Intercomparison experiments: First involvements with Joël

Jean-François Mahfouf
DR/CNRM/GMAP/OBS (Toulouse, France)

The (special) place of Joël in my career

- **1983-1985**: PhD @ LAMP (HAPEX-MOBILHY preparation: land surface scheme in mesoscale model)
- **1988**: Stage de fin d'études ENM @ MC2 (ISBA during rainy days of HAPEX-MOBILHY)
- **1988-1990**: FCPLR @ MC2 (further evaluations of ISBA – soil analysis with ISBA)
- **1990-1994**: Climate modelling activities @ GMGEC (intercomparison projects) - HDR degree
- **2006**: Back from Canada @ GMME (LDAS within SURFEX)

METEO FRANCE

Further evaluations of the ISBA scheme (1)

After Noilhan and Planton (1989) ….

Bruno's contributions

A Study of Rainfall Interception Using a Land Surface Parameterization for Mesoscale Meteorological Models

JEAN-FRANÇOIS MAHFOUF AND BRUNO JACQUEMIN
Centre National de Recherches Météorologiques (DMN/EERM), Toulouse, France

(Manuscript received 6 Februrary 1989, in final form 23 June 1989)

JAMC, 1989

SENSITIVITY STUDY AND VALIDATION OF A LAND SURFACE PARAMETERIZATION USING THE HAPEX-MOBILHY DATA SET

BRUNO JACQUEMIN and JOËL NOILHAN
Centre National de Recherches Météorologiques (DMN/EERM), 31057 Toulouse Cedex, France

(Received in final form 2 January, 1990)

BLM, 1990

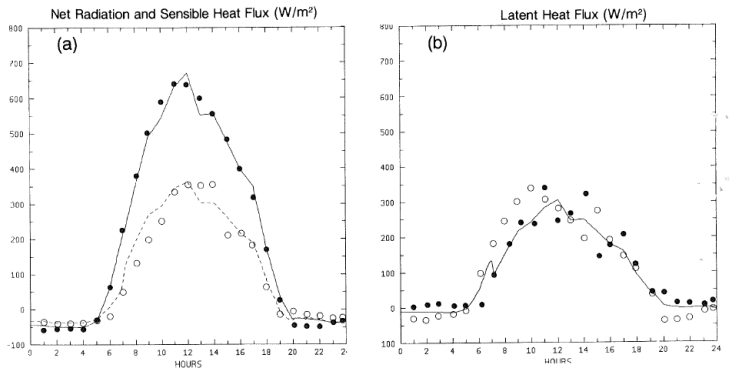
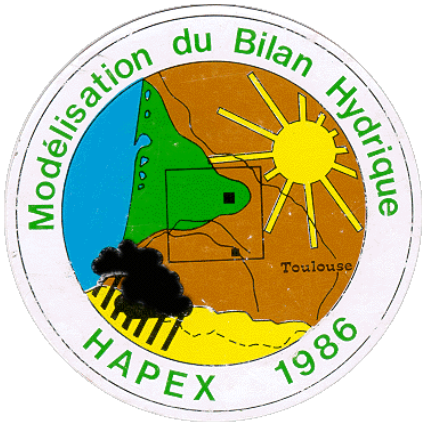


Fig. 21. Diurnal variations of observed and predicted surface fluxes over the Landes forest for June 13, 1986: (a) Net radiation Rn observed (●) and predicted (———). Sensible heat flux H observed (○) and predicted (------); (b) Latent heat flux LE observed (●) and predicted (———); observed residual $(Rn - H)$ (○).



… but still crops and pine forest

METEO FRANCE

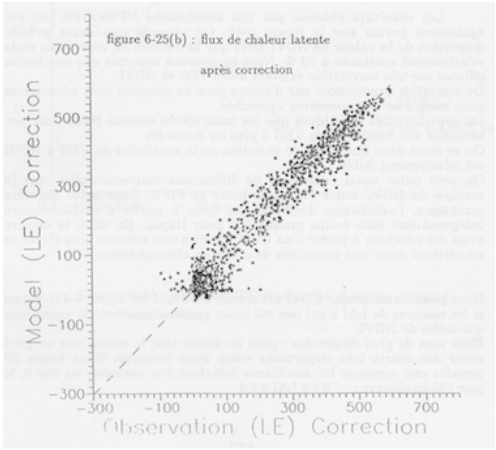
Further evaluations of the ISBA scheme (2)

FIFE 1987 : Konza prairie (US)

Marie-Jo's contributions

Stage de fin d'études ITM

Under the initiative of **Piers Sellers (NASA)**



New results on surface evapotranspiration:

- Vapour pressure deficit in canopy resistance (vegetation)
- Inclusion of a soil resistance (bare ground)

METEO FRANCE

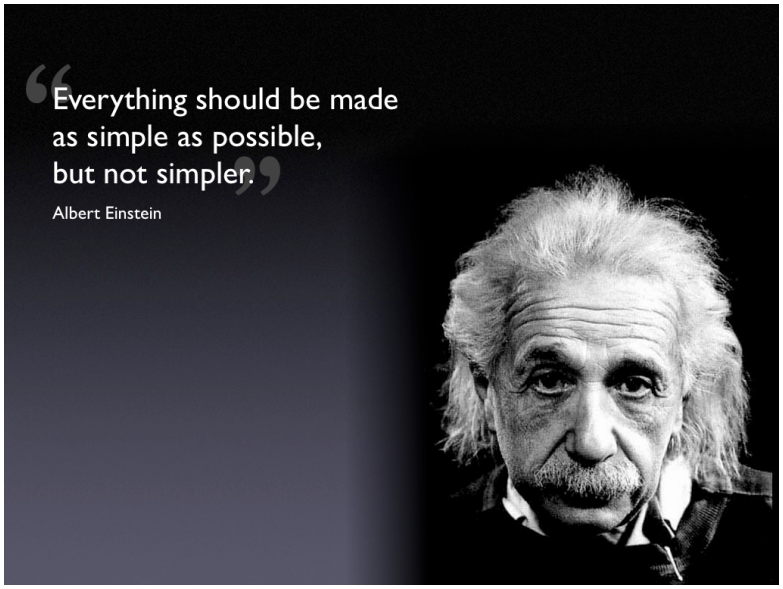
A glimpse into their future

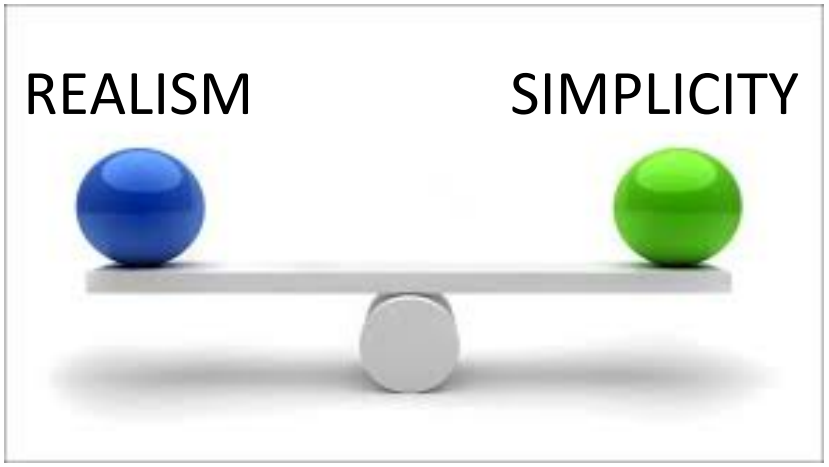
Piers Sellers after being involved in the BOREAS field campaign became an astronaut (1996-2011) Space shuttle crew

Marie-José became a writer of fantasy books for children

METEO FRANCE

ISBA vs. other land surface schemes





ISBA

Comparative Study of Various Formulations of Evaporation from Bare Soil Using In Situ Data

J. F. MAHFOUF AND J. NOILHAN

Météo-France/CNRM, 31057 Toulouse, France

(Manuscript received 17 October 1990, in final form 11 February 1991)

JAMC, 1991

METEO FRANCE

Bare soil evaporation : comparative study

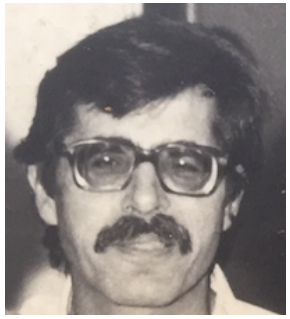
First step : literature review

TABLE 1. Methods for calculating E_g: w_{wilt}, w_{fc} and w_{sat} are the volumetric water content at the wilting point, field capacity, and saturation, respectively. The molecular diffusion D_m is given by Eq. (6) from Kondo et al. (1990). The coefficients D and K are the near-surface hydraulic diffusivity and conductivity, respectively. An average soil diffusivity $\hat{D}$ is defined by Eq. (4b) of Dickinson (1984). The coefficient C_K is given by Eq. (4) of Dickinson (1984) and d, d_1, and d_2 are the depth at which the diurnal cycle of soil moisture is damped, the depth of the top soil layer, and the depth of the total active layer, respectively. The coefficients B and b are textural dependent parameters expressed by Eq. (7) of Wetzel and Chang (1987) and Clapp and Hornberger (1978), respectively.

Bulk aerodynamic formulation		Threshold formulation
$\frac{\rho}{R_a}[\alpha q_{sat}(T_s) - q_a]$	$\frac{\rho}{R_a}\beta[hq_{sat}(T_s) - q_a]$	$\min\left\{\rho_w E_t, \frac{\rho}{R_a}[q_{sat}(T_s) - q_a]\right\}$
$\alpha = \min\left(1, \frac{1.8w_g}{w_g + 0.30}\right)$ (B79) (Barton 1979)	$\beta = \min\left(1, \frac{w_g}{0.75w_{sat}}\right)$ $h = 1$ (D78) (Deardorff 1978)	$E_t = 2D\frac{w_g - w_{wilt}}{d_1} - K$ (MP84) (Mahrt and Pan 1984)
$\alpha = \min\left(1, \frac{1.8w_g}{0.7w_g + 0.40}\right)$ (YT81) (Yasuda and Toya 1981)	$\beta = \frac{R_a}{R_a + R_{soil}}$ $h = 1$	$E_t = C_K\hat{D}\frac{w_2}{w_{sat}\sqrt{d_1 d_2}}$ (D84) (Dickinson 1984)
$\alpha = \frac{1}{2}\left[1 - \cos\left(\frac{w_g}{w_{fc}}\frac{\pi}{2}\right)\right]$ if $w_g < w_{fc}$	$R_{soil} = 3.5\left(\frac{w_{sat}}{w_g}\right)^{2.3} + 33.5$ (S82) (Sun 1982)	$E_t = \frac{B}{\Delta W}\{w_2^{b+4} - w_{wilt}^{b+3}[w_2(b+4) - w_{wilt}(b+3)]\}$ $\Delta W = -d(w_g - w_2)$ (WC87) (Wetzel and Chang 1987)
$\alpha = 1$ if $w_g \geq w_{fc}$ (NP89) (Noilhan and Planton 1989)	$R_{soil} = 3.8113 \times 10^4 \exp\left(-13.515\frac{w_g}{w_{fc}}\right)$ (P86) (Passerat 1986)	$E_t = \frac{Dw_g\pi^2}{4d_1}$ (A88) (Abramopoulos et al. 1988)
	$R_{soil} = 216(w_{sat} - w_g)^{10}/D_m$ (K90) (Kondo et al. 1990)	
	$R_{soil} = 4140(w_{sat} - w_g) - 805$ (CG86) $h =$ Eq. (1) (Camillo and Gurney 1986) (Dorman and Sellers 1989)	

Intrumented field from INRA in Montfavet

Data from **Michel Vauclin** *IMG Grenoble*



Decoded and made usable by **Charles Mercusot**

Bare soil evaporation: comparative study

A nice skech from Joël

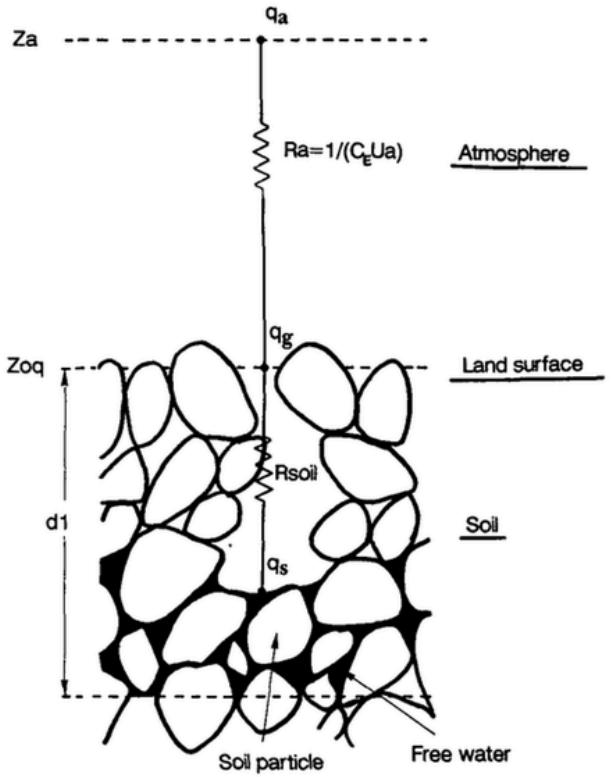


FIG. 1. A schematic description of a surface layer of depth d_1 as proposed by Kondo et al. (1990). Water vapor is diffused through the large pore from the free-water surface to the land surface.

TABLE 2. Summary of evaporation formulation used in the five tests.

Test	Evaporation formulation	
1	$E_g = \frac{\rho}{R_a}(q_g - q_a)$	with $q_g = \max[\alpha q_{sat}(T_s), q_a]$ and α = Eq. (NP89) if $q_{sat}(T_s) \geq q_a$ with $q_g = q_{sat}(T_s)$ if $q_{sat}(T_s) < q_a$
2	$E_g = \frac{\rho}{R_a + R_{soil}}[q_{sat}(T_s) - q_a]$	with R_{soil} = Eq. (P86)
3	$E_g = \frac{\rho}{R_a}\beta[q_{sat}(T_s) - q_a]$	with β = Eq. (NP89)
4	$E_g = \frac{\rho}{R_a + R_{soil}}[hq_{sat}(T_s) - q_a]$	with R_{soil} = Eq. (P86) and h = Eq. (1)
5	$E_g = \min\left\{\rho_w E_t, \frac{\rho}{R_a}[q_{sat}(T_s) - q_a]\right\}$	with E_t = Eq. (WC87)

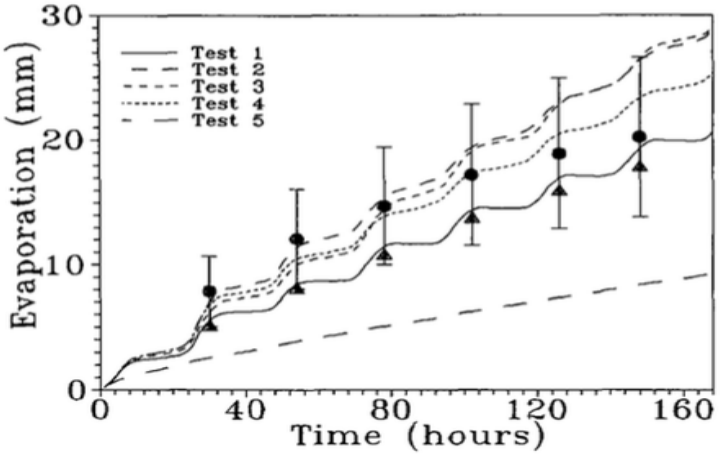


FIG. 7. As in Fig. 6 but for cumulative evaporation. Estimations are deduced from observed water budget (full circles with standard deviations) and aerodynamic measurements (full triangles).

Realistic behaviour of ISBA: importance of thermal and hydraulic properties => extended by Isabelle Braud using EFEDA field data

METEO FRANCE

First participation to PILPS (Phase 1)

PILPS

Projet for
Intercomparison
Land Surface
Parameterization
Schemes

Ann Henderson-Sellers
Iron fist leader

Global Energy and Water Cycle Experiment
GEWEX
WCRP

World Meteorological Organization
Working Group on Numerical Experimentation (WGNE)

Climate Dynamics (1999) 15:673–684

A. J. Pitman · A. Henderson-Sellers
C. E. Desborough · Z.-L. Yang · F. Abramopoulos
A. Boone · R. E. Dickinson · N. Gedney · R. Koster
E. Kowalczyk · D. Lettenmaier · X. Liang
J.-F. Mahfouf · J. Noilhan · J. Polcher · W. Qu
A. Robock · C. Rosenzweig · C. A. Schlosser
A. B. Shmakin · J. Smith · M. Suarez · D. Verseghy
P. Wetzel · E. Wood · Y. Xue

1-year offline simulation over various surfaces – forcing from NCAR GCM

ISBA better than NP89

Key results and implications from phase 1(c) of the Project for Intercomparison of Land-surface Parametrization Schemes

Received: 15 October 1997 / Accepted: 22 April 1999

First participation to PILPS (Phase 1)

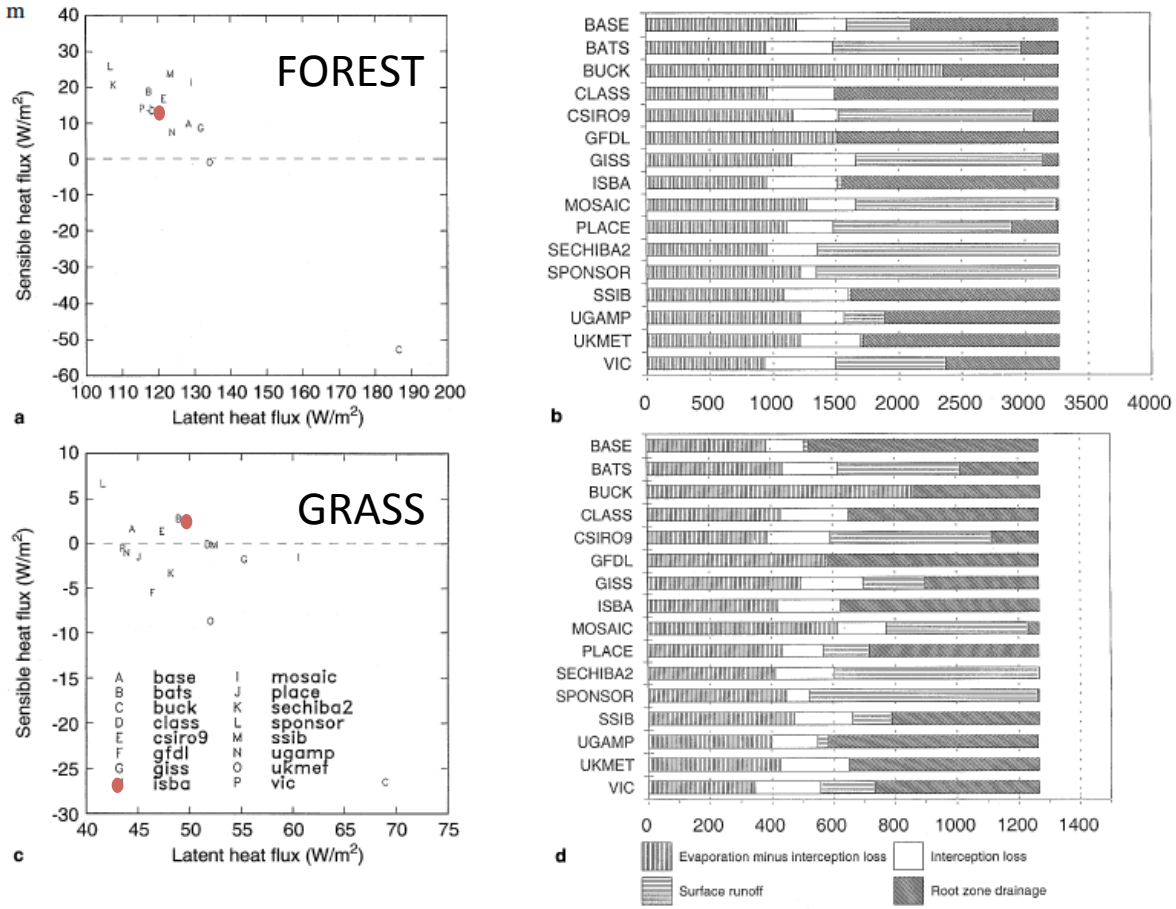


Fig. 1 a Relationship between annually averaged simulated sensible and latent heat fluxes from the models participating in PILPS for FOREST. **b** Water balance quantities for each model for FOREST (in mm y^{-1}). Note that root zone drainage for ISBA includes 1041 mm for root zone drainage and 675 mm for interflow. **c** As **a** but for GRASS. **d** As **b** but for GRASS

Behaviour of ISBA in the average of other (simpler and more complex) land surface schemes

Need of observations for a ground truth reference

With Joël we made fun of the lack of realism of the NCAR GCM forcing

16 land surface models

METEO FRANCE

Towards a second PILPS exercice

With Joël we proposed to provide a one-year 30-min data set forcing and validation (fluxes, soil moisture) from HAPEX-MOBILHY (at Caumont station in 1986) for PILPS (available in SURFEX)

This has been followed by similar initiatives: MUREX, SMOSREX, Météopole-flux

Activity carefully undertaken by **Patrick Péris** (quality controls, missing data, …)

Inclusion of Gravitational Drainage in a Land Surface Scheme Based on the Force–Restore Method

J.-F. MAHFOUF

ECMWF, Shinfield Park, Reading, Berkshire, United Kingdom

J. NOILHAN

Météo-France/CNRM, Toulouse, France

(Manuscript received 7 July 1995, in final form 20 November 1995)

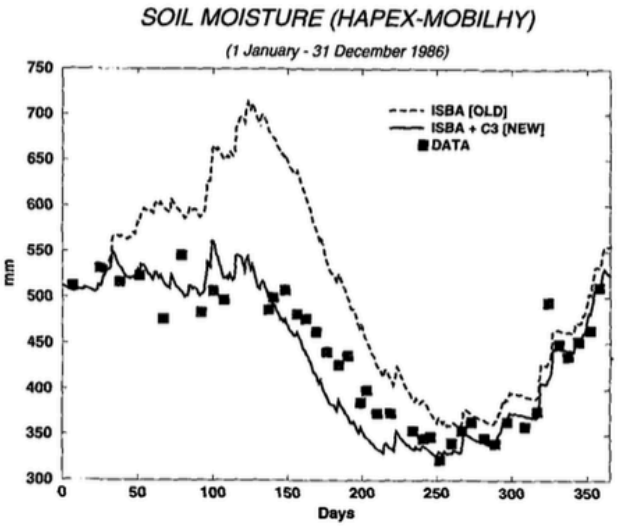


FIG. 3. Annual cycle of total soil water content (mm) in the top 1.6 m simulated by ISBA with (solid line) and without drainage (dotted line) and in comparison with HAPEX data (solid squares).

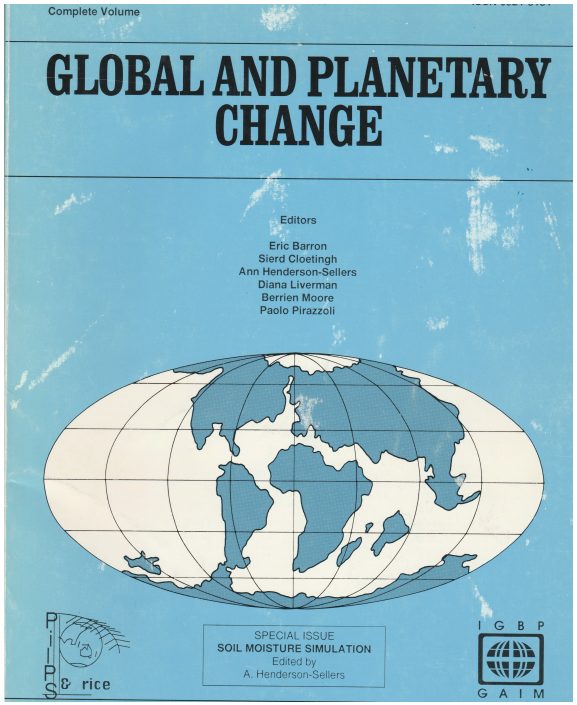
PILPS-RICE workshop (Sydney, 1994)

Soil moisture simulation workshop during 2 weeks (14-25 November 1994) with 15 worldwide participants

Intercomparisons of land surface schemes using the HAPEX-MOBILHY data set (validation and sensitivity experiments) - Results and land surface models presented in a special issue of *Global and Planetary Change*

Workshop participants and landsurface parameterisation schemes studied in the RICE and PILPS workshop

Participant	Landsurface schemes
Zong Liang Yang	[BATS]
Andy Pitman	[BEST]
Peter Thornton	[BGC]
Alex Haxeltine	[BIOME2]
Parviz Irannejad	[BUCKET]
William J. Parton	[CENTURY]
Diana Verseghy	[CLASS]
Eva Kowalczyk	[CSIRO9]
Jean-Francois Mahfouf, Joel Noilhan	[ISBA]
Dragutin T. Mihailovic	[LAPS]
Peter Wetzel	[PLACE]
Agnes Ducharne	[SECHIBA2]
Yong Kang Xue	[SSiB]
Xu Liang	[VIC]



METEO FRANCE

PILPS-RICE workshop (Sydney, 1994)

ELSEVIER

Global and Planetary Change 13 (1996) 145–159

GLOBAL AND PLANETARY CHANGE

The ISBA land surface parameterisation scheme

J. Noilhan, J.-F. Mahfouf [1]

Météo-France / CNRM, 42 Avenue Coriolis, 31057 Toulouse Cedex, France

Received 5 May 1995; accepted 28 August 1995

[1] ECMWF

Revised description of the ISBA scheme: changes with respect to the Noilhan and Planton (1989) paper and additional validation studies undertaken between 1989 and 1996.

All the equations needed to code the 2 layer ISBA scheme (without snow) are given in this paper (except the numerical scheme)

Opportunity to start collaborations with worldwide scientists
In particular with Peter Wetzel (NASA) and his young collaborator

METEO FRANCE

Subsequent intercomparisons

1D Climate change

1D Cabauw

1D Snow

2D GSWP

2D ALMIP

2D Red Arkansas

2D Rhône AGG

METEO FRANCE

Final thoughts: working with Joël was …

challenging

stimulating

fun

rewarding

enjoyable

supportive
dedicated

bright
knowledgeable

Thank you Joël for your legacy!