Identification_Information:
    Citation:
        Citation_Information:
            Originator: Air Force Combat Climatology Center (AFCCC)
            Publication_Date: 20070215
            Title: RTNEPH-Real Time Nephanalysis Database
            Geospatial_Data_Presentation_Form: Planetary
            Publication_Information :
                Publication_Place : Asheville, NC
                Publisher : Air Force Combat Climatology Center
    Description:
        Abstract: Consists of cloud and weather information compiled from both conventional surface and upper-air reports and satellite data. Observed clouds are place within one of four floating layers, with the first layer defined as the highest. The analysis data is on a 512x512 grid and includes data for both hemispheres, eitght times a day on each synoptic hour. Each hemisphere is divided into 60 boxes (64x64 grid points in each) on the eigth mesh grid. Information for a particular grid point may include either 0, 1, 2, 3, or 4 layers of cloud information, depending on observed conditions.
        Purpose: Support DoD projects.
    Time_Period_of_Content:
        Time_Period_Information:
            Range_of_Dates/Times:
                Beginning_Date: 198401
                Ending_Date: 200206
        Currentness_Reference: From the data
    Status:
        Progress: Complete
        Maintenance_and_Update_Frequency: Monthly
    Spatial_Domain:
        Bounding_Coordinates:
            West_Bounding_Coordinate: -180
            East_Bounding_Coordinate: 180
            North_Bounding_Coordinate: 90
            South_Bounding_Coordinate: -90
    Keywords:
        Theme:
            Theme_Keyword_Thesaurus: None
            Theme_Keyword: Meteorology
            Theme_Keyword: Cloud Analysis
            Theme_Keyword: Cloud Height
            Theme_Keyword: Cloud
        Place:
            Place_Keyword_Thesaurus: None
            Place_Keyword: Global
        Stratum:
            Stratum_Keyword_Thesaurus: None
            Stratum_Keyword: Stratosphere
            Stratum_Keyword: Troposphere
        Temporal:
            Temporal_Keyword_Thesaurus: None
            Temporal_Keyword: Climatology-daily
            Temporal_Keyword: Synoptic Hours
            Temporal_Keyword: 3-hourly
    Access_Constraints: Access through AFCCC is limited to DoD agencies and their contractors. All other requests are filled through the National Climatic Data Center in Asheville, N.C.

Use_Constraints: None
Point_of_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Branch Chief, AFCCC/DOD
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Hours_of_Service: 0730-1630 Eastern Time M-F
Data_Set_Credit: Collected and decoded by the Air Force Weather Agency (AFWA), Offutt AFB, NE
Security_Information:
Security_Classification_System: DoD
Security_Classification: Unclassified
Security_Handling_Description: None
Cross_Reference:
Citation_Information:
Originator: Air Force Combat Climatology Center, Asheville, NC
Title: Worldwide Merge Cloud Analysis
Publication_Date: 20070215
Online_Linkage:
https://notus2.afccc.af.mil/SCIS/services/databases.asp
Data_Quality_Information:
Logical_Consistency_Report: Data checked for gross errors to eliminate impossible values or contradictions
Completeness_Report: If the data for a "Box-Time" is missing, the data are persisted for the missing time period. A flag is set to indicate persisted data.
08/01/83
Satellite Data Mapper Processor/Algorithm(s): The Satellite Data Mapper Processor is the first of six main programs that make up the RTNEPH model, which is run at AFWA. This processor remaps incoming polar-orbiter imagery to a polar-stereographic database. Since the RTNEPH is produced on a polar-stereographic projection, AFWA maps incoming visual (VIS) and infrared (IR) satellite imagery to a database in the same projection. The processor that performs this mapping is called SYNAPS and the output database is called the satellite global database (SGDB). The SGDB consists of two hemispheric files containing 64th-mesh data. Associated control information (zenith angles, scan angles, satellite identifiers, observation times) are stored in the same files, but only for each quarter-mesh (95-km) box. As AFWA receives imagery from a new satellite pass each 101 minutes (a pass is a complete revolution of the earth by a polar-orbiting satellite), computer hardware averages the original high-resolution 3-km data to 6 km, decreasing the necessary disk storage by a factor of 4. At the same time, the temperature and albedo measurements are degraded to allow more compact storage of information; the original 256 grayshades are degraded to 63. For IR data, these 63 gray shades are a linear quantization of brightness temperature that span a range from 192 to 310 K with

a separation of 1.9 K between adjacent grayshades. The hardware also cuts the pass into four pole-to-equator "quarter orbits" and sends the compacted imagery for each quarter orbit in succession to the UNISYS mainframe for processing. SYNAPS earth-locates each imagery pixel to the proper coordinate in the SGDB, and replicates existing pixels to fill any remaining gaps between pixels on the polar-stereographic grid. Pixel replication is done since a given 64th-mesh box on the polar-stereographic projection actually varies in size from over 6 km at the pole to near 3 km at the equator. Information from the satellite is available after the initial averagi ng at approximately 6-km resolution, so a one-to-one mapping of raw satellite data to the contorted polar-stereographic database can not be achieved for all points; gaps are assured in lower latitudes, and pixel duplication is required to fill each available grid box. Similarly, some of the original data is lost near the poles, as more original 6-km pixels are available than can be put into the 64th-mesh projection. For regions outside the viewing range of the current DMSP pass, the original, older satellite data is persisted. Thus, the SGDB is a mosaic of satellite data with different times, from near current to 6 hours or more old. For additional information refer to "The AFWA Automated Real-Time Cloud Analysis Model" (Kiess and Cox, 1988) and "A Description of the Air Force Real-Time Nephanalysis Model" (Weather and Forecasting, Vol. 7, No. 2, pp 288-306).

08/01/83

Surface Temperature Analysis and Forecast Processor/Algorithm(s):

The Surface Temperature Analysis and Forecast Processor is the second of six main programs that make up the RTNEPH model, which is run at AFWA. This model processor produces an analysis and forecast of shelter and skin temperatures for comparison to satellite-measured infrared (IR) brightness temperatures. Since the RTNEPH requires a high-quality, IR-derived nephanalysis, an accurate specification of the surface temperature is necessary. This surface temperature is used to determine the cloud/no cloud threshold on the satellite data processor. To accurately specify a background scene temperature for the IR cloud analysis, AFWA has a global, eighth-mesh shelter and skin (ground) temperature analysis and forecast model (SFCTMP). This model runs every 3 hours and produces an analysis, a 3-hour forecast, and a four and one-half hour forecast. Forecasts are necessary because of delays in receiving surface observations worldwide. DMSP satellites are in sun-synchronous orbits, configured to overfly areas at times when surface temperatures are changing rapidly, so simply using a persisted analysis would result in systematic biases of IR-derived cloud amount. By using a short-term temperature forecast instead, such biases are minimized. SFCTMP runs approximately 1 hour 40 minutes after synoptic data time in the Northern Hemisphere, and 2 hours 30 minutes after for the Southern Hemisphere. A large fraction of the possible surface data observations are available by these times. For additional information refer to "The AFWA Automated Real-Time Cloud Analysis Model " (Kiess and Cox, 1988) and "A Description of the Air Force Real-Time Nephanalysis Model" (Weather and Forecasting, Vol. 7, No. 2, pp 288-306).

08/01/83

Satellite Data Processor/Algorithm(s):

The Satellite Data Processor is the third of six main programs which make up the RTNEPH model, which is run at AFWA. This processor reads in the new satellite data and produces a satellite-derived cloud analysis. NEFSAT is the satellite cloud-detection algorithm. It provides separate analyses of both visual (VIS) and infrared (IR) data. Its processing algorithm simulates the simplest algorithm a forecaster would use to analyze data. In general, the colder (IR data) or brighter (VIS data) an SGDB pixel is, the more likely it is to be cloudy. NEFSAT's algorithm makes a simplifying assumption that any pixels colder (for IR) or brighter (for VIS) than a computed clear-scene threshold are considered totally cloudy. Fractional cloud cover is derived by summing the

cloudy and clear decisions for all 64th-mesh pixels within an eighth-mesh box. NEFSAT generates separate eighth-mesh IR- and VIS-derived cloud analyses from new data in the SGDB. By separating the IR and VIS processing, nighttime or low-light pr ocessing can proceed by analyzing only the IR data. When both algorithms can be run, VIS- and IR-derived nephanalyses may determine different cloud amounts. Dealing with such discrepancies is postponed until later in the analysis scheme when the merge processor is run, where the conventional data are also assimilated. Two non-satellite supporting databases required for the processing of IR data are surface temperatures and upper-air temperature/humidity/height profiles. Surface temperatures are necessary to accurately estimate the satellite-sensed ground Temperature used in calculating an IR threshold. For most regions, the surface temperatures are simply extracted from the database created by the SFCTMP model. However, for many land areas, NEFSAT also obtains an independent estimate of a satellite-sensed ground temperature from SSM/I microwave data. Upper-air temperature and height profiles are used to assign cloud-top altitudes. Humidity and temperature profiles are used to estimate water vapor attenuation, another necessary step in the determination of an accurate satellite-sensed ground temperature.

1) Infrared Satellite Data Processing The infrared satellite processor generates a cloud analysis from IR data in the SGDB. The IR spectral bands range from 10.2 to 12.8 um for DMSP data, and 10.3 to 11.3 um for NOAA/AVHRR (Advanced Very High Resolution Radiometer) data. Infrared satellite data is the primary and most reliable source of global cloud observations for the RTNEPH because of the frequent updates and availability of the data both day and night. The IR processor determines cloud amount by comparing measured IR brightness temperatures against an expected underlying surface temperature. If a pixel's brightness temperature is sufficiently colder than an independently derived estimate of the satellite-sensed ground temperature, cloud is detected. Cloud fraction is determined from the ratio of cloudy pixels to the total number of pixels within an eighth-mesh box. Once cloud amount has been determined, NEFSAT will also perform a layer analysis on the cloudy pixels and determine the resultant clou d type. In an 8 X 8 array comprised of clear and cloudy pixels, each represented by a certain grayshade, the selection of a cloud/no-cloud cutoff that separates the clear and the cloudy grayshades is first made by determining the measured brightness temperature of the scene using a lookup table to convert grayshade to temperature. Then the measured brightness temperature of the scene and the underlying temperature are compared, where the underlying temperature is an estimate of the temperature that the satellite would measure if the scene were cloud-free. The cloud/no-cloud decision is complicated by the existence of surface inversions, uncertainties in RTNEPH surface temperatures, atmospheric water vapor attenuation in IR temperature measurements, and the differing responses of individual IR sensors. With a one-channel IR threshold algorithm, there is little that can be done to detect cloud in the presence of inversions. The failure to detect the "black stratus" clouds, which appear darker than surrou nding clear regions, is a recognized defect of the algorithm. However, the other problems can be addressed. For example, the amount of water vapor attenuation can be estimated. It is known that a cool, dry atmosphere will attenuate little of the upwelling surface radiation, while a warm, moist atmosphere may attenuate 10 K or more. With a knowledge of the temperature and moisture profiles, the amount of attenuation can be estimated as follows. The RTNEPH optimizes an IR threshold calculation in two ways. First, data are adjusted to yield the most accurate possible estimated underlying temperature (to correct for satellite or surface temperature biases and for water vapor attenuation). Tables of corrections to the SFCTMP-supplied shelter temperature estimate are used. The tables are a function of: 1) satellite sensor, to account for differences in sensor response;

2) estimated surface temperature, to grossly account for the dependence of water vapor attenuation on absolute temperature; and 3) satell ite scan angle and earth location, since water vapor attenuation exhibits a dependence on scan angle and latitude. No functions are available to tailor the amount of correction to analyzed air temperature and/or humidity profiles. The second approach to optimizing the IR threshold calculation is to deal with uncertainties in the estimate of the underlying temperature and to recognize the general dependence of cloud height on low-level humidity. Infrared pixels are forced to be colder than the underlying temperature by an arbitrary amount before cloud is detected. This amount varies with scene background brightness, so for dark, forested regions the threshold is only a few K, while over deserts the threshold approaches 10 K. By forcing pixels to be colder than the estimate of the underlying temperature, some error is allowed, and, by associating it with a surface brightness, the general dependence of cloud height on low-level moisture is implicitly recognized. For brighter areas (desert), the moisture c ontent is lower, and clouds should have higher lifted condensation levels. Conversely, for darker backgrounds, lifted condensation levels are generally lower. So, the determination is made as to whether the pixel is cloudy or clear by comparing the result of the measured brightness temperature minus the estimated underlying temperature against a predetermined term that depends on background brightness. With each individual pixel in an eighth-mesh box classified as cloudy or clear, a total cloud fraction for the analysis point can be defined as the ratio of cloudy pixels to total pixels (64). Having screened out the cloudy pixels, the remaining clear pixels are excluded from any further cloud processing. The cloudy pixels are then analyzed for cloudlayers. From the original array of IR data, a grayshade histogram is constructed using only the cloudy grayshades. Histograms typically show peaks and valleys that in theory separate one cloud layer from the next. The job of the layer algorithm is to objectiv ely determine where the layer grayshade boundaries are, and to pass this information on to the part of the IR processor that determines layer cloud-top heights and amounts. The RTNEPH uses a layer-analysis algorithm that processes IR data from a 2 X 2 square of four adjacent eighth-mesh boxes. This gives a possible array of 16 X 16 pixels (8 X 8 for each box). By combining four together, some peaks and valleys in the histogram that may occur due to small sample size are avoided. A necessary result, however, is that layer grayshade boundaries are identical for all four eighth-mesh boxes. The layering algorithm is described in more detail by d'Entremont et al. (1982) and Hawkins 1980). Once layer grayshade boundaries are specified for each eighth-mesh box, the cloud amount for that layer with grayshade values that fall between the given layer grayshade boundaries, and dividing that count by the total number of pixels within the analysis array. In order to compute the layer-top height, the lowest IR brigh tness temperature for the layer is determined. The lowest temperature is presumed to be the least contaminated by upwelling background radiation and thus most representative of the true cloud-top temperature. This temperature is then corrected for atmospheric attenuation and satellite sensor biases before it is used to calculate a cloud height using a temperature-height profile valid for the location being analyzed

2) Visible Satellite Data Processing

The visible satellite data processor generates a total cloud analysis that is derived from DMSP VIS data (approximately 0.4-1.1um spectral bandwidth) and a database of earth surface brightness. It is essentially a threshold technique whereby satellite brightness measurements are compared to expected background brightnesses. Background brightness is the expected clear-column grayshade value as previously measured by the visible sensor. Measurements that are brighter than the background (plus an uncertainty factor) indicate the presence of cloud. Supporting databases are snow- and ice-cover analyses, and a background brightness analysis at eighth-mesh resolution. The

visible processor outputs eighth-mesh total cloud cover and updates the background brightness database if conditions are clear. The visible processor performs four main functions for each eighth-mesh box: 1) screen the data for points covered by snow, ice, or sunlight; 2) perform a cloud/no-cloud decision on each pixel within the eighth-mesh box in order to determine total cloud; 3) determine total cloud; and 4) update the background brightness analysis if appropriate. The first step in the processing of the visible data is to determine whether snow or ice exists within the eighth-mesh box. Snow- and ice-cover information is supplied to the nephanalysis from the AFWA snow analysis model at eighth-mesh resolution. Geography flags from a geography database indicate whether each eighth-mesh box is composed predominantly of water, land, ice, or coastline. If the background contains snow or ice, then the visible clear-column grayshade will be bright and hence difficult to distinguish from cloud cover. For this reason, points flagged as containing either of these two background types are eliminated from further analysis by the visible processor. Another circumstance that prevents visible data from being further processed is if the scene contains sunglint. Scenes are flagged for sunglint processing based on background type (it must be water), scene solar geometry, and satellite position. If the scene lies within a possible sunglint area, the mean and variance of the visible grayshades are computed. If the mean is high and the variance is low, enough sunglint-contaminated pixels are likely present within the eighth-mesh box so as to be confused with patchy low clouds. In such a case, the box is precluded from further processing. On the other hand, if the variance is high, the presence of clouds is inferred and processing will continue. The background brightness grayshade (BBGS) is defined as the brightest visible SGDB grayshade that a pixel within a particular eighth-mesh box is expected to have when the pixel is cloud-free. The background brightness analysis is a dynamic database that is maintained by the RTNEPH in real-time. There is one database per satellite. Updates in background brightness are necessary due to changes in snow/ice cover and vegetation (week-to-week variations), seasonal variations, and other natural effects. Visible grayshades in the SGDB are representative of scene brightness. Once the background type has been determined as non-snow or non-ice, then a cloud/no-cloud determination is made by comparing the average of 8 X 8 SGDB brightness values to a single background brightness grayshade for the corresponding eighth-mesh box. The cloud/no-cloud decision is made first by the visible processor on an eighth-mesh box basis. Once this is done, a more detailed cloud analysis is made on a pixel-by-pixel (64th-mesh) basis within the "cloudy" eighth-mesh box. A clear/cloudy grayshade cutoff is calculated for the box using the background brightness (BBGS) and a "64th-mesh" parameter that accounts for the variability of individual pixel VIS grayshade values within the eighth-mesh box. Like its eighth-mesh counterpart, the parameter is a function of the satellite sensor, background brightness grayshade, and time (of day, year, etc.). Once a clear/cloud grayshade cutoff for the box is computed, the number of 64th-mesh pixels within the analysis box that have values greater than or equal to the clear/cloud grayshade cutoff is determined. From this the visible processor can then determine the total cloud amount. Values of the visible grayshade mean and variance are also computed and stored for later use by the RTNEPH cloud-typing program. These latter statistics include both clear and cloudy pixels. The background brightness field is a dynamic database that is monitored and updated by the RTNEPH in real-time. It is updated automatically as a by-product of the cloud analysis. There is one database for each satellite. In general, the RTNEPH model is conservative in updating the background brightness field to ensure no contamination by cloud, snow, or sunglint.

3) Cloud Typin

The output from the satellite data processor includes a distinct cloud type for each layer detected by the IR processor. Cloud typing will depend upon the IR-derived cloud height, the variance of IR pixel grayshades in a cloud layer, the mean IR brightness temperature, and, if available, the variance of the 64 visible pixels within the analysis point. The first step in this process is to decide if the cloud is a low-, mid-, or high-level cloud. For each layer archived by the IR processor, the cloud height obtained from the layer analysis is compared to a fixed mid- and high-cloud threshold. If the above-ground layer height is 6500 meters or greater, it is typed as high cloud; if greater than or equal to 3000 meters but less than 6500 meters, it is typed as mid cloud; if less than 3000 meters, it is typed as low cloud. Next, the cloud-typing processor attempts to distinguish between cumuliform and stratiform clouds by examining the IR grayshade variance and, if available, the VIS grayshade variance. The underlying philosophy is simple; the greater the variance, the more cumuliform the cloud. An index is calculated for both the IR layer variance and the VIS variance. If visual data are not available, the VIS index is arbitrarily assumed stratiform. Once the level and variance information are available, a cloud- type decision is made based on a decision matrix. For additional information refer to "The AFGWC Automated Real-Time Cloud Analysis Model" (Kiess and Cox, 1988) and "A Description of the Air Force Real-Time Nephanalysis Model" (Weather and Forecasting, Vol. 7, No. 2, pp 288-306).

08/01/8

Conventional Data Processor/Algorithm(s)

The Conventional Data Processor is the fourth of six main programs that make up the RTNEPH model, which is run at AFWA. This processor retrieves and reformats cloud information from conventional observations. There are known deficiencies with satellite-derived nephanalyses, such as an inability to accurately detect low clouds and cloud bases using IR data. For this reason, the RTNEPH retrieves cloud parameters from conventional (surface-based) observations each hour and stores them to another eighth-mesh database so it can supplement the satellite- derived nephanalysis where appropriate. The program that stores these data is the conventional data processor, called CONRTN. It runs approximately one-half hour after data time and uses both standard hourly and synoptic observations in the production of a nephanalysis. The overall object of this processor is to produce one "best report" on cloud conditions for each eighth-mesh box inside which a conventional observation is available. All other boxes are left blank. This best report will contain total and layered cloud amounts, layered cloud types, bases, tops, present weather, and visibility. If any of these parameters are not available from the conventional data, they are flagged as "missing". Most eighth-mesh boxes will contain zero or one observation, but if more than one are available, a best report is selected as follows: first, all observations older than 3 hours are not considered; second, the report with the highest total cloud is used, regardless of whether a more recent report has lower cloud amount. If two reports have identical total cloud, the report with the lowest cloud base is used. If cloud bases are again the same, the most recent report is used. If the report indicates low-level clouds, older reports (up to 3 hours) are then searched for additional cloud information above the lower-level cloud deck. These processing rules maximize the probability of detecting any obscurations to vision. For additional information refer to "The A FGWC Automated Real-Time Cloud Analysis Model" (Kiess and Cox, 1988) and "A Description of the Air Force Real-Time Nephanalysis Model" (Weather and Forecasting, Vol. 7, No. 2, pp 288-306).

08/01/8

Merge Processor/Algorithm(s):

The Merge Processor (NEFMRG) is the fifth of six main programs that make up the RTNEPH model, which is run at AFWA. This processor combines the

satellite- and conventional-derived cloud analyses into a final nephanalysis. The satellite-derived nephanalysis cannot stand on its own because it produces separate analyses for IR and VIS data, and it makes no attempt to define cloud bases. Similarly, the conventional database is unsuitable for use as a final cloud analysis because of the relatively few observations worldwide, yet it can be beneficial in defining lower cloud layers not detected in the satellite-derived cloud analysis. Thus, an intelligent merging of these data sources produces a better final cloud analysis than either would alone. As the processor runs, it produces a final cloud analysis from three sources: the persisted (previous) RTNEPH cloud analysis, the satellite cloud analysis from NEFSAT, and the conventional cloud analysis from CONRTN. This final cloud analysis is produced in a series of steps executed in sequence for each analysis box considered. The first step is to read in the persisted RTNEPH database. Next, conventional data are combined with the persisted nephanalysis, and finally, the new satellite data are combined and the output stored to the database. There is a complex set of rules for the data assimilation with each step. These rules have been developed over many years through extensive scrutiny of the satellite and conventional data by operational forecasters at AFWA.

1) Conventional Data Assimilation

Before allowing the assimilation of conventional data for an eighth-mesh box, NEFMRG checks the persisted RTNEPH database to see if it has been quality controlled, or "bogused", recently. If it has been bogused recently (a user-definable time threshold currently set at 120 minutes), no new satellite or conventional data are allowed to overwrite this eighth-mesh box. Since the box has been recently bogused by a forecaster, his evaluation of the cloud cover is assumed to be more realistic than a new satellite or conventionally derived nephanalysis. For points without recent boguses, the next step is to assimilate the gridded conventional observations from CONRTN with the persisted RTNEPH into a "combined analysis". First, where available, the gridded conventional cloud nephanalysis replaces the persisted analysis. After this, the merge processor "spreads" the conventional observations, taking the isolated observations and allowing their cloud information to be copied to adjacent eighth-mesh boxes, provided those boxes did not already have conventional data. This expands the influence of conventional observations so that a higher percentage of the eighth-mesh boxes worldwide will have new hourly information. Currently, high- and mid-cloud observations are spread two boxes; low clouds, one box; and clear areas, three boxes. These spreading distances are based on estimates of how far an observer can see toward the horizon with varying cloud height. Spreading of any height cloud is limited to one eighth-mesh box along a coastline. If two conventional observations could potentially spread to a new box, the nearer of the two is chosen. If both are equally distant, the more timely of the two is chosen. If the two are equally timely, the one with the lesser cloud cover and higher visibility is chosen, since the observer at the point with less cloud probably was better able to factor in the cloud cover in that adjacent area. Finally, spreading is limited in complex terrain. If the terrain height of the grid point being spread to is greater than the cloud base, the cloud base is raised to the terrain height. If the terrain is higher than the cloud top of the conventional observation being spread, the spreading to this grid point is not performed.

2) Satellite Data Assimilation

The merge processor then assimilates new satellite-derived nephanalysis data where available. Again, it considers only boxes that do not have a timely bogus. The first step here is to fill in missing cloud tops and bases, both for the conventional observations and the IR-derived nephanalysis, respectively. To determine these, a default thickness is added to the available

base or top. The default thicknesses for acceptable RTNEPH cloud types are as follows:

Cloud Type	Thickness (m)
Stratus	300
Cumulonimbus	6500
Stratocumulus	1800
Cumulus	2000
Altostratus	1000
Nimbostratus	1800
Altocumulus	2000
Cirrostratus	1800
Cirrocumulus	2000
Cirrus	1000

If no cloud-height information is supplied by the conventional data, a climatological value for low, mid, or high cloud base is assigned, and the cloud top is again calculated using default thicknesses. For each eighth-mesh box, a decision is made concerning which cloud layers in the combined analysis to use and which to discard. This decision is based on a comparison of the timeliness of the combined analysis and The satellite analysis. If the satellite analysis is older or the same time as the combined analysis, as would happen if the DMSP satellite had not flown over the point recently and the combined analysis provided a new surface observation, then the final nephanalysis consists solely of the combined analysis. If the time for a given box in the satellite nephanalysis is only slightly newer than the combined analysis time ("slightly newer" is user definable, currently set at 70 minutes or less time difference), then the satellite analysis is preferentially weighted over the combined analysis. T he general rationale is that the satellite analysis should be more reliable since it is newer, but it may not detect low cloud with its threshold method. Thus, if the satellite detects no cloud, it would be prudent to preserve a conventional observation's low cloud but any higher cloud should already be detected by satellite. However, if the satellite observation detects any cloud, its full view of the box is obstructed and all the information content of the conventional observation should be preserved. Thus the algorithm specifies that middle and high clouds will be stripped from the combined analysis if the satellite observation indicated clear conditions. Similarly, if the satellite observation was cloudy, the layer structure of the combined analysis is preserved. Next, consider the case when conventional data are of intermediate age (the combined observation is not drastically older than the satellite observation). Again, the term "intermediate" is user definable. Currently this refers to a combi ned nephanalysis time between 70 and 90 minutes older than the satellite-derived nephanalysis. In this case, mid and high clouds are always stripped away from the persistence nephanalysis. Only the remaining low cloud needs to be assimilated with the satellite nephanalysis into the final cloud analysis. It is assumed that higher-level clouds, subjected to greater-magnitude winds aloft, are likely to advect beyond the eighth-mesh box and thus should be removed in favor of the more recent satellite input. If the satellite analysis is much newer, the satellite data totally overwrites the combined nephanalysis. The reasoning here is that beyond this time, the combined analysis is not useful. A few problems remain, notably how satellite nephanalyses derived from VIS data are assimilated, how to account for upper-layer clouds obscuring lower-layer clouds in the satellite-derived analysis, and how cloud layers are arranged into the final database. For VIS data, an extra-low cloud layer is added to the final cloud analysis if a timely VIS-derived observation indicated ore cloud than an IR observation. In such a case, a

stratus cloud with a layer amount equal to the difference between the VIS and IR total cloud amounts is inserted. The stratus cloud is placed at a height of 620m above ground level, and the default stratus thickness is used to calculate the cloud-top height. The rationale here is that the missed IR cloud in all likelihood is low cloud or fog because of the limitations of the IR threshold method. If the satellite processor detected more than one cloud layer for the box, the lower layer amounts are increased to account for the percent that was obscured by the higher-level clouds. The equation determining the increase, I, is I = (CL*CA) / (100 - CA), where CL is the current layer amount from the IR-derived satellite nephanalysis, and CA is the layered cloud amount above. Then, I is added to CL to determine the new layer amount. The final step of the merge processor is to sort the layers in order of decreasing height of cloud base and, if necessary, to merge layers together so no more than four layers exist for a grid point (the RTNEPH database can only accomodate four layers). If no more than four layers exist, nothing is done. If more than four layers exist, compatible cloud types are used for merging as shown below:

	CB	ST	SC	CU	AS	NS	AC	CS	CC	CI
CB	1									
ST	1	1	1							
SC	1	1	1							
CU	1	1	1							
AS					1	1	1			
NS					1	1	1			
AC					1	1	1			
CS							1	1	1	
CC							1	1	1	
CI							1	1	1	

A "1" indicates that cloud types are compatible. If two layers are compatible, the more cumuliform type is chosen, and the higher cloud-top height and lower cloud-base height are chosen for the final output. The selection of cloud-layer amount depends on from which analysis (persistence, conventional, or satellite) the layer was derived. If the two layers to be merged are both satellite-derived, the final layer cloud amount is the sum of the two layer amounts. If not, the larger of the two amounts is chosen. For additional information refer to "The AFGWC Automated Real-Time Cloud Analysis Model" (Kiess and Cox, 1988) and "A Description of the Air Force Real-Time Nephanalysis Model" (Weather and forecasting, Vol. 7, No. 2, pp 288-306).

08/01/8

Bogus Processor/Algorithm(s):

The Bogus Processor is the last of six main programs that make up the RTNEPH model, which is run at AFWA. This processor allows forecasters to manually correct the nephanalysis where appropriate. The automated algorithms for processing IR, VIS, and conventional data in the RTNEPH do not always produce a high-quality cloud analysis. For example, low clouds often are not well analyzed by NEFSAT's IR processing algorithm when the cloud-top temperature is very similar to the ground temperature. Quality control by trained forecasters is therefore an important part of the RTNEPH. Immediately after a new quarter orbit of satellite data has been processed by SYNAPS, NEFSAT, and NEFMRG, displays of the RTNEPH database and the new satellite imagery are shipped to a graphics workstation. Using the workstation, trained forecasters overlay the nephanalysis cloud amounts on displays of the latest satellite imagery. They note the areas where, in their judgment, total cloud is not correctly analyzed, draw a perimeter around the area using a graphics tablet and mouse, and label points within the perimeter with a layer cloud amount and type. Once the whole quarter orbit has been examined by a forecaster

and all misanalyzed areas bounded and labeled, the bogus information is packed into a file and shipped back to the UNISYS mainframe, where BOGCHG, the bogus processor, assimilates the new changes into the RTNEPH database. Because forecasters cannot define a cloud top or base, BOGCHG must insert the boguses of amount and type and supply an internally generated cloud top and base. The cloud-top and -base heights are set from the cloud type as shown below:

Cloud Type	Base (m)	Top (m)
Cumulonimbus	15	9157
Stratus	152	458
Stratocumulus	762	1524
Cumulus	915	2134
Altostratus	2135	3353
Nimbostratus	1829	3658
Altocumulus	2439	4268
Cirrostratus	5487	8231
Cirrocumulus	6097	8536
Cirrus	6097	8536

BOGCHG must also rearrange the cloud layers in a consistent manner, as well as recompute a total cloud. For example, within a particular area, the RTNEPH may have originally analyzed 3/8 stratus cloud and 1/8 cirrus, and the forecaster may have added a thin cirrostratus layer of 5/8 coverage. BOGCHG will redefine the RTNEPH database to have two cloud layers, a 3/8 stratus and a 5/8 cirrus, and will recompute the total cloud. For additional information refer to "The AFGWC Automated Real-Time Cloud Analysis Model" (Kiess and Cox, 1988) and "A Description of the Air Force Real-Time Nephanalysis Model" (Weather and Forecasting, Vol. 7, No. 2, pp 288-306).

01/01/8

Automated gross ID field check algorithm #4: This quality control algorithm is used at OL-A, AFCCC in the daily processing of the RTNEPH data received from AFWA and checks for missing records.

01/01/8

Automated gross ID field check algorithm #5: This quality control algorithm is used at OL-A, AFCCC in the daily processing of the RTNEPH data received from AFWA and checks for missing hours.

01/01/8

Automated gross quality control check algorithm #7: This meteorological gross check algorithm is run by OL-A, AFCCC during daily processing of the RTNEPH data received from AFWA. If present weather code values are greater than 49 and less than 100, the total cloud amount must not equal zero (0). Since present weather codes greater than 49 represent conditions with some type of precipitation occurring, there cannot be a total cloud amount of zero in these cases.

01/01/8

Automated gross quality control check algorithm #8: This meteorological gross check algorithm is run by OL-A, AFCCC during daily processing of the RTNEPH data received from AFWA. If data are persisted more than 24 hours, the present hour's data must be exactly the same as the previous hour's.

01/01/8

OL-A, AFCCC persist algorithm: Occasionally, AFWA will declare certain data records as "unrecoverable", leaving a hole in the data for a particular month. To avoid this and "fill in the hole(s)", OL-A, AFCCC uses a "persisting" algorithm as part of the monthly database build procedure where data from the previous synoptic hour is used to fill in the missing records. Data is persisted by box-hour, such that if only a portion of the data is

missing for a particular box for a certain synoptic hour, the entire box will be persisted for that hour. This pratice was discontinued in Dec 98.

04/27/9

On 27 April 1991, the version of SFCTMP that has been operating unchanged since 1979 was replaced with a totally new SFCTMP. For water points, analysis and forecast temperatures are derived from a U.S. Navy-supplied sea surface temperature analysis, updated daily. For land and coastal areas, the new model produces shelter and skin temperature analyses using a simplified optimum interpolation technique. It also uses a new temperature forecast scheme based on a simplified version of the Oregon State University soil hydrology and planetary boundary-layer model. Whereas the older version of the SFCTMP model produced only a 3-hour shelter temperature forecast, the new model extends both shelter and skin forecasts out to four and one-half hours, allowing near-complete temporal coverage from one cycle to the next. For example, the 1200 UTC analysis and forecast cycle produces forecasts through 1630 UTC, and the 1500 UTC analysis and forecast cycle will normally be completed around 1640 UTC.

04/27/9

Since April 1991, new corrections to the SFCTMP-supplied shelter temperature estimate have been used in the Infrared Satellite Data Processor. The new corrections take the form of a set of regression equations. Separate regression equations are used for each satellite, and for each satellite there are separate equations for day and night, and for three surface characteristics: water, land, and snow/ice. Each regression equation calculates the conventionally derived estimate of the IR clear-column temperature. This new technique represents a step toward more fully utilizing the available meteorological information while remaining computationally efficient. Another advantage of the new regression equations is built-in weighting according to information content. Analysis of the weights generally that the SFCTMP-supplied estimate of the shelter temperature, and this temperature minus the 850mb temperature (a measure of low-level stability), were both reliable, whereas the other independent variables exhib ited less reliability. Earlier tests with a more computationally intensive correction algorithm exhibited great sensitivity to the analyzed water vapor loading. The regression method avoids this over sensitivity to errors in the input data. Clear-column brightness temperature estimates are also available from the SSM/I sensor where its surface-type classifier indicates vegetated land or arable soil, deserts, or snow. Specifically, a clear-column brightness temperature estimate is derived from a linear combination of SSM/I channel brightness temperatures. The regression coefficients, which vary with surface type and satellite, were derived from historical coincident OLS IR and SSM/I temperatures of clear scenes, with the SSM/I temperatures used to estimate the IR temperature. In cloudy scenes, observed IR temperatures are significantly colder than SSM/I-estimated temperatures, since the IR channel is much more sensitive to clouds. The final estimate of the underlying temperature is derived from combin ing the conventionally derived estimate of the IR clear-column temperature and the clear-column brightness temperature estimate derived from a linear combination of SSM/I channel brightness temperatures using a weighting factor based on data availability and accuracy of each estimate. For additional information refer to "A Description of the Air Force Real-Time Nephanalysis Model" (Weather and Forecasting, Vol. 7, No. 2, pp 288-306).

05/31/9

The "Journal of Climate" in March 1995 published an article by Poore et al. entitled "Cloud Layer Thickness from a Combination of Surface and Upper-Air Observations". This article provided AFWA with the first documentation they were aware of that dealt with cloud thicknesses for various cloud types other than cumulonimbus. As a result, AFWA upgraded the RTNEPH model's default cloud

thicknesses in the summer of 1995. The cloud types and associated new default thicknesses are shown below:

Cloud Type	New Thickness (m)
Stratus	6300
Cumulonimbus	1000
Stratocumulus	1800
Cumulus	1200
Altostratus	1200
Nimbostratus	2100
Altocumulus	1800
Cirrostratus	1800
Cirrocumulus	1800
Cirrus	900

06/30/9

In early 1995, AFWA attempted to improve RTNEPH's sensitivity to cloud over cold ocean currents, a region of persistent under analysis. Initial efforts to "tune" these areas were met with mixed success, since reducing under analysis over cold ocean currents led to over analysis in many other oceanic areas. AFWA reevaluated the problem and decided a better approach was to redefine what the RTNEPH model considered to be "tropical". As a result, AFWA implemented a change in June 1995 which increased the number of locations the RTNEPH considered as tropical (warm ocean currents were added away from the equator). This allowed AFWA to increase the sensitivity over cold ocean currents without affecting other oceanic areas. Cloud detection increased approximately 10% over colder waters, with no adverse impact elsewhere.

03/01/9

AFWA found an error in the RTNEPH model in November 1995 where altostratus clouds were being changed to nimbostratus clouds if the present weather indicator was missing. Their investigation discovered numerous nimbostratus clouds over water, when altostratus was the appropriate type. Since the present weather indicator is usually absent over water points (there are extremely few conventional observations over ocean areas), AFWA was able to trace the error to a missing present weather value. A correction was implemented in March 1996.

03/01/9

When AFWA upgraded the RTNEPH model's default cloud thicknesses in the summer of 1995, an error was discovered in the cloud typing scheme. Stratus clouds with top heights near the low/mid cloud height value cutoff were being re-identified as altostratus. A correction for this error was implemented in March 1996.

04/10/9

In the summer of 1995, OL-A, AFCCC and AFWA agreed to transition two meteorological gross error check algorithms used by OL-A, AFCCC in the daily processing of RTNEPH data from OL-A to AFWA. One algorithm checked that the present weather indicator was compatible with the cloud cover, while the other algorithm ensured all layers below a layer of no cloud also contained no cloud. These changes were implemented in April 1996.

04/10/9

A change was made which corrected the tendency for the RTNEPH model to place cloud bases at the ground. Again, stratus clouds were the source of the problem. The RTNEPH had exception coding which allowed stratus clouds to have bases under the cutoff values established for all other cloud types. These stratus clouds could then be merged with other cloud layers, thus exaggerating the problem. This exception was removed and the change implemented in April 1996.

Lineage:
Source_Information:
Source_Citation:
Citation_Information:
Originator: Air Force Global Weather Central (AFGWC), Offutt AFB, NE
Publication_Date: 198803
Title: The AFGWC Automated Real-Time Cloud Analysis Model – Tech Note-88-001
Geospatial_Data_Presentation_Form: Global
Publication_Information:
Publication_Place: Air Force Global Weather Central
Publisher: 1LT Raymond B. Kiess and LT COL William M. Cox
Type_of_Source_Media: Digital file
Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 198401
Ending_Date: 200206
Source_Currentness_Reference: Creation Date
Source_Citation_Abbreviation: RTNEPH-Real Time Nephanalysis
Source_Contribution: AFCCC maintains the dataset.
Process_Step:
Process_Description: Data used All satellite and conventional data available within each grid point area used in the analysis.

Satellite Data

The Defense Meteorological Satellite Program (DMSP) acquires and processes meteorological satellite data from DMSP satellites. Although there is a capability to input National Oceanographic and Atmospheric Administration (NOAA) polar orbited imagery directly in RTNEPH, it's not included routinely because of limited computer resources. Both DMSP and NOAA satellites provide infrared and visual imagery for the daylight side of the globe, and infrared imagery on the night side. The first step of the analysis process integrates all available satellite date to produce an RTNEPH satellite analysis for a grid point. Although RTNEPH can operate without satellite data, the resultant analysis would be very limited.

Conventional Data

In the second step, AFWA collects all available conventional data (surface and radiosonde) from the Automated Weather Network (AWN) and integrates it into the RTNEPH conventional analysis, producing a "best report" for a given grid point. In some areas of the world (North America and Western Europe, or example), conventional data is abundant. Grid points in these regions may contain numerous surface reporting stations. For example, grid point I-13, J-51 in Box 45 of the Northern Hemisphere (latitude 40.67 north, longitude 73.99 west) offers five possible sources of surface data: Newark International Airport, NJ; John F. Kennedy International Airport, NY; and Fort Tilden, NY. The AFWA RTNEPH model, in "decision tree" fashion, selects which observations, will be used to build a "best report" type observation.

Merge Processor

The final automated step in producing an RTNEPH analysis is merging the outputs of the satellite and conventional analyses. The merge processor decides which data to use from the two inputs to produce the final

product. If recent conventional and satellite data is not available for the RTNEPH analysis, AFWA will "persist" the RTNEPH data from the previous hour's analysis.

Process_Date: 19950701
Process_Step:
Process_Description: AFCCC collected the data from AFWA every 3 synoptic hours (8 times per day) in 1/8 mesh grid by 60 boxes per hemisphere. AFCCC resorted the files into climatological records by BX, YR, MO, DAY, HR and archived monthly in chunks of 5 boxes from 198401-199608 and in chunks of 6 boxes from 199609-200206.
Process_Date: Unknown

Entity_and_Attribute_Information:
Detailed_Description:
Entity_Type:
Entity_Type_Label: RTNEPH - Real Time Nephanalysis
Entity_Type_Definition: Data Description
RTNEPH Climatic Database Format

Data Field	Byte Location	Code Definition
BX	1	Box 2-7, 9-56, 102-107, 109-156, 158-163
Year	2	Year
Mo	3	Month
Da	4	Day
Hr	5	Hour
#	6	Record # 1-8 of box if byte 1
j	7	J-Coordinate 1,9,17,24,33,41,49,57
Ind	8	Indicator: OL-A did/did not persist record 1 = Persisted by OL-A 2 = Not persisted by OL-A (if record was missing or deleted by quality control procedures)
PWX	9	*Present Weather 00-99, 255; WMO Code 4677
VSBY	10	*Visibility 00-50, 56-99, 255; WMO Code 4377
TF	11	Time flag 00-255, see Time Flag For the Grid Point
TA	12	Total ccloud amount 0-100 percent
SF1	13	Data source flags-Layer 1 (see Source Flags For Cloud Layer)
SF2	14	Data source flags-Layer 2 (see Source Flags For Cloud Layer)
SF3	15	Data source flags-Layer 3 (see Source Flags For Cloud Layer)
SF4	16	Data source flags-Layer 4 (see Source Flags For Cloud Layer)
Amt	17	Layer 1 cloud amount (0-103, see layer Cloud Amount)
Typ	18	Layer 1 cloud type (0-10, 25 see Cloud Types)
Bas	19	Layer 1 cloud base (0-255, see Cloud Heights (bases and tops)

Top 20 Layer 1 cloud top (0-255, see Cloud Heights (bases and tops)

Note: Elements from bytes 17-20 are repeated for layer 2, layer, 3 and layer 4.

FLAGS 33-36 Diagnostic flags (see Diagnostic Flags)

Data for grid points 2-512; 37-14,344 Same as for grid point 1.

28 bytes x 512 points = 14,336 bytes

*Prior to June 23, 1986, at 2100Z, missing/not reported present weather and visibility data is indicated by code zero; after that data/time, Code 255 is used (see Documented Problems)

Time Flag For The Grid Point

This reflects the time of the newest data at the grid point

Code Value	Definition
0-229	indicates age of data used in RTNEPH analysis (in hours)
230	indicates that data used in RTNEPH analysis is more than 229 hours old
231-254	indicates that data used in the analysis is for a data time after analysis time (code value - 230)
255	indicates that data used in RTNEPH analysis are more than 24 hours after analysis time

Source Flags For Cloud Layer Data

Bit	Definition
1	Low cloud type persisted
2	Layer cloud base estimated
3	Layer cloud top estimated
4	Best report from radiosonde data
5	Not used
6	Best report from surface data
7	Visual satellite data used as input
8	IR satellite data used as input

Note: If the bit is set on, the source condition exited.

Layer Cloud Amount

Layer cloud amount code range is 0-103, with the layer cloud amount rounded up to the next highest 5 percent. Additional values added to the layer cloud amount indicates the following:

An added one indicates a thin cloud layer.

An added two indicates the cloud layer was derived from merging two cloud decks.

An added three indicates the combination of the one and two.

Cloud Types

Code Value	Cloud Type
0	Clear
1	Cumulonimbus
2	Stratus
3	Stratocumulus

4	Cumulus
5	Altostratus
6	Nimbostratus
7	Altocumulus
8	Cirrostratus
9	Cirrocumulus
10	Cirrus
25	Unknown

Note: If all four RTNEPH layers contain clouds, and a ground base layer of fog is located beneath the lowest reported cloud deck, the RTNEPH will indicate the fog by adding 10 to the cloud type code for layer 4 (the lowest layers contain clouds and a ground base layer of fog is located beneath the lowest reported cloud deck and the codes for the other cloud layers are unchanged.

Cloud Heights (Bases And Tops)

Code Value	Definition
0-200	30-meter increments for 0-6,000 meters MS
201-253	300-meter increments for 6,300-21,900 meters MSL. MSL height=(code - 200) x 300 + 6,000
254	Greater than 21,900 meters
255	Height not available

Diagnostic Flags

Byte	Bit	Definition
1	1	Not received (bogus flag)
	2	Best report flag-a conventional report was included in this point
	3	Spread data-data from a best report was spread to this point
	4	Visual satellite data was included in this analysis
	5	IR satellite data was included in this analysis
	6	Low-level cloud has been persisted past normal data cutoff time
	7	Identifies that although the visual satellite observed cloudy, the point is marked clear for lack of other supporting data
	8	Fog/haze superseded by other weather elements if present weather
2	1-3	Bits indicate the age of the oldest conventional data used in this report. This hour indicator will be used in situations when a conventional low-level cloud report was persisted while new satellite data was used as input for the analysis
.	4-8	Not used
3	1	Not used
	2	The "best report" contained radiosonde data
	3	Not used
	4	The "best report" contained surface data
	5	Ice-water point was iced over
	6	Snow--snow flag was set
	7	Tropics--point is in the tropics

8 IR daylight quarter orbit (q.o.)-this IR q.o. was in daylight
4 1 IR sunside quarter orbit-this point was on the sunward side of the IR q.o.
. 2 Visual daylight quarter orbit-this visual q.o. was in daylight
3 Visual sunside quarter orbit-the visual data was on the sunward side of the visual q.o.
4 Sunglint-visual data for this point fell in the sunglint cone
5-6 IR satellite ID, the IR satellite ID minus 1. This an internal ID (1-4) used to select tuning parameters at AFWA
7-8 visual satellite ID, the visual satellite ID minus 1

Entity_Type_Definition_Source: AFCCC
Overview_Description:
Entity_and_Attribute_Overview: Due to the volume of the data, customers are requested to specify the specific fields and/or regions they require.
Entity_and_Attribute_Detail_Citation: RTNEPH, AFCCC Climatic Database Users Handbook No. 1, USAFETAC/UH-86/001, September 1986 (Revised November 1996).

Distribution_Information:
Distributor:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: AFCCC/DOO
Contact_Address:
Address_Type: Mailing and Physical
Address: 151 Patton Avenue, Room 120
City: Asheville
State_or_Province: NC
Postal_Code: 28801-5002
Country: USA
Contact_Voice_Telephone: (828) 271-4291
Contact_Voice_Telephone: DSN 673-9004
Contact_Facsimile_Telephone: (828) 271-4334
Contact_Facsimile_Telephone: DSN 673-9024
Contact_Electronic_Mail_Address: doo_all@afccc.af.mil
Hours_of_Service: 0730-1630 Eastern Time M-F
Resource_Description: RTNEPH-Real Time Nephanalysis Database
Distribution_Liability: The data represents the results of data collection/processing for a specific U.S. Air Force activity and indicates the general existing conditions. As such, it is only valid for its intended use, content, time, and accuracy specifications. The user is responsible for the results of any application of the data for other then its intended purpose.
Custom_Order_Process: Order through the above distribution contact or this web site: https://www2.afccc.af.mil/forms_mil/html/restricted/sarform.html

Metadata_Reference_Information:
Metadata_Date: 20070215
Metadata_Review_Date: 20070215
Metadata_Future_Review_Date: 20080215
Metadata_Contact:
Contact_Information:

Contact_Organization_Primary:
Contact_Organization: AFCCC/DOD
Contact_Address:
Address_Type: Mailing and physical.
Address: 151 Patton Avenue Room 120
City: Asheville
State_or_Province: NC
Postal_Code: 28801-5002
Country: USA
Contact_Voice_Telephone: (828) 271-4299
Contact_Voice_Telephone: DSN 673-9006
Contact_Facsimile_Telephone: (828) 271-4334
Contact_Facsimile_Telephone: DSN 673-9024
Contact_Electronic_Mail_Address: dod@afccc.af.mil
Hours_of_Service: 0730-1630 EST M-F
Metadata_Standard_Name: FGDC-Content Standards for Digital Geospatial Metadata.
Metadata_Standard_Version: FGDC-STD-001-1998
Metadata_Time_Convention: Universal Time
Metadata_Access_Constraints: None
Metadata_Use_Constraints: None
Metadata_Security_Information:
Metadata_Security_Classification_System: DoD
Metadata_Security_Classification: Unclassified
Metadata_Security_Handling_Description: None