



# Understanding Upper-Air Climate Change

## Part II. Stratospheric temperature trends and links to other climate changes

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ARL Laboratory Review

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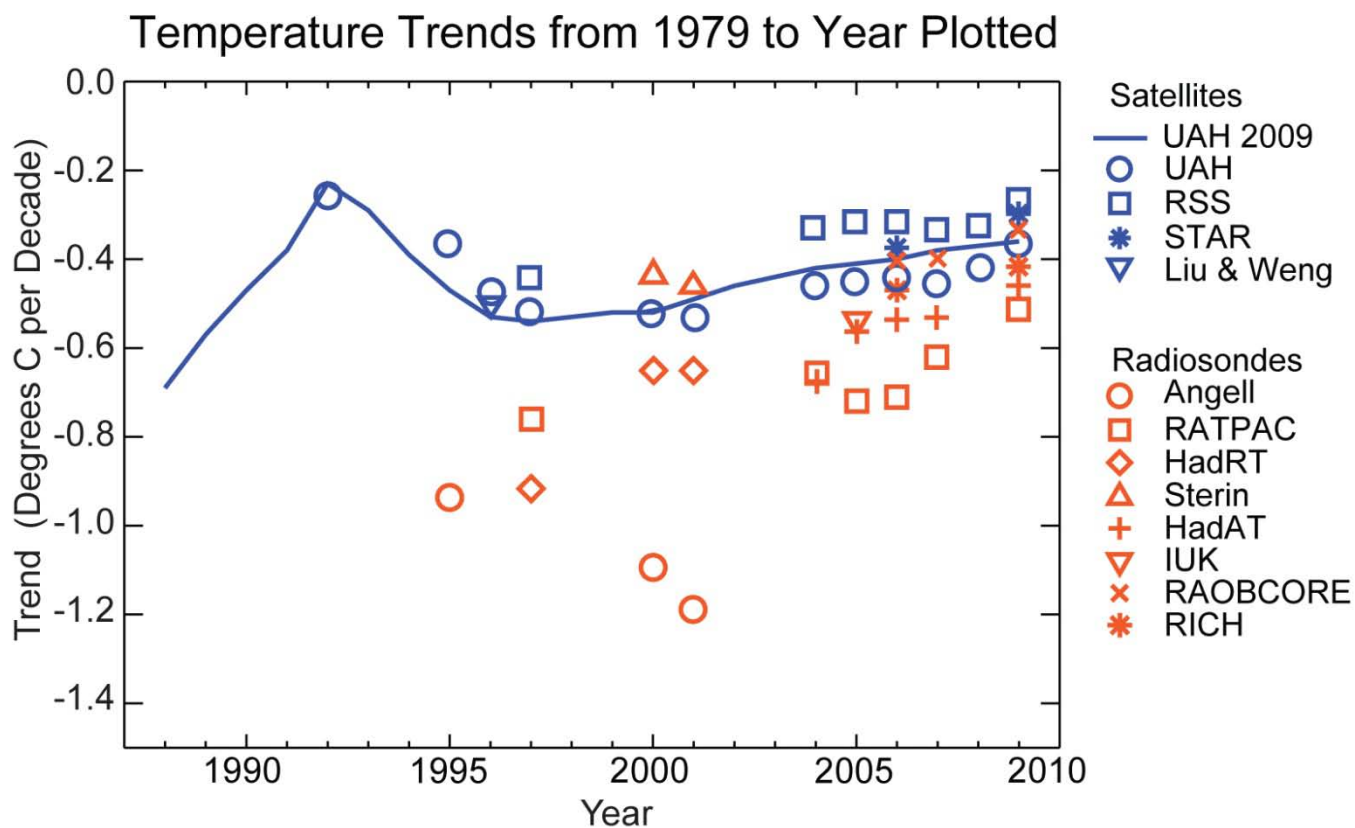


## Focus Areas

- Global stratospheric temperature trends
- Tropopause studies
- Tropical belt expansion



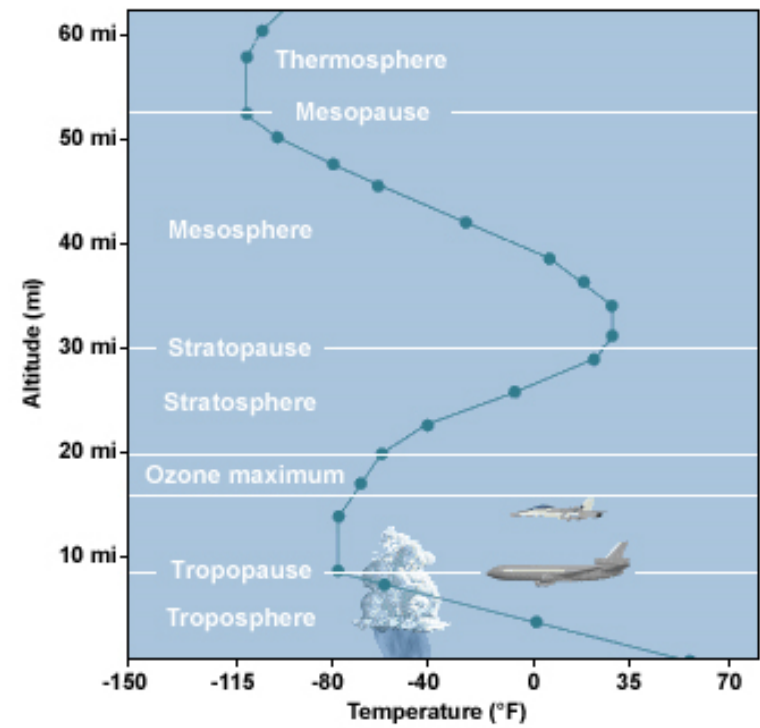
# Accomplishments - Stratospheric temperature trends



Seidel , Gillett, Lanzante, Shine and Thorne  
(Wiley Interdisciplinary Reviews: Climate Change, in review)

# Accomplishments – Tropopause studies

- Climatological analysis of tropical tropopause (Seidel, Ross, Angell and Reid, JGR, 2001)
- Global tropopause variability and trends, and relation to temperature changes (Seidel and Randel, JGR, 2006)
- Analysis of double tropopause climatology (Randel, Seidel, and Pan, JGR, 2007)

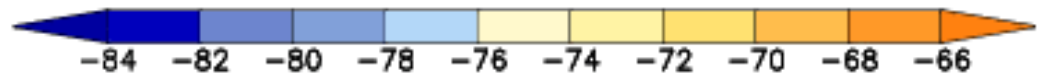
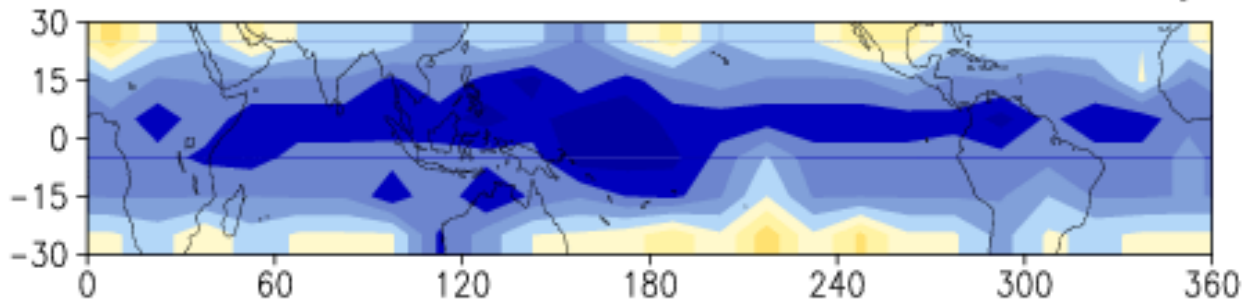


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# Tropical tropopause climatology

1961–1990 Climatological Monthly Mean

January

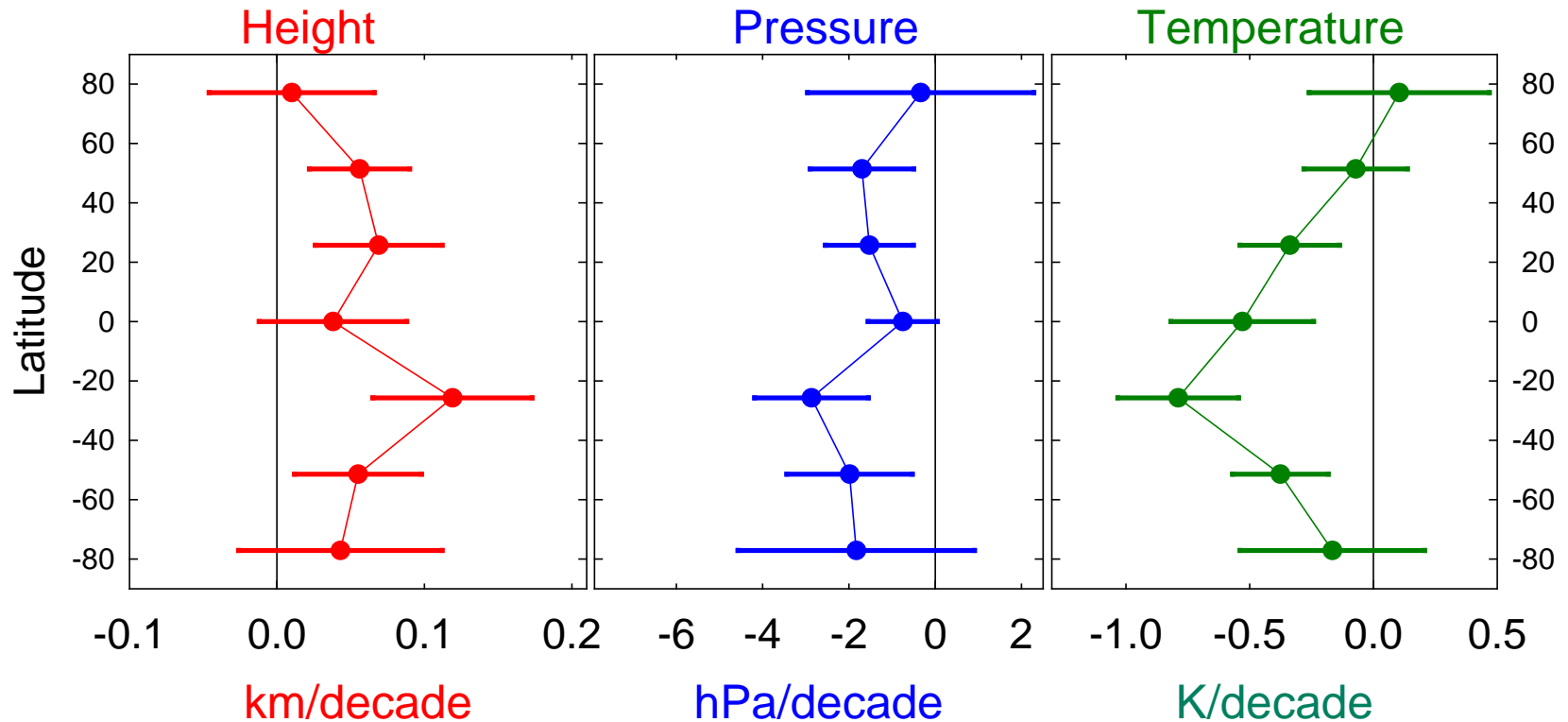


Temperature (°C)  
Cold-Point Tropopause

Seidel, Ross, Angell and Reid  
(JGR, 2001)

# Global tropopause trends

## 1980-2004 Zonal-Mean Tropopause Trends



Global-mean 25-yr changes : **160 m rise**, **4 hPa pressure decrease**, **1 K cooling**

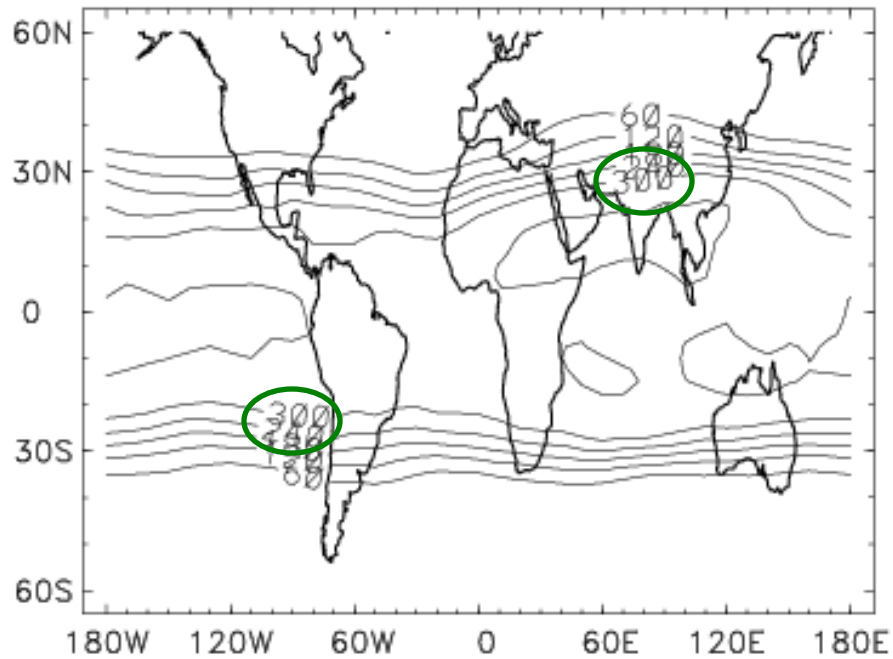
Seidel and Randel (JGR, 2006)



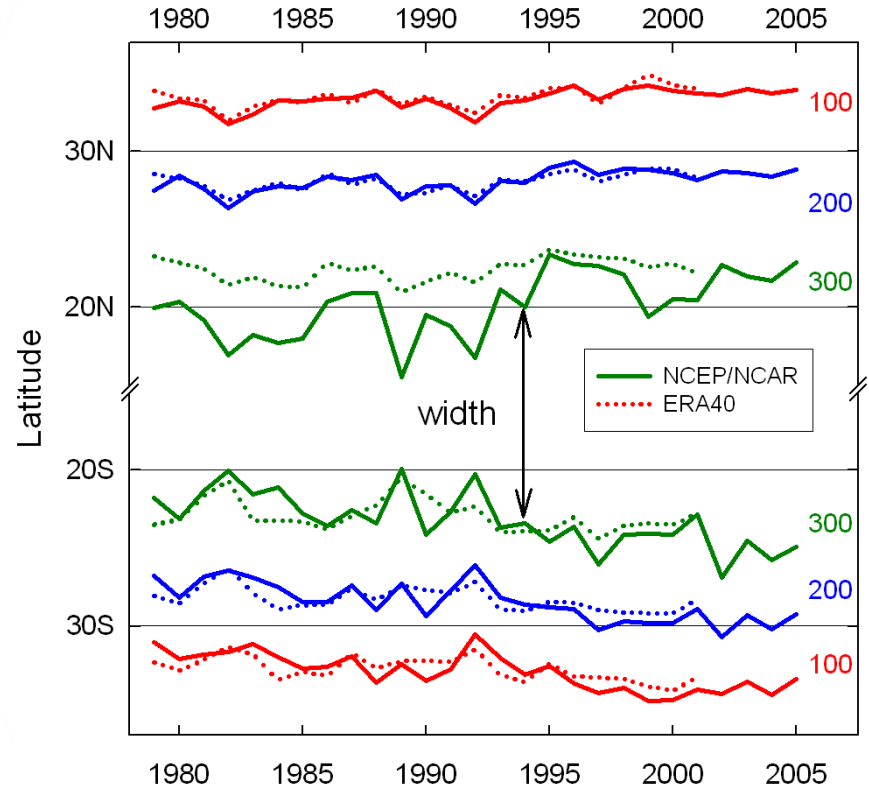
# Accomplishments – Tropical belt expansion

- Identified tropopause height as a metric of the extent of the tropical belt (Seidel and Randel, JGR, 2007)
- Integrated tropopause metric with other observations to show recent widening of the tropics (Seidel, Fu, Randel and Reichler, Nature Geoscience, 2008)
- Motivated other studies on this topic

# High tropopause in tropics



Days/Yr with Height > 15 km

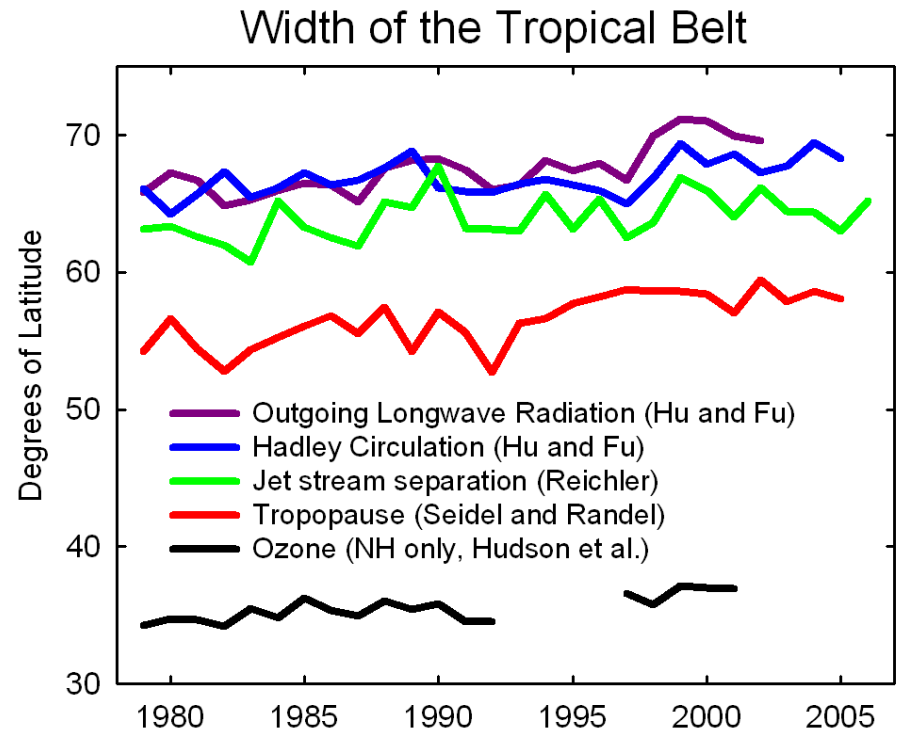
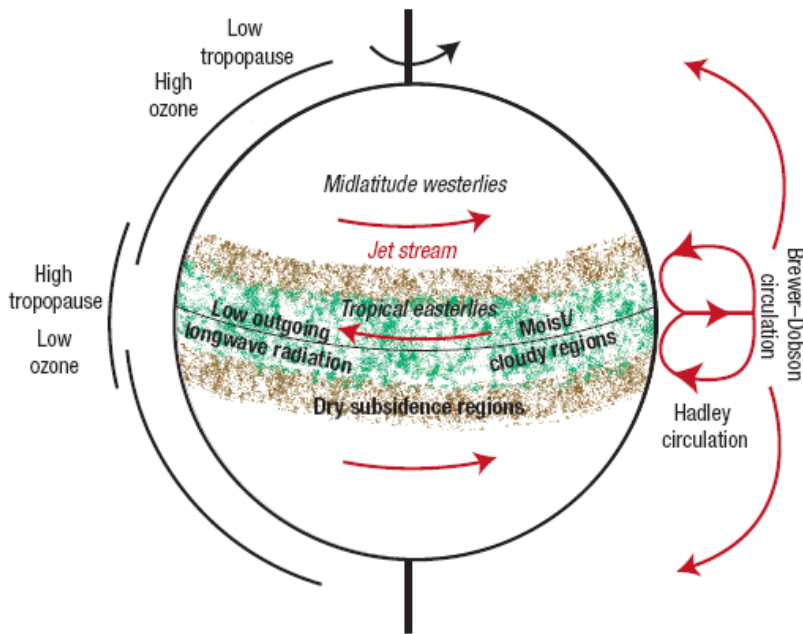


Seidel and Randel (JGR, 2007)

Total widening 1979-2005: 5-8 deg. latitude



# Comparison of metrics of tropical width



Seidel et al. (Nature Geosci. 2008)



# Indicators of success

- Publications; Citations in climate and ozone assessments
- Community use of datasets for climate monitoring and research
- Angell Symposium (November 2003)
- Dept. of Commerce and NOAA medals and awards
  - 1995 Silver Medal (Angell/ozone and temperature studies)
  - 2007 Gold Medal (Seidel/vertical temperature trends)
  - 2007 Bronze Medal (Free, Seidel/radiosonde data products)
  - NOAA Research Outstanding Scientific Paper Awards
- Transformation of the scientific discussion and research
  - Importance of data quality and need for reference observations
  - Characterizing uncertainty in trends
  - Reconciling atmospheric temperature trends
  - Tropical belt expansion and outstanding questions



# Collaborators (2001-2011)

## NOAA

- OAR/GFDL (Klein, Lanzante, Ramaswamy)
- NESDIS/NCDC (Durre, Karl, Peterson)



## US Academia

- NCAR (Randel)
- Lawrence Livermore National Lab (Santer)
- University of Washington (Fu)
- University of Utah (Reichler)
- University of Alabama in Huntsville (Christy, Spencer)



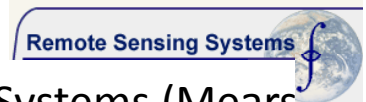
## International

- UK Met Office (Parker, Thorne)
- Univ. of Reading (Shine)
- Univ. of Portsmouth (Pepin)
- Canadian Centre for Modeling and Analysis (Gillett)
- All-Russian Institute for Hydrometeorological Information (Sterin)



## Private Sector

- Remote Sensing Systems (Mears, Schabel, Wentz)





# Future directions

- Temperature trends – ongoing interest
- Tropopause studies (James Wang, NRC Senior Associate)
  - Tropical cold-point tropopause changes and relation to stratospheric water vapor
  - Radiosonde and GPS Radio Occultation observations
- Tropical expansion
  - Contribution to IPCC 5<sup>th</sup> Assessment Report
  - Analysis of robustness of tropopause-based tropical width metrics
  - Update of published results (through 2005)



*Thank You!*