

# **The SBUV and TOMS Satellite Instruments and the Montreal Protocol**

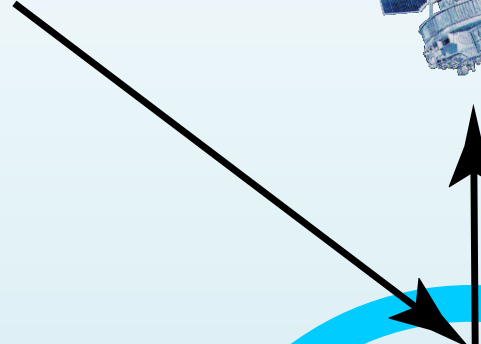
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Johns Hopkins University  
(NASA Goddard Emeritus)

# **I will focus on the backscatter ultraviolet (BUV) satellite instruments and their importance to the Montreal Protocol**

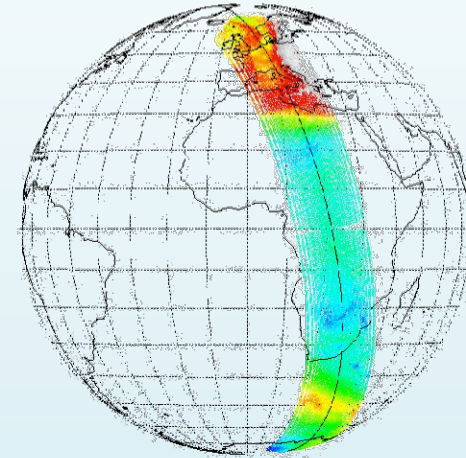
## **Two Major Topics**

- **TOMS/SBUV and the ozone hole**
- **SBUV as a long-term global ozone data set**

# Backscatter Ultraviolet Measurement from a Satellite



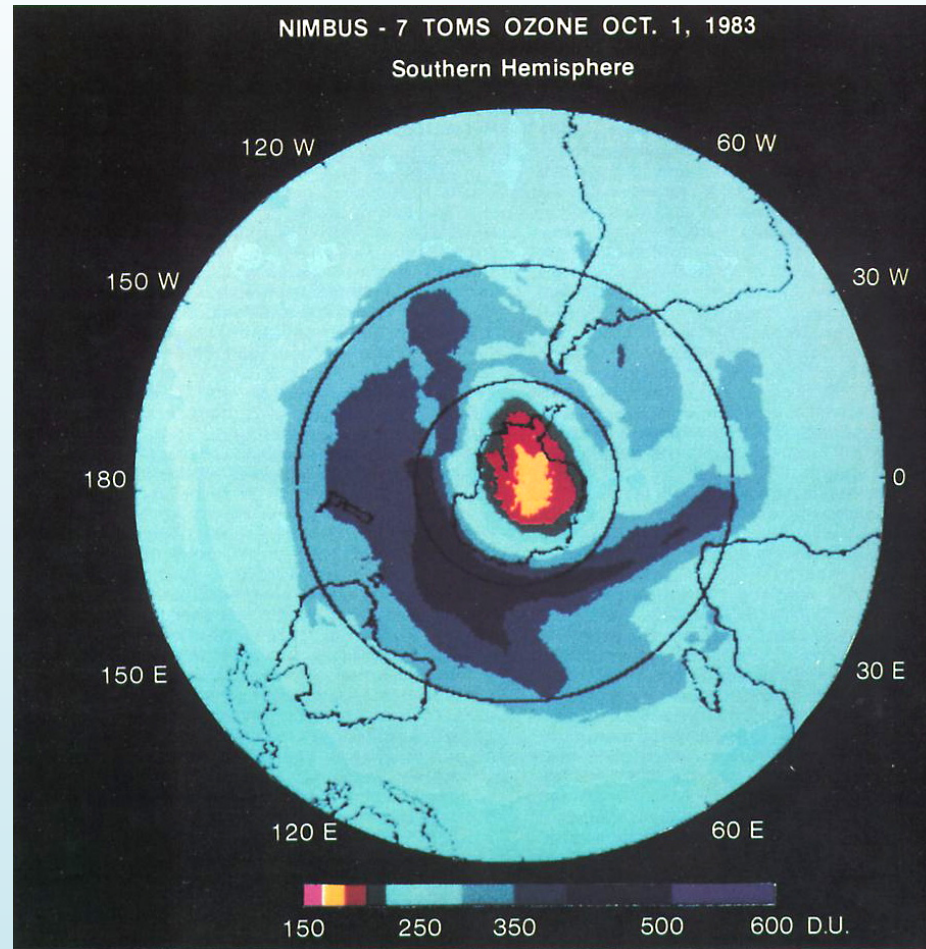
Ozone Layer



16 March 2000

Single Orbit Above  
14 Orbits per Day

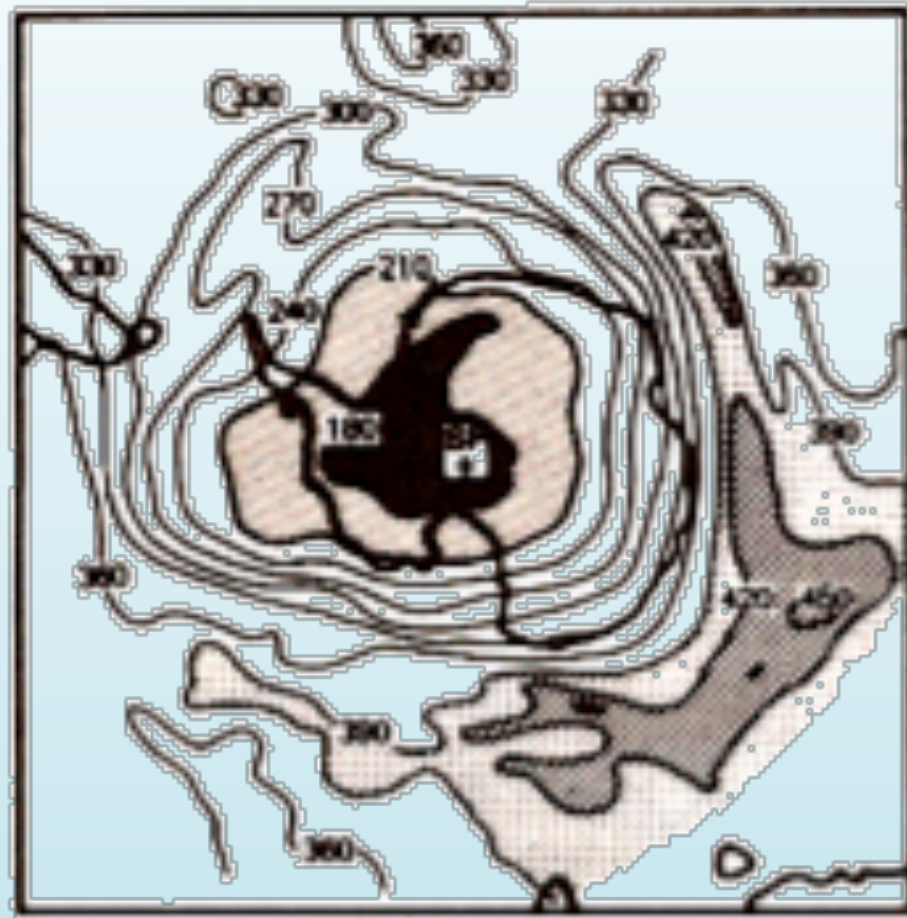
# TOMS/SBUV and the ozone hole



**First ozone hole image made from TOMS data  
(shown by P.K. Bhartia at IAGA meeting in Prague, Aug. 1985)**

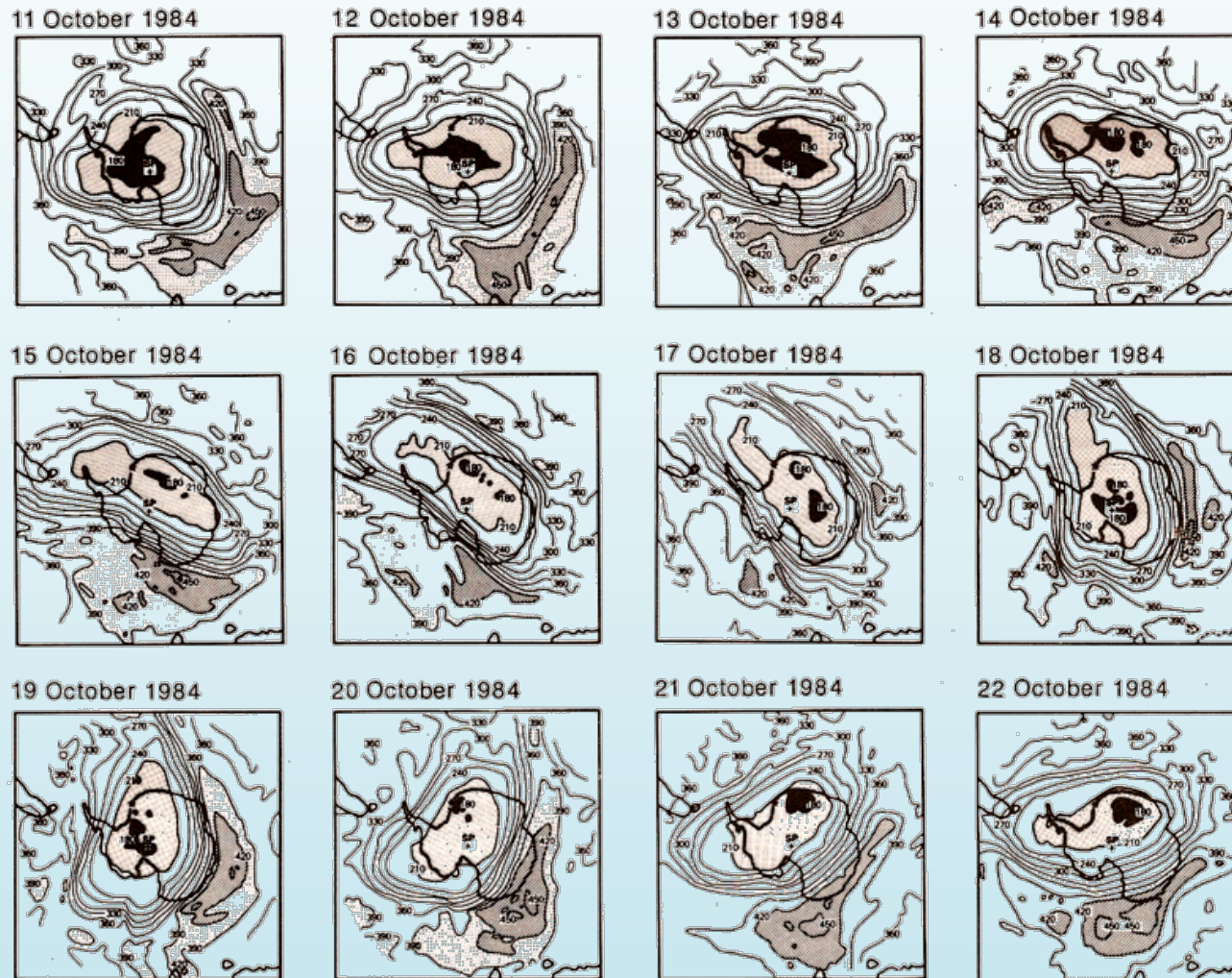
# Daily TOMS measurements showing rotation of ozone minimum with Antarctic vortex

11 October 1984

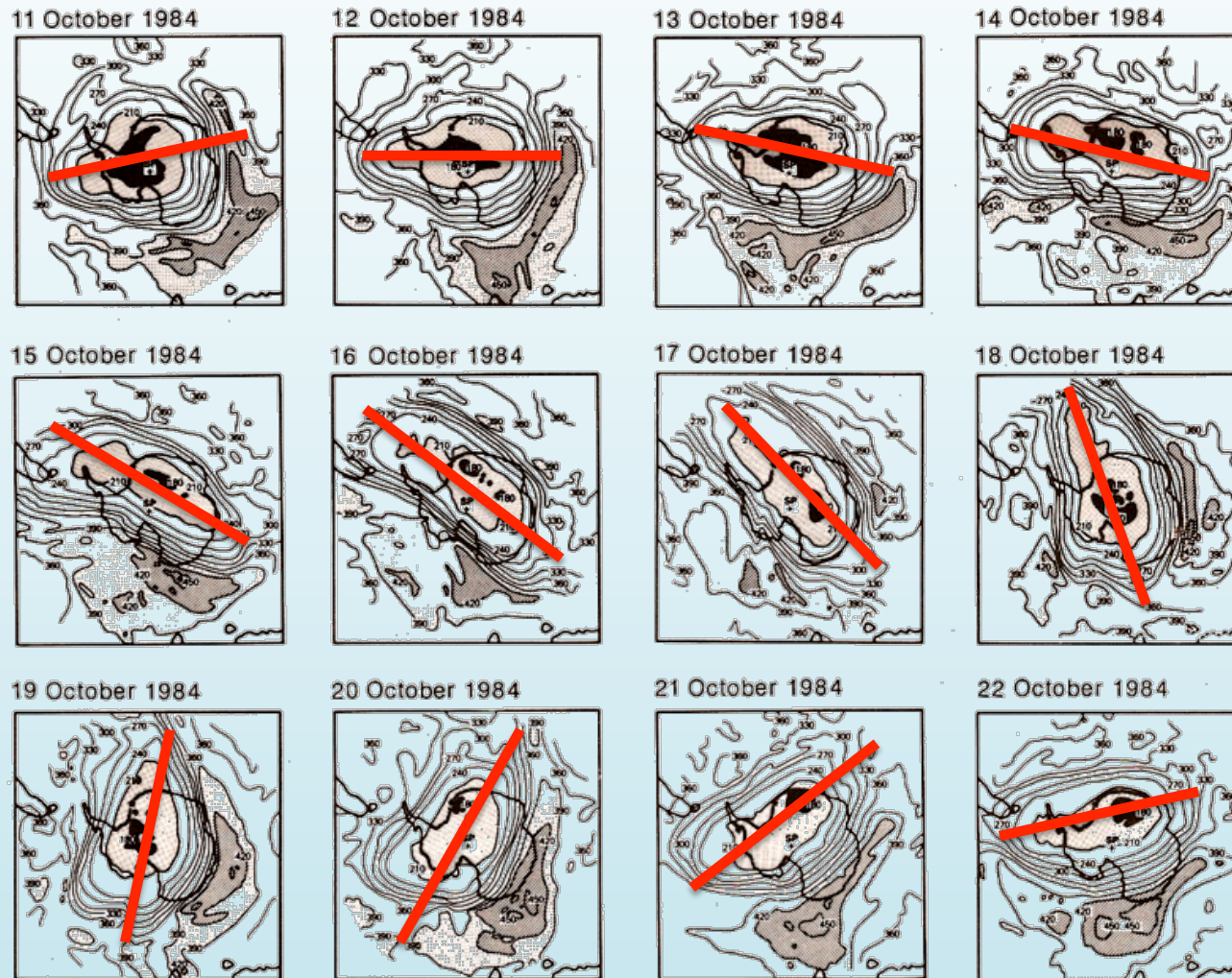




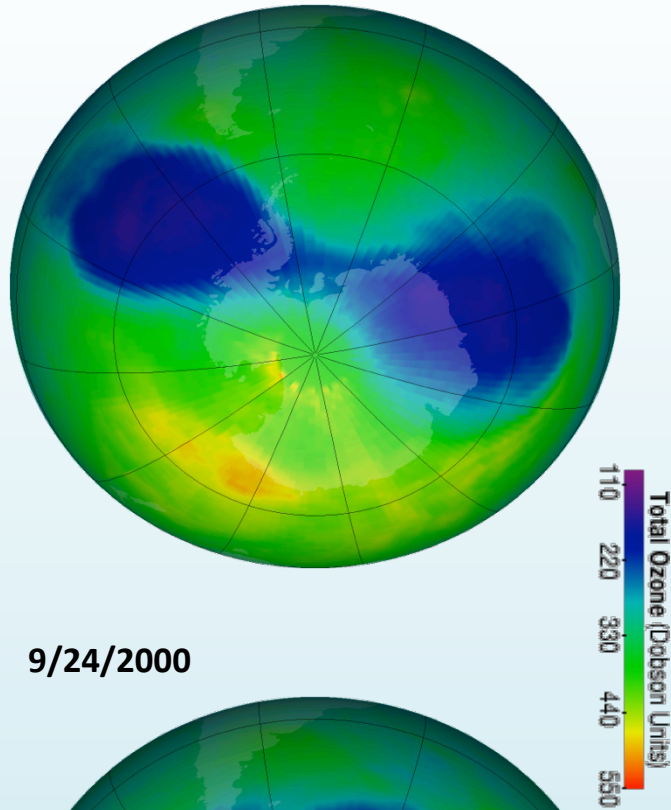
# Daily TOMS measurements showing rotation of ozone minimum with Antarctic vortex



# Daily TOMS measurements showing rotation of ozone minimum with Antarctic vortex

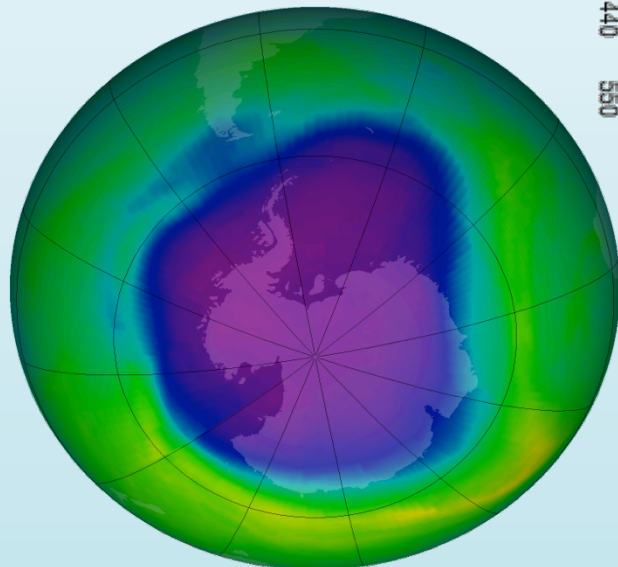


9/24/2002



**Daily mapping shows  
some odd features of  
ozone hole such as split  
in 2002**

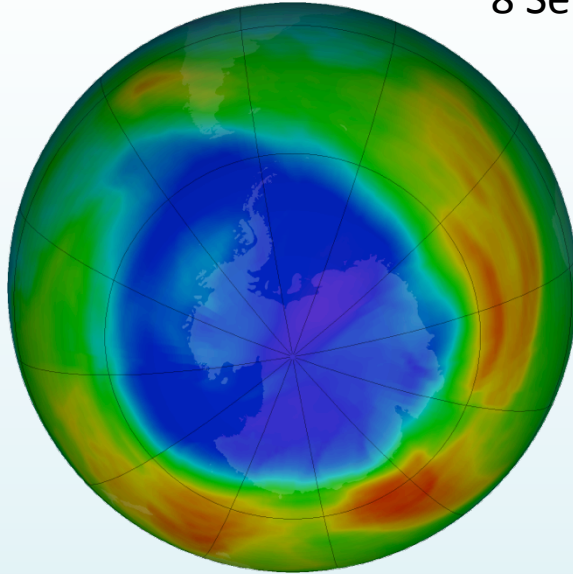
9/24/2000



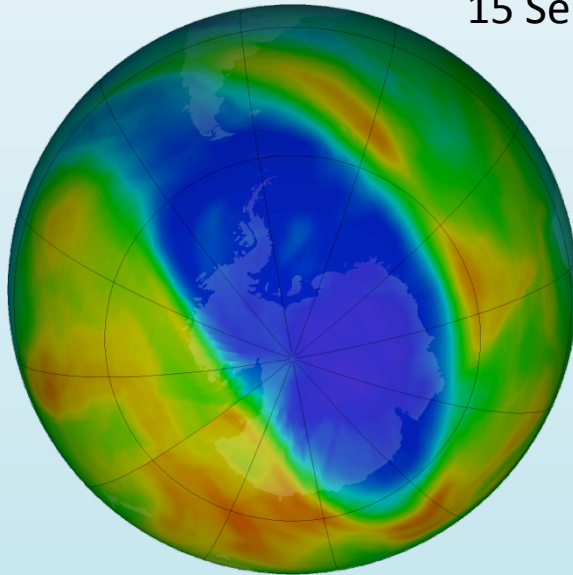
**or more normal year in  
2000**



8 September 2017



15 September 2017

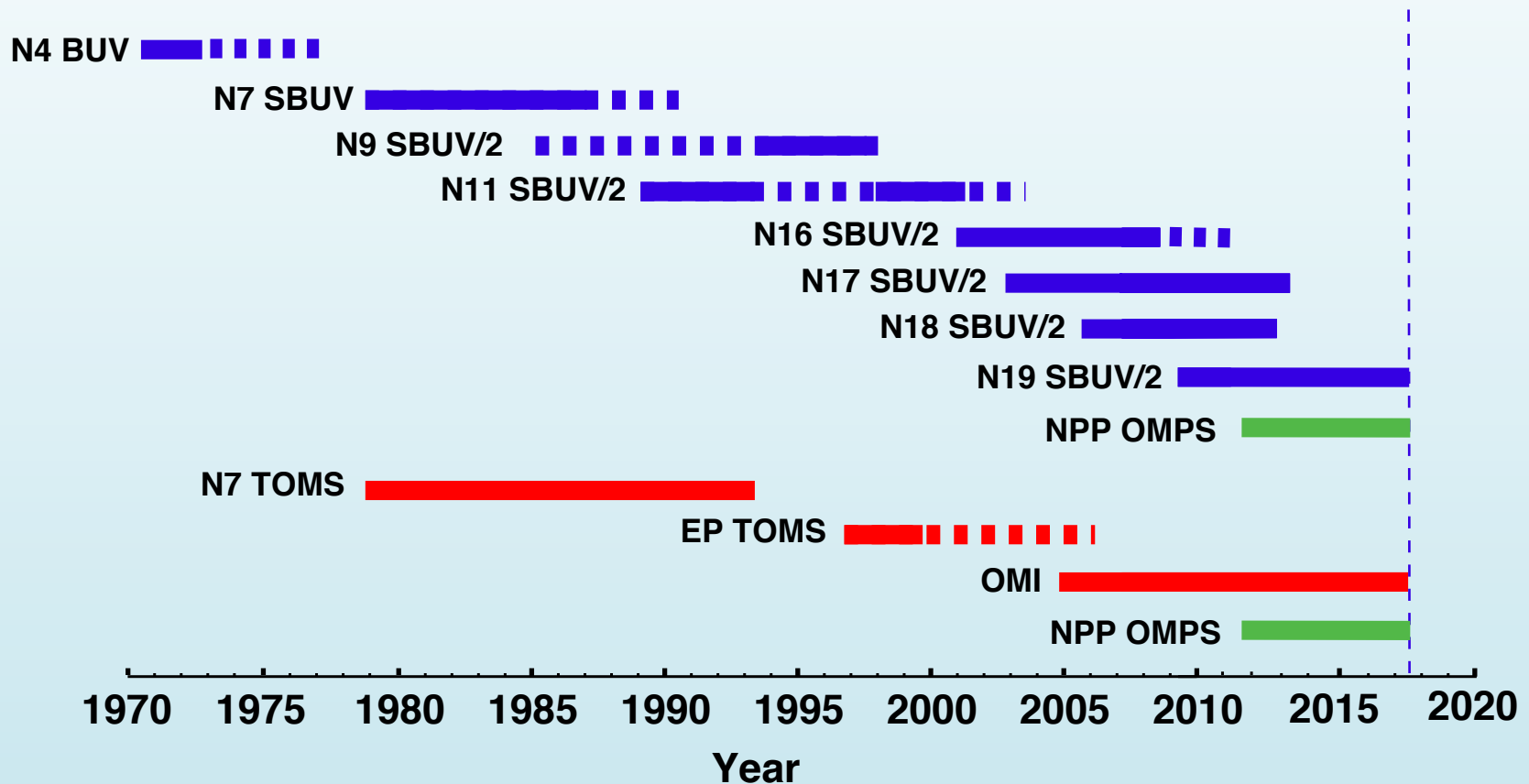


**2017 ozone hole  
beginning to see  
significant  
distortion of  
vortex**

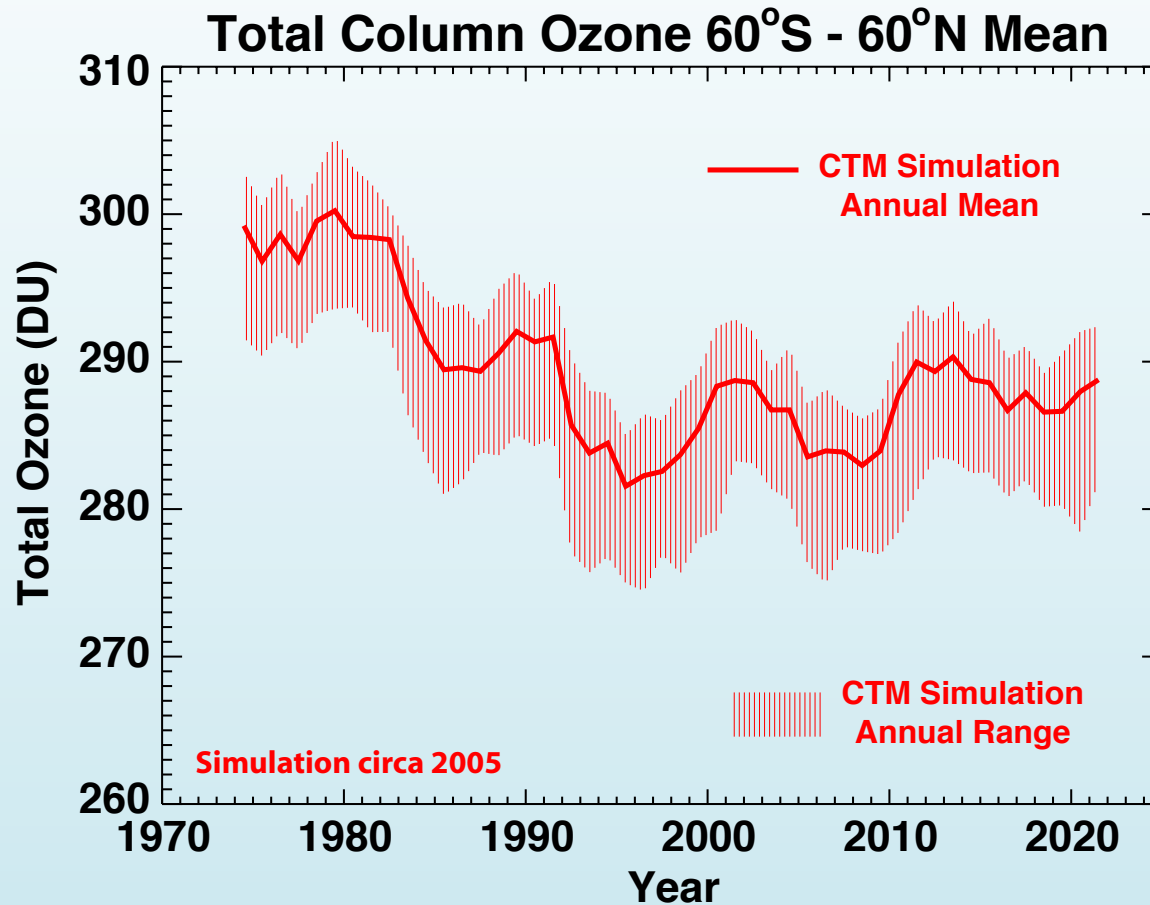
**Images from NPP OMPS instrument**

# SBUV as a long-term global ozone data set

## Backscatter Ultraviolet Satellite Instruments

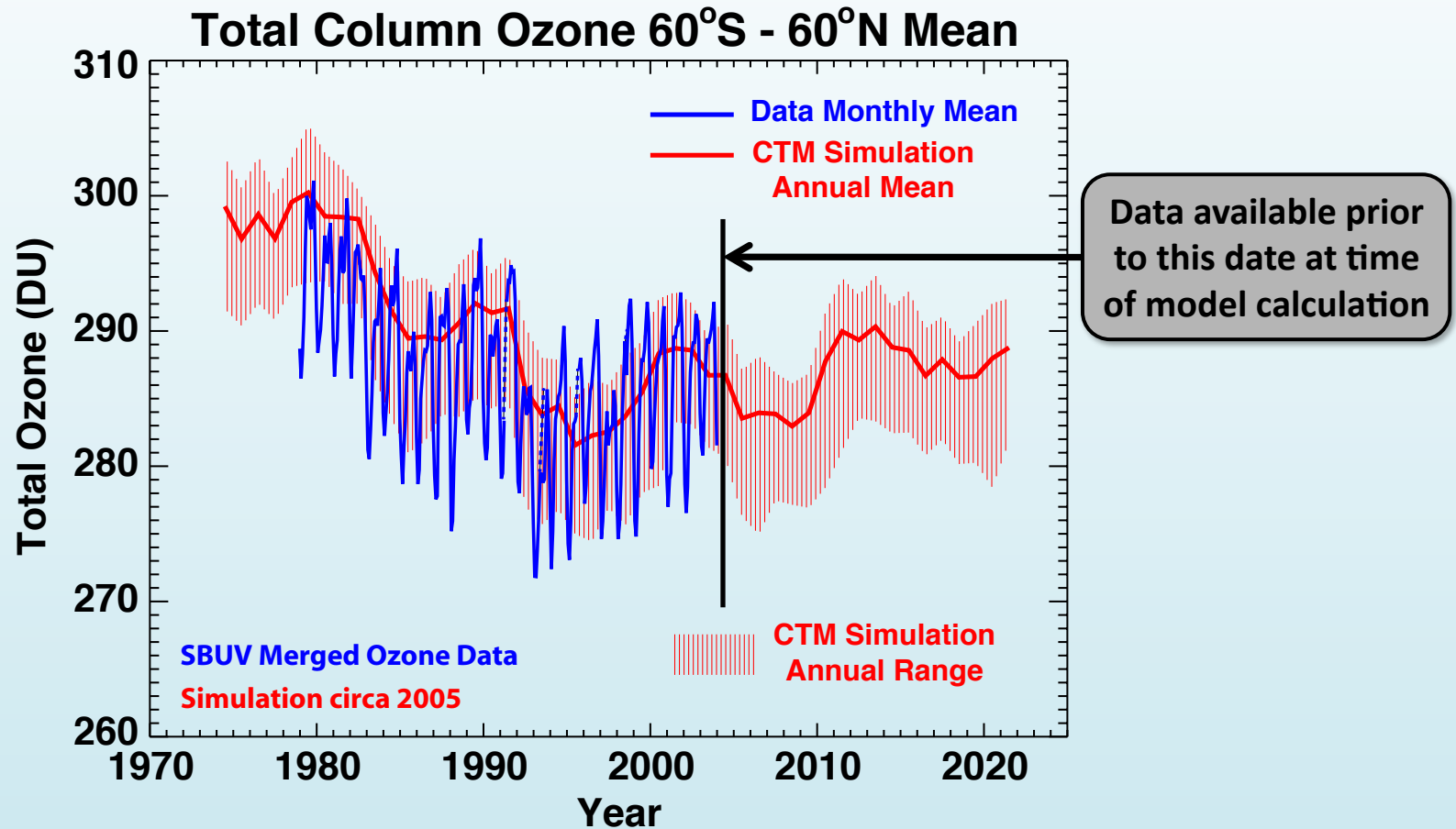


# CTM projection of total ozone including CFCs, solar cycle and volcanoes



Model: Stolarski et al. (2006), *J. Atmos. Sci.*, 63, 1028–1041

# Model comparison with SBUV ozone data

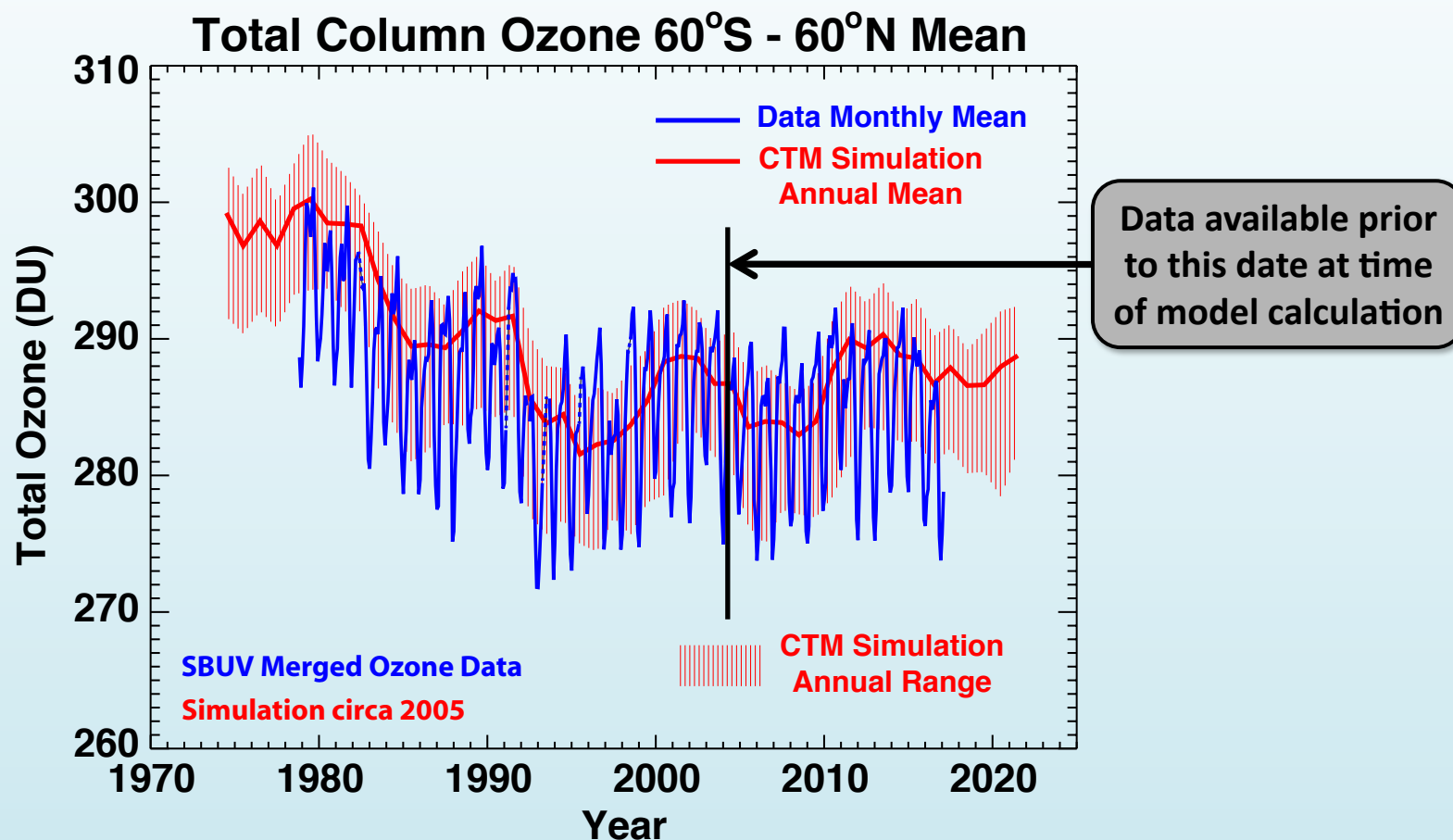


Data: Stolarski and Frith, (2006) ACP 6, 4057-4065

Model: Stolarski et al. (2006), J. Atmos. Sci., 63, 1028–1041



# Extension of SBUV data through Feb-2017



Data: Frith et al. (2014) JGR, 119, 9735-9751 (updated)

Model: Stolarski et al. (2006), J. Atmos. Sci., 63, 1028-1041

Data available at [https://acd-ext.gsfc.nasa.gov/Data\\_services/merged](https://acd-ext.gsfc.nasa.gov/Data_services/merged)

# Backscatter UV Instruments (Summary)

- **Provided early maps of ozone hole and its relationship to polar meteorology**
- **Launched on both research and operational polar-orbiting satellites providing past and future continuous global measurements**

Ozone hole maps available at:

<https://ozonewatch.gsfc.nasa.gov>

Merged ozone data available at

[https://acd-ext.gsfc.nasa.gov/Data\\_services/merged](https://acd-ext.gsfc.nasa.gov/Data_services/merged)