DFS Deutsche Flugsicherung

WakeNet3-Europe Concepts Workshop

Benefits of Conditional Reduction of Wake Turbulence Separation Minima

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Outline

- Capacity
- Determining Factors & Assessment Methods
- Issues with Conditional Reduction of Separation Minima
- Examples of Crosswind Procedures/Systems
- Conclusions

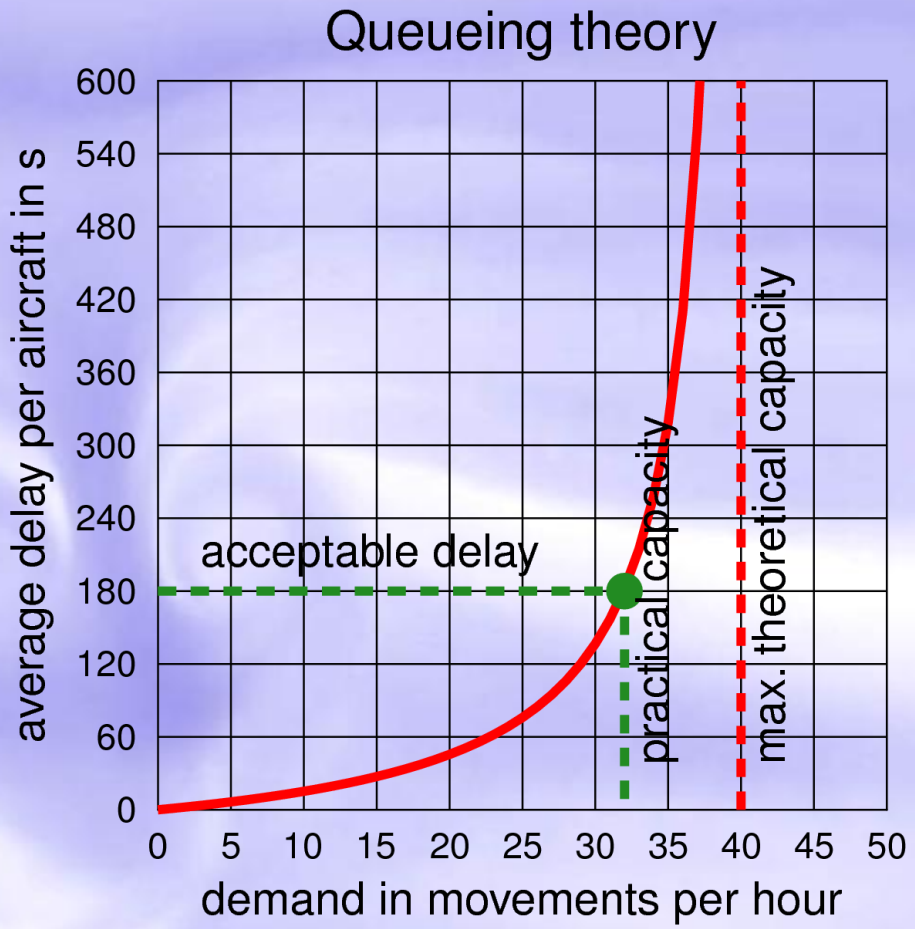
Capacity

- **Static:** Ability to hold something
  - volume of a glass
  - number of aircraft that can be parked on Apron at one time

- Dynamic: Capability of a facility to process something/ to provide service within some period, **when there is continuous demand**
  - fluid flow through a pipeline
  - rate of incoming calls, which can be handled by a call centre
  - number of aircraft that can take off during a specified time

Ultimate Capacity vs. Practical Capacity

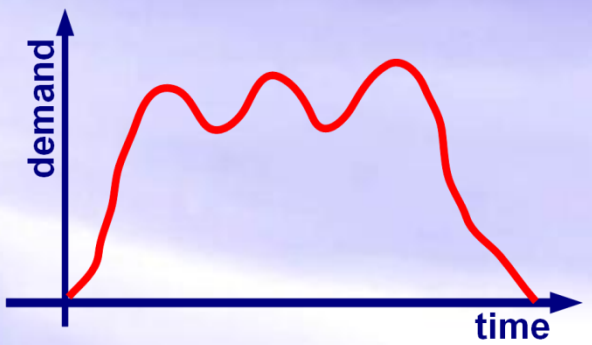
- scheduled airport capacity is due to trade-off, namely
- maximising throughput, while
- keeping quality of service (delay) at acceptable levels

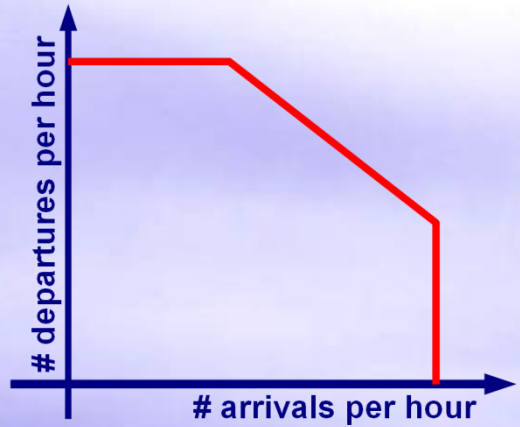


one aircraft every 90s

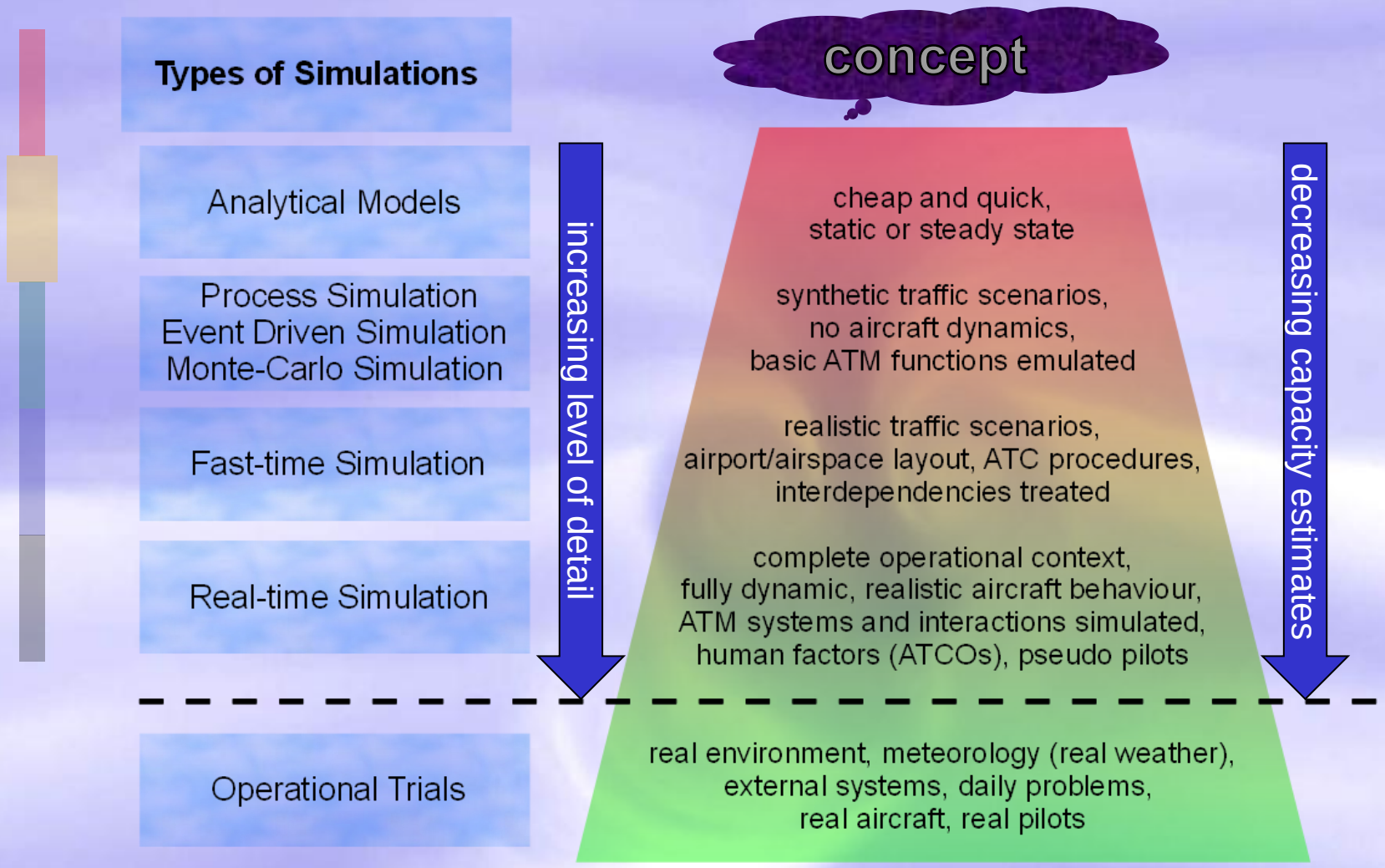
What Determines the Capacity when Invoking ‚Wake Procedures‘?

- frequency and duration of those conditions that permit reduced separations
- traffic mix
- IFR capacity different from VFR capacity
- evolution of demand over time
- accepted delay
- ability of ATM, i.e. ATC, AMAN, DMAN to establish capacity optimized queues
- arrival and departure interdependencies
- capacity of other resources (RT, ATC sectors)
- airspace and procedural constraints



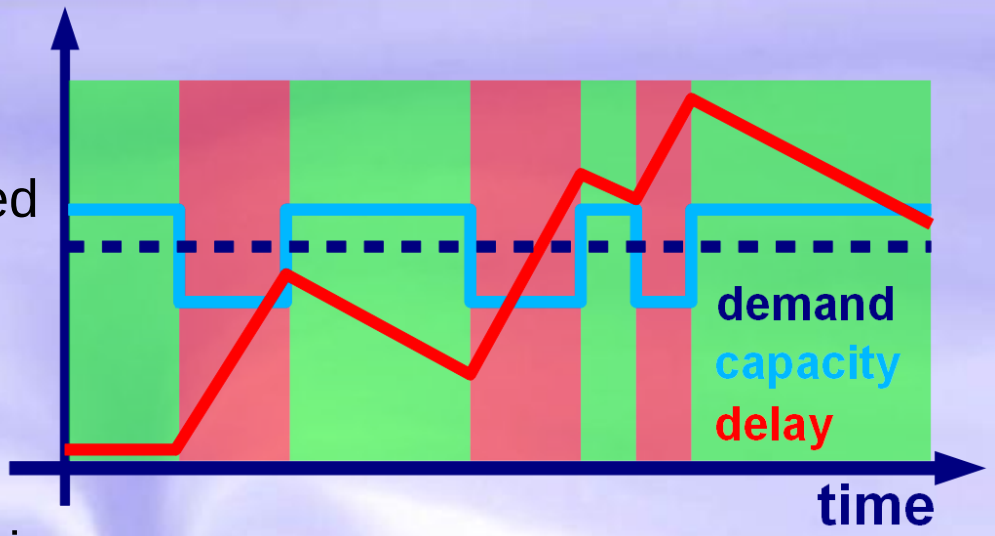


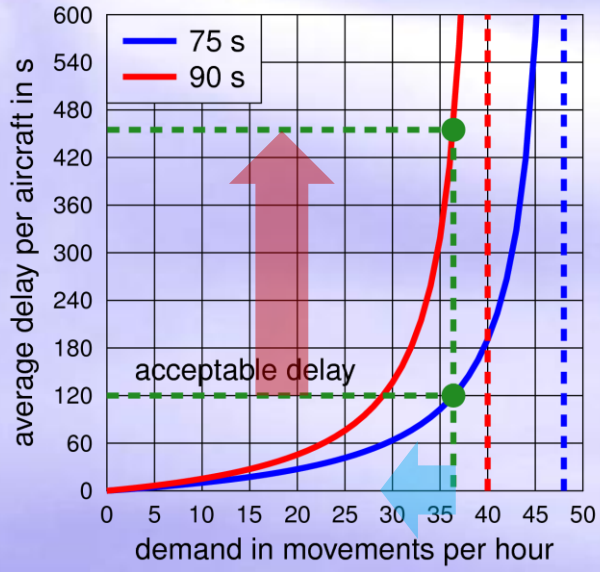
Assessment Methods: Levels of Sophistication



Scheduled vs. Tactical Capacity

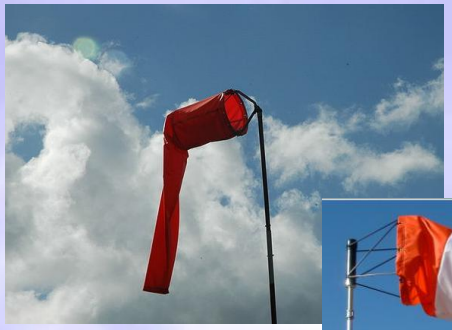
- *standard capacity:* capacity when ICAO wake turbulence separation minima are applied
- if a demand (inbound or outbound flow) higher than the *standard capacity* is permitted, but conditions (wind, visibility etc.) for reducing separation are no longer given
  - delay is drastically amplified, flights might need to be cancelled
  - delay stays high, even long time after the system has returned to operate with reduced separations





Meteorology Dependent Wake Concepts

- most of the proposed wake concepts require the presence of favourable meteorological conditions
- those conditions need to be sensed and forecasted
- forecast for landings more critical than for departures
- persistence is crucial, as well as the stability of the forecast
- sudden, unpredicted transitions from „go“ to „no-go“ must be avoided,
- but nature is not always supportive

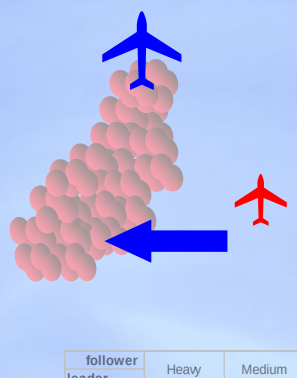


Example 1: Wake Vortex Warning System for Frankfurt Airport

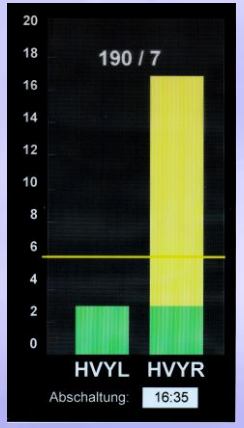
- development by DFS
- 1994-2005
- system intended for staggered approaches to CSPRs at EDDF
- crosswind concept all along the glidepath
- measurements of wind and wind profiles
- nowcasting 20 min. ahead
- never became operational

Min. Radar Separation 2-2.5 NM

ICAO WT Separation 5-6 NM



follower / leader	Heavy	Medium	Light
Heavy	WVWS	WVWS	WVWS
Medium	Minimum		WVWS
Light	Radar Separation		



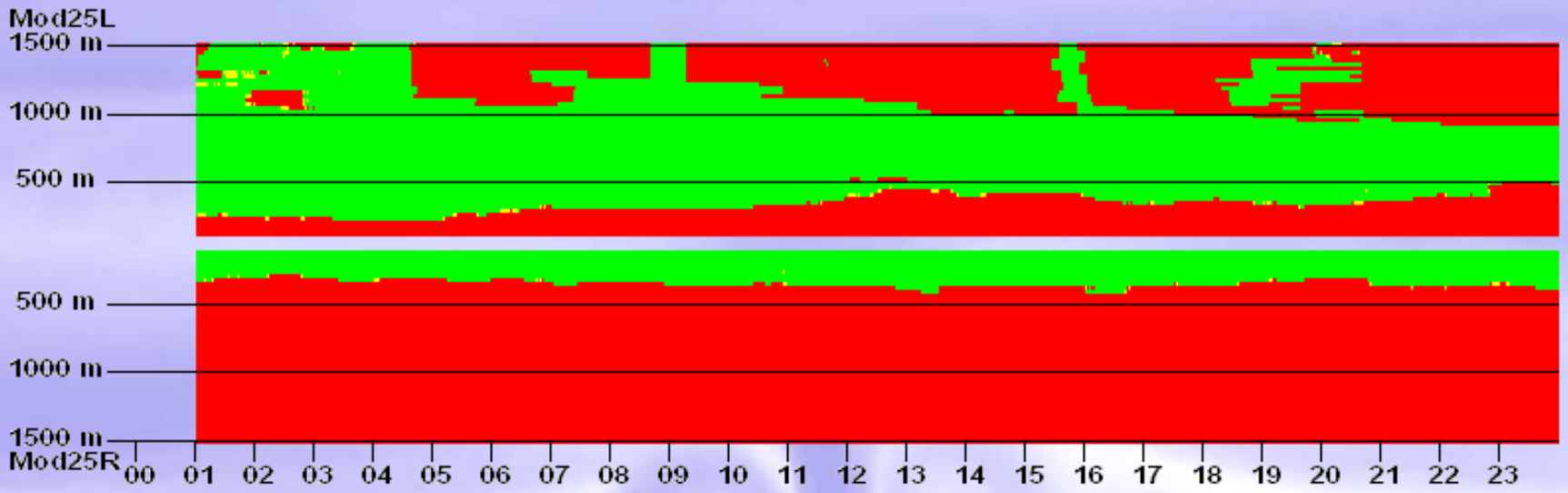
Capacity Gain: Crosswind Based Wake Vortex Warning System

- Generally speaking the benefit of any wake avoidance system or procedure can be expressed as a composition of two terms:

Number of additional movements when the system is used for reducing separation **X** **Fraction of time when system allows for operations with reduced separation**

- The first factor depends on traffic mix and other airport particularities. For Frankfurt airport estimates exceed two additional landings per hour.
- The second factor is – in our case – mainly influenced by the meteorological conditions. The meteorological influence is twofold:
  - Influence on the sensor performance.
  - Influence on the vortex behaviour.

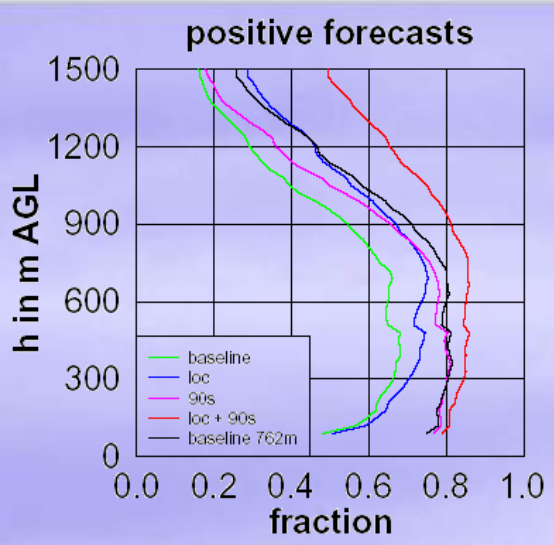
Case Study: Crosswind Profiles

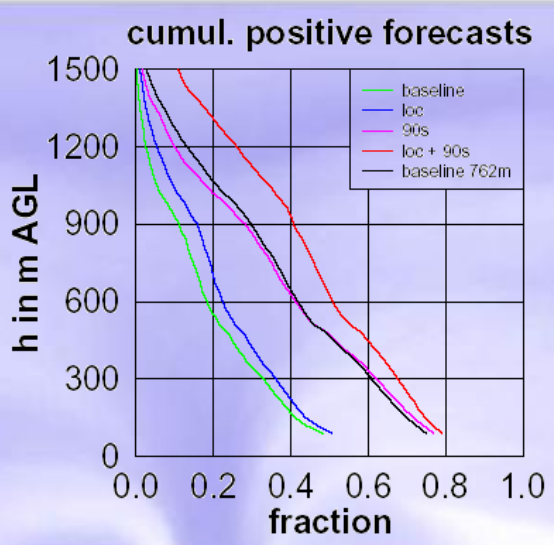


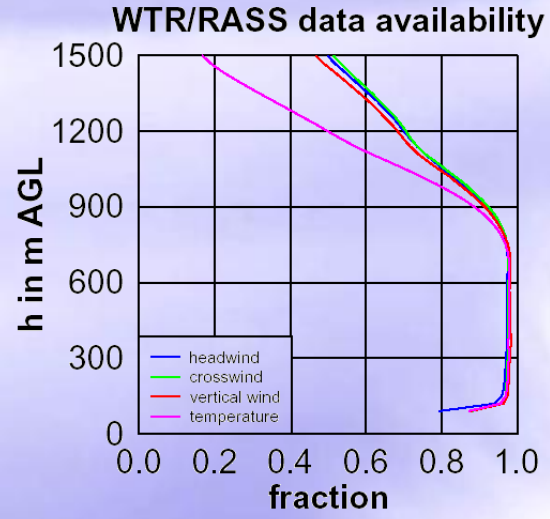
Recommended Procedure 2004-11-16

- validity of assumptions had to be monitored
- crosswind criterion to be fulfilled everywhere along the glidepath

Key Problem: Guaranteed Safety all along the Glidepath





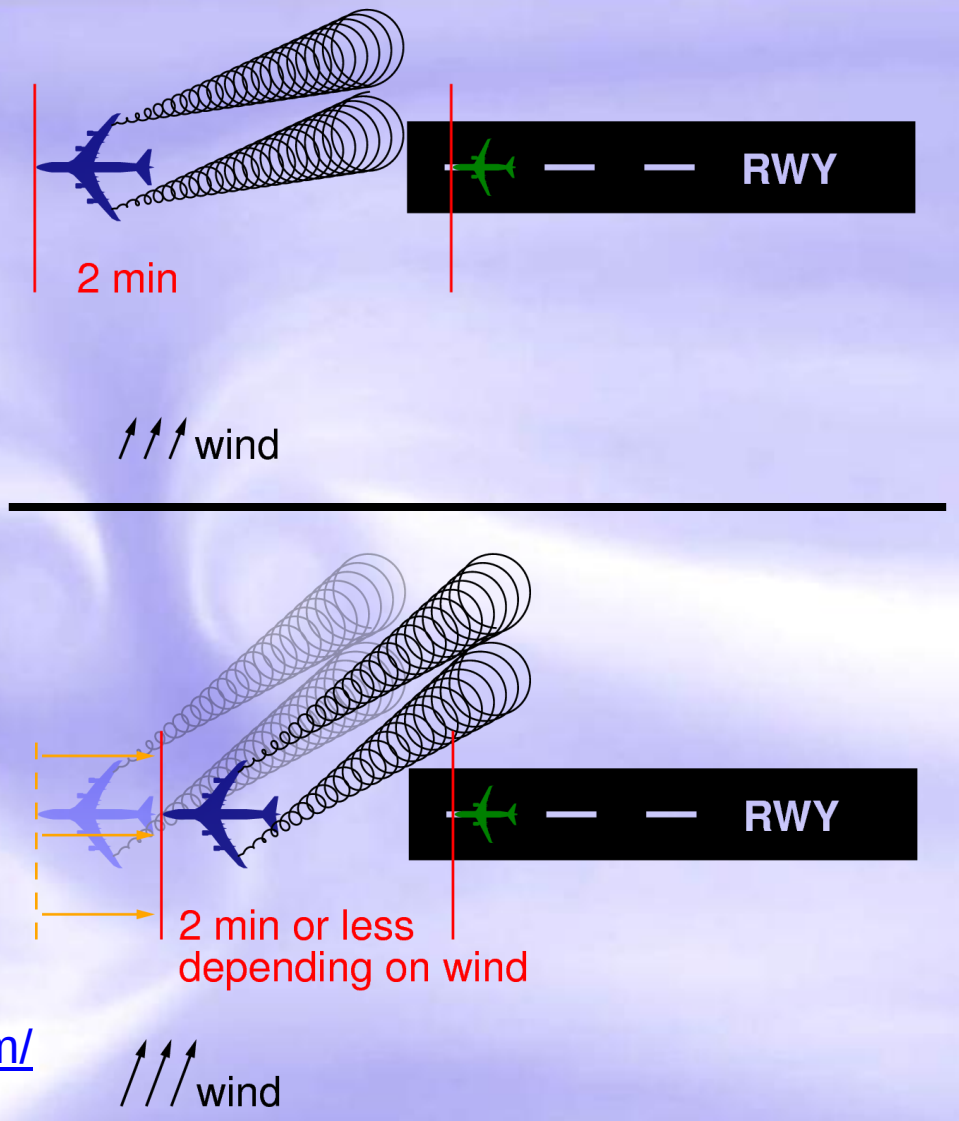


- For a single height bin, the amount of positive forecasts is quite satisfactory.
- The fraction of positive forecasts in the full height range rapidly diminishes with increasing maximum height.

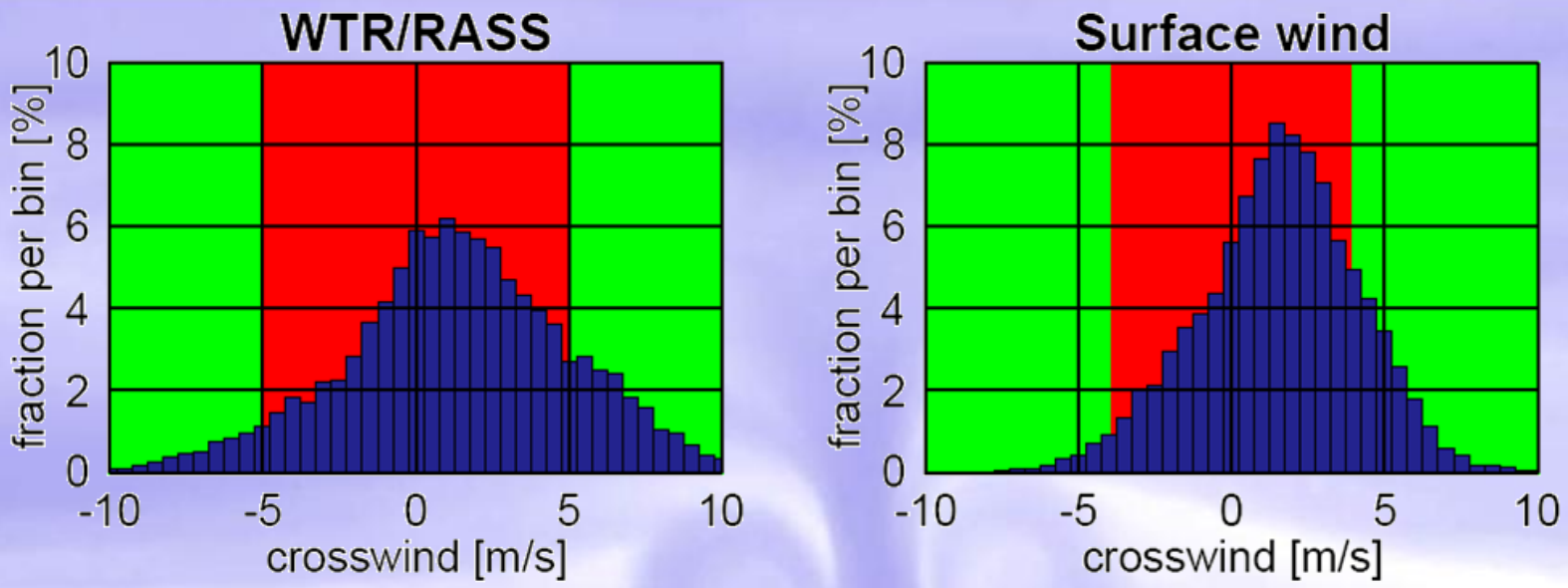
Example 2: Crosswind-Reduced Separations for Departure Ops

- R&D project CREDOS within FP6 of the EC
- Duration 42 months, 06/2006 – 11/2009
- wake turbulence behaviour during the initial climb phase of flight
- develop a concept of operation allowing reduced separations for single runway departures
- stakeholder information package

  http://credos.bluskyservices.com/

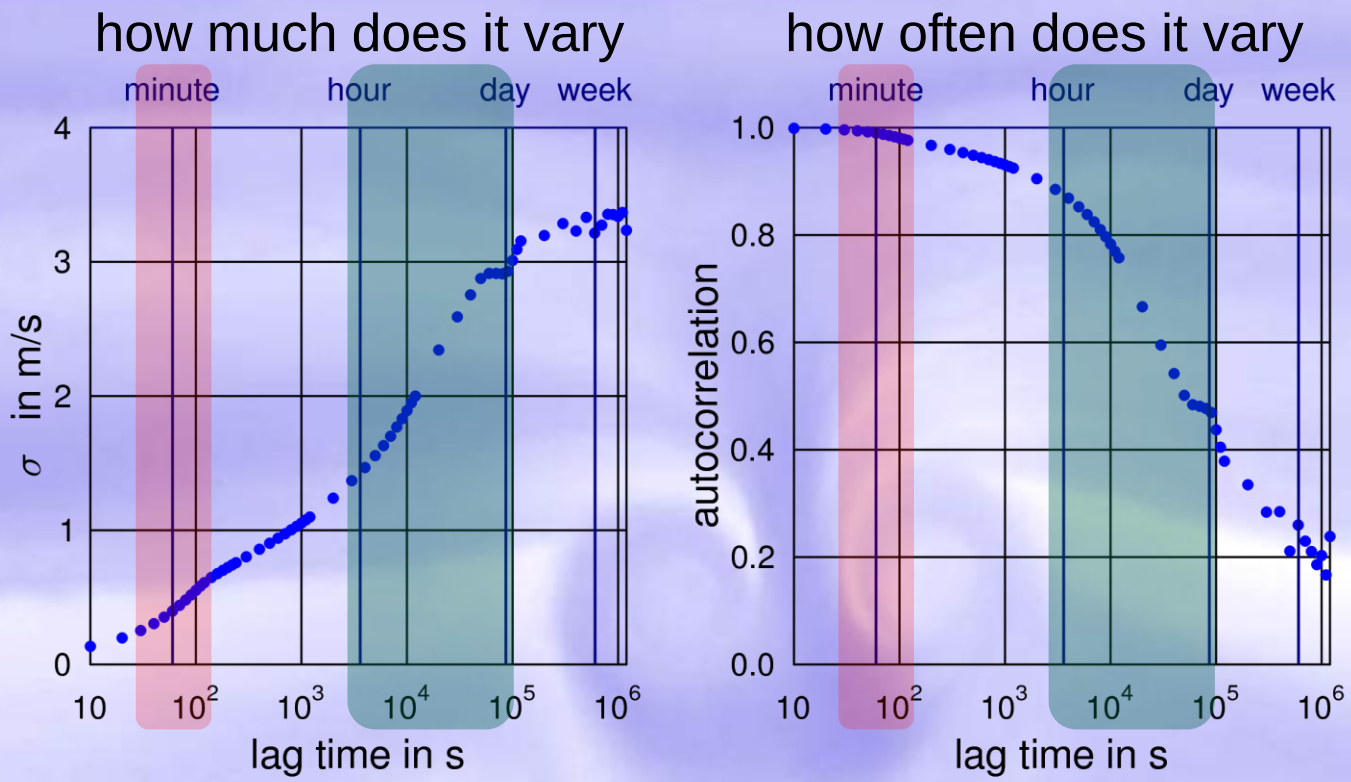


Crosswind Exceeds Required Threshold



- EDDF RWY 25: < 20% meet crosswind criterion
  EDDF RWY 18: approx.1/3 meets crosswind criterion at altitude
- other aspects will reduce potential benefit further
  - duration and stability of periods where crosswind criterion is met
  - safety margins

Time Regimes of Persistence of Crosswind



safety: time between actual measurement and take-off

capacity: time between changes of procedure

Conclusions

- Capacity gains due to conditional reduction of wake turbulence separation is depending on many factors other than wake.
- Practical capacity is always smaller than ultimate or theoretical capacity. The latter however is much easier to be determined.
- Applying reduced separation minima on a tactical basis: Additional, unscheduled flights can be accommodated, delay is reduced.
- Albeit the benefits under favourable conditions, meteorology dependent wake concepts might worsen average delay situation if the complete benefit is translated into strategic capacity increase.
- A thorough analysis of the occurrence of favourable meteorological conditions (frequency and duration) is required before conditional reduction of separation minima are introduced.