

# Relating TS Occurrence to Flow Types in the Eastern Alpine Region

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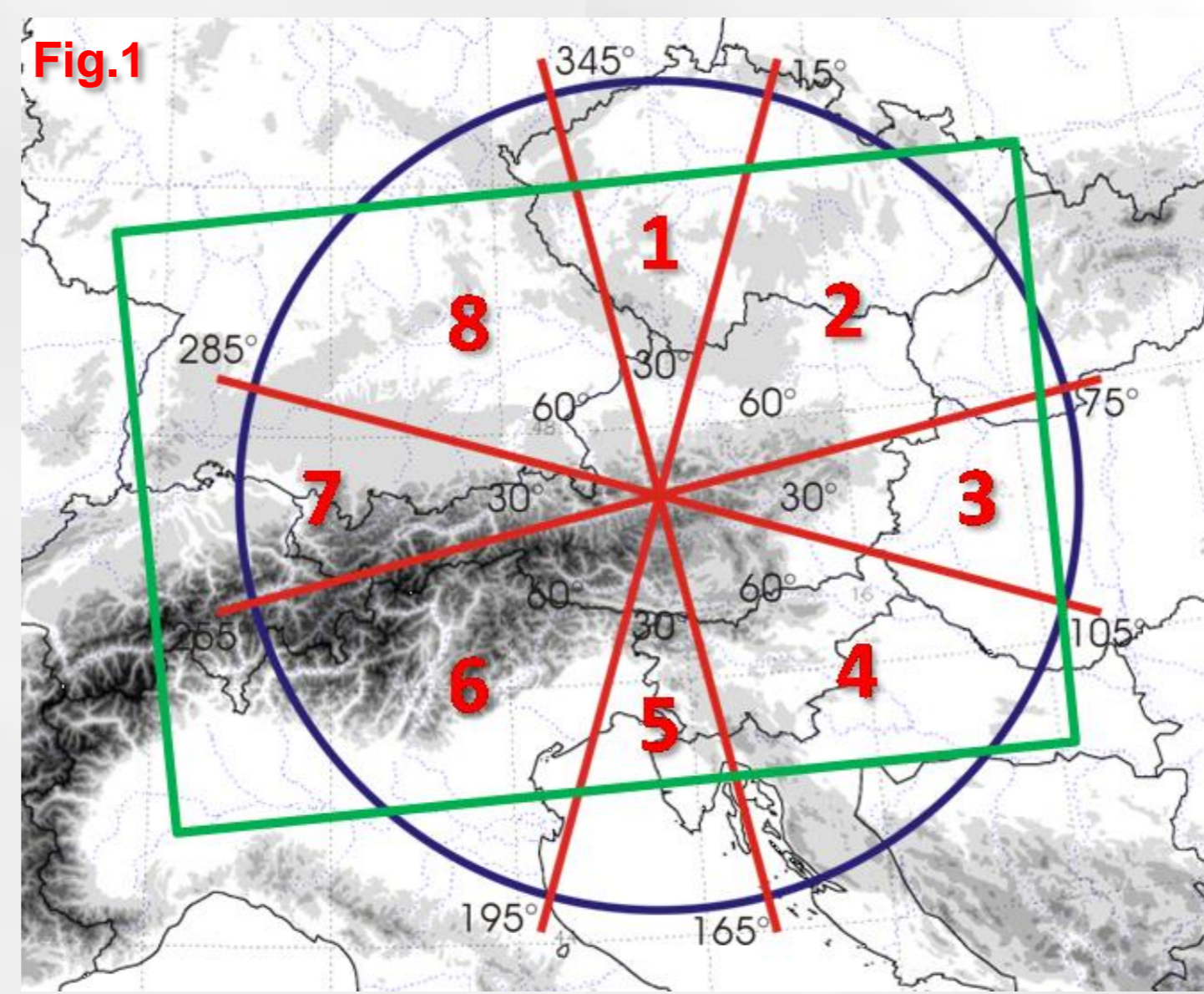
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For the period from the year 2010 to 2014, the relation between the occurrence and characteristics of thunderstorms in Austria and their predominant circulation patterns was investigated. Days with thunderstorms have been identified with data from the Austrian Lightning detection system ALDIS, based on a lightning activity threshold. For the classification of the flow patterns, the automated method WLKC733 (Philipp et al., 2011) was chosen.

**Conclusions:** Despite the short investigation period, a significant trend of 4 dominating WLKC733 circulation regimes became evident for days with TS. Also, expected properties within those classes can be shown: i.e. TS type and organization, percentage of MCS, intensity of TS and MCS and their respective morphologies.

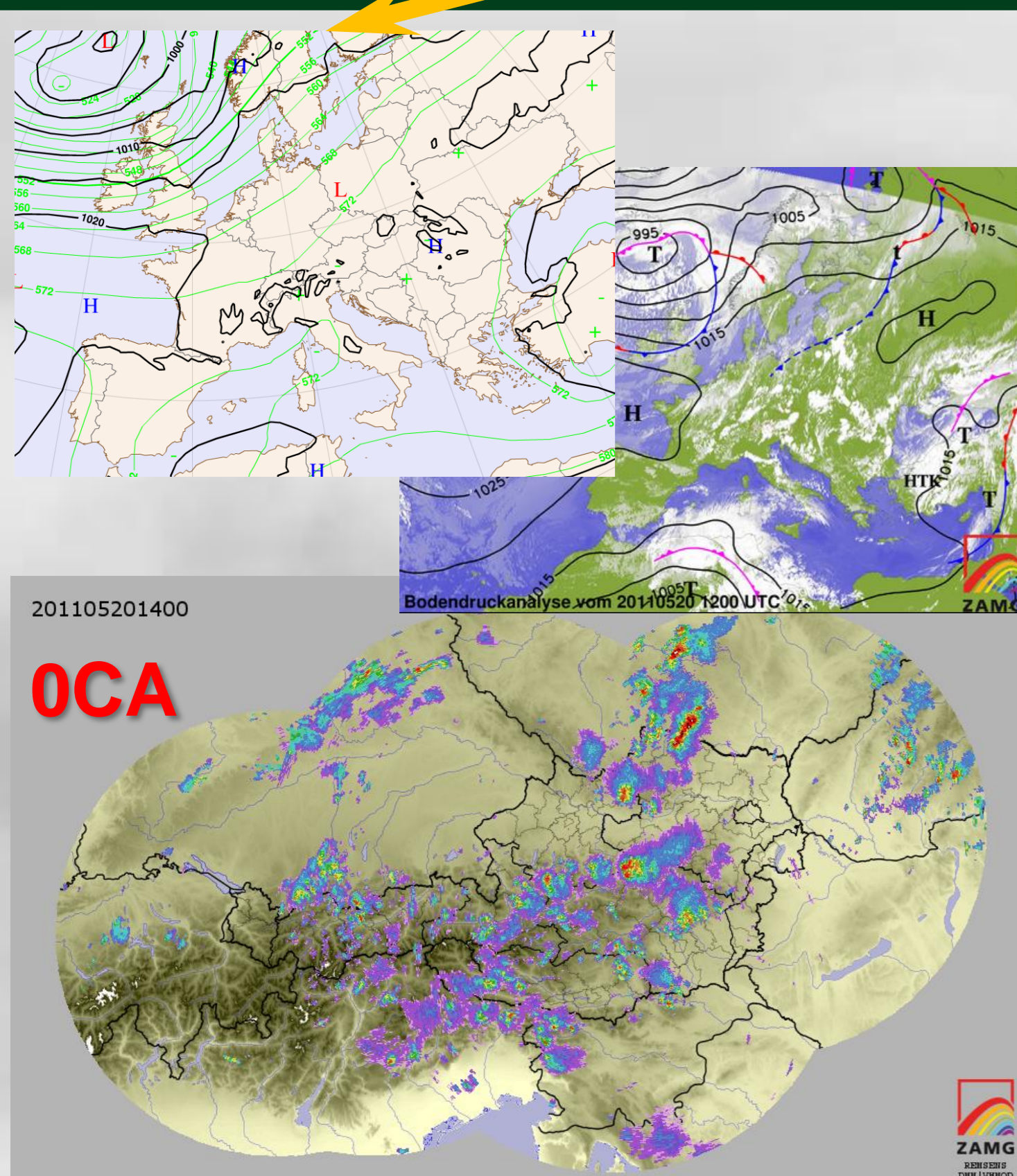
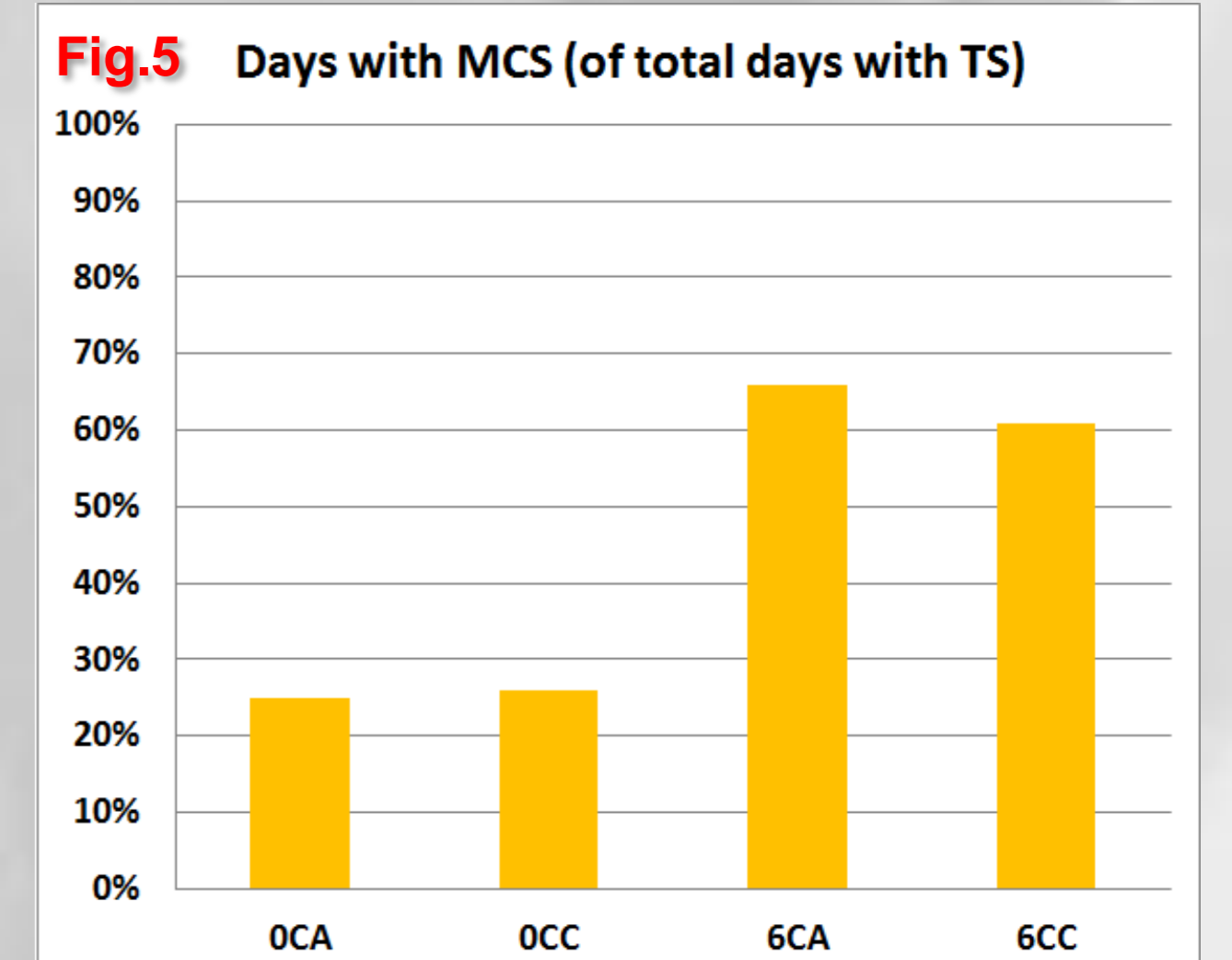
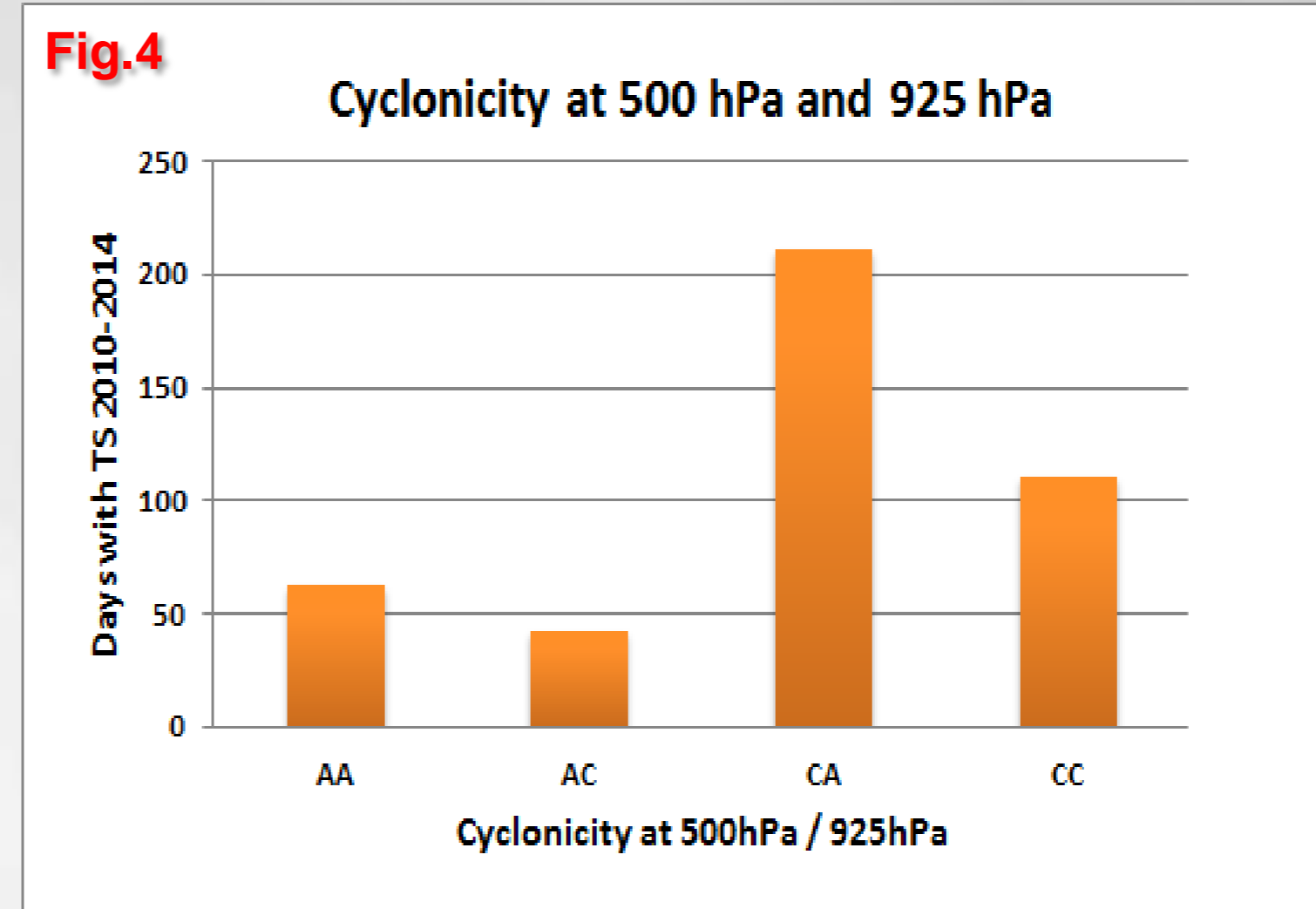
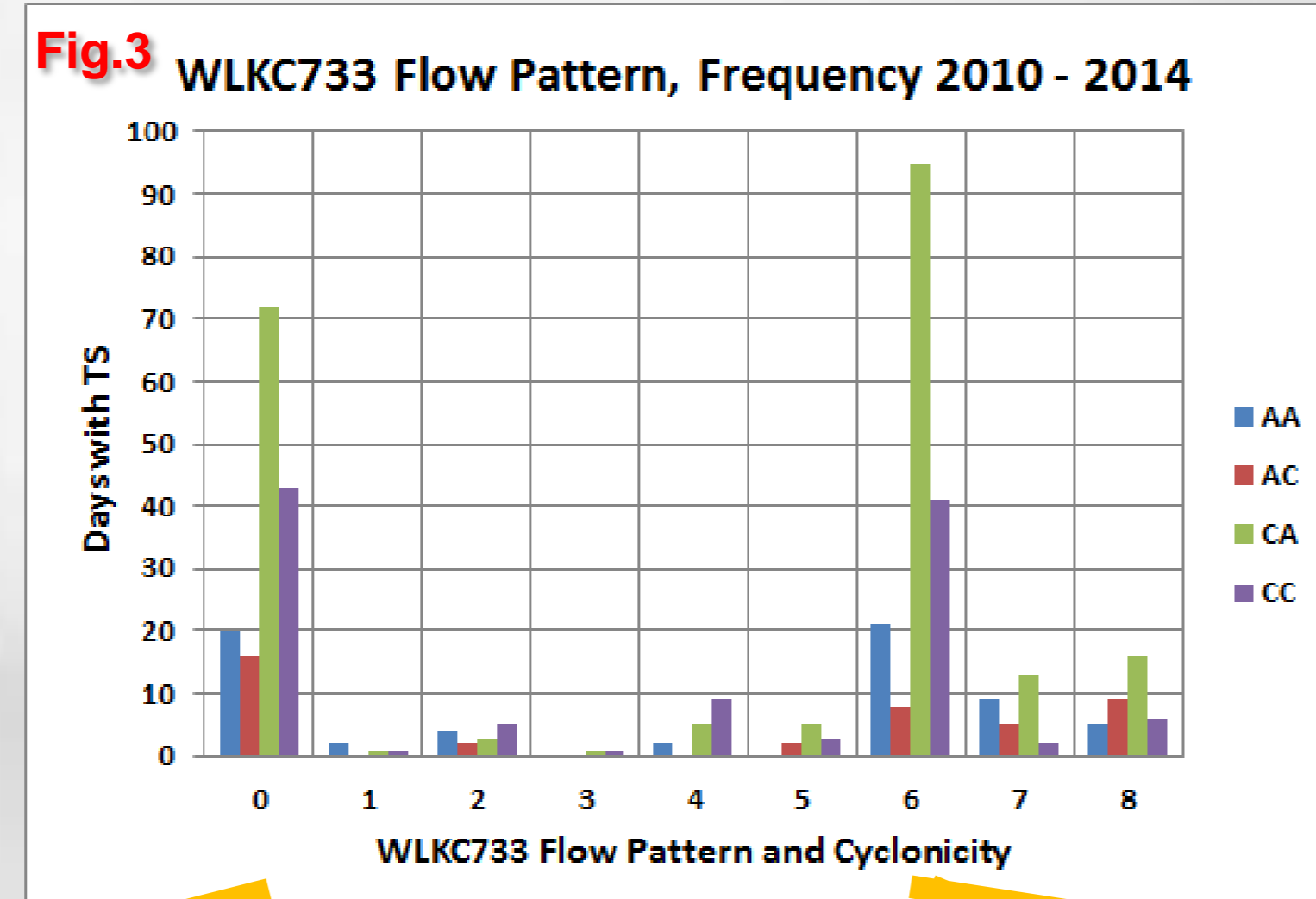
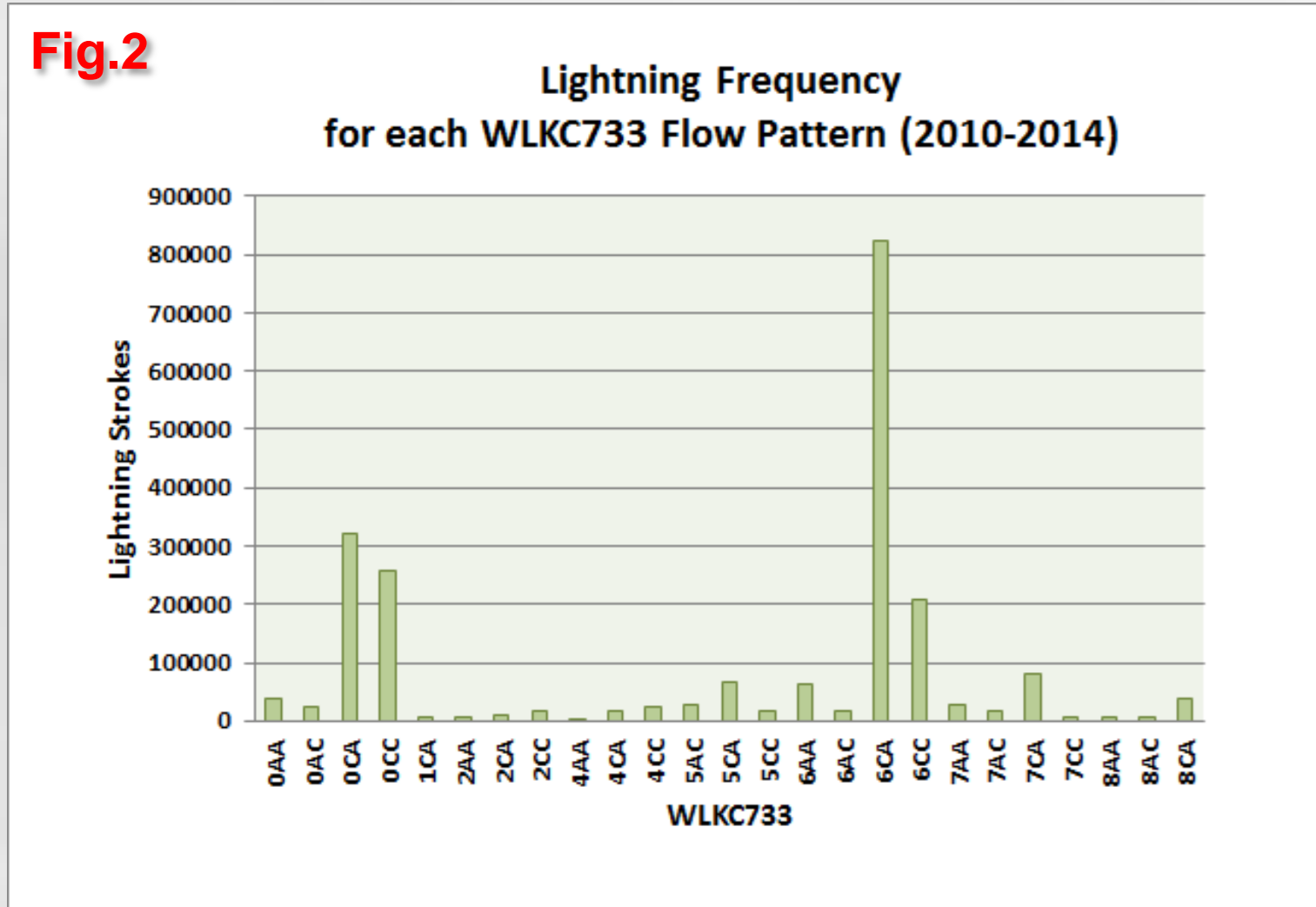
## WLKC733 Method:

- Daily ECMWF model analysis (12 UTC), calculated for the Eastern Alpine domain (green square Fig.1)
- 9 types for the classification of the circulation regime (Fig.1):
  - Circulation patterns are derived from a simple majority (threshold) of wind field vectors counting the respective wind directions with a weighting mask
  - Calculation of one dominant wind sector (flow direction) from U and V components of the true wind at 700 hPa,
  - 4 main directions with 30 degree segments (classes 1,3,5,7),
  - 4 sub directions with 60 degree segments (classes 2,4,6,8),
  - 1 class with low gradient or a centre of pressure maximum or minimum (class type 0)
- Cyclonicity
  - Cyclonic or anticyclonic (letters C,A) flow at 500 hPa (first letter) and 925 hPa (second letter)
  - Based on the weighted mean value of the quasi-geostrophic vorticity



## Selection Method:

- Pre-selection: for the whole year, days with more than 100 lightning strokes within Austria are selected for further analysis
- Application of the weather classification method WLKC733, resulting in:
  - frequency distribution of lightning per WLKC733 class (Fig.2)
  - frequency distribution of TS days for each WLKC733 class type (Fig.3)
  - frequency distribution of cyclonicity for all TS days (Fig.4)
- Seasonal (May–Sept.) selection of the 4 most frequent WLKC733 flow types for further analysis:
- Criteria for RADAR data:
  - TS typology after Schiesser (1994)
  - Classification of MCS (Schiesser, 1994), (Fig.5):
    - Maximum elongation of 25 dBZ contour > 100km containing at least one cell exceeding 47 dBZ
    - Life span greater than 30 minutes

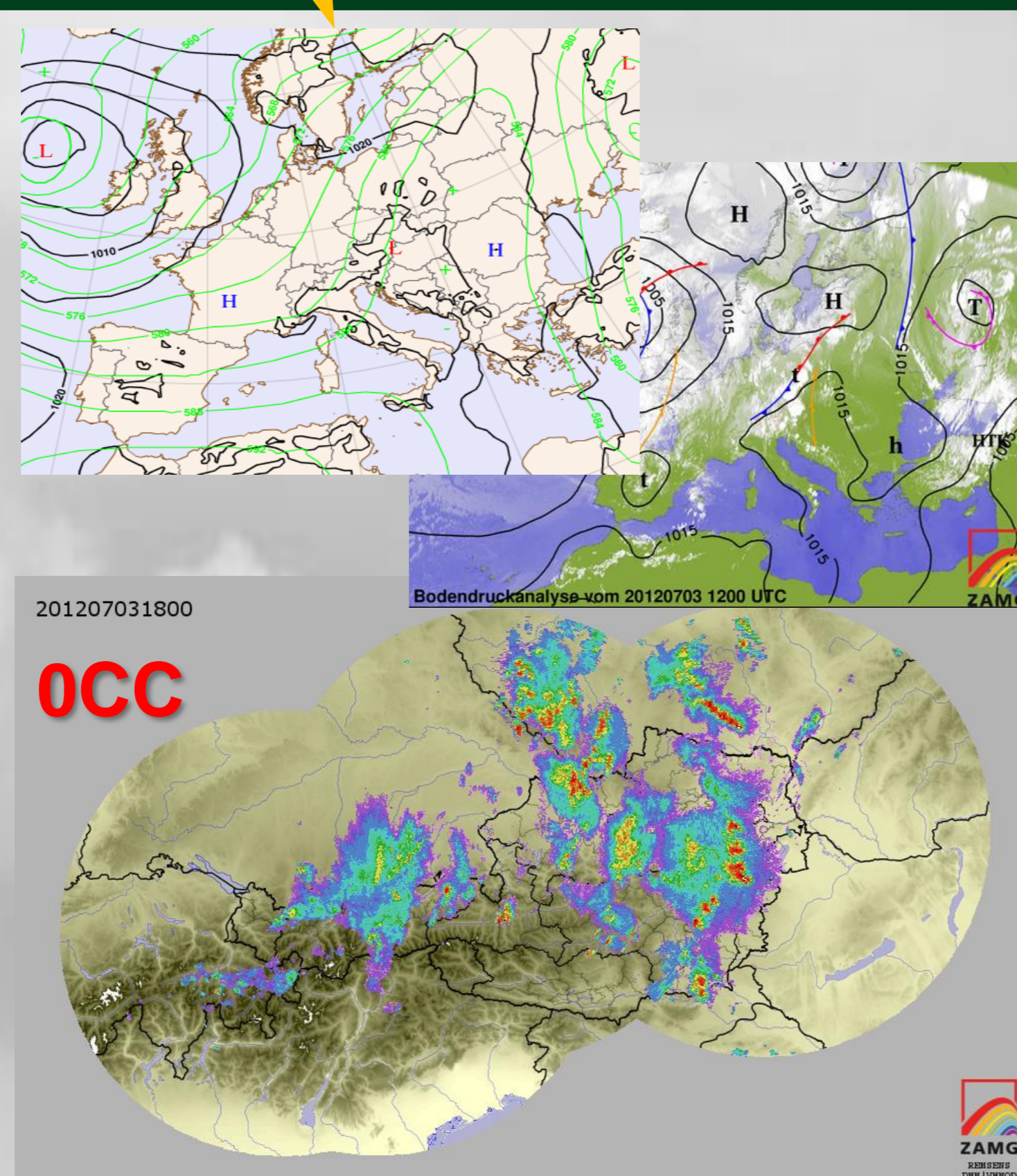


Representative case, 20 May 2011: (model data ECMWF)

- 700hPa: No distinctive flow pattern (class 0)
- 500hPa: Weak trough from NW (green lines, top image)
- 925hPa: Ridge of high pressure across Central Europe, low gradient (black lines, top and center image)
- RADAR: MAXCAPPi composite Austria (lower image)

General properties 0CA:

- Single- and multicellular storms dominate
- MCS and organized clusters remain rare and short lived
- Orographically induced TS, low propagation speed

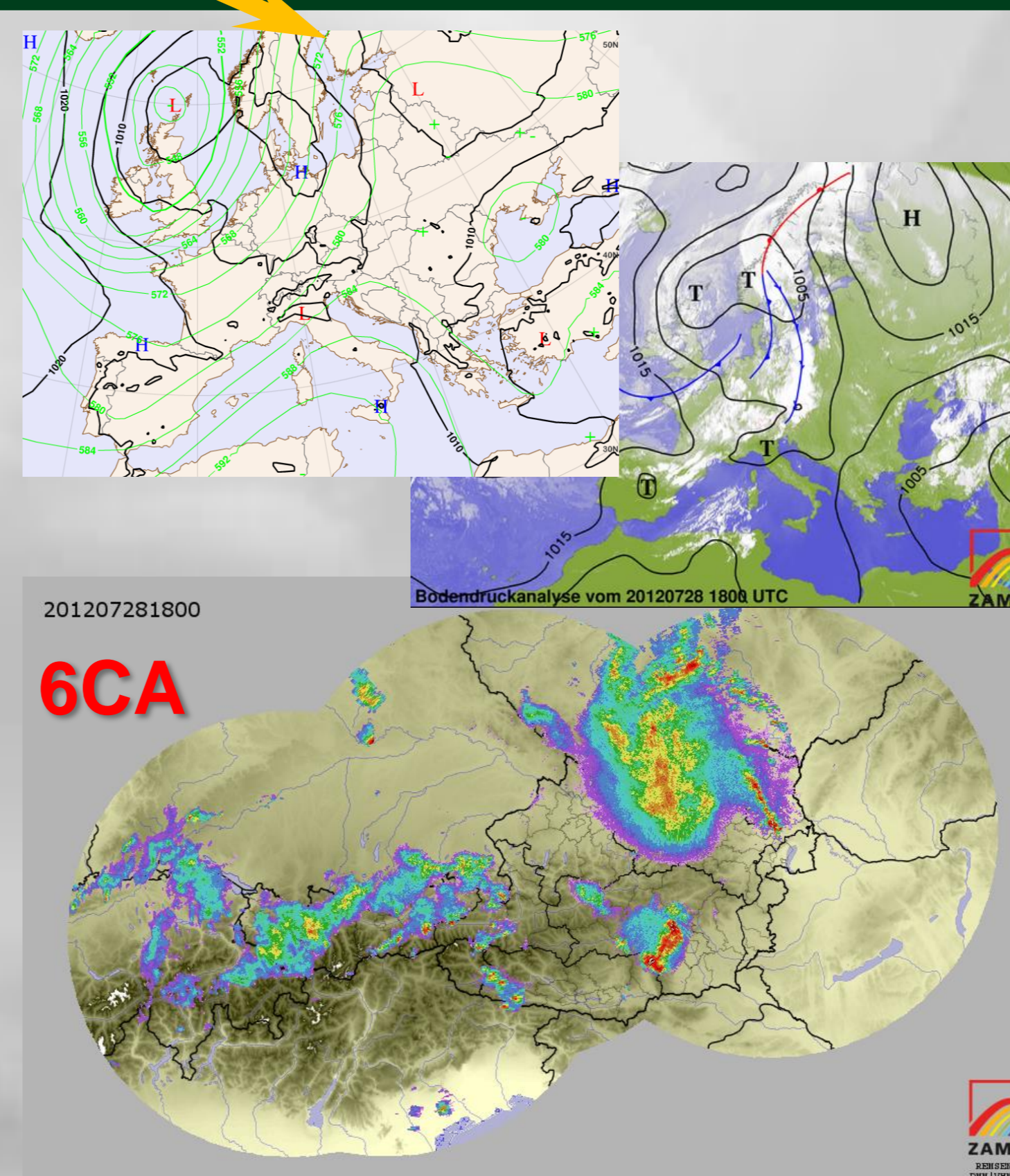


Representative case, 3 July 2012:

- 700hPa: No distinctive flow pattern (class 0)
- 500hPa: Trough from W/NW (green lines, top image)
- MSLP: Low pressure from S, (black lines, top and center)

General properties OCC:

- TS development often in conjunction with Occlusions
- Multi- and single-cell storms dominate
- Zero or low propagation speed

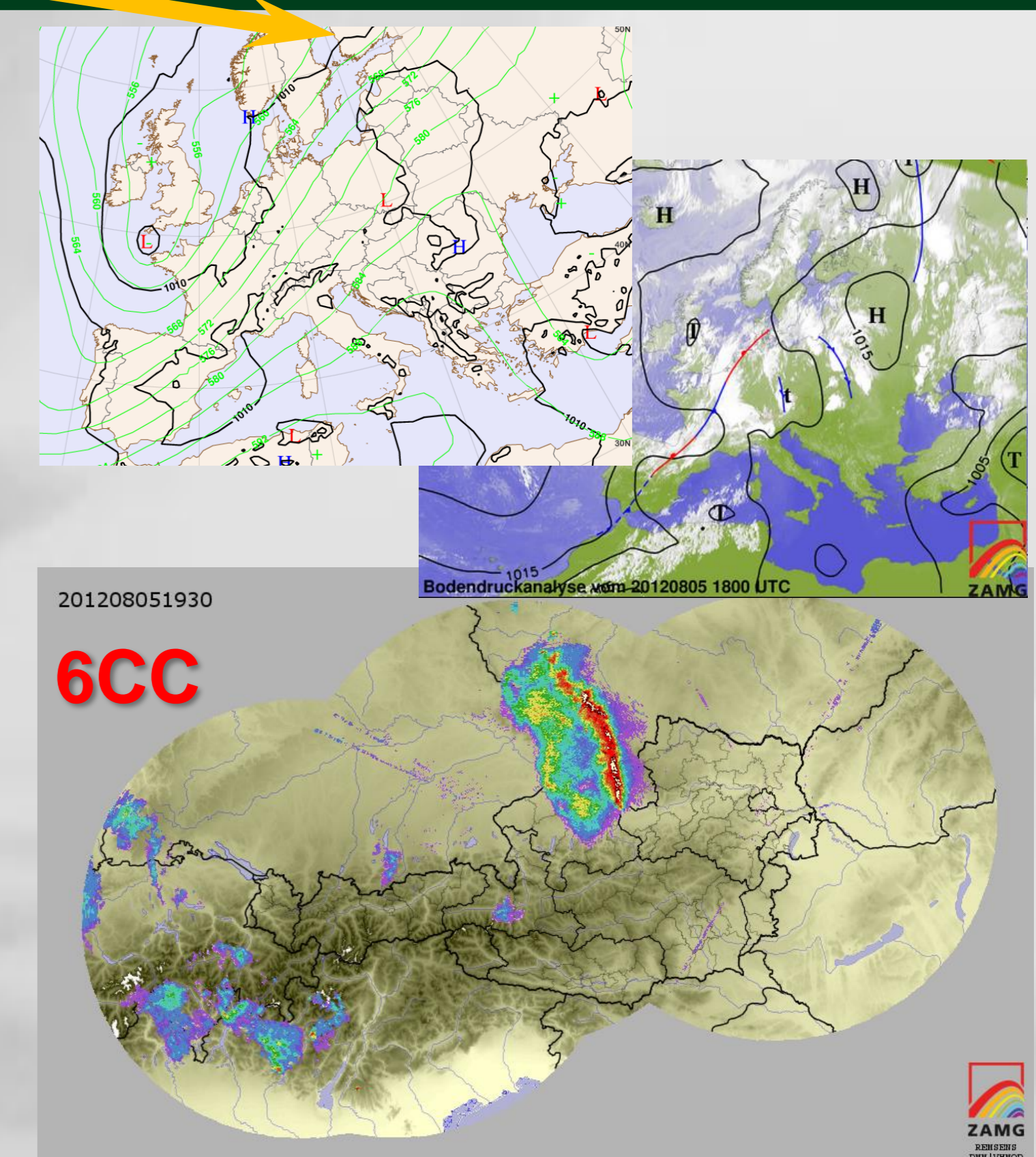


Representative case, 28 July 2012:

- 700hPa: westerly flow pattern (class 6)
- 500hPa: Elongated trough from NW (green lines, top)
- MSLP: Postfrontal ridge of high pressure from the West (black lines, top and center image)

General properties 6CA:

- MCS, MCC and organized storms dominating
- Most severe storms of all investigated classes
- Development in conjunction with pre-frontal convergence lines



Representative case, 5 August 2012:

- 700hPa: westerly flow pattern (class 6)
- 500hPa: Elongated trough from W (green lines, top)
- MSLP: Surface low (black lines, top and center image)

General properties 6CC:

- Frontal TS dominating, high propagation speed
- Severe TS organized also in conjunction with pre-frontal convergence lines or within pre-frontal moist-warm air during May and June