Introduction Conceptual Models Sat(rep)Manu(al)

Ab Maas

EUMeTrain

eumetcal

*A **conceptual model** is a model made of the composition of concepts, which are used to help people know, understand, or simulate a subject the model represents. Some models are physical objects; for example, a toy model which may be assembled, and may be made to work like the object it represents or a simple model of a meteorological phenomenon.*

Why conceptual models?

The human brain can store a lot of impressions,
but processing is a problem.

Communication
is even worse

Why conceptual models?

Why CM's in forecasting??

models

10.000

satellites

1000

radar

160

160.000

observations

CM's are not new

CM of a cyclone with fronts. Bjerknes 1918

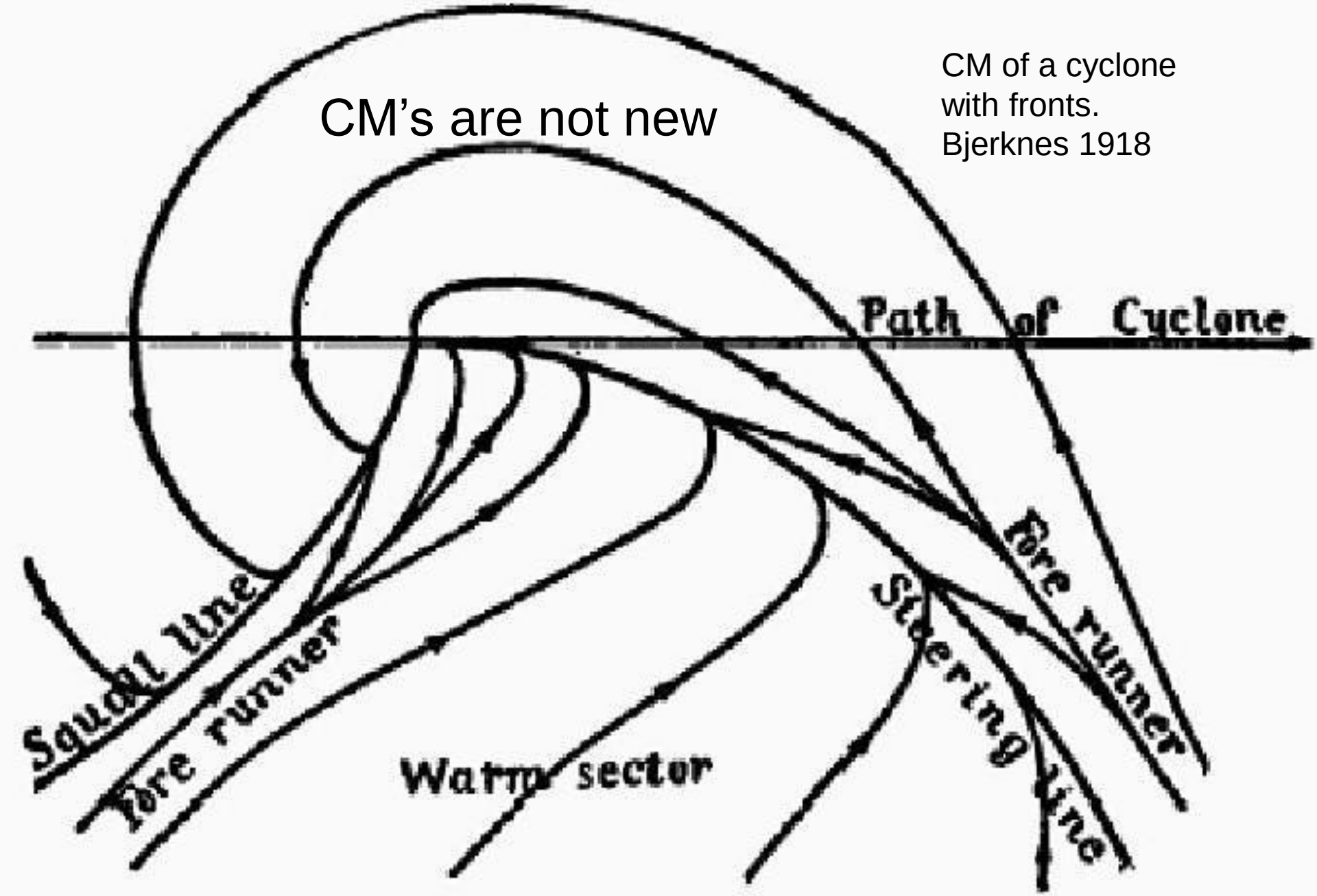
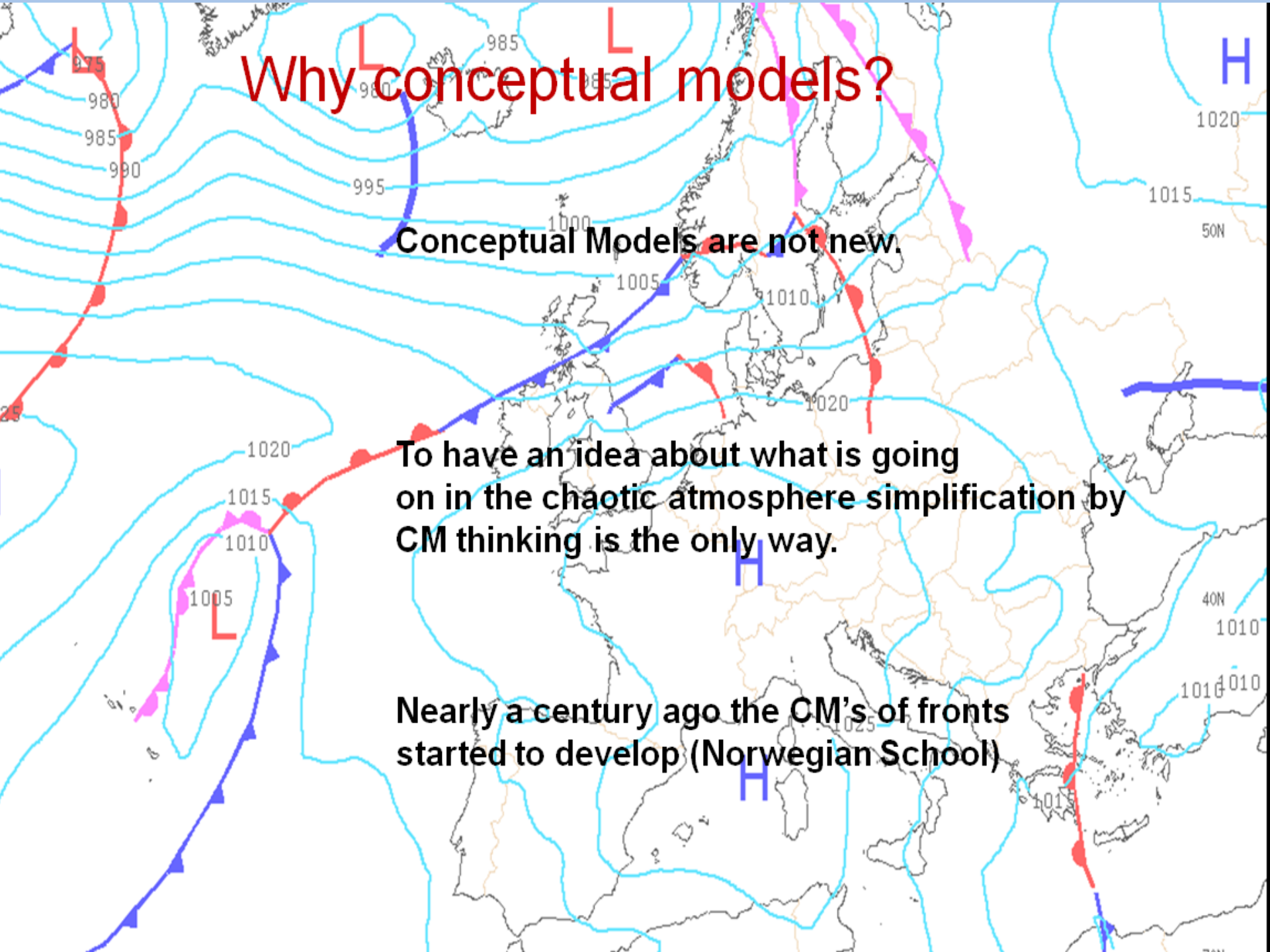


FIG. 1.—Lines of flow in a moving cyclone.

Why conceptual models?

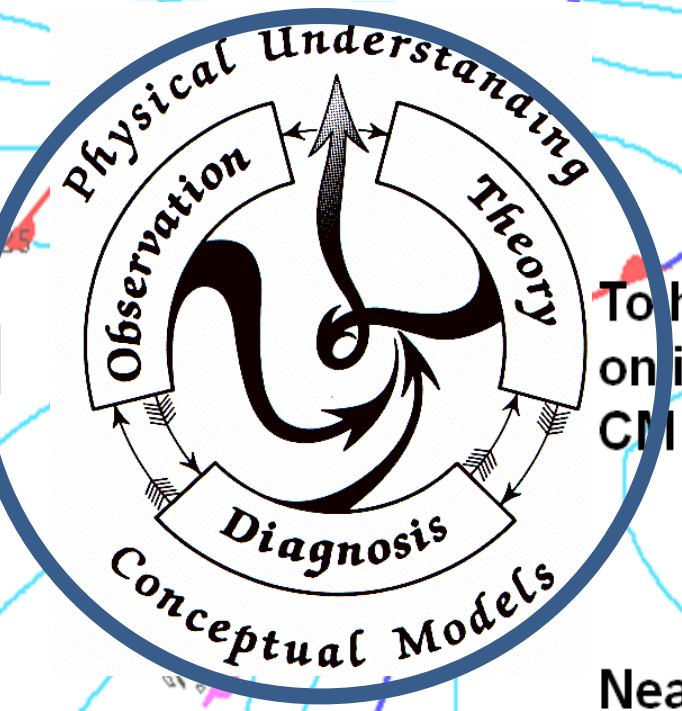


Conceptual Models are not new.

To have an idea about what is going on in the chaotic atmosphere simplification by CM thinking is the only way.

Nearly a century ago the CM's of fronts started to develop (Norwegian School)

Why conceptual models?



Conceptual Models are not new.

To have an idea about what is going on in the chaotic atmosphere simplification by CM thinking is the only way.

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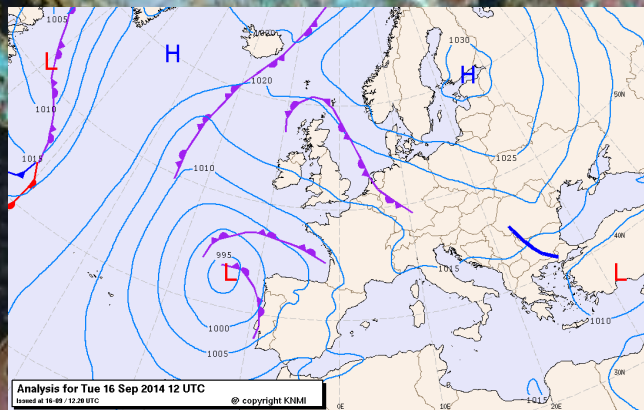
Conceptual models are abstractions of weather phenomena used for teaching and research.

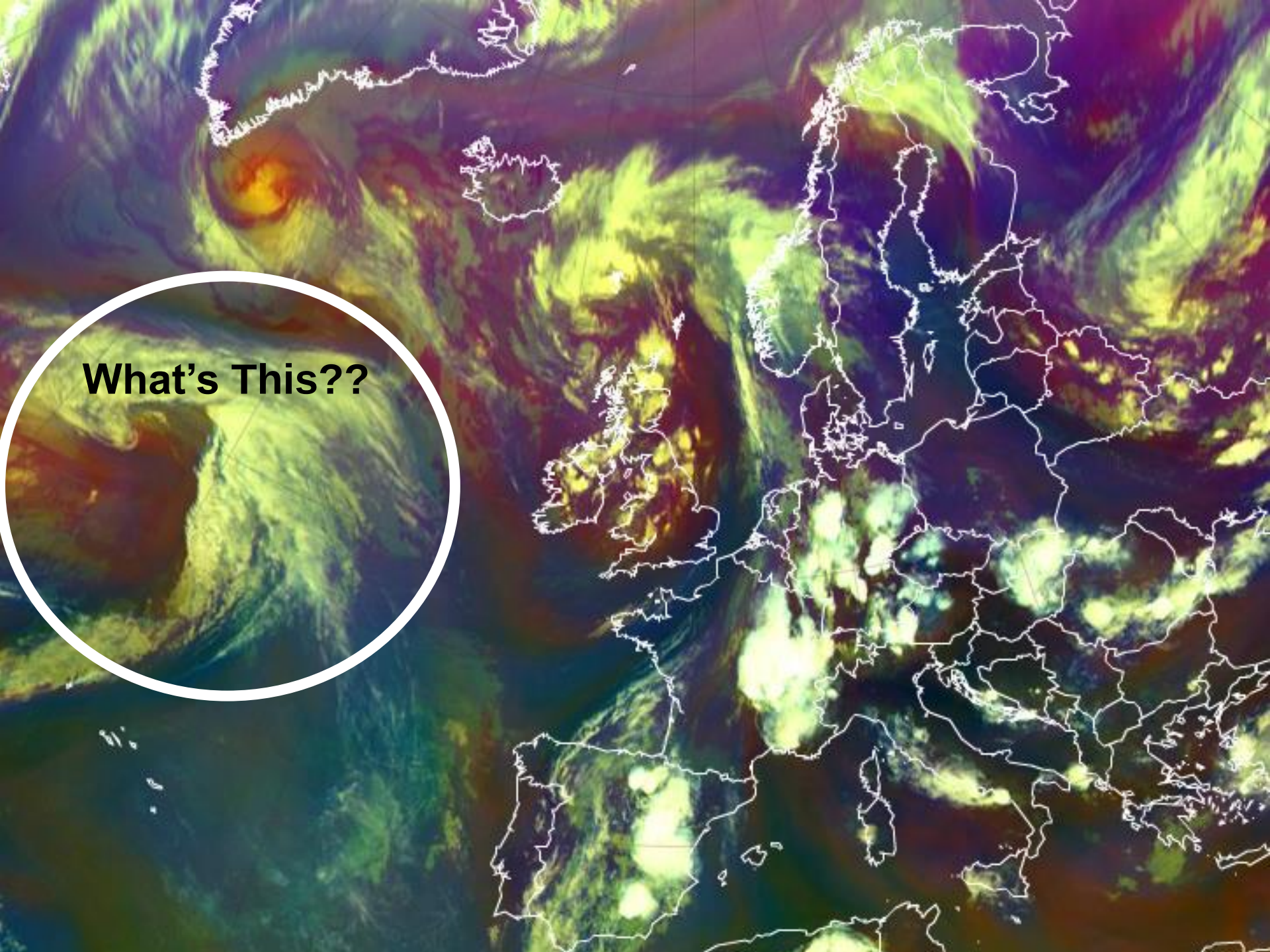
- Give scientists and forecasters a common language
- Synthesize lots of data and analysis into a visual schematic.
- Distill important processes and structures
- Omit unimportant details and variability among individual cases

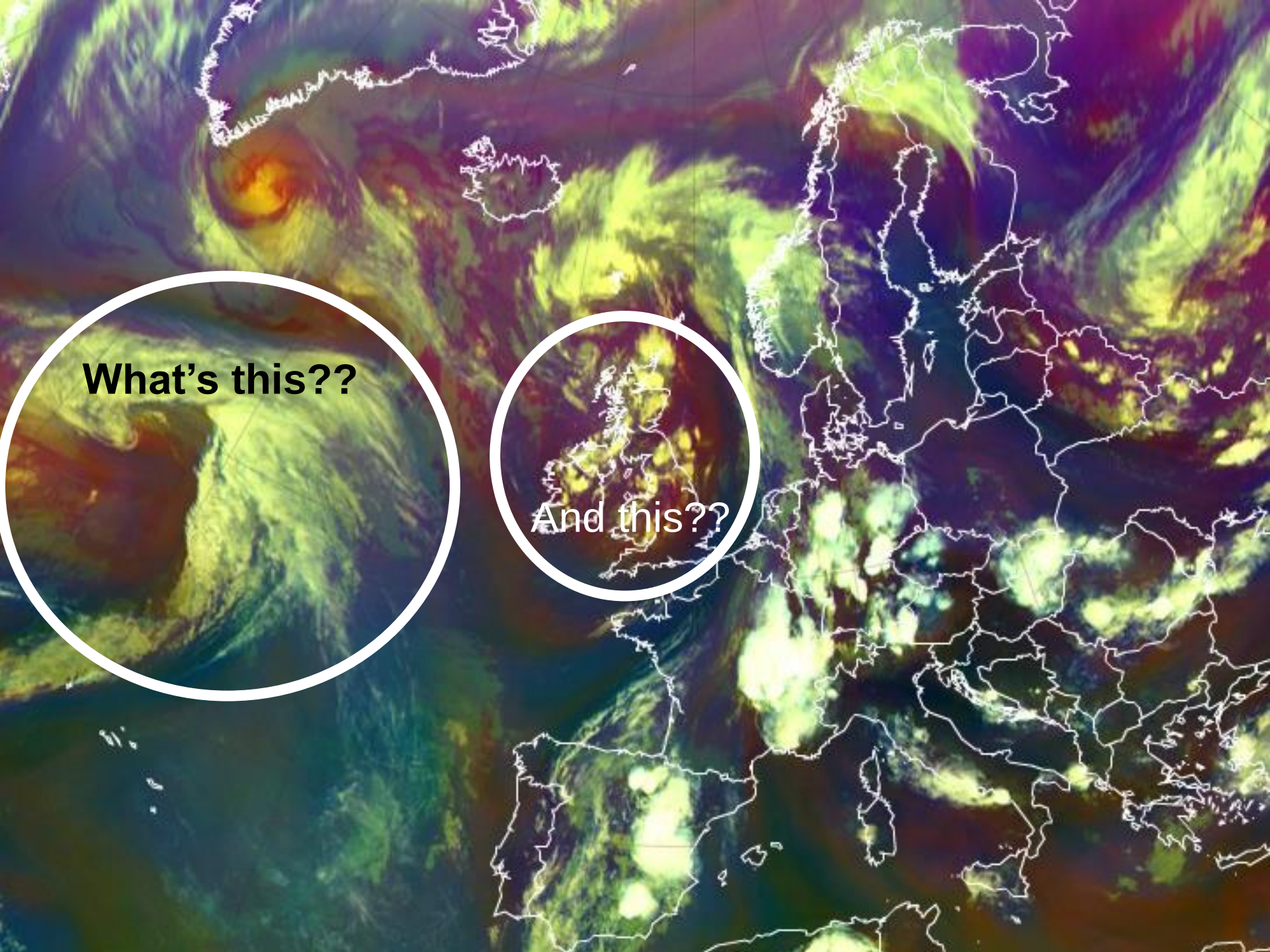
Prof. David Schulz

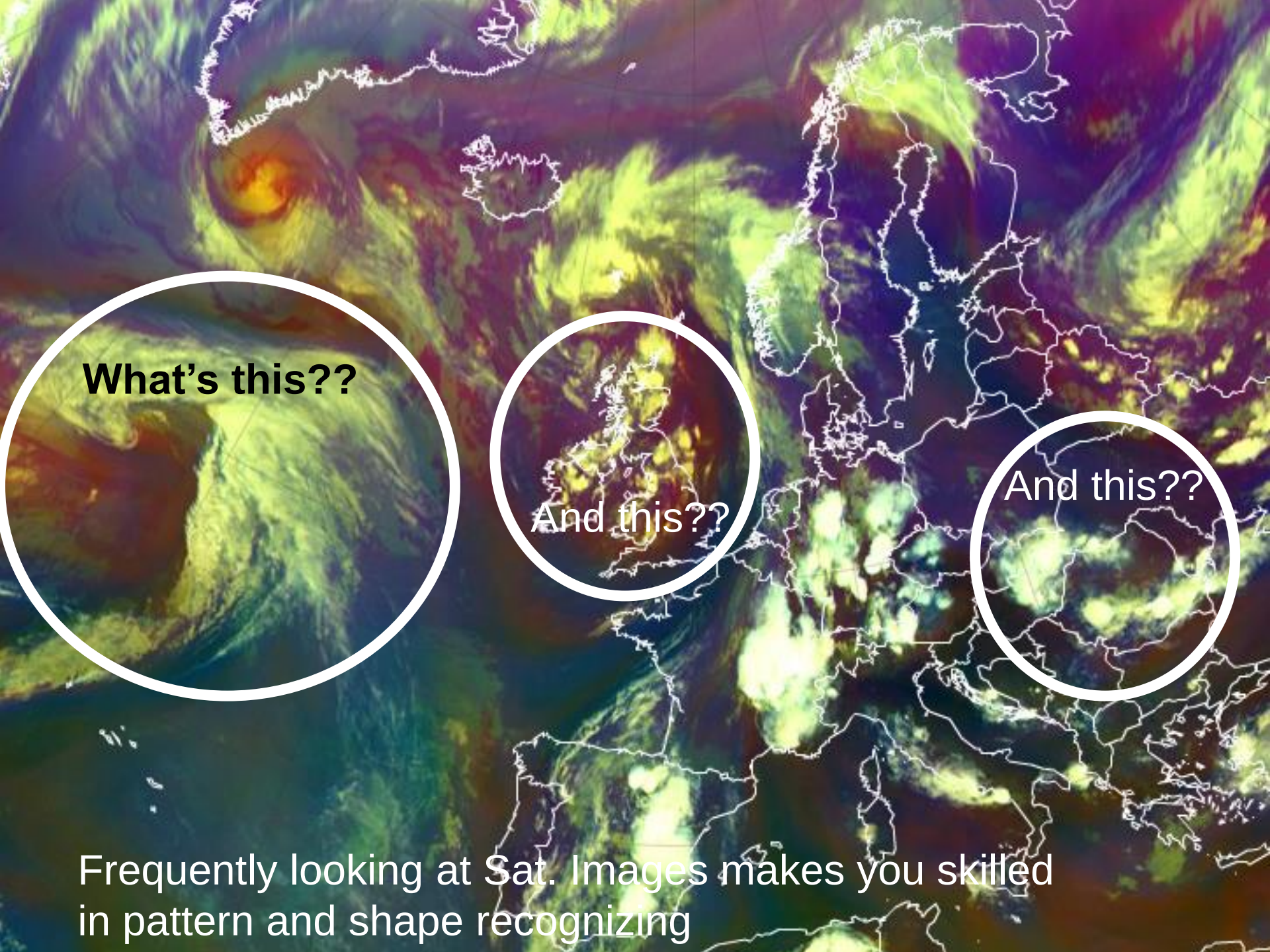
Satellites showed that there is much more than fronts alone



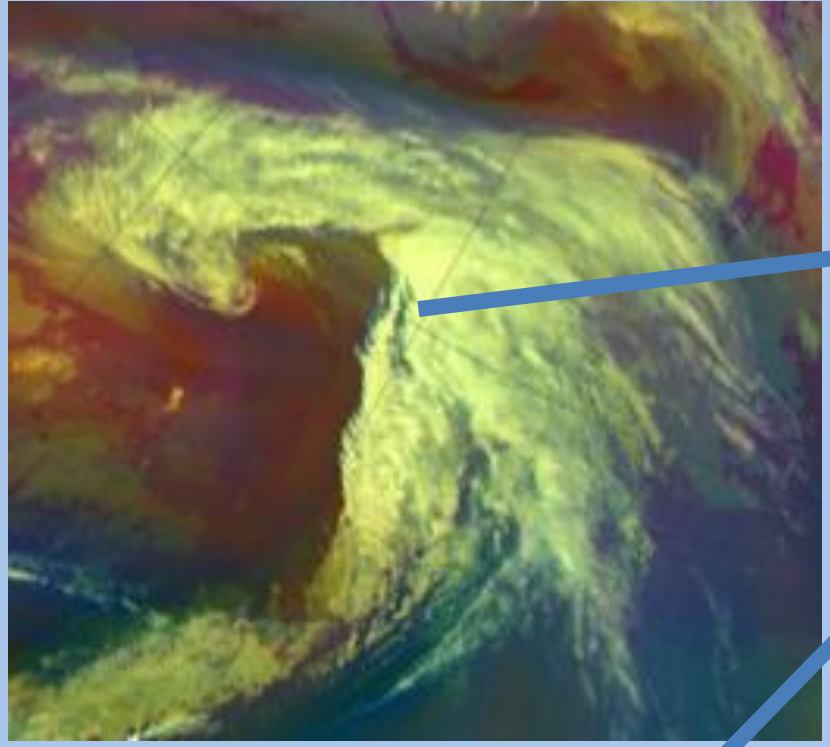

Much More!!


What's This??

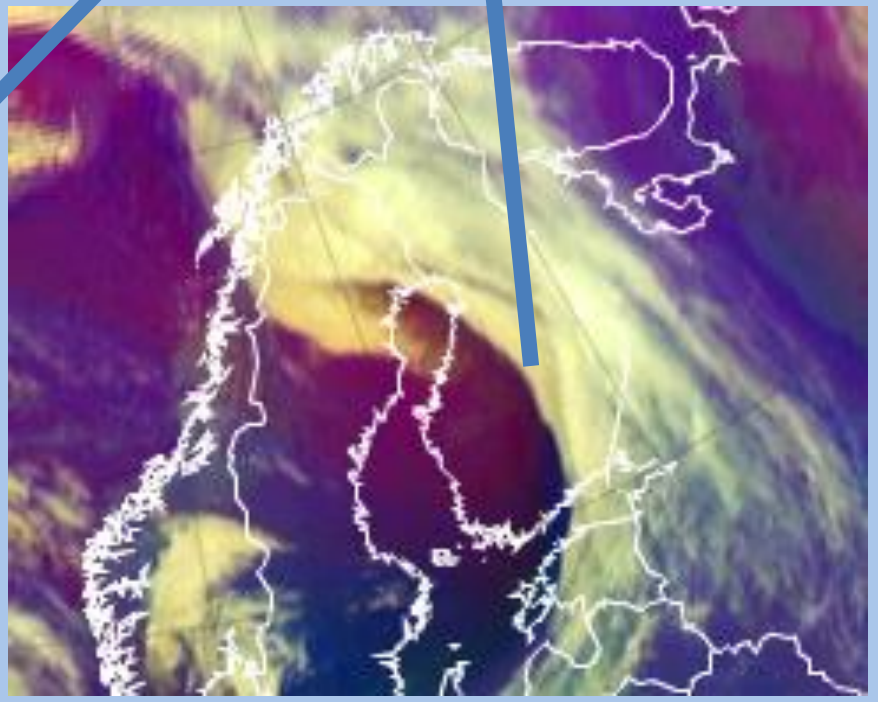

What's this??
And this??

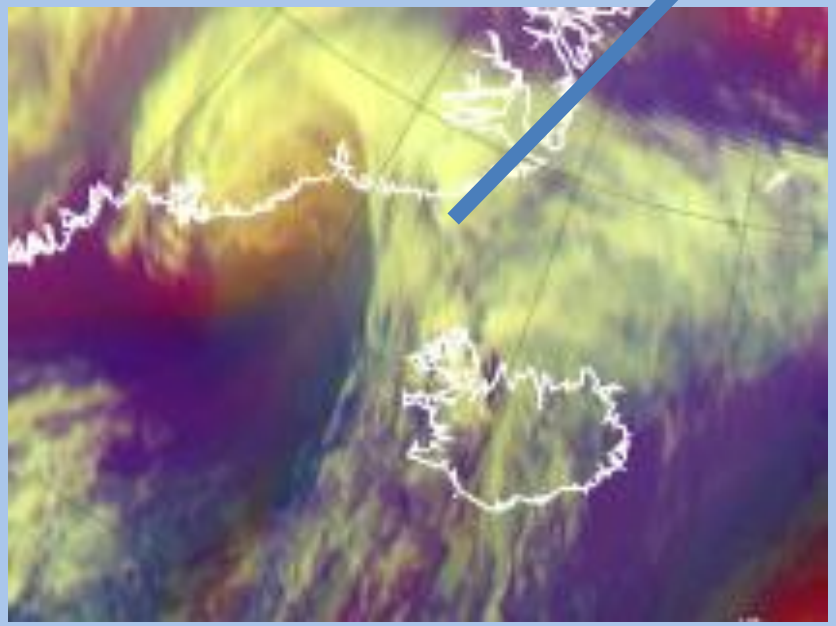


Frequently looking at Sat. Images makes you skilled in pattern and shape recognizing

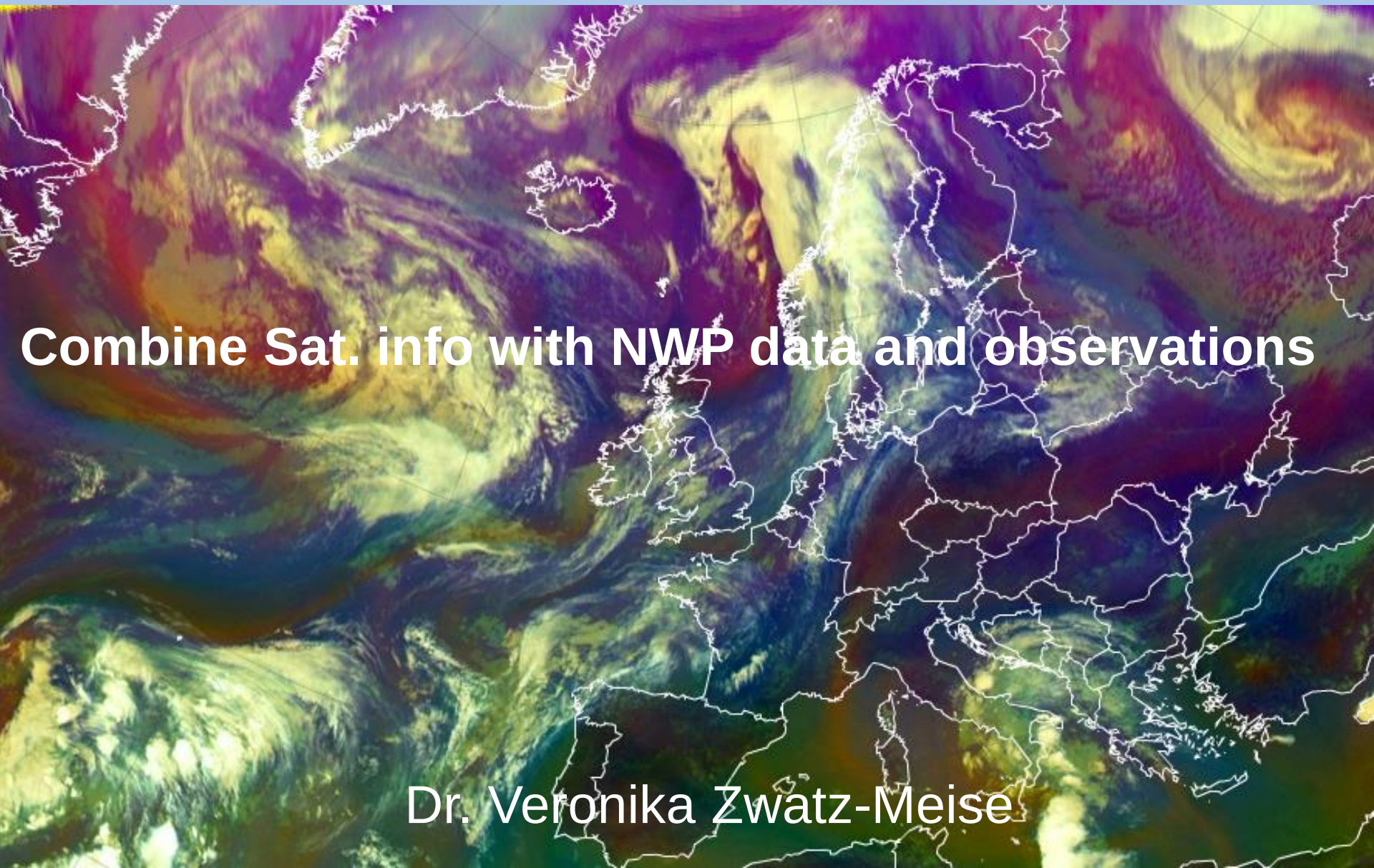


Similarities in shape and patterns in Cloud configurations give the first ideas of certain Conceptual Model





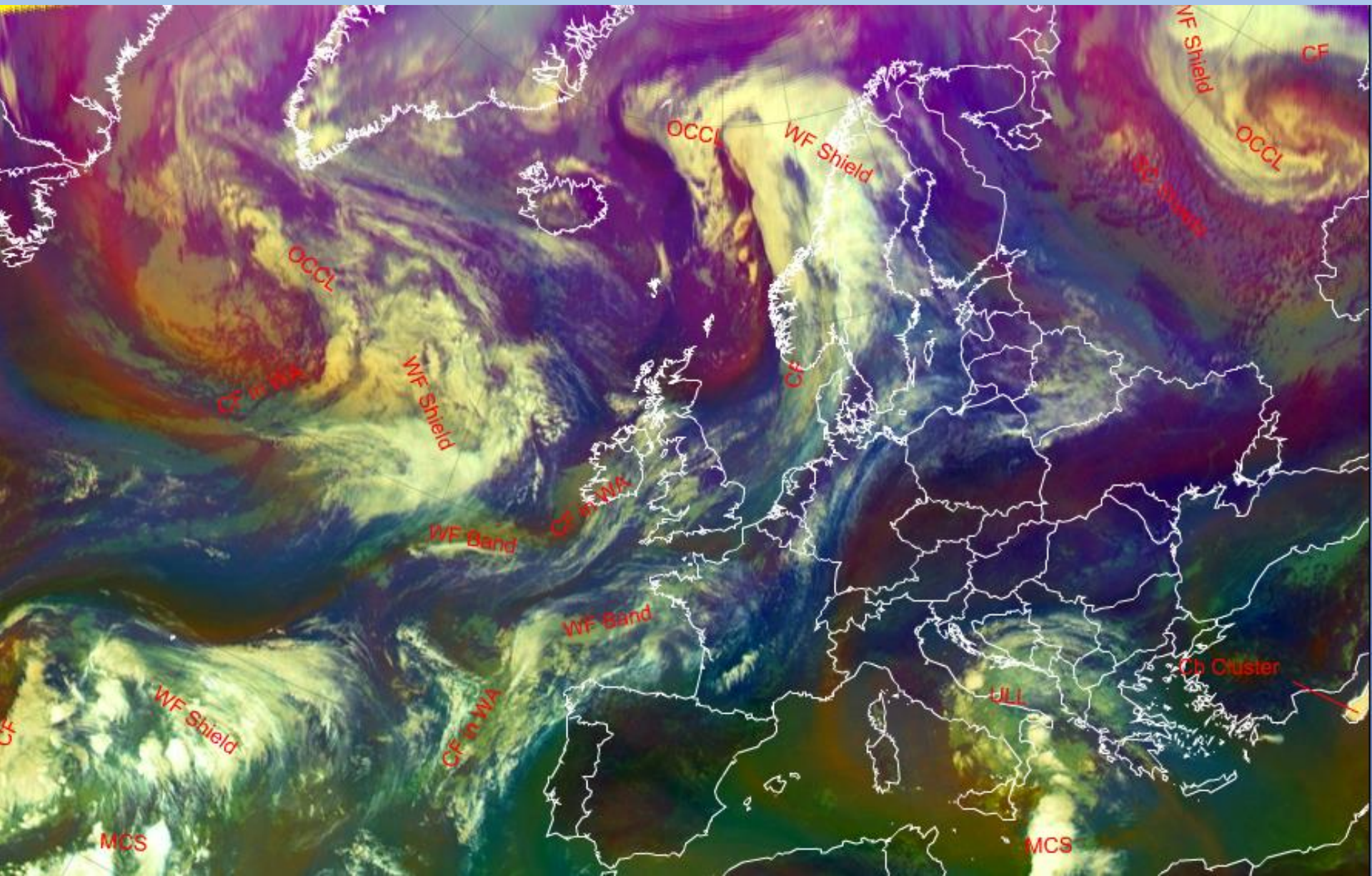
Using Satellite Images as a basis for analyzing CM's



Combine Sat. info with NWP data and observations

Dr. Veronika Zwatz-Meise

First guess of CM's from Sat. Image alone



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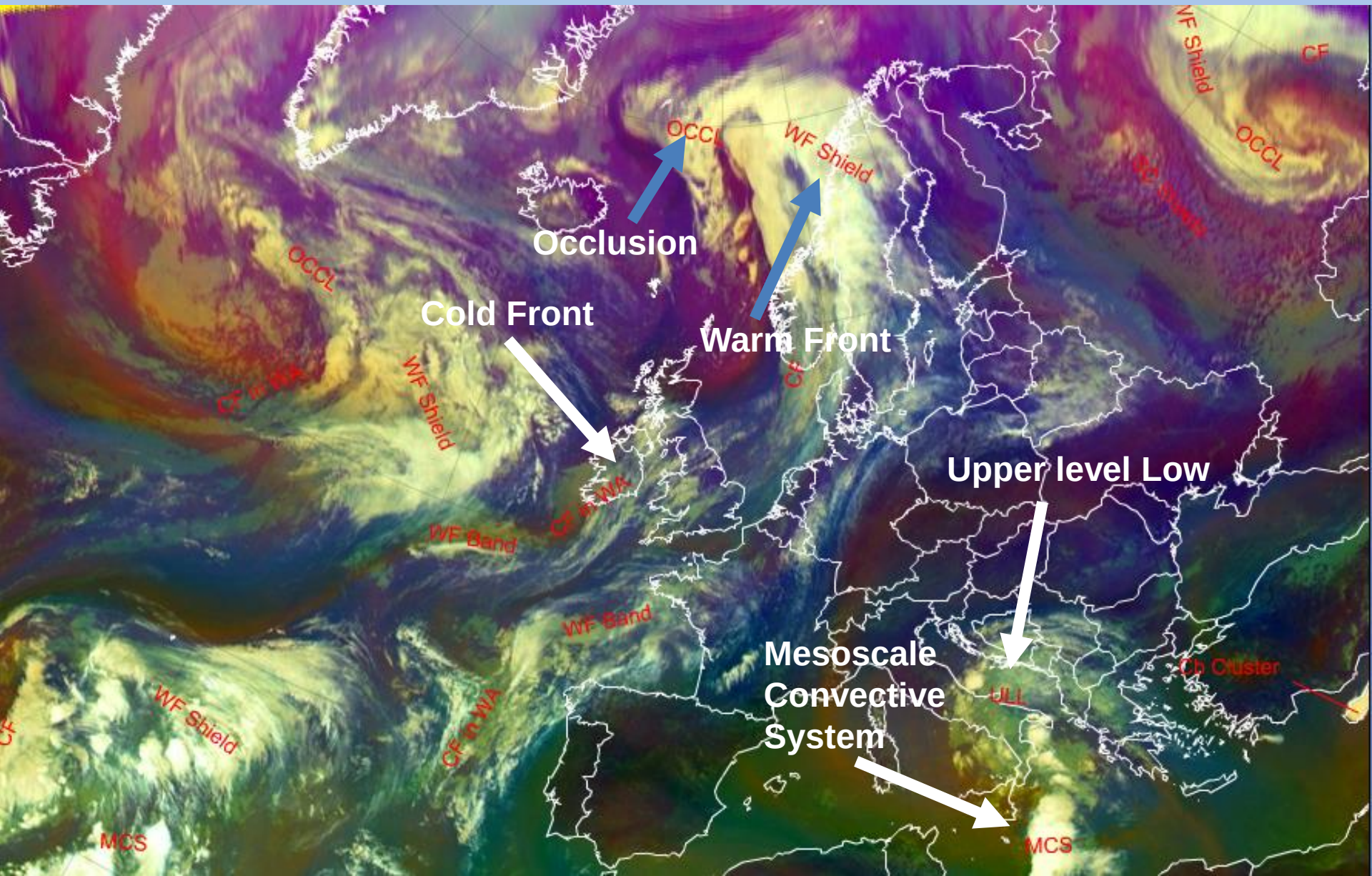
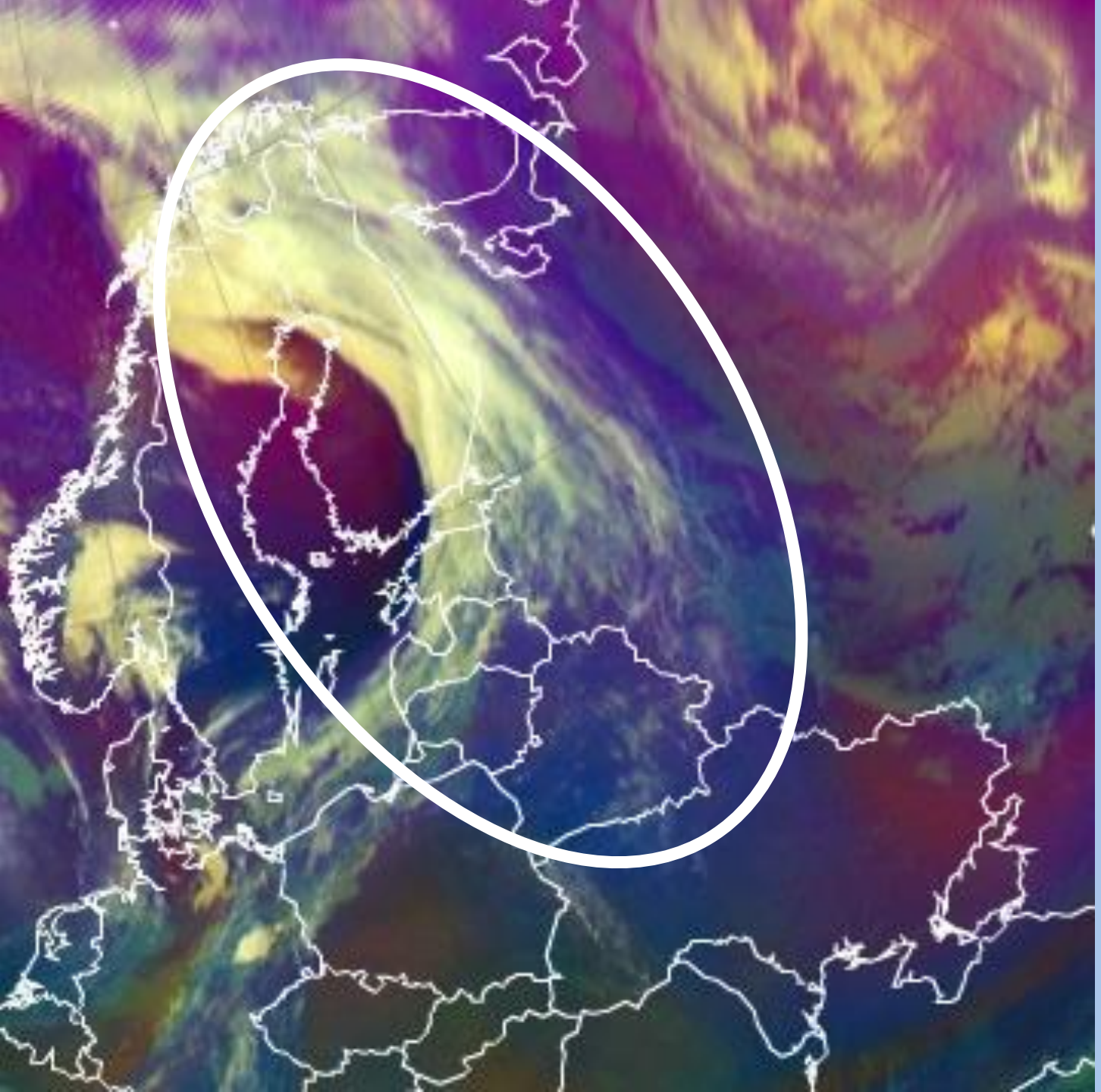
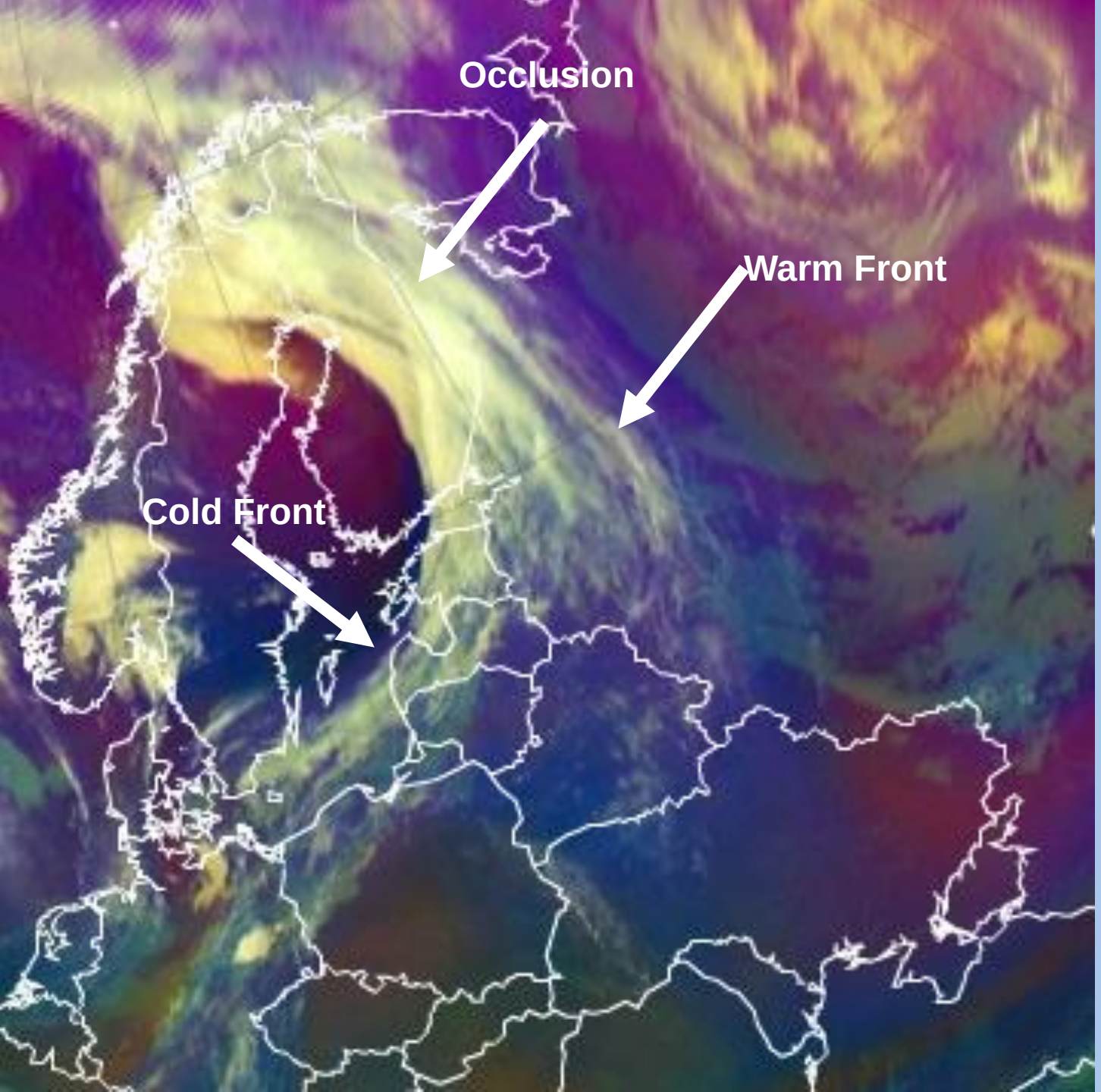


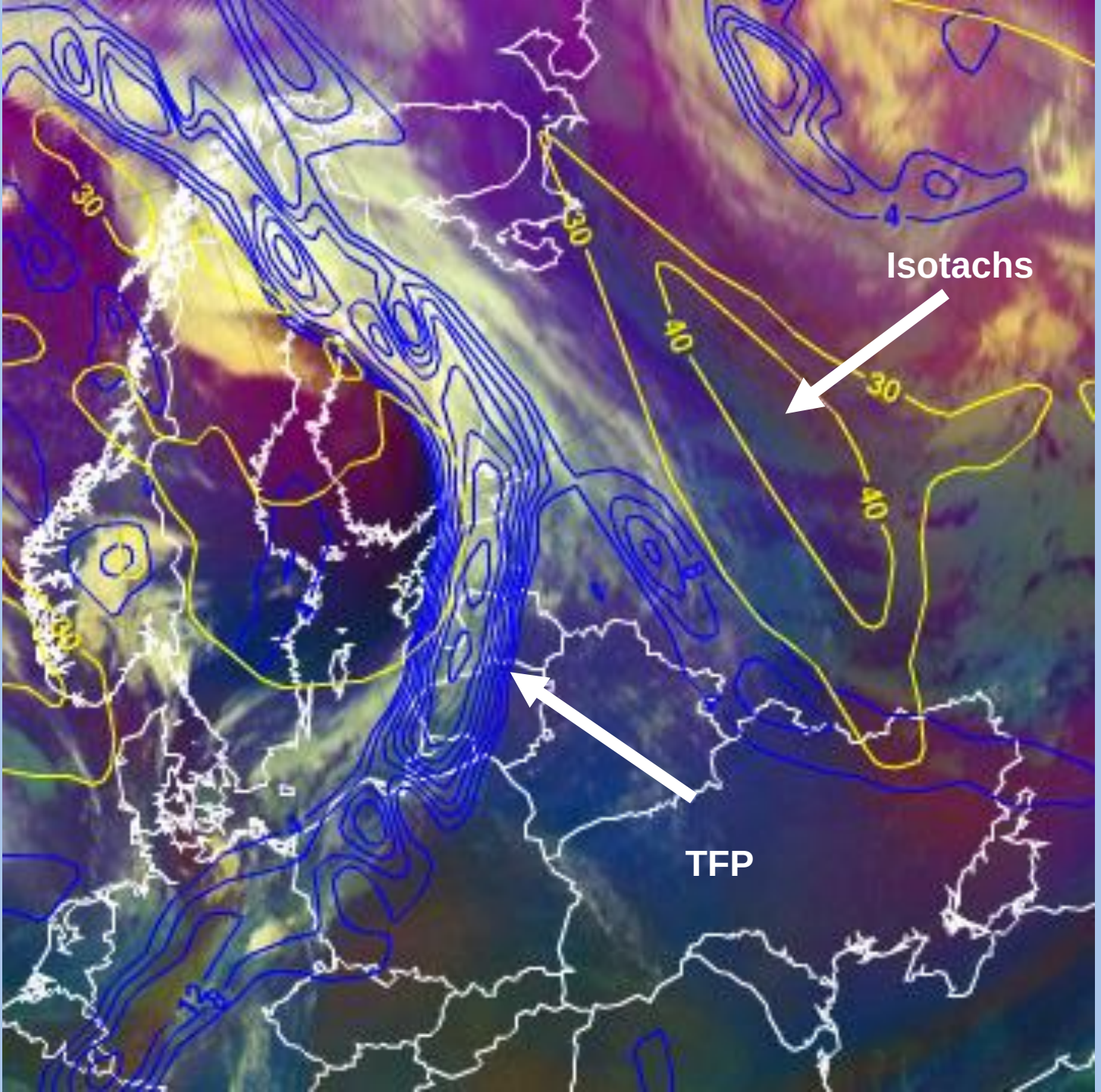


How to analyze a
Conceptual Model?

First!
Cloud feature
Here frontal system

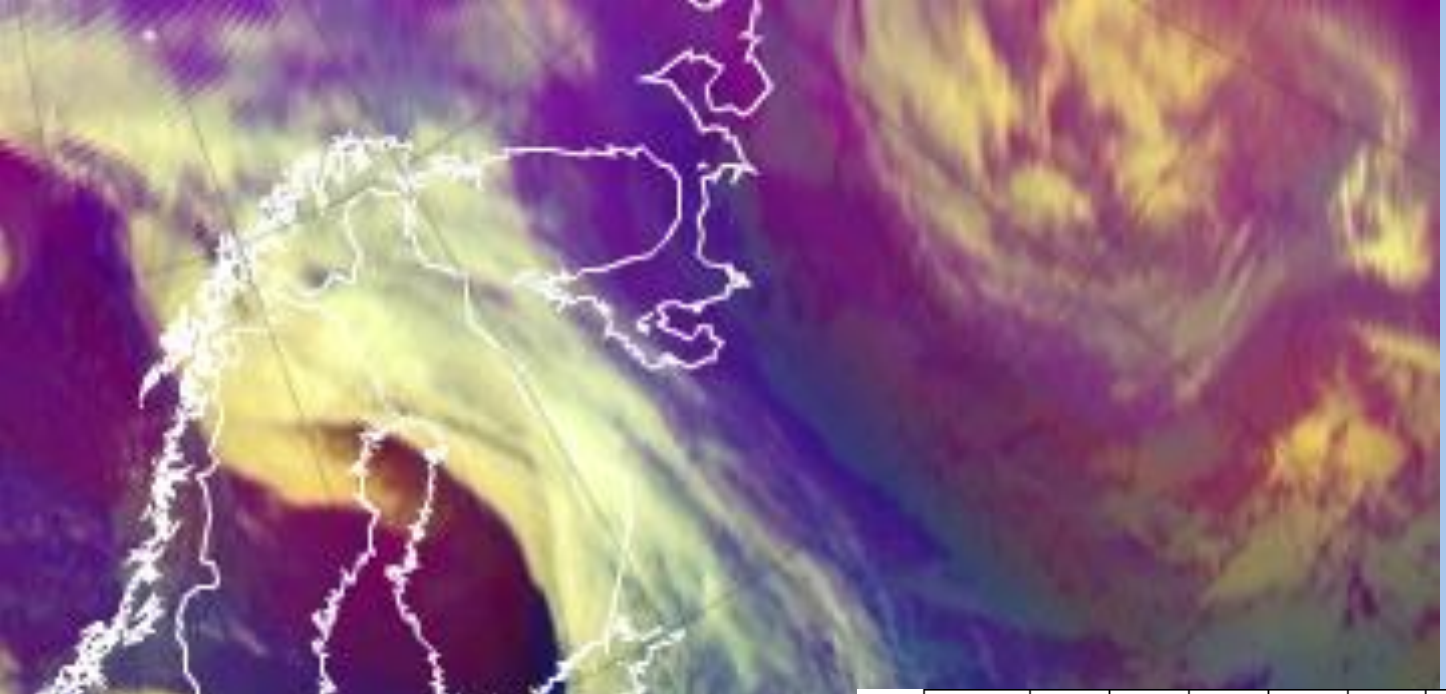


Knowledge of the Physical background (Here CF, WF and Occlusion)

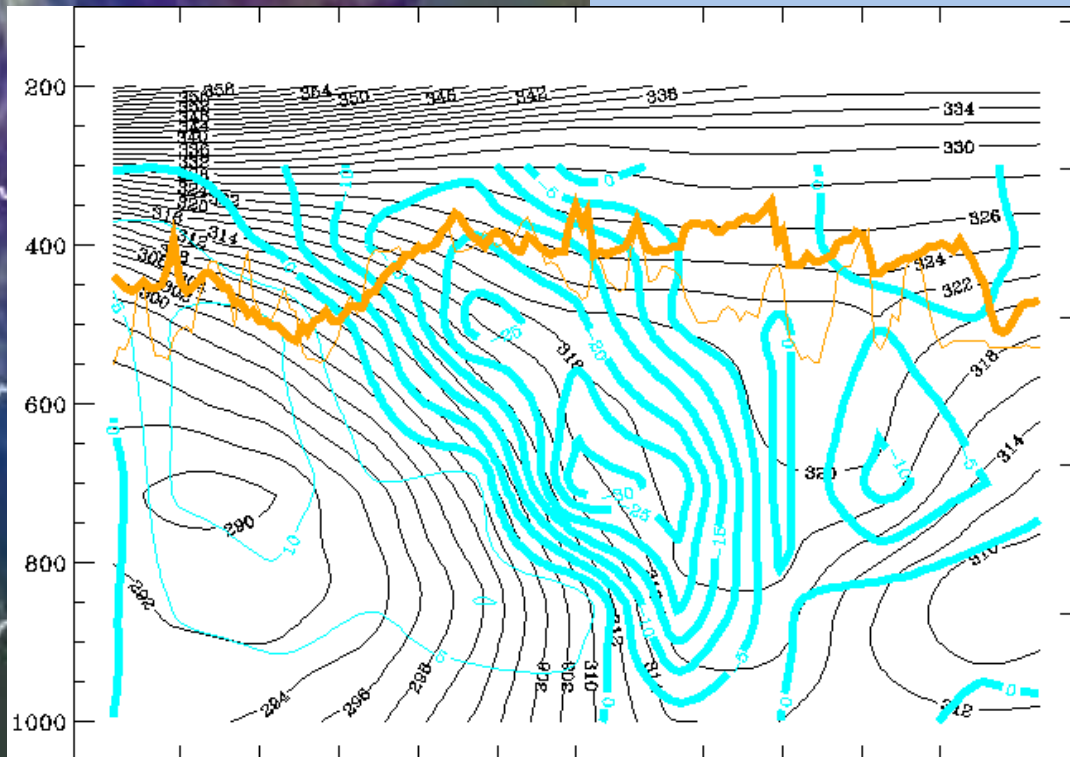


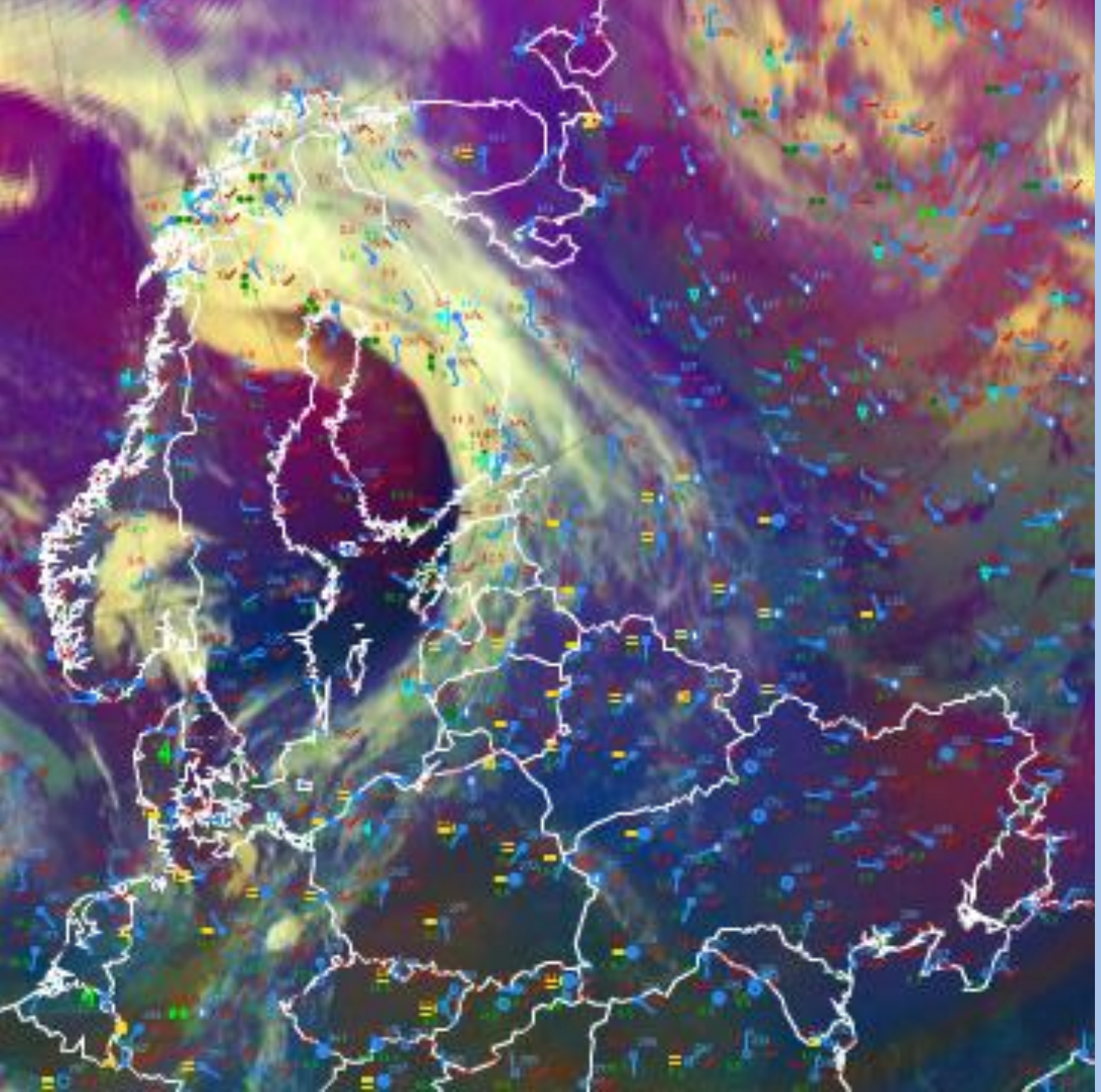
Cloud feature in combination with relevant model parameters(Thermal Front Parameter (TFP) and Isotachs 300 hPa)

Checking first guess



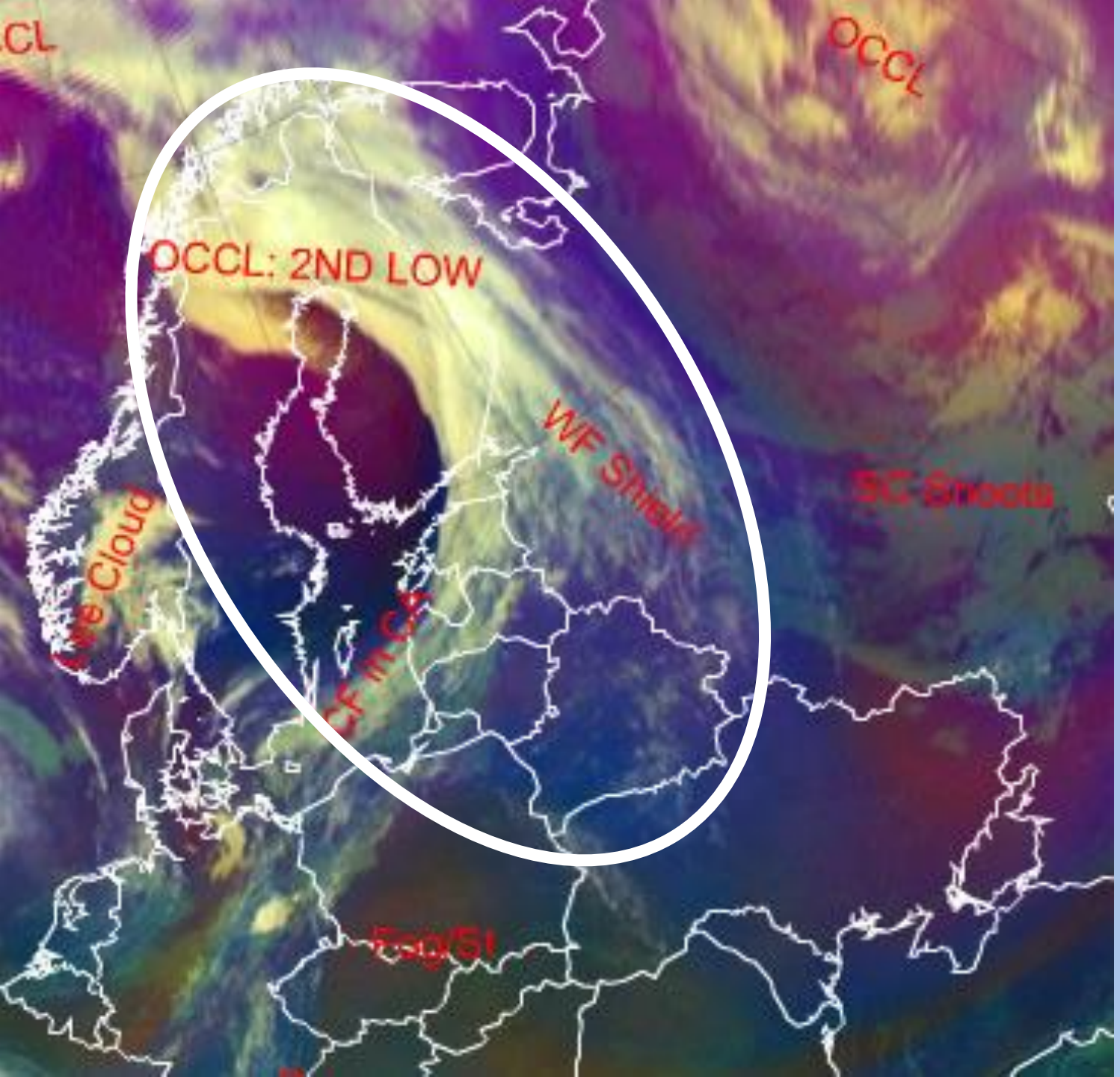
Cross Section (potential temperature and vertical velocity (ω))





Cloud feature
in combination
with observations

Weather events



Conceptual Models

After investigation Confirmation

Achieving a 3D – or even 4D-mental weather picture.

Construction of a Conceptual Model in SatManu

I. Appearance in Satellite Data
Learn about how to recognise and detect.

II. Meteorological Physical Background
Find out more about the meteorlogical and physical background.

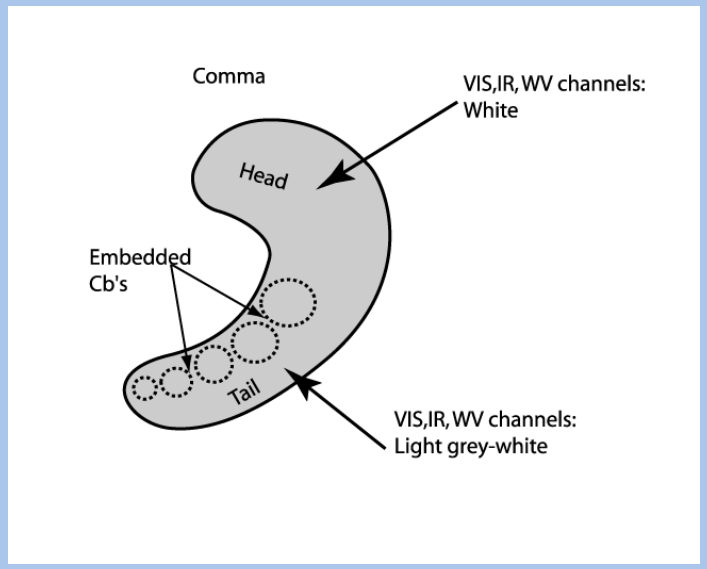
III. Key Parameters
Learn which key parameters to use for monitoring.

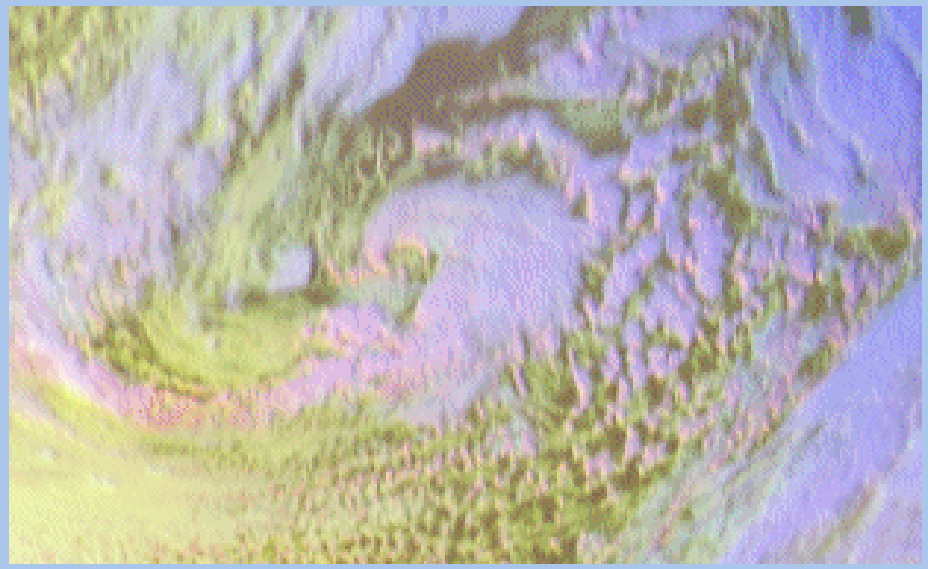
IV. Typical Appearance In Vertical Cross Sections
Find out the typical appearance in vertical cross sections.

V. Weather Events
Explore the weather events.

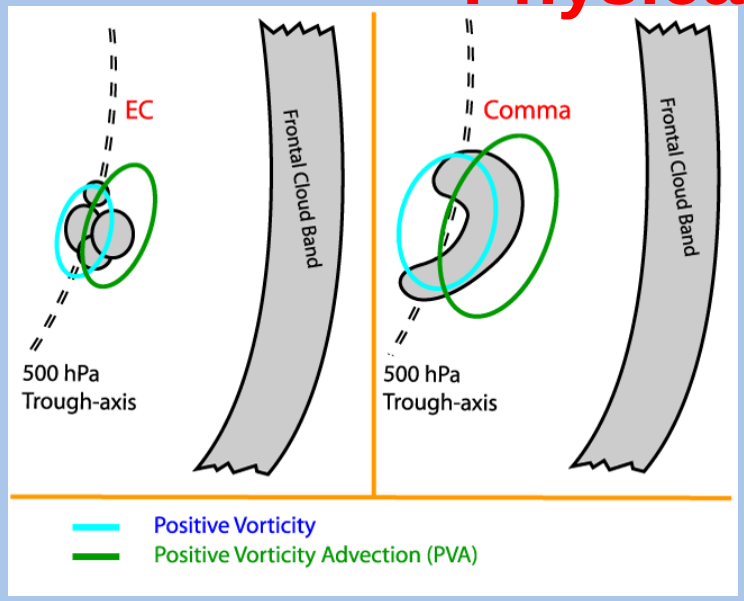
VI. References

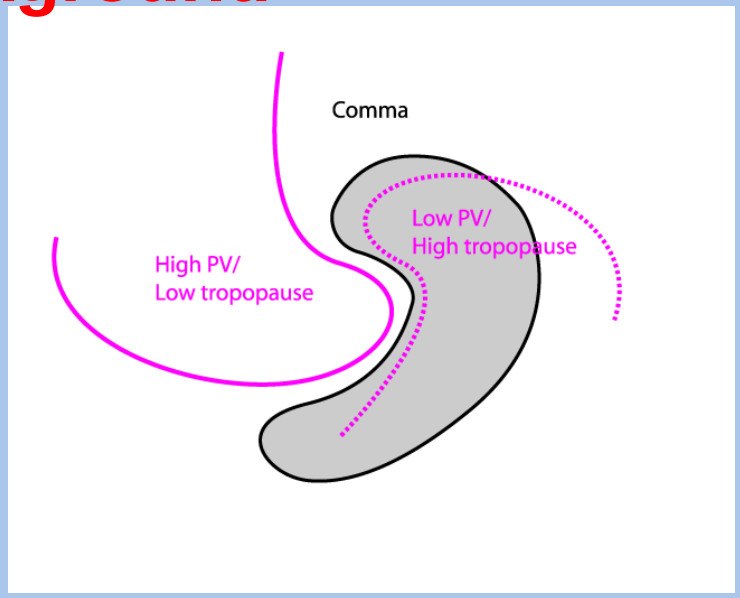
Construction of a Conceptual Model in SatManu
Cloud Structure in Satellite Image



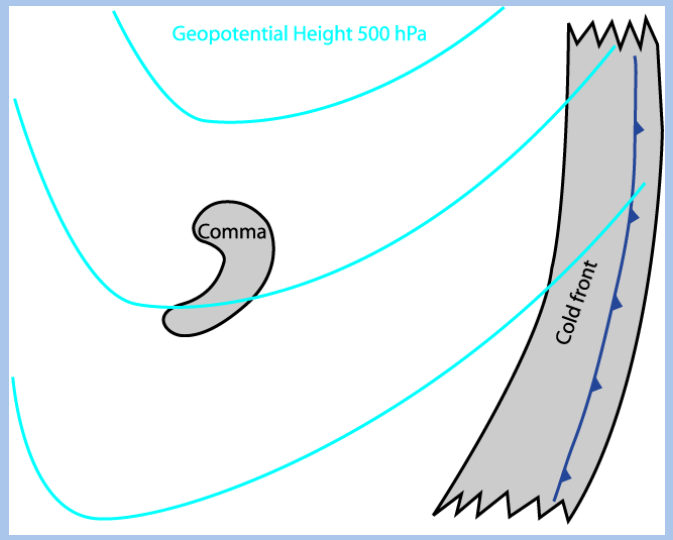


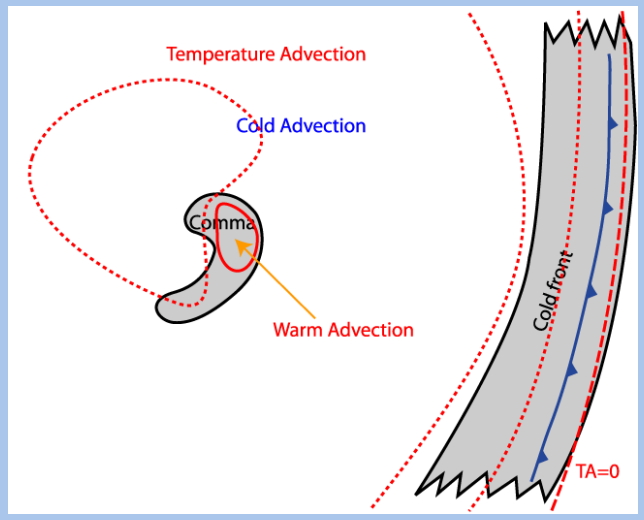
Physical Background



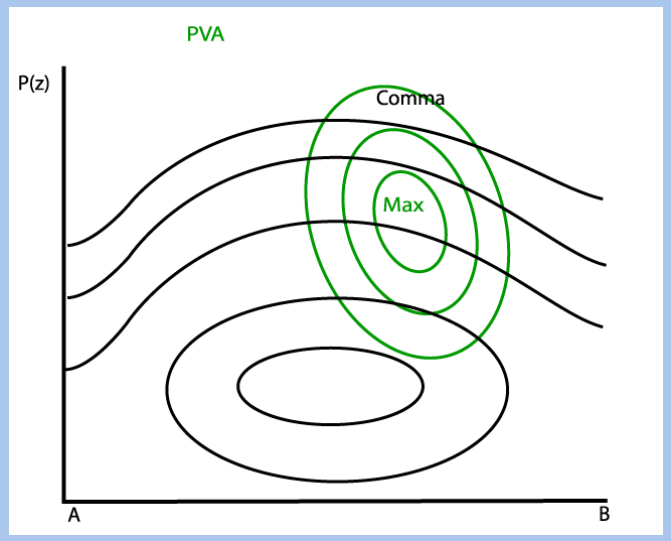


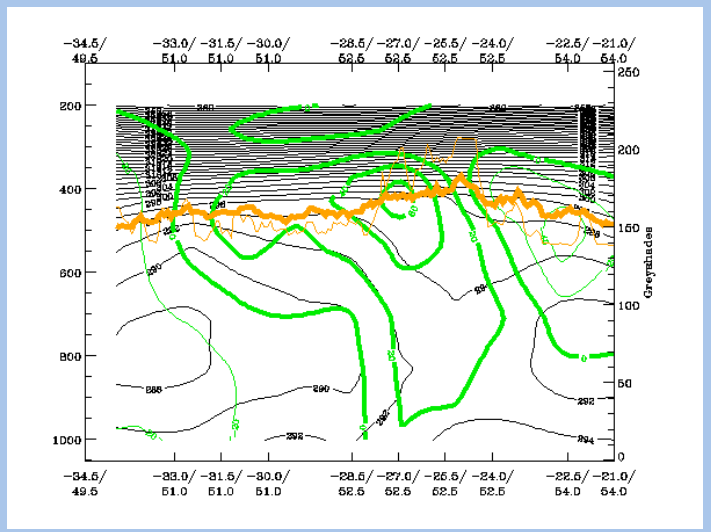
Construction of a Conceptual Model in SatManu
Key Parameters



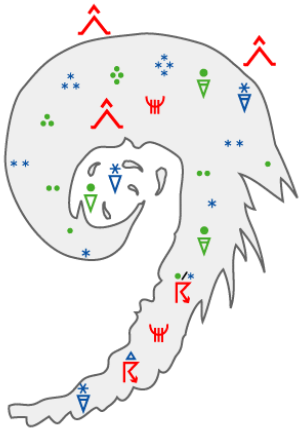


Cross Sections

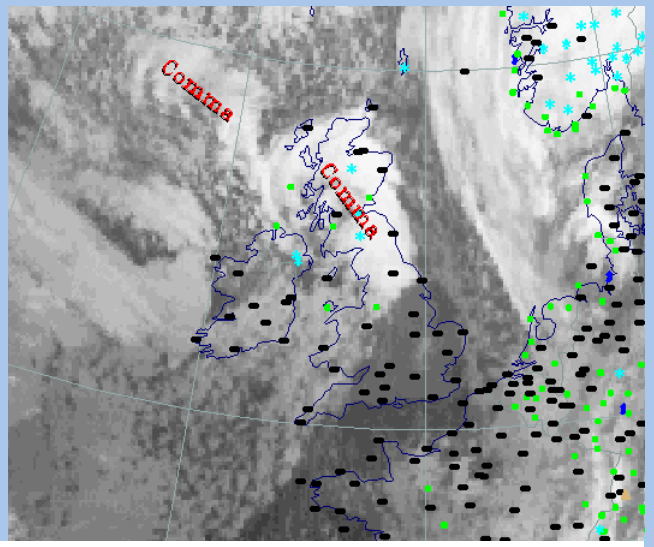




Construction of a Conceptual Model in SatManu
Weather Events



COMMA



Parameter	Description
Precipitation (incl. thunder)	• Moderate to heavy precipitation, rain or snow, in Comma head • In Comma tail more showery precitation • In Comma tail quite often hail and thunderstorms are observed.
Temperature	• Surface temperature and sea surface temperature are forcing features of convection.
Wind (incl. gusts)	• In surface trough strong winds can be expected. • Ahead of the Comma head strong gusts are common. • In and near showers also strong gusts can be observed.
Other relevant information	• Risk of moderate to severe icing and turbulence • Poor visibility during heavy snowfall • Heavy snow fall can cause hazardous weather for society • Different behaviour over sea and land

References

General Meteorology and Basics

•FORBES, LOTTES (1985): Classification of Mesoscale Vortices in Polar Airstreams and the Influence of the Large-scale Environment on their Evolutions, Tellus, 37A, 132 - 155

•RASMUSSEN (1979): The Polar Low as an Extratropical CISK Disturbance, Quart. J. Royal Meteor. Soc., 105, 531-549

•REED (1979): Cyclogenesis in Polar Air Streams, Monthly Weather Review, 107, 38-52

•TURNER, LACHLAN-COPE, THOMAS (1993): A Comparison of Arctic and Antarctic Mesoscale Vortices, J. Geophysical Research, 98, D7, 13019-13034

General Satellite Meteorology

•CARLETON, CARPENTER (1989): Satellite climatology of Polar Lows and Broadscale Climatic Associations for the Southern Hemisphere, Int. J. Climatology, 10 (3), 219-246

•CLAUD ET AL (1993): Satellite Observations of a Polar Low over the Norwegian Sea by Special Sensor Microwave Imager, Geosat, and TIOS-N Operational Vertical Sounder, J. Geophysical Research, 98, C8, 14487-14506

Specific Satellite Meteorology

•BROWNING (1993): Evolution of a Mesoscale Upper Tropospheric Vorticity Maximum and Comma Cloud from a Cloud-free Two-dimensional Potential Vorticity Anomaly, Quar. J. Meteor. Soc., 119, 513, 883-906

•CRAIG (1992): A Study of Two Cases of Comma-Cloud Cyclogenesis Using a Semigeostrophic Model, Monthly Weather Review, 2942-2961

•REED (1979): A Case study of Comma Cloud Development, Monthly Weather Review, 114, 1681-1695

•REED (1979): A Further Case study of Comma Cloud Development, Monthly Weather Review, 114, 1696 - 17

53 Conceptual models are described

COLD FRONT
- Arctic Cold Front
- Cold Front
- Cold Front in Cold Advection
- Cold Front in Warm Advection
- Split Front

WARM FRONT
- Detached Warm Front
- Warm Front Band
- Warm Front Shield

OCCLUSION
- Back-Bent Occlusion
- Cold Air Development
- Instant Occlusion
- Occlusion: Cold Conveyor Belt Type
- Occlusion: Warm Conveyor Belt Type

BAROCLINIC BOUNDARY
- Baroclinic Boundary

SUBSTRUCTURES IN FRONTS and INITIAL STAGES OF CYCLOGENESIS
- Front Decay
- Front Intensification by Jet Crossing
- Rapid Cyclogenesis
- Secondary Low Centres in Occlusion Cloud Bands
- Upper Wave
- Wave

NON-FRONTAL SYNOPTIC SCALE PHENOMENA
- Deformation Band
- Thickness Ridge Cloudiness
- Upper Level Low
- Warm Conveyor Belt

MESOSCALE PHENOMENA
- Comma
- Convergence Cloudiness
- Enhanced Cumulus
- Jet Fibres
- Open Cell Convection and Closed Cell Convection
- Polar Low

CONVECTIVE WEATHER FEATURES
- Cumulonimbus Cluster
- Cumulonimbus (Cb) and Mesoscale Convective System (MCS)

CONVECTIVE WEATHER FEATURES IN TYPICAL SYNOPTIC ENVIRONMENT
- At the Leading Edge of Frontal Cloud Bands
- Enhancement of Convection by PV
- Fair Weather Conditions
- The Warm Sector
- The Warm Sector: Spanish Plume

OROGRAPHICAL WEATHER FEATURES
- Barrage Cloud
- Orographic Effects on Frontal Cloudiness
- Lee Cloudiness

WIND RELATED PHENOMENA
- Foehn
- Piteraq
- Bora

LOW CLOUDS
- Cloud Streets
- Fog and Stratus
- Stratocumulus Sheets

WV
- Dark Stripes
- Water Vapour Vortices

SMALL SCALE CONCEPTUAL MODELS
- Coastal Convergence
- Convergence Lines Over Seas and Lakes
- Non-orographic Convergence Lines
- Orographically Induced Convergence Lines
- Sea-Breeze

15 Conceptual models are described in Southern Hemisphere

ARGENTINA
- The South American Low Level Jet (SALLJ)
- Zonda
- Cloud Patterns Associated with Cold Fronts in Central Argentina
- Bolivian High and its Relationship with Deep Convection over Northern Argentina

ATLANTIC
- Tropical Cyclones

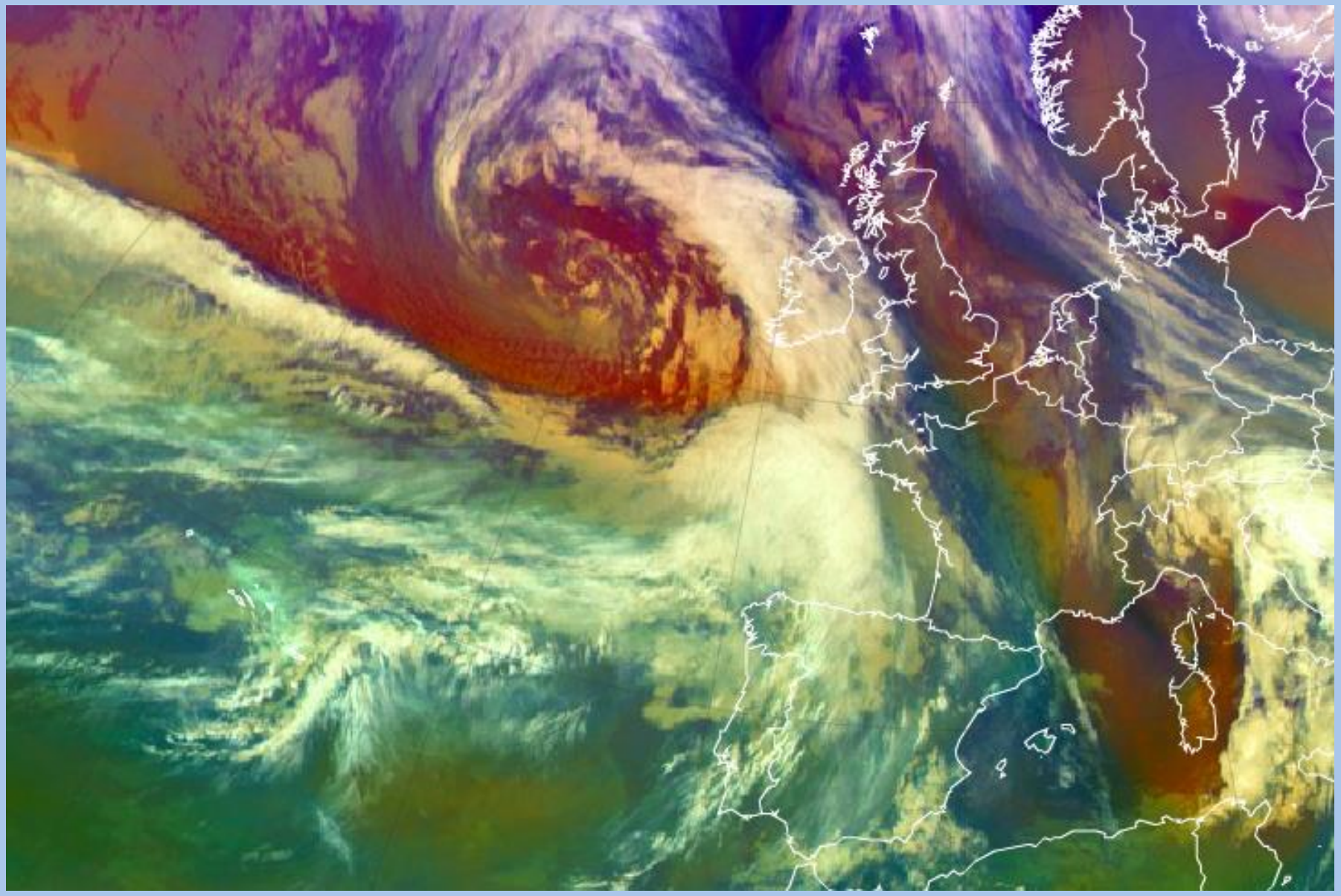
AUSTRALIA
- Explosive Cyclogenesis in the Southeast Australian Region
- Shallow Cold Fronts

BRAZIL
- Atlantic Convergence Zone (ZCAS)
- Mesoscale Convective Complexes (MCCs)
- Cyclogenesis and Extra-tropical Cyclones Over Southeastern South America
- Upper Tropospheric Cyclonic Vortices in The Tropical South Atlantic

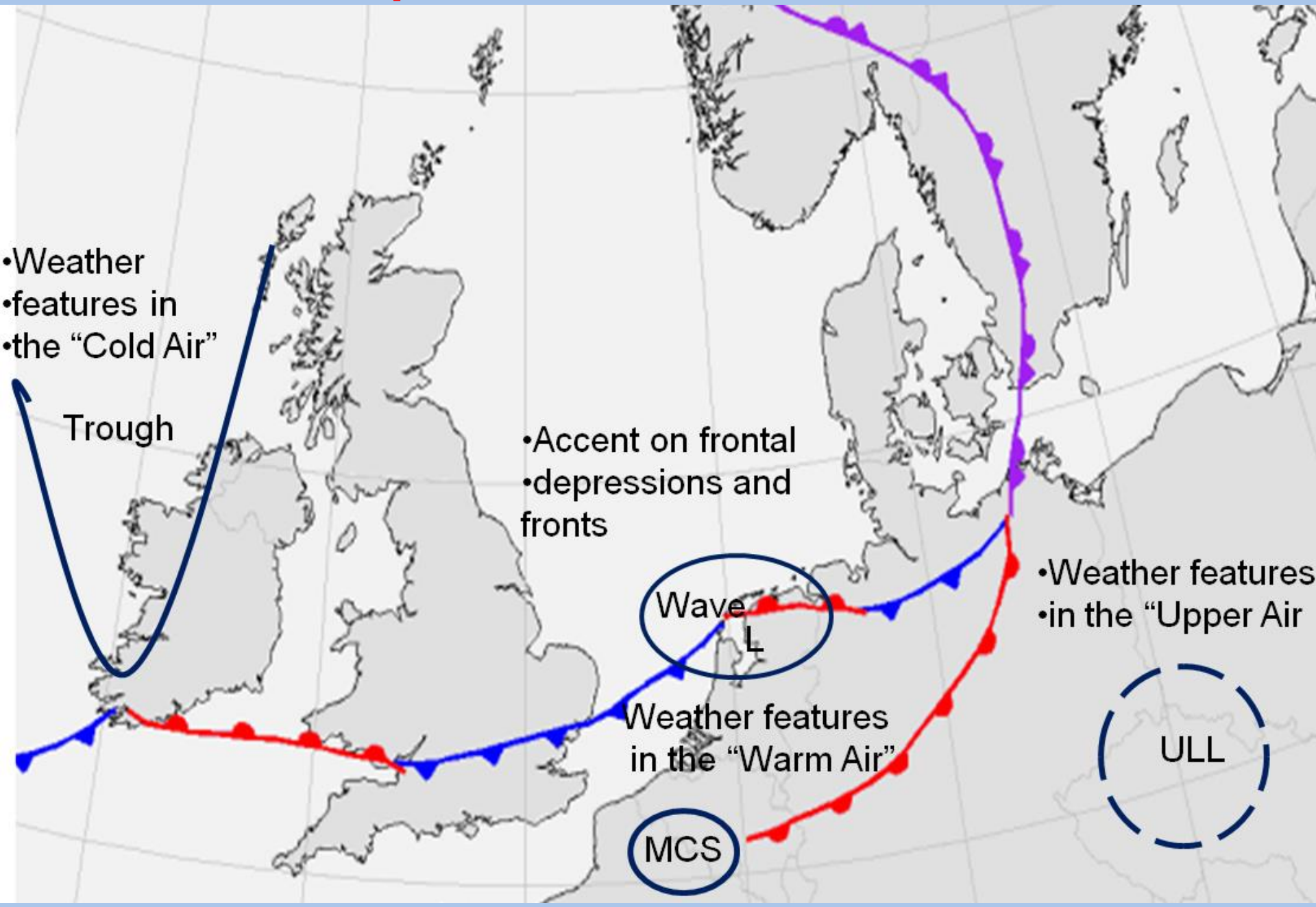
INDONESIA
- Northerly Cold Surge

SOUTH AFRICA
- Cut-Off Low pressure systems
- Tropical Lows in Southern Africa
- South African Cold Front

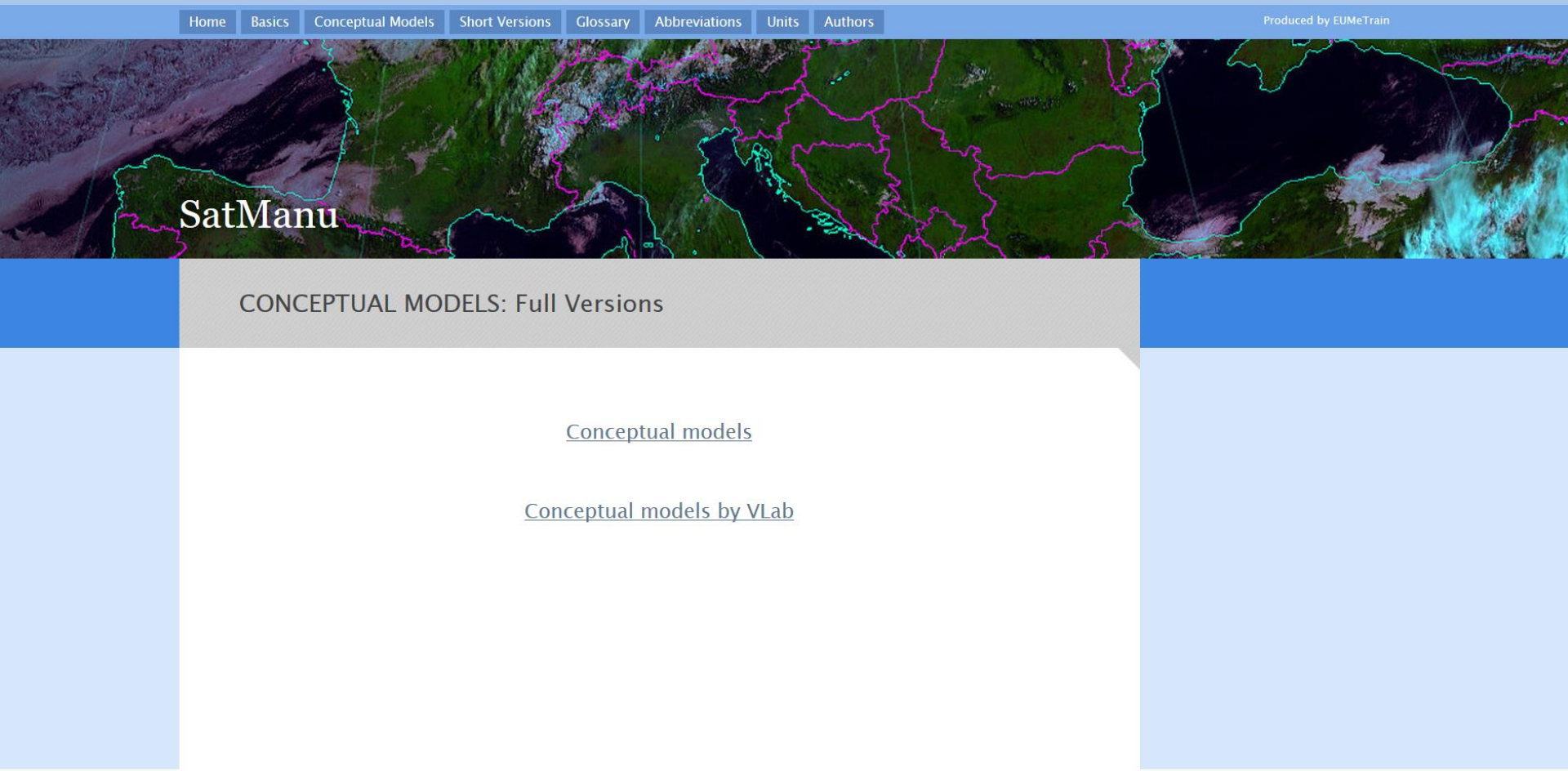
Conceptual models and air masses



Conceptual models and air masses

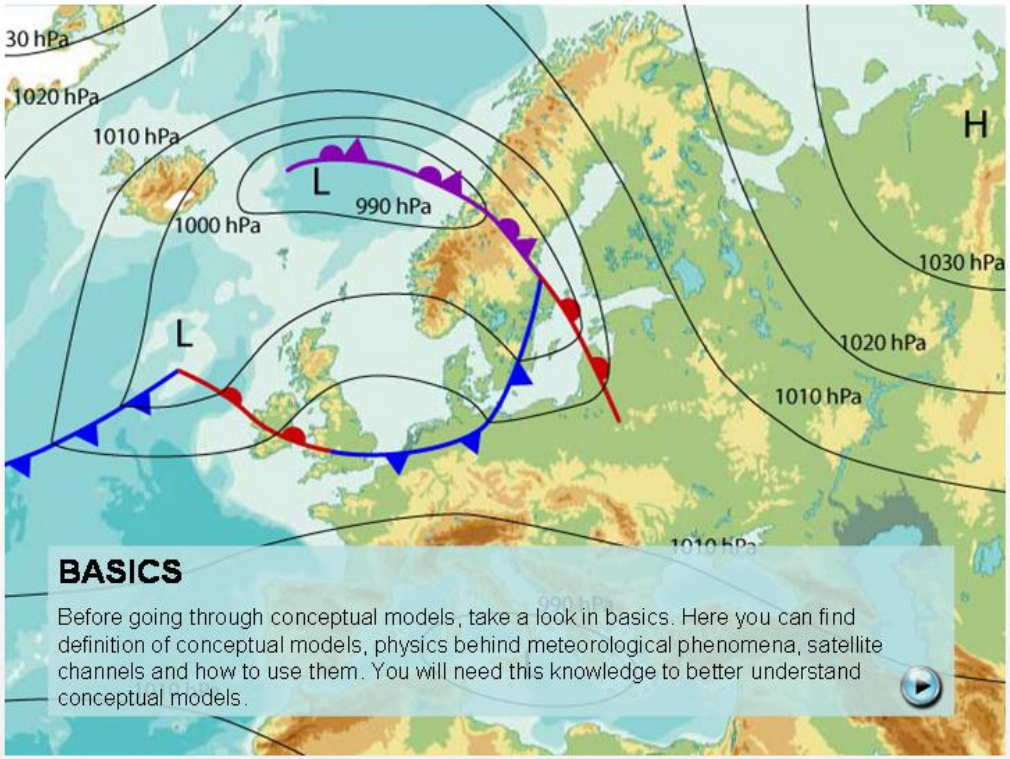


The construction of the manual



Home Page

In 1996, the compilation of a "Manual of Synoptic Satellite Meteorology – Conceptual Models" (or CMs SatManu) was started, initially by the Austrian Meteorological Institute (ZAMG), but later in co-operation with the Dutch- and Finnish Meteorological Institutes (KNMI and FMI, resp.). The material in this manual was produced in electronic form as a CD-ROM within the framework of the sponsored "SATREP" Project of EUMETSAT and is also available online. This type of Computer Aided Learning-material is now widely used as part of EUMETSAT training courses in satellite meteorology, in the training and operational environments of several Member and Co-operating States and by many other meteorological services and research institutes such as Universities world-wide.



BASICS

SATELLITE CHANNELS

- Basic Channels
- Artificial and Combination Channels

CONCEPTUAL MODELS

- Definition

RELATION OF CLOUD FEATURES and NUMERICAL MODEL PARAMETERS

Numerical Parameters for Synoptic- to Mesoscale Cloud Systems

- The Quasi-geostrophic Approach
- Divergence
- Vertical Motion – Omega Equation
- Vorticity and Vorticity Advection
- Potential Vorticity
- Temperature Advection
- Thermal Front Parameter

Numerical Parameters for Small Scale Convective Cloud Systems

- Cape
- Stability Indices
- Convection and Instability

ADDITIONAL TOOLS

- Relative Streams
- Vertical Cross Sections

DIVERGENCE

$$\text{div } V_2 = \nabla V_2 = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}$$

V_2	2-dimensional wind vector
u	zonal wind component
v	meridional wind component

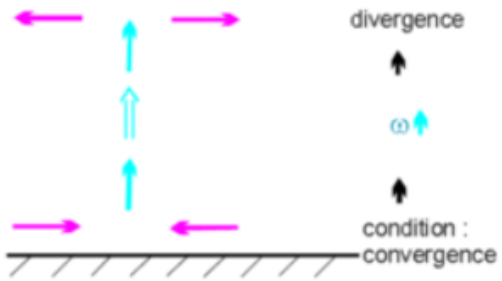
> 0	Divergence
< 0	Convergence

Divergence is a property of the flow field. There is a connection to vertical motion through the Richardson equation:

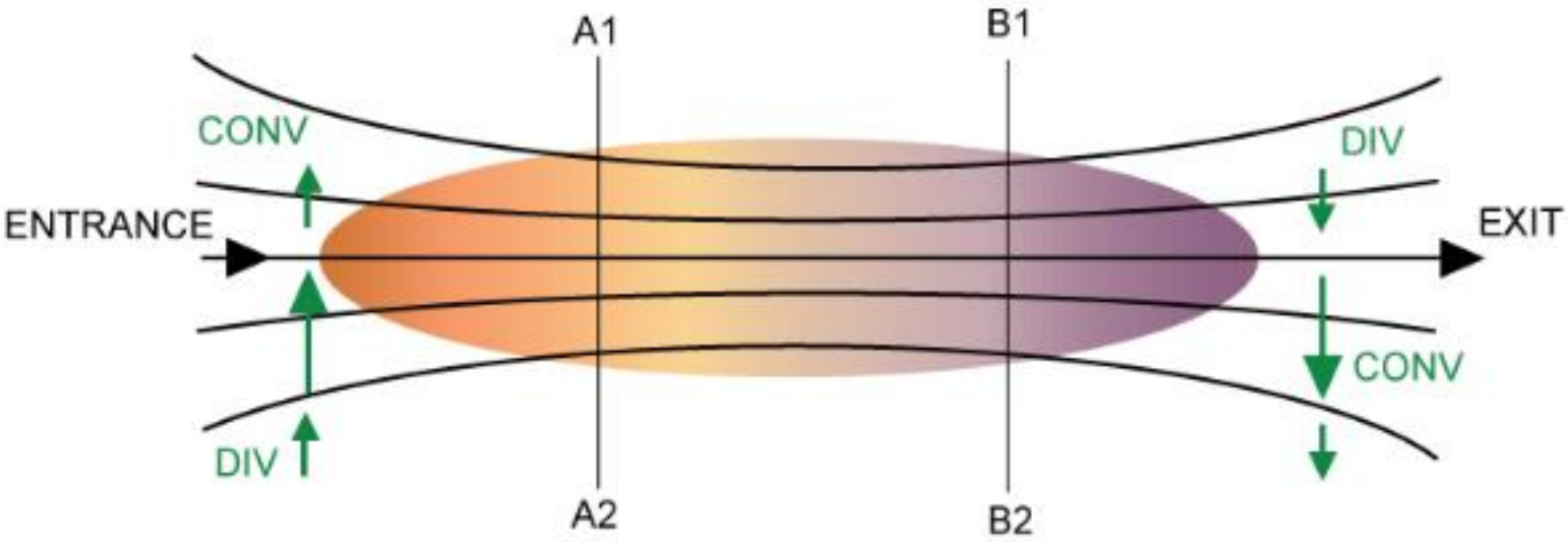
$$\text{div}_p V_2 = -\frac{\partial \omega}{\partial p}$$

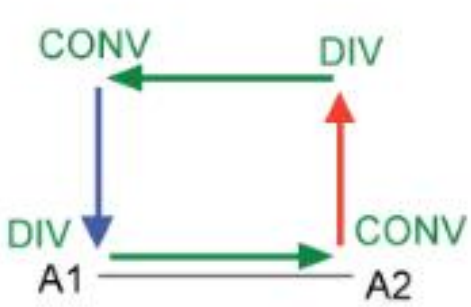
DIVERGENCE
Dynes scheme

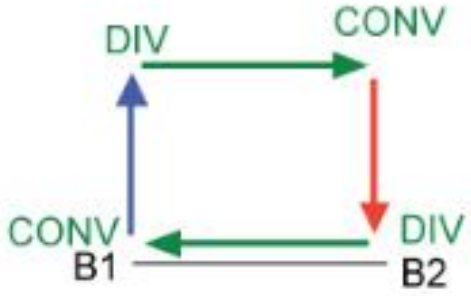
A very simple model describing an ideal situation leads to the following considerations: If there is the assumption of convergence existing at the surface level, upward motion results in the levels above up to the tropopause; at this barrier air cannot rise further and consequently has to diverge there. Therefore a circulation cell is created and cloudiness may develop in the upward motion.

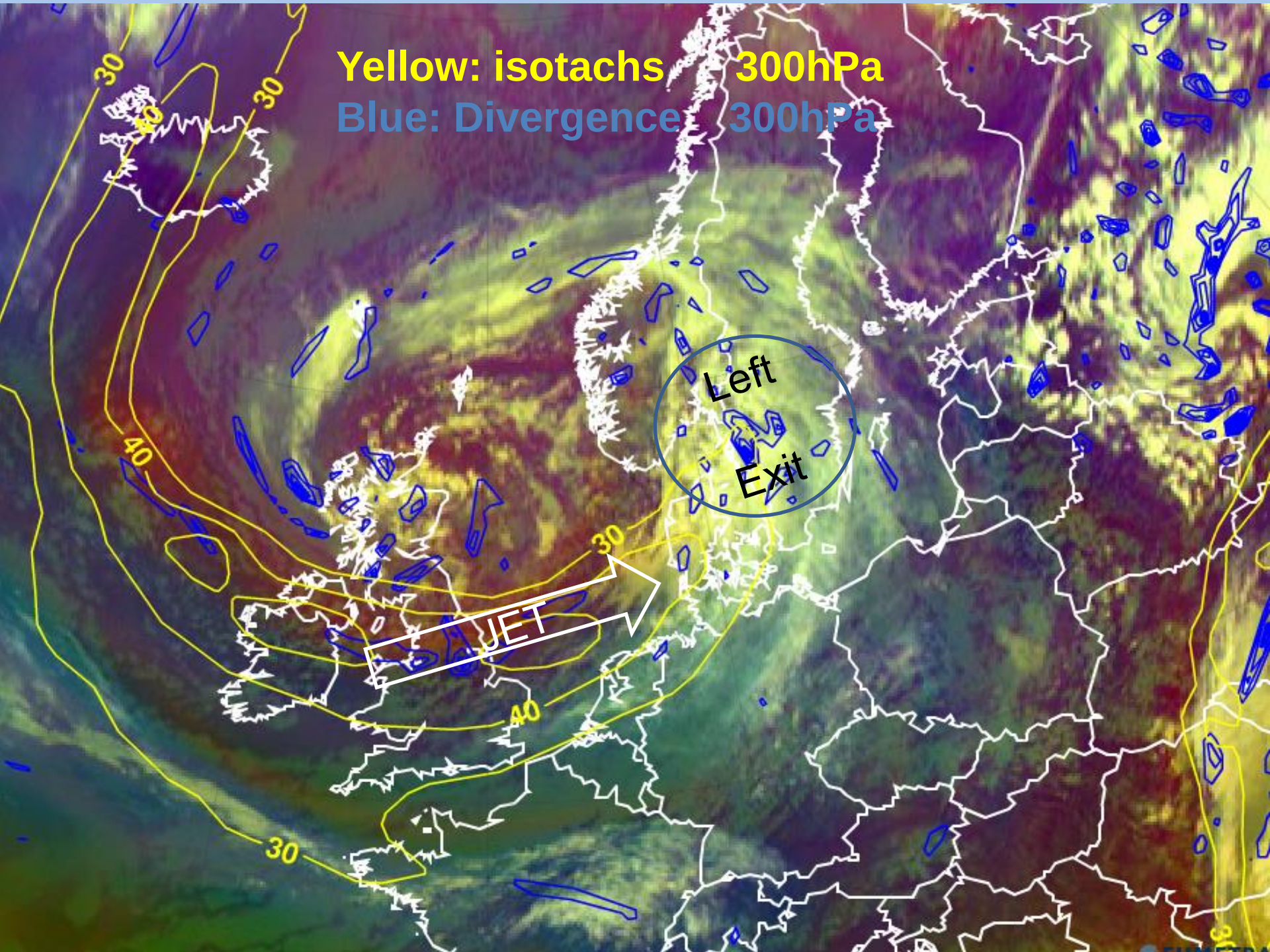


Divergence and Jetstreaks








Yellow: isotachs 300hPa
Blue: Divergence 300hPa
30
30
40
40
30
30
Left
Exit
JET

Contributing Countries

10 years project
Started in 1995

EUMETSAT

After 2005 maintenance and updating

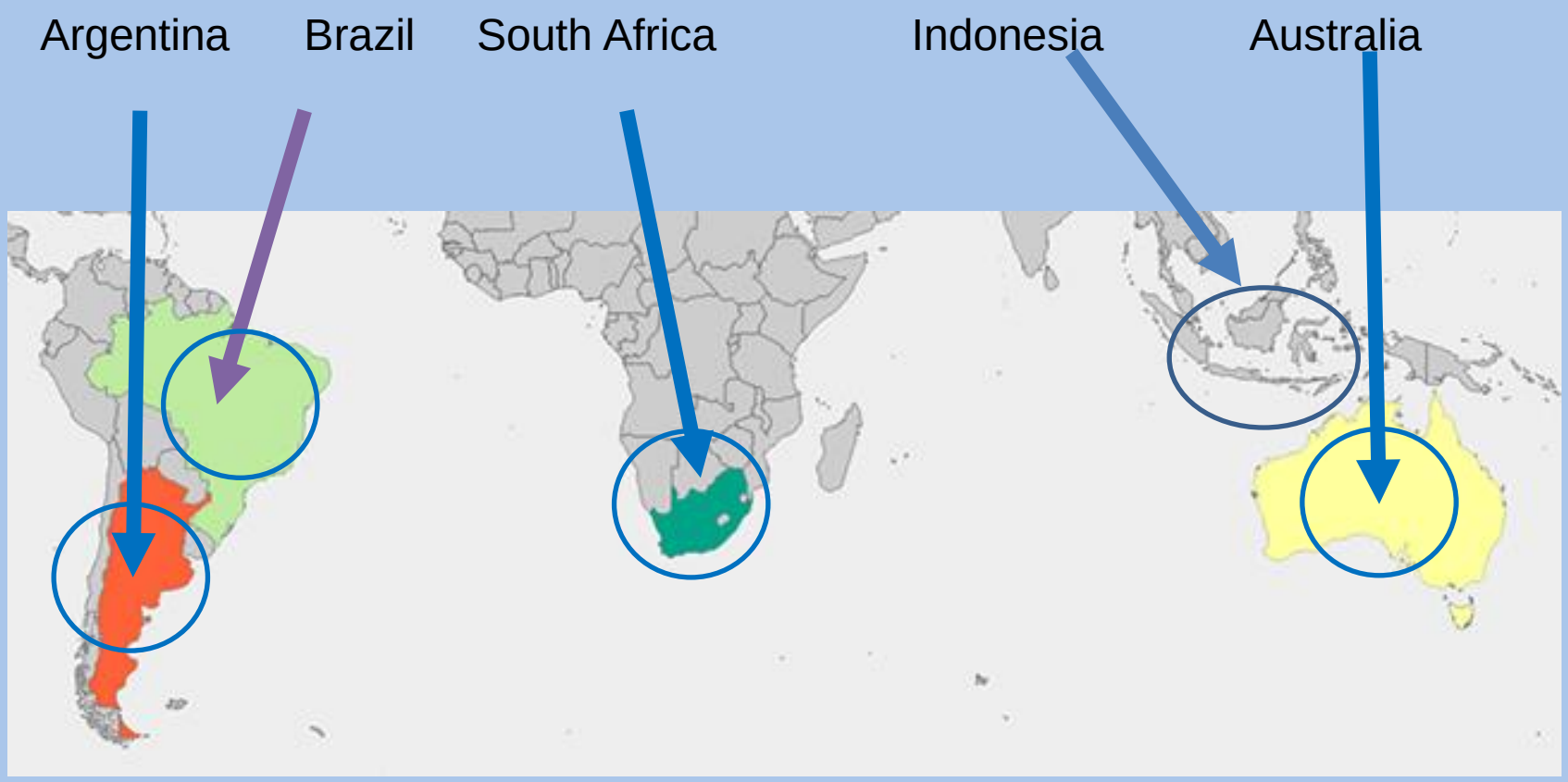
EUMeTrain

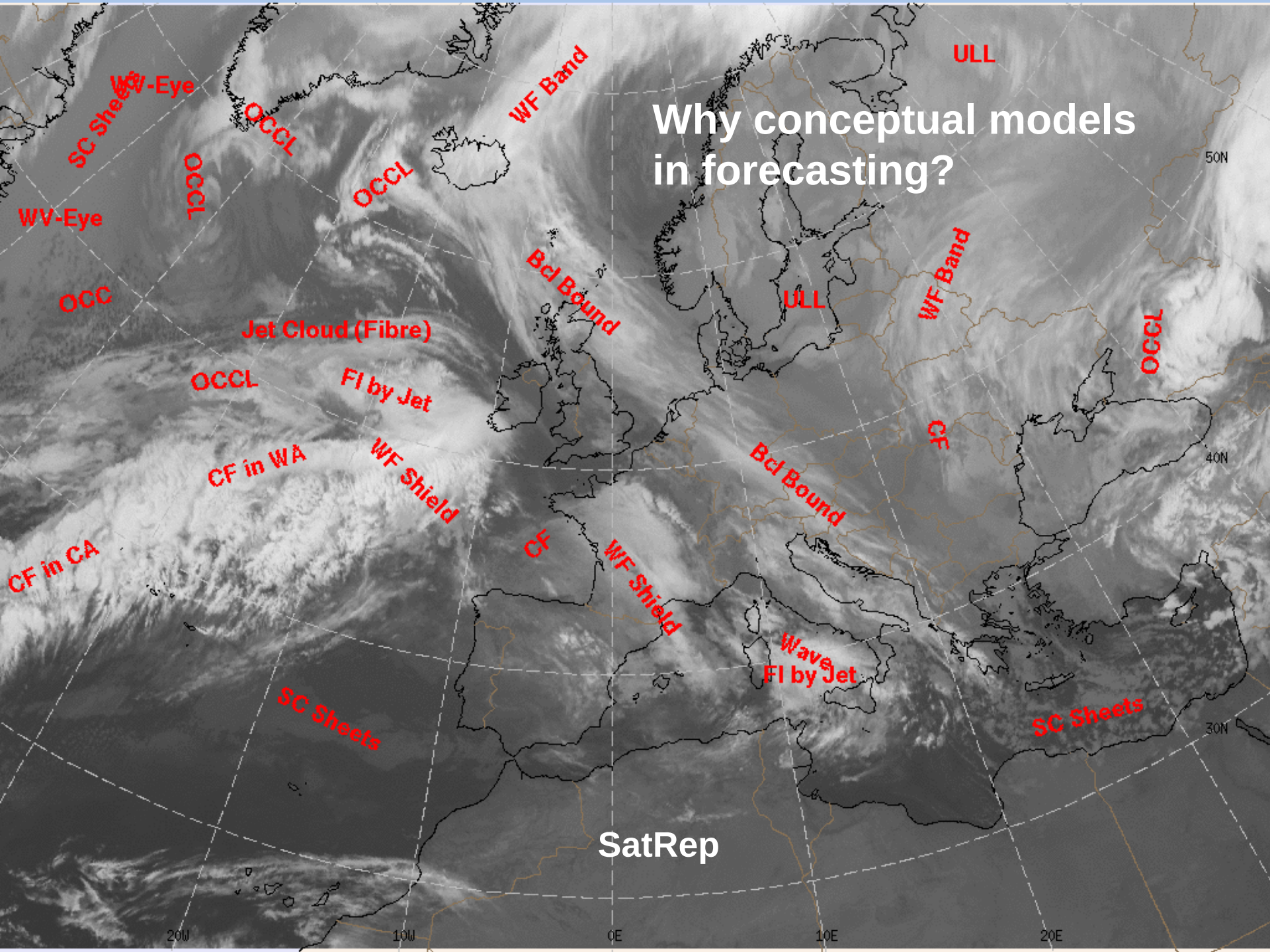
Conceptual Models for Southern Hemisphere (CM4SH)

Project team: CoE experts

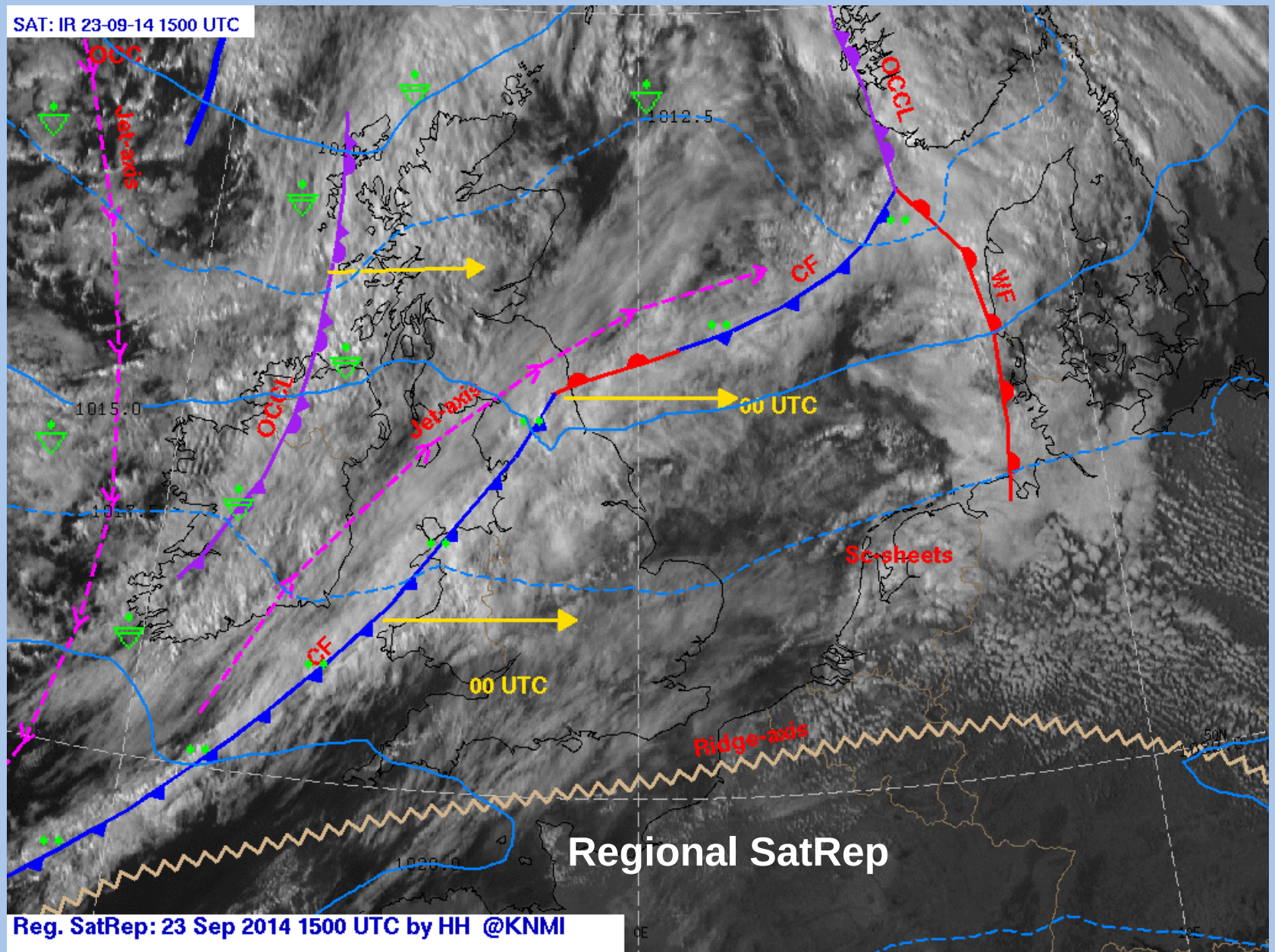
Review: CIRA + NOAA

Funding: WMO+EUMETSAT




Why conceptual models in forecasting?
ULL
WF Band
SC Sheets
WV-Eye
OCCL
OCCL
OCCL
WV-Eye
Bcl Bound
OCC
Jet Cloud (Fibre)
ULL
WF Band
OCCL
OCCL
Fl by Jet
CF
CF in WA
WF Shield
Bcl Bound
CF
WF Shield
CF in CA
Wave
Fl by Jet
SC Sheets
SC Sheets
SatRep
50N
40N
30N
20W
10W
0E
10E
20E

Why conceptual models in forecasting?



Why conceptual models in forecasting?

*CM's are not perfect… but…

*Help you to understand the most important Weather Phenomena.

*Help you to keep alert in the nowcast period.

*Help you in cases the NWP output is not confirm the reality or the output of different models conflicts.

*Always think for your self as the expert.

*NWP output is also not perfect.

*But the combination of the two improve your forecast substantially

*Both can still be improved and broadened.

*Challenge to you ??

Thank You For

Your Attention