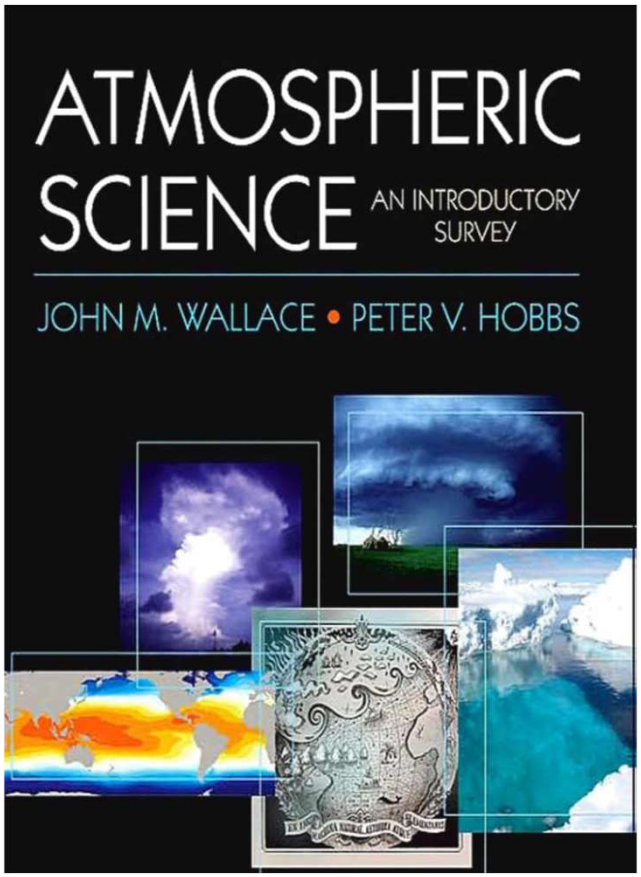
Physics and Chemistry of Atmosphere



Lecture 8 – added
Weather dynamics, case study

Grzegorz Karwasz

This chapter is entirely based on the quoted book, Chapter 8 „Weather Systems”, with Lynn McMurdie and Robert A. Houzem, Department of Atmospheric Sciences, University of Washington

I refer students to careful reading of that chapter, exceptionally documented.

Weather symbols

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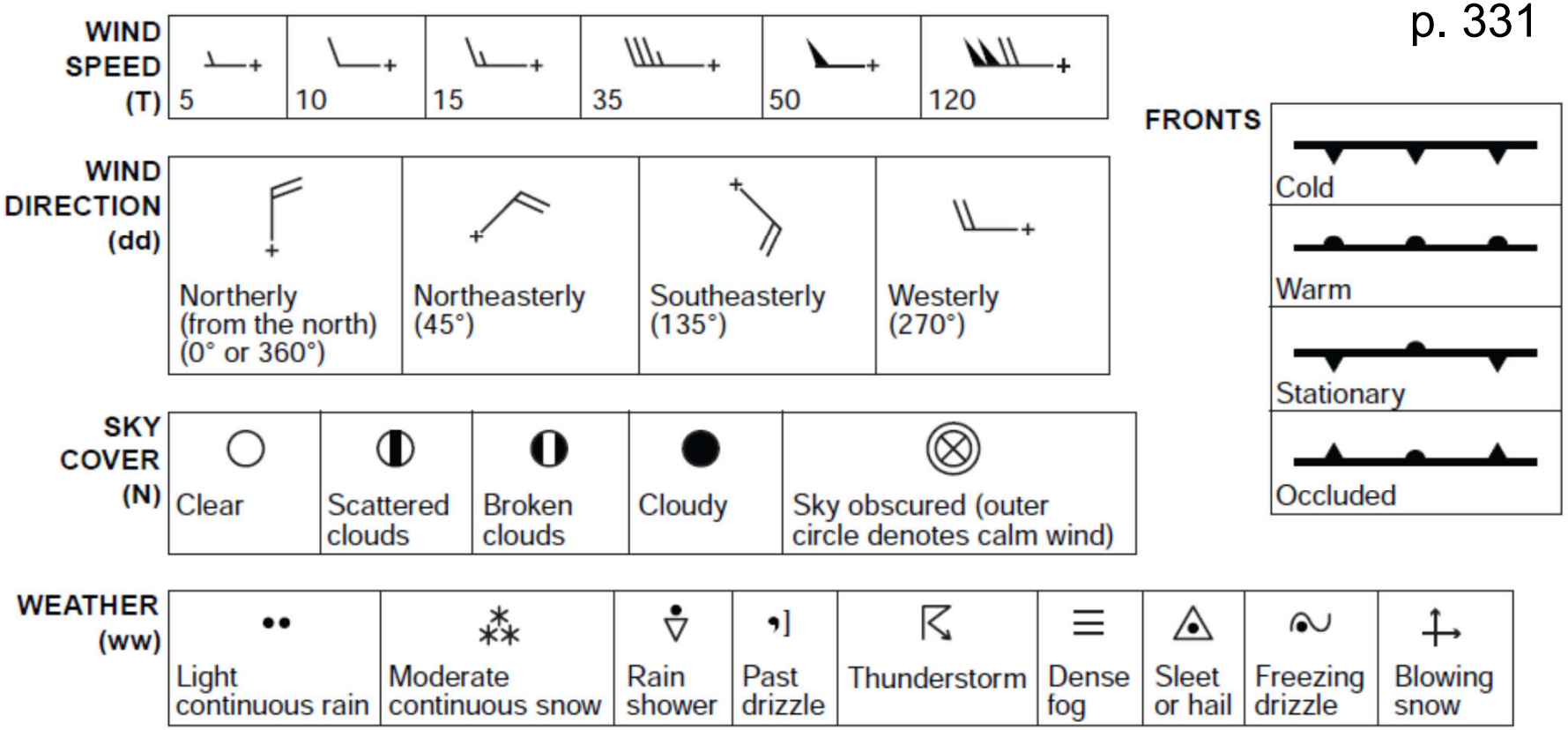


Pogoda (ang weather ≈ whether, wł. tempo ≈ czas) jest widoczna na poziomie ziemi, ale lekcje o dynamice uczą, że:

1) troposfera, z definicji, to warstwa mieszania się powietrza
2) przepływy w wyższych warstwach troposfery (5 km) są znacznie gwałtowniejsze
3) przepływy dotyczą również mieszania się w pionie (nie tylko konwekcji)

Poza tym, w prostych modelach …

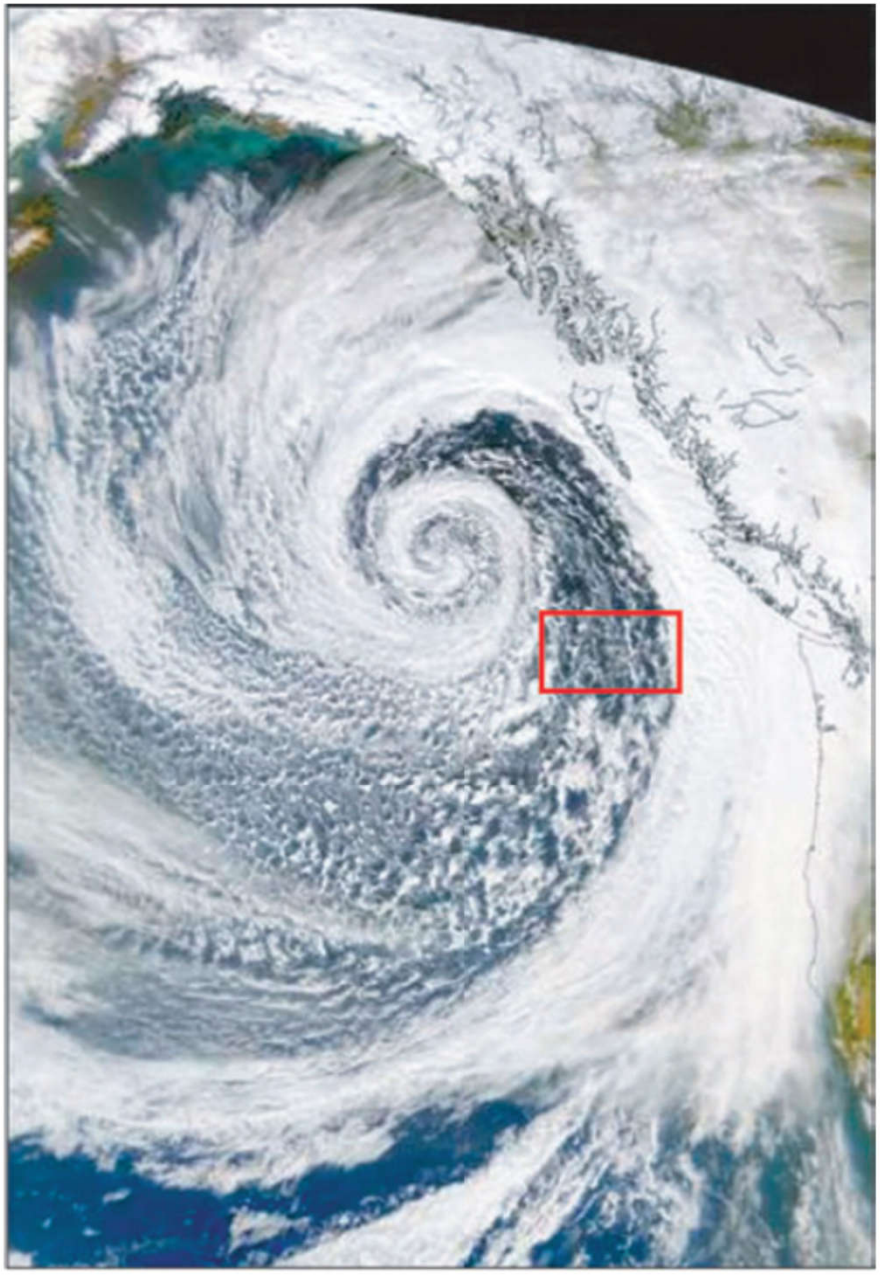


Fig. 1.12 An intense extratropical cyclone over the North Pacific. The spiral cloud pattern, with a radius of nearly 2000 km, is shaped by a vast counterclockwise circulation around a deep low pressure center. Some of the elongated cloud bands are associated with frontal zones. The region enclosed by the red rectangle is shown in greater detail in Fig. 1.21. [NASA

1. Zapominamy, że zagadnienia dotyczą więcej niż jednej strefy klimatycznej: fizycy mówią o komórkach Hadleya, Ferrela, polarnej – przeciwbieżnych przepływach pionowych, wynikającychi tak z istnienia termodynamicznych „grzejników” jak „chłodnic”, sił Coriolisa, różnic w liniowej prędkości obrotu Ziemia na różnych szerokościach geograficznych

2. Zapominamy o obecności lądów/ mórz, które jak pokazuje np. „wyż Azorski”, niż Islandzki, monsuny przed Himalajami a wyże w Kazachstanie, istotnie modyfikują przepływy

3. Zapominamy o różnicach między przepływami lepkimi i turbulentnymi, itd. itp.

Dwa obrazy różnią się nie tylko rozmiarami niżów ale przede wszystkim złożonością procesów.

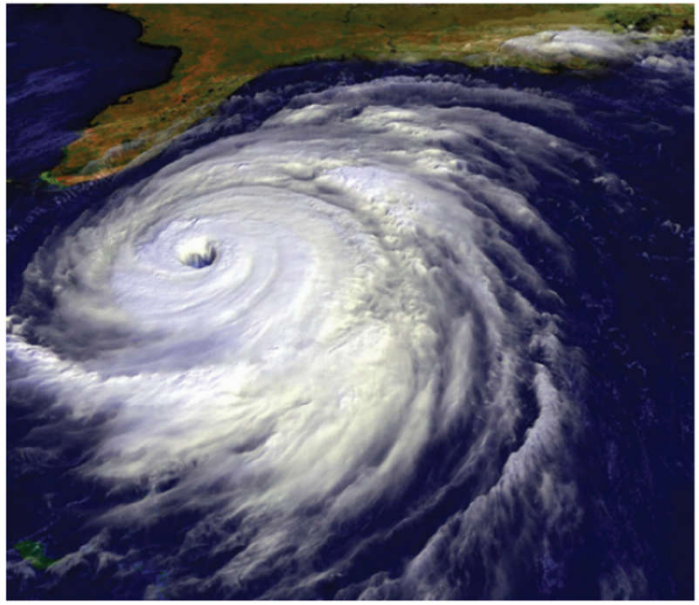
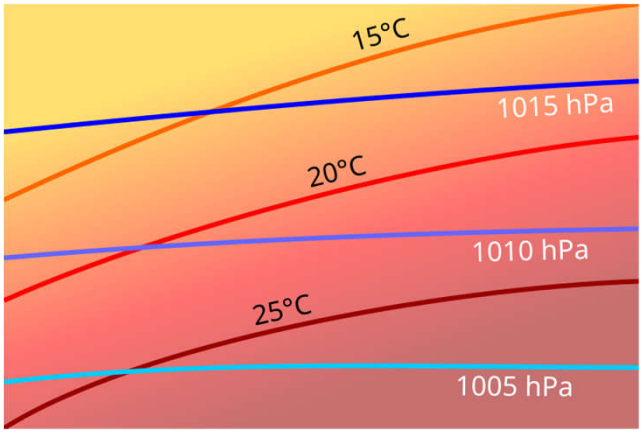


Fig. 1.13 The cloud pattern associated with an intense tropical cyclone approaching Florida. The eye is clearly visible at the center of the storm. The radius of the associated cloud system is ~600 km. [NOAA GOES imagery. Photograph

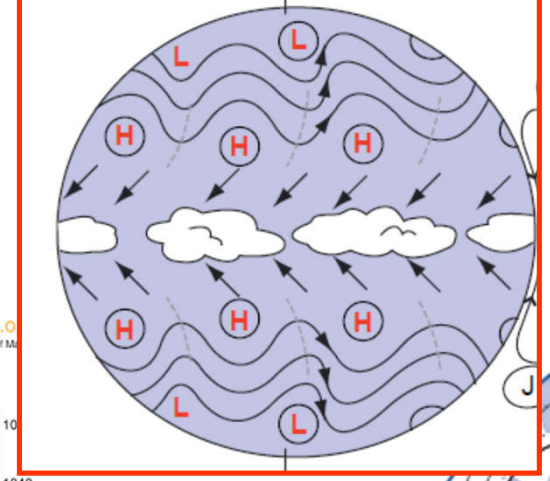


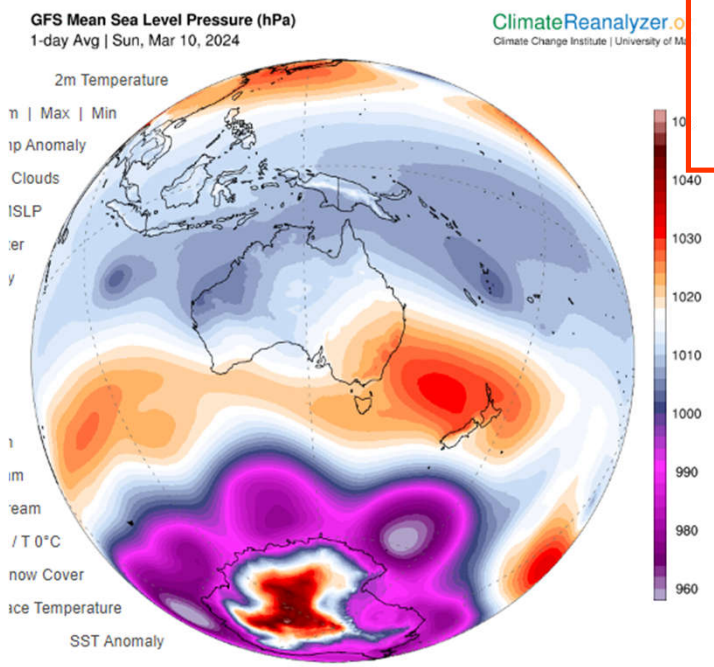
(na rysunku powyżej ciśnienie maleje z wysokością, co jest ewenementem!)

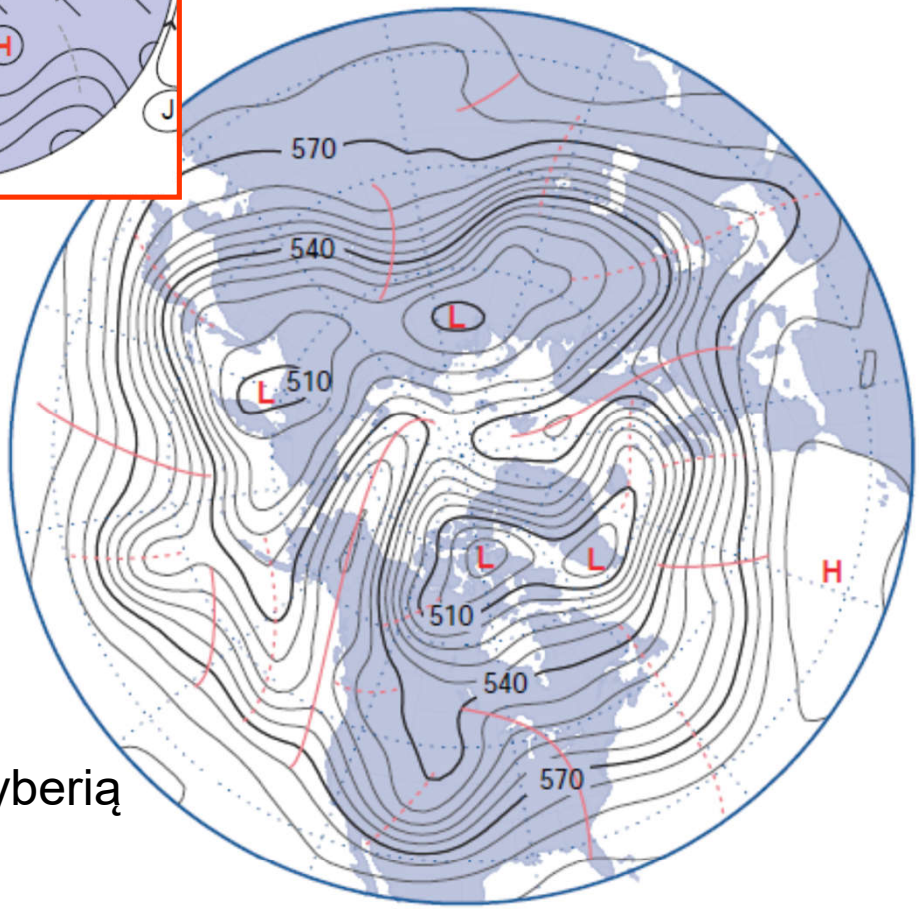
Baroclinic

Atmosfera (płyn) baro-kliniczny [inklinacja = nachylenie], to taki, w którym izobary nie są równoległe do izoterm. Związane to jest np. z różną wilgotnością powietrza albo napływem „innych" mas powietrza. Sytuacja baroklinicz-na jest typowa dla średnich szerokości geograficznych i w dużej mierze jest odpowiedzialna za powstawanie cyrkulacji cyklonowej i anty-cyklonowej w mezoskali

Baroclinic waves





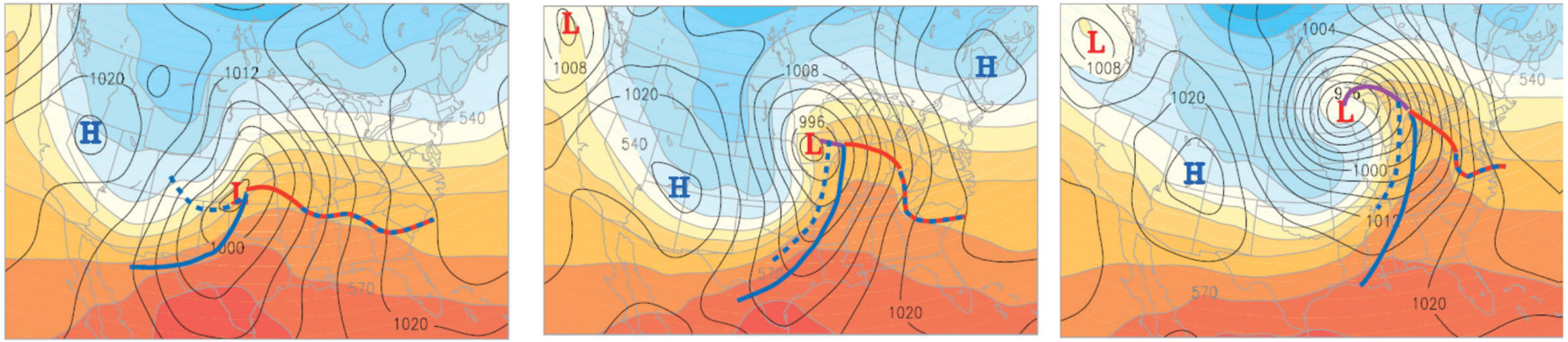


10/11/1998 Dwa wiry polarne: nad Kanadą i Syberią „Wybrzuszenia” ku północy nad Skandynawią i nad Alaską; na południe – nad Morzem Czarnym, Oklahomą i Pacyfikiem

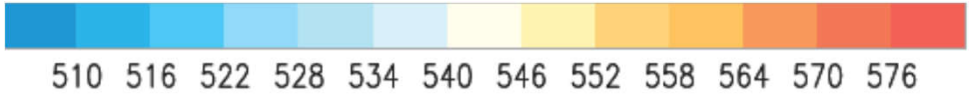
Całość przesuwa się na wschód ok. 10 m/s czyli pogoda powraca co 5-7 dni: cykl Fouriera objawowy, czyli **„synoptyczny”**

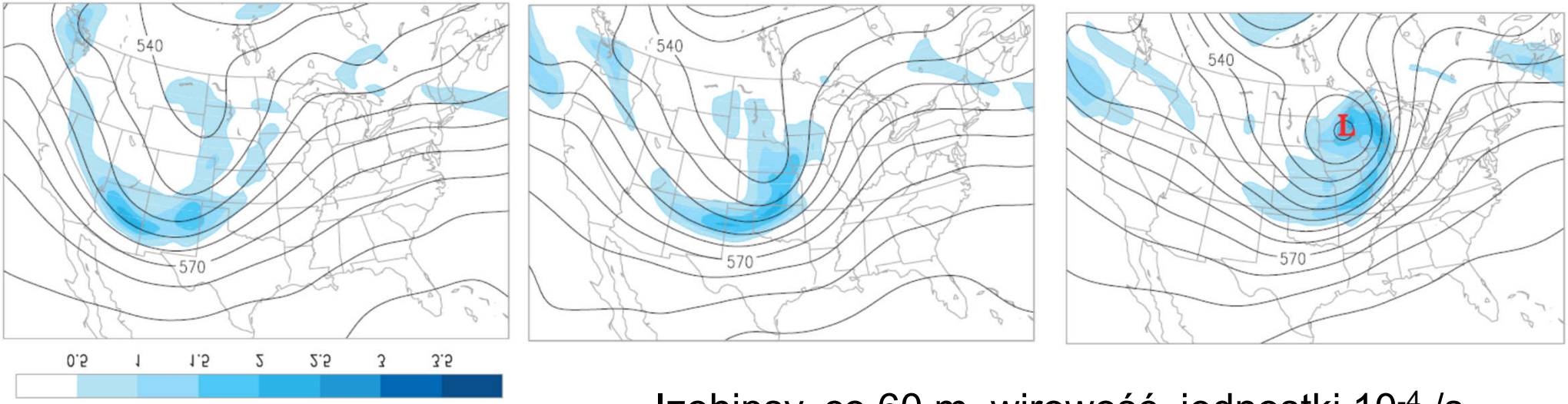
Fig. 8.2 Hemispheric 500-hPa height chart for 00 UTC Nov. 10, 1998. Contours at 60-m intervals. Contours labeled in tens of meters (decameters, dkm). Solid red lines denote the axes of *ridges*, and dashed red lines denote the axes of *troughs* in the 500-hPa wave pattern. [Courtesy of Jennifer Adams, COLA/IGES.]

Case study: USA, 10 Nov. 1998, 00, 09, 18 UTC



Ciśnienie na poziomie morza i grubość warstwy 1000 do 500 hPa (co 6 dm). Niż pogłębia się i przesuwa w kierunku cyklonowym. „Surface frontal positions, as defined by a skilled human analyst, are overlaid (8.3)





Izohipsy, co 60 m, wirowość, jednostki 10^{-4} /s

Fig. 8.3 Synoptic charts at 00, 09, and 18 UTC Nov. 10, 1998. (Left) The 500-hPa height (contours at 60-m intervals; labels in dkm) and relative vorticity (blue shading; scale on color bar in units of $10^{-4}\,s^{-1}$). (Right) Sea-level pressure (contours at 4-hPa intervals) and 1000- to 500-hPa thickness (colored shading: contour interval 60 m; labels in dkm). Surface frontal

Ciśnienie i wiatry: 00, 09, 18 UTC

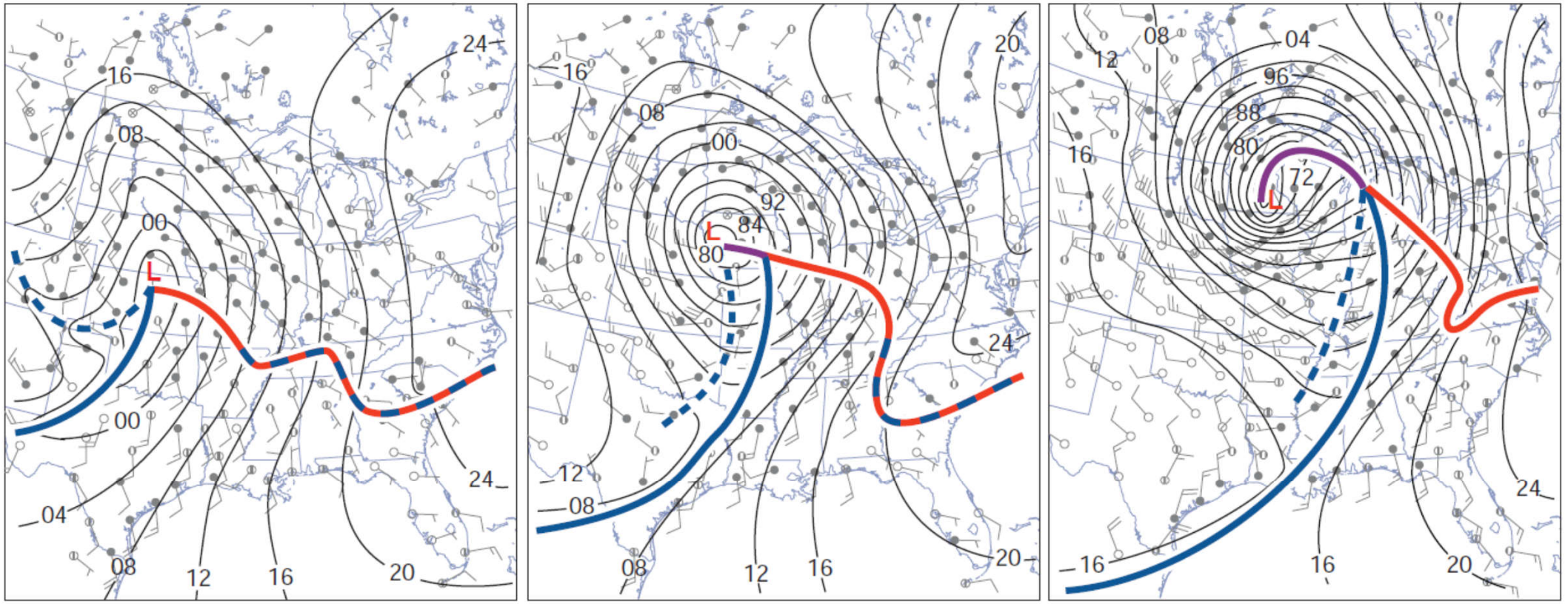


Fig. 8.6 Sea-level pressure, surface winds and frontal positions at 00, 09, and 18 UTC 10 Nov. 1998. Frontal symbols and wind symbols are plotted in accordance with Fig. 8.1. The dashed blue line denotes the secondary cold front. In this figure and in subsequent figures in this section, the frontal positions are defined by a human analyst. The contour interval for sea-level pressure is 4 hPa. [Sea-level pressure and frontal analyses by Lynn McMurdie, figure Courtesy of Jennifer

Ciśnienie na poziomie morza i wiatry. Nad frontem chłodnym wiatry z północy, pod frontem ciepłym wiatry z południa. Siła wiatru się wzmaga, i pod koniec dnia, wokół L przyjmuje kierunek geostroficzny.

Temperatura na powierzchni: 00, 09, 18 UTC

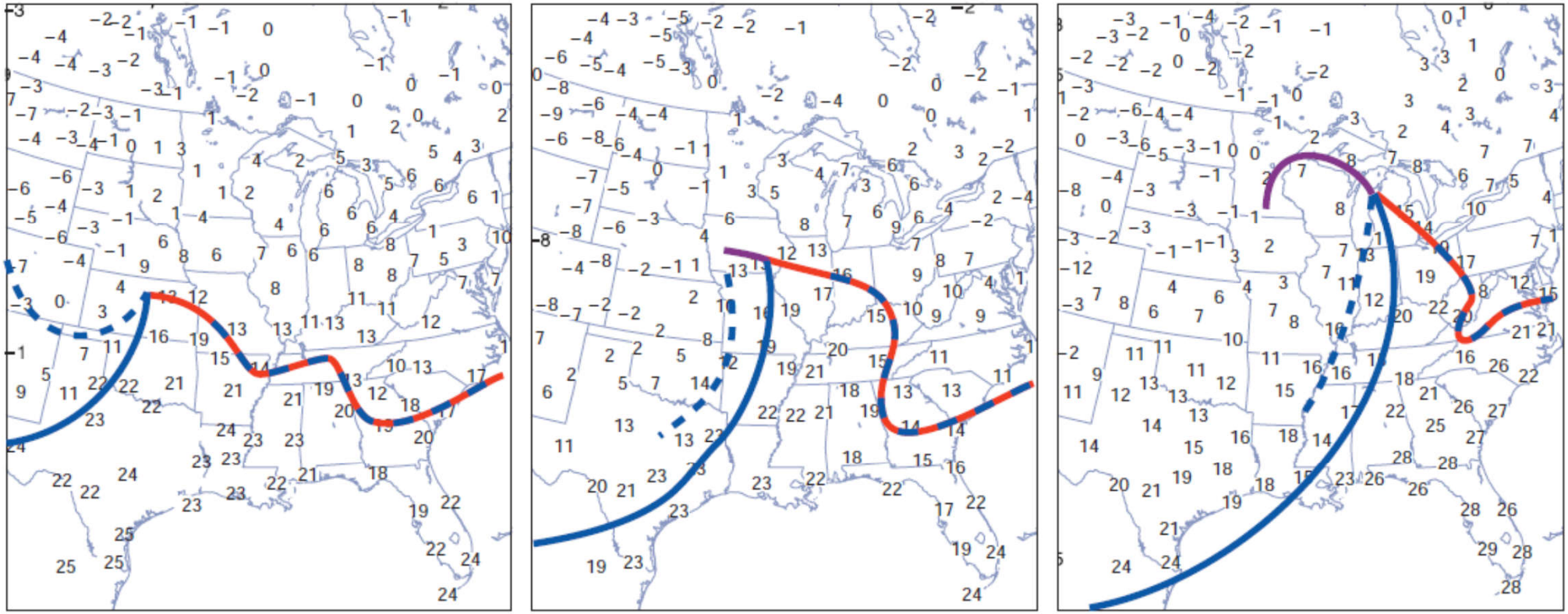


Fig. 8.7 Surface air temperature (in °C) and frontal positions at 00, 09, and 18 UTC 10 Nov. 1998. [Courtesy of Jennifer Adams, COLA/IGES.]

Znaczne różnice temperatur po obu stronach frontów.

Opady, mgły, i burze

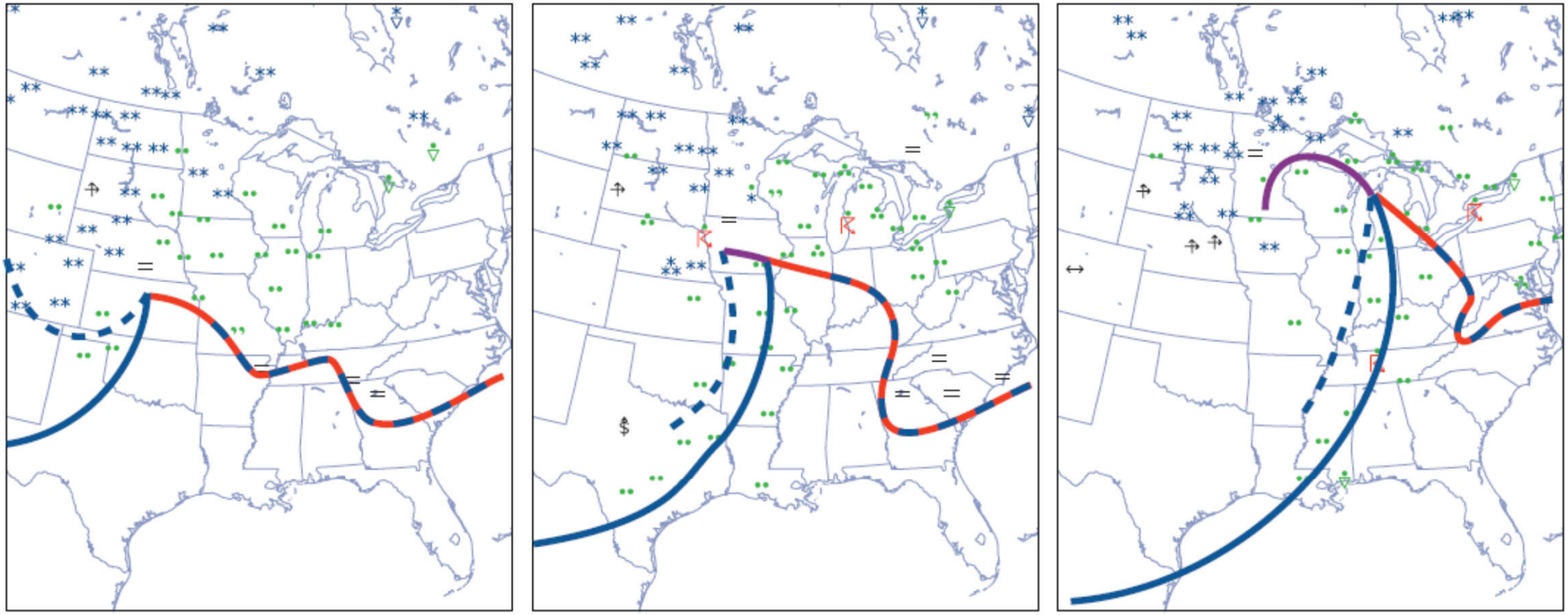


Fig. 8.15 Surface weather observations of rain, snow, fog, and thunderstorms at 00, 09, and 18 UTC 10 Nov. 1998. For plotting conventions see Fig. 8.1. [Courtesy of Jennifer Adams, COLA/IGES.]

Śnieg za frontem chłodnym, mgły przed frontem ciepłym.

Zachmurzenie w mapy „radarowej”

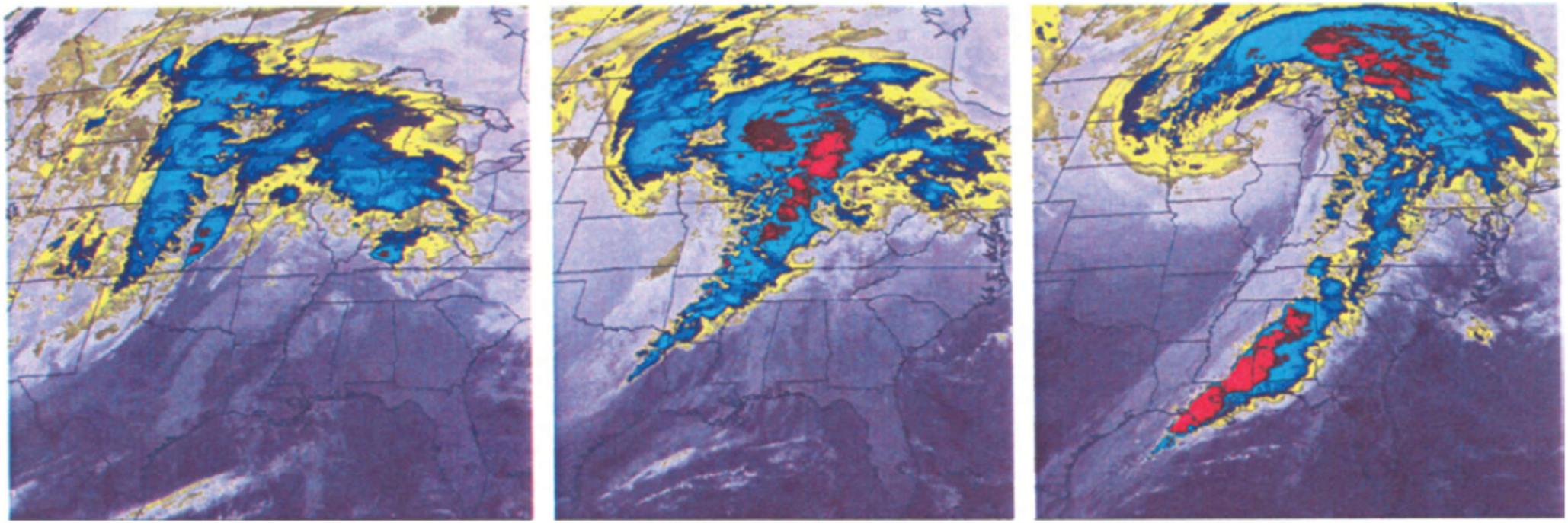


Fig. 8.17 Infrared satellite imagery for 00, 09, and 18 UTC Nov. 10, 1998, based on radiation in the 10.7-μm channel, in which the atmosphere is relatively transparent in the absence of clouds. Radiances, indicative of equivalent black-body temperatures T_E of the Earth's surface or the cloud top, are rendered on a scale ranging from black for the highest values (indicative of cloud-free conditions and a warm surface) with progressively lighter shades of gray indicative of lower temperatures and higher cloud tops. Color is used to enhance the prominence of the coldest (highest) cloud tops in the image.

Mapa w zakresie długości fali 10,7 um: ekwiwalentna temperatura ciała czarnego.
Obszary granatowe – brak chmur (wysoka riadiancja) .

Nasycenie parą wodną

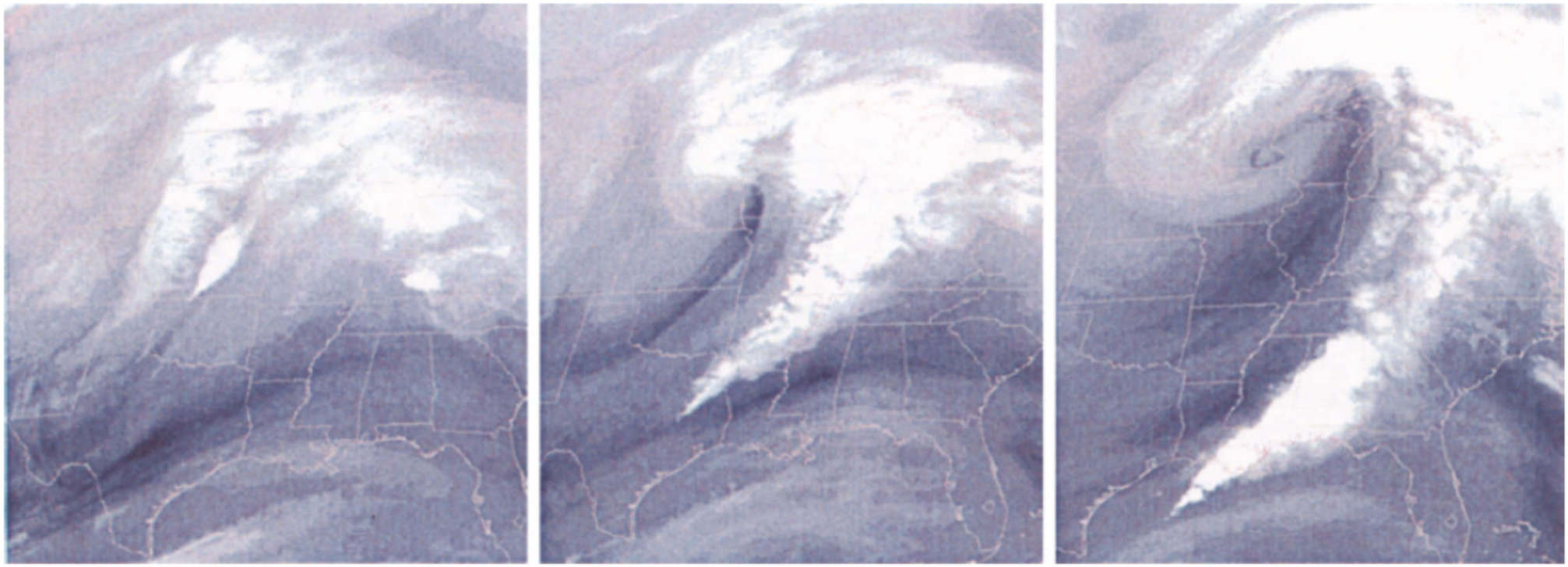


Fig. 8.18 Satellite imagery for 00, 19 and 18 UTC Nov. 10, 1998, based on the 6.7 μm "water vapor channel." The radiances in this band provide a measure of the mid- and upper tropospheric humidity which, in turn, is determined by the air trajectories. Air that has been rising tends to be moist, resulting in a high optical depth, a low equivalent blackbody temperature and a low radiance, and vice versa. Low radiances, indicative of ascent are rendered by the lighter gray shades and high radiances, indicative of subsidence, by the darker shades. The brightest features in the images are clouds with high, cold tops.

Mapa w zakresie długości fali 6,7 um: „water vapour channel” .

Przekroje pionowe

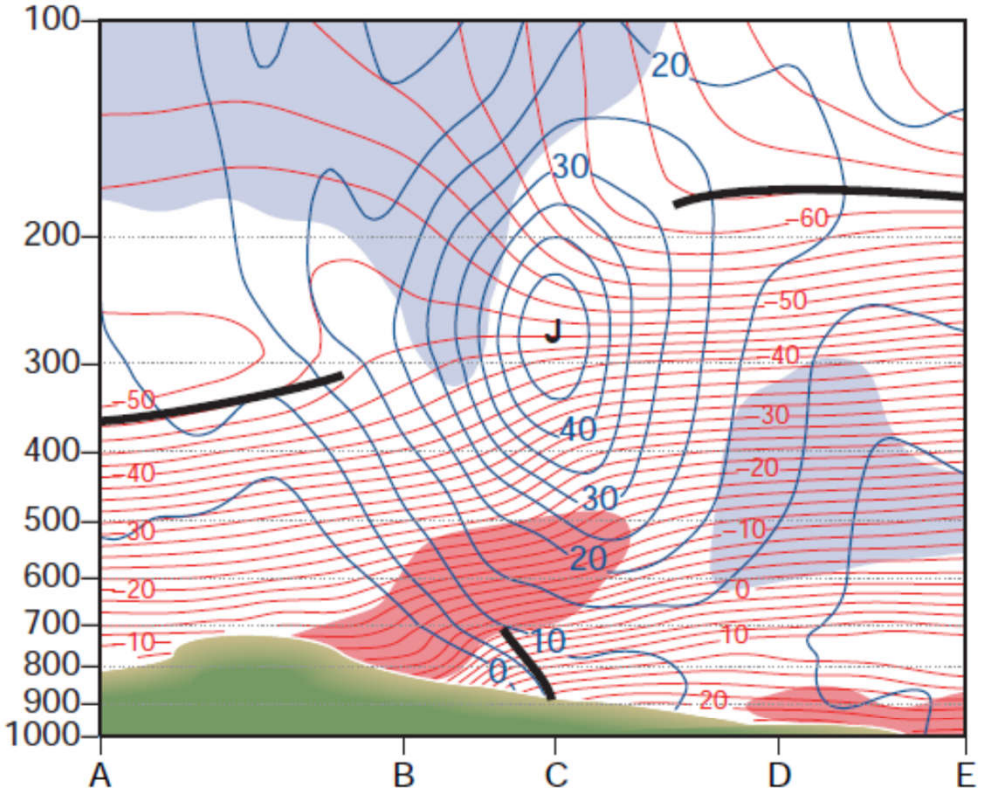


Fig. 8.27 Vertical cross section of wind and temperature for 00 UTC Nov. 10, 1998. This section extends from Riverton, Wyoming to Lake Charles, Louisiana (KRIW to KLCH; see Fig. 8.36). Temperature is indicated by red contours, and isotachs of geostrophic wind speed normal to the section, with positive values defined as southwesterly winds directed into the section, are plotted in blue. Regions with relative humidities in excess of 80% are shaded in red and below 20% in blue. Heavy black lines indicate positions of the surface-based fronts and the tropopause. The orientation of the section relative to the front is indicated in Fig. 8.36 at the end of this section. [Courtesy of Jennifer Adams, COLA/IGES.]

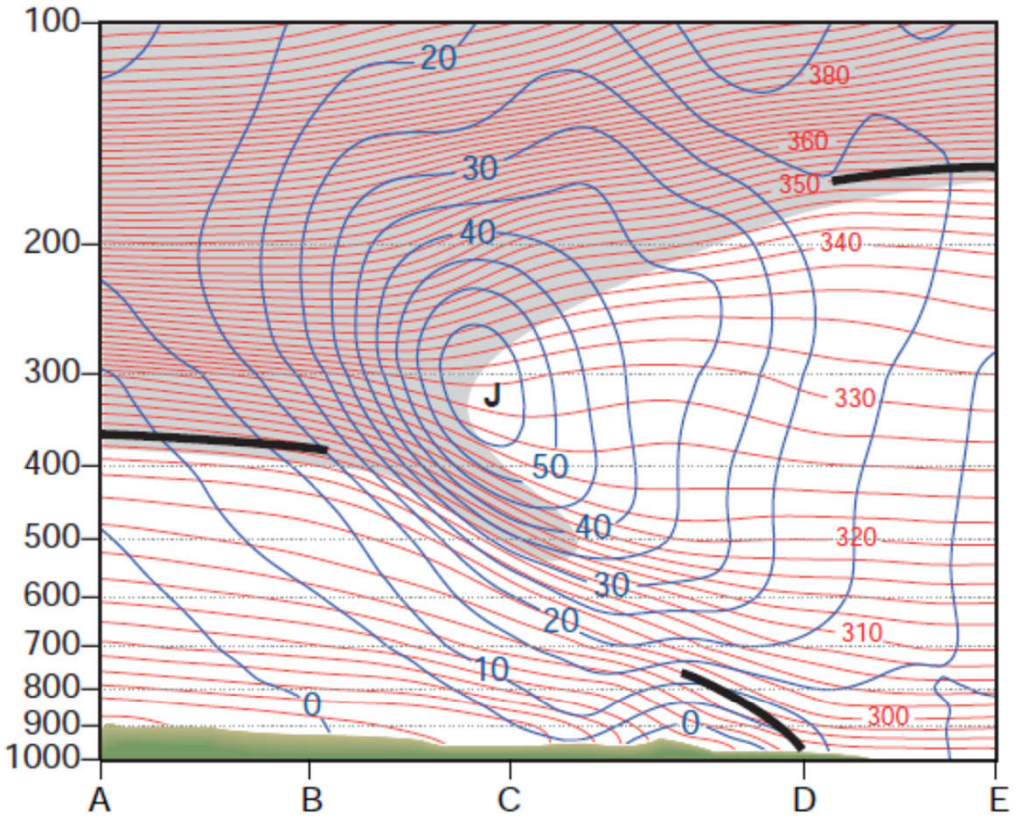


Fig. 8.28 Vertical cross section of wind and potential temperature for 12 UTC Nov. 10, 1998. This section extends from North Platte, Nebraska to Jackson, Mississippi (KLBF to KJAN; see Fig. 8.36). Potential temperature is indicated by red contours, and isotachs of geostrophic wind speed normal to the section are plotted in blue with positive values defined as southwesterly winds directed into the section. The region in which isentropic potential vorticity exceeds 10^{-6} K m^2 s^{-1} kg^{-1} is indicated by shading. Heavy black lines represent the position of the surface-based fronts and tropopause. [Courtesy of Jennifer Adams, COLA/IGES.]

Przejście frontu

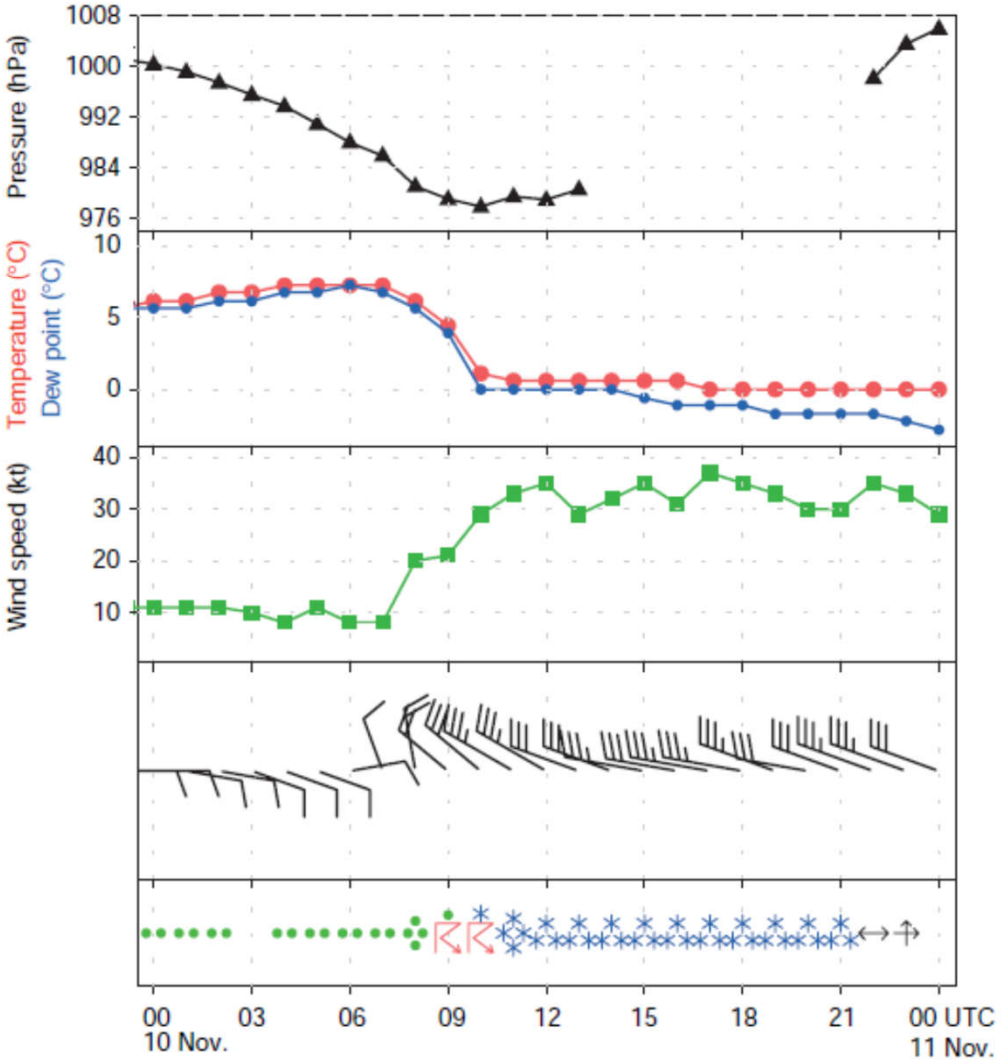


Fig. 8.16 Hourly surface observations for Sioux Falls, South Dakota (KSUX in Fig. 8.36) just to the west of the track of the center of the surface low. Some of the pressure data are missing. [Courtesy of Jennifer Adams, COLA/IGES.]

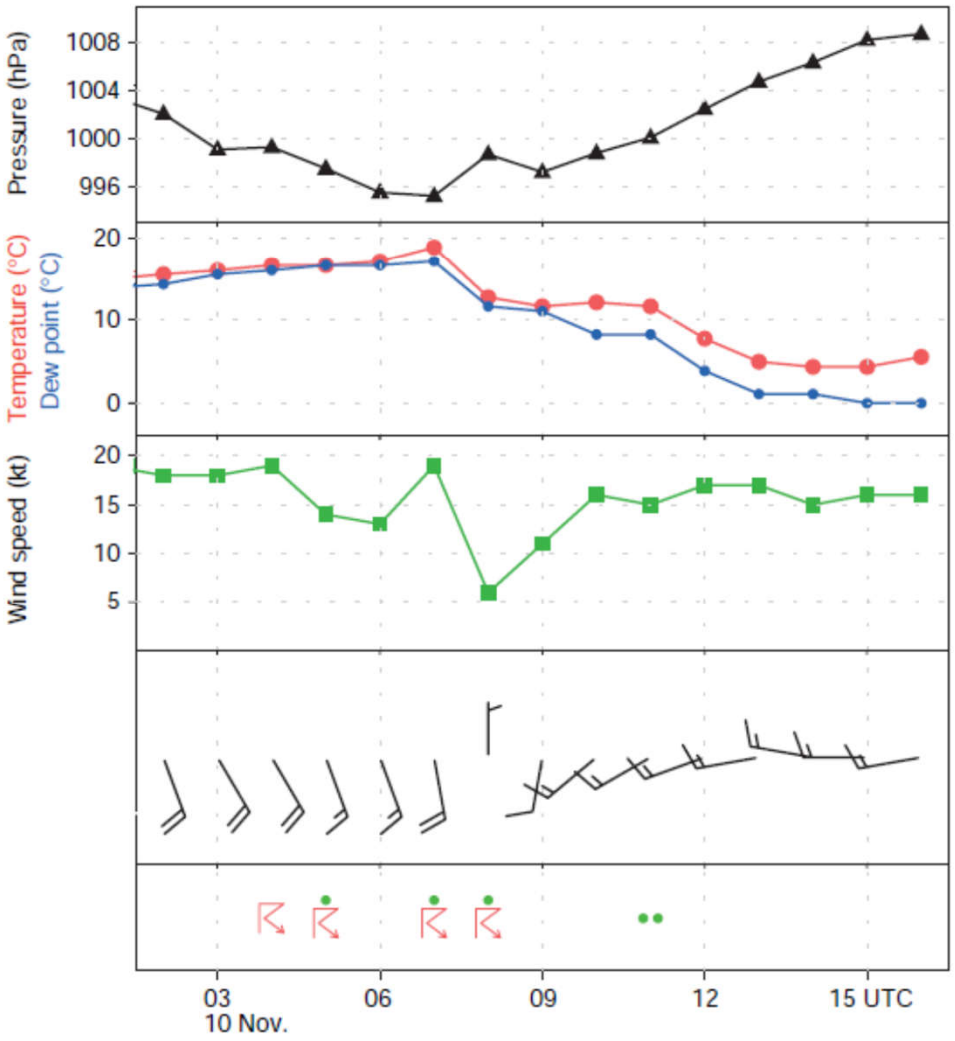


Fig. 8.20 Hourly surface reports for Springfield, Missouri (KSGF in Fig. 8.36) showing the passage of the squall line and primary cold front around 07–08 UTC. [Courtesy of Jennifer Adams, COLA/IGES.]

Opady po obu stronach frontów

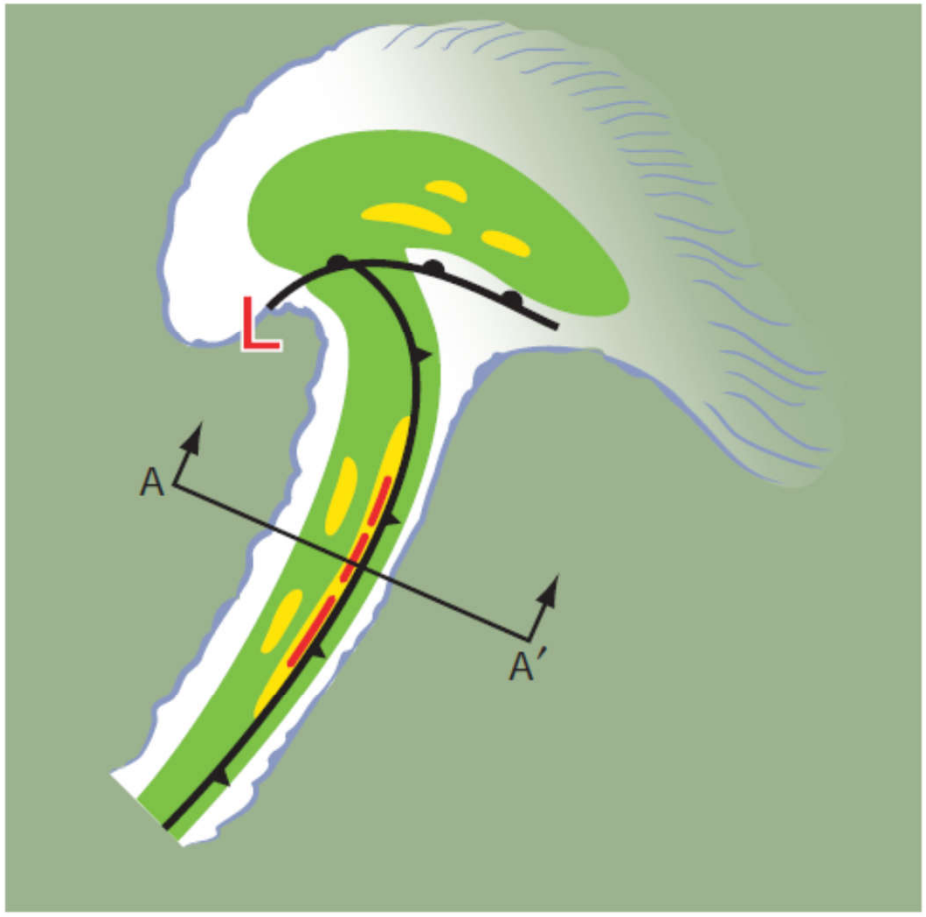


Fig. 8.34 Idealized schematic emphasizing the kinds c mesoscale rain bands frequently observed in association wit a mature extratropical cyclone. The green shading withi the cloud shield denotes light precipitation, yellow shadin denotes moderate precipitation, and red shading denote heavy precipitation. [Courtesy of Robert A. Houze.]

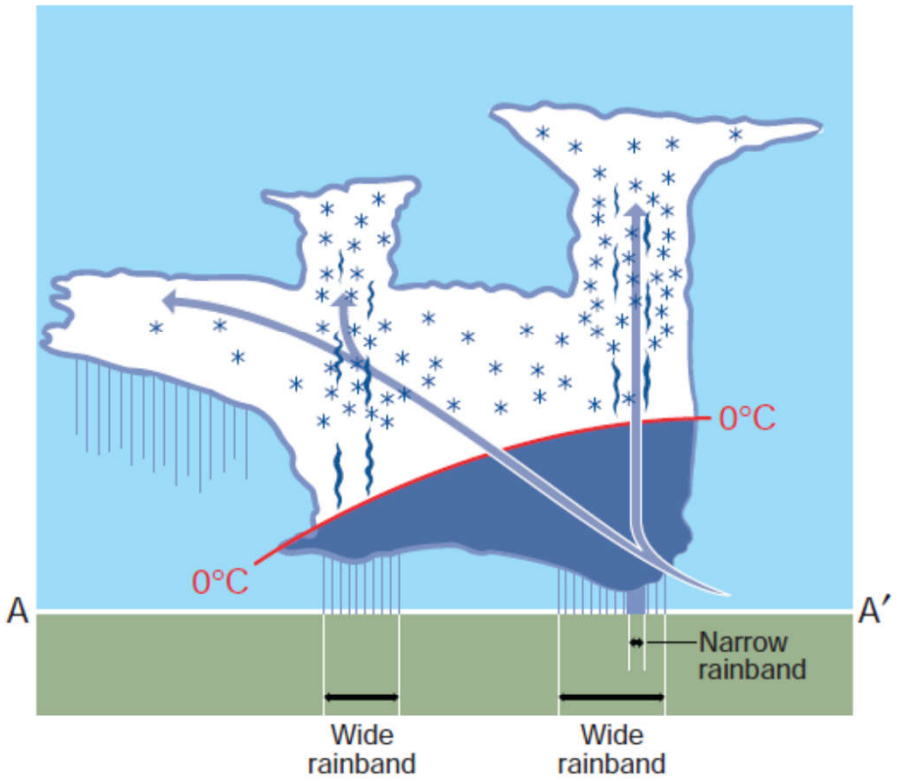


Fig. 8.35 Vertical cross section along AA′ in Fig. 8.34. The position of the cold front at the Earth's surface coincides with the leading edge of the narrow cold frontal rainband, and the frontal surface tilts upward toward the west with a slope comparable to that of the air trajectory. The dark blue shading indicates areas of high liquid water concentration, and the density of the blue asterisks is proportional to the local concentration of ice particles. High liquid water contents are restricted to the layer below the 0 °C isotherm except in regions of strong updrafts in convective cells, as represented by the narrow, dark blue "chimneys." See text for further explanation. [Adapted from *Cloud Dynamics*, R. A. Houze, p. 480, Copyright (1993), with permission from Elsevier.]

Wnioski

- Prognozowanie pogody wiąże się z koniecznością zbierania ogromnej ilości danych, z różnych warstw atmosfery
- W konsekwencji, modele matematyczne muszą te dane przetworzyć.
- Ale jak piszą autorzy tego „case study”: okład frontów jest wykreślony przez „skilfull human”
- I często lokalne prognozy (zachód Słońca) mówi więcej, niż prognoza z TV

Tuchom, 18/08/2023, 20:17, foto Maria Karwasz