

How much can we learn about nitrous oxide emissions from background sites and simple box models?

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NOAA HATS is cooperating network of NDACC.
NOAA's Mauna Loa Observatory shown.



Motivation for studying N₂O

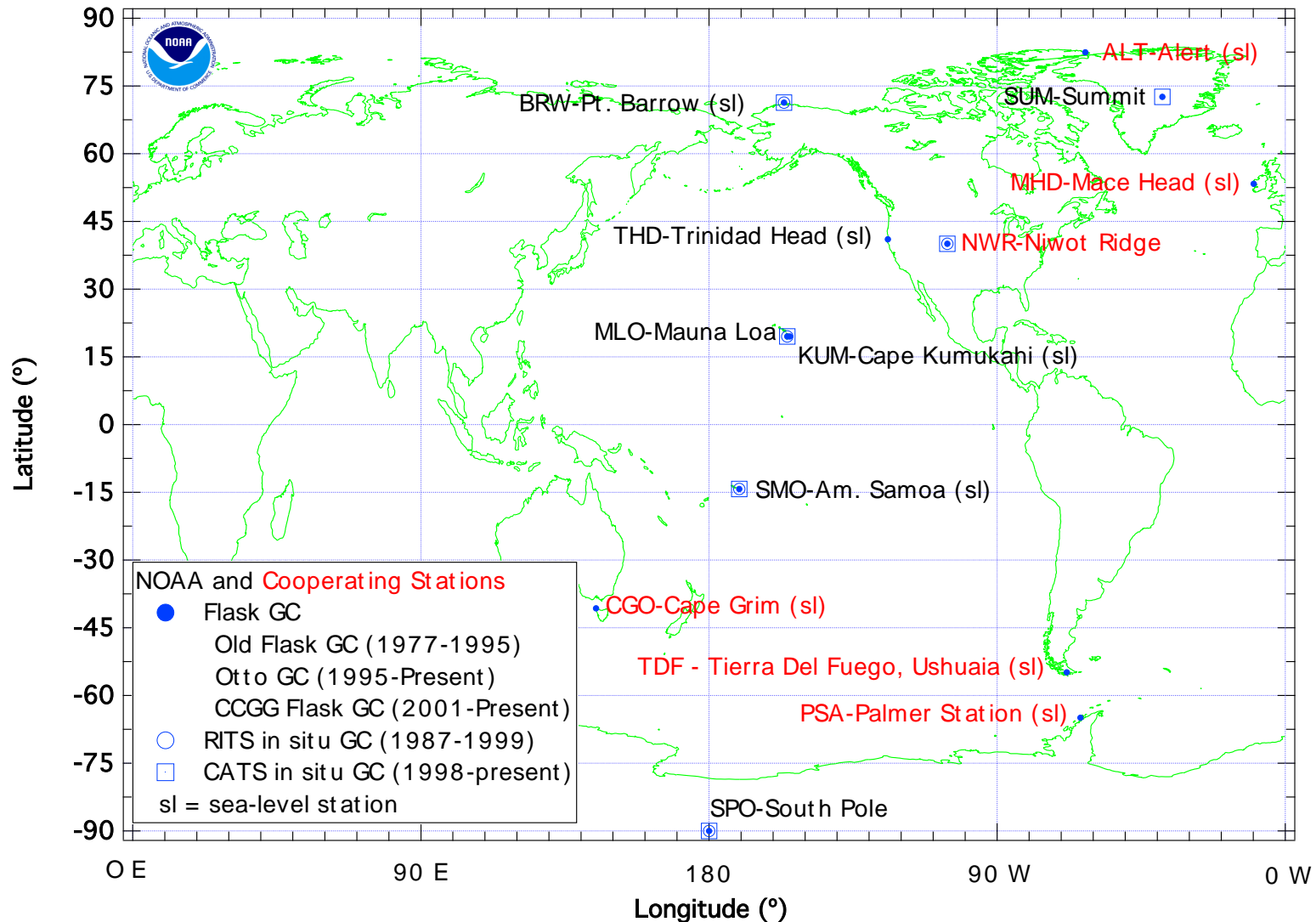
- Atmospheric N₂O is the third strongest greenhouse gas.
- Since the CFCs are in decline, N₂O is the largest ozone-depleting gas based on future emissions.
- Isopleths of N₂O are used as an proxy for altitude (tracer-tracer plots for determining ozone depletion).
- The atmospheric budget of N₂O is ~30% out of balance, because of man-made emissions.



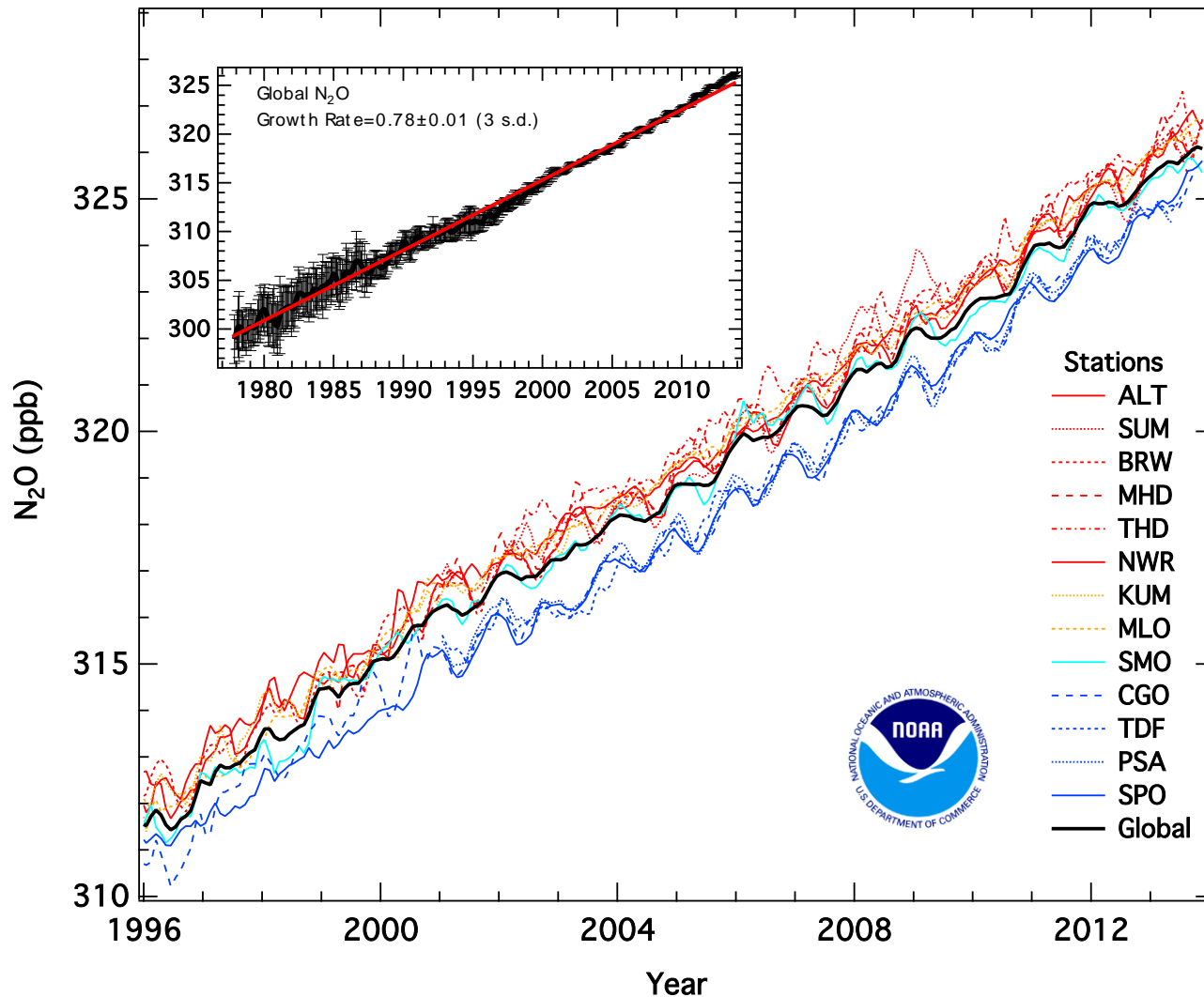
Location of major emissions of N_2O ?

- Natural sinks of N_2O are in the stratosphere (atmospheric lifetime = 120 years).
- N_2O produced by natural decay in soils and ocean. Man-made sources include additional decay from fertilizers (inorganic and organic), catalytic converters (NO_x to N_2O), and various types of chemical production.
- Small differences in concentrations can amount to large differences in emissions.
- Previous studies have used Global Climate Models with combined data sets (AGAGE+NOAA+others). Our approach is different, use simple boxes with data from one network (consistent scale & methods).

Location of flask and in situ measurements



Background N₂O ground based-observations

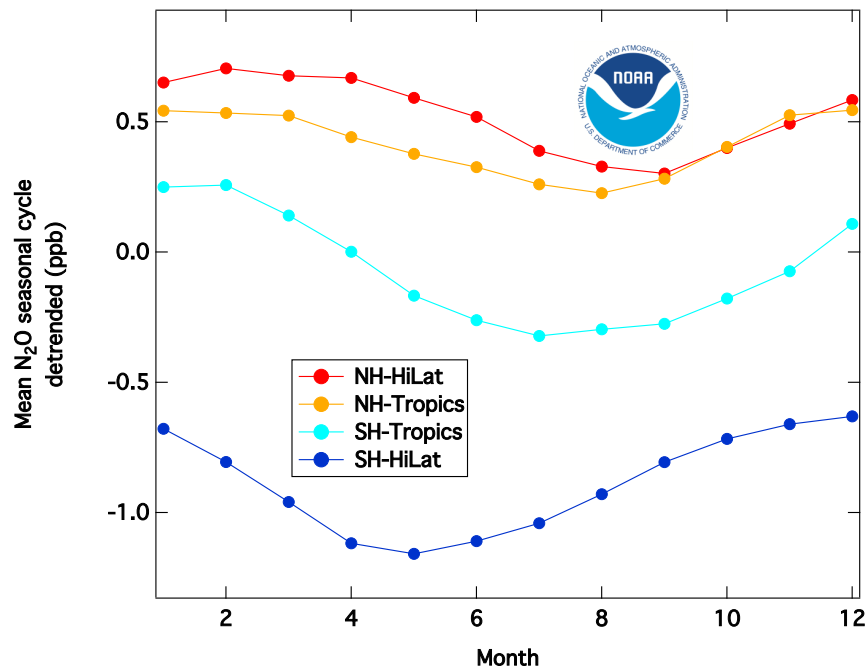


**Growth rate is
Constant at
 0.78 ± 0.01 ppb/yr
 ~ 4.5 Tg N/yr**

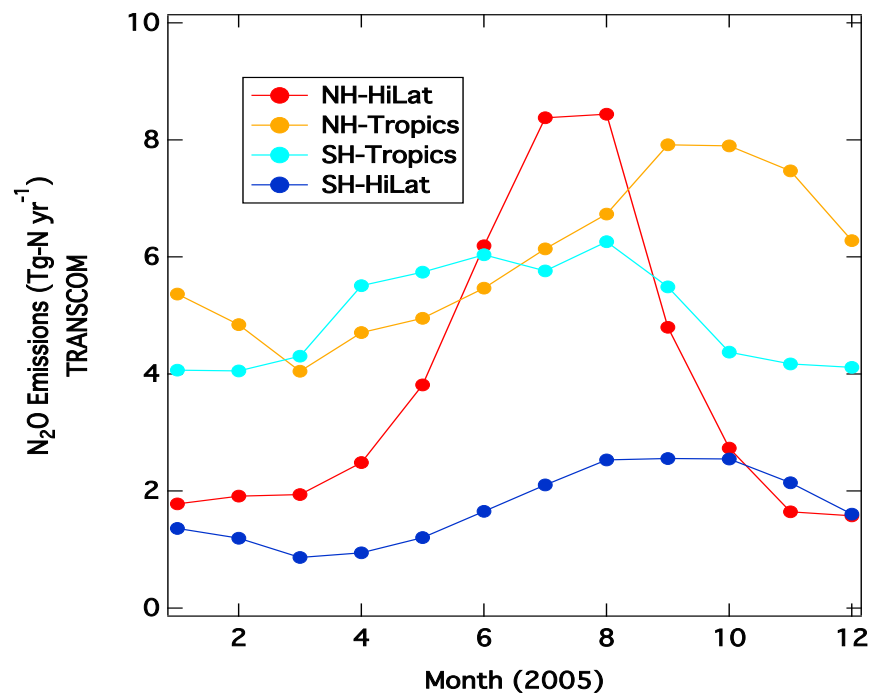
**Interhemispheric
Gradient is
 0.96 ± 0.04 ppb**

Seasonal Cycle from Observations and Prior Emissions

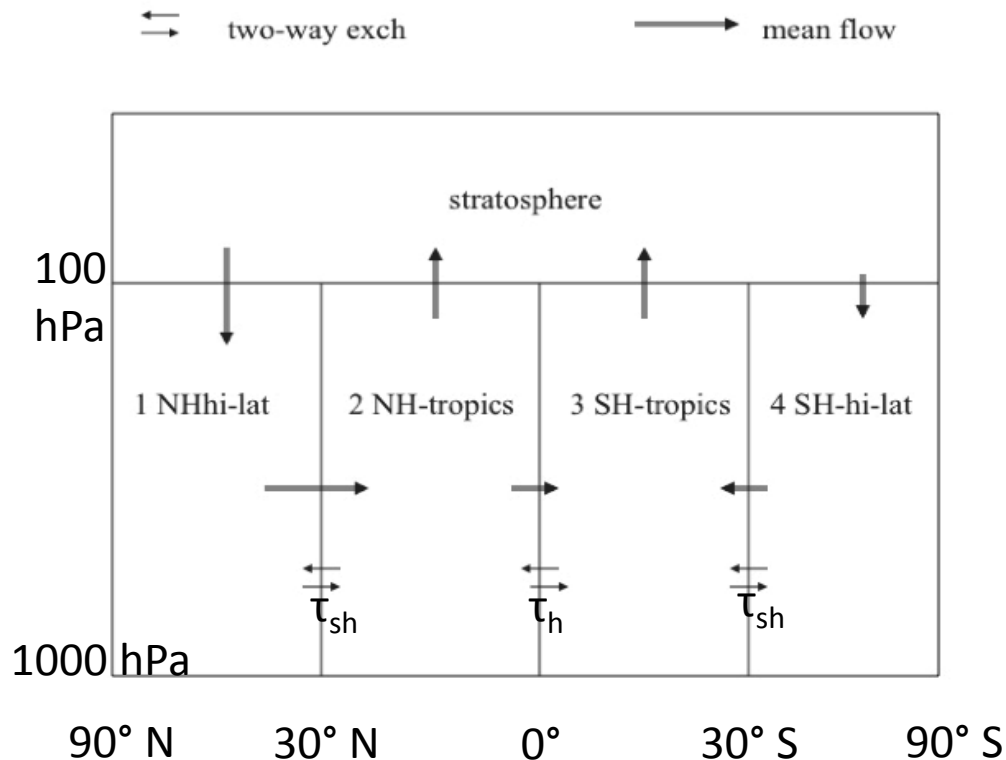
NOAA



TRANSCOM



Harvard 5 box model: four semi-hemispheres and one stratospheric box

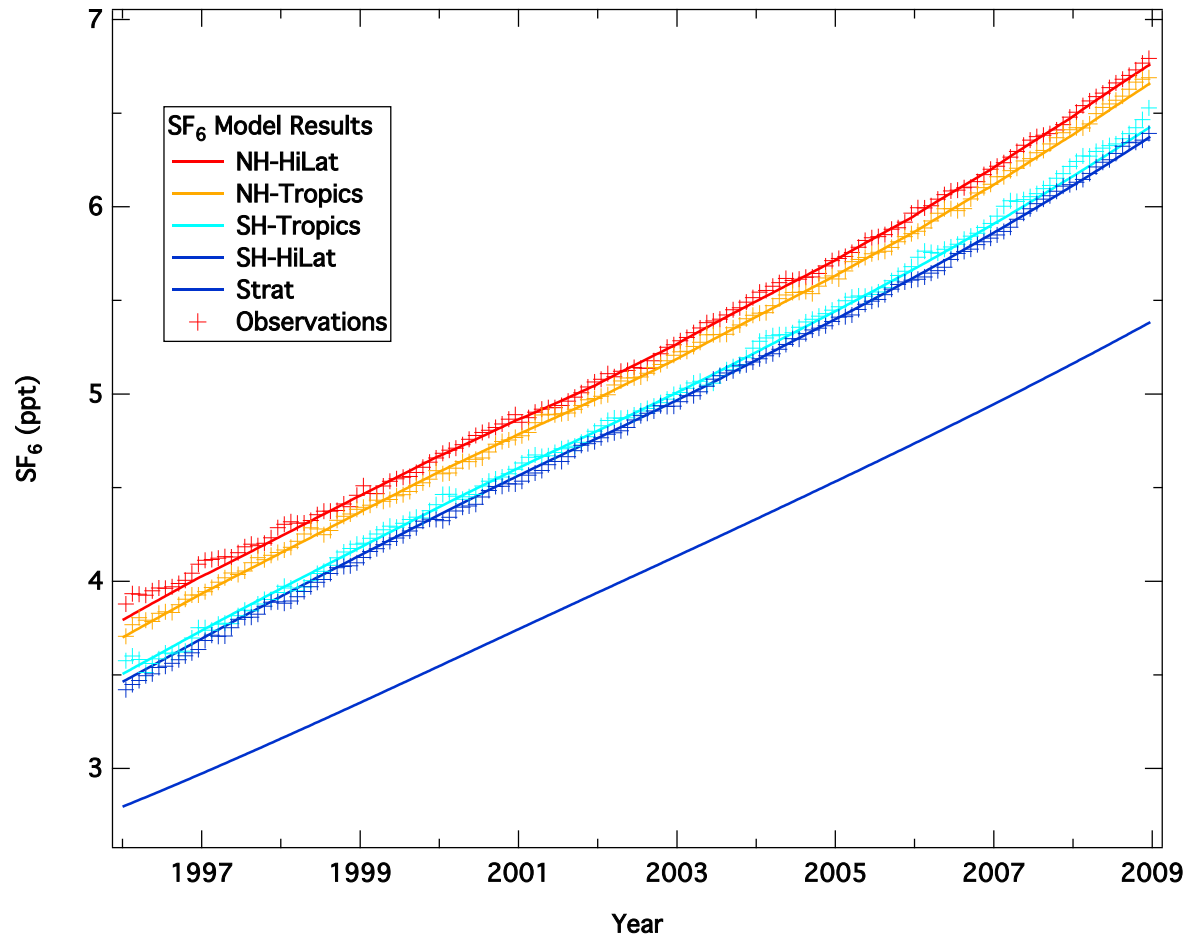


- Parameters

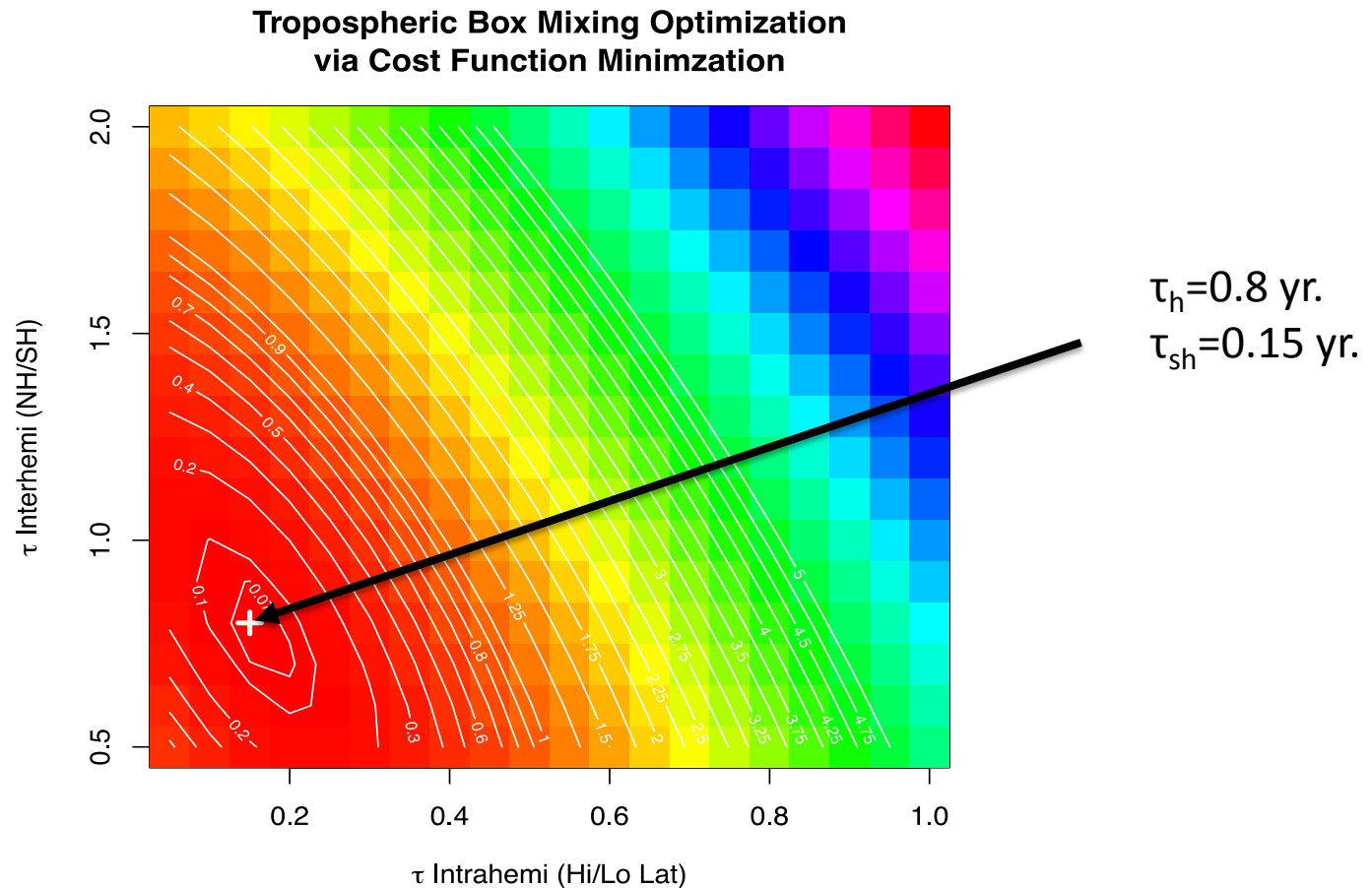
- Atmospheric lifetime, 120 yr.
- Stratospheric turnover time, 4 yr.
- Advection rates are derived from Brewer-Dobson asymmetry in circulation, 55% NH, 45% SH
- Initial guess for stratospheric value



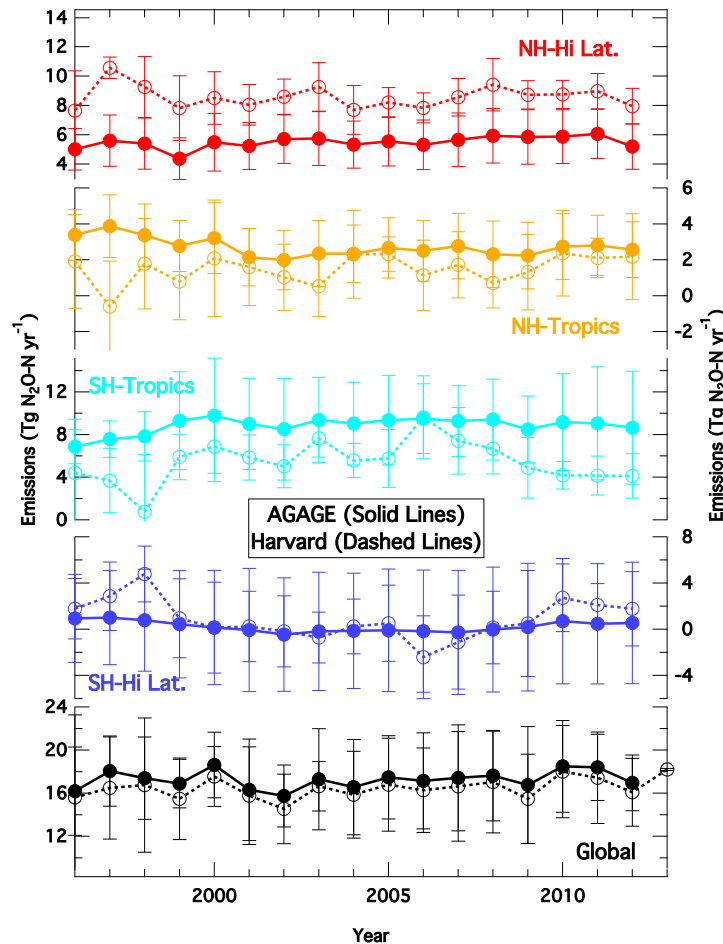
Obtaining atmospheric parameters from NOAA SF_6 using 5-box model



Cost function for finding interhemispheric (τ_h) and intrahemispheric (τ_{sh})



5-box Harvard vs 12-box AGAGE Model



- NH-HiLatitudes: 5-box model predicts higher %
- NH-Tropics: Both models similar results
- SH-Tropics: 12-box model predicts higher %
- SH-HiLatitudes: Almost no emissions here.
- Emissions = 17 Tg N/yr

Conclusions

- 5-box model doesn't need prior emissions, only a starting stratospheric value.
- 12-box AGAGE model requires priors, but different priors only give slightly different results.
- Largest emissions in the NH-HiLatitudes (95% of population) in the 5 box model. 12 box model pushes more emissions in the SH-Tropics than NH-HiLatitudes.
- 12-box AGAGE model uses transport from long-lived gases, and older vs newer transport parameters give different greatly different results for the CFCs. We will use airborne and ground based SF₆ observations to calibrate transport in the 12-box model in the future.

Any Questions?

Thanks for listening!

For more information, see web:
<http://www.esrl.noaa.gov/gmd/hats>

ESRL Global Monitoring Division - Halocarbons and other Atmospheric Trace Species

www.esrl.noaa.gov/gmd/hats/

Home - Dropbox

ESRL Global Monitoring Division - Halocarbons and other Atmospheric Trace Species

7 Ways to Take a Screenshot in Mac OS X - wikiHow

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HATS Information

- HATS Group
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- Safety Program
- Stations

Data

→ HATS Data Page ←

- N₂O
- SF₆
- CFC-11
- CFC-12
- CFC-113
- CCl₄
- CH₃CCl₃
- C₂Cl₄
- CH₂Cl₂
- HCFC-22
- HCFC-141b
- HCFC-142b
- HFC-134a
- HFC-152a
- halon-1211
- halon-1301
- halon-2402
- CH₃Br
- CH₃Cl
- OCS

FTP Site
in situ Program
HIPPO (via CDIAC)

Projects

- Airborne
- Flasks
- in situ Program
- Standards
- Instrumentation
- Ocean
- IHALACE

Halocarbons & other Atmospheric Trace Species Group (HATS)

The general mission of the Halocarbons and other Atmospheric Trace Species group is to quantify the distributions and magnitudes of sources and sinks for atmospheric nitrous oxide (N₂O) and halogen containing compounds. HATS utilizes numerous types of platforms, including ground-based stations, towers, ocean vessels, aircraft, and balloons, to accomplish its mission. For a detailed mission statement, consult our [FAQ](#).

You can also read about [CFCs and their substitutes in stratospheric ozone depletion](#).

Global Mean Mixing Ratios

parts-per-billion (ppb)

Date

NOAA/ESRL halocarbons group (last April 15, 2013)

Airborne

Projects involve measuring trace gases in the upper troposphere and stratosphere on balloons and aircraft including Unpiloted Airborne Vehicles (UAVs) to help understanding the chemistry and transport of the upper atmosphere.

In Situ Program

Hourly in situ observations at NOAA/ESRL baseline observatories, Niwot Ridge, Colorado and Summit, Greenland provide information on transport, emissions, and trends.

Instrumentation

Custom instrumentation for measuring greenhouse gases, halocarbons, substitute halocarbons, and hydrocarbons have been built for unique platforms. Some instrumentation has been provided to other countries to monitor trace gases.

Flasks

Research centers on obtaining the maximum science from weekly to monthly flask samples collected worldwide and analyzed in our Boulder labs. These samples are used to determine current and historical trends, trace gas and OH distributions, emissions, and inventories.

Ocean

The oceans play an important role as sources and sinks for atmospheric trace species. The determination of fluxes between the surface seawater and the marine air require knowledge of the saturation anomaly with air and the gas exchange rate.

Standards

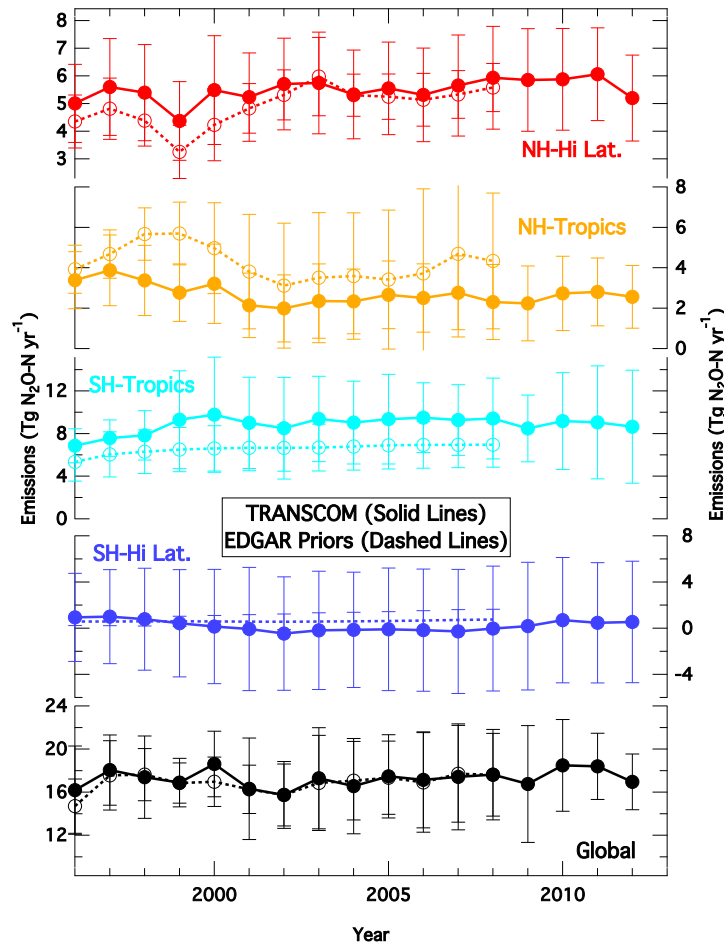
Research is conducted for developing and maintaining standard gas mixtures of atmospheric gases to calibrate instrumentation on the many platforms used in our studies. Custom standards provided as tertiary calibration mixtures are available.

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Earth System Research Laboratory | Global Monitoring Division
<http://www.esrl.noaa.gov/gmd/hats/index.html>

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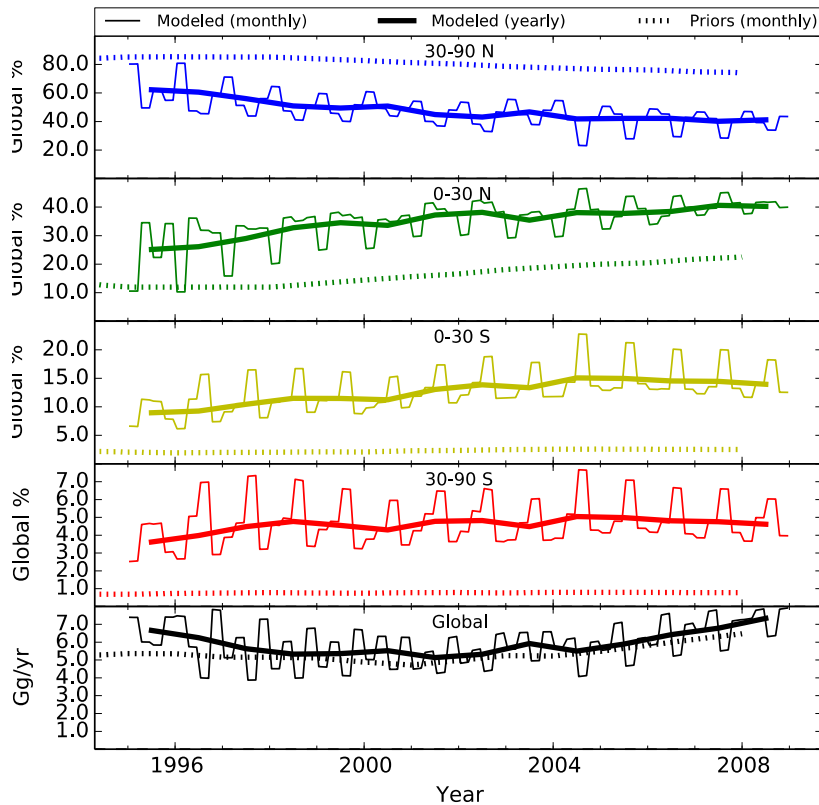
Extra slides

Test of different priors on AGAGE 12 box model



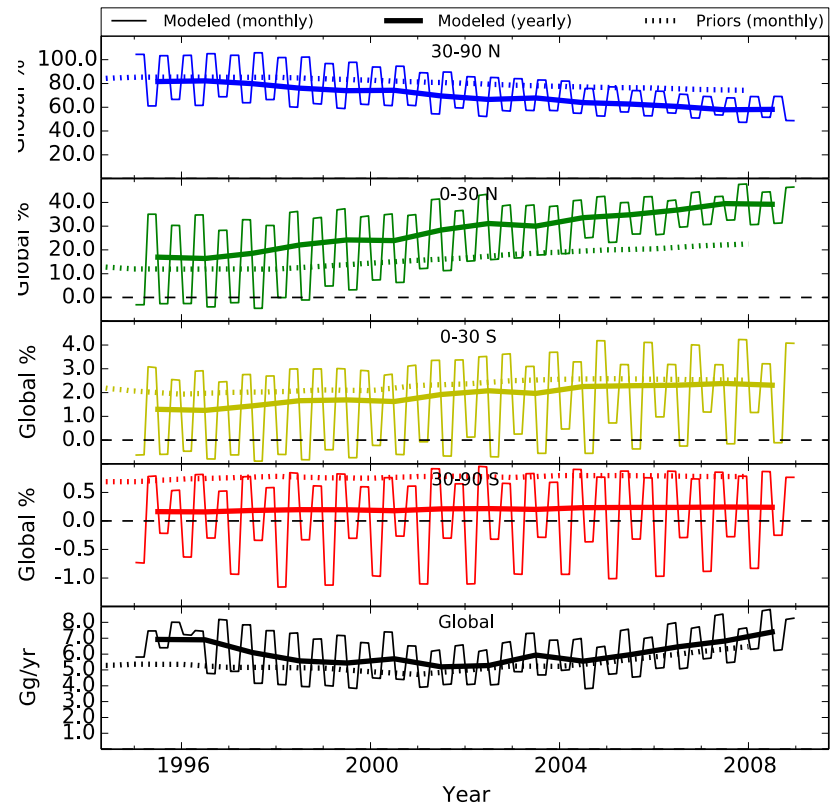
Different Transport 12 Box

AGAGE 12-Box Model Inversion Run "test": SF₆
[Conc: HATS; Priors: EDGAR; Transport: Cunnold]
Emissions by Latitude Band



Puts 20% of total emissions in the SH

AGAGE 12-Box Model Inversion Run "SF6_01": SF₆
[Conc: HATS; Priors: EDGAR; Transport: Rigby]
Emissions by Latitude Band



Puts 2.5% of total emissions in the SH