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MASTER STUDY & ECOSYSTEM BUILDING

## Application des SIG dans le Calcul de la température de surface (LST)

Coordinator

Partners



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info@mastermehmed.com  
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PROJECT NUMBER: 598826-EPP-1-2018-1-ES-EPPKA2-CBHE-JP





صالح بوبنيدر  
SALAH BOUBNIDER

MASTER STUDY & ECOSYSTEM BUILDING



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Présenté par : Dounia KHELLAF



- ✓ Membre du Laboratoire Architecture Bioclimatique & Environnement,
- ✓ Faculté d'architecture et d'urbanisme,
- ✓ Université Salah Boubnider, Constantine 3.

- 08 juin 2021 -

Coordinator



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# Application des SIG dans le Calcul de la température de surface (LST)

## Comparaison entre trois sites différents dans le globe terrestre

**Matière: SIG appliqué  
à l'environnement**

Coordinator

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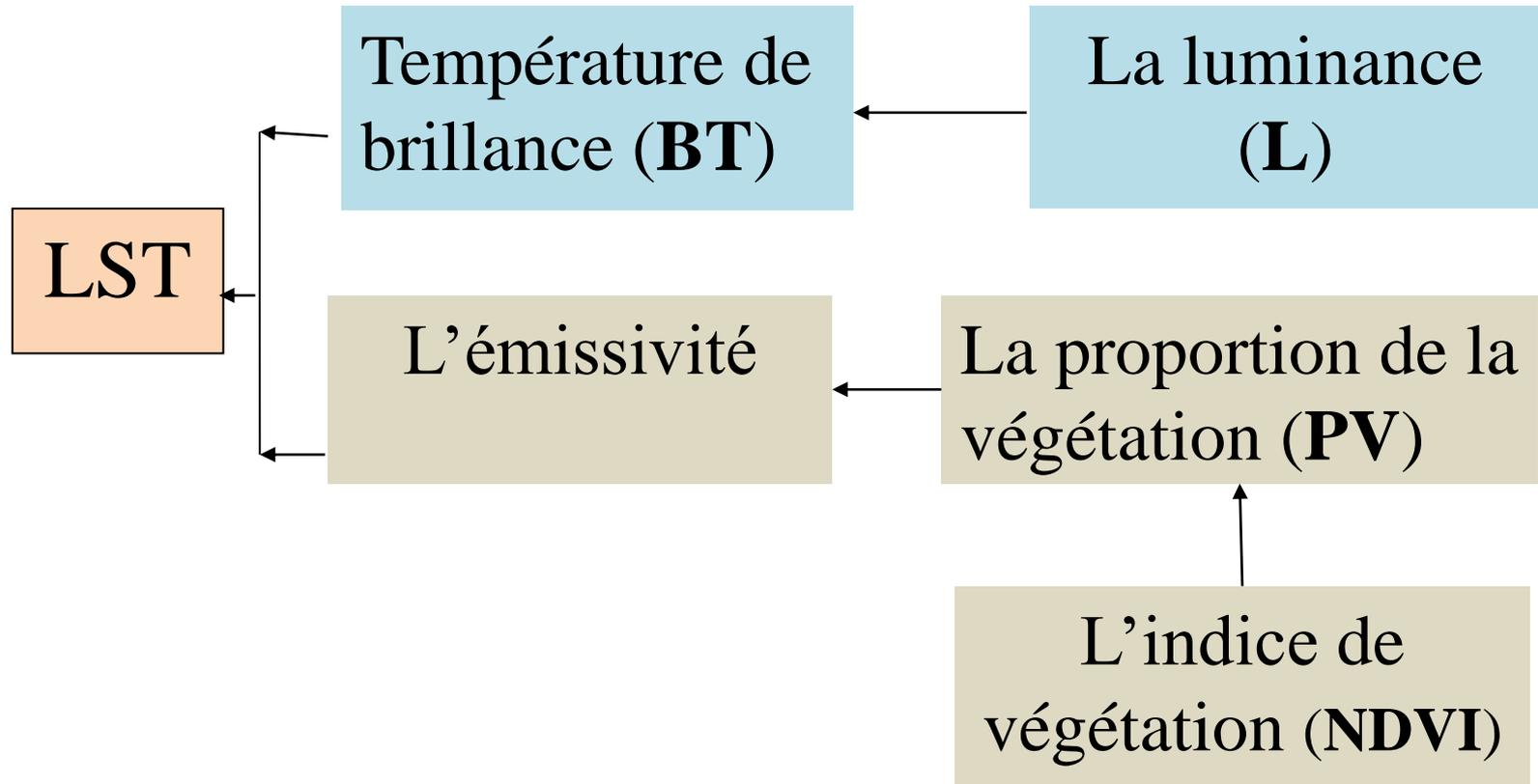
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## Diagramme de calcul de la température de surface LST



1

Convertir les valeurs numériques de la bande thermique (band10/ band11) en **luminance (TOA)**

$$L_{\lambda} = M_L \times Q_{cal} + A_L$$

- $L_{\lambda}$  = Luminance
- $M_L$  = RADIANCE\_MULT\_BAND\_x,
- $A_L$  = RADIANCE\_ADD\_BAND\_x,
- $Q_{cal}$  = la bande spectral thermique considérée

EXEMPLE:

$$L_{B10} = 0.0003342 \times BAND10 + 0.1$$

Luminance = Radiance = Top Of the Atmosphere (TOA)

Ordinateur > Disque local (D:) > GIS-Remote sensing > amira données > scènes > Constantine\_OLI\_01-NOV-14 > Constantine\_OLI\_01-NOV-14~

Rechercher dans : Constantine\_OLI\_01...

Fichier Edition Affichage Outils ?

Organiser Ouvrir Imprimer Graver Nouveau dossier

Favoris

- Bureau
- Emplacements récents
- Téléchargements
- Bureau
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- 2nya
- Ordinateur
- Réseau
- Panneau de configurati...
- Corbeille
- COURS 01
- COURS 01 ENVI
- décor intérieur
- ESSAIS
- imp
- important
- mme Abdou
- Nouveau dossier
- travx pratique
- info
- LANDSAT5
- landsat8

Nom	Modifié le	Type	Taille
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LC81930352014305LGN00_B5.TIF.ov			
LC81930352014305LGN00_B6			
LC81930352014305LGN00_B6.TIF.aux			
LC81930352014305LGN00_B6.TIF.en			
LC81930352014305LGN00_B6.TIF.ov			
LC81930352014305LGN00_B7			
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LC81930352014305LGN00_BQA			
LC81930352014305LGN00_BQA.TIF.aux	14/01/2016 23:09	Document XML	1 Ko
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LC81930352014305LGN00_MTL	25/08/2015 07:44	Document texte	8 Ko

LC81930352014305LGN00\_MTL - Bloc-notes

Fichier Edition Format Affichage ?

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CORNER_LL_LON_PRODUCT = 6.00541 CORNER_LR_LAT_PRODUCT = 34.97720 CORNER_LR_LON_PRODUCT = 8.56725 CORNER_L
CORNER_UL_PROJECTION_Y_PRODUCT = 4108500.000 CORNER_UR_PROJECTION_X_PRODUCT = 460500.000 CORNER_UR_PROJECTI
CORNER_LL_PROJECTION_X_PRODUCT = 226500.000 CORNER_LR_PROJECTION_Y_PRODUCT = 3870600.000 CORNER_LR_PROJECTI
CORNER_LR_PROJECTION_Y_PRODUCT = 3870600.000 PANCHROMATIC_LINES = 15861 PANCHROMATIC_SAMPLES = 15601 REFL
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GROUND_CONTROL_POINTS_VERIFY = 145 GEOMETRIC_RMSE_VERIFY = 5.466 END_GROUP = IMAGE_ATTRIBUTES GROUP = MIN_MAX
RADIANCE_MAXIMUM_BAND_1 = 771.52625 RADIANCE_MINIMUM_BAND_1 = -63.71289 RADIANCE_MAXIMUM_BAND_2 = 790.05225
RADIANCE_MINIMUM_BAND_2 = -65.24277 RADIANCE_MAXIMUM_BAND_3 = 728.02643 RADIANCE_MINIMUM_BAND_3 = -60.12066
RADIANCE_MAXIMUM_BAND_4 = 613.91290 RADIANCE_MINIMUM_BAND_4 = -50.69712 RADIANCE_MAXIMUM_BAND_5 = 375.68408
RADIANCE_MINIMUM_BAND_5 = -31.02411 RADIANCE_MAXIMUM_BAND_6 = 93.42921 RADIANCE_MINIMUM_BAND_6 = -7.71541
RADIANCE_MAXIMUM_BAND_7 = 31.49065 RADIANCE_MINIMUM_BAND_7 = -2.60051 RADIANCE_MAXIMUM_BAND_8 = 694.78040
RADIANCE_MINIMUM_BAND_8 = -57.37519 RADIANCE_MAXIMUM_BAND_9 = 146.82585 RADIANCE_MINIMUM_BAND_9 = -12.12493
RADIANCE_MAXIMUM_BAND_10 = 22.00180 RADIANCE_MINIMUM_BAND_10 = 0.10033 RADIANCE_MAXIMUM_BAND_11 = 22.00180
RADIANCE_MINIMUM_BAND_11 = 0.10033 END_GROUP = MIN_MAX_RADIANCE GROUP = MIN_MAX_REFLECTANCE REFLECTANCE_MAXIM
REFLECTANCE_MINIMUM_BAND_1 = -0.099980 REFLECTANCE_MAXIMUM_BAND_2 = 1.210700 REFLECTANCE_MINIMUM_BAND_2 = -0.
REFLECTANCE_MINIMUM_BAND_3 = 1.210700 REFLECTANCE_MAXIMUM_BAND_3 = -0.099980 REFLECTANCE_MINIMUM_BAND_4 = 1.2
REFLECTANCE_MINIMUM_BAND_4 = -0.099980 REFLECTANCE_MAXIMUM_BAND_5 = 1.210700 REFLECTANCE_MINIMUM_BAND_5 = -0.
REFLECTANCE_MINIMUM_BAND_6 = 1.210700 REFLECTANCE_MAXIMUM_BAND_6 = -0.099980 REFLECTANCE_MINIMUM_BAND_7 = 1.2
REFLECTANCE_MINIMUM_BAND_7 = -0.099980 REFLECTANCE_MAXIMUM_BAND_8 = 1.210700 REFLECTANCE_MINIMUM_BAND_8 = -0.
REFLECTANCE_MINIMUM_BAND_9 = 1.210700 REFLECTANCE_MAXIMUM_BAND_9 = -0.099980 END_GROUP = MIN_MAX_REFLECTANCE G

```

LC81930352014305LGN00\_MTL Modifié le : 25/08/2015 07:44 Date de création : 10/01/2016 10:00

Document texte Taille : 7,70 Ko

Ouvrir le fichier métadonnées de la scène satellitaire(MTL),  
Copier les données dans un fichier word pour faciliter la lecture

RADIANCE\_ADD\_BAND\_10 = 0.10000  
RADIANCE\_ADD\_BAND\_11 = 0.10000  
REFLECTANCE\_MULT\_BAND\_1 = 2.0000E-05  
REFLECTANCE\_MULT\_BAND\_2 = 2.0000E-05

QUANTIZE\_CAL\_MAX\_BAND\_9 = 65535  
QUANTIZE\_CAL\_MIN\_BAND\_9 = 1  
QUANTIZE\_CAL\_MAX\_BAND\_10 = 65535  
QUANTIZE\_CAL\_MIN\_BAND\_10 = 1

REFLECTANCE\_MULT\_BAND\_3 = 2.0000E-05  
REFLECTANCE\_MULT\_BAND\_4 = 2.0000E-05  
REFLECTANCE\_MULT\_BAND\_5 = 2.0000E-05  
REFLECTANCE\_MULT\_BAND\_6 = 2.0000E-05

QUANTIZE\_CAL\_MAX\_BAND\_11 = 65535  
QUANTIZE\_CAL\_MIN\_BAND\_11 = 1  
END\_GROUP = MIN\_MAX\_PIXEL\_VALUE  
GROUP = RADIOMETRIC\_RESCALING

REFLECTANCE\_MULT\_BAND\_7 = 2.0000E-05  
REFLECTANCE\_MULT\_BAND\_8 = 2.0000E-05  
REFLECTANCE\_MULT\_BAND\_9 = 2.0000E-05  
REFLECTANCE\_ADD\_BAND\_1 = -0.100000

RADIANCE\_MULT\_BAND\_1 = 1.2745E-02  
RADIANCE\_MULT\_BAND\_2 = 1.3051E-02  
RADIANCE\_MULT\_BAND\_3 = 1.2027E-02  
RADIANCE\_MULT\_BAND\_4 = 1.0141E-02

REFLECTANCE\_ADD\_BAND\_2 = -0.100000  
REFLECTANCE\_ADD\_BAND\_3 = -0.100000  
REFLECTANCE\_ADD\_BAND\_4 = -0.100000  
REFLECTANCE\_ADD\_BAND\_5 = -0.100000

RADIANCE\_MULT\_BAND\_5 = 6.2061E-03  
RADIANCE\_MULT\_BAND\_6 = 1.5434E-03  
RADIANCE\_MULT\_BAND\_7 = 5.2021E-04  
RADIANCE\_MULT\_BAND\_8 = 1.1477E-02

REFLECTANCE\_ADD\_BAND\_6 = -0.100000  
REFLECTANCE\_ADD\_BAND\_7 = -0.100000  
REFLECTANCE\_ADD\_BAND\_8 = -0.100000  
REFLECTANCE\_ADD\_BAND\_9 = -0.100000

RADIANCE\_MULT\_BAND\_9 = 2.4255E-03  
RADIANCE\_MULT\_BAND\_10 = 3.3420E-04  
RADIANCE\_MULT\_BAND\_11 = 3.3420E-04  
RADIANCE\_ADD\_BAND\_1 = -63.72563

END\_GROUP = RADIOMETRIC\_RESCALING  
GROUP = TIRS\_THERMAL\_CONSTANTS

K1\_CONSTANT\_BAND\_10 = 774.89  
K1\_CONSTANT\_BAND\_11 = 480.89  
K2\_CONSTANT\_BAND\_10 = 1321.08  
K2\_CONSTANT\_BAND\_11 = 1201.14

RADIANCE\_ADD\_BAND\_2 = -65.25582  
RADIANCE\_ADD\_BAND\_3 = -60.13268  
RADIANCE\_ADD\_BAND\_4 = -50.70727  
RADIANCE\_ADD\_BAND\_5 = -31.03032

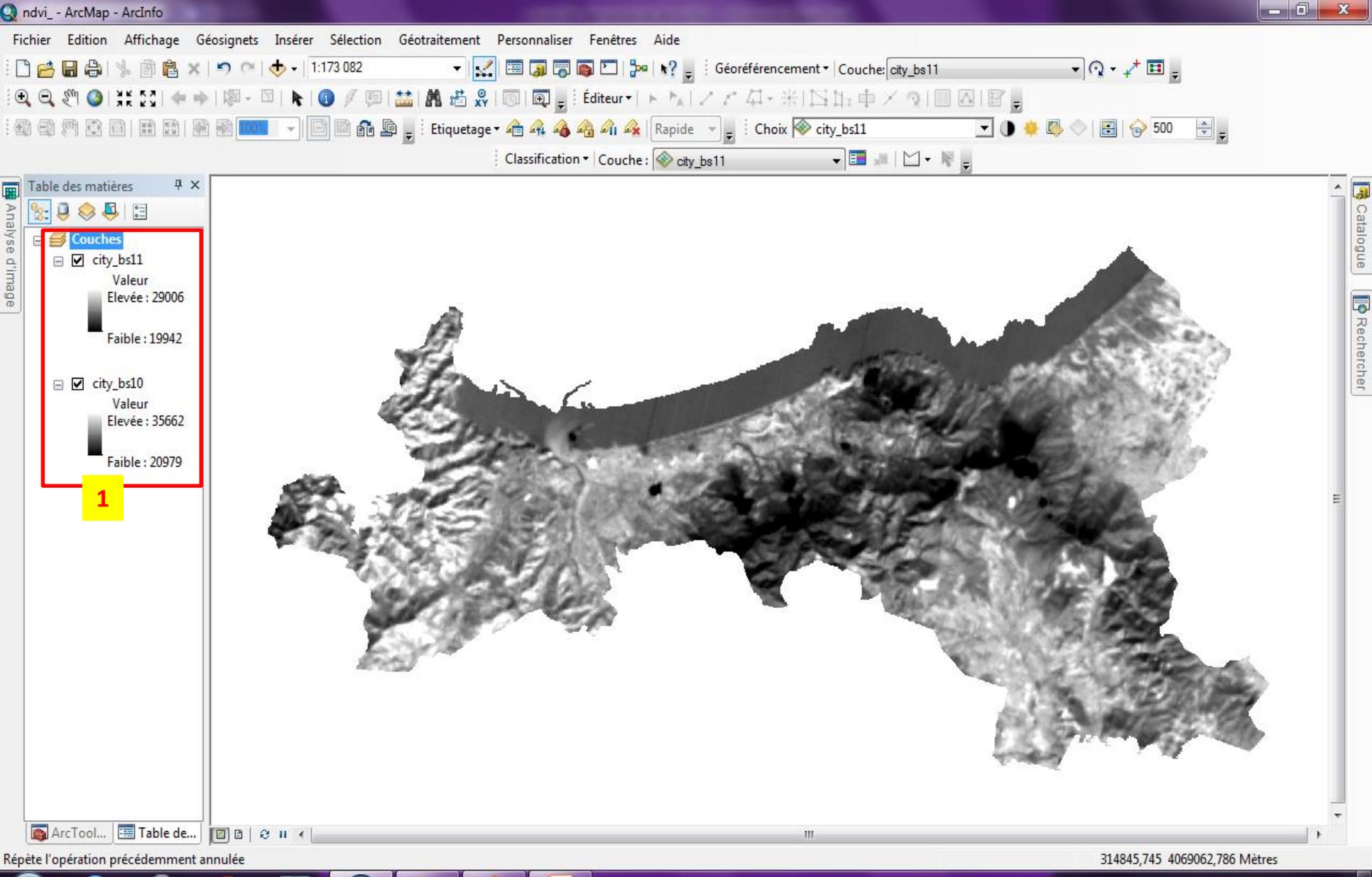
END\_GROUP = TIRS\_THERMAL\_CONSTANTS  
GROUP = PROJECTION\_PARAMETERS

## Conversion les valeurs numériques en luminance (TOA)

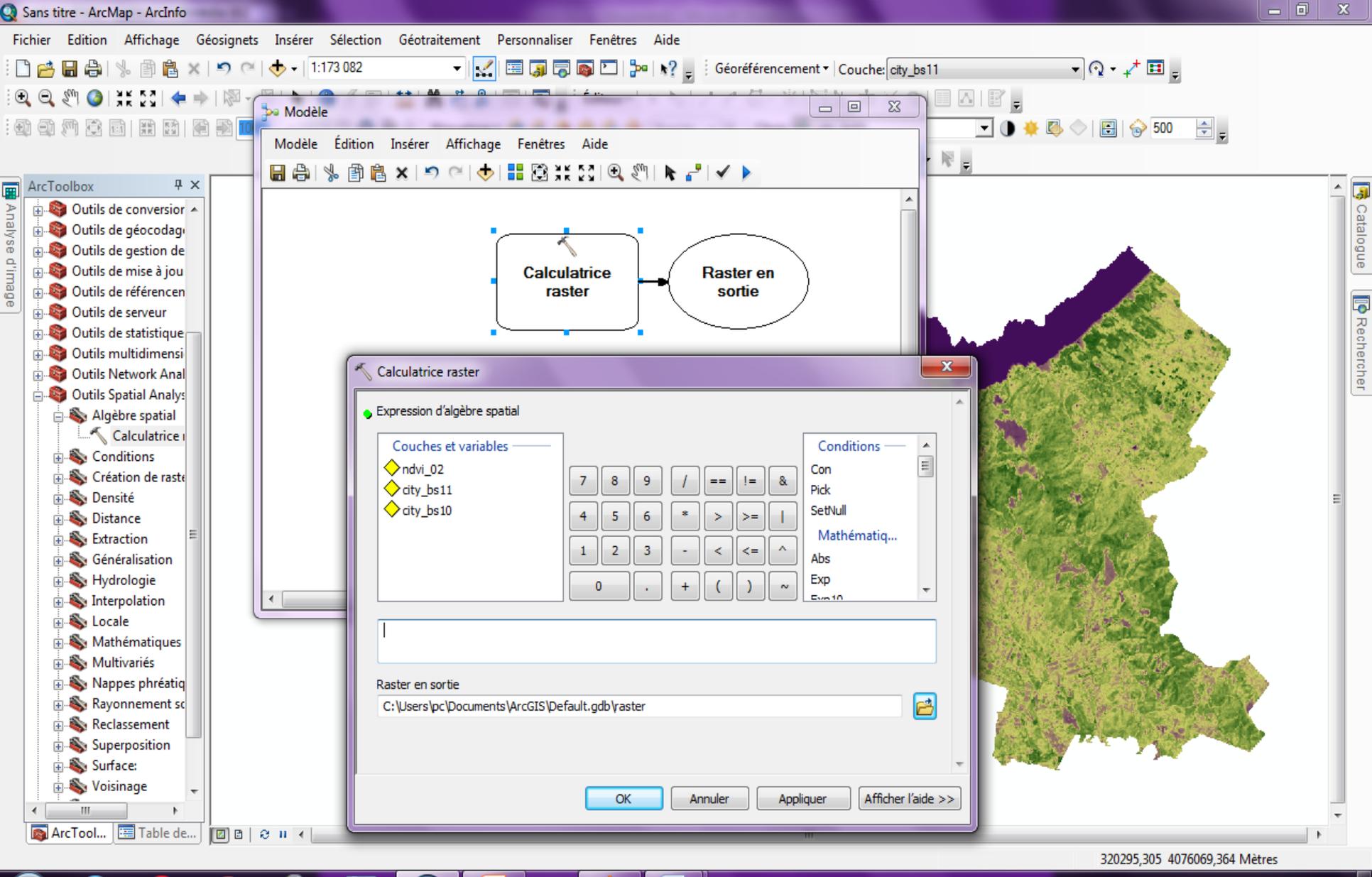
$$L_{\lambda} = M_L \times Q_{cal} + A_L$$

**BANDE 10:**  
**L<sub>B10</sub> = 0.0003342 \* BAND10 + 0.1**

**BANDE 11:**  
**L<sub>B11</sub> = 0.0003342 \* BAND11 + 0.1**

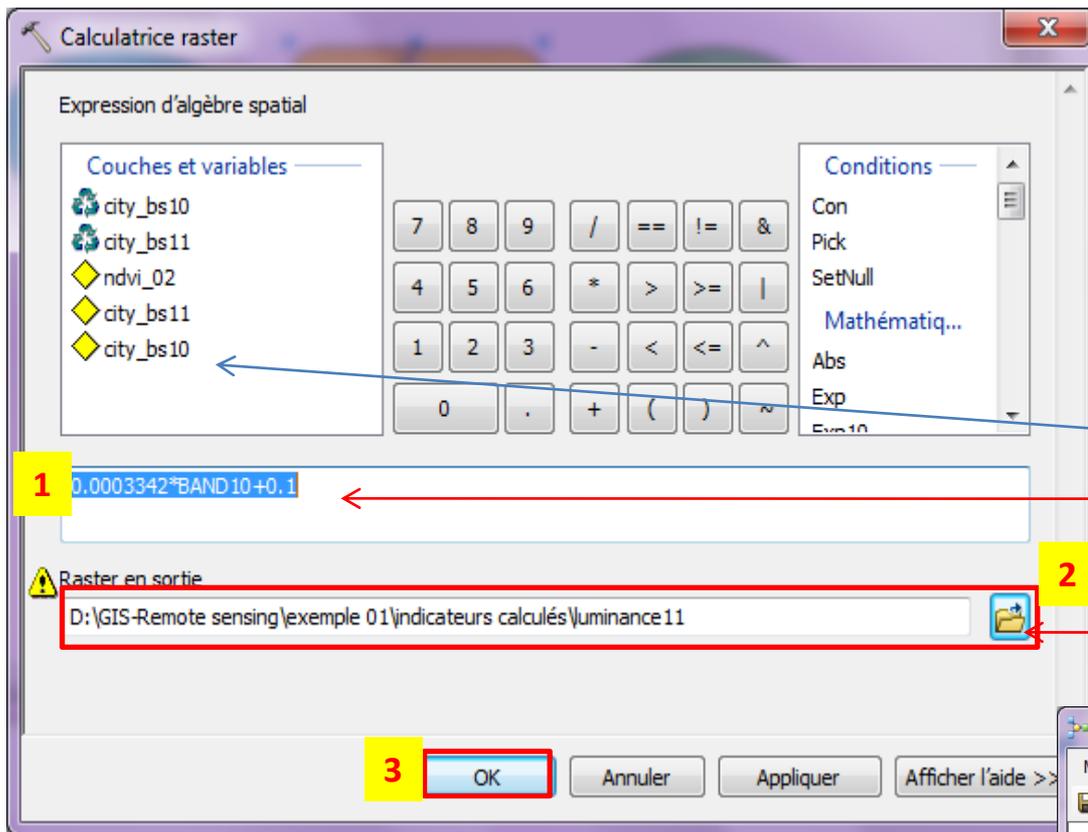


**01: ajouter les couches thermiques 10 / 11.**



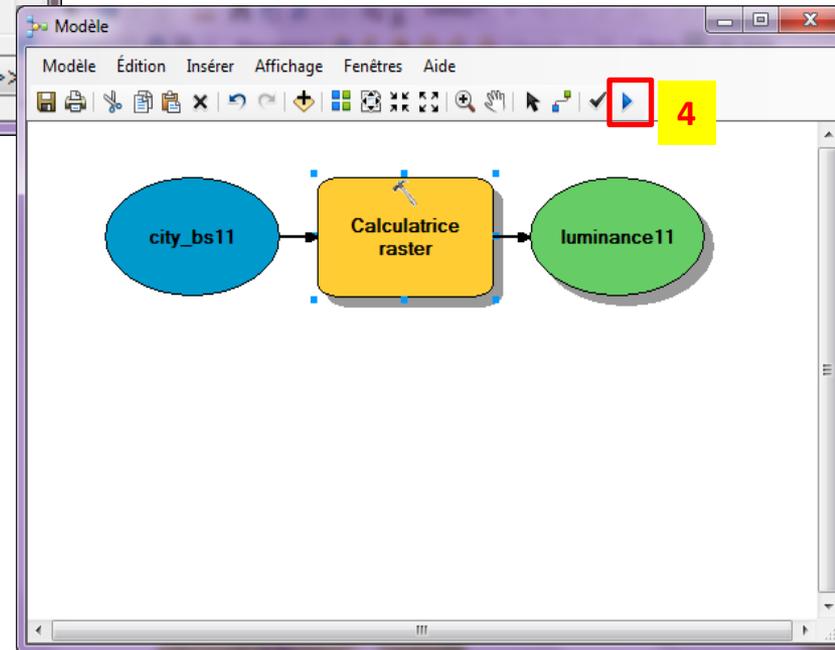
320295,305 4076069,364 Mètres

**Arctoolbox/spatial analysis tools/Map Algebra/ Raster calculator**



$0.0003342 * \text{BAND10} + 0.1$

Gérer l'emplacement



- Dans la formule «BAND10 » doit être remplacé par la couche réel

2

## Convertir la luminance (TOA) en **température de brillance (BT)**

$$BT = \left( \frac{K_2}{\ln\left(\frac{K_1}{L_\lambda} + 1\right)} \right) - 273.15$$

- $L_\lambda$ : Luminance
- $K_1$ ,  $K_2$ : des constantes

EXEMPLE:

$$BT_{10} = (1321.08 / \ln(774.89/L_{10} + 1)) - 273.15$$

**(-273,1)** pour convertir les kelvins en **Celsius**

## Convertir la luminance en température de brillance (BT)

$$BT = \left( \frac{K_2}{\ln\left(\frac{K_1}{L_\lambda} + 1\right)} \right) - 273.15$$

**BANDE 11:**

$$T_{\text{band11}} = \left( \frac{1201.14}{\ln(480.89 / L_{B11} + 1)} \right) - 273,15$$

**BANDE 10:**

$$T_{\text{band10}} = \left( \frac{1321.08}{\ln(774.89 / L_{B10} + 1)} \right) - 273,15$$

**-272,15 pour convertir les kelvin en Celsius.**

REFLECTANCE\_MULT\_BAND\_1 = 2.0000E-05  
REFLECTANCE\_MULT\_BAND\_2 = 2.0000E-05

REFLECTANCE\_MULT\_BAND\_3 = 2.0000E-05  
REFLECTANCE\_MULT\_BAND\_4 = 2.0000E-05  
REFLECTANCE\_MULT\_BAND\_5 = 2.0000E-05  
REFLECTANCE\_MULT\_BAND\_6 = 2.0000E-05

REFLECTANCE\_MULT\_BAND\_7 = 2.0000E-05  
REFLECTANCE\_MULT\_BAND\_8 = 2.0000E-05  
REFLECTANCE\_MULT\_BAND\_9 = 2.0000E-05  
REFLECTANCE\_ADD\_BAND\_1 = -0.100000

REFLECTANCE\_ADD\_BAND\_2 = -0.100000  
REFLECTANCE\_ADD\_BAND\_3 = -0.100000  
REFLECTANCE\_ADD\_BAND\_4 = -0.100000  
REFLECTANCE\_ADD\_BAND\_5 = -0.100000

REFLECTANCE\_ADD\_BAND\_6 = -0.100000  
REFLECTANCE\_ADD\_BAND\_7 = -0.100000  
REFLECTANCE\_ADD\_BAND\_8 = -0.100000  
REFLECTANCE\_ADD\_BAND\_9 = -0.100000

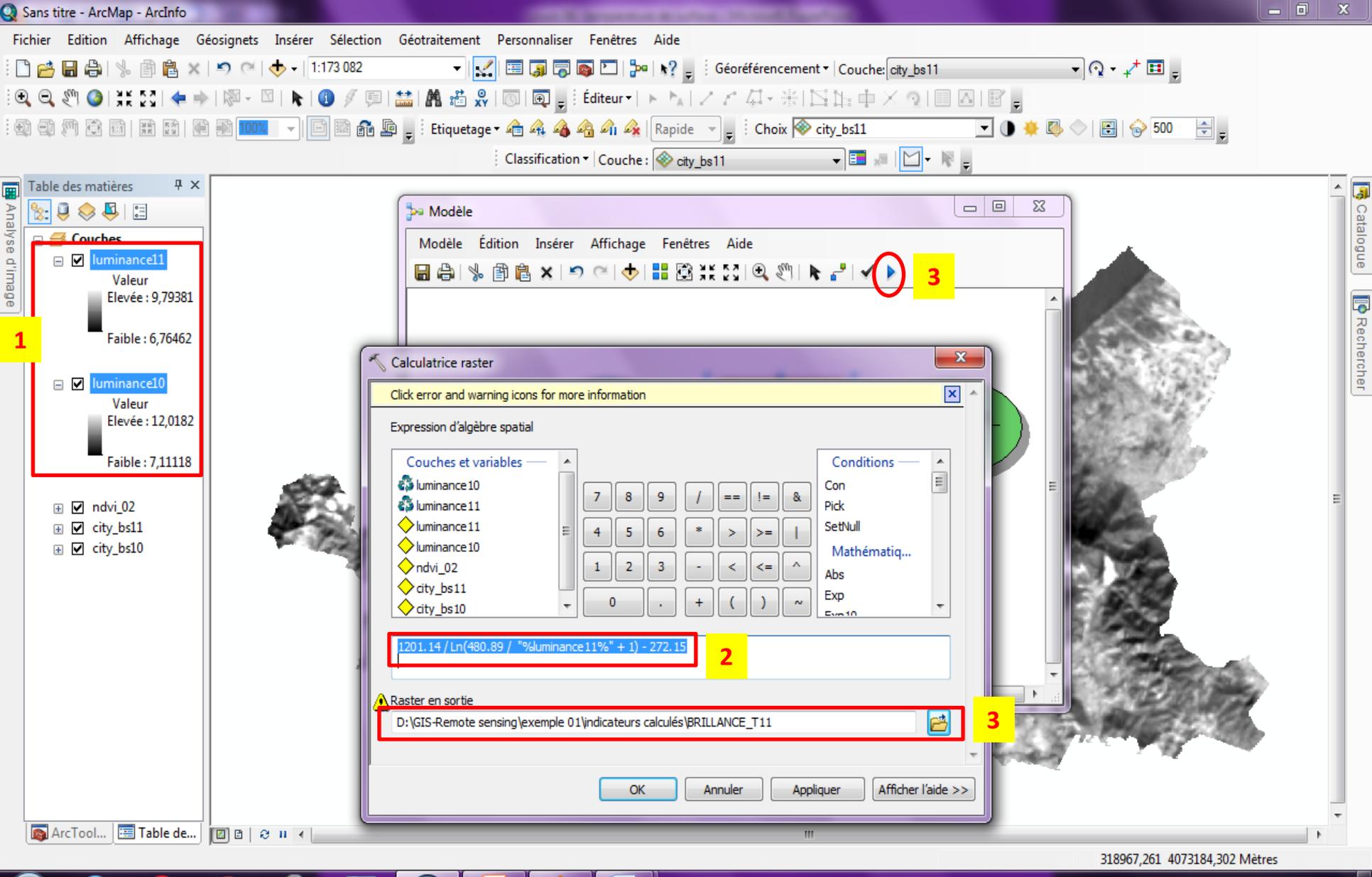
END\_GROUP = RADIOMETRIC\_RESCALING  
GROUP = TIRS\_THERMAL\_CONSTANTS

K1\_CONSTANT\_BAND\_10 = 774.89  
K1\_CONSTANT\_BAND\_11 = 480.89  
K2\_CONSTANT\_BAND\_10 = 1321.08

K2\_CONSTANT\_BAND\_11 = 1201.14

END\_GROUP = TIRS\_THERMAL\_CONSTANTS  
GROUP = PROJECTION\_PARAMETERS

**Metadata nécessaire**



- 1: ajouter les couches « luminance »
- 2: la formule de conversion convenable
- 3: gérer l'emplacement et OK
- 4: exécution

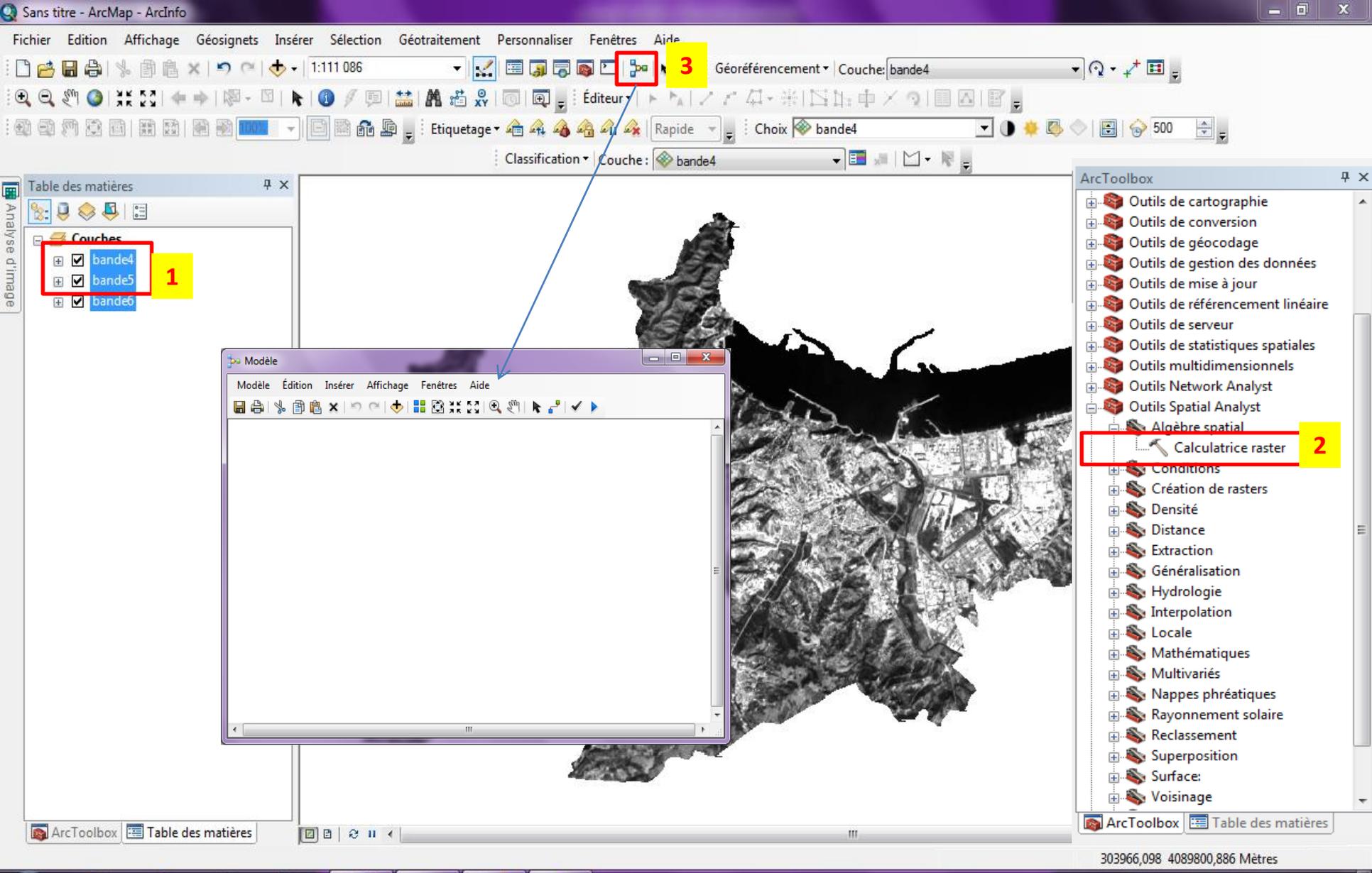
$$\text{NDVI} = (\text{NIR} - \text{RED}) / (\text{NIR} + \text{RED})$$

$$\text{NDVI} = (\text{band5} - \text{band4}) / (\text{band5} + \text{band 4})$$

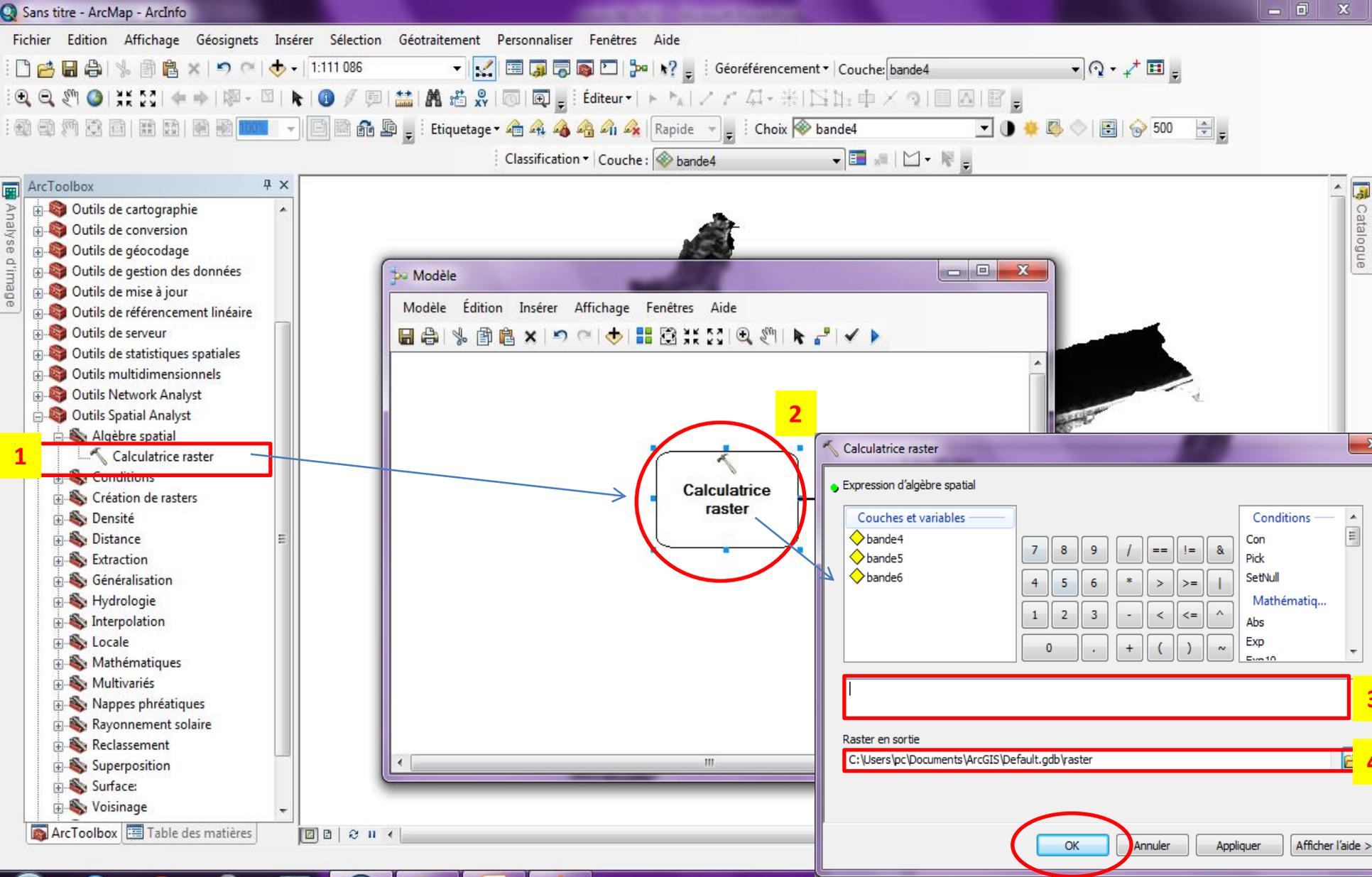
EXEMPLE:

$$\text{NDVI} = \text{float}(\text{couche 5} - \text{couche 4}) / \text{float}(\text{couche 5} + \text{couche 4})$$

---



- 01: charger les couches « 4,5 »
- 02: ArcToolbox, choisir « calculatrice raster »
- 03: cliquer sur « ModelBuilder »



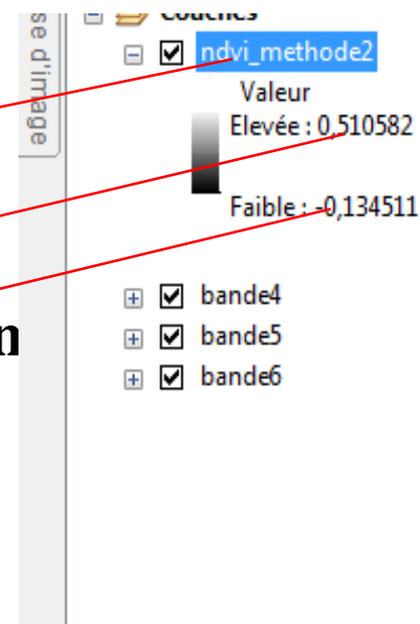
- 01: glisser l'option « calculatrice Raster » dans la fenêtre « modelBuilder »
- 02: double cliques sur « calculatrice raster »
- 03: la formule « float (couche 5-couche 4)/ float (couche 5+couche 4) »

4

Calcul de la proportion de la végétation – **PV** –

$$PV = \left( \frac{NDVI - NDVI_{min}}{NDVI_{max} - NDVI_{min}} \right)^2$$

PV = **square** (NDVI - NDVI min / NDVI max - NDVI min)



Calcul de l'émissivité – **ε** –

5

$$\varepsilon = 0.004 \times PV + 0.986$$

Utiliser la même procédure (RASTER CALCULATOR) dans le calcul

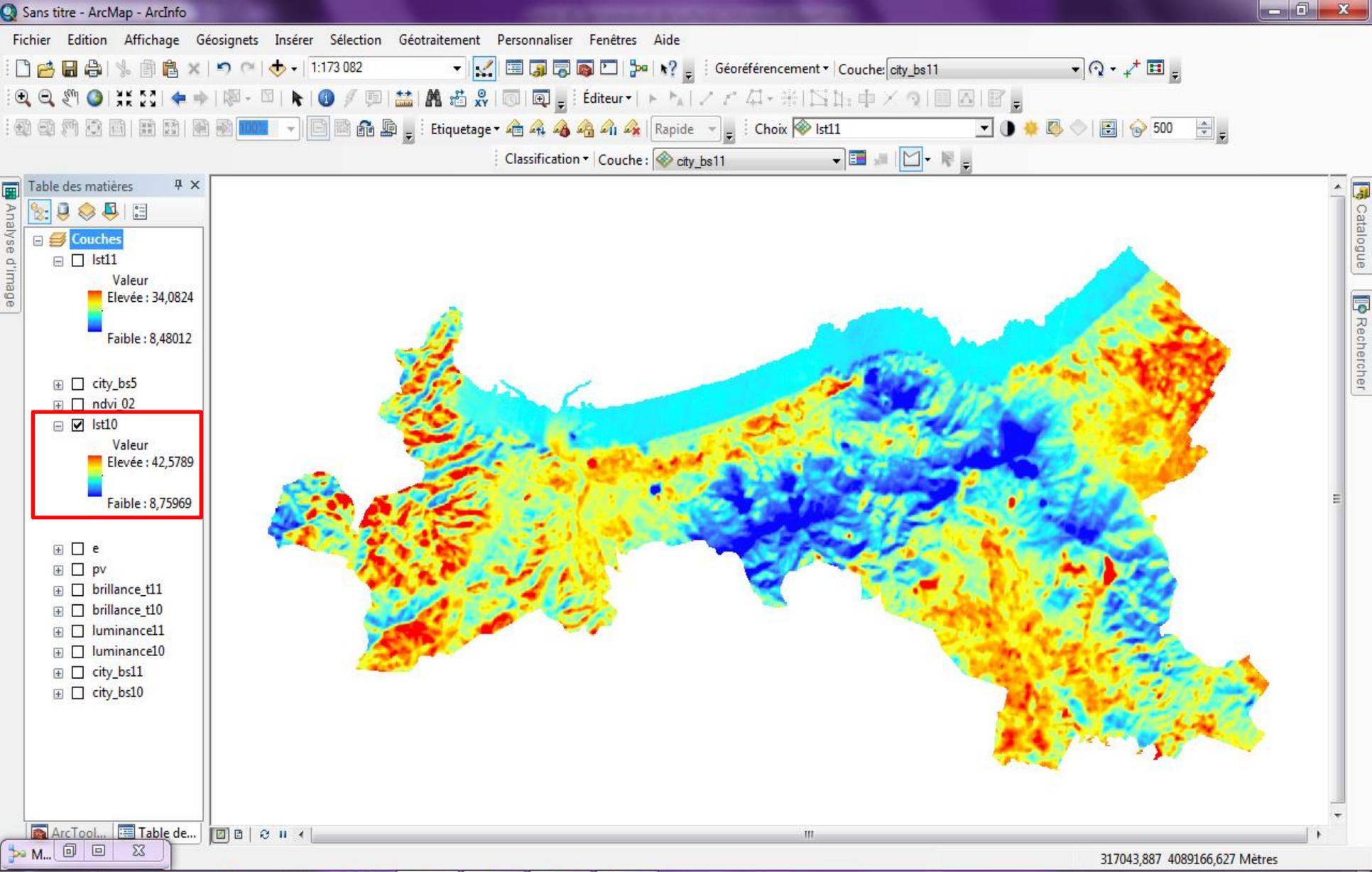
$$LST = \left( \frac{BT}{1 + \left( w \times \frac{BT}{P} \right) \times \ln(\epsilon)} \right)$$

- **BT** = la température de brillance
- $\epsilon$  = l'émissivité
- **P** = 14388
- **w** = la bande spectrale  $\lambda$ .

EXEMPLE:

$$LST_{10} = BT / 1 + BAND_{10} \times ( BT_{10}/14388) \times \ln(\epsilon)$$

$$LST_{11} = BT / 1 + BAND_{11} \times ( BT_{11}/14388) \times \ln(\epsilon)$$



Résultats LST (température de surface)



Co-funded by the Erasmus+ Programme of the European Union



# Merci de votre attention



Coordinator



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info@mastermehmed.com  
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Partners

