Forecasting thunderstorms on the Po Valley using sounding–derived and satellite (Eumetsat IASI) derived indicies with Neural Networks

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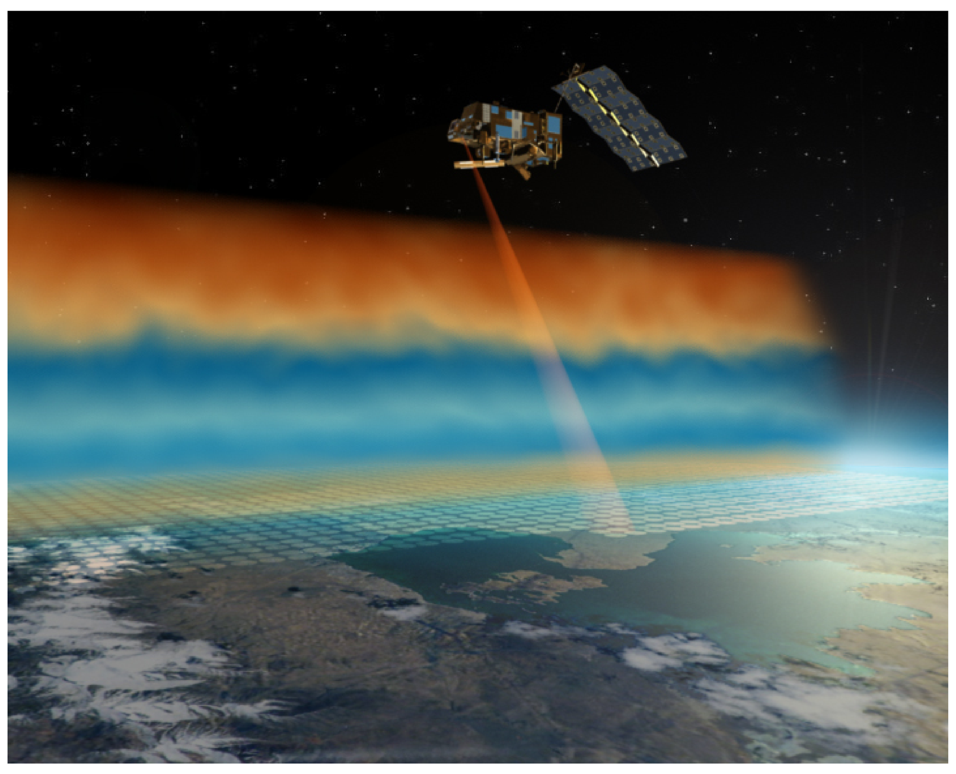
INTRODUCTION

- Will remote–sensing observations like the infrared measures taken from satellite be able to replace in–situ observations like those taken by radiosoundings?
- Given that sounding–derived indices have some skill in forecasting thunderstorm, a first answer could be obtained checking how much useful are the same indices when derived from satellite thermodynamic retrievals, like those taken by Eumetsat IASI.
- Following Antonelli et al. (2011a), the aim of this work is to compare a multivariate neural–network based forecast of storm occurrence made from radiosounding or from satellite data.



Infrared Atmospheric Sounding Interferometer (IASI) instrument onboard of EUMETSAT MetOp polar satellite (courtesy of ESA).

20090910 12 UTC radiosounding launch from the Udine station of A.M. using a Vaisala RS-92 sonde (courtesy of M. Mariano).

TARGET AREA AND DATASETS

- Two areas inside the Po Valley were used to study the occurrence of convection (defined as at least 3 or 5 C2G lightnings respectively) in the six hours (11–17 UTC) after the "12 UTC" sounding launch. The first target area is around the Milan RDS base (NW Italy), while the second is around the Udine RDS station (NE Italy).

- Data are instability indices computed by the SOUND_ANALYS.PY software (Manzato and Morgan 2003) from the radiosoundings (2004–2010) or from the IASI retrievals or the radiance Principal Components (2007–2010), as presented in the poster by Antonelli et al. (2011b), where also a bivariate analysis was done.

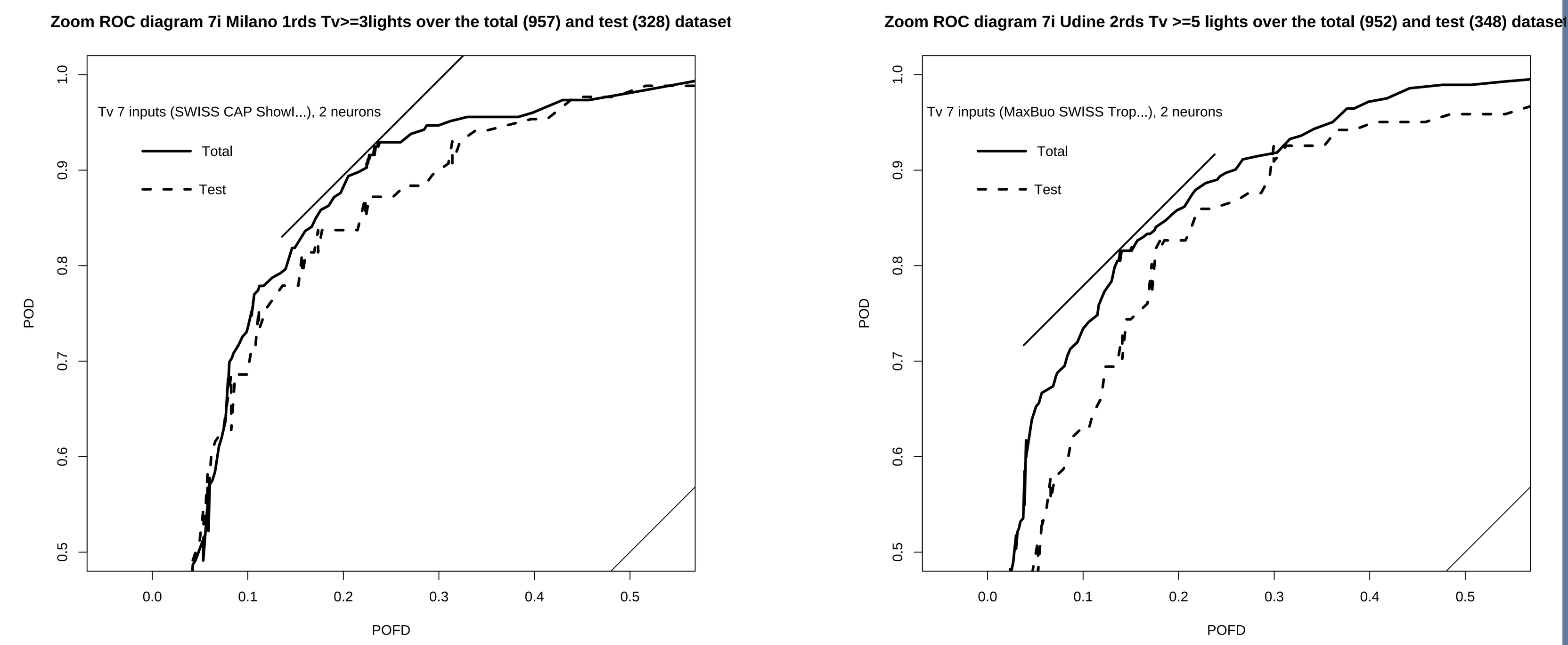
METHODS

- The *total* dataset is divided in training and validation subsets in 12 different ways and fit each time with a neural-network (**R** `nnet` module). An input–selection algorithm selects the input list (instability indices) that minimize the *Cross–Entropy training error* averaged on the 12 bootstraps.
- The "whole" system performance is evaluated with the Cross-Entropy error (**CEE**) on the total set and on an independent *test* set. The continuous output is then dichotomized using the event probability as threshold (Manzato 2007) and the binary output is used to build the contingency table. Peirce Skill Score (**PSS**), Odds Ratio and BIAS are then used as measures of performance for the binary classifier.
- Since the RDS database is much longer then the IASI database (limited to the 2007–2010 storm seasons with clear sky conditions at 9:30 UTC) the *reduced* RDS database is introduced, using only the subset of RDSs when there is the IASI retrieval available.

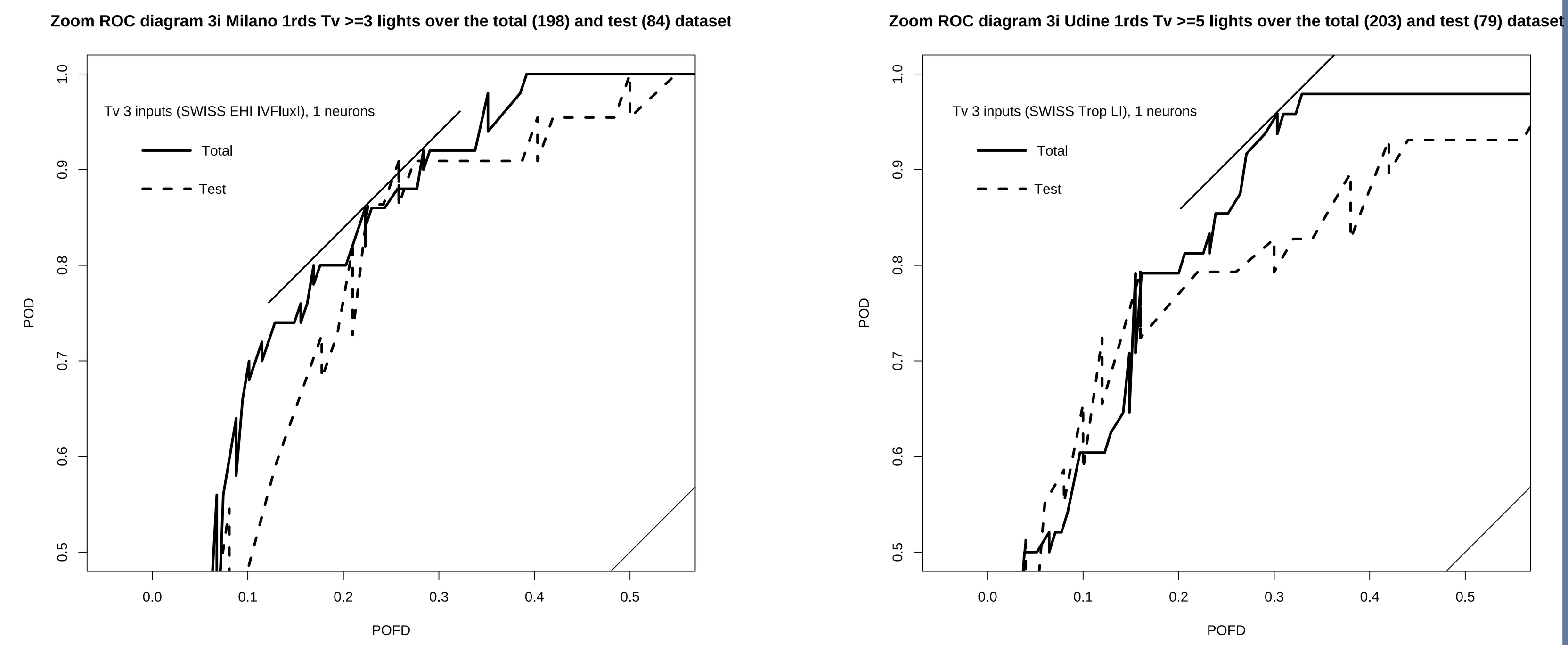
ZOOMED ROC DIAGRAMS AND SCORES (MILAN - UDINE)

- Zoomed Receiver Operating Characteristic for the database used to develop the neural network and for the independent test set.

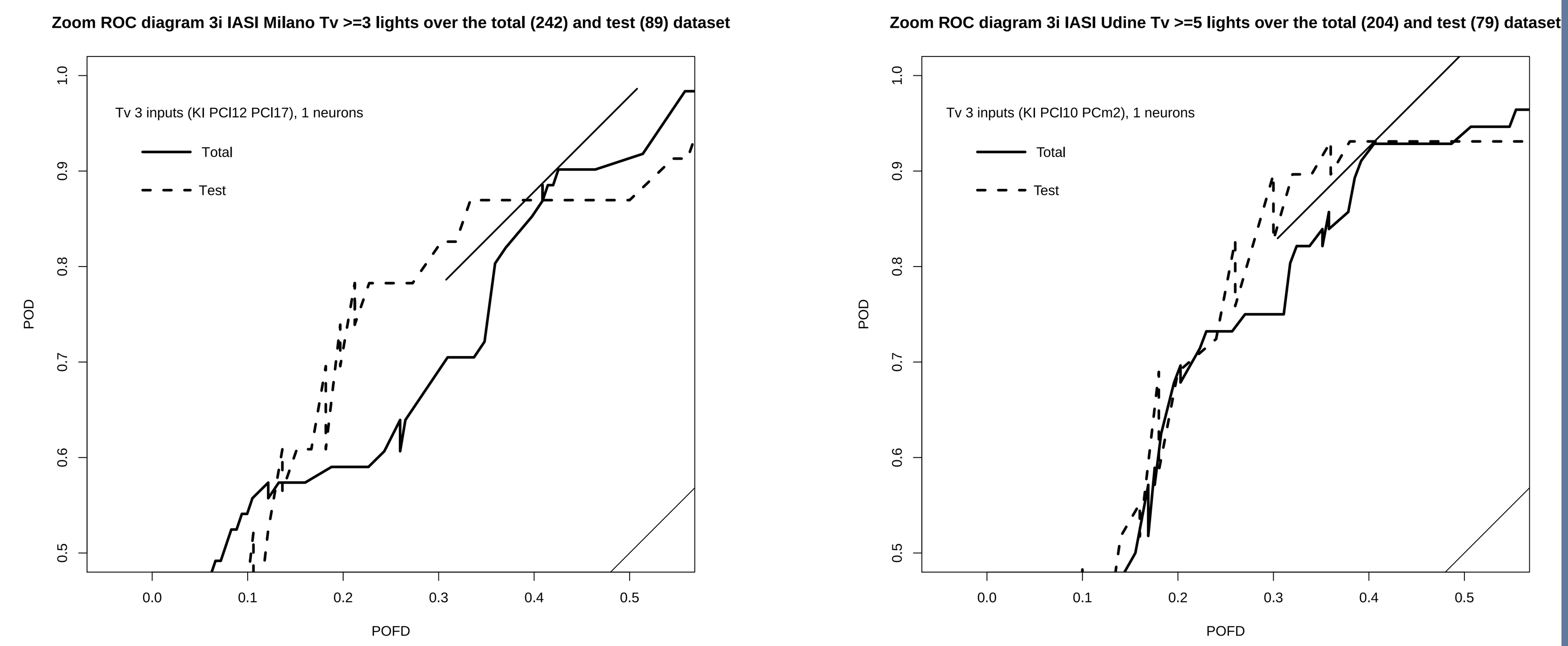
RDS full dataset (2004-2010)



RDS reduced database



IASI 2007-2010 data



- Cross–Entropy Error for the NN continuous output. PSS, Odds Ratio and BIAS from the contingency table of the dichotomized output.

	Milan				Udine			
experiment	CEE	PSS	Odds R.	BIAS	CEE	PSS	Odds R.	BIAS
RDS total	0.30	0.67	26	1.3	0.32	0.66	24	1.2
RDS test	0.33	0.64	21	1.4	0.41	0.65	22	1.2
RDS reduced total	0.35	0.62	18	1.5	0.35	0.62	18	1.4
RDS reduced test	0.41	0.51	15	2.0	0.45	0.57	14	1.2
IASI total	0.41	0.36	5	1.3	0.45	0.48	9	1.7
IASI test	0.42	0.54	12	1.3	0.55	0.60	20	1.4

CONCLUSIONS

- Reasonable performances have been found on the 2004–2010 RDS database using NNs with 7–inputs and 2–neurons in the hidden layer.
- Promising –but not yet satisfying– results have been found using the 2007–2010 IASI database (indices + Principal Components). Lower performances could be partially explained by the limited dataset (as happened with the RDS reduced dataset), that limits the complexity of the statistical model to NNs with only 3–inputs and 1–neuron.
- This suggests the integration of both data (from RDS and from satellite) together for an improved spatial resolution. Since IASI provides only two observation per day, results could improve by using more frequent observations (e.g. IRS on the future Eumetsat MTG).

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