Operational forecasting of bird migration intensities in Finland

©Jarmo Koistinen/
Finnish Meteorological Institute

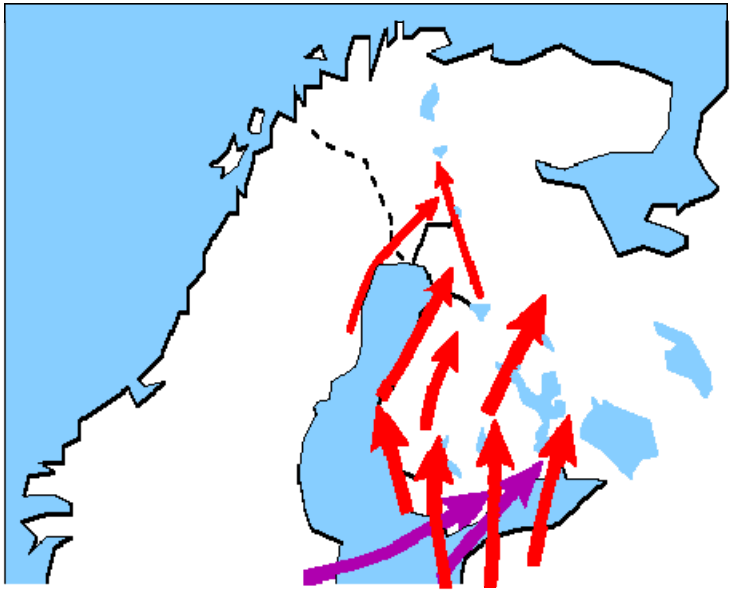
Migration forecasts by FMI

- 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 given for 4 migration types (nocturnal, morning, soaring, arctic).
- Based on a climatological model between weather quantities and migration.

How many birds arrive Finland (M)

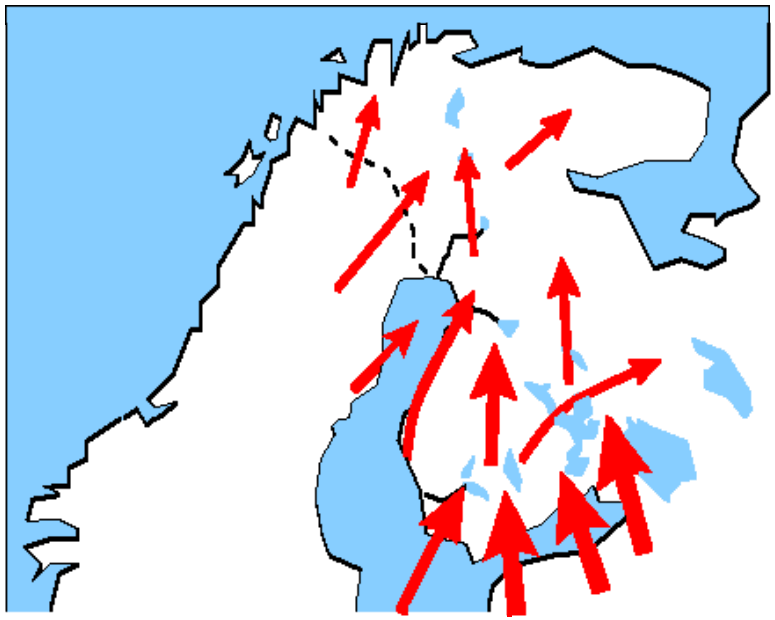
- The migrating population of each species across each latitude is relatively well known (Väisänen et al., 1998 & migration climatology).
- Total M (all species) across 60°N (20-30 °E) is ~80 million individuals (200 million leave in autumn).
- Seasonal distribution of M for each species obeys average climatology, which is modulated daily by the actual weather S.

Morning migration



30 million birds in total
Finches, pipits, gulls, doves, crows, thrushes, starlings, waders, geese, swans…
Peak: 1 Apr – 10 May

Nocturnal migration

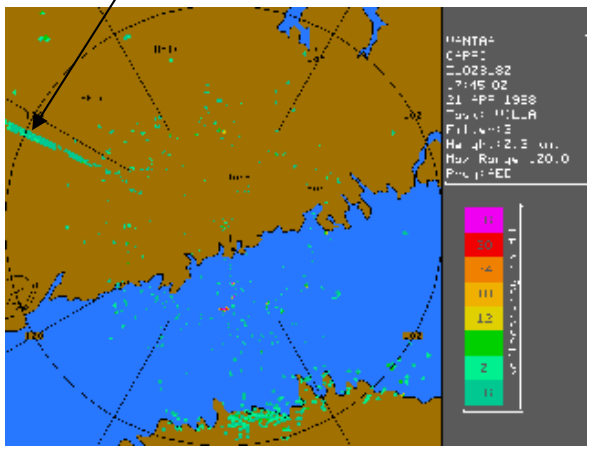


40 million birds in total
Small passerines, thrushes, waders, waterfowl …
Peak: 10 Apr – 10 Jun

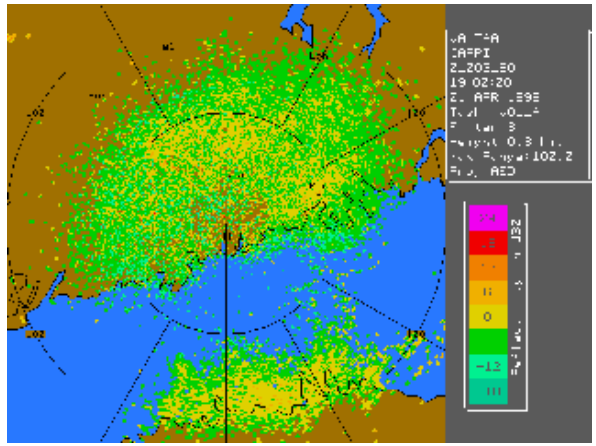
Weather radars detect well morning and nocturnal migrations.

Example of the onset of nocturnal migration:

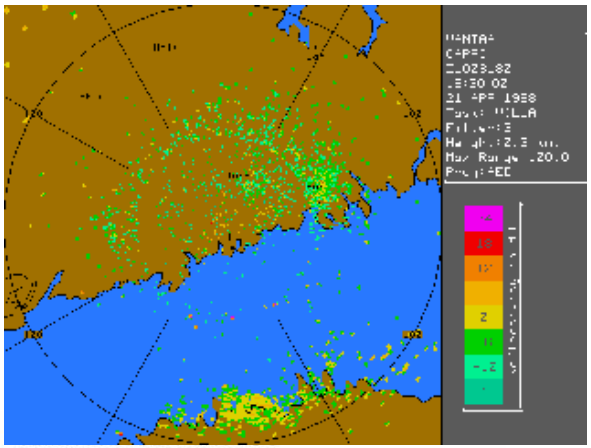
Sun set



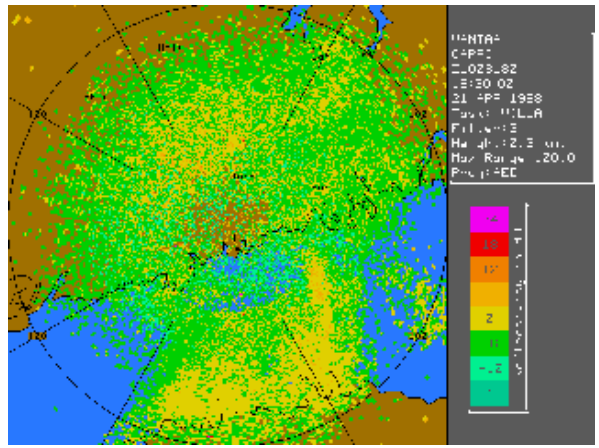
17.45



19.00



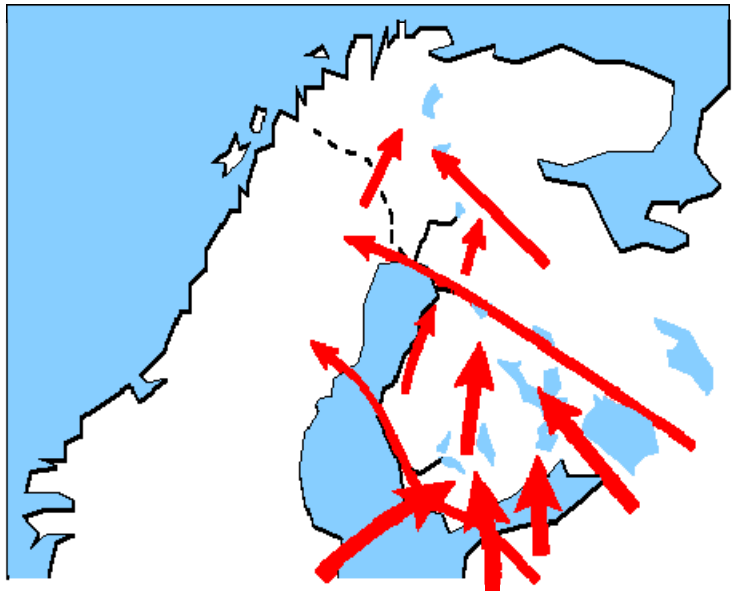
18.30



19.30

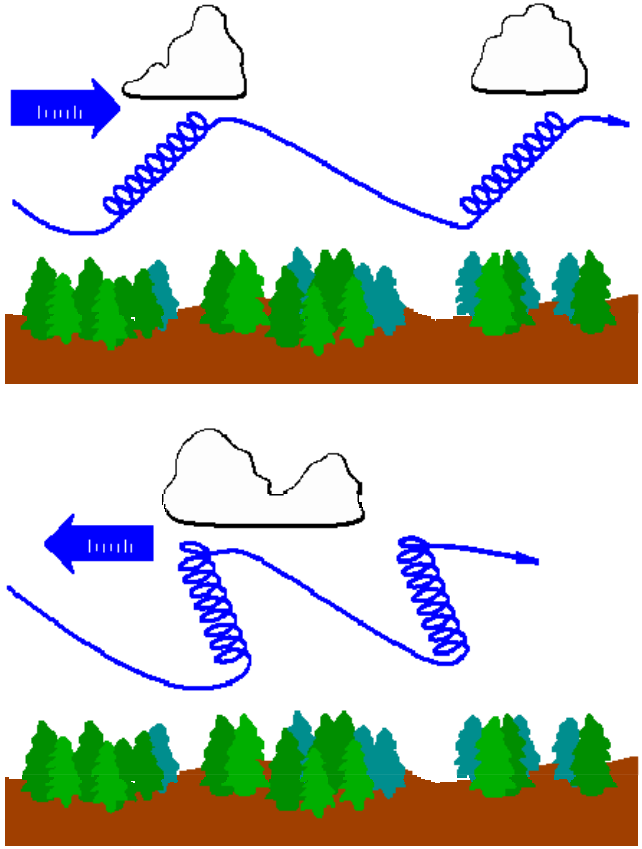
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Soaring migration

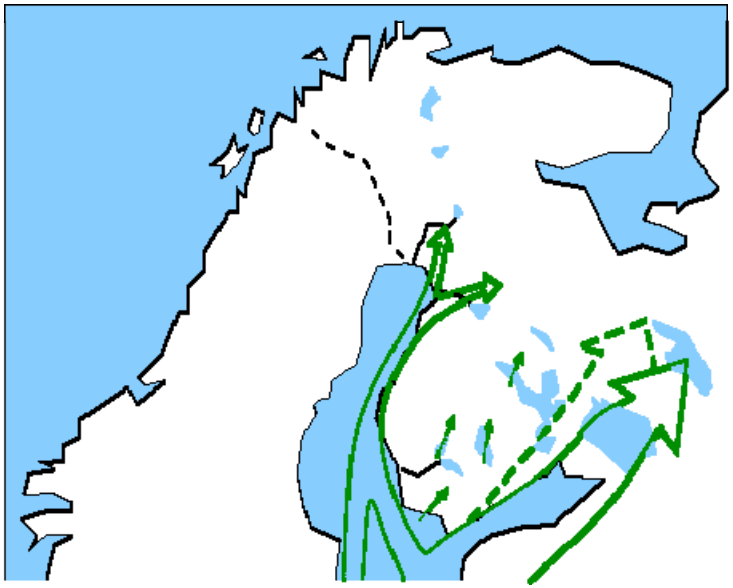


50 000 birds in total
Hawks, cranes
Peak: April

Soaring migration applies thermals

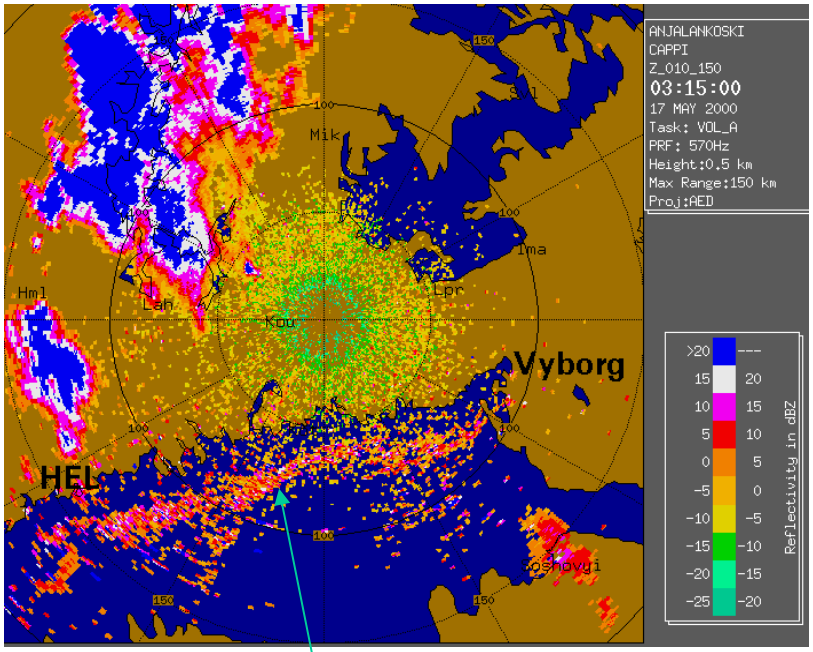


Arctic migration

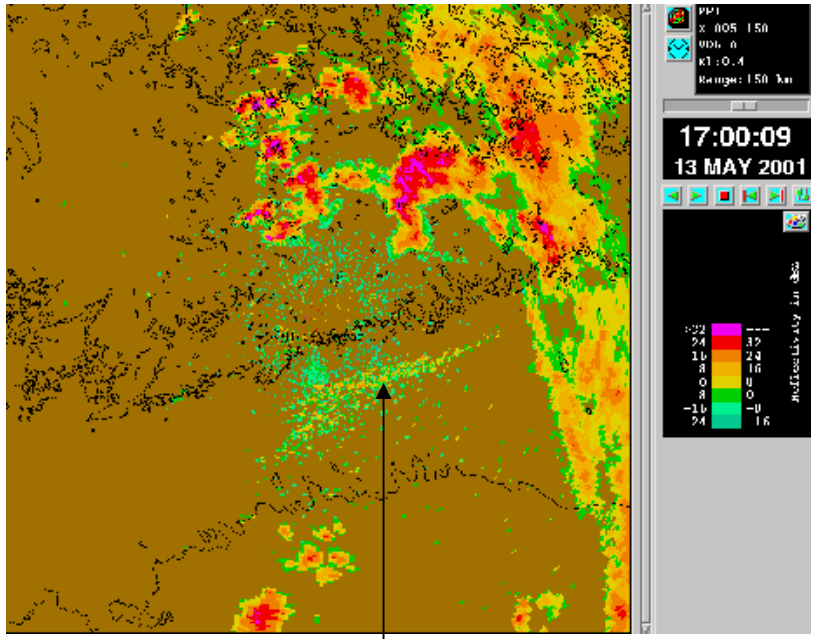


1-6 million birds in total (wind drift important)
Waterfowl, waders, geese, divers
Peak: 10 May – 5 Jun

Examples: Barnacle geese and Common scoters



Geese



Scoters

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

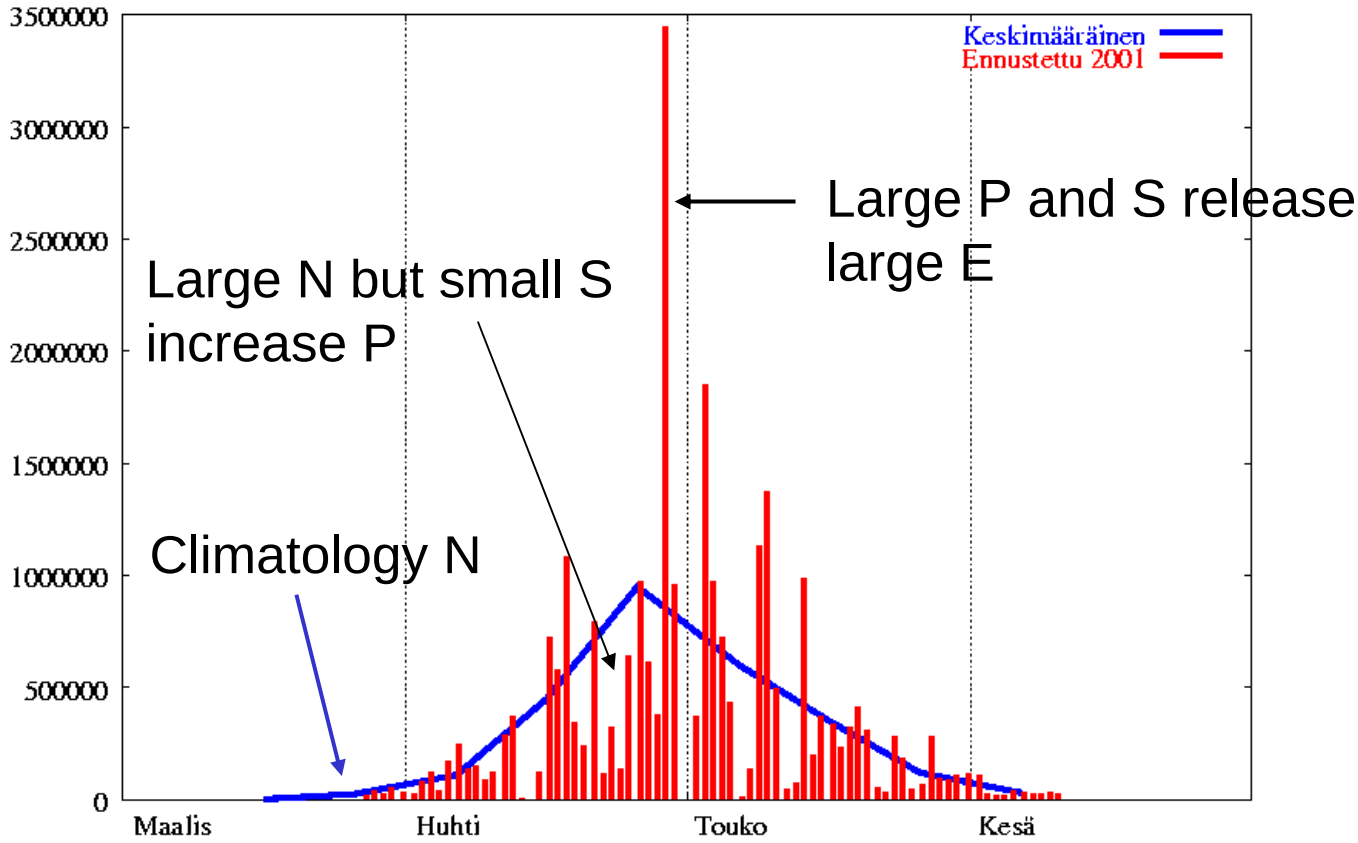
Migration forecast (E)

Estimated intensity of migration (forecast) is obtained daily from

E = M × S = (P+N)×S, where

- **E** is the number of individuals crossing a latitude in Finland/ migration event (day)
- **M** is the number of individuals ready for departure in the takeoff region consisting of two groups of birds i.e. **P**, delayed ”storage”, and **N**, climatological amount. M decreases towards north.
- **S** is total weather factor in the takeoff region, $0 \leq S \leq 1$, e.g. when all take off S=1, when 50 % S=0.5, when none S=0.

Morning migration across 62N: climatological (N) and daily forecast (E), spring 2001



METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Model weaknesses

- In cases of long periods of very favourable weather the climatological model (N) lags the actual situation
- Climatology spreads too much actual peaks (e.g. crane)
- Meteorologists have no knowledge of the actual species involved but take them from a tentative list

Weather factors (S)

Several weather factors modulate migration:

S = U × D × d × V × H × R × L × K

- **U is wind speed**
- **D is wind direction**
- **d is wind drift**
- **V is visibility**
- **H is cloud height and coverage**
- **R is precipitation intensity and type (snow, rain)**
- **L is snow and ice cover**
- **K is convection (thermals)**

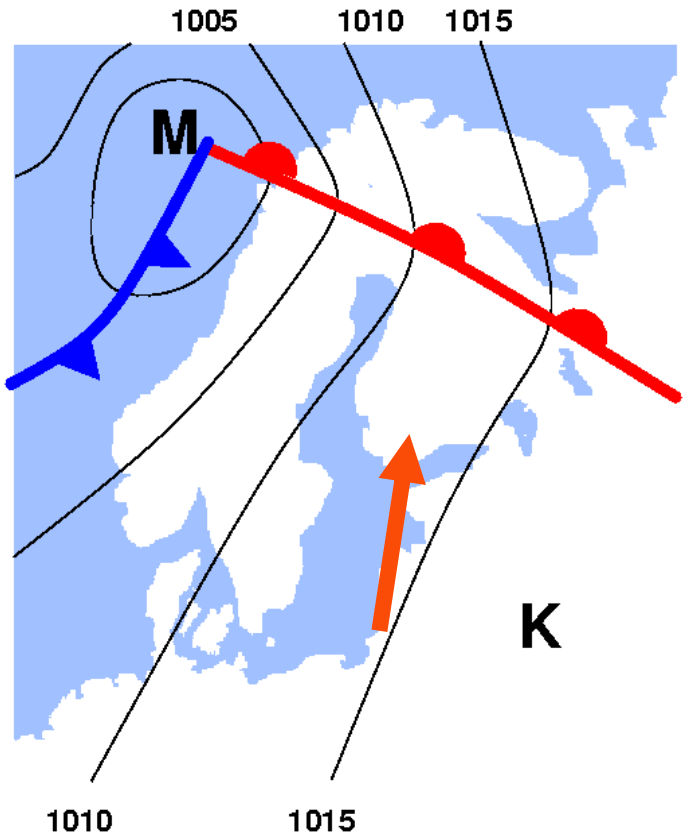
Each factor has a specific statistical influence on the total factor S of 8 migration subgroups of birds.

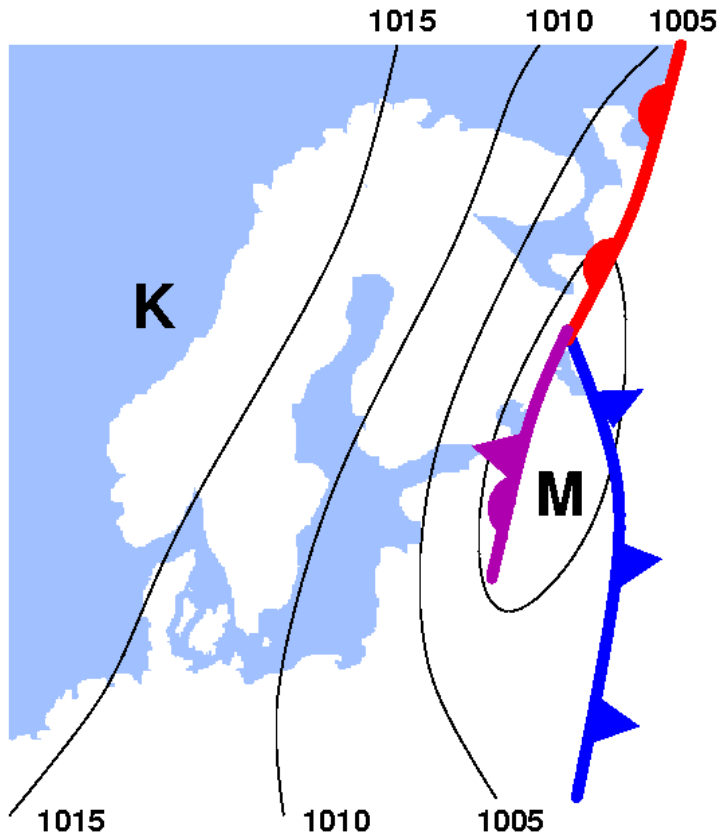
Example: Wind speed

Migration intensity decreases in strong winds – also in tailwind – as mechanical turbulence becomes too risky for takeoff.

Speed at 10 m (m/s)	Factor U
0-8	1
9-11	0.8
12-16	0.2
17-	0

Summary of S: Favourable migration weather can be seen from the synoptic map





ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Practical forecasting and validation

- The model of E is run in Tampere, Kuopio and Rovaniemi
- Forecast E is programmed into an exel Table which requires as input (P is updated automatically):
  - daily 18-36 h weather forecasts (factors of S)
  - climatology N is given as daily averages in 10 day periods
- Output: E (individuals) for 8 groups of migrants, formatted into intensity categories of the main migration types
- Height of migration is also estimated
- Note: It is not possible to verify actual number of migrants applying field or radar observations!

Forecast example (in Finnish)

Lintujen muuttosääennuste keskiviikoksi 27.4. 2005:

- Katsaus: Heikkotuulisessa ja aurinkoisessa säässä muutto on melko vilkasta
- Aamumuutto (klo 6-10 SA): kovaa (klimatologinen lajiluettelo), muuttokorkeus 5000 ft (1500 m) asti.
- Konvektiomuutto, kurjet (klo 10-18 SA): kovaa
- Konvektiomuutto, haukat (klo 10-15 SA): kovaa (klimatologinen lajiluettelo), muuttokorkeus 5000 ft (1500 m) asti.
- Yömuutto (klo 22-04 SA): kohtalaista (klimatologinen lajiluettelo), muuttokorkeus 5000 ft (1500 m) asti.
- Arktinen muutto, Pohjanlahti (klo 0-24 SA): heikkoa (klimatologinen lajiluettelo)
- Arktinen muutto, Suomenlahti (klo 0-24 SA): kohtalaista (klimatologinen lajiluettelo), muuttokorkeus 3000 ft (1000 m) asti.
- Odotettavissa torstaina: muutto voi heiketä hieman.
- Laadittu 26.4. klo 10:20 SA