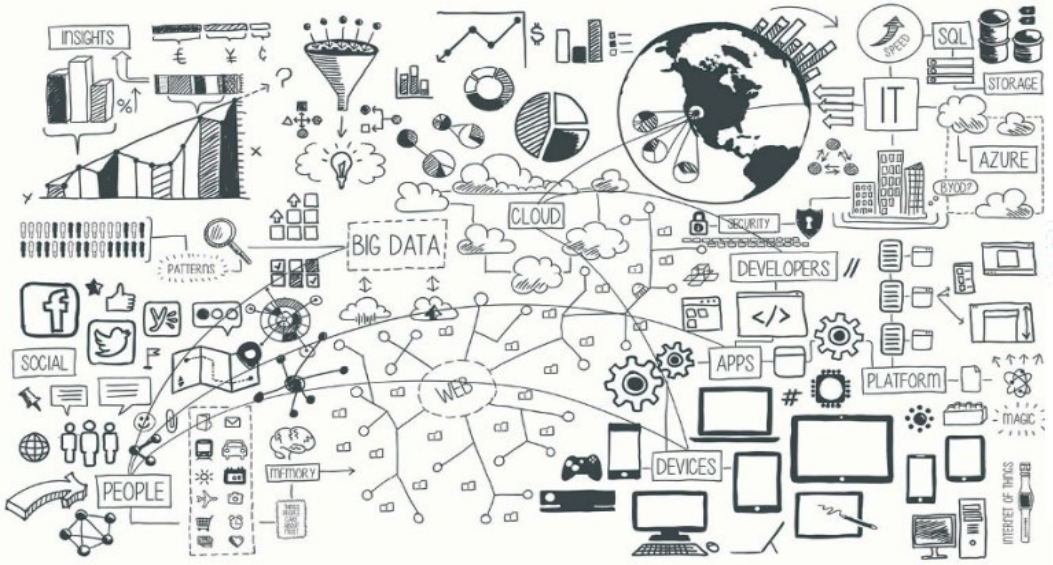
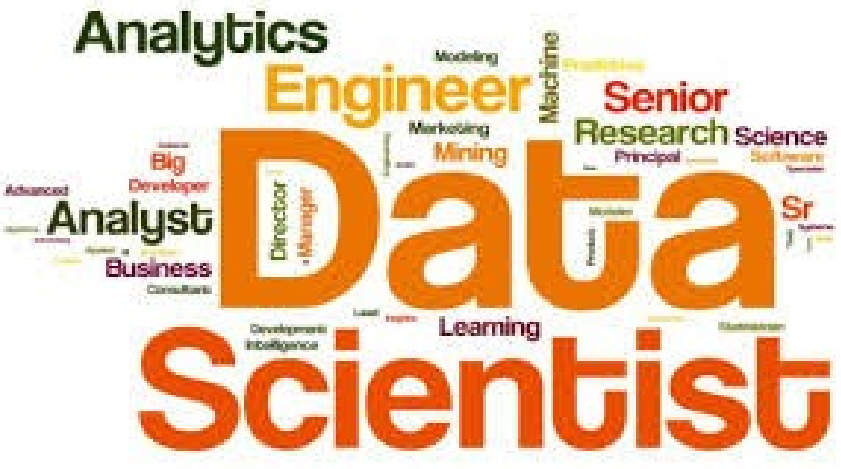
DataLab: Environment and Meteorology

Introduction





Sixto Herrera García

Grupo de Meteorología

Univ. de Cantabria – CSIC
MACC / IFCA

3.1 RESULTADOS DE APRENDIZAJE

--Conocer los portales, bases de datos, repositorios, y el software y herramientas más relevantes para abordar un caso de uso en un área de conocimiento.
-Saber modelar problemas en cada área de conocimiento a un marco abstracto de Data Science e identificar qué puntos críticos pueden impactar el lograr los objetivos.

4. OBJETIVOS

Los datalab propuestos en el Mástes de Data Science tienen como objetivo que el estudiante pueda conocer de la mano de expertos en las distintas áreas de conocimiento (física, medicina, genética, medioambiente, biodiversidad, economía, redes sociales, etc.) las técnicas y conjuntos de datos más relevantes en el entorno Open Science. En particular, el presente datalab se centrará en el problema de la regionalización estadística en predicción/proyección climática con técnicas de minería de datos.

3.1 RESULTADOS DE APRENDIZAJE

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-Saber modelar
críticos pueden i

4. OBJETIVOS

Los datalab propu
expertos en las di
sociales, etc.) las
datalab se centra
minería de datos.

5. MODALIDADES ORGANIZATIVAS Y MÉTODOS DOCENTES

ACTIVIDADES	HORAS DE LA ASIGNATURA
ACTIVIDADES PRESENCIALES	
HORAS DE CLASE (A)	
- Teoría (TE)	8
- Prácticas en Aula (PA)	15
- Prácticas de Laboratorio (PL)	
- Horas Clínicas (CL)	
Subtotal horas de clase	23
ACTIVIDADES DE SEGUIMIENTO (B)	
- Tutorías (TU)	7,5
- Evaluación (EV)	2
Subtotal actividades de seguimiento	9,5
Total actividades presenciales (A+B)	32,5
ACTIVIDADES NO PRESENCIALES	
Trabajo en grupo (TG)	7,5
Trabajo autónomo (TA)	35
Tutorías No Presenciales (TU-NP)	
Evaluación No Presencial (EV-NP)	
Total actividades no presenciales	42,5
HORAS TOTALES	75

3.1 RESULTADOS DE APRENDIZAJE

--Conocer los porta
uso en un área c
-Saber modelar
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4. OBJETIVOS

Los datalab propu
expertos en las di
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datalab se centra
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7. MÉTODOS DE LA EVALUACIÓN

Descripción	Tipología	Eval. Final	Recuper.	%
Valoración de informes y trabajos escritos	Actividad de evaluación con soporte virtual	Sí	Sí	60,00

Calif. mínima	3,00
Duración	
Fecha realización	Según el calendario
Condiciones recuperación	
Observaciones	Evaluación de los trabajos de grupo e individuales entregados por el alumno.

Valoración de exposiciones orales	Trabajo	Sí	Sí	40,00

Calif. mínima	0,00
Duración	
Fecha realización	Durante el periodo de impartición de la asignatura.
Condiciones recuperación	
Observaciones	

Realización de prácticas	Evaluación en laboratorio	No	No	0,00

Calif. mínima	0,00
Duración	
Fecha realización	en las sesiones prácticas
Condiciones recuperación	
Observaciones	

TOTAL	100,00

Observaciones

Si la nota final del alumno fuese menor que 5 sobre 10, entonces la recuperación consistirá en la realización de cada una de las tareas en las que hubiera obtenido una calificación menor que 5 sobre 10. El procedimiento de evaluación de una actividad recuperable será equivalente al de la actividad original.

Observaciones para alumnos a tiempo parcial

Será necesaria la asistencia, por lo que se aplicará la misma evaluación que a los estudiantes a tiempo completo, teniendo en cuenta su disponibilidad de tiempo en cuanto a los plazos de entrega de los trabajos.

M1980 – Data Laboratory: Environment & Meteorology (18:00-20:00)				
04/01	**L**	**Introduction: Clime and Models**	**T**	**SH**
04/02	M	Data Repositories: ESGF & MARS	TL	SH
04/03	X	Data Repositories: ESGF & MARS	TL	SH
04/04	J	Lab: Climate4R – Example 1	L	JB
04/05	V	Lab: Climate4R – Example 2	L	JB
04/08	L	Downscaling: Data Mining in Clime	T	SH
04/09	M	Lab: downscaleR	L	JB
04/10	X	Evaluation and Validation	T	SH
04/11	J	Lab: Evaluation and Validation	L	JB
04/15	L	Impacts	L	JB & SH
04/16	M	Impacts	L	JB & SH
04/17	X	Impacts	L	JB & SH

SH - Sixto Herrera | **JB** – Joaquín Bedia

http://www.meteo.unican.es

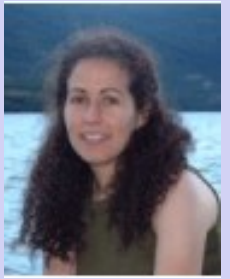
A joint group of Univ. of Cantabria (**UC**) and Spanish National Resarch Council (**CSIC**) formed by 17 (6 staff) researchers based on Santander (Spain).

Spin-Off

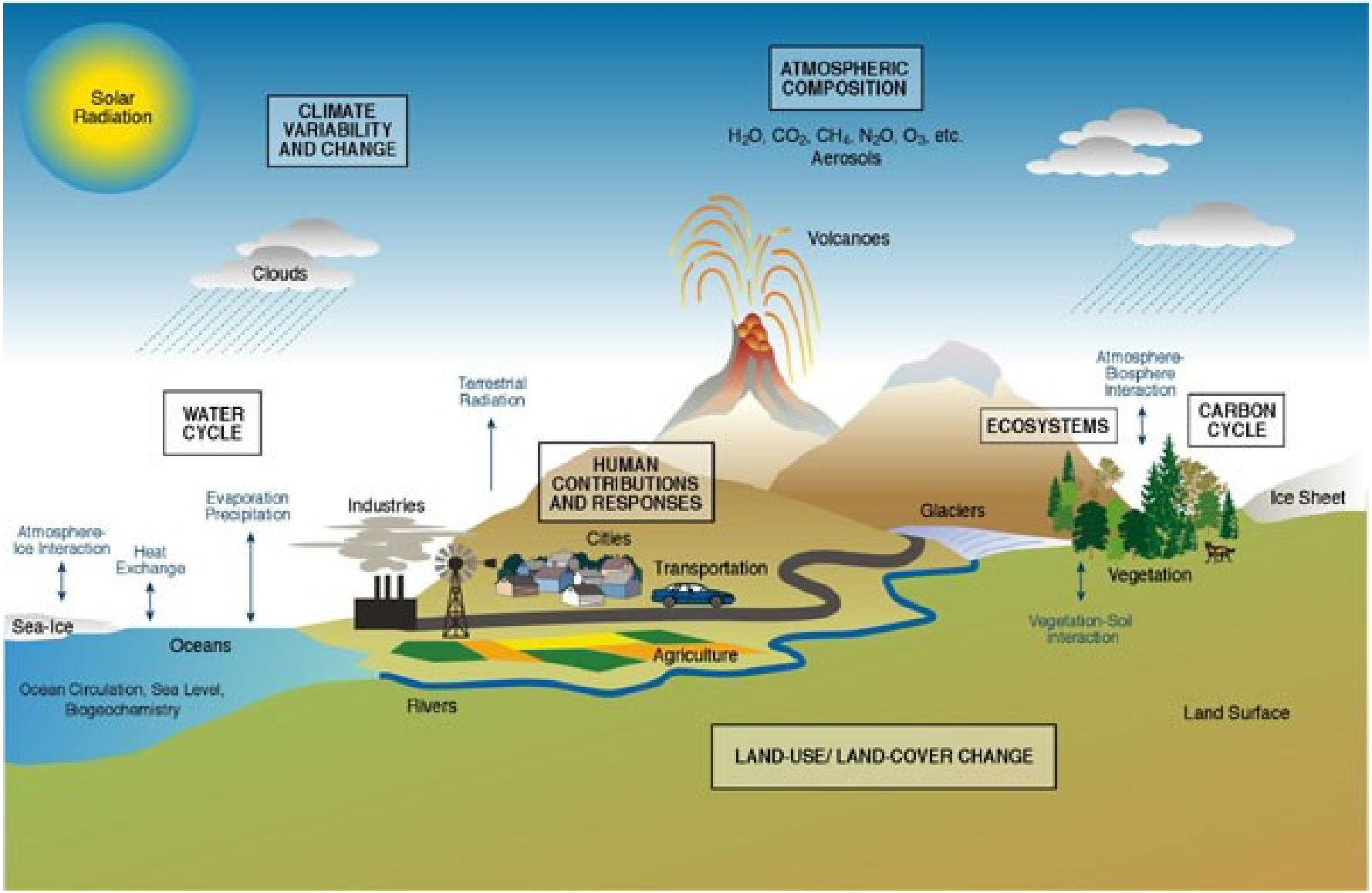
predictia
INTELLIGENT DATA SOLUTIONS

Daniel San-Martín

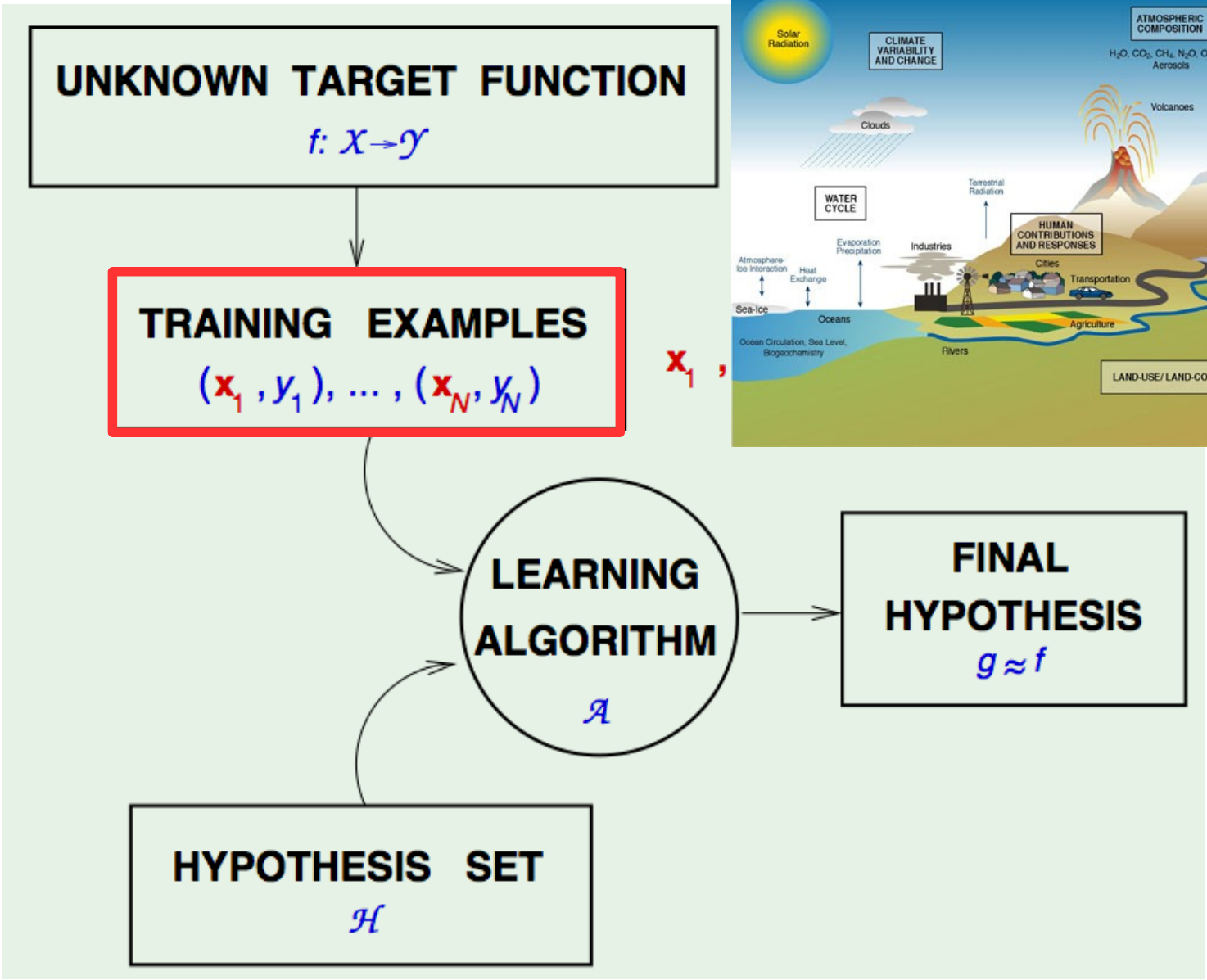
Our main research activities are:

José M. Gutiérrez	**Miguel A. Rodríguez**	**Antonio Cofiño**	**Jesús Fernández**	**Sixto Herrera**	**M. Dolores Frías**
Statistical downscaling	Nonlinear physics	Computing data management	Numerical modeling	Data Mining	Climate Services
					
Head	**Staff – Key Persons**				

Atmosphere + Hydrosphere + Cryosphere + Lithosphere + Biosphere



Atmosphere + Hydrosphere + Cryosphere + Lithosphere + Biosphere



Atmosphere + Hydrosphere + Cryosphere + Lithosphere + Biosphere

What should be observed? → Essential Climate Variables (ECVs)

Atmosphere

Surface

- Precipitation
- Pressure
- Radiation budget
- Temperature
- Water vapour
- Wind speed and direction

Upper-air

- Earth radiation budget
- Lightning
- Temperature
- Water vapor
- Wind speed and direction

Atmospheric Composition

- Aerosol and ozone precursors
- Aerosols properties
- Carbon dioxide, methane and other greenhouse gases
- Cloud properties
- Ozone

Land

Hydrosphere

- Groundwater
- Lakes
- River discharge

Cryosphere

- Glaciers
- Ice sheets and ice shelves
- Permafrost
- Snow

Biosphere

- Above-ground biomass
- Albedo
- Evaporation from land
- Fire
- Fraction of absorbed photosynthetically active radiation (FAPAR)
- Land cover
- Land surface temperature
- Leaf area index
- Soil carbon
- Soil moisture

Anthroposphere

- Anthropogenic Greenhouse gas fluxes
- Anthropogenic water use

Ocean

Physical

- Ocean surface heat flux
- Sea ice
- Sea level
- Sea state
- Sea surface currents
- Sea surface salinity
- Sea surface stress
- Sea surface temperature
- Subsurface currents
- Subsurface salinity
- Subsurface temperature

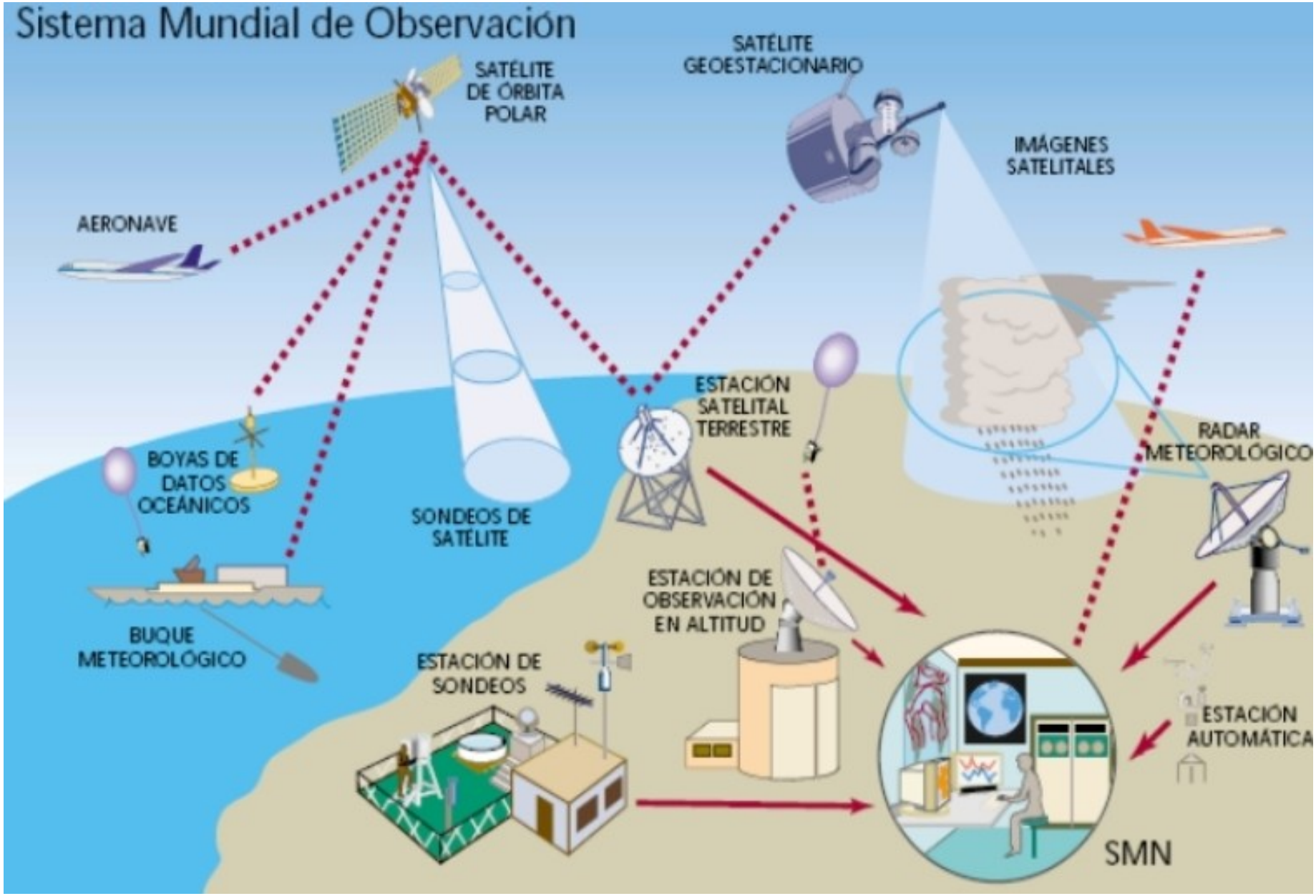
Biogeochemical

- Inorganic carbon
- Nitrous oxide
- Nutrients
- Ocean colour
- Oxygen
- Transient tracers

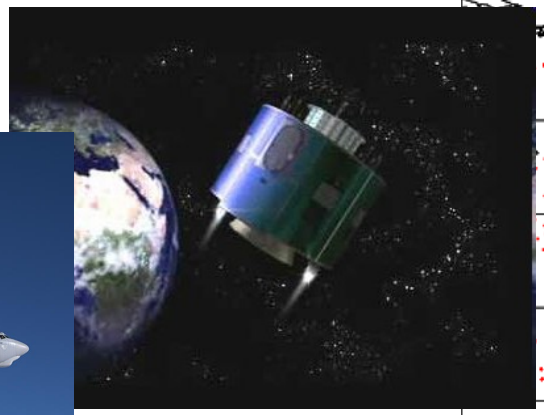
Biological/ecosystems

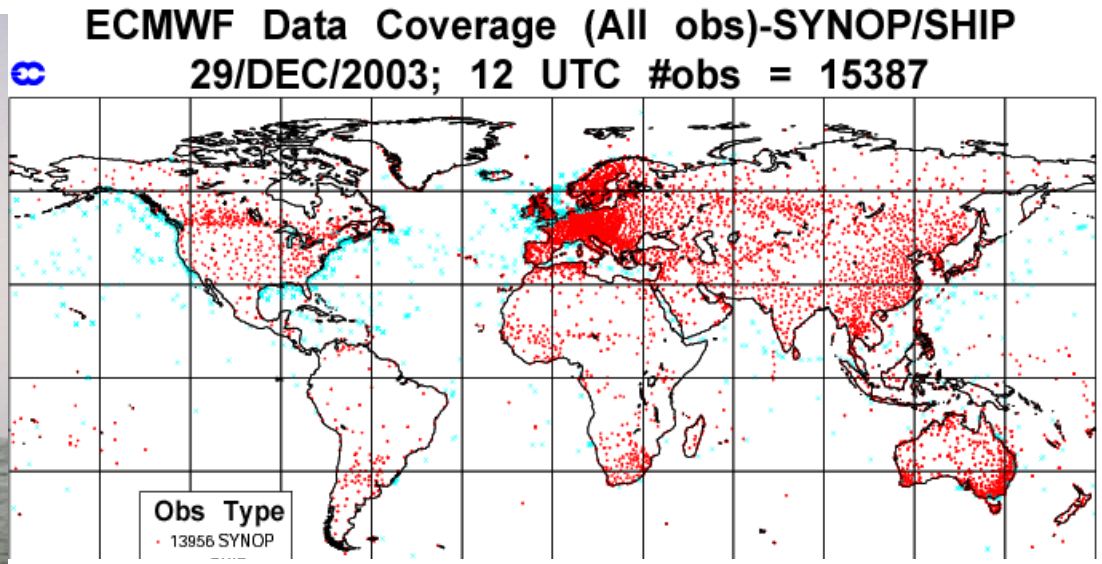
- Marine habitat properties
- Plankton

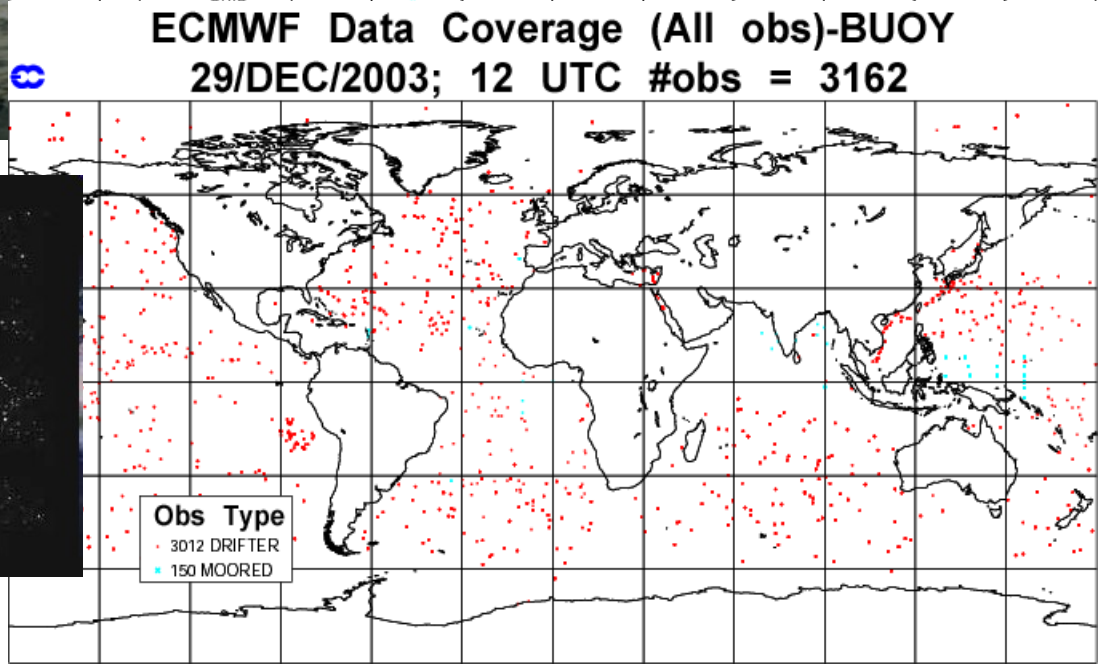
Atmosphere + Hydrosphere + Cryosphere + Lithosphere + Biosphere



Atmosphere + Hydrosphere + Cryosphere + Lithosphere + Biosphere







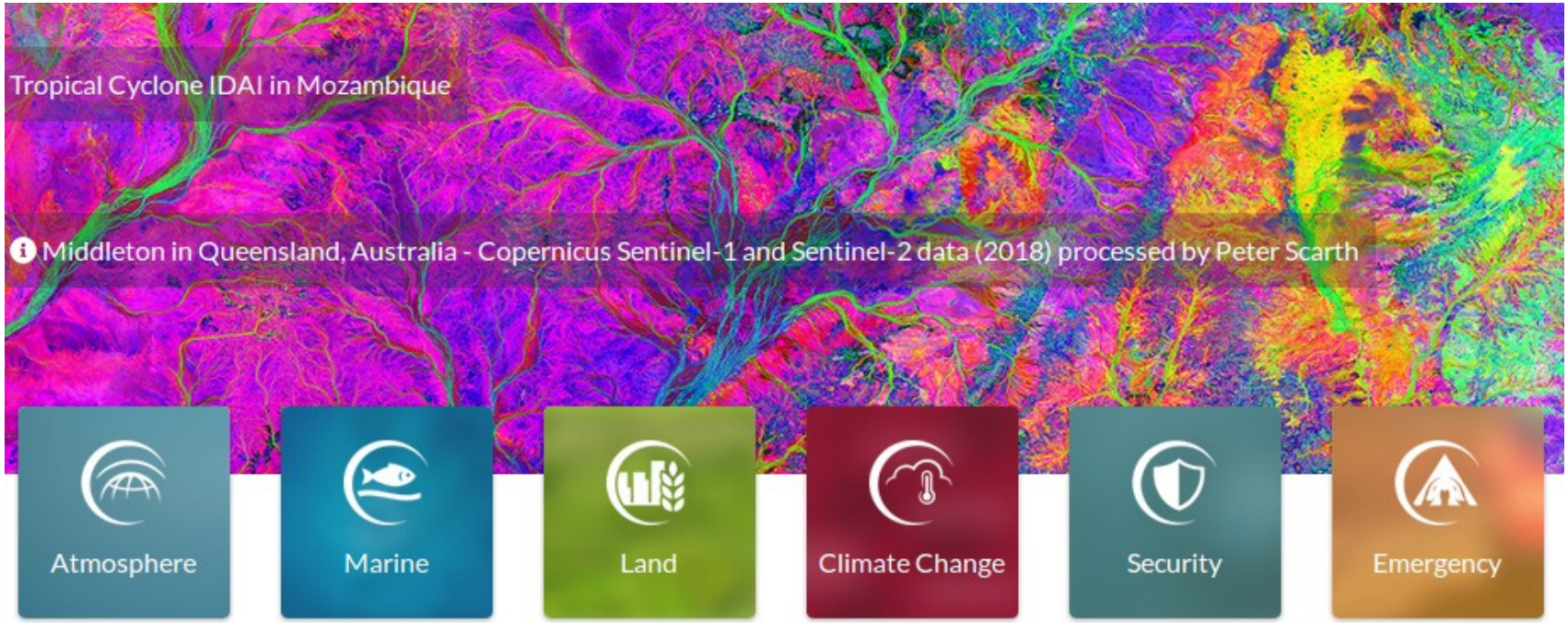
Atmosphere + Hydrosphere + Cryosphere + Lithosphere + Biosphere

Satellite: ~12 Sentinels in the following 10 years (**ESA**, **EUMETSAT 6**)

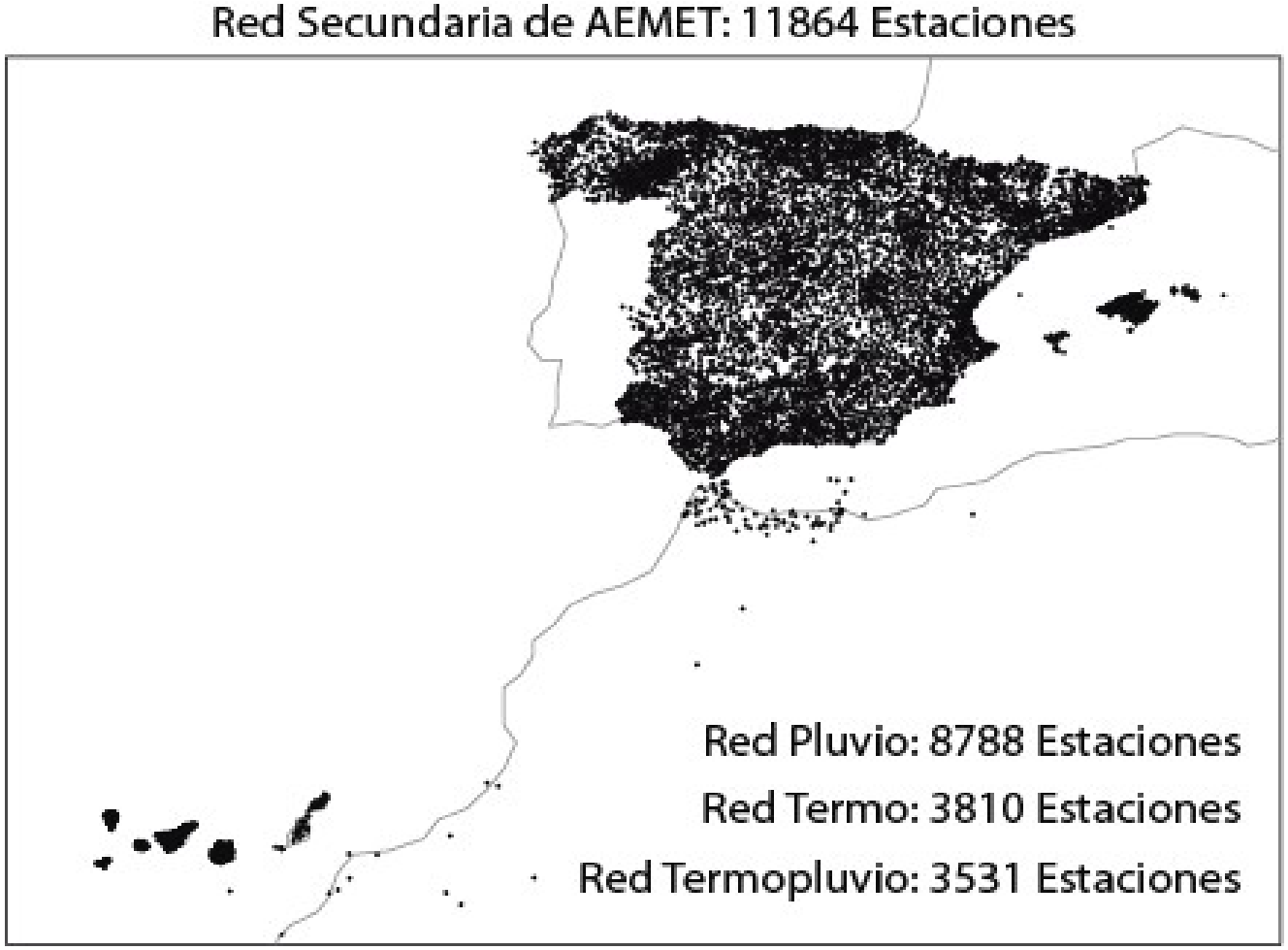
Local observations (In situ):

- Sensors in the shore of the rivers
- Ocean buoys
- Meteorological globes
- Non-static radars (ships, airplane, etc.)
- ….

Local observations are needed to calibrate the data provided by the satellite.



https://www.copernicus.eu/en



Daily data (1950-2019):

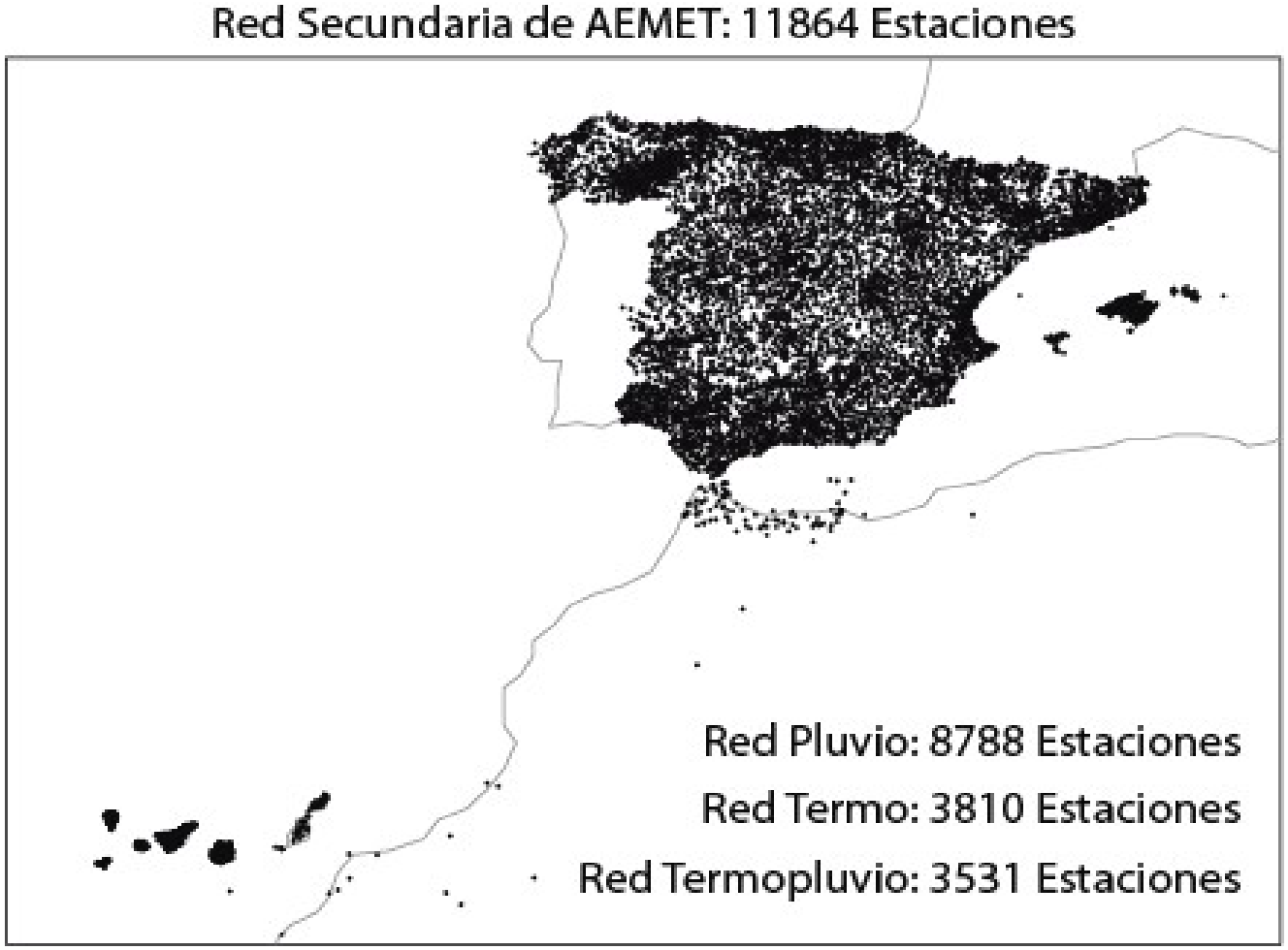
- ~25000 values

Variables:

- Precipitation
- Temperatures
- Snow
- Wind
- ….

~25000 values
x ~3000 stations
x ~10 variables

~750000000 values



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~25000 values
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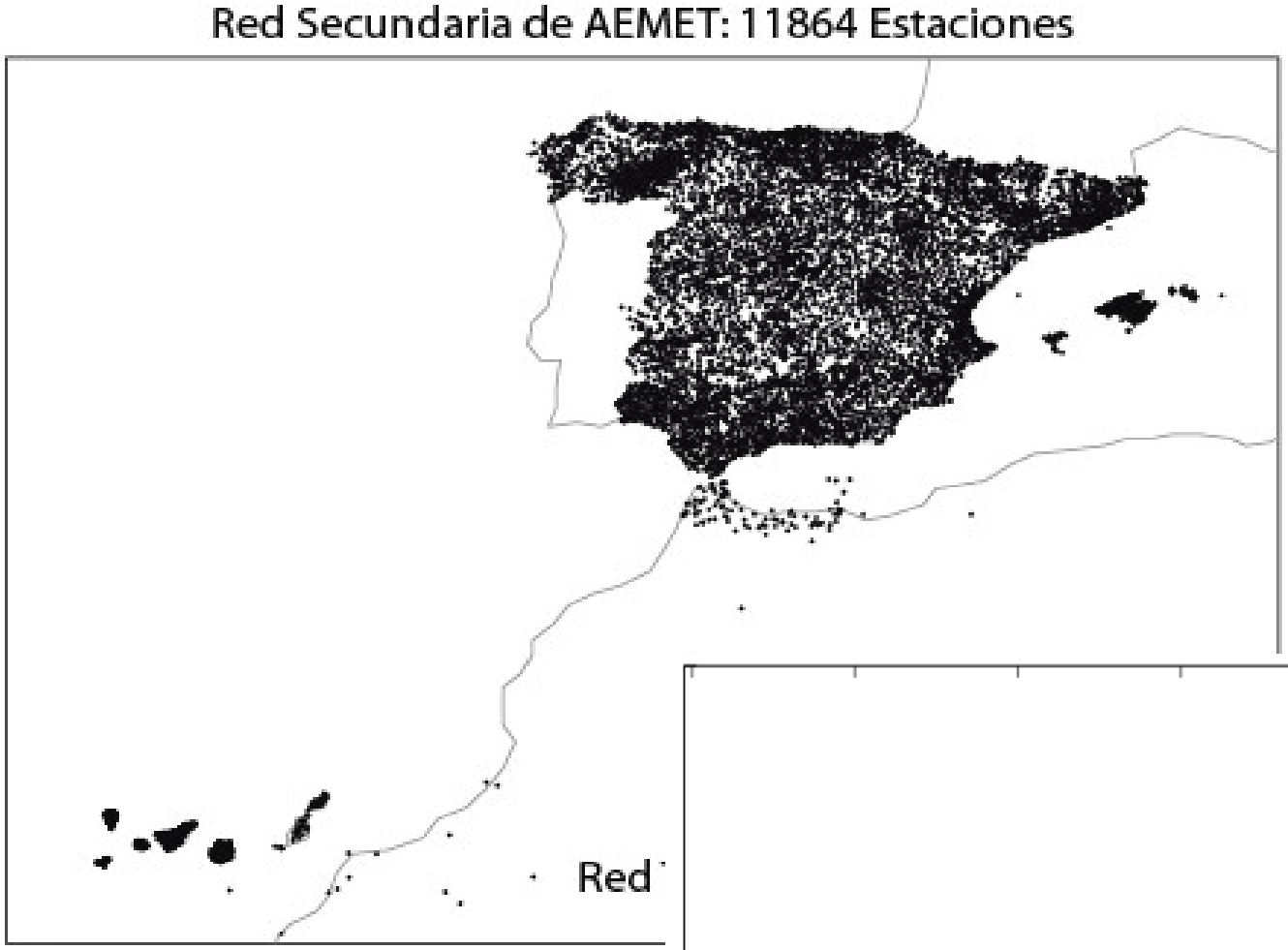
~750000000 values

We need efficient techniques to deal with this information → **Data Mining/Big Data**



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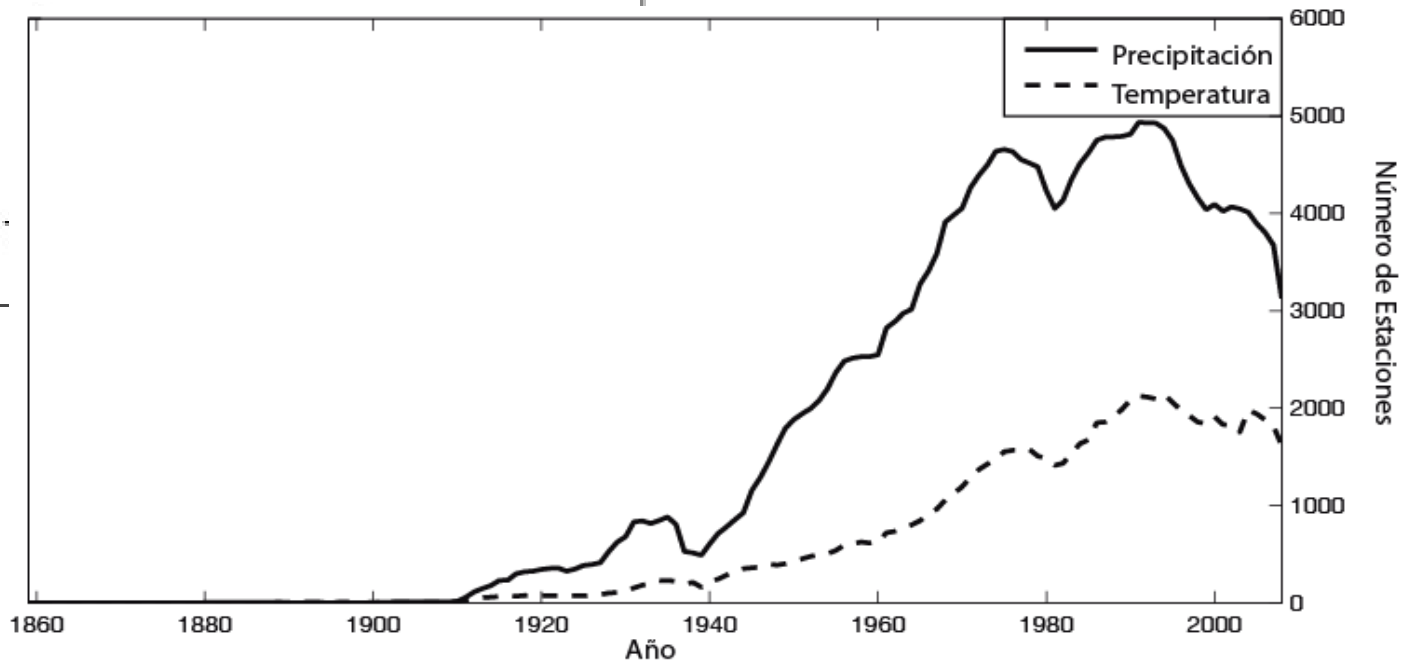

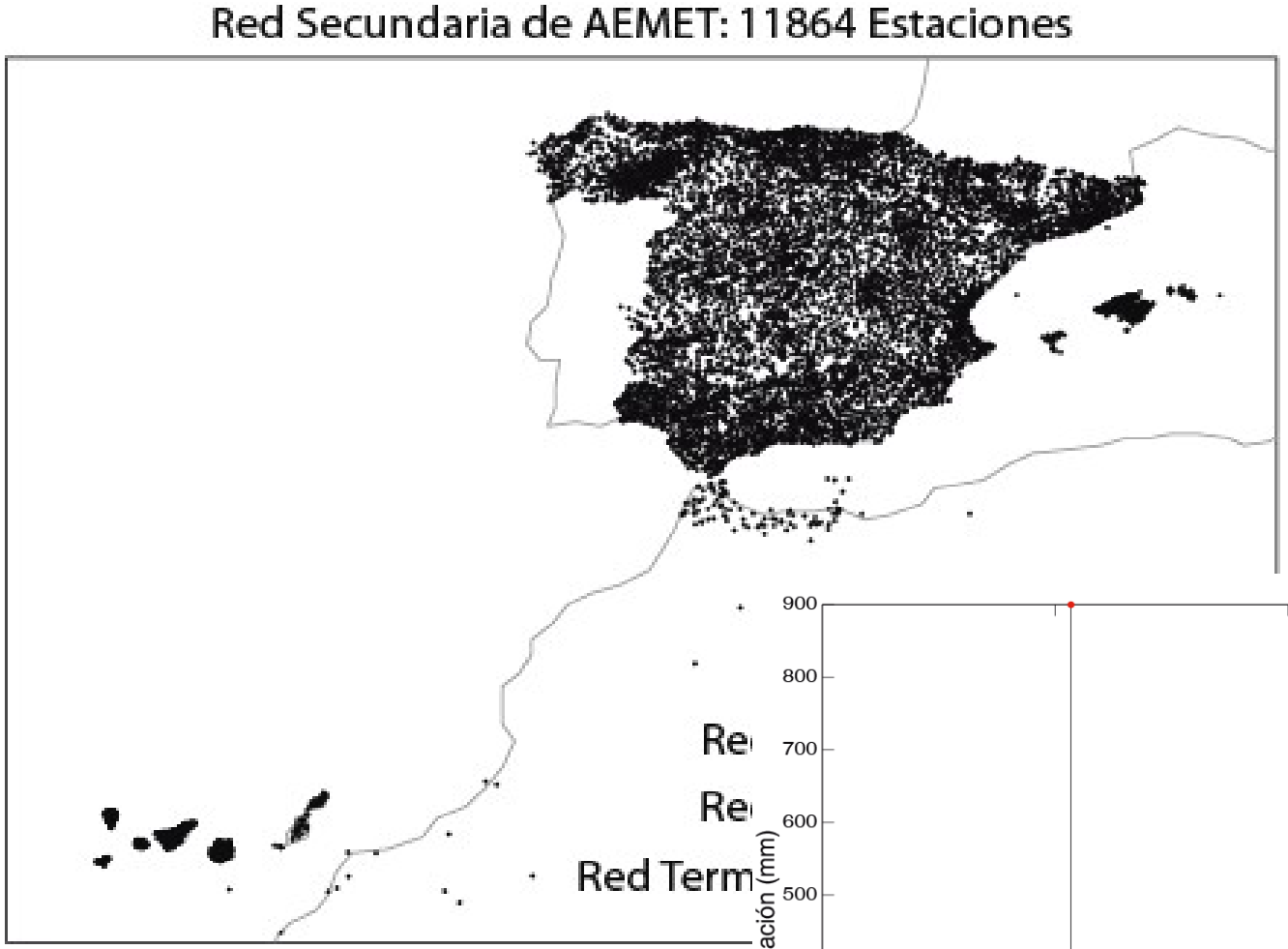

Daily data (1950-2019):

- Outliers
- Missing Data

Variables:

- Precipitation
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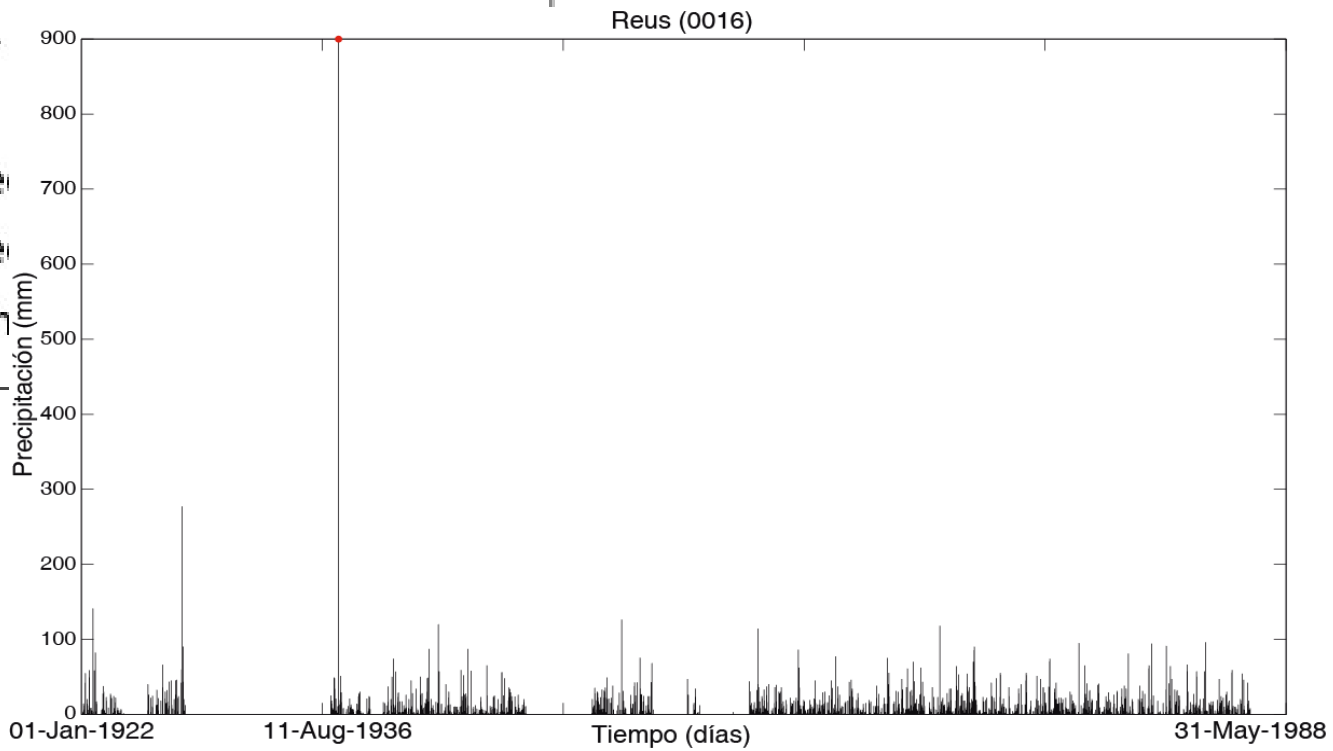
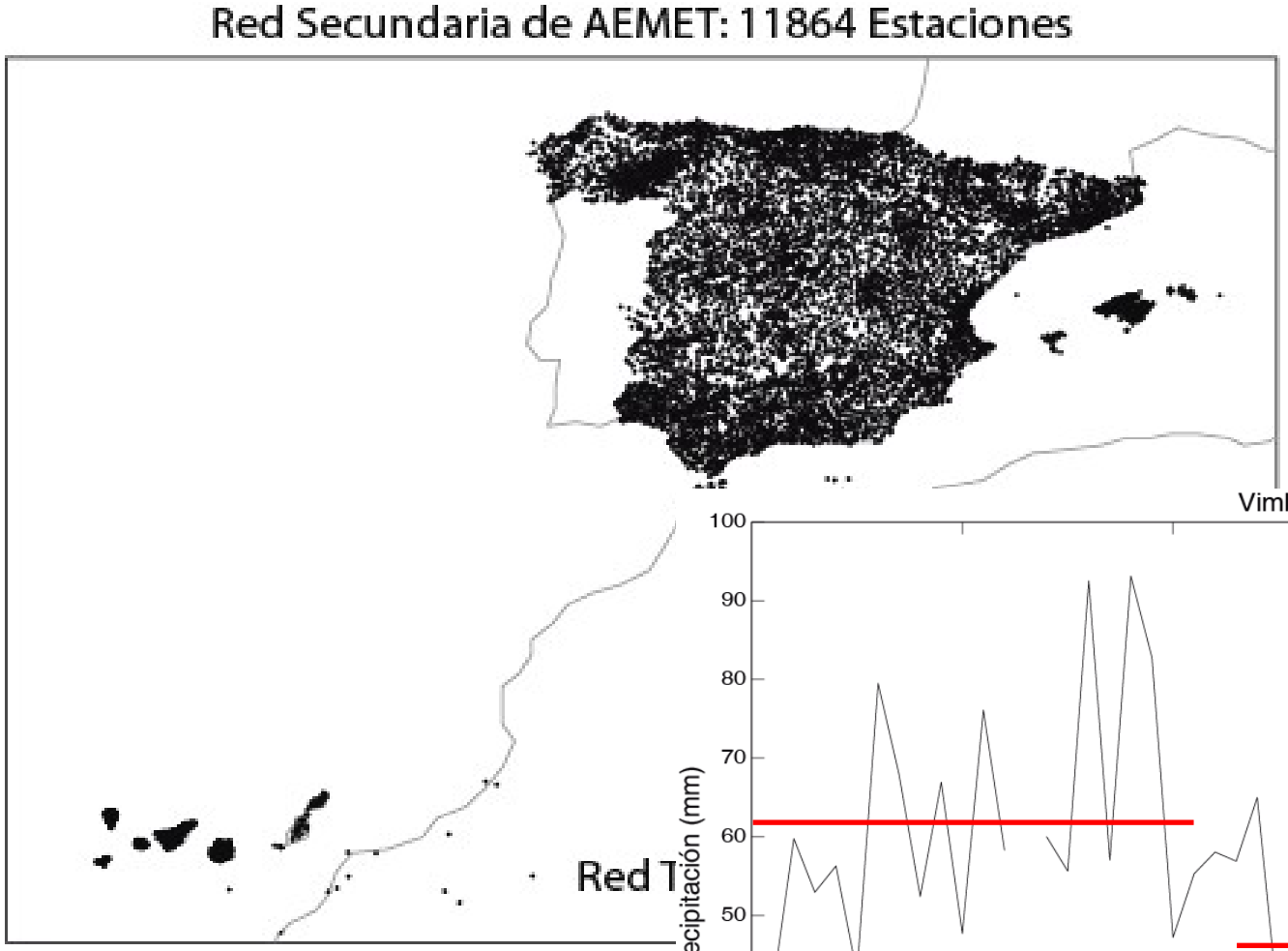
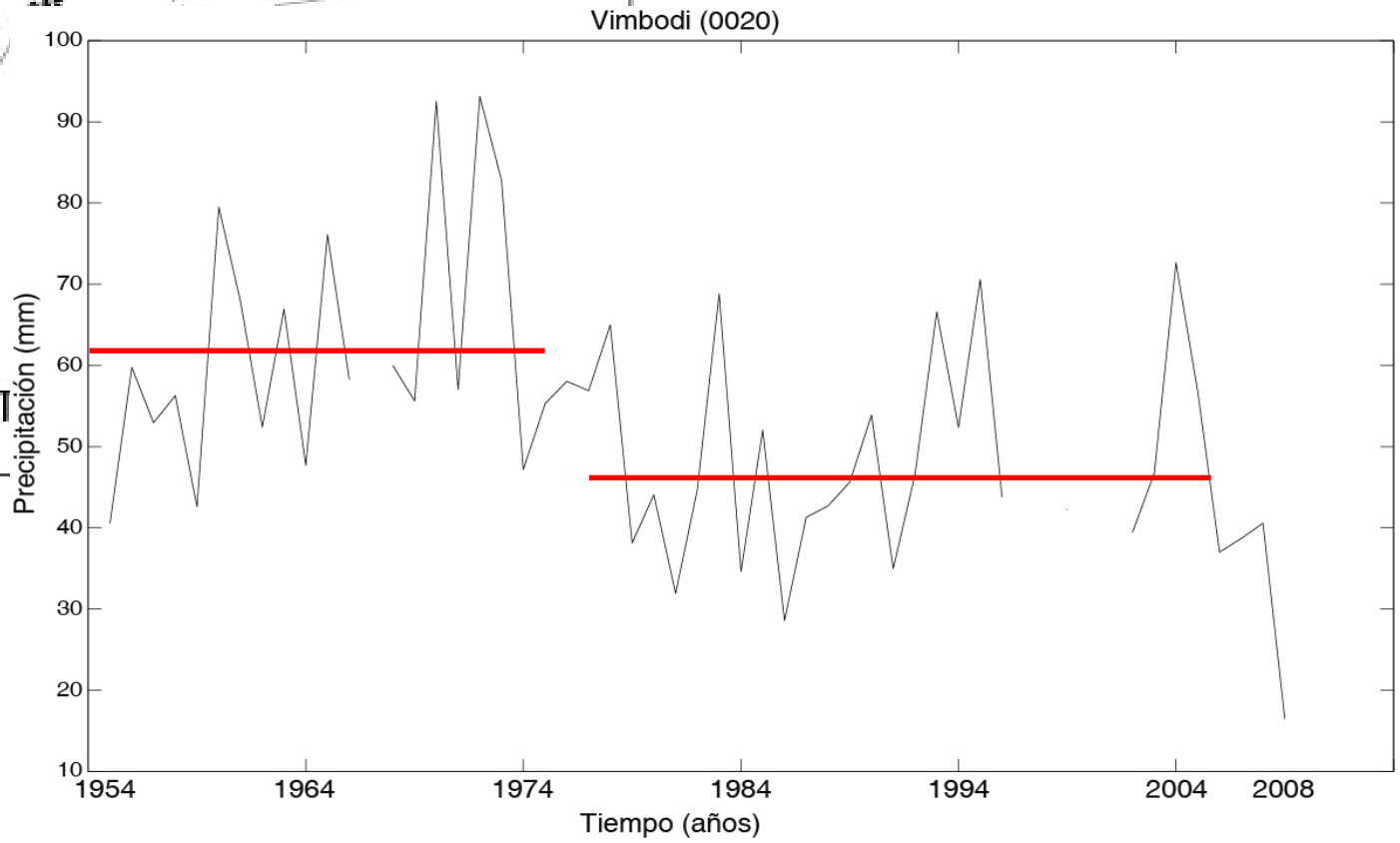
- ….

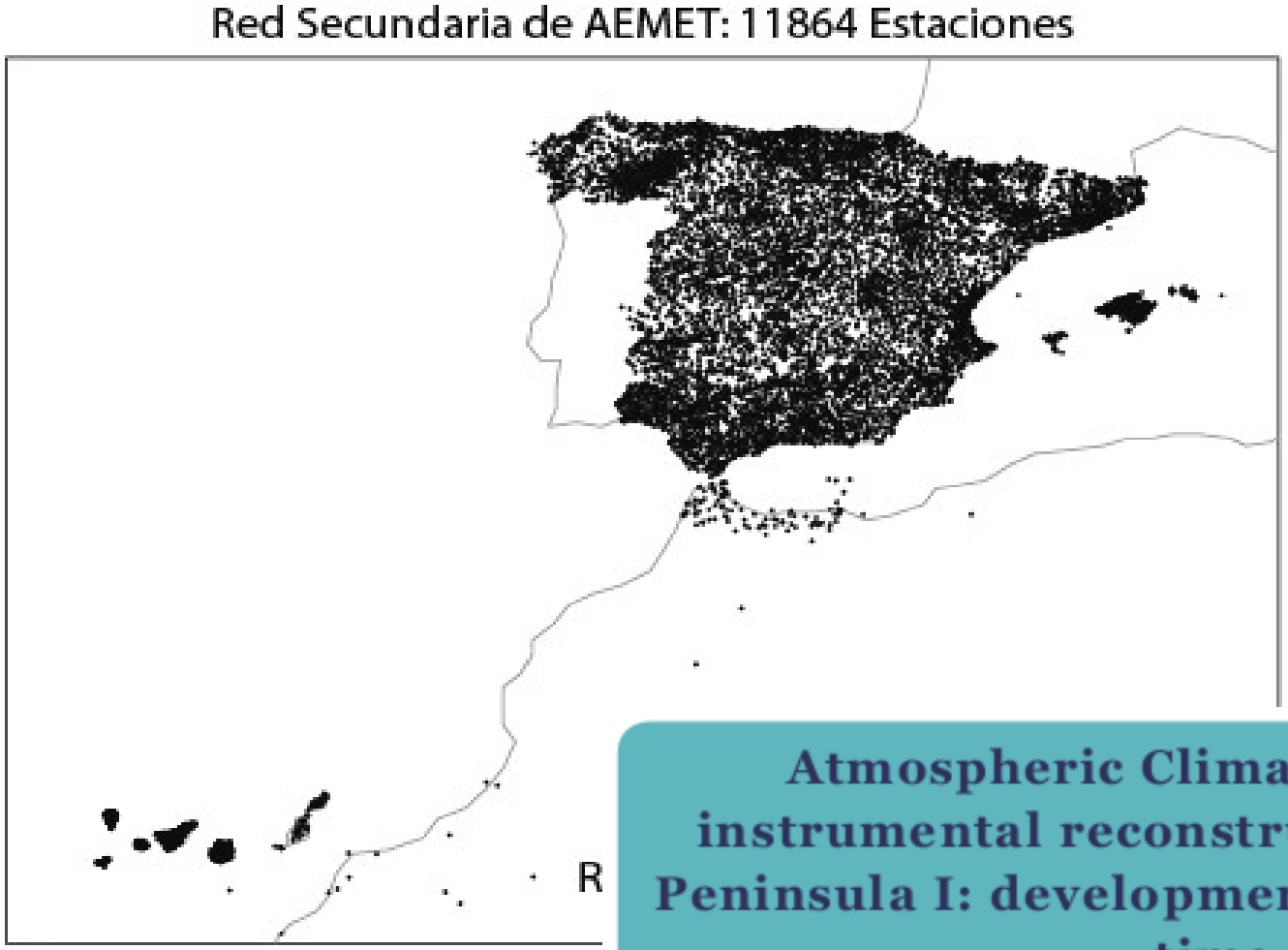




Daily data (1950-2019):

- Outliers
- Missing Data
- Inhomogeneities
- ….





Daily data (1950-2019):

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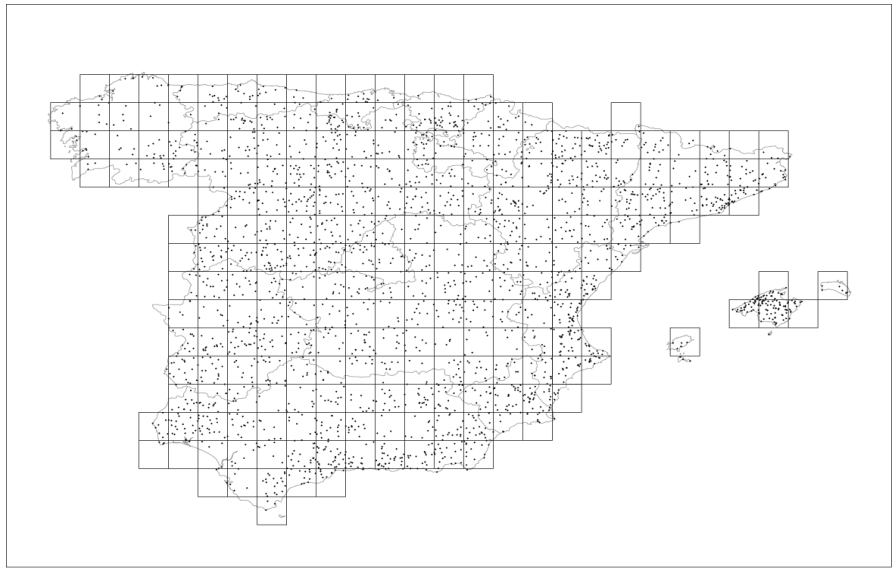
- Missing Data
- Inhomogeneities
- ….

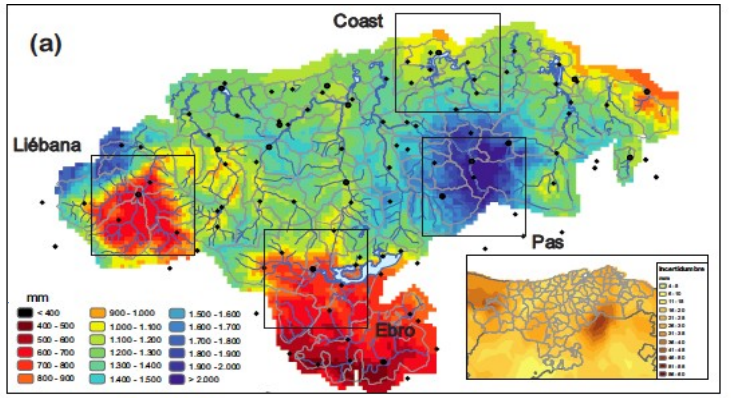
¡¡¡DATA CURATION IS MANDATORY!!!

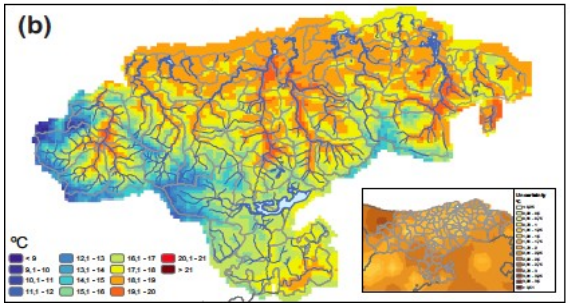
Atmospheric Climatic observations and instrumental reconstructions over the Iberian Peninsula I: development of high-quality climatic time series.

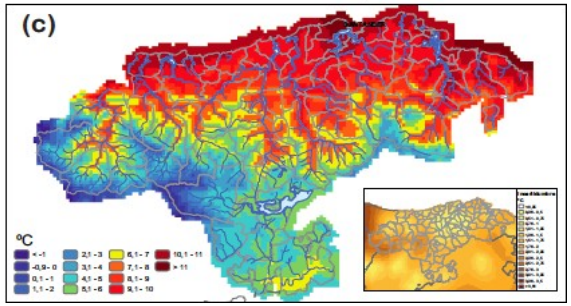
José Antonio Guijarro[1], Cesar Azorin-Molina[3], José Carlos González-Hidalgo[4], Arturo Sanchez-Lorenzo[5], Sixto Herrera[2],José Antonio López[1]

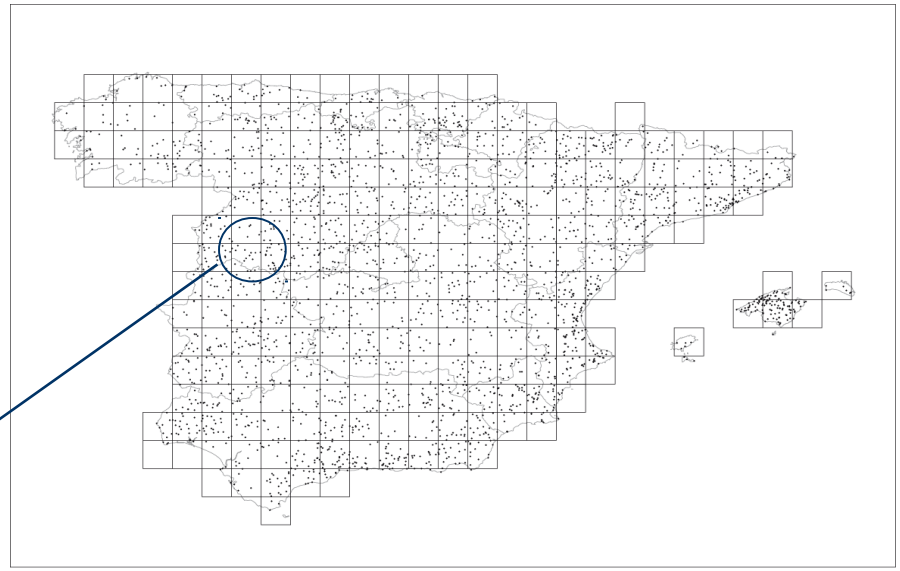
CLIVAR Exchanges, No. 73 September, 2017: Special Issue on climate over the Iberian Peninsula: an overview of CLIVAR-Spain coordinated science, **Editor:** Nico Caltabiano (ICPO), **Guest editors:** Enrique Sánchez (UCLM) and Belén Rodríguez (UCM-CSIC)

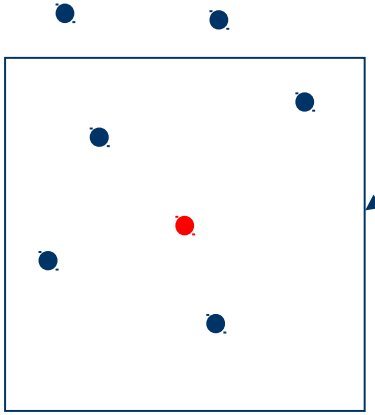



(a)
Coast
Liébana
Pas
Ebro
mm


(b)
°C

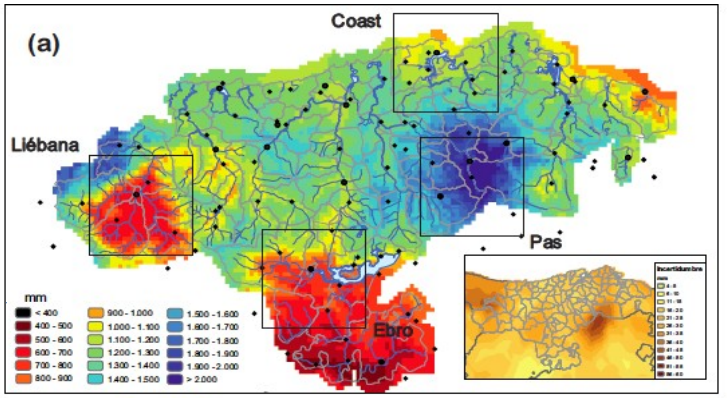

(c)
°C

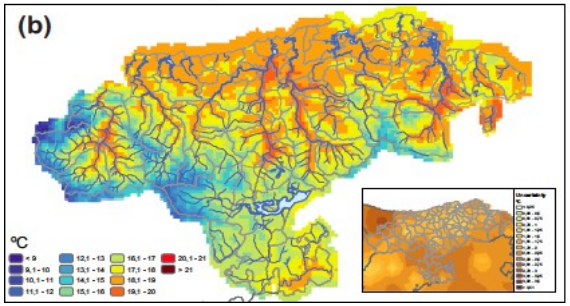


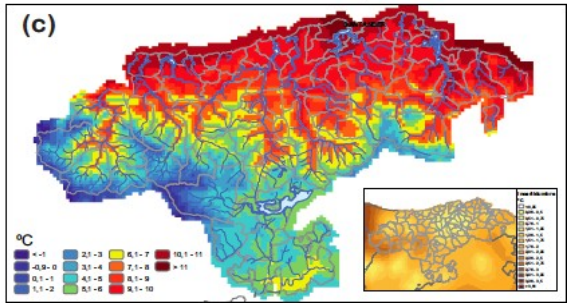


Grid point

Observations



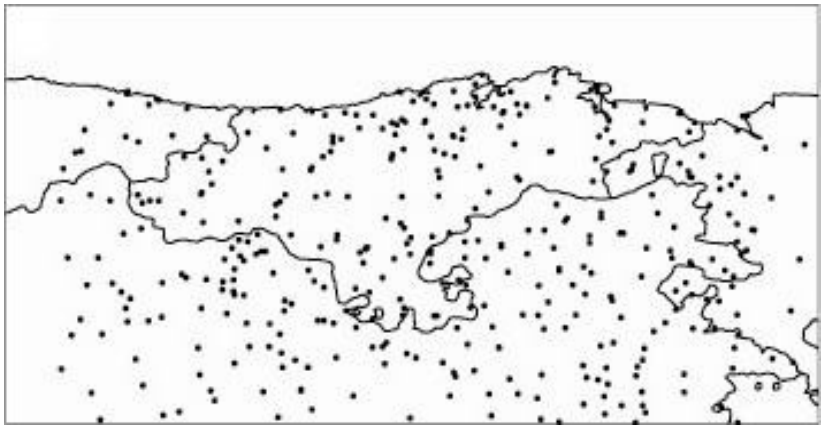




OBSERVACIONES

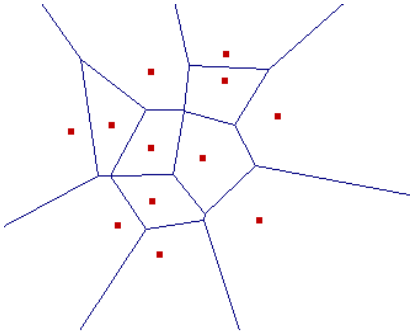
10km

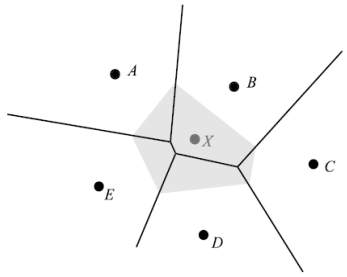
$$y_{interp}(x) = \sum_{i=1}^{n} w_i \, y_{obs}(x_i)$$



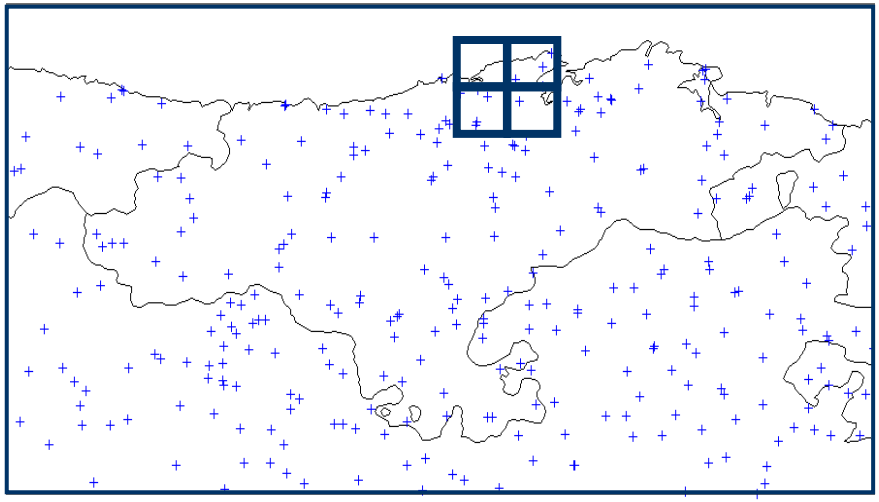
$$w_i = \frac{1}{d(x, x_i)^p}$$

Deterministic





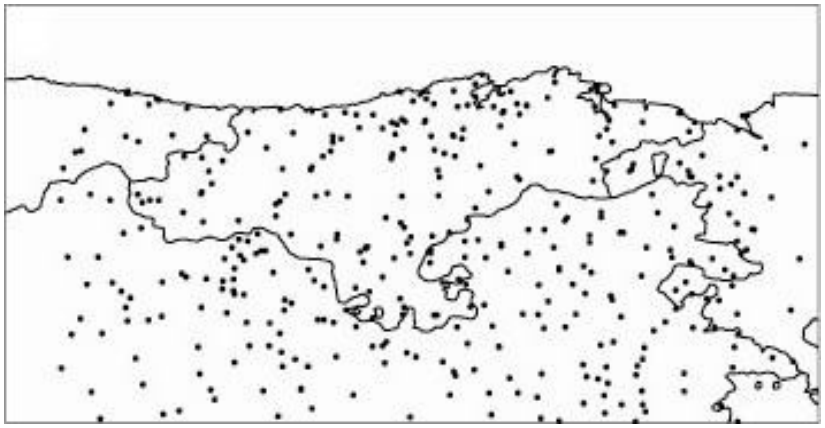
Interpolation Methods



$$\begin{cases} \gamma^*(h) = \dfrac{1}{2N(h)} \displaystyle\sum_{\|x_i - x_j\| = h}^{N(h)} \left(y(x_i) - y(x_j) \right)^2 \\ -\sum_{i=1}^{k} w_i \gamma(\|x_i - x_j\|) + \mu = -\gamma(\|x - x_j\|) \\ \sum_{i=1}^{k} w_i = 1 \end{cases}$$

Geoestatistic

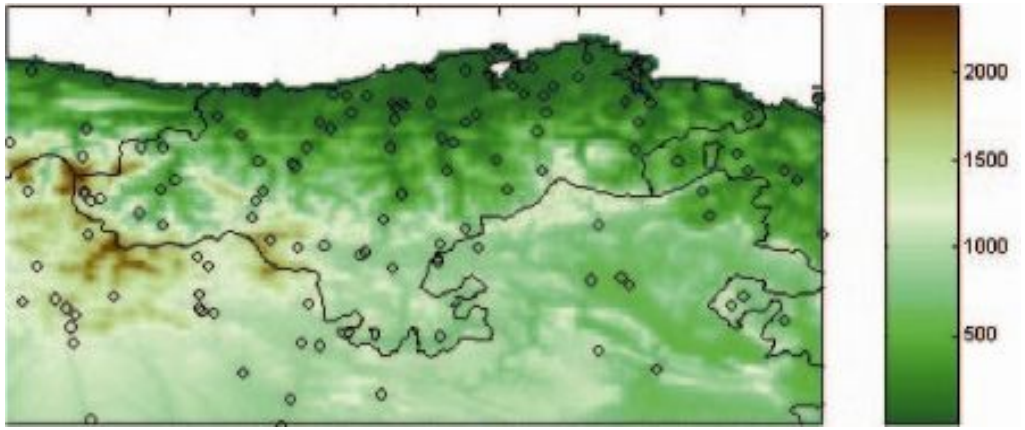
$$y_{interp}(x) = \sum_{i=1}^{n} w_i \, y_{obs}(x_i) + f(x) \qquad f(x) = a_0 + \sum_{k=1}^{m} a_k V_k(x)$$



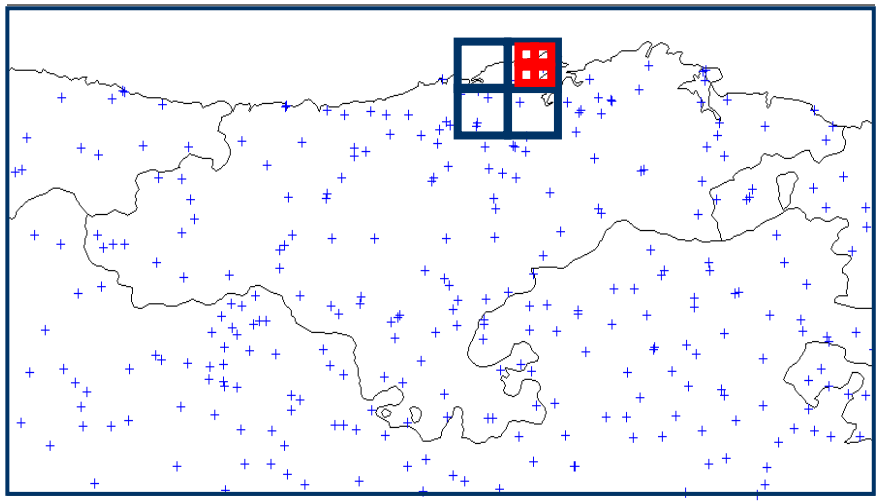
Interpolation Methods + Regression

DIGITAL ELEVATION MODEL

Orography, blocking, continentality, etc..



1km

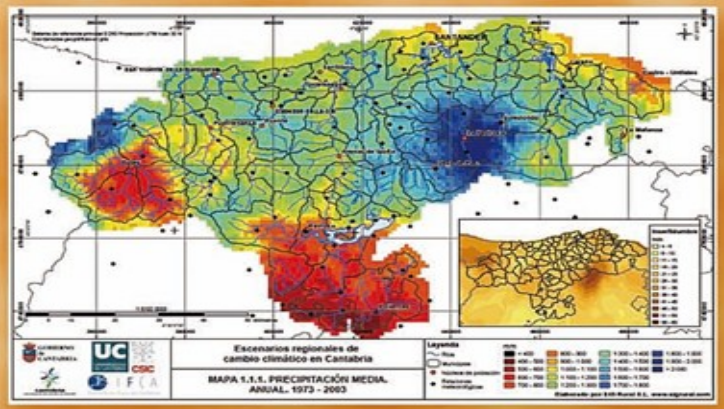


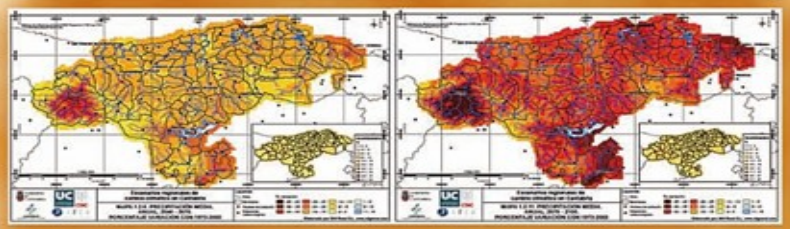
GOBIERNO de CANTABRIA
CONSEJERÍA DE MEDIO AMBIENTE

UC UNIVERSIDAD DE CANTABRIA

Escenarios Regionales Probabilísticos de Cambio Climático en Cantabria: Termopluviometría

J.M. Gutiérrez, S. Herrera, D. San-Martín, C. Sordo,
J.J. Rodríguez, M. Frochoso, R. Ancell, J. Fernández,
A.S. Cofiño, M.R. Pons, M.A. Rodríguez



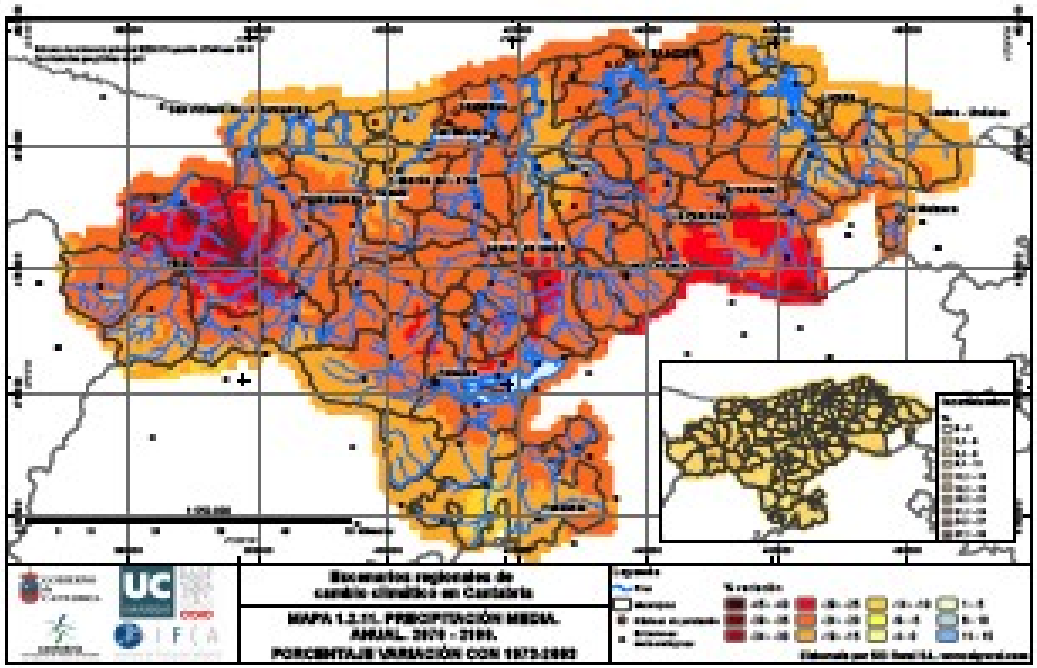


(Santander, 2010)

Annual, monthly and daily series of precipitation and temperatures. Present climate and future climate change projections.

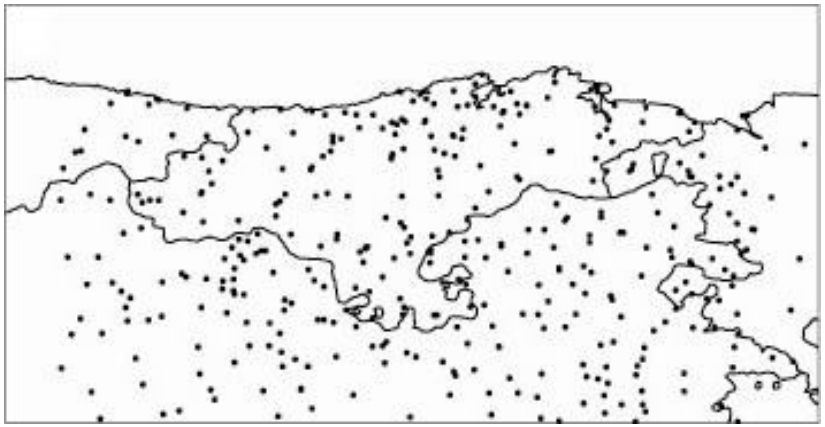
Formats:

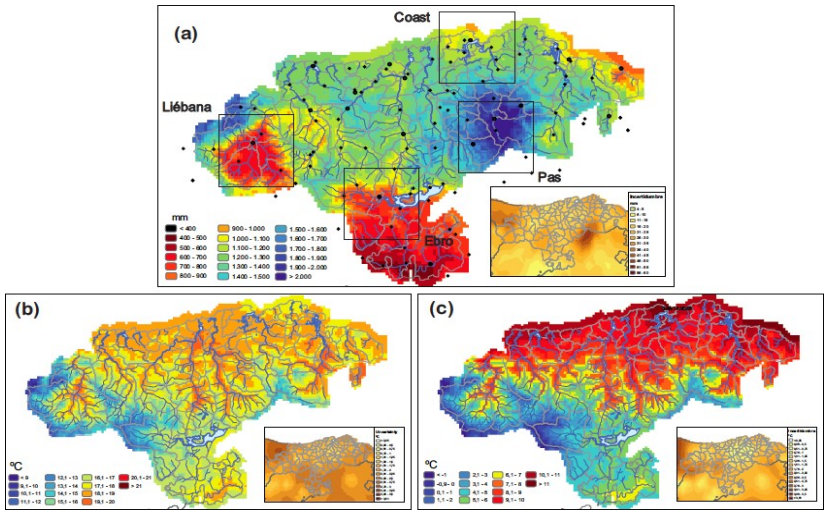
- GIS (ASCII-ESRII)
- NetCDF (binary)



http://www.meteo.unican.es/escenariosCantabria

$$y_{interp}(x) = \sum_{i=1}^{n} w_i \, y_{obs}(x_i) + f(x) \qquad f(x) = a_0 + \sum_{k=1}^{m} a_k V_k(x)$$



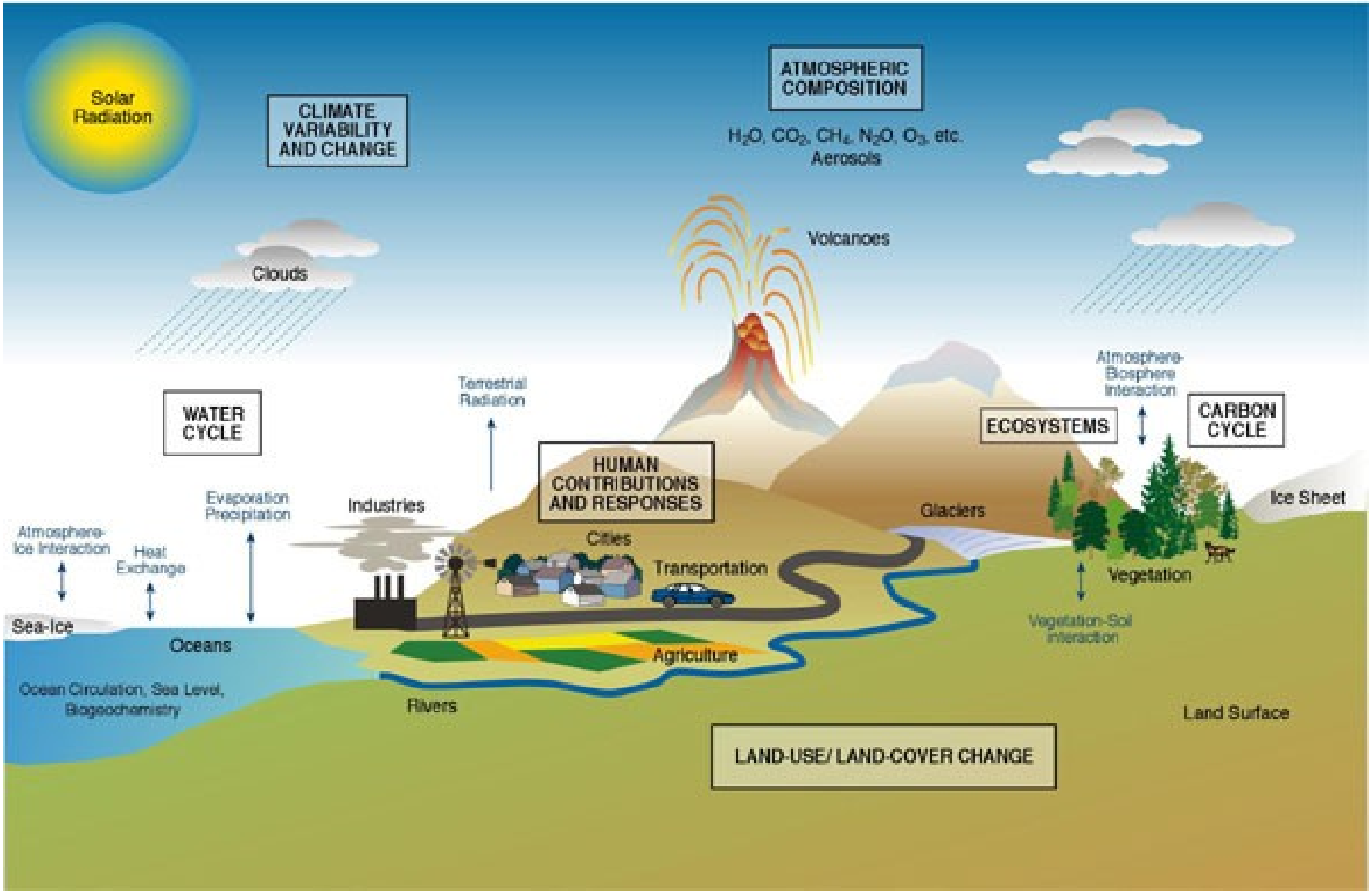


Climatic observations and instrumental reconstructions: development of high-quality climatic gridded products

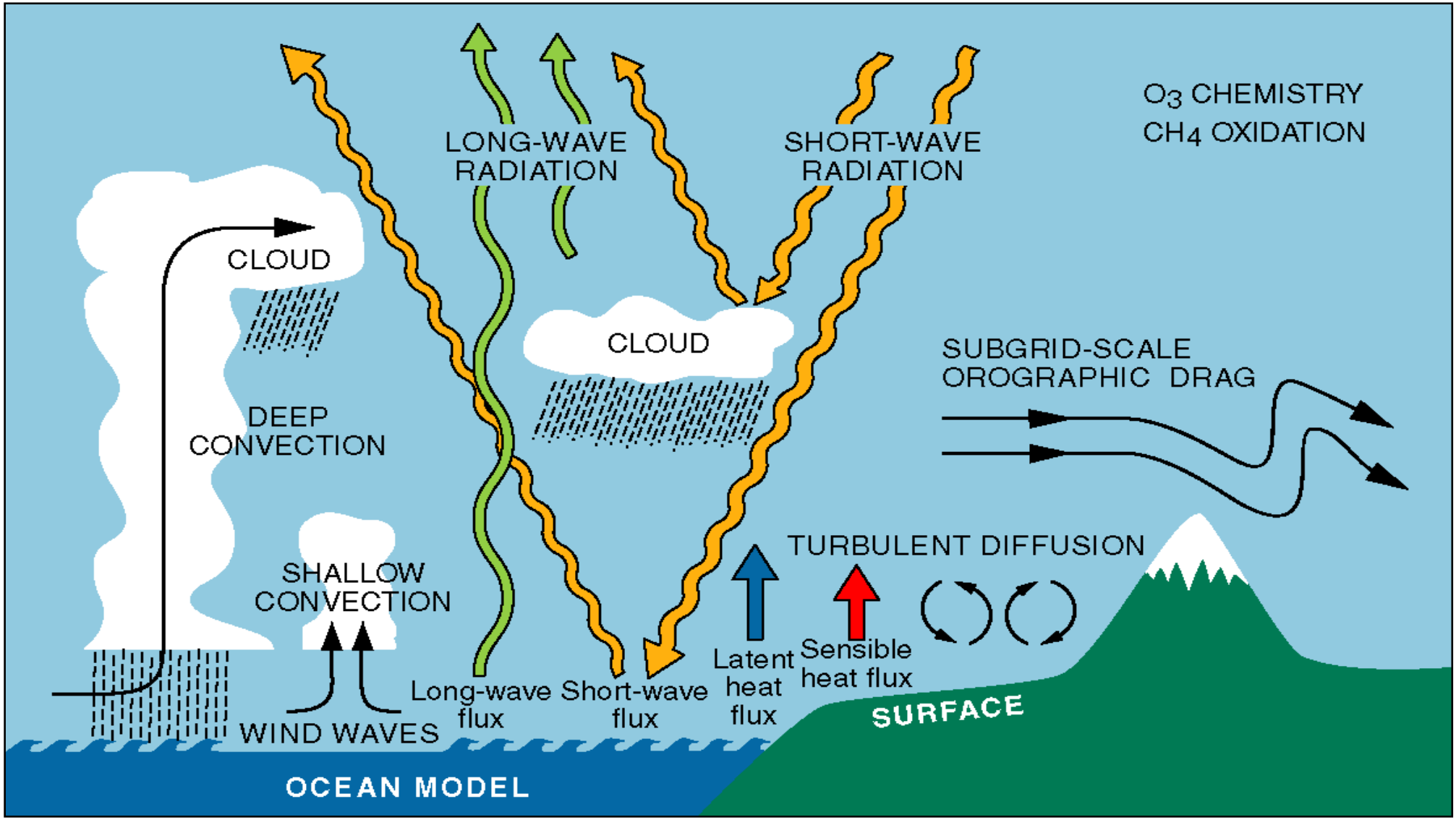
Sixto Herrera[2], Juan Javier Miró Pérez[4], Pere Quintana-Seguí[5], Julián Gonzalo[6], José Antonio Ruiz-Arias[7], Jose Carlos González-Hidalgo[8], José Antonio Guijarro[3], Jose Antonio López[1]

CLIVAR Exchanges, No. 73 September, 2017: Special Issue on climate over the Iberian Peninsula: an overview of CLIVAR-Spain coordinated science, **Editor:** Nico Caltabiano (ICPO), **Guest editors:** Enrique Sánchez (UCLM) and Belén Rodríguez (UCM-CSIC)

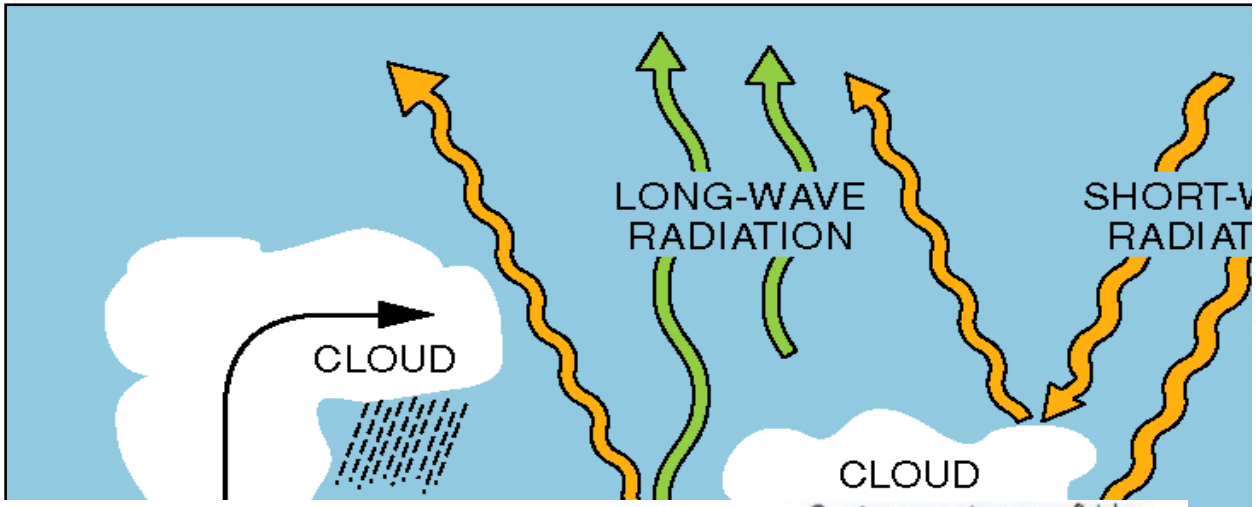
Atmosphere + Hydrosphere + Cryosphere + Lithosphere + Biosphere

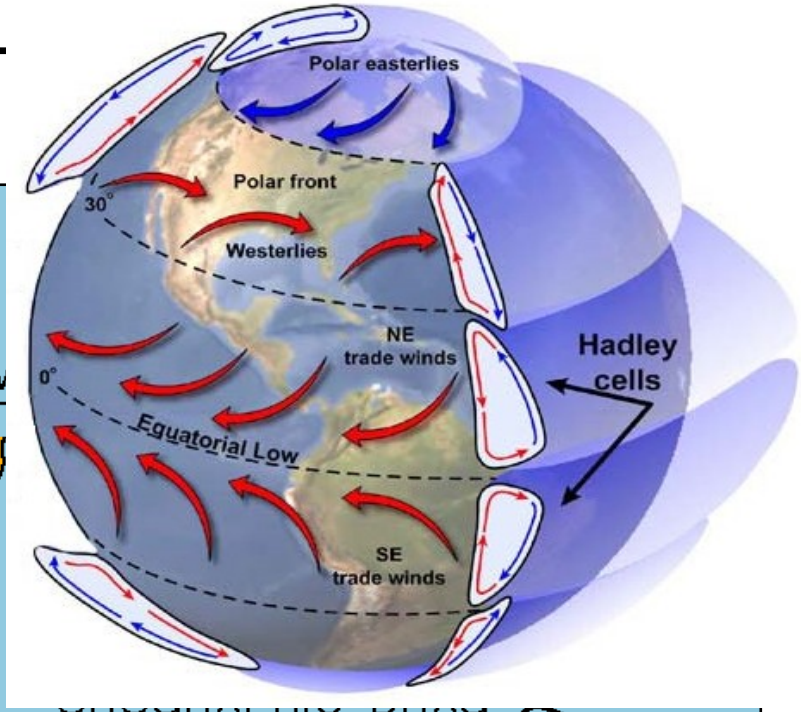


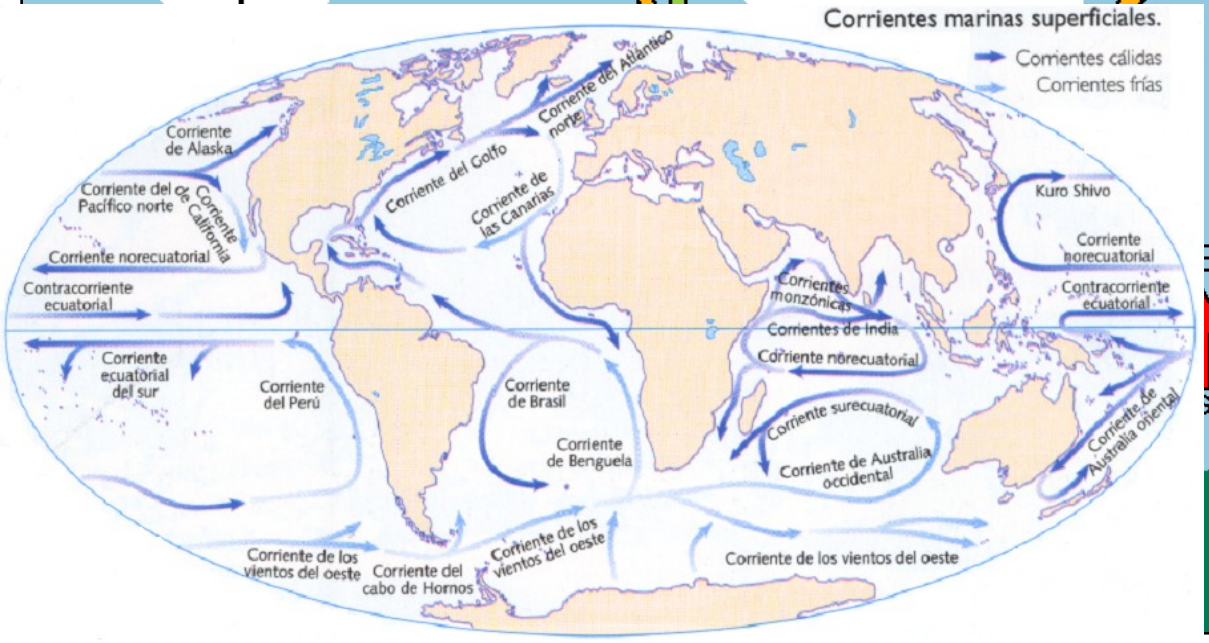
Atmosphere + Hydrosphere + Cryosphere + Lithosphere + Biosphere

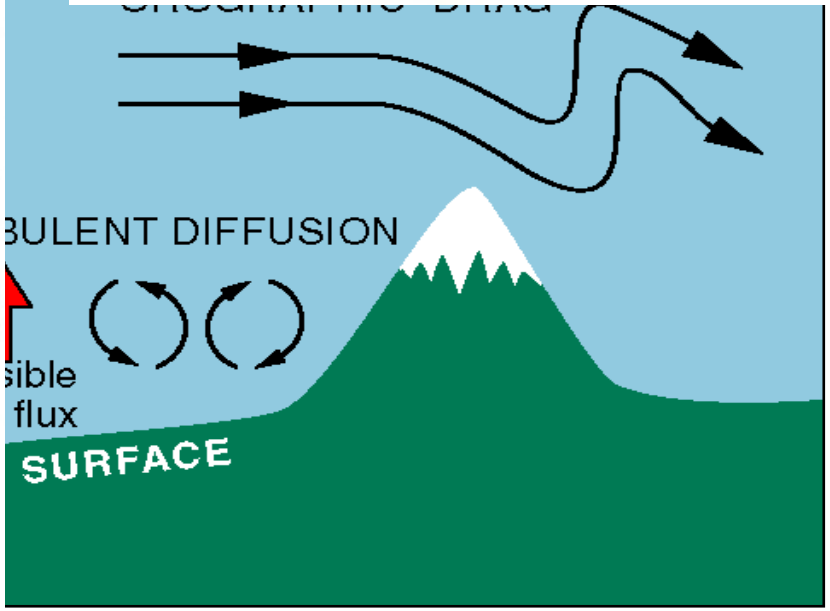


Atmosphere + Hydrosphere + Cryosphere -









Atmosphere Equations: Conservation Laws (Energy, Mass, Moment, etc..)

$$
\begin{cases}
\dfrac{d\boldsymbol{v}}{dt} &= -\alpha\boldsymbol{\nabla}p - \boldsymbol{\nabla}\phi + \boldsymbol{F} - 2\boldsymbol{\Omega}\times\boldsymbol{v} \\
\dfrac{\partial\rho}{\partial t} &= -\boldsymbol{\nabla}\cdot(\rho\,\boldsymbol{v}) \\
p\,\alpha &= RT \\
Q &= C_p\dfrac{dT}{dt} - \alpha\dfrac{dp}{dt} \\
\dfrac{\partial\rho\,q}{\partial t} &= -\boldsymbol{\nabla}\cdot(\rho\,\boldsymbol{v}\,q) + \rho\,(E-C)
\end{cases}
$$

$\boldsymbol{v} = (u, v, w)$, T, p, $\rho = 1/\alpha$ y q

Atmosphere Equations

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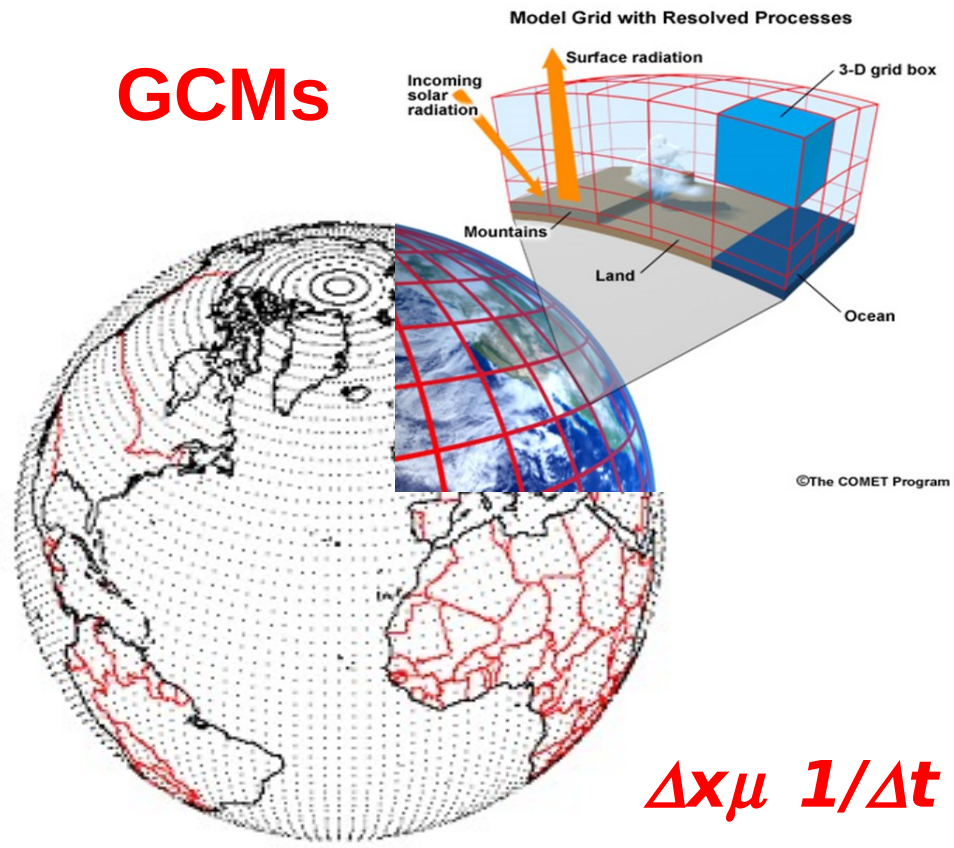
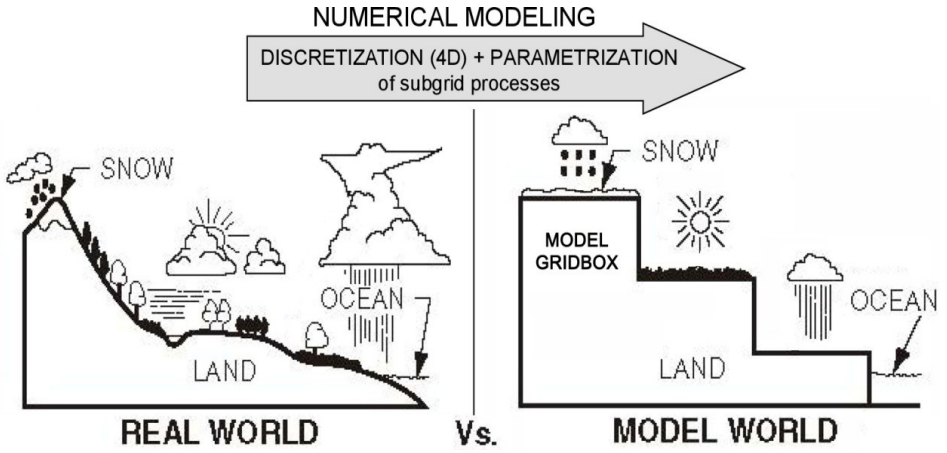
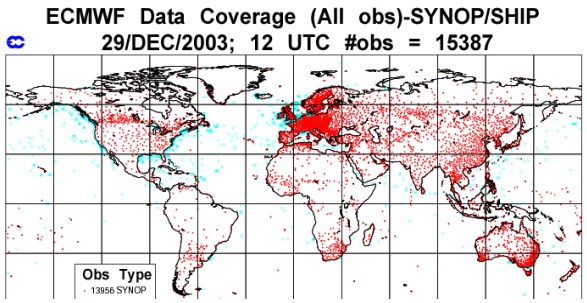
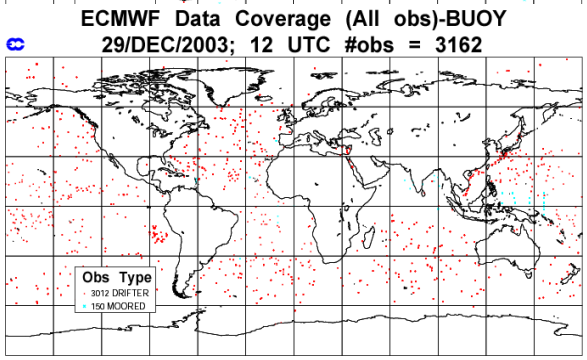
GCMs



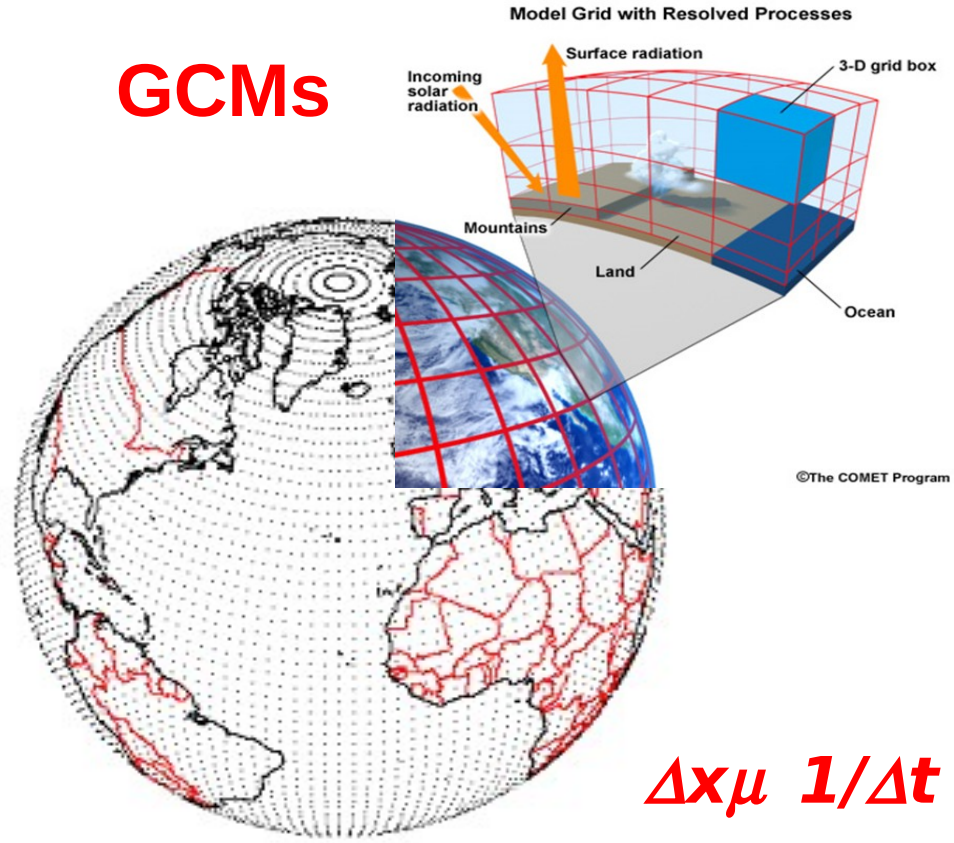
$\Delta x \mu\ 1/\Delta t$





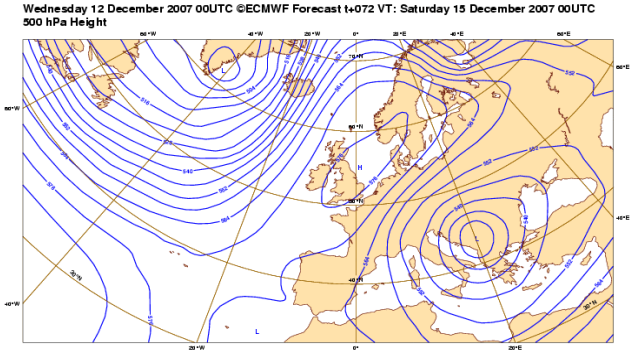


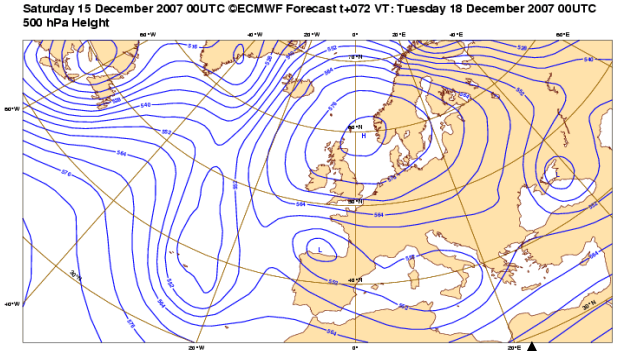
GCMs

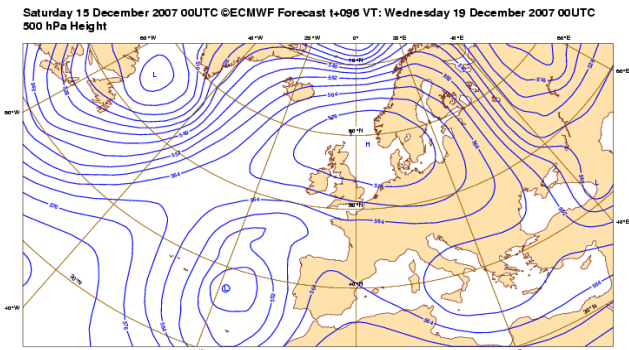


Assimilation

$\Delta x \mu 1/\Delta t$

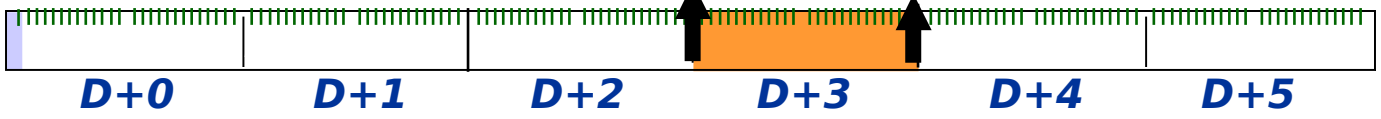






Initial Condition

H+0



Initialization
Verification

Weather Services

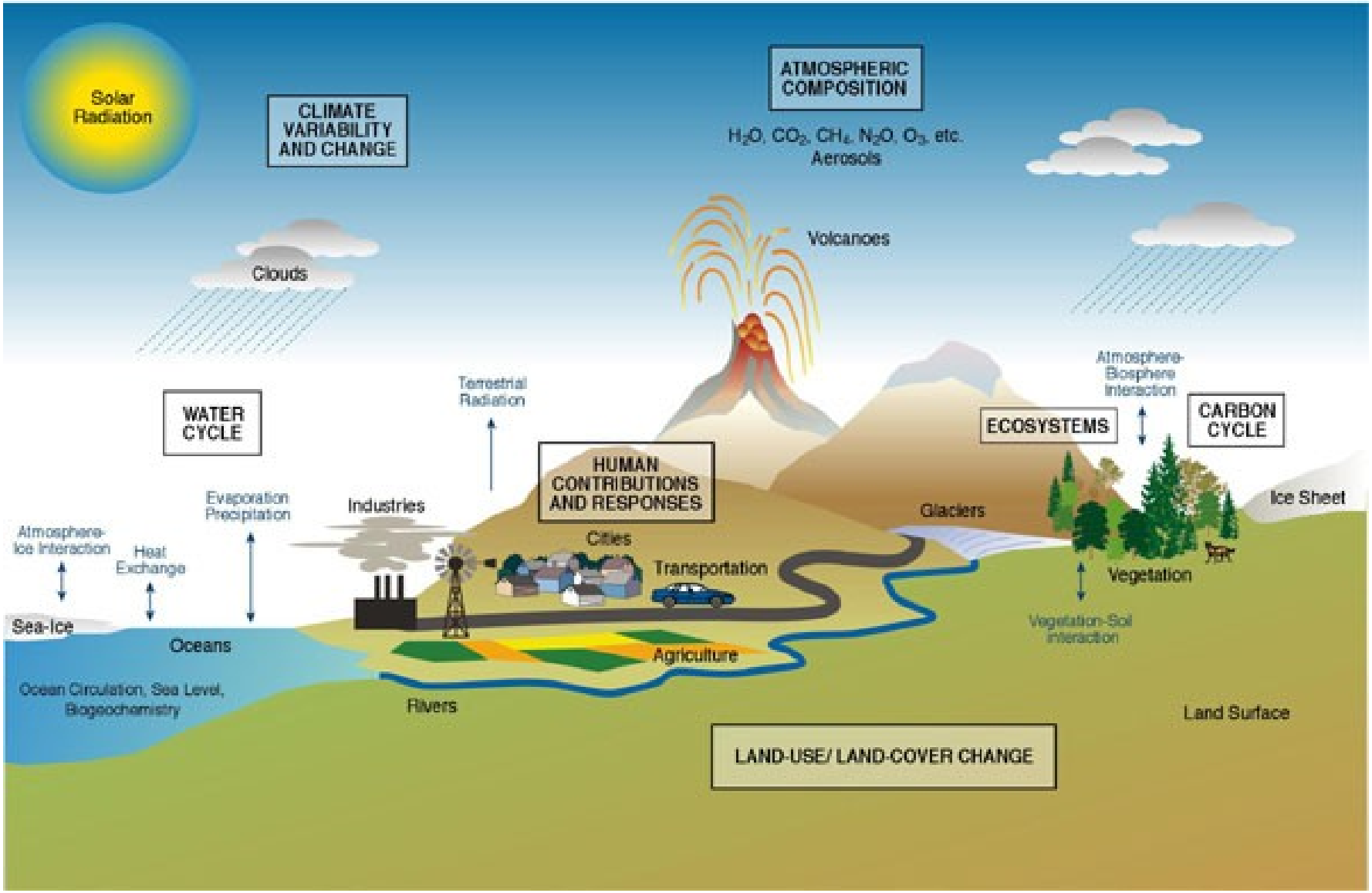
Short-Medium Range Forecast

Days-Weeks

2019-04-01

Atmosphere + Hydrosphere + Cryosphere + Lithosphere + Biosphere

1-7 days → Weather Forecast



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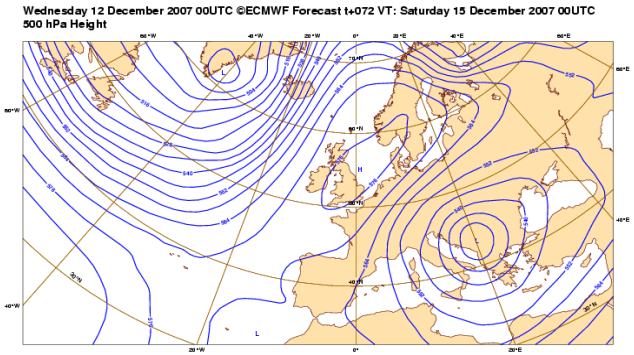
\end{aligned}
$$

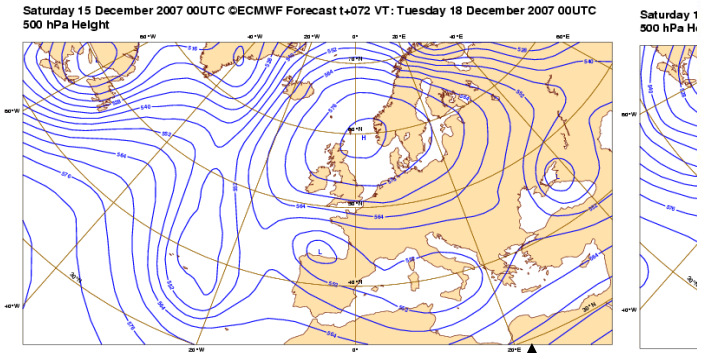
Non-Linear Equations ¡¡¡¡

predictable

Semi-predictable

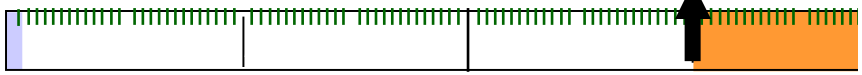
Unpredictable





Initial Condition

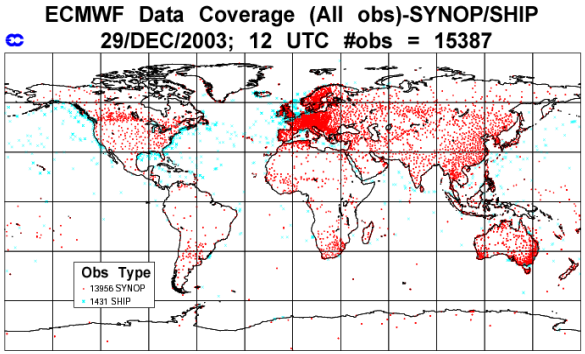
H+0



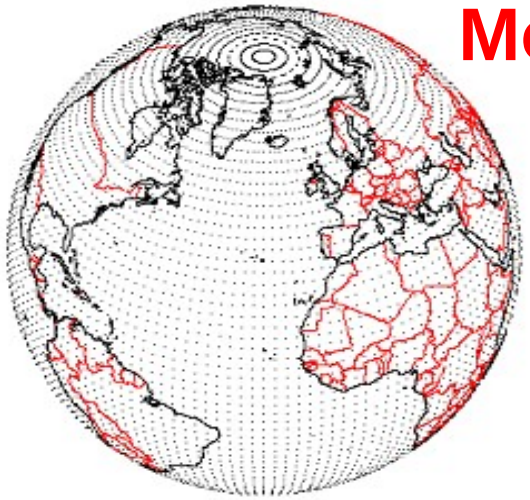
D+0 ***D+1*** ***D+2*** ***D+3*** ***D+4*** ***D+5***

Uncertainty in the initial conditions: Perturbing the **Initial Conditions** of the atmosphere and ocean.

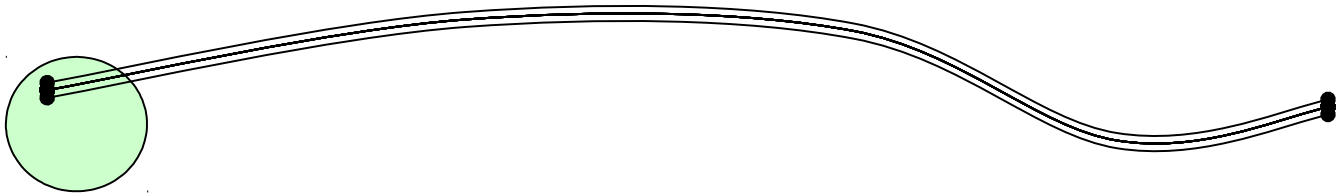
Real World



Model



Deterministic Prediction

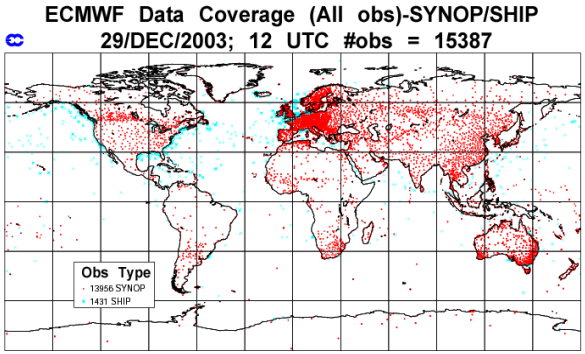


Initial Conditions

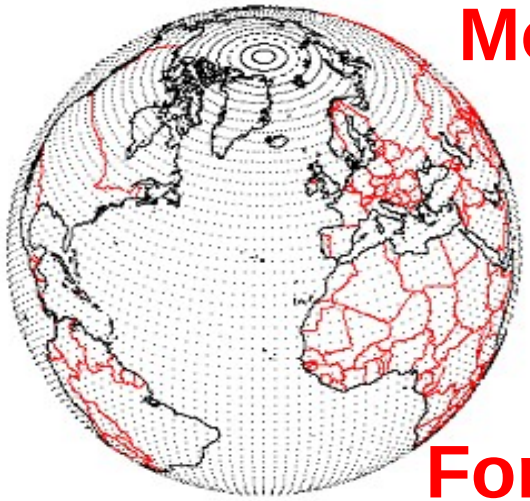
time

Uncertainty in the initial conditions: Perturbing the **Initial Conditions** of the atmosphere and ocean.

Real World



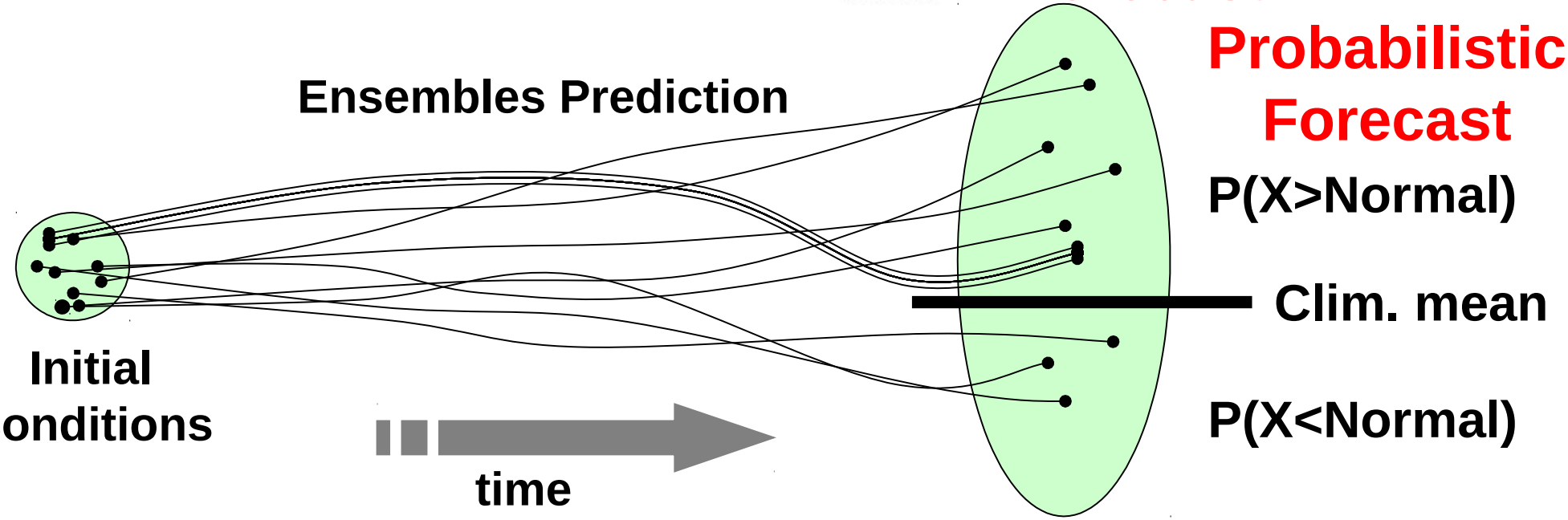
Model



Forecast

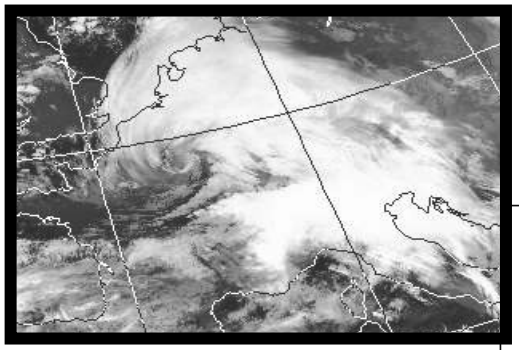
Probabilistic Forecast

Ensembles Prediction



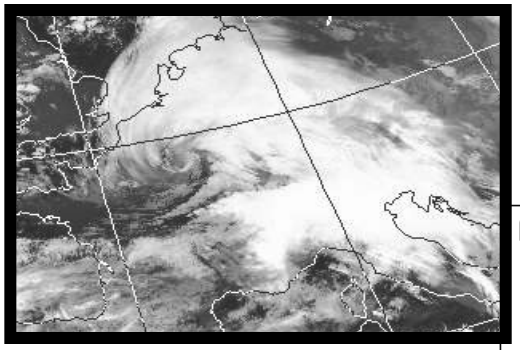
Uncertainty in the initial conditions: Perturbing the **Initial Conditions** of the atmosphere and ocean.

Borrasca Lothar: Francia/Alemania, 26/12/1999



100 deads y 3 millions persons without services (e.g. water and electricity)

Borrasca Lothar: Francia/Alemania, 26/12/1999



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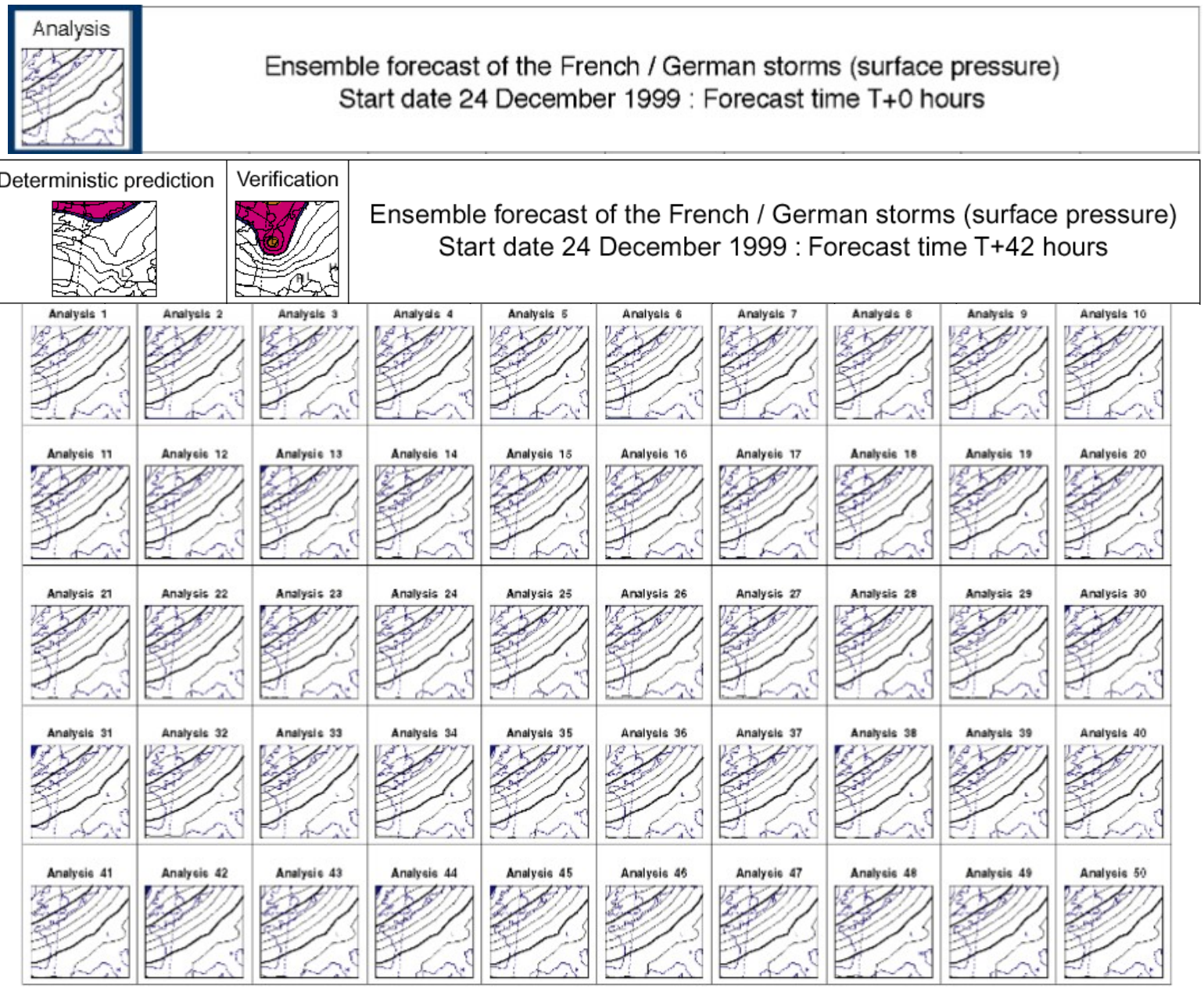

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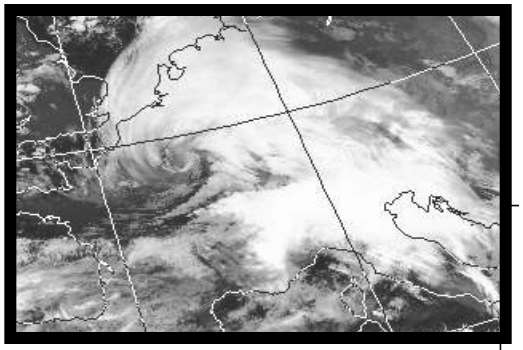

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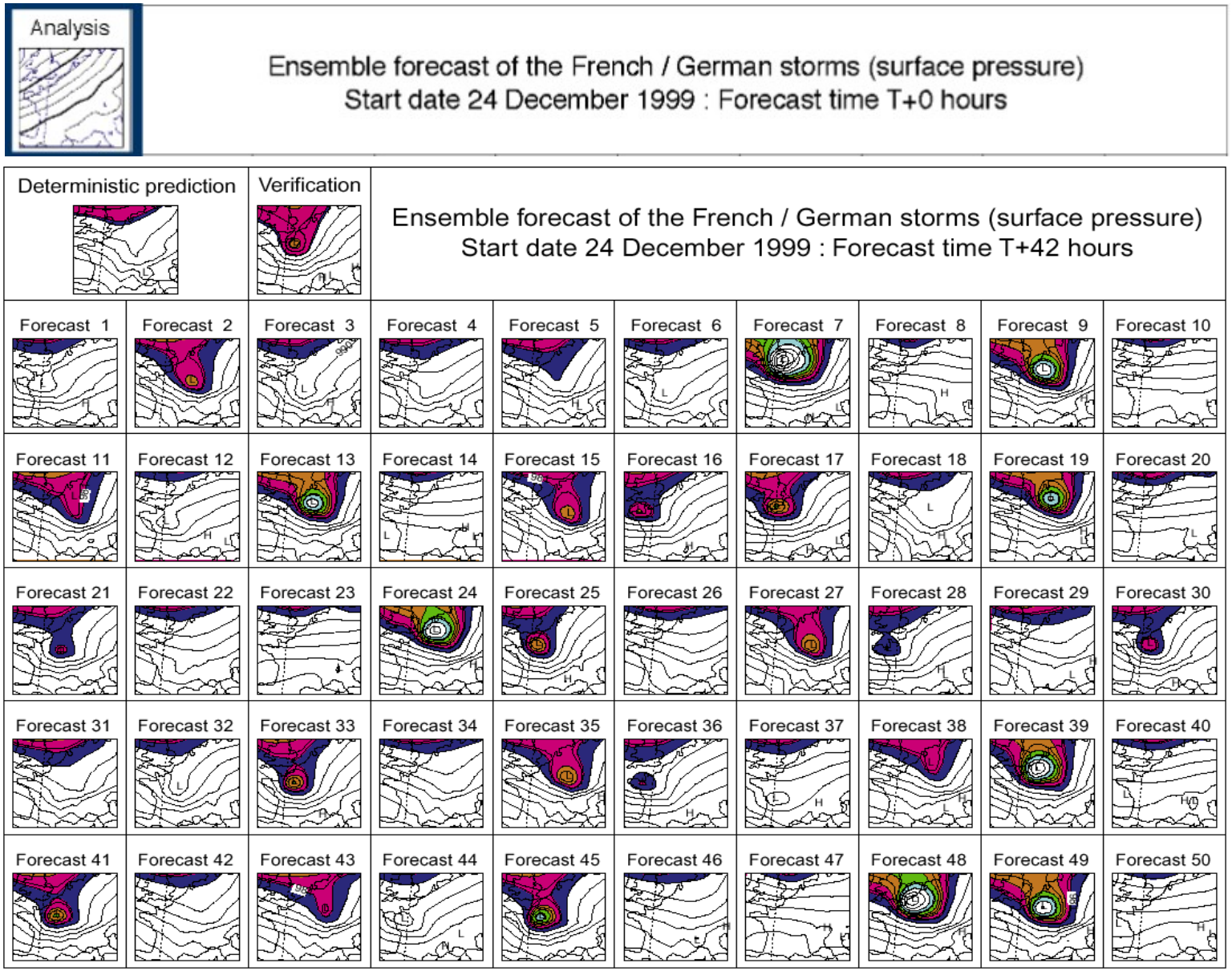

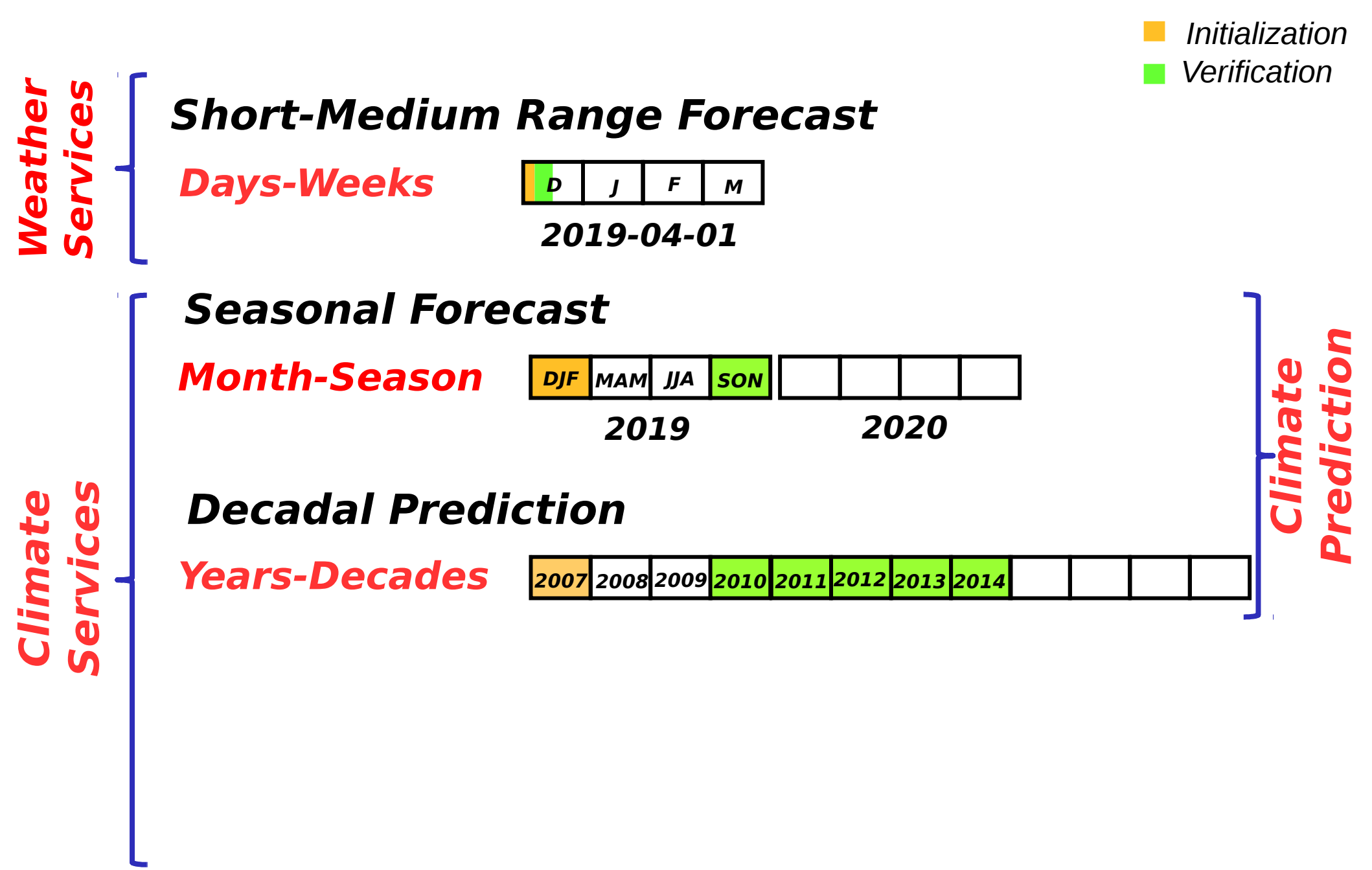
Initialization
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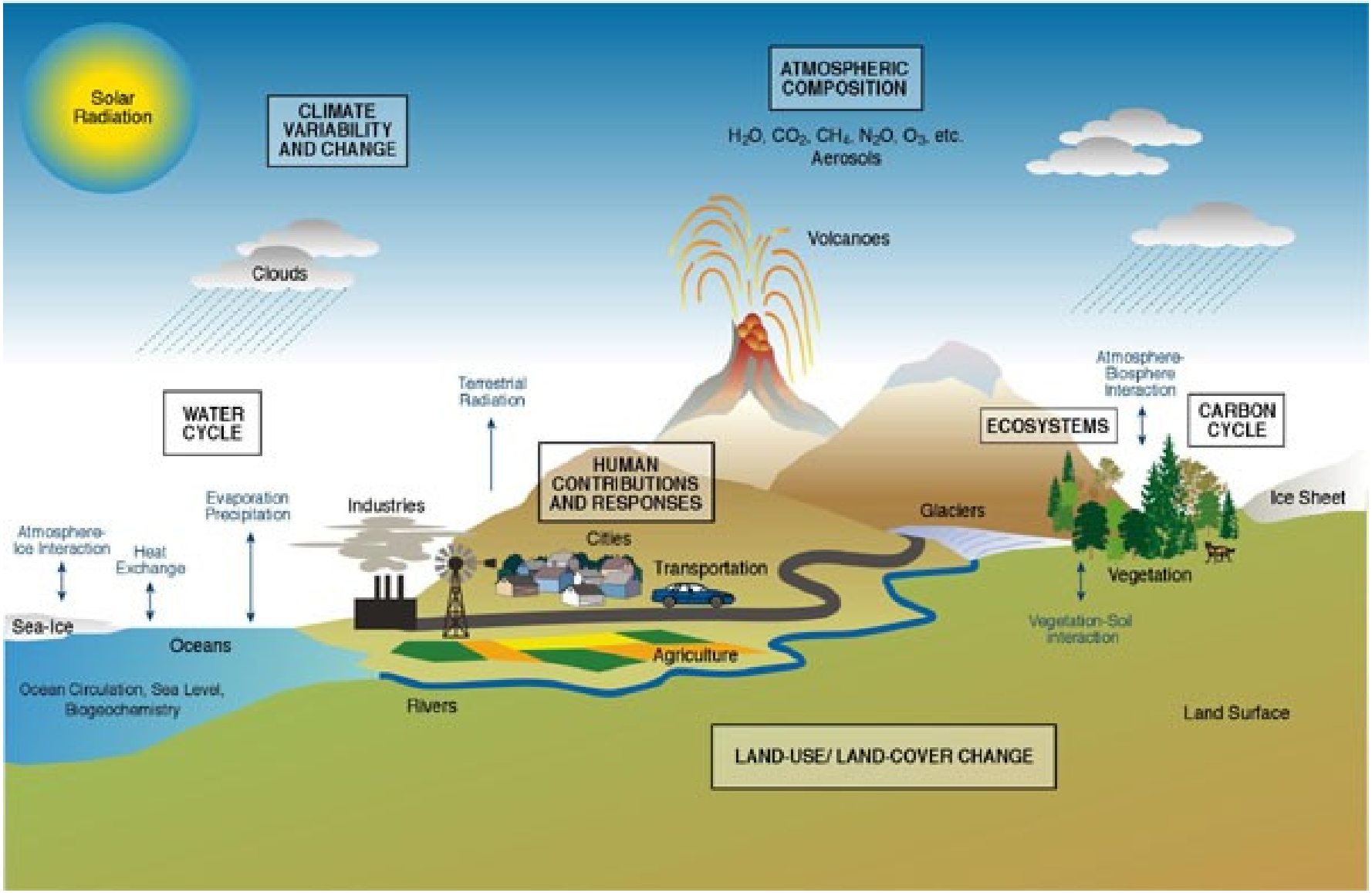
Short-Medium Range Forecast
Days-Weeks
D
J
F
M
2019-04-01
Climate Services
Seasonal Forecast
Month-Season
DJF
MAM
JJA
SON
2019
2020
Decadal Prediction
Years-Decades
2007
2008
2009
2010
2011
2012
2013
2014
Climate Prediction

Atmosphere + Hydrosphere + Cryosphere + Lithosphere + Biosphere

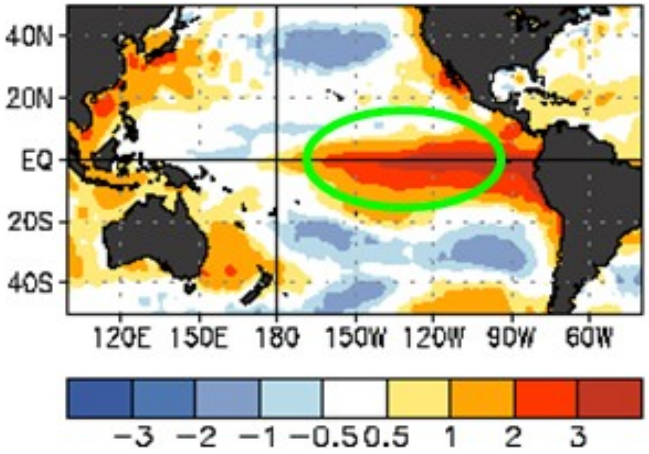
1-7 months → Seasonal Forecast



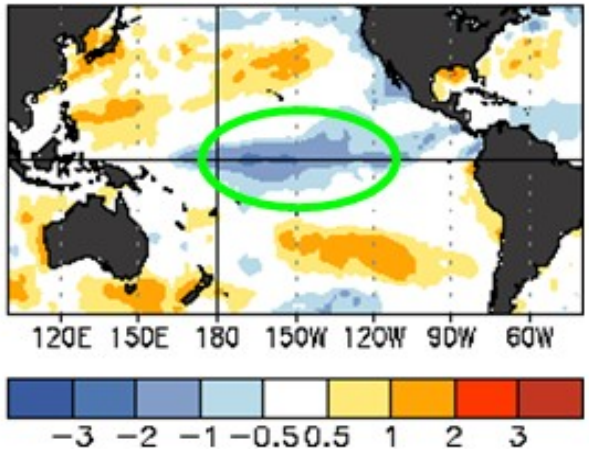
Atmosphere + Hydrosphere + Cryosphere + Lithosphere + Biosphere

At this time-scale the El Niño event is the main driver at global scale

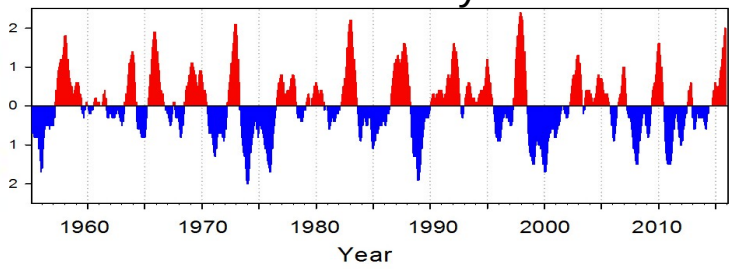
El Niño



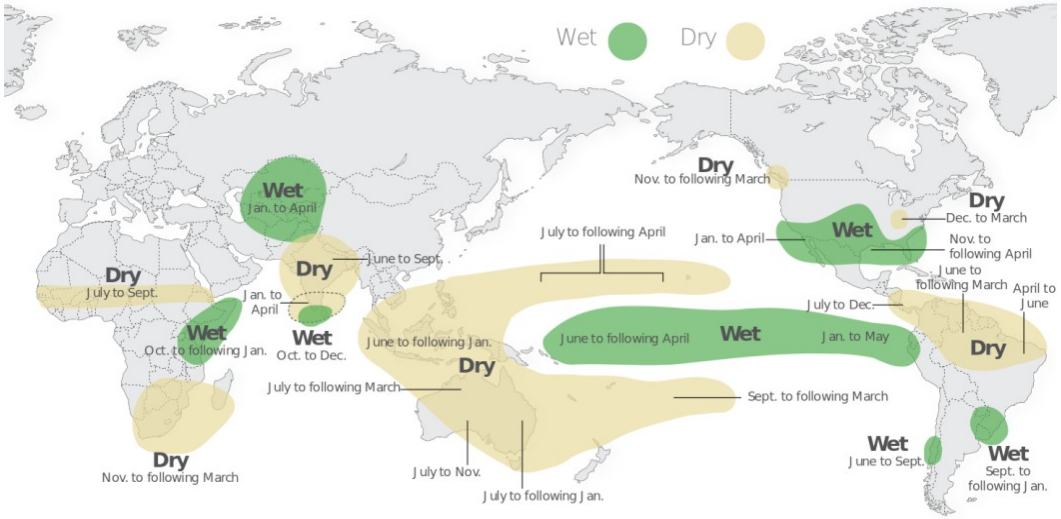
La Niña

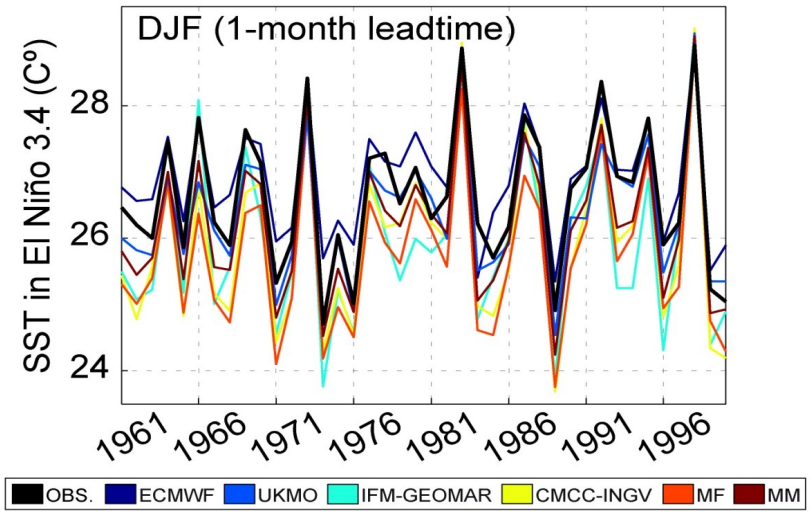


Interannual variability of El Niño



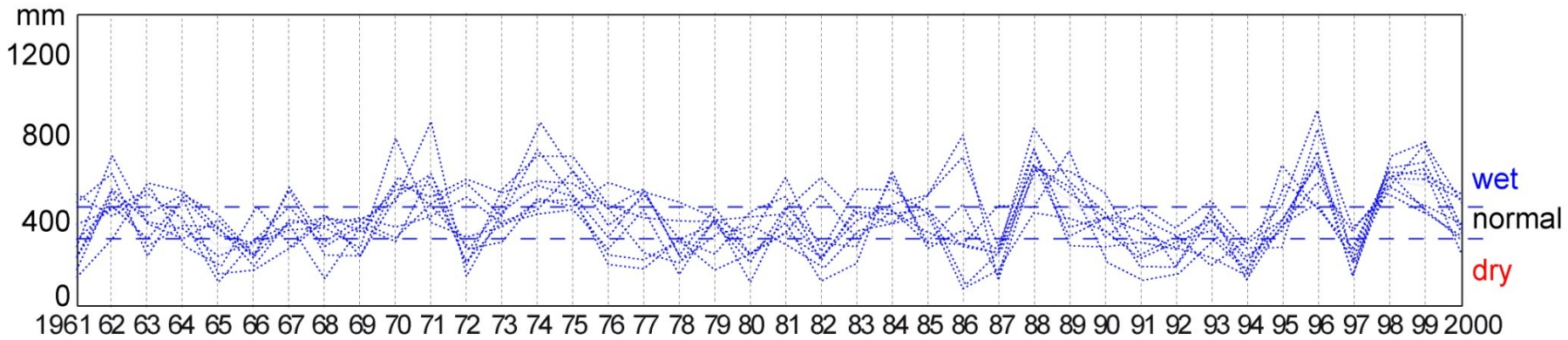
El Niño teleconnections

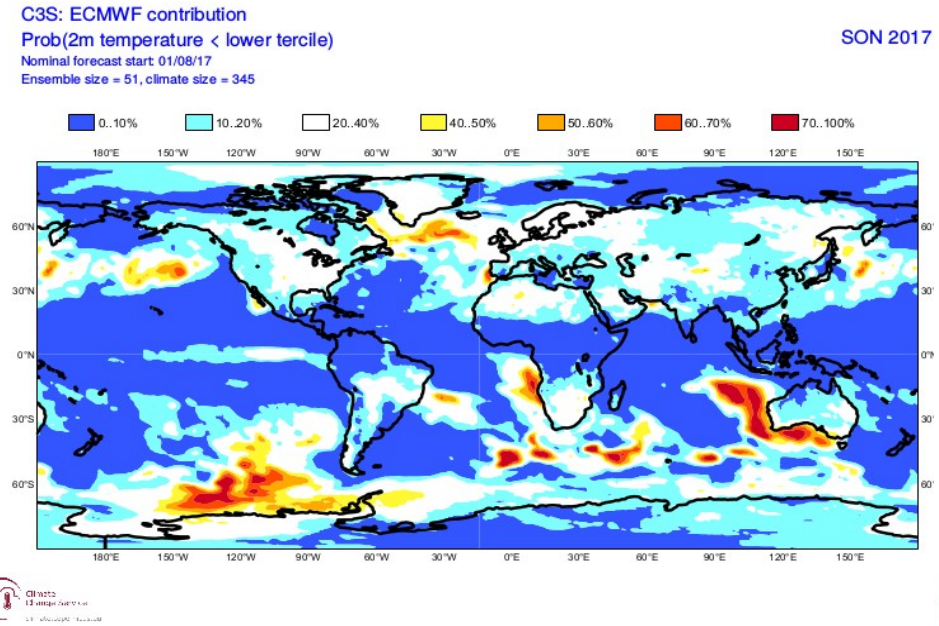


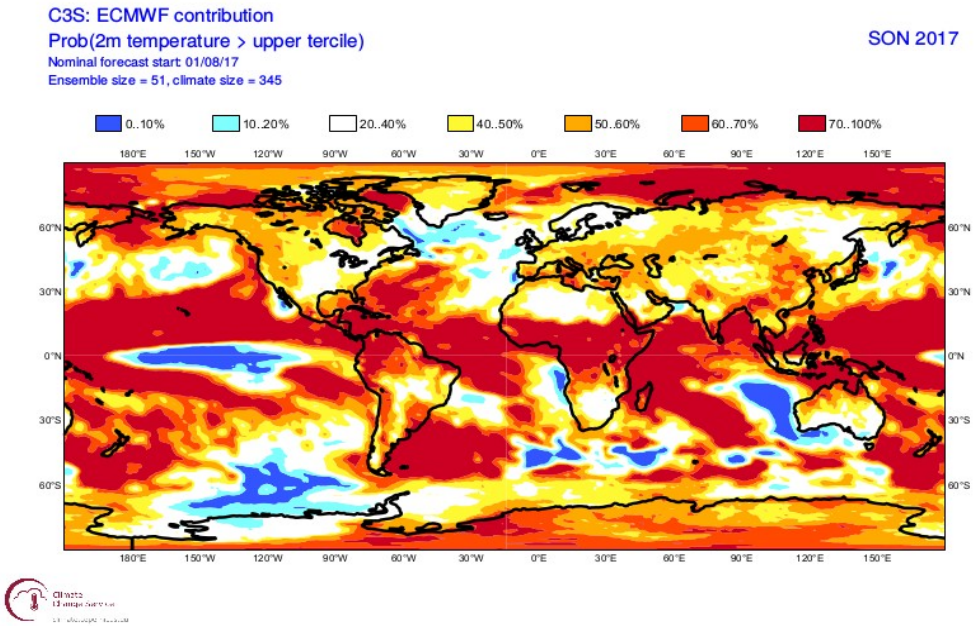


Atmosphere + Hydrosphere + Cryosphere + Lithosphere + Biosphere

The predictions are commonly expressed in terms of terciles:







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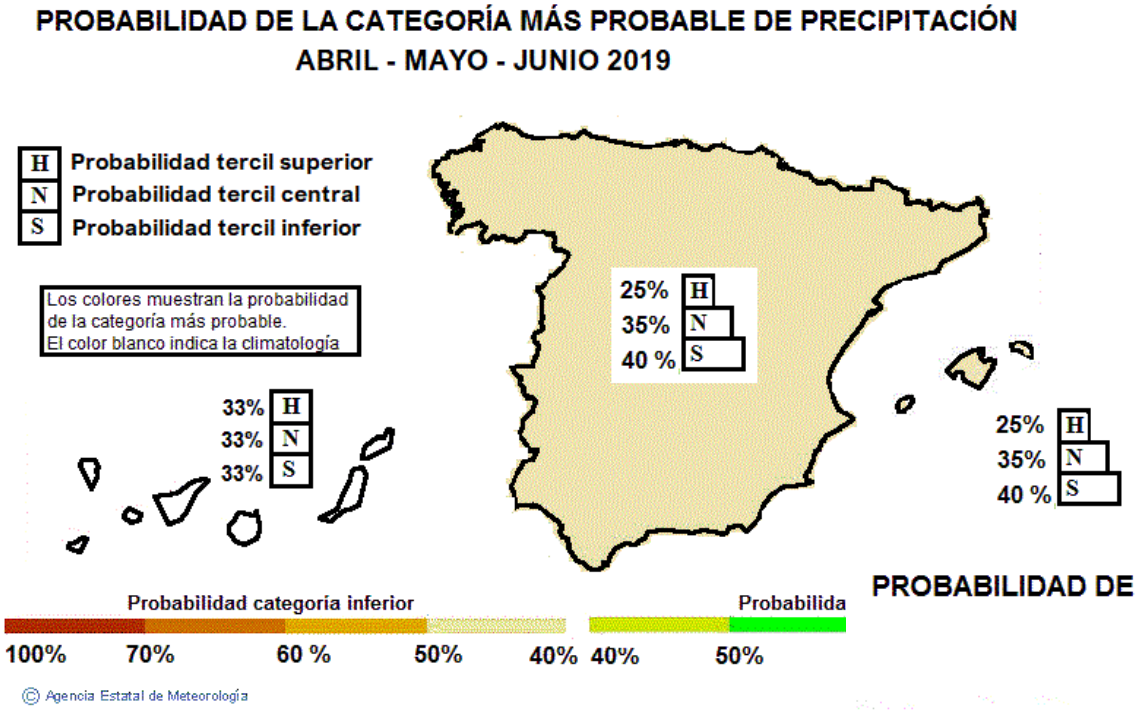

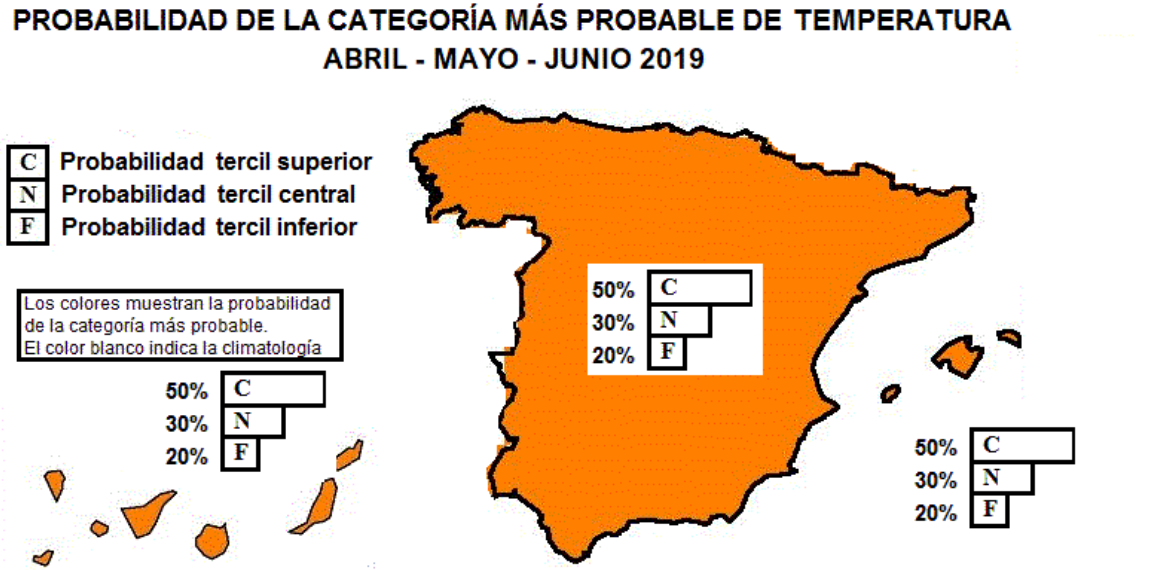

Atmosphere + Hydrosphere + Cryosphere + Lithosphere + Biosphere

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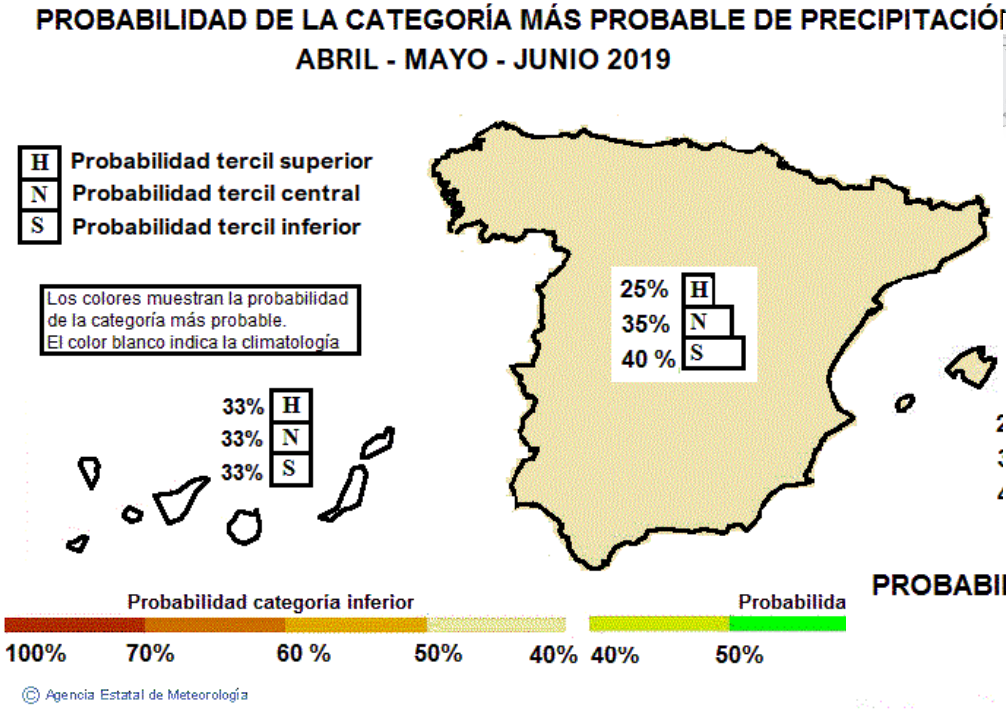
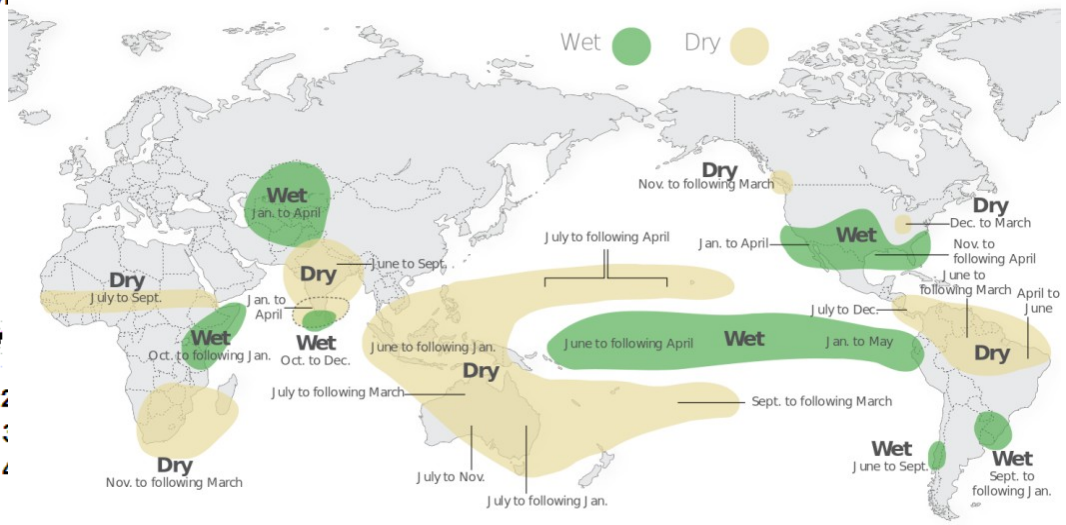
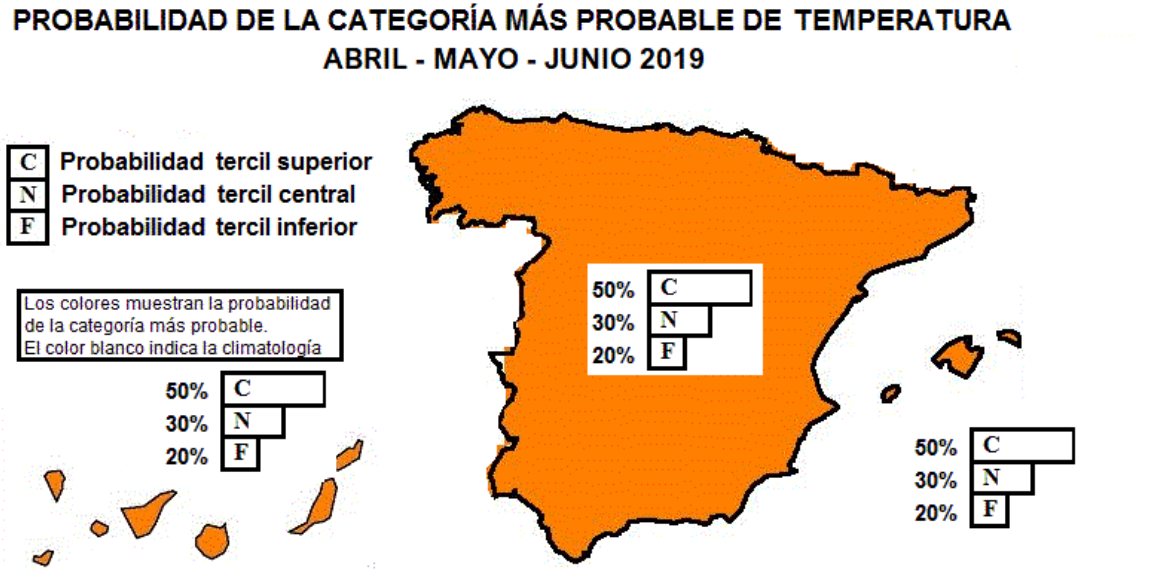




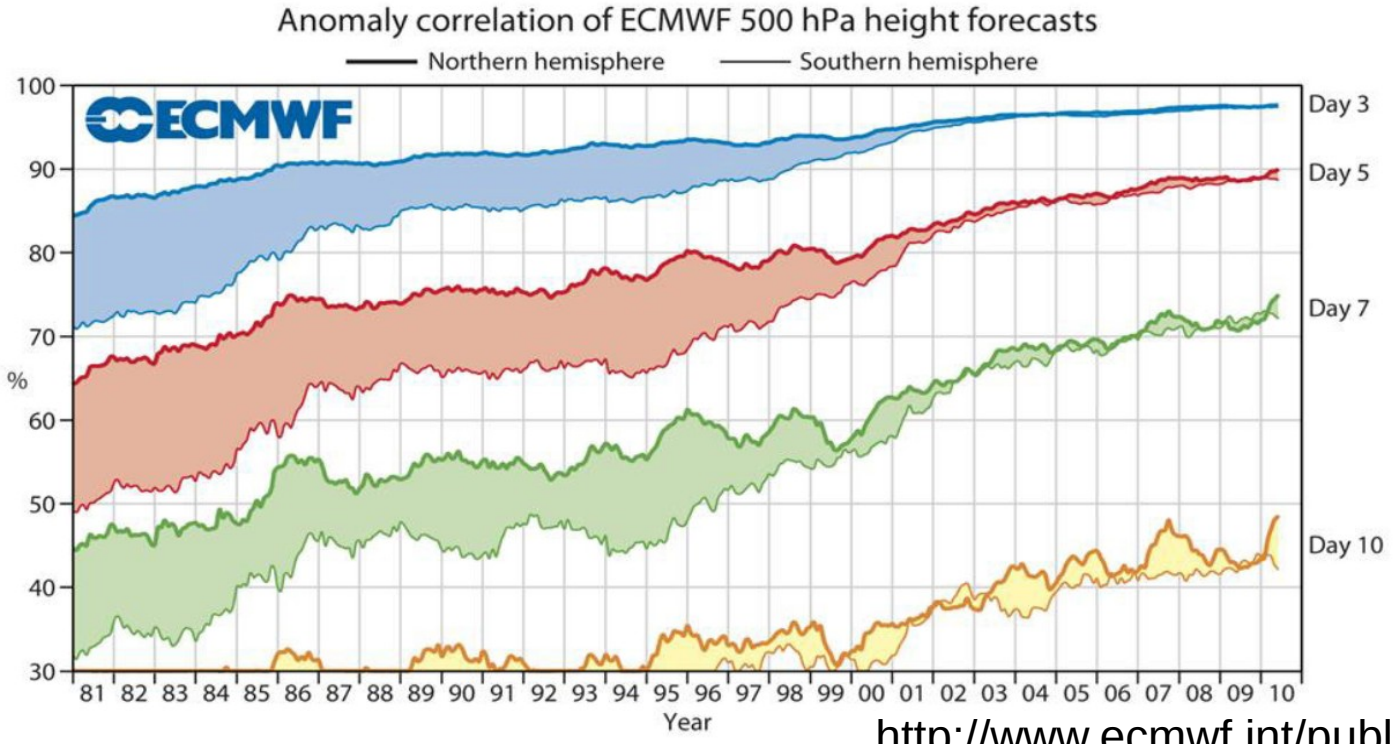


There is not teleconnection
In Europe → Poor skill

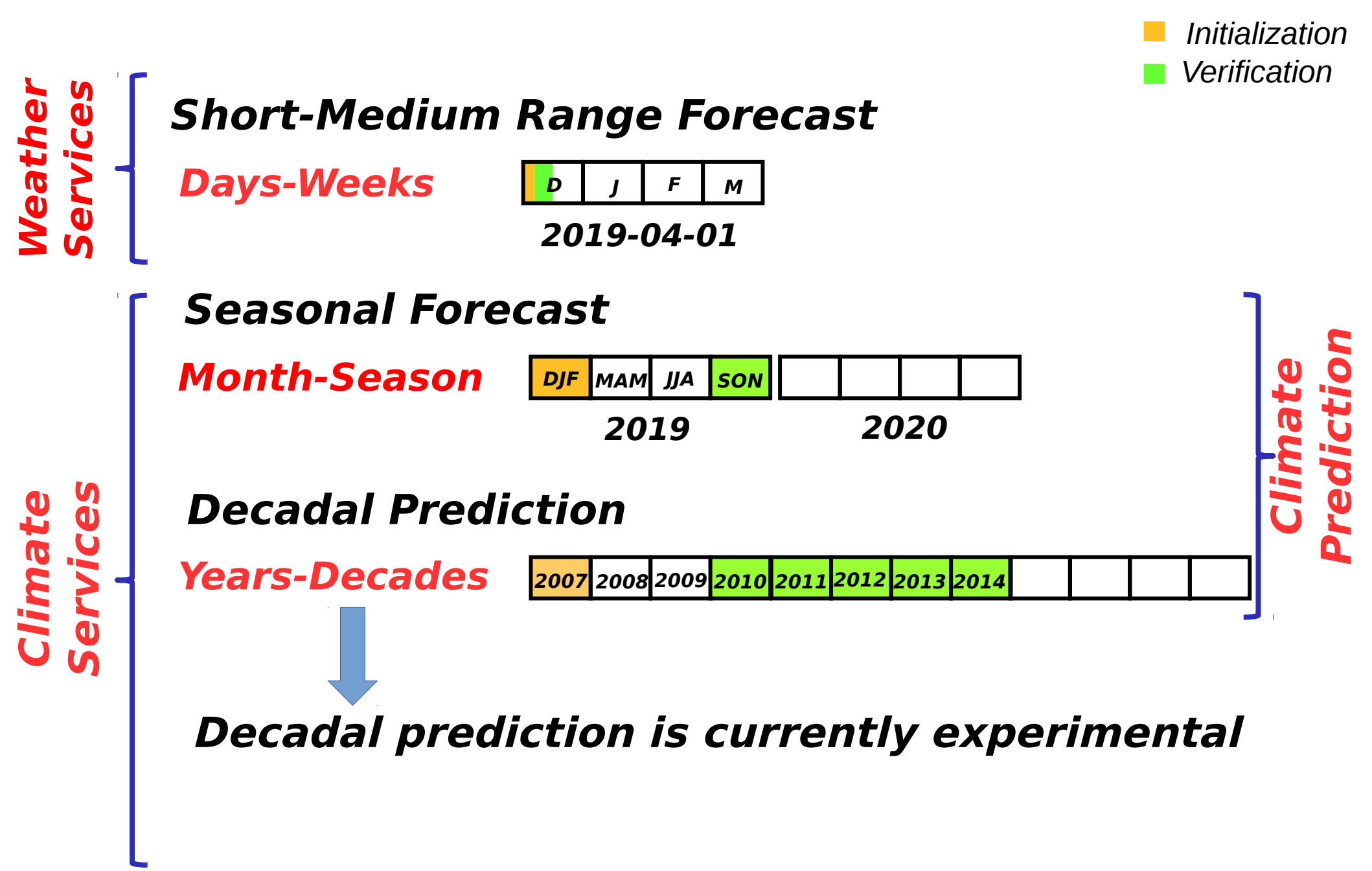
Reanalysisis a database of assimilated atmospheric states for a climatic period.

An **operational forecast** is a prediction for the future. Typically, only the recent past is stored.

A **reforecast (retrospective forecast)** is a database of historical forecasts performed with the same model for a long (climatic) period 1981-2010. In a **hindcast**, the initial conditions are taken from reanalysis.



http://www.ecmwf.int/publications/newsletters/pdf/122.pdf


Initialization
Verification
Weather Services
Short-Medium Range Forecast
Days-Weeks
D
J
F
M
2019-04-01
Climate Services
Seasonal Forecast
Month-Season
DJF
MAM
JJA
SON
2019
2020
Decadal Prediction
Years-Decades
2007
2008
2009
2010
2011
2012
2013
2014
Climate Prediction
Decadal prediction is currently experimental

Initialization
Verification

Weather Services

Short-Medium Range Forecast

Days-Weeks

2019-04-01

Climate Services

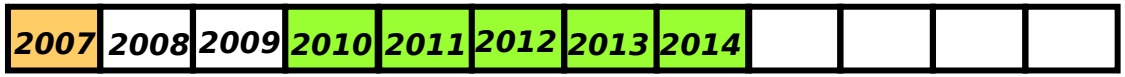
Seasonal Forecast

Month-Season

2019 2020

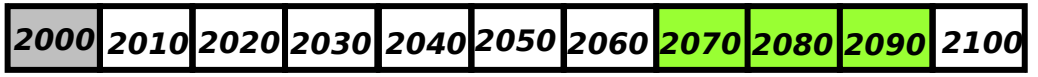
Decadal Prediction

Years-Decades



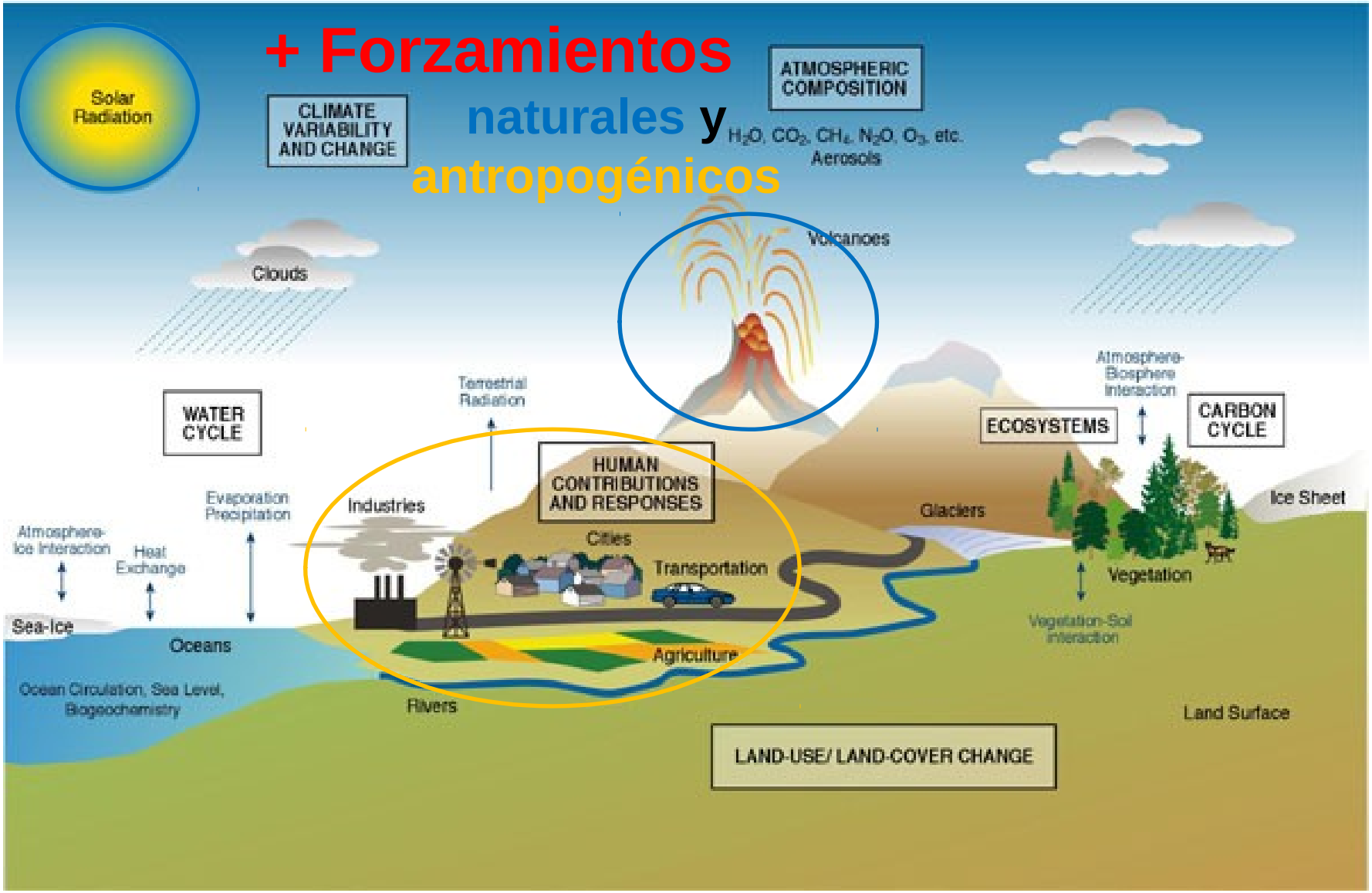
Anthropogenic Climate Change Projections

Decades-Century



Atmosphere + Hydrosphere + Cryosphere + Lithosphere + Biosphere

10-100 years → Decadal and Climate Change Projections

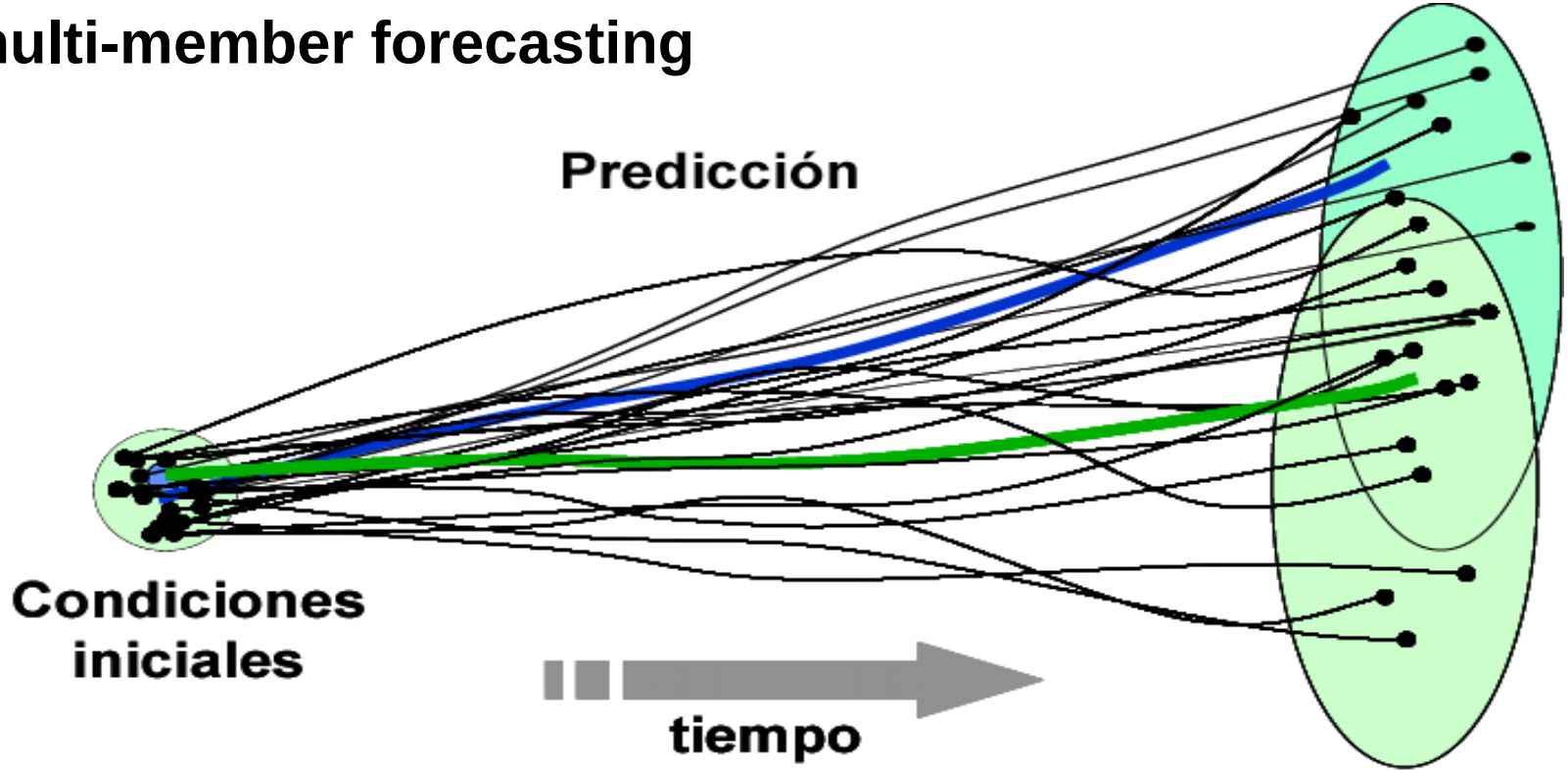


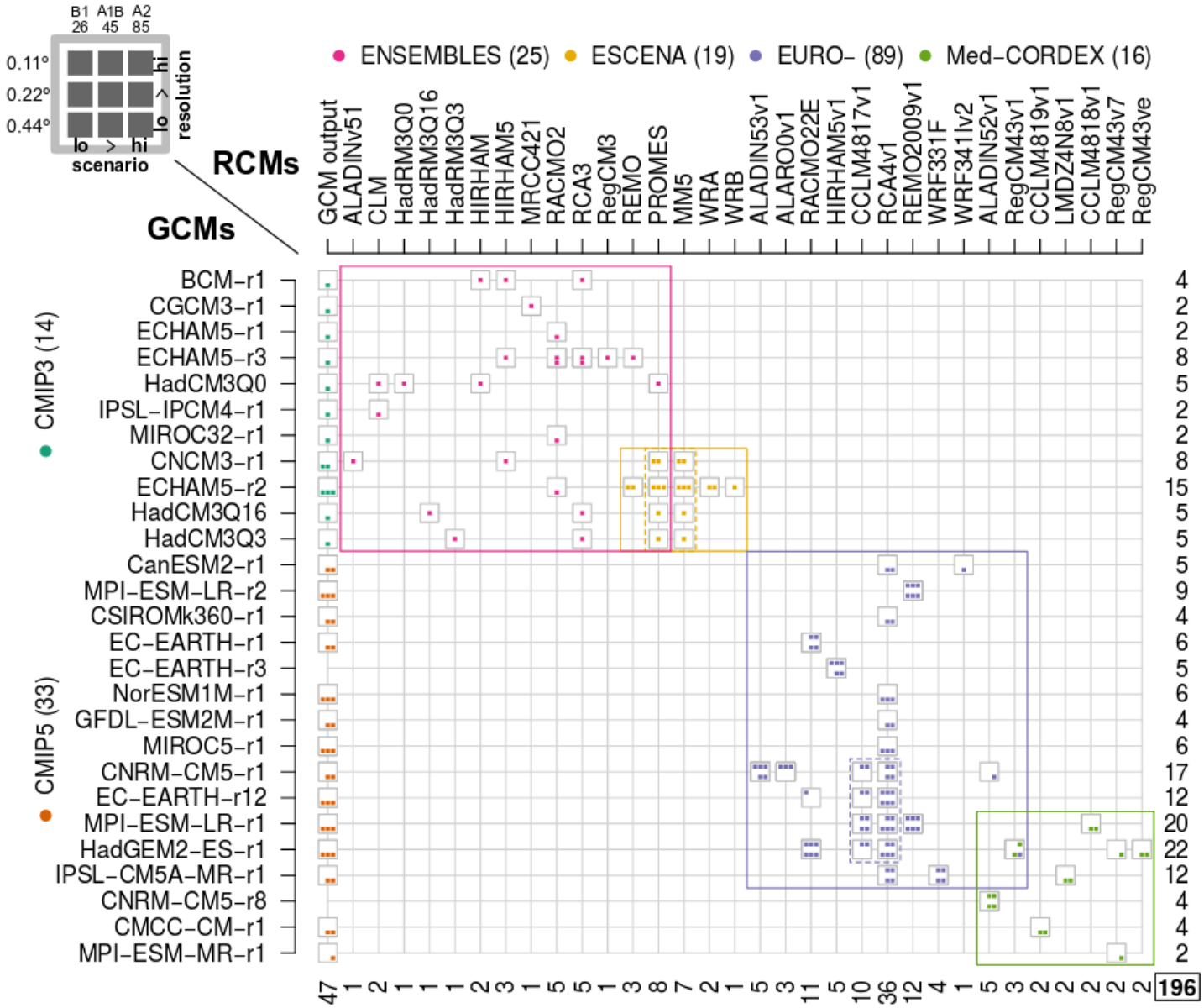
Uncertainty in the initial conditions: Perturbing the **Initial Conditions** of the atmosphere and ocean.

Other Uncertainties (model, scenario, etc.):

- Considering several models (**multi-model**)
- Stochastically perturbing the parameterizations of the model
- Considering several future scenarios.

Multi-model multi-member forecasting





Climate Change:

- Global Models (**GCM**)
- Regional Models (**RCM**)
- Scenarios/Experiments
- Runs
- Parameterizations
- ...

Petabytes → Exabytes!!!

Source: Fernández, J. et al. 2018, Consistency of climate change projections from multiple global and regional model intercomparison projects. Climate Dynamics. Doi:10.1007/s00382-018-4181-8

Seasonal Forecast

seasons

2017 **2018** **2019**

Seasonal Forecast has a great impact in several socio-economic fields:

- Agriculture
- Energy
- Transport
- Health
- Tourism
- Etc.

2010-2013 FUME / QWeCI

2011-2014 CLIM-RUN

2012-2017 EUPORIAS / SPECS

2016- Copernicus Climate Change Service; ERA4CS European Research Area for Climate Services

UC-IFCA (GMS)

AfriCultuReS (HORIZON 2020)

ECLISEA (ERA4CS European Research Area for Climate Services)

WATER

Anthropogenic Climate Change Projections

Decades-Century

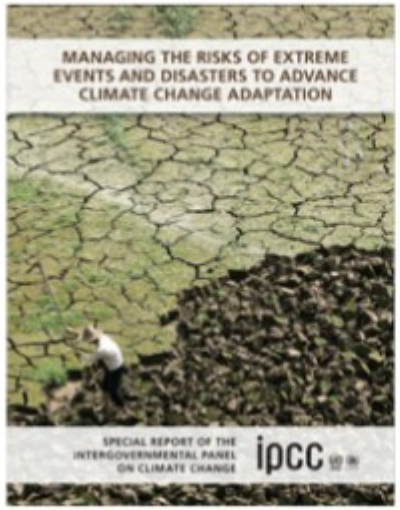
2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100

United Nations created the Intergovernnmental Panel on Climate Change (IPCC) in 1988 to improve the knowledge on climate change and to provide of authorized/contrast scientific information to the administrations. Three main branches were defined:

I. Scientific information on climate change.

II. Impact of and adaptation to the climate change.

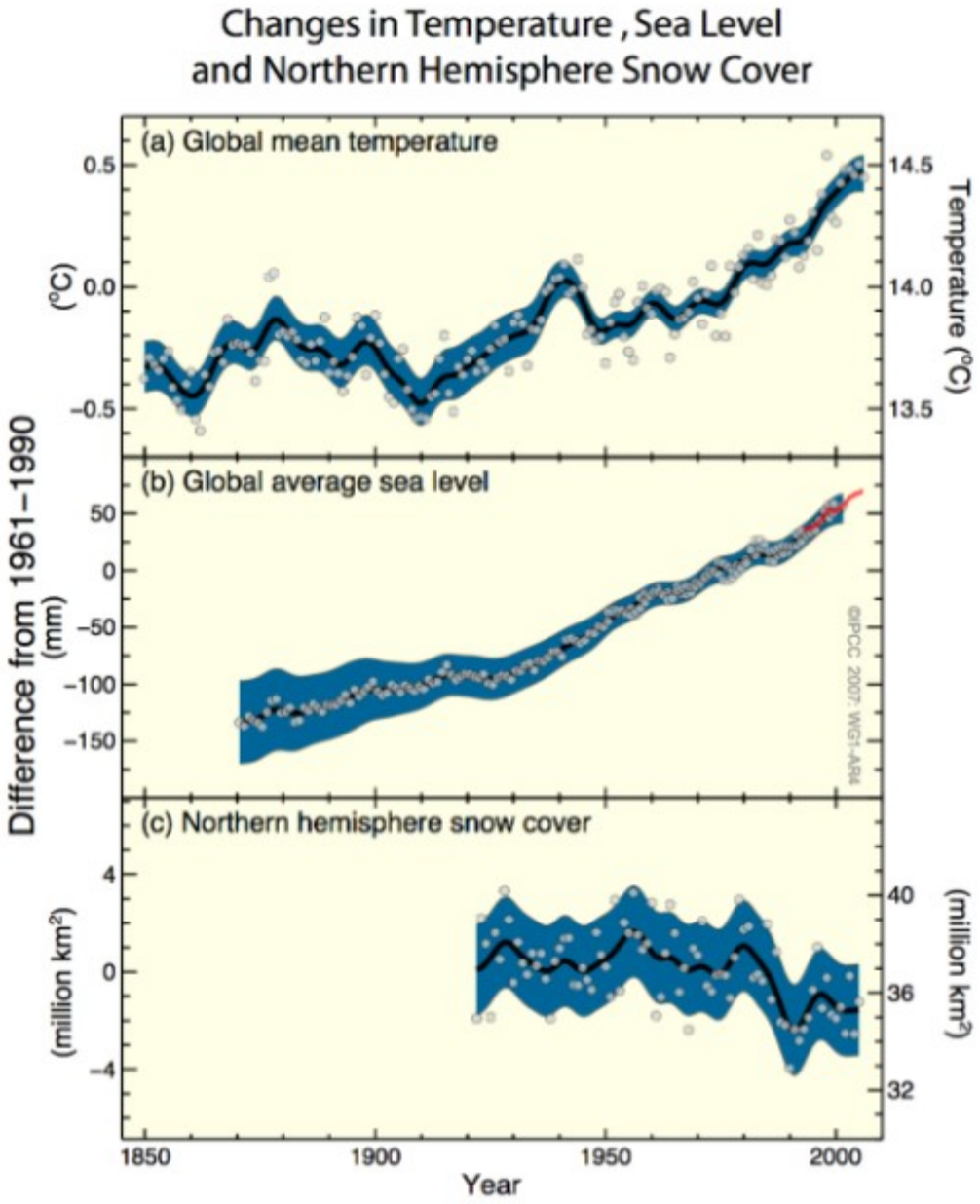
III. Political and economical aspects (mitigation).



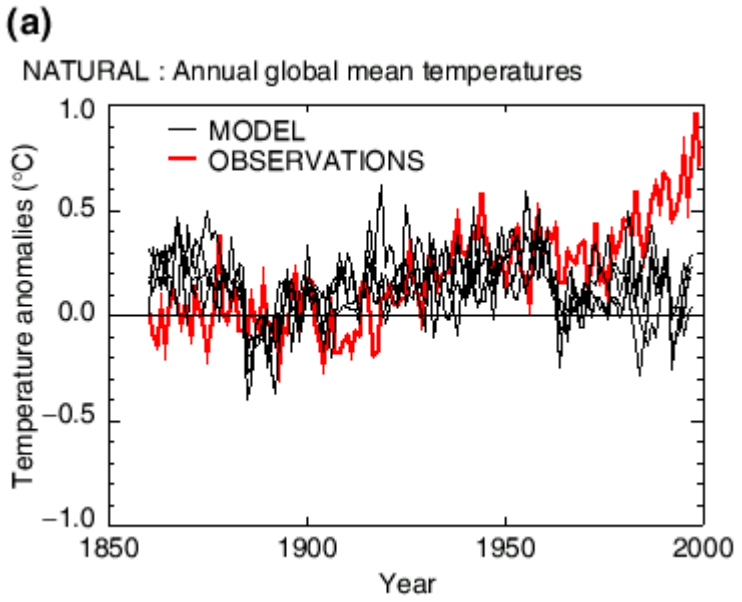
SRES Special Rep. (2012)

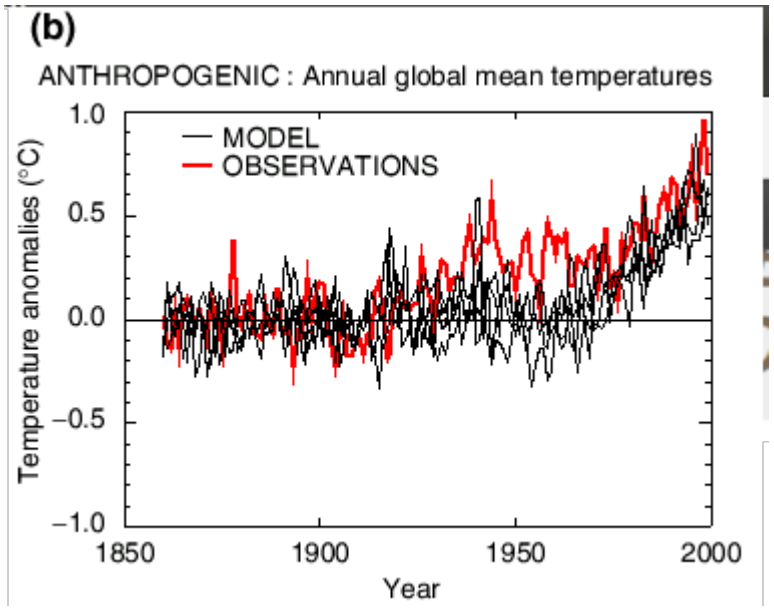
Five reports have been published since 1988, all of the available at http://www.ipcc.ch.

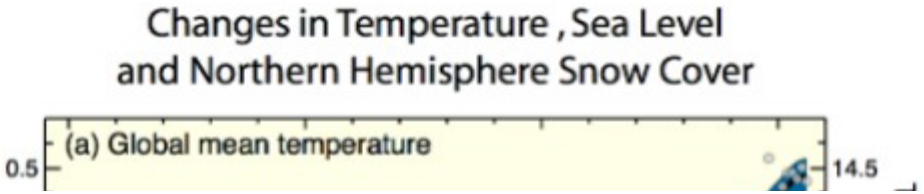
Recent Climate Change is evident:

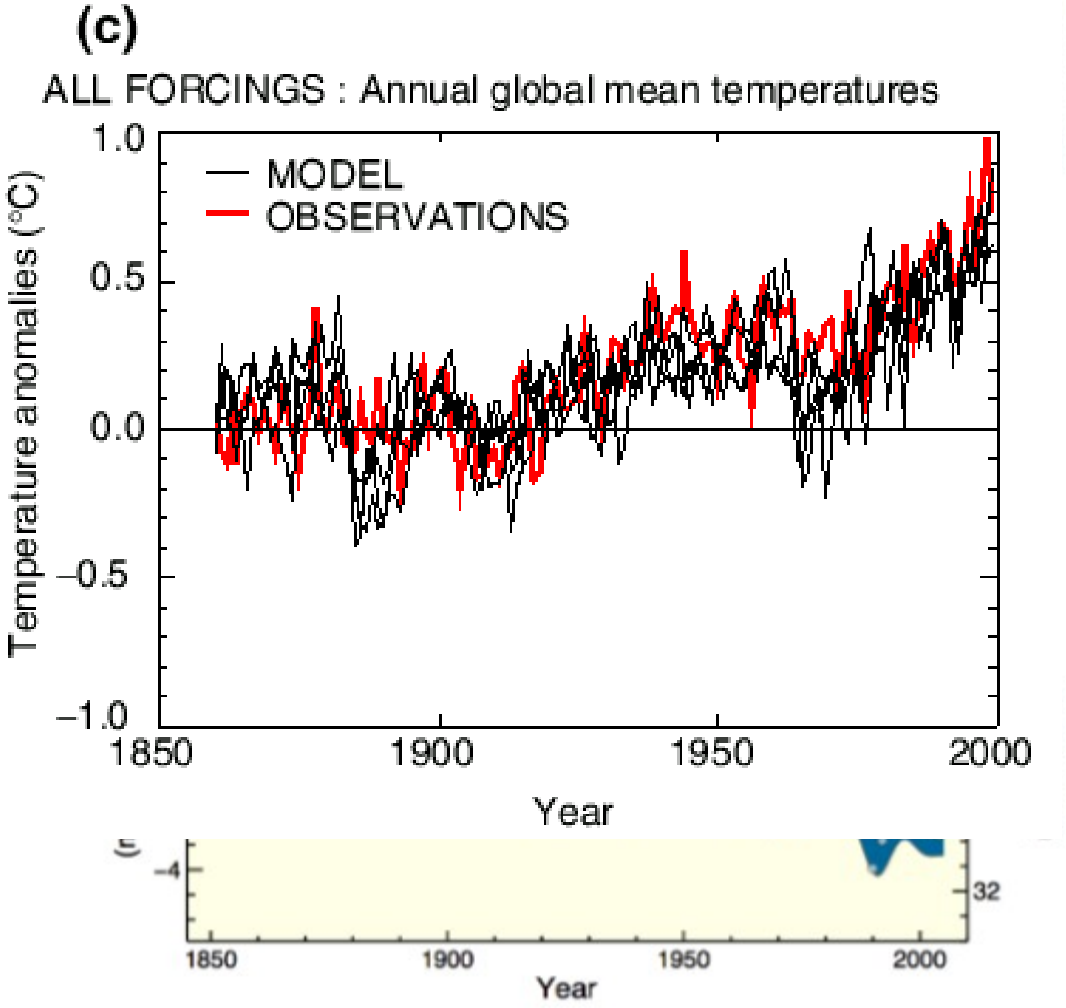


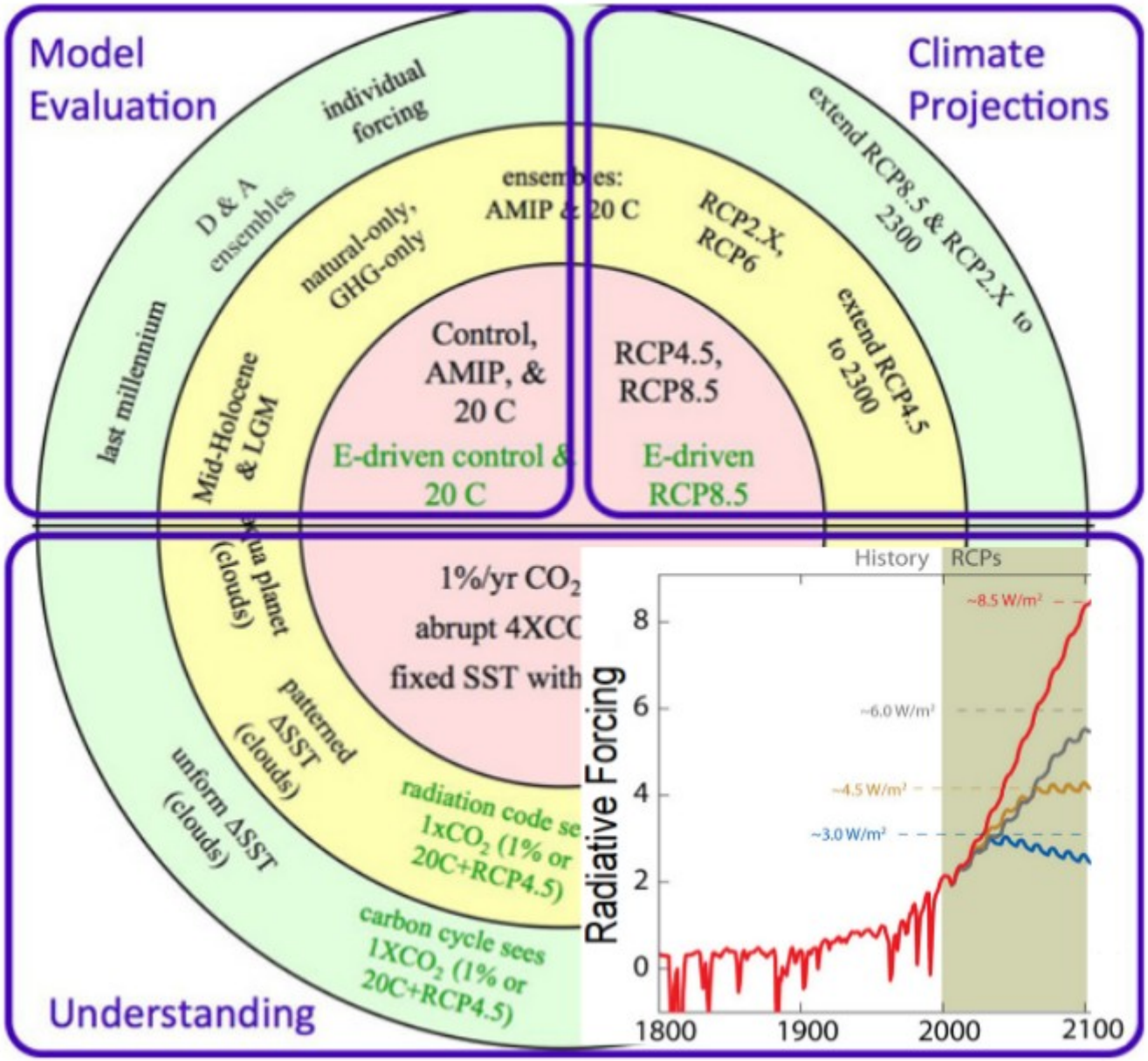
Recent Climate Change is evident → Attribution



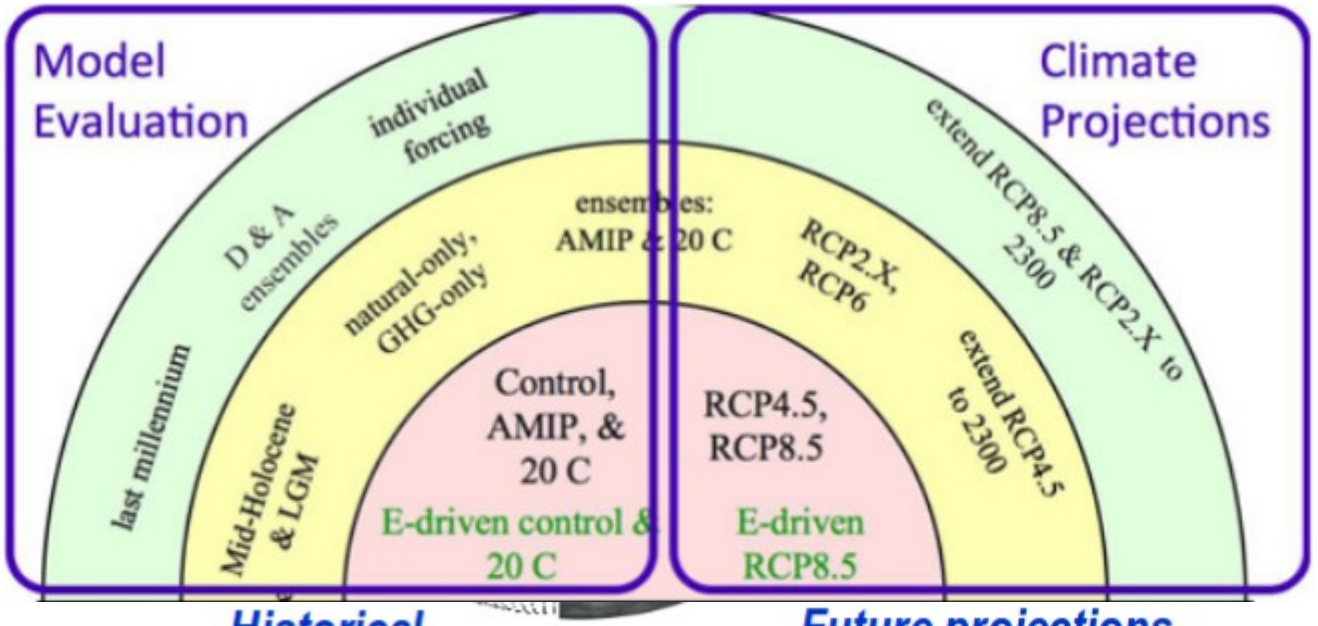








Multi-decadal forcing conditions are given for a number of historical and future scenarios for model validation and climate change attribution and projection.



Multi-decadal forcing conditions are given for a number of historical and future scenarios for model validation and climate change attribution and projection.

Historical simulations

1980 | 1990 | 2000

1h step x 30 years

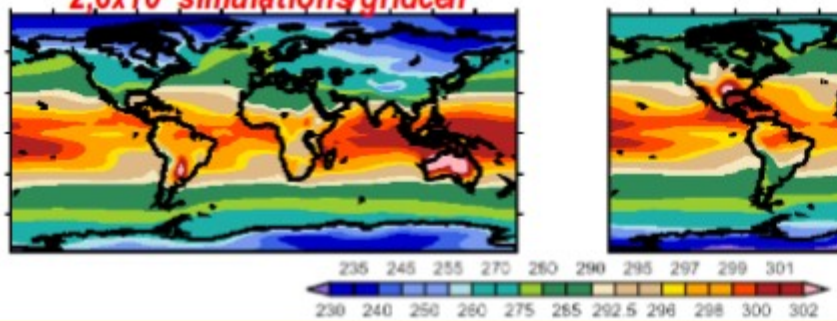
2,6x10⁵ simulations/gridcell

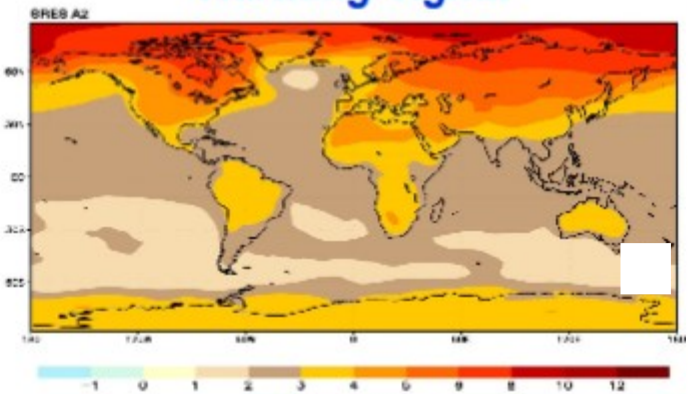
Future projections (scenarios)

2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | 2080 | 2090

"delta" method

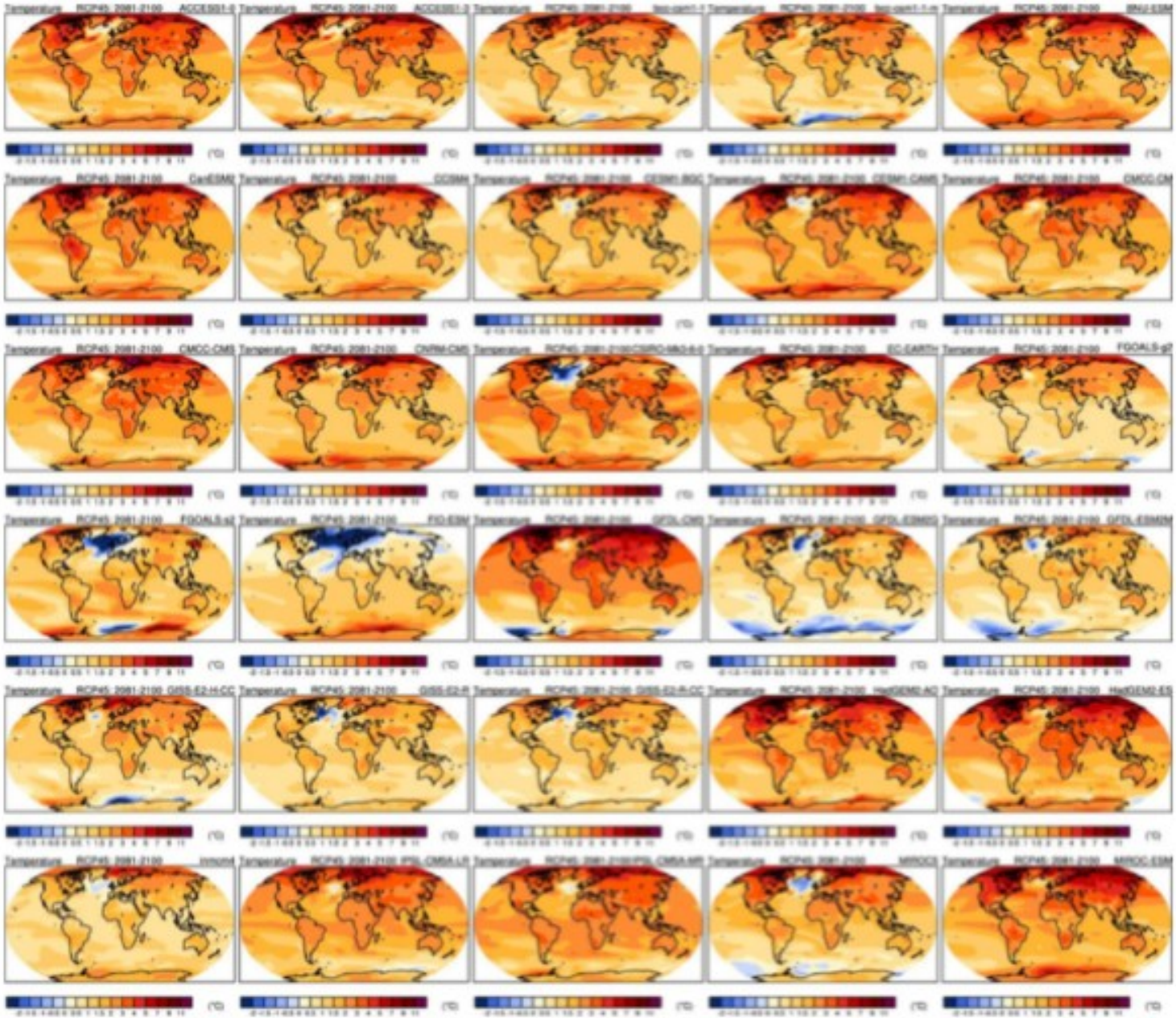
Warming signal





Computational (and physical) constraints limit the resolution (~100-200 Km)

Climate change projections are based on consensus multi-model information.



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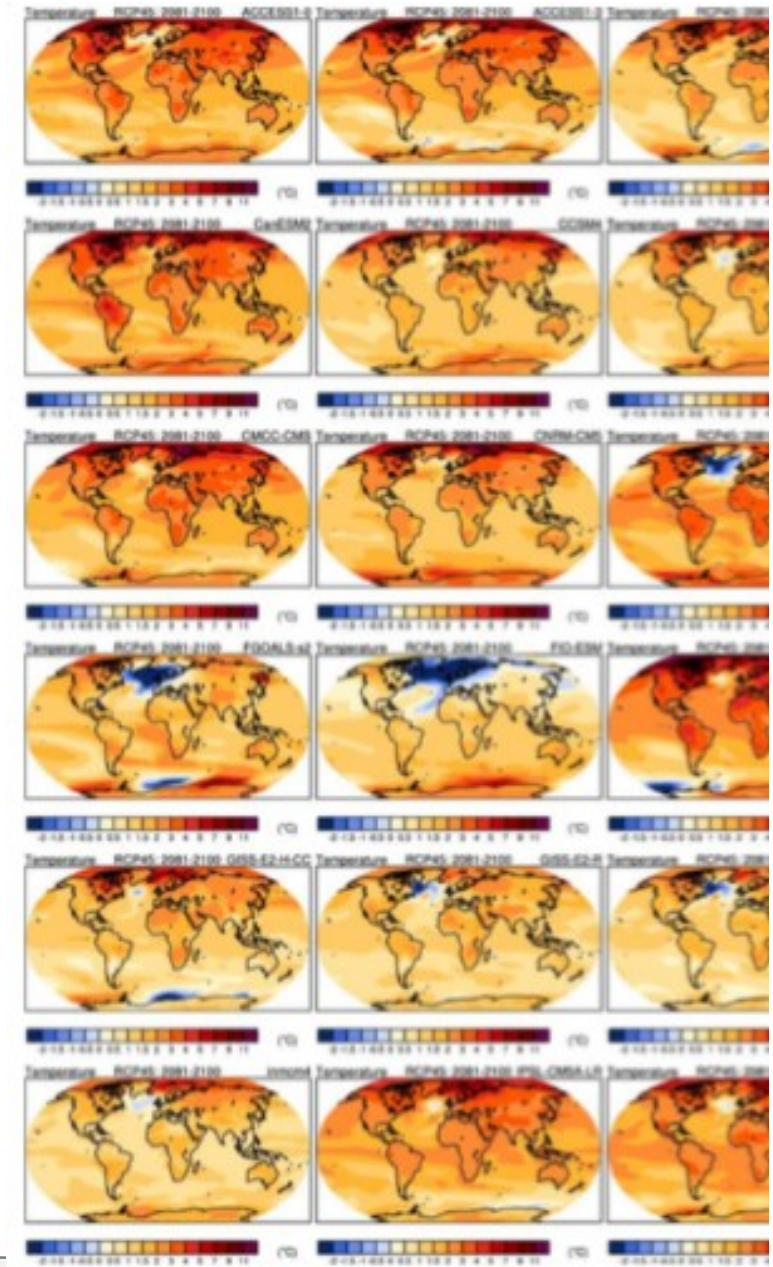
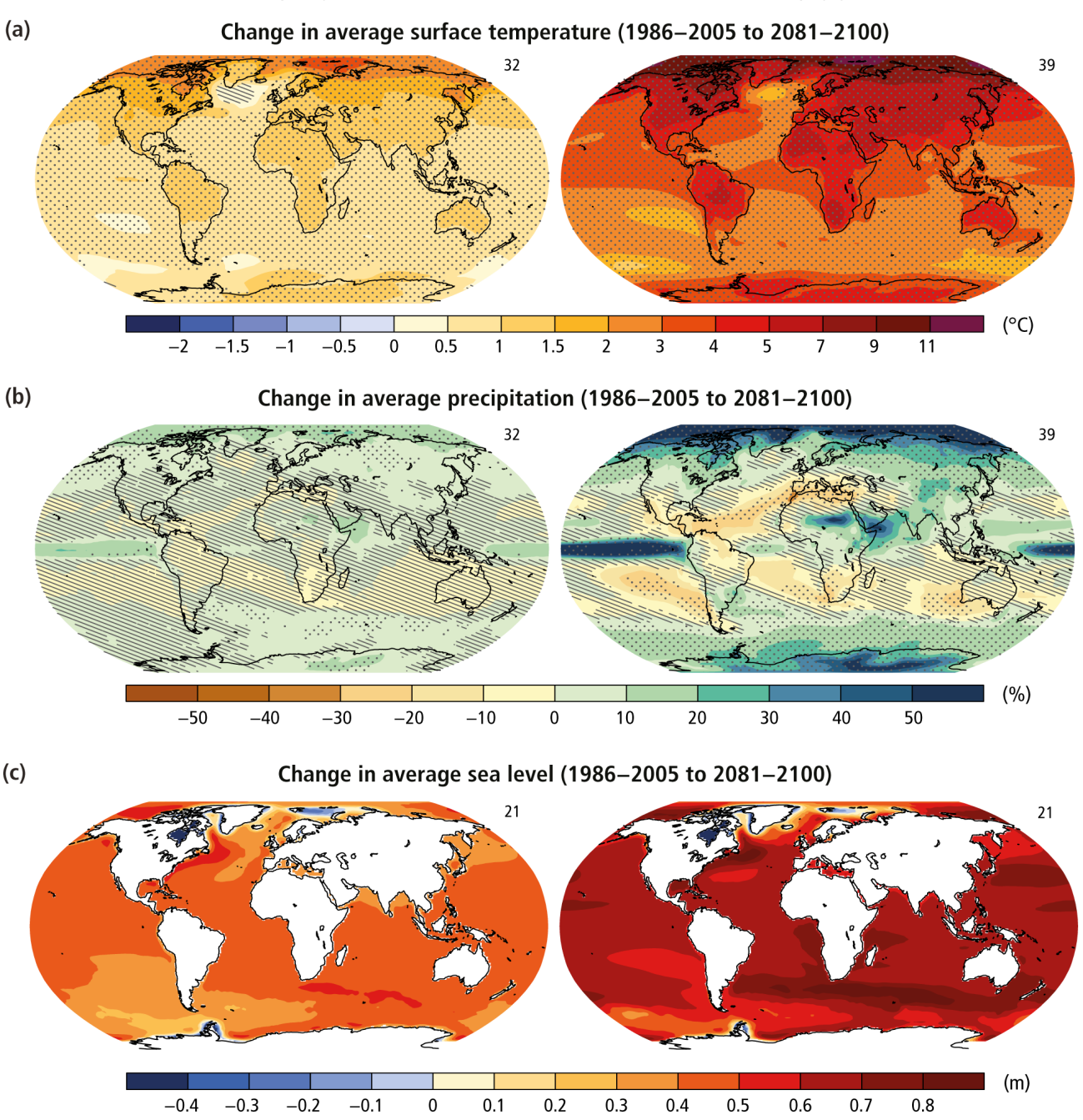
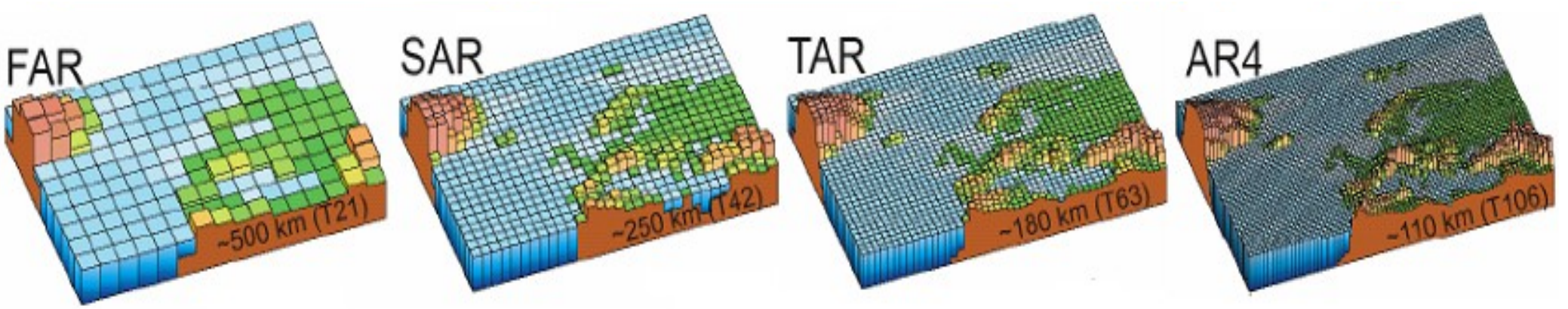
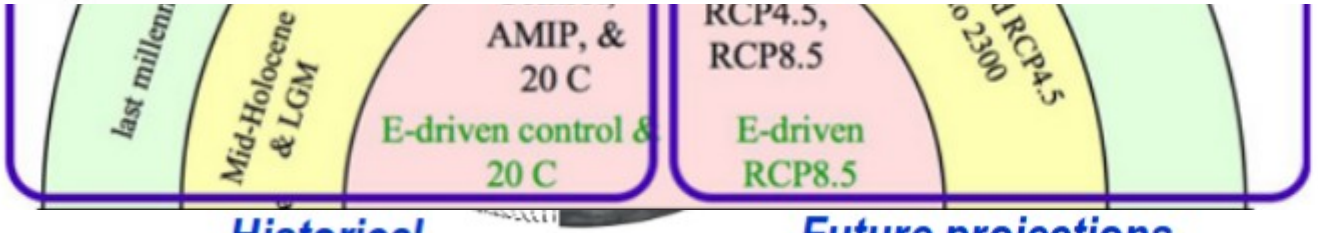




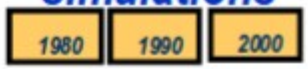
Intr





validation and climate change attribution and projection.

Historical simulations



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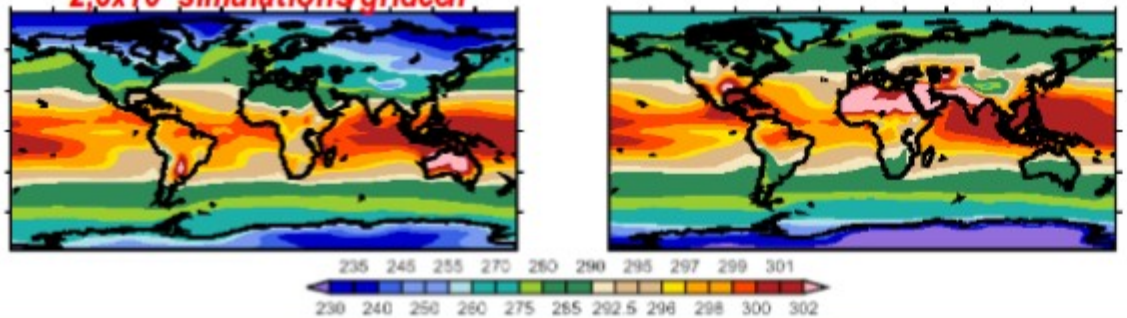

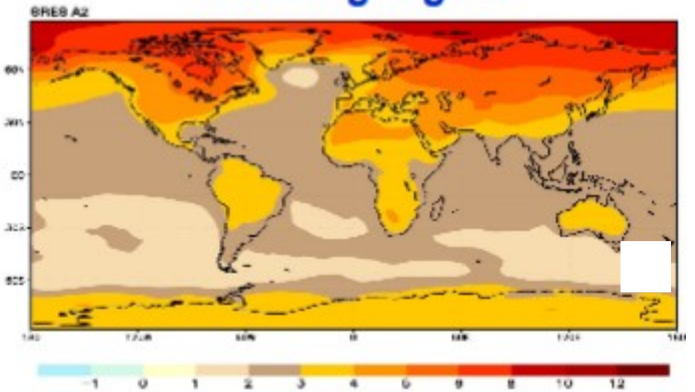

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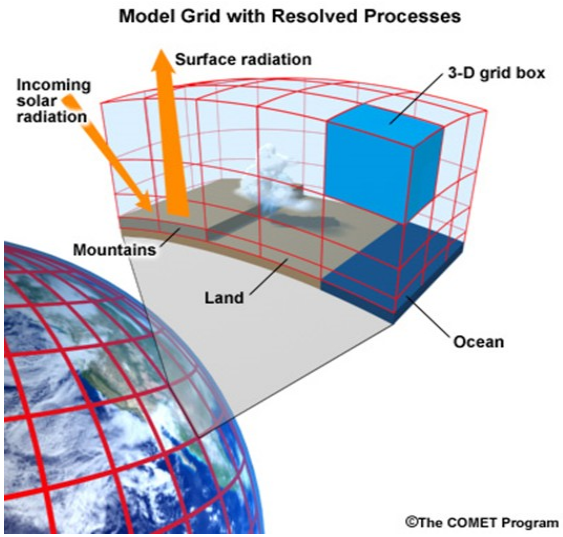
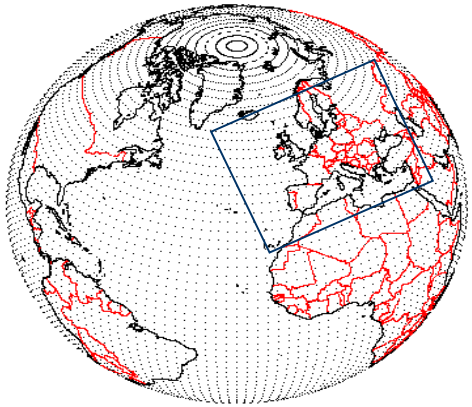
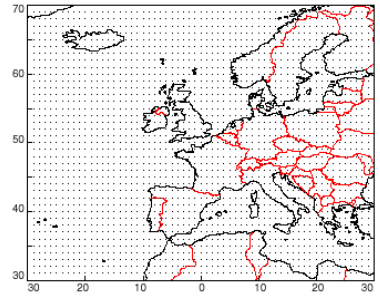
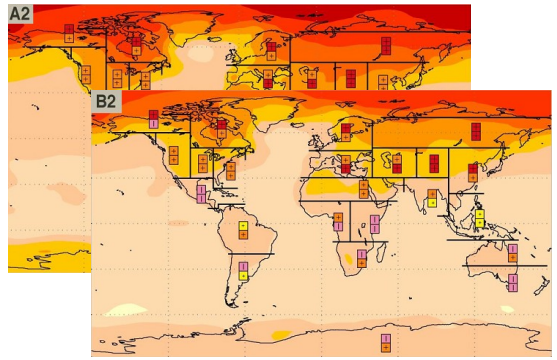

Model Grid with Resolved Processes
Surface radiation
3-D grid box
Incoming solar radiation
Mountains
Land
Ocean
©The COMET Program

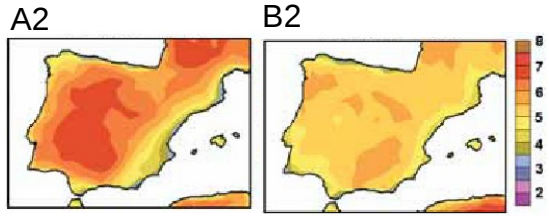

HadCM3Q0: 3.75° x 2.5°
„Reality“
0 100 200 300 500 750 1000 1250 1500 2000 2500 3000 [m]

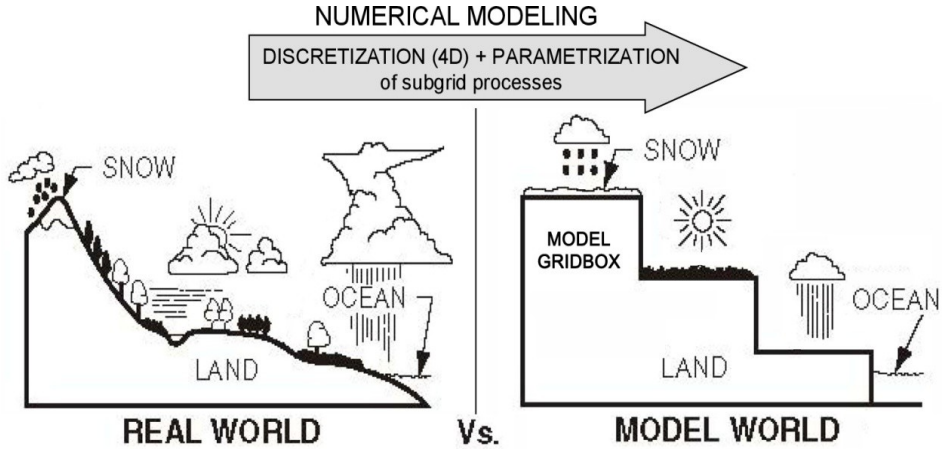


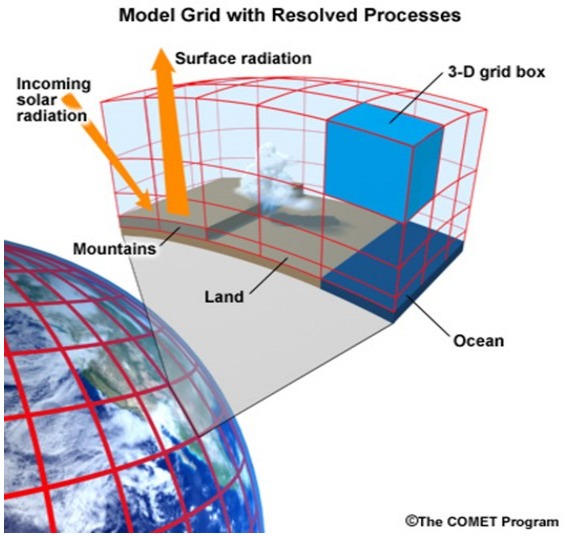
RCM

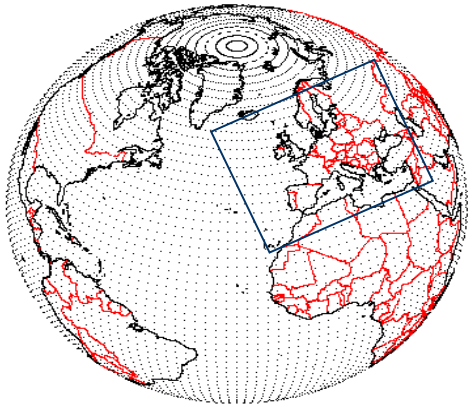

70
60
50
40
30
30 20 10 0 10 20 30


A2
B2

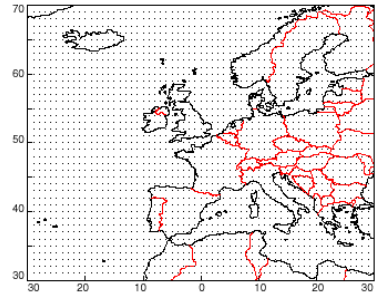

A2
B2
8
7
6
5
4
3
2

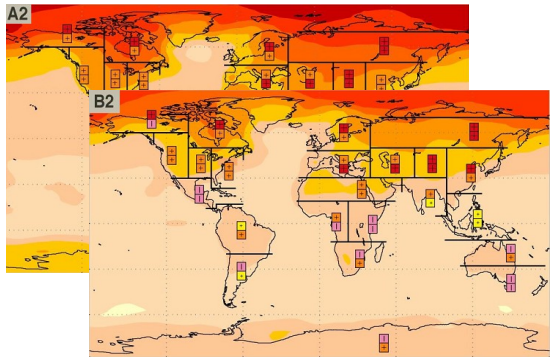

NUMERICAL MODELING
DISCRETIZATION (4D) + PARAMETRIZATION
of subgrid processes
SNOW
OCEAN
LAND
REAL WORLD
Vs.
SNOW
MODEL GRIDBOX
OCEAN
LAND
MODEL WORLD

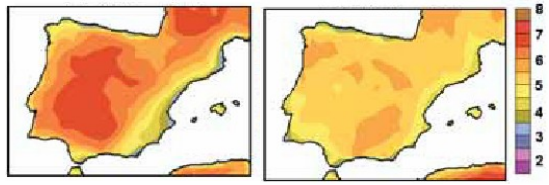




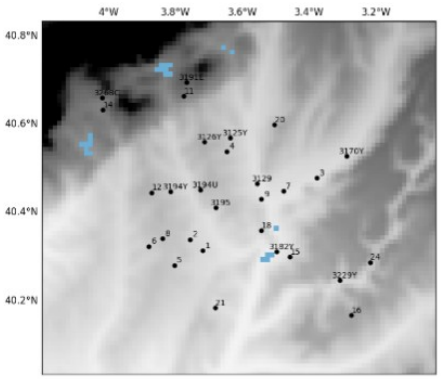
RCM

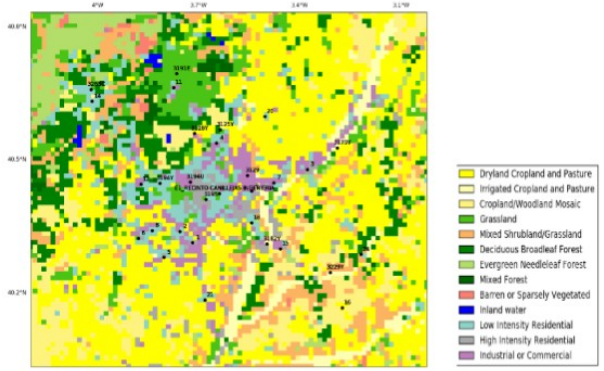






Depending on the target resolution some boundary conditions, as the land use, should be considered and Introduced in the model.

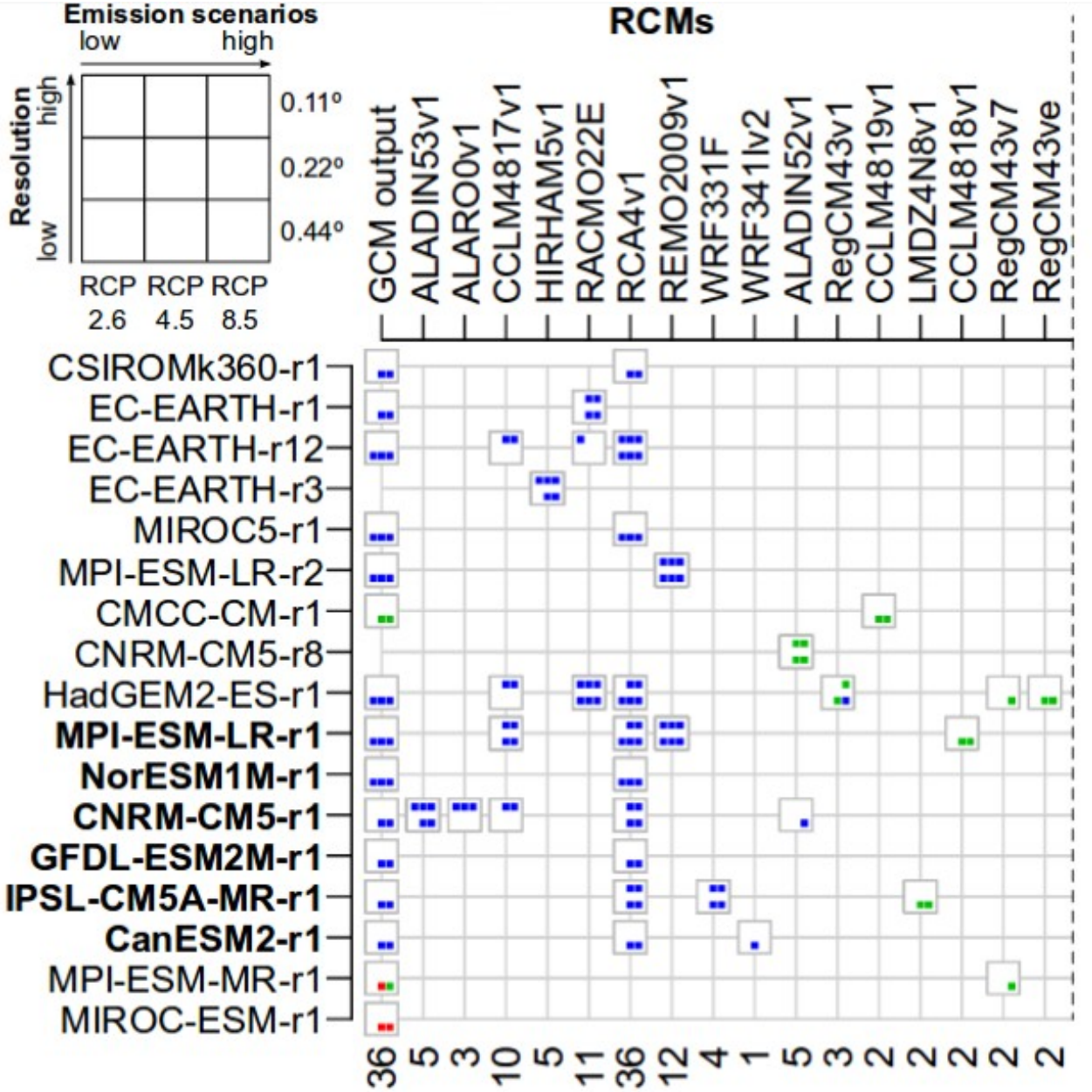


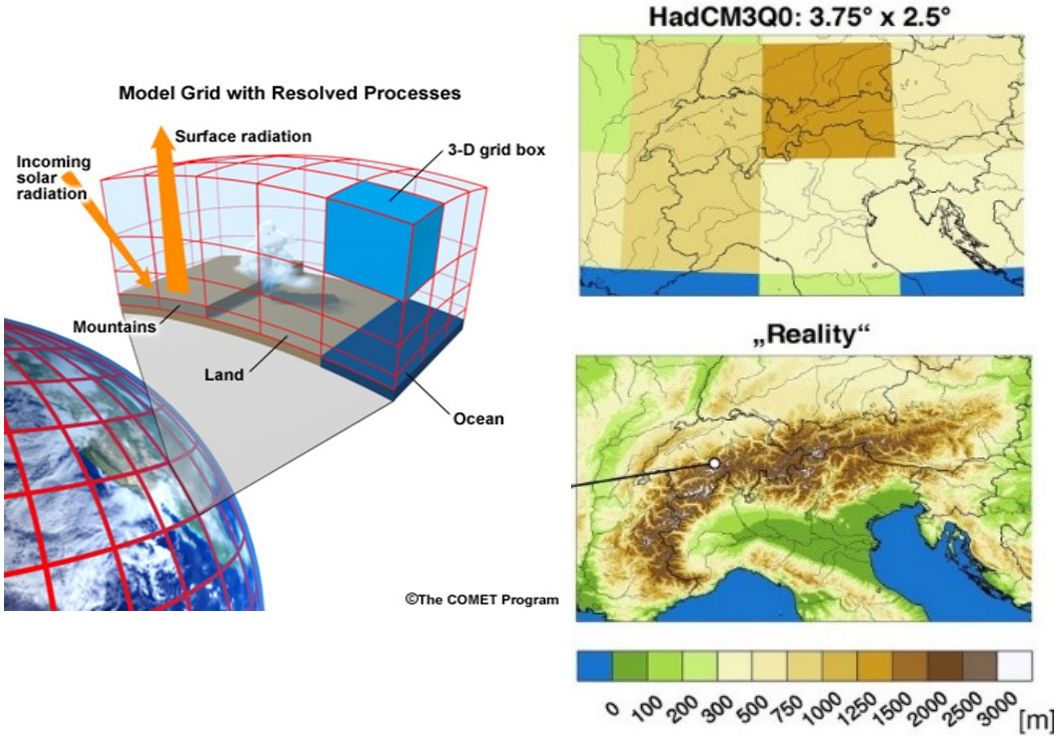


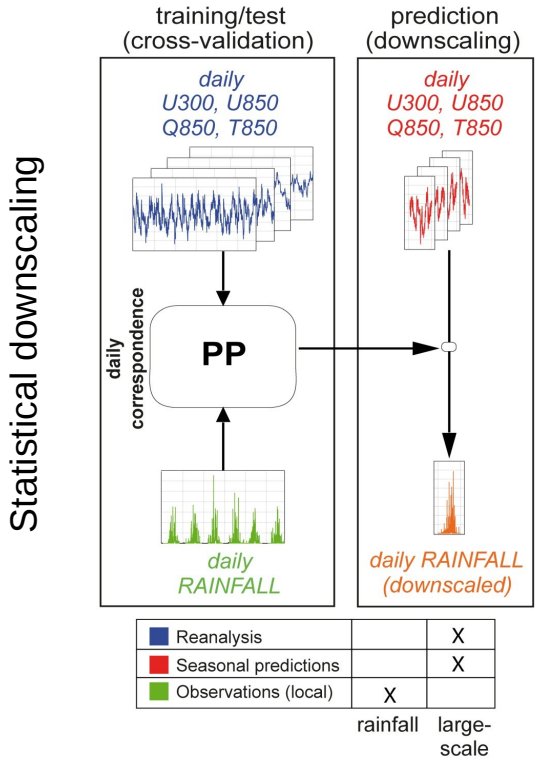
CORINE, en lugar de USGS33

Euro-CORDEX is the last of a series of international initiatives for regional climate change projection over Europe.

0.11º and **0.44º** resolution.

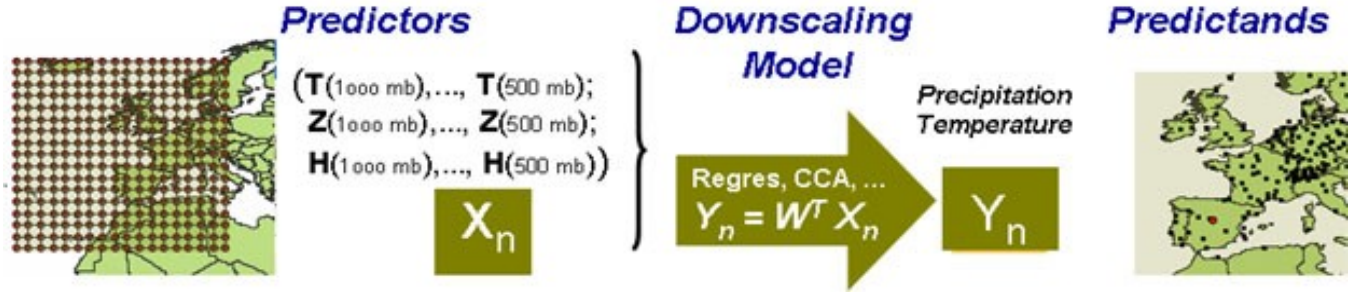






Statistical Downscaling

Statistical methods linking the local observed climate (**predictand *Y***) with the global simulations given by the GCMs (**predictors *X***), through some **function *f*** and/or **parameters *θ* :** $\mathbf{Y} = f(\mathbf{X};\boldsymbol{\theta})$



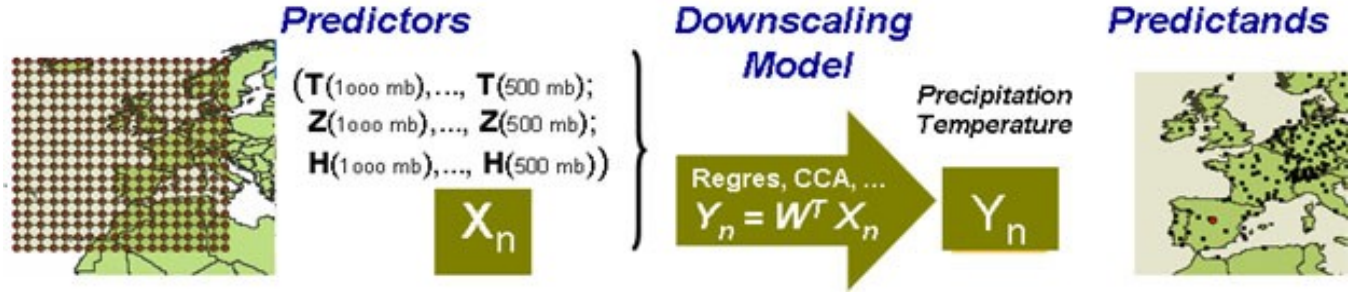
Appro. \ Tech.		Generative		non-Generative	
		Deterministic	Stochastic	Deterministic	Stochastic
PP	Eventwise	Regression, Neural Nets.	GLMs	Analogs, weather types	Analog resampling
	Distribution	Regression on PDF parameters			
MOS	Eventwise	Regression, Neural Nets.	GLMs	Analogs	Analog resampling
	Distribution	Bias correction, parametric q-q map	Nonhomogeneous HMM	q-q map	

There is **day-to-day** correspondence.

There is **not day-to-day** correspondence.

Statistical Downscaling

Statistical methods linking the local observed climate (**predictand *Y***) with the global simulations given by the GCMs (**predictors *X***), through some **function *f*** and/or **parameters θ :** $\mathbf{Y} = f(\mathbf{X};\theta)$



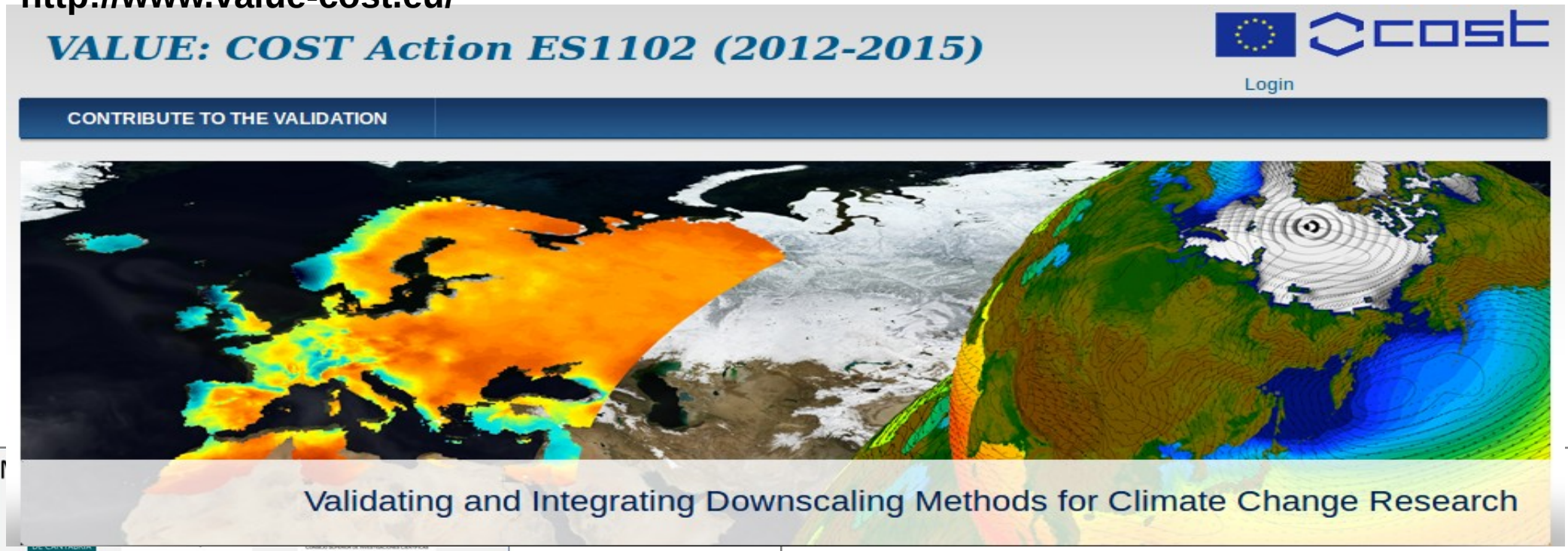
http://www.cordex.org/domains/cordex-esd/

Cordex ESD

Experiment protocol – Empirical statistical downscaling

- ESD Overview
- ESD Background
- ESD Experiment1 protocols
- ESD Reference Document
- Register for CORDEX ESD Experiment 1

http://www.value-cost.eu/



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Weather Types:

The goal is obtaining a partitioning of the atmospheric space (using reanalysis data) in a predefined number of groups (weather types).

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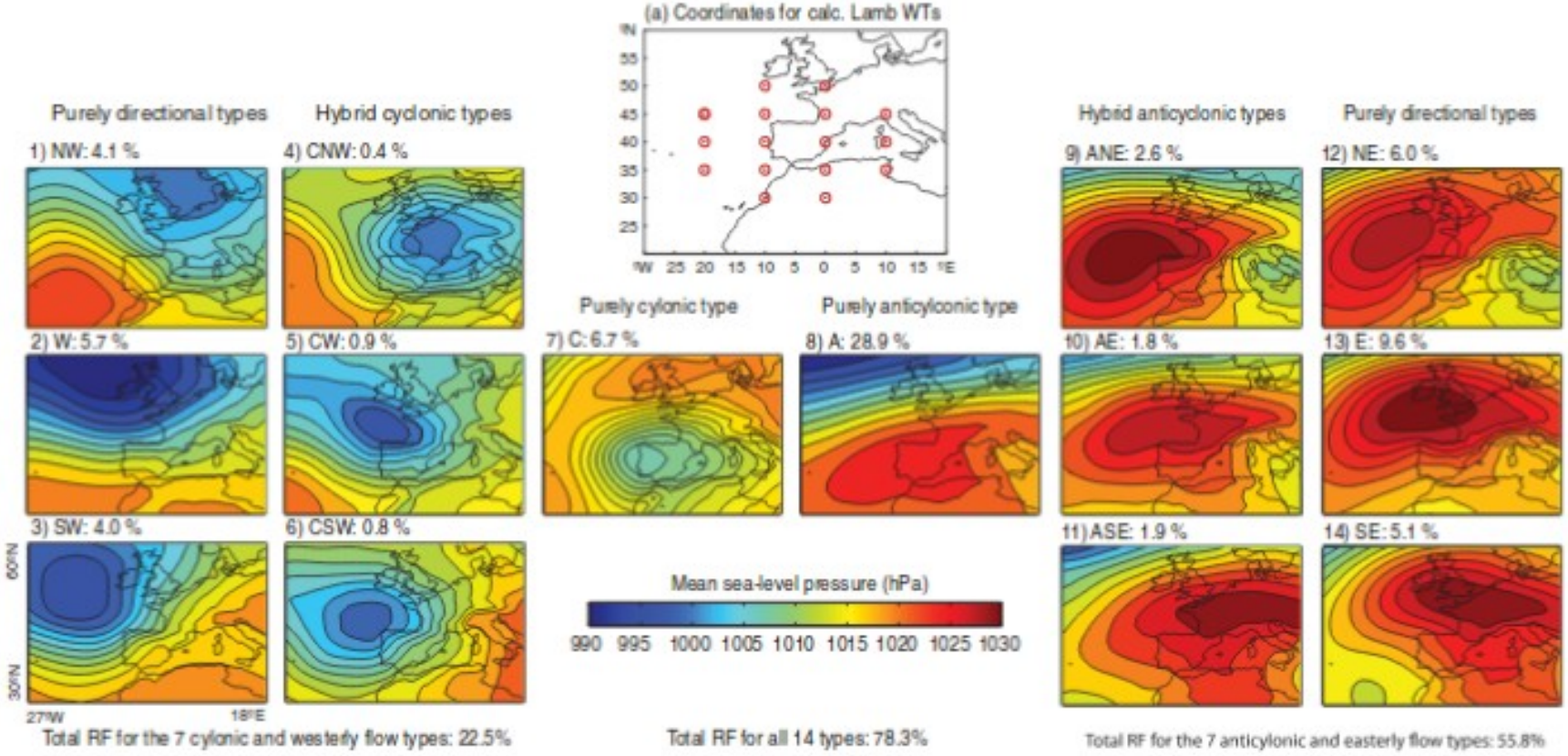
Lamb Weather Types (Expert Approach)



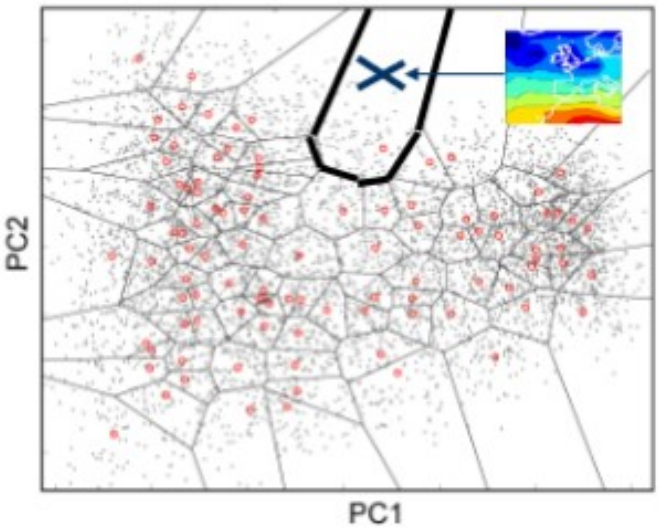
Source: Brands et al. 2014, http://meteo.unican.es/en/node/73157

Weather Types:

The goal is obtaining a partitioning of the atmospheric space (using reanalysis data) in a predefined number of groups (weather types).

Clustering algorithms:

OPT (optimization methods)					
48	CKMEANSC09	9	MSLP	Y	Enke and Spekat (1997)
49	CKMEANSC18	18	MSLP	Y	
50	CKMEANSC27	27	MSLP	Y	
51	PCACA	4–5	MSLP	Y	Yamal (1993)
52	PCACAC09	9	MSLP	Y	
53	PCACAC18	18	MSLP	Y	
54	PCACAC27	27	MSLP	Y	
55	PETISCO	25–38	MSLP, Z500	Y	Petisco et al. (2005)
56	PETISCOC09	9	MSLP	Y	
57	PETISCOC18	18	MSLP	Y	
58	PETISCOC27	27	MSLP	Y	
59	PCAXTRKM	11–17	MSLP	Y	Esteban et al. (2005, 2006)
60	PCAXTRKMC09	9–10	MSLP	Y	
61	PCAXTRKMC18	15–18	MSLP	Y	



Given a new pattern (**X**), the group is obtained Ck. Then, the forecast is P(y>u|Ck).

Weather Types:

The goal is obtaining a partitioning of the atmospheric space (using reanalysis data) in a predefined number of groups (weather types).

Clustering algorithms:

The SOM is made with an arbitrary number of centers/prototypes arranged in a 2D grid.

Each prototype $\mathbf{w_i}=(w_{i1}, \ldots, w_{in})$
n is the dimension of the original space.

The training is made in cycles **(t=1,…,n)**:

1) Compute the winner prototype (closest) $\mathbf{w_{i(t)}}$ for each pattern v_k :

$$\| v_k - w_{i(t)} \| = \min_i \{\| v_k - w_i \|, i=1,\ldots,m\}.$$

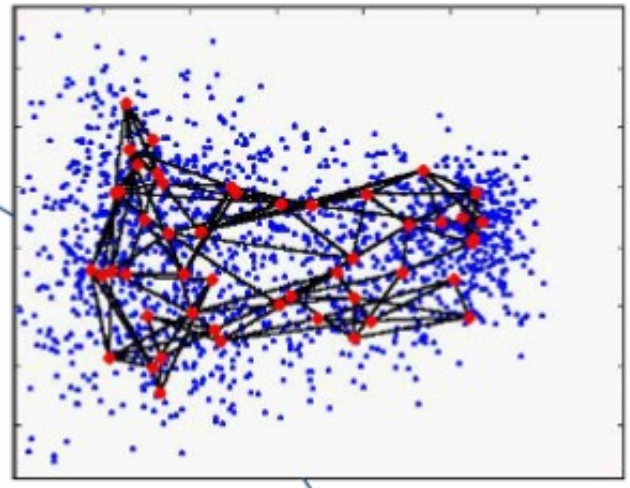
2) The winner prototype and the neighbors are moved towards the data point:

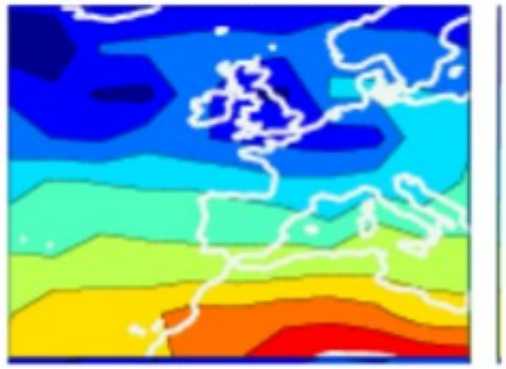
$$w_i(t+1)=w_i(t)+a(t)\ \mathbf{v_k}\ h(\|w_i(t) - w_{i(k)}(t)\|),$$

a(t) learning rate **(linear decreasing)**;
h(x) neighborhood kernel **(linear decreasing of the variance)**

Oja E. And Kaski S., 1999: Kohonen Maps. Amsterdam, Elsevier

SOM 7 x 7

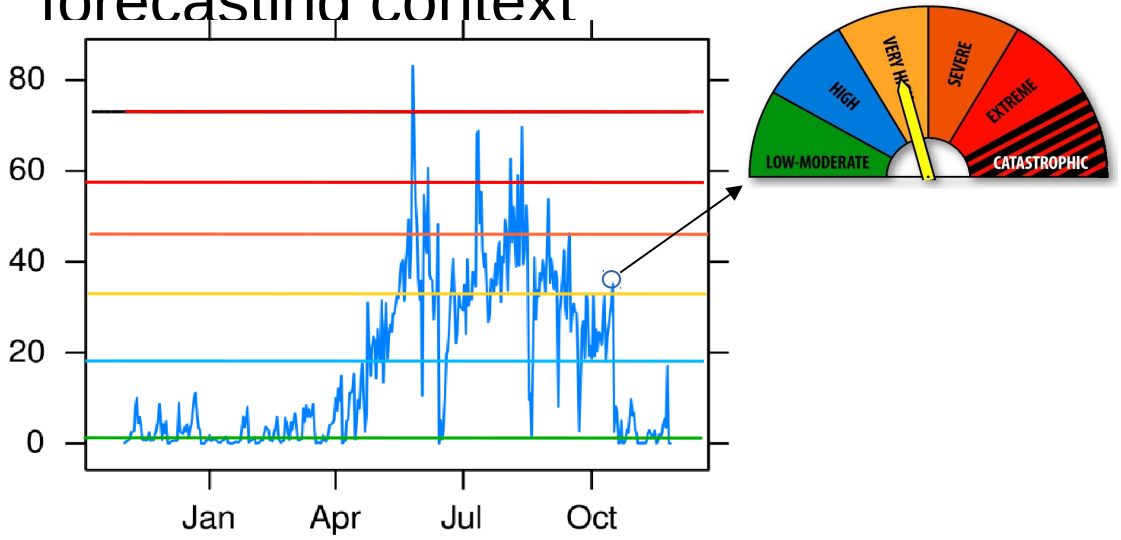


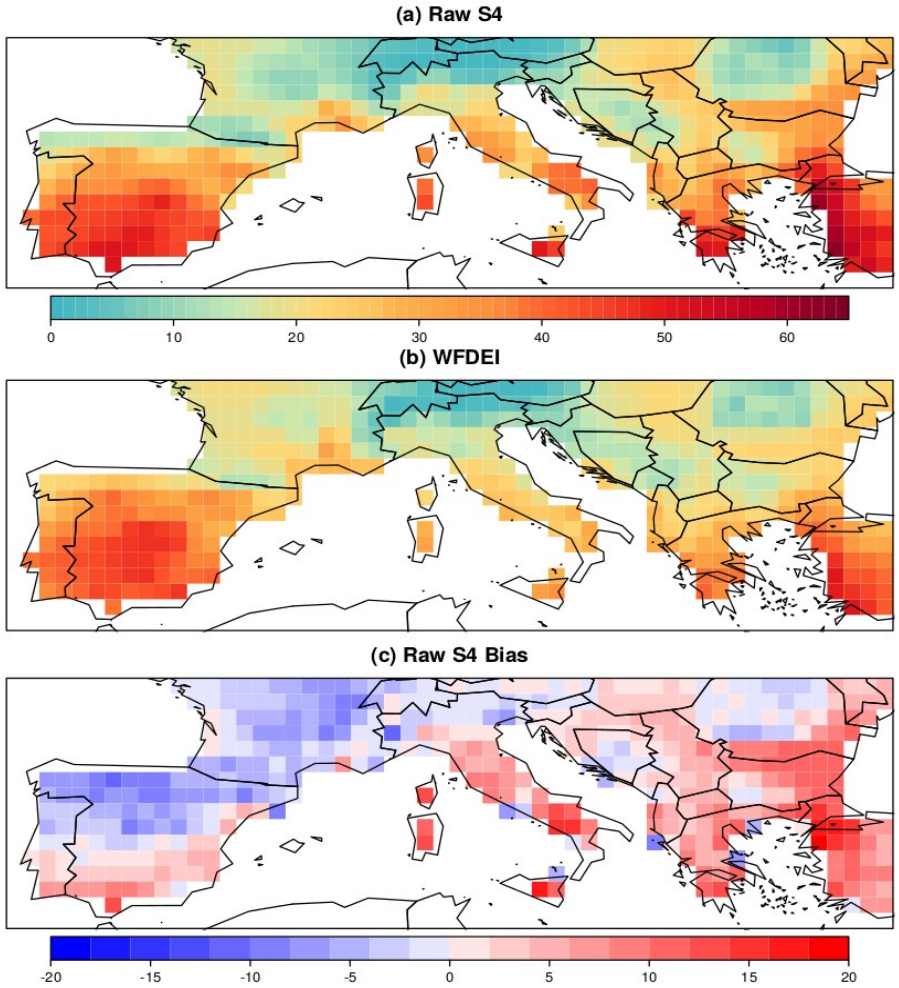


- FWI is a **daily**-based, **multivariable** CII rating the potential for fire ignition and spread given the atmospheric conditions

FWI: f(hurs, tas, wss, precip)

- Fire managers require **bias correction** for operational applicability
- Standard protocols and **user-friendly tools** are still lacking in a seasonal forecasting context



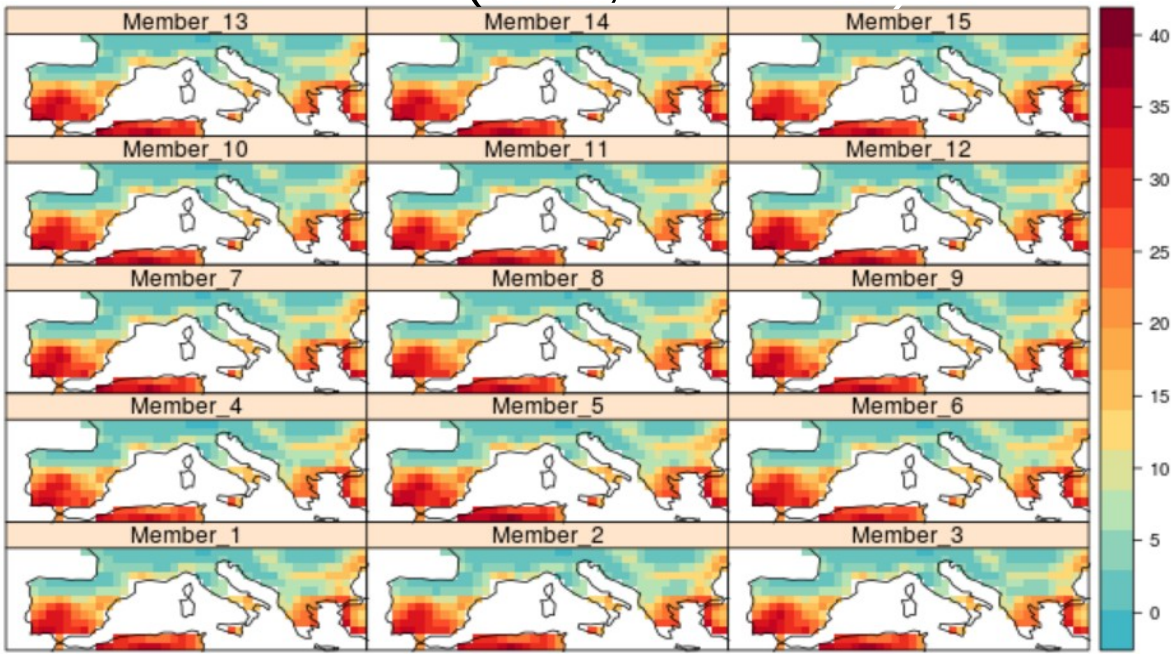


Bias correction (Empirical Quantile Mapping) of System4 JJAS FWI forecast over EU-MED region (May init., 15 members)

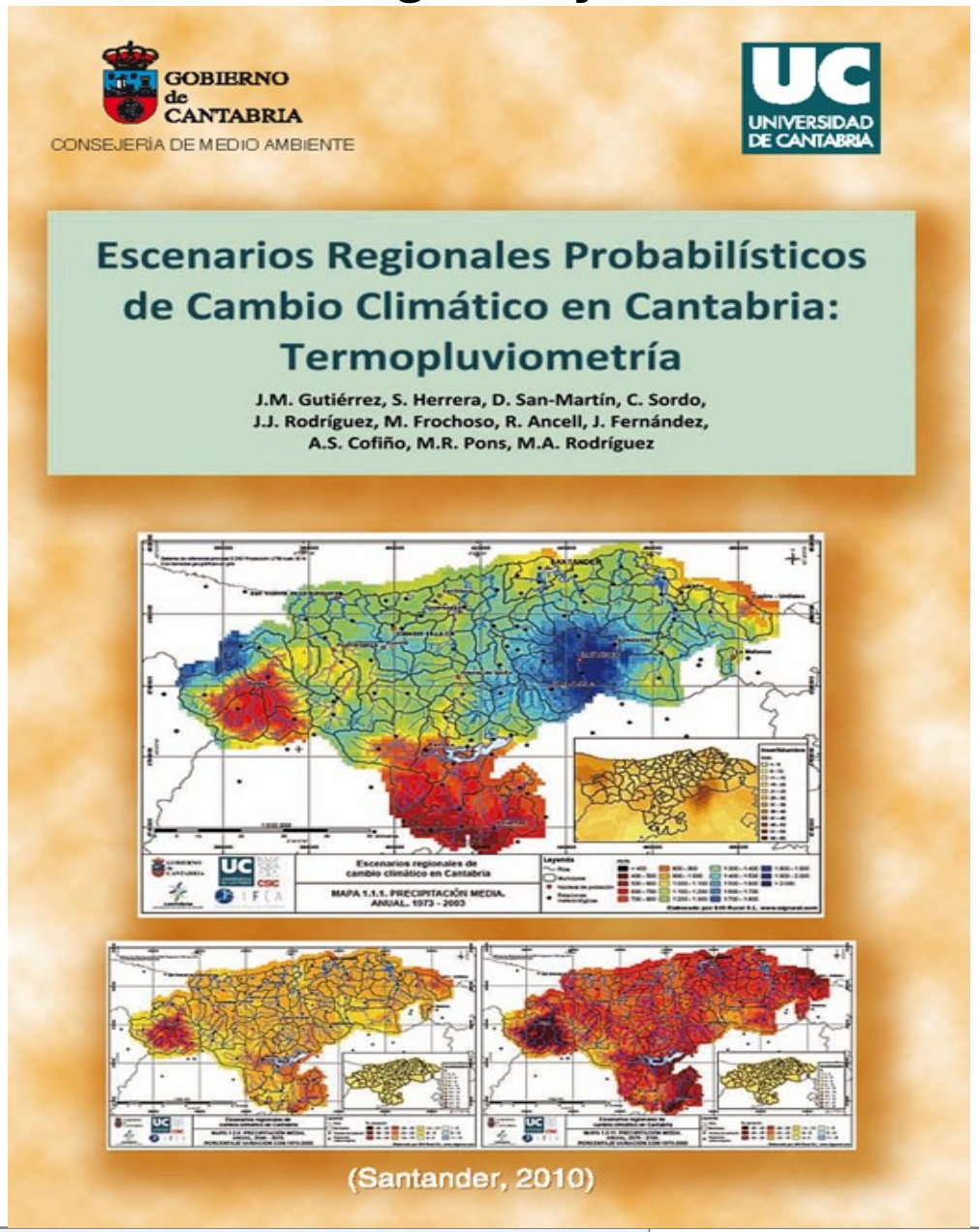
Worked example: https://github.com/SantanderMetGroup/fireDanger/wiki/CS_Bedia-et-al-2016-(submitted)

A relatively complex task usually involving many intermediate steps from data loading to FWI calculation and analysis of the results.

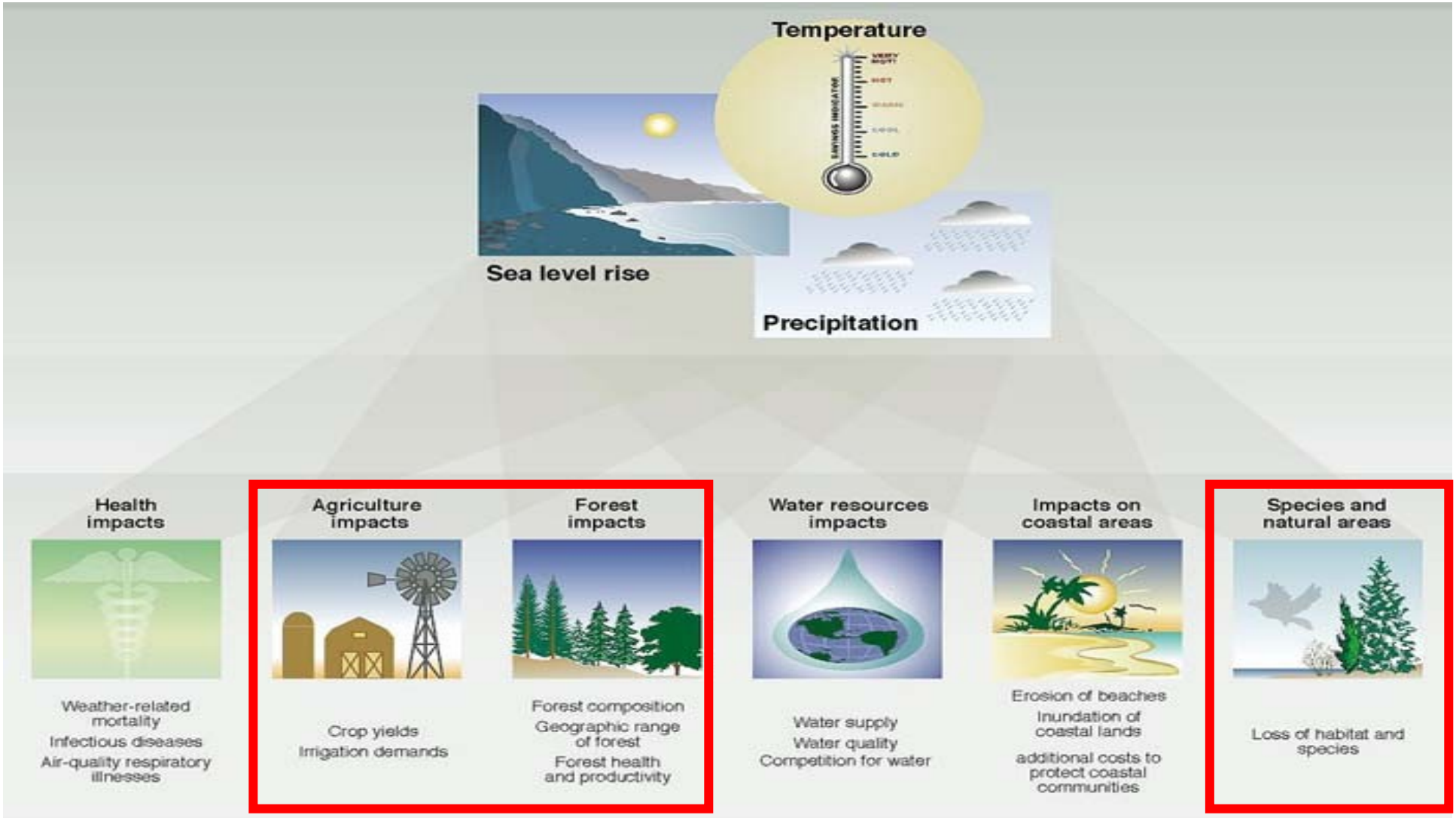
Mean FWI (JJAS, 1981-2010



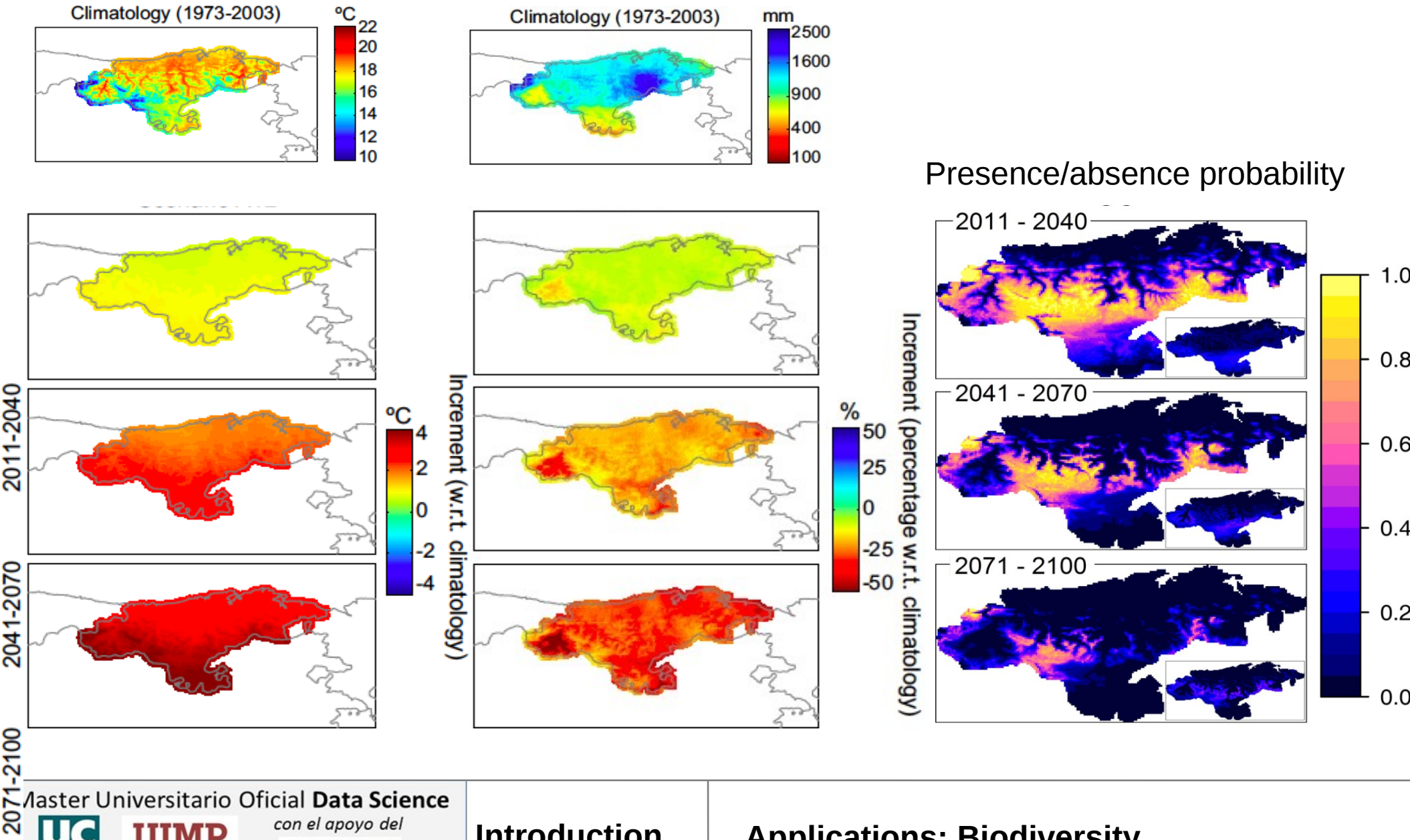
Climate Change Projections in Cantabria



Climate Change Projections in Cantabria



Projections of Species Distribution (fagus) in Cantabria



Climate Change Projections in Cantabria

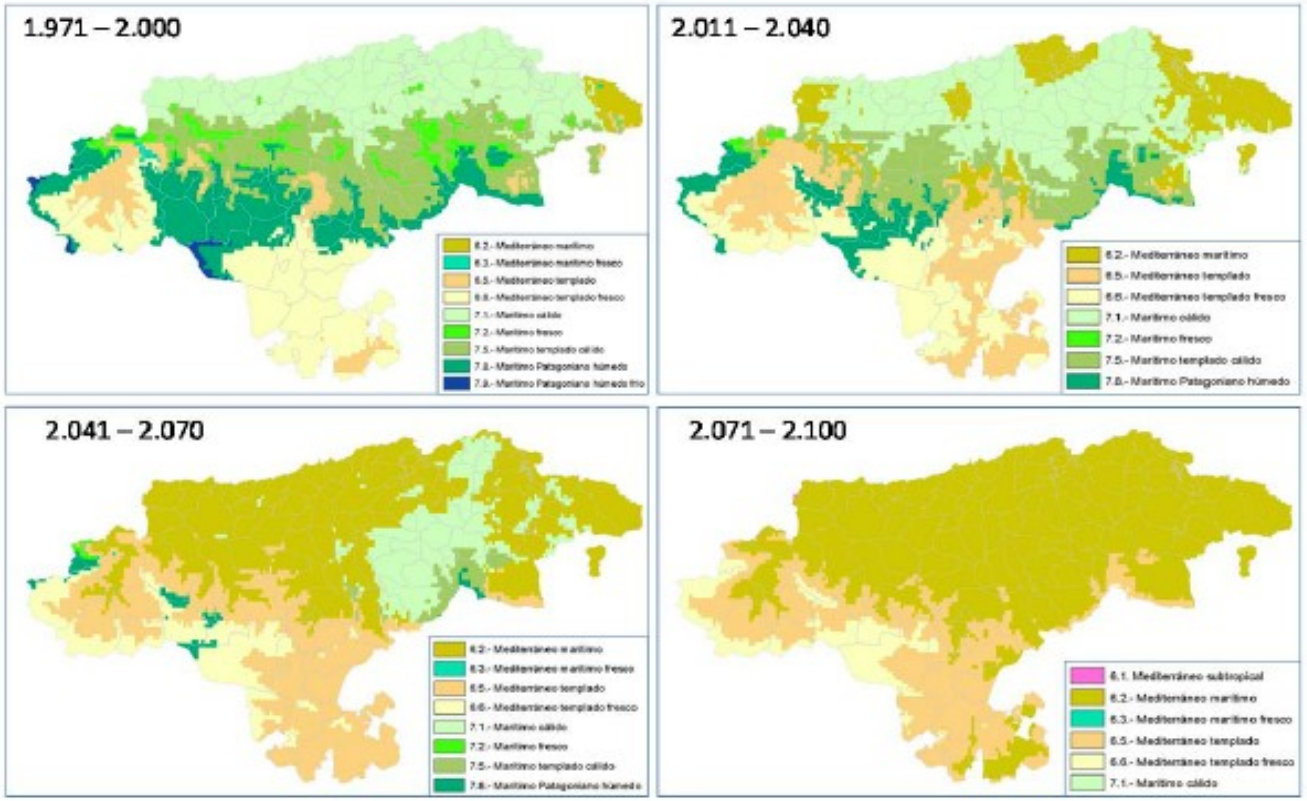
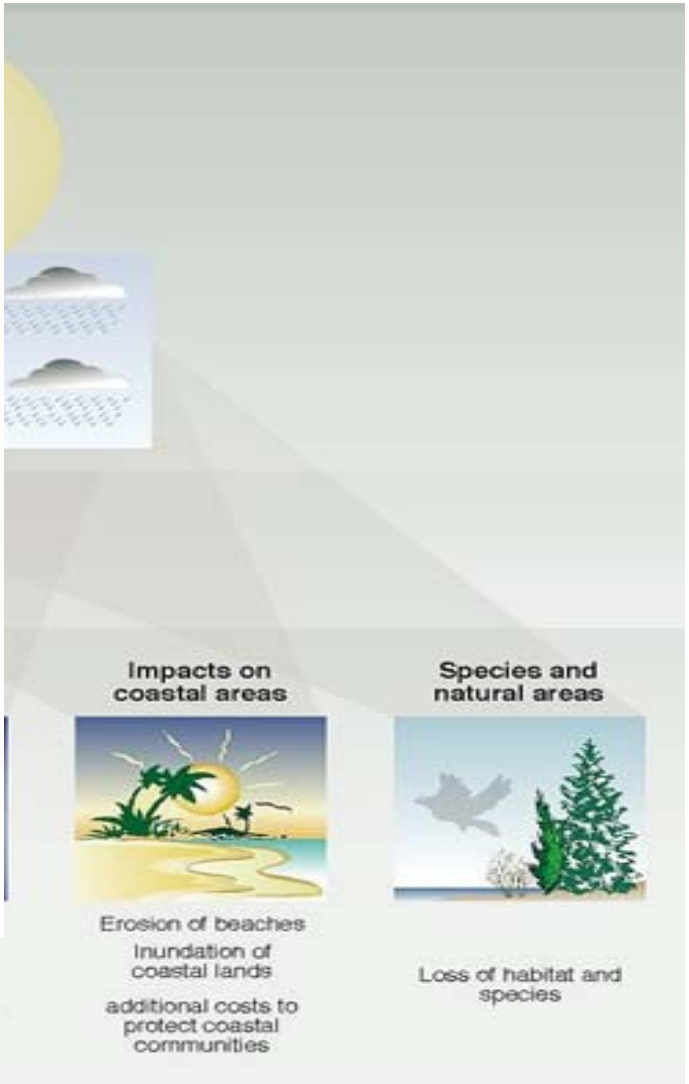


Figura 5. EVOLUCIÓN PREVISTA PARA EL MAPA CLIMÁTICO DE PAPADAKIS, A LO LARGO DEL PRESENTE SIGLO.



Climate Change Projections in Cantabria

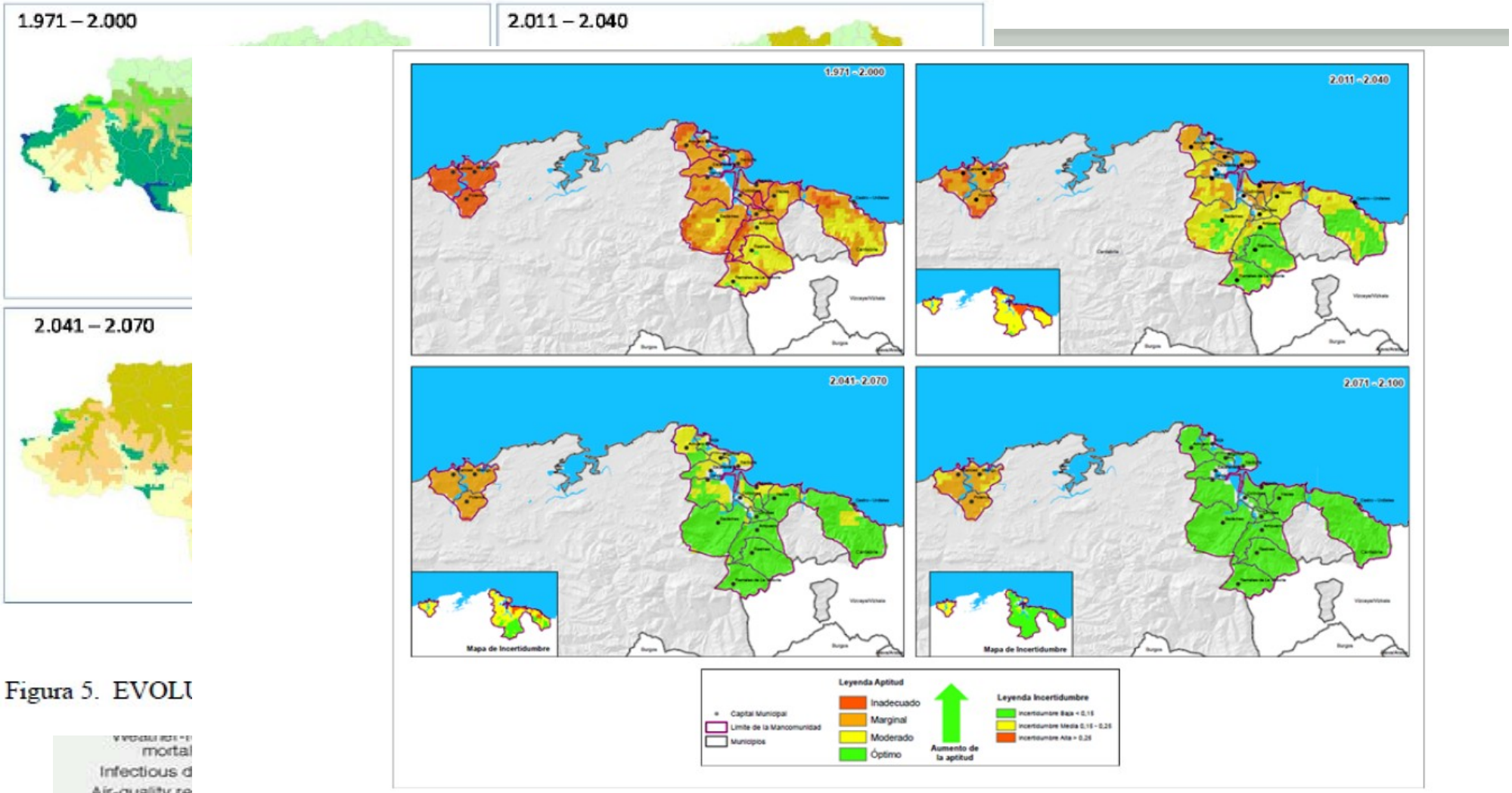


Figura 5. EVOLU

Figura 4. EVOLUCIÓN DE LA POTENCIALIDAD BIOCLIMÁTICA DE LA ENCINA.

Climate Change Projections in Cantabria

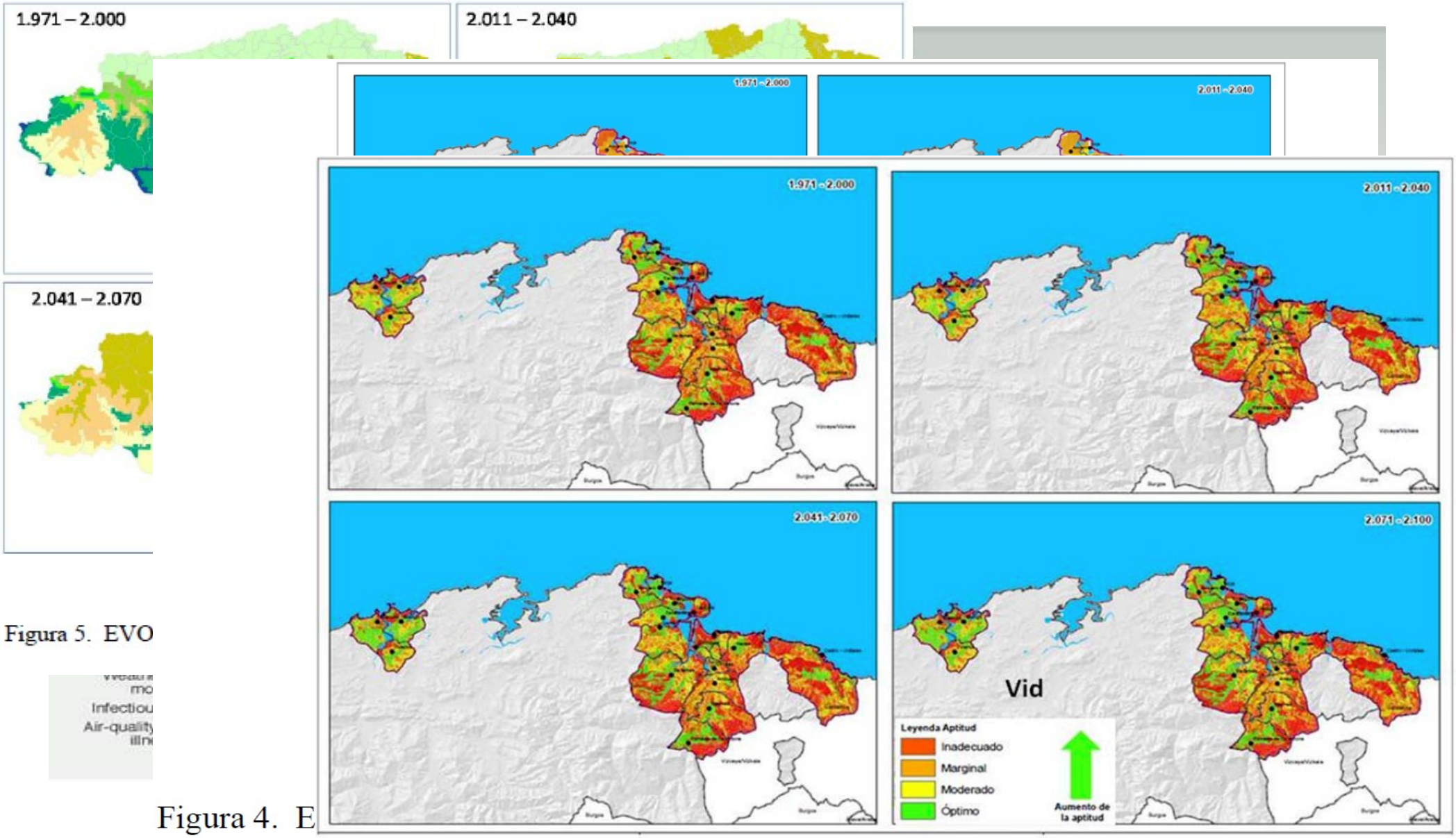


Figura 5. EVO

Figura 4. E

Figura 7. EVOLUCIÓN DE LA APTITUD DE LA VID.

M1980 – Data Laboratory: Environment & Meteorology (18:00-20:00)				
04/01	**L**	**Introduction: Clime and Models**	**T**	**SH**
04/02	M	Data Repositories: ESGF & MARS	TL	SH
04/03	**X**	**Lab: Climate4R – Example 1**	**L**	**SH**
04/04	**J**	**Lab: Climate4R – Example 2**	**L**	**JB**
04/05	L	Downscaling: Data Mining in Clime	T	SH
04/08	M	Lab: downscaleR	L	JB
04/09	X	Evaluation and Validation	T	SH
04/10	J	Lab: Evaluation and Validation	L	JB
04/11	L	Impacts	L	JB & SH
04/15	M	Impacts	L	JB & SH
04/16	X	Impacts	L	JB & SH
04/17	J	Impacts	L	JB & SH

Task: Install the R-packages included in Climate4R http://meteo.unican.es/en/climate4R.
Pay attention to the known problems of installing Rjava and notify any problem: https://github.com/SantanderMetGroup/loadeR/wiki/Installation