots of various ozone profile data sets from 1980-2015 at 2 hPa for NH mid lats, Tropics, and SH mid lats.
Inverted EESC curve is added to show expected effective chlorine levels.
NH and Tropics data set trends somewhat agree with EESC upward trend since 2000. SH mid lat data set trends appear to be flatter than EESC trend.
A new version of the SBUV v8.6 Coh NOAA has been released.

NOAA Cohesive SBUV v8.6 CDR

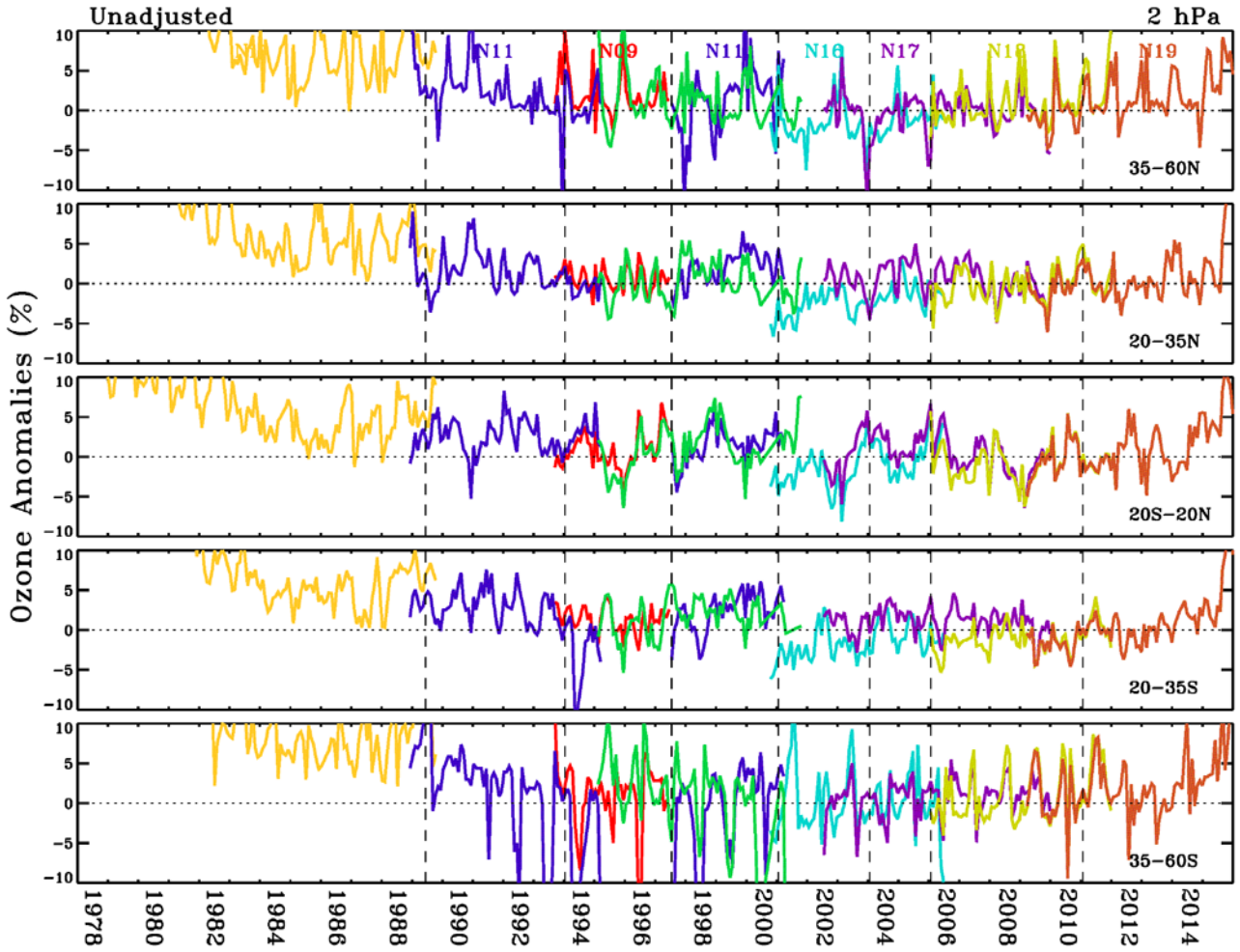




Upper graph shows equator crossing times for all available SBUV(/2) observations. Note that N19 is precessing towards later Equator crossing times. NPP and JPSS satellites will have stable Eq crossing times.

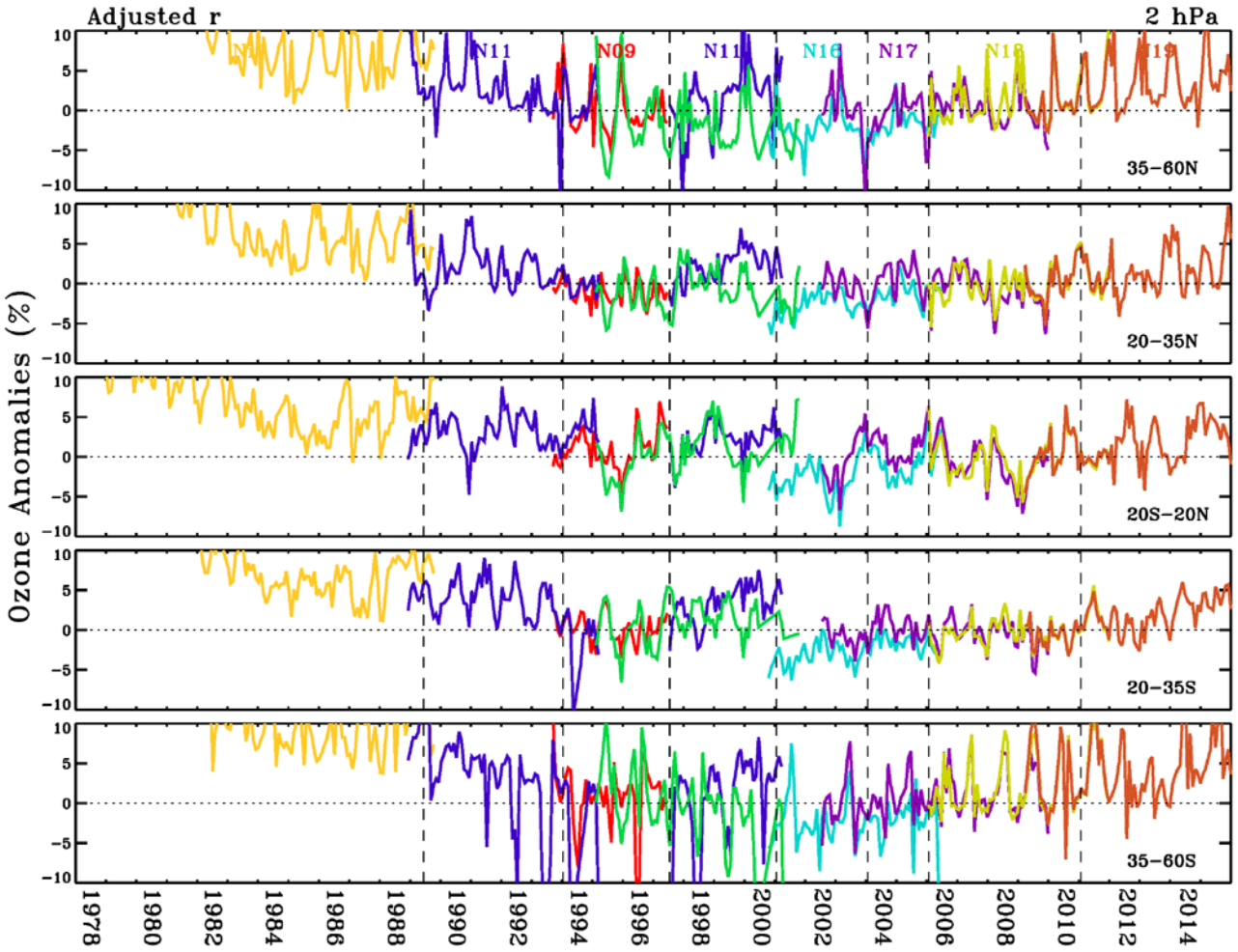
Lower graph shows satellites and time periods used for the latest version of v8.6 Coh. N14 is only used to bridge N9 and N11. N17 is minimally used to keep diurnal diff to a minimum.

2 hPa Unadjusted



N14 used just to tie N9 and N11
No attempt to match N11 and N16

2 hPa Adjusted



Adjustments provide better transition between satellites.

Summary

- Satellite ozone observations are used for multiple applications
  - Primarily for monitoring and assimilation into weather/climate models
- Several types of ozone observing satellites have extensive data spans so long term Climate Data Records can be created and used for trend detection
  - Adds assurance that any one type is observing the ozone trends correctly
- Ozone satellite missions need to be continued to extend these CDRs
  - Where used to monitor the ozone decline
  - Needed to monitor the longer term recovery
  - Complicated by climate change
- NOAA Cohesive SBUV v8.6 CDR adjustments have been finalized
  - Much improved over earlier versions
  - Sent to NCEI for distribution
- OMPS NP (LP) needs to be used to extend the SBUV v8.6 data record
  - N19 drifting away
  - NPP and JPSS have stable orbits