

Turbulence Mitigation Workshop IV, 8 - 10 November 2021

The Use of EDR Data in Flight Planning for Turbulence Avoidance



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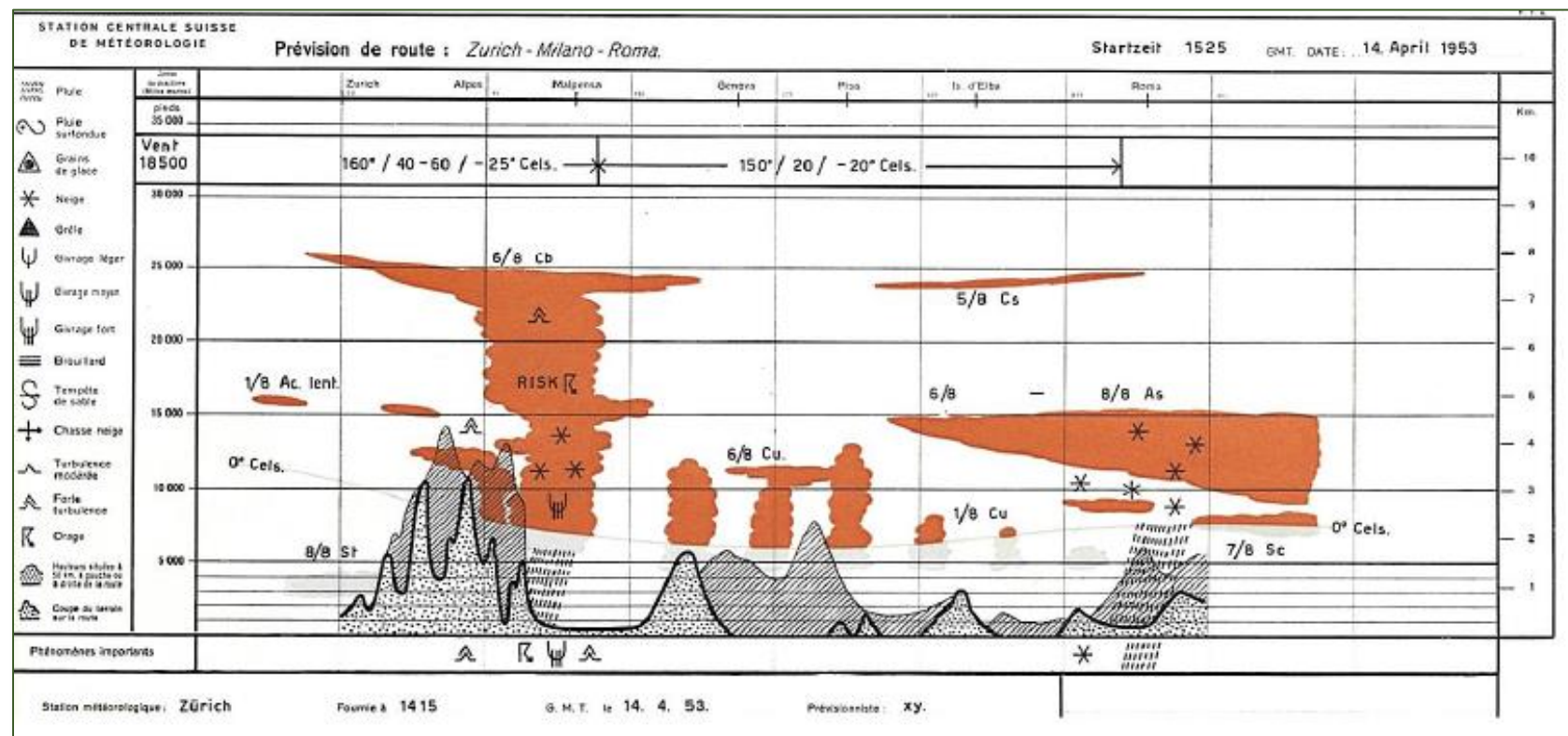


Turbulence Avoidance: Yesterday

Weather information used in 1953



Flight weather service at Zurich Airport, maps drawn for every flight.

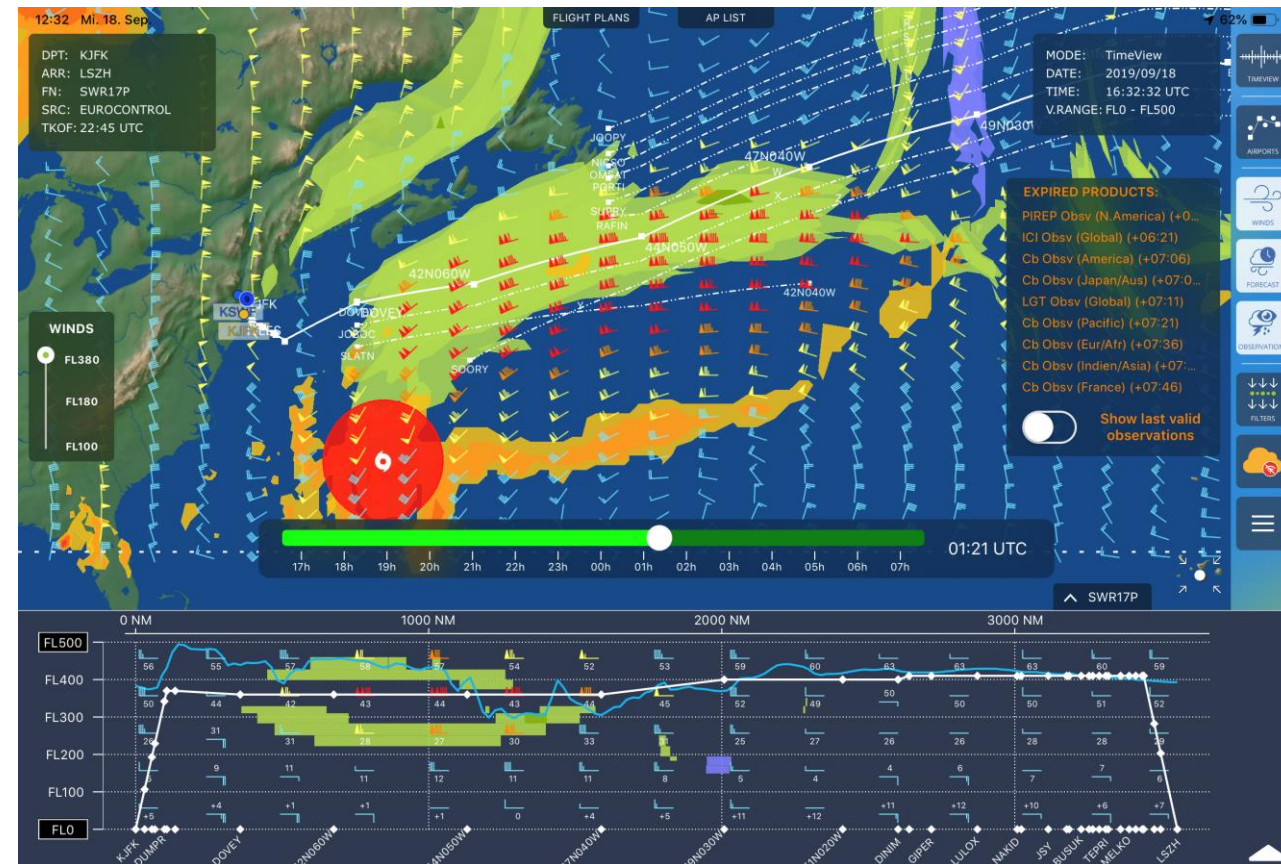
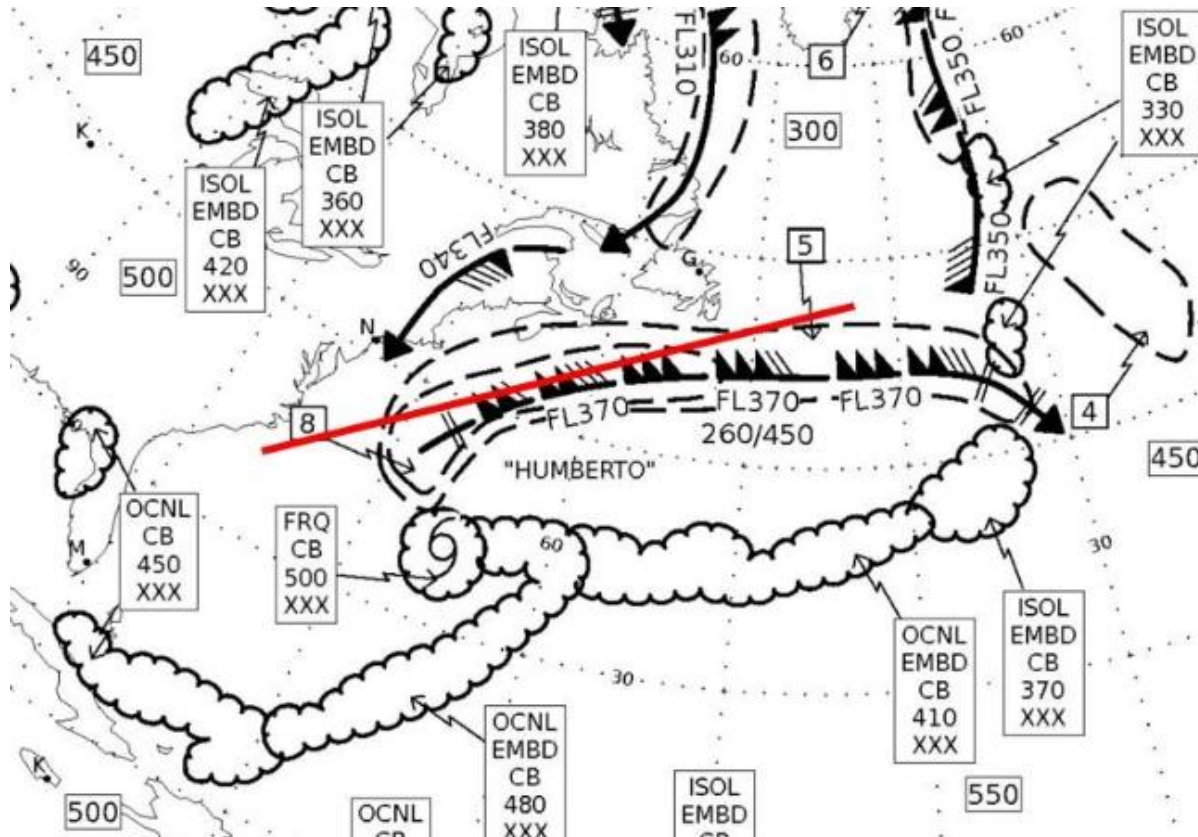


Source: Direktion der Öffentlichen Bauten des Kantons Zürich – Bericht 'Interkontinentaler Flughafen Zürich', 1953

Turbulence Avoidance: Tomorrow

Finding the smooth flight: example from SWISS flight MIA-ZRH, 18 Sep 2019

B/W Significant Weather Chart versus inflight weather with hi-res turbulence forecast



Source: Fabian Fusina, Pilot Swiss Airlines / SITA eWAS Flight Weather App with Météo France Forecast.

Turbulence Avoidance: Real-Time Measurement

How to improve the turbulence forecasts: validation with objective observation data

Yesterday: PIREP

"If you can still drink your coffee, it's light turbulence."



→ subjective, aircraft-dependent

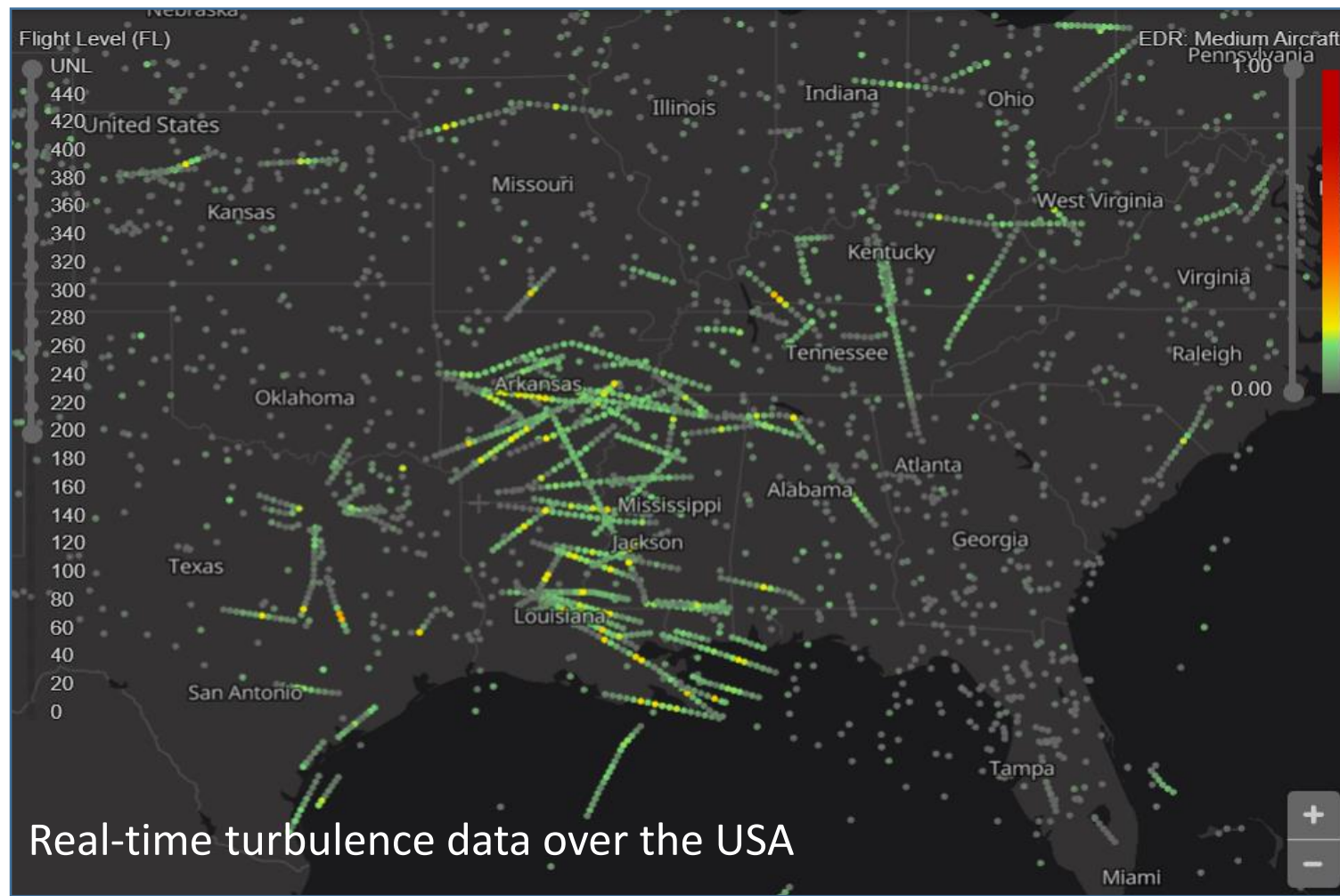
Now: Automated turbulence reports



→ objective, aircraft-independent

Turbulence Avoidance: Global Data Sharing

Real-time data exchange with IATA Turbulence Aware Platform

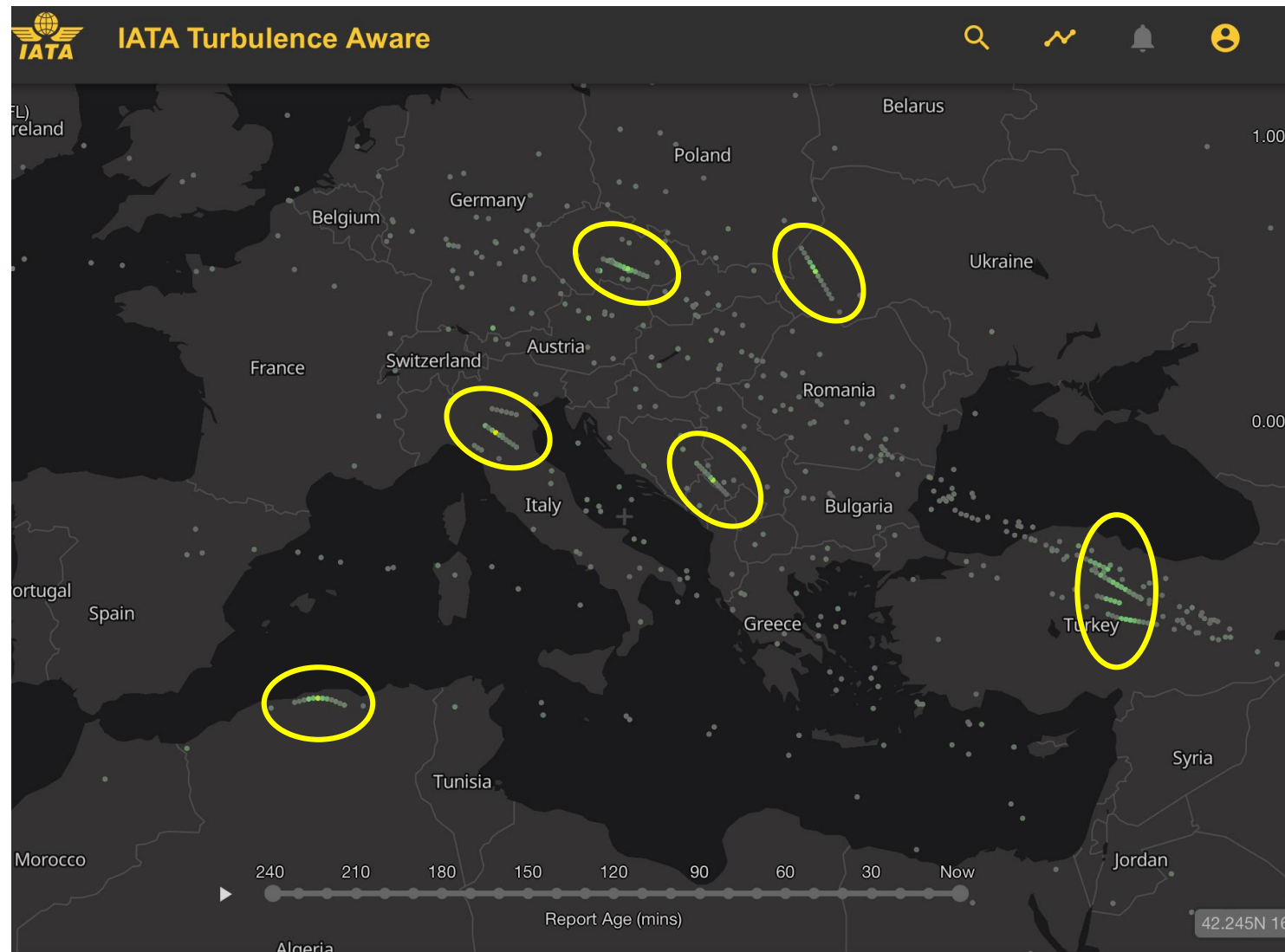


Airlines Involved

EDR Data and Turbulence Forecast Models

Example: 3 NOV 2021, 18:30 UTC – EDR Data (4 hour frame) versus DWD EDP Model

All data filtered for
FL300-420

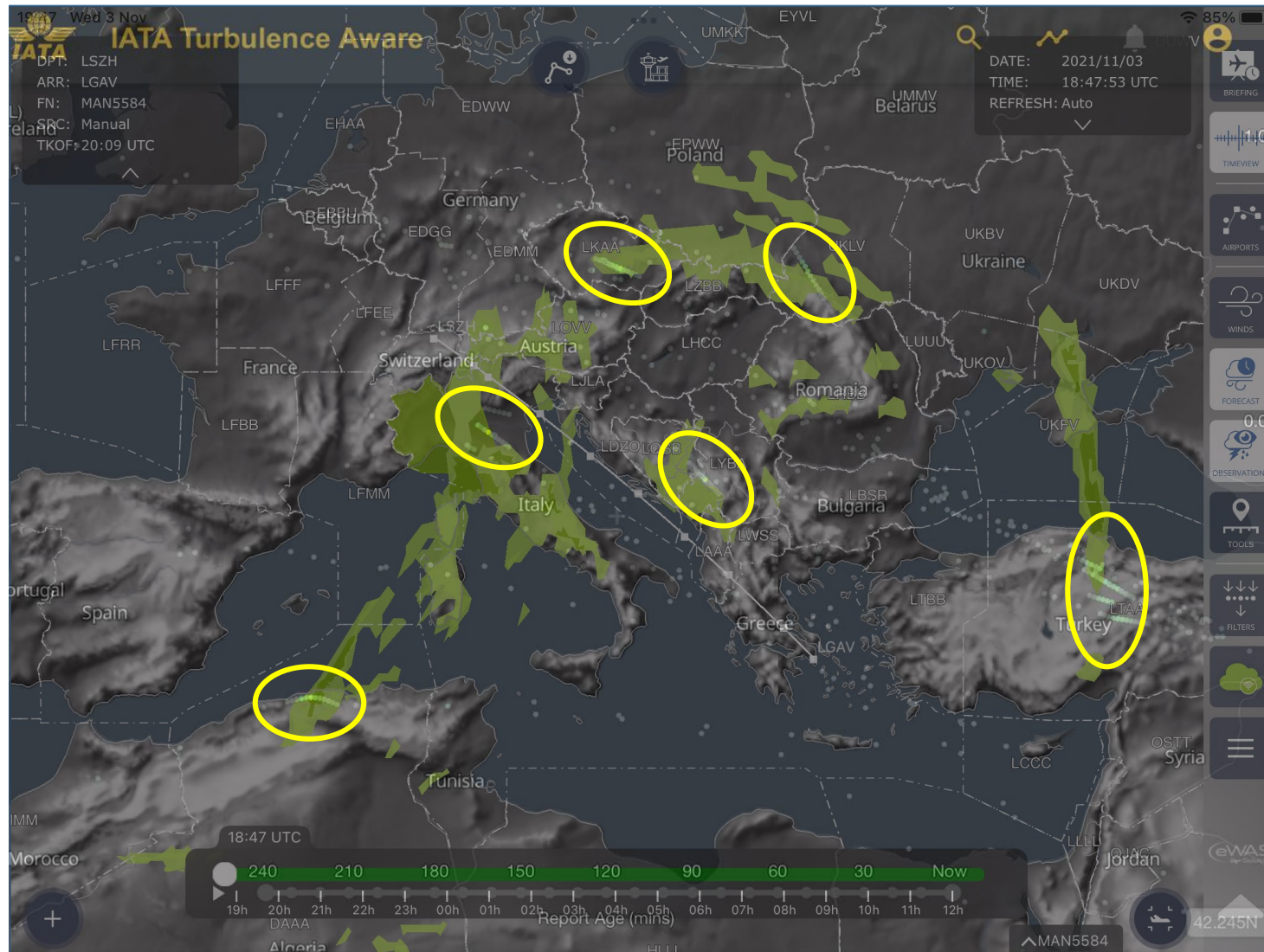


Display of EDR in
IATA Turbulence
Aware

EDR Data and Turbulence Forecast Models

Example: 3 NOV 2021, 18:30 UTC – EDR Data (4 hour frame) versus DWD EDP Model

All data filtered for
FL300-420

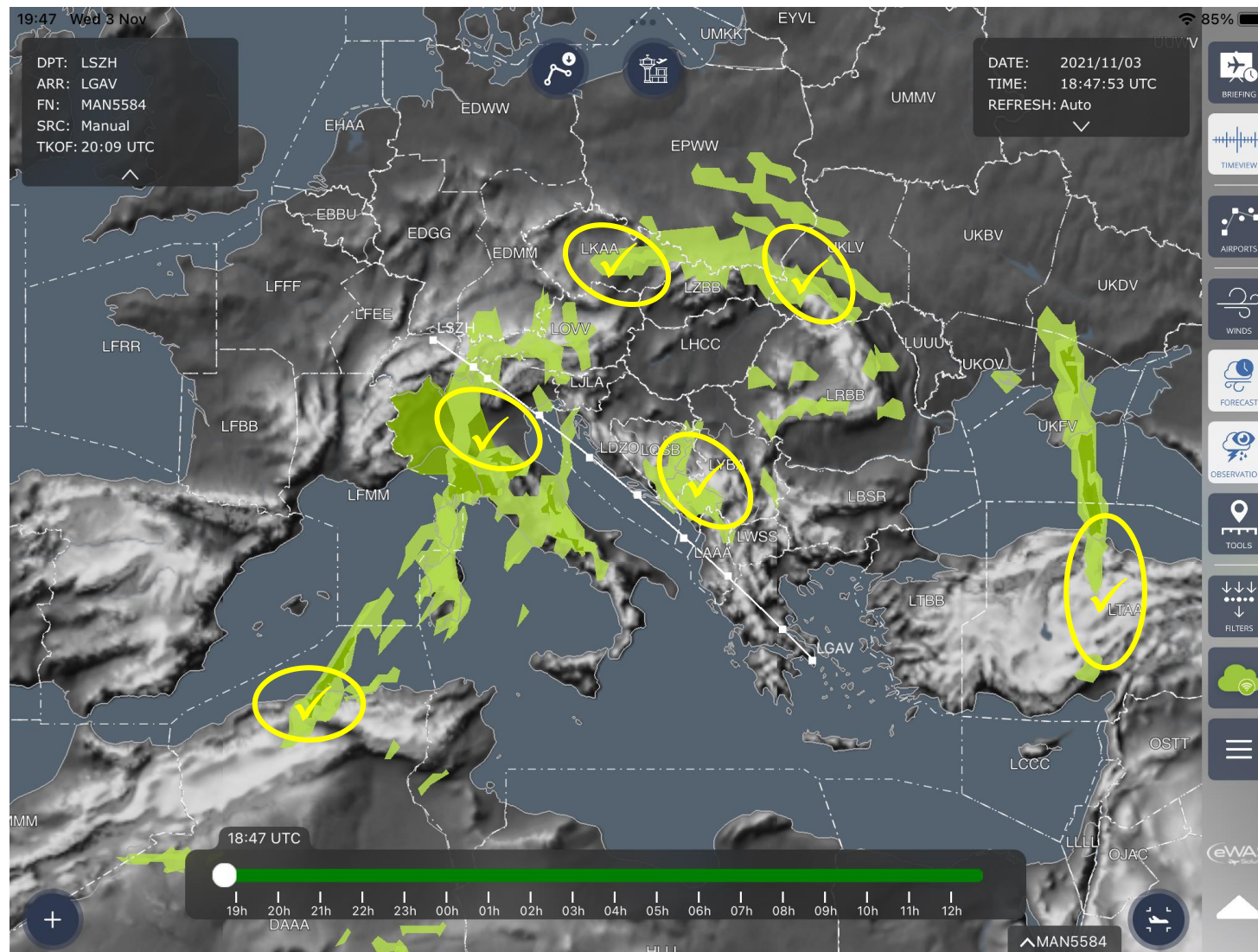


Display of DWD Turbulence Forecast in SITA eWAS

EDR Data and Turbulence Forecast Models

Example: 3 NOV 2021, 18:30 UTC – EDR Data (4 hour frame) versus DWD EDP Model

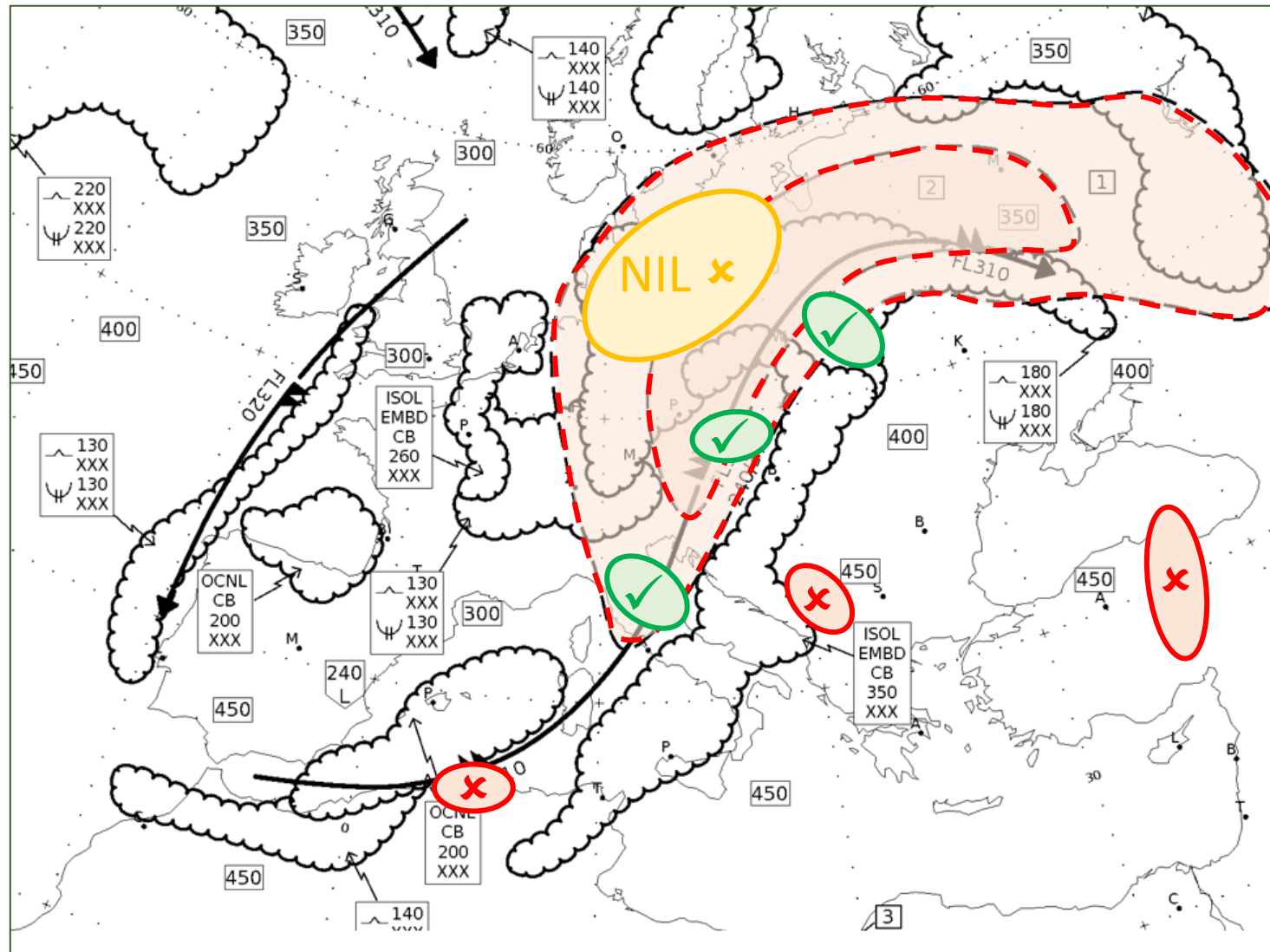
All data filtered for
FL300-420



Display of DWD
Turbulence Forecast
in SITA eWAS

EDR Data and Turbulence Forecast Models

Example: 3 NOV 2021, 18:30 UTC – EDR Data (4 hour frame) versus SWC

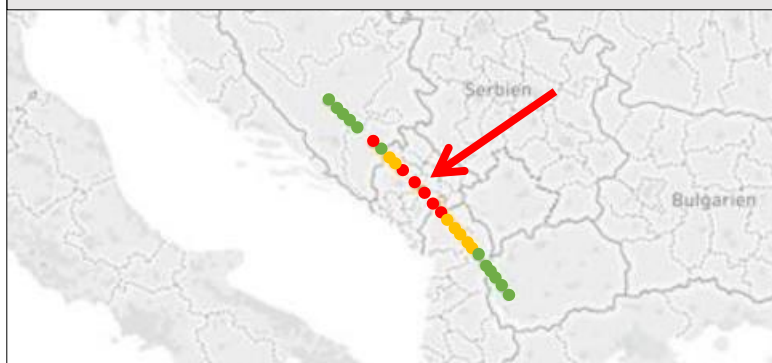


Turbulence Avoidance: Case Study

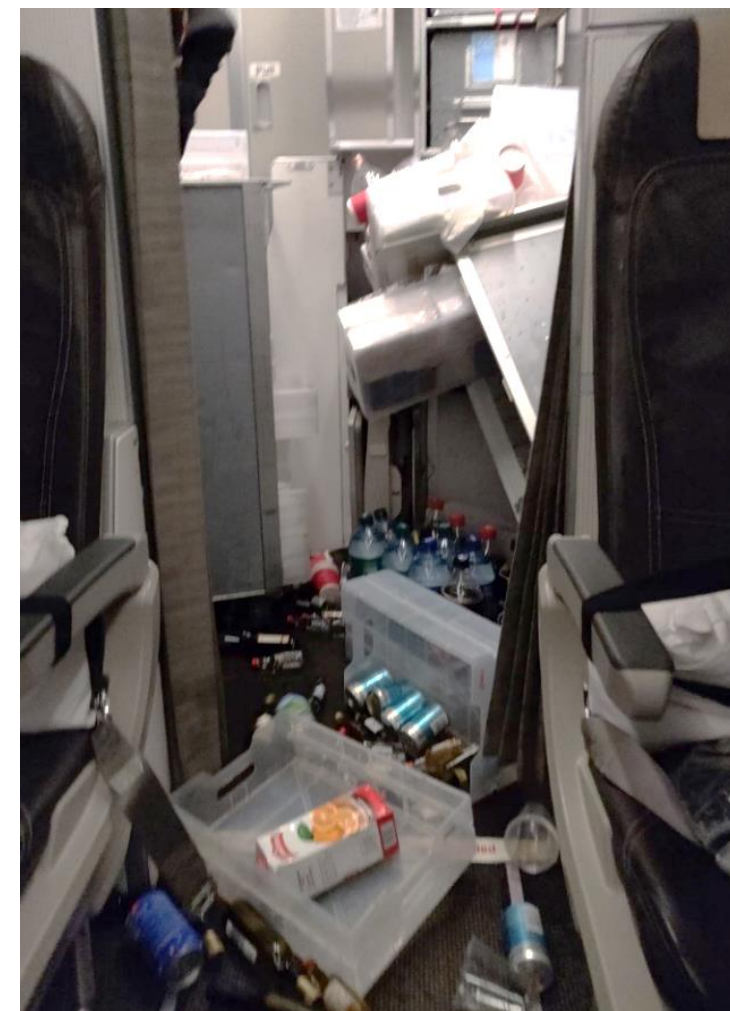
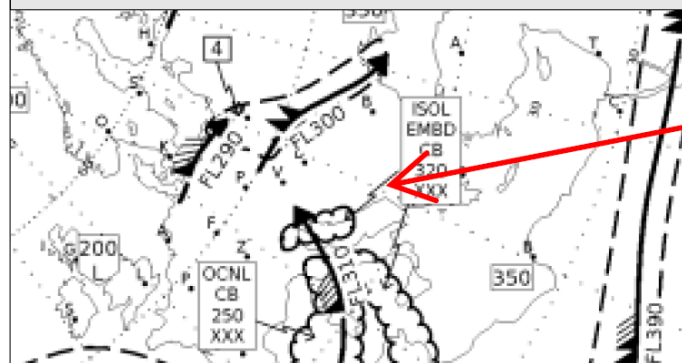
Example: SWC versus Numerical Turbulence Forecast, 3 March 2020

Pilot report: «During Cruise after about 1.20 hour flight time with occasional light turbulence [...] there has been no turbulence for the last 10 min. Also **no entries in the SWC** for the further routing. Suddenly we encountered moderate to severe turbulence with some really heavy bumps.»

Measured EDR Data A320



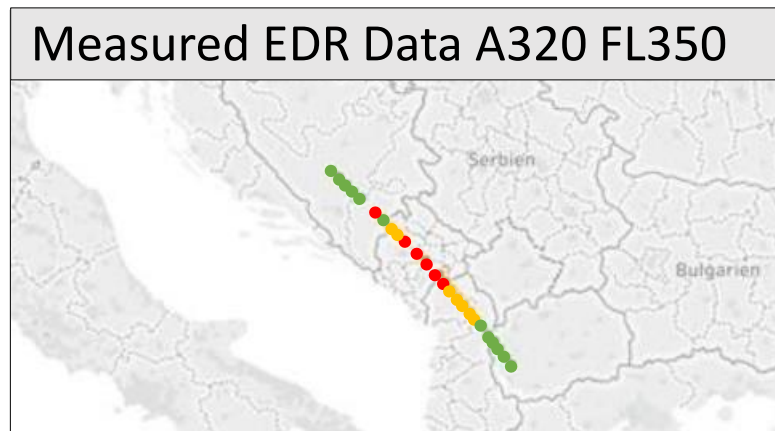
Significant Weather Chart



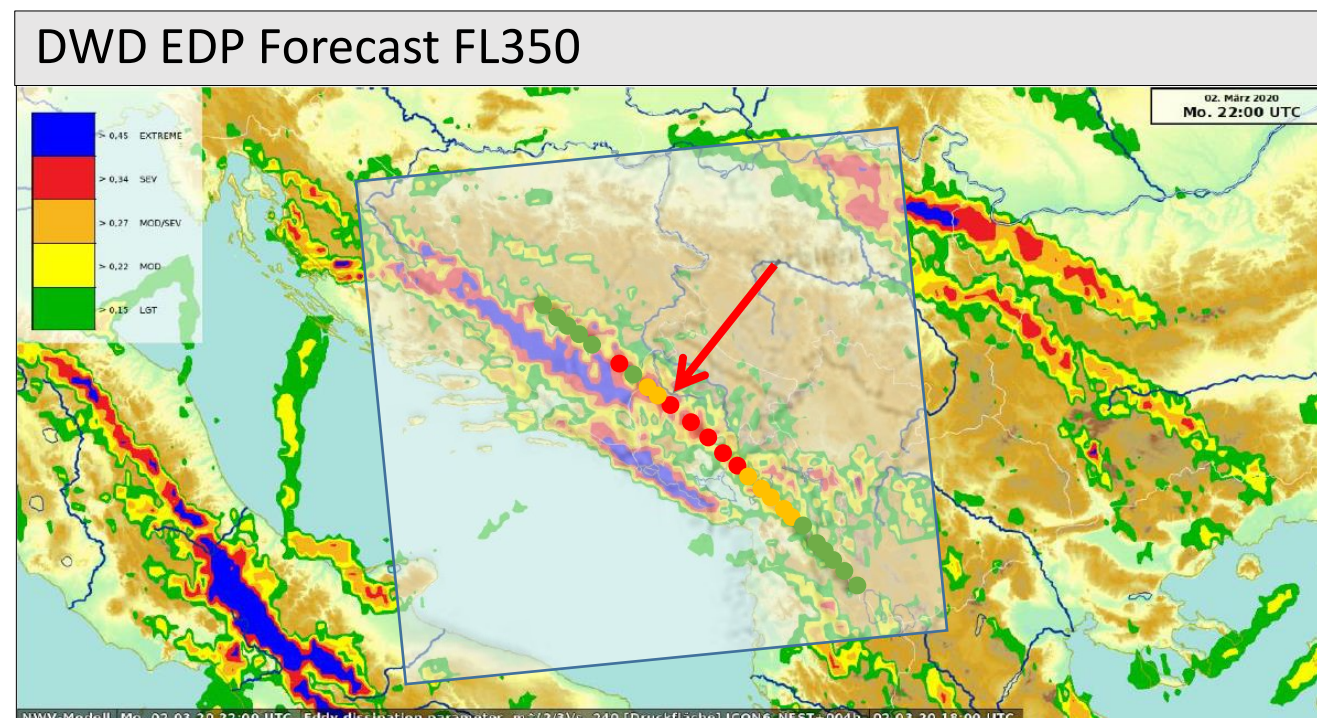
Turbulence Avoidance: Case Study

Example: SWC versus Numerical Turbulence Forecast, 3 March 2020

Could have been avoided by using EDP forecast!



EDR measurement



EDP forecast

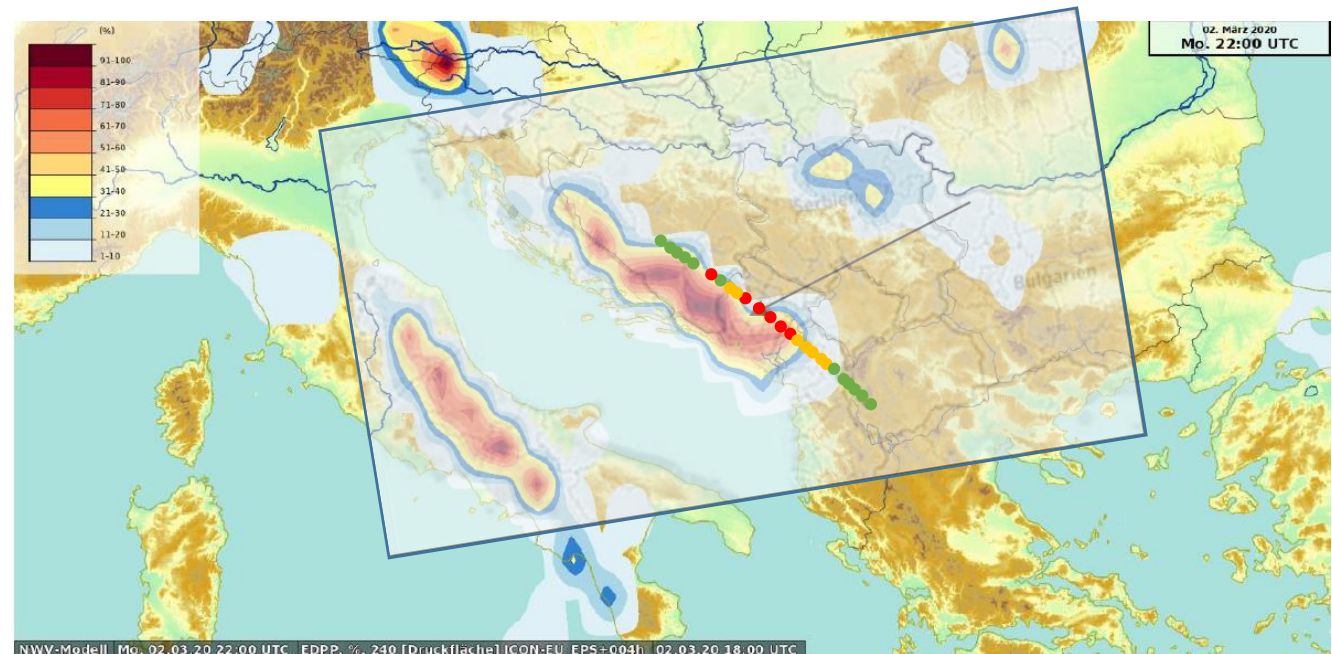


Deterministic vs. Probabilistic Turbulence Models

Example: SWC versus Numerical Turbulence Forecast, 3 March 2020

Probabilistic Models: The perfect turbulence forecast for flight planning?

- **EDPP** from DWD: probability prediction for EDP exceeding severe threshold (ICAO SEV: EDR>0.45 for medium a/c)
- Easy interpretation from pilots point of view
- **Probabilistic Forecast** e.g. for flight planning (strategical) **versus** **Turbulence Nowcast** (tactical) for inflight mitigation...?



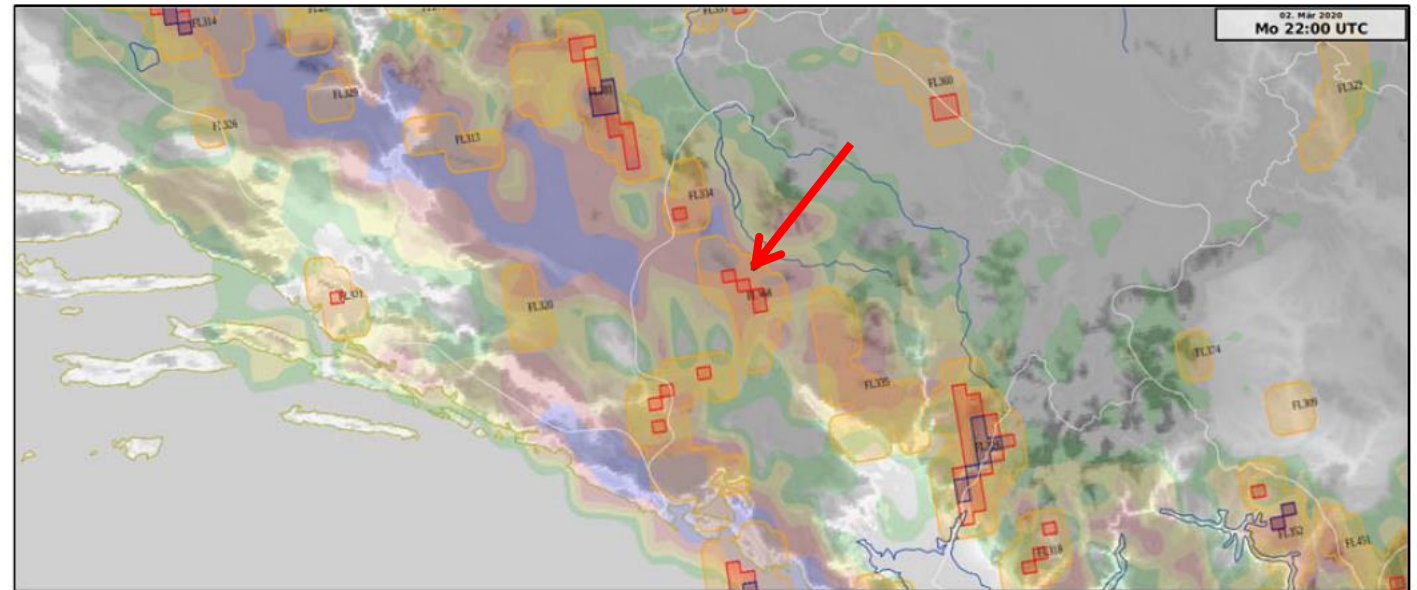
Source: DWD, Probabilistic EDP.

Outlook: Turbulence Nowcast (NC-Turb)

Example: SWC versus Numerical Turbulence Forecast, 3 March 2020

Merging EDR- and Satellite-Observation with Turbulence Prediction

- Turbulence Nowcast is calculated with satellite data, and shifted forward in time using motion based on optical flow estimates and atmospheric motion vector.
- NC-Turb: 2 March 2020 22:00 UTC
Red arrow →: A320 SEV EDR FL370
Red squares □: NC-Turb SEV EDP
Transparent: EDP Forecast FL350



Source: Axel Barleben, Stéphane Haussler, Richard Müller and Matthias Jerg. A Novel Approach for Satellite-Based Turbulence Nowcasting for Aviation. Remote Sensing 14 July 2020.

Turbulence mitigation from preflight to inflight

Requirements depending on phase of flight operation

Preflight

- Large bandwidth for data
- Cabin service planning
- General synoptic: **Probabilistic Forecast**



Inflight

- Limited bandwidth
- Tactical turbulence mitigation
- High data accuracy required:
Turbulence Nowcast



Thank you!

