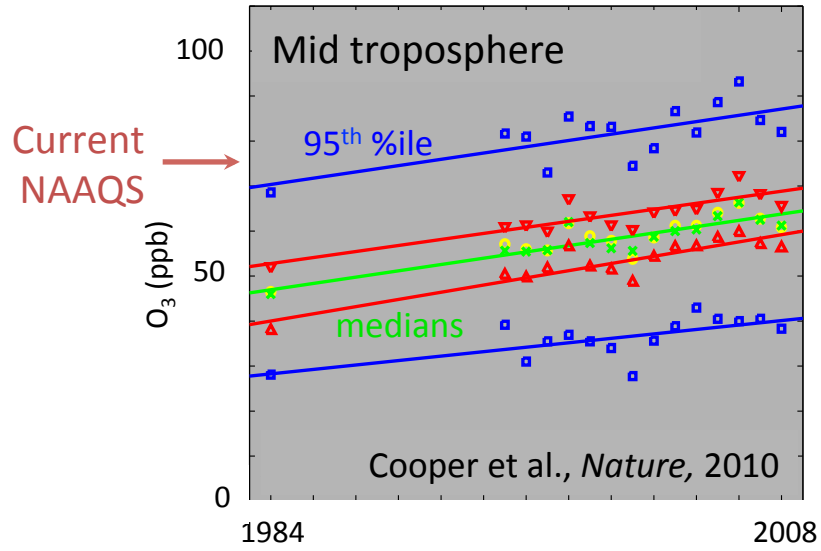
Assessing global chemistry-climate model performance: Tropospheric O_3

David Parrish

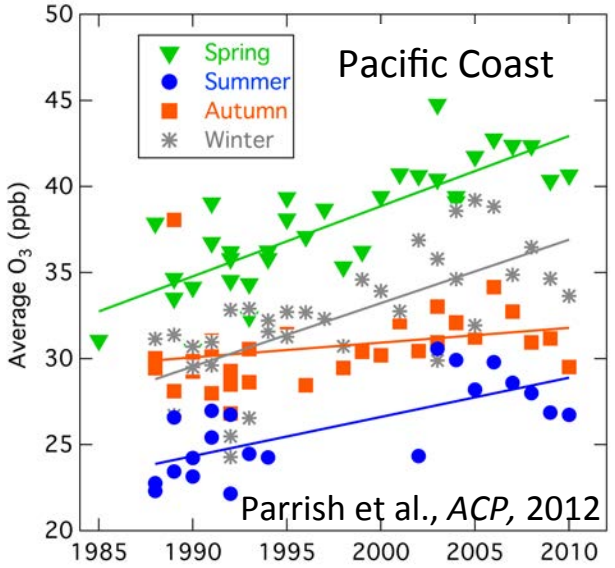
CSD has taken lead in quantifying concentrations of O_3 transported to the US from the North Pacific:

- Equals a large fraction of the National Ambient Air Quality Standard (NAAQS)
- Has been increasing over past 3 decades



Important for Air Quality - Accurate background O_3 simulations by chemistry-climate models (CCMs) can inform policy formulation (e.g., EPA proposal to lower NAAQS to 65 – 70 ppbv range)

- Standards set to protect health and well-being, but..
- What fraction is contributed by transported background O_3?



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Important for climate - radiative forcing calculations require accurate CCMs to quantify long-term changes in tropospheric O_3

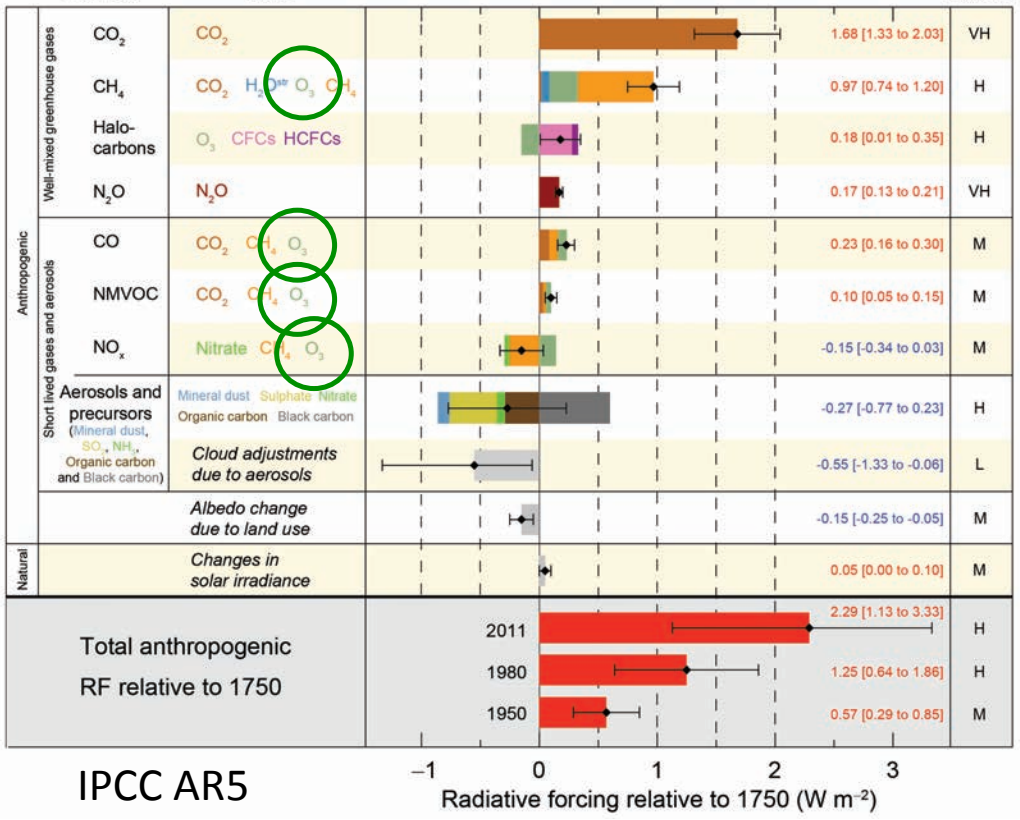
CSD has taken lead in quantitatively assessing the accuracy of CCM simulations of tropospheric O_3

Parrish et al., *ACP,* 2012
Parrish et al., *GRL,* 2013
Parrish et al., *JGR,* 2014

Goals of this research:

Quantitatively Compare model results with measurements

Effect significant model improvements



IPCC AR5

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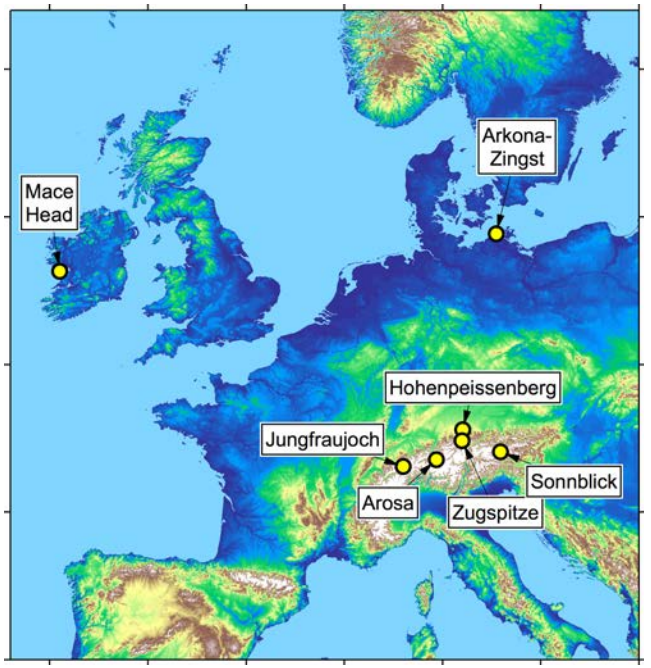
CSD approach:



Identify most important issues to investigate – policy significance and insight to model performance

- Long-term changes in tropospheric O_3
- Seasonal cycles of tropospheric O_3

Collaborate with measurement folks: ~ 575 years of data from ~ 29 sites!

Collaborate with modelers: 3 CCMs used in AR5

- CAM-chem – National Center for Atmospheric Research
- GFDL-CM3 – NOAA Geophysical Fluid Dynamics Laboratory
- GISS-E2-R – NASA Goddard Institute of Space Studies

Develop and Apply quantitative techniques for comparisons

Yield Comparison Metrics that can be efficiently used in future comparisons

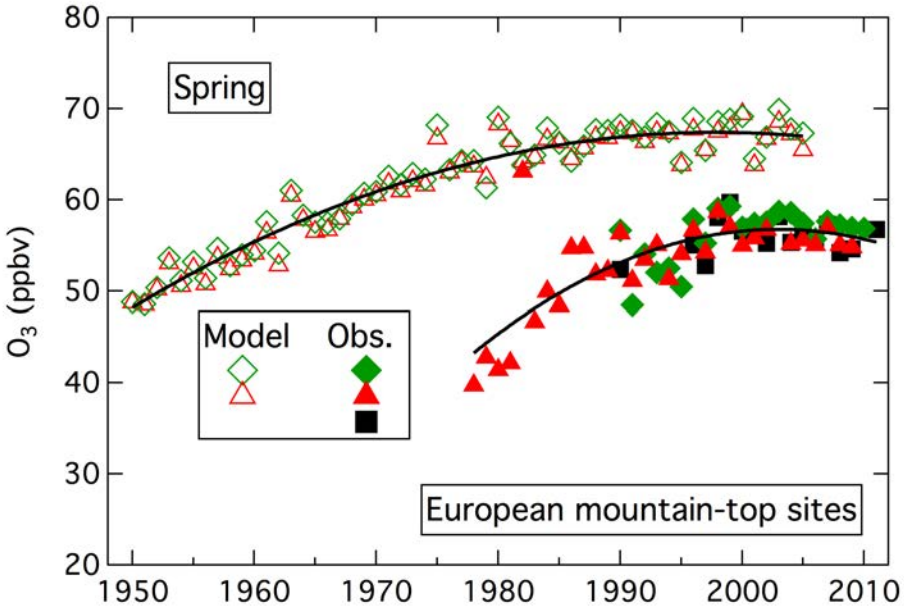
Long-term changes in tropospheric O_3

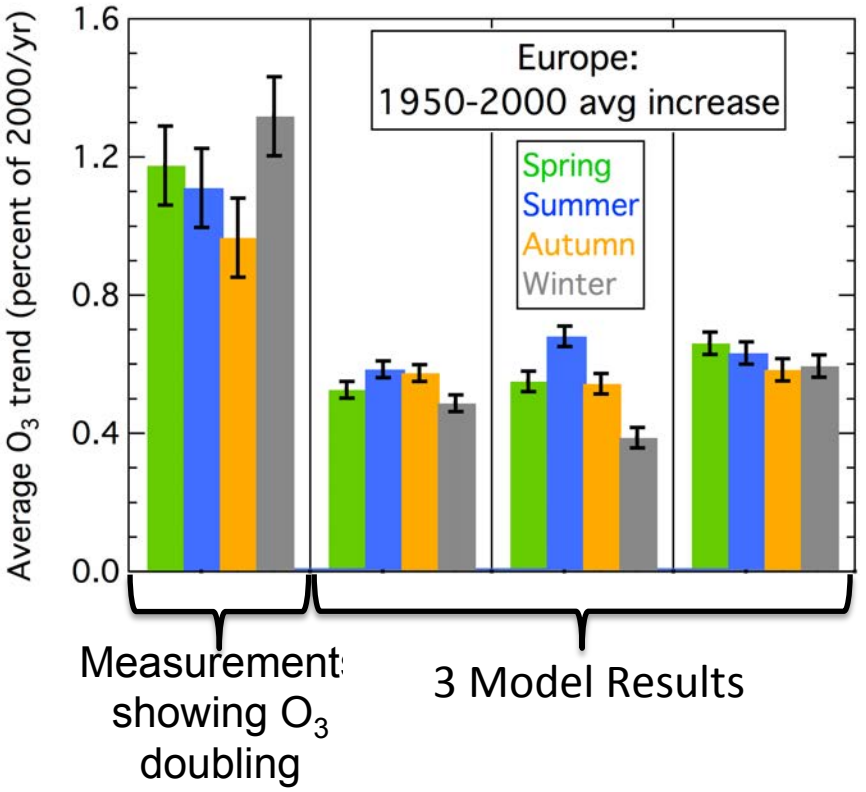
Bottom line: *Parrish et al.* [2014] show that Models:

- Overestimate background O_3 concentrations
- Capture only ~ one-half of average annual changes, none of seasonal variation

Implications:

- Cannot accurately apportion sources of North American O_3
- Inaccurate estimates of trends in background O_3 transported to North America.
- Inaccurate estimates of radiative forcing of tropospheric O_3.



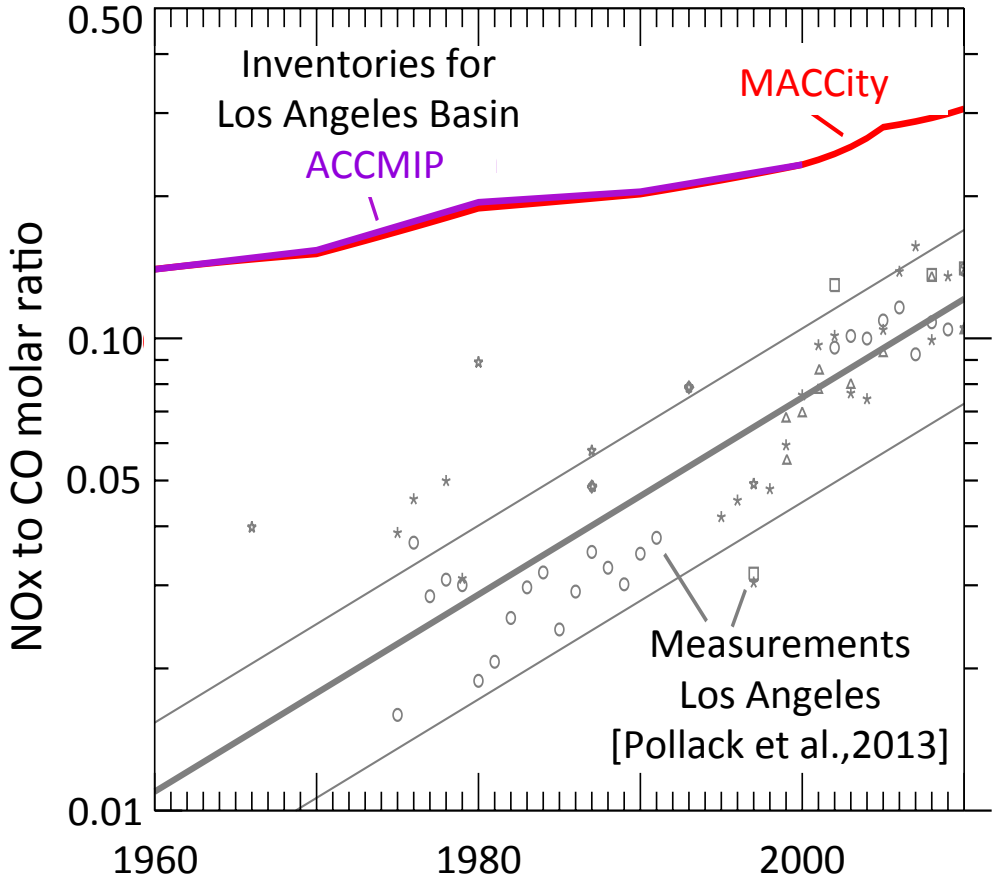


Long-term changes in tropospheric O_3

CSD Approach to Model Improvement:

- Improve CCM inventories – Emission input is not accurate, Model output cannot be accurate.

Hassler et al., 2015, in preparation



(NOx to CO ratio is proxy for NOx to VOC ratio, which controls pollution photochemistry)

O_3 Seasonal cycles in the marine troposphere

Parrish et al., 2015, in preparation

Importance:

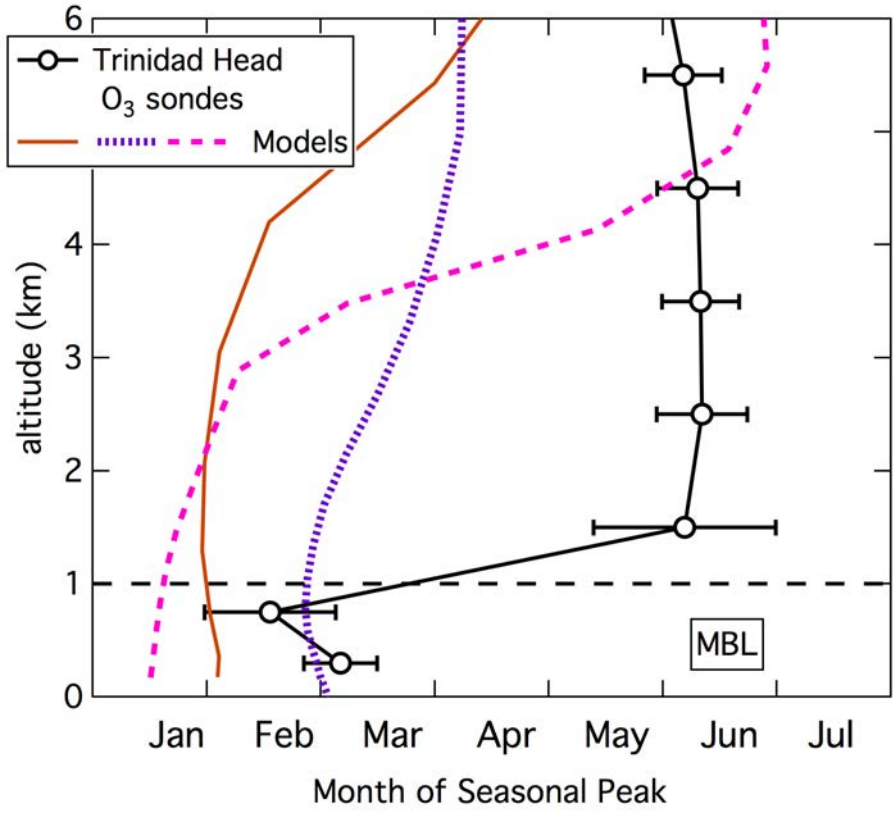
- Environment upwind from US.
- Limited precursor sources and simplified chemistry
- Best model performance may be expected?

Bottom line - Models

- Fail to properly isolate MBL.
- Cannot properly balance O_3 production and loss

Implication: We cannot accurately apportion sources of North American O_3.

CSD Approach to Model Improvement: Investigate model MBL structure and dynamics



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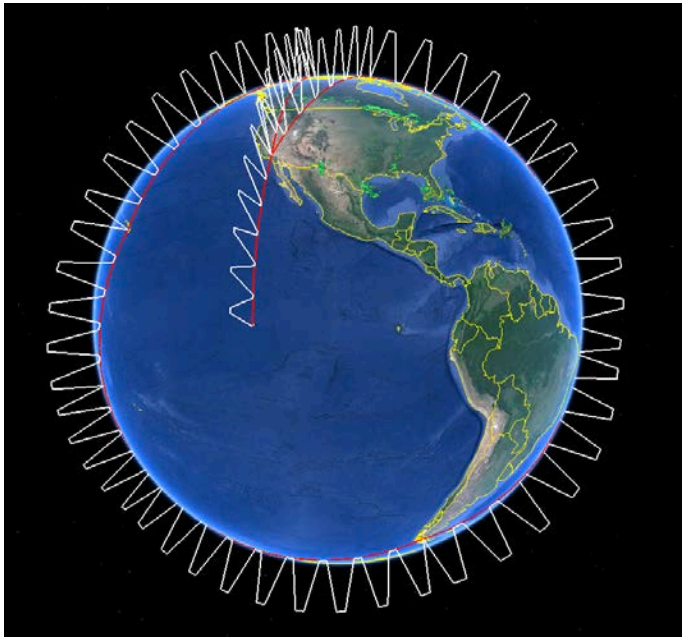
Future work:

Quantitatively compare model results with measurements; develop quantitative comparison metrics for future comparisons

Effectively communicate with model developers – Follow through on model improvements – Shared post-doc

Focus on specific processes in CCM treatment of transport and processing of O_3 precursors

Our past and future field campaigns (e.g., NASA ATom) provide essential resource for these comparisons



Planned NASA ATom flights