

Verification of sectoral cloud motion based global and direct normal irradiance nowcasting

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Introduction

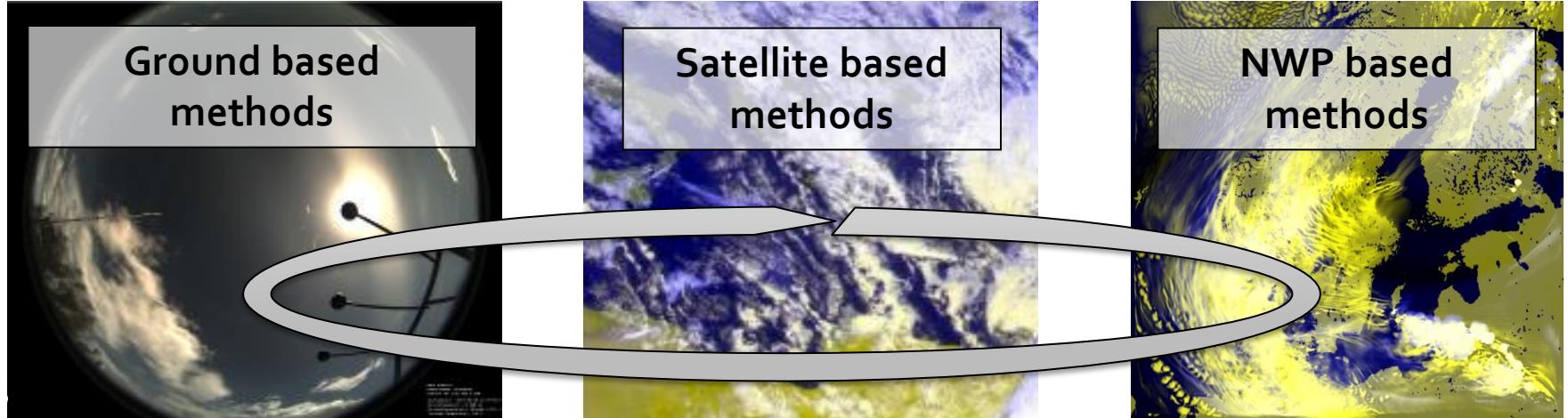
- Systematic assessment for GHI (global irradiance) forecasting and nowcasting has been published (e.g. Perez et al., 2010)
- Systematic assessment of DNI nowcasting?
- Can we extend nowcasting duration/accuracy further?

- ECMWF was performing best in EU, US and Canada;
Mathiesen et al., 2013: all models show typically positive biases

- Talk is about ongoing work – any discussion and feedback is appreciated



DNICast project



DNI nowcasting methods for optimized operation of CST

**Concentrating Solar
Technology (CST)**



Day-ahead irradiance forecasts used as reference

- ECMWF IFS GHI
 - Global horizontal irradiance
- ECMWF IFS GHI2DNI
 - DNI is derived from GHI using Skartveith and Olseth (1998) empirical parameterisation

Details

- GHI = global horizontal irradiance
- DNI = direct normal irradiance
- 3-hourly sums -> hourly values
- 2011 and 2012
- 0.15 deg
- Day zero (0 – 24 UTC) and day ahead (25 – 48 UTC)



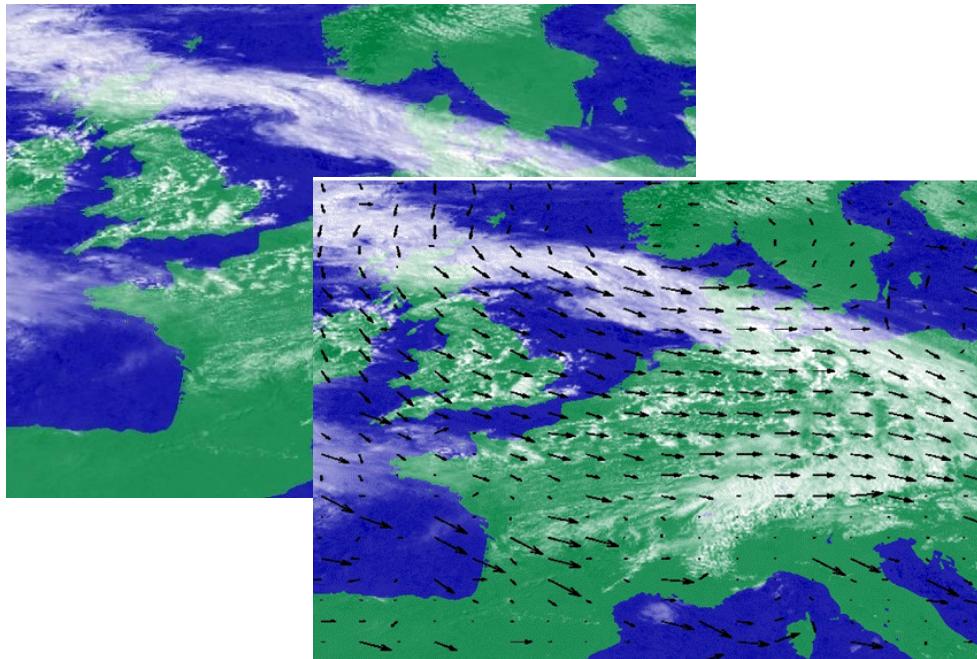
Ground-based observations

Name	ID	Code	Lat. (°)	Lon (°)	Elev (m)	Period
DLR/PSA	1	PSA	37.091	-2.358	492	2002-2012
Cabauw (BSRN)	2	CAB	51.971	4.927	0	2006-2012
Camborne (BSRN)	3	CAM	50.217	-5.317	88	2002-2006
Carpentras (BSRN)	4	CAR	44.083	5.059	100	2002-2012
Cener (BSRN)	5	CEN	39.816	-2.601	100	2002-2012
Izana (BSRN)	6	IZA	37.416	-5.000	1000	2002-2012
Maan (EnerMena)	9	MAN	37.100	-5.000	1000	2002-2012
Payerne (BSRN)	11	PAY	46.400	2.333	1000	2002-2012
Sede Boquer (BSRN)	12	SEB	37.500	-1.000	1000	2002-2012
Tamanrasset (BSRN)	13	TAM	32.500	2.500	1000	2002-2012
Tataouine (EnerMENA)	14	TAT	34.500	10.000	1000	2002-2012
Toravere (BSRN)	15	TOR	37.500	1.000	1000	2002-2012

Additional 11 stations in Spain



Traditional cloud motion vectors based on satellite imagery

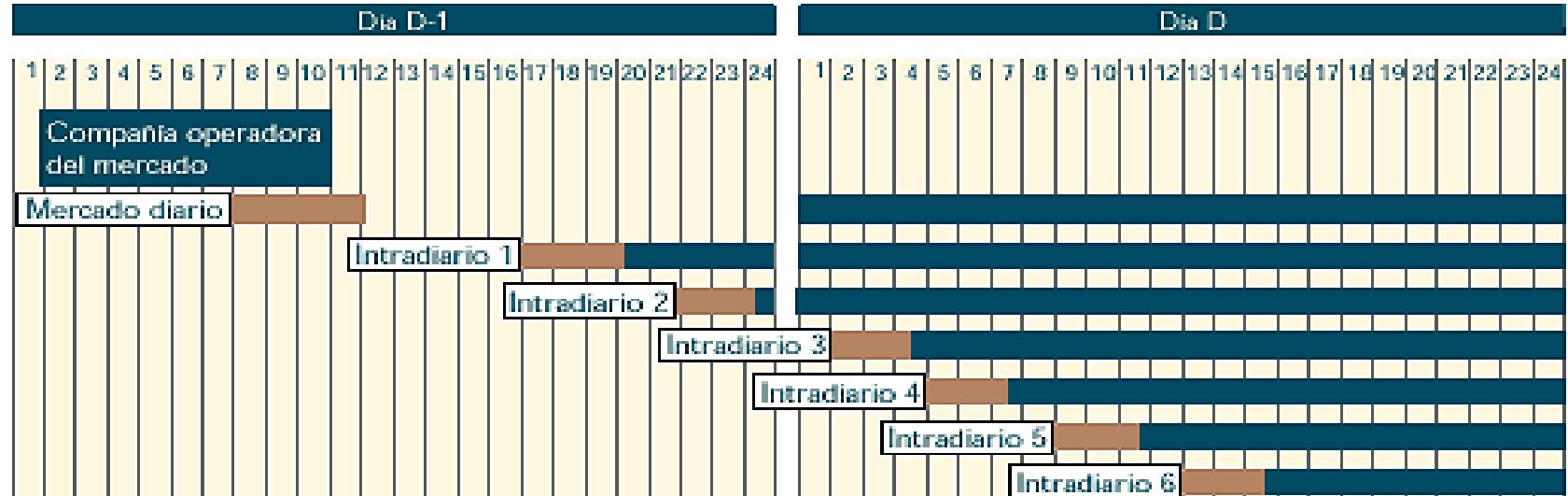


Example of cloud motion vector fields
as basis for short term solar irradiance predictions,
source Engel, 2006.

See work of
A. Hammer, 1999
E. Lorenz, 2004
Univ. Oldenburg



Spanish intra-day market scheme

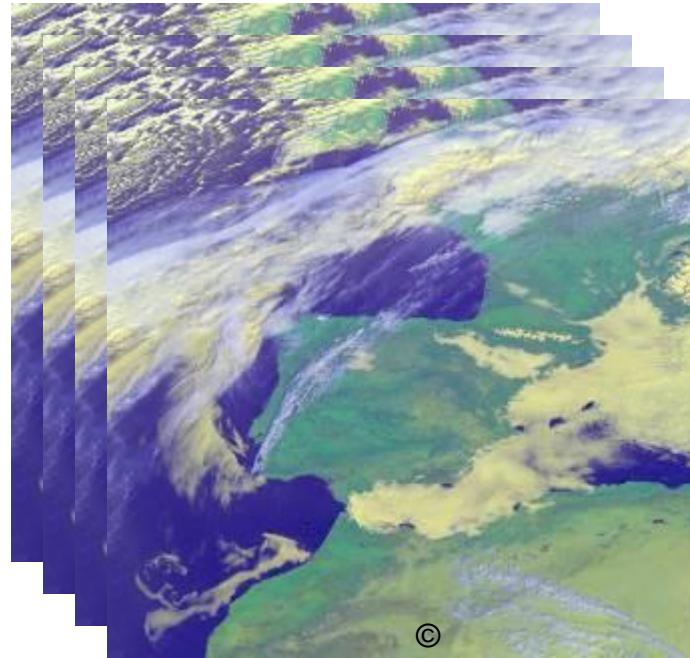


1-2 h nowcast range (Sue Ellen Haupt's talk)
4 h (Perez et al. papers)

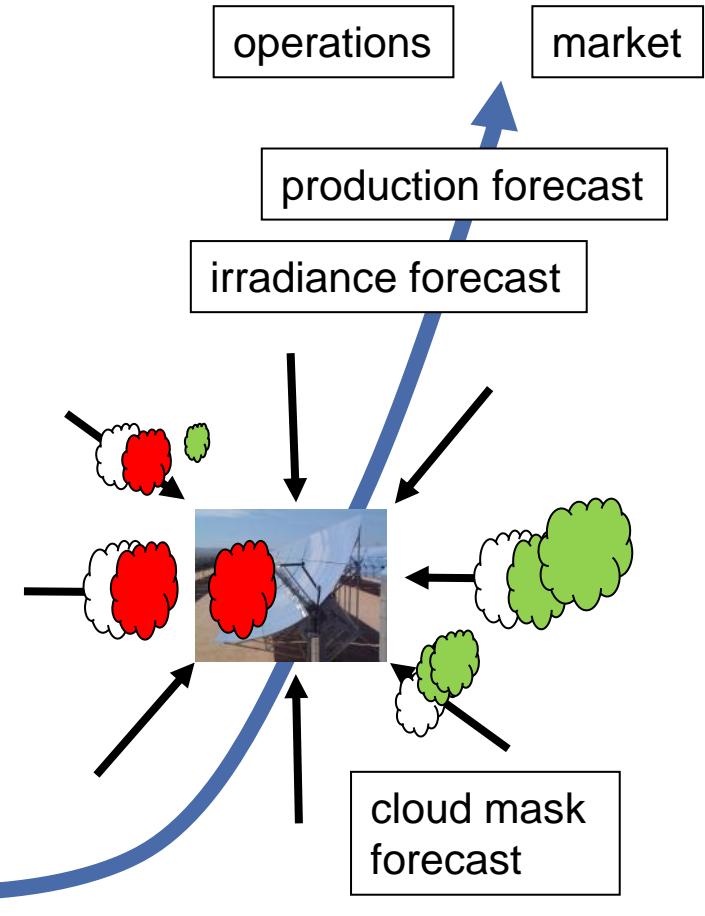
What to do? Can't use it for that? Only for operations of solar plant? Or do something else?



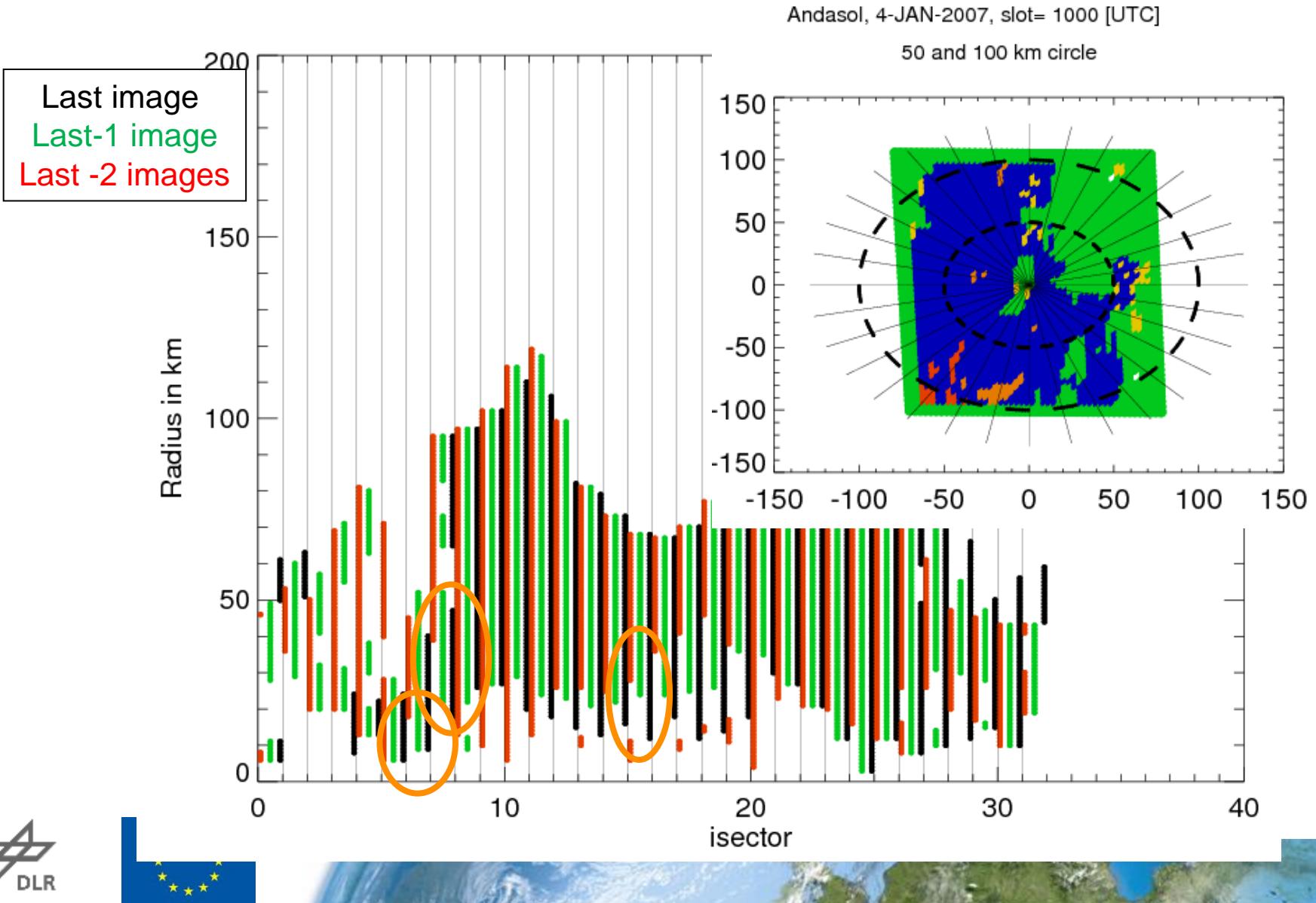
A receptor-like approach



sequence of cloud masks
thin ice clouds
water/mixed phase clouds

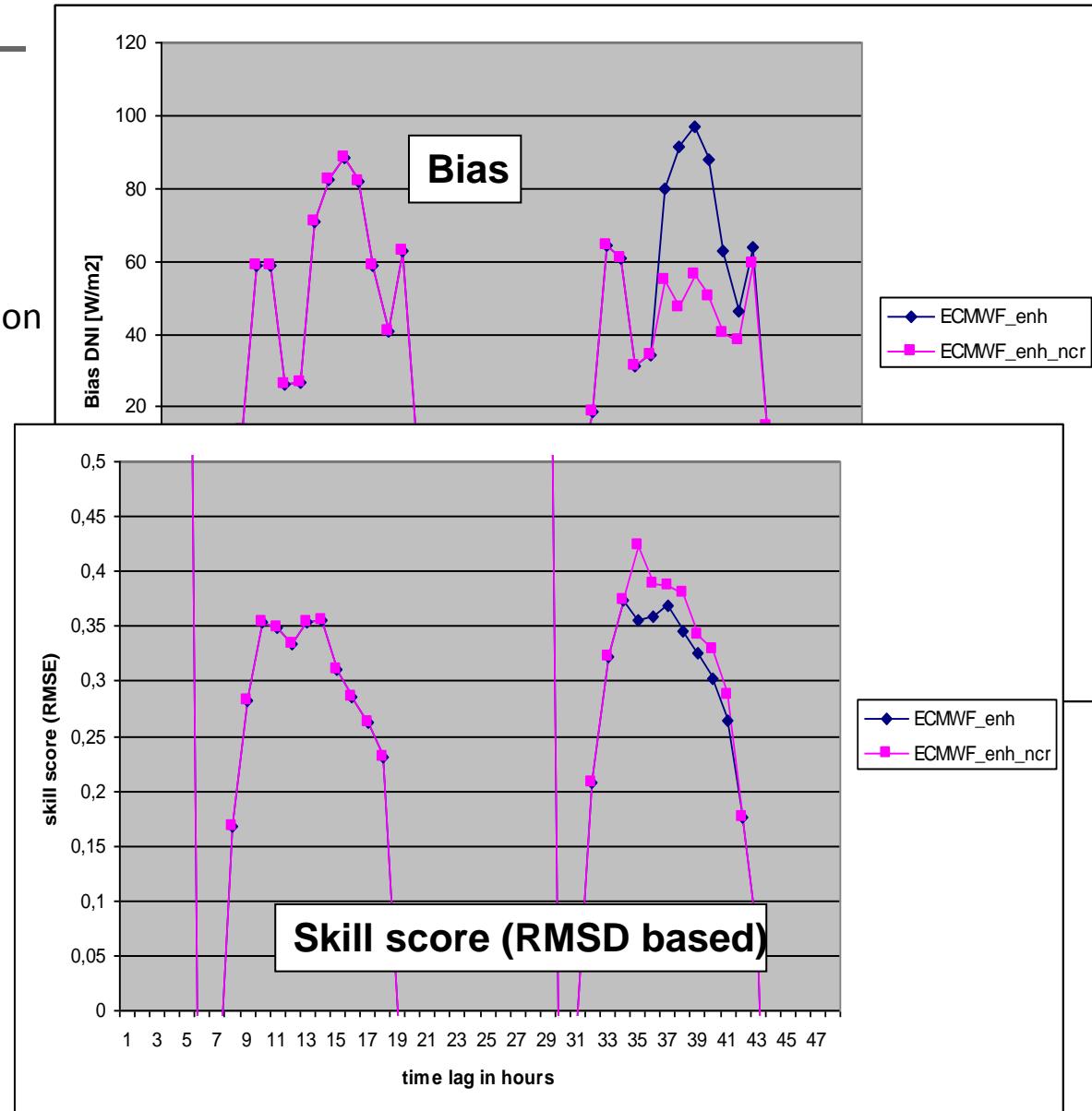


Principle

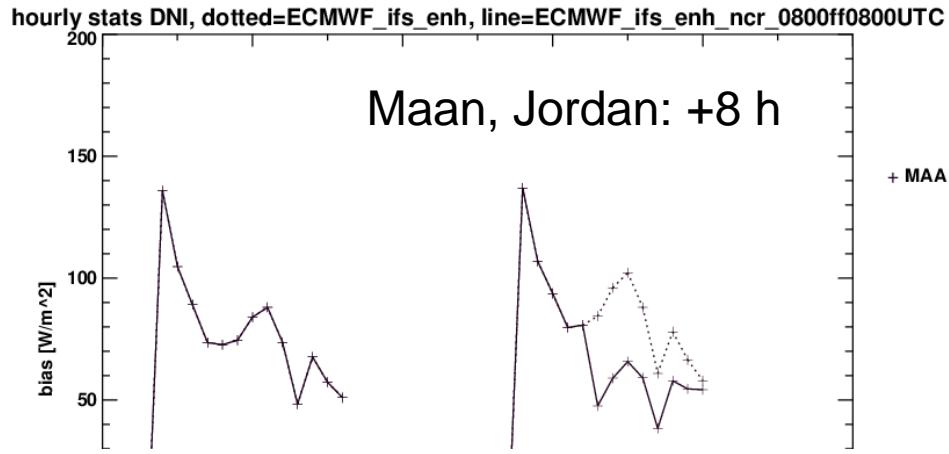


Statistical evaluation – Andasol site

- Receptor model, cloud motions
- 9:30 to 10:00 UTC satellite data
- Very simple use of cloud information (no COD, no scattered index)
- Statistics here over all cases
-> also those many without nowcasting
- Andasol-3 location, 1 year
- Day ahead forecast as reference
- Only use daytime hours
- Use time series of the nearest neighbour ECMWF grid box to the station's location
- 7 hours positive impact

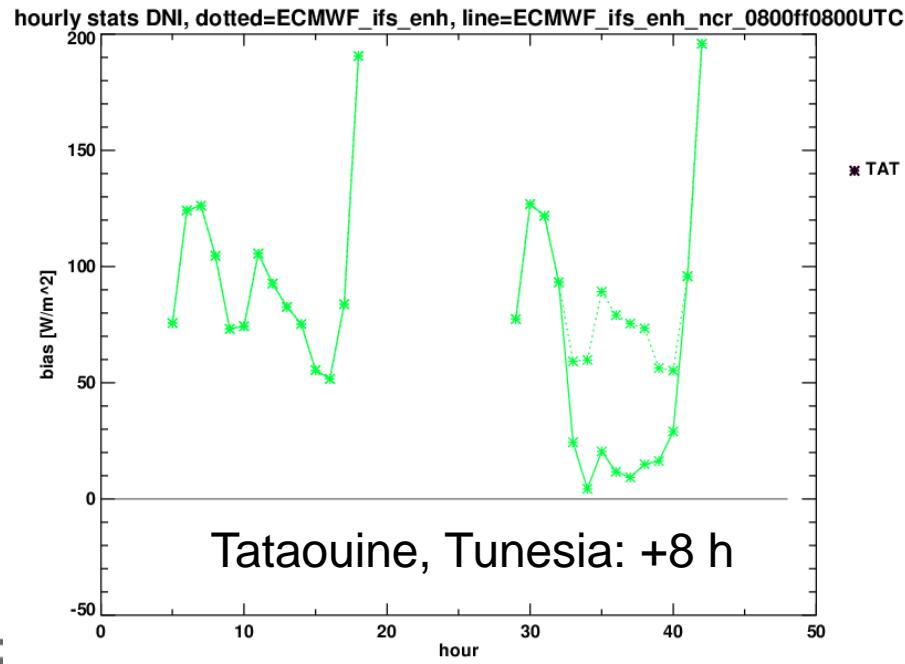


Does it apply to other stations?

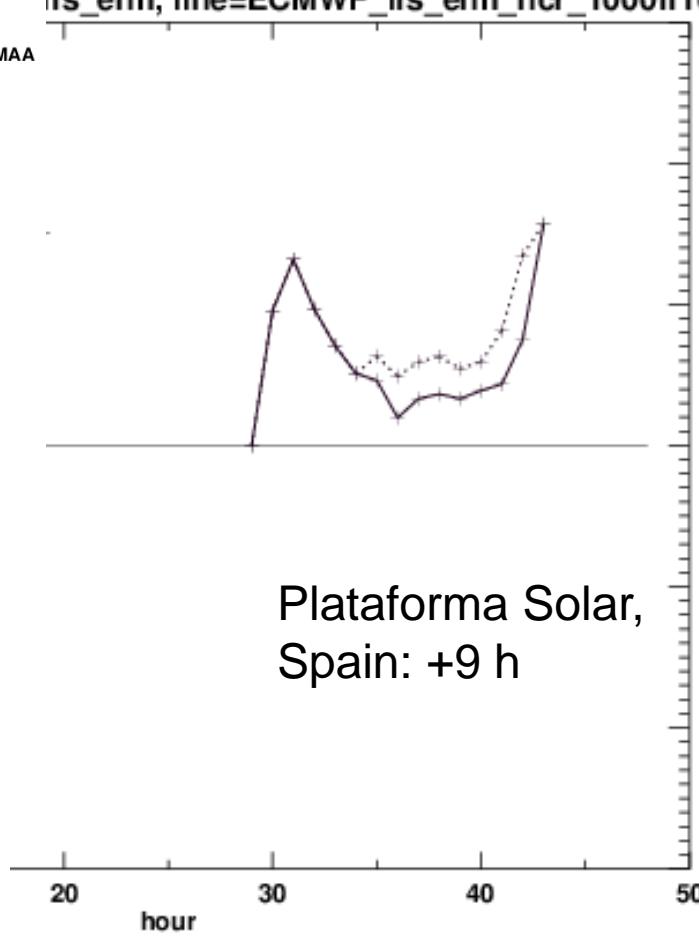


ifs_enh, line=ECMWF_ifs_enh_ncr_1000ff1000UTC

+ MAA

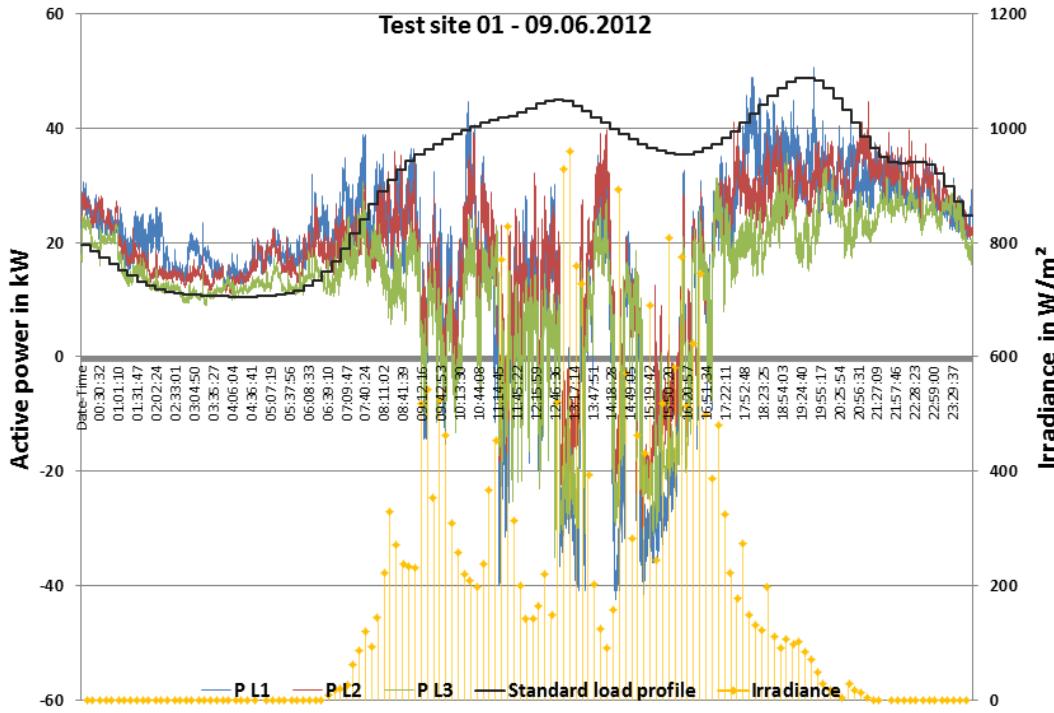


* TAT

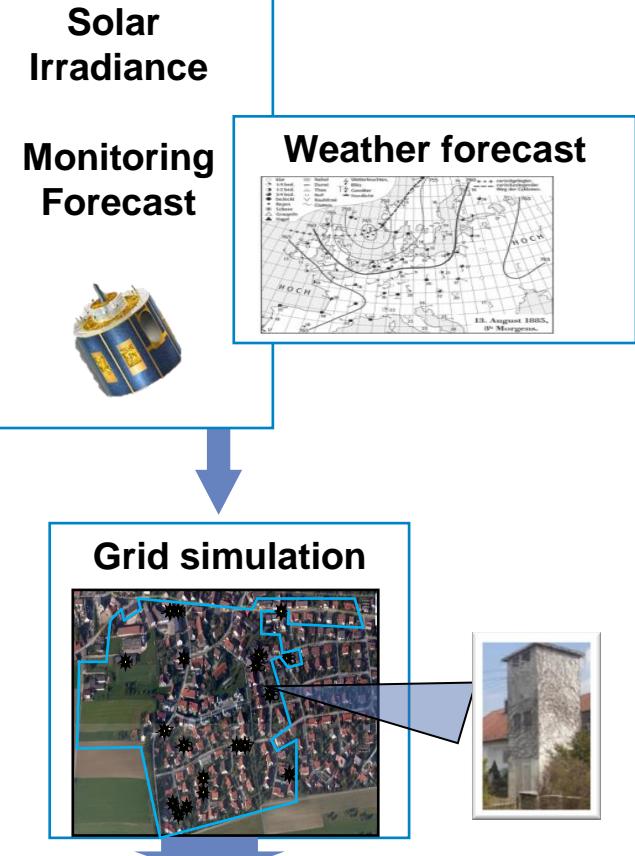




Large solar shares in nowadays electricity grid



See talk H. Ruf
on Friday



Optimized integration of solar electricity
into existing distribution grids

Conclusions

- Nowcasting for GHI up to 2-4 hours has been shown successfully for years
- DNI new approach - impact up to 9 hours vs NWP day ahead forecast
- Routinely used in test phase in Andasol-3 power plant
will be implemented soon for La Africana, Seville as next test case
- Next steps:
 - Apply for GHI in smart city project in Ulm
 - Connect to Heliosat-4 fast radiative transfer parameterization to enhance cloud -> irradiance transfer
 - Compare to traditional CMV
- See <http://dnicast-project.net/> on method development
- See <http://www.orpheus-project.eu> on how to use these nowcasts for smart cities with larger solar shares



Thanks to ...

- ... the BSRN team for providing ground data
- ... the EnerMENA team for providing ground data
- ... ECMWF for providing forecast data
- ... EUMETSAT for providing MSG satellite observations

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