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Barcelona, 13 May 2015

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

EXCELENCIA SEVERO OCHOA

EARTH SCIENCE SERVICES

Seasonal and Sub-seasonal climate predictions

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Earth Sciences Department

Barcelona Supercomputing Center
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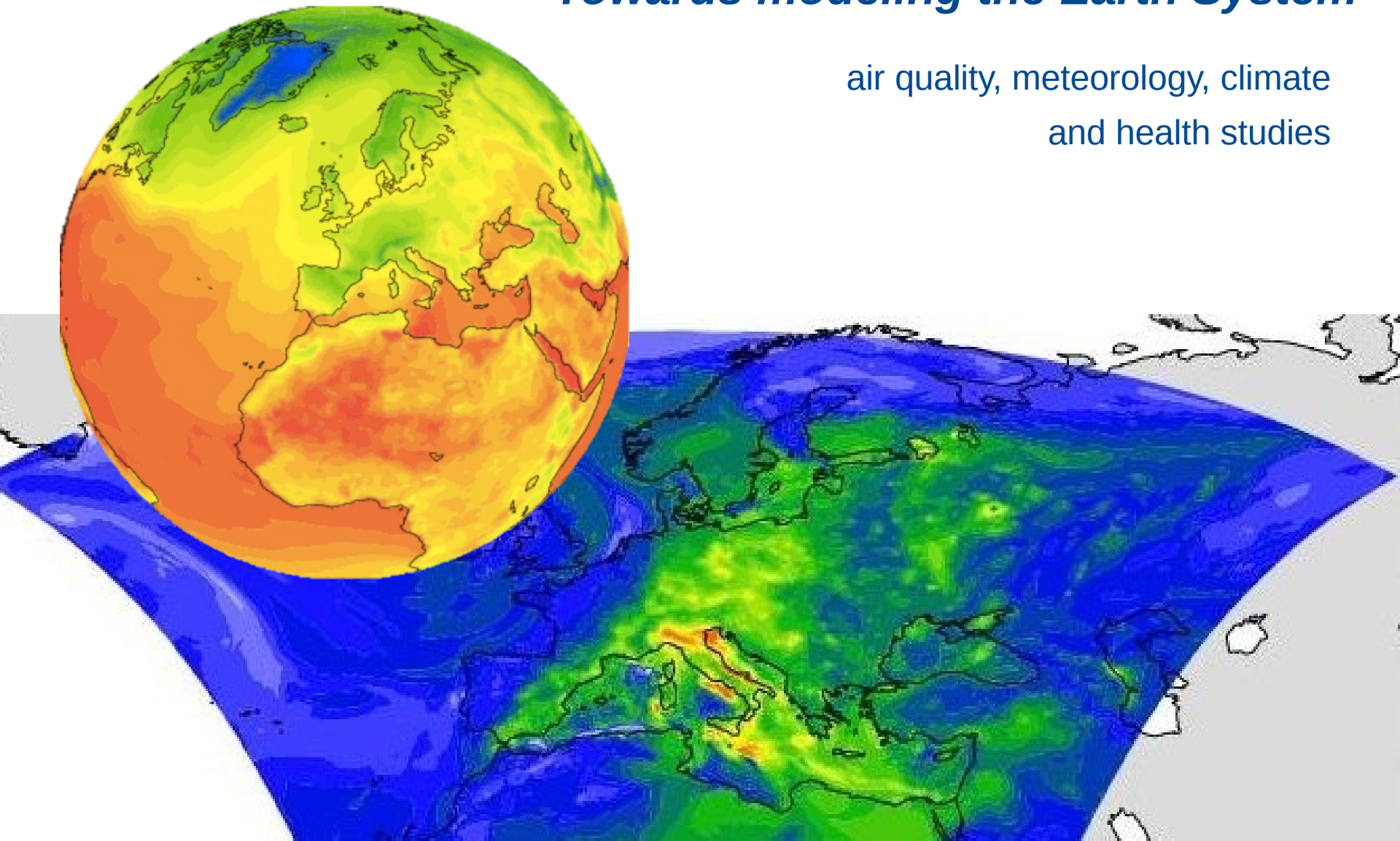
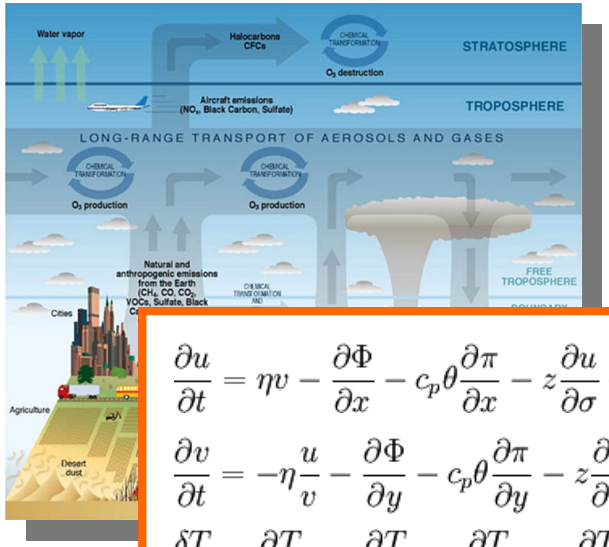
Towards modeling the Earth System

air quality, meteorology, climate

and health studies



Earth system modelling



$$\frac{\partial u}{\partial t} = \eta v - \frac{\partial \Phi}{\partial x} - c_p \theta \frac{\partial \pi}{\partial x} - z\frac{\partial u}{\partial \sigma} - \frac{\partial(\frac{u^2+v^2}{2})}{\partial x}$$

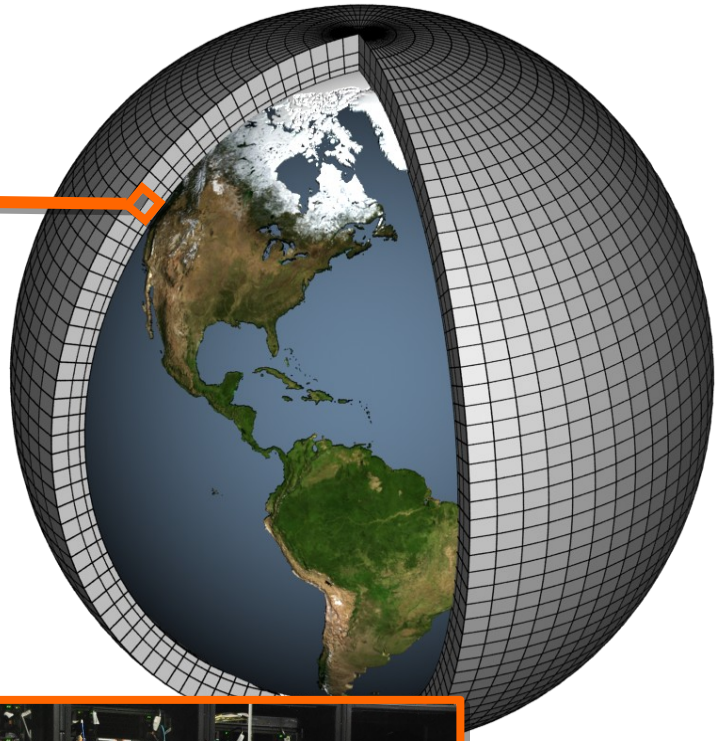
$$\frac{\partial v}{\partial t} = -\eta \frac{u}{v} - \frac{\partial \Phi}{\partial y} - c_p \theta \frac{\partial \pi}{\partial y} - z\frac{\partial v}{\partial \sigma} - \frac{\partial(\frac{u^2+v^2}{2})}{\partial y}$$

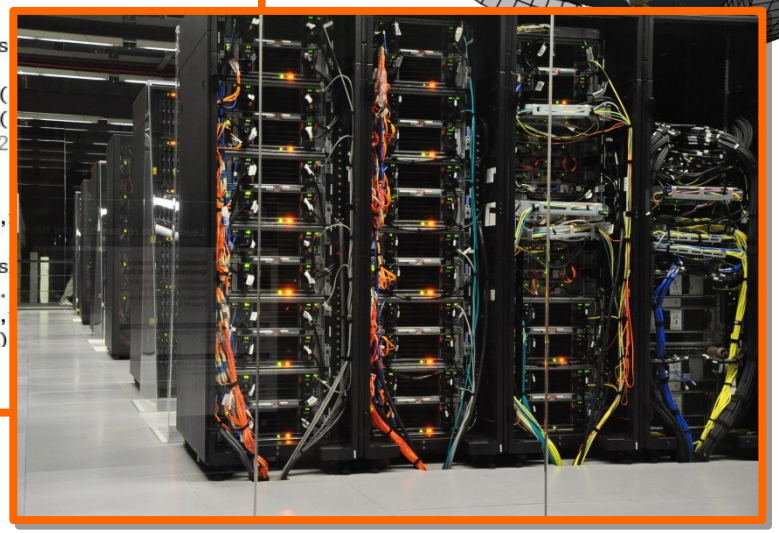
$$\frac{\delta T}{\partial t} = \frac{\partial T}{\partial t} + u\frac{\partial T}{\partial x} + v\frac{\partial T}{\partial y} + w\frac{\partial T}{\partial z}$$

$$\frac{\delta W}{\partial t} = u\frac{\partial V}{\partial}$$

$$\frac{\partial}{\partial t}\frac{\partial p}{\partial \sigma} = u$$

```
if (diagts .and. eots) then
  do 1500 m=1,nt
    do 1490 k=1,km
      fx = cst(j)*dyt(j)*dzt(k)/(c2dtts
      do 1480 i=2,imtm1
        boxfx           = fx*dxt(i)*fm(
        sddt            = (ta(i,k,m)-t(
        svar            = (ta(i,k,m)**2
                          *boxfx
        n               = 0
        termbt(k,1,m,n) = termbt(k,1,m,
        tvar(k,m,n)     = tvar(k,m,n)
        n      = nhreg*(mskvr(k)-1) + ms
        if (n .gt. 0 .and. mskhr(i,j) .
          termbt(k,1,m,n) = termbt(k,1,
          tvar(k,m,n)     = tvar(k,m,n)
```





Spatial scales

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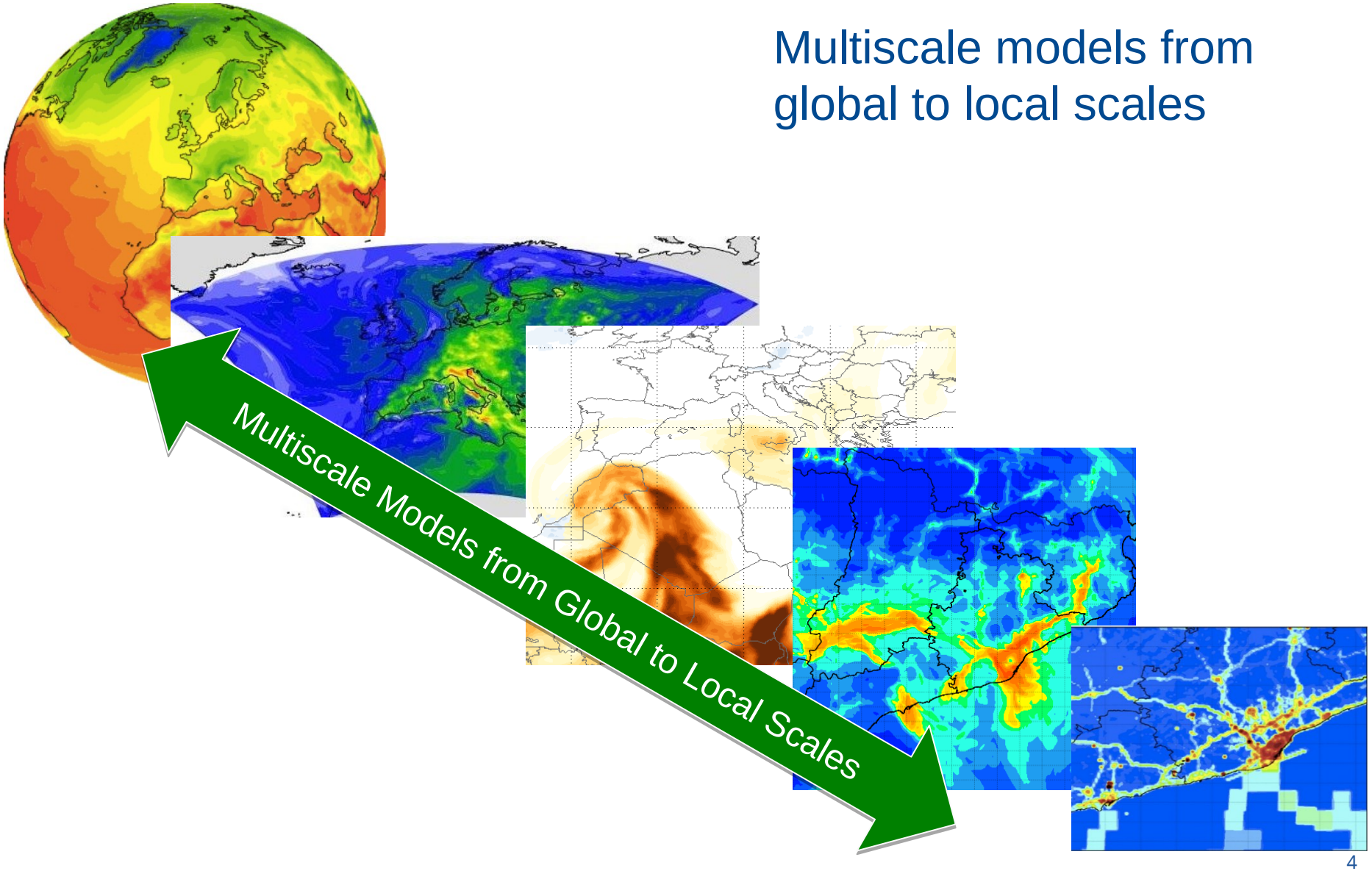
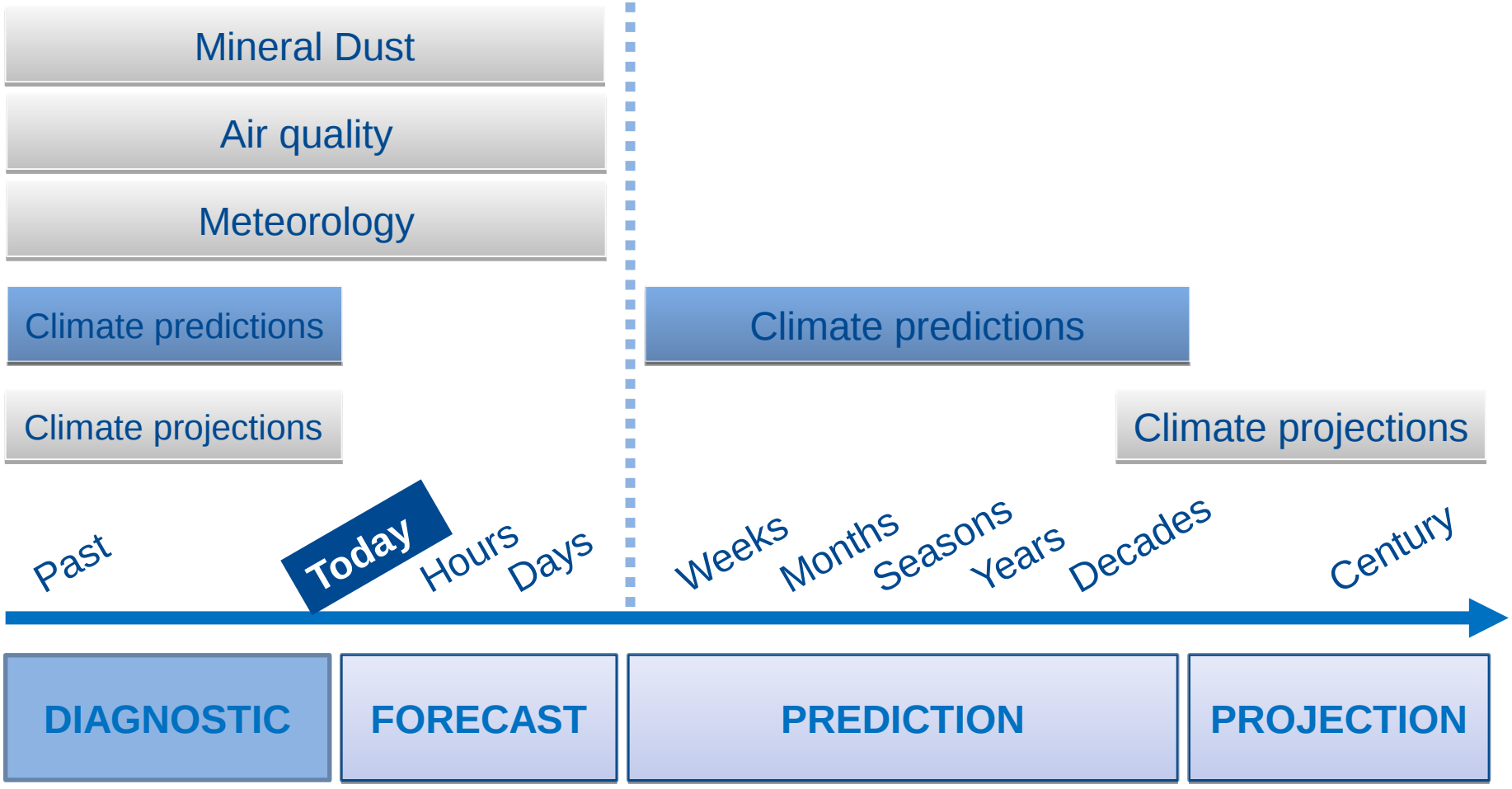
Multiscale models from global to local scales



Temporal scales



Climate predictions

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How can we predict climate for the coming season if we cannot predict the weather next week?

Weather forecasts

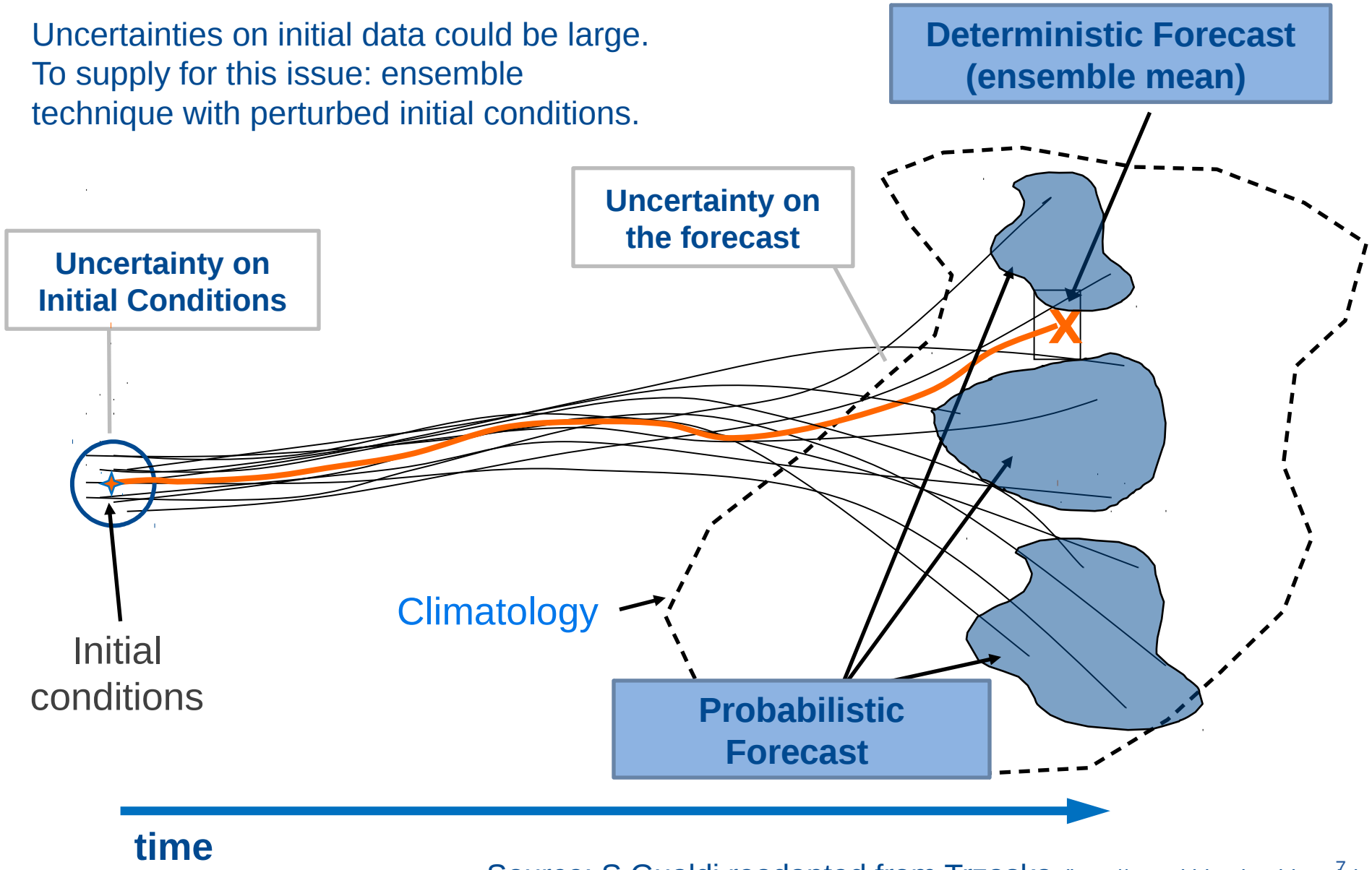
The forecasts are based in the initial conditions of the **atmosphere**, which is highly variable and develops a chaotic behaviour after a few days

Climate predictions

The predictions are based in the initial conditions of the **sea surface temperature**, **snow cover** or **sea ice**, which have a slow evolution that can range from few months to years.

Climate predictions and predictability

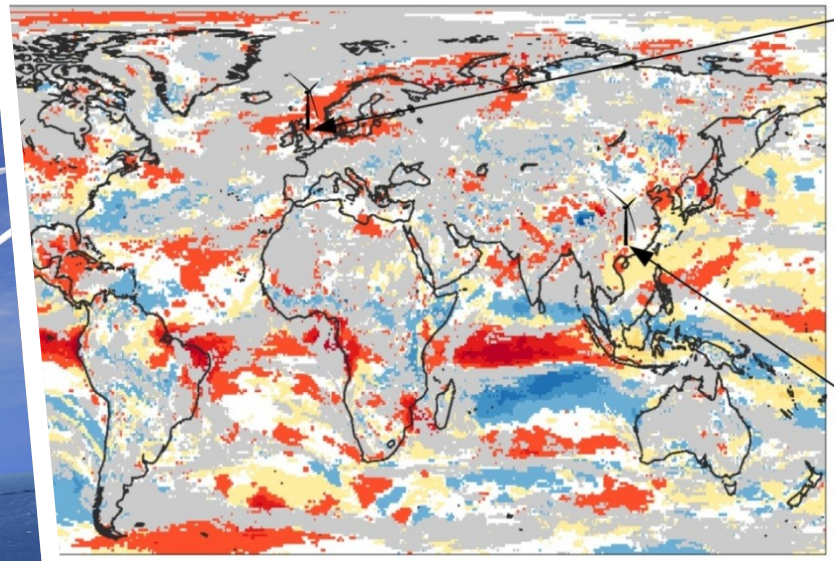
Uncertainties on initial data could be large.
To supply for this issue: ensemble technique with perturbed initial conditions.

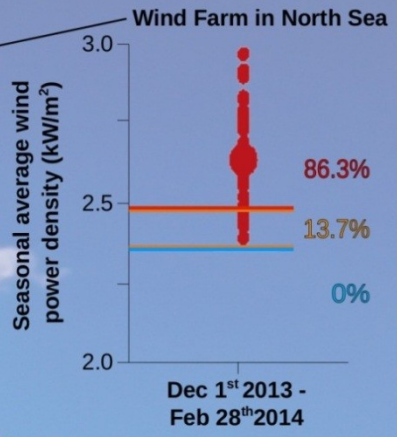


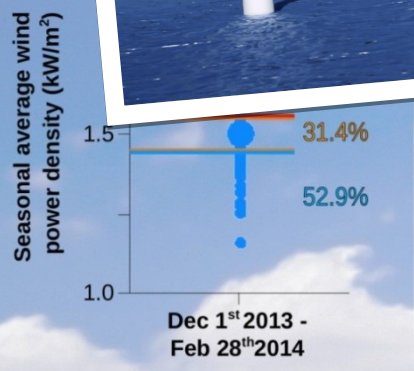
Source: S.Gualdi readapted from Trzaska (http://portal.iri.columbia.edu)

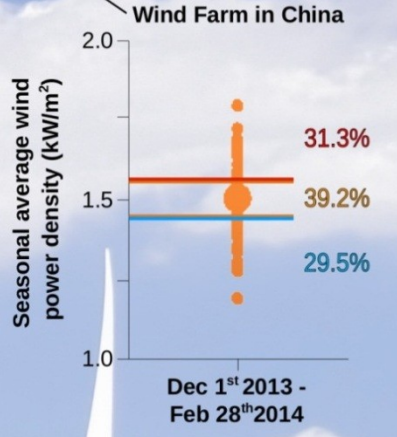
Example: wind power predictions

mples of seasonal wind power predictions









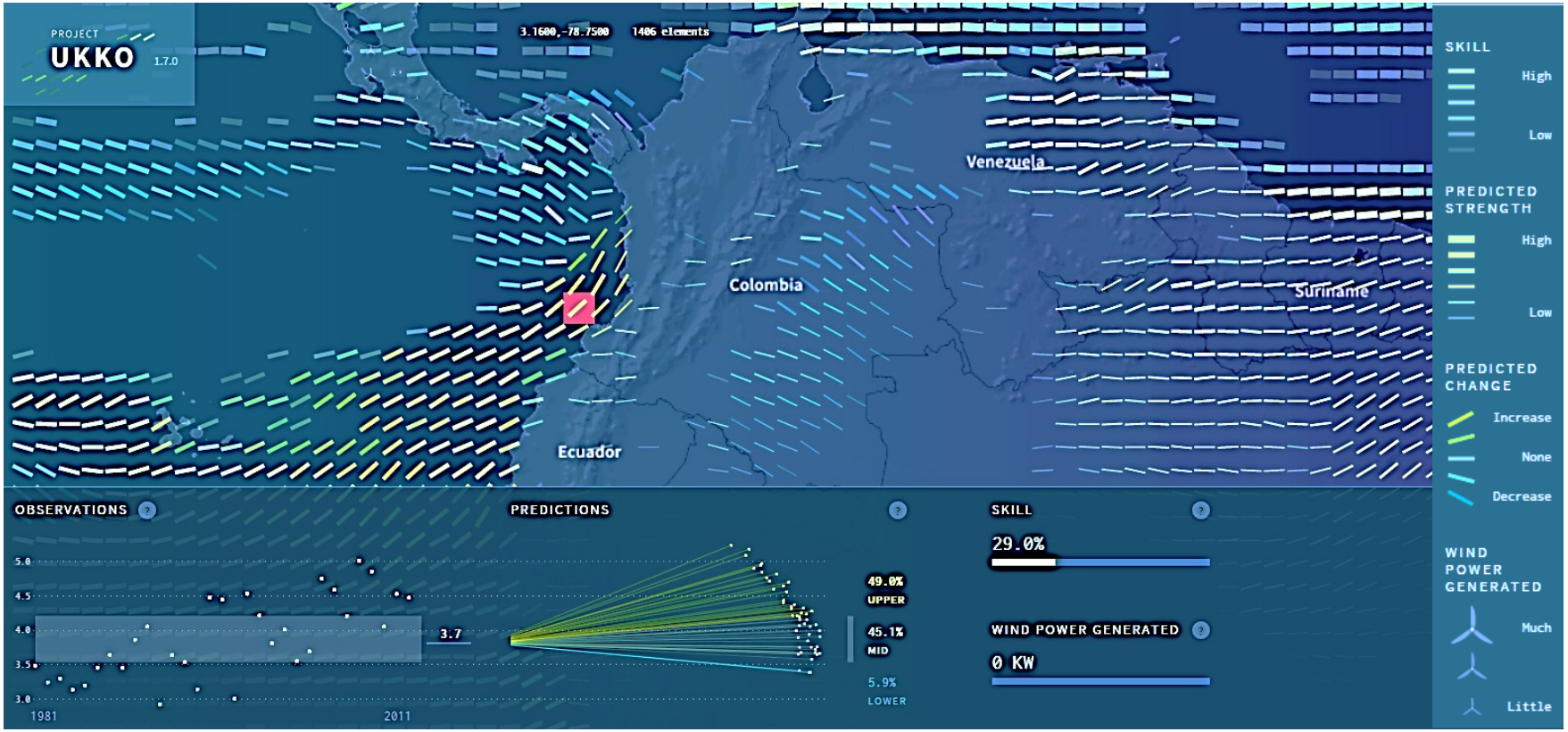
Wind power prediction for December 1st 2013 - February 28th 2014, issued on November 1st 2013.

The most likely wind power category (**below normal**, normal or **above normal**), and its percentage probability to occur is shown. "Normal" represents the average of the past 30 years.

White areas demonstrate where the probability is <40% and approximately equal for all three categories.

Grey areas show where the climate prediction model does not improve upon the standard and current approach, which projects past climate data into the future.

Example: wind power predictions



RESILIENCE
PROTOTYPE

SPECS
EUPORIAS
SEVENTH FRAMEWORK PROGRAMME
eDF
edp renewables
ALSTOM
VORTEX
natural power
EnBW

Seasonal climate predictions

Seasonal **wind speed** predictions

The **same methodology** can be applied to many **other climatic variables:**

Evaporation,
Precipitation-Evaporation balance,
relative and specific Humidity,
Humidity fluxes,

Precipitation,
Precipitable water,
min. and max. Temperature,
Heat fluxes,

Water management and seasonal predictions

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Water management and seasonal predictions

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MARITIME INFRASTRUCTURES:

- Sub-seasonal predictions (one month ahead) of stormy periods

- Planning of transportation of special goods
- Early warning systems for harbors (days ahead)
- Operational planning / maintenance

Collaboration with **LIM-UPC** (Laboratori d'Enginyeria Marítima) in different projects

Water management and seasonal predictions

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Water management and seasonal predictions

FLOOD RISK - WATER SUPPLY

- Sub-seasonal predictions (one month ahead)
- Seasonal predictions (the season ahead)
  - General trends for precipitation,Temperature, etc.
- Downscaling of climate variables.

- Informing Hydroelectric power management
- Early warning systems for extreme events
- Information on drought periods or flood risk

Partners in the H2020 project **IMPREX** (Improving predictions and management of hydrological extremes)

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Thank you!

For further information please contact
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