

Winter Ozone Production: Uintah Basin, Utah

Chelsea Stephens³, Russ Schnell¹, Samuel Oltmans¹, Gabrielle Petron^{1,2}, Colm Sweeney^{1,2}, Anna Karion^{1,2}, Patrick Cullis^{1,2}, Emrys Hall^{1,2}, Allen Jordan^{1,2} and Thomas Mefford^{1,2}

¹ NOAA Global Monitoring Division, Boulder, CO 80305

² CIRES, University of Colorado, Boulder, CO, ³ INSTAAR, University of Colorado, Boulder, CO

The Ozone Problem

- EPA ozone air quality standards were enacted to address urban, summer time ozone production.
- Winter ozone production in gas and oil fields can be well in excess of EPA allowable levels.
- GMD scientists showed that winter ozone precursors come from fossil fuel extraction activities (Fig. 1 and 2).
- Elevated ozone is produced in basins (Fig. 1) where effluents collect beneath temperature inversions, and;
- Snow is deep enough (Fig. 3) to cover low vegetation allowing for sunlight reflections off high albedo snow.
- Photochemical ozone production can produce >50 ppb of ozone in 4-6 hours throughout the boundary layer (Fig. 5).
- Moderate winds mix the boundary layer rapidly reducing ozone concentrations (Fig. 3).
- Ozone production ceases immediately upon snowmelt.
- Winter ozone is a \$ billion issue in Utah and Wyoming.

Physiography of the Uintah Basin

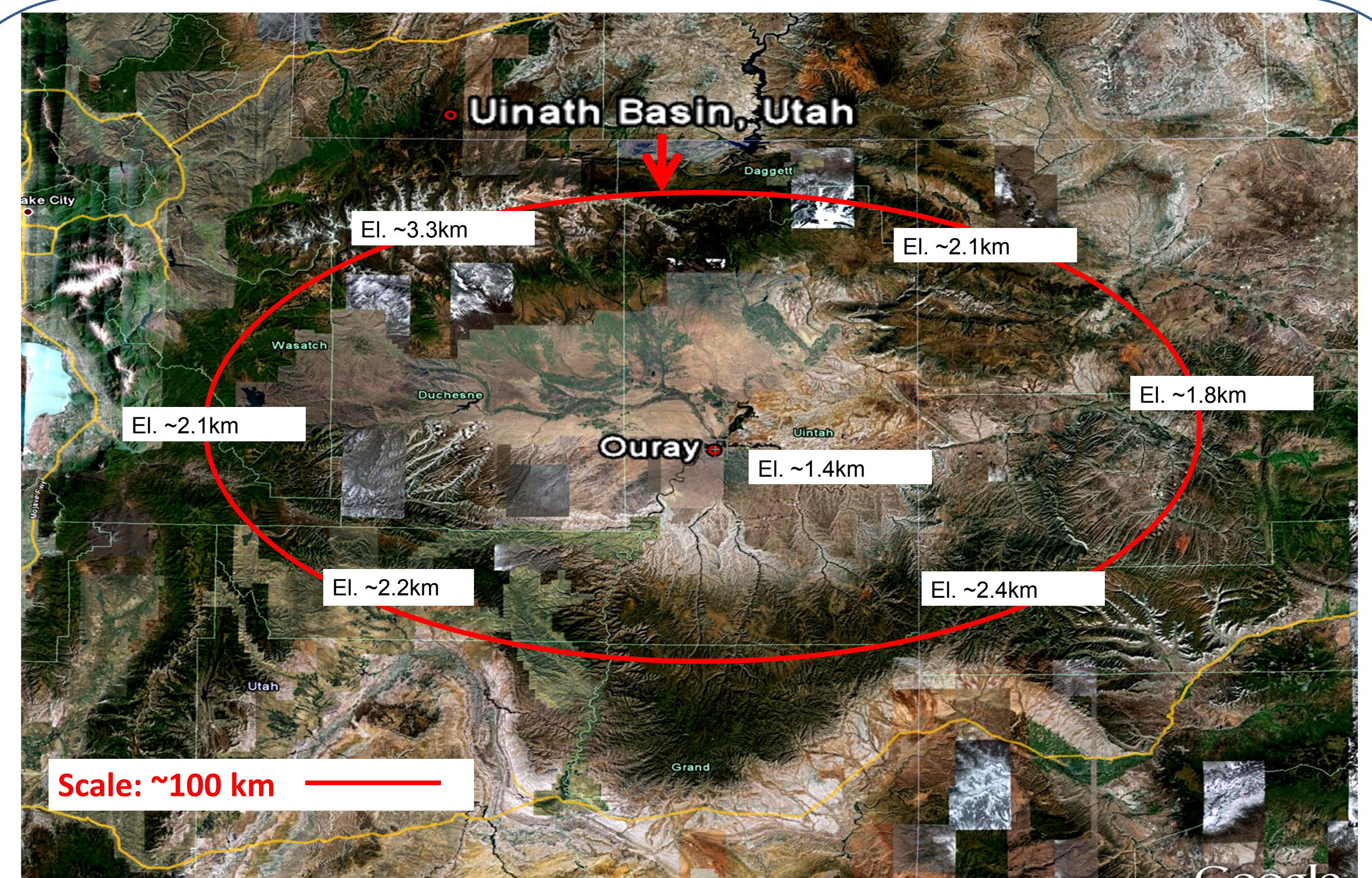


Fig. 1. The Uintah Basin is ringed by mountains.

Ozone, snow depth, temperature and wind, Ouray, Uintah Basin, Feb. 2, 2013

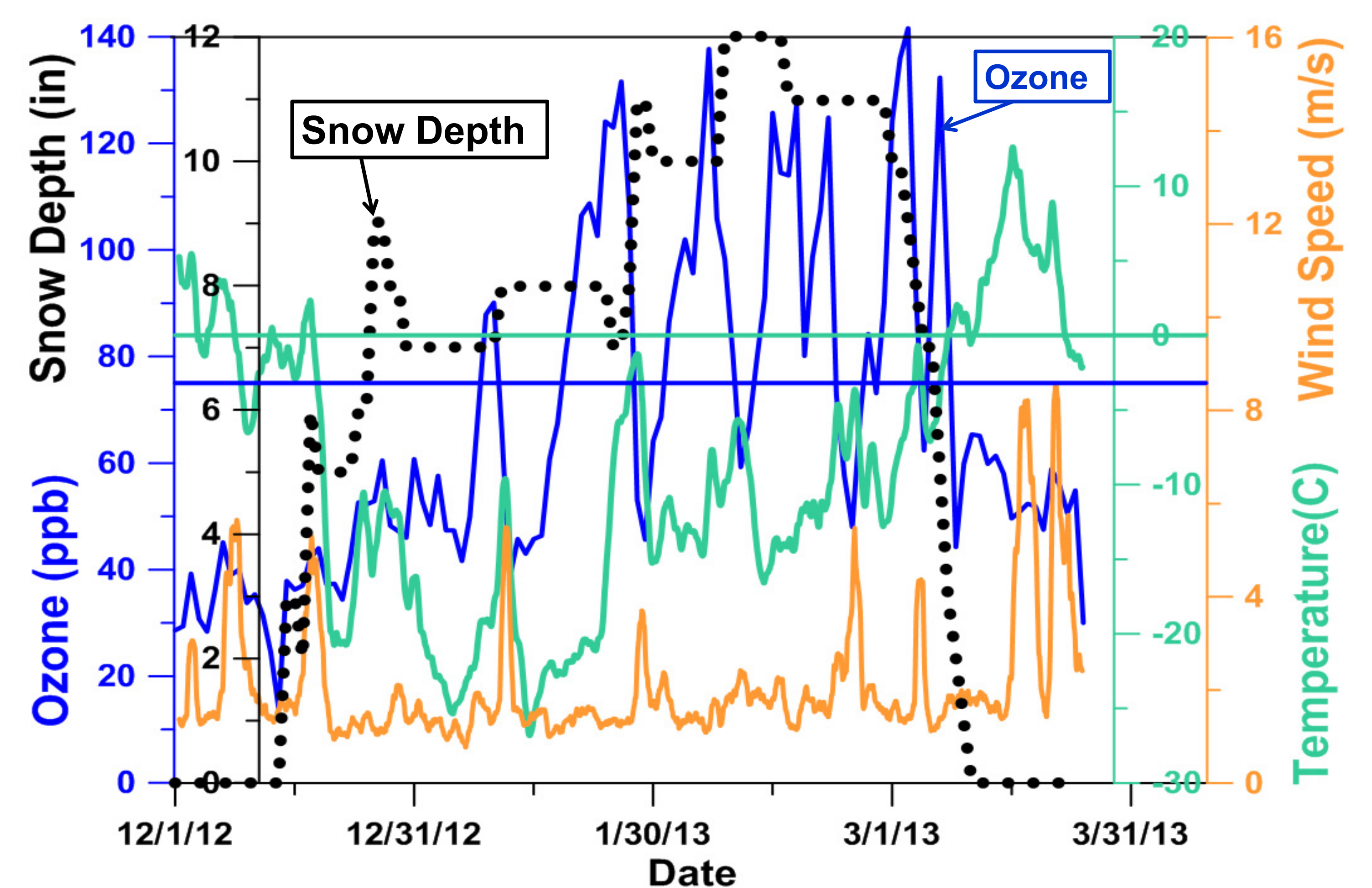


Fig. 3. Photochemical ozone production begins and ends with snow cover. Snow intensifies temperature inversions and may be involved in radical chemistry. Average of the highest 8 hourly ozone values on each day is plotted. Moderate winds remove O₃. The NAAQS 75 ppb allowable O₃ level is shown (blue line).

Source of ozone precursors

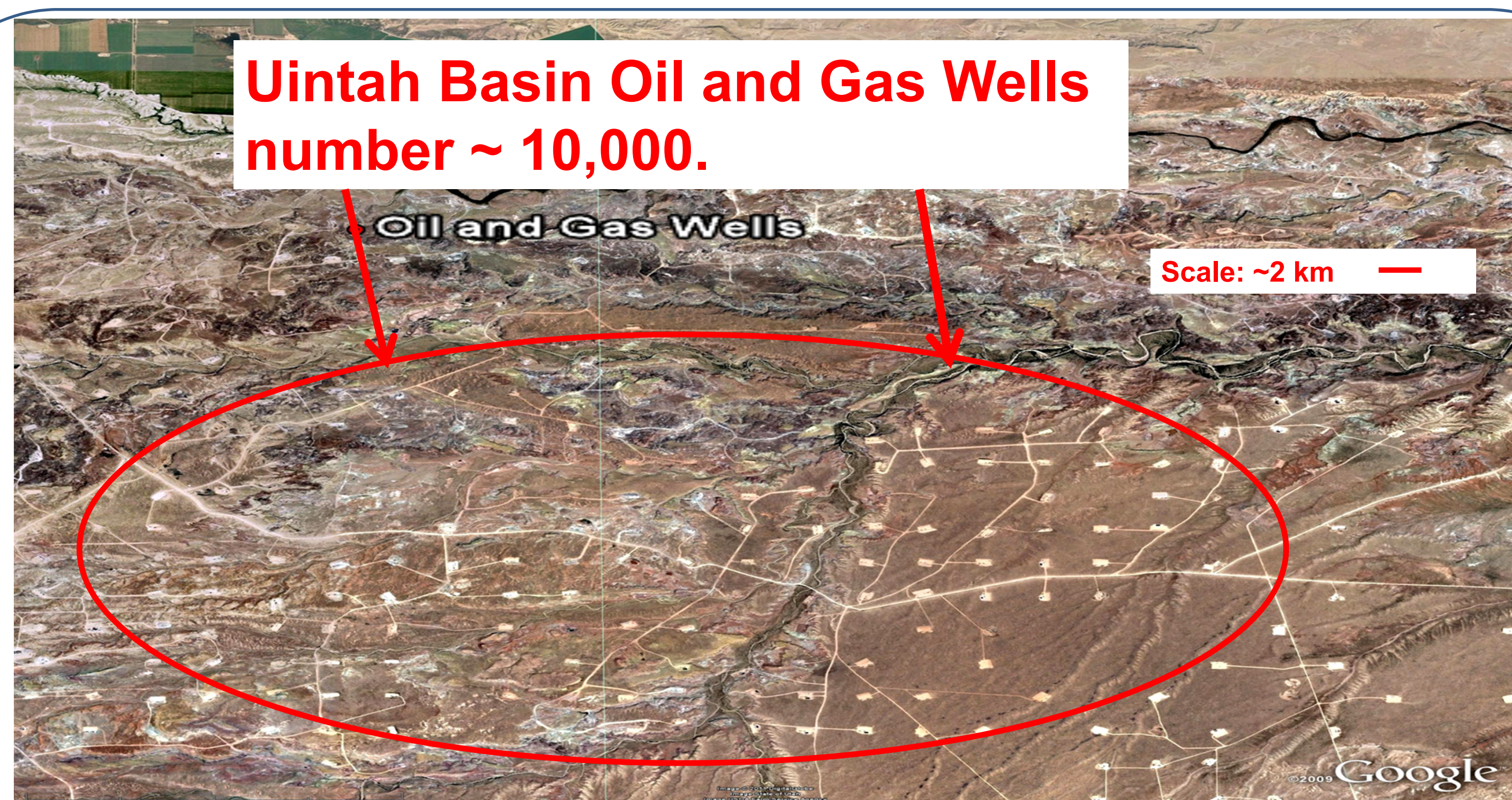


Fig. 2. Oil and gas operations leak ozone precursors.

Concentrations of O₃, NO₂, CH₄ and CO, Feb 2, 2013, Uintah

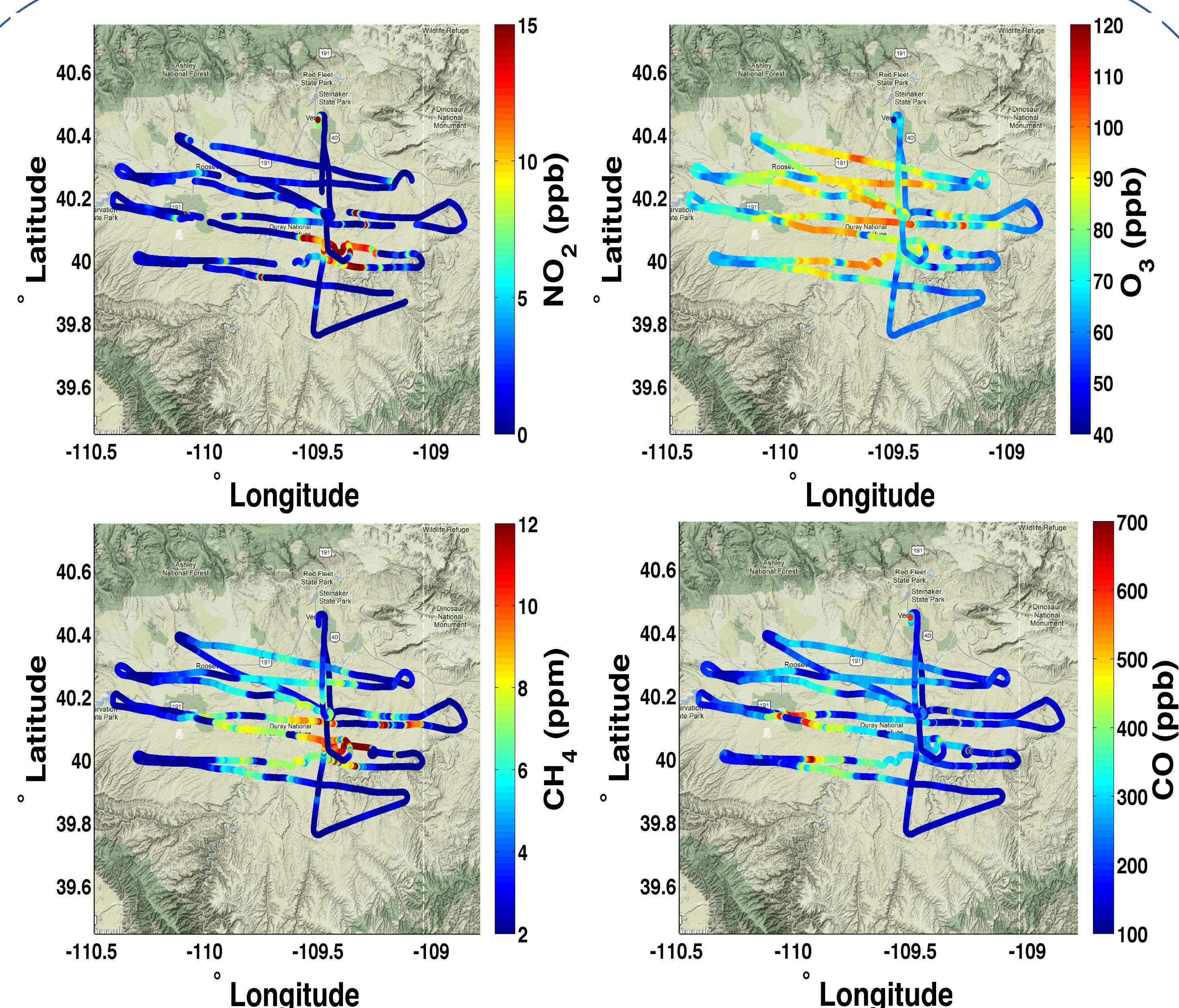


Fig. 4. Airborne measurements showing elevated O₃ and CH₄ in the center of the basin. Lower concentrations of these species occur above the boundary layer.

Profiles of ozone through the boundary layer, Feb 2, 2013.

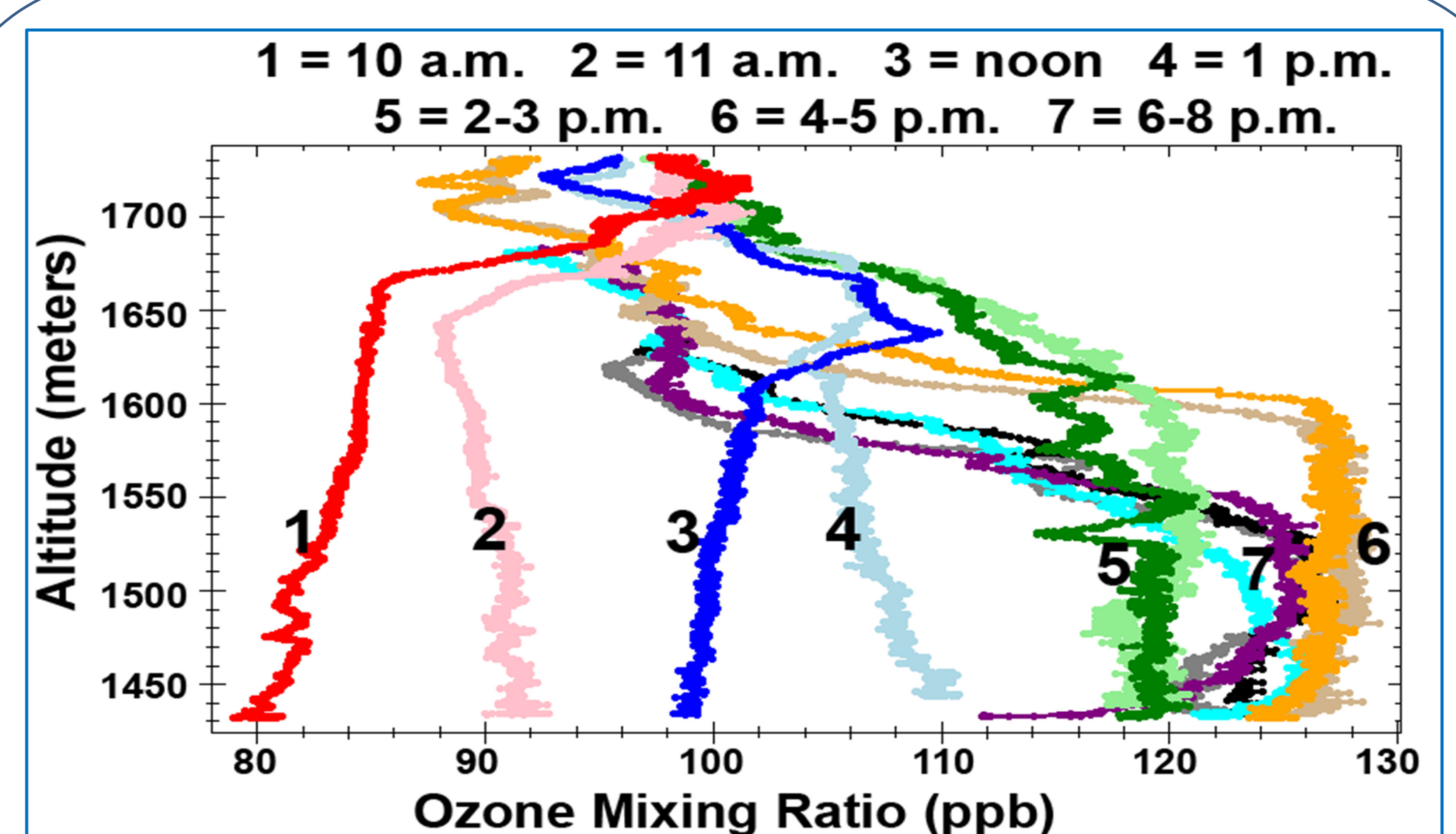


Fig. 5. Ozone production between 10 AM and 5 PM was rapid throughout the boundary layer.