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Bundesamt für Meteorologie und Klimatologie
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Event-based forecasting and collaboration

EGOWS 2014, Oslo (Norway)

Sören Kalesse/DWD

Agenda

- Introduction
- Events and Meteorological depictions
- AWEM
- Advanced aspects
- Conclusion

Introduction – Event based forecasting

Observation

- Over the years workstation software more and more became production tools
- Shifts forecaster work away from analyzing and monitoring weather towards production
- Examples from NinJo
  - » Graphical products (LL-SigWx, SFC analysis/forecast)
  - » SIGMET/AIRMET, Gafor, TAFs
  - » MMO (modified model output)
  - » Hurricane forecasts
  - » Public warnings … and probably many, many more

Introduction – Event based forecasting

Observation (continued)

- Many of these products describe the same weather phenomena
- Products are “re”-created because
  - » Weather changes (adjust attributes)
  - » Different scales (synopic, meso-/micro-scale)
  - » Different purposes (graphical vs. bulletins)
  - » Different area of responsibility (phenomenon moves out of / into the AOR of another service or forecast centre)

→Forecasters are asking for product monitoring tools

- Reason: be able to cope with the vast amount of products

Introduction – Event based forecasting

Let's try a different approach: **Event-based forecasting**

1. Let the forecaster analyze/describe/monitor the weather

2. Let the software generate/disseminate/monitor the products

Idea

Use interactive graphical editing to allow the forecaster to depict his **conceptual model of the state of the atmosphere and transfer it to an IT system** where it is saved, transmitted and kept for further modification and processing.

Meteorological depictions

- Significant instances of weather phenomena become weather events represented by met-objects
  - » Traceable representation of the phenomenon
  - » Stored in central met-object database
  - » Create/updated/retired using graphical editing
- Meteorological depictions
  - » Snap-shots that describe weather at a particular point in time
  - » Contain one or more met-objects to represent the phenomenon
  - » Depictions are updated if weather changes significantly
  - » Very much like key-frames

Meteorological depictions – Benefits

- Object-oriented forecaster workflow
  - » Forecaster analyzes/depicts/monitors weather events (not products)
- Collaboration is a given
  - » Objects can be shared easily
- First-guess met-objects can be generated easily from all types of sources
  - » VA met-objects from VA advisories
  - » Icing/turbulence from models, TS from CbTRAM/RadTRAM
- Enables single-voice across centres and services
- Objects and depictions can be used to generate products

Conclusion

- Conceptual model becomes data itself
  - » Forecaster maintains these conceptual models

    → Analyze/document/monitor weather
  - » Dissemination systems make this data available to every other system that needs it

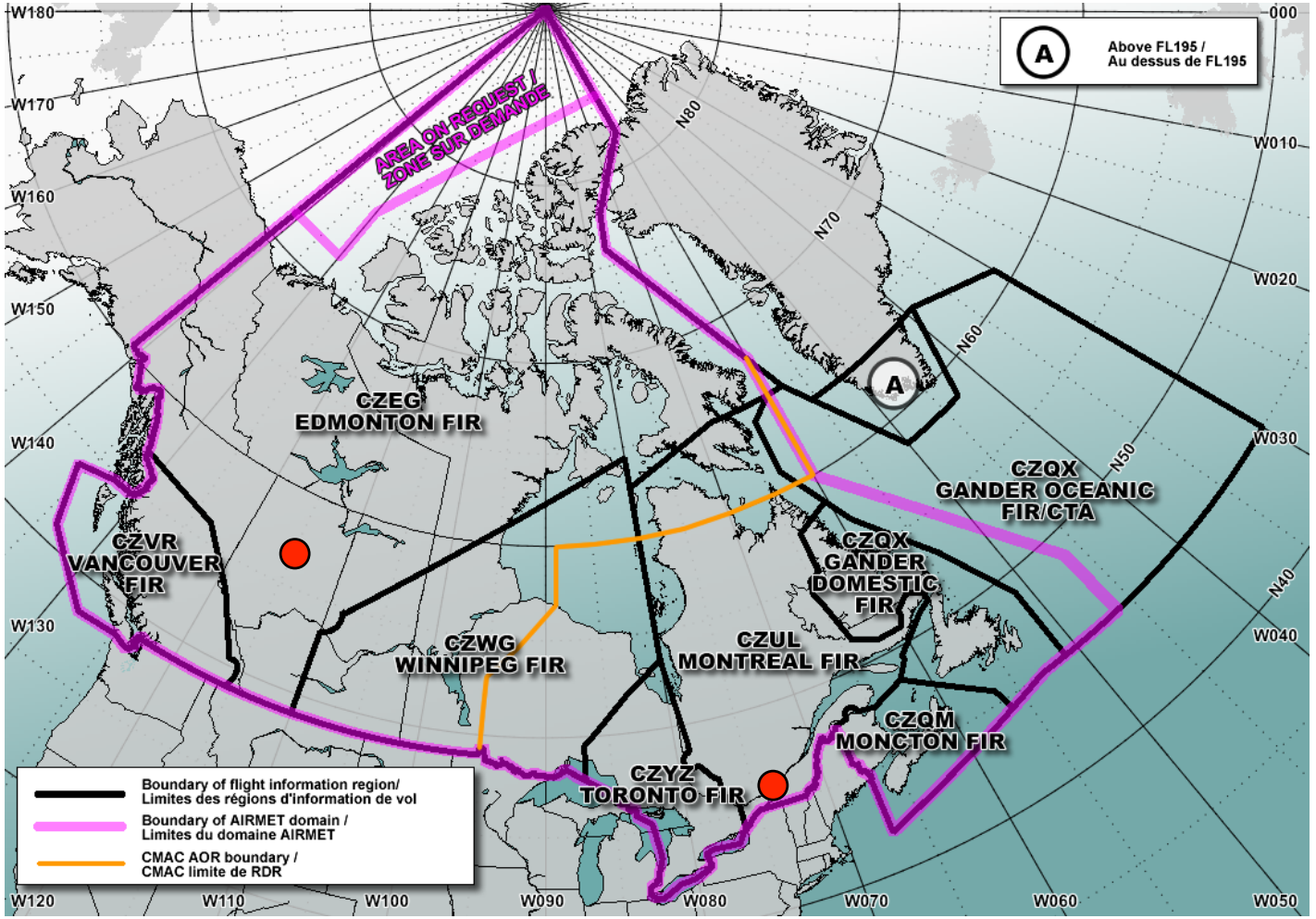
    → Share these models for collaboration, re-use and product generation
  - » Batch systems generate products (graphics, warnings etc.)
- Everybody involved does what he can do best ☺

AWEM – Aviation Weather Event Manager

- Operational proof-of-concept for event-based forecasting
  - » Put into operations on Nov 14th 2013 for the Meteorological Service of Canada to generate SIGMET/AIRMET warnings
  - » Used at the two aviation centres in Edmonton and Montréal
- Forecaster creates, updates, monitors SED metobjects
  - » Significant Event Descriptions
  - » Three different states: draft, active, retired
- All events are continuously synchronized among the two centres
  - » All forecasters have the same view on what is going on
  - » Collaboration typically weather moves across boundary of area of responsibility

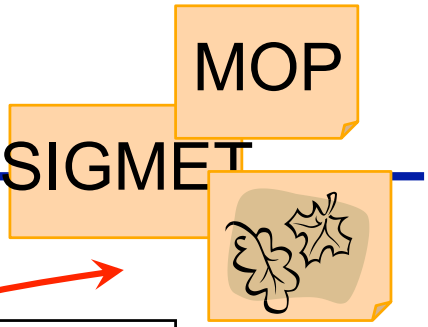
AWEM – Aviation Weather Event Manager

- The AOR of the two Canadian aviation centres



AWEM – Concept

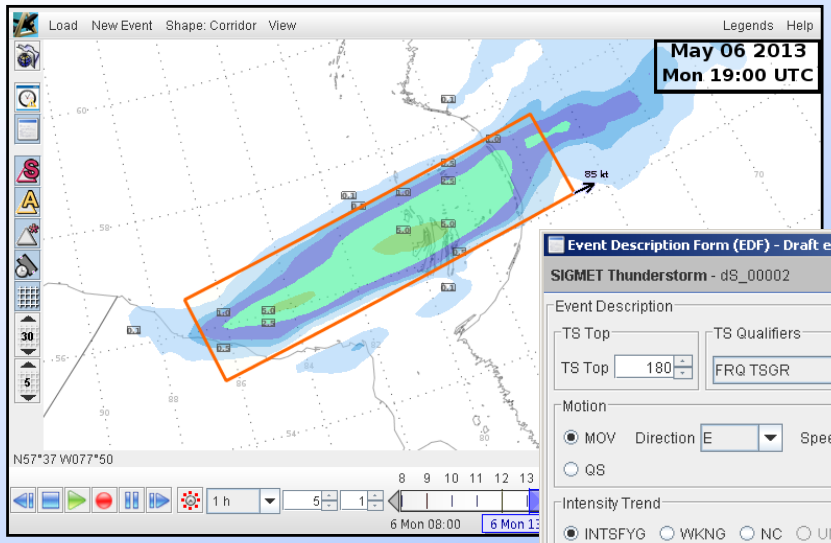
Forecaster depicts weather using significant event descriptions (SED)

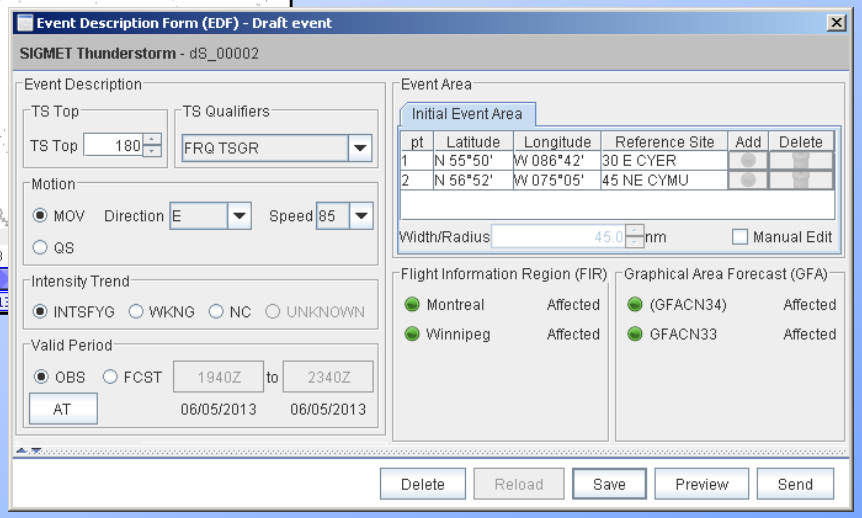


Products are generated based on SED metobjects

storage and production system

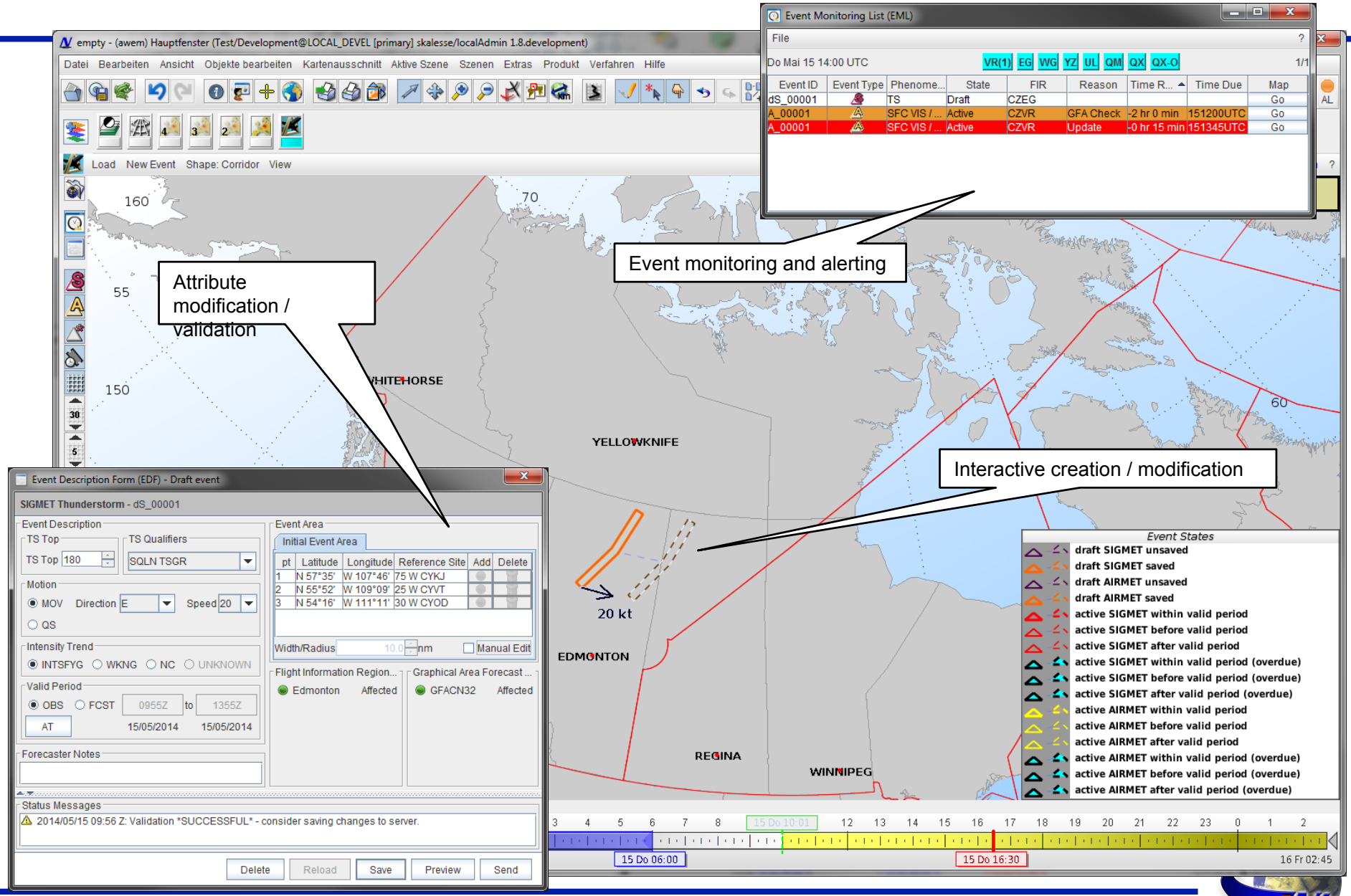
SED metobject are stored



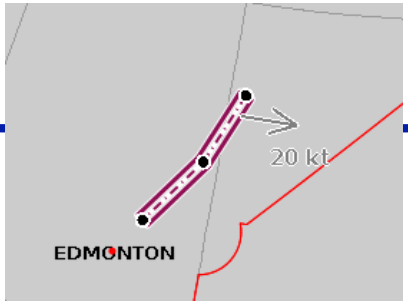


NinJo and IGE

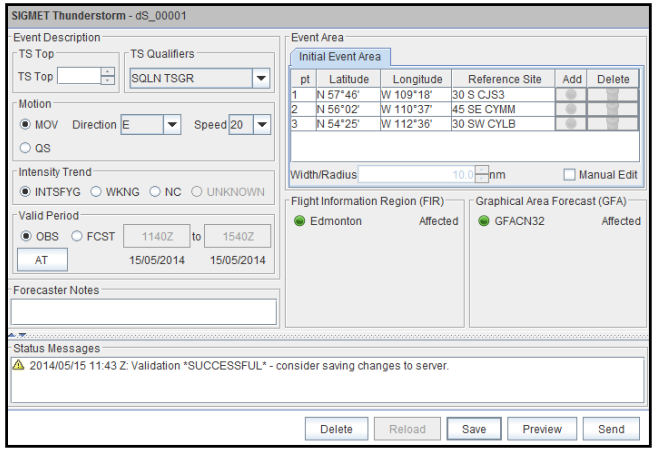
AWEM – Layer

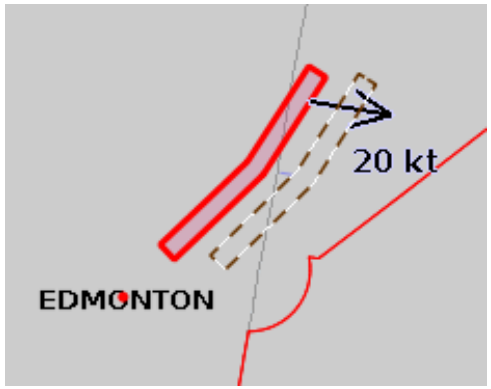

Event Monitoring List (EML)
Event monitoring and alerting
Attribute modification / validation
Interactive creation / modification
Event Description Form (EDF) - Draft event
SIGMET Thunderstorm - dS_00001
Event States
draft SIGMET unsaved
draft SIGMET saved
draft AIRMET unsaved
draft AIRMET saved
active SIGMET within valid period
active SIGMET before valid period
active SIGMET after valid period
active SIGMET within valid period (overdue)
active SIGMET before valid period (overdue)
active SIGMET after valid period (overdue)
active AIRMET within valid period
active AIRMET before valid period
active AIRMET after valid period
active AIRMET within valid period (overdue)
active AIRMET before valid period (overdue)
active AIRMET after valid period (overdue)
WHITEHORSE
YELLOWKNIFE
EDMONTON
REGINA
WINNIPEG
20 kt

AWEM – a typical scenario



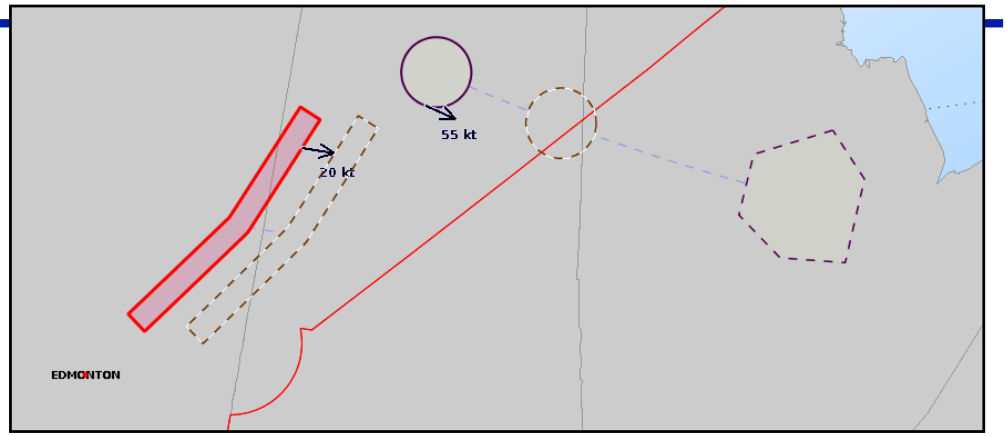
- Forecaster creates a new draft for a TS
  - » Manually or import from first-guess metobject
- Forecaster adds the defined attributes
- Forecaster saves the event
  - » A draft event version is saved and distributed to all other workstations
- Forecaster activates the event
  - » An active event version is saved and distributed to all other workstations
  - » Products get generated (Sigmet/Airmet warnings for all covered FIRs)
  - » AWEM starts monitoring the event





AWEM – a typical scenario

- Event is visually advected (“drifted”) by its defined motion or the position of a final event area



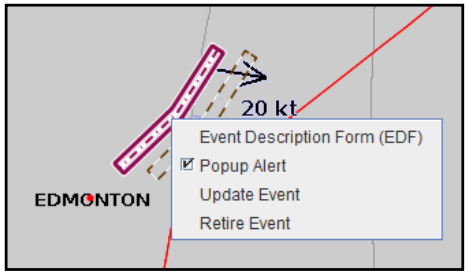
- Different monitoring rules currently implemented
  - » E.g. drifting: *“Defined motion drifts the event out of FIR CZEG within 20mins. Consider updating”*

File ?

Do Mai 15 11:49 UTC VR(1) EG(1) WG YZ UL QM QX QX-O 2/2

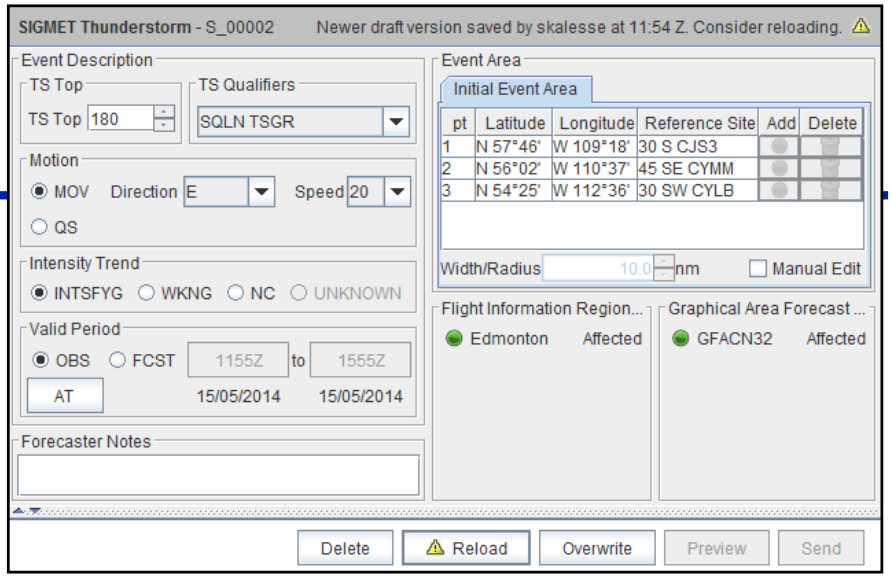
Event ID	Event Type	Phenome...	State	FIR	Reason	Time R...	Time Due	Map
A_00001		SFC VIS / ...	Active	CZVR	GFA Check	0 hr 11 min	151200UTC	Go
A_00001		SFC VIS / ...	Active	CZVR	Update	1 hr 56 min	151345UTC	Go
S_00002		TS	Active	CZEG	Update	3 hr 56 min	151545UTC	Go

- Forecaster updates the event
  - » Modifies shape, motion, attributes



- Forecaster saves intermediate draft event version
  - » Event version gets distributed to all other workstations

AWEM – a typical scenario



AWEM collaboration, allowing forecasters to share and edit draft event versions

- At CMAC AOR boundaries, forecasters will collaborate by sharing intermediate draft versions
- Forecaster publishes new active event version
  - » Cancellation products get generated for all FIRs that are not covered anymore
  - » Update products get generated for all still covered FIRs
  - » New products are generated for newly covered FIRs
- Once the phenomenon disappeared or moves out the Canadian AOR, the forecaster retires the event
  - » Cancellation products are sent for all covered FIRs

AWEM – Notes

- Forecasting workflow is event-based
  - » Forecaster updates his depiction of the weather
  - » Configurable list of phenomena with their met. attributes
  - » Forecaster does not create products
  - » AWEM doesn't even show any products
  - » Almost no ties to products (although we are not 100% there)
    - – Events still categorized SIGMET/AIRMET events
    - – Event shapes according to product requirements
    - – Monitoring rules exist for FIR boundary/coverage violations
    - – Latest version even includes a product preview (but will be eliminated in one of next versions)

AWEM – Notes

- For dissemination purposes the metobject is a product itself
  - » MOP == “Metobject product” := metobject + meta-data
  - » Metobject: purely meteorological information
  - » Meta-data: product identification and extra data
- SIGMET/AIRMET bulletins generated from the MOP
  - » Ideally outside of NinJo (optionally from within NinJo)

→ This really makes the workstation independent of the final products

  - → Generate graphical products (images) using NinJo batch
  - → Generate IWXXM, GML as input for external customers

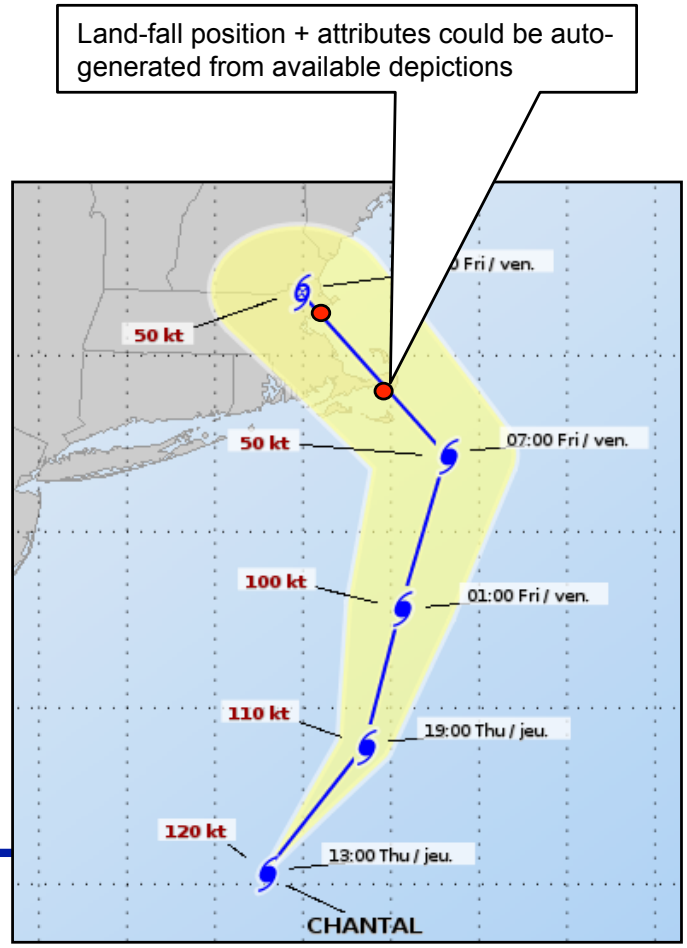
Advanced aspects

Conceptual changes:

- Event based forecasting could reduce responsibility of the forecaster from many products to one
  - » Define the metobject (or MOP) to be the one and only product the forecaster is responsible for (make him monitor that one)
  - » All other products are software generated. In the future software will need to be responsible for correctness
- Event based forecasting can improve quality of products
  - » Forecaster focusses on describing the weather, he doesn't create a great number of products
  - » E.g.: AWEM generates at least 5 products for each update in case the event covers two FIRs.
  - » Monitors one event instead of five products

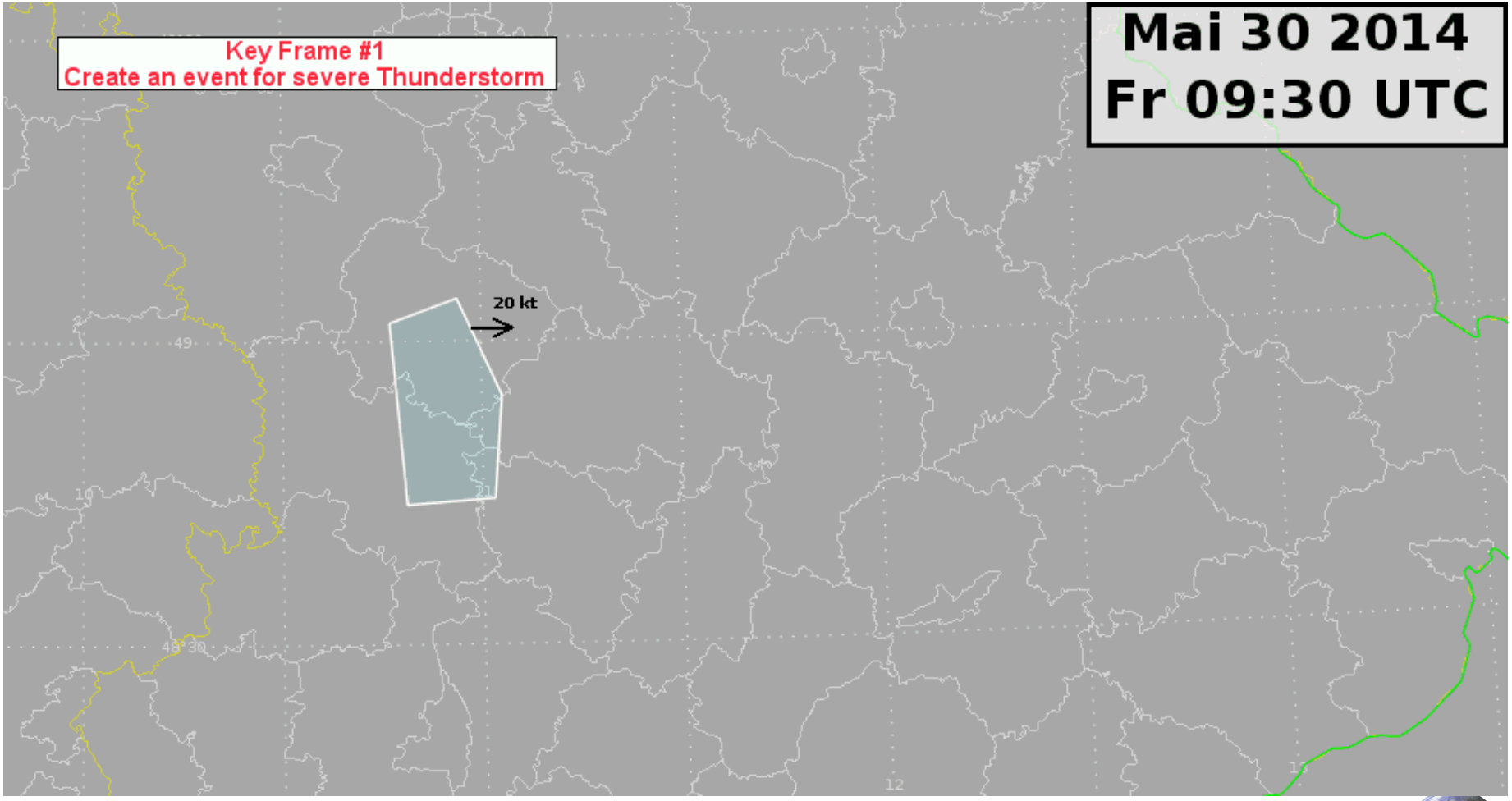
Advanced aspects

- Object-oriented meteorological depictions behave like key-frames
  - » Created and updated whenever there are significant changes
- Allows for inter-frame interpolation
  - » Apply shape morphing techniques
  - » Interpolate: Object shape, Object motion, Object attributes
- Auto-generate products
- Example: Hurricane track forecast
  - » From track forecast, interpolate land-fall
  - » Then auto-generate warnings



Key frames and automatic warning production

- Severe thunderstorm event moves over Bavaria



Conclusion

- Observation:
  - » Event-based forecasting is not so much a technical novelty
  - » It is a gigantic conceptual change in the forecasting workflow
- Challenges:
  - » How do we (re-) define responsibilities for forecasters and it systems
  - » How to coordinate collaboration between services …
    - – … when presently we don't even collaborate within the services
    - – … when responsibilities don't cross borders even though weather usually does?

Conclusion – Benefits

- Stream-lined forecaster workflow:
  - » create, save, send, update, retire
  - » Forecaster works on weather not products
- Workflow is product independent
- Products to be auto-generated
  - » Software takes over product responsibility
- Objects to be re-used for different use-cases and products
- Object-based collaboration, post-processing, archiving built-in
  - » Why do we have to share pngs when we can share objects!