European Geosciences Union General Assembly 2011 Vienna Austria 03-08 April 2011

Verification of the new ECMWF ERA-Interim reanalysis and use in a land surface model for the monitoring of Mediterranean droughts

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Verification of the new ECMWF ERA-Interim reanalysis: Context

- HYMEX Project
- HYdrological cycle in Mediterranean Experiment
- Objective of the study
- → Developing a soil moisture and vegetation biomass climatology
- → Study over the whole ECOCLIMAP-II area







- Land Surface Model ISBA-A-gs
- Using of ERA-Interim Data (0.5°)





Verification of the new ECMWF ERA-Interim reanalysis: Data sets and methods

→ Qualification of the ERA-Interim reanalysis was necessary for the verification of the forcings before running ISBA-A-gs

- Verification: forcing studies over France
 - Precipitation: SAFRAN (8 km), GPCC (0.5°), GPCP (2.5 °) [1991-2008 period]
 - Incoming Solar Radiation (ISR): Brion (8 km) [1995-2006 period]
 - Air humidity, air temperature and wind speed: SAFRAN (8 km) [1991-2008 period]

(Szczypta et al., 2011)





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(Szczypta et al., 2011)

- Precipitation rescaling: verification over France
 - GPCP-corrected version of ERA-Interim (ERA-I-R) [1991-2008 period]
 - ERA-I-R rescaling with the monthly GPCC water volume [1991-2008 period]



$$\mathbf{P}_{gPCC}^{3h} = \mathbf{P}_{ERA-I-R}^{3h} \times \mathbf{P}_{gPCC}^{month} / \mathbf{P}_{ERA-I-R}^{month}$$







Daily time step

- Good correlations ($R^2 > 0.8$)

Daily time step

- → Good correlations (R² > 0.8)
- In comparison to SAFRAN:

GPCC bias	<	ERA-I-R bias	<	ERA-I bias
6%		13%		27%

Year	Score	ERA-I	ERA-I-R	GPCC	GPCP
	R²	0.953	0.982	0.986	0.974
[1001 2008]	Bias (mm.month ⁻¹)	-21.4	-10.4	-4.4	0.5
[1991-2008]	RMSE (mm.month ⁻¹)	23.7	11.7	6.2	5.9
	Mean Precipitation (SA	FRAN)	951 m	m on avera	age









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→ Precipitation verification was extended over the Ecoclimap-II area (Europe, North Africa and Middle-East)









ERA-I-R increase precipitation values: - biases are smaller over Europe

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CNIS

Trend seems to be different in the area between the Black Sea and the Caspian Sea

South of the area: dry climate with weak precipitation



Verification of the new ECMWF ERA-Interim reanalysis: Incoming Solar Radiation (ISR) over France



Daily time step (2001 = standard year)

- Good correlations (R² > 0.9)
- SAFRAN tends to underestimate ISR (4%)
- ERA-I tends to overestimate ISR (7%)
- ERA-I overestimation is greater in summer



EGU 03-08 April 2011 HS2.8 – Verification of ERA-Interim reanalysis camille.szczypta@cnrm.meteo.fr

Monthly time step [1995-2006]

- Same results
- ERA-I overestimation is high during summer

6



Toujours un tem



352

264

176

88

0

2001

SR (W.m⁻²)

SAFRAN ISR

2002

2003

2004

2005

6

2000

2006

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Toujours un tem

Use of ERA-Interim forcings to generate biophysical variables: Impact on the ISBA-A-gs simulations

- ERA-Interim forcings are used to run the Land Surface Model (ISBA-A-gs)
- Permit to generate biophysical variables
 - → Leaf Area Index (LAI)
 - → Surface soil moisture (Wg)
 - → Root zone soil moisture (W_2)
- **Impact study:** simulations compared with simulations obtained with SAFRAN + use of ERA-Interim rescaled precipitation
- <u>Sensitivity study</u>: How do the different forcing variables impact the LAI and root zone soil moisture simulations ?





Studies of the ISBA-A-gs simulations over France: Root zone (w_2) , surface (w_q) soil moisture and Leaf Area Index (LAI)

- Very good correlations between SAFRAN and the other simulations
- Regarding biases: (ERA-Interim, ERA-Interim rescaled and GPCC, respectively)
 - → w₂: 7%, 4% and 3% bias
 - \rightarrow w_g : 10%, 6% and 5% bias
 - → LAI: 17%, 7% and 2% bias

Forcing	Scores	W ₂	Wg	LAI
	R²	0.95	0.96	0.82
ERA-Interim	Bias	0.016 m ³ .m ⁻³	0.024 m ³ .m ⁻³	0.357 m ² .m ⁻²
	RMSE	0.017 m ³ .m ⁻³	0.029 m ³ .m ⁻³	0.618 m ² .m ⁻²
EP A_Intorim	R²	0.97	0.96	0.88
rescaled	Bias	0.010 m ³ .m ⁻³ 0.016 m ³ .m ⁻³		0.145 m ² .m ⁻²
	RMSE	0.012 m ³ .m ⁻³	0.023 m ³ .m ⁻³	0.431 m ² .m ⁻²
	R²	0.98	0.95	0.91
GPCC	Bias	0.008 m ³ .m ⁻³	0.014 m ³ .m ⁻³	0.042 m ² .m ⁻²
	RMSE	0.010 m ³ .m ⁻³	0.020 m ³ .m ⁻³	0.346 m ² .m ⁻²
SAFRAN	Mean value	0.239 m ³ .m ⁻³	0.253 m ³ .m ⁻³	2.129 m ² .m ⁻²





Studies of the ISBA-A-gs simulations over France:

Leaf Area Index (LAI)



- LAI simulations (ISBA-A-gs) are compared with LAI satellite observations (MODIS and CYCLOPES)
- Satellites LAI tends to saturate at high values → LAI satellite values are smaller than real LAI values
- Min LAI values at Wintertime are fixed \rightarrow difficult to compare the curves during this season

Data	Score	SAFRAN	ERA-I	ERA-I-R	GPCC
Cyclones	R²	0.52	0.82	0.76	0.73
Cyclopes -	Bias (m ² .m- ²)	0.45	0.05	0.29	0.39
Modie	R²	0.55	0.80	0.75	0.72
Modis -	Bias (m ² .m- ²)	0.53	0.14	0.38	0.47





Studies of the ISBA-A-gs simulations over France: Leaf Area Index (LAI)



• LAI simulations (ISBA-A-gs) are compared with LAI satellite observations (MODIS and CYCLOPES)

- 2002 and 2003 present different LAI cycle: slow and fast decrease for 2002 and 2003, respectively
 - → Different curves have the same general aspect
 - → Simulations describe correctly these tendencies
- Forcings have strong impacts on ISBA-A-gs simulations
- ERA-I permits to better represent beginning of LAI cycle





Studies of the ISBA-A-gs simulations over France: Sensitivity study to different forcing use on the LAI



Studies of the ISBA-A-gs simulations over France: Sensitivity study to different forcing use on the W₂



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Verification of the new ECMWF ERA-Interim reanalysis: Conclusion and Perspectives

→ Conclusion

- ERA-I-R precipitation tends to be better than ERA-I precipitation
- On average for precipitation: 27% bias with ERA-I, 13% with ERA-I-R and 6% with GPCC
- On average for ISR: underestimation by 4% for SAFRAN and overestimation by 7% for ERA-I
- These biases have an impact on LAI, W_2 and W_g simulations over France
- ISR tends to impact the start of the LAI cycle and precipitation has more effects on LAI senescence





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→ Prospects

- Radiative transfer improvement in ISBA-A-gs to reduce the impact of ISR
- Simulations over the Ecoclimap-II area and comparison with satellite data
- Hydrological studies with runoff model, TRIP model (Oki et al., 1997) over the whole area
- Developing of a soil moisture and vegetation biomass climatology over the area



Impact study of different cases in the climate change context



THANK YOU FOR YOUR ATTENTION

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