Indecis
Sectorial Climate Services

Integrated approach for the **d**evelopment across **E**urope of user oriented **c**limate **i**ndicators for GFCS high-priority **s**ectors: Agriculture, disaster risk reduction, energy, health, water and tourism

Work Package 2

Deliverable 2.1

Inventory and Catalog of Climate Datasets

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Summary: The search for daily temperature and precipitation observational data and the efforts to discover and include more such data lead to the analysis of two global station-based dataset, availability of a new regional dataset in Italy. Non-standard variables intended for specific usage in specific sectors, as the tall wind mast data from 292 sites around the globe, were also investigated. Progress in the identification and inclusion of pan-European global radiation data is quantified.

TABLE OF CONTENTS

1. Introduction

High quality climate services must be based on reliable data with an adequate geographical and spatial coverage and free of errors and biases. At European level, one of the most comprehensive dataset at the daily resolution is the European Climate Dataset and Assessment (www.ecad.eu). It constitutes the Climate Data node for the WMO Regional Climate Center for Europe, data being contributed mostly by NMHSs and other data holding institutions. It contains time series for 62 countries across Europe and the Mediterranean Basin, the highest data density for air temperature and precipitation series.

Within the INDECIS project, ECA&D is used as the starting point for the proposed INDECIS dataset INDECIS-Raw Data Set (INDECIS-RDS), which aims to extend the available obervation-based data by including data present in other datasets but not in ECA&D, making available more data at regional level as well as enlarging the number and type of variables included (e.g. with non-standard variables).

The objectives of deliverable D2.1 is to identify and characterize climatic datasets regarding targeted ECVs (temperature, precipitation, wind, radiation) over Europe. The analysis of the identified datasets focused on the availability, accesability, spatial and temporal coverage of the data, by comparison with ECA&D content where it was the case. Also, the search payed attention to inclusion of non-standard variables intended for specific usage in specific sectors, as it is the case for wind data from tall towers and oil-drilling installations at sea.

2. Temperature and precipitation datasets

Pan-European datasets

Two global station-based datasets (GHCN-Daily and GSOD) containing temperature and precipitation data were investigated with respect to daily values of air temperature and precipitation.

GHCN (Global Historical Climatology Network)-Daily is an integrated database of daily climate summaries from land surface stations across the globe, comprised of daily climate records from numerous sources that have been integrated and subjected to a common suite of quality assurance reviews. The Global Summary of the Day (GSOD) dataset contains 24-hour summaries encoded in the special “climatological code” group transmitted with SYNOP reports on the GTS. Data from both datasets is available through NCEI portal (https://gis.ncdc.noaa.gov/maps/ncei/cdo/daily).

An analysis of the data contained in these datasets and relevant for the European area was performed with regard to the spatial coverage (number of stations) and temporal coverage (the longest record of either temperature or precipitation observations). In order to facilitate the comparison, an area covering (apoximatively) the regions included in ECA&D was selected for each of the above datasets and the information on the station network was represented (Fig.1). Here the restriction is made that data should span at least 20 years and the most recent daat must be from 2010 or later. The comparison showed that GSOD, in particular, may contain data from some stations not present in ECA&D; however, such data is subject to restricted acces (WMO Resolution 40 restrictions) as it is stated in the documents associated with GSOD.

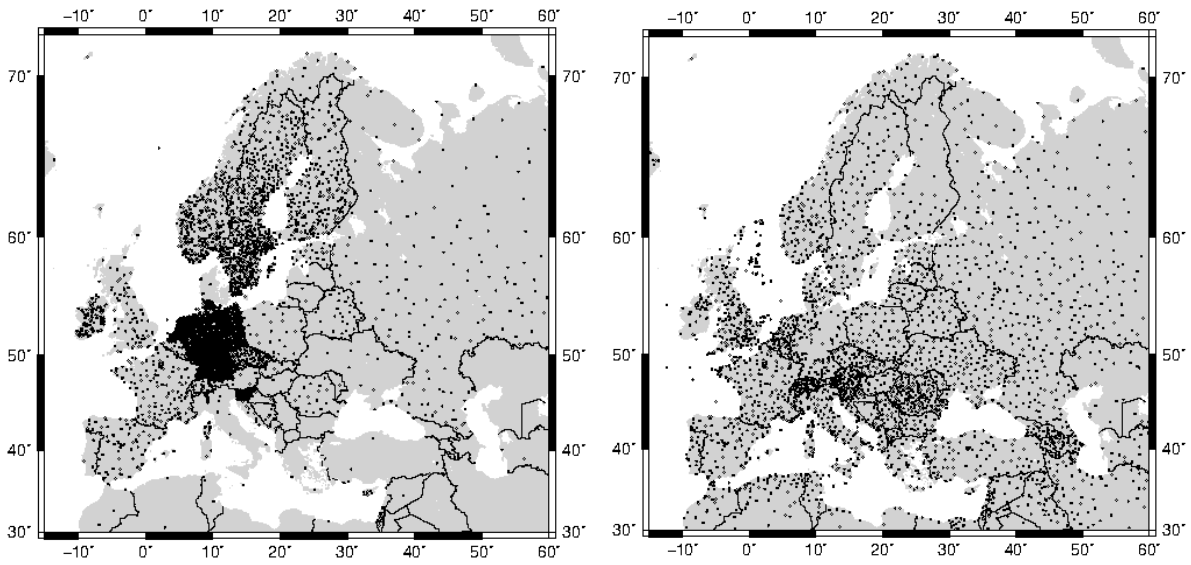

Fig.1: Station coverage for temperature in the ECA&D dataset (left) and the GSOD dataset (right).

National datasets

Other directions of interest in the dataset identification was the search for regional/local datasets as well as the efforts to engage more actively selected National Meteorological and Hydrological Service in ECA&D - and thus INDECIS-RDS- activities. One of the focal areas in this search was Italy because the rather poor station coverage in the circum-Mediterranean region and in Italy in particular. In Italy, a regionalized approach in the form of Regional Protection Agencies (Agenzia regionale per la protezione ambientale, or ARPA) exists. Within INDECIS, new efforts to liaise with ARPAs have been employed and this resulted in a number of long-term observations from ARPA-Sardinia, ARPA-Lombardia and ARPA Calabria (about 30 stations with about 70 years period of records). Maps with the locations of the shared stations for the Calabria region are shown in fig. 2. These data have become available to be included in ECA&D and thus INDECIS-RDS. Also, some other few data will become available in the near future from ARSAC (Agency for Agriculture in Calabria), with records of about 15 years long.

Recently, efforts are made to set-up a pan-Italian collection of climatological data. Within the INDECIS project, contacts with the Italian Institute for Environmental Protection and Research, ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale) who will host this pan-Italian dataset, has been made. This institute acts as the go-between between the regional ARPAs and the ECA&D and INDECIS-RDS. Figure 3 shows the coverage of the datasets from the various sources available to ISPRA.

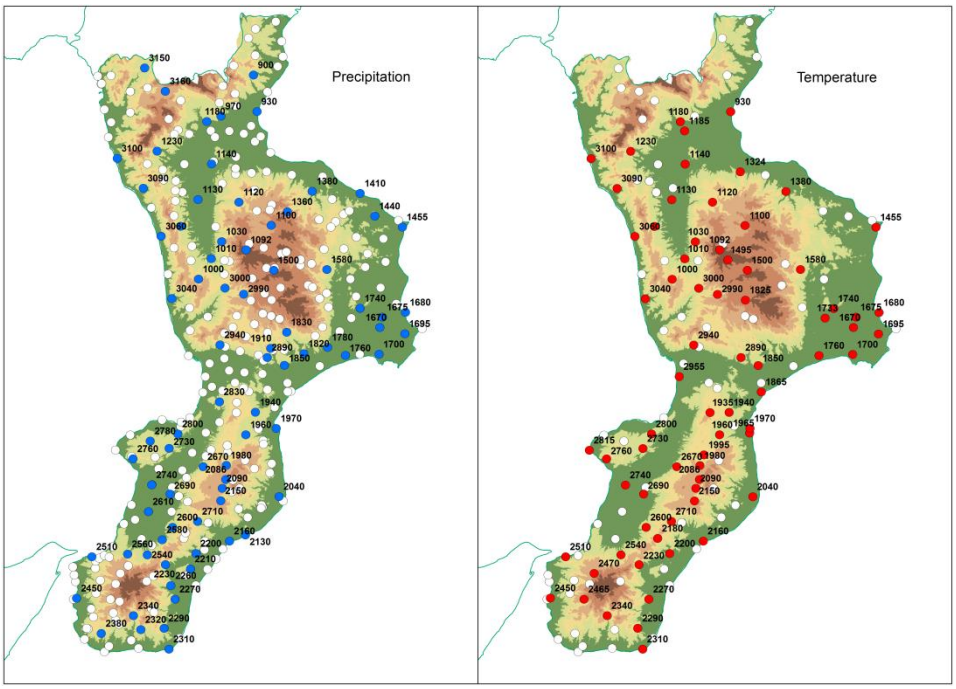

Fig 2: Station coverage for precipitation (left) and temperature right) from the Calabria region which are shared within the INDECIS project.

3. Wind-related dataset: Tall wind mast data

In the last three decades, in-situ measurements have become very popular in the wind energy industry. The need of inferring the characteristics of the wind flow at the turbine hub height (around 100 m above ground level for modern turbines) has driven the installation of meteorological tall towers for the measurement and characterization of local winds. The basic structure of these masts is a high vertical tower (reaching heights close to 400 meters above ground level in some cases) with different instrumented platforms or booms along the mast. In this way, measurements can be obtained at several heights. This allows the characterization of the vertical profile of the wind in the area. In addition, for each level they usually have several booms, pointing to different directions. This fact allows the placement of more than one measurement sensor for a given height (this is what is called redundancy). This will be of great importance when carrying out the different tasks of cleaning and homogenization techniques of these meteorological data. Failures in measurement by a sensor, either because it has entered a wind shadow zone produced by the mast itself, or by a technical failure, can be corrected by replacing these measurements with those of a sensor at its same height. Regarding temporal resolution, wind speed and direction are commonly sampled every second and processed to the mean for each 10-minute period (which is the standard recommended by the World Meteorological Organization).

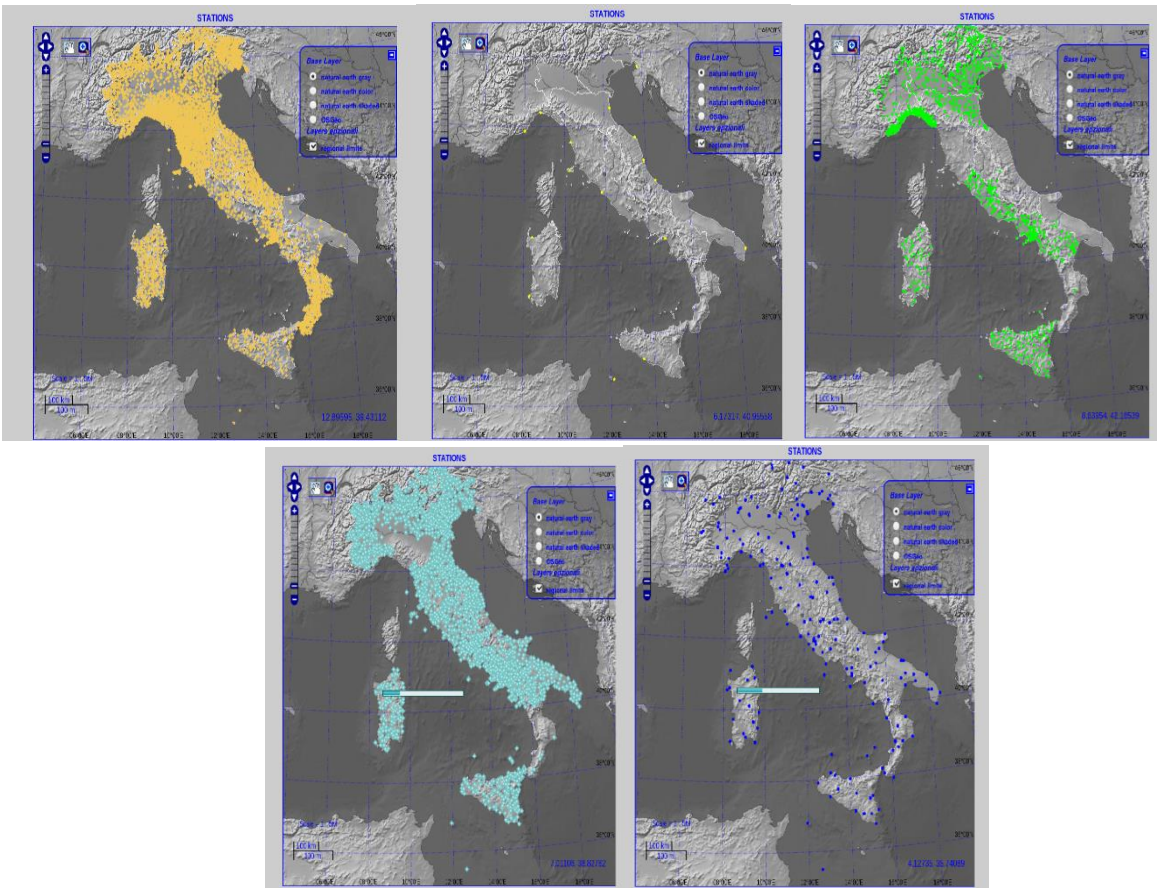

Fig 3: Station coverage for the various pan-Italian datasets as available from the ISPRA institute. The upper panels show Idrografica, Mareografica, Regionale, Regione (ExSimn) and Synoptical data.

Most of the installed tall towers in the world belong to private companies that develop new wind farm projects and are reluctant to share their measurements. However, many public institutions, research centers, universities and even some private initiatives also have instrumented tall towers that can be freely used for research purposes. Those initiatives are sparse and with diverging goals, and there is a lack of coordination regarding formats, data access, quality control and general information. This makes the usage of those datasets very difficult. For the INDECIS project, a total of 292 sites with meteorological masts have been identified (see Annex 1), with the intent to provide an easier and unified access to quality controlled observations. Its global distribution (Fig. 4) is markedly irregular. Clusters appear in North America and Europe, as well as in Iran and South Africa. These last two come from national databases. The time period covered by the data is also remarkably diverse. For some historical meteorological observatories, it is up to 37 years. However, for some towers the temporal coverage is only 1 or 2 years (although some of them continue measuring at present). The period of record (POR) of some towers is imprecise (indicating in some cases only the initial year or latest year of measurements) or unknown. Regarding the re-distribution of data, several data policies have been faced. On behalf the INDECIS project, the conditions that owners have imposed to shared their data will be scrupulously respected.

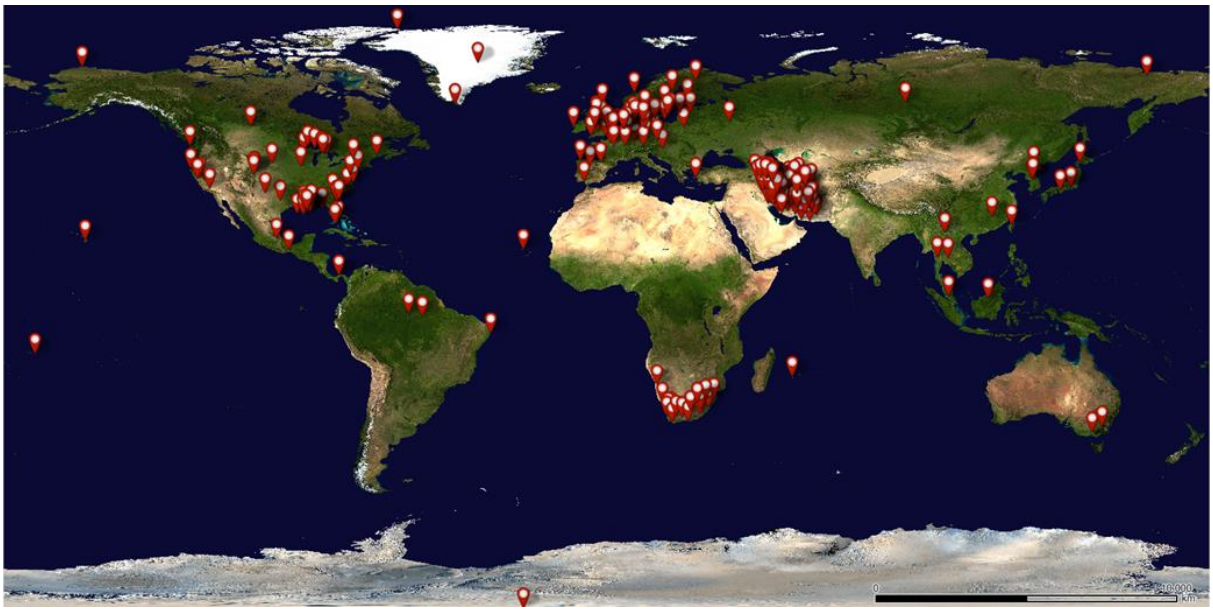

Fig.4 Global distribution of the identified sites for the Tall Wind Masts

4. Radiation data

The aim of ECA&D is to provide data from all surface Essential Climate Variables (ECVs). One of the ECVs which was lacking from ECA&D is global radiation. Although a fairly dense coverage exists for sunshine duration – which has an obvious but not trivial relation to global radiation – measurements of global radiation is the more valuable data source. Global radiation is used in many derived quantities, like heat stress indices and (potential) evapotranspiration. For this reason, sectors like health, tourism, agriculture and hydrology are interested in this element.

Within the INDECIS project, contacts have been made with the World Radiation. The World Radiation Data Center (WRDC), located at the Main Geophysical Observatory in St. Petersburg, Russia, serves as a central depository for solar radiation data collected at over 1000 measurement sites throughout the world. A map with the global and European station coverage is show in fig. 5. The WRDC centrally collects, archives, and publishes radiometric data from the world to ensure the availability of these data for research by the international scientific community.

Daily sums of global radiation data sources from the WRDC are included in the ECA&D/INDECIS-RDS and amount to 441 stations.

Parallel to establishing contacts with the WRDC, contacts with the Baseline Surface Radiation Network (BSRN) are made. BSRN is a project of the Data and Assessments Panel from the Global Energy and Water Cycle Experiment (GEWEX) under the umbrella of the World Climate Research Programme (WCRP) and as such is aimed at detecting important changes in the Earth's radiation field at the Earth's surface which may be related to climate changes. In 2004 the BSRN was designated as the global baseline network for surface radiation for the Global Climate Observing System (GCOS). The BSRN stations also contribute to the Global Atmospheric Watch (GAW).

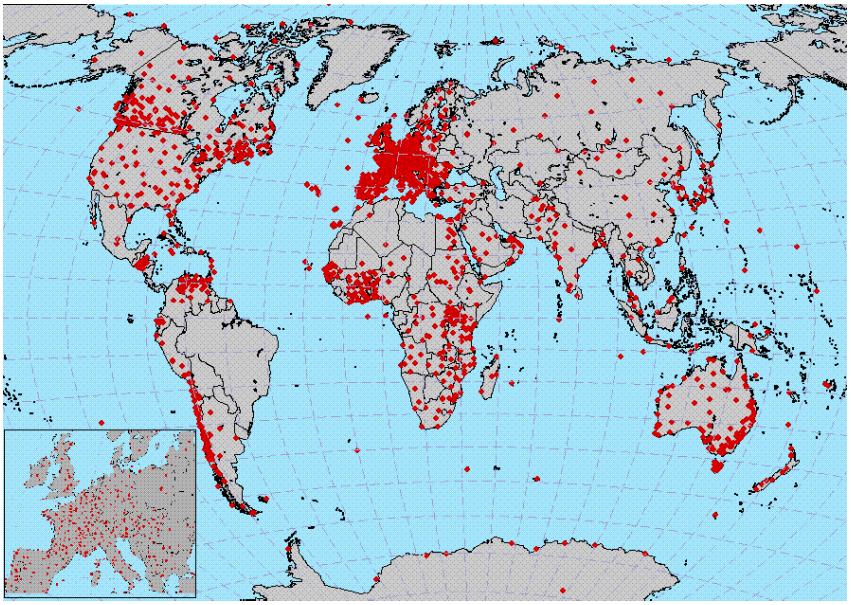

Fig.5 Global distribution of stations for global radiation included in the dataset of the World Radiation Data Centre.

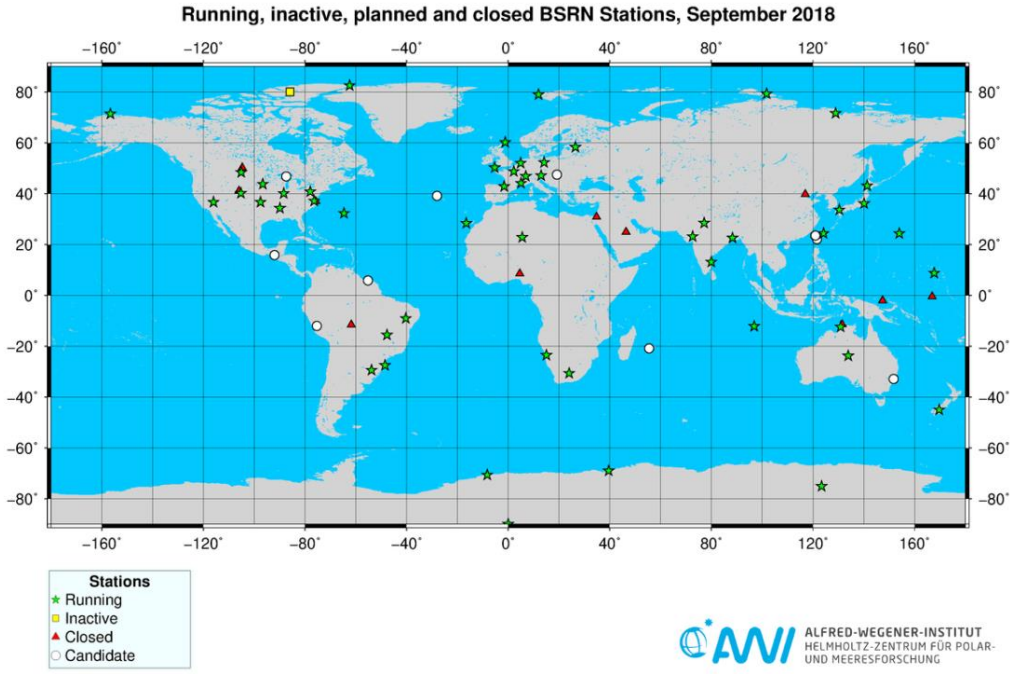

Fig.6. Global distribution of stations for global radiation included in the Baseline Surface Radiation Network.

Although the BSRN network is not very dense – there are only about 10 station in the European realm – the accuracy of these measurements are unsurpassed and deserve to be shared to the wider community through ECA&D/INDECIS-RDS. The BSRN provides data mainly for supporting the validation and confirmation of satellite and computer model estimates of these quantities. At a small number of stations (currently 64) in contrasting climatic zones, covering a latitude range from 80°N to 90°S, solar and atmospheric radiation is measured with instruments of the highest available accuracy and with high time resolution (1 to 3 minutes). Note that in ECA&D/INDECIS-RDS only daily sums of global radiation will be made available.

Apart from the global datasets of WRDC and BSRN, efforts are undertaken to liaise with the National Meteorological Services in Europe to collect global radiation data. These efforts combined have resulted in the coverage of stations shown in fig. 7.

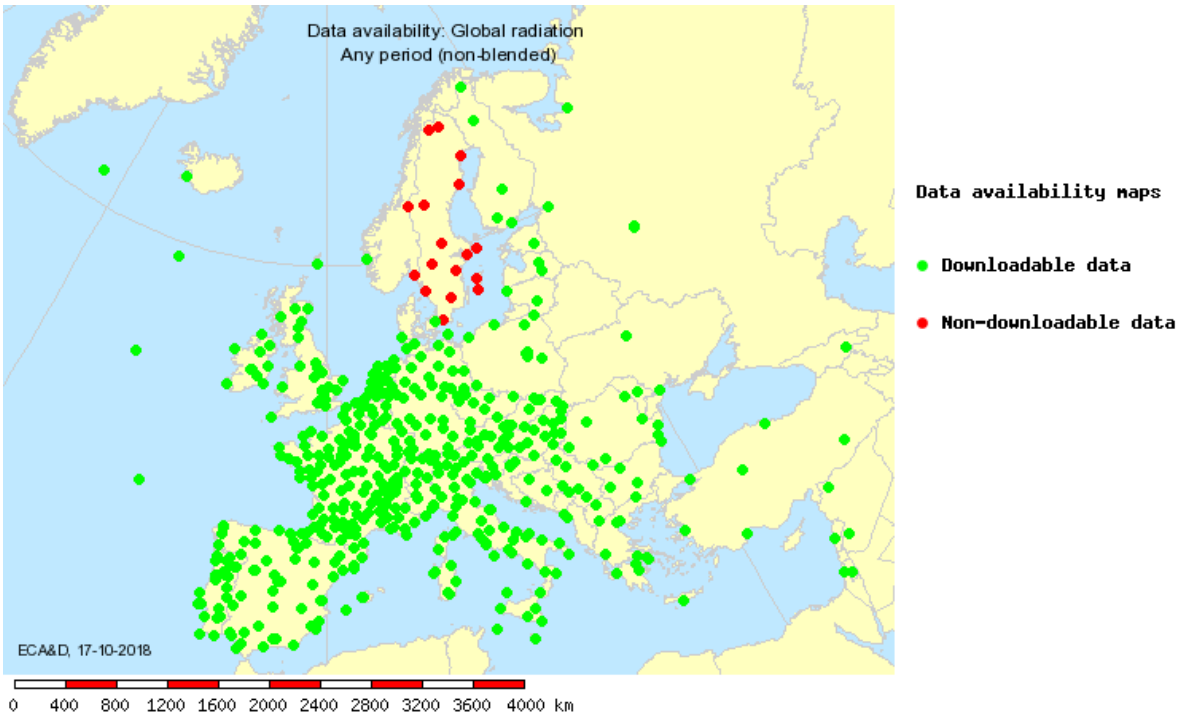

Fig.7. Distribution of stations for global radiation included in the European Climate Assessment & Dataset at the time of writing.

5. Annex 1. List of met masts identified

Tower name	Institution	Country[1]	Longitude	Latitude	POR start	POR end
Cabauw	KNMI	NL	4.926	51.971	200101	201703
Sodankyla	FMI	FI	26.638	67.362	200012	201412
Lindenberg	DWD	DE	14.123	52.166	2003	2009
Norunda	Lund university	SE	17.459	60.082	1994	
Hamburg	Hamburg university	DE	10.103	53.519	1995	
Saclay	CEA	FR	2.142	48.723		
Fino1	Fino Project	DE	6.588	54.015	2003	
Fino2	Fino Project	DE	13.154	55.007	2007	
Fino3	Fino Project	DE	7.158	55.195	2009	
BAO	ESRL	US	-105.004	40.050	200706	201607
Mauna Loa	ESRL	US	-155.576	19.536	199101	201605
Trinidad Head	ESRL	US	-124.151	41.054	200204	201605
Summit	ESRL	GL	-38.480	72.580	200806	201605
American Samoa	ESRL	AS	-170.564	-14.247	199406	201605
South Pole	ESRL	US	-24.800	-89.980	197901	201605
Barrow	ESRL	US	-156.611	71.323	198801	201605
WLEF	ESRL	US	-90.273	45.945	200301	201711
Argyle Maine	ESRL	US	-68.680	45.030	2003	2008
Cherskii	ESRL	RU	161.531	68.514		
WITN	ESRL	US	-77.393	35.365	1997	1999
South Carolina	Savannah River National Laboratory	US	-81.833	33.406	200904	201712
West Branch	ESRL; IOWA university	US	-91.353	41.725	200801	200807
Moody	ESRL	US	-97.327	31.315	2001	
Walnut Grove	ESRL/DOE	US	-121.491	38.265	200508	201611
Cardington	UKMO	GB	-0.417	52.100	200405	201303
El Arenosillo	INTA	ES	-6.736	37.102	200811	
CIBA	Valladolid university; AEMET	ES	-4.930	41.810	2009	
Risoe	DTU	DK	12.104	55.692	1995	

1 . ISO ALPHA-2 Country codes

Hoevsoere	Risoe	DK	8.152	56.444	2005	2013
Oesterild	Risoe	DK	12.088	55.694	2015	
Imk Tro	Karlsruhe Institute of Technology	DE	8.426	49.093	1972	
Zotto	ZOTTO project	RU	89.352	60.799	2007	
Obninsk	Institute of Experimental Technology	RU	36.598	55.111	200712	201604
Atto	MPI	BR	-59.006	-2.146		
Kosetice	Czech Hydrometeorological institute	CZ			2006	
Dukovany	Czech Hydrometeorological institute	CZ				
Hegyhatsal	Hungarian met service	HU	16.652	46.956	199408	201611
Sotavento	Sotavento Wind Farm	ES	-7.881	43.354		
Horstermeer	Vrije Universiteit Amsterdam	NL	5.075	52.240	2004	2011
Angus	Edinburg University; MetOffice	GB	-2.986	56.555	2005	
Lutjewad	Gronigen university	NL	6.353	53.404		
Mace Head	Bristol university	IE	-9.900	53.333	1990	
OS2	INRA Orléans	FR	1.367	48.383		
NWTC M2	NREL	US	-105.235	39.911	199609	201701
NWTC M4	NREL	US	-105.225	39.906	201201	201604
NWTC M5	NREL	US	-105.225	39.206	201208	201705
Bialystok	MPI	PL	23.030	53.230	2003	
Ochsenkopf	MPI	DE	11.809	50.030	2003	
Tacolneston	East Anglia university	GB	1.139	52.518	2012	
Hyttiala	Helsinki university	FI	24.295	61.847	199512	201710
Ridge Hill	Bristol university	GB	-2.540	51.998	2012	
Matisi	Ventspils Augstskola	LV	25.167	57.689	2009	
Irbene	Ventspils Augstskola	LV	21.857	57.560	2007	2016
Braschaat	INBO	BE	4.520	51.308	199512	201412
Vielsalm	Université Catholique de Louvian	BE	5.998	50.305	1996	
La Reunion - Maido	Aeronomie	RE	55.485	-20.901		
La Muela	Falck Group	ES				
Hyltemossa	Lund university	SE	13.418	56.098	2014	
Ostergarnsholm	Uppsala university	SE	18.983	57.433	1995	
Svartberget	Swedish Agricultural university	SE	19.770	64.250	2011	

Alaiz	CENER	ES	-1.566	42.691		
Peninsula talltower	TUBITAK	TR	26.650	38.310	2016	
Ijmuiden	ECN	NL	3.436	52.848	201111	201603
Egmond aan zee	ECN	NL	4.390	52.606	200508	201012
Docking Shoal	Centrica	GB	0.648	53.158	200606	200908
BURL1	NBDC	US	-89.428	28.905	198402	201612
CHLV2	NBDC	US	-75.713	36.905	198408	201606
DESW1	NBDC	US	-124.485	47.675	198408	201612
FWYF1	NBDC	US	-80.097	25.591	199106	201612
ROAM4	NBDC	US	-89.313	47.867	198310	201612
SGOF1	NBDC	US	-84.858	29.408	200310	201612
SMKF1	NBDC	US	-81.111	24.628	198802	201508
STDM4	NBDC	US	-87.225	47.184	198407	201612
42361	Shell International E&P	US	-92.490	27.550	200507	201612
42362	Enven Energy Corporation	US	-90.648	27.795	200507	201612
42363	Shell International E&P	US	-89.220	28.160	200507	201606
42364	Shell International E&P	US	-88.090	29.060	200709	201612
42365	Shell International E&P	US	-89.120	28.200	201201	201311
42369	BP Inc	US	-90.283	27.207	201005	201612
42370	BP Inc	US	-90.536	27.322	201005	201211
42375	BP Inc	US	-88.289	28.521	201005	201612
42394	Shell International E&P	US	-89.240	28.157	201409	201612
42887	BP Inc	US	-88.496	28.191	200911	201612
bygl1	NOAA's National Ocean Service	US	-90.420	29.789	200502	201612
fmoa1	NOAA's National Ocean Service	US	-88.024	30.228	200810	201612
fsnm2	NOAA's National Ocean Service	US	-76.525	39.219	201604	201612
lopl1	Louisiana Offshore Oil Port	US	-90.025	28.885	201108	201612
mhrn6	NOAA's National Ocean Service	US	-74.162	40.641	201505	201612
prim4	National Weather Service Central Region	US	-83.492	45.357	201003	201510
secg1	NC-COOS: North Carolina Coastal Ocean Observing System	US	-80.316	30.800	200410	200511

skmg1	Skidaway Institute of Oceanography	US	-80.236	31.534	200409	200801
spag1	Skidaway Institute of Oceanography	US	-80.567	31.375	200401	200909
tybg1	Skidaway Institute of Oceanography	US	-79.925	31.633	200401	200801
upbc1	NOAA's National Ocean Service	US	-122.121	38.038	201302	201612
wdel1	Shell International E&P	US	-89.551	28.662	200812	201609
wslm4	Great Lakes Environmental Research Laboratory	US	-85.135	45.842	201504	201612
CVO	Cape Verde Atmospheric Observatory	CV	-24.868	16.850	2007	
NDAO	Max Plank Institute	NA	15.030	-23.550	2012	
Alert	Max Plank Institute	CA	-62.508	82.451	2004	
Stora Middelgrund	DTU	SE	12.105	56.561	2008	2015
WM01	Republic of SouthAfrica, department of Energy	ZA	16.664	-28.602	201006	201701
WM02	Republic of SouthAfrica, department of Energy	ZA	19.361	-31.525	201006	201701
WM03	Republic of SouthAfrica, department of Energy	ZA	18.420	-31.731	201006	201701
WM04	Republic of SouthAfrica, department of Energy	ZA	18.109	-32.846	201005	201306
WM05	Republic of SouthAfrica, department of Energy	ZA	19.692	-34.612	201005	201701
WM06	Republic of SouthAfrica, department of Energy	ZA	20.691	-32.557	201009	201612
WM07	Republic of SouthAfrica, department of Energy	ZA	22.557	-32.967	201005	201701
WM08	Republic of SouthAfrica, department of Energy	ZA	24.514	-34.110	201008	201701
WM09	Republic of SouthAfrica, department of Energy	ZA	25.028	-31.253	201009	201612
WM10	Republic of SouthAfrica, department of Energy	ZA	28.136	-32.091	201008	201612
WM11	Republic of SouthAfrica, department of Energy	ZA	28.074	-30.814	201510	201707
WM12	Republic of SouthAfrica, department of Energy	ZA	30.529	-29.850	201510	201707
WM13	Republic of SouthAfrica, department of Energy	ZA	32.166	-27.426	201510	201707
WM14	Republic of SouthAfrica, department of Energy	ZA	29.543	-27.882	201510	201707
WM15	Republic of SouthAfrica, department of Energy	ZA	27.123	-28.620	201509	201707
Nanortalik	DTU	DK	-45.226	60.143	200706	200906
Perdigao	EOL	PT			1995	
Shetland	DTU	SE	-1.320	60.250	2005	
Olinda	DTU	BR	-34.510	-8.100	1995	
Sodra Midsjobanken	E.ON	SE	17.333	55.720	2012	

Taggen	Taggen Vindfarm	SE	14.519	55.873	2014	
Rampion	MarineTraffic	GB	-0.343	50.688	2012	2013
Shell Flats Mast 1 – Clean data	Centrica UK	GB	-3.295	53.860	201107	201208
Shell Flats Mast 1 – Raw data	Centrica UK	GB	-3.295	53.860	201107	201312
Shell Flats Mast 2 – Raw data	Centrica UK	GB	-3.202	53.874	201107	201401
Race Bank – Clean data	Race Bank	GB	0.748	53.314	200606	200812
Race Bank – Raw data	Race Bank	GB	0.748	53.314	200606	201304
NOAH	FoundOcean	GB	-1.490	55.136	201209	201403
Methil	Offshore Energy Renewable Catapult	GB	-3.009	56.163	2013	2015
London Array – Clean data	E.ON; Caisse; Dong Energy; Masdar	GB	1.386	51.594	200412	201012
London Array – Raw data	E.ON; Caisse; Dong Energy; Masdar	GB	1.386	51.594	200412	201012
Kentish Flats	Vatenfall AB	GB	1.090	51.460	200210	200501
Inner Dowsing	UK Green Investment Bank	GB	0.436	53.128	199908	200802
Humber Gateway – Clean data	E.ON	GB	0.266	53.638	200910	201107
Humber Gateway – Raw data	E.ON	GB	0.266	53.638	2011	2012
Gwynt Y Mor - Clean data	UK Green Investment Bank,Stadtwerke München GmbH;Siemens AG;Innogy SE	GB	-3.508	53.482	200509	200804
Gunfleet Sands	Development Back of Japan;Marubeni Corporation;Dong Energy	GB	1.197	51.726	200201	200711
Greater Gabbard MMZ Mast – Clean Data	Innogy SE; SSE Renewables	GB	1.922	51.944	200509	201006
Greater Gabbard MMZ Mast – Raw data	Innogy SE; SSE Renewables	GB	1.922	51.944	200509	201412
Greater Gabbard MMX Mast – Clean data	Innogy SE; SSE Renewables	GB	1.895	51.858	201205	201501
Greater Gabbard MMX Mast – Raw data	Innogy SE; SSE Renewables	GB	1.895	51.858	201205	201406
Trainou	CEA	FR	2.113	47.965	2007	

Ope Andra	ANDRA	FR	5.500	48.550		
Julich	DWD	DE	6.220	50.928		
Hohenpeissenberg	DWD	DE	11.025	47.801		
Gartow		DE	11.443	53.066		
Kresin u pacova	Czech Hydrometeorological institute	CZ	15.080	49.572		
Ainswort	NREL	US	-99.872	42.462		
Belmont	Hrafnkel SARL	FR	5.554	47.714		
Calwind	NREL	US	-118.376	35.054		
Delabole	ETSU	GB	-4.708	50.630		
Hidalgo	Instituto de Investigaciones Electricas	MX	-98.553	20.008		
Lyse	Uppsala univ	SE	11.394	58.315	1993	1995
Nasudden	Uppsala univ	DK	18.221	57.072	1980	1997
Ski	Norwegian University of Science and Technology	NO	8.343	63.666	1982	1995
Tjare	DTU	DK	8.594	55.448	1988	1993
Tughill	NREL	US	-75.668	43.931		
Ventosa	Instituto de Investigaciones Electricas	MX	-94.828	16.575	2002	
Vindeby2	Risoe	DK	11.130	54.954		
Wise	Wind Science and Engineering Research Center	US	-102.007	33.598	2005	2007
EWTW1	ECN	NL	5.080	52.814	2003	
EWTW2	ECN	NL	5.091	52.814	2004	
EWTW3	ECN	NL	5.082	52.828	2005	
Abadan	SATBA	IR	48.307	30.447	200709	200908
Abadeh	SATBA	IR	52.251	31.094	200606	200711
Afriz	SATBA	IR	58.963	33.447	200608	200802
Agh Ghala	SATBA	IR	54.473	37.108	200607	200710
Abarkooh	SATBA	IR	53.663	31.303	200608	200801
Abhar	SATBA	IR	49.390	36.111	200706	200907
Ardakan	SATBA	IR	54.266	32.591	200609	200802
Esfaryen	SATBA	IR	57.403	37.053	200608	200803
Eshtahard	SATBA	IR	50.687	35.727	200807	200912
Eghlid	SATBA	IR	52.619	30.887	200606	200805
Enjilavand	SATBA	IR	50.672	34.941	201105	201207

Ahar	SATBA	IR	47.218	38.587	200811	201504
Bonab	SATBA	IR	46.025	37.401	200607	200710
Bojnoord	SATBA	IR	57.246	38.135	200608	200805
Bardkhoon	SATBA	IR	51.492	27.985	200606	200802
Barzook	SATBA	IR	51.140	33.813	201506	201601
Boroojen	SATBA	IR	51.314	31.974	200606	200711
Behabad	SATBA	IR	56.117	31.779	200606	200801
Papooli	SATBA	IR	50.056	36.079	200907	201011
Tafresh	SATBA	IR	50.057	34.683	201009	201302
Tange Hashi	SATBA	IR	52.962	29.182	201503	201509
Too Takaboon	SATBA	IR	49.524	36.907	200204	200312
Jask	SATBA	IR	58.110	25.685	200608	200709
Jangal	SATBA	IR	59.208	34.702	200607	200803
Javim	SATBA	IR	54.085	28.193	200606	200711
Jirandeh	SATBA	IR	49.782	36.707	200303	200407
Chabahar	SATBA	IR	60.663	25.328	200807	200912
Chaldoran	SATBA	IR	44.452	39.051	200607	200710
Hadadeh	SATBA	IR	54.730	36.246	200608	200802
Hoseinieh	SATBA	IR	48.181	30.795	200711	200908
Hesarak	SATBA	IR	51.320	35.797	201102	201201
Halvan	SATBA	IR	56.298	33.963	200607	200802
Khash	SATBA	IR	61.065	28.097	200606	200712
Khalkhal Bafrajerd	SATBA	IR	48.574	37.540	201109	201410
Khalkhal Eilkhichi	SATBA	IR	48.246	37.634	200906	201103
Khomein	SATBA	IR	50.165	33.799	200607	200709
Khaf	SATBA	IR	60.309	34.486	200707	200903
Hormozgan University	SATBA	IR	56.437	27.262	201402	201601
Davarzan	SATBA	IR	56.813	36.269	200607	200803
Delgan	SATBA	IR	59.458	27.486	200608	200712
Delvar	SATBA	IR	51.046	28.835	200609	200801
Dehake Saravan	SATBA	IR	62.672	27.144	200606	200712

Deilaman	SATBA	IR	49.906	36.883	201001	201012
Rafsanjan	SATBA	IR	56.222	30.321	200606	200807
Roodab	SATBA	IR	57.347	36.053	200808	201003
Zahedan	SATBA	IR	60.805	29.472	201101	201201
Zartoshtabad	SATBA	IR	48.505	37.611	201408	201504
Zarrineh2	SATBA	IR	46.925	36.059	201503	201601
Shiraz Site	SATBA	IR	52.613	29.374	200712	200906
Taleghan Site	SATBA	IR	50.571	36.123	200712	201002
Saveh Site	SATBA	IR	50.397	35.076	200805	200909
Saravan	SATBA	IR	62.259	27.419	201010	201110
Sarakhs	SATBA	IR	61.144	36.311	200609	200711
Semnan	SATBA	IR	53.454	35.616	200907	201011
Sanar	SATBA	IR	51.309	36.504	200607	200708
Songhoor	SATBA	IR	47.472	34.831	201205	201409
Shandol	SATBA	IR	61.663	31.149	201010	201201
Shorjeh	SATBA	IR	49.445	36.072	200807	201001
Shooshtar	SATBA	IR	48.756	31.792	200711	200908
Shahr Abad	SATBA	IR	56.200	37.651	201104	201112
Shahr Babak	SATBA	IR	55.219	30.092	200609	200807
Sheykh Tapeh	SATBA	IR	45.080	37.524	201207	201504
Tarom	SATBA	IR	49.026	36.656	201106	201306
Fadashk	SATBA	IR	58.790	32.783	200608	200802
Falideh	SATBA	IR	49.399	36.815	200207	200403
Ghadamgah	SATBA	IR	59.007	36.057	200609	200803
Ghorveh	SATBA	IR	47.748	35.177	200810	200912
Kohein	SATBA	IR	49.710	36.338	201105	201504
Kahrizak	SATBA	IR	51.324	35.468	200708	200903
Kahak Garmsar	SATBA	IR	52.318	35.121	200607	200802
Kaboodar Ahang	SATBA	IR	48.746	35.350	200607	200710
Kerend Gharb	SATBA	IR	46.187	34.435	201204	201407
Gardaneh Almas	SATBA	IR	48.673	37.593	200906	201009
Ganje	SATBA	IR	49.462	36.859	200207	200310

Larijan	SATBA	IR	52.222	35.982	201006	201105
Latman	SATBA	IR	51.226	35.771	200708	200808
Langrood	SATBA	IR	50.234	37.258	200607	200804
Lootak Zabol	SATBA	IR	61.394	30.726	200606	201001
Likak	SATBA	IR	50.124	30.856	201009	201106
Manjil	SATBA	IR	49.397	36.739	200402	200411
Mahshahr	SATBA	IR	49.086	30.579	200709	200908
Mahidasht	SATBA	IR	46.734	34.392	200606	200709
Mayan	SATBA	IR	46.048	38.085	200607	200801
Marvdasht	SATBA	IR	52.920	29.984	200606	200711
Meshkin Shahr	SATBA	IR	47.731	38.272	200811	201003
Moalleman	SATBA	IR	54.574	34.866	200608	200802
Moghar	SATBA	IR	52.185	33.572	200606	200711
Mir Javeh	SATBA	IR	61.437	29.028	200905	201008
Mir Khand	SATBA	IR	49.400	36.669	200207	200310
Mil Nader	SATBA	IR	61.156	31.086	201009	201203
Nosrat Abad	SATBA	IR	60.158	29.813	200606	200712
Namin	SATBA	IR	48.375	38.375	200607	200712
Nahavand	SATBA	IR	48.208	34.270	200607	200709
Nikooye	SATBA	IR	49.534	36.312	200911	201206
Nir	SATBA	IR	47.979	38.033	201305	201411
Varzaneh	SATBA	IR	52.617	32.465	200606	200810
Vasf	SATBA	IR	50.933	34.193	200809	200902
Hendijan	SATBA	IR	49.769	30.116	201004	201110
Abdar	SATBA	IR	56.946	29.423	200808	200811
Haft Chah	SATBA	IR	52.432	27.717	201002	201107
Izeh	SATBA	IR	49.867	31.834	201004	201004
Korit	SATBA	IR	56.949	33.437	200607	200801
Binalood	SATBA	IR	59.388	35.992	200212	200309
Asfestan	SATBA	IR	47.600	37.934	200503	200602
Ghoroghchi	SATBA	IR	51.000	33.590	201305	201408
Old Aspen	UCAR	CA	-106.200	53.629	200210	200912

Xishuangbanna	Xishuangbanna Tropical Botanical Garden	CN	101.200	21.950		
Changbaishan	Institute of Applied Ecology	CN	127.715	41.697		
Fujiyoshida	Research Institute 1 Matsunosato	JP	138.762	35.455		
Fuji Hokuroku	NIES	JP	138.765	35.444		
Gwangneung Forest	Seoul National University	KR	127.162	37.748	2007	2008
Gwangneung Deciduous Forest	Seoul National University	KR	127.149	37.749	2004	2008
Mae Klong	National Institute of Advanced Industrial Science and Technology	TH	98.844	14.576	2003	2004
Palangkaraya	Hokkaido Universit	ID	114.036	2.345	2002	2005
Pasoh	Kyoto University	MY	102.300	2.967	2003	2009
Qianyanzhou	Northwest Plateau Institute of Biology	CN	115.067	26.733	2003	2004
Sakai	Osaka Prefectural University	JP	135.489	34.574	2009	2009
Sakaerat	National Institute of Advanced Industrial Science and Technology	TH	101.916	14.492	2001	2003
Tomakomai	NIES	JP	141.519	42.737	2001	2003
Huisun	National Chung Hsing University	TW	121.126	24.076	2011	2013
Wallaby Creek	University of Western Australia	AU	145.187	-37.426	200501	200812
Tumbarumba	CSIRO Marine and Atmospheric Research	AU	148.152	-35.657	200101	201412
Barro Colorado Island	Princeton Environmental Institute	PA	-79.850	9.167	200112	201710
Barro Colorado Island	Princeton Environmental Institute	PA	-79.850	9.167	200112	201710
Ohio State University	Ohio State University	US	-84.714	45.560	200701	201707
Santarem	University of California	BR	-54.971	-3.018	2000	2004
Boseong	Yonsei University	KR	127.350	38.267		
Rostamabad	SATBA	IR	49.491	36.898	200201	200307
Gwynt Y Mor - Raw Data	UK Green Investment Bank,Stadtwerke München GmbH;Siemens AG;Innogy SE	GB	-3.508	53.482	200509	200804