

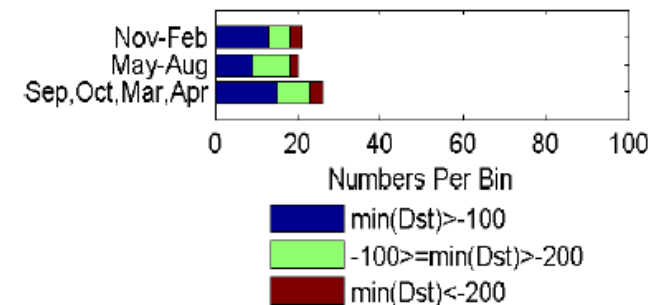
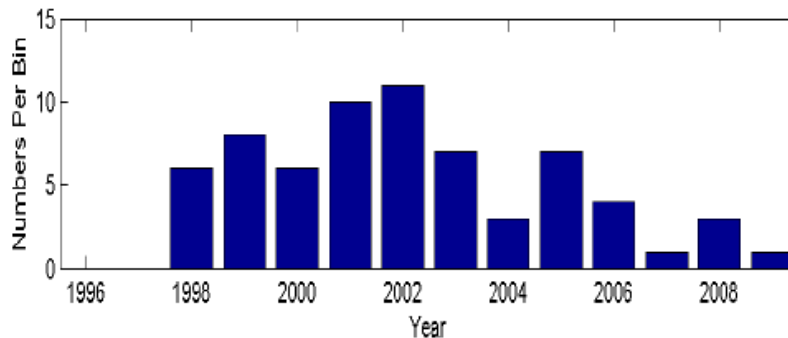
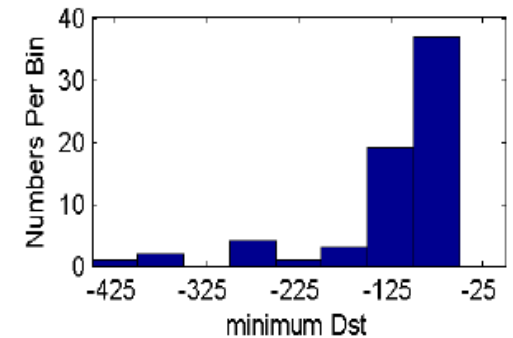
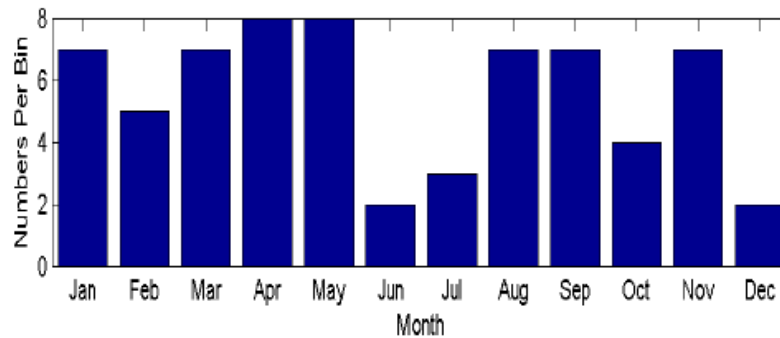
Forecast of Total Electron Content over Europe for disturbed ionospheric conditions

Presentation by Jens Berdermann





Storm sample selection



Used Sample:

- 67 selected geomagnetic storms in the period from 1995-2009 depending on season and year

- Classified due to their minimum in Dst

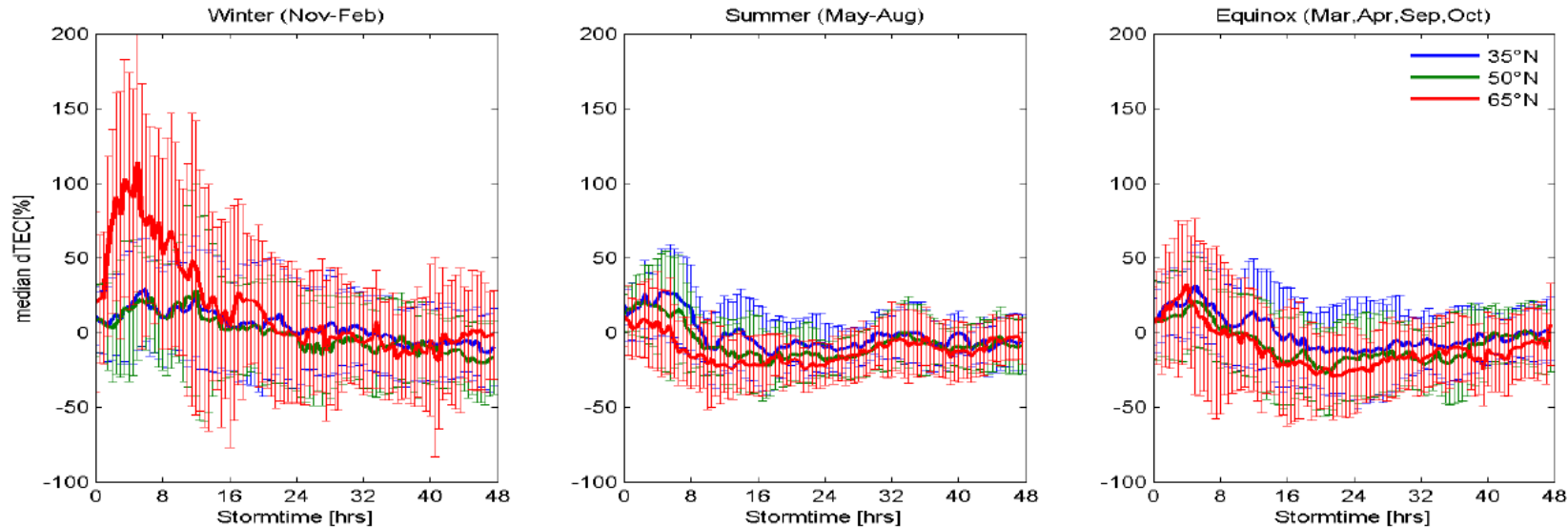
Selection criteria:

- Only single event, nominal ionosphere before (quiet conditions)





Mean storm characteristics



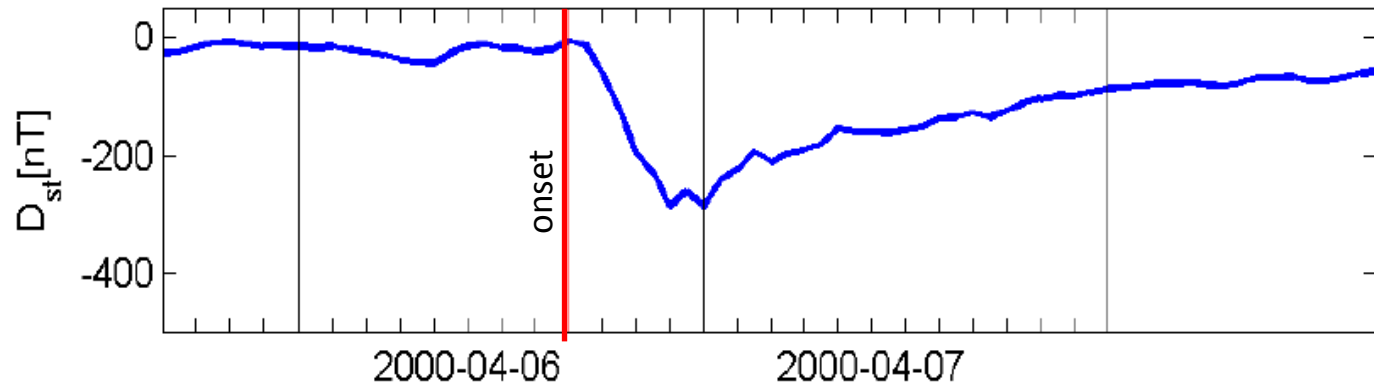
Superposition of median dTEC for storm samples depending on season, stormtime and latitude

- Quite different storm pattern in Europe depending on stormtime, season and latitude





Storm onset definition



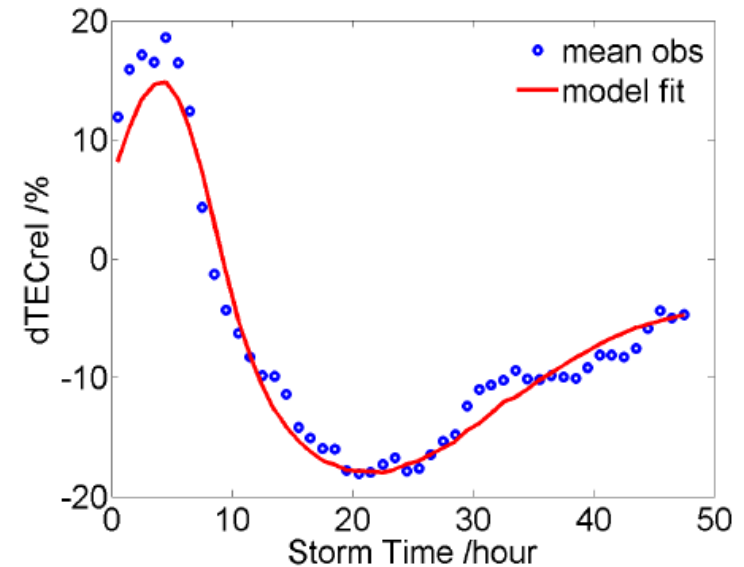
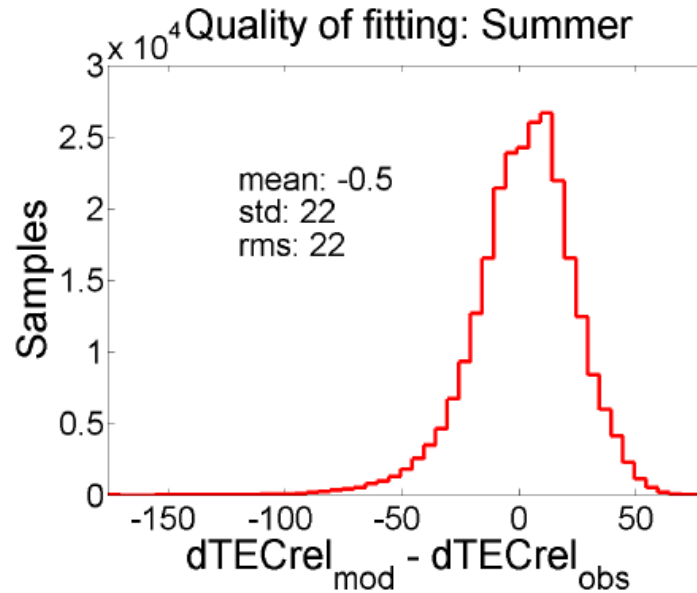
Example for onset definition using the Dst index.

1. Local maximum exceeds a threshold value (e.g. $\Delta D_{st}/\Delta t_{ons} > 4 \text{ nT/1h}$)
2. Check if Dst value falls below another threshold 3h later (e.g. $D_{st} < -40 \text{ nT}$)
→ Dst forecast module GMA_FC (Aleksei Parnowski)
3. The initial strength of the storm is characterised by this second threshold
4. Second check nowcast Dst values





TEC storm model



- If a storm onset has been identified the storm model will be added to an useful reference value representing the average behaviour of TEC at a given location and time (e.g. 27 days medians)

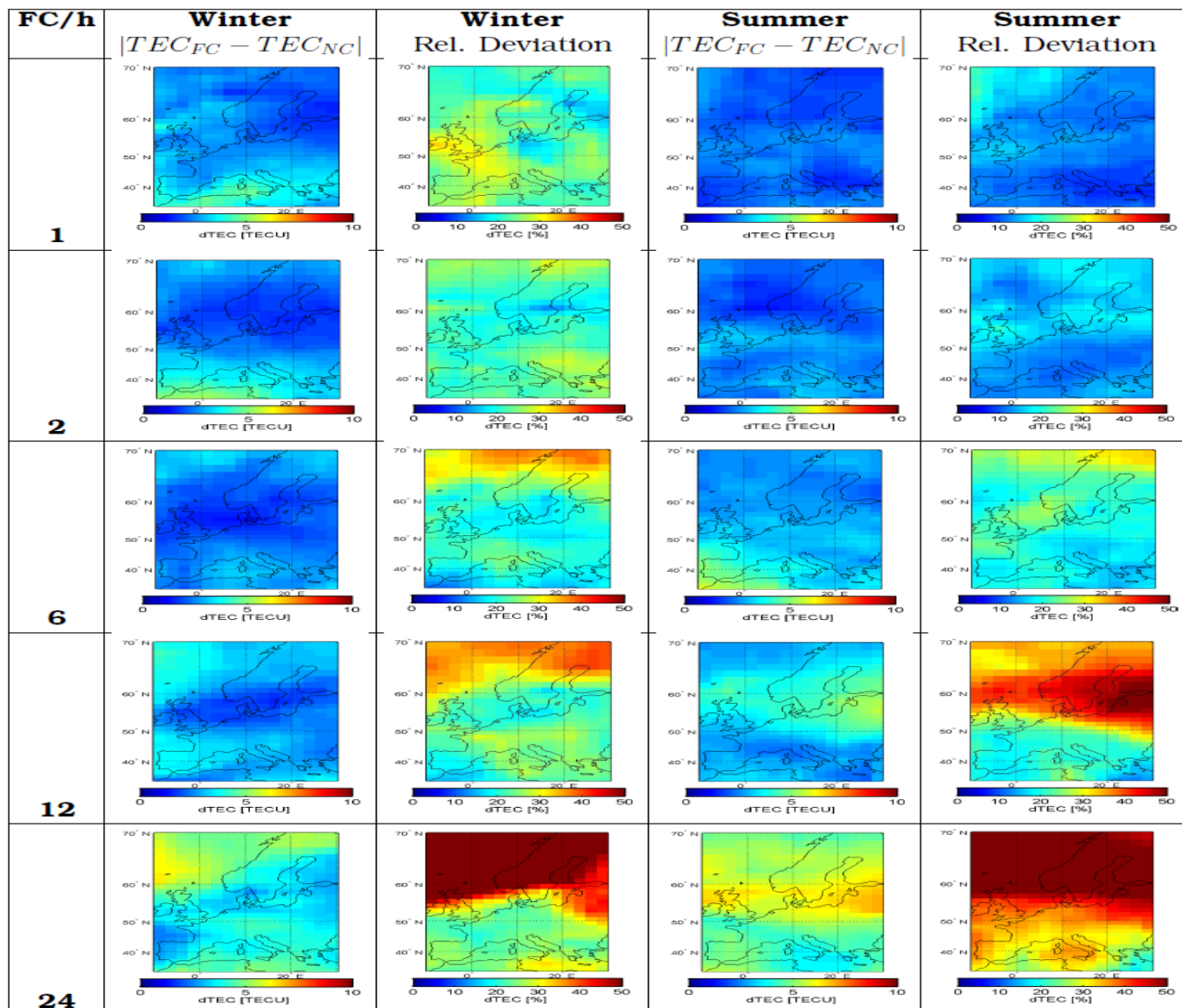
$$TEC_{SM} = TEC_{ave} + TEC_s$$

- TEC storm model depends on stormtime, local time, season, geomagnetic latitude and storm power (coefficients are derived via a least squares fitting)
- TEC_s is a function of the storm time beginning with the storm onset, which is measured in universal time (UT)





TEC/TECU	L1/m
0	0
10	1,62
20	3,24
30	4,86
40	6,48
50	8,10
60	9,72
70	11,34
80	12,96

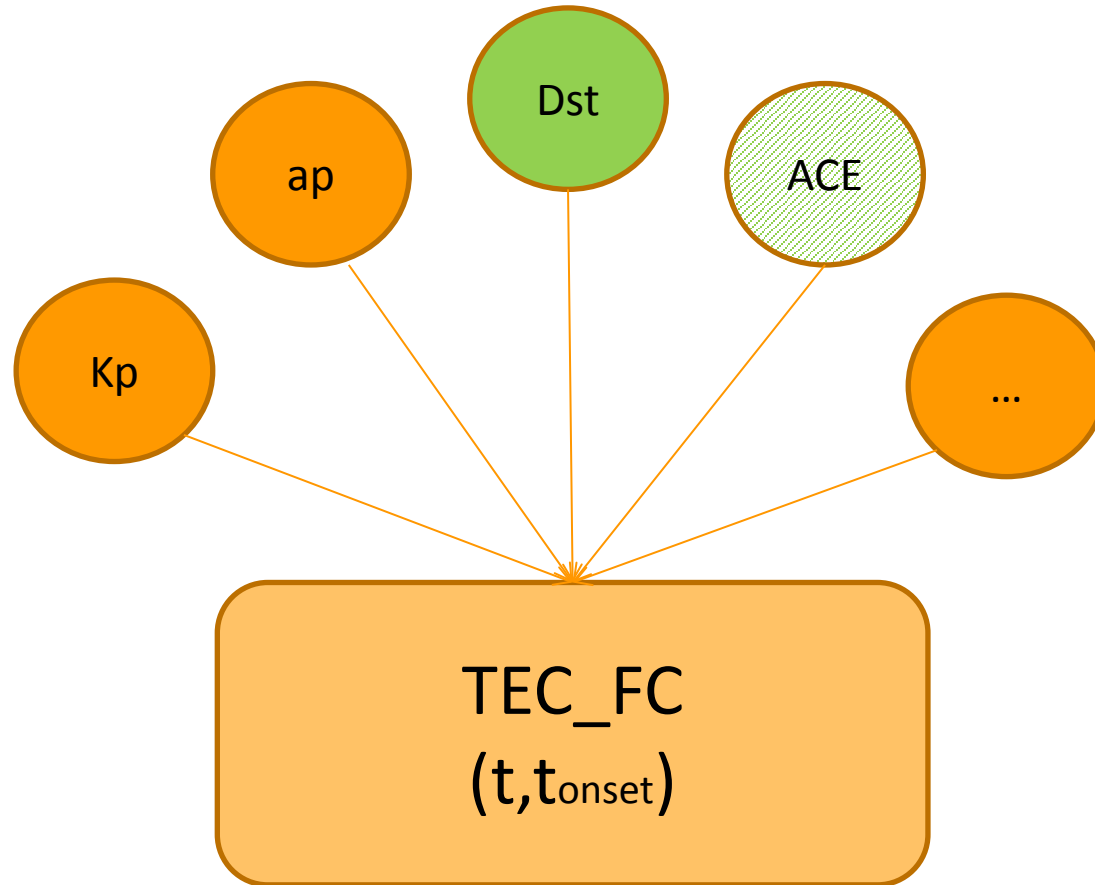


The results indicate range errors less than 1.5m on L1 GNSS frequency in average for predictions up to 24 hours in advance





Software module TEC_FC



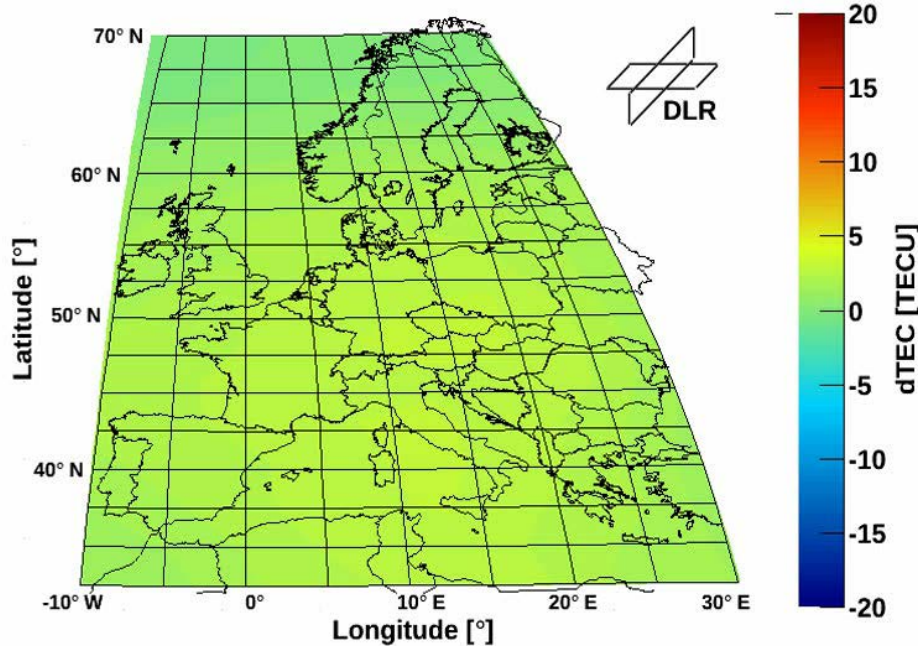


Storm examples

14.12.2006

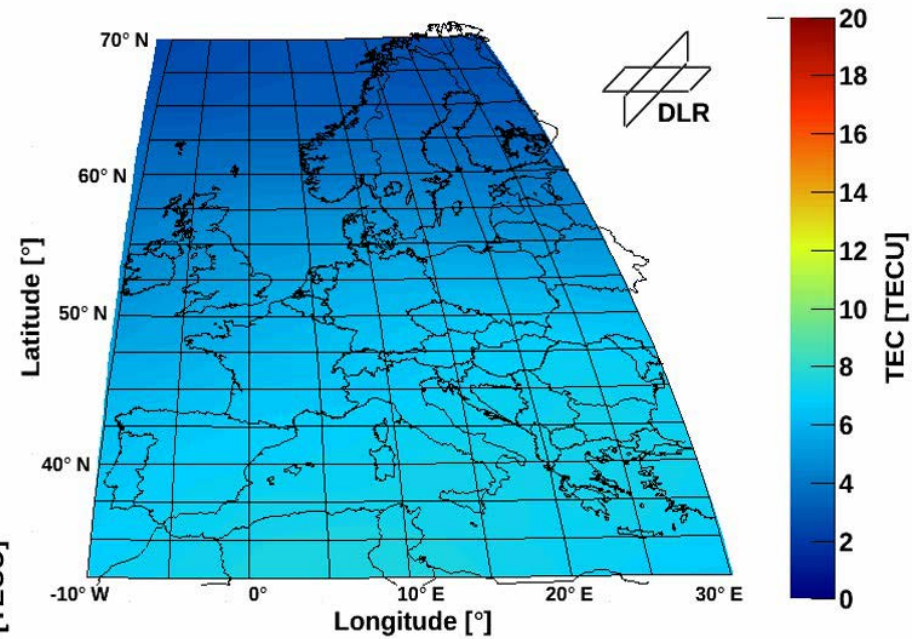
TEC forecast (60min) - TEC nowcast

14-Dec-2006 01:00:00 UT



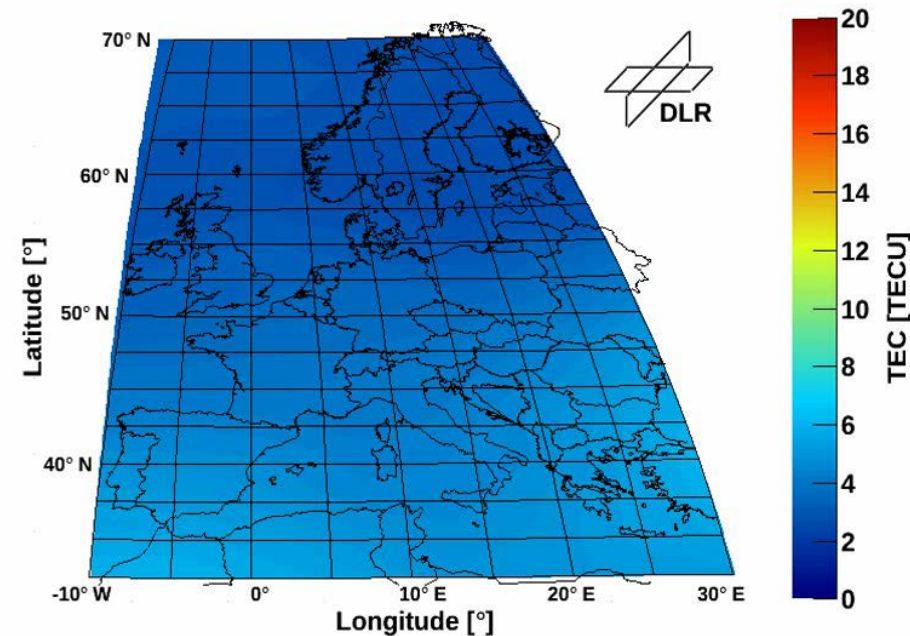
TEC forecast 60min

14-Dec-2006 01:00:00 UT



TEC nowcast

14-Dec-2006 01:00:00 UT



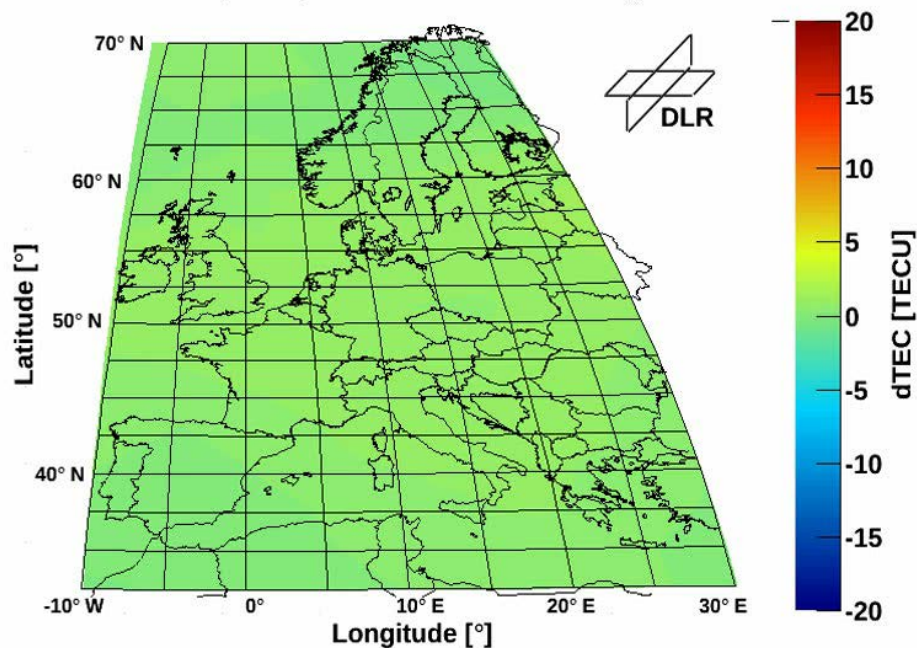


Storm examples

24.08.2005

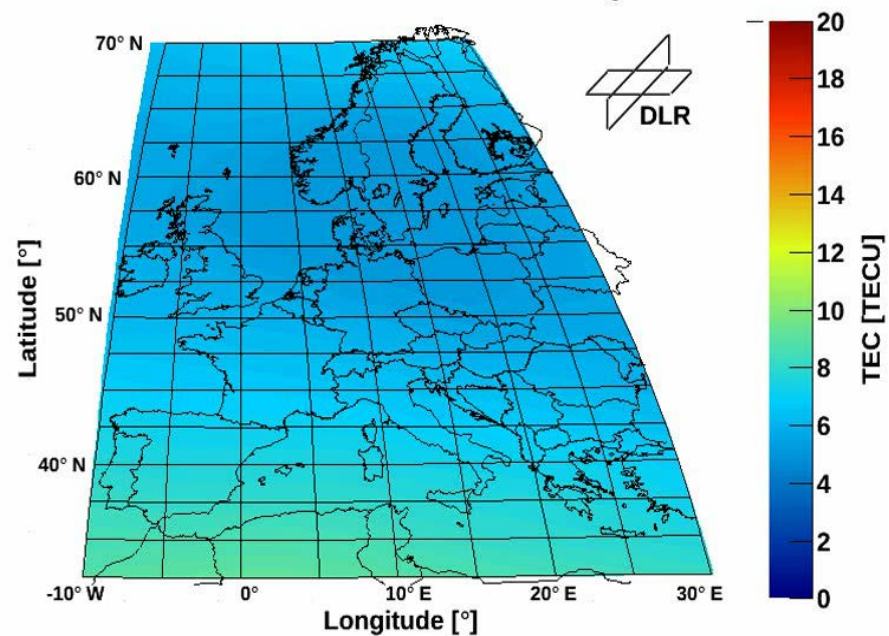
TEC forecast (60min) - TEC nowcast

24-Aug-2005 01:00:00 UT



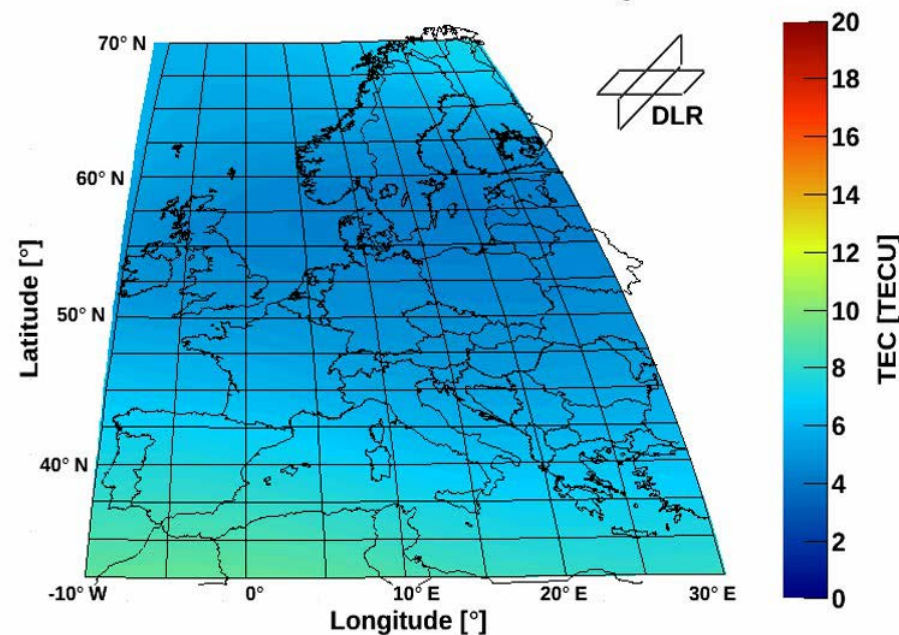
TEC forecast 60min

24-Aug-2005 01:00:00 UT



TEC nowcast

24-Aug-2005 01:00:00 UT





Summary/Conclusion

- A software tool has been developed, which computes the forecast of TEC up to 24 hours in advance taking into account perturbations due to space weather events.
- A prototype, to demonstrate its capabilities, has already been implemented.
- Complete Integration into the FSI until end of April
- The recent results indicate range errors less than 1.5m on L1 GNSS frequency in average for predictions up to 24 hours in advance.





Thanks for your attention!

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