École des Ponts ParisTech

Fondation des Ponts

VEOLIA EAU

Chair 'Hydrology for Resilient City': high-resolution urban water management

D. Schertzer

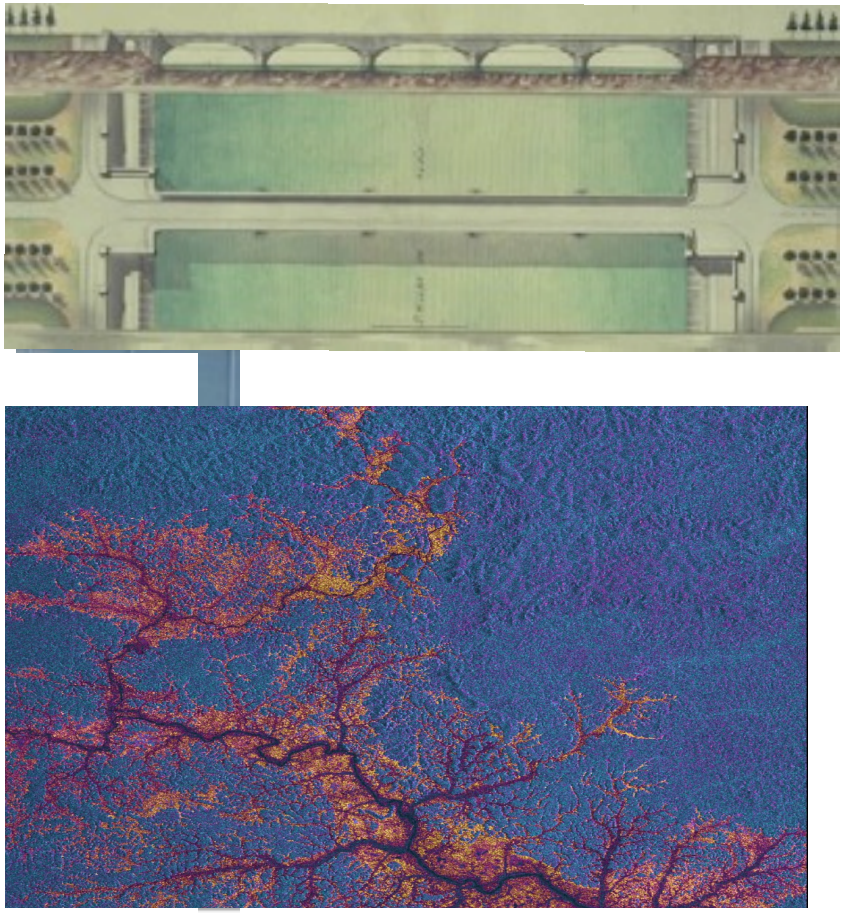
Rain Gain

Local Authorities Meeting

23/10/13

UNIVERSITÉ PARIS-EST

Ecole des Ponts ParisTech



ERS view of the Amazon basin

- Formerly Ecole Nationale des Ponts et Chaussées ("National School of Bridges and Roads")
  - one of the world's oldest Civil Engineering School (1747)
  - Belgrand, Cauchy, Carnot, Coriolis, Darcy, Navier, Saint-Venant...
- last decades
  - beyond its more traditional fields and into an international institution,
  - adapting to the changing demands of the modern world
    - cofounder of the ParisTech cluster and Paris-Est University
    - teaching complex systems, multifractals, etc. to young generations of engineers and managers

Chair “Hydrology for Resilient Cities”

- Partners

  Ecole des Ponts, Fondation des Ponts, VEOLIA EAU

- Duration: 10 ans, 30/08/10 - 31/12/20

- General goal

  to develop within an *international* framework around École des Ponts ParisTech, and in relation with VEOLIA and its subsidies, a cutting edge research and education on **Hydrology for Resilient Cities**

Urbanisation is going on…

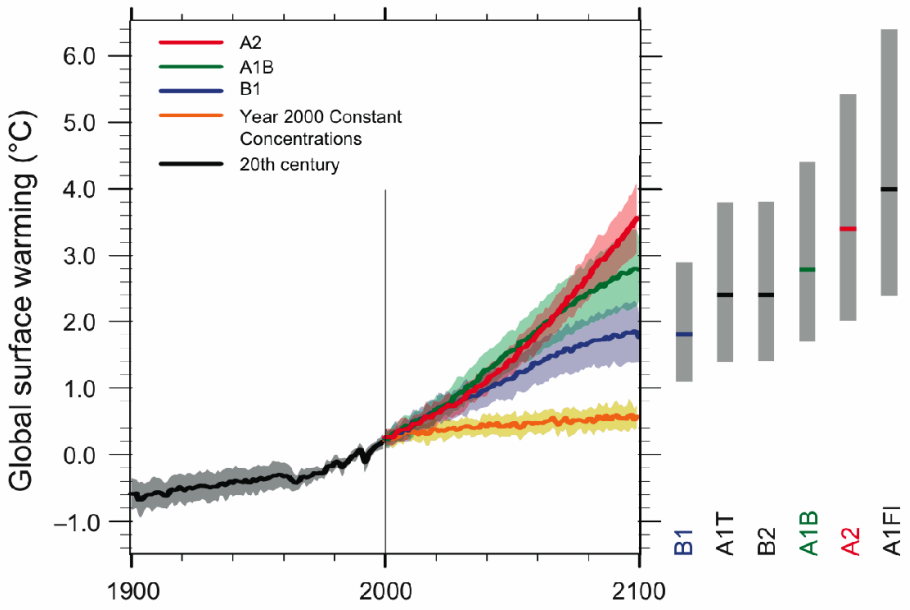
Extreme vulnerabilty of our urban and mobility systems to extreme weather conditions

- European Union directives:
  - « live with floods »
  - « back to good ecological state »

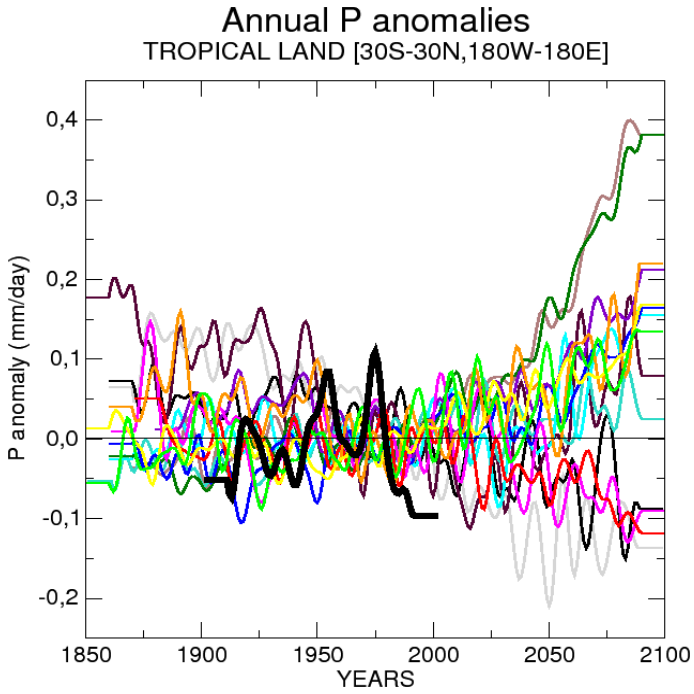
Transition from risk management to resilient systems

…in the context of climate change

- How to achieve resilient cities and mobility?
- Which strategies of reduction/adaptation to climate change?
- How to downscale climate scenarios to relevant scales?



Agreement of models on a temperature increase…

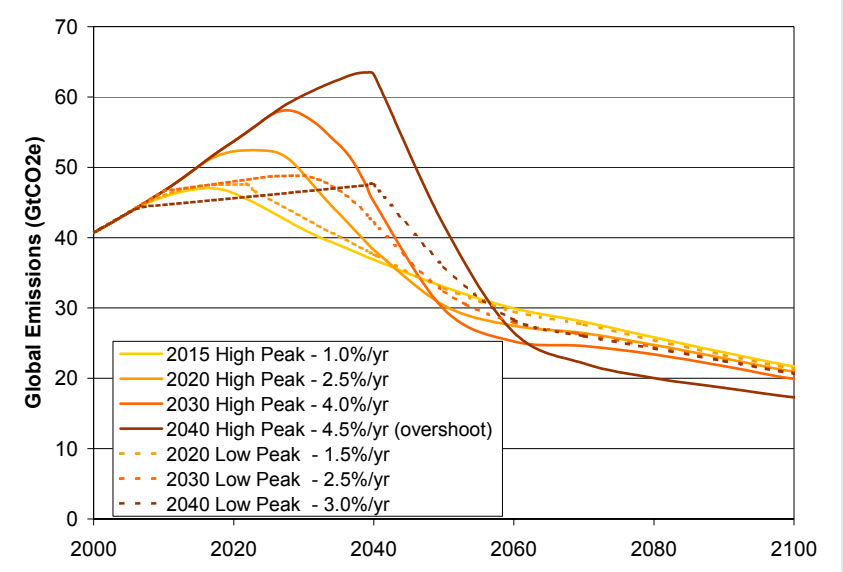


but **disagreement** on the evolution of precipitation extremes

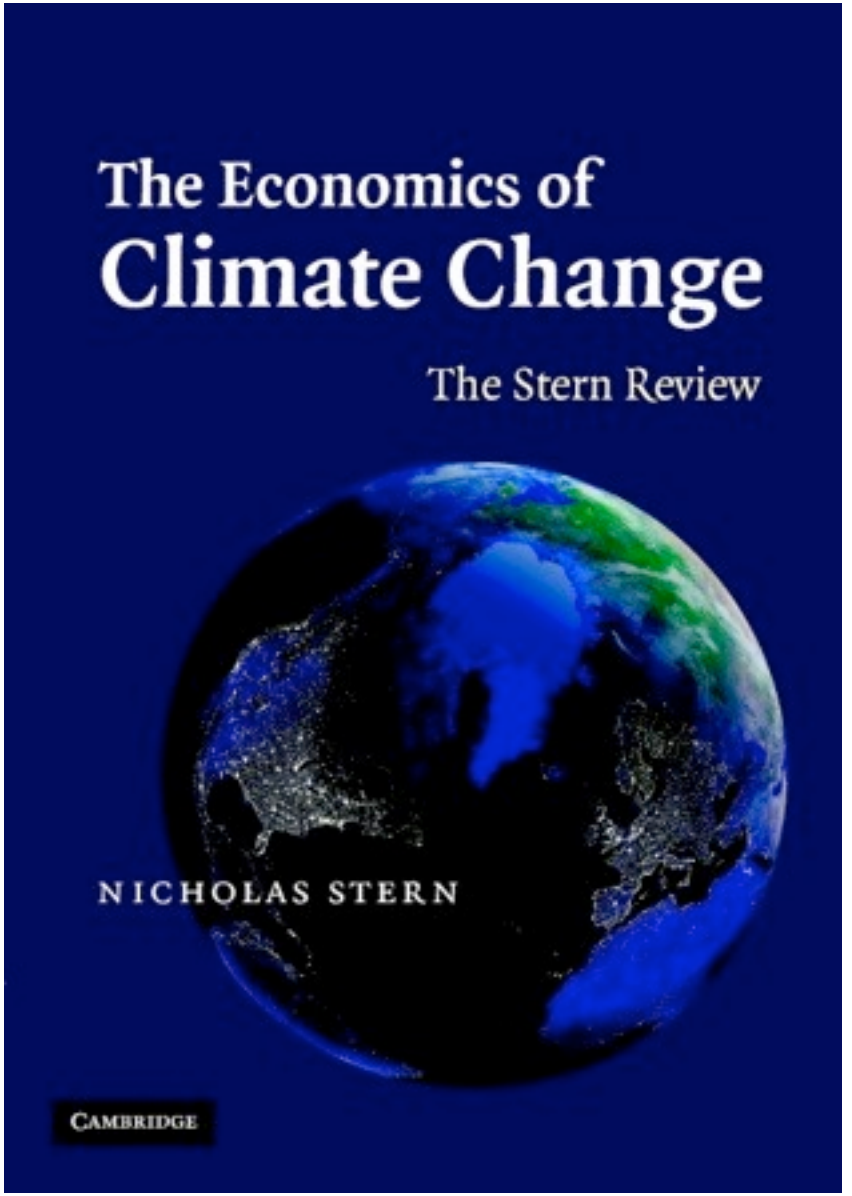
A Trillion Dollar Challenge !

Figure 3 Illustrative emissions paths to stabilise at 550ppm CO_2e.

The figure below shows six illustrative paths to stabilisation at 550ppm CO_2e. The rates of emissions cuts given in the legend are the *maximum* 10-year average rate of decline of global emissions. The figure shows that delaying emissions cuts (shifting the peak to the right) means that emissions must be reduced more rapidly to achieve the same stabilisation goal. The rate of emissions cuts is also very sensitive to the height of the peak. For example, if emissions peak at 48 $GtCO_2$ rather than 52 $GtCO_2$ in 2020, the rate of cuts is reduced from 2.5%/yr to 1.5%/yr.



Source: Reproduced by the Stern Review based on Meinshausen, M. (2006): 'What does a 2°C target mean for greenhouse gas concentrations? A brief analysis based on multi-gas emission pathways and several climate sensitivity uncertainty estimates', Avoiding dangerous climate change, in H.J. Schellnhuber et al. (eds.), Cambridge: Cambridge University Press, pp.265 - 280.



Light and versatile radars for urban hydrology?

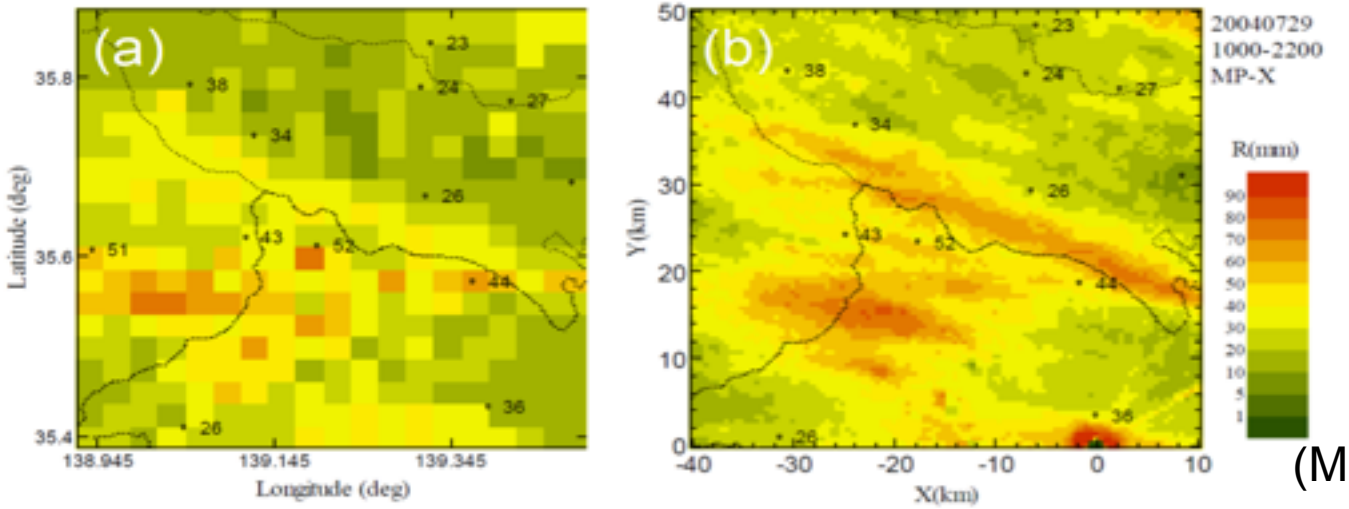
S-band radar
(Marshall Observatory, U. McGill),

X-band radar
(FRAMEA, Provence)

(NIED mobile X-band radars)

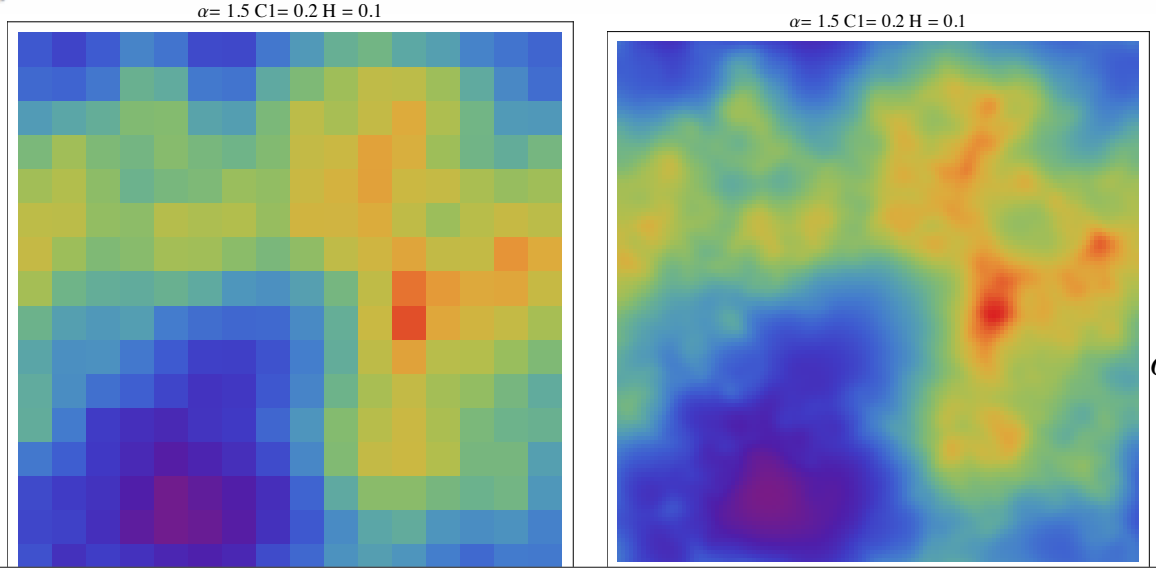
close-up remote sensing of precipitation ?

Space resolution increase with X -band radar



(Maki et al., 2009)

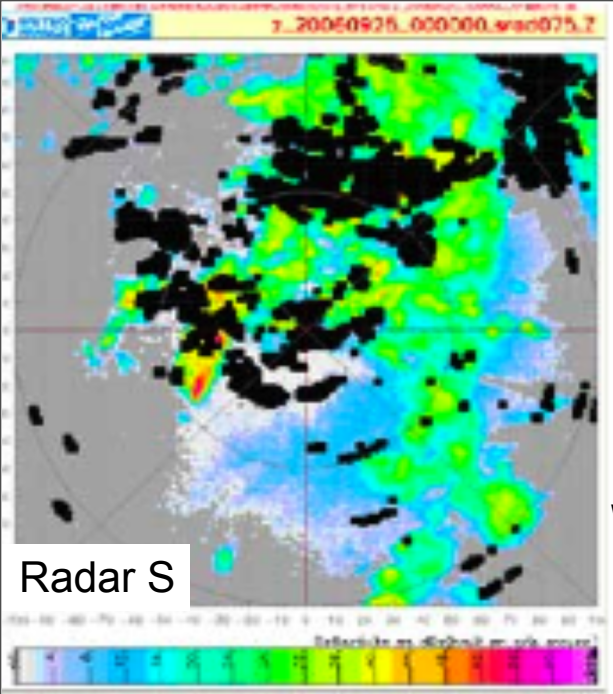
Fig.3 Urban area, fast moving rain cell measured on July 29, 2004.
(a) Conventional radar rainfall estimates adjusted with raingauge network data.
(b) MP-X radar rainfall estimates.

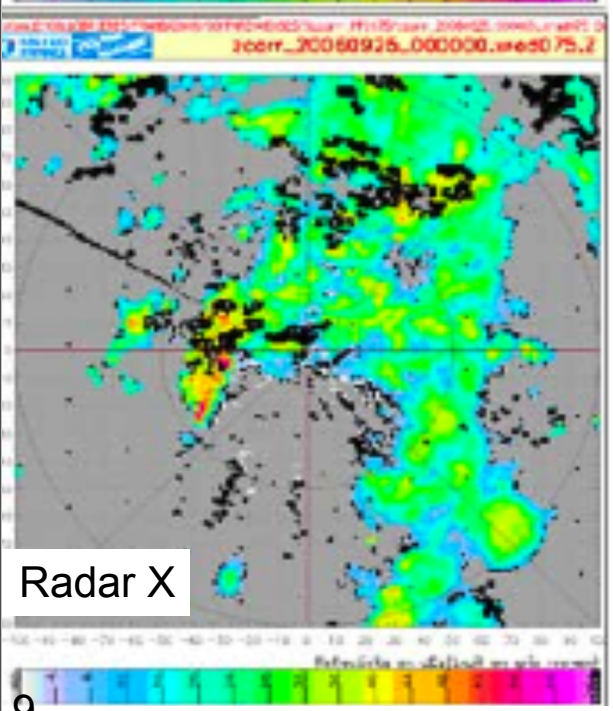


Snapshots of a multifractal rain fall simulation with resolutions

$$\lambda = 16,\ 128$$
$$\alpha = 1.5,\ C_1 = .2,\ H = .1$$

Self-calibration of polarimetric radars





Why not to use Phi$_{DP}$?
(see Testud et al.)

Rainfall Estimation with MP-X

Specific differential phase (K_{DP}), as measured by multi-parameter radar, is a key parameter for accurate rainfall estimation.

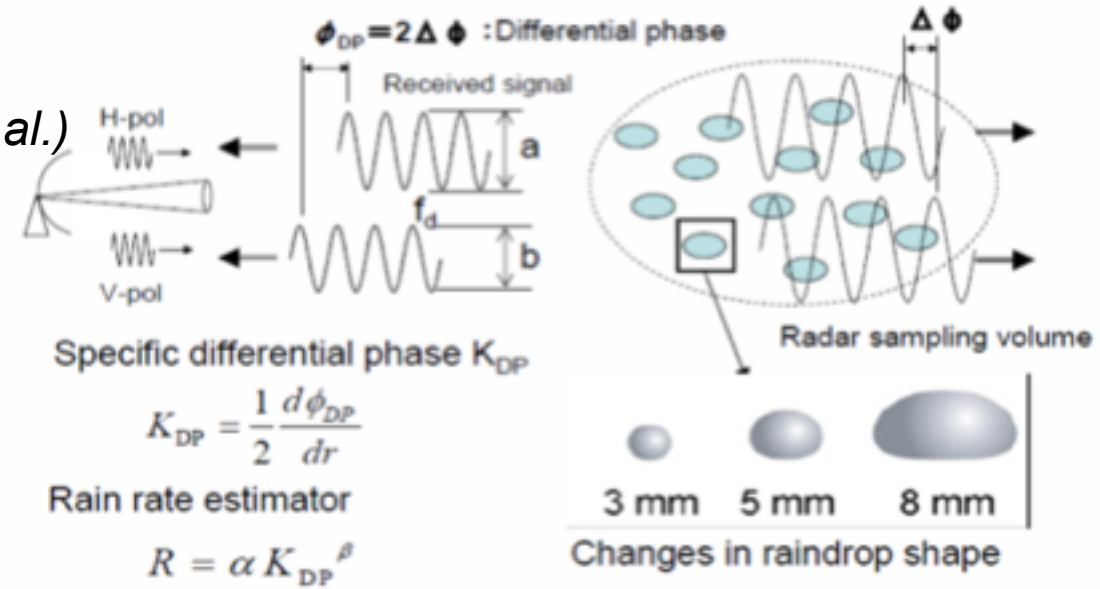


Fig.1 The principle of rain rate estimation by K_{DP}. Multi-parameter radar uses two polarimetric waves to measure the difference in phase velocity per unit distance of horizontally- and vertically-polarized waves.

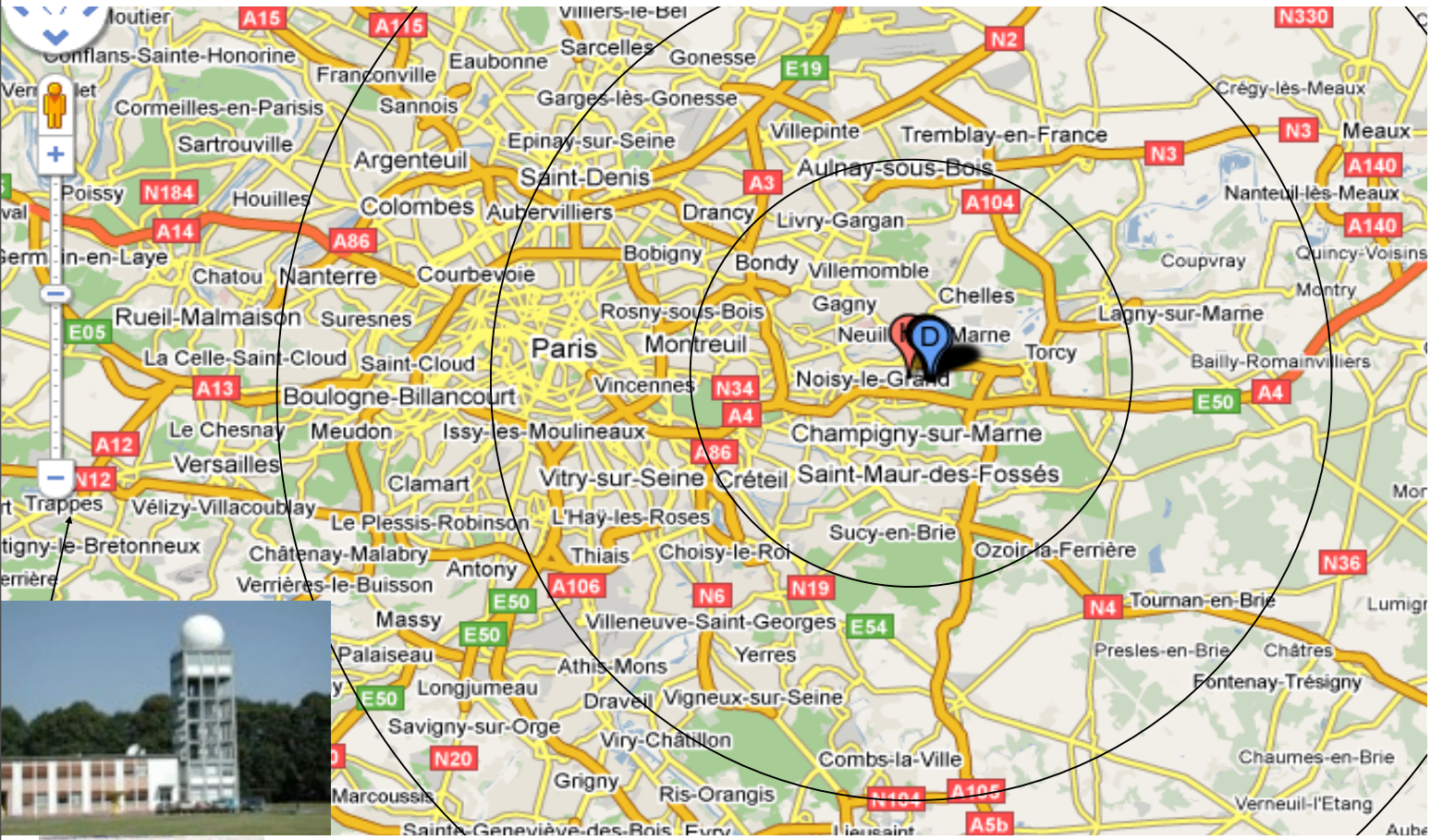
Ground clutter (black) comparison between S and X-band radars, (Tabary et Eideliman, 2007)

RainGain

- http://www.raingain.eu
- **Sites:** Leuwen, London, Paris, Rotterdam
- **Objective**: to improve **fine-scale measurement and prediction** of rainfall and to enhance urban pluvial flood prediction in order to enable urban water managers to adequately cope with intense storms, so that the vulnerability of populations and critical infrastructure can be reduced.
- **Budget**: 7 M€

RadX@IdF: Ile-de-France Council support

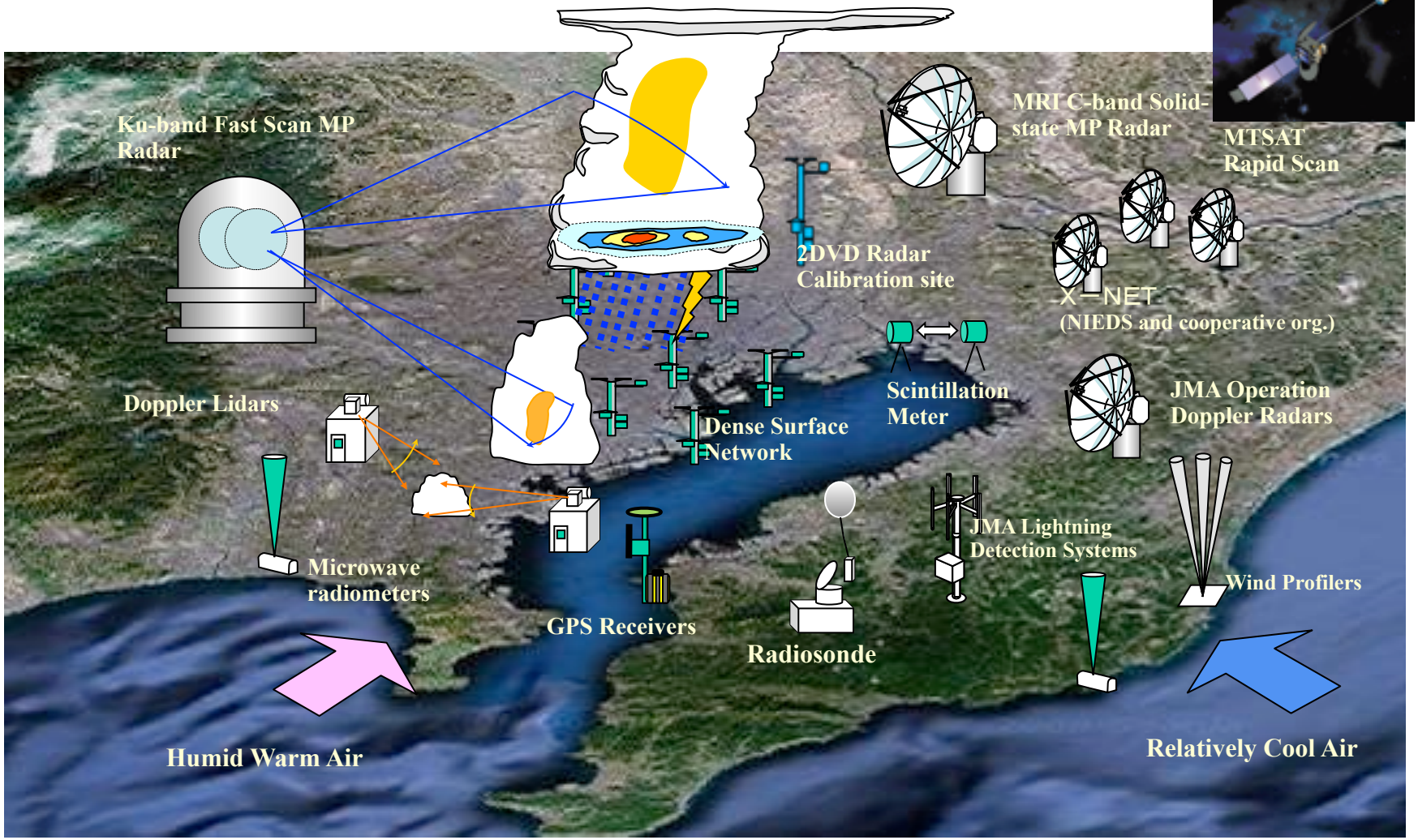
Circles of 10, 20, and 30 km, centered on PST Paris-East



- Objectives
  - develop R&D synergies on higher resolution rainfall measurement and prediction
- Budget
  - 1.2 M€

A complementary radar to the Meteo-France C-band radar of Trapes (SW) is already indispensable.

TOMACS



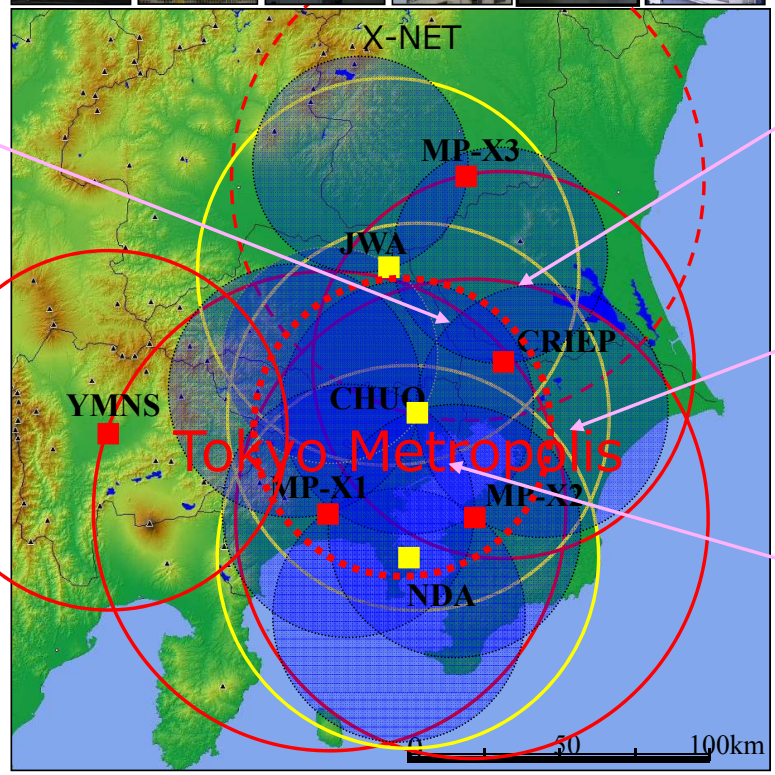
A field campaign in the Tokyo metropolitan area with a dense observation network is conducted by MRI, NIED and 12 research institutions in the summers 2011-2013, as a testbed for deep convection.

Tokyo X-Net

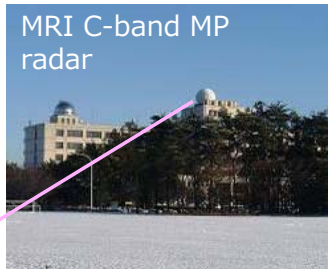
14 Doppler Radars

Research/operation weather radars concentrate in the Tokyo Metropolitan Area: X-NET(5 X-band MP radars and 3 Doppler radars), two X-band MP radars of River Bureau, MRI C-band MP radar and 3 JMA C-band operational Doppler radars.

JMA Kashiwa C-band Doppler radar



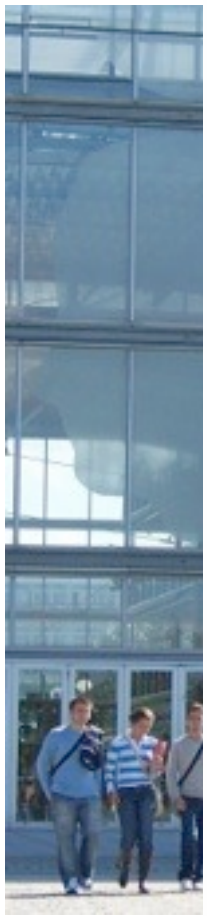
M. Maki of NIED and X-NET Group

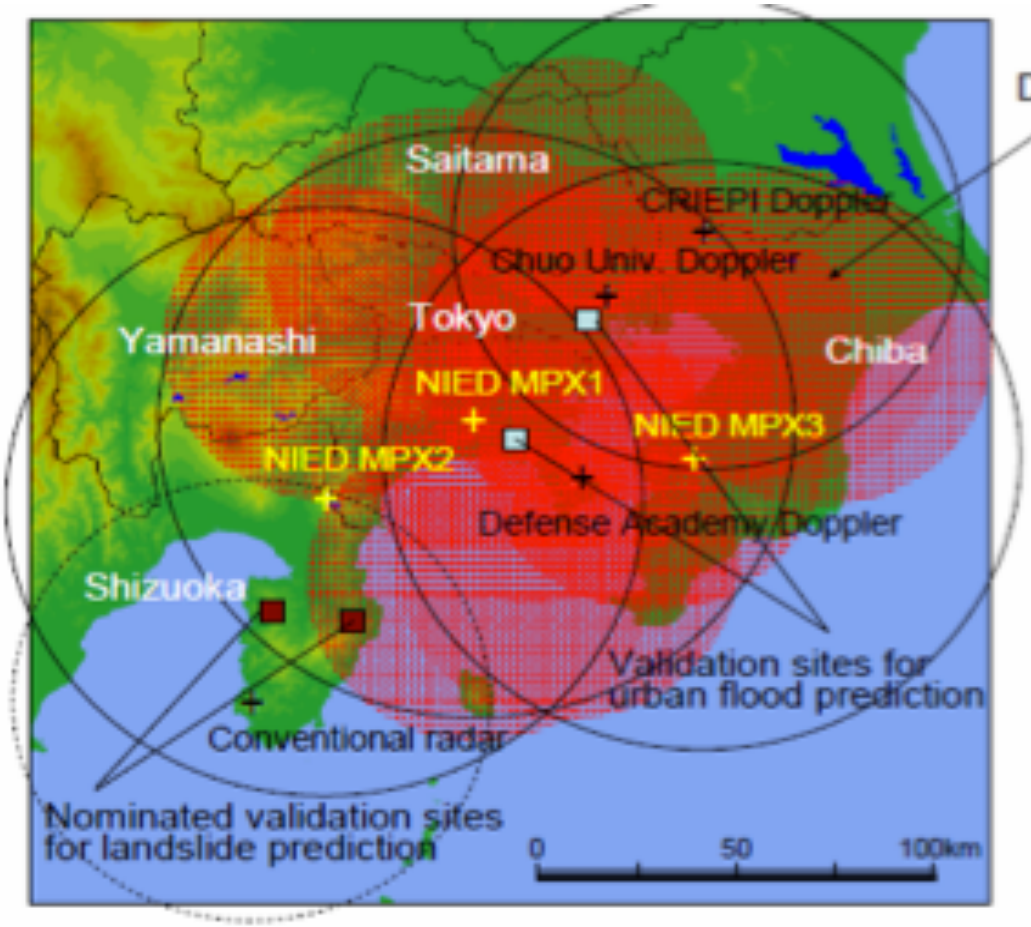


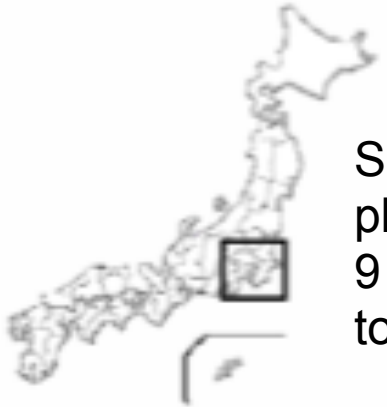
JMA Narita Airport C-band Doppler radar

JMA Haneda Airport C-band Doppler radar

X-band radar networks







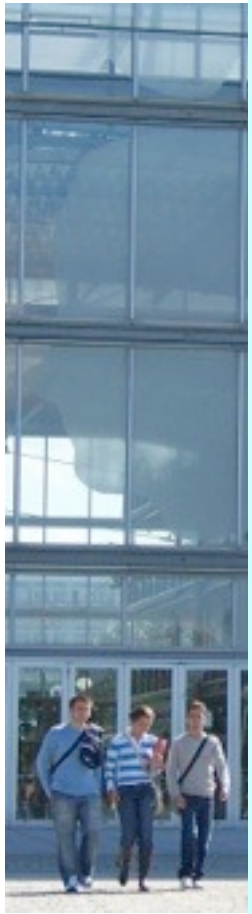
Similar plans for 9 major towns

Fig.6 Planned X-band multi-parameter radar network (X-NET). The network, to be named X-NET, consists of three X-band multi-parameter radars owned by NIED and three X-band Doppler radars operated by other research institutes.

CASA

École des Ponts ParisTech

Colorado State University

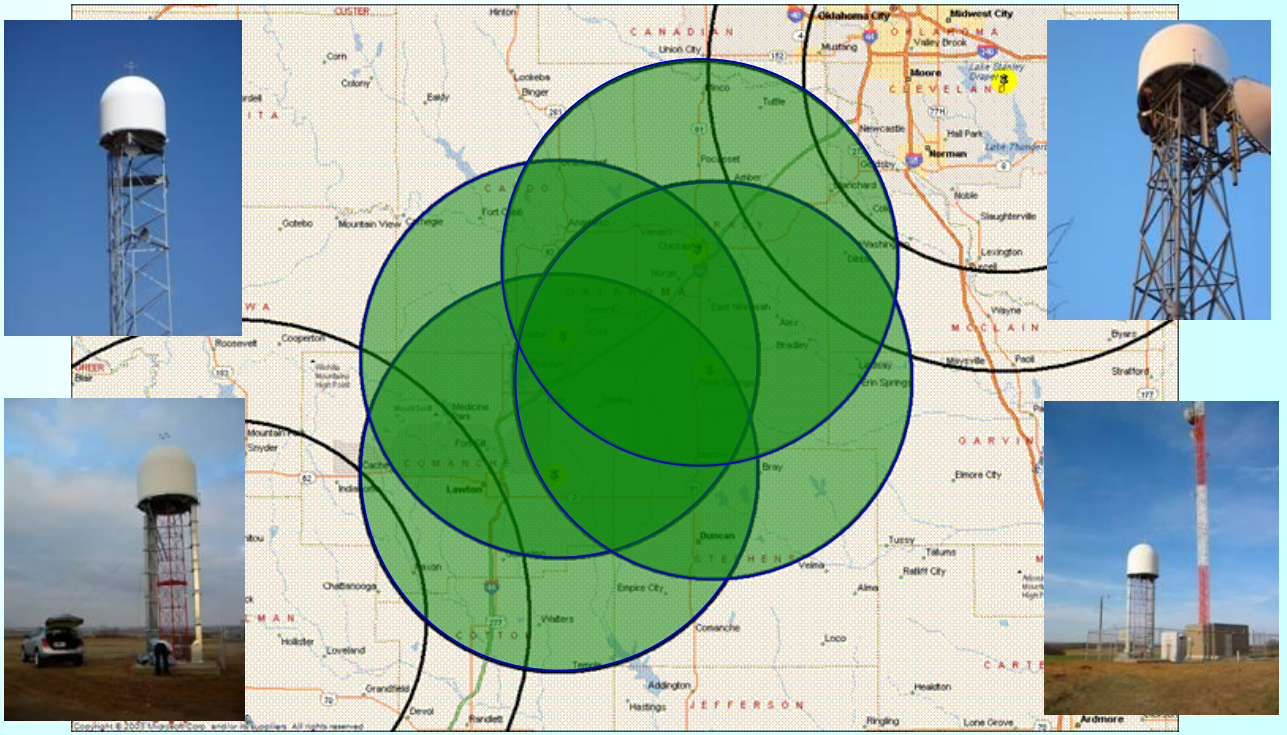


IP1: X-band Radar Network

- IP1: Integrated Project 1, the first system-level test-bed, developed and operated in the DCAS paradigm
- Southwestern OK, part of the “tornado alley”

IP1 test bed: the first DCAS radar network

Southwestern OK
~ 7000 km^2
4 radar nodes
X-band
Dual-polarization



UNIVERSITÉ PARIS-EST

Republic of Korea:
Weather Information Service Engine(WISE)

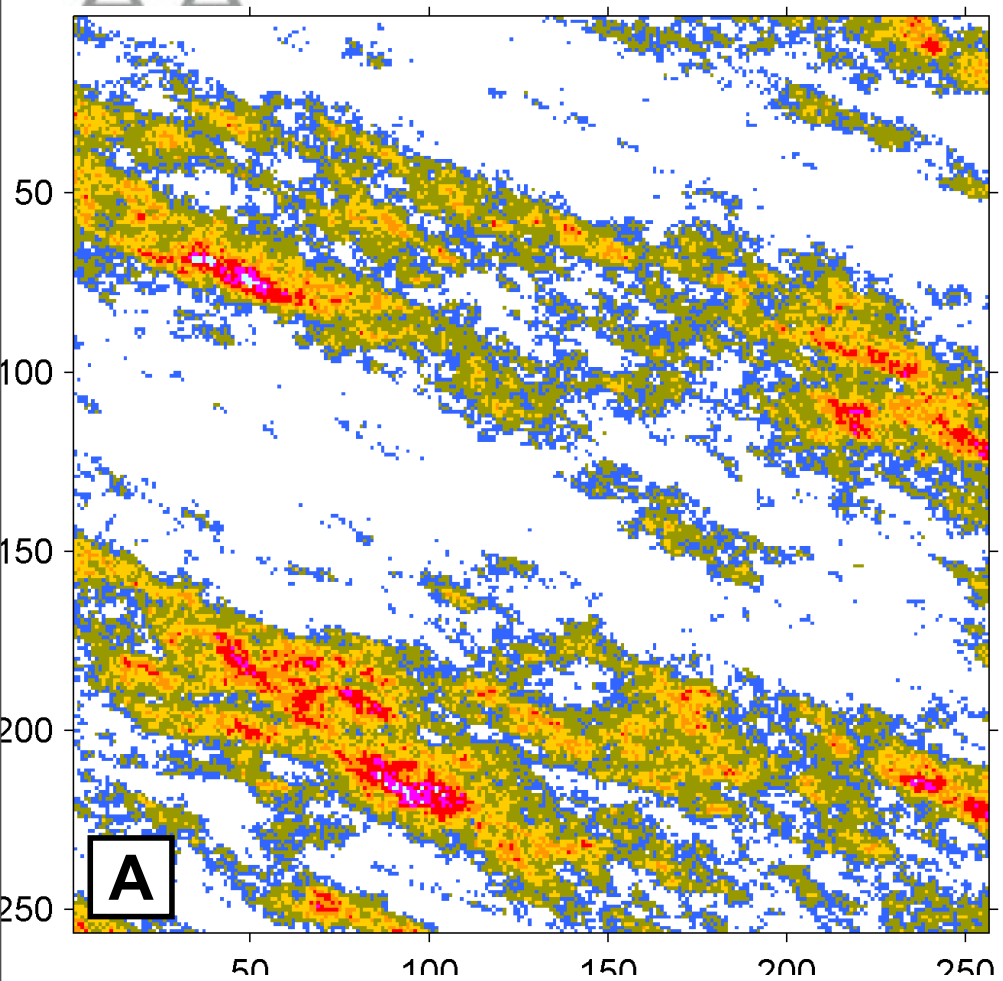
The objective of the project is
to develop the WISE platform in order to produce more accurate, detailed and customized weather information services.

The goal of the project is
to better understand the micro scale phenomenon through observation, In order to develop multi scale, multiple modeling system and micro observation system, especially in the boundary layer.

In order to reach these goals,
International cooperation, communication and integration with related field is needed.

UNIVERSITÉ PARIS-EST

Bilateral collaborations

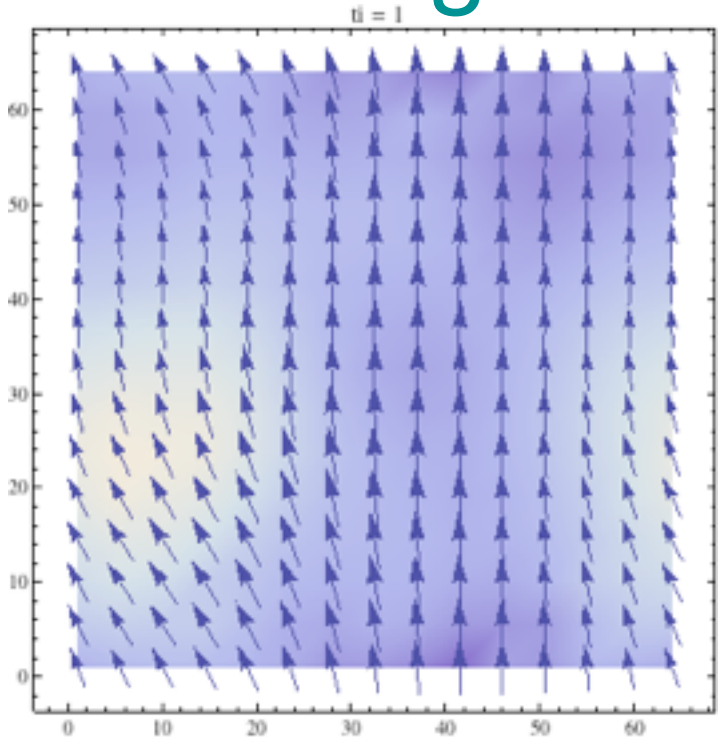


GSI et frontogenesis in STEP (Seed et al., 2013)

- *Bureau of Meteorology*, Melbourne, AU
- Auckland U., NZ
- McGill U., Montréal, CA
- Iowa U. Iowa City, USA
- UC Davis & UC SB, USA
- IME, Rio de Janeiro, BR
- UNL, Santa Fe, AR
- EPFL, Lausanne, SW
- ETZH, Zurich, SW

Conclusion: complexity and heterogeneity of the precipitation as a challenge!

Art piece ‘Windswept’ (Ch. Sowers, 2012, courtesy of G. Fitton): 612 freely rotating wind direction indicators to help a large public to understand the complexity of environment near the Earth surface



Multifractal FIF simulation (Schertzer et al., 2013) of a 2D+1 cut of wind and its vorticity (color). This stochastic model has only a few parameters that are physically meaningful.

Both movies illustrate the challenge of the near surface wind that plays a key role in the heterogeneity of the precipitations... under active investigation !