Arguments for improvements in the surface observing network over the interior of Antarctica

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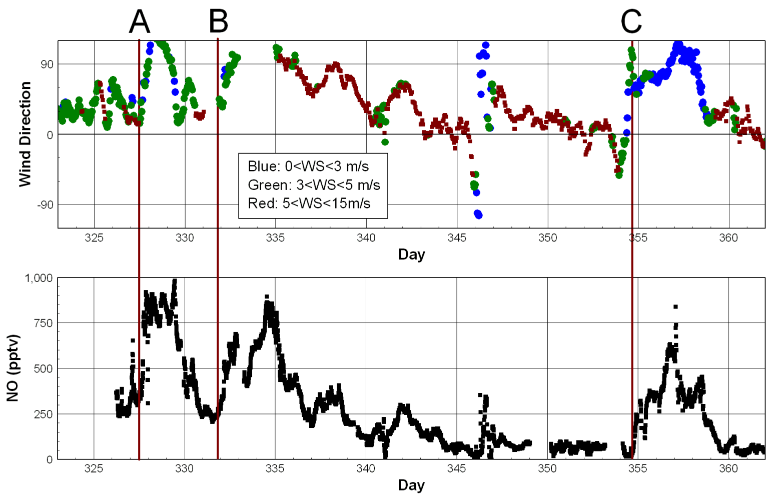
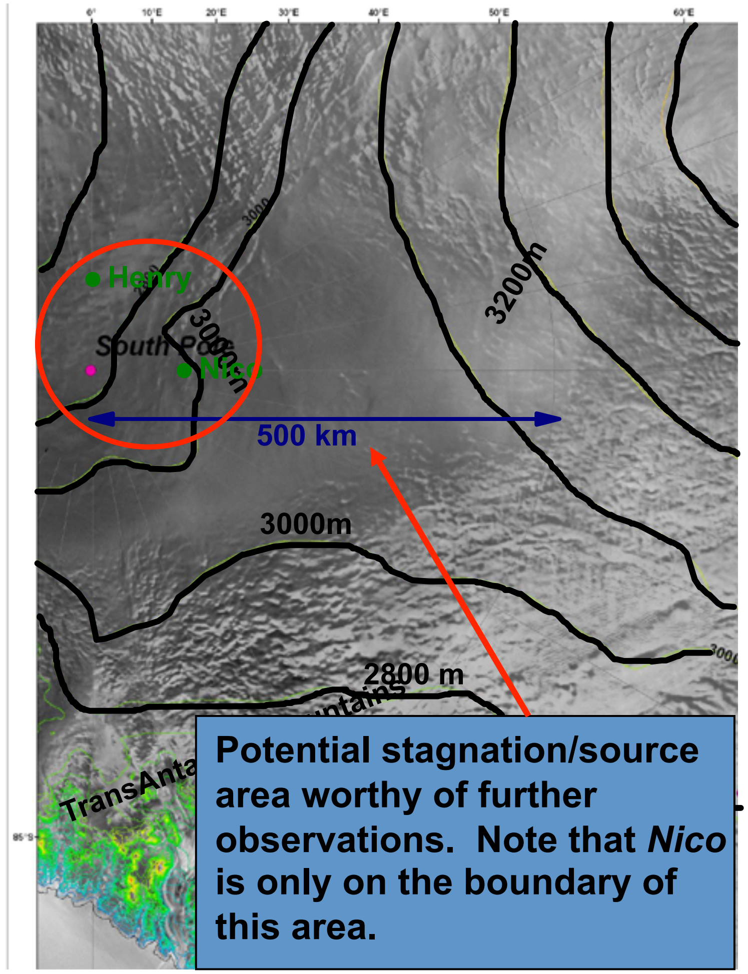
Motivation

Analysis of surface chemistry changes at the South Pole (ISCAT, ANTCI) suggested a closer examination of local production (NO, O3 etc) versus transport:



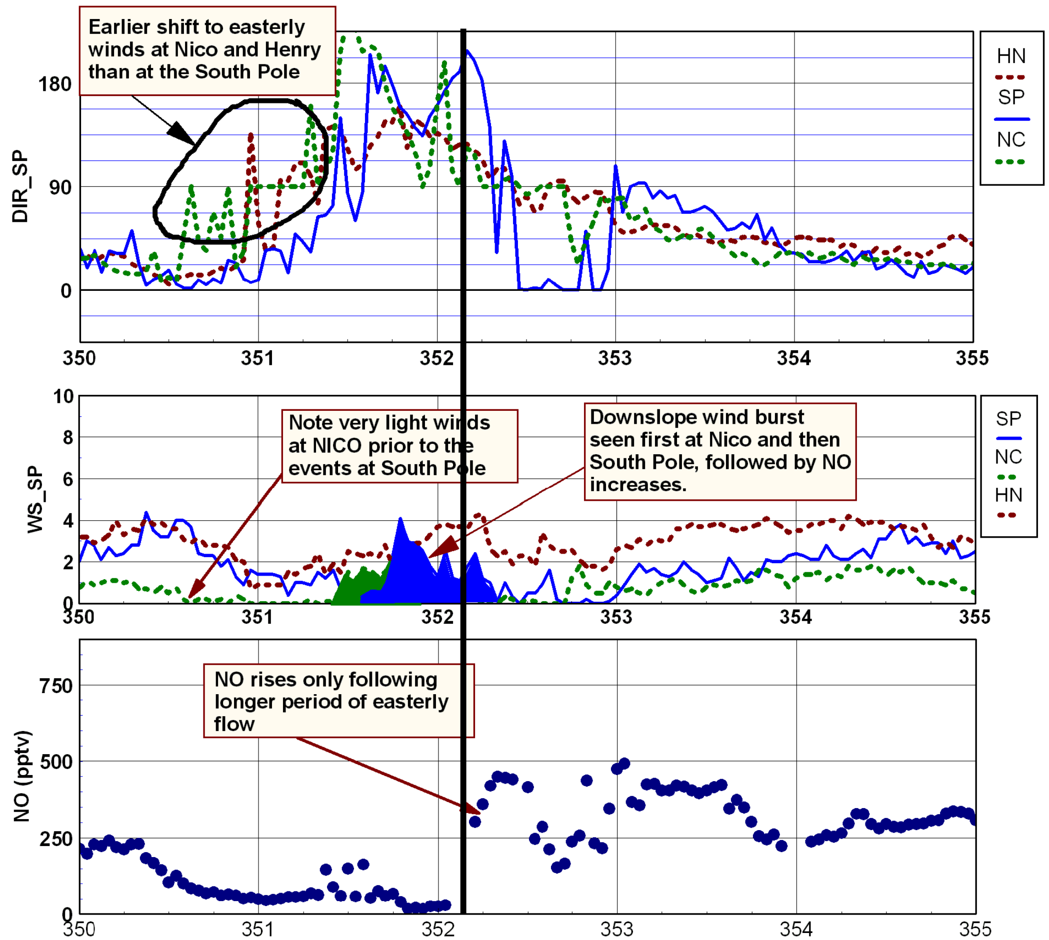


Of the three surface chemistry field programs at the South Pole, only the 1998 program had data available from all AWS sites near the Pole

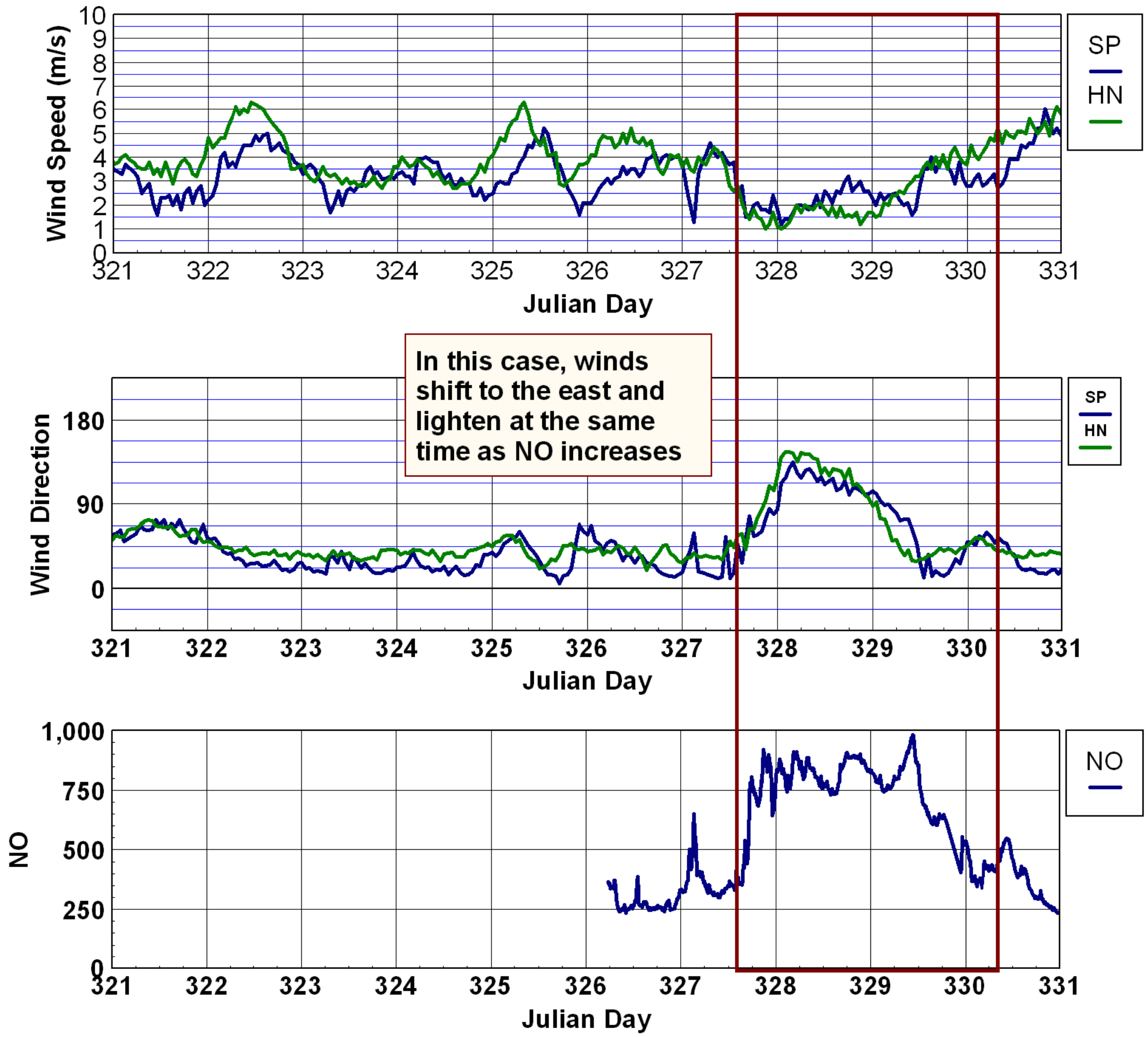
1998 ISCAT Episode:
In this case, the wind shifted to east and then southeast at all three sites well before the NO increases at the South Pole. This suggests transport over distances on the order of 100 km at low levels (but further with higher wind speeds above 2 m).

Note also that the wind speed at *Nico* (NC) is much less than at *Henry* (HN) or the *South Pole* (SP), particular in the period prior to the episode. (During strong winds in November the difference was only 10%). Thus, the light-to-calm winds during the episode at *Nico*, supports the hypothesis that more stagnant conditions exist in the region east of the Station with downslope bursts of transport.

During this period in 1998, winds aloft favored light surface winds and strong inversions.



During the 2003 ANTCI field program, with South Pole and Henry data, changes were simultaneous (Nico not operating, repaired in January):



Issues with back-trajectory calculations:

Trajectory analyses based on reanalysis data sets typically only reveal the synoptic scale origins of the air at the South Pole. In the case at the right, the trajectories show generally northerly flow whereas the surface observations reveal a shallow easterly circulation from the potential stagnation region to the east of the Pole (shown in the figure to the left).

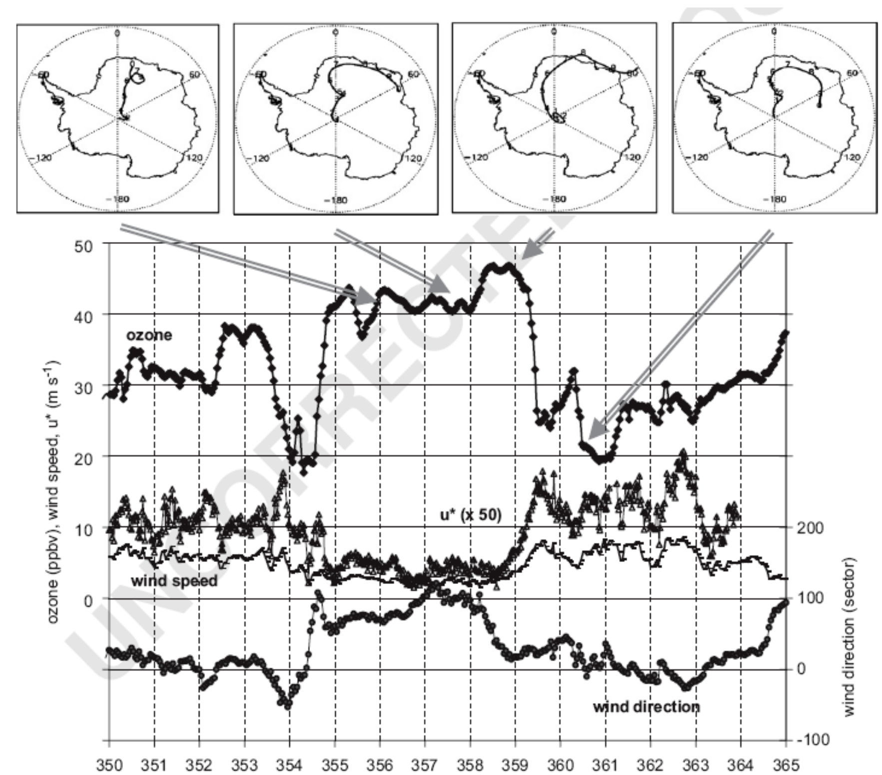


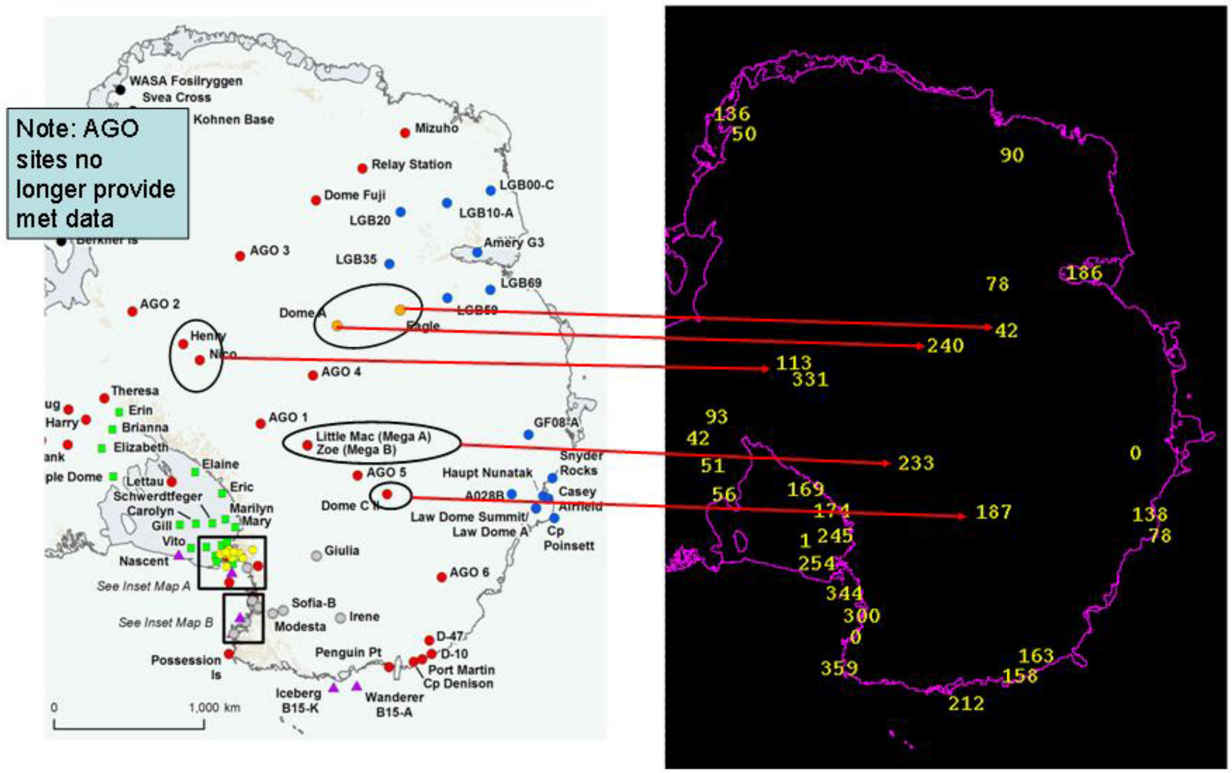
Fig. 7. Ozone (ARO at 17 m), wind speed and wind direction (NOAA tower at 13 m), and u^* (from turbulence eddy correlation measurements at 2 m near the balloon launch site) during calendar day 2003 at SP. The 10-day back trajectories during four selected times and at 36 h spacing (356.0; 357.5, 359.0; 360.5), and as indicated by the arrows, are shown in the upper part of the figure. Numbers along the trajectories indicate transport time in days.

--from Helmig, D, Johnson, B., Oltmans, S., Neff, W., Eisele, F., Davis, D., 2007, Elevated ozone in the boundary layer at south pole, *Atmos. Env.,* In press

Conclusions from the field programs and past work:

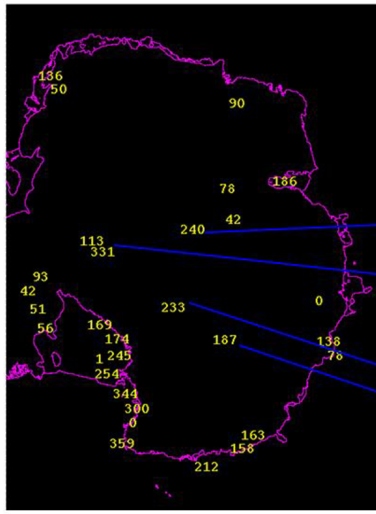
- *Past work indicated the strong linkage between the orientation of 300 hPa winds and surface winds and inversion strength at the South Pole.*
- *This same work indicated that downslope, cold-air flows were an intermittent phenomenon.*
- *Recent studies of excessive nitrogen oxide and synoptic analyses showed that downslope events correlate well with high concentrations.*
- *An automatic weather station east of the South Pole, when compared with ones at the Pole and to the 'north," suggest that the area to the east is a stagnation area where NO can accumulate.*
- *Analyses of time delays revealed that both transport and local accumulation are important.*
- *Further observations are needed over the higher plateau east of the South Pole.*

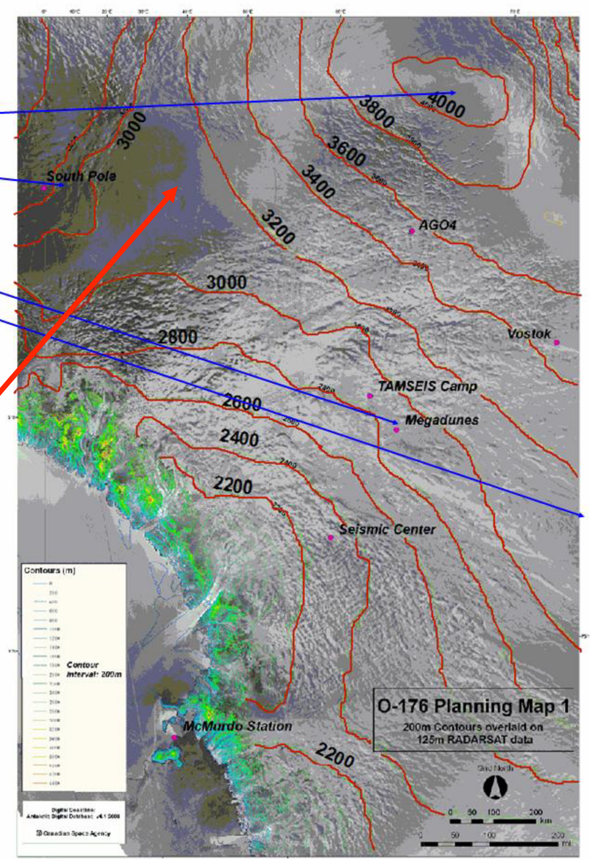
Current data available for a larger-scale view, a snapshot from April, 2007:



Station locations vis-à-vis real-time data (AMRC)

Current data relative to the terrain:

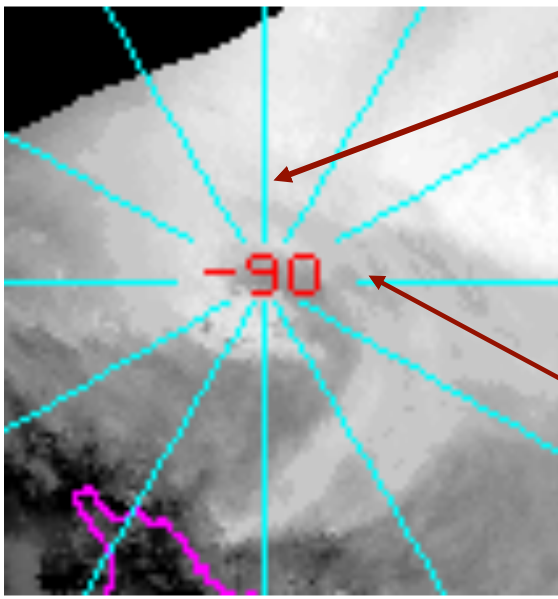


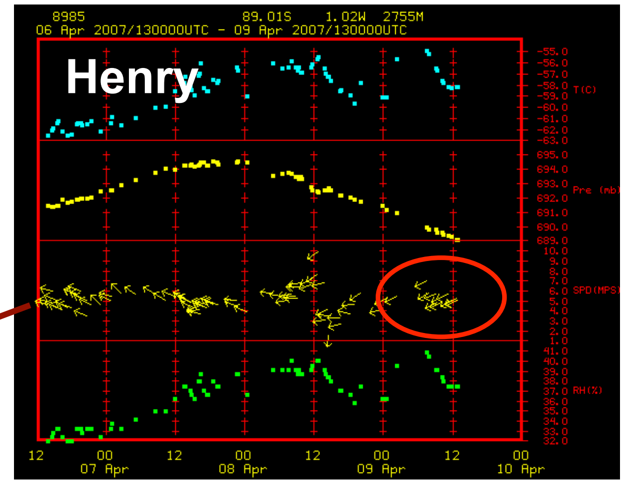


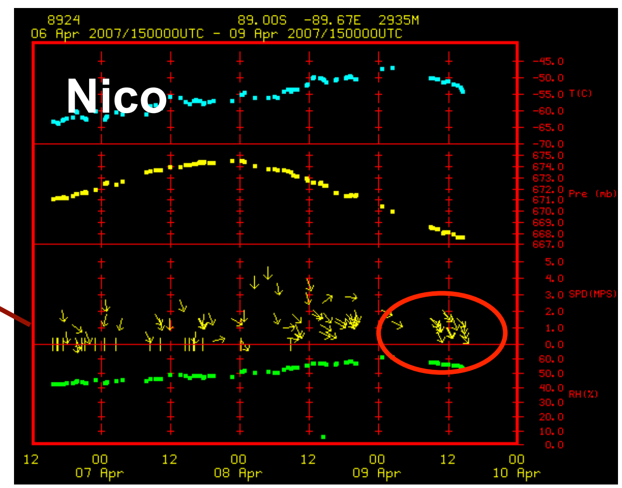
Note the limitation in data availability "upwind" of the South Pole

Example: ***Anticyclonic vortex over the South Pole on 9 April, 2007***

- Winds at AWS Henry are easterly at 4-6 m/s whereas winds at AWS Nico at 1-2 m/s from the northwest. Nico is located in the "stagnation area" as shown above to the left.

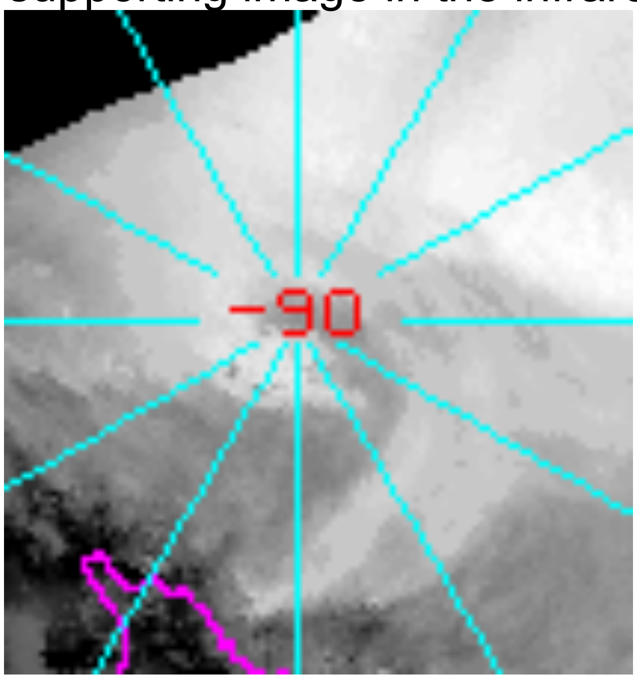


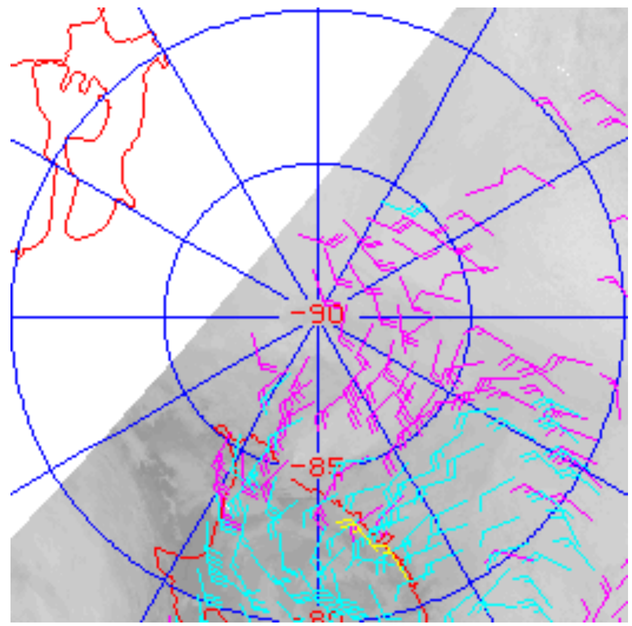




Example: *Part II*

- Cloud-drift winds from Aqua (http://stratus.ssec.wiscedu/products/ rtpolarwinds/rtpolarwinds.html) show the anticyclonic system within 500 km of the South Pole with a supporting image in the infrared.

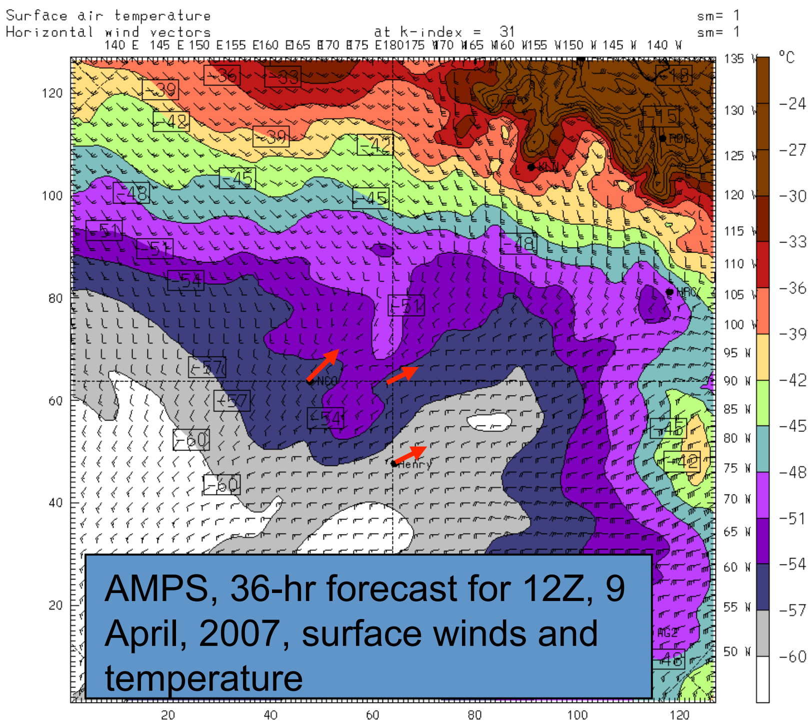




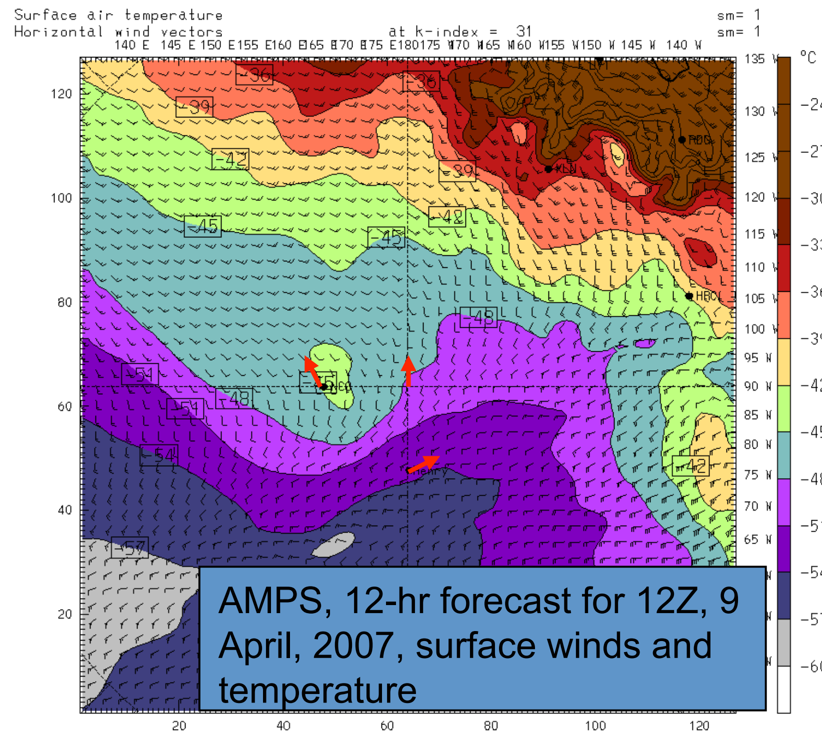
(Not to the same scale…)

Example: *Part III*

•12-hr and 36-hr AMPS simulations show significant fidelity in the circulation pattern but with a colder pattern in the 36-hr simulation http://www.mmm.ucar.edu/rt/mm5/amps/). Only the center of the circulation is offset in the two simulations and a more divergent flow develops in the 12-hr simulation. Note the scale separation of the AWS stations compared to the scale of the system.



AMPS, 36-hr forecast for 12Z, 9 April, 2007, surface winds and temperature



AMPS, 12-hr forecast for 12Z, 9 April, 2007, surface winds and temperature

Recommendations:

- ***While a number of AWS stations are available on the high plateau, their data are not systematically collected except through the efforts of the AMRC (http://amrc.ssec.wisc.edu/). Additional support should be applied to this collection effort.***

- ***Only a few stations lie in areas of large scale slope or stagnation areas of importance to surface chemistry at the South Pole. New stations should be added in these areas.***

- ***Typical spatial separation does not address intermediate scale weather systems (200 km to 500 km). A larger scale network should be in place between Dome A, the South Pole and the Megadunes area.***

- ***It would be useful to have additional sensors on the AWS stations for chemistry. New technology such as cavity-ringdown spectroscopy for NO2 may be available in a few years (low-power needs). Similarly techniques for O3 may also be available but pose challenges in maintenance and power.***