YAĞIŞ

2. BÖLÜM

Yağış

- Sıvı haldeki yağış
  - *Yağmur*
- Katı haldeki yağış
  - *Kar*
  - *Dolu*
  - *Kırağı*
  - *Çiğ*

Yağışın Meydana gelmesi için gerekli koşullar;

1. Havanın soğuması
2. Yoğunlaşmanın olması
3. Yeryüzüne düşebilecek irilikte damlaların oluşması
4. Atmosferin o bölgesinde yeterli su buharı olması

BULUTLAR

YÜKSEK VE ORTA YÜKSEKLİKTEKİ BULUTLAR

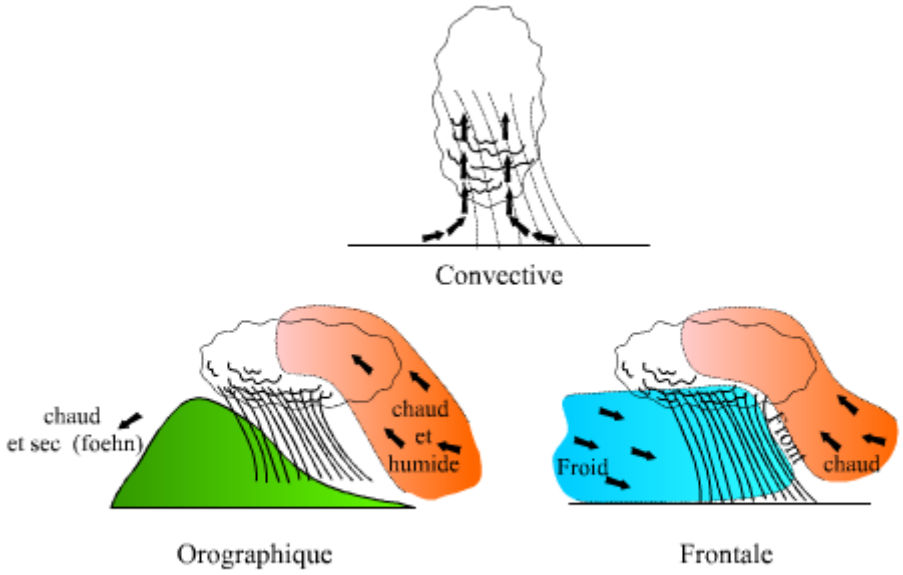
KÜMÜLÜS YAĞMUR BULUTLARI

KÜMÜLO-NİMBÜS YAĞMUR BULUTLARI

(http://www.windows.ucar.edu/)

Yağışın Oluşum mekanizmasına göre türleri

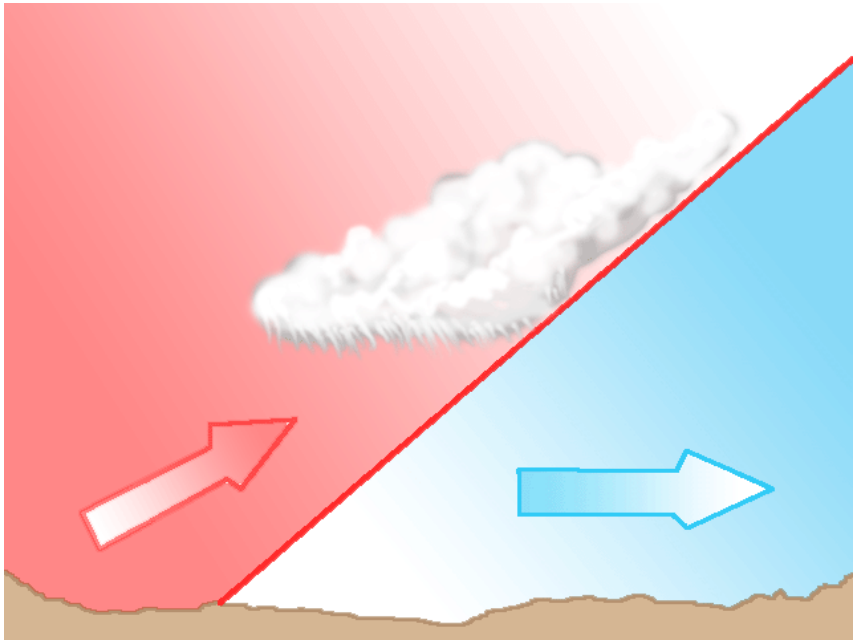
- Konvektif Yağışlar
- Orografik Yağışlar
- Cephesel (Siklonik, Depresyonik) Yağışlar



Konvektif Yağışlar

Orografik Yağışlar

Cephesel (Siklonik, Depresyonik) Yağışlar

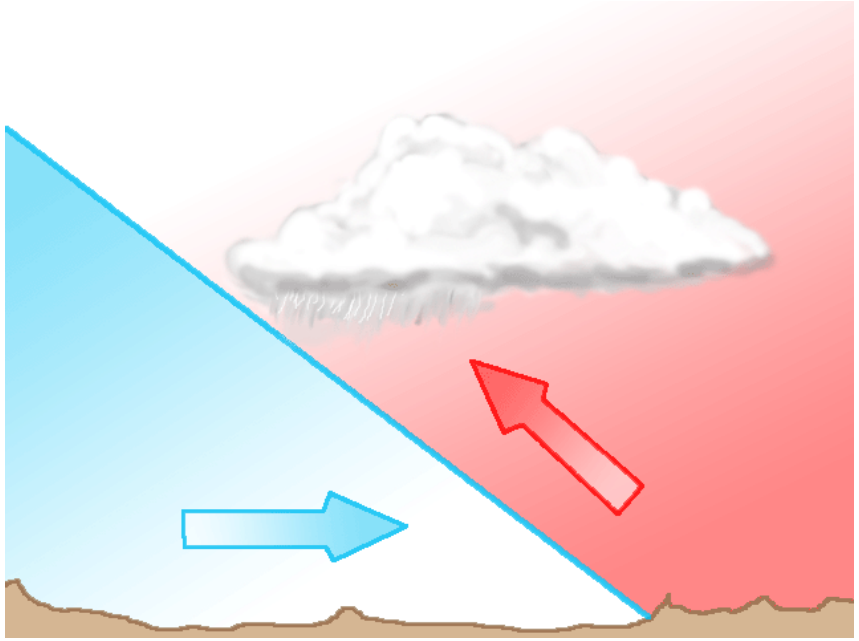


Sıcak Cephe Yağışları

Sıcak hava kütlesi soğuk hava kütlesini iterken daha az yoğun olduğundan yükselerek soğur..

Soğuk Cephe Yağışları

Soğuk hava kütlesi sıcak hava kütlesini iterken çok yoğun olduğundan kama şeklinde alta sokulur. Sıcak hava kamanın üzerinde yükselerek soğur..



YAĞIŞIN ÖLÇÜLMESİ

1. Plüviometreler
2. Plüviograflar (Yazıcılı)
   - Tartılı
   - Şamandıralı
   - Devrilen kovalı
3. Radarlar
4. Uydular (Araştırma döneminde)

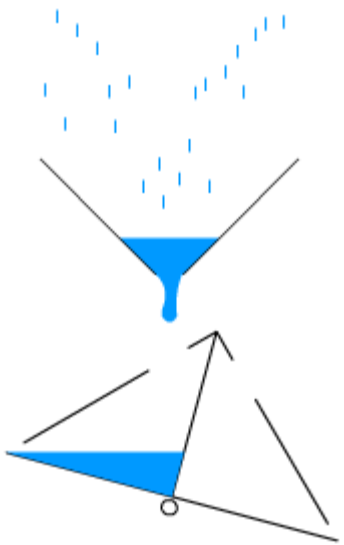
HELMAN PLÜVİOMETRESİ

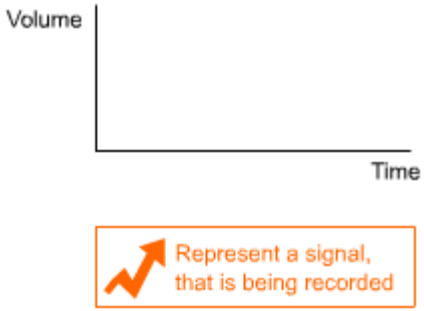
Standart plüviometre

This gage is called the SRG, or Standard Rain Gage. This is the most common form of non-mechanical rain gages used for official measurements for the National Weather Service.

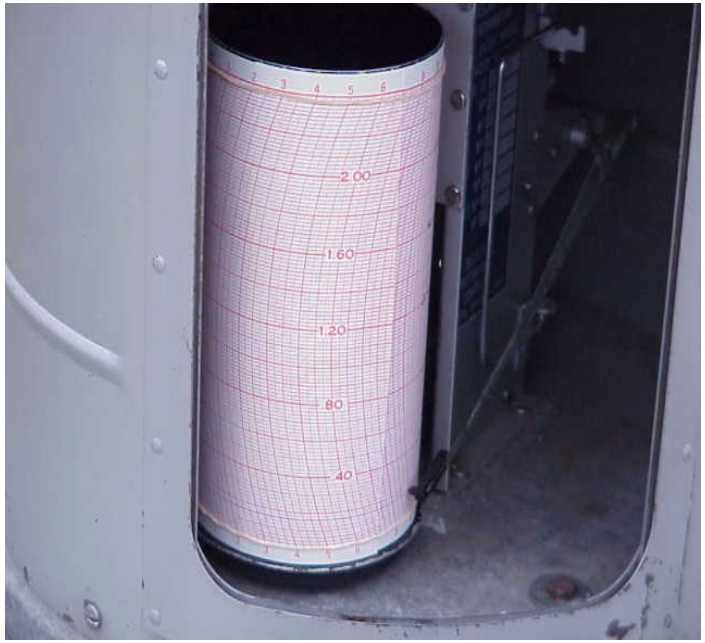
http://www.crh.noaa.gov/ind/coop.htm

Tartılı Plüviograf





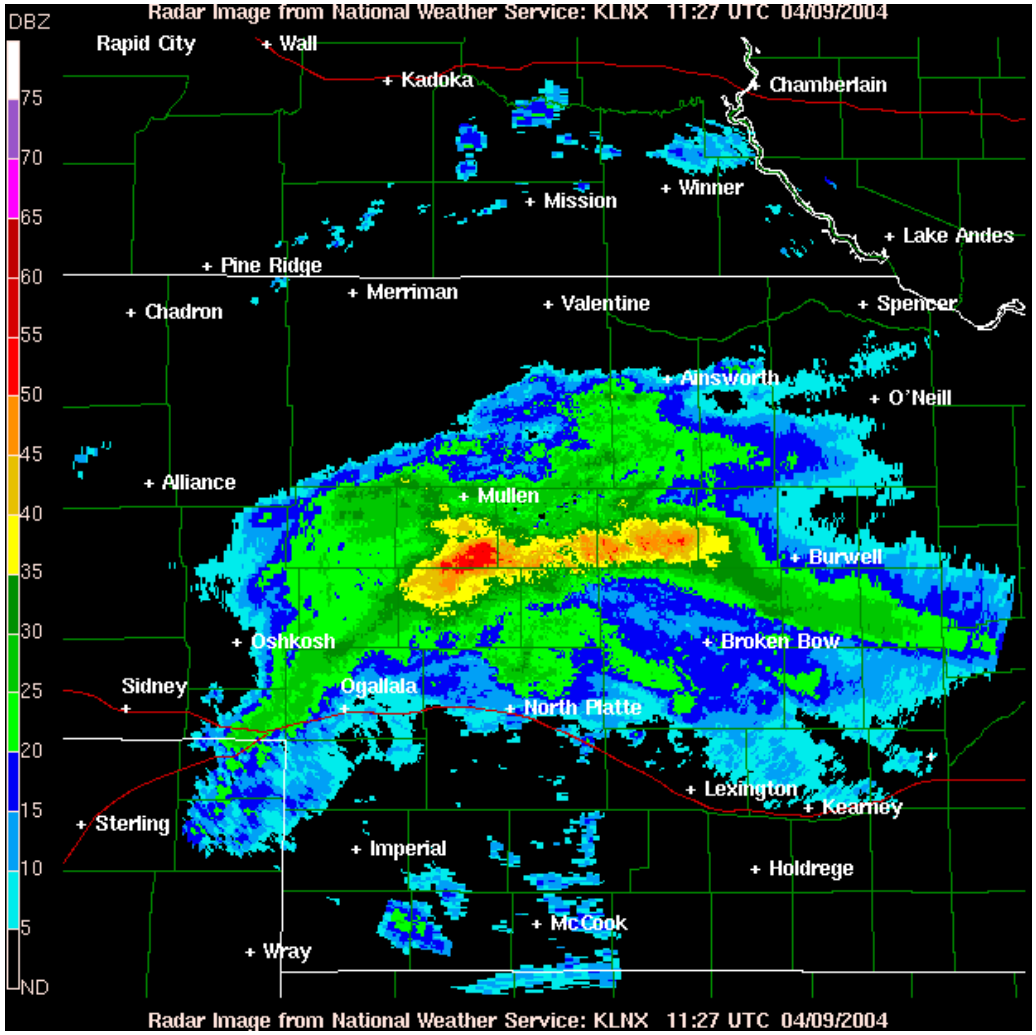
Alter perdeli pluviograf



Pluviografın etrafını çevreleyen hareketli perdeler rüzgar estiğinde vakum yaratır. Oluşan bu vakum rüzgar etkisini (türbülans etkilerini) minimuma indirerek yağışın daha sağlıklı ölçülmesini sağlar.

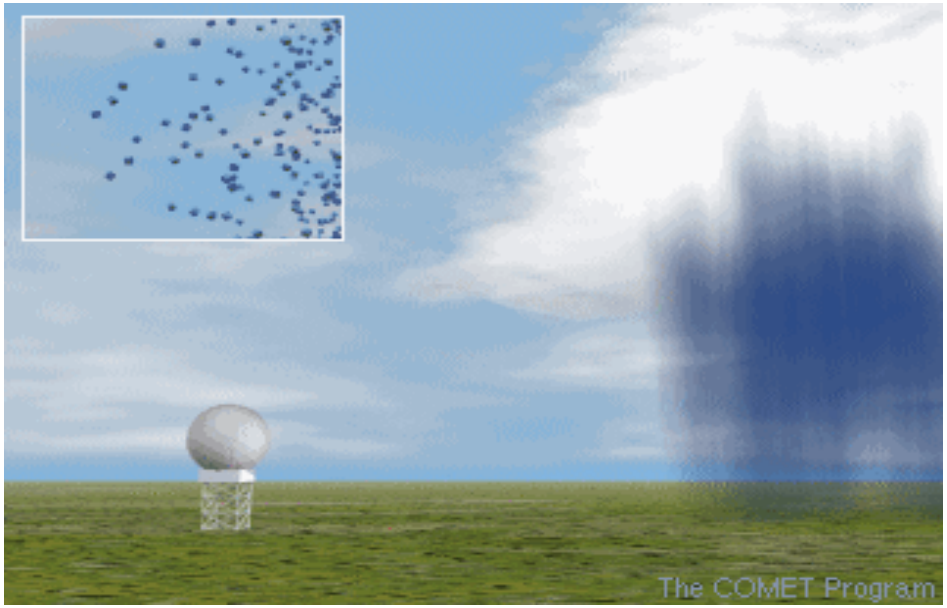
http://www.crh.noaa.gov/ind/coop.htm

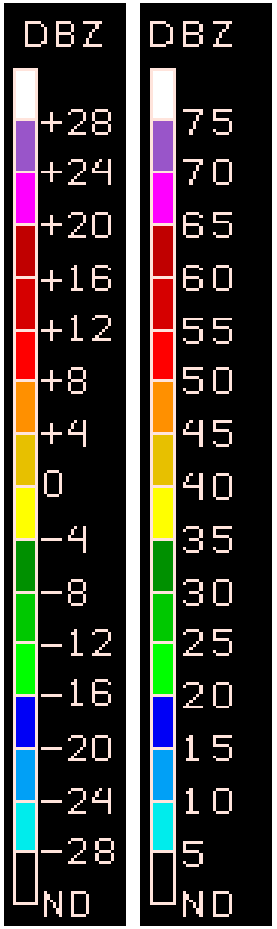
RADAR



http://weather.noaa.gov/radar/

Radar eko şiddeti ve renk kodları





- DBZ Decibel

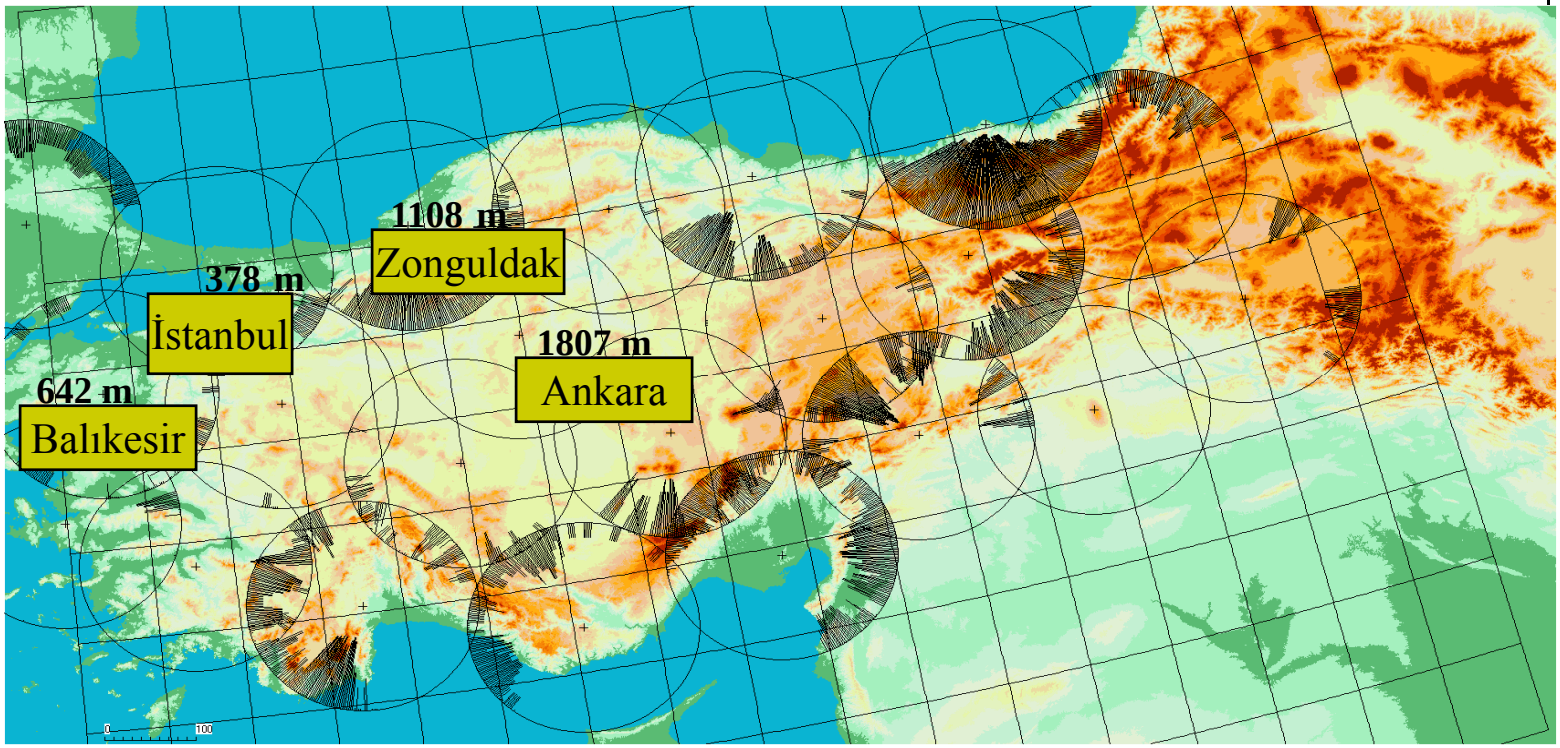
  The dBZ values increase as the strength of the signal returned to the radar increases. Each reflectivity image you see includes one of two color scales. One scale (far left) represents dBZ values when the radar is in clear air mode (dBZ values from -28 to +28). The other scale (near left) represents dBZ values when the radar is in precipitation mode (dBZ values from 5 to 75). *Notice the color on each scale remains the same in both operational modes, only the values change.* The value of the dBZ depends upon the mode the radar is in at the time the image was created.

  The scale of dBZ values is also related to the intensity of rainfall. Typically, light rain is occurring when the dBZ value reaches 20. The higher the dBZ, the stronger the rainrate. Depending on the type of weather occurring and the area of the U.S., forecasters use a set of rainrates which are associated to the dBZ values.

Radarlar ile verilen hizmetler

- Herhangi bir noktaya herhangi bir anda kaç mm yağış düştüğü, belirli bir süre zarfında toplam yağış miktarı,
- Yağış başladıktan sonraki 30-60 dakikalık süre içerisinde ne kadar daha yağışın düşeceği tahmini
- Herhangi bir noktada ve herhangi bir anda yağış tipinin ne olduğu (120 km doppler modunda) ve bu yağışlı sistemin hangi yöne doğru hareket edeceği

Türkiyedeki Radar Kaplaması



Ankara, Elmadağ İlçesinde,

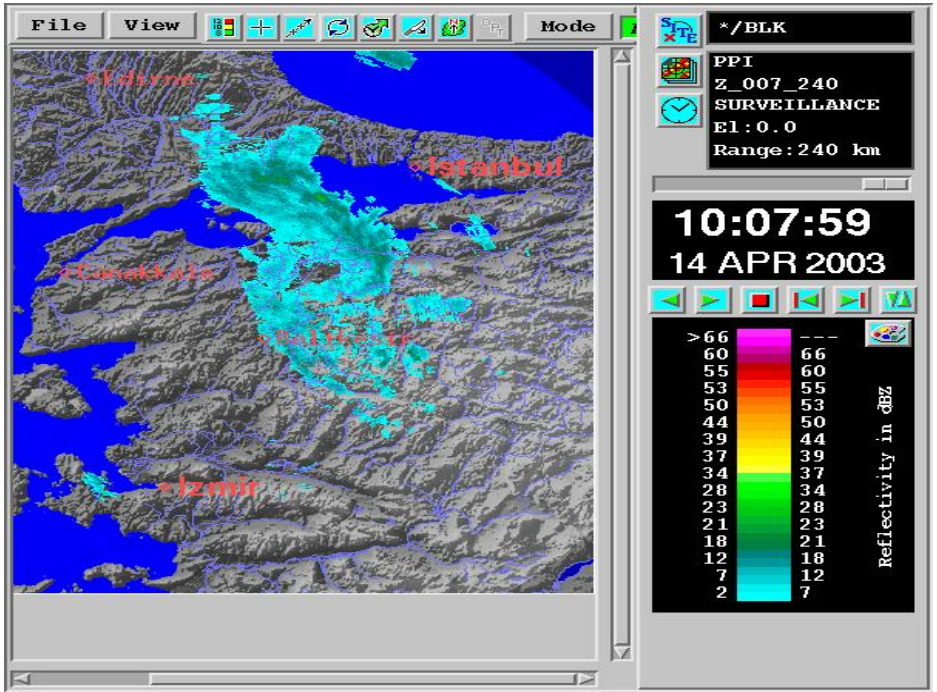
İstanbul, Büyükkuşkaya Tepesi, Çatalca nın 35 km kuzeyinde

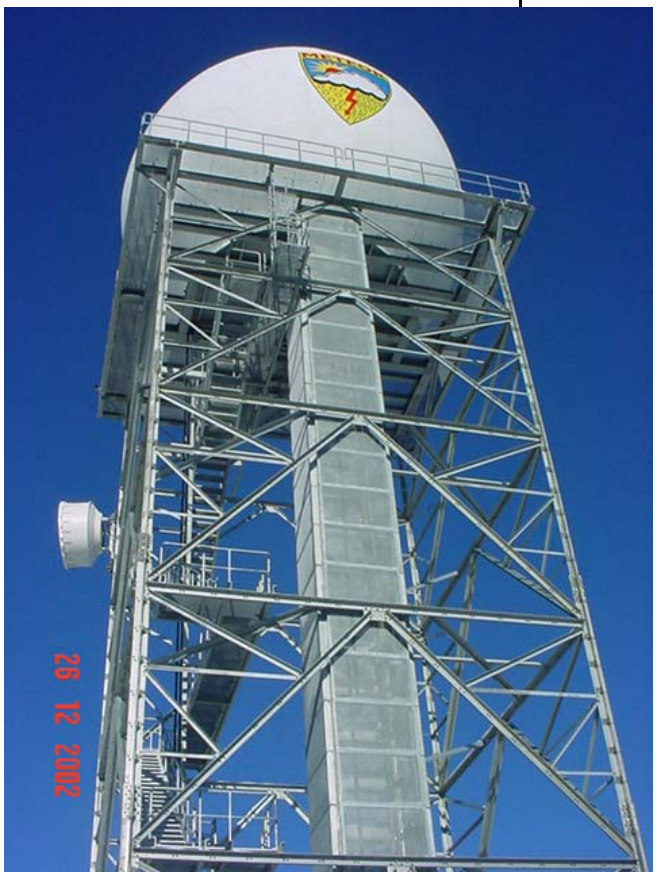
Zonguldak, Acısu tepesi, Zonguldak'ın güneyinde, Ereğli- Devrek arasında

Balıkesir, Akçaldede Tepesi, Balya ilçesi yakınlarında, Balıkesir'in batısında

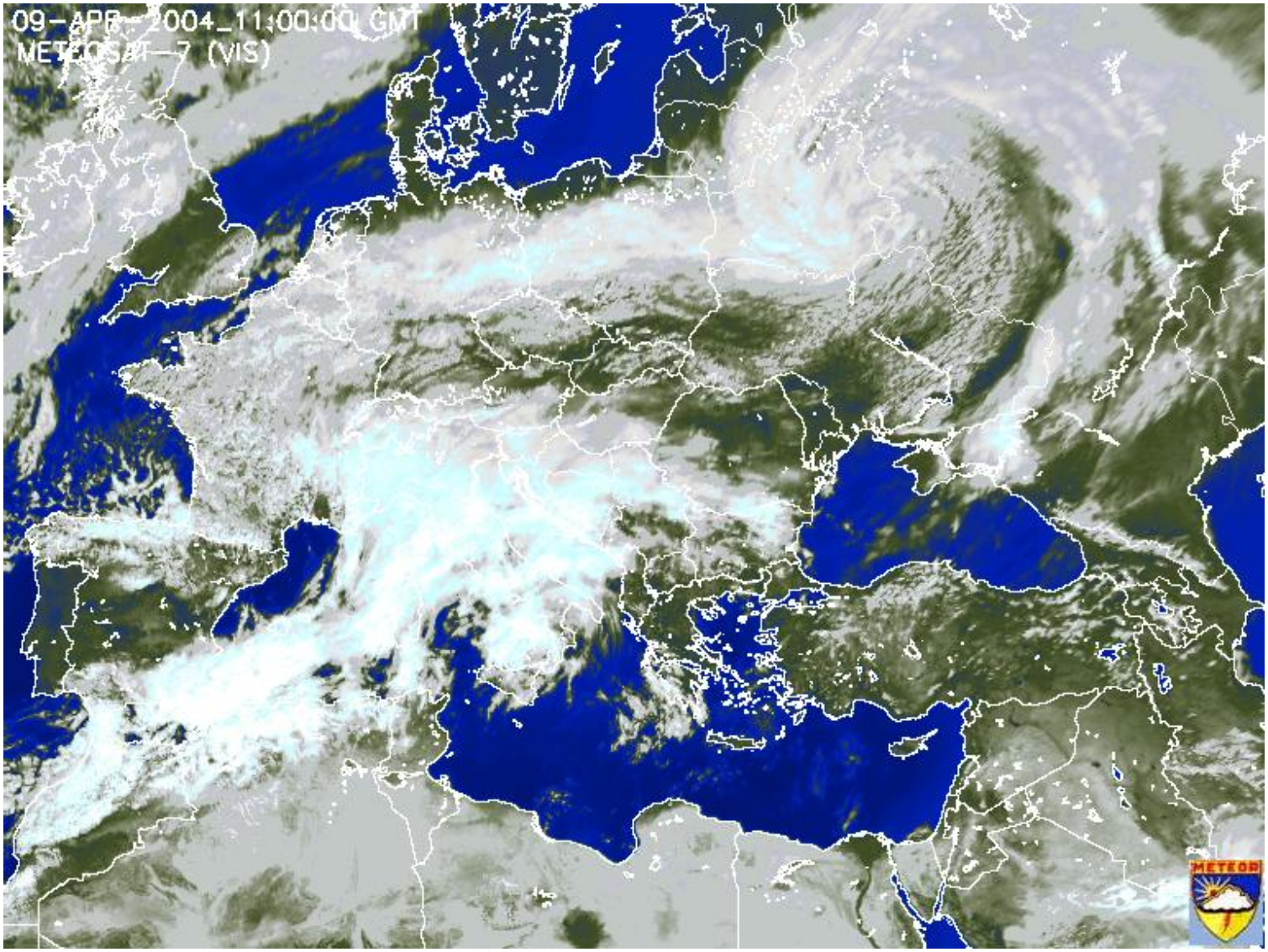
Balıkesir Radarı

C-Band Doppler Meteoroloji Radarı
Mart 2003 yılında işletmeye alınmıştır
Balikesir (Akcaldedesi Tepesi)
Yükseklik : 642m
Enlem : 39° 44′ 26″ N
Boylam : 27° 37′ 10″ E
Kule :20m , Çelik Konstrüksiyon
Firma : Mitsubishi - Japonya

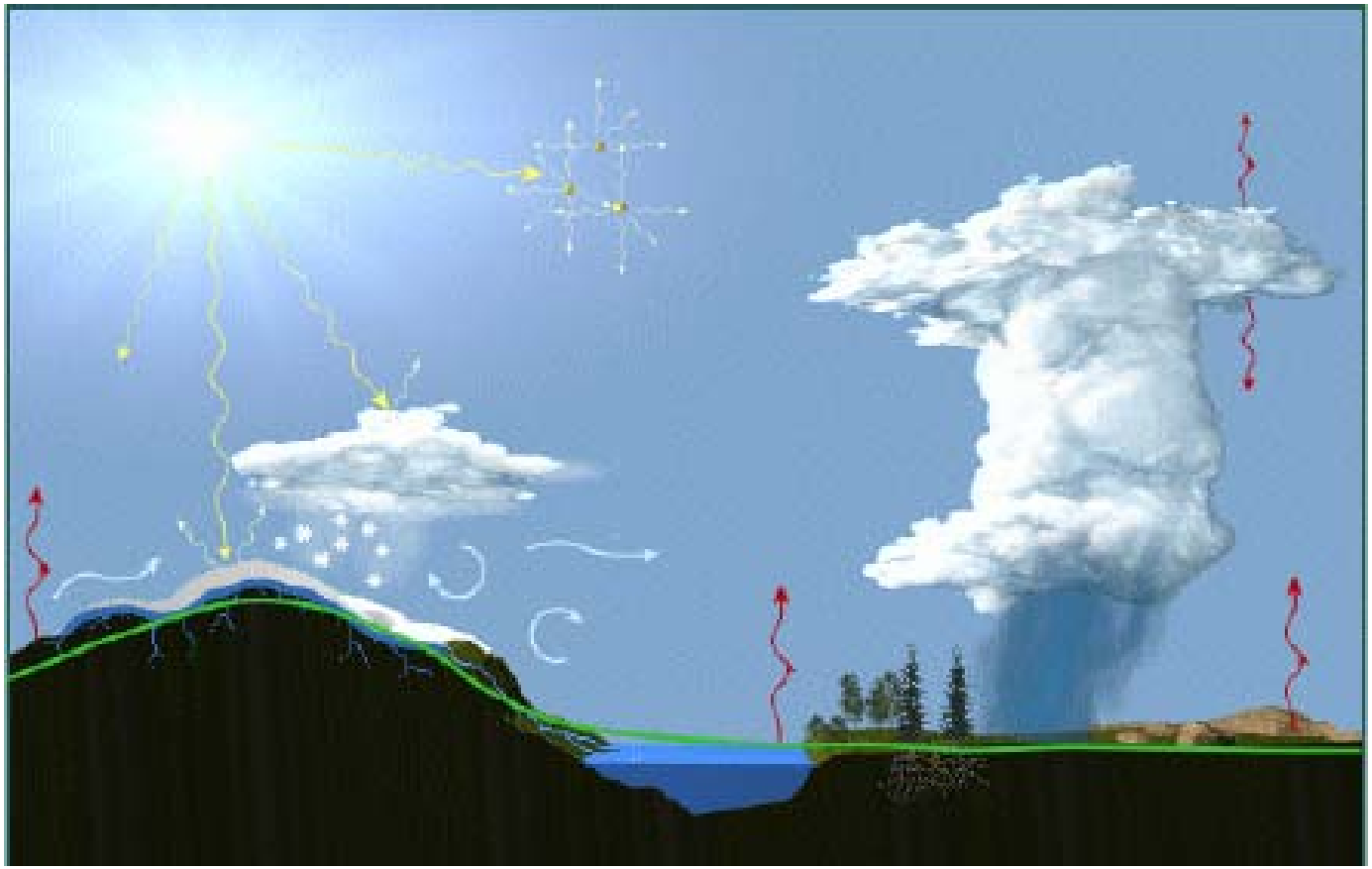




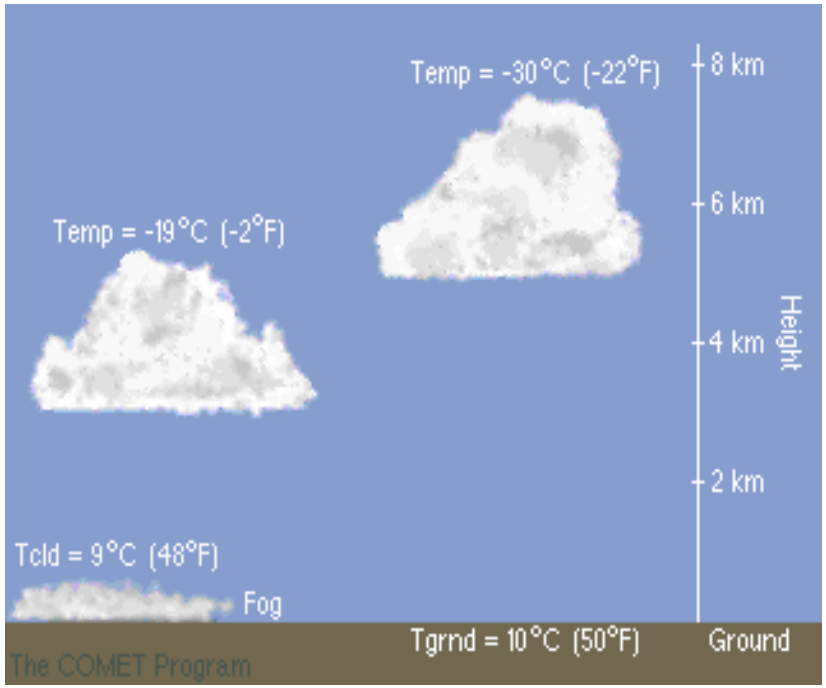
Uydular

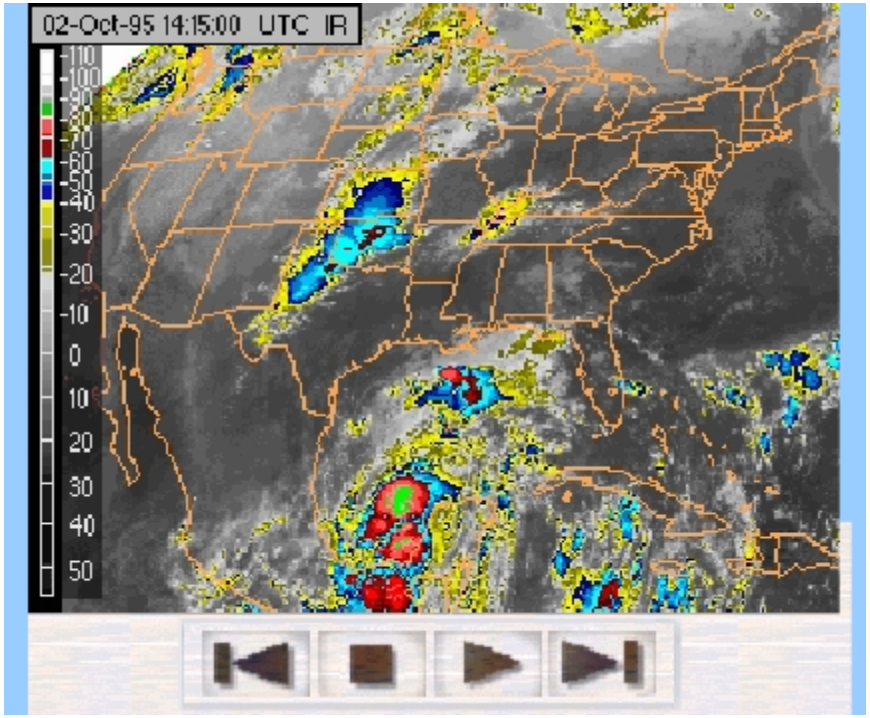


Güneş , Atmosfer – Yerküre arasındaki elektromanyetik enerji transferi



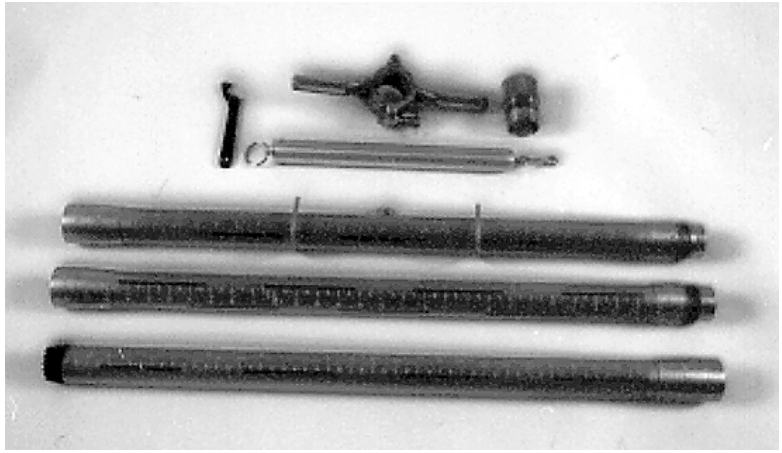
Uydu görüntüleri



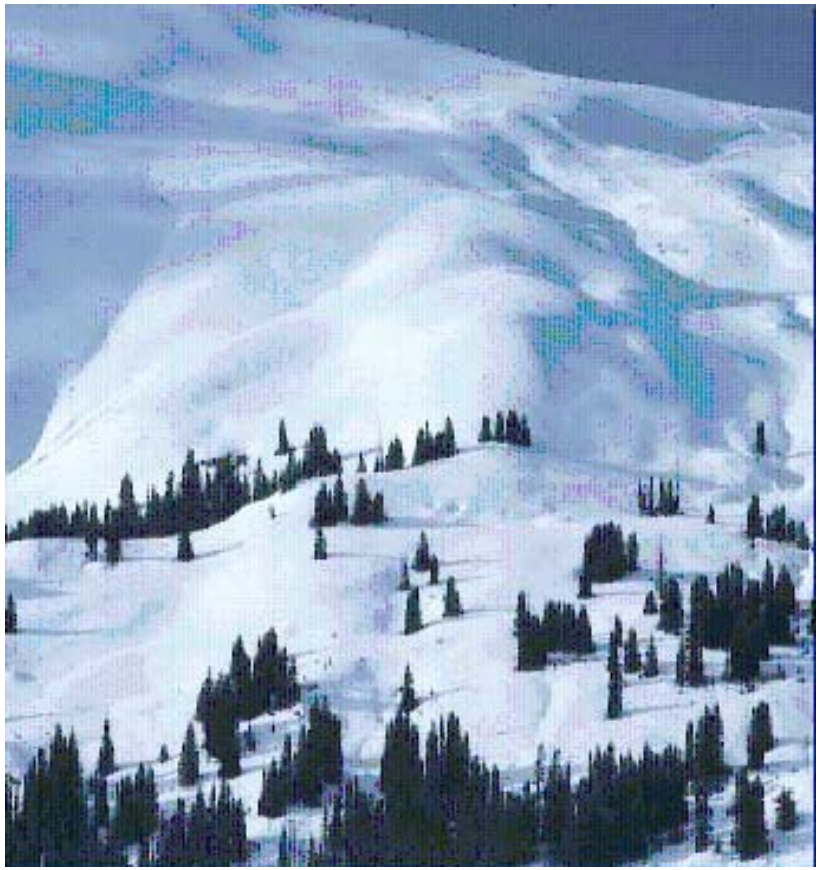


Karın ölçülmesi

- Kar yağışının ölçülmesi (Plüviometre ve Plüviograflarla)
- Kar örtüsünün ölçülmesi



Kar örtüsünün ölçülmesi



Kar örtüsünün dağılımını etkileyen parametreler

- *Eğim*
- *Yön*
- *Yükseklik*
- *Çevre koşulları (view factor).*
- *Diğer yüzeylerden yansıtılan enerji.*
- *Yeryüzeyinden gelen uzun dalga emisyonu, vb.*
- *Rüzgar etkisi.*

Kar örtüsünün ölçülmesi

1. Kar izi yöntemi
2. Kar yastıkları
3. Gama ışını ölçme

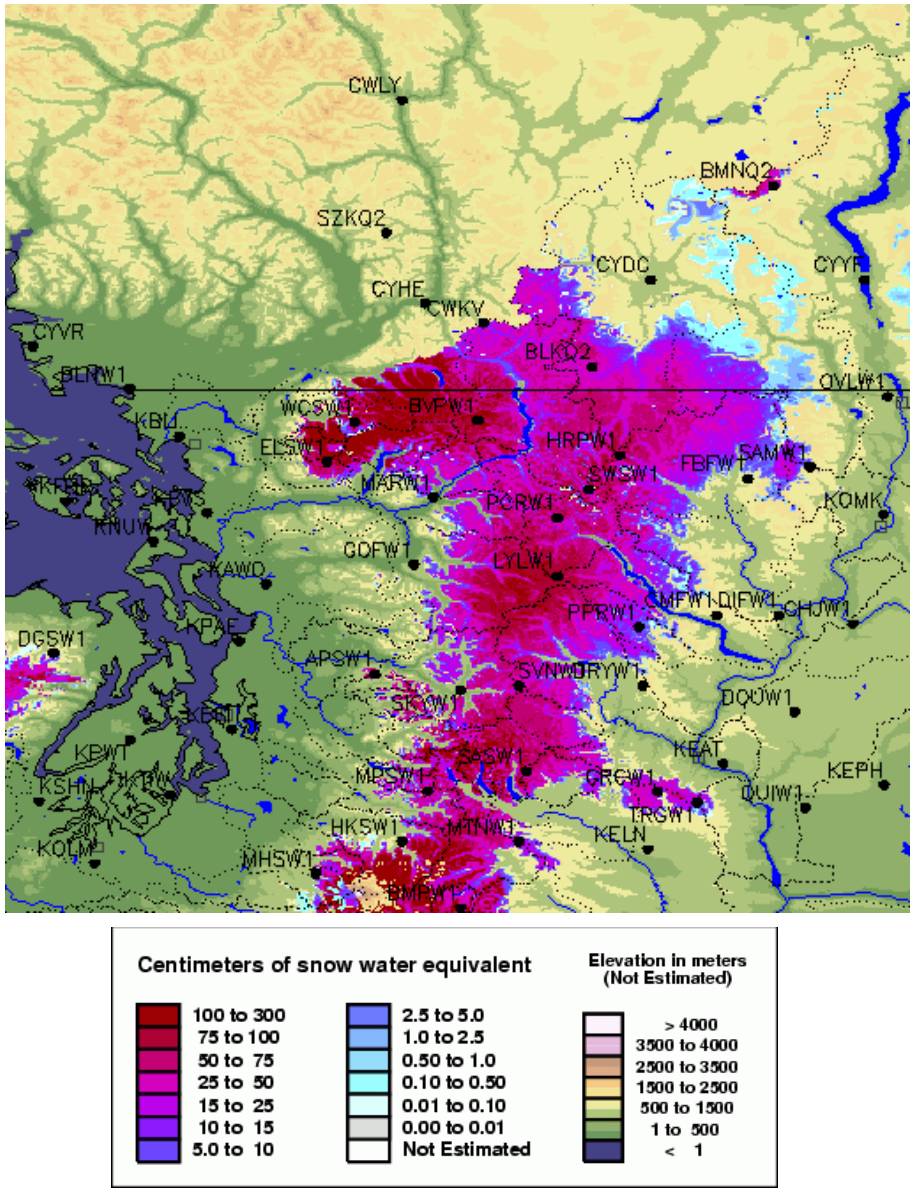
Kar izi çalışmaları

http://snobear.colorado.edu/Markw/SnowHydro/Measuring_Snow/snow_measuring.html#belfort

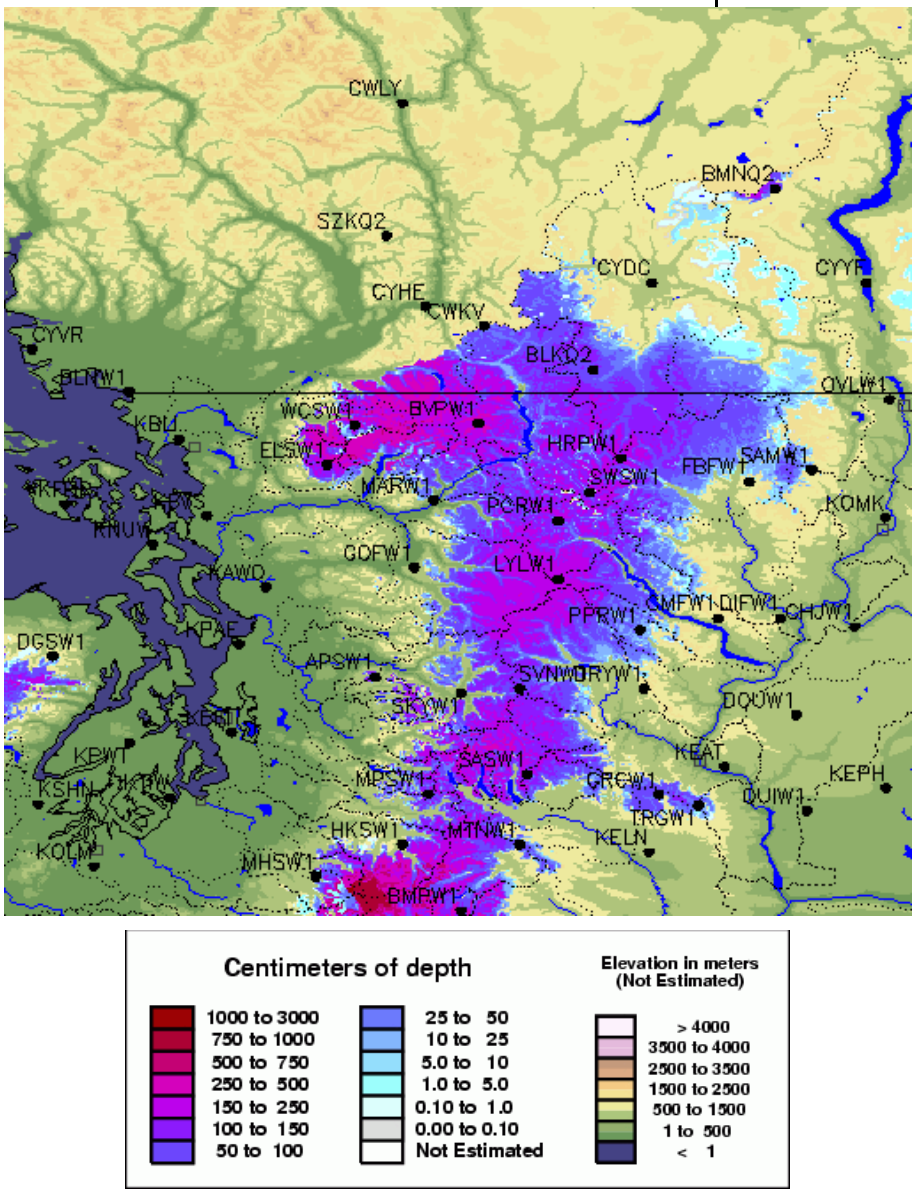
Kar örtüsü ölçümü

Kar yüksekliği ve kar su eşdeğer haritaları

Snow water equivalent for 2004 April 16,



Snow depth for 2004 April 16, 4:00 Z



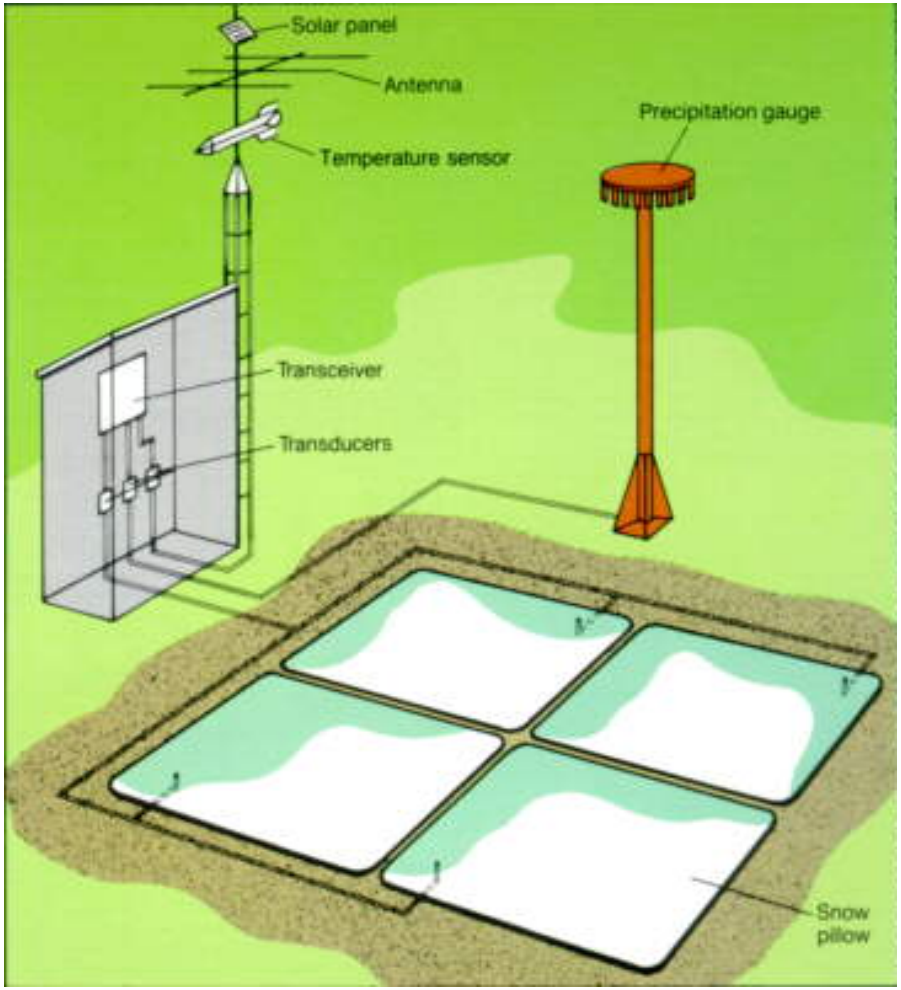
http://www.nohrsc.nws.gov/interactive/html/map

Kar yastıkları ve totalizatör

The pillow, made of rubber, steel, hypalon, etc, is filled with an antifreeze solution (50/50 mix of water and ethanol with flouresceine dye to make it a flourescent green). As the snowpack accumulates on the pillow, it increases the fluid pressure (obviously as this is a quasi closed system) within the pillow.

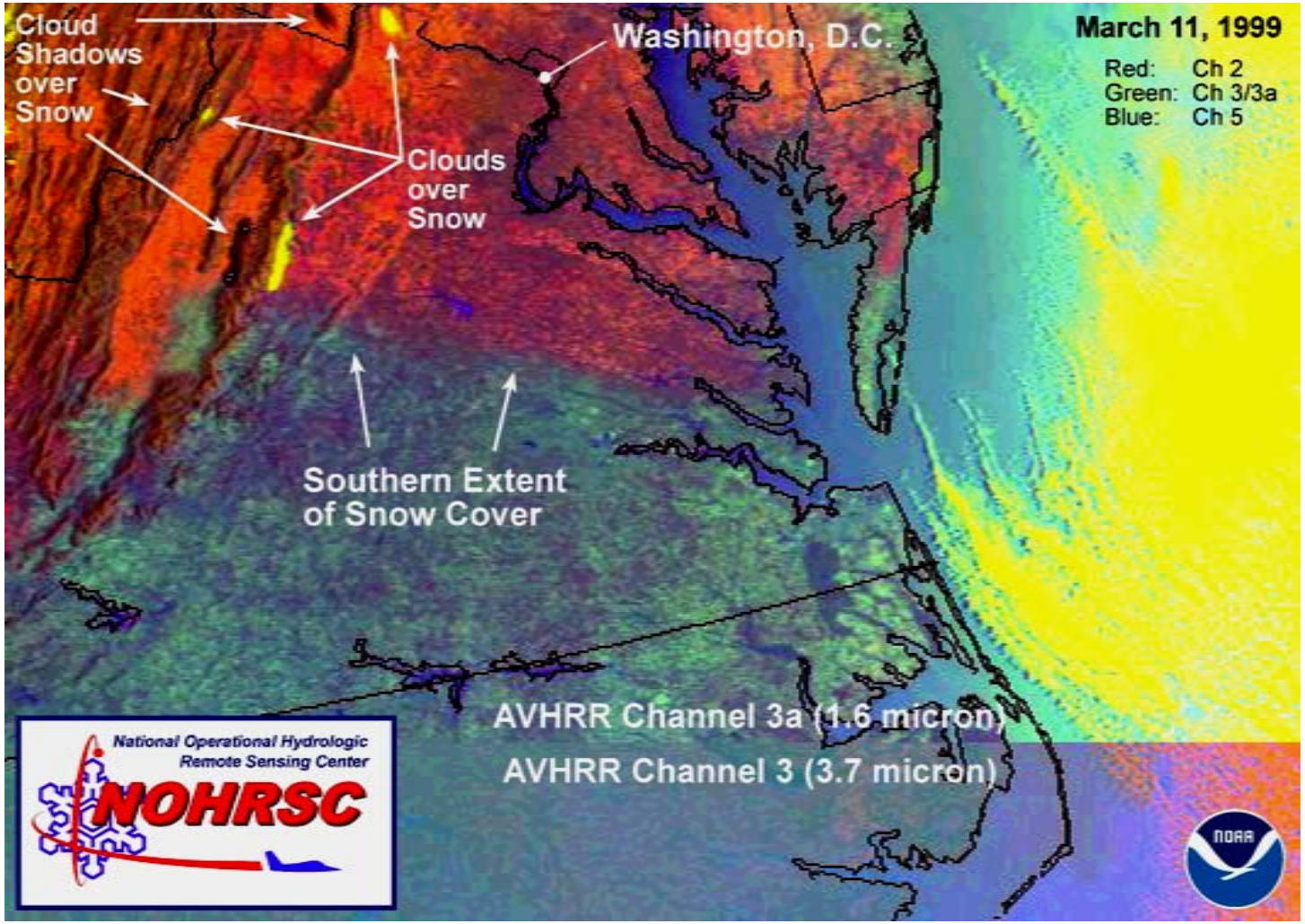
http://snobear.colorado.edu/Markw/SnowHydro/Measuring_Snow/Snotel/snotel.html

Kar yastığı istasyonu



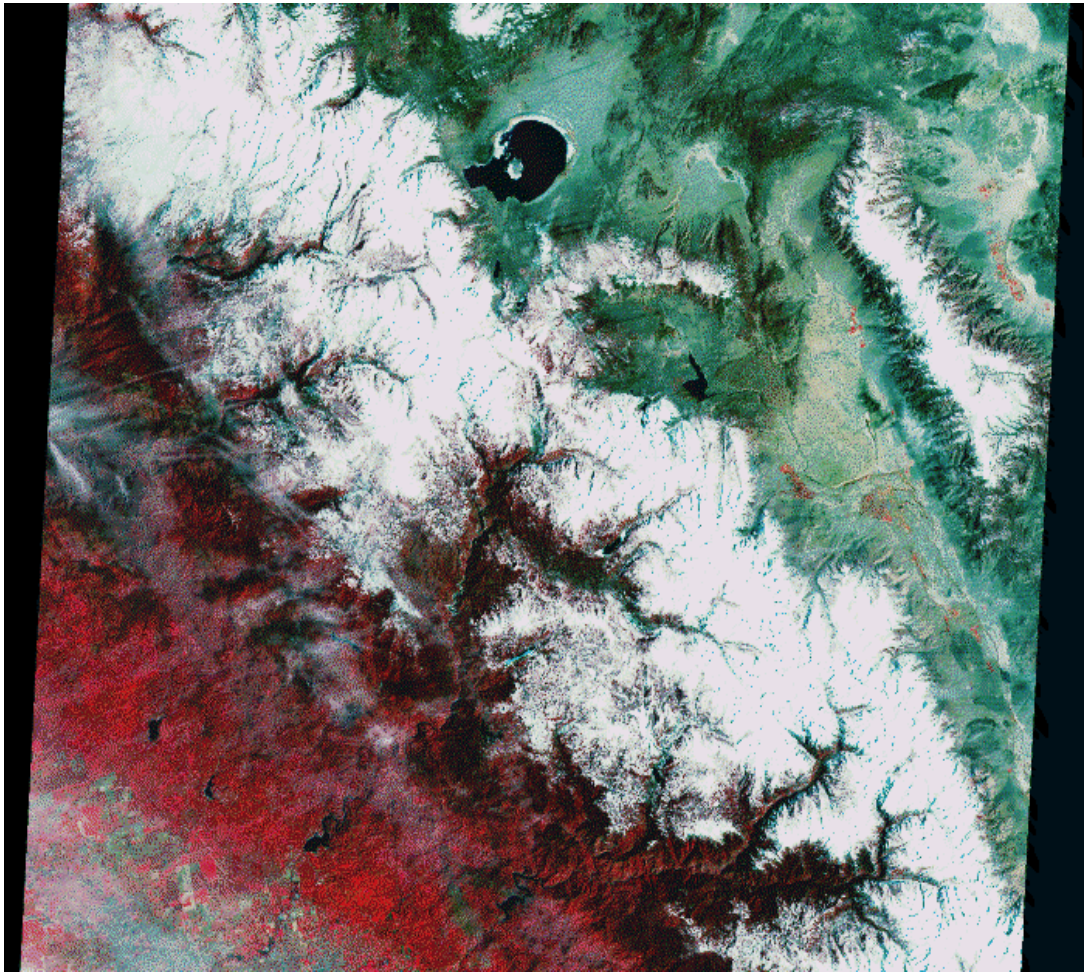
Uzaktan algılama yöntemleri ile kar ölçümü

- NOAA-15 1.6 Micron Channel



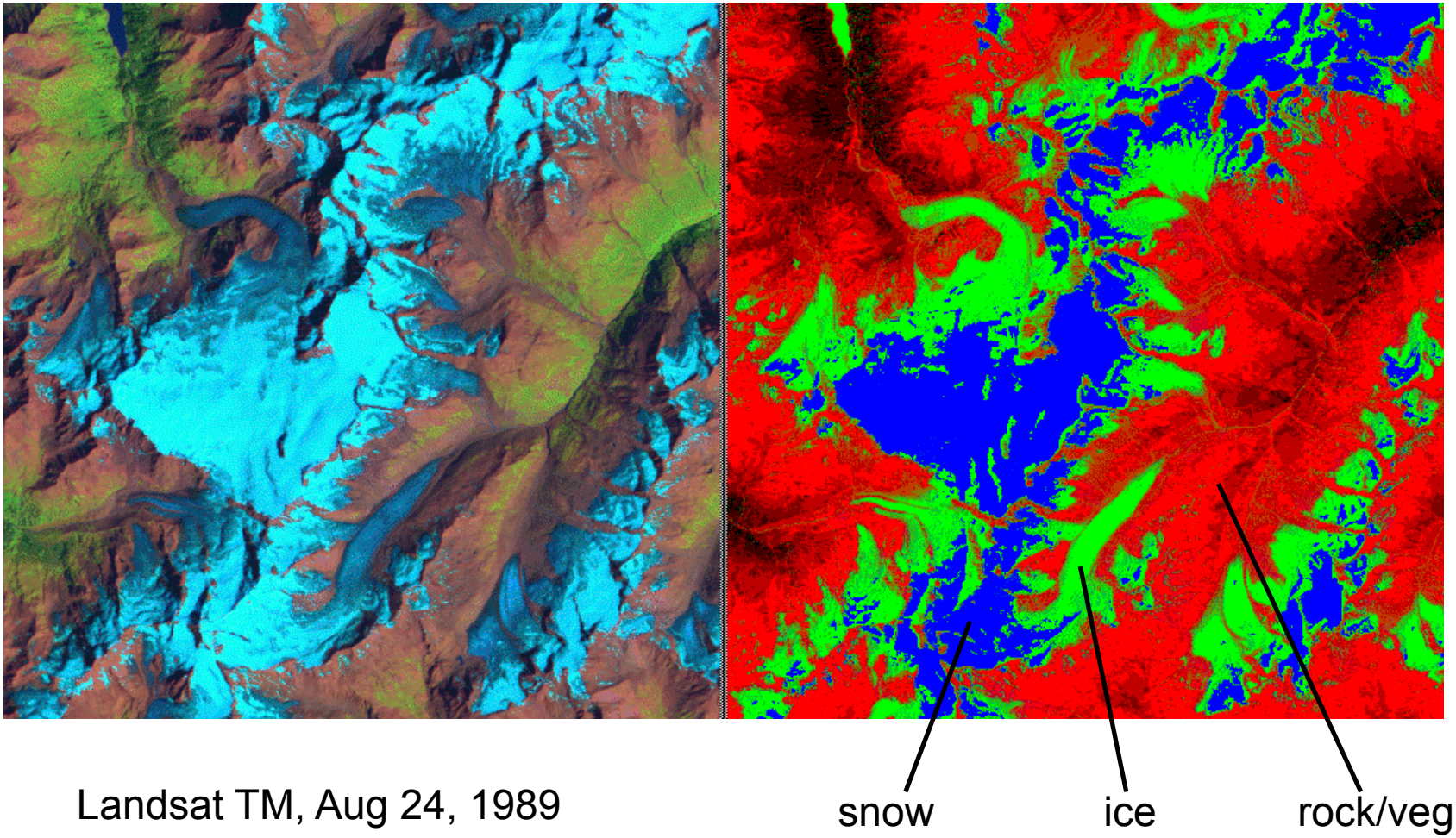
http://snobear.colorado.edu/Markw/SnowHydro/Remote/

Landsat Thematic Mapper (TM)



- 30 m spatial resolution
- 185 km FOV
- Spectral resolution
  1. 0.45-0.52 µm
  2. 0.52-0.60 µm
  3. 0.63-0.69 µm
  4. 0.76-0.90 µm
  5. 1.55-1.75 µm
  6. 10.4-12.5 µm
  7. 2.08-2.35 µm
- 16 day repeat pass

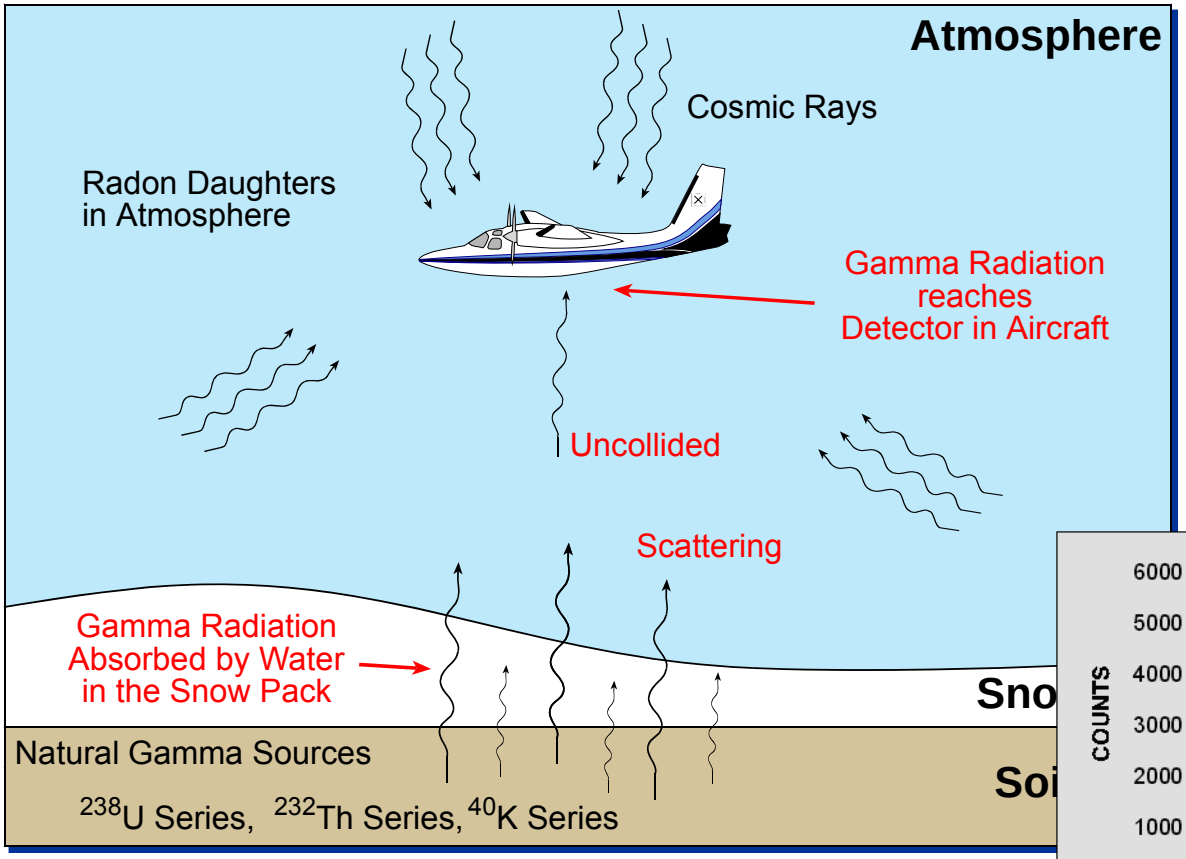
Discrimination between Snow and Glacier Ice, Ötztal Alps

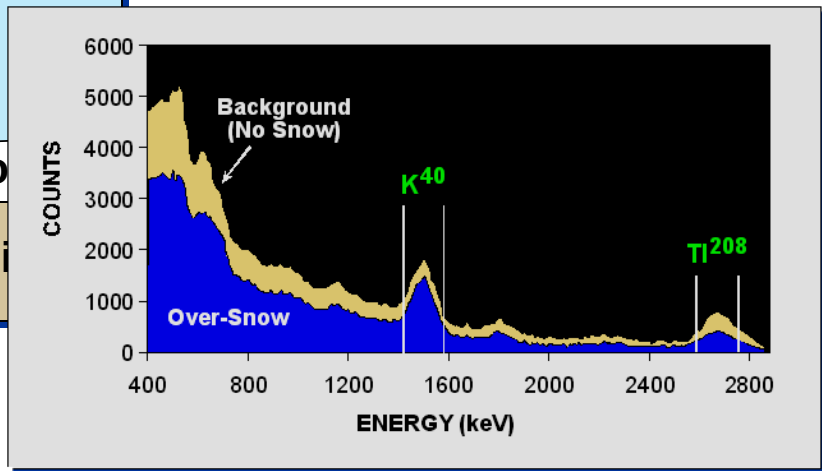


Landsat TM, Aug 24, 1989

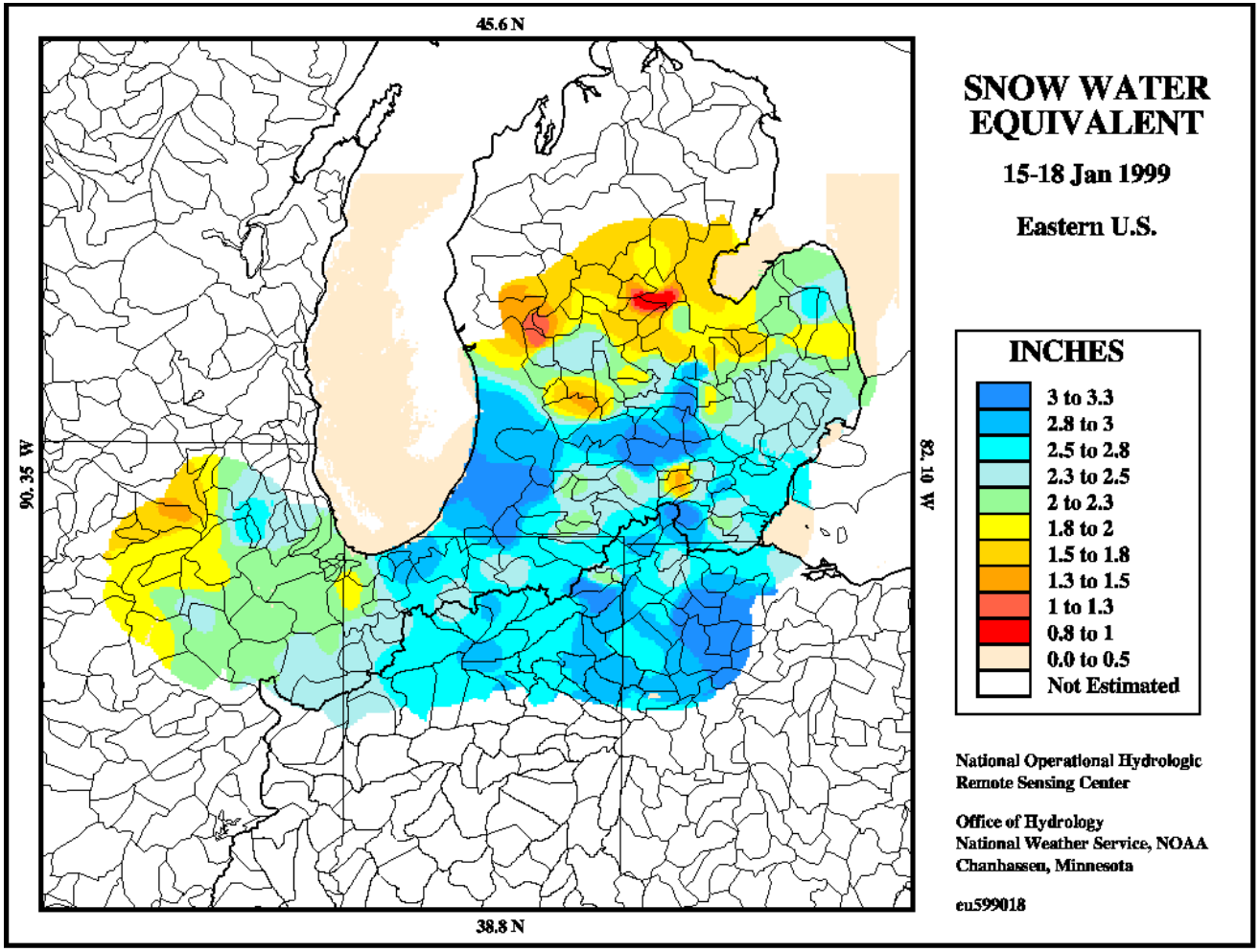
Snow Measurement

- **Airborne Snow Survey Program**





Airborne Snow Survey Products



Kar erime modelleri

- **TEMPERATURE-INDEX METHODS**
- M = Mf (Ta - To)
  - M = snowmelt (mm/day)
  - Mf = degree day factor (mm/degreeC/day)
  - Ta = air temp (degrees C); daily mean, daytime mean, maximum daily Ta; user must decide
  - To = threshold or base temperature (degreesC) above which snow melt occurs, usually 0 degreesC.
- range is usually 1 mm/degreeC/day < Mf < 7 mm/degreeC/day
- The degree-day factor is the heart of the approach.
- The degree-day factor must be calibrated for each basin and may change with elevation on the same time step and over time at the same point within a basin.
- **Snowmelt Runoff Model (SRM) developed by Martinec and Rango**
- Q = [C a T S) + P] A
  - Q = discharge
  - c = runoff coefficient; essentially runoff efficiency or what fraction of snowmelt gets converted to discharge. Calibrate for each basin.
  - a = degree day factor
  - T = number of degree days
  - S = ratio of snow covered area to total area, e.g. how much of the basin has snow to melt.
  - P = new precipitation which gets added in to the system
  - A = basin area
- T, S, and P need to be measured (or estimated) daily
- a = 1.1 rhos/rhow is the initial estimate if no calibration done, based on the concept that as the density of snow increases (rhos), albedo decreases and liquid water content increases, leading to more efficient melt for the same number of degree days.
- This is a model based on empirical calibrations.

http://snobear.colorado.edu/Markw/SnowHydro/Modeling/modeling.html

Enerji bütçesi

- Energy balance submodel
- calculate the energy balance of the snow surface
- Q = R + G + H + LE + A + dQ/dt
  - Q = net energy
  - R = net radiation
  - G = ground heat flux
  - H = sensible heat flux
  - LE = latent heat flux
  - A = advected energy (rain-on-snow)
  - dQ/dt = change in internal snowpack energy
- since a surface has no volume, Q = zero.
- we understand snow/atmosphere energy transfers well from first principles, so we can model this part well at a point if we can measure the meteorological variables.
- where this gets tricky is that over a basin of interest, there are usually few meteorological stations. Spatially distributing the meteorological variables is difficult.
- Snowpack Model
- Another difficult problem
- We know little about liquid water retention and movement
- Essentially, once we melt snow at the surface of the snowpack, we lose track of the snow.
- Snow Depletion Model
- We need to keep track of the change in SCA and SWE over time.
- Obviously, as the amount of SCA decreases with time, the same amount of energy per unit area melts less snow because there is less snow to melt.
- There are a number of good methods to estimate changes in SCA with time, including remote sensing measurements and aerial photography. With this information you can calculate areal depletion curves (linear, exponential, etc).
- Again, our ability to estimate changes in the spatial distribution of SWE over time is a challenge.

Yağış ölçekleri ağı

- Dünya Meteoroloji Örgütünün önerdiği istasyon sıklığı:
-