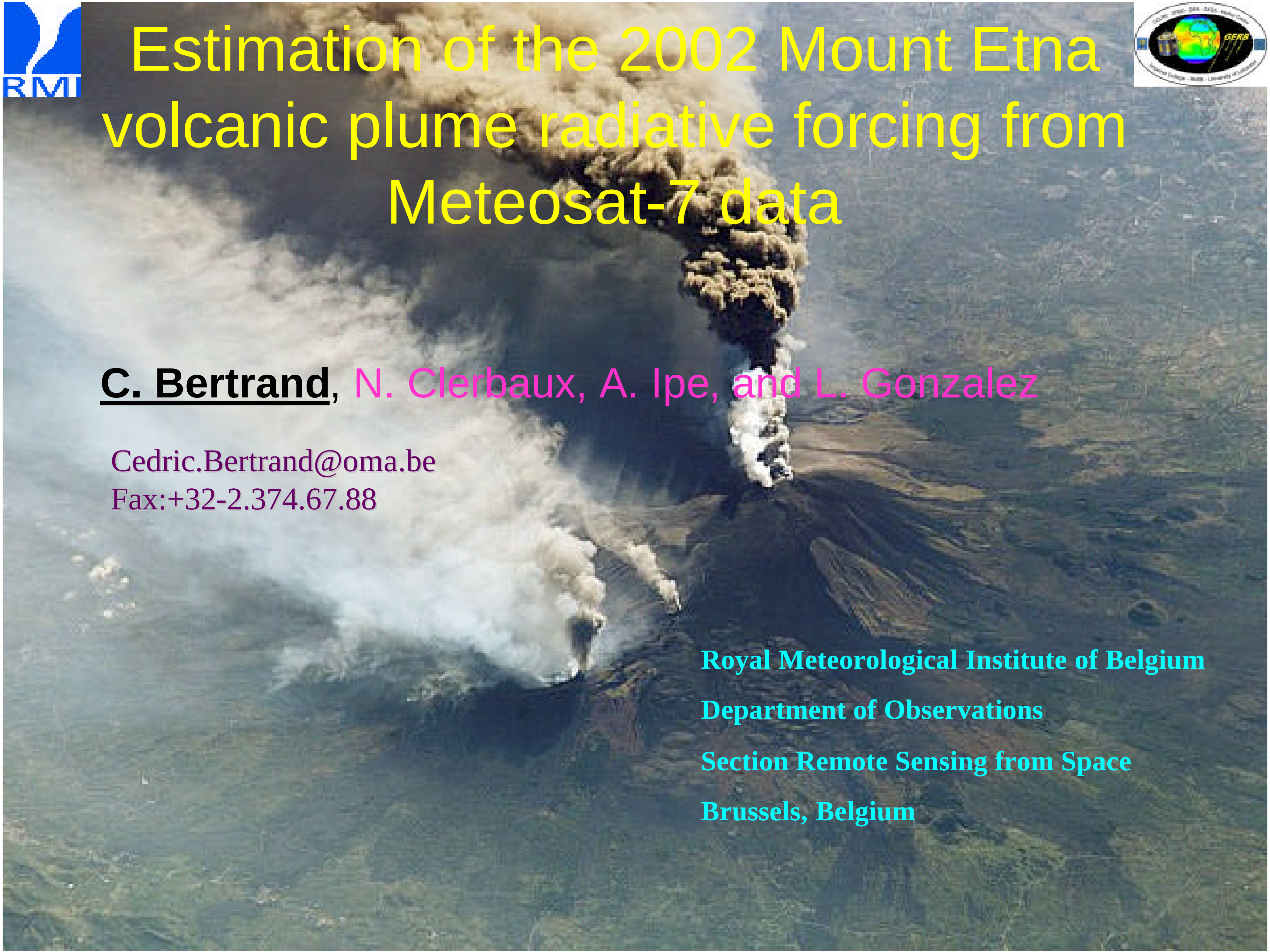


Estimation of the 2002 Mount Etna volcanic plume radiative forcing from Meteosat-7 data

C. Bertrand, N. Clerbaux, A. Ipe, and L. Gonzalez

Cedric.Bertrand@oma.be
Fax:+32-2.374.67.88

Royal Meteorological Institute of Belgium

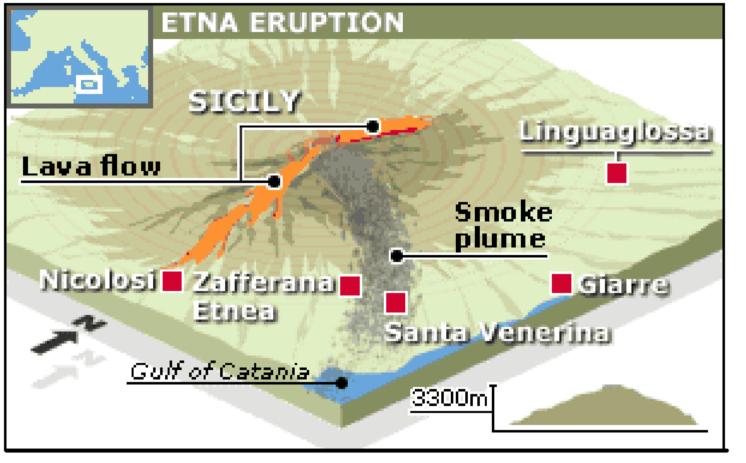
Department of Observations

Section Remote Sensing from Space

Brussels, Belgium

Etna's Location:

2002's Eruption:



METEOSAT-7 ½ hourly VIS, IR, and WV imagery to identify,track and estimate the RF operated by the volcanic cloud during the 4 first days (October 27 to 30).

OUTLINE

- **“GERB-LIKE” FLUXES GENERATION**
- **ERUPTION CLOUD DETECTION AND TRACKING**
- **RADIATIVE FORCING ESTIMATION**
- **CONCLUSIONS AND PERPECTIVE**

“GERB-LIKE” FLUXES GENERATION

Available at: http://gerb.oma.be

- **Calibration**:
- **VIS**: RMIB Calibration
  WV & IR: EUMETSAT Calibrations
  NB to BB Conversion:
- **VIS**: solar reflected BB radiance
  WV&IR: thermally emitted radiance
  Radiance to flux conversion:
- **Solar**: scene id. + CERES ADM’s
  Thermal : RMIB Thermal ADM version 2 (no-spectral)

➡ **Solar & Thermal Fluxes at TOA at the same temporal rate than MS7**

ERUPTION CLOUD DETECTION AND TRACKING

METEOSAT SENSOR → Thermal bands substraction technique ($\Delta T = T4 - T5$) not allowed

→ Thermal radiance anomaly procedure

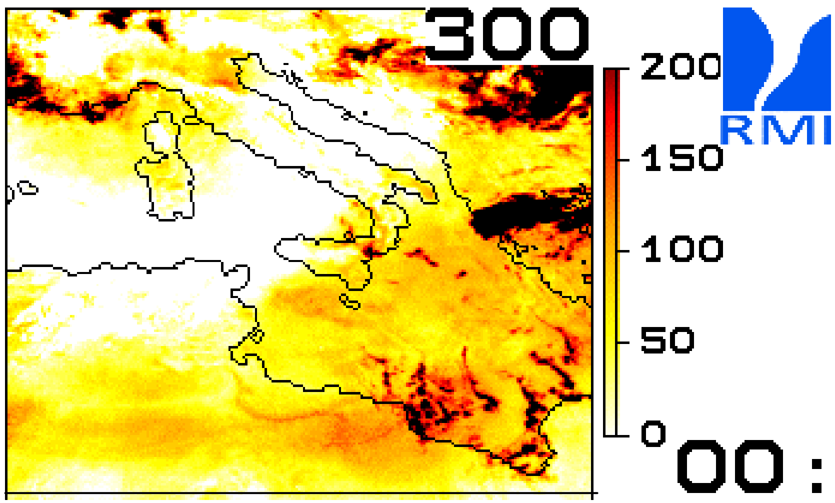
- Estimation of 48 (one for each ½ hourly Meteosat slot over a day; x=1,48) clear sky directional emitted thermal radiance images, L_{clr}
- To minimize the impact of meteorological cloud a composite over 14 days is used (d_i=1,14).

→ For each slot, S, and each pixel, p,

$$\forall S_x \in S, \quad L_{clr}(S_x, p) = Max[L(d_i, S_x, p)]$$

→ For each S, substraction of the unfiltered thermal radiance from the clear sky one

Time evolution of the unfiltered thermal radiance anomalies from October 27 00:00 UTC to October 30 23:00 using data sampled at one hour interval.
(units are given in 0.05 Wm-2.sr-1).



Available at ftp://gerb.oma.be/cedric/Rad_D.gif

Etna eruption cloud radiative forcing

Definition:

Cloud Radiative Forcing (CRF) at the TOA

⇓

Eruption Cloud Radiative Forcing (ECRF) at the TOA

$$NETECRF = \underbrace{(OSR_{clr} - OSR)}_{\text{SWECRF}} + \underbrace{(OLR_{clr} - OLR)}_{\text{LWECRF}}$$

➡ As for the CRF, values of ECRF are negative for a cooling effect with respect to clear sky and positive for a warming effect

Reference clear sky fluxes determination

Compositing technique but:

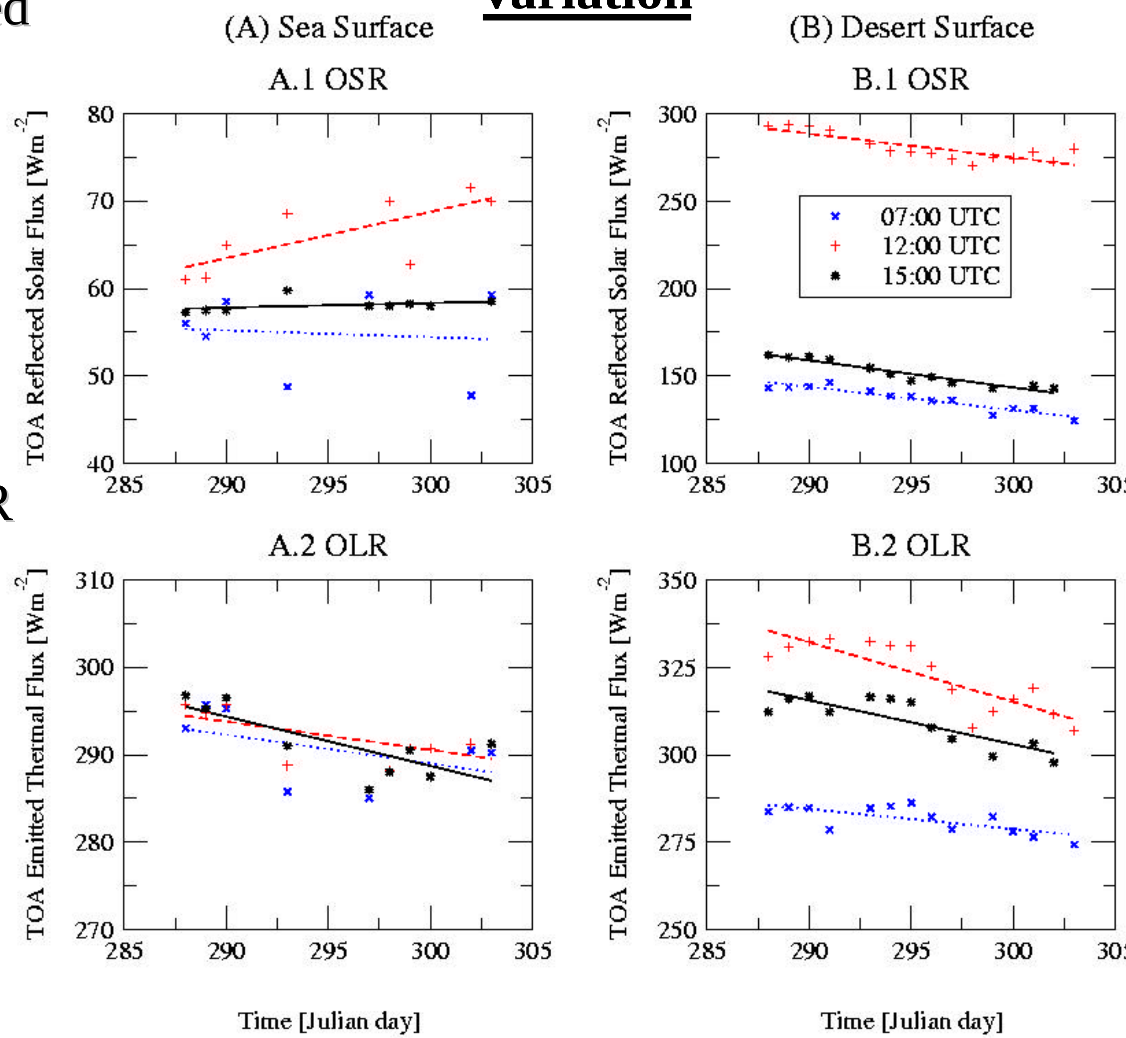
Larger accuracy than for unfiltered clear-sky thermal radiance due to

(1) unforced daily variation

(2) shadow contamination

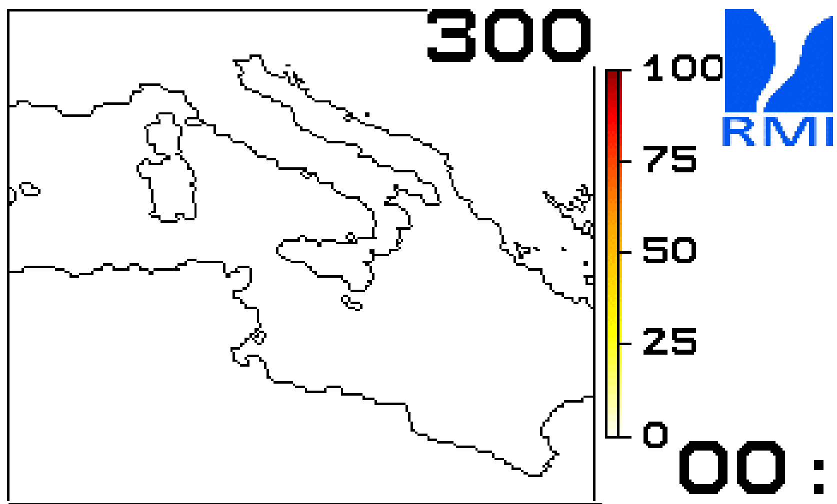
➡ For each of the 192 available Meteosat-7 slots a corresponding reference clear sky OSR and OLR image are estimated

Unforced TOA OSR and OLR fluxes daily variation



Results: TOA LWECRF (W.m-2)

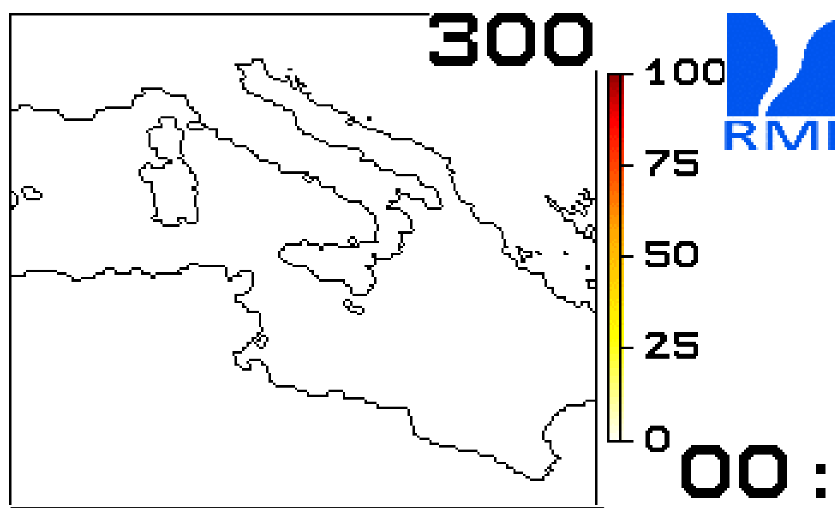
POSITIVE FORCING



Animation available at ftp://gerb.oma.be/cedric/Therm_F.gif

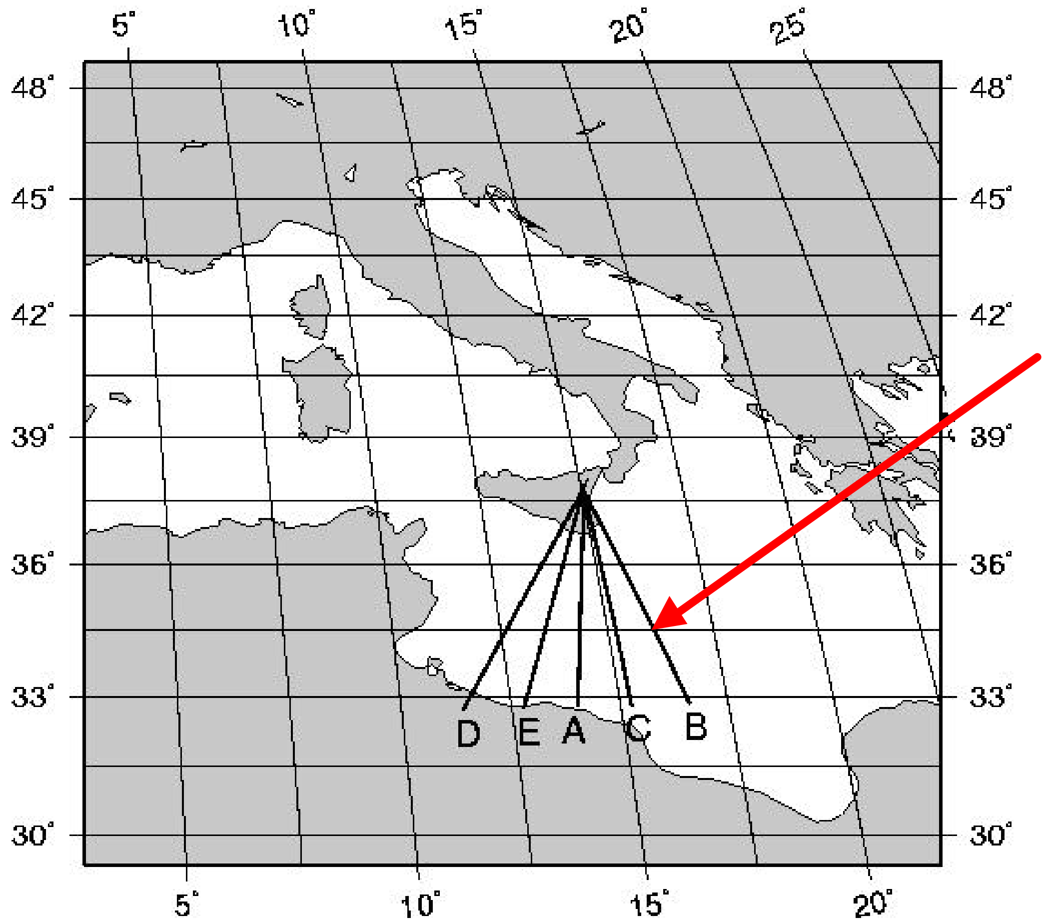
Results: TOA SWECRF (W.m-2)

NEGATIVE FORCING

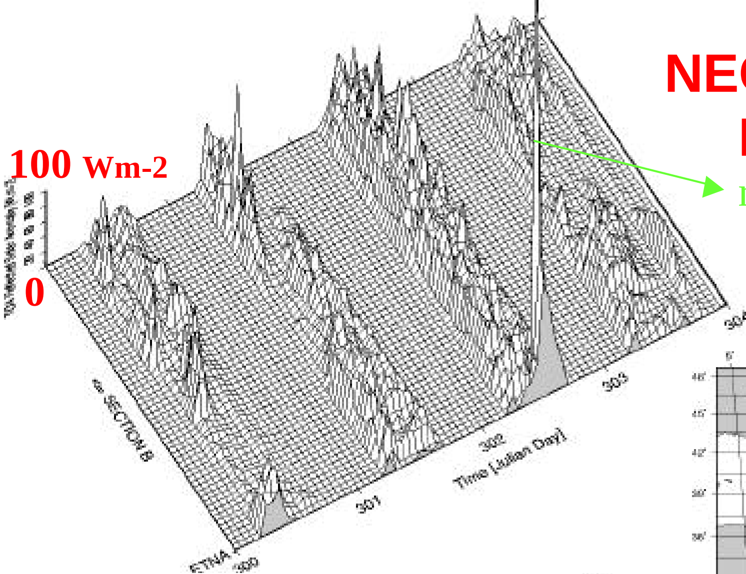


Animation available at ftp://gerb.oma.be/cedric/Solar_F.gif

Results

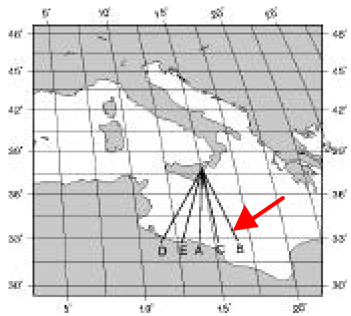


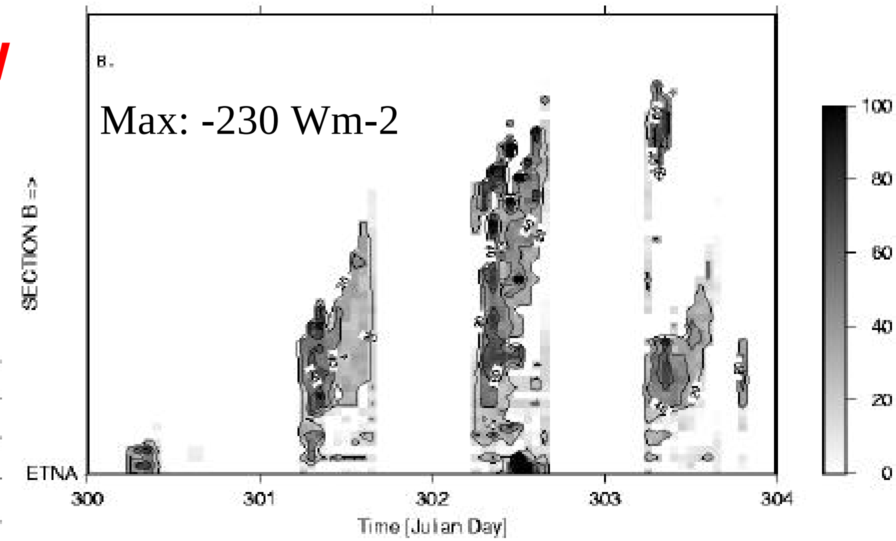
Results: SW and LW TOA RF

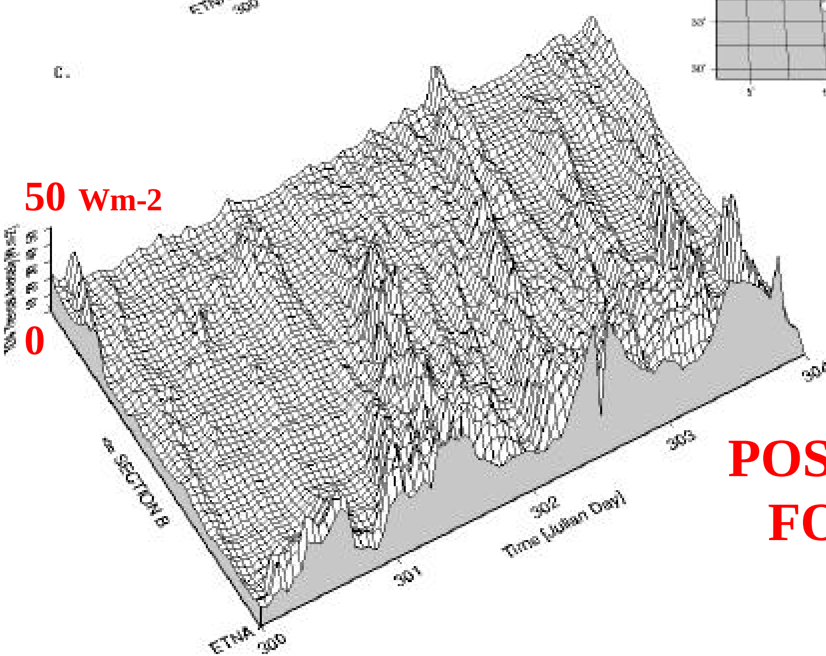


NEGATIVE SW FORCING

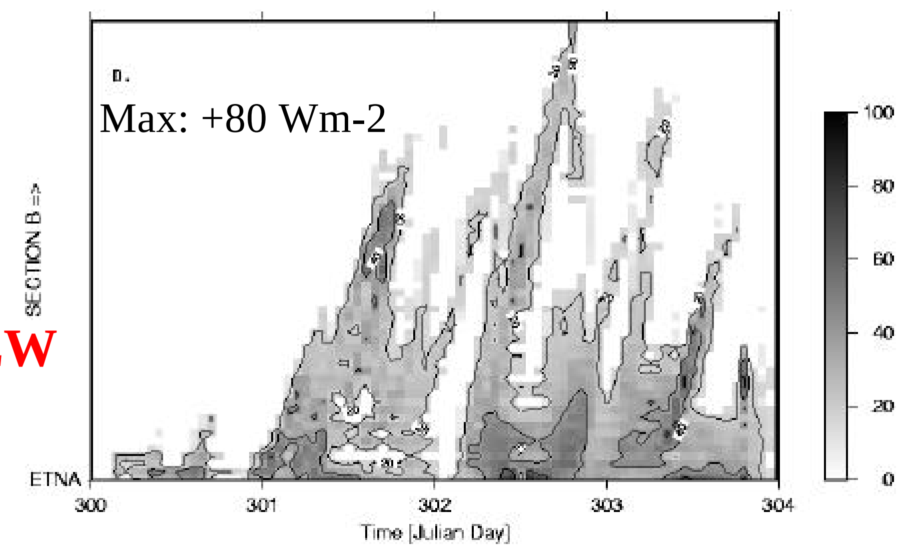
reception error



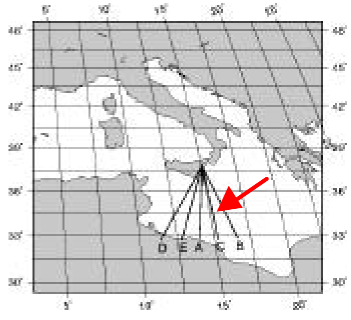


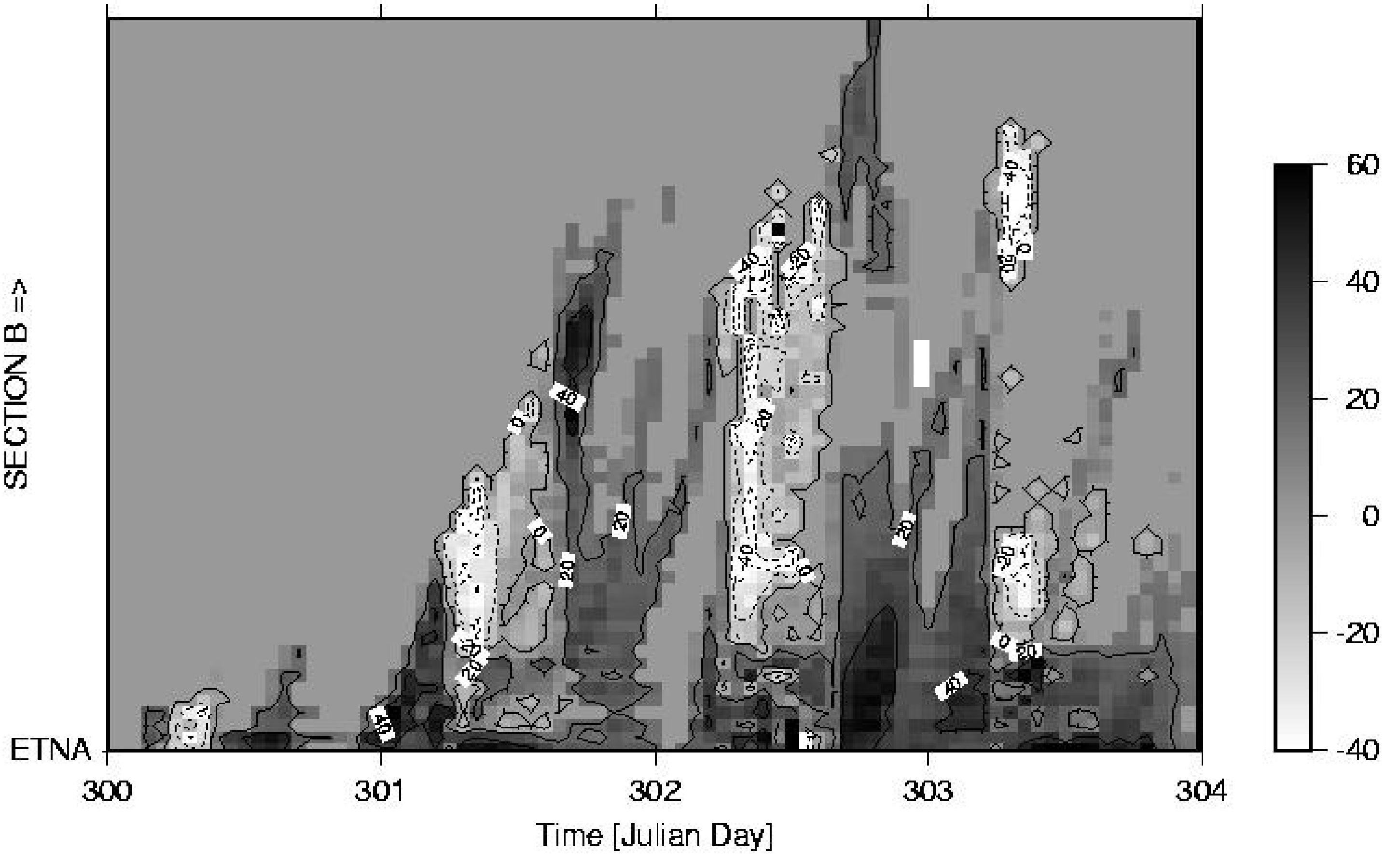


POSITIVE LW FORCING



Results: NET TOA RF





Max:-185 Wm-2

Conclusions and Perspective

- Possible to identify and track the eruption cloud from the Mount Etna location to the north African coast by computing TOA LW thermal radiance anomalies

- Estimation of the SW, LW, and NET TOA radiative forcing induced by the introduction of the volcanic cloud in a previously clear sky by performing angular conversion on both solar and thermal radiance to determine the TOA BB unfiltered fluxes

- Our results indicate that as for meteorological clouds, the volcanic eruption cloud presents a negative SW forcing and a positive LW forcing at the TOA.

Conclusions and Perspective

- The net effect may be positive or negative according to the time and distance from the origin of the perturbation (volcano dependent ?)
- Magnitude of the TOA SW volcanic cloud forcing similar to the forcing generated by large meteorological clouds above the Mediterranean Sea
- While the magnitude of the TOA LW forcing is lower than the TOA SW forcing, it is larger than the perturbation introduced by large meteorological clouds

Eruption Cloud Radiative Forcing (ECRF)

$$LWECRF = FN_{lw} - FN_{lw}(clr)$$

$$SWECRF = S(a_{clr} - a)$$

S = mean incoming solar flux
α = TOA clear-sky albedo

$$NETECRF = LWECRF + SWECRF$$

$$NETECRF = (S - OSR - OLR) - (S_{clr} - OSR_{clr} - OLR_{clr})$$

$$NETECRF = (OSR_{clr} - OSR) + (OLR_{clr} - OLR)$$