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SUBJECT	**Geophysical and Solar Data Broadcast Beacons DK0WCY and DRA5 – INFORMATION PAPER**		
Society	**DARC**	**Country:**	**Germany**
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Geophysical and Solar Data Broadcast from DK0WCY and DRA5

Optimum use of HF propagation remains to be an issue between knowledge, experience and a bit of luck. Propagation predictions are only accurate when talking about a trend but cannot tell with sufficient reliability how the bands will perform in 24 or 48 hours from now – and the chances for short-term improvements are little as ionosphere physics is not a top ranked science issue.

It is therefore of great importance to DXers to be able to instantly check conditions using beacons and marker stations. This gives a picture of the current situation; in order to extend it to the hours to come it is necessary to complement it with data from solar and geophysical observations. So what lies nearer than using the HF bands to spread this news among radio amateurs and other interested parties? And to give a listener a chance to copy the information without the need for computer machinery? This way closing the gap between researchers and users of HF bands to the benefit of radio amateurs is the driving force behind the DK0WCY beacon project.

DK0WCY made its first transmission in 1983 as a shortwave beacon with the additional designation to alert amateurs when VHF aurora qso opportunities arise. Around the same time the French stations FTK77, FTN87 and FTH42 ceased the broadcast of solar and geomagnetic data, compiled by the *Observatoire de Meudon*, leaving European radio amateurs without a source for those data.

Favourable circumstances allowed the DK0WCY team to develop and operate a computer based system which retrieved relevant data via telephone lines from a German Research Center (later from *Space Environment Center* Boulder/Colorado) and to distribute the information on shortwave using Morse code.

The beacon broadcast started on the frequency of 10144 kHz which is still in use. Later it turned out that the skip was unfavourable for listeners in the northern part of Germany (DK0WCY is located in JO44VQ, about 25 km south of the Danish-German border). A parallel transmission on a lower band was desirable and so a permission was requested and granted to operate a transmitter on the 80m band (now on 3579 kHz). As this band is in heavy use by radio amateurs and moreover must be shared with other services transmissions are restricted to a few hours around local sunrise and sunset.

Stations located less than 1000 km from the beacon were still handicapped, mostly during periods of low solar activity, as the skip zone swallows the 30m beacon signal most of the time. Computer simulations showed that an additional transmission around 5 MHz could improve the situation. Unfortunately the German radio amateur rules do not allow for a special permit to operate on a frequency outside of the allocated amateur radio bands. However, the German administration allowed the group of radio amateurs around DK0WCY to operate a station of the Fixed Service using the callsign DRA5 and assigned the frequency of 5195 kHz.

Since the start of the DK0WCY project in 1983 the service was improved and extended step by step:

- RTTY and PSK31 modes were added making it possible to broadcast more data and to extend the user group to people which do not understand morse code.
- Every hour a short data telegram is sent to the DX-cluster node network (try show/wcy).
- A homebrew magnetometer provides information on the current geomagnetic conditions.
- A VHF receiver is used to permanently monitor the frequency of the beacon SK4MPI which serves as an aurora indicator – as soon as the typical “aurora sound” is detected DK0WCY and DRA5 start to transmit a special alert notice.

An agreement was reached that real-time ionospheric data (e.g. MUF - maximum usable frequency), measured by a German ionosounder in Juliusruh may be included in our transmissions.

Meanwhile we learned that not only radio amateurs benefit from DK0WCY/DRA5 – there are also operators of other radio services which are interested in the data.

February, 2005 Ulrich Mueller, DK4VW

ANNEX 1: DK0WCY

ANNEX 2: DRA5

DK0WCY -- 10144 kHz and 3579 kHz
A beacon station for solar, ionospheric, geomagnetic data and aurora alert

80-m-band	3579 kHz, output 30 watts into dipole antenna
Time	6.30-8 UTC and 15-18 UTC
30-m-band	10144 kHz, output 30 watts into dipole antenna
Time	24 hours

Normal loop:	DK0WCY BEACON _____		(carrier)
During Aurora:	DK0WCY BEACON	AURORA	(dots)
	DK0WCY BEACON	STRONG AURORA	(dots)

Transmitted data

Below is a sample text as transmitted in CW mode (for sample for other modes see DRA5)

```
INFO 12 FEB 0900 UTC   KIEL k   2   2  =   NEXT EXPECTED KIEL K   5   5
FORECASTS 12 FEB   SUNACT  ERUPTIVE  MAGFIELD  QUIET =
11 FEB  R  73   73  FLUX  114    114   BOULDER A  11   11 =
11 FEB  KIEL A  13   13   AR
```

Remark: NEXT EXPECTED KIEL K n n
will be transmitted only if, according to current measurements, the next 3-hour KIEL K figure will be 5 or more.

Explanations

Date, Time	**time of measurement (end of previous 3 hour period of „k“-measurement)**
KIEL k	index k of geomagnetic field, measured at beacon
FLUX	solar flux at 10 cm wavelength, measured at Penticton, Canada
BOULDER A	index A of the geomagnetic field, measured at Boulder/Colorado
KIEL A	index A of the geomagnetic field, measured at beacon location
SUNACT	state of solar activity
	- quiet — less than 50 % probability of class C flares
	- eruptive — C-class flares expected (probability > 50 %)
	- active — M-class flares expected
	- major flares expected — X-class flares expected (probability > 50 %)
	- proton flares expected
	- warning condition — activity levels expected to increase
MAGFIELD	state of the geomagnetic field
	- quiet — K < 4
	- active conds expected — K ≥ 4, A > 20
	- minor storm expected — K ≥ 5, A > 30
	- major storm expected — K ≥ 6, A > 50
	- magstorm in progress — K ≥ 4, A > 30
	- warning condition — activity levels expected to increase

Transmission schedule: (minute after the hour)

CW:	00	05	10	15		25	30		40	45		55
RTTY:					20							
PSK31/BPSK:								35				
PSK31/QPSK:										50		

DRA5 – 5195 kHz

A data station for solar, ionospheric and geomagnetic data

The shortwave data station DRA5 transmits similar data like DK0WCY from the same site located north of Kiel, Germany (JO44VQ, 54.7°N, 9.8°E).

Transmitter:
DRA5 transmits on a nominal frequency of 5195 kHz with an output power of about 30 watts. A dipole antenna is used. The transmitter frequency is exact by +/- 2 Hz.

Current transmission schedule

Transmissions take place 24 hours a day and use several operating modes. Each mode lasts about 90 to 150 seconds and starts at certain minutes of the hour.

min	mode
00	CW
03	RTTY
06	PSK31/BPSK
09	PSK31/QPSK
12	multimode

min	mode
15	CW
18	RTTY
21	PSK31/BPSK
24	PSK31/QPSK
27	test tones

min	mode
30	CW
33	RTTY
36	PSK31/BPSK
39	PSK31/QPSK
42	multi mode

min	mode
45	CW
48	RTTY
51	PSK31/BPSK
54	PSK31/QPSK
57	test tones

At other times a CW loop is transmitted which consists of the text vvv de dra5 followed by a tuning tone. In case of an alert for possible or detected radio aurora the tuning tone is replaced by a series of 16 dots.

Operating modes

CW standard morse code (keyed carrier) with about 12 w.p.m.

RTTY frequency shift keying (CCITT No.2) with a speed of 45.45 Baud and a shift of 170 Hz centred at the nominal frequency.

PSK31/BPSK binary phase shift keying with 31 Baud following the standard introduced by Peter Martinez, G3PLX. The phase shifted carrier is centred at the nominal frequency.

PSK31/QPSK quaternary phase shift keying with 31 Baud following the standard introduced by Peter Martinez, G3PLX. The phase shifted carrier is centred at the nominal frequency.

multi mode parallel transmission of RTTY, BPSK and QPSK in a 1 kHz bandwidth
- BPSK centred at nominal frequency,
- QPSK centred 150 Hz above nominal frequency,
- RTTY centred 485 Hz above nominal frequency.

test tones a series of test-tones with the following characteristics:
- 14 sec carrier at nominal frequency
- 1 sec pause
- 14 sec PSK31 idle signal (180 degree phase shift between symbols)
- 1 sec pause
- 14 sec dual carrier at offsets +0 Hz/+500 Hz from nominal frequency
- 1 sec pause
- 14 sec triple carrier at offsets +0 Hz/+250 Hz/+500 Hz from nominal frequency
- 1 sec pause
- 30 sec pattern of 6 carrier signals with one second duration each.

Frequency and approximate relative power level of signals:

100% at nominal frequency

50%	40 Hz below nominal frequency
25%	80 Hz below nominal frequency
12.5%	120 Hz below nominal frequency
6.25%	160 Hz below nominal frequency
3.125%	200 Hz below nominal frequency

The usual idle signal introducing a PSK31 transmission is prolonged to 10 seconds. This provides more time to measure IMD and to tune in before data is transmitted.

Transmitted data:

Below is a sample text as transmitted by DRA5 in PSK31 or RTTY
(for sample of CW transmission see DK0WCY)

ZCZC
+++ TEST TRANSMISSION DE DRA5 DRA5+++

SOLAR AND GEOMAGNETIC INDICES OBSERVED ON 19FEB:

SUNSPOT NUMBER	73	73	73
SOLAR FLUX	114	114	114
BOULDER A	11	11	11
KIEL A	13	13	13

GEOMAGNETIC CONDITIONS:

3-HOUR KIEL k	2	2	2	at 09.00 UTC
CURRENT KIEL k 1.80	1.80	1.80		at 09.21 UTC *(see Note 1)*

FORECASTS VALID FOR 12 FEB:

SOLAR ACTIVITY ERUPTIVE
MAGNETIC FIELD QUIET

IONOSPHERIC CONDITIONS at 09.00 UTC *(see Note 2)*

CRITICAL SOUNDER FREQUENCY
FOR F2-LAYER 5.95 5.95 5.95 MHz

MAX USUABLE FREQUENCY FOR CERTAIN DISTANCES:

D KM	100	200	400	600	800	1000	1500	3000
MUF MHz	6.7	6.7	7.0	7.6	8.3	9.4	12.5	20.5
MUF MHz	6.7	6.7	7.0	7.6	8.3	9.4	12.5	20.5

NNNN

Note 1: *Current k* gives the k value for the last 180 minutes independent of the standard three hour period (0-3, 3-6, 6-9, 9-12, 12-15, 15-18, 18-21, 21-24 UTC).
Note 2: Transmission of ionospheric data will commence mid 2005; the shown format is still preliminary. Measurements will be updated every 15 minutes.

Data originate from these sources:

- Sun spot number, flux, solar activity forecast, geomagnetic field forecast and Boulder A are courtesy of SEC, Boulder/Colorado.
- Kiel k, current k and A are continuously measured at the location of DK0WCY/DRA5.
- Critical frequency foF2 and maximum usable frequency MUF are courtesy of IAP Kuehlungsborn/Juliusruh (Island of Ruegen).