



# Toward Safe, Weather Resilient ATM Systems: Wind & Wake-Vortex Mitigation

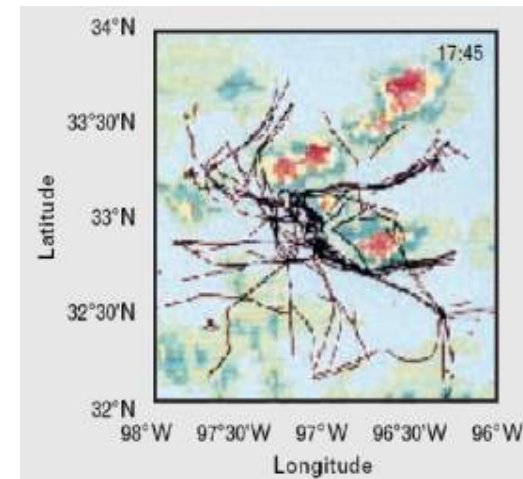
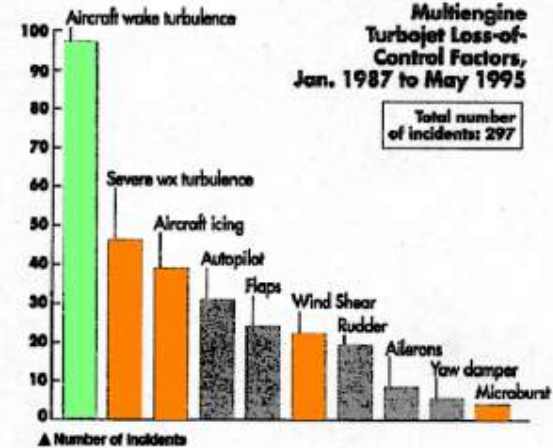
Thierry Beauvais



- **Adverse meteorological conditions & weather hazards have a tremendous impact on ATM with limitations of :**
    - Capacity
    - Flexibility
    - Safety
  - **Impact of weather on aviation are huge:**
    - Delays (1/3 of all)
    - Extra fuel consumption & associated costs
    - Greenhouse emission Increase
- ⇒ 900 Meuros overall extra costs per year in Europe



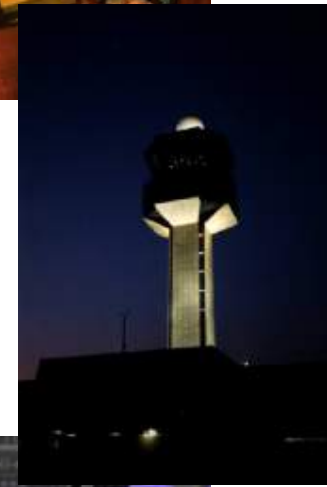
- A significant part of these costs could be reduced by :
  - Improving **Wind** nowcasting/forecasting (e.g. wind-shear event,...)
  - monitoring & alerting **Wake Vortex** hazards
  - Tracking of convective weather evolution (heavy rain, hail, Lightning stroke,...)
  - Detecting Icing conditions
  - Predicting Low-visibility conditions
- Implementation of solutions requires a tight cooperation between:
  - MET service providers
  - ATM operations
  - Airlines
  - Aircraft



## Improving exploitation of MET information during :

- **flight planning :**
  - e.g. flight route optimization
- **flight execution :**
  - e.g. through ATC, AOC and pilots increased collaboration
- **flight critical phases :**
  - e.g. through **wake vortex** & **wind** hazard alerts from ground to aircraft

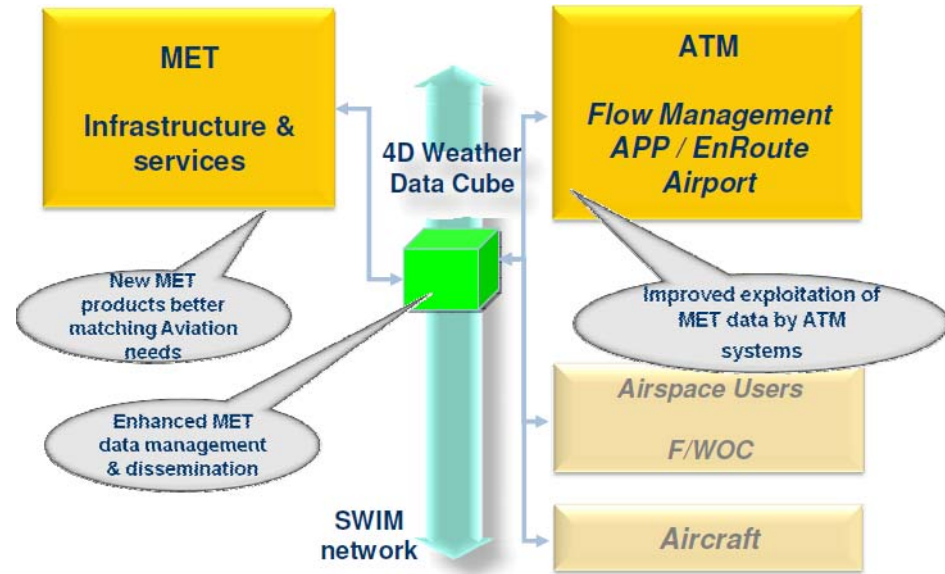
would directly impact flight flexibility, capacity and safety



# New key weather services for airport



- **Weather CDM (Collaborative Decision Making)** : prediction of capacity based on **winds**, icing, visibility / ceiling, ...
- **ITWS (Integrated Terminal Weather Systems)** : dedicated nowcasting / forecasting infrastructure to improve safety and capacity
- **AMAN / DMAN tools using MET data** (**wind**, **windshear**, visibility, **wake vortex transport & decay**, runway surface conditions,...)





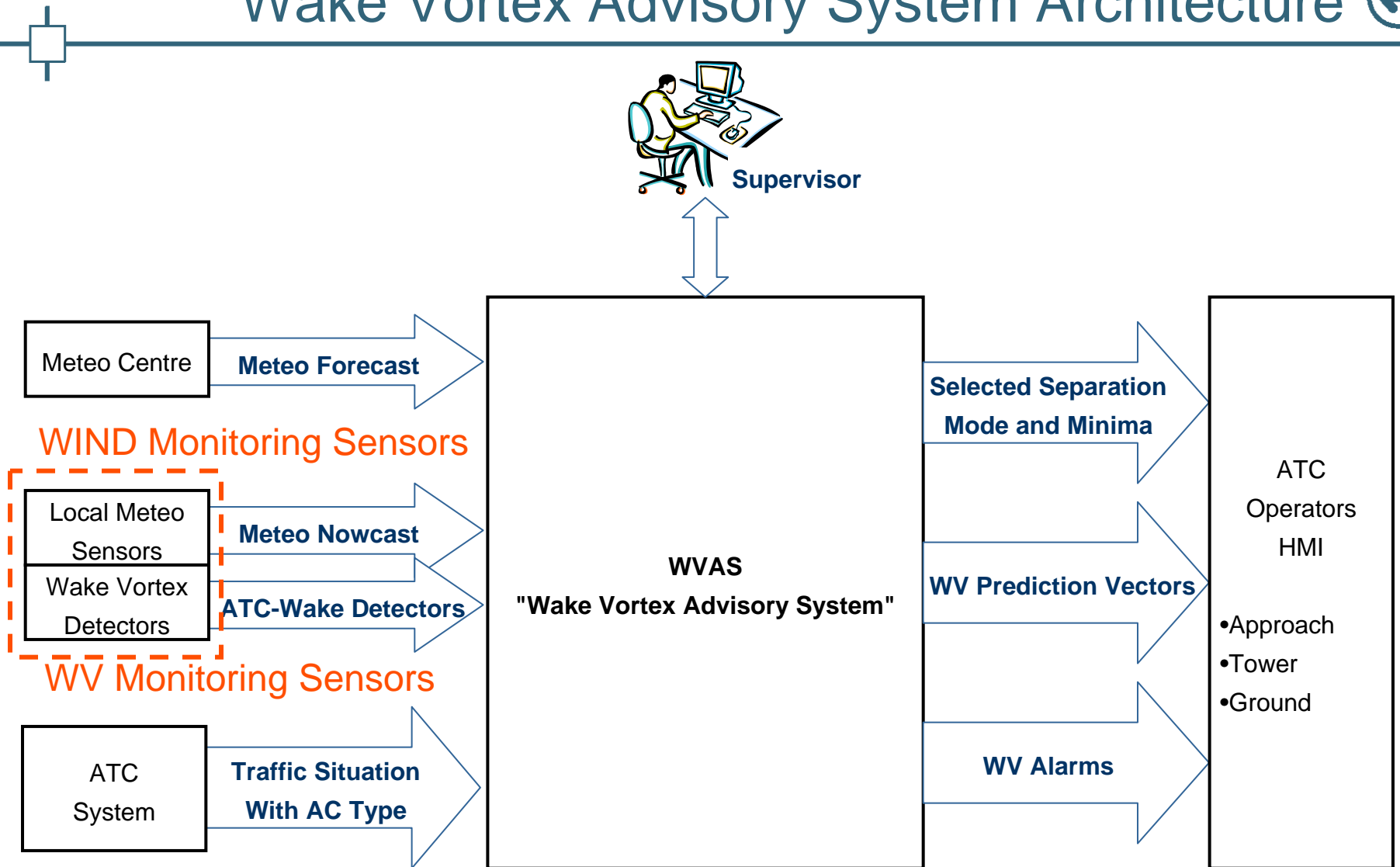
New solutions need to be introduced in a stepwise approach :

- **Extension of weather observation infrastructure :**
  - e.g. turbulence, icing, wind shears,... with accuracy relevant to system requirements
- **Observation assimilation :**
  - in weather nowcasting / forecasting for high confident prediction
- **Progressive exploitation of MET information :**
  - Semi-automated with « man in the loop »
  - Shared by all users
- **Enhanced weather global picture in cockpit :**
  - ground / on-board merge of MET information
  - Safe re-routing proposals
- **Extension of ground-air datalink capacity**



- **Sensors** (Radar, Lidar ,Acoustic ,...) to monitor weather information and hazards
- **Weather models** (Nowcasting & Forecasting) to match aviation requirements
- **ATM system evolution** to process new MET information
- **SWIM, Data-links**
- **Standards**

# Wake Vortex Advisory System Architecture





- **Weather resilient ATM system based on new dedicated systems :**
  - **ITWS** : Integrated Terminal Weather Systems
  - **WVAS** : Wake Vortex Advisory Systems
- **New weather systems and associated sensor requirements :**
  - High resolution wind monitoring sensors
  - High resolution wake vortex monitoring sensors
- **New sensor observation assimilation to improve :**
  - Nowcasting performance
  - Forecasting confidence



**The key enablers for better mitigation of weather hazards**