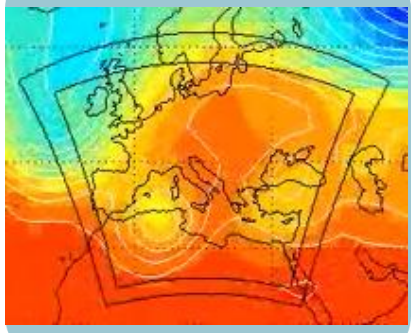
des services

Les défis scientifiques

climatiques



Merci à:
S Somot (CNRM)
M DeFelice (ENEA)
R Vautard (CEA)

PM Ruti

ENEA

Les défis scientifiques des services climatiques

- Une petite histoire des services climatiques
- La recherche et les services climatiques
- Formation pour élèves et société

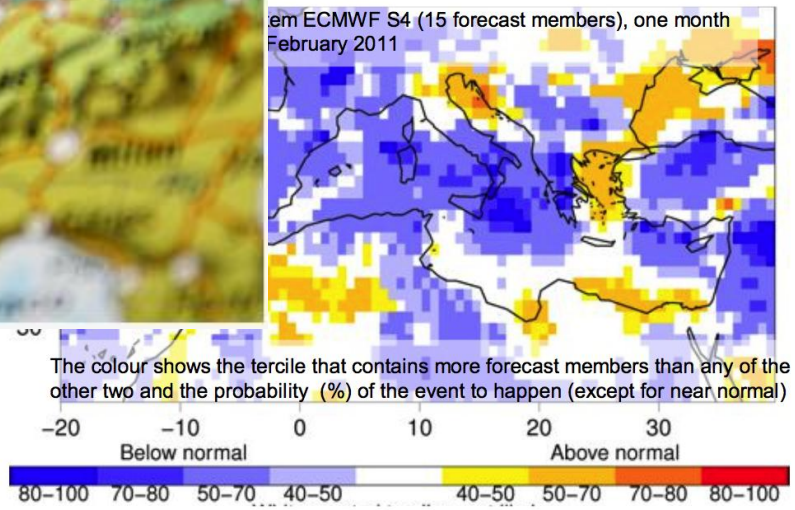
Ex1 – le réseau électrique

Source : RTE

Est-ce que le réseau électrique en 2050 ca sera celui la?
La transition énergétique (23% ENR) que va t'elle changer?

Ex2 – Planification des parcs éoliens

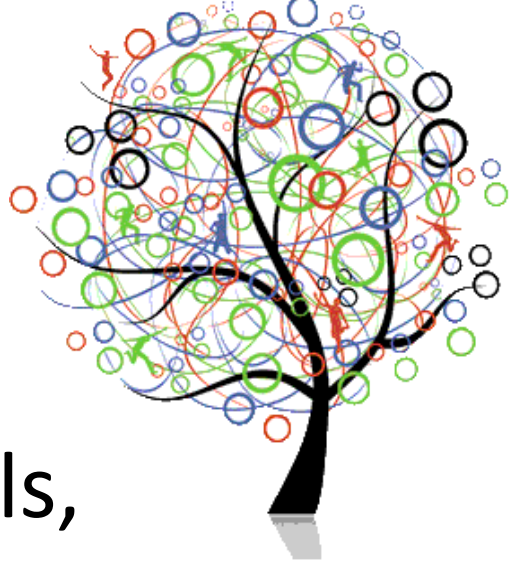
Évaluation des ressources renouvelables. Est-ce que c'est sufisant utiliser des mâts météorologiques pour recueillir diverses données sur la vitesse du vent et d'autres conditions climatiques sur une période d'au moins un an?



Ex3 – Infrastructures critiques

le besoin d’adapter les infrastructures critiques au risque d’événements climatiques extrêmes …

Les points communs



- Les usagers (politiciens, industriels, assurances, etc) ont des questions ciblées.

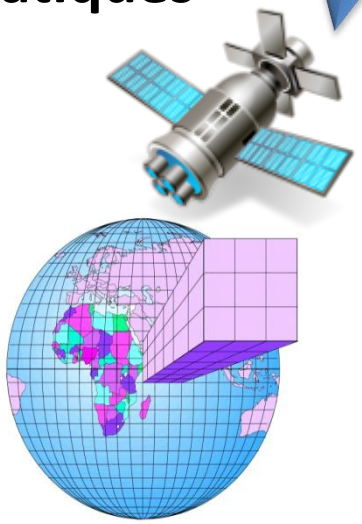
- Nécessite une information au niveau régional et local

- Le climat actuel et le future proche

Définition de services climatiques

Information

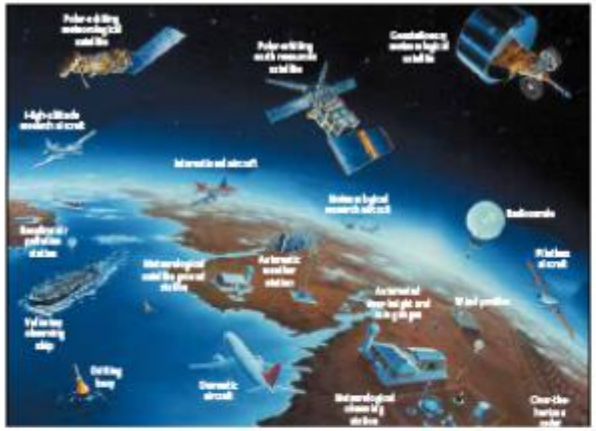
Données climatiques



Développement de connaissances de géophysiques fondamentales, des questions aux interfaces de la mécanique comme la sécurité des infrastructures, la sécurité aérienne

Nécessitées des usagers

Point de départ: OMM 2009



Enable better management of the risks of climate variability and change and adaptation to climate change, through the development and incorporation of **science-based** climate information and prediction into planning, policy and practice on the global, regional and national scale

GFCS

Le premier projet européen

CLIM-RUN

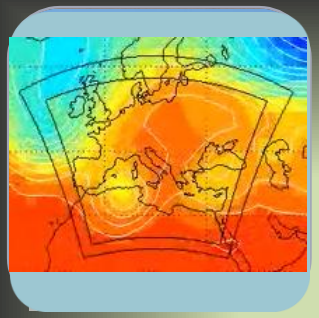
Tourism: Tunisia, France, Cyprus, Croatia

Energy: Spain, Morocco, Cyprus, Croatia

Wild Fires: Greece

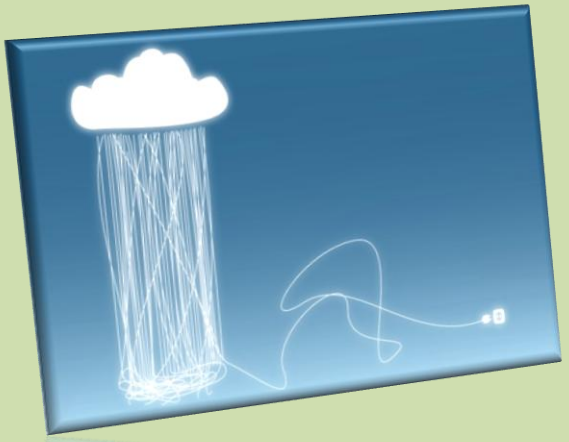
Integrated Case Study: North Adriatic

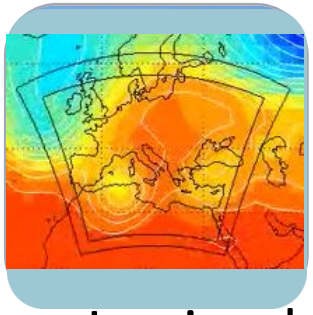
www.climrun.eu



Les défis scientifiques des services climatiques

- Une petite histoire des services climatiques
- La recherche et les services climatiques
- Formation pour élèves et société

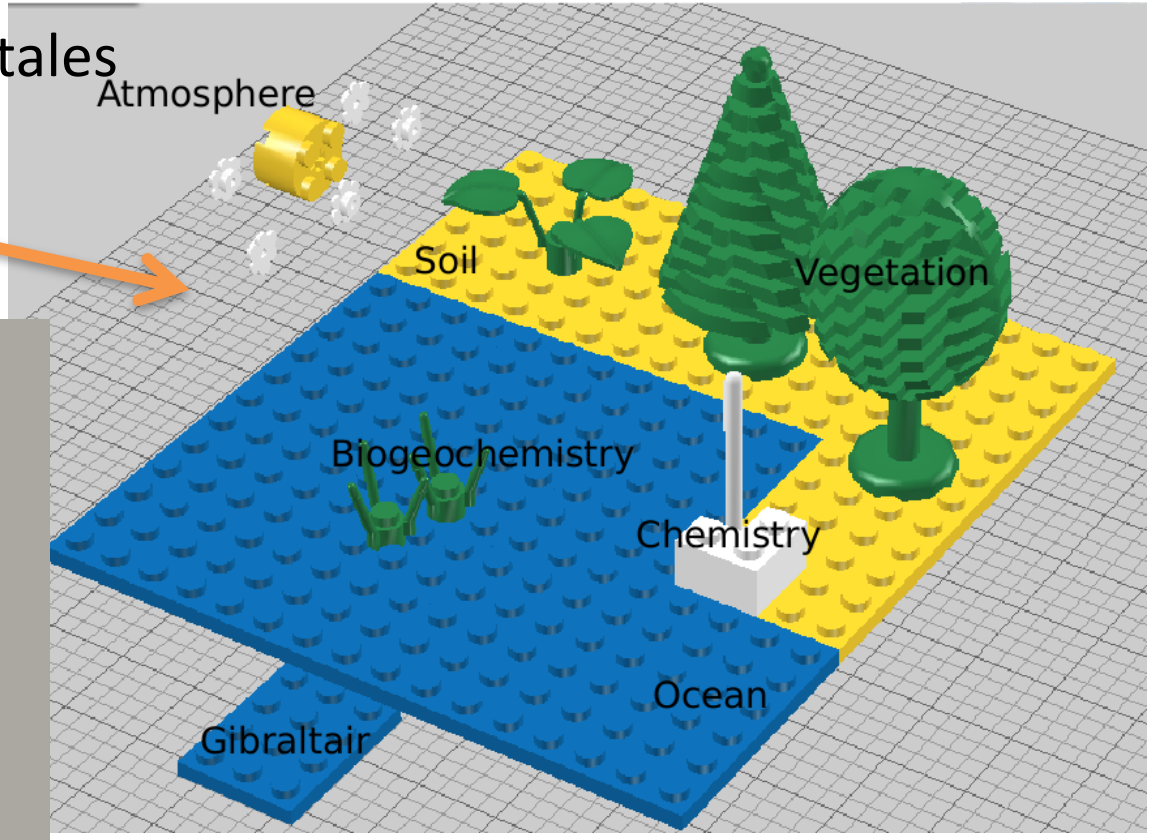




Simulations climatiques et prévisions

La simulation des changements climatiques nécessite de définir le système climatique, constitué de:

- l'atmosphère
- les surfaces continentales
- l'hydrosphère
- la cryosphère
- la biosphère



The Primitive Equations

$$\frac{du}{dt} - \left(f + \frac{u\tan\phi}{a}\right)v + \frac{1}{\rho}\frac{\partial p}{\partial x} + F_x = 0$$

$$\frac{dv}{dt} + \left(f + \frac{u\tan\phi}{a}\right)u + \frac{1}{\rho}\frac{\partial p}{\partial y} + F_y = 0$$

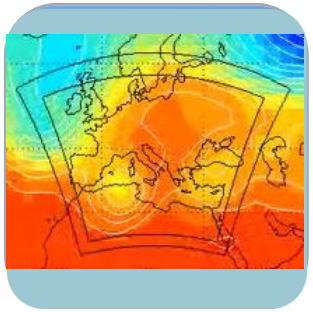
$$p = R\rho T$$

$$\frac{\partial p}{\partial z} + g\rho = 0$$

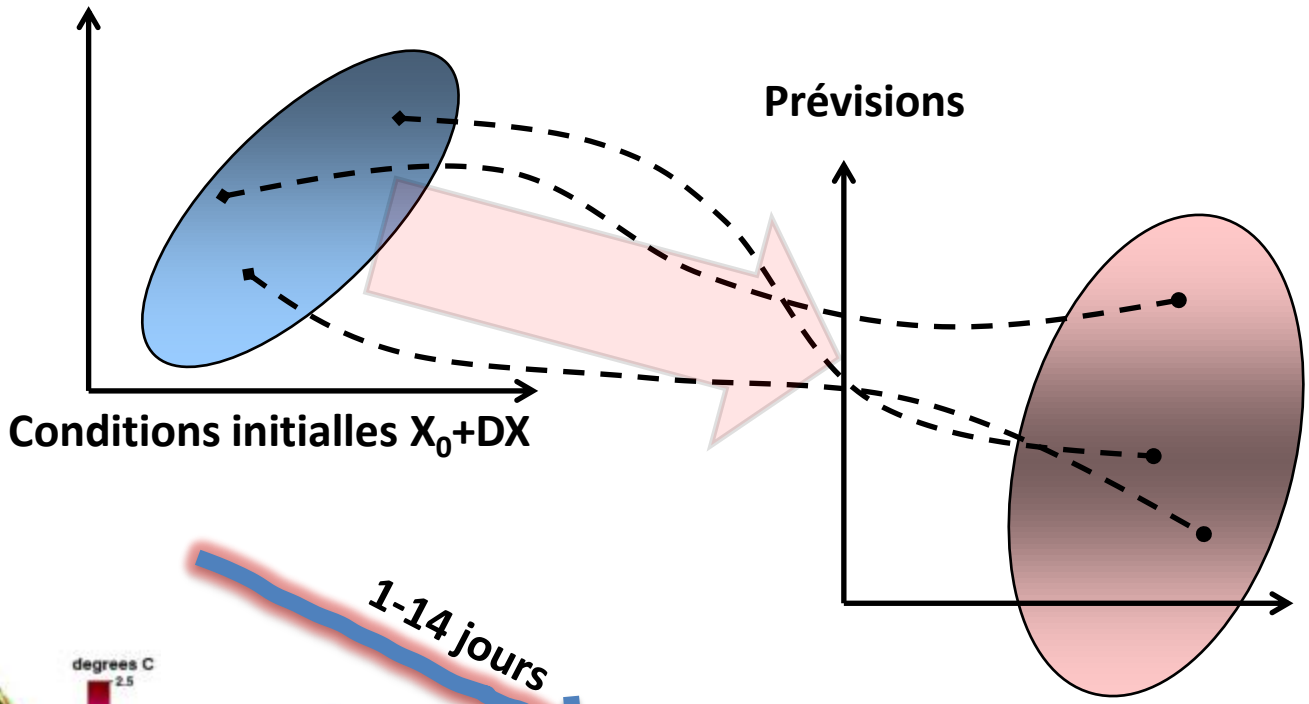
$$\frac{dT}{dt} + (\gamma - 1)T\nabla\cdot\mathbf{V} = \frac{Q}{c_p}$$

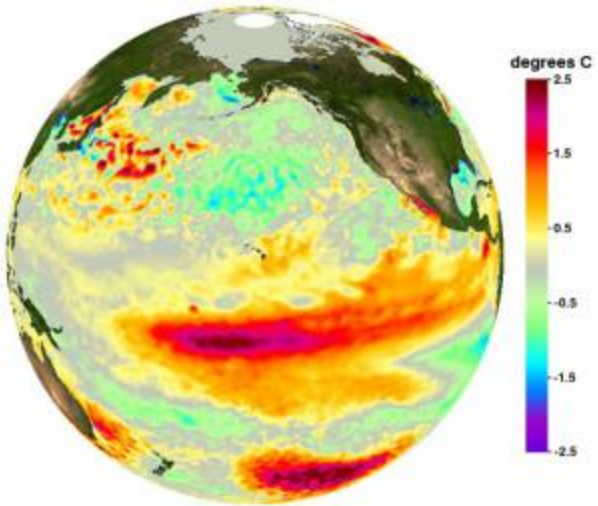
$$\frac{\partial \rho}{\partial t} + \nabla\cdot\rho\mathbf{V} = 0$$

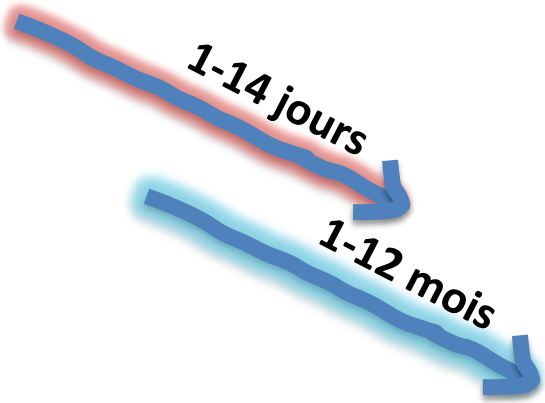
$$\frac{\partial \rho_w}{\partial t} + \nabla\cdot\rho_w\mathbf{V} = [\text{Sources} - \text{Sinks}]$$

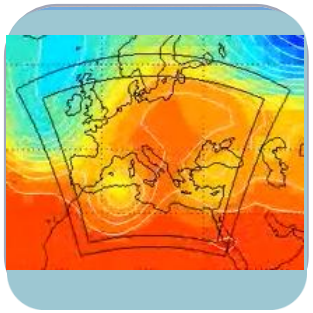


Prévisions météo et saisonnières



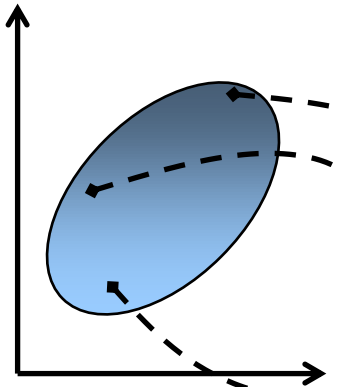




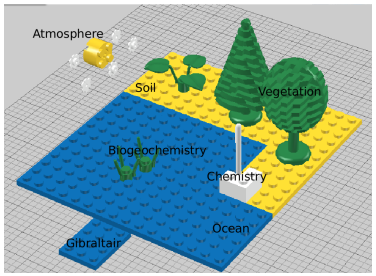


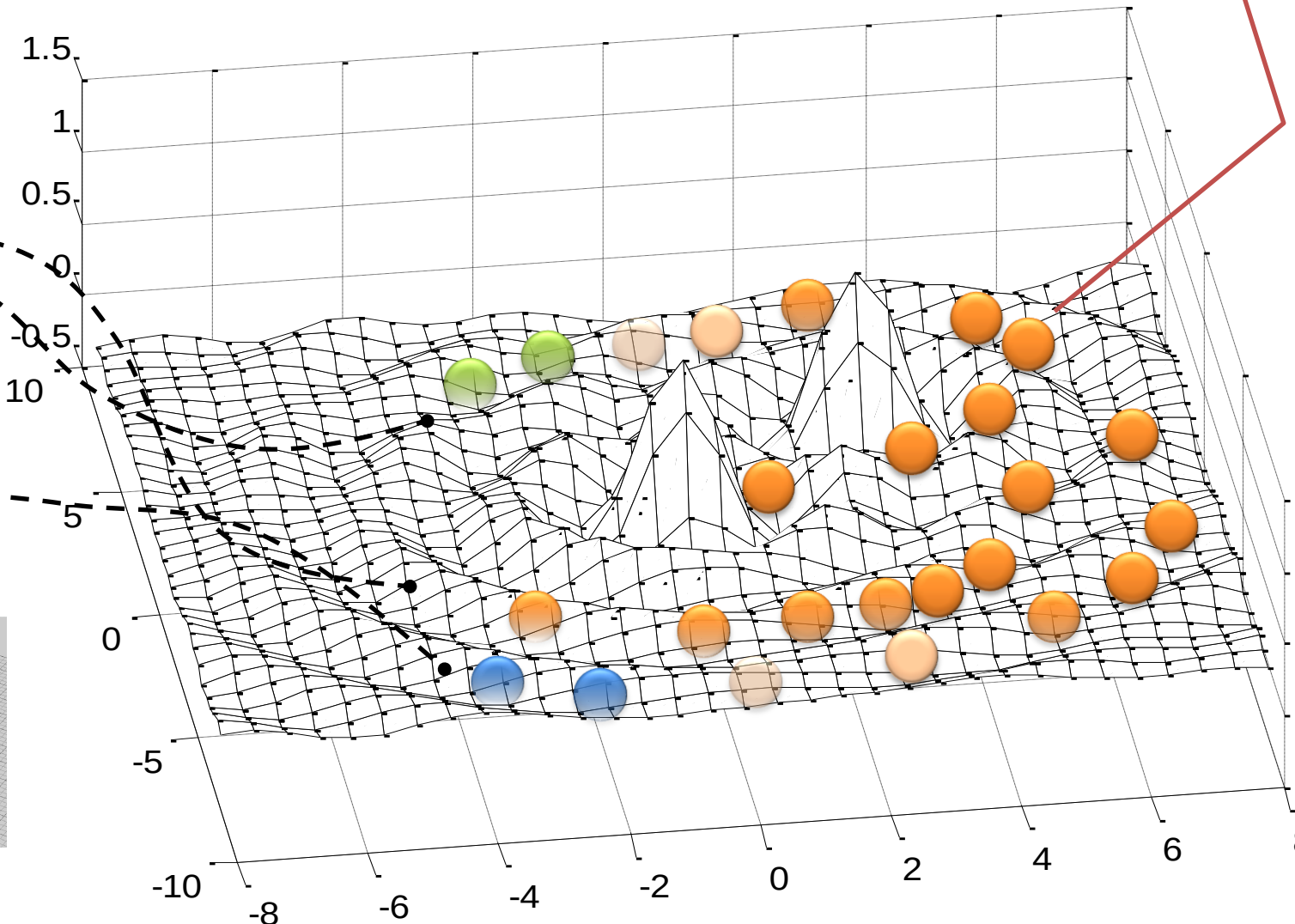
Simulations climatiques et projections

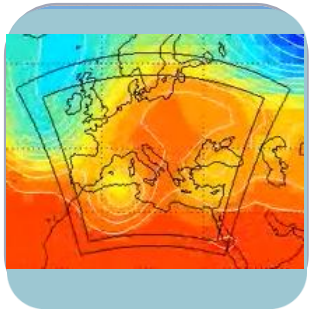
Forçage extérieur:
orbital fac, CO2, etc



Conditions initiales
X_0+DX







Echéances temporelles des prévisions

Changement Climatique

Forecast Uncertainty

Years

Seasons

Months

2 Week

1 Week

Days

Hours

Minutes

Boundary Conditions

Initial Conditions

Prévision du System. Climatique

Prévision Meteo

Outlook

Guidance

Threats Assessments

Forecasts

Watches

Warnings & Alert Coordination

Forecast Lead Time

Benefits

Protection of Life & Property

Flood Mitigation & Navigation

Space Operation

Transportation

Fire Weather

Hydropower

Agriculture

Reservoir Control

Recreation

Ecosystem

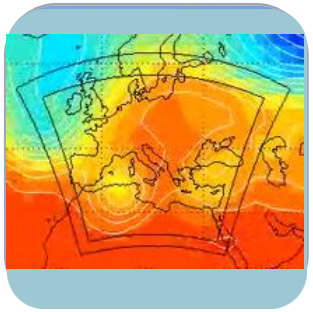
Energy

Health

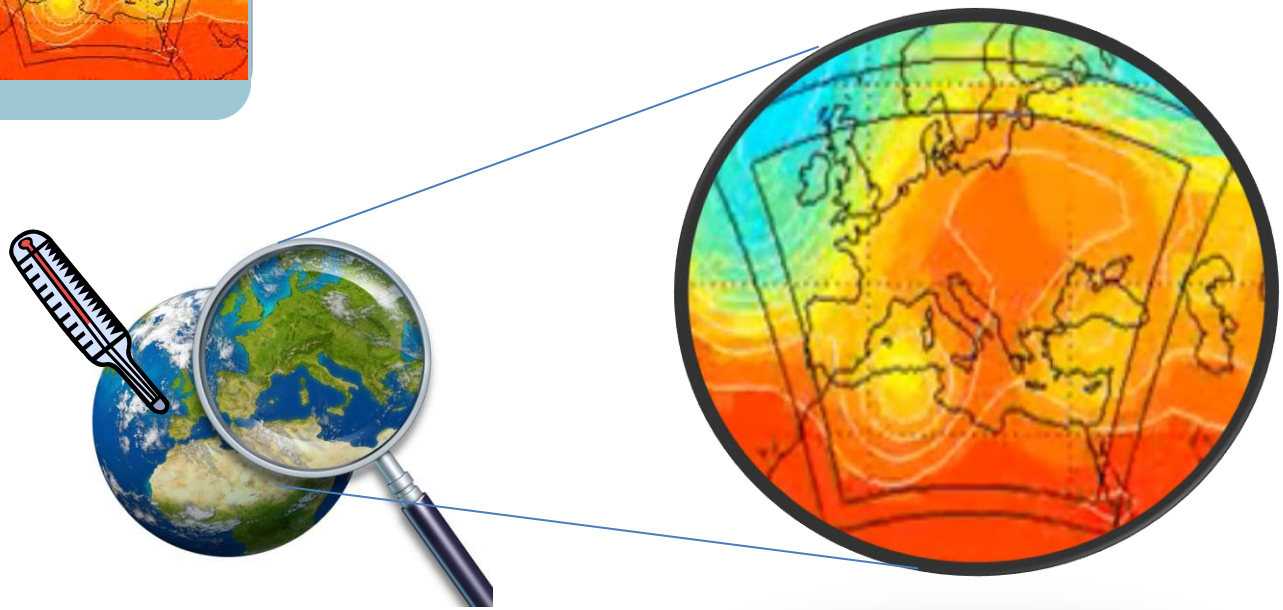
Commerce

State/Local Planning

Environment

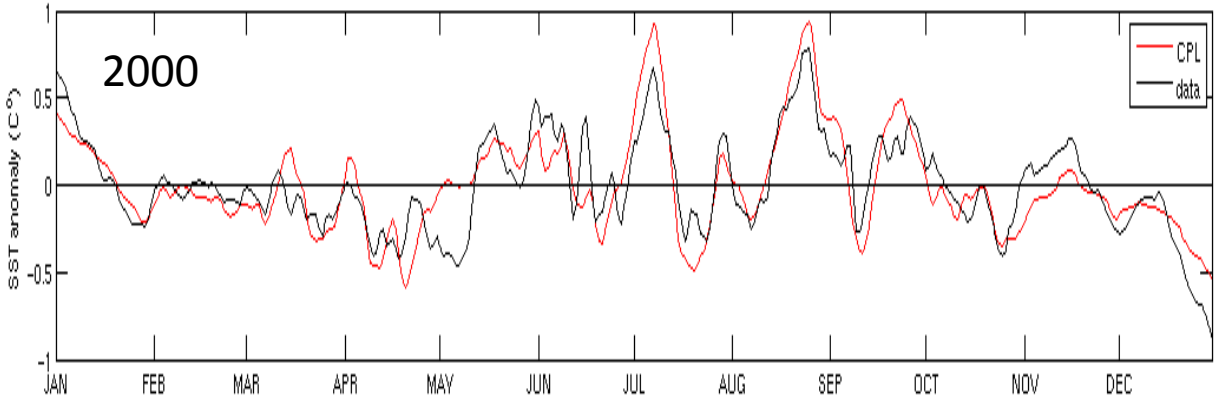


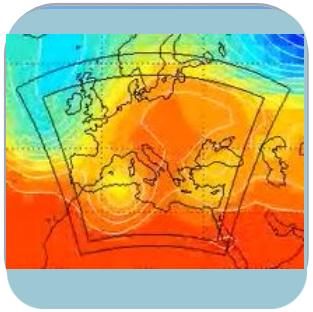
Information climatique au niveau régional



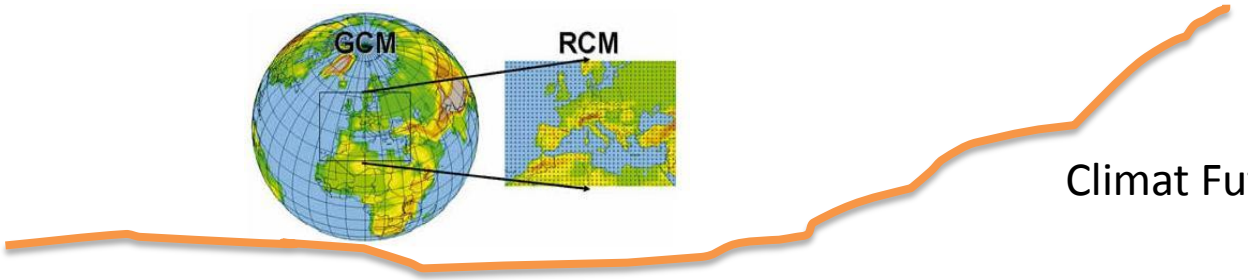
la modélisation régionale comme outils pour la reconstruction des données climatiques et pour évaluer la probabilité annuelle des extrêmes

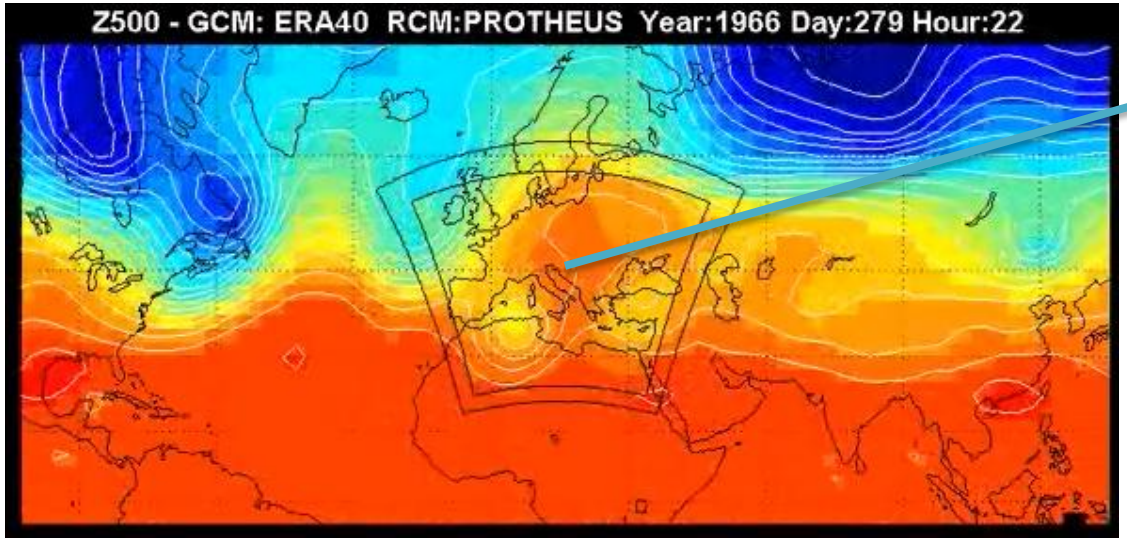
… après 40 ans de simulation …

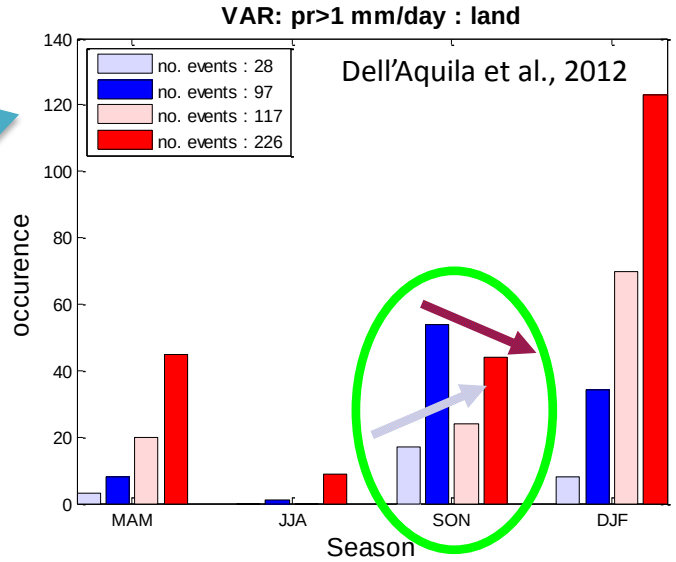




Information climatique au niveau régional







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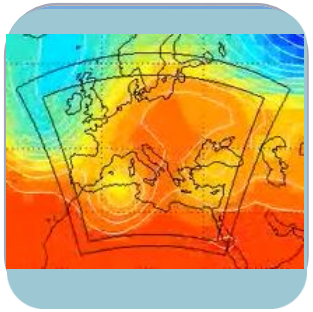
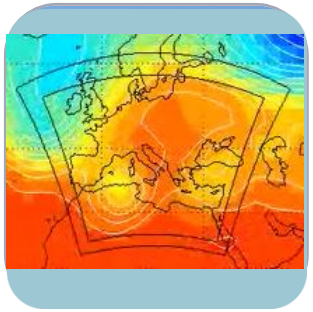


La recherche dans les services climatiques

- Le Secteur des Energies Renouvelables

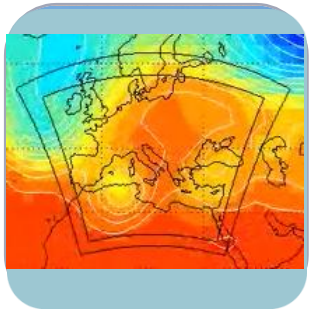
- Les événements climatiques extrêmes

CLIM-RUN



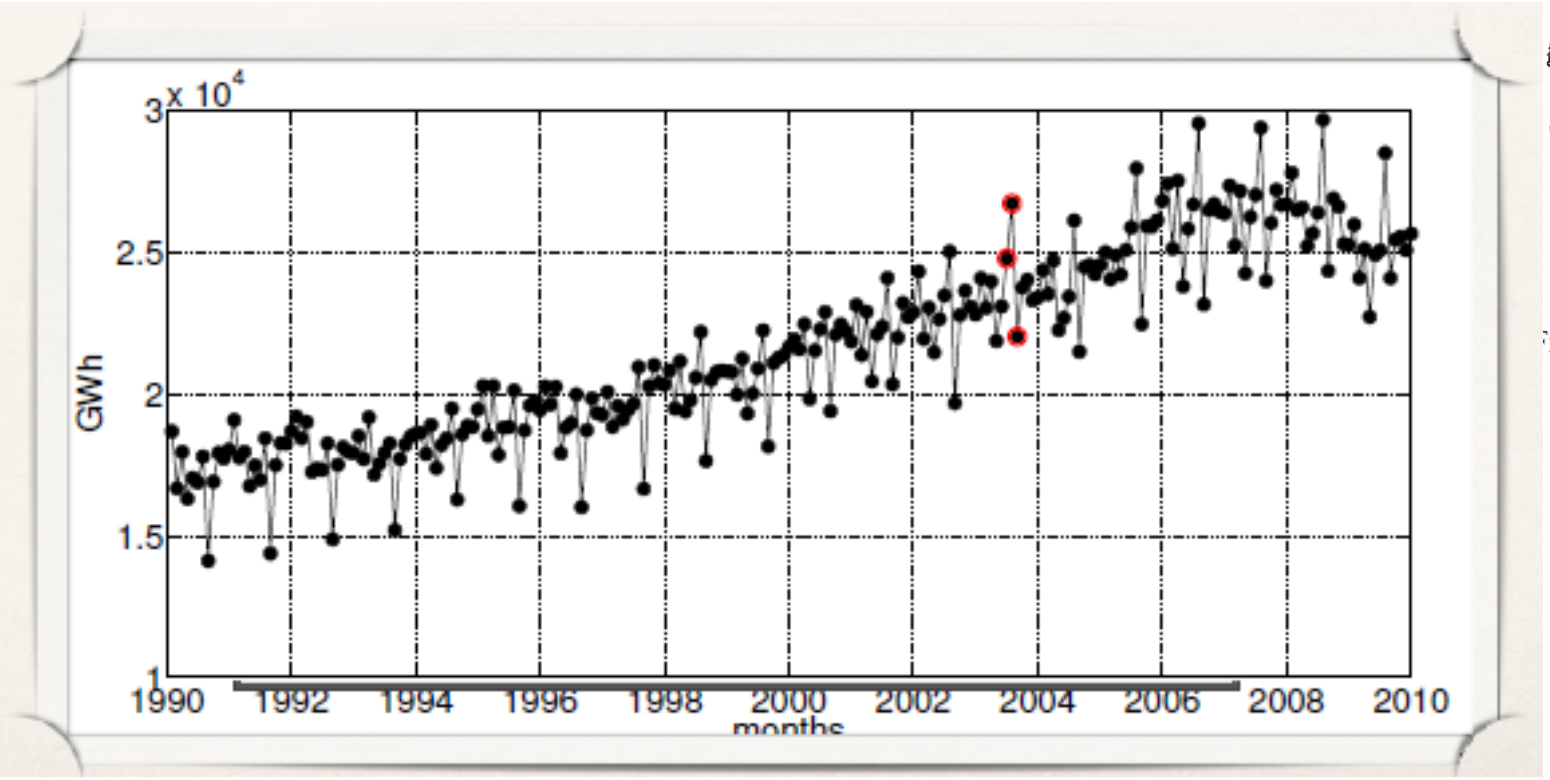
Le Secteur des Energies Renouvelables

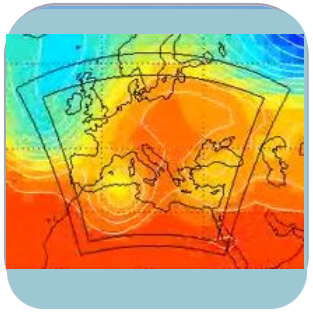
- REN Technologies & Climate Variables
  - Wind
    - wind intensity (80-100 m height)
    - ailing wind direction
    - wind speed variability
  - Solar & Wind
    - Extreme Wind Speeds (>35 km/hr)
    - Frequency & Duration of extreme wind speeds
  - Solar
    - Radiation - DNI, GHI
  - General
    - Hail storms - Frequency & Duration
    - Snow cover - Frequency/Duration
    - Humidity
    - Aerosol Variability
    - Temperature
  - Hydro
    - Precipitation
    - Frequency/Duration of high rainfall events
  - hydrolienne



Prévision pour le réseau électrique

ig. 1: Regional data sets





Prévision pour le réseau électrique

Fig. 1: Regional data sets

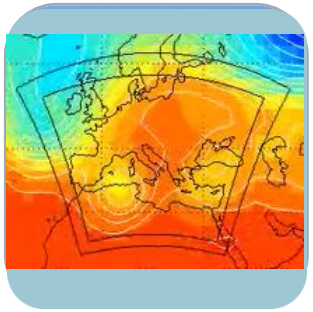
Consomation

1996-2002

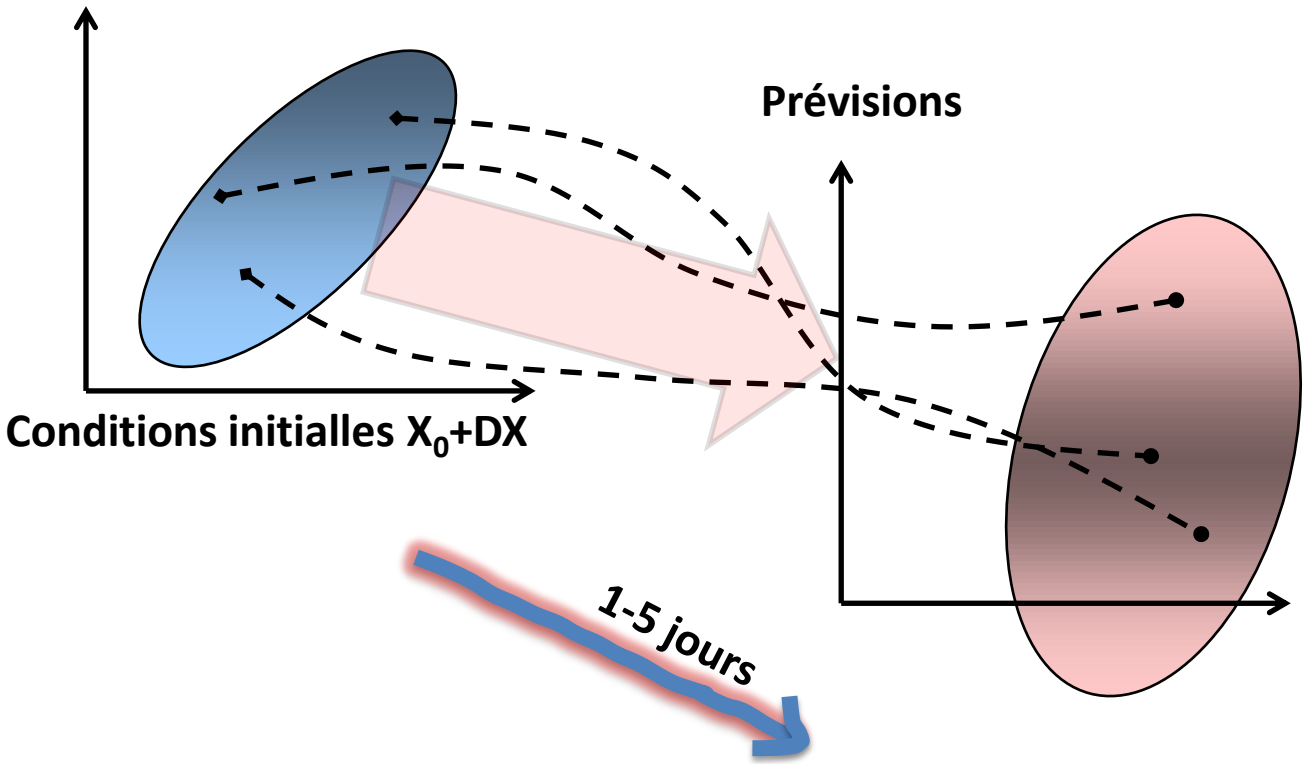
North-West and South

2003-2010

Température



Prévisions météo de température



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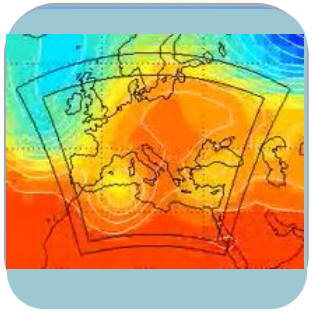


Prévision pour le réseau électrique

Prévision statistique

Prévision parfaite

Prévision dynamique et stat

Erreur

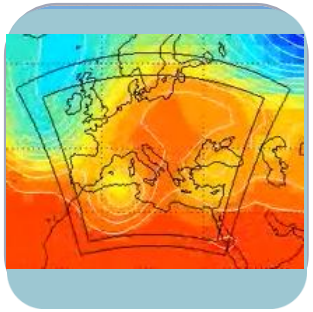
Avg. MAE

0 4000 10000 17000 24000 31000 38000

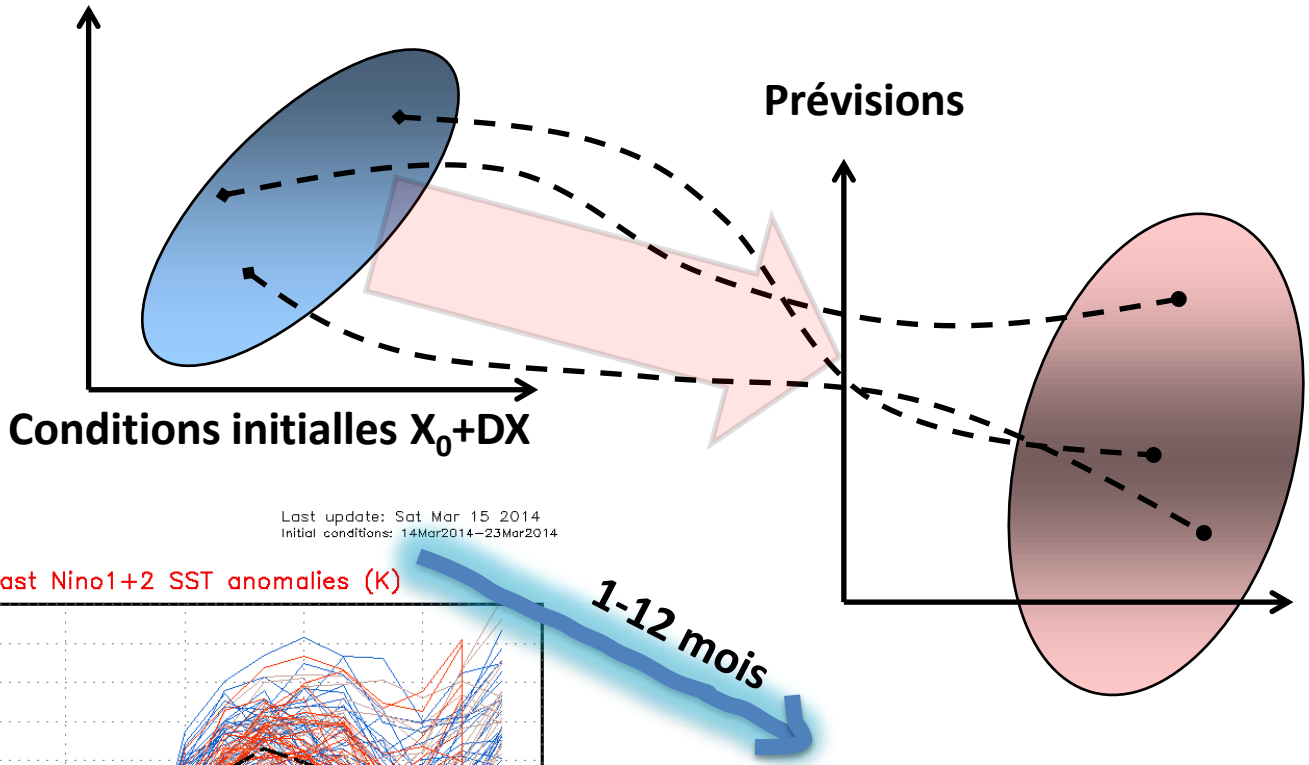
1 2 3 4 5

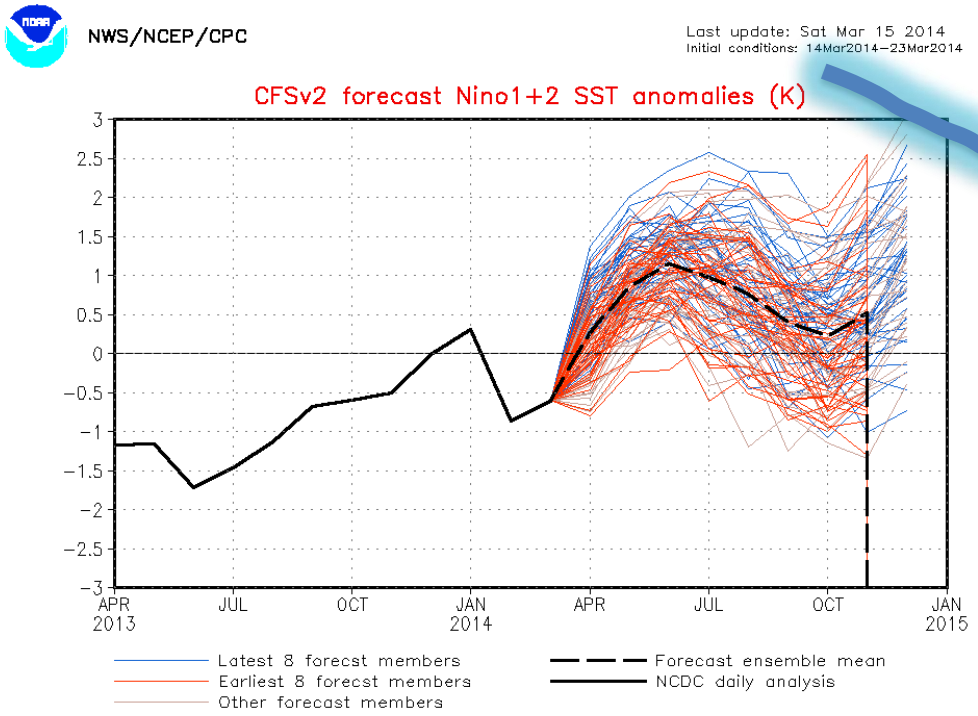
Lead Time (days)

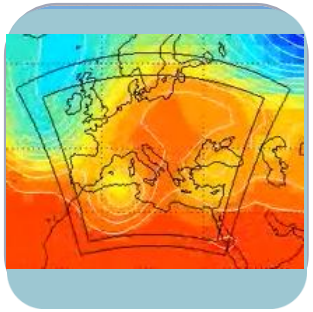
ARIMA(1,0,3)
ARIMAX(1,0,3)−reanal.
ARIMAX(1,0,3)−op.for.
naive



Prévisions saisonnière de Température





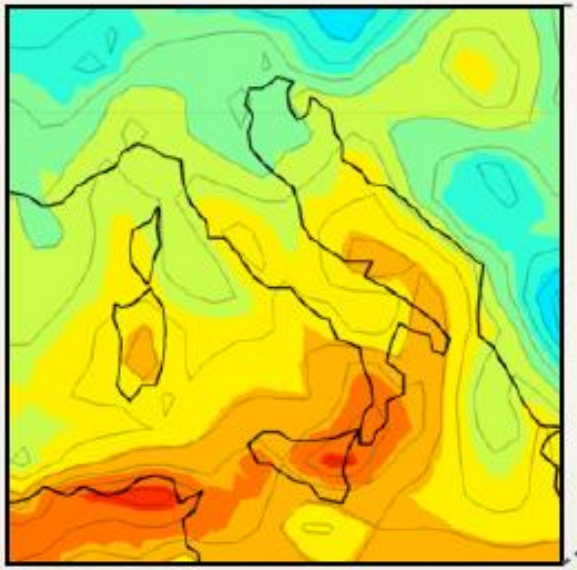


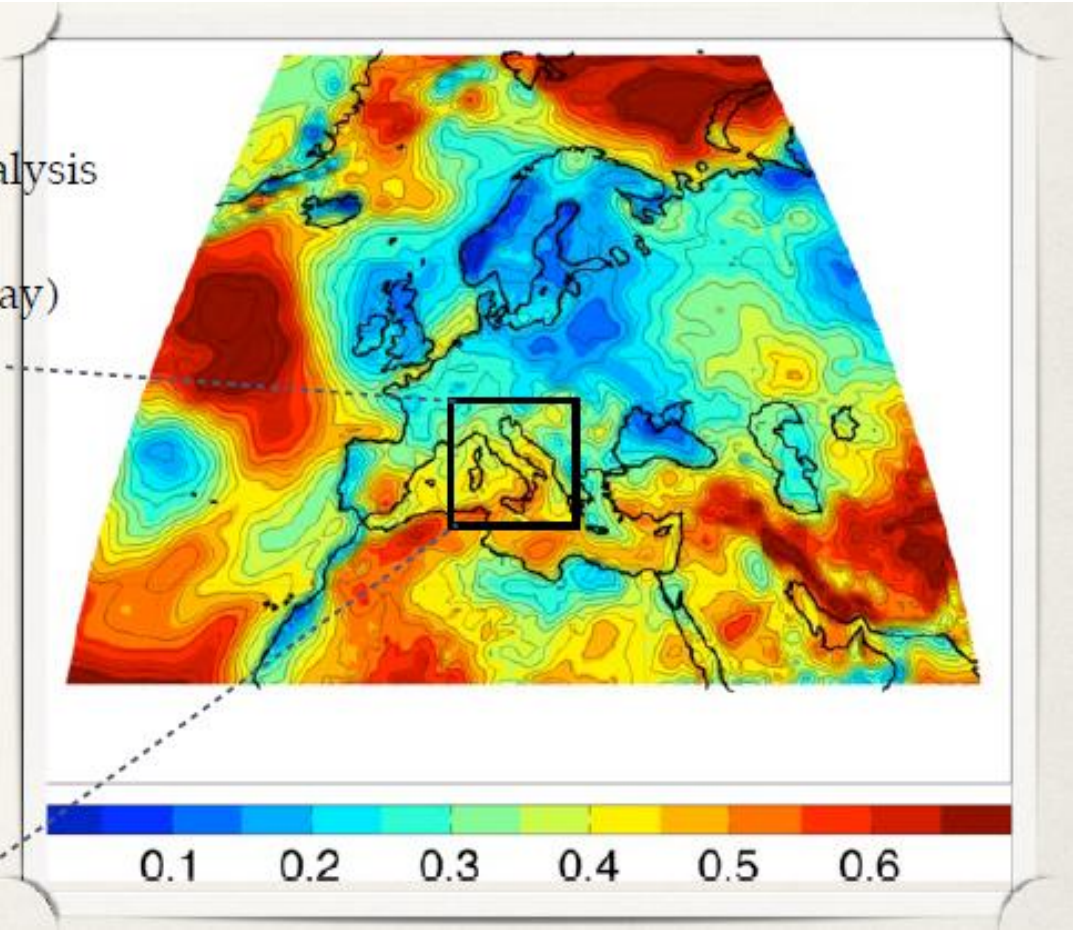
Prévision saisonnière pour le réseau

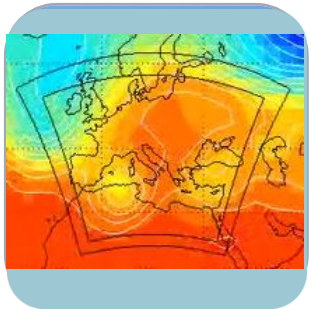
- 2-metres temperature from:

I) ECMWF ERA-INTERIM Reanalysis

II) ECMWF System4 (issued in May)

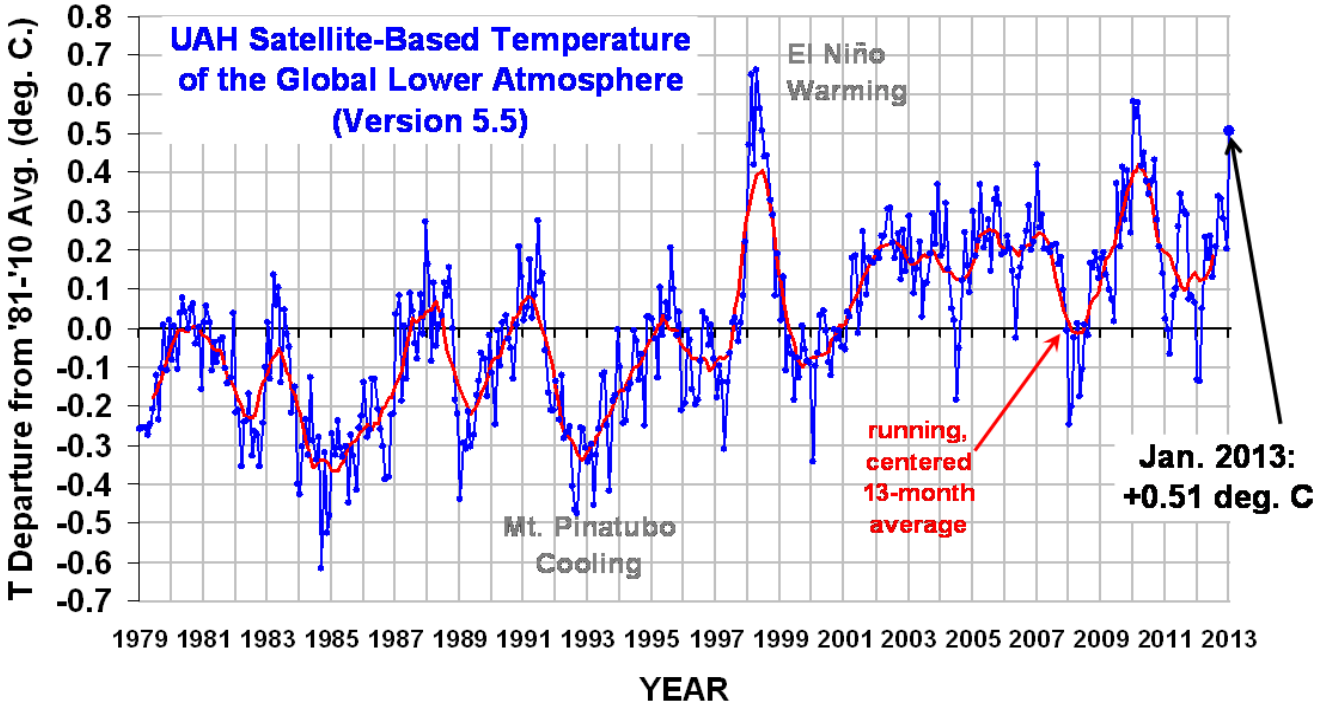


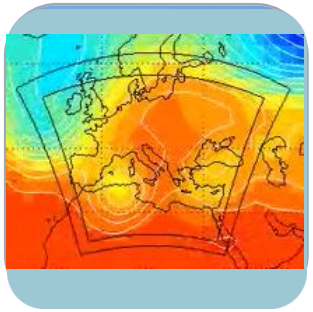




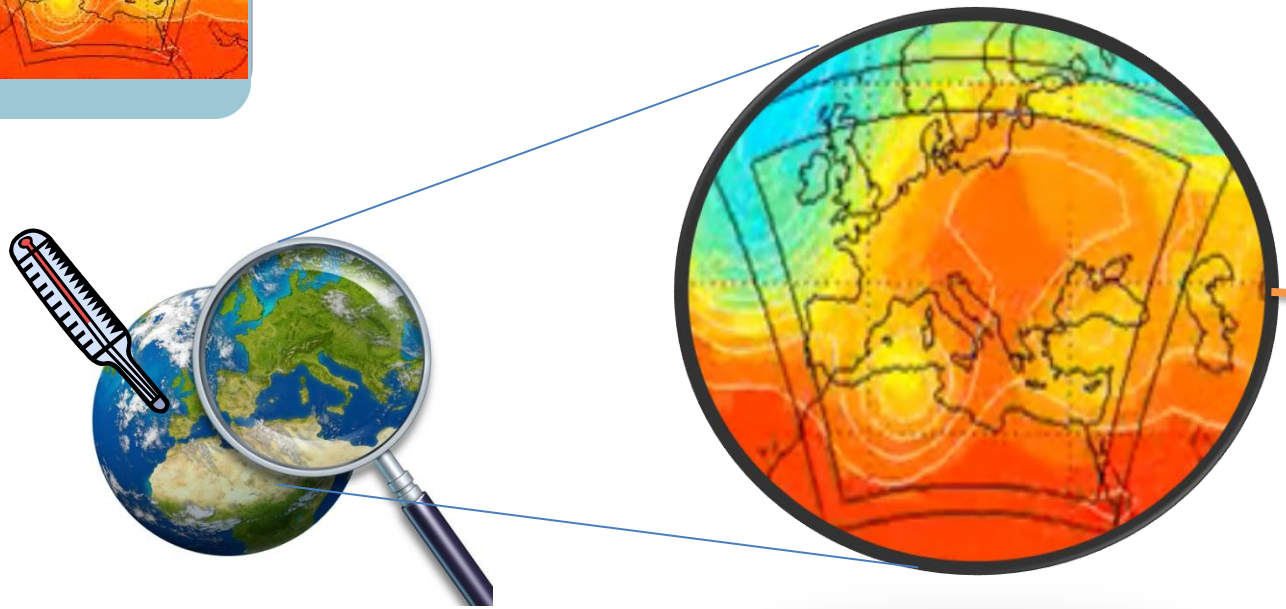
Projections climatiques …

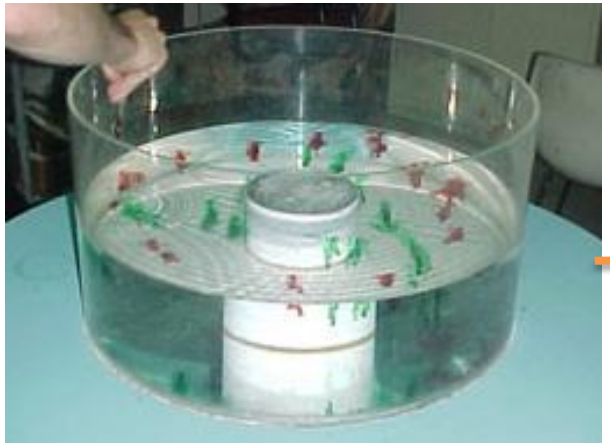
- Application prévision court terme
- Prévision saisonnière
- Et pour le long terme …

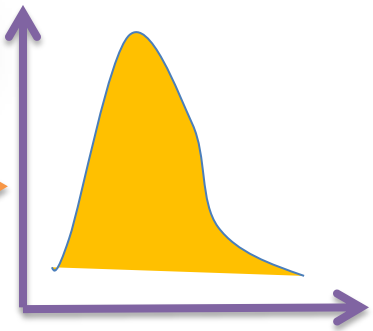


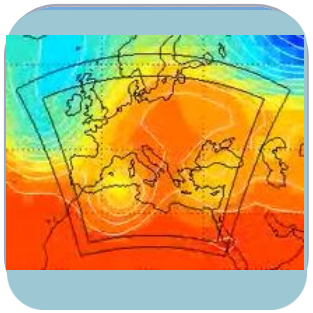


Projections climatiques et éolien

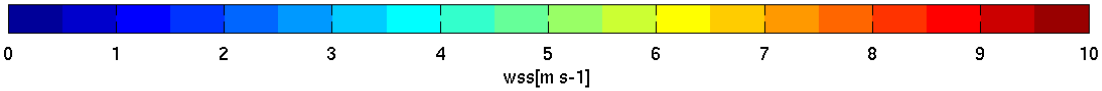




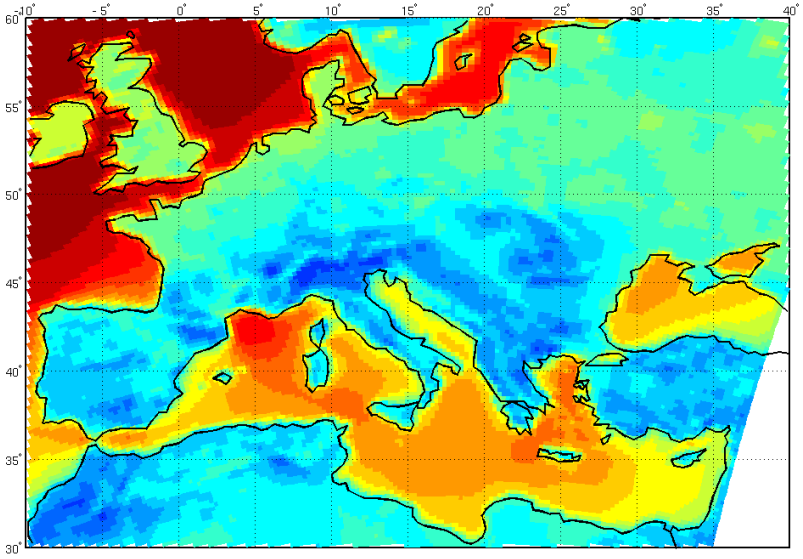




Reconstruction du climat actuel

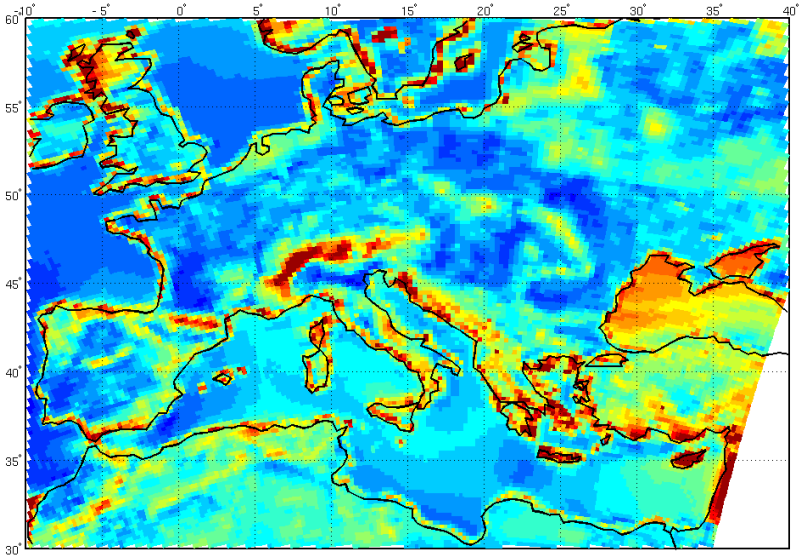


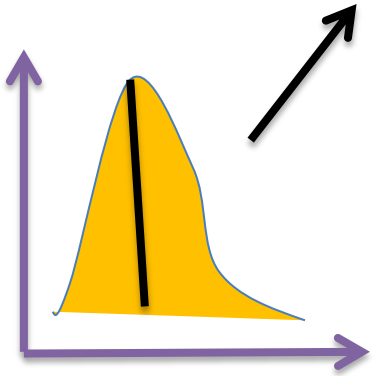
ENSEMBLES RCMs 25Km ERA40 Mean DJF

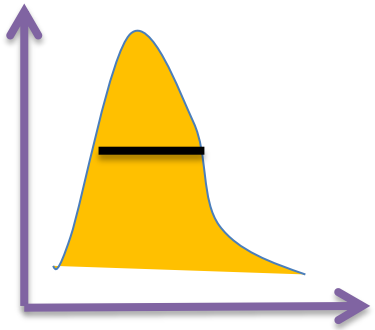


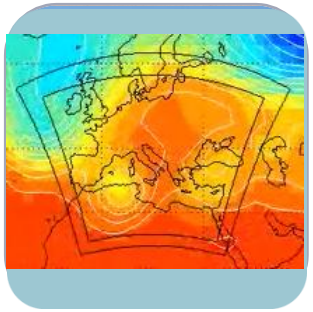
Hiver

ENSEMBLES RCMs 25Km ERA40 SPREAD DJF

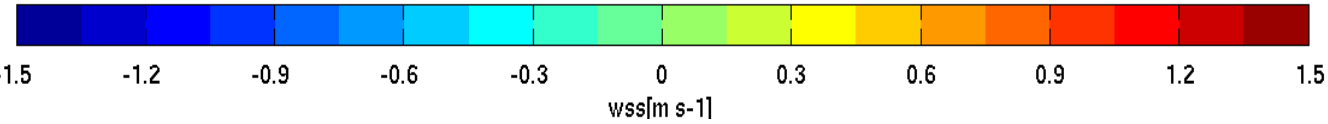


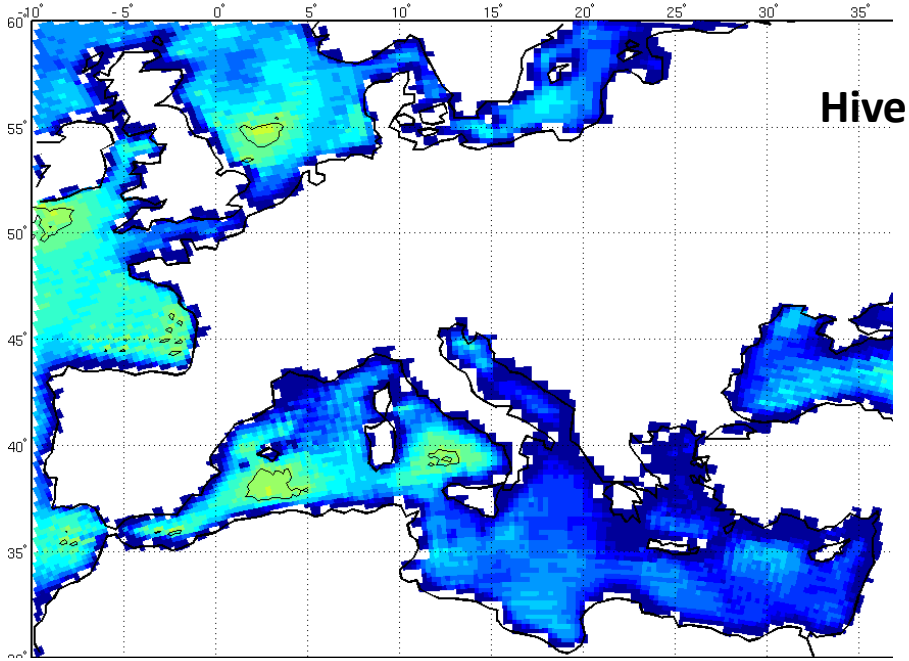


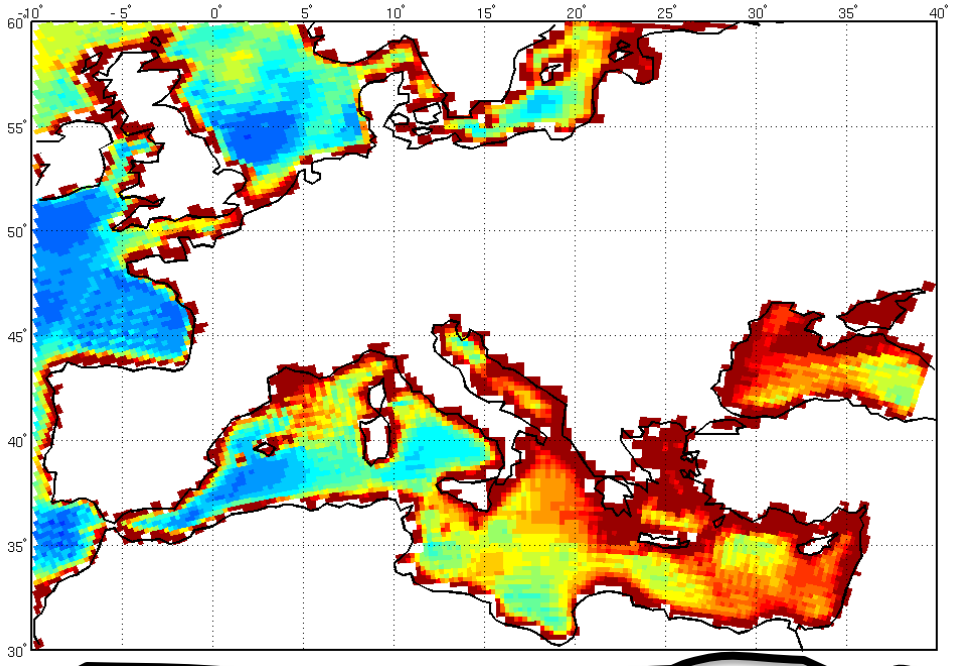


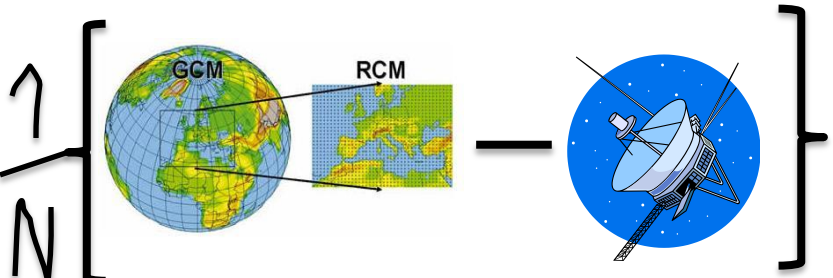


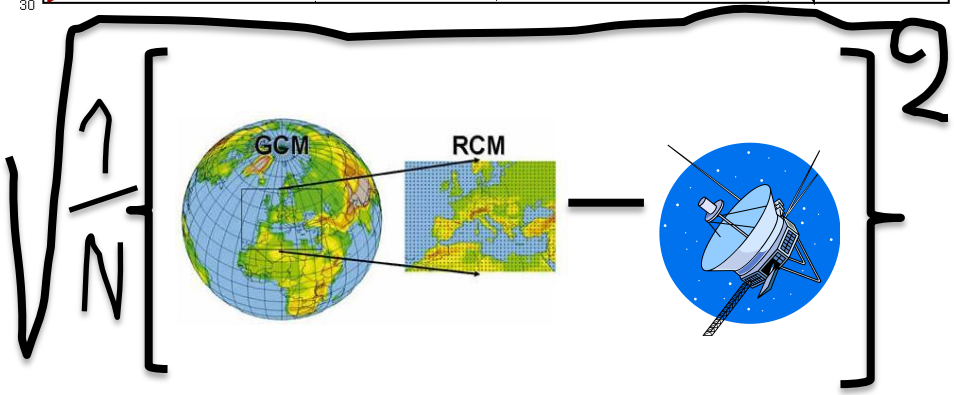
Comparaison avec données sat.

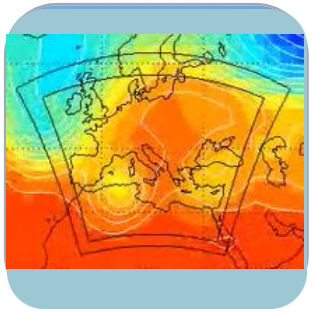




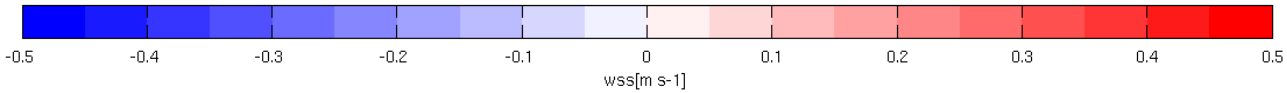


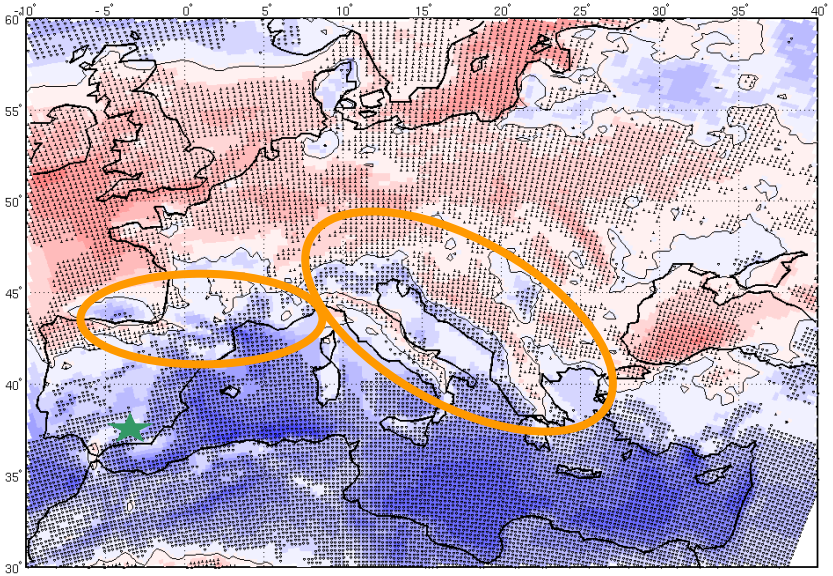




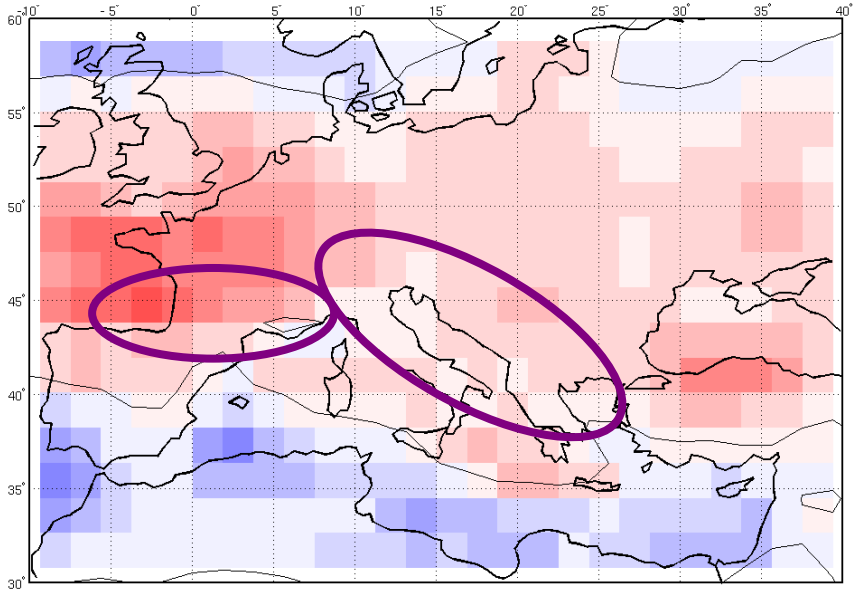


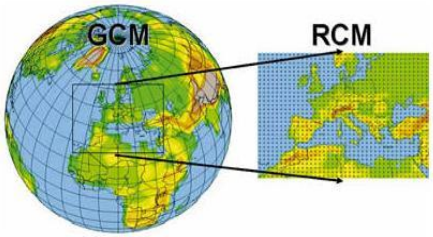
Changement climatique x éoliens





Hiver

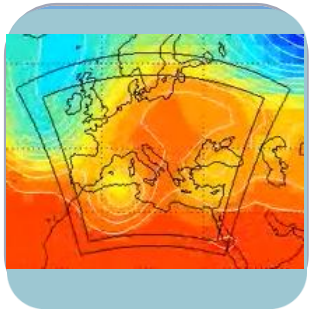




2021/2050 – 1961/1990

IMPACT2

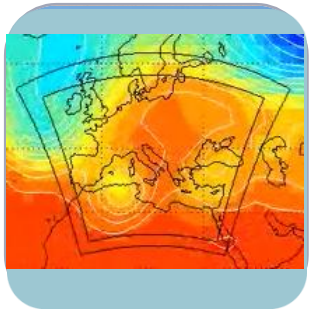
CLIM-RUN



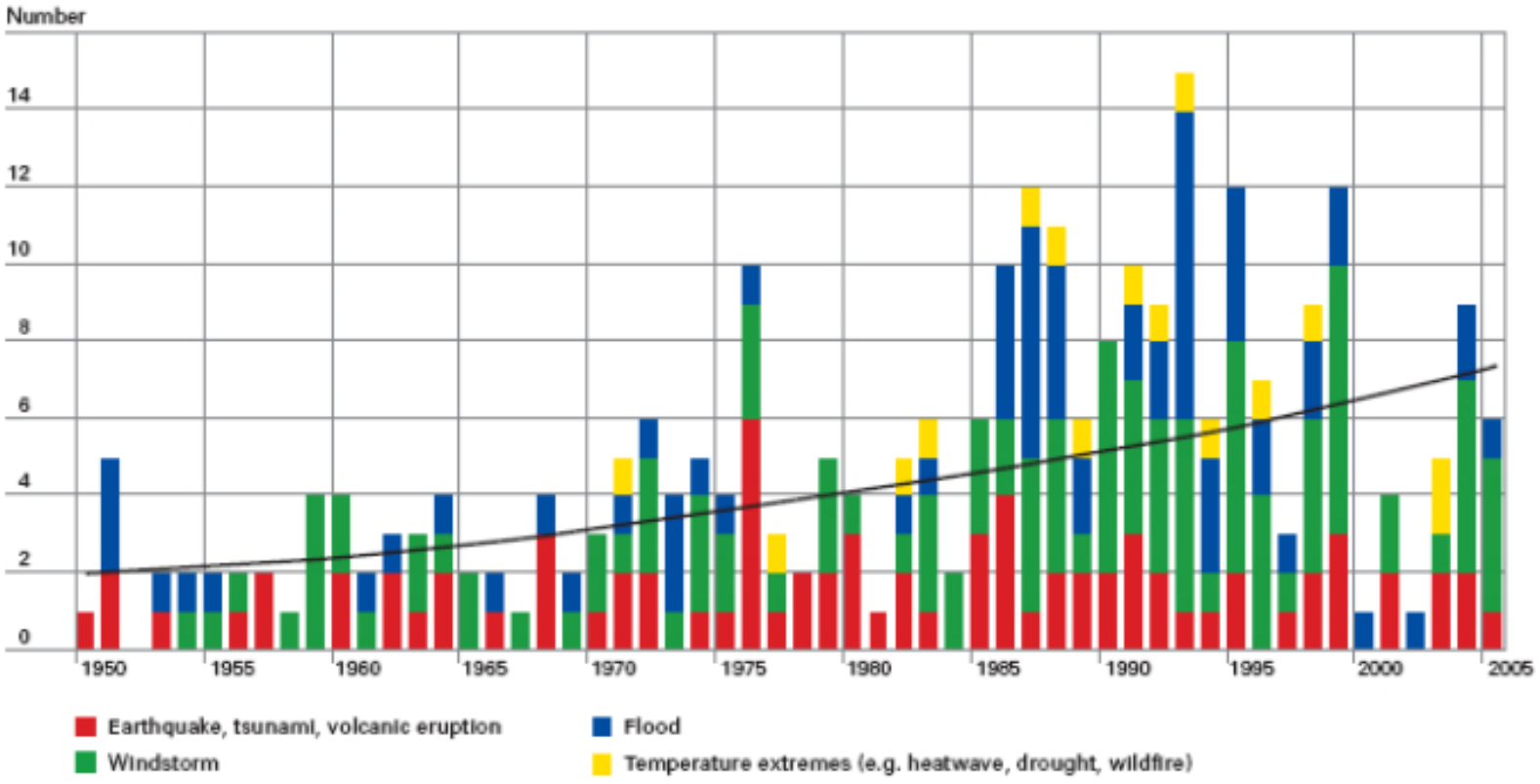
Evénements extrêmes

- Evénements extrêmes de pluie au niveau régional
- Vagues de chaleur et impacts

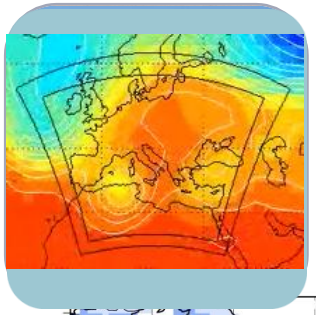
CLIM-RUN



Risques climatiques et naturels

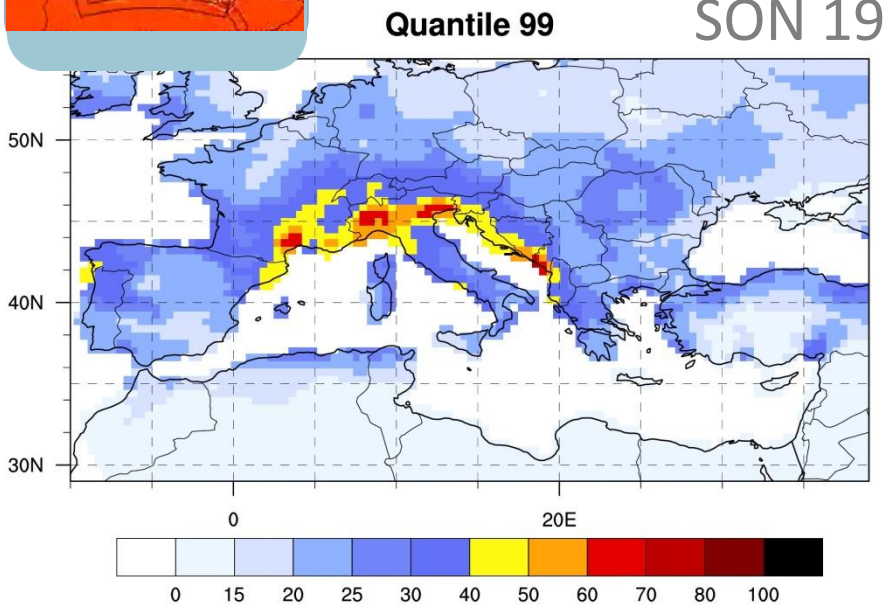


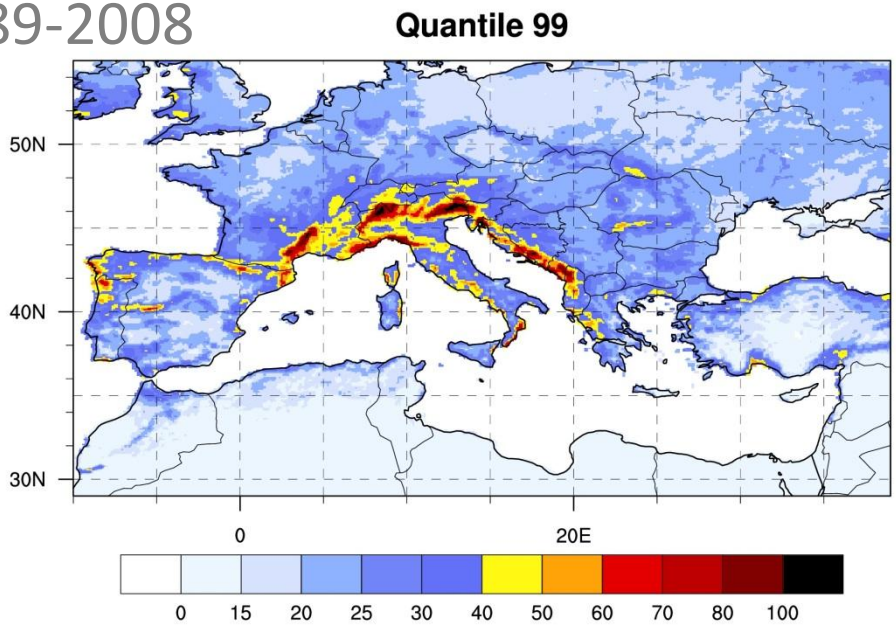
The number of great natural catastrophes by year & types of events, 1950-2005 (Munich Re, 2005)



Evénements extrêmes de pluie

SON 1989-2008

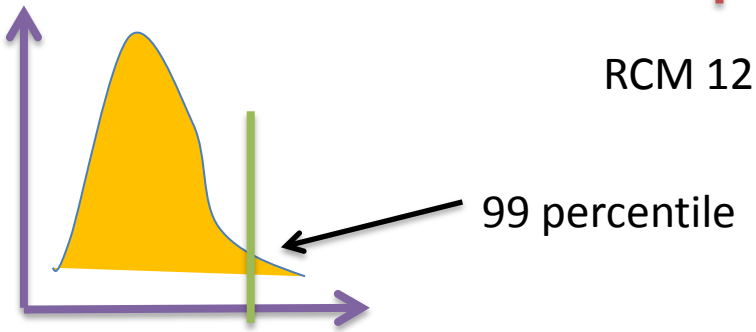


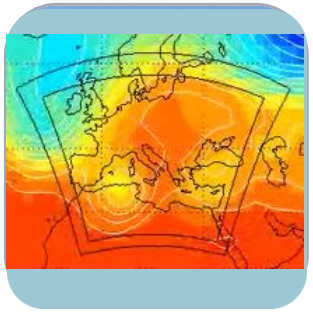


la résolution est-elle importante ?

RCM 50 km

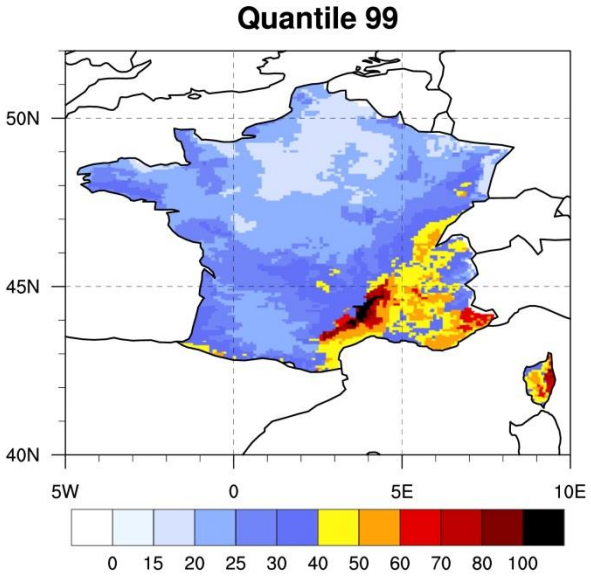
RCM 12 km

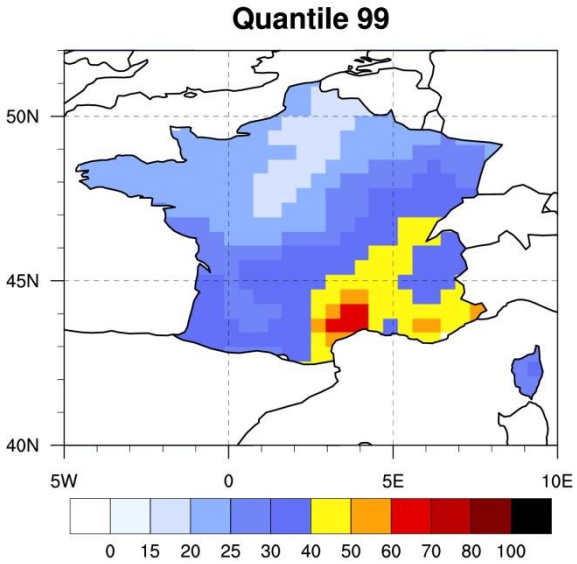


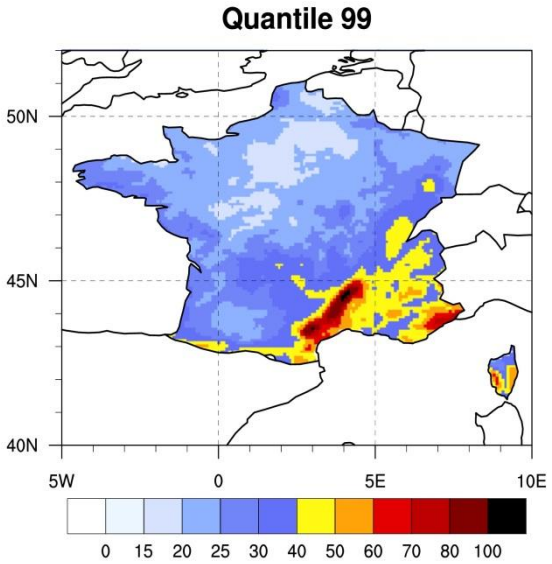


Evénements extrêmes de pluie

SON 1989-2008







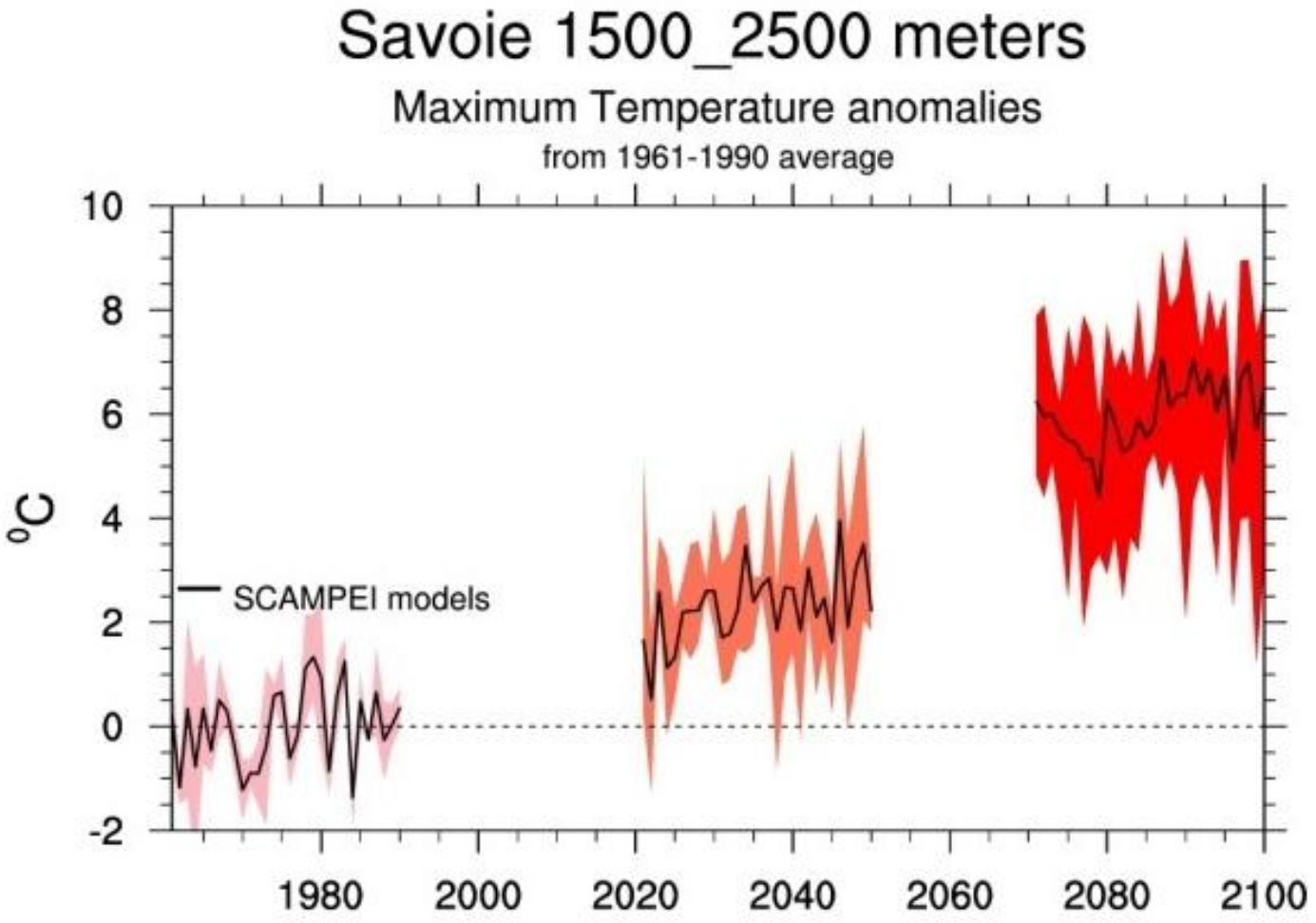
Obs Safran

RCM 50 km

RCM 12 km

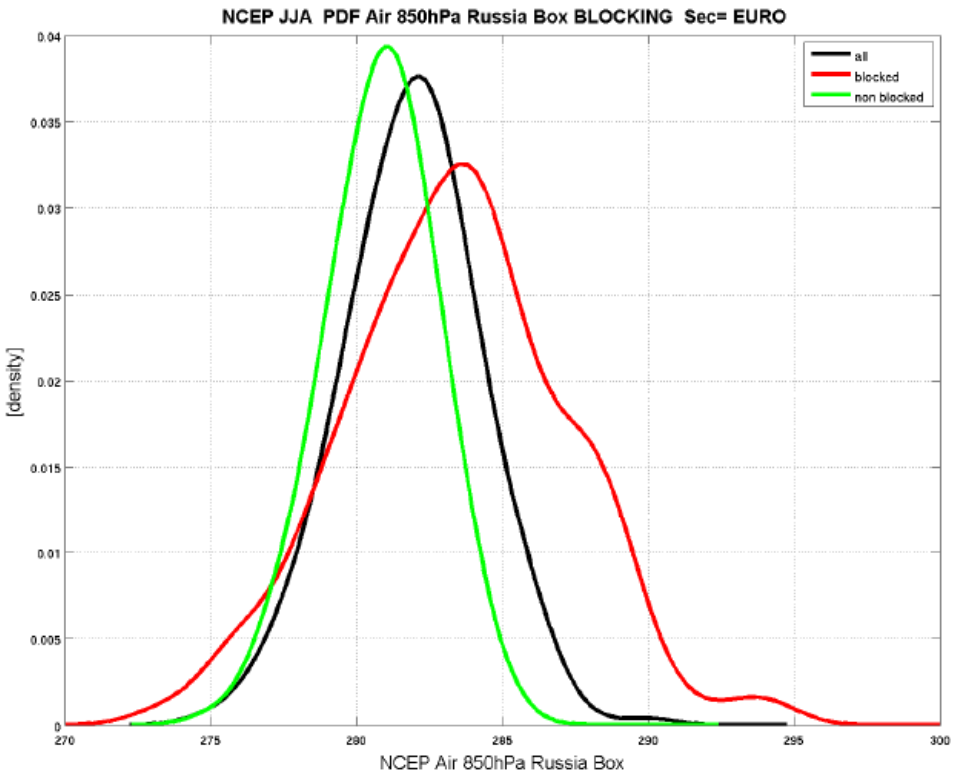
Sécheresses et vagues de chaleur: tourisme

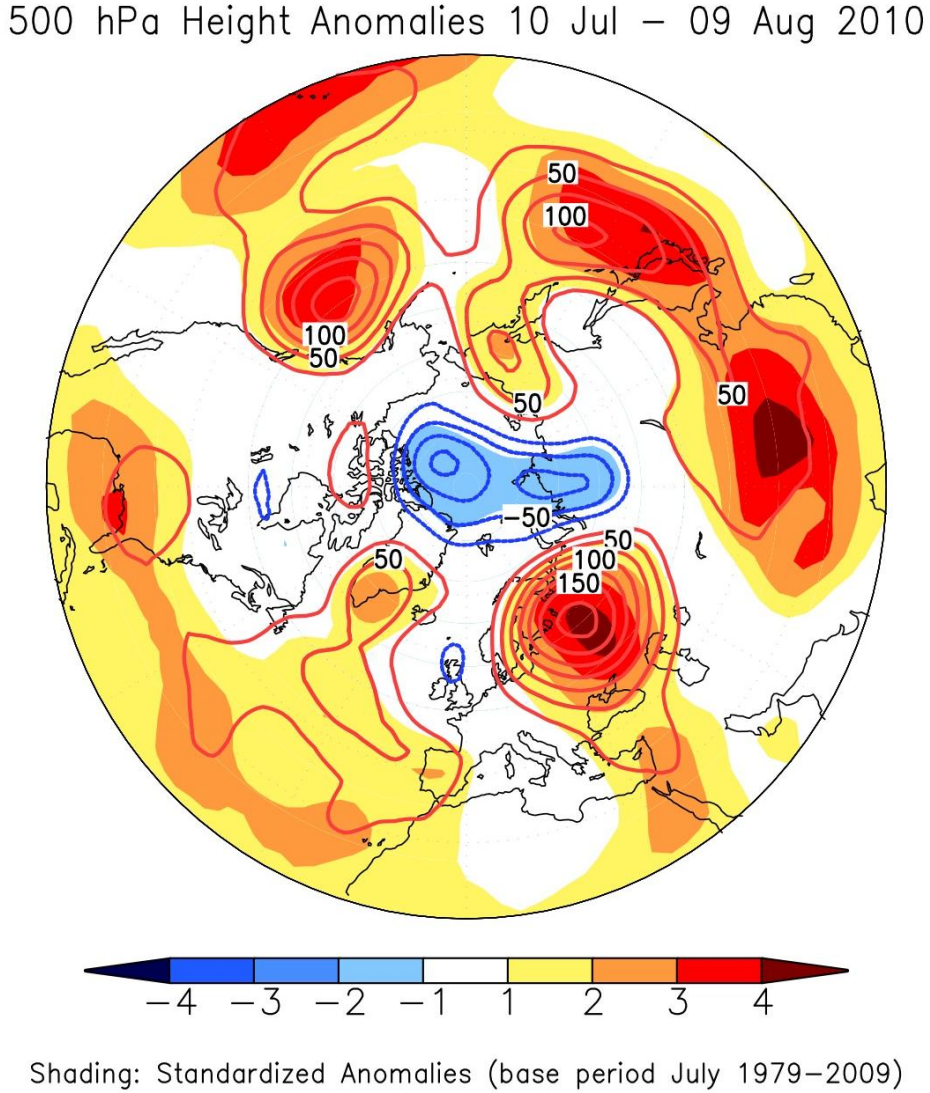
°C	T_{min}	T_{mean}	T_{max}
2021 -2050	1.1	2.3	3.7
2071 -2100	3.8	6.0	7.7

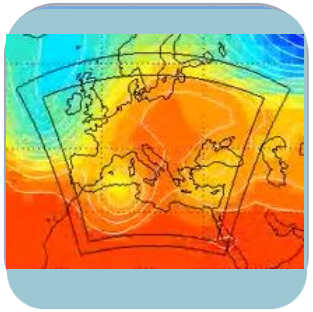


CLIM-RUN

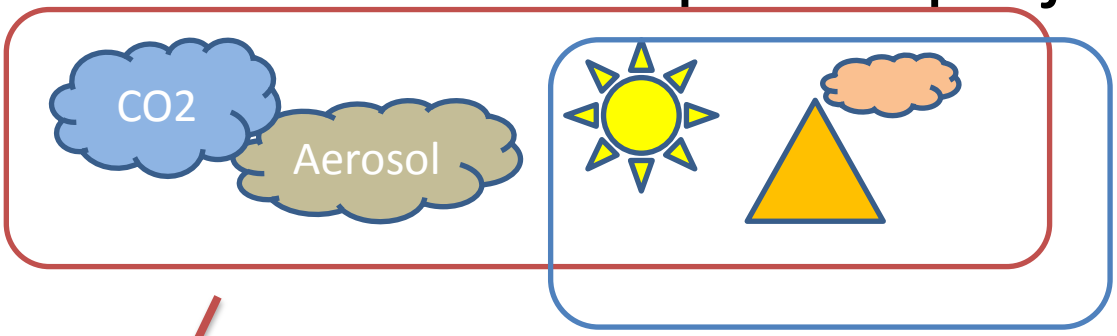
Sécheresses et vagues de chaleur: remonte d'échelle

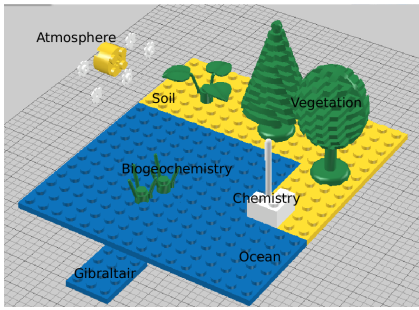


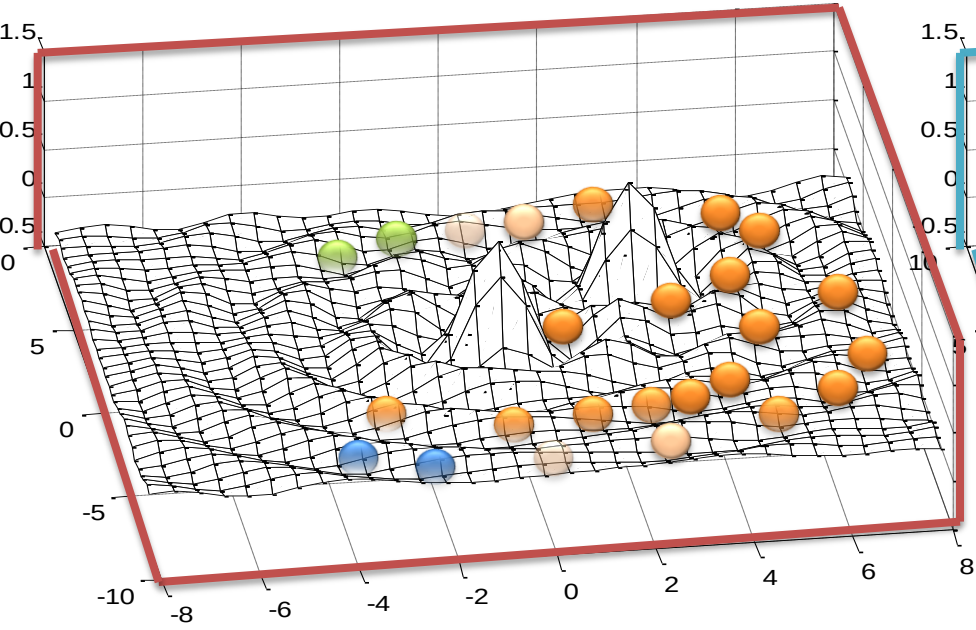


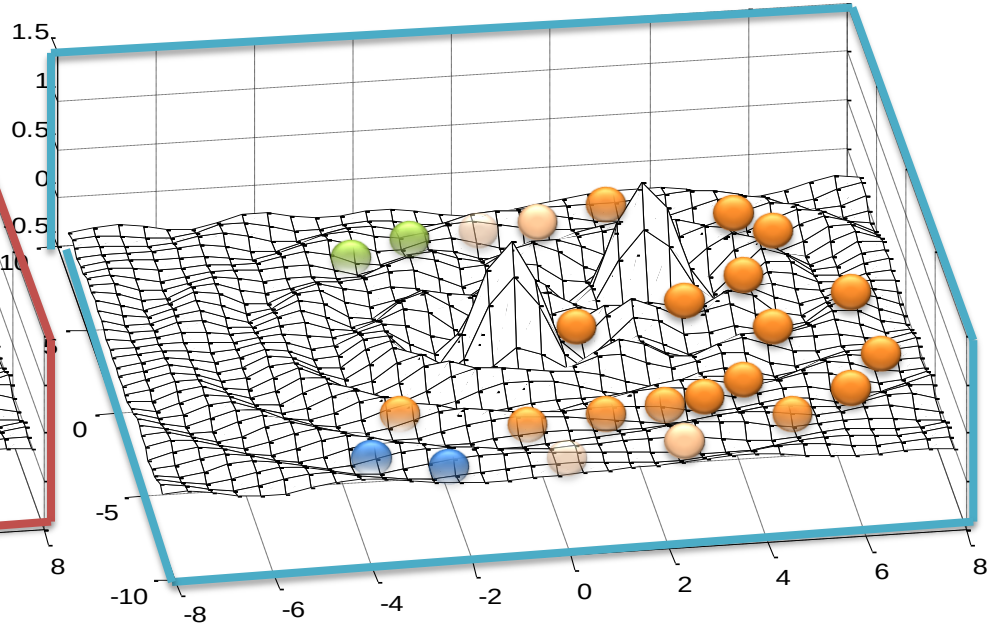


Simulations climatiques et projections

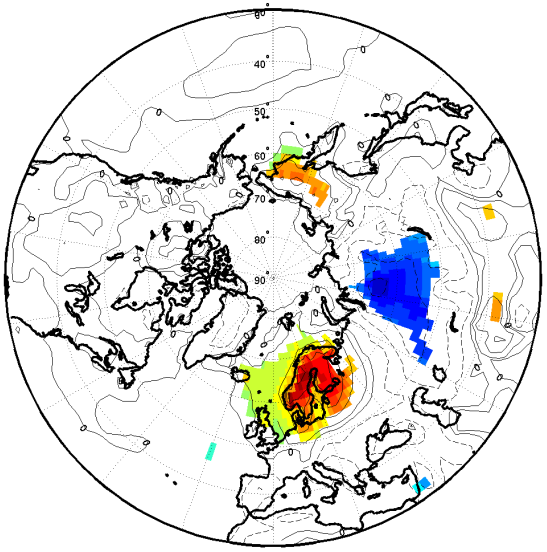




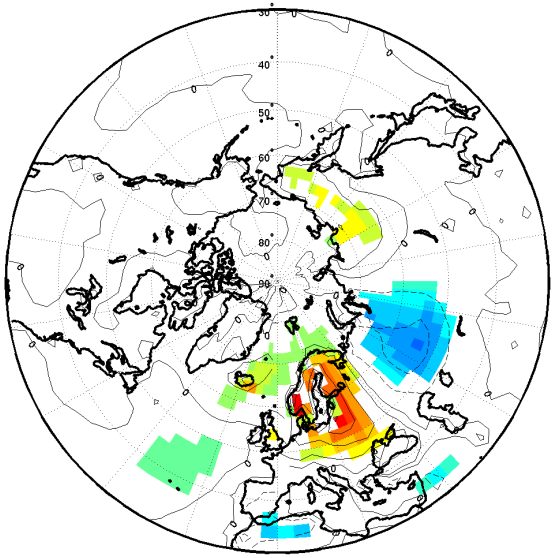




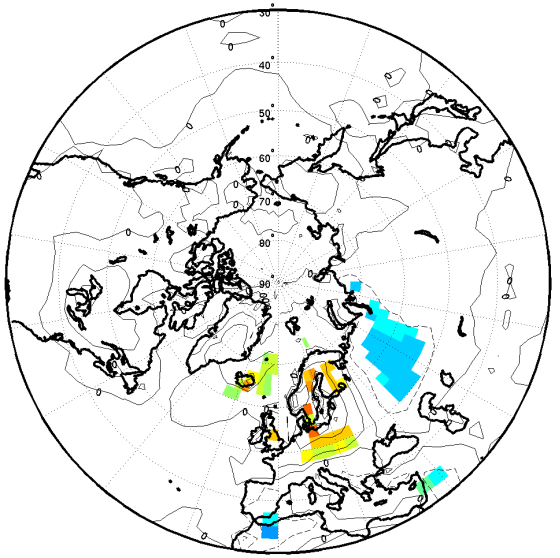
vagues de chaleur et écoulement atmosphérique grande échelle



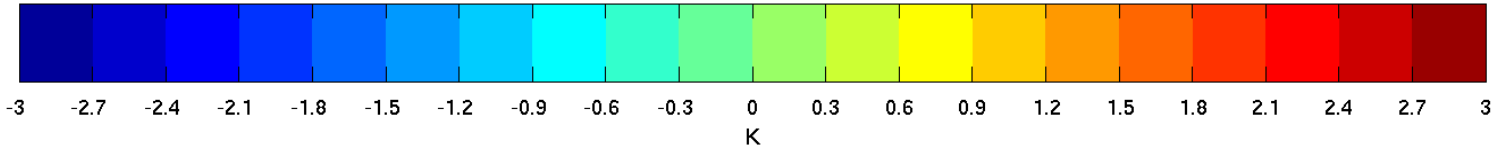
Climat actuel



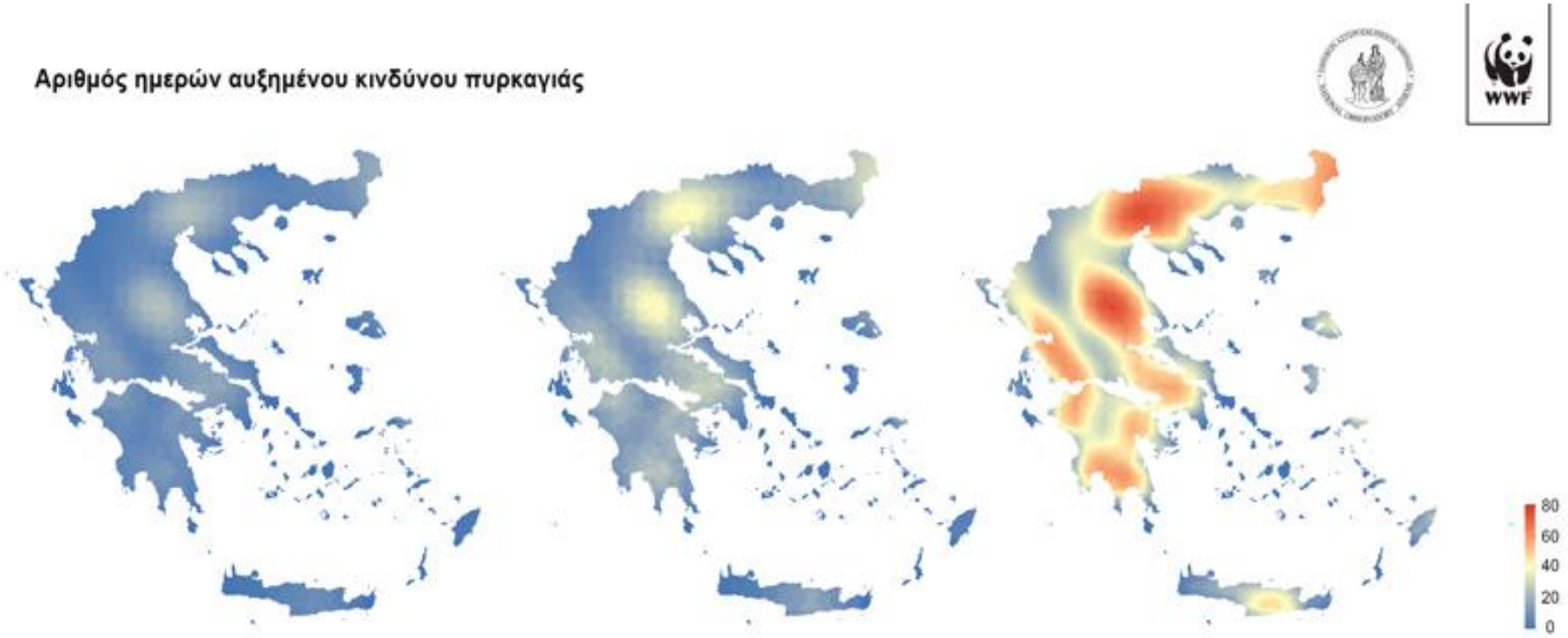
effet anthropogénique



partie naturelle



Impact – feu de forêt

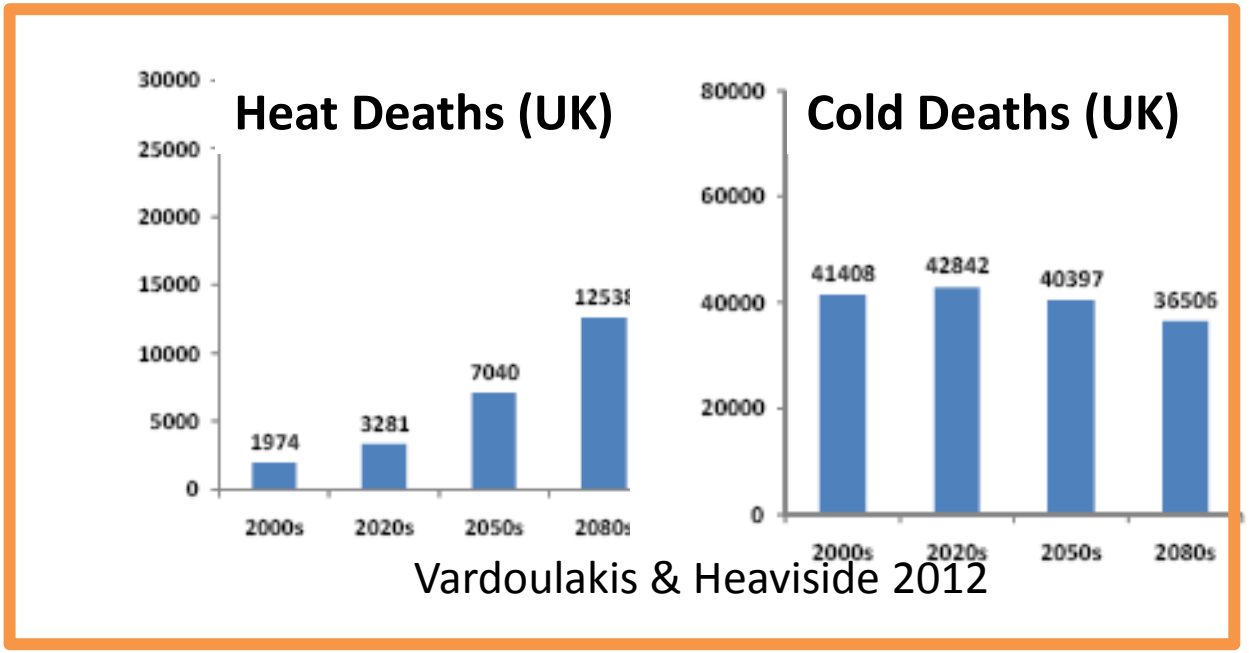


Impact dans le secteur de la santé

Users (public health) familiar with climate indicators

Needs

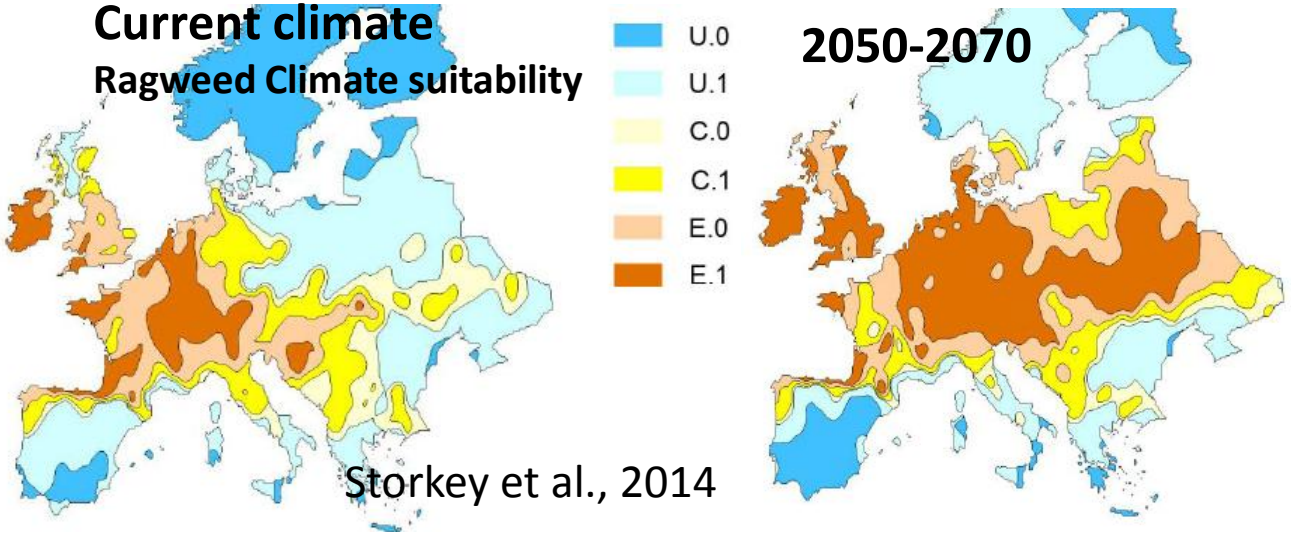
- Heat/cold effect indicators for mortality
- Air pollution
- Pollen-related risks
- Infectious disease
- Vector-borne disease
- Extreme events
- Animal health



Vardoulakis & Heaviside 2012

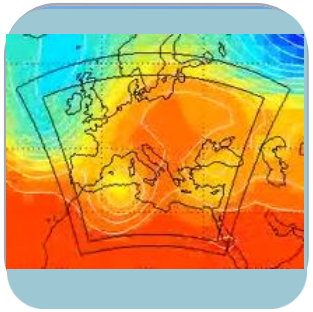
Current climate

Ragweed Climate suitability



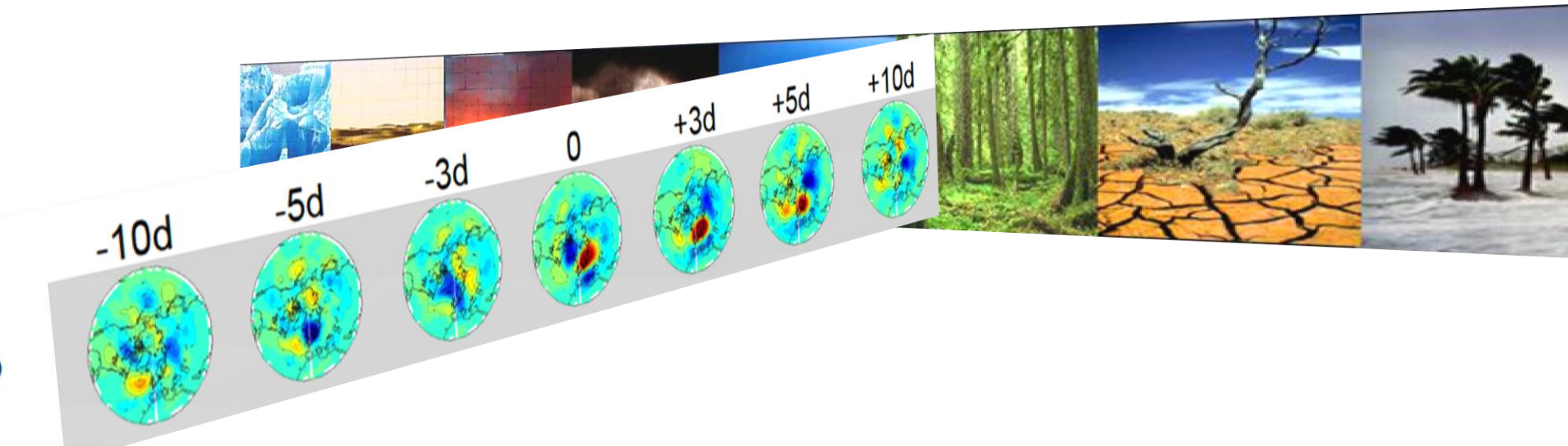
Storkey et al., 2014

ATOPICA
FP7



Services et Evénements extrêmes

- Le potentiel de la modélisation
- La meilleur compréhension de al dynamique des fluides
- Approche multi - disciplinaire



Les défis scientifiques des services climatiques

- Une petite histoire des services climatiques
- La recherche et les services climatiques
- Formation pour élèves et société

Formation pour les services climatiques

Les services climatiques -un thème d'enseignement reposant sur:

- des concepts fondamentaux de la mécanique fondamentale (météorologie, hydrologie, climat),
- des approches transverses de la mécanique sur des questions plus applicatives (sécurité des infrastructure, énergie),
- des actions multi-disciplinaires (couplées avec l'économie, la sociologie, la physique).

Nouveaux métiers …