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## Chapter 1 : Intellicast - GreenlandNorth America Local Weather Forecast, Reports and Maps

*Summaries of meteorological upper-air observations, , Angmagssalik, Greenland by Danske meteorologiske institut. 1 edition - first published in Summaries of meteorological upper-air observations , Danmarkshavn, Greenland.*

For westerly and easterly winds detached jets form at the southern tip, where coastal jets converge, which propagate large distances across the ocean. This is despite it being the largest ice-capped structure in the Northern Hemisphere see Fig. Greenland is critically sensitive to climate change e. For example, it acts as a large atmospheric heat sink through ice albedo feedback. Flow over and Vol. Here there are extremely sharp gradients in roughness and elevation. Both models showed that there are marked positive and negative perturbations in mean velocity i. These jets are associated with rising and falling airstreams which induce changes to cloudiness and precipitation. General concepts arising from these studies are reviewed in section 2. Most of the coastal stations are run by A. Imagery collected from polar orbiting satellites can give a qualitative analyses of the surface wind patterns. Case studies for four contrasting synoptic conditions over Greenland are studied here using numerical modelling and observations. The numerical model simulations combine mesoscale simu- lations with a horizontal resolution of approximately 12 km and ECMWF operational analysis data at 0: The observations combine satellite imagery and the ground-based observations discussed above. AVHRR channel 4 thermal infra- red was employed. Observations are included for the purpose of comparison, to corroborate model results, and to give a more comprehensive overview of meteorological conditions prevailing over southern Greenland during each of the case-study days. Section 3 will analyse the synoptic conditions for each case study. Section 4 describes the numerical mesoscale model used. Section 6 examines air-sea interaction. Section 7 examines cloudiness and precipitation over southern Greenland. Section 8 is a discussion. This causes weather systems to behave somewhat like turbulent eddies passing over or around an obstacle. This parameter characterises the strength of the inertial to buoyancy forces. In this situation if FH is less than about 0. In the upper layer above zd the streamlines pass over the mountain, but asymmetrically; ascending on the upwind side where the velocity decreases and descending on the downwind side close to the surface, where the velocity increases and internal waves are generated. Lee waves propagate above the mountain and A. D is the half-width of the mountain and H its height. In the interface between the layers intense shearing motions occur, especially on the downwind side. A third layer the base or lower layer is also shown. This means that more low level dense air passes over the mountain, causing longer wavelength K lee waves, and a lower value of zd , on the left than on the right. The saddle point S2 that was on the downwind side of the dividing streamline in Fig. At the same time the downwind saddle point S3 moves to the right- hand side of the eddies. The dividing streamline on the surface shown as dashed line is an attachment line upwind of PL ; PR. S1 ; S2 ; S3 are saddle points on the surface. The outline of the mountain is indicated by the thick black line. Note the separated detached pair of recirculating cyclones eddies , which extend up to the height zd of the dividing streamline. This can lead to concentrations of vorticity at R1 and R3 , where the velocity decreases, but a decreased concentration of vorticity at R2. This may have considerable implications for the future climate to the east and southeast of Greenland and the Rocky Mountains. This is why realistic case studies are necessary. Synoptic Explanation of Case Studies Below is a short explanation of the synoptic conditions for each case study. Conditions were representative for approximately a hour period. These are based on interpolation and NWP calculations, i. In addition, spot readings are given for representative DMI stations on the southwest coast of Greenland Paamiut and Nunarsuit , the east coast Tasiilaq , the southeastern coast Timmiarmiut and Ikermiuarsuk and the extreme southern coast Prins Christian Sund. The data used are temperature at a height of 2 m and the wind velocity and direction at a height of 10 m note for GC-Net data this height can vary depending on the amount of snow. The infrared satellite picture for approximately 05UTC see Fig. During the course of the day the cloud travelled across southern Greenland see Fig. They are typically marked by high pressure over northern Greenland. The depression was fully mature, as marked by its three occluded fronts and broken spiral cloud bands see Fig. The depression was a near-stationary feature throughout the day. The infrared satellite picture for approx- imately 05UTC see Fig. However, the bulk of Greenland was under clear skies. Table 2 shows the station reports for 12UTC. Conditions were coldâ€”â€”very cold at South Dome. Most of the station reports show a strong northeast wind incident on Southern Greenland. Figure 6 Synoptic analysis for 3 June, southerly case. Distinct cases are relatively uncommon and they typically occur with a low-pressure system anchored southwest of Greenland and tend to yield precipitation around the southern and south-south-west margins. This case is unique in being near midsummer; the others are all winter cases. There were further low pressure systems situated on the west coast of Greenland and south of Iceland. Table 3 shows the station reports for 12UTC. A couple of the stations and have a near southerly wind; the others have something closer to a northerly! Consequently Greenland was in the grip of a strong northerly air stream. The infrared satellite picture for approximately 15UTC see Fig. An intricate herringbone structure of partly open cloud cells suggests strong convection in destabilised polar air as it hit open waters around the south of Greenland. The area immediately around Iceland, including the Denmark Strait, was considerably cloudier with very large convective cloud cells. Table 4 illustrates the extremely cold conditions at 12UTC. Figure 7 Synoptic analysis for 21 February, northerly case. Here the model is run in NWP mode as a mesoscale model. A limited-area domain was used with uniform resolution within the domain achieved through a rotated pole, i. Lateral boundary conditions are generated by nesting the limited-area domain within UM 4. The domain size was a by latitude-longitude grid with 0: Computed using UM 4. Wind speed vectors are averaged over 8 grid points. At the mb height which is roughly the same height as the summit of Greenland the UM 4. At mb height see Fig. The width of the jet here is greater than km i. In this wake region the wind vectors in surface and mb plots appear to re curve slightly to the right up to several hundred kilometres downstream of Cape Farewell not purely synoptic factors. At the mb height the UM 4. Over the plateau itself the UM 4. South-easterly katabatic winds are evident in the western part of Greenland. Easterly Approach Flow Fig. The width of the jet here is roughly â€” km i. In this wake region the wind vectors curve slightly to the right due to the deep, low pressure system situated south of Greenland see Fig. As the jet passes the tip it curves slightly to the right looking downwind and its velocity begins to decrease. Additional contour data show very sharp velocity gradients at the edges of the jet. An infrared satellite image see Fig. A synoptic high is stationed over the main plateau. Southerly Approach Flow Fig. The width of the jet here is roughly â€” km. This is also evident 12 hours earlier in the UM 4. No equivalent northerly wind vectors are seen in the and mb height data see Fig. Northerly Approach Flow Fig. Inspection of contoured data show sharp gradients of velocity parallel to the coastline. The width of the jet here is approximately km. As the jet passes around the tip it curves markedly to the left looking downwind , due to the combination of Coriolis and interaction with the low pressure system centred in the Denmark Strait see Fig. Westerly Approach Flow The strong speed-up jet evident southeast of Greenland and discussed in section 5. This suggests that for this case study evaporation associated with the jet, more than the jet itself, is cooling the sea-surface southeast of southern Greenland. We therefore have cooling and evaporation of relatively warm sea water, resulting in downwelling. Upstream of Cape Farewell weak downwelling might occur. But downstream of Cape Farewell the A.

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## Chapter 3 : Upper Atmosphere | Open Library

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Long time series of stratospheric temperature data, carefully screened and corrected to remove errors, are available for this purpose. Normal reporting practice usually ascribes a fixed time and position the station location to all data reported in the ascent. In reality, the ascent may take around 90 min to complete and the spatial drift of the radiosonde may exceed km. This note examines the magnitude of the errors associated with this practice using simulated radiosonde data generated from the ECMWF reanalysis archive. The results suggest that the temperature errors, while generally small in the troposphere, are locally significant in the stratosphere, particularly in the jet stream areas. However, the impact of the drift errors on global climate statistics is very small. Errors in the wind and humidity data are also examined. Comparisons between temperature for radiative heating or cooling of the temperature sen- datasets derived from radiosondes and the satellite- sors, or changes in the reporting practice make it a based Microwave Sounding Units MSU and Ad- challenging task to identify genuine climate change sig- vanced MSU AMSU instruments show reasonable nals in a sequence of observations. The situation is par- agreement, but there is a large spread in the tempera- ticularly acute in the stratosphere where the low air ture trends estimated from the different datasets density may lead to inadequate sensor ventilation and spuriously high temperatures arising from solar heat- Seidel et al. Discrepancies between the surface ing. In spite of this, considerable effort has been de- and tropospheric temperature trends may be related to voted to identifying and correcting the errors, enabling errors arising from the solar heating of the radiosonde the construction of homogeneous datasets acceptable sensor Sherwood et al. The remainder of this report is organized as follows: Drift error related to coding practices for radiosonde data 3. Simulated radiosonde observations The data routinely available to researchers are usu- a. Rationale and data generation ally based on the products disseminated internationally Even if the original station data are available, it is not for Numerical Weather Prediction NWP. The original possible, without further information, to estimate the station data will normally contain information at sig- data that would have been recorded if the balloon as- nificantly more levels in the vertical compared with the cent were instantaneous time tref and without hori- disseminated product and will also record the position zontal displacement. One possible approach would be and time of the balloon at each level. The disseminated to match the observed data with high-quality NWP subset is usually coded using the World Meteorological analyses valid for tref and examine the differences, here- Organization WMO alphanumeric TEMP code after referred to as drift error. For may be available in datasets as metadata. To facilitate NWP the bal- polated reanalysis fields see appendix for details. The s sampling interval, producing analysis time. However, for some stations one suspects around points for an ascent to 10 hPa, was chosen that the official observation time corresponds with the to ensure reasonable accuracy in the interpolation of main hours and not with the balloon release time. Re- the data to standard levels; tests with a finer sampling gardless of local practices even if the raw data are avail- interval did not produce significantly different results. Three types of simu- the ascent. Note, however, that this does not affect ra- lated observations were generated: However, this is c Static offset simulations: The s, for example, were a significant period of the reported time to ensure that the midpoint of the for the assimilation system: In the presatellite era the qual- place of ERA data for a 3-month overlapping period ity of the stratospheric ERA data is more problem- to quantify the accuracy of the method. For conve- atical compared with data in the troposphere. Changes nience, individual ascent data will be referred to using in the number of observations have also impacted ho- the WMO identifier of the physical station. All refer- mogeneity Bengtsson et al. The lack ences are to simulated data. For the simulated observations, the generation ERA reanalysis project] used in conjunction cutoff point was fixed at km. All discussions from with the observational records Pawson and Fiorino hereon refer to the simulated observations generated , ;

Santer et al. Note from this dataset. Furthermore, only the differences be- that the ERA assimilation system did not allow for tween the simulations, as discussed above, are used; drift in the radiosonde data. Note that in this application the accuracy of the around 0. Haimberger key issue for the reliability of the results. Data quality found similar trends in corrected radiosondes for the According to WMO , most modern radiosonde period â€"; for the later period, â€", the systems measure temperature in the troposphere with a trend is stronger, exceeding 1 K per decade. The re- standard error between 0. For relative humidity, the error difference data is not straightforward. For wind, the sug- will not be reflected in the difference data. Also, if the mean flow pattern is upper troposphere. Drift errorâ€"General considerations The scatterplot in Fig. An examination of indi- vidual cases shows that, in general, the largest errors are associated with extreme horizontal drift when the ascent takes place in the vicinity of jet streams. Note that even for modest horizontal drift less than 50 km the errors are larger for type I data and occasionally of the order of 1 K. Analyses of data from other sites show similar patterns: Temperature drift errors at 50 hPa for type I data: Scatterplot of temperature drift errors at 50 hPa for a type I and b type II data for station Keflavik: Data are appendix for data details. The time series plots Fig. The mean vertical errors Fig. In general the spread in the error pattern is smaller with the higher-resolution op- erational analyses; this is more marked when the spread is large, as in the case of station Fig. The differences between the results give an in- dication of the sensitivity to interpolation errors and differences in the assimilation systems. In view of the reasonable agreement in the results, we believe that the simulated data have merit in evaluating mean drift er- rors, particularly in data-rich areas; in data-sparse ar- eas, the results need to be treated more cautiously. To investigate the impact of the drift error on climate averages the simulated data are stratified by season winter: Septemberâ€"Novem- ber and geographical region: Data-rich regions Figure 3 shows the mean temperature drift error at the hPa level, stratified by season, for sample sta- tions for the temporally offset type II data. For the Icelandic station Fig. The pattern for the Greenland station Ang- magssalik â€"located about km west of â€"is very similar Fig. In both cases there is some evidence of a small negative trend in the bias: For station Kirensk, Russia the bias is positive Fig. Note that for station North Front, Gibraltar the mean drift errors are very small Fig. For type I data the mean drift errors are in all cases slightly larger not shown. Mean seasonal temperature drift errors at 50 hPa for type II data for a station Keflavik: Data are for and UTC for the period â€"79 Fig. Note that in â€" stratified by season winter: Plots for other stations show similar results. For station , the displacement has a slight southerly bias with the trajectories at 50 hPa moving into warmer regions, in agreement with Fig. Figure 5a shows the vertical profile of the mean win- ter bias and root-mean-square rms error for for type I and type II data. The type II drift error has a much larger rms error in the lower atmosphere but is approximately the same, or slightly lower than, the type I rms error above hPa when the measurements are temporally closer to the reference data. The extreme drift errors are FIG. Scatterplot of the trajectory endpoints at 50 hPa from the simulated observations for station Keflavik: Shading is based on box numbers as per legend. There are small differences between the two yr periods that could be due to genuine change in the mean flow pattern or simply errors in the ERA- 40 analyses. A comparison between the mean winter ERA temperatures at 50 hPa in the vicinity of sta- tion shows that the mean northâ€"south tempera- ture gradient of the order of 0. Bias and rms error are bias. However, the mean winds have also changed be- shown for type I and type II data. Figure 5b shows the same plot for station data. The maximum positive bias occurs around 30 hPa. Again, the type II data produce slightly reduced bias and rms error statis- tics above hPa, but both types show small negative biases below hPa. It is difficult to find independent evidence for the temperature biases suggested by the simulated obser- vations. Modern NWP analysis systems provide feed- back on the differences between the observed radio- sonde data and a background NWP field; averaged over time these differences are often used to identify system- atic errors in the observations. However, instrumenta- tion and model errors may mask the relatively small errors attributable to radiosonde drift, particularly in the stratosphere. For example, mean differences ob- served minus background for station for the pe- riod December to February from the EC- MWF operational forecast system show a positive tem- perature bias of around 1 K at 50 hPa. Data-sparse regions Time series plots of the temperature bias at 30 hPa for two Antarctic stations are shown in Fig. Station Molodezhnaya shows a rise of about 1 K in the autumn bias type I from to Fig. Results for station Mawson; Figs. Global impact Figure 7 shows the vertical pattern of the bias and rms of the drift error for the combined stations in the NH. In general, the biases are very small and less than 0. Note that the sign of the bias is positive for the temporally offset type II data up to about hPa and that the corresponding rms errors are larger relative to the type I data. Above about hPa, the rms errors are generally smaller for type II data, particularly in summer. For the SH Fig. Seasonal mean temperature drift errors at 30 hPa for those in the NH apart from a seasonal dependence in station Molodezhnaya: Data are for and UTC for perature errors are a little larger but less than 0. Decemberâ€" Time series of the mean temperature bias and stan- February; spring: As an example, Fig. This is also reflected in some, but not all, Compared with type I data the wind errors for station data.

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