Wind Networking in North Atlantic Oceanic Airspace

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Plan

- Context and objectives
- Wind networking concept
- Simulation results
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Organized Track System (OTS) in North Atlantic (NAT)
Objectives

- Ameliorate cruising time prediction
- Ameliorate conflict prediction
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Real and estimated wind simulation

Real wind

10 December 2013
Time 0000UTC
Altitude 200hPa

Estimated wind
Flight simulation

Flight simulation with real winds

Flight prediction with estimated winds
Wind networking concept

Aircraft \( f \) precedes aircraft \( g \) on the same track

Wind adjusting by networking

\[
\begin{align*}
\text{Real wind } & \quad W(t_g, \lambda, \phi, h) \\
\text{Estimated wind } & \quad \tilde{W}(\tilde{t}_g, \lambda, \phi, h) \\
\text{Adjusted wind: } & \quad \hat{W}(\hat{t}_g, \lambda, \phi, h) \approx W^f(t_f, \lambda, \phi, h)
\end{align*}
\]

\( \Leftrightarrow \) Real time \( t_g \)

\( \Leftrightarrow \) Estimated time \( \tilde{t}_g \)

\( \Leftrightarrow \) Adjusted time \( \hat{t}_g \)
Aircraft $f_1, \ldots, f_m$ precede aircraft $g$ on the same or close tracks.

Adjusted wind:
\[
\hat{W}(\hat{t}_g, \lambda, \phi, h) = F[W^{f_n}], \ n = 1, \ldots, m
\]
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Time prediction comparison

Purpose:
To compare the error of prediction of the time of passing the aircraft route points when using estimated winds $\tilde{W}$ and adjusted winds $\hat{W}$:

- $t$ - real time of passing the waypoint
- $\tilde{t}$ - estimated time of passing the same waypoint
- $\hat{t}$ - adjusted time of passing the same waypoint
- $\tilde{e} = \tilde{t} - t$ - prediction error with estimations
- $\hat{e} = \hat{t} - t$ - prediction error with adjustments
Time prediction comparison. Test for 378 flights

- 10 Decembre 2013
- 378 aircraft (real flight plans)
- from 0000UTC to 0900UTC
- 5 tracks
- 8 waypoints
- from FL320 to FL400
- 2646 measurements of waypoint time passing
Purpose: evaluate the difference between

- the number of real and predicted conflicts:
  - Conflicts that are predicted and would happen in the reality ($C_t$)
  - Conflicts that are predicted but would not happen in the reality (false alarm) ($C_p$)
  - Conflicts that are not predicted but would happen in the reality (urgency) ($C_r$)

- real and predicted conflict duration times.
Conflict prediction comparison. Test for 1000 flights

1000 aircraft (random)

Number of conflicts:

<table>
<thead>
<tr>
<th></th>
<th>Estim</th>
<th>Adjust</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_t$</td>
<td>1175</td>
<td>1229</td>
</tr>
<tr>
<td>$C_p$</td>
<td>48</td>
<td>13</td>
</tr>
<tr>
<td>$C_r$</td>
<td>70</td>
<td>16</td>
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</tbody>
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Total conflict duration prediction error (min)

<table>
<thead>
<tr>
<th></th>
<th>Estim</th>
<th>Adjust</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>242.7</td>
<td>63.4</td>
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</table>
Implementing new technologies enables aircraft to exchange the measured meteorological data with each other directly.

The data obtained with wind networking is much more accurate than the initial estimations.

Adjusted predictions of cruising time and conflicts are much closer to the reality.

Wind networking evolves great amelioration of flight prediction.

Wind networking is especially efficient in dense traffic conditions.
Thank you for your attention!