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Significant-hail-producing thunderstorms in Finland: Synoptic environment

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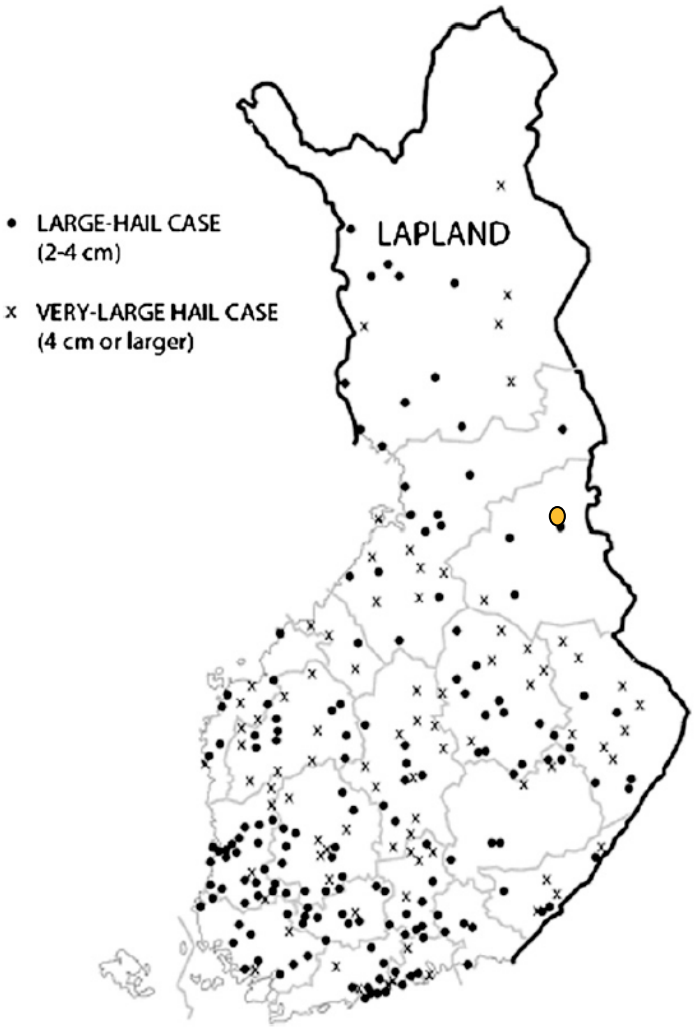
Background

- Systematic collecting hail reports started in FMI in 2006
- *Climatology of severe hail in Finland: 1930–2006* (Tuovinen et al. 2009)
  - 240 severe-hail cases (2 cm or larger)
  - Occur mostly between June and August, maximum in July
  - Most cases occur in southern and western Finland, generally decreasing north

- Annual average of 17 severe-hail days (2008-12) (Tuovinen et al. 2015)
- The largest hail diameter 9 cm (31 July 2014)



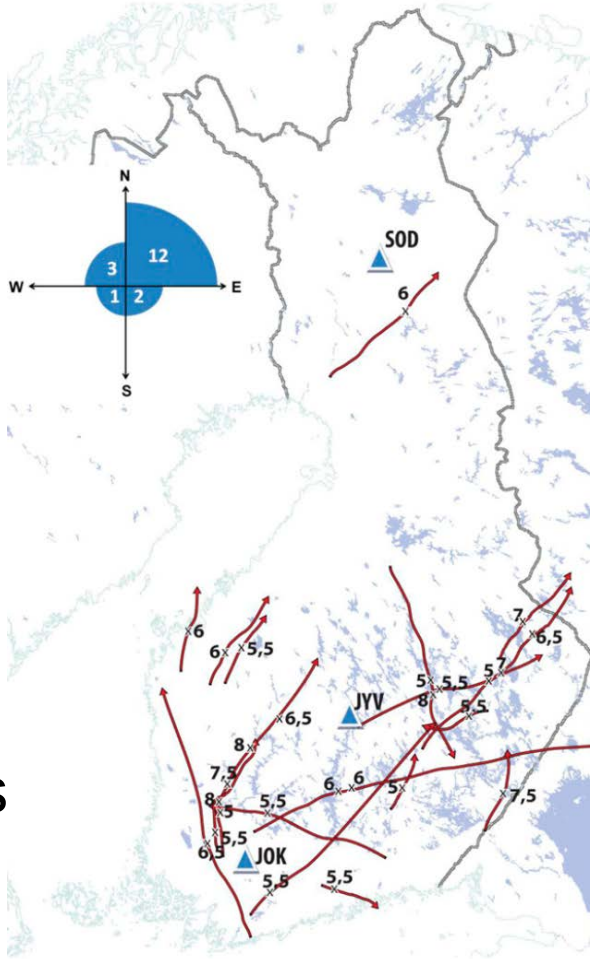
Geographical distribution of severe-hail cases in Finland during 1930–2006 (Tuovinen et al. 2009)

Background

Significant-hail-producing storms in Finland: Convective-storm environment and mode (Tuovinen et al. 2015)

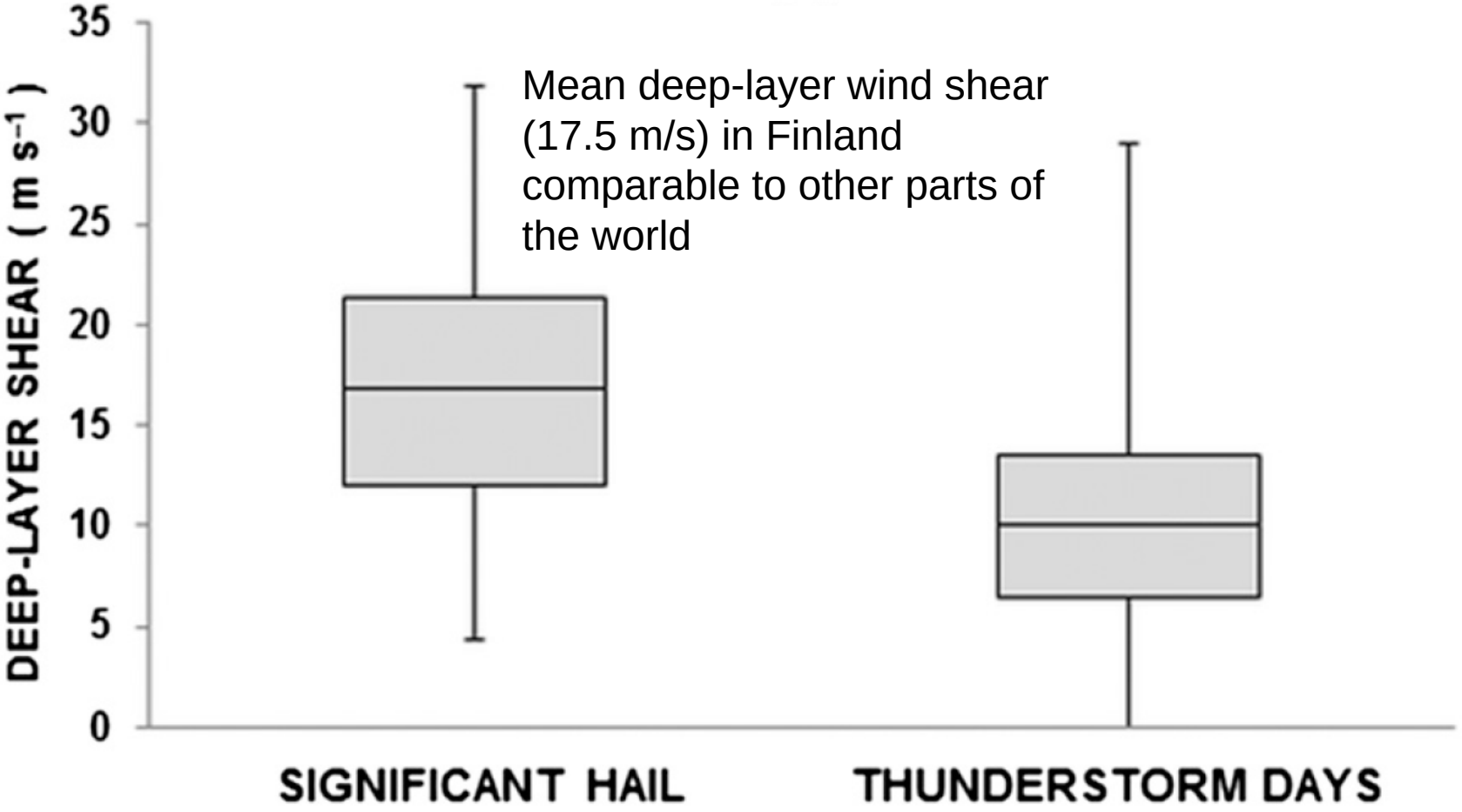
- Storm characteristics of 18 significant-hail-producing storms
- 23 significant-hail-day proximity soundings

- All significant hail produced by cellular convection
- Most storms (14/18) were supercell storms
  - Right-moving cluster supercells (8)
  - Right-moving discrete supercells (5)
  - A left-moving discrete supercell (1)
  - Cluster cells (2) and discrete cells (2)



All significant-hail observations during 1999–2011 with hail diameter (cm) and their 18 parent-storm tracks (Tuovinen et al. 2015)

0-6 km shear for significant-hail and thunderstorm days in Finland



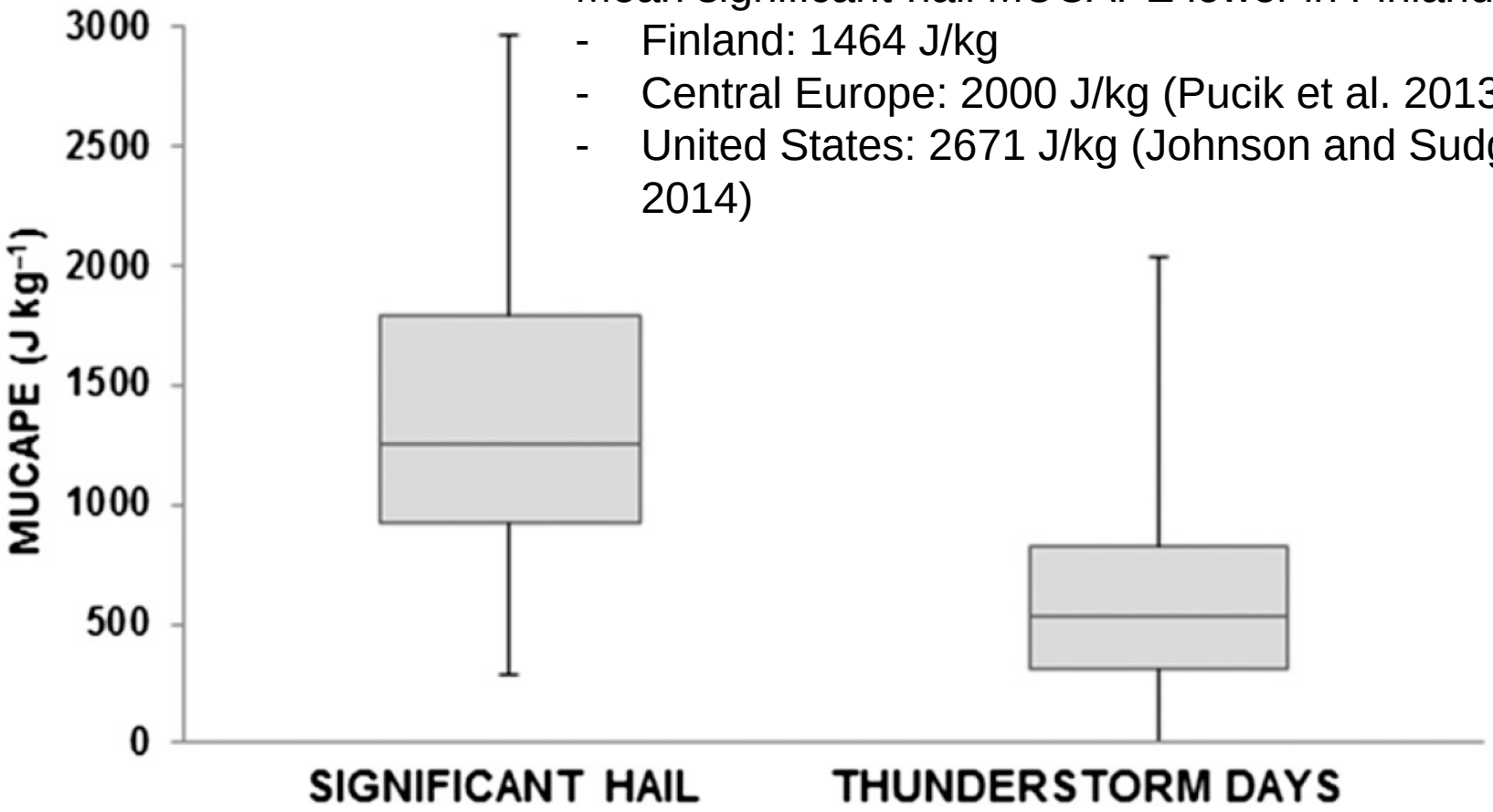
Mean deep-layer wind shear (17.5 m/s) in Finland comparable to other parts of the world

Tuovinen et al. 2015

MUCAPE for significant-hail and thunderstorm days in Finland

Mean significant-hail MUCAPE lower in Finland

- Finland: 1464 J/kg
- Central Europe: 2000 J/kg (Pucik et al. 2013)
- United States: 2671 J/kg (Johnson and Sudgen 2014)



Tuovinen et al. 2015

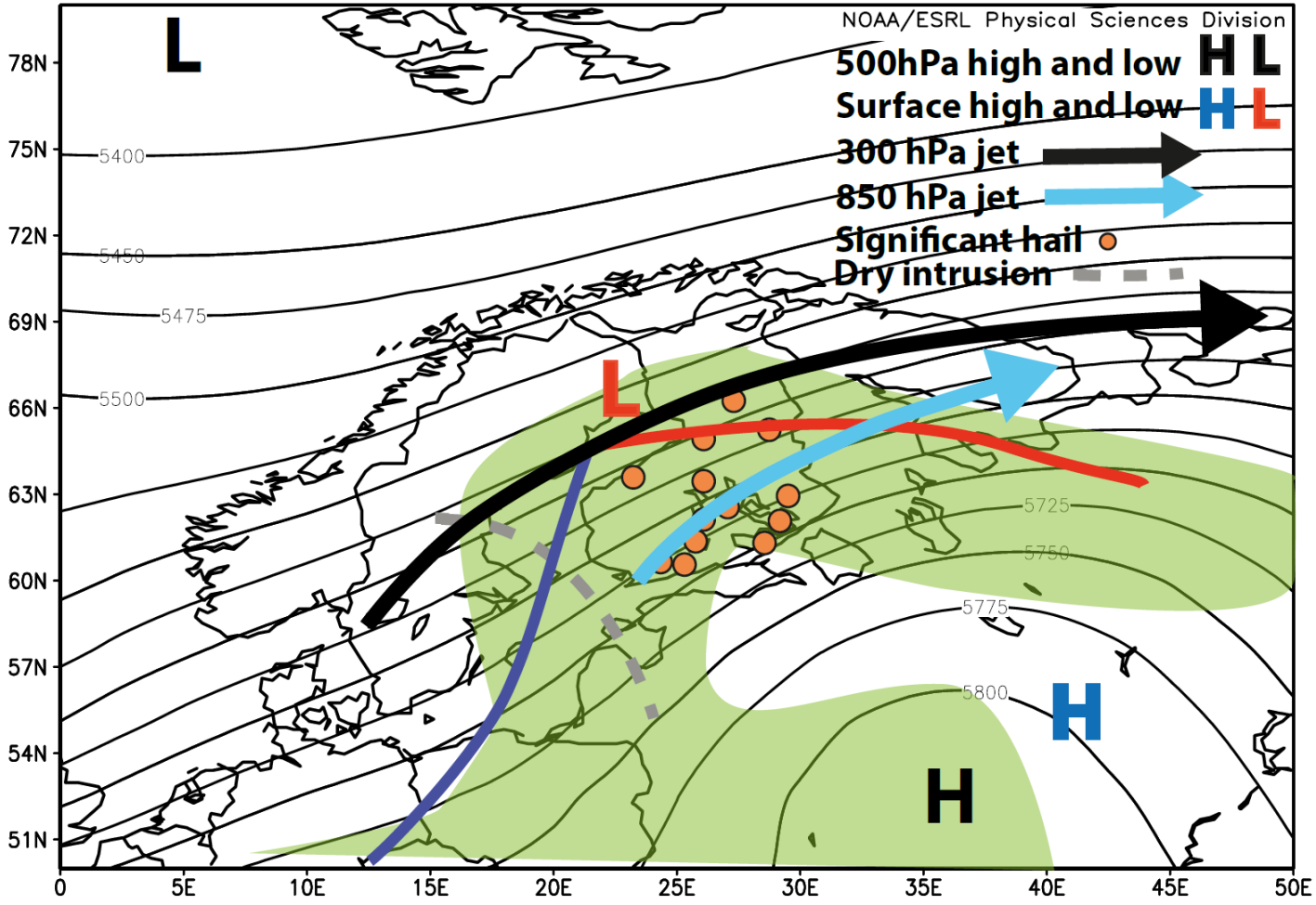
- Environmental properties (vertical wind shear, instability and moisture) are likely quite similar during significant-hail events anywhere
- The synoptic setting that brings the right ingredients together may vary from place to place
- Pattern recognition in severe weather forecasting
- Are there severe weather settings that could be called synoptically evident?

Which weather patterns are most common for significant-hail-producing storms in Finland?

Synoptic-scale circulation patterns during 35 significant-hail days

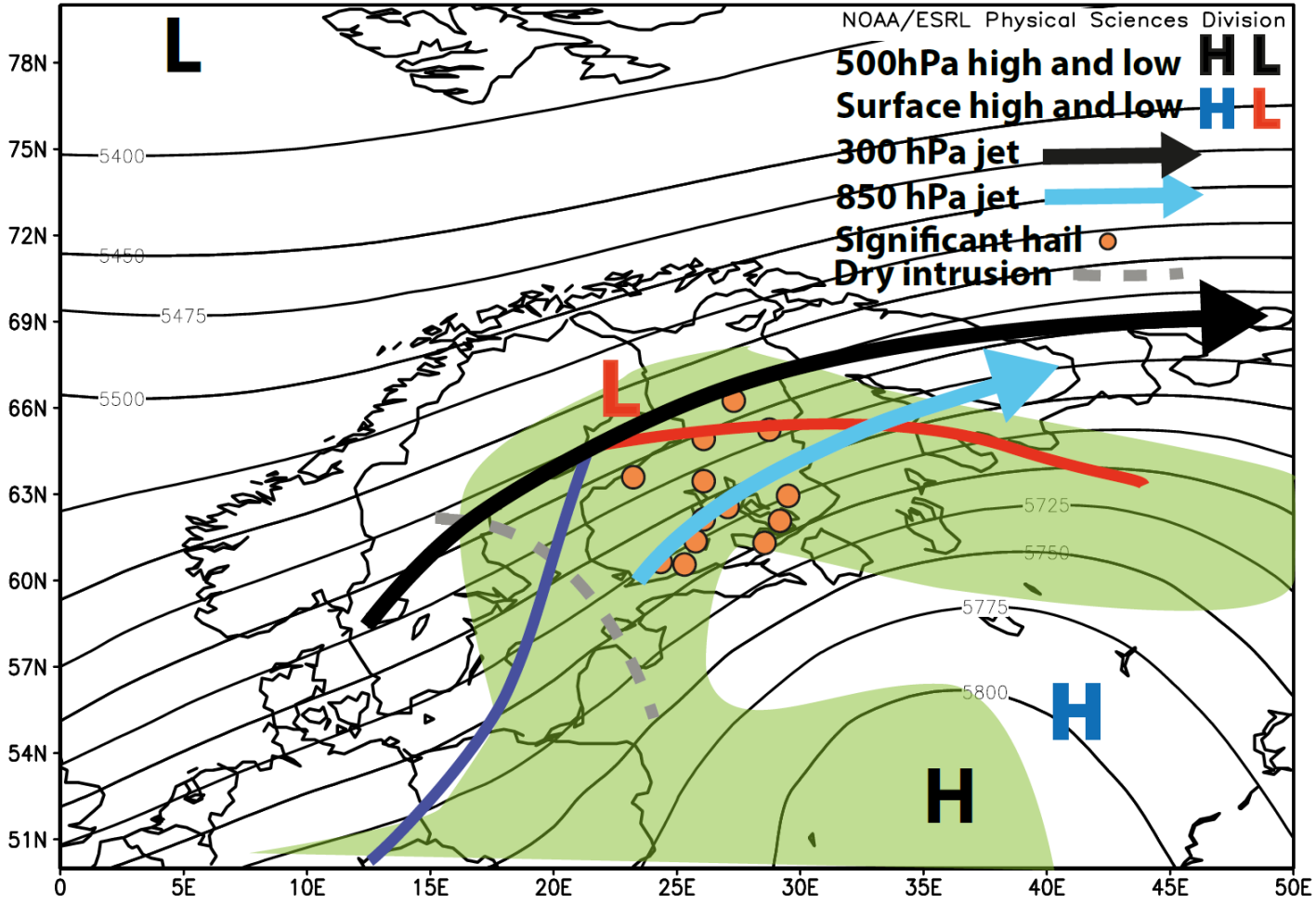
- 50 significant-hail reports 1957–2016 (35 days)
- NCEP–NCAR reanalysis data (National Centers for Environmental Prediction–National Center for Atmospheric Research)
- 300-hPa, 500-hPa, 850-hPa and surface maps for each day (0000, 0600, 1200 or 1800 UTC)
- Daily synoptic settings clustered
  - 4 synoptic classes
  - Unclassified category
- Composite means and synoptic composite maps with conceptual models

4 composite charts



1. Composite mean 500-hPa height
2. Composite mean location
   - 500-hPa low and high
   - Surface low and high
   - 300-hPa jet
   - 850-hPa jet
   - Frontal boundaries
   - Strongest 700-hPa humidity gradient
3. All significant-hail reports

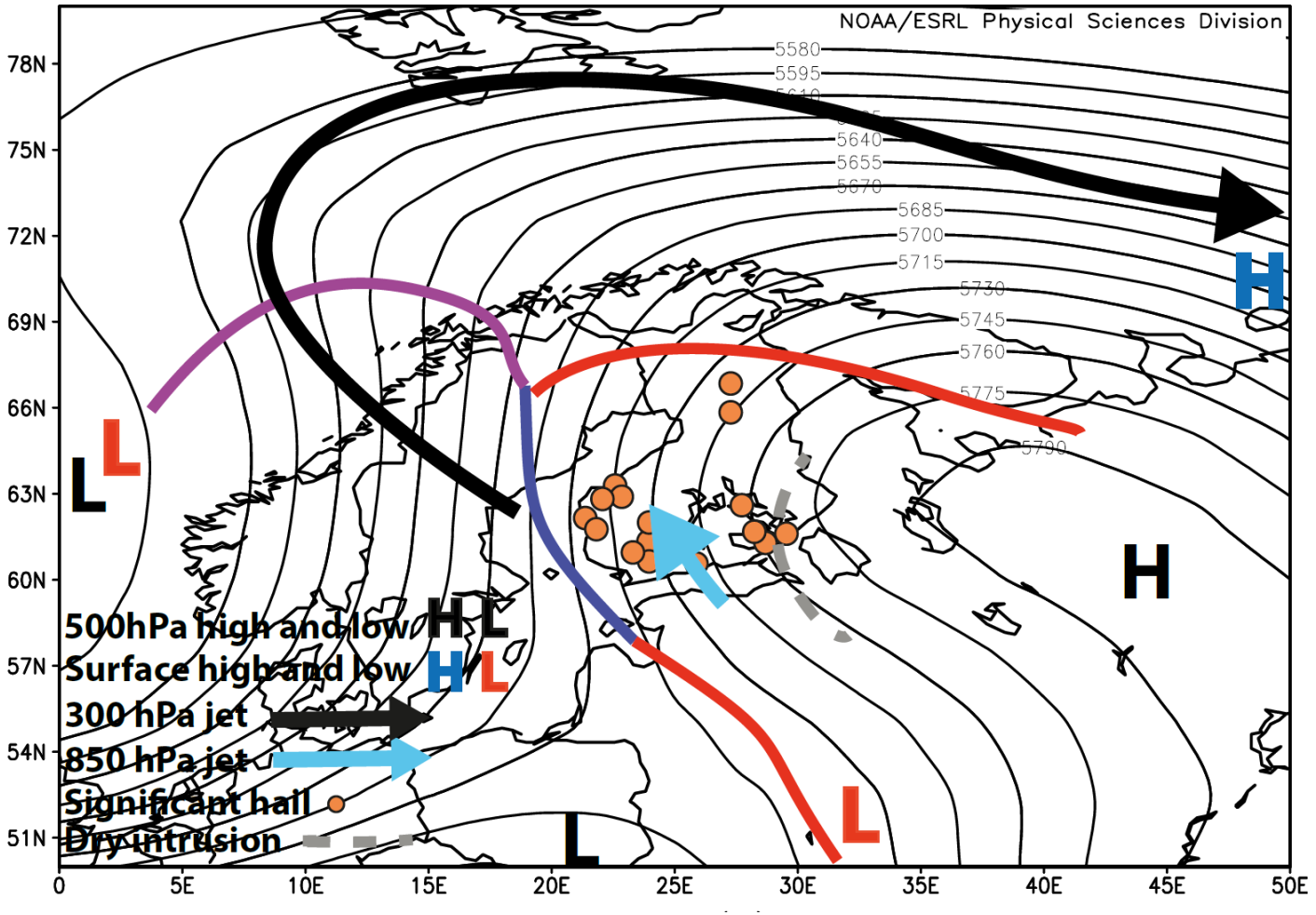
Class A synoptic composite chart



Most common 31% (11/35)

1. Significant hail occurs south of the 300-hPa jet
2. A large-scale trough over Norwegian Sea
3. Surface low center over or west of Finland
4. Southwesterly low-level jet is strong in most of the cases

Class B synoptic composite chart



26% (9/35)

1. Upper low at Norwegian Sea, weaker upper low south of Finland
2. Significant hail occurs in the right entrance region of the 300-hPa jet
3. Surface low over the Norwegian Sea or Scandinavia and another south of Finland
4. Weak low-level jet

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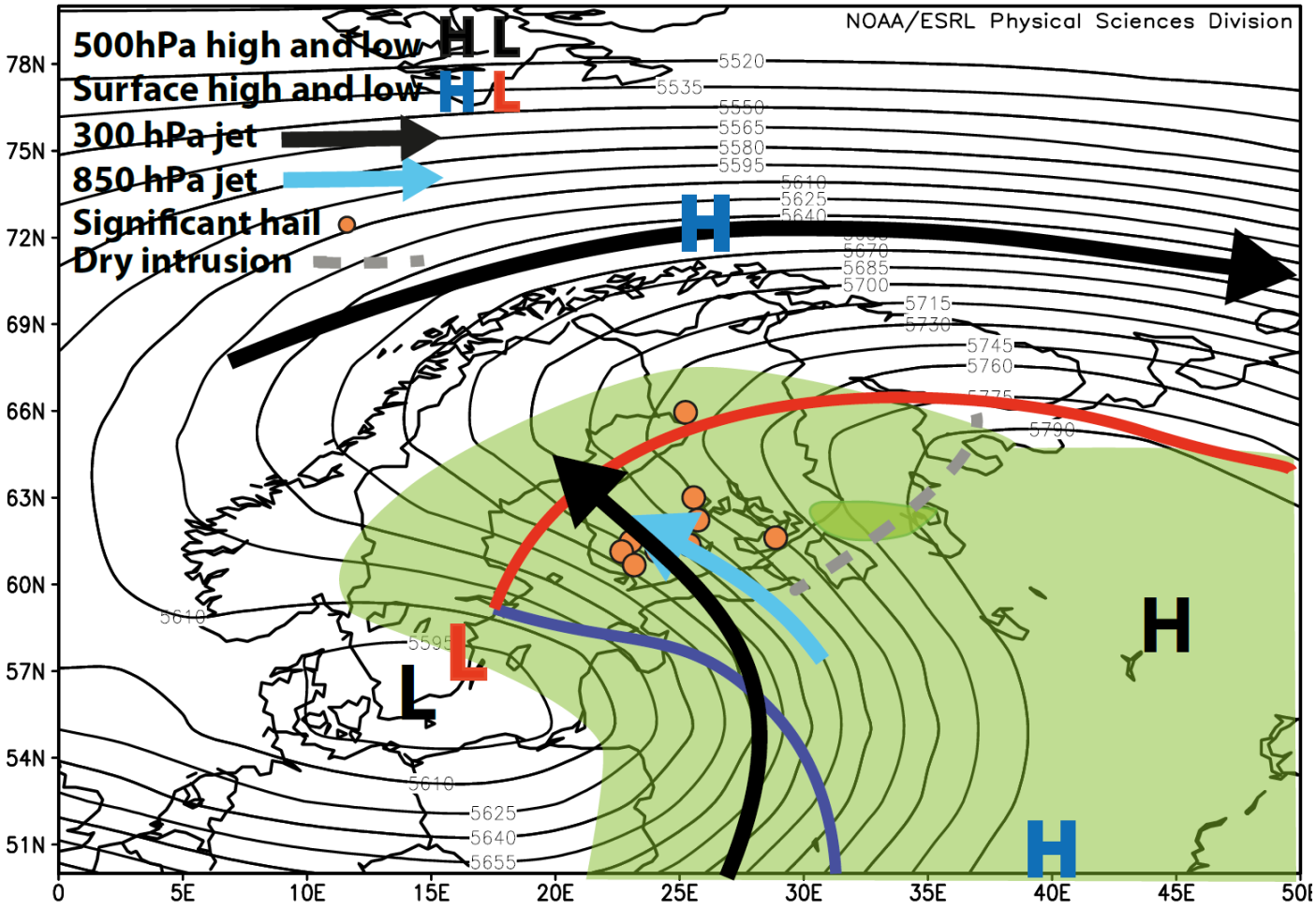
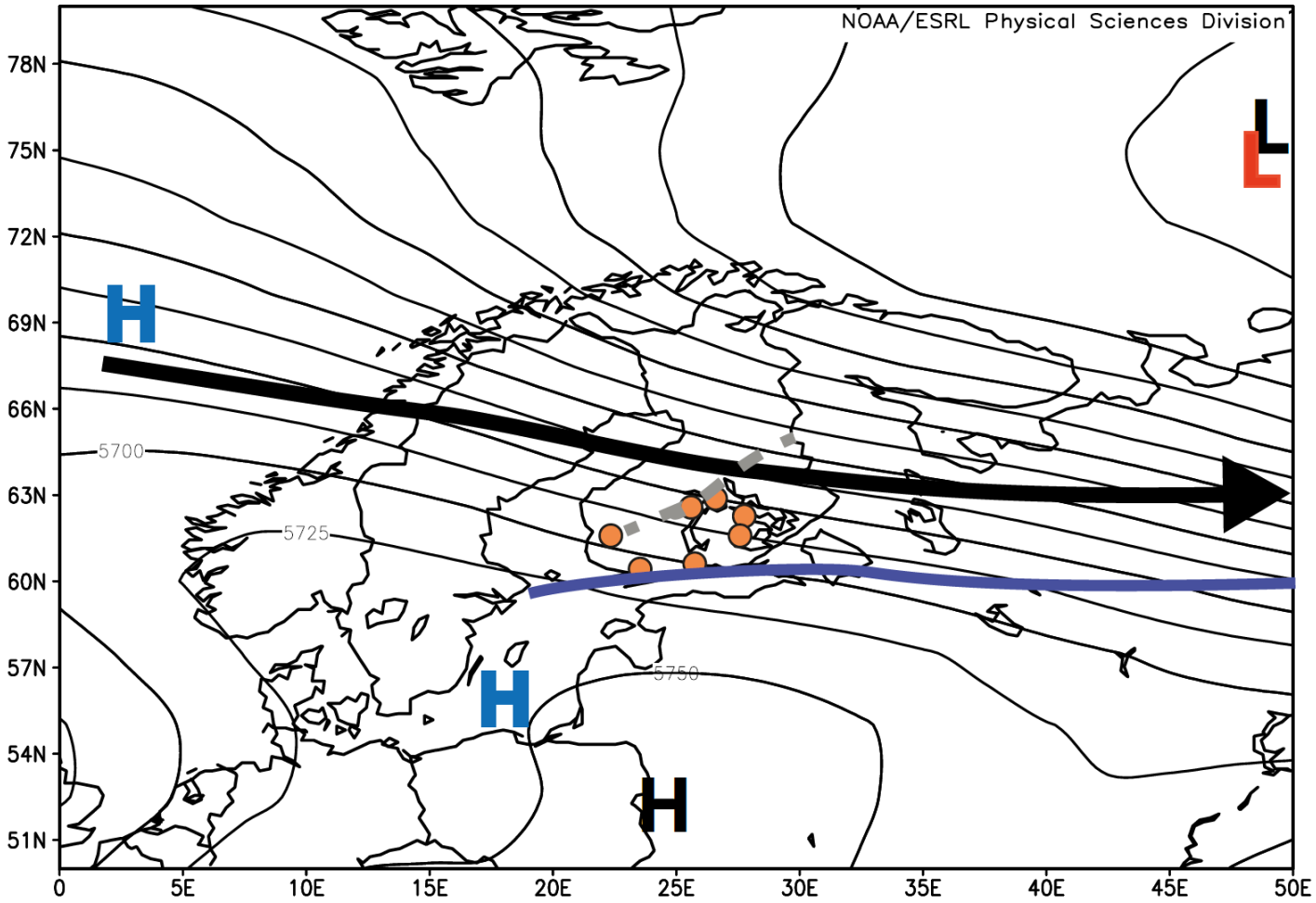
Class C synoptic composite chart



20% (7/35)

1. Strong 500-hPa upper low southwest of Finland
2. 300-hPa jet southerly or southeasterly
3. Strong southerly or southeasterly low-level jet

D synoptic composite chart



11% (4/35)

1. Upper low northeast of Finland
2. Southward moving cold front
3. Nearly parallel upper-level jet

Summary of significant-hail synoptic patterns

- All classes - strong baroclinic weather systems
- All classes - strong upper-level flow and an upper-level jet in vicinity
- All classes - frontal boundaries close to the event
- 3 classes - events occur in the warm sector of frontal boundaries close to the location of a low-level jet
- 1 class - hail seems to form on the cold side of the surface cold front

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References

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- Pucik, T., K. Miroslav, and D. Ryva, 2013: Sounding-derived parameters and their ability to forecast individual severe weatherthreats for the region of Central Europe. *Preprints*, Seventh European Conf. on Severe Storms, Helsinki, Finland, European Meteorological Society.
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- Tuovinen, J.-P., A.-J. Punkka, J. Rauhala, H. Hohti, and D. M. Schultz, 2009: Climatology of severe hail in Finland: 1930–2006. Mon. Wea. Rev., **137**, 2238–2249.