POLAR WINDS FROM MODIS

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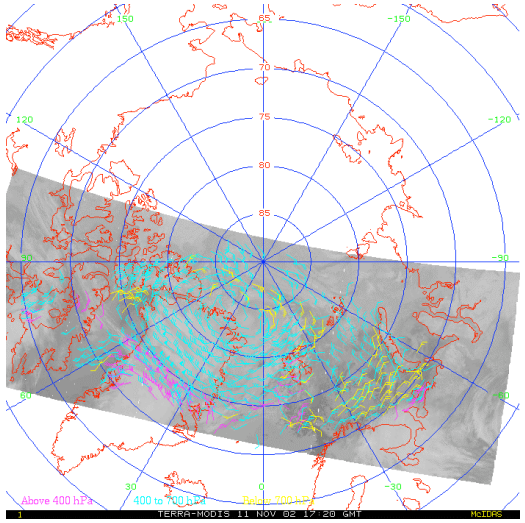
Introduction

MODIS data are currently being used to retrieve tropospheric winds (speed, direction, and height) in the polar regions by tracking cloud and water vapor features. Model impact studies have demonstrated a positive impact on forecasts in the Arctic, Antarctic, and extratropics when the MODIS winds are assimilated.

Wind derivation with MODIS data is based on the established procedure used for the Geostationary Operational Environmental Satellite (GOES). With MODIS, cloud features are tracked in the infrared window band at 11 μm; water vapor features are tracked in the 6.7 μm band. After remapping the orbital data, potential tracking features are identified. Tracking employs a simple search for the minimum of the sum of squared radiance differences between the target and the search boxes in two subsequent images. A model forecast of the upper level wind is used to choose the appropriate search areas. Displacement vectors are derived for each of the two subsequent images, which are then subject to consistency checks. Height assignments can be made with the infrared window, CO_2-slicing, or the H_2O-intercept methods. An example of the derived winds for one orbit is given in the figure below.



Real-Time MODIS Winds

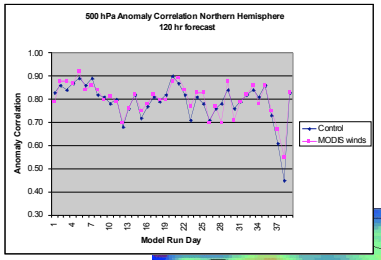
MODIS winds are generated in near real-time at CIMSS and at the NESDIS Office of Research and Applications. Wind information is estimated from three successive orbits/images spanning 200 minutes. The winds are typically available 2-4 hours after the middle image time. AVHRR GAC winds are also generated in near real-time. Both are available at http://stratus.ssec.wisc.edu/products/rtpolarwinds.

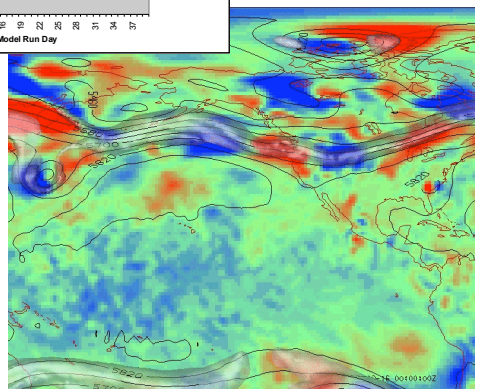
Nine NWP centers in six countries are currently using the MODIS polar winds in their operational forecast systems:

- NASA Global Modeling and Assimilation Office
- European Centre for Medium-Range Weather Forecasts (ECMWF)
- Japan Meteorological Agency (Arctic only)
- Canadian Meteorological Centre
- Deutscher Wetterdienst (German weather service)
- U.S. Navy Fleet Numerical Meteorology and Oceanography Center
- Met Office (UK)
- MeteoFrance
- National Centers for Environmental Prediction (NCEP)

Positive Impact: Where, When, and Why

The figure below shows a time sequence of the anomaly correlation at 500 hPa from the GFS model, with and without MODIS winds. Similar improvements are seen with other models, with the most notable improvement in forecast 'bust' situations.





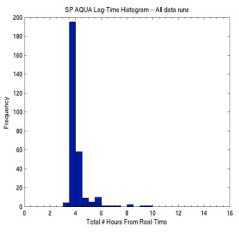
The figure above shows the 1000-500 hPa thickness differences between a model forecast control run and a forecast in which the MODIS winds were assimilated. This is a 120 hr forecast. Blue indicates that the addition of the MODIS winds resulted in a lower thickness (cooling); red shows the opposite. Alternating positive and negative differences can be seen along the jetstream, indicating a change in the amplitude and position of the waves. This may explain how the MODIS winds can impact midlatitude and even subtropical weather. In fact, through displacements of the jetstream, hurricane tracks can be altered.

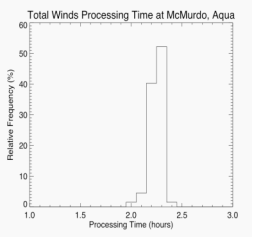
Direct Broadcast MODIS Winds

Unfortunately, much of the MODIS wind information cannot be generated fast enough for use in early NWP model runs due to the delay in obtaining MODIS data (typically 1-4 hrs). Direct broadcast (DB) sites provide real-time access to MODIS data, and hence an opportunity to improve the timeliness of the wind data.

As of March 2005, polar wind information covering much of Antarctica has been generated with MODIS data received by the National Science Foundation's direct broadcast system in McMurdo, Antarctica. All processing is done at McMurdo; only the wind data and plots are transferred back to CIMSS. In March 2006, a similar system was implemented at Tromsø, Norway, using data collected with the Integrated Program Office antenna on Svalbard. Tropospheric winds and other products are available approximately 45 minutes after data acquisition.

As expected, the MODIS polar winds can be generated much more quickly at DB sites than with our current source of MODIS data, the NOAA Real-Time System (or "bent-pipe"). DB winds are available approximately 2 hours sooner than the bent-pipe winds.

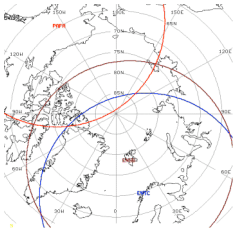


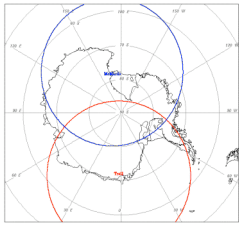


Processing times are for the middle image in a 3-orbit triplet. Actual processing time from image acquisition to availability of wind vectors is 100 minutes (1.67 hrs) less than shown.

The MODIS DB winds are now used operationally by the Fleet Numerical Meteorology and Oceanography Center. Other centers are testing the DB product.

Two other Arctic DB sites are being investigated to complement the Tromsø site: Fairbanks, Alaska, and Soldonkylä, Finland. In the Antarctic, Troll, Norway is being considered.





Real-time products generated at McMurdo and Tromsø are available at http://stratus.ssec.wisc.edu/products/db.