La UOM arreu de Mallorca 2024

Simulació per ordinador de l'atmosfera: des del més petit fins al més gran

Romu Romero

. . . tots els detalls en aquest ARTICLE

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RESEARCH ARTICLE

TRAM: A new non-hydrostatic fully compressible numerical model suited for all kinds of regional atmospheric predictions

R. Romero

Grup de Meteorologia, Departament de Física, Universitat de les Illes Balears, Palma de Mallorca, Spain

Correspondence
R. Romero, Grup de Meteorologia, Departament de Física, Universitat de les Illes Balears, Ctra. de Valldemossa km. 7.5, Palma de Mallorca 07122, Spain.
Email: romu.romero@uib.es

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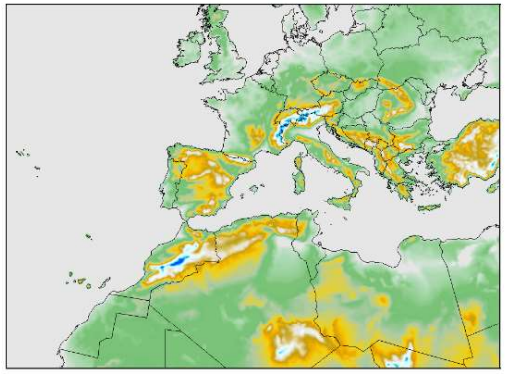
Abstract

A new limited-area numerical model (TRAM, for Triangle-based Regional Atmospheric Model) has been built using a non-hydrostatic and fully compressible version of the Navier–Stokes equations. Advection terms are solved using a Reconstruct–Evolve–Average (REA) strategy over the computational cells. These cells consist of equilateral triangles in the horizontal. The classical z-coordinate is used in the vertical, allowing arbitrary stretching (e.g., higher resolution in the Planetary Boundary Layer, PBL). Proper treatment of terrain slopes in the bottom boundary conditions allows for accurately representing the orographic forcing. To gain computational efficiency, time splitting is used to integrate fast and slow terms separately and acoustic modes in the vertical are solved implicitly. For real cases on the globe, the Lambert map projection

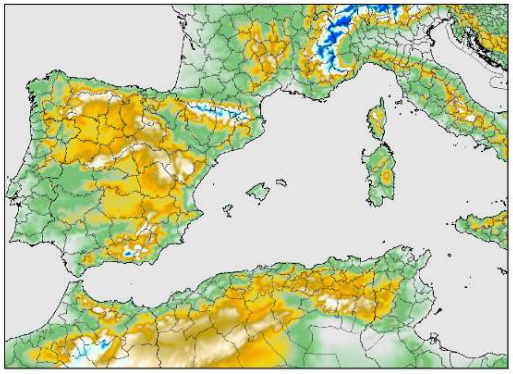
Versió OPERACIONAL aquí: http://meteo.uib.es/tram

TRAM / MeteoUIB

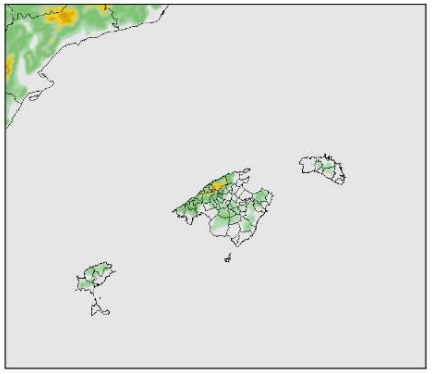
MR (17 km)



HR (6 km)



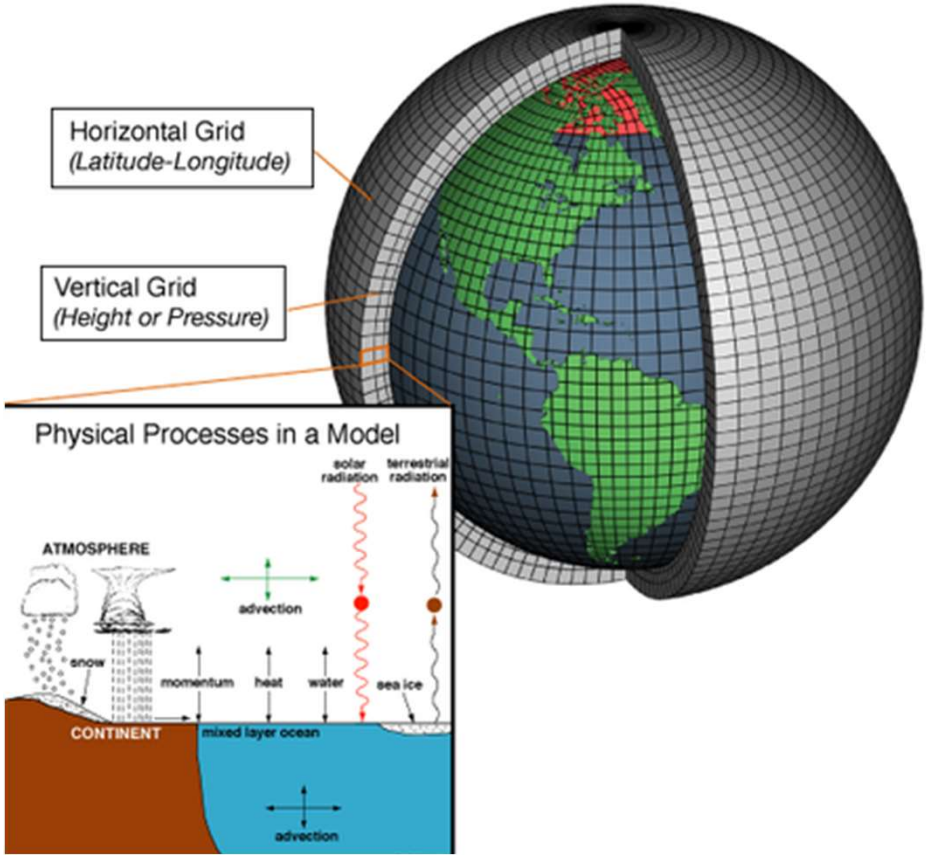
SR (2 km)

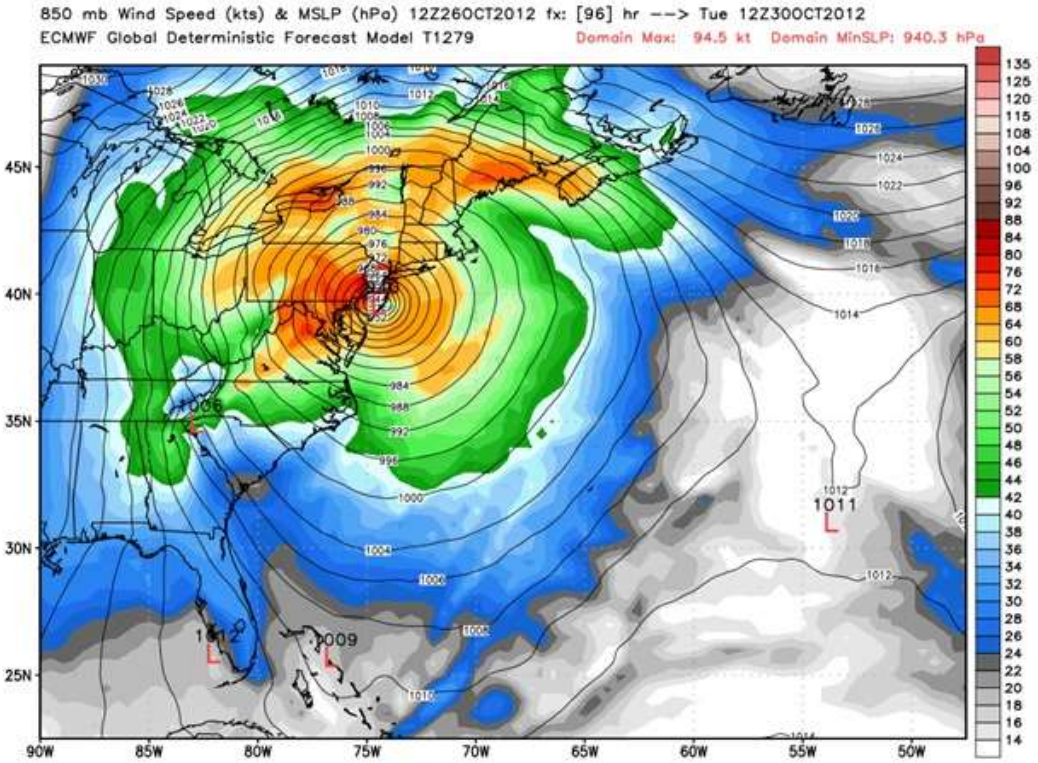


Grup de Meteorologia

UIB Universitat de les Illes Balears

SIMULACIÓ Numèrica de l'Atmosfera





> EQUACIONS per a la pressió, temperatura i vent

$$\frac{\partial \pi'}{\partial t} = -u\frac{\partial \pi'}{\partial x} - v\frac{\partial \pi'}{\partial y} - w\frac{\partial \pi'}{\partial z} - w\frac{\partial \bar{\pi}}{\partial z} - \frac{R}{c_v}(\bar{\pi} + \pi')\left[\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z}\right]$$

$$\frac{\partial \theta'}{\partial t} = -u\frac{\partial \theta'}{\partial x} - v\frac{\partial \theta'}{\partial y} - w\frac{\partial \theta'}{\partial z} - w\frac{\partial \bar{\theta}}{\partial z} + \mu\left[\nabla^2\theta' + \frac{\partial^2(\bar{\theta}+\theta')}{\partial z^2}\right]$$

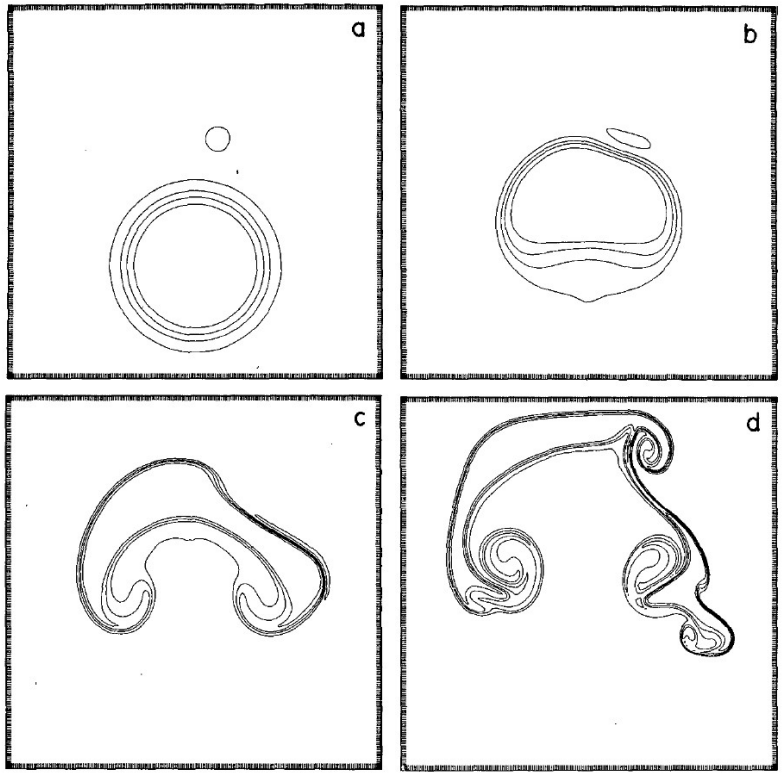
$$\frac{\partial u}{\partial t} = -u\frac{\partial u}{\partial x} - v\frac{\partial u}{\partial y} - w\frac{\partial u}{\partial z} - c_p(\bar{\theta} + \theta')\frac{\partial \pi'}{\partial x} + fv - \hat{f}w + \mu\left[\nabla^2 u + \frac{\partial^2 u}{\partial z^2}\right]$$

$$\frac{\partial v}{\partial t} = -u\frac{\partial v}{\partial x} - v\frac{\partial v}{\partial y} - w\frac{\partial v}{\partial z} - c_p(\bar{\theta} + \theta')\frac{\partial \pi'}{\partial y} - fu + \mu\left[\nabla^2 v + \frac{\partial^2 v}{\partial z^2}\right]$$

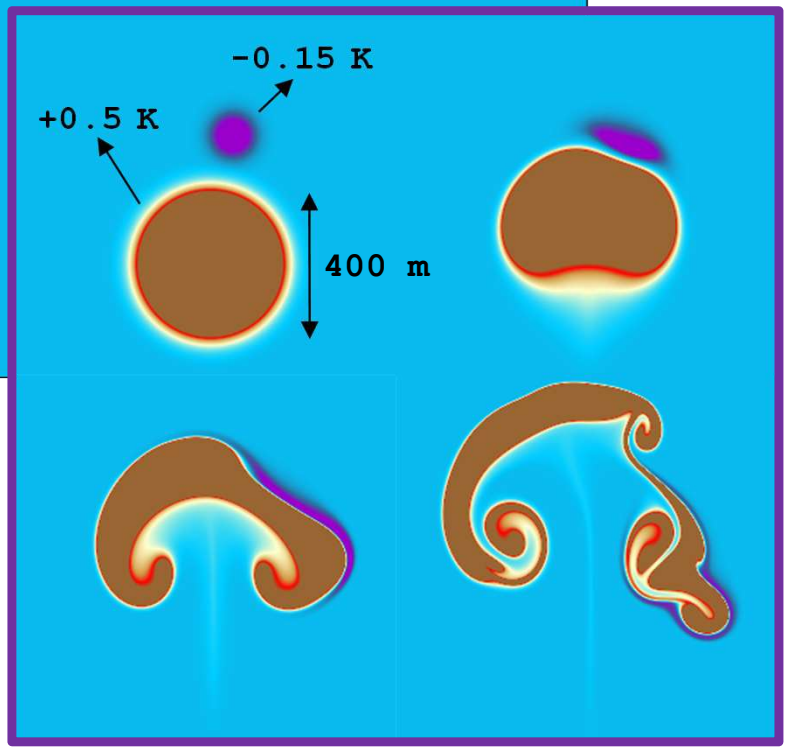
$$\frac{\partial w}{\partial t} = -u\frac{\partial w}{\partial x} - v\frac{\partial w}{\partial y} - w\frac{\partial w}{\partial z} - c_p(\bar{\theta} + \theta')\frac{\partial \pi'}{\partial z} + g\frac{\theta'}{\bar{\theta}} + \hat{f}u + \mu\left[\nabla^2 w + \frac{\partial^2 w}{\partial z^2}\right]$$

> Bombolles: CALENTA Gran - FREDA Petita

Robert (1993)



Inicial

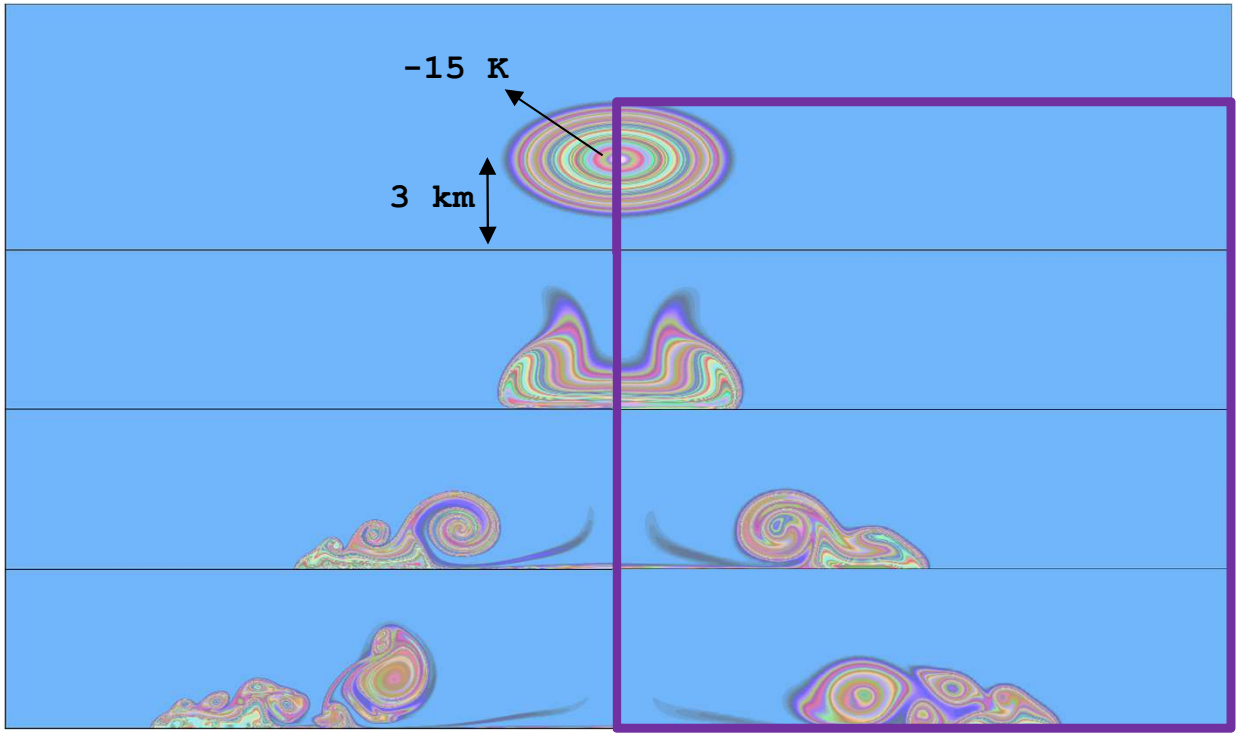


Animació

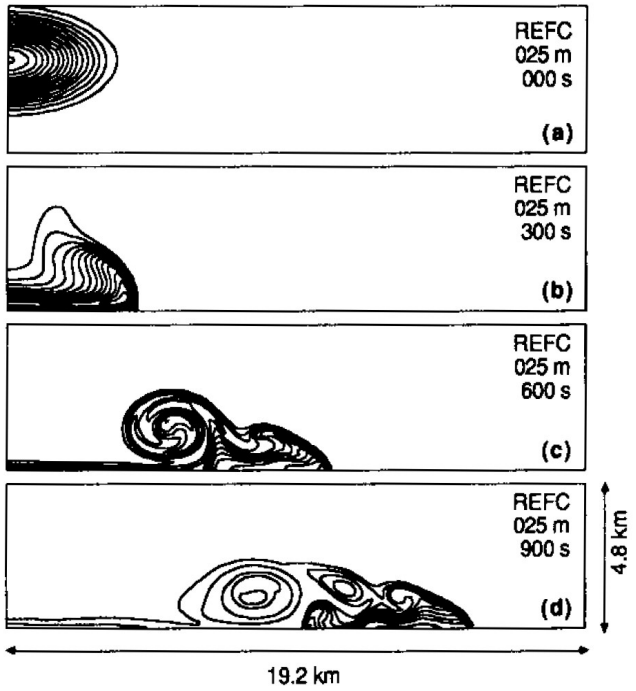
> Corrent de Densitat

Resolució Quàdruple

Inicial

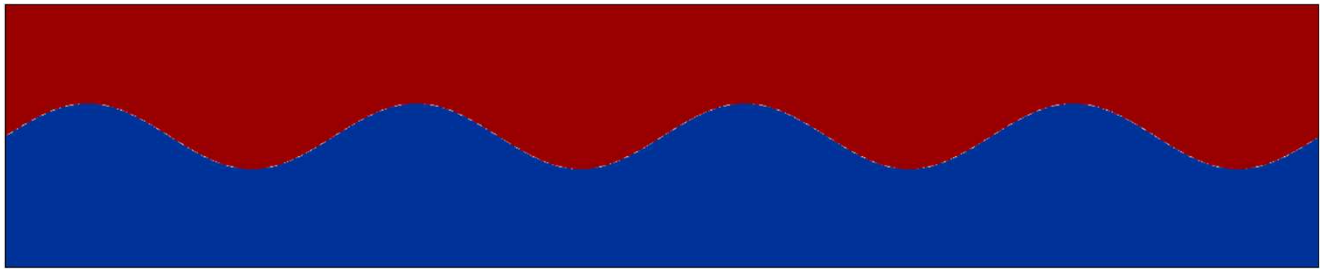


Straka et al. (1993)



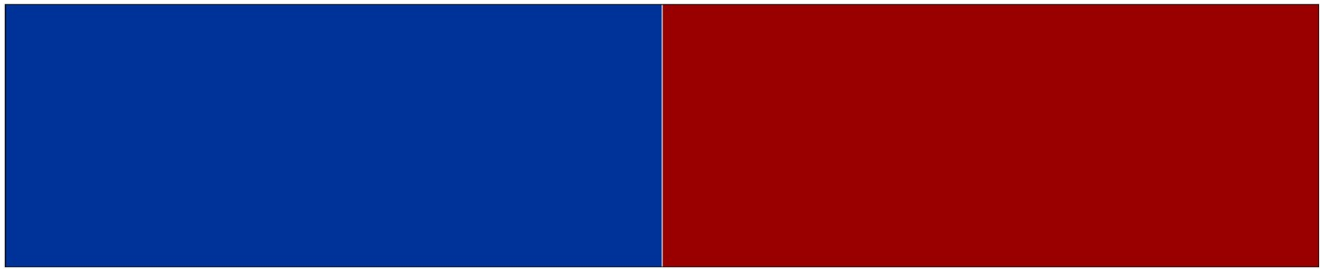
> Combinacions: CALENT - FRED

Animació

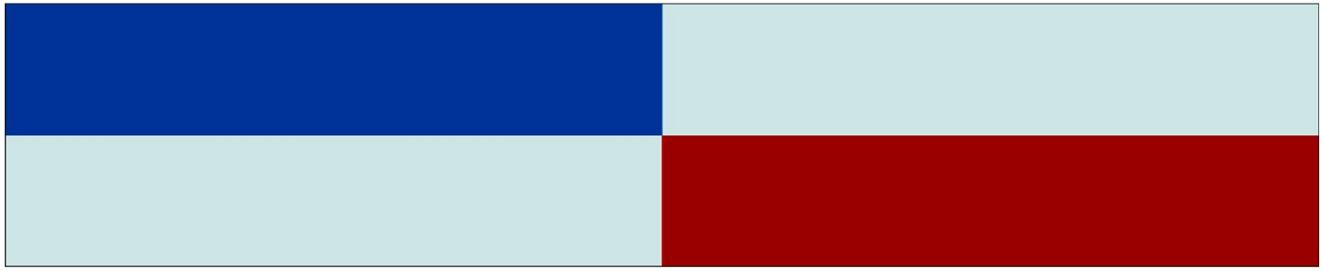


Animació

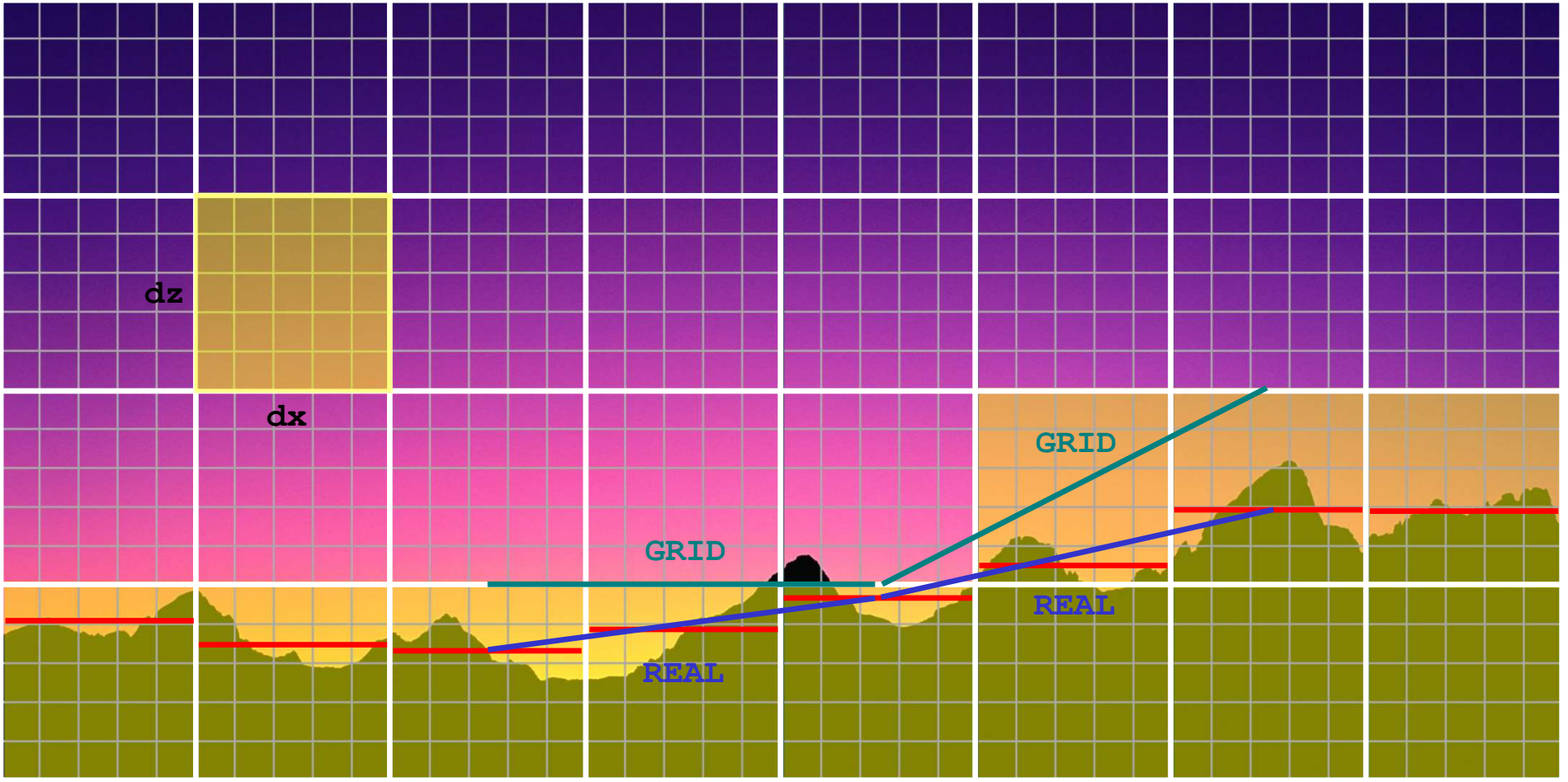
Animació



Animació

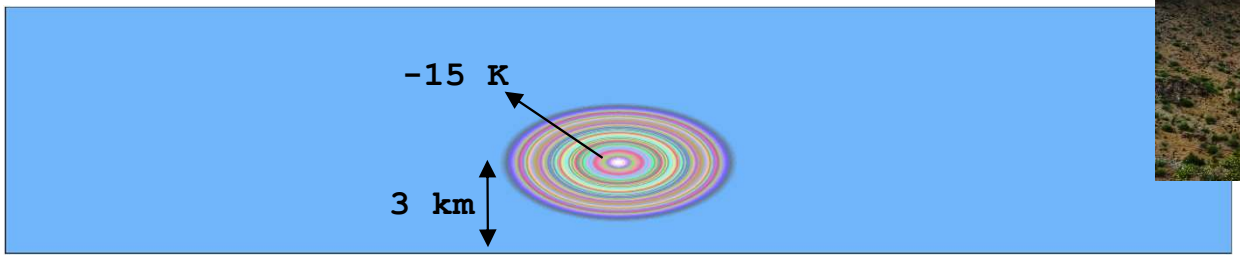


> Pendent del Terreny REAL *vs* GRID

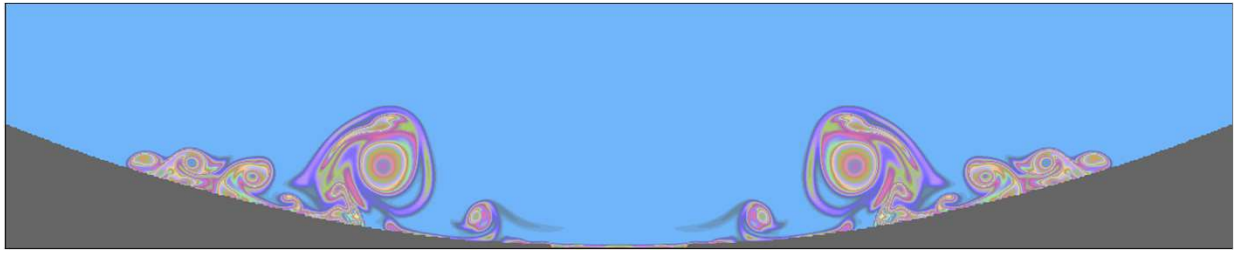


> Corrent de Densitat

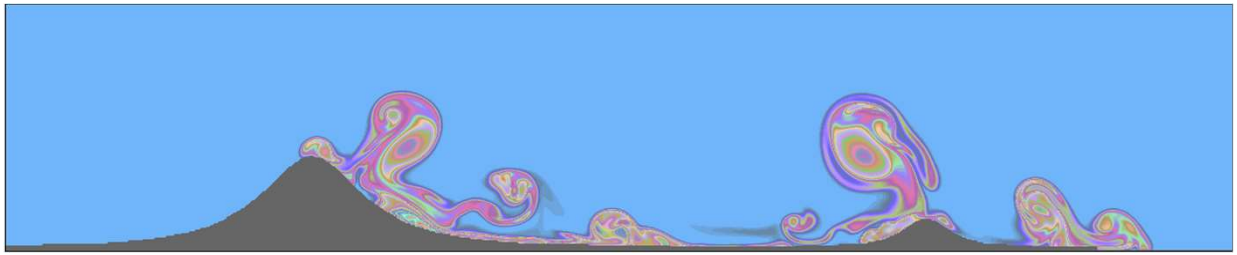
Inicial



Terreny pla



Pendent parabòlic



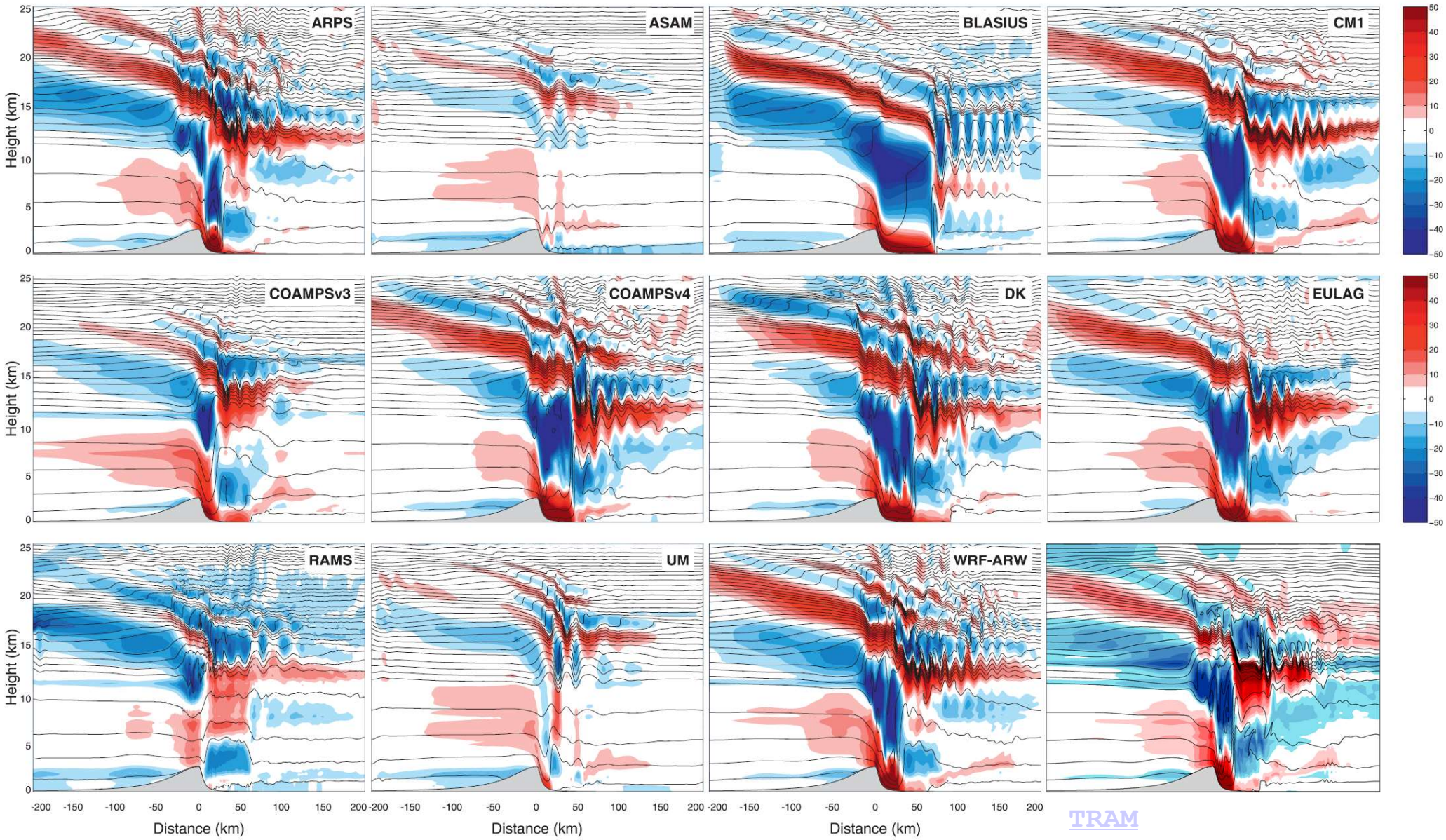
Dues muntanyes

t=21min

> Ona Intensa de Muntanya

t=4h

Doyle et al. (2011)

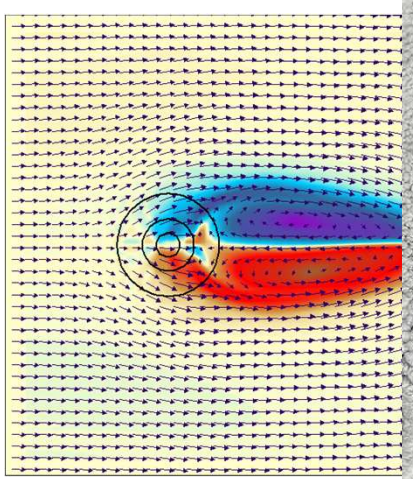


TRAM

Anim

> Carrers de Vòrtexs de Von Kármán

p.e. Schär and Durran (1997)



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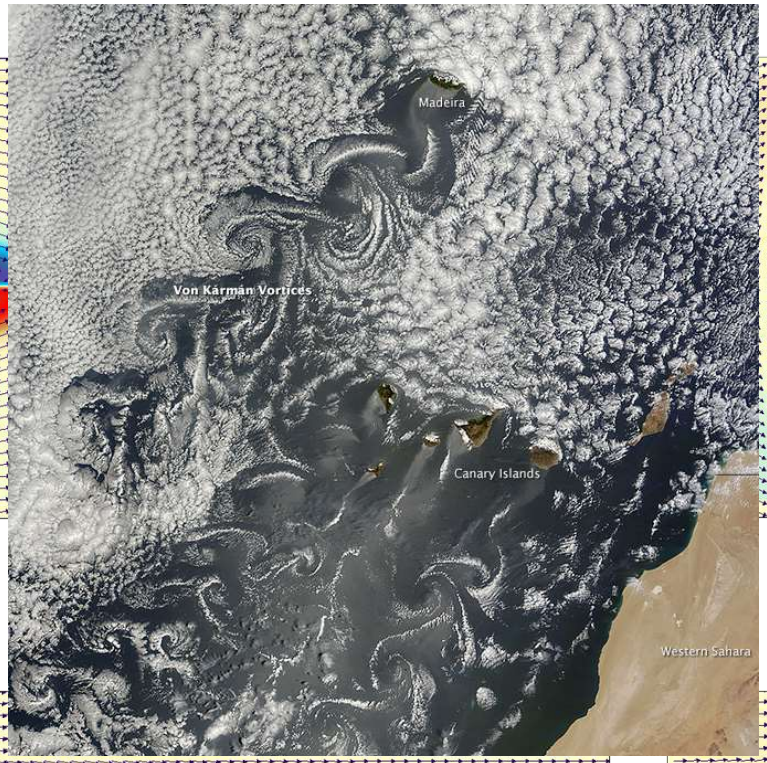
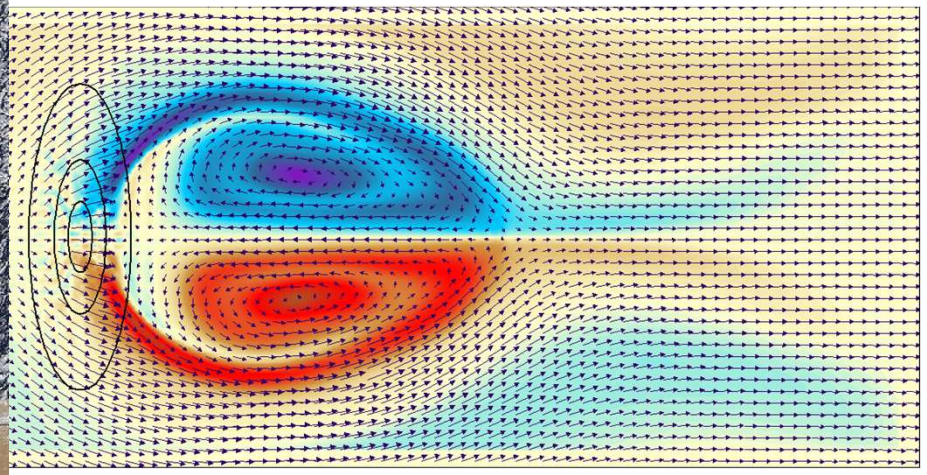
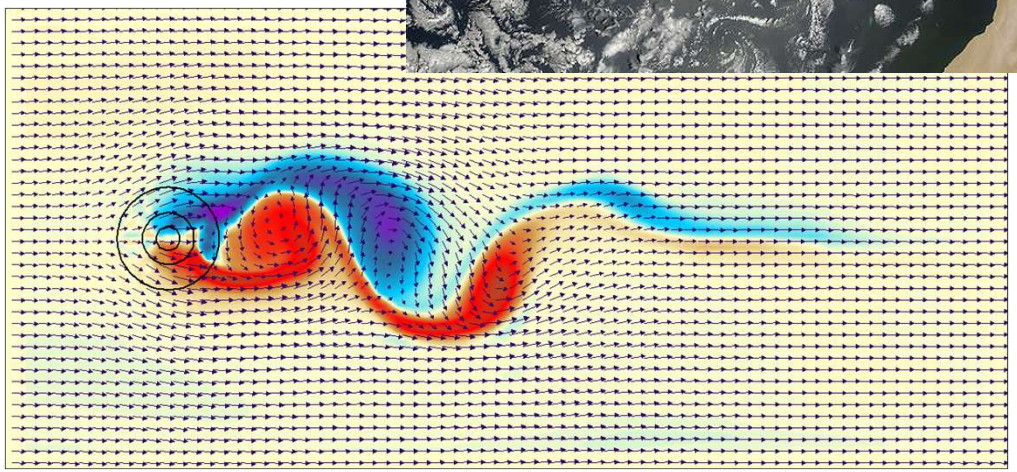
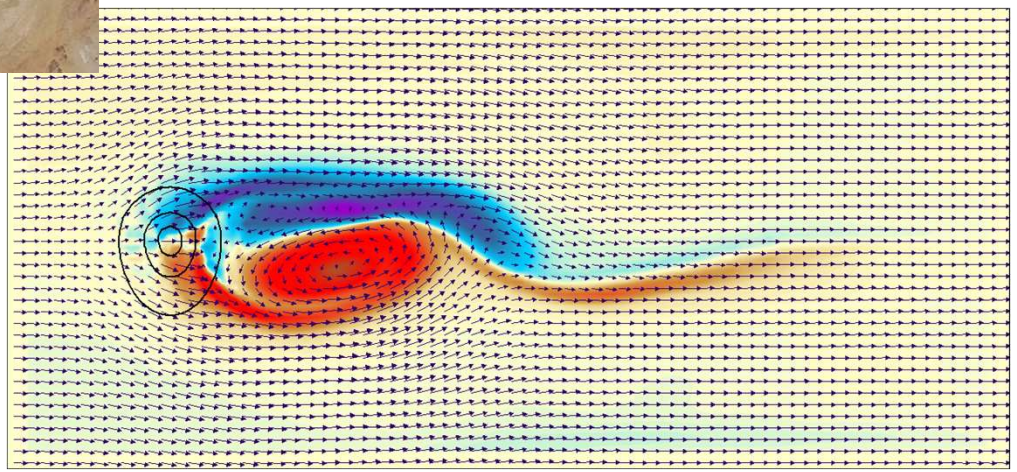




h=3000m



h=3000m (C.I asimètrica)



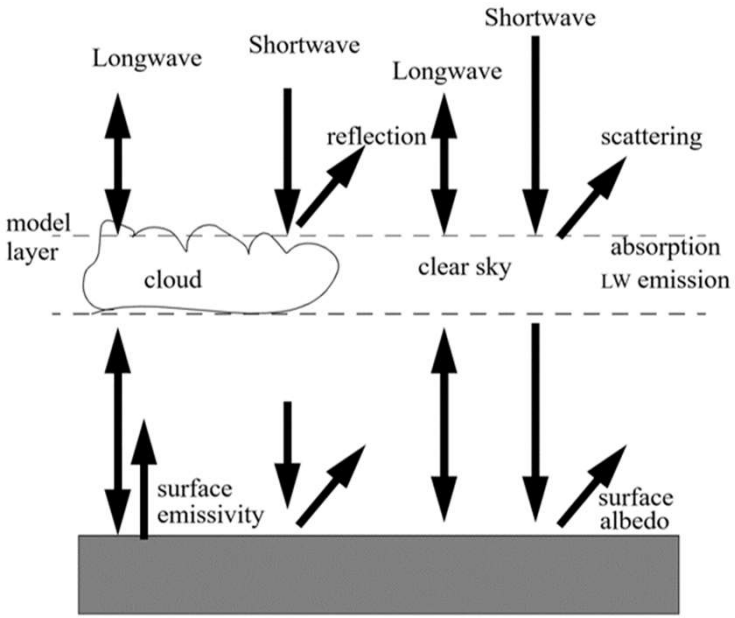
Animació

Traçador

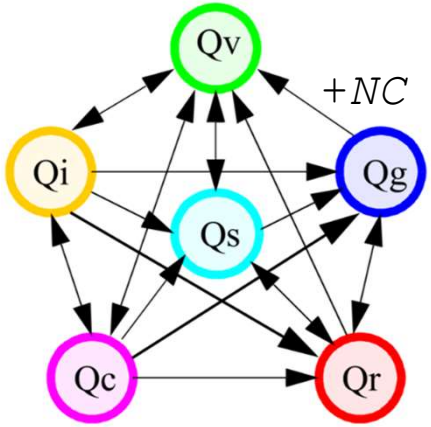
h=3000m

Atmosfera HUMIDA i amb TOTA LA FÍSICA

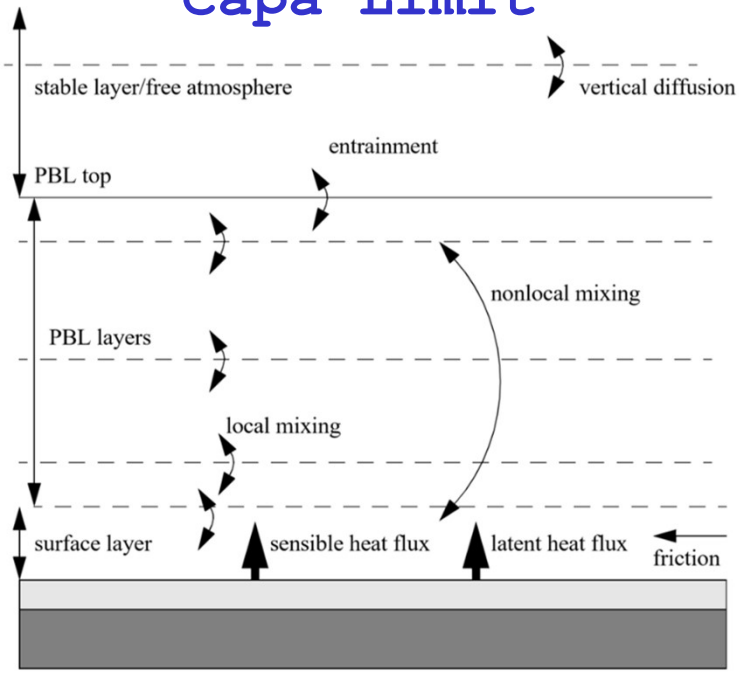
Radiació



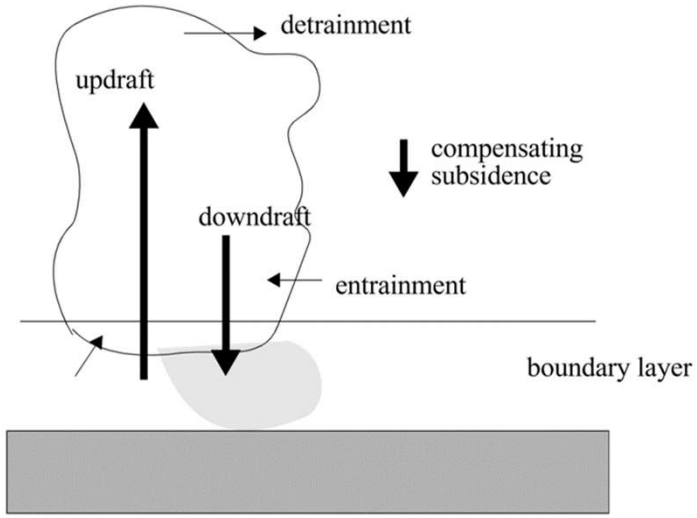
Niguls



Capa Límit



Cúmuls



NOUS

Pronòstics

Q_χ

Forçaments

F_{Q_χ}

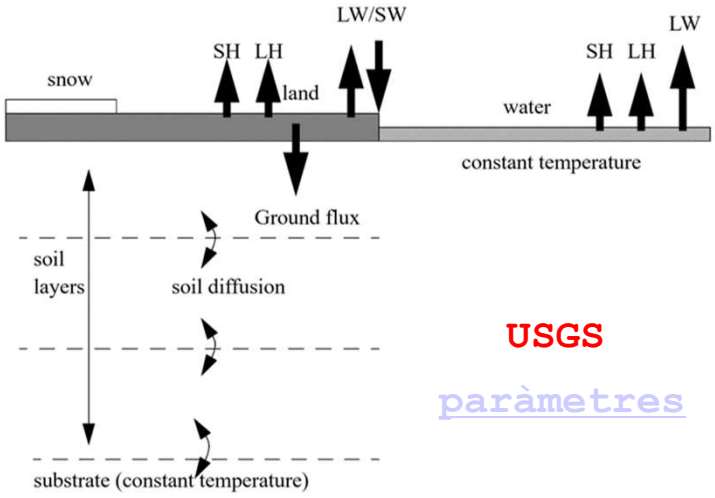
F_T

$F_u \quad F_v$

Camps Superficials

$T_g \quad R_{nc} \quad R_c \quad \ldots$

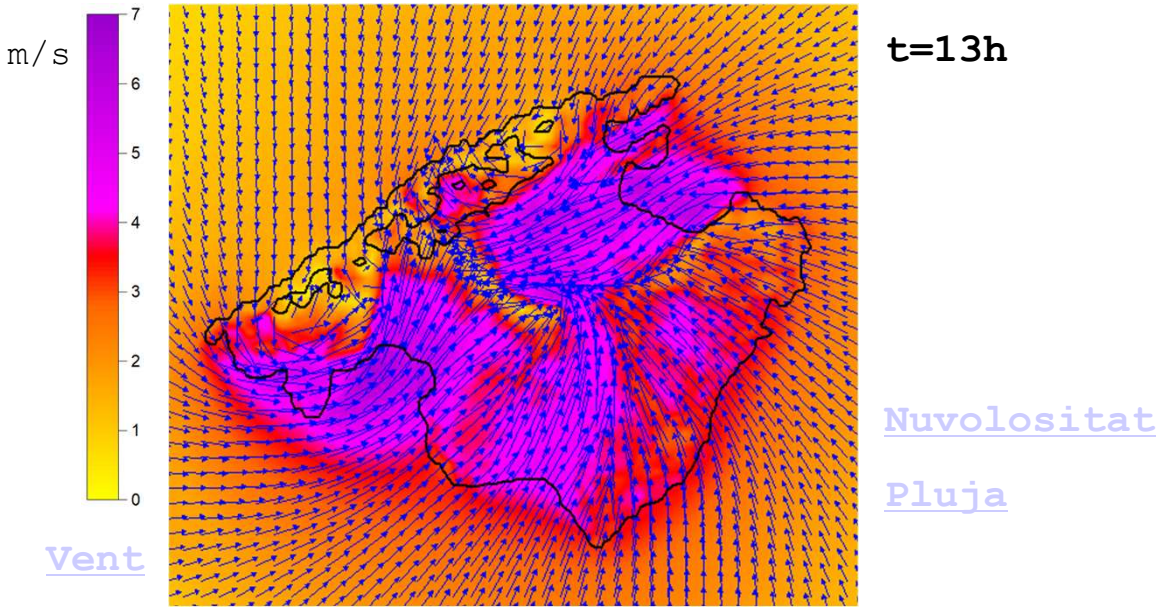
Superfície

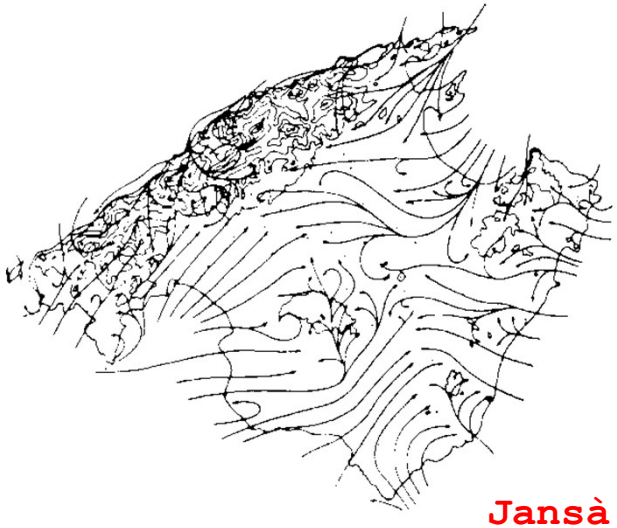


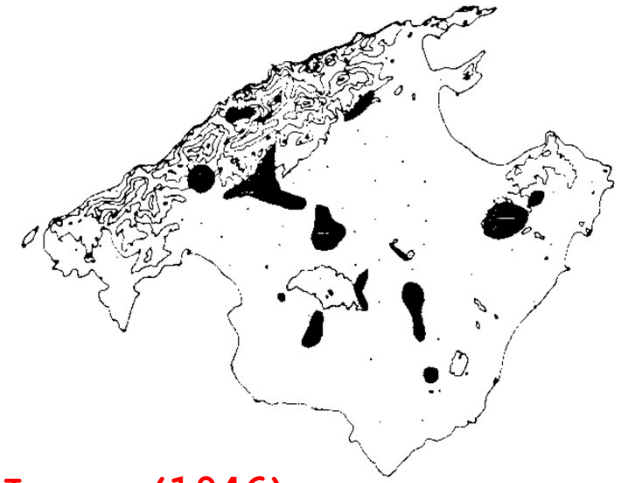
USGS

paràmetres

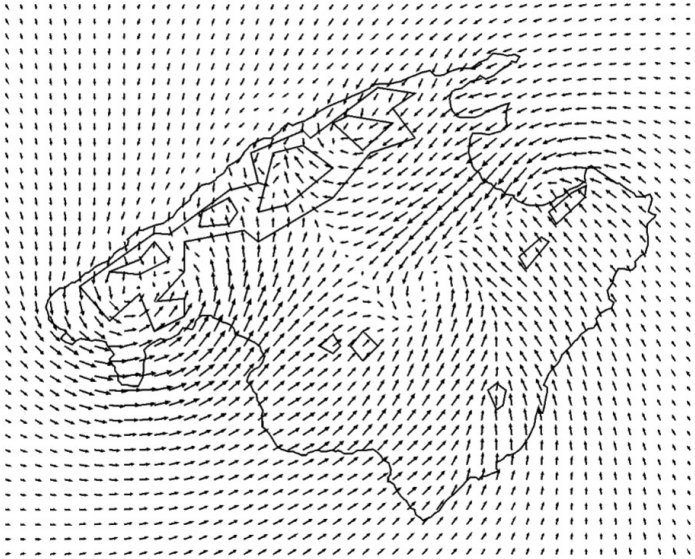
> Brisa a Mallorca





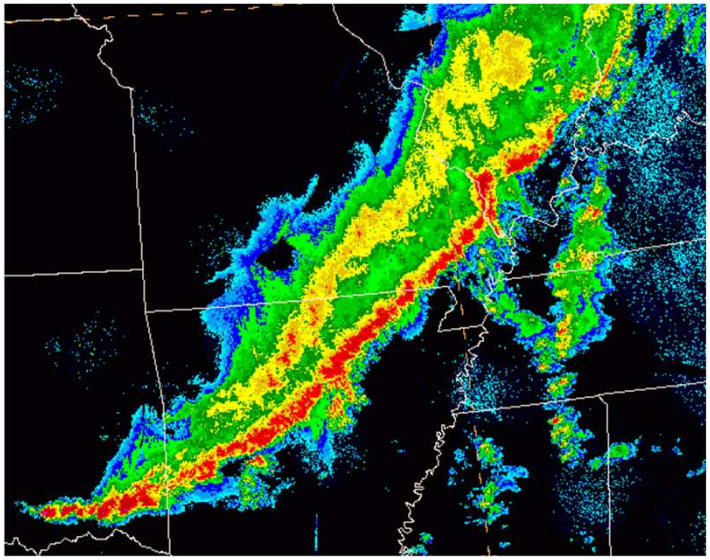


Jansà & Jaume (1946)



Ramis & Romero (1995)

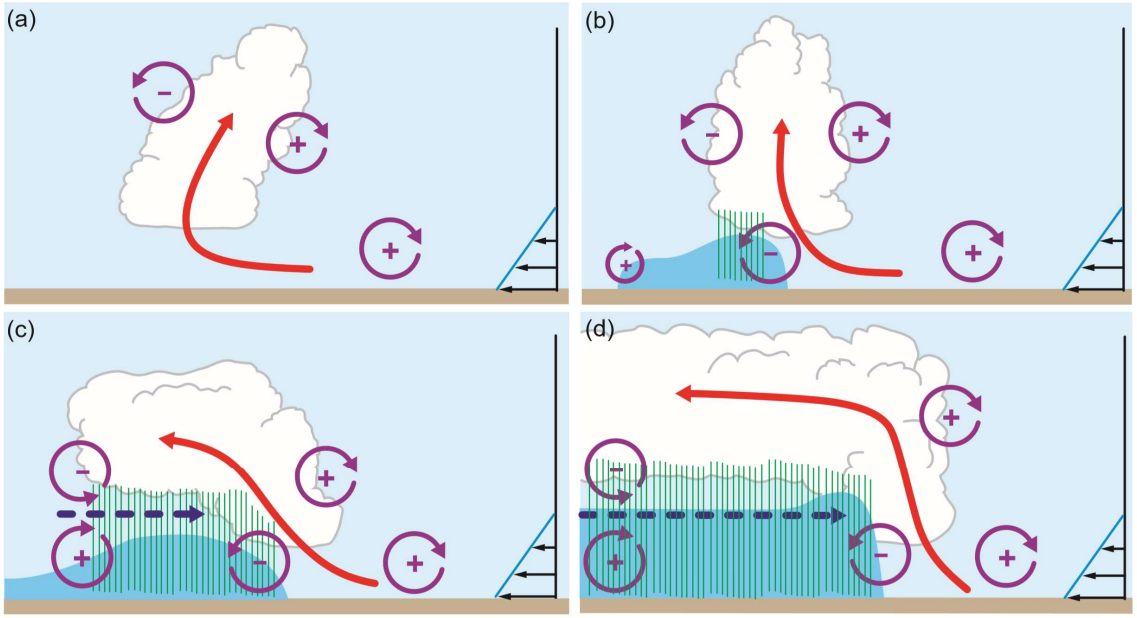
> Tempestes Violentes



Línia de Turbonada

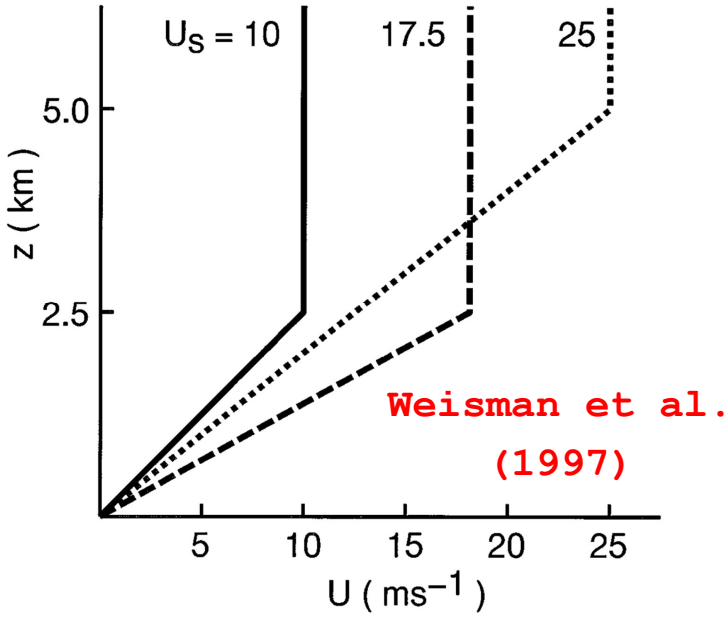
Supercèl·lula

> Línia de Turbonada

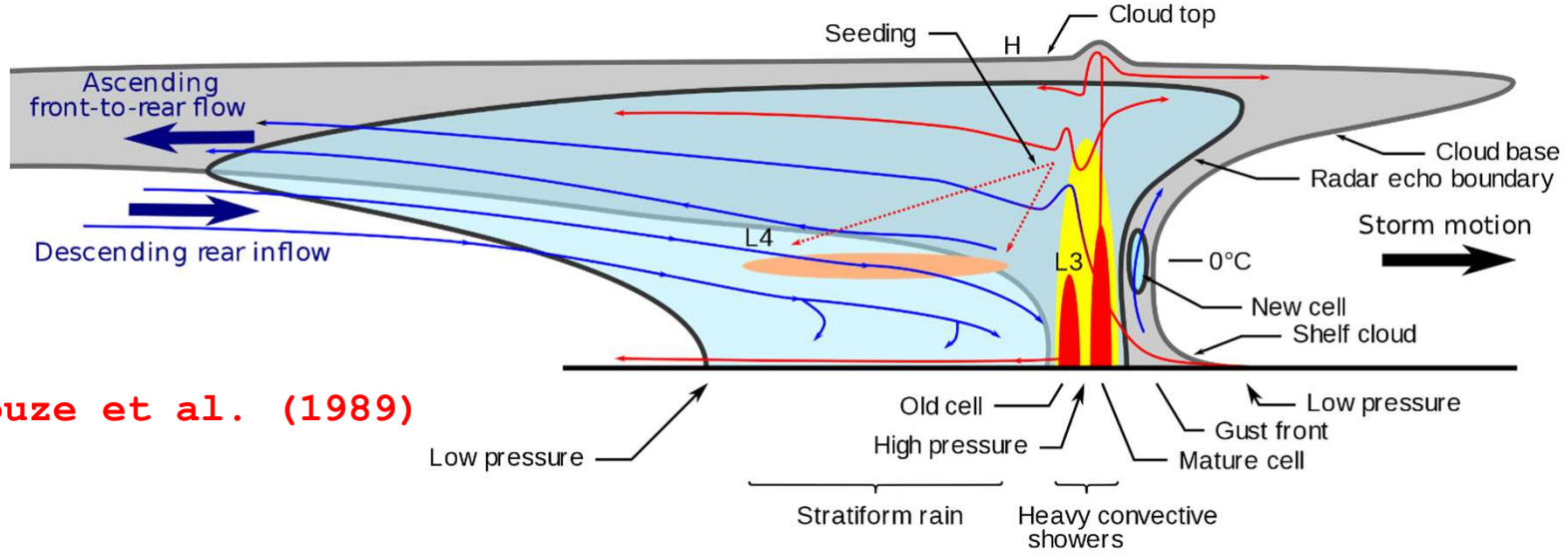


Weisman (1993)

CISALLAMENT: Dèbil Moderat Fort



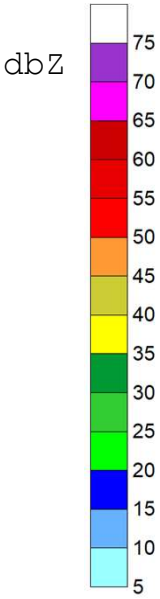
Weisman et al. (1997)

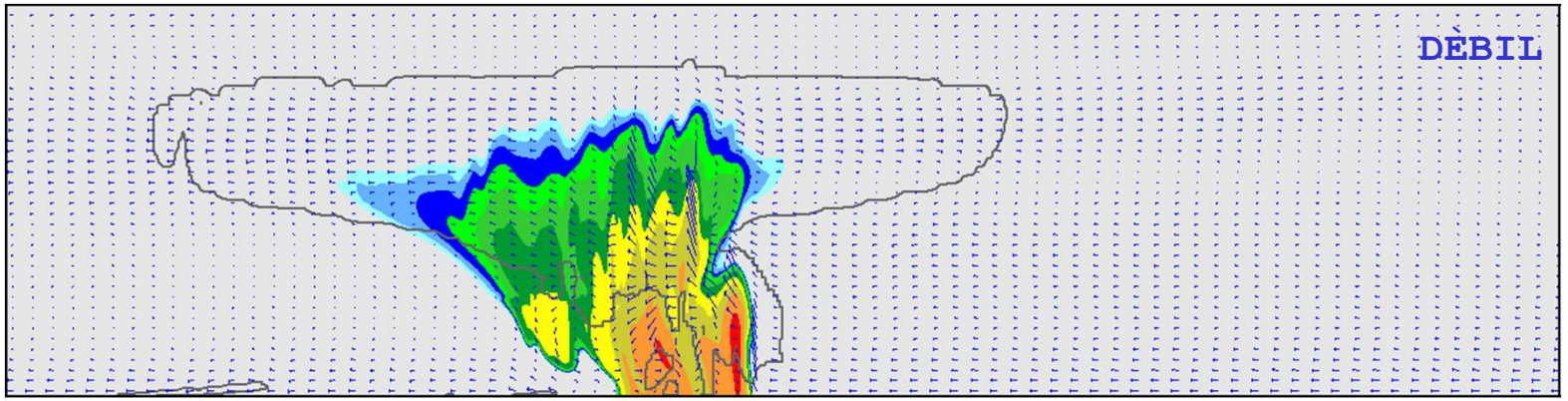


Houze et al. (1989)

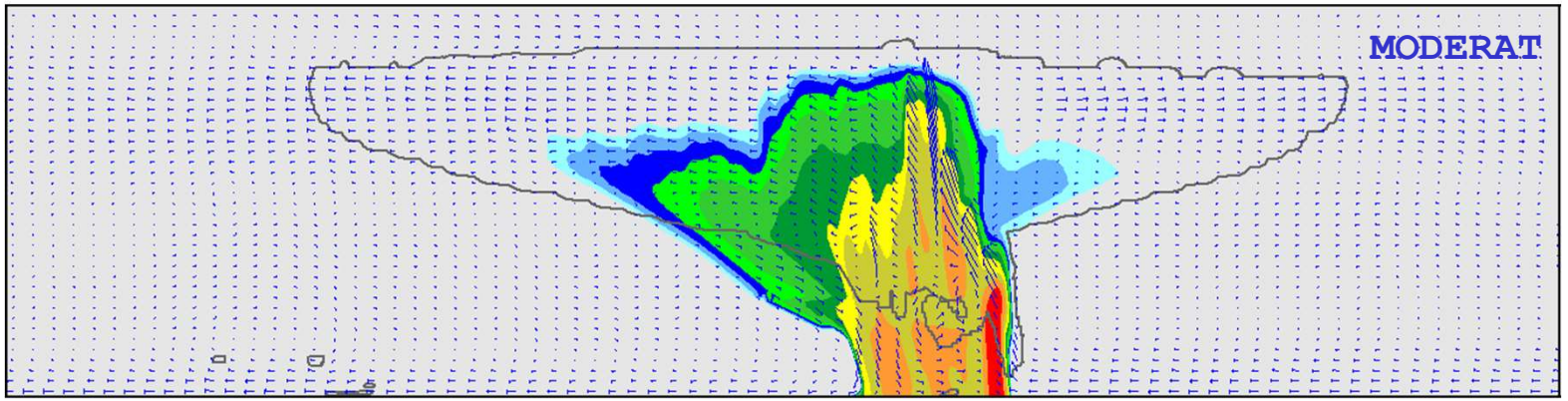
> Línia de Turbonada

t=5h

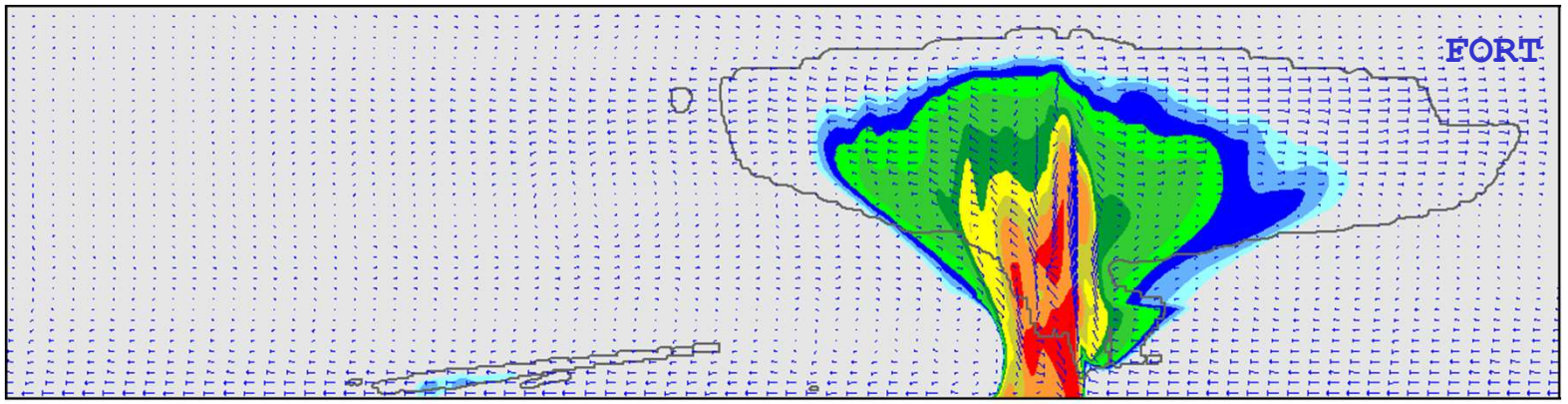




Animació

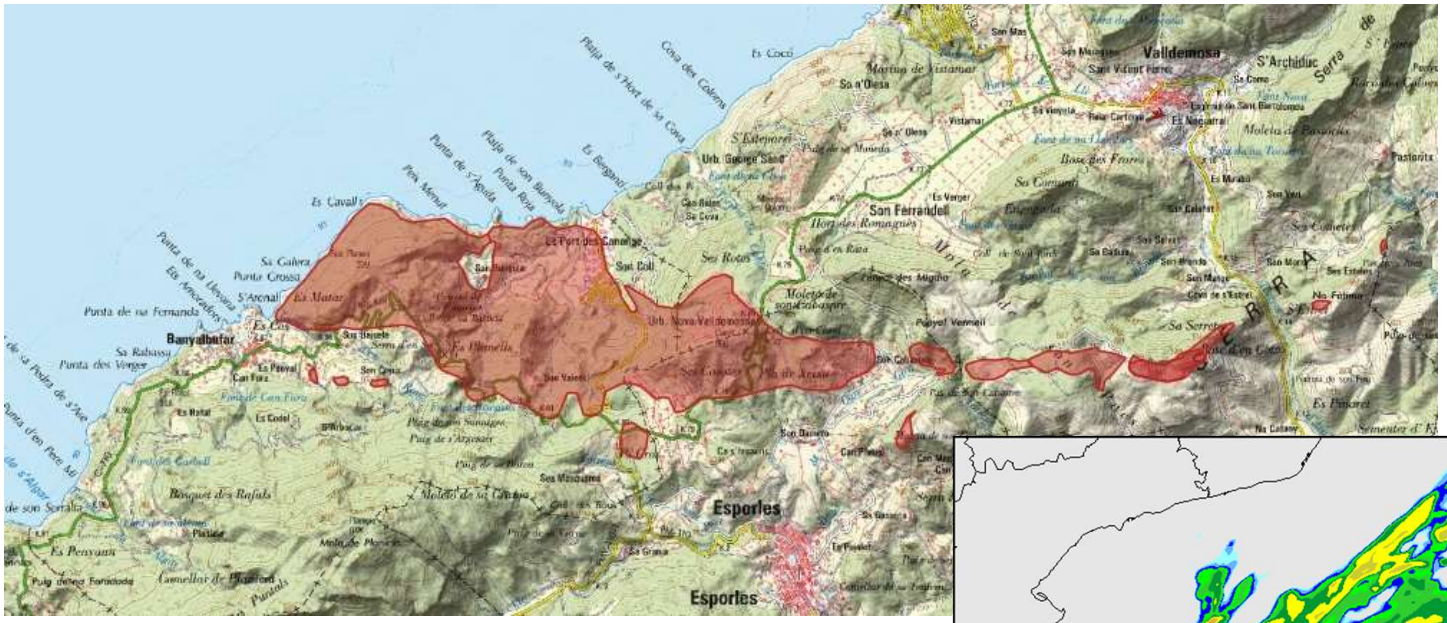


Animació

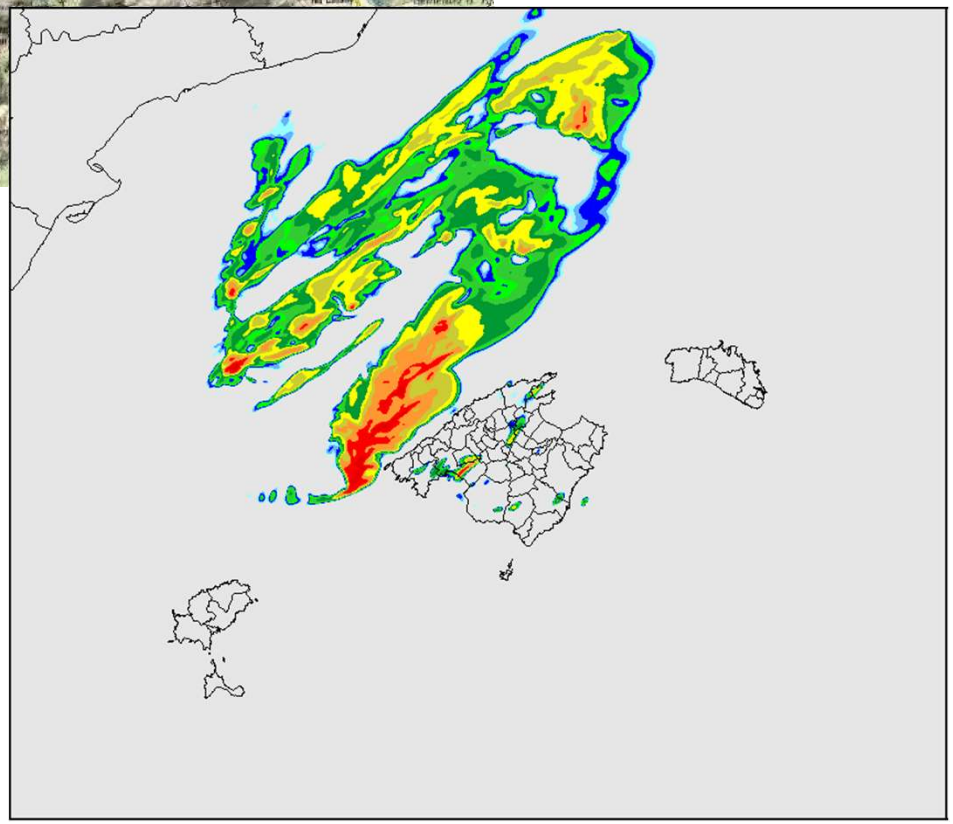


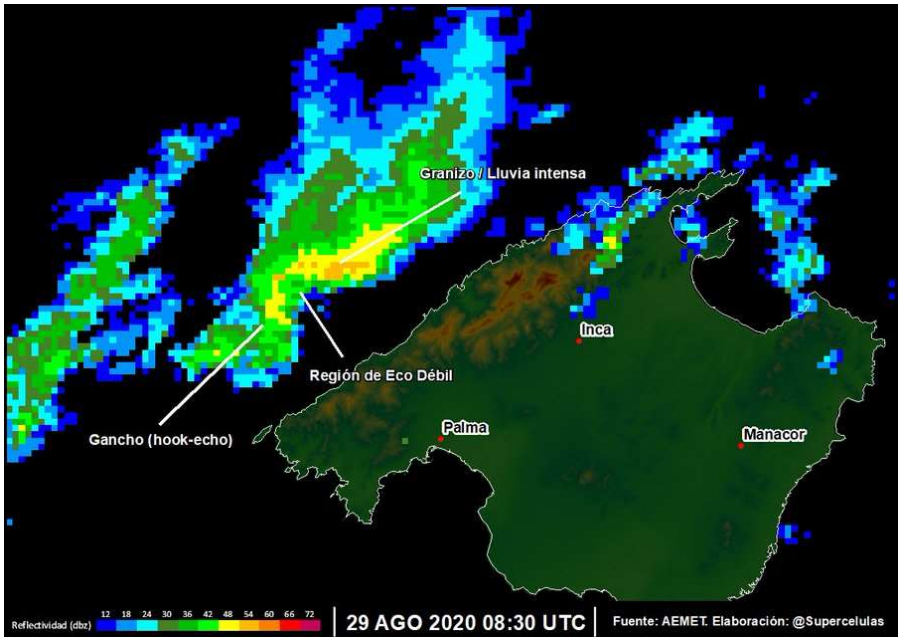
Animació

> Supercèl·lula "Banyalbufar-Esporles" (Agost 2020)



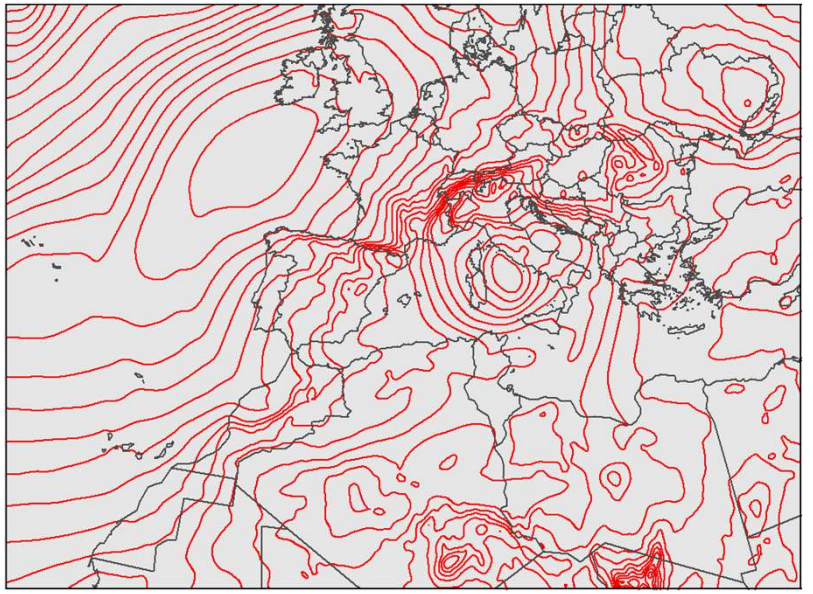
Animació



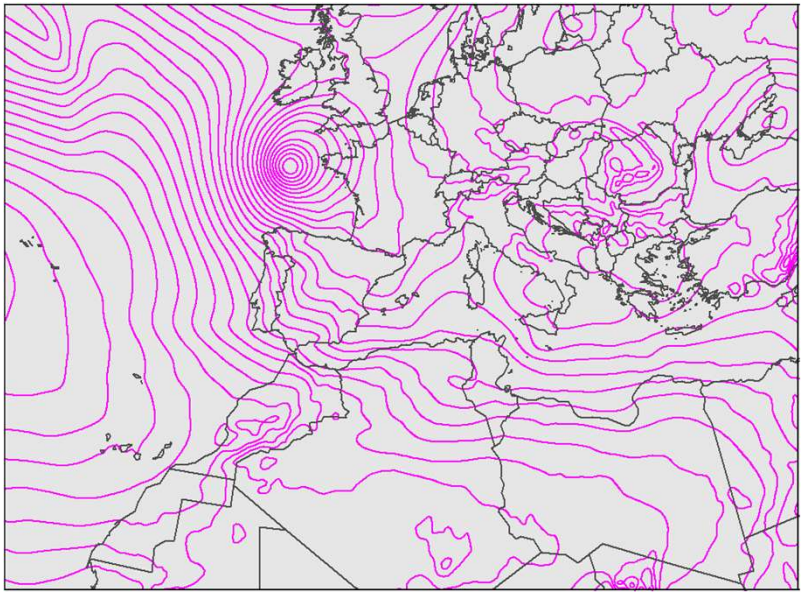


Vent Velocitat Pluja Temperatura

> Tempesta Ciclònica Intensa "HUGO" (Març 2018)



t=0h



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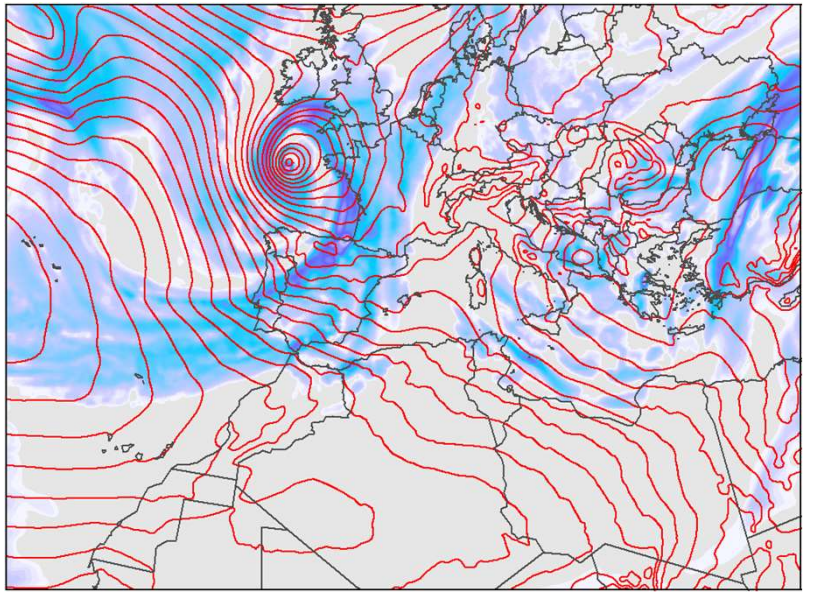
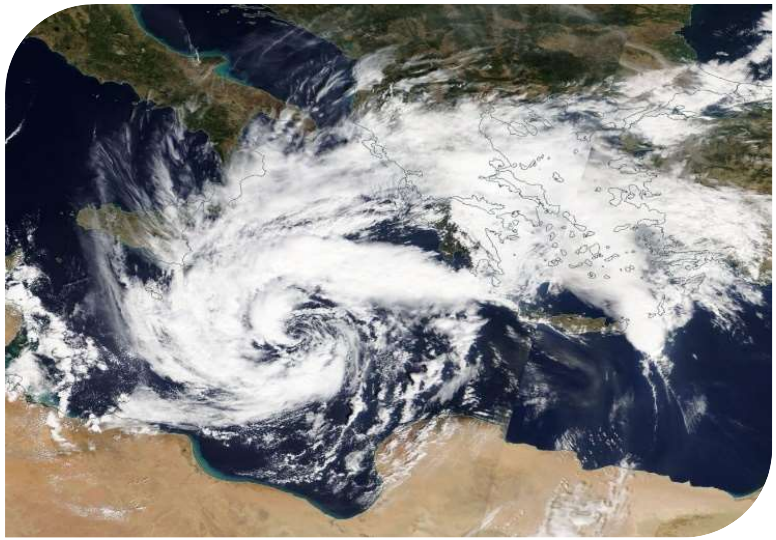


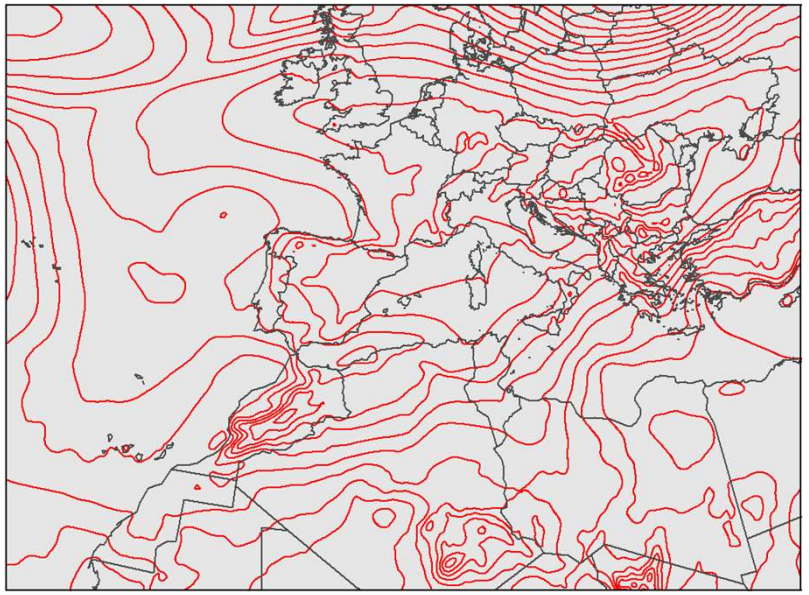
ERA-5

TRAM

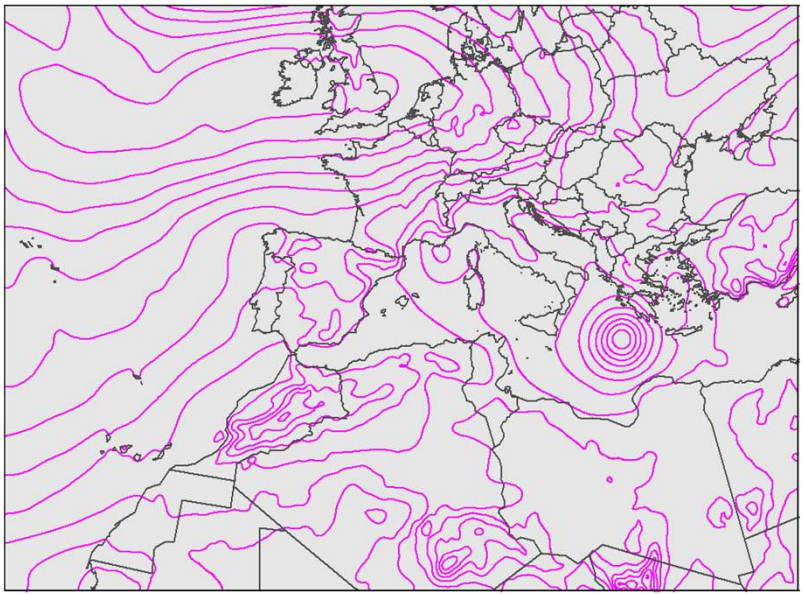
Vent Pluja

> Medicà del Mar Jònic "ZORBAS" (Setembre 2018)





t=0h



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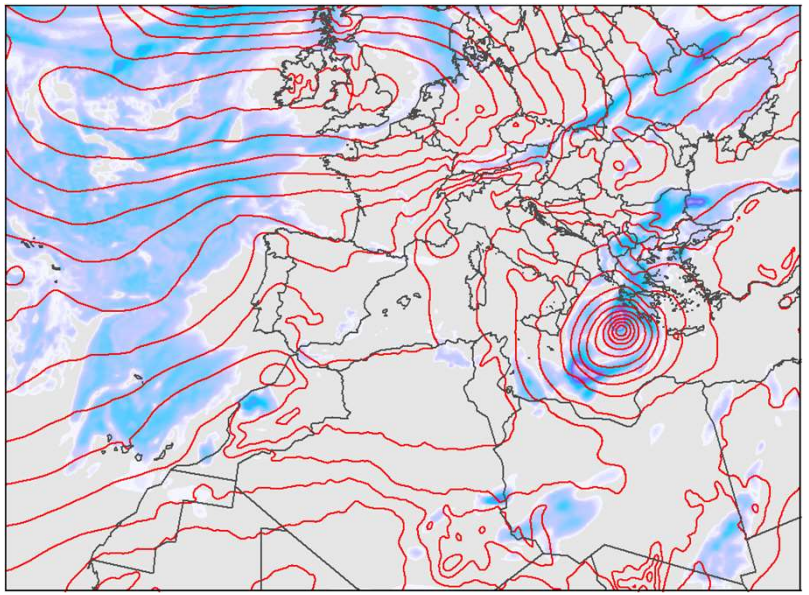
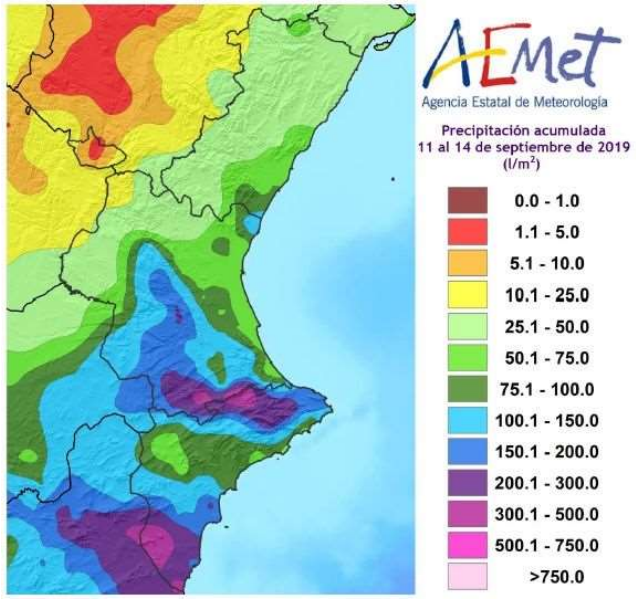


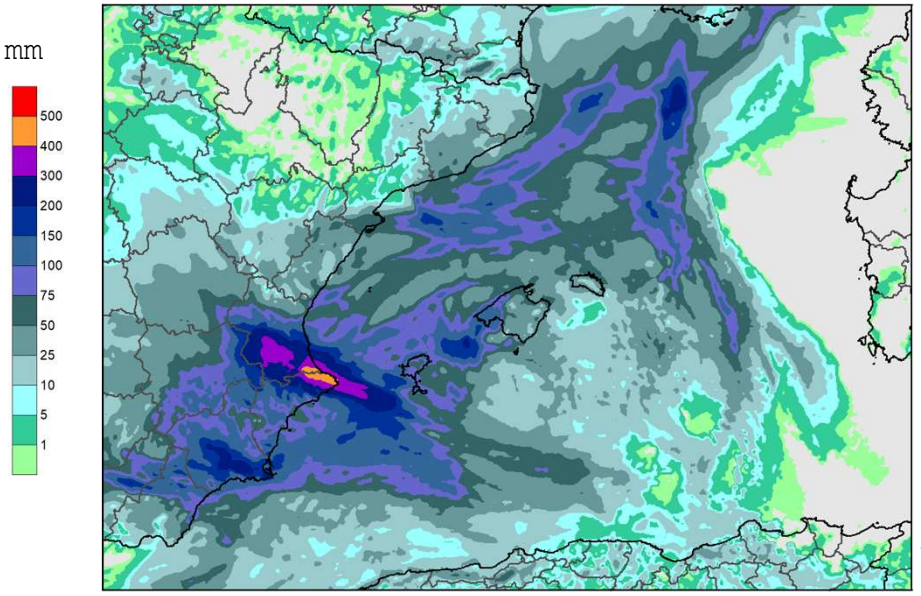
ERA-5

TRAM

Vent Pluja

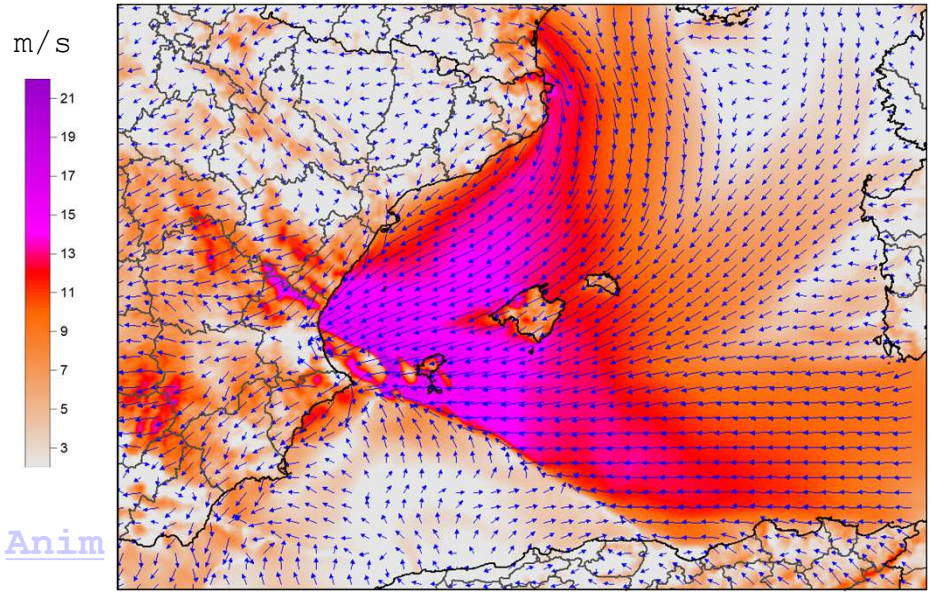
> Inundacions a València-Murcia per "DANA" (Setembre 2019)





total

Anim



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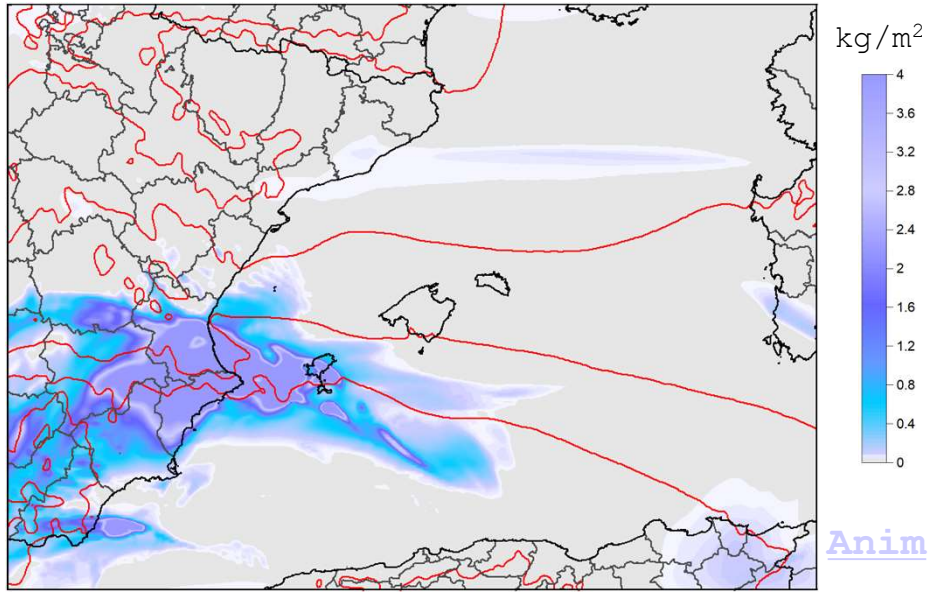
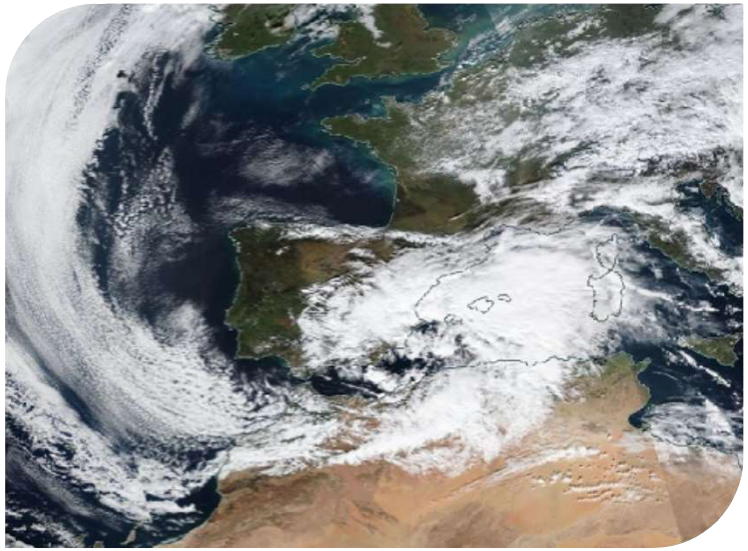
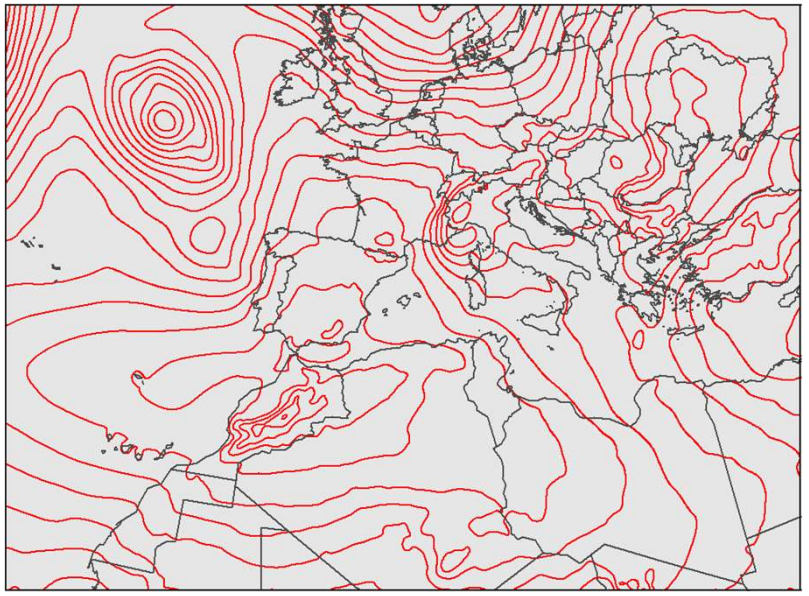


Anim

> Tempesta Extraordinària "GLORIA" (Gener 2020)





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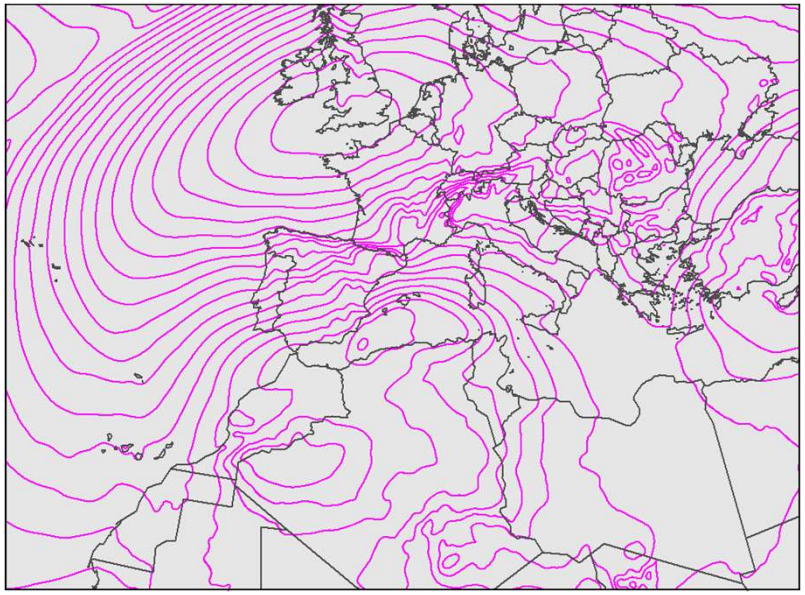
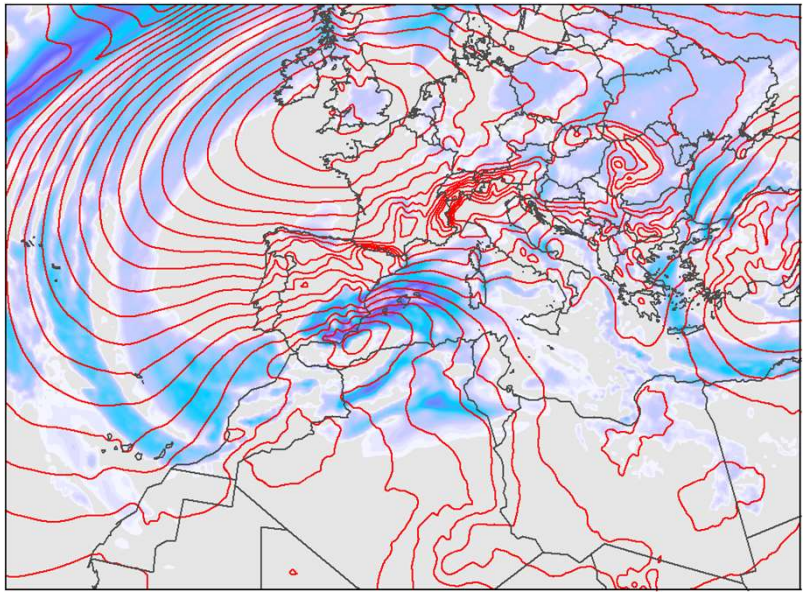


t=48h

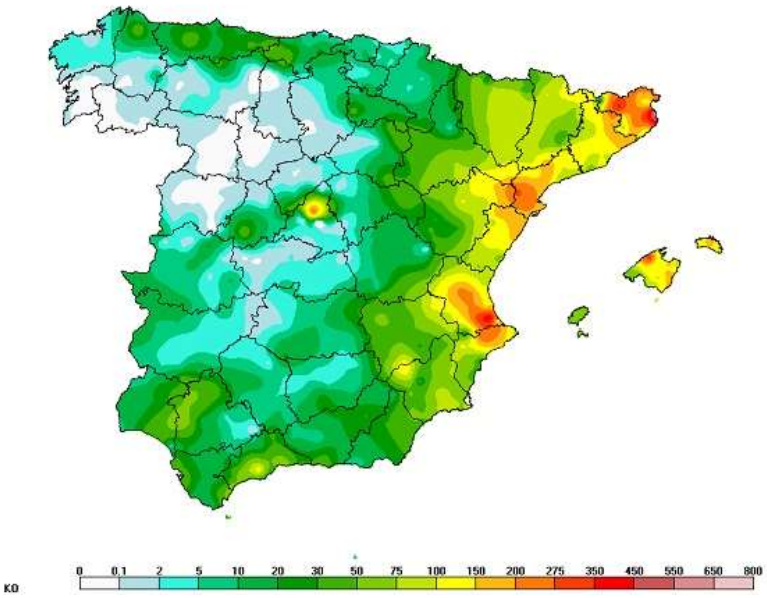


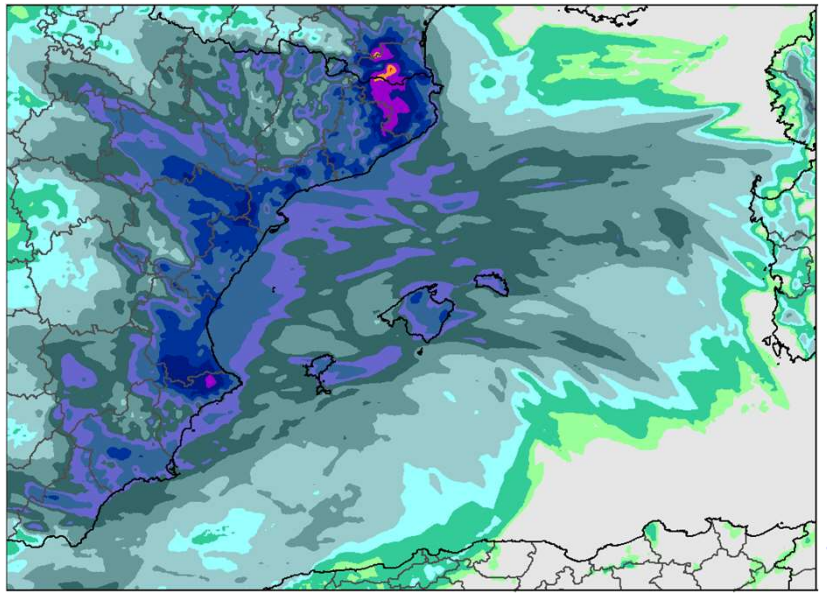
ERA-5

TRAM

Vent Pluja

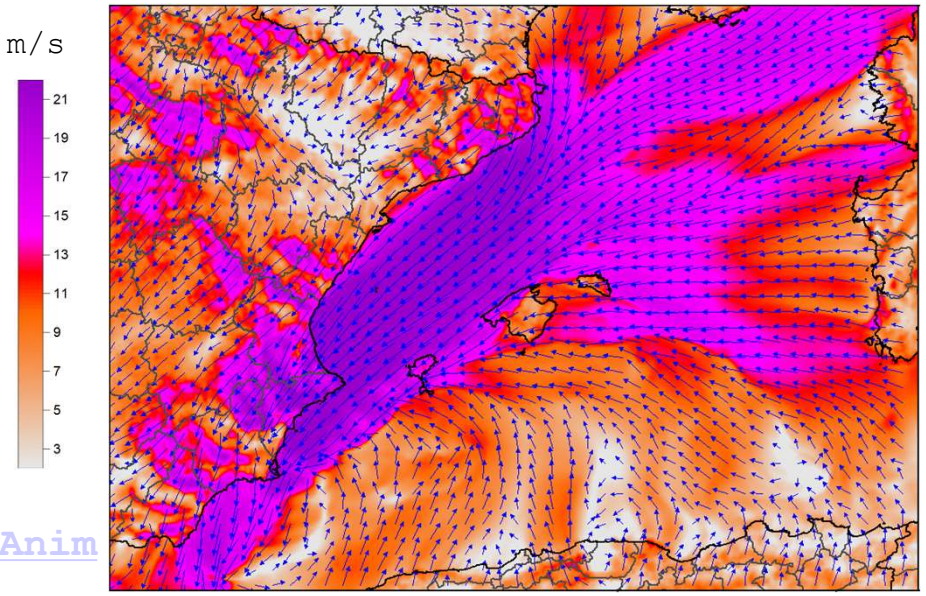
> Tempesta Extraordinària "GLORIA" (Gener 2020)





total

Anim



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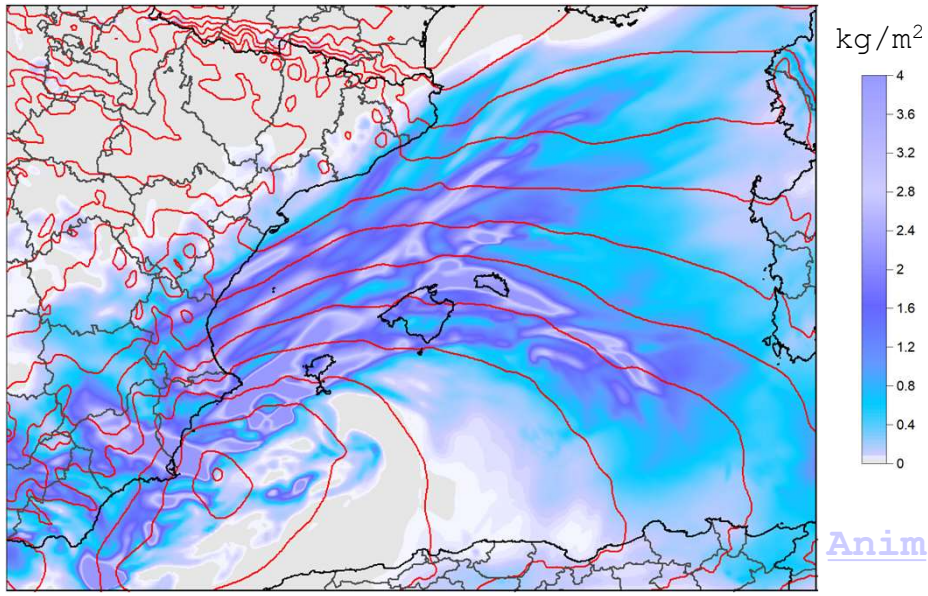

Anim

Anim

MOLTES GRÀCIES

per la

vostra atenció