Meteorological forecasting of arctic bird migration to warn air traffic in Finland

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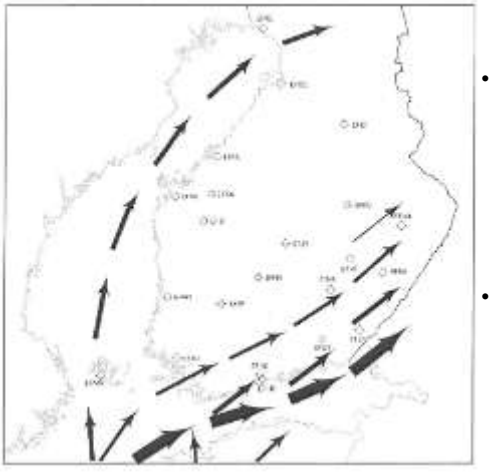
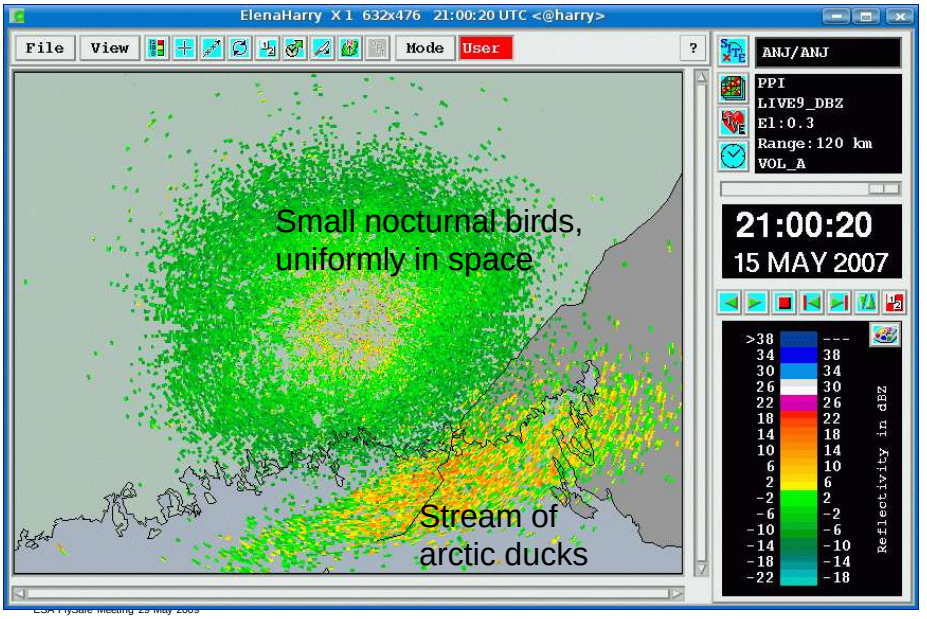
Arctic migration



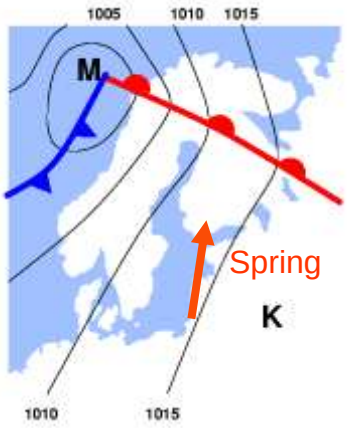
- **About 20 species totalling several millions of birds participate the arctic migration event. Arrows illustrate the main flyways of arctic migration in spring in the Gulf of Finland (south-eastern way) and in the Gulf of Bothnia (western way).**
- **In autumn the arctic migration applies reversed flyways.**

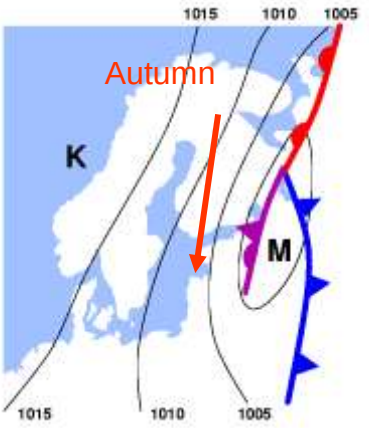
Weather radar example



Forecasting of migration

Weather, especially wind, modulates strongly daily migration intensity, height and location





Migration forecasts by FMI

- Since spring 2001 FMI has provided daily forecasts of migration intensity for the Finnish Air Force (Mar-Jun, Jul-Nov).
- Forecast length 18-54 hours.
- Intensity is calculated for 5 migration types (nocturnal, morning, hawks and eagles, cranes, arctic).
- Based on a climatologically based statistical model between weather quantities and migration.

Migration forecast (E)

Estimated number of migrating arctic birds (E) is obtained daily from

$E = [(P+N) \times S] \times d$, where

- P is accumulated number of resting migrants which did not migrate during the previous days
- N (climatological daily amount)
- S is takeoff region weather factor ($0 \leq S \leq 1$), e.g. when all take off S=1, when 50 % S=0.5, when none S=0.
- d denotes drifting factor ($0 \leq d \leq 1$), the proportion of migrants which take off and pass the Finnish territory

Weather factors (S)

Weather factors modulating arctic migration:

$S = U \times D \times V \times H \times R$

- U is wind speed
- D is wind direction
- V is visibility
- H is cloud base height and coverage
- R is precipitation intensity and type (snow, rain)

Each factor specifies how favourable the weather is in the takeoff region (Baltic Sea in spring, White Sea in autumn) of arctic migration.