Ozone Depletion Events in the Ross Island Region, Antarctica and the Associated Meteorological Conditions

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Introduction:

Naturally occurring near-surface ozone depletion events have been observed during the austral spring in the Ross Island region, Antarctica. The ozone depletion events (ODE) require sunlight and a source of bromine. It is still unclear how the reactive bromine is released from the sea salt. There is a possible meteorology connection.

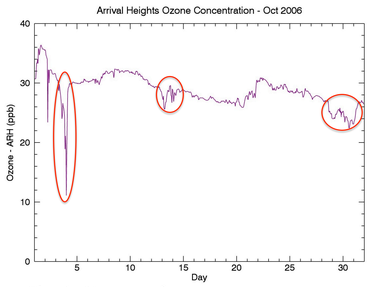


Fig. 1: Near-surface ozone concentration for McMurdo Station (Arrival Heights) for October 2003.

Fig. 2: Location map of the Ross Island region feautring AWS sites with co-located ozone sensors highlighted.

Five near-surface ozone sensors were installed at automatic weather station (AWS) sites during the 2011-12 field season. The sensors are operating year round with a focus on the ozone depletion events. An understanding of the meteorology of the region will assist in establishing the source and evolution of ozone depleted air masses. Meanwhile, a study of the ozone concentration from nearby McMurdo Station (Arrival Heights) provides a good characterization of the ozone climatology to establish the context for the observations from the ozone sensor network.

- During the summer months the O_3 concentration is around 10-20 ppb.
- During the fall months there is a steady recovery in O_3 concentration.
- The O_3 levels off at approximately 36 ppb.
- The same general pattern is observed every year.

Overall, the location (above the ice surface, near McMurdo, etc.) has limitations in understanding ODEs.

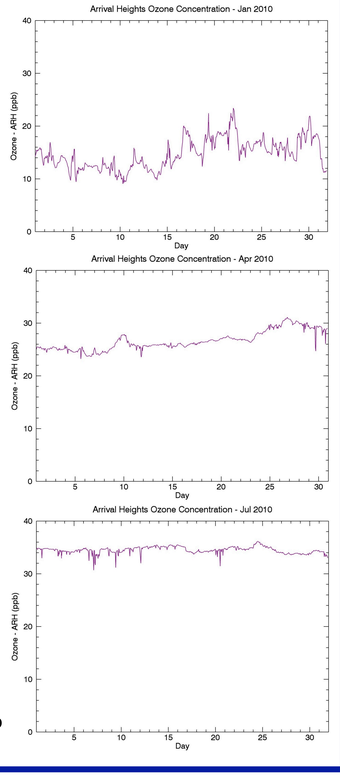


Fig. 3: Near-surface ozone concentration for McMurdo Station (Arrival Heights) for Jan., Apr., and July 2010.

Ozone Depletion Events:

- It is critical to distinguish between anthropogenic ozone depletion and ODEs
- Anthropogenic ozone depletion is observed year round
- ODEs are primarily observed during the austral spring (August to November)
- Overall, the identification of ODEs, based solely on ozone observations is subjective

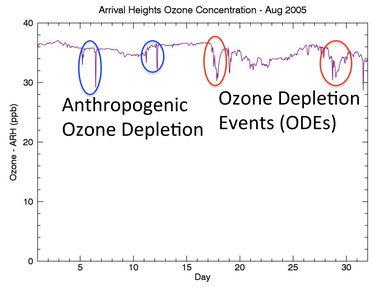


Fig. 4: Near-surface O_3 concentration for McMurdo Station for August 2005.

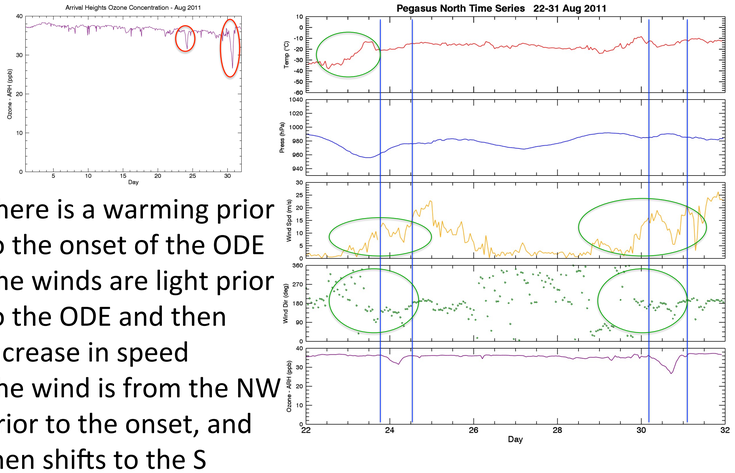
Types of ODEs:

The type of ODE can be classified based on the mechanism or process that is resulting in the ozone loss.

- Transport-Controlled Events: A rapid onset with significant ozone loss, often occurs with wind speed / direction changes
  - Horizontal advection of ozone depleted air mass
  - Changes in boundary layer depth
- Chemically-Controlled ODE: More gradual and not as intense
  - The ozone depletion chemistry occurring locally
  - Can be amplified with increased release of bromine

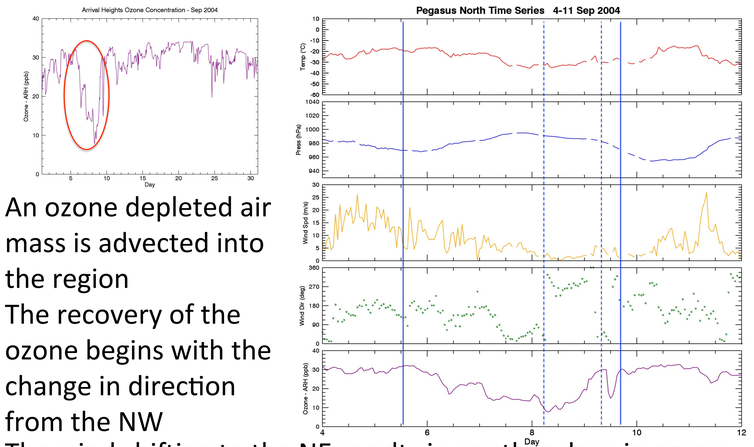
An analysis of the associated meteorology can provide a better understanding of the type of ODE and the associated mechanisms to the ozone loss. In the following cases a nearby AWS is used for the meteorological study.

Case Study – August 2011:



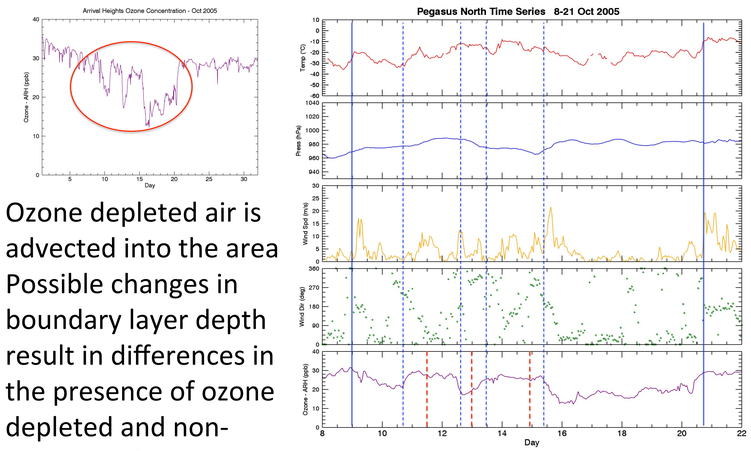
- There is a warming prior to the onset of the ODE
- The winds are light prior to the ODE and then increase in speed
- The wind is from the NW prior to the onset, and then shifts to the S
- The associated AWS observations indicate that this ODE is a transport related event

Case Study – September 2004:

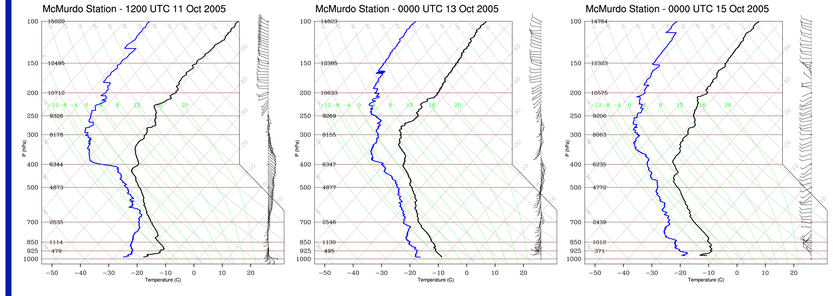


- An ozone depleted air mass is advected into the region
- The recovery of the ozone begins with the change in direction from the NW
- The wind shifting to the NE results in another drop in ozone

Case Study – October 2005:



- Ozone depleted air is advected into the area
- Possible changes in boundary layer depth result in differences in the presence of ozone depleted and non-depleted air



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