GES DISC Users Group and MEaSUREs Meeting
Greenbelt, MD
April 29-30, 2009

GOZCARDS: Global OZone Chemistry And Related trace gas Data records for the Stratosphere

[GOZCARDS JPL website at http://gozcards.jpl.nasa.gov]

A NASA MEaSUREs [Making Earth Science Data Records for Use in Research Environments] Project

[MEaSUREs website at http://esdswg.eosdis.nasa.gov/measures]

Principal Investigator: *Lucien Froidevaux*
Jet Propulsion Laboratory, Caltech, Pasadena, California

Motivation

"Data sets encapsulating the behaviour of the Earth system are one of the greatest technological achievements of our age – and one of the most deserving of future investment."

[Nature, vol. 450, Dec. 2007, pg. 761, "Patching together a world view."]

- **The MEaSUREs GOZCARDS project aims to provide a stratospheric view of T and key chemical species (O_3, HCl, ClO, ClO_x, HF, H_2O, CH_4, N_2O, NO, NO_2, NO_x, HNO_3, zonal and equivalent latitude average profiles) from the 1980's into the next decade of global satellite observations.**

- **This Stratospheric Earth System Data Record (ESDR) should lead to**
  - **a better characterization and understanding of the changing state of the stratosphere, as well as**
  - **improvements in global atmospheric and climate models, including predictive capabilities.**

[NASA sponsorship is acknowledged]

GOZCARDS: Global OZone Chemistry And Related trace gas Data records for the Stratosphere

Principal Investigator: *Lucien Froidevaux, Jet Propulsion Laboratory, Caltech*

Goal: To produce, distribute, and preserve global long-term Earth System Data Records (ESDRs) relevant to stratospheric ozone

Approach: Create time series of zonally-averaged profiles for stratospheric ozone (O_3), related gases (HCl, ClO, HF, H_2O, CH_4, HNO_3, NO_2, NO, N_2O, and inferred ClO_x and NO_x), as well as T, using satellite data from 1979 to now.

- Merge solar occultation and thermal emission data
- Use latitude and equivalent latitude coordinates
- Include uncertainties, some ground-based cal/val
- Provide common formats, documentation, website

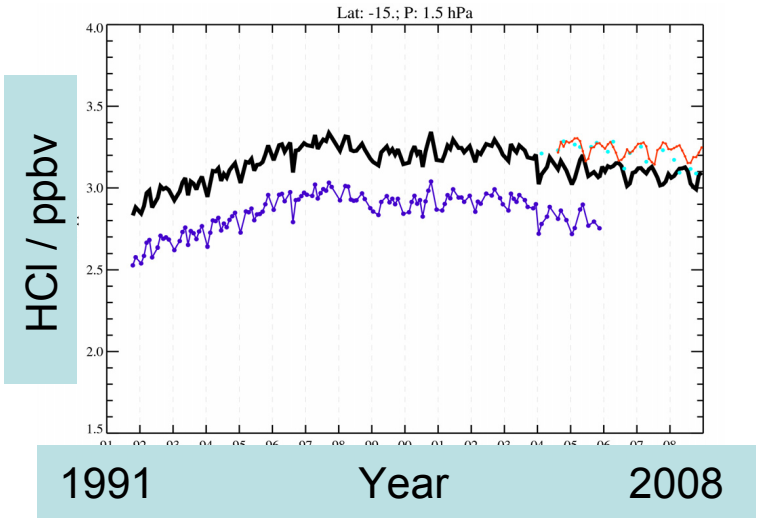


Illustration for HCl at 10S-20S, 1.5 hPa

The use of overlapping satellite datasets for HCl (from **HALOE**, **ACE-FTS**, and **Aura MLS**) can lead to a long-term data record (in **black**)

NASA Relevance: To track and understand the variability and long-term behavior of the Earth's atmosphere, including the ozone decline & recovery, as well as other stratospheric trends

Accomplishments to date (April, 2009):

- Creation of over 50 commonly formatted yearly files (netCDF) for comparisons, analyses, planning
- Presentation of plans and early results at three meetings [with international participation]
- **Website**: **http://gozcards.jpl.nasa.gov**

Schedule (08/09 means 03/08 to 03/09):

08/09: Compilaton, exploration, initial planning

09/10: Team Mtg (JPL, 04/09), ATBD (Fall 09)

10/11: Finalize/deliver v1 ESDRs (Fall 2010)

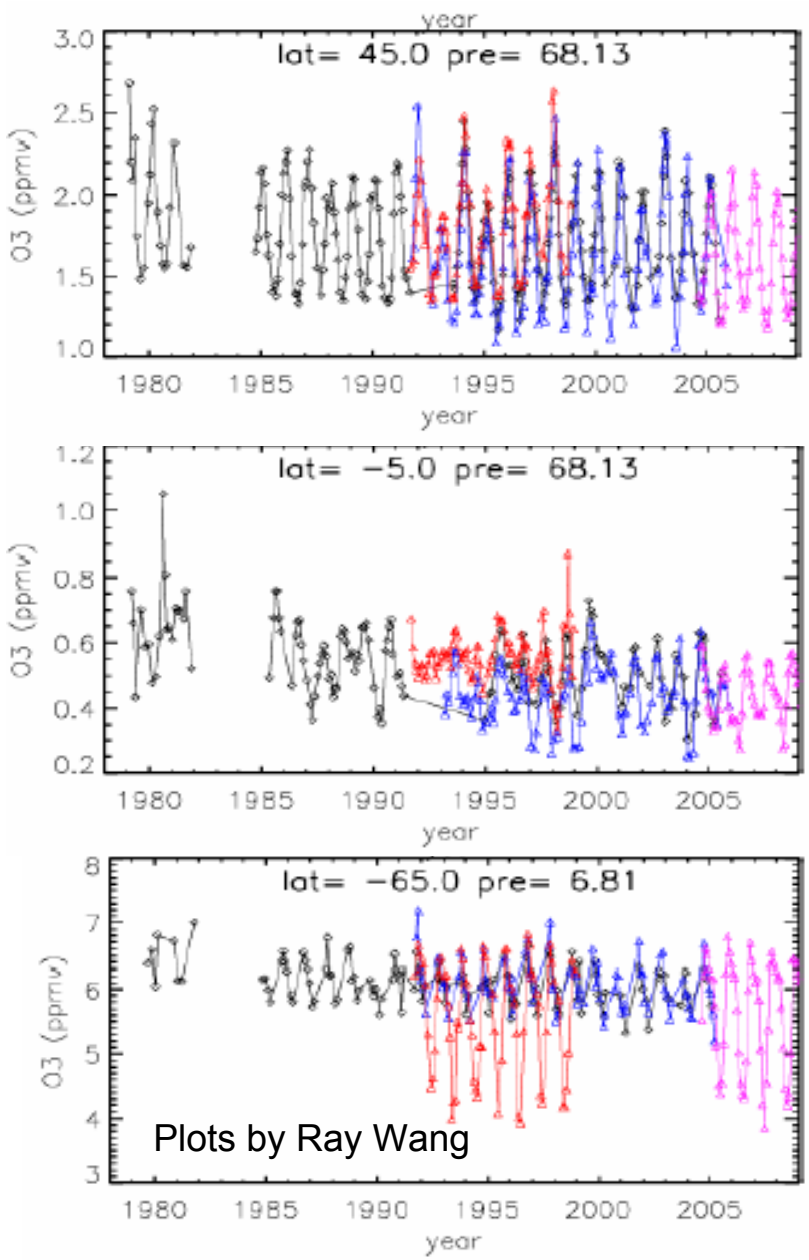
11/12: Make ESDRs public (late 2010 – 2011), including linkage to GES DISC linkage

12/13: Continued production of ESDRs and improvements (website, documentation/tools)

Team: JPL, Georgia Tech, Univ.Hampton, Univ. Maryland (College Park), + collaborators

Satellite data records for the stratosphere: Ozone

SAGE-I and II **HALOE**
UARS MLS **Aura MLS**



▸ Investigation of ozone datasets

- Some of the "connections" between datasets will be fairly easy to make (e.g.: top left panel – good agreement).
- In the lower stratosphere at low lats. (middle panel), missing data from solar occultation measurements (affected by the volcanic aerosols) are complemented by the more continuous information from UARS MLS during part of the post-Pinatubo period (mid-1991 to 1993).
- Some issues deserve further scrutiny. See high lat. example (bottom left panel) of strong seasonal changes obtained from emission global data (UARS and Aura MLS), in contrast to the smaller variations sampled by solar occultation.

GOZCARDS Data: Usage, Schedule, Files

Comparisons of data with model results

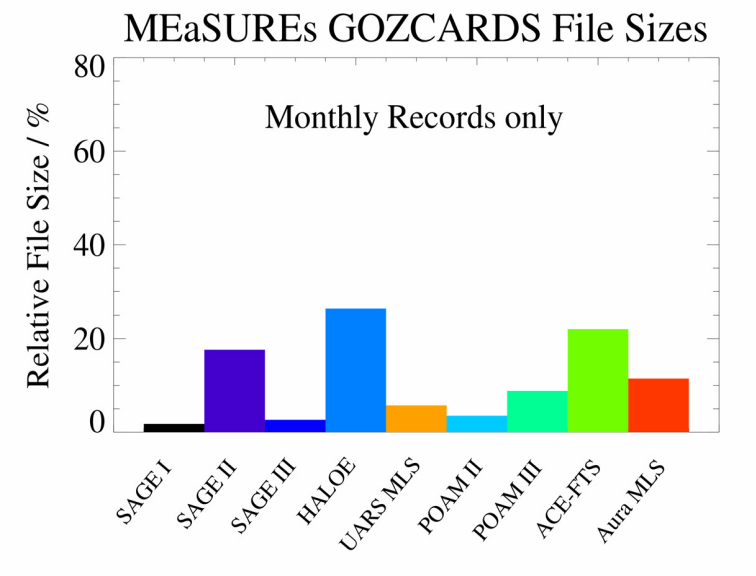
Some of these datasets will be compared to coupled chemistry climate models (CCMs) and chemical transport models (CTMs) [CCMVal, WMO efforts].

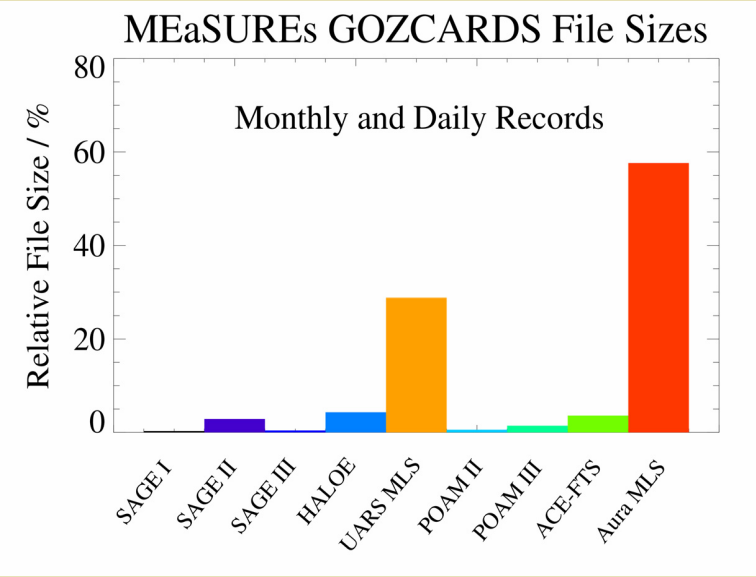
GOZCARDS planned as a 5 yr effort

- Year 1 (now): Exploration of data & documentation of approach for Earth System Data Records (ESDRs).
- Years 2 and 3: Generation of most of the ESDRs. Comparisons versus other efforts.
- Years 4 and 5: Finish off remaining issues and include more of the continuing datasets from Aura MLS and ACE-FTS. Enable public distribution, and provide documentation + plots/tools for data users.

GOZCARDS Data Files

- Plans are to use **netCDF files**. Include values and uncertainties, variability, measurement conditions (e.g. solar zenith angle information).
- About **20 different products**, with up to 4 different coordinate systems / units, from 1979 to present.
- **File sizes** are "small": **~ 10 to 50 GB total size**, mostly in daily files [original datasets can be large].

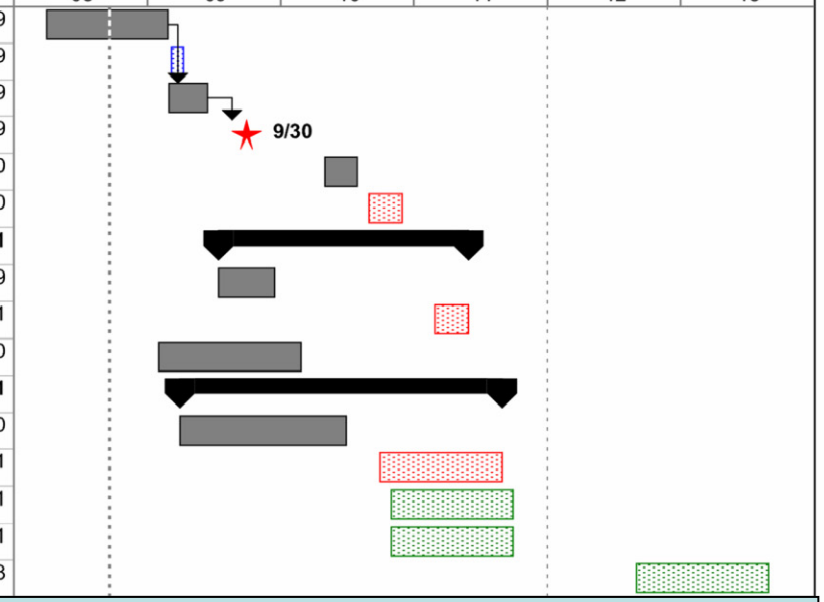




MEaSUREs GOZCARDS Project: SCHEDULE

MEaSUREs-GOZCARDS-Schedule-2008-09 Lucien Froidevaux Sep. 19, 2008

ID	Task Name	Start	Finish
1	Exploration Phase	Tue 4/1/08	Fri 2/27/09
2	GOZCARDS Team Meeting	Mon 3/9/09	Fri 4/10/09
3	ATBD write-up	Mon 3/2/09	Mon 6/15/09
4	**Deliver ATBD**	Wed 9/30/09	Wed 9/30/09
5	Zonal Mean ESDRs (V0 internal)	Mon 5/3/10	Fri 7/30/10
6	**Zonal Mean ESDRs V1**	Wed 9/1/10	Tue 11/30/10
7	**ClOx and NOx Zonal Mean ESDRs**	**Thu 7/16/09**	**Tue 5/31/11**
8	ClOx/NOx ESDRs V0	Thu 7/16/09	Wed 12/16/09
9	**ClOx/NOx ESDRs V1**	Tue 3/1/11	Tue 5/31/11
10	Derived Met Products File Generation	Mon 2/2/09	Fri 2/26/10
11	**Equivalent Latitude ESDRs**	**Wed 4/1/09**	**Wed 8/31/11**
12	EqLat ESDRs V0	Wed 4/1/09	Wed 6/30/10
13	**EqLat ESDRs V1**	Fri 10/1/10	Wed 8/31/11
14	**ESDRs Public Distribution**	Mon 11/1/10	Fri 9/30/11
15	GES DISC linkage/certification	Mon 11/1/10	Fri 9/30/11
16	Final ESDRs + docs to GES DISC	Mon 9/3/12	Fri 8/30/13



(Top-level) Schedule covers 5 years total

- Initial year: exploration of initial datasets and refinement of approach for generating this project's Earth System Data Records (ESDRs)

- Work, computer orders & telecons started; exploratory datasets created
- Team Mtg (Spring 2009); also, GISS & ESDSWG Mtgs, (Oct. 08), AGU (Dec. 08); EGU (April, 2009)
- Documentation of approach/algorithms (ATBD)

- First 3 years: work for JPL and non-JPL co-Is

→ Generation of ESDRs using past & current atmospheric composition datasets

- Final 2 years: continuing datasets (from Aura MLS and ACE-FTS), enabling public distribution, and providing documentation and plots for data users

Long-term data records: Planned MEaSUREs GOZCARDS products

Stratospheric Products	Satellite Data Sets
O_3 (zonal mean time series): profiles & strat. cols	SAGEs, HALOE, UARS MLS, POAMs, ACE-FTS, Aura MLS
HCl (zonal mean series)	HALOE, ACE-FTS, Aura MLS
ClO (zonal mean series)	UARS MLS, Aura MLS
ClO_x (zonal mean series)	UARS MLS, Aura MLS
HNO_3 (zonal mean series)	UARS MLS, ACE-FTS, Aura MLS
H_2O (zonal mean series)	SAGEs, HALOE, UARS MLS, POAM III, ACE-FTS, Aura MLS
N_2O (zonal mean series)	ACE-FTS, Aura MLS
NO_2 (zonal mean series)	SAGEs, HALOE, POAM II & III, ACE-FTS
NO (zonal mean series)	HALOE, ACE-FTS
NO_x (zonal mean series)	SAGEs, HALOE, POAM II & III, ACE-FTS
CH_4 (zonal mean series)	HALOE, ACE-FTS
HF (zonal mean series)	HALOE, ACE-FTS
T (zonal mean series)	GMAO MERRA reanalysis
EqL/ θ binned products	All of the above

MEaSUREs GOZCARDS Products/Team

Co-investigators

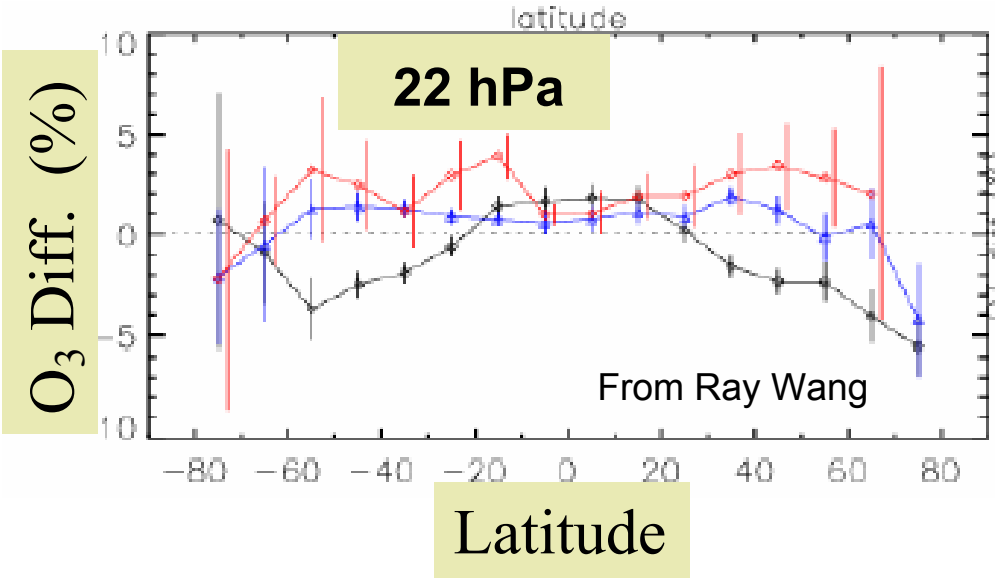
- M. Santee (JPL)
- M. Schwartz (JPL)
- R. Wang (Georgia Tech)
- J. Anderson (Hampton Univ.)
- R. Salawitch (Univ. Maryland,College Park)

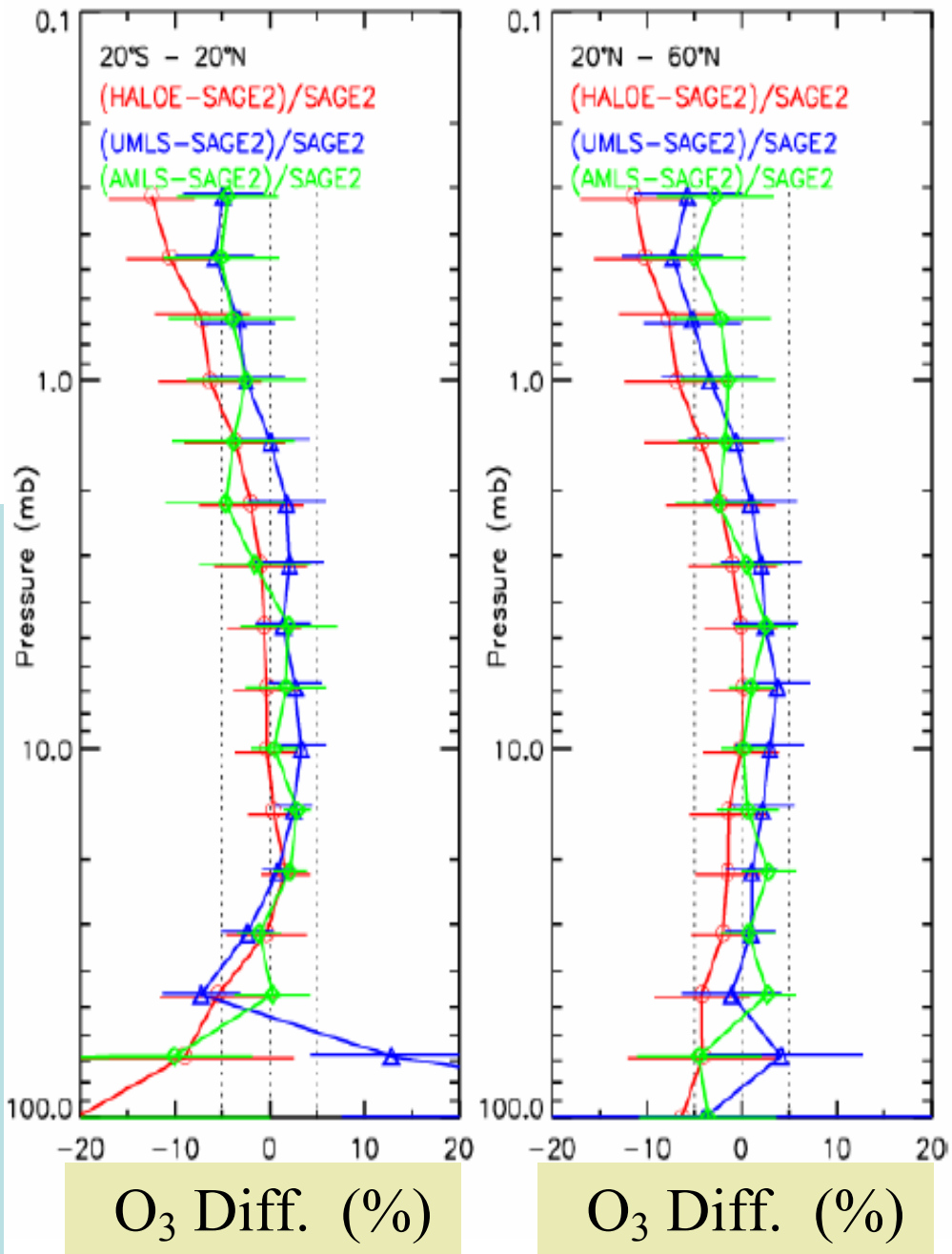
Collaborators

- P. Bernath (York Univ.)
- T. Canty (UMCP)
- D. Cunnold (Georgia Tech) [Rest in Peace]
- K. Hoppel (NRL)
- N. Livesey (JPL)
- G. Manney (JPL)
- S. Pawson (GSFC)
- J. Russell (Hampton Univ.)

+ others

Satellite data records for the stratosphere: Ozone

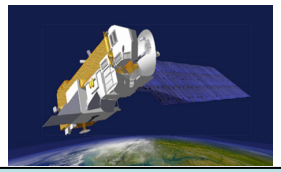




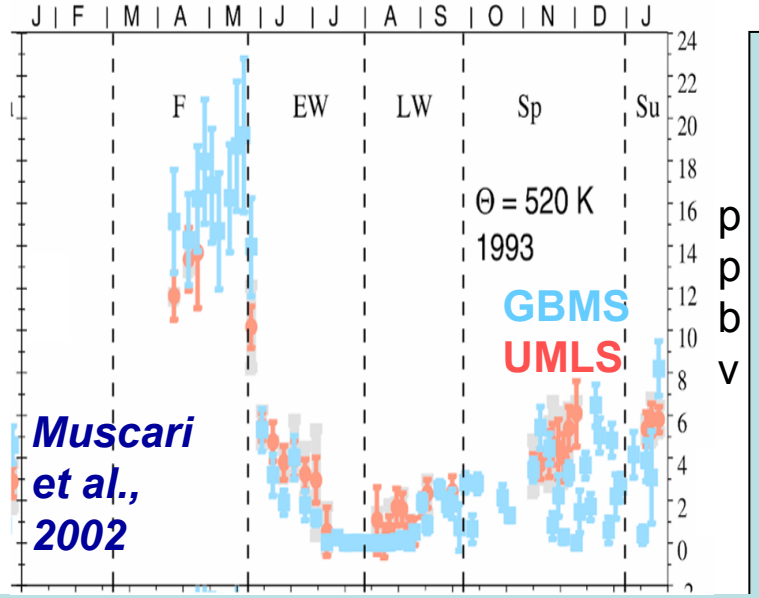
- The goal is to document the latitudinal & vertical dependence of offsets between datasets.
- Some regions show larger diffs., but agreement for O_3 is generally very good (< ~5%)
- Offset corrections will then be recommended for providing an average (or "merged") record.

Satellite data records for the stratosphere: HNO_3

- Ground-based data records will also help the cross-calibration of HNO_3 satellite data
  - ground-based (GBMS) HNO_3 profile info (+ columns)
  - additional information from other measurements (e.g., from Kiruna, Sweden)

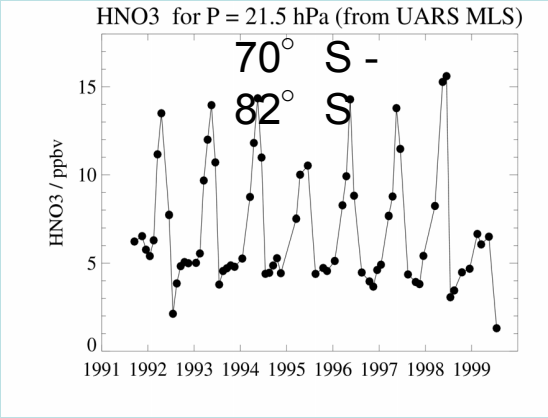


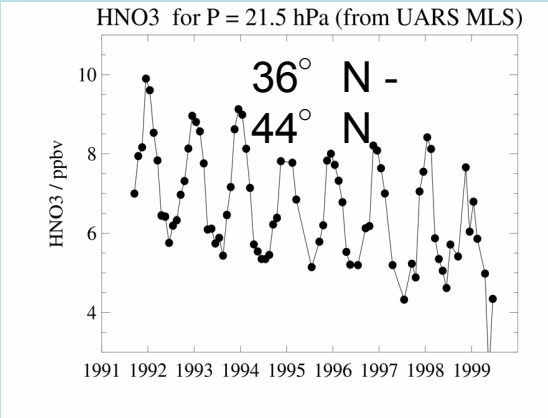
Ground-based HNO_3 (S. Pole)



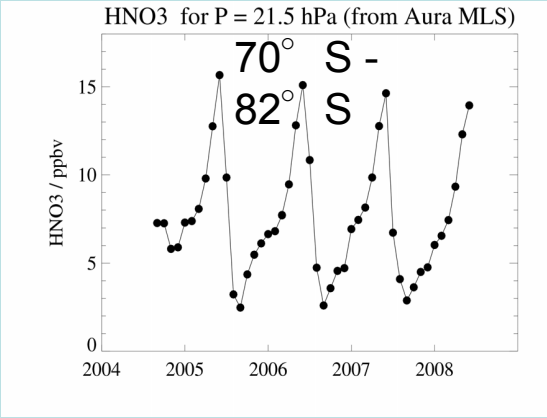
GBMS South Pole data (1993,1995,1999) + will have additional GBMS data from Italy (2005, 2006) and Thule (2009)

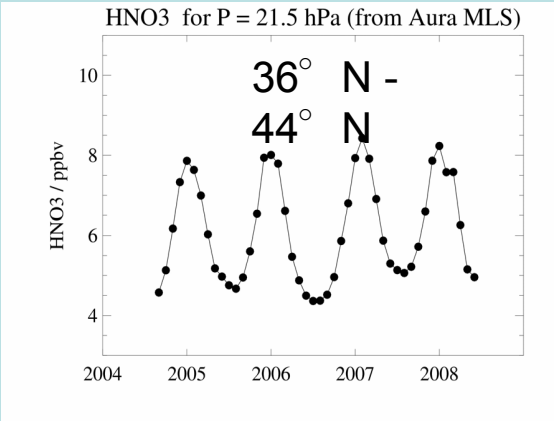
UARS MLS HNO_3

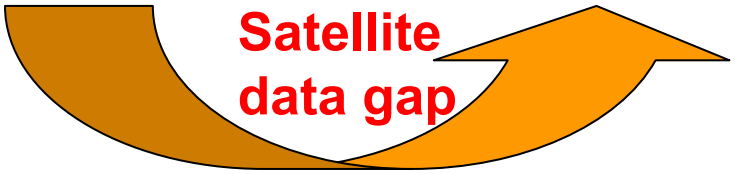




Aura MLS HNO_3



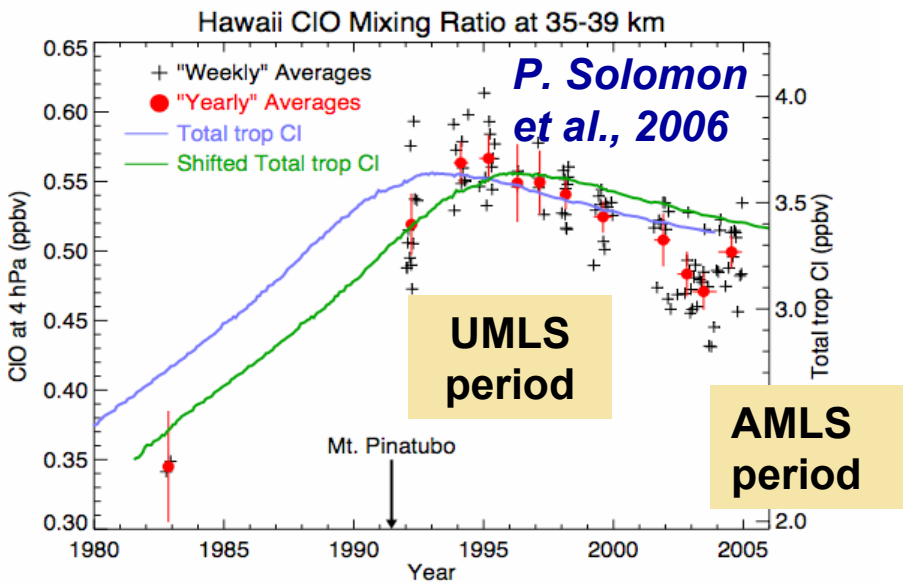


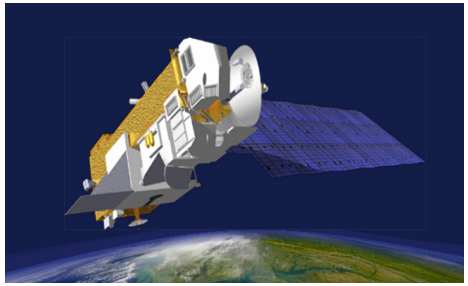


Satellite data records for the stratosphere: ClO

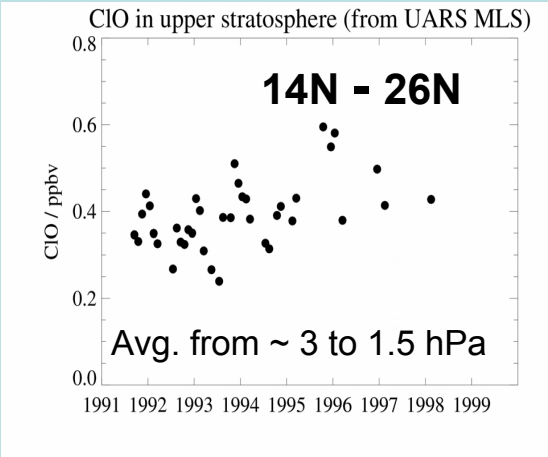
- Stratospheric ClO from ground-based microwave measurements should help create the link & cross-calibration for ClO data from UARS MLS & Aura MLS
  - There is a fairly long (~ 5 year) **gap** between the UARS and Aura MLS datasets
  - Need to **minimize biases** between UARS and Aura MLS data; also check columns
- Have started collaboration with G. Nedoluha (NRL) and B. Connor (New Zealand)
  - early results look promising

Ground-based ClO

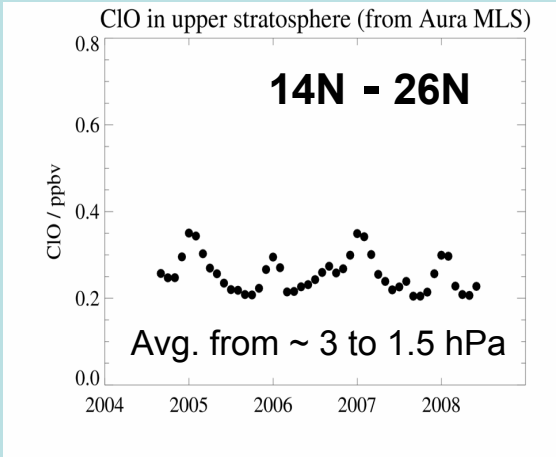




UARS MLS ClO



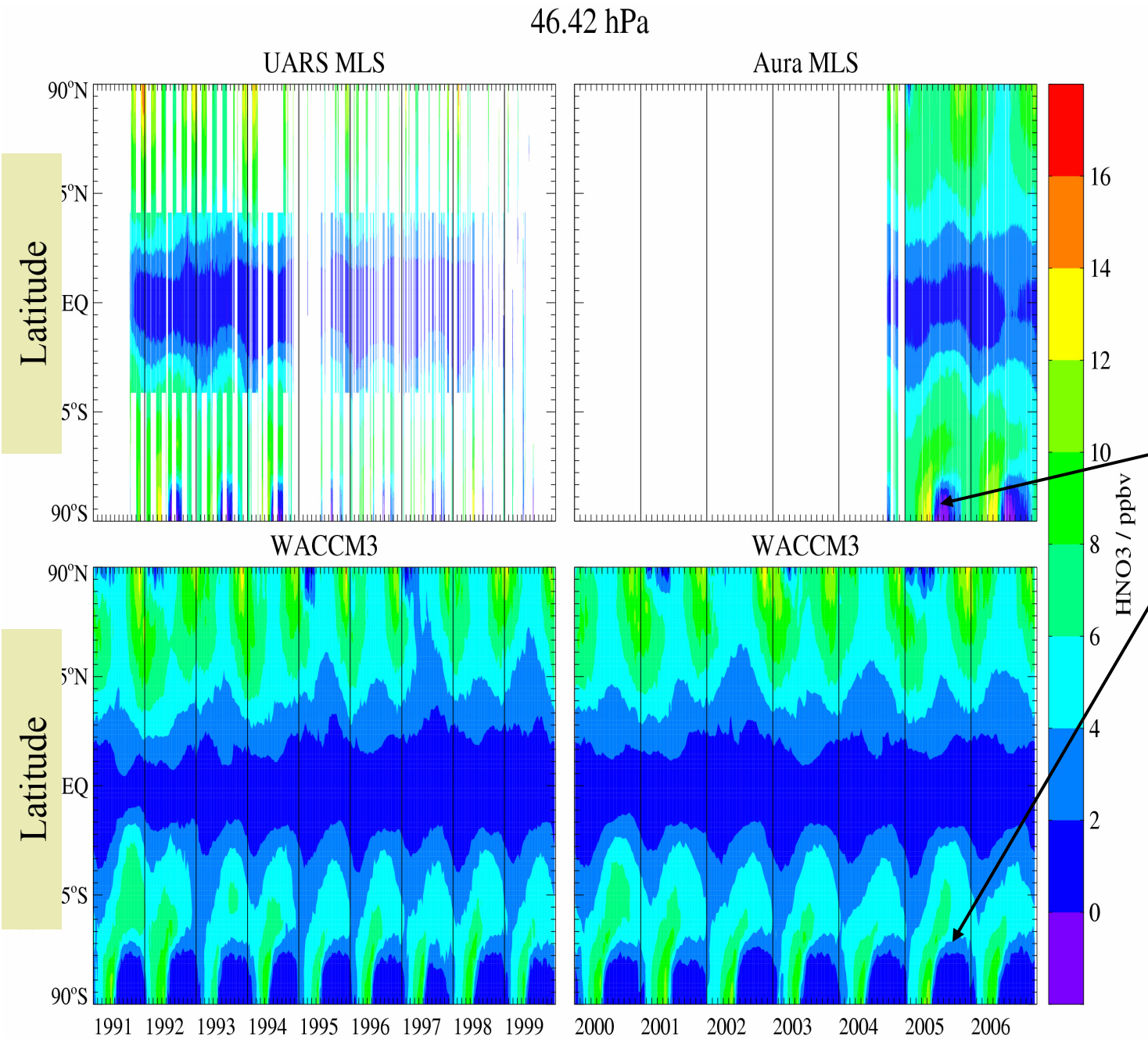
Aura MLS ClO



Also, compare with ground-based ClO from Scott Base (1996-present) [more variable]

Satellite data gap

Data/Model comparisons (e.g., data vs NCAR WACCM3 model)



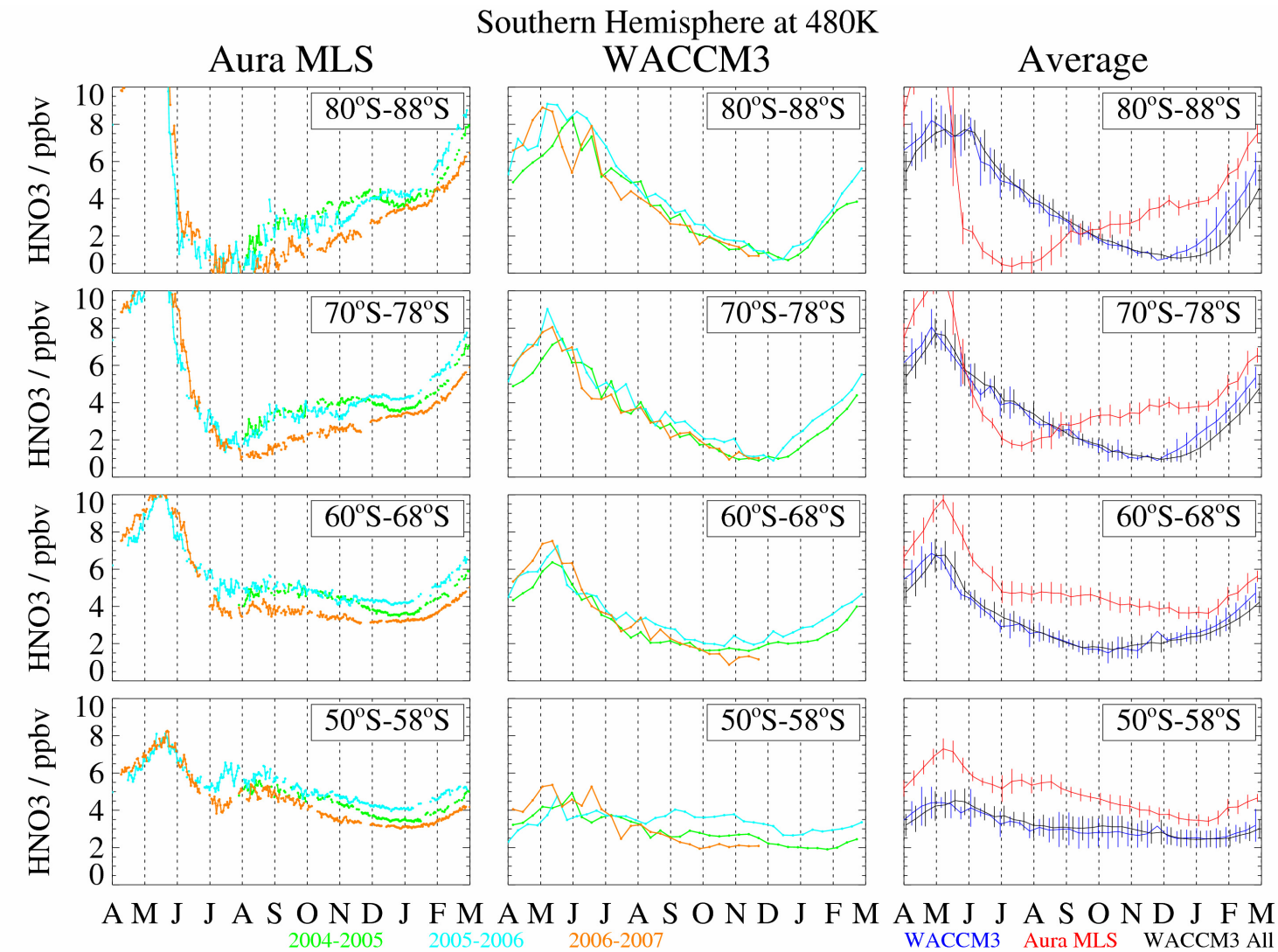
The seasonal time period for low HNO_3 (denitrification) at high SH lats. is shorter in Aura MLS observations than in the model.

The latitudinal extent differs as well.

[work done in collaboration between JPL and D. Kinnison + others at NCAR]

Polar processing issues: data versus WACCM3 model

- For further comparison efforts (and for more than one model), EqLat / theta analyses will be pursued (not simply lat / P averages)



Future goals:
- Ascertain to what extent certain issues are duplicated in climate models (and how to best diagnose different models)

- SPARC / CCMVal activity