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Data Sources

Surface Analysis

The original surface analysis charts were created by NOAA’s Ocean Prediction Center and are archived at https://nomads.ncdc.noaa.gov/ncep-charts/new_charts/. These images (along with many others) are organized by year and month (YYYYMM), and then subdivided by day (YYYYMMDD). For example, surface analysis charts for 2015-11-23 can be found at https://nomads.ncdc.noaa.gov/ncep-charts/new_charts/201511/20151123/.

There are two separate surface analysis domains over the North Atlantic, each with their own chart and file name. The files covering the eastern domain have a file name pattern of “atle.sfcanal.HV.YYYYYMMDDHI.gif”, where YYYYYMMDD is the UTC year, month, and day for which the analysis is valid, HV is the UTC hour for which it is valid, and HI is the UTC hour it was issued. Files covering the western domain have a similar file name pattern, except the file names begin with “atlw” instead of “atle”.

The full URL of the surface analysis image covering the eastern North Atlantic on 2015-11-23 at 18:00 UTC is https://nomads.ncdc.noaa.gov/ncep-charts/new_charts/201511/20151123/atle.sfcanal.18.2015112320.gif.

R/V Atlantis Location

The 1-minute location of the R/V Atlantis was obtained from the GSFC SeaBASS archive at https://seabass.gsfc.nasa.gov/archive/OSU/NAAMES/documents/ship_underway_data. Each cruise has its own data file: “samos_naames_#_data.csv”, where # is the deployment number (1-4). The fields that were parsed out and used include the date (“YMD”), time (“HMS”), latitude (“LA”), and longitude (“LO”).

Satellite Imagery

Visible satellite imagery was accessed via NASA Worldview (<https://worldview.earthdata.nasa.gov>). The products used included the Corrected Reflectance (True Color) datasets for Aqua/MODIS, Terra/MODIS, and Suomi NPP/VIIRS (when available).

Technique

Surface Analysis Stitching

First, the eastern and western domain surface analysis images were combined into a single image for each analysis period. Since the images overlap in their coverage slightly, the eastern domain image was overlaid on top of the western domain image in the overlap region (40°W-50°W, or pixels 534-640 in the horizontal direction).

The eastern and western domain images were 640x768 pixels each (width x height) with an overlap of 1/6th of the image, or 106 pixels. Therefore, the combined image size is 1174x768.

These images can be found in the NASA LaRC archive under the "SURFACE.ANALYSIS" section of the "Analysis" tab. The file is named "NAAMES-SfcAnalysis_Analysis_RO_YYYY.zip", where YYYY is the year of the deployment. Individual files within the zip file have the form "atlc.sfcanal.YYYYMMDDHI.HVz.gif", where YYYYMMDD is the UTC year, month, and day for which the analysis is valid, HI is the UTC hour it was issued, and HV is the UTC hour for which it is valid.

R/V Atlantis Location Averaging

The latitude and longitude data from the R/V was subsetted to a +/- 3 hour window for each surface analysis time. The median latitude and longitude were then calculated for this subset of data.

Platform Plotting

The median latitude and longitude of the ship for a given analysis image was converted to pixels using the following equations:

$$x_{pixel} = 1066.7 + 10.676 * lon$$

$$y_{pixel} = 933 - 11.85 * lat + 0.030833 * lat^2 - 0.0005 * lat^3 - .0000083333 * lat^4$$

Note that the conversion from latitude to y_{pixel} is not linear because of the projection of the image; the farther north in the image, the more distance (or pixels) a degree of latitude takes up.

After calculating the pixel location of the ship for a given surface analysis image, a red circle with a 15-pixel diameter (centered on the ship location) was drawn on the image.

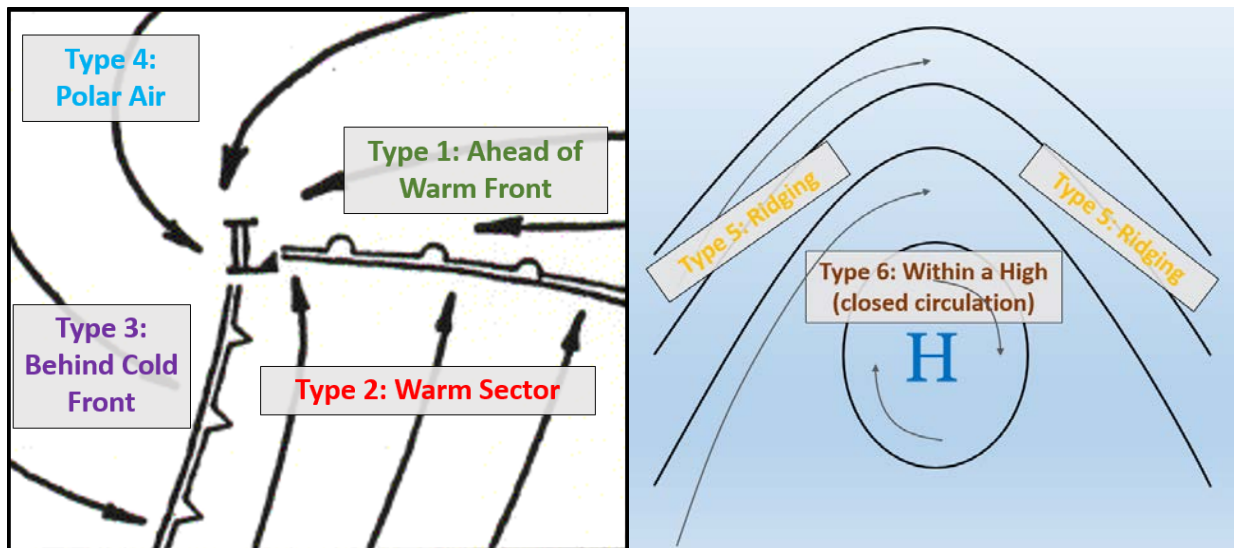
Manual Typing

For each surface analysis image and ship location, the synoptic meteorology at the ship was manually typed. The different types were roughly based on the four quadrants of the Norwegian Cyclone Model, plus three extra types outside of cyclone influence (ridge, high, and non-typed).

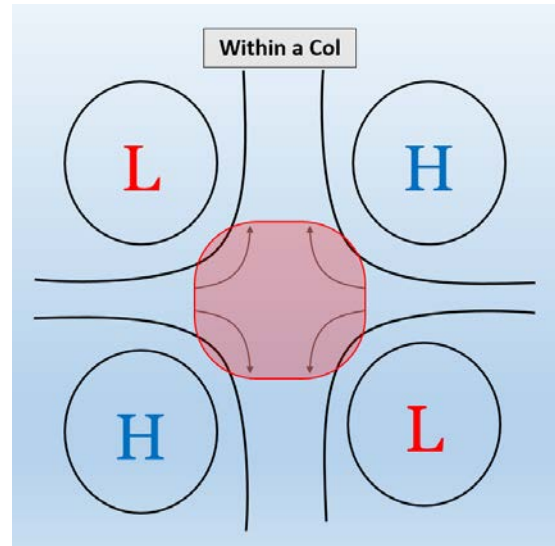
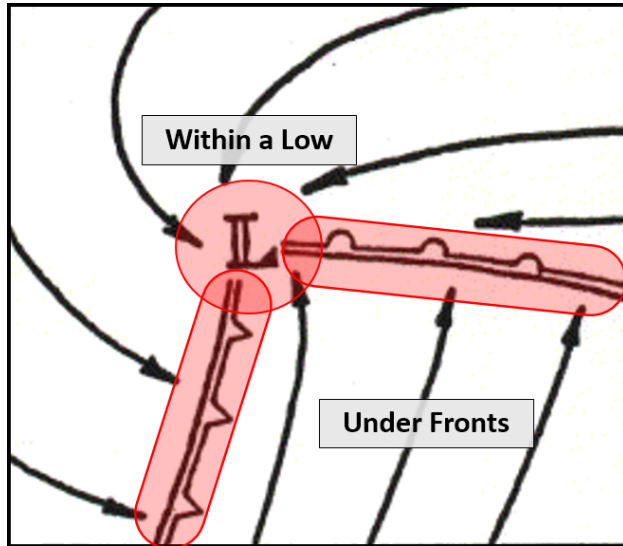
The typing was performed twice and by two different analysts before creating the finalized types to ensure consistency.

A table listing the different types, their descriptions, and the general criteria for designating an area as that type is listed below, along with schematics representing where the locations of the typed regions with respect to low and high pressure systems.

Type	Name	General Criteria
0	Non-Typed	<ul style="list-style-type: none"> Under a front, within a low (within 4 hPa of local pressure minimum), or within a col
1	Ahead of Warm Front	<ul style="list-style-type: none"> On cold side of warm front Flow is roughly parallel to front and toward low pressure (generally easterly)
2	Warm Sector	<ul style="list-style-type: none"> On warm side of cold and warm fronts Flow is roughly parallel to cold front and perpendicular to warm front (generally south or southwesterly) Isobars curve toward low pressure
3	Behind Cold Front	<ul style="list-style-type: none"> On cold side of cold front Flow is roughly perpendicular to cold front Wind has a southerly component
4	Polar Air/Cold Air Outbreak	<ul style="list-style-type: none"> On cold side of cold front or northwest of the low Wind has a northerly component Satellite imagery may show a region of broken-overcast clouds (open or closed cell stratocumulus)
5	Ridging	<ul style="list-style-type: none"> Within or ahead of a ridge axis Isobars curve toward high pressure
6	Within a High	<ul style="list-style-type: none"> Within a closed high pressure circulation (within 4 hPa of the local pressure maximum)



Four types as sectors of an idealized Norwegian Cyclone (left), and two types in relation to a closed high pressure system and its associated ridge (right). Left figure adapted from <http://profhorn.meteor.wisc.edu/wxwise/wxpilot/lesson8/midlatbkgrnd.html>



Red shaded areas indicate regions of an idealized Norwegian Cyclone that were designated as “Non-typed” (left), as well as a region in between (and generally not directly influenced by) high and low pressure systems, known as a col (right)

Caveats

There is no such thing as a Norwegian Cyclone! The Norwegian Cyclone Model is a conceptual representation, and that model doesn’t always (or ever) match reality.

The atmosphere is continuous, and distinct boundaries between different types don’t really exist for the most part (the exceptions are fronts). Therefore, the transition between Type 2 and Type 5, or Type 3 and Type 4 (for example) can be blurry, and the conditions at the ship likely won’t fall neatly into one or the other.

The typing was done based on the roughly instantaneous surface analysis over the North Atlantic every 6 hours and the median location of the Atlantis during the +/- 3 hour window of that analysis. However, the atmosphere is constantly in motion, and transitions between the types can occur at a higher resolution than the 6 hour resolution of the surface analysis and typing. Conditions at the ship may have changed from one type to another (or even included Type 0 for some duration) during the 6 hour period for which the type is valid.

Seven types may not be the correct number of categories necessary to fully understand and distinguish between conditions in the NAAMES region. For example, conditions within Type 6 (high pressure) regions may be very different depending on whether the high came from the Arctic or the subtropics, and it might be more appropriate to identify these systems as two different types. Conversely, there may not be enough of a distinction between Type 3 (Behind a Cold Front) and Type 4 (Polar Air) to warrant separating them into different types.

Contact Information

For more information, contact Michael Shook. Code for downloading/stitching surface analysis images, parsing R/V Atlantis data, and plotting ship location on analysis images is available upon request.

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