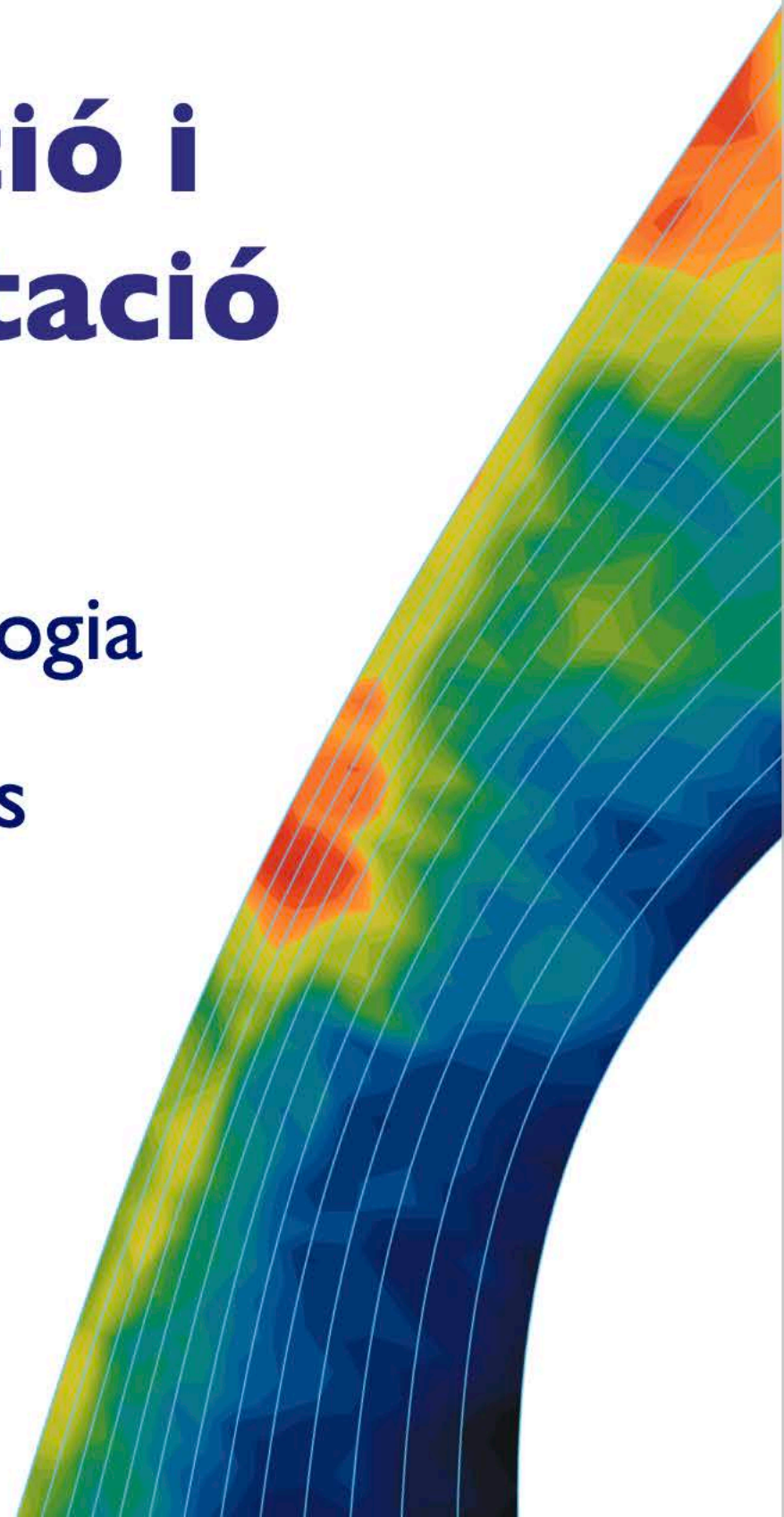


Classe I I: Observació i mesura de la Precipitació

Processos atmosfèrics i hidrologia

Prof. Daniel Sempere Torres

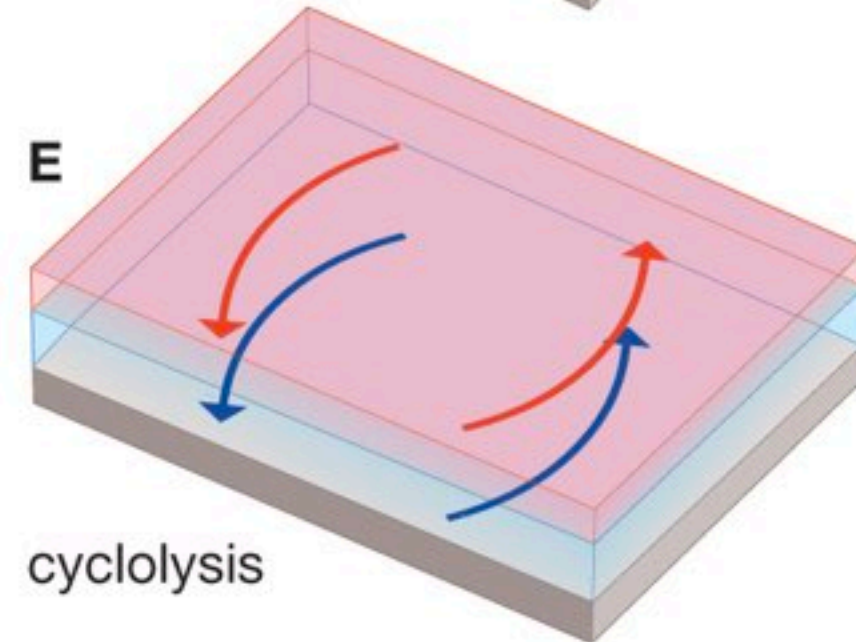
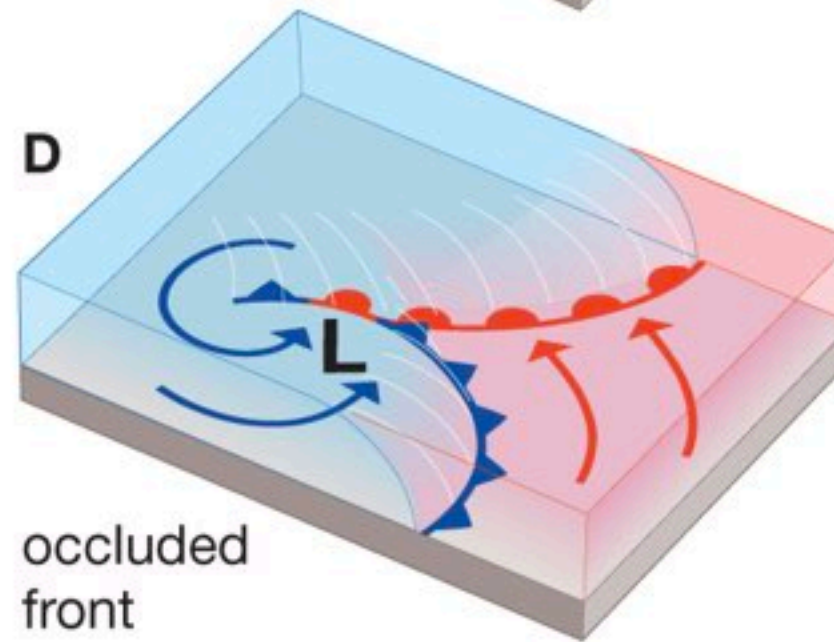
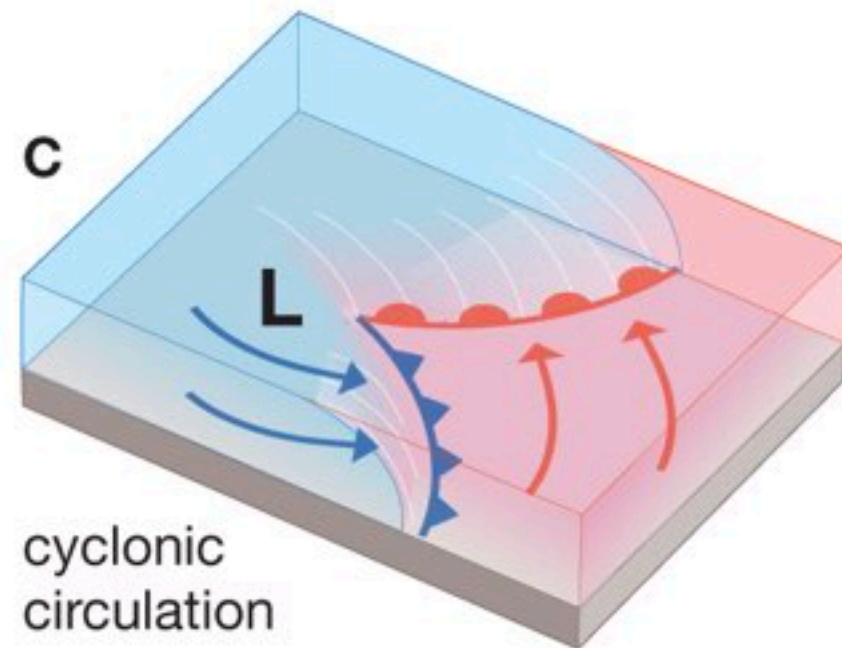
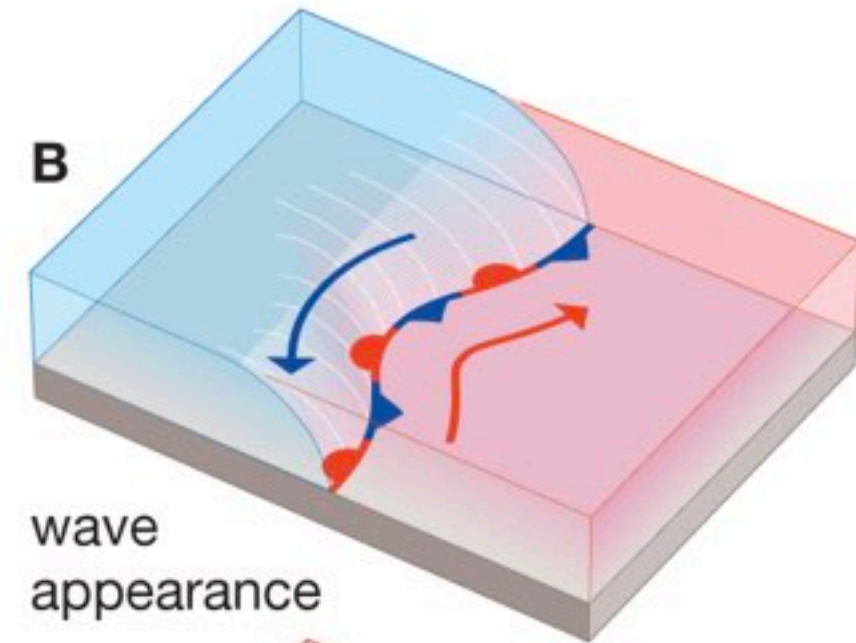
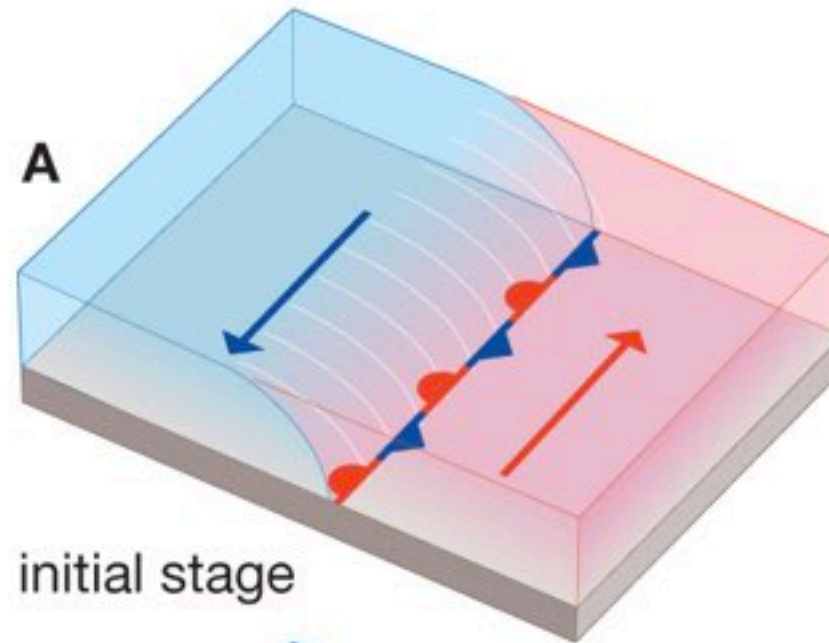
Prof. Shinju Park



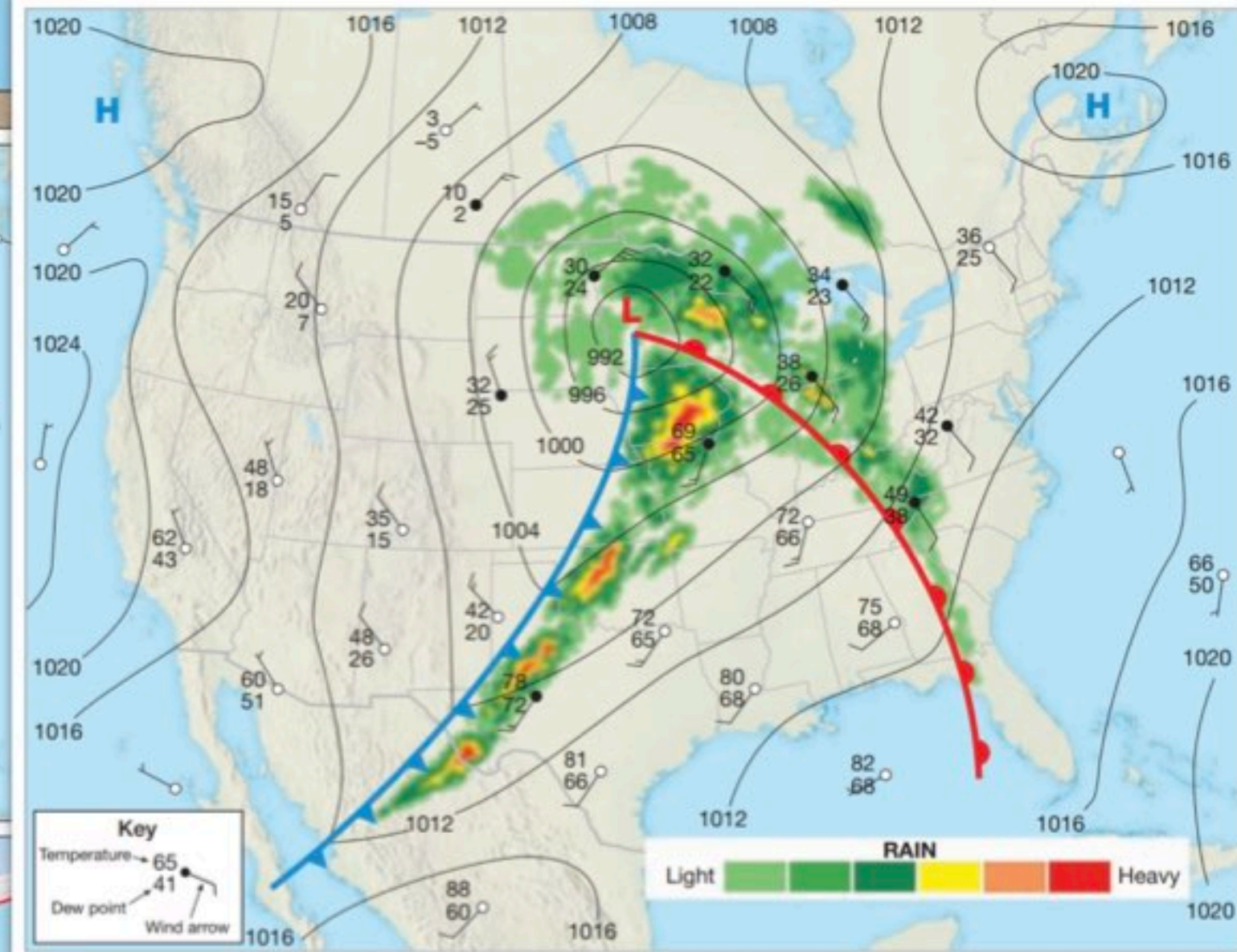
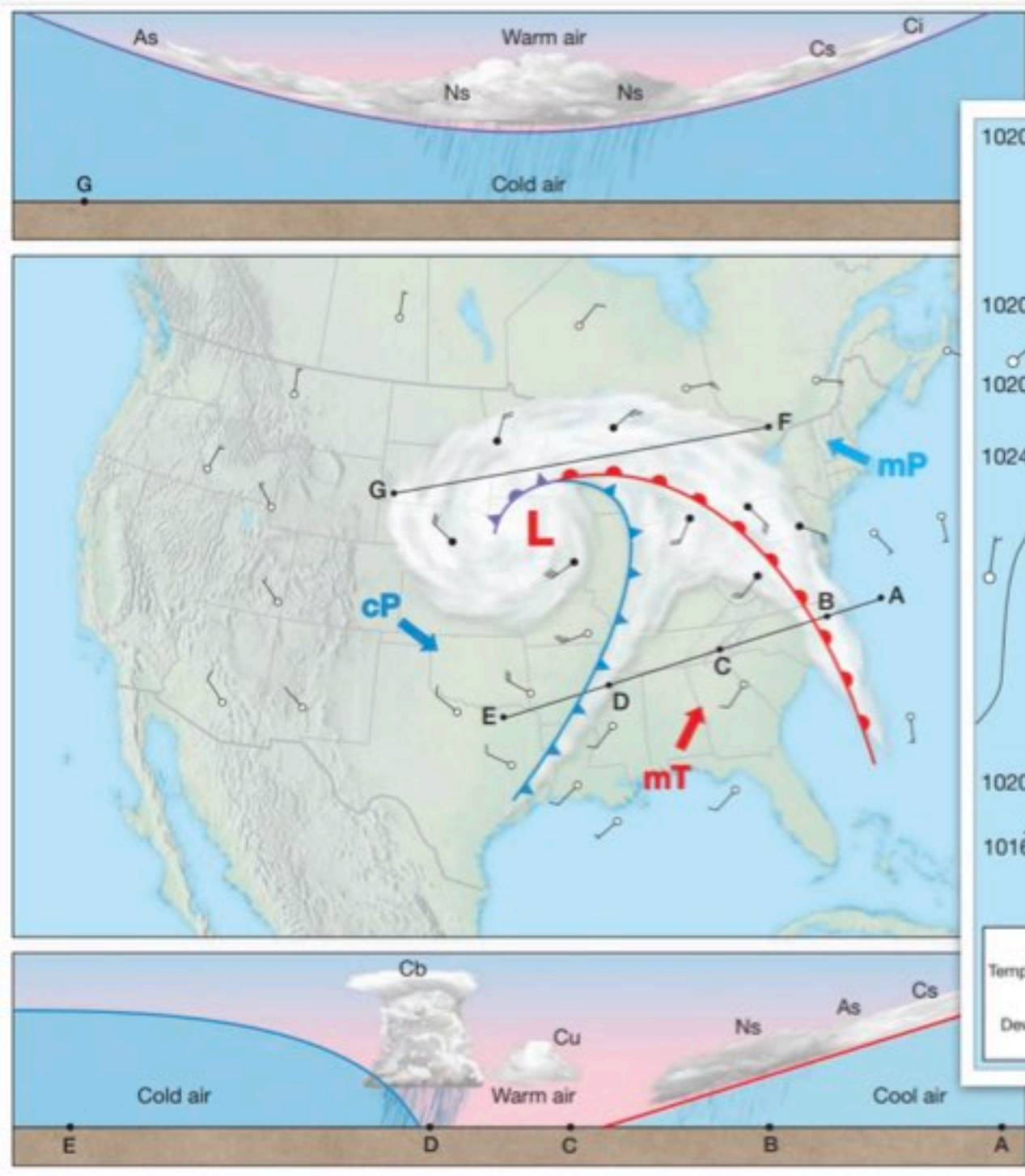
CICLOGÈNESI: Generació de ciclons extratropicals (latituds mitjanes, entre 23.5 i 66.5°)

Cyclogenesis

-  Cold air
-  Cold-air flow
-  Warm air
-  Warm-air flow



CICLOGÈNESI: Generació de ciclons extratropicals (latituds mitjanes, entre 23.5 i 66.5°)



meteoblue

near ✱ close to you

tempo 7 dias

tempo 14 dias

tempo hoy

webcams

mapas
meteorológicos

televisión

re libre y
reportes

riación

gricultura

storia y Clima

story+

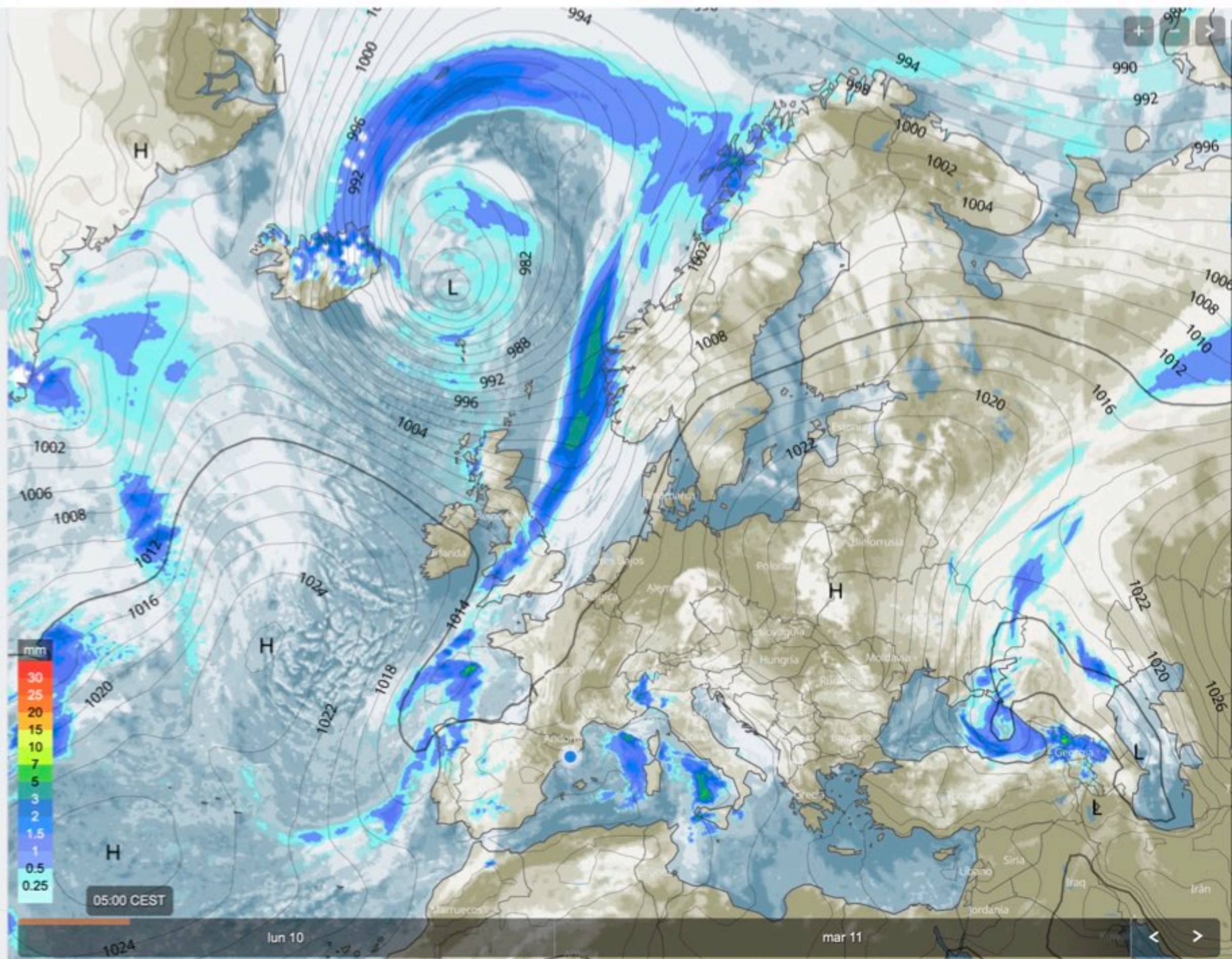
oductos

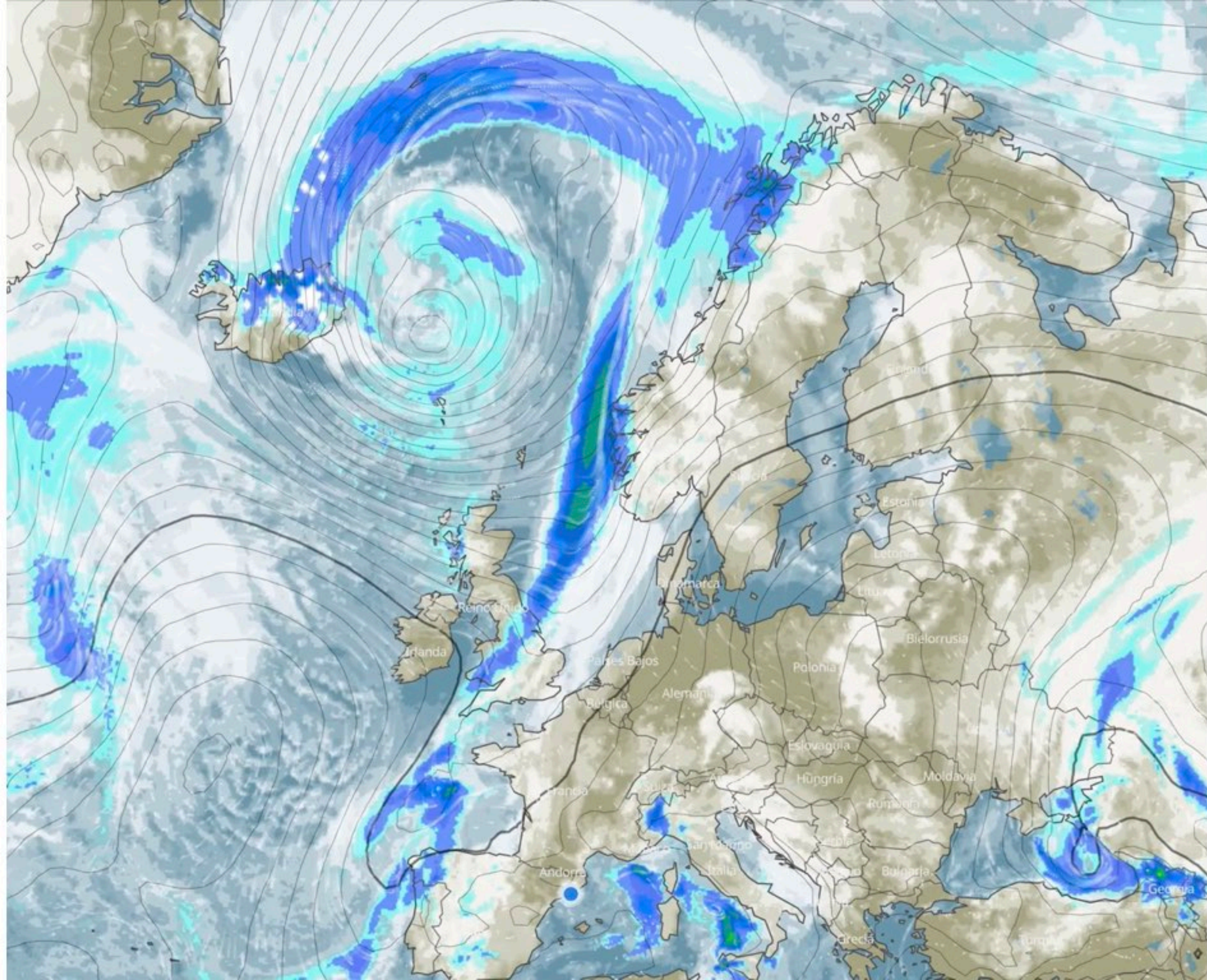
PI+ meteorológica

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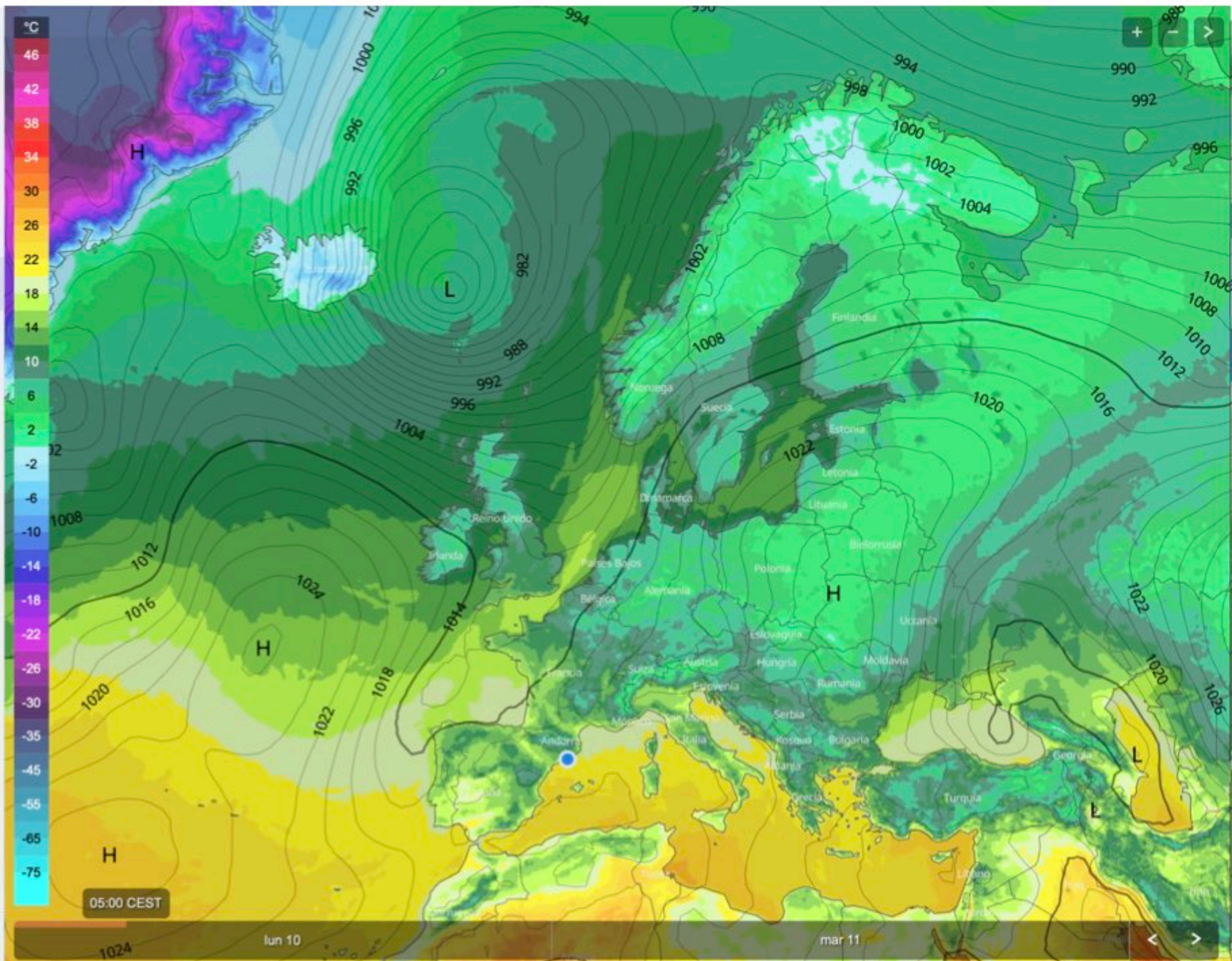
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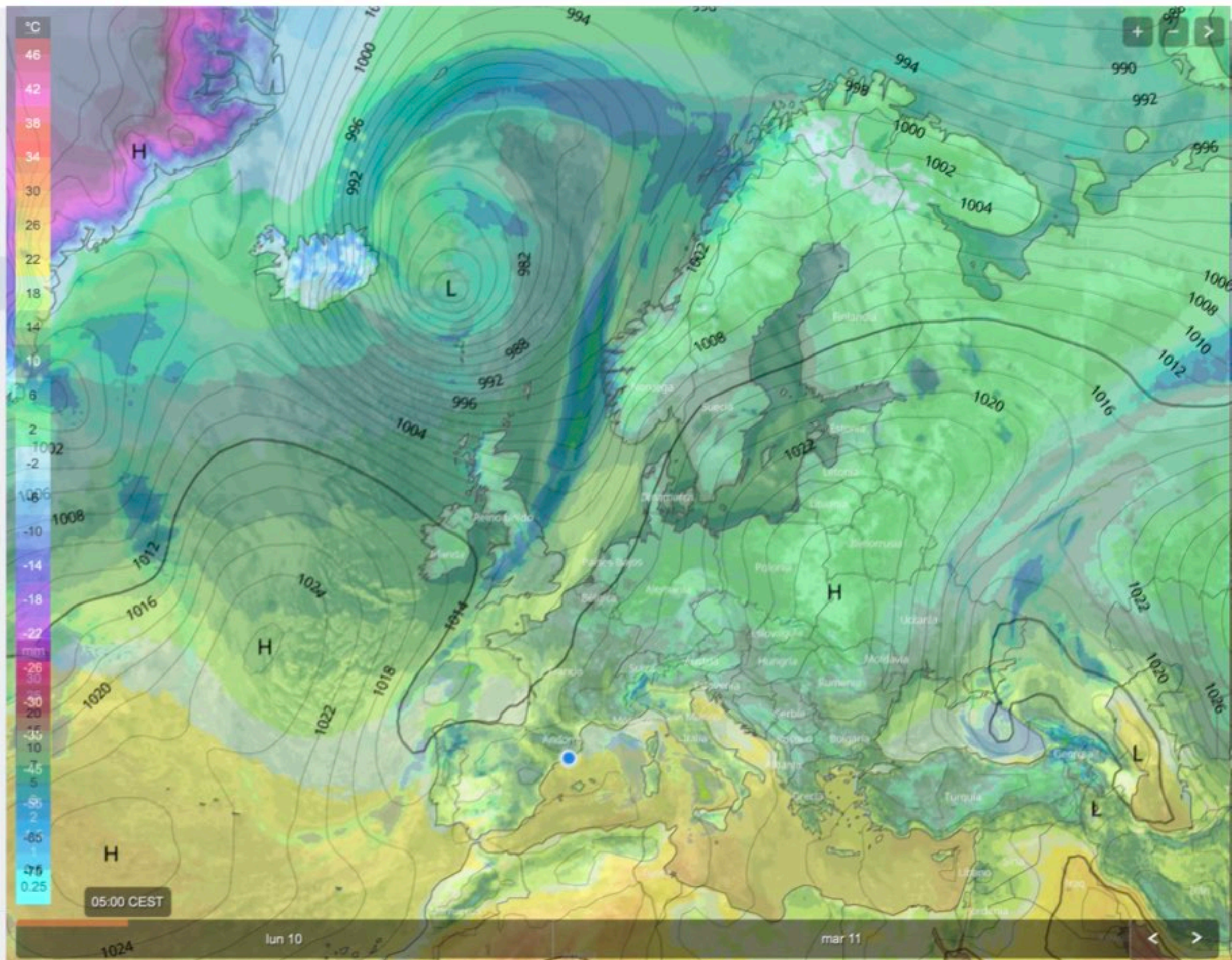
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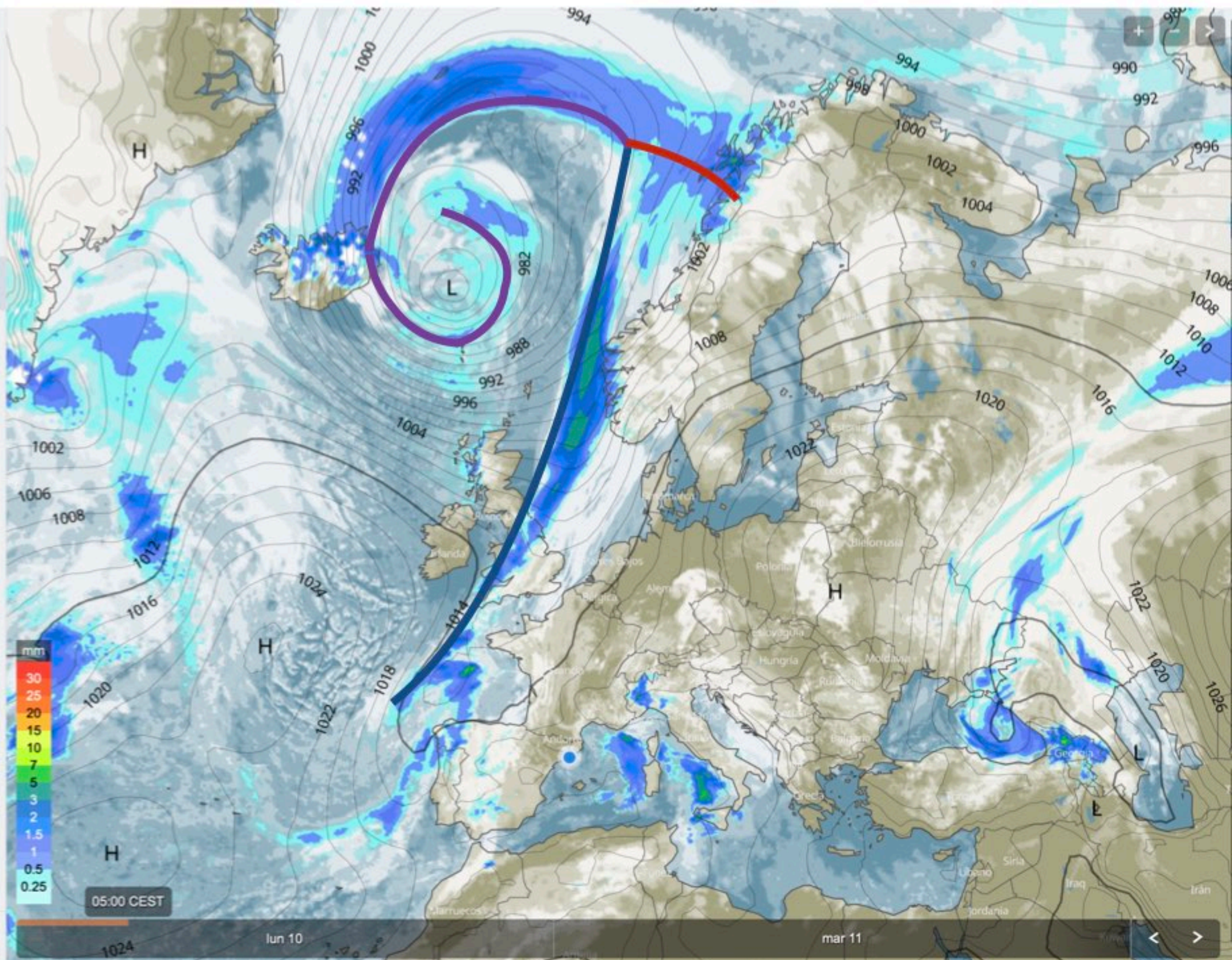
productos

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noticias

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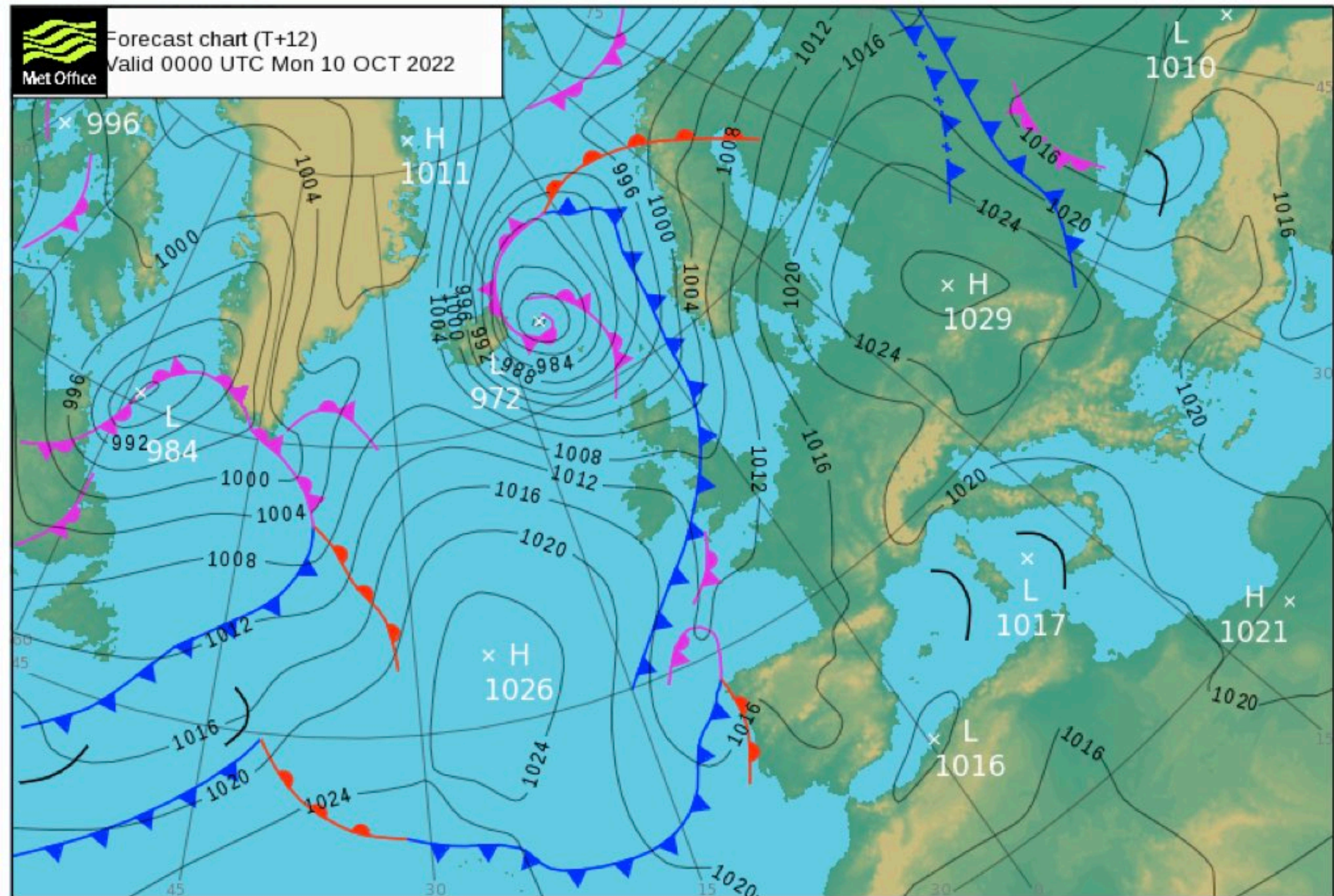




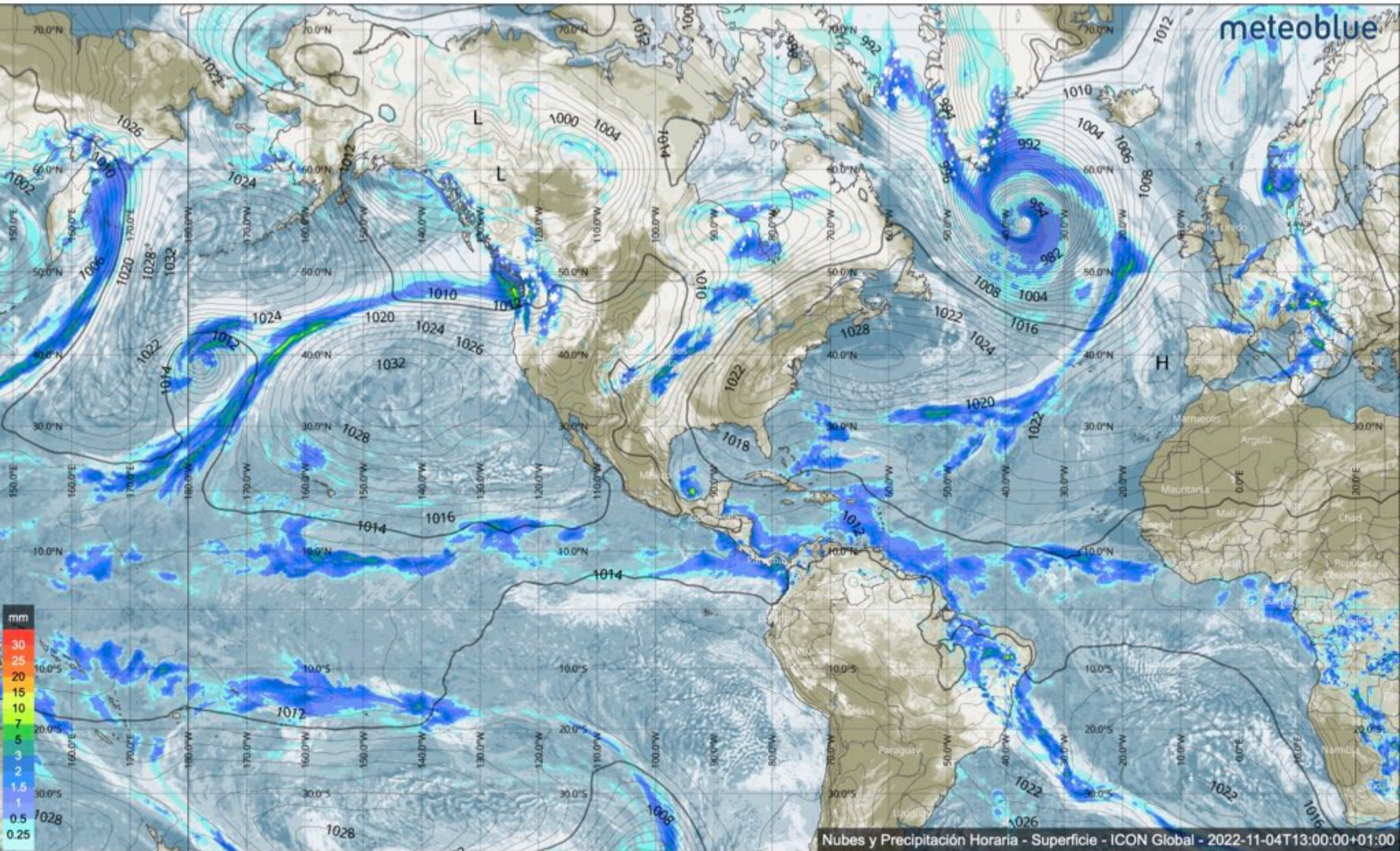
Met Office

Forecast chart (T+12)

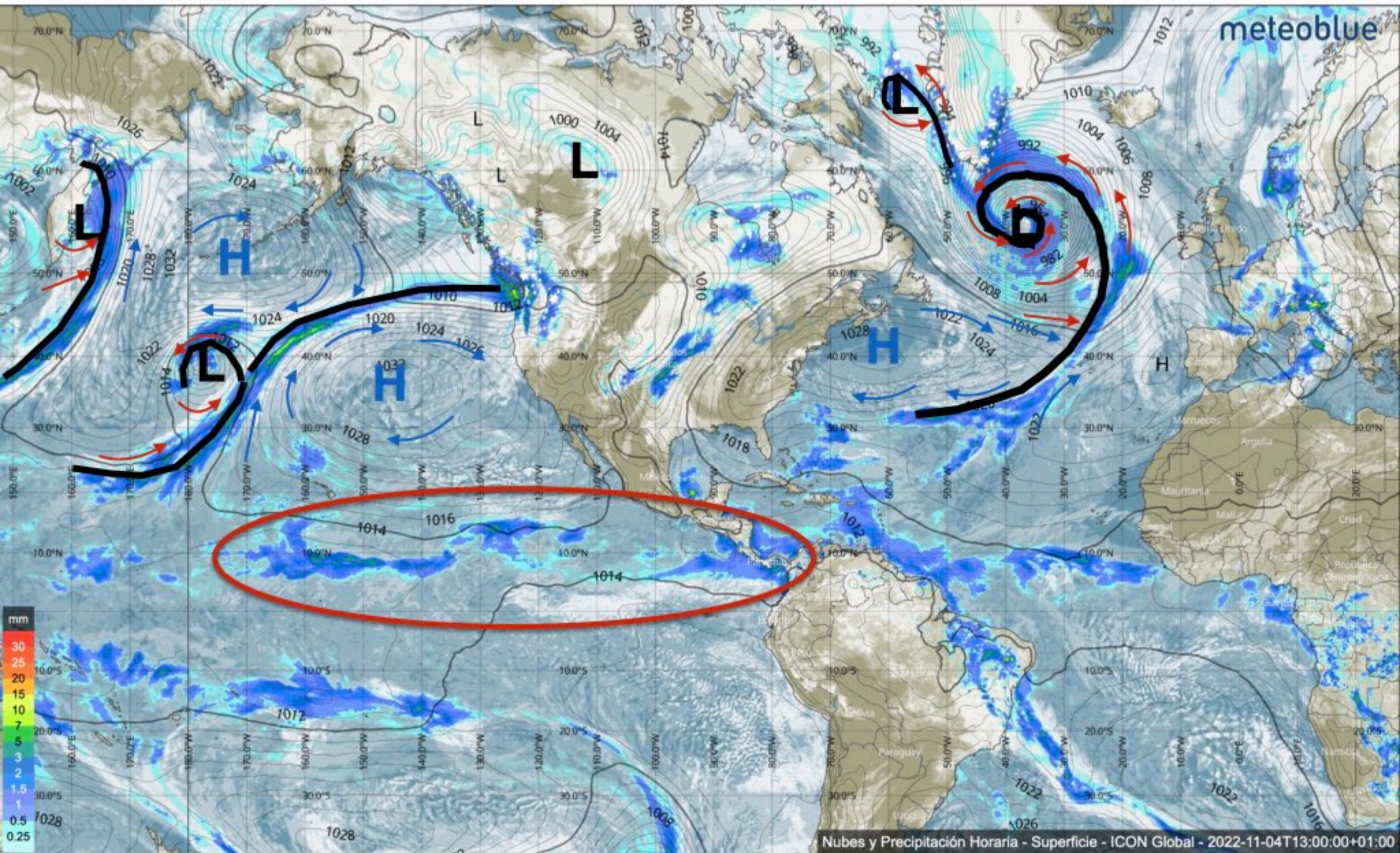
Valid 0000 UTC Mon 10 OCT 2022

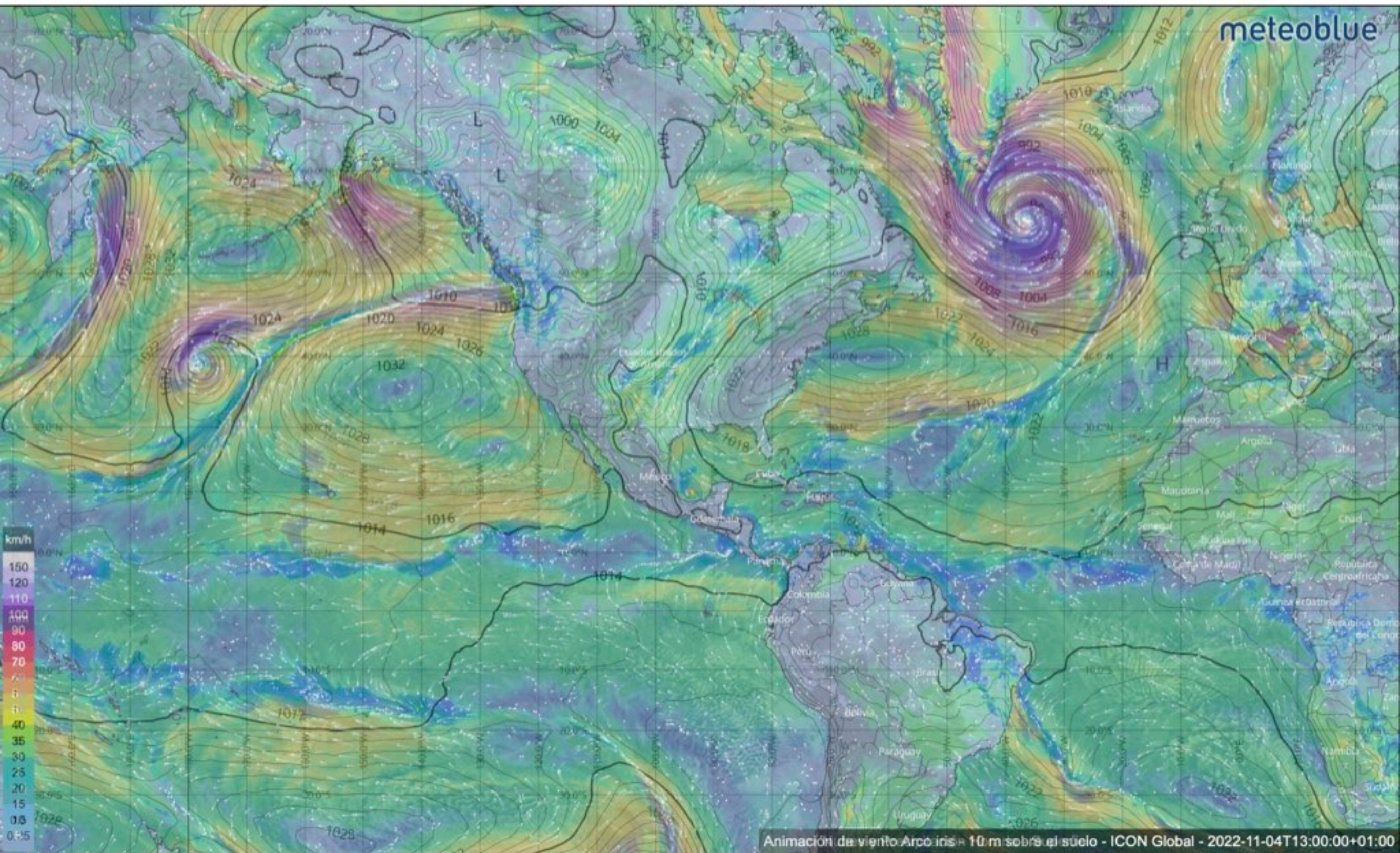


EXERCICI 8



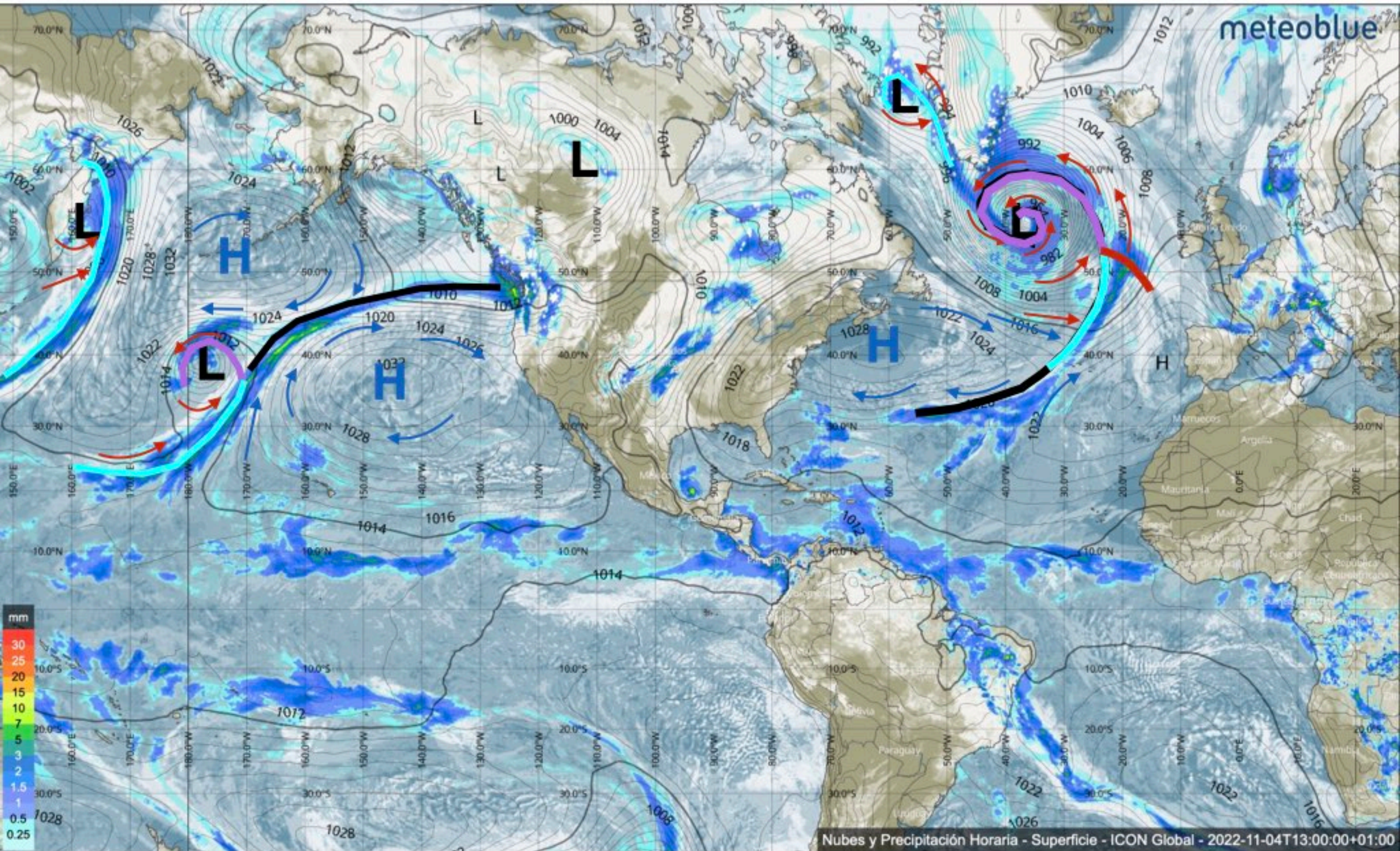
EXERCICI 8





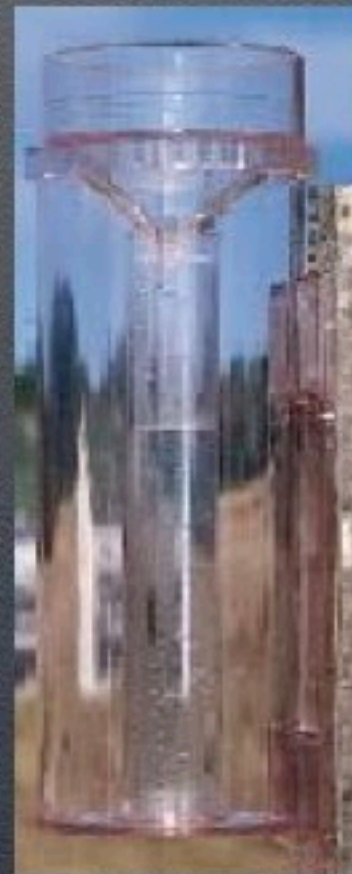
Animación de viento Arco iris a 10 m sobre el suelo - ICON Global - 2022-11-04T13:00:00+01:00

EXERCICI 8



Mesura de la precipitació

- **Raingauges**

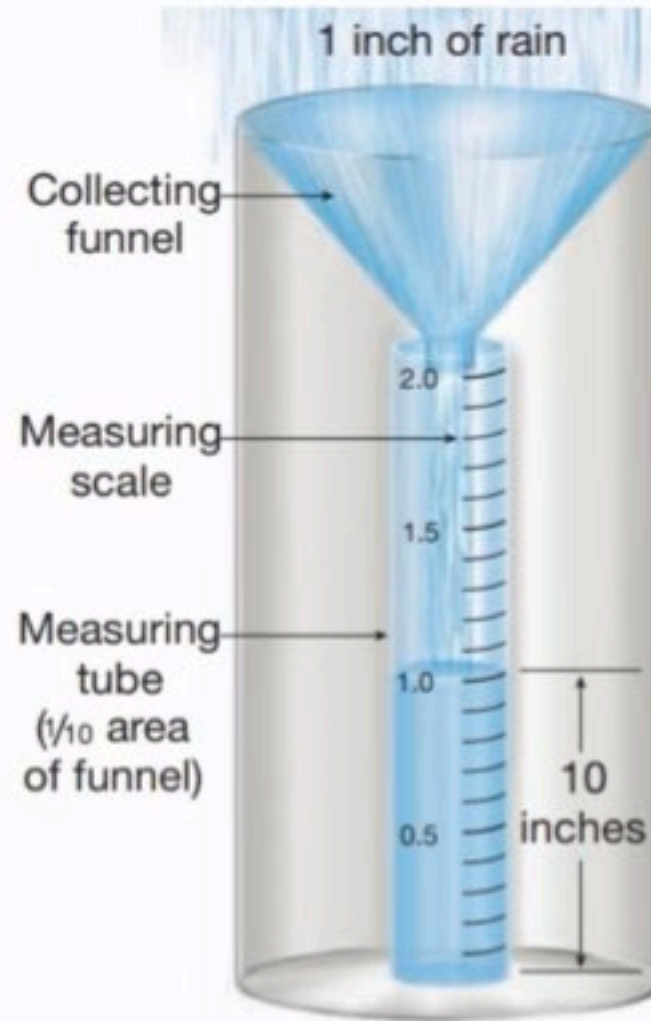


Measuring the precipitation at ground on 200 cm²

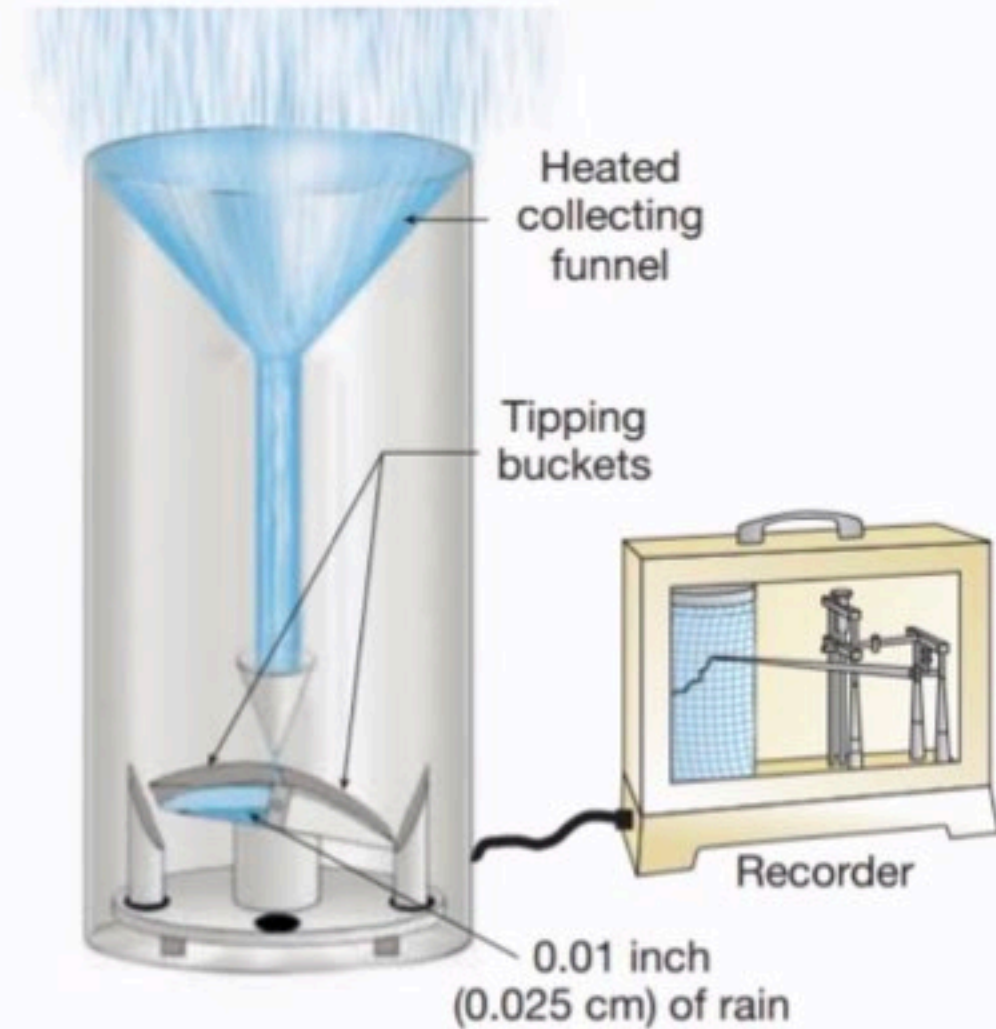
MESURA DE LA PRECIPITACIÓ



(a) Simple rain gauge



(b) Standard rain gauge



(c) Tipping-bucket gauge

Precipitation at ground?

- **Disdrometers**

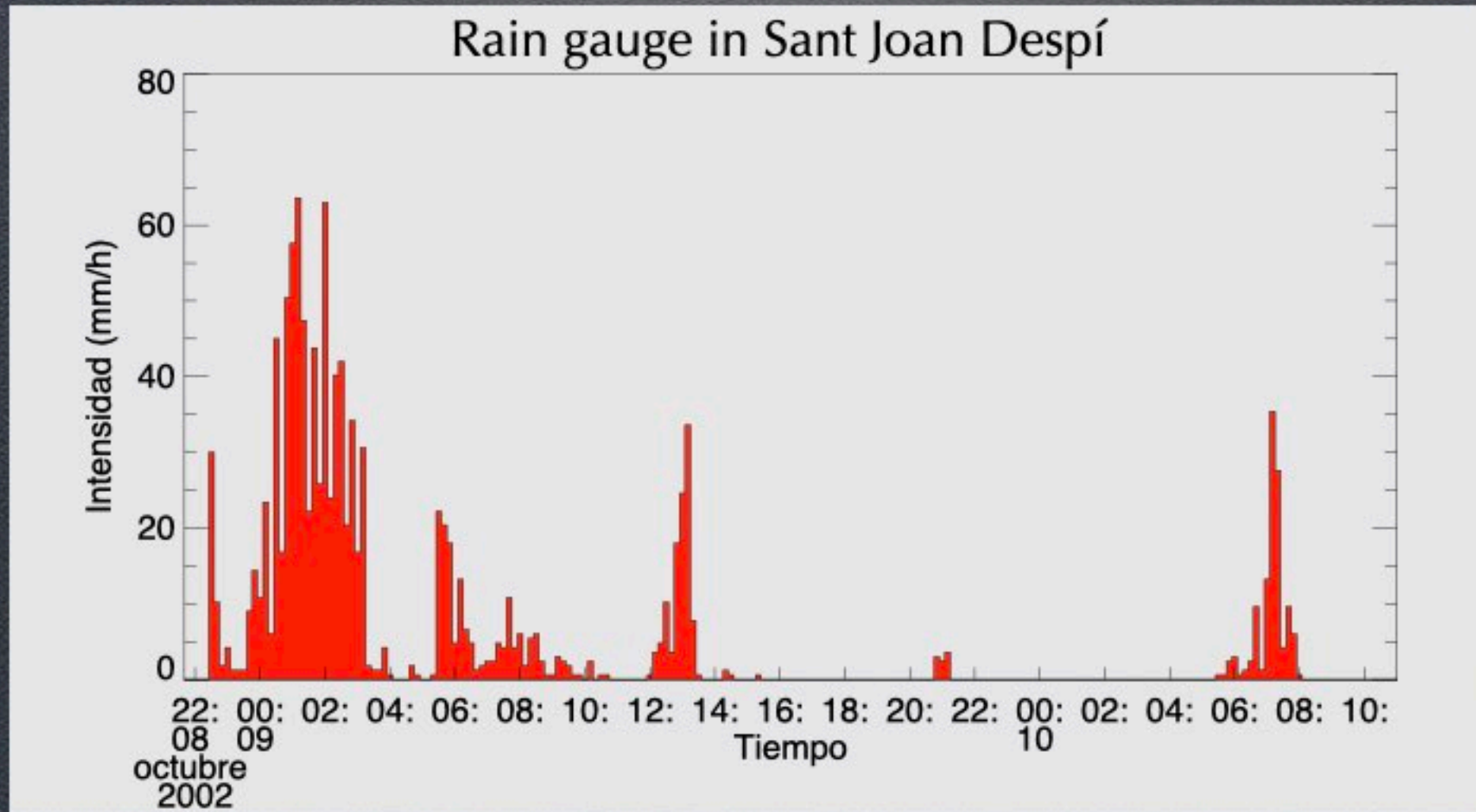


Measuring the number and the drop size distribution

Precipitation at ground?

Raingauges and disdrometers:

Very good **temporal** description of precipitation

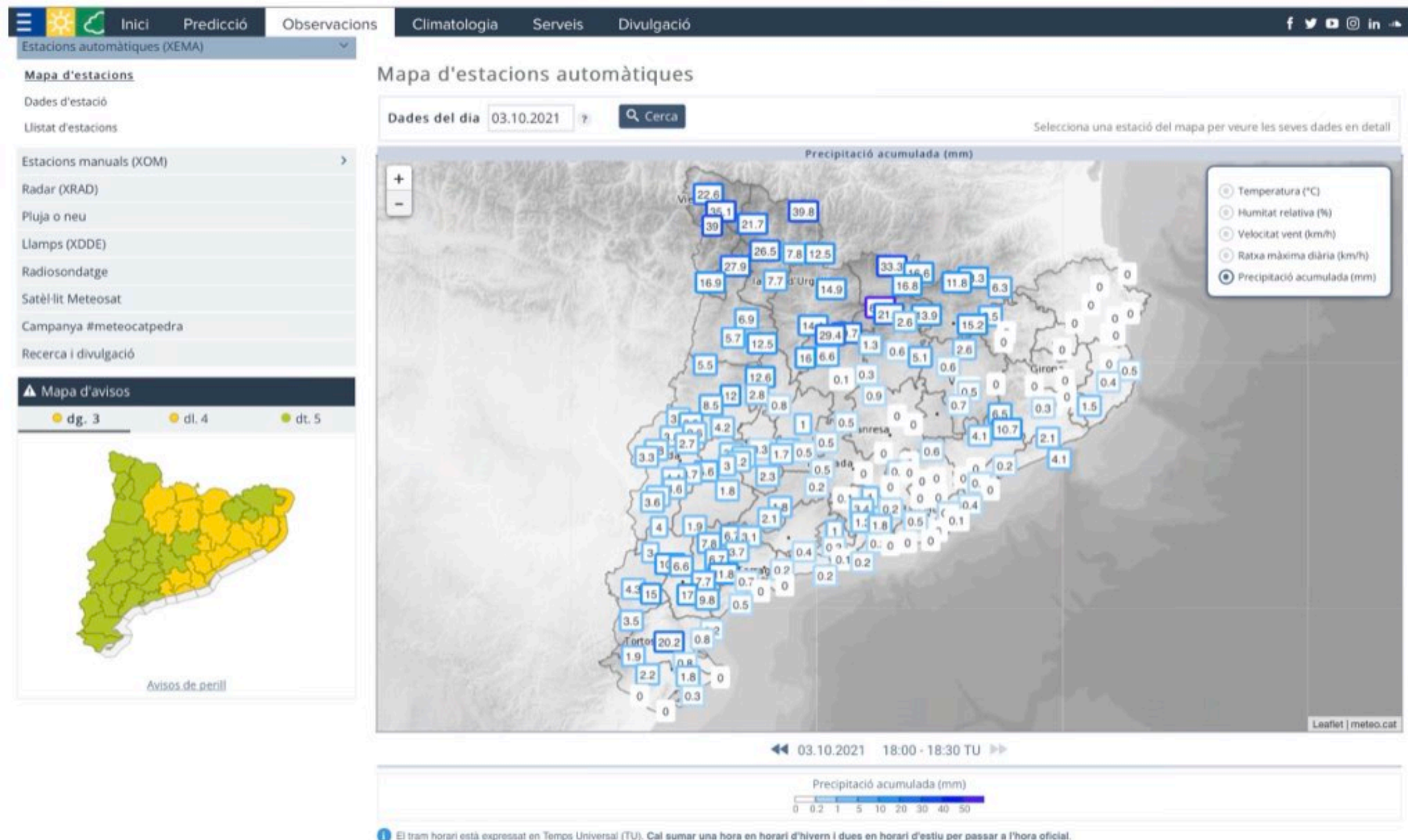


Provide a limited **spatial** description of the rainfall field

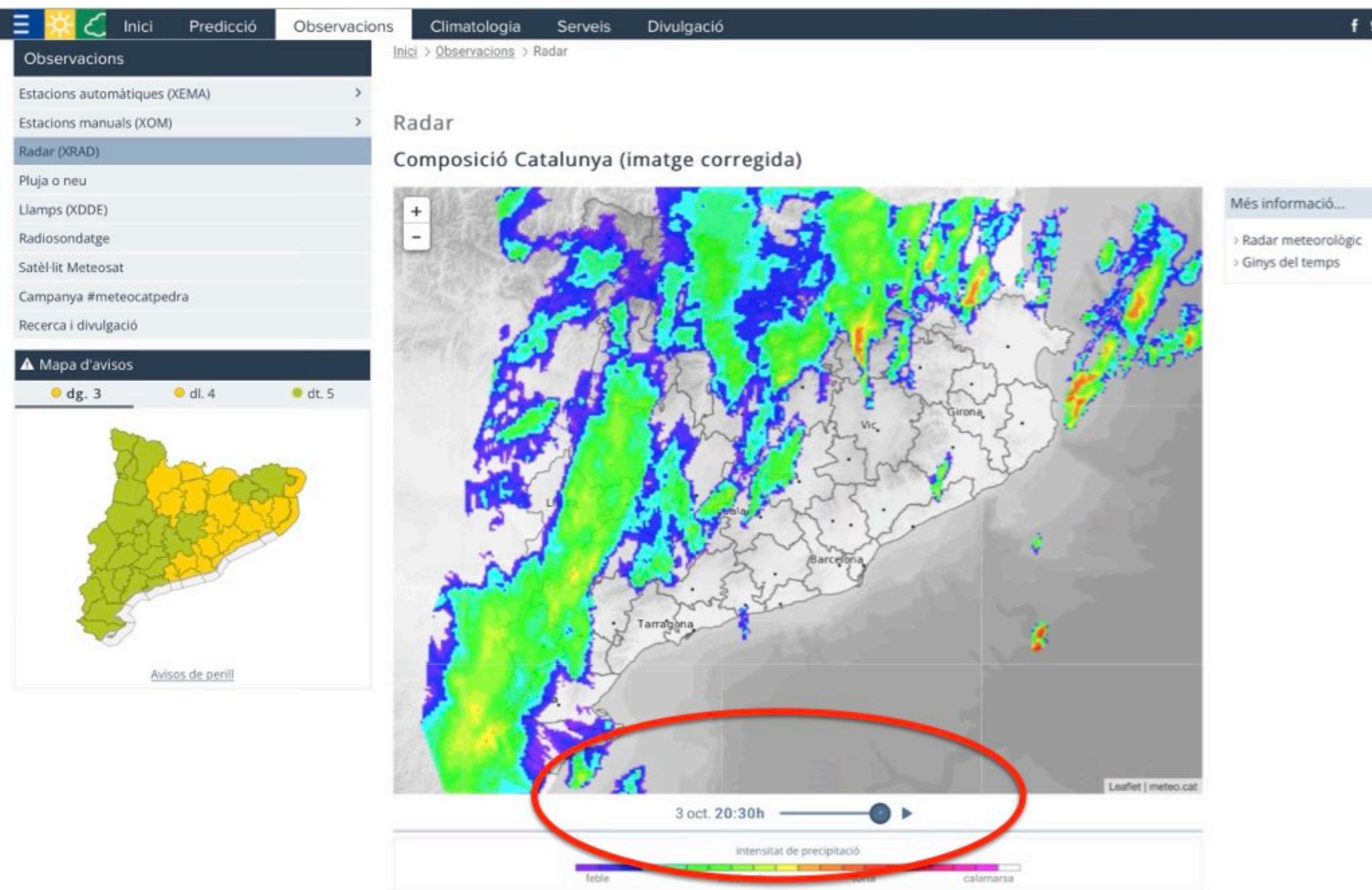
REQUIRE SPATIAL INTERPOLATION

Observació de Pluja (pluviòmetres SMC) a Barcelona el 3/10/2021

<https://www.meteo.cat/observacions/xema>

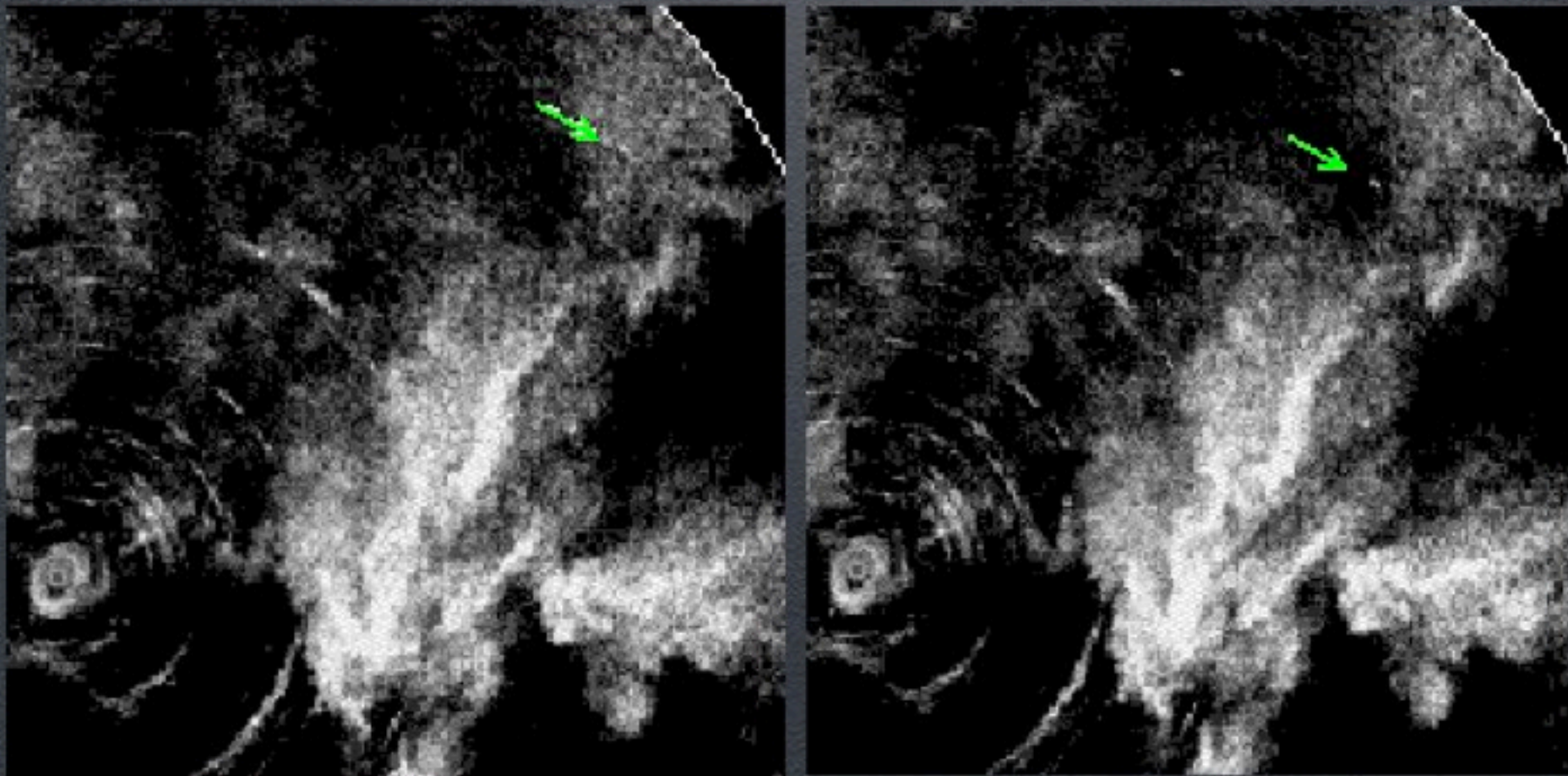


Pluja radar a Barcelona el 03/10/2021

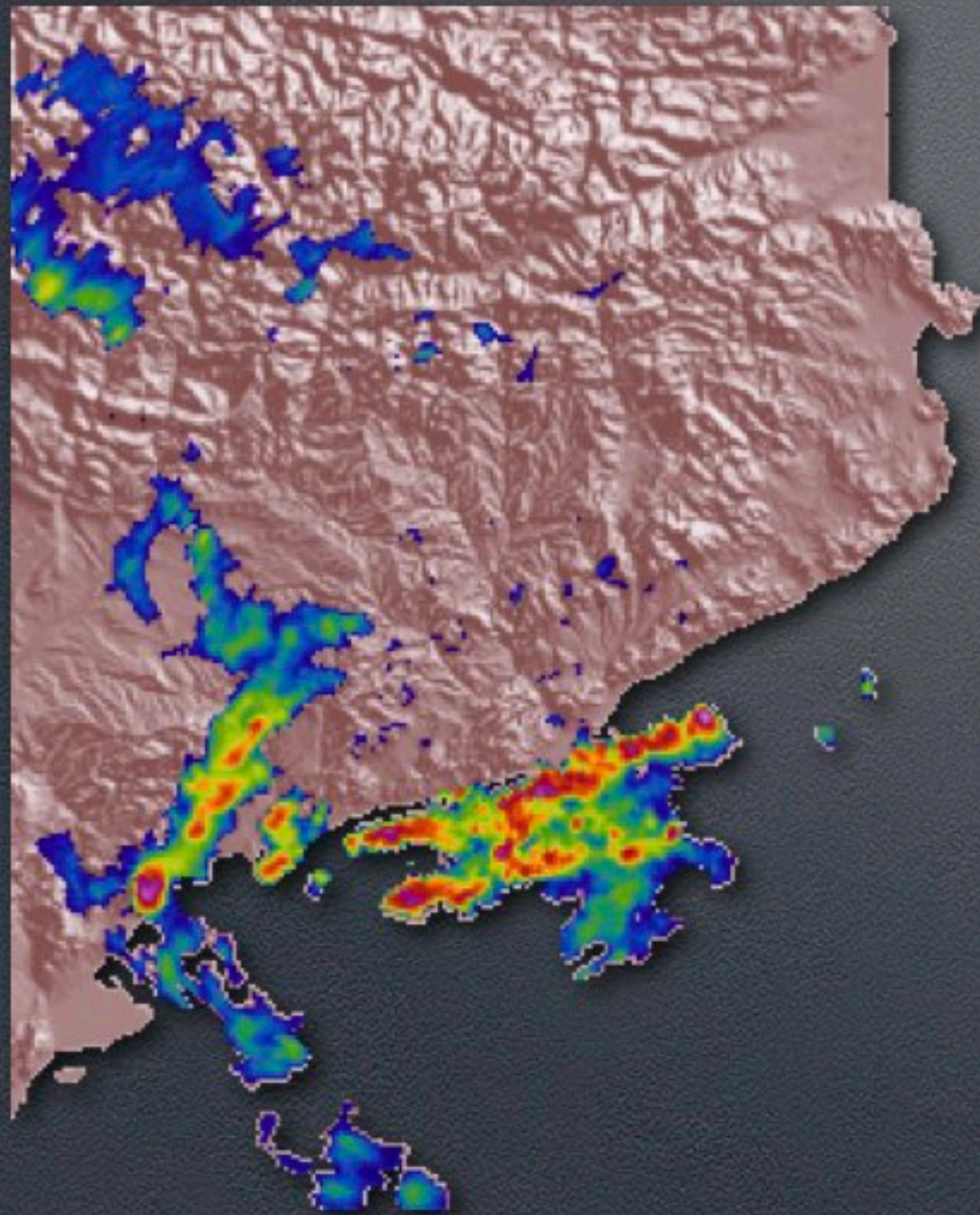


Meteorological Radar

- Acronym for “RAdio Detection And Ranging”
The invention that changed the world; R. Buderer, 1996.
- Start used for METEOROLOGICAL PURPOSES just after WW II



Meteorological Radar

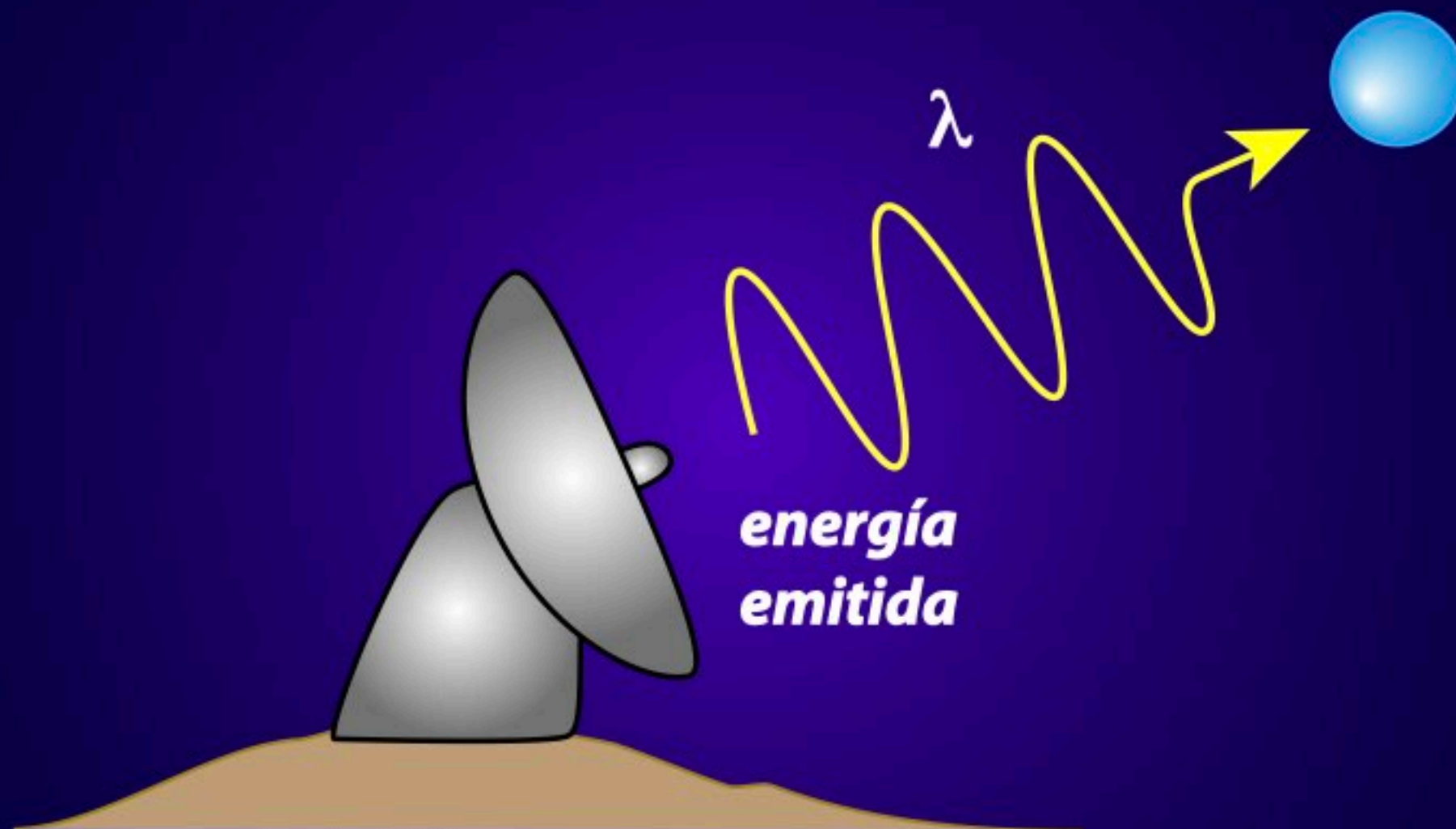


- **Remote indirect measurement** of precipitation
- Measurement of **high spatial and temporal resolution**
- $\Delta t \approx 5 - 10$ minutes
- $\Delta x \approx 1 \text{ km}^2$
- Resolution able to fulfill **hydrological requirements**
- Covering **large areas** from a central site ($200 \times 200 \text{ km}^2$)

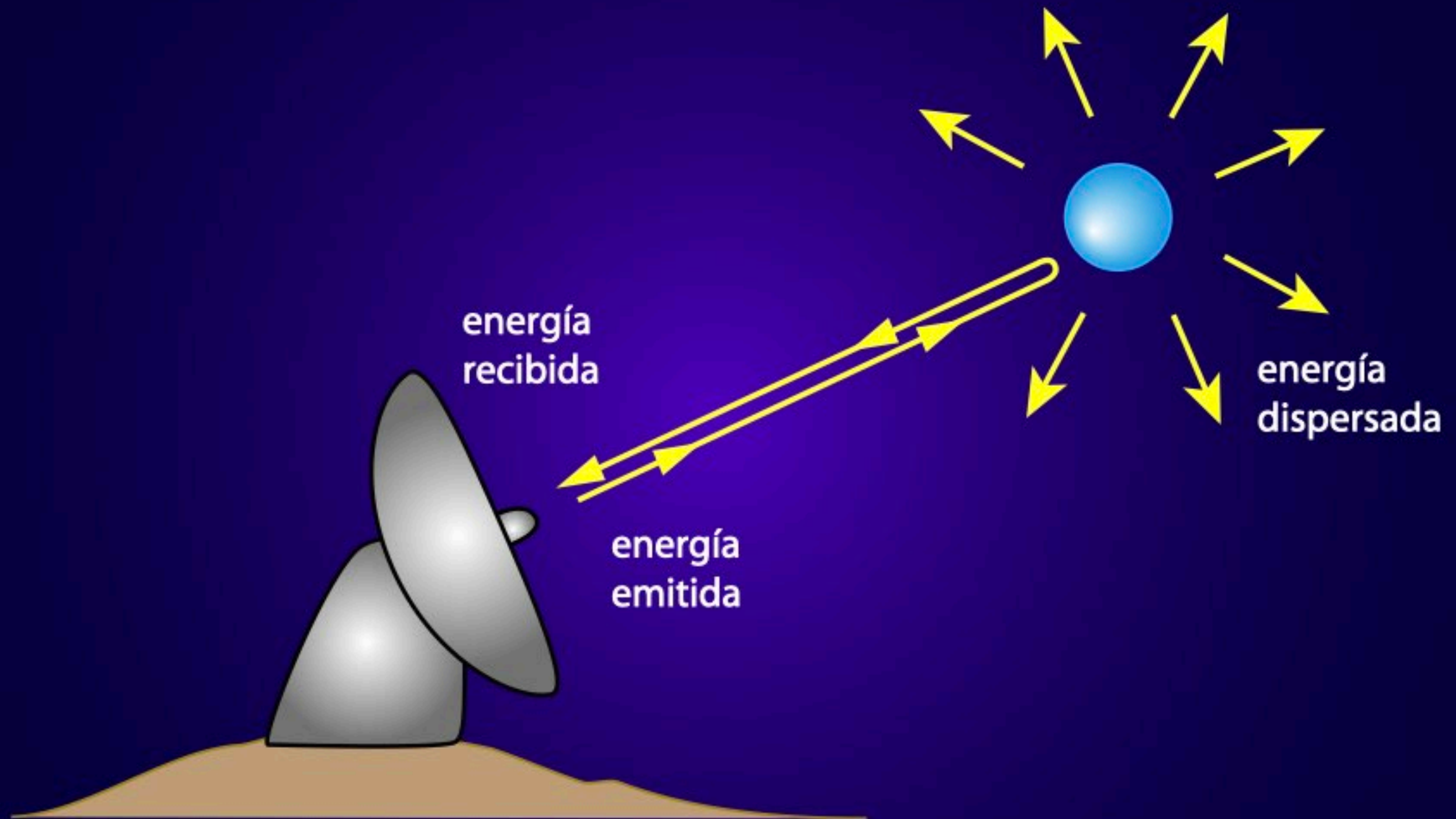


considered as **KEY TOOL FOR HYDROLOGICAL APPLICATIONS**

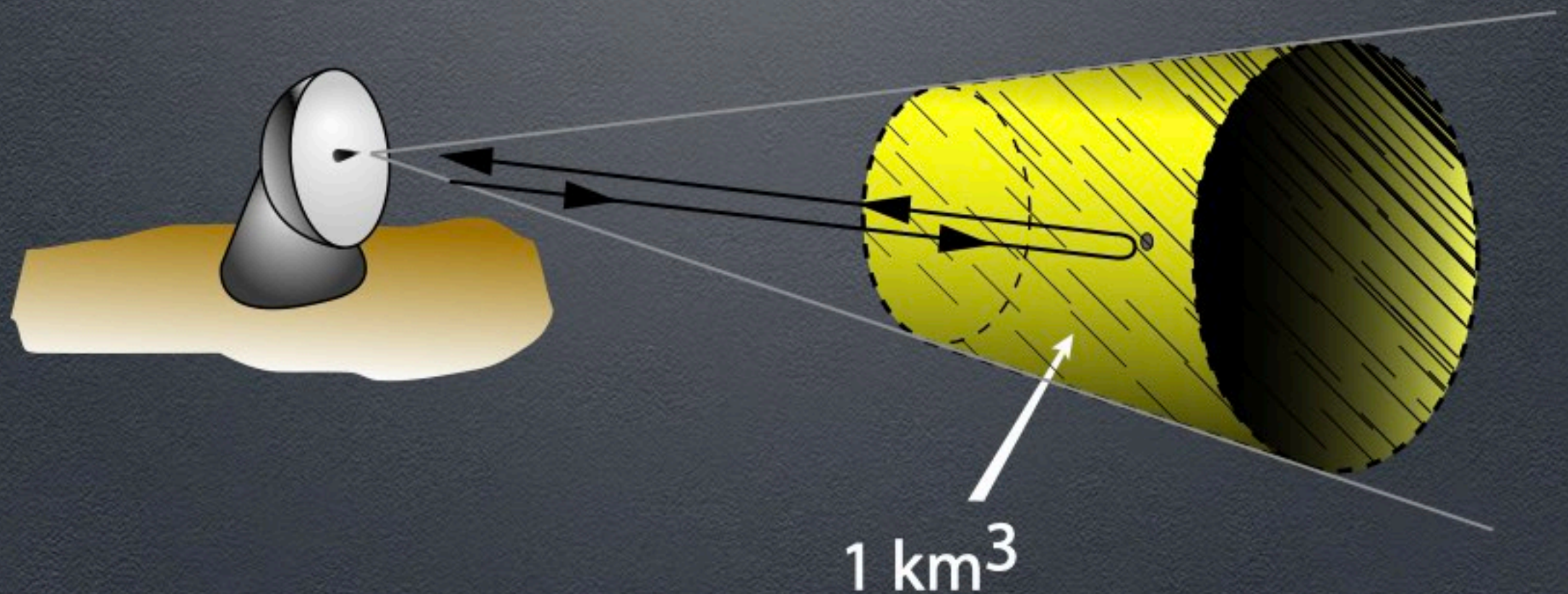
Radar measurements



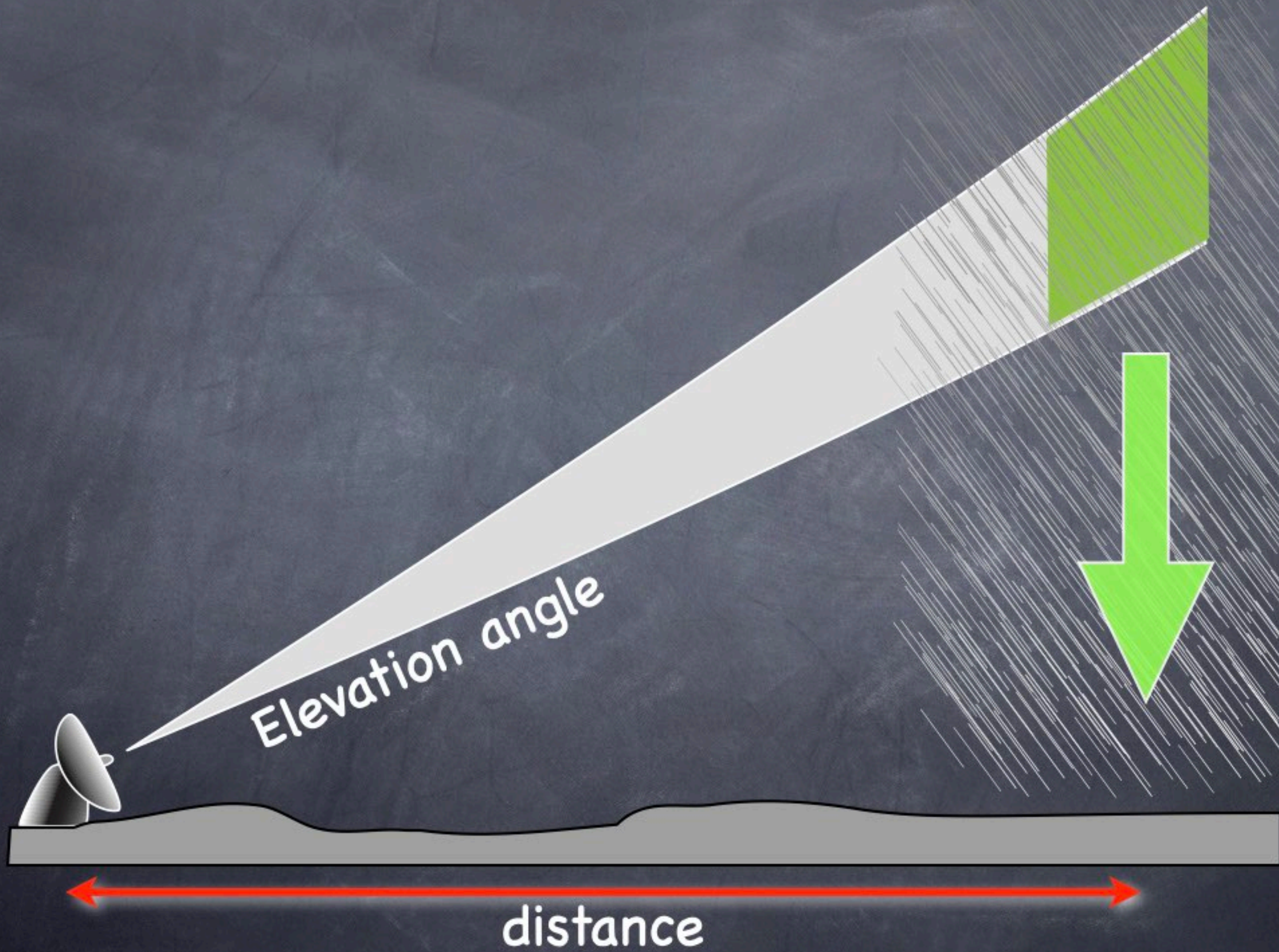
Radar measurements



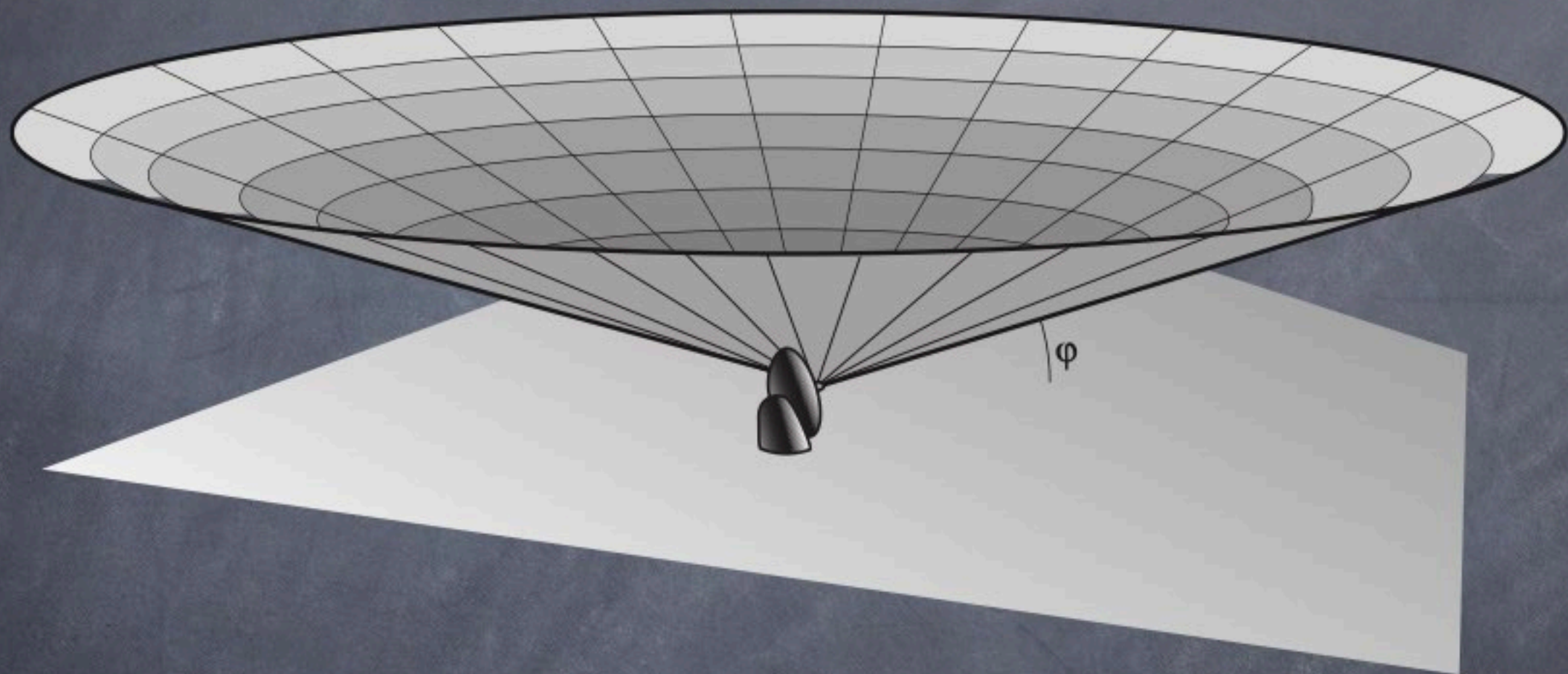
Radar measurements



**Weighted average precipitation measurement on a volume
(It measures reflectivity (Z) instead of intensity (R))**

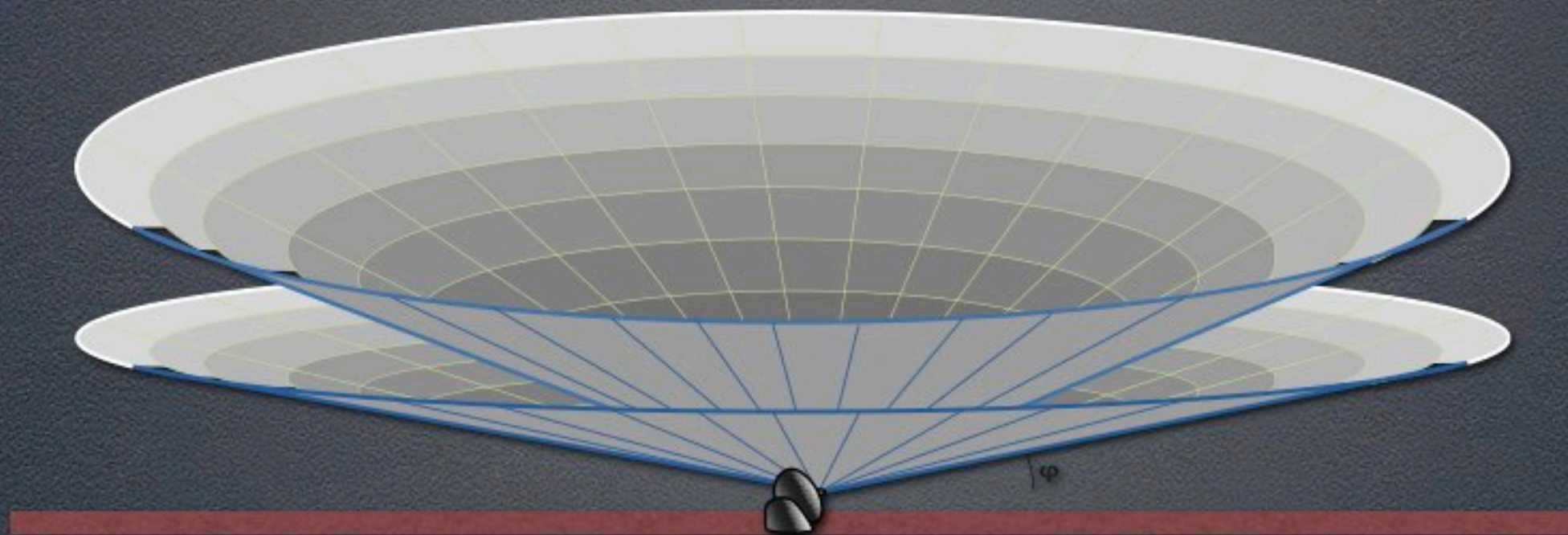


Radar measurements

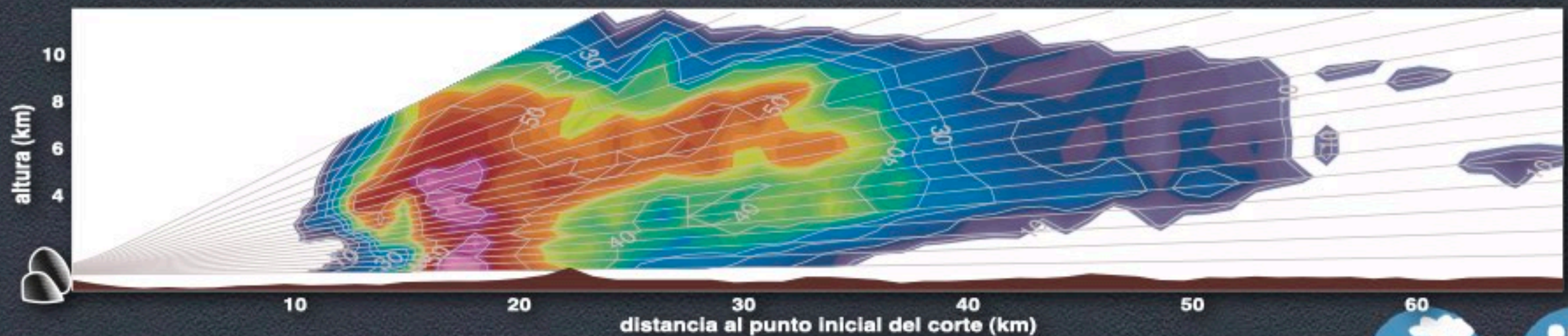


**It samples in different directions
during the antenna rotation**

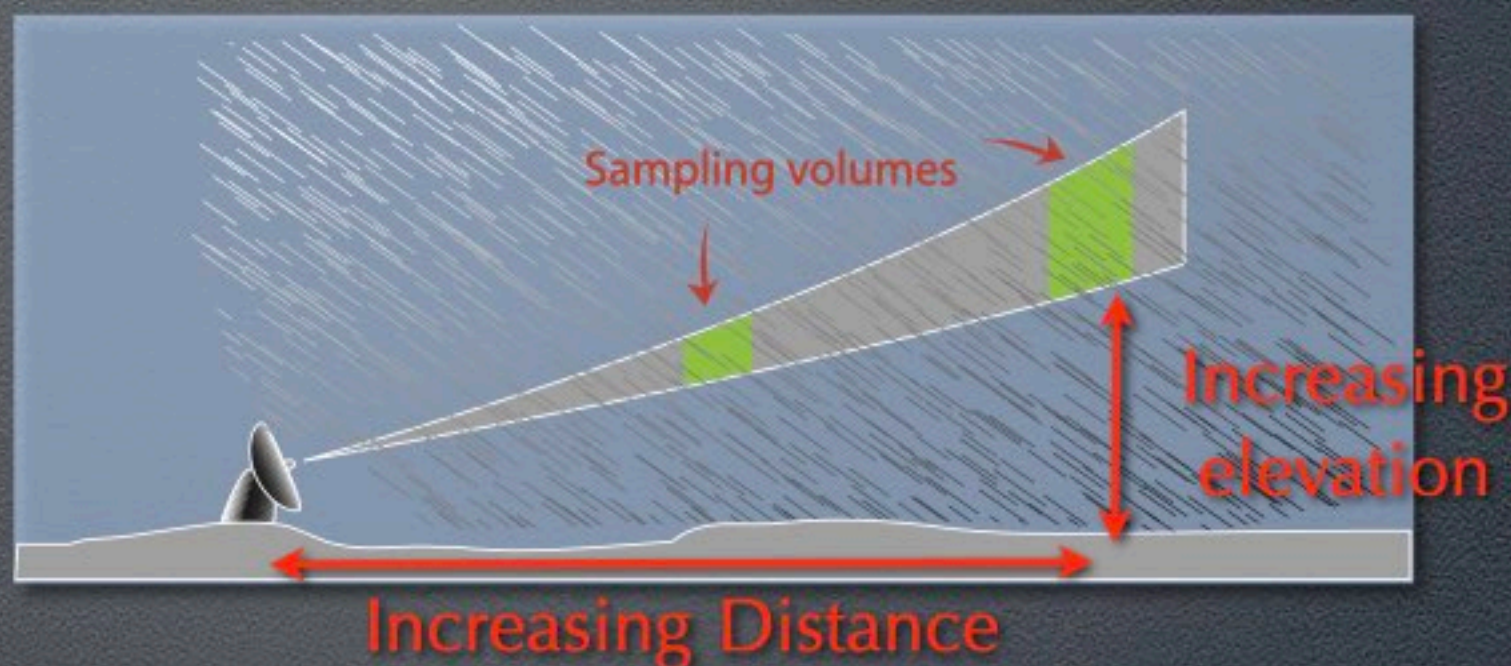
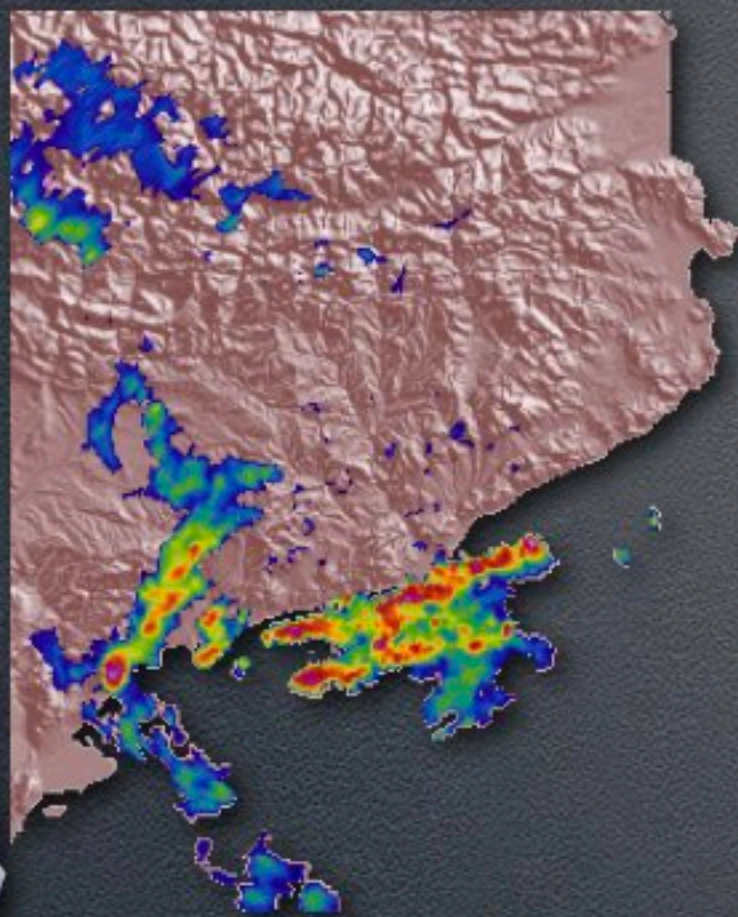
Radar precipitation measurements



Radar measures conical surfaces at different elevation angles obtaining atmosphere volumes

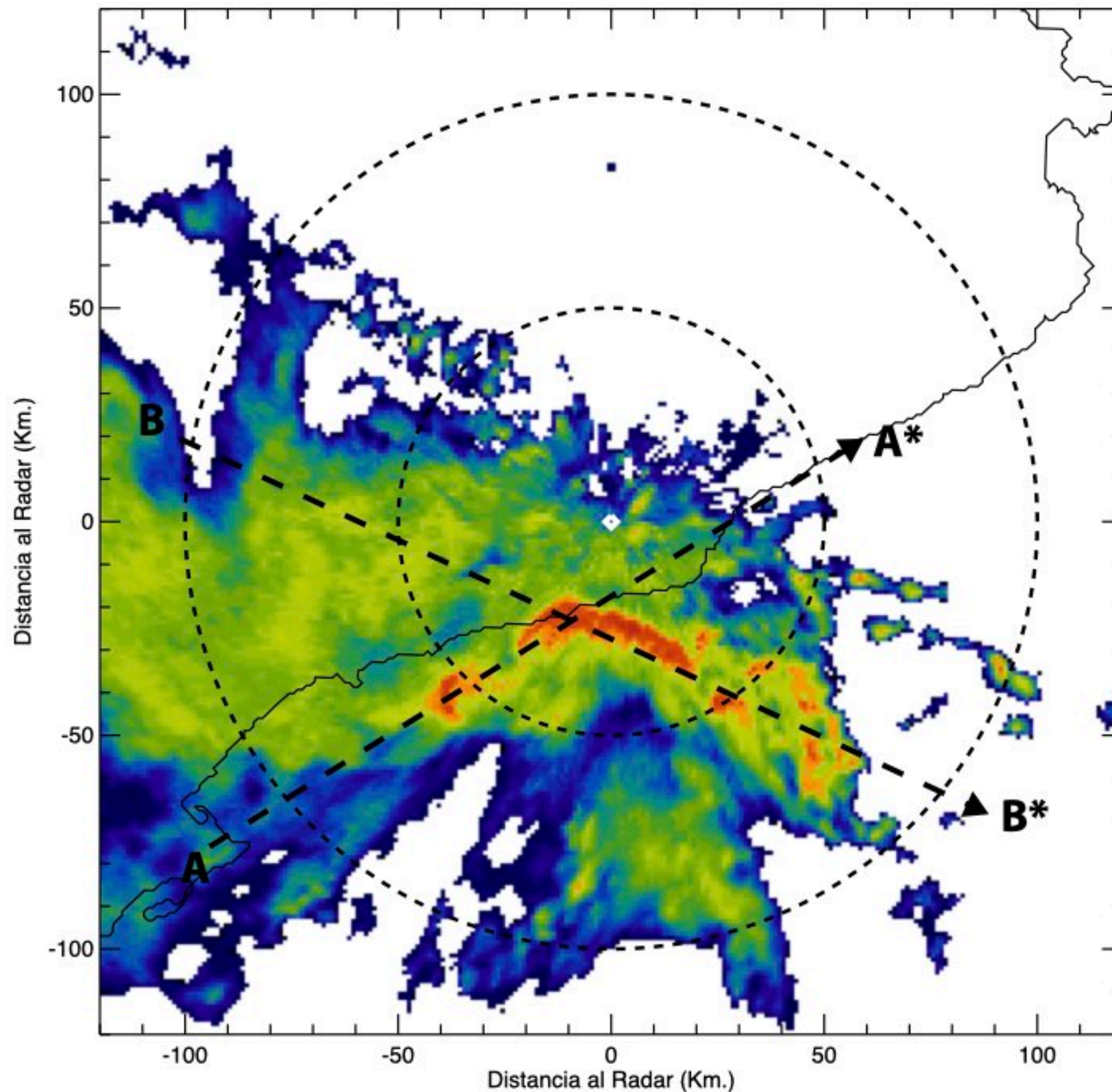


Radar estimates



Indirect measurement of precipitation

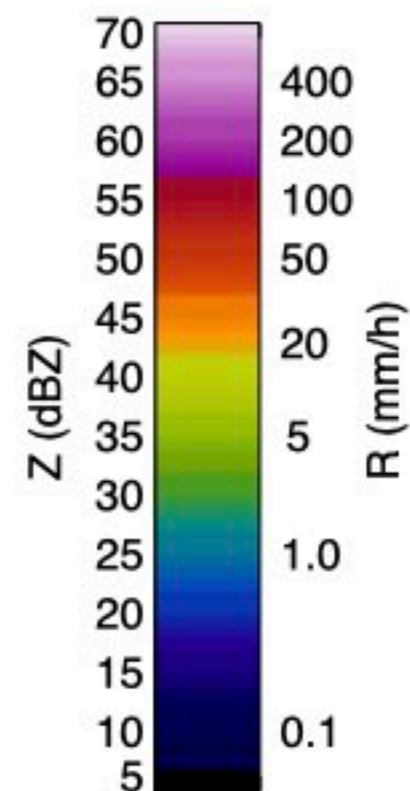
- Weighted average on a 1-km³ volume
- Z related to R through the DSD
- Measurements at different altitudes
- Effects with distance to the radar



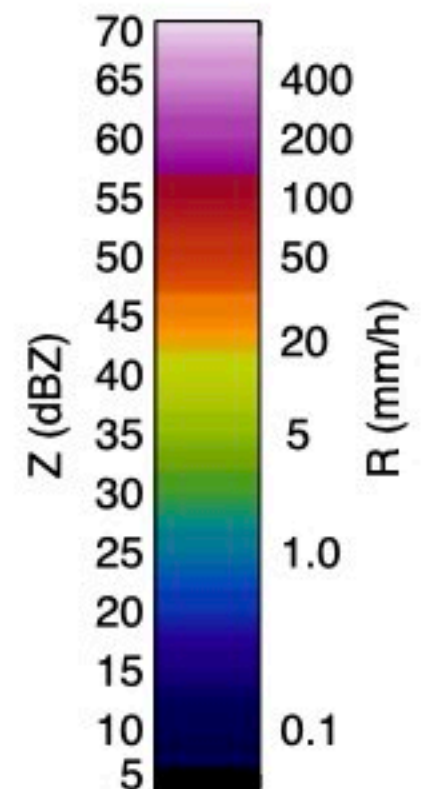
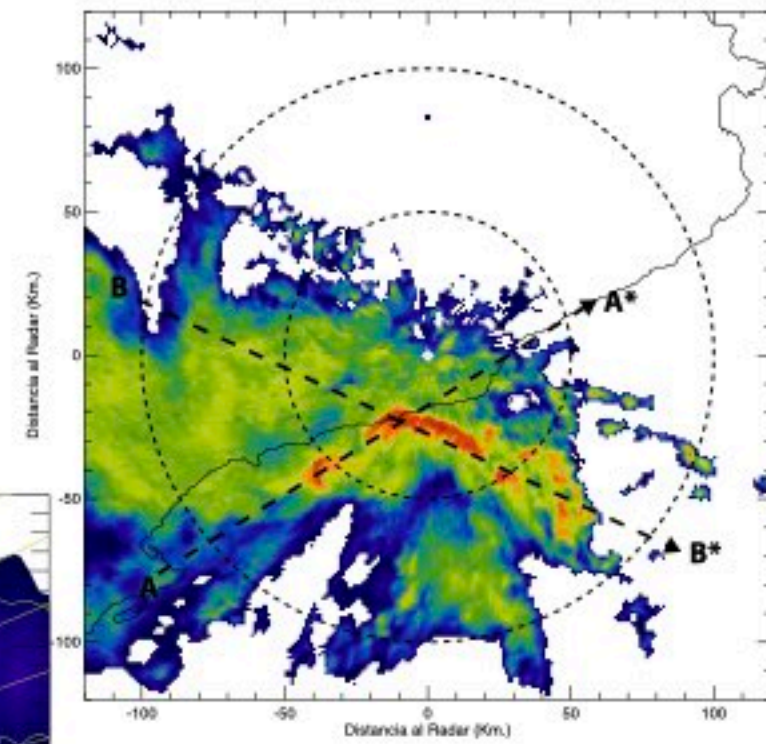
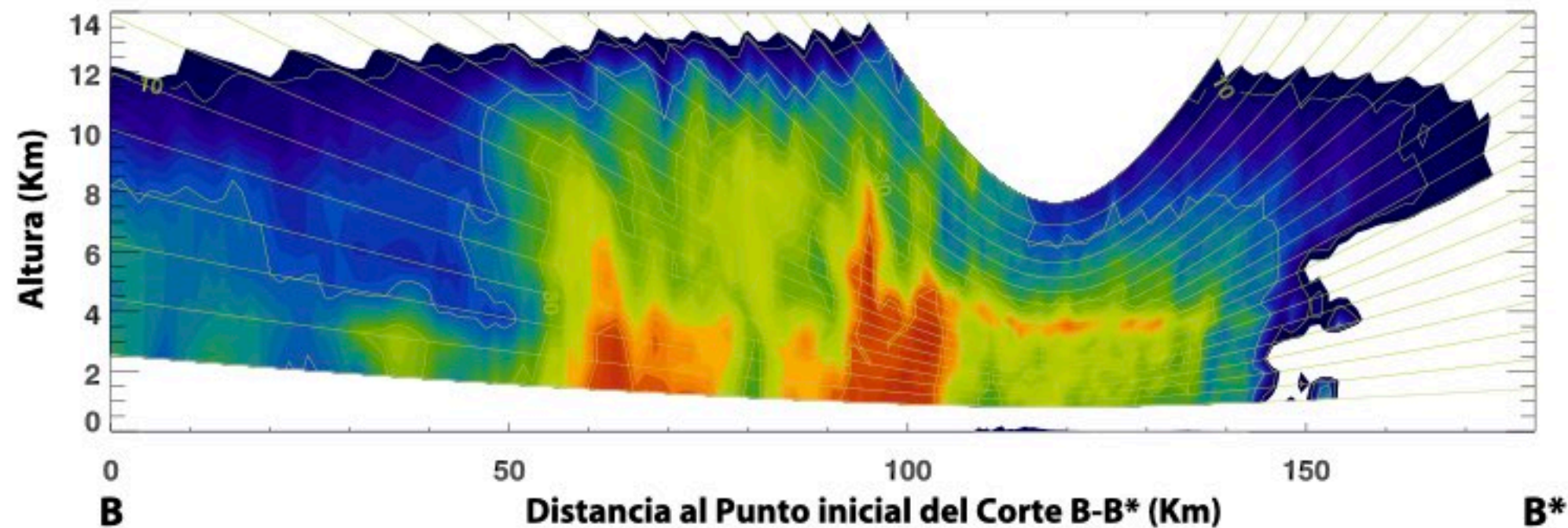
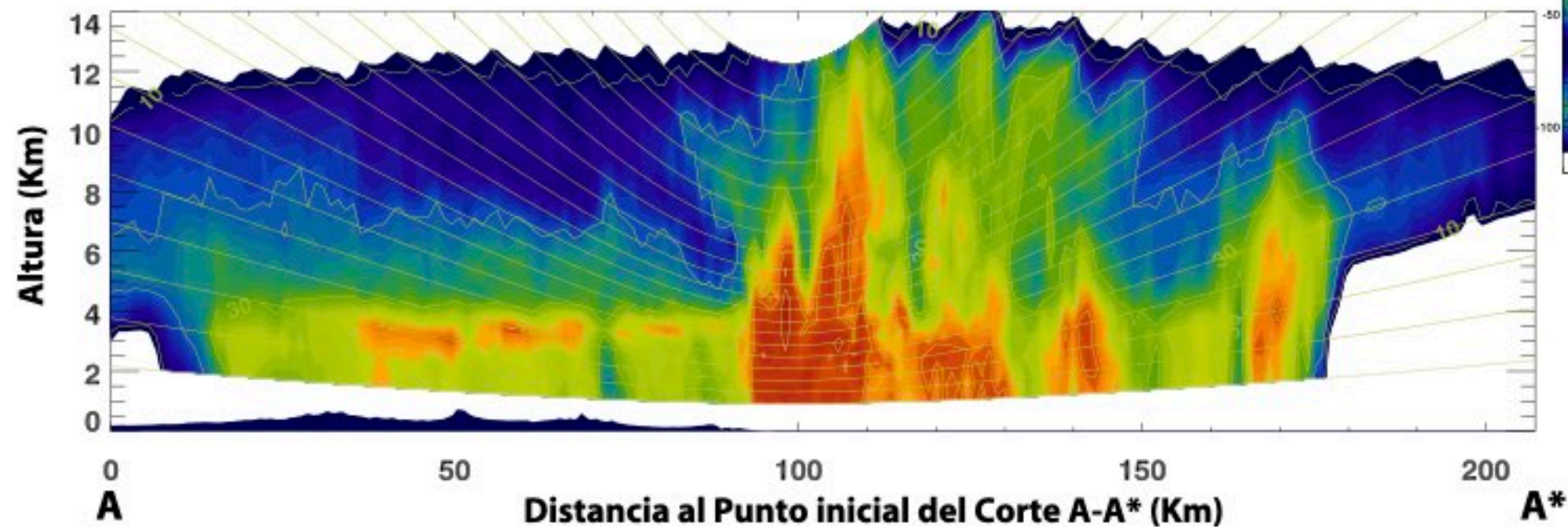
Processed Radar rainfall field

**Cartesian
Coordinates**

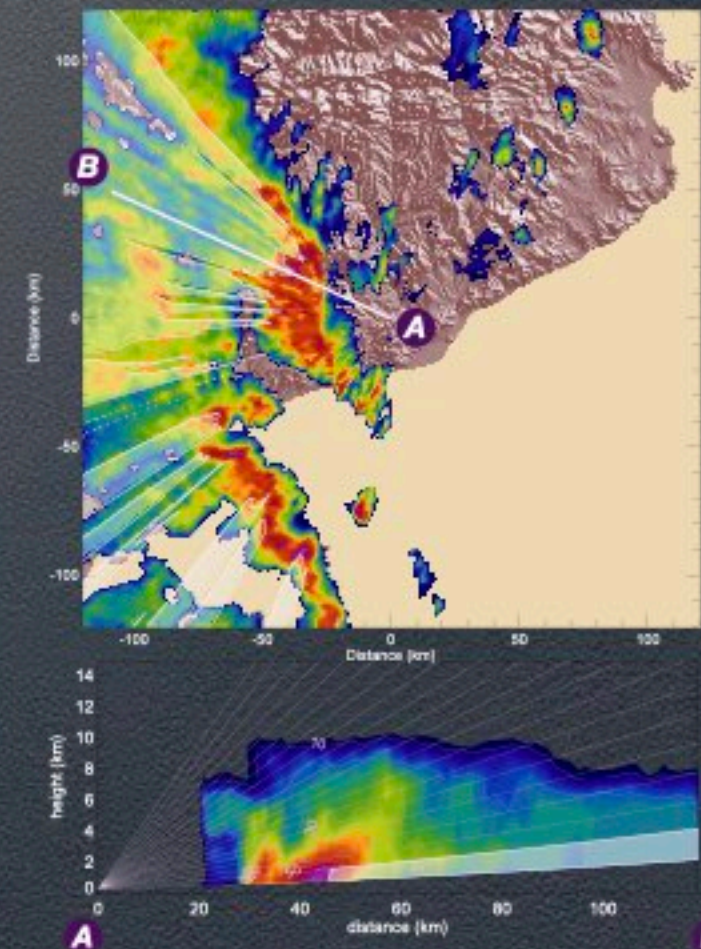
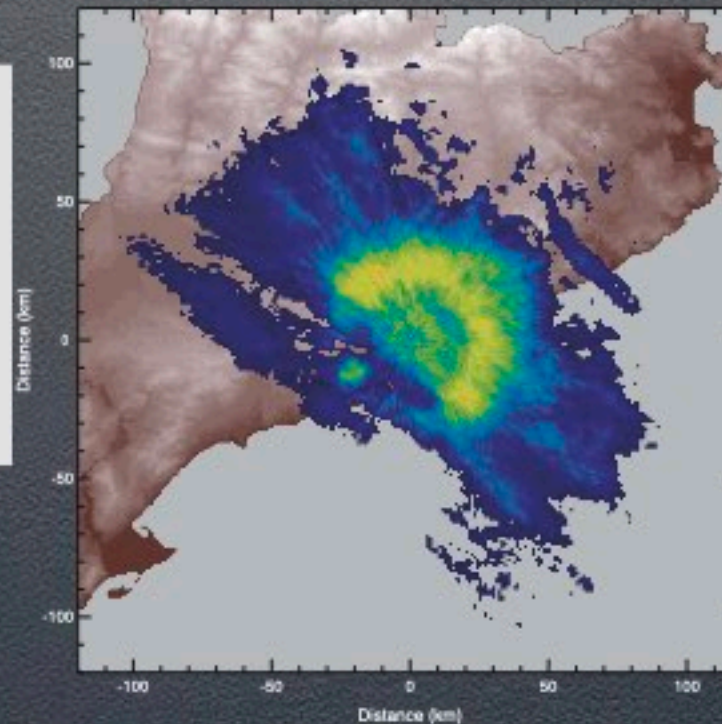
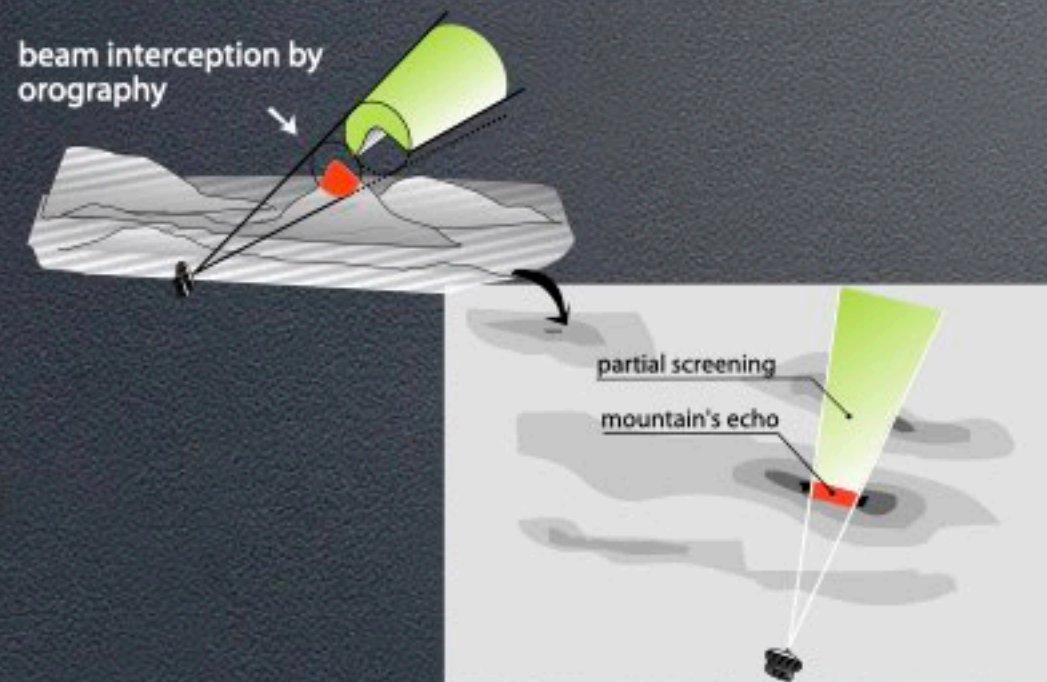
**Processing
applied
Groundclutter
Attenuation
Signal stability**



The radar provides a 3D measurement of the precipitation field structure



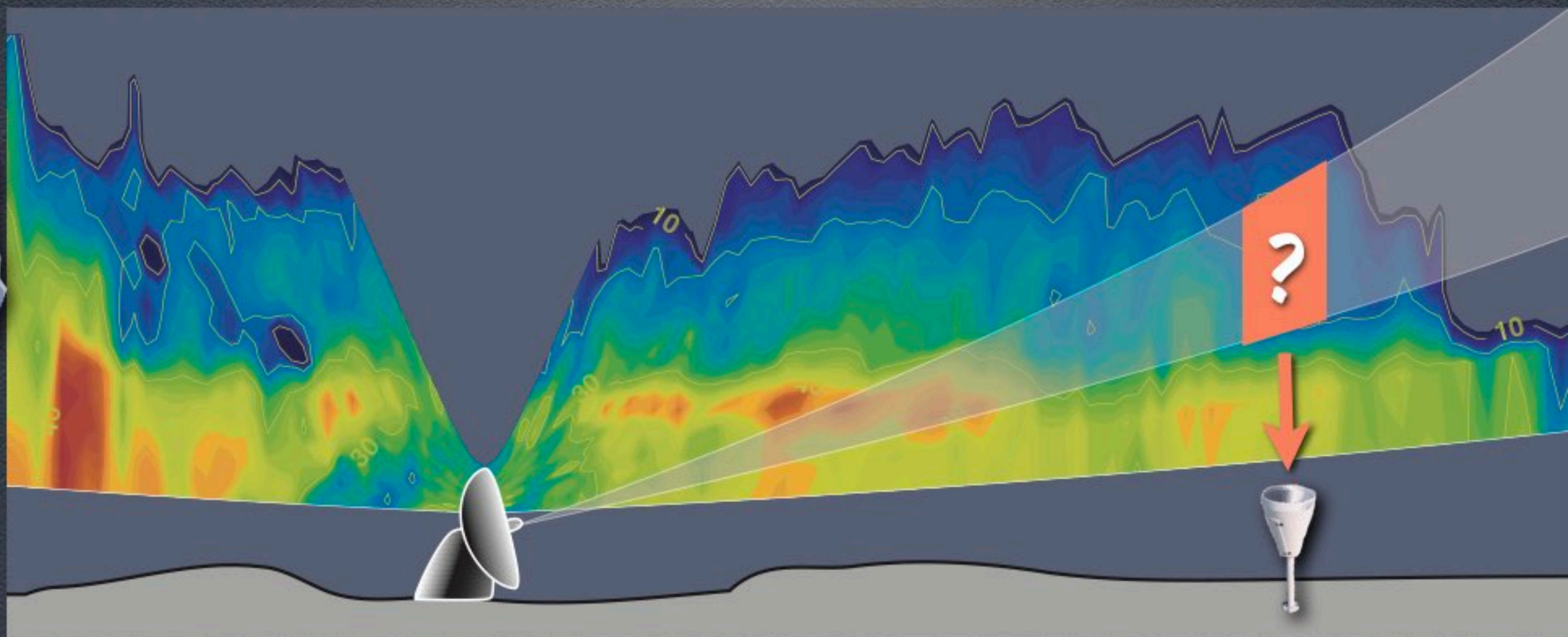
Quantitative estimation only possible if VERY careful processing is carried out



MILESTONE: Zawadzki 1984

Factors affecting the precision of radar measurement of rain

The first thing hydrologists want to do when getting radar data is to compare them with raingauges...



ATTENTION: comparing weighted average precipitation on 1-km³ volume aloft with estimates over 200 cm² at ground

Usually in hydrology: Raingauge network



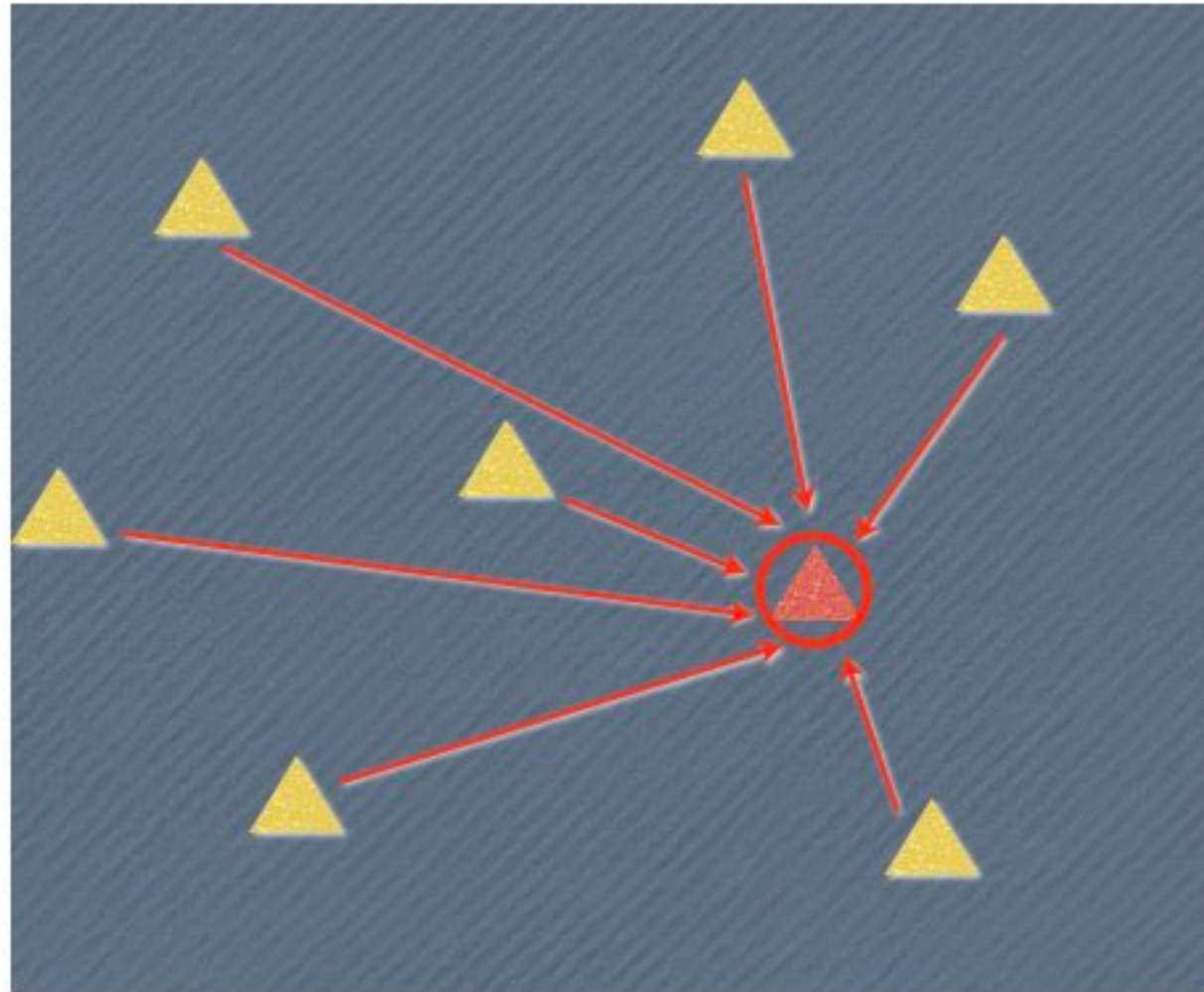
- **Point measurements** (200 cm^2)
- **Irregularly widespread** over the land
- **Low spatial** density
usually 1 raingauge per $200\text{-}300 \text{ km}^2$



Unable to fulfill the requirements for
hydrological modelling
1 raingauge per $5\text{-}10 \text{ km}^2$

NEED INTERPOLATION

Spatial Interpolation

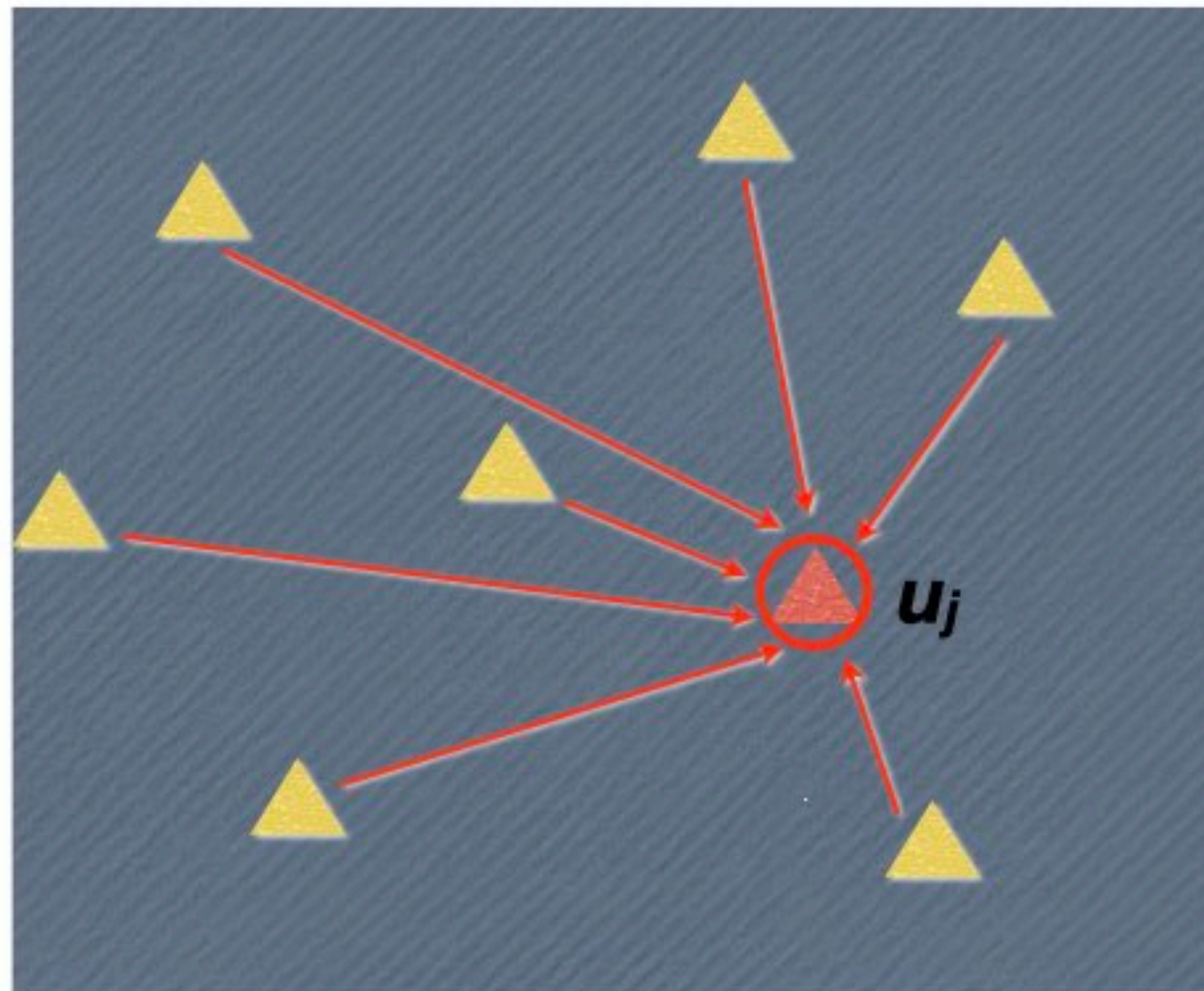


SPATIAL INTERPOLATION

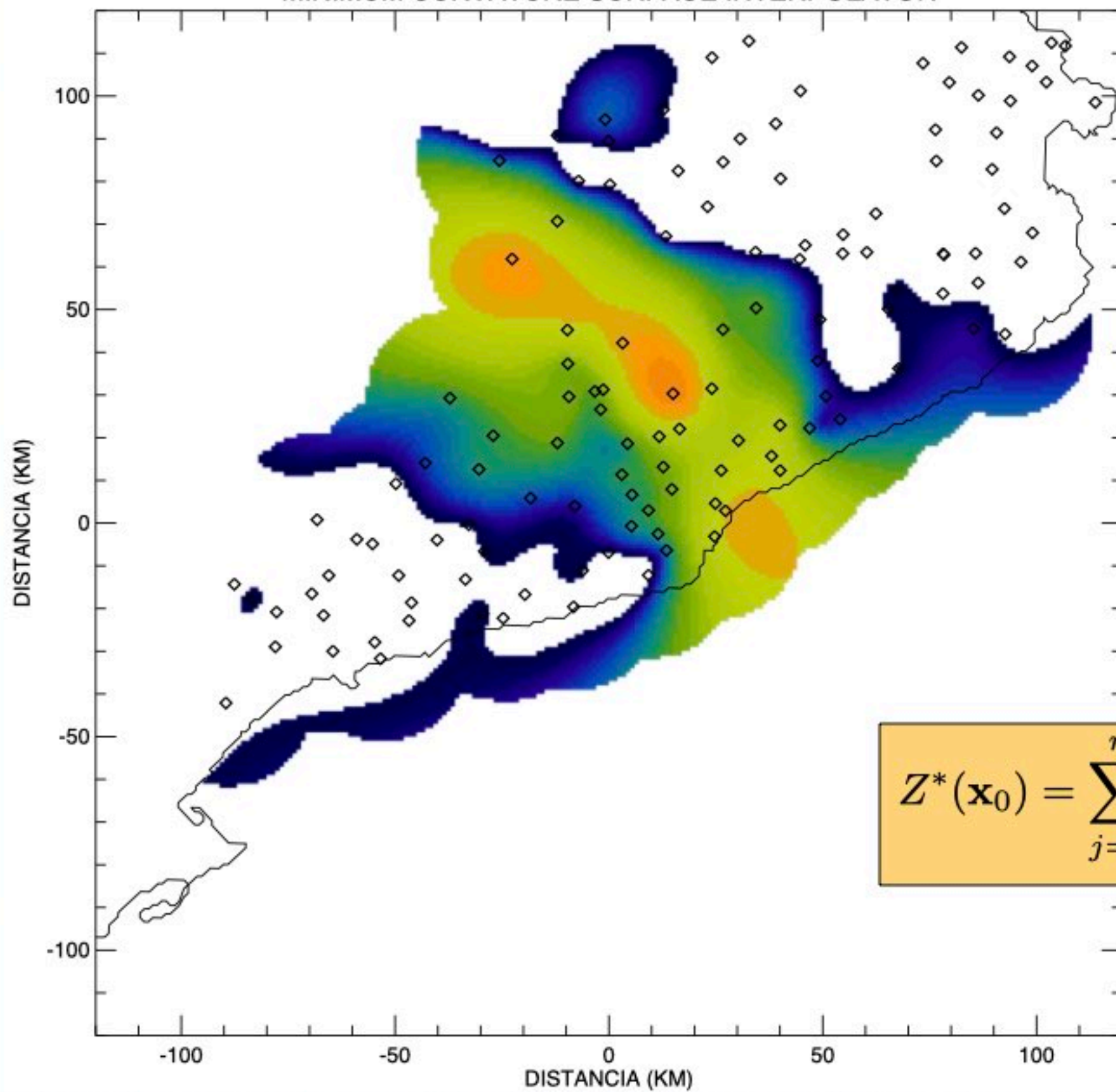
The spatial variable Z takes values that depend on the position on the ground, given by the position vector $\mathbf{u}$ ($\mathbf{u}$ being a vector given by its components on the x and y axes)

$$Z(\vec{u}) = Z(\mathbf{u}) = Z(x,y)$$

If we know the value of $Z(\mathbf{u}_i)$ at various points $\mathbf{u}_i$ $i=1, \dots, N$; How can we estimate the value $Z(\mathbf{u}_j)$ in a position $\mathbf{u}_j$ in which there is no observation?

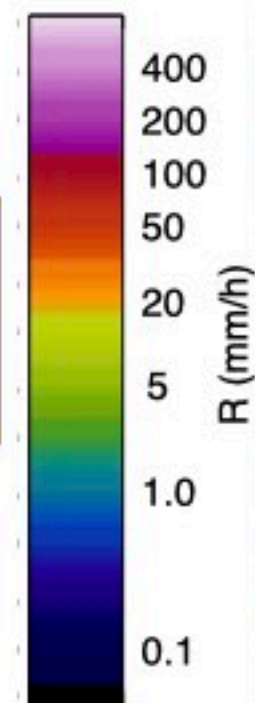


MINIMUM CURVATURE SURFACE INTERPOLATOR



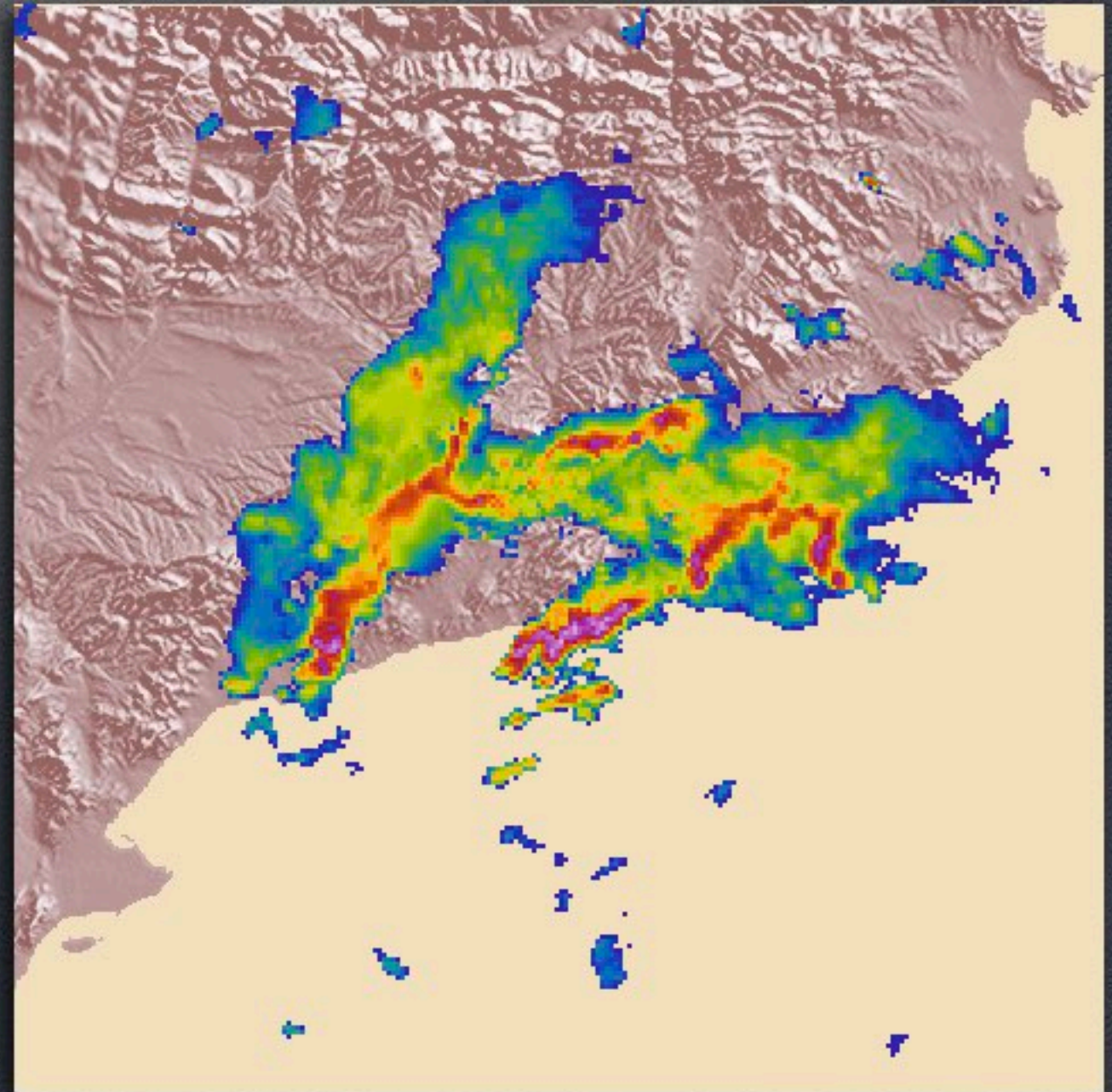
**Surface of
minimal
curvature**

$$Z^*(\mathbf{x}_0) = \sum_{j=1}^n \lambda_j Z(\mathbf{x}_j)$$



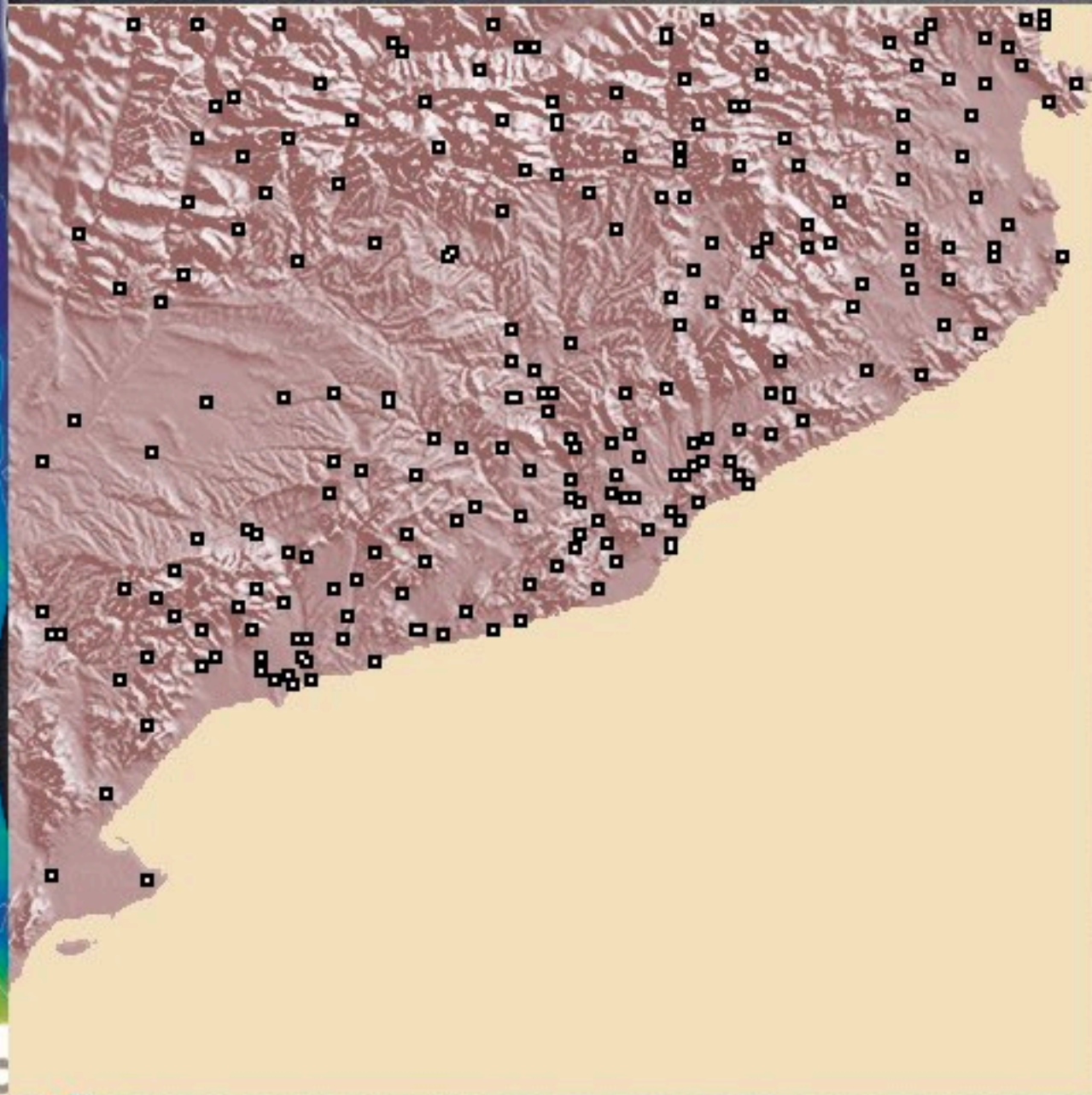
Comparison radar/rain gauge interpolation

Radar

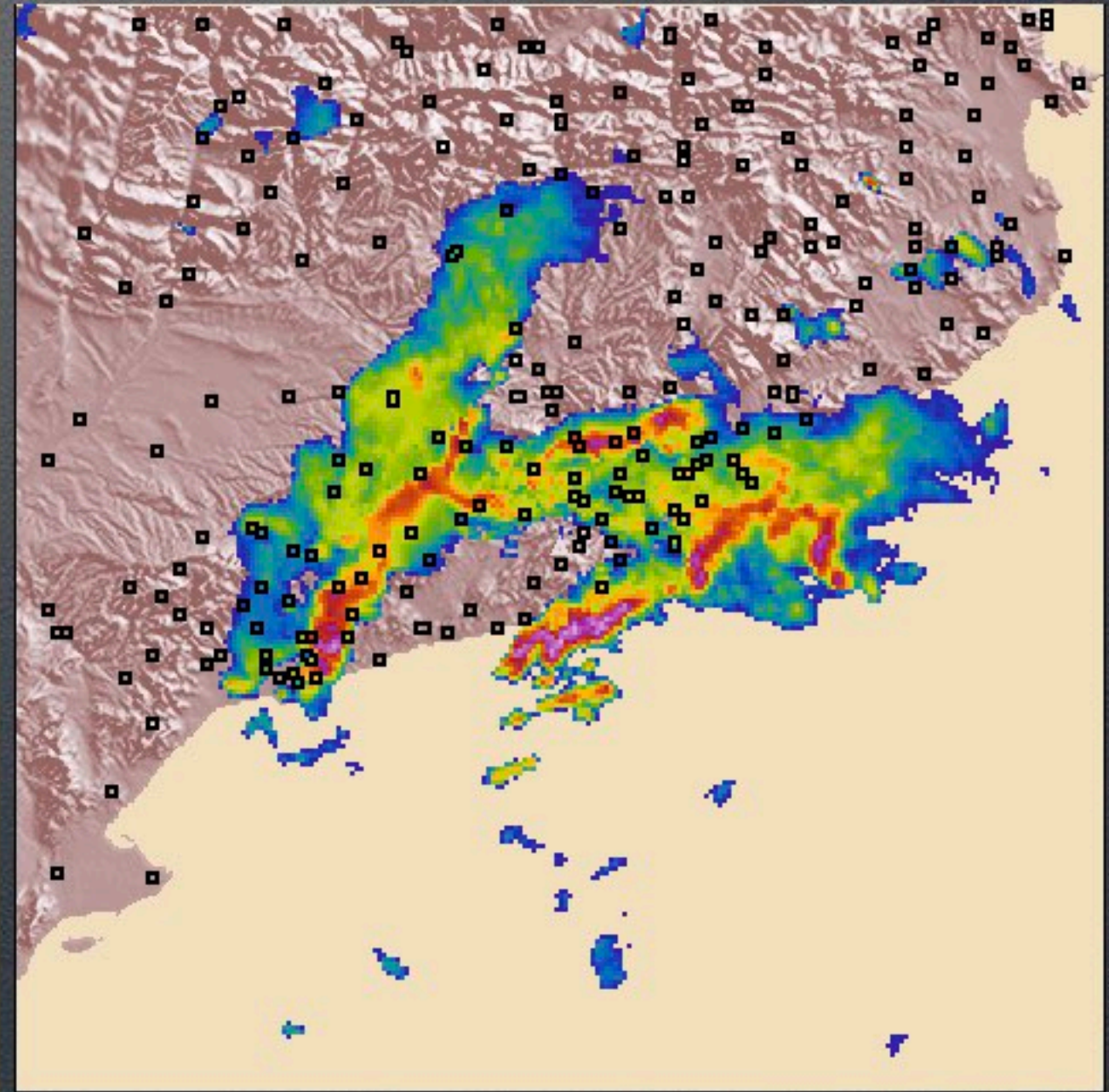


Comparison radar/raingauge interpolation

Raingauge network

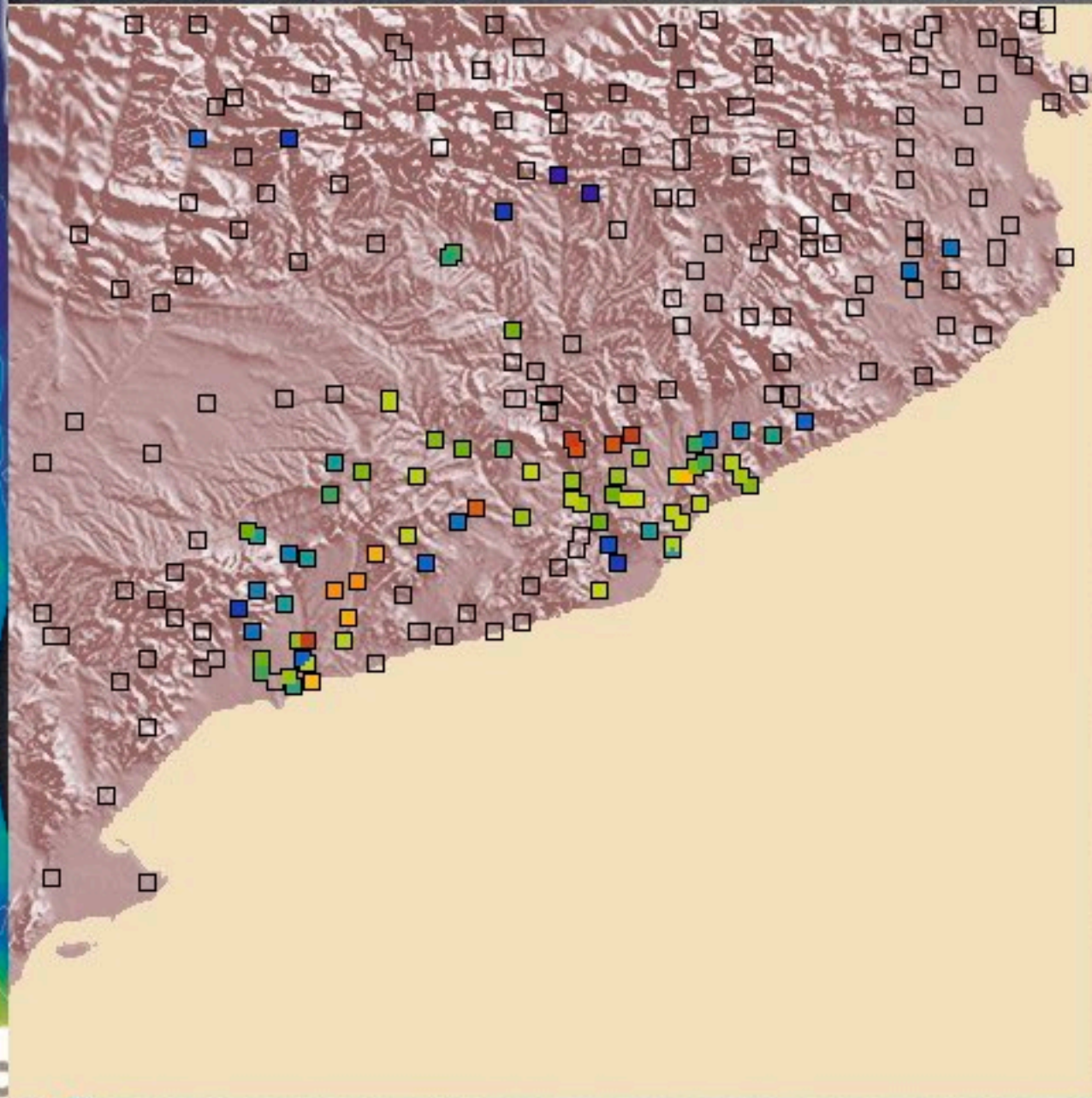


Radar

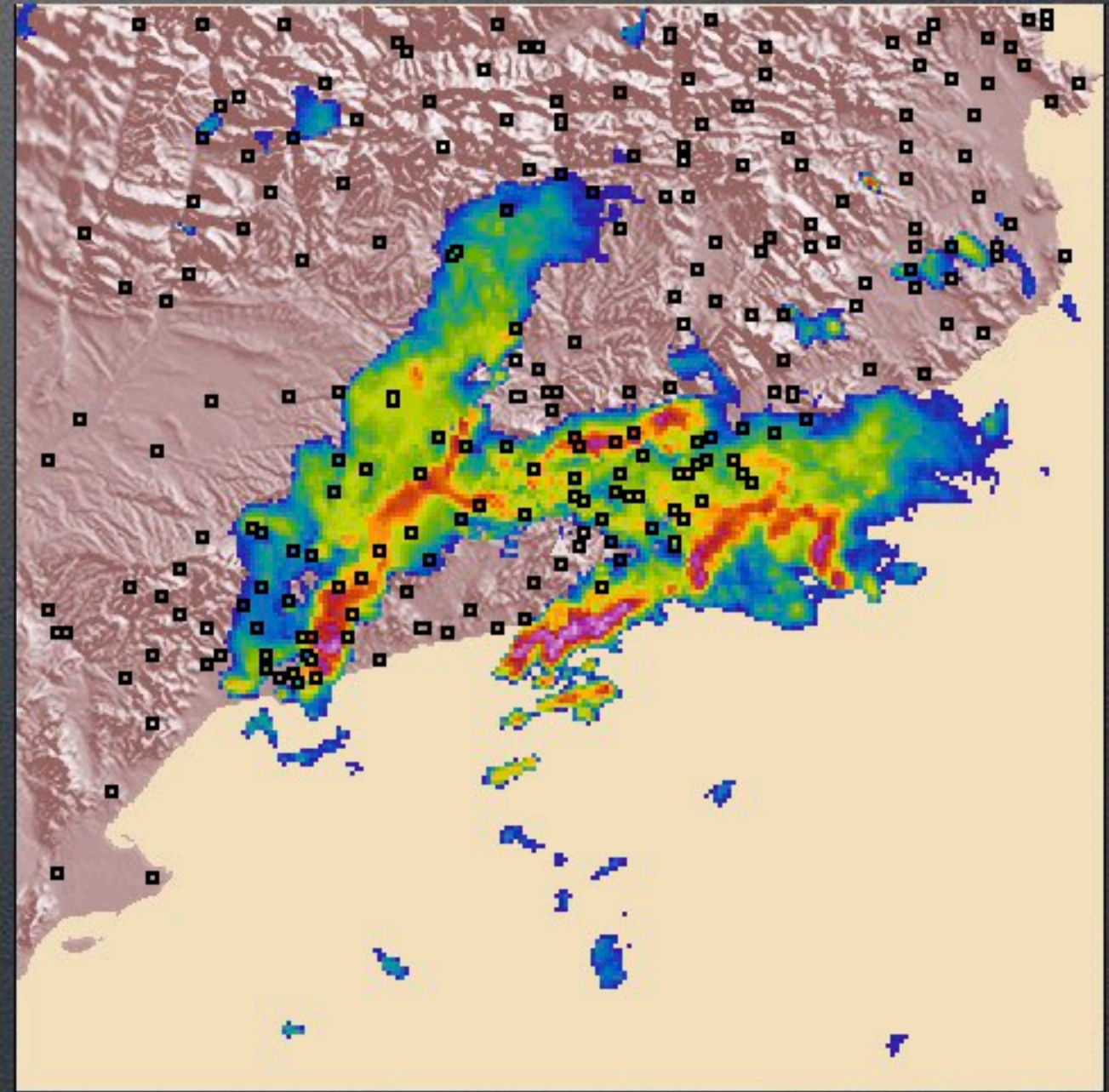


Comparison radar/raingauge interpolation

Rain rates from Radar

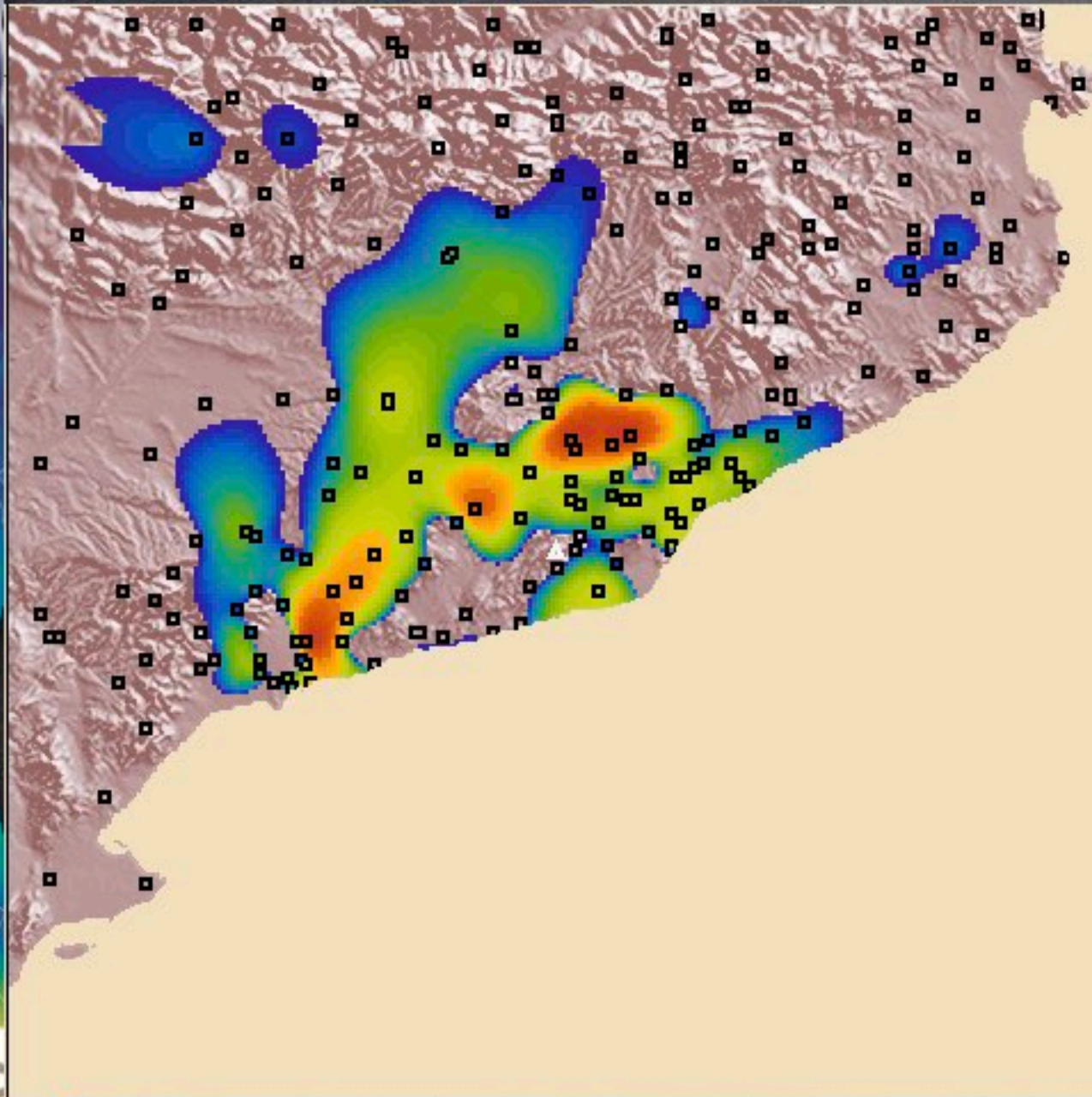


Radar

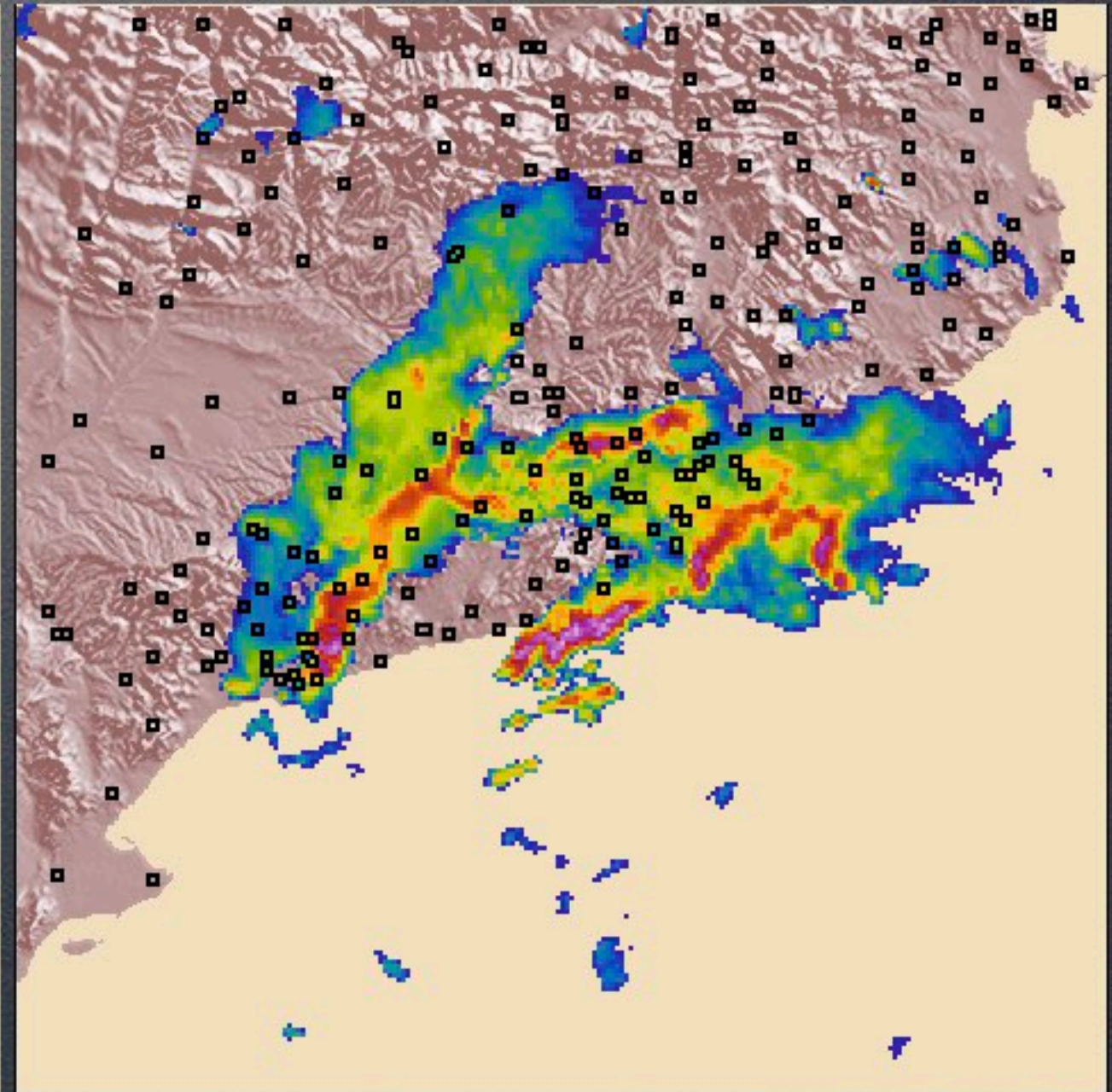


Comparison radar/raingauge interpolation

Interpolation

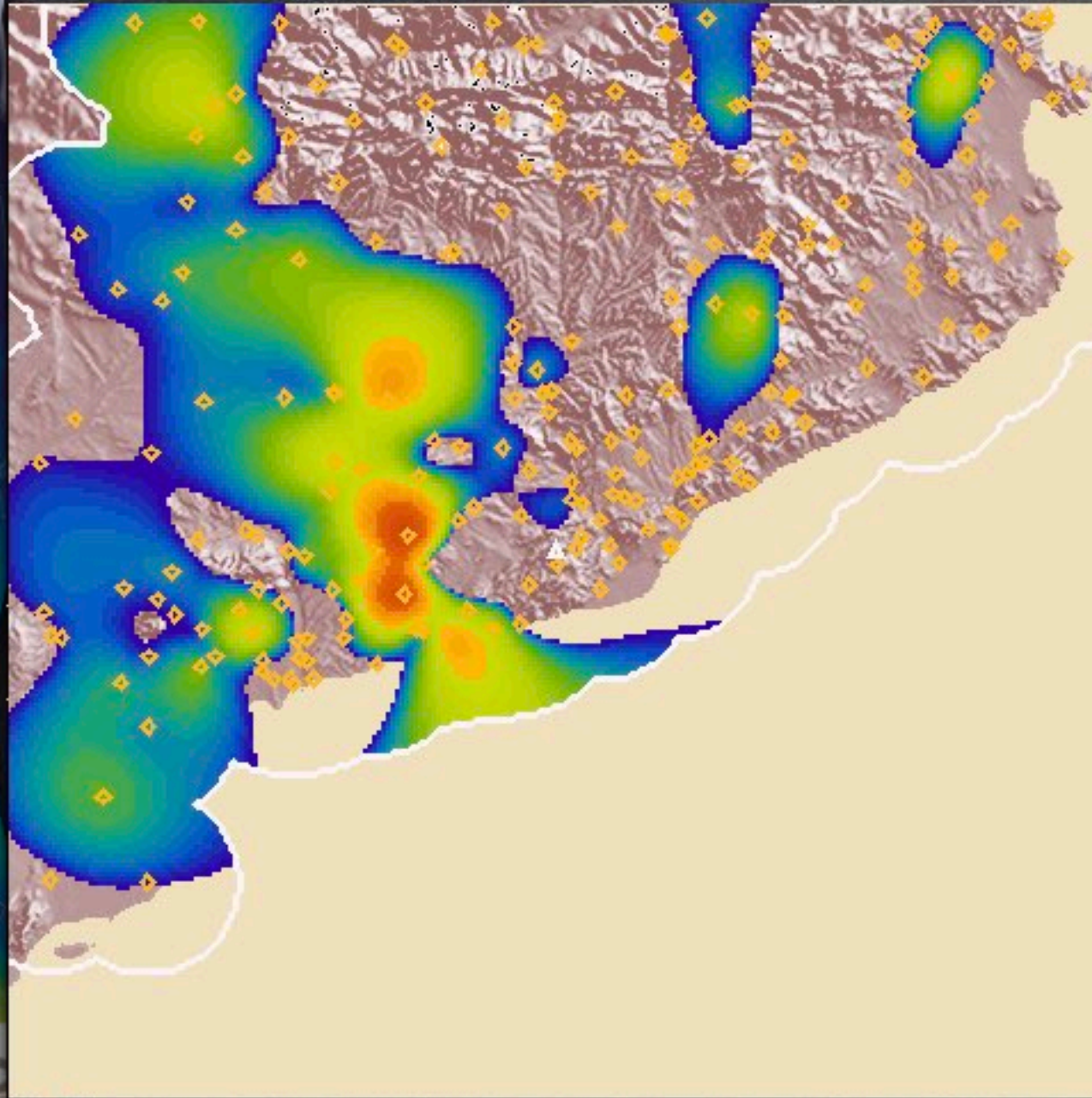


Radar

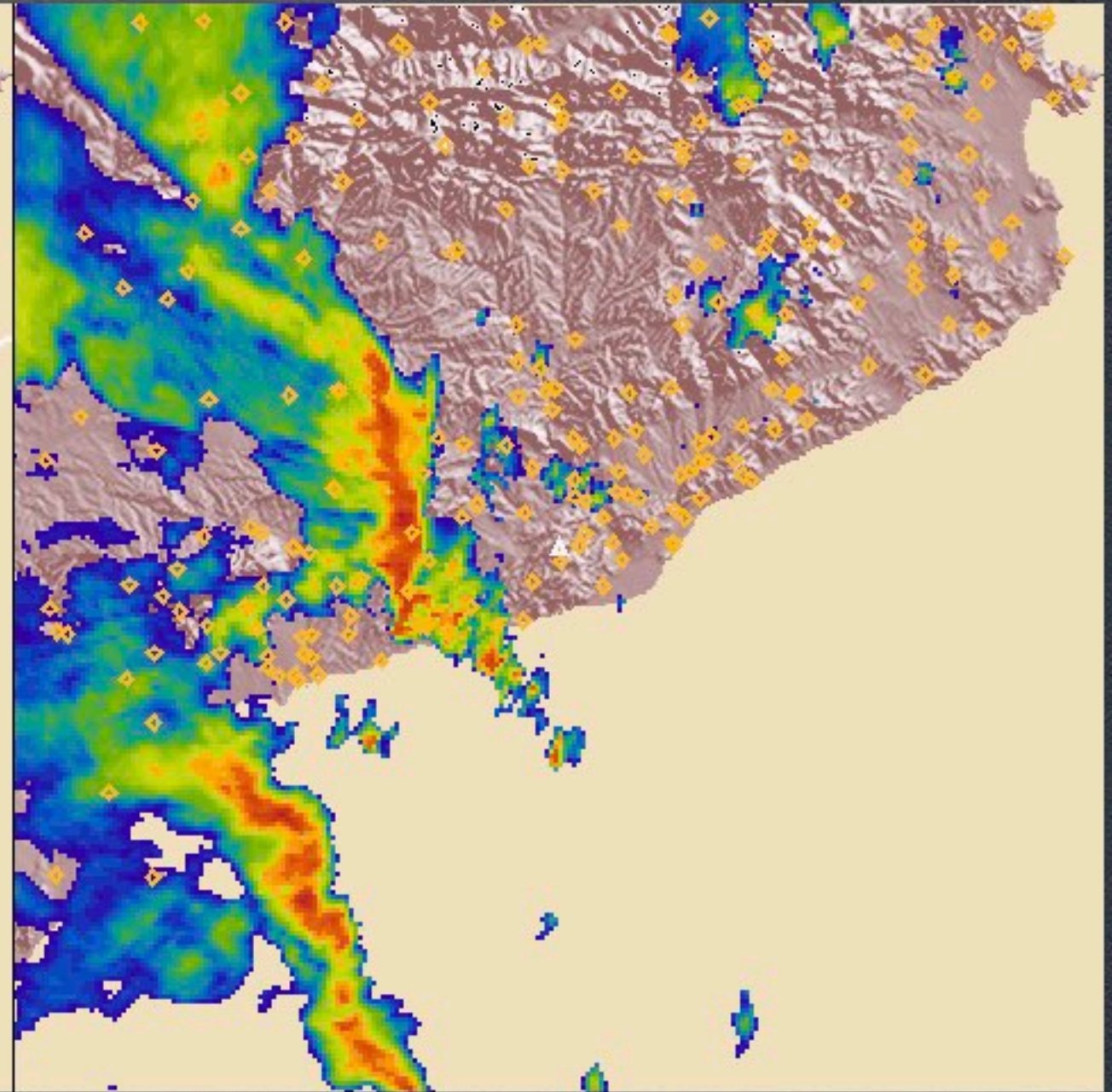


Comparison radar/raingauge interpolation

Interpolation



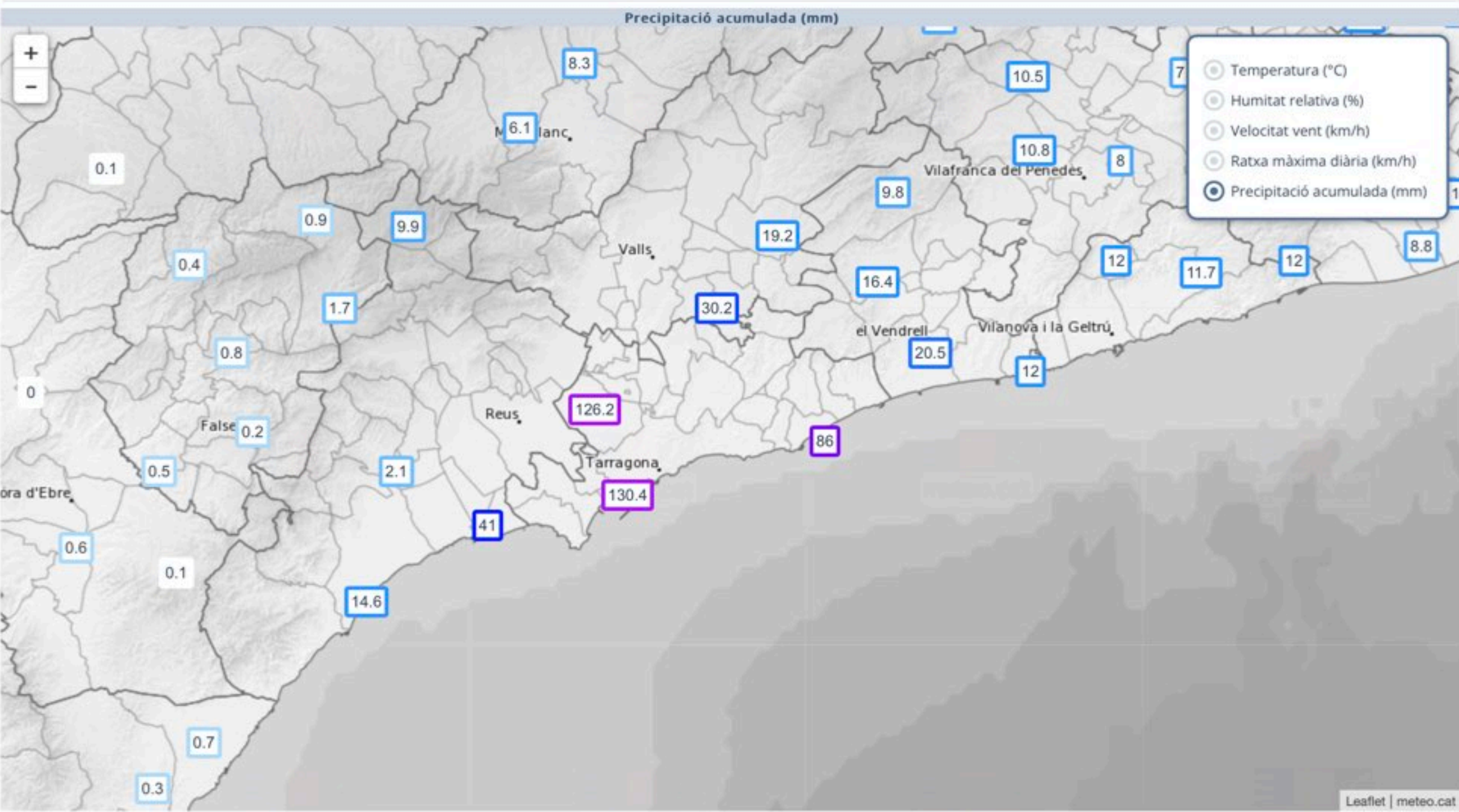
Radar



Mapa d'estacions automàtiques

Dades del dia 23.09.2022 ? Cerca

Selecciona una estació del mapa per veure les seves dades en detall



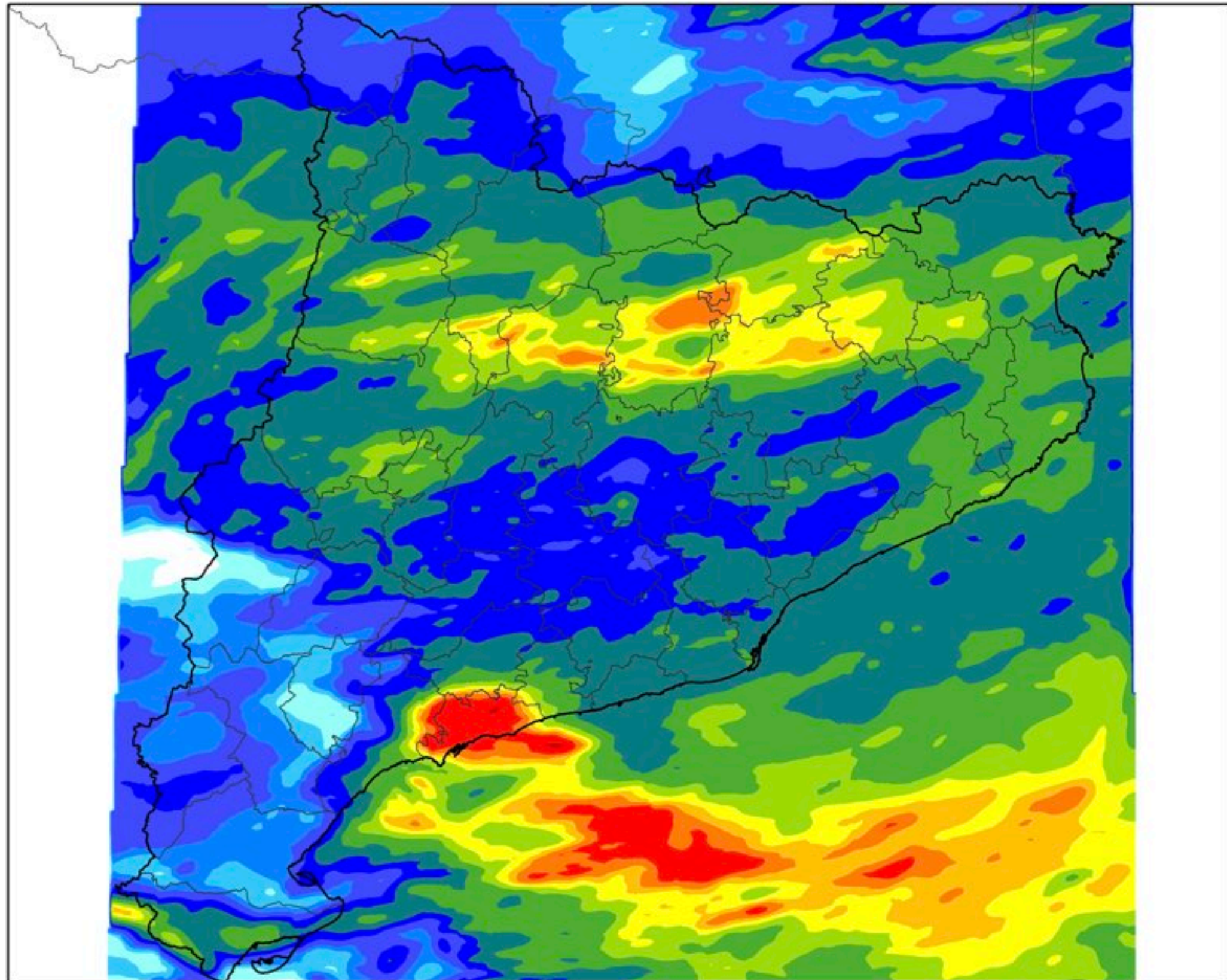
23.09.2022 23:30 - 00:00 TU



Estimació de la precipitació acumulada (mm)

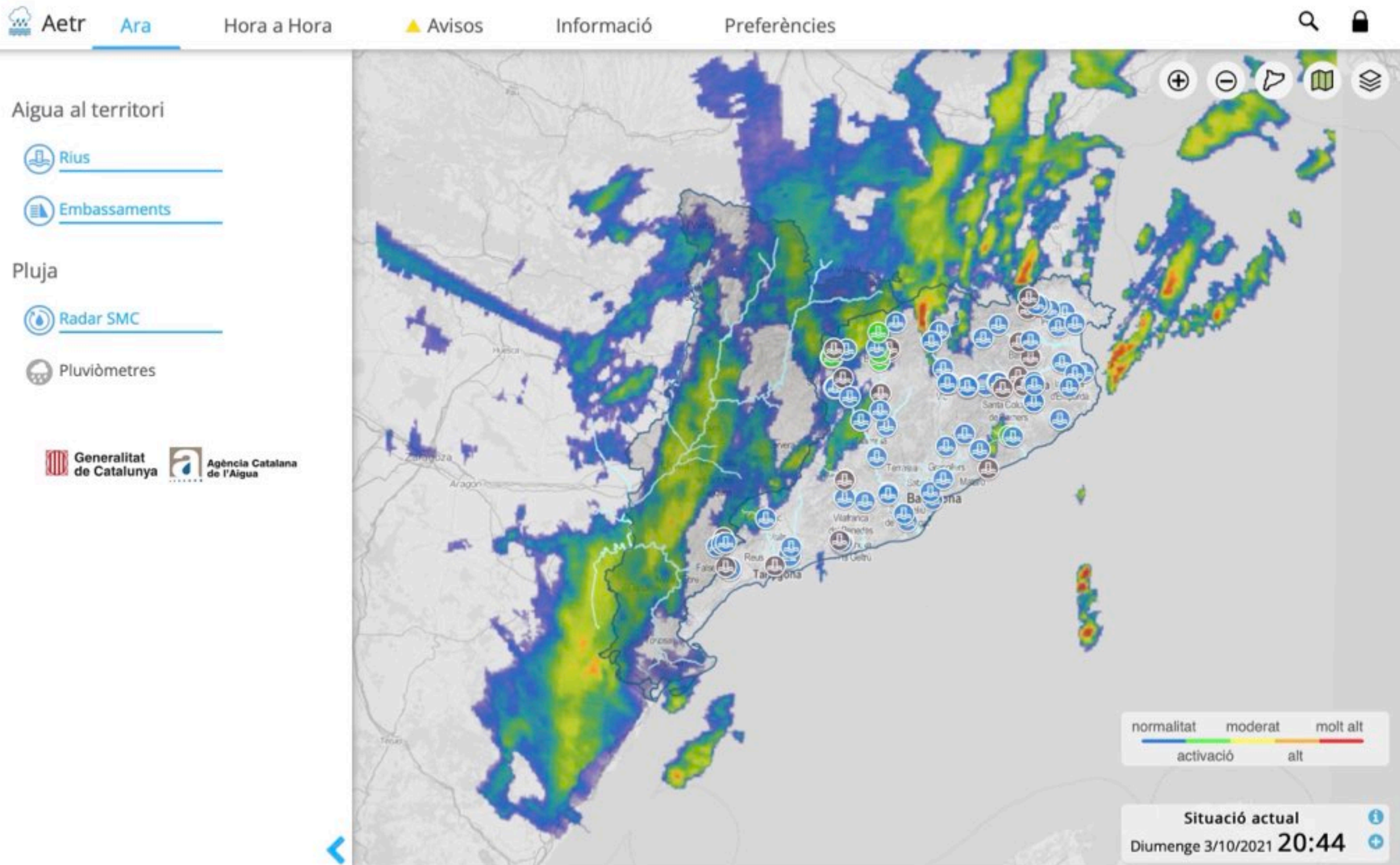
23 i 24 de setembre de 2022 fins a les 7 h

S'obté combinant les dades dels radars de la XRAD i dels pluviòmetres de la XEMA



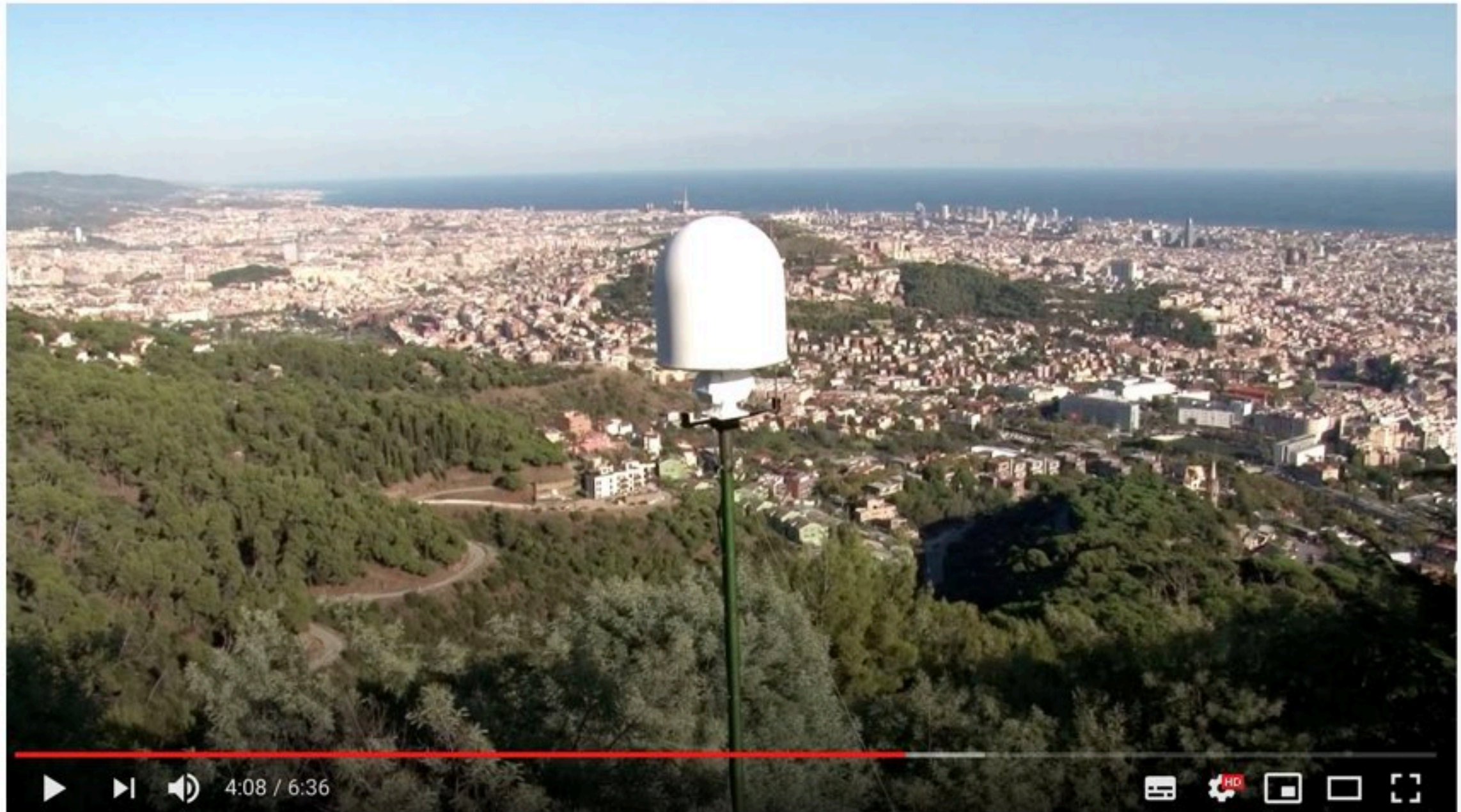
L'Aigua en Temps Real (AETR) - ACA - Gencat

<http://aca-web.gencat.cat/aetr/vishid#ara>



Mini radar a Barcelona

<https://www.youtube.com/watch?v=oGfhgggW69uM>



GPM mission: entenent la precipitació a escala planetaria des dels satel·lits

<https://www.youtube.com/watch?v=zUQqe3n01VI>

Videos recomanats

Fronts

<https://www.youtube.com/watch?v=huKYKykjcm0>

<https://www.youtube.com/watch?v=dwlQds-4l7I>

Tropical cyclons

<https://www.youtube.com/watch?v=UKL9NIxLIIE>

Jet Streams

<https://www.youtube.com/watch?v=Lg91eowtfbw>

Extra tropical cyclones

<https://www.youtube.com/watch?v=d29XoUML6Do>

<https://www.youtube.com/watch?v=Vwo9cuDxmVk>

El Niño

<https://www.youtube.com/watch?v=WPA-KpldDVc>