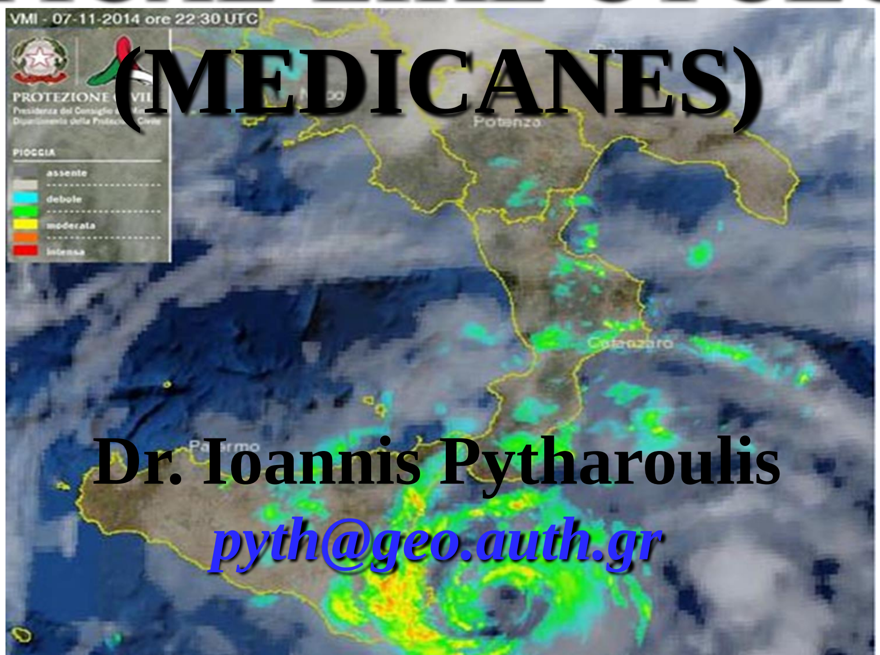
MEDITERRANEAN TROPICAL-LIKE CYCLONES (MEDICANES)



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Greece
http://meteo.geo.auth.gr

Aristotle University of Thessaloniki, Greece

Source: maps.google.com

http://www.auth.gr


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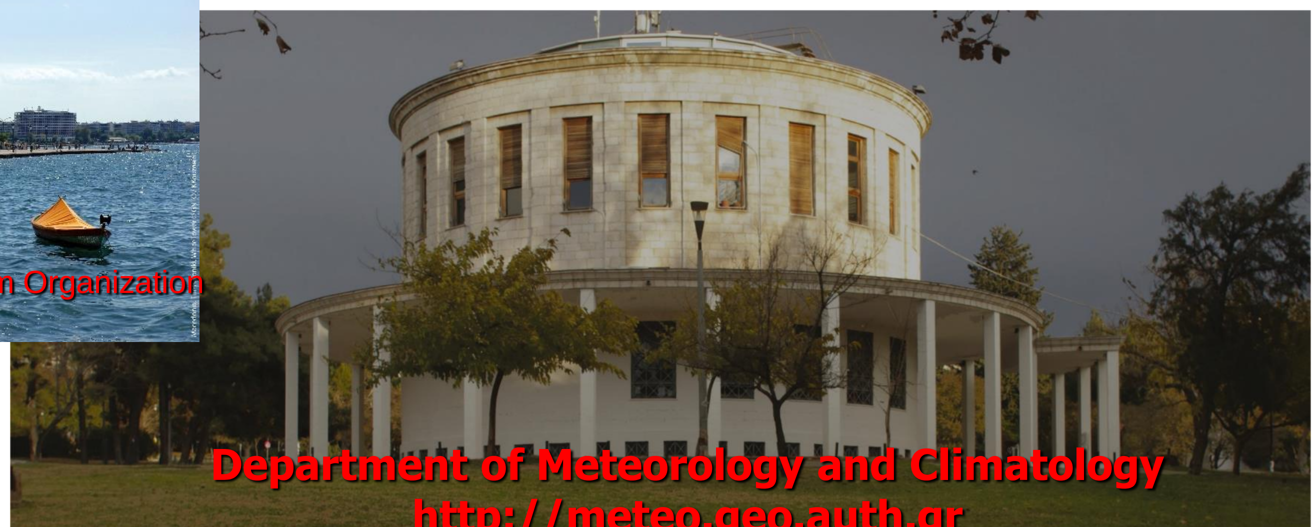
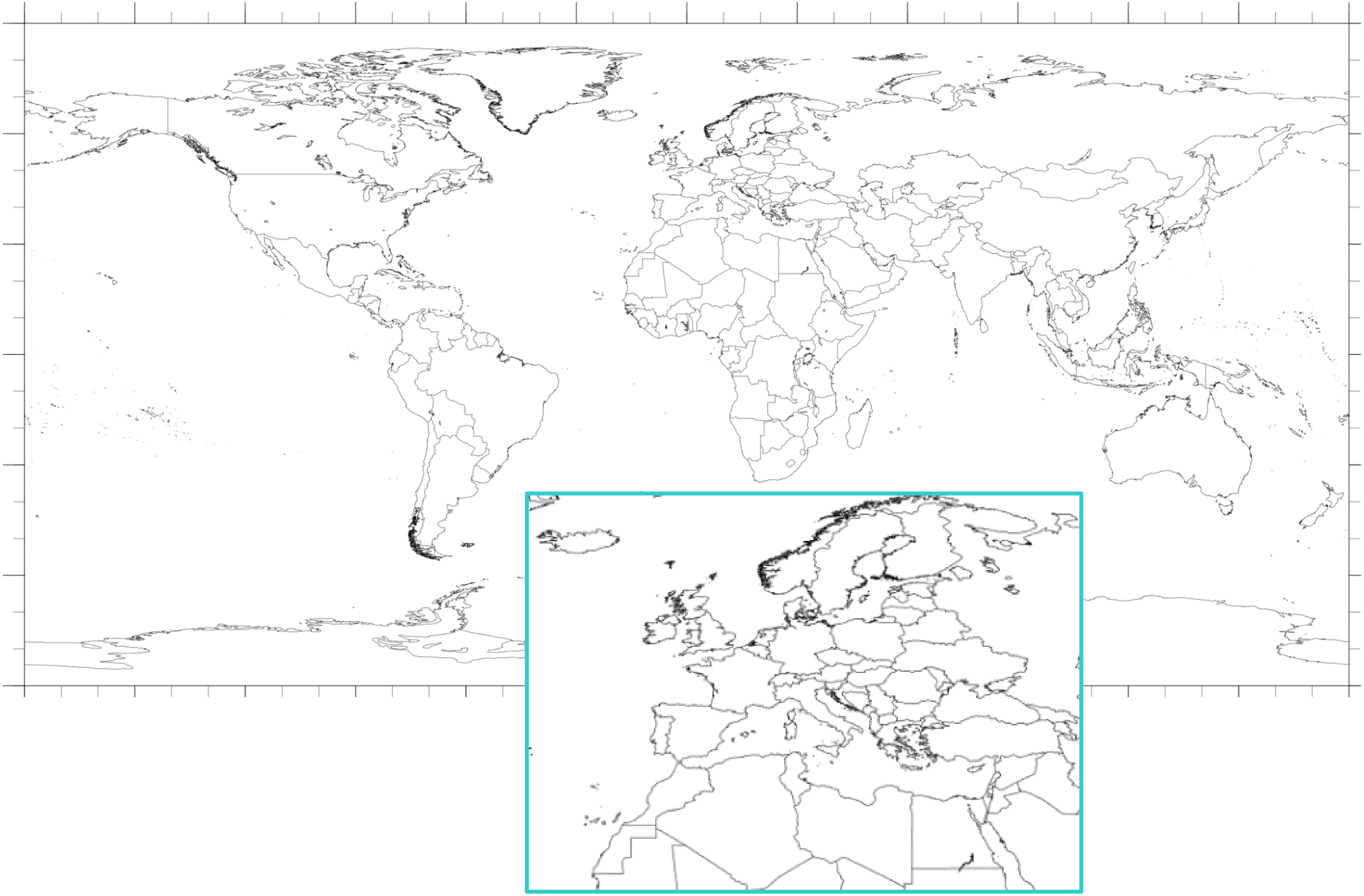
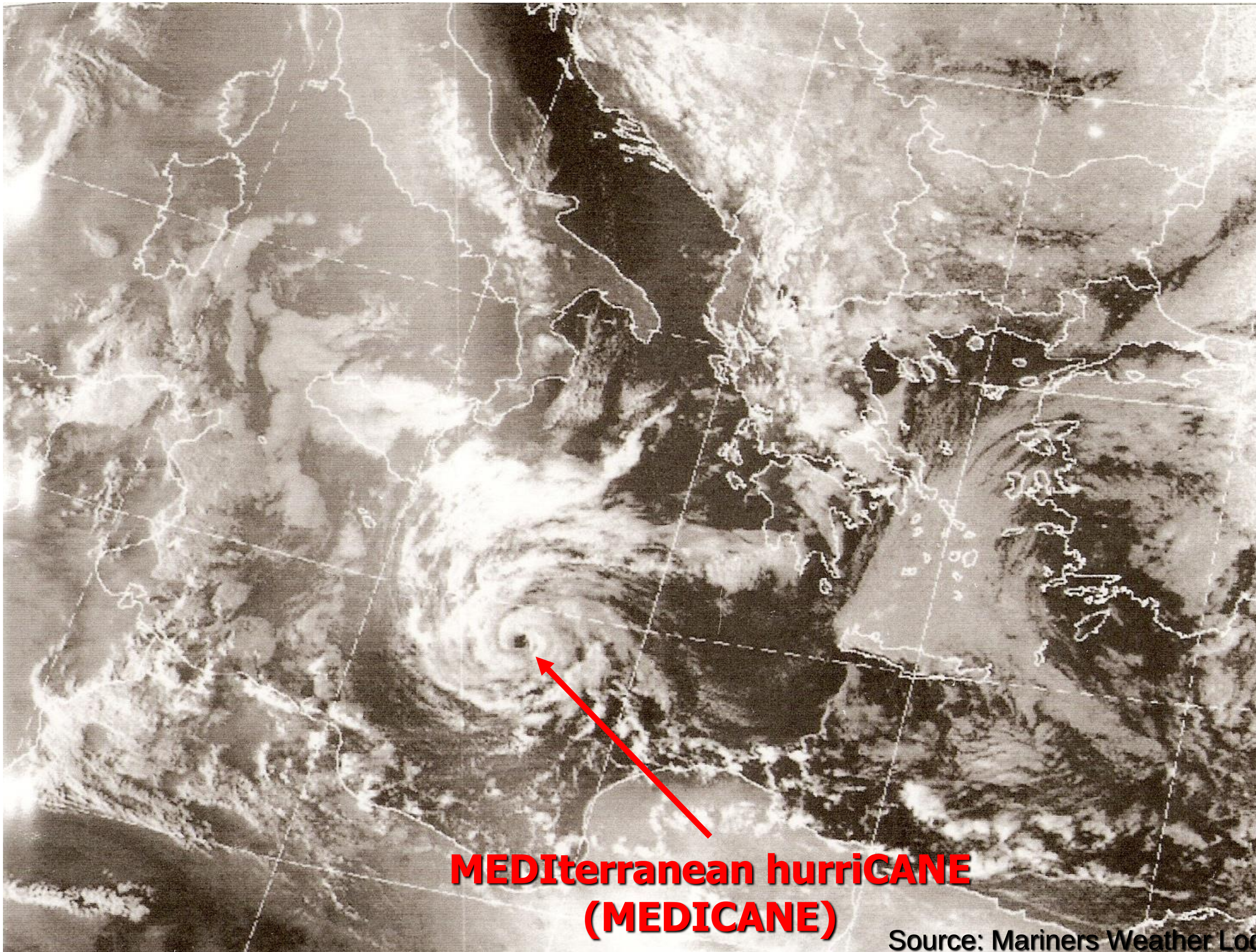
Photographer: K. Kouzouni


Department of Meteorology and Climatology
http://meteo.geo.auth.gr

Please mark your location!



1616 UTC, 16 January 1995

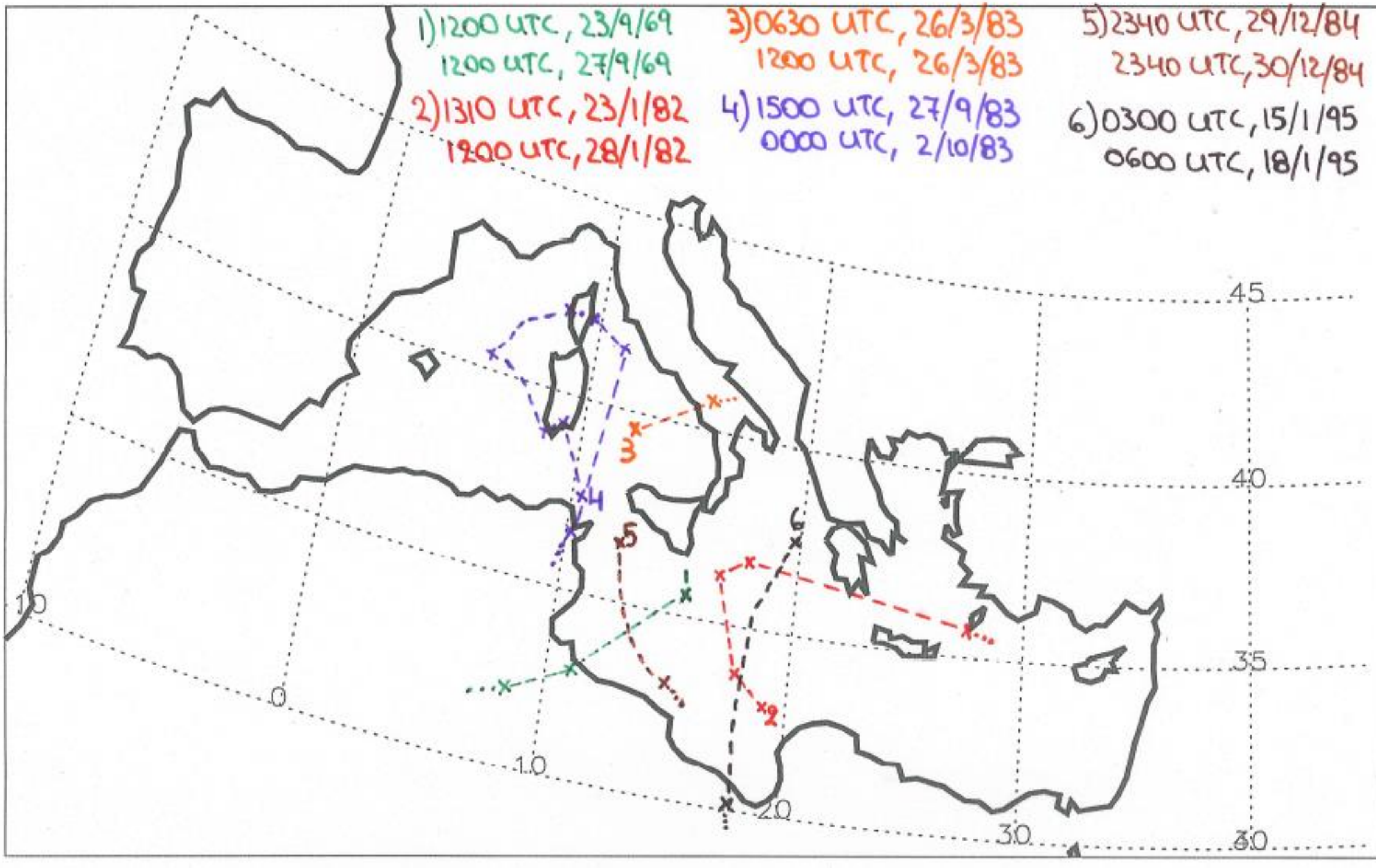


Outline

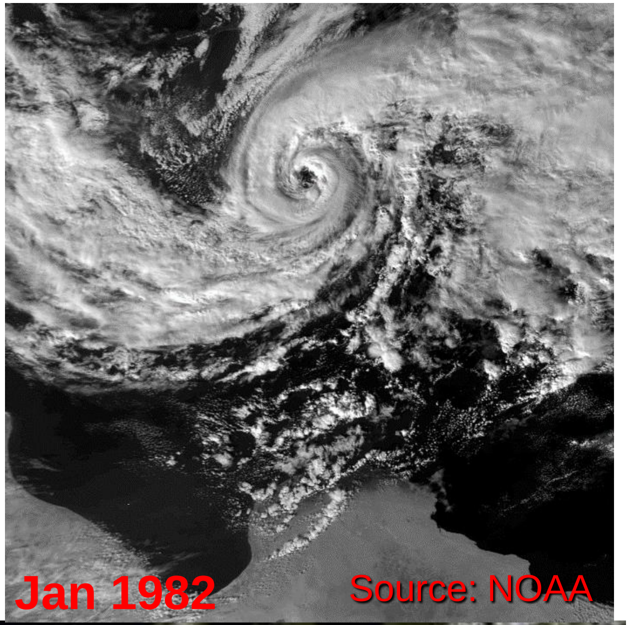
- Past cases of medicanes
- Structure – Characteristics – Definition
- Mechanisms for development
- Climatology
- Consequences
- Case study

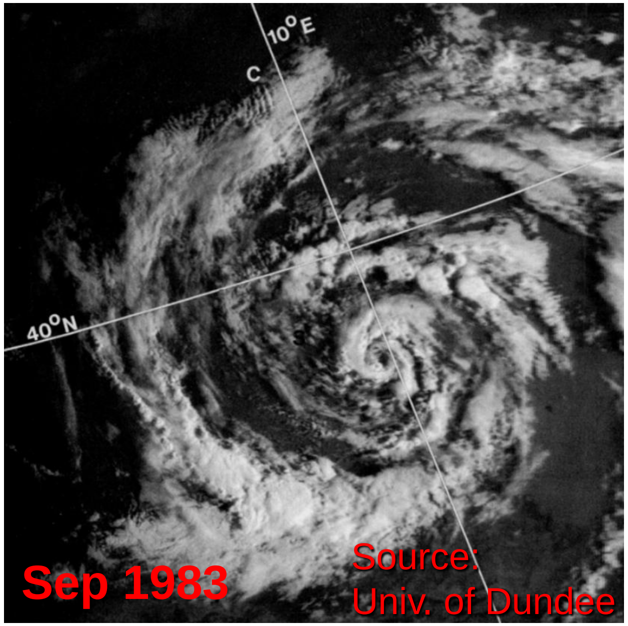
  - 7-8 November 2014 (Qendresa)
- Questions/Discussion

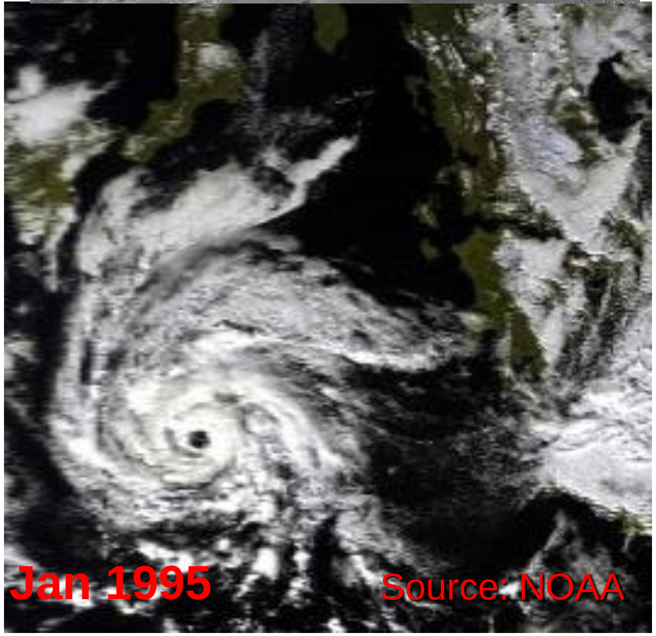
Past cases of medicanes

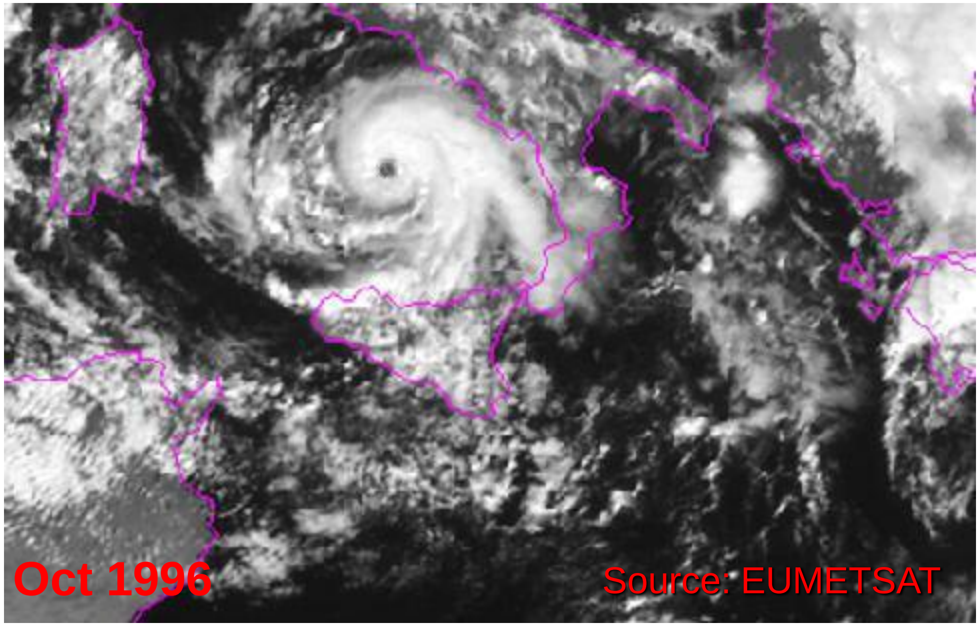


1)1200 UTC, 23/9/69
1200 UTC, 27/9/69
2)1310 UTC, 23/1/82
1200 UTC, 28/1/82
3)0630 UTC, 26/3/83
1200 UTC, 26/3/83
4)1500 UTC, 27/9/83
0000 UTC, 2/10/83
5)2340 UTC, 29/12/84
2340 UTC, 30/12/84
6)0300 UTC, 15/1/95
0600 UTC, 18/1/95
45
40
35
30
10
0
10
20
30









Rasmussen and Zick 1987: Tellus, 39A, 408-425
Paranos 2016: M.Sc. Thesis, Aristotle Univ. of Thessaloniki, Greece (http://ikee.lib.auth.gr/record/284902)
https://en.wikipedia.org

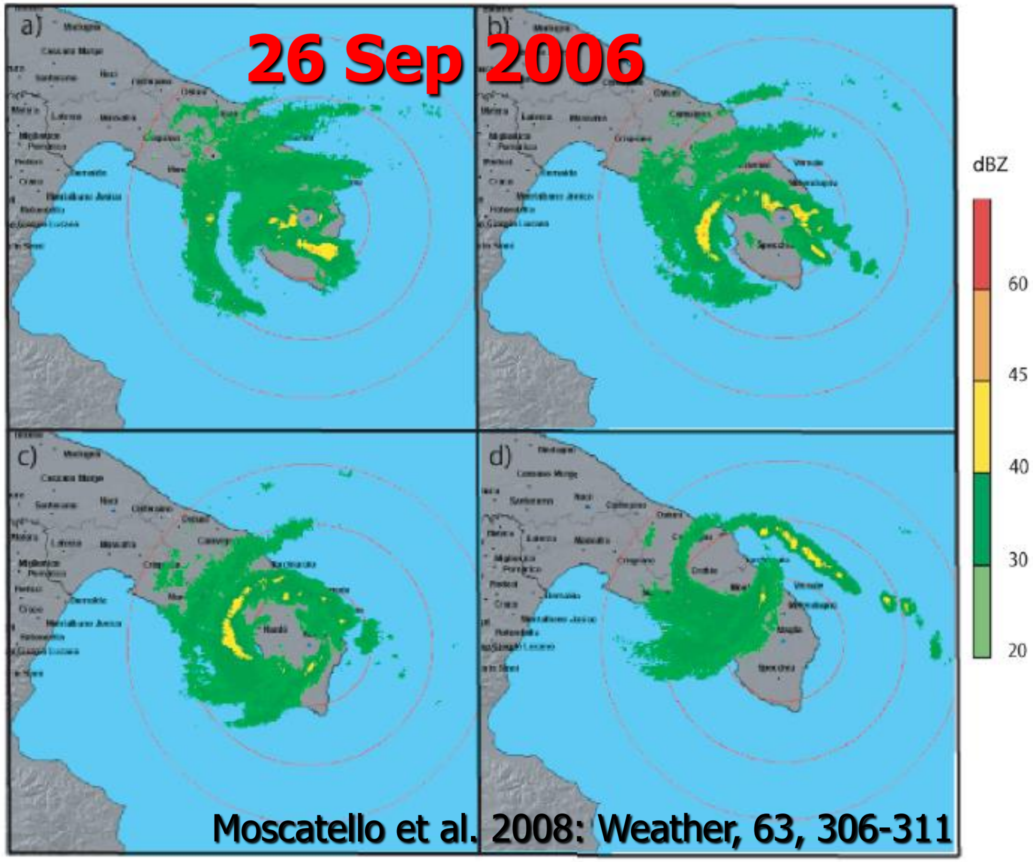
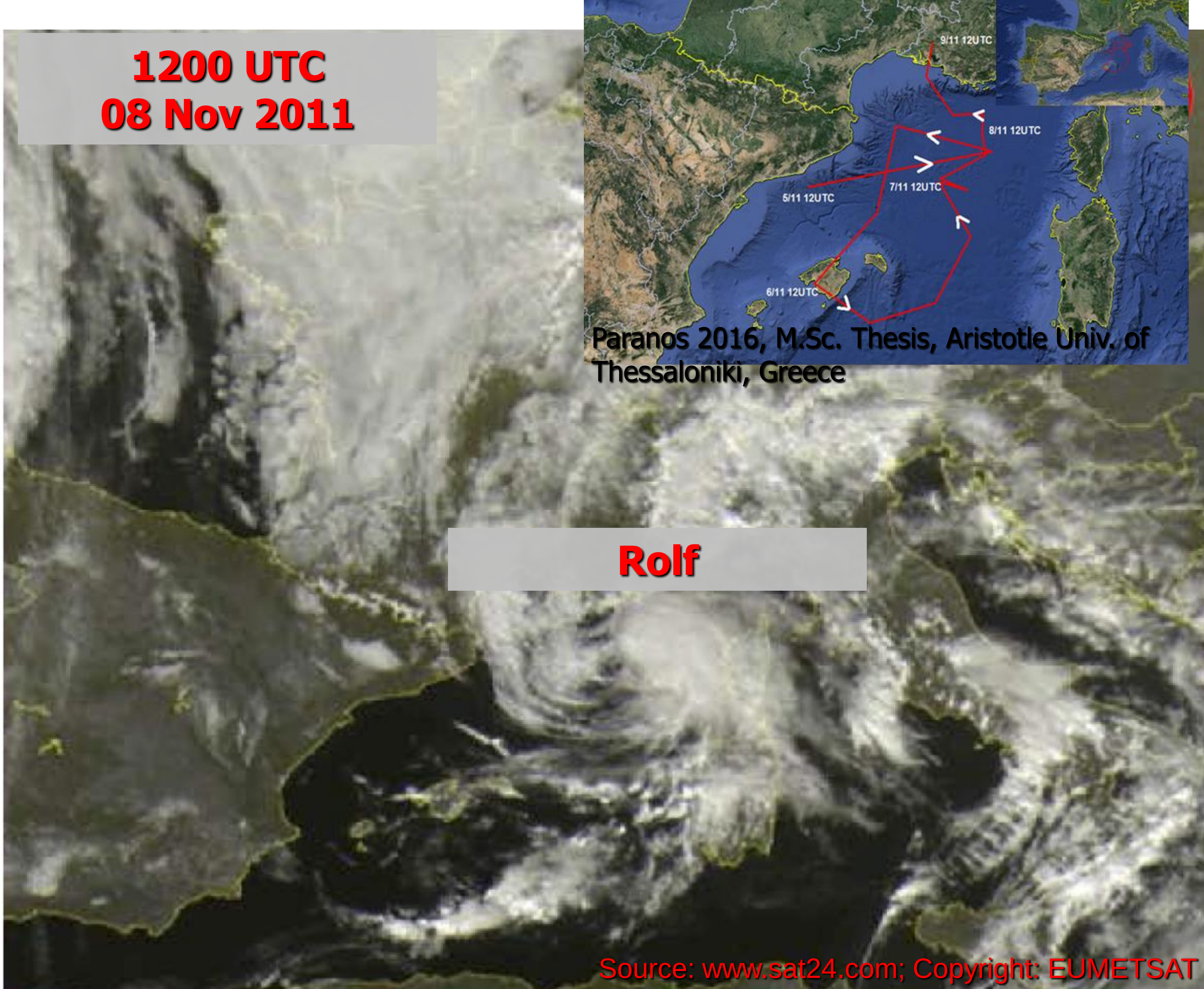
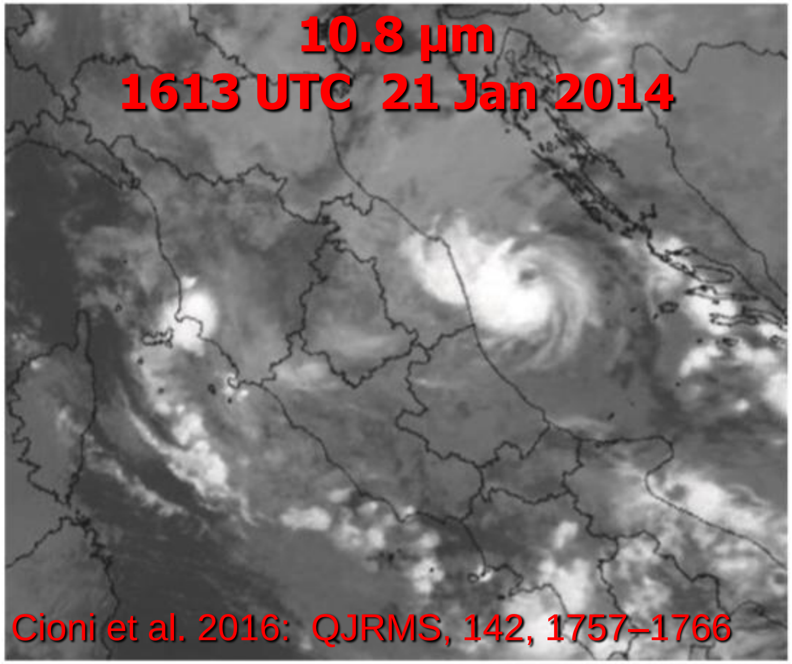


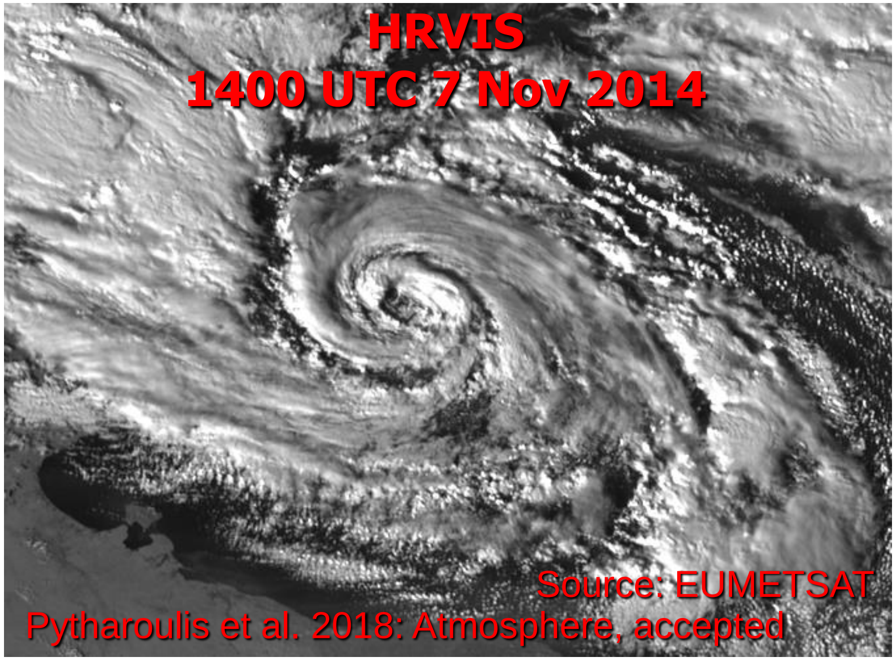
Figure 5. Reflectivity maps (elevation 2.75°) in dBZ from the radar in Maglie (SMA S.p.A.) on 26 September 2006 at (a) 0820 UTC, (b) 0840 UTC, (c) 0900 UTC and (d) 0940 UTC.

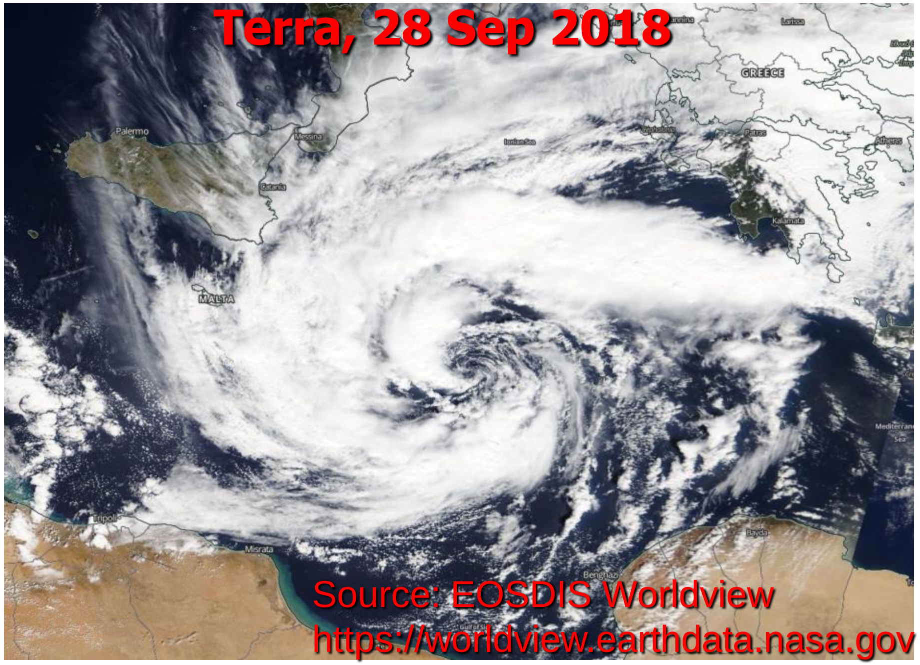
Moscatello et al. 2008: Mon. Wea. Rev., 136, 4373-4397
Davolio et al. 2009: NHESS, 9, 551-562
Conte et al. 2011: Atmos. Res., 101, 264-279
Miglietta et al. 2011: Atmos. Res., 101, 412–426
Chaboureau et al. 2012: QJRMS, 138, 596-611
Miglietta et al. 2013: Geophys. Res. Lett. 40, 2400–2405
Miglietta et al. 2015: Atmos. Res., 153, 360–375
Miglietta et al. 2017: Geophys. Res. Lett., 44, 2537-2545



Ricchi et al. 2017: Atmosphere, 8(5), 92.


10.8 µm
1613 UTC 21 Jan 2014
Cioni et al. 2016: QJRMS, 142, 1757–1766


HRVIS
1400 UTC 7 Nov 2014
Source: EUMETSAT
Pytharoulis et al. 2018: Atmosphere, accepted


Terra, 28 Sep 2018
Palermo
MALTA
GREECE
Source: EOSDIS Worldview
https://worldview.earthdata.nasa.gov

Structure – Characteristics – Definition

Main Characteristics

- Sub-synoptic maritime cyclones

(usually R $\cong$ 50-200 km; Miglietta et al. 2013: GRL)

- Cloud-free 'eye' at the center

(Detected in satellite images)

- Eyewall with deep convection

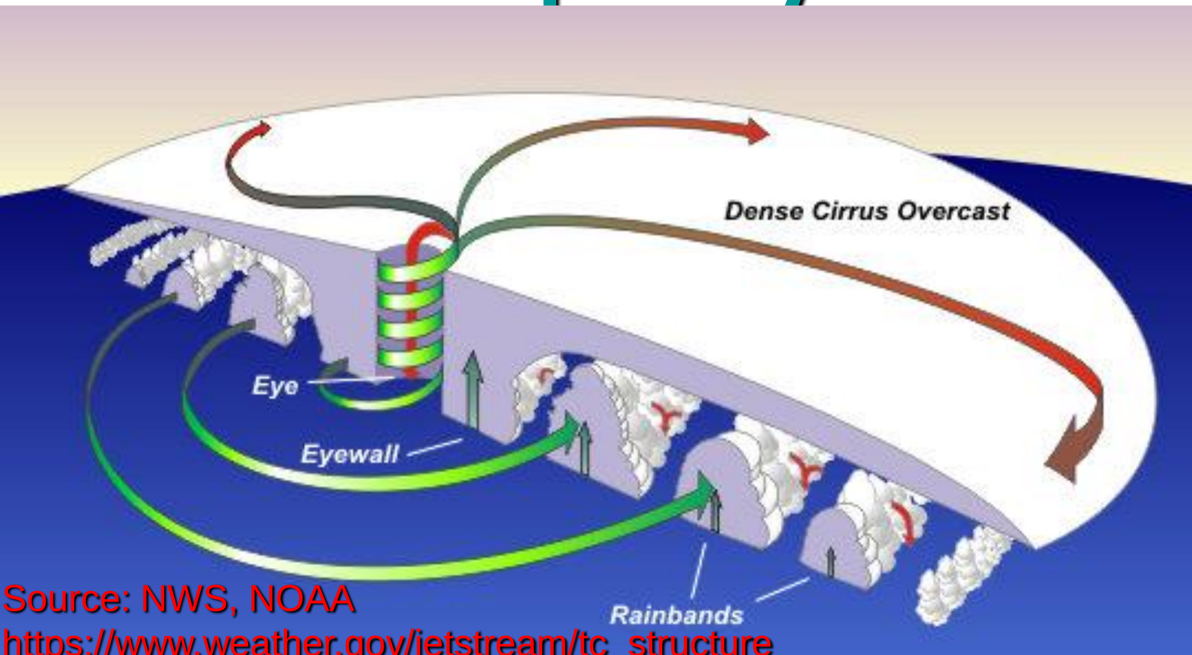
and spiral bands of clouds

(Detected in satellite images)

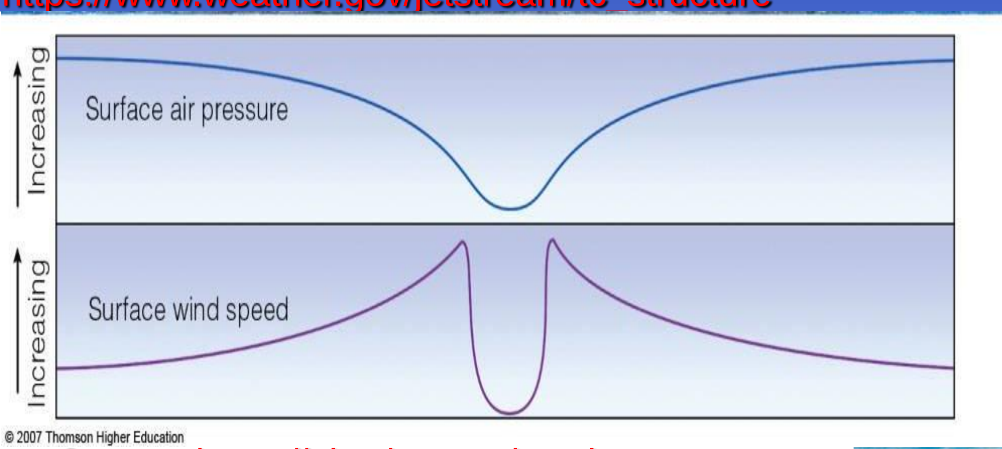
- Strong near surface winds
- Warm - core structure

Source: EOSDIS Worldview
https://worldview.earthdata.nasa.gov

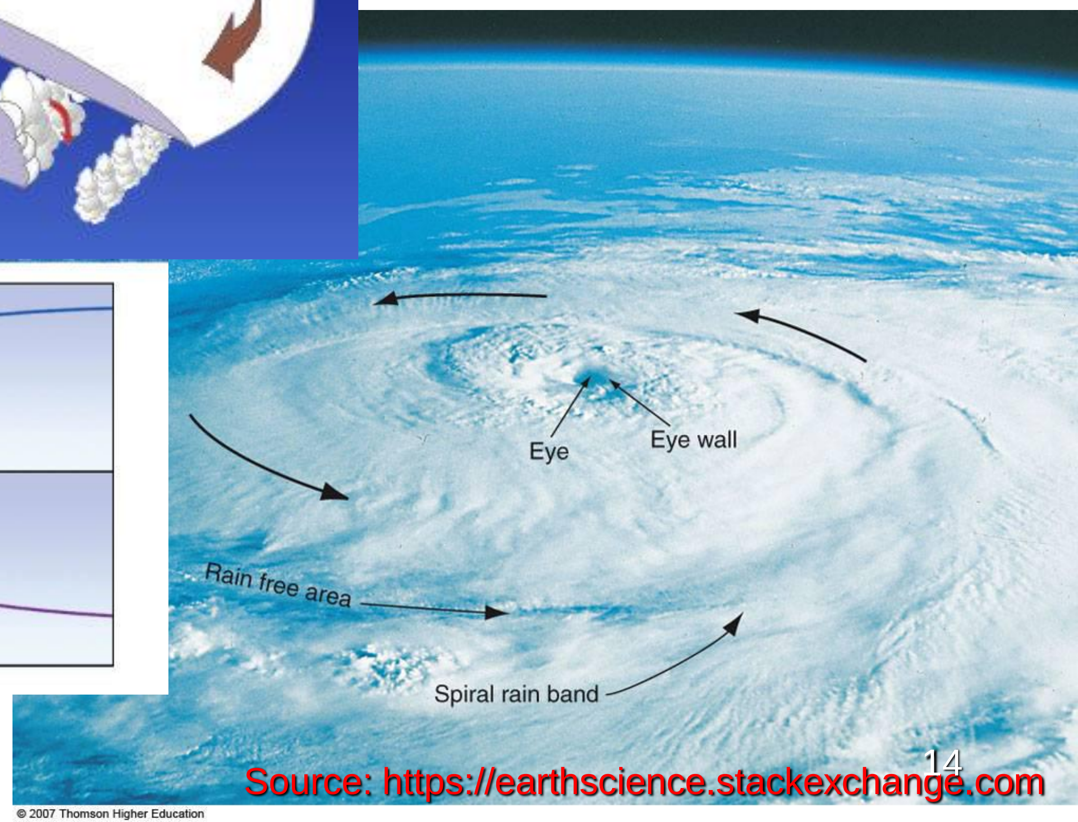
Tropical cyclone structure



Source: NWS, NOAA
https://www.weather.gov/jetstream/tc_structure



Source: https://physics.stackexchange.com



Source: https://earthscience.stackexchange.com

Warm – core structure

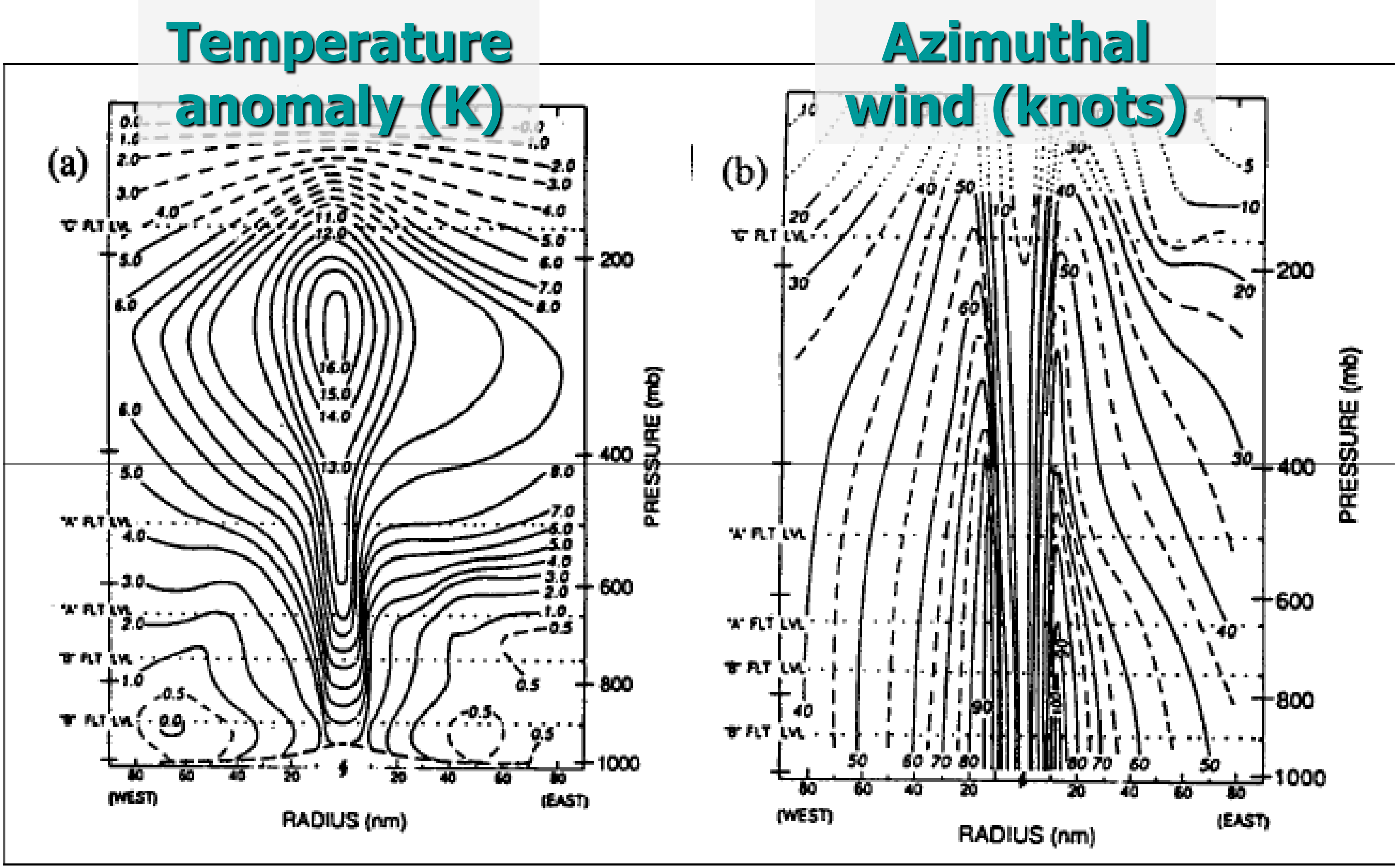
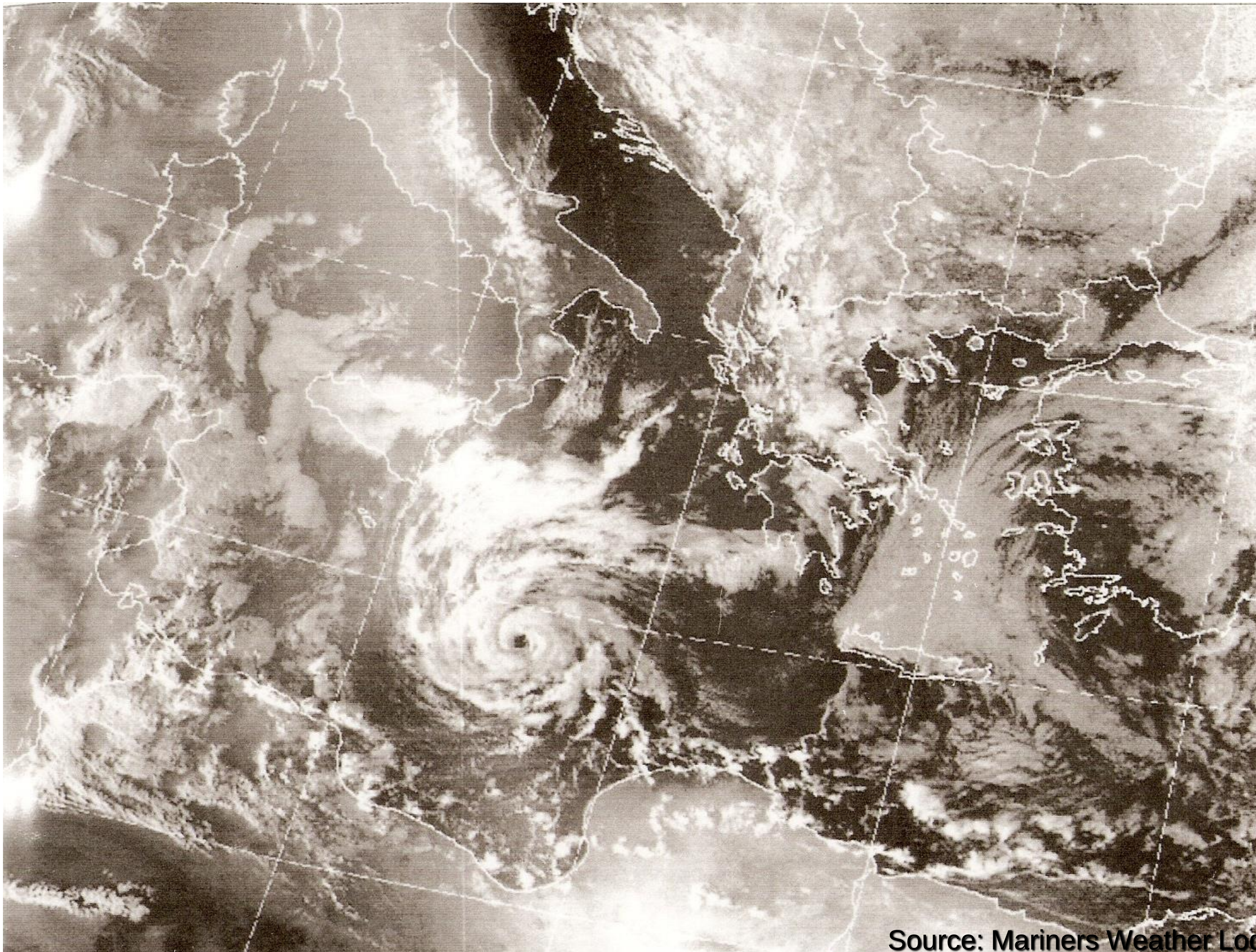


Figure 1.8 Vertical cross sections of: a) temperature anomaly (K), and b) azimuthal wind (knots) in Hurricane Hilda of 1964 (Hawkins and Rubsam 1968). 1 knot= 0.515 m/s

1616 UTC, 16 January 1995



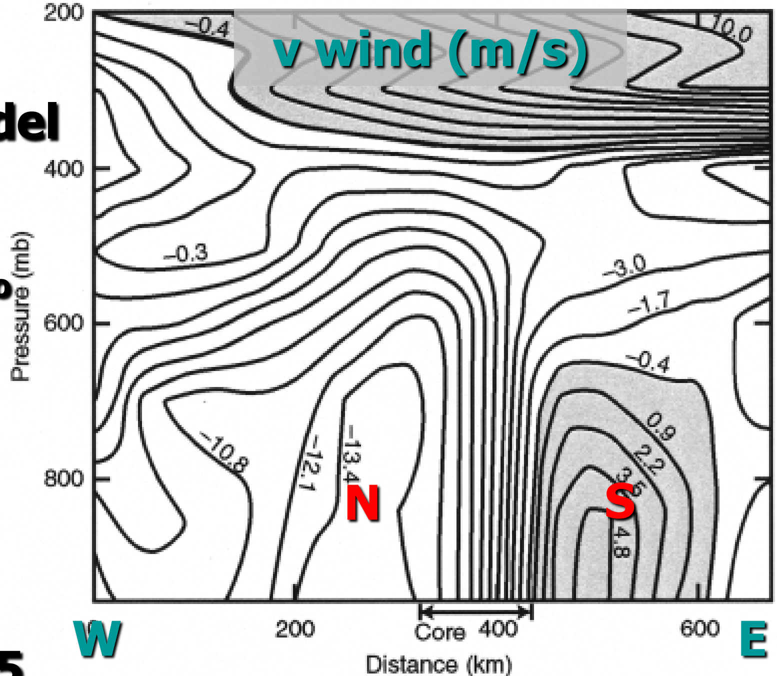
Source: Mariners Weather Log

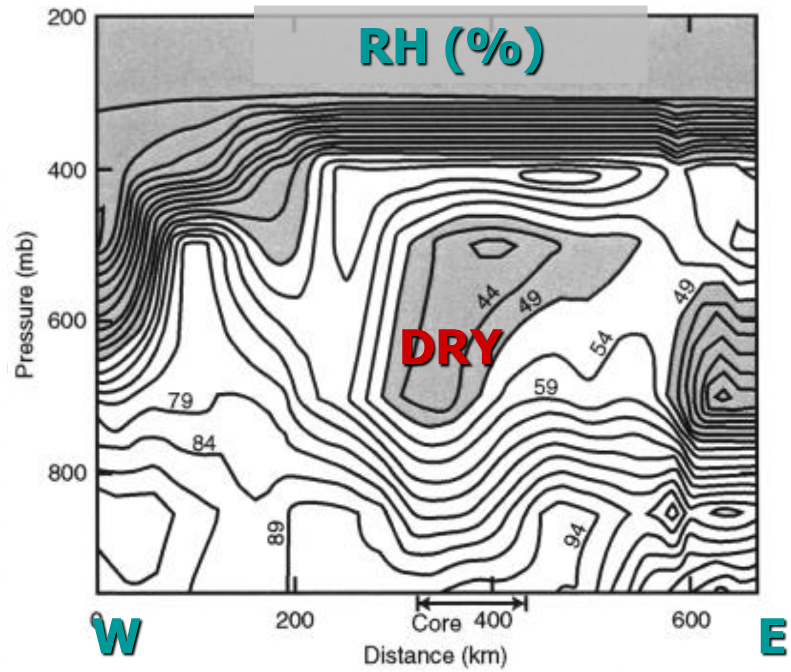
UKMO Unified Model

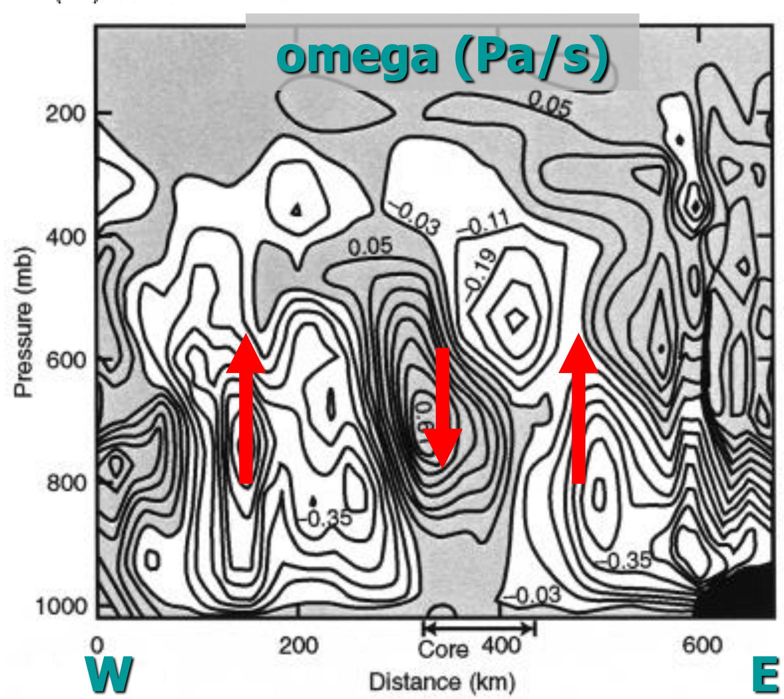
0.15°x0.15°

T+36 hr

Init.: 00 UTC 15 Jan 1995







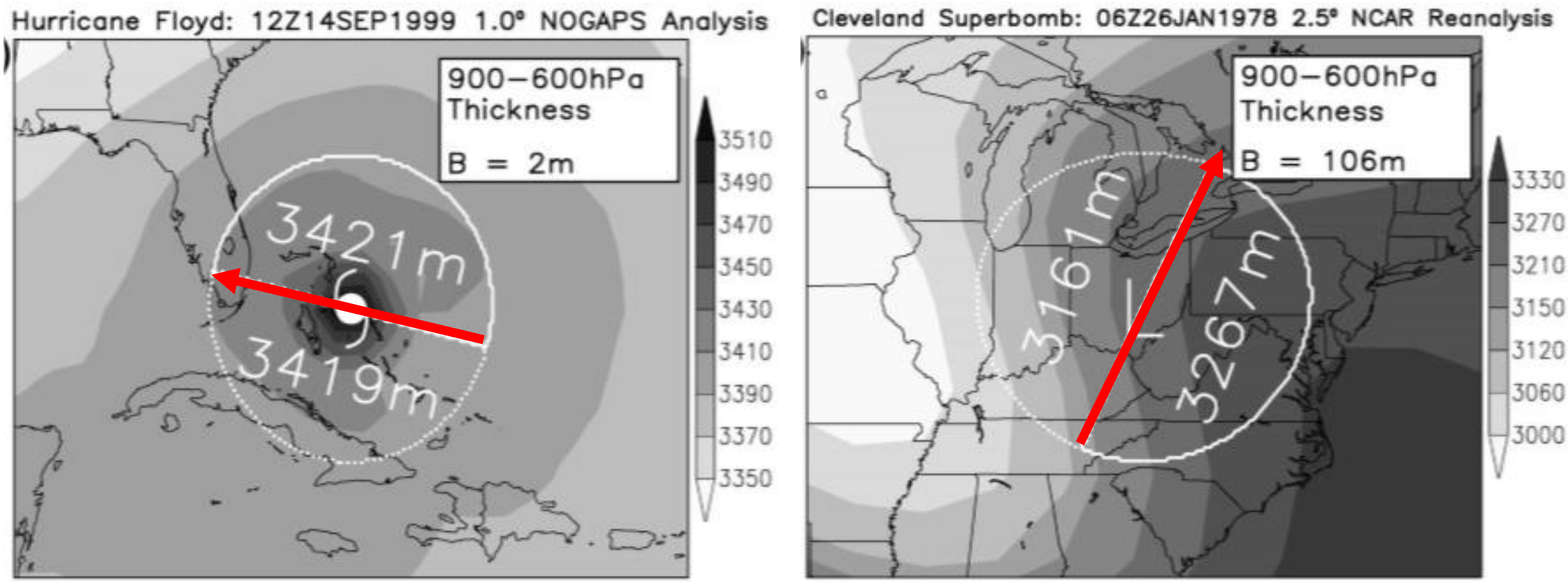
Pytharoulis et al. 2000: Meteorological Applications

The satellite images are invaluable for detecting medicanes.

However, further analysis is required in order to classify a cyclonic system as medicane.

<u>There is NOT an official definition of medicanes as for the tropical cyclones</u>.

Thermal symmetry/asymmetry parameter B



$$B = h\left(\overline{Z_{600\ \mathrm{hPa}} - Z_{900\ \mathrm{hPa}}}\,\Big|_R - \overline{Z_{600\ \mathrm{hPa}} - Z_{900\ \mathrm{hPa}}}\,\Big|_L\right);$$

B > 10 m in extratropical cyclones

B ≅ 0 m in tropical cyclones (B < 10 m)

Hart 2003: Mon. Wea. Rev., 131, 585-616

Scaled Thermal Wind Magnitude ($-V_T^L$, $-V_T^U$)

$$\left.\frac{\partial(\Delta Z)}{\partial \ln p}\right|_{900\text{ hPa}}^{600\text{ hPa}} = -\left|V_T^L\right|$$

$$\left.\frac{\partial(\Delta Z)}{\partial \ln p}\right|_{600\text{ hPa}}^{300\text{ hPa}} = -\left|V_T^U\right|$$

$$\Delta Z = Z_{\mathrm{MAX}} - Z_{\mathrm{MIN}}$$

Z = geopot. height

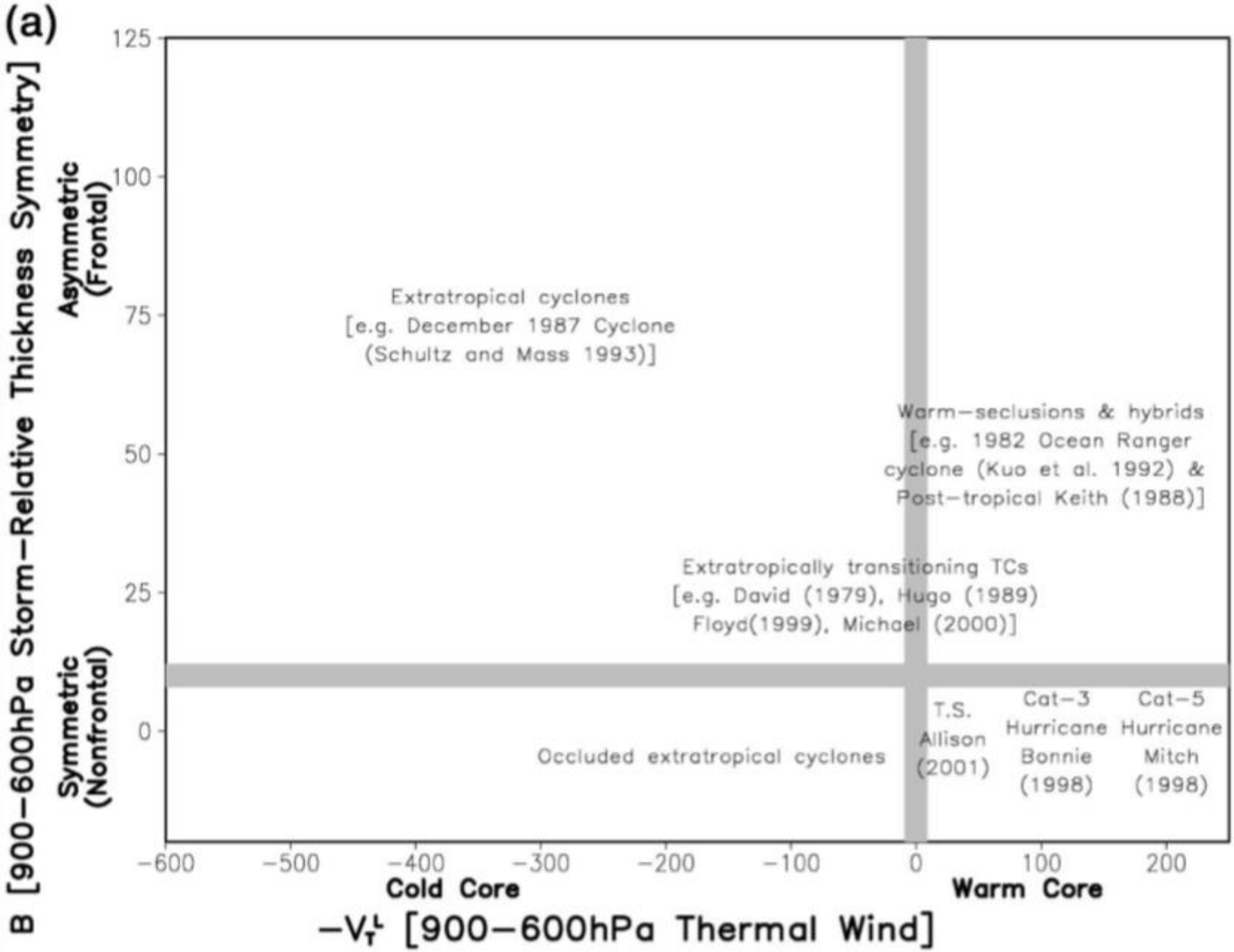
$-V_T^L > 0$ Lower layer Warm Core

$-V_T^U > 0$ Upper layer Warm Core

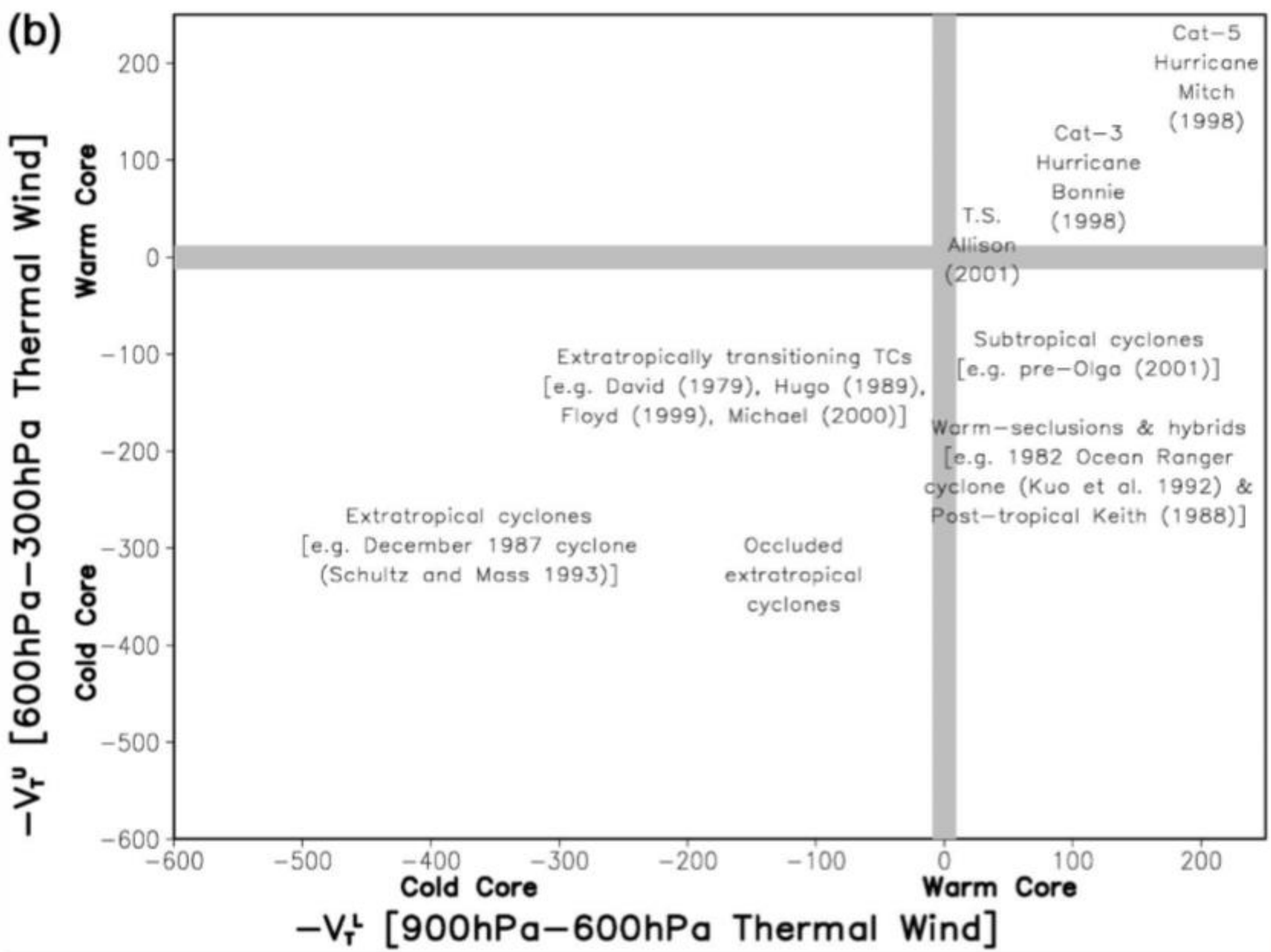
$-V_T^L < 0$ Lower layer Cold Core

$-V_T^U < 0$ Upper layer Cold Core

Hart 2003: Mon. Wea. Rev., 131, 585-616



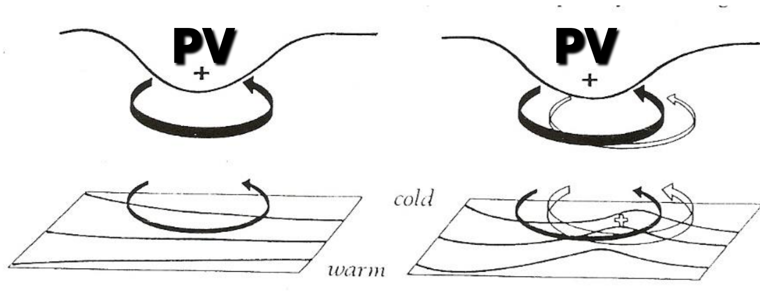
Hart 2003: Mon. Wea. Rev., 131, 585-616



Hart 2003: Mon. Wea. Rev., 131, 585-616

Mechanisms for development

Mechanisms:



- Baroclinic instability

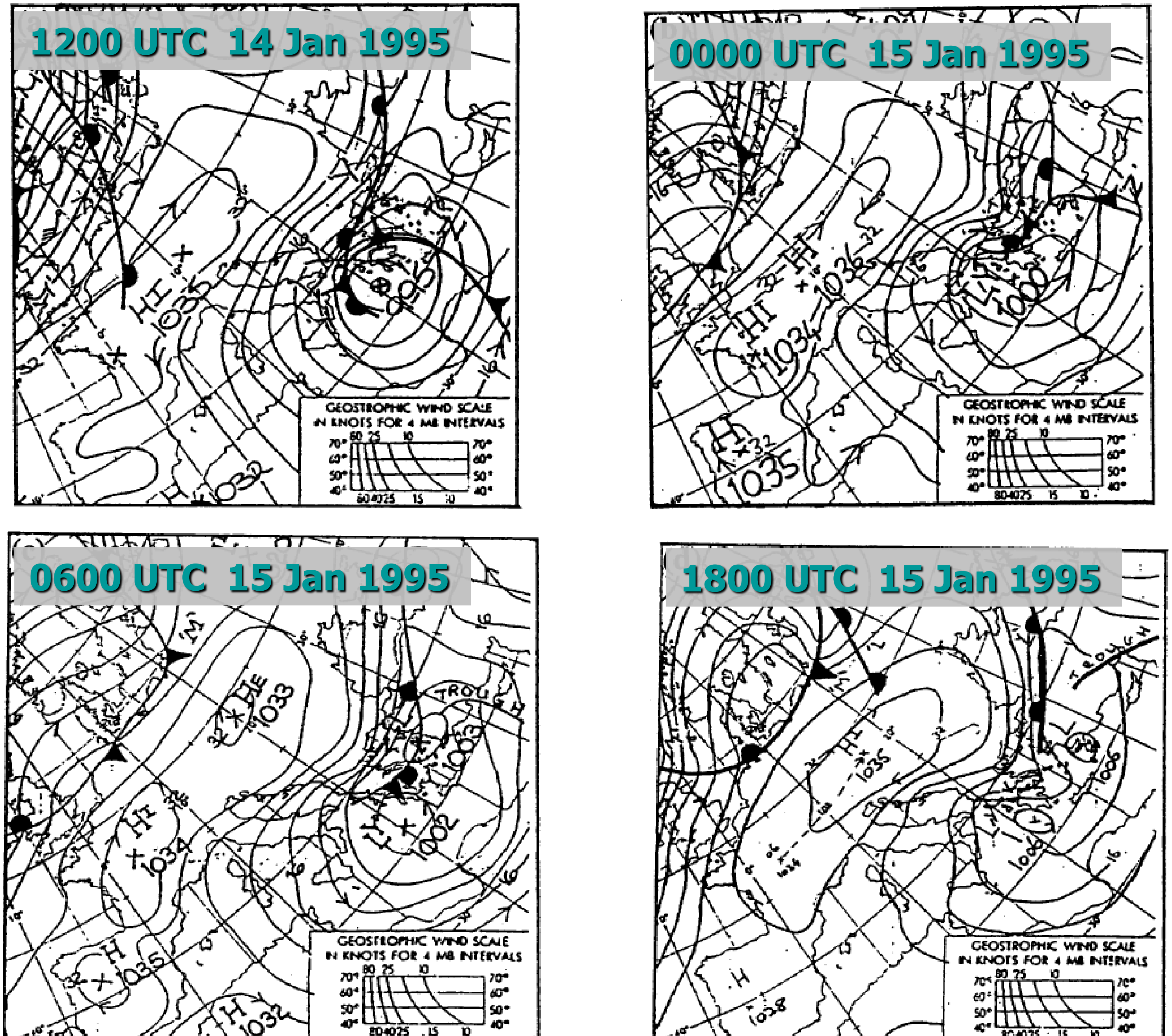
Hoskins et al. 1985: QJRMS, 111, 877-946

- Wind Induced Surface Heat Exchange (WISHE)

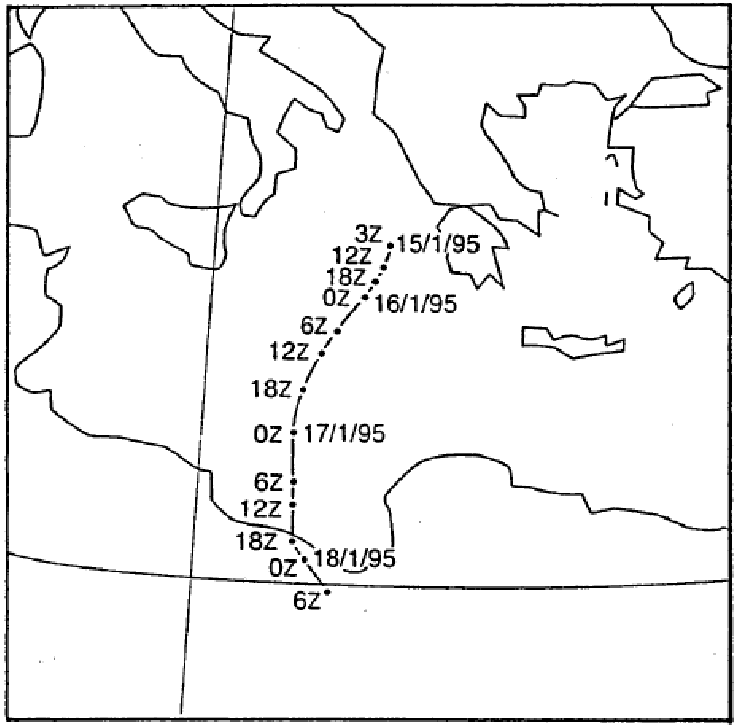
  e.g. Emanuel 1986: J Atmos Sci, 43, 585-604

Important Factors:

- Sea-surface sensible and latent heat fluxes
- Latent Heating
- Upper level PV anomalies
- Jet stream
- Orography
- Vertical shear of the horizontal wind



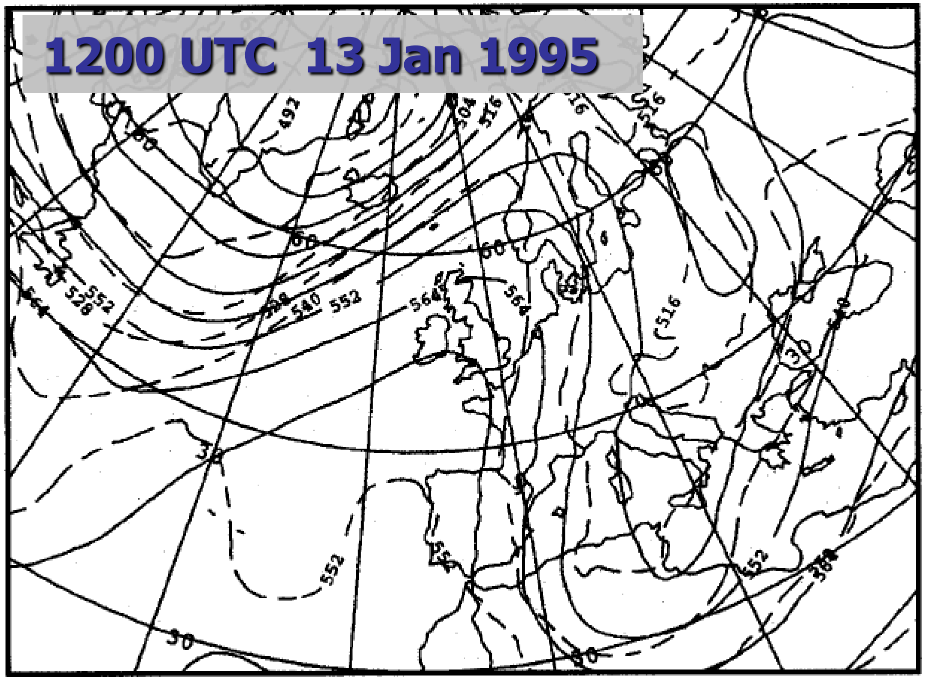
1200 UTC 14 Jan 1995
0000 UTC 15 Jan 1995
0600 UTC 15 Jan 1995
1800 UTC 15 Jan 1995
GEOSTROPHIC WIND SCALE
IN KNOTS FOR 4 MB INTERVALS
TROUGH

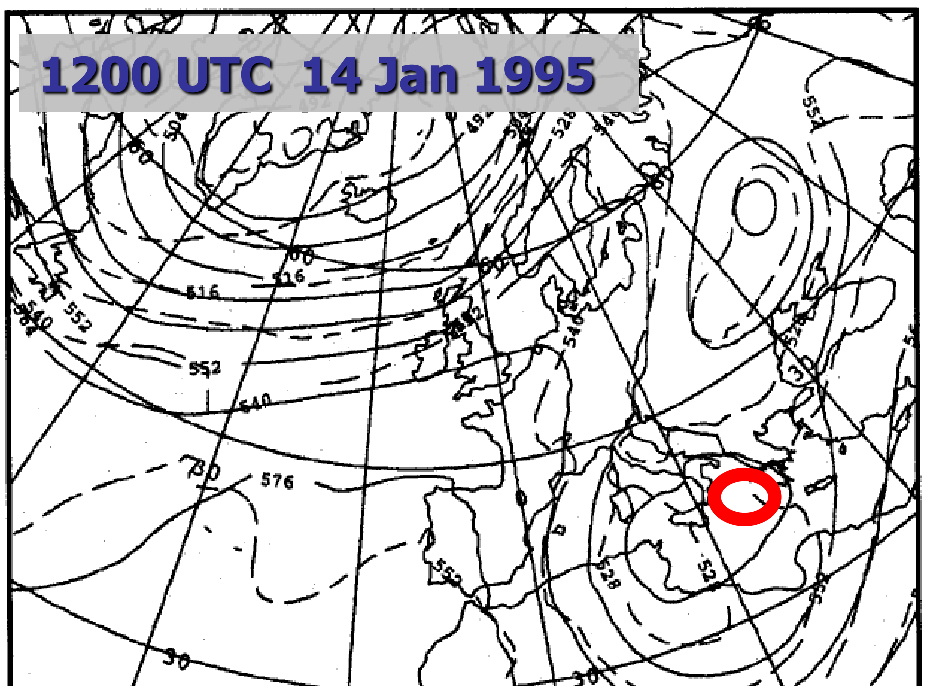


Ship reports of maximum wind:

1200 UTC 15 Jan 1995	15.5 m/s
0000 UTC 16 Jan 1995	17.5 m/s

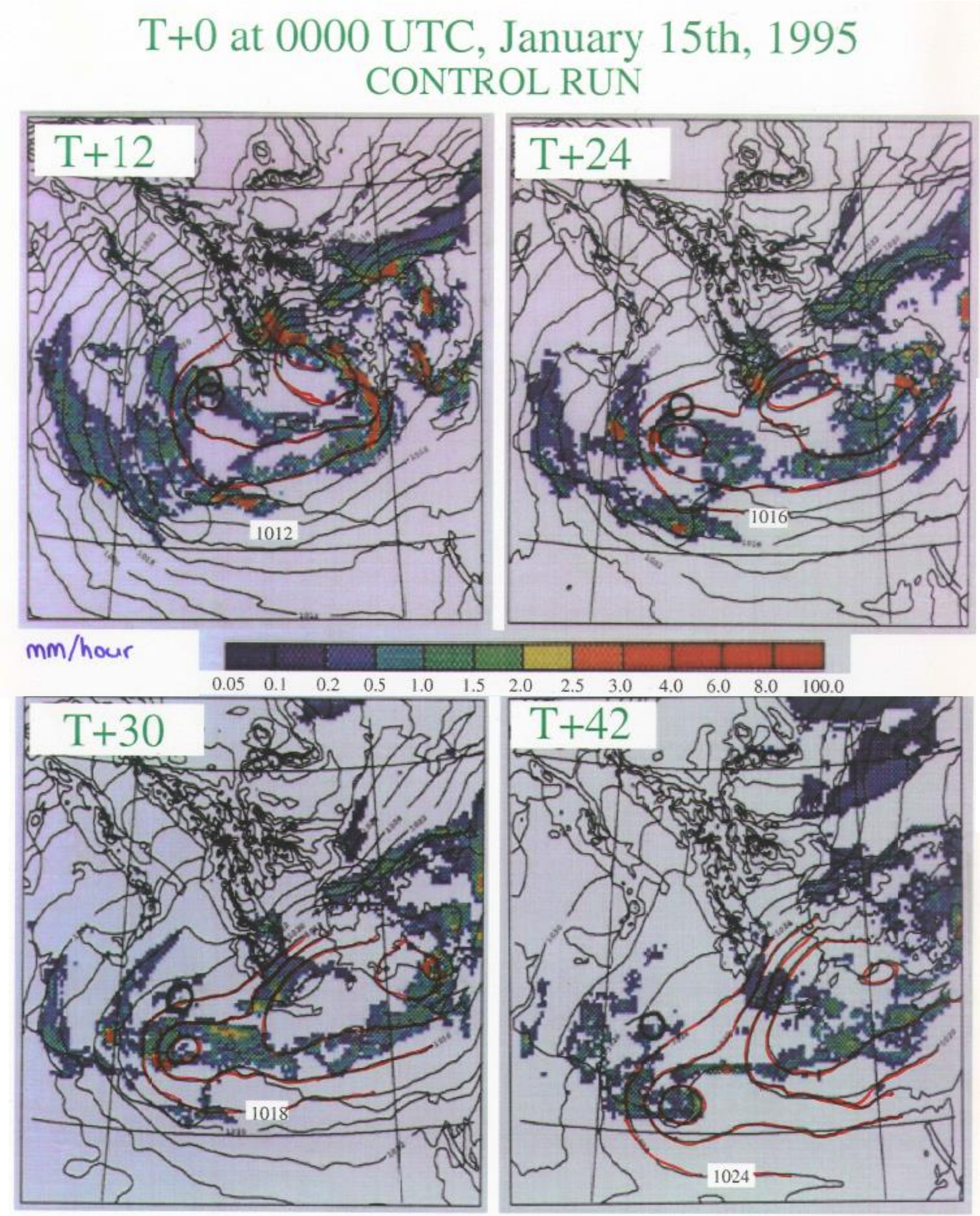
Forecast period and time/date		Central pressure (hPa)
		Actual
T+6	0600 UTC 15/01/95	1002
T+12	1200	1004
T+18	1800	1006
T+24	0000 UTC 16/01/95	1013
T+30	0600	1012
T+36	1200	1010
T+42	1800	1012
T+48	0000 UTC 17/01/95	1012
—	0600	1018
—	1200	1016
—	1800	1022
—	0000 UTC 18/01/95	1022





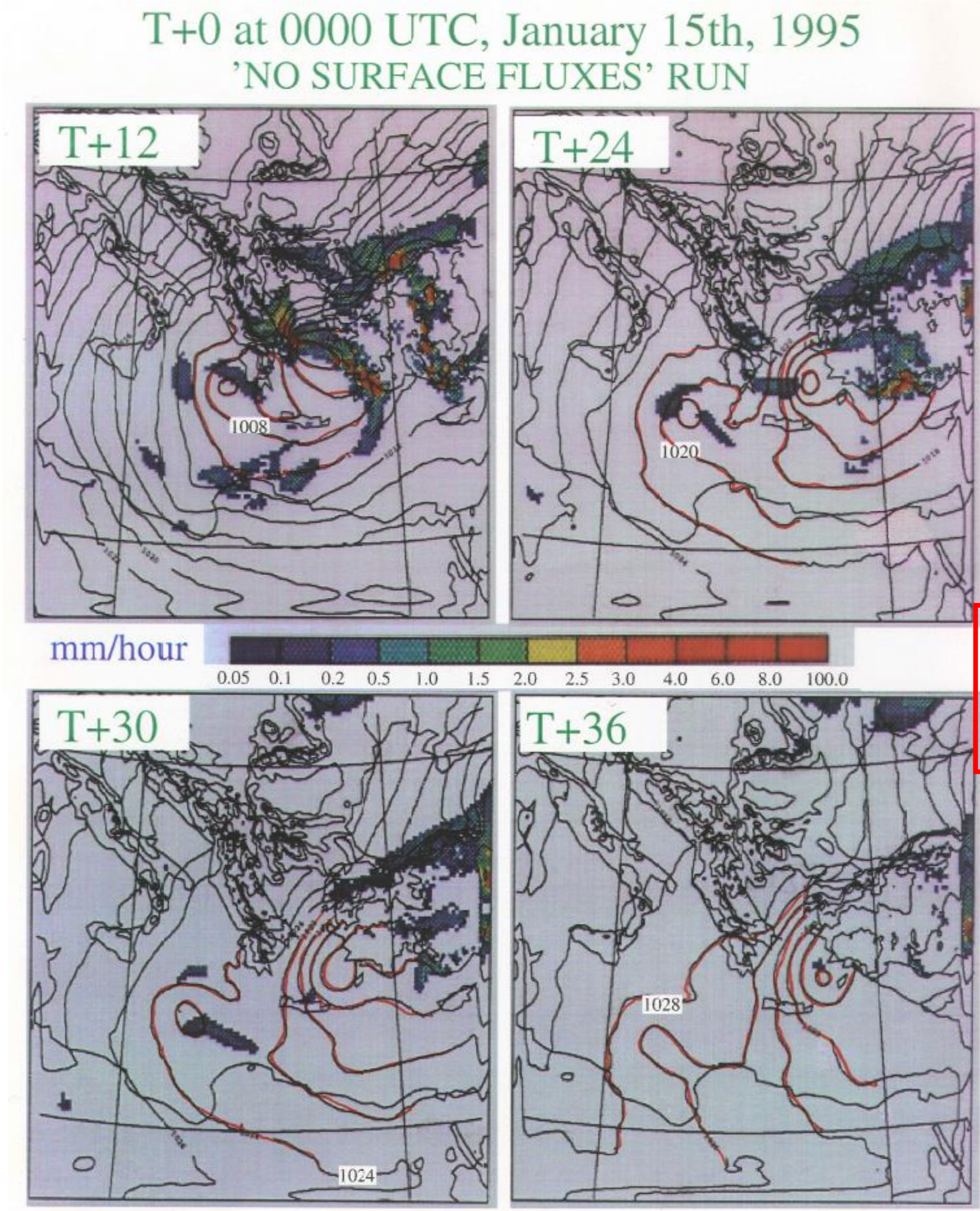
Solid lines: gph 500 hPa

Dashed lines: 1000-500 hPa thickness



Forecast period and time/date		Central pressure (hPa)	
		Actual	Predicted
T+6	0600 UTC 15/01/95	1002	—
T+12	1200	1004	1004
T+18	1800	1006	1006
T+24	0000 UTC 16/01/95	1013	1011
T+30	0600	1012	1014
T+36	1200	1010	1016
T+42	1800	1012	1019
T+48	0000 UTC 17/01/95	1012	1020
—	0600	1018	—
—	1200	1016	—
—	1800	1022	—
—	0000 UTC 18/01/95	1022	—

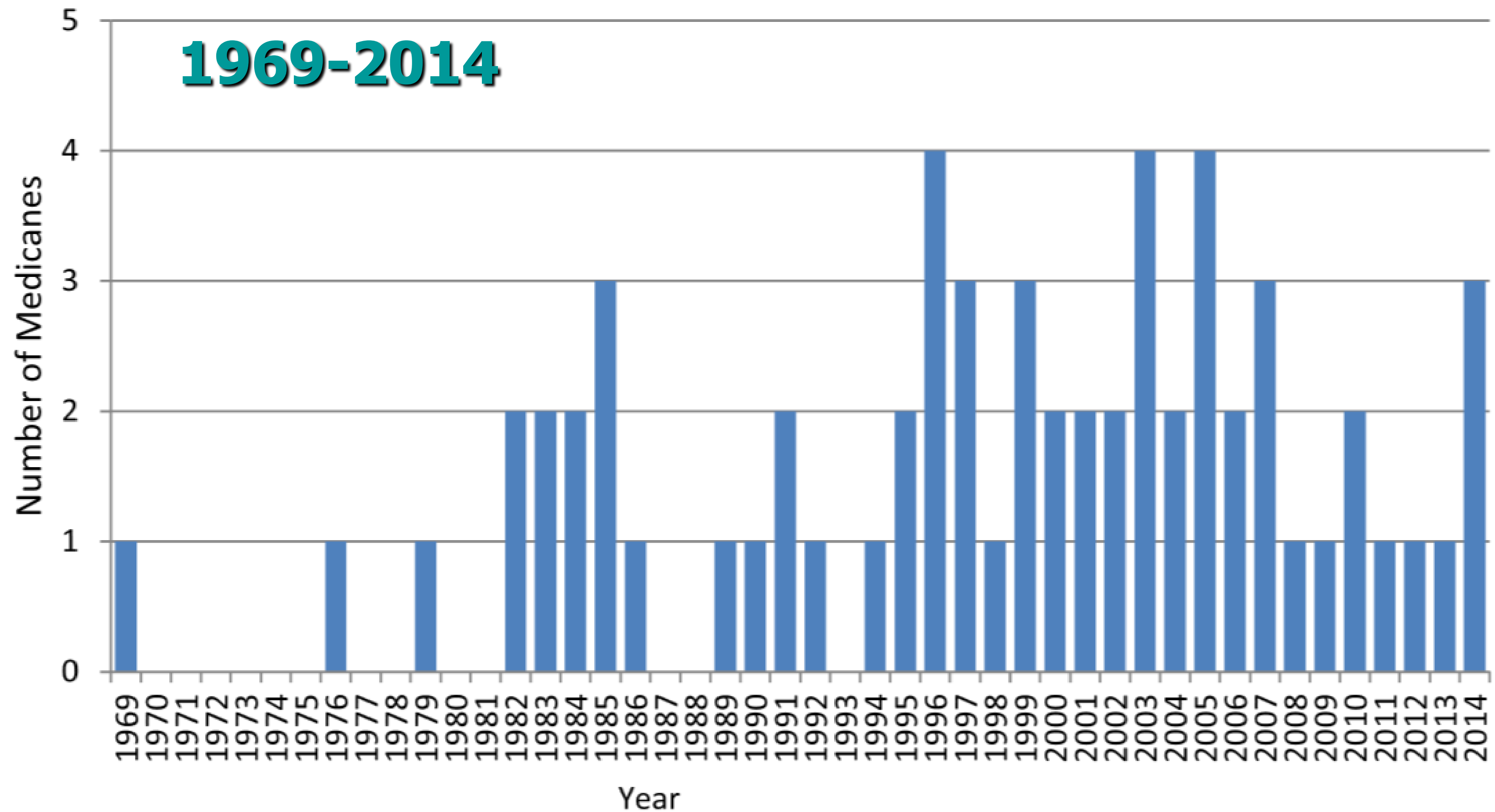
Pytharoulis et al. 2000: Meteorological Applications



The sfc heat fluxes were very important for its development.

Pytharoulis et al. 2000: Meteorological Applications

Climatology



Nastos et al. 2018: Atmospheric Research

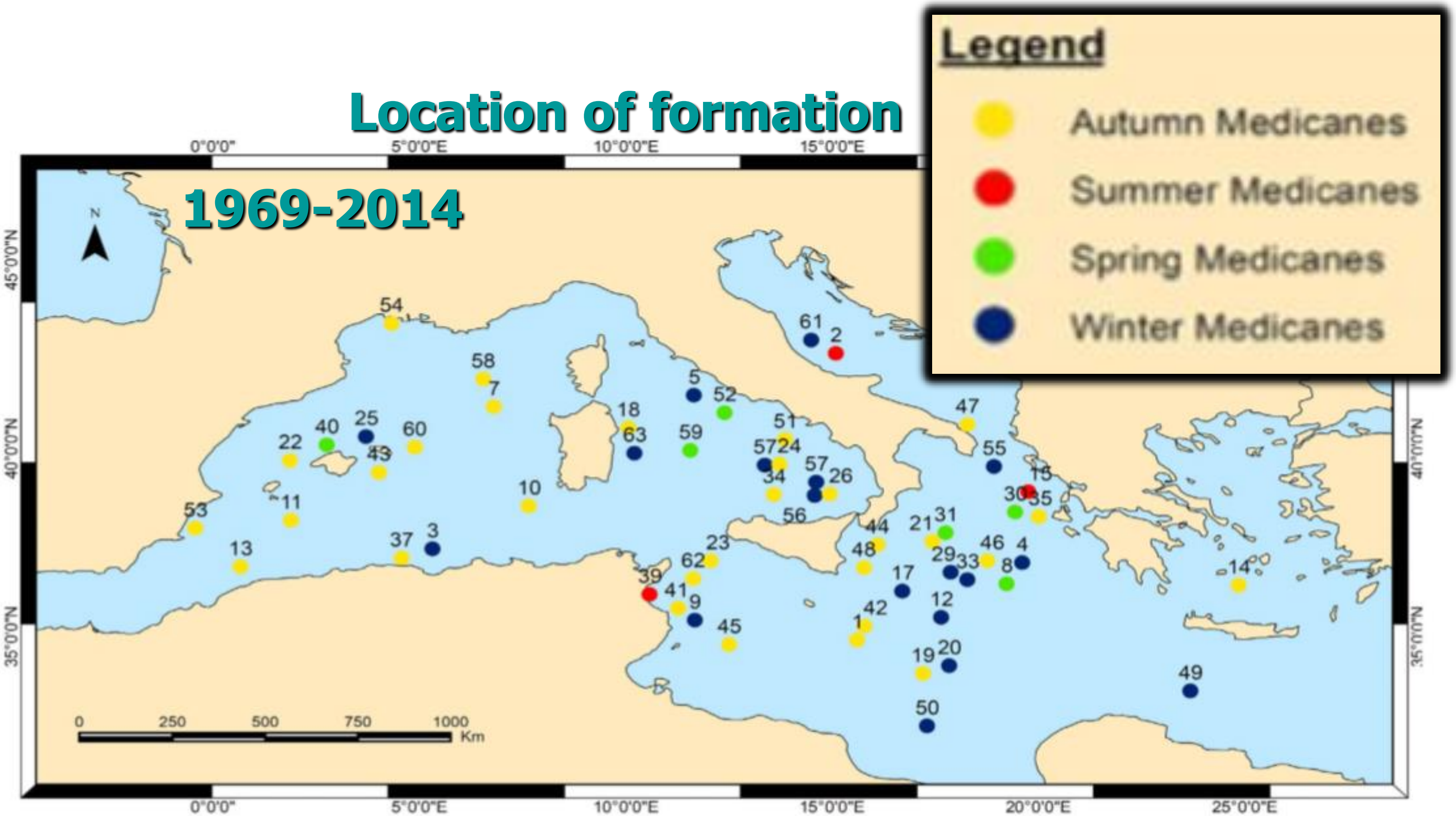
<u>Annual number of medicanes:</u>

Miglietta et al. (2013), modelling & satellite analysis, 1999-2011: 1.1

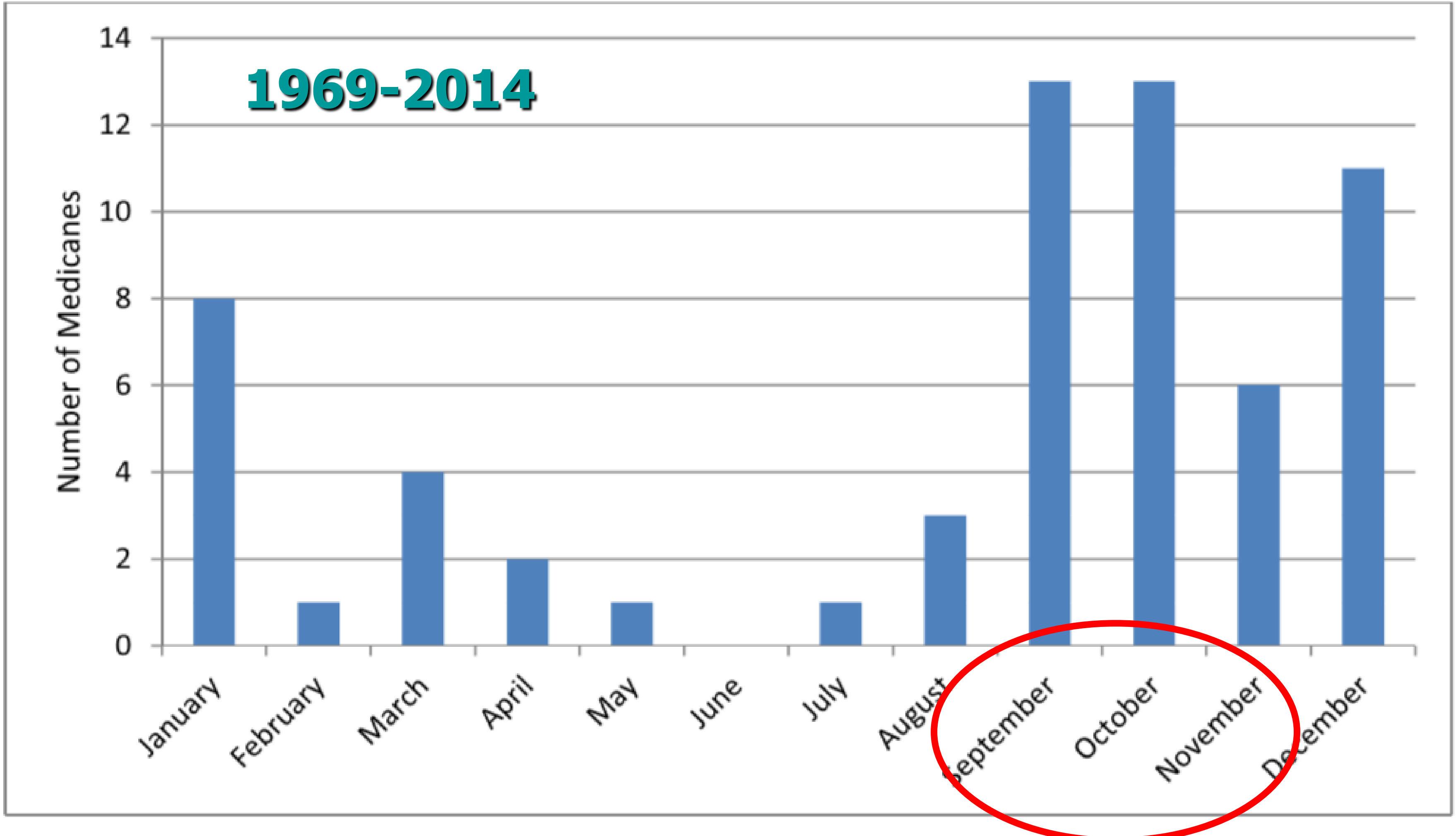
Cavicchia et al. (2014), dynamical downscaling, 1948-2011: 1.6±1.3

Nastos et al. (2018), synoptic & satellite analysis, 1969-2014: 1.4±1.3

Location of formation



Nastos et al. 2018: Atmospheric Research
(http://dx.doi.org/10.1016/j.atmosres.2017.10.023)



Nastos et al. 2018: Atmospheric Research

Domain	Area	Date (Day/Month/Year)	Radius (km)	TLC Phase (h)	Min. Pressure (hPa)	Max. Wind at 900 hPa ($m\ s^{-1}$)	SST and Anomaly (°C)	Jet Stream
				Central				
1	Ionian	13/09/1999	150	6	1007	23	25–27	yes
2	Sicily	10-11/09/2000	100	15	1006	22	21–26	yes
3	SE Italy	26/09/2006	100	12	980	45	20–26 (+1)	yes
4	Ionian	04/12/2008	100	3	990	42	16–18 (+1)	yes
5	S Italy	13-14/04/2012	50–150	21	982	39	14–17(+1)	in the initial phase
				South				
6	Ionian	19/09/2004	50	3	1005	26	23–26(+1)	no
7	Sicily Strait	03-06/11/2004	50–50	3-3	1000–1005	30–24	22–25(+3)	yes
				East				
8	Aegean Sea	09/10/2000	50	3	1000	24	19–23	yes
9	Libya-Crete	13-15/12/2005	50–100	6-12-15	996-986-986	40-38-26	17–21(+1.5)	yes
				West				
10	West Sardinia	27/05/2003	50–100	24	1000	30	18–20 (−1)	yes
11	Balearic Islands	17-18/10/2003	100–150	18	990	42	19–23(+1.5)	yes
12	Balearic Islands	17/10/2007	50–100	12	1011	24	21–23(+2)	no
13	S France	26/10/2007	100	6	996	38	17–20 (0)	no
14	Balearic Islands and S France	06-08/11/2011	150–200	63	990	46	17–22(+2.5)	in the initial phase

Miglietta et al. 2013: Geophys. Res. Lett. 40, 2400–2405

Consequences

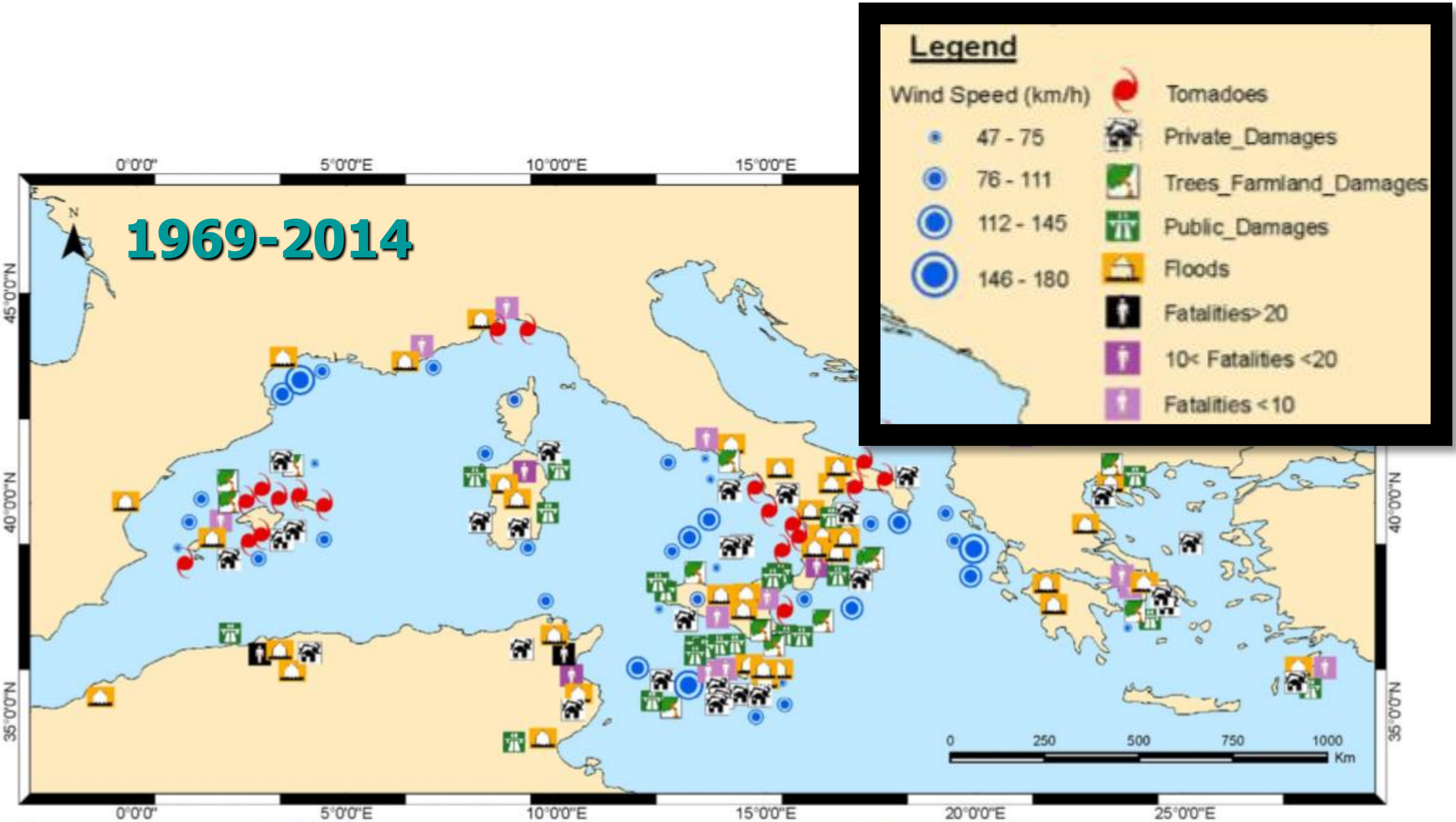


Fig. 7. Geographical distribution of medicane impacts based on the selected 63 cases over Mediterranean during the study period 1969–2014.

Sep 1969: > 600 deaths in Tunisia and NE Algeria due to floods. A tanker sunk.

10-12 Nov 2001: > 600 deaths and $250M damages in Algeria, mudflows

Nastos et al. 2018: Atmospheric Research (http://dx.doi.org/10.1016/j.atmosres.2017.10.023)

Case study:

November 2014

Carrio et al. 2017: Atmospheric Research (http://dx.doi.org/10.1016/j.atmosres.2017.07.018)

Pytharoulis et al. 2017: Springer (https://doi.org/10.1007/978-3-319-35095-0_17)

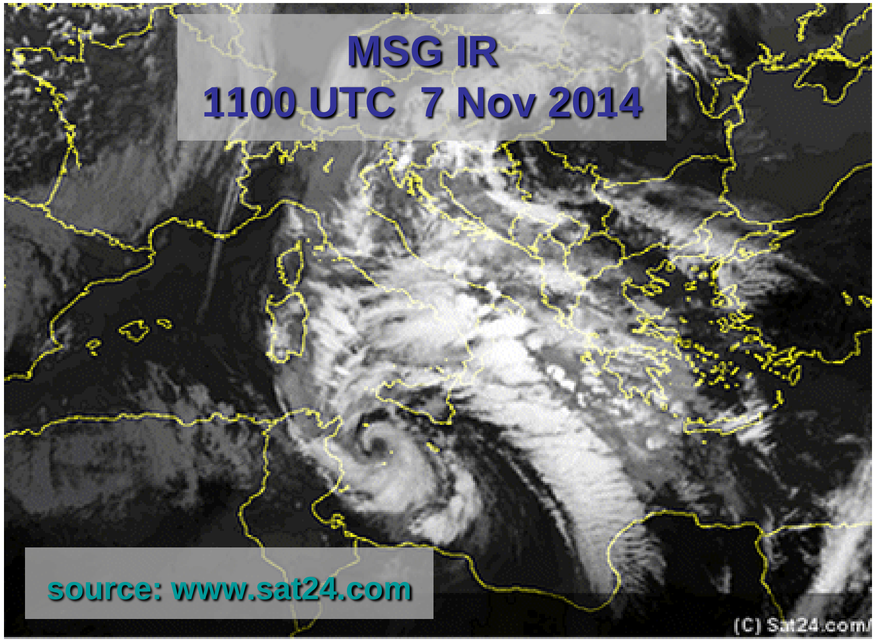
Dimitriadou 2017: MSc Thesis, Aristotle Univ. of Thessaloniki (in Greek) (http://ikee.lib.auth.gr/record/294318)

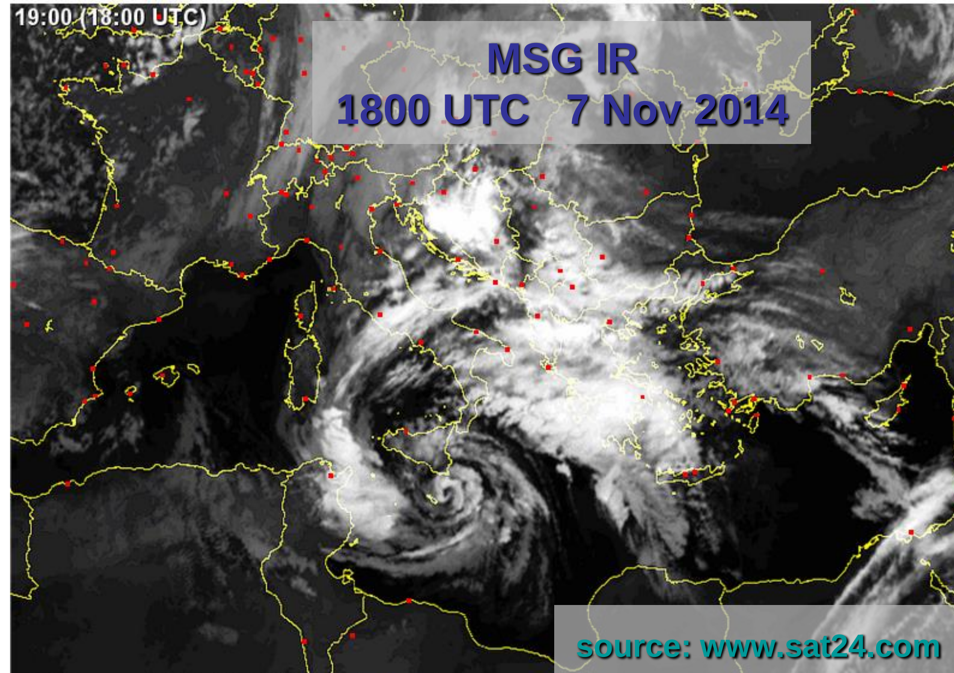
Pytharoulis 2018: Atmospheric Research (http://dx.doi.org/10.1016/j.atmosres.2017.08.009)

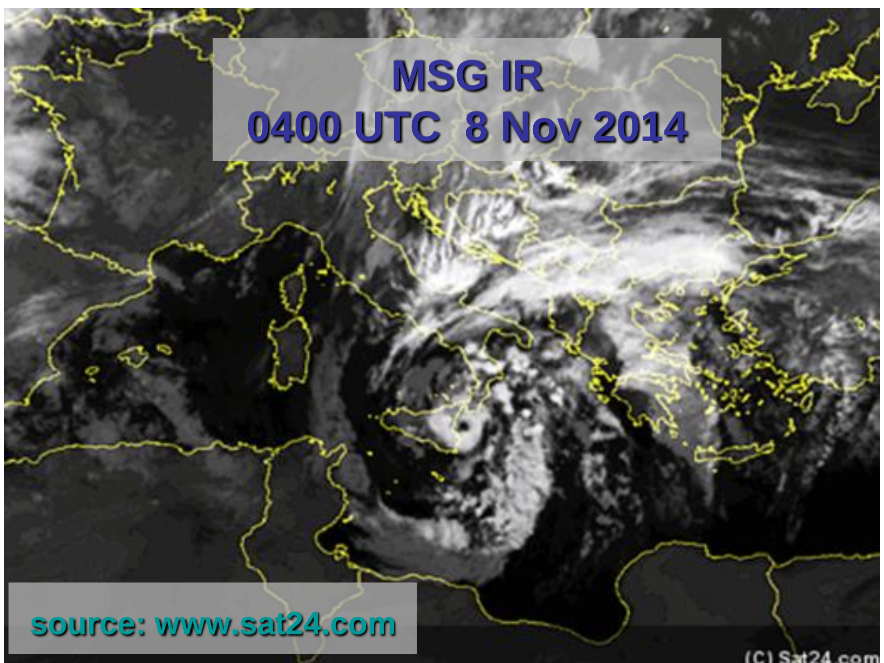
Pytharoulis et al. 2018: Atmosphere, accepted

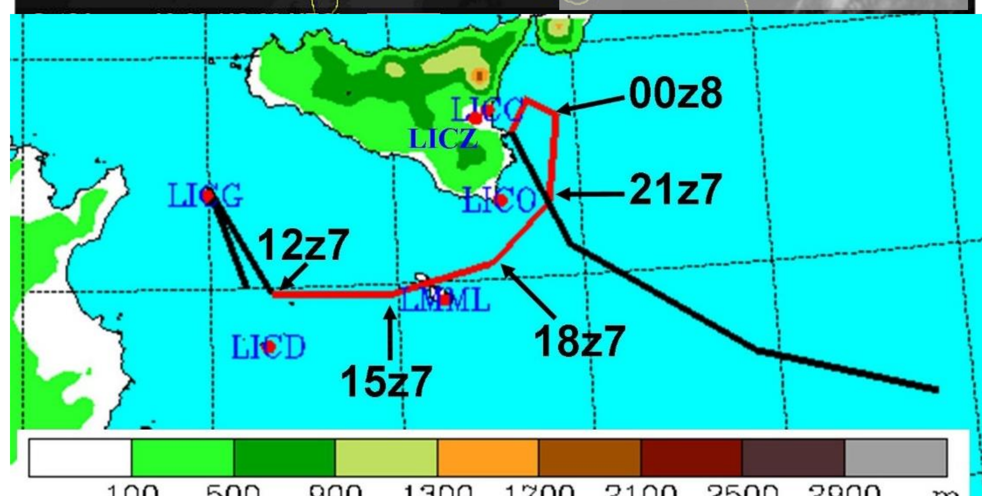
Image credit: Protezionecivile Italy
Source: www.wunderground.com

QENDRESA

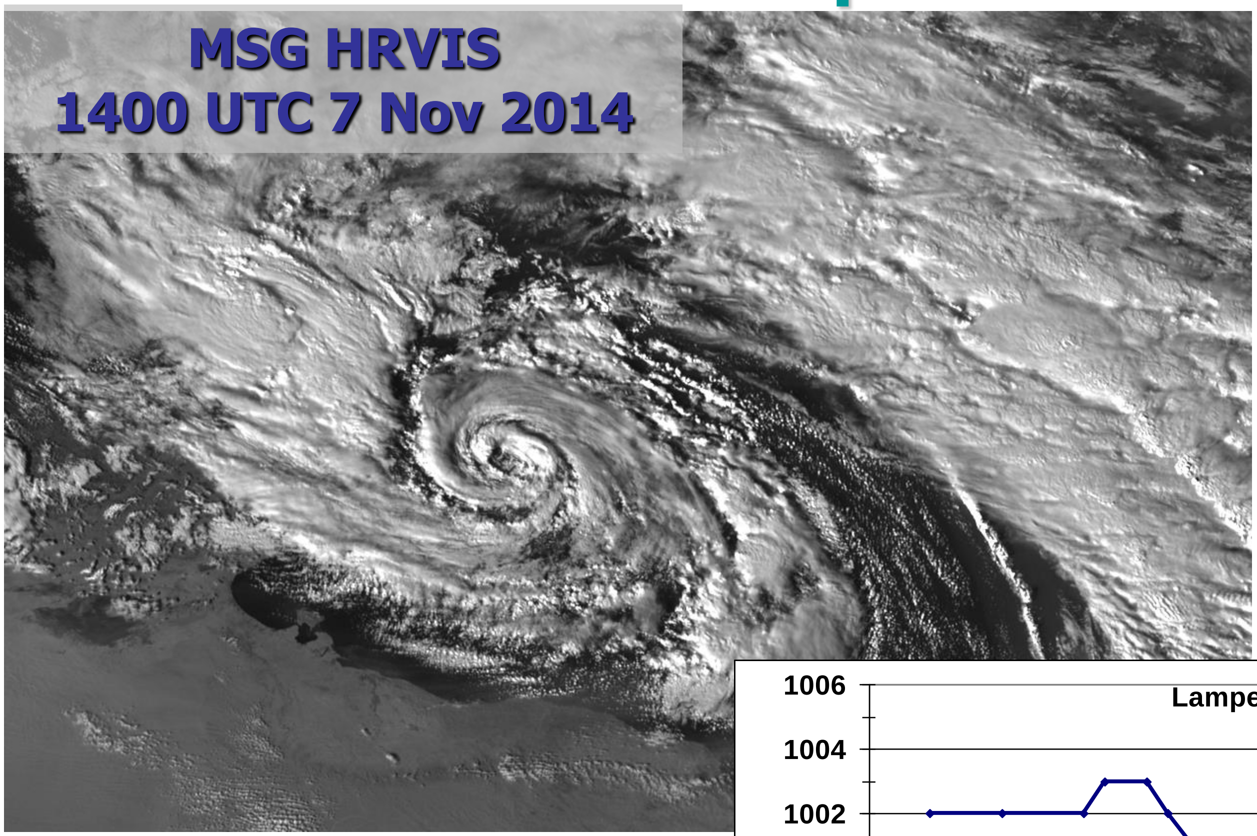

MSG IR
1100 UTC 7 Nov 2014
source: www.sat24.com
(C) Sat24.com

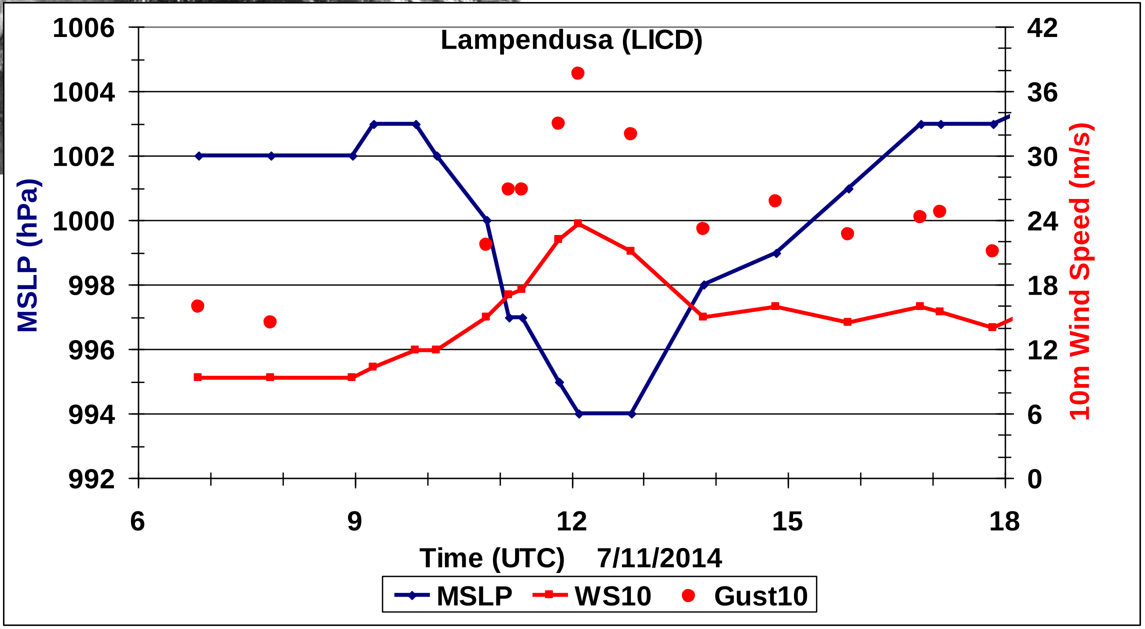

19:00 (18:00 UTC)
MSG IR
1800 UTC 7 Nov 2014
source: www.sat24.com


MSG IR
0400 UTC 8 Nov 2014
source: www.sat24.com
(C) Sat24.com

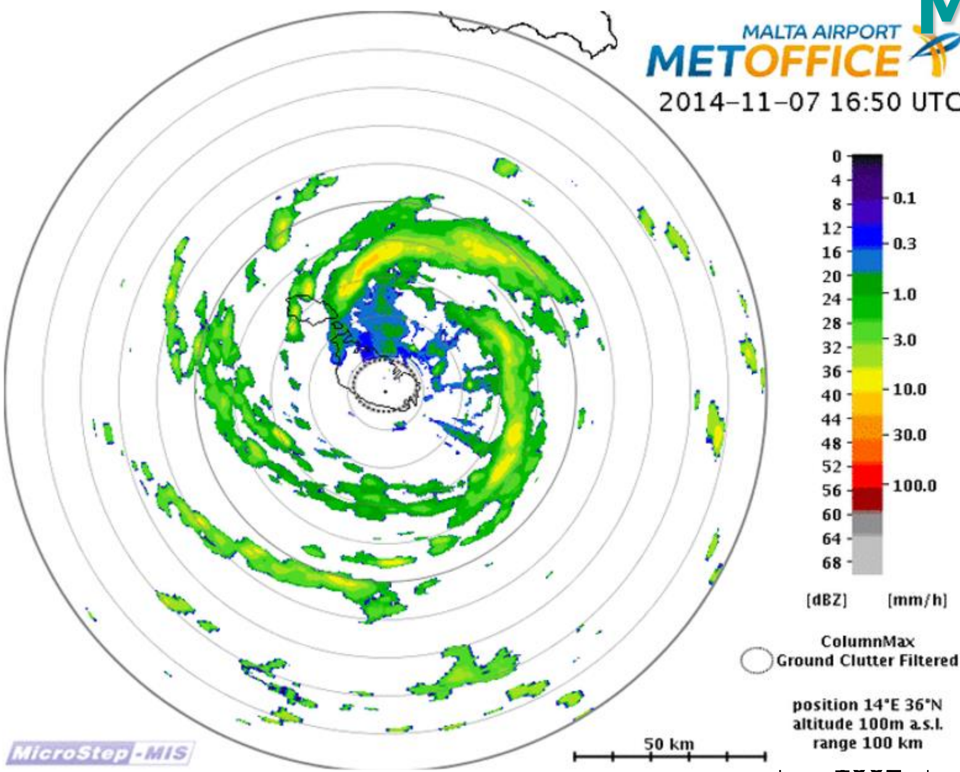

00z8
LICC
LICZ
21z7
LICG
LICO
12z7
LMML
18z7
LICD
15z7
100
500
900
1300
1700
2100
2500
2900
m

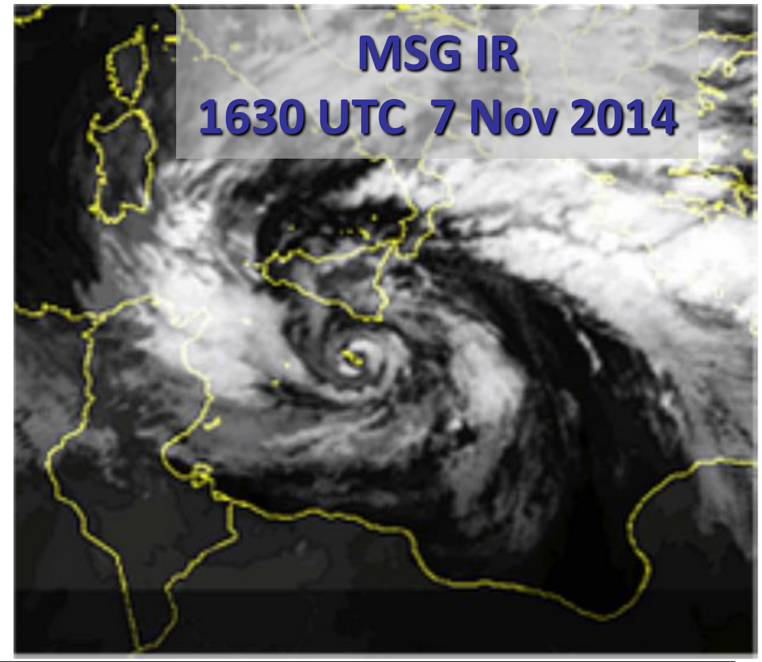
Lampedusa


MSG HRVIS
1400 UTC 7 Nov 2014

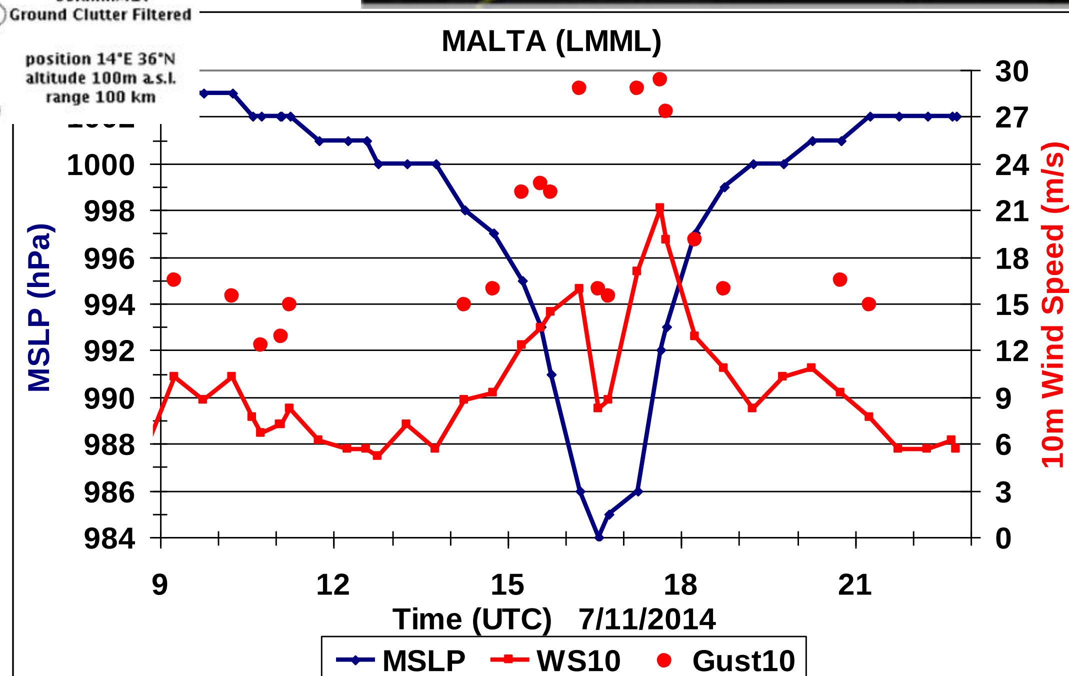

Lampendusa (LICD)
MSLP (hPa)
10m Wind Speed (m/s)
1006
1004
1002
1000
998
996
994
992
42
36
30
24
18
12
6
0
6
9
12
15
18
Time (UTC) 7/11/2014
MSLP
WS10
Gust10

Malta





www.wunderground.com



Medicane:

Thermally symmetric
B < 10 m (**red dots**)

Lower layer Warm Core
$-V_T^L > 0$

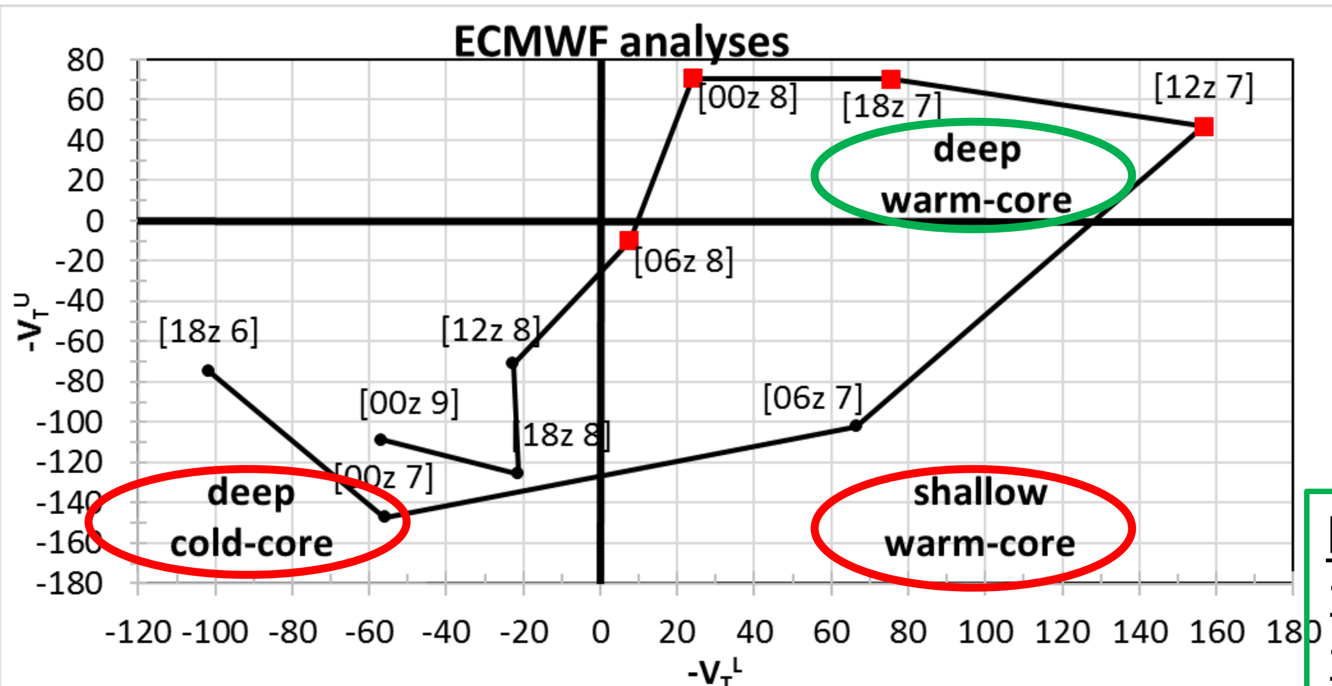
Upper layer Warm Core
$-V_T^U > 0$

$$B = h(\overline{Z_{600\ \text{hPa}} - Z_{900\ \text{hPa}}}|_R - \overline{Z_{600\ \text{hPa}} - Z_{900\ \text{hPa}}}|_L)$$

Based on Hart (2003, MWR)

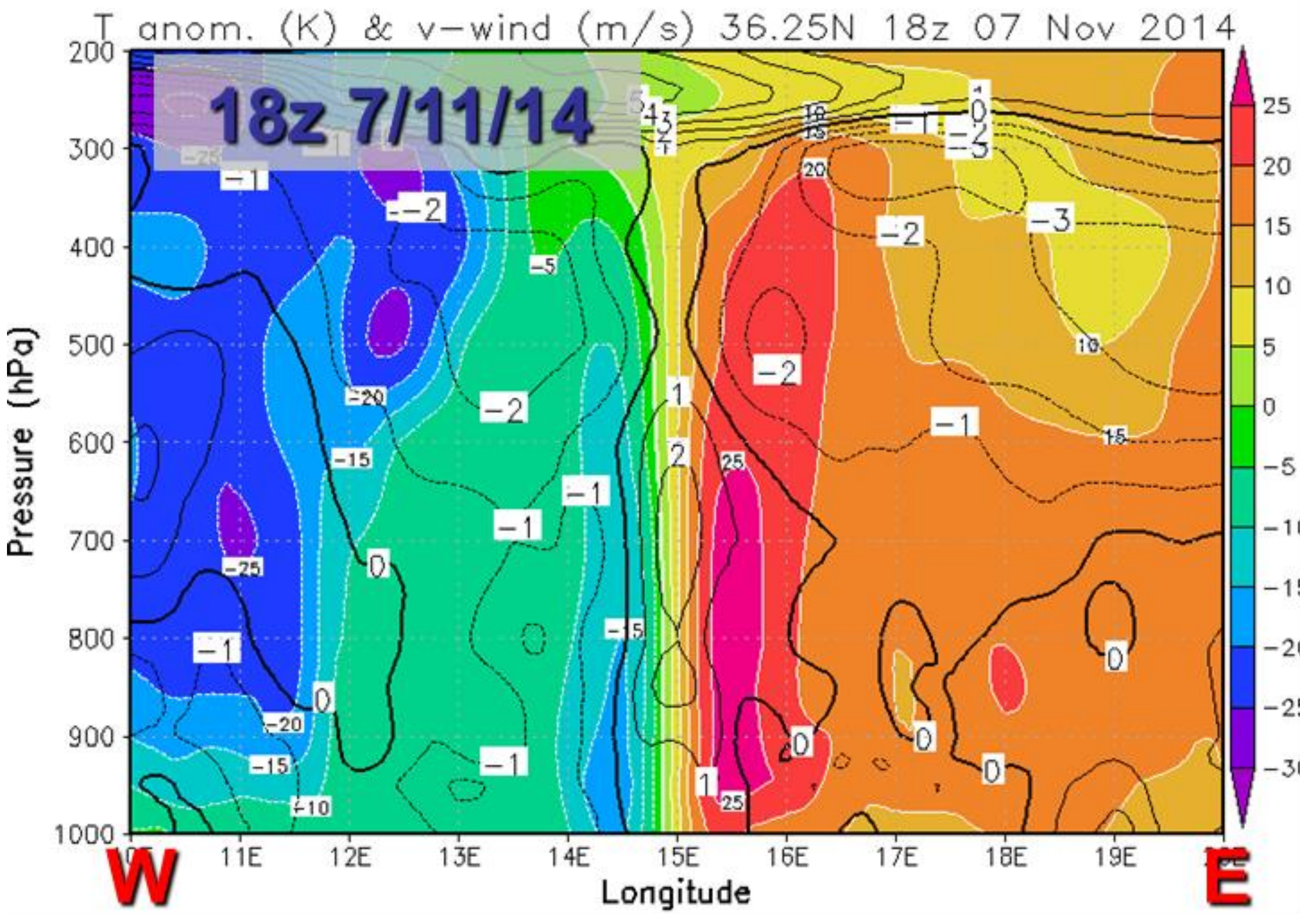
Radius=200km

600-300 hPa



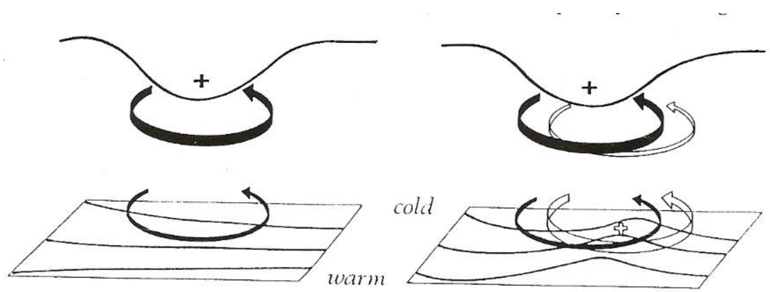
900-600 hPa

Medicane:
12 UTC 7 Nov 2014
18 UTC 7 Nov 2014
00 UTC 8 Nov 2014

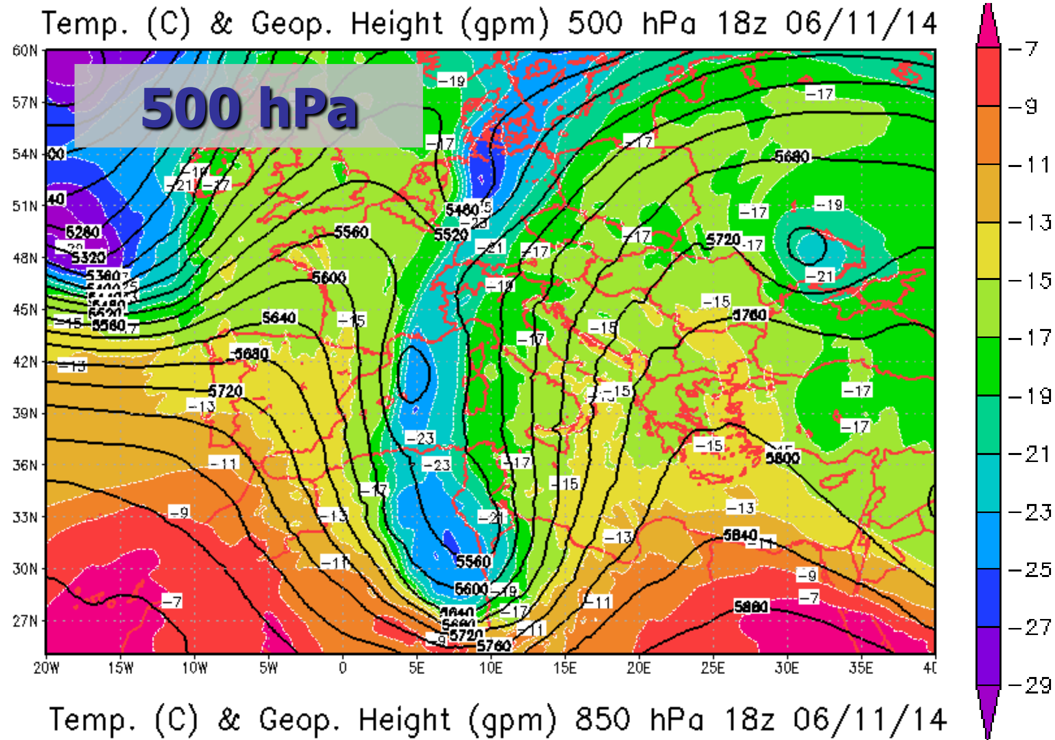

T anom. (K) & v-wind (m/s) 36.25N 18z 07 Nov 2014
18z 7/11/14
Pressure (hPa)
Longitude
W
E

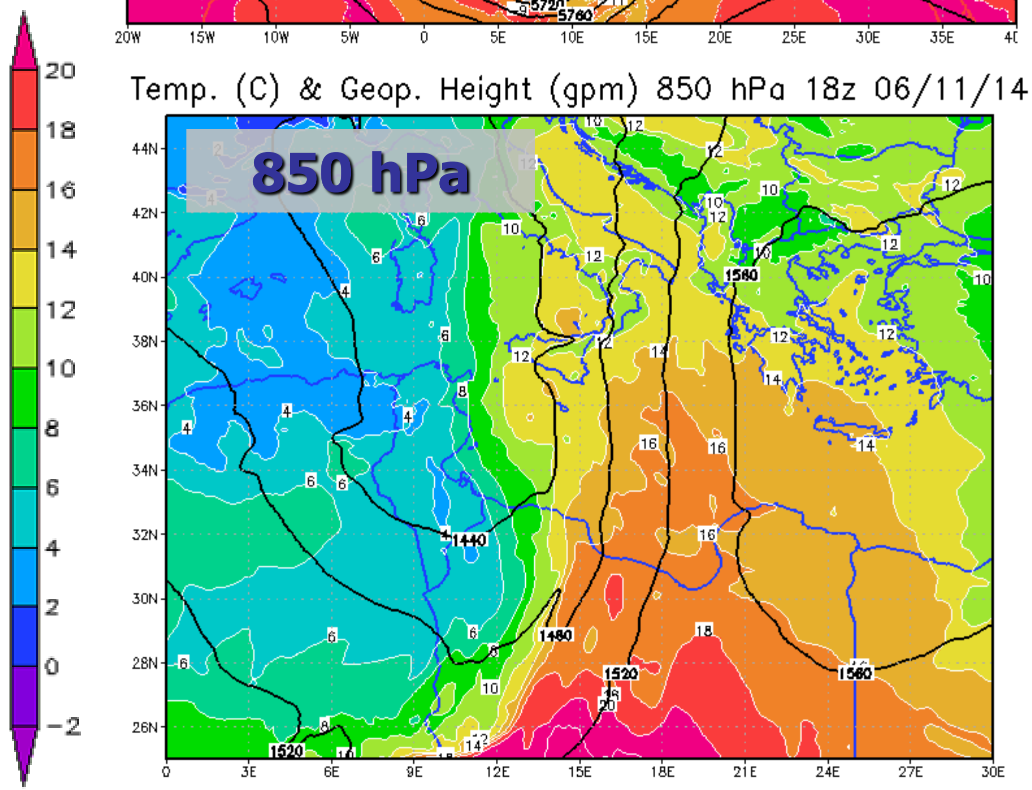
ECMWF analyses

18z 6 Nov 2014



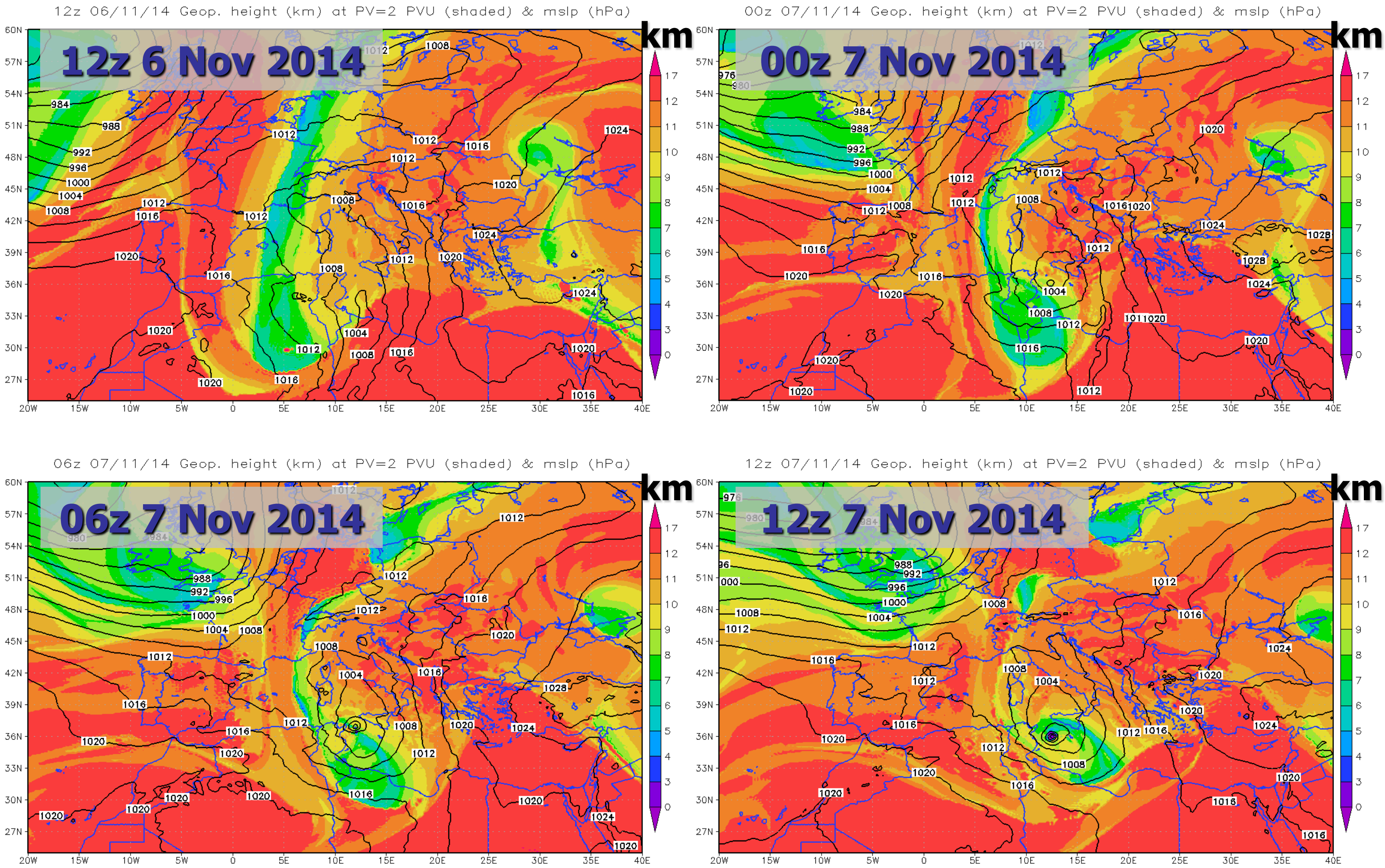
Hoskins et al. 1985:
QJRMS, 111, 877-946





ECMWF analyses

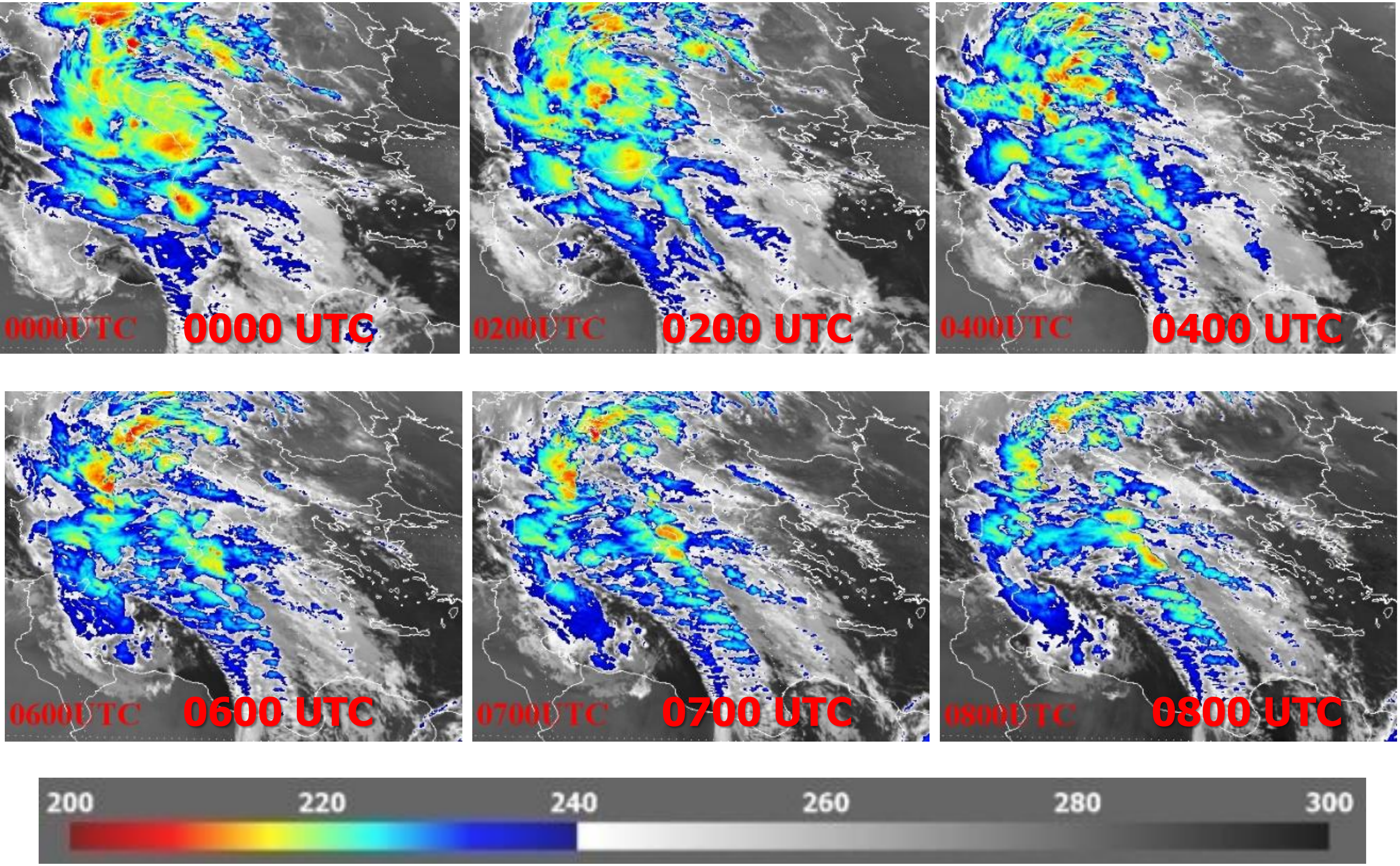
mslp (hPa) & geop. height of PV=2 PVU



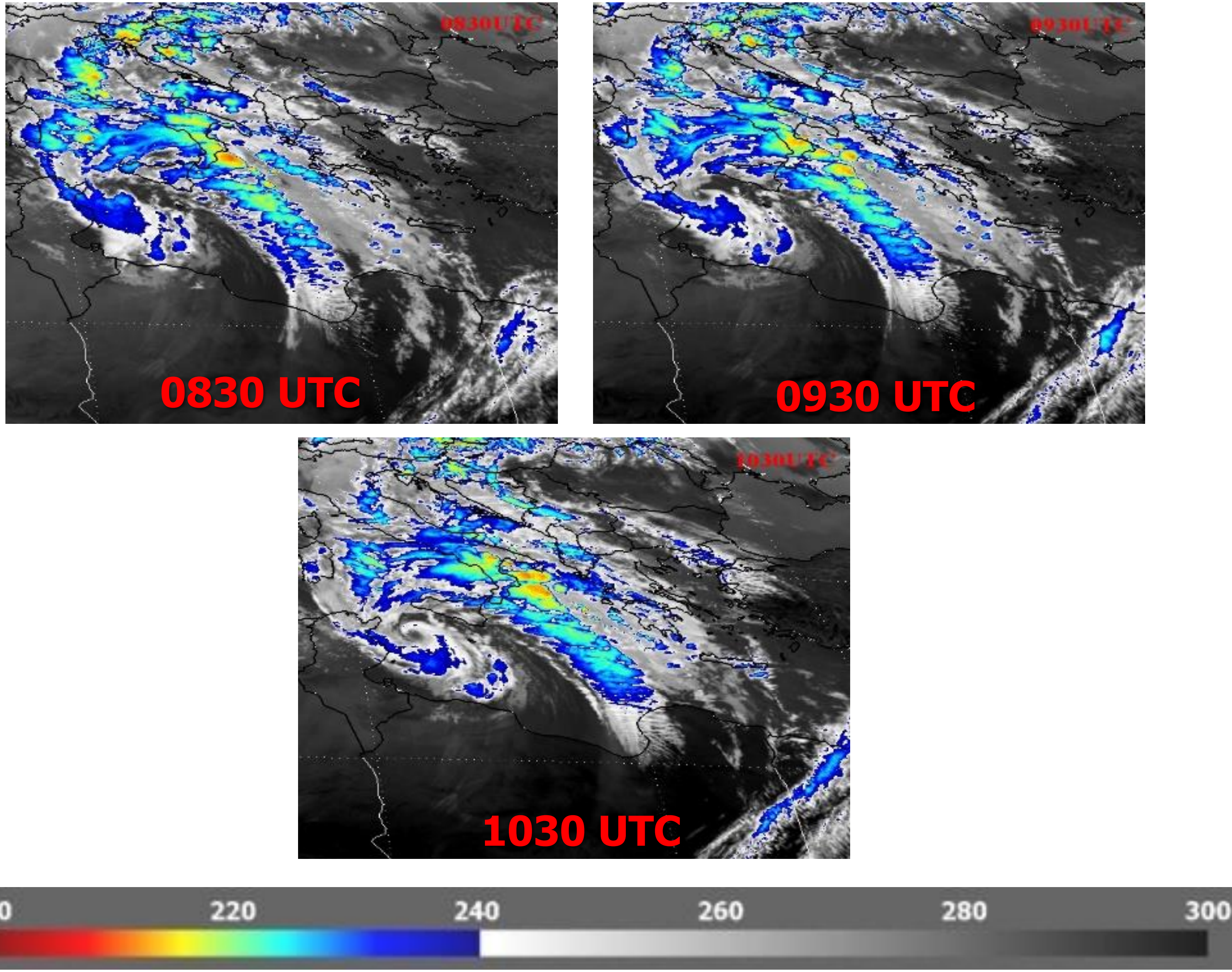
Case study, Satellite analysis

Dimitriadou 2017: MSc Thesis, Aristotle Univ. of Thessaloniki (in Greek)
(http://ikee.lib.auth.gr/record/294318)

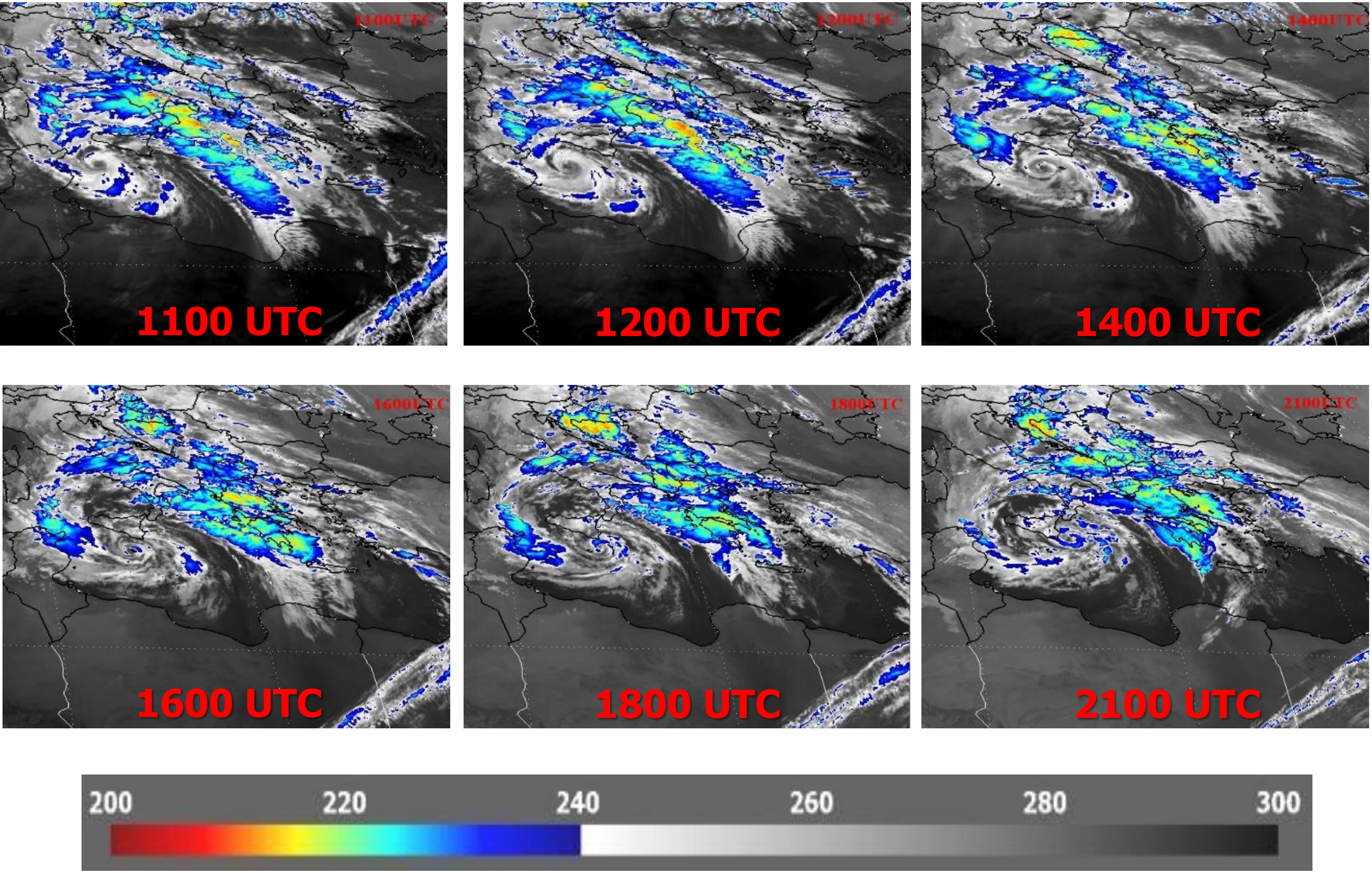
MSG, channel 9, Thermal IR, 10.8 μm,
7 Nov 2014



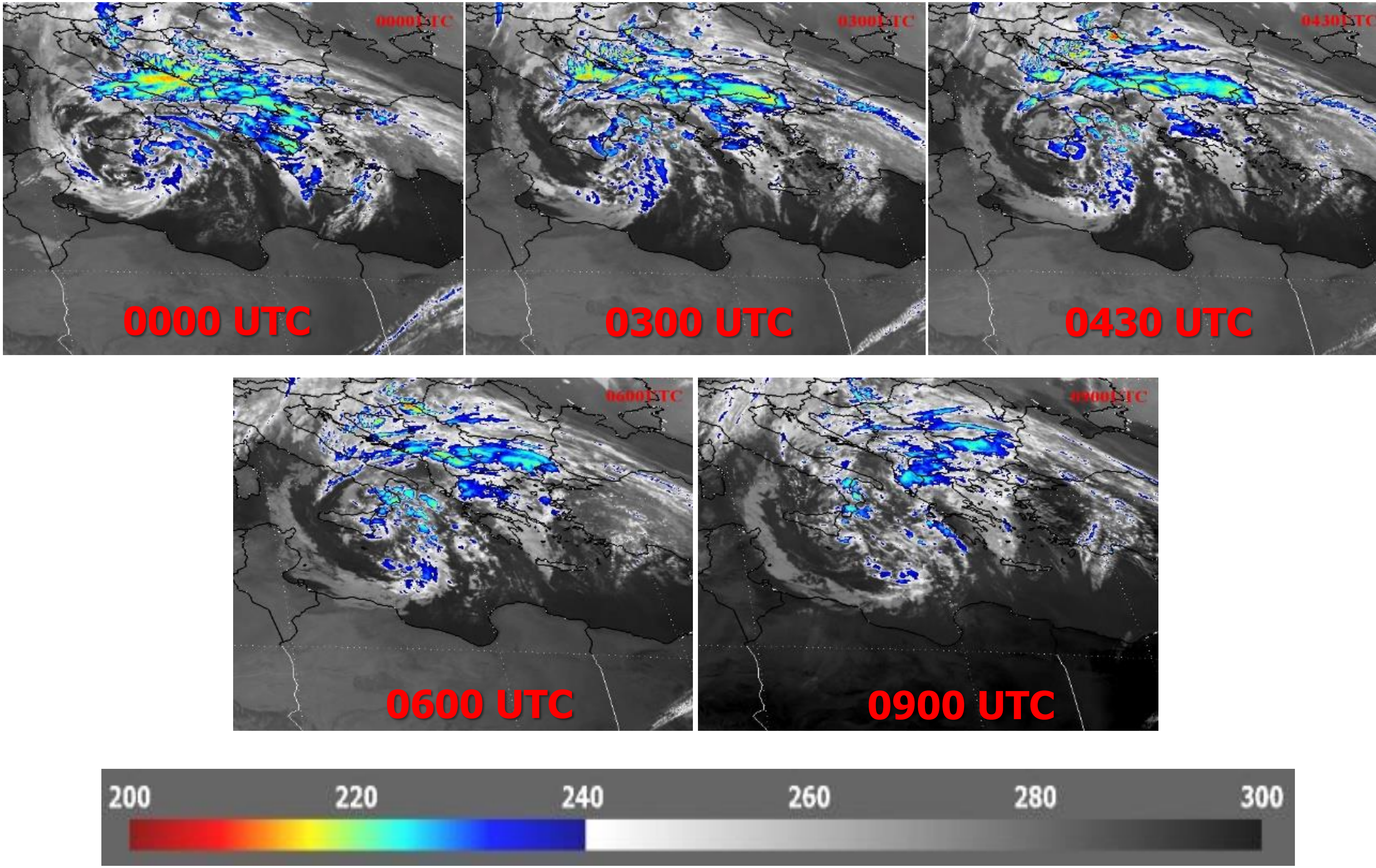
MSG, channel 9, Thermal IR, 10.8 µm, 7 Nov 2014



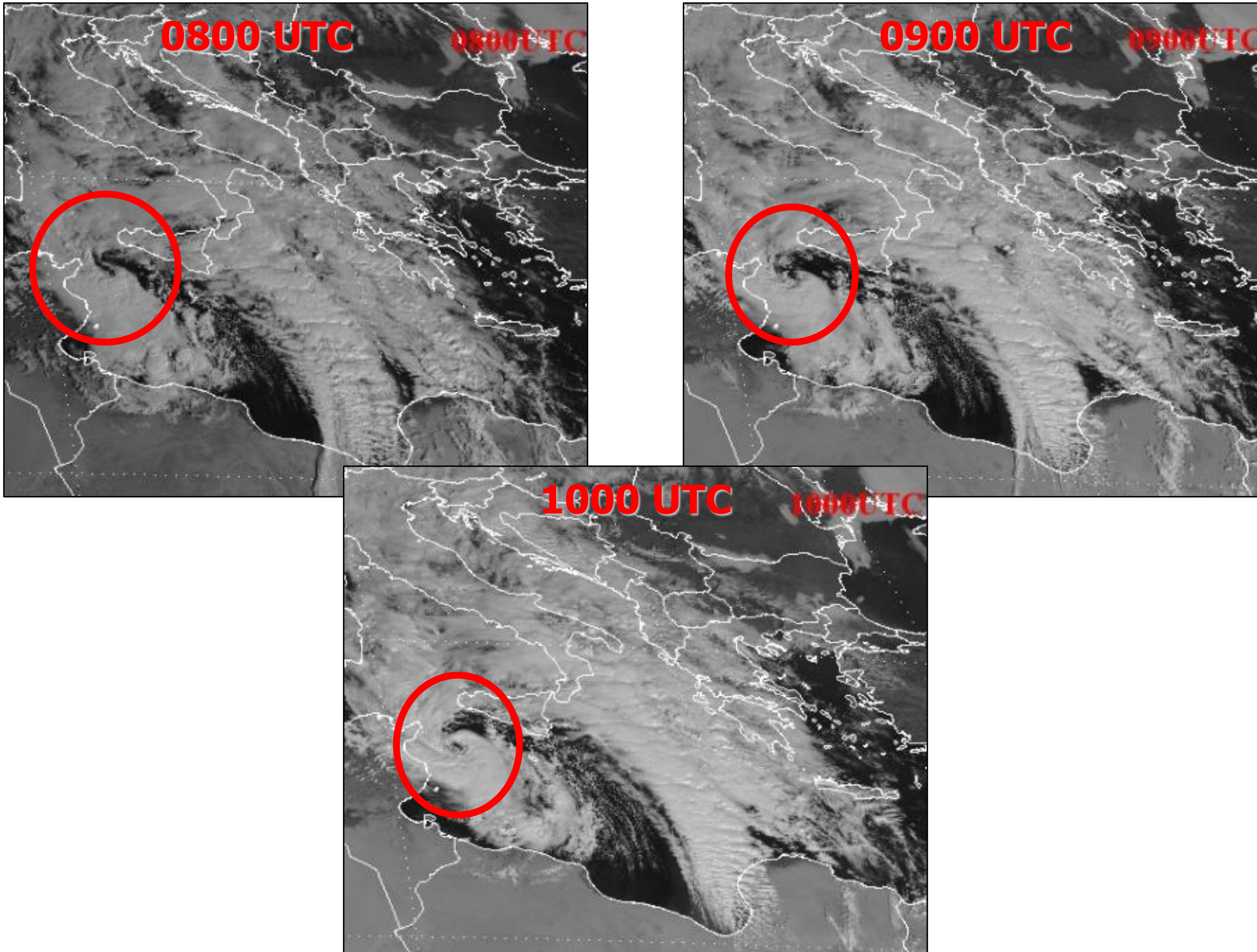
MSG, channel 9, Thermal IR, 10.8 μm, 7 Nov 2014



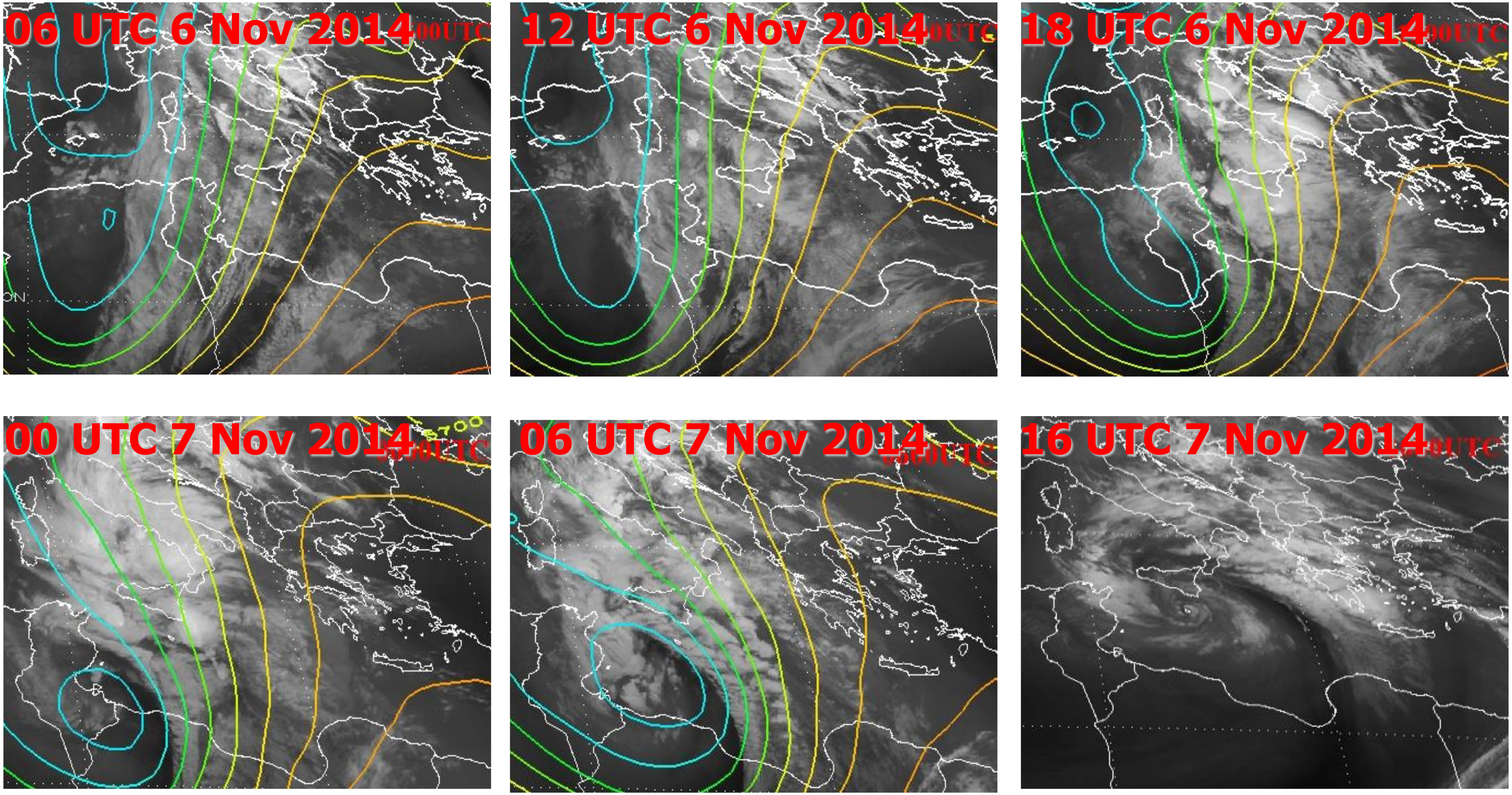
MSG, channel 9, Thermal IR, 10.8 μm, 8 Nov 2014



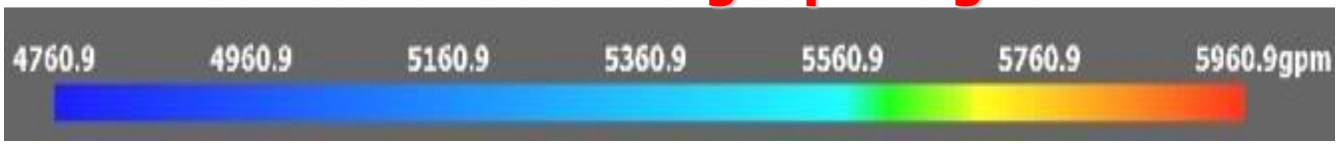
MSG, HRV
7 Nov 2014



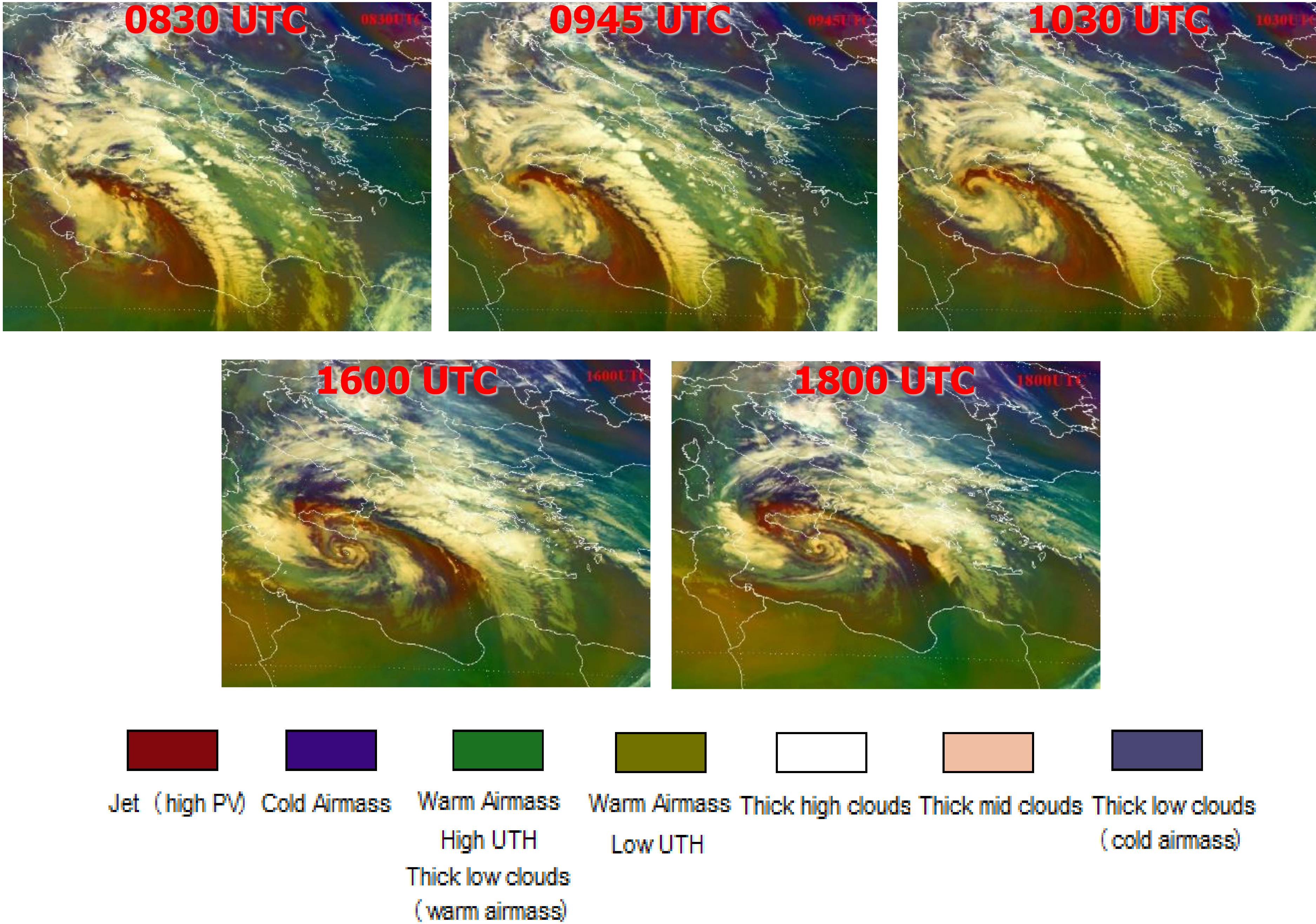
MSG, channel 6, WV, 7.3 µm



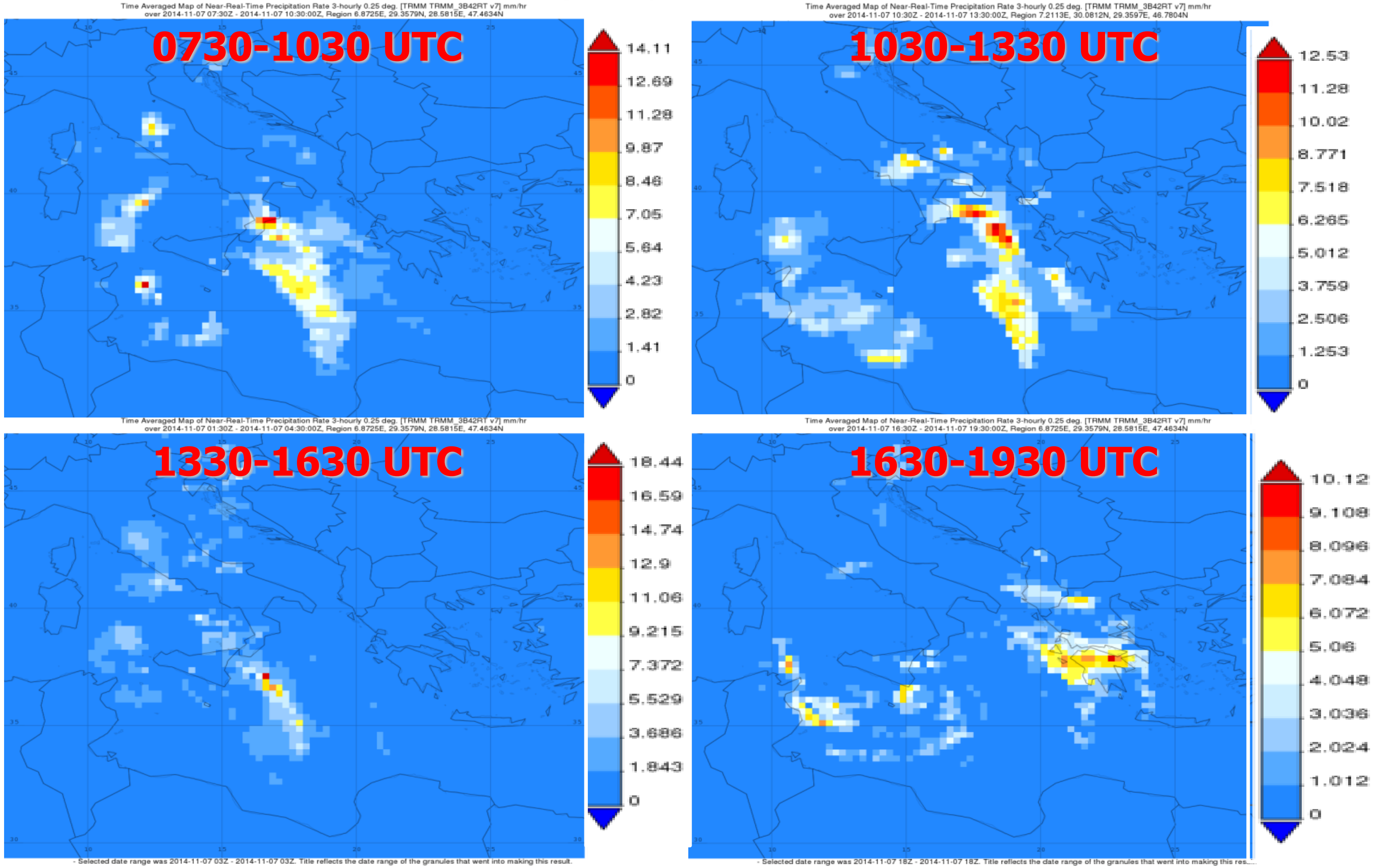
Contours: 500 hPa geop. height



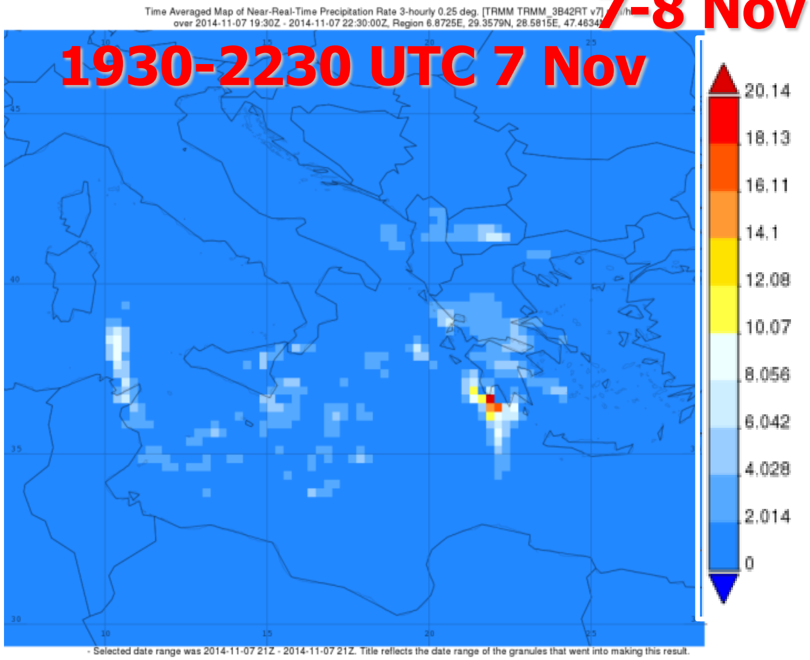
MSG, Air Mass RGB, 7 Nov 2014

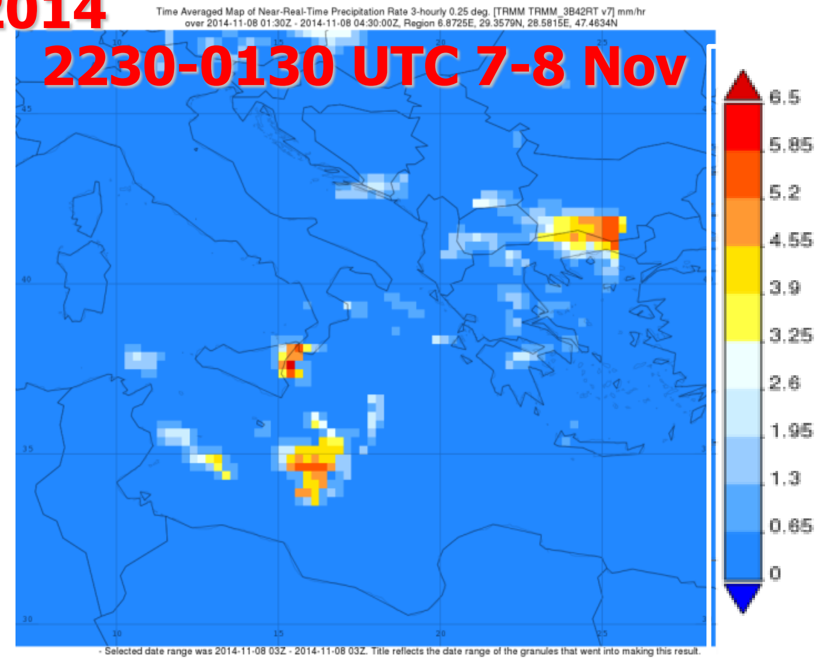


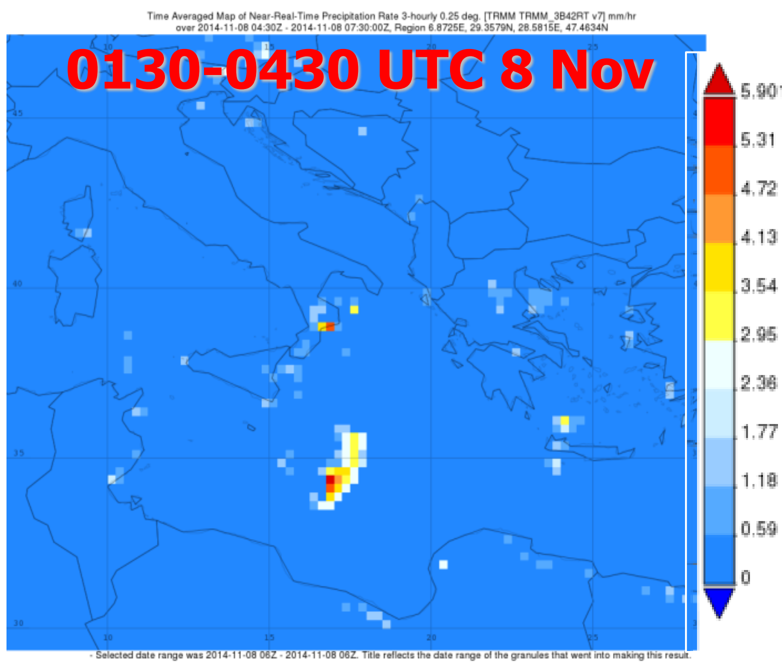
TRMM, time aver. precip. (mm/hr), 7 Nov 2014



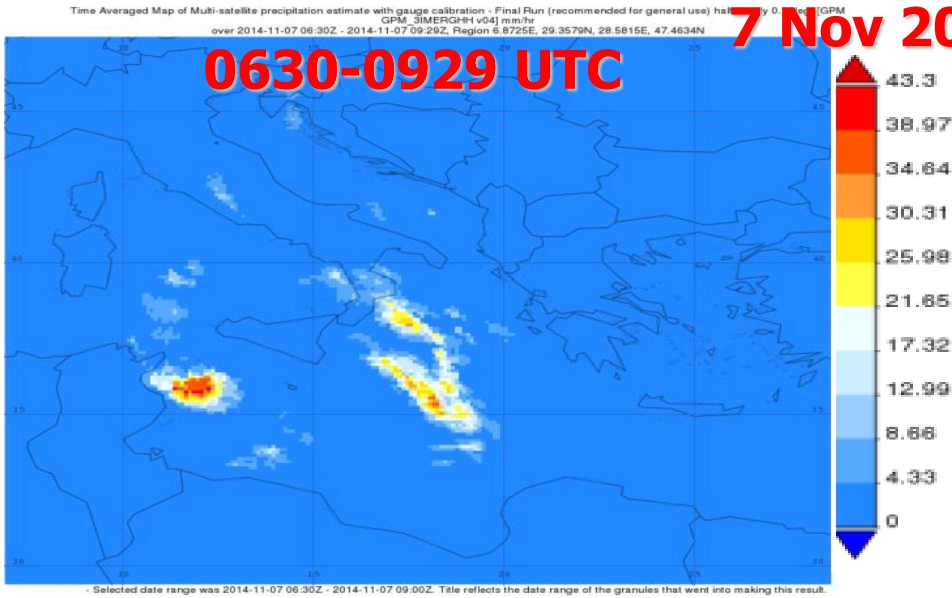
TRMM, time aver. precip. (mm/hr), 7-8 Nov 2014

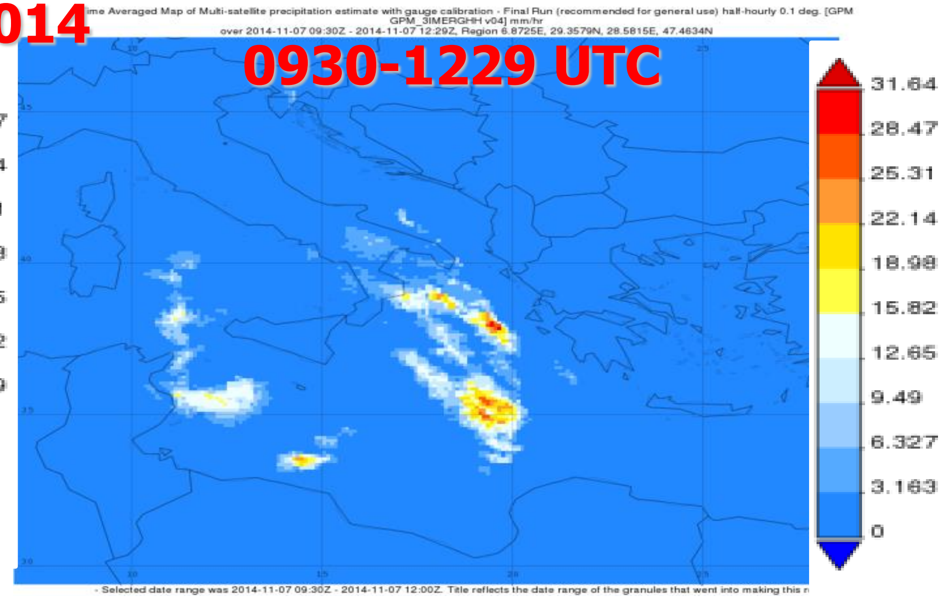


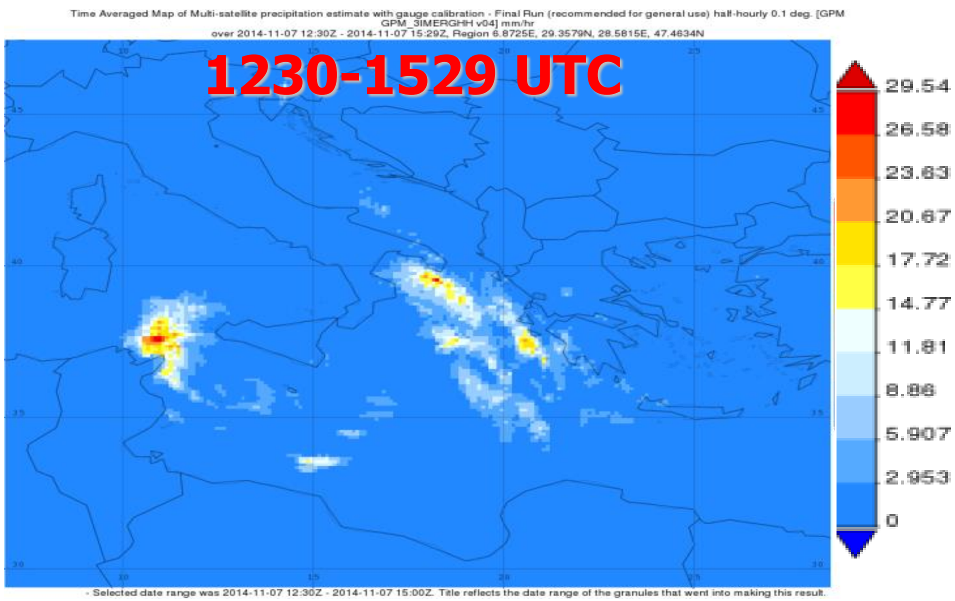


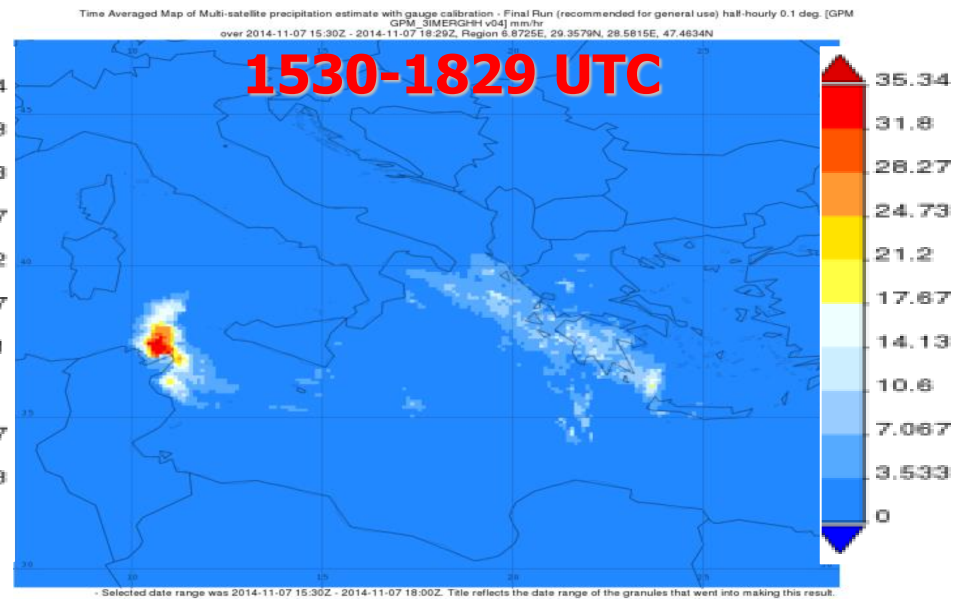


GPM, time aver. precip. (mm/hr), 7 Nov 2014



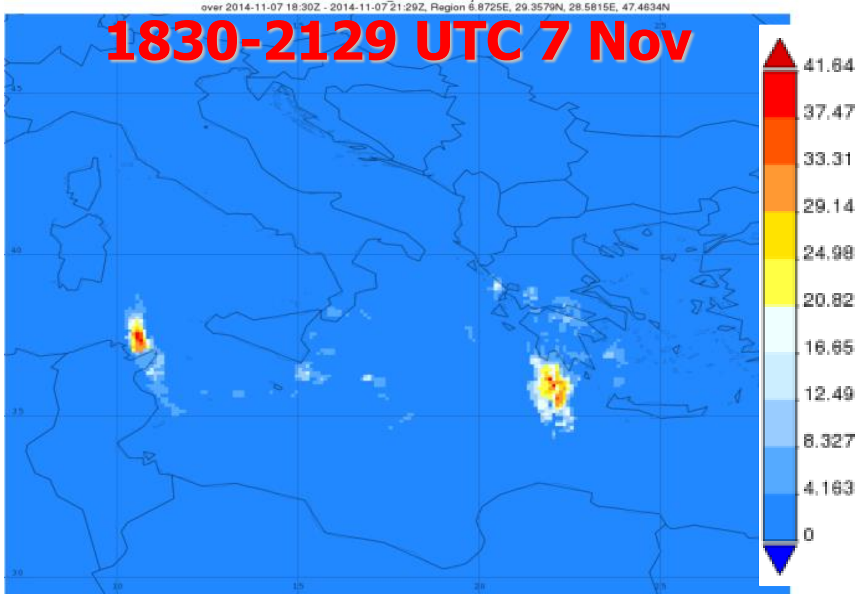






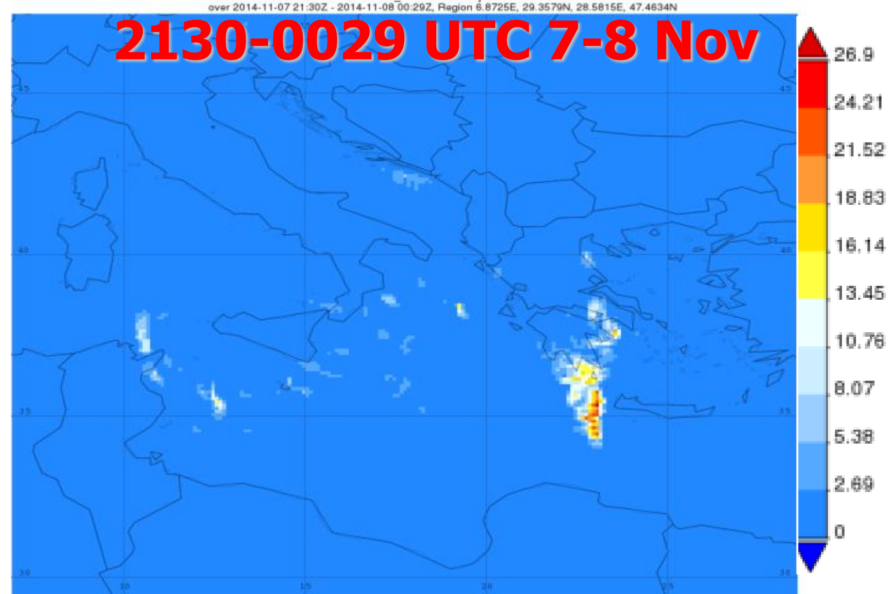
GPM, time aver. precip. (mm/hr), 7-8 Nov 2014

Time Averaged Map of Multi-satellite precipitation estimate with gauge calibration - Final Run (recommended for general use) half-hourly 0.1 deg. [GPM GPM_3IMERGHH v04] mm/hr
over 2014-11-07 18:30Z - 2014-11-07 21:29Z, Region 6.8725E, 29.3579N, 28.5815E, 47.4634N



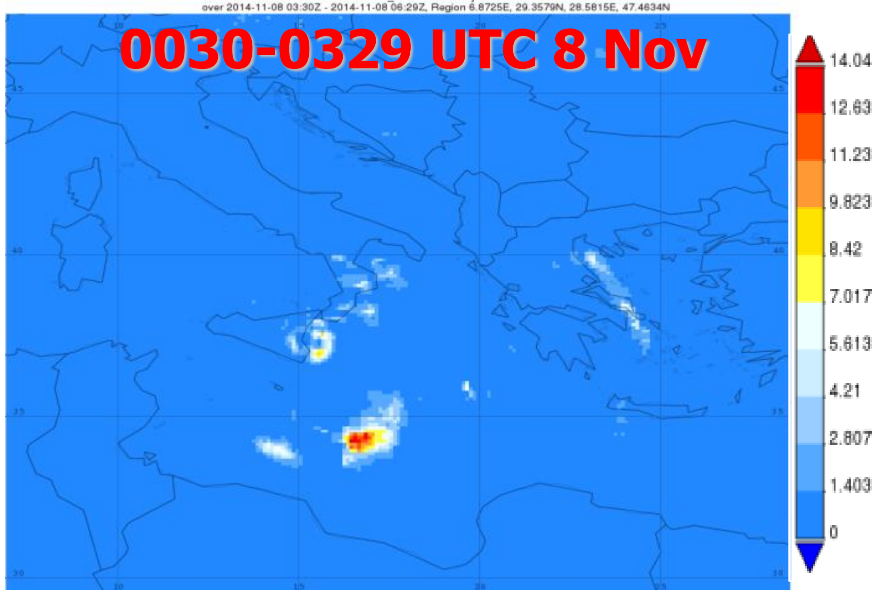
- Selected date range was 2014-11-07 18:30Z - 2014-11-07 21:00Z. Title reflects the date range of the granules that went into making this result.

Time Averaged Map of Multi-satellite precipitation estimate with gauge calibration - Final Run (recommended for general use) half-hourly 0.1 deg. [GPM GPM_3IMERGHH v04] mm/hr
over 2014-11-07 21:30Z - 2014-11-08 00:29Z, Region 6.8725E, 29.3579N, 28.5815E, 47.4634N



- Selected date range was 2014-11-07 21:30Z - 2014-11-08 00:00Z. Title reflects the date range of the granules that went into making this result.

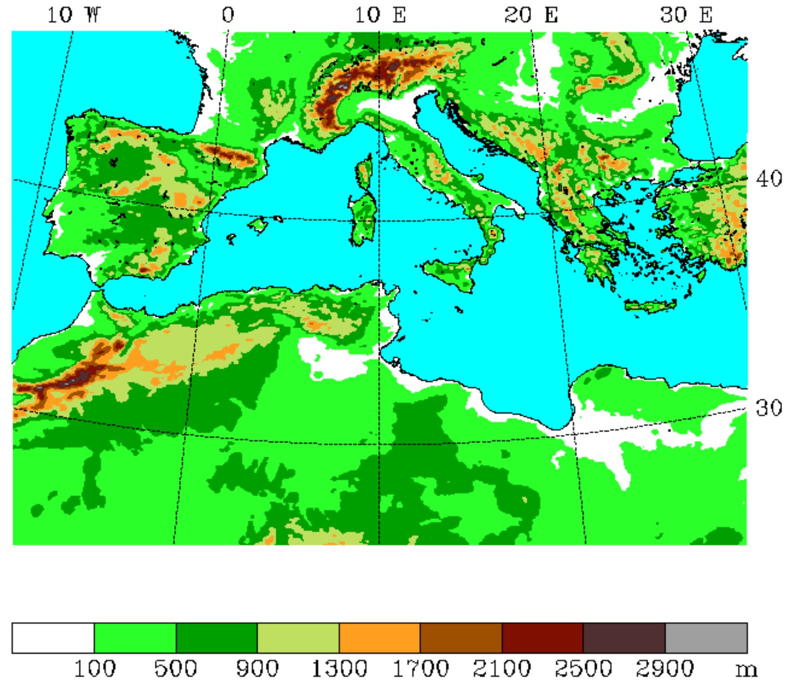
Time Averaged Map of Multi-satellite precipitation estimate with gauge calibration - Final Run (recommended for general use) half-hourly 0.1 deg. [GPM GPM_3IMERGHH v04] mm/hr
over 2014-11-08 03:30Z - 2014-11-08 06:29Z, Region 6.8725E, 29.3579N, 28.5815E, 47.4634N



- Selected date range was 2014-11-08 03:30Z - 2014-11-08 06:00Z. Title reflects the date range of the granules that went into making this result.

Case study, Simulations

WRF-ARW model V3.7.1



- Non-hydrostatic NWP model
- Horizontal grid spacing: 7.5 km x 7.5 km
- 39 sigma levels up to 25 hPa
- High-resolution (30”) land use data
- NCEP satellite SSTs ($1/12^o$ x $1/12^o$)
- 0.125° x 0.125° 6-hourly ECMWF analyses for initial and boundary conditions
- Init: 12 UTC 6/11/2014

- Microphysics: WSM6
- Boundary layer/ surface layer: YSU – Revised MM5
- SW/LW Radiation: RRTMG
- Land surface: NOAH

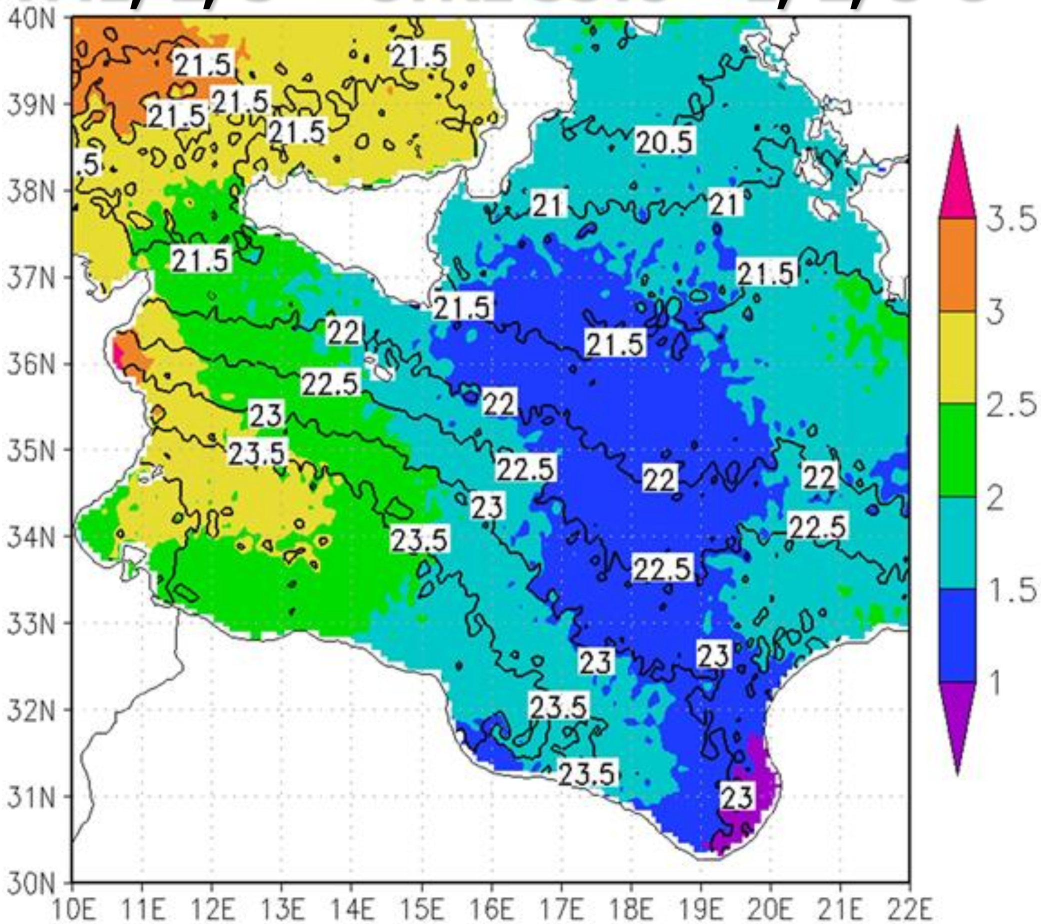
Experiments (set 1):

CTRL = control run

SSTCLIM = climatological SSTs

SSTP1, 2, 3 = CTRL SSTs + 1, 2, 3^{o}C

SSTM1, 2, 3 = CTRL SSTs – 1, 2, 3^{o}C



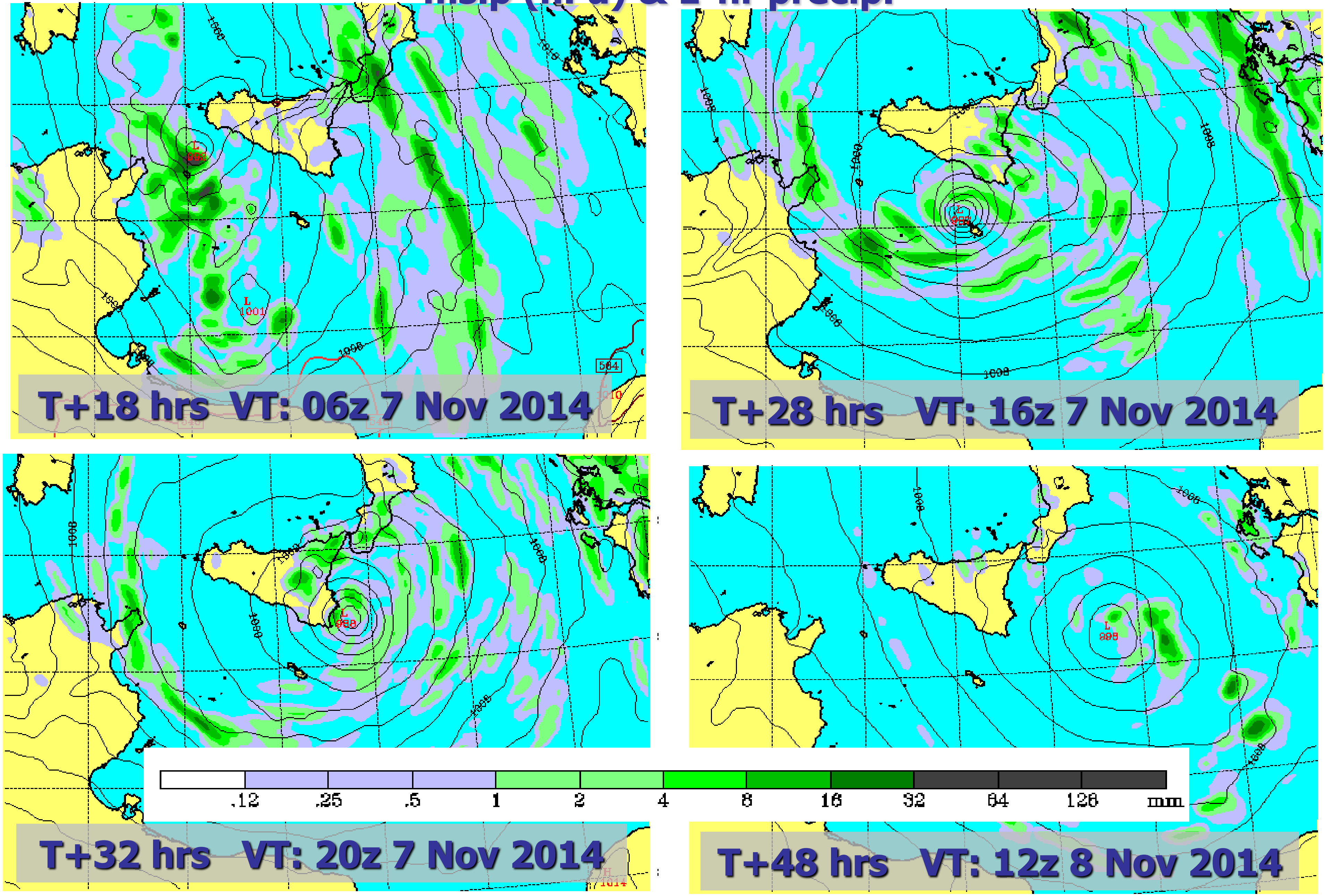
<u>Contours</u>: SSTs 6 Nov 2014

<u>Colour shading</u>: SST anomalies relative to the clim. of Nov 1971-2000

Pytharoulis 2018: Atmospheric Research

WRF – control run

mslp (hPa) & 1-hr precip.

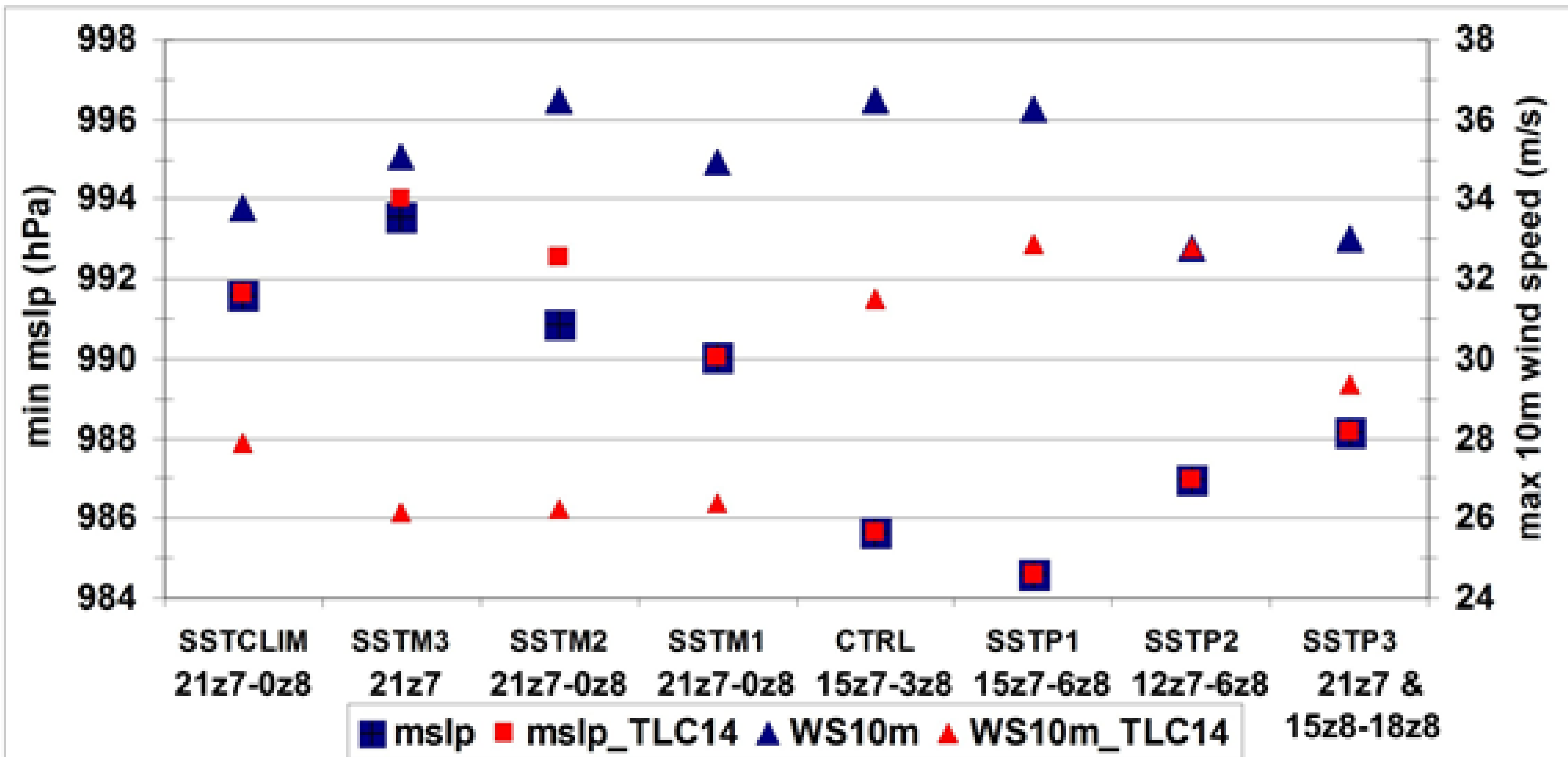


CTRL = control run

SSTCLIM = climatological SSTs

SSTP1, 2, 3 = CTRL SSTs + 1, 2, 3^{o}C

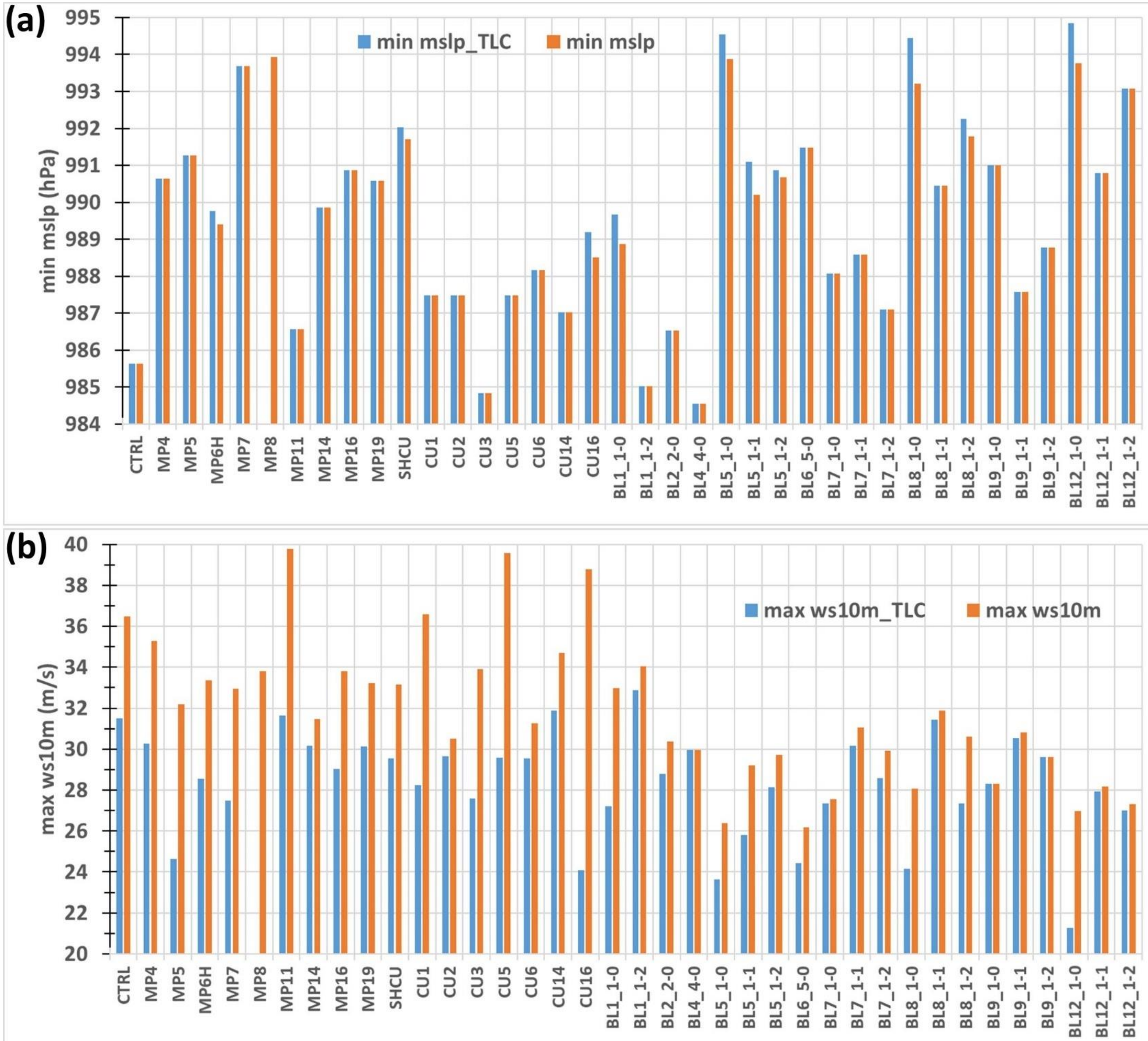
SSTM1, 2, 3 = CTRL SSTs – 1, 2, 3^{o}C



Experiments (set 2): Model Configuration

Pytharoulis et al. 2018: Atmosphere, accepted

Exp. Name	Microphysics	Microphysical Species	Cumulus	PBL/ Surface Layer/ surface fluxes (isftcflx)
ctrl	WSM6	vcrisg	inactive	YSU/ revised MM5/ 1
mp4	WSM5	vcris		
mp5	Eta (Ferrier)	vcrst		
mp6h	WSM6	vcrish		
mp7	Goddard	vcrisg		
mp8	new Thompson	vcrisg		
mp11	CAM5.1	vcris		
mp14	WDM5	vcris		
mp16	WDM6	vcrisg		
mp19	NSSL	vcrisgh		
shcu			shallow GRIMS	
cu1			KF	
cu2			BMJ	
cu3			GF	
cu5			Grell 3D	
cu6			Tiedtke	
cu14			new SAS	
cu16			new Tiedtke	
bl1_1-0				YSU/ revised MM5/ 0
bl1_1-2				YSU/ revised MM5/ 2
bl2_2-0				MYJ/ Eta/ -
bl4_4-0				QNSE/ QNSE/ -
bl5_1-0				MYNN2.5/ revised MM5/ 0
bl5_1-1				MYNN2.5/ revised MM5/ 1
bl5_1-2				MYNN2.5/ revised MM5/ 2
bl6_5-0				MYNN3/ MYNN/ -
bl7_1-0				ACM2/ revised MM5/ 0
bl7_1-1				ACM2/ revised MM5/ 1
bl7_1-2				ACM2/ revised MM5/ 2
bl8_1-0				Boulac/ revised MM5/ 0
bl8_1-1				Boulac/ revised MM5/ 1
bl8_1-2				Boulac/ revised MM5/ 2
bl9_1-0				UW/ revised MM5/ 0
bl9_1-1				UW/ revised MM5/ 1
bl9_1-2				UW/ revised MM5/ 2
bl12_1-0				GBM/ revised MM5/ 0
bl12_1-1				GBM/ revised MM5/ 1
bl12_1-2				GBM/ revised MM5/ 2


(a)
min mslp_TLC
min mslp
min mslp (hPa)
995
994
993
992
991
990
989
988
987
986
985
984
CTRL
MP4
MP5
MP6H
MP7
MP8
MP11
MP14
MP16
MP19
SHCU
CU1
CU2
CU3
CU5
CU6
CU14
CU16
BL1_1-0
BL1_1-2
BL2_2-0
BL4_4-0
BL5_1-0
BL5_1-1
BL5_1-2
BL6_5-0
BL7_1-0
BL7_1-1
BL7_1-2
BL8_1-0
BL8_1-1
BL8_1-2
BL9_1-0
BL9_1-1
BL9_1-2
BL12_1-0
BL12_1-1
BL12_1-2
(b)
max ws10m_TLC
max ws10m
max ws10m (m/s)
40
38
36
34
32
30
28
26
24
22
20
CTRL
MP4
MP5
MP6H
MP7
MP8
MP11
MP14
MP16
MP19
SHCU
CU1
CU2
CU3
CU5
CU6
CU14
CU16
BL1_1-0
BL1_1-2
BL2_2-0
BL4_4-0
BL5_1-0
BL5_1-1
BL5_1-2
BL6_5-0
BL7_1-0
BL7_1-1
BL7_1-2
BL8_1-0
BL8_1-1
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BL9_1-0
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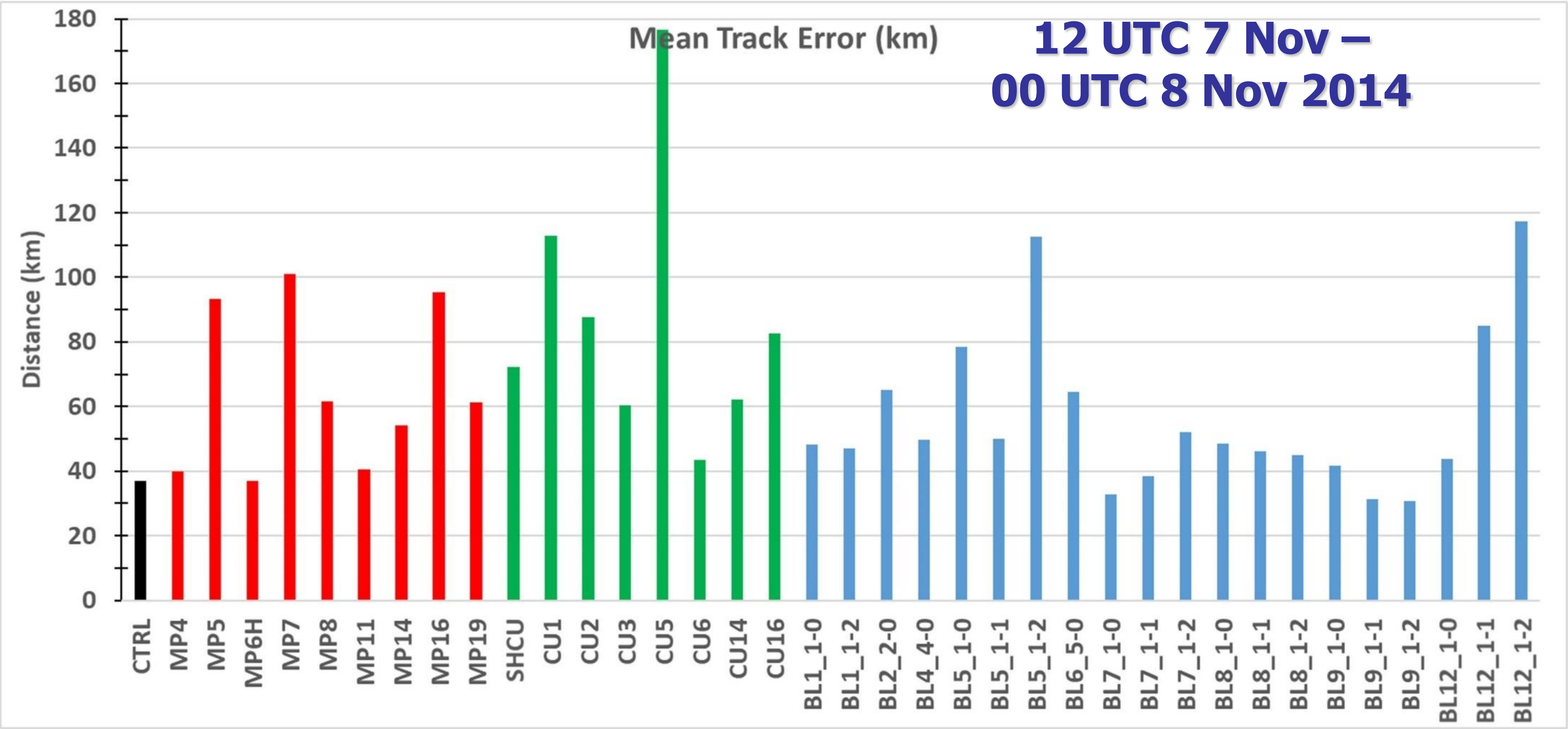
BL12_1-0
BL12_1-1
BL12_1-2


Mean Track Error (km)
12 UTC 7 Nov –
00 UTC 8 Nov 2014
Distance (km)
0
20
40
60
80
100
120
140
160
180
CTRL
MP4
MP5
MP6H
MP7
MP8
MP11
MP14
MP16
MP19
SHCU
CU1
CU2
CU3
CU5
CU6
CU14
CU16
BL1_1-0
BL1_1-2
BL2_2-0
BL4_4-0
BL5_1-0
BL5_1-1
BL5_1-2
BL6_5-0
BL7_1-0
BL7_1-1
BL7_1-2
BL8_1-0
BL8_1-1
BL8_1-2
BL9_1-0
BL9_1-1
BL9_1-2
BL12_1-0
BL12_1-1
BL12_1-2

6hr ECMWF analyses

Duration of medicane (hr)

	ctrl	mp4	mp5	mp6h	mp7	mp8	mp11	mp14	mp16	mp19	shcu	cu1	cu2	cu3	cu5	cu6	cu14	cu16	bl1_1-0	bl1_1-2	bl2_2-0	bl4_4-0	bl5_1-0	bl5_1-1	bl5_1-2	bl6_5-0	bl7_1-0	bl7_1-1	bl7_1-2	bl8_1-0	bl8_1-1	bl8_1-2	bl9_1-0	bl9_1-1	bl9_1-2	bl12_1-0	bl12_1-1	bl12_1-2
Duration	15	15	3	12	6	0	18	18	12	12	6	9	21	9	9	15	21	12	12	15	15	21	3	9	9	6	18	18	18	3	18	9	9	15	15	6	12	6
7 Nov 06z																																						
09z																																						
12z																																						
15z																																						
18z																																						
21z																																						
8 Nov 00z																																						
03z																																						
06z																																						
09z																																						
12z																																						

<u>Medicanes:</u>

Thermally symmetric

B < 10 m

Lower layer Warm Core

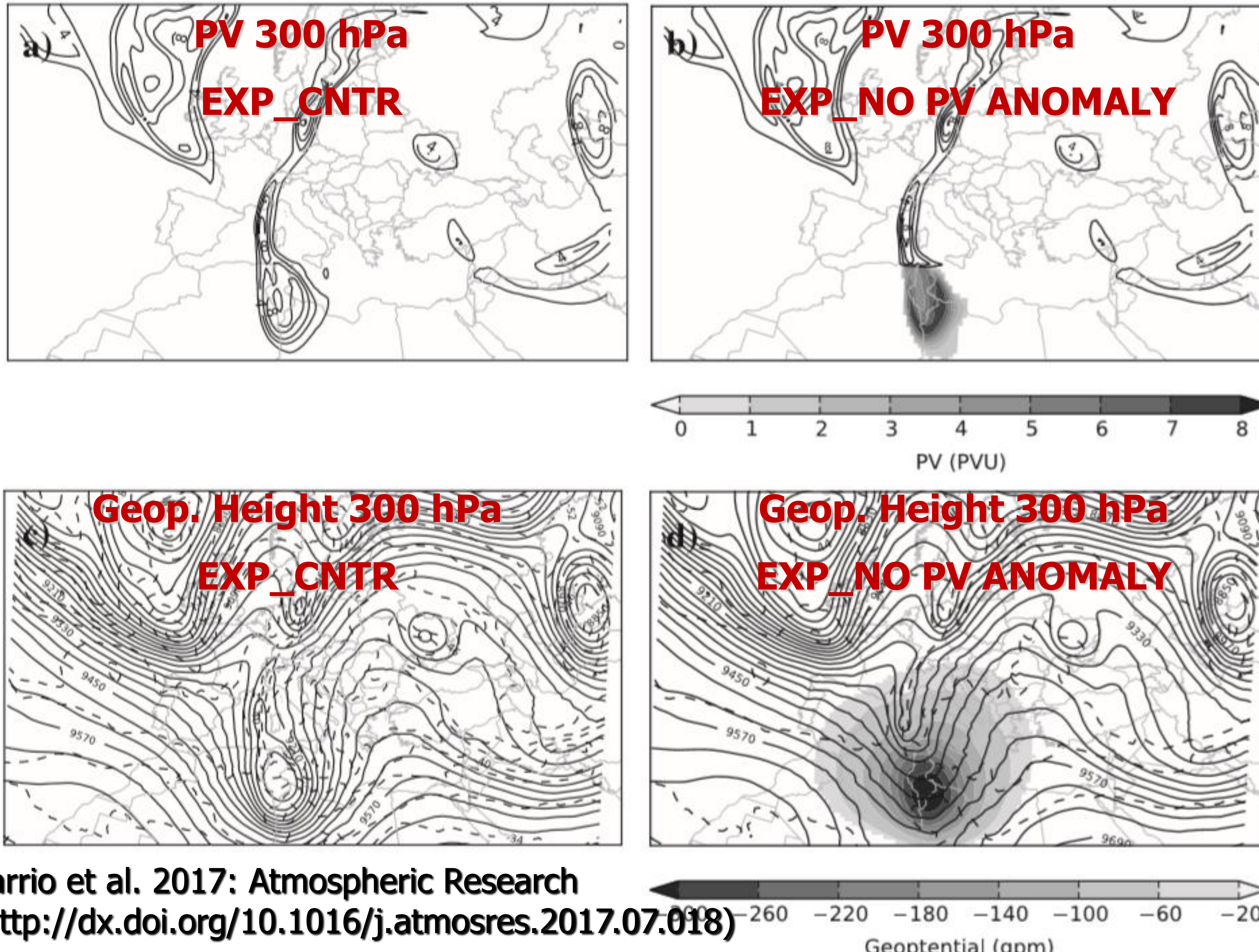
$$-V_T^L > 0$$

Upper layer Warm Core

$$-V_T^U > 0$$

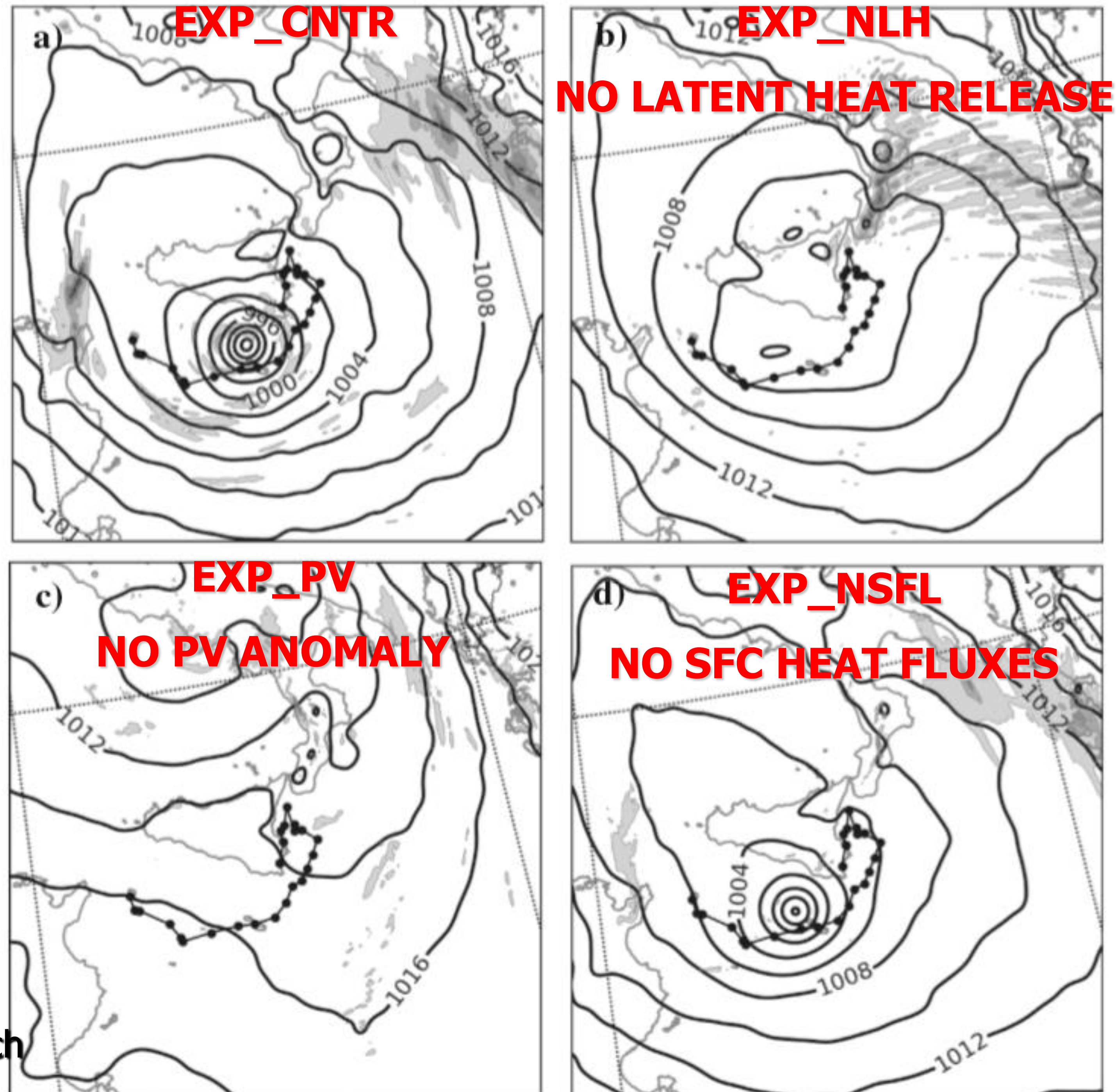
R=200km

Experiments (set 3): Initial conditions: 0000 UTC 7 Nov 2014



Carrio et al. 2017: Atmospheric Research
(http://dx.doi.org/10.1016/j.atmosres.2017.07.018)

1800 UTC
7 Nov 2014



Carrio et al. 2017:
Atmospheric Research

Case Study: Conclusions

- The medicane Qendresa of November 2014 formed south of Sicily in an environment of pre-existing convection and cold temperatures aloft.

- Baroclinic instability appears to be important for its triggering.

- The minimum mslp reached 984 hPa at Malta while sustained 10m wind speed of 24 m/s and gusts of 37 m/s were recorded at Lampedusa.

- The satellite imagery, the radar data and the ECMWF operational analyses showed that it exhibited hurricane-like characteristics such as an ‘eye’, eyewall convection and warm core structure.

- The non-hydrostatic WRF-ARW model provided a satisfactory representation of the main features of the medicane.

- Numerical experiments showed the significant role of the dynamic tropopause anomaly (Carrio et al. 2017).

- An almost linear deepening of the medicane by about 9 hPa was evident as the SST anomalies increased from −3 °C to +1 °C.

- There is a strong sensitivity of the simulated medicane to the physics parameterizations of the numerical model.

Thank you!