Informing North American Background Ozone from Observations: Characterizing Ozone Levels in North America from Ozonesonde and Surface Observations

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Bottom Lines

- Trinidad Head Observatory in N. California is a well located site for monitoring air entering the west coast of the U.S. and regularly measures air under background conditions
- Monthly average background ozone concentrations entering the west coast of the U.S. in the spring are >43 ppb with daily 8-hour average amounts ≥50 ppb. The number of hourly average concentrations ≥50 ppb for April varies from 30 to 187. The range of maximum hourly average concentrations is 54 to 65 ppb.
- Intensive ozonesonde measurements confirm that Trinidad Head is representative of ozone levels entering the west coast of the U.S. and North America has minimal influence on levels at the coast.
- Biomass burning can produce large ozone enhancements that contribute to "background" ozone on an episodic basis and elevate average background values. Ozone data from relatively remote locations along with ancillary constituent data suggests that such ozone observations are often representative of background.
- Recent model results suggest that background ozone has a greater contribution from stratospheric sources than earlier model results suggest, especially relative to the Asian transport component.
- Background ozone makes a substantial contribution to observed ozone at concentrations ≥50 ppb especially in the western U.S.
- A broader perspective on "background" ozone can be provided using observations along with the modeled background ozone.

Observations at west coast North American locations can inform background ozone values

- Measurements at Trinidad Head, California are in large part (not just occasionally) of air from off the Pacific Ocean without influence from the North American continent.
- Surface ozone observations at Trinidad Head provide a valid representation of air entering the west coast of the U.S.
- The observations provide a picture of the full range of atmospheric concentrations.
- Processes that elevate ozone concentrations of air entering the west coast of North America make an important contribution to ozone levels over western North America.

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Location of the NOAA Trinidad Head (THD) Observatory

Trinidad Head is a well exposed site in a relatively remote location.

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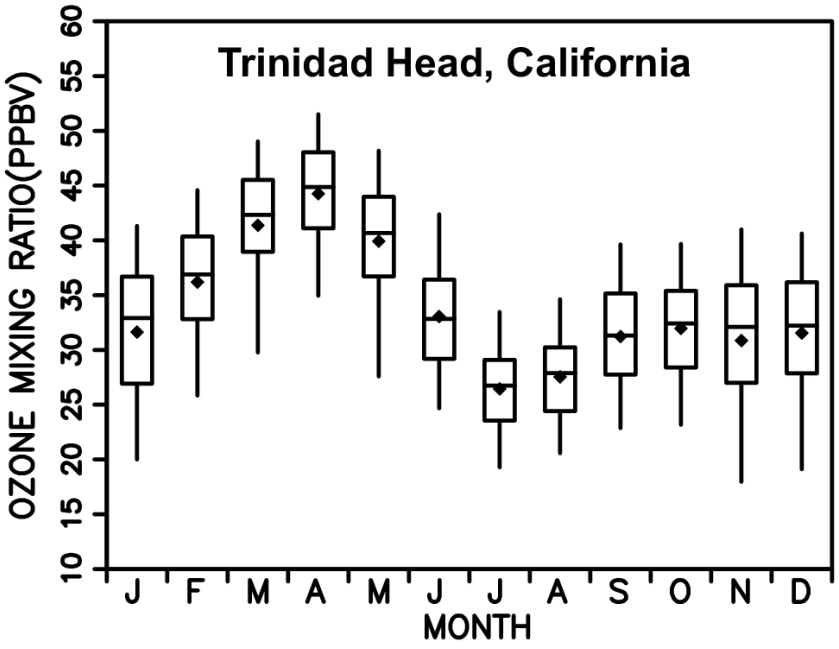
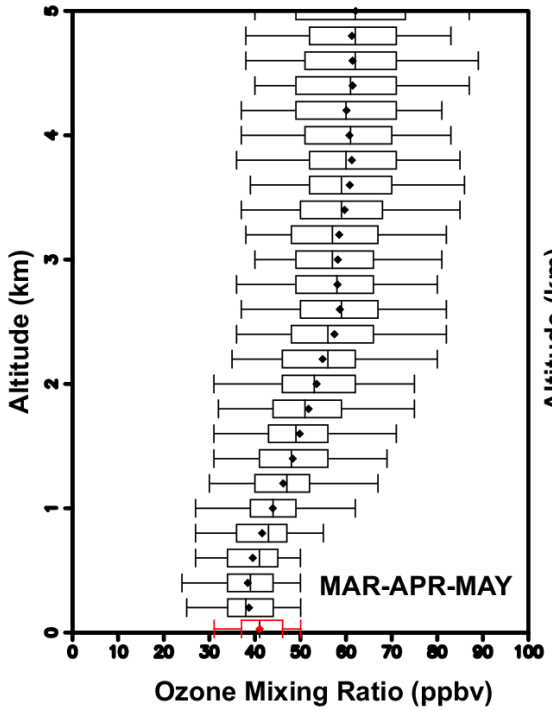
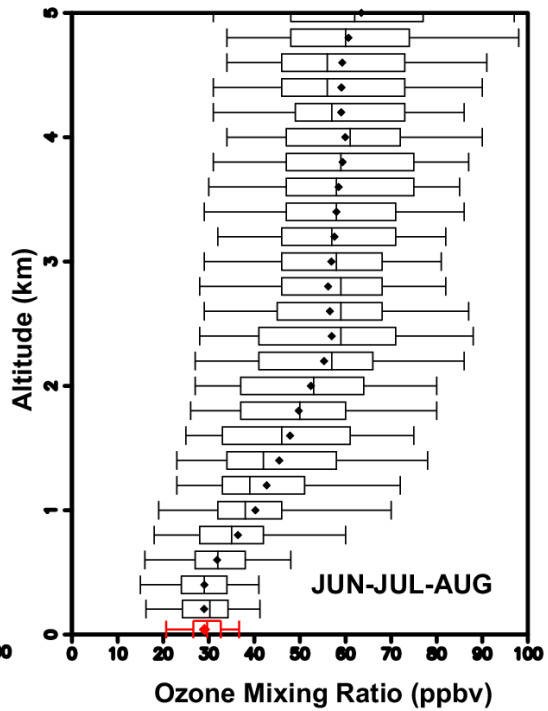
All drafts of the ISA (including the third) underestimate the value of observations in informing background ozone levels

- **The ISA suggests that the screening procedures for selecting contributions from background sources at Trinidad Head limit these conditions to ~30% of the time.**
- **This is clearly in contradiction to the study of Goldstein et al. (2004) which states "***... air sampled during the day was typically of marine origin with little recent continental influence. Filtering out local influences removed 20 to 40% of the observations, depending on the constraints applied, decreased the mean CO mixing ratio by 5%, and increased the mean O3 mixing ratio by 8%***".**
- **In other words, under background conditions at Trinidad Head air has more ozone not less than under non background conditions in agreement with the findings of Oltmans et al. (2008).**







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Surface (daytime) and profile ozone at THD

Diamond = Mean
Horizontal/Vertical Line Inside Box = Median
Box = Inner 50th Percentile (25th & 75th)
Whiskers = Inner 90th Percentile (5th & 95th)
Red = Surface Values Superimposed on the Profile.

Conclusion:

1) Average spring daytime (or 8-hr max) surface ozone at Trinidad Head is ~43 ppb. 25% of the hourly avgs. >45 ppb.
2) Above the boundary layer (~2 km) avg. O_3 is ≥50 ppb in spring and summer (air reaching the interior of the U.S.)

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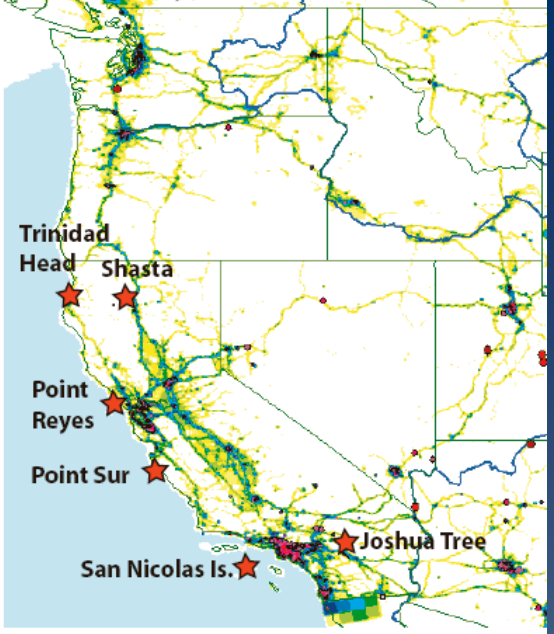
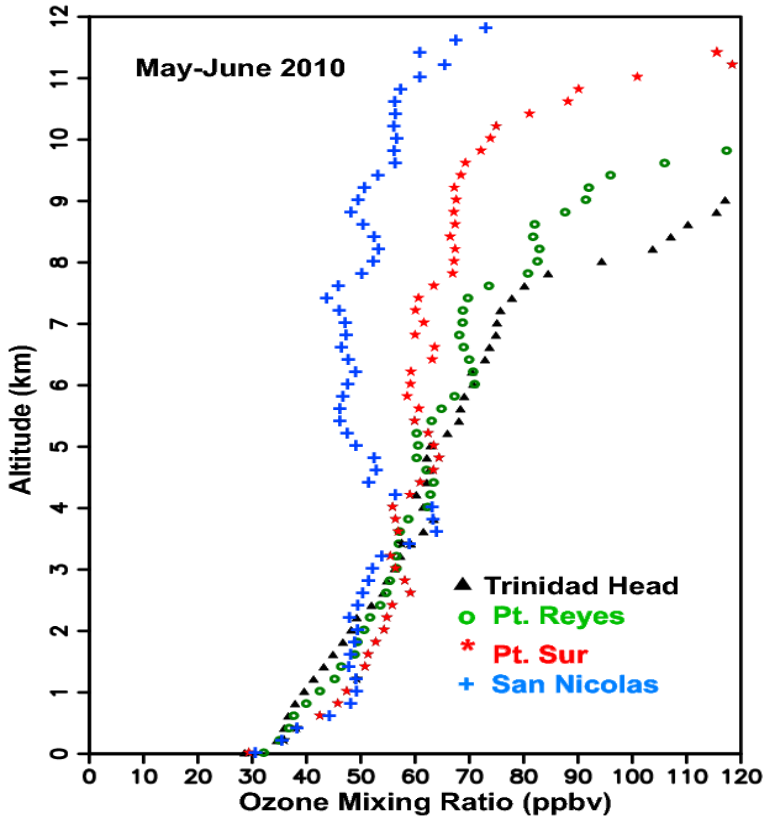
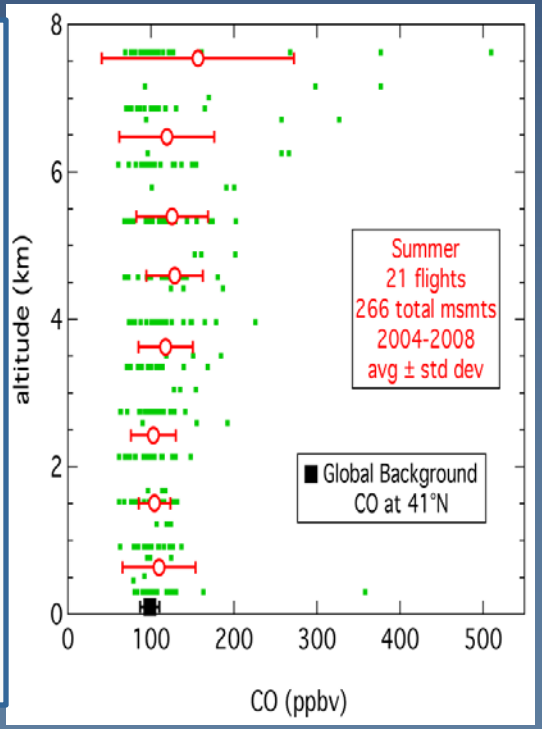
What do vertical profiles say about ozone reaching the California coast?





Vertical profiles of carbon monoxide measured in flasks collected on aircraft flights above Trinidad Head CA. The green pts give the individual obs and the red circles indicate avgs. and standard deviations.

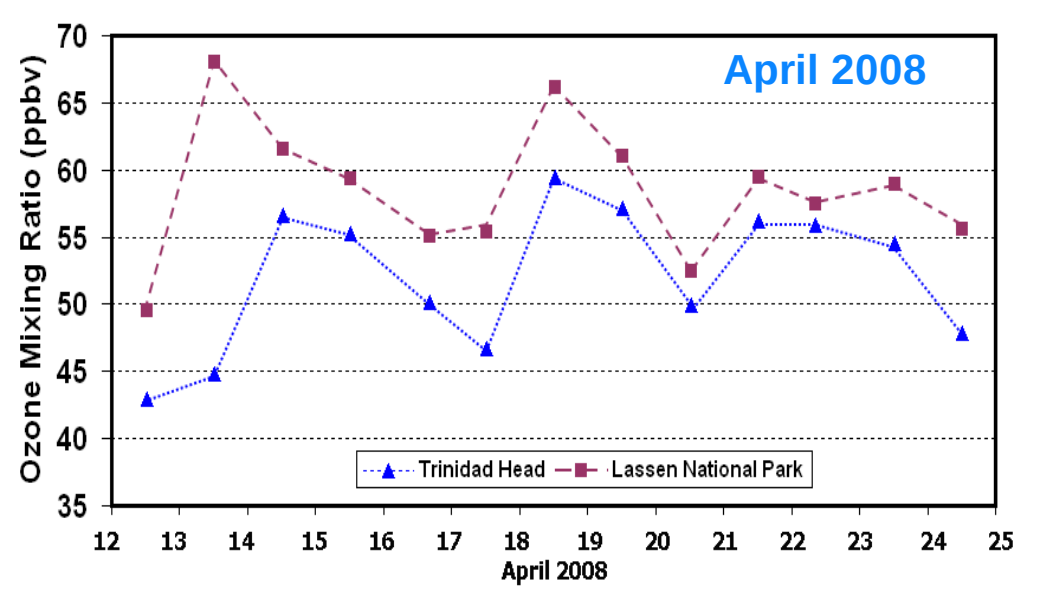
Conclusion: Air flowing into Trinidad Head represents the Pacific "background".

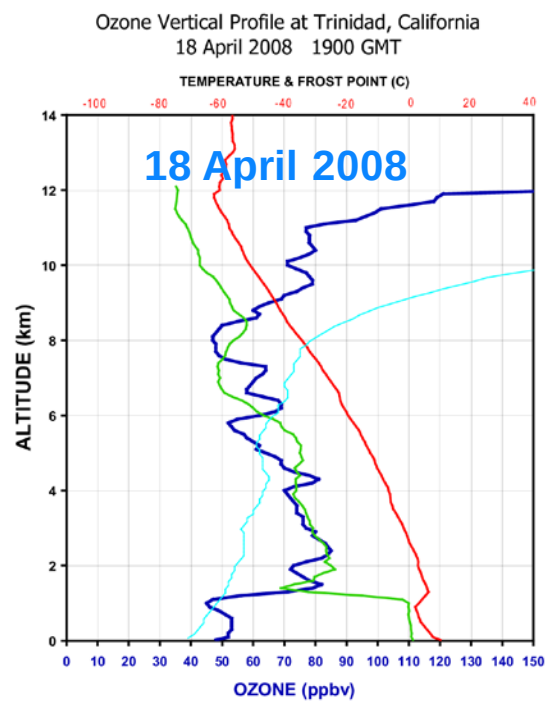


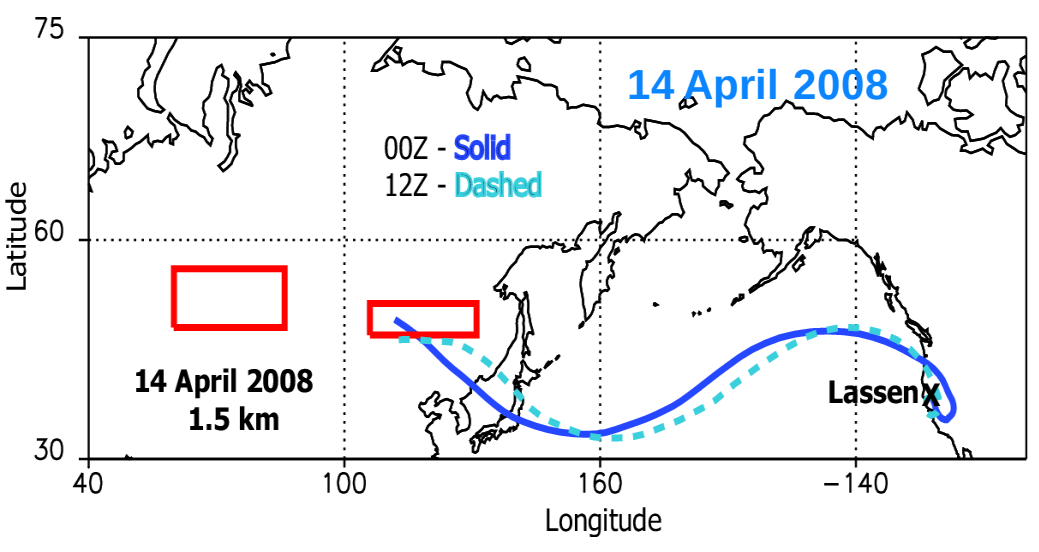
Average ozone mixing ratio profiles at four sites making ozonesonde observations during the IONS 2010-CalNex Campaign in May-June 2010.

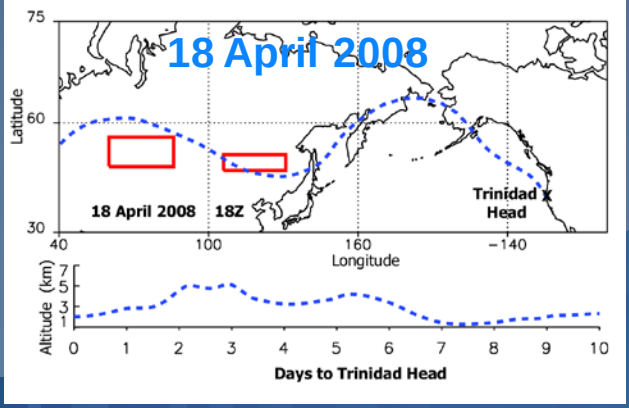
Conclusion: In the lower troposphere (<4 km) average ozone amounts are similar along the California coast.

Slide 8 Surface ozone in California in April 2008 (Influence of Eurasian biomass burning)









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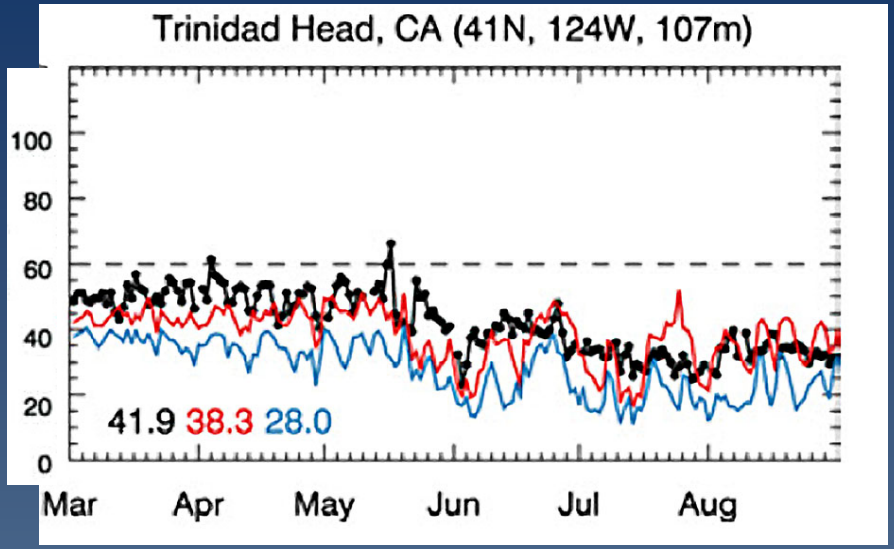
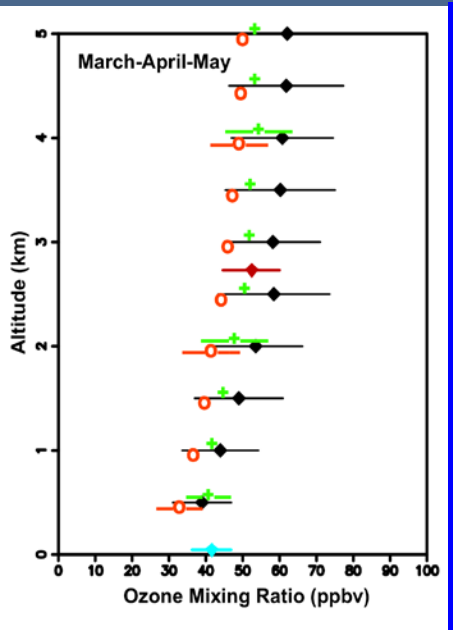
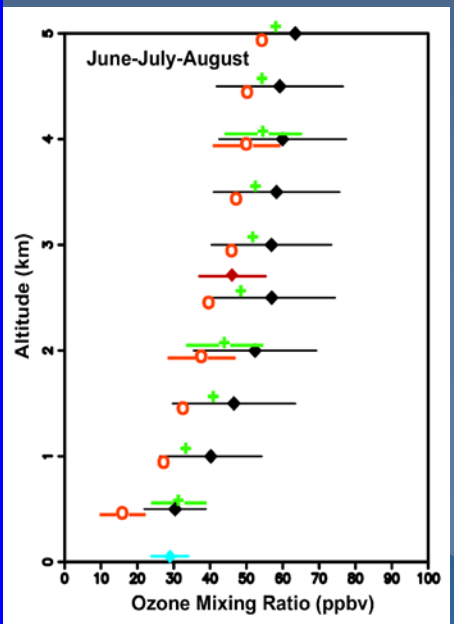
Comparison of Observations with Model Results



Comparison of daily maximum 8-h average O_3 predicted using GEOS-Chem at 0.5° × 0.667° with measurements at Trinidad Head, CA from March to August 2006. Source: US EPA (2012a). The modeled O_3 (red) is ~5 ppb less than observed (black) and background (blue) is ~10 ppb less than observed in the spring.



Diamonds are Trinidad ozonesondes. Blue symbols are the seasonal surface ozone average at Trinidad Head. Red symbols are the Mt. Bachelor seasonal average plotted at the altitude of the observatory. Profile results from the GEOS-Chem model for 2006 are shown as green pluses. The contribution from PRB the model profile is shown by orange circles. (McDonald-Buller et al., 2011).



Comparison of model results from the high resolution GEOS Chem Model (Zhang et al., 2011) and observations at Trinidad Head and Mt. Bachelor, OR (McDonald-Buller et al., 2011). The modeled O_3 and background O_3 are generally less than the observed value.

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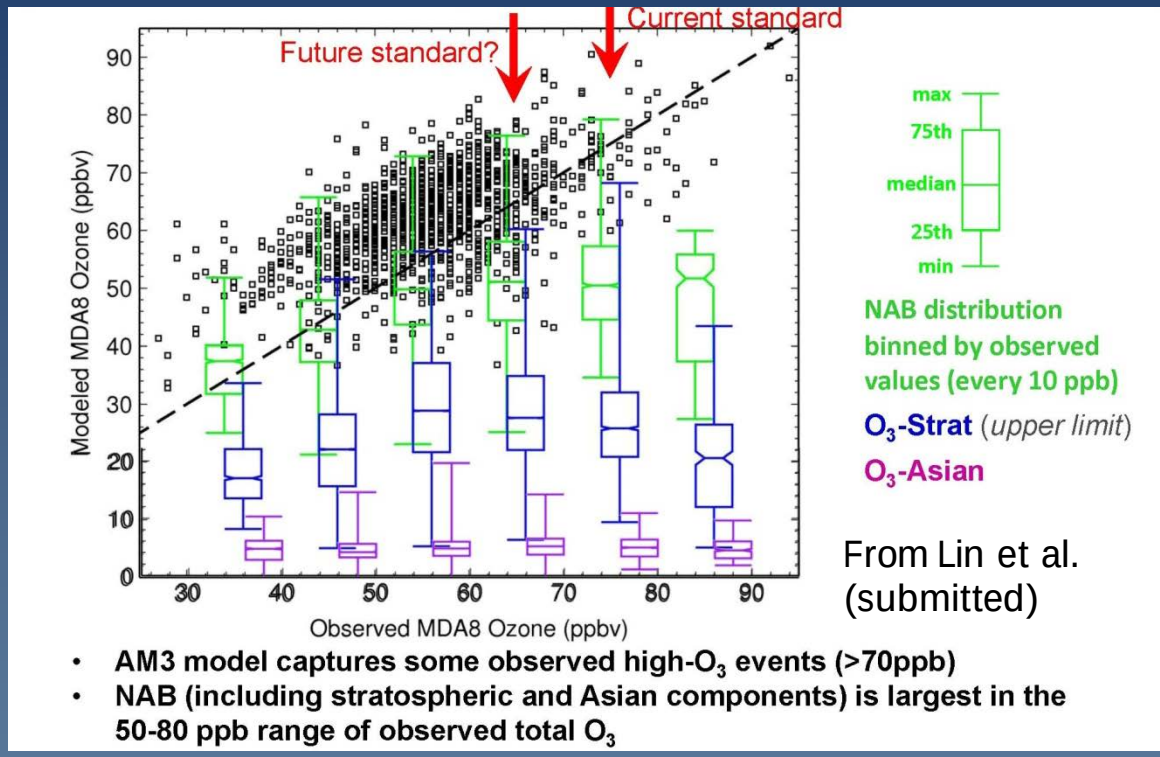
Comparison of Observations with Model Results: Impact of Background Over the Western U.S.

Comparison of model results from the GFDL AM3 (with a full stratospheric module) with observations over the western US in May-June 2010.

Note the important contribution from the stratosphere, especially relative to the Asian contribution and the contribution from NA background to the observed O_3 above 50 ppb.



The contribution from the stratosphere for MDA8 levels above 50 ppb makes a substantial contribution to the overall North American background .

Slide 11 Conclusions (the Bottom Lines)

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